

## Abstract Archives of the RSNA, 2023

M4-PL02

### Plenary Session: Leading Through Technology: Valuing Artificial and Human Intelligence

Monday, Nov. 27 11:00AM - 12:00PM Room: Arie Crown

#### COURSE DESCRIPTION

Radiology has successfully led many technological revolutions. Mindful of challenges inherent in major change, we embark on another paradigm shift as Artificial Intelligence (AI) inexorably permeates clinical radiology practice ushering in another pivotal phase in the history of our specialty. Values-based leadership emphasizing patient well-being, accuracy, efficiency, transparency, and fairness will be crucially important. We must intentionally preserve core manifestations of human intelligence, especially those at the heart of patient care -- including judgment, transparency, and communication. Fostering lifelong learning across the entire radiology workforce to identify and advance the opportunities and recognize and call out the pitfalls of generative AI is mission critical. Human values like altruism, truth, and trust (i.e., equity, accuracy, and realized positive impact of diagnostic imaging and intervention) must drive leadership decision-making to forcefully mitigate the unintended consequences of this new human + AI paradigm as it develops. This plenary talk will invoke leadership models like functional leadership, servant leadership, and transformational leadership to develop a framework designed to maintain a culture of stakeholder empowerment, collaboration, and continuous learning to reap the benefits of this fast-paced AI-informed phase for which our specialty is poised.

#### Sub-Events

#### **M4-PL02A** **Leading Through Technology: Valuing Artificial and Human Intelligence**

Elizabeth S. Burnside, MD, MPH (*Presenter*) Research Grant, Hologic, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M4-PL02A

### **Leading Through Technology: Valuing Artificial and Human Intelligence**

Monday, Nov. 27 11:00AM - 12:00PM Room: Arie Crown

Elizabeth S. Burnside, MD, MPH (*Presenter*) Research Grant, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-PL03

### Image Interpretation Session

Monday, Nov. 27 4:30PM - 5:30PM Room: Arie Crown

C. Douglas Phillips, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) View a few interesting cases and hear them discussed by experts. 2) Learn a bit about some fellow RSNA members. 3) Learn some differential diagnostic points.

#### COURSE DESCRIPTION

Teaching through reviewing problematic and interesting cases from the prior year.

#### Sub-Events

##### **M8-PL03B Abdominal Imaging**

Aya Kamaya, MD (*Presenter*) Royalties, RELX; Research Grant, Canon Medical Systems Corporation

##### **M8-PL03C Cardiothoracic Radiology**

Prachi P. Agarwal, MD (*Presenter*) Nothing to Disclose

##### **M8-PL03D Musculoskeletal Radiology**

Behrang Amini, MD, PhD (*Presenter*) Nothing to Disclose

##### **M8-PL03E Neuroradiology/CNS Imaging**

Soonmee Cha, MD (*Presenter*) Nothing to Disclose

##### **M8-PL03F Neuroradiology/Head & Neck Imaging**

Richard H. Wiggins III, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-PL03B

### **Abdominal Imaging**

Monday, Nov. 27 4:30PM - 5:30PM Room: Arie Crown

Aya Kamaya, MD (*Presenter*) Royalties, RELX;Research Grant, Canon Medical Systems Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-PL03C

### Cardiothoracic Radiology

Monday, Nov. 27 4:30PM - 5:30PM Room: Arie Crown

Prachi P. Agarwal, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-PL03D

### **Musculoskeletal Radiology**

Monday, Nov. 27 4:30PM - 5:30PM Room: Arie Crown

Behrang Amini, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-PL03E

### Neuroradiology/CNS Imaging

Monday, Nov. 27 4:30PM - 5:30PM Room: Arie Crown

Soonmee Cha, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-PL03F

### Neuroradiology/Head & Neck Imaging

Monday, Nov. 27 4:30PM - 5:30PM Room: Arie Crown

Richard H. Wiggins III, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-PL07

### RSNA/AAPM Symposium: Together We Can Make A Difference

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450A

Guang-Hong Chen, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain how the technological developers can work with clinical radiologists to impact current and future clinical care.

#### COURSE DESCRIPTION

Radiologists employ innovative imaging technologies to conduct clinical diagnoses, while developers specializing in medical physics and biomedical imaging relentlessly introduce new concepts and techniques to optimize patient care. However, outstanding ideas and technological notions do not always translate into clinically viable products for real-world practice. Consequently, technological innovators and clinicians must collaborate synergistically to realize a shared goal: enhancing patient care. For the past three years, this objective has been the focal point of the RSNA/AAPM Plenary sessions. This year, we aim to showcase another successful collaboration that brought total-body PET imaging to clinical practices.

#### Sub-Events

##### R4-PL07B Total Body PET Imaging (Technical)

Simon R. Cherry, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Researcher, Shanghai United Imaging Healthcare Co, Ltd; Support, Shanghai United Imaging Healthcare Co, Ltd;

##### R4-PL07C Total Body PET Imaging (Clinical)

Lorenzo Nardo, MD, PhD (*Presenter*) Nothing to Disclose

##### R4-PL07D Total Body PET Imaging

Ramsey Badawi, PhD (*Presenter*) Research Grant, Shanghai United Imaging Healthcare Co, Ltd; Institutional research agreement, Shanghai United Imaging Healthcare Co, Ltd

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-PL07B

### **Total Body PET Imaging (Technical)**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450A

Simon R. Cherry, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Researcher, Shanghai United Imaging Healthcare Co, Ltd; Support, Shanghai United Imaging Healthcare Co, Ltd;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-PL07C

### **Total Body PET Imaging (Clinical)**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450A

Lorenzo Nardo, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-PL07D

### **Total Body PET Imaging**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450A

Ramsey Badawi, PhD (*Presenter*) Research Grant, Shanghai United Imaging Healthcare Co, Ltd; Institutional research agreement, Shanghai United Imaging Healthcare Co, Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S6-PL01

### President's Address and Opening Session

Sunday, Nov. 26 4:00PM - 5:30PM Room: Arie Crown

#### Sub-Events

#### S6-PL01A Leading Through Change

Matthew A. Mauro, MD (*Presenter*) Board Member, Boston Scientific Corporation; Investor, Medtronic plc; Investor, Bayer AG

#### LEARNING OBJECTIVES

Radiology has revolutionized medicine, embracing change and fostering progress by pursuing innovation that improves our ability to diagnose and treat patients more effectively and efficiently. Now, as the pace of change rapidly accelerates in the modern medical landscape, radiology's leadership in driving health care innovation becomes increasingly important. We are experiencing transformations in all facets of patient care, from our clinical knowledge base and technological capacities to modes of health care delivery and practice management. These transformations are happening at every level, in every country in the world, in academia and in private practice. Change is not only inevitable, but also necessary as we commit to continuous improvement for our practices and our patients. That is why leading teams through change in an uncertain healthcare environment is an essential skill for today's radiologist. To lead through change, we must first be able to identify when change is necessary. After identifying a need for change, we can form a clear strategic vision for moving forward. By effectively communicating that vision, we inspire others to join us in removing barriers to change and empowering our teams to work as one to achieve our goal. RSNA President Matthew A. Mauro, MD, will explore how radiologists, regardless of setting, can embrace and influence change among their teams and throughout the radiology community; and—in so doing—spark a renewed commitment to ingenuity and innovation among practitioners across multiple disciplines of patient care. By strengthening our foundation as leaders to address the transformative challenges of our specialty, radiologists will be well positioned to secure our future and advance health care for the good of our patients.

#### S6-PL01B History Never Repeats Itself, But It Does Often Rhyme

Howard B. Chrisman, MD (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

"History never repeats itself, but it does often rhyme", is often mistakenly credited to Mark Twain. Regardless of the origin, the notion that events, discoveries and circumstances are "unprecedented", when evaluated more thoughtfully, turn out to have precedent. While the nature of disruptive events and change can be uncomfortable, it must be embraced by leaders. Is today's world more complex than the past, perhaps? But do we leaders need to thoughtfully embrace advancements such as Artificial Intelligence, I think so. And as radiologist, while many may suggest AI might lead us to irrelevancy, I would argue, like past challenges, we should be excited to continue to do what we do best, which is be agile and innovative.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S6-PL01A

### Leading Through Change

Sunday, Nov. 26 4:00PM - 5:30PM Room: Arie Crown

Matthew A. Mauro, MD (*Presenter*) Board Member, Boston Scientific Corporation; Investor, Medtronic plc; Investor, Bayer AG

#### LEARNING OBJECTIVES

Radiology has revolutionized medicine, embracing change and fostering progress by pursuing innovation that improves our ability to diagnose and treat patients more effectively and efficiently. Now, as the pace of change rapidly accelerates in the modern medical landscape, radiology's leadership in driving health care innovation becomes increasingly important. We are experiencing transformations in all facets of patient care, from our clinical knowledge base and technological capacities to modes of health care delivery and practice management. These transformations are happening at every level, in every country in the world, in academia and in private practice. Change is not only inevitable, but also necessary as we commit to continuous improvement for our practices and our patients. That is why leading teams through change in an uncertain healthcare environment is an essential skill for today's radiologist. To lead through change, we must first be able to identify when change is necessary. After identifying a need for change, we can form a clear strategic vision for moving forward. By effectively communicating that vision, we inspire others to join us in removing barriers to change and empowering our teams to work as one to achieve our goal. RSNA President Matthew A. Mauro, MD, will explore how radiologists, regardless of setting, can embrace and influence change among their teams and throughout the radiology community; and—in so doing—spark a renewed commitment to ingenuity and innovation among practitioners across multiple disciplines of patient care. By strengthening our foundation as leaders to address the transformative challenges of our specialty, radiologists will be well positioned to secure our future and advance health care for the good of our patients.

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## Abstract Archives of the RSNA, 2023

S6-PL01B

### History Never Repeats Itself, But It Does Often Rhyme

Sunday, Nov. 26 4:00PM - 5:30PM Room: Arie Crown

Howard B. Chrisman, MD (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

"History never repeats itself, but it does often rhyme", is often mistakenly credited to Mark Twain. Regardless of the origin, the notion that events, discoveries and circumstances are "unprecedented", when evaluated more thoughtfully, turnout to have precedent. While the nature of disruptive events and change can be uncomfortable, it must be embraced by leaders. Is today's world more complex than the past, perhaps? But do we leaders need to thoughtfully embrace advancements such as Artificial Intelligence, I think so. And as radiologist, while many may suggest AI might lead us to irrelevancy, I would argue, like past challenges, we should be excited to continue to do what we do best, which is be agile and innovative.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-PL04

### Plenary Session: The Future of Healthcare Delivery: Considerations for Patients and Providers

Tuesday, Nov. 28 11:00AM - 12:00PM Room: Arie Crown

#### COURSE DESCRIPTION

Technology has accelerated the transformation of healthcare, resulting in innovative new treatments and previously unimagined capabilities for keeping on top of our health and wellness. Having spent close to two decades at the forefront of efforts to advance public health, Harvard-trained specialist and leading healthcare futurist Dr. Vin Gupta possesses unparalleled insights into current and future healthcare trends; how your organization might be impacted by new advancements, technologies, and policies; and what you need to know in order to adapt accordingly.

#### Sub-Events

#### **T4-PL04A The Future of Healthcare Delivery: Considerations for Patients and Providers**

Vin Gupta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-PL04A

### **The Future of Healthcare Delivery: Considerations for Patients and Providers**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: Arie Crown

Vin Gupta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W4-PL05

### Plenary Session Game Show: Oncology Imaging and Interventions: The Radiology Jeopardy

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Julius Chapiro, MD, PhD (*Moderator*) Research Grant, Guerbet SA;Consultant, Guerbet SA;Research Grant, Boston Scientific Corporation;Consultant, AstraZeneca PLC;Consultant, Bayer AG

Anna Shapiro, MD (*Moderator*) Nothing to Disclose

Nikitha Murali, MD (*Presenter*) Nothing to Disclose

Anne Sailer, MD (*Presenter*) Nothing to Disclose

Mansur A. Ghani, MD (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explore the latest advancements in oncology imaging modalities: Understand the recent breakthroughs in imaging technologies and their application in the diagnosis and staging of various malignancies. 2) Stay updated on evidence-based practice in radiation oncology: Review recent clinical trials that have influenced the standard of care and the implications of these findings on treatment decision-making and patient outcomes. 3) Gain insights into functional and molecular imaging: Learn about novel imaging techniques, including diffusion-weighted imaging (DWI), perfusion imaging, spectroscopy, and radiomics, and understand their utility in evaluating tumor heterogeneity, angiogenesis, metabolic activity, and treatment response. 4) Identify emerging trends in image-guided interventions: Discover the evolving role of interventional oncology in minimally invasive tumor treatments and understand the current challenges and future prospects in this domain. 5) Discuss the multidisciplinary approach to oncology imaging and interventions: Recognize the importance of collaboration among radiologists, oncologists, surgeons, and pathologists to optimize patient care through integrated imaging protocols, clinical decision support systems, and standardized reporting.

#### COURSE DESCRIPTION

The plenary session is a comprehensive educational opportunity that focuses on the latest developments, cutting-edge technologies, and emerging trends in the field of oncology imaging and intervention. Attendees will be provided with a rich learning experience that explores innovative imaging techniques and their impact on cancer diagnosis, treatment planning, and therapies presented in a game-show format with participation of leading experts in the fields of Diagnostic Radiology, Interventional Radiology, Radiation Oncology and Nuclear Medicine.

#### Sub-Events

##### W4-PL05F Team 1

Suresh K. Mukherji, MD, MBA (*Presenter*) Nothing to Disclose

##### W4-PL05G Team 1

Riad Salem, MBA (*Presenter*) Consultant, Boston Scientific Corporation;Consultant, Eisai Co, Ltd;Consultant, Sirtex Medical Ltd;Consultant, Cook Group Incorporated;Consultant, Siemens AG

##### W4-PL05H Team 1

Richard L. Wahl, MD (*Presenter*) Investigator, Siemens AG;Researcher, Siemens AG;Consultant, Clarity Pharmaceuticals;Scientific Advisory Board, Clarity Pharmaceuticals;Stock Options, Clarity Pharmaceuticals;Scientific Advisory Board, Seno Medical Instruments, Inc;Speaker, ITM Instruments Inc;Researcher, ITM Instruments Inc;Investigator, ITM Instruments Inc;Investigator, Bayer AG;Researcher, Bayer AG;Scientific Advisory Board, Voximetry Incorporated;Stock Options, Voximetry Incorporated

##### W4-PL05I Team 1

Jeffrey A. Bogart, MD (*Presenter*) Shareholder, Mobius Imaging

##### W4-PL05J Team 2

MD, MPH (*Presenter*) Consultant, ViewRay, Inc

**W4-PL05K Team 2**

Elliot K. Fishman, MD (*Presenter*) Co-founder, HipGraphics, Inc Stockholder, HipGraphics, Inc Institutional Grant support, Siemens AG Institutional Grant support, General Electric Company Consultant, Exact Sciences Corporation Consultant, Imaging Endpoints II LLC

**W4-PL05L Team 2**

Michael C. Soulen, MD (*Presenter*) Consultant, F. Hoffmann-La Roche Ltd;Consultant, Guerbet SA;Consultant, AstraZeneca PLC;Research support, Guerbet SA;Research support, Sirtex Medical Ltd;Research support, Pfizer Inc

**W4-PL05M Team 2**

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

**W4-PL05N Team 3**

Linda B. Haramati, MD, MS (*Presenter*) Nothing to Disclose

**W4-PL05O Team 3**

Anne M. Covey, MD (*Presenter*) Stockholder, Amgen Inc

**W4-PL05P Team 3**

Simon S. Lo, MBChB (*Presenter*) Committee member, Elekta AB

**W4-PL05Q Team 3**

Mishal Mendiratta-Lala, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W4-PL05F

### Team 1

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Suresh K. Mukherji, MD, MBA (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W4-PL05G

### Team 1

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Riad Salem, MBA (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Eisai Co, Ltd; Consultant, Sirtex Medical Ltd; Consultant, Cook Group Incorporated; Consultant, Siemens AG

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## Abstract Archives of the RSNA, 2023

W4-PL05H

### Team 1

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Richard L. Wahl, MD (*Presenter*) Investigator, Siemens AG; Researcher, Siemens AG; Consultant, Clarity Pharmaceuticals; Scientific Advisory Board, Clarity Pharmaceuticals; Stock Options, Clarity Pharmaceuticals; Scientific Advisory Board, Seno Medical Instruments, Inc; Speaker, ITM Instruments Inc; Researcher, ITM Instruments Inc; Investigator, ITM Instruments Inc; Investigator, Bayer AG; Researcher, Bayer AG; Scientific Advisory Board, Voximetry Incorporated; Stock Options, Voximetry Incorporated

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-PL05I

### Team 1

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Jeffrey A. Bogart, MD (*Presenter*) Shareholder, Mobius Imaging

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## Abstract Archives of the RSNA, 2023

W4-PL05J

### Team 2

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Ann Raldow, MD, MPH (*Presenter*) Consultant, ViewRay, Inc

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## Abstract Archives of the RSNA, 2023

W4-PL05K

### Team 2

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Elliot K. Fishman, MD (*Presenter*) Co-founder, HipGraphics, Inc Stockholder, HipGraphics, Inc Institutional Grant support, Siemens AG Institutional Grant support, General Electric Company Consultant, Exact Sciences Corporation Consultant, Imaging Endpoints II LLC

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W4-PL05L

### Team 2

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Michael C. Soulen, MD (*Presenter*) Consultant, F. Hoffmann-La Roche Ltd;Consultant, Guerbet SA;Consultant, AstraZeneca PLC;Research support, Guerbet SA;Research support, Sirtex Medical Ltd;Research support, Pfizer Inc

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## Abstract Archives of the RSNA, 2023

W4-PL05M

### Team 2

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

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## Abstract Archives of the RSNA, 2023

W4-PL05N

### Team 3

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Linda B. Haramati, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-PL050

### Team 3

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Anne M. Covey, MD (*Presenter*) Stockholder, Amgen Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-PL05P

### Team 3

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Simon S. Lo, MBChB (*Presenter*) Committee member, Elekta AB

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## Abstract Archives of the RSNA, 2023

W4-PL05Q

### Team 3

Wednesday, Nov. 29 11:00AM - 12:00PM Room: Arie Crown

Mishal Mendiratta-Lala, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-PL06

### Plenary Session: Understanding and Revitalizing the Radiology Workforce

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E450A

#### Sub-Events

#### **W6-PL06A Understanding and Revitalizing the Radiology Workforce**

Jocelyn D. Chertoff, MD, MS (*Presenter*) Director, Varex Imaging Corporation

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## **Abstract Archives of the RSNA, 2023**

W6-PL06A

### **Understanding and Revitalizing the Radiology Workforce**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E450A

Jocelyn D. Chertoff, MD, MS (*Presenter*) Director, Varex Imaging Corporation

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL01

### RSNA Deep Learning Lab: Basics of NLP in Radiology (Beginner Friendly)

Sunday, Nov. 26 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Jae Ho Sohn, MD, MS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand common terminology and preprocessing techniques in NLP. 2) Identify several classic and modern approaches used to capture semantic meaning in text. 3) Learn how to implement a basic NLP pipeline from preprocessing to performance evaluation.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This session will feature a brief lecture introducing the basics of natural language processing (NLP) and highlight potential uses for it in radiology. The goal is to survey standard text preprocessing techniques and traditional NLP approaches as well as modern neural network based approaches. We will follow up the didactic portion with a hands-on Google Colab demo implementing discussed concepts for a text classification task. For best experience, we highly recommend attendees bring a laptop with a keyboard as well as have a Gmail account to access Google Colab.

#### Sub-Events

##### **DLL01B RSNA Deep Learning Lab: Basics of NLP in Radiology**

Timothy L. Chen, MD (*Presenter*) Nothing to Disclose

##### **DLL01C RSNA Deep Learning Lab: Basics of NLP in Radiology**

Gunvant R. Chaudhari, MD (*Presenter*) Nothing to Disclose

##### **DLL01D RSNA Deep Learning Lab: Basics of NLP in Radiology**

Jae Ho Sohn, MD, MS (*Presenter*) Nothing to Disclose

##### **DLL01E RSNA Deep Learning Lab: Basics of NLP in Radiology**

Cody Savage, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL01B

### **RSNA Deep Learning Lab: Basics of NLP in Radiology**

Sunday, Nov. 26 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Timothy L. Chen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL01C

### **RSNA Deep Learning Lab: Basics of NLP in Radiology**

Sunday, Nov. 26 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Gunvant R. Chaudhari, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL01D

### **RSNA Deep Learning Lab: Basics of NLP in Radiology**

Sunday, Nov. 26 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Jae Ho Sohn, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL01E

### **RSNA Deep Learning Lab: Basics of NLP in Radiology**

Sunday, Nov. 26 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Cody Savage, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL02

### **RSNA Deep Learning Lab: CT Body Part Classification (Beginner Friendly)**

Sunday, Nov. 26 11:30AM - 12:30PM Room: Learning Center, Deep Learning Lab

Ross W. Filice, MD (*Moderator*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

#### **LEARNING OBJECTIVES**

1) Evaluate an artificial intelligence model designed to determine body part in CT after development. 2) Learn how to interpret raw outputs from this model. 3) Build graphs and visualizations to help understand model performance and interpretability.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited.Come to this hands-on learning lab for lessons on how to interpret and evaluate an AI model after development.

#### **Sub-Events**

##### **DLL02B RSNA Deep Learning Lab: CT Body Part Classification**

Ish A. Talati, MD (*Presenter*) Nothing to Disclose

##### **DLL02C RSNA Deep Learning Lab: CT Body Part Classification**

Ross W. Filice, MD (*Presenter*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

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## Abstract Archives of the RSNA, 2023

DLL02B

### **RSNA Deep Learning Lab: CT Body Part Classification**

Sunday, Nov. 26 11:30AM - 12:30PM Room: Learning Center, Deep Learning Lab

Ish A. Talati, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL02C

### **RSNA Deep Learning Lab: CT Body Part Classification**

Sunday, Nov. 26 11:30AM - 12:30PM Room: Learning Center, Deep Learning Lab

Ross W. Filice, MD (*Presenter*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL03

### **RSNA Deep Learning Lab: Data Processing and Curation for Deep Learning (Beginner Friendly)**

Sunday, Nov. 26 2:30PM - 3:30PM Room: Learning Center, Deep Learning Lab

Kirti Magudia, MD, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Extract relevant data from radiology and pathology reports. 2) Understand how to manage and process image-based annotations. 3) Perform image registration and normalization. 4) Recognize features of data formats ideal for deep learning.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This course will provide attendees with the essential tools to perform data processing and curation necessary for deep learning projects. Attendees will start with free text radiology and pathology reports as well as anonymized DICOM data and process data into a unified data file ready for deep learning applications.

#### **Sub-Events**

#### **DLL03B RSNA Deep Learning Lab: Data Processing & Curation for Deep Learning**

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

#### **DLL03C RSNA Deep Learning Lab: Data Processing & Curation for Deep Learning**

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

DLL03B

### **RSNA Deep Learning Lab: Data Processing & Curation for Deep Learning**

Sunday, Nov. 26 2:30PM - 3:30PM Room: Learning Center, Deep Learning Lab

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

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## Abstract Archives of the RSNA, 2023

DLL03C

### **RSNA Deep Learning Lab: Data Processing & Curation for Deep Learning**

Sunday, Nov. 26 2:30PM - 3:30PM Room: Learning Center, Deep Learning Lab

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL04

### **RSNA Deep Learning Lab: DICOM Data Wrangling with Python (Beginner Friendly)**

Monday, Nov. 27 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Katherine P. Andriole, PhD (*Moderator*) Nothing to Disclose

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Additional information coming soon.

#### **Sub-Events**

#### **DLL04B RSNA Deep Learning Lab: DICOM Data Wrangling with Python**

Katherine P. Andriole, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL04B

### **RSNA Deep Learning Lab: DICOM Data Wrangling with Python**

Monday, Nov. 27 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Katherine P. Andriole, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL05

### **RSNA Deep Learning Lab: NCI Imaging Data Commons - Curated Data and Reproducible AI Workflows (Beginner Friendly)**

Monday, Nov. 27 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Andriy Fedorov, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

- 1) Learn about the functionality of NCI imaging data commons related to selection and preparation of data cohorts for developing AI workflows.
- 2) Introduce the basic capabilities of IDC in support of development of reproducible AI workflows.
- 3) Experiment with the application of open source AI tools to public imaging datasets.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. NCI Imaging Data Commons (IDC), <https://imaging.datacommons.cancer.gov>, is a cloud-based repository of publicly available cancer imaging data co-located with the analysis and exploration tools and resources. IDC contains over 40TB of publicly available images and image annotations spanning a variety of cancer types and modalities. Attendees of this course will learn how to search, visualize and download IDC data, and how to build reproducible and shareable analysis workflows using Google Colab. The educational format will combine a lecture followed by a hands-on component and interactive discussions to gain familiarity with this resource.

#### **Sub-Events**

### **DLL05B RSNA Deep Learning Lab: NCI Imaging Data Commons - Curated Data and Reproducible AI Workflows**

Andriy Fedorov, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL05B

### **RSNA Deep Learning Lab: NCI Imaging Data Commons - Curated Data and Reproducible AI Workflows**

Monday, Nov. 27 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Andriy Fedorov, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL06

### RSNA Deep Learning Lab: ChatGPT - DICOM de-identification using ChatGPT (Beginner Friendly)

Monday, Nov. 27 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

George L. Shih, MD, MS (*Moderator*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

#### LEARNING OBJECTIVES

1) Introduction to DICOM tags and PHI stored in these tags. 2) Explain the issues around DICOM de-identification (DeID) and provide examples of DeID tools. 3) Leverage Large Language Model (eg, ChatGPT / GPT-4) to create a script to assist with DICOM DeID. 4) Hands-On DICOM DeID using GPT-4 generated scripts. 5) Other ways to leverage GPT-4 for DICOM DeID. 6) DICOM Pixel DeID

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited.Hands-On learning lab that leverages conventional and AI tools (LLMs like ChatGPT / GPT-4) to help with DICOM de-identification (DeID). Will practice DeID using scripts generated by LLMs and leverage GPT-4 in other ways for the de-identification process.

#### Sub-Events

##### **DLL06B New Anonymizer Demo**

Adam E. Flanders, MD (*Presenter*) Nothing to Disclose

##### **DLL06C MIDRC De-Identification Process**

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

##### **DLL06D DICOM Tag Exploration in Browser**

Errol Colak, MD (*Presenter*) Nothing to Disclose

##### **DLL06E Hands-On GPT-4 Script for De-ID**

Chinmay Singhal, MS (*Presenter*) Nothing to Disclose

##### **DLL06F DICOM Tags Exploration with Chat GPT and other LLMs**

Hui Ming Lin, BSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL06B

### **New Anonymizer Demo**

Monday, Nov. 27 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Adam E. Flanders, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL06C

### **MIDRC De-Identification Process**

Monday, Nov. 27 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL06D

### **DICOM Tag Exploration in Browser**

Monday, Nov. 27 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Errol Colak, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL06E

### **Hands-On GPT-4 Script for De-ID**

Monday, Nov. 27 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Chinmay Singhal, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL06F

### **DICOM Tags Exploration with Chat GPT and other LLMs**

Monday, Nov. 27 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Hui Ming Lin, BSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL07

### RSNA Deep Learning Lab: NLP - Text Classification with RNN's Transformer's (Beginner Friendly)

Monday, Nov. 27 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Walter F. Wiggins, MD, PhD (*Moderator*) Advisor, Qure.ai;

#### LEARNING OBJECTIVES

- 1) Develop a general understanding of how large language models (LLMs) for natural language processing (NLP) are trained.
- 2) Define the basic concepts of NLP preprocessing for text analysis (e.g. tokenization, embedding).
- 3) Use embeddings from an LLM to classify chest x-ray reports as positive or negative for specific findings.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This interactive course will provide participants with the opportunity to learn the basic principles of information extraction from radiology reports by working through a step-by-step example using radiology reports from a chest x-ray data set. Learners will use a large language model (LLM) to classify radiology reports as positive or negative for specific findings. This session will cover basic concepts in preparing data and training LLMs, as well as using a pre-trained LLM to classify radiology reports. No prior coding or machine learning experience is necessary.

#### Sub-Events

##### **DLL07B RSNA Deep Learning Lab: NLP - Text Classification with RNNs & Transformers**

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

##### **DLL07C RSNA Deep Learning Lab: NLP - Text Classification with RNNs & Transformers**

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL07B

### **RSNA Deep Learning Lab: NLP - Text Classification with RNNs & Transformers**

Monday, Nov. 27 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL07C

### **RSNA Deep Learning Lab: NLP - Text Classification with RNNs & Transformers**

Monday, Nov. 27 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL08

### **RSNA Deep Learning Lab: Accessing Freely Available Public Datasets from The Cancer Imaging Archive (TCIA) (Beginner Friendly)**

Monday, Nov. 27 3:00PM - 4:00PM Room: Learning Center, Deep Learning Lab

Justin Kirby (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Learn how TCIA makes data sharing easier for researchers and hear a summary of existing datasets that are freely available for download. 2) Practice utilizing TCIA for data exploration, cohort definition, and downloading of data. 3) Learn how to access public and restricted access datasets using TCIA's REST APIs and other command line tools via Jupyter Notebooks.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Access to large, high quality data is essential for researchers to understand disease and precision medicine pathways, especially in cancer. However HIPAA constraints make sharing medical images outside an individual institution a complex process. The Cancer Imaging Archive (TCIA) is a public service funded by the National Cancer Institute which addresses this challenge by providing de-identification and data publication services to take major burdens of data sharing off researchers. TCIA has published over 200 unique data collections containing more than 70 million images. Recognizing that images alone are not enough to conduct meaningful research, most collections are linked to rich supporting data including patient outcomes, treatment information, genomic / proteomic analyses, and expert image analyses (segmentations, annotations, and radiomic / radiogenomic features). In this course we will address basic use cases for identifying TCIA datasets of interest and downloading them via Jupyter Notebooks.

#### **Sub-Events**

### **DLL08B RSNA Deep Learning Lab: Accessing Freely Available Public Datasets from The Cancer Imaging Archive (TCIA)**

Justin Kirby (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL08B

### **RSNA Deep Learning Lab: Accessing Freely Available Public Datasets from The Cancer Imaging Archive (TCIA)**

Monday, Nov. 27 3:00PM - 4:00PM Room: Learning Center, Deep Learning Lab

Justin Kirby (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL09

### **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks (Beginner Friendly)**

Tuesday, Nov. 28 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Spyridon Bakas, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify the processes and tools used to curate and process raw DICOM imaging data. 2) Learn how to train a robust AI model with zero/low code. 3) Recognize the practical applications of the model, deploy it in a clinical setting, and leverage federated learning to train from other institutions' data.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This course aims to enable participants to conduct federated learning studies without writing any code. The main use case will focus on training and deploying a fully automated image segmentation model. The course will cover the end-to-end workflow to develop an AI model, starting from curating and preprocessing DICOM data all the way to using supervised and human-in-the-loop learning to train robust models. Finally, participants will learn how to deploy their models in the clinic and as federated studies. All the tools and code used will be open-source and be made available to the participants prior to the course.

#### **Sub-Events**

**DLL09B** **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Ujjwal R. Baid, PhD (*Presenter*) Nothing to Disclose

**DLL09C** **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Sarthak Pati, MSc (*Presenter*) Nothing to Disclose

**DLL09D** **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Evan D. Calabrese, MD, PhD (*Presenter*) Nothing to Disclose

**DLL09E** **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Spyridon Bakas, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL09B

### **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Tuesday, Nov. 28 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Ujjwal R. Baid, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL09C

### **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Tuesday, Nov. 28 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Sarthak Pati, MSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL09D

### **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Tuesday, Nov. 28 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Evan D. Calabrese, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL09E

### **RSNA Deep Learning Lab: Zero-code Implementation of Federated Learning for Radiology Tasks**

Tuesday, Nov. 28 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Spyridon Bakas, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10

### RSNA Deep Learning Lab: MIDRC - Building and using AI-ready Datasets from a Massive Open Data Commons (Beginner Friendly)

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Adam E. Flanders, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the genesis and development of the Medical Imaging and Data Resource Center (MIDRC). 2) Appreciate how an imaging based data commons that links to clinical metadata can accelerate machine learning research. 3) Experience how to build your own data cohort for AI research using the MIDRC publication platform - Gen3.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. The Medical Imaging Data and Resource Center (MIDRC) is a multi-institutional effort supported by the AAPM, ACR and RSNA that is funded by the National Institute of Biomedical Imaging and Bioengineering (NIBIB) to collect and publish imaging and related clinical data to accelerate research into uses of imaging based AI. MIDRC provides a model for collecting and publishing data to support research that can be applied across all areas of medical imaging. MIDRC initially began in 2020 by aggregating hundreds of thousands of imaging studies of COVID-19 patients. MIDRC has now transitioned into collecting patient data relevant to post-acute sequelae of COVID or "long COVID" and will be pivoting into other medical use cases in the future. This session, led by principal investigators of MIDRC will give an overview of the structure of the MIDRC data commons and a tour of the open access data portal published on the Gen3 platform. During this session, attendees will have the opportunity to experience how to build a selected data cohort direct from the MIDRC data commons for AI research.

#### Sub-Events

##### DLL10B Introduction to MIDRC

Maryellen L. Giger, PhD (*Presenter*) Stockholder, Hologic, Inc; Royalties, Hologic, Inc; Shareholder, Quantitative Insights, Inc; Co-founder, Quantitative Insights, Inc; Shareholder, QView Medical, Inc; Royalties, General Electric Company; Royalties, Median Technologies; Royalties, Riverain Technologies, LLC

##### DLL10C How are Data Important to Deep Learning

Adam E. Flanders, MD (*Presenter*) Nothing to Disclose

##### DLL10D Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading

Paul E. Kinahan, PhD (*Presenter*) Co-founder, PET/X LLC

##### DLL10E Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading

Jordan Fuhrman, PhD (*Presenter*) Nothing to Disclose

##### DLL10F Demonstration of Grand Challenges and Annotations

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc; Shareholder, MD.ai, Inc

##### DLL10G Demonstration of Grand Challenges and Annotations

Samuel G. Armato III, PhD (*Presenter*) Nothing to Disclose

##### DLL10H Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading

Heather M. Whitney, PhD (*Presenter*) Nothing to Disclose



**DLL10I MIDRC Resources**

Karen Drukker, PHD (*Presenter*) Royalties, Hologic, Inc

**DLL10J Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading**

Rui Carlos Sa, PhD (*Presenter*) Nothing to Disclose

**DLL10K Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading**

Christopher Meyer, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10B

### Introduction to MIDRC

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Maryellen L. Giger, PhD (*Presenter*) Stockholder, Hologic, Inc;Royalties, Hologic, Inc;Shareholder, Quantitative Insights, Inc;Co-founder, Quantitative Insights, Inc;Shareholder, QView Medical, Inc;Royalties, General Electric Company;Royalties, Median Technologies;Royalties, Riverain Technologies, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10C

### How are Data Important to Deep Learning

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Adam E. Flanders, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10D

### **Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Paul E. Kinahan, PhD (*Presenter*) Co-founder, PET/X LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10E

### **Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Jordan Fuhrman, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10F

### **Demonstration of Grand Challenges and Annotations**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10G

### **Demonstration of Grand Challenges and Annotations**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Samuel G. Armato III, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10H

### **Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Heather M. Whitney, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL10I

### **MIDRC Resources**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Karen Drukker, PHD (*Presenter*) Royalties, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10J

### **Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Rui Carlos Sa, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL10K

### **Building Cohorts, LOINC Mapping, Jupyter Notebooks, and Downloading**

Tuesday, Nov. 28 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Christopher Meyer, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL11

### RSNA Deep Learning Lab: MedNIST Exam Classification with MONAI (Beginner Friendly)

Tuesday, Nov. 28 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Bradley J. Erickson, MD, PhD (*Moderator*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FLOWSIGMA Inc; Officer, FLOWSIGMA Inc; Stockholder, FLOWSIGMA Inc; Officer, Yunu Inc; Stockholder, Yunu Inc

#### LEARNING OBJECTIVES

1) Collect, format, and standardize medical image data. Use MONAI transforms to pre-process data. 2) Architect and train a convolutional neural network (CNN) in Pytorch for classification. 3) Evaluate the trained model on test dataset.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Medical image classification plays an essential role in aiding clinical diagnosis and treatment. With the rapid development of artificial intelligence (AI) and computer vision (CV), deep learning-based methods become more accurate and applicable to a variety of clinical tasks ---- potentially serving as a valuable ally for radiologists and pathologists. In this course, learners will get a hands-on practical introduction to deep learning for radiology and medical imaging. An end-to-end training and evaluation example based on the MedNIST dataset will be covered. We will introduce the "MONAI" deep learning platform, which is a Pytorch-based, open-source framework for deep learning in healthcare imaging.

#### Sub-Events

##### **DLL11B RSNA Deep Learning Lab: MedNIST Exam Classification with MONAI**

Jayashree Kalpathy-Cramer, PhD (*Presenter*) Institutional Research Grant, General Electric Company; Institutional Research Grant, F. Hoffmann-La Roche Ltd; Institutional Research Grant, Bayer AG

##### **DLL11C RSNA Deep Learning Lab: MedNIST Exam Classification with MONAI**

Bradley J. Erickson, MD, PhD (*Presenter*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FLOWSIGMA Inc; Officer, FLOWSIGMA Inc; Stockholder, FLOWSIGMA Inc; Officer, Yunu Inc; Stockholder, Yunu Inc

##### **DLL11D RSNA Deep Learning Lab: MedNIST Exam Classification with MONAI**

Kuan Zhang, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL11B

### **RSNA Deep Learning Lab: MedNIST Exam Classification with MONAI**

Tuesday, Nov. 28 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Jayashree Kalpathy-Cramer, PhD (*Presenter*) Institutional Research Grant, General Electric Company; Institutional Research Grant, F. Hoffmann-La Roche Ltd; Institutional Research Grant, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL11C

### **RSNA Deep Learning Lab: MedNIST Exam Classification with MONAI**

Tuesday, Nov. 28 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Bradley J. Erickson, MD, PhD (*Presenter*) Board of Directors, VoiceIt Technologies, LLC;Stockholder, VoiceIt Technologies, LLC;Board of Directors, FLOWSIGMA Inc;Officer, FLOWSIGMA Inc;Stockholder, FLOWSIGMA Inc;Officer, Yunu Inc;Stockholder, Yunu Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL11D

### **RSNA Deep Learning Lab: MedNIST Exam Classification with MONAI**

Tuesday, Nov. 28 12:00PM - 1:00PM Room: Learning Center, Deep Learning Lab

Kuan Zhang, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL12

### RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology

Tuesday, Nov. 28 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Paul H. Yi, MD (*Moderator*) Consultant, FH Orthopedics SAS; Consultant, BunkerHill Health

#### LEARNING OBJECTIVES

1) Learn basic concepts of fairness evaluation in AI for radiology. 2) Learn how to evaluate for fairness in AI models in radiology.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This hands-on session will comprise a short tutorial about fairness in AI for radiology followed by hands-on, interactive coding session to learn how to evaluate for fairness in trained AI models.

#### Sub-Events

##### **DLL12B RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Jacopo Teneggi (*Presenter*) Nothing to Disclose

##### **DLL12C RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Jeremias Sulam, PhD (*Presenter*) Nothing to Disclose

##### **DLL12D RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Paul H. Yi, MD (*Presenter*) Consultant, FH Orthopedics SAS; Consultant, BunkerHill Health

##### **DLL12E RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Beepul Bharti, BS, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL12B

### **RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Jacopo Teneggi (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL12C

### **RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Jeremias Sulam, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL12D

### **RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Paul H. Yi, MD (*Presenter*) Consultant, FH Orthopedics SAS; Consultant, BunkerHill Health

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL12E

### **RSNA Deep Learning Lab: Evaluating for Fairness of AI Models in Radiology**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: Learning Center, Deep Learning Lab

Beepul Bharti, BS, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL13

### **RSNA Deep Learning Lab: Best Practices for Model Training: Architectures, Hyperparameters Optimization**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: Learning Center, Deep Learning Lab

Peter Chang, MD (*Moderator*) Co-founder, Avicenna.ai; Stockholder, Avicenna.ai; Research Grant, Canon Medical Systems Corporation; Speakers Bureau, Canon Medical Systems Corporation; Research Grant, General Electric Company

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Additional information coming soon.

#### **Sub-Events**

### **DLL13B RSNA Deep Learning Lab: Best Practices for Model Training: Architectures, Hyperparameters & Optimization**

Peter Chang, MD (*Presenter*) Co-founder, Avicenna.ai; Stockholder, Avicenna.ai; Research Grant, Canon Medical Systems Corporation; Speakers Bureau, Canon Medical Systems Corporation; Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL13B

### **RSNA Deep Learning Lab: Best Practices for Model Training: Architectures, Hyperparameters & Optimization**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: Learning Center, Deep Learning Lab

Peter Chang, MD (*Presenter*) Co-founder, Avicenna.ai; Stockholder, Avicenna.ai; Research Grant, Canon Medical Systems Corporation; Speakers Bureau, Canon Medical Systems Corporation; Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL14

### RSNA Deep Learning Lab: Object Detection in Medical Imaging

Wednesday, Nov. 29 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Bradley J. Erickson, MD, PhD (*Moderator*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FLOWSIGMA Inc; Officer, FLOWSIGMA Inc; Stockholder, FLOWSIGMA Inc; Officer, Yunu Inc; Stockholder, Yunu Inc

#### LEARNING OBJECTIVES

1) To become familiar with the use cases for generative models in radiology. 2) To understand the strengths and weaknesses of GANS and DDPMS, with particular emphasis on diffusion models.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This course will introduce you to generative models for radiology. There will be a brief description of some of the technologies being used. We will then develop a more in depth investigation of diffusion models, including hands-on coding of a diffusion model for radiology image generation.

#### Sub-Events

##### **DLL14B** RSNA Deep Learning Lab: Object Detection in Medical Imaging

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

##### **DLL14C** RSNA Deep Learning Lab: Object Detection in Medical Imaging

Bradley J. Erickson, MD, PhD (*Presenter*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FLOWSIGMA Inc; Officer, FLOWSIGMA Inc; Stockholder, FLOWSIGMA Inc; Officer, Yunu Inc; Stockholder, Yunu Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL14B

### **RSNA Deep Learning Lab: Object Detection in Medical Imaging**

Wednesday, Nov. 29 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL14C

### **RSNA Deep Learning Lab: Object Detection in Medical Imaging**

Wednesday, Nov. 29 10:00AM - 11:00AM Room: Learning Center, Deep Learning Lab

Bradley J. Erickson, MD, PhD (*Presenter*) Board of Directors, VoiceIt Technologies, LLC;Stockholder, VoiceIt Technologies, LLC;Board of Directors, FLOWSIGMA Inc;Officer, FLOWSIGMA Inc;Stockholder, FLOWSIGMA Inc;Officer, Yunu Inc;Stockholder, Yunu Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL15

### RSNA Deep Learning Lab: Medical Image Generation

Wednesday, Nov. 29 11:30AM - 12:30PM Room: Learning Center, Deep Learning Lab

Bradley J. Erickson, MD, PhD (*Moderator*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FLOWSIGMA Inc; Officer, FLOWSIGMA Inc; Stockholder, FLOWSIGMA Inc; Officer, Yunu Inc; Stockholder, Yunu Inc

#### LEARNING OBJECTIVES

1) Identify the applications of generative adversarial networks (GANs) in Radiology. 2) Explain the general intuition behind GAN training. 3) Train a GAN-based model to create synthetic lesions to augment the real data.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Generative adversarial networks (GANs) have evolved over the past several years and are being widely used for faster image acquisition, image quality improvement, and data augmentation, among many other applications. This hands-on workshop will cover the theoretical bases of GAN training and its applications in Radiology and introduce some of the well-known algorithms in this field. Finally, we will train a GAN to create synthetic lesions for data augmentation.

#### Sub-Events

##### **DLL15B** RSNA Deep Learning Lab: Medical Image Generation

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

##### **DLL15C** RSNA Deep Learning Lab: Medical Image Generation

Bradley J. Erickson, MD, PhD (*Presenter*) Board of Directors, VoiceIt Technologies, LLC; Stockholder, VoiceIt Technologies, LLC; Board of Directors, FLOWSIGMA Inc; Officer, FLOWSIGMA Inc; Stockholder, FLOWSIGMA Inc; Officer, Yunu Inc; Stockholder, Yunu Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL15B

### **RSNA Deep Learning Lab: Medical Image Generation**

Wednesday, Nov. 29 11:30AM - 12:30PM Room: Learning Center, Deep Learning Lab

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL15C

### **RSNA Deep Learning Lab: Medical Image Generation**

Wednesday, Nov. 29 11:30AM - 12:30PM Room: Learning Center, Deep Learning Lab

Bradley J. Erickson, MD, PhD (*Presenter*) Board of Directors, VoiceIt Technologies, LLC;Stockholder, VoiceIt Technologies, LLC;Board of Directors, FLOWSIGMA Inc;Officer, FLOWSIGMA Inc;Stockholder, FLOWSIGMA Inc;Officer, Yunu Inc;Stockholder, Yunu Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL16

### RSNA Deep Learning Lab: MONAI Core on Amazon SageMaker Studio Lab

Wednesday, Nov. 29 1:00PM - 2:00PM Room: Learning Center, Deep Learning Lab

Alex Lemm (*Moderator*) Nothing to Disclose  
Andrew Crabb (*Moderator*) Nothing to Disclose

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Amazon SageMaker Studio Lab provides no-cost access to a JupyterLab-based machine learning development environment for everyone with an email address. MONAI Core is a PyTorch-based, open-source library for training deep learning models in medical imaging. In this workshop, we will provide a brief introduction to MONAI and its various components, including MONAI Auto3Dseg—a low-code tool that empowers developers to address the complex task of 3D medical image segmentation. Notably, a team of NVIDIA researchers utilized Auto3Dseg to achieve success in several MICCAI 2023 challenges. Participants will engage in hands-on experience by running several MONAI labs within their own SageMaker Studio Lab environment, which will be provided as part of the course. Towards the end, we will also discuss leveraging another service—Amazon SageMaker—for training your cutting-edge image models at scale.

#### Sub-Events

##### **DLL16C**    **RSNA Deep Learning Lab: MONAI Core on Amazon SageMaker Studio Lab**

Alex Lemm (*Presenter*) Nothing to Disclose

##### **DLL16D**    **RSNA Deep Learning Lab: MONAI Core on Amazon SageMaker Studio Lab**

Andrew Crabb (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL16C

### **RSNA Deep Learning Lab: MONAI Core on Amazon SageMaker Studio Lab**

Wednesday, Nov. 29 1:00PM - 2:00PM Room: Learning Center, Deep Learning Lab

Alex Lemm (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL16D

### **RSNA Deep Learning Lab: MONAI Core on Amazon SageMaker Studio Lab**

Wednesday, Nov. 29 1:00PM - 2:00PM Room: Learning Center, Deep Learning Lab

Andrew Crabb (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL17

### **RSNA Deep Learning Lab: Developing and Implementing a 3D Segmentation Model: from DICOM to Deployment**

Wednesday, Nov. 29 2:30PM - 3:30PM Room: Learning Center, Deep Learning Lab

Evan D. Calabrese, MD, PhD (*Moderator*) Nothing to Disclose

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited.

#### **Sub-Events**

#### **DLL17B RSNA Deep Learning Lab: Developing and Implementing a 3D Segmentation Model: from DICOM to Deployment**

Jikai Zhang, MS, BS (*Presenter*) Nothing to Disclose

#### **DLL17C RSNA Deep Learning Lab: Developing and Implementing a 3D Segmentation Model: from DICOM to Deployment**

Spyridon Bakas, PhD (*Presenter*) Nothing to Disclose

#### **DLL17D RSNA Deep Learning Lab: Developing and Implementing a 3D Segmentation Model: from DICOM to Deployment**

Evan D. Calabrese, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

DLL17B

### **RSNA Deep Learning Lab: Developing and Implementing a 3D Segmentation Model: from DICOM to Deployment**

Wednesday, Nov. 29 2:30PM - 3:30PM Room: Learning Center, Deep Learning Lab

Jikai Zhang, MS, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL17C

### **RSNA Deep Learning Lab: Developing and Implementing a 3D Segmentation Model: from DICOM to Deployment**

Wednesday, Nov. 29 2:30PM - 3:30PM Room: Learning Center, Deep Learning Lab

Spyridon Bakas, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL17D

### **RSNA Deep Learning Lab: Developing and Implementing a 3D Segmentation Model: from DICOM to Deployment**

Wednesday, Nov. 29 2:30PM - 3:30PM Room: Learning Center, Deep Learning Lab

Evan D. Calabrese, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL18

### **RSNA Deep Learning Lab: DICOM In, DICOM Out for Segmentation**

Thursday, Nov. 30 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Thomas W. Loehfelm, MD, PhD (*Moderator*) Nothing to Disclose

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited.

#### **Sub-Events**

### **DLL18B RSNA Deep Learning Lab: DICOM In, DICOM Out for Segmentation**

Thomas W. Loehfelm, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL18B

### **RSNA Deep Learning Lab: DICOM In, DICOM Out for Segmentation**

Thursday, Nov. 30 9:00AM - 10:00AM Room: Learning Center, Deep Learning Lab

Thomas W. Loehfelm, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL19

### **RSNA Deep Learning Lab: Deploy Your Own Model in Huggingface**

Thursday, Nov. 30 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Felipe C. Kitamura, MD, PhD (*Moderator*) Consultant, MD.ai, Inc Speaker, General Electric Company Speaker, SPCC (Sharing Progress in Cancer Care)

#### **LEARNING OBJECTIVES**

1) Learn the fundamentals of deep learning by training a model in PyTorch. 2) Build and deploy a custom pneumonia classification model in Hugging Face.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Dive into applied deep learning in this focused, hands-on course. You'll directly engage with the process of constructing a pneumonia classification model in PyTorch and deploying it using the Hugging Face platform. This session emphasizes learning through action. You won't be lost in theory but rather immersed in the practical application of deep learning technologies.

#### **Sub-Events**

#### **DLL19B RSNA Deep Learning Lab: Deploy Your Own Model in Huggingface**

Ian Pan, MD (*Presenter*) Consultant, MD.ai, Inc; Consultant, Centaur Labs Inc; Consultant, Diagnosticos da America SA; Consultant, CoRead AI

#### **DLL19C RSNA Deep Learning Lab: Deploy Your Own Model in Huggingface**

Felipe C. Kitamura, MD, PhD (*Presenter*) Consultant, MD.ai, Inc Speaker, General Electric Company Speaker, SPCC (Sharing Progress in Cancer Care)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL19B

### **RSNA Deep Learning Lab: Deploy Your Own Model in Huggingface**

Thursday, Nov. 30 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Ian Pan, MD (*Presenter*) Consultant, MD.ai, Inc; Consultant, Centaur Labs Inc; Consultant, Diagnosticos da America SA; Consultant, CoRead AI

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

DLL19C

### **RSNA Deep Learning Lab: Deploy Your Own Model in Huggingface**

Thursday, Nov. 30 10:30AM - 11:30AM Room: Learning Center, Deep Learning Lab

Felipe C. Kitamura, MD, PhD (*Presenter*) Consultant, MD.ai, Inc Speaker, General Electric Company Speaker, SPCC (Sharing Progress in Cancer Care)

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CAS01

### Impacts on Radiology and Lessons Learned After Large Storms (Sponsored by the RSNA Associated Sciences Consortium)

Monday, Nov. 27 8:00AM - 9:00AM Room: N230B

Brandy J. Reed, MBA, RT (*Moderator*) Nothing to Disclose

Brian Fox, MBA (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Sharing lessons learned in emergent large scale natural Disasters. 2) Being prepared to react, learn and execute. 3) How we navigated the unforeseen circumstances.

#### COURSE DESCRIPTION

Hear perspectives from an administrator and a quality officer on what they experienced during two different hurricanes that had substantial impact to patient care. How an open-mind to learn what they didn't know help navigate their teams to successful recovery.

#### Sub-Events

##### **M1-CAS01C Hurricane Harvey: How MD Anderson's Division of Diagnostic Imaging Weathered the Unusual Storm**

Brett W. Carter, MD (*Presenter*) Nothing to Disclose

##### **M1-CAS01D Lessons Learned: Be Prepared to Learn from What You Didn't Know**

Aziz Benamar, RT, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CAS01C

### **Hurricane Harvey: How MD Anderson's Division of Diagnostic Imaging Weathered the Unusual Storm**

Monday, Nov. 27 8:00AM - 9:00AM Room: N230B

Brett W. Carter, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CAS01D

### **Lessons Learned: Be Prepared to Learn from What You Didn't Know**

Monday, Nov. 27 8:00AM - 9:00AM Room: N230B

Aziz Benamar, RT, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCA11

### **Cardiac CT Mentored Case Review: Imaging The Heart: Imaging Techniques, Anatomy, and Function**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450B

Jacobo Kirsch, MD, MBA (*Moderator*) Medical Advisory Board, Zebra Medical Vision Ltd

#### **LEARNING OBJECTIVES**

1. To recognize normal anatomic structures of the heart on cross sectional CT images. 2. To identify normal and abnormal appearance of cardiac valves and cardiac function on cardiac CT. 3. To describe techniques for optimizations of the coronary CTA images. 4. To identify signs of non-obstructive coronary disease on CTA.

#### **COURSE DESCRIPTION**

This is a session with four didactic presentations that will primarily help radiologists that are new to cardiac CT recognize normal anatomic structures and normal valvular and myocardial function on cardiac CT. In addition, the audience will learn technical optimizations that can be applied to cardiac CT to improve visualization of the coronary arteries and cardiac structures. Finally, an introduction to coronary artery disease without obstructive coronary lesions will be presented. The session is heavily case based, so audience can get familiar with the appearance of normal and diseased hearts on cardiac CT.

#### **Sub-Events**

##### **M1-CCA11B Normal Anatomy and Congenital Coronary Arteries Variants**

Kyle S. Spearman, MD (*Presenter*) Nothing to Disclose

##### **M1-CCA11C Coronary CTA: Major Technical Aspects to Achieve a Successful Scan**

Diana Litmanovich, MD (*Presenter*) Nothing to Disclose

##### **M1-CCA11D Non-atherosclerotic Coronary Artery Disease**

Carole A. Ridge, FFR(RCSI) (*Presenter*) Nothing to Disclose

##### **M1-CCA11E CT of Cardiac Valves and CT Cardiac Function, Including Normal Cardiac Chamber Sizes**

Suhny Abbara, MD (*Presenter*) Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCA11B

### Normal Anatomy and Congenital Coronary Arteries Variants

Monday, Nov. 27 8:00AM - 9:00AM Room: E450B

Kyle S. Spearman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCA11C

### **Coronary CTA: Major Technical Aspects to Achieve a Successful Scan**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450B

Diana Litmanovich, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCA11D

### **Non-atherosclerotic Coronary Artery Disease**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450B

Carole A. Ridge, FFR(RCSI) (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M1-CCA11E

### **CT of Cardiac Valves and CT Cardiac Function, Including Normal Cardiac Chamber Sizes**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450B

Suhny Abbara, MD (*Presenter*) Royalties, RELX

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CCH03

### Lung Cancer Multidisciplinary Tumor Board Meeting

Monday, Nov. 27 8:00AM - 9:00AM Room: S406B

Michelle S. Ginsberg, MD (*Moderator*) Speaker, Ultimate Opinions In Medicine LLC

#### LEARNING OBJECTIVES

1) To discuss the diagnosis and staging of lung cancer. 2) Discuss the current multidisciplinary management of lung cancer. 3) Discuss the role of imaging in the post-treatment evaluation.

#### COURSE DESCRIPTION

This case-based discussion will expose the attendees to multidisciplinary discussion when treating lung cancer, The panel will demonstrate specific imaging findings that directly affect staging and treatment decisions and will provide the audience with specific information they should include in their reports regarding description of findings during the management of lung cancer patients.

#### Sub-Events

##### **M1-CCH03B Lung Cancer Multidisciplinary Tumor Board Meeting**

Michelle S. Ginsberg, MD (*Presenter*) Speaker, Ultimate Opinions In Medicine LLC

##### **M1-CCH03C Radiologist**

Jeremy J. Erasmus, MD (*Presenter*) Nothing to Disclose

##### **M1-CCH03D Surgeon**

Ravi Rajaram, MD, MSc (*Presenter*) Nothing to Disclose

##### **M1-CCH03E Medical Oncologist**

Gregory J. Riely, MD, PhD (*Presenter*) Consultant, Boehringer Ingelheim GmbH Consultant, Merck & Co, Inc Consultant, F. Hoffmann-La Roche Ltd

##### **M1-CCH03F Radiation Oncologist**

Andreas Rimner, MD (*Presenter*) Research Consultant, General Electric Company Research Consultant, Varian Medical Systems, Inc Research Grant, Varian Medical Systems, Inc

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M1-CCH03B

### **Lung Cancer Multidisciplinary Tumor Board Meeting**

Monday, Nov. 27 8:00AM - 9:00AM Room: S406B

Michelle S. Ginsberg, MD (*Presenter*) Speaker, Ultimate Opinions In Medicine LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCH03C

### **Radiologist**

Monday, Nov. 27 8:00AM - 9:00AM Room: S406B

Jeremy J. Erasmus, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCH03D

### Surgeon

Monday, Nov. 27 8:00AM - 9:00AM Room: S406B

Ravi Rajaram, MD, MSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCH03E

### Medical Oncologist

Monday, Nov. 27 8:00AM - 9:00AM Room: S406B

Gregory J. Riely, MD, PhD (*Presenter*) Consultant, Boehringer Ingelheim GmbH Consultant, Merck & Co, Inc Consultant, F. Hoffmann-La Roche Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CCH03F

### **Radiation Oncologist**

Monday, Nov. 27 8:00AM - 9:00AM Room: S406B

Andreas Rimner, MD (*Presenter*) Research Consultant, General Electric CompanyResearch Consultant, Varian Medical Systems, IncResearch Grant, Varian Medical Systems, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CER05

### Fundamentals of Abdominopelvic Trauma

Monday, Nov. 27 8:00AM - 9:00AM Room: E451B

Christina A. LeBedis, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explore the role of CT, including CT protocols, in the diagnosis of patients who have sustained abdominopelvic trauma specifically with respect to pancreatic trauma, splenic trauma, and bowel and mesenteric trauma. 2) Identify key CT imaging findings in these organ injury types through case examples. 3) Discuss the imaging findings crucial to patient triage and management.

#### COURSE DESCRIPTION

In this didactic course on Abdominopelvic trauma, learn state-of-the-art imaging of pancreatic trauma, splenic trauma and bowel and mesenteric trauma from expert emergency radiologists. Radiologists at all levels of training will benefit from the material presented as it can be readily incorporated into their core knowledge base to care for acutely injured patients.

#### Sub-Events

##### M1-CER05B Pancreas Injuries

Christina A. LeBedis, MD (*Presenter*) Nothing to Disclose

##### M1-CER05C Bowel & Mesenteric Injuries

Vincent M. Mellnick, MD (*Presenter*) Nothing to Disclose

##### M1-CER05D Splenic Trauma

Carrie N. Hoff, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CER05B

### **Pancreas Injuries**

Monday, Nov. 27 8:00AM - 9:00AM Room: E451B

Christina A. LeBedis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CER05C

### **Bowel & Mesentric Injuries**

Monday, Nov. 27 8:00AM - 9:00AM Room: E451B

Vincent M. Mellnick, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CER05D

### Splenic Trauma

Monday, Nov. 27 8:00AM - 9:00AM Room: E451B

Carrie N. Hoff, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CGI02

### Crohn's Disease Imaging

Monday, Nov. 27 8:00AM - 9:00AM Room: S404

Tracy A. Jaffe, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Refresh understanding of pathophysiology and presentation of Crohn's disease. 2) Identify up to date imaging techniques and advances in diagnosing and reporting Crohn's disease. 3) Appreciate the role of the Radiologist in multidisciplinary care of patients with Crohn's disease.

#### COURSE DESCRIPTION

This course will include 5 short lectures to provide up to date knowledge regarding current concepts in imaging of Crohn's disease including CT, MRI and Ultrasound technology with a focus on identification and reporting of disease activity and response to treatment.

#### Sub-Events

##### **M1-CGI02B Assessment of Stricturing and Penetrating Crohn Disease**

Tracy A. Jaffe, MD (*Presenter*) Nothing to Disclose

##### **M1-CGI02C CT and MR Enterography: Assessment of Disease Activity and Response Treatment**

Jonathan R. Dillman, MD, MSc (*Presenter*) Research Grant, Perspectum Ltd; Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation; Research support, Koninklijke Philips NV; Research support, General Electric Company; Research support, Motilent Ltd

##### **M1-CGI02D CT and MR Enterography in Crohn's Disease: Patient Preparation and Techniques**

Bari Dane, MD (*Presenter*) Nothing to Disclose

##### **M1-CGI02E MRI of Perianal Fistula**

Mahmoud M. Al-Hawary, MD (*Presenter*) Nothing to Disclose

##### **M1-CGI02F Bowel Ultrasound for Crohn's Disease: How to Get Started?**

Sudha A. Anupindi, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M1-CGI02B

### **Assessment of Strictureing and Penetrating Crohn Disease**

Monday, Nov. 27 8:00AM - 9:00AM Room: S404

Tracy A. Jaffe, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CGI02C

### **CT and MR Enterography: Assessment of Disease Activity and Response Treatment**

Monday, Nov. 27 8:00AM - 9:00AM Room: S404

Jonathan R. Dillman, MD, MSc (*Presenter*) Research Grant, Perspectum Ltd; Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation; Research support, Koninklijke Philips NV; Research support, General Electric Company; Research support, Motilent Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CGI02D

### **CT and MR Enterography in Crohn's Disease: Patient Preparation and Techniques**

Monday, Nov. 27 8:00AM - 9:00AM Room: S404

Bari Dane, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CGI02E

### **MRI of Perianal Fistula**

Monday, Nov. 27 8:00AM - 9:00AM Room: S404

Mahmoud M. Al-Hawary, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CGI02F

### **Bowel Ultrasound for Crohn's Disease: How to Get Started?**

Monday, Nov. 27 8:00AM - 9:00AM Room: S404

Sudha A. Anupindi, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CIN07

### The MIDRC Experience with Curating DICOM Images for use in AI Research

Monday, Nov. 27 8:00AM - 9:00AM Room: S401

Paul E. Kinahan, PhD (*Moderator*) Co-founder, PET/X LLC

#### LEARNING OBJECTIVES

1) Develop artificial intelligence (AI) methods with improved repeatability and reproducibility, a recognized need is for large, publicly available, and curated imaging data sets. 2) Near-universal adoption of the Digital Imaging and Communications in Medicine (DICOM) standard enables this goal using a well-defined common data model. 3) As useful as DICOM is, improvements are needed in harmonization and standardization to better achieve FAIR (Findable, Accessible, Interoperable, Reusable) principles, which we will describe.

#### Sub-Events

##### **M1-CIN07B The Role and Potential of DICOM in Imaging AI Research**

Andriy Fedorov, PhD (*Presenter*) Nothing to Disclose

##### **M1-CIN07C Approaches to Annotation**

Adam E. Flanders, MD (*Presenter*) Nothing to Disclose

##### **M1-CIN07D Helper AI for Annotation**

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

##### **M1-CIN07E Helping Users Create Cohorts of Image Data: The Use of Coding Schemes Such as LOINC to Identify Specific Subsets of Imaging Exams**

Michael F. McNitt-Gray, PhD (*Presenter*) Institutional research agreement, Siemens AG;Research Grant, Siemens AG;Scientific Advisory Board, Hura Imaging, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CIN07B

### **The Role and Potential of DICOM in Imaging AI Research**

Monday, Nov. 27 8:00AM - 9:00AM Room: S401

Andriy Fedorov, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CIN07C

### Approaches to Annotation

Monday, Nov. 27 8:00AM - 9:00AM Room: S401

Adam E. Flanders, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CIN07D

### Helper AI for Annotation

Monday, Nov. 27 8:00AM - 9:00AM Room: S401

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc; Shareholder, MD.ai, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CIN07E

### **Helping Users Create Cohorts of Image Data: The Use of Coding Schemes Such as LOINC to Identify Specific Subsets of Imaging Exams**

Monday, Nov. 27 8:00AM - 9:00AM Room: S401

Michael F. McNitt-Gray, PhD (*Presenter*) Institutional research agreement, Siemens AG; Research Grant, Siemens AG; Scientific Advisory Board, Hura Imaging, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMK11

### Imaging in Sports: Common Patterns of Muscle Injury

Monday, Nov. 27 8:00AM - 9:00AM Room: E450A

Emma L. Rowbotham, FRCR (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Knowledge of normal anatomy and anatomical variants in the key regions for sports injury – hamstring, calf, proximal thigh chest wall, and abdominal wall. 2) To become familiar with the common injury patterns in these regions. 3) To be able to describe the injury patterns accurately with emphasis on clinically relevant factors. 4) To have an awareness of the relevant grading systems – understanding both the strengths and weaknesses of grading of injuries.

#### COURSE DESCRIPTION

This is a sports imaging session based around common and interesting areas of sports injury. Experts in sports imaging will cover: Pectoralis major injury, hamstring, calf, proximal thigh and chest wall injuries. The series of short lectures will cover the anatomy and typical injury patterns for these commonly injured areas of the body, appearances of the usual injury patterns and description of associated grading systems used in these regions. Knowledge of sports specific injury is important in providing a clear report to the team and will aid the reporter in producing a clear, concise and helpful report.

#### Sub-Events

##### **M1-CMK11B Acute Chest Wall and Abdominal Injury in Athletes**

Emma L. Rowbotham, FRCR (*Presenter*) Nothing to Disclose

##### **M1-CMK11C Anatomy and Injury of Pectoralis Major**

Michael J. Tuite, MD (*Presenter*) Nothing to Disclose

##### **M1-CMK11D Rectus Femoris: Anatomy and Patterns of Injury**

Ara Kassarian, MD, FRCPC (*Presenter*) Research Consultant, ArthroSurface, Inc

##### **M1-CMK11E Hamstring Injury and Classification**

James M. Linklater, FRANZCR, BMedSc (*Presenter*) Nothing to Disclose

##### **M1-CMK11F Soleus Tears, Patterns and Prognosis Factors**

Eva Llopis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M1-CMK11B

### **Acute Chest Wall and Abdominal Injury in Athletes**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450A

Emma L. Rowbotham, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMK11C

### **Anatomy and Injury of Pectoralis Major**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450A

Michael J. Tuite, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CMK11D

### **Rectus Femoris: Anatomy and Patterns of Injury**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450A

Ara Kassarian, MD, FRCPC (*Presenter*) Research Consultant, ArthroSurface, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMK11E

### Hamstring Injury and Classification

Monday, Nov. 27 8:00AM - 9:00AM Room: E450A

James M. Linklater, FRANZCR, BMedSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMK11F

### **Soleus Tears, Patterns and Prognosis Factors**

Monday, Nov. 27 8:00AM - 9:00AM Room: E450A

Eva Llopis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMS03

### **Immunotherapy: New Paradigms for Interpretation and Imaging**

Monday, Nov. 27 8:00AM - 9:00AM Room: S406A

Malak Itani, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Understand basics of immunotherapy and image interpretation. 2) Identify imaging features of side effects and complications associated with immunotherapy in the chest and abdomen. 3) Learn about interventional radiology applications of immunotherapy.

#### **COURSE DESCRIPTION**

A review of how newer immunotherapy changes the paradigm for cancer treatment and image interpretation. This session will also review potential side effects and complications associated with immunotherapy in the chest and abdomen, and interventional radiology applications of immunotherapy

#### **Sub-Events**

##### **M1-CMS03B Basics of Immunotherapy and Image Interpretation**

Priya R. Bhosale, MD (*Presenter*) Nothing to Disclose

##### **M1-CMS03C Immunotherapy Side Effects on PET CT in the Chest**

Malak Itani, MD (*Presenter*) Nothing to Disclose

##### **M1-CMS03D Abdominal Immunotherapy-Related Adverse Events (irAEs)**

Ranjodh Dhami, MD (*Presenter*) Nothing to Disclose

##### **M1-CMS03E Immuno Oncology and Interventional Oncology**

Hyun S. Kim, MD (*Presenter*) Boston Scientific Corporation; Galil Medical Ltd; Sirtex Medical Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMS03B

### Basics of Immunotherapy and Image Interpretation

Monday, Nov. 27 8:00AM - 9:00AM Room: S406A

Priya R. Bhosale, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMS03C

### **Immunotherapy Side Effects on PET CT in the Chest**

Monday, Nov. 27 8:00AM - 9:00AM Room: S406A

Malak Itani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMS03D

### **Abdominal Immunotherapy-Related Adverse Events (irAEs)**

Monday, Nov. 27 8:00AM - 9:00AM Room: S406A

Ranjodh Dhimi, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CMS03E

### **Immuno Oncology and Interventional Oncology**

Monday, Nov. 27 8:00AM - 9:00AM Room: S406A

Hyun S. Kim, MD (*Presenter*) Boston Scientific Corporation; Galil Medical Ltd; Sirtex Medical Ltd

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CNPM07

### Clinical Trials Methodology Workshop Spotlight (Sponsored by the RSNA Research Development Committee)

Monday, Nov. 27 8:00AM - 9:00AM Room: S502

Janie M. Lee, MD, MSc (*Moderator*) Research Grant, General Electric Company; Investigator, General Electric Company  
Susanna I. Lee, MD, PhD (*Moderator*) Royalties, Wolters Kluwer nv

#### LEARNING OBJECTIVES

1) Review how and why clinical trial protocols change through the development process. 2) Learn about potential facilitators and barriers to launching a clinical trial initially “workshopped” at the CTMW course. 3) Learn key biostatistical lessons regarding trial design and data analysis directly from CTMW biostatisticians using the trials presented by the Principal Investigators.

#### COURSE DESCRIPTION

RSNA's Clinical Trials Methodology Workshop (CTMW) has provided first-class education in clinical trials methodology and has greatly expanded interest and successful efforts in radiology and radiation oncology clinical research. While previously available exclusively to those accepted to the in-person CTMW, this course will make accessible to all RSNA annual meeting attendees the rigor and expertise of the CTMW in a lecture course format. This course highlights the development of clinical trial protocols and pragmatic real world lessons from implementing them, presented by two alumni of the successful RSNA Clinical Trials Methodology Workshop, with biostatistical commentary from a course faculty member. The session will conclude with Q&A with the audience.

#### Sub-Events

##### **M1- CNPM07C** CTMW Overview

Susanna I. Lee, MD, PhD (*Presenter*) Royalties, Wolters Kluwer nv

##### **M1- CNPM07D** CTMW Alumnus

Amir Iravani, MD (*Presenter*) Nothing to Disclose

##### **M1- CNPM07E** CMW Alumnus

Iman Khodarahmi, MD, PhD (*Presenter*) Nothing to Disclose

##### **M1- CNPM07F** Biostatistics Discussion

Nancy A. Obuchowski, PhD, MS (*Presenter*) Research Consultant, Siemens AG; Research Consultant, IBM Corporation; Research Consultant, Elucid Bioimaging Inc; Research Consultant, Takeda Pharmaceutical Company Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CNPM07C

### **CTMW Overview**

Monday, Nov. 27 8:00AM - 9:00AM Room: S502

Susanna I. Lee, MD, PhD (*Presenter*) Royalties, Wolters Kluwer nv

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## Abstract Archives of the RSNA, 2023

M1-CNPM07D

### **CTMW Alumnus**

Monday, Nov. 27 8:00AM - 9:00AM Room: S502

Amir Iravani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CNPM07E

### **CMW Alumnus**

Monday, Nov. 27 8:00AM - 9:00AM Room: S502

Iman Khodarahmi, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CNPM07F

### **Biostatistics Discussion**

Monday, Nov. 27 8:00AM - 9:00AM Room: S502

Nancy A. Obuchowski, PhD, MS (*Presenter*) Research Consultant, Siemens AG; Research Consultant, IBM Corporation; Research Consultant, Elucid Bioimaging Inc; Research Consultant, Takeda Pharmaceutical Company Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CNR01

### Stroke and Cerebrovascular: Current Imaging Markers and Future Horizons

Monday, Nov. 27 8:00AM - 9:00AM Room: E353C

Achala S. Vagal, MD (*Moderator*) Departmental Research Grant, Johnson & Johnson  
Mahmud Mossa-Basha, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand correct nomenclature of imaging of small vessel disease. 2) Identify imaging makers of pulsatility and arterial stiffness. 3) Identify and learn about the conventional and advanced imaging biomarkers of secondary ischemic stroke.

#### COURSE DESCRIPTION

Imaging provides essential insights into small vessel disease and for secondary stroke prevention. Radiologists must be aware of the correct terminology for small vessel disease. Further, the course will help learners to understand the various conventional and advanced imaging biomarkers of cerebrovascular disease and secondary ischemic stroke.

#### Sub-Events

##### **M1-CNR01C Small Vessel Disease-What Radiologists Need to Know**

Achala S. Vagal, MD (*Presenter*) Departmental Research Grant, Johnson & Johnson

##### **M1-CNR01D Advanced Neuroimaging Markers for Secondary Stroke**

Mahmud Mossa-Basha, MD (*Presenter*) Nothing to Disclose

##### **M1-CNR01E Pulsatility and Arterial Stiffness: Contributions to Cerebrovascular Disease**

Niranjan Balu, PhD (*Presenter*) Nothing to Disclose

##### **M1-CNR01F Conventional Neuroimaging Markers for Secondary Stroke**

Luca Saba, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CNR01C

### **Small Vessel Disease-What Radiologists Need to Know**

Monday, Nov. 27 8:00AM - 9:00AM Room: E353C

Achala S. Vagal, MD (*Presenter*) Departmental Research Grant, Johnson & Johnson

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CNR01D

### Advanced Neuroimaging Markers for Secondary Stroke

Monday, Nov. 27 8:00AM - 9:00AM Room: E353C

Mahmud Mossa-Basha, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CNR01E

### **Pulsatility and Arterial Stiffness: Contributions to Cerebrovascular Disease**

Monday, Nov. 27 8:00AM - 9:00AM Room: E353C

Niranjan Balu, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CNR01F

### **Conventional Neuroimaging Markers for Secondary Stroke**

Monday, Nov. 27 8:00AM - 9:00AM Room: E353C

Luca Saba, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-COB04

### Case based Review of Crazy OB/GYN Cases

Monday, Nov. 27 8:00AM - 9:00AM Room: E451A

Anne M. Kennedy, MBBCh (*Moderator*) Author with royalties, RELX

#### LEARNING OBJECTIVES

1) Develop a logical, systematic approach to complex OB and GYN cases. 2) Identify strategies to reduce a broad differential to a specific diagnosis or a short list of likely options.

#### COURSE DESCRIPTION

This will be a case-based interactive session. We will present cases with multiple choice questions for audience response using Poll Everywhere. We will review the correct diagnosis with tips for problem solving and narrowing a lengthy, generic list of differential diagnoses down to more focused list relevant to the case in hand. For OB cases we will provide postnatal or autopsy confirmation and for GYN cases operative results and pathology confirmation. Attendees will have a better visual database of unusual OBGYN pathology and learn a practical approach to complex cases.

#### Sub-Events

##### **M1-COB04B Case Based Review of Crazy OB/GYN Cases**

Anne M. Kennedy, MBBCh (*Presenter*) Author with royalties, RELX

##### **M1-COB04C Case Based Review of Crazy OB/GYN Cases**

Paula J. Woodward, MD (*Presenter*) Royalties, RELX

##### **M1-COB04D Case Based Review of Crazy OB/GYN Cases**

Roya Sohaey, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-COB04B

### Case Based Review of Crazy OB/GYN Cases

Monday, Nov. 27 8:00AM - 9:00AM Room: E451A

Anne M. Kennedy, MBBCh (*Presenter*) Author with royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-COB04C

### Case Based Review of Crazy OB/GYN Cases

Monday, Nov. 27 8:00AM - 9:00AM Room: E451A

Paula J. Woodward, MD (*Presenter*) Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-COB04D

### Case Based Review of Crazy OB/GYN Cases

Monday, Nov. 27 8:00AM - 9:00AM Room: E451A

Roya Sohaey, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CPH12

### Advanced Ultrasound Technology and Applications

Monday, Nov. 27 8:00AM - 9:00AM Room: N228

Thaddeus A. Wilson, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain the principles that enable software beamforming, and the advantages over conventional sequential delay-and-sum beamforming. 2) Describe the benefits of advanced ultrasound transducer technologies and geometries, and their clinical impact.

#### COURSE DESCRIPTION

Provide an update in current ultrasound technologies in flow imaging, beamforming techniques and advanced transducers.

#### Sub-Events

##### M1-CPH12B Flow Imaging in Ultrasound

Carl Herickhoff, PhD (*Presenter*) Technical Advisory Board, Maui Imaging, Inc;Shareholder, Maui Imaging, Inc;Consultant, Bioventus LLC;Consultant, Open Water Internet, Inc;Shareholder, Open Water Internet, Inc;Consultant, Scitus Engineering

##### M1-CPH12C They Don't Make 'Em Like They Used To: Modern Ultrasound Imaging

Stephen McAleavey, PhD (*Presenter*) Research collaboration, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CPH12B

### Flow Imaging in Ultrasound

Monday, Nov. 27 8:00AM - 9:00AM Room: N228

Carl Herickhoff, PhD (*Presenter*) Technical Advisory Board, Maui Imaging, Inc; Shareholder, Maui Imaging, Inc; Consultant, Bioventus LLC; Consultant, Open Water Internet, Inc; Shareholder, Open Water Internet, Inc; Consultant, Scitus Engineering

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CPH12C

### **They Don't Make 'Em Like They Used To: Modern Ultrasound Imaging**

Monday, Nov. 27 8:00AM - 9:00AM Room: N228

Stephen McAleavey, PhD (*Presenter*) Research collaboration, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CRO02

### Head & Neck Case Based Multidisciplinary Review

Monday, Nov. 27 8:00AM - 9:00AM Room: S402

Suresh K. Mukherji, MD, MBA (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Expose the attendees to multidisciplinary discussion when treating head and neck cancer. 2) Demonstrate specific imaging findings that directly affect staging and treatment decisions. 3) Provide the audience with specific information they should include in their reports that directly affect prognosis and management.

#### COURSE DESCRIPTION

The purpose of this course will be to replicate a real-world Head & Neck tumor. We will discuss actual cases with a focus on how imaging findings directly change stage, modify treatment and predict outcome.

#### Sub-Events

##### M1-CRO02B Head & Neck Case Based Multidisciplinary Review

Sung Kim, MD (*Presenter*) Consultant, Nanobiotix

##### M1-CRO02C Head & Neck Case Based Multidisciplinary Review

Francis P. Worden, MD (*Presenter*) Speaker, Merck & Co, Inc; Advisory Board, Merck & Co, Inc; Institutional research support, Merck & Co, Inc; Travel support, Merck & Co, Inc; Speaker, Eisai Co, Ltd; Advisory Board, Eisai Co, Ltd; Institutional research support, Eisai Co, Ltd; Speaker, Bristol-Myers Squibb Company; Advisory Board, Bristol-Myers Squibb Company; Research funded, Bristol-Myers Squibb Company; Speaker, Eli Lilly and Company; Advisory Board, Eli Lilly and Company; Research funded, Eli Lilly and Company; Speaker, Bayer AG; Advisory Board, Bayer AG; Travel support, Bayer AG; Speaker, Cue Biopharma, Inc; Advisory Board, Cue Biopharma, Inc; Advisory Board, Rakuten Group, Inc; Research funded, Orogenics, Inc; Institutional research support, Pfizer Inc

##### M1-CRO02D Head & Neck Case Based Multidisciplinary Review

Chad Zender, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M1-CRO02B

### **Head & Neck Case Based Multidisciplinary Review**

Monday, Nov. 27 8:00AM - 9:00AM Room: S402

Sung Kim, MD (*Presenter*) Consultant, Nanobiotix

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CRO02C

### Head & Neck Case Based Multidisciplinary Review

Monday, Nov. 27 8:00AM - 9:00AM Room: S402

Francis P. Worden, MD (*Presenter*) Speaker, Merck & Co, Inc;Advisory Board, Merck & Co, Inc;Institutional research support, Merck & Co, Inc;Travel support, Merck & Co, Inc;Speaker, Eisai Co, Ltd;Advisory Board, Eisai Co, Ltd;Institutional research support, Eisai Co, Ltd;Speaker, Bristol-Myers Squibb Company;Advisory Board, Bristol-Myers Squibb Company;Research funded, Bristol-Myers Squibb Company;Speaker, Eli Lilly and Company;Advisory Board, Eli Lilly and Company;Research funded, Eli Lilly and Company;Speaker, Bayer AG;Advisory Board, Bayer AG;Travel support, Bayer AG;Speaker, Cue Biopharma, Inc;Advisory Board, Cue Biopharma, Inc;Advisory Board, Rakuten Group, Inc;Research funded, Oragenics, Inc;Institutional research support, Pfizer Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CRO02D

### Head & Neck Case Based Multidisciplinary Review

Monday, Nov. 27 8:00AM - 9:00AM Room: S402

Chad Zender, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CVA06

### Vascular Imaging After Surgery and Intervention: Expected Findings and Complications

Monday, Nov. 27 8:00AM - 9:00AM Room: N226

Anushri Parakh, MBBS, MD (*Moderator*) Nothing to Disclose  
Demetrios A. Raptis, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Recognize the postoperative imaging appearance of aortic graft and stent repairs and their complications. 2) Understand the key imaging findings of complications of aortic graft repairs and how they alter management. 3) Understand the imaging of extracorporeal membrane oxygenation.

#### COURSE DESCRIPTION

The course will review the key imaging findings of aortic stent and graft repairs in the chest, abdomen, and pelvis. Emphasis will be placed on recognition of post-surgical complications and how they alter management. The imaging of extracorporeal membrane oxygenation will be

#### Sub-Events

#### **M1-CVA06C Imaging After Graft Repairs (Ascending, Descending, and Thoracoabdominal): Expected Post-Surgical findings and Complications**

Christopher Mehta (*Presenter*) Nothing to Disclose

#### **M1-CVA06D Imaging After Graft Repairs: Key Considerations for the Radiologist**

Carlos S. Restrepo, MD (*Presenter*) Nothing to Disclose

#### **M1-CVA06E Imaging After Endovascular Stent Grafts**

Gilles P. Soulez, MD, MSc (*Presenter*) Speaker, Siemens AG; Research Grant, Siemens AG; Research Grant, Cook Group Incorporated; Advisory Board, Cook Group Incorporated; Patent agreement, Cook Group Incorporated; Research Grant, ViTAA Medical Solutions Inc; Advisory Board, ViTAA Medical Solutions Inc

#### **M1-CVA06F Imaging in Extracorporeal Membrane Oxygenation**

Jody Shen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CVA06C

### **Imaging After Graft Repairs (Ascending, Descending, and Thoracoabdominal): Expected Post-Surgical findings and Complications**

Monday, Nov. 27 8:00AM - 9:00AM Room: N226

Christopher Mehta (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CVA06D

### **Imaging After Graft Repairs: Key Considerations for the Radiologist**

Monday, Nov. 27 8:00AM - 9:00AM Room: N226

Carlos S. Restrepo, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-CVA06E

### Imaging After Endovascular Stent Grafts

Monday, Nov. 27 8:00AM - 9:00AM Room: N226

Gilles P. Soulez, MD, MSc (*Presenter*) Speaker, Siemens AG;Research Grant, Siemens AG;Research Grant, Cook Group Incorporated;Advisory Board, Cook Group Incorporated;Patent agreement, Cook Group Incorporated;Research Grant, ViTAA Medical Solutions Inc;Advisory Board, ViTAA Medical Solutions Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-CVA06F

### **Imaging in Extracorporeal Membrane Oxygenation**

Monday, Nov. 27 8:00AM - 9:00AM Room: N226

Jody Shen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-RCP12

### **Engaging the Mid-Career Radiologist: Challenges, Retention, and Opportunities (Sponsored by the RSNA Professionalism Committee)**

Monday, Nov. 27 8:00AM - 9:00AM Room: S501

Kate Hanneman, MD, MPH (*Moderator*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

#### **LEARNING OBJECTIVES**

1) Identify challenges facing the mid-career radiologist. 2) Discuss opportunities and strategies for retention and engagement of mid-career radiologists including both academic and private practice perspectives. 3) Evaluate faculty development programming for the mid-career radiologist.

#### **COURSE DESCRIPTION**

This session will focus on challenges facing the mid-career radiologist, and opportunities and strategies for retention and engagement including both academic and private practice perspectives.

#### **Sub-Events**

##### **M1-RCP12B Challenges and Strategies for the Mid-career Radiologist in Academic Practice**

Tara M. Catanzano, MD (*Presenter*) Nothing to Disclose

##### **M1-RCP12C Challenges and Strategies for the Mid-career Radiologist in Private Practice**

Brent J. Wagner, MD, MBA (*Presenter*) Executive Director, American Board of Radiology

##### **M1-RCP12D Retention of Radiologists: How to Build Loyalty, Support and Fulfill at Work, and Create Leadership Opportunities**

Brandon P. Brown, MD, MA (*Presenter*) Nothing to Disclose

##### **M1-RCP12E Faculty Development Programming for the Mid-career Radiologist**

Cheri L. Canon, MD (*Presenter*) Royalties, The McGraw-Hill Companies Member of ABR Board of Governors (volunteer appointment)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-RCP12B

### Challenges and Strategies for the Mid-career Radiologist in Academic Practice

Monday, Nov. 27 8:00AM - 9:00AM Room: S501

Tara M. Catanzano, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-RCP12C

### Challenges and Strategies for the Mid-career Radiologist in Private Practice

Monday, Nov. 27 8:00AM - 9:00AM Room: S501

Brent J. Wagner, MD, MBA (*Presenter*) Executive Director, American Board of Radiology

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-RCP12D

### **Retention of Radiologists: How to Build Loyalty, Support and Fulfill at Work, and Create Leadership Opportunities**

Monday, Nov. 27 8:00AM - 9:00AM Room: S501

Brandon P. Brown, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-RCP12E

### Faculty Development Programming for the Mid-career Radiologist

Monday, Nov. 27 8:00AM - 9:00AM Room: S501

Cheri L. Canon, MD (*Presenter*) Royalties, The McGraw-Hill Companies Member of ABR Board of Governors (volunteer appointment)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Margarita V. Revzin, MD, MS (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify essential scanning techniques in ultrasound evaluation of the carotid system and abdominal vasculature that ensure accurate assessment and diagnosis. 2) Explain changes in the arterial waveforms encountered in various pathological processes affecting the carotid system and abdominal vasculature. 3) Describe most accepted diagnostic criteria for significant diseases in the carotid and abdominal vascular systems.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This is a hands-on course which will provide a brief didactic review followed by detailed hands-on instructions of basic scanning techniques utilized in the evaluation of the carotid system and abdominal vasculature, including, aorta, IVC, hepatic, mesenteric, and renal systems. Main accepted sonographic criteria for significant diseases of the aorta and its branches and the carotid system will be described. Tips and tricks in scanning will also be provided.

#### **Sub-Events**

### **M2-CMS09B Key Imaging Technique in Evaluation of the Abdominal Vasculature including Aorta and its Main Branches and the IVC**

Nirvikar Dahiya, MD (*Presenter*) Nothing to Disclose

### **M2-CMS09C Key Imaging Technique in Evaluation of the Carotid System**

Corinne Deurdulian, MD (*Presenter*) Nothing to Disclose

### **M2-CMS09D RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Sheila Sheth, MD (*Presenter*) Speakers Bureau , Koninklijke Philips NV

### **M2-CMS09E RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Vikram S. Dogra, MD (*Presenter*) Nothing to Disclose

### **M2-CMS09F RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

### **M2-CMS09G RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Gayatri Joshi, MD (*Presenter*) Royalties from Elsevier.

### **M2-CMS09H RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**



Michelle L. Robbin, MD, MS (*Presenter*) Research Grant, Koninklijke Philips NV

**M2-CMS09I RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Deborah J. Rubens, MD (*Presenter*) Nothing to Disclose

**M2-CMS09J RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Mary C. Frates, MD (*Presenter*) Nothing to Disclose

**M2-CMS09KRSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

John S. Pellerito, MD (*Presenter*) Nothing to Disclose

**M2-CMS09L RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Jade J. Wong-You-Cheong, MD (*Presenter*) Author, Reed Elsevier

**M2-CMS09M RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Lori Mankowski Gettle, MD, MBA (*Presenter*) Stockholder, Elucent Medical; Research support, General Electric Company; Research support, HistoSonics, Inc; Royalties, RELX

**M2-CMS09NRSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Wui K. Chong, MBBS (*Presenter*) Research Consultant, Koios Medical, Inc

**M2-CMS09ORSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Mark E. Lockhart, MD, MPH (*Presenter*) Author, Jaypee Brothers Medical Publishers Ltd; Author, Reed Elsevier; Employee, Journal of Ultrasound in Medicine;

**M2-CMS09PRSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Leslie M. Scutt, MD (*Presenter*) Speaker, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09B

### **Key Imaging Technique in Evaluation of the Abdominal Vasculature including Aorta and its Main Branches and the IVC**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Nirvikar Dahiya, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M2-CMS09C

### **Key Imaging Technique in Evaluation of the Carotid System**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Corinne Deurdulian, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09D

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Sheila Sheth, MD (*Presenter*) Speakers Bureau , Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09E

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Vikram S. Dogra, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09F

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09G

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Gayatri Joshi, MD (*Presenter*) Royalties from Elsevier.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09H

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Michelle L. Robbin, MD, MS (*Presenter*) Research Grant, Koninklijke Philips NV

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-CMS09I

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Deborah J. Rubens, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09J

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Mary C. Frates, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09K

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

John S. Pellerito, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09L

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Jade J. Wong-You-Cheong, MD (*Presenter*) Author, Reed Elsevier

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09M

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Lori Mankowski Gettle, MD, MBA (*Presenter*) Stockholder, Elucent Medical; Research support, General Electric Company; Research support, HistoSonics, Inc; Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09N

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Wui K. Chong, MBBS (*Presenter*) Research Consultant, Koios Medical, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS090

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Mark E. Lockhart, MD, MPH (*Presenter*) Author, Jaypee Brothers Medical Publishers Ltd; Author, Reed Elsevier; Employee, Journal of Ultrasound in Medicine;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-CMS09P

### **RSNA Hands-On Lab: Ultrasound Doppler Hands-On Course of the Carotid System and Abdominal Vasculature**

Monday, Nov. 27 9:00AM - 10:30AM Room: S504CD

Leslie M. Scutt, MD (*Presenter*) Speaker, Koninklijke Philips NV

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-CAS03

**Creating Experiential Designs that Add Value and Improve Performance (Sponsored by the RSNA Associated Sciences Consortium) (Supported in part by an Unrestricted Medical Education Grant from GE Healthcare, Inc.)**

Monday, Nov. 27 9:30AM - 10:30AM Room: N230B

Morris A. Stein, BArch (*Moderator*) Nothing to Disclose  
Catherine Gunn, MBA, RT (*Moderator*) Nothing to Disclose  
Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Create design expectations and measure outcomes. 2) Learn from prototyping solutions. 3) Deliver new models of spatial and functional organization.

### COURSE DESCRIPTION

It is not just about designing rooms or departments, or detailing technology, but designing experiences that impact our patients, staff, and families. Seize the opportunity to learn from current disruptive forces and cast a design vision for the future. Now more than ever, design solutions are process oriented and data driven, beyond product or technology installed.

### Sub-Events

#### **M3-CAS03D Creating Experiential Designs that Add Value and Improve Performance**

Morris A. Stein, BArch (*Presenter*) Nothing to Disclose

#### **M3-CAS03E Creating Experiential Designs that Add Value and Improve Performance**

Carlos L. Amato, MArch (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CAS03D

### **Creating Experiential Designs that Add Value and Improve Performance**

Monday, Nov. 27 9:30AM - 10:30AM Room: N230B

Morris A. Stein, BArch (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CAS03E

### Creating Experiential Designs that Add Value and Improve Performance

Monday, Nov. 27 9:30AM - 10:30AM Room: N230B

Carlos L. Amato, MArch (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CBR04

### Multi-modality Challenging Breast Cases

Monday, Nov. 27 9:30AM - 10:30AM Room: S406A

Bonnie N. Joe, MD, PhD (*Moderator*) Institutional Research Grant, Kheiron Medical Technologies Ltd; Institutional research agreement, General Electric Company; Institutional research agreement, Siemens AG

#### LEARNING OBJECTIVES

1) Recognize challenging cases that occur in screening to avoid delayed diagnosis of breast cancer. 2) Learn strategies for incorporating multi-modality breast imaging in the diagnostic setting. 3) Apply a skillful approach to radiologic-pathologic correlation in breast imaging.

#### COURSE DESCRIPTION

This course will use an interactive case-based review format presented by an international group of breast imaging experts and will be followed by a live question and answer session.

#### Sub-Events

##### M3-CBR04B Multi-Modality Challenging Cases in Diagnostics

Bonnie N. Joe, MD, PhD (*Presenter*) Institutional Research Grant, Kheiron Medical Technologies Ltd; Institutional research agreement, General Electric Company; Institutional research agreement, Siemens AG

##### M3-CBR04C Multi-Modality Challenging Cases in Screening

Jean M. Seely, MD, FRCPC (*Presenter*) Nothing to Disclose

##### M3-CBR04D Multi-Modality Challenging Cases and Rad-path Correlation

Fleur Kilburn-Toppin, MBBChir, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CBR04B

### Multi-Modality Challenging Cases in Diagnostics

Monday, Nov. 27 9:30AM - 10:30AM Room: S406A

Bonnie N. Joe, MD, PhD (*Presenter*) Institutional Research Grant, Kheiron Medical Technologies Ltd; Institutional research agreement, General Electric Company; Institutional research agreement, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CBR04C

### Multi-Modality Challenging Cases in Screening

Monday, Nov. 27 9:30AM - 10:30AM Room: S406A

Jean M. Seely, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CBR04D

### **Multi-Modality Challenging Cases and Rad-path Correlation**

Monday, Nov. 27 9:30AM - 10:30AM Room: S406A

Fleur Kilburn-Toppin, MBBChir, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CCA12

### **Cardiac CT Mentored Case Review: Coronary Atherosclerotic Disease - From Straightforward to Most Complicated**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450B

Carole A. Ridge, FFR(RCSI) (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Learn about the diagnostic methods which detect coronary calcifications, their clinical implications and management strategies. 2) Develop an understanding of atherosclerotic plaque analysis techniques. 3) Understand the components and categories of the CAD-RAD system and how apply it in clinical practice. 4) Become familiar with the key concepts and application of CT fractional flow reserve and myocardial perfusion.

#### **COURSE DESCRIPTION**

This course is a comprehensive synopsis of the complexities of quantitative and qualitative assessment of coronary artery disease, beyond liminal narrowing.

#### **Sub-Events**

##### **M3-CCA12B All You Need to Know About Cardiac Calcifications**

Rozemarijn Vliegenthart, MD, PhD (*Presenter*) Institutional Research Grant, Siemens Healthineers Speaker's Bureau, Siemens Healthineers Speaker's Bureau, Bayer

##### **M3-CCA12C Coronary Atherosclerosis I: Approach to Atherosclerotic Plaque Analysis and Severity of Stenosis Assessment**

Brian B. Ghoshhajra, MD, MBA (*Presenter*) Research Grant, Siemens AG;Consultant, Koninklijke Philips NV;Consultant, Siemens AG

##### **M3-CCA12D Coronary Atherosclerosis II: CAD-RAD System**

Prachi P. Agarwal, MD (*Presenter*) Nothing to Disclose

##### **M3-CCA12E Coronary Atherosclerosis III: How do I Assess the Severity of CAD Role of CT FFR and CT MP**

U. Joseph Schoepf, MD, PhD (*Presenter*) Research Grant, Bayer AG;Research Grant, Bracco Group;Research Grant, Elucid BioImaging Inc;Consultant, Elucid BioImaging Inc;Research Grant: General Electric Company;Research Grant, Guerbet SA;Research Grant, Heartflow, Inc;Speakers Bureau, Heartflow Inc

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## Abstract Archives of the RSNA, 2023

M3-CCA12B

### All You Need to Know About Cardiac Calcifications

Monday, Nov. 27 9:30AM - 10:30AM Room: E450B

Rozemarijn Vliegenthart, MD, PhD (*Presenter*) Institutional Research Grant, Siemens Healthineers Speaker's Bureau, Siemens Healthineers Speaker's Bureau, Bayer

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CCA12C

### **Coronary Atherosclerosis I: Approach to Atherosclerotic Plaque Analysis and Severity of Stenosis Assessment**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450B

Brian B. Ghoshhajra, MD, MBA (*Presenter*) Research Grant, Siemens AG; Consultant, Koninklijke Philips NV; Consultant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CCA12D

### **Coronary Atherosclerosis II: CAD-RAD System**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450B

Prachi P. Agarwal, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CCA12E

### **Coronary Atherosclerosis III: How do I Assess the Severity of CAD Role of CT FFR and CT MP**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450B

U. Joseph Schoepf, MD, PhD (*Presenter*) Research Grant, Bayer AG;Research Grant, Bracco Group;Research Grant, Elucid BioImaging Inc;Consultant, Elucid BioImaging Inc;Research Grant: General Electric Company;Research Grant, Guerbet SA;Research Grant, Heartflow, Inc;Speakers Bureau, Heartflow Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CER06

### GI causes of Acute Abdominal Pain: Case-Based Approach

Monday, Nov. 27 9:30AM - 10:30AM Room: E451B

Robin B. Levenson, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review GI causes of acute abdominal pain that may be seen on imaging in the acute setting. 2) Identify key imaging findings seen in acute GI related conditions causing acute abdominal pain, including tricky bowel obstruction, hepatobiliary-related, and lower abdominal pain related cases. 3) Discuss potential diagnostic pitfalls.

#### COURSE DESCRIPTION

Patients presenting with acute abdominal pain can represent a diagnostic challenge. The differential diagnosis may be vast, ranging from minor to life-threatening conditions, and the clinical symptoms may be nonspecific. Radiologist familiarity with the potential range of imaging findings for cases of acute abdominal pain is important for optimal imaging diagnosis. In this case-based session, cases of acute GI-related conditions will be presented with discussion of pertinent imaging features. This includes cases of hepatobiliary conditions, tricky bowel obstruction, GI causes of lower abdominal pain.

#### Sub-Events

##### M3-CER06B Lower Abdominal Pain

Robin B. Levenson, MD (*Presenter*) Nothing to Disclose

##### M3-CER06C Hepato-Pancreato-Biliary Emergencies

Meghan G. Lubner, MD (*Presenter*) Spouse, Consultant, Elephas Bio

##### M3-CER06D Tricky Bowel Obstruction Cases and Internal Hernia

Carl C. Flink, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CER06B

### Lower Abdominal Pain

Monday, Nov. 27 9:30AM - 10:30AM Room: E451B

Robin B. Levenson, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CER06C

### **Hepato-Pancreato-Biliary Emergencies**

Monday, Nov. 27 9:30AM - 10:30AM Room: E451B

Meghan G. Lubner, MD (*Presenter*) Spouse, Consultant, Elephas Bio

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M3-CER06D

### **Tricky Bowel Obstruction Cases and Internal Hernia**

Monday, Nov. 27 9:30AM - 10:30AM Room: E451B

Carl C. Flink, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-CGU08

### Imaging Ovarian Cancer: Radiologists as Partners in Cancer Care

Monday, Nov. 27 9:30AM - 10:30AM Room: N228

Evis Sala, MD, PhD (*Moderator*) Co-founder, Lucida Medical Ltd

#### LEARNING OBJECTIVES

1) Learn the current treatment paradigms available to patients with ovarian cancer. 2) Review the role of multi-modality imaging in treatment selection and planning of patients with ovarian cancer. 3) Highlight the potential added value of radiogenomics and AI in prediction of treatment response and outcome in patients with ovarian cancer.

#### COURSE DESCRIPTION

This course will provide a comprehensive review of the current and state of the art treatments for patients with ovarian cancer. It will review the role of multimodality imaging in treatment selection and planning focusing on the added value of various imaging modalities for detection of peritoneal implants that change management. It will also provide a glimpse into the future of personalized care by highlighting the role of artificial intelligence and radiogenomics in improving prediction of response to neoadjuvant chemotherapy and early detection of treatment resistance which determines patient outcome.

#### Sub-Events

##### **M3-CGU08B Ovarian Cancer: Current Treatment Paradigms**

Annie Leung, MD (*Presenter*) Nothing to Disclose

##### **M3-CGU08C Ovarian Cancer Staging: Pretreatment Imaging Evaluation (CT, MRI, PET)**

Yuliya Lakhman, MD (*Presenter*) Stockholder, Y-mAbs Therapeutics Inc; Consultant, Perceptive Informatics, LLC

##### **M3-CGU08D Ovarian Cancer Implants: The Tip of the Iceberg - A Case based Discussion**

Stephanie Nougaret, MD, PhD (*Presenter*) Nothing to Disclose

##### **M3-CGU08E Ovarian Cancer: A Glimpse into the Future of Personalized Care**

Evis Sala, MD, PhD (*Presenter*) Co-founder, Lucida Medical Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CGU08B

### **Ovarian Cancer: Current Treatment Paradigms**

Monday, Nov. 27 9:30AM - 10:30AM Room: N228

Annie Leung, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M3-CGU08C

### **Ovarian Cancer Staging: Pretreatment Imaging Evaluation (CT, MRI, PET)**

Monday, Nov. 27 9:30AM - 10:30AM Room: N228

Yuliya Lakhman, MD (*Presenter*) Stockholder, Y-mAbs Therapeutics Inc; Consultant, Perceptive Informatics, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CGU08D

### **Ovarian Cancer Implants: The Tip of the Iceberg - A Case based Discussion**

Monday, Nov. 27 9:30AM - 10:30AM Room: N228

Stephanie Nougaret, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CGU08E

### **Ovarian Cancer: A Glimpse into the Future of Personalized Care**

Monday, Nov. 27 9:30AM - 10:30AM Room: N228

Evis Sala, MD, PhD (*Presenter*) Co-founder, Lucida Medical Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CHN05

### Imaging of Endocrine Disease in the Head and Neck

Monday, Nov. 27 9:30AM - 10:30AM Room: S401

Francis Deng, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Implement a standardized risk-stratification system for reporting thyroid nodules on ultrasound. 2) Describe the typical and atypical imaging characteristics of thyroid cancer, parathyroid adenomas, and paragangliomas in the head and neck. 3) Identify clinically consequential findings during the imaging workup of thyroid nodules, thyroid cancer, hyperparathyroidism, and paragangliomas in the head and neck.

#### COURSE DESCRIPTION

This session offers an exploration of head and neck endocrine imaging, blending lectures with case studies and audience response. Topics include risk stratification of thyroid nodules using ACR TI-RADS and K-TIRADS, imaging approaches for thyroid cancer, parathyroid adenoma preoperative localization, and head and neck paragangliomas. Typical and atypical imaging examples will be shared, emphasizing differentiation from common mimics, interpretation pitfalls, and clinical management considerations with which radiologists should be familiar. Get ready to hone your interpretation skills to razor sharpness under the guidance of world experts!

#### Sub-Events

##### M3-CHN05B Workup of Thyroid Nodules: TI-RADS and K-TIRADS

Ji-Hoon Kim, MD, PhD (*Presenter*) Nothing to Disclose

##### M3-CHN05C Thyroid Cancer Imaging

Maria K. Gule-Monroe, MD (*Presenter*) Nothing to Disclose

##### M3-CHN05D Imaging for Difficult Parathyroid Cases

Hillary R. Kelly, MD (*Presenter*) Investigator, Bayer AG; Institutional research agreement, Bayer AG

##### M3-CHN05E Paragangliomas in the Head and Neck

David Zander, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CHN05B

### **Workup of Thyroid Nodules: TI-RADS and K-TIRADS**

Monday, Nov. 27 9:30AM - 10:30AM Room: S401

Ji-Hoon Kim, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CHN05C

### Thyroid Cancer Imaging

Monday, Nov. 27 9:30AM - 10:30AM Room: S401

Maria K. Gule-Monroe, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-CHN05D

### **Imaging for Difficult Parathyroid Cases**

Monday, Nov. 27 9:30AM - 10:30AM Room: S401

Hillary R. Kelly, MD (*Presenter*) Investigator, Bayer AG; Institutional research agreement, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CHN05E

### **Paragangliomas in the Head and Neck**

Monday, Nov. 27 9:30AM - 10:30AM Room: S401

David Zander, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIN26

### Understanding the Foundations: An Introduction to Large Language Models

Monday, Nov. 27 9:30AM - 10:30AM Room: S402

Tara A. Retson, MD, PhD (*Moderator*) Research Consultant, CureMetrix, Inc; Stock options, CureMetrix, Inc

#### LEARNING OBJECTIVES

1) Learn what makes an LLM different than traditional AI for radiology. 2) Learn about prompts and how to ask the best questions. 3) Learn how LLMs can go astray. 4) Learn about biases that may be present in LLMs.

#### Sub-Events

### M3-CIN26B Demystifying LLMs: An Introduction to the Science Behind the Magic of Large Language Models

Tara A. Retson, MD, PhD (*Presenter*) Research Consultant, CureMetrix, Inc; Stock options, CureMetrix, Inc

### M3-CIN26C The State-of-the-art Visual Linguistic Transformer-based Models for Radiology Application

Man Luo, PhD, BS (*Presenter*) Nothing to Disclose

### M3-CIN26D Evolving with AI - An Introduction to Prompt Generation

Ali S. Tejani, MD (*Presenter*) Nothing to Disclose

### M3-CIN26E The Double-edged Sword: Potentials and Pitfalls of LLMs in Radiology

Woojin Kim, MD (*Presenter*) Co-founder, Equium Intelligence, Inc; Shareholder, Equium Intelligence, Inc; Stockholder, Nuance Communications, Inc; Consultant, Nuance Communications, Inc; Stockholder, Hyperfine Research, Inc; Consultant, Hyperfine Research, Inc; Stockholder, Nanox Imaging LTD; Advisory Board, Braid Health, Inc; Advisory Board, ImageBiopsy Lab; Advisory Board, Inference Analytics; Advisory Board, Infiniti Medical, LLC; Advisory Board, Luxsonic Technologies Inc; Advisory Board, Rad AI; Advisory Board, Xcel Capital Pty Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIN26B

### **Demystifying LLMs: An Introduction to the Science Behind the Magic of Large Language Models**

Monday, Nov. 27 9:30AM - 10:30AM Room: S402

Tara A. Retson, MD, PhD (*Presenter*) Research Consultant, CureMetrix, IncStock options, CureMetrix, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIN26C

### **The State-of-the-art Visual Linguistic Transformer-based Models for Radiology Application**

Monday, Nov. 27 9:30AM - 10:30AM Room: S402

Man Luo, PhD, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIN26D

### **Evolving with AI - An Introduction to Prompt Generation**

Monday, Nov. 27 9:30AM - 10:30AM Room: S402

Ali S. Tejani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIN26E

### **The Double-edged Sword: Potentials and Pitfalls of LLMs in Radiology**

Monday, Nov. 27 9:30AM - 10:30AM Room: S402

Woojin Kim, MD (*Presenter*) Co-founder, Equium Intelligence, Inc; Shareholder, Equium Intelligence, Inc; Stockholder, Nuance Communications, Inc; Consultant, Nuance Communications, Inc; Stockholder, Hyperfine Research, Inc; Consultant, Hyperfine Research, Inc; Stockholder, Nanox Imaging LTD; Advisory Board, Braid Health, Inc; Advisory Board, ImageBiopsy Lab; Advisory Board, Inference Analytics; Advisory Board, Infiniti Medical, LLC; Advisory Board, Luxsonic Technologies Inc; Advisory Board, Rad AI; Advisory Board, Xcel Capital Pty Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIR09

### Managing Complications in IR

Monday, Nov. 27 9:30AM - 10:30AM Room: N229

Robert A. Morgan, MBChB, FRCR (*Moderator*) Proctor, Medtronic plc

#### LEARNING OBJECTIVES

1) Key imaging findings of complications of interventional radiology procedures. 2) How to decide which complications of interventional radiology procedures require treatment and which complications can be managed conservatively. 3) How to treat complications of interventional radiology procedures.

#### COURSE DESCRIPTION

The aim of this course is to describe the key complications of the wide range interventional radiology procedures including vascular, non-vascular and ablation procedures. Important imaging findings will be discussed and methods will be described regarding how to manage complications. Many complications will be presented and discussed in a case-based format and discussion after each lecture will be encouraged.

#### Sub-Events

##### **M3-CIR09B Complications of Biopsy and Drainage Procedures**

Robert A. Morgan, MBChB, FRCR (*Presenter*) Proctor, Medtronic plc

##### **M3-CIR09C Arterial Complications**

Uei Pua, MBBS, FRCR (*Presenter*) Nothing to Disclose

##### **M3-CIR09D Complications of Vascular Access and Dialysis Maintenance Procedures**

Robert L. Vogelzang, MD (*Presenter*) Nothing to Disclose

##### **M3-CIR09E Venous Interventions Gone Wrong**

Maha M. Jarmakani, DO, BS (*Presenter*) Nothing to Disclose

##### **M3-CIR09F Complications of Interventional Oncology Procedures**

William S. Rilling, MD (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Agilent Technologies, Inc; Consultant, Terumo Corporation; Consultant, Becton, Dickinson and Company; Consultant, Sirtex Medical Ltd; Consultant, AstraZeneca PLC

##### **M3-CIR09G Complications of Interventions for Pulmonary Thromboembolism**

Venkat Tummala, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

M3-CIR09B

### **Complications of Biopsy and Drainage Procedures**

Monday, Nov. 27 9:30AM - 10:30AM Room: N229

Robert A. Morgan, MBChB, FRCR (*Presenter*) Proctor, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIR09C

### Arterial Complications

Monday, Nov. 27 9:30AM - 10:30AM Room: N229

Uei Pua, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M3-CIR09D

### **Complications of Vascular Access and Dialysis Maintenance Procedures**

Monday, Nov. 27 9:30AM - 10:30AM Room: N229

Robert L. Vogelzang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIR09E

### **Venous Interventions Gone Wrong**

Monday, Nov. 27 9:30AM - 10:30AM Room: N229

Maha M. Jarmakani, DO, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIR09F

### Complications of Interventional Oncology Procedures

Monday, Nov. 27 9:30AM - 10:30AM Room: N229

William S. Rilling, MD (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Agilent Technologies, Inc; Consultant, Terumo Corporation; Consultant, Becton, Dickinson and Company; Consultant, Sirtex Medical Ltd; Consultant, AstraZeneca PLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CIR09G

### **Complications of Interventions for Pulmonary Thromboembolism**

Monday, Nov. 27 9:30AM - 10:30AM Room: N229

Venkat Tummala, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CMK04

### Imaging Differentials of Hip and Groin Pain

Monday, Nov. 27 9:30AM - 10:30AM Room: E450A

Christopher F. Beaulieu, MD, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Improve understanding of pre- and postoperative imaging for femoroacetabular impingement. 2) Learn to recognize clinically important tendon derangements about the hip and groin. 3) Assess the value of advanced imaging methods in acute hip trauma.

#### COURSE DESCRIPTION

This five part lecture course focuses on common, clinically important disorders associated with hip and groin pain. Attendees will hear from experts on key issues in assessment of femoroacetabular impingement, including how to assess the painful postoperative hip. Acute hip trauma will be highlighted including how to assess for bone marrow changes on CT as well as MRI in fracture diagnosis. Tendon disorders about the hip and pubis will also be covered, with an aim to understand which abnormalities are more likely to be clinically relevant.

#### Sub-Events

##### **M3-CMK04B Core Muscle Injuries - Pubalgia and "Sports Hernia"**

Christopher F. Beaulieu, MD, PhD (*Presenter*) Nothing to Disclose

##### **M3-CMK04C Femoroacetabular Impingement - Imaging Workup**

Daniel E. Wessell, MD, PhD (*Presenter*) Nothing to Disclose

##### **M3-CMK04D Acute Hip Trauma - Fracture Detection and Characterization**

Pamela J. Walsh, MD (*Presenter*) Nothing to Disclose

##### **M3-CMK04E Clinically Important Tendinopathies about the Hip**

Angela Atinga, MBBChir, FRCPC (*Presenter*) Nothing to Disclose

##### **M3-CMK04F Painful Hip after FAI Surgery - Now What?**

Christian W. Pfirrmann, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M3-CMK04B

### **Core Muscle Injuries - Pubalgia and "Sports Hernia"**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450A

Christopher F. Beaulieu, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-CMK04C

### **Femoroacetabular Impingement - Imaging Workup**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450A

Daniel E. Wessell, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M3-CMK04D

### **Acute Hip Trauma - Fracture Detection and Characterization**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450A

Pamela J. Walsh, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M3-CMK04E

### **Clinically Important Tendinopathies about the Hip**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450A

Angela Atinga, MBBChir, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CMK04F

### **Painful Hip after FAI Surgery - Now What?**

Monday, Nov. 27 9:30AM - 10:30AM Room: E450A

Christian W. Pfirrmann, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CNMMI03

### Musculoskeletal Imaging: When Molecular Imaging Helps

Monday, Nov. 27 9:30AM - 10:30AM Room: S406B

Kevin P. Banks, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To review cases with musculoskeletal pathology and correlative imaging. 2) To discuss where/ when to use molecular imaging with an emphasis on malignancy, trauma, and infection. 3) To illustrate incidental findings and review what to do with them.

#### COURSE DESCRIPTION

This course will provide a review of when molecular imaging (including PET/CT and SPECT/CT) is most helpful in the evaluation of musculoskeletal pathology.

#### Sub-Events

##### **M3- CNMMI03B** Musculoskeletal PET: The Good, the Bad, and the Indeterminant

Gary A. Ulaner, MD, PhD (*Presenter*) Speaker, Siemens AG; Speaker, Lantheus Holdings; Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd; Research support, Lantheus Holdings; Research support, Novartis AG

##### **M3- CNMMI03C** PET/CT Imaging in Musculoskeletal Pathology

Olga G. James, MD (*Presenter*) Nothing to Disclose

##### **M3- CNMMI03D** SPECT-CT for the Assessment of Hardware Complications

Kevin P. Banks, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CNMMI03B

### **Musculoskeletal PET: The Good, the Bad, and the Indeterminant**

Monday, Nov. 27 9:30AM - 10:30AM Room: S406B

Gary A. Ulaner, MD,PhD (*Presenter*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CNMMI03C

### **PET/CT Imaging in Musculoskeletal Pathology**

Monday, Nov. 27 9:30AM - 10:30AM Room: S406B

Olga G. James, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M3-CNMMI03D

### **SPECT-CT for the Assessment of Hardware Complications**

Monday, Nov. 27 9:30AM - 10:30AM Room: S406B

Kevin P. Banks, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-CPD01

### **Pediatric Neuroradiology: Difficult Concepts Simplified for all Practices**

Monday, Nov. 27 9:30AM - 10:30AM Room: E451A

Tina Y. Poussaint, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Acquire knowledge of the etiologies and risk factors associated with stroke in children and understand how imaging can aid in their diagnosis and management. 2) Interpret neuroimaging findings and genetic profiles to establish a comprehensive understanding of congenital brain malformations. 3) Recognize the role of neuroimaging and molecular profiling in the diagnosis and management of pediatric brain tumors.

#### **COURSE DESCRIPTION**

This is an educational session designed to provide in-depth knowledge and practical insights into three critical areas of pediatric neuroradiology: neuroimaging of pediatric stroke, neuroimaging of brain tumors, and neuroimaging of congenital brain malformations. Through lecture format and detailed discussion, participants will gain the necessary tools to accurately diagnose these entities on imaging ultimately improving patient care and outcomes.

#### **Sub-Events**

##### **M3-CPD01B Stroke Imaging in Children: Smart Techniques and Practical Diagnoses**

Susan Palasis, MD (*Presenter*) Nothing to Disclose

##### **M3-CPD01C Neuroimaging and Genetic Profiles of Congenital Brain Malformations: Putting the Pieces Together**

Winnie C. Chu, MD, FRCR (*Presenter*) Nothing to Disclose

##### **M3-CPD01D Pediatric Brain Tumors in the Child: Updates in Classification and Genetics**

Manohar M. Shroff, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CPD01B

### **Stroke Imaging in Children: Smart Techniques and Practical Diagnoses**

Monday, Nov. 27 9:30AM - 10:30AM Room: E451A

Susan Palasis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CPD01C

### **Neuroimaging and Genetic Profiles of Congenital Brain Malformations: Putting the Pieces Together**

Monday, Nov. 27 9:30AM - 10:30AM Room: E451A

Winnie C. Chu, MD, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-CPDO1D

### **Pediatric Brain Tumors in the Child: Updates in Classification and Genetics**

Monday, Nov. 27 9:30AM - 10:30AM Room: E451A

Manohar M. Shroff, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-RCP18

### **Pearls and Pitfalls of Social Media in Radiology (Sponsored by the RSNA Resident and Fellow Committee)**

Monday, Nov. 27 9:30AM - 10:30AM Room: N226

Yasha Parikh Gupta, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

- 1) To illustrate effective ways to utilize Twitter for radiology education.
- 2) Illustrate why branding is important professionally.
- 3) How to get started with Education on Social Media.

#### **COURSE DESCRIPTION**

This course will help radiologists utilize social media for their own personal branding, education, and networking in addition to understanding how social media can impact their career.

#### **Sub-Events**

##### **M3-RCP18B Pearls and Pitfalls of Using Twitter in Radiology Education Today**

Judith A. Gadde, DO, MBA (*Presenter*) Nothing to Disclose

##### **M3-RCP18C Pearls and Pitfalls of Social Media in Radiology (Sponsored by the RSNA Resident & Fellow Committee)**

Yasha Parikh Gupta, MD (*Presenter*) Nothing to Disclose

##### **M3-RCP18D How to Multipurpose Educational Content across Social Media Platforms**

Puneet Bhargava, MD (*Presenter*) Editor, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-RCP18B

### **Pearls and Pitfalls of Using Twitter in Radiology Education Today**

Monday, Nov. 27 9:30AM - 10:30AM Room: N226

Judith A. Gadde, DO, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-RCP18C

### **Pearls and Pitfalls of Social Media in Radiology (Sponsored by the RSNA Resident & Fellow Committee)**

Monday, Nov. 27 9:30AM - 10:30AM Room: N226

Yasha Parikh Gupta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-RCP18D

### **How to Multipurpose Educational Content across Social Media Platforms**

Monday, Nov. 27 9:30AM - 10:30AM Room: N226

Puneet Bhargava, MD (*Presenter*) Editor, RELX

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M4-CAS02

### **Instability in PE-Backed Radiology Groups (Sponsored by the RSNA Associated Sciences Consortium)**

Monday, Nov. 27 11:00AM - 12:00PM Room: N230B

Jennifer Kroken, MBA (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1. Discuss market instability and where it has led to some high-profile bankruptcies—was this avoidable and is your group at risk? 2) Examine the role of various market pressures contributing to instabilities in this model.

#### **COURSE DESCRIPTION**

No doubt the growing trend in the past decade or so has been for radiologists to run to the “stability” of a private equity-backed group but the breakdown of some of very large groups has begun. Is this the beginning of a trend or just poor luck and market pressures meeting bad timing? We’ll examine the current events and predict your future.

#### **Sub-Events**

### **M4-CAS02B Instability in PE-Backed Radiology Groups (Sponsored by the RSNA Associated Sciences Consortium)**

Kurt A. Schoppe, MD (*Presenter*) Nothing to Disclose

### **M4-CAS02C Instability in PE-Backed Radiology Groups (Sponsored by the RSNA Associated Sciences Consortium)**

William K. Davis Jr, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CAS02B

### **Instability in PE-Backed Radiology Groups (Sponsored by the RSNA Associated Sciences Consortium)**

Monday, Nov. 27 11:00AM - 12:00PM Room: N230B

Kurt A. Schoppe, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CAS02C

### **Instability in PE-Backed Radiology Groups (Sponsored by the RSNA Associated Sciences Consortium)**

Monday, Nov. 27 11:00AM - 12:00PM Room: N230B

William K. Davis Jr, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN02

### **Informatics and Patient Centered Care- Creating the Tools For a Better Radiology Experience (Supported in part by an Unrestricted Medical Education Grant from Siemens Healthineers of Siemens Medical Solutions, USA, Inc.)**

Monday, Nov. 27 11:00AM - 12:00PM Room: N229

Nina S. Vincoff, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Explain the challenges and opportunities to make price transparency tools useful for patients. 2) Describe how informatics tools can minimize missed care opportunities. 3) Understand how to partner with a patient and family advisory council to develop informatics tools that improve patient experience.

#### **COURSE DESCRIPTION**

In this educational session and panel discussion, informatics innovations that improve the patient experience and promote patient and family centered care will be presented. Hot topics including price transparency, follow up recommendations and missed care opportunities, and incorporation of patient feedback into practice operations will be discussed. This session will present practical informatics solutions that can be implemented in a variety of radiology practice settings.

#### **Sub-Events**

##### **M4-CIN02B Partnering with Patients**

Nina S. Vincoff, MD (*Presenter*) Nothing to Disclose

##### **M4-CIN02C Price Transparency**

Gelareh Sadigh, MD (*Presenter*) Nothing to Disclose

##### **M4-CIN02D Reducing Missed Care Opportunities**

Efren J. Flores, MD (*Presenter*) Speaker, WebMD LLC; Speaker, Consulting Medical Associates, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN02B

### Partnering with Patients

Monday, Nov. 27 11:00AM - 12:00PM Room: N229

Nina S. Vincoff, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN02C

### Price Transparency

Monday, Nov. 27 11:00AM - 12:00PM Room: N229

Gelareh Sadigh, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN02D

### **Reducing Missed Care Opportunities**

Monday, Nov. 27 11:00AM - 12:00PM Room: N229

Efren J. Flores, MD (*Presenter*) Speaker, WebMD LLC; Speaker, Consulting Medical Associates, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN13

### Best Practices for Procuring AI Platforms

Monday, Nov. 27 11:00AM - 12:00PM Room: S401

Christopher J. Roth, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand industry's process to translate new technology and research into their product roadmap. 2) Grasp how innovative private practices and university hospitals weigh AI product return on investment and return on health against financial realities today. 3) Learn steps to ensure purchased products meet the expected ROI and ROH.

#### Sub-Events

##### **M4-CIN13B Do You Fund AI Software, Higher Staff Salaries, or Infrastructure?**

Christopher J. Roth, MD (*Presenter*) Nothing to Disclose

##### **M4-CIN13C How Private Practices Should Consider ROI and Governance**

Nina E. Kottler, MD, MS (*Presenter*) Partner, Radiology Partners Stockholder, Radiology Partners (Radiology Partners owns a minority interest in Aidoc medical and an indirect minority interest in Rad AI) Employee, Radiology Partners Consultant, ES3 Consultant, W.L. Gore & Associates, Inc Consultant, Synapsica Healthcare Pvt Ltd

##### **M4-CIN13D Onboarding Clinical AI, From Procurement to Go Live**

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

##### **M4-CIN13E Translating New Technology Into A Product Roadmap Imagers Want**

Matthew P. Lungren, MD (*Presenter*) Advisor, Segmed, Inc; Shareholder, Segmed, Inc; Advisor, Bunkerhill Health; Shareholder, Bunkerhill Health; Employee, Microsoft Corporation

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M4-CIN13B

### **Do You Fund AI Software, Higher Staff Salaries, or Infrastructure?**

Monday, Nov. 27 11:00AM - 12:00PM Room: S401

Christopher J. Roth, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN13C

### How Private Practices Should Consider ROI and Governance

Monday, Nov. 27 11:00AM - 12:00PM Room: S401

Nina E. Kottler, MD, MS (*Presenter*) Partner, Radiology Partners Stockholder, Radiology Partners (Radiology Partners owns a minority interest in Aidoc medical and an indirect minority interest in Rad AI) Employee, Radiology Partners Consultant, ES3 Consultant, W.L. Gore & Associates, Inc Consultant, Synapsica Healthcare Pvt Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN13D

### **Onboarding Clinical AI, From Procurement to Go Live**

Monday, Nov. 27 11:00AM - 12:00PM Room: S401

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CIN13E

### Translating New Technology Into A Product Roadmap imagers Want

Monday, Nov. 27 11:00AM - 12:00PM Room: S401

Matthew P. Lungren, MD (*Presenter*) Advisor, Segmed, Inc; Shareholder, Segmed, Inc; Advisor, Bunkerhill Health; Shareholder, Bunkerhill Health; Employee, Microsoft Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CNPM05

### 21st Century Cures Act Information Blocking Provision: Friend or Foe? - A Debate

Monday, Nov. 27 11:00AM - 12:00PM Room: E351

Jennifer L. Kemp, MD (*Moderator*) Stockholder, Scanslated, Inc

#### LEARNING OBJECTIVES

1) Recognize the potential benefits of patient access to radiology reports, including improved patient education, increased transparency, and the ability to make more informed healthcare decisions. 2) Evaluate the potential harms associated with patient access to reports that patients may not fully understand, including increased patient anxiety, confusion, and potential misinterpretation of medical information. 3) Explore the perspective of referring physicians from a large academic center on patients having immediate access to radiology reports, including potential benefits, concerns, and impact on patient care and the physician-patient relationship.

#### COURSE DESCRIPTION

In this thought-provoking course, we delve into the complex and controversial topic of the Information Blocking Provision within the 21st Century Cures Act. The course features three engaging lectures, each presenting a different perspective on the impact and implications of this provision. Through a lively debate-style format, we aim to explore the benefits, challenges, and potential unintended consequences of this regulatory change.

#### Sub-Events

**M4-  
CNPM05B** **Could we be Doing More Harm than Good?**

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

**M4-  
CNPM05C** **Radiologists Should Embrace this Opportunity to Provide Patient Centered Care**

Jonathan L. Mezrich, MD, JD (*Presenter*) Nothing to Disclose

**M4-  
CNPM05D** **Immediate Release of Results: A CMIO Report from the Front Lines of a 12-Hospital, 800-Clinic Organization**

CT Lin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CNPM05B

### **Could we be Doing More Harm than Good?**

Monday, Nov. 27 11:00AM - 12:00PM Room: E351

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CNPM05C

### **Radiologists Should Embrace this Opportunity to Provide Patient Centered Care**

Monday, Nov. 27 11:00AM - 12:00PM Room: E351

Jonathan L. Mezrich, MD, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-CNPM05D

### **Immediate Release of Results: A CMIO Report from the Front Lines of a 12-Hospital, 800-Clinic Organization**

Monday, Nov. 27 11:00AM - 12:00PM Room: E351

CT Lin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-CAS04

### **Preventing Workplace Violence: Guidance from the FBI Behavioral Analysis Unit (Sponsored by the RSNA Associated Sciences Consortium)**

Monday, Nov. 27 1:30PM - 2:30PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose  
Jennifer Kroken, MBA (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Define workplace violence. 2) Prevention and intervention programs. 3) Response and incident management. 4) Safe separation practices.

#### **COURSE DESCRIPTION**

This session is an in-person only session and will not be live streamed or available for on demand. Presenters: Special Agent Cassie Carnright, FBI Threat Management Coordinator Special Agent Eileen McChrystal, FBI Behavioral Analysis Unit Coordinator Preventing Workplace Violence is a 60-minute Federal Bureau of Investigation (FBI) Behavioral Analysis Unit (BAU) presentation for private-sector and corporate security managers on preventing targeted violence in the workplace. This presentation identifies systems for identifying and reducing risks of workplace violence. It introduces the concept of threat assessment threat management (TATM) and how to apply TATM principles to threat assessment investigations within your organization.

#### **Sub-Events**

##### **M6-CAS04C Preventing Workplace Violence**

Eileen McChrystal (*Presenter*) Nothing to Disclose

##### **M6-CAS04D Preventing Workplace Violence**

Cassie Carnright (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CAS04C

### **Preventing Workplace Violence**

Monday, Nov. 27 1:30PM - 2:30PM Room: N230B

Eileen McChrystal (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CAS04D

### **Preventing Workplace Violence**

Monday, Nov. 27 1:30PM - 2:30PM Room: N230B

Cassie Carnright (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CBR05

### **BIRADS 6th Edition Update**

Monday, Nov. 27 1:30PM - 2:30PM Room: S406A

Wendy B. Demartini, MD (*Moderator*) Advisory Board, Kheiron Medical Technologies Ltd

#### **LEARNING OBJECTIVES**

1) Understand the important anticipated changes to the BI-RADS 6th edition Mammography, Breast Ultrasound, Breast MRI and Audit and Outcomes Monitoring sections.

#### **COURSE DESCRIPTION**

This image-rich course will describe the anticipated updates to the Breast Imaging and Data System (BI-RADS) 6th Edition. The important anticipated upcoming changes to the Mammography, Breast Ultrasound, Breast MRI and Audit and Outcomes Monitoring sections will be reviewed.

#### **Sub-Events**

##### **M6-CBR05B BIRADS Atlas Update in Mammography**

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

##### **M6-CBR05C BIRADS Atlas Update in Ultrasound**

Jessica W. Leung, MD (*Presenter*) Scientific Advisory Board, Subtle Medical, Inc;Speaker, General Electric Company;Speaker, Hologic, Inc;Scientific Advisory Board, Seno Medical Instruments, Inc

##### **M6-CBR05D BIRADS Atlas Update in Auditing and Outcomes Monitoring**

Donna M. Plecha, BA, MD (*Presenter*) Hologic Inc., speaking engagement at SBI 2022.Mammotome Inc, speaking engagement at AsBRS 2022

##### **M6-CBR05E BIRADS Atlas Update in MRI**

Wendy B. Demartini, MD (*Presenter*) Advisory Board, Kheiron Medical Technologies Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CBR05B

### **BIRADS Atlas Update in Mammography**

Monday, Nov. 27 1:30PM - 2:30PM Room: S406A

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CBR05C

### **BIRADS Atlas Update in Ultrasound**

Monday, Nov. 27 1:30PM - 2:30PM Room: S406A

Jessica W. Leung, MD (*Presenter*) Scientific Advisory Board, Subtle Medical, Inc; Speaker, General Electric Company; Speaker, Hologic, Inc; Scientific Advisory Board, Seno Medical Instruments, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CBR05D

### **BIRADS Atlas Update in Auditing and Outcomes Monitoring**

Monday, Nov. 27 1:30PM - 2:30PM Room: S406A

Donna M. Plecha, BA, MD (*Presenter*) Hologic Inc., speaking engagement at SBI 2022. Mammotome Inc, speaking engagement at AsBRS 2022

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CBR05E

### **BIRADS Atlas Update in MRI**

Monday, Nov. 27 1:30PM - 2:30PM Room: S406A

Wendy B. Demartini, MD (*Presenter*) Advisory Board, Kheiron Medical Technologies Ltd

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-CCA13

### Cardiac CT Mentored Case Review: Imaging of Post Coronary and Valvular Surgical and Trans Vascular Interventions

Monday, Nov. 27 1:30PM - 2:30PM Room: E450B

Kate Hanneman, MD, MPH (*Moderator*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

#### LEARNING OBJECTIVES

- 1) Describe cardiac imaging for pre and post TAVR planning.
- 2) Discuss and identify imaging for pre and post TMVR planning.
- 3) Discuss the Approach to Assessment of Coronary Stents/CABG Patency.

#### COURSE DESCRIPTION

Cardiac CT Mentored Case Review: Imaging of Post Coronary and Valvular Surgical and Trans Vascular Interventions

#### Sub-Events

##### M6-CCA13B Pre- TAVR Imaging

Amar B. Shah, MD, MA (*Presenter*) Nothing to Disclose

##### M6-CCA13C Post- TAVR Imaging

Cristina Fuss, MD, PhD (*Presenter*) Nothing to Disclose

##### M6-CCA13D Pre- and Post TMVR Imaging

Eric E. Williamson, MD (*Presenter*) Nothing to Disclose

##### M6-CCA13E Approach to Assessment of Coronary Stents/CABG Patency

Harold I. Litt, MD, PhD (*Presenter*) Research Grant, Siemens AG; Research Grant, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCA13B

### **Pre- TAVR Imaging**

Monday, Nov. 27 1:30PM - 2:30PM Room: E450B

Amar B. Shah, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCA13C

### Post- TAVR Imaging

Monday, Nov. 27 1:30PM - 2:30PM Room: E450B

Cristina Fuss, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCA13D

### **Pre- and Post TMVR Imaging**

Monday, Nov. 27 1:30PM - 2:30PM Room: E450B

Eric E. Williamson, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCA13E

### Approach to Assessment of Coronary Stents/CABG Patency

Monday, Nov. 27 1:30PM - 2:30PM Room: E450B

Harold I. Litt, MD, PhD (*Presenter*) Research Grant, Siemens AG; Research Grant, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCH04

### Fundamentals of Diffuse Lung Disease

Monday, Nov. 27 1:30PM - 2:30PM Room: E450A

David M. Naeger, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Evaluate chest CT images for the presence of diffuse lung disease. 2) Define key imaging features used to characterize diffuse lung diseases. 3) Formulate a differential diagnosis based on the presence or absence of key chest CT imaging features.

#### COURSE DESCRIPTION

This course will review four important topics needed to evaluate diffuse lung disease. The course is intended for radiologists re-reviewing the fundamentals of this important aspect of chest radiology. We will use didactic and case-based material to review how to evaluate consolidations and ground-glass opacities, cystic lung disease, mosaic lung attenuation, and micronodular lung disease.

#### Sub-Events

##### M6-CCH04B Cystic Lung Disease

Joanna G. Escalon, MD (*Presenter*) Research Consultant, Vingroup

##### M6-CCH04C Airspace Opacity

David M. Naeger, MD (*Presenter*) Nothing to Disclose

##### M6-CCH04D Mosaic Lung Attenuation

Saurabh Agarwal, MD (*Presenter*) Nothing to Disclose

##### M6-CCH04E Micronodular Lung Disease

Smita Patel, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCH04B

### Cystic Lung Disease

Monday, Nov. 27 1:30PM - 2:30PM Room: E450A

Joanna G. Escalon, MD (*Presenter*) Research Consultant, Vingroup

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCH04C

### **Airspace Opacity**

Monday, Nov. 27 1:30PM - 2:30PM Room: E450A

David M. Naeger, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-CCH04D

### **Mosaic Lung Attenuation**

Monday, Nov. 27 1:30PM - 2:30PM Room: E450A

Saurabh Agarwal, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CCH04E

### **Micronodular Lung Disease**

Monday, Nov. 27 1:30PM - 2:30PM Room: E450A

Smita Patel, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CER07

### GU Causes of Acute Abdominal Pain: Case-Based Approach

Monday, Nov. 27 1:30PM - 2:30PM Room: E451B

Refky Nicola, DO, MSc (*Moderator*) Royalties, RELX

#### LEARNING OBJECTIVES

1) To point out the role of CT and MRI in the management of patients with acute gynecological diseases. 2) To be able to identify the specific findings that help correctly classify the etiology of obstructive urinary symptoms, that are not always due to urolithiasis. 3) To be aware of the possible differential diagnoses of renal colic in patients with flank pain. 4) To know the imaging findings of infectious processes of the genitourinary system and the particularities of some of them to make a more accurate diagnosis. 5) To remember that postoperative patients, both urologic and non-urologic, are at high risk for damage to the urinary tract. 6) Do not ignore findings suggestive of this and perform special imaging protocols to properly characterize Scrotal and penile emergencies are relatively uncommon but need to be diagnosed and treated urgently. The focus of this talk is on imaging techniques, interpretation and differential diagnosis as well as on clinical pictures of non-traumatic causes of scrotal and penile emergencies.

#### COURSE DESCRIPTION

Discuss the common and uncommon causes of gynecological, genitourinary and scrotal emergencies. The session will focus on imaging findings on US, CT, and MRI.

#### Sub-Events

##### M6-CER07B Gynecological Emergencies

Olivera Nikolic, MD, PhD (*Presenter*) Nothing to Disclose

##### M6-CER07C Penile and Scrotal Emergencies

Tiina Lehtimaki, MD (*Presenter*) Nothing to Disclose

##### M6-CER07D Renal Emergencies

Javier Cuetos, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M6-CER07B

### Gynecological Emergencies

Monday, Nov. 27 1:30PM - 2:30PM Room: E451B

Olivera Nikolic, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CER07C

### **Penile and Scrotal Emergencies**

Monday, Nov. 27 1:30PM - 2:30PM Room: E451B

Tiina Lehtimaki, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CER07D

### Renal Emergencies

Monday, Nov. 27 1:30PM - 2:30PM Room: E451B

Javier Cuetos, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CGI03

### Dual- and Multi-energy CT of the Abdomen and Pelvis

Monday, Nov. 27 1:30PM - 2:30PM Room: S406B

Benjamin M. Yeh, MD (*Moderator*) Grant, Koninklijke Philips NV; Grant, General Electric Company; Consultant, Canon Medical Systems Corporation; Speaker, Canon Medical Systems Corporation; Royalties, Oxford University Press; Shareholder, Nextrast, Inc; Board Member, Nextrast, Inc

#### LEARNING OBJECTIVES

1) Identify ways that multi-energy CT can improve clinical image interpretation. 2) Explain how to introduce multi-energy CT imaging to everyday clinical practice. 3) Describe advantages of photon counting CT for reducing radiation dose and medical errors. 4) Identify strategies for use of contrast agents with multi-energy CT.

#### COURSE DESCRIPTION

Multi-energy CT is increasingly utilized and the scanners are rapidly evolving. In particular, abdominal imaging benefits from the ability of multi-energy CT to emphasize iodine signal, differentiate iodine from non-iodine radiodensities, reduce artifacts, and improve lesion detection. This course will explore ways to adopt multi-energy CT in every day clinical practice. The basics of photon counting as they pertain to clinical imaging will be reviewed, and the advantages of photon counting CT for body imaging applications will be explored. New considerations for contrast agent usage for body applications in the setting of multi energy CT will be explored.

#### Sub-Events

##### M6-CGI03B Interpretation of Abdominal Pelvic Dual Energy CT in Clinical Practice

Bari Dane, MD (*Presenter*) Nothing to Disclose

##### M6-CGI03C Practical Clinical Adoption of Dual Energy CT

Alvin C. Silva, MD (*Presenter*) Scientific Advisory Committee, HealthMyne, Inc; Consultant, Exact Sciences Corporation; Research Grant, Ascelia Pharma AB

##### M6-CGI03D Fundamentals of Photon Detector Counting CT

Cynthia H. McCollough, PhD (*Presenter*) Research Grant, Siemens AG

##### M6-CGI03E Clinical Experience with Photon Counting CT

Joel G. Fletcher, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Pfizer Inc; Research Grant, Takeda Pharmaceutical Company Limited; Consultant, Takeda Pharmaceutical Company Limited; Research Grant, Nextrast, Inc; Consultant, Medtronic plc

##### M6-CGI03F Contrast Agents

Benjamin M. Yeh, MD (*Presenter*) Grant, Koninklijke Philips NV; Grant, General Electric Company; Consultant, Canon Medical Systems Corporation; Speaker, Canon Medical Systems Corporation; Royalties, Oxford University Press; Shareholder, Nextrast, Inc; Board Member, Nextrast, Inc

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M6-CGI03B

### **Interpretation of Abdominal Pelvic Dual Energy CT in Clinical Practice**

Monday, Nov. 27 1:30PM - 2:30PM Room: S406B

Bari Dane, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-CGI03C

### Practical Clinical Adoption of Dual Energy CT

Monday, Nov. 27 1:30PM - 2:30PM Room: S406B

Alvin C. Silva, MD (*Presenter*) Scientific Advisory Committee, HealthMyne, Inc;Consultant, Exact Sciences Corporation;Research Grant, Ascelia Pharma AB

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## Abstract Archives of the RSNA, 2023

M6-CGI03D

### **Fundamentals of Photon Detector Counting CT**

Monday, Nov. 27 1:30PM - 2:30PM Room: S406B

Cynthia H. McCollough, PhD (*Presenter*) Research Grant, Siemens AG

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## Abstract Archives of the RSNA, 2023

M6-CGI03E

### Clinical Experience with Photon Counting CT

Monday, Nov. 27 1:30PM - 2:30PM Room: S406B

Joel G. Fletcher, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Pfizer Inc; Research Grant, Takeda Pharmaceutical Company Limited; Consultant, Takeda Pharmaceutical Company Limited; Research Grant, Nextrast, Inc; Consultant, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CGI03F

### Contrast Agents

Monday, Nov. 27 1:30PM - 2:30PM Room: S406B

Benjamin M. Yeh, MD (*Presenter*) Grant, Koninklijke Philips NV; Grant, General Electric Company; Consultant, Canon Medical Systems Corporation; Speaker, Canon Medical Systems Corporation; Royalties, Oxford University Press; Shareholder, Nextrast, Inc; Board Member, Nextrast, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CIN14

### Best Practices for AI Model Creation

Monday, Nov. 27 1:30PM - 2:30PM Room: S401

Benjamin W. Strong, MD (*Moderator*) Officer, Virtual Radiologic Corporation

#### LEARNING OBJECTIVES

1) Understand the principles involved in selecting, developing, and deploying artificial intelligence algorithms in radiology.

#### COURSE DESCRIPTION

This course will be comprised of 5 short 10-minute presentations on selecting, developing, and deploying AI algorithms, including deployment in private practice, academics, and through third-party platforms.

#### Sub-Events

##### **M6-CIN14B Focused Selection of AI Algorithms**

Benjamin W. Strong, MD (*Presenter*) Officer, Virtual Radiologic Corporation

##### **M6-CIN14C Practical Application of Platform AI**

Ryan K. Lee, MD, MBA (*Presenter*) Bayer, Speaker's BureauPhilips, Speaker's BureauBracco, Advisor

##### **M6-CIN14D Academic Aspirations in AI Application**

Hanna M. Zafar, MD (*Presenter*) Nothing to Disclose

##### **M6-CIN14E AI Development Processes**

Robert J. Harris, PhD (*Presenter*) Scientist, Virtual Radiologic Corporation

##### **M6-CIN14F AI Platforms and Widespread Access**

Pelu Tran (*Presenter*) Employee, Ferrum

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## Abstract Archives of the RSNA, 2023

M6-CIN14B

### Focused Selection of AI Algorithms

Monday, Nov. 27 1:30PM - 2:30PM Room: S401

Benjamin W. Strong, MD (*Presenter*) Officer, Virtual Radiologic Corporation

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## Abstract Archives of the RSNA, 2023

M6-CIN14C

### Practical Application of Platform AI

Monday, Nov. 27 1:30PM - 2:30PM Room: S401

Ryan K. Lee, MD, MBA (*Presenter*) Bayer, Speaker's BureauPhilips, Speaker's BureauBracco, Advisor

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## Abstract Archives of the RSNA, 2023

M6-CIN14D

### Academic Aspirations in AI Application

Monday, Nov. 27 1:30PM - 2:30PM Room: S401

Hanna M. Zafar, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-CIN14E

### AI Development Processes

Monday, Nov. 27 1:30PM - 2:30PM Room: S401

Robert J. Harris, PhD (*Presenter*) Scientist, Virtual Radiologic Corporation

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## Abstract Archives of the RSNA, 2023

M6-CIN14F

### **AI Platforms and Widespread Access**

Monday, Nov. 27 1:30PM - 2:30PM Room: S401

Pelu Tran (*Presenter*) Employee, Ferrum

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## Abstract Archives of the RSNA, 2023

M6-CIR02

### Cutting Edge HCC Management

Monday, Nov. 27 1:30PM - 2:30PM Room: S404

Julius Chapiro, MD, PhD (*Moderator*) Research Grant, Guerbet SA;Consultant, Guerbet SA;Research Grant, Boston Scientific Corporation;Consultant, AstraZeneca PLC;Consultant, Bayer AG

#### LEARNING OBJECTIVES

1) Explore the latest advancements in data science of HCC and familiarize themselves with breakthroughs in image-analysis, machine learning, and novel forms of outcome prediction and clinical endpoints relevant to HCC diagnosis and therapy. 2) Understand the role of a multi-disciplinary tumor board in a rapidly evolving landscape of novel ablative modalities, image-guided navigational support, therapy guidelines, and staging systems pertinent to HCC. 3) Gain insights into current recommendations and ongoing trials combining loco-regional therapies with immunotherapy of HCC, with focus on novel concepts in adjuvant, and neoadjuvant therapy. 4) Identify emerging trends in combining radioembolization and chemoembolization with immunotherapy across stages. 5) Discuss the multidisciplinary approach to oncology imaging endpoints, including novel tumor response assessment techniques and standards pertinent to targeted HCC therapies.

#### COURSE DESCRIPTION

The educational course session is a comprehensive learning opportunity that focuses on the latest developments, cutting-edge technologies, and emerging trends in the field of primary liver cancer interventions. Attendees will be provided with a rich learning experience that explores innovative imaging techniques, novel guidelines and therapeutics and their impact on hepatocellular carcinoma (HCC) management, with lectures provided by global experts in the field of image-guided intervention in HCC.

#### Sub-Events

##### M6-CIR02B Data Science in HCC

Julius Chapiro, MD, PhD (*Presenter*) Research Grant, Guerbet SA;Consultant, Guerbet SA;Research Grant, Boston Scientific Corporation;Consultant, AstraZeneca PLC;Consultant, Bayer AG

##### M6-CIR02C A Hepatologist's Vision for Multidisciplinary Care in HCC

Mario Strazzabosco, MD, PhD (*Presenter*) Advisory Board, Bayer AG;Advisory Board, Engitix Limited;Advisory Board, Merck & Co, Inc;Advisory Board, Eisai Co, Ltd

##### M6-CIR02D The Future of Ablation Technology and its Role in HCC

Jeong Min Lee, MD, PhD (*Presenter*) Grant, Bayer AG Grant, Canon Medical Systems Corporation Grant, Koninklijke Philips NV Grant, General Electric Healthcare Grant, Guerbet SA Grant, Samsung Electronics Co, Ltd Grant, Bracco Group Grant, Dongkuk Pharma Grant, Starmed Ltd Grant, RF medical Grant, Siemens AG Speakers, Bayer AG Speakers, Philips Healthcare Speakers, Samsung Medison Speakers, GE Healthcare

##### M6-CIR02E Imaging Response to Local and Systemic Therapies of HCC

Laura Crocetti, MD, PhD (*Presenter*) Speaker, Terumo Corporation;Advisory Board, Boston Scientific Corporation;Research Consultant, Biomedical;Speaker, Eisai Co, Ltd

##### M6-CIR02F Combining TACE and Immunotherapy

Valerie Vilgrain, MD (*Presenter*) Expert Witness, Bayer AG;Speaker, Canon Medical Systems Corporation;Speaker, General Electric Company;Advisory Board, Guerbet SA;Expert Witness, Guerbet SA;Expert Witness, Zimmer Biomet Holdings, Inc;Speaker, Sirtex Medical Ltd;Expert Witness, Sirtex Medical Ltd;Investigator, AIdream Group LLC;Expert Witness, Terumo Corporation;;

##### M6-CIR02G Combining Y90 and Immunotherapy

MBA (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Eisai Co, Ltd; Consultant, Sirtex Medical Ltd; Consultant, Cook Group Incorporated; Consultant, Siemens AG  
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## Abstract Archives of the RSNA, 2023

M6-CIR02B

### Data Science in HCC

Monday, Nov. 27 1:30PM - 2:30PM Room: S404

Julius Chapiro, MD, PhD (*Presenter*) Research Grant, Guerbet SA;Consultant, Guerbet SA;Research Grant, Boston Scientific Corporation;Consultant, AstraZeneca PLC;Consultant, Bayer AG

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## Abstract Archives of the RSNA, 2023

M6-CIR02C

### **A Hepatologist's Vision for Multidisciplinary Care in HCC**

Monday, Nov. 27 1:30PM - 2:30PM Room: S404

Mario Strazzabosco, MD, PhD (*Presenter*) Advisory Board, Bayer AG; Advisory Board, Engitix Limited; Advisory Board, Merck & Co, Inc; Advisory Board, Eisai Co, Ltd

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## Abstract Archives of the RSNA, 2023

M6-CIR02D

### **The Future of Ablation Technology and its Role in HCC**

Monday, Nov. 27 1:30PM - 2:30PM Room: S404

Jeong Min Lee, MD, PhD (*Presenter*) Grant, Bayer AG Grant, Canon Medical Systems Corporation Grant, Koninklijke Philips NV Grant, General Electric Healthcare Grant, Guerbet SA Grant, Samsung Electronics Co, Ltd Grant, Bracco Group Grant, Dongkuk Pharma Grant, Starmed Ltd Grant, RF medical Grant, Siemens AG Speakers, Bayer AG Speakers, Philips Healthcare Speakers, Samsung Medison Speakers, GE Healthcare

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## Abstract Archives of the RSNA, 2023

M6-CIR02E

### Imaging Response to Local and Systemic Therapies of HCC

Monday, Nov. 27 1:30PM - 2:30PM Room: S404

Laura Crocetti, MD, PhD (*Presenter*) Speaker, Terumo Corporation; Advisory Board, Boston Scientific Corporation; Research Consultant, Biomedical; Speaker, Eisai Co, Ltd

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## Abstract Archives of the RSNA, 2023

M6-CIR02F

### Combining TACE and Immunotherapy

Monday, Nov. 27 1:30PM - 2:30PM Room: S404

Valerie Vilgrain, MD (*Presenter*) Expert Witness, Bayer AG; Speaker, Canon Medical Systems Corporation; Speaker, General Electric Company; Advisory Board, Guerbet SA; Expert Witness, Guerbet SA; Expert Witness, Zimmer Biomet Holdings, Inc; Speaker, Sirtex Medical Ltd; Expert Witness, Sirtex Medical Ltd; Investigator, AIdream Group LLC; Expert Witness, Terumo Corporation;;

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## Abstract Archives of the RSNA, 2023

M6-CIR02G

### **Combining Y90 and Immunotherapy**

Monday, Nov. 27 1:30PM - 2:30PM Room: S404

Riad Salem, MBA (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Eisai Co, Ltd; Consultant, Sirtex Medical Ltd; Consultant, Cook Group Incorporated; Consultant, Siemens AG

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## Abstract Archives of the RSNA, 2023

M6-CMK16

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Viviane Khoury, BSc, MD (*Moderator*) Nothing to Disclose  
Linda Probyn, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Review anatomy and ultrasound imaging techniques for evaluation of the shoulder. 2) Describe useful dynamic imaging techniques to enhance assessment of the shoulder. 3) Discuss ultrasound imaging of common pathologic musculoskeletal conditions at the shoulder.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This session will review an approach to ultrasound of the shoulder including dynamic maneuvers. Part 1: There will be a hands-on demonstration by an instructor showing an approach to ultrasound examination of the shoulder. This will include assessment of the long head of biceps tendon, rotator cuff tendons, acromioclavicular joint, subacromial/subdeltoid bursa, posterior labrum, spinoglenoid notch and will include dynamic evaluation for biceps subluxation and subacromial impingement. This will be followed by a brief presentation highlighting common pathologic musculoskeletal conditions about the shoulder that are seen on ultrasound. Part 2: The participants will be divided into small groups and will practice an approach to ultrasound of the shoulder on a model with an instructor teaching the participants. Proper patient positioning will be shown. Tips on how to optimize ultrasound imaging to best evaluate the area of concern will be discussed.

#### **Sub-Events**

### **M6-CMK16A RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Jon A. Jacobson, MD (*Presenter*) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, RELX; Contactor, POCUS PRO

### **M6-CMK16B RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Theodore T. Miller, MD (*Presenter*) Nothing to Disclose

### **M6-CMK16C RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Mark Cresswell, MBBCh, BSc (*Presenter*) Consultant, Koninklijke Philips NV

### **M6-CMK16D RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Robert S. Campbell, MBChB, FRCR (*Presenter*) Nothing to Disclose

### **M6-CMK16E RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Luca Maria Sconfienza, MD, PhD (*Presenter*) Travel support, Bracco Group; Travel support, Esaote SpA; Speakers Bureau, Esaote SpA; Travel support, ABIOMED PHARMA SpA; Speakers Bureau, P&R Holding; Speakers Bureau, Pfizer Inc ; Speaker, Novartis AG; Speaker, Merck KGaA; Speaker, MSD

**M6-CMK16H RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Humberto G. Rosas, MD (*Presenter*) Co-founder, AyrFlo; Stockholder, AyrFlo

**M6-CMK16I RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Carlo Martinoli, MD (*Presenter*) Speaker, Koninklijke Philips NV; Speaker, Canon Medical Systems Corporation; Speaker, Novo Nordisk AS; Speaker, Pfizer Inc; Speaker, Novartis AG; Speaker, Swedish Orphan Biovitrum AB

**M6-CMK16J RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Etienne Cardinal, MD, BSc (*Presenter*) Nothing to Disclose

**M6-CMK16K RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Angela Atinga, MBBChir, FRCPC (*Presenter*) Nothing to Disclose

**M6-CMK16L RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Emma L. Rowbotham, FRCR (*Presenter*) Nothing to Disclose

**M6-CMK16M RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Andrew J. Grainger, MD (*Presenter*) Speakers Bureau, General Electric Company

**M6-CMK16N RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Christopher F. Beaulieu, MD, PhD (*Presenter*) Nothing to Disclose

**M6-CMK16O RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

**M6-CMK16P RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Kenneth S. Lee, MD, MBA (*Presenter*) Grant, NFL; Research support, Hologic, Inc; Royalties, RELX

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## Abstract Archives of the RSNA, 2023

M6-CMK16C

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Jon A. Jacobson, MD (*Presenter*) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, RELX; Contactor, POCUS PRO

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## Abstract Archives of the RSNA, 2023

M6-CMK16D

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Theodore T. Miller, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M6-CMK16E

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Mark Cresswell, MBBCh, BSc (*Presenter*) Consultant, Koninklijke Philips NV

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## Abstract Archives of the RSNA, 2023

M6-CMK16F

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Robert S. Campbell, MBChB, FRCR (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M6-CMK16G

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Luca Maria Sconfienza, MD, PhD (*Presenter*) Travel support, Bracco Group; Travel support, Esaote SpA; Speakers Bureau, Esaote SpA; Travel support, ABIOMED PHARMA SpA; Speakers Bureau, P&R Holding; Speakers Bureau, Pfizer Inc ; Speaker, Novartis AG; Speaker, Merck KGaA; Speaker, MSD

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## Abstract Archives of the RSNA, 2023

M6-CMK16H

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Humberto G. Rosas, MD (*Presenter*) Co-founder, AyrFlo; Stockholder, AyrFlo

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## Abstract Archives of the RSNA, 2023

M6-CMK16I

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Carlo Martinoli, MD (*Presenter*) Speaker, Koninklijke Philips NV; Speaker, Canon Medical Systems Corporation; Speaker, Novo Nordisk AS; Speaker, Pfizer Inc; Speaker, Novartis AG; Speaker, Swedish Orphan Biovitrum AB

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## Abstract Archives of the RSNA, 2023

M6-CMK16J

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Etienne Cardinal, MD, BSc (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M6-CMK16K

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Angela Atinga, MBBChir, FRCPC (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M6-CMK16L

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Emma L. Rowbotham, FRCR (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M6-CMK16M

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Andrew J. Grainger, MD (*Presenter*) Speakers Bureau, General Electric Company

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## Abstract Archives of the RSNA, 2023

M6-CMK16N

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Christopher F. Beaulieu, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M6-CMK160

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CMK16P

### **RSNA Hands-On Lab: Musculoskeletal Ultrasound: Approach to Ultrasound Assessment of the Shoulder with Dynamic Maneuvers**

Monday, Nov. 27 2:00PM - 3:30PM Room: S504CD

Kenneth S. Lee, MD, MBA (*Presenter*) Grant, NFL; Research support, Hologic, Inc; Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CNR03

### **Multidisciplinary (Adult) Brain Tumor Board**

Monday, Nov. 27 1:30PM - 2:30PM Room: E451A

Javier Villanueva-Meyer, MD (*Moderator*) Research Grant, General Electric Company  
Rajan Jain, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Explain the current standard of care for diagnosis and treatment of adult diffuse gliomas. 2) Demonstrate the importance of role various sub-specialists play in multidisciplinary tumor board.

#### **COURSE DESCRIPTION**

We will present mullite cases of adult diffuse gliomas in a setting similar to multidisciplinary tumor board. Each case will be discussed by a neuro-radiologist, followed by a neuropathologist and a neurosurgeon to enhance various aspects of multidisciplinary contribution to patient care. Each specialist will discuss pertinent important aspects of adult diffuse glioma diagnosis, treatment and surveillance.

#### **Sub-Events**

##### **M6-CNR03C Neurosurgeon: Buck Stops Here!**

Isabelle Germano, MD (*Presenter*) Nothing to Disclose

##### **M6-CNR03D Neuropathologist: Leading The (Genomic) Innovations!**

Daniel J. Brat, MD, PhD (*Presenter*) Nothing to Disclose

##### **M6-CNR03E Neuroradiologist: Movers and Shakers!**

Javier Villanueva-Meyer, MD (*Presenter*) Research Grant, General Electric Company

##### **M6-CNR03F Neuroradiologist: Movers and Shakers!**

Rajan Jain, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CNR03C

### **Neurosurgeon: Buck Stops Here!**

Monday, Nov. 27 1:30PM - 2:30PM Room: E451A

Isabelle Germano, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CNR03D

### **Neuropathologist: Leading The (Genomic) Innovations!**

Monday, Nov. 27 1:30PM - 2:30PM Room: E451A

Daniel J. Brat, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CNR03E

### **Neuroradiologist: Movers and Shakers!**

Monday, Nov. 27 1:30PM - 2:30PM Room: E451A

Javier Villanueva-Meyer, MD (*Presenter*) Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CNR03F

### **Neuroradiologist: Movers and Shakers!**

Monday, Nov. 27 1:30PM - 2:30PM Room: E451A

Rajan Jain, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-COB02

### Leiomyosarcoma: Clinical Perspective and MRI Update

Monday, Nov. 27 1:30PM - 2:30PM Room: N227B

Nicole M. Hindman, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review current clinical challenges for Gynecologists in surgical resection of symptomatic fibroids- role of laparoscopic myomectomy and morcellation. 2) Identify role of MR imaging in risk-stratification of uterine masses that have features suspicious for leiomyosarcoma. 3) Learn to apply an imaging flow chart to uterine masses to differentiate subtypes of uterine fibroids. 4) Review a management flowchart that balances preserving fertility with optimal treatment of suspicious uterine masses.

#### COURSE DESCRIPTION

The prevalence of uterine leiomyosarcoma is greater than previously believed, with the American College of Obstetricians and Gynecologists reporting a prevalence of 1 in 770 (0.1%). The high profile deaths of previously healthy women after iatrogenic spread of an unsuspected uterine leiomyosarcoma had reverberating effects in the gynecologic community and affected subsequent FDA policies around surgical techniques from 2014 to the present. MR imaging can serve as an important role in pre-operative risk stratification for symptomatic uterine fibroids that are planned for surgery. This course will review the background of this clinical need, and apply an MR imaging evaluation of fibroids and a proposed management algorithm.

#### Sub-Events

##### M6-COB02B MR Evaluation for Uterine Masses for Risk for LMS

Nicole M. Hindman, MD (*Presenter*) Nothing to Disclose

##### M6-COB02C Case-based Review of Uterine Masses

Angela Tong, MD (*Presenter*) Equipment support, Siemens AG

##### M6-COB02D Surgeon's Perspective: Preoperative Determination of Leiomyoma vs Leiomyosarcoma: Why is it so Important

Annie Leung, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-COB02B

### **MR Evaluation for Uterine Masses for Risk for LMS**

Monday, Nov. 27 1:30PM - 2:30PM Room: N227B

Nicole M. Hindman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-COB02C

### Case-based Review of Uterine Masses

Monday, Nov. 27 1:30PM - 2:30PM Room: N227B

Angela Tong, MD (*Presenter*) Equipment support, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-COB02D

### **Surgeon's Perspective: Preoperative Determination of Leiomyoma vs Leiomyosarcoma: Why is it so Important**

Monday, Nov. 27 1:30PM - 2:30PM Room: N227B

Annie Leung, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CPH03

### **Dose Calculation Tools for Fluoroscopic Imaging: An Overview of Their Development, Accessibility, and What Role They Play in Communicating and Managing Patient Risk**

Monday, Nov. 27 1:30PM - 2:30PM Room: N228

Emily Marshall, PhD (*Moderator*) Scientific Advisory Board, Bayer AG;Consultant, Bayer AG;Scientific Advisory Board, Radimetrics Dosimetry Services;Consultant, Radimetrics Dosimetry Services  
David Borrego, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Explain the limitations and challenges in estimating radiation dose to the patient.2) Evaluate the various dose metrics available and how these may be useful within their clinical workflow in communicating with patients and managing their risk.3) Discuss the current state and future needs of radiation dosimetry in the context of low-dose research studies and what role attendees may play as stakeholders in the field.

#### **COURSE DESCRIPTION**

There are several tools and resources available to estimate the amount of radiation delivered to patients during fluoroscopic imaging procedures. This session, with a special emphasis on pediatric fluoroscopic imaging, will provide an overview of the current state of radiation dosimetry, the challenges in estimating patient dose, and what role these tools may play in improving communication and the management of patient risk. Attendees will leave the course with a developed understanding of appropriate applications and limitations of radiation dose estimates and tools available for their own educational use. This course, delivered lecture style, will provide practitioners the background needed to confidently produce, explain, and contextualize patient dose and risk following fluoroscopic imaging procedures.

#### **Sub-Events**

#### **M6-CPH03C A Comprehensive Discussion on Dose Coefficients and Dose Metrics: Their Development, Computation, and Appropriateness in Dose Estimation to the Patient**

Emily Marshall, PhD (*Presenter*) Scientific Advisory Board, Bayer AG;Consultant, Bayer AG;Scientific Advisory Board, Radimetrics Dosimetry Services;Consultant, Radimetrics Dosimetry Services

#### **M6-CPH03D Practical Tools for Patient Dose Calculation Following Fluoroscopic Procedures: NCIRF Case Study**

Choonsik Lee, PhD (*Presenter*) Nothing to Disclose

#### **M6-CPH03E Patient-Care Driven Discussions on Dose and Risk for Pediatric Patients and Their Caregivers**

Lisa H. Kang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CPH03C

### **A Comprehensive Discussion on Dose Coefficients and Dose Metrics: Their Development, Computation, and Appropriateness in Dose Estimation to the Patient**

Monday, Nov. 27 1:30PM - 2:30PM Room: N228

Emily Marshall, PhD (*Presenter*) Scientific Advisory Board, Bayer AG; Consultant, Bayer AG; Scientific Advisory Board, Radimetrics Dosimetry Services; Consultant, Radimetrics Dosimetry Services

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CPH03D

### **Practical Tools for Patient Dose Calculation Following Fluoroscopic Procedures: NCIRF Case Study**

Monday, Nov. 27 1:30PM - 2:30PM Room: N228

Choonsik Lee, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CPH03E

### **Patient-Care Driven Discussions on Dose and Risk for Pediatric Patients and Their Caregivers**

Monday, Nov. 27 1:30PM - 2:30PM Room: N228

Lisa H. Kang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-CPH15

### Radiography Quality Assurance

Monday, Nov. 27 1:30PM - 2:30PM Room: N229

Matt Vanderhoek, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Define and examine the roles of technologists, QA techs, physicists, radiologists, and engineers with respect to quality assurance. 2) Recognize and describe methods of quality assurance for application to routine clinical practice. 3) Understand the importance of regular quality control testing in radiographic imaging and its impact on clinical image quality and patient radiation exposure. 4) Understand the principles and application of the IAEA's remote, automated quality control solution.

#### COURSE DESCRIPTION

Enhance your understanding of routine quality assurance (QA) practices in radiography through this two-part lecture. Emphasizing teamwork, this course delves into the roles and relationships of technologists, physicists, engineers, and radiologists pertaining to QA. The course examines the QA significance of routine tasks performed by technologists such as reviewing images for proper exposure, positioning, and artifacts to maintain high standards in image quality. Course participants also gain valuable insights into annual QA procedures performed by physicists. In addition, the course dives into the use of remote and automated tools as part of a quality assurance program. Participants explore the IAEA's novel solution for cost-effective, automated quality control using simple test objects and free software. A practical guide is provided on use of the IAEA dedicated software & supplementary material to ensure consistent and superior image quality.

#### Sub-Events

##### M6-CPH15B Practical Implementation of Radiography Quality Assurance

Nicole Lafata, MS (*Presenter*) Nothing to Disclose

##### M6-CPH15C Quality Control of Radiographic Imaging Systems

Zahra Razi, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-CPH15B

### Practical Implementation of Radiography Quality Assurance

Monday, Nov. 27 1:30PM - 2:30PM Room: N229

Nicole Lafata, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M6-CPH15C

### **Quality Control of Radiographic Imaging Systems**

Monday, Nov. 27 1:30PM - 2:30PM Room: N229

Zahra Razi, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-RCP04

### Neoplasias del Pancreas/Pancreatic Neoplasms (CIR)

Monday, Nov. 27 1:30PM - 3:00PM Room: E353C

Pablo Soffia, MD (*Moderator*) Nothing to Disclose  
Fatima Matute Teresa, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Learn how to diagnose the most common malignant tumors of the pancreas using computed tomography and magnetic resonance imaging. 2) Learn how to image pancreatic tumors undergoing chemotherapy treatment and how to differentiate fibrosis from recurrence. 3) Learn the radiological features of neuroendocrine neoplasms of the pancreas and how to differentiate them from other types of tumors. 4) Learn to detect and characterize the most frequent cystic neoplasms of the pancreas and what are their signs of aggressiveness and malignancy.

#### COURSE DESCRIPTION

In this course, attendees will be able to refresh their knowledge about pancreatic neoplasms and their different forms of presentation. The most frequent malignant neoplasms, such as adenocarcinoma, will be reviewed, emphasizing the criteria of resectability and irresectability. It will also discuss how to follow up these tumors after starting chemotherapy treatment and how to detect fibrosis from recurrences. A review of the diagnostic criteria for neuroendocrine tumors of the pancreas and expert recommendations for their detection and follow-up will be presented. Finally, the spectrum of cystic neoplasms of the pancreas will be shown, highlighting when aggressiveness or malignancy should be suspected.

#### Sub-Events

##### **M6-RCP04C Adenocarcinomas of the Pancreas: Role of the Radiologist in Multidisciplinary Hospital Committees**

Daniel Upegui Jimenez, MD, MBA (*Presenter*) Nothing to Disclose

##### **M6-RCP04D Tips and Tricks for Postoperative and Chemotherapeutic Follow-up**

Juan C. Spina JR, MD (*Presenter*) Nothing to Disclose

##### **M6-RCP04E Update on Neuroendocrine Neoplasms of the Pancreas**

Manoel S. Rocha, MD, PhD (*Presenter*) Nothing to Disclose

##### **M6-RCP04F Cystic Neoplasms of the Pancreas: Worrisome features and High Risk Stigmata - Which Guidelines?**

Pablo Soffia, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M6-RCP04C

### **Adenocarcinomas of the Pancreas: Role of the Radiologist in Multidisciplinary Hospital Committees**

Monday, Nov. 27 1:30PM - 3:00PM Room: E353C

Daniel Upegui Jimenez, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-RCP04D

### **Tips and Tricks for Postoperative and Chemotherapeutic Follow-up**

Monday, Nov. 27 1:30PM - 3:00PM Room: E353C

Juan C. Spina JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-RCP04E

### **Update on Neuroendocrine Neoplasms of the Pancreas**

Monday, Nov. 27 1:30PM - 3:00PM Room: E353C

Manoel S. Rocha, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M6-RCP04F

### **Cystic Neoplasms of the Pancreas: Worrisome features and High Risk Stigmata - Which Guidelines?**

Monday, Nov. 27 1:30PM - 3:00PM Room: E353C

Pablo Soffia, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-RCP11

### From the Editors of **RADIOLOGY**: New Research that Should Impact your Practice

Monday, Nov. 27 1:30PM - 2:30PM Room: S402

Linda Moy, MD (*Moderator*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

#### LEARNING OBJECTIVES

1) To highlight key articles published in Radiology in 2023. 2) To review how novel imaging techniques and AI are impacting our field.

#### Sub-Events

##### **M6-RCP11B Top Breast Imaging Papers That Should Impact Your Practice**

Linda Moy, MD (*Presenter*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

##### **M6-RCP11C Gastrointestinal Imaging: Research that Should Impact your Practice**

Kathryn J. Fowler, MD (*Presenter*) Consultant, Bayer AG; Research support, General Electric Company; Research Grant, Pfizer Inc; Institutional Grant, MEDIAN Technologies; Consultant, General Electric Company

##### **M6-RCP11D New Research That Should Impact Your Practice Neuroradiology**

Yoshimi Anzai, MD, MPH (*Presenter*) Nothing to Disclose

##### **M6-RCP11E Genitourinary Imaging: Research that Should Impact your Practice**

Vicky J. Goh, MBCh (*Presenter*) Research Grant, Siemens AG

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-RCP11B

### Top Breast Imaging Papers That Should Impact Your Practice

Monday, Nov. 27 1:30PM - 2:30PM Room: S402

Linda Moy, MD (*Presenter*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-RCP11C

### **Gastrointestinal Imaging: Research that Should Impact your Practice**

Monday, Nov. 27 1:30PM - 2:30PM Room: S402

Kathryn J. Fowler, MD (*Presenter*) Consultant, Bayer AG; Research support, General Electric Company; Research Grant, Pfizer Inc; Institutional Grant, MEDIAN Technologies; Consultant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-RCP11D

### **New Research That Should Impact Your Practice Neuroradiology**

Monday, Nov. 27 1:30PM - 2:30PM Room: S402

Yoshimi Anzai, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-RCP11E

### **Genitourinary Imaging: Research that Should Impact your Practice**

Monday, Nov. 27 1:30PM - 2:30PM Room: S402

Vicky J. Goh, MBBCh (*Presenter*) Research Grant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CAS06

### Shift Work and Mental Health Among R.T.s (Sponsored by the RSNA Associated Sciences Consortium)

Monday, Nov. 27 3:00PM - 4:00PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Discuss the current state of mental health in the United States and assess anxiety and depression among a working sample of radiologic technologists. 2) Evaluate the relationship between mental health and working various shifts, including weekends, and taking call. 3) Identify coping strategies used to deal with anxiety and depression.

#### COURSE DESCRIPTION

Shift work is essential in health care where 24-hour access and service are expected. Engaging in shift work, however, is associated with mental health issues like depression and anxiety. Shift workers are also at a high risk for adverse health outcomes, such as stroke, obesity, gastrointestinal issues, and various types of cancer. This lecture (a) emphasizes the importance of assessing and managing mental health among health care professionals and (b) shares results from an original research study that explored shift work and mental health among a sample of working medical imaging and radiation therapy professionals.

#### Sub-Events

#### M7-CAS06B Shift Work and Mental Health Among R.T.s

Kevin R. Clark, RT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CAS06B

### **Shift Work and Mental Health Among R.T.s**

Monday, Nov. 27 3:00PM - 4:00PM Room: N230B

Kevin R. Clark, RT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CBR01

### Contrast Enhanced Mammography

Monday, Nov. 27 3:00PM - 4:00PM Room: S406A

Janice S. Sung, MD (*Moderator*) Research Grant, General Electric Company

#### LEARNING OBJECTIVES

1) Review how to perform contrast enhanced mammography (CEM) and considerations when starting a CEM program. 2) Discuss the emerging roles of contrast enhanced mammography in both the screening and diagnostic settings.

#### COURSE DESCRIPTION

Contrast enhanced mammography (CEM) is an FDA approved technique that is emerging as an alternative vascular based technique to conventional breast imaging and MRI in both the screening and diagnostic settings. This session will review considerations in beginning a CEM program and review data supporting the use of CEM in both the screening and diagnostic settings.

#### Sub-Events

##### **M7-CBR01B Contrast Enhanced Mammography: Technique, Indications and Outcomes**

Janice S. Sung, MD (*Presenter*) Research Grant, General Electric Company

##### **M7-CBR01C Contrast Enhanced Mammography: Is MRI Better?**

Ulrich Bick, MD (*Presenter*) License agreement, Hologic, Inc; Royalties, Hologic, Inc

##### **M7-CBR01D Contrast Enhanced Mammography: Ready for Screening?**

Jordana Phillips, MD (*Presenter*) Research Grant, General Electric Company; Consultant, General Electric Company; Consultant, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CBR01B

### **Contrast Enhanced Mammography: Technique, Indications and Outcomes**

Monday, Nov. 27 3:00PM - 4:00PM Room: S406A

Janice S. Sung, MD (*Presenter*) Research Grant, General Electric Company

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-CBR01C

### **Contrast Enhanced Mammography: Is MRI Better?**

Monday, Nov. 27 3:00PM - 4:00PM Room: S406A

Ulrich Bick, MD (*Presenter*) License agreement, Hologic, Inc;Royalties, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CBR01D

### **Contrast Enhanced Mammography: Ready for Screening?**

Monday, Nov. 27 3:00PM - 4:00PM Room: S406A

Jordana Phillips, MD (*Presenter*) Research Grant, General Electric Company;Consultant, General Electric Company;Consultant, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CCA14

### **Cardiac CT Mentored Case Review: Imaging of Pulmonary Veins, Pericardium, and Adult Congenital Heart Disease**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450B

Daniel Ocazonez-Trujillo, MD (*Moderator*) Nothing to Disclose

#### **Sub-Events**

#### **M7-CCA14B Cardiac and Pericardial Neoplasms**

Jacobo Kirsch, MD, MBA (*Presenter*) Medical Advisory Board, Zebra Medical Vision Ltd

#### **M7-CCA14C Left Atrial Pre- and Post-Ablation Imaging**

Phillip M. Young, MD (*Presenter*) Nothing to Disclose

#### **M7-CCA14D Adult Congenital Heart Disease**

Dominique C. DaBreo, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **M7-CCA14E Mixed Case-Review - Summary**

Gautham P. Reddy, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CCA14B

### **Cardiac and Pericardial Neoplasms**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450B

Jacobo Kirsch, MD, MBA (*Presenter*) Medical Advisory Board, Zebra Medical Vision Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CCA14C

### **Left Atrial Pre- and Post-Ablation Imaging**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450B

Phillip M. Young, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CCA14D

### Adult Congenital Heart Disease

Monday, Nov. 27 3:00PM - 4:00PM Room: E450B

Dominique C. DaBreo, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CCA14E

### **Mixed Case-Review - Summary**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450B

Gautham P. Reddy, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CER14

### Hot Topics in Emergency Radiology

Monday, Nov. 27 3:00PM - 4:00PM Room: E451B

Douglas S. Katz, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To understand how emergency radiology practices are being covered following the COVID pandemic and how the paradigm has changed in Canada, the US, and elsewhere. 2) To review the current practice of peer review and peer learning in emergency radiology and how quality assurance in radiology has changed, with examples from recent practice. 3) To overview the current role of point-of-care ultrasound and to understand how radiologists, emergency medicine practitioners, and other clinical providers are utilizing ultrasound at the patient's bedside, and the implications for other imaging and patient practice.

#### COURSE DESCRIPTION

The ER 'hot topics' session will include three relevant current topics in emergency radiology practice: staffing given the challenges of COVID and following the COVID pandemic, with changes in practice and remote coverage; peer learning and peer review, with evolution of how quality assurance is being performed in emergency radiology and in radiology in general; and the current use of point-of-care ultrasound and how it fits in with emergency radiology practice during the day time and after hours, and the implications for other imaging and for coverage.

#### Sub-Events

##### **M7-CER14B Peer Learning and Peer Review/Quality Assurance in Emergency Radiology**

Douglas S. Katz, MD (*Presenter*) Nothing to Disclose

##### **M7-CER14C Current Role of Point of Care Emergency Ultrasound in North America and Elsewhere**

John S. Pellerito, MD (*Presenter*) Nothing to Disclose

##### **M7-CER14D Staffing of Emergency Radiology in the Era of COVID**

Michael N. Patlas, MD, FRCPC (*Presenter*) Royalties, Holtzbrinck Publishing Group

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-CER14B

### Peer Learning and Peer Review/Quality Assurance in Emergency Radiology

Monday, Nov. 27 3:00PM - 4:00PM Room: E451B

Douglas S. Katz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CER14C

### **Current Role of Point of Care Emergency Ultrasound in North America and Elsewhere**

Monday, Nov. 27 3:00PM - 4:00PM Room: E451B

John S. Pellerito, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CER14D

### Staffing of Emergency Radiology in the Era of COVID

Monday, Nov. 27 3:00PM - 4:00PM Room: E451B

Michael N. Patlas, MD, FRCPC (*Presenter*) Royalties, Holtzbrinck Publishing Group

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGI04

### Pancreatic Tumor Imaging

Monday, Nov. 27 3:00PM - 4:00PM Room: E350

Avinash R. Kambadakone, MD, FRCR (*Moderator*) Advisory Board, Bayer AG Research Grant, General Electric Company Research Grant, Koninklijke Philips NV Research Grant, PanCAN Research Grant, Bayer

#### LEARNING OBJECTIVES

1) Describe the key updates in the imaging diagnosis of pancreatic cancer. 2) Explain the current role of imaging in assessment of therapeutic response in pancreatic cancer. 3) Discuss the importance of structured reporting in pancreatic cancer and implications for patient management. 4) Review the current and emerging applications of artificial intelligence in pancreatic cancer. 5) Explain recent advances in pancreatic neuroendocrine tumor imaging.

#### COURSE DESCRIPTION

This course will review the current state-of-the-art and recent advances in imaging of pancreatic cancer and pancreatic neuroendocrine tumors. The attendees will also learn the role of structured reporting and emerging applications of artificial intelligence in pancreatic cancer.

#### Sub-Events

##### **M7-CGI04B Diagnosis and Staging of Pancreatic Cancer: State of the Art**

Avinash R. Kambadakone, MD, FRCR (*Presenter*) Advisory Board, Bayer AG Research Grant, General Electric Company Research Grant, Koninklijke Philips NV Research Grant, PanCAN Research Grant, Bayer

##### **M7-CGI04C Pearls and Pitfalls in Pancreatic Cancer Response Assessment**

Zhen J. Wang, MD (*Presenter*) Stockholder, Nexttrast, Inc

##### **M7-CGI04D Pancreatic Cancer: Structured Reporting**

Olga R. Brook, MD, MBA (*Presenter*) Nothing to Disclose

##### **M7-CGI04E Artificial Intelligence in the Fight Against Pancreatic Cancer**

Michael H. Rosenthal, MD, PhD (*Presenter*) Nothing to Disclose

##### **M7-CGI04F Pancreatic Neuroendocrine Neoplasms**

Motoyo Yano, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGI04B

### **Diagnosis and Staging of Pancreatic Cancer: State of the Art**

Monday, Nov. 27 3:00PM - 4:00PM Room: E350

Avinash R. Kambadakone, MD, FRCR (*Presenter*) Advisory Board, Bayer AG Research Grant, General Electric Company Research Grant, Koninklijke Philips NV Research Grant, PanCAN Research Grant, Bayer

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M7-CGI04C

### **Pearls and Pitfalls in Pancreatic Cancer Response Assessment**

Monday, Nov. 27 3:00PM - 4:00PM Room: E350

Zhen J. Wang, MD (*Presenter*) Stockholder, Nextrast, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGI04D

### **Pancreatic Cancer: Structured Reporting**

Monday, Nov. 27 3:00PM - 4:00PM Room: E350

Olga R. Brook, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGI04E

### Artificial Intelligence in the Fight Against Pancreatic Cancer

Monday, Nov. 27 3:00PM - 4:00PM Room: E350

Michael H. Rosenthal, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-CGI04F

### **Pancreatic Neuroendocrine Neoplasms**

Monday, Nov. 27 3:00PM - 4:00PM Room: E350

Motoyo Yano, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGU01

### Cutting Edge GU-Specific Diagnostic Classification Systems

Monday, Nov. 27 3:00PM - 4:00PM Room: N227B

Nicola Schieda, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Integrate standardized reporting of GU body systems into clinical practice. 2) Appreciate the importance of newer GU classification systems including Bosniak v2019, O-RADS and VI-RADS.

#### COURSE DESCRIPTION

In this 5 speaker course, attendees will be given an introduction to the importance of standardized reporting and emerging GU classification systems including Bosniak version 2019, O-RADS and VI-RADS. Standardized reporting in general and the implications of artificial intelligence and machine learning on reporting in GU will be discussed.

#### Sub-Events

##### **M7-CGU01B Adding Value through Disease-Specific Structured Reporting**

Atul B. Shinagare, MD (*Presenter*) Consultant, VirtualScopics, Inc; Consultant, Imaging Endpoints

##### **M7-CGU01C Bosniak Classification v.2019: Dose Emerging Evidence Support Clinical Use?**

Nicola Schieda, MD (*Presenter*) Nothing to Disclose

##### **M7-CGU01D Vesical Imaging Reporting and Data System (VI-RADS): Diagnostic Accuracy, Inter-observer Agreement, and Clinical Use**

Valeria Panebianco, MD (*Presenter*) Nothing to Disclose

##### **M7-CGU01E O-RADS for MRI**

Andrea G. Rockall, FRCR, MRCP (*Presenter*) Nothing to Disclose

##### **M7-CGU01F How Will Machine Learning Influence our Diagnostic Classification Systems?**

Caroline Reinhold, MD, MSc (*Presenter*) Research Grant, Imagia Cybernetics Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGU01B

### **Adding Value through Disease-Specific Structured Reporting**

Monday, Nov. 27 3:00PM - 4:00PM Room: N227B

Atul B. Shinagare, MD (*Presenter*) Consultant, VirtualScopics, Inc; Consultant, Imaging Endpoints

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## Abstract Archives of the RSNA, 2023

M7-CGU01C

### **Bosniak Classification v.2019: Dose Emerging Evidence Support Clinical Use?**

Monday, Nov. 27 3:00PM - 4:00PM Room: N227B

Nicola Schieda, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGU01D

### **Vesical Imaging Reporting and Data System (VI-RADS): Diagnostic Accuracy, Inter-observer Agreement, and Clinical Use**

Monday, Nov. 27 3:00PM - 4:00PM Room: N227B

Valeria Panebianco, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGU01E

### **O-RADS for MRI**

Monday, Nov. 27 3:00PM - 4:00PM Room: N227B

Andrea G. Rockall, FRCR, MRCP (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CGU01F

### How Will Machine Learning Influence our Diagnostic Classification Systems?

Monday, Nov. 27 3:00PM - 4:00PM Room: N227B

Caroline Reinhold, MD, MSc (*Presenter*) Research Grant, Imagia Cybernetics Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CHN02

### **T-Bone Central: High-Yield Topics in Temporal Bone Imaging**

Monday, Nov. 27 3:00PM - 4:00PM Room: E451A

Salman Qureshi, MBChB (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To understand radiological anatomy of the temporal bone with a systematic approach. 2) To identify the clinical context of hearing loss management via surgical approaches. 3) To assess the radiological manifestations of hearing loss in paediatrics.

#### **COURSE DESCRIPTION**

Lecture format reviewing spectrum of temporal bone pathology from childhood to adulthood.

#### **Sub-Events**

##### **M7-CHN02B Practical Temporal Bone Anatomy**

Bruno A. Policeni, MD, MBA (*Presenter*) Nothing to Disclose

##### **M7-CHN02C Surgical Approaches in the Temporal Bone**

Amy F. Juliano, MA (*Presenter*) Nothing to Disclose

##### **M7-CHN02D Pediatric Sensorineural Hearing Loss**

Caroline D. Robson, MBChB (*Presenter*) Author with royalties, Reed Elsevier

##### **M7-CHN02E Infection in the Temporal Bone**

Kalen Riley, MD, MBA (*Presenter*) Nothing to Disclose

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## **Abstract Archives of the RSNA, 2023**

M7-CHN02B

### **Practical Temporal Bone Anatomy**

Monday, Nov. 27 3:00PM - 4:00PM Room: E451A

Bruno A. Policeni, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CHN02C

### **Surgical Approaches in the Temporal Bone**

Monday, Nov. 27 3:00PM - 4:00PM Room: E451A

Amy F. Juliano, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M7-CHN02D

### **Pediatric Sensorineural Hearing Loss**

Monday, Nov. 27 3:00PM - 4:00PM Room: E451A

Caroline D. Robson, MBChB (*Presenter*) Author with royalties, Reed Elsevier

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CHN02E

### **Infection in the Temporal Bone**

Monday, Nov. 27 3:00PM - 4:00PM Room: E451A

Kalen Riley, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CIN15

### **Best Practices for AI Model Regulation and Human-AI Collaboration (Supported in part by an Unrestricted Medical Education Grant from Siemens Healthineers of Siemens Medical Solutions, USA, Inc.)**

Monday, Nov. 27 3:00PM - 4:00PM Room: S401

Krishna Juluru, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Describe the FDA clearance and approval process for AI models including the necessary steps, timelines, and costs. Attendees will gain an understanding of the regulatory landscape and learn how to access up-to-date information about FDA regulated AI models. 2) Examine regulatory compliance when implementing AI models in the healthcare setting. 3) Illustrate practical strategies for enhancing human-AI interaction.

#### **COURSE DESCRIPTION**

This course is part of the "Best Practices in AI" series, designed to assist practicing radiologists and administrators in comprehending and enhancing process related to AI regulation and human-AI interaction. The course is comprised of three lectures by industry experts followed by an open Q and A session. The discussion will focus on two key topics. The first two lectures will provide an overview of the FDA process, covering important aspects such as timelines, costs associated with FDA clearance/approval, how to access an up-to-date list of FDA regulated AI models, understanding clearance documents, and ensuring compliant with regulatory guidelines when implementing an AI model. The second topic and final lecture will explore strategies to optimize human-machine interaction. It will delve into methods for integrating AI capabilities with clinical intelligence (medical knowledge) to improve the accuracy of AI systems, enhance explainability of AI-generated results, and expedite the development of clinician trust in AI technology.

#### **Sub-Events**

##### **M7-CIN15B How the FDA Considers AI**

Krishna Juluru, MD (*Presenter*) Nothing to Disclose

##### **M7-CIN15C FDA AI Basics**

Lisa M. Baumhardt, BSc, MS (*Presenter*) Nothing to Disclose

##### **M7-CIN15D Human - AI Collaboration**

Shandong Wu, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M7-CIN15B

### **How the FDA Considers AI**

Monday, Nov. 27 3:00PM - 4:00PM Room: S401

Krishna Juluru, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CIN15C

### **FDA AI Basics**

Monday, Nov. 27 3:00PM - 4:00PM Room: S401

Lisa M. Baumhardt, BSc, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CIN15D

### Human - AI Collaboration

Monday, Nov. 27 3:00PM - 4:00PM Room: S401

Shandong Wu, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-CMK03

### High Resolution Imaging of Common Pathology in the Wrist and Hand

Monday, Nov. 27 3:00PM - 4:00PM Room: E450A

Hillary W. Garner, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Demonstrate the imaging features of common pathologies of the wrist and hand. 2) Explain the advantages and limitations of radiographs, ultrasound, CT, and MRI in the evaluation of hand and wrist pathology.

#### COURSE DESCRIPTION

Common pathologies of the hand and wrist will be demonstrated in a case-based lecture format using radiographs and ultrasound as well as high-resolution CT and MRI. Tips and tricks on how to hone the differential diagnosis will be incorporated. At the end of the session, the audience will have a better understanding of optimal imaging techniques for various hand and wrist pathologies.

#### Sub-Events

#### **M7-CMK03B Radiographic and CT Evaluation of Metacarpal and Phalangeal Fractures and Dislocations**

Hillary W. Garner, MD (*Presenter*) Nothing to Disclose

#### **M7-CMK03C Radiographic, CT, and MR Evaluation of Carpal Fractures, Dislocations, and Instability**

Naveen Subhas, MD, MPH (*Presenter*) Research support, Siemens AG

#### **M7-CMK03D MRI of Wrist and Thumb Ligamentous Injuries**

Christine B. Chung, MD (*Presenter*) Nothing to Disclose

#### **M7-CMK03E Imaging Evaluation of Common Nerve Pathology in the Wrist and Hand**

Zaid Jibri, FRCR, MRCS (*Presenter*) Nothing to Disclose

#### **M7-CMK03F Ultrasound Evaluation of Tendon and Pulley Injuries in the Wrist and Hand**

Aline Serfaty Sr, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M7-CMK03B

### **Radiographic and CT Evaluation of Metacarpal and Phalangeal Fractures and Dislocations**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450A

Hillary W. Garner, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M7-CMK03C

### **Radiographic, CT, and MR Evaluation of Carpal Fractures, Dislocations, and Instability**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450A

Naveen Subhas, MD, MPH (*Presenter*) Research support, Siemens AG

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## Abstract Archives of the RSNA, 2023

M7-CMK03D

### **MRI of Wrist and Thumb Ligamentous Injuries**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450A

Christine B. Chung, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CMK03E

### **Imaging Evaluation of Common Nerve Pathology in the Wrist and Hand**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450A

Zaid Jibri, FRCR, MRCS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CMK03F

### **Ultrasound Evaluation of Tendon and Pulley Injuries in the Wrist and Hand**

Monday, Nov. 27 3:00PM - 4:00PM Room: E450A

Aline Serfaty Sr, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CNPM15

### Reimbursement Issues: Updates in 2023

Monday, Nov. 27 3:00PM - 4:00PM Room: E351

Richard E. Heller III, MD (*Moderator*) Consultant, Gerson Lehrman Group, Inc;

#### LEARNING OBJECTIVES

1) Identify key changes to Medicare reimbursement, including both the physician fee schedule and the Quality Payment Program, that are relevant to radiology reimbursement. 2) Identify key issues with implementation of the No Surprises Act that are relevant to radiology reimbursement. 3) List actions that medical practices and physicians can take to help protect patients' access to high quality medical imaging.

#### COURSE DESCRIPTION

The session will provide updates on three important aspects of radiology reimbursement policy: the Medicare physician fee schedule, the Quality Payment Program (created by MACRA) and the No Surprises Act.

#### Sub-Events

##### **M7- CNPM15B Medicare Fee Schedule Update**

Richard E. Heller III, MD (*Presenter*) Consultant, Gerson Lehrman Group, Inc;

##### **M7- CNPM15C Medicare: Quality Payment Program Updates**

Lauren P. Nicola, MD (*Presenter*) Nothing to Disclose

##### **M7- CNPM15D No Surprises Act**

Edward R. Gaines III, JD (*Presenter*) Officer, Zotec Partners LLC

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## Abstract Archives of the RSNA, 2023

M7-CNPM15B

### Medicare Fee Schedule Update

Monday, Nov. 27 3:00PM - 4:00PM Room: E351

Richard E. Heller III, MD (*Presenter*) Consultant, Gerson Lehrman Group, Inc;

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## Abstract Archives of the RSNA, 2023

M7-CNPM15C

### **Medicare: Quality Payment Program Updates**

Monday, Nov. 27 3:00PM - 4:00PM Room: E351

Lauren P. Nicola, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CNPM15D

### **No Surprises Act**

Monday, Nov. 27 3:00PM - 4:00PM Room: E351

Edward R. Gaines III, JD (*Presenter*) Officer, Zotec Partners LLC

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## Abstract Archives of the RSNA, 2023

M7-CPD02

### Protecting the Innocent: Recognizing Child Abuse on Imaging

Monday, Nov. 27 3:00PM - 4:00PM Room: N228

Yoshino Tamaki T. Sameshima, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Differentiating metabolic bone disease and child abuse. 2) Develop an understanding of pathophysiology of neuroimaging findings in non-accidental trauma and recognize suspicious imaging findings. 3) Differentiating accidental and non-accidental abdominal injuries in children.

#### COURSE DESCRIPTION

This comprehensive series of lectures focuses on various aspects of child abuse recognition and diagnosis through imaging techniques. Participants will learn how to protect innocent children by recognizing signs of abuse on imaging, including skeletal injuries, head trauma, and abdominal injuries. The lectures cover differentiating between metabolic bone diseases and child abuse, identifying abusive head trauma and describing it accurately, as well as determining whether abdominal injuries in children are accidental or non-accidental. By acquiring these skills and knowledge, attendees will be better equipped to safeguard vulnerable children and provide appropriate care and intervention when necessary.

#### Sub-Events

##### **M7-CPD02B The Pediatric Skeleton: Differentiating Metabolic Bone Disease and Child Abuse**

Jeannette M. Perez-Rossello, MD (*Presenter*) Nothing to Disclose

##### **M7-CPD02C Abusive Head Trauma: What to Look for and How to Describe It**

Murat Alp Oztek, MD (*Presenter*) Nothing to Disclose

##### **M7-CPD02D Abdominal Injuries in Children: Accidental or not?**

Peter J. Strouse, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M7-CPD02B

### **The Pediatric Skeleton: Differentiating Metabolic Bone Disease and Child Abuse**

Monday, Nov. 27 3:00PM - 4:00PM Room: N228

Jeannette M. Perez-Rossello, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CPD02C

### **Abusive Head Trauma: What to Look for and How to Describe It**

Monday, Nov. 27 3:00PM - 4:00PM Room: N228

Murat Alp Oztek, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CPD02D

### **Abdominal Injuries in Children: Accidental or not?**

Monday, Nov. 27 3:00PM - 4:00PM Room: N228

Peter J. Strouse, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CPH16

### Chicago Fireside Chat: Best of AAPM Summer School - MRgRT (MR-guided Radiation Therapy)

Monday, Nov. 27 3:00PM - 4:00PM Room: E353B

Vrinda Narayana, PhD (*Moderator*) Nothing to Disclose  
Daniel A. Low, PhD (*Presenter*) Scientific Advisory Board, ViewRay, Inc  
R. Jason Stafford, PhD (*Presenter*) Nothing to Disclose  
Eenas Omari, PhD (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Overview the state of the art in MRgRT. 2) Understand the basic clinical implementation of MRgRT. 3) Understand the promise and challenges of MRgRT.

#### COURSE DESCRIPTION

With the introduction of MRgRT systems, Magnetic Resonance Imaging-Guided Radiation Therapy has expanded into community practice settings. Using an interactive Q and A session with participants, this session aims to educate new and seasoned users on the practical implementation of MRgRT and the workflows related to online adapted therapy as discussed at the AAPM Summer School. (<https://w4.aapm.org/meetings/2021SS/programInfo/postMeetingAccess.php>).

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## Abstract Archives of the RSNA, 2023

M7-CRO07

### GYN Case Based Multidisciplinary Review

Monday, Nov. 27 3:00PM - 4:00PM Room: S402

Aoife Kilcoyne, MBBCh (*Moderator*) Royalties, Wolters Kluwer nv; Author, Wolters Kluwer nv

#### LEARNING OBJECTIVES

1) Expose the attendees to a multidisciplinary discussion related to diagnosis and treatment of Gynecologic malignancies. 2) Demonstrate important imaging findings that directly affect staging and treatment decisions. 3) Provide the audience with specific information they should include in their reports that can directly affect prognosis and management.

#### COURSE DESCRIPTION

This is a case-based multidisciplinary review, for Radiologists and Radiation Oncologists, on the diagnosis and management of Gynecologic Malignancy.

#### Sub-Events

##### M7-CRO07B GYN Case Based Multidisciplinary Review

Madeleine Sertic, MBBCh (*Presenter*) Nothing to Disclose

##### M7-CRO07C GYN Case Based Multidisciplinary Review

Stephanie Markovina, MD, PhD (*Presenter*) Research Grant, GlaxoSmithKline plc

##### M7-CRO07D GYN Case Based Multidisciplinary Review

Lilie Lin, MD (*Presenter*) Investigator, AstraZeneca PLC; Research Grant, Pfizer Inc

##### M7-CRO07E GYN Case Based Multidisciplinary Review

Premal Thaker, MD (*Presenter*) Advisory Board, Mersana Therapeutics, Inc; Advisory Board, ImmunoGen, Inc; Advisory Board, NovoCure Ltd; Advisory Board, Merck & Co, Inc; Advisory Board, AstraZeneca PLC; Advisory Board, GSK plc; Advisory Board, Clovis Oncology, Inc; Advisory Board, Zentalis Pharmaceuticals, Inc; Advisory Board, Eisai Co, Ltd; Advisory Board, Novartis AG; Data Safety Monitoring Board, Celsion Corporation; Data Safety Monitoring Board, Iovance Biotherapeutics, Inc; Research Grant, Merck & Co, Inc; Research Grant, GSK plc; Stockholder, Celsion Corporation

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-CRO07B

### **GYN Case Based Multidisciplinary Review**

Monday, Nov. 27 3:00PM - 4:00PM Room: S402

Madeleine Sertic, MBBCh (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CRO07C

### **GYN Case Based Multidisciplinary Review**

Monday, Nov. 27 3:00PM - 4:00PM Room: S402

Stephanie Markovina, MD, PhD (*Presenter*) Research Grant, GlaxoSmithKline plc

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## Abstract Archives of the RSNA, 2023

M7-CRO07D

### **GYN Case Based Multidisciplinary Review**

Monday, Nov. 27 3:00PM - 4:00PM Room: S402

Lilie Lin, MD (*Presenter*) Investigator, AstraZeneca PLC; Research Grant, Pfizer Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CRO07E

### **GYN Case Based Multidisciplinary Review**

Monday, Nov. 27 3:00PM - 4:00PM Room: S402

Premal Thaker, MD (*Presenter*) Advisory Board, Mersana Therapeutics, Inc;Advisory Board, ImmunoGen, Inc;Advisory Board, NovoCure Ltd;Advisory Board, Merck & Co, Inc;Advisory Board, AstraZeneca PLC;Advisory Board, GSK plc;Advisory Board, Clovis Oncology, Inc;Advisory Board, Zentalis Pharmaceuticals, Inc;Advisory Board, Eisai Co, Ltd;Advisory Board, Novartis AG;Data Safety Monitoring Board, Celsion Corporation;Data Safety Monitoring Board, Iovance Biotherapeutics, Inc;Research Grant, Merck & Co, Inc;Research Grant, GSK plc;Stockholder, Celsion Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CVA07

### Non-Atherosclerotic Arterial Vascular Disease

Monday, Nov. 27 3:00PM - 4:00PM Room: N226

Felipe A. Sanchez, MD (*Moderator*) Nothing to Disclose

Brian B. Ghoshhajra, MD, MBA (*Moderator*) Research Grant, Siemens AG; Consultant, Koninklijke Philips NV; Consultant, Siemens AG

#### LEARNING OBJECTIVES

1) Review essential pathological and clinical features of non-atherosclerotic vascular arterial diseases. 2) Illustrate multimodality imaging findings of different non-atherosclerotic arterial disorders and congenital vascular anomalies. 3) Explain the role of non-invasive imaging in non-atherosclerotic arterial diseases.

#### COURSE DESCRIPTION

Besides atherosclerosis, arterial vessels may be affected by several pathological entities. This session is focused on non-atherosclerotic arterial vascular diseases, including inflammatory, non-inflammatory, congenital, and heritable disorders. Format: Lectures

#### Sub-Events

##### M7-CVA07C Vasculitis and Inflammatory Aortic Disease

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

##### M7-CVA07D Fibromuscular Dysplasia and Related Non-Inflammatory Disorders

Brian B. Ghoshhajra, MD, MBA (*Presenter*) Research Grant, Siemens AG; Consultant, Koninklijke Philips NV; Consultant, Siemens AG

##### M7-CVA07E Congenital Vascular Anomalies and Malformations

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

##### M7-CVA07F Imaging in Heritable Thoracic Aortic Disease

Gauri R. Karur, MBBS, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M7-CVA07C

### **Vasculitis and Inflammatory Aortic Disease**

Monday, Nov. 27 3:00PM - 4:00PM Room: N226

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CVA07D

### **Fibromuscular Dysplasia and Related Non-Inflammatory Disorders**

Monday, Nov. 27 3:00PM - 4:00PM Room: N226

Brian B. Ghoshhajra, MD, MBA (*Presenter*) Research Grant, Siemens AG; Consultant, Koninklijke Philips NV; Consultant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-CVA07E

### **Congenital Vascular Anomalies and Malformations**

Monday, Nov. 27 3:00PM - 4:00PM Room: N226

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-CVA07F

### **Imaging in Heritable Thoracic Aortic Disease**

Monday, Nov. 27 3:00PM - 4:00PM Room: N226

Gauri R. Karur, MBBS, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CAS05

### **Diving Deeper from Diagnostics - Theranostics and Radiotherapeutics (Sponsored by the RSNA Associated Sciences Consortium)**

Monday, Nov. 27 4:30PM - 5:30PM Room: N230B

Nancy McDonald, MS (*Moderator*) Nothing to Disclose  
Napapong Pongnapang, BSc, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify the use of theranostic agents in cancer diagnosis, staging and treatment. 2) Explain operational and logistical needs to build your own Theranostics Program. 3) Gain a comprehensive understanding of theranostics and radiotherapeutics to contribute to the development and implementation of Radioligand Therapy Program.

#### **COURSE DESCRIPTION**

This program is designed to provide an in-depth understanding of the principles, techniques and applications of Theranostics and Radiotherapeutics in medicine. This interdisciplinary course explores the triaging, ancillary medications needed, billing and design of Radioligand Program.

#### **Sub-Events**

##### **M8-CAS05C Evolution of Radiotherapeutics**

Dena Abdelhameed, PharmD (*Presenter*) Nothing to Disclose

##### **M8-CAS05D Basics of Establishing a Radioligand Therapy Program**

Lyndsi Hay, MS, BS (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M8-CAS05C

### Evolution of Radiotherapeutics

Monday, Nov. 27 4:30PM - 5:30PM Room: N230B

Dena Abdelhameed, PharmD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

M8-CAS05D

### **Basics of Establishing a Radioligand Therapy Program**

Monday, Nov. 27 4:30PM - 5:30PM Room: N230B

Lyndsi Hay, MS, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CIN16

### Best Practices for AI Model Selection

Monday, Nov. 27 4:30PM - 5:30PM Room: S401

Judy W. Gichoya, MBChB, MS (*Moderator*) Consultant, Softbrew Digital LTD

#### LEARNING OBJECTIVES

1) Learn how to evaluate an AI model effectively in practice (accuracy, ROI, scalability). 2) Learn how to prioritize use cases of AI that work the best for your practice. 3) Learn about the AI Vendor Market Landscape.

#### COURSE DESCRIPTION

Join a panel discussion of experts to learn about strategies for AI model selection, pilot evaluation, and the overall market landscape.

#### Sub-Events

##### **M8-CIN16B How to Evaluate an AI Model (Accuracy, Reliability, ROI)**

Ryan K. Lee, MD, MBA (*Presenter*) Bayer, Speaker's BureauPhilips, Speaker's BureauBracco, Advisor

##### **M8-CIN16C How to Evaluate AI use Cases and Vendors**

K. Elizabeth Hawk, MD, PhD (*Presenter*) Nothing to Disclose

##### **M8-CIN16D AI Vendor and Market Landscape Overview**

Lyndsey A. Burton, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

M8-CIN16B

### **How to Evaluate an AI Model (Accuracy, Reliability, ROI)**

Monday, Nov. 27 4:30PM - 5:30PM Room: S401

Ryan K. Lee, MD, MBA (*Presenter*) Bayer, Speaker's BureauPhilips, Speaker's BureauBracco, Advisor

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## Abstract Archives of the RSNA, 2023

M8-CIN16C

### How to Evaluate AI use Cases and Vendors

Monday, Nov. 27 4:30PM - 5:30PM Room: S401

K. Elizabeth Hawk, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CIN16D

### **AI Vendor and Market Landscape Overview**

Monday, Nov. 27 4:30PM - 5:30PM Room: S401

Lyndsey A. Burton, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M8-CNMMI04

### Chest Imaging: When Molecular Imaging Helps

Monday, Nov. 27 4:30PM - 5:30PM Room: N227B

Ryan J. Avery, MD (*Moderator*) Research Consultant, Konica Minolta, Inc

#### LEARNING OBJECTIVES

1) A case-based review discussing the emerging of Molecular Imaging techniques, which can improve detection of ischemic heart disease, infiltrative cardiomyopathies, and inflammatory cardiomyopathies, with a focus on sarcoidosis. 2) Provide a discussion of new Molecular Imaging techniques that are available for routine clinical diagnosis of pathologies related to coronary artery disease and infiltrative/inflammatory cardiomyopathies. Further, the rationale of the examinations will be provided by explaining the medical and imaging sciences that necessitate when and how to perform these examinations. 3) The case-based approach will discuss the key imaging findings that can be used to improve diagnosis of cardiothoracic diseases. Given the novelty of these exams, a review of important incidental findings and imaging pitfalls will also be provided to improve examination implementation and interpretation.

#### COURSE DESCRIPTION

Imaging of the heart and lungs has increasingly become a multi-modality approach. With numerous recent advances in Molecular Imaging, physicians increasingly need an approach as to when hybrid or targeted Molecular Imaging examinations can confirm pathophysiologic processes affecting the Cardiothoracic system.

#### Sub-Events

##### **M8-CNMMI04B** Multimodality Perspective of Cardiac Sarcoidosis - Hybridizing FDG-PET and Cardiac MR Imaging

Ryan J. Avery, MD (*Presenter*) Research Consultant, Konica Minolta, Inc

##### **M8-CNMMI04C** Complementary Roles of PET, MRI, and CT in Cardiac Ischemia, Small Vessel Disease, and COVID

Pamela K. Woodard, MD (*Presenter*) Researcher, Siemens AG;Consulting, Medtronic plc;Researcher, Bayer AG;Patent, Washington University

##### **M8-CNMMI04D** Multimodality Imaging of Infiltrative and Inflammatory Cardiomyopathy

Robert K. Zeman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CNMMI04B

### **Multimodality Perspective of Cardiac Sarcoidosis - Hybridizing FDG-PET and Cardiac MR Imaging**

Monday, Nov. 27 4:30PM - 5:30PM Room: N227B

Ryan J. Avery, MD (*Presenter*) Research Consultant, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CNMMI04C

### **Complementary Roles of PET, MRI, and CT in Cardiac Ischemia, Small Vessel Disease, and COVID**

Monday, Nov. 27 4:30PM - 5:30PM Room: N227B

Pamela K. Woodard, MD (*Presenter*) Researcher, Siemens AG; Consulting, Medtronic plc; Researcher, Bayer AG; Patent, Washington University

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CNMMI04D

### **Multimodality Imaging of Infiltrative and Inflammatory Cardiomyopathy**

Monday, Nov. 27 4:30PM - 5:30PM Room: N227B

Robert K. Zeman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CNPM06

### Spotlight on Safety Net Hospitals, Health Disparities, and Unique Barriers to Rural Care (Sponsored by the RSNA Health Equity Committee and the RSNA Committee on Diversity, Equity and Inclusion)

Monday, Nov. 27 4:30PM - 5:30PM Room: N229

Lucy B. Spalluto, MD, MPH (*Moderator*) Nothing to Disclose  
Gwendolyn M. Bryant-Smith, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain the history of safety net hospitals in the United States and the role of these hospitals in current day healthcare. 2) Identify unique barriers to radiologic care for rural populations. 3) Discuss developing breast and lung cancer screening programs for underserved populations.

#### COURSE DESCRIPTION

This course will spotlight safety net hospitals, health disparities, challenges to providing care for underserved and rural populations, and strategies to overcome these challenges. Many physicians and other members of the health care team are unaware of the history and purpose of the safety net hospital system in the United States. The safety net hospital system addresses unique barriers to care that marginalized and diverse populations endure, including rural populations. Many health care team members have limited understanding of how safety net hospitals meet these challenges. This course will provide an opportunity to gain an understanding of unique barriers to care for marginalized populations, immigrant, rural, urban, and gender diverse groups so that we might improve and become more helpful during our physician-patient interactions.

#### Sub-Events

##### **M8- CNPM06C** History of Safety Net Hospitals in the US: Are They Still Needed?

Jinel A. Scott, MD (*Presenter*) Nothing to Disclose

##### **M8- CNPM06D** Developing Programs for Breast Cancer Screening for Underserved Populations

Ronda Henry-Tillman, MD (*Presenter*) Nothing to Disclose

##### **M8- CNPM06E** Unique Barriers to Rural Populations Concerning Breast Health

Daniela A. Ochoa, MD (*Presenter*) Nothing to Disclose

##### **M8- CNPM06F** Partnering with Rural Community Hospitals to Establish a Satellite Lung Cancer Screening Network

Cecelia Brewington, MD (*Presenter*) Research Grant, Canon Medical Systems Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CNPM06C

### **History of Safety Net Hospitals in the US: Are They Still Needed?**

Monday, Nov. 27 4:30PM - 5:30PM Room: N229

Jinel A. Scott, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CNPM06D

### **Developing Programs for Breast Cancer Screening for Underserved Populations**

Monday, Nov. 27 4:30PM - 5:30PM Room: N229

Ronda Henry-Tillman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CNPM06E

### **Unique Barriers to Rural Populations Concerning Breast Health**

Monday, Nov. 27 4:30PM - 5:30PM Room: N229

Daniela A. Ochoa, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

M8-CNPM06F

### **Partnering with Rural Community Hospitals to Establish a Satellite Lung Cancer Screening Network**

Monday, Nov. 27 4:30PM - 5:30PM Room: N229

Cecelia Brewington, MD (*Presenter*) Research Grant, Canon Medical Systems Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CPH04

### Clinical Implementation and Standardization of Proton Magnetic Resonance Spectroscopy

Monday, Nov. 27 4:30PM - 5:30PM Room: E353B

Yuxiang Zhou, PHD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review the physical principles of magnetic resonance spectroscopy (MRS) and MRS pulse sequences. 2) Describe strategies to effectively acquire, analyze, and quantify the quality of MRS data. 3) Discuss emerging applications of MRS in clinical practice. 4) Provide MRS reporting standards and discuss future perspectives in clinical reality.

#### COURSE DESCRIPTION

Magnetic resonance spectroscopy (MRS) permits the quantification of metabolites within a diverse range of tissues and pathologies. This metabolic information has been shown to enable better diagnoses, personalized treatments, and rapid assessment of treatment response. However, implementation of MRS remains challenging and consistent acquisition of high-quality data remains difficult due to the lack of technical standardization. This session will provide experts' advice, consensus recommendations, standardization of MRS acquisition, analysis and reporting to improve MRS quality in routine clinical practice. First, this educational course will introduce the physical principles of MRS and describe the latest clinically available MRS pulse sequences. Next, this course will present strategies to effectively and consistently acquire high-quality MRS data, robustly analyze this data, and perform MRS quality management in routine clinical practice. Finally, this session will discuss established and emerging applications of MRS, reporting standards and future perspectives in clinical reality.

#### Sub-Events

##### **M8-CPH04B Magnetic Resonance Spectroscopy: Fundamental Physics and Emerging Technologies**

Samuel A. Einstein, PhD (*Presenter*) Nothing to Disclose

##### **M8-CPH04C Standardization of Data Acquisition and Analysis of Clinical Magnetic Resonance Spectroscopy**

Yuxiang Zhou, PHD (*Presenter*) Nothing to Disclose

##### **M8-CPH04D MRS Applications, Reporting Standards and Future Perspectives in Clinical Reality**

Ichiro Ikuta, MD, MMedSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CPH04B

### **Magnetic Resonance Spectroscopy: Fundamental Physics and Emerging Technologies**

Monday, Nov. 27 4:30PM - 5:30PM Room: E353B

Samuel A. Einstein, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CPH04C

### **Standardization of Data Acquisition and Analysis of Clinical Magnetic Resonance Spectroscopy**

Monday, Nov. 27 4:30PM - 5:30PM Room: E353B

Yuxiang Zhou, PHD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-CPH04D

### **MRS Applications, Reporting Standards and Future Perspectives in Clinical Reality**

Monday, Nov. 27 4:30PM - 5:30PM Room: E353B

Ichiro Ikuta, MD, MMedSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP09

### The Academy for Radiology and Biomedical Imaging Research 2023 Imaging Shark Bait Session

Monday, Nov. 27 4:00PM - 5:30PM Room: S406B

Scott A. Penner, JD (*Moderator*) Spouse, Research Grant, General Electric Company; Spouse, Consultant, Human Longevity, Inc; Spouse, Stockholder, CureMetrix, Inc; Spouse, Stock options, Cortechs.ai

#### LEARNING OBJECTIVES

1) Identifying strategies for bringing research to the competitive marketplace. 2) Presenting a proposal in a way that elicits interest from potential investors. 3) Taking steps to secure investor funding while developing and protecting their intellectual property. 4) Identifying ways to generate business value through licensing and collaborations.

#### COURSE DESCRIPTION

This year, the Academy for Radiology & Biomedical Imaging Research's traditional Shark Tank program will shift from our traditional competition style format to a more inclusive and broader-reaching Shark Bait Session. We will welcome an expert panel composed of venture capitalists, an intellectual property attorney, leaders of industry & academia, and a former pitcher/entrepreneur that has successfully obtained funding. In this session attendees will learn what experts look for and expect when deciding to invest in an innovative idea, providing tips, shared experiences, and an opportunity to ask questions. If you have ever wondered how to pitch your idea or if you wish to consider alternative funding resources, do not miss this fun, educational, and interactive session!

#### Sub-Events

##### **M8-RCP09B Expert Shark - Intellectual Property Law**

Scott A. Penner, JD (*Presenter*) Spouse, Research Grant, General Electric Company; Spouse, Consultant, Human Longevity, Inc; Spouse, Stockholder, CureMetrix, Inc; Spouse, Stock options, Cortechs.ai

##### **M8-RCP09C Expert Shark - Academia**

Miriam A. Bredella, MD, MBA (*Presenter*) Nothing to Disclose

##### **M8-RCP09D Expert Shark - Industry**

Susan Harris, MS (*Presenter*) Employee, General Electric Company

##### **M8-RCP09E Expert Shark - Venture Capital**

Emir S. Sandhu, MD, MBA (*Presenter*) Nothing to Disclose

##### **M8-RCP09F Expert Shark - Entrepreneur**

Andrew D. Smith, MD, PhD (*Presenter*) Owner, AI Metrics LLC; Chairman, AI Metrics LLC; Officer, AI Metrics LLC; Patent agreement, AI Metrics LLC; Owner, Radiostics LLC; CEO, Radiostics LLC; Speaker, Canon Medical Systems Corporation; Patent holder, AI and Image Processing Algorithms

##### **M8-RCP09G Expert Shark - Venture Capital**

Kelsey Tsai, MBA (*Presenter*) Employee, Blue Venture Fund

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP09B

### **Expert Shark - Intellectual Property Law**

Monday, Nov. 27 4:00PM - 5:30PM Room: S406B

Scott A. Penner, JD (*Presenter*) Spouse, Research Grant, General Electric Company; Spouse, Consultant, Human Longevity, Inc; Spouse, Stockholder, CureMetrix, Inc; Spouse, Stock options, Cortechs.ai

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP09C

### Expert Shark - Academia

Monday, Nov. 27 4:00PM - 5:30PM Room: S406B

Miriam A. Bredella, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M8-RCP09D

### Expert Shark - Industry

Monday, Nov. 27 4:00PM - 5:30PM Room: S406B

Susan Harris, MS (*Presenter*) Employee, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP09E

### Expert Shark - Venture Capital

Monday, Nov. 27 4:00PM - 5:30PM Room: S406B

Emir S. Sandhu, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP09F

### Expert Shark - Entrepreneur

Monday, Nov. 27 4:00PM - 5:30PM Room: S406B

Andrew D. Smith, MD, PhD (*Presenter*) Owner, AI Metrics LLC;Chairman, AI Metrics LLC;Officer, AI Metrics LLC;Patent agreement, AI Metrics LLC;Owner, Radiostics LLC;CEO, Radiostics LLC;Speaker, Canon Medical Systems Corporation;Patent holder, AI and Image Processing Algorithms

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M8-RCP09G

### Expert Shark - Venture Capital

Monday, Nov. 27 4:00PM - 5:30PM Room: S406B

Kelsey Tsai, MBA (*Presenter*) Employee, Blue Venture Fund

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP22

### **Solving the Retention Problem: Addressing Moral Injury in Radiology Practice (Sponsored by the RSNA Quality Improvement Committee)**

Monday, Nov. 27 4:30PM - 5:30PM Room: N226

Bettina Siewert, MD (*Moderator*) Editor, Wolters Kluwer nv;Reviewer, Wolters Kluwer nv

#### **LEARNING OBJECTIVES**

1) Describe the impact of moral distress on radiologists' well-being and staff retention. 2) Identify the most common contributors to moral distress in radiologists. 3) Identify countermeasures to moral distress in radiology practice.

#### **COURSE DESCRIPTION**

18% of radiologists have left a position because of moral distress and 28% have considered doing. This course will explore the impact of moral distress on radiologists' well-being and explore its connection to burn-out. Common causes of moral distress will be discussed as well as countermeasures mitigating its impact. The course consists of five 10-minutes lectures with time for discussion. Participants will be provided with practical action items for implementation in their work environment to decrease moral distress.

#### **Sub-Events**

##### **M8-RCP22B Moral Distress and Its Impact on Burn-out**

Rama S. Ayyala, MD (*Presenter*) Nothing to Disclose

##### **M8-RCP22C Common Contributors to Moral Distress in Radiology**

Bettina Siewert, MD (*Presenter*) Editor, Wolters Kluwer nv;Reviewer, Wolters Kluwer nv

##### **M8-RCP22D Managing the Workload-radiologist Mismatch**

Michael A. Bruno, MD, MS (*Presenter*) Nothing to Disclose

##### **M8-RCP22E Maintaining the Teaching Mission to Reduce Moral Distress in Academic Radiology**

Marion A. Hughes, MD, JD (*Presenter*) Nothing to Disclose

##### **M8-RCP22F Importance of Leadership in Countering Moral Distress**

Frank J. Lexa, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP22B

### **Moral Distress and Its Impact on Burn-out**

Monday, Nov. 27 4:30PM - 5:30PM Room: N226

Rama S. Ayyala, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP22C

### **Common Contributors to Moral Distress in Radiology**

Monday, Nov. 27 4:30PM - 5:30PM Room: N226

Bettina Siewert, MD (*Presenter*) Editor, Wolters Kluwer nv; Reviewer, Wolters Kluwer nv

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP22D

### **Managing the Workload-radiologist Mismatch**

Monday, Nov. 27 4:30PM - 5:30PM Room: N226

Michael A. Bruno, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M8-RCP22E

### **Maintaining the Teaching Mission to Reduce Moral Distress in Academic Radiology**

Monday, Nov. 27 4:30PM - 5:30PM Room: N226

Marion A. Hughes, MD, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M8-RCP22F

### **Importance of Leadership in Countering Moral Distress**

Monday, Nov. 27 4:30PM - 5:30PM Room: N226

Frank J. Lexa, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CER16

### **Pregnancy in the Emergency Room, Collaborative Session OB/GYN and Multisystem**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S406B

Peter M. Doubilet, MD, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Diagnose normal and abnormal intrauterine and ectopic pregnancy. 2) Diagnose or exclude placental abruption based on sonographic findings. 3) Understand how best to use imaging modalities in pregnant women who present to the emergency room following trauma.

#### **COURSE DESCRIPTION**

This course will cover the use of diagnostic imaging in evaluating pregnant woman who present to the emergency room. One focus will be on women who present following trauma, where the course will address the appropriate use of imaging modalities, including ultrasound and computed tomography, and approaches to diagnosis (including the FAST ultrasound exam). A second focus will be on women who present with emergency symptoms, most commonly pain or vaginal bleeding, in the first trimester, where the course will address diagnosis of ectopic pregnancy, miscarriage of intrauterine pregnancy, and ovarian torsion. The third focus will be on women who present with emergency symptoms in the second and third trimesters, where the course will address diagnosis of placenta previa or abruption, cervical shortening, and assessment of fetal well-being.

#### **Sub-Events**

##### **R1-CER16B Trauma and the ER Pregnant Patient**

Kedar G. Sharbidre, MD (*Presenter*) Nothing to Disclose

##### **R1-CER16C First Trimester in the Emergency Room**

Peter M. Doubilet, MD, PhD (*Presenter*) Nothing to Disclose

##### **R1-CER16D Second and Third Trimester in the Emergency Room**

Carol B. Benson, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CER16B

### **Trauma and the ER Pregnant Patient**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S406B

Kedar G. Sharbidre, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CER16C

### **First Trimester in the Emergency Room**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S406B

Peter M. Doubilet, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CER16D

### **Second and Third Trimester in the Emergency Room**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S406B

Carol B. Benson, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CGI12

### **Pancreaticobiliary Imaging**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N230B

Kumaresan Sandrasegaran, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Be able to recognize causes of secondary sclerosing cholangitis. 2) Recognize the clinical implications of the level of biliary obstruction in malignant bile duct obstruction. 3) Learn the importance of template reporting of severe acute pancreatitis. 3) Understand the revised Atlanta criteria for acute pancreatitis.

#### **COURSE DESCRIPTION**

1. Cover common and uncommon causes of secondary sclerosing cholangitis. 2. Focus on the importance of accurate and detailed review of imaging prior to percutaneous biliary intervention for malignant bile duct obstruction. 3. Understand the revised Atlanta criteria for acute pancreatitis.

#### **Sub-Events**

#### **R1-CGI12B Biliary Pathology (Example, PSC, IgG4, Stones, Recurrent Pyogenic Cholangitis, etc.)**

Mark A. Anderson, MD (*Presenter*) Nothing to Disclose

#### **R1-CGI12C Cholangiocarcinoma**

Meghan G. Lubner, MD (*Presenter*) Spouse, Consultant, Elephas Bio

#### **R1-CGI12D Pancreatitis**

Kumaresan Sandrasegaran, MD (*Presenter*) Nothing to Disclose

#### **R1-CGI12E Biliary Interventions**

Anne M. Covey, MD (*Presenter*) Stockholder, Amgen Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CGI12B

**Biliary Pathology (Example, PSC, IgG4, Stones, Recurrent Pyogenic Cholangitis, etc.)**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N230B

Mark A. Anderson, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-CGI12C

### **Cholangiocarcinoma**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N230B

Meghan G. Lubner, MD (*Presenter*) Spouse, Consultant, Elephas Bio

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CGI12D

### **Pancreatitis**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N230B

Kumaresan Sandrasegaran, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CGI12E

### **Biliary Interventions**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N230B

Anne M. Covey, MD (*Presenter*) Stockholder, Amgen Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIN09

### Coronary Artery Calcium Opportunistic Screening with Real-World Implementation Experience

Thursday, Nov. 30 8:00AM - 9:00AM Room: S401

Ross W. Filice, MD (*Moderator*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

#### LEARNING OBJECTIVES

1) Understand the utility and expanded screening population enabled by this technology. 2) Learn about real-world implementation challenges, opportunities, and considerations. 3) Consider how to establish care pathways with cardiology and other specialties.

#### COURSE DESCRIPTION

Coronary artery calcium (CAC) scoring is one of the cornerstones of cardiology risk assessment providing an opportunity to intervene on patients at risk and to save lives. Artificial intelligence now allows us to reliably obtain a CAC score on routine non-gated chest CTs and establish care pathways for referral and treatment. Learn about the underlying technology but also important regulatory and deployment considerations as well as how to establish a care pathway with an important perspective from a cardiologist.

#### Sub-Events

##### **R1-CIN09B Coronary Calcium Screening Deployment Considerations**

John Mongan, MD, PhD (*Presenter*) Research Grant, General Electric Company;Research Grant, Siemens AG;Research Grant, Amazon Web Services, Inc;Royalties, General Electric Company;Spouse, Employee, Annexon, Inc;Spouse, Employee, AbbVie Inc

##### **R1-CIN09C Coronary Calcium Meets AI**

Bhavik N. Patel, MD, MBA (*Presenter*) Nothing to Disclose

##### **R1-CIN09D Referral Pathways for Patients with a High Coronary Artery Calcium Score Detected by AI**

Ross W. Filice, MD (*Presenter*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

##### **R1-CIN09E Perks and Pitfalls of General Coronary Artery Calcium Score Screening from the Cardiologist's Perspective**

Monvadi Barbara Srichai-Parsia, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIN09B

### Coronary Calcium Screening Deployment Considerations

Thursday, Nov. 30 8:00AM - 9:00AM Room: S401

John Mongan, MD, PhD (*Presenter*) Research Grant, General Electric Company; Research Grant, Siemens AG; Research Grant, Amazon Web Services, Inc; Royalties, General Electric Company; Spouse, Employee, Annexon, Inc; Spouse, Employee, AbbVie Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIN09C

### Coronary Calcium Meets AI

Thursday, Nov. 30 8:00AM - 9:00AM Room: S401

Bhavik N. Patel, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIN09D

### Referral Pathways for Patients with a High Coronary Artery Calcium Score Detected by AI

Thursday, Nov. 30 8:00AM - 9:00AM Room: S401

Ross W. Filice, MD (*Presenter*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIN09E

### **Perks and Pitfalls of General Coronary Artery Calcium Score Screening from the Cardiologist's Perspective**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S401

Monvadi Barbara Srichai-Parsia, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-CIR05

### Acute Pulmonary Embolism and Venous Interventions

Thursday, Nov. 30 8:00AM - 9:00AM Room: E350

Robert A. Lookstein, MD, MSc (*Moderator*) Consultant, Boston Scientific Corporation; Consultant, Medtronic plc; Consultant, Penumbra, Inc; Consultant, ShockWave Medical

#### LEARNING OBJECTIVES

1) Review the evidence base for endovascular management of venous thromboembolism. 2) Discuss the current status of prospective research related to the endovascular management of venous thromboembolism.

#### COURSE DESCRIPTION

Endovascular Therapy is increasingly being utilized to treat patients with symptomatic venous thromboembolism (Acute Pulmonary Embolism and Deep Vein Thrombosis). A number of prospective research trials are currently underway or are being planned to define the exact role of this growing practice. A diverse faculty will review the current evidence base and give insight for the data needed for the future.

#### Sub-Events

##### R1-CIR05B State of Science: Trial Landscape and Future Prospects

Robert A. Lookstein, MD, MSc (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Medtronic plc; Consultant, Penumbra, Inc; Consultant, ShockWave Medical

##### R1-CIR05C Therapeutic Options: Endovascular Lysis

Julie C. Bulman, MD (*Presenter*) Nothing to Disclose

##### R1-CIR05D Therapeutic Options: Endovascular Thrombectomy

Leigh Casadaban, MD (*Presenter*) Nothing to Disclose

##### R1-CIR05E How to Start a PE Program: Lessons Learned

Lisa Rauschert, MD (*Presenter*) Nothing to Disclose

##### R1-CIR05F IVC Reconstruction and Filters

Gordon McLennan, MD (*Presenter*) Consulting, Becton, Dickinson and Company; Consulting, General Electric Company; Stock Options, TriSalus Life Sciences; Grant, TriSalus Life Sciences

##### R1-CIR05G Acute and Chronic DVT Management

Juan Carlos Perez Lozada, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R1-CIR05B

### State of Science: Trial Landscape and Future Prospects

Thursday, Nov. 30 8:00AM - 9:00AM Room: E350

Robert A. Lookstein, MD, MSc (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Medtronic plc; Consultant, Penumbra, Inc; Consultant, ShockWave Medical

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIR05C

### **Therapeutic Options: Endovascular Lysis**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E350

Julie C. Bulman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIR05D

### **Therapeutic Options: Endovascular Thrombectomy**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E350

Leigh Casadaban, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIR05E

### **How to Start a PE Program: Lessons Learned**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E350

Lisa Rauschert, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CIR05F

### **IVC Reconstruction and Filters**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E350

Gordon McLennan, MD (*Presenter*) Consulting, Becton, Dickinson and Company; Consulting, General Electric Company; Stock Options, TriSalus Life Sciences; Grant, TriSalus Life Sciences

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R1-CIR05G

### **Acute and Chronic DVT Management**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E350

Juan Carlos Perez Lozada, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CMK09

### From Skin to Bone: Imaging of Infection

Thursday, Nov. 30 8:00AM - 9:00AM Room: N229

Erin F. Alaia, MD (*Moderator*) Biorez Inc, Consultant

#### LEARNING OBJECTIVES

1) To recognize the characteristic imaging findings of bone and soft tissue infection. 2) To review important pearls and common pitfalls in the diagnosis of musculoskeletal infection.

#### COURSE DESCRIPTION

This course will include lectures which review in detail the imaging of musculoskeletal infection. The attendee will gain understanding of the imaging of osteomyelitis, chronic bone infection, and spine infection, as well as joint, tendon sheath, bursa, and soft tissue infection.

#### Sub-Events

##### R1-CMK09B Imaging of Osteomyelitis

Erin F. Alaia, MD (*Presenter*) Biorez Inc, Consultant

##### R1-CMK09C Imaging of Spine Infection

David C. Gimarc, MD (*Presenter*) Nothing to Disclose

##### R1-CMK09D Imaging Features of Infection in Joints, Tendon Sheaths and Bursae

Felix Gonzalez, MD (*Presenter*) Nothing to Disclose

##### R1-CMK09E Imaging of Soft Tissue Infection

William B. Morrison, MD (*Presenter*) Co-founder, Trace Orthopedics; Patent agreement, Trace Orthopedics; Consultant, AprioMed AB; Patent agreement, AprioMed AB; Consultant, Centinel Spine, LLC; Consultant, Medical Metrics, Inc

##### R1-CMK09F Imaging of Chronic Bone Infection

Matthew D. Bucknor, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-CMK09B

### **Imaging of Osteomyelitis**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N229

Erin F. Alaia, MD (*Presenter*) Biorez Inc, Consultant

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CMK09C

### **Imaging of Spine Infection**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N229

David C. Gimarc, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CMK09D

### **Imaging Features of Infection in Joints, Tendon Sheaths and Bursae**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N229

Felix Gonzalez, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CMK09E

### Imaging of Soft Tissue Infection

Thursday, Nov. 30 8:00AM - 9:00AM Room: N229

William B. Morrison, MD (*Presenter*) Co-founder, Trace Orthopedics;Patent agreement, Trace Orthopedics;Consultant, AprioMed AB;Patent agreement, AprioMed AB;Consultant, Centinel Spine, LLC;Consultant, Medical Metrics, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CMK09F

### **Imaging of Chronic Bone Infection**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N229

Matthew D. Bucknor, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CNPM12

### **Mentorship, Sponsorship and Coaching: Not Just for Early Career (Sponsored by the RSNA Committee on Diversity, Equity and Inclusion)**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E351

Judy Yee, MD (*Moderator*) Research Grant, General Electric Company  
Charlotte J. Yong-Hing, MD, FRCPC (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Understand the importance of using mentorship, sponsorship and coaching to help decrease the loss of mid career women and URiM in radiology.2) Identify the challenges of invisible minorities including LGBTQ radiologists and how we can provide support.3) Learn how to implement institution and department specific strategies to assure that all radiologists thrive after hire.

#### **COURSE DESCRIPTION**

The percentage of women and URiM faculty in radiology has remained stagnant despite an increase in medical school matriculants who have been traditionally underrepresented. There is a distinct need to increase the number of women and URiM entering radiology and to assure that they receive appropriate mentorship, sponsorship and coaching to succeed and to be promoted to higher ranks. This session will focus on the mid-career leaky pipeline that occurs for women and URiM and will provide potential solutions. The perspective of invisible minorities including LGBTQ faculty will be provided and how we can also provide support. Because institutions can be quite different, understanding the local culture is key to successfully implementing strategies to help with fixing the leaky pipeline.

#### **Sub-Events**

##### **R1- CNPM12C The Mid-Career Leaky Pipeline**

Charlotte J. Yong-Hing, MD, FRCPC (*Presenter*) Nothing to Disclose

##### **R1- CNPM12D The Importance of Supporting Invisible Minorities**

Justin Holder, MD (*Presenter*) Nothing to Disclose

##### **R1- CNPM12E How to Effectively Mentor and Sponsor Mid-Career Faculty**

Christine M. Glastonbury, MBBS (*Presenter*) Author with royalties, RELX;

##### **R1- CNPM12F Assuring that Women Radiologists Thrive in Your Program**

Gloria M. Salazar, MD (*Presenter*) Consultant, Speakers Bureau, Medtronic plc;Consultant, Boston Scientific Corporation;Speakers Bureau, Boston Scientific Corporation;Speakers Bureau, Cook Group Incorporated;Consultant, Avail Medsystems, Inc;Consultant, Mentice AB

##### **R1- CNPM12G Panel Discussion**

Daria Manos, FRCPC (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH;Advisory Board, AstraZeneca PLC

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## Abstract Archives of the RSNA, 2023

R1-CNPM12C

### **The Mid-Career Leaky Pipeline**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E351

Charlotte J. Yong-Hing, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CNPM12D

### **The Importance of Supporting Invisible Minorities**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E351

Justin Holder, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-CNPM12E

### **How to Effectively Mentor and Sponsor Mid-Career Faculty**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E351

Christine M. Glastonbury, MBBS (*Presenter*) Author with royalties, RELX;

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## Abstract Archives of the RSNA, 2023

R1-CNPM12F

### **Assuring that Women Radiologists Thrive in Your Program**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E351

Gloria M. Salazar, MD (*Presenter*) Consultant, Speakers Bureau, Medtronic plc; Consultant, Boston Scientific Corporation; Speakers Bureau, Boston Scientific Corporation; Speakers Bureau, Cook Group Incorporated; Consultant, Avail Medsystems, Inc; Consultant, Mentice AB

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CNPM12G

### Panel Discussion

Thursday, Nov. 30 8:00AM - 9:00AM Room: E351

Daria Manos, FRCPC (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH; Advisory Board, AstraZeneca PLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CNR10

### What's New in Pediatric Neuroinfectious and Neuroinflammatory Disorders

Thursday, Nov. 30 8:00AM - 9:00AM Room: S404

Rupa Radhakrishnan, MD, MS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Familiar with characteristic imaging patterns of pediatric CNS infectious conditions. 2) Understand the impact of perinatal infections on the developing brain. 3) Be aware of advances in pediatric autoimmune and demyelinating disorders.

#### Sub-Events

##### **R1-CNR10B They Read the Book: Classic Presentations of Common Pediatric CNS Infections**

Julie B. Guerin, MD (*Presenter*) Nothing to Disclose

##### **R1-CNR10C Alphabet Soup of CNS: Autoimmune and Demyelinating Conditions in Children**

Susan Palasis, MD (*Presenter*) Nothing to Disclose

##### **R1-CNR10D More than TORCH: Neuroimaging of Perinatal and Neonatal Infections**

Rupa Radhakrishnan, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CNR10B

### **They Read the Book: Classic Presentations of Common Pediatric CNS Infections**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S404

Julie B. Guerin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CNR10C

### **Alphabet Soup of CNS: Autoimmune and Demyelinating Conditions in Children**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S404

Susan Palasis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CNR10D

### **More than TORCH: Neuroimaging of Perinatal and Neonatal Infections**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S404

Rupa Radhakrishnan, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CPD10

### AI in Pediatric Radiology: What is a Reality Now and in the Near Future

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450A

David B. Larson, MD, MBA (*Moderator*) Research Grant, Siemens AG ;Advisor, Bunkerhill Health;Shareholder, Bunkerhill Health

#### LEARNING OBJECTIVES

1) Learn about how both interpretive and non-interpretive AI tools can help improve efficiency and productivity in a pediatric radiology practice. 2) Understand why AI designed for adults may not be expected to perform similarly in pediatric patients and what may be done to mitigate this risk.

#### COURSE DESCRIPTION

We will explore the current state of understanding regarding benefits, challenges, and risks in implementing AI in a pediatric radiology practice, including risks associated with the use of AI models trained on adults applied to pediatric populations. The session will feature four expert presenters followed by a panel Q&A.

#### Sub-Events

##### R1-CPD10B Guidelines for AI use in Pediatric Radiology Practice

Susan C. Shelmerdine, MBBS, FRCR (*Presenter*) Nothing to Disclose

##### R1-CPD10C Interpretive AI: How Can it Help the Busy Pediatric Radiologist?

Safwan Halabi, MD (*Presenter*) Advisor, Change Healthcare

##### R1-CPD10D Non-interpretative AI: Enhancing Workflow and Simplifying Processes

Nabile M. Safdar, MD, MPH (*Presenter*) Nothing to Disclose

##### R1-CPD10E Deploying AI Algorithms in Pediatric Radiology: Risks and Opportunities of Emulating Models of Adults

Marla Sammer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

R1-CPD10B

### **Guidelines for AI use in Pediatric Radiology Practice**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450A

Susan C. Shelmerdine, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CPD10C

### **Interpretive AI: How Can it Help the Busy Pediatric Radiologist?**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450A

Safwan Halabi, MD (*Presenter*) Advisor, Change Healthcare

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CPD10D

### **Non-interpretative AI: Enhancing Workflow and Simplifying Processes**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450A

Nabile M. Safdar, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CPD10E

### **Deploying AI Algorithms in Pediatric Radiology: Risks and Opportunities of Emulating Models of Adults**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450A

Marla Sammer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-CPH10

### Deep Learning in MRI

Thursday, Nov. 30 8:00AM - 9:00AM Room: S402

Fang Liu, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain the current clinical applications of deep learning in MRI. 2) Understand the basic methods applied in rapid MRI and MRI analysis.

#### COURSE DESCRIPTION

This course offers an overview of present deep learning (DL) techniques for MRI, including an introduction to DL principles in rapid image acquisition, reconstruction, post-processing, and analysis. Speakers will deliver a review of current DL utility and impact in clinical MRI, for example, musculoskeletal imaging, and an outlook on challenges and future directions of DL in MRI translational and clinical applications.

#### Sub-Events

##### **R1-CPH10B Rapid MRI Using AI: Methodology, Evaluation, and Clinical Translation**

Susie Y. Huang, MD, PhD (*Presenter*) Research Grant, Siemens AG

##### **R1-CPH10C Applications of AI in Musculoskeletal MRI: Disease Diagnosis and Prediction**

Richard Kijowski, MD (*Presenter*) Research Consultant, Boston Imaging Core Lab, LLC

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## Abstract Archives of the RSNA, 2023

R1-CPH10B

### **Rapid MRI Using AI: Methodology, Evaluation, and Clinical Translation**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S402

Susie Y. Huang, MD, PhD (*Presenter*) Research Grant, Siemens AG

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## Abstract Archives of the RSNA, 2023

R1-CPH10C

### **Applications of AI in Musculoskeletal MRI: Disease Diagnosis and Prediction**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S402

Richard Kijowski, MD (*Presenter*) Research Consultant, Boston Imaging Core Lab, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-RCP21

### Artificial Intelligence (AI) in Medical Imaging - The Pathway to Translation (Translational Research Educational Course (TREC) (Sponsored by the RSNA Research Development Committee)

Thursday, Nov. 30 8:00AM - 9:00AM Room: N228

J. Brian Fowlkes, PhD (*Moderator*) Research Grant, Koninklijke Philips NV; Equipment support, General Electric Company  
Shadi Abdar Esfahani, MD, MPH (*Moderator*) Scientific Advisory Board, RefleXion Medical Inc; Scientific Advisory Board, ImaginAb, Inc; Scientific Advisory Board, General Electric Company; Scientific Advisory Board, Trevarx Biomedical, Inc; Consultant, General Electric Company; Spouse, CEO, Trevarx Biomedical, Inc; Spouse, Owner, Trevarx Biomedical, Inc

#### LEARNING OBJECTIVES

1) Describe the current landscape for translating new AI tools to the clinic. 2) Understand aspects needed to move a new AI tool from an academic research lab to a commercial product. 3) Recognize essential needs of startup companies in this environment.

#### COURSE DESCRIPTION

This 1-hour session is designed to address the knowledge gap concerning guiding researchers to successfully translate research into clinical practice. This year it will provide a specific example on Artificial Intelligence (AI) as applied to robotics for image-guided intervention in the context of a startup company. This course will cover some of the steps needed such as developing the idea, assessing the clinical need, commercial demand, securing funding, making a team of collaborators to translate and commercialize the product. These topics will be addressed by speakers with expertise on different aspects of translational imaging research in the context of AI. The format will be presentations by 1) Translational clinician-investigator involved in the AI tool development and testing, 2) Computer/data scientist that helped develop the AI tools used and 3) the company CEO considering the commercialization, regulatory approval and marketing, with a Q&A panel session. The outcome of the course will be to provide the audience with a representative example of such translation efforts and the opportunity to discuss with the speakers their experiences.

#### Sub-Events

##### R1-RCP21C Artificial Intelligence (AI) in Medical Imaging - Conceptualizing Clinical Needs

Anthony E. Samir, MD, MPH (*Presenter*) Consultant, AstraZeneca PLC; Research funded, AstraZeneca PLC; Consultant, Bracco Group; Consultant, Bristol-Myers Squibb Company; Consultant, General Electric Company; Scientific Advisory Board, General Electric Company; Research support, General Electric Company

##### R1-RCP21D Artificial Intelligence (AI) in Medical Imaging - From Need to Functioning and Investible Prototype Technology

Matthew R. Johnson, MS (*Presenter*) Nothing to Disclose

##### R1-RCP21E Artificial Intelligence (AI) in Medical Imaging - From Prototype Technology to Translational Plan

Romeo Catracchia, MBA, BSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-RCP21C

### **Artificial Intelligence (AI) in Medical Imaging - Conceptualizing Clinical Needs**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N228

Anthony E. Samir, MD, MPH (*Presenter*) Consultant, AstraZeneca PLC; Research funded, AstraZeneca PLC; Consultant, Bracco Group; Consultant, Bristol-Myers Squibb Company; Consultant, General Electric Company; Scientific Advisory Board, General Electric Company; Research support, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-RCP21D

### **Artificial Intelligence (AI) in Medical Imaging - From Need to Functioning and Investible Prototype Technology**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N228

Matthew R. Johnson, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-RCP21E

### **Artificial Intelligence (AI) in Medical Imaging - From Prototype Technology to Translational Plan**

Thursday, Nov. 30 8:00AM - 9:00AM Room: N228

Romeo Catracchia, MBA, BSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CBR12

### Localization and Biopsy Techniques for the Breast

Thursday, Nov. 30 9:30AM - 10:30AM Room: N229

Sarah M. Friedewald, MD (*Moderator*) Consultant, Hologic, Inc;Research Grant, Alphabet Inc

#### LEARNING OBJECTIVES

1) Identify different ways to optimize tomosynthesis, US and MRI guided biopsies. 2) Appreciate different methods of image guided localizations, and understand their strengths and limitations.

#### COURSE DESCRIPTION

In this course, the attendee will learn the basics of DBT, US and MRI guided biopsies as well as different localization techniques. The most recent literature supporting these techniques will be reviewed. Additionally, through imaging examples, different scenarios will be presented that the radiologist may encounter during these procedures. A practical guide on how to troubleshoot various issues that might arise will be presented.

#### Sub-Events

##### R3-CBR12B Tomo Guided Biopsy and Localization Techniques

Sarah M. Friedewald, MD (*Presenter*) Consultant, Hologic, Inc;Research Grant, Alphabet Inc

##### R3-CBR12C US Guided Biopsy, Localization and Seeds

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

##### R3-CBR12D MRI Guided Biopsy and Localization Techniques

Laurie R. Margolies, MD (*Presenter*) Stock options, Nuevozen Corporation Medical Advisory Board, Screenpoint Medical

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CBR12B

### **Tomo Guided Biopsy and Localization Techniques**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N229

Sarah M. Friedewald, MD (*Presenter*) Consultant, Hologic, Inc; Research Grant, Alphabet Inc

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## Abstract Archives of the RSNA, 2023

R3-CBR12C

### **US Guided Biopsy, Localization and Seeds**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N229

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R3-CBR12D

### **MRI Guided Biopsy and Localization Techniques**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N229

Laurie R. Margolies, MD (*Presenter*) Stock options, Nuevozen Corporation Medical Advisory Board, Screenpoint Medical

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CCH10

### Lung Cancer Screening

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450A

Caroline Chiles, MD (*Moderator*) Advisory Board, AstraZeneca PLC

#### LEARNING OBJECTIVES

1) Recognize important additions to Lung-RADS 2022. 2) Understand how radiologists can optimize the risk: benefit ratio in their lung cancer screening patients. 3) Compare human intelligence and artificial intelligence in the interpretation and reporting of lung screening CT. 4) Appreciate the need for lung nodule tracking tools in lung cancer screening and incidental pulmonary nodule programs.

#### COURSE DESCRIPTION

Lung-RADS 2022 contains significant revisions that, in part, move suspected infectious lesions to “Lung-RADS 0, incomplete” rather than Lung-RADS 4, suspicious, allow juxtapleural nodules the same assessment as perifissural nodules, and define a Stepped Management to the follow-up of nodules. CT screening for lung cancer can reduce lung-cancer specific mortality, but this benefit must be weighed in each patient against potential risks. We describe how radiologists can mitigate the risks associated with CT screening. As the number of lung screening CTs increases, radiologists may benefit from artificial intelligence that can not only identify nodules but also provide risk assessment. Appropriate follow-up of lung nodules is necessary for the early detection of lung cancer. Tools for tracking lung nodules are essential for successful lung nodule management in lung cancer screening and incidental pulmonary nodule programs.

#### Sub-Events

##### **R3-CCH10B Lung-RADS 2022 - A User's Guide**

Ashley E. Prosper, MD (*Presenter*) Nothing to Disclose

##### **R3-CCH10C The Role of Radiologists in Mitigating the Harms of Lung Cancer Screening**

Terrance T. Healey, MD (*Presenter*) Nothing to Disclose

##### **R3-CCH10D Humans and Machines in Early Lung Cancer Detection**

Denise R. Aberle, MD (*Presenter*) Investigator, Johnson & Johnson; Research Grant, Johnson & Johnson

##### **R3-CCH10E Tools for Tracking Lung Nodule Follow-up**

Debra S. Dyer, MD (*Presenter*) Consultant, AstraZeneca PLC; Clinical Advisory Board, IMIDEX Inc

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## Abstract Archives of the RSNA, 2023

R3-CCH10B

### **Lung-RADS 2022 - A User's Guide**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450A

Ashley E. Prosper, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CCH10C

### **The Role of Radiologists in Mitigating the Harms of Lung Cancer Screening**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450A

Terrance T. Healey, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CCH10D

### **Humans and Machines in Early Lung Cancer Detection**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450A

Denise R. Aberle, MD (*Presenter*) Investigator, Johnson & Johnson; Research Grant, Johnson & Johnson

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CCH10E

### Tools for Tracking Lung Nodule Follow-up

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450A

Debra S. Dyer, MD (*Presenter*) Consultant, AstraZeneca PLC;Clinical Advisory Board, IMIDEX Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CGU06

### Emerging Technologies in GU Imaging

Thursday, Nov. 30 9:30AM - 10:30AM Room: S406B

Fiona M. Fennessy, MBBCh, PhD (*Moderator*) Consultant, Imaging Endpoints II LLC

#### LEARNING OBJECTIVES

1) Understand the current and future roles of targeted molecular imaging in improving GU cancer diagnosis, treatment planning, and surveillance. 2) Understand when and how to use a radiofrequency needle track cautery device to prevent bleeding or tumor track seeding during abdominal biopsies. 3) Identify the benefits and limitations of AI in improving workflow efficiency and patient outcomes in GU imaging.

#### COURSE DESCRIPTION

This course will provide participants information on how the future of GU imaging looks, outlining new MR, molecular, interventional and AI imaging pathways, and demonstrate how these will have the potential to improve accuracy and efficiency of complex GU imaging.

#### Sub-Events

##### R3-CGU06B Artificial Intelligence

Andrew D. Smith, MD, PhD (*Presenter*) Owner, AI Metrics LLC;Chairman, AI Metrics LLC;Officer, AI Metrics LLC;Patent agreement, AI Metrics LLC;Owner, Radiostics LLC;CEO, Radiostics LLC;Speaker, Canon Medical Systems Corporation;Patent holder, AI and Image Processing Algorithms

##### R3-CGU06C Molecular Imaging

Jan Grimm, MD, PhD (*Presenter*) Nothing to Disclose

##### R3-CGU06D MRI Technology

Sadhna Verma, MD (*Presenter*) Nothing to Disclose

##### R3-CGU06E Radiofrequency Track Cautery to Prevent Biopsy-Related Bleeding or Tumor Seeding

Paul B. Shyn, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R3-CGU06B

### Artificial Intelligence

Thursday, Nov. 30 9:30AM - 10:30AM Room: S406B

Andrew D. Smith, MD, PhD (*Presenter*) Owner, AI Metrics LLC;Chairman, AI Metrics LLC;Officer, AI Metrics LLC;Patent agreement, AI Metrics LLC;Owner, Radiostics LLC;CEO, Radiostics LLC;Speaker, Canon Medical Systems Corporation;Patent holder, AI and Image Processing Algorithms

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## Abstract Archives of the RSNA, 2023

R3-CGU06C

### **Molecular Imaging**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S406B

Jan Grimm, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CGU06D

### **MRI Technology**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S406B

Sadhna Verma, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-CGU06E

### Radiofrequency Track Cautery to Prevent Biopsy-Related Bleeding or Tumor Seeding

Thursday, Nov. 30 9:30AM - 10:30AM Room: S406B

Paul B. Shyn, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CNMMI05

### Revolution in Alzheimer's Disease Therapy is Finally Here: What does the Radiologist Need to Know

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403A

Katherine A. Zukotynski, MD, PhD (*Moderator*) Research Consultant, Konica Minolta, Inc; Research Consultant, General Electric Company; Speakers Bureau, Jubilant DraxImage Inc

#### LEARNING OBJECTIVES

1) Understand the roles of amyloid PET and MRI in the treatment protocol for anti-amyloid therapy. 2) Review appropriate use criteria of amyloid PET in the era of anti-amyloid therapy. 3) Discuss the neurologist's perspective on what the radiologist/ nuclear medicine physician needs to know.

#### COURSE DESCRIPTION

We are on the cusp of a revolution in dementia therapy. In particular, new anti-amyloid therapy may have a meaningful impact in slowing cognitive impairment. Neurologists, neuroradiologists and nuclear medicine specialists will play key role determining the impact of this therapy.

#### Sub-Events

##### **R3-CNMMI05B Introduction to PET Biomarkers for Alzheimer's Disease**

Katherine A. Zukotynski, MD, PhD (*Presenter*) Research Consultant, Konica Minolta, Inc; Research Consultant, General Electric Company; Speakers Bureau, Jubilant DraxImage Inc

##### **R3-CNMMI05C Molecular Imaging for Optimal Patient Selection for Anti-Amyloid Therapy**

Phillip H. Kuo, MD, PhD (*Presenter*) Consultant, Konica Minolta, Inc; Consultant, Amgen Inc; Consultant, Blue Earth Diagnostics Ltd; Research Grant, Blue Earth Diagnostics Ltd; Consultant, Novartis AG; Speaker, Novartis AG; Consultant, Chimerix, Inc; Consultant, Fusion Pharmaceuticals Inc; Consultant, Bayer AG; Consultant, General Electric Company; Speaker, General Electric Company; Research Grant, General Electric Company; Speaker, Digital Science Press, Inc; Consultant, Radionetics; Former Employee, Konica Minolta, Inc

##### **R3-CNMMI05D What your Neurologist Wants You to Know about Diagnosis and Therapy of Alzheimer's Disease**

Gil Rabinovici, MD (*Presenter*) Scientific Advisory Board, Eisai Co, Ltd; Committee member, Johnson & Johnson; Research Grant, Eli Lilly and Company; Research Grant, General Electric Company; Research Grant, Life Molecular Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CNMMI05B

### **Introduction to PET Biomarkers for Alzheimer's Disease**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403A

Katherine A. Zukotynski, MD, PhD (*Presenter*) Research Consultant, Konica Minolta, Inc; Research Consultant, General Electric Company; Speakers Bureau, Jubilant DraxImage Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CNMMI05C

### **Molecular Imaging for Optimal Patient Selection for Anti-Amyloid Therapy**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403A

Phillip H. Kuo, MD, PhD (*Presenter*) Consultant, Konica Minolta, Inc;Consultant, Amgen Inc;Consultant, Blue Earth Diagnostics Ltd;Research Grant, Blue Earth Diagnostics Ltd;Consultant, Novartis AG;Speaker, Novartis AG;Consultant, Chimerix, Inc;Consultant, Fusion Pharmaceuticals Inc;Consultant, Bayer AG;Consultant, General Electric Company;Speaker, General Electric Company;Research Grant, General Electric Company;Speaker, Digital Science Press, Inc;Consultant, Radionetics;Former Employee, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CNMMI05D

### **What your Neurologist Wants You to Know about Diagnosis and Therapy of Alzheimer's Disease**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403A

Gil Rabinovici, MD (*Presenter*) Scientific Advisory Board, Eisai Co, Ltd; Committee member, Johnson & Johnson; Research Grant, Eli Lilly and Company; Research Grant, General Electric Company; Research Grant, Life Molecular Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CNPM13

### Reimagining Academia

Thursday, Nov. 30 9:30AM - 10:30AM Room: E351

Saurabh Jha, MBBS, MRCS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify challenges faced with recruitment and retention in academia. 2) Explain how these challenges can be met through orthodox and novel operational approaches.

#### COURSE DESCRIPTION

With growing radiologist shortage, increasing hospital consolidation, and growth of teleradiology, the academic landscape looks very different today from twenty years ago. How does academia maintain its traditional mission and yet support high clinical output in a competitive market without the faculty suffering burnout?

#### Sub-Events

##### **R3- CNPM13B**      **Leveraging Teleradiology for Academic Medical Centers**

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

##### **R3- CNPM13C**      **How to Recruit & Retain in Academia in Current Job Market**

Mitchell D. Schnall, MD, PhD (*Presenter*) Research Grant, Siemens AG

##### **R3- CNPM13D**      **Does Academia Still Glitter?**

Jessica G. Fried, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CNPM13B

### Leveraging Teleradiology for Academic Medical Centers

Thursday, Nov. 30 9:30AM - 10:30AM Room: E351

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CNPM13C

### **How to Recruit & Retain in Academia in Current Job Market**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E351

Mitchell D. Schnall, MD, PhD (*Presenter*) Research Grant, Siemens AG

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-CNPM13D

### **Does Academia Still Glitter?**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E351

Jessica G. Fried, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-COB07

### Dysfunctional Uterine Bleeding

Thursday, Nov. 30 9:30AM - 10:30AM Room: S502

Liina Poder, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Define normal and abnormal uterine bleeding in premenopausal, pregnant and postmenopausal patients. 2) Outline etiologies of abnormal uterine bleeding in premenopausal, pregnant and postmenopausal patients. 3) Explain the role of appropriate imaging algorithms in different clinical scenarios.

#### COURSE DESCRIPTION

This course will enhance skills in formulating accurate and comprehensive radiology reports for patients with dysfunctional uterine bleeding throughout the life cycle. Structural and nonstructural causes of dysfunctional uterine bleeding in premenopausal: pregnant, non pregnant and in postmenopausal patients will be reviewed. A detailed explanation of appropriate imaging approach including US, CT, MRI, Hysterosalpingography will be provided for all entities involving the premenopausal, pregnant and postmenopausal patients who present with dysfunctional uterine bleeding. After completion of this course the attendees will have a comprehensive understanding and have developed an expertise in most common causes to rare etiologies of dysfunctional uterine bleeding.

#### Sub-Events

##### R3-COB07B Abnormal Premenopausal Bleeding

Catherine R. Phillips, MD (*Presenter*) Nothing to Disclose

##### R3-COB07C Postmenopausal Bleeding

Mark D. Sugi, MD (*Presenter*) Consultant, Nextrast, Inc; Author with royalties, RELX

##### R3-COB07D Bleeding in Pregnancy

Liina Poder, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R3-COB07B

### **Abnormal Premenopausal Bleeding**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S502

Catherine R. Phillips, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-COB07C

### **Postmenopausal Bleeding**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S502

Mark D. Sugi, MD (*Presenter*) Consultant, Nextrast, Inc; Author with royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-COB07D

### **Bleeding in Pregnancy**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S502

Liina Poder, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CRO06

### Musculoskeletal Case Based Multidisciplinary Review

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450B

Edward Y. Kim, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Expose the attendees to multidisciplinary discussion when treating sarcomas and other musculoskeletal malignancies. 2) Demonstrate specific imaging findings that directly affect staging and treatment decisions. 3) Provide the audience with specific information they should include in their reports that directly affect prognosis and management.

#### COURSE DESCRIPTION

This multidisciplinary panel will discuss a series of challenging soft tissue and bone sarcoma cases. The session will highlight the importance of imaging in the diagnosis and treatment of these rare tumors. Panelists will represent radiology, orthopedic oncology, medical oncology, and radiation oncology.

#### Sub-Events

##### R3-CRO06B Musculoskeletal Case Based Multidisciplinary Review

Meng X. Welliver, MD, PhD (*Presenter*) Advisory Board, NovoCure Ltd; Advisory Board, Eli Lilly and Company

##### R3-CRO06C Musculoskeletal Case Based Multidisciplinary Review

Seth Pollack, MD (*Presenter*) Consultant, Bayer AG; Consultant, Deciphera Pharmaceuticals, LLC; Consultant, Apexigen Inc; Consultant, T-Knife, GmbH; Consultant, Aadi Bioscience, Inc; Consultant, Epizyme, Inc; Consultant, Obsidian; Consultant, Sensei; Consultant, SpringWorks Therapeutics, Inc

##### R3-CRO06D Musculoskeletal Case Based Multidisciplinary Review

Kevin Raskin, MD (*Presenter*) Nothing to Disclose

##### R3-CRO06E Musculoskeletal Case Based Multidisciplinary Review

F. Joseph Simeone, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CRO06B

### **Musculoskeletal Case Based Multidisciplinary Review**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450B

Meng X. Welliver, MD, PhD (*Presenter*) Advisory Board, NovoCure Ltd; Advisory Board, Eli Lilly and Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CRO06C

### **Musculoskeletal Case Based Multidisciplinary Review**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450B

Seth Pollack, MD (*Presenter*) Consultant, Bayer AG;Consultant, Deciphera Pharmaceuticals, LLC;Consultant, Apexigen Inc;Consultant, T-Knife, GmbH;Consultant, Aadi Bioscience, Inc;Consultant, Epizyme, Inc;Consultant, Obsidian;Consultant, Sensei;Consultant, SpringWorks Therapeutics, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-CRO06D

### **Musculoskeletal Case Based Multidisciplinary Review**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450B

Kevin Raskin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CRO06E

### **Musculoskeletal Case Based Multidisciplinary Review**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E450B

F. Joseph Simeone, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CVA01

### Multimodality Thoracic Aortic Imaging: What the Radiologist and Surgeon Need to Know

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403B

Kate Hanneman, MD, MPH (*Moderator*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc  
James C. Carr, MD (*Moderator*) Institutional Research Grant, Siemens AG; Advisory Board, Siemens AG; Travel support, Siemens AG; Institutional Research Grant, Bayer AG; Advisory Board, Bayer AG; Travel support, Bayer AG; Speaker, Bayer AG; Institutional Research Grant, Guerbet SA; Advisory Board, Bracco Group

#### LEARNING OBJECTIVES

1) Describe key aortic imaging findings for the radiologist including measurements. 2) Discuss imaging findings and reporting from the surgeons perspective. 3) Identify aortic imaging findings for interventional planning and post-intervention evaluation.

#### COURSE DESCRIPTION

This educational course will discuss aortic imaging from the perspective of the surgeon, diagnostic radiologist, and intervention radiologist.

#### Sub-Events

##### R3-CVA01C Thoracic Aortic Imaging: What the Surgeon Needs to Know

Jennifer Chung, MD (*Presenter*) Nothing to Disclose

##### R3-CVA01D Thoracic Aortic Imaging for the Diagnostic Radiologist: Measurements and Practical Considerations

Bradley D. Allen, MD, MS (*Presenter*) Consultant, Circle Cardiovascular Imaging Inc; Speaker, WebMD LLC

##### R3-CVA01E Thoracic Aortic Imaging: What the Interventional Radiologist Needs to Know

William Sherk, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CVA01C

### **Thoracic Aortic Imaging: What the Surgeon Needs to Know**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403B

Jennifer Chung, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R3-CVA01D

### **Thoracic Aortic Imaging for the Diagnostic Radiologist: Measurements and Practical Considerations**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403B

Bradley D. Allen, MD, MS (*Presenter*) Consultant, Circle Cardiovascular Imaging Inc; Speaker, WebMD LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-CVA01E

### **Thoracic Aortic Imaging: What the Interventional Radiologist Needs to Know**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S403B

William Sherk, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-RCP23

### **MR Safety: Case Based Approach to Scanning Patients with Active Implants (Sponsored by the RSNA Quality Improvement Committee)**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

William F. Sensakovic, PhD (*Moderator*) Nothing to Disclose  
Samuel J. Fahrenholtz, PhD (*Moderator*) Stockholder, Nano X Imaging

#### **LEARNING OBJECTIVES**

1) Identify safety issues related to active implants. 2) Describe strategies to meet implant scanning requirements. 3) Review considerations for scanning off-label. 4) Understand actions to take when a safety incident occurs.

#### **COURSE DESCRIPTION**

Description of Program: A unique challenge to MR safety is the logistics of managing patients with active implants due to the diversity of device safety labeling and large number of requested exams. In this session, there are four talks presenting case-based examples of managing patients with active implants. These talks progress from initial screening, to MR scanning protocol modifications, to off-label considerations, to managing safety events.

#### **Sub-Events**

##### **R3-RCP23C Safety Assessment of Patients with Active Implants**

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

##### **R3-RCP23D Safety Assessment of Patients with Active Implants**

Maureen N. Hood, PhD, RN (*Presenter*) In-kind support, General Electric Company

##### **R3-RCP23E Heating and Scan Time Management: Tricks of the Trade**

Yuxiang Zhou, PHD (*Presenter*) Nothing to Disclose

##### **R3-RCP23F Heating and Scan Time Management: Tricks of the Trade**

Scott B. Reeder, MD, PhD (*Presenter*) Owner, Calimetrix; Owner, Reveal Pharmaceuticals; Owner, Collectar Biosciences, Inc; Owner, Elucent Medical; Owner, HeartVista, Inc;;

##### **R3-RCP23G Off-label Scanning of Patients with Active Implants**

Candice Bookwalter, MD, PhD (*Presenter*) Nothing to Disclose

##### **R3-RCP23H Off-label Scanning of Patients with Active Implants**

Samuel J. Fahrenholtz, PhD (*Presenter*) Stockholder, Nano X Imaging

##### **R3-RCP23I What to Do When an Incident, or Near Miss, Occurs**

Anshuman Panda, PhD (*Presenter*) Nothing to Disclose

##### **R3-RCP23J What to Do When an Incident, or Near Miss, Occurs**

Andrew Bowman, MD, PhD (*Presenter*) Nothing to Disclose

## Abstract Archives of the RSNA, 2023

R3-RCP23C

### **Safety Assessment of Patients with Active Implants**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

R3-RCP23D

### **Safety Assessment of Patients with Active Implants**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

Maureen N. Hood, PhD, RN (*Presenter*) In-kind support, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-RCP23E

### Heating and Scan Time Management: Tricks of the Trade

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

Yuxiang Zhou, PHD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-RCP23F

### Heating and Scan Time Management: Tricks of the Trade

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

Scott B. Reeder, MD, PhD (*Presenter*) Owner, Calimetrix;Owner, Reveal Pharmaceuticals;Owner, Collectar Biosciences, Inc;Owner, Elucent Medical;Owner, HeartVista, Inc;;

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## **Abstract Archives of the RSNA, 2023**

R3-RCP23G

### **Off-label Scanning of Patients with Active Implants**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

Candice Bookwalter, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R3-RCP23H

### **Off-label Scanning of Patients with Active Implants**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

Samuel J. Fahrenholtz, PhD (*Presenter*) Stockholder, Nano X Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-RCP23I

### **What to Do When an Incident, or Near Miss, Occurs**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

Anshuman Panda, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-RCP23J

### **What to Do When an Incident, or Near Miss, Occurs**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N230B

Andrew Bowman, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CBR13

### Breast Screening Update

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450B

Thomas H. Helbich, MD, MBA (*Moderator*) Grant, Siemens AG; Grant, Bracco Group; Grant, Guerbet SA; Grant, Hologic, Inc; Grant, Novomed GmbH

#### LEARNING OBJECTIVES

1) To provide an update on breast screening strategies in the US, Canada, Europe and Australia. 2) To be aware how AI, supplement screening and screening with tomosynthesis has been introduced in these countries.

#### COURSE DESCRIPTION

Build your knowledge with top experts on different screening programs in US, Canada, Europe, and Australia. At the completion of the session, attendees should understand the current up to date thinking about screening programs and how their different approaches impact results and outcome.

#### Sub-Events

##### R4-CBR13B Status of Screening in USA

Murray Rebner, MD (*Presenter*) Nothing to Disclose

##### R4-CBR13C Status of Screening in Canada

Paula B. Gordon, MD, FRCPC (*Presenter*) Stockholder, OncoGenex Pharmaceuticals, Inc; Stockholder, Volpara Health Technologies Limited; Scientific Advisor, Besins Healthcare SA

##### R4-CBR13D Status of Screening in Australia

Helen Frazer, FRANZCR, MBBS (*Presenter*) Nothing to Disclose

##### R4-CBR13E Status of Screening in Europe

Rosalind M. Given-Wilson, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CBR13B

### Status of Screening in USA

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450B

Murray Rebner, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CBR13C

### Status of Screening in Canada

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450B

Paula B. Gordon, MD, FRCPC (*Presenter*) Stockholder, OncoGenex Pharmaceuticals, Inc; Stockholder, Volpara Health Technologies Limited; Scientific Advisor, Besins Healthcare SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CBR13D

### **Status of Screening in Australia**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450B

Helen Frazer, FRANZCR, MBBS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CBR13E

### **Status of Screening in Europe**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E450B

Rosalind M. Given-Wilson, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CCA02

### Cardiac Transcatheter Intervention: The Whole Journey from Planning to Fixing it

Thursday, Nov. 30 11:00AM - 12:00PM Room: N226

Prabhakar Rajiah, MD, FRCR (*Moderator*) Nothing to Disclose  
Phillip M. Young, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To become familiar with the more common structural heart interventions and the role of CT in pre-procedural planning. 2) To understand potential complications of these interventions and the role of imaging in post-procedural care.

#### COURSE DESCRIPTION

Several speakers will review current state-of-the-art imaging for procedural planning and followup. Radiologists should come out with a better understanding of how to support this rapidly growing field.

#### Sub-Events

##### R4-CCA02C TMVR: MAC, Rings and Other Things

Jonathon A. Leipsic, MD (*Presenter*) Consultant, Heartflow, Inc; Consultant, Circle Cardiovascular Imaging Inc; Speakers Bureau, General Electric Company; Research Grant, Edwards Lifesciences Corporation; Research Grant, Medtronic plc; Research Grant, Abbott Laboratories; Research Grant, Boston Scientific Corporation; Research Grant, PI-Cardia Ltd

##### R4-CCA02D When Things Go Sideways: TAVR and Beyond

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

##### R4-CCA02E Plugs & Baskets: Imaging for LAA Closure

Monika Radike, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CCA02C

### **TMVR: MAC, Rings and Other Things**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N226

Jonathon A. Leipsic, MD (*Presenter*) Consultant, Heartflow, Inc;Consultant, Circle Cardiovascular Imaging Inc;Speakers Bureau, General Electric Company;Research Grant, Edwards Lifesciences Corporation;Research Grant, Medtronic plc;Research Grant, Abbott Laboratories;Research Grant, Boston Scientific Corporation;Research Grant, PI-Cardia Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CCA02D

### **When Things Go Sideways: TAVR and Beyond**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N226

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CCA02E

### **Plugs & Baskets: Imaging for LAA Closure**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N226

Monika Radike, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CER17

### Scary Stories Told in the Dark: Nightmare on Night Float - Trauma Cases

Thursday, Nov. 30 11:00AM - 12:00PM Room: S406B

Laura L. Avery, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

- 1) Learners will improve time to recognition of traumatic diagnoses, helping to establish dominance over the trauma team.
- 2) Learners will gain confidence with tricky trauma diagnoses decreasing the learner's fight-or-flight response to trauma cases.
- 3) Learners will enjoy entertaining trauma cases, never let the truth get in the way of a good story.

#### COURSE DESCRIPTION

As your grandmother said, "Nothing good happens after midnight, the only thing open is the 7-11 and trouble". Unfortunately, you are on the receiving end of bad choices resulting in full-body CT scans. Spend an hour reviewing rapid-fire trauma cases with an emphasis on tricky traumatic injuries.

#### Sub-Events

#### R4-CER17B Hold My Beer and Watch This: High Force Trauma to the Spine and Pelvis

Laura L. Avery, MD (*Presenter*) Nothing to Disclose

#### R4-CER17C Should Have Taken an Uber: MVC Chest and Aortic Trauma

Ashwin V. Asrani, MD (*Presenter*) Nothing to Disclose

#### R4-CER17D It's Not How Fast You Go- it's How Quickly You Stop: MVC Abdominal Trauma

Polina Kanj, MD (*Presenter*) Nothing to Disclose

#### R4-CER17E Brought a Knife to a Gun Fight: Gunshot Injuries

Noah G. Ditzkowsky, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CER17B

### **Hold My Beer and Watch This: High Force Trauma to the Spine and Pelvis**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S406B

Laura L. Avery, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CER17C

### **Should Have Taken an Uber: MVC Chest and Aortic Trauma**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S406B

Ashwin V. Asrani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CER17D

### **It's Not How Fast You Go- it's How Quickly You Stop: MVC Abdominal Trauma**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S406B

Polina Kanj, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CER17E

### **Brought a Knife to a Gun Fight: Gunshot Injuries**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S406B

Noah G. Ditkofsky, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CGI13

### Colorectal Imaging

Thursday, Nov. 30 11:00AM - 12:00PM Room: N227B

Judy Yee, MD (*Moderator*) Research Grant, General Electric Company

#### LEARNING OBJECTIVES

1) Explain the disparities in colorectal cancer screening and how CT Colonography can be used to improve health equity. 2) Provide best practices for state-of-the-art CTC technique. 3) Understand MRI staging and reporting of rectal cancer and evaluation following neoadjuvant treatment.

#### COURSE DESCRIPTION

The drivers of disparities in colorectal cancer screening and treatment are based in the social determinants of health. Current state-of-the-art CT Colonography technique will be provided and we will describe how CTC can positively impact health equity. Additionally, the use of MR for accurate rectal cancer staging and efficient reporting will be included as well as a review of MR findings following neoadjuvant therapy.

#### Sub-Events

##### **R4-CGI13B Colorectal Cancer Screening and Using CT Colonography to Improve Health Equity**

Judy Yee, MD (*Presenter*) Research Grant, General Electric Company

##### **R4-CGI13C Optimizing CT Colonography Technique**

Kevin J. Chang, MD (*Presenter*) Speaker, RELX; Speaker, Koninklijke Philips NV

##### **R4-CGI13D Rectal Cancer MRI Staging and Reporting**

Kartik S. Jhaveri, MD, FRCPC (*Presenter*) Research Grant, General Electric Company; Research Grant, Bayer AG; Research Consultant, Perspectum Diagnostics Ltd;

##### **R4-CGI13E Rectal MRI Evaluation after Neoadjuvant Therapy**

Natally Horvat, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R4-CGI13B

### **Colorectal Cancer Screening and Using CT Colonography to Improve Health Equity**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N227B

Judy Yee, MD (*Presenter*) Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CGI13C

### Optimizing CT Colonography Technique

Thursday, Nov. 30 11:00AM - 12:00PM Room: N227B

Kevin J. Chang, MD (*Presenter*) Speaker, RELX;Speaker, Koninklijke Philips NV

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CGI13D

### **Rectal Cancer MRI Staging and Reporting**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N227B

Kartik S. Jhaveri, MD, FRCPC (*Presenter*) Research Grant, General Electric Company; Research Grant, Bayer AG; Research Consultant, Perspectum Diagnostics Ltd;

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## Abstract Archives of the RSNA, 2023

R4-CGI13E

### **Rectal MRI Evaluation after Neoadjuvant Therapy**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N227B

Natally Horvat, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R4-CIN22

### Algorithms Without Borders

Thursday, Nov. 30 11:00AM - 12:00PM Room: S401

Saurabh Jha, MBBS, MRCS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the use cases for AI in LMICs. 2) Appreciate the opportunities and challenges of implementing an AI product. 3) Appreciate the importance of big data in Africa. 4) Appreciate the role of radiologists in facilitating the adoption of AI in LMICs.

#### COURSE DESCRIPTION

In LMICs, where there's a shortage of radiologists, AI algorithms improves access to imaging. Thus, AI is an equity promoting technology and its widespread use in LMICs is an example of reverse innovation. The state of AI in LMICs is discussed. The implications of reverse innovation for AI in the American market are analyzed.

#### Sub-Events

##### R4-CIN22B Reverse Innovation: an Overview of AI in LMICs

Saurabh Jha, MBBS, MRCS (*Presenter*) Nothing to Disclose

##### R4-CIN22C Big Data: This Time for Africa

Udunna Anazodo, PhD (*Presenter*) Nothing to Disclose

##### R4-CIN22D The Challenges in Implementing an AI Product

Khan M. Siddiqui, MD (*Presenter*) Officer, Hyperfine Research, Inc; Founder and Chairman, IntellixAI, Inc (DBA "HOPPR"); Founder and CMO, High SH Holdings, Inc; Stockholder, Lunit Inc; Advisory Board, Lunit Inc; Stockholder, Inference Analytics, Inc; Advisory Board, Inference Analytics, Inc; Stockholder, mHealthCoach, Inc; Advisory Board, mHealthCoach, Inc; Stockholder, KalMed, Inc; Advisory Board, KalMed, Inc; Advisory Board, Pier88health, Inc

##### R4-CIN22E Keeping Radiologists in the Loop with AI

Farouk Dako, MD, MPH (*Presenter*) Nothing to Disclose

##### R4-CIN22F Regulating AI in Africa - Should the Regulations be Difficult or Different?

Hugh Harvey, MBBS, MD (*Presenter*) Advisor, Segmed.ai; Advisor, AlgoMedica, Inc; Advisor, Regulatory Agency; Consultant, Qure.ai; Managing Director, Hardian Health

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIN22B

### **Reverse Innovation: an Overview of AI in LMICs**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S401

Saurabh Jha, MBBS, MRCS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIN22C

### **Big Data: This Time for Africa**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S401

Udunna Anazodo, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIN22D

### **The Challenges in Implementing an AI Product**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S401

Khan M. Siddiqui, MD (*Presenter*) Officer, Hyperfine Research, Inc; Founder and Chairman, IntellixAI, Inc (DBA "HOPPR"); Founder and CMO, high SH Holdings, Inc; Stockholder, Lunit Inc; Advisory Board, Lunit Inc; Stockholder, Inference Analytics, Inc; Advisory Board, Inference Analytics, Inc; Stockholder, mHealthCoach, Inc; Advisory Board, mHealthCoach, Inc; Stockholder, KalMed, Inc; Advisory Board, KalMed, Inc; Advisory Board, Pier88health, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIN22E

### **Keeping Radiologists in the Loop with AI**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S401

Farouk Dako, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIN22F

### **Regulating AI in Africa - Should the Regulations be Difficult or Different?**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S401

Hugh Harvey, MBBS, MD (*Presenter*) Advisor, Segmed.ai;Advisor, AlgoMedica, Inc;Advisor, Regulatory Agency;Consultant, Qure.ai;Managing Director, Hardian Health

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CIR03

### Advanced Pediatric Interventions

Thursday, Nov. 30 11:00AM - 12:00PM Room: E352

Joao G. Amaral, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Recognize pediatric pathologies that can be treated with Interventional Radiology. 2) Learn some pediatric techniques in Genitourinary, MSK, Oncologic, Gastrointestinal, Vascular Malformations, and Vascular Access interventions that differ from Adult Interventional Radiology. 3) Learn some tips and tricks on Pediatric Interventional Radiology.

#### COURSE DESCRIPTION

Advanced Pediatric Interventions is a course for the Adult Interventional Radiologist that is familiar with interventional techniques but has limited experience with pediatric patients, and for the General and/ or Pediatric Radiologist who performs some procedures in children but would like to expand their practice. This course will consist of a series of lectures given by experts on the field. It will showcase a broad spectrum of common pediatric procedures, including Genitourinary, MSK, Oncologic, Gastrointestinal, Vascular Malformations and Vascular Access interventions. Of particular importance is the fact that, although similar in many aspects, Pediatric Interventional Radiology techniques have several subtle differences in comparison to Adult Interventional Radiology. These include the type of disease, the longer life expectancy, the proper clinical management and the appropriate material/ device to be used in children. Lecturers will focus on pediatric indications and how these procedures may differ from adult interventions. There will be an opportunity for some questions and brief discussion at the end of each lecture. Attendees will be able to learn some tips and tricks and refine their knowledge in Pediatric Interventional Radiology.

#### Sub-Events

##### R4-CIR03B GI Interventions and Enteric Access

Joao G. Amaral, MD (*Presenter*) Nothing to Disclose

##### R4-CIR03C Urological Interventions

Alex Barnacle, BMBS, FRCR (*Presenter*) Nothing to Disclose

##### R4-CIR03D Interventional Oncology

Michael J. Temple, MD (*Presenter*) Nothing to Disclose

##### R4-CIR03E MSK Interventions

Shankar Rajeswaran, MD (*Presenter*) Nothing to Disclose

##### R4-CIR03F Venous Access

Brian L. Han, MD, MS (*Presenter*) Nothing to Disclose

##### R4-CIR03G Vascular Malformations

Stacey T. Bass, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIR03B

### **GI Interventions and Enteric Access**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E352

Joao G. Amaral, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIR03C

### **Urological Interventions**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E352

Alex Barnacle, BMBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIR03D

### **Interventional Oncology**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E352

Michael J. Temple, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIR03E

### **MSK Interventions**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E352

Shankar Rajeswaran, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIR03F

### **Venous Access**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E352

Brian L. Han, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CIR03G

### **Vascular Malformations**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E352

Stacey T. Bass, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMK07

### Nerve Imaging: Latest Perspectives and Advances

Thursday, Nov. 30 11:00AM - 12:00PM Room: N228

Darryl B. Sneag, MD (*Moderator*) Researcher, General Electric Company; Researcher, Siemens AG; Research support, AMAG Pharmaceuticals, Inc

#### LEARNING OBJECTIVES

1) Explain strategies to improve diagnostic image quality in qualitative and quantitative MR neurography. 2) Identify the role of whole-body MRI in peripheral nerve tumor assessment. 3) Appreciate the role of high-resolution ultrasound for diagnostic and therapeutic management of peripheral neuropathies.

#### COURSE DESCRIPTION

Imaging plays an increasingly important role in the diagnostic and therapeutic management of peripheral neuropathies. This educational program, in the form of lectures and question/answer sessions and geared towards both clinical radiologists and researchers, will focus on the latest ultrasound and MRI techniques for peripheral nerve evaluation. Emerging research topics, in particular use of quantitative diffusion MRI for evaluation of muscle denervation, will be presented. At the program's conclusion, attendees will gain a deeper appreciation of the role of both imaging modalities in clinical and research practice.

#### Sub-Events

##### R4-CMK07B Advances in Qualitative MR Neurography

Darryl B. Sneag, MD (*Presenter*) Researcher, General Electric Company; Researcher, Siemens AG; Research support, AMAG Pharmaceuticals, Inc

##### R4-CMK07C Role of Whole-Body MRI in Peripheral Nerve Tumor Syndromes

Shivani Ahlawat, MD (*Presenter*) Nothing to Disclose

##### R4-CMK07D Ultra High-Resolution Peripheral Nerve Ultrasound

Swati Deshmukh, MD (*Presenter*) Nothing to Disclose

##### R4-CMK07E Advances in Quantitative MR Neurography and Muscle Denervation Imaging

Ek Tsoon Tan, PhD (*Presenter*) Research Grant, General Electric Company Research Grant, Siemens AG Research Grant, Medtronic Inc Research Grant, AMAG Pharmaceuticals

##### R4-CMK07F Ultrasound-Guided Perineural Injections

Theodore T. Miller, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CMK07B

### Advances in Qualitative MR Neurography

Thursday, Nov. 30 11:00AM - 12:00PM Room: N228

Darryl B. Sneag, MD (*Presenter*) Researcher, General Electric Company; Researcher, Siemens AG; Research support, AMAG Pharmaceuticals, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMK07C

### **Role of Whole-Body MRI in Peripheral Nerve Tumor Syndromes**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N228

Shivani Ahlawat, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMK07D

### **Ultra High-Resolution Peripheral Nerve Ultrasound**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N228

Swati Deshmukh, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMK07E

### Advances in Quantitative MR Neurography and Muscle Denervation Imaging

Thursday, Nov. 30 11:00AM - 12:00PM Room: N228

Ek Tsoon Tan, PhD (*Presenter*) Research Grant, General Electric Company Research Grant, Siemens AG Research Grant, Medtronic Inc Research Grant, AMAG Pharmaceuticals

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMK07F

### **Ultrasound-Guided Perineural Injections**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N228

Theodore T. Miller, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMS07

### **Pitfalls and Mimics in Oncologic Imaging**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S404

Khaled M. Elsayes, MD, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify various pitfalls in Oncological imaging that can lead to erroneous diagnoses. 2) Describe relevant technical background, pathophysiology, and hemodynamics of these pitfalls. 3) Be familiar with various clues to reach a specific diagnosis.

#### **COURSE DESCRIPTION**

The purpose of this course is to illustrate the various pitfalls, mimics, and atypical features that can lead to inaccurate diagnosis in cancer patients. The content includes relevant pathogenesis and background as well as specific clues that can be used to reach an accurate diagnosis. It is important to avoid pitfalls and misdiagnoses that can alter the management plan. Helpful strategies for avoiding pitfalls include paying close attention to the clinical history of the patient, carefully evaluating all of the available imaging studies, and being aware of the various radiologic mimics.

#### **Sub-Events**

##### **R4-CMS07B Tumor Mimics in Abdomen**

Khaled M. Elsayes, MD, PhD (*Presenter*) Nothing to Disclose

##### **R4-CMS07C Tumor Mimics in Pelvis**

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

##### **R4-CMS07D Tumor Mimics in Brain**

John C. Heymann, MD (*Presenter*) Nothing to Disclose

##### **R4-CMS07E Tumor Mimics in Thorax**

Cristina Fuss, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMS07B

### **Tumor Mimics in Abdomen**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S404

Khaled M. Elsayes, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMS07C

### **Tumor Mimics in Pelvis**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S404

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CMS07D

### **Tumor Mimics in Brain**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S404

John C. Heymann, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CMS07E

### **Tumor Mimics in Thorax**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S404

Cristina Fuss, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNPM11

### Health Equity in Radiology: Clinical Practice (Sponsored by the RSNA Research Development Committee and the RSNA Health Equity Committee)

Thursday, Nov. 30 11:00AM - 12:00PM Room: E351

Randy C. Miles, MD, MPH (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand how to improve operational efficiency through strategies and innovations in breast imaging centers located in resource limited settings. 2) Understand the importance of equity into and inclusion in lung cancer screening. 3) Learn how to leverage Community-Based Participatory Research and community outreach to inform the development of health equity programs focused on improving access to care among Latino/Hispanic communities. 4) Discuss practical methods to incorporate health equity principles radiology care.

#### COURSE DESCRIPTION

As a result of participation in this course, radiology practitioners will learn best practices of providing equitable care to diverse patient groups. The course will include practical, high yield, lectures focused on equipping radiology practices with discrete tools and resources to improve health equity and inclusivity in their practice.

#### Sub-Events

##### **R4-CNPM11B Leveraging Operational Tools and Local Resources to Establish Health Equity in Breast Imaging**

Randy C. Miles, MD, MPH (*Presenter*) Nothing to Disclose

##### **R4-CNPM11C Lung Cancer Screening in Historically Underserved Groups: The Time to Act Is Now**

Ashley E. Prosper, MD (*Presenter*) Nothing to Disclose

##### **R4-CNPM11D Bridging the Gap in Radiology: Strategies to Create an Equitable System for Latino Communities**

Efren J. Flores, MD (*Presenter*) Speaker, WebMD LLC; Speaker, Consulting Medical Associates, Inc

##### **R4-CNPM11E Promoting Health Equity in Radiology: From Theory to Action**

Lucy B. Spalluto, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNPM11B

### Leveraging Operational Tools and Local Resources to Establish Health Equity in Breast Imaging

Thursday, Nov. 30 11:00AM - 12:00PM Room: E351

Randy C. Miles, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNPM11C

### **Lung Cancer Screening in Historically Underserved Groups: The Time to Act Is Now**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E351

Ashley E. Prosper, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNPM11D

### **Bridging the Gap in Radiology: Strategies to Create an Equitable System for Latino Communities**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E351

Efren J. Flores, MD (*Presenter*) Speaker, WebMD LLC; Speaker, Consulting Medical Associates, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNPM11E

### **Promoting Health Equity in Radiology: From Theory to Action**

Thursday, Nov. 30 11:00AM - 12:00PM Room: E351

Lucy B. Spalluto, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNR13

### **The Many Faces of Post-Treatment Adult and Pediatric Brain Tumors**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S402

Vinodh A. Kumar, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Review the imaging manifestations of treated adult and pediatric brain tumors. 2) Become familiar with the use of radiogenomics in gliomas.

#### **COURSE DESCRIPTION**

The session will review post-treatment brain tumor MR perfusion imaging, glioma pseudoresponse & pseudoprogression, glioma radiogenomics, and post-therapy related complications in pediatric brain tumors. Format: Case-based & Didactic

#### **Sub-Events**

#### **R4-CNR13B Advanced Imaging of Treated Brain Tumors: A Case-Based Session**

Vinodh A. Kumar, MD (*Presenter*) Nothing to Disclose

#### **R4-CNR13C Did we get that right? Differentiating Treatment Response from Pseudoresponse and Pseudoprogression**

Kiran S. Talekar, MBBS, MD (*Presenter*) Spouse, Employee, GlaxoSmithKline plc

#### **R4-CNR13D Glioma Radiogenomics**

Rivka R. Colen, MD (*Presenter*) Nothing to Disclose

#### **R4-CNR13E Consequences and Complications of Treated Pediatric Brain Tumors**

Hisham Dahmouh, MBBCh (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CNR13B

### **Advanced Imaging of Treated Brain Tumors: A Case-Based Session**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S402

Vinodh A. Kumar, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNR13C

### **Did we get that right? Differentiating Treatment Response from Pseudoresponse and Pseudoprogression**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S402

Kiran S. Talekar, MBBS, MD (*Presenter*) Spouse, Employee, GlaxoSmithKline plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNR13D

### **Glioma Radiogenomics**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S402

Rivka R. Colen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CNR13E

### **Consequences and Complications of Treated Pediatric Brain Tumors**

Thursday, Nov. 30 11:00AM - 12:00PM Room: S402

Hisham Dahmouh, MBBCh (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CPD12

### **Appropriate Use of Intravascular Contrast in Children: It Ain't Just Water! (Supported in part by an Unrestricted Medical Education Grant from GE Healthcare, Inc.)**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N229

Judy H. Squires, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Review different types of contrast media and safety considerations in ultrasound, CT, and MRI, as well as availability, considerations for use, and possible substitutions. 2) Review considerations for implementing contrast-enhanced ultrasound in pediatric practice. 4) Evaluate potential methods to improve sustainability in pediatric radiology practice, including decreasing contrast media utilization.

#### **COURSE DESCRIPTION**

Many diagnostic imaging studies require the use of IV and/or enteric contrast media, however, emerging technologies are decreasing the need in some circumstances. When contrast is necessary, there are different types of contrast, with some better suited for use in certain clinical scenarios. Additionally, there are many important short and long term safety considerations when using contrast media. Finally, contrast media have unique considerations for institutional, regulatory, and supply chain constraints. This course will review important considerations when using contrast media in children for imaging at ultrasound, CT, and MRI, including possible alternatives, safety considerations, and anticipated upcoming advancements.

#### **Sub-Events**

##### **R4-CPD12B Herding CAT(Scans): When and How to Use IV Contrast**

Rajesh Krishnamurthy, MD (*Presenter*) Nothing to Disclose

##### **R4-CPD12C Living in a (Micro)Bubble: Building a Program for Contrast-enhanced Ultrasound**

Susan J. Back, MD (*Presenter*) Nothing to Disclose

##### **R4-CPD12D Apple of my (MR)I: Updates in MRI Contrast Media**

Shreyas S. Vasanawala, MD, PhD (*Presenter*) Research collaboration, General Electric Company; Consultant, Arterys Inc; Advisory Board, HeartVista, Inc

##### **R4-CPD12E Waste not, Want not: Working Together to Eliminate Waste in the Radiology Department**

Helen Hye Ryong Kim, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CPD12B

### **Herding CAT(Scans): When and How to Use IV Contrast**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N229

Rajesh Krishnamurthy, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CPD12C

### **Living in a (Micro)Bubble: Building a Program for Contrast-enhanced Ultrasound**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N229

Susan J. Back, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-CPD12D

### **Apple of my (MR)I: Updates in MRI Contrast Media**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N229

Shreyas S. Vasanawala, MD, PhD (*Presenter*) Research collaboration, General Electric Company; Consultant, Arterys Inc; Advisory Board, HeartVista, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-CPD12E

### **Waste not, Want not: Working Together to Eliminate Waste in the Radiology Department**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N229

Helen Hye Ryong Kim, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-RCP25

### From Bench to Bedside: Practical Considerations for AI in Medical Imaging

Thursday, Nov. 30 11:00AM - 12:00PM Room: N230B

Samuel G. Armato III, PhD (*Moderator*) Nothing to Disclose  
Lubomir M. Hadjiiski, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the importance of data (in terms of sources, demographic distributions, and ethical uses) for training CAD-AI systems in a manner that promotes generalizability. 2) Describe the role of clinical acceptance testing from the perspectives of generalizability, efficiency in a clinical workflow, output explainability, and performance stability over time. 3) Identify practical considerations for the translation of CAD-AI tools to the clinic, including the human-machine interface, user training, and prospective surveillance.

#### COURSE DESCRIPTION

Rapid advances in artificial intelligence (AI) and machine learning (specifically, deep learning techniques) have enabled broad application of these methods in healthcare. The promise of deep-learning has promoted further interest in computer-aided diagnosis (CAD) development and applications using both “traditional” machine learning and newer deep-learning-based approaches; this expanded clinical decision support environment is referred to as “CAD-AI.” It is of paramount importance to ensure that a clinical decision support tool undergoes proper training and rigorous validation of its generalizability and robustness before adoption for patient care. A task group of the American Association of Physicists in Medicine (AAPM) developed recommendations on practices and standards for the development and performance assessment of decision support systems in a CAD-AI environment. With CAD applications expanding to new stages of the patient care process, this educational session will explore the broader issues common to the development of CAD-AI applications and their translation from the bench to the clinic. The goal of this lecture-based session (followed by discussion) is to bring attention to the proper training and validation of machine learning algorithms that may improve their generalizability and reliability, thus accelerating the adoption of CAD-AI systems for clinical decision support.

#### Sub-Events

##### R4-RCP25C Data Collection and Use in AI for Medical Imaging

Karen Drukker, PHD (*Presenter*) Royalties, Hologic, Inc

##### R4-RCP25D Clinical Acceptance of AI in Radiology

Berkman Sahiner, PhD (*Presenter*) Nothing to Disclose

##### R4-RCP25E Clinical Translation of AI in Radiology

Ronald M. Summers, MD, PhD (*Presenter*) Royalties, iCAD, Inc; Royalties, Koninklijke Philips NV; Royalties, ScanMed, LLC; Royalties, Ping An Insurance (Group) Company of China, Ltd; Royalties, Translation Holdings; Research support, Ping An Insurance (Group) Company of China, Ltd

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## **Abstract Archives of the RSNA, 2023**

R4-RCP25C

### **Data Collection and Use in AI for Medical Imaging**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N230B

Karen Drukker, PHD (*Presenter*) Royalties, Hologic, Inc

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## Abstract Archives of the RSNA, 2023

R4-RCP25D

### **Clinical Acceptance of AI in Radiology**

Thursday, Nov. 30 11:00AM - 12:00PM Room: N230B

Berkman Sahiner, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-RCP25E

### Clinical Translation of AI in Radiology

Thursday, Nov. 30 11:00AM - 12:00PM Room: N230B

Ronald M. Summers, MD, PhD (*Presenter*) Royalties, iCAD, Inc; Royalties, Koninklijke Philips NV; Royalties, ScanMed, LLC; Royalties, Ping An Insurance (Group) Company of China, Ltd; Royalties, Translation Holdings; Research support, Ping An Insurance (Group) Company of China, Ltd

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## Abstract Archives of the RSNA, 2023

R6-CCH11

### Issues in Thoracic Malignancy

Thursday, Nov. 30 1:30PM - 2:30PM Room: S406B

Mylene T. Truong, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review the imaging evaluation of thoracic malignancies, including neuroendocrine carcinoma, thymic malignancies, and rare tumors. 2) Discuss the imaging of lung cancer following radiation therapy.

#### COURSE DESCRIPTION

This session includes lectures pertaining to the imaging evaluation of thoracic malignancies, including neuroendocrine carcinoma, thymic malignancies and rare tumors. In addition, the spectrum of imaging manifestations following radiation therapy for lung cancer will also be addressed.

#### Sub-Events

##### R6-CCH11B Post Radiation Imaging in NSCLC

Jane P. Ko, MD (*Presenter*) Research collaboration, Siemens AG

##### R6-CCH11C Carcinoid and DIPNECH

Kristopher W. Cummings, MD (*Presenter*) Nothing to Disclose

##### R6-CCH11D Thymoma Update

Edith M. Marom, MD (*Presenter*) Speaker, Boehringer Ingelheim GmbH; Speaker, Merck & Co, Inc; Speaker, AstraZeneca PLC

##### R6-CCH11E Rare Tumors of the Thorax

John P. Lichtenberger III, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R6-CCH11B

### Post Radiation Imaging in NSCLC

Thursday, Nov. 30 1:30PM - 2:30PM Room: S406B

Jane P. Ko, MD (*Presenter*) Research collaboration, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CCH11C

### **Carcinoid and DIPNECH**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S406B

Kristopher W. Cummings, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R6-CCH11D

### Thymoma Update

Thursday, Nov. 30 1:30PM - 2:30PM Room: S406B

Edith M. Marom, MD (*Presenter*) Speaker, Boehringer Ingelheim GmbH; Speaker, Merck & Co, Inc; Speaker, AstraZeneca PLC

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## Abstract Archives of the RSNA, 2023

R6-CCH11E

### **Rare Tumors of the Thorax**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S406B

John P. Lichtenberger III, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CHN07

### Best Head and Neck Cases of 2023 From the Experts

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450A

Tanya J. Rath, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Recognize typical and atypical entities that occur within the head and neck. 2) Differentiate between common head and neck pathologies from relevant mimics.

#### COURSE DESCRIPTION

In this case-based head and neck imaging session, attendees will be presented with classic, unusual and diagnostic dilemma cases within the head and neck as selected by the experts. Speakers will emphasize pearls for differentiating each entity from common mimics, pitfalls of interpretation to avoid, and relevant clinical management considerations with which radiologists should be familiar. This session offers attendees the opportunity to refine their interpretation of complex head and neck imaging studies by incorporating tips from world experts.

#### Sub-Events

##### R6-CHN07B Best Head and Neck Cases of 2023 From the Experts

Deborah R. Shatzkes, MD (*Presenter*) Nothing to Disclose

##### R6-CHN07C Best Head and Neck Cases of 2023 From the Experts

C. Douglas Phillips, MD (*Presenter*) Nothing to Disclose

##### R6-CHN07D Best Head and Neck Cases of 2023 From the Experts

Ilona M. Schmalfuss, MD (*Presenter*) Nothing to Disclose

##### R6-CHN07E Best Head and Neck Cases of 2023 From the Experts

Philip R. Chapman, MD (*Presenter*) Nothing to Disclose

##### R6-CHN07F Best Head and Neck Cases of 2023 From the Experts

William T. O'Brien Sr, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CHN07B

### **Best Head and Neck Cases of 2023 From the Experts**

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450A

Deborah R. Shatzkes, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CHN07C

### **Best Head and Neck Cases of 2023 From the Experts**

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450A

C. Douglas Phillips, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R6-CHN07D

### **Best Head and Neck Cases of 2023 From the Experts**

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450A

Ilona M. Schmalfluss, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CHN07E

### Best Head and Neck Cases of 2023 From the Experts

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450A

Philip R. Chapman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CHN07F

### Best Head and Neck Cases of 2023 From the Experts

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450A

William T. O'Brien Sr, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R6-CIN04

### Informatics Tools for QI

Thursday, Nov. 30 1:30PM - 2:30PM Room: S401

Thomas W. Loehfelm, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R6-CIN04B Custom Web Applications for Quality and Workflow Optimizations**

Ross W. Filice, MD (*Presenter*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

#### **R6-CIN04C NLP Pipelines to Collect and Analyze Patient Feedback, Assess Report Quality and Practice Patterns**

Imon Banerjee, PhD (*Presenter*) Nothing to Disclose

#### **R6-CIN04D Custom Toolbars to Collect Structured Data at the Point of Care for Radiologist Dictations**

David S. Hirschorn, MD (*Presenter*) Nothing to Disclose

#### **R6-CIN04E Flexible Process for Developing Custom Report Classifiers to Organize Radiology and Pathology Reports for Downstream QA and Operational Workflows**

Thomas W. Loehfelm, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CIN04B

### Custom Web Applications for Quality and Workflow Optimizations

Thursday, Nov. 30 1:30PM - 2:30PM Room: S401

Ross W. Filice, MD (*Presenter*) Advisor, BunkerHill Health, Inc;Shareholder, BunkerHill Health, Inc;Speaker, General Electric Company;Speaker, Koios Medical;Researcher, Koios Medical

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CIN04C

**NLP Pipelines to Collect and Analyze Patient Feedback, Assess Report Quality and Practice Patterns**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S401

Imon Banerjee, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CIN04D

### **Custom Toolbars to Collect Structured Data at the Point of Care for Radiologist Dictations**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S401

David S. Hirschorn, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CIN04E

### **Flexible Process for Developing Custom Report Classifiers to Organize Radiology and Pathology Reports for Downstream QA and Operational Workflows**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S401

Thomas W. Loehfelm, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CVA02

### Vascular Access Imaging for Structural Heart Practices

Thursday, Nov. 30 1:30PM - 2:30PM Room: S402

Jonathon A. Leipsic, MD (*Moderator*) Consultant, Heartflow, Inc; Consultant, Circle Cardiovascular Imaging Inc; Speakers Bureau, General Electric Company; Research Grant, Edwards Lifesciences Corporation; Research Grant, Medtronic plc; Research Grant, Abbott Laboratories; Research Grant, Boston Scientific Corporation; Research Grant, PI-Cardia Ltd  
Jeremy D. Collins, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R6-CVA02C Vascular Access for Transcatheter Procedures and Minimally Invasive Surgery: Surgical Perspective**

Jennifer Chung, MD (*Presenter*) Nothing to Disclose

#### **R6-CVA02D Vascular Access Needs for TAVR**

Jeremy D. Collins, MD (*Presenter*) Nothing to Disclose

#### **R6-CVA02E Vascular Access Needs for Transcatheter Mitral and Tricuspid Valve Interventions**

Amar B. Shah, MD, MA (*Presenter*) Nothing to Disclose

#### **R6-CVA02F Multi-Modal Imaging Guidance to Enable Minimally Invasive Surgeries and Percutaneous Structural Heart Interventions**

Dianna M. Bardo, MD (*Presenter*) Speaker, Koninklijke Philips NV; Consultant, Koninklijke Philips NV; License agreement, Koninklijke Philips NV; Author, Thieme Medical Publishers, Inc; Research support, Bracco Group; Consultant, Guerbet SA; Consultant, RELX

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R6-CVA02C

### **Vascular Access for Transcatheter Procedures and Minimally Invasive Surgery: Surgical Perspective**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S402

Jennifer Chung, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CVA02D

### **Vascular Access Needs for TAVR**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S402

Jeremy D. Collins, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R6-CVA02E

### **Vascular Access Needs for Transcatheter Mitral and Tricuspid Valve Interventions**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S402

Amar B. Shah, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-CVA02F

### **Multi-Modal Imaging Guidance to Enable Minimally Invasive Surgeries and Percutaneous Structural Heart Interventions**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S402

Dianna M. Bardo, MD (*Presenter*) Speaker, Koninklijke Philips NV;Consultant, Koninklijke Philips NV;License agreement, Koninklijke Philips NV;Author, Thieme Medical Publishers, Inc;Research support, Bracco Group;Consultant, Guerbet SA;Consultant, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CBR14

### Practice Issues and Reimbursement Improvement

Thursday, Nov. 30 3:00PM - 4:00PM Room: N230B

Cherie M. Kuzmiak, DO (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify & describe strategies to improve reimbursement & overall profitability of your practice in the fragmented US healthcare payer landscape. 2) Understand the sources of practice dissatisfaction/burnout & explain strategies for staff engagement/retention. 3) Discuss Post-Pandemic practice issues & how to implement changes to overcome a reduced workforce.

#### COURSE DESCRIPTION

This session will focus on the unique ways to improve practice issues and profitability, including methods to achieve staff retention, in the Post-Pandemic era. The course is applicable to radiologists and technologists of all career levels. The educational format of this course is lecture form with discussion.

#### Sub-Events

##### **R7-CBR14B How to Improve Reimbursement and Overall Profitability of your Practice**

Dana H. Smetherman, MD, MPH (*Presenter*) Nothing to Disclose

##### **R7-CBR14C How to Achieve Staff Retention and Make Physicians Happy**

Vilert A. Loving, MD, MMM (*Presenter*) Nothing to Disclose

##### **R7-CBR14D Practice Issues Post Pandemic and Remote Reading**

Cherie M. Kuzmiak, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CBR14B

### **How to Improve Reimbursement and Overall Profitability of your Practice**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N230B

Dana H. Smetherman, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CBR14C

### **How to Achieve Staff Retention and Make Physicians Happy**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N230B

Vilert A. Loving, MD, MMM (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CBR14D

### Practice Issues Post Pandemic and Remote Reading

Thursday, Nov. 30 3:00PM - 4:00PM Room: N230B

Cherie M. Kuzmiak, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CCA01

### Cardiac Rapid Fire: 60 Cases in 60 minutes

Thursday, Nov. 30 3:00PM - 4:00PM Room: S402

Liisa L. Bergmann, MD, MBA (*Moderator*) Nothing to Disclose  
Jean Jeudy JR, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Interpret and recognize cardiac and pericardial masses through the review of clinical cases and enabling participants to feel more confident in their ability to identify such conditions in their patients. 2) Improve the management of valvular disease by understanding the different imaging techniques used and by gaining a thorough knowledge of the diagnosis and treatment of such diseases. 3) Implement a better understanding of congenital heart disease in clinical scenarios and explain the imaging methods used for the diagnosis, management, and treatment plans for patients with this condition.

#### COURSE DESCRIPTION

This advanced course is designed to provide attendees with an extensive review of cardiac imaging, with a particular focus on cardiac CT and cardiac MRI. Through the presentation of clinical cases, participants will be able to better identify and manage the diverse range of cardiovascular issues that they may encounter in their practice. The course is composed of primary topics that aim to explore the problems cardiovascular specialists typically encounter. Attendees will gain a greater understanding of cardiac and pericardial masses, valvular disease, and congenital heart disease. Radiology professionals at all levels of experience are encouraged to participate. This session will be delivered as a rapid-fire case presentation format with summary knowledge review. Attendees will be able to interact with the presenter and ask questions at the end of the session. After completing the course, attendees will be able to apply their enhanced knowledge of cardiac imaging in practical, real-world situations. Join us at #RSNA23 for an engaging and fast-paced educational experience that will enrich your practice and benefit your patients. #CV60in60

#### Sub-Events

##### R7-CCA01C Cases 1-20 - Cardiac & Pericardial Masses

Jean Jeudy JR, MD (*Presenter*) Nothing to Disclose

##### R7-CCA01D Cases 21-40 - Valvular Disease

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

##### R7-CCA01E Cases 41-60 - Congenital Heart Disease

Liisa L. Bergmann, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CCA01C

### Cases 1-20 - Cardiac & Pericardial Masses

Thursday, Nov. 30 3:00PM - 4:00PM Room: S402

Jean Jeudy JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R7-CCA01D

### Cases 21-40 - Valvular Disease

Thursday, Nov. 30 3:00PM - 4:00PM Room: S402

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CCA01E

### Cases 41-60 - Congenital Heart Disease

Thursday, Nov. 30 3:00PM - 4:00PM Room: S402

Liisa L. Bergmann, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CCH12

### **Pearls and Pitfalls in Chest Radiography**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450B

Gerald F. Abbott, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

- 1) To recognize the various chest radiographic features of diffuse interstitial lung diseases and their respective CT correlates.
- 2) To recognize the various chest radiographic features of pleural diseases and their respective CT correlates.
- 3) To learn the normal anatomy demonstrated on lateral chest radiography and recognize imaging abnormalities unique to the lateral view with their respective CT correlations.

#### **COURSE DESCRIPTION**

The chest radiograph is a foundational modality in thoracic imaging that remains one of the most frequently ordered diagnostic studies. It serves an important function in multiple healthcare settings – in emergency departments, intensive care units, outpatient clinics –and in the diagnosis and monitoring of oncologic disease. The effective interpretation of chest radiographs requires experience and a knowledge of radiographic anatomy, imaging signs of disease, and important pitfalls to avoid. This session will feature three case-based lectures presented by experienced thoracic radiologists whose teaching skills will be focused on giving attendees an expanded appreciation and skill in the interpretation of chest radiographs.

#### **Sub-Events**

##### **R7-CCH12B If These Images Could Talk: Diffuse ILD on Chest Radiography**

Andetta R. Hunsaker, MD (*Presenter*) Nothing to Disclose

##### **R7-CCH12C Imaging of Pleural Disease: Chest Radiography**

Gerald F. Abbott, MD (*Presenter*) Nothing to Disclose

##### **R7-CCH12D The Lateral Chest Radiograph: Test Your Knowledge & Skills**

Mark S. Parker, MD (*Presenter*) Co-author, Thieme Medical Publishers, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CCH12B

### **If These Images Could Talk: Diffuse ILD on Chest Radiography**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450B

Andetta R. Hunsaker, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CCH12C

### **Imaging of Pleural Disease: Chest Radiography**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450B

Gerald F. Abbott, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CCH12D

### **The Lateral Chest Radiograph: Test Your Knowledge & Skills**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450B

Mark S. Parker, MD (*Presenter*) Co-author, Thieme Medical Publishers, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CER13

### Disaster Preparedness - Are you Ready for Chaos?

Thursday, Nov. 30 3:00PM - 4:00PM Room: S406B

Ferco H. Berger, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To understand what changes when disaster strikes and (examples of) things to consider to be well prepared. 2) To explore the value provided by your residency and how to embed it in your disaster preparedness plan. 3) To explain the use of exercises for plan development and testing.

#### COURSE DESCRIPTION

Disaster can happen at any time and any place to anyone, so your hospital and department and you should be prepared to deal with the consequences of a variety of types of potential disasters in your region. This course will provide insight in how operations may have to change in this setting and how to best include and prepare your personnel for these rare occasions. Your residency is a valuable part and thinking about its role and preparedness is a unique feature that will be highlighted in this session.

#### Sub-Events

##### **R7-CER13B What to Think About to be Prepared**

Ronald M. Bilow, MD (*Presenter*) Nothing to Disclose

##### **R7-CER13C Evaluate and Value Your Residency for Disaster Preparedness**

Courtney P. Orsbon, MD, PhD (*Presenter*) Nothing to Disclose

##### **R7-CER13D Reality Check: Using Exercises to be Prepared**

Ferco H. Berger, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CER13B

### **What to Think About to be Prepared**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S406B

Ronald M. Bilow, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R7-CER13C

### **Evaluate and Value Your Residency for Disaster Preparedness**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S406B

Courtney P. Orsbon, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CER13D

### **Reality Check: Using Exercises to be Prepared**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S406B

Ferco H. Berger, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CGI14

### GI Transplant Imaging

Thursday, Nov. 30 3:00PM - 4:00PM Room: E351

Reena C. Jha, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review the findings which should be reported in patients undergoing evaluation for potential living donor liver transplant. 2) Describe the findings that may be contraindications for living donor liver transplant. 3) Review the normal appearance of the liver post-transplant and early and late complications. 3) Illustrate the typical bowel and vascular anatomy of small bowel transplants and describe imaging techniques and postoperative complications. 4) Discuss the role of imaging in pancreatic transplantation focusing on post-surgical evaluation and review normal and abnormal appearances after pancreas transplantation.

#### COURSE DESCRIPTION

This lecture series will review the indications, imaging anatomy, surgical techniques and critical findings in patients undergoing evaluation for potential small bowel, pancreas and living liver transplant and review imaging post liver transplant.

#### Sub-Events

##### **R7-CGI14B Liver Transplant - Pre- Op**

Jeff L. Fidler, MD (*Presenter*) Nothing to Disclose

##### **R7-CGI14C Liver Transplant - Post Op**

Reena C. Jha, MD (*Presenter*) Nothing to Disclose

##### **R7-CGI14D Pancreas Transplant**

Avinash R. Kambadakone, MD, FRCR (*Presenter*) Advisory Board, Bayer AG Research Grant, General Electric Company Research Grant, Koninklijke Philips NV Research Grant, PanCAN Research Grant, Bayer

##### **R7-CGI14E Bowel Transplant**

Erick M. Remer, MD (*Presenter*) Advisory Panel, Concept Pharmaceuticals Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CGI14B

### **Liver Transplant - Pre- Op**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E351

Jeff L. Fidler, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CGI14C

### **Liver Transplant - Post Op**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E351

Reena C. Jha, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CGI14D

### **Pancreas Transplant**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E351

Avinash R. Kambadakone, MD, FRCR (*Presenter*) Advisory Board, Bayer AG Research Grant, General Electric Company Research Grant, Koninklijke Philips NV Research Grant, PanCAN Research Grant, Bayer

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CGI14E

### **Bowel Transplant**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E351

Erick M. Remer, MD (*Presenter*) Advisory Panel, Concept Pharmaceuticals Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIN08

### **Radiology Informatics Legislation Update**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S401

Po-Hao Chen, MD, MBA (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Know when, in what context and under what names the most impactful recent legislation on informatics has presented. 2) Understand implications of current legislative product or debate on Informatics. 3) Perceive the political context in which Informatics-relevant legislation has occurred.

#### **COURSE DESCRIPTION**

This course is will help attendees stay updated and informed about the latest legislative developments relevant to radiology informatics. During this traditional lecture format, we will address crucial issues related to informatics such as the cybersecurity implications of new regulations, the political context in which informatics-relevant legislation occurs, and the history and updates of significant acts like the No Surprise Act. Additionally, we will discuss the new rules on data sharing introduced by the Office of the National Coordinator for Health Information Technology (ONC). Attending this session will give you a deep understanding of the legislative landscape and its impact on informatics.

#### **Sub-Events**

##### **R7-CIN08B FDA's Cybersecurity Modernization Action Plan**

Po-Hao Chen, MD, MBA (*Presenter*) Nothing to Disclose

##### **R7-CIN08C Is Clinical Decision Support a Software Medical Device? Review of Current FDA Position**

Shinjini Kundu, MD, PhD (*Presenter*) Nothing to Disclose

##### **R7-CIN08D PAMA/Appropriate Use Criteria Program: Where We Are, How We Got Here, and Where We Are Going**

Keith D. Hentel, MD, MS (*Presenter*) Nothing to Disclose

##### **R7-CIN08E New ONC Rules on Data Sharing**

Bibb Allen JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R7-CIN08B

### **FDA's Cybersecurity Modernization Action Plan**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S401

Po-Hao Chen, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIN08C

### **Is Clinical Decision Support a Software Medical Device? Review of Current FDA Position**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S401

Shinjini Kundu, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIN08D

### **PAMA/Appropriate Use Criteria Program: Where We Are, How We Got Here, and Where We Are Going**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S401

Keith D. Hentel, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIN08E

### **New ONC Rules on Data Sharing**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S401

Bibb Allen JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIR11

### GI Interventions and Pain Management

Thursday, Nov. 30 3:00PM - 4:00PM Room: E352

David M. Mauro, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand clinical indications and procedures for palliative care, emergencies, and pain management. 2) Recognize appropriate anatomy as it relates to the interventional procedural techniques. 3) Explain clinical outcomes of different interventional procedures.

#### COURSE DESCRIPTION

In this course learners will be exposed to didactic lectures regarding different procedures in interventional radiology as it relates to gastrointestinal interventions, pain management and palliative care

#### Sub-Events

##### R7-CIR11B Upper GI Bleed

David M. Mauro, MD (*Presenter*) Nothing to Disclose

##### R7-CIR11C Lower GI Bleed

Dania Daye, MD, PhD (*Presenter*) Research Consultant, Sigilon Therapeutics, Inc; Research Consultant, Medtronic plc

##### R7-CIR11D Management of Enteric Access and Feeding Tubes in IR

Fabian M. Laage Gaupp, MD (*Presenter*) Nothing to Disclose

##### R7-CIR11E Management of Malignant Ascites

Hooman Yarmohammadi, MD (*Presenter*) Grant, Guerbet SA

##### R7-CIR11F Ablation and Embolization for Pain Therapy

Merve Ozen, MD (*Presenter*) Nothing to Disclose

##### R7-CIR11G Nerve Blocks in Unresectable Cancers

Dimitrios Filippiadis, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIR11B

### Upper GI Bleed

Thursday, Nov. 30 3:00PM - 4:00PM Room: E352

David M. Mauro, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIR11C

### Lower GI Bleed

Thursday, Nov. 30 3:00PM - 4:00PM Room: E352

Dania Daye, MD, PhD (*Presenter*) Research Consultant, Sigilon Therapeutics, Inc; Research Consultant, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIR11D

### Management of Enteric Access and Feeding Tubes in IR

Thursday, Nov. 30 3:00PM - 4:00PM Room: E352

Fabian M. Laage Gaupp, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R7-CIR11E

### Management of Malignant Ascites

Thursday, Nov. 30 3:00PM - 4:00PM Room: E352

Hooman Yarmohammadi, MD (*Presenter*) Grant, Guerbet SA

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## Abstract Archives of the RSNA, 2023

R7-CIR11F

### **Ablation and Embolization for Pain Therapy**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E352

Merve Ozen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CIR11G

### **Nerve Blocks in Unresectable Cancers**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E352

Dimitrios Filippiadis, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMK08

### Musculoskeletal Tumor Imaging: Current Trends and Recent Advances

Thursday, Nov. 30 3:00PM - 4:00PM Room: N228

Mark D. Murphey, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Recognize imaging differences between lipoma and well differentiated liposarcoma and current cytogenetic aberrations used in this distinction. 2) Understand recent advances in multidisciplinary management of spinal bone metastases and imaging of post-tumor resection reconstructions. 3) Identify updates to musculoskeletal tumor staging and use of T2 Dixon imaging of musculoskeletal tumors.

#### COURSE DESCRIPTION

This lecture format course includes a discussion of a range of topics concerning musculoskeletal tumor imaging and both current trends and recent advances. Topics range from a discussion of adipocytic neoplasms and use of cytogenetic aberrations that allow their distinction, imaging of post-resection reconstructions, the use of T2 Dixon imaging of neoplasms, recent advances in multidisciplinary management of spinal bone metastases and an update on musculoskeletal tumor staging. Attendees should expect a review and update on these important topics on imaging of musculoskeletal tumors.

#### Sub-Events

##### **R7-CMK08B Update on Musculoskeletal Tumor Staging**

Mark D. Murphey, MD (*Presenter*) Nothing to Disclose

##### **R7-CMK08C T2 Dixon Imaging of Tumors: Advantages and Disadvantages**

Stephanie A. Bernard, MD (*Presenter*) Nothing to Disclose

##### **R7-CMK08D Imaging of Post-Resection Reconstructions: Tricks of the Trade**

Ty K. Subhawong, MD (*Presenter*) Research Consultant, Arog Pharmaceuticals, Inc; Stockholder, AbbVie Inc; Stockholder, AstraZeneca PLC; Stockholder, Johnson & Johnson; Stockholder, Pfizer Inc ; Stockholder, F. Hoffmann-La Roche Ltd; Stockholder, Teva Pharmaceutical Industries Ltd

##### **R7-CMK08E Recent Advances in Multidisciplinary Management of Spinal Bone Metastases**

Behrang Amini, MD, PhD (*Presenter*) Nothing to Disclose

##### **R7-CMK08F Imaging of Fatty Tumors: Lipoma versus Atypical Lipomatous Tumor**

Doris E. Wenger, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMK08B

### **Update on Musculoskeletal Tumor Staging**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N228

Mark D. Murphey, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMK08C

### **T2 Dixon Imaging of Tumors: Advantages and Disadvantages**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N228

Stephanie A. Bernard, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMK08D

### **Imaging of Post-Resection Reconstructions: Tricks of the Trade**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N228

Ty K. Subhawong, MD (*Presenter*) Research Consultant, Arog Pharmaceuticals, Inc; Stockholder, AbbVie Inc; Stockholder, AstraZeneca PLC; Stockholder, Johnson & Johnson; Stockholder, Pfizer Inc ; Stockholder, F. Hoffmann-La Roche Ltd; Stockholder, Teva Pharmaceutical Industries Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMK08E

### Recent Advances in Multidisciplinary Management of Spinal Bone Metastases

Thursday, Nov. 30 3:00PM - 4:00PM Room: N228

Behrang Amini, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R7-CMK08F

### **Imaging of Fatty Tumors: Lipoma versus Atypical Lipomatous Tumor**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N228

Doris E. Wenger, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMS02

### Acute Ultrasound Pearls and Pitfalls: Case Based Review

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450A

Shweta Bhatt, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify the role of ultrasound in common and uncommon pediatric emergencies. 2) Understand some common and uncommon causes of acute pelvic pain in women. 3) Identify the ultrasound findings of musculoskeletal pathologies presenting in the acute setting.

#### COURSE DESCRIPTION

This course is designed to highlight the vital role ultrasound plays in imaging and diagnosis throughout the body with a focus on challenging emergent cases. A wide range of applications will be covered including vascular, pelvic, pediatric, and musculoskeletal. Attendees will have the opportunity to test their knowledge in real time as interesting unknown cases are presented in question/answer format with topic review by the speakers. Our goal is to provide a broad update in the field while addressing new opportunities and challenges for everyday practice

#### Sub-Events

##### R7-CMS02B Acute Abdominal Pain- Challenging Cases

Shweta Bhatt, MD (*Presenter*) Nothing to Disclose

##### R7-CMS02C Challenging Pediatric Ultrasound Cases

Edward Y. Lee, MD, MPH (*Presenter*) Nothing to Disclose

##### R7-CMS02D Acute Pelvic Pain - Challenging Cases

Akshya Gupta, MD (*Presenter*) Nothing to Disclose

##### R7-CMS02E Acute Pain Rapid Fire Challenging MSK Cases

Humberto G. Rosas, MD (*Presenter*) Co-founder, AyrFlo; Stockholder, AyrFlo

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R7-CMS02B

### **Acute Abdominal Pain- Challenging Cases**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450A

Shweta Bhatt, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMS02C

### Challenging Pediatric Ultrasound Cases

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450A

Edward Y. Lee, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMS02D

### **Acute Pelvic Pain - Challenging Cases**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450A

Akshya Gupta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CMS02E

### **Acute Pain Rapid Fire Challenging MSK Cases**

Thursday, Nov. 30 3:00PM - 4:00PM Room: E450A

Humberto G. Rosas, MD (*Presenter*) Co-founder, AyrFlo; Stockholder, AyrFlo

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNMMI08

### Therapy Response Assessment: Read with the Experts

Thursday, Nov. 30 3:00PM - 4:00PM Room: S403A

David A. Mankoff, MD, PhD (*Moderator*) Speaker, Siemens AG Advisory Board, ImaginAb, Inc Advisory Board, RefleXion Medical Inc Consultant, Blue Earth Diagnostics Ltd Consultant, General Electric Company Research funded, Siemens AG Spouse, Owner, Trevarx Biomedical, Inc

#### LEARNING OBJECTIVES

1) Review current response assessment criteria applicable to PET/CT. 2) Illustrate the applications of these response assessment criteria in clinical practice. 3) Discuss advances in the field of PET/CT and response assessment.

#### COURSE DESCRIPTION

This course reviews the application of PET molecular imaging assessment of response to therapy and provides example of current disease-specific applications and response criteria. Presenters provide an overview on the approach to cancer response assessment and provide some cases examples to illustrate principles and practice of this methodology.

#### Sub-Events

##### **R7-CNMMI08B** Update on PET CT Application of Response Assessment to Therapy in Gynecological Malignancies

Esma A. Akin, MD (*Presenter*) Nothing to Disclose

##### **R7-CNMMI08C** Updates and Controversies in PET/CT Response Assessment

Eric M. Rohren, PhD, MD (*Presenter*) Nothing to Disclose

##### **R7-CNMMI08D** Update on Prostate Therapy Response Assessment

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNMMI08B

### **Update on PET CT Application of Response Assessment to Therapy in Gynecological Malignancies**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S403A

Esma A. Akin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R7-CNMMI08C

### **Updates and Controversies in PET/CT Response Assessment**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S403A

Eric M. Rohren, PhD, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNMMI08D

### **Update on Prostate Therapy Response Assessment**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S403A

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNPM18

### Unprofessionalism in the Workplace

Thursday, Nov. 30 3:00PM - 4:00PM Room: S502

Vikas Gulani, MD, PhD (*Moderator*) Research support, Siemens AG;Consulting, Cook Group Incorporated

#### LEARNING OBJECTIVES

1) Recognize the manifestations of professional disruptions in the workplace. 2) Identify mitigation strategies for professional disruptions in the workplace.

#### COURSE DESCRIPTION

Unprofessional and disruptive behavior in the radiology workplace can be on the spectrum of overt to insidious. In this course, we will explore microaggressions, sexual harassment, and professionalism transgressions, and consider trainee professionalism and wellness. We will discuss how these behaviors may manifest themselves and provide examples of mitigation strategies.

#### Sub-Events

##### **R7- CNPM18B**      **Microaggressions**

Tracy A. Jaffe, MD (*Presenter*) Nothing to Disclose

##### **R7- CNPM18C**      **Trainee Professionalism and Wellness**

Steven S. Harris, MD, PhD (*Presenter*) Nothing to Disclose

##### **R7- CNPM18D**      **Professionalism Transgressions**

Vikas Gulani, MD, PhD (*Presenter*) Research support, Siemens AG;Consulting, Cook Group Incorporated

##### **R7- CNPM18E**      **Gender Harassment**

Vaz A. Zavaletta, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R7-CNPM18B

### **Microaggressions**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S502

Tracy A. Jaffe, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNPM18C

### Trainee Professionalism and Wellness

Thursday, Nov. 30 3:00PM - 4:00PM Room: S502

Steven S. Harris, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNPM18D

### Professionalism Transgressions

Thursday, Nov. 30 3:00PM - 4:00PM Room: S502

Vikas Gulani, MD, PhD (*Presenter*) Research support, Siemens AG;Consulting, Cook Group Incorporated

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNPM18E

### **Gender Harassment**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S502

Vaz A. Zavaletta, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CNR08

### Emerging Neuroimaging Techniques: Stuck in the Research Realm or Ready for Prime-Time?

Thursday, Nov. 30 3:00PM - 4:00PM Room: N227B

Hediyeh Baradaran, MD, MS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review advances in 7T imaging as it pertains to specific clinical applications. 2) Identify potential benefits in clinical adoption of PET MR imaging. 3) Explain the difficulties with widespread use of 7T and PET MR imaging.

#### COURSE DESCRIPTION

Are 7T and PET MR imaging going to revolutionize neuroimaging or will they be relegated to the research realm? In this session, we will describe the current potential uses and limitations in using both 7T and PET/MR imaging. This lecture based session will provide evidence-based discussion of newer MR imaging technology to prepare neuroradiologists for potential changes in future practice.

#### Sub-Events

##### R7-CNR08B 7T Vascular and CSVD Imaging: Clinical Utility of Higher Resolution

Hediyeh Baradaran, MD, MS (*Presenter*) Nothing to Disclose

##### R7-CNR08C Epilepsy Imaging: What More Can We See With 7T?

Erik H. Middlebrooks, MD (*Presenter*) Research Consultant, Siemens AG; Research support, Siemens AG; Consultant, Boston Scientific Corporation; Research support, Boston Scientific Corporation

##### R7-CNR08D PET/MR in Oncologic Imaging: Does PET/MR Improve Patient Outcomes?

Jana Ivanidze, MD, PhD (*Presenter*) Research Grant, Novartis AG;

##### R7-CNR08E PET/MR for Neurodegeneration and Alzheimer's Dementia

Tammie S. Benzinger, MD, PhD (*Presenter*) Research Grant, Eli Lilly and Company; Investigator, Eli Lilly and Company; Investigator, F. Hoffmann-La Roche Ltd; Consultant, Siemens AG; Research Grant, Siemens AG; Consultant, ADM Diagnostics, LLC; Speakers Bureau, Biogen Idec Inc; Advisory Board, Biogen Idec Inc

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## Abstract Archives of the RSNA, 2023

R7-CNR08B

### **7T Vascular and CSVD Imaging: Clinical Utility of Higher Resolution**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N227B

Hediyeh Baradaran, MD, MS (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R7-CNR08C

### **Epilepsy Imaging: What More Can We See With 7T?**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N227B

Erik H. Middlebrooks, MD (*Presenter*) Research Consultant, Siemens AG; Research support, Siemens AG; Consultant, Boston Scientific Corporation; Research support, Boston Scientific Corporation

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## Abstract Archives of the RSNA, 2023

R7-CNR08D

### **PET/MR in Oncologic Imaging: Does PET/MR Improve Patient Outcomes?**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N227B

Jana Ivanidze, MD, PhD (*Presenter*) Research Grant, Novartis AG;

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## Abstract Archives of the RSNA, 2023

R7-CNR08E

### **PET/MR for Neurodegeneration and Alzheimer's Dementia**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N227B

Tammie S. Benzinger, MD, PhD (*Presenter*) Research Grant, Eli Lilly and Company; Investigator, Eli Lilly and Company; Investigator, F. Hoffmann-La Roche Ltd; Consultant, Siemens AG; Research Grant, Siemens AG; Consultant, ADM Diagnostics, LLC; Speakers Bureau, Biogen Idec Inc; Advisory Board, Biogen Idec Inc

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## Abstract Archives of the RSNA, 2023

R7-COB06

### Endometrial and Cervical Cancer Staging: How to Get it Right the First Time!

Thursday, Nov. 30 3:00PM - 4:00PM Room: S501

Andrea G. Rockall, FRCR, MRCP (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the requirements to optimise imaging-based staging of endometrial and cervical cancer staging. 2) Be aware of key findings on imaging that will impact treatment planning.

#### COURSE DESCRIPTION

This lecture-based course will describe protocols and top tips to ensure accurate staging of endometrial and cervical cancer and will include ultrasound, MRI, and FDG-PET/CT. Pitfalls will be described. The key findings on imaging that will influence treatment planning will be discussed.

#### Sub-Events

##### **R7-COB06B MRI of Cervical Cancer: Radiologists Guiding the Way**

Andrea G. Rockall, FRCR, MRCP (*Presenter*) Nothing to Disclose

##### **R7-COB06C US and MRI of Endometrial Cancer Staging: Tips and Tricks**

Krupa K. Patel-Lippmann, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R7-COB06B

### **MRI of Cervical Cancer: Radiologists Guiding the Way**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S501

Andrea G. Rockall, FRCR, MRCP (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-COB06C

### **US and MRI of Endometrial Cancer Staging: Tips and Tricks**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S501

Krupa K. Patel-Lippmann, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CPD05

### **Pediatric Body MR Imaging: Whole Body Screening, Pitfalls, and Standardized Reports**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N226

Govind B. Chavhan, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Discuss the protocols and current clinical applications of whole body MRI and Rapid Abdominal MRI in children. 2) Identify pitfalls of MR Enterography in children and describe its applications beyond inflammatory bowel disease. 3) List the benefits and methods to use reporting template effectively in clinical practice.

#### **COURSE DESCRIPTION**

MR imaging is playing important role in body imaging in children with ever expanding clinical applications in various disease process. Update on new techniques and protocols as well as new emerging clinical applications of MR in pediatric body is essential. This educational session is designed to provide learners with updates on current techniques, protocols and pitfalls in pediatric body MR imaging via lectures. Clinical applications of whole-body MRI in screening of children with oncologic and non-oncologic disease processes, and applications of MR Enterography in evaluations of gastrointestinal diseases other than inflammatory bowel disease will be discussed. Strategies to use rapid abdominal MRI and its potential applications in children will be illustrated. Finally, importance and methods in communicating the imaging findings effectively through standardized reporting will be discussed.

#### **Sub-Events**

##### **R7-CPD05B Whole Body MRI in Pediatric Patients: Clinical Applications and Up-to-Date Protocols**

Andrea S. Doria, MD, PhD (*Presenter*) Baxalta-Shire (Research Grant), Novo Nordisk (Research Grant), Terry Fox Foundation (Research Grant), PSI Foundation (Research Grant), Society of Pediatric Radiology (Research Grant), Garron Family Cancer Centre (Research Grant)

##### **R7-CPD05C Pitfalls with MR Enterography: Beyond Inflammatory Bowel Disease**

Ethan A. Smith, MD (*Presenter*) Nothing to Disclose

##### **R7-CPD05D Cut to the Chase: Potential Uses of Rapid MRI in Children**

Govind B. Chavhan, MD (*Presenter*) Nothing to Disclose

##### **R7-CPD05E Reporting Templates: Here to Save the Day Extra?**

Sherwin S. Chan, MD, PhD (*Presenter*) Consultant, Jazz Pharmaceuticals plc; Research Grant, Jazz Pharmaceuticals plc; Research Grant, Hyperfine, Inc; Research Grant, General Electric Company

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## Abstract Archives of the RSNA, 2023

R7-CPD05B

### **Whole Body MRI in Pediatric Patients: Clinical Applications and Up-to-Date Protocols**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N226

Andrea S. Doria, MD, PhD (*Presenter*) Baxalta-Shire (Research Grant), Novo Nordisk (Research Grant), Terry Fox Foundation (Research Grant), PSI Foundation (Research Grant), Society of Pediatric Radiology (Research Grant), Garron Family Cancer Centre (Research Grant)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CPD05C

### **Pitfalls with MR Enterography: Beyond Inflammatory Bowel Disease**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N226

Ethan A. Smith, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CPD05D

### **Cut to the Chase: Potential Uses of Rapid MRI in Children**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N226

Govind B. Chavhan, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CPD05E

### Reporting Templates: Here to Save the Day Extra?

Thursday, Nov. 30 3:00PM - 4:00PM Room: N226

Sherwin S. Chan, MD, PhD (*Presenter*) Consultant, Jazz Pharmaceuticals plc; Research Grant, Jazz Pharmaceuticals plc; Research Grant, Hyperfine, Inc; Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CPH11

### Data Curation for AI with Proper Medical Imaging Physics Context

Thursday, Nov. 30 3:00PM - 4:00PM Room: S405

Zhihua Qi, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To review the process and to demonstrate methods and tools to collect and prepare clinical data for AI model development and related research. 2) To learn how data quality and data size affect the performance and generalizability of deep neural network models. 3) To understand practical methods for series and study selection for clinically deployed AI models, common issues that arise in deployment, and several techniques for evaluating AI in an ongoing fashion.

#### COURSE DESCRIPTION

This course reviews the selection, procurement, quality and evaluation of data for AI development and deployment in radiology. With a focus on the technical and imaging physics aspects of AI in radiology, it is of high educational value to those interested in active involvement in such activities.

#### Sub-Events

##### R7-CPH11B Preparing High Quality Data for AI

Zhihua Qi, PhD (*Presenter*) Nothing to Disclose

##### R7-CPH11C Data Quality and Generalizability in AI

Ran Zhang, PhD (*Presenter*) Nothing to Disclose

##### R7-CPH11D Clinical Integration of AI Models

John W. Garrett, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R7-CPH11B

### Preparing High Quality Data for AI

Thursday, Nov. 30 3:00PM - 4:00PM Room: S405

Zhihua Qi, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CPH11C

### **Data Quality and Generalizability in AI**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S405

Ran Zhang, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CPH11D

### **Clinical Integration of AI Models**

Thursday, Nov. 30 3:00PM - 4:00PM Room: S405

John W. Garrett, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R7-CR003

### **Breast Cancer Case Based Multidisciplinary Review**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N229

Bethany L. Niell, MD, PhD (*Moderator*) Equipment support, Hologic, Inc

#### **LEARNING OBJECTIVES**

1) Describe the latest advances in breast cancer imaging before, during, and after treatment. 2) Facilitate a multidisciplinary approach to the diagnosis, management, and treatment of breast cancer.

#### **COURSE DESCRIPTION**

This course utilizes a case-based multi-disciplinary approach to discuss appropriate breast imaging examinations, radiologic-pathologic correlation, available radiotherapy options, as well as medical and surgical oncologic treatment planning in the setting of breast cancer.

#### **Sub-Events**

##### **R7-CR003B Breast Cancer Case Based Multidisciplinary Review**

Anna Shapiro, MD (*Presenter*) Nothing to Disclose

##### **R7-CR003C Breast Cancer Case Based Multidisciplinary Review**

Lorena Gonzalez, MD (*Presenter*) Nothing to Disclose

##### **R7-CR003D Breast Cancer Case Based Multidisciplinary Review**

Avan Armaghani, MD (*Presenter*) Nothing to Disclose

##### **R7-CR003E Breast Cancer Case Based Multidisciplinary Review**

Rohin Mehta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CRO03B

### **Breast Cancer Case Based Multidisciplinary Review**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N229

Anna Shapiro, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

R7-CR003C

### **Breast Cancer Case Based Multidisciplinary Review**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N229

Lorena Gonzalez, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CR003D

### **Breast Cancer Case Based Multidisciplinary Review**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N229

Avan Armaghani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-CRO03E

### **Breast Cancer Case Based Multidisciplinary Review**

Thursday, Nov. 30 3:00PM - 4:00PM Room: N229

Rohin Mehta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CBR02

### AI in Breast Imaging

Sunday, Nov. 26 9:00AM - 10:00AM Room: S406A

Constance D. Lehman, MD, PhD (*Moderator*) Institutional Grant, General Electric Company; Institutional Grant, Hologic, Inc; Co-founder, Clairity, Inc.

#### LEARNING OBJECTIVES

1) Develop critical thinking and understanding of the terminology in the development and evaluation of AI systems for breast cancer screening, diagnosis and treatment. 2) Gain insights from prospective interventional studies including diagnostic improvements, biases, and limitations. 3) Attain a realistic appreciation for the opportunities and challenges in the implementation of AI in clinical practice.

#### COURSE DESCRIPTION

Build your knowledge with top experts in evaluating, implementing, and understanding the wider impact of AI systems in breast cancer screening, diagnosis and intervention. There will be three lectures followed by an open panel discussion. We will cover the full cycle from development and evaluation of AI systems, including how the FDA evaluates AI algorithms, what developers might expect for post-market surveillance requirements, implications of results of large clinical trials, and future opportunities and challenges when implementing AI in routine clinical practice. In the final panel discussion, all presenters are available to discuss important topics brought forward by the panel and audience.

#### Sub-Events

##### S1-CBR02B AI in Breast Imaging: Development and Testing of Breast AI

Etta D. Pisano, MD (*Presenter*) Nothing to Disclose

##### S1-CBR02C AI in Breast Imaging: Pearls and Pitfalls of Implementation

Constance D. Lehman, MD, PhD (*Presenter*) Institutional Grant, General Electric Company; Institutional Grant, Hologic, Inc; Co-founder, Clairity, Inc.

##### S1-CBR02D AI in Breast Imaging: Outcomes from Screening Trials

Fredrik Strand, MD, PhD (*Presenter*) Speaker, Lunit Inc

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## Abstract Archives of the RSNA, 2023

S1-CBR02B

### **AI in Breast Imaging: Development and Testing of Breast AI**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S406A

Etta D. Pisano, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CBR02C

### **AI in Breast Imaging: Pearls and Pitfalls of Implementation**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S406A

Constance D. Lehman, MD, PhD (*Presenter*) Institutional Grant, General Electric Company; Institutional Grant, Hologic, Inc; Co-founder, Clarity, Inc.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-CBR02D

### **AI in Breast Imaging: Outcomes from Screening Trials**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S406A

Fredrik Strand, MD, PhD (*Presenter*) Speaker, Lunit Inc

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## Abstract Archives of the RSNA, 2023

S1-CCA05

### Mapping the Target & Pushing the Limits: Imaging Guidance for Electrophysiology Procedure Planning

Sunday, Nov. 26 9:00AM - 10:00AM Room: N230B

Jiayin Zhang, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

- 1) Identify the MR biomarkers in electrophysiology (EP) planning and learn how to guide procedure by the use of biomarkers.
- 2) Discover the latest advanced CT techniques for EP imaging.
- 3) Learn how to use interactive 3D modeling to plan EP procedure.

#### COURSE DESCRIPTION

Pre-procedural imaging is essential for guiding electrophysiology procedure planning. Learning the advanced EP imaging techniques is of educational importance for radiologists and cardiologists. This 1-hour course includes lectures from 3 distinguished professors, focusing on CMR, CT and 3D modelling respectively. In this session, you will be guided through the up-to-date MR and CT application in pre-procedural EP imaging and learn how to perform in clinical practice.

#### Sub-Events

##### S1-CCA05B Cardiac MRI Biomarkers in EP Planning

Harold I. Litt, MD, PhD (*Presenter*) Research Grant, Siemens AG; Research Grant, Koninklijke Philips NV

##### S1-CCA05C Beyond the Scar: Advanced CT Imaging

Jamie L. Schroeder, MD, DPhil (*Presenter*) Nothing to Disclose

##### S1-CCA05D Interactive 3D Modeling: Creating the Cardiac Avatar

Menhel Kinno, MD, MPH (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

S1-CCA05B

### **Cardiac MRI Biomarkers in EP Planning**

Sunday, Nov. 26 9:00AM - 10:00AM Room: N230B

Harold I. Litt, MD, PhD (*Presenter*) Research Grant, Siemens AG; Research Grant, Koninklijke Philips NV

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## Abstract Archives of the RSNA, 2023

S1-CCA05C

### **Beyond the Scar: Advanced CT Imaging**

Sunday, Nov. 26 9:00AM - 10:00AM Room: N230B

Jamie L. Schroeder, MD, DPhil (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CCA05D

### **Interactive 3D Modeling: Creating the Cardiac Avatar**

Sunday, Nov. 26 9:00AM - 10:00AM Room: N230B

Menhel Kinno, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CER01

### Essential Head and Neck Trauma

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451B

Koenraad H. Nieboer, MD (*Moderator*) Speakers Bureau, General Electric Company

#### LEARNING OBJECTIVES

1) Identify and describe correctly acute traumatic lesions on CT scan of the head, skull base, and lesions of the soft-tissues of the neck. 2) When to use advanced neuroimaging techniques in the setting of traumatic brain injury. 3) What is important to include in your report.

#### COURSE DESCRIPTION

This session offers 3 highly recommended lectures. From basic assessment of CT scan of the brain, skull base and soft-tissue lesions of the neck in the context of acute trauma to advanced imaging, for all experience levels. Clear identification and description of acute traumatic lesions are essential for rapid communication with referring physicians and trauma surgeons. And when do you recommend advanced imaging?

#### Sub-Events

##### S1-CER01B Essentials of Acute Brain Trauma

Koenraad H. Nieboer, MD (*Presenter*) Speakers Bureau, General Electric Company

##### S1-CER01C Skull Base Trauma (Including Mastoid)

Divya Gunda, MD (*Presenter*) Nothing to Disclose

##### S1-CER01D Traumatic Emergencies of the Soft Tissues of the Neck

Carlota C. Andreu Arasa, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CER01B

### Essentials of Acute Brain Trauma

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451B

Koenraad H. Nieboer, MD (*Presenter*) Speakers Bureau, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CER01C

### **Skull Base Trauma (Including Mastoid)**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451B

Divya Gunda, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-CER01D

### **Traumatic Emergencies of the Soft Tissues of the Neck**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451B

Carlota C. Andreu Arasa, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CGI01

### GI/GU Jeopardy

Sunday, Nov. 26 9:00AM - 10:00AM Room: S406B

Christine O. Menias, MD (*Moderator*) Royalties, RELX  
David J. DiSantis, MD (*Moderator*) Nothing to Disclose  
Gaurav Khatri, MD (*Presenter*) Nothing to Disclose  
Shaun A. Wahab, MD (*Presenter*) Consultant, GlaxoSmithKline plc;Consultant, BioClinica, Inc;Consultant, Mersana Therapeutics, Inc  
Nataly Horvat, MD, PhD (*Presenter*) Nothing to Disclose  
Sarah Bastawrous, DO (*Presenter*) Nothing to Disclose  
Satheesh Krishna, MD (*Presenter*) Nothing to Disclose  
Rachita Khot, MD (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Attendees will broaden their abdominal imaging skills as experts guide them through their approach to diagnosing difficult cases.

#### COURSE DESCRIPTION

Using the popular game show format, experts will tackle abdominal imaging cases as challenging unknowns. Discussion will highlight working through differential diagnoses, and clues to getting it right.

#### Sub-Events

##### S1-CGI01C Moderator/MC

Olga R. Brook, MD, MBA (*Moderator*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CGI01C

**Moderator/MC**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S406B

Olga R. Brook, MD, MBA (*Moderator*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CIN10

### Pearls and Pitfalls of 3D Printing from Imaging Data

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450B

Nicole Wake, PhD (*Moderator*) Employee, GE HealthCare

#### LEARNING OBJECTIVES

1) Understand how to evaluate and optimize the accuracy of clinical 3D printing. 2) Identify strategies to improve efficiency of 3D printing workflows. 3) Explain how to pitch the business case for 3D printing in healthcare facilities.

#### COURSE DESCRIPTION

Safety and quality in clinical 3D printing depend on many technical and operational factors. 3D printed anatomic models must reliably represent the patient's anatomy to be useful to the clinician, but the workflow required to create these models from medical imaging data is complex and time consuming. The inherent complexity of image-based 3D printing allows the possibility of errors at any stage of the process. These stages include imaging acquisition, fusion of multiple exam types, segmentation, computer aided design, 3D printing, and post processing of the final 3D printed product. In this educational course, the stages where variances in the 3D printing workflow can occur will be reviewed. Specific clinical scenarios and challenges will be used to illustrate strategies for successful 3D printing. Tips on how to assess quality as well as improve efficiency and address variances will be described. From an operational standpoint, strategies for making the business case for 3D printing capabilities in health care facilities will also be discussed. 3D printed models will be circulated as examples. Interactive polling questions will be used throughout the session to engage the audience and assess their knowledge base. This interactive didactic session addresses the needs outlined above and provides a framework to address potential pitfalls in performing clinical 3D printing. This topic is relevant to trainees and practicing radiologists engaged in the management of complex surgical conditions, as well as technologists and scientists involved in image optimization and processing for visualization and 3D modeling.

#### Sub-Events

##### **S1-CIN10B Evaluating and Optimizing Accuracy of Clinical 3D Printing**

Nicole Wake, PhD (*Presenter*) Employee, GE HealthCare

##### **S1-CIN10C Improving Efficiency of 3D Printing Workflows**

David H. Ballard, MD (*Presenter*) Nothing to Disclose

##### **S1-CIN10D Pitching the Business Case for 3D Printing in Health Care Facilities**

Summer J. Decker, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CIN10B

### **Evaluating and Optimizing Accuracy of Clinical 3D Printing**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450B

Nicole Wake, PhD (*Presenter*) Employee, GE HealthCare

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CIN10C

### **Improving Efficiency of 3D Printing Workflows**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450B

David H. Ballard, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CIN10D

### **Pitching the Business Case for 3D Printing in Health Care Facilities**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450B

Summer J. Decker, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CMK12

### Emerging Imaging Techniques in MSK Imaging

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450A

Iman Khodarahmi, MD, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

- 1) Review the latest clinical advancements and translational techniques in MRI of metal-containing body parts and muscles.
- 2) Recognize the potential and challenges of photon counting CT in the diagnosis and management of musculoskeletal disease.
- 3) Describe the basic principles and novelties in artificial intelligence and their utility and impact on image reconstruction and analysis.

#### COURSE DESCRIPTION

Radiology and radiological sciences are the pioneers of technology development and implementation among all medical specialties. Knowledge of recent advancements is essential for the imaging community for timely incorporation of such developments in the clinical workflow. Through five lecture series, this educational course discusses the emerging techniques in MRI and CT imaging of the musculoskeletal system as well as the current state-of-the-art artificial intelligence methods applied to musculoskeletal imaging.

#### Sub-Events

##### S1-CMK12B MR Imaging of Metallic Orthopedic Hardware

Iman Khodarahmi, MD, PhD (*Presenter*) Nothing to Disclose

##### S1-CMK12C Photon-counting CT in the MSK Practice: Opportunities and Challenges

Francis I. Baffour, MD (*Presenter*) Nothing to Disclose

##### S1-CMK12D Machine Learning for MRI Analysis

Benjamin Fritz, MD (*Presenter*) Nothing to Disclose

##### S1-CMK12E New Ways to Assess Muscle with MRI

Timothy J. Bray, MBBChir, PhD (*Presenter*) Nothing to Disclose

##### S1-CMK12F Deep Learning for Image Reconstruction

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-CMK12B

### **MR Imaging of Metallic Orthopedic Hardware**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450A

Iman Khodarahmi, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CMK12C

### **Photon-counting CT in the MSK Practice: Opportunities and Challenges**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450A

Francis I. Baffour, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CMK12D

### Machine Learning for MRI Analysis

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450A

Benjamin Fritz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CMK12E

### **New Ways to Assess Muscle with MRI**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450A

Timothy J. Bray, MBBChir, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CMK12F

### Deep Learning for Image Reconstruction

Sunday, Nov. 26 9:00AM - 10:00AM Room: E450A

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNPM04

### **From Careerism to Professionalism: A Personal and Institutional Imperative (Sponsored by the RSNA Professionalism Committee)**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E351

R. Paul Guillerman, MD (*Moderator*) Nothing to Disclose  
Sarah D. Bixby, MD, MBA (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Learn how to fit in and stand out by developing self-awareness of personal strengths/weaknesses and institutional culture and opportunities. 2) Learn how to avoid career self-sabotage by focusing on productive habits rather than goals, negotiating resources and authority commensurate with authority, engaging in supportive rather than exploitative relationships, and responding to challenges with resilience and antifragility. 3) Learn how to lead with or without titles to guide and inspire others to thrive and move beyond status-seeking careerism to professionalism based on a commitment to excellence and magnanimity.

#### **COURSE DESCRIPTION**

This course will be comprised of several presentations addressing how to best facilitate a successful transition from trainee to early and mid career radiologist and recognize the important distinction between "careerism" and professionalism. Advice will be provided on how to fit in and stand out by achieving the self-awareness to determine what practice setting and roles are best aligned to take advantage of personal strengths and promote professional growth. Tips for avoiding career self-sabotage will be offered, including focusing on productive habits rather than all-or-none goals, negotiating resources and authority commensurate with responsibility, engaging in supportive rather than exploitative relationships, developing resilience and antifragility in response to challenges, and adapting to cultural norms. While professional success can be measured in terms of metrics such as publications, citations, invited lectures, awards, grants, degrees, and titles, status-seeking "careerism" is ultimately much less fulfilling than building a strong sense of professionalism based on a passion for excellence and magnanimity that guides and inspires others to thrive.

#### **Sub-Events**

##### **S1- CNPM04C Fitting In and Standing Out**

R. Paul Guillerman, MD (*Presenter*) Nothing to Disclose

##### **S1- CNPM04D Avoiding Career Self-Sabotage**

Charles M. Maxfield, MD (*Presenter*) Nothing to Disclose

##### **S1- CNPM04E Leading With or Without Titles - Part A**

Sarah D. Bixby, MD, MBA (*Presenter*) Nothing to Disclose

##### **S1- CNPM04F Leading With or Without Titles - Part B**

Mariana L. Meyers, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNPM04C

### **Fitting In and Standing Out**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E351

R. Paul Guillerman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNPM04D

### **Avoiding Career Self-Sabotage**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E351

Charles M. Maxfield, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-CNPM04E

### Leading With or Without Titles - Part A

Sunday, Nov. 26 9:00AM - 10:00AM Room: E351

Sarah D. Bixby, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNPM04F

### Leading With or Without Titles - Part B

Sunday, Nov. 26 9:00AM - 10:00AM Room: E351

Mariana L. Meyers, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNR02

### Essential Updates in Ischemic Stroke Imaging and Treatment

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451A

Jeremy J. Heit, MD, PhD (*Moderator*) Consultant, Medtronic plc; Consultant, Terumo Corporation; Consultant, iSchemaView, Inc; Scientific Advisory Board, iSchemaView, Inc; Medical Advisory Board, iSchemaView, Inc; Committee Member, Vesalio

#### LEARNING OBJECTIVES

1) To describe new large artery occlusion targets for thrombectomy treatment in acute ischemic stroke patients. 2) To understand existing evidence for the treatment of medium and small artery occlusion targets by thrombectomy. 3) To understand new thrombectomy eligibility criteria based upon non-invasive imaging studies. 4) To describe new frontiers in endovascular thrombectomy and how they may impact ischemic stroke treatment in the near future.

#### COURSE DESCRIPTION

Acute ischemic stroke is the leading cause of disability in the United States and results in significant mortality worldwide. New randomized trials published in the past two years have substantially increased patient eligibility for endovascular thrombectomy. In this course, we will review new selection criteria for endovascular thrombectomy (such as patients with large ischemic cores and low ASPECTS) and the evidence for expanded treatment of vessel occlusions (such as basilar artery occlusions and small/medium vessel occlusions). In addition, we will describe existing and emerging changes in hospital systems to facilitate expeditious transfer and treatment of thrombectomy-eligible patients and discuss commonly encountered challenges in patient treatment through a case-based discussion.

#### Sub-Events

##### **S1-CNR02B Expanded Eligibility for Endovascular Thrombectomy: Treatment of Patients with Low ASPECTS and Large Ischemic Cores**

Jeremy J. Heit, MD, PhD (*Presenter*) Consultant, Medtronic plc; Consultant, Terumo Corporation; Consultant, iSchemaView, Inc; Scientific Advisory Board, iSchemaView, Inc; Medical Advisory Board, iSchemaView, Inc; Committee Member, Vesalio

##### **S1-CNR02C Large Vessel Occlusions to Not-So-Large Vessel Occlusions: What's the Evidence for Thrombectomy?**

Michele H. Johnson, MD (*Presenter*) Medical Advisory Board, iSchemaView, Inc

##### **S1-CNR02D Hospital Systems of Care for Ischemic Stroke Patients and the Changing Role of the Radiologist**

Mahesh V. Jayaraman, MD (*Presenter*) Nothing to Disclose

##### **S1-CNR02E Challenges in Ischemic Stroke Treatment: A Case-Based Discussion**

Katyucia De Macedo Rodrigues, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNR02B

### **Expanded Eligibility for Endovascular Thrombectomy: Treatment of Patients with Low ASPECTS and Large Ischemic Cores**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451A

Jeremy J. Heit, MD, PhD (*Presenter*) Consultant, Medtronic plc; Consultant, Terumo Corporation; Consultant, iSchemaView, Inc; Scientific Advisory Board, iSchemaView, Inc; Medical Advisory Board, iSchemaView, Inc; Committee Member, Vesalio

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNR02C

### **Large Vessel Occlusions to Not-So-Large Vessel Occlusions: What's the Evidence for Thrombectomy?**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451A

Michele H. Johnson, MD (*Presenter*) Medical Advisory Board, iSchemaView, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNR02D

### **Hospital Systems of Care for Ischemic Stroke Patients and the Changing Role of the Radiologist**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451A

Mahesh V. Jayaraman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CNR02E

### Challenges in Ischemic Stroke Treatment: A Case-Based Discussion

Sunday, Nov. 26 9:00AM - 10:00AM Room: E451A

Katyucia De Macedo Rodrigues, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-COB05

### Placenta Accreta Spectrum (PAS): Pearls, Pitfalls, and Perils

Sunday, Nov. 26 9:00AM - 10:00AM Room: S405

Diane M. Twickler, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain current clinical implications of placenta accreta spectrum (PAS) diagnosis. 2) Evaluate 1st trimester PAS with US, and PAS beyond 14 weeks gestation with US and MRI. 3) Understand the pathology of PAS and current FIGO classifications.

#### COURSE DESCRIPTION

Placenta Accreta Spectrum is a serious complication of pregnancy. This lecture will address how imaging with US and MRI can affect surgical planning that improves outcomes. Current US and MRI evaluation recommendations of PAS in pregnancy will be reviewed, including case presentations. The importance of correlation with pathologic outcomes and recommended FIGO classifications will be discussed.

#### Sub-Events

#### **S1-COB05B Perspectives of the Maternal Fetal Medicine Specialist and 1st Trimester US Cesarean Scar of Pregnancy**

Catherine Y. Spong, MD (*Presenter*) Nothing to Disclose

#### **S1-COB05C Beyond 14 Weeks: US Placenta Accreta Index and 2nd Opinion MR**

Diane M. Twickler, MD (*Presenter*) Nothing to Disclose

#### **S1-COB05D Perspectives of the Pathologist: FIGO Classifications and Case Review**

Jonathan Hecht, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-COB05B

### **Perspectives of the Maternal Fetal Medicine Specialist and 1st Trimester US Cesarean Scar of Pregnancy**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S405

Catherine Y. Spong, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-COB05C

### **Beyond 14 Weeks: US Placenta Accreta Index and 2nd Opinion MR**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S405

Diane M. Twickler, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-COB05D

### **Perspectives of the Pathologist: FIGO Classifications and Case Review**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S405

Jonathan Hecht, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13

### RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Andrea S. Doria, MD, PhD (*Moderator*) Baxalta-Shire (Research Grant), Novo Nordisk (Research Grant), Terry Fox Foundation (Research Grant), PSI Foundation (Research Grant), Society of Pediatric Radiology (Research Grant), Garron Family Cancer Centre (Research Grant)

#### LEARNING OBJECTIVES

1) Review the anatomy and common pediatric pathologic musculoskeletal conditions in three pediatric joints: the elbow, hand and ankle. 2) Use dynamic scanning of the joints to better demonstrate the anatomy of soft tissue and osteochondral components of three pediatric joints and will point out the distinction of soft tissue structures by a compression technique. 3) Discuss pathologies in the aforementioned joints as an overview of common pediatric pathologic musculoskeletal conditions.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. This 90-min pediatric musculoskeletal hands-on session is targeted to general radiologists who aim to get an overview of technical and clinical application perspectives on ultrasound scanning and interpreting pathology of elbows, hands and ankles of children and adolescents. The information provided in this session adds value to the diagnostic tools that can be used for assessment of musculoskeletal disorders that affect growing joints, particularly in young children who may require general anesthesia for MRI assessment of their joints. The session has two parts, a 60-min hands-on part where pre-assigned radiologists scan teenager models' joints in real time and a second 30-min knowledge application part where the audience has the opportunity to scan models' joints by themselves. In the first part of the session lecturers will demonstrate ultrasound protocols for scanning of pediatric elbows, hands and ankles in real-time and will discuss ultrasound findings of pathologies in these joints. In the second part of the session tutoring to scanning by the audience will be provided by assigned radiologists in a controlled educational environment where the audience will have the opportunity to apply the a priori discussed ultrasound protocols into scanning the models' joints.

#### Sub-Events

##### S1-CPD13B RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound

Erica K. Schallert, MD (*Presenter*) Nothing to Disclose

##### S1-CPD13C RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound

Andrea S. Doria, MD, PhD (*Presenter*) Baxalta-Shire (Research Grant), Novo Nordisk (Research Grant), Terry Fox Foundation (Research Grant), PSI Foundation (Research Grant), Society of Pediatric Radiology (Research Grant), Garron Family Cancer Centre (Research Grant)

##### S1-CPD13D RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound

Monica Kalume Brigido, MD (*Presenter*) Nothing to Disclose

##### S1-CPD13E RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound

Emilio Inarejos Clemente, MD (*Presenter*) Nothing to Disclose

##### S1-CPD13F RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound

Jonathan D. Samet, MD (*Presenter*) Nothing to Disclose

##### S1-CPD13G RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound

Kathryn S. Milks, MD (*Presenter*) Nothing to Disclose

**S1-CPD13H RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Abra Kilgore, RDMS (*Presenter*) Nothing to Disclose

**S1-CPD13I RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Izabella L. Karney, RDMS (*Presenter*) Nothing to Disclose

**S1-CPD13J RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Lauren A. May, MD (*Presenter*) Nothing to Disclose

**S1-CPD13K RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Matthew R. Hammer, MD (*Presenter*) Nothing to Disclose

**S1-CPD13L RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Natalie M. Anzaldi (*Presenter*) Nothing to Disclose

**S1-CPD13M RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Anna Alexiev, RDMS (*Presenter*) Nothing to Disclose

**S1-CPD13N RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Swati Patel, BS, RDMS (*Presenter*) Nothing to Disclose

**S1-CPD13O RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Ayla Kljako, RDMS (*Presenter*) Nothing to Disclose

**S1-CPD13P RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Stephanie Caputo, RDMS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13B

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Erica K. Schallert, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13C

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Andrea S. Doria, MD, PhD (*Presenter*) Baxalta-Shire (Research Grant), Novo Nordisk (Research Grant), Terry Fox Foundation (Research Grant), PSI Foundation (Research Grant), Society of Pediatric Radiology (Research Grant), Garron Family Cancer Centre (Research Grant)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13D

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Monica Kalume Brigido, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-CPD13E

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Emilio Inarejos Clemente, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13F

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Jonathan D. Samet, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13G

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Kathryn S. Milks, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13H

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Abra Kilgore, RDMS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13I

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Izabella L. Karney, RDMS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13J

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Lauren A. May, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13K

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Matthew R. Hammer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13L

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Natalie M. Anzaldi (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-CPD13M

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Anna Alexiev, RDMS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13N

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Swati Patel, BS, RDMS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD130

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Ayla Kljako, RDMS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CPD13P

### **RSNA Hands-On Lab: Pediatric Musculoskeletal Ultrasound**

Sunday, Nov. 26 10:00AM - 11:30AM Room: S504CD

Stephanie Caputo, RDMS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CRO09

### **Lung/Mediastinum Case Based Multidisciplinary Review**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S402

Simon S. Lo, MBChB (*Moderator*) Committee member, Elekta AB

#### **LEARNING OBJECTIVES**

1) Identify imaging strategies in the diagnosis and staging of thoracic malignancies. 2) Explain the current multidisciplinary management of thoracic malignancies. 3) Identify imaging strategies for post-treatment evaluation.

#### **COURSE DESCRIPTION**

This case-based discussion will expose the attendees to multidisciplinary discussion when treating thoracic malignancies. The panel will demonstrate specific imaging findings that directly affect staging and treatment decisions and will provide the audience with specific information they should include in their reports that directly affect prognosis and management. The cases to be discussed will be stage III non-small cell lung cancer, superior vena cava obstruction from small cell lung carcinoma, and mesothelioma.

#### **Sub-Events**

##### **S1-CRO09B Lung/Mediastinum Case Based Multidisciplinary Review**

Michelle S. Ginsberg, MD (*Presenter*) Speaker, Ultimate Opinions In Medicine LLC

##### **S1-CRO09C Lung/Mediastinum Case Based Multidisciplinary Review**

David W. Johnstone, MD (*Presenter*) Nothing to Disclose

##### **S1-CRO09D Lung/Mediastinum Case Based Multidisciplinary Review**

Rafael Santana-Davila, MD (*Presenter*) Nothing to Disclose

##### **S1-CRO09E Lung/Mediastinum Case Based Multidisciplinary Review**

Stephen Chun, MD (*Presenter*) Consultant, AstraZeneca PLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CRO09B

### **Lung/Mediastinum Case Based Multidisciplinary Review**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S402

Michelle S. Ginsberg, MD (*Presenter*) Speaker, Ultimate Opinions In Medicine LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CRO09C

### **Lung/Mediastinum Case Based Multidisciplinary Review**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S402

David W. Johnstone, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CRO09D

### **Lung/Mediastinum Case Based Multidisciplinary Review**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S402

Rafael Santana-Davila, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

S1-CRO09E

### **Lung/Mediastinum Case Based Multidisciplinary Review**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S402

Stephen Chun, MD (*Presenter*) Consultant, AstraZeneca PLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CVA08

### Aortic Dissection

Sunday, Nov. 26 9:00AM - 10:00AM Room: N226

Bradley D. Allen, MD, MS (*Moderator*) Consultant, Circle Cardiovascular Imaging Inc;Speaker, WebMD LLC  
Kate Hanneman, MD, MPH (*Moderator*) Speaker, Groupe Sanofi;Speaker, Amicus Therapeutics, Inc

#### LEARNING OBJECTIVES

1) Understand the subtypes and imaging appearance of aortic pathologies that are associated with acute aortic syndrome. 2) Explain the role of imaging for interventional planning in aortic dissection. 3) Describe the changes in imaging appearance of aortic dissection over time and the implications for patient risk.

#### COURSE DESCRIPTION

Aortic dissection and acute aortic syndromes are frequently encountered in clinical practice, but there is often confusion related to appropriate imaging and creating clinically impactful radiology reports. This session will review imaging approaches in acute aortic syndrome while providing learners with expert recommendation on reporting terminology and measurements, imaging for interventional planning in aortic dissection, and imaging in chronic aortic dissection.

#### Sub-Events

##### S1-CVA08C Imaging Acute Aortic Syndrome

Diana Litmanovich, MD (*Presenter*) Nothing to Disclose

##### S1-CVA08D Imaging for Surgical and Intervention Planning in Aortic Dissection

Dominik Fleischmann, MD (*Presenter*) Research Grant, Siemens AG;Stockholder, iSchemaView, Inc;Stockholder, Segmed, Inc

##### S1-CVA08E Imaging Chronic Aortic Dissection

Nicholas S. Burris, MD (*Presenter*) Royalties, ImBio, LLC

##### S1-CVA08F Limited Tears and Ulcer-Like Aortic Lesions

Kacie Steinbrecher, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CVA08C

### **Imaging Acute Aortic Syndrome**

Sunday, Nov. 26 9:00AM - 10:00AM Room: N226

Diana Litmanovich, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CVA08D

### **Imaging for Surgical and Intervention Planning in Aortic Dissection**

Sunday, Nov. 26 9:00AM - 10:00AM Room: N226

Dominik Fleischmann, MD (*Presenter*) Research Grant, Siemens AG;Stockholder, iSchemaView, Inc;Stockholder, Segmed, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CVA08E

### **Imaging Chronic Aortic Dissection**

Sunday, Nov. 26 9:00AM - 10:00AM Room: N226

Nicholas S. Burris, MD (*Presenter*) Royalties, ImBio, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-CVA08F

### Limited Tears and Ulcer-Like Aortic Lesions

Sunday, Nov. 26 9:00AM - 10:00AM Room: N226

Kacie Steinbrecher, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-RCP24

### **Contract Review and Negotiation for Trainees (Sponsored by the RSNA Resident & Fellow Committee)**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E352

Heba Albasha, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify the key elements of a contract. 2) Define and explain common contract terms. 3) Compare and contrast different compensation models. 4) Assess the fairness of benefits and compensation packages. 5) Identify and understand the business and legal consequences of contracts.

#### **Sub-Events**

### **S1-RCP24B Contract Review and Negotiation for Trainees (Sponsored by the RSNA Resident & Fellow Committee)**

Seetharam C. Chadalavada, MD, MS (*Presenter*) Consultant, Cook Group Incorporated; Grant, Cook Group Incorporated; Speaker, Cook Group Incorporated; Consultant, Koninklijke Philips NV; Speaker, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-RCP24B

### **Contract Review and Negotiation for Trainees (Sponsored by the RSNA Resident & Fellow Committee)**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E352

Seetharam C. Chadalavada, MD, MS (*Presenter*) Consultant, Cook Group Incorporated; Grant, Cook Group Incorporated; Speaker, Cook Group Incorporated; Consultant, Koninklijke Philips NV; Speaker, Koninklijke Philips NV

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CCH01

### HRCT Topics

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406B

Brett M. Elicker, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Describe the typical findings of different patterns of injury within the lungs. 2) Understand the histologic, clinical, and radiologic aspects of organizing pneumonia. 3) Describe the role of HRCT in the setting of connective tissue disease and drug induced lung disease. 4) Explain the spectrum of findings and patterns seen in patients with hypersensitivity pneumonitis.

#### COURSE DESCRIPTION

The course will be a review of several topics in the field of diffuse lung disease. It will focus on a practical approach to reading high-resolution chest CTs, and identifying common findings and patterns of disease. A particular emphasis will be on patterns of injury seen in connective tissue disease and drug induced lung disease. It will also include a review of the multi-disciplinary approach to hypersensitivity pneumonitis and organizing pneumonia.

#### Sub-Events

##### S2-CCH01B Organizing Pneumonia

Jeffrey R. Galvin, MD (*Presenter*) Nothing to Disclose

##### S2-CCH01C Collagen Vascular/Autoimmune Disease in the Lungs

Brett M. Elicker, MD (*Presenter*) Nothing to Disclose

##### S2-CCH01D Hypersensitivity Pneumonitis

Justus E. Roos, MD (*Presenter*) Nothing to Disclose

##### S2-CCH01E Drug Induced Lung Disease

Kimberly G. Kallianos, MD (*Presenter*) Nothing to Disclose

##### S2-CCH01F HRCT Topics

Teri J. Franks, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CCH01B

### **Organizing Pneumonia**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406B

Jeffrey R. Galvin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CCH01C

### **Collagen Vascular/Autoimmune Disease in the Lungs**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406B

Brett M. Elicker, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CCH01D

### **Hypersensitivity Pneumonitis**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406B

Justus E. Roos, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CCH01E

### **Drug Induced Lung Disease**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406B

Kimberly G. Kallianos, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CCH01F

### HRCT Topics

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406B

Teri J. Franks, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CER02

### Essentials of Spine Trauma

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451B

Nicholas M. Beckmann, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Describe mechanisms and associated injury patterns of cervical and thoracolumbar spine trauma. 2) Demonstrate common classifications used for spine trauma and understand their clinical relevance. 3) Recognize significant traumatic spine soft tissue injuries on MRI.

#### COURSE DESCRIPTION

The anatomy of the spine is complex and traumatic spine injuries can be subtle, which can make it challenging to correctly diagnosis significant traumatic spine injuries. In this three-part didactic session, the typical injury patterns and classification systems used for diagnosing traumatic spine injuries on CT will be presented along with the role and interpretation of MRI in imaging spine trauma.

#### Sub-Events

##### S2-CER02B CT of Cervical Spine Trauma

Nicholas M. Beckmann, MD (*Presenter*) Nothing to Disclose

##### S2-CER02C CT of Thoracolumbar Spine Trauma

Ken F. Linnau, MD, MS (*Presenter*) Royalties, Cambridge University Press; Research Grant, Siemens AG

##### S2-CER02D MRI in Spine Trauma

Kuang-Chun J. Hsieh, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CER02B

### CT of Cervical Spine Trauma

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451B

Nicholas M. Beckmann, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CER02C

### **CT of Thoracolumbar Spine Trauma**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451B

Ken F. Linnau, MD, MS (*Presenter*) Royalties, Cambridge University Press; Research Grant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CER02D

### **MRI in Spine Trauma**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451B

Kuang-Chun J. Hsieh, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CGU07

### Best of Sessions in GU Oncology

Sunday, Nov. 26 10:30AM - 11:30AM Room: E352

Antonio C. Westphalen, MD, PhD (*Moderator*) Shareholder, ScanMed, LLC; Research funded, BotImage, Inc

#### LEARNING OBJECTIVES

1) Familiarize oneself with the most up-to-date data pertaining to genitourinary oncology, radiology, and associated fields.

#### COURSE DESCRIPTION

In this session we will summarize the newest and best GU oncology research published and presented at the most recent meetings in and outside radiology. Speakers will present research in their area of practice, but that are relevant for practicing radiologists.

#### Sub-Events

##### S2-CGU07B Radiology

Vicky J. Goh, MBBCh (*Presenter*) Research Grant, Siemens AG

##### S2-CGU07C Urology

Yaw Nyame, MD (*Presenter*) Research Consultant, Ortho-Clinical Diagnostics, Inc

##### S2-CGU07D Radiation Oncology

Michael J. Zelefsky, MD (*Presenter*) Nothing to Disclose

##### S2-CGU07E Radiology

Victoria Chernyak, MD, MS (*Presenter*) Consultant, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CGU07B

### **Radiology**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E352

Vicky J. Goh, MBBCh (*Presenter*) Research Grant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CGU07C

### **Urology**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E352

Yaw Nyame, MD (*Presenter*) Research Consultant, Ortho-Clinical Diagnostics, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CGU07D

### **Radiation Oncology**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E352

Michael J. Zelefsky, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CGU07E

### **Radiology**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E352

Victoria Chernyak, MD, MS (*Presenter*) Consultant, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIN12

### **The Symbiotic Relationship of AI and Patient Centered Radiology (Sponsored by the RSNA Public Information Committee)**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353B

Jennifer L. Kemp, MD (*Moderator*) Stockholder, Scanslated, Inc

#### **LEARNING OBJECTIVES**

1) How to include patients as our partner in AI implementation. 2) List 5 uses of AI to improve patient experience. 3) Learn how AI is seen by patients around the world.

#### **COURSE DESCRIPTION**

Both Artificial Intelligence and Patient Centered Care are hot topics in radiology, but the concepts at first glance may seem contradictory. This course will help its audience better understand how these two concepts can have a symbiotic relationship. Listeners will learn what patients want to know about AI and how to discuss how AI may affect their care. Specific AI tools to improve the patient experience in the radiologic care journey will be discussed. AI and patient-centric radiology may look different depending on practice demographics and geographic locations; how can we learn from each other?

#### **Sub-Events**

##### **S2-CIN12B Patient Preferences Determine AI Boundaries- An International Perspective**

Derya Yakar, MD, PhD (*Presenter*) Research Grant, Siemens AG

##### **S2-CIN12C Noninterpretive use of AI in Radiology to Improve Patient Experience**

Judy W. Gichoya, MBChB, MS (*Presenter*) Consultant, Softbrew Digital LTD

##### **S2-CIN12D Using AI to Improve Patient-Reported Outcomes**

Scott J. Adams, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CIN12B

### **Patient Preferences Determine AI Boundaries- An International Perspective**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353B

Derya Yakar, MD, PhD (*Presenter*) Research Grant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIN12C

### **Noninterpretive use of AI in Radiology to Improve Patient Experience**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353B

Judy W. Gichoya, MBChB, MS (*Presenter*) Consultant, Softbrew Digital LTD

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIN12D

### Using AI to Improve Patient-Reported Outcomes

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353B

Scott J. Adams, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIN21

### Accelerating to the Future of AI in Radiology: A Demonstration of Imaging AI in Practice

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450B

Katherine P. Andriole, PhD (*Moderator*) Nothing to Disclose  
Ali S. Tejani, MD (*Presenter*) Nothing to Disclose  
Madhavi V. Duvvuri, MD, MS (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

- 1) Understand the future of AI applications throughout the entire radiology workflow.
- 2) Recognize practical implementation considerations, most importantly semantic and interoperability standards necessary to implement AI into the clinical arena.
- 3) Consider what the future of radiology AI implementation may hold.

#### Sub-Events

##### **S2-CIN21B RSNA Imaging AI in Practice (IAIP): Introduction and Clinical Considerations**

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

##### **S2-CIN21C Under the Hood of IAIP: Technical Considerations for a Successful Live Demo**

Mohannad Hussain (*Presenter*) Consultant, Techie Maestro Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIN21B

### **RSNA Imaging AI in Practice (IAIP): Introduction and Clinical Considerations**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450B

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIN21C

### **Under the Hood of IAIP: Technical Considerations for a Successful Live Demo**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450B

Mohannad Hussain (*Presenter*) Consultant, Techie Maestro Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIR01

### Trauma Interventions

Sunday, Nov. 26 10:30AM - 11:30AM Room: N227B

Maxime Ronot, MD, PhD (*Moderator*) Speaker, General Electric Company; Speaker, Ipsen SA; Speaker, Canon Medical Systems Corporation; Speaker, Alexion Pharmaceuticals, Inc; Speaker, Guerbet SA; Speaker, Sirtex Medical Ltd

#### LEARNING OBJECTIVES

1) Understand the principles and techniques of interventions for trauma, including the use of imaging modalities, and vascular and non-vascular interventions. 2) Assess and prioritize traumatic injuries in the context of interventional radiology, recognizing indications and contraindications for different interventional procedures, and developing appropriate treatment plans. 3) Effectively communicate and collaborate with interdisciplinary teams involved in trauma care, contributing their knowledge and expertise in interventional radiology to facilitate comprehensive and coordinated management of trauma patients.

#### COURSE DESCRIPTION

The session is a comprehensive course that delves into the vital connection between interventional radiology and trauma. This session is designed to provide healthcare professionals with a deep understanding of the key topics in this field, including imaging workup, indications for trauma interventions, and management of various traumatic injuries. Through a combination of engaging lectures and interactive discussions, participants will gain the knowledge and skills necessary to effectively utilize interventional radiology techniques in trauma care. By the end of this session, participants will have a comprehensive understanding of the principles and techniques involved in interventional radiology for trauma intervention. They will be able to apply this knowledge to make informed decisions. Additionally, participants will develop the skills to effectively collaborate with multidisciplinary teams, facilitating improved outcomes for trauma patients through the integration of interventional radiology into trauma care protocols.

#### Sub-Events

##### S2-CIR01B Imaging Workup and Indications for Trauma Interventions

Maxime Ronot, MD, PhD (*Presenter*) Speaker, General Electric Company; Speaker, Ipsen SA; Speaker, Canon Medical Systems Corporation; Speaker, Alexion Pharmaceuticals, Inc; Speaker, Guerbet SA; Speaker, Sirtex Medical Ltd

##### S2-CIR01C Splenic Artery Embolization

Theresa M. Caridi, MD (*Presenter*) Consultant, Boston Scientific Corporation; Speaker, Boston Scientific Corporation; Consultant, Cook Group Incorporated; Speaker, Cook Group Incorporated; Consultant, Terumo Corporation; Speaker, Terumo Corporation; Consultant, Siemens AG; Speaker, Siemens AG; Speaker, Penumbra, Inc; Research Grant, Siemens AG

##### S2-CIR01D Management of Traumatic Hepatic AV Fistulas

Maria del Pilar Bayona Molano, MD (*Presenter*) Nothing to Disclose

##### S2-CIR01E Thoracic Vascular Injury Management

Claudia J. Gonzalez Nieto, MD (*Presenter*) Nothing to Disclose

##### S2-CIR01F IVC Filters and Venous Interventions in Trauma

Bernhard Gebauer, MD (*Presenter*) Speaker, PAREXEL International Corporation; Speaker, Becton, Dickinson and Company; Speaker, Sirtex Medical Ltd; Speaker, Abbott Laboratories; Speaker, Cook Group Incorporated; Speaker, AngioDynamics, Inc; Speaker, PharmCept; Speaker, ewimed GmbH; Speaker, Novartis AG; Speaker, F. Hoffmann-La Roche Ltd; Speaker, Merck & Co, Inc; Speaker, ICON plc; Speaker, Ipsen SA; Speaker, Bayer AG; Speaker, Pfizer Inc; Speaker, Guerbet SA; Speaker, Terumo Corporation

## **S2-CIR01G Non-Vascular Injury Management**

Shelagh C. Dyer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CIR01B

### Imaging Workup and Indications for Trauma Interventions

Sunday, Nov. 26 10:30AM - 11:30AM Room: N227B

Maxime Ronot, MD, PhD (*Presenter*) Speaker, General Electric Company; Speaker, Ipsen SA; Speaker, Canon Medical Systems Corporation; Speaker, Alexion Pharmaceuticals, Inc; Speaker, Guerbet SA; Speaker, Sirtex Medical Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIR01C

### Splenic Artery Embolization

Sunday, Nov. 26 10:30AM - 11:30AM Room: N227B

Theresa M. Caridi, MD (*Presenter*) Consultant, Boston Scientific Corporation;Speaker, Boston Scientific Corporation;Consultant, Cook Group Incorporated;Speaker, Cook Group Incorporated;Consultant, Terumo Corporation;Speaker, Terumo Corporation;Consultant, Siemens AG;Speaker, Siemens AG;Speaker, Penumbra, Inc;Research Grant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIR01D

### Management of Traumatic Hepatic AV Fistulas

Sunday, Nov. 26 10:30AM - 11:30AM Room: N227B

Maria del Pilar Bayona Molano, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

S2-CIR01E

### **Thoracic Vascular Injury Management**

Sunday, Nov. 26 10:30AM - 11:30AM Room: N227B

Claudia J. Gonzalez Nieto, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIR01F

### **IVC Filters and Venous Interventions in Trauma**

Sunday, Nov. 26 10:30AM - 11:30AM Room: N227B

Bernhard Gebauer, MD (*Presenter*) Speaker, PAREXEL International Corporation;Speaker, Becton, Dickinson and Company;Speaker, Sirtex Medical Ltd;Speaker, Abbott Laboratories;Speaker, Cook Group Incorporated;Speaker, AngioDynamics, Inc;Speaker, PharmCept;Speaker, ewimed GmbH;Speaker, Novartis AG;Speaker, F. Hoffmann-La Roche Ltd;Speaker, Merck & Co, Inc;Speaker, ICON plc;Speaker, Ipsen SA;Speaker, Bayer AG;Speaker, Pfizer Inc;Speaker, Guerbet SA;Speaker, Terumo Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CIR01G

### **Non-Vascular Injury Management**

Sunday, Nov. 26 10:30AM - 11:30AM Room: N227B

Shelagh C. Dyer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMK15

### Current Controversies in MSK Imaging

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450A

Robert D. Boutin, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify practical solutions to address common challenges and controversies experienced in musculoskeletal imaging.

#### COURSE DESCRIPTION

Speakers from diverse perspectives share highlights of their struggles and strategies for overcoming obstacles experienced in their clinical practices – with ample time for audience questions and discussion.

#### Sub-Events

##### **S2-CMK15B Controversies & Solutions at Stanford: From Knee MRI to Opportunistic Imaging**

Robert D. Boutin, MD (*Presenter*) Nothing to Disclose

##### **S2-CMK15C Controversies & Solutions at Johns Hopkins: From Spine Protocols to Diagnosis of Foot Osteomyelitis**

Laura M. Fayad, MD (*Presenter*) Nothing to Disclose

##### **S2-CMK15D Controversies & Solutions at Jefferson: From Coping with Increased Volumes to Thriving in Daily Clinical Practice**

Adam C. Zoga, MD, MBA (*Presenter*) Nothing to Disclose

##### **S2-CMK15E Controversies & Solutions at Wake Forest: From Geroscience to Biologic Age**

Leon Lenchik, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMK15B

### **Controversies & Solutions at Stanford: From Knee MRI to Opportunistic Imaging**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450A

Robert D. Boutin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CMK15C

### **Controversies & Solutions at Johns Hopkins: From Spine Protocols to Diagnosis of Foot Osteomyelitis**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450A

Laura M. Fayad, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMK15D

### **Controversies & Solutions at Jefferson: From Coping with Increased Volumes to Thriving in Daily Clinical Practice**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450A

Adam C. Zoga, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMK15E

### **Controversies & Solutions at Wake Forest: From Geroscience to Biologic Age**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E450A

Leon Lenchik, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMS05

### Multisystem Imaging Manifestations of COVID-19 and Related Complications

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406A

Margarita V. Revzin, MD, MS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Briefly explain pathophysiology of COVID-19. 2) Review diagnostic imaging hallmarks of COVID-19. 3) Describe multisystem immediate and long-term complications of COVID-19 including CNS, cardiovascular, pulmonary, and abdominal systems. 4) Discuss controversies of post COVID-19 vaccination.

#### COURSE DESCRIPTION

This session will provide a comprehensive review of the diagnostic imaging hallmarks, imaging features, multisystemic involvement, and evolution of imaging findings in patients with COVID-19. Neurologic, cardiac, abdominal, chest (early and chronic) complications will be discussed. Specific imaging considerations in COVID-19 related myocarditis and post vaccination complications will be also provided.

#### Sub-Events

##### S2-CMS05B Adominopelvic Imaging in COVID: Lessons Learned

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

##### S2-CMS05C Neuroimaging of the SARS-CoV-2 Infection and Post-vaccination Neurological Syndromes

Otto Rapalino, MD (*Presenter*) Nothing to Disclose

##### S2-CMS05D Cardiac Imaging in COVID and After Vaccination (with Myocarditis)

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

##### S2-CMS05E CT of Post-Acute Lung Complications of COVID-19

David A. Lynch, MBBCh (*Presenter*) Research Consultant, CALYX Inc; Research Consultant, Boehringer Ingelheim GmbH; Research Consultant, Veracyte, Inc; Research Consultant, DAIICHI SANKYO Group; Research Consultant, AstraZeneca PLC; Consultant, Polarean, Inc; Consultant, Bristol Myers Squibb Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMS05B

### **Adominopelvic Imaging in COVID: Lessons Learned**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406A

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMS05C

### **Neuroimaging of the SARS-CoV-2 Infection and Post-vaccination Neurological Syndromes**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406A

Otto Rapalino, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMS05D

### **Cardiac Imaging in COVID and After Vaccination (with Myocarditis)**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406A

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CMS05E

### CT of Post-Acute Lung Complications of COVID-19

Sunday, Nov. 26 10:30AM - 11:30AM Room: S406A

David A. Lynch, MBBCh (*Presenter*) Research Consultant, CALYX Inc;Research Consultant, Boehringer Ingelheim GmbH;Research Consultant, Veracyte, Inc;Research Consultant, DAIICHI SANKYO Group;Research Consultant, AstraZeneca PLC;Consultant, Polarean, Inc;Consultant, Bristol Myers Squibb Company

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CNMMI01

### Update and Advances in Pediatric Nuclear Medicine

Sunday, Nov. 26 10:30AM - 11:30AM Room: E350

Helen R. Nadel, MD, FRCPC (*Moderator*) Consultant, ICON plc;;

#### LEARNING OBJECTIVES

1) To discuss advances in pediatric general nuclear medicine and PET. 2) To review patient preparation and clinical indications for nuclear medicine and PET studies in pediatrics. 3) To illustrate pearls and pitfalls of imaging in the pediatric population.

#### Sub-Events

##### **S2- CNMMI01B Update on Pediatric Renal Scintigraphy**

Reza Vali, MD (*Presenter*) Nothing to Disclose

##### **S2- CNMMI01C Current Practices in Pediatric Thyroid Disease**

Frederick D. Grant, MD (*Presenter*) Nothing to Disclose

##### **S2- CNMMI01D Pediatric PET Hybrid Imaging**

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNMMI01B

### **Update on Pediatric Renal Scintigraphy**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E350

Reza Vali, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNMMI01C

### Current Practices in Pediatric Thyroid Disease

Sunday, Nov. 26 10:30AM - 11:30AM Room: E350

Frederick D. Grant, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNMMI01D

### **Pediatric PET Hybrid Imaging**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E350

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNPM20

### **Radiology Workforce Shortage: Considerations for Rural and Sprawling Systems**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E351

Saurabh Jha, MBBS, MRCS (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify the economic challenges in bringing radiology to rural areas. 2) Understand how policy and radiology financing can improve access to radiology in rural areas.

#### **COURSE DESCRIPTION**

Despite the public and private sector investment in imaging, access to imaging remains anemic in rural and underserved areas in the US. Increasingly responsibility for providing imaging to underserved populations falls on large hospitals. However, small practices have an important role, too. What can radiology leverage to improve access to imaging across the income gradient?

#### **Sub-Events**

##### **S2- CNPM20B**      **Big vs. Small - The Economics of Getting Radiologists, not Corporations, to Rural Areas**

Danny Hughes, PhD (*Presenter*) Nothing to Disclose

##### **S2- CNPM20C**      **Leveraging Private Equity to Help Rural Inhabitants**

Catherine J. Everett, MD, MBA (*Presenter*) Shareholder, Radiology Partners; Officer, Radiology Partners; President, Eidetico Radiology Solutions; Medical Director, MSN Healthcare Solutions

##### **S2- CNPM20D**      **Race, Poverty, and Imaging: The Challenge of Improving Access in Rural Mississippi**

Richard Duszak JR, MD (*Presenter*) Advisor, Ethos Medical, Inc; Shareholder, Ethos Medical, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNPM20B

### **Big vs. Small - The Economics of Getting Radiologists, not Corporations, to Rural Areas**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E351

Danny Hughes, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNPM20C

### Leveraging Private Equity to Help Rural Inhabitants

Sunday, Nov. 26 10:30AM - 11:30AM Room: E351

Catherine J. Everett, MD, MBA (*Presenter*) Shareholder, Radiology Partners; Officer, Radiology Partners; President, Eidetico Radiology Solutions; Medical Director, MSN Healthcare Solutions

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

S2-CNPM20D

### **Race, Poverty, and Imaging: The Challenge of Improving Access in Rural Mississippi**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E351

Richard Duszak JR, MD (*Presenter*) Advisor, Ethos Medical, Inc; Shareholder, Ethos Medical, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CNR05

### Alzheimer's Disease Neuroimaging: State-Of-The-Art

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451A

Gloria C. Chiang, MD (*Moderator*) Advisory Board, Biogen Idec Inc;Consultant, Life Molecular Imaging;Speaker, Horizon CME

#### LEARNING OBJECTIVES

1) Review the imaging biomarkers of common neurodegenerative diseases that are encountered in routine clinical practice, including the sequences that should be included in a dementia protocol. 2) Describe the role of neuroradiologists in diagnosing and monitoring amyloid-related imaging abnormalities (ARIA). 3) Identify new imaging biomarkers that could play a role in understanding Alzheimer's disease, including vascular, glymphatic, and inflammatory biomarkers.

#### COURSE DESCRIPTION

The diagnosis of Alzheimer's disease has shifted dramatically in the last 10 years from clinical/phenotypic criteria to a biological definition of the disease, for which imaging is crucial. Beyond assessing atrophy on MRI and hypometabolism on FDG-PET, radiologists play a key role in reviewing amyloid and tau PET scans, both clinically and in research, and performing lumbar punctures for CSF biomarkers. In the new era of anti-amyloid immunotherapies, imaging will also form the basis for diagnosing and monitoring amyloid-related imaging abnormalities (ARIA) in patients receiving aducanumab and lecanemab. This course will provide an update on state-of-the-art imaging of Alzheimer's disease, both in the context of differential diagnosis and therapy.

#### Sub-Events

##### S2-CNR05B Imaging of Alzheimer's Disease: An Update

Petrice M. Cogswell, MD, PhD (*Presenter*) Nothing to Disclose

##### S2-CNR05C Anti-Amyloid Therapies and ARIA: The Radiologist's Role

Greg Zaharchuk, MD, PhD (*Presenter*) Research Grant, General Electric Company;Research Grant, Bayer AG;Stockholder, Subtle Medical, Inc;Advisory Board, Biogen Idec Inc

##### S2-CNR05D Vascular Contributions to Alzheimer's and Dementia

Laura B. Eisenmenger, MD (*Presenter*) Nothing to Disclose

##### S2-CNR05E Alzheimer's Disease Biomarkers: What's on the Horizon

Gloria C. Chiang, MD (*Presenter*) Advisory Board, Biogen Idec Inc;Consultant, Life Molecular Imaging;Speaker, Horizon CME

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNR05B

### **Imaging of Alzheimer's Disease: An Update**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451A

Petrice M. Cogswell, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNR05C

### **Anti-Amyloid Therapies and ARIA: The Radiologist's Role**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451A

Greg Zaharchuk, MD, PhD (*Presenter*) Research Grant, General Electric Company; Research Grant, Bayer AG; Stockholder, Subtle Medical, Inc; Advisory Board, Biogen Idec Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNR05D

### **Vascular Contributions to Alzheimer's and Dementia**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451A

Laura B. Eisenmenger, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CNR05E

### **Alzheimer's Disease Biomarkers: What's on the Horizon**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E451A

Gloria C. Chiang, MD (*Presenter*) Advisory Board, Biogen Idec Inc; Consultant, Life Molecular Imaging; Speaker, Horizon CME

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CPH01

### Updates to MRI Safety Guidance for Varied MR Environments and Devices (Supported in part by an Unrestricted Medical Education Grant from GE Healthcare, Inc.)

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353C

Michael N. Hoff, PhD (*Moderator*) Nothing to Disclose  
R. Jason Stafford, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

- 1) Describe unique MRI safety considerations and corresponding guidance in radiation oncology environments.
- 2) Describe unique MRI safety considerations and corresponding guidance in low field, high field, and alternate layout MR environments.
- 3) Understand unique concerns of implants and devices within the context of new MR environments.

#### COURSE DESCRIPTION

MRI safety guidance is continually evolving to keep pace with the changing MRI landscape. Recent years have seen the introduction of novel clinical MR environments, including those with the MR/LINAC and ultra-high and low field systems, challenging the abilities of institutions, governing bodies, and regulators to stay abreast of the wave of change. It is not only essential that new safety standards for these diverse environments are established, but it is also necessary to clearly communicate new guidance to radiological personnel in a timely fashion. These lectures will outline key MRI safety considerations involving radiation oncology, variable magnetic fields, and patients with implants and devices, with special attention paid to the unique challenges in each environment, how radiologists, physicists, and technologists can address them.

#### Sub-Events

##### S2-CPH01C MRI Safety Guidance in Alternate Fields: The Highs and Lows

Michael N. Hoff, PhD (*Presenter*) Nothing to Disclose

##### S2-CPH01D Current MR Safety Guidance in Radiation Oncology Environments

Lisa Singer, MD, PhD (*Presenter*) Nothing to Disclose

##### S2-CPH01E Updates on MR Safety Guidance for Imaging Patients with Implanted Medical Devices

R. Jason Stafford, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CPH01C

### **MRI Safety Guidance in Alternate Fields: The Highs and Lows**

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353C

Michael N. Hoff, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-CPH01D

### Current MR Safety Guidance in Radiation Oncology Environments

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353C

Lisa Singer, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-CPH01E

### Updates on MR Safety Guidance for Imaging Patients with Implanted Medical Devices

Sunday, Nov. 26 10:30AM - 11:30AM Room: E353C

R. Jason Stafford, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29

### NIH Grantsmanship Workshop

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Gayle E. Woloschak, BS, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To gain insights as to how to approach preparation of an R01 award. 2) To learn about other awards such as fellowships and clinical trials. 3) To hear from NIH on current perspectives on grant applications. 4) To witness a mock study section.

#### COURSE DESCRIPTION

The goal of this course is to help students gain insights into the NIH process from proposal preparation to review of applications. It will also review R, K, and clinical trials applications. The review process will be considered from the lens of a mock study section done for the entire class.

#### Sub-Events

##### S3-RCP29B Welcome and Introductory Remarks

Gayle E. Woloschak, BS, PhD (*Presenter*) Nothing to Disclose

##### S3-RCP29C Preparing an R01 Research Application

Maryellen L. Giger, PhD (*Presenter*) Stockholder, Hologic, Inc;Royalties, Hologic, Inc;Shareholder, Quantitative Insights, Inc;Co-founder, Quantitative Insights, Inc;Shareholder, QView Medical, Inc;Royalties, General Electric Company;Royalties, Median Technologies;Royalties, Riverain Technologies, LLC

##### S3-RCP29D Preparing K Awards

Ruth C. Carlos, MD, MS (*Presenter*) In-kind support, RELX;Editor, RELX;Travel support, General Electric Company

##### S3-RCP29E Clinical Trials in Applications

Michael W. Vannier, MD (*Presenter*) Nothing to Disclose

##### S3-RCP29F Program Perspectives

Tina Gatlin, PhD (*Presenter*) Nothing to Disclose

##### S3-RCP29G Mock Study Section

Ruth C. Carlos, MD, MS (*Presenter*) In-kind support, RELX;Editor, RELX;Travel support, General Electric Company

##### S3-RCP29H Mock Study Section

Elizabeth A. Krupinski, PhD (*Presenter*) Nothing to Disclose

##### S3-RCP29I Mock Study Section

David A. Mankoff, MD, PhD (*Presenter*) Speaker, Siemens AG Advisory Board, ImaginAb, Inc Advisory Board, Reflexion Medical Inc Consultant, Blue Earth Diagnostics Ltd Consultant, General Electric Company Research funded, Siemens AG Spouse, Owner, Trevarx Biomedical, Inc

##### S3-RCP29J Mock Study Section

Michael W. Vannier, MD (*Presenter*) Nothing to Disclose

### **S3-RCP29K Questions to the Faculty**

Gayle E. Woloschak, BS, PhD (*Presenter*) Nothing to Disclose

### **S3-RCP29L Summary**

Gayle E. Woloschak, BS, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29B

### Welcome and Introductory Remarks

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Gayle E. Woloschak, BS, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29C

### Preparing an R01 Research Application

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Maryellen L. Giger, PhD (*Presenter*) Stockholder, Hologic, Inc;Royalties, Hologic, Inc;Shareholder, Quantitative Insights, Inc;Co-founder, Quantitative Insights, Inc;Shareholder, QView Medical, Inc;Royalties, General Electric Company;Royalties, Median Technologies;Royalties, Riverain Technologies, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29D

### Preparing K Awards

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Ruth C. Carlos, MD, MS (*Presenter*) In-kind support, RELX;Editor, RELX;Travel support, General Electric Company

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## Abstract Archives of the RSNA, 2023

S3-RCP29E

### Clinical Trials in Applications

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Michael W. Vannier, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29F

### Program Perspectives

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Tina Gatlin, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

S3-RCP29G

### Mock Study Section

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Ruth C. Carlos, MD, MS (*Presenter*) In-kind support, RELX;Editor, RELX;Travel support, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29H

### Mock Study Section

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Elizabeth A. Krupinski, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29I

### Mock Study Section

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

David A. Mankoff, MD, PhD (*Presenter*) Speaker, Siemens AG Advisory Board, ImaginAb, Inc Advisory Board, RefleXion Medical Inc Consultant, Blue Earth Diagnostics Ltd Consultant, General Electric Company Research funded, Siemens AG Spouse, Owner, Trevarx Biomedical, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29J

### Mock Study Section

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Michael W. Vannier, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29K

### Questions to the Faculty

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Gayle E. Woloschak, BS, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-RCP29L

### Summary

Sunday, Nov. 26 12:00PM - 3:30PM Room: S102AB

Gayle E. Woloschak, BS, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CBR03

### Reducing Overtreatment in Early Stage Breast Cancer

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406A

Lars J. Grimm, MD (*Moderator*) Advisor, Hologic, Inc; Consultant, Hologic, Inc; Editorial Advisory Board, WebMD Health Corp (WebMD, Inc)

#### LEARNING OBJECTIVES

1) Describe overtreatment and the implications for patient care. 2) Explain the limitations of current strategies to identify patients at risk for overtreatment. 3) Identify promising new approaches in development that can triage patients away from overtreatment.

#### COURSE DESCRIPTION

Overtreatment is one of the principal harms of breast cancer screening programs that primarily originates new diagnosed early stage breast cancers. Identifying which patients will be overtreated is a key challenge as the underlying natural history of breast cancer is poorly understood. Drs. Grimm, Niell, and Wallis will lecture on key elements of the overtreatment debate including radiology, radiomics, and population data. At the completion of the session, attendees should understand the current up to date thinking about overtreatment, identify which patients are at risk, and understand new and emerging strategies for triage currently in development.

#### Sub-Events

##### **S4-CBR03B Reducing Overtreatment in Early Stage Breast Cancer: Insights from Radiology**

Lars J. Grimm, MD (*Presenter*) Advisor, Hologic, Inc; Consultant, Hologic, Inc; Editorial Advisory Board, WebMD Health Corp (WebMD, Inc)

##### **S4-CBR03C Reducing Overtreatment in Early Stage Breast Cancer: Promise of Radiomics**

Bethany L. Niell, MD, PhD (*Presenter*) Equipment support, Hologic, Inc

##### **S4-CBR03D Reducing Overtreatment in Early Stage Breast Cancer: Insights from Population Data**

Nisha Sharma, MBChB, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CBR03B

### **Reducing Overtreatment in Early Stage Breast Cancer: Insights from Radiology**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406A

Lars J. Grimm, MD (*Presenter*) Advisor, Hologic, Inc;Consultant, Hologic, Inc;Editorial Advisory Board, WebMD Health Corp (WebMD, Inc)

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-CBR03C

### **Reducing Overtreatment in Early Stage Breast Cancer: Promise of Radiomics**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406A

Bethany L. Niell, MD, PhD (*Presenter*) Equipment support, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CBR03D

### **Reducing Overtreatment in Early Stage Breast Cancer: Insights from Population Data**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406A

Nisha Sharma, MBChB, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CCA07

### Efficient and Focused Cardiac MRI

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406B

Karen G. Ordovas, MD, MS (*Moderator*) Nothing to Disclose  
Jens Bremerich, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify strategies to obtain a focused cardiac MRI and to enhance efficiency. 2) List technical tips to improve speed on imaging acquisition. 3) Describe the series of sequences needed for a focused stress CMR protocol.

#### COURSE DESCRIPTION

Cardiac MRI is a powerful tool to assess morphology, tissue and function. Unfocused imaging of "everything", however, results in frustration among patients, referring physicians, and hospital administrators. Thus Radiologists must establish strategies for concise and focused examinations.

#### Sub-Events

##### S4-CCA07C Fast & Focused: Cardiac MRI in 20 Minutes

Michael Markl, PhD (*Presenter*) Research support, Siemens AG Research Grant, Circle Cardiovascular Imaging Inc

##### S4-CCA07D Stress, Don't Sweat: Quick Ischemia Imaging With Cardiac MRI

Ming-Yen Ng, BMBS, FRCR (*Presenter*) Education Grant, General Electric Company; Education Grant, Bayer AG; Education Grant, Circle Cardiovascular Imaging Inc; Education Grant, TeraRecon, Inc; Education Grant, Arterys Inc; Speakers Bureau, Boehringer Ingelheim GmbH

##### S4-CCA07E Go With The Flow: All-In-One 4D Flow MRI

James C. Carr, MD (*Presenter*) Institutional Research Grant, Siemens AG; Advisory Board, Siemens AG; Travel support, Siemens AG; Institutional Research Grant, Bayer AG; Advisory Board, Bayer AG; Travel support, Bayer AG; Speaker, Bayer AG; Institutional Research Grant, Guerbet SA; Advisory Board, Bracco Group

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CCA07C

### **Fast & Focused: Cardiac MRI in 20 Minutes**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406B

Michael Markl, PhD (*Presenter*) Research support, Siemens AG Research Grant, Circle Cardiovascular Imaging Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CCA07D

### **Stress, Don't Sweat: Quick Ischemia Imaging With Cardiac MRI**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406B

Ming-Yen Ng, BMBS, FRCR (*Presenter*) Education Grant, General Electric Company; Education Grant, Bayer AG; Education Grant, Circle Cardiovascular Imaging Inc; Education Grant, TeraRecon, Inc; Education Grant, Arterys Inc; Speakers Bureau, Boehringer Ingelheim GmbH

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CCA07E

### **Go With The Flow: All-In-One 4D Flow MRI**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S406B

James C. Carr, MD (*Presenter*) Institutional Research Grant, Siemens AG;Advisory Board, Siemens AG;Travel support, Siemens AG;Institutional Research Grant, Bayer AG;Advisory Board, Bayer AG;Travel support, Bayer AG;Speaker, Bayer AG;Institutional Research Grant, Guerbet SA;Advisory Board, Bracco Group

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CER03

### **Fundamentals of Thoracic Trauma**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451B

Krystal Archer-Arroyo, MD (*Moderator*) Nothing to Disclose

#### **Sub-Events**

#### **S4-CER03B Acute Traumatic Lung Injury**

Gary H. Danton, MD, PhD (*Presenter*) Nothing to Disclose

#### **S4-CER03C Don't Miss Cardiovascular Lesions**

Constantine A. Raptis, MD (*Presenter*) Nothing to Disclose

#### **S4-CER03D Musculoskeletal Chest Trauma**

Krystal Archer-Arroyo, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CER03B

### Acute Traumatic Lung Injury

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451B

Gary H. Danton, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-CER03C

### **Don't Miss Cardiovascular Lesions**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451B

Constantine A. Raptis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CER03D

### **Musculoskeletal Chest Trauma**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451B

Krystal Archer-Arroyo, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI06

### Abdominal AI

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450B

George L. Shih, MD, MS (*Moderator*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

#### LEARNING OBJECTIVES

1) Learn about AI applied in GI Imaging. 2) Learn about the application of natural language processing in radiology, including about large language models (eg, ChatGPT). 3) Learn about different aspects of AI in medical imaging including bias, fairness, and safety.

#### COURSE DESCRIPTION

This session will focus on various aspects of Abdominal AI including specific applications in GI Imaging. Natural language processing (NLP) including newer techniques like Large Language Models (LLMs) and other AI issues like bias, fairness, and safety will also be discussed.

#### Sub-Events

##### **S4-CGI06B AI Bias and Fairness**

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

##### **S4-CGI06C AI and Natural Language Processing**

Tessa S. Cook, MD, PhD (*Presenter*) Grant, Independence Blue Cross;Speaker, Sectra AB;

##### **S4-CGI06D Safety in AI**

Errol Colak, MD (*Presenter*) Nothing to Disclose

##### **S4-CGI06E AI for GI Imaging**

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

S4-CGI06B

### **AI Bias and Fairness**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450B

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI06C

### AI and Natural Language Processing

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450B

Tessa S. Cook, MD, PhD (*Presenter*) Grant, Independence Blue Cross;Speaker, Sectra AB;

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## Abstract Archives of the RSNA, 2023

S4-CGI06D

### **Safety in AI**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450B

Errol Colak, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI06E

### AI for GI Imaging

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450B

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15

### RSNA Hands-On Lab: Liver Elastography

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Richard G. Barr, MD, PhD (*Moderator*) Consultant, Siemens AG;Speakers Bureau, Siemens AG;Research Grant, Siemens AG;Consultant, Koninklijke Philips NV;Speakers Bureau, Koninklijke Philips NV;Consultant, Canon Medical Systems Corporation;Advisor, Hologic, Inc;Research Grant, Hologic, Inc

#### LEARNING OBJECTIVES

1) Review the protocol required for accurate liver stiffness measurements. 2) Discuss the confounding factors needed to be considered when interpreting results. 3) Identify the various quantitative ultrasound methods for liver fat quantification.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited.Chronic Liver disease is a world-wide health problem. The use of multiparametric ultrasound can assess the presence of disease, severity of the disease, and monitor treatment. This course will review how to perform and interpret liver elastography. For accurate measurements a strict protocol is required. The protocol will be reviewed, and potential acquisition errors will be discussed. Confounding factors will be discussed as they can significantly affect the interpretation of the results. The course will also review the state-of-the-art for quantitative ultrasound assessment of liver fat content which is critical in making the diagnosis of non-alcoholic fatty liver disease. The combination of these techniques will be discussed on how to evaluate chronic liver disease.

#### Sub-Events

##### S4-CGI15B RSNA Hands-On Lab: Liver Elastography

Richard G. Barr, MD, PhD (*Presenter*) Consultant, Siemens AG;Speakers Bureau, Siemens AG;Research Grant, Siemens AG;Consultant, Koninklijke Philips NV;Speakers Bureau, Koninklijke Philips NV;Consultant, Canon Medical Systems Corporation;Advisor, Hologic, Inc;Research Grant, Hologic, Inc

##### S4-CGI15C RSNA Hands-On Lab: Liver Elastography

Giovanna Ferraioli, MD (*Presenter*) Speakers Bureau, Koninklijke Philips NV;Speakers Bureau, FUJIFILM Holdings Corporation;Speakers Bureau, Canon Medical Systems Corporation;Speakers Bureau, Shenzhen Mindray Bio-Medical Electronics Co, Ltd;Speakers Bureau, Siemens AG

##### S4-CGI15D RSNA Hands-On Lab: Liver Elastography

Nitin G. Chaubal, MD (*Presenter*) Nothing to Disclose

##### S4-CGI15E RSNA Hands-On Lab: Liver Elastography

Rajas N. Chaubal, MBBS, MD (*Presenter*) Nothing to Disclose

##### S4-CGI15F RSNA Hands-On Lab: Liver Elastography

Jonathan R. Dillman, MD, MSc (*Presenter*) Research Grant, Perspectum Ltd;Research Grant, Siemens AG;Research Grant, Canon Medical Systems Corporation;Research support, Koninklijke Philips NV;Research support, General Electric Company;Research support, Motilent Ltd

##### S4-CGI15G RSNA Hands-On Lab: Liver Elastography

Vito Cantisani, MD (*Presenter*) Speaker, Canon Medical Systems Corporation;Speaker, Bracco Group;Speaker, Samsung Electronics Co, Ltd;

##### S4-CGI15H RSNA Hands-On Lab: Liver Elastography



Gaudio (*Presenter*) Nothing to Disclose

**S4-CGI15I RSNA Hands-On Lab: Liver Elastography**

Maija Radzina, MD, PhD (*Presenter*) Speakers Bureau, Canon Medical Systems Corporation; Speakers Bureau, Bayer AG; Speakers Bureau, Medtronic plc; Speakers Bureau, Bracco Group

**S4-CGI15J RSNA Hands-On Lab: Liver Elastography**

Ronald V. Hidalgo, MD, BS (*Presenter*) Nothing to Disclose

**S4-CGI15K RSNA Hands-On Lab: Liver Elastography**

Chander Lulla, MD, MBBS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15B

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Richard G. Barr, MD, PhD (*Presenter*) Consultant, Siemens AG;Speakers Bureau, Siemens AG;Research Grant, Siemens AG;Consultant, Koninklijke Philips NV;Speakers Bureau, Koninklijke Philips NV;Consultant, Canon Medical Systems Corporation;Advisor, Hologic, Inc;Research Grant, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15C

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Giovanna Ferraioli, MD (*Presenter*) Speakers Bureau, Koninklijke Philips NV;Speakers Bureau, FUJIFILM Holdings Corporation;Speakers Bureau, Canon Medical Systems Corporation;Speakers Bureau, Shenzhen Mindray Bio-Medical Electronics Co, Ltd;Speakers Bureau, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15D

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Nitin G. Chaubal, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15E

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Rajas N. Chahal, MBBS, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15F

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Jonathan R. Dillman, MD, MSc (*Presenter*) Research Grant, Perspectum Ltd; Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation; Research support, Koninklijke Philips NV; Research support, General Electric Company; Research support, Motilent Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15G

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Vito Cantisani, MD (*Presenter*) Speaker, Canon Medical Systems Corporation; Speaker, Bracco Group; Speaker, Samsung Electronics Co, Ltd;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15H

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Giovanni del Gaudio (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-CGI15I

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Maija Radzina, MD, PhD (*Presenter*) Speakers Bureau, Canon Medical Systems Corporation; Speakers Bureau, Bayer AG; Speakers Bureau, Medtronic plc; Speakers Bureau, Bracco Group

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15J

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Ronald V. Hidalgo, MD, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CGI15K

### **RSNA Hands-On Lab: Liver Elastography**

Sunday, Nov. 26 2:00PM - 3:30PM Room: S504CD

Chander Lulla, MD, MBBS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CHN01

### **Horse or Zebra: Case Based Review of Common Mimics in the Brain, Spine, Head and Neck (Joint Session)**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450A

Courtney M. Tomblinson, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Recognize typical and atypical imaging features of stroke, degenerative disc disease, inflammatory sinus disease, and metastatic cervical lymph nodes. 2) Differentiate stroke, degenerative disc disease, inflammatory sinus disease, and metastatic cervical lymph nodes from relevant mimics.

#### **COURSE DESCRIPTION**

In this case-based combined Neuroradiology and Head and Neck session, attendees will be presented with frequent imaging diagnoses in the brain, spine, sinuses and neck. Speakers will emphasize imaging pearls that distinguish these diagnoses from common mimics. This session offers attendees the opportunity to refine their interpretation of complex neuroradiology and head and neck imaging studies by incorporating tips from world experts.

#### **Sub-Events**

##### **S4-CHN01B Inflammatory Sinus Disease or Mimic?**

Nicholas A. Koontz, MD (*Presenter*) Nothing to Disclose

##### **S4-CHN01C Degenerative Disc Disease or Mimic?**

Wende N. Gibbs, MD, MA (*Presenter*) Nothing to Disclose

##### **S4-CHN01D Stroke or Mimic?**

Carlos H. Torres, MD, FRCPC (*Presenter*) Nothing to Disclose

##### **S4-CHN01E Metastatic Cervical Lymph Node or Mimic?**

Ann K. Jay, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CHN01B

### **Inflammatory Sinus Disease or Mimic?**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450A

Nicholas A. Koontz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CHN01C

### **Degenerative Disc Disease or Mimic?**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450A

Wende N. Gibbs, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CHN01D

### **Stroke or Mimic?**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450A

Carlos H. Torres, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CHN01E

### **Metastatic Cervical Lymph Node or Mimic?**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E450A

Ann K. Jay, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-CNPM19

### Financial Planning: A Shield from Burnout

Sunday, Nov. 26 1:00PM - 2:00PM Room: E350

Sherwin S. Chan, MD, PhD (*Moderator*) Consultant, Jazz Pharmaceuticals plc; Research Grant, Jazz Pharmaceuticals plc; Research Grant, Hyperfine, Inc; Research Grant, General Electric Company

#### LEARNING OBJECTIVES

1) Understand the basics of budgeting, debt reduction, and planning for retirement. 2) Recognize the importance of wealth building and advantages of major asset classes for radiologists. 3) Gain insight into asset protection, insurance and loan forgiveness programs.

#### COURSE DESCRIPTION

Many radiologists are unable to translate their high income into a high net worth. This is due to high student debt, poor financial literacy and lifestyle creep. High debt drives choices in career path for trainees and practicing radiologists and contributes to physician burnout and mental health issues. Despite the importance of personal financial health, education on finances is absent from the majority of radiology training programs. Some highly successful and intelligent radiologists who contribute enormously to research, radiology education, and clinical care have not spent the necessary time learning about finances and preparing for retirement. The gap in financial literacy for women is even greater.

#### Sub-Events

##### **S4- CNPM19B** Wealth Building with Real Estate

Jenny K. Hoang, MBBS, MBA (*Presenter*) Spouse, Employee, Merck & Co, Inc

##### **S4- CNPM19C** Fundamentals on Financial Literacy

Christopher Walker, MD (*Presenter*) Author, RELX; Speakers Bureau, Boehringer Ingelheim GmbH

##### **S4- CNPM19D** Insurance Basics

Sherwin S. Chan, MD, PhD (*Presenter*) Consultant, Jazz Pharmaceuticals plc; Research Grant, Jazz Pharmaceuticals plc; Research Grant, Hyperfine, Inc; Research Grant, General Electric Company

##### **S4- CNPM19E** Loan Forgiveness Programs

Grace S. Mitchell, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-CNPM19B

### **Wealth Building with Real Estate**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E350

Jenny K. Hoang, MBBS, MBA (*Presenter*) Spouse, Employee, Merck & Co, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CNPM19C

### **Fundamentals on Financial Literacy**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E350

Christopher Walker, MD (*Presenter*) Author, RELX;Speakers Bureau, Boehringer Ingelheim GmbH

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## Abstract Archives of the RSNA, 2023

S4-CNPM19D

### Insurance Basics

Sunday, Nov. 26 1:00PM - 2:00PM Room: E350

Sherwin S. Chan, MD, PhD (*Presenter*) Consultant, Jazz Pharmaceuticals plc; Research Grant, Jazz Pharmaceuticals plc; Research Grant, Hyperfine, Inc; Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CNPM19E

### **Loan Forgiveness Programs**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E350

Grace S. Mitchell, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CPD11

### **Pediatric Genitourinary Anomalies: The Prenatal-Postnatal Continuum**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451A

Amy R. Mehollin-Ray, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify and discuss key imaging features in the prenatal ultrasound and MRI evaluation of fetal lower urinary tract obstruction. 2) Understand appropriate postnatal imaging evaluation of prenatally-detected renal and bladder disorders, with an emphasis on the use of ultrasound and nuclear scintigraphy. 3) Explore MR urography as an important adjunct anatomic and functional imaging study, with a focus on optimizing protocols and avoiding common pitfalls.

#### **COURSE DESCRIPTION**

Learners will explore the imaging evaluation of pediatric urinary tract obstruction using multiple imaging modalities (fetal ultrasound, fetal MRI, postnatal ultrasound, nuclear scintigraphy and MR urography), following a logical progression from fetal to postnatal life. Key fetal imaging findings will be emphasized, and the course will provide important, up-to-date information on which prenatal findings require postnatal work-up and when. The use of functional imaging data from scintigraphy and MR urography will be translated for everyday practice.

#### **Sub-Events**

#### **S4-CPD11B There's a Problem with Your Plumbing: Fetal Imaging of Urinary Tract Obstruction**

Jennifer N. Kucera, MD, MS (*Presenter*) Nothing to Disclose

#### **S4-CPD11C You get a Renal Ultrasound! Appropriate Postnatal Follow-up for Antenatally Detected Renal and Bladder Abnormalities**

Harriet J. Paltiel, MD (*Presenter*) Nothing to Disclose

#### **S4-CPD11D MR Urography: Protocol and Interpretation Tips for Adjunct Imaging**

Joo Cho, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

S4-CPD11B

### **There's a Problem with Your Plumbing: Fetal Imaging of Urinary Tract Obstruction**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451A

Jennifer N. Kucera, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CPD11C

### **You get a Renal Ultrasound! Appropriate Postnatal Follow-up for Antenatally Detected Renal and Bladder Abnormalities**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451A

Harriet J. Paltiel, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-CPD11D

### **MR Urography: Protocol and Interpretation Tips for Adjunct Imaging**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E451A

Joo Cho, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-CPH13

### Tutorial on Ultrasound Imaging

Sunday, Nov. 26 1:00PM - 2:00PM Room: N230B

Thaddeus A. Wilson, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain the advantages and challenges of software beamforming, and its impact for the sonographer. 2) Describe ultrasound methods of tissue property quantification, including elastography, tomography, and backscatter methods. 3) Summarize advancements in transducer technology and their impact on image quality.

#### COURSE DESCRIPTION

This lecture will review the physics and principles underlying current diagnostic ultrasound imaging. Advances in computing power and transducer technology have driven significant changes in how ultrasound can be used to form images, map blood flow, measure tissue elasticity, and track contrast agents. Developments in both conventional and tomographic ultrasound are further enabling quantitative tissue characterization. This course will describe the fundamentals of these technologies and provide the student with an understanding of their capabilities and current challenges.

#### Sub-Events

#### S4-CPH13B Tutorial on Ultrasound Imaging

Stephen McAleavey, PhD (*Presenter*) Research collaboration, Siemens AG

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## Abstract Archives of the RSNA, 2023

S4-CPH13B

### **Tutorial on Ultrasound Imaging**

Sunday, Nov. 26 1:00PM - 2:00PM Room: N230B

Stephen McAleavey, PhD (*Presenter*) Research collaboration, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CCH02

### Interstitial Lung Abnormality (ILA): What to do and Why

Sunday, Nov. 26 2:30PM - 3:30PM Room: N228

David A. Lynch, MBBCh (*Moderator*) Research Consultant, CALYX Inc; Research Consultant, Boehringer Ingelheim GmbH; Research Consultant, Veracyte, Inc; Research Consultant, DAIICHI SANKYO Group; Research Consultant, AstraZeneca PLC; Consultant, Polarean, Inc; Consultant, Bristol Myers Squibb Company  
Andrea Oh, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Define interstitial lung abnormalities (ILAs) and identify the different subtypes. 2) Differentiate between ILAs and early/subclinical interstitial lung disease (ILD). 3) Understand the clinical significance and management of ILAs.

#### COURSE DESCRIPTION

This session will provide the latest imaging and clinical updates on interstitial lung abnormalities (ILAs). Discussion topics will include defining ILAs and the different CT patterns, smoking related interstitial abnormalities, the clinical significance of ILAs from a pulmonologist's perspective, and identifying early ILD in connective tissue diseases.

#### Sub-Events

##### S5-CCH02C Clinical Significance of Interstitial Lung Abnormality

Rachel K. Putman, MD, MPH (*Presenter*) Nothing to Disclose

##### S5-CCH02D Interstitial Lung Abnormality: Definition and Patterns

Andrea Oh, MD (*Presenter*) Nothing to Disclose

##### S5-CCH02E Smoking Related Interstitial Abnormalities

David A. Lynch, MBBCh (*Presenter*) Research Consultant, CALYX Inc; Research Consultant, Boehringer Ingelheim GmbH; Research Consultant, Veracyte, Inc; Research Consultant, DAIICHI SANKYO Group; Research Consultant, AstraZeneca PLC; Consultant, Polarean, Inc; Consultant, Bristol Myers Squibb Company

##### S5-CCH02F Early Interstitial Lung Disease in Connective Tissue Diseases

Jonathan H. Chung, MD (*Presenter*) Speaker, Veracyte, Inc; Consultant, Veracyte, Inc; Consultant, Boehringer Ingelheim GmbH; Speaker, Boehringer Ingelheim GmbH; Consultant, F. Hoffmann-La Roche Ltd; Speaker, F. Hoffmann-La Roche Ltd

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## Abstract Archives of the RSNA, 2023

S5-CCH02C

### Clinical Significance of Interstitial Lung Abnormality

Sunday, Nov. 26 2:30PM - 3:30PM Room: N228

Rachel K. Putman, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CCH02D

### **Interstitial Lung Abnormality: Definition and Patterns**

Sunday, Nov. 26 2:30PM - 3:30PM Room: N228

Andrea Oh, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CCH02E

### Smoking Related Interstitial Abnormalities

Sunday, Nov. 26 2:30PM - 3:30PM Room: N228

David A. Lynch, MBBCh (*Presenter*) Research Consultant, CALYX Inc; Research Consultant, Boehringer Ingelheim GmbH; Research Consultant, Veracyte, Inc; Research Consultant, DAIICHI SANKYO Group; Research Consultant, AstraZeneca PLC; Consultant, Polarean, Inc; Consultant, Bristol Myers Squibb Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CCH02F

### Early Interstitial Lung Disease in Connective Tissue Diseases

Sunday, Nov. 26 2:30PM - 3:30PM Room: N228

Jonathan H. Chung, MD (*Presenter*) Speaker, Veracyte, Inc;Consultant, Veracyte, Inc;Consultant, Boehringer Ingelheim GmbH;Speaker, Boehringer Ingelheim GmbH;Consultant, F. Hoffmann-La Roche Ltd;Speaker, F. Hoffmann-La Roche Ltd

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-CER12

### **Emergency Radiology: Are You Game For It?**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406B

Jennifer W. Uyeda, MD (*Moderator*) Nothing to Disclose

#### **Sub-Events**

#### **S5-CER12B Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint**

Hei Shun Yu, MD (*Presenter*) Nothing to Disclose

#### **S5-CER12C Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint**

Karen Buch, MD, MD (*Presenter*) Nothing to Disclose

#### **S5-CER12D Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint**

Laura Kohl, MD (*Presenter*) Nothing to Disclose

#### **S5-CER12E Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint**

Scott D. Steenburg, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CER12B

### **Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406B

Hei Shun Yu, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CER12C

### **Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406B

Karen Buch, MD, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CER12D

### **Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406B

Laura Kohl, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CER12E

### Emergency Radiology-Are you game for it? Jeopardy Session using PowerPoint

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406B

Scott D. Steenburg, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CIN01

### **Opportunistic CT Screening for Population Health: Radiology Scientific Expert Panel (Supported in part by an Unrestricted Medical Education Grant from Siemens Healthineers of Siemens Medical Solutions, USA, Inc.)**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S401

Perry J. Pickhardt, MD (*Moderator*) Advisor, Bracco Group; Advisor, Zebra Medical Vision Ltd; Advisor, Nano X Imaging;

#### **LEARNING OBJECTIVES**

1) Explain the systematic opportunistic use of quantitative imaging findings on CT for population health purposes. 2) Explain how Artificial intelligence (AI) may facilitate the widespread implementation of opportunistic CT screening. 3) Identify barriers to acceptance of opportunistic screening, including managing regulatory clearance, demonstrating cost-effectiveness, and achieving reimbursement.

#### **COURSE DESCRIPTION**

This session will cover the promise and challenges related to the implementation of AI-based opportunistic CT screening for population health. All speakers are members of the recently convened Radiology Scientific Expert Panel on this topic, which recently published its findings in Radiology.

#### **Sub-Events**

##### **S5-CIN01B Rationale for Leveraging Opportunistic CT Data**

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group; Advisor, Zebra Medical Vision Ltd; Advisor, Nano X Imaging;

##### **S5-CIN01C Technical Considerations for Implementation**

John W. Garrett, PhD (*Presenter*) Nothing to Disclose

##### **S5-CIN01D Challenges to Clinical Implementation**

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

##### **S5-CIN01E Regulatory Hurdles & Pathways to Reimbursement**

Bernardo C. Bizzo, MD, PhD (*Presenter*) Consultant, Diagnosticos da America (Dasa)

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## Abstract Archives of the RSNA, 2023

S5-CIN01B

### **Rationale for Leveraging Opportunistic CT Data**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S401

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group;Advisor, Zebra Medical Vision Ltd;Advisor, Nano X Imaging;

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## Abstract Archives of the RSNA, 2023

S5-CIN01C

### Technical Considerations for Implementation

Sunday, Nov. 26 2:30PM - 3:30PM Room: S401

John W. Garrett, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-CIN01D

### Challenges to Clinical Implementation

Sunday, Nov. 26 2:30PM - 3:30PM Room: S401

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

S5-CIN01E

### **Regulatory Hurdles & Pathways to Reimbursement**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S401

Bernardo C. Bizzo, MD, PhD (*Presenter*) Consultant, Diagnosticos da America (Dasa)

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## Abstract Archives of the RSNA, 2023

S5-CIR06

### Advanced Biliary Interventions

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353B

Todd Schlachter, MD (*Moderator*) Research Grant, Guerbet SA

#### LEARNING OBJECTIVES

1) Gained the knowledge and expertise necessary to optimize patient outcomes through advanced diagnostic and therapeutic interventions in biliary disorders. 2) Identify what is cutting-edge right now and what may come next.

#### COURSE DESCRIPTION

The Advanced Biliary Interventions lecture series is a didactic program designed to provide IR physicians with knowledge and skills in biliary interventions. This course aims to equip participants with an advanced understanding of complex biliary disorders' diagnosis, management, and treatment through interactive lectures and case-based discussions. Throughout the course, participants will delve into the latest advancements, techniques, and evidence-based practices in biliary interventions, focusing on therapeutic and diagnostic procedures. The course will cover a wide range of topics, including but not limited to: Emerging Technologies and Innovations: Examining emerging technologies, minimally invasive approaches, and novel therapeutic options in biliary interventions, emphasizing what is cutting-edge right now and what may come next. Interventional Techniques: Detailed exploration of advanced interventional techniques, such as percutaneous transhepatic cholangiography and drainage (PTCD), endoscopic interventions, biliary stenting, and ablation. Biliary Anatomy and Physiology: A review of the anatomy and physiology of the biliary system, gallbladder, bile ducts, and connections. Benign Biliary Disorders: Discussion of the diagnosis and management of benign biliary conditions, including biliary strictures, stones, bile leaks, and other lesions. Malignant Biliary Disorders: Overview of the diagnostic and therapeutic approaches for malignant biliary disorders, including cholangiocarcinoma and metastatic disease. Complications and Management: Understanding the potential complications associated with biliary interventions and developing strategies for their prevention and management. The course will be delivered through a combination of didactic lectures, interactive case discussions, and multimedia presentations. Expert faculty, comprising experienced clinicians and researchers in the field, will guide participants through the course material, emphasizing evidence-based practice and clinical decision-making. Upon completion of the Advanced Biliary Interventions lecture series, participants will have gained the knowledge and expertise necessary to optimize patient outcomes through advanced diagnostic and therapeutic interventions in biliary disorders.

#### Sub-Events

##### **S5-CIR06B Cholangioscopy in the Treatment of Benign / Indeterminate / Malignant Biliary Strictures**

John B. Smirniotopoulos, MD,MS (*Presenter*) Nothing to Disclose

##### **S5-CIR06C Billing for Biliary Procedures**

Ahsun Riaz, MD (*Presenter*) Consultant, Boston Scientific Corporation

##### **S5-CIR06D Cholangioscopy in the Treatment of Secondary Assisted Patency of Malignant Strictures**

Andrew (AJ) J. Gunn, MD (*Presenter*) Consultant, Boston Scientific Corporation; Speaker, Boston Scientific Corporation; Research support, Penumbra, Inc; Research support, Varian Medical Systems, Inc; Consultant, Varian Medical Systems, Inc

##### **S5-CIR06E Cholangioscopy and Lithotripsy of Biliary Stone Disease**

Todd Schlachter, MD (*Presenter*) Research Grant, Guerbet SA

##### **S5-CIR06F Cryoablation of the Gallbladder**

Hugh C. McGregor, MD (*Presenter*) Nothing to Disclose

##### **S5-CIR06G Cystic Duct Interventions**



## Abstract Archives of the RSNA, 2023

S5-CIR06B

### **Cholangioscopy in the Treatment of Benign / Indeterminate / Malignant Biliary Strictures**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353B

John B. Smirniotopoulos, MD,MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CIR06C

### **Billing for Biliary Procedures**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353B

Ahsun Riaz, MD (*Presenter*) Consultant, Boston Scientific Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CIR06D

### **Cholangioscopy in the Treatment of Secondary Assisted Patency of Malignant Strictures**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353B

Andrew (AJ) J. Gunn, MD (*Presenter*) Consultant, Boston Scientific Corporation; Speaker, Boston Scientific Corporation; Research support, Penumbra, Inc; Research support, Varian Medical Systems, Inc; Consultant, Varian Medical Systems, Inc

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

S5-CIR06E

### **Cholangioscopy and Lithotripsy of Biliary Stone Disease**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353B

Todd Schlachter, MD (*Presenter*) Research Grant, Guerbet SA

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-CIR06F

### **Cryoablation of the Gallbladder**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353B

Hugh C. McGregor, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CIR06G

### **Cystic Duct Interventions**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353B

Meaghan Dendy, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMK01

### Shoulder Imaging: Fundamentals

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450A

Soterios Gyftopoulos, MD, MBA (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Recognize frequently encountered imaging findings of pathologic processes of the acromioclavicular joint on radiographic and cross section imaging. 2) To review the post-operative imaging appearance of common shoulder surgeries involving the labrum, rotator cuff tendons, and shoulder joints. 3) To review MRI and US findings of rotator cuff abnormalities.

#### COURSE DESCRIPTION

Shoulder Imaging: Fundamentals will provide an overview of the important clinical and imaging findings for common shoulder conditions. Expert musculoskeletal radiologists will present live lectures on topics including shoulder instability, acromioclavicular pathologies, rotator cuff tears, superior labral tears, and post-operative shoulder imaging. Individuals who attend this course will leave with crucial pearls and pitfalls of shoulder imaging, including MRI, CT, ultrasound, and x-ray, that can be easily applied to everyday practice. This is a can't miss session for all RSNA attendees, from medical students to attending physicians!

#### Sub-Events

##### **S5-CMK01B Bone Injuries: Anterior Shoulder Instability**

Soterios Gyftopoulos, MD, MBA (*Presenter*) Nothing to Disclose

##### **S5-CMK01C Approach to Imaging of Rotator Cuff and Biceps Tendon: MRI and Ultrasound**

Connie Y. Chang, MD (*Presenter*) Nothing to Disclose

##### **S5-CMK01D Acromioclavicular Joint Imaging**

Megan K. Mills, MD (*Presenter*) Nothing to Disclose

##### **S5-CMK01E Post-operative Shoulder Imaging**

Mohammad M. Samim, MD, MRCS (*Presenter*) Nothing to Disclose

##### **S5-CMK01F Glenoid Labrum Tears**

Tony T. Wong, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMK01B

### **Bone Injuries: Anterior Shoulder Instability**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450A

Soterios Gyftopoulos, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMK01C

### **Approach to Imaging of Rotator Cuff and Biceps Tendon: MRI and Ultrasound**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450A

Connie Y. Chang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMK01D

### Acromioclavicular Joint Imaging

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450A

Megan K. Mills, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMK01E

### **Post-operative Shoulder Imaging**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450A

Mohammad M. Samim, MD, MRCS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMK01F

### **Glenoid Labrum Tears**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450A

Tony T. Wong, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-CMS01

### Imaging Considerations in Challenging Population

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406A

Marcia C. Javitt, MD (*Moderator*) Spouse, Consultant, NeuroRx, Inc

#### LEARNING OBJECTIVES

1) Gain increased awareness about caring for vulnerable or marginalized patients in the Radiology Department. 2) Understand the imaging modalities best suited to safe and appropriate personalized care of these populations. 3) Recognize and respond quickly and effectively to urgent and emergent conditions requiring imaging triage to essential treatment and intervention.

#### COURSE DESCRIPTION

This session will review imaging challenges and specific health related issues in obese, elderly, pediatric, and pregnant patients. Relevant problem-solving techniques, clinical information and multidisciplinary collaboration will be discussed. Imaging pearls and pitfalls will be provided. The format will be lectures and some discussion.

#### Sub-Events

#### **S5-CMS01B Cancer in Pregnancy: Challenges and Insights for Safe, Effective, and Compassionate Care**

Marcia C. Javitt, MD (*Presenter*) Spouse, Consultant, NeuroRx, Inc

#### **S5-CMS01C Imaging Obese Patients: Physicist Perspective**

Kalpna M. Kanal, PHD (*Presenter*) Nothing to Disclose

#### **S5-CMS01D Child Abuse Imaging: Protocol Updates and Challenges**

Megan B. Marine, MD (*Presenter*) Nothing to Disclose

#### **S5-CMS01E Nonaccidental Injury in the Elderly: What Radiologists Need to Know**

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMS01B

### **Cancer in Pregnancy: Challenges and Insights for Safe, Effective, and Compassionate Care**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406A

Marcia C. Javitt, MD (*Presenter*) Spouse, Consultant, NeuroRx, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMS01C

### **Imaging Obese Patients: Physicist Perspective**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406A

Kalpana M. Kanal, PHD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMS01D

### **Child Abuse Imaging: Protocol Updates and Challenges**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406A

Megan B. Marine, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CMS01E

### **Nonaccidental Injury in the Elderly: What Radiologists Need to Know**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S406A

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNMMI02

### Neurologic Molecular Imaging: Read with the Experts

Sunday, Nov. 26 2:30PM - 3:30PM Room: E350

Paulo Henrique Rosado de Castro, MD, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To discuss advances in imaging of dementia and Parkinsonism using radiopharmaceuticals. 2) To review imaging interpretation. 3) To illustrate advances and imaging interpretation with images from the field.

#### COURSE DESCRIPTION

This course will provide an update on molecular imaging for neurologic applications. There will be a series of lectures including a mix of core materials and new innovations. We will also include clinical pearls and pitfalls and illustrative case examples.

#### Sub-Events

##### **S5-CNMMI02B** Movement Disorders and the Spectrum of Parkinsonian Syndromes

Alexander Drzezga, MD (*Presenter*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

##### **S5-CNMMI02C** PET Imaging Evaluation of Dementia: New Diseases and Co-pathologies

Satoshi Minoshima, MD, PhD (*Presenter*) Consultant, Hamamatsu Photonics KK;Grant, Hamamatsu Photonics KK;Grant, Nihon Medi-Physics Co, Ltd;Grant, FUJIFILM Holdings Corporation

##### **S5-CNMMI02D** Current and Emerging Approaches to Brain Tumor Imaging

Jonathan E. McConathy, MD, PhD (*Presenter*) Research Consultant, Eli Lilly and Company;Research Grant, Eli Lilly and Company;Research Consultant, Blue Earth Diagnostics Ltd;Research Grant, Blue Earth Diagnostics Ltd;Research Consultant, General Electric Company;Research support, General Electric Company;Research support, CytoSite Biopharma;Research Consultant, ImaginAb, Inc;Research support, ImaginAb, Inc;Spouse, Research Consultant, Baird Capital;Spouse, Research Grant, Navidea Biopharmaceuticals, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNMMI02B

### **Movement Disorders and the Spectrum of Parkinsonian Syndromes**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E350

Alexander Drzezga, MD (*Presenter*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNMMI02C

### **PET Imaging Evaluation of Dementia: New Diseases and Co-pathologies**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E350

Satoshi Minoshima, MD, PhD (*Presenter*) Consultant, Hamamatsu Photonics KK;Grant, Hamamatsu Photonics KK;Grant, Nihon Medi-Physics Co, Ltd;Grant, FUJIFILM Holdings Corporation

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-CNMMI02D

### Current and Emerging Approaches to Brain Tumor Imaging

Sunday, Nov. 26 2:30PM - 3:30PM Room: E350

Jonathan E. McConathy, MD, PhD (*Presenter*) Research Consultant, Eli Lilly and Company; Research Grant, Eli Lilly and Company; Research Consultant, Blue Earth Diagnostics Ltd; Research Grant, Blue Earth Diagnostics Ltd; Research Consultant, General Electric Company; Research support, General Electric Company; Research support, CytoSite Biopharma; Research Consultant, ImaginAb, Inc; Research support, ImaginAb, Inc; Spouse, Research Consultant, Baird Capital; Spouse, Research Grant, Navidea Biopharmaceuticals, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNPM01

### **Beyond Binary: Supporting Gender Diversity in Radiology (Sponsored by the RSNA Committee on Diversity, Equity and Inclusion)**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E351

David S. Pryluck, MD, MBA (*Moderator*) Nothing to Disclose  
Courtney M. Tomblinson, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Describe the foundational terms and concepts used within the transgender community and discuss the experiences of transgender patients in healthcare and radiologic subspecialties. 2) Understand the challenges faced by TGD people in the radiology workforce and learn how radiology practices can adapt facilities and practices to be more inclusive. 3) Present the importance of collecting robust Gender Data for radiology health care and for radiology research. Discuss how robust data leads to a better understanding of health outcomes and effectiveness of preventive interventions. 4) Discuss examples and tools to foster a supportive workplace environment and facilitate change, including: pronoun usage, being a vocal and visible ally, reviewing & updating local policies.

#### **COURSE DESCRIPTION**

The field of Radiology must adapt to support patients and workforce members whose identity extends beyond traditional binary gender models of male and female. In this session, participants will learn about experiences of transgender and/or gender diverse (TGD) persons as they navigate the current healthcare environment. Employees in the Radiology workforce will also discuss challenges faced by TGD persons and how Radiology practices can adapt facilities and practices to be more inclusive. We will discuss how to accurately collect more inclusive and comprehensive gender data to drive initiatives for recruitment and retention in Radiology. The session will close with a panel discussion offering tangible examples for supporting TGD peers and patients in our Radiology community.

#### **Sub-Events**

##### **S5-CNPM01C Navigating Healthcare as a Person Who Is Transgender**

Nicolas Freeman, BA (*Presenter*) Nothing to Disclose

##### **S5-CNPM01D Gender in the Radiology Workplace**

Evelyn Carroll, MD (*Presenter*) Nothing to Disclose

##### **S5-CNPM01E Collecting Gender Data: From Collection to Direction**

Vaz A. Zavaletta, MD, PhD (*Presenter*) Nothing to Disclose

##### **S5-CNPM01F Panel Discussion: Supporting Peers Who Are Transgender and/or Gender Diverse**

Florence X. Doo, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNPM01C

### **Navigating Healthcare as a Person Who Is Transgender**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E351

Nicolas Freeman, BA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNPM01D

### **Gender in the Radiology Workplace**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E351

Evelyn Carroll, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNPM01E

### Collecting Gender Data: From Collection to Direction

Sunday, Nov. 26 2:30PM - 3:30PM Room: E351

Vaz A. Zavaletta, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNPM01F

### **Panel Discussion: Supporting Peers Who Are Transgender and/or Gender Diverse**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E351

Florence X. Doo, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNR14

### Reaching a Tipping Point: Balancing Workload and Staffing of Neuroradiologists

Sunday, Nov. 26 2:30PM - 3:30PM Room: E352

Melissa M. Chen, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand how work RVUs are derived and potential consequences of using these values as measurements of productivity. 2) Explore ways to objectively measure non-clinical work efforts. 3) Review academic work practice volumes and potential need for establishing limits.

#### COURSE DESCRIPTION

Demand for imaging continues to increase and will likely outpace the workforce supply. Academic and private radiology practice will face significant challenges. Sustaining the academic mission of radiology will also be a challenge. This session will review common metrics and benchmarks used to measure productivity of radiologists. Limitations of the systems will be discussed. Attendees will learn potential ways to measure non-clinical work efforts and productivity. Data from recent work survey of neuroradiology academic department productivity will be reviewed. Finally, the session will explore whether it is time for work limits for radiologists and what types of limits should be established.

#### Sub-Events

##### **S5-CNR14B RVU: Is it an Effective Measurement of Productivity?**

Melissa M. Chen, MD (*Presenter*) Nothing to Disclose

##### **S5-CNR14C Academic Performance Based Value Unit**

William A. Mehan, MD, MBA (*Presenter*) Researcher, Kura Oncology

##### **S5-CNR14D Realistic Productivity in an Academic Setting**

Max Wintermark, MD (*Presenter*) Consultant, Magnetic Insight, Inc;Consultant, icoMetrix NV;Consultant, Subtle Medical, Inc;Consultant, EMTensor Imaging

##### **S5-CNR14E Duty Hours Limits, is it time?**

Frank J. Lexa, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNR14B

### **RVU: Is it an Effective Measurement of Productivity?**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E352

Melissa M. Chen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-CNR14C

### Academic Performance Based Value Unit

Sunday, Nov. 26 2:30PM - 3:30PM Room: E352

William A. Mehan, MD, MBA (*Presenter*) Researcher, Kura Oncology

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNR14D

### **Realistic Productivity in an Academic Setting**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E352

Max Wintermark, MD (*Presenter*) Consultant, Magnetic Insight, Inc;Consultant, icoMetrix NV;Consultant, Subtle Medical, Inc;Consultant, EMTensor Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CNR14E

### **Duty Hours Limits, is it time?**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E352

Frank J. Lexa, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPD09

### **STAT! Emergency Imaging of the Pediatric Patient**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451B

Kassa Darge, MD, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Demonstrate the utility of ultrasound and other modalities in the diagnosis of targeted pediatric abnormalities from the emergency room. 2) Identify tips and tricks to avoid pitfalls when diagnosing gonadal torsion, midgut volvulus and acute neck emergencies.

#### **COURSE DESCRIPTION**

This course focuses on the diagnostic aspects of specific pediatric emergencies which include gonadal torsion, midgut volvulus and acute neck abnormalities. The utility of different modalities will be covered.

#### **Sub-Events**

#### **S5-CPD09B Don't Stick your Neck Out: Dissecting the Spectrum of Pediatric Neck Emergencies**

Ajay Malhotra, MD, MMM (*Presenter*) Nothing to Disclose

#### **S5-CPD09C Here's the Twist: Multimodality Imaging of Gonadal Torsion**

Summer L. Kaplan, MD, MS (*Presenter*) Nothing to Disclose

#### **S5-CPD09D When the Gut Turns: Midgut Volvulus and Beyond**

Haithuy N. Nguyen, MD (*Presenter*) Research Grant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPD09B

### **Don't Stick your Neck Out: Dissecting the Spectrum of Pediatric Neck Emergencies**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451B

Ajay Malhotra, MD, MMM (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPD09C

### **Here's the Twist: Multimodality Imaging of Gonadal Torsion**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451B

Summer L. Kaplan, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPD09D

### **When the Gut Turns: Midgut Volvulus and Beyond**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451B

Haithuy N. Nguyen, MD (*Presenter*) Research Grant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPH02

### Cone Beam Breast CT: Technology, Clinical Application, and Quality Image

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353C

Mahadevappa Mahesh, PhD, MS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To learn the principles of CBCT and cone beam breast CT systems. 2) To understand image acquisition and dose measurement in cone beam breast CT. 3) To become familiar with clinical application of cone beam breast CT.

#### COURSE DESCRIPTION

Cone-beam CT (CBCT) is increasingly used in diagnostic imaging and image-guided procedures, ranging from interventional radiology to breast imaging, radiation therapy and surgery. The proliferation of CBCT systems that are used as standalone or as part of the fluoroscopy systems are used not only in radiology but in surgery, pain clinic, dental clinics, etc. Even though the fundamentals of cone beam breast CT are similar to CBCT, there are distinct differences between the two technologies, in terms of acquisition, image processing and radiation dose estimation. This course is aimed to cover the general principles of CBCT and Cone Beam Breast CT systems, along with the challenges of quality control evaluation, radiation dose measurements and clinical applications. The course has three presentations with first two aimed at describing the physics principles of CBCT and cone beam breast CT, while the final presentation will focus on clinical applications of breast CT.

#### Sub-Events

##### S5-CPH02B Overview of Cone Beam CT and the Challenges in Quality Control

Jeffrey H. Siewerdsen, PhD (*Presenter*) Research Grant, Siemens AG; Advisory Board, Siemens AG; Research Grant, Medtronic plc; Advisory Board, Carestream Health, Inc; License agreement, Carestream Health, Inc; License agreement, Precision X-Ray, Inc; License agreement, Elekta AB;;;

##### S5-CPH02C CBCT Breast: Clinical Applications

Shadi Aminololama-Shakeri, MD (*Presenter*) Consultant, Becton, Dickinson and Company; Consultant, Izotropic Corporation; Stock options, Izotropic Corporation

##### S5-CPH02D Breast Cone Beam CT Imaging System, Technology, Image Quality and Dose

Ioannis Sechopoulos, PhD (*Presenter*) Research Grant, Siemens AG; Speakers Bureau, Siemens AG; Research Grant, Canon Medical Systems Corporation; Research Grant, Sectra AB; Research Grant, ScreenPoint Medical BV; Research Grant, Volpara Health Technologies Limited

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-CPH02B

### Overview of Cone Beam CT and the Challenges in Quality Control

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353C

Jeffrey H. Siewerdsen, PhD (*Presenter*) Research Grant, Siemens AG; Advisory Board, Siemens AG; Research Grant, Medtronic plc; Advisory Board, Carestream Health, Inc; License agreement, Carestream Health, Inc; License agreement, Precision X-Ray, Inc; License agreement, Elekta AB;;;

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## Abstract Archives of the RSNA, 2023

S5-CPH02C

### **CBCT Breast: Clinical Applications**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353C

Shadi Aminololama-Shakeri, MD (*Presenter*) Consultant, Becton, Dickinson and Company; Consultant, Izotropic Corporation; Stock options, Izotropic Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPH02D

### **Breast Cone Beam CT Imaging System, Technology, Image Quality and Dose**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E353C

Ioannis Sechopoulos, PhD (*Presenter*) Research Grant, Siemens AG;Speakers Bureau, Siemens AG;Research Grant, Canon Medical Systems Corporation;Research Grant, Sectra AB;Research Grant, ScreenPoint Medical BV;Research Grant, Volpara Health Technologies Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPH14

### Tutorial on the Use of Ultrasound Contrast Agent and Parametric Imaging

Sunday, Nov. 26 2:30PM - 3:30PM Room: N230B

Zheng Feng Lu, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To understand the basics of contrast-enhanced ultrasound (CEUS) and ultrasound parametric imaging. 2) To gain knowledge of these emerging ultrasound technologies in various clinical applications. 3) To identify the technical considerations when implementing CEUS and parametric imaging in clinical applications.

#### COURSE DESCRIPTION

The first half of the course will provide a comprehensive understanding of contrast-enhanced ultrasound (CEUS) and its clinical applications by introducing the basics of contrast-enhanced ultrasound (CEUS), describing the technical considerations specific to CEUS, and explaining its clinical implementations as well as utilities. The second half of the course will showcase the emerging ultrasound parametric imaging. You will learn the basic physics principles underlying this technology. Various clinical applications of ultrasound parametric imaging will be explored.

#### Sub-Events

##### S5-CPH14B Ultrasound Contrast Agent

Shuchi K. Rodgers, MD (*Presenter*) Royalties, RELX

##### S5-CPH14C Ultrasound Parametric Imaging

Thaddeus A. Wilson, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPH14B

### Ultrasound Contrast Agent

Sunday, Nov. 26 2:30PM - 3:30PM Room: N230B

Shuchi K. Rodgers, MD (*Presenter*) Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CPH14C

### Ultrasound Parametric Imaging

Sunday, Nov. 26 2:30PM - 3:30PM Room: N230B

Thaddeus A. Wilson, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-CRO08

### **Lymphoma: Imaging for Diagnosis and Prognosis**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S402

Sarah A. Johnson, MD, FRCPC (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To enable participants to use standardized tools for response assessment in lymphoma.2) To identify strategies for diagnosis of lymphoma in the head and neck.3) To recognize current clinical challenges in lymphoma diagnosis and treatment.

#### **COURSE DESCRIPTION**

Imaging of lymphoma will be encountered by radiologists in all subspecialties and general practice. Accurate diagnosis and response assessment are of great clinical importance for lymphoma patients. This series of case-based lectures will enable participants to become comfortable with diagnosis and response assessment for imaging of lymphoma.

#### **Sub-Events**

##### **S5-CRO08B Lymphoma: Imaging for Diagnosis and Prognosis**

Eugene Yu, MD (*Presenter*) Nothing to Disclose

##### **S5-CRO08C Lymphoma: Imaging for Diagnosis and Prognosis**

Anca Prica (*Presenter*) Speaker, AstraZeneca PLC;Speaker, Kite Gilead

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## Abstract Archives of the RSNA, 2023

S5-CRO08B

### **Lymphoma: Imaging for Diagnosis and Prognosis**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S402

Eugene Yu, MD (*Presenter*) Nothing to Disclose

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## **Abstract Archives of the RSNA, 2023**

S5-CRO08C

### **Lymphoma: Imaging for Diagnosis and Prognosis**

Sunday, Nov. 26 2:30PM - 3:30PM Room: S402

Anca Prisca (*Presenter*) Speaker, AstraZeneca PLC; Speaker, Kite Gilead

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-RCP10

### Peer Review in Diagnostic Radiology: Mentoring our Next Generation of Leaders

Sunday, Nov. 26 2:30PM - 3:30PM Room: N226

Linda Moy, MD (*Moderator*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

#### LEARNING OBJECTIVES

1) To highlight the elements of a good peer review and to discuss Radiology's Mentor Review Program. 2) To illustrate the importance of the mentor-mentee relationship. 3) To explain how mentoring and networking within a peer review community can help reviewers build a pipeline to academic success.

#### Sub-Events

##### **S5-RCP10B Radiology's Mentor Review Program**

Jacob Sosna, MD (*Presenter*) Stockholder, HighRAD Ltd

##### **S5-RCP10C Mentor-mentee Relationship: Finding the Right Fit**

Susanna I. Lee, MD, PhD (*Presenter*) Royalties, Wolters Kluwer nv

##### **S5-RCP10D Leveraging your Peer Review Skills to Expand your Network**

Linda Moy, MD (*Presenter*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-RCP10B

### **Radiology's Mentor Review Program**

Sunday, Nov. 26 2:30PM - 3:30PM Room: N226

Jacob Sosna, MD (*Presenter*) Stockholder, HighRAD Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-RCP10C

### **Mentor-mentee Relationship: Finding the Right Fit**

Sunday, Nov. 26 2:30PM - 3:30PM Room: N226

Susanna I. Lee, MD, PhD (*Presenter*) Royalties, Wolters Kluwer nv

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-RCP10D

### Leveraging your Peer Review Skills to Expand your Network

Sunday, Nov. 26 2:30PM - 3:30PM Room: N226

Linda Moy, MD (*Presenter*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CAS07

### Supporting Patients with Neuro Diverse Needs Within Radiology (Sponsored by the RSNA Associated Sciences Consortium)

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N230B

Charlotte Beardmore, MBA (*Moderator*) Nothing to Disclose  
Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explore the factors which influenced the experiences of autistic children and their parents in a diagnostic imaging department. 2) Discuss various types of dementia and how to identify patients who may have dementia. 3) Discuss lessons learned and recommend strategies to enhance patient and family centered care for neuro diverse individuals.

#### COURSE DESCRIPTION

Neurodiverse individuals have cognitive differences that affects how their brain works, resulting in unique strengths and challenges. These individuals may experience barriers in healthcare related to access, communication, sensory challenges, and provider knowledge, which can affect their experiences in medical imaging settings. This presentation will explore the experiences of autistic children and patients with dementia in medical imaging departments and discuss strategies to enhance patient-centered care for individuals with neuro diverse needs.

#### Sub-Events

##### T1-CAS07C Exploring the Experiences of Autistic Children Within Radiology

Jane Harvey Lloyd, PhD, MSc (*Presenter*) Nothing to Disclose

##### T1-CAS07D Caring for Patients with Dementia Within Radiology

Miranda Hurley, ARRT, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CAS07C

### Exploring the Experiences of Autistic Children Within Radiology

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N230B

Jane Harvey Lloyd, PhD, MSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CAS07D

### **Caring for Patients with Dementia Within Radiology**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N230B

Miranda Hurley, ARRT, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-CBR06

### Essentials of Breast Imaging

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406A

Katja Pinker-Domenig, MD, PhD (*Moderator*) Speakers Bureau, European Society of Breast Imaging;Speakers Bureau, Siemens AG;Speakers Bureau, IDKD;Speakers Bureau, Canon Medical Systems Corporation;Consultant, F. Hoffmann-La Roche Ltd;Consultant, Merantix Healthcare;Consultant, AURA Health

#### LEARNING OBJECTIVES

1) To have a basic knowledge of the advantages and limitations of x-ray-based breast imaging methods. 2) To understand when to do ultrasound in symptomatic breast practice and in what situations add-on US techniques are useful. 3) To have a basic understanding of breast MRI techniques, indications, reporting and consequent management recommendations.

#### COURSE DESCRIPTION

This educational course will explain the technique and indications of breast ultrasound, digital breast tomosynthesis and breast MRI and summarize its indications in clinical breast imaging. Upon completion of this course participants will understand the current clinical applications and limitations of the methods.

#### Sub-Events

##### T1-CBR06B Diagnostic Practice with MRI

Katja Pinker-Domenig, MD, PhD (*Presenter*) Speakers Bureau, European Society of Breast Imaging;Speakers Bureau, Siemens AG;Speakers Bureau, IDKD;Speakers Bureau, Canon Medical Systems Corporation;Consultant, F. Hoffmann-La Roche Ltd;Consultant, Merantix Healthcare;Consultant, AURA Health

##### T1-CBR06C Diagnostic Practice with US

Jocelyn A. Rapelyea, MD (*Presenter*) Speakers Bureau, General Electric Company

##### T1-CBR06D Diagnostic Practice with Tomo

Sarah M. Friedewald, MD (*Presenter*) Consultant, Hologic, Inc;Research Grant, Alphabet Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CBR06B

### **Diagnostic Practice with MRI**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406A

Katja Pinker-Domenig, MD, PhD (*Presenter*) Speakers Bureau, European Society of Breast Imaging;Speakers Bureau, Siemens AG;Speakers Bureau, IDKD;Speakers Bureau, Canon Medical Systems Corporation;Consultant, F. Hoffmann-La Roche Ltd;Consultant, Merantix Healthcare;Consultant, AURA Health

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CBR06C

### **Diagnostic Practice with US**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406A

Jocelyn A. Rapelyea, MD (*Presenter*) Speakers Bureau, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CBR06D

### **Diagnostic Practice with Tomo**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406A

Sarah M. Friedewald, MD (*Presenter*) Consultant, Hologic, Inc; Research Grant, Alphabet Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CCA03

### **The Heart of the Matter: MRI Case Based Review in Nonischemic Cardiomyopathies (Supported in part by an Independent Medical Education Grant from Pfizer, Inc.)**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406B

Dominique C. DaBreo, MD, FRCPC (*Moderator*) Nothing to Disclose

Bradley D. Allen, MD, MS (*Moderator*) Consultant, Circle Cardiovascular Imaging Inc;Speaker, WebMD LLC

#### **LEARNING OBJECTIVES**

1) Review current best-practices for CMR evaluation of non-ischemic cardiomyopathy. 2) Demonstrate through cases the role of CMR in non-ischemic cardiomyopathy for diagnosis and risk-stratification. 3) Highlight areas of uncertainty in the current imaging approach and when other modalities can be used to aid in diagnosis.

#### **COURSE DESCRIPTION**

Cardiac MRI (CMR) is an important tool for providing accurate diagnosis and risk-stratification for non-ischemic cardiomyopathies. In this course, learners will be presented with a broad overview of the current state-of-the-art for CMR evaluation of multiple non-ischemic cardiomyopathies. Topics will be presented in a case-based lecture format highlighting relevant CMR acquisitions and interpretation approaches, with a data-driven focus on current best-practices.

#### **Sub-Events**

##### **T1-CCA03C Differentiating Hypertrophic Heart Diseases**

Bradley D. Allen, MD, MS (*Presenter*) Consultant, Circle Cardiovascular Imaging Inc;Speaker, WebMD LLC

##### **T1-CCA03D Restrictive Cardiomyopathy: Causes and Imaging Appearance**

Jadranka Stojanovska, MD, MS (*Presenter*) Nothing to Disclose

##### **T1-CCA03E Systemic Diseases Affecting the Heart**

Karen G. Ordovas, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CCA03C

### **Differentiating Hypertrophic Heart Diseases**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406B

Bradley D. Allen, MD, MS (*Presenter*) Consultant, Circle Cardiovascular Imaging Inc; Speaker, WebMD LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CCA03D

### **Restrictive Cardiomyopathy: Causes and Imaging Appearance**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406B

Jadranka Stojanovska, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CCA03E

### **Systemic Diseases Affecting the Heart**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S406B

Karen G. Ordovas, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-CER09

### Critical Musculoskeletal Trauma in the ER- A Case Based Approach

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451B

Susanna C. Spence, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Learn to identify several critical "not to miss" findings on ER musculoskeletal cases via an engaging joint by joint case-based. 2) Identify subtle injuries and recognize the clinical implications of musculoskeletal injuries.

#### COURSE DESCRIPTION

Join our panel of experts in the field for a overview of a variety of musculoskeletal trauma cases, with key features to look out for, pitfalls, and how best to image and evaluate the cases in question.

#### Sub-Events

##### T1-CER09B Wrist

Susanna C. Spence, MD (*Presenter*) Nothing to Disclose

##### T1-CER09C Shoulder

Claire K. Sandstrom, MD (*Presenter*) Nothing to Disclose

##### T1-CER09D Ankle and Foot

Sameer B. Raniga, MD, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CER09B

### **Wrist**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451B

Susanna C. Spence, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CER09C

### Shoulder

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451B

Claire K. Sandstrom, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CER09D

### **Ankle and Foot**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451B

Sameer B. Raniga, MD, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CGU02

### Prostate MRI and Molecular Imaging: Core and Advanced Applications

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N228

Aytekin Oto, MD (*Moderator*) Research Grant, Koninklijke Philips NV; Medical Advisory Board, Profound Medical Inc; Consultant, IBM Corporation; Co-founder, Qmis LLC; Co-owner, Qmis LLC

#### LEARNING OBJECTIVES

- 1) Learn about the latest updates on prostate imaging with special emphasis on MRI and PET imaging.
- 2) Review the quality control efforts for prostate MR and explain the current and future applications of artificial intelligence on prostate imaging.
- 3) Understand the potential roles and added value of PSMA PET and PET MR in the management of patients with prostate cancer.
- 4) Identify how MRI could be optimized for and be used to mitigate the harm of prostate cancer screening.

#### COURSE DESCRIPTION

This session aims to provide a comprehensive update on the latest developments in prostate imaging with a special focus on MRI and PET imaging. The presentations are well-balanced and broad in scope, from practical updated tips for optimized prostate MR acquisition and interpretation to new techniques such as PET-MRI and PSMA-PET imaging. The role in the management of prostate cancer patients will be reviewed in addition to other hot topics including molecular imaging impacts, quality control, artificial intelligence applications, screening and disparities in prostate imaging.

#### Sub-Events

##### T1-CGU02B Prostate MR Update: What is in the Horizon?

Aytekin Oto, MD (*Presenter*) Research Grant, Koninklijke Philips NV; Medical Advisory Board, Profound Medical Inc; Consultant, IBM Corporation; Co-founder, Qmis LLC; Co-owner, Qmis LLC

##### T1-CGU02C Molecular Imaging of Prostate Cancer for Biochemical Recurrence and Metastatic Disease

Delphine L. Chen, MD (*Presenter*) Grant, Telix Pharmaceuticals Limited; Speaker, Telix Pharmaceuticals Limited

##### T1-CGU02D AI in Prostate MRI: Clinical Performance Expectations and Limitations

Baris Turkbey, MD (*Presenter*) Nothing to Disclose

##### T1-CGU02E MRI for Prostate Cancer Screening - Getting Ready

Anwar R. Padhani, MBBS, FRCR (*Presenter*) Advisory Board, Siemens AG; Speakers Bureau, Siemens AG; Advisory Board, Lucida Medical Ltd; Stockholder, Lucida Medical Ltd

##### T1-CGU02F Healthcare Disparities in Prostate Cancer Imaging

Judy W. Gichoya, MBChB, MS (*Presenter*) Consultant, Softbrew Digital LTD

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## Abstract Archives of the RSNA, 2023

T1-CGU02B

### **Prostate MR Update: What is in the Horizon?**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N228

Aytekin Oto, MD (*Presenter*) Research Grant, Koninklijke Philips NV; Medical Advisory Board, Profound Medical Inc; Consultant, IBM Corporation; Co-founder, Qmis LLC; Co-owner, Qmis LLC

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T1-CGU02C

### **Molecular Imaging of Prostate Cancer for Biochemical Recurrence and Metastatic Disease**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N228

Delphine L. Chen, MD (*Presenter*) Grant, Telix Pharmaceuticals Limited; *Speaker*, Telix Pharmaceuticals Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CGU02D

### **AI in Prostate MRI: Clinical Performance Expectations and Limitations**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N228

Baris Turkbey, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-CGU02E

### **MRI for Prostate Cancer Screening - Getting Ready**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N228

Anwar R. Padhani, MBBS, FRCR (*Presenter*) Advisory Board, Siemens AG;Speakers Bureau, Siemens AG;Advisory Board, Lucida Medical Ltd;Stockholder, Lucida Medical Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CGU02F

### Healthcare Disparities in Prostate Cancer Imaging

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N228

Judy W. Gichoya, MBChB, MS (*Presenter*) Consultant, Softbrew Digital LTD

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CIN17

### Best Practices for AI Model Deployment

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S401

Catherine M. Jones, MBBS (*Moderator*) Researcher, Annalise-AI Pty Ltd

#### LEARNING OBJECTIVES

1) To identify the key areas of consideration when deploying AI into clinical radiology practice. 2) To explore the approaches to change management and governance in AI. 3) Outline the key technological considerations in deploying AI into real world practice.

#### COURSE DESCRIPTION

This one hour session is an overview of the key areas essential to the safe, responsible and effective deployment of artificial intelligence (AI) into clinical radiological practice. The session is split into three lectures - change management strategies, AI governance considerations and an overview of the technological decision making process in AI deployment. This session is important for any radiologists, allied health professionals and medical imaging managers interested in incorporating AI into their practice.

#### Sub-Events

##### **T1-CIN17B Change Management: An Approach to Widespread AI Deployment**

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

##### **T1-CIN17C The Governance Around AI Deployment**

Ameena Elahi, MS, ARRT (*Presenter*) Nothing to Disclose

##### **T1-CIN17D The Technical Side of AI Deployment**

R. Kent Hutson JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CIN17B

### **Change Management: An Approach to Widespread AI Deployment**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S401

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CIN17C

### **The Governance Around AI Deployment**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S401

Ameena Elahi, MS, ARRT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CIN17D

### **The Technical Side of AI Deployment**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S401

R. Kent Hutson JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMK02

### Elbow Imaging in the Athlete

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450A

Donna G. Blankenbaker, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain the mechanism and imaging features of tendon and ligament injuries. 2) Identify elbow fractures and the importance of these injuries. 3) Differentiate and explain the imaging appearance of nerve entrapments.

#### COURSE DESCRIPTION

This course will review elbow anatomy and the injury patterns in the patient presenting with elbow pain. Various aspects of sport injuries will be discussed in the acute, subacute, and chronic setting.

#### Sub-Events

##### T1-CMK02B Throwing Injuries

Donna G. Blankenbaker, MD (*Presenter*) Nothing to Disclose

##### T1-CMK02C Nerve Entrapments about the Elbow

Jeffrey J. Peterson, MD (*Presenter*) Nothing to Disclose

##### T1-CMK02D Elbow Fractures: What is Important?

Stacy E. Smith, MD (*Presenter*) Nothing to Disclose

##### T1-CMK02E Imaging Biceps and Triceps Injuries

Kirkland W. Davis, MD (*Presenter*) Nothing to Disclose

##### T1-CMK02F Elbow Instability

Bethany U. Casagrande, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMK02B

### Throwing Injuries

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450A

Donna G. Blankenbaker, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-CMK02C

### **Nerve Entrapments about the Elbow**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450A

Jeffrey J. Peterson, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMK02D

### **Elbow Fractures: What is Important?**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450A

Stacy E. Smith, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMK02E

### **Imaging Biceps and Triceps Injuries**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450A

Kirkland W. Davis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMK02F

### **Elbow Instability**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450A

Bethany U. Casagrande, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMS06

### Head to Toe Tumor Challenging Cases: Lessons Learned

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450B

Rachna Madan, MBBS, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand key principles in radiologic-pathologic correlation as applicable to a variety of head & neck, thoracic, abdominal and musculoskeletal malignancies. 2) Formulate a focused differential diagnosis for head & neck, thoracic, abdominal, and musculoskeletal malignancies based on these principles. 3) The differential diagnoses would cover cases with infection, inflammation, and hemorrhage.

#### COURSE DESCRIPTION

This course will use a case-based format and highlight the role of imaging in the diagnosis of challenging oncology cases using a multimodality approach. The session will focus on a variety of head and neck, pediatric, chest, musculoskeletal, and abdominal malignancies. Clinical presentation and pathological correlations will be provided when possible. Differential diagnoses will include infection, inflammation, neoplasm, ischemia, hemorrhage. The session will provide a broad update in imaging advances that help to make the correct diagnosis.

#### Sub-Events

##### **T1-CMS06B Challenging Chest Oncology Cases: Practical Tips and Pitfalls in the Interpretation**

Rachna Madan, MBBS, MD (*Presenter*) Nothing to Disclose

##### **T1-CMS06C Challenging Musculoskeletal Soft Tissue Tumors in Pediatrics**

Jack A. Porrino JR, MD (*Presenter*) Nothing to Disclose

##### **T1-CMS06D Challenging Oncology Cases: Gastrointestinal Tumors**

Maria A. Manning, MD (*Presenter*) Nothing to Disclose

##### **T1-CMS06E Challenging Neuroradiology Tumor Cases**

Alexander Kessler, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T1-CMS06B

### **Challenging Chest Oncology Cases: Practical Tips and Pitfalls in the Interpretation**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450B

Rachna Madan, MBBS, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMS06C

### Challenging Musculoskeletal Soft Tissue Tumors in Pediatrics

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450B

Jack A. Porrino JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CMS06D

### **Challenging Oncology Cases: Gastrointestinal Tumors**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450B

Maria A. Manning, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-CMS06E

### Challenging Neuroradiology Tumor Cases

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E450B

Alexander Kessler, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CNMMI09

### Case-based Review of PET/CT: Brain, Head, Neck

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353C

Phillip H. Kuo, MD, PhD (*Moderator*) Consultant, Konica Minolta, Inc; Consultant, Amgen Inc; Consultant, Blue Earth Diagnostics Ltd; Research Grant, Blue Earth Diagnostics Ltd; Consultant, Novartis AG; Speaker, Novartis AG; Consultant, Chimerix, Inc; Consultant, Fusion Pharmaceuticals Inc; Consultant, Bayer AG; Consultant, General Electric Company; Speaker, General Electric Company; Research Grant, General Electric Company; Speaker, Digital Science Press, Inc; Consultant, Radionetics; Former Employee, Konica Minolta, Inc

#### LEARNING OBJECTIVES

1) Understand best clinical practices for use and interpretation of dementia PET imaging. 2) Understand best clinical practices for use and interpretation of PET/CT in patients with head/neck cancer.

#### COURSE DESCRIPTION

The head/neck is an area of high anatomic and metabolic complexity. In this session, experts on dementia imaging and PET/CT for head/neck malignancy will use clinical cases to demonstrate fundamentals of interpretation, as well as pearls and pitfalls to help improve interpretation of these studies.

#### Sub-Events

##### **T1- Dementia** **CNMMI09B**

Phillip H. Kuo, MD, PhD (*Presenter*) Consultant, Konica Minolta, Inc; Consultant, Amgen Inc; Consultant, Blue Earth Diagnostics Ltd; Research Grant, Blue Earth Diagnostics Ltd; Consultant, Novartis AG; Speaker, Novartis AG; Consultant, Chimerix, Inc; Consultant, Fusion Pharmaceuticals Inc; Consultant, Bayer AG; Consultant, General Electric Company; Speaker, General Electric Company; Research Grant, General Electric Company; Speaker, Digital Science Press, Inc; Consultant, Radionetics; Former Employee, Konica Minolta, Inc

##### **T1- Head and Neck Cancer** **CNMMI09C**

Lawrence E. Ginsberg, MD, BA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CNMMI09B

### Dementia

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353C

Phillip H. Kuo, MD, PhD (*Presenter*) Consultant, Konica Minolta, Inc;Consultant, Amgen Inc;Consultant, Blue Earth Diagnostics Ltd;Research Grant, Blue Earth Diagnostics Ltd;Consultant, Novartis AG;Speaker, Novartis AG;Consultant, Chimerix, Inc;Consultant, Fusion Pharmaceuticals Inc;Consultant, Bayer AG;Consultant, General Electric Company;Speaker, General Electric Company;Research Grant, General Electric Company;Speaker, Digital Science Press, Inc;Consultant, Radionetics;Former Employee, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CNMMI09C

### Head and Neck Cancer

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353C

Lawrence E. Ginsberg, MD, BA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CNR11

### Demystifying Postoperative Spine Imaging: Imaging Techniques and Case Based Review

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451A

J. Levi Chazen, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify imaging optimization techniques for postoperative spine imaging with MRI and CT. 2) Understand common surgical approaches to the spine, expected postoperative changes, and surgical complications.

#### COURSE DESCRIPTION

Postoperative spine imaging is challenging with varied surgical approaches, instrumentation hardware, and related imaging artifact. This interactive case-based course will cover techniques to optimize postoperative spine imaging on both CT and MRI. Surgical techniques, hardware malplacement, postoperative collections, and neurovascular complications will be reviewed.

#### Sub-Events

##### T1-CNR11B Post-Op Spine MRI and CT Imaging Optimization

Vinil Shah, MD (*Presenter*) Nothing to Disclose

##### T1-CNR11C Surgical Approaches and Misadventures in Instrumentation

Mary Kristen Jesse, MD (*Presenter*) Faculty, Medtronic plc

##### T1-CNR11D Collections, Pseudomeningoceles, and Seromas

J. Levi Chazen, MD (*Presenter*) Nothing to Disclose

##### T1-CNR11E Surgical Complications and Long-Term Failure

Wende N. Gibbs, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T1-CNR11B

### **Post-Op Spine MRI and CT Imaging Optimization**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451A

Vinil Shah, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T1-CNR11C

### **Surgical Approaches and Misadventures in Instrumentation**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451A

Mary Kristen Jesse, MD (*Presenter*) Faculty, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CNR11D

### **Collections, Pseudomeningoceles, and Seromas**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451A

J. Levi Chazen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-CNR11E

### **Surgical Complications and Long-Term Failure**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E451A

Wende N. Gibbs, MD, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CRO10

### CNS Case Based Multidisciplinary Review

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S402

Soonmee Cha, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Expose the attendees to multidisciplinary discussion when treating CNS malignancies. 2) Demonstrate specific imaging findings that directly affect staging and treatment decisions. 3) Provide the audience with specific information they should include in their reports that directly affect prognosis and management.

#### Sub-Events

##### **T1-CRO10B Latest Update on Brain Tumor Imaging: What All Radiologists Must Know**

Soonmee Cha, MD (*Presenter*) Nothing to Disclose

##### **T1-CRO10C Neuroimaging Associated with Local, Adjuvant Neurosurgical Treatment**

Clark C. Chen, PhD (*Presenter*) Consultant, Medtronic plc; Consultant, MRI Interventions, Inc; Consultant, GT Medical Technologies, Inc

##### **T1-CRO10D Recent Advances in Systemic Treatment of Brain Tumors**

Roger Stupp, MD (*Presenter*) Research Consultant, Carthera; Research Grant, Carthera; Scientific Advisory Board, Alpeus Medical Inc; Scientific Advisory Board, Hemispherian AS; Consultant, GT Medical Technologies, Inc; Consultant, Triact Therapeutics Inc; Research Consultant, AstraZeneca PLC; Research Consultant, Boston Scientific Corporation

##### **T1-CRO10E Comprehensive Review of Radiotherapy for Brain Tumors**

Christina I. Tsien, MD (*Presenter*) Advisory Board, Blue Earth Diagnostics Ltd; Speakers Bureau, Agilent Technologies, Inc; Consultant, Carl Zeiss AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CRO10B

### **Latest Update on Brain Tumor Imaging: What All Radiologists Must Know**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S402

Soonmee Cha, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-CRO10C

### **Neuroimaging Associated with Local, Adjuvant Neurosurgical Treatment**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S402

Clark C. Chen, PhD (*Presenter*) Consultant, Medtronic plc;Consultant, MRI Interventions, Inc;Consultant, GT Medical Technologies, Inc

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## Abstract Archives of the RSNA, 2023

T1-CRO10D

### Recent Advances in Systemic Treatment of Brain Tumors

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S402

Roger Stupp, MD (*Presenter*) Research Consultant, Carthera; Research Grant, Carthera; Scientific Advisory Board, Alpeus Medical Inc; Scientific Advisory Board, Hemispherian AS; Consultant, GT Medical Technologies, Inc; Consultant, Triact Therapeutics Inc; Research Consultant, AstraZeneca PLC; Research Consultant, Boston Scientific Corporation

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## Abstract Archives of the RSNA, 2023

T1-CRO10E

### **Comprehensive Review of Radiotherapy for Brain Tumors**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S402

Christina I. Tsien, MD (*Presenter*) Advisory Board, Blue Earth Diagnostics Ltd;Speakers Bureau, Agilent Technologies, Inc;Consultant, Carl Zeiss AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Stamatia V. Destounis, MD (*Moderator*) Medical Advisory Board, iCad, Inc

#### **LEARNING OBJECTIVES**

1) Attendees will review various needle biopsy devices for ultrasound guided procedures along with opportunity to perform needle biopsy procedures under the supervision of breast radiologists. 2) Review of cyst aspiration and wire localization procedures will be performed along with clip placement.

#### **COURSE DESCRIPTION**

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Hands on opportunity for cyst aspiration, needle biopsy and wire localization procedures under ultrasound guidance and direct supervision by expert radiologists. Didactic lecture on the performance of the most common biopsy procedures in the breast followed by hands on opportunity to perform procedures.

#### **Sub-Events**

##### **T2-CBR15B RSNA Hands-On Lab: Breast US Biopsy**

Sarah M. Pittman, MD, FRCPC (*Presenter*) Nothing to Disclose

##### **T2-CBR15C RSNA Hands-On Lab: Breast US Biopsy**

Georgia G. Spear, MD (*Presenter*) Research Grant, General Electric Company; Speakers Bureau, General Electric Company; Scientific Advisory Board, Hologic, Inc

##### **T2-CBR15D RSNA Hands-On Lab: Breast US Biopsy**

Erin I. Neuschler, MD (*Presenter*) Nothing to Disclose

##### **T2-CBR15E RSNA Hands-On Lab: Breast US Biopsy**

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

##### **T2-CBR15F RSNA Hands-On Lab: Breast US Biopsy**

Laurie R. Margolies, MD (*Presenter*) Stock options, Nuevozen Corporation Medical Advisory Board, Screenpoint Medical

##### **T2-CBR15G RSNA Hands-On Lab: Breast US Biopsy**

Regina J. Hooley, MD (*Presenter*) Consultant, Hologic, Inc

##### **T2-CBR15H RSNA Hands-On Lab: Breast US Biopsy**

Maria Helena S. Mendonca, MD, PhD (*Presenter*) Expert Advisory Committee, Guerbet SA

##### **T2-CBR15I RSNA Hands-On Lab: Breast US Biopsy**

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

##### **T2-CBR15J RSNA Hands-On Lab: Breast US Biopsy**

Phan T. Huynh, MD (*Presenter*) Nothing to Disclose

### **T2-CBR15K RSNA Hands-On Lab: Breast US Biopsy**

Paula B. Gordon, MD, FRCPC (*Presenter*) Stockholder, OncoGenex Pharmaceuticals, Inc; Stockholder, Volpara Health Technologies Limited; Scientific Advisor, Besins Healthcare SA

### **T2-CBR15L RSNA Hands-On Lab: Breast US Biopsy**

Tanya W. Moseley, MD, PhD (*Presenter*) Consultant, Hologic, Inc; Consultant, Merit Medical Systems, Inc; Owner, TW Moseley, LLC; CEO, TW Moseley, LLC

### **T2-CBR15M RSNA Hands-On Lab: Breast US Biopsy**

Marcio M. Saito, MD (*Presenter*) Speaker, General Electric Company

### **T2-CBR15N RSNA Hands-On Lab: Breast US Biopsy**

Gary J. Whitman, MD (*Presenter*) Consultant, Siemens AG; Editor, Wolters Kluwer nv

### **T2-CBR15O RSNA Hands-On Lab: Breast US Biopsy**

Gloria Palazuelos, MD (*Presenter*) Nothing to Disclose

### **T2-CBR15P RSNA Hands-On Lab: Breast US Biopsy**

Beatriz E. Adrada, MD (*Presenter*) Nothing to Disclose

### **T2-CBR15Q RSNA Hands-On Lab: Breast US Biopsy**

Athina Vourtsi, MD (*Presenter*) Research Consultant, General Electric Company; Research Grant, General Electric Company; Educator, Arbutus Biopharma Corporation; Research collaboration, ScreenPoint Medical BV; Medical Advisory Board, Volpara Health Technologies Limited

### **T2-CBR15R RSNA Hands-On Lab: Breast US Biopsy**

Cecilia L. Mercado, MD (*Presenter*) Nothing to Disclose

### **T2-CBR15S RSNA Hands-On Lab: Breast US Biopsy**

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

### **T2-CBR15T RSNA Hands-On Lab: Breast US Biopsy**

Michael N. Linver, MD (*Presenter*) Medical Advisory Board, Three Palm Software LLC; Scientific Advisory Board, Seno Medical Instruments, Inc

### **T2-CBR15U RSNA Hands-On Lab: Breast US Biopsy**

Marcela G. Uchida, MD (*Presenter*) Nothing to Disclose

### **T2-CBR15V RSNA Hands-On Lab: Breast US Biopsy**

Linda J. Warren, MD (*Presenter*) Shareholder, Hologic, Inc

### **T2-CBR15W RSNA Hands-On Lab: Breast US Biopsy**

Norran H. Said, MD, FRCR (*Presenter*) Nothing to Disclose

### **T2-CBR15X RSNA Hands-On Lab: Breast US Biopsy**

Shadi Aminololama-Shakeri, MD (*Presenter*) Consultant, Becton, Dickinson and Company; Consultant, Izotropic Corporation; Stock options, Izotropic Corporation

### **T2-CBR15Y RSNA Hands-On Lab: Breast US Biopsy**

Richard G. Barr, MD, PhD (*Presenter*) Consultant, Siemens AG; Speakers Bureau, Siemens AG; Research Grant, Siemens AG; Consultant, Koninklijke Philips NV; Speakers Bureau, Koninklijke Philips NV; Consultant, Canon Medical Systems Corporation; Advisor, Hologic, Inc; Research Grant, Hologic, Inc

### **T2-CBR15Z RSNA Hands-On Lab: Breast US Biopsy**



Leung, MD (*Presenter*) Scientific Advisory Board, Subtle Medical, Inc; Speaker, General Electric Company; Speaker, Hologic, Inc; Scientific Advisory Board, Seno Medical Instruments, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15B

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Sarah M. Pittman, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15C

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Georgia G. Spear, MD (*Presenter*) Research Grant, General Electric Company;Speakers Bureau, General Electric Company;Scientific Advisory Board, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15D

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Erin I. Neuschler, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15E

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15F

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Laurie R. Margolies, MD (*Presenter*) Stock options, Nuevozen Corporation Medical Advisory Board, Screenpoint Medical

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15G

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Regina J. Hooley, MD (*Presenter*) Consultant, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15H

### RSNA Hands-On Lab: Breast US Biopsy

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Maria Helena S. Mendonca, MD, PhD (*Presenter*) Expert Advisory Committee, Guerbet SA

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## Abstract Archives of the RSNA, 2023

T2-CBR15I

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15J

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Phan T. Huynh, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15K

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Paula B. Gordon, MD, FRCPC (*Presenter*) Stockholder, OncoGenex Pharmaceuticals, Inc; Stockholder, Volpara Health Technologies Limited; Scientific Advisor, Besins Healthcare SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15L

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Tanya W. Moseley, MD, PhD (*Presenter*) Consultant, Hologic, Inc; Consultant, Merit Medical Systems, Inc; Owner, TW Moseley, LLC; CEO, TW Moseley, LLC

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## Abstract Archives of the RSNA, 2023

T2-CBR15M

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Marcio M. Saito, MD (*Presenter*) Speaker, General Electric Company

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## Abstract Archives of the RSNA, 2023

T2-CBR15N

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Gary J. Whitman, MD (*Presenter*) Consultant, Siemens AG; Editor, Wolters Kluwer nv

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## Abstract Archives of the RSNA, 2023

T2-CBR150

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Gloria Palazuelos, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15P

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Beatriz E. Adrada, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-CBR15Q

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Athina Vourtsi, MD (*Presenter*) Research Consultant, General Electric Company; Research Grant, General Electric Company; Educator, Arbutus Biopharma Corporation; Research collaboration, ScreenPoint Medical BV; Medical Advisory Board, Volpara Health Technologies Limited

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## Abstract Archives of the RSNA, 2023

T2-CBR15R

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Cecilia L. Mercado, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T2-CBR15S

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

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## Abstract Archives of the RSNA, 2023

T2-CBR15T

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Michael N. Linver, MD (*Presenter*) Medical Advisory Board, Three Palm Software LLC; Scientific Advisory Board, Seno Medical Instruments, Inc

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## Abstract Archives of the RSNA, 2023

T2-CBR15U

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Marcela G. Uchida, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15V

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Linda J. Warren, MD (*Presenter*) Shareholder, Hologic, Inc

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## Abstract Archives of the RSNA, 2023

T2-CBR15W

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Norran H. Said, MD, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15X

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Shadi Aminololama-Shakeri, MD (*Presenter*) Consultant, Becton, Dickinson and Company; Consultant, Izotropic Corporation; Stock options, Izotropic Corporation

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## Abstract Archives of the RSNA, 2023

T2-CBR15Y

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Richard G. Barr, MD, PhD (*Presenter*) Consultant, Siemens AG;Speakers Bureau, Siemens AG;Research Grant, Siemens AG;Consultant, Koninklijke Philips NV;Speakers Bureau, Koninklijke Philips NV;Consultant, Canon Medical Systems Corporation;Advisor, Hologic, Inc;Research Grant, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-CBR15Z

### **RSNA Hands-On Lab: Breast US Biopsy**

Tuesday, Nov. 28 9:00AM - 10:30AM Room: S504CD

Jessica W. Leung, MD (*Presenter*) Scientific Advisory Board, Subtle Medical, Inc; Speaker, General Electric Company; Speaker, Hologic, Inc; Scientific Advisory Board, Seno Medical Instruments, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CAS08

### Diversity in Access to Breast Imaging (Sponsored by the RSNA Associated Sciences Consortium)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N230B

Brandy J. Reed, MBA, RT (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the barriers to access in breast imaging that are related to diversity. 2) Describe data reflecting breast cancer screening center element disparities. 3) Describe potential solutions for addressing diversity-related barriers to breast imaging access.

#### COURSE DESCRIPTION

Asymmetries in health care access related to health care disparities have been amplified through and after the COVID pandemic. This course will include two interactive presentations (lectures) reviewing diversity-related barriers to access in breast imaging. Barriers reviewed include costs of care as a function of household income and insurance carriers, national screening guideline inconsistencies and variability, patient education and awareness, geocoding indicators of social determinants of health. Data on screening center element disparities will be described. Potential solutions and strategic plans to address this widening asymmetry in access to breast imaging care across vulnerable populations will be discussed.

#### Sub-Events

##### T3-CAS08B Diversity, Women, Minority Platform in the Imaging World

Wei T. Yang, MD, FRCR (*Presenter*) Royalties, Reed Elsevier; Advisory Board, Lux Capital

##### T3-CAS08C Diversity in Breast Imaging

Miral M. Patel, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T3-CAS08B

### **Diversity, Women, Minority Platform in the Imaging World**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N230B

Wei T. Yang, MD, FRCR (*Presenter*) Royalties, Reed Elsevier; Advisory Board, Lux Capital

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CAS08C

### **Diversity in Breast Imaging**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N230B

Miral M. Patel, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CCH05

### Acute Lung Injury

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406A

Ioannis Vlahos, MBBS, FRCR (*Moderator*) Director, Grayscale Ltd;Co-owner, Grayscale Ltd;

#### LEARNING OBJECTIVES

1) To evaluate appearances of acute lung injury and their clinical/pathological correlates. 2) To understand specific lung injuries in inhalation disorders and oncological patients. 3) Imaging assessment of patients with lung injury treated by ECMO.

#### COURSE DESCRIPTION

Lecture format with 4 lectures:1. Differentiating diffuse alveolar damage and acute fibrinous and organizing pneumonia, radiology and pathology. 2. E-cigarette or vaping use-associated lung injury (EVALI). 3. Oncological lung emergencies: common and uncommon imaging scenarios to be aware of.4. Assessing expected appearances and complications in ICU extracorporeal membrane oxygenation (ECMO) patients.

#### Sub-Events

##### T3-CCH05B DAD and AFOP

Anu Brixey, MD (*Presenter*) Research support, 4D Medical

##### T3-CCH05C EVALI

Travis S. Henry, MD (*Presenter*) Advisor, Aer Therapeutics, Inc;Stockholder, Aer Therapeutics, Inc

##### T3-CCH05D Thoracic Emergencies in Oncology Patients

Ioannis Vlahos, MBBS, FRCR (*Presenter*) Director, Grayscale Ltd;Co-owner, Grayscale Ltd;

##### T3-CCH05E ECMO Imaging

Demetrios A. Raptis, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T3-CCH05B

### **DAD and AFOP**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406A

Anu Brixey, MD (*Presenter*) Research support, 4D Medical

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## Abstract Archives of the RSNA, 2023

T3-CCH05C

### **EVALI**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406A

Travis S. Henry, MD (*Presenter*) Advisor, Aer Therapeutics, Inc; Stockholder, Aer Therapeutics, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-CCH05D

### **Thoracic Emergencies in Oncology Patients**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406A

Ioannis Vlahos, MBBS, FRCR (*Presenter*) Director, Grayscale Ltd; Co-owner, Grayscale Ltd;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CCH05E

### **ECMO Imaging**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406A

Demetrios A. Raptis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CGI08

### LIRADS

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450A

Jeong Min Lee, MD, PhD (*Moderator*) Grant, Bayer AG Grant, Canon Medical Systems Corporation Grant, Koninklijke Philips NV Grant, General Electric Healthcare Grant, Guerbet SA Grant, Samsung Electronics Co, Ltd Grant, Bracco Group Grant, Dongkuk Pharma Grant, Starmed Ltd Grant, RF medical Grant, Siemens AG Speakers, Bayer AG Speakers, Philips Healthcare Speakers, Samsung Medison Speakers, GE Healthcare

#### LEARNING OBJECTIVES

1) Apply the updated LI-RADS guidelines in the interpretation and reporting of liver imaging studies, ensuring accurate identification, and characterization of liver lesions. 2) Evaluate treatment response of liver lesions using CEUS techniques within the LI-RADS framework, enabling participants to assess therapeutic outcomes effectively. 3) Discuss challenging areas encountered in CT/MRI interpretation according to LI-RADS guidelines, enhancing participants' proficiency, and confidence in the assessment of liver lesions.

#### COURSE DESCRIPTION

This course is meticulously designed to keep radiologists informed and updated on the latest developments in LI-RADS (Liver Imaging Reporting and Data System) through focused educational sessions. Esteemed experts will deliver an all-encompassing overview of the latest advancements in LI-RADS assessment and reporting. This course is an opportunity to cultivate practical skills for accurately interpreting liver imaging studies by leveraging the latest guidelines, assessing treatment response with CEUS, and adeptly managing complex areas in CT/MRI interpretation. This training aims to elevate your proficiency and instill confidence in LI-RADS reporting, thereby promoting standardized and superior-quality reports. We invite you to join us, expand your understanding of LI-RADS, stay abreast of current developments, and polish your proficiency in liver imaging.

#### Sub-Events

##### T3-CGI08B LI-RADS Treatment Response Assessment with CEUS

David T. Fetzer, MD (*Presenter*) Research support, General Electric Company; Research support, Koninklijke Philips NV; Research support, Siemens AG; Consultant, Koninklijke Philips NV; Advisory Board, Koninklijke Philips NV; Consultant, General Electric Company; Advisory Board, General Electric Company

##### T3-CGI08C Difficult Areas in CT/MRI LI-RADS

Victoria Chernyak, MD, MS (*Presenter*) Consultant, Bayer AG

##### T3-CGI08D Updates on HCC Surveillance with US LI-RADS

Shuchi K. Rodgers, MD (*Presenter*) Royalties, RELX

##### T3-CGI08E Prognostic Imaging Features of HCC: Emerging Evidence

Kathryn J. Fowler, MD (*Presenter*) Consultant, Bayer AG; Research support, General Electric Company; Research Grant, Pfizer Inc; Institutional Grant, MEDIAN Technologies; Consultant, General Electric Company

##### T3-CGI08F Challenges and Opportunities in LI-RADS Reporting

Alexandra Roudenko, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T3-CGI08B

### **LI-RADS Treatment Response Assessment with CEUS**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450A

David T. Fetzer, MD (*Presenter*) Research support, General Electric Company; Research support, Koninklijke Philips NV; Research support, Siemens AG; Consultant, Koninklijke Philips NV; Advisory Board, Koninklijke Philips NV; Consultant, General Electric Company; Advisory Board, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CGI08C

### Difficult Areas in CT/MRI LI-RADS

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450A

Victoria Chernyak, MD, MS (*Presenter*) Consultant, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CGI08D

### Updates on HCC Surveillance with US LI-RADS

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450A

Shuchi K. Rodgers, MD (*Presenter*) Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CGI08E

### **Prognostic Imaging Features of HCC: Emerging Evidence**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450A

Kathryn J. Fowler, MD (*Presenter*) Consultant, Bayer AG;Research support, General Electric Company;Research Grant, Pfizer Inc;Institutional Grant, MEDIAN Technologies;Consultant, General Electric Company

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T3-CGI08F

### **Challenges and Opportunities in LI-RADS Reporting**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450A

Alexandra Roudenko, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-CIN06

### People, Process and Technology: 3 Pillars for Successful Rad IT Integration

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S404

Namita S. Gandhi, MD, MSc (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Discuss challenges and considerations of integrating disparate radiology technology systems (EHR, RIS, PACS, Dictation systems) during merger and acquisitions. 2) Discuss radiology operational challenges and change management which go hand in hand when integrating technology from different organizations.

#### COURSE DESCRIPTION

Mergers and acquisitions (M & As) are becoming a common practice in healthcare. For M & As to be successful, the IT teams are usually asked to integrate the (often) disparate technologies across the different organizations. A successful integration is not only dependant on technological integration but also on change management and addressing operational considerations. In this course, we will discuss challenges and considerations for all three pillars of a successful IT integration - technology, people and processes, along with post go live optimization strategies.

#### Sub-Events

#### **T3-CIN06B Challenges and Considerations with Radiology Technology Integration (EHR, RIS, PACS, Dictation Systems)**

Namita S. Gandhi, MD, MSc (*Presenter*) Nothing to Disclose

#### **T3-CIN06C Operational Challenges and Considerations for Radiology Processes**

Amy L. Kotsenas, MD (*Presenter*) Nothing to Disclose

#### **T3-CIN06D Change (People) Management**

Peter S. Liu, MD (*Presenter*) Nothing to Disclose

#### **T3-CIN06E Post Go-Live Optimization**

Stacy D. O'Connor, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CIN06B

### **Challenges and Considerations with Radiology Technology Integration (EHR, RIS, PACS, Dictation Systems)**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S404

Namita S. Gandhi, MD, MSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CIN06C

### **Operational Challenges and Considerations for Radiology Processes**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S404

Amy L. Kotsenas, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CIN06D

### Change (People) Management

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S404

Peter S. Liu, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CIN06E

### Post Go-Live Optimization

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S404

Stacy D. O'Connor, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CIN18

### Best Practices for AI Education

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S401

Tessa S. Cook, MD, PhD (*Moderator*) Grant, Independence Blue Cross; Speaker, Sectra AB;

#### LEARNING OBJECTIVES

1) Introduce the concept of an educational framework, and how to educate radiologists and residents on AI. 2) Demonstrate how to concretely show radiologists the value of AI beyond the hype, and how it can integrate into the imaging workflow. 3) Discuss strategies for educating the entire care team (including our technologists and referring clinicians) as well as our patients about AI.

#### COURSE DESCRIPTION

AI isn't just coming; it's here. Do you know how you'll educate your fellow radiologists or our future colleagues about AI? What about our technologists, referring clinicians, and patients? In this didactic session, three experts will discuss best practices for AI education across the care continuum.

#### Sub-Events

##### **T3-CIN18B Educating the Care Team and Our Patients About AI**

Tessa S. Cook, MD, PhD (*Presenter*) Grant, Independence Blue Cross; Speaker, Sectra AB;

##### **T3-CIN18C Educating Radiologists and Residents on AI**

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

##### **T3-CIN18D AI Throughout the Imaging Workflow: Value Over Hype**

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CIN18B

### **Educating the Care Team and Our Patients About AI**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S401

Tessa S. Cook, MD, PhD (*Presenter*) Grant, Independence Blue Cross; Speaker, Sectra AB;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CIN18C

### **Educating Radiologists and Residents on AI**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S401

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-CIN18D

### **AI Throughout the Imaging Workflow: Value Over Hype**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S401

Kirti Magudia, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CNMMI10

### Case-based Review of PET/CT: Breast Cancer

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353C

Gary A. Ulaner, MD,PhD (*Moderator*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

#### LEARNING OBJECTIVES

1) Understand best clinical practices for use and interpretation of PET imaging in patient with lung cancer. 2) Understand best clinical practices for use and interpretation of FES PET/CT in patients with breast cancer.

#### COURSE DESCRIPTION

PET/CT has greatly impacted the imaging and therapy of chest malignancies, including longstanding value for staging of lung cancer, as well as novel Estrogen Receptor targeted imaging for breast cancer. In this session, experts on lung and breast cancers will use clinical cases to demonstrate fundamentals of interpretation, as well as pearls and pitfalls to help improve interpretation of FES (Cerianna) PET.

#### Sub-Events

##### **T3- CNMMI10B** Breast Cancer - FDG PET

Maxine S. Jochelson, MD (*Presenter*) Speaker, General Electric Company

##### **T3- CNMMI10C** Breast Cancer - FES PET

Gary A. Ulaner, MD,PhD (*Presenter*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CNMMI10B

### **Breast Cancer - FDG PET**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353C

Maxine S. Jochelson, MD (*Presenter*) Speaker, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CNMMI10C

### **Breast Cancer - FES PET**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353C

Gary A. Ulaner, MD,PhD (*Presenter*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CNPM03

### **Errors in Radiology: The Human Factor is the X-Factor (Sponsored by the RSNA Professionalism Committee)**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353B

Kate Hanneman, MD, MPH (*Moderator*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc  
Michael K. Atalay, MD, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To identify and reduce or eliminate causes of human error. 2) To enhance productivity and system efficiency. 3) To improve safety, health, and well-being of both patients and care providers.

#### **COURSE DESCRIPTION**

The goals of this course will be to understand the salient features of human factors, why they occur, how they lead to errors in radiology, and strategies for managing them and reducing their adverse effects.

#### **Sub-Events**

##### **T3- CNPM03C      The Scope of Human Factors: What are They and Why are They Important?**

Grainne M. Murphy, MBBCh, MMedSc (*Presenter*) Nothing to Disclose

##### **T3- CNPM03D      Types and Causes of Errors in Radiology**

Michael A. Bruno, MD, MS (*Presenter*) Nothing to Disclose

##### **T3- CNPM03E      Errors in Radiology Due to Perception, Judgment, and Noise**

Michael K. Atalay, MD, PhD (*Presenter*) Nothing to Disclose

##### **T3- CNPM03F      Solutions and Strategies for Error Reduction**

Elizabeth A. Krupinski, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CNPM03C

### **The Scope of Human Factors: What are They and Why are They Important?**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353B

Grainne M. Murphy, MBBCh, MMedSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CNPM03D

### **Types and Causes of Errors in Radiology**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353B

Michael A. Bruno, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CNPM03E

### **Errors in Radiology Due to Perception, Judgment, and Noise**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353B

Michael K. Atalay, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-CNPM03F

### **Solutions and Strategies for Error Reduction**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E353B

Elizabeth A. Krupinski, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CPD07

### **Pediatric Thoracic Abnormalities: Congenital and Acquired**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450B

Donald P. Frush, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Develop the appropriate imaging approach in children to be able to characterize vascular rings and slings, lung lucencies as well as disorders of the diaphragm and chest wall.

#### **COURSE DESCRIPTION**

The types of thoracic disorders as well as the imaging approach to best characterize may be unique in the pediatric population. In this didactic session, four pediatric imaging experts will focus on four different regions of the chest: the lungs, vascular system, chest wall and diaphragm and discuss relevant, often commonly encountered disorders. Objectives include gaining an understanding of the benefits and challenges with imaging approaches for regional thoracic disorders and enhancing the ability to characterize abnormalities especially for guiding clinical management.

#### **Sub-Events**

##### **T3-CPD07B Lung Lucencies and Bubbles in the Chest: What to do?**

Bernard F. Laya, MD, DO (*Presenter*) Nothing to Disclose

##### **T3-CPD07C Vascular Rings and Slings: Imaging Tips and Tricks**

LaDonna J. Malone, MD (*Presenter*) Nothing to Disclose

##### **T3-CPD07D Diaphragmatic Ultrasound: Technique and Interpretation**

Ailish Coblenz, MD (*Presenter*) Nothing to Disclose

##### **T3-CPD07E Pediatric Thoracic Wall Abnormalities**

R. Paul Guillerman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CPD07B

### **Lung Lucencies and Bubbles in the Chest: What to do?**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450B

Bernard F. Laya, MD, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CPD07C

### **Vascular Rings and Slings: Imaging Tips and Tricks**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450B

LaDonna J. Malone, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T3-CPD07D

### **Diaphragmatic Ultrasound: Technique and Interpretation**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450B

Ailish Coblenz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T3-CPD07E

### **Pediatric Thoracic Wall Abnormalities**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E450B

R. Paul Guillerman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CPH09

### Deep Learning in CT Image Formation

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451B

Lifeng Yu, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

- 1) Describe deep learning applications in CT image formation process, including image reconstruction and artifact reduction.
- 2) Explain current clinical implementations of deep learning reconstruction methods on CT scanners and how to evaluate these methods.

#### COURSE DESCRIPTION

This course will provide an overview of deep learning applications in CT image formation, including image reconstruction and artifact correction. It will also summarize current clinical implementations of deep learning-based image reconstruction and noise reduction methods on CT scanners and describe how to appropriately evaluate these methods. Potential pitfalls of deep learning methods in CT image formation will be described. There are three lectures in this course:(1) Deep learning in CT reconstruction(2) Deep learning in CT artifact correction(3) Clinical implementation and evaluation

#### Sub-Events

##### **T3-CPH09B Deep Learning in CT Image Reconstruction**

Guang-Hong Chen, PhD (*Presenter*) Nothing to Disclose

##### **T3-CPH09C Deep Learning in CT Artifacts Correction**

Marc Kachelriess, PhD (*Presenter*) Nothing to Disclose

##### **T3-CPH09D Deep Learning in CT Image Quality Assessment**

Lifeng Yu, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CPH09B

### Deep Learning in CT Image Reconstruction

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451B

Guang-Hong Chen, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-CPH09C

### Deep Learning in CT Artifacts Correction

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451B

Marc Kachelriess, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CPH09D

### Deep Learning in CT Image Quality Assessment

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451B

Lifeng Yu, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CVA03

### Principles and Applications of 4D Flow MRI

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N229

Jordi Broncano, MD (*Moderator*) Nothing to Disclose  
Christopher J. Francois, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Explain strategies for acquiring 4D Flow MRI and addressing challenges in its acquisition. 2) Describe methods for implementing 4D Flow MRI into routine clinical cardiovascular MRI studies. 3) Identify indications for including 4D Flow MRI in assessment of aorta, abdominal vascular, and congenital heart diseases.

#### COURSE DESCRIPTION

In this course, attendees will learn how to acquire and analyzed 4D Flow MRI. This will include a summary of approaches to acquiring 4D Flow MRI and addressing technical challenges in performing 4D Flow MRI. Recommendations for integrating 4D Flow MRI into routine clinical workflows will be provided. The use of 4D Flow MRI in evaluating aortic, abdominal vascular, and congenital heart diseases will be highlighted.

#### Sub-Events

##### T3-CVA03C 4D Flow MRI: Technical Principles and Solutions

Michael Markl, PhD (*Presenter*) Research support, Siemens AG Research Grant, Circle Cardiovascular Imaging Inc

##### T3-CVA03D 4D Flow MRI: Clinical Workflow and Implementation

Albert Hsiao, MD, PhD (*Presenter*) Co-founder, Arterys Inc;Shareholder, Arterys Inc;Co-founder, Vektor.AI;Shareholder, Vektor.AI;Research Grant, Bayer AG;Research Grant, General Electric Company;Research Grant, KA Imaging

##### T3-CVA03E 4D Flow MRI: Aortic and Abdominal Imaging Applications

Scott B. Reeder, MD, PhD (*Presenter*) Owner, Calimetrix;Owner, Reveal Pharmaceuticals;Owner, Collectar Biosciences, Inc;Owner, Elucent Medical;Owner, HeartVista, Inc;;

##### T3-CVA03F Congenital Heart Disease 4D flow MRI Applications

Melany B. Atkins, MD (*Presenter*) Consultant, General Electric Company;Speaker, General Electric Company

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T3-CVA03C

### **4D Flow MRI: Technical Principles and Solutions**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N229

Michael Markl, PhD (*Presenter*) Research support, Siemens AG Research Grant, Circle Cardiovascular Imaging Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CVA03D

### **4D Flow MRI: Clinical Workflow and Implementation**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N229

Albert Hsiao, MD, PhD (*Presenter*) Co-founder, Arterys Inc; Shareholder, Arterys Inc; Co-founder, Vektor.AI; Shareholder, Vektor.AI; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, KA Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-CVA03E

### **4D Flow MRI: Aortic and Abdominal Imaging Applications**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N229

Scott B. Reeder, MD, PhD (*Presenter*) Owner, Calimetrix;Owner, Reveal Pharmaceuticals;Owner, Collectar Biosciences, Inc;Owner, Elucent Medical;Owner, HeartVista, Inc;;

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T3-CVA03F

### **Congenital Heart Disease 4D flow MRI Applications**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N229

Melany B. Atkins, MD (*Presenter*) Consultant, General Electric Company; Speaker, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP01

### Fast 5

Tuesday, Nov. 28 10:30AM - 11:00AM Room: Arie Crown

Angel A. Gomez-Cintron, MD, MPH (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T3-RCP01B Teaching Future Radiologists: What's In It For Me?**

Kara D. Gaetke-Udager, MD (*Presenter*) Nothing to Disclose

#### **T3-RCP01C MORE: Mentoring, Outreach, & Resources for Equity**

Anne Darrow, MD (*Presenter*) Nothing to Disclose

#### **T3-RCP01D AI Needs to Know What It Doesn't Know**

Cooper U. Gamble, BS (*Presenter*) Nothing to Disclose

#### **T3-RCP01E X-rays on Mount Everest**

Saurabh Jha, MBBS, MRCS (*Presenter*) Nothing to Disclose

#### **T3-RCP01F Is Colorblindness Doing More Harm Than Good in Combatting Racial Health Disparities**

Jessica T. Wen, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-RCP01B

### Teaching Future Radiologists: What's In It For Me?

Tuesday, Nov. 28 10:30AM - 11:00AM Room: Arie Crown

Kara D. Gaetke-Udager, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP01C

### **MORE: Mentoring, Outreach, & Resources for Equity**

Tuesday, Nov. 28 10:30AM - 11:00AM Room: Arie Crown

Anne Darrow, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP01D

### **AI Needs to Know What It Doesn't Know**

Tuesday, Nov. 28 10:30AM - 11:00AM Room: Arie Crown

Cooper U. Gamble, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP01E

### **X-rays on Mount Everest**

Tuesday, Nov. 28 10:30AM - 11:00AM Room: Arie Crown

Saurabh Jha, MBBS, MRCS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP01F

### **Is Colorblindness Doing More Harm Than Good in Combatting Racial Health Disparities**

Tuesday, Nov. 28 10:30AM - 11:00AM Room: Arie Crown

Jessica T. Wen, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP02

### Singapore Presents: Radiology in the Lion City - The Pursuit of Excellence Within 284 Square Miles

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E350

Swee T. Quek, MBBS, FRCR (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Gain insight into the evolving Singapore healthcare structure and financing. 2) Understand the current and emerging trends in Singapore Radiology. 3) Appreciate how the future Singapore Radiology workforce may evolve. 4) Know key Radiology research interests and Interventional Radiology practices in the Singapore context.

#### COURSE DESCRIPTION

This course provides an overview of the Singapore healthcare system as a prelude to understanding how recent trends have impacted the practice of Radiology in our country, including the drive towards value-based imaging and shift towards population health in the face of an ageing population. The challenges placed on the Radiology workforce and how it may evolve in response to these demands are also discussed. Finally, we share highlights of Radiology research and future directions of Interventional Radiology practice in our country.

#### Sub-Events

##### **T3-RCP02B Introduction to Singapore's Healthcare System**

Charles X. Goh, FRCR, MEd (*Presenter*) Nothing to Disclose

##### **T3-RCP02C Current and Emerging Trends for Radiology in Singapore**

Cher Heng Tan, MBBS, FRCR (*Presenter*) Nothing to Disclose

##### **T3-RCP02D Future Singapore Radiology Workforce- From Evolution to Revolution**

Lionel Cheng, MBBS, FRCR (*Presenter*) Nothing to Disclose

##### **T3-RCP02E Radiology Research Landscape in Singapore**

Ling Ling Chan, MBBS, FRCR (*Presenter*) Nothing to Disclose

##### **T3-RCP02F IR Practice in the Far East: Status Quo and Future Directions**

Uei Pua, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP02B

### **Introduction to Singapore's Healthcare System**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E350

Charles X. Goh, FRCR, MMed (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP02C

### Current and Emerging Trends for Radiology in Singapore

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E350

Cher Heng Tan, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

T3-RCP02D

### **Future Singapore Radiology Workforce- From Evolution to Revolution**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E350

Lionel Cheng, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP02E

### **Radiology Research Landscape in Singapore**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E350

Ling Ling Chan, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP02F

### **IR Practice in the Far East: Status Quo and Future Directions**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E350

Uei Pua, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP15

### How To's of Publishing Your Research: Ask the Trainee Editors

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S403A

Gary D. Luker, MD (*Moderator*) Institutional Research Grant, Polyphor, Ltd

#### LEARNING OBJECTIVES

1) Describe the the editorial training opportunities for residents, fellows, graduate students, and postdocs offered by the Radiology suite of journals. 2) Understand the manuscript submission and peer review process. 3) Identify resources to assist with research and publishing in imaging.

#### COURSE DESCRIPTION

This interactive panel discussion is intended familiarize radiology residents, fellows, graduate students, and postdocs on the process of journal publishing. The panel will be comprised of members of the trainee editorial boards of the RSNA suite of journals (Radiology, Radiology Imaging Cancer, Radiology Artificial Intelligence, Radiology Cardiothoracic) and moderated by the journal editors. Each panel member will present a brief introduction of their journal's trainee activities and how it contributes to career development. This will be followed by a Q&A discussion where questions from the audience will be encouraged. Sample questions from past sessions include "How do you select the right journal?" "How do you handle peer reviewer comments?" "Should I publish first in a preprint server?" "How do I become a peer reviewer for a journal?" Resources and platforms available to authors for writing, statistical analysis, graphics design, and reporting criteria will be discussed.

#### Sub-Events

##### T3-RCP15B Practical Tips on Publishing Cardiothoracic Imaging Research

Domenico Mastrodicasa, MD (*Presenter*) Stockholder, Segmed, Inc;Consultant, Segmed, Inc

##### T3-RCP15C Practical Tips on Publishing Cancer Imaging Research

Xiaoyang Liu, MD, PhD (*Presenter*) Nothing to Disclose

##### T3-RCP15D Practical Tips on Publishing Artificial Intelligence Research

Iwan Paolucci, PhD (*Presenter*) Stockholder, Intuitive Surgical, Inc ;Stockholder, SOPHiA GENETICS

##### T3-RCP15E Practical Tips on Publishing Radiology Research

Simon Lennartz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP15B

### Practical Tips on Publishing Cardiothoracic Imaging Research

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S403A

Domenico Mastrodicasa, MD (*Presenter*) Stockholder, Segmed, Inc; Consultant, Segmed, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP15C

### Practical Tips on Publishing Cancer Imaging Research

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S403A

Xiaoyang Liu, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP15D

### Practical Tips on Publishing Artificial Intelligence Research

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S403A

Iwan Paolucci, PhD (*Presenter*) Stockholder, Intuitive Surgical, Inc ;Stockholder, SOPHiA GENETICS

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-RCP15E

### Practical Tips on Publishing Radiology Research

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S403A

Simon Lennartz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T4-CIN19

### Best Practices for Continuous AI Model Evaluation

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S401

Matthew P. Lungren, MD (*Moderator*) Advisor, Segmed, Inc;Shareholder, Segmed, Inc;Advisor, Bunkerhill Health;Shareholder, Bunkerhill Health;Employee, Microsoft Corporation

#### LEARNING OBJECTIVES

1) Understand the necessity and significance of continuous AI model evaluation in the field of radiology. 2) Identify key performance indicators for AI model monitoring, and learn strategies for their ongoing tracking and evaluation. 3) Gain insights into best practices for validation, recalibration, and adjustment of AI models to ensure their robustness and relevance over time. 4) Recognize ethical considerations and regulatory guidelines related to the application of AI in radiology, contributing to the responsible use of these technologies. 5) Apply practical techniques for continuous AI model evaluation in their own clinical or research context, enhancing the effectiveness of AI implementation in radiology.

#### COURSE DESCRIPTION

With the surge in the application of Artificial Intelligence (AI) in radiology, maintaining the performance of these models becomes paramount. This course will focus on the strategies and techniques required to continuously evaluate and improve AI models in order to maintain their reliability, safety, and efficacy in radiological practice. Drawing from a wealth of expertise and research, attendees will learn the key principles of AI model lifecycle management, performance monitoring, validation, recalibration techniques, and the ethics and regulations surrounding AI in radiology. Attendees will leave the session equipped with practical knowledge and resources that they can apply to their own AI models and radiological practices. This session is perfect for radiologists, AI researchers, clinicians, data scientists, and healthcare professionals who are leveraging or planning to leverage AI in their work and want to ensure the optimum performance of their AI models over time. With a blend of theory and practice, the session will provide essential knowledge and tools to help you navigate the rapidly evolving landscape of AI in radiology.

#### Sub-Events

##### T4-CIN19B Post Deployment Monitoring

Matthew P. Lungren, MD (*Presenter*) Advisor, Segmed, Inc;Shareholder, Segmed, Inc;Advisor, Bunkerhill Health;Shareholder, Bunkerhill Health;Employee, Microsoft Corporation

##### T4-CIN19C Model Evaluation Best Practices

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

##### T4-CIN19D Governance for Medical Imaging Deployment

Dania Daye, MD, PhD (*Presenter*) Research Consultant, Sigilon Therapeutics, Inc;Research Consultant, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CIN19B

### Post Deployment Monitoring

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S401

Matthew P. Lungren, MD (*Presenter*) Advisor, Segmed, Inc;Shareholder, Segmed, Inc;Advisor, Bunkerhill Health;Shareholder, Bunkerhill Health;Employee, Microsoft Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CIN19C

### Model Evaluation Best Practices

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S401

Walter F. Wiggins, MD, PhD (*Presenter*) Advisor, Qure.ai;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CIN19D

### **Governance for Medical Imaging Deployment**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S401

Dania Daye, MD, PhD (*Presenter*) Research Consultant, Sigilon Therapeutics, Inc; Research Consultant, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CNPM02

### **What Does Climate Change Have to do With Radiology? Impetus for Change and a Call to Action (Sponsored by the RSNA Professionalism Committee)**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S402

Kate Hanneman, MD, MPH (*Moderator*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

#### **LEARNING OBJECTIVES**

1) Discuss climate change and radiology. 2) Describe the impact of medical imaging on climate change and highlight opportunities for change. 3) Discuss research considerations with respect to studying the energy expenditure and other contributions to greenhouse gas emissions in radiology including the impact of interventions to mitigate emissions from our departments. 4) Evaluate actions that we can all take to address climate change outside of work in our personal lives including lighting, diet, and waste.

#### **COURSE DESCRIPTION**

The purpose of this course is to discuss the impact of radiology on climate change, impetus for change, and outline actionable steps we can take to address climate change in our personal and professional lives linked to the anticipated impact.

#### **Sub-Events**

##### **T4- CNPM02B** Climate Change and Planetary Health

Reed A. Omary, MD, MS (*Presenter*) Nothing to Disclose

##### **T4- CNPM02C** What Does Radiology Have to do With Climate Change?

Jonathan Gross, MD (*Presenter*) Nothing to Disclose

##### **T4- CNPM02D** How can Radiologists Address the Climate Crisis at in our Departments and Relationships with Vendors

Julia Schoen, MD, MS (*Presenter*) Stockholder, Merck & Co, Inc; Stockholder, Moderna, Inc; Stockholder, Aurinia Pharmaceuticals Inc; Speaker, Koninklijke Philips NV

##### **T4- CNPM02E** Research in Climate Change and Radiology

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

##### **T4- CNPM02F** Actions and Opportunities to Address Climate Change Outside of Work

Maura J. Brown, MD, FRCPC (*Presenter*) Synthesis Health Inc - research collaboration, no financial relationship at this time (Nov 2022).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CNPM02B

### Climate Change and Planetary Health

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S402

Reed A. Omary, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CNPM02C

### **What Does Radiology Have to do With Climate Change?**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S402

Jonathan Gross, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CNPM02D

### **How can Radiologists Address the Climate Crisis at in our Departments and Relationships with Vendors**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S402

Julia Schoen, MD, MS (*Presenter*) Stockholder, Merck & Co, Inc; Stockholder, Moderna, Inc; Stockholder, Aurinia Pharmaceuticals Inc; Speaker, Koninklijke Philips NV

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T4-CNPM02E

### Research in Climate Change and Radiology

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S402

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CNPM02F

### **Actions and Opportunities to Address Climate Change Outside of Work**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S402

Maura J. Brown, MD, FRCPC (*Presenter*) Synthesis Health Inc - research collaboration, no financial relationship at this time (Nov 2022).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CRT01

### **ASRT@RSNA: Strategies to Reduce Retraumatization in Medical Imaging and Radiation Therapy**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Recognize challenges when caring for trauma patients in imaging and therapy departments. 2) Identify potential triggers for retraumatization in medical imaging and radiation therapy. 3) Apply trauma-informed interventions in a sexual assault case study.

#### **COURSE DESCRIPTION**

Delivery of health care often involves assessment and interventions in locations on the patient's body where trauma has previously occurred, increasing the probability of retraumatization and manifestation of signs and symptoms of trauma. Considering professionals providing imaging studies and radiation therapy treatment for patients who may have a high probability of a history of trauma, specific interventions should be employed to reduce retraumatizing a patient. This lecture offers strategies to provide quality care to a patient who has been unintentionally retraumatized in medical imaging and radiation therapy.

#### **Sub-Events**

#### **T4-CRT01B ASRT@RSNA: Strategies to Reduce Retraumatization in Medical Imaging and Radiation Therapy**

Kevin R. Clark, RT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-CRT01B

**ASRT@RSNA: Strategies to Reduce Retraumatization in Medical Imaging and Radiation Therapy**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: N230B

Kevin R. Clark, RT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-RCP19

### **Building a Quantitative Imaging Research Study (Sponsored by the RSNA Quantitative Imaging Biomarkers Alliance)**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S405

Gudrun Zahlmann, PhD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To understand what is needed to start an imaging research study. 2) To learn about imaging hypothesis generation. 3) To learn about basic statistical consideration for such a study. 4) To learn about imaging based measurements and its validation. 5) To understand how the above comes together with legal, ethical, clinical and other considerations to make an imaging study a reality.

#### **COURSE DESCRIPTION**

This course is intended to encourage you to start your own imaging research study. All necessary elements are discussed using a real life example. Experienced experts will share their insights. An interactive component is included in the workshop.

#### **Sub-Events**

##### **T4-RCP19B Building a Quantitative Imaging Research Study - Introduction**

Gudrun Zahlmann, PhD (*Presenter*) Nothing to Disclose

##### **T4-RCP19C Building a Quantitative Imaging Research Study - Real Life Study Description and Hypothesis Generation**

Laure S. Fournier, MD, PhD (*Presenter*) Nothing to Disclose

##### **T4-RCP19D Building a Quantitative Imaging Research Study - Making the Measurement**

Angel Alberich-Bayarri, MS, PhD (*Presenter*) Co-founder, Quibim SL;CEO, Quibim SL

##### **T4-RCP19E Building a Quantitative Imaging Research Study - Statistical Considerations**

Nancy A. Obuchowski, PhD, MS (*Presenter*) Research Consultant, Siemens AG;Research Consultant, IBM Corporation;Research Consultant, Elucid Bioimaging Inc;Research Consultant, Takeda Pharmaceutical Company Limited

##### **T4-RCP19F Building a Quantitative Imaging Research Study - How to Make it Work (Experiences, Best Practices and Opportunities based on NCI NCTN)**

Michael V. Knopp, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T4-RCP19B

### **Building a Quantitative Imaging Research Study - Introduction**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S405

Gudrun Zahlmann, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-RCP19C

### **Building a Quantitative Imaging Research Study - Real Life Study Description and Hypothesis Generation**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S405

Laure S. Fournier, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-RCP19D

### **Building a Quantitative Imaging Research Study - Making the Measurement**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S405

Angel Alberich-Bayarri, MS, PhD (*Presenter*) Co-founder, Quibim SL;CEO, Quibim SL

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## Abstract Archives of the RSNA, 2023

T4-RCP19E

### **Building a Quantitative Imaging Research Study - Statistical Considerations**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S405

Nancy A. Obuchowski, PhD, MS (*Presenter*) Research Consultant, Siemens AG; Research Consultant, IBM Corporation; Research Consultant, Elucid Bioimaging Inc; Research Consultant, Takeda Pharmaceutical Company Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T4-RCP19F

### **Building a Quantitative Imaging Research Study - How to Make it Work (Experiences, Best Practices and Opportunities based on NCI NCTN)**

Tuesday, Nov. 28 11:00AM - 12:00PM Room: S405

Michael V. Knopp, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CBR07

### New Techniques in Breast MRI

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406A

Christiane K. Kuhl, MD, PhD (*Moderator*) Advisory Board, Guerbet SA; Speaker, Bracco Group; Speaker, Bayer AG

#### LEARNING OBJECTIVES

1) Explain the theoretical background of abbreviated breast MRI. 2) Identify strategies to translate abbreviated breast MRI into a busy clinical practice. 3) List the different technical approaches to abbreviated breast MRI.

#### COURSE DESCRIPTION

This course will review the current evidence on the use of new breast MRI techniques with a focus on abbreviated breast MRI and its different subtypes.

#### Sub-Events

##### T6-CBR07B Breast MRI: Role of Abbreviated MRI

Christiane K. Kuhl, MD, PhD (*Presenter*) Advisory Board, Guerbet SA; Speaker, Bracco Group; Speaker, Bayer AG

##### T6-CBR07C Breast MRI: Ultrafast MRI

Ritse M. Mann, MD, PhD (*Presenter*) Researcher, Siemens AG; Consultant, Siemens AG; Researcher, Bayer AG; Consultant, Bayer AG; Researcher, Medtronic plc; Consultant, Medtronic plc; Researcher, Becton, Dickinson and Company; Consultant, Becton, Dickinson and Company; Researcher, ScreenPoint Medical BV

##### T6-CBR07D Breast MRI: Role of Multiparametric MRI

Pascal A. Baltzer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CBR07B

### **Breast MRI: Role of Abbreviated MRI**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406A

Christiane K. Kuhl, MD, PhD (*Presenter*) Advisory Board, Guerbet SA; Speaker, Bracco Group; Speaker, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CBR07C

### **Breast MRI: Ultrafast MRI**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406A

Ritse M. Mann, MD, PhD (*Presenter*) Researcher, Siemens AG; Consultant, Siemens AG; Researcher, Bayer AG; Consultant, Bayer AG; Researcher, Medtronic plc; Consultant, Medtronic plc; Researcher, Becton, Dickinson and Company; Consultant, Becton, Dickinson and Company; Researcher, ScreenPoint Medical BV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CBR07D

### **Breast MRI: Role of Multiparametric MRI**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406A

Pascal A. Baltzer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CCA04

### What Cardiac Device is That? Interactive Session On Imaging Heart Failure Patients

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406B

Byoung Wook Choi, MD, PhD (*Moderator*) Nothing to Disclose  
Carole J. Dennie, MD, FRCPC (*Moderator*) Research Consultant, AstraZeneca PLC

#### LEARNING OBJECTIVES

1) Identify and describe the X-ray and CT appearances of different cardiac devices used in heart failure patients. 2) Recognize and overcome technical challenges in CT imaging of severe heart failure to optimize image quality and diagnostic accuracy. 3) Understand the imaging considerations, protocols, and potential complications associated with left ventricular assist devices (LVAD) and right ventricular assist devices (RVAD).

#### COURSE DESCRIPTION

This educational session is a comprehensive exploration of cardiac devices and their imaging appearances in heart failure patients. The session consists of three lectures that cover essential aspects of cardiac device imaging, including X-ray and CT appearances, technical challenges in CT imaging of severe heart failure, and imaging of left ventricular assist devices (LVAD) and right ventricular assist devices (RVAD). The session aims to enhance participants' knowledge and proficiency in imaging heart failure patients with various cardiac devices, ultimately improving patient care and diagnostic accuracy.

#### Sub-Events

##### T6-CCA04C Toolbelt of Cardiac Devices: X-ray and CT Appearance

Byoung Wook Choi, MD, PhD (*Presenter*) Nothing to Disclose

##### T6-CCA04D Technical Challenges in CT: Imaging Severe Heart Failure

Carole J. Dennie, MD, FRCPC (*Presenter*) Research Consultant, AstraZeneca PLC

##### T6-CCA04E Who Needs Assistance? Imaging of LVAD & RVAD

Daniel Vargas, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T6-CCA04C

### **Toolbelt of Cardiac Devices: X-ray and CT Appearance**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406B

Byoung Wook Choi, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-CCA04D

### Technical Challenges in CT: Imaging Severe Heart Failure

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406B

Carole J. Dennie, MD, FRCPC (*Presenter*) Research Consultant, AstraZeneca PLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CCA04E

### **Who Needs Assistance? Imaging of LVAD & RVAD**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S406B

Daniel Vargas, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CER10

### Role of AI in Emergency Radiology-What you need to know in 2023

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451B

Melissa A. Davis, MD, MBA (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the impact of AI tools within emergent radiology. 2) Gain insight on new tools within the emergent radiology space.

#### COURSE DESCRIPTION

AI tools have become increasingly common within the emergency radiology space. In this session we will discuss the impact of those tools including how they may and/or may not be useful, how they are expanding throughout our departments and new tools on the horizon.

#### Sub-Events

##### T6-CER10B Human to AI, and Back

Anjali Agrawal, MD (*Presenter*) Nothing to Disclose

##### T6-CER10C The Expanding Role of AI in the Emergency and Trauma Department

Sabeena Jalal, MSc, MBBS (*Presenter*) Nothing to Disclose

##### T6-CER10D New Tools and Developments for the Emergent Radiologist

David Dreizin, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T6-CER10B

### **Human to AI, and Back**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451B

Anjali Agrawal, MD (*Presenter*) Nothing to Disclose

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## **Abstract Archives of the RSNA, 2023**

T6-CER10C

### **The Expanding Role of AI in the Emergency and Trauma Department**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451B

Sabeena Jalal, MSc, MBBS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CER10D

### **New Tools and Developments for the Emergent Radiologist**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451B

David Dreizin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CGI05

### Focused/Fast Abdomino-Pelvic MRI Protocols

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S404

Hersh Chandarana, MD, MBA (*Moderator*) Institutional research agreement, Siemens AG; Equipment support, Siemens AG; Software support, Siemens AG

#### LEARNING OBJECTIVES

1) Explain developments in artificial intelligence that enable fast acquisitions and opportunities to maximize efficiency in the reporting of abbreviated MRI exams. 2) Understand opportunities and challenges of implementing abbreviated and fast MRI techniques in clinical practice. 3) Identify the clinical, financial, and medico-legal implications of abbreviated MRI exams.

#### COURSE DESCRIPTION

Indications for fast/focused MRI in abdomino-pelvic conditions continue to increase. We review challenges and opportunities to maximize the efficiency in the implementation of such protocols in a busy clinical practice.

#### Sub-Events

##### **T6-CGI05B Artificial Intelligence to Empower Focused/Fast Abdomino Pelvis MRI**

Hersh Chandarana, MD, MBA (*Presenter*) Institutional research agreement, Siemens AG; Equipment support, Siemens AG; Software support, Siemens AG

##### **T6-CGI05C Clinical Opportunities for Abbreviated MRI Low vs High Risk Patients**

Pari V. Pandharipande, MD, MPH (*Presenter*) I serve as a member of the Association of University Radiologists (AUR) General Electric (GE) Radiology Research Academic Fellowship (GERRAF) Board of Review (term: 7/1/22-2/28/23).

##### **T6-CGI05D From Image Acquisition to Report: How to Maximize Efficiency with Focused/Fast MRI Protocols**

Ivan Pedrosa, MD, PhD (*Presenter*) Scientific Advisor, Health Tech International; Scientific Advisor, Merck & Co, Inc

##### **T6-CGI05E Financial and Medicolegal Implications of Focused/Fast Abdominopelvic MRI Exams**

Jonathan L. Mezrich, MD, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CGI05B

### **Artificial Intelligence to Empower Focused/Fast Abdomino Pelvis MRI**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S404

Hersh Chandarana, MD, MBA (*Presenter*) Institutional research agreement, Siemens AG; Equipment support, Siemens AG; Software support, Siemens AG

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-CGI05C

### **Clinical Opportunities for Abbreviated MRI Low vs High Risk Patients**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S404

Pari V. Pandharipande, MD, MPH (*Presenter*) I serve as a member of the Association of University Radiologists (AUR) General Electric (GE) Radiology Research Academic Fellowship (GERRAF) Board of Review (term: 7/1/22-2/28/23).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CGI05D

### **From Image Acquisition to Report: How to Maximize Efficiency with Focused/Fast MRI Protocols**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S404

Ivan Pedrosa, MD, PhD (*Presenter*) Scientific Advisor, Health Tech International;Scientific Advisor, Merck & Co, Inc

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## Abstract Archives of the RSNA, 2023

T6-CGI05E

### **Financial and Medicolegal Implications of Focused/Fast Abdominopelvic MRI Exams**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S404

Jonathan L. Mezrich, MD, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIN24

### State of the Art Analytics and Dashboarding: Quality, Finance, and AI

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S401

Hanna M. Zafar, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Discuss the key metrics to follow on value-based care, quality, financial, and AI analytics and dashboards. 2) Learn how to integrate analytics and dashboards into retrospective process improvement and prospective daily and strategic planning.

#### COURSE DESCRIPTION

The session will include 30 minutes of traditional didactics and 30 minutes of Ask the Experts case-based discussion. Lectures will include best practices for creation, metrics to follow, and methods of dashboard utilization.

#### Sub-Events

##### **T6-CIN24B Intents and Technical Requirements of Dashboards**

Keith D. Hentel, MD, MS (*Presenter*) Nothing to Disclose

##### **T6-CIN24C Order Decision Support Dashboards**

Brandyn D. Lau, MPH (*Presenter*) Nothing to Disclose

##### **T6-CIN24D Financial Dashboards**

Christopher J. Roth, MD (*Presenter*) Nothing to Disclose

##### **T6-CIN24E Data Science Monitoring Dashboards**

Christina Geatrakas, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIN24B

### **Intents and Technical Requirements of Dashboards**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S401

Keith D. Hentel, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIN24C

### Order Decision Support Dashboards

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S401

Brandyn D. Lau, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIN24D

### Financial Dashboards

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S401

Christopher J. Roth, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIN24E

### **Data Science Monitoring Dashboards**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: S401

Christina Geatrakas, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-CIR07

### Management of Portal Hypertension

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451A

Juan C. Camacho, MD (*Moderator*) Research Grant, Elesta Echolaser

#### LEARNING OBJECTIVES

1) Review the medical management of portal hypertension. 2) Understand the physiopathology of portal hypertension. 3) Discuss recent advancement in imaging of portal hypertension. 4) Discuss the role of interventional radiology in portal hypertension, from TIPSS creation to portosystemic collaterals embolization with especial attention to complications that IRs can encounter during specific therapies.

#### COURSE DESCRIPTION

In the last few decades, there have been significant advancements in understanding the pathophysiology of portal hypertension. This knowledge has led to the development of safer and more effective minimally invasive approaches. The main objective is to provide alternatives to prevent life-threatening complications from clinically significant portal hypertension and to allow the continuation of treatments that would otherwise be stopped. Clinicians involved in portal hypertension care should be aware of risk factors, associated complications, and management of portal hypertension. Interventional radiology offers minimally invasive alternatives that play a central role in improving clinical outcomes and survival of these patients.

#### Sub-Events

##### **T6-CIR07B What IRs Need to Know about Medical Management of Portal Hypertension**

Anjana Pillai (*Presenter*) Nothing to Disclose

##### **T6-CIR07C Advances in Non Invasive Imaging of Portal Hypertension**

Kathryn J. Fowler, MD (*Presenter*) Consultant, Bayer AG;Research support, General Electric Company;Research Grant, Pfizer Inc;Institutional Grant, MEDIAN Technologies;Consultant, General Electric Company

##### **T6-CIR07D Advances in TIPSS/DIPSS Creation: IVUS, Trans Splenic Approach and PVR Recanalization**

Juan C. Camacho, MD (*Presenter*) Research Grant, Elesta Echolaser

##### **T6-CIR07E Portosystemic Shunt Embolization: When and How to do it**

Jens Ricke, MD, PhD (*Presenter*) Research Grant, Sirtex Medical Ltd;Research Grant, Bayer AG;Research Grant, Terumo Corporation;Research Grant, Boston Scientific Corporation

##### **T6-CIR07F Complications during Portal Hypertension Interventions: What to Avoid and How to Save Yourself**

Bartley Thornburg, MD (*Presenter*) Nothing to Disclose

##### **T6-CIR07G Management of Ascites and Pleural Effusion in the Setting of Portal Hypertension**

David C. Madoff, MD (*Presenter*) Advisory Board, Zimmer Biomet Holdings, Inc;Consultant, General Electric Company;Consultant, Guerbet SA;Consultant, Merck & Co, Inc;Consultant, Sirtex Medical Ltd;Consultant, Boston Scientific Corporation;Consultant, Johnson & Johnson;Consultant, Siemens AG

## Abstract Archives of the RSNA, 2023

T6-CIR07B

### **What IRs Need to Know about Medical Management of Portal Hypertension**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451A

Anjana Pillai (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIR07C

### **Advances in Non Invasive Imaging of Portal Hypertension**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451A

Kathryn J. Fowler, MD (*Presenter*) Consultant, Bayer AG;Research support, General Electric Company;Research Grant, Pfizer Inc;Institutional Grant, MEDIAN Technologies;Consultant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIR07D

### **Advances in TIPSS/DIPSS Creation: IVUS, Trans Splenic Approach and PVR Recanalization**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451A

Juan C. Camacho, MD (*Presenter*) Research Grant, Elesta Echolaser

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## Abstract Archives of the RSNA, 2023

T6-CIR07E

### **Portosystemic Shunt Embolization: When and How to do it**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451A

Jens Ricke, MD, PhD (*Presenter*) Research Grant, Sirtex Medical Ltd; Research Grant, Bayer AG; Research Grant, Terumo Corporation; Research Grant, Boston Scientific Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIR07F

### **Complications during Portal Hypertension Interventions: What to Avoid and How to Save Yourself**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451A

Bartley Thornburg, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CIR07G

### Management of Ascites and Pleural Effusion in the Setting of Portal Hypertension

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E451A

David C. Madoff, MD (*Presenter*) Advisory Board, Zimmer Biomet Holdings, Inc;Consultant, General Electric Company;Consultant, Guerbet SA;Consultant, Merck & Co, Inc;Consultant, Sirtex Medical Ltd;Consultant, Boston Scientific Corporation;Consultant, Johnson & Johnson;Consultant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CMK10

### **Musculoskeletal Ultrasound: Normal Appearances, Pathologic Conditions and Hands-on Demo (Elbow, Ankle, Peripheral Nerves of the Upper Extremity)**

Tuesday, Nov. 28 1:30PM - 3:00PM Room: E450A

Robert S. Campbell, MBChB, FRCR (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Learn the relevant US anatomy for each of the 3 body areas. 2) Gain knowledge of techniques to optimally visualise the relevant anatomical structures. 3) Apply that knowledge to be able to perform US examination of clinical cases. 4) Understand the limitations of US and when to consider alternative image modalities.

#### **COURSE DESCRIPTION**

The 90-minute Ultrasound module will include the following topics: - The elbow- The ankle - Peripheral nerves of the upper limb Each 30-minute section will comprise a "live demonstration" of normal US anatomy followed by a case-based presentation of pathological cases discussing the utility of MSK Ultrasound in clinical practice. This session will provide a basis on which to develop your skills in MSK US.

#### **Sub-Events**

##### **T6-CMK10B PPT**

Linda Probyn, MD (*Presenter*) Nothing to Disclose

##### **T6-CMK10C Hands on Demo**

Viviane Khoury, BSc, MD (*Presenter*) Nothing to Disclose

##### **T6-CMK10D Hands on Demo**

Jon A. Jacobson, MD (*Presenter*) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, RELX; Contactor, POCUS PRO

##### **T6-CMK10E PPT**

Marnix T. Van Holsbeeck, MD (*Presenter*) Stockholder, Koninklijke Philips NV; Stockholder, General Electric Company; Stockholder, MedEd3D

##### **T6-CMK10F PPT**

Etienne Cardinal, MD, BSc (*Presenter*) Nothing to Disclose

##### **T6-CMK10G Hands on Demo**

Mark Cresswell, MBChB, BSc (*Presenter*) Consultant, Koninklijke Philips NV

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## Abstract Archives of the RSNA, 2023

T6-CMK10B

**PPT**

Tuesday, Nov. 28 1:30PM - 3:00PM Room: E450A

Linda Probyn, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CMK10C

### **Hands on Demo**

Tuesday, Nov. 28 1:30PM - 3:00PM Room: E450A

Viviane Khoury, BSc, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CMK10D

### Hands on Demo

Tuesday, Nov. 28 1:30PM - 3:00PM Room: E450A

Jon A. Jacobson, MD (*Presenter*) Research Consultant, BioClinica, Inc; Advisory Board, Koninklijke Philips NV; Royalties, RELX; Contactor, POCUS PRO

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CMK10E

**PPT**

Tuesday, Nov. 28 1:30PM - 3:00PM Room: E450A

Marnix T. Van Holsbeeck, MD (*Presenter*) Stockholder, Koninklijke Philips NV; Stockholder, General Electric Company; Stockholder, MedEd3D

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CMK10F

**PPT**

Tuesday, Nov. 28 1:30PM - 3:00PM Room: E450A

Etienne Cardinal, MD, BSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CMK10G

### **Hands on Demo**

Tuesday, Nov. 28 1:30PM - 3:00PM Room: E450A

Mark Cresswell, MBBCh, BSc (*Presenter*) Consultant, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CNMMI11

### Case-based Review of PET/CT: Genitourinary Cancers

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E353C

Gary A. Ulaner, MD,PhD (*Moderator*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

#### LEARNING OBJECTIVES

1) Understand the limitations urinary excretion of PET tracers can cause for interpretation of images around the kidneys, ureters, and bladder. 2) Understand best clinical practices for use of PSMA-targeted PET/CT for patients with prostate cancer.

#### COURSE DESCRIPTION

Novel PET/CT agents are revolutionizing the imaging and therapy of patients with prostate cancer. In this session, experts on 18F-fluciclovine (Axumin) and PSMA-targeted PET/CT will use clinical cases to demonstrate fundamentals of interpretation, as well as pearls and pitfalls to help improve interpretation of these studies.

#### Sub-Events

##### **T6- CNMMI11B PSMA PET: Pearls and Pitfalls**

Gary A. Ulaner, MD,PhD (*Presenter*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

##### **T6- CNMMI11C PSMA PET: Tips from the SNMMI Reader Training**

Steven P. Rowe, MD, PhD (*Presenter*) Consultant, Lantheus Holdings;Research support, Lantheus Holdings;Stockholder, D&D Pharmatech;Consultant, D&D Pharmatech;Research support, D&D Pharmatech;Stockholder, PlenaryAI, Inc;Research support, PlenaryAI, Inc

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## Abstract Archives of the RSNA, 2023

T6-CNMMI11B

### **PSMA PET: Pearls and Pitfalls**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E353C

Gary A. Ulaner, MD,PhD (*Presenter*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-CNMMI11C

### **PSMA PET: Tips from the SNMMI Reader Training**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E353C

Steven P. Rowe, MD, PhD (*Presenter*) Consultant, Lantheus Holdings; Research support, Lantheus Holdings; Stockholder, D&D Pharmatech; Consultant, D&D Pharmatech; Research support, D&D Pharmatech; Stockholder, PlenaryAI, Inc; Research support, PlenaryAI, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CNPM16

### Medicolegal Updates: What Radiologists Should Know About Error Disclosure

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E353B

Stephen D. Brown, MD (*Moderator*) Stockholder, GSK plc ;Stockholder, Johnson & Johnson;Stockholder, AbbVie Inc;Stockholder, Merck & Co, Inc;Stockholder, CVS Health Corporation;Stockholder, Pfizer Inc

#### LEARNING OBJECTIVES

1) Identify systems processes that facilitate open communication with patients and families about medical errors. 2) Understand practical legal perspectives regarding open communication with patients and families about medical errors. 3) Describe executive level considerations regarding the implementation of coordinated enterprise-wide open communication practices around medical errors.

#### COURSE DESCRIPTION

This course will explore several timely issues relevant to communication with patients and families about adverse events and errors. 1) Process Considerations: Responsibly discussing medical errors with patients and families requires the implementation of principled, coordinated, enterprise-wide processes that support both patients and providers. This presentation, by a pediatric radiologist with extensive experience speaking on ethics, communication, professionalism, and error disclosure, will discuss systems processes that facilitate open communication with patients and families about medical errors. 3) Legal Perspective: Lofty ideals about “doing the right thing” in communicating honestly and transparently with patients and families about preventable adverse events feel unattainable to many physicians fearful of the legal consequences. This presentation, by an attorney with extensive malpractice expertise, will offer perspectives about the practical realities involved and consequences for physicians when considering whether and how to bring open communication about errors to patients and families. 3) Executive Perspective: Establishing institutional expectations regarding direct, transparent communication with patients and families about medical errors requires top-down leadership articulation of priorities, principles, and culture, coupled with integration of a complex web of stakeholders including insurers and risk managers, offices of legal counsel, quality and safety leaders, patient and personnel support systems, and front-line staff. The speaker, a senior academic radiologist and healthcare system executive, will present perspectives and experiences regarding management of disclosure processes at the broad enterprise level.

#### Sub-Events

##### **T6- CNPM16B** Error Disclosure: Process Considerations

Stephen D. Brown, MD (*Presenter*) Stockholder, GSK plc ;Stockholder, Johnson & Johnson;Stockholder, AbbVie Inc;Stockholder, Merck & Co, Inc;Stockholder, CVS Health Corporation;Stockholder, Pfizer Inc

##### **T6- CNPM16C** Error Disclosure: Legal Perspective

Kelly Yousem, JD (*Presenter*) Nothing to Disclose

##### **T6- CNPM16D** Error Disclosure: Executive Perspective

Jonathan S. Lewin, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T6-CNPM16B

### **Error Disclosure: Process Considerations**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E353B

Stephen D. Brown, MD (*Presenter*) Stockholder, GSK plc ;Stockholder, Johnson & Johnson;Stockholder, AbbVie Inc;Stockholder, Merck & Co, Inc;Stockholder, CVS Health Corporation;Stockholder, Pfizer Inc

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## Abstract Archives of the RSNA, 2023

T6-CNPM16C

### **Error Disclosure: Legal Perspective**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E353B

Kelly Yousem, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CNPM16D

### **Error Disclosure: Executive Perspective**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E353B

Jonathan S. Lewin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CNR09

### AI - Applications of Neuroradiology

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E450B

Yvonne W. Lui, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1. Understand the breadth of neuroimaging applications being addressed by machine learning approaches including less-talked about applications in spine imaging and pediatric neuroradiology. 2. Know the current state-of-the-art in terms of machine learning in MR image reconstruction. 3. Have a basic, working knowledge of the use of machine learning in radiomics for brain tumors.

#### COURSE DESCRIPTION

What's the buzz? Get yourself up-to-date on deep learning and Neuroradiology! This course will cover cutting-edge advances in neuroimaging applications of machine learning from image reconstruction to radiogenomics to practical clinical advances including in pediatric populations. The course will cover state-of-the-art techniques and approaches in an accessible way and give you an easily digestible update overview on the topic. This course will equip you with relevant information to engage with colleagues, referring physicians, scientists, and vendors on this topic.

#### Sub-Events

##### T6-CNR09B The Pediatric Brain Meets AI

Susan Sotardi, MD, MEng (*Presenter*) Nothing to Disclose

##### T6-CNR09C The Future of Radiomics in Neuroimaging

Reza Forghani, MD, PhD (*Presenter*) Consultant, General Electric Company; Research Grant, General Electric Company; Research Grant, Intel Corporation; Research Grant, Toronto-Dominion Bank; Research Grant, McGill University Health Centre Foundation; President, Montreal Imaging Experts Inc

##### T6-CNR09D Machine Learning Applications in Spine Imaging

Nathan M. Cross, MD, MS (*Presenter*) Nothing to Disclose

##### T6-CNR09E Advances in Deep Learning Approaches in Brain MRI Reconstruction

Yvonne W. Lui, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T6-CNR09B

### **The Pediatric Brain Meets AI**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E450B

Susan Sotardi, MD, MEng (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CNR09C

### **The Future of Radiomics in Neuroimaging**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E450B

Reza Forghani, MD, PhD (*Presenter*) Consultant, General Electric Company; Research Grant, General Electric Company; Research Grant, Intel Corporation; Research Grant, Toronto-Dominion Bank; Research Grant, McGill University Health Centre Foundation; President, Montreal Imaging Experts Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-CNR09D

### **Machine Learning Applications in Spine Imaging**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E450B

Nathan M. Cross, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CNR09E

### Advances in Deep Learning Approaches in Brain MRI Reconstruction

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E450B

Yvonne W. Lui, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CPD04

### Small Parts Ultrasound in Children: A Roadmap to Appropriate Biopsy

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N228

Claudia M. Martinez Rios Arellano, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Discuss how to recognize the sonographic features of solid pediatric breast masses and how to apply an appropriate lexicon. 2) Learn how to appreciate features of the normal breast to avoid iatrogenic injury to the developing breast and how to differentiate benign from concerning breast masses in children to guide an appropriate management. 3) Discuss sonographic appearances of pediatric thyroid nodules, using a practical approach for characterization and management. 4) Provide detailed explanations of various lumps and bumps encountered in children, describing the sonographic technique, highlighting the role of ultrasound and the clinical information when assessing these lesions, that can help to differentiate those that are best to watch versus those that should be removed.

#### COURSE DESCRIPTION

This lecture course will address the sonographic features of lesions of the breast, thyroid and various lumps and bumps in children. Lesions of these small parts in children can be benign or malignant, and reaching a final diagnosis based on imaging alone can be challenging. Awareness of the distinct imaging features of these lesions, can help in guiding a management approach, deciding when it is best to biopsy or to watch.

#### Sub-Events

##### **T6-CPD04B Lesions in the Pediatric Breast: Differential Diagnosis and When to Biopsy**

Teresa Chapman, MD, MA (*Presenter*) Nothing to Disclose

##### **T6-CPD04C Practical Approach to Pediatric Thyroid Nodules**

Ricardo Restrepo, MD (*Presenter*) Nothing to Disclose

##### **T6-CPD04D Pediatric Lumps and Bumps: When Watchful Waiting is the Right Plan**

Oscar M. Navarro, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T6-CPD04B

### **Lesions in the Pediatric Breast: Differential Diagnosis and When to Biopsy**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N228

Teresa Chapman, MD, MA (*Presenter*) Nothing to Disclose

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## **Abstract Archives of the RSNA, 2023**

T6-CPD04C

### **Practical Approach to Pediatric Thyroid Nodules**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N228

Ricardo Restrepo, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CPD04D

### **Pediatric Lumps and Bumps: When Watchful Waiting is the Right Plan**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N228

Oscar M. Navarro, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-CRT08

### **ASRT@RSNA: Combatting Exclusive Behaviors in the Workplace**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Recognize the subtle and covert ways that exclusionary behaviors are conveyed through speech and behavior. 2) Understand the impact that exclusionary behaviors have in the workplace. 3) Implement strategies to pro-actively address exclusionary behaviors.

#### **COURSE DESCRIPTION**

Inclusive workplaces are associated with improved job satisfaction, reduced turnover, and increased organizational commitment. Creating an inclusive workplace requires leaders, teams, and individuals to pay attention to the subtle ways in which they may exclude team members. This course includes a practical lecture focused on equipping radiology professionals with discrete tools and resources to identify and pro-actively address exclusionary behaviors.

#### **Sub-Events**

### **T6-CRT08B ASRT@RSNA: Combatting Microaggressions in the Workplace**

Anand K. Narayan, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T6-CRT08B

### **ASRT@RSNA: Combatting Microaggressions in the Workplace**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N230B

Anand K. Narayan, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-RCP17

### **Framing Health Equity Through the Lens of Organizational Readiness and Accountability (Sponsored by the RSNA Health Equity Committee)**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E352

Efren J. Flores, MD (*Moderator*) Speaker, WebMD LLC; Speaker, Consulting Medical Associates, Inc  
Lucy B. Spalluto, MD, MPH (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Participants will be competent to describe the concept of health equity from a radiology perspective and its importance of addressing disparities seen in healthcare organizations. 2) Participants will gain insight about key policies set by the Joint Commission and the CMS, learning about their requirements and the evolving national frameworks used to advance health equity. 3) Participants will learn how to employ existing quality tools and metrics to identify healthcare gaps measure progress in programs aimed to improve health equity within radiology. 4) Participants will gain an understanding of the application of cultural dexterity in radiology to promote an organizations' accountability towards improving health equity. 5) Participants will be equipped to understand the implications of health equity-based payment models within radiology departments. They will be confident to align existing efforts made in the radiology departments with these new models to ensure readiness for change.

#### **COURSE DESCRIPTION**

Health equity is a vehicle for organizational change and a catalyst for personalized care. This growing role has resulted in an increase attention by national quality and safety organizations, private and public payors, and government and industry collaborators. Radiology continues to play a central role in patient care and are poised to lead health equity efforts at their respective institutions. Therefore, it is paramount that radiologists are equipped with a knowledge toolkit that will enable them to lead institutional readiness efforts to successfully comply with the evolving accountability requirements to reduce health disparities and future equity-based payment models. Beyond the increasing focus on health equity by healthcare and academic institutions and industry collaborators, addressing health care disparities has become a quality and safety priority in radiology. New and revised requirements to reduce health care disparities will apply to radiology practices and health organizations as part of the Joint Commission's accreditation requirements. Additionally, the Centers for Medicare and Medicaid Services (CMS) have updated their framework to further advance health equity, and the President's Cancer Panel and the Cancer Moonshot have made health equity in cancer screening a key pillar of these efforts. These frameworks set the foundation and priorities to eliminate health disparities and drive structural change with evolving payment models that will impact all health care systems and radiology practices. Therefore, it is vital that radiologists are equipped with a knowledge toolkit to lead healthcare institutional readiness efforts to ensure radiology practices and healthcare systems are compliant with these evolving requirements. Leveraging the CMS framework for health equity and the Department of Health and Human Services Health People 2030, the purpose of this session is to discuss high-yield topics that will provide practical examples and on how to lead data-driven institutional efforts and system-wide outcomes measures that will support organizational readiness to advance health equity. The topics covered will be discussed with national radiology leaders and will include the following: 1. Effective standardization of sociodemographic data collection and root cause analyses to identify care gaps in radiology. 2. Building capacity by enhancing diversity efforts in radiology. 3. Understanding and successfully navigating the health equity Joint Commission requirements 4. Developing and implementing system-wide outcomes metrics to measure progress in disparities. 5. Aligning radiology efforts to ensure readiness for evolving payment models.

#### **Sub-Events**

### **T6-RCP17C Framing Health Equity Through the Lens of Organizational Readiness and Accountability (Sponsored by the RSNA Health Equity Committee)**

Jinel A. Scott, MD (*Presenter*) Nothing to Disclose

### **T6-RCP17D Framing Health Equity Through the Lens of Organizational Readiness and Accountability (Sponsored by the RSNA Health Equity Committee)**

Gezzer Ortega, MD, MPH (*Presenter*) Nothing to Disclose

**T6-RCP17E Framing Health Equity Through the Lens of Organizational Readiness and Accountability  
(Sponsored by the RSNA Health Equity Committee)**

Carolyn C. Meltzer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-RCP17C

**Framing Health Equity Through the Lens of Organizational Readiness and Accountability (Sponsored by the RSNA Health Equity Committee)**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E352

Jinel A. Scott, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T6-RCP17D

**Framing Health Equity Through the Lens of Organizational Readiness and Accountability (Sponsored by the RSNA Health Equity Committee)**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E352

Gezzer Ortega, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-RCP17E

**Framing Health Equity Through the Lens of Organizational Readiness and Accountability (Sponsored by the RSNA Health Equity Committee)**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E352

Carolyn C. Meltzer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CCH06

### **Pulmonary Vascular Imaging: CTEPH/Pulmonary Hypertension**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451B

Ann N. Leung, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Recognize and diagnose CTEPH on imaging studies. 2) Distinguish CTEPH from other conditions that affect the pulmonary vasculature.

#### **COURSE DESCRIPTION**

Chronic thromboembolic pulmonary hypertension (CTEPH) is a potentially curable form of pulmonary hypertension that develops in approximately 3% of patients with pulmonary embolism. CTEPH is a dual vascular disorder characterized by obstruction of the pulmonary vasculature by organized thromboembolic material and a secondary arteriopathic process affecting small resistance vessels. Untreated, CTEPH can lead to right heart failure and death. Diagnosis of CTEPH is made on the basis of imaging. This course presented in lecture-style format will discuss the relative strengths and weaknesses of the different diagnostic modality options as well as the characteristic imaging features of CTEPH on each. The session will include a case-based review to reinforce the imaging appearance of CTEPH and allow its differentiation from mimics.

#### **Sub-Events**

##### **T7-CCH06B Introduction to CTEPH/PH**

Ann N. Leung, MD (*Presenter*) Nothing to Disclose

##### **T7-CCH06C Diagnosis of CTEPH/PH**

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG;Speaker, Siemens AG

##### **T7-CCH06D Imaging Findings of CTEPH**

Seth J. Kligerman, MD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH;Consultant, Riverain Technologies, LLC;Consultant, Bayer AG

##### **T7-CCH06E CTEPH/PH Case Review**

Constantine A. Raptis, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T7-CCH06B

### **Introduction to CTEPH/PH**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451B

Ann N. Leung, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CCH06C

### **Diagnosis of CTEPH/PH**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451B

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG;Speaker, Siemens AG

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## Abstract Archives of the RSNA, 2023

T7-CCH06D

### Imaging Findings of CTEPH

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451B

Seth J. Kligerman, MD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH;Consultant, Riverain Technologies, LLC;Consultant, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CCH06E

### **CTEPH/PH Case Review**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451B

Constantine A. Raptis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CGU03

### GU Essentials! A Case-Based Audience Participation Session

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406A

Tharakeswara K. Bathala, MD, MS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Develop a systematic approach to assess genitourinary imaging studies, accurately identifying anatomical structures, abnormalities, and pathology. 2) Apply advanced imaging techniques and protocols for the evaluation of various genitourinary disorders. 3) Differentiate between benign and malignant genitourinary lesions based on imaging characteristics and implement appropriate management strategies. 4) Incorporate evidence-based guidelines and best practices into clinical practice, ensuring accurate diagnoses, appropriate patient selection, and timely interventions in genitourinary imaging. 5) Evaluate the limitations and potential pitfalls of genitourinary imaging techniques, enabling participants to make informed decisions and prevent diagnostic errors.

#### COURSE DESCRIPTION

"GU Essentials! A Case-Based Audience Participation Session" is an engaging and interactive lecture series designed to provide a comprehensive understanding of genitourinary imaging for radiologists, trainees, and healthcare professionals involved in diagnosing and managing genitourinary conditions. Through dynamic case-based discussions and active audience participation, this series aims to enhance participants' interpretation skills and provide valuable insights into genitourinary imaging studies.

#### Sub-Events

##### T7-CGU03B Kidney

Andrew D. Smith, MD, PhD (*Presenter*) Owner, AI Metrics LLC;Chairman, AI Metrics LLC;Officer, AI Metrics LLC;Patent agreement, AI Metrics LLC;Owner, Radiostics LLC;CEO, Radiostics LLC;Speaker, Canon Medical Systems Corporation;Patent holder, AI and Image Processing Algorithms

##### T7-CGU03C Bladder/Ureters

Tristan Barrett, MBBS, MD (*Presenter*) Nothing to Disclose

##### T7-CGU03D Prostate

Tharakeswara K. Bathala, MD, MS (*Presenter*) Nothing to Disclose

##### T7-CGU03E Benign Gynecology

Lori Mankowski Gettle, MD, MBA (*Presenter*) Stockholder, Elucent Medical;Research support, General Electric Company;Research support, HistoSonics, Inc;Royalties, RELX

##### T7-CGU03F Malignant Gynecology

Bahar Mansoori, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T7-CGU03B

### **Kidney**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406A

Andrew D. Smith, MD, PhD (*Presenter*) Owner, AI Metrics LLC;Chairman, AI Metrics LLC;Officer, AI Metrics LLC;Patent agreement, AI Metrics LLC;Owner, Radiostics LLC;CEO, Radiostics LLC;Speaker, Canon Medical Systems Corporation;Patent holder, AI and Image Processing Algorithms

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## Abstract Archives of the RSNA, 2023

T7-CGU03C

### **Bladder/Ureters**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406A

Tristan Barrett, MBBS, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CGU03D

### **Prostate**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406A

Tharakeswara K. Bathala, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CGU03E

### Benign Gynecology

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406A

Lori Mankowski Gettle, MD, MBA (*Presenter*) Stockholder, Elucent Medical; Research support, General Electric Company; Research support, HistoSonics, Inc; Royalties, RELX

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## Abstract Archives of the RSNA, 2023

T7-CGU03F

### **Malignant Gynecology**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406A

Bahar Mansoori, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-CNMMI12

### Case-based Review of PET/CT: Neuroendocrine Cancers

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353C

Lisa Bodei, MD, PhD (*Moderator*) Consultant, Novartis AG ;Speaker, Novartis AG;Research Grant, Novartis AG;Consultant, Ipsen SA;Consultant, ITM Isotopen Technologien Muenchen AG;Speaker, ITM Isotopen Technologien Muenchen AG;Consultant, Clovis Oncology, Inc;Consultant, Ion Beam Applications, SA

#### LEARNING OBJECTIVES

1) Understand best clinical practices for use and interpretation of PET/CT in patients with neuroendocrine tumors. 2) Compared and contrast Ga68-Dotatate with 64Cu-Dotatate.

#### COURSE DESCRIPTION

PET/CT has greatly impacted the imaging and therapy of neuroendocrine malignancies, including continuing improvements in somatostatin receptor-targeted PET. In this session, experts on neuroendocrine tumors will use clinical cases to demonstrate fundamentals of interpretation, as well as pearls and pitfalls to help improve interpretation of PET studies.

#### Sub-Events

##### **T7- CNMMI12B** Response Assessment after PRRT

Lisa Bodei, MD, PhD (*Presenter*) Consultant, Novartis AG ;Speaker, Novartis AG;Research Grant, Novartis AG;Consultant, Ipsen SA;Consultant, ITM Isotopen Technologien Muenchen AG;Speaker, ITM Isotopen Technologien Muenchen AG;Consultant, Clovis Oncology, Inc;Consultant, Ion Beam Applications, SA

##### **T7- CNMMI12C** Update on Neuroendocrine Tumor Imaging

Nadine Mallak, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T7-CNMMI12B

### Response Assessment after PRRT

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353C

Lisa Bodei, MD, PhD (*Presenter*) Consultant, Novartis AG ;Speaker, Novartis AG;Research Grant, Novartis AG;Consultant, Ipsen SA;Consultant, ITM Isotopen Technologien Muenchen AG;Speaker, ITM Isotopen Technologien Muenchen AG;Consultant, Clovis Oncology, Inc;Consultant, Ion Beam Applications, SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CNMMI12C

### **Update on Neuroendocrine Tumor Imaging**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353C

Nadine Mallak, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CNR12

### Spine Imaging - Core Concepts & Cutting Edge

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E450B

Peter G. Kranz, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review core concepts essential for all radiologists interpreting spine imaging: adjacent-segment degeneration and imaging of painful facet joints. 2) Explain cutting-edge techniques that will shape spine imaging in the future: AI and CSF-venous fistula imaging.

#### COURSE DESCRIPTION

This session will consist of 4 lectures targeted to both general practice radiologists and spine imaging specialists. Content will include two lectures addressing core concepts of that are commonly encountered in practice, and are crucial to understand how spine imaging interfaces with clinical decision-making. In addition, two lectures will address cutting-edge topics expected to influence spine imaging and shape changes in practice in the near future.

#### Sub-Events

##### **T7-CNR12B Core Concept: Adjacent Segment Degeneration**

Marin A. McDonald, MD, PhD (*Presenter*) Speakers Bureau, Canon Medical Systems Corporation

##### **T7-CNR12C Core Concept: Imaging of Painful Facet Joints**

Lubdhha M. Shah, MD, MSc (*Presenter*) Nothing to Disclose

##### **T7-CNR12D Cutting Edge: CSF-Venous Fistula Imaging**

Peter G. Kranz, MD (*Presenter*) Nothing to Disclose

##### **T7-CNR12E Cutting Edge: Spine AI & Bone MRI**

Amish H. Doshi, MD (*Presenter*) Speaker, Becton, Dickinson and Company; Consultant, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CNR12B

**Core Concept: Adjacent Segment Degeneration**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E450B

Marin A. McDonald, MD, PhD (*Presenter*) Speakers Bureau, Canon Medical Systems Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CNR12C

### **Core Concept: Imaging of Painful Facet Joints**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E450B

Lubdha M. Shah, MD, MSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CNR12D

### **Cutting Edge: CSF-Venous Fistula Imaging**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E450B

Peter G. Kranz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CNR12E

### **Cutting Edge: Spine AI & Bone MRI**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E450B

Amish H. Doshi, MD (*Presenter*) Speaker, Becton, Dickinson and Company; Consultant, Siemens AG

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-COB01

### Endometriosis: US, MR, and Surgical Correlations

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451A

Scott W. Young, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the MR appearance of endometriosis phenotypes: superficial endometriosis, endometrioma, and deep endometriosis. 2) Learn the sonographic appearance of common sites of deep endometriosis, how to acquire high-yield ultrasound images of DE in the posterior compartment, and how to report DE on augmented routine pelvic ultrasound in compliance with Society of Radiologists in Ultrasound (SRU) Consensus Statement on ultrasound of endometriosis. 3) Understand the utility of preoperative imaging in the management and resection of advanced-stage endometriosis.

#### COURSE DESCRIPTION

Endometriosis is a prevalent condition affecting approximately 10% of individuals, especially during reproductive age. Currently, affected persons undergo significant diagnostic delay and suboptimal medical and surgical treatment due to a lack of awareness. Imaging plays an increasingly vital role in diagnosis and management. Lecturers will provide critical information on how to decrease diagnostic delay, improve communication of important imaging observations, and the impact of imaging information on surgical treatment and medical management.

#### Sub-Events

##### **T7-COB01B Endometriosis: Ultrasound and the New SRU Consensus Conference Guidelines**

Scott W. Young, MD (*Presenter*) Nothing to Disclose

##### **T7-COB01C Endometriosis: US, MR & Surgical Correlation**

Rosanne Kho, MD (*Presenter*) Nothing to Disclose

##### **T7-COB01D MR of Endometriosis: Hiding in Plain Site**

Nancy Kim, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-COB01B

### **Endometriosis: Ultrasound and the New SRU Consensus Conference Guidelines**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451A

Scott W. Young, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-COB01C

### **Endometriosis: US, MR & Surgical Correlation**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451A

Rosanne Kho, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-COB01D

### **MR of Endometriosis: Hiding in Plain Site**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E451A

Nancy Kim, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CRT03

**ASRT@RSNA: AI for Good: How Collaboration Should Inform Responsible Future Practice (Supported in part by an Unrestricted Medical Education Grant from Siemens Healthineers of Siemens Medical Solutions, USA, Inc.)**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Appreciate the ways in which AI is poised to impact medical imaging and radiation therapy practice from a clinical, technical, professional, and ethical lens. 2) Champion the value of equipping medical radiation technologists (MRTs) to be literate in relevant technologies, data, and system level considerations. 3) Leverage the unique perspective and expertise of MRTs to inform an AI-enabled future through advocacy and collaboration.

### COURSE DESCRIPTION

Artificial intelligence (AI) is emerging as an important tool in medical imaging and radiation therapy – but it should only ever be considered exactly that – a tool, leveraged to inform responsible and high quality care. To realize a desired future state that makes most appropriate use of technology and most effective use of diverse skill sets within the interprofessional team, it is important that medical radiation technologists (MRTs) equip themselves to be part of relevant conversations and decisions. Education, advocacy, and collaboration are all necessary as we build towards AI-enabled medical imaging and radiation therapy practice. This presentation will highlight the diverse applications of AI, and the considerations for responsible implementation from the perspective of MRTs as members of the interprofessional team, at both the practice and system level.

### Sub-Events

#### **T7-CRT03B ASRT@RSNA: AI for Good: How Collaboration Should Inform Responsible Future Practice**

Caitlin Gillan, PhD, MEd (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CRT03B

**ASRT@RSNA: AI for Good: How Collaboration Should Inform Responsible Future Practice**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N230B

Caitlin Gillan, PhD, MEd (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CVA05

### Visceral Vascular Imaging

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N226

Jody Shen, MD (*Moderator*) Nothing to Disclose  
Iain D. Kirkpatrick, MD, FRCPC (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Describe how to optimize CT protocols for the diagnosis of acute mesenteric ischemia or the localization of gastrointestinal hemorrhage, and the imaging findings most helpful in making a diagnosis. 2) Identify which imaging modalities are most appropriate for the investigation of pelvic congestion syndrome or renal arterial pathology in 2023, and associated radiologic findings.

#### COURSE DESCRIPTION

Abdominal vascular pathology crosses subspecialties and can be challenging for general radiologists, the abdominal radiologist who rarely interprets CT/MR angiography or the cardiovascular radiologist/interventionalist who is less familiar with visceral abdominal imaging. This Refresher Course consists of four lectures covering the vascular and visceral findings seen in acute mesenteric ischemia, gastrointestinal hemorrhage, renal arterial disease and pelvic congestion syndrome, as well as the appropriate selection of imaging modalities and protocols for these constantly evolving diagnoses. At the end of the course, attendees should feel comfortable prescribing and interpreting studies for all of these indications.

#### Sub-Events

##### T7-CVA05C Mesenteric Ischemia

Iain D. Kirkpatrick, MD, FRCPC (*Presenter*) Nothing to Disclose

##### T7-CVA05D Renal Artery Imaging

Nicole A. Keefe, MD (*Presenter*) Nothing to Disclose

##### T7-CVA05E Pelvic Congestion Syndrome

Rebecca Rakow-Penner, MD, PhD (*Presenter*) Research Grant, General Electric Company; Consultant, Human Longevity Inc; Stockholder, CureMetrix, Inc; Stock options, CorTechs Labs, Inc

##### T7-CVA05F Gastrointestinal Bleeding

Avneesh Gupta, MD (*Presenter*) Speaker, Koninklijke Philips NV;;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CVA05C

### **Mesenteric Ischemia**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N226

Iain D. Kirkpatrick, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-CVA05D

### Renal Artery Imaging

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N226

Nicole A. Keefe, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CVA05E

### **Pelvic Congestion Syndrome**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N226

Rebecca Rakow-Penner, MD, PhD (*Presenter*) Research Grant, General Electric Company; Consultant, Human Longevity Inc; Stockholder, CureMetrix, Inc; Stock options, CorTechs Labs, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-CVA05F

### **Gastrointestinal Bleeding**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N226

Avneesh Gupta, MD (*Presenter*) Speaker, Koninklijke Philips NV;;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP03

### Italy Presents: Radiology in the NextGenerationEU Plan

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Andrea Giovagnoni, MD (*Moderator*) Nothing to Disclose  
Emanuele Neri, MD (*Moderator*) Speakers Bureau, General Electric Company

#### LEARNING OBJECTIVES

1) Vision and transformation of an historical scientific society born in 1913 and now representing more than 12,000 members in Italy. 2) Italy best practices for success stories such as its main journal, La Radiologia Medica, which hit an IF of 6.313 in 2021. 3) Italian radiologists' contributions to the National Recovery and Resilience Plan, a Similar Marshall plan post-pandemic. 4) Evolution of society reflecting in the scientific and professional area: How to embrace diversity and inclusion to express radiologists' full potential. The Italian initiatives to strengthen connections and synergies among regions. 5) Insight into the Italian College of Interventional radiology: SIRM's role in guiding and training young IR residents. 6) An innovative partnership between radiology and the Italian Winter Olympic games 2026: Among the branches of sports medicines radiology can excel to become an ally of winter sport athletes.

#### COURSE DESCRIPTION

Cav. Mico Delianova Licastro – US Delegate for CONI- Italian National Olympic Committee This course is structured to provide an overview of the Italian Society of Medical and Interventional Radiology, one of the largest Italian and European scientific societies which experienced an accelerated growth in recent years (up to 12K members, 46% are women and 49% of members belong to the young age groups, 25-44y, that is progressively increasing). The pandemic experience brought a new perspective on the structure of educational activities, opening to a multidisciplinary approach and involving younger radiologist to take an active part in the society. The National Recovery and Resilience Plan (PNRR) is part of an extraordinary post-pandemic European funding program involving the Italian university system in the field of Precision Medicine. The contributions of the Italian radiologists involved in the project in the development of pre clinical studies and clinical trials for new therapeutic approaches will be presented. The project includes 12 universities, the Italian National Institute of Health, 5 scientific research and treatment institutes (IRCCS), 6 companies and a research foundation, and represents the first national network of scientists, technologists and young researchers who, with holistic and multidisciplinary approach, they share and develop knowledge, research and innovative technologies in order to bring the National Health System into the contemporary era of Precision Medicine. SIRM has a long-standing commitment to supporting IR education and making resources available to interventional radiologists. SIRM have played an important role in this framework by establishing high-quality standards in the training and practice of IRs throughout country. Several activities will be described to support IR residents throughout their careers and are regularly revised by IR experts to ensure that they reflect the most up-to-date techniques and technologies. A recent partnership with the National Olympic Committee at last 2022 SIRM Annual Meeting opened to a new form of collaboration between Italian radiology and the sports universe, showing the importance of diagnostic imaging not just in health but also in sports medicine.

#### Sub-Events

##### T7-RCP03C From Past to the Future: New Horizons for SIRM

Andrea Giovagnoni, MD (*Presenter*) Nothing to Disclose

##### T7-RCP03D "La Radiologia Medica" The SIRM Journal: A Success Story

Antonio Barile, MD (*Presenter*) Nothing to Disclose

##### T7-RCP03E NextGenerationEU: The National Plan of Recover and Resilience in Radiology

Carlo Catalano, MD (*Presenter*) Nothing to Disclose

##### T7-RCP03F Diversity, Equity, Inclusion: A New Project for Italian Radiologists

Stefania Montemezzi, MD (*Presenter*) Nothing to Disclose

**T7-RCP03G Disequality, Equity, Inclusion: A New Project for Italian Radiologists**

Nicoletta Gandolfo, MD (*Presenter*) Nothing to Disclose

**T7-RCP03H The Italian College of Interventional Radiology: Old Tradition for Next Generation**

Gianpaolo Carrafiello, PhD (*Presenter*) Nothing to Disclose

**T7-RCP03I Radiology at the Italian Winter Olympic Games 2026: A SIRM Project with the National Olympic Committee**

Ettore Squillaci, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP03C

### **From Past to the Future: New Horizons for SIRM**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Andrea Giovagnoni, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP03D

### **"La Radiologia Medica" The SIRM Journal: A Success Story**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Antonio Barile, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP03E

### **NextGenerationEU: The National Plan of Recover and Resilience in Radiology**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Carlo Catalano, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-RCP03F

### **Diversity, Equity, Inclusion: A New Project for Italian Radiologists**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Stefania Montemezzi, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP03G

### **Disequality, Equity, Inclusion: A New Project for Italian Radiologists**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Nicoletta Gandolfo, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP03H

### **The Italian College of Interventional Radiology: Old Tradition for Next Generation**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Gianpaolo Carrafiello, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP031

### **Radiology at the Italian Winter Olympic Games 2026: A SIRM Project with the National Olympic Committee**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E350

Ettore Squillaci, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP28

### Planning for Your Future: How to Minimize Taxes and Create Your Legacy

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S405

#### LEARNING OBJECTIVES

1) What you need for a solid estate plan. 2) How to save on taxes and be charitable at the same time. 3) Popular ways to leave a legacy at R&E Foundation.

#### COURSE DESCRIPTION

In today's uncertain economic environment, creating a solid estate plan can be a challenge. It can be difficult to determine how to manage your assets to save on taxes, protect your loved ones, and support the future of organizations important to you such as the R&E Foundation. Many RSNA members are motivated to "give back" to our field by making a legacy gift to R&E Foundation to help us support the next generation of radiologists. In addition to the comprehensive discussion outlined above, the session will include ample opportunity for Q&A at the end of the session.

#### Sub-Events

#### **T7-RCP28A Planning for Your Future: How to Minimize Taxes and Create Your Legacy**

Lynn M. Gaumer, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-RCP28A

### **Planning for Your Future: How to Minimize Taxes and Create Your Legacy**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S405

Lynn M. Gaumer, JD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CBR08

### Case-based Review of Breast Modalities

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406A

Maxine S. Jochelson, MD (*Moderator*) Speaker, General Electric Company

#### LEARNING OBJECTIVES

1) Identify the differences in accuracy when using pure anatomic imaging compared to anatomic imaging plus vascular imaging. 2) Demonstrate the best approach to interpreting DBT, US, CEM and breast MRI

#### COURSE DESCRIPTION

During this session, the three presenters Drs. Jochelson, Lewin and Bitencourt will lecture on various breast imaging modalities and show clinical examples of cases imaged by Digital Breast Tomosynthesis (DBT), Breast Ultrasound, Contrast Enhanced Mammography (CEM) and MRI to demonstrate interpretive pearls of wisdom, utility of these modalities and limitations of these modalities. This course is important as it will address the pros and cons of breast imaging using anatomic imaging technology vs vascular imaging as well as the best approaches to imaging in various clinical situations.

#### Sub-Events

##### T8-CBR08B Case Based Breast Review: Focus on CEM & MRI & US

Maxine S. Jochelson, MD (*Presenter*) Speaker, General Electric Company

##### T8-CBR08C Case Based Breast Review: Focus on CEM & MRI

John M. Lewin, MD (*Presenter*) Officer, Novian Health Inc

##### T8-CBR08D Case Based Breast Review: Focus on CEM & Mammography Including Tomosynthesis

Almir Bitencourt, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CBR08B

### Case Based Breast Review: Focus on CEM & MRI & US

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406A

Maxine S. Jochelson, MD (*Presenter*) Speaker, General Electric Company

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-CBR08C

### **Case Based Breast Review: Focus on CEM & MRI**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406A

John M. Lewin, MD (*Presenter*) Officer, Novian Health Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CBR08D

### **Case Based Breast Review: Focus on CEM & Mammography Including Tomosynthesis**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406A

Almir Bitencourt, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CCA06

### The Future is Here: Artificial Intelligence in Cardiovascular Imaging

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451A

Marly Van Assen, MSc, PhD (*Moderator*) Nothing to Disclose

Albert Hsiao, MD, PhD (*Moderator*) Co-founder, Arterys Inc;Shareholder, Arterys Inc;Co-founder, Vektor.AI;Shareholder, Vektor.AI;Research Grant, Bayer AG;Research Grant, General Electric Company;Research Grant, KA Imaging

#### LEARNING OBJECTIVES

1) Identify current opportunities for artificial intelligence (AI) to improve clinical workflows and diagnostic capabilities in cardiac imaging. 2) Apply foundational concepts necessary for evaluation of new AI technologies. 3) Recognize fields of interest for future AI development to improve diagnosis and management of cardiovascular disease.

#### COURSE DESCRIPTION

This course will provide practical examples of the daily application of artificial intelligence (AI) technologies to clinical practice of cardiac imaging, including cardiac MRI and CT. We will review the rapid advancement of new technologies that have become necessary components of every day practice and clinical workflows at several institutions, current data supporting their effectiveness, and opportunities ahead for AI and related technologies to improve the diagnosis and management of cardiovascular disease.

#### Sub-Events

##### T8-CCA06C AI in Cardiac MRI Pipeline: From Protocol to Classification

Albert Hsiao, MD, PhD (*Presenter*) Co-founder, Arterys Inc;Shareholder, Arterys Inc;Co-founder, Vektor.AI;Shareholder, Vektor.AI;Research Grant, Bayer AG;Research Grant, General Electric Company;Research Grant, KA Imaging

##### T8-CCA06D AI in Cardiac CT: Are We There Yet?

Damini Dey, PhD (*Presenter*) Nothing to Disclose

##### T8-CCA06E Gazing at the Crystal Ball: Risk Prediction With AI and Radiomics in Cardiac Imaging

Marly Van Assen, MSc, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CCA06C

### **AI in Cardiac MRI Pipeline: From Protocol to Classification**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451A

Albert Hsiao, MD, PhD (*Presenter*) Co-founder, Arterys Inc; Shareholder, Arterys Inc; Co-founder, Vektor.AI; Shareholder, Vektor.AI; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, KA Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CCA06D

### **AI in Cardiac CT: Are We There Yet?**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451A

Damini Dey, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CCA06E

### **Gazing at the Crystal Ball: Risk Prediction With AI and Radiomics in Cardiac Imaging**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451A

Marly Van Assen, MSc, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CER11

### Practical Multi-Energy CT in the ER

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451B

Savvas Nicolaou, MD, FRCPC (*Moderator*) Institutional research agreement, Siemens AG; Stockholder, Canada Diagnostic Centres

#### LEARNING OBJECTIVES

1) Demonstrate proficient understanding of multi-energy CT principles and technical aspects, enabling participants to effectively utilize this advanced imaging technique in emergency medicine. 2) Apply knowledge of multi-energy CT image interpretation and analysis to accurately diagnose and triage emergency conditions, resulting in improved patient care and optimized treatment planning. 3) Collaborate with radiologists and other healthcare professionals in a multidisciplinary approach, leveraging multi-energy CT findings to enhance decision-making, and facilitate seamless communication in emergency scenarios.

#### COURSE DESCRIPTION

**Course Description:** Join us for an engaging educational session on Practical Multi-Energy CT in the ER, where we delve into the powerful applications of this cutting-edge imaging technology in emergency medicine. This course is designed to equip healthcare professionals with the knowledge and skills to harness the full potential of multi-energy CT, enabling them to deliver enhanced patient care and expedite critical decision-making in emergency scenarios. Through a combination of dynamic lectures, interactive discussions, hands-on training, and case-based workshops, participants will gain a comprehensive understanding of multi-energy CT principles, technical aspects, and clinical applications. This course addresses the crucial need for accurate and efficient diagnostic imaging in the emergency room, providing valuable insights into the optimized use of multi-energy CT for prompt and precise diagnosis, treatment planning, and triage.

**Educational Format:**

- Engaging lectures led by renowned experts in the field of emergency radiology
- Interactive discussions and case-based workshops for collaborative learning
- Hands-on training sessions on multi-energy CT scanner operation and image acquisition optimization
- Utilization of advanced post-processing techniques and software tools through practical demonstrations
- Integration of real-life emergency scenarios for enhanced learning and skill application

**Expected Outcome:** By the end of this educational session, participants will have acquired a solid foundation in multi-energy CT imaging, enabling them to:

- o Understand the principles and technical aspects of multi-energy CT
- o Identify and differentiate energy levels for specific emergency conditions
- o Optimize image acquisition parameters for accurate diagnostic imaging
- o Interpret multi-energy CT images to facilitate prompt and precise diagnosis
- o Apply advanced post-processing techniques to enhance image analysis
- o Collaborate effectively with radiologists and other healthcare professionals in emergency management
- o Overcome challenges and limitations associated with multi-energy CT
- o Stay updated with the latest advancements in the field

**Course Structure and Subspecialties:**

- Module 1: Introduction to Multi-Energy CT in the Emergency Room
  - o Understanding the principles and physics of multi-energy CT
  - o Clinical advantages and applications of multi-energy CT in emergency medicine
  - o Role of multi-energy CT in trauma assessment and triage
- Module 2: Technical Aspects and Image Acquisition
  - o Multi-energy CT scanner technology and workflow
  - o Selection of appropriate energy levels and protocols for different emergency scenarios
  - o Optimization of image acquisition parameters
- Module 3: Image Interpretation and Diagnosis
  - o Evaluation and interpretation of multi-energy CT images in emergency cases
  - o Identification of acute pathologies and critical findings
  - o Case-based discussions and interactive sessions
- Module 4: Advanced Post-Processing Techniques
  - o Utilizing advanced post-processing tools for accurate image analysis
  - o Virtual monoenergetic imaging and material decomposition techniques
  - o 3D visualization and volume rendering in emergency medicine
- Module 5: Clinical Applications in Specific Emergency Subspecialties
  - o Multi-energy CT in neurologic emergencies
  - o Multi-energy CT in cardiovascular emergencies
  - o Multi-energy CT in abdominal and pelvic emergencies
  - o Multi-energy CT in musculoskeletal emergencies
  - o Multi-energy CT in pediatric emergencies
- Module 6: Hands-on Training and Workshop
  - o Practical training sessions on operating multi-energy CT scanners
  - o Hands-on experience with post-processing techniques and software tools
  - o Case simulations and interactive workshops to reinforce learning
- Module 7: Multidisciplinary Approach and Collaboration
  - o Effective communication and collaboration with radiologists and other healthcare professionals in emergency settings

#### Sub-Events

### T8-CER11B Photon Counting CT Introduction and Neuroradiology Applications

Michael D. Malinzak, MD, PhD (*Presenter*) Nothing to Disclose

### **T8-CER11C Oncological Applications**

Myrna C. Godoy, MD, PhD (*Presenter*) Siemens Healthineers Research Grant

### **T8-CER11D Acute Abdominal Emergencies**

Lakshmi Ananthakrishnan, MD (*Presenter*) Nothing to Disclose

### **T8-CER11E Musculoskeletal Emergent Applications**

Ismail T. Ali, MBBCh, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-CER11B

### **Photon Counting CT Introduction and Neuroradiology Applications**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451B

Michael D. Malinzak, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CER11C

### **Oncological Applications**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451B

Myrna C. Godoy, MD, PhD (*Presenter*) Siemens Healthineers Research Grant

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CER11D

### **Acute Abdominal Emergencies**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451B

Lakshmi Ananthkrishnan, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CER11E

### **Musculoskeletal Emergent Applications**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E451B

Ismail T. Ali, MBBCh, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CGI09

### GI Post-Operative Imaging

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450B

Lauren M. Burke, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the common GI surgical interventions. 2) Be able to identify typical post-surgical imaging findings and complications.

#### COURSE DESCRIPTION

This course is designed to be an “all you need to know” course that covers the typical post-surgical findings following common hepatic, pancreatic, bariatric and gastrointestinal surgeries. Topics will be discussed through a multimodality approach with CT, MR, US, and fluoroscopy findings highlighted throughout the session. With continued advances in surgical interventions and institutional variations in surgical technique, radiologists are expected to have a broad understanding of the post-surgical abdomen. Throughout the four didactic lectures, participants should be familiar with common gastrointestinal surgical interventions and the typical post-surgical findings and complications.

#### Sub-Events

##### T8-CGI09B Liver

So Yeon Kim, MD, PhD (*Presenter*) Nothing to Disclose

##### T8-CGI09C Whipple

Atif Zaheer, MD (*Presenter*) Nothing to Disclose

##### T8-CGI09D GI Track

Kristina T. Flicek, MD (*Presenter*) Nothing to Disclose

##### T8-CGI09E Bariatric Surgery

Lauren M. Burke, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CGI09B

### Liver

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450B

So Yeon Kim, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CGI09C

### **Whipple**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450B

Atif Zaheer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CGI09D

### GI Track

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450B

Kristina T. Flicek, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-CGI09E

### **Bariatric Surgery**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450B

Lauren M. Burke, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CHN06

### Head and Neck Cancer: Read Like the Experts and Tumor Board Discussion

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406B

Kristen L. Baugnon, MD (*Moderator*) Nothing to Disclose

Ashley H. Aiken, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review the key imaging findings in evaluation of head and neck cancer patients, including at staging, treatment response and surveillance time points. 2) Recognize the important imaging findings that impact clinical management of patients with head and neck cancer.

#### COURSE DESCRIPTION

In this "Best of" head and neck imaging session, attendees will hear short talks from experts focusing on the key information the multidisciplinary tumor board (surgeons, radiation oncologists and oncologists) needs to know from the imaging at diagnosis and follow-up of tumors in the head and neck. Speakers will emphasize imaging pearls and important clinical management considerations with which radiologists should be familiar. These talks will be followed by a case-based discussion by a panel of experts in a simulated tumor board session. Sample cases will be presented and discussed by radiologists, a head and neck cancer surgeon and a radiation oncologist. This session offers attendees a real world glimpse into how imaging interpretation impacts decision-making in the clinical management of head and neck cancer patients.

#### Sub-Events

##### T8-CHN06C Imaging of Sinonasal Tumors

Luke N. Ledbetter, MD (*Presenter*) Royalties, RELX

##### T8-CHN06D Imaging of Oropharyngeal Squamous Cell Carcinoma

Kristen L. Baugnon, MD (*Presenter*) Nothing to Disclose

##### T8-CHN06E Imaging of Squamous Cell Carcinoma of the Larynx

Hilda E. Stambuk, MD (*Presenter*) Nothing to Disclose

##### T8-CHN06F Post-Treatment Imaging: NI-RADS

Ashley H. Aiken, MD (*Presenter*) Nothing to Disclose

##### T8-CHN06G Tumor Board Case Discussion from the Surgeon's Perspective

Mihir R. Patel (*Presenter*) Nothing to Disclose

##### T8-CHN06H Tumor Board Case Discussion from the Radiation Oncologist's Perspective

Sue S. Yom, MD, PhD (*Presenter*) Research Grant, F. Hoffmann-La Roche Ltd; Research Grant, Merck & Co, Inc.; Research Grant, Bristol-Myers Squibb Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CHN06C

### **Imaging of Sinonasal Tumors**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406B

Luke N. Ledbetter, MD (*Presenter*) Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CHN06D

### **Imaging of Oropharyngeal Squamous Cell Carcinoma**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406B

Kristen L. Baugnon, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T8-CHN06E

### **Imaging of Squamous Cell Carcinoma of the Larynx**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406B

Hilda E. Stambuk, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CHN06F

### **Post-Treatment Imaging: NI-RADS**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406B

Ashley H. Aiken, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CHN06G

### **Tumor Board Case Discussion from the Surgeon's Perspective**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406B

Mihir R. Patel (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CHN06H

### **Tumor Board Case Discussion from the Radiation Oncologist's Perspective**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S406B

Sue S. Yom, MD, PhD (*Presenter*) Research Grant, F. Hoffmann-La Roche Ltd; Research Grant, Merck & Co, Inc; Research Grant, Bristol-Myers Squibb Company

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-CIN11

### **MIDRC: Using a Massive Multi-Institutional Open Imaging Data Commons for Machine Learning Research**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S401

Maryellen L. Giger, PhD (*Moderator*) Stockholder, Hologic, Inc;Royalties, Hologic, Inc;Shareholder, Quantitative Insights, Inc;Co-founder, Quantitative Insights, Inc;Shareholder, QView Medical, Inc;Royalties, General Electric Company;Royalties, Median Technologies;Royalties, Riverain Technologies, LLC  
Curtis P. Langlotz, MD, PhD (*Moderator*) Stockholder, whiterabbit.ai;Advisor, whiterabbit.ai;Stockholder, Galileo CDS, Inc;Advisor, Galileo CDS, Inc;Stockholder, Bunker Hill, Inc;Board of Directors, Bunker Hill, Inc;Stockholder, Sirona Medical, Inc;Advisor, Sirona Medical, Inc

#### **LEARNING OBJECTIVES**

1) Become familiar with MIDRC, including how to contribute and how to use its open medical imaging data. 2) Understand the need for appropriate data curation processes and annotation in order to train and test AI algorithms. 3) Realize the potential for biases in AI systems and means with which to mitigate them. 4) Understand the benefit of a sequestered imaging data commons in effectively and efficiently enabling translation of AI algorithms through regulatory for public health.

#### **COURSE DESCRIPTION**

This course will describe the Medical Imaging and Data Resource Center (<https://www.midrc.org/>), the first and only national COVID-19 image repository in the United States, which has collected over 300,000 studies from dozens of sites around the country. MIDRC is a collaborative project between the Radiological Society of North America (RSNA), the American College of Radiology (ACR), and the American Association of Physicists in Medicine (AAPM), funded by the National Institute of Biomedical Imaging and Bioengineering (NIBIB). Its underlying technology can support repositories for other diseases. We will describe how you can use its open medical data, and how to contribute new data. We will discuss the challenges and opportunities presented by such a national imaging research repository and review its role in supporting machine learning research.

#### **Sub-Events**

##### **T8-CIN11C Introduction**

Maryellen L. Giger, PhD (*Presenter*) Stockholder, Hologic, Inc;Royalties, Hologic, Inc;Shareholder, Quantitative Insights, Inc;Co-founder, Quantitative Insights, Inc;Shareholder, QView Medical, Inc;Royalties, General Electric Company;Royalties, Median Technologies;Royalties, Riverain Technologies, LLC

##### **T8-CIN11D MIDRC Overview and Long COVID**

Curtis P. Langlotz, MD, PhD (*Presenter*) Stockholder, whiterabbit.ai;Advisor, whiterabbit.ai;Stockholder, Galileo CDS, Inc;Advisor, Galileo CDS, Inc;Stockholder, Bunker Hill, Inc;Board of Directors, Bunker Hill, Inc;Stockholder, Sirona Medical, Inc;Advisor, Sirona Medical, Inc

##### **T8-CIN11E Contributing Data, MIDRC as a Data Source, Cohort Building, and Annotations**

Carol C. Wu, MD (*Presenter*) Nothing to Disclose

##### **T8-CIN11F Algorithmic Approaches to Reduce Bias**

Akshay Chaudhari, PhD (*Presenter*) Research support, General Electric Company;Research support, Koninklijke Philips NV;Research Consultant, Subtle Medical, Inc

##### **T8-CIN11G Multi-Omics Research Through Interoperability as a User**

Heather M. Whitney, PhD (*Presenter*) Nothing to Disclose

## Abstract Archives of the RSNA, 2023

T8-CIN11C

### Introduction

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S401

Maryellen L. Giger, PhD (*Presenter*) Stockholder, Hologic, Inc;Royalties, Hologic, Inc;Shareholder, Quantitative Insights, Inc;Co-founder, Quantitative Insights, Inc;Shareholder, QView Medical, Inc;Royalties, General Electric Company;Royalties, Median Technologies;Royalties, Riverain Technologies, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CIN11D

### **MIDRC Overview and Long COVID**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S401

Curtis P. Langlotz, MD, PhD (*Presenter*) Stockholder, whiterabbit.ai;Advisor, whiterabbit.ai;Stockholder, Galileo CDS, Inc;Advisor, Galileo CDS, Inc;Stockholder, Bunker Hill, Inc;Board of Directors, Bunker Hill, Inc;Stockholder, Sirona Medical, Inc;Advisor, Sirona Medical, Inc

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## Abstract Archives of the RSNA, 2023

T8-CIN11E

### **Contributing Data, MIDRC as a Data Source, Cohort Building, and Annotations**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S401

Carol C. Wu, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CIN11F

### **Algorithmic Approaches to Reduce Bias**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S401

Akshay Chaudhari, PhD (*Presenter*) Research support, General Electric Company; Research support, Koninklijke Philips NV; Research Consultant, Subtle Medical, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CIN11G

### **Multi-Omics Research Through Interoperability as a User**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S401

Heather M. Whitney, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CIR08

### Interventional Radiology Residency

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353B

Anne M. Covey, MD (*Moderator*) Stockholder, Amgen Inc

#### LEARNING OBJECTIVES

1) Review the current options to obtain IR/DR certification. 2) Understand controversies in the ESIR pathway, the potential merits of additional post-residency training options, and the T32 pathway for research during residency.

#### COURSE DESCRIPTION

IR/DR became a primary specialty in 2012 and there are several options for candidates to achieve ABR certification. The purpose of this course is to provide an update on the status of the IR/DR training pathways and highlight current challenges and opportunities.

#### Sub-Events

##### **T8-CIR08B 6 Years of IR Residency - Where do we stand?**

John A. Kaufman, MD (*Presenter*) Consultant, Argon Medical Devices, Inc; Consultant, OptiMed Technologies, Inc; Consultant, Shape Medical Systems, Inc; Co-owner, AUXETICS, INC; Co-owner, Hatch Medical LLC; Co-owner, VuMedi, Inc; Co-owner, EndoShape, Inc; Research Grant, Cook Group Incorporated; Royalties, Reed Elsevier; Editor, Reed Elsevier ; ;

##### **T8-CIR08C ESIR and the Independent IR Residency - The Case Against**

Douglas D. Silin, MD (*Presenter*) Nothing to Disclose

##### **T8-CIR08D ESIR and the Independent IR Residency - The Case In Favor**

Jennifer E. Gould, MD (*Presenter*) Spouse, Consultant, Entellus Medical, Inc; Spouse, Speaker, Entellus Medical, Inc; Spouse, Researcher, Entellus Medical, Inc; Spouse, Investor, Frontenac Surgery Center; Spouse, Investor, Twin Cities Surgery Center; Royalties, Reed Elsevier

##### **T8-CIR08E Getting Certified in IR by the ABR**

Anne M. Covey, MD (*Presenter*) Stockholder, Amgen Inc

##### **T8-CIR08F A Case for the IO Fellowship**

Michael C. Soulen, MD (*Presenter*) Consultant, F. Hoffmann-La Roche Ltd; Consultant, Guerbet SA; Consultant, AstraZeneca PLC; Research support, Guerbet SA; Research support, Sirtex Medical Ltd; Research support, Pfizer Inc

##### **T8-CIR08G T32 Track and Research during IR Residency - Challenges and Opportunities**

Terence P. Gade, MD, PhD (*Presenter*) Scientific Advisory Board, TriSalus Life Sciences; Research Consultant, Instylla, Inc; Research Grant, Instylla, Inc

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## Abstract Archives of the RSNA, 2023

T8-CIR08B

### 6 Years of IR Residency - Where do we stand?

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353B

John A. Kaufman, MD (*Presenter*) Consultant, Argon Medical Devices, Inc;Consultant, OptiMed Technologies, Inc;Consultant, Shape Medical Systems, Inc;Co-owner, AUXETICS, INC;Co-owner, Hatch Medical LLC;Co-owner, VuMedi, Inc;Co-owner, EndoShape, Inc;Research Grant, Cook Group Incorporated;Royalties, Reed Elsevier;Editor, Reed Elsevier ;;

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## Abstract Archives of the RSNA, 2023

T8-CIR08C

### **ESIR and the Independent IR Residency - The Case Against**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353B

Douglas D. Silin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CIR08D

### **ESIR and the Independent IR Residency - The Case In Favor**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353B

Jennifer E. Gould, MD (*Presenter*) Spouse, Consultant, Entellus Medical, Inc; Spouse, Speaker, Entellus Medical, Inc; Spouse, Researcher, Entellus Medical, Inc; Spouse, Investor, Frontenac Surgery Center; Spouse, Investor, Twin Cities Surgery Center; Royalties, Reed Elsevier

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## Abstract Archives of the RSNA, 2023

T8-CIR08E

### Getting Certified in IR by the ABR

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353B

Anne M. Covey, MD (*Presenter*) Stockholder, Amgen Inc

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## Abstract Archives of the RSNA, 2023

T8-CIR08F

### **A Case for the IO Fellowship**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353B

Michael C. Soulen, MD (*Presenter*) Consultant, F. Hoffmann-La Roche Ltd;Consultant, Guerbet SA;Consultant, AstraZeneca PLC;Research support, Guerbet SA;Research support, Sirtex Medical Ltd;Research support, Pfizer Inc

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## Abstract Archives of the RSNA, 2023

T8-CIR08G

### **T32 Track and Research during IR Residency - Challenges and Opportunities**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353B

Terence P. Gade, MD, PhD (*Presenter*) Scientific Advisory Board, TriSalus Life Sciences; Research Consultant, Instylla, Inc; Research Grant, Instylla, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMK06

### **Ankle: The Common, Uncommon and Easily Overlooked**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450A

Reto Sutter, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Identify common abnormalities and normal variants of ankle imaging. 2) Describe easily overlooked features of ankle pathologies and how to recognize them on imaging.

#### **COURSE DESCRIPTION**

Imaging the ankle can be easy and difficult at the same time. Some pathologies are very common and are easily recognized, while others are uncommon or easily overlooked. This course will shine spotlights on various aspects of ankle imaging, including common abnormalities and normal variants as well as less common and easily overlooked pathologies that are important to keep in mind and should not be missed.

#### **Sub-Events**

##### **T8-CMK06B Disease Mimickers and Variants**

Reto Sutter, MD (*Presenter*) Nothing to Disclose

##### **T8-CMK06C Manifestations of Arthritis**

Girish Gandikota, MD (*Presenter*) Nothing to Disclose

##### **T8-CMK06D Nerve Entrapment of the Foot**

Anne Cotten, MD (*Presenter*) Nothing to Disclose

##### **T8-CMK06E Chopart and Lisfranc Joint**

Jenny T. Bencardino, MD (*Presenter*) Nothing to Disclose

##### **T8-CMK06F Ultrasound**

Luca Maria Sconfienza, MD, PhD (*Presenter*) Travel support, Bracco Group; Travel support, Esaote SpA; Speakers Bureau, Esaote SpA; Travel support, ABIOMED PHARMA SpA; Speakers Bureau, P&R Holding; Speakers Bureau, Pfizer Inc ; Speaker, Novartis AG; Speaker, Merck KGaA; Speaker, MSD

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## Abstract Archives of the RSNA, 2023

T8-CMK06B

### **Disease Mimickers and Variants**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450A

Reto Sutter, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMK06C

### **Manifestations of Arthritis**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450A

Girish Gandikota, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-CMK06D

### **Nerve Entrapment of the Foot**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450A

Anne Cotten, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMK06E

### **Chopart and Lisfranc Joint**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450A

Jenny T. Bencardino, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMK06F

### Ultrasound

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E450A

Luca Maria Sconfienza, MD, PhD (*Presenter*) Travel support, Bracco Group; Travel support, Esaote SpA; Speakers Bureau, Esaote SpA; Travel support, ABIOMED PHARMA SpA; Speakers Bureau, P&R Holding; Speakers Bureau, Pfizer Inc ; Speaker, Novartis AG; Speaker, Merck KGaA; Speaker, MSD

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMS08

### **Infection Induced Tumors and Tumorlike Conditions Multimodality Imaging and Complications**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N229

Vincent M. Mellnick, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Discuss the increased risk of cancer in transplant patients. 2) Review infection-induced malignancies in the chest, abdomen, and pelvis. 3) Discuss the spectrum of imaging appearances of post-transplant lymphoproliferative disease in the abdomen/pelvis. 4) Review common tumor mimics in the abdomen and pelvis.

#### **COURSE DESCRIPTION**

Lecturers discuss infection-induced malignancies infectious and malignant complications after transplant, and tumor mimics in body imaging using illustrative cases and teaching points.

#### **Sub-Events**

##### **T8-CMS08B Infection Induced Malignancy in Abdomen**

Vincent M. Mellnick, MD (*Presenter*) Nothing to Disclose

##### **T8-CMS08C Infection induced Malignancy after Transplant**

Meghan G. Lubner, MD (*Presenter*) Spouse, Consultant, Elephas Bio

##### **T8-CMS08D Chest/Cardiac Infection induced Malignancies**

Jonathan Revels, DO (*Presenter*) Nothing to Disclose

##### **T8-CMS08E Viral and Bacterial Induced Malignancies: Multimodality Imaging Spectrum**

Venkata S. Katabathina, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMS08B

### **Infection Induced Malignancy in Abdomen**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N229

Vincent M. Mellnick, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMS08C

### **Infection induced Malignancy after Transplant**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N229

Meghan G. Lubner, MD (*Presenter*) Spouse, Consultant, Elephas Bio

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T8-CMS08D

### **Chest/Cardiac Infection induced Malignancies**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N229

Jonathan Revels, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CMS08E

### **Viral and Bacterial Induced Malignancies: Multimodality Imaging Spectrum**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N229

Venkata S. Katabathina, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-CNPM08

### **Nuts and Bolts: Essentials of Building a Radiology Learning Healthcare System (Sponsored by the RSNA Research Development Committee)**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E350

Jeffrey G. Jarvik, MD, MPH (*Moderator*) Royalties, Mannheim Media;Co-editor, Mannheim Media;Travel support, General Electric Company;Author with royalties, Wolters Kluwer nv  
Marta E. Heilbrun, MD, MS (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Review fundamentals of learning healthcare systems and special considerations for radiology. 2) Discuss the strengths and limitations of leveraging your organizational electronic medical record for clinical operational quality improvement initiatives and clinical research studies. 3) Introduce the concept of culture as learning healthcare system infrastructure and why buy-in from teams and key stakeholders is critical for successful implementation.

#### **COURSE DESCRIPTION**

Radiologists have little exposure to the ideas that are fundamental to learning healthcare systems (LHS). This course will introduce radiologists to key concepts underlying LHS, and explain why LHS are important to radiologists and their health systems, clinicians, patients, and researchers. We will focus on special considerations for radiology LHS. We will focus on leveraging the electronic medical record and why addressing the culture of the system, by getting a commitment from teams and individuals to integrate the LHS framework into routine care processes, is important.

#### **Sub-Events**

##### **T8-CNPM08C Fundamentals of Learning Health Systems: Special Considerations for Radiology**

Elizabeth S. Burnside, MD, MPH (*Presenter*) Research Grant, Hologic, Inc

##### **T8-CNPM08D Leveraging Your Organizational Electronic Medical Record**

Sean D. Mooney, PhD (*Presenter*) Nothing to Disclose

##### **T8-CNPM08E Culture as Learning Health System Infrastructure**

Alexandra Vinson, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CNPM08C

### **Fundamentals of Learning Health Systems: Special Considerations for Radiology**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E350

Elizabeth S. Burnside, MD, MPH (*Presenter*) Research Grant, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CNPM08D

### Leveraging Your Organizational Electronic Medical Record

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E350

Sean D. Mooney, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CNPM08E

### **Culture as Learning Health System Infrastructure**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E350

Alexandra Vinson, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CPD03

### Is It A Tumor? Pediatric Body and Skeletal Neoplasms Made Easy

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N228

Lisa J. States, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) List the common and uncommon solid and cystic focal liver lesions that occur in children. 2) Recognize the key imaging features that enable differentiation of pediatric gynecological tumors. 3) Identify imaging features of pediatric bone lesions requiring biopsy.

#### COURSE DESCRIPTION

This lecture-based session will provide learners with an in depth understanding of the differential diagnosis of tumors that occur in children with a focus on lesions found in the liver, pediatric female pelvis, and bones. Updates in diagnostic tools, protocols and techniques will be provided for each topic. After this session, the participant will be able to formulate a focused differential and recommend an approach to diagnosis, as well as be able to update current protocols to create a state-of-the-art practice for pediatric patients.

#### Sub-Events

##### T8-CPD03B Diagnosing Pediatric Liver Lesions: Role of MRI in Problem-solving

Jonathan R. Dillman, MD, MSc (*Presenter*) Research Grant, Perspectum Ltd; Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation; Research support, Koninklijke Philips NV; Research support, General Electric Company; Research support, Motilent Ltd

##### T8-CPD03C Marbles in the Belly: Spectrum of Gynecologic Tumors in the Pediatric Population

Domen Plut, MD (*Presenter*) Nothing to Disclose

##### T8-CPD03D Bone Tumors of the Child: When Tumor is the Rumor, Tissue is the Issue

Randheer Shailam, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CPD03B

### **Diagnosing Pediatric Liver Lesions: Role of MRI in Problem-solving**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N228

Jonathan R. Dillman, MD, MSc (*Presenter*) Research Grant, Perspectum Ltd; Research Grant, Siemens AG; Research Grant, Canon Medical Systems Corporation; Research support, Koninklijke Philips NV; Research support, General Electric Company; Research support, Motilent Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CPD03C

### **Marbles in the Belly: Spectrum of Gynecologic Tumors in the Pediatric Population**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N228

Domen Plut, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CPD03D

### **Bone Tumors of the Child: When Tumor is the Rumor, Tissue is the Issue**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N228

Randheer Shailam, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-CPH05

### Virtual Clinical Trial

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S404

Ehsan Samei, PHD (*Moderator*) Research Grant, General Electric Company; Advisory Board, General Electric Company; Research Grant, Siemens AG; Advisory Board, Siemens AG; Advisory Board, medInt Holdings, LLC; Advisory Board, Metis Health Analytics; Research Consultant, Nanox Imaging Ltd; Royalties, General Electric Company; Royalties, medInt Holdings, LLC; Royalties, 12 Sigma Technologies; Royalties, Mirion Technologies, Inc; Royalties, Cambridge University Press; Royalties, John Wiley & Sons, Inc

#### LEARNING OBJECTIVES

- 1) Understand the role of virtual trials in medicine and in radiology.
- 2) Understand the components of virtual imaging trials.
- 3) Understand the research, clinical, and regulatory potentials of virtual trials.

#### COURSE DESCRIPTION

The complexity and diversity of medical imaging technologies have continued to accelerate, outpacing our ability to optimize their use. This has become a significant challenge across the spectra of scientific inquiries, product designs, and clinical applications. New imaging technology has been traditionally evaluated through clinical trials. However, such trials are often not feasible or even definitive due to ethical limitations, expense, time requirements, difficulty in accruing enough subjects - especially with low prevalence conditions, or the fundamental lack of ground truth. Virtual Clinical Trials (VCT) provide a new paradigm to assess the impact of medical imaging innovations on patient care. VCTs offer a new disease-known approach to conduct medical trials that can be clinically relevant, timely, and accurate while reflecting the variabilities of human subjects and disease, as well as the complexities of technologies, providing answers that would otherwise be impractical to obtain or simply unattainable. A VCT consists of 1) realistic populations of computational patients spanning ages and a range of phenotypical characteristics including sex and race with realistic models of disease, 2) detailed models of clinical imaging systems, and 3) computational models of the image interpretation processes. This session offers a summary of VCT methods and processes in the field of radiology and highlights applications in clinical practice and in the regulatory assessment of imaging products.

#### Sub-Events

##### T8-CPH05B VCT in Service of Clinical Practice

Hilde Bosmans, PhD (*Presenter*) Stockholder, Qaelum NV; Research Grant, Siemens AG; Research Grant, General Electric Company

##### T8-CPH05C VCT in Service of Device Assessment

Aldo Badano, PhD (*Presenter*) Research Grant, Barco nv

##### T8-CPH05D VCT and Its Role in Radiology

Ehsan Samei, PHD (*Presenter*) Research Grant, General Electric Company; Advisory Board, General Electric Company; Research Grant, Siemens AG; Advisory Board, Siemens AG; Advisory Board, medInt Holdings, LLC; Advisory Board, Metis Health Analytics; Research Consultant, Nanox Imaging Ltd; Royalties, General Electric Company; Royalties, medInt Holdings, LLC; Royalties, 12 Sigma Technologies; Royalties, Mirion Technologies, Inc; Royalties, Cambridge University Press; Royalties, John Wiley & Sons, Inc

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## Abstract Archives of the RSNA, 2023

T8-CPH05B

### **VCT in Service of Clinical Practice**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S404

Hilde Bosmans, PhD (*Presenter*) Stockholder, Qaelum NV; Research Grant, Siemens AG; Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CPH05C

### **VCT in Service of Device Assessment**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S404

Aldo Badano, PhD (*Presenter*) Research Grant, Barco nv

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CPH05D

### **VCT and Its Role in Radiology**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S404

Ehsan Samei, PHD (*Presenter*) Research Grant, General Electric Company; Advisory Board, General Electric Company; Research Grant, Siemens AG; Advisory Board, Siemens AG; Advisory Board, medInt Holdings, LLC; Advisory Board, Metis Health Analytics; Research Consultant, Nanox Imaging Ltd; Royalties, General Electric Company; Royalties, medInt Holdings, LLC; Royalties, 12 Sigma Technologies; Royalties, Mirion Technologies, Inc; Royalties, Cambridge University Press; Royalties, John Wiley & Sons, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CRO01

### **Pancreatic Cancer Case Based Multidisciplinary Review**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S402

Ann Raldow, MD, MPH (*Moderator*) Consultant, ViewRay, Inc

#### **LEARNING OBJECTIVES**

1) Expose the attendees to multidisciplinary discussion when treating pancreatic cancer. 2) Demonstrate specific imaging findings that directly affect staging and treatment decisions. 3) Provide the audience with specific information they should include in their reports that directly affect prognosis and management.

#### **COURSE DESCRIPTION**

This comprehensive course aims to provide attendees with a multidisciplinary understanding of pancreatic cancer diagnosis and management. Through interactive discussions, expert opinions, and case studies, participants will gain valuable insights into the integration of various disciplines in the treatment of this challenging disease. The course will focus on the critical role of imaging findings, their impact on staging and treatment decisions, and the specific information that should be included in reports to guide management.

#### **Sub-Events**

##### **T8-CRO01B Pancreatic Cancer Case Based Multidisciplinary Review**

Katelyn Atkins, MD, PhD (*Presenter*) Nothing to Disclose

##### **T8-CRO01C Pancreatic Cancer Case Based Multidisciplinary Review**

Daniel A. King, MD, PhD (*Presenter*) Nothing to Disclose

##### **T8-CRO01D Pancreatic Cancer Case Based Multidisciplinary Review**

Spencer C. Behr, MD (*Presenter*) Grant, Cancer Targeted Technology;Scientific Advisory Board, Novartis AG;Research Consultant, GenVivo

##### **T8-CRO01E Pancreatic Cancer Case Based Multidisciplinary Review**

Danielle DePeralta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

T8-CRO01B

### **Pancreatic Cancer Case Based Multidisciplinary Review**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S402

Katelyn Atkins, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CRO01C

### **Pancreatic Cancer Case Based Multidisciplinary Review**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S402

Daniel A. King, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-CRO01D

### **Pancreatic Cancer Case Based Multidisciplinary Review**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S402

Spencer C. Behr, MD (*Presenter*) Grant, Cancer Targeted Technology;Scientific Advisory Board, Novartis AG;Research Consultant, GenVivo

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

T8-CRO01E

### **Pancreatic Cancer Case Based Multidisciplinary Review**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: S402

Danielle DePeralta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-RCP27

### **Vice Chair of DEI? What does that Mean? (Sponsored by the RSNA Committee on Diversity, Equity and Inclusion)**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E351

Jinel A. Scott, MD (*Moderator*) Nothing to Disclose  
Maureen P. Kohi, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Discuss selection criteria for DEI leaders. 2) Share strategies for Departmental and Institutional Support. 3) Discuss metrics to assess the success and impact of your DEI leader and program. 4) Share early experiences of DEI leaders.

#### **COURSE DESCRIPTION**

As the position of Vice Chair of DEI is a relatively new position in leadership of Radiology Departments, the session will offer information and guidance on how to craft this position to reflect the needs of your individual Departments.

#### **Sub-Events**

##### **T8-RCP27C Selection Criteria for DEI Vice Chair/Director**

Reed A. Omary, MD, MS (*Presenter*) Nothing to Disclose

##### **T8-RCP27D Key Metrics (What Does Success Look Like?)**

Marques L. Bradshaw, MD, MS (*Presenter*) Nothing to Disclose

##### **T8-RCP27E Early Experiences of DEI Vice Chairs (What Works, What Doesn't?)**

Gloria M. Salazar, MD (*Presenter*) Consultant, Speakers Bureau, Medtronic plc; Consultant, Boston Scientific Corporation; Speakers Bureau, Boston Scientific Corporation; Speakers Bureau, Cook Group Incorporated; Consultant, Avail Medsystems, Inc; Consultant, Mentice AB

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-RCP27C

### **Selection Criteria for DEI Vice Chair/Director**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E351

Reed A. Omary, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-RCP27D

### **Key Metrics (What Does Success Look Like?)**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E351

Marques L. Bradshaw, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-RCP27E

### Early Experiences of DEI Vice Chairs (What Works, What Doesn't?)

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E351

Gloria M. Salazar, MD (*Presenter*) Consultant, Speakers Bureau, Medtronic plc; Consultant, Boston Scientific Corporation; Speakers Bureau, Boston Scientific Corporation; Speakers Bureau, Cook Group Incorporated; Consultant, Avail Medsystems, Inc; Consultant, Mentice AB

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CBR09

### Management of Elevated Risk Breast Lesions

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406A

Sarah J. Vinnicombe, FRCR, MRCP (*Moderator*) Consultant, Bayer AG

#### LEARNING OBJECTIVES

1) Gain an understanding of the nature of high risk breast lesions. 2) Appreciate the differing strategies to manage these lesions from an international perspective.

#### COURSE DESCRIPTION

This course will review the management of high risk breast lesions, which are diagnosed through breast core needle biopsy. High risk lesions are a heterogeneous group of pathologies which, while not malignant, are associated with malignancy, either synchronous or metachronous. This series of three lectures will discuss the challenges in diagnosing these lesions and the differing management approaches in the USA and Europe.

#### Sub-Events

#### W1-CBR09B Management of Elevated Risk Breast Lesions: Lessons Learned from Pathology

Husain Sattar, MD, BA (*Presenter*) Nothing to Disclose

#### W1-CBR09C Management of Elevated Risk Breast Lesions: European View

Sarah J. Vinnicombe, FRCR, MRCP (*Presenter*) Consultant, Bayer AG

#### W1-CBR09D Management of Elevated Risk Breast Lesions: USA View

Peter R. Eby, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CBR09B

### **Management of Elevated Risk Breast Lesions: Lessons Learned from Pathology**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406A

Husain Sattar, MD, BA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CBR09C

### **Management of Elevated Risk Breast Lesions: European View**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406A

Sarah J. Vinnicombe, FRCR, MRCP (*Presenter*) Consultant, Bayer AG

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W1-CBR09D

### **Management of Elevated Risk Breast Lesions: USA View**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406A

Peter R. Eby, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CCA08

### Cardiac Imaging in Private Practice: Maximizing Efficiency with Quality

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353C

Amar B. Shah, MD, MA (*Moderator*) Nothing to Disclose  
Michael F. Morris, MD (*Moderator*) Educator, Medtronic plc

#### LEARNING OBJECTIVES

1) Understand how CT protocols can drive output. 2) Explore how blending imaging modalities in cardiovascular imaging can provide customized and optimized care to the patient. 3) Discuss the role of a 3D Lab can solve imaging problems.

#### COURSE DESCRIPTION

As the utilization of Cardiac CTA increase, imagers are challenged to expand services while maintaining a high standard of image quality, accuracy and identify the ideal use of the technology to optimize patient care. The speakers in the session will review imaging protocol tips, the role of complementary imaging modalities and how technology processing teams and labs can support a program and drive quality care.

#### Sub-Events

##### W1-CCA08C Efficient Cardiac CT Protocols for High Throughput

Brian B. Ghoshhajra, MD, MBA (*Presenter*) Research Grant, Siemens AG; Consultant, Koninklijke Philips NV; Consultant, Siemens AG

##### W1-CCA08D Multimodality and Multidisciplinary Imaging Practice: The Secret to High Quality Care

Joao Cavalcante, MD (*Presenter*) Nothing to Disclose

##### W1-CCA08E Virtual or Live 3D Lab: The Solution to all Your Problems

Michael F. Morris, MD (*Presenter*) Educator, Medtronic plc

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## Abstract Archives of the RSNA, 2023

W1-CCA08C

### Efficient Cardiac CT Protocols for High Throughput

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353C

Brian B. Ghoshhajra, MD, MBA (*Presenter*) Research Grant, Siemens AG; Consultant, Koninklijke Philips NV; Consultant, Siemens AG

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## Abstract Archives of the RSNA, 2023

W1-CCA08D

### **Multimodality and Multidisciplinary Imaging Practice: The Secret to High Quality Care**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353C

Joao Cavalcante, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CCA08E

### **Virtual or Live 3D Lab: The Solution to all Your Problems**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353C

Michael F. Morris, MD (*Presenter*) Educator, Medtronic plc

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## Abstract Archives of the RSNA, 2023

W1-CCH07

### Understanding Thoracic AI/Radiomics: Where Are We and Where We Are Going?

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S404

Carol C. Wu, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Compare and contrast artificial intelligence (AI) and machine learning strategies used in thoracic imaging. 2) Interpret radiomics research trial outcomes. 3) Explain the benefits and pitfalls of applications of AI in thoracic imaging.

#### COURSE DESCRIPTION

Artificial intelligence (AI) and radiomics are increasingly used in thoracic imaging research and clinical practice. This session aims to provide attendees a basic understanding of these tools and their applications in thoracic imaging. The knowledge should facilitate appropriate interpretation and utilization of the results generated by these techniques.

#### Sub-Events

##### W1-CCH07BAI, Machine Learning and the Rest: A Guide for All of Us

Chi Wan Koo, MD (*Presenter*) Nothing to Disclose

##### W1-CCH07C Understanding Radiomics and Trial Outcomes

Anastasia Oikonomou, MD, PhD (*Presenter*) Nothing to Disclose

##### W1-CCH07D Pragmatic Thoracic AI/Data Science Implementations and the Near Future

Carol C. Wu, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CCH07B

### **AI, Machine Learning and the Rest: A Guide for All of Us**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S404

Chi Wan Koo, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CCH07C

### Understanding Radiomics and Trial Outcomes

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S404

Anastasia Oikonomou, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W1-CCH07D

### **Pragmatic Thoracic AI/Data Science Implementations and the Near Future**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S404

Carol C. Wu, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CER04

### Non-Traumatic Thoracic Emergencies

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E451B

Felipe Munera, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W1-CER04B Acute PE: Becoming a Pro on Call**

Sanjeev Bhalla, MD (*Presenter*) Advisory Board, Precisa Gravimetrics AG

#### **W1-CER04C Ascending Order: Making Sense of the Type of Aortic Dissections and Variants**

Felipe Munera, MD (*Presenter*) Nothing to Disclose

#### **W1-CER04D Challenges for the Radiologist in the Emergency Room: The Heart and its Vessels**

Monique Brink, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CER04B

### **Acute PE: Becoming a Pro on Call**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E451B

Sanjeev Bhalla, MD (*Presenter*) Advisory Board, Precisa Gravimetrics AG

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## Abstract Archives of the RSNA, 2023

W1-CER04C

### **Ascending Order: Making Sense of the Type of Aortic Dissections and Variants**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E451B

Felipe Munera, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CER04D

### **Challenges for the Radiologist in the Emergency Room: The Heart and its Vessels**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E451B

Monique Brink, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CGI10

### Essentials of GI Imaging

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N228

Courtney C. Moreno, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify common and uncommon imaging findings in patients with biliary disease, diverticulitis, and small bowel obstruction. 2) Review the imaging appearance of liver lesions in non-cirrhotic patients. 3) Describe fluoroscopic imaging techniques.

#### COURSE DESCRIPTION

This session will include lectures describing imaging findings in patients with biliary disease, diverticulitis, and small bowel obstruction. The imaging appearances of liver lesions in non-cirrhotic patients will be reviewed. Gastrointestinal fluoroscopic techniques will also be discussed.

#### Sub-Events

##### W1-CGI10B Biliary Imaging

Courtney C. Moreno, MD (*Presenter*) Nothing to Disclose

##### W1-CGI10C Diverticulitis

Mark D. Sugi, MD (*Presenter*) Consultant, Nextrast, Inc; Author with royalties, RELX

##### W1-CGI10D Liver Lesions in Noncirrhotic Patients

Silvia D. Chang, MD, FRCPC (*Presenter*) Nothing to Disclose

##### W1-CGI10E Fluoroscopic Imaging

David J. DiSantis, MD (*Presenter*) Nothing to Disclose

##### W1-CGI10F Small Bowel Obstruction Including Internal Hernia

Anil K. Dasyam, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CGI10B

### **Biliary Imaging**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N228

Courtney C. Moreno, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CGI10C

### **Diverticulitis**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N228

Mark D. Sugi, MD (*Presenter*) Consultant, Nextrast, Inc; Author with royalties, RELX

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W1-CGI10D

### **Liver Lesions in Noncirrhotic Patients**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N228

Silvia D. Chang, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CGI10E

### Fluoroscopic Imaging

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N228

David J. DiSantis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CGI10F

### Small Bowel Obstruction Including Internal Hernia

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N228

Anil K. Dasyam, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CGU04

### Case-Based Audience Participation Peer-Learning

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353B

Priyanka Jha, MBBS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Learn hard-to-diagnose or interesting misdiagnosed GU-related disease from emergency to oncology.

#### COURSE DESCRIPTION

This course is a case-based learning session focusing on GU-cases that are difficult to diagnose or easily missed. There will be cases of renal masses, prostate, bladder and upper urinary tract, adrenal glands, and GU emergencies. All presentations will encourage audience participation, and pearls will be presented after each case. This course is designed for all levels, including trainees and attendings.

#### Sub-Events

##### **W1- CGU04B Renal Masses**

Priyanka Jha, MBBS (*Presenter*) Nothing to Disclose

##### **W1- CGU04C Prostate Case**

Angela Tong, MD (*Presenter*) Equipment support, Siemens AG

##### **W1- CGU04D Bladder and Upper Tract Pathology**

Kristen Olinger, MD (*Presenter*) Nothing to Disclose

##### **W1-CGU04E Adrenal Gland Case**

Anugayathri Jawahar, MD (*Presenter*) Nothing to Disclose

##### **W1-CGU04F GU Emergency**

Priyanka Jha, MBBS (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CGU04B

### Renal Masses

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353B

Priyanka Jha, MBBS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CGU04C

### Prostate Case

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353B

Angela Tong, MD (*Presenter*) Equipment support, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CGU04D

### Bladder and Upper Tract Pathology

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353B

Kristen Olinger, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CGU04E

### Adrenal Gland Case

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353B

Anugayathri Jawahar, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W1-CGU04F

### **GU Emergency**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E353B

Priyanka Jha, MBBS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CIN03

### Structured Reporting - Why, How, and Future Directions

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S401

Patricia Balthazar, MD (*Moderator*) Dr. Balthazar received research support from the Association of University Radiologists GE Radiology Research Academic Fellowship.

#### LEARNING OBJECTIVES

1) Understand the importance and benefits of using structured reporting templates. 2) Acquire practical knowledge on how to create and use structured reporting to maximize efficiency, quality and compliance with real-life examples. 3) Discuss future applications of structured reporting.

#### COURSE DESCRIPTION

This course explores the importance, creation, and future implementation of structured reporting in radiology. Speakers will delve into key topics including the use of structured report templates and macros, the influence of radiology report elements on patient care, and the evolving future of radiology reports in the context of Common Data Elements and FHIR observations. Participants can anticipate an engaging format combining lectures and interactive panel discussion. The vital role structured reporting plays in enhancing clinical decision-making, improving communication, promoting standardization, and improving quality of care will be discussed with real-life examples. The expected outcome is for attendees to gain an enriched understanding of structured reporting and the capability to implement learned strategies into their practices for enhanced patient outcomes.

#### Sub-Events

##### W1-CIN03B Structured Report Templates and Macros: Why, How, Tips and Tricks"

Patricia Balthazar, MD (*Presenter*) Dr. Balthazar received research support from the Association of University Radiologists GE Radiology Research Academic Fellowship.

##### W1-CIN03C Common Data Elements, FHIR Observations, and the Future of Radiology Reports

Tarik K. Alkasab, MD, PhD (*Presenter*) Consultant, Nuance Communications, Inc; Medical Advisory Board, Nuance Communications, Inc

##### W1-CIN03D Radiology Report Elements do Drive Care: Real Examples From a Learning Health System

Marta E. Heilbrun, MD, MS (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CIN03B

### **Structured Report Templates and Macros: Why, How, Tips and Tricks"**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S401

Patricia Balthazar, MD (*Presenter*) Dr. Balthazar received research support from the Association of University Radiologists GE Radiology Research Academic Fellowship.

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## Abstract Archives of the RSNA, 2023

W1-CIN03C

### **Common Data Elements, FHIR Observations, and the Future of Radiology Reports**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S401

Tarik K. Alkasab, MD, PhD (*Presenter*) Consultant, Nuance Communications, Inc; Medical Advisory Board, Nuance Communications, Inc

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## Abstract Archives of the RSNA, 2023

W1-CIN03D

### **Radiology Report Elements do Drive Care: Real Examples From a Learning Health System**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S401

Marta E. Heilbrun, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CIR04

### Advanced MSK, Head & Neck Interventions

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E352

Kazim Narsinh, MD (*Moderator*) Nothing to Disclose  
Gina Landinez, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify scenarios where Interventional Radiology modalities (embolization, ablation) can enable and complement surgical and medical treatment plans for benign and malignant head and neck conditions. 2) Understand vertebroplasty, including devices that are yet to become available in the United States. 3) Understand novel musculoskeletal interventional image guidance platforms. 4) Understand the approach to Desmoid tumors including NCCN guideline updates.

#### COURSE DESCRIPTION

With major updates to the NCCN Guidelines completed (MSK) and to the ATA guidelines imminent in 2023-2024 (Thyroid) this session aims to provide advanced pearls for Interventional Radiologists entering the MSKIR and ThyroidIR domains.

#### Sub-Events

##### W1-CIR04C IR for Benign Disease of the Head and Neck

Auh-Whan Park (*Presenter*) Nothing to Disclose

##### W1-CIR04D IR for Malignant Disease of the Head and Neck

Kazim Narsinh, MD (*Presenter*) Nothing to Disclose

##### W1-CIR04E Vertebroplasty Blitz

Sean M. Tutton, MD (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Galil Medical Ltd; Consultant, Stryker Corporation; Consultant, Siemens AG;

##### W1-CIR04F Desmoid Tumors: NCCN Guideline update, Radiologic Workup, Approach, and Follow-up

Gina Landinez, MD (*Presenter*) Nothing to Disclose

##### W1-CIR04G New MSK Devices In Use in Europe Not Yet Available in the USA

Stefano Marcia, MD (*Presenter*) Consultant, Techlamed Srl; Consultant, Spineart SA; Consultant, Stryker Corporation

##### W1-CIR04H Novel Image Guidance Platforms for MSK Interventions

Jonathan M. Morris, MD (*Presenter*) Consultant, Medtronic plc; Speaker, Medtronic plc; Consultant, Merit Medical Systems, Inc; Speaker, Merit Medical Systems, Inc; Consultant, Landauer Inc; Speaker, Johnson & Johnson

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## Abstract Archives of the RSNA, 2023

W1-CIR04C

### **IR for Benign Disease of the Head and Neck**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E352

Auh-Whan Park (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CIR04D

### **IR for Malignant Disease of the Head and Neck**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E352

Kazim Narsinh, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CIR04E

### Vertebroplasty Blitz

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E352

Sean M. Tutton, MD (*Presenter*) Consultant, Boston Scientific Corporation; Consultant, Galil Medical Ltd; Consultant, Stryker Corporation; Consultant, Siemens AG;

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## Abstract Archives of the RSNA, 2023

W1-CIR04F

### **Desmoid Tumors: NCCN Guideline update, Radiologic Workup, Approach, and Follow-up**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E352

Gina Landinez, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CIR04G

### **New MSK Devices In Use in Europe Not Yet Available in the USA**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E352

Stefano Marcia, MD (*Presenter*) Consultant, Techlamed Srl; Consultant, Spineart SA; Consultant, Stryker Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CIR04H

### **Novel Image Guidance Platforms for MSK Interventions**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E352

Jonathan M. Morris, MD (*Presenter*) Consultant, Medtronic plc;Speaker, Medtronic plc;Consultant, Merit Medical Systems, Inc;Speaker, Merit Medical Systems, Inc;Consultant, Landauer Inc;Speaker, Johnson & Johnson

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CMK14

### Arthritis and Body Composition: How Imaging Influences Clinical Decision Making

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450A

David A. Rubin, MD (*Moderator*) Scientific Advisory Board, ImageBiopsy Lab

#### LEARNING OBJECTIVES

1) Describe how imaging findings can influence the choice of drugs and assess their effectiveness in patients with rheumatoid arthritis and seronegative spondyloarthropathies. 2) Explain the impact of imaging for predicting natural history and prognosticating disease course in patients with arthritis and disorders of body composition. 3) Discuss the role of imaging in disease surveillance for arthritis and disorders of body composition.

#### COURSE DESCRIPTION

This lecture-based educational course will review how imaging findings influence clinical decision-making for patients with osteoarthritis, rheumatoid arthritis, seronegative spondyloarthritis, and disorders of body composition. Presenters will use case-examples and data from the literature to emphasize the ways in which advanced imaging informs management decisions, disease surveillance, prognostication, and assessment of drug responses, remission, and progression.

#### Sub-Events

##### **W1- CMK14B** Axial Spondyloarthropathy

Robert G. Lambert, MBBCh, FRCPC (*Presenter*) Nothing to Disclose

##### **W1- CMK14C** Osteoarthritis

Thomas M. Link, MD, PhD (*Presenter*) Research Consultant, General Electric Company

##### **W1- CMK14D** BMD Body Composition

Miriam A. Bredella, MD, MBA (*Presenter*) Nothing to Disclose

##### **W1- CMK14E** Rheumatoid Arthritis

Monique Reijnierse, MD, PhD (*Presenter*) Research Consultant, ASAS Group, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CMK14B

### **Axial Spondyloarthritis**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450A

Robert G. Lambert, MBBCh, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CMK14C

### **Osteoarthritis**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450A

Thomas M. Link, MD, PhD (*Presenter*) Research Consultant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CMK14D

### **BMD Body Composition**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450A

Miriam A. Bredella, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W1-CMK14E

### **Rheumatoid Arthritis**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450A

Monique Reijnierse, MD, PhD (*Presenter*) Research Consultant, ASAS Group, LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CNR07

### Neuroradiologists Under Pressure - Global Perspectives

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N227B

C. C. Tchoyoson Lim, MMedSc, MBBS (*Moderator*) Research Consultant, Hanalytics Pte Ltd; Research Consultant, Iota MedTech Pte Ltd; Royalties from intellectual property; Research Grant, PI

#### LEARNING OBJECTIVES

1) To review the diversity or similarity of burden of health delivery workload on practicing neuroradiologists in different parts of the world: including emerging trends/challenges in clinical/academic/reimbursement issues. 2) To understand what steps neuroradiologists are taking to relieve the pressure, and if this is working, if this is generalizable. 3) To discuss how to balance clinical workload and academic mission for neuroradiologists.

#### COURSE DESCRIPTION

Post-pandemic, clinical workload for neuroradiologists has increased, exacerbating pre-existing difficult working conditions; but is this increased pressure on us the same around the world? There's a sense that the altruistic, ethical and academic missions are under threat, to the detriment of our patients. This session will explore problems and possible solutions in diverse parts of the world.

#### Sub-Events

##### **W1- CNR07B** Under Pressure: US Perspectives

Suyash Mohan, MD (*Presenter*) Research Grant, NovoCure Ltd; Research Grant, Galileo CDS, Inc; Consultant, Northwest Biotherapeutics, Inc; Consultant, AIRS Medical Inc; Consultant, Qynapse SAS

##### **W1- CNR07C** UK Perspectives: Life in the NHS

Lalani Carlton Jones, MBBS, FRCR (*Presenter*) Nothing to Disclose

##### **W1- CNR07D** Under Pressure: Singapore Style

C. C. Tchoyoson Lim, MMedSc, MBBS (*Presenter*) Research Consultant, Hanalytics Pte Ltd; Research Consultant, Iota MedTech Pte Ltd; Royalties from intellectual property; Research Grant, PI

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CNR07B

### **Under Pressure: US Perspectives**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N227B

Suyash Mohan, MD (*Presenter*) Research Grant, NovoCure Ltd; Research Grant, Galileo CDS, Inc; Consultant, Northwest Biotherapeutics, Inc; Consultant, AIRS Medical Inc; Consultant, Qynapse SAS

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CNR07C

### **UK Perspectives: Life in the NHS**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N227B

Lalani Carlton Jones, MBBS, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CNR07D

### **Under Pressure: Singapore Style**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N227B

C. C. Tchoyoson Lim, MMedSc, MBBS (*Presenter*) Research Consultant, Hanalytics Pte Ltd; Research Consultant, Iota MedTech Pte Ltd; Royalties from intellectual property; Research Grant, PI

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-COB03

### Integrating US and MR O-RADS in your Practice

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S405

Elizabeth A. Sadowski, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Learn how the O-RADS US and MRI risk stratification system can be incorporated into clinical practice. 2) Understand which lesions may be adequately characterized with US. 3) Identify lesions that would benefit from further assessment on MRI before definitive management.

#### COURSE DESCRIPTION

This series of lectures will review how the O-RADS US and MRI risk stratification system can be incorporated into your practice, with a focus on when US is enough and when MRI adds value.

#### Sub-Events

##### **W1-COB03B** O-RADS: Ready for Prime Time

Isabelle Thomassin-Naggara, MD (*Presenter*) Researcher, General Electric Company; Research funded, General Electric Company; Researcher, Canon Medical Systems Corporation; Research funded, Canon Medical Systems Corporation; Research funded, Hologic, Inc; Research funded, Siemens AG; Research funded, Guerbet SA

##### **W1-COB03C** O-RADS US Cases: When US is Enough

Loretta M. Strachowski, MD (*Presenter*) Royalties, RELX; Speaker, World Class CME

##### **W1-COB03D** O-RADS MRI Cases: When MRI adds Value

Elizabeth A. Sadowski, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-COB03B

### **O-RADS: Ready for Prime Time**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S405

Isabelle Thomassin-Naggara, MD (*Presenter*) Researcher, General Electric Company; Research funded, General Electric Company; Researcher, Canon Medical Systems Corporation; Research funded, Canon Medical Systems Corporation; Research funded, Hologic, Inc; Research funded, Siemens AG; Research funded, Guerbet SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-COB03C

### **O-RADS US Cases: When US is Enough**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S405

Loretta M. Strachowski, MD (*Presenter*) Royalties, RELX; Speaker, World Class CME

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W1-COB03D

### **O-RADS MRI Cases: When MRI adds Value**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S405

Elizabeth A. Sadowski, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CPH06

### Photon Counting CT

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E451A

Shuai Leng, PhD (*Moderator*) License agreement, Siemens AG

#### LEARNING OBJECTIVES

1) Understand principles of photon counting detector (PCD) and PCD-CT. 2) Explore benefits of PCD-CT in comparison with energy integrating detector CT. 3) Identify potential applications of PCD-CT in various clinical areas.

#### COURSE DESCRIPTION

Photon counting detector (PCD) has been an active research area in recent years. Commercial PCD-CT has been available for routine clinical use since the FDA cleared the first PCD-CT in late 2021, representing a major imaging device advancement for CT. In this lecture, we will discuss the fundamental principles of PCD and explain major benefits of this technology relative to energy integrating detectors which are used on most commercial CT scanners. History and current status of PCD-CT will also be discussed. Potential applications in various clinical areas will be demonstrated using sample phantom and patient images. Challenges and opportunities will also be discussed.

#### Sub-Events

##### **W1-CPH06B Clinical Applications of Photon Counting CT**

Shuai Leng, PhD (*Presenter*) License agreement, Siemens AG

##### **W1-CPH06C Basic Principles of Photon Counting CT**

Ke Li, PhD (*Presenter*) Research Consultant, Pulmera Inc.

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## Abstract Archives of the RSNA, 2023

W1-CPH06B

### **Clinical Applications of Photon Counting CT**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E451A

Shuai Leng, PhD (*Presenter*) License agreement, Siemens AG

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## Abstract Archives of the RSNA, 2023

W1-CPH06C

### Basic Principles of Photon Counting CT

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E451A

Ke Li, PhD (*Presenter*) Research Consultant, Pulmera Inc.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-CRT04

### **ASRT@RSNA: Shaping the Future of Imaging: Quality Initiatives for Enhanced Effectiveness and Efficiency**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Understand the evolution of imaging services to pinpoint areas for quality enhancement. 2) Identify core quality dimensions, emphasizing safety and patient-centered approaches. 3) Explain CQI principles using the PDCA cycle in imaging settings. 4) Discuss the impact of AI and machine learning on imaging service efficiency. 5) Create a strategic plan integrating quality initiatives and technological advancements for innovative imaging services.

#### **COURSE DESCRIPTION**

This presentation explores the pivotal quality initiatives steering modern health care imaging services. Attendees will gain a nuanced understanding of the comprehensive approach to quality, encompassing vital facets such as safety, timeliness and patient-centeredness. The speaker will discuss the transformation of imaging services and unravel the pivotal role of continuous quality improvement through the plan-do-check-act cycle for enhancing efficiency and effectiveness. Attendees will delve into the exciting realm of technological innovations like artificial intelligence and machine learning that are revolutionizing workflow dynamics and understand the necessity of continuous education in upholding the highest standards of patient care. Designed for health care professionals, radiologists and decision-makers, this presentation aims to provide tools to navigate the evolving landscape of imaging services, ensuring a patient-centric approach grounded in innovation and efficiency. Join us to forge the path to a future where quality is not just a benchmark but a sustained promise.

#### **Sub-Events**

### **W1-CRT04B ASRT@RSNA: Shaping the Future of Imaging: Quality Initiatives for Enhanced Effectiveness and Efficiency**

Fredrick Lee II, MBA, MPH (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-CRT04B

### **ASRT@RSNA: Shaping the Future of Imaging: Quality Initiatives for Enhanced Effectiveness and Efficiency**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N230B

Fredrick Lee II, MBA, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-RCP05

### RSNA/ESR Symposium: Imaging of Neurodegenerative Disorders - Basics of Neuroimaging in Neurodegeneration

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450B

Meike W. Vernooij, MD, PhD (*Moderator*) Nothing to Disclose  
Alexander Drzezga, MD (*Moderator*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

#### LEARNING OBJECTIVES

1) To understand the standard MR Imaging protocol, normal aging findings, as well as Alzheimer disease mimic on structural brain MR imaging. 2) To become familiar with existing and new molecular imaging tracers for dementia and parkinsonian disorders. 3) To comprehend the evolving role of imaging biomarkers in standard clinical practice as well as trials (including imaging of side effects such as ARIA).

#### COURSE DESCRIPTION

Structural MRI and molecular imaging techniques are key modalities in the diagnosis (and increasingly also in early detection) of neurodegenerative disorders. This session is part of an educational ESR-RSNA transatlantic course (of 4 sessions in total) that discusses imaging in neurodegeneration, from basics to advanced applications. This first educational session will discuss the basics of MRI and PET imaging, choices of imaging protocols, PET tracers and MR sequences, changes that occur with normal aging and other mimics, and what the role is of imaging biomarkers in general in clinical practice versus trials. At the end of the course, the participants will better understand the basics of molecular and structural imaging in neurodegenerative disorders.

#### Sub-Events

##### W1-RCP05C The Basics of MR Imaging in Neurodegeneration

Yoshimi Anzai, MD, MPH (*Presenter*) Nothing to Disclose

##### W1-RCP05D The Basics of Molecular Imaging in Neurodegeneration

Javier Arbizu Lostao, MD, PhD (*Presenter*) Speaker, F. Hoffmann-La Roche Ltd;Speaker, Novartis AG;Speaker, General Electric Company;Research Grant, Siemens AG;Speaker, Life Molecular Imaging GmbH;Speaker, Biogen Idec Inc

##### W1-RCP05E Role of Imaging Biomarkers for Dementia in Clinical Routine and Trials

Meike W. Vernooij, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-RCP05C

### **The Basics of MR Imaging in Neurodegeneration**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450B

Yoshimi Anzai, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W1-RCP05D

### **The Basics of Molecular Imaging in Neurodegeneration**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450B

Javier Arbizu Lostao, MD, PhD (*Presenter*) Speaker, F. Hoffmann-La Roche Ltd; Speaker, Novartis AG; Speaker, General Electric Company; Research Grant, Siemens AG; Speaker, Life Molecular Imaging GmbH; Speaker, Biogen Idec Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-RCP05E

### **Role of Imaging Biomarkers for Dementia in Clinical Routine and Trials**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E450B

Meike W. Vernooij, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-RCP14

### Overcoming Staff Shortages in Radiology: How to Ensure Patient Safety during the 'Great Resignation'?

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N229

Zi Zhang, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Ensuring patient safety and workflow efficiency in radiology. This lecture will discuss strategies to optimize and standardize radiology workflow to improve patient safety, eases pressure on radiologists and supporting staff. 2) Investing in education to mobilize and develop our imaging workforce. This lecture will discuss learning and development initiatives to engage and upskill the radiology staff to improve work quality and patient safety. 3) Improving recruitment and retention in radiology. This lecture will address reasons behind the "Great Resignation" and discuss strategies to create an enjoyable workplace in radiology practice to improve recruitment and retention of clinical staff. 4) Implementing artificial intelligence in different aspects of radiology practice. This lecture will discuss appropriate clinical implications of artificial intelligence in different aspects of radiology practice, such as patient scheduling, image acquisition and reporting, to increase work efficiency and improve patient safety.

#### COURSE DESCRIPTION

The shortage of healthcare staff is becoming the nation's top patient safety concern. The prompt and accurate results of imaging studies can be the difference between life and death. Yet shortage of practicing radiologists in the United States is projected to worsen while demands for radiology services continue to grow. Radiology practices have been experiencing staff shortages across various positions, struggling to both maintain staffing and bring in new talent. Thus, many patients have been forced to endure long wait when seeking care in radiology. The goal of our course is to discuss strategies to ensure patient safety and address workforce challenges facing radiology.

#### Sub-Events

##### W1-RCP14B Ensuring Patient Safety and Workflow Efficiency in Radiology

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

##### W1-RCP14C Investing in Education to Mobilize and Develop our Imaging Workforce

Pari V. Pandharipande, MD, MPH (*Presenter*) I serve as a member of the Association of University Radiologists (AUR) General Electric (GE) Radiology Research Academic Fellowship (GERRAF) Board of Review (term: 7/1/22-2/28/23).

##### W1-RCP14D Improving Recruitment and Retention in Radiology

Geraldine B. McGinty, MD, MBA (*Presenter*) Board Member, NextGen Healthcare ; Stockholder, NextGen Healthcare

##### W1-RCP14E Implementing Artificial Intelligence in different Aspects of Radiology Practice

Zi Zhang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-RCP14B

### Ensuring Patient Safety and Workflow Efficiency in Radiology

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N229

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-RCP14C

### Investing in Education to Mobilize and Develop our Imaging Workforce

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N229

Pari V. Pandharipande, MD, MPH (*Presenter*) I serve as a member of the Association of University Radiologists (AUR) General Electric (GE) Radiology Research Academic Fellowship (GERRAF) Board of Review (term: 7/1/22-2/28/23).

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## Abstract Archives of the RSNA, 2023

W1-RCP14D

### **Improving Recruitment and Retention in Radiology**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N229

Geraldine B. McGinty, MD, MBA (*Presenter*) Board Member, NextGen Healthcare ;Stockholder, NextGen Healthcare

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## Abstract Archives of the RSNA, 2023

W1-RCP14E

### **Implementing Artificial Intelligence in different Aspects of Radiology Practice**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N229

Zi Zhang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-RCP20

### Who is Paying for Radiology Education? (Sponsored by the American Association for Women in Radiology)

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S402

Kristin K. Porter, MD, PhD (*Moderator*) Stockholder, Pfizer Inc; Medical Advisory Board, Bracco Group

#### LEARNING OBJECTIVES

1) Discuss who is and who should pay for radiology education. 2) Consider whether our current compensation models are disincentivizing radiologists from pursuing careers in academics. 3) Examine the potential impact of under-funding radiology education on the gender pay-gap in radiology.

#### COURSE DESCRIPTION

The demand for medical imaging is outstripping the supply of radiologists. From 2010 to 2020, the number of DR trainees entering the workforce increased just 2.5% (1), compared to a 180% increase in the number of CT and US examinations in the same decade. (2) On March 29, 2023, the Resident Physician Shortage Reduction Act of 2023 was proposed; if passed, it would expand the number of Medicare-supported medical residency positions by 14,000 over seven years. A similar bill was proposed in 2021 but did not pass. As lawmakers struggle to provide additional funding for medical workforce education, medical trainees in the United States continue to take on debt for medical education and training. As of 2018, early-career radiologists owed an average of \$190,000 after graduate programs. (3) Once trained, early-career radiologists encounter a decision regarding whether to choose academics or to enter private practice. If they choose academics, they will earn an average of \$141,628 less per year than their private practice counterparts. (4) Radiology education does not end with employment. All radiologists must participate in continuing medical education (CME). The average CME allowance of a physician was \$3,691 in 2022 (5), which is typically considered part of a physician's overall compensation package. Providing and paying for CME is big business. The worldwide sales of academic publishing will exceed 19 billion dollars in 2023 and Elsevier, a leader in academic publishing, has a profit margin approaching 40%, which is higher than that of Microsoft, Google and Coca Cola. (6) Academic radiologists are expected to author, review, and edit articles for these academic journals for nominal, if any, compensation. Similarly, many radiologists earn CME at radiology conferences, typically organized, and staffed by academic radiologists for nominal, if any, compensation. Please join us as we discuss these observations and the question of who is and who should pay for radiology education. This question particularly impacts women in radiology, since, while the percentage of women in radiology has hovered around 25% since 2007 (7), there is a greater percentage of women in academic radiology (34.7%). (8) Please join us as we consider whether our current compensation models are disincentivizing radiologists from pursuing careers in academics; examine what impact, if any, the under-funding of radiology education has on the gender pay-gap in radiology; and contemplate how we as a field can overcome these challenges.

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- 8.

#### Sub-Events

### W1-RCP20B Who is Paying for Radiology Education? (Sponsored by the American Association for Women in Radiology)

Alexander M. Norbash, MD, MS (*Presenter*) Co-founder, Boston Imaging Core Lab, LLC; Stockholder, Boston Imaging Core Lab, LLC;



**W1-RCP20C Who is Paying for Radiology Education? (Sponsored by the American Association for Women in Radiology)**

Carolyn C. Meltzer, MD (*Presenter*) Nothing to Disclose

**W1-RCP20D Who is Paying for Radiology Education? (Sponsored by the American Association for Women in Radiology)**

Kristin K. Porter, MD, PhD (*Presenter*) Stockholder, Pfizer Inc; Medical Advisory Board, Bracco Group

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## Abstract Archives of the RSNA, 2023

W1-RCP20B

### **Who is Paying for Radiology Education? (Sponsored by the American Association for Women in Radiology)**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S402

Alexander M. Norbash, MD, MS (*Presenter*) Co-founder, Boston Imaging Core Lab, LLC; Stockholder, Boston Imaging Core Lab, LLC;

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## Abstract Archives of the RSNA, 2023

W1-RCP20C

### **Who is Paying for Radiology Education? (Sponsored by the American Association for Women in Radiology)**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S402

Carolyn C. Meltzer, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W1-RCP20D

### **Who is Paying for Radiology Education? (Sponsored by the American Association for Women in Radiology)**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S402

Kristin K. Porter, MD, PhD (*Presenter*) Stockholder, Pfizer Inc; Medical Advisory Board, Bracco Group

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## Abstract Archives of the RSNA, 2023

W2-CMS10

### RSNA Hands-On Lab: Contrast Reaction Management

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Carolyn L. Wang, MD (*Moderator*) Research Grant, General Electric Company

#### LEARNING OBJECTIVES

1) Recognize various types of contrast reactions and the proper management of various types of contrast reactions through simulation-based training. 2) Learn with hands-on practice the proper administration of various routes of epinephrine as well as other medications to treat the more common allergic-like contrast reactions. 3) Recognize and manage a contrast reaction in a sedated patient. 4) Recognize and manage a contrast reaction in a pediatric patient 5) Recognize and practice team communication skills necessary for high stress infrequent scenarios using simulation-based training.

#### COURSE DESCRIPTION

In Person Session Only. Tickets must be purchased in advance for this course. This course can be added through the registration portal or by stopping by the Registration Desk. Space is limited. Through hands-on high-fidelity simulation scenario training, learners will practice recognizing and managing various types of contrast reactions. Following a brief lecture, learners will rotate through multiple stations during the course to gain individual hands-on experience. To enhance the learner's experience and allow for more time in the hands-on stations, we ask all learners for the course to watch this short 15 min. video on contrast reaction management prior to the course [https://youtu.be/9r-\\_E8dmJ0A](https://youtu.be/9r-_E8dmJ0A).

#### Sub-Events

##### **W2-CMS10B** RSNA Hands-On Lab: Contrast Reaction Management

Carolyn L. Wang, MD (*Presenter*) Research Grant, General Electric Company

##### **W2-CMS10C** RSNA Hands-On Lab: Contrast Reaction Management

Carina W. Yang, MD (*Presenter*) Nothing to Disclose

##### **W2-CMS10D** RSNA Hands-On Lab: Contrast Reaction Management

Alisa Sumkin, DO (*Presenter*) Speaker, Siemens AG; Speaker, Devicor Medical Products, Inc

##### **W2-CMS10E** RSNA Hands-On Lab: Contrast Reaction Management

Melissa M. Picard, MD (*Presenter*) Nothing to Disclose

##### **W2-CMS10F** RSNA Hands-On Lab: Contrast Reaction Management

Benjamin Mervak, MD (*Presenter*) Nothing to Disclose

##### **W2-CMS10G** RSNA Hands-On Lab: Contrast Reaction Management

Erik Soloff, MD (*Presenter*) Nothing to Disclose

##### **W2-CMS10H** RSNA Hands-On Lab: Contrast Reaction Management

Kirk G. Banerian, BS, MD (*Presenter*) Nothing to Disclose

##### **W2-CMS10I** RSNA Hands-On Lab: Contrast Reaction Management

Anup J. Alexander, MD (*Presenter*) Nothing to Disclose

##### **W2-CMS10J** RSNA Hands-On Lab: Contrast Reaction Management

Mody, MD (*Presenter*) Nothing to Disclose

**W2-  
CMS10K**      **RSNA Hands-On Lab: Contrast Reaction Management**

Kevin Paul, BS (*Presenter*) Nothing to Disclose

**W2-CMS10LRSNA Hands-On Lab: Contrast Reaction Management**

Stephen C. O'Connor, MD (*Presenter*) Nothing to Disclose

**W2-  
CMS10M**      **RSNA Hands-On Lab: Contrast Reaction Management**

Mohamed Shaif S. Yusufishaq, MD, BEng (*Presenter*) Nothing to Disclose

**W2-  
CMS10N**      **RSNA Hands-On Lab: Contrast Reaction Management**

Senta M. Berggruen, MD (*Presenter*) Nothing to Disclose

**W2-  
CMS10O**      **RSNA Hands-On Lab: Contrast Reaction Management**

Andrew Williams (*Presenter*) Nothing to Disclose

**W2-  
CMS10P**      **RSNA Hands-On Lab: Contrast Reaction Management**

Michael Zhang, MD (*Presenter*) Nothing to Disclose

**W2-  
CMS10Q**      **RSNA Hands-On Lab: Contrast Reaction Management**

Lindsay Yang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

W2-CMS10B

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Carolyn L. Wang, MD (*Presenter*) Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10C

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Carina W. Yang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-CMS10D

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Alisa Sumkin, DO (*Presenter*) Speaker, Siemens AG; Speaker, Devicor Medical Products, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10E

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Melissa M. Picard, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10F

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Benjamin Mervak, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10G

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Erik Soloff, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10H

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Kirk G. Banerian, BS, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10I

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Anup J. Alexander, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10J

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Rekha N. Mody, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10K

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Kevin Paul, BS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-CMS10L

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Stephen C. O'Connor, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10M

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Mohamed Shaif S. Yusufishaq, MD, BEng (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10N

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Senta M. Berggruen, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS100

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Andrew Williams (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10P

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Michael Zhang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-CMS10Q

### **RSNA Hands-On Lab: Contrast Reaction Management**

Wednesday, Nov. 29 9:00AM - 10:30AM Room: E265

Lindsay Yang, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CHN03

### The Eyes Have It: Essentials in Orbital Imaging

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S405

Elizabeth George, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the imaging algorithm and search patterns for patients presenting with eye pain, diplopia, and vision loss. 2) Understand the imaging algorithm and search patterns in the pediatric orbit.

#### COURSE DESCRIPTION

In this Head and Neck session devoted to the orbit, attendees will review the imaging approach and will be presented with clinical case examples of patients with eye pain, diplopia, and vision loss. Attendees will also review the imaging approaches and pathologies in the pediatric orbit. Speakers will emphasize pearls for imaging evaluation and differentiating each entity from common mimics, pitfalls of interpretation to avoid, and relevant clinical management considerations with which radiologists should be familiar. This session offers attendees the opportunity to refine their interpretation of complex head and neck imaging studies by incorporating tips from world experts.

#### Sub-Events

##### **W3-CHN03B**      **Imaging Workup of Eye Pain**

Blair A. Winegar, MD (*Presenter*) Nothing to Disclose

##### **W3-CHN03C**      **Imaging Workup of Diplopia**

Paul M. Bunch, MD (*Presenter*) Research Grant, General Electric Company

##### **W3-CHN03D**      **Imaging Workup of Vision Loss**

Mari Hagiwara, MD (*Presenter*) Nothing to Disclose

##### **W3-CHN03E**      **Imaging and Pathology in the Pediatric Orbit**

Karen Moeller, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CHN03B

### **Imaging Workup of Eye Pain**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S405

Blair A. Winegar, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-CHN03C

### **Imaging Workup of Diplopia**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S405

Paul M. Bunch, MD (*Presenter*) Research Grant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CHN03D

### **Imaging Workup of Vision Loss**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S405

Mari Hagiwara, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

W3-CHN03E

### **Imaging and Pathology in the Pediatric Orbit**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S405

Karen Moeller, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNMMI07

### Prostate Theranostics

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N229

Don C. Yoo, MD (*Moderator*) Consultant, Konica Minolta, Inc

#### LEARNING OBJECTIVES

1) To review clinical interpretation of PET/CT with PSMA-targeting agents. 2) To discuss how to do PSMA targeted-therapy.

#### COURSE DESCRIPTION

This course will provide an update on molecular imaging and targeted therapy for prostate cancer. We will include clinical pearls and pitfalls and illustrative case examples.

#### Sub-Events

##### **W3- CNMMI07B** Introduction and Unusual Pitfalls in PSMA PET/CT

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

##### **W3- CNMMI07C** PSMA PET/CT Imaging

Terence Z. Wong, MD, PhD (*Presenter*) Consultant, General Electric Company

##### **W3- CNMMI07D** PSMA Therapy

Andrei Iagaru, MD (*Presenter*) Research Grant, General Electric Company; Research Grant, Lantheus Holdings; Research Grant, Novartis AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNMMI07B

### **Introduction and Unusual Pitfalls in PSMA PET/CT**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N229

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNMMI07C

### **PSMA PET/CT Imaging**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N229

Terence Z. Wong, MD, PhD (*Presenter*) Consultant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNMMI07D

### **PSMA Therapy**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N229

Andrei Iagaru, MD (*Presenter*) Research Grant, General Electric Company; Research Grant, Lantheus Holdings; Research Grant, Novartis AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNPM09

### **Radiology Dashboarding 2.0 (Sponsored by the RSNA Quality Improvement Committee)**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E351

Matthew E. Zygmunt, MD (*Moderator*) Nothing to Disclose  
Melissa A. Davis, MD, MBA (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) To describe sensible radiologist performance metrics. 2) To weigh the role of metrics use in achieving health equity. 3) To implement dashboarding in your practice.

#### **COURSE DESCRIPTION**

Dashboards help us understand how our departments function. It is important for radiologists to know how to leverage these tools to make decisions within their practices. In this session we will discuss how to leverage dashboards in our operations, educational initiatives, and in regard to equitable decision making.

#### **Sub-Events**

##### **W3- CNPM09C My Radiologist Performance Metrics Dashboard- What Makes the Most Sense**

Michael M. Moore, MD (*Presenter*) Nothing to Disclose

##### **W3- CNPM09D Education Program Metrics: Meeting Goals and Driving Improvements**

Matthew E. Zygmunt, MD (*Presenter*) Nothing to Disclose

##### **W3- CNPM09E Equity Metrics: Opportunities and Barriers**

Melissa A. Davis, MD, MBA (*Presenter*) Nothing to Disclose

##### **W3- CNPM09F Dashboarding Tools: Easy Peasy**

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-CNPM09C

### **My Radiologist Performance Metrics Dashboard- What Makes the Most Sense**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E351

Michael M. Moore, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNPM09D

### Education Program Metrics: Meeting Goals and Driving Improvements

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E351

Matthew E. Zygmunt, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNPM09E

### **Equity Metrics: Opportunities and Barriers**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E351

Melissa A. Davis, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CNPM09F

### **Dashboarding Tools: Easy Peasy**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E351

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CPD06

### **Pediatric Musculoskeletal Imaging: Cutting-edge Updates for Common Conditions**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451A

Kirsten Ecklund, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Understand perfusion imaging and current applications of artificial intelligence (AI) in evaluation of hip dysplasia. 2) Construct an imaging algorithm for the work up of the limping child and recognize common and uncommon etiologies of acute limp. 3) Define updated imaging protocols for evaluation of pediatric musculoskeletal infections with an emphasis on high resolution US, vascular imaging, and MR DWI.

#### **COURSE DESCRIPTION**

This 3-lecture session will review state-of-the-art, updated multimodality techniques for imaging common pediatric musculoskeletal conditions at diagnosis and during follow-up.

#### **Sub-Events**

#### **W3-CPD06B Developmental Dysplasia of the Hip: Updates in Imaging Protocols**

Michael F. Fadell II, MD (*Presenter*) Nothing to Disclose

#### **W3-CPD06C The Limping Child: Etiologies and Appropriate Imaging**

Arthur B. Meyers, MD (*Presenter*) Author with royalties, Reed Elsevier; Editor with royalties, Reed Elsevier

#### **W3-CPD06D MSK Infection: New Techniques for Well-known Pathologies**

Emilio Inarejos Clemente, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CPD06B

### **Developmental Dysplasia of the Hip: Updates in Imaging Protocols**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451A

Michael F. Fadell II, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CPD06C

### **The Limping Child: Etiologies and Appropriate Imaging**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451A

Arthur B. Meyers, MD (*Presenter*) Author with royalties, Reed Elsevier;Editor with royalties, Reed Elsevier

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CPD06D

### **MSK Infection: New Techniques for Well-known Pathologies**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451A

Emilio Inarejos Clemente, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-CPH07

### AI in Ultrasound Imaging

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406B

Karen Drukker, PHD (*Moderator*) Royalties, Hologic, Inc

#### LEARNING OBJECTIVES

1) Ultrasonic imaging modalities and devices, methods for ultrasonic beamforming, image reconstruction, speckle reduction, and image artifact removal. 2) Robotics and ultrasound-guided interventions. 3) Ultrasound image analysis for detection, diagnosis, and prognosis of disease.

#### COURSE DESCRIPTION

This updated course will consist of 3 lectures that will inform the audience on new developments in all aspects of AI for medical ultrasound from high-quality image generation, including beam formation, image reconstruction, and microbubbles, to robotics, to ultrasound image analysis intended as a decision aid to radiologists in clinical practice.

#### Sub-Events

##### **W3-CPH07B Incorporating Ultrasound Imaging Physics into Artificial Intelligence**

Jeremy J. Dahl, PhD (*Presenter*) Technical Advisory Board, MAUI Imaging, Inc; Technical Advisory Board, Cephasonics Ultrasound; Technical Advisor, Vortex Imaging

##### **W3-CPH07CAI and Robotics for Ultrasound Guided Interventions**

Laura Brattain, PhD (*Presenter*) Nothing to Disclose

##### **W3-CPH07D AI in Medical Image Analysis: Ultrasound Imaging for Detection, Diagnosis, and Prognosis of Disease**

Karen Drukker, PHD (*Presenter*) Royalties, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CPH07B

### **Incorporating Ultrasound Imaging Physics into Artificial Intelligence**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406B

Jeremy J. Dahl, PhD (*Presenter*) Technical Advisory Board, MAUI Imaging, Inc; Technical Advisory Board, Cephasonics Ultrasound; Technical Advisor, Vortex Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CPH07C

### **AI and Robotics for Ultrasound Guided Interventions**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406B

Laura Brattain, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CPH07D

### **AI in Medical Image Analysis: Ultrasound Imaging for Detection, Diagnosis, and Prognosis of Disease**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406B

Karen Drukker, PHD (*Presenter*) Royalties, Hologic, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CRO04

### Pediatric MDC Review

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S501

Hesham Elhalawani, MD, MSc (*Moderator*) Nothing to Disclose  
Camilo Jaimes Cobos, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Engage in a multidisciplinary discussion concerning three complex pediatric oncology cases, focusing on their clinical and imaging characteristics. 2) Present recommendations from the COG/SPR consensus papers pertaining to image acquisition and interpretation. 3) Examine the role of radiation therapy in these cases, emphasizing strategic planning, and delivery considerations.

#### COURSE DESCRIPTION

This interactive panel discussion will delve into three complex pediatric oncology cases. The panel, composed of two pediatric radiologists, a radiation oncologist, and a medical oncologist, will guide the conversation. Each case will be introduced through its clinical presentation and initial imaging. The medical oncologist will provide insights into the biology of the tumor, its staging, and the standard medical management. Following this, the radiation oncologist will discuss treatment alternatives, intricacies of radiation planning, and crucial aspects of delivery. The discussion will emphasize key aspects of medical imaging for each case, drawing on the recent recommendations from the Children's Oncology Group (COG)/Society for Pediatric Radiology (SPR) guidelines.

#### Sub-Events

##### **W3-CRO04C** Pediatric MDC Review

Michael S. Gee, MD, PhD (*Presenter*) Researcher, General Electric Company Researcher, Siemens AG Researcher, Motilent LLC

##### **W3-CRO04D** Pediatric MDC Review

Jessica Clymer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CRO04C

### **Pediatric MDC Review**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S501

Michael S. Gee, MD, PhD (*Presenter*) Researcher, General Electric Company Researcher, Siemens AG Researcher, Motilent LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CRO04D

### **Pediatric MDC Review**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S501

Jessica Clymer, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CRT05

### **ASRT@RSNA: Cybersecurity Primer for Radiology Professionals**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Recognize the sources of cyber threats and how our equipment and people make us vulnerable. 2) Prepare in advance of cyberattacks. 3) Describe the business continuity and recovery processes in the hours and days after an attack.

#### **COURSE DESCRIPTION**

Cybersecurity is relevant to all modern industries – especially radiology, as imaging is leading the way as the first truly digital specialty, fully dependent on networked computer systems. We all need to take a thoughtful and systematic approach to preventing cyberattack, including all radiology infrastructure and staff. This effort must include investment in technology, deployment, and management. We must practice good "cyber hygiene" to protect infrastructure and ensure that staff are educated and aware of the threats. The human element is one of the most common points of failure against cyberattacks. This lecture will cover the most likely sources of cyber threats, how to prepare for these attacks in advance, and how to maintain business continuity in the event of an attack.

#### **Sub-Events**

##### **W3-CRT05BASRT@RSNA: Cybersecurity Primer for Radiology Professionals**

Christoph Wald, MD, MBA (*Presenter*) Nothing to Disclose

##### **W3-CRT05CASRT@RSNA: Cybersecurity Primer for Radiology Professionals**

Po-Hao Chen, MD, MBA (*Presenter*) Nothing to Disclose

##### **W3-CRT05DASRT@RSNA: Cybersecurity Primer for Radiology Professionals**

Christopher J. Roth, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-CRT05B

### **ASRT@RSNA: Cybersecurity Primer for Radiology Professionals**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N230B

Christoph Wald, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CRT05C

### **ASRT@RSNA: Cybersecurity Primer for Radiology Professionals**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N230B

Po-Hao Chen, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-CRT05D

### **ASRT@RSNA: Cybersecurity Primer for Radiology Professionals**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N230B

Christopher J. Roth, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-RCP06

### RSNA/ESR Symposium: Imaging of Neurodegenerative Disorders - Dementia: Towards an Aetiologic Diagnosis

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450B

Meike W. Vernooij, MD, PhD (*Moderator*) Nothing to Disclose

Alexander Drzezga, MD (*Moderator*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

#### LEARNING OBJECTIVES

1) Explain the current use of MRI for etiologic dementia diagnosis. 2) Explain the current use of molecular imaging for etiologic dementia diagnosis. 3) Demonstrate structured selection and assessment of imaging exams through cases.

#### COURSE DESCRIPTION

Structural MRI and molecular imaging techniques are key modalities in the diagnosis (and increasingly also in early detection) of neurodegenerative disorders. This session is part of an educational ESR-RSNA transatlantic course (of 4 sessions in total) that discusses imaging in neurodegeneration, from basics to advanced applications. This second educational session will discuss how in current clinical practice imaging modalities such as MRI and molecular imaging techniques can be used to support an etiologic diagnosis of dementia. This session will give general radiologists and those interested in neuroradiology and nuclear medicine/molecular imaging the knowledge needed for appropriate selection and structured assessment of imaging exams in diagnostic work-up of dementia. The session format consist of in part lectures, followed by an interactive case-based discussion.

#### Sub-Events

#### W3-RCP06CMR Imaging in Dementia Aetiology: Patterns of Atrophy and Vascular Lesions

Meike W. Vernooij, MD, PhD (*Presenter*) Nothing to Disclose

#### W3-RCP06D Molecular Imaging in Dementia Aetiology: Current Concepts

Alexander Drzezga, MD (*Presenter*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

#### W3-RCP06E Dementia Etiology: Interactive Case Discussion

Meike W. Vernooij, MD, PhD (*Presenter*) Nothing to Disclose

#### W3-RCP06F Dementia Etiology: Interactive Case Discussion

Alexander Drzezga, MD (*Presenter*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

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## Abstract Archives of the RSNA, 2023

W3-RCP06C

### **MR Imaging in Dementia Aetiology: Patterns of Atrophy and Vascular Lesions**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450B

Meike W. Vernooij, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-RCP06D

### **Molecular Imaging in Dementia Aetiology: Current Concepts**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450B

Alexander Drzezga, MD (*Presenter*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

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## Abstract Archives of the RSNA, 2023

W3-RCP06E

### **Dementia Etiology: Interactive Case Discussion**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450B

Meike W. Vernooij, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-RCP06F

### **Dementia Etiology: Interactive Case Discussion**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450B

Alexander Drzezga, MD (*Presenter*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company

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## Abstract Archives of the RSNA, 2023

W3-RCP13

### RadioGraphics: Editor's Picks/Choice over the Years

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S502

Mark M. Hammer, MD (*Moderator*) Nothing to Disclose  
Christine O. Menias, MD (*Moderator*) Royalties, RELX  
Antonio Luna, MD, PhD (*Moderator*) Speaker, General Electric Company

#### LEARNING OBJECTIVES

1) Identify and comprehend the key characteristics of different disease entities discussed in top RadioGraphics papers from the past year. 2) Correlate anatomic, pathologic, and imaging findings for a variety of pathologic conditions relevant to clinical radiology practice. 3) Understand the clinical significance and management implications of diseases from select RadioGraphics papers from the past year.

#### COURSE DESCRIPTION

RadioGraphics: Editor's Choice course will highlight 4 published papers from the last year, where authors will summarize key points from their manuscripts highlighting the significance of imaging findings, clinical significance and management implications to the wider radiology community

#### Sub-Events

##### **W3-RCP13D Pancreatic Cystic Lesions and Malignancy: Assessment, Guidelines, and the Field Defect**

Frank H. Miller, MD (*Presenter*) Advisory Board, Bayer AG; Advisory Board, Guerbet SA

##### **W3-RCP13E Benign-appearing Incidental Adnexal Cysts at US, CT, and MRI: Putting the ACR, O-RADS, and SRU Guidelines All Together**

Peter S. Wang, MD (*Presenter*) Speaker, Koninklijke Philips NV

##### **W3-RCP13F Interstitial Lung Abnormalities at CT: Subtypes, Clinical Significance, and Associations with Lung Cancer**

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

##### **W3-RCP13G Coronary Artery Calcium Scoring: Current Status and Future Directions**

Amit Gupta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

W3-RCP13D

### **Pancreatic Cystic Lesions and Malignancy: Assessment, Guidelines, and the Field Defect**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S502

Frank H. Miller, MD (*Presenter*) Advisory Board, Bayer AG; Advisory Board, Guerbet SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-RCP13E

### **Benign-appearing Incidental Adnexal Cysts at US, CT, and MRI: Putting the ACR, O-RADS, and SRU Guidelines All Together**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S502

Peter S. Wang, MD (*Presenter*) Speaker, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-RCP13F

### **Interstitial Lung Abnormalities at CT: Subtypes, Clinical Significance, and Associations with Lung Cancer**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S502

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

W3-RCP13G

### **Coronary Artery Calcium Scoring: Current Status and Future Directions**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S502

Amit Gupta, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CIN05

### **Through the Looking Glass (Informatics Lens); Enhancing Patient Journey Through Imaging (Supported in part by an Unrestricted Medical Education Grant from Siemens Healthineers of Siemens Medical Solutions, USA, Inc.)**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: S401

Namita S. Gandhi, MD, MSc (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Informatics strategy and initiatives to enhance the pre imaging exam journey. 2) Informatics strategy and challenges with patient friendly report. 3) Informatics strategies for patient friendly image exchange. 4) Informatics considerations for patient reported outcomes.

#### **COURSE DESCRIPTION**

Patient journey refers to patient's experience throughout an episode of care; for radiology this begins at the time when an imaging order is placed and carries through till the patients receive their imaging reports. The reports impact further patient care and outcomes. Traditionally, strategies to improve patient experience and care in radiology are focused on enhancing only the radiology encounter. This course will focus on the entire episode of care (pre and post radiology encounter) in a patient's imaging journey and discuss informatics strategies and considerations to enhance the entire journey. The session will be organized as short presentations by the speakers followed by a panel discussion at the end. The panel will be available for audience questions.

#### **Sub-Events**

##### **W4-CIN05B Informatics Strategy and Initiatives to Enhance the Pre Imaging Exam Journey**

Namita S. Gandhi, MD, MSc (*Presenter*) Nothing to Disclose

##### **W4-CIN05C Informatics Strategy and Challenges with Patient Friendly Reports**

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

##### **W4-CIN05D Patient Friendly Image Access**

Marc D. Kohli, MD (*Presenter*) Founder, Alara Imaging; Stockholder, Alara Imaging

##### **W4-CIN05E Patient Reported Outcomes and Lung Cancer Screening**

Dania Daye, MD, PhD (*Presenter*) Research Consultant, Sigilon Therapeutics, Inc; Research Consultant, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CIN05B

### **Informatics Strategy and Initiatives to Enhance the Pre Imaging Exam Journey**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: S401

Namita S. Gandhi, MD, MSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CIN05C

### **Informatics Strategy and Challenges with Patient Friendly Reports**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: S401

Arun Krishnaraj, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W4-CIN05D

### **Patient Friendly Image Access**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: S401

Marc D. Kohli, MD (*Presenter*) Founder, Alara Imaging; Stockholder, Alara Imaging

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CIN05E

### **Patient Reported Outcomes and Lung Cancer Screening**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: S401

Dania Daye, MD, PhD (*Presenter*) Research Consultant, Sigilon Therapeutics, Inc; Research Consultant, Medtronic plc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CNPM14

### US Radiology Reimbursement in Context: What Comes Next?

Wednesday, Nov. 29 11:00AM - 12:00PM Room: E351

Richard E. Heller III, MD (*Moderator*) Consultant, Gerson Lehrman Group, Inc;

#### LEARNING OBJECTIVES

1) Identify the macroeconomic forces that are influencing reimbursement for radiology services. 2) Identify actions that private, commercial health insurance companies are taking that influence reimbursement for radiology services. 3) Explain the challenges facing radiology under the Medicare Physician Fee Schedule. 4) List actions that medical practices and physicians can take to help protect patients' access to high quality medical imaging.

#### COURSE DESCRIPTION

The session will focus on the future of radiology reimbursement within the broader context of health care reform and macroeconomic forces in the United States. This includes value-based payment, Medicare and the physician fee schedule, private payor issues, digital medicine and others. This will be a hybrid session, pairing presentations with moderated dialogue and Q/A.

#### Sub-Events

##### **W4- CNPM14B**      **The Future Economics of Health Care in the US: Doing More for Less**

David Meltzer (*Presenter*) Nothing to Disclose

##### **W4- CNPM14C**      **Radiology Reimbursement in the Academic Setting: What Comes Next?**

Geraldine B. McGinty, MD, MBA (*Presenter*) Board Member, NextGen Healthcare ;Stockholder, NextGen Healthcare

##### **W4- CNPM14D**      **Private Practice Radiology: Challenges, Opportunities, and Uncertainties**

Ezequiel Silva III, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CNPM14B

### **The Future Economics of Health Care in the US: Doing More for Less**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: E351

David Meltzer (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CNPM14C

### **Radiology Reimbursement in the Academic Setting: What Comes Next?**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: E351

Geraldine B. McGinty, MD, MBA (*Presenter*) Board Member, NextGen Healthcare ;Stockholder, NextGen Healthcare

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CNPM14D

### **Private Practice Radiology: Challenges, Opportunities, and Uncertainties**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: E351

Ezequiel Silva III, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CRT06

### **ASRT@RSNA: Interventional Radiology and Pediatric Care: The Changing Role of the Technologist/Radiographer**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Gain an overview of Pediatric Interventional Radiology. 2) Learn about advanced practice roles within Interventional Radiology and how these could be applied to their own clinical practice. 3) Learn how advanced practice roles benefit patients, and the wider healthcare system.

#### **COURSE DESCRIPTION**

This session will provide an overview of interventional procedures performed for pediatric patients, including recent innovations. It will also examine the technologist/radiographer role in Interventional Radiology and how this is developing to include advanced roles.

#### **Sub-Events**

### **W4-CRT06B ASRT@RSNA: Topic: Interventional Radiology: The Technologists/ Radiographers Changing Role & Changing Techniques in Pediatric Care**

Emma Rose, MSc, BSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W4-CRT06B

**ASRT@RSNA: Topic: Interventional Radiology: The Technologists/ Radiographers Changing Role & Changing Techniques in Pediatric Care**

Wednesday, Nov. 29 11:00AM - 12:00PM Room: N230B

Emma Rose, MSc, BSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-CBR10

### Breast Screening and Breast Cancer Risk

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406A

Wendie A. Berg, MD, PhD (*Moderator*) Institutional Research Grant, Koios Medical, Inc

#### LEARNING OBJECTIVES

1) Identify patients who should have breast screening beyond mammography. 2) Describe expected results from MRI screening. 3) Discuss alternatives to MRI screening for those recommended for it but unable to tolerate it, including ultrasound or, potentially, contrast-enhanced mammography.

#### COURSE DESCRIPTION

This session will detail which people meet current guidelines for supplemental breast cancer screening beyond mammography based on risk, including ages to start and stop screening. The latest ACR, NCCN, and EUSOBI guidelines will be discussed.

#### Sub-Events

##### W6-CBR10B Breast Screening with US: Should We Do It?

Wendie A. Berg, MD, PhD (*Presenter*) Institutional Research Grant, Koios Medical, Inc

##### W6-CBR10C Factors Influencing Breast Cancer Risk on Imaging

Emily F. Conant, MD (*Presenter*) Research Grant, Hologic, Inc; Advisory Panel, Hologic, Inc; Research Grant, OM1, Inc; Research Grant, iCad, Inc; Advisory Panel, iCad, Inc; Speaker, WebMD LLC

##### W6-CBR10D Breast Screening with MRI

Christopher E. Comstock, MD (*Presenter*) Speakers Bureau, Bracco Group; Advisory Board, Guerbet SA; Consultant, Bayer AG; Speaker, Northwest Imaging Forums, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CBR10B

### **Breast Screening with US: Should We Do It?**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406A

Wendie A. Berg, MD, PhD (*Presenter*) Institutional Research Grant, Koios Medical, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CBR10C

### Factors Influencing Breast Cancer Risk on Imaging

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406A

Emily F. Conant, MD (*Presenter*) Research Grant, Hologic, Inc;Advisory Panel, Hologic, Inc;Research Grant, OM1, Inc;Research Grant, iCad, Inc;Advisory Panel, iCad, Inc;Speaker, WebMD LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CBR10D

### **Breast Screening with MRI**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406A

Christopher E. Comstock, MD (*Presenter*) Speakers Bureau, Bracco Group; Advisory Board, Guerbet SA; Consultant, Bayer AG; Speaker, Northwest Imaging Forums, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CCA09

### Hot Topics in Coronary CTA in 2023

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N228

Jill E. Jacobs, MD (*Moderator*) Nothing to Disclose  
Pamela K. Woodard, MD (*Moderator*) Researcher, Siemens AG;Consulting, Medtronic plc;Researcher, Bayer AG;Patent, Washington University

#### LEARNING OBJECTIVES

1) Identify the strengths and limitations of using CCTA to assess CAD in women. 2) Understand some of the advantages and challenges of using CTFFR for assessing coronary stenosis. 3) Explore the concept of quantitative plaque assessment using CADRAD 2.0.

#### COURSE DESCRIPTION

This course will explore some of the current hot topics in CCTA: the strengths and limitations of its use for assessing CAD in women, the advantages and challenges of utilizing CTFFR when assessing coronary stenosis, and quantitative plaque assessment and reporting with CADRAD 2.0.

#### Sub-Events

#### W6-CCA09C Strengths and Limitations of Coronary CT for Assessment of Heart Disease in Women

Luba Frank, MD (*Presenter*) Nothing to Disclose

#### W6-CCA09D Truth and Myths About CT FFR - A Decade of Experience

U. Joseph Schoepf, MD, PhD (*Presenter*) Research Grant, Bayer AG;Research Grant, Bracco Group;Research Grant, Elucid BioImaging Inc;Consultant, Elucid BioImaging Inc;Research Grant: General Electric Company;Research Grant, Guerbet SA;Research Grant, Heartflow, Inc;Speakers Bureau, Heartflow Inc

#### W6-CCA09E Quantitative Atherosclerotic Plaque Imaging: Pushing the Limits with CAD RAD 2.0

Geoffrey D. Rubin, MD, MBA (*Presenter*) Consultant, Fovia, Inc;Advisor, HeartFlow, Inc;Advisor, Nano-X Imaging Ltd;Advisor, Bayer AG

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## Abstract Archives of the RSNA, 2023

W6-CCA09C

### **Strengths and Limitations of Coronary CT for Assessment of Heart Disease in Women**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N228

Luba Frank, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CCA09D

### Truth and Myths About CT FFR - A Decade of Experience

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N228

U. Joseph Schoepf, MD, PhD (*Presenter*) Research Grant, Bayer AG; Research Grant, Bracco Group; Research Grant, Elucid BioImaging Inc; Consultant, Elucid BioImaging Inc; Research Grant: General Electric Company; Research Grant, Guerbet SA; Research Grant, Heartflow, Inc; Speakers Bureau, Heartflow Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CCA09E

### **Quantitative Atherosclerotic Plaque Imaging: Pushing the Limits with CAD RAD 2.0**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N228

Geoffrey D. Rubin, MD, MBA (*Presenter*) Consultant, Fovia, Inc;Advisor, HeartFlow, Inc;Advisor, Nano-X Imaging Ltd;Advisor, Bayer AG

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## Abstract Archives of the RSNA, 2023

W6-CCH08

### Chest MRI, PET-CT and Photon Counting CT Updates

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N229

Lea Azour, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Describe updates in Chest MRI for Acute PE and Mediastinal Mass Evaluation. 2) Review recent innovations in thoracic PET/CT. 3) Illustrate applications of photon counting CT in the chest.

#### COURSE DESCRIPTION

This course will highlight practical, and clinically applied advances in thoracic cross-sectional imaging spanning MRI for pulmonary artery and mediastinal evaluation, PET/CT, and photon-counting CT.

#### Sub-Events

##### W6-CCH08B Update on MRI for Acute PE

Christopher J. Francois, MD (*Presenter*) Nothing to Disclose

##### W6-CCH08C Update on Mediastinal Mass Imaging

Lea Azour, MD (*Presenter*) Nothing to Disclose

##### W6-CCH08D Technical Update: Recent Innovations in Thoracic PET-CT

Osama R. Mawlawi, PhD (*Presenter*) Nothing to Disclose

##### W6-CCH08E Technical Update: Photon Counting CT for Thoracic Imaging

Shuai Leng, PhD (*Presenter*) License agreement, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CCH08B

### **Update on MRI for Acute PE**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N229

Christopher J. Francois, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CCH08C

### **Update on Mediastinal Mass Imaging**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N229

Lea Azour, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CCH08D

### Technical Update: Recent Innovations in Thoracic PET-CT

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N229

Osama R. Mawlawi, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CCH08E

### Technical Update: Photon Counting CT for Thoracic Imaging

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N229

Shuai Leng, PhD (*Presenter*) License agreement, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CER08

### **Pediatric Trauma: A Case-Based Approach**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451B

Arnold C. Merrow JR, MD (*Moderator*) Consultant, RELX; Author with royalties, RELX

#### **LEARNING OBJECTIVES**

- 1) Explain common mechanisms of injury in the child.
- 2) Become familiar with normal developmental anatomic changes in the child and understand how these can mimic pathology and will result in different patterns of injury compared to an adult.
- 3) Review optimized imaging strategies for the pediatric patient.

#### **COURSE DESCRIPTION**

A sampling of common and/or critical injuries will be covered in a case-based format with attention to the pediatric spine, extremities, and thoraco-abdominal regions. This will include brief reviews of key developmental features that can mimic pathology by imaging and alter the results of trauma applied to these levels as compared to adults. Both accidental and nonaccidental traumatic mechanisms will be discussed, and imaging strategies appropriate to the pediatric patient will be shared.

#### **Sub-Events**

##### **W6-CER08B Spinal Trauma**

Birgit B. Ertl-Wagner, MD, PhD (*Presenter*) Spouse, Employee, Siemens AG

##### **W6-CER08C Non-Accidental Trauma**

Sara E. Lay, MD (*Presenter*) Nothing to Disclose

##### **W6-CER08D Chest Trauma**

Summer L. Kaplan, MD, MS (*Presenter*) Nothing to Disclose

##### **W6-CER08E Abdominal Trauma**

Arnold C. Merrow JR, MD (*Presenter*) Consultant, RELX; Author with royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CER08B

### Spinal Trauma

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451B

Birgit B. Ertl-Wagner, MD, PhD (*Presenter*) Spouse, Employee, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CER08C

### **Non-Accidental Trauma**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451B

Sara E. Lay, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-CER08D

### Chest Trauma

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451B

Summer L. Kaplan, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CER08E

### Abdominal Trauma

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451B

Arnold C. Merrow JR, MD (*Presenter*) Consultant, RELX; Author with royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGI07

### Liver Diffuse Disease

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N227B

Sudhakar K. Venkatesh, MD, FRCR (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the principles and clinical applications of MR elastography and US elastography in evaluating liver fibrosis and diffuse liver diseases. 2) Recognize new fat quantification techniques in liver imaging to accurately assess and monitor hepatic steatosis. 3) Utilize iron quantification methods in liver imaging to evaluate and monitor iron overload disorders. 4) Integrate these advanced imaging techniques into clinical practice to improve the diagnosis and management of patients with diffuse liver diseases.

#### COURSE DESCRIPTION

This educational session aims to provide participants with a comprehensive understanding of advanced imaging techniques for evaluating diffuse liver diseases, with a focus on MR elastography, US elastography, fat quantification, and iron quantification. The session will delve into the principles, clinical applications, advantages, and limitations of each technique, enabling radiologists (participants) to make informed decisions about their use in clinical practice.

#### Sub-Events

##### W6-CGI07B MR Elastography

Sudhakar K. Venkatesh, MD, FRCR (*Presenter*) Nothing to Disclose

##### W6-CGI07C US Elastography

Jeong Hee Yoon, MD (*Presenter*) Speaker, Bayer AG; Grant, Koninklijke Philips NV

##### W6-CGI07D Fat Quantification

Claude B. Sirlin, MD (*Presenter*) Research Grant, General Electric Company; Research Grant, Siemens AG; Research Grant, Bayer AG; Research Grant, Gilead Sciences, Inc; Research collaboration, Gilead Sciences, Inc; Research Grant, Koninklijke Philips NV; Research Grant, Pfizer Inc; Equipment support, General Electric Company; Consultant, Pfizer Inc; Consultant, AMRA AB; Consultant, Guerbet SA; Officer, Livivos, Inc; Advisor, Quantix Bio LLC

##### W6-CGI07E Iron Quantification

Takeshi Yokoo, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGI07B

### **MR Elastography**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N227B

Sudhakar K. Venkatesh, MD, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGI07C

### **US Elastography**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N227B

Jeong Hee Yoon, MD (*Presenter*) Speaker, Bayer AG; Grant, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGI07D

### Fat Quantification

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N227B

Claude B. Sirlin, MD (*Presenter*) Research Grant, General Electric Company; Research Grant, Siemens AG; Research Grant, Bayer AG; Research Grant, Gilead Sciences, Inc; Research collaboration, Gilead Sciences, Inc; Research Grant, Koninklijke Philips NV; Research Grant, Pfizer Inc; Equipment support, General Electric Company; Consultant, Pfizer Inc; Consultant, AMRA AB; Consultant, Guerbet SA; Officer, Livivos, Inc; Advisor, Quantix Bio LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGI07E

### **Iron Quantification**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N227B

Takeshi Yokoo, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGU05

### **GU Tumor Boards: How to Bring Value and Become Indispensable**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E350

Atul B. Shinagare, MD (*Moderator*) Consultant, VirtualScopics, Inc; Consultant, Imaging Endpoints

#### **LEARNING OBJECTIVES**

1) Use case-based format to identify key imaging features that significantly impact management. 2) Understand the common pitfalls in imaging assessment of GU tumors. 3) Improve communication with referring providers to help improve outcomes.

#### **COURSE DESCRIPTION**

With advances in oncology, the role of radiologist in management of GU cancers is rapidly evolving. At GU tumor boards, the radiologist plays a key role in diagnosis, staging, and clinical decision-making. This course guides the attendees through the various challenges and pitfalls faced by the radiologist at the GU tumor boards to successfully guide patient management.

#### **Sub-Events**

##### **W6-CGU05B Radiologist at the GU Tumor Boards: Speaking the Common Language**

Atul B. Shinagare, MD (*Presenter*) Consultant, VirtualScopics, Inc; Consultant, Imaging Endpoints

##### **W6-CGU05C Renal Masses: What the Urologists Need to Know**

Matthew S. Davenport, MD (*Presenter*) Royalties, Wolters Kluwer nv

##### **W6-CGU05D Common Pitfalls in Imaging Assessment of Prostate Cancer**

Antonio C. Westphalen, MD, PhD (*Presenter*) Shareholder, ScanMed, LLC; Research funded, BotImage, Inc

##### **W6-CGU05EGynecologic Malignancies: Radiologist Guiding the Way**

Krupa K. Patel-Lippmann, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-CGU05B

### **Radiologist at the GU Tumor Boards: Speaking the Common Language**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E350

Atul B. Shinagare, MD (*Presenter*) Consultant, VirtualScopics, Inc; Consultant, Imaging Endpoints

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGU05C

### **Renal Masses: What the Urologists Need to Know**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E350

Matthew S. Davenport, MD (*Presenter*) Royalties, Wolters Kluwer nv

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGU05D

### Common Pitfalls in Imaging Assessment of Prostate Cancer

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E350

Antonio C. Westphalen, MD, PhD (*Presenter*) Shareholder, ScanMed, LLC; Research funded, BotImage, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CGU05E

### **Gynecologic Malignancies: Radiologist Guiding the Way**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E350

Krupa K. Patel-Lippmann, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CIN23

### Ransomware: Principles, Detection, and Recovery

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S401

Benoit Desjardins, MD, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Evaluate the growing impact of ransomware. 2) Describe how to detect early signs of compromise from a cyberattack. 3) Describe the lessons learned from recovery after a ransomware attack.

#### COURSE DESCRIPTION

Cybercrime against healthcare institutions has exploded in recent years. Seven years ago, the Hollywood Presbyterian Medical Center paid a \$17,000 ransom to regain access to its medical records blocked by ransomware. In 2021, more than 1 in 3 organizations, and in 2022, more than 2 in 3 organizations reported being hit by ransomware. The Russia-tied Ryuk group hit over 235 healthcare facilities, raking in more than \$100 million in ransoms. Although paying ever-increasing ransoms can be costly for medical centers, refusing to pay them often leads to even bigger losses. The University of Vermont Health system lost \$50 million and Universal Health System lost \$67 million for refusing to pay ransoms in 2020. The Scripps Institute was recently victim of a ransomware attack and lost \$100 million in revenue in the recovery process. The situation has been considerably worsened by the pandemic, which produced a triple threat for healthcare systems: (1) a rapid expansion of internet-connected technologies and services causing an expanded attack surface, (2) an increase in many types of cyberattacks, and (3) fewer available resources to defend against cyberattacks. Recently, the zero-day vulnerability Log4j in Apache software has been leading to hundreds of cyber-attacks around the world since December 2021. Cybersecurity has become an important part of healthcare, and we must address this topic at RSNA since every radiology practice can become a victim of a cyber-attack. This explosion in cyber-attacks against medical centers is the result of (1) the increased connectivity of hospitals through medical devices and networks, (2) the commoditization of cyber-attack tools, and (3) the US Justice System penalizing cyber-attack victims, rather than going after the perpetrators. In this refresher course, we will provide an update on ransomware on hospitals, how to recover from it and the increased interconnectivity of medical devices which worsens the consequences of these attacks. In more details: The status of ransomware in 2023. This will be discussed by Dr Desjardins, an academic radiologist and ex-hacker and specialist in cybersecurity in healthcare. He will not only describe the evolution of ransomware over the past several years, but also explain the basic operating principles of ransomware and how ransomware attacks against hospitals are getting more prevalent and costly. He will also provide an overview of national initiatives to defend against ransomware. Detecting compromise and attacks against medical devices. This will be discussed by Prof Fu, a well-known leader in the cybersecurity of medical devices, who just finished his term as Acting Director of Medical Device Cybersecurity at the FDA. He will not only describe the common, easily avoided, cybersecurity design problems in medical devices, but how to detect early signs of compromise from a pending cyberattack, and how to improve the security of medical devices. Lessons learned from hospital ransomware recovery and planning considerations. This will be discussed by Dr Chen from the Cleveland Clinic. One of the facilities in Cleveland Clinic's network was recently victim of a huge ransomware attack, and Dr Chen published a great overview of lessons learned from this attack and developed a four-phase plan for the recovery from such a cyberattack (J Digit Imaging. 2021 Jun). He will provide a practical overview of these lessons and plan. This refresher course will bring the radiology community up to date on the exponentially growing threat of ransomware affecting healthcare, including recent attacks, and techniques of defense. The course will be presented by radiologists and top cybersecurity experts. The information technology issues will be addressed at a technical level appropriate for the radiology community at large, to make the community aware of this growing era of digital warfare and its implications for radiology practices. Our refresher course will have

#### Sub-Events

##### W6-CIN23B The Status of Ransomware in 2023

Benoit Desjardins, MD, PhD (*Presenter*) Nothing to Disclose

##### W6-CIN23C Detecting Compromise and Attacks Against Medical Devices

Richard Staynings, MS, MA (*Presenter*) Nothing to Disclose

## **W6-CIN23D Lessons Learned from Hospital Ransomware Recovery and Planning Considerations**

Po-Hao Chen, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CIN23B

### **The Status of Ransomware in 2023**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S401

Benoit Desjardins, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CIN23C

### **Detecting Compromise and Attacks Against Medical Devices**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S401

Richard Staynings, MS, MA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## **Abstract Archives of the RSNA, 2023**

W6-CIN23D

### **Lessons Learned from Hospital Ransomware Recovery and Planning Considerations**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S401

Po-Hao Chen, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CMK05

### Challenges in Imaging the Knee

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406B

Andrew J. Grainger, MD (*Moderator*) Speakers Bureau, General Electric Company

#### LEARNING OBJECTIVES

1) Understand areas of knee imaging and intervention that offer particular challenges to the radiologist. 2) Develop strategies to review and report knee MRI that avoid these challenging pitfalls. 3) Understand techniques and their rationale for the imaging guided intervention of patellar tendon disease.

#### COURSE DESCRIPTION

The knee is one of the most commonly imaged peripheral joints. However, advances in surgical techniques and our understanding of the functional anatomy of the knee mean that new challenges to the radiologist exist. This course aims to highlight particularly challenging areas in the interpretation of knee imaging studies. It will primarily focus on MRI, but an additional presentation will discuss the role that radiology has in the management of patellar tendon disease.

#### Sub-Events

##### **W6-CMK05B** Challenges of Imaging the Menisci

Andrew J. Grainger, MD (*Presenter*) Speakers Bureau, General Electric Company

##### **W6-CMK05C** Partial Thickness Cruciate Tears

Bruce B. Forster, MD, FRCPC (*Presenter*) Stockholder, Canada Diagnostic Centres

##### **W6-CMK05D** Imaging the Posterolateral Corner

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

##### **W6-CMK05E** Patellofemoral Joint Assessment: What Matters

Jan Fritz, MD (*Presenter*) Institutional research support, Siemens AG;Scientific Advisor, Siemens AG;Patent agreement, Siemens AG;Institutional research support, Johnson & Johnson;Institutional research support, Zimmer Biomet Holdings, Inc;Institutional research support, BTG International Ltd

##### **W6-CMK05F** Intervention for Patellar Tendinosis

Kenneth S. Lee, MD, MBA (*Presenter*) Grant, NFL;Research support, Hologic, Inc;Royalties, RELX

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

W6-CMK05B

### **Challenges of Imaging the Menisci**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406B

Andrew J. Grainger, MD (*Presenter*) Speakers Bureau, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CMK05C

### Partial Thickness Cruciate Tears

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406B

Bruce B. Forster, MD, FRCPC (*Presenter*) Stockholder, Canada Diagnostic Centres

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CMK05D

### Imaging the Posterolateral Corner

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406B

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CMK05E

### **Patellofemoral Joint Assessment: What Matters**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406B

Jan Fritz, MD (*Presenter*) Institutional research support, Siemens AG;Scientific Advisor, Siemens AG;Patent agreement, Siemens AG;Institutional research support, Johnson & Johnson;Institutional research support, Zimmer Biomet Holdings, Inc;Institutional research support, BTG International Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CMK05F

### **Intervention for Patellar Tendinosis**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S406B

Kenneth S. Lee, MD, MBA (*Presenter*) Grant, NFL; Research support, Hologic, Inc; Royalties, RELX

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNPM10

### Health Equity in Radiology: Research (Sponsored by the RSNA Research Development Committee and the RSNA Health Equity Committee)

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E351

Anand K. Narayan, MD, PhD (*Moderator*) Nothing to Disclose  
Marissa B. Lawson, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Implement best practices in the use and reporting of race and ethnicity in radiology research studies. 2) Incorporate social determinants of health data in health services research. 3) Reduce biases and improve fairness in the design and use of artificial intelligence methods in medical imaging. 4) Develop a research proposal or action plan that addresses health equity issues.

#### COURSE DESCRIPTION

As a result of participation in this course, radiology researchers will be able to incorporate best practices in health equity and inclusive writing into their own clinical research studies. The course will include practical, high yield, lectures focused on equipping radiology researchers with discrete tools and resources for their own research studies.

#### Sub-Events

##### **W6-CNPM10C** Special Considerations for Reporting Race and Ethnicity in Radiology Research

Anand K. Narayan, MD, PhD (*Presenter*) Nothing to Disclose

##### **W6-CNPM10D** Incorporating Social Determinants of Health into Radiology Research" or "How to Incorporate Social Determinants of Health into Your Research

Marissa B. Lawson, MD (*Presenter*) Nothing to Disclose

##### **W6-CNPM10E** Accounting for Diversity in Medical Imaging and Artificial Intelligence Research

Antonio Porras Perez, PhD (*Presenter*) Nothing to Disclose

##### **W6-CNPM10F** Creation of a Radiology Health Equity Laboratory: Raising Awareness and Promoting Action to Reduce Disparities in Care

Joseph R. Osborne, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-CNPM10C

### Special Considerations for Reporting Race and Ethnicity in Radiology Research

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E351

Anand K. Narayan, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNPM10D

### **Incorporating Social Determinants of Health into Radiology Research" or "How to Incorporate Social Determinants of Health into Your Research**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E351

Marissa B. Lawson, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNPM10E

### **Accounting for Diversity in Medical Imaging and Artificial Intelligence Research**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E351

Antonio Porras Perez, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNPM10F

### **Creation of a Radiology Health Equity Laboratory: Raising Awareness and Promoting Action to Reduce Disparities in Care**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E351

Joseph R. Osborne, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNR04

### Emergency Neuroimaging: Pearls and Pitfalls from Coccyx to Vertex

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451A

Jason F. Talbott, MD, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Gain familiarity with key CT and MRI findings and up-to-date classification systems in the setting of spine, head and neck, and intracranial emergencies. 2) Review appropriate indications for obtaining MRI and key MRI imaging findings in patients with acute spine emergency. 3) Review an algorithmic approach for evaluating spinal, head and neck, and intracranial imaging findings in the setting of suspected neurological emergencies.

#### COURSE DESCRIPTION

The radiologist plays a critical role in the evaluation, triage, and management planning for patients with neurological emergencies. Often, subtle imaging findings on CT and MRI are important for accurate diagnosis, timely triage, and appropriate management of patients with neurological emergencies. The primary focus of this session is to familiarize the radiologist with the spectrum of imaging findings that must be included in the search pattern for CT and MRI exams of the head, neck, and spine in the setting of non-traumatic neurologic emergency. A case-based approach will be utilized implementing up-to-date classification systems for a variety of neurological emergencies. Evidenced-based indications for obtaining follow-up and/or advanced imaging such as MRI for subtle CT findings will also be emphasized.

#### Sub-Events

##### **W6-CNR04B Spine Emergencies--An Algorithmic Approach**

Jason F. Talbott, MD, PhD (*Presenter*) Nothing to Disclose

##### **W6-CNR04C Head and Neck Emergencies: Fallor Ergo Sum!**

Richard H. Wiggins III, MD (*Presenter*) Nothing to Disclose

##### **W6-CNR04D Rapid Fire Neuroradiology Emergency Cases**

Brent D. Weinberg, MD, PhD (*Presenter*) Research Consultant, Canon Medical Systems Corporation

##### **W6-CNR04E Lessons Learned: A Career of Neuroradiology Intracranial Emergencies in 15 Minutes!**

Nancy J. Fischbein, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNR04B

### **Spine Emergencies--An Algorithmic Approach**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451A

Jason F. Talbott, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNR04C

### **Head and Neck Emergencies: Fallor Ergo Sum!**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451A

Richard H. Wiggins III, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CNR04D

### **Rapid Fire Neuroradiology Emergency Cases**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451A

Brent D. Weinberg, MD, PhD (*Presenter*) Research Consultant, Canon Medical Systems Corporation

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-CNR04E

### **Lessons Learned: A Career of Neuroradiology Intracranial Emergencies in 15 Minutes!**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E451A

Nancy J. Fischbein, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CPD08

### **Pediatric Radiology Protocols: Everyday and Advanced Techniques**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S404

Lauren W. Averill, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Recognize indications suitable for real-time MRI in children. 2) Explain technical parameters of photon counting CT using different scan modes, as well as their limitations. 3) Illustrate state-of-the-art cartilage imaging in children.

#### **COURSE DESCRIPTION**

This session will review everyday and advanced imaging techniques in children. Real-time MRI will be discussed as an entirely new imaging option for children, which can significantly reduce the need for sedation. State-of-the-art imaging of pediatric cartilage disorders will be illustrated. Best uses of photon counting CT in children will also be discussed, including technical parameters and protocol details.

#### **Sub-Events**

#### **W6-CPD08B Pediatric Cartilage Disorders: Not Always so Smooth**

Diego Jaramillo, MD, MPH (*Presenter*) Pfizer Consultant in a trial

#### **W6-CPD08C Real Time MRI in Pediatric Radiology**

Franz Wolfgang Hirsch, MD (*Presenter*) Nothing to Disclose

#### **W6-CPD08D Photocounting CT: How Can we Best use it in Children?**

Kelly K. Horst, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W6-CPD08B

### **Pediatric Cartilage Disorders: Not Always so Smooth**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S404

Diego Jaramillo, MD, MPH (*Presenter*) Pfizer Consultant in a trial

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CPD08C

### Real Time MRI in Pediatric Radiology

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S404

Franz Wolfgang Hirsch, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CPD08D

### **Photocounting CT: How Can we Best use it in Children?**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S404

Kelly K. Horst, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CRO05

### Prostate Cancer Case Based Multidisciplinary Review

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S402

Tristan Barrett, MBBS, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To understand the typical imaging findings of prostate cancer on mpMRI. 2) To assess the impact of MRI on staging prostate cancer in a multidisciplinary setting. 3) To assess the role of imaging in the diagnosis of prostate cancer through case examples.

#### COURSE DESCRIPTION

This course uses a case-based approach to diagnostic and management decision making in the work-up of patients presenting with prostate cancer. The panel includes radiologists, urologists and radiation oncologists.

#### Sub-Events

##### **W6-CRO05B Prostate Cancer Case Based Multidisciplinary Review**

Angela Y. Jia, MD, PhD (*Presenter*) Nothing to Disclose

##### **W6-CRO05C Prostate Cancer Case Based Multidisciplinary Review**

Michael Leapman, MD (*Presenter*) Nothing to Disclose

##### **W6-CRO05D Prostate Cancer Case Based Multidisciplinary Review**

Andrei S. Purysko, MD (*Presenter*) Contract, Profound Medical Inc;Research support, Blue Earth Diagnostics Ltd;Consultant, KOELIS;

##### **W6-CRO05E Prostate Cancer Case Based Multidisciplinary Review**

Tyler Seibert, MD, PhD (*Presenter*) Research Consultant, Cortechs.ai;Scientific Advisory Board, Cortechs.ai;Stock options, Cortechs.ai;Travel support, Siemens AG;Speaker, Siemens AG;Institutional research agreement, General Electric Company

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## Abstract Archives of the RSNA, 2023

W6-CRO05B

### **Prostate Cancer Case Based Multidisciplinary Review**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S402

Angela Y. Jia, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CRO05C

### **Prostate Cancer Case Based Multidisciplinary Review**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S402

Michael Leapman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-CRO05D

### **Prostate Cancer Case Based Multidisciplinary Review**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S402

Andrei S. Purysko, MD (*Presenter*) Contract, Profound Medical Inc; Research support, Blue Earth Diagnostics Ltd; Consultant, KOELIS;

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## Abstract Archives of the RSNA, 2023

W6-CRO05E

### Prostate Cancer Case Based Multidisciplinary Review

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S402

Tyler Seibert, MD, PhD (*Presenter*) Research Consultant, Cortechs.ai;Scientific Advisory Board, Cortechs.ai;Stock options, Cortechs.ai;Travel support, Siemens AG;Speaker, Siemens AG;Institutional research agreement, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CRT07

**ASRT@RSNA: Reflection in Practice: An Approach for Reducing Patients Radiation Dose (Supported in part by an Independent Medical Education Grant from Bayer HealthCare Pharmaceuticals Inc.)**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Explain reflective practice, its purpose, and the reflective cycle. 2) Discuss the three components of reflective practice and four levels of individual reflection. 3) Apply reflection before, during, and after practice.

### COURSE DESCRIPTION

Reflective practice is a term coined by Donald Schon in the 1980s, which is based in the idea that practitioners should think about what they are doing while they are doing it. Reflective practice is based on identifying a problem and devising ways to address the problem, thereby formulating best practice. It results in the development of profession practice into professional artistry. The reflective cycle, along with the application of the reflection before, during, and after practice, lends the ability to evaluate one's practice critically, thereby reducing errors. This approach can be used to reduce patients' radiation dose. This lecture will address practical applications of reflective practice.

### Sub-Events

**W6-CRT07BASRT@RSNA: Reflection in Practice: An Approach for Reducing Patients? Radiation Dose**

Sean Richardson, RT, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CRT07B

**ASRT@RSNA: Reflection in Practice: An Approach for Reducing Patients? Radiation Dose**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N230B

Sean Richardson, RT, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CVA04

### Peripheral Vascular Imaging

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N226

Dominik Fleischmann, MD (*Moderator*) Research Grant, Siemens AG; Stockholder, iSchemaView, Inc; Stockholder, Segmed, Inc  
Dominika Sucha, MD, PhD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand the principles, techniques, and roles of peripheral vascular CTA and MRA. 2) Characterize vascular pathologies in thoracic outlet syndrome (TOS) and peripheral arterial disease (PAD). 3) Understand clinical implications and applications of peripheral vascular imaging in endovascular treatment planning.

#### COURSE DESCRIPTION

This educational course emphasizes the importance of peripheral vascular imaging in diagnosing and characterizing vascular conditions affecting the upper and lower extremities and highlights how vascular imaging contributes to endovascular treatment planning. Global peripheral vascular disease burden is high and substantially contributes to major cardiovascular event rate. With increasing endovascular treatment options, anatomic assessment is important. Imaging peripheral vessels, however, presents significant challenges, requiring a comprehensive understanding of acquisition techniques for optimal patient assessment. Participate and gain insights to support clinical decisions effectively.

#### Sub-Events

##### W6-CVA04C Thoracic Outlet Syndrome

Constantine A. Raptis, MD (*Presenter*) Nothing to Disclose

##### W6-CVA04D Upper and Lower Extremity CTA

Richard L. Hallett II, MD (*Presenter*) Consultant, Bracco Group

##### W6-CVA04E Upper and Lower Extremity MRA

Nanda Deepa Thimmappa, MD (*Presenter*) Nothing to Disclose

##### W6-CVA04F How Imaging Enables Endovascular Treatment in Peripheral Artery Disease

Jeffrey D. Jaskolka, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CVA04C

### **Thoracic Outlet Syndrome**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N226

Constantine A. Raptis, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CVA04D

### Upper and Lower Extremity CTA

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N226

Richard L. Hallett II, MD (*Presenter*) Consultant, Bracco Group

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-CVA04E

### Upper and Lower Extremity MRA

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N226

Nanda Deepa Thimmappa, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-CVA04F

### How Imaging Enables Endovascular Treatment in Peripheral Artery Disease

Wednesday, Nov. 29 1:30PM - 2:30PM Room: N226

Jeffrey D. Jaskolka, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-RCP07

### RSNA/ESR Symposium: Imaging of Neurodegenerative Disorders - Movement Disorders

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E450B

Meike W. Vernooij, MD, PhD (*Moderator*) Nothing to Disclose  
Kejal Kantarci, MD (*Moderator*) Research support, Eli Lilly and Company;Consultant, Biogen Idec Inc

#### LEARNING OBJECTIVES

1) Explain the current use of MRI in Lewy body disease and movement disorders. 2) Explain the current use of molecular imaging in Lewy body disease and movement disorders. 3) Demonstrate structured selection and assessment of imaging exams through cases.

#### COURSE DESCRIPTION

Structural MRI and molecular imaging techniques are key modalities in the diagnosis (and increasingly also in early detection) of neurodegenerative disorders. This session is part of an educational ESR-RSNA transatlantic course (of 4 sessions in total) that discusses imaging in neurodegeneration, from basics to advanced applications. This third educational session will discuss how MRI and molecular imaging techniques can be used to understand the underlying pathology in patients with Parkinson's Disease, atypical parkinsonism and other movement disorders. This session will give general radiologists and those interested in neuroradiology and nuclear medicine/molecular imaging the knowledge needed for appropriate selection and structured assessment of imaging exams in diagnostic work-up of movement disorders. The session format consists of in part lectures, followed by an interactive case-based discussion.

#### Sub-Events

##### W6-RCP07CMR Imaging in Movement Disorders

Stephane Lehericy, MD, PhD (*Presenter*) Research Grant, Biogen Idec Inc;Consultant, F. Hoffmann-La Roche Ltd

##### W6-RCP07D Molecular Imaging in Movement Disorders

Kejal Kantarci, MD (*Presenter*) Research support, Eli Lilly and Company;Consultant, Biogen Idec Inc

##### W6-RCP07E Movement Disorders: Interactive Case Discussion

Stephane Lehericy, MD, PhD (*Presenter*) Research Grant, Biogen Idec Inc;Consultant, F. Hoffmann-La Roche Ltd

##### W6-RCP07F Movement Disorders: Interactive Case Discussion

Kejal Kantarci, MD (*Presenter*) Research support, Eli Lilly and Company;Consultant, Biogen Idec Inc

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## Abstract Archives of the RSNA, 2023

W6-RCP07C

### **MR Imaging in Movement Disorders**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E450B

Stephane Lehericy, MD, PhD (*Presenter*) Research Grant, Biogen Idec Inc; Consultant, F. Hoffmann-La Roche Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-RCP07D

### **Molecular Imaging in Movement Disorders**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E450B

Kejal Kantarci, MD (*Presenter*) Research support, Eli Lilly and Company; Consultant, Biogen Idec Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-RCP07E

### **Movement Disorders: Interactive Case Discussion**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E450B

Stephane Lehericy, MD, PhD (*Presenter*) Research Grant, Biogen Idec Inc; Consultant, F. Hoffmann-La Roche Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-RCP07F

### **Movement Disorders: Interactive Case Discussion**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E450B

Kejal Kantarci, MD (*Presenter*) Research support, Eli Lilly and Company; Consultant, Biogen Idec Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CHN04

### Cranial Nerve Deficits - A Symptom Based Session

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450A

Remy R. Lobo, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Identify various causes of cranial nerve deficits based on clinical features and imaging findings.

#### COURSE DESCRIPTION

This lecture series will explore various clinical imaging scenarios with special focus on cranial neuropathies. Several classic entities as well as more rare pathologies will be shared on this whirlwind through the skull base! Come join us to deepen your understanding (and enjoyment) of Head & Neck imaging!

#### Sub-Events

##### **W7- CHN04B**      **Anosmia**

Katie S. Traylor, DO (*Presenter*) Nothing to Disclose

##### **W7- CHN04C**      **Hoarseness Plus?: Upper vs. Lower Vagal Neuropathy**

Alok A. Bhatt, MD (*Presenter*) Nothing to Disclose

##### **W7- CHN04D**      **Tinnitus**

Katherine L. Reinshagen, MD, FRCPC (*Presenter*) Nothing to Disclose

##### **W7- CHN04E**      **Dysarthria: Hypoglossal Nerve Palsy**

Xin Wu, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CHN04B

### **Anosmia**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450A

Katie S. Traylor, DO (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-CHN04C

### **Hoarseness Plus?: Upper vs. Lower Vagal Neuropathy**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450A

Alok A. Bhatt, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CHN04D

### **Tinnitus**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450A

Katherine L. Reinshagen, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CHN04E

### **Dysarthria: Hypoglossal Nerve Palsy**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450A

Xin Wu, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIN25

### Writing AI Abstracts: Tips for Success

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S401

Ali S. Tejani, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Understand key elements of an abstract on artificial intelligence (AI) in imaging. 2) Learn to structure an abstract using pertinent components of the Checklist for Artificial Intelligence in Medical Imaging (CLAIM). 3) Identify and correct errors in example imaging AI abstracts. 4) Evaluate example abstracts to augment one's skills as a reviewer.

#### COURSE DESCRIPTION

It can be daunting to write a concise, yet sufficiently detailed abstract about a radiology artificial intelligence (AI) application. Abstracts often lack key information that allows readers to determine the quality and reproducibility of the submitted work. This session will help participants improve the quality of abstracts they submit to journals and conferences. Presenters will introduce the Checklist for Artificial Intelligence in Medical Imaging (CLAIM), share their experiences as AI abstract reviewers, describe best practices, and identify frequently seen errors. Participants will be equipped to build upon this course's lessons to write high-quality abstracts and to serve as abstract reviewers. This session will feature both a discussion with an expert panel and an interactive session to allow participants to evaluate and edit intentionally flawed AI abstracts.

#### Sub-Events

##### W7-CIN25B Key Elements of an Imaging AI Abstract

Ali S. Tejani, MD (*Presenter*) Nothing to Disclose

##### W7-CIN25C Applying the CLAIM Guideline

John D. Mayfield, MD, MS (*Presenter*) Nothing to Disclose

##### W7-CIN25D Identifying Gaps in Imaging AI Abstracts

Merel Huisman, MD, PhD (*Presenter*) Nothing to Disclose

##### W7-CIN25E Improving Your Skills as a Reviewer

Linda Moy, MD (*Presenter*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

##### W7-CIN25F Critical Thinking: Putting it all Together

Charles E. Kahn JR, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIN25B

### **Key Elements of an Imaging AI Abstract**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S401

Ali S. Tejani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIN25C

### Applying the CLAIM Guideline

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S401

John D. Mayfield, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIN25D

### Identifying Gaps in Imaging AI Abstracts

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S401

Merel Huisman, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIN25E

### **Improving Your Skills as a Reviewer**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S401

Linda Moy, MD (*Presenter*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-CIN25F

### **Critical Thinking: Putting it all Together**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S401

Charles E. Kahn JR, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIR10

### Cholangiocarcinoma and Oligometastatic Disease

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S501

Muneeb Ahmed, MD (*Moderator*) Stockholder, Agile Devices, Inc;Scientific Advisory Board, Agile Devices, Inc;Consultant, Canon Medical Systems Corporation;Consultant, RevOps Health, Inc;

#### LEARNING OBJECTIVES

1) Explain current criteria used to determine whether patients with liver metastases can undergo surgical resection. 2) Explain how hepatic venous deprivation is performed and when it should be used to induce pre-operative liver hypertrophy. 3) Be familiar with current clinical outcome data for thermal ablation, TACE, and Y90-TARE used to treat intrahepatic cholangiocarcinoma and colorectal liver metastases. 4) Explain how Interventional Radiology treatments are used in locally-advanced and metastatic pancreatic cancer.

#### COURSE DESCRIPTION

Interventional and surgical treatments for cholangiocarcinoma, hepatic colorectal metastases, and pancreatic cancer can lead to good clinical outcomes in well-selected patients. This lecture-based course will review how Interventional Oncology, Surgery, and Combined approaches are applied in these cancers, and the current clinical data in each of these diseases. Attendees of this course will learn how interventional radiology and surgery can be used and combined to achieve optimal patient outcomes, and will be familiar with the most recent literature on these approaches.

#### Sub-Events

##### W7-CIR10B Criteria for Resectability for Metastatic Disease of the Liver

Kiran Turaga (*Presenter*) Nothing to Disclose

##### W7-CIR10C Portal Vein Embolization and Liver-Venous Deprivation

Muneeb Ahmed, MD (*Presenter*) Stockholder, Agile Devices, Inc;Scientific Advisory Board, Agile Devices, Inc;Consultant, Canon Medical Systems Corporation;Consultant, RevOps Health, Inc;

##### W7-CIR10D Colorectal Cancer Metastases

Nadine Abi-Jaoudeh, MD (*Presenter*) Institutional research collaboration, Koninklijke Philips NV;Institutional research collaboration, Teclison Limited;Intellectual property, Bruin Biosciences Inc;Owner, Bruin Biosciences Inc;Institutional research collaboration, Sirtex Medical Ltd

##### W7-CIR10E Ablative Therapy in Cholangiocarcinoma

Alda L. Tam, MD (*Presenter*) Consultant, Johnson & Johnson;Research Grant, Boston Scientific Corporation;Research Grant, Johnson & Johnson;Consultant, AstraZeneca PLC;Consultant, Endocare, Inc;

##### W7-CIR10F Embolotherapy in Cholangiocarcinoma

Nima Kokabi, MD (*Presenter*) Research support, Sirtex Medical Ltd;Consultant, Sirtex Medical Ltd;;

##### W7-CIR10G Locally Advanced and Metastatic Pancreatic Cancer

Govindarajan Narayanan, MD (*Presenter*) Consultant, AngioDynamics, Inc;Consultant, Boston Scientific Corporation;Consultant, Stryker Corporation;Consultant, Agilent Technologies, Inc

## Abstract Archives of the RSNA, 2023

W7-CIR10B

### Criteria for Resectability for Metastatic Disease of the Liver

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S501

Kiran Turaga (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIR10C

### Portal Vein Embolization and Liver-Venous Deprivation

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S501

Muneeb Ahmed, MD (*Presenter*) Stockholder, Agile Devices, Inc; Scientific Advisory Board, Agile Devices, Inc; Consultant, Canon Medical Systems Corporation; Consultant, RevOps Health, Inc;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIR10D

### Colorectal Cancer Metastases

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S501

Nadine Abi-Jaoudeh, MD (*Presenter*) Institutional research collaboration, Koninklijke Philips NV; Institutional research collaboration, Teclison Limited; Intellectual property, Bruin Biosciences Inc; Owner, Bruin Biosciences Inc; Institutional research collaboration, Sirtex Medical Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIR10E

### **Ablative Therapy in Cholangiocarcinoma**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S501

Alda L. Tam, MD (*Presenter*) Consultant, Johnson & Johnson; Research Grant, Boston Scientific Corporation; Research Grant, Johnson & Johnson; Consultant, AstraZeneca PLC; Consultant, Endocare, Inc;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIR10F

### **Embolotherapy in Cholangiocarcinoma**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S501

Nima Kokabi, MD (*Presenter*) Research support, Sirtex Medical Ltd; Consultant, Sirtex Medical Ltd;;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CIR10G

### Locally Advanced and Metastatic Pancreatic Cancer

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S501

Govindarajan Narayanan, MD (*Presenter*) Consultant, AngioDynamics, Inc; Consultant, Boston Scientific Corporation; Consultant, Stryker Corporation; Consultant, Agilent Technologies, Inc

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-CMS04

### **Contrast Enhanced Ultrasound (CEUS) - A Problem-Solving Tool (Supported in part by an Unrestricted Medical Education Grant from GE Healthcare, Inc.)**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406A

Andrej Lyshchik, MD, PhD (*Moderator*) Royalties, RELX; Speaker, General Electric Company; Consultant, General Electric Company; Research support, General Electric Company; Consultant, BioClinica, Inc; Consultant, WCC, Inc; Consultant, Bracco Group; Advisory Board, Bracco Group

#### **LEARNING OBJECTIVES**

1) Explain the current clinical applications of contrast-enhanced ultrasound in radiology.

#### **COURSE DESCRIPTION**

Identify learning strategies to translate contrast-enhanced ultrasound applications into clinical practice.

#### **Sub-Events**

##### **W7- CMS04B**      **Interventional CEUS**

Andrej Lyshchik, MD, PhD (*Presenter*) Royalties, RELX; Speaker, General Electric Company; Consultant, General Electric Company; Research support, General Electric Company; Consultant, BioClinica, Inc; Consultant, WCC, Inc; Consultant, Bracco Group; Advisory Board, Bracco Group

##### **W7- CMS04C**      **Vascular CEUS**

John S. Pellerito, MD (*Presenter*) Nothing to Disclose

##### **W7- CMS04D**      **Scrotal CEUS**

Paul S. Sidhu, BSc, FRCR (*Presenter*) Consultant, Samsung Electronics Co, Ltd; Speaker, Samsung Electronics Co, Ltd; Speaker, Bracco Group; Consultant, Itreas Ltd; Speaker, Siemens AG

##### **W7- CMS04E**      **Liver and Renal Nonvascular CEUS**

David T. Fetzer, MD (*Presenter*) Research support, General Electric Company; Research support, Koninklijke Philips NV; Research support, Siemens AG; Consultant, Koninklijke Philips NV; Advisory Board, Koninklijke Philips NV; Consultant, General Electric Company; Advisory Board, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CMS04B

### Interventional CEUS

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406A

Andrej Lyshchik, MD, PhD (*Presenter*) Royalties, RELX; Speaker, General Electric Company; Consultant, General Electric Company; Research support, General Electric Company; Consultant, BioClinica, Inc; Consultant, WCC, Inc; Consultant, Bracco Group; Advisory Board, Bracco Group

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CMS04C

### **Vascular CEUS**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406A

John S. Pellerito, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CMS04D

### Scrotal CEUS

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406A

Paul S. Sidhu, BSc, FRCR (*Presenter*) Consultant, Samsung Electronics Co, Ltd;Speaker, Samsung Electronics Co, Ltd;Speaker, Bracco Group;Consultant, Itreas Ltd;Speaker, Siemens AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CMS04E

### **Liver and Renal Nonvascular CEUS**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406A

David T. Fetzer, MD (*Presenter*) Research support, General Electric Company; Research support, Koninklijke Philips NV; Research support, Siemens AG; Consultant, Koninklijke Philips NV; Advisory Board, Koninklijke Philips NV; Consultant, General Electric Company; Advisory Board, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CNMMI06

### Neuroendocrine Theranostics

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E352

Terence Z. Wong, MD, PhD (*Moderator*) Consultant, General Electric Company

#### LEARNING OBJECTIVES

1) Learn applications, pitfalls, and recommendations for imaging neuroendocrine neoplasms with DOTATATE and MIBG radiotracers. 2) Understand clinical applications, patient selection, and the different practical aspects of treating patients with <sup>177</sup>Lu-DOTATATE and <sup>131</sup>I-MIBG radiopharmaceuticals.

#### COURSE DESCRIPTION

This course will include two lectures followed by a panel discussion. Theranostic approaches have been used to treat neuroendocrine tumors for decades, first using MIBG for imaging and therapy, and more recently somatostatin receptor based imaging and therapy with DOTATATE. This course will provide an update on the imaging and patient selection as well as practical aspects of providing these treatments.

#### Sub-Events

##### **W7-CNMMI06B** Molecular Imaging and Therapy for Neuroendocrine Neoplasms

Delphine L. Chen, MD (*Presenter*) Grant, Telix Pharmaceuticals Limited; *Speaker*, Telix Pharmaceuticals Limited

##### **W7-CNMMI06C** Molecular Imaging and Therapy of Pheochromocytoma and Paraganglioma

Amir Iravani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

W7-CNMMI06B

### **Molecular Imaging and Therapy for Neuroendocrine Neoplasms**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E352

Delphine L. Chen, MD (*Presenter*) Grant, Telix Pharmaceuticals Limited; *Speaker*, Telix Pharmaceuticals Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CNMMI06C

### **Molecular Imaging and Therapy of Pheochromocytoma and Paraganglioma**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E352

Amir Iravani, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-CNPM17

### Evaluating Economic Favorability and Outcomes of Imaging: Cost Effectiveness and Beyond

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E351

Stella Kang, MD, MSc (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Describe principles of cost effectiveness analysis, one of the major forms of economic evaluation. 2) Identify economic tools and methods to convey programmatic costs and projected impact on desired clinical goals. 3) Understand the role of economic evaluation in shaping policies and clinical practice internationally.

#### COURSE DESCRIPTION

How do we allocate resources towards programs and strategies that will make the biggest impact on gains in health? In this course, participants will understand principles underlying economic evaluation for healthcare. We will describe cost effectiveness analysis and its roots in outcomes as well as costs (both as an input and as an output reflecting downstream effects). We will also explore the forms of economic analyses that influence health policy and practices, both by government and locally by decision-makers of health systems. Practical tools and applications for imagers will be a major emphasis of the session.

#### Sub-Events

##### **W7-CNPM17B** A Brief Introduction to Economic Evaluation for Imaging

Stella Kang, MD, MSc (*Presenter*) Nothing to Disclose

##### **W7-CNPM17C** Cost-Effectiveness Analysis: How it Works in Imaging

Pari V. Pandharipande, MD, MPH (*Presenter*) I serve as a member of the Association of University Radiologists (AUR) General Electric (GE) Radiology Research Academic Fellowship (GERRAF) Board of Review (term: 7/1/22-2/28/23).

##### **W7-CNPM17D** How Do Health Systems and Payers Use Cost Effectiveness to Inform Health Care Decisions about Imaging?

Bart Ferket, MD, PhD (*Presenter*) Nothing to Disclose

##### **W7-CNPM17E** LungPlan: Financial Planning for Your Lung Cancer Screening and Incidental Lung Nodule Programs

Ella A. Kazerooni, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CNPM17B

### **A Brief Introduction to Economic Evaluation for Imaging**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E351

Stella Kang, MD, MSc (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CNPM17C

### **Cost-Effectiveness Analysis: How it Works in Imaging**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E351

Pari V. Pandharipande, MD, MPH (*Presenter*) I serve as a member of the Association of University Radiologists (AUR) General Electric (GE) Radiology Research Academic Fellowship (GERRAF) Board of Review (term: 7/1/22-2/28/23).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CNPM17D

### **How Do Health Systems and Payers Use Cost Effectiveness to Inform Health Care Decisions about Imaging?**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E351

Bart Ferket, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CNPM17E

### **LungPlan: Financial Planning for Your Lung Cancer Screening and Incidental Lung Nodule Programs**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E351

Ella A. Kazerooni, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CRT02

### **ASRT@RSNA: Leading and Developing Remote Imaging in a Radiology Department**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N230B

Susie M. Moseley, MS, RT (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Understand the general challenges and benefits of remote imaging. 2) Identify safety and regulatory aspects of remote imaging. 3) Develop and implement a plan to incorporate remote technology in your radiology department or imaging center.

#### **COURSE DESCRIPTION**

Remote Scanning or Remote Imaging has been an increasingly important topic of radiology meetings and discussion boards, especially regarding CT and MRI. With the technical improvements over the years, it has become feasible to image a patient from a remote location. This session will discuss the overall challenges and benefits of remote scanning in the radiology department, as well as the various leadership perceptions of remote scanning, from vendor solutions to the technologists' implementation of the technology. Our discussion will also include the important safety aspects of remote scanning in general terms for radiology and more specific details of safety regulations with CT and MRI. Other topics will include how remote imaging currently and, in the future, can serve as an adjunct in supporting leaders' ability to increase staff coverage, competence, retention, and improved department safety profiles.

#### **Sub-Events**

#### **W7-CRT02B Leading and Developing Remote Imaging in a Radiology Department**

Paul McElvogue, ARRT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-CRT02B

### **Leading and Developing Remote Imaging in a Radiology Department**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N230B

Paul McElvogue, ARRT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-RCP08

### RSNA/ESR Symposium: Imaging of Neurodegenerative Disorder - The Next Frontier in Imaging in Neurodegeneration

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450B

Alexander Drzezga, MD (*Moderator*) Research support, Siemens AG ;Research support, Life Molecular Imaging;Research support, General Electric Company;Research support, Eli Lilly and Company;Research support, Eisai Co, Ltd;Consultant, Siemens AG ;Consultant, General Electric Company  
Yoshimi Anzai, MD, MPH (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) To describe the changing role of anatomical and molecular imaging for patients with neurodegenerative disorders, and the shift from nosological diagnosis to a biomarker-defined diagnosis. 2) To identify newest developments in PET tracers for specific neurodegenerative diseases. 3) To explain the role of advances in AI and imaging hardware in the diagnosis of neurodegenerative disease.

#### COURSE DESCRIPTION

Structural MRI and molecular imaging techniques are key modalities in the diagnosis (and increasingly also in early detection) of neurodegenerative disorders. This session is part of an educational ESR-RSNA transatlantic course (of 4 sessions in total) that discusses imaging in neurodegeneration, from basics to advanced applications. This final educational session will give a broader perspective of in which direction the field of imaging in neurodegeneration is moving, including biomarker-based diagnoses, advanced hardware and software applications for novel imaging and AI-based diagnoses.

#### Sub-Events

##### W7-RCP08C The Future of your Dementia Imaging Practice: MRI

Yoshimi Anzai, MD, MPH (*Presenter*) Nothing to Disclose

##### W7-RCP08D The Future of your Dementia Imaging Practice: PET

Javier Arbizu Lostao, MD, PhD (*Presenter*) Speaker, F. Hoffmann-La Roche Ltd;Speaker, Novartis AG;Speaker, General Electric Company;Research Grant, Siemens AG;Speaker, Life Molecular Imaging GmbH;Speaker, Biogen Idec Inc

##### W7-RCP08E To Infinity and Beyond: Disruptive Software and Hardware Developments for Imaging Neurodegeneration

Ciprian Catana, PhD, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-RCP08C

### **The Future of your Dementia Imaging Practice: MRI**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450B

Yoshimi Anzai, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-RCP08D

### **The Future of your Dementia Imaging Practice: PET**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450B

Javier Arbizu Lostao, MD, PhD (*Presenter*) Speaker, F. Hoffmann-La Roche Ltd; Speaker, Novartis AG; Speaker, General Electric Company; Research Grant, Siemens AG; Speaker, Life Molecular Imaging GmbH; Speaker, Biogen Idec Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-RCP08E

### **To Infinity and Beyond: Disruptive Software and Hardware Developments for Imaging Neurodegeneration**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E450B

Ciprian Catana, PhD, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-RCP16

### Achieving Health Equity and Care Delivery Through Sustainable Community Partnerships in Radiology (Sponsored by the RSNA Health Equity Committee)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N228

Efren J. Flores, MD (*Moderator*) Speaker, WebMD LLC; Speaker, Consulting Medical Associates, Inc  
Somiah Almecky, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Participants will learn the best practices to foster trust and longitudinal relationships to establish meaningful partnerships between key community members and enhance effectiveness of collaborations. 2) Participants will be able to identify how to effectively engage with patients and community members to identify the social determinants of health that influence access to radiology care in their practice. 3) Participants will learn to bring in a cultural lens to community engagement to foster bi-directional learning, learn to acknowledge and respect the distinctive values of individuals coming from diverse communities. 4) Participants will be able to describe the importance of Community-Based Participatory Research in health equity efforts and other community-based grass roots efforts and outreach that can be employed in the advancement of program development to advance health equity.

#### COURSE DESCRIPTION

In many instances, radiologists are seeking opportunities to learn practical ways to engage in community outreach in their practices. This session will provide participants with an opportunity to participate in an interactive session with radiologists and community organizations that have successfully established meaningful partnerships that foster trust and longitudinal partnerships to advance health equity and care delivery transformation in radiology. Radiology practices and the communities of the patients they serve are directly impacted by the social determinants of health that influence their radiology care. Radiology is a leader in healthcare innovation and care delivery transformation, but often the communities served are not included in the creative process or implementation of novel care models and technologies aimed to benefit them. Therefore, the implementation of new technologies in radiology without the input of the community creates a disconnect that ultimately results in the health disparities we see in our radiology practices. Meaningful community engagement requires working transdisciplinary collaborations that breaks silos between healthcare, public health, and community health sectors. This type of engagement is one that foster trusts and sustainable relationships that result in community partnerships and coalitions across healthcare organizations to serve as catalysts for transformational change in radiology. Thus, the purpose of this session is to engage in an interactive session with the audience and members of the panel in a discussion on how to successfully form community partnerships between radiologists and community organizations. The Chicago Southwest Organizing Project (SWOP) is a local transdisciplinary community organization that is collaborating with the RSNA Health Equity Committee representative members will be invited to participate in this session as well as radiologists that have successfully established community relationships in their practices and improve access to care. Leveraging the National Academy of Medicine framework for Health Equity and Community Engagement, topics to be covered will include: 1. Strengthening Community Partnerships Through Diversity, Inclusion and Trust 2. Designing and Implementing community-aligned programs to increase access to care. 3. Culturally-centered, sustainable partnerships to foster bi-directional learning 4. The role of community-based participatory research in guiding health equity efforts. 5. Transforming the radiology education experience and fostering well-being through community outreach experiences.

#### Sub-Events

##### W7-RCP16C Leveraging your Power to Build Health Equity with Communities

Priyanka Reddy, MD, MPH (*Presenter*) Nothing to Disclose

##### W7-RCP16D Opportunities for Community Engagement in Radiology Research

Lucy B. Spalluto, MD, MPH (*Presenter*) Nothing to Disclose

## **W7-RCP16E Creating Inclusive Spaces and Community Engagement through Art**

Daniel B. Chonde, MD, PhD (*Presenter*) Stockholder, Alkermes plcStockholder, Biogen Idec IncStockholder, Hologic, IncStockholder, Jaguar HealthStockholder, Mylan NVStockholder, Myomo IncStockholder, Novartis AGStockholder, Nuance Communications, IncStockholder, ResmedStockholder, Teladoc HealthStockholder, Teva Pharmaceutical Industries LtdStockholder, Uniqure NV

## **W7-RCP16F Improving Cancer Screening Access in Rural Communities**

Gwendolyn M. Bryant-Smith, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-RCP16C

### **Leveraging your Power to Build Health Equity with Communities**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N228

Priyanka Reddy, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-RCP16D

### **Opportunities for Community Engagement in Radiology Research**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N228

Lucy B. Spalluto, MD, MPH (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-RCP16E

### Creating Inclusive Spaces and Community Engagement through Art

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N228

Daniel B. Chonde, MD, PhD (*Presenter*) Stockholder, Alkermes plcStockholder, Biogen Idec IncStockholder, Hologic, IncStockholder, Jaguar HealthStockholder, Mylan NVStockholder, Myomo IncStockholder, Novartis AGStockholder, Nuance Communications, IncStockholder, ResmedStockholder, Teladoc HealthStockholder, Teva Pharmaceutical Industries LtdStockholder, Uniqure NV

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-RCP16F

### **Improving Cancer Screening Access in Rural Communities**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N228

Gwendolyn M. Bryant-Smith, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CBR11

### Multimodality Challenging Breast Cases

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406A

Steven P. Poplack, MD (*Moderator*) Faculty, Ultimate Opinions in Medicine LLC; Speaker, Efficiency Learning Systems Inc

#### LEARNING OBJECTIVES

1) Recognize digital tomosynthesis artifacts that mimic breast cancer. 2) Define the role of breast ultrasound in personalized breast cancer screening. 3) Understand when and how MRI can help manage patients presenting with breast symptoms.

#### COURSE DESCRIPTION

This is a case-based interactive educational session focused on challenging breast imaging cases. Each presentation will highlight diagnostic challenges and / or potential pitfalls inherent to each modality (DBT, US, MRI). This is relevant to clinical practice, wherein recognition of interpretive challenges is critical to establishing appropriate differential diagnosis and management. Whenever possible speakers will relate discussion and learning points to accepted peer reviewed standards. We look forward to a thought provoking session with active audience participation.

#### Sub-Events

##### W8-CBR11B Case Based Review: Challenging Cases with Focus on DBT

Steven P. Poplack, MD (*Presenter*) Faculty, Ultimate Opinions in Medicine LLC; Speaker, Efficiency Learning Systems Inc

##### W8-CBR11C Case Based Review: Challenging Cases with focus on US

Athina Vourtsi, MD (*Presenter*) Research Consultant, General Electric Company; Research Grant, General Electric Company; Educator, Arbutus Biopharma Corporation; Research collaboration, ScreenPoint Medical BV; Medical Advisory Board, Volpara Health Technologies Limited

##### W8-CBR11D Case Based Review: Challenging Cases with Focus on MRI

Priscilla J. Slanetz, MD, MPH (*Presenter*) Royalties, Wolters Kluwer nv

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CBR11B

### Case Based Review: Challenging Cases with Focus on DBT

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406A

Steven P. Poplack, MD (*Presenter*) Faculty, Ultimate Opinions in Medicine LLC; Speaker, Efficiency Learning Systems Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CBR11C

### Case Based Review: Challenging Cases with focus on US

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406A

Athina Vourtsi, MD (*Presenter*) Research Consultant, General Electric Company; Research Grant, General Electric Company; Educator, Arbutus Biopharma Corporation; Research collaboration, ScreenPoint Medical BV; Medical Advisory Board, Volpara Health Technologies Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CBR11D

### Case Based Review: Challenging Cases with Focus on MRI

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406A

Priscilla J. Slanetz, MD, MPH (*Presenter*) Royalties, Wolters Kluwer nv

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CCA10

### **The Cardiac Debate: Where on The Map is Parametric Mapping**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: N226

Jacobo Kirsch, MD, MBA (*Moderator*) Medical Advisory Board, Zebra Medical Vision Ltd

#### **LEARNING OBJECTIVES**

1. To list advantages and disadvantages of T1 mapping for diagnosis of cardiomyopathies. 2. To describe the most clinically useful applications of T1 mapping. 3. To recognize when T1 map does not add significant value to standard CMR study.

#### **COURSE DESCRIPTION**

This session is a debate on the topic of T1 mapping in CMR. Two experts in the field will present their opinion in favor or against the routine utilization of this CMR technique in clinical practice. A moderated discussion will then happen with participation from speakers and audience.

#### **Sub-Events**

##### **W8-CCA10B Parametric Mapping is all I Need**

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

##### **W8-CCA10C Parametric Mapping: Is It Necessary?**

Elsie Nguyen, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CCA10B

### **Parametric Mapping is all I Need**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: N226

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CCA10C

### **Parametric Mapping: Is It Necessary?**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: N226

Elsie Nguyen, MD, FRCPC (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W8-CCH09

### Thoracic Imaging in Select Populations

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E350

Santiago E. Rossi, MD (*Moderator*) Speaker, Boehringer Ingelheim GmbH

#### LEARNING OBJECTIVES

1) Improve knowledge and skills relevant to clinical practice. 2) Review new imaging concepts.

#### COURSE DESCRIPTION

The course will review imaging in both post transplantation and post lung surgery. It will also cover cardiac devices and congenital cardiac disease in adult population

#### Sub-Events

##### W8-CCH09B Imaging Patients Post Lung Surgery

Girish S. Shroff, MD (*Presenter*) Nothing to Disclose

##### W8-CCH09C Imaging Patients Post Lung Transplantation

Micheal McInnis, MD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH; Speakers Bureau, Bayer AG

##### W8-CCH09D Imaging Patients with Cardiac Devices

Claudio Silva, MD, MBA (*Presenter*) Nothing to Disclose

##### W8-CCH09E Imaging Adults with Congenital Cardiac Disease

Sanjeev Bhalla, MD (*Presenter*) Advisory Board, Precisa Gravimetrics AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CCH09B

### **Imaging Patients Post Lung Surgery**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E350

Girish S. Shroff, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CCH09C

### **Imaging Patients Post Lung Transplantation**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E350

Micheal McInnis, MD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH;Speakers Bureau, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CCH09D

### **Imaging Patients with Cardiac Devices**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E350

Claudio Silva, MD, MBA (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CCH09E

### **Imaging Adults with Congenital Cardiac Disease**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E350

Sanjeev Bhalla, MD (*Presenter*) Advisory Board, Precisa Gravimetrics AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CER15

### Emergency Radiology Practice Management in 2023: Health Equity, Sustainability, and Cost in the US and Europe

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E451B

Suzanne T. Chong, MD, MS (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Describe health equity as a Joint Commission national patient safety goal. 2) Explore ways in which radiology practices can contribute to achieving health equity. 3) Understand state of the EU for ER and discuss challenges to its growth and success. 4) Discuss sustainability and explore the business case for growing a thriving ER practice. 5) Realize the shared goals, values, and mission of ER in the US and Europe.

#### COURSE DESCRIPTION

As Emergency Radiology continues its growth and expansion in the US and around the world, its singular vantage point at the intersection of healthcare for all and 24/7 service provision highlights unique challenges in the domains of quality and sustainability, and sparks debate on the costs of doing business. In this session, we focus on health equity as a national patient safety goal, discuss the challenges facing our European colleagues as the global mandate for emergency radiology marches onward, and explore the business case for sustainability in successful ER practices.

#### Sub-Events

##### **W8-CER15B Sustainability and Cost: Building the Business Case for a Successful ER Practice**

Suzanne T. Chong, MD, MS (*Presenter*) Nothing to Disclose

##### **W8-CER15CA New National Patient Safety Goal: Department of Radiology**

Jinel A. Scott, MD (*Presenter*) Nothing to Disclose

##### **W8-CER15DER in Europe: Challenges and Opportunities**

Raffaella Basilico, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CER15B

### **Sustainability and Cost: Building the Business Case for a Successful ER Practice**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E451B

Suzanne T. Chong, MD, MS (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CER15C

### **A New National Patient Safety Goal: Department of Radiology**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E451B

Jinel A. Scott, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W8-CER15D

### **ER in Europe: Challenges and Opportunities**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E451B

Raffaella Basilio, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CGI11

### Case-Based Review of GI

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406B

Douglas S. Katz, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review a series of cases using interactive technology with the audience of various challenging patients. 2) Review a variety of disorders of the biliary tract, of COVID in the abdomen, or fluoroscopy applications and demonstration of disorders in the abdomen, and of the spleen and pancreas. 3) Understand the differential diagnosis of these conditions, if there is one, and the implications for patient management.

#### COURSE DESCRIPTION

Case-based interactive review of patients at various levels of difficult on various imaging modalities of the abdomen will be reviewed by experienced faculty for several organs/organ systems in the abdomen, with review of the current relevant literature. The expected outcome is that the learner/attendee will understand the differential diagnosis - if there is one (some of the cases may have just one diagnosis), and the implications for patient management.

#### Sub-Events

##### W8-CGI11B Biliary Cases

Jorge A. Soto, MD (*Presenter*) Nothing to Disclose

##### W8-CGI11C COVID Cases

Douglas S. Katz, MD (*Presenter*) Nothing to Disclose

##### W8-CGI11D Fluoroscopy

Linda N. Morimoto, MD (*Presenter*) Nothing to Disclose

##### W8-CGI11E Spleen

Khaled M. Elsayes, MD, PhD (*Presenter*) Nothing to Disclose

##### W8-CGI11F Pancreas

Abraham Fourie Bezuidenhout, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CGI11B

### **Biliary Cases**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406B

Jorge A. Soto, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CGI11C

### COVID Cases

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406B

Douglas S. Katz, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CGI11D

### Fluoroscopy

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406B

Linda N. Morimoto, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CGI11E

### Spleen

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406B

Khaled M. Elsayes, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CGI11F

### **Pancreas**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S406B

Abraham Fourie Bezuidenhout, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CIN20

### Connecting Imaging Systems, Workflows, and AI: An Overview of IHE Radiology

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S401

Brad Genereaux (*Moderator*) Employee, NVIDIA Corporation Faculty, Johns Hopkins University

#### LEARNING OBJECTIVES

1) Appreciate the role that IHE plays in connecting systems in the radiology technology ecosystem. 2) Understand the types of profiles and how they coherently form clinical working solutions. 3) Understand the constructs within IHE to quickly find the most pertinent information necessary to solve local business and clinical needs.

#### Sub-Events

##### W8-CIN20B Introduction

Seetharam C. Chadalavada, MD, MS (*Presenter*) Consultant, Cook Group Incorporated; Grant, Cook Group Incorporated; Speaker, Cook Group Incorporated; Consultant, Koninklijke Philips NV; Speaker, Koninklijke Philips NV

##### W8-CIN20C Insight-Driven Orders Workflows

R. Kent Hutson JR, MD (*Presenter*) Nothing to Disclose

##### W8-CIN20D Computer Vision-Augmented Acquisition and Smart Modality Workflow

Kevin O'Donnell (*Presenter*) Employee, Canon Medical Systems Corporation

##### W8-CIN20E AI-Augmented Reporting Workflow

Kinson Ho, MSc (*Presenter*) Employee, McKesson Corporation

##### W8-CIN20F Enterprise Imaging and Distribution Workflow

Ameena Elahi, MS, ARRT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W8-CIN20B

### Introduction

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S401

Seetharam C. Chadalavada, MD, MS (*Presenter*) Consultant, Cook Group Incorporated; Grant, Cook Group Incorporated; Speaker, Cook Group Incorporated; Consultant, Koninklijke Philips NV; Speaker, Koninklijke Philips NV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CIN20C

### **Insight-Driven Orders Workflows**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S401

R. Kent Hutson JR, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CIN20D

### Computer Vision-Augmented Acquisition and Smart Modality Workflow

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S401

Kevin O'Donnell (*Presenter*) Employee, Canon Medical Systems Corporation

Printed on: 08/22/24

## **Abstract Archives of the RSNA, 2023**

W8-CIN20E

### **AI-Augmented Reporting Workflow**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S401

Kinson Ho, MSc (*Presenter*) Employee, McKesson Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CIN20F

### **Enterprise Imaging and Distribution Workflow**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S401

Ameena Elahi, MS, ARRT (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CMK13

### Small Joints-Big Problems: Imaging of the Hands and Feet

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E450A

Tetyana A. Gorbachova, MD (*Moderator*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Review imaging features and technical and interpretational pitfalls in the diagnosis of the abnormalities of the small joints of the hand, wrist, and foot. 2) Analyze the biomechanics and clinical significance of injuries to the small joints of the upper and lower extremity.

#### COURSE DESCRIPTION

This course is composed of a series of lectures focused on imaging of the joints of the hand, wrist and foot, in a format of short didactic lectures and Q&A. Individual lectures will highlight the tips and pitfalls of imaging diagnosis of common conditions that occur in clinical practice.

#### Sub-Events

##### **W8-CMK13B MRI of the Thumb: Is it all about Stener Lesion?**

Tetyana A. Gorbachova, MD (*Presenter*) Nothing to Disclose

##### **W8-CMK13C Triangular Fibrocartilage Complex: Complex, but Not Triangular**

Donald L. Resnick, MD (*Presenter*) Nothing to Disclose

##### **W8-CMK13D Turf Toe: What is your Turf on Imaging it?**

Corrie M. Yablon, MD (*Presenter*) Nothing to Disclose

##### **W8-CMK13E Lesser Metatarsophalangeal Joints: Such Little Joints, so Much to Learn!**

Hilary R. Umans, MD (*Presenter*) Nothing to Disclose

##### **W8-CMK13F Lisfranc Joint Complex: Where is the Key?**

Yulia Melenevsky, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W8-CMK13B

### **MRI of the Thumb: Is it all about Stener Lesion?**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E450A

Tetyana A. Gorbachova, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CMK13C

### **Triangular Fibrocartilage Complex: Complex, but Not Triangular**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E450A

Donald L. Resnick, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W8-CMK13D

### **Turf Toe: What is your Turf on Imaging it?**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E450A

Corrie M. Yablon, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CMK13E

### **Lesser Metatarsophalangeal Joints: Such Little Joints, so Much to Learn!**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E450A

Hilary R. Umans, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CMK13F

### **Lisfranc Joint Complex: Where is the Key?**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E450A

Yulia Melenevsky, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CNR06

### **CRASH COURSE! Traumatic Injuries of the Brain, Cerebrovasculature, Orbits, and Skull Base**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E353B

Nancy Pham, MD (*Moderator*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Review the primary injury patterns of traumatic brain injuries and secondary injuries that can occur as complications of mass effect and herniation. When to use advanced neuroimaging as well as Identify and describe the mechanism associated with traumatic cerebrovascular injuries. 2) Review the imaging manifestations of various traumatic injuries of the orbits, potential complications, and the current imaging approach for evaluation. 3) Review the imaging manifestations of various traumatic injuries of the temporal bones, potential complications, and the current imaging approach for evaluation.

#### **COURSE DESCRIPTION**

This session is comprised of 4 high-yield lectures focused on the spectrum of traumatic imaging findings related to the brain, cerebrovasculature, orbits, and temporal bones. Discussion will address the relevant anatomy, interesting cases, potential complications, and current imaging strategies for evaluating these injuries.

#### **Sub-Events**

##### **W8-CNR06B Coup, Contrecoup, and Contusions**

Christopher T. Whitlow, MD, PhD (*Presenter*) Consultant, Biogen Idec Inc

##### **W8-CNR06C The Seatbelt Sign?**

Nancy Pham, MD (*Presenter*) Nothing to Disclose

##### **W8-CNR06D Fix this Blow Out and Flat Tire**

Tabassum A. Kennedy, MD (*Presenter*) Nothing to Disclose

##### **W8-CNR06EI was T-boned on the Petrous Ridge**

Osamu Sakai, MD, PhD (*Presenter*) Consultant, Boston Imaging Core Lab LLC

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CNR06B

### **Coup, Contrecoup, and Contusions**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E353B

Christopher T. Whitlow, MD, PhD (*Presenter*) Consultant, Biogen Idec Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CNR06C

### **The Seatbelt Sign?**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E353B

Nancy Pham, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CNR06D

### **Fix this Blow Out and Flat Tire**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E353B

Tabassum A. Kennedy, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CNR06E

### **I was T-boned on the Petrous Ridge**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: E353B

Osamu Sakai, MD, PhD (*Presenter*) Consultant, Boston Imaging Core Lab LLC

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W8-CPH08

### Practical Aspects of MRI

Wednesday, Nov. 29 4:30PM - 5:30PM Room: N229

Nicole Seiberlich, PhD (*Moderator*) Royalties, Siemens AG; Research support, Siemens AG

#### LEARNING OBJECTIVES

1) Describe how differences in contrast can be induced by the selection of particular pulse sequence settings to differentiate tissues using MRI. 2) Explain how data collection in MRI is related to image resolution and scan time, and make practical tradeoffs between these factors. 3) Describe several common artifacts encountered in MRI, what causes them, and how to mitigate them.

#### COURSE DESCRIPTION

In this course, comprised of three 20-minute lectures, practical aspects of deploying Magnetic Resonance Imaging will be discussed. The aim of this course is to help radiologists to better understand the basics of MRI, and why clinical MRI exams are structured the way that they are. A detailed understanding of MRI physics is not required. MRI is complex due to the large number of parameters that can be adjusted and the unexpected artifacts that can arise, especially in the presence of motion. Determining an appropriate protocol for a clinical question balances the need for contrast between healthy and diseased tissue, the speed of the individual sequences, exam length, and the incremental diagnostic utility provided by adding to the protocol. This course will tackle these questions by focusing on three topics: 1) image contrast, and how it is generated and used to discriminate different tissues; 2) image resolution and how it relates to data collection, and 3) common artifacts, their causes, and how to mitigate them.

#### Sub-Events

##### **W8-CPH08B** Image Contrast in MRI

Jesse I. Hamilton, PhD (*Presenter*) Nothing to Disclose

##### **W8-CPH08C** Resolution in MRI

Walter R. Witschey, PhD (*Presenter*) Nothing to Disclose

##### **W8-CPH08D** Managing Basic Artifacts

Catherine J. Moran, PhD (*Presenter*) Research support, General Electric Company

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## Abstract Archives of the RSNA, 2023

W8-CPH08B

### **Image Contrast in MRI**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: N229

Jesse I. Hamilton, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CPH08C

### **Resolution in MRI**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: N229

Walter R. Witschey, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-CPH08D

### Managing Basic Artifacts

Wednesday, Nov. 29 4:30PM - 5:30PM Room: N229

Catherine J. Moran, PhD (*Presenter*) Research support, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-RCP26

### Cardiothoracic Imaging What Drives the Field - Editor's Perspectives

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S402

Fernando U. Kay, MD, PhD (*Moderator*) Research Grant, Edwards Lifesciences Corporation  
Suhny Abbara, MD (*Moderator*) Royalties, RELX

#### LEARNING OBJECTIVES

1) To identify latest scientific trends and current and future developments in cardiothoracic Imaging. 2) Identify key topics of interest and educational and research opportunities in the fields of chest imaging, cardiovascular CT and cardiac MRI. 3) To give the editor's perspective on scholarly publishing trends and future needs in the field of cardiovascular and thoracic imaging.

#### COURSE DESCRIPTION

This program has Editors from several cardiovascular imaging journals share the latest and most impactful published science and educational articles in their respective journals and discuss current priorities and future directions and initiatives in their respective fields. The represented journals include Radiology CTI (RSNA), JCCT (SCCT Cardiac CT), JCMR (SCMR cardiovascular MRI) and JTI (STR Thoracic Imaging)

#### Sub-Events

##### W8-RCP26C Radiology: Cardiothoracic Imaging

Suhny Abbara, MD (*Presenter*) Royalties, RELX

##### W8-RCP26D Journal of Cardiovascular Magnetic Resonance

Tim Leiner, MD, PhD (*Presenter*) Research support, Pie Medical Imaging BV; Advisory Board, Cart-Tech BV; Advisory Board, AI4MedImaging; Advisor, Quantib BV; Consultant, Guerbet SA

##### W8-RCP26E Journal of Cardiovascular Computed Tomography

Armin A. Zadeh, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

##### W8-RCP26F Journal of Thoracic Imaging

U. Joseph Schoepf, MD, PhD (*Presenter*) Research Grant, Bayer AG; Research Grant, Bracco Group; Research Grant, Elucid BioImaging Inc; Consultant, Elucid BioImaging Inc; Research Grant: General Electric Company; Research Grant, Guerbet SA; Research Grant, Heartflow, Inc; Speakers Bureau, Heartflow Inc

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## Abstract Archives of the RSNA, 2023

W8-RCP26C

### **Radiology: Cardiothoracic Imaging**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S402

Suhny Abbara, MD (*Presenter*) Royalties, RELX

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## Abstract Archives of the RSNA, 2023

W8-RCP26D

### Journal of Cardiovascular Magnetic Resonance

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S402

Tim Leiner, MD, PhD (*Presenter*) Research support, Pie Medical Imaging BV; Advisory Board, Cart-Tech BV; Advisory Board, AI4MedImaging; Advisor, Quantib BV; Consultant, Guerbet SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W8-RCP26E

### **Journal of Cardiovascular Computed Tomography**

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S402

Armin A. Zadeh, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W8-RCP26F

### Journal of Thoracic Imaging

Wednesday, Nov. 29 4:30PM - 5:30PM Room: S402

U. Joseph Schoepf, MD, PhD (*Presenter*) Research Grant, Bayer AG;Research Grant, Bracco Group;Research Grant, Elucid BioImaging Inc;Consultant, Elucid BioImaging Inc;Research Grant: General Electric Company;Research Grant, Guerbet SA;Research Grant, Heartflow, Inc;Speakers Bureau, Heartflow Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSBR03

### Breast Imaging (Update on Breast Density and Risk)

Monday, Nov. 27 8:00AM - 9:00AM Room: E352

Thomas H. Helbich, MD, MBA (*Moderator*) Grant, Siemens AG; Grant, Bracco Group; Grant, Guerbet SA; Grant, Hologic, Inc; Grant, Novomed GmbH

Nisha Sharma, MBChB, FRCR (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M1-SSBR03-2 The Dual Role of Breast Density in Masking Cancers and Predicting Future Risk of Breast Cancer: What is the Impact?**

Elizabeth A. Morris, MD (*Presenter*) Scientific Advisory Board, Bracco Group; Speaker, Bayer AG; Scientific Advisory Board, Bayer AG; Speaker, Guerbet SA; Researcher, Guerbet SA; Stockholder, Revel Transit Inc; Stockholder, Kheiron Medical Technologies Ltd

#### PURPOSE

To assess the impact of mammographic breast density on masking cancers and predicting future risk of breast cancer in a large multi-facility screening mammography center.

#### METHODS AND MATERIALS

This retrospective study included 201,864 consecutive bilateral 2D full field digital screening mammograms from a multi-facility U.S.-based screening program from January 2011 through December 2016. Patient age, radiologist reported BI-RADS assessment (0-5), and breast density (dense (c+d) vs not dense (a+b)) were extracted from electronic medical records. Cancer outcomes and cancer type (pure DCIS vs any invasive breast cancer) were obtained from local tumor registries. Interval cancers were defined as exams with BI-RADS assessment of 1 or 2 followed by cancer diagnosis within one year. Age-adjusted cancer rates (observed cancers/exams) were compared by breast density category using odds ratios and 95% confidence intervals, using "not dense" as the reference group.

#### RESULTS

Patients with dense breast tissue had significantly higher odds than patients without dense breast tissue of an interval cancer (adjusted OR, 2.83; 95% CI, 2.05-3.96;  $p < .001$ ) and higher odds of a cancer diagnosis overall (adjusted OR, 1.38; 95% CI, 1.31-1.45;  $p < .001$ ). This trend was similar for both DCIS (adjusted OR, 1.53; 95% CI, 1.40-1.67;  $p < .001$ ) and for invasive cancers (adjusted OR, 1.33; 95% CI, 1.24-1.43;  $p < .001$ ).

#### CONCLUSION

Breast density impacts both interval cancer rates and overall cancer rates. The impact of breast density as a cancer masking agent appears stronger than as a breast cancer risk factor for DCIS and invasive cancer.

#### CLINICAL RELEVANCE/APPLICATION

Our findings support current language mandated by U.S. federal legislation for dual impact of breast density on cancer masking and risk prediction, and suggest the impact on masking is greater than the impact on future risk of cancer.

#### **M1-SSBR03-3 Molecular Breast Imaging for Women with Dense Breasts: Results Update from the Density MATTERS Trial**

Carrie B. Hruska, PhD (*Presenter*) Institutional license agreement, CMR Naviscan Corporation; Researcher, Siemens AG

#### PURPOSE

To assess the performance of molecular breast imaging (MBI) relative to digital breast tomosynthesis (DBT) screening among asymptomatic women with dense breasts in the Density MATTERS trial (ClinicalTrials.gov NCT03220893).

## METHODS AND MATERIALS

Across five participating centers, women age 40-75 presenting for screening DBT, with dense breasts (ACR BI-RADS C or D) on last mammogram and no prior supplemental screening, were prospectively enrolled to undergo MBI over two annual screening rounds. MBI was performed with a dedicated dual-head CZT gamma camera and 300 MBq Tc-99m sestamibi (effective dose of 2 mSv). MQSA-certified radiologists independently interpreted DBT and MBI; positive findings on either led to integrated interpretation and possible workup. Performance of screening with DBT alone, MBI alone, and the combination of DBT with supplemental MBI was evaluated.

## RESULTS

Median age of participants at enrollment was 57 years. Among 2978 women completing initial screening, the rate of recall for diagnostic workup was 8.5% for DBT, 11.4% for MBI, and 17.9% for DBT plus MBI. Of 35 breast cancers diagnosed within 1 year of follow-up, DBT detected 13 (37%), MBI detected 25 (71%), and DBT plus MBI detected 33 (94%). The cancer detection rate (CDR) per 1000 screened was 4.4 for DBT alone, 8.4 for MBI alone, and 11.1 for DBT plus MBI. The rate of interval cancers per 1000 screened was 0.7 (2 of 2978). Twenty-three of 35 cancers were invasive: DBT detected 8 (35%), MBI detected 18 (78%), and DBT plus MBI detected 22 (96%). Cancers detected only by supplemental MBI were mostly invasive (14/20) with median size of 0.9 cm (range 0.2-2.6 cm). The proportion of biopsies resulting in cancer, PPV3, was 19.7% (13/66) for DBT, 22.3% (25/112) for MBI, and 22.1% (33/149) for DBT+MBI. At the second screening round, completed in 2456 women thus far, the rate of recall was 8.7% for DBT, 5.8% for MBI, and 13.3% for DBT plus MBI. Of 16 patients with cancers detected at second screening, DBT detected 10 (63%) and MBI detected 11 (69%). Seven of 16 cancers at second screen were invasive; DBT detected 3 of 7 invasive (44%) and MBI detected 6 of 7 invasive (85%).

## CONCLUSION

In women with dense breasts, MBI as a supplement to DBT provided an incremental CDR of 6.7 for all cancers and 4.7 for invasive cancers in the first screening round and continued to detect invasive cancers undetected on DBT in a second screening round. Recall rate of MBI was reduced by half from first to second screening round.

## CLINICAL RELEVANCE/APPLICATION

The 2.5-fold increase in invasive cancer detection and modest increase in recall rate provided by MBI in this multicenter trial supports use of MBI as a supplemental screening test for women with dense breasts.

## M1-SSBR03-4 Real World Use of Artificial Intelligence Risk Scores to Identify Women at High Risk for Breast Cancer with Subanalyses Based on Histopathology and Time of Detection

Axel Graewingholt, MD (*Presenter*) Research Consultant, iCad, Inc

## PURPOSE

To assess an Artificial Intelligence (AI) risk tool for identifying women as high risk on prior full field digital mammography (FFDM) exams who are detected with different breast cancer histopathologies within the next two years in biennial screening.

## METHODS AND MATERIALS

A retrospective case-control study was conducted at a single German institution with a double reading scenario between 2013 and 2016 (n= 53,453 screening exams) evaluating the 2-year risk scores of prior FFDM exams for screen-detected (n=205) and interval cancers (n=94). An imaging only AI risk model (iCAD ProFound AI® Risk) utilizes mammographic features, density and age at exam to provide a risk score enabling identification of women more likely to be diagnosed with breast cancer prior to or at next biennial screening exam. Women were considered high risk with a score of more than 1.2% absolute risk. Risk scores were evaluated on prior screens for all cancers subanalyzed by histopathology and for 355 non-cancer exams in same time period, with 4 years of cancer-free follow-up. Two-sample independent ANOVA was used for statistical analyses with 95% Confidence Intervals (CI).

## RESULTS

The algorithm identified 128 of 299 (42.8%) women who were high risk on the mammogram read as normal prior to cancer detection. The sample of 355 cancer-free women had 26 (7.3%) with high risk. Risk scores relative to screen-detected cancer (SDC) histopathology were analyzed for high risk on prior: 59 of 145 (40.7%) were invasive ductal (IDC), 15 of 23 (65.2%) were invasive lobular (ILC) and 13 of 37 (35.1%) were ductal carcinoma in situ (DCIS). For 94 interval cancers (IC): 3 of 4 (75%) DCIS and 38 of 90 (42.2%) invasive were high risk. Average risk for priors of 299 cancers was 1.29% (95%CI:1.21%-1.37%) and of 355 non-cancers 0.54% (95%CI:0.47%-0.61%), difference 0.75%, p<0.0001. Average risk on priors for 205 SDC was 1.23% (95%CI:1.10%-1.36%) vs average risk on priors of 94 IC was 1.42% (95%CI:1.23%-1.61%), difference 0.19%, p=0.1016. The average risk for priors of SDC was 1.21% (95%CI:1.07%-1.35%) for 145 IDC, 1.7% (95%CI:1.32%-2.08%) for 23 ILC and 0.98% (95%CL:0.69%-1.27%) for 37 DCIS, p=0.0085.

## CONCLUSION

An image-derived AI risk model can identify women who will have breast cancer detected within the next 2 years who have a 2.4 times (1.29%/0.54%) higher average risk score compared to women who remain cancer free. Average risk for invasive

cancers and particularly lobular cancers was higher than that of DCIS.

#### **CLINICAL RELEVANCE/APPLICATION**

Risk assessment with an AI risk tool in screening may be useful to stratify women with higher risk for supplemental screening or shortening intervals to detect cancers earlier without increasing overdiagnosis by overestimating DCIS.

#### **M1-SSBR03-5 Radiomics and Genomics: Image-Only Deep Learning Risk Model Performance Improves with Polygenic Risk Scores**

Leslie Lamb, MD, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Mammograms contain highly predictive biomarkers of future breast cancer risk, which can be identified by deep learning (DL) risk stratification models. Traditional risk assessment models have demonstrated improved performance with the inclusion of genetic risk variants. The purpose of this study is to assess the performance of an image-only DL model risk score with the addition of polygenic risk scores (PRS).

#### **METHODS AND MATERIALS**

This nested case-control study included participants undergoing routine bilateral 2D full field digital screening mammography across the US between 01/2001-01/2017, as part of the prospective Nurses' Health Study (NHSII). NHSII was established in 1989 and followed 116,429 female registered nurses aged 25-42 years over time with biennial questionnaires about diseases and health-related topics. DL and Gail five-year models were used to assess risk. PRS were calculated using 67 single nucleotide polymorphisms. Participants with a diagnosis of cancer within one month of mammogram were excluded. Patient demographics, mammograms, PRS, and cancer outcomes were collected as part of NHSII. DL and Gail model performance with and without PRS were compared using areas under the receiver operating characteristic curve (AUCs) unconditional logistic regression models with Delong test ( $p < 0.05$ ).

#### **RESULTS**

926 participants (350 cases of breast cancer, 576 controls) underwent screening mammography. 68 were had a diagnosis of breast cancer within one month of mammogram. 491, 67, and 54 were missing a PRS, Gail score, and DL score, respectively. 804 (268 cases, 536 controls) had DL score, 313 (110 cases, 203 controls) DL+PRS, 684 (220 cases, 464 controls) Gail score and 263 (94 cases, 169 controls) Gail+PRS. This resulted in a study population of 858 participants (282 cases, 576 controls). Mean age was 55.3y (SD 5.4y). All participants were White. 310 (36.1%) were pre-menopausal and 548 (63.8%) post-menopausal. 398 (46.3%) had non-dense and 457 (53.2%) had dense breasts. The AUC of DL model was 0.65 (95% CI: 0.61-0.70) vs 0.72 (95% CI 0.66-0.78) in DL+PRS ( $p < 0.05$ ). The AUC of Gail model was 0.50 (95% CI: 0.45-0.54) vs 0.68 (95% CI: 0.61-0.74) in Gail+PRS ( $p < 0.001$ ). The AUC of DL model was significantly higher than Gail model ( $p < 0.001$ ) however there was no evidence of a significant difference in DL+PRS vs Gail+PRS ( $p = 0.34$ ).

#### **CONCLUSION**

A screening mammography DL breast cancer risk assessment model has high risk discriminatory accuracy which can be improved with the addition of PRS.

#### **CLINICAL RELEVANCE/APPLICATION**

A DL image-only risk model derived automatically at the time of screening mammography, can be improved with genetic information. Identification of high-risk patients by DL model could assist in triaging women for genetic testing.

#### **M1-SSBR03-6 Performance of a Deep Learning Image Based 5-year Breast Cancer Risk Model Developed Across Global Imaging Centers that Provides a Percent Probability Output for Use in Existing Clinical Workflows and Decision Making**

Christiane K. Kuhl, MD, PhD (*Presenter*) Advisory Board, Guerbet SA; Speaker, Bracco Group; Speaker, Bayer AG

#### **PURPOSE**

To train, validate, test, and calibrate a deep learning, image-based five-year breast cancer risk prediction model in a multi-center international data consortium.

#### **METHODS AND MATERIALS**

This retrospective, multi-center international study included 318,101 consecutive bilateral 2D full field digital screening mammograms obtained from 129,498 patients between January 2007 and December 2016, after excluding exams that lacked five-year follow up. Test datasets, held out of model development, included 46,104 exams from Europe and the U.S., along with all 5,888 exams from South America. Patient demographics including age and race/ethnicity were retrieved from electronic medical records and cancer outcomes were obtained from local tumor registries. We leveraged a deep convolutional neural network using federated learning to create the DL model, which was trained to predict the development of breast cancer within five years of the mammogram, based only on the four standard mammography views (RCC, LCC, RMLO and

LMLO). A calibration algorithm was used to create percent probabilities of future cancer from the DL score. Model performance on each center's held-out test data sets was estimated using areas under the receiver operating characteristic curve (AUCs) with 95% CIs. To assess calibration, held-out test sets were combined and segmented into five equally sized bins based on increasing predicted risk, and used to generate observed-to-expected ratios (O/E ratios) with 95% CIs.

## RESULTS

We found point estimate AUCs consistently at or above 0.75 across centers. AUC by center: United States 0.75 [95% CI 0.74, 0.77] (n = 30,335); Europe 0.80 [95% CI 0.78, 0.82] (n = 15,769); and South America 0.80 [95% CI 0.77, 0.82] (n = 5,888). Observed-to-expected ratios overall and for spectrum of predicted low- to high-risk bins demonstrated strong calibration of the model with future cancer occurrence: overall 1.00 [95% CI 0.95, 1.06] (n = 52,981); first bin 1.01 [95% CI 0.76, 1.29] (n = 10,597), second bin 0.80 [95% CI 0.64, 0.98] (n = 10,596), third bin 1.04 [95% CI 0.90, 1.20] (n = 10,595), fourth bin 0.99 [95% CI 0.88, 1.11] (n = 10,596), fifth bin 1.03 [95% CI 0.96, 1.10] (n = 10,597).

## CONCLUSION

A deep learning model trained and calibrated on an international mammography screening consortium data resource, based on the screening mammogram alone, provides strong predictive accuracy (AUC of 0.75-0.80) and is well calibrated for use in current standard of care clinical workflows that rely on five-year breast cancer risk predictions.

## CLINICAL RELEVANCE/APPLICATION

A deep learning breast cancer risk model can be calibrated to provide five-year risk estimates to support more personalized screening and risk reduction interventions as recommended by clinical practice guidelines.

### **M1-SSBR03-7 Using Density-Specific Calibration of AI Thresholds in a Double-Reader Setting to Achieve Equal Sensitivity for Women With High Mammographic Density**

Haiko Schurz, BSc, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Higher mammographic density, BIRADS category C and D, is associated with lower radiologist sensitivity and increased risk of breast cancer. Artificial Intelligence Computer-Aided Detection (AI CAD) generates a continuous score translated to a normal/abnormal decision by thresholding. In this study, we explore whether the lower radiologist sensitivity could be counteracted by lowering the AI threshold for high density mammograms.

## METHODS AND MATERIALS

The Swedish platform for Validation of AI in Breast imaging (VAI-B) with mammograms from 2008-2021 was used. A three-year follow-up period with biopsy-verification defined the reference standard of breast cancer or healthy. Mammograms were processed by AI CAD (Lunit, South Korea) to produce a continuous abnormality score and a density class. We determined the sensitivity of the radiologist double reading for each density category. We then combined single radiologist assessment and AI calibrated to maintain sensitivity, first, overall, for the entire dataset and, second, re-calibrated to enforce the same sensitivity for density C and D as for density B. Finally, we compare the performance between the radiologist double-reading with single reader plus AI calibrated on overall-sensitivity, and with single reader plus AI calibrated to maintain sensitivity for density C and D.

## RESULTS

Overall, 38529 (upscaled to 972522) screening mammograms from 28580 healthy and 5773 women diagnosed with cancer were included in this study. The radiologist's double reading sensitivity was 52.8% overall and 63.4%, 56.4%, 48.6% 43.8% for density A, B, C and D respectively. Radiologist double-reading had 16.3 false positives per detected cancer (FP/C). Simulating double-reading by AI and one radiologist, calibrated to maintain overall sensitivity without taking density into account, reduced FP/C by 24.4% to 11.5. After re-calibrating to enforce that density B sensitivity (56.4%) was maintained for density C and D, the cancers detected increased by 7.5%, while the FP/C of 14.7 showed a decrease of 9.7% compared to radiologist double-reading and an increase of 19.5% compared to the density-ignorant AI workflow.

## CONCLUSION

Calibrating the AI threshold separately for each density category to ensure having the same sensitivity for women with density C and D as for with density B is feasible. Density-specific calibration would equalize sensitivity between density B, C and D, through a 7.5% increase in cancer detection at the cost of around 20% increase in false positives per cancer.

## CLINICAL RELEVANCE/APPLICATION

Implementing AI CAD systems with density-specific calibration could improve fairness of the screening system giving women with higher mammographic density an equal chance of screen-detection.

## Abstract Archives of the RSNA, 2023

M1-SSBR03-2

### **The Dual Role of Breast Density in Masking Cancers and Predicting Future Risk of Breast Cancer: What is the Impact?**

Monday, Nov. 27 8:00AM - 9:00AM Room: E352

Elizabeth A. Morris, MD (*Presenter*) Scientific Advisory Board, Bracco Group; Speaker, Bayer AG; Scientific Advisory Board, Bayer AG; Speaker, Guerbet SA; Researcher, Guerbet SA; Stockholder, Revel Transit Inc; Stockholder, Kheiron Medical Technologies Ltd

#### **PURPOSE**

To assess the impact of mammographic breast density on masking cancers and predicting future risk of breast cancer in a large multi-facility screening mammography center.

#### **METHODS AND MATERIALS**

This retrospective study included 201,864 consecutive bilateral 2D full field digital screening mammograms from a multi-facility U.S.-based screening program from January 2011 through December 2016. Patient age, radiologist reported BI-RADS assessment (0-5), and breast density (dense (c+d) vs not dense (a+b)) were extracted from electronic medical records. Cancer outcomes and cancer type (pure DCIS vs any invasive breast cancer) were obtained from local tumor registries. Interval cancers were defined as exams with BI-RADS assessment of 1 or 2 followed by cancer diagnosis within one year. Age-adjusted cancer rates (observed cancers/exams) were compared by breast density category using odds ratios and 95% confidence intervals, using "not dense" as the reference group.

#### **RESULTS**

Patients with dense breast tissue had significantly higher odds than patients without dense breast tissue of an interval cancer (adjusted OR, 2.83; 95% CI, 2.05-3.96;  $p < .001$ ) and higher odds of a cancer diagnosis overall (adjusted OR, 1.38; 95% CI, 1.31-1.45;  $p < .001$ ). This trend was similar for both DCIS (adjusted OR, 1.53; 95% CI, 1.40-1.67;  $p < .001$ ) and for invasive cancers (adjusted OR, 1.33; 95% CI, 1.24-1.43;  $p < .001$ ).

#### **CONCLUSION**

Breast density impacts both interval cancer rates and overall cancer rates. The impact of breast density as a cancer masking agent appears stronger than as a breast cancer risk factor for DCIS and invasive cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings support current language mandated by U.S. federal legislation for dual impact of breast density on cancer masking and risk prediction, and suggest the impact on masking is greater than the impact on future risk of cancer.

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## Abstract Archives of the RSNA, 2023

M1-SSBR03-3

### **Molecular Breast Imaging for Women with Dense Breasts: Results Update from the Density MATTERS Trial**

Monday, Nov. 27 8:00AM - 9:00AM Room: E352

Carrie B. Hruska, PhD (*Presenter*) Institutional license agreement, CMR Naviscan Corporation; Researcher, Siemens AG

#### **PURPOSE**

To assess the performance of molecular breast imaging (MBI) relative to digital breast tomosynthesis (DBT) screening among asymptomatic women with dense breasts in the Density MATTERS trial (ClinicalTrials.gov NCT03220893).

#### **METHODS AND MATERIALS**

Across five participating centers, women age 40-75 presenting for screening DBT, with dense breasts (ACR BI-RADS C or D) on last mammogram and no prior supplemental screening, were prospectively enrolled to undergo MBI over two annual screening rounds. MBI was performed with a dedicated dual-head CZT gamma camera and 300 MBq Tc-99m sestamibi (effective dose of 2 mSv). MQSA-certified radiologists independently interpreted DBT and MBI; positive findings on either led to integrated interpretation and possible workup. Performance of screening with DBT alone, MBI alone, and the combination of DBT with supplemental MBI was evaluated.

#### **RESULTS**

Median age of participants at enrollment was 57 years. Among 2978 women completing initial screening, the rate of recall for diagnostic workup was 8.5% for DBT, 11.4% for MBI, and 17.9% for DBT plus MBI. Of 35 breast cancers diagnosed within 1 year of follow-up, DBT detected 13 (37%), MBI detected 25 (71%), and DBT plus MBI detected 33 (94%). The cancer detection rate (CDR) per 1000 screened was 4.4 for DBT alone, 8.4 for MBI alone, and 11.1 for DBT plus MBI. The rate of interval cancers per 1000 screened was 0.7 (2 of 2978). Twenty-three of 35 cancers were invasive: DBT detected 8 (35%), MBI detected 18 (78%), and DBT plus MBI detected 22 (96%). Cancers detected only by supplemental MBI were mostly invasive (14/20) with median size of 0.9 cm (range 0.2-2.6 cm). The proportion of biopsies resulting in cancer, PPV3, was 19.7% (13/66) for DBT, 22.3% (25/112) for MBI, and 22.1% (33/149) for DBT+MBI. At the second screening round, completed in 2456 women thus far, the rate of recall was 8.7% for DBT, 5.8% for MBI, and 13.3% for DBT plus MBI. Of 16 patients with cancers detected at second screening, DBT detected 10 (63%) and MBI detected 11 (69%). Seven of 16 cancers at second screen were invasive; DBT detected 3 of 7 invasive (44%) and MBI detected 6 of 7 invasive (85%).

#### **CONCLUSION**

In women with dense breasts, MBI as a supplement to DBT provided an incremental CDR of 6.7 for all cancers and 4.7 for invasive cancers in the first screening round and continued to detect invasive cancers undetected on DBT in a second screening round. Recall rate of MBI was reduced by half from first to second screening round.

#### **CLINICAL RELEVANCE/APPLICATION**

The 2.5-fold increase in invasive cancer detection and modest increase in recall rate provided by MBI in this multicenter trial supports use of MBI as a supplemental screening test for women with dense breasts.

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## Abstract Archives of the RSNA, 2023

M1-SSBR03-4

### Real World Use of Artificial Intelligence Risk Scores to Identify Women at High Risk for Breast Cancer with Subanalyses Based on Histopathology and Time of Detection

Monday, Nov. 27 8:00AM - 9:00AM Room: E352

Axel Graewingholt, MD (*Presenter*) Research Consultant, iCad, Inc

#### PURPOSE

To assess an Artificial Intelligence (AI) risk tool for identifying women as high risk on prior full field digital mammography (FFDM) exams who are detected with different breast cancer histopathologies within the next two years in biennial screening.

#### METHODS AND MATERIALS

A retrospective case-control study was conducted at a single German institution with a double reading scenario between 2013 and 2016 (n= 53,453 screening exams) evaluating the 2-year risk scores of prior FFDM exams for screen-detected (n=205) and interval cancers (n=94). An imaging only AI risk model (iCAD ProFound AI® Risk) utilizes mammographic features, density and age at exam to provide a risk score enabling identification of women more likely to be diagnosed with breast cancer prior to or at next biennial screening exam. Women were considered high risk with a score of more than 1.2% absolute risk. Risk scores were evaluated on prior screens for all cancers subanalyzed by histopathology and for 355 non-cancer exams in same time period, with 4 years of cancer-free follow-up. Two-sample independent ANOVA was used for statistical analyses with 95% Confidence Intervals (CI).

#### RESULTS

The algorithm identified 128 of 299 (42.8%) women who were high risk on the mammogram read as normal prior to cancer detection. The sample of 355 cancer-free women had 26 (7.3%) with high risk. Risk scores relative to screen-detected cancer (SDC) histopathology were analyzed for high risk on prior: 59 of 145 (40.7%) were invasive ductal (IDC), 15 of 23 (65.2%) were invasive lobular (ILC) and 13 of 37 (35.1%) were ductal carcinoma in situ (DCIS). For 94 interval cancers (IC): 3 of 4 (75%) DCIS and 38 of 90 (42.2%) invasive were high risk. Average risk for priors of 299 cancers was 1.29% (95%CI:1.21%-1.37%) and of 355 non-cancers 0.54% (95%CI:0.47%-0.61%), difference 0.75%, p<0.0001. Average risk on priors for 205 SDC was 1.23% (95%CI:1.10%-1.36%) vs average risk on priors of 94 IC was 1.42% (95%CI:1.23%-1.61%), difference 0.19%, p=0.1016. The average risk for priors of SDC was 1.21% (95%CI:1.07%-1.35%) for 145 IDC, 1.7% (95%CI:1.32%-2.08%) for 23 ILC and 0.98% (95%CL:0.69%-1.27%) for 37 DCIS, p=0.0085.

#### CONCLUSION

An image-derived AI risk model can identify women who will have breast cancer detected within the next 2 years who have a 2.4 times (1.29%/0.54%) higher average risk score compared to women who remain cancer free. Average risk for invasive cancers and particularly lobular cancers was higher than that of DCIS.

#### CLINICAL RELEVANCE/APPLICATION

Risk assessment with an AI risk tool in screening may be useful to stratify women with higher risk for supplemental screening or shortening intervals to detect cancers earlier without increasing overdiagnosis by overestimating DCIS.

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## Abstract Archives of the RSNA, 2023

M1-SSBR03-5

### Radiomics and Genomics: Image-Only Deep Learning Risk Model Performance Improves with Polygenic Risk Scores

Monday, Nov. 27 8:00AM - 9:00AM Room: E352

Leslie Lamb, MD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Mammograms contain highly predictive biomarkers of future breast cancer risk, which can be identified by deep learning (DL) risk stratification models. Traditional risk assessment models have demonstrated improved performance with the inclusion of genetic risk variants. The purpose of this study is to assess the performance of an image-only DL model risk score with the addition of polygenic risk scores (PRS).

#### METHODS AND MATERIALS

This nested case-control study included participants undergoing routine bilateral 2D full field digital screening mammography across the US between 01/2001-01/2017, as part of the prospective Nurses' Health Study (NHSII). NHSII was established in 1989 and followed 116,429 female registered nurses aged 25-42 years over time with biennial questionnaires about diseases and health-related topics. DL and Gail five-year models were used to assess risk. PRS were calculated using 67 single nucleotide polymorphisms. Participants with a diagnosis of cancer within one month of mammogram were excluded. Patient demographics, mammograms, PRS, and cancer outcomes were collected as part of NHSII. DL and Gail model performance with and without PRS were compared using areas under the receiver operating characteristic curve (AUCs) unconditional logistic regression models with DeLong test ( $p < 0.05$ ).

#### RESULTS

926 participants (350 cases of breast cancer, 576 controls) underwent screening mammography. 68 were had a diagnosis of breast cancer within one month of mammogram. 491, 67, and 54 were missing a PRS, Gail score, and DL score, respectively. 804 (268 cases, 536 controls) had DL score, 313 (110 cases, 203 controls) DL+PRS, 684 (220 cases, 464 controls) Gail score and 263 (94 cases, 169 controls) Gail+PRS. This resulted in a study population of 858 participants (282 cases, 576 controls). Mean age was 55.3y (SD 5.4y). All participants were White. 310 (36.1%) were pre-menopausal and 548 (63.8%) post-menopausal. 398 (46.3%) had non-dense and 457 (53.2%) had dense breasts. The AUC of DL model was 0.65 (95% CI: 0.61-0.70) vs 0.72 (95% CI 0.66-0.78) in DL+PRS ( $p < 0.05$ ). The AUC of Gail model was 0.50 (95% CI: 0.45-0.54) vs 0.68 (95% CI: 0.61-0.74) in Gail+PRS ( $p < 0.001$ ). The AUC of DL model was significantly higher than Gail model ( $p < 0.001$ ) however there was no evidence of a significant difference in DL+PRS vs Gail+PRS ( $p = 0.34$ ).

#### CONCLUSION

A screening mammography DL breast cancer risk assessment model has high risk discriminatory accuracy which can be improved with the addition of PRS.

#### CLINICAL RELEVANCE/APPLICATION

A DL image-only risk model derived automatically at the time of screening mammography, can be improved with genetic information. Identification of high-risk patients by DL model could assist in triaging women for genetic testing.

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## Abstract Archives of the RSNA, 2023

M1-SSBR03-6

### Performance of a Deep Learning Image Based 5-year Breast Cancer Risk Model Developed Across Global Imaging Centers that Provides a Percent Probability Output for Use in Existing Clinical Workflows and Decision Making

Monday, Nov. 27 8:00AM - 9:00AM Room: E352

Christiane K. Kuhl, MD, PhD (*Presenter*) Advisory Board, Guerbet SA; Speaker, Bracco Group; Speaker, Bayer AG

#### PURPOSE

To train, validate, test, and calibrate a deep learning, image-based five-year breast cancer risk prediction model in a multi-center international data consortium.

#### METHODS AND MATERIALS

This retrospective, multi-center international study included 318,101 consecutive bilateral 2D full field digital screening mammograms obtained from 129,498 patients between January 2007 and December 2016, after excluding exams that lacked five-year follow up. Test datasets, held out of model development, included 46,104 exams from Europe and the U.S., along with all 5,888 exams from South America. Patient demographics including age and race/ethnicity were retrieved from electronic medical records and cancer outcomes were obtained from local tumor registries. We leveraged a deep convolutional neural network using federated learning to create the DL model, which was trained to predict the development of breast cancer within five years of the mammogram, based only on the four standard mammography views (RCC, LCC, RMLO and LMLO). A calibration algorithm was used to create percent probabilities of future cancer from the DL score. Model performance on each center's held-out test data sets was estimated using areas under the receiver operating characteristic curve (AUCs) with 95% CIs. To assess calibration, held-out test sets were combined and segmented into five equally sized bins based on increasing predicted risk, and used to generate observed-to-expected ratios (O/E ratios) with 95% CIs.

#### RESULTS

We found point estimate AUCs consistently at or above 0.75 across centers. AUC by center: United States 0.75 [95% CI 0.74, 0.77] (n = 30,335); Europe 0.80 [95% CI 0.78, 0.82] (n = 15,769); and South America 0.80 [95% CI 0.77, 0.82] (n = 5,888). Observed-to-expected ratios overall and for spectrum of predicted low- to high-risk bins demonstrated strong calibration of the model with future cancer occurrence: overall 1.00 [95% CI 0.95, 1.06] (n = 52,981); first bin 1.01 [95% CI 0.76, 1.29] (n = 10,597), second bin 0.80 [95% CI 0.64, 0.98] (n = 10,596), third bin 1.04 [95% CI 0.90, 1.20] (n = 10,595), fourth bin 0.99 [95% CI 0.88, 1.11] (n = 10,596), fifth bin 1.03 [95% CI 0.96, 1.10] (n = 10,597).

#### CONCLUSION

A deep learning model trained and calibrated on an international mammography screening consortium data resource, based on the screening mammogram alone, provides strong predictive accuracy (AUC of 0.75-0.80) and is well calibrated for use in current standard of care clinical workflows that rely on five-year breast cancer risk predictions.

#### CLINICAL RELEVANCE/APPLICATION

A deep learning breast cancer risk model can be calibrated to provide five-year risk estimates to support more personalized screening and risk reduction interventions as recommended by clinical practice guidelines.

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## Abstract Archives of the RSNA, 2023

M1-SSBR03-7

### Using Density-Specific Calibration of AI Thresholds in a Double-Reader Setting to Achieve Equal Sensitivity for Women With High Mammographic Density

Monday, Nov. 27 8:00AM - 9:00AM Room: E352

Haiko Schurz, BSc, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Higher mammographic density, BIRADS category C and D, is associated with lower radiologist sensitivity and increased risk of breast cancer. Artificial Intelligence Computer-Aided Detection (AI CAD) generates a continuous score translated to a normal/abnormal decision by thresholding. In this study, we explore whether the lower radiologist sensitivity could be counteracted by lowering the AI threshold for high density mammograms.

#### METHODS AND MATERIALS

The Swedish platform for Validation of AI in Breast imaging (VAI-B) with mammograms from 2008-2021 was used. A three-year follow-up period with biopsy-verification defined the reference standard of breast cancer or healthy. Mammograms were processed by AI CAD (Lunit, South Korea) to produce a continuous abnormality score and a density class. We determined the sensitivity of the radiologist double reading for each density category. We then combined single radiologist assessment and AI calibrated to maintain sensitivity, first, overall, for the entire dataset and, second, re-calibrated to enforce the same sensitivity for density C and D as for density B. Finally, we compare the performance between the radiologist double-reading with single reader plus AI calibrated on overall-sensitivity, and with single reader plus AI calibrated to maintain sensitivity for density C and D.

#### RESULTS

Overall, 38529 (upscaled to 972522) screening mammograms from 28580 healthy and 5773 women diagnosed with cancer were included in this study. The radiologist's double reading sensitivity was 52.8% overall and 63.4%, 56.4%, 48.6% 43.8% for density A, B, C and D respectively. Radiologist double-reading had 16.3 false positives per detected cancer (FP/C). Simulating double-reading by AI and one radiologist, calibrated to maintain overall sensitivity without taking density into account, reduced FP/C by 24.4% to 11.5. After re-calibrating to enforce that density B sensitivity (56.4%) was maintained for density C and D, the cancers detected increased by 7.5%, while the FP/C of 14.7 showed a decrease of 9.7% compared to radiologist double-reading and an increase of 19.5% compared to the density-ignorant AI workflow.

#### CONCLUSION

Calibrating the AI threshold separately for each density category to ensure having the same sensitivity for women with density C and D as for with density B is feasible. Density-specific calibration would equalize sensitivity between density B, C and D, through a 7.5% increase in cancer detection at the cost of around 20% increase in false positives per cancer.

#### CLINICAL RELEVANCE/APPLICATION

Implementing AI CAD systems with density-specific calibration could improve fairness of the screening system giving women with higher mammographic density an equal chance of screen-detection.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSBR04

### Breast Imaging (CEM in Screening and Diagnosis)

Monday, Nov. 27 8:00AM - 9:00AM Room: E351

Maxine S. Jochelson, MD (*Moderator*) Speaker, General Electric Company  
Jordana Phillips, MD (*Moderator*) Research Grant, General Electric Company; Consultant, General Electric Company; Consultant, Hologic, Inc  
Paola Clauser, MD, PhD (*Moderator*) Speaker, Siemens AG

#### Sub-Events

#### **M1-SSBR04-1 Contrast Enhanced Mammography Screening for Women with Extremely Dense Breasts**

Noam Nissan, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the diagnostic performance of contrast-enhanced mammography (CEM) for breast cancer screening in women with extremely dense breasts.

#### **METHODS AND MATERIALS**

This IRB-approved retrospective single center study included screening CEMs reporting extremely dense breast composition, performed between December 2012 and March 2022. Electronic medical records were reviewed for demographic, radiological and clinical characteristics. Sensitivity, specificity, negative and positive predictive value (NPV and PPV, respectively) were calculated, including PPV1 for positive screening mammograms (BI-RADS 0,4 and 5) and PPV3 for biopsies performed.

#### **RESULTS**

1300 screening CEMs were performed among 609 women with extremely dense breasts. Mean age was 49.9 years  $\pm$  9.4 (standard deviation). 114 (18.7%) had a family history of breast cancer in a first-degree relative younger than 50 years, and 235 (38.6%) had a personal history of breast cancer. The final BI-RADS score was 1 or 2 in 1137 (87.5%) women, BI-RADS 3 in 98 (7.5%) women, and BI-RADS 4 or 5 in 65 (5.0%) patients. Overall, 15 cancers were diagnosed (cancer detection-rate, 11.5 per 1000). At least 1-year follow up was available for 1265 exams. There were two interval cancers. Sensitivity was 29.4% (5/17) on the low-energy images compared with 88.2% (15/17) for the entire study (low-energy and contrast images) ( $p < 0.001$ ). PPV1 was 6.6% (15/227), and PPV3 was 23.4% (15/64). Specificity was 87.7% (1108/1263) and NPV was 99.8% (1108/1110). Contrast-reaction was observed in 0.5% of examinations (7/1300) experienced, all mild.

#### **CONCLUSION**

CEM detects mammographically-occult cancers in women with extremely dense breast tissue while maintaining high diagnostic accuracy.

#### **CLINICAL RELEVANCE/APPLICATION**

CEM has the potential to serve as a supplementary screening modality for women with extremely dense breasts at increased risk for developing breast cancer.

#### **M1-SSBR04-2 A Large-Scale Single Center Evaluation of Contrast Enhanced Mammography (CEM) In the Pre-operative Staging of Breast Cancer**

Chiara Bellini, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the efficacy of CEM in the pre-operative staging in patients with biopsy-proven Breast Cancer.

## METHODS AND MATERIALS

Four radiologists reviewed 524 Contrast Enhanced Mammography (CEM) exams conducted at our center between 2017 and 2020. All CEMs were pre-operative staging exams of 525 malignant lesions. Our gold standard was the final histology after surgery. Based on CEMs results, the surgical plan made on conventional imaging (CI) was either confirmed or changed and each exam has been catalogued as either True Negative (TN), True Positive (TP), False Negative (FN) or False Positive (FP). Patients were subdivided according to breast density, lesion's palpability, enhancing behavior in CEM. Sensitivity, specificity, positive (PPV) and negative (NPV) predictive values of CEM in each different group were calculated.

## RESULTS

In 226/525 cases, CEM showed at least one additional lesion: 50 resulted as B5 after biopsy and 45 as malignant at the final histology (TP). 124 were negative either at second-look, biopsy or final histology (TN). 6 CEMs were FP, because CEM overestimated the extension of the disease and one FN, when CEM underestimated it. On 299/525 CEMs, no additional lesions were detected: in 280/299, final histology confirmed the absence of other lesions (TN); in 10/299, the enhancement area matched the extension of the IL at the final histology (TP); in 9/299 there was a mismatch between what CEM and final histology showed due to an underestimation (5 FN) or overestimation (4 FP) of CEM disease extension. In the whole population, 394 TN, 108 TP, 6 FN, 17 FP were recorded. CEM changed the surgical plan in 22.5% of the cases (118/525). Subsequently, final histology confirmed the absence of other lesions (TN) or the presence of additional ones emerged in CEM (TP) and the real extension of the IL leading us to categorize CEMs as FP, when it overestimated the extension of the IL and FN when CEM underestimated it. Overall CEM sensitivity was 94.8%, specificity 95.9%, PPV 86.4% and NPV 98.5%; the accuracy was 95.6% and AUC of ROC curve was 0.953. The statistical analysis showed a higher diagnostic performance in patients with palpable lesions ( $p: 0.0022$ ).

## CONCLUSION

CEM changed the surgical plan in 22.5% of our series, proving to be an accurate exam in the presurgical staging of breast cancer (95.6 %), especially for palpable lesions ( $p: 0.0022$ ). It had high sensitivity, specificity, NPV and PPV (respectively 94.8%, 95.9%, 98.5% and 86.4%). Since its diagnostic performances, CEM stands as an efficient asset, essential in the surgical planning.

## CLINICAL RELEVANCE/APPLICATION

CEM diagnostic performances support its reliability in the presurgical staging setting, for a lesion-tailored management, leading to the best surgical plan, avoiding over- or undertreatment.

## **M1- SSBRO4-3 A Prospective Study of Supplemental Screening with Contrast Enhanced Mammography in Women with Elevated Risk of Breast Cancer: Results of the Prevalence Round**

Bhavika N. Patel, MD (*Presenter*) Research support, GRAIL, Inc; Research Grant, Hologic, Inc

## PURPOSE

To prospectively investigate the role of supplemental screening CEM to detect cancer in high-risk patients.

## METHODS AND MATERIALS

This prospective, single institution, IRB approved observational study was conducted in asymptomatic patients 35 years of age or older who were deemed at elevated risk of breast cancer, defined as IBIS v.8.0 lifetime risk of breast cancer score >15% or a prior personal history of breast cancer. Enrollment was from January 2019 to April 2020. Patients with negative (BI-RADS 1 or 2) conventional 2D/3D screening mammography (MG) within 6 months were invited to undergo supplemental CEM screening. Patients with prior screening molecular breast imaging, ultrasound or MR within 12 months were excluded from study participation. Outcome measures were the incremental cancer detection rate, sensitivity, specificity, positive predictive value, and negative predictive value of CEM. Secondary outcomes included biological profiles of MG-occult, CEM detected cancers.

## RESULTS

A total of 461 patients were enrolled in this prospective study over a 16-month period. Average age of the participants was 56.4 years  $\pm$  9.5 (standard deviation); 409 (89%) were dense and 52 (11%) non-dense. Forty-four lesions were identified on CEM in 36 patients. Biopsy revealed benign changes in 22 patients (22/36, 61%), 4 patients with high-risk lesions (4/36, 11%), and 11 patients with breast cancer (11/36, 31%). Fourteen cancers were diagnosed during CEM screening study in 11 patients; for an overall supplemental cancer detection rate of 21.7 per 1000 patients, 95% CI (10.4, 39.5). CEM imaging screening offered high specificity (0.922, 95% CI: 0.897, 0.947), high NPV (0.998, 95% CI: 0.993, 1.000), moderate PPV1 (0.239, 95% CI: 0.116, 0.362), moderate PPV3 (0.297, 95% CI: 0.150, 0.445), and high sensitivity (0.917, 95% CI: 0.760, 1.000). At least 1 year follow up was available on all patients: 1 developed an interval cancer, 430 cases with negative follow-up MG, 31 with clinical history of no interval breast cancer.

## CONCLUSION

This pilot trial demonstrates a supplemental cancer detection rate of 21.7 per 1000 during prevalence round of CEM screening in patients at an elevated risk for breast cancer, comparable to results reported for high-risk surveillance MR imaging. Larger, multi institutional, multi-year high-risk CEM trials are needed for those patients who are not otherwise undergoing regular supplemental surveillance MR imaging.

## CLINICAL RELEVANCE/APPLICATION

CEM had a supplemental cancer detection rate of 21.7 per 1000 patients and had high specificity (0.922) and high sensitivity (0.917). These findings are comparable to results reported for high-risk surveillance MR imaging.

### M1-SSBR04-4 **Screening Contrast-Enhanced Mammography as an Alternative to MRI (SCEMAM)**

Wendie A. Berg, MD, PhD (*Presenter*) Institutional Research Grant, Koios Medical, Inc

## PURPOSE

To evaluate the impact of contrast-enhanced mammography (CEM) on cancer detection, false-positive recalls (FPR), and positive predictive value of biopsies (PPV3) when added to tomosynthesis (DBT) in women eligible for screening MRI without a personal history of breast cancer (PHBC).

## METHODS AND MATERIALS

From 3/15/2021 - 12/2/2022, 615 eligible women consented to an IRB-approved, HIPAA-compliant protocol to have a single screening CEM examination with clinical DBT. Nine of 615 (1.5%) lacked IV access. There were two equipment failures and one each vasovagal reaction, low initial blood pressure, and contrast reaction (rash) prior to obtaining CEM images. A total of 4/606 (0.7%) women receiving contrast developed rash or hives within 24 hours of the examination. Two radiologists interpreted each study: R1 reviewed DBT first and R2, CEM. We assessed incremental cancer detection rate (ICDR), cancer type/nodal status, FPR rates, PPV3 of biopsies performed, and interval cancer rate. At least one-year follow-up or cancer diagnosis is available for 373 participants to date.

## RESULTS

601 women age 30-75 years, median 56, completed CEM. Twelve women (2.0%) were diagnosed with 16 sites of breast cancer. Of the 12 women with cancer, 5 (42%) were detected by R1 on DBT (and one was seen on DBT by R2, also seen on CEM by both observers). Another 6 women (ICDR 10.0/1000, 95%CI 3.3, 18.3) were identified only on CEM (one seen only by R2). Of the six women with cancer seen only on CEM, five had invasive disease, all node negative, median size 0.7 cm (range 0.4-1.1 cm); three were ILC. Two women with calcifications due to DCIS were identified only on low-energy images and DBT (one intermediate grade, ER/PR+, and one high grade DCIS, ER/PR-); no cancers were seen only on DBT. FPR of combined DBT+CEM was 127/589 (21.6%) for R1, an increase of 13.3% over DBT alone at 49/589 (8.3%, P<.001). Of the 601 women, 54 (9.0%) were recommended for biopsy based only on CEM by R1, and 6/54 (11.1%) women were diagnosed with cancer. At the lesion level, PPV3 was 7/61 (11.5%) for biopsies prompted only by CEM. There have been no interval cancers to date.

## CONCLUSION

We observed significantly increased detection of early-stage breast cancer using CEM after DBT. In this elevated risk population without PHBC, CEM produced a large number of false-positive recalls and showed relatively low PPV3 of biopsies performed.

## CLINICAL RELEVANCE/APPLICATION

In women eligible for MRI screening, CEM is a reasonable alternative, but women need to be informed of the substantial risk of false-positive recalls for additional testing and often biopsy.

### M1-SSBR04-5 **Shedding Light on Shadows: Initial Experience of First Implementation of Contrast-Enhanced Mammography in a Lower Income Country**

Zohaib M. Mallick, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

To report our initial experience and challenges with contrast-enhanced mammograms (CEM) in a low-income country and to describe the enhancement patterns of breast lesions on CEM.

## METHODS AND MATERIALS

A retrospective review of 23 CEM examinations performed at our institution between January 1, 2022 and March 31, 2023. The demographic information, clinical indications, previous mammogram findings, previous ultrasound findings, and enhancement patterns and morphology of the lesions and the histopathologic diagnosis were obtained from the patient's electronic health record.



## RESULTS

CEM reduced cost by more than 70% when compared to MRI. However, the major challenges faced in the beginning of launch of the service were lack of skilled professionals and lack of awareness among clinicians. This study included 23 patients (mean age of 49 years) who underwent CEM. Nineteen patients showed contrast enhancement and underwent biopsy, and all were found to be malignant. Rest of the four cases appeared to be benign on ultrasound. Conventional mammography missed the majority of these malignant cases (13 out of 19). Fifteen cases had mass-like enhancement, with the majority of them having ill-defined or spiculated morphology. Invasive ductal carcinoma (n=14) was the most common type of cancer with the majority of cases being grade II. The most common indication was preoperative staging (n=10), followed by treatment response evaluation (n=4).

## CONCLUSION

CEM is feasible in lower income countries, and a valuable diagnostic tool for detecting and characterising breast lesions, particularly in high-risk cases.

## CLINICAL RELEVANCE/APPLICATION

"Shedding Light on Shadows" presents the initial experiences and challenges faced during the first implementation of contrast-enhanced mammography (CEM) in a lower-income country. The study underscores the potential benefits of CEM in enhancing breast cancer detection rates and overall patient care, while also addressing the specific barriers and limitations that may be unique to resource-limited settings. By sharing these insights, the study aims to provide valuable information for other lower-income countries considering the adoption of this advanced diagnostic tool, ultimately contributing to improved global healthcare outcomes in the fight against breast cancer.

## M1-SSBR04-6 CEM in Evaluation of Suspicious Microcalcifications to Reduce Unnecessary Biopsies

Davide Pupo, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Contrast-enhanced mammography (CEM) combines conventional mammography with iodinated contrast to improve cancer detection. The aim of the study was to evaluate CEM diagnostic performance in predicting the malignancy of suspicious microcalcification, so that the number of biopsies for benign lesions could be reduced.

## METHODS AND MATERIALS

The enrollment period for this study was from January 2021 to January 2022. 251 patients (average age 54.76) with suspicious microcalcification in conventional mammography were reviewed and analyzed by two radiologists in this preliminary retrospective study. We excluded 149 cases of patients who had undergone biopsy procedures before CEM and patients whose histological examinations were not available. All the lesions were evaluated using BIRADS criteria, with 4-categories qualitative scale based on enhancement intensity. Histological results were considered the gold standard.

## RESULTS

On 102 suspicious microcalcifications, 64 showed contrast enhancement (CE) and underwent biopsy: 28/64 were malignant lesions (43.75%) and 36/64 were benign ones (56.25%). Instead, 38/102 suspicious microcalcifications didn't show any CE in CEM, 18/38 underwent biopsy because of their high-suspect morphology. On the other hand, 27/38, underwent a radiological follow-up, performed at 12, 18, 24 and 32 months (av. 18 months). None of them upgraded to malignancies. Between all suspicious microcalcifications that didn't show CE, just one of them was a malignant lesion (DCIS), the only one false negative in our study. We considered lesions resulting B2 or B3 after biopsy as true negative if they didn't have any CE and as false positive if they showed enhancement. Instead, we considered lesions resulting B5 after biopsy as true positive if they showed enhancement and false negative if they didn't. The sensitivity, specificity, positive and negative predictive values (PPV and NPV), and accuracy of CEM were 96.5%, 50.7%, 43.75%, 97.4% and 63.7%, respectively.

## CONCLUSION

These preliminary results, if confirmed on a large scale, suggest that the enhancement of suspicious microcalcifications in CEM has high sensitivity in predicting malignancy (96.5%); on the other hand, due to its high NPV (97.4%), if suspicious microcalcifications don't show enhancement, they could be candidate to radiological follow-up, reducing number of biopsies for benign lesions and patients' distress.

## CLINICAL RELEVANCE/APPLICATION

If suspicious microcalcifications don't show enhancement in CEM, they have a low risk of malignancy (NPV 97.4%), so they could be candidate to radiological follow-up, reducing biopsies for benign lesions and patients' distress.

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## Abstract Archives of the RSNA, 2023

M1-SSBR04-1

### Contrast Enhanced Mammography Screening for Women with Extremely Dense Breasts

Monday, Nov. 27 8:00AM - 9:00AM Room: E351

Noam Nissan, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance of contrast-enhanced mammography (CEM) for breast cancer screening in women with extremely dense breasts.

#### METHODS AND MATERIALS

This IRB-approved retrospective single center study included screening CEMs reporting extremely dense breast composition, performed between December 2012 and March 2022. Electronic medical records were reviewed for demographic, radiological and clinical characteristics. Sensitivity, specificity, negative and positive predictive value (NPV and PPV, respectively) were calculated, including PPV1 for positive screening mammograms (BI-RADS 0,4 and 5) and PPV3 for biopsies performed.

#### RESULTS

1300 screening CEMs were performed among 609 women with extremely dense breasts. Mean age was 49.9 years  $\pm$  9.4 (standard deviation). 114 (18.7%) had a family history of breast cancer in a first-degree relative younger than 50 years, and 235 (38.6%) had a personal history of breast cancer. The final BI-RADS score was 1 or 2 in 1137 (87.5%) women, BI-RADS 3 in 98 (7.5%) women, and BI-RADS 4 or 5 in 65 (5.0%) patients. Overall, 15 cancers were diagnosed (cancer detection-rate, 11.5 per 1000). At least 1-year follow up was available for 1265 exams. There were two interval cancers. Sensitivity was 29.4% (5/17) on the low-energy images compared with 88.2% (15/17) for the entire study (low-energy and contrast images) ( $p < 0.001$ ). PPV1 was 6.6% (15/227), and PPV3 was 23.4% (15/64). Specificity was 87.7% (1108/1263) and NPV was 99.8% (1108/1110). Contrast-reaction was observed in 0.5% of examinations (7/1300) experienced, all mild.

#### CONCLUSION

CEM detects mammographically-occult cancers in women with extremely dense breast tissue while maintaining high diagnostic accuracy.

#### CLINICAL RELEVANCE/APPLICATION

CEM has the potential to serve as a supplementary screening modality for women with extremely dense breasts at increased risk for developing breast cancer.

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## Abstract Archives of the RSNA, 2023

M1-SSBR04-2

### A Large-Scale Single Center Evaluation of Contrast Enhanced Mammography (CEM) In the Pre-operative Staging of Breast Cancer

Monday, Nov. 27 8:00AM - 9:00AM Room: E351

Chiara Bellini, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the efficacy of CEM in the pre-operative staging in patients with biopsy-proven Breast Cancer.

#### METHODS AND MATERIALS

Four radiologists reviewed 524 Contrast Enhanced Mammography (CEM) exams conducted at our center between 2017 and 2020. All CEMs were pre-operative staging exams of 525 malignant lesions. Our gold standard was the final histology after surgery. Based on CEMs results, the surgical plan made on conventional imaging (CI) was either confirmed or changed and each exam has been catalogued as either True Negative (TN), True Positive (TP), False Negative (FN) or False Positive (FP). Patients were subdivided according to breast density, lesion's palpability, enhancing behavior in CEM. Sensitivity, specificity, positive (PPV) and negative (NPV) predictive values of CEM in each different group were calculated.

#### RESULTS

In 226/525 cases, CEM showed at least one additional lesion: 50 resulted as B5 after biopsy and 45 as malignant at the final histology (TP). 124 were negative either at second-look, biopsy or final histology (TN). 6 CEMs were FP, because CEM overestimated the extension of the disease and one FN, when CEM underestimated it. On 299/525 CEMs, no additional lesions were detected: in 280/299, final histology confirmed the absence of other lesions (TN); in 10/299, the enhancement area matched the extension of the IL at the final histology (TP); in 9/299 there was a mismatch between what CEM and final histology showed due to an underestimation (5 FN) or overestimation (4 FP) of CEM disease extension. In the whole population, 394 TN, 108 TP, 6 FN, 17 FP were recorded. CEM changed the surgical plan in 22.5% of the cases (118/525). Subsequently, final histology confirmed the absence of other lesions (TN) or the presence of additional ones emerged in CEM (TP) and the real extension of the IL leading us to categorize CEMs as FP, when it overestimated the extension of the IL and FN when CEM underestimated it. Overall CEM sensitivity was 94.8%, specificity 95.9%, PPV 86.4% and NPV 98.5%; the accuracy was 95.6% and AUC of ROC curve was 0.953. The statistical analysis showed a higher diagnostic performance in patients with palpable lesions ( $p: 0.0022$ ).

#### CONCLUSION

CEM changed the surgical plan in 22.5% of our series, proving to be an accurate exam in the presurgical staging of breast cancer (95.6 %), especially for palpable lesions ( $p: 0.0022$ ). It had high sensitivity, specificity, NPV and PPV (respectively 94.8%, 95.9%, 98.5% and 86.4%). Since its diagnostic performances, CEM stands as an efficient asset, essential in the surgical planning.

#### CLINICAL RELEVANCE/APPLICATION

CEM diagnostic performances support its reliability in the presurgical staging setting, for a lesion-tailored management, leading to the best surgical plan, avoiding over- or undertreatment.

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## Abstract Archives of the RSNA, 2023

M1-SSBR04-3

### **A Prospective Study of Supplemental Screening with Contrast Enhanced Mammography in Women with Elevated Risk of Breast Cancer: Results of the Prevalence Round**

Monday, Nov. 27 8:00AM - 9:00AM Room: E351

Bhavika N. Patel, MD (*Presenter*) Research support, GRAIL, Inc; Research Grant, Hologic, Inc

#### **PURPOSE**

To prospectively investigate the role of supplemental screening CEM to detect cancer in high-risk patients.

#### **METHODS AND MATERIALS**

This prospective, single institution, IRB approved observational study was conducted in asymptomatic patients 35 years of age or older who were deemed at elevated risk of breast cancer, defined as IBIS v.8.0 lifetime risk of breast cancer score >15% or a prior personal history of breast cancer. Enrollment was from January 2019 to April 2020. Patients with negative (BI-RADS 1 or 2) conventional 2D/3D screening mammography (MG) within 6 months were invited to undergo supplemental CEM screening. Patients with prior screening molecular breast imaging, ultrasound or MR within 12 months were excluded from study participation. Outcome measures were the incremental cancer detection rate, sensitivity, specificity, positive predictive value, and negative predictive value of CEM. Secondary outcomes included biological profiles of MG-occult, CEM detected cancers.

#### **RESULTS**

A total of 461 patients were enrolled in this prospective study over a 16-month period. Average age of the participants was 56.4 years  $\pm$  9.5 (standard deviation); 409 (89%) were dense and 52 (11%) non-dense. Forty-four lesions were identified on CEM in 36 patients. Biopsy revealed benign changes in 22 patients (22/36, 61%), 4 patients with high-risk lesions (4/36, 11%), and 11 patients with breast cancer (11/36, 31%). Fourteen cancers were diagnosed during CEM screening study in 11 patients; for an overall supplemental cancer detection rate of 21.7 per 1000 patients, 95% CI (10.4, 39.5). CEM imaging screening offered high specificity (0.922, 95% CI: 0.897, 0.947), high NPV (0.998, 95% CI: 0.993, 1.000), moderate PPV1 (0.239, 95% CI: 0.116, 0.362), moderate PPV3 (0.297, 95% CI: 0.150, 0.445), and high sensitivity (0.917, 95% CI: 0.760, 1.000). At least 1 year follow up was available on all patients: 1 developed an interval cancer, 430 cases with negative follow-up MG, 31 with clinical history of no interval breast cancer.

#### **CONCLUSION**

This pilot trial demonstrates a supplemental cancer detection rate of 21.7 per 1000 during prevalence round of CEM screening in patients at an elevated risk for breast cancer, comparable to results reported for high-risk surveillance MR imaging. Larger, multi institutional, multi-year high-risk CEM trials are needed for those patients who are not otherwise undergoing regular supplemental surveillance MR imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

CEM had a supplemental cancer detection rate of 21.7 per 1000 patients and had high specificity (0.922) and high sensitivity (0.917). These findings are comparable to results reported for high-risk surveillance MR imaging.

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## Abstract Archives of the RSNA, 2023

M1-SSBR04-4

### Screening Contrast-Enhanced Mammography as an Alternative to MRI (SCEMAM)

Monday, Nov. 27 8:00AM - 9:00AM Room: E351

Wendie A. Berg, MD, PhD (*Presenter*) Institutional Research Grant, Koios Medical, Inc

#### PURPOSE

To evaluate the impact of contrast-enhanced mammography (CEM) on cancer detection, false-positive recalls (FPR), and positive predictive value of biopsies (PPV3) when added to tomosynthesis (DBT) in women eligible for screening MRI without a personal history of breast cancer (PHBC).

#### METHODS AND MATERIALS

From 3/15/2021 - 12/2/2022, 615 eligible women consented to an IRB-approved, HIPAA-compliant protocol to have a single screening CEM examination with clinical DBT. Nine of 615 (1.5%) lacked IV access. There were two equipment failures and one each vasovagal reaction, low initial blood pressure, and contrast reaction (rash) prior to obtaining CEM images. A total of 4/606 (0.7%) women receiving contrast developed rash or hives within 24 hours of the examination. Two radiologists interpreted each study: R1 reviewed DBT first and R2, CEM. We assessed incremental cancer detection rate (ICDR), cancer type/nodal status, FPR rates, PPV3 of biopsies performed, and interval cancer rate. At least one-year follow-up or cancer diagnosis is available for 373 participants to date.

#### RESULTS

601 women age 30-75 years, median 56, completed CEM. Twelve women (2.0%) were diagnosed with 16 sites of breast cancer. Of the 12 women with cancer, 5 (42%) were detected by R1 on DBT (and one was seen on DBT by R2, also seen on CEM by both observers). Another 6 women (ICDR 10.0/1000, 95%CI 3.3, 18.3) were identified only on CEM (one seen only by R2). Of the six women with cancer seen only on CEM, five had invasive disease, all node negative, median size 0.7 cm (range 0.4-1.1 cm); three were ILC. Two women with calcifications due to DCIS were identified only on low-energy images and DBT (one intermediate grade, ER/PR+, and one high grade DCIS, ER/PR-); no cancers were seen only on DBT. FPR of combined DBT+CEM was 127/589 (21.6%) for R1, an increase of 13.3% over DBT alone at 49/589 (8.3%,  $P < .001$ ). Of the 601 women, 54 (9.0%) were recommended for biopsy based only on CEM by R1, and 6/54 (11.1%) women were diagnosed with cancer. At the lesion level, PPV3 was 7/61 (11.5%) for biopsies prompted only by CEM. There have been no interval cancers to date.

#### CONCLUSION

We observed significantly increased detection of early-stage breast cancer using CEM after DBT. In this elevated risk population without PHBC, CEM produced a large number of false-positive recalls and showed relatively low PPV3 of biopsies performed.

#### CLINICAL RELEVANCE/APPLICATION

In women eligible for MRI screening, CEM is a reasonable alternative, but women need to be informed of the substantial risk of false-positive recalls for additional testing and often biopsy.

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## Abstract Archives of the RSNA, 2023

M1-SSBR04-5

### Shedding Light on Shadows: Initial Experience of First Implementation of Contrast-Enhanced Mammography in a Lower Income Country

Monday, Nov. 27 8:00AM - 9:00AM Room: E351

Zohaib M. Mallick, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

To report our initial experience and challenges with contrast-enhanced mammograms (CEM) in a low-income country and to describe the enhancement patterns of breast lesions on CEM.

#### METHODS AND MATERIALS

A retrospective review of 23 CEM examinations performed at our institution between January 1, 2022 and March 31, 2023. The demographic information, clinical indications, previous mammogram findings, previous ultrasound findings, and enhancement patterns and morphology of the lesions and the histopathologic diagnosis were obtained from the patient's electronic health record.

#### RESULTS

CEM reduced cost by more than 70% when compared to MRI. However, the major challenges faced in the beginning of launch of the service were lack of skilled professionals and lack of awareness among clinicians. This study included 23 patients (mean age of 49 years) who underwent CEM. Nineteen patients showed contrast enhancement and underwent biopsy, and all were found to be malignant. Rest of the four cases appeared to be benign on ultrasound. Conventional mammography missed the majority of these malignant cases (13 out of 19). Fifteen cases had mass-like enhancement, with the majority of them having ill-defined or spiculated morphology. Invasive ductal carcinoma (n=14) was the most common type of cancer with the majority of cases being grade II. The most common indication was preoperative staging (n=10), followed by treatment response evaluation (n=4).

#### CONCLUSION

CEM is feasible in lower income countries, and a valuable diagnostic tool for detecting and characterising breast lesions, particularly in high-risk cases.

#### CLINICAL RELEVANCE/APPLICATION

"Shedding Light on Shadows" presents the initial experiences and challenges faced during the first implementation of contrast-enhanced mammography (CEM) in a lower-income country. The study underscores the potential benefits of CEM in enhancing breast cancer detection rates and overall patient care, while also addressing the specific barriers and limitations that may be unique to resource-limited settings. By sharing these insights, the study aims to provide valuable information for other lower-income countries considering the adoption of this advanced diagnostic tool, ultimately contributing to improved global healthcare outcomes in the fight against breast cancer.

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## Abstract Archives of the RSNA, 2023

M1-SSBR04-6

### CEM in Evaluation of Suspicious Microcalcifications to Reduce Unnecessary Biopsies

Monday, Nov. 27 8:00AM - 9:00AM Room: E351

Davide Pupo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast-enhanced mammography (CEM) combines conventional mammography with iodinated contrast to improve cancer detection. The aim of the study was to evaluate CEM diagnostic performance in predicting the malignancy of suspicious microcalcification, so that the number of biopsies for benign lesions could be reduced.

#### METHODS AND MATERIALS

The enrollment period for this study was from January 2021 to January 2022. 251 patients (average age 54.76) with suspicious microcalcification in conventional mammography were reviewed and analyzed by two radiologists in this preliminary retrospective study. We excluded 149 cases of patients who had undergone biopsy procedures before CEM and patients whose histological examinations were not available. All the lesions were evaluated using BIRADS criteria, with 4-categories qualitative scale based on enhancement intensity. Histological results were considered the gold standard.

#### RESULTS

On 102 suspicious microcalcifications, 64 showed contrast enhancement (CE) and underwent biopsy: 28/64 were malignant lesions (43.75%) and 36/64 were benign ones (56.25%). Instead, 38/102 suspicious microcalcifications didn't show any CE in CEM, 18/38 underwent biopsy because of their high-suspect morphology. On the other hand, 27/38, underwent a radiological follow-up, performed at 12, 18, 24 and 32 months (av. 18 months). None of them upgraded to malignancies. Between all suspicious microcalcifications that didn't show CE, just one of them was a malignant lesion (DCIS), the only one false negative in our study. We considered lesions resulting B2 or B3 after biopsy as true negative if they didn't have any CE and as false positive if they showed enhancement. Instead, we considered lesions resulting B5 after biopsy as true positive if they showed enhancement and false negative if they didn't. The sensitivity, specificity, positive and negative predictive values (PPV and NPV), and accuracy of CEM were 96.5%, 50.7%, 43.75%, 97.4% and 63.7%, respectively.

#### CONCLUSION

These preliminary results, if confirmed on a large scale, suggest that the enhancement of suspicious microcalcifications in CEM has high sensitivity in predicting malignancy (96.5%); on the other hand, due to its high NPV (97.4%), if suspicious microcalcifications don't show enhancement, they could be candidate to radiological follow-up, reducing number of biopsies for benign lesions and patients' distress.

#### CLINICAL RELEVANCE/APPLICATION

If suspicious microcalcifications don't show enhancement in CEM, they have a low risk of malignancy (NPV 97.4%), so they could be candidate to radiological follow-up, reducing biopsies for benign lesions and patients' distress.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSCA03

### Cardiac Imaging (Photon-Counting CT)

Monday, Nov. 27 8:00AM - 9:00AM Room: E353B

Dominik Fleischmann, MD (*Moderator*) Research Grant, Siemens AG; Stockholder, iSchemaView, Inc; Stockholder, Segmed, Inc  
Prabhakar Rajiah, MD, FRCR (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M1-SSCA03-1 Improved Detection of Small and Low-density Plaques in Virtual Non-iodine-based Coronary Artery Calcium Scoring on Photon-Counting Detector CT**

Nicola Fink, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

With improved multi-material separation, photon-counting detector (PCD)-CT allows to create virtual non-iodine (VNI) reconstructions for coronary artery calcium scoring (CACS) based on contrast-enhanced scans. VNI-CACS has been shown to outperform previous virtual non-contrast (VNC) images. However, previous studies focused on total scores. This study aimed to assess the impact of plaque size and density on the algorithm's performance and to provide recommendations regarding "safety net" reconstructions for an improved detection of subtle plaques.

#### METHODS AND MATERIALS

CACS was evaluated in phantoms simulating three chest diameters and containing nine calcifications with different sizes (5, 3, 1mm) and densities (800, 400, 200 mg/cm<sup>3</sup>), and in patients (n=63; 57.8±15.5 years; 58.7% male) who underwent true non-contrast (TNC) and contrast-enhanced cardiac PCD-CT. VNI images were reconstructed at different VMI (55-80keV) and quantum iterative reconstructions (QIR; strength 1-4). TNC scans at 70keV, QIR off served as reference. In vitro CACS was analyzed with standard CACS settings (3.0mm slices, kernel Qr36, threshold 130HU). In addition, the number of detected calcifications and CACS of small and low-density plaques were investigated using adjusted reconstructions (1.0mm, kernel Qr44, thresholds 120/110HU). Based on background Agatston scores of best performing settings, "safety net" reconstructions were defined and assessed in in vivo TNC plaques initially not detected by standard VNI reconstructions.

#### RESULTS

Correlation and agreement between standard CACSVNI and CACSTNC was higher in large/medium-sized and high/medium-density plaques than in low-density plaques (ICC=0.90, r>0.9 vs. ICC=0.20-0.48, r =0.47-0.56). Small plaques were not detectable using standard VNI. The highest detectability of calcifications was achieved using slice thickness 1.0mm, kernel Qr44, CACS thresholds 120/110HU, and QIR=2. Compared to standard VNI settings, using our proposed "safety net" reconstructions (55keV, QIR2; threshold 110HU) for in vivo CACS increased detectability of subtle plaques by 89.3% and improved correlation and agreement of CACSVNI with CACSTNC (ICC=0.51, r=0.60; with standard settings not detectable).

#### CONCLUSION

Compared to TNC-CACS, the performance of the VNI algorithm is limited for small and low-density plaques, which can be improved using "safety net" reconstructions. These should additionally be performed in patients with a standard CACS<sub>VNI</sub> of zero to identify missed plaques.

#### CLINICAL RELEVANCE/APPLICATION

The proposed "safety net" improves accurate cardiovascular risk assessment using VNI-based CACS, especially in patients who would otherwise be classified as false-negative due to missed subtle plaques.

#### **M1-SSCA03-2 Ultra High Resolution Photon Counting CT Results in Improved Spatial Accuracy during Simulated Coronary Motion**

Audrey Rich, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Ultra high resolution photon counting CT (PCCT) has the potential for improved visualization of minute anatomic structures. Yet, increases in spatial resolution are susceptible to motion related image degradation. A major challenge in cardiac imaging is the intrinsic motion of the heart. Motion artifacts compromise image quality and the visualization of coronary anatomy and disease. The purpose of the study is to determine if the increased spatial accuracy of PCCT is preserved in moving structures, such as coronary arteries.

## METHODS AND MATERIALS

A dynamic cardiac phantom device simulated cardiac coronary motion by mechanically transferring device movement to a tungsten wire. Wire motion corresponded to different device rates, which equated to different cardiac rates. The tungsten wire was imaged while stationary and moving, using a coronary CT angiography protocol with sequential ECG triggered axial acquisition settings on a PCCT using a conventional reconstruction mode at 120kV with 0.6mm slice thickness and the Bv36u kernel. The moving wire was reimaged on the same PCCT system with the same protocol but using a prospectively triggered method on the ultra high resolution mode at 140kV with 0.2mm slice thickness using the Bv56u kernel. In each setting, images were acquired using a top gantry speed of 264m/s, 66ms temporal resolution, and 120x0.2mm collimation. Image reconstruction was performed using a 512 x 512 matrix and processed using ImageJ software. Images were compared using the full width at half maximum (FWHM) area of the point spread function as a numerical estimate of spatial accuracy.

## RESULTS

Using the standard acquisition mode, at a device rate of 70bpm, the point object images were degraded in shape and attenuation to different degrees during the motion cycle. The FWHM area corresponded to our visual assessment and ranged from 5.1mm<sup>2</sup> to 23.8mm<sup>2</sup>, depending on the time of image reconstruction. Conversely, using the UHR reconstructions, the best image reconstruction yielded a smaller point image with better definition than the best reconstruction from the standard stationary and dynamic resolution series. The FWHM area ranged from 0.8mm<sup>2</sup> to 5.9mm<sup>2</sup>.

## CONCLUSION

Object motion degraded image quality to variable degrees over the motion cycle. The UHR mode improves overall spatial accuracy at rest and during moving conditions when comparing the two settings that exist within photon counting.

## CLINICAL RELEVANCE/APPLICATION

High resolution photon counting CT improves spatial accuracy under dynamic conditions.

## M1-SSCA03-3 Coronary Stent Imaging in Photon Counting Computed Tomography: Assessability of In-Stent Stenoses

Jan Robert Kroger, MD (*Presenter*) Travel Support, Otsuka Holdings Co, Ltd;

## PURPOSE

To evaluate the assessment of in-stent stenosis in coronary artery stents in a phantom using photon counting computed tomography (PCCT) with standard resolution mode (SRM) and ultra-high-resolution mode (UHR) as well as different reconstruction kernels.

## METHODS AND MATERIALS

6 coronary artery stents (diameter 3 mm) were implanted in plastic tubes. Hypodense stenoses were implanted. Tubes were filled with contrast medium and examined using rotational angiography to define the ground-truth. For CT examinations tubes were filled with a solution of saline and contrast medium adjusted to measure 600 HU and were scanned at a PCCT (Naeotom Alpha, Siemens Healthineers) in SRM and UHR. Images were reconstructed using a standard vascular kernel (BV72c, e.g. UHRc) and an experimental kernel optimized for stent imaging (BV72o, e.g. SRMo). Analysis was performed by 5 readers, measuring lumen diameter inside the stent and residual lumen inside the stenosis and rating the assessability of the stenosis on a five-point Likert scale. One-way ANOVA or Friedman test were used for the comparison of multiple means as appropriate. Post-hoc testing with Bonferroni corrected p-values was performed in case of significant differences.

## RESULTS

The visible in-stent lumen averaged 0.27±0.49 mm in SRM, 1.37±0.55 mm in UHR (p<0.001). In UHRc, the visible lumen averaged 1.32±0.57 mm, and in UHRo it was 1.43±0.54 mm (p=0.033). The residual lumen was measured significantly more accurately in UHR than in SRM (mean SRM 0.11±0.19 mm vs. UHR 0.41±0.22 mm). The difference between UHRc and UHRo is also significant in favor of UHRo (UHRc 0.35±0.23 mm vs. UHRo 0.47±0.19 mm, corrected p=0.021). Compared to angiography, UHRo achieved the best classification of in-stent stenosis grade but still overestimated the stenosis grade. UHRo received the highest rating regarding the assessability of the stenosis (3.31±1.20). The difference between SRM and UHR and between UHRc and UHRo was significant (for both comparisons p<0.001).



## CONCLUSION

PCCT in UHR mode enables the evaluation of in-stent stenosis in small-diameter coronary artery stents in a phantom. The assessability of the stenosis can be further enhanced by optimizing image reconstruction kernels for stent imaging.

## CLINICAL RELEVANCE/APPLICATION

Coronary artery computed tomography plays a major role in the evaluation of coronary artery disease and PCCT with UHR might overcome limitations of standard CTA when examining patients with coronary stents.

### **M1-SSCA03-4 Pure Calcium Virtual Unenhanced Images from Photon-counting Coronary Angiography Provide Accurate Coronary Artery Calcium Scoring**

Nina Pauline Haag, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary artery calcium scoring (CACS) is an important predictor of morbidity in chronic coronary artery disease (CAD). CACS requires an unenhanced CT scan in addition to contrast-enhanced coronary CT angiography (cCTA). Photon counting CT (PCCT) provides a customized algorithm for the reconstruction of virtual unenhanced images from cCTA specifically for calcium scoring (PureCalcium, Siemens Healthineers). This study aimed to evaluate the accuracy of PureCalcium images derived from contrast-enhanced photon counting cCTA in comparison to unenhanced CACS images (uCACS).

#### METHODS AND MATERIALS

In this retrospective study, 128 patients receiving PCCT (Naeotom Alpha, syngo.CT VB50, Siemens Healthineers) with uCACS and cCTA for CAD between August 2022 and April 2023 were included. PureCalcium images were reconstructed from cCTA data. UCASC and PureCalcium data sets were evaluated using a semiautomatic workflow (Calciumscoring, Syngo.Via VB60, Siemens Healthineers). Agatston scores were generated for both data sets. DLP values for the entire examination and the uCACS scan were analyzed. Data are presented as mean  $\pm$  standard deviation. Differences in the Agatston score between uCACS and PureCalcium were evaluated using the paired sample t-test and Pearson's correlation coefficient as well as the intra-class correlation coefficient between both scores were calculated. Bland Altman analysis was performed, and bias and limits of agreement (LoA) are presented. The intra-class correlation coefficient was calculated for Agatston scores from both measurements. P-values of  $< 0.05$  were considered statistically significant.

#### RESULTS

84 patients had an Agatston score of  $> 0$ . The mean Agatston score was equivalent between uCACS and PureCalcium ( $115.5 \pm 270.7$  vs.  $112.4 \pm 275.5$ ,  $p=0.519$ ); the correlation between both scores was excellent ( $r=0.98$ ,  $p < 0.001$ ). ICC between both measurements was excellent with 0.981. Bland Altman analysis showed a bias of  $3.1 \pm 54.0$  (LoA:  $-102.7/108.9$ ). The mean DLP for the entire examination was  $236.9 \pm 213.2$  mGy\*cm, while DLP for uCACS was  $32.2 \pm 11.7$  mGy\*cm. Thus, the uCACS share of the radiation dose of the entire examination was  $19 \pm 9$  %.

## CONCLUSION

Agatston scores derived from PureCalcium images of PCCT scanners and standard uCACS correlate to a high degree and do not differ significantly. Omitting a dedicated unenhanced scan in PCCT cCTA could reduce radiation dose by  $19 \pm 9$  %.

## CLINICAL RELEVANCE/APPLICATION

Coronary artery calcium scoring is an important predictor of morbidity in chronic coronary artery disease. Deriving Agatston scores directly from contrast-enhanced CTA could reduce the radiation dose of a typical CT examination of the coronary arteries substantively.

### **M1-SSCA03-5 Ultra-High-Resolution K-Edge Imaging for Characterization of Coronary Arteries with Deep-Silicon Photon-Counting CT: Comparison with Conventional Dual-Energy CT**

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detectors (PCD) may improve image quality and diagnostic value of CT compared to the energy-integrating detectors (EID). Reduced radiation dose, spectral information, and improved spatial resolution are three advantages of PCD. Edge-irradiated deep-Si PCD promises better spectral and spatial resolution compared to CdTe and CdZnTe PCDs. Here we investigate the utility of deep-Si PCD for characterizing coronary artery plaques and stents.

#### METHODS AND MATERIALS

We fabricate custom coronary artery phantoms with diameter ( $d$ ) = 2-3.5 mm. Calcified and soft plaques, and 7 coronary stents are added to the arteries and filled with iodine- or gadolinium-based contrast agents (IBCA, GBCA). The inserts are placed inside water cylinders ( $d=12$ cm). 15 mL-diameter vials with calibrated dilutions and mixtures of IBCA and GBCA, water, and fat are also included. We scan the phantoms using a prototype deep-Si PCD-CT scanner at 120 kVp, 400 mAs, 1-s



rotation, with 8 energy bins. Dual-energy fast kV-switching EID-CT is used for comparison. Iodine density maps, water maps, and virtual monoenergetic images (VMIs) are reconstructed using a filtered-backprojection algorithm with "Detail" kernel for EID, vs a prototype high-resolution kernel for PCD (MTF 10% at 7.8 lp/cm vs 21.2 lp/cm). Reconstruction field-of-view is 128 mm for both scanners. Image voxel size was  $250 \times 250 \times 625 \mu\text{m}^3$  vs  $125 \times 125 \times 417 \mu\text{m}^3$  for EID vs PCD, respectively. We measure iodine density in ROIs with  $d > 8 \text{ mm}$  ( $N = 8$ ). Lumen diameter ( $N = 24$ ) was used as a metric for effective spatial resolution (blooming) in 70 keV VMIs. The Wilcoxon signed rank test is used to compare the two scanners with  $p < 0.05$  considered statistically significant.

## RESULTS

Errors in iodine density measured in IBCA dilutions with water are significantly different and in the  $[-0.3 \ 3.2]$  vs  $[-2.2 \ -0.02]$  mg I/mL range for EID and PCD, respectively. PCD material decomposition separates IBCA and GBCA into iodine density and water maps with good accuracy in iodine quantification in both mixtures (error range  $[-0.3 \ 0.3]$  mg I/mL) whereas the EID erroneously decomposes GBCA into both iodine and water (error range  $[0.0 \ 11.0]$  mg I/mL). Lumen diameter measurements are more accurate for PCD vs EID (error 173 vs 352  $\mu\text{m}$ ).

## CONCLUSION

Deep-Si PCD demonstrates good accuracy in iodine quantification and can accurately decompose mixtures of two contrast agents. Its improved spatial resolution results in sharper images with blooming artifacts reduced by 50% compared to a state-of-the-art dual-energy EID scanner.

## CLINICAL RELEVANCE/APPLICATION

UHR spectral evaluation of coronary arteries with deep-Si photon-counting CT can help improve visualization of plaques and stents by providing spectral information at 150  $\mu\text{m}$  resolution.

## M1-SSCA03-6 In-human Evaluation of Coronary Stent Patency using Ultra-High-Resolution Photon-Counting Detector CT: A Comparison to Invasive Angiography

Muhammad Taha Hagar, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the diagnostic accuracy of ultra-high-resolution photon-counting detector CT angiography (UHR PCD-CTA) in assessing coronary stent patency, using invasive coronary angiography (ICA) as a reference.

## METHODS AND MATERIALS

Consecutive patients with previous coronary stent placement were prospectively enrolled between August 2022 and March 2023 and underwent UHR PCD-CTA (collimation:  $120 \times 0.2 \text{ mm}$ ). Two blinded and independent readers assessed the image quality of the in-stent lumen by applying a 5-point Likert scale (1="excellent" to 5="non-diagnostic") and evaluated stents for relevant in-stent stenosis of 50% or greater. UHR PCD-CTA's diagnostic accuracy was determined using ICA as the reference standard.

## RESULTS

The study involved 44 coronary stents in 18 participants (mean age: 83 years  $\pm$  6 [SD], 12 women). In 3 out of 44 stents, both readers rated image quality as non-diagnostic, while reader 2 considered another stent's image quality insufficient. Compared to ICA, UHR PCD-CTA showed sensitivity, specificity, and accuracy of 100% (95% CI: 47.8, 100), 92.3% (95% CI: 79.1, 98.4), and 93.2% (95% CI: 81.3, 98.6) for reader one and 100% (95% CI: 47.8, 100), 87.2% (95% CI: 72.6, 95.7), and 88.6% (95% CI: 75.4, 96.2) for reader two. Both readers reported a 100% negative predictive value (36 out of 36 stents and 34 out of 34 stents). Inter-reader agreement for stent patency was 90.1%, yielding a substantial Cohen's kappa value of 0.72.

## CONCLUSION

UHR PCD-CTA offers non-invasive coronary stent patency evaluation with elevated image quality and diagnostic accuracy.

## CLINICAL RELEVANCE/APPLICATION

UHR PCD-CTA is a reliable technique for assessing coronary stent patency. Its high negative predictive value makes it a promising non-invasive approach for excluding in-stent stenosis in patients with prior stent implantation.

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## Abstract Archives of the RSNA, 2023

M1-SSCA03-1

### Improved Detection of Small and Low-density Plaques in Virtual Non-iodine-based Coronary Artery Calcium Scoring on Photon-Counting Detector CT

Monday, Nov. 27 8:00AM - 9:00AM Room: E353B

Nicola Fink, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

With improved multi-material separation, photon-counting detector (PCD)-CT allows to create virtual non-iodine (VNI) reconstructions for coronary artery calcium scoring (CACS) based on contrast-enhanced scans. VNI-CACS has been shown to outperform previous virtual non-contrast (VNC) images. However, previous studies focused on total scores. This study aimed to assess the impact of plaque size and density on the algorithm's performance and to provide recommendations regarding "safety net" reconstructions for an improved detection of subtle plaques.

#### METHODS AND MATERIALS

CACS was evaluated in phantoms simulating three chest diameters and containing nine calcifications with different sizes (5, 3, 1mm) and densities (800, 400, 200 mg/cm<sup>3</sup>), and in patients (n=63; 57.8±15.5 years; 58.7% male) who underwent true non-contrast (TNC) and contrast-enhanced cardiac PCD-CT. VNI images were reconstructed at different VMI (55-80keV) and quantum iterative reconstructions (QIR; strength 1-4). TNC scans at 70keV, QIR off served as reference. In vitro CACS was analyzed with standard CACS settings (3.0mm slices, kernel Qr36, threshold 130HU). In addition, the number of detected calcifications and CACS of small and low-density plaques were investigated using adjusted reconstructions (1.0mm, kernel Qr44, thresholds 120/110HU). Based on background Agatston scores of best performing settings, "safety net" reconstructions were defined and assessed in in vivo TNC plaques initially not detected by standard VNI reconstructions.

#### RESULTS

Correlation and agreement between standard CACSVNI and CACSTNC was higher in large/medium-sized and high/medium-density plaques than in low-density plaques (ICC=0.90, r>0.9 vs. ICC=0.20-0.48, r =0.47-0.56). Small plaques were not detectable using standard VNI. The highest detectability of calcifications was achieved using slice thickness 1.0mm, kernel Qr44, CACS thresholds 120/110HU, and QIR=2. Compared to standard VNI settings, using our proposed "safety net" reconstructions (55keV, QIR2; threshold 110HU) for in vivo CACS increased detectability of subtle plaques by 89.3% and improved correlation and agreement of CACSVNI with CACSTNC (ICC=0.51, r=0.60; with standard settings not detectable).

#### CONCLUSION

Compared to TNC-CACS, the performance of the VNI algorithm is limited for small and low-density plaques, which can be improved using "safety net" reconstructions. These should additionally be performed in patients with a standard CACS<sub>VNI</sub> of zero to identify missed plaques.

#### CLINICAL RELEVANCE/APPLICATION

The proposed "safety net" improves accurate cardiovascular risk assessment using VNI-based CACS, especially in patients who would otherwise be classified as false-negative due to missed subtle plaques.

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## Abstract Archives of the RSNA, 2023

M1-SSCA03-2

### Ultra High Resolution Photon Counting CT Results in Improved Spatial Accuracy during Simulated Coronary Motion

Monday, Nov. 27 8:00AM - 9:00AM Room: E353B

Audrey Rich, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultra high resolution photon counting CT (PCCT) has the potential for improved visualization of minute anatomic structures. Yet, increases in spatial resolution are susceptible to motion related image degradation. A major challenge in cardiac imaging is the intrinsic motion of the heart. Motion artifacts compromise image quality and the visualization of coronary anatomy and disease. The purpose of the study is to determine if the increased spatial accuracy of PCCT is preserved in moving structures, such as coronary arteries.

#### METHODS AND MATERIALS

A dynamic cardiac phantom device simulated cardiac coronary motion by mechanically transferring device movement to a tungsten wire. Wire motion corresponded to different device rates, which equated to different cardiac rates. The tungsten wire was imaged while stationary and moving, using a coronary CT angiography protocol with sequential ECG triggered axial acquisition settings on a PCCT using a conventional reconstruction mode at 120kV with 0.6mm slice thickness and the Bv36u kernel. The moving wire was reimaged on the same PCCT system with the same protocol but using a prospectively triggered method on the ultra high resolution mode at 140kV with 0.2mm slice thickness using the Bv56u kernel. In each setting, images were acquired using a top gantry speed of 264m/s, 66ms temporal resolution, and 120x0.2mm collimation. Image reconstruction was performed using a 512 x 512 matrix and processed using ImageJ software. Images were compared using the full width at half maximum (FWHM) area of the point spread function as a numerical estimate of spatial accuracy.

#### RESULTS

Using the standard acquisition mode, at a device rate of 70bpm, the point object images were degraded in shape and attenuation to different degrees during the motion cycle. The FWHM area corresponded to our visual assessment and ranged from 5.1mm<sup>2</sup> to 23.8mm<sup>2</sup>, depending on the time of image reconstruction. Conversely, using the UHR reconstructions, the best image reconstruction yielded a smaller point image with better definition than the best reconstruction from the standard stationary and dynamic resolution series. The FWHM area ranged from 0.8mm<sup>2</sup> to 5.9mm<sup>2</sup>.

#### CONCLUSION

Object motion degraded image quality to variable degrees over the motion cycle. The UHR mode improves overall spatial accuracy at rest and during moving conditions when comparing the two settings that exist within photon counting.

#### CLINICAL RELEVANCE/APPLICATION

High resolution photon counting CT improves spatial accuracy under dynamic conditions.

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## Abstract Archives of the RSNA, 2023

M1-SSCA03-3

### Coronary Stent Imaging in Photon Counting Computed Tomography: Assessability of In-Stent Stenoses

Monday, Nov. 27 8:00AM - 9:00AM Room: E353B

Jan Robert Kroger, MD (*Presenter*) Travel Support, Otsuka Holdings Co, Ltd;

#### PURPOSE

To evaluate the assessment of in-stent stenosis in coronary artery stents in a phantom using photon counting computed tomography (PCCT) with standard resolution mode (SRM) and ultra-high-resolution mode (UHR) as well as different reconstruction kernels.

#### METHODS AND MATERIALS

6 coronary artery stents (diameter 3 mm) were implanted in plastic tubes. Hypodense stenoses were implanted. Tubes were filled with contrast medium and examined using rotational angiography to define the ground-truth. For CT examinations tubes were filled with a solution of saline and contrast medium adjusted to measure 600 HU and were scanned at a PCCT (Naeotom Alpha, Siemens Healthineers) in SRM and UHR. Images were reconstructed using a standard vascular kernel (BV72c, e.g. UHRc) and an experimental kernel optimized for stent imaging (BV72o, e.g. SRMo). Analysis was performed by 5 readers, measuring lumen diameter inside the stent and residual lumen inside the stenosis and rating the assessability of the stenosis on a five-point Likert scale. One-way ANOVA or Friedman test were used for the comparison of multiple means as appropriate. Post-hoc testing with Bonferroni corrected p-values was performed in case of significant differences.

#### RESULTS

The visible in-stent lumen averaged  $0.27 \pm 0.49$  mm in SRM,  $1.37 \pm 0.55$  mm in UHR ( $p < 0.001$ ). In UHRc, the visible lumen averaged  $1.32 \pm 0.57$  mm, and in UHRo it was  $1.43 \pm 0.54$  mm ( $p = 0.033$ ). The residual lumen was measured significantly more accurately in UHR than in SRM (mean SRM  $0.11 \pm 0.19$  mm vs. UHR  $0.41 \pm 0.22$  mm). The difference between UHRc and UHRo is also significant in favor of UHRo (UHRc  $0.35 \pm 0.23$  mm vs. UHRo  $0.47 \pm 0.19$  mm, corrected  $p = 0.021$ ). Compared to angiography, UHRo achieved the best classification of in-stent stenosis grade but still overestimated the stenosis grade. UHRo received the highest rating regarding the assessability of the stenosis ( $3.31 \pm 1.20$ ). The difference between SRM and UHR and between UHRc and UHRo was significant (for both comparisons  $p < 0.001$ ).

#### CONCLUSION

PCCT in UHR mode enables the evaluation of in-stent stenosis in small-diameter coronary artery stents in a phantom. The assessability of the stenosis can be further enhanced by optimizing image reconstruction kernels for stent imaging.

#### CLINICAL RELEVANCE/APPLICATION

Coronary artery computed tomography plays a major role in the evaluation of coronary artery disease and PCCT with UHR might overcome limitations of standard CTA when examining patients with coronary stents.

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## Abstract Archives of the RSNA, 2023

M1-SSCA03-4

### Pure Calcium Virtual Unenhanced Images from Photon-counting Coronary Angiography Provide Accurate Coronary Artery Calcium Scoring

Monday, Nov. 27 8:00AM - 9:00AM Room: E353B

Nina Pauline Haag, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary artery calcium scoring (CACS) is an important predictor of morbidity in chronic coronary artery disease (CAD). CACS requires an unenhanced CT scan in addition to contrast-enhanced coronary CT angiography (cCTA). Photon counting CT (PCCT) provides a customized algorithm for the reconstruction of virtual unenhanced images from cCTA specifically for calcium scoring (PureCalcium, Siemens Healthineers). This study aimed to evaluate the accuracy of PureCalcium images derived from contrast-enhanced photon counting cCTA in comparison to unenhanced CACS images (uCACS).

#### METHODS AND MATERIALS

In this retrospective study, 128 patients receiving PCCT (Naeotom Alpha, syngo.CT VB50, Siemens Healthineers) with uCACS and cCTA for CAD between August 2022 and April 2023 were included. PureCalcium images were reconstructed from cCTA data. UCASC and PureCalcium data sets were evaluated using a semiautomatic workflow (Calciumscoring, Syngo.Via VB60, Siemens Healthineers). Agatston scores were generated for both data sets. DLP values for the entire examination and the uCACS scan were analyzed. Data are presented as mean  $\pm$  standard deviation. Differences in the Agatston score between uCACS and PureCalcium were evaluated using the paired sample t-test and Pearson's correlation coefficient as well as the intra-class correlation coefficient between both scores were calculated. Bland Altman analysis was performed, and bias and limits of agreement (LoA) are presented. The intra-class correlation coefficient was calculated for Agatston scores from both measurements. P-values of  $< 0.05$  were considered statistically significant.

#### RESULTS

84 patients had an Agatston score of  $> 0$ . The mean Agatston score was equivalent between uCACS and PureCalcium ( $115.5 \pm 270.7$  vs.  $112.4 \pm 275.5$ ,  $p=0.519$ ); the correlation between both scores was excellent ( $r=0.98$ ,  $p < 0.001$ ). ICC between both measurements was excellent with 0.981. Bland Altman analysis showed a bias of  $3.1 \pm 54.0$  (LoA:  $-102.7/108.9$ ). The mean DLP for the entire examination was  $236.9 \pm 213.2$  mGy\*cm, while DLP for uCACS was  $32.2 \pm 11.7$  mGy\*cm. Thus, the uCACS share of the radiation dose of the entire examination was  $19 \pm 9$  %.

#### CONCLUSION

Agatston scores derived from PureCalcium images of PCCT scanners and standard uCACS correlate to a high degree and do not differ significantly. Omitting a dedicated unenhanced scan in PCCT cCTA could reduce radiation dose by  $19 \pm 9$  %.

#### CLINICAL RELEVANCE/APPLICATION

Coronary artery calcium scoring is an important predictor of morbidity in chronic coronary artery disease. Deriving Agatston scores directly from contrast-enhanced CTA could reduce the radiation dose of a typical CT examination of the coronary arteries substantively.

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## Abstract Archives of the RSNA, 2023

M1-SSCA03-5

### Ultra-High-Resolution K-Edge Imaging for Characterization of Coronary Arteries with Deep-Silicon Photon-Counting CT: Comparison with Conventional Dual-Energy CT

Monday, Nov. 27 8:00AM - 9:00AM Room: E353B

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detectors (PCD) may improve image quality and diagnostic value of CT compared to the energy-integrating detectors (EID). Reduced radiation dose, spectral information, and improved spatial resolution are three advantages of PCD. Edge-irradiated deep-Si PCD promises better spectral and spatial resolution compared to CdTe and CdZnTe PCDs. Here we investigate the utility of deep-Si PCD for characterizing coronary artery plaques and stents.

#### METHODS AND MATERIALS

We fabricate custom coronary artery phantoms with diameter ( $d$ ) = 2-3.5 mm. Calcified and soft plaques, and 7 coronary stents are added to the arteries and filled with iodine- or gadolinium-based contrast agents (IBCA, GBCA). The inserts are placed inside water cylinders ( $d=12$ cm). 15 mL-diameter vials with calibrated dilutions and mixtures of IBCA and GBCA, water, and fat are also included. We scan the phantoms using a prototype deep-Si PCD-CT scanner at 120 kVp, 400 mAs, 1-s rotation, with 8 energy bins. Dual-energy fast kV-switching EID-CT is used for comparison. Iodine density maps, water maps, and virtual monoenergetic images (VMIs) are reconstructed using a filtered-backprojection algorithm with "Detail" kernel for EID, vs a prototype high-resolution kernel for PCD (MTF 10% at 7.8 lp/cm vs 21.2 lp/cm). Reconstruction field-of-view is 128 mm for both scanners. Image voxel size was  $250 \times 250 \times 625 \mu\text{m}^3$  vs  $125 \times 125 \times 417 \mu\text{m}^3$  for EID vs PCD, respectively. We measure iodine density in ROIs with  $d > 8$  mm ( $N = 8$ ). Lumen diameter ( $N = 24$ ) was used as a metric for effective spatial resolution (blooming) in 70 keV VMIs. The Wilcoxon signed rank test is used to compare the two scanners with  $p < 0.05$  considered statistically significant.

#### RESULTS

Errors in iodine density measured in IBCA dilutions with water are significantly different and in the  $[-0.3 \ 3.2]$  vs  $[-2.2 \ -0.02]$  mg I/mL range for EID and PCD, respectively. PCD material decomposition separates IBCA and GBCA into iodine density and water maps with good accuracy in iodine quantification in both mixtures (error range  $[-0.3 \ 0.3]$  mg I/mL) whereas the EID erroneously decomposes GBCA into both iodine and water (error range  $[0.0 \ 11.0]$  mg I/mL). Lumen diameter measurements are more accurate for PCD vs EID (error 173 vs 352  $\mu\text{m}$ ).

#### CONCLUSION

Deep-Si PCD demonstrates good accuracy in iodine quantification and can accurately decompose mixtures of two contrast agents. Its improved spatial resolution results in sharper images with blooming artifacts reduced by 50% compared to a state-of-the-art dual-energy EID scanner.

#### CLINICAL RELEVANCE/APPLICATION

UHR spectral evaluation of coronary arteries with deep-Si photon-counting CT can help improve visualization of plaques and stents by providing spectral information at 150  $\mu\text{m}$  resolution.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSCA03-6

### **In-human Evaluation of Coronary Stent Patency using Ultra-High-Resolution Photon-Counting Detector CT: A Comparison to Invasive Angiography**

Monday, Nov. 27 8:00AM - 9:00AM Room: E353B

Muhammad Taha Hagar, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the diagnostic accuracy of ultra-high-resolution photon-counting detector CT angiography (UHR PCD-CTA) in assessing coronary stent patency, using invasive coronary angiography (ICA) as a reference.

#### **METHODS AND MATERIALS**

Consecutive patients with previous coronary stent placement were prospectively enrolled between August 2022 and March 2023 and underwent UHR PCD-CTA (collimation: 120 x 0.2 mm). Two blinded and independent readers assessed the image quality of the in-stent lumen by applying a 5-point Likert scale (1="excellent" to 5="non-diagnostic") and evaluated stents for relevant in-stent stenosis of 50% or greater. UHR PCD-CTA's diagnostic accuracy was determined using ICA as the reference standard.

#### **RESULTS**

The study involved 44 coronary stents in 18 participants (mean age: 83 years  $\pm$  6 [SD], 12 women). In 3 out of 44 stents, both readers rated image quality as non-diagnostic, while reader 2 considered another stent's image quality insufficient. Compared to ICA, UHR PCD-CTA showed sensitivity, specificity, and accuracy of 100% (95% CI: 47.8, 100), 92.3% (95% CI: 79.1, 98.4), and 93.2% (95% CI: 81.3, 98.6) for reader one and 100% (95% CI: 47.8, 100), 87.2% (95% CI: 72.6, 95.7), and 88.6% (95% CI: 75.4, 96.2) for reader two. Both readers reported a 100% negative predictive value (36 out of 36 stents and 34 out of 34 stents). Inter-reader agreement for stent patency was 90.1%, yielding a substantial Cohen's kappa value of 0.72.

#### **CONCLUSION**

UHR PCD-CTA offers non-invasive coronary stent patency evaluation with elevated image quality and diagnostic accuracy.

#### **CLINICAL RELEVANCE/APPLICATION**

UHR PCD-CTA is a reliable technique for assessing coronary stent patency. Its high negative predictive value makes it a promising non-invasive approach for excluding in-stent stenosis in patients with prior stent implantation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSGU03

### Genitourinary Imaging (Technical Advances and Quality Improvement in Prostate MRI)

Monday, Nov. 27 8:00AM - 9:00AM Room: S405

Masoom A. Haider, MD (*Moderator*) Nothing to Disclose  
Alice Schuch, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M1-SSGU03-1 The Diagnostic Value of Dynamic Contrast Enhanced MRI for Clinically Significant Prostate Cancer: An International Multi-Reader Study with 61 Radiologists (The PI-CAI Reader Study)**

Jasper J. Twilt, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The PI-CAI Reader Study evaluated the added value of dynamic contrast enhanced (DCE) MRI to diagnose clinically significant prostate cancer (csPCa) within a large international multi-reader multi-case (MRMC) observer study (61 radiologists, 45 centers from 20 countries).

#### METHODS AND MATERIALS

Readers assessed 400 retrospective prostate MRI exams without prior prostate treatment or csPCa presence, acquired between 2012-2021 from four Dutch and one Norwegian tertiary center. Presence of csPCa (Gleason Grade Group = 2) was defined as a positive biopsy or radical prostatectomy within 3 years. Readers were divided into four blocks, reading 100 cases each. Readers provided a patient-level suspicion score (0-100) of harboring csPCa on bpMRI and annotated each suspected csPCa lesion with a PI-RADS 3-5 score. Next, readers were unblinded to DCE and could update the case and lesion assessments, if deemed necessary. The difference in diagnostic performance between bpMRI and mpMRI was assessed using MRMC analysis based on Area under the Receiver Operating Characteristic Curve (AUROC), and index PI-RADS = 3 and PI-RADS = 4 operating points. Subgroup analysis was performed for expert (>1000 cases read in total, >200 cases/year) and non-expert (<1000 cases read in total, <200 cases/year) readers.

#### RESULTS

Reader experience varied between 1-23 years (median: 7). 133 patients (34%) harbored csPCa. The AUROC performance at bpMRI and mpMRI was  $0.855 \pm 0.02$  and  $0.862 \pm 0.02$ . Subgroup analysis showed AUROC at bpMRI and mpMRI of  $0.863 \pm 0.02$  and  $0.869 \pm 0.02$  for experts and  $0.830 \pm 0.02$  and  $0.839 \pm 0.02$  for non-experts, respectively. Considering performance using index PI-RADS scores, 91% of readings did not change upon mpMRI assessment. At an operating point of PI-RADS = 3, sensitivity for bpMRI and mpMRI was  $0.89 \pm 0.02$  and  $0.90 \pm 0.02$  with specificity of  $0.59 \pm 0.03$  and  $0.58 \pm 0.03$ . At PI-RADS = 4, DCE improved sensitivity ( $0.81 \pm 0.03$  at bpMRI and  $0.85 \pm 0.03$  at mpMRI) at the cost of specificity ( $0.76 \pm 0.02$  at bpMRI and  $0.72 \pm 0.02$  at mpMRI).

#### CONCLUSION

bpMRI showed a similar ability to diagnose csPCa compared to mpMRI, indicating limited added value of DCE. Compared to expert readers, non-experts had overall lower accuracy for diagnosing csPCa. No difference between bpMRI and mpMRI after stratification to level of experience was observed. At PI-RADS  $\geq 4$  DCE might improve csPCa diagnosis at the cost of increased false positives.

#### CLINICAL RELEVANCE/APPLICATION

Within a large international multi-reader multi-case study, results showed that the ability to diagnose csPCa remains similar when DCE MRI is omitted potentially saving costs and patient burden from the injection of contrast agent.

#### **M1-SSGU03-2 Comparison of a Diagnostic Performance of ADC Maps Generated Based on Intermediate and High B-Values in Detection and Grading of Prostate Cancer: An Intra-patient Study**



Roberta Catania, MD (*Presenter*) Institutional Research Grant, Siemens AG

## **PURPOSE**

To compare the diagnostic performance of apparent diffusion coefficient (ADC) values calculated based on intermediate (1000 s/mm<sup>2</sup>) and high (1600 s/mm<sup>2</sup>) b-values for detection and assessment of prostate cancer.

## **METHODS AND MATERIALS**

This retrospective study was approved by the institutional review board and informed consent was waived. One hundred and one lesions in 57 adult men who underwent magnetic resonance imaging (MRI) of the prostate between December 2020 and November 2021 and had subsequent fused MRI/ultrasound (US) targeted biopsy were included. Two separate diffusion weighted images (DWI) sequences were obtained using b-values of 50, 500, 1000 s/mm<sup>2</sup> and b-value of 50, 1600 s/mm<sup>2</sup> and 2 separate ADC maps were generated based on b-values of 1000 or 1600 (herein referred to as ADC1000 and ADC1600, respectively). Regions of interests were drawn inside the lesions on the corresponding ADC maps by two fellowship-trained radiologists. Qualitative assessment was also evaluated based on conspicuity of the lesions on the two different ADC maps according to a three-points Likert scale (1: high, 2: intermediate, 3: low). ADC values and lesion conspicuity scores were compared using univariate paired tests. Receiver operating characteristic (ROC) curves were constructed to compare the performance of ADC1000 and ADC1600 for diagnosis, and grading, of prostate cancer.

## **RESULTS**

One hundred and one lesions were included, 39 of them were malignant. ADC values were significantly lower at ADC1600 ( $p < 0.001$ ) for both readers with a mean difference of  $1.294 \times 10^{-3}$  mm<sup>2</sup>/s ( $\pm 148.8$ ) and  $1.595 \times 10^{-3}$  mm<sup>2</sup>/s ( $\pm 1.255$ ), respectively. Conspicuity of the lesions was superior at ADC1600 ( $p < 0.001$ ). Performance of ADC1600 for detection of prostate cancer was slightly higher (area under curve of 0.81 versus 0.77;  $p < 0.001$ ). An ADC1600 value lower than  $0.780 \times 10^{-3}$  mm<sup>2</sup>/s had a sensitivity and specificity of 82% and 66%, respectively, for detection of prostate cancer. The correlation between ADC values and different Gleason scores was strong and slightly better at ADC1600 ( $r = 0.53$  vs.  $0.47$ ;  $p < 0.05$ ).

## **CONCLUSION**

Quantitative and qualitative assessment demonstrated superior performance of ADC<sub>1600</sub> for lesion detection and for discrimination of benign from malignant lesions.

## **CLINICAL RELEVANCE/APPLICATION**

PI-RADS v2.1 recommends using ADC map calculated from intermediate b-value (800-1000 sec/mm<sup>2</sup>) to avoid diffusion kurtosis effect. Results of this cohort shows superior performance of ADC1600 for visualization and characterization of prostate lesions.

## **M1-SSGU03-3 The Power of PI-QUAL Metrics and Multidisciplinary Collaboration: Building a Robust and Comfortable Non-endorectal Prostate MRI Protocol**

Scott H. Robertson, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To utilize PI-QUAL scoring to assess the efficacy of protocol optimizations in enhancing the image quality of non-endorectal multiparametric prostate MRI. Furthermore, we aim to quantify the inter-reader agreement of PI-QUAL scores between radiologists, technologists, and physicists to determine whether future PI-QUAL investigations should incorporate a broader scope of team-members.

## **METHODS AND MATERIALS**

This retrospective IRB-approved study considered 1114 multiparametric prostate MRI exams that were obtained according to the PI-RADS v2/2.1 guidelines during a national quality improvement project. Each exam was scored according to the PI-QUAL standard, which provided both ratings of overall exam-level image quality as well as descriptors of image quality at the pulse sequence level. A set of 4 radiologists, 2 technologists, and 1 medical physicist audited an additional 150 exams that spanned both pre- and post-improvement phases to assess overall improvement. The two-tailed Wilcoxon rank sum test was used to assess differences in image quality between the exams. Inter-reader variability was assessed in 100 exams using the percent majority agreement and the average standard deviation of PI-QUAL scores between evaluators.

## **RESULTS**

Average PI-QUAL scores improved from  $3.67 \pm 0.75$  to  $4.16 \pm 0.59$  ( $p < 0.01$ ) after implementing a series of protocol changes to address common image quality issues. Distortion in DWI was reduced from 21.6% (41/190) to 11.5% (30/261) by adopting R/L rather than A/P phase encoding ( $p < 0.01$ ). Similarly, T2WI breathing motion artifacts were reduced from 34.6% (94/272) to 12.8% (23/179) with R/L phase encoding ( $p < 0.01$ ). DWI wraparound artifact was mitigated by employing a full-pelvis shim and enabling the abdomen shim option. The occurrence of low-SNR was reduced from 19.4% (19/98) to 6.3% (10/160) by instituting a 200-lb weight-limit for using an ERC ( $p < 0.01$ ). The percent majority agreement was similar between radiologists, technologists and physicists, and all evaluators combined (72%, 77%, and 67%, respectively).

## CONCLUSION

PI-QUAL is a highly useful tool for assessing image quality at the exam-level and for assessing the effects of MR protocol changes at the individual sequence level. PI-QUAL can be used by radiologists as well as other members of the MRI team, including physicists and technologists. Increasing multidisciplinary participation could substantially impact the performance of future QI studies.

## CLINICAL RELEVANCE/APPLICATION

PI-QUAL scores offer valuable insights at the exam- and series-level for optimizing protocols. Broadening the scope of PI-QUAL reviewers could provide more holistic and effective quality improvement initiatives.

### **M1-SSGU03-4 Inter-rater Reproducibility of the Prostate Imaging Quality (PI-QUAL) Score: A Multi-reader from Multicenter Study with Large Sample Size Data**

Liang Wang (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the inter-rater reproducibility of the Prostate imaging quality (PI-QUAL) for multiparametric magnetic resonance imaging (mpMRI) in a multireader from multicenter study.

## METHODS AND MATERIALS

Patients who underwent mpMRI and 24-core coaxial needle saturation biopsy of the prostate by the transperineal approach between January 2019 and February 2020 were retrospectively included. The mpMRI included multiplanar T2-weighted imaging (T2WI), Diffusion-weighted imaging (DWI), and dynamic contrast-enhanced imaging (DCE). Three readers from different general medical centers with at least 6 years of experience in diagnostic imaging independently assessed the PI-QUAL score of each mpMRI sequence. Training was conducted before scoring. Inter-rater agreement was assessed using Kendall's w-coefficient. Pairwise agreement was assessed using Cohen's kappa coefficient.

## RESULTS

Of 813 patients, 595 patients were enrolled. The three readers had strong agreement in PI-QUAL scores, Kendall's w coefficient was 0.678. Moderate to strong agreement was observed when comparing the three sequences individually, for the T2WI sequence, Kendall's w coefficient was 0.579; for the DWI sequence, Kendall's w coefficient was 0.763; for DCE sequences, Kendall's w coefficient was 0.666. Furthermore, the kappa value between R1 and R2 was 0.71 (95% CI: 0.65-0.76), the kappa value between R1 and R3 was 0.75 (95% CI: 0.70-0.80), the kappa value between R2 and R3 was 0.75 (95% CI: 0.70-0.80).

## CONCLUSION

PI-QUAL not only has good inter-reader consistency, but also has high reproducibility among physicians from different centers.

## CLINICAL RELEVANCE/APPLICATION

Our study observed that simplification is likely inevitable for future iterations of the PI-QUAL based on a 5-point scale or simplified into a 3-point scale.

### **M1-SSGU03-5 AI-based Reconstruction Improves Image Quality and Shortens Acquisition Time in DWI for Multiparametric Prostate MRI**

Elene Iordanishvili, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Multiparametric prostate MRI (mpMRI) and its standardization using the prostate imaging reporting and data system (PIRADS) have increased the detection rate of clinically significant prostate cancers. Yet, MRI availability is limited, and the exam is time consuming. Diffusion weighted imaging (DWI) is an essential sequence to diagnose prostate cancer. However, it suffers from low signal-to-noise (SNR) and contrast-to-noise ratios (CNR). Recently, reconstruction techniques using artificial intelligence (AI) have shown to improve T2w image quality and shorten acquisition time (TA). To evaluate image quality and diagnostic capability of an AI-reconstructed DWI sequence for mpMRI.

## METHODS AND MATERIALS

Ongoing study, so far including 45 consecutive patients undergoing standardized mpMRI (including T2wTSE, T1w dynamic CE GRE and DWI with ADC map) on a 3T system. Patients received a standard (std) and AI-DWI sequence with ADC maps (b 50, 400, 1000 s/mm<sup>2</sup>) plus a separate b1400 s/mm<sup>2</sup>). AI-DWI used less averages than std-DWI. Std-DWI image reconstruction employed Compressed SENSE (CS). AI-DWI image reconstruction was based on the Adaptive-CS-Net, i.e., including a convolutional neural network. 2 blinded radiologists assessed the PIRADS category for each patient based on the standard protocol first with AI-and then with std-DWI. Image quality (noise, delineation of lesion, artefacts) was ranked on a 10-point

Likert scale. ROI-based apparent SNR and CNR were calculated for semiquantitative analysis. Significance was tested using a generalised linear model.

## RESULTS

All patients were assigned the same PIRADS category based on std-, as well as AI-DWI. Regarding image quality, AI-DWI was ranked significantly less noisy than the std-DWI (median noise 5 vs 7;  $p < 0.001$ ). Delineation of lesions and presence of artefacts did not differ significantly between both sequences. CNR and SNR of the AI-ADC were significantly higher compared to the std-ADC (mean-CNR-AI-ADC = 9; mean-CNR-ADC = 8;  $P = 0.005$ ; mean-aSNR-AI-ADC = 10.5; mean-aSNR-ADC = 7;  $P = 0.001$ ). AI-b1400 showed higher aSNR and aCNR than the std-DWI, without statistical significance. TA was 3:12 minutes shorter for the AI-DWI compared to the std-DWI. (7:30 min vs. 4:18 min).

## CONCLUSION

AI-reconstruction significantly improves DWI quality, while maintaining diagnostic certainty and reducing TA by 57 %.

## CLINICAL RELEVANCE/APPLICATION

AI-DWI outperforms the standard DWI with regards to image quality and TA in patients, undergoing screening prostate MRI.

## M1-SSGU03-6 Deep Learning-Based Interpretable AI for Prostate T2W MRI Quality Evaluation

Mason Belue, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop an image quality evaluation artificial intelligence (AI) model for T2 weighted (T2W) prostate MRI and to generate interpretable 3D quality heatmaps.

## METHODS AND MATERIALS

This retrospective study included 994 patients scanned between January 2011 and December 2021 for clinical suspicion or follow-up of prostate cancer from an in-house institutional database ( $n=699$ ) and public PROSTATEx dataset ( $n=294$ ). T2W MRIs were given a quality score (class 0 = non-diagnostic, class 1 = equivocal, class 2 = diagnostic) based on evaluation of both general distortions (e.g., motion, distortion, noise, aliasing) and perceptual distortions (e.g., obscured delineation of prostatic capsule, prostatic zones, and excess rectal gas) by an expert genitourinary radiologist with 20 years of experience. A train-validation-test split of 70:15:15 was applied. All quality classification models were based on 3D DenseNet121 architecture using the MONAI framework. In addition to multi-classification, binary classification was utilized (Class 0/1 versus class 2). Partial occlusion sensitivity maps were generated for anatomical correlation. Reproducibility of quality scores was assessed within a subset of the testing dataset (60 cases, with quality score distribution of 1:1:1) in a blinded reader study with two experienced body radiologists, evaluated using weighted Cohen Kappa.

## RESULTS

Best validation multi-class accuracy of 77% was achieved during training. In the test dataset (149 cases, 101 class 2, 31 class 1, and 17 class 0), the multi-classification accuracy was 72.5% (108/149) whereas the binary accuracy was 83.9% (125/149). The sub-class sensitivity for binary quality distortion classification for class 0 was 100% (17/17) and the sub-class specificity for T2W classification of the absence of any quality distortions for class 2 was 89.1% (90/101). Within the multi-reader study for 3-class quality, both readers showed moderate to substantial agreement with ground truth ( $\kappa = 0.59$ ,  $\kappa = 0.65$  respectively), substantial agreement with each other ( $\kappa = 0.60$ ), and moderate agreement with AI ( $\kappa = 0.42$ ,  $\kappa = 0.43$  respectively). 3D quality heatmap evaluation revealed that the most important non-diagnostic quality imaging features from the AI perspective were interslice motion, rectal gas, and obscured capsule/prostatic zones.

## CONCLUSION

The 3D AI model can assess prostate T2W image quality with moderate accuracies and can translate whole sequence-level classification labels into 3D voxel-level quality heatmaps.

## CLINICAL RELEVANCE/APPLICATION

Image quality has a significant downstream impact on ruling out clinically significant cancers. AI may be able to help with reproducible identification of MRI sequences requiring re-acquisition with explainability.

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## Abstract Archives of the RSNA, 2023

M1-SSGU03-1

### **The Diagnostic Value of Dynamic Contrast Enhanced MRI for Clinically Significant Prostate Cancer: An International Multi-Reader Study with 61 Radiologists (The PI-CAI Reader Study)**

Monday, Nov. 27 8:00AM - 9:00AM Room: S405

Jasper J. Twilt, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The PI-CAI Reader Study evaluated the added value of dynamic contrast enhanced (DCE) MRI to diagnose clinically significant prostate cancer (csPCa) within a large international multi-reader multi-case (MRMC) observer study (61 radiologists, 45 centers from 20 countries).

#### **METHODS AND MATERIALS**

Readers assessed 400 retrospective prostate MRI exams without prior prostate treatment or csPCa presence, acquired between 2012-2021 from four Dutch and one Norwegian tertiary center. Presence of csPCa (Gleason Grade Group = 2) was defined as a positive biopsy or radical prostatectomy within 3 years. Readers were divided into four blocks, reading 100 cases each. Readers provided a patient-level suspicion score (0-100) of harboring csPCa on bpMRI and annotated each suspected csPCa lesion with a PI-RADS 3-5 score. Next, readers were unblinded to DCE and could update the case and lesion assessments, if deemed necessary. The difference in diagnostic performance between bpMRI and mpMRI was assessed using MRMC analysis based on Area under the Receiver Operating Characteristic Curve (AUROC), and index PI-RADS = 3 and PI-RADS = 4 operating points. Subgroup analysis was performed for expert (>1000 cases read in total, >200 cases/year) and non-expert (<1000 cases read in total, <200 cases/year) readers.

#### **RESULTS**

Reader experience varied between 1-23 years (median: 7). 133 patients (34%) harbored csPCa. The AUROC performance at bpMRI and mpMRI was  $0.855 \pm 0.02$  and  $0.862 \pm 0.02$ . Subgroup analysis showed AUROC at bpMRI and mpMRI of  $0.863 \pm 0.02$  and  $0.869 \pm 0.02$  for experts and  $0.830 \pm 0.02$  and  $0.839 \pm 0.02$  for non-experts, respectively. Considering performance using index PI-RADS scores, 91% of readings did not change upon mpMRI assessment. At an operating point of PI-RADS = 3, sensitivity for bpMRI and mpMRI was  $0.89 \pm 0.02$  and  $0.90 \pm 0.02$  with specificity of  $0.59 \pm 0.03$  and  $0.58 \pm 0.03$ . At PI-RADS = 4, DCE improved sensitivity ( $0.81 \pm 0.03$  at bpMRI and  $0.85 \pm 0.03$  at mpMRI) at the cost of specificity ( $0.76 \pm 0.02$  at bpMRI and  $0.72 \pm 0.02$  at mpMRI).

#### **CONCLUSION**

bpMRI showed a similar ability to diagnose csPCa compared to mpMRI, indicating limited added value of DCE. Compared to expert readers, non-experts had overall lower accuracy for diagnosing csPCa. No difference between bpMRI and mpMRI after stratification to level of experience was observed. At PI-RADS  $\geq 4$  DCE might improve csPCa diagnosis at the cost of increased false positives.

#### **CLINICAL RELEVANCE/APPLICATION**

Within a large international multi-reader multi-case study, results showed that the ability to diagnose csPCa remains similar when DCE MRI is omitted potentially saving costs and patient burden from the injection of contrast agent.

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## Abstract Archives of the RSNA, 2023

M1-SSGU03-2

### Comparison of a Diagnostic Performance of ADC Maps Generated Based on Intermediate and High B-Values in Detection and Grading of Prostate Cancer: An Intra-patient Study

Monday, Nov. 27 8:00AM - 9:00AM Room: S405

Roberta Catania, MD (*Presenter*) Institutional Research Grant, Siemens AG

#### PURPOSE

To compare the diagnostic performance of apparent diffusion coefficient (ADC) values calculated based on intermediate (1000 s/mm<sup>2</sup>) and high (1600 s/mm<sup>2</sup>) b-values for detection and assessment of prostate cancer.

#### METHODS AND MATERIALS

This retrospective study was approved by the institutional review board and informed consent was waived. One hundred and one lesions in 57 adult men who underwent magnetic resonance imaging (MRI) of the prostate between December 2020 and November 2021 and had subsequent fused MRI/ultrasound (US) targeted biopsy were included. Two separate diffusion weighted images (DWI) sequences were obtained using b-values of 50, 500, 1000 s/mm<sup>2</sup> and b-value of 50, 1600 s/mm<sup>2</sup> and 2 separate ADC maps were generated based on b-values of 1000 or 1600 (herein referred to as ADC1000 and ADC1600, respectively). Regions of interests were drawn inside the lesions on the corresponding ADC maps by two fellowship-trained radiologists. Qualitative assessment was also evaluated based on conspicuity of the lesions on the two different ADC maps according to a three-points Likert scale (1: high, 2: intermediate, 3: low). ADC values and lesion conspicuity scores were compared using univariate paired tests. Receiver operating characteristic (ROC) curves were constructed to compare the performance of ADC1000 and ADC1600 for diagnosis, and grading, of prostate cancer.

#### RESULTS

One hundred and one lesions were included, 39 of them were malignant. ADC values were significantly lower at ADC1600 ( $p < 0.001$ ) for both readers with a mean difference of  $1.294 \times 10^{-3}$  mm<sup>2</sup>/s ( $\pm 148.8$ ) and  $1.595 \times 10^{-3}$  mm<sup>2</sup>/s ( $\pm 1.255$ ), respectively. Conspicuity of the lesions was superior at ADC1600 ( $p < 0.001$ ). Performance of ADC1600 for detection of prostate cancer was slightly higher (area under curve of 0.81 versus 0.77;  $p < 0.001$ ). An ADC1600 value lower than  $0.780 \times 10^{-3}$  mm<sup>2</sup>/s had a sensitivity and specificity of 82% and 66%, respectively, for detection of prostate cancer. The correlation between ADC values and different Gleason scores was strong and slightly better at ADC1600 ( $r = 0.53$  vs.  $0.47$ ;  $p < 0.05$ ).

#### CONCLUSION

Quantitative and qualitative assessment demonstrated superior performance of ADC<sub>1600</sub> for lesion detection and for discrimination of benign from malignant lesions.

#### CLINICAL RELEVANCE/APPLICATION

PI-RADS v2.1 recommends using ADC map calculated from intermediate b-value (800-1000 sec/mm<sup>2</sup>) to avoid diffusion kurtosis effect. Results of this cohort shows superior performance of ADC1600 for visualization and characterization of prostate lesions.

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## Abstract Archives of the RSNA, 2023

M1-SSGU03-3

### The Power of PI-QUAL Metrics and Multidisciplinary Collaboration: Building a Robust and Comfortable Non-endorectal Prostate MRI Protocol

Monday, Nov. 27 8:00AM - 9:00AM Room: S405

Scott H. Robertson, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To utilize PI-QUAL scoring to assess the efficacy of protocol optimizations in enhancing the image quality of non-endorectal multiparametric prostate MRI. Furthermore, we aim to quantify the inter-reader agreement of PI-QUAL scores between radiologists, technologists, and physicists to determine whether future PI-QUAL investigations should incorporate a broader scope of team-members.

#### METHODS AND MATERIALS

This retrospective IRB-approved study considered 1114 multiparametric prostate MRI exams that were obtained according to the PI-RADS v2/2.1 guidelines during a national quality improvement project. Each exam was scored according to the PI-QUAL standard, which provided both ratings of overall exam-level image quality as well as descriptors of image quality at the pulse sequence level. A set of 4 radiologists, 2 technologists, and 1 medical physicist audited an additional 150 exams that spanned both pre- and post-improvement phases to assess overall improvement. The two-tailed Wilcoxon rank sum test was used to assess differences in image quality between the exams. Inter-reader variability was assessed in 100 exams using the percent majority agreement and the average standard deviation of PI-QUAL scores between evaluators.

#### RESULTS

Average PI-QUAL scores improved from  $3.67 \pm 0.75$  to  $4.16 \pm 0.59$  ( $p < 0.01$ ) after implementing a series of protocol changes to address common image quality issues. Distortion in DWI was reduced from 21.6% (41/190) to 11.5% (30/261) by adopting R/L rather than A/P phase encoding ( $p < 0.01$ ). Similarly, T2WI breathing motion artifacts were reduced from 34.6% (94/272) to 12.8% (23/179) with R/L phase encoding ( $p < 0.01$ ). DWI wraparound artifact was mitigated by employing a full-pelvis shim and enabling the abdomen shim option. The occurrence of low-SNR was reduced from 19.4% (19/98) to 6.3% (10/160) by instituting a 200-lb weight-limit for using an ERC ( $p < 0.01$ ). The percent majority agreement was similar between radiologists, technologists and physicists, and all evaluators combined (72%, 77%, and 67%, respectively).

#### CONCLUSION

PI-QUAL is a highly useful tool for assessing image quality at the exam-level and for assessing the effects of MR protocol changes at the individual sequence level. PI-QUAL can be used by radiologists as well as other members of the MRI team, including physicists and technologists. Increasing multidisciplinary participation could substantially impact the performance of future QI studies.

#### CLINICAL RELEVANCE/APPLICATION

PI-QUAL scores offer valuable insights at the exam- and series-level for optimizing protocols. Broadening the scope of PI-QUAL reviewers could provide more holistic and effective quality improvement initiatives.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSGU03-4

### Inter-rater Reproducibility of the Prostate Imaging Quality (PI-QUAL) Score: A Multi-reader from Multicenter Study with Large Sample Size Data

Monday, Nov. 27 8:00AM - 9:00AM Room: S405

Liang Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the inter-rater reproducibility of the Prostate imaging quality (PI-QUAL) for multiparametric magnetic resonance imaging (mpMRI) in a multireader from multicenter study.

#### METHODS AND MATERIALS

Patients who underwent mpMRI and 24-core coaxial needle saturation biopsy of the prostate by the transperineal approach between January 2019 and February 2020 were retrospectively included. The mpMRI included multiplanar T2-weighted imaging (T2WI), Diffusion-weighted imaging (DWI), and dynamic contrast-enhanced imaging (DCE). Three readers from different general medical centers with at least 6 years of experience in diagnostic imaging independently assessed the PI-QUAL score of each mpMRI sequence. Training was conducted before scoring. Inter-rater agreement was assessed using Kendall's w-coefficient. Pairwise agreement was assessed using Cohen's kappa coefficient.

#### RESULTS

Of 813 patients, 595 patients were enrolled. The three readers had strong agreement in PI-QUAL scores, Kendall's w coefficient was 0.678. Moderate to strong agreement was observed when comparing the three sequences individually, for the T2WI sequence, Kendall's w coefficient was 0.579; for the DWI sequence, Kendall's w coefficient was 0.763; for DCE sequences, Kendall's w coefficient was 0.666. Furthermore, the kappa value between R1 and R2 was 0.71 (95% CI: 0.65-0.76), the kappa value between R1 and R3 was 0.75 (95% CI: 0.70-0.80), the kappa value between R2 and R3 was 0.75 (95% CI: 0.70-0.80).

#### CONCLUSION

PI-QUAL not only has good inter-reader consistency, but also has high reproducibility among physicians from different centers.

#### CLINICAL RELEVANCE/APPLICATION

Our study observed that simplification is likely inevitable for future iterations of the PI-QUAL based on a 5-point scale or simplified into a 3-point scale.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-SSGU03-5

### AI-based Reconstruction Improves Image Quality and Shortens Acquisition Time in DWI for Multiparametric Prostate MRI

Monday, Nov. 27 8:00AM - 9:00AM Room: S405

Elene Iordanishvili, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Multiparametric prostate MRI (mpMRI) and its standardization using the prostate imaging reporting and data system (PIRADS) have increased the detection rate of clinically significant prostate cancers. Yet, MRI availability is limited, and the exam is time consuming. Diffusion weighted imaging (DWI) is an essential sequence to diagnose prostate cancer. However, it suffers from low signal-to-noise (SNR) and contrast-to-noise ratios (CNR). Recently, reconstruction techniques using artificial intelligence (AI) have shown to improve T2w image quality and shorten acquisition time (TA). To evaluate image quality and diagnostic capability of an AI-reconstructed DWI sequence for mpMRI.

#### METHODS AND MATERIALS

Ongoing study, so far including 45 consecutive patients undergoing standardized mpMRI (including T2wTSE, T1w dynamic CE GRE and DWI with ADC map) on a 3T system. Patients received a standard (std) and AI-DWI sequence with ADC maps (b 50, 400, 1000 s/mm<sup>2</sup>) plus a separate b1400 s/mm<sup>2</sup>). AI-DWI used less averages than std-DWI. Std-DWI image reconstruction employed Compressed SENSE (CS). AI-DWI image reconstruction was based on the Adaptive-CS-Net, i.e., including a convolutional neural network. 2 blinded radiologists assessed the PIRADS category for each patient based on the standard protocol first with AI-and then with std-DWI. Image quality (noise, delineation of lesion, artefacts) was ranked on a 10-point Likert scale. ROI-based apparent SNR and CNR were calculated for semiquantitative analysis. Significance was tested using a generalised linear model.

#### RESULTS

All patients were assigned the same PIRADS category based on std-, as well as AI-DWI. Regarding image quality, AI-DWI was ranked significantly less noisy than the std-DWI (median noise 5 vs 7;  $p < 0.001$ ). Delineation of lesions and presence of artefacts did not differ significantly between both sequences. CNR and SNR of the AI-ADC were significantly higher compared to the std-ADC (mean-CNR-AI-ADC = 9; mean-CNR-ADC = 8;  $P = 0.005$ ; mean-aSNR-AI-ADC = 10.5; mean-aSNR-ADC = 7;  $P = 0.001$ ). AI-b1400 showed higher aSNR and aCNR than the std-DWI, without statistical significance. TA was 3:12 minutes shorter for the AI-DWI compared to the std-DWI. (7:30 min vs. 4:18 min).

#### CONCLUSION

AI-reconstruction significantly improves DWI quality, while maintaining diagnostic certainty and reducing TA by 57 %.

#### CLINICAL RELEVANCE/APPLICATION

AI-DWI outperforms the standard DWI with regards to image quality and TA in patients, undergoing screening prostate MRI.

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## Abstract Archives of the RSNA, 2023

M1-SSGU03-6

### Deep Learning-Based Interpretable AI for Prostate T2W MRI Quality Evaluation

Monday, Nov. 27 8:00AM - 9:00AM Room: S405

Mason Belue, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop an image quality evaluation artificial intelligence (AI) model for T2 weighted (T2W) prostate MRI and to generate interpretable 3D quality heatmaps.

#### METHODS AND MATERIALS

This retrospective study included 994 patients scanned between January 2011 and December 2021 for clinical suspicion or follow-up of prostate cancer from an in-house institutional database (n=699) and public PROSTATEx dataset (n=294). T2W MRIs were given a quality score (class 0 = non-diagnostic, class 1 = equivocal, class 2 = diagnostic) based on evaluation of both general distortions (e.g., motion, distortion, noise, aliasing) and perceptual distortions (e.g., obscured delineation of prostatic capsule, prostatic zones, and excess rectal gas) by an expert genitourinary radiologist with 20 years of experience. A train-validation-test split of 70:15:15 was applied. All quality classification models were based on 3D DenseNet121 architecture using the MONAI framework. In addition to multi-classification, binary classification was utilized (Class 0/1 versus class 2). Partial occlusion sensitivity maps were generated for anatomical correlation. Reproducibility of quality scores was assessed within a subset of the testing dataset (60 cases, with quality score distribution of 1:1:1) in a blinded reader study with two experienced body radiologists, evaluated using weighted Cohen Kappa.

#### RESULTS

Best validation multi-class accuracy of 77% was achieved during training. In the test dataset (149 cases, 101 class 2, 31 class 1, and 17 class 0), the multi-classification accuracy was 72.5% (108/149) whereas the binary accuracy was 83.9% (125/149). The sub-class sensitivity for binary quality distortion classification for class 0 was 100% (17/17) and the sub-class specificity for T2W classification of the absence of any quality distortions for class 2 was 89.1% (90/101). Within the multi-reader study for 3-class quality, both readers showed moderate to substantial agreement with ground truth ( $\kappa = 0.59$ ,  $\kappa = 0.65$  respectively), substantial agreement with each other ( $\kappa = 0.60$ ), and moderate agreement with AI ( $\kappa = 0.42$ ,  $\kappa = 0.43$  respectively). 3D quality heatmap evaluation revealed that the most important non-diagnostic quality imaging features from the AI perspective were interslice motion, rectal gas, and obscured capsule/prostatic zones.

#### CONCLUSION

The 3D AI model can assess prostate T2W image quality with moderate accuracies and can translate whole sequence-level classification labels into 3D voxel-level quality heatmaps.

#### CLINICAL RELEVANCE/APPLICATION

Image quality has a significant downstream impact on ruling out clinically significant cancers. AI may be able to help with reproducible identification of MRI sequences requiring re-acquisition with explainability.

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## Abstract Archives of the RSNA, 2023

M1-SSIR01

### Science Session with Keynote: Interventional Radiology (Clinical Science)

Monday, Nov. 27 8:00AM - 9:00AM Room: N229

Kirema I. Garcia-Reyes, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **M1-SSIR01-New Therapeutic Strategy in Biliary Stenosis in Liver Transplant Pediatric Patients: Biodegradable Stent as One-step Treatment**

Manuel Perez Toran (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To present the effectiveness of one-step treatment of biliary strictures in liver-transplant pediatric patients.

#### **METHODS AND MATERIALS**

Post-transplant biliary strictures treated with biodegradable biliary stents in one time (2013- 2022) were reviewed. The following data were collected: epidemiological data of patients and transplantation, type of stricture (choledochocholedochal / bilioenteric), degree of bile duct dilatation, pre-dilatation of stricture (balloon size), number and dimensions of the stents, subsequent dilatation (balloon size), technical and clinical success (primary patency at 12 months), intravenous antibiotic regimen peri- and post-procedure, and analytical data before and up to 12 months post-procedure.

#### **RESULTS**

17 procedures in 16 patients (mean 7.4 years [8m-18y]). Anastomotic stenosis in 68.8% (68.8% bilioenteric, 31.32% choledochocholedochal), 20% multiple stenosis and 12.5% stenosis associated with biliary leak. Two patients (12.5%) had a previous arterial complication (stenosis and thrombosis). The 87.5% had dilatation proximal to the stenosis. Predilatation of the stenosis was performed in 88.2% (balloons 53.4% 6 mm; 26.6% 7 mm; 20% 8 mm) and post-stent dilatation in 73.3% (balloons 16.67% 6 mm; 50% 7 mm; 33.3% 8 mm). 100% of intrahepatic tract embolization performed and 100% technical and clinical success were obtained at 12 months.

#### **CONCLUSION**

One-step treatment of biliary strictures in liver transplant pediatric patients is safe and effective, reducing the number of general anesthesia, days of hospitalization, morbidity (due to the absence of drainage catheter) and improving the quality of life of the child and family.

#### **CLINICAL RELEVANCE/APPLICATION**

It may be considered in the future as the treatment of choice in pediatric transplant patients.

### **M1-SSIR01-Pulmonary Arteriovenous Malformation Embolization with 0.018 coils: Long-Term Safety, Efficacy and Persistence Rate Comparison with Amplatzer Vascular Plugs**

Alexander Botsford, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Micro-coils are increasingly popular for pulmonary arteriovenous malformations (PAVMs) embolization due to their small atraumatic delivery system and their detachability but their safety and efficacy to embolize PAVMs is not well documented. The purpose of this study is to compare the safety and efficacy of 0.018 coils to Amplatzer Vascular Plugs (AVP) for PAVM embolization.

## METHODS AND MATERIALS

All 157 patients who underwent 633 PAVM embolizations between November 2002 and August 2020 were evaluated retrospectively. PAVMs with multiple feeders, those with no follow up or with missing data and those not embolized with 0.018 coils or AVP were excluded. Remaining PAVMs embolizations were split into 4 groups according to the embolization material: 1- non-fibered 0.018 coils (NFC), 2- fibered 0.018 coils (FC), 3- combination of NFC and FC, 4- AVP. PAVM persistence was defined as persistent flow through coils or from adjacent pulmonary arteries on DSA or as <30% diameter reduction of the aneurysmal sac on CT. Kaplan-Meier analysis and cox regression were used to assess PAVM persistence free survival.

## RESULTS

A total of 109 patients (30 men and 79 women; mean age, 49 years; age range, 33-65 years) who underwent embolization of 312 PAVMs with NFC (43 PAVMs), FC (127 PAVMs), combination of NFC and FC (12 PAVMs) or AVP (130 PAVMs) were included. PAVM feeding artery diameter and distance between embolization devices and PAVM aneurysmal sac were larger in the AVP than in the 0.018 coil group ( $p < 0.0001$  and  $p = 0.10$ ; respectively). Technical success was 100% (312/312), with no major complication. Re-embolizations rates were 44.2% (19/43); 22.9% (29/127) and 6.2% (8/130) for PAVMs treated with NFC, FC and AVP respectively. There were 0.44 (80/182) and 0.07 (9/130) re-embolization procedures per PAVM in the 0.018 coils and AVP groups, respectively. PAVM persistence free survival rates at 10 years follow-up were 40.8% and 44.7% in the NFC and FC groups ( $p = 0.22$ ) and 47.3% and 81% in the 0.018 coil (NFC+FC) and AVP groups ( $p < 0.0001$ ). In multivariate analysis, the distance between embolization devices and PAVM aneurysmal sac was associated to PAVM persistence ( $p = 0.017$ ) but the PAVM feeding artery diameter was not ( $p = 0.934$ ).

## CONCLUSION

PAVM embolization with 0.018 coils was associated with a significantly higher PAVM persistence and re-embolization rates in comparison with AVP. PAVMs persistence rate was not significantly improved with 0.018 FC than with 0.018 NFC.

## CLINICAL RELEVANCE/APPLICATION

Although 0.018 coils are safe and effective for PAVM embolization, they are associated with high reperfusion and re-embolization rates and, hence, other embolization material should be preferred whenever possible.

## M1-SSIR01-Factors Associated with Initial Incomplete Ablation for Benign Thyroid Nodules after Radiofrequency Ablation: First Results of CEUS Evaluation

Chong-Ke Zhao, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the factors associated with initial incomplete ablation (ICA) after radiofrequency ablation for benign thyroid nodules (BTNs).

## METHODS AND MATERIALS

A total of 69 BTNs (mean volume  $6.35 \pm 5.66$  ml, range 1.00-25.04 ml) confirmed by fine-needle aspiration cytology (FNAC) in fifty-four patients were treated with ultrasound-guided percutaneous radiofrequency ablation (RFA) and the local treatment efficacy was immediately assessed by intra-procedural contrast-enhanced ultrasound (CEUS). The RFA was performed with a bipolar electrode (CelonProSurge 150-T20, output power: 20 W). CEUS was performed with a second-generation contrast agent under low acoustic power (i.e. coded phase inversion, CPI). Characteristics of clinical factors, findings on conventional gray-scale ultrasound, color-Doppler ultrasound, and CEUS were evaluated preoperatively. Factors associated with initial ICA and initial ICA patterns on CEUS were assessed. Volume reduction ratios (VRRs) of ICA nodules were compared with those with complete ablation (CA).

## RESULTS

The RFA procedures were accomplished with a mean ablation time and mean total energy deposition of  $11.13 \pm 3.39$  min (range, 5.38-22.13 min) and  $12612 \pm 4466$  J (range, 6310-26130 J) respectively. CEUS detected initial ICA in 21 of 69 (30.8%) BTNs and 16 (76.2%) of the 21 BTNs with initial ICA achieved CA after additional RFA, leading to a final CA rate of 92.8% (64/69). The factors associated with initial ICA were predominantly solid nodule, nodule close to danger triangle area, nodule close to carotid artery, and peripheral blood flow on color-Doppler ultrasound (all  $P < 0.05$ ). The mean VRRs of all BTNs were 23.4%, 54.4% and 81.9% at the 1-, 3- and 6-month follow-up, respectively. All BTNs achieved therapeutic success in this series in that all had VRRs of >50% at the 6-month follow-up, among which 7 nodules (10.1%) had VRRs of >90%. There were significant differences in VRRs between ICA nodules and CA nodules at the 3- and 6-month follow-up (all  $P < 0.05$ ).

## CONCLUSION

The factors associated with initial ICA after RFA for BTNs were predominantly solid nodules, nodule close to danger triangle area, nodule close to carotid artery, and peripheral blood flow on color-Doppler ultrasound.

## CLINICAL RELEVANCE/APPLICATION

The factors associated with initial ICA after RFA for BTNs were predominantly solid nodules, nodule close to danger triangle area, nodule close to carotid artery, and peripheral blood flow on color-Doppler ultrasound. CEUS assists quick treatment response evaluation and facilitates subsequent additional RFA and final CA of the nodules. Nodules with CA achieve a better outcome in terms of VRR in comparison with those with ICA.

### **M1-SSIR01-Prospective Margin Estimates Predict Local Tumor Progression Following Microwave Ablation of Small Renal Masses**

Franklin Iheanacho, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the relationship between prospectively generated ablative margin estimates and local tumor progression (LTP) among patients undergoing microwave ablation (MWA) of small renal masses (SRM).

#### **METHODS AND MATERIALS**

This HIPAA-compliant study was performed with a waiver for informed consent following institutional review board approval. Between 2017 and 2020, all patients who underwent MWA for SRM at one institution were retrospectively identified. Prior to MWA, manual segmentation of tumor and kidney shapes was performed in 3DSlicer using contrast-enhanced CT or MR imaging. During the MWA procedure, these shapes were coregistered with helical non-contrast CT images obtained after MWA antenna placement. Predicted ablation zone shape and size (based on manufacturer estimates) were then overlaid onto the resultant model based on antenna-tumor geometry. A model-to-model distance algorithm was employed to calculate multiple ablative margin estimates including mean, median, first and third quartiles (Q1, Q3), minimum, maximum, standard deviation, range, and variance. All patients were followed with CT imaging to assess for LTP. LTP was modeled as a function of each margin estimate by hazard regression, and models were evaluated using hazard ratios and Akaike information criterion (AIC). Receiver operating characteristic curve area under the curve (ROC-AUC) was estimated using Harrell's and Uno's C indices. Significance was set at  $p=0.05$ .

#### **RESULTS**

128 consecutive patients were evaluated (median age, 72.1 years; 55.5% male). Mean tumor diameter was  $2.4 \pm 0.9$  cm. Median follow-up duration was 1.2 years. LTP was observed in nine (7%) patients. Analysis showed Q1, minimum, and average estimated ablative margins were significantly associated with LTP. For every one-unit increase of Q1 margin, the hazard of recurrence increased 67% (HR: 1.67 [1.25-2.20],  $p= 0.002$ ) with an ROC-AUC of .93 (Uno) and .77 (Harrell). Likewise, for every one-unit increase of minimum ablative margin, the hazard of recurrence increased 32% (HR: 1.32 [1.09-1.60],  $p= 0.007$ ) with an ROC-AUC of .93 (Uno) and .76 (Harrell). Finally, for every one-unit increase of mean margin, the hazard of recurrence increased 48% (HR: 1.48 [1.18-1.85],  $p= 0.013$ ) with an ROC-AUC of .83 (Uno) and .75 (Harrell). Other margin estimates were not associated with significant LTP risk.

#### **CONCLUSION**

Prospectively generated ablative margin estimates can be used to predict local tumor progression risk following microwave ablation of small renal masses.

## CLINICAL RELEVANCE/APPLICATION

Prognostic margin estimates obtained during microwave ablation procedures may allow interventional radiologists to modify treatment approach in real-time to optimize outcomes for patients with small renal masses.

### **M1-SSIR01-Keynote Speaker**

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Alexios Kelekis, MD, PhD (*Presenter*) Research Grant, Medtronic plc;Speaker, Medtronic plc;Speaker, Mindray Medical International Ltd

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## Abstract Archives of the RSNA, 2023

M1-SSIR01-1

### **New Therapeutic Strategy in Biliary Stenosis in Liver Transplant Pediatric Patients: Biodegradable Stent as One-step Treatment**

Monday, Nov. 27 8:00AM - 9:00AM Room: N229

Manuel Perez Toran (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To present the effectiveness of one-step treatment of biliary strictures in liver-transplant pediatric patients.

#### **METHODS AND MATERIALS**

Post-transplant biliary strictures treated with biodegradable biliary stents in one time (2013- 2022) were reviewed. The following data were collected: epidemiological data of patients and transplantation, type of stricture (choledochocholedochal / bilioenteric), degree of bile duct dilatation, pre-dilatation of stricture (balloon size), number and dimensions of the stents, subsequent dilatation (balloon size), technical and clinical success (primary patency at 12 months), intravenous antibiotic regimen peri- and post-procedure, and analytical data before and up to 12 months post-procedure.

#### **RESULTS**

17 procedures in 16 patients (mean 7.4 years [8m-18y]). Anastomotic stenosis in 68.8% (68.8% bilioenteric, 31.32% cholecodocho-choledocholedochal), 20% multiple stenosis and 12.5% stenosis associated with biliary leak. Two patients (12.5%) had a previous arterial complication (stenosis and thrombosis). The 87.5% had dilatation proximal to the stenosis. Predilatation of the stenosis was performed in 88.2% (balloons 53.4% 6 mm; 26.6% 7 mm; 20% 8 mm) and post-stent dilatation in 73.3% (balloons 16.67% 6 mm; 50% 7 mm; 33.3% 8 mm). 100% of intrahepatic tract embolization performed and 100% technical and clinical success were obtained at 12 months.

#### **CONCLUSION**

One-step treatment of biliary strictures in liver transplant pediatric patients is safe and effective, reducing the number of general anesthesia, days of hospitalization, morbidity (due to the absence of drainage catheter) and improving the quality of life of the child and family.

#### **CLINICAL RELEVANCE/APPLICATION**

It may be considered in the future as the treatment of choice in pediatric transplant patients.

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## Abstract Archives of the RSNA, 2023

M1-SSIR01-2

### **Pulmonary Arteriovenous Malformation Embolization with 0.018 coils: Long-Term Safety, Efficacy and Persistence Rate Comparison with Amplatzer Vascular Plugs**

Monday, Nov. 27 8:00AM - 9:00AM Room: N229

Alexander Botsford, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Micro-coils are increasingly popular for pulmonary arteriovenous malformations (PAVMs) embolization due to their small atraumatic delivery system and their detachability but their safety and efficacy to embolize PAVMs is not well documented. The purpose of this study is to compare the safety and efficacy of 0.018 coils to Amplatzer Vascular Plugs (AVP) for PAVM embolization.

#### **METHODS AND MATERIALS**

All 157 patients who underwent 633 PAVM embolizations between November 2002 and August 2020 were evaluated retrospectively. PAVMs with multiple feeders, those with no follow up or with missing data and those not embolized with 0.018 coils or AVP were excluded. Remaining PAVMs embolizations were split into 4 groups according to the embolization material: 1- non-fibered 0.018 coils (NFC), 2- fibered 0.018 coils (FC), 3- combination of NFC and FC, 4- AVP. PAVM persistence was defined as persistent flow through coils or from adjacent pulmonary arteries on DSA or as <30% diameter reduction of the aneurysmal sac on CT. Kaplan-Meier analysis and cox regression were used to assess PAVM persistence free survival.

#### **RESULTS**

A total of 109 patients (30 men and 79 women; mean age, 49 years; age range, 33-65 years) who underwent embolization of 312 PAVMs with NFC (43 PAVMs), FC (127 PAVMs), combination of NFC and FC (12 PAVMs) or AVP (130 PAVMs) were included. PAVM feeding artery diameter and distance between embolization devices and PAVM aneurysmal sac were larger in the AVP than in the 0.018 coil group ( $p < 0.0001$  and  $p = 0.10$ ; respectively). Technical success was 100% (312/312), with no major complication. Re-embolizations rates were 44.2% (19/43); 22.9% (29/127) and 6.2% (8/130) for PAVMs treated with NFC, FC and AVP respectively. There were 0.44 (80/182) and 0.07 (9/130) re-embolization procedures per PAVM in the 0.018 coils and AVP groups, respectively. PAVM persistence free survival rates at 10 years follow-up were 40.8% and 44.7% in the NFC and FC groups ( $p = 0.22$ ) and 47.3% and 81% in the 0.018 coil (NFC+FC) and AVP groups ( $p < 0.0001$ ). In multivariate analysis, the distance between embolization devices and PAVM aneurysmal sac was associated to PAVM persistence ( $p = 0.017$ ) but the PAVM feeding artery diameter was not ( $p = 0.934$ ).

#### **CONCLUSION**

PAVM embolization with 0.018 coils was associated with a significantly higher PAVM persistence and re-embolization rates in comparison with AVP. PAVMs persistence rate was not significantly improved with 0.018 FC than with 0.018 NFC.

#### **CLINICAL RELEVANCE/APPLICATION**

Although 0.018 coils are safe and effective for PAVM embolization, they are associated with high reperfusion and re-embolization rates and, hence, other embolization material should be preferred whenever possible.

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## Abstract Archives of the RSNA, 2023

M1-SSIR01-3

### Factors Associated with Initial Incomplete Ablation for Benign Thyroid Nodules after Radiofrequency Ablation: First Results of CEUS Evaluation

Monday, Nov. 27 8:00AM - 9:00AM Room: N229

Chong-Ke Zhao, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the factors associated with initial incomplete ablation (ICA) after radiofrequency ablation for benign thyroid nodules (BTNs).

#### METHODS AND MATERIALS

A total of 69 BTNs (mean volume  $6.35 \pm 5.66$  ml, range 1.00-25.04 ml) confirmed by fine-needle aspiration cytology (FNAC) in fifty-four patients were treated with ultrasound-guided percutaneous radiofrequency ablation (RFA) and the local treatment efficacy was immediately assessed by intra-procedural contrast-enhanced ultrasound (CEUS). The RFA was performed with a bipolar electrode (CelonProSurge 150-T20, output power: 20 W). CEUS was performed with a second-generation contrast agent under low acoustic power (i.e. coded phase inversion, CPI). Characteristics of clinical factors, findings on conventional gray-scale ultrasound, color-Doppler ultrasound, and CEUS were evaluated preoperatively. Factors associated with initial ICA and initial ICA patterns on CEUS were assessed. Volume reduction ratios (VRRs) of ICA nodules were compared with those with complete ablation (CA).

#### RESULTS

The RFA procedures were accomplished with a mean ablation time and mean total energy deposition of  $11.13 \pm 3.39$  min (range, 5.38-22.13 min) and  $12612 \pm 4466$  J (range, 6310-26130 J) respectively. CEUS detected initial ICA in 21 of 69 (30.8%) BTNs and 16 (76.2%) of the 21 BTNs with initial ICA achieved CA after additional RFA, leading to a final CA rate of 92.8% (64/69). The factors associated with initial ICA were predominantly solid nodule, nodule close to danger triangle area, nodule close to carotid artery, and peripheral blood flow on color-Doppler ultrasound (all  $P < 0.05$ ). The mean VRRs of all BTNs were 23.4%, 54.4% and 81.9% at the 1-, 3- and 6-month follow-up, respectively. All BTNs achieved therapeutic success in this series in that all had VRRs of  $>50\%$  at the 6-month follow-up, among which 7 nodules (10.1%) had VRRs of  $>90\%$ . There were significant differences in VRRs between ICA nodules and CA nodules at the 3- and 6-month follow-up (all  $P < 0.05$ ).

#### CONCLUSION

The factors associated with initial ICA after RFA for BTNs were predominantly solid nodules, nodule close to danger triangle area, nodule close to carotid artery, and peripheral blood flow on color-Doppler ultrasound.

#### CLINICAL RELEVANCE/APPLICATION

The factors associated with initial ICA after RFA for BTNs were predominantly solid nodules, nodule close to danger triangle area, nodule close to carotid artery, and peripheral blood flow on color-Doppler ultrasound. CEUS assists quick treatment response evaluation and facilitates subsequent additional RFA and final CA of the nodules. Nodules with CA achieve a better outcome in terms of VRR in comparison with those with ICA.

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## Abstract Archives of the RSNA, 2023

M1-SSIR01-4

### Prospective Margin Estimates Predict Local Tumor Progression Following Microwave Ablation of Small Renal Masses

Monday, Nov. 27 8:00AM - 9:00AM Room: N229

Franklin Iheanacho, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the relationship between prospectively generated ablative margin estimates and local tumor progression (LTP) among patients undergoing microwave ablation (MWA) of small renal masses (SRM).

#### METHODS AND MATERIALS

This HIPAA-compliant study was performed with a waiver for informed consent following institutional review board approval. Between 2017 and 2020, all patients who underwent MWA for SRM at one institution were retrospectively identified. Prior to MWA, manual segmentation of tumor and kidney shapes was performed in 3DSlicer using contrast-enhanced CT or MR imaging. During the MWA procedure, these shapes were coregistered with helical non-contrast CT images obtained after MWA antenna placement. Predicted ablation zone shape and size (based on manufacturer estimates) were then overlaid onto the resultant model based on antenna-tumor geometry. A model-to-model distance algorithm was employed to calculate multiple ablative margin estimates including mean, median, first and third quartiles (Q1, Q3), minimum, maximum, standard deviation, range, and variance. All patients were followed with CT imaging to assess for LTP. LTP was modeled as a function of each margin estimate by hazard regression, and models were evaluated using hazard ratios and Akaike information criterion (AIC). Receiver operating characteristic curve area under the curve (ROC-AUC) was estimated using Harrell's and Uno's C indices. Significance was set at  $p=0.05$ .

#### RESULTS

128 consecutive patients were evaluated (median age, 72.1 years; 55.5% male). Mean tumor diameter was  $2.4 \pm 0.9$  cm. Median follow-up duration was 1.2 years. LTP was observed in nine (7%) patients. Analysis showed Q1, minimum, and average estimated ablative margins were significantly associated with LTP. For every one-unit increase of Q1 margin, the hazard of recurrence increased 67% (HR: 1.67 [1.25-2.20],  $p= 0.002$ ) with an ROC-AUC of .93 (Uno) and .77 (Harrell). Likewise, for every one-unit increase of minimum ablative margin, the hazard of recurrence increased 32% (HR: 1.32 [1.09-1.60],  $p= 0.007$ ) with an ROC-AUC of .93 (Uno) and .76 (Harrell). Finally, for every one-unit increase of mean margin, the hazard of recurrence increased 48% (HR: 1.48 [1.18-1.85],  $p= 0.013$ ) with an ROC-AUC of .83 (Uno) and .75 (Harrell). Other margin estimates were not associated with significant LTP risk.

#### CONCLUSION

Prospectively generated ablative margin estimates can be used to predict local tumor progression risk following microwave ablation of small renal masses.

#### CLINICAL RELEVANCE/APPLICATION

Prognostic margin estimates obtained during microwave ablation procedures may allow interventional radiologists to modify treatment approach in real-time to optimize outcomes for patients with small renal masses.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-SSIR01-6

### Keynote Speaker

Monday, Nov. 27 8:00AM - 9:00AM Room: N229

Alexios Kelekis, MD, PhD (*Presenter*) Research Grant, Medtronic plc;Speaker, Medtronic plc;Speaker, Mindray Medical International Ltd

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSNMMI02

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Breast Cancer)

Monday, Nov. 27 8:00AM - 9:00AM Room: E350

Esma A. Akin, MD (*Moderator*) Nothing to Disclose  
Elizabeth H. Dibble, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

##### M1-SSNMMI02-1 **Keynote Speaker**

Esma A. Akin, MD (*Presenter*) Nothing to Disclose

##### M1-SSNMMI02-2 **<sup>18</sup>F-Fluorothantrate Pharmacokinetics and Metabolism in Breast Cancer: Implications for PARP Inhibitor Binding and Translational Imaging**

Anthony J. Young, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

PARP-1 is a DNA repair enzyme targeted for cancer therapy via PARP inhibitors (PARPi). PARPi have variable efficacy in breast and other cancers, and a biomarker to predict response is an unmet clinical need. PARPi binding is poorly understood, but one hypothesized mechanism is trapping activated PARP-1 on DNA, preventing repair and triggering cell death. <sup>18</sup>F-Fluorothantrate (<sup>18</sup>F-FTT) is a PARPi-based radioligand that has shown promise as a non-invasive predictor of PARPi engagement and clinical efficacy. To aid ongoing clinical trials of <sup>18</sup>F-FTT and development of PARP-1 theranostics, we sought to investigate the kinetics and metabolism of <sup>18</sup>F-FTT, relate them to PARP-1 expression, and provide imaging recommendations.

#### METHODS AND MATERIALS

30 women with breast cancer underwent dynamic <sup>18</sup>F-FTT PET/CT. Tumor activity was measured and modeled with normal breast and muscle reference tissues to calculate distribution volume ratios (DVR) in PMOD. A two-tissue compartmental model was used to calculate total volumes of distribution (VT). DVR, VT, static standardized uptake values (SUV), and SUV to normal tissue ratios (SUVR) were tested for correlations with PARP-1 expression in surgical resections. In mouse xenograft models, uptake and radiometabolite concentrations in tumor, blood, and muscle were compared with histology and microPET imaging.

#### RESULTS

Pharmacokinetics were well fit by reference region models of reversible binding, however, blood input models assuming negligible metabolite uptake were unstable. In vivo DVR of <sup>18</sup>F-FTT in breast cancer correlated with ex vivo PARP-1 expression,  $r = 0.72$ ,  $p = 0.02$ ,  $n = 10$ . SUVR at 40-60 minutes highly correlated with DVR estimates,  $r^2 = 0.88$ ,  $p < 1 \times 10^{-13}$ ,  $n = 30$ . <sup>18</sup>F-FTT metabolism was faster in mice than humans, and tumor and muscle showed similarly significant metabolites uptake.

#### CONCLUSION

<sup>18</sup>F-FTT uptake in breast cancer is associated with PARP-1 expression, and imaging 40-60 minutes post-injection reasonably estimates kinetics, corroborating findings in ovarian cancer. <sup>18</sup>F-FTT quantitation is likely influenced by metabolites, which can be partially controlled for via reference tissue modeling to estimate specific binding. Rapid metabolism in mice suggests earlier imaging may reduce noise. Similar metabolite uptake in tumor and muscle supports normalization to muscle reference tissue. The significant tumor concentration of <sup>18</sup>F-FTT metabolites suggests PARPi studies may benefit from characterization of metabolites for insight into binding pathways.

## CLINICAL RELEVANCE/APPLICATION

18F-FTT can serve as a biomarker for PARPi in breast cancer. Ongoing clinical trials could benefit from standardized PET imaging protocols and theranostics may be informed by additional study of radiometabolites.

### **M1-SSNMMI02-3 18F-FDG PET-CT Versus Conventional Staging in Patients with Locally Advanced Breast Cancer: A Randomised Trial (PETABC)**

Ur Metser, MD, FRCPC (*Presenter*) Consultant, POINT Biopharma Inc

#### PURPOSE

Staging tests are performed when a patient presents with locally advanced breast cancer (LABC). Treatment is combined modality therapy of curative intent (neoadjuvant chemotherapy, surgery, and regional radiation) if no metastases are found. Positive emission tomography-computed tomography (PET-CT) can detect more asymptomatic distant metastases than conventional staging, but the evidence is based on uncontrolled studies. We hypothesized that PET-CT would identify more patients with metastatic breast cancer than staging with usual imaging tests, and that upstaging to Stage IV breast cancer would change treatment away from multimodality therapy of curative intent.

#### METHODS AND MATERIALS

For inclusion, patients had histological evidence of invasive ductal carcinoma of the breast; TNM Stage III or Stage IIb (T3N0, but not T2N1). Consenting patients from six regional cancer centres in Ontario were randomized to 18F-Fluorodeoxyglucose PET-CT or conventional staging (bone scan, CT chest/abdomen and pelvis). The primary endpoint was upstaging to Stage IV. A key secondary outcome was receiving curative intent combined modality therapy. Trial registration number NCT02751710.

#### RESULTS

Between December 2016 and April 2022, 184 patients were randomized to whole body PET-CT and 185 patients to conventional staging. Forty-three (23%) PET-CT patients were upstaged to Stage 4 compared to 21 (11%) conventional staged patients, absolute difference, 12.3%; 95% CI, 3.9 to 19.9; P = 0.002. Consequently, treatment was changed in 35 (81.3%) of 43 upstaged PET-CT patients and 20 (95.2%) of the 21 upstaged conventional patients. Subsequently, 149 (81%) in the PET-CT group received combined modality treatment versus 165 (89.2%) in the conventional staging group, absolute difference, 8.2%; 95% CI, 0.1 to 15.4; P = 0.03.

#### CONCLUSION

In patients with LABC, PET-CT detected more distant metastases than conventional staging and fewer PET-CT patients received curative intent combined modality therapy. Our randomized trial demonstrates the utility of the PET-CT staging strategy.

## CLINICAL RELEVANCE/APPLICATION

\* PET-CT upstages to stage IV more often than conventional imaging (CT chest, abdomen and pelvis bone scintigraphy).\* This impacts patient management with fewer patients receiving combined modality therapy after PET than after conventional workup.\* The results have had policy implications in our jurisdiction with PET-CT now being funded for this indication in Ontario.

### **M1-SSNMMI02-4 Prospective Evaluation of N- and M-staging in Conventional Imaging, MRI and 18F-FDG PET/MRI in Newly Diagnosed Breast Cancer**

Janna Morawitz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic potential of whole-body MRI, whole-body 18F-FDG PET/MRI and conventional staging (CT, axillary sonography and bone scintigraphy) for N and M staging in newly diagnosed breast cancer

#### METHODS AND MATERIALS

208 patients (age 53.5±12.0 years) with newly diagnosed breast cancer were prospectively included in this study. All patients underwent whole-body 18F-FDG PET/MRI, thoracoabdominal CT, whole-body scintigraphy and axillary sonography. Images were evaluated separately regarding lesion count, lesion localization, and lesion characterization. Histopathology and follow-up imaging served as reference standard. A McNemar test was used to compare diagnostic performance of 18F-FDG PET/MRI, MRI and conventional staging

#### RESULTS

In N-staging conventional imaging (axillary sonography and CT combined) showed a sensitivity of 80.9%, a specificity of 99.2%, a positive predictive value of 98.6%, a negative predictive value of 87.4%, and an accuracy of 91.4%. The corresponding values for MRI were 79.6%, 100.0%, 100.0%, 87.0%, and 91.4%, and for 18F-FDG PET/MRI 86.5%, 94.1%, 91.7%, 90.3%, and 90.9%. The differences between conventional imaging and PET/MRI (p<0.001) and MRI and PET/MRI

( $p=0.005$ ) were statistically significant. 18FDG PET/MRI classified 94.8% of the nodal positive patients into the correct cN stage (cN1-cN3c). The results for MRI and conventional imaging were 82.9% and 75.0%, respectively. For M staging, conventional imaging (CT and bone scintigraphy combined) showed a sensitivity of 83.3%, a specificity of 98.5%, a positive predictive value of 76.9%, a negative predictive value of 98.9%, and an accuracy of 97.6%. The corresponding values for MRI and 18F-FDG PET/MRI were 100.0%, 98.5%, 80.0%, 100.0% and 98.6% respectively. There were no significant differences in the detection of distant metastases in 18F-FDG PET/MRI and MRI compared to conventional imaging ( $p=0.705$  and  $p=0.157$ ).

#### CONCLUSION

In nodal staging of primary breast cancer patients  $^{18}\text{F}$ -FDG PET/MRI showed a significantly better diagnostic performance than MRI alone and conventional staging. No significant differences were seen in the detection of distant metastases.

#### CLINICAL RELEVANCE/APPLICATION

$^{18}\text{F}$ -FDG PET/MRI can be reliably used for staging purpose in patients with newly diagnosed breast cancer.

### M1-SSNMMI02-5 **Is $^{18}\text{F}$ -fluciclovine or $^{68}\text{Ga}$ -PSMA PET Superior to Conventional Imaging in the Detection of Metastatic Breast Lobular Carcinoma?**

Aliza Mushtaq, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine if  $^{18}\text{F}$ -fluciclovine or  $^{68}\text{Ga}$ -PSMA PET has superior detection of metastatic disease from invasive lobular carcinoma (ILC) of the breast compared with conventional imaging (CI) with either CT and bone scan, or  $^{18}\text{F}$ -FDG PET.

#### METHODS AND MATERIALS

20 women with de-novo or suspected recurrent ILC underwent two PET-CT scans after IV administration of mean  $9.7\pm 1.04$  (range: 7.14-10.9) mCi  $^{18}\text{F}$ -fluciclovine and mean  $4.9\pm 0.7$  (range: 2.9-5.5) mCi  $^{68}\text{Ga}$ -PSMA on separate days to allow for radiotracer decay. Uptake per patient as well as in 3 regions per patient: ipsilateral axillary lymph node (LN), extra-axillary LN (ipsilateral supraclavicular, internal mammary), or distant disease was interpreted by 3 readers in consensus and was compared to clinician choice of CI (CT/bone scan in 13 patients and  $^{18}\text{F}$ -FDG PET in 7 patients). True positive detection rate was calculated after comparison to a composite standard of truth (confirmatory imaging or biopsy), excluding false positive activity. SUVmax and tumor: background (blood pool) of the hottest lesion for each positive region was recorded for  $^{18}\text{F}$ -fluciclovine and  $^{68}\text{Ga}$ -PSMA to calculate mean uptake, and differences evaluated by T-test.

#### RESULTS

Conventional imaging detected metastasis in 5/20 patients in 7/60 regions (2 axillary, 2 extra-axillary and 3 distant).  $^{68}\text{Ga}$ -PSMA PET-CT detected metastasis in 7/20 patients in 7/60 regions (4 axillary and 3 distant).  $^{18}\text{F}$ -fluciclovine detected metastasis in 9/20 patients in 13/60 regions (5 axillary, 3 extra-axillary and 5 distant).  $^{18}\text{F}$ -fluciclovine was positive in all regions positive on PSMA. However, in 6 regions positive on  $^{18}\text{F}$ -fluciclovine,  $^{68}\text{Ga}$ -PSMA was negative. Mean SUVmax and T:B for  $^{18}\text{F}$ -fluciclovine ( $n=13$ ) was  $5.25(\pm 3.3)$  and  $3.7(\pm 2.3)$  respectively. Mean SUVmax and T:B for  $^{68}\text{Ga}$ -PSMA ( $n=9$ ) was  $3.84(\pm 3.42)$  and  $3.29(\pm 2.65)$ , respectively.  $p$ -value for the difference in SUVmax for  $^{18}\text{F}$ -fluciclovine and  $^{68}\text{Ga}$ -PSMA is 0.34 (ns) and  $p$ -value for the difference in T:B is 0.70 (ns).

#### CONCLUSION

$^{68}\text{Ga}$ -PSMA PET-CT has higher detection for metastases compared to CI on a patient, but not region level (ipsilateral axillary, extra-axillary, distant).  $^{18}\text{F}$ -fluciclovine PET-CT has higher detection for metastases compared to CI and  $^{68}\text{Ga}$ -PSMA on a patient and region level. Though  $^{18}\text{F}$ -fluciclovine seems to have higher SUVmax and T:B of lesions compared with  $^{68}\text{Ga}$ -PSMA, the differences are not statistically significant. One limitation of this study may be the small sample size and therefore larger trials are recommended.

#### CLINICAL RELEVANCE/APPLICATION

In the management of patients with ILC, novel molecular imaging, especially with  $^{18}\text{F}$ -fluciclovine PET-CT seems to result in greater metastases detection and deserves further study.

### M1-SSNMMI02-6 **Keynote Speaker**

Elizabeth H. Dibble, MD (*Presenter*) Nothing to Disclose

## Abstract Archives of the RSNA, 2023

M1-SSNMMI02-1

### Keynote Speaker

Monday, Nov. 27 8:00AM - 9:00AM Room: E350

Esma A. Akin, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSNMMI02-2

### **<sup>18</sup>F-Fluorothantrace Pharmacokinetics and Metabolism in Breast Cancer: Implications for PARP Inhibitor Binding and Translational Imaging**

Monday, Nov. 27 8:00AM - 9:00AM Room: E350

Anthony J. Young, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

PARP-1 is a DNA repair enzyme targeted for cancer therapy via PARP inhibitors (PARPi). PARPi have variable efficacy in breast and other cancers, and a biomarker to predict response is an unmet clinical need. PARPi binding is poorly understood, but one hypothesized mechanism is trapping activated PARP-1 on DNA, preventing repair and triggering cell death. <sup>18</sup>F-Fluorothantrace (<sup>18</sup>F-FTT) is a PARPi-based radioligand that has shown promise as a non-invasive predictor of PARPi engagement and clinical efficacy. To aid ongoing clinical trials of <sup>18</sup>F-FTT and development of PARP-1 theranostics, we sought to investigate the kinetics and metabolism of <sup>18</sup>F-FTT, relate them to PARP-1 expression, and provide imaging recommendations.

#### **METHODS AND MATERIALS**

30 women with breast cancer underwent dynamic <sup>18</sup>F-FTT PET/CT. Tumor activity was measured and modeled with normal breast and muscle reference tissues to calculate distribution volume ratios (DVR) in PMOD. A two-tissue compartmental model was used to calculate total volumes of distribution (VT). DVR, VT, static standardized uptake values (SUV), and SUV to normal tissue ratios (SUVR) were tested for correlations with PARP-1 expression in surgical resections. In mouse xenograft models, uptake and radiometabolite concentrations in tumor, blood, and muscle were compared with histology and microPET imaging.

#### **RESULTS**

Pharmacokinetics were well fit by reference region models of reversible binding, however, blood input models assuming negligible metabolite uptake were unstable. In vivo DVR of <sup>18</sup>F-FTT in breast cancer correlated with ex vivo PARP-1 expression,  $r = 0.72$ ,  $p = 0.02$ ,  $n = 10$ . SUVR at 40-60 minutes highly correlated with DVR estimates,  $r^2 = 0.88$ ,  $p < 1 \times 10^{-13}$ ,  $n = 30$ . <sup>18</sup>F-FTT metabolism was faster in mice than humans, and tumor and muscle showed similarly significant metabolites uptake.

#### **CONCLUSION**

<sup>18</sup>F-FTT uptake in breast cancer is associated with PARP-1 expression, and imaging 40-60 minutes post-injection reasonably estimates kinetics, corroborating findings in ovarian cancer. <sup>18</sup>F-FTT quantitation is likely influenced by metabolites, which can be partially controlled for via reference tissue modeling to estimate specific binding. Rapid metabolism in mice suggests earlier imaging may reduce noise. Similar metabolite uptake in tumor and muscle supports normalization to muscle reference tissue. The significant tumor concentration of <sup>18</sup>F-FTT metabolites suggests PARPi studies may benefit from characterization of metabolites for insight into binding pathways.

#### **CLINICAL RELEVANCE/APPLICATION**

<sup>18</sup>F-FTT can serve as a biomarker for PARPi in breast cancer. Ongoing clinical trials could benefit from standardized PET imaging protocols and theranostics may be informed by additional study of radiometabolites.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSNMMI02-3

### **18F-FDG PET-CT Versus Conventional Staging in Patients with Locally Advanced Breast Cancer: A Randomised Trial (PETABC)**

Monday, Nov. 27 8:00AM - 9:00AM Room: E350

Ur Metser, MD, FRCPC (*Presenter*) Consultant, POINT Biopharma Inc

#### **PURPOSE**

Staging tests are performed when a patient presents with locally advanced breast cancer (LABC). Treatment is combined modality therapy of curative intent (neoadjuvant chemotherapy, surgery, and regional radiation) if no metastases are found. Positive emission tomography-computed tomography (PET-CT) can detect more asymptomatic distant metastases than conventional staging, but the evidence is based on uncontrolled studies. We hypothesized that PET-CT would identify more patients with metastatic breast cancer than staging with usual imaging tests, and that upstaging to Stage IV breast cancer would change treatment away from multimodality therapy of curative intent.

#### **METHODS AND MATERIALS**

For inclusion, patients had histological evidence of invasive ductal carcinoma of the breast; TNM Stage III or Stage IIb (T3N0, but not T2N1). Consenting patients from six regional cancer centres in Ontario were randomized to 18F-Fluorodeoxyglucose PET-CT or conventional staging (bone scan, CT chest/abdomen and pelvis). The primary endpoint was upstaging to Stage IV. A key secondary outcome was receiving curative intent combined modality therapy. Trial registration number NCT02751710.

#### **RESULTS**

Between December 2016 and April 2022, 184 patients were randomized to whole body PET-CT and 185 patients to conventional staging. Forty-three (23%) PET-CT patients were upstaged to Stage 4 compared to 21 (11%) conventional staged patients, absolute difference, 12.3%; 95% CI, 3.9 to 19.9;  $P = 0.002$ . Consequently, treatment was changed in 35 (81.3%) of 43 upstaged PET-CT patients and 20 (95.2%) of the 21 upstaged conventional patients. Subsequently, 149 (81%) in the PET-CT group received combined modality treatment versus 165 (89.2%) in the conventional staging group, absolute difference, 8.2%; 95% CI, 0.1 to 15.4;  $P = 0.03$ .

#### **CONCLUSION**

In patients with LABC, PET-CT detected more distant metastases than conventional staging and fewer PET-CT patients received curative intent combined modality therapy. Our randomized trial demonstrates the utility of the PET-CT staging strategy.

#### **CLINICAL RELEVANCE/APPLICATION**

\* PET-CT upstages to stage IV more often than conventional imaging (CT chest, abdomen and pelvis bone scintigraphy).\* This impacts patient management with fewer patients receiving combined modality therapy after PET than after conventional workup.\* The results have had policy implications in our jurisdiction with PET-CT now being funded for this indication in Ontario.

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## Abstract Archives of the RSNA, 2023

M1-SSNMMI02-4

### Prospective Evaluation of N- and M-staging in Conventional Imaging, MRI and <sup>18</sup>F-FDG PET/MRI in Newly Diagnosed Breast Cancer

Monday, Nov. 27 8:00AM - 9:00AM Room: E350

Janna Morawitz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic potential of whole-body MRI, whole-body 18F-FDG PET/MRI and conventional staging (CT, axillary sonography and bone scintigraphy) for N and M staging in newly diagnosed breast cancer

#### METHODS AND MATERIALS

208 patients (age 53.5±12.0 years) with newly diagnosed breast cancer were prospectively included in this study. All patients underwent whole-body 18F-FDG PET/MRI, thoracoabdominal CT, whole-body scintigraphy and axillary sonography. Images were evaluated separately regarding lesion count, lesion localization, and lesion characterization. Histopathology and follow-up imaging served as reference standard. A McNemar test was used to compare diagnostic performance of 18F-FDG PET/MRI, MRI and conventional staging

#### RESULTS

In N-staging conventional imaging (axillary sonography and CT combined) showed a sensitivity of 80.9%, a specificity of 99.2%, a positive predictive value of 98.6%, a negative predictive value of 87.4%, and an accuracy of 91.4%. The corresponding values for MRI were 79.6%, 100.0%, 100.0%, 87.0%, and 91.4%, and for 18F-FDG PET/MRI 86.5%, 94.1%, 91.7%, 90.3%, and 90.9%. The differences between conventional imaging and PET/MRI ( $p < 0.001$ ) and MRI and PET/MRI ( $p = 0.005$ ) were statistically significant. 18F-FDG PET/MRI classified 94.8% of the nodal positive patients into the correct cN stage (cN1-cN3c). The results for MRI and conventional imaging were 82.9% and 75.0%, respectively. For M staging, conventional imaging (CT and bone scintigraphy combined) showed a sensitivity of 83.3%, a specificity of 98.5%, a positive predictive value of 76.9%, a negative predictive value of 98.9%, and an accuracy of 97.6%. The corresponding values for MRI and 18F-FDG PET/MRI were 100.0%, 98.5%, 80.0%, 100.0% and 98.6% respectively. There were no significant differences in the detection of distant metastases in 18F-FDG PET/MRI and MRI compared to conventional imaging ( $p = 0.705$  and  $p = 0.157$ ).

#### CONCLUSION

In nodal staging of primary breast cancer patients <sup>18</sup>F-FDG PET/MRI showed a significantly better diagnostic performance than MRI alone and conventional staging. No significant differences were seen in the detection of distant metastases.

#### CLINICAL RELEVANCE/APPLICATION

18F-FDG PET/MRI can be reliably used for staging purpose in patients with newly diagnosed breast cancer.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-SSNMMI02-5

### Is $^{18}\text{F}$ -fluciclovine or $^{68}\text{Ga}$ -PSMA PET Superior to Conventional Imaging in the Detection of Metastatic Breast Lobular Carcinoma?

Monday, Nov. 27 8:00AM - 9:00AM Room: E350

Aliza Mushtaq, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine if  $^{18}\text{F}$ -fluciclovine or  $^{68}\text{Ga}$ -PSMA PET has superior detection of metastatic disease from invasive lobular carcinoma (ILC) of the breast compared with conventional imaging (CI) with either CT and bone scan, or  $^{18}\text{F}$ -FDG PET.

#### METHODS AND MATERIALS

20 women with de-novo or suspected recurrent ILC underwent two PET-CT scans after IV administration of mean  $9.7 \pm 1.04$  (range: 7.14-10.9) mCi  $^{18}\text{F}$ -fluciclovine and mean  $4.9 \pm 0.7$  (range: 2.9-5.5) mCi  $^{68}\text{Ga}$ -PSMA on separate days to allow for radiotracer decay. Uptake per patient as well as in 3 regions per patient: ipsilateral axillary lymph node (LN), extra-axillary LN (ipsilateral supraclavicular, internal mammary), or distant disease was interpreted by 3 readers in consensus and was compared to clinician choice of CI (CT/bone scan in 13 patients and  $^{18}\text{F}$ -FDG PET in 7 patients). True positive detection rate was calculated after comparison to a composite standard of truth (confirmatory imaging or biopsy), excluding false positive activity. SUVmax and tumor: background (blood pool) of the hottest lesion for each positive region was recorded for  $^{18}\text{F}$ -fluciclovine and  $^{68}\text{Ga}$ -PSMA to calculate mean uptake, and differences evaluated by T-test.

#### RESULTS

Conventional imaging detected metastasis in 5/20 patients in 7/60 regions (2 axillary, 2 extra-axillary and 3 distant).  $^{68}\text{Ga}$ -PSMA PET-CT detected metastasis in 7/20 patients in 7/60 regions (4 axillary and 3 distant).  $^{18}\text{F}$ -fluciclovine detected metastasis in 9/20 patients in 13/60 regions (5 axillary, 3 extra-axillary and 5 distant).  $^{18}\text{F}$ -fluciclovine was positive in all regions positive on PSMA. However, in 6 regions positive on  $^{18}\text{F}$ -fluciclovine,  $^{68}\text{Ga}$ -PSMA was negative. Mean SUVmax and T:B for  $^{18}\text{F}$ -fluciclovine (n=13) was  $5.25 (\pm 3.3)$  and  $3.7 (\pm 2.3)$  respectively. Mean SUVmax and T:B for  $^{68}\text{Ga}$ -PSMA (n=9) was  $3.84 (\pm 3.42)$  and  $3.29 (\pm 2.65)$ , respectively. p-value for the difference in SUVmax for  $^{18}\text{F}$ -fluciclovine and  $^{68}\text{Ga}$ -PSMA is 0.34 (ns) and p-value for the difference in T:B is 0.70 (ns).

#### CONCLUSION

$^{68}\text{Ga}$ -PSMA PET-CT has higher detection for metastases compared to CI on a patient, but not region level (ipsilateral axillary, extra-axillary, distant).  $^{18}\text{F}$ -fluciclovine PET-CT has higher detection for metastases compared to CI and  $^{68}\text{Ga}$ -PSMA on a patient and region level. Though  $^{18}\text{F}$ -fluciclovine seems to have higher SUVmax and T:B of lesions compared with  $^{68}\text{Ga}$ -PSMA, the differences are not statistically significant. One limitation of this study may be the small sample size and therefore larger trials are recommended.

#### CLINICAL RELEVANCE/APPLICATION

In the management of patients with ILC, novel molecular imaging, especially with  $^{18}\text{F}$ -fluciclovine PET-CT seems to result in greater metastases detection and deserves further study.

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## Abstract Archives of the RSNA, 2023

M1-SSNMMI02-6

### Keynote Speaker

Monday, Nov. 27 8:00AM - 9:00AM Room: E350

Elizabeth H. Dibble, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSPD02

### Pediatric Imaging (Intervention and Oncology)

Monday, Nov. 27 8:00AM - 9:00AM Room: N227B

Anne Marie Cahill, MBBCh (*Moderator*) Advisory Committee, Siemens AG; Speakers Bureau, Avanos Medical, Inc  
Adina L. Alazraki, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M1-SSPD02-1 CT-based Segmentation Model for Pediatric Hepatoblastoma Trained on Data From COG AHEP0731 Liver Tumor Trial: Performance and Comparison to Adult-based Model**

Vidya Sankar Viswanathan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Hepatoblastoma is a rare malignant liver tumor affecting children. To date, no automated segmentation models exist for this tumor. Adult hepatocellular carcinoma (HCC)-based segmentation models may not perform optimally due to differences in tumor characteristics. Therefore, we aimed to train a segmentation model on pediatric hepatoblastoma CT data and compare its performance with an adult HCC-based liver tumor segmentation model in a clinical trial dataset.

#### METHODS AND MATERIALS

We derived the dataset from the Children's Oncology Group AHEP0731 trial. Our data included 227 CT scans from hepatoblastoma patients obtained at diagnosis, after 2 cycles of chemotherapy, or prior to resection. Two pediatric radiologists manually annotated 56 randomly selected CTs for liver tumor segmentation. These were used to train an nnU-Net-based segmentation model, denoted as MP. An additional validation set of 50 CTs was annotated for segmentation by three radiologists (50 scans, divided into two groups of 25 with each group manually annotated by 2 of 3 radiologists). We optimized training by using a 5-fold cross-validation strategy with 5000 epochs and evaluated the model's performance on the validation set using the Dice similarity coefficient (DSC). DSC was also calculated between human annotations within the validation set. We compared the performance of a publicly available segmentation model trained on adult HCC CT scans using DSC, denoted as MA.

#### RESULTS

MP was tested on 50 CT scans and achieved an average Dice similarity coefficient (DSC) of  $0.83 \pm 0.03$  for the segmentation of pediatric hepatoblastoma from CT scans. In contrast, MA performed poorly on hepatoblastoma cases, with an average DSC of  $0.53 \pm 0.04$  (Figure 1). Inter-rater agreement between the reviewers on the validation set was  $0.88 \pm 0.01$  and  $0.89 \pm 0.02$  (Table 1) for MP.

#### CONCLUSION

An adult HCC-based liver tumor segmentation model performed poorly when segmenting hepatoblastoma. In contrast, our nnU-Net-based segmentation model was accurate and displayed a comparable degree of dissimilarity to that observed between radiologists.

#### CLINICAL RELEVANCE/APPLICATION

Our findings suggest that AI algorithms for liver tumor segmentation should be specifically trained on pediatric data to achieve the best results in children with hepatoblastoma.

#### **M1-SSPD02-2 Fractal Analysis of Perfusion MRI in Neuroblastoma Correlates with Tumor Microvasculature and Predicts Chemotherapy Response**

Florian Michallek, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To establish perfusion fractal analysis of magnetic resonance imaging (MRI) in neuroblastoma primary tumors for assessing vascularity and predicting response to induction chemotherapy. We hypothesized that perfusion heterogeneity is inversely correlated with volumetric response potential due to the effect on vascular supply for therapeutic agents.

## METHODS AND MATERIALS

We retrospectively included patients with high-risk neuroblastoma. Contrast-enhanced MRI was performed at diagnosis (timepoint, TP1) and prior to surgery (TP2). Patients received 4-7 cycles of N5 and N6 chemotherapy. Imaging was performed at 1.5 or 3T with clinical routine protocols including a contrast-enhanced, fat-saturated T1-weighted sequence. Tumor volume was defined as paravertebral or adrenal tumor formation including connected local lymph node metastases. Segmentation was performed at TP1 and TP2 in consensus by two readers. Fractal analysis was performed as previously established in prostate cancer, pancreatic cancer, and hepatic adenoma and carcinoma. Spatially resolved fractal dimension (FD) maps were calculated. Histological fractal analysis of CD34-stained microvessels was available in a small subgroup of five patients at TP1 and TP2. Agreement of predicted volume response with measured volume response was evaluated in the validation cohort by Bland-Altman statistics.

## RESULTS

We included 73 patients, n=36 as discovery cohort (one center) and n=37 as separate validation cohort (29 centers), with an average tumor volume of 239.4 ml (standard deviation, SD: 237.3 ml) and 235.3 ml (SD: 204.9 ml) at TP1, which reduced to 35.8 ml (SD: 45.1 ml) and 32.6 ml (SD: 49.2 ml) at TP2. Fractal analysis demonstrated that regional tumor response depended on local perfusion heterogeneity as quantified on FD maps: Tumor regions with low FD at TP1 showed markedly better volumetric response than regions with high FD. In the validation cohort, histogram-based evaluation of FD predicted relative volumetric response with high accuracy (mean bias: -5%, limits of agreement: -35 - 25%). On CD34-staining, microvascular FD was low at TP1 (mean FD=1.23, SD=0.09) and increased at TP2 (mean FD=1.44, SD=0.07;  $p<0.001$ ), hinting at increasing microvascular heterogeneity after chemotherapy, which was reflected in MRI (TP1: mean FD=3.40, SD=0.04; TP2: mean FD=3.53, SD=0.07;  $p<0.001$ ).

## CONCLUSION

Fractal analysis of neuroblastoma perfusion predicted primary tumor response to induction chemotherapy and allowed to regionally resolve tumor response potential, based on heterogeneity of tumor vascularity.

## CLINICAL RELEVANCE/APPLICATION

Fractal analysis allows spatially resolved prediction of local tumor tissue response to chemotherapy based on perfusion heterogeneity.

## M1-SSPD02-3 Whole-body MRI Quantitative Parameters as Biomarkers for Predicting the Efficacy of CAR-T Therapy in Pediatric Patients with Mature Aggressive B-Cell Non-Hodgkin Lymphoma

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the role of whole-body MRI quantitative parameters, such as T2 signal intensity, ADCmin, ADCmax, and ADCmean, as potential biomarkers for predicting the efficacy of CAR-T therapy in the treatment of pediatric patients with mature aggressive B-cell non-Hodgkin lymphoma.

## METHODS AND MATERIALS

This was a prospective multicenter study that included patients with aggressive mature B-cell NHL who received CAR-T therapy. Whole-body MRI was performed before and within 2 weeks after CAR-T infusion to evaluate the extent of tumor involvement throughout the body. The patients were divided into two groups, complete response (CR) and non-CR, by a multidisciplinary team using all available imaging and clinical investigations based on international pediatric NHL criteria. Quantitative parameters of MRI, including T2 signal intensity, ADCmin, ADCmax, and ADCmean, were measured by trained radiologists. The relationship between these parameters and the achievement of CR was analyzed using statistical methods. Models were established to predict CR using single-factor analysis, and the best threshold, specificity, sensitivity, and area under the curve (AUC) were determined and compared to identify the most accurate predictive model.

## RESULTS

A total of 45 patients were included in the study, with 19 patients achieving CR after CAR-T therapy. The T2 signal intensity before CAR-T infusion was significantly higher in the non-CR group than in the CR group ( $266\pm 152$  vs.  $363\pm 156$ ,  $P<0.05$ ). There was a significant difference in ADCmin, ADCmax, and ADCmean measured within 2 weeks after CAR-T infusion between the CR and non-CR groups ( $0.94\pm 0.38$  vs.  $0.52\pm 0.37$ ,  $P<0.05$ ;  $1.73\pm 0.69$  vs.  $0.83\pm 0.42$ ,  $P<0.05$ ;  $1.28\pm 0.48$  vs.  $0.65\pm 0.32$ ,  $P<0.05$ ; respectively). The AUC values for the prediction of CR using ADCmax, T2 signal intensity, and ADCmean were 0.96, 0.872, and 0.802, respectively.

## CONCLUSION

Our findings suggest that MRI quantitative parameters, particularly T2 signal intensity and ADC values, can serve as useful tools in predicting the response to CAR-T therapy in pediatric and adolescent patients with aggressive mature B-cell NHL. Our results show that early follow-up MRI can be used as a non-invasive biomarker to predict complete response.

## CLINICAL RELEVANCE/APPLICATION

The results of this study highlight the importance of using MRI quantitative parameters in predicting response to CAR-T therapy in pediatric patients with mature aggressive B-cell NHL. Clinicians may use these non-invasive biomarkers to detect treatment response at an early stage, which could guide personalized treatment strategies and ultimately improve patient outcomes.

## M1-SSPD02-4 Brain Lesions Following Selective Intra-arterial Chemotherapy Treatment for Retinoblastoma

Daniel Vossough (*Presenter*) Nothing to Disclose

## PURPOSE

Selective intra-arterial chemotherapy (IAC) has become a widespread treatment method for children with retinoblastoma (RB). There is a paucity of literature on potential complications of this form of treatment. In this study, we investigate the presence and development of focal brain lesions above baseline rates on MRI after systemic chemotherapy (SC), IAC, or both.

## METHODS AND MATERIALS

In this retrospective IRB-approved study, clinical and brain MRI examinations of RB patients undergoing SC, IAC, or both were collected at a large pediatric retinoblastoma referral center. IAC was performed by interventional staff from two different institutions. Pre-treatment, post-treatment, and last available MRI exams were reviewed, blinded to treatment regimen. Associations between type of treatment, presence and distribution of lesions were explored.

## RESULTS

A total of 194 patients treated in a 10-year period were included. Median age at diagnosis was 10.4 months (IQR: 4-21). There was unilateral RB in 92 (47.4%) and bilateral RB in 102 (52.6%) patients. 95 patients (48.9%) had SC only, 36 (18.6%) had IAC only, and 63 (32.5%) had both. In those with IAC treatment, 37 (37.3%) were for the right, 49 (49.4%) for the left, and 13 (13.1%) for bilateral treatment. The median IAC cycles was 3 (IQR: 2-4) and the median systemic chemotherapy cycles was 6 (IQR: 6-6). The presence of excess focal brain lesions in the brain was associated with use of IAC compared to SC alone (50.5% vs 14.7%,  $p < 0.001$ , OR=5.9). The rate was higher in those with both SC and IAC compared to SC alone (OR=7.7,  $p < 0.001$ ). There was no significant difference in brain lesions between the IAC group and those not receiving IAC at baseline ( $p = 0.227$ ). There was an association between the side of IAC (left, right, bilateral) and the side of brain lesions after IAC ( $p = 0.001$ ). No significant association was found between the cumulative IAC agent dose and number of brain lesions ( $p = 0.384$ ). The common distribution of the lesions was in the white matter of the frontal lobes (79%), parietal lobes (51%), temporal lobes (5%), and the thalami (8%).

## CONCLUSION

Selective intra-arterial chemotherapy for RB is associated with the incidence and development of post-treatment focal brain lesions. The incidence of these lesions is much higher than historical catheter angiography cerebral complications in children. The causes and potential long-term effects of these changes should be explored.

## CLINICAL RELEVANCE/APPLICATION

Focal brain lesions develop after IAC for retinoblastoma. The exact mechanism and long-term clinical and developmental implications of these lesions, if any, is unknown and deserves further evaluation.

## M1-SSPD02-5 Chemoablation of Salivary Glands: A Definitive Solution for Sialorrhea

Mabel Garcia-Hidalgo Alonso, PhD, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Chemical ablation of salivary glands is a safe and effective treatment with stable long-term results in pediatric patients. The primary objective is to assess the effectiveness of chemical ablation in reducing sialorrhea in pediatric patients with neurological disorders. The secondary objectives are to evaluate the permanence of the benefits in the long term, to analyze post-treatment complications, to assess the subjective satisfaction of the families of the treated patients and, finally, to evaluate the impact of the changes in the lives of the patients and their families.

## METHODS AND MATERIALS

A retrospective longitudinal and analytical cohort, multicenter, retrospective study is designed, including all patients with sialorrhoea treated by chemical ablation of the salivary glands at our institution during the period 2011-2019. After establishing the inclusion and exclusion criteria, a final sample size of 29 patients was obtained. The treatment includes the chemical ablation of two glands (parotid and ipsilateral submandibular glands) in the same procedure. The procedure starts by cannulating the Stenon's duct and Wharton's duct using a dilator and introducing a sialography needle (22G). Sialography is carried out by scopic control to check and then, under ultrasound control, ethoxysclerol 3% is injected. After 5 minutes of waiting, ethanol is injected, which will be seen as intraductal echogenic material. It is important to inject the sclerosing substances at a slow and steady rhythm to avoid perforation of the ducts and extraparenchymal outflow of the pharmacological agents into the subcutaneous cellular tissue. The cannulation of both ducts, thus avoiding percutaneous injections, allows a better diffusion of the drug and a lower risk of vascular or nerve damage.

## RESULTS

The pre-treatment Quantitative Score in our study population obtained a mean of 8.68, which decreased drastically to 5.48 after treatment. In ALL items of the Sialorrhoea Impact Scale, statistically significant differences were obtained pre-treatment and post-treatment ( $p < 0.001$ ). Treatment efficacy was maintained in the medium term (12 months) in more than 80% of patients, as well as in more than 75% in the long term (18 months). More than 75% of patients were satisfied or very satisfied with the treatment.

## CONCLUSION

Chemical ablation of the salivary glands is a minimally invasive, safe and effective treatment of sialorrhoea in paediatric age with long-term results in patients with cerebral palsy and other neurological disorders.

## CLINICAL RELEVANCE/APPLICATION

Sialorrhoea is especially prevalent in children with cerebral palsy and has a great impact on the patient's quality of life and their families leading to psychological and social disturbances in their daily lives.

## M1- SSPD02-6 Mid-Term Outcomes of Biliary Drainage with New Biodegradable Stents in Pediatric Liver Transplantation

Paolo Marra, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To report the mid-term outcomes of percutaneous biliary drainage with double biodegradable stent placement for the treatment of benign anastomotic biliary strictures in pediatric liver transplants (PLT).

## METHODS AND MATERIALS

From March 2022 all consecutive patients with PLT who underwent percutaneous transhepatic cholangiography (PTC), bilioplasty and placement of two side-by-side 10F helical-shaped (non-expandable) biodegradable (slow degradation profile of 11 weeks) biliary stents were prospectively enrolled. The primary endpoint was freedom from biliary stricture recurrence considered as absence of bile duct dilation at imaging (US/MRI) and absence of cholestasis at laboratory tests. The secondary endpoint was the assessment of procedure-related complications.

## RESULTS

Percutaneous transhepatic stent placement was performed in 15 patients (10 females; median age 7 years, range 3-11 years) for the treatment of perianastomotic strictures (14 hepatico-jejunostomy; 1 duct-to-duct anastomosis). Stenting was performed after the maintenance of an internal-external biliary drainage for a median time of 28 days (range 11.5-53 days). Median follow-up was 233.5 days (range 182.5-263 days). In 6/15 patients the external drainage was exchanged with the biodegradable stents within 2 weeks from PTC. Bile duct dilation was present at imaging in 15 patients before PTC and in 7 patients at the last imaging follow-up. Median values of direct bilirubin, alkaline phosphatase and gamma-glutamyl-transferase levels measured before the procedure and at last follow-up decreased from 0.3 to 0.25 mg/dL, from 440 to 343.5 U/L, and from 98 to 31 U/L, respectively. One case (1/15; 7%) of cholangitis after stent placement required rehospitalization and was managed conservatively; no other complications occurred during the follow-up. One patient (1/15; 7%) developed clinical cholestasis with imaging-confirmed restenosis.

## CONCLUSION

Preliminary data suggests that placement of biodegradable biliary stents for the treatment of benign biliary strictures in PLT patients may provide good outcomes. Biodegradable stents can be considered to replace poorly tolerated external biliary drainage.

## CLINICAL RELEVANCE/APPLICATION

New biodegradable stents may represent a valid treatment option to mitigate concerns related to the maintenance of external biliary drainage in pediatric patients affected by benign biliary strictures after liver transplantation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSPD02-1

### CT-based Segmentation Model for Pediatric Hepatoblastoma Trained on Data From COG AHEP0731 Liver Tumor Trial: Performance and Comparison to Adult-based Model

Monday, Nov. 27 8:00AM - 9:00AM Room: N227B

Vidya Sankar Viswanathan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Hepatoblastoma is a rare malignant liver tumor affecting children. To date, no automated segmentation models exist for this tumor. Adult hepatocellular carcinoma (HCC)-based segmentation models may not perform optimally due to differences in tumor characteristics. Therefore, we aimed to train a segmentation model on pediatric hepatoblastoma CT data and compare its performance with an adult HCC-based liver tumor segmentation model in a clinical trial dataset.

#### METHODS AND MATERIALS

We derived the dataset from the Children's Oncology Group AHEP0731 trial. Our data included 227 CT scans from hepatoblastoma patients obtained at diagnosis, after 2 cycles of chemotherapy, or prior to resection. Two pediatric radiologists manually annotated 56 randomly selected CTs for liver tumor segmentation. These were used to train an nnU-Net-based segmentation model, denoted as MP. An additional validation set of 50 CTs was annotated for segmentation by three radiologists (50 scans, divided into two groups of 25 with each group manually annotated by 2 of 3 radiologists). We optimized training by using a 5-fold cross-validation strategy with 5000 epochs and evaluated the model's performance on the validation set using the Dice similarity coefficient (DSC). DSC was also calculated between human annotations within the validation set. We compared the performance of a publicly available segmentation model trained on adult HCC CT scans using DSC, denoted as MA.

#### RESULTS

Mp was tested on 50 CT scans and achieved an average Dice similarity coefficient (DSC) of  $0.83 \pm 0.03$  for the segmentation of pediatric hepatoblastoma from CT scans. In contrast, MA performed poorly on hepatoblastoma cases, with an average DSC of  $0.53 \pm 0.04$  (Figure 1). Inter-rater agreement between the reviewers on the validation set was  $0.88 \pm 0.01$  and  $0.89 \pm 0.02$  (Table 1) for Mp.

#### CONCLUSION

An adult HCC-based liver tumor segmentation model performed poorly when segmenting hepatoblastoma. In contrast, our nnU-Net-based segmentation model was accurate and displayed a comparable degree of dissimilarity to that observed between radiologists.

#### CLINICAL RELEVANCE/APPLICATION

Our findings suggest that AI algorithms for liver tumor segmentation should be specifically trained on pediatric data to achieve the best results in children with hepatoblastoma.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M1-SSPD02-2

### Fractal Analysis of Perfusion MRI in Neuroblastoma Correlates with Tumor Microvasculature and Predicts Chemotherapy Response

Monday, Nov. 27 8:00AM - 9:00AM Room: N227B

Florian Michallek, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish perfusion fractal analysis of magnetic resonance imaging (MRI) in neuroblastoma primary tumors for assessing vascularity and predicting response to induction chemotherapy. We hypothesized that perfusion heterogeneity is inversely correlated with volumetric response potential due to the effect on vascular supply for therapeutic agents.

#### METHODS AND MATERIALS

We retrospectively included patients with high-risk neuroblastoma. Contrast-enhanced MRI was performed at diagnosis (timepoint, TP1) and prior to surgery (TP2). Patients received 4-7 cycles of N5 and N6 chemotherapy. Imaging was performed at 1.5 or 3T with clinical routine protocols including a contrast-enhanced, fat-saturated T1-weighted sequence. Tumor volume was defined as paravertebral or adrenal tumor formation including connected local lymph node metastases. Segmentation was performed at TP1 and TP2 in consensus by two readers. Fractal analysis was performed as previously established in prostate cancer, pancreatic cancer, and hepatic adenoma and carcinoma. Spatially resolved fractal dimension (FD) maps were calculated. Histological fractal analysis of CD34-stained microvessels was available in a small subgroup of five patients at TP1 and TP2. Agreement of predicted volume response with measured volume response was evaluated in the validation cohort by Bland-Altman statistics.

#### RESULTS

We included 73 patients, n=36 as discovery cohort (one center) and n=37 as separate validation cohort (29 centers), with an average tumor volume of 239.4 ml (standard deviation, SD: 237.3 ml) and 235.3 ml (SD: 204.9 ml) at TP1, which reduced to 35.8 ml (SD: 45.1 ml) and 32.6 ml (SD: 49.2 ml) at TP2. Fractal analysis demonstrated that regional tumor response depended on local perfusion heterogeneity as quantified on FD maps: Tumor regions with low FD at TP1 showed markedly better volumetric response than regions with high FD. In the validation cohort, histogram-based evaluation of FD predicted relative volumetric response with high accuracy (mean bias: -5%, limits of agreement: -35 - 25%). On CD34-staining, microvascular FD was low at TP1 (mean FD=1.23, SD=0.09) and increased at TP2 (mean FD=1.44, SD=0.07;  $p<0.001$ ), hinting at increasing microvascular heterogeneity after chemotherapy, which was reflected in MRI (TP1: mean FD=3.40, SD=0.04; TP2: mean FD=3.53, SD=0.07;  $p<0.001$ ).

#### CONCLUSION

Fractal analysis of neuroblastoma perfusion predicted primary tumor response to induction chemotherapy and allowed to regionally resolve tumor response potential, based on heterogeneity of tumor vascularity.

#### CLINICAL RELEVANCE/APPLICATION

Fractal analysis allows spatially resolved prediction of local tumor tissue response to chemotherapy based on perfusion heterogeneity.

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## Abstract Archives of the RSNA, 2023

M1-SSPD02-3

### Whole-body MRI Quantitative Parameters as Biomarkers for Predicting the Efficacy of CAR-T Therapy in Pediatric Patients with Mature Aggressive B-Cell Non-Hodgkin Lymphoma

Monday, Nov. 27 8:00AM - 9:00AM Room: N227B

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the role of whole-body MRI quantitative parameters, such as T2 signal intensity, ADC<sub>min</sub>, ADC<sub>max</sub>, and ADC<sub>mean</sub>, as potential biomarkers for predicting the efficacy of CAR-T therapy in the treatment of pediatric patients with mature aggressive B-cell non-Hodgkin lymphoma.

#### METHODS AND MATERIALS

This was a prospective multicenter study that included patients with aggressive mature B-cell NHL who received CAR-T therapy. Whole-body MRI was performed before and within 2 weeks after CAR-T infusion to evaluate the extent of tumor involvement throughout the body. The patients were divided into two groups, complete response (CR) and non-CR, by a multidisciplinary team using all available imaging and clinical investigations based on international pediatric NHL criteria. Quantitative parameters of MRI, including T2 signal intensity, ADC<sub>min</sub>, ADC<sub>max</sub>, and ADC<sub>mean</sub>, were measured by trained radiologists. The relationship between these parameters and the achievement of CR was analyzed using statistical methods. Models were established to predict CR using single-factor analysis, and the best threshold, specificity, sensitivity, and area under the curve (AUC) were determined and compared to identify the most accurate predictive model.

#### RESULTS

A total of 45 patients were included in the study, with 19 patients achieving CR after CAR-T therapy. The T2 signal intensity before CAR-T infusion was significantly higher in the non-CR group than in the CR group (266±152 vs. 363±156, P<0.05). There was a significant difference in ADC<sub>min</sub>, ADC<sub>max</sub>, and ADC<sub>mean</sub> measured within 2 weeks after CAR-T infusion between the CR and non-CR groups (0.94±0.38 vs. 0.52±0.37, P<0.05; 1.73±0.69 vs. 0.83±0.42, P<0.05; 1.28±0.48 vs. 0.65±0.32, P<0.05; respectively). The AUC values for the prediction of CR using ADC<sub>max</sub>, T2 signal intensity, and ADC<sub>mean</sub> were 0.96, 0.872, and 0.802, respectively.

#### CONCLUSION

Our findings suggest that MRI quantitative parameters, particularly T2 signal intensity and ADC values, can serve as useful tools in predicting the response to CAR-T therapy in pediatric and adolescent patients with aggressive mature B-cell NHL. Our results show that early follow-up MRI can be used as a non-invasive biomarker to predict complete response.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study highlight the importance of using MRI quantitative parameters in predicting response to CAR-T therapy in pediatric patients with mature aggressive B-cell NHL. Clinicians may use these non-invasive biomarkers to detect treatment response at an early stage, which could guide personalized treatment strategies and ultimately improve patient outcomes.

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## Abstract Archives of the RSNA, 2023

M1-SSPD02-4

### Brain Lesions Following Selective Intra-arterial Chemotherapy Treatment for Retinoblastoma

Monday, Nov. 27 8:00AM - 9:00AM Room: N227B

Daniel Vossough (*Presenter*) Nothing to Disclose

#### PURPOSE

Selective intra-arterial chemotherapy (IAC) has become a widespread treatment method for children with retinoblastoma (RB). There is a paucity of literature on potential complications of this form of treatment. In this study, we investigate the presence and development of focal brain lesions above baseline rates on MRI after systemic chemotherapy (SC), IAC, or both.

#### METHODS AND MATERIALS

In this retrospective IRB-approved study, clinical and brain MRI examinations of RB patients undergoing SC, IAC, or both were collected at a large pediatric retinoblastoma referral center. IAC was performed by interventional staff from two different institutions. Pre-treatment, post-treatment, and last available MRI exams were reviewed, blinded to treatment regimen. Associations between type of treatment, presence and distribution of lesions were explored.

#### RESULTS

A total of 194 patients treated in a 10-year period were included. Median age at diagnosis was 10.4 months (IQR: 4-21). There was unilateral RB in 92 (47.4%) and bilateral RB in 102 (52.6%) patients. 95 patients (48.9%) had SC only, 36 (18.6%) had IAC only, and 63 (32.5%) had both. In those with IAC treatment, 37 (37.3%) were for the right, 49 (49.4%) for the left, and 13 (13.1%) for bilateral treatment. The median IAC cycles was 3 (IQR: 2-4) and the median systemic chemotherapy cycles was 6 (IQR: 6-6). The presence of excess focal brain lesions in the brain was associated with use of IAC compared to SC alone (50.5% vs 14.7%,  $p < 0.001$ , OR=5.9). The rate was higher in those with both SC and IAC compared to SC alone (OR=7.7,  $p < 0.001$ ). There was no significant difference in brain lesions between the IAC group and those not receiving IAC at baseline ( $p = 0.227$ ). There was an association between the side of IAC (left, right, bilateral) and the side of brain lesions after IAC ( $p = 0.001$ ). No significant association was found between the cumulative IAC agent dose and number of brain lesions ( $p = 0.384$ ). The common distribution of the lesions was in the white matter of the frontal lobes (79%), parietal lobes (51%), temporal lobes (5%), and the thalami (8%).

#### CONCLUSION

Selective intra-arterial chemotherapy for RB is associated with the incidence and development of post-treatment focal brain lesions. The incidence of these lesions is much higher than historical catheter angiography cerebral complications in children. The causes and potential long-term effects of these changes should be explored.

#### CLINICAL RELEVANCE/APPLICATION

Focal brain lesions develop after IAC for retinoblastoma. The exact mechanism and long-term clinical and developmental implications of these lesions, if any, is unknown and deserves further evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M1-SSPD02-5

### Chemoablation of Salivary Glands: A Definitive Solution for Sialorrhea

Monday, Nov. 27 8:00AM - 9:00AM Room: N227B

Mabel Garcia-Hidalgo Alonso, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Chemical ablation of salivary glands is a safe and effective treatment with stable long-term results in pediatric patients. The primary objective is to assess the effectiveness of chemical ablation in reducing sialorrhea in pediatric patients with neurological disorders. The secondary objectives are to evaluate the permanence of the benefits in the long term, to analyze post-treatment complications, to assess the subjective satisfaction of the families of the treated patients and, finally, to evaluate the impact of the changes in the lives of the patients and their families.

#### METHODS AND MATERIALS

A retrospective longitudinal and analytical cohort, multicenter, retrospective study is designed, including all patients with sialorrhoea treated by chemical ablation of the salivary glands at our institution during the period 2011-2019. After establishing the inclusion and exclusion criteria, a final sample size of 29 patients was obtained. The treatment includes the chemical ablation of two glands (parotid and ipsilateral submandibular glands) in the same procedure. The procedure starts by cannulating the Stenon's duct and Wharton's duct using a dilator and introducing a sialography needle (22G). Sialography is carried out by scopic control to check and then, under ultrasound control, ethoxysclerol 3% is injected. After 5 minutes of waiting, ethanol is injected, which will be seen as intraductal echogenic material. It is important to inject the sclerosing substances at a slow and steady rhythm to avoid perforation of the ducts and extraparenchymal outflow of the pharmacological agents into the subcutaneous cellular tissue. The cannulation of both ducts, thus avoiding percutaneous injections, allows a better diffusion of the drug and a lower risk of vascular or nerve damage.

#### RESULTS

The pre-treatment Quantitative Score in our study population obtained a mean of 8.68, which decreased drastically to 5.48 after treatment. In ALL items of the Sialorrhoea Impact Scale, statistically significant differences were obtained pre-treatment and post-treatment ( $p < 0.001$ ). Treatment efficacy was maintained in the medium term (12 months) in more than 80% of patients, as well as in more than 75% in the long term (18 months). More than 75% of patients were satisfied or very satisfied with the treatment.

#### CONCLUSION

Chemical ablation of the salivary glands is a minimally invasive, safe and effective treatment of sialorrhoea in paediatric age with long-term results in patients with cerebral palsy and other neurological disorders.

#### CLINICAL RELEVANCE/APPLICATION

Sialorrhea is especially prevalent in children with cerebral palsy and has a great impact of on the patient's quality of life and their families leading to psychological and social disturbances in their daily lives.

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## Abstract Archives of the RSNA, 2023

M1-SSPD02-6

### Mid-Term Outcomes of Biliary Drainage with New Biodegradable Stents in Pediatric Liver Transplantation

Monday, Nov. 27 8:00AM - 9:00AM Room: N227B

Paolo Marra, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To report the mid-term outcomes of percutaneous biliary drainage with double biodegradable stent placement for the treatment of benign anastomotic biliary strictures in pediatric liver transplants (PLT).

#### METHODS AND MATERIALS

From March 2022 all consecutive patients with PLT who underwent percutaneous transhepatic cholangiography (PTC), bilioplasty and placement of two side-by-side 10F helical-shaped (non-expandable) biodegradable (slow degradation profile of 11 weeks) biliary stents were prospectively enrolled. The primary endpoint was freedom from biliary stricture recurrence considered as absence of bile duct dilation at imaging (US/MRI) and absence of cholestasis at laboratory tests. The secondary endpoint was the assessment of procedure-related complications.

#### RESULTS

Percutaneous transhepatic stent placement was performed in 15 patients (10 females; median age 7 years, range 3-11 years) for the treatment of perianastomotic strictures (14 hepatico-jejunostomy; 1 duct-to-duct anastomosis). Stenting was performed after the maintenance of an internal-external biliary drainage for a median time of 28 days (range 11.5-53 days). Median follow-up was 233.5 days (range 182.5-263 days). In 6/15 patients the external drainage was exchanged with the biodegradable stents within 2 weeks from PTC. Bile duct dilation was present at imaging in 15 patients before PTC and in 7 patients at the last imaging follow-up. Median values of direct bilirubin, alkaline phosphatase and gamma-glutamyl-transferase levels measured before the procedure and at last follow-up decreased from 0.3 to 0.25 mg/dL, from 440 to 343.5 U/L, and from 98 to 31 U/L, respectively. One case (1/15; 7%) of cholangitis after stent placement required rehospitalization and was managed conservatively; no other complications occurred during the follow-up. One patient (1/15; 7%) developed clinical cholestasis with imaging-confirmed restenosis.

#### CONCLUSION

Preliminary data suggests that placement of biodegradable biliary stents for the treatment of benign biliary strictures in PLT patients may provide good outcomes. Biodegradable stents can be considered to replace poorly tolerated external biliary drainage.

#### CLINICAL RELEVANCE/APPLICATION

New biodegradable stents may represent a valid treatment option to mitigate concerns related to the maintenance of external biliary drainage in pediatric patients affected by benign biliary strictures after liver transplantation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPBR-1

### Stand-alone Performance of Artificial Intelligence-based Computer-assisted Diagnosis in Screening Automated Breast Ultrasound

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Haejung Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the stand-alone performance of artificial intelligence-based computer-assisted diagnosis (AI-CAD) in screening automated breast ultrasound (ABUS) interpretation and find the factors associated with false-negative and false-positive results.

#### METHODS AND MATERIALS

The ABUS source data of 435 women in a single institution were retrospectively analyzed using AI-CAD system (LUCAS). Three volume data of antero-posterior, medial, and lateral scanning were obtained for each breast. Of total 435 women, 97 were breast cancer patients with screening detected single malignant lesion between October 2019 and June 2020, and 338 were women who underwent screening ABUS between May 2019 and June 2019 and showed negative final diagnosis. We reviewed the results of AI-CAD system in detecting malignant lesion on ABUS and analyzed the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Also the associated factors with false-negative and false-positive results were analyzed.

#### RESULTS

The sensitivity, specificity, PPV, and NPV of AI-CAD in ABUS interpretation were 0.75 (73 of 97; 95% confidence interval, 0.65 to 0.83), 0.58 (195 of 338; 95% CI, 0.52 to 0.63), 0.34 (73 of 216; 95% CI, 0.30 to 0.37), and 0.89 (195 of 219; 95% CI, 0.85 to 0.92), respectively. The average number of CAD-detected lesion was 1.2 per study (1.8 in patients with cancer, and 1.0 in patients without cancer). True positive lesions were detected in 1.81 of 3 volumes of breast, while false positive lesions were detected in 1.30 of 3 volumes (1.5 in benign lesions and 1.1 in pseudo-lesions). False-negative results in breast cancer were more frequent for isoechoic mass ( $p < 0.001$ ) and mass without echogenic rind ( $p = 0.043$ ). Among 143 patients with false-positive results, 49 (34.3%) had pseudo-lesions. False-positive results were more frequent for dense breasts on mammography ( $p < 0.001$ ), however, the background echotexture of ABUS was not associated with false positive results or pseudo-lesions.

#### CONCLUSION

AI system showed NPV of 89% for negative interpretation of ABUS. However, radiologists should carefully recheck the results of AI-CAD system to reduce false-positive results and recall rate.

#### CLINICAL RELEVANCE/APPLICATION

By providing information on the stand-alone performance of AI-CAD in screening ABUS interpretation, it helps to correctly understand the advantages and disadvantages of AI-CAD system and apply them to clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPBR-2

### **A Novel Triage Model for Screening Mammograms Based on a Density AI and a Cancer Detection AI**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Serena Pacile, PhD (*Presenter*) Employee, Therapixel SA

#### **PURPOSE**

To estimate the effectiveness of a triage model for breast cancer screening examinations based on two AI systems: one for breast density assessment and one for cancer detection.

#### **METHODS AND MATERIALS**

For this retrospective simulation study, a dataset of 2,981 tomosynthesis screening examinations was collected. The dataset included 696 biopsy-proven cancer cases and 2,285 negative screens (verified by a negative follow-up). For each collected screen, the interpretation made by the primary reader was also collected. A two-steps triage model was set up based on two AI systems: one estimating the breast composition, and one detecting and characterizing regions suspicious for malignancy (hereafter referred to as AI-density and AI-detection). The first step was based on density: examinations whose density was assessed as C or D by AI-density were considered as requiring human interpretation. Examinations whose density was assessed as A or B were further processed by AI-detection: those with an AI-detection score lower than a given threshold were considered negative and not worth of reader interpretation, otherwise they were considered as requiring human interpretation. The proposed triage model is based on the French breast screening context where patients with high density breasts systematically undergo both mammography and ultrasound, and autonomous offloading of examinations by AI is mainly applicable to low density breasts. We examined the effect on recall rate and workload reduction keeping constant the cancer detection rate. We used inverse probability weighting to compensate for distribution differences between the used dataset and a typical screening population.

#### **RESULTS**

AI-density assessed 611 exams (20.5%) as density A, 1,024 (34.35%) exams as density B, 967 exams (32.44%) as density C and 379 exams (12.71%) as density D. Based on AI-detection scores of examinations assigned with densities A and B, 26.43% of women were considered negative without significantly affecting the cancer detection rate (which remained constant around 5/1000 - 95% CI 4.6/1000 to 5.7/1000). The recall rate decreased from 10.02% (8.74% - 11.29%) to 8.2% (7.07% - 9.32%).

#### **CONCLUSION**

Results have shown that the proposed two-step triage strategy could safely select patients to be removed from radiologists' workload without affecting the cancer detection rate. A prospective study that applies this model has been set up in France and is supposed to start including patients on January 2024.

#### **CLINICAL RELEVANCE/APPLICATION**

Using two AI systems (one for density and one for cancer detection) to triage mammograms could potentially reduce radiologist workload at constant cancer detection rate, and decrease the rate of women recalled back for further examinations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPBR-3

### **Automated Assessment of Breast Positioning and Image Quality Using Artificial Intelligence for Digital Breast Tomosynthesis (DBT) with Two-Dimensional Synthetic Mammography and Full-Field Digital Mammography (FFDM)**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Ying Guo (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to evaluate the accuracy of an artificial intelligence based tool for automated assessment of breast positioning and image quality in DBT, using synthetically reconstructed projection images.

#### **METHODS AND MATERIALS**

A total of 150 mammography examinations were enrolled in this study. Subjects underwent screening mammography including DBT with 2D-SM and FFDM. The AI-assisted automated assessment tool evaluated the quality of breast positioning in each image set. Nine image quality criteria evaluating the appearance of the nipple, breast rotation, pectoral muscle, inframammary fold, pectoral nipple line, shoulder overlap shadow, abdominal skin, contralateral breast and foreign body were used for craniocaudal and mediolateral-oblique views. Image quality of cases were also evaluated with the standards of Mammography Quality Standards Act (MQSA) as grade "adequate" or "inadequate". The performance of the AI system was evaluated using accuracy, sensitivity, and specificity. The inter-rater agreement and comparison of their findings with those reported by the AI system was calculated using Cohen's kappa coefficient.

#### **RESULTS**

The AI algorithm demonstrated high accuracy in distinguishing between adequate and inadequate images, with an overall accuracy of 93%, sensitivity of 94% and specificity of 92% for FFDM and an accuracy of 92%, sensitivity of 95 and specificity of 91% for DBT with 2D-SM. In terms of breast positioning, the AUC of poor imaging quality prediction by AI system according to incomplete gland, incomplete pectoralis muscle, over or insufficient exposure was (0.903 vs 0.937 vs 0.982). Overall accuracy of AI system were 0.958 for FFDM and 0.932 for DBT with 2D-SM. Inter-observer agreement for image quality assessment was found to be 0.82 (95% confidence interval [CI]: 0.77-0.87), indicating substantial agreement between radiologists and AI system using 2D-SM images. The kappa coefficients for breast positioning assessment were also calculated and found to be moderate to substantial, with values ranging from 0.57 to 0.83 (95% CI: 0.48-0.67 and 0.78-0.88, respectively).

#### **CONCLUSION**

The results showed a high degree of agreement between the automated and manual assessments, also indicating the performance of the AI tool in assessing breast positioning and image quality in DBT using 2D-SM images was comparable with that in FFDM.

#### **CLINICAL RELEVANCE/APPLICATION**

The study demonstrated the potential of this AI assisted system to improve the efficiency, accuracy, and reliability in DBT screening.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-SPBR-4

### TopoTxR: A Topology-based Framework for Breast Parenchyma Characterization on DCE-MRI

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Prateek Prasanna, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

In order to comprehensively analyze the biology of breast cancer, it is necessary to examine the surrounding breast parenchyma. Automated characterization of breast parenchyma using DCE-MRI is challenging due to the intricacy of the parenchymal tissue structures. Existing quantitative techniques, when combined with deep learning, are unable to accurately represent the complex structures, such as fibroglandular tissue. The fibroglandular tissue may undergo malignant transformation. To better evaluate the subtle structures of the breast, we propose a novel approach, TopoTxR, that incorporates topological features extracted from persistence diagrams as auxiliary information. This enables the convolutional neural network (CNN) to directly focus on the biologically-relevant topological structures.

#### METHODS AND MATERIALS

We train and validate TopoTxR to predict pathological complete response (pCR) using ISPY-1 post-contrast DCE-MRI data. Our study involves 161 patients, with 47 achieving pCR and 114 not. To enhance the performance of the 3D CNN, we integrated a mask-guided attention module that leverages a prepared topology-related mask. This mask approximates the curvilinear tissue-like structures enclosed by tissues and glands in their proximity. While inputting the raw DCE-MRI as the input of the CNN backbone, we applied the topological structure mask to guide the generation of the attention map in the latent space. TopoTxR takes advantage of the noise-free topological structures while retaining other biologically relevant information of the original data. Finally, we employed a classifier to the attention-filtered features for pCR prediction, followed by a custom loss function combined mask guided loss and refined the classification loss to address the sample imbalance problem.

#### RESULTS

TopoTxR utilizes the topological mask as supplementary input combined with the original image and incorporating Focal Loss. It improves pCR prediction significantly compared to previous methods and it also surpasses the state-of-the-art, Densenet-KD, by 3% in accuracy. Our ablation studies show the effectiveness of mask-guided attention modules and Focal Loss, respectively.

#### CONCLUSION

Our novel method leverages pre-computed topological biomarkers to enhance the performance of 3D CNN in pCR prediction. This model reasonably integrates both topology and full image information to obtain and evaluate high biological related features.

#### CLINICAL RELEVANCE/APPLICATION

Predicting treatment response enables physicians to plan and determine the most effective treatment strategy for their patients prior to disease progression (i.e. immediate surgical intervention in cases where neoadjuvant chemotherapy is predicted to fail).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPBR-5

### Cloud-Based Machine Learning Platform for the Detection and Localization of Breast Cancer on DCE-MR Scans

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Gavin Jones (*Presenter*) Nothing to Disclose

#### PURPOSE

Breast cancer is the most common cancer diagnosed in US women and is second to lung cancer as a cause of death in women. Machine learning (ML) can play a role in aiding breast radiologists with the detection and localization of tumors on MRI. The aim of this project was to create an ML algorithm using cloud-based software capable of accurately identifying breast cancer on DCE-MRI. The trained algorithm may be used as a radiologist adjunct in the early identification of lesions.

#### METHODS AND MATERIALS

Breast cancer MR images were obtained from a publicly available dataset of 922 radiologist-annotated and biopsy-confirmed breast cancer. The provided annotations denoted a 3D bounding box of each tumor. Using these coordinates, multiple 2D slices of the tumor were selected to augment the total number of tumor-containing images to 1267 training and 396 test images. Tumor images were further processed to exploit contrast enhancement data by compiling pre-contrast tumor slices with their corresponding early and late post-contrast slices into a single RGB image. Cloud-based ML software was then used to train the algorithm on the processed 1267 pre-annotated MR images. Following training, the algorithm's accuracy and precision were assessed using the remaining 396 test images. Tumor subgroup analyses were also performed to assess detection performance on classifiers such as ductal and lobular histology and molecular features such as luminal A/B, HER2+/-, ER +/-, PR+/-, and triple-negative carcinomas.

#### RESULTS

The trained ML model had 94.3% recall and 89.8% precision when the probability and overlap thresholds were set to 95% and 30% respectively. When tested on the 396 non-annotated validation images, the model localized breast cancer tumors with a recall of 88.6% and an average precision of 86.5% with a confidence interval of 0.95 and an F1 score of 0.89. For the subgroup analyses, HER2 enriched molecular subtype (n=20) had the highest overall average precision (95.5%), recall (95.5%), and F1 (0.95). The lowest-performing subgroup was lobular carcinoma (n=31) with average precision (88.8%), recall (84.4%), and F1 (0.90).

#### CONCLUSION

Our study has shown that ML techniques trained on a large set of annotated MR images can produce a highly accurate breast cancer detection and identification tool. The performance of tumor classifiers varies depending on tumor type, receptor status, and molecular subtype.

#### CLINICAL RELEVANCE/APPLICATION

An ML tool that can accurately detect and localize breast cancer tumors can improve care by providing women with diagnoses and thus treatment options more quickly. In the future, this ML model can be made accessible within an online tool that will quickly review breast MR slices and determine if there is breast cancer and localize tumors.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPBR-6

### Artificial Intelligence-Supported Additional Review of Screening Mammography Improves Radiologist Cancer Detection Rate

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Matthew McCabe, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Studies estimate that for every 5 cancers detected by screening mammography, there is 1 false negative. A common method of reducing the false negative rate is "double-reading," where two readers interpret mammograms. However, double-reading is costly, and single-reading is standard practice in the USA. The purpose of this study was to explore the utility of an Artificial Intelligence (AI) supported additional review process (AIAR) where AI identifies the most suspicious exams for selective additional review. The goal is to realize the benefit of decreased false negatives through double-reading while minimizing additional workload.

#### METHODS AND MATERIALS

A total of 522,078 digital breast tomosynthesis screening mammograms from March 2021 to August 2022 underwent AIAR at 5 practices in the US. The dataset contained 2,739 screen-caught cancers. In the AIAR process, screening mammograms were assessed using a custom AI algorithm. Exams considered suspicious by the AI algorithm that were not recalled by the interpreting radiologist (i.e. given a BIRADS 1 or 2) were flagged for review by an experienced radiologist. The reviewer could consult with the interpreting radiologist if they thought a recall was warranted, who could decide whether to revise to a BIRADS 0 and recall the patient. Performance metrics, including recall rate (RR), cancer detection rate (CDR), and positive predictive value 1 (PPV1) were computed for 98 individual interpreting radiologists.

#### RESULTS

A total of 19,560 exams were flagged by AIAR, and 201 additional cancers were detected. Thus, with AIAR only 4% of exams required an additional review, while yielding an 8% increase in cancer detection. AIAR increased CDR across practices (range 5-21%), while minimally impacting RR (range 1-3%). PPV1 also increased at every practice (range 3-16%), indicating AIAR finds more cancers for each recall. Radiologists with lower pre-AIAR CDRs improved more compared to those with high pre-AIAR CDR (e.g., CDR increase of 0.55 vs 0.35 for radiologists with pre-AIAR CDR of 2-4 vs 4-6). Finally, AIAR could be further improved to identify up to 243 more cancers by standardizing the consult rate to ~5 consults per 100 reviews which would maximize the positive predictive value of consults at ~35 cancers per 100 consults.

#### CONCLUSION

AIAR increases cancers detected, while minimizing the additional workload required to identify and recall at-risk patients in a large real-world dataset.

#### CLINICAL RELEVANCE/APPLICATION

AIAR is a practical means to improve cancer detection in the real-world, and therefore reduce false negatives without incurring substantial additional costs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPBR-7

### Sonographic Prediction of Breast Cancer Patients Non-Responding to Neoadjuvant Chemotherapy at Baseline: Comparison of Standard B-mode and a Deep-Learning Model

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Panagiotis Kapetas, MD,PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether pre-therapeutic breast ultrasound (US) can serve in the prediction of breast cancer (BC) patients non-responding to neoadjuvant chemotherapy (NAC) and to compare two different models.

#### METHODS AND MATERIALS

This retrospective, IRB-approved study included 245 patients with histologically confirmed invasive BC who underwent NAC. The dataset was divided into a training (165 cases) and a validation set (80 cases). A representative B-mode US image of each tumor from the pre-treatment examination was selected. 2 experienced breast fellows independently evaluated the lesions using standard BI-RADS descriptors. Logistic regression was used to identify independent predictors of response to NAC in the training set and create a model. Additionally, a Resnet18-based neural network with Dropout layers to decrease the amount of overfitting was trained to predict the treatment outcome. The performance of both models was evaluated on the validation set using descriptive statistics. Postoperative histology was the standard of reference for treatment response: absence (pathological complete response- pCR) or presence of residual invasive tumor in the breast or axillary lymph nodes.

#### RESULTS

145 patients (59.2%) did not achieve a pCR. From the BI-RADS descriptors, oval or round shape, microlobulated or spiculated margin and the presence of calcifications or edema proved to be independent predictors of pCR. A model using these showed an accuracy, sensitivity, specificity, positive and negative predictive value of respectively 65%, 82%, 41%, 67% and 61% for the prediction of non-responders to NAC. Compared to that, the DL-based model achieved an accuracy, sensitivity, specificity, positive and negative predictive value of 72%, 83%, 55%, 74% and 69%.

#### CONCLUSION

Breast US can accurately predict lack of response to NAC for BC patients prior to its initiation. A DL model using images from the baseline US examination demonstrates an increased diagnostic performance as compared to standard B-mode BI-RADS descriptors.

#### CLINICAL RELEVANCE/APPLICATION

Pre-therapeutic breast ultrasound offers accurate information, which may aid in the management of breast cancer patients, planned to undergo neoadjuvant chemotherapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPBR-8

### **Prediction of Pathologic Response to Neoadjuvant Chemotherapy in Patients with Breast Cancer Based on Artificial Intelligence Techniques**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Ahmed Sharafeldeen, MSc, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim is to develop a computer aided diagnosis (CAD) system to accurately predict the response of neoadjuvant chemotherapy on breast cancer patients based on magnetic resonance imaging (MRI). The system aims to predict three possible responses, which are complete response (indicating the complete disappearance of the lesion), partial response (in which the tumor partially disappeared), or no response (suggesting that the tumor did not respond to chemotherapy).

#### **METHODS AND MATERIALS**

The proposed system is composed of four distinct stages. The first stage involves manual delineation of the breast tumor by an experienced radiologist. Secondly, four distinct features are extracted from the manually segmented tumor, namely functional imaging markers, apparent diffusion coefficient (ADC), computed from diffusion-weighted imaging (DWI) using baseline scans and b-500, b-1000, and b-1500 scans, along with texture features, grey level co-occurrence matrix (GLCM) and grey level run length matrix (GLRLM), extracted from T1-weighted, T2-weighted, and STIR models. Thirdly, these features are statistically represented using percentiles, which helps to capture the salient aspects of the data distribution while minimizing the impact of outliers. Finally, the features are combined together and then fed into a gradient boosting classifier.

#### **RESULTS**

To evaluate the effectiveness of the proposed system, a dataset of 110 breast cancer patients was used, with 28 patients showing complete response, 53 with partial response, and 29 with no response. The system's performance is assessed using k=15 cross-validation approach. The findings demonstrated that the proposed system outperforms the accuracy of classifying each feature individually as well as other statistical machine learning classifiers, achieving an impressive accuracy of 85.5 a specificity of 73.5 a sensitivity of 98.5. The results clearly indicate that integrating functional imaging markers and texture markers using majority voting approach significantly enhances the diagnostic system's performance.

#### **CONCLUSION**

The proposed CAD system accurately predicts the response of neoadjuvant chemotherapy on breast cancer patients by utilizing various markers related to the pathology. The system's performance is further improved by integrating functional imaging markers and texture markers in a non-invasive manner.

#### **CLINICAL RELEVANCE/APPLICATION**

The motivation behind this objective is to reduce the risk of exposure to neoadjuvant chemotherapy, which can be painful and dangerous. By assessing the response of the impact of chemotherapy exposure, physicians can determine whether chemotherapy is necessary or if the patient should undergo surgery directly.

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## Abstract Archives of the RSNA, 2023

M2-SPBR-9

### Analyzing the Collinearity of Race and Breast Tissue Density in Misclassification of Abnormality in Screening Mammograms

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Linglin Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep learning techniques have been developed to assist the assessment of potential breast cancer in screening mammograms. Research has shown gaps in model performance within subgroups of some demographic and imaging features in classifying abnormality in mammograms presenting region of interests (ROIs); However, the collinearity between such features is unknown. The purpose of this study was to investigate the collinearity of those demographic and imaging characteristics in association with the performance of deep learning model in classifying abnormality in screening mammograms.

#### METHODS AND MATERIALS

We applied a modified ResNet152V2 convolutional neural network structure trained on 39,054 and tested on 13,390 mammogram patches from (REDACTED) dataset. Positive patches are the ROIs annotated by the original interpreting radiologists on BI-RADS 0 images; Negative patches were randomly selected from regions in BI-RADS 0 images avoiding ROIs, and regions in BI-RADS 1 and BI-RADS 2 images. The classification result of test set patches was aggregated to their source images, while only images containing all correctly classified patches were considered as successful prediction. Image-level classification results on 5,723 test images containing ROIs were analyzed by logistic regression models for the association with race and tissue densities, separately and together. Variance inflation factor (VIF) was calculated for race and tissue density.

#### RESULTS

VIF between race and density is 1.000005, showing features are moderately, nearly not correlated. Experiment 1 combined three race groups and four densities into 12 subgroups, no significant correlation with image misclassification was found. Experiment 2 had three models built in White, Black and Other races populations separately, we found that only in Black population, BI-RADS densities C ( $p=0.026$ ) and D ( $p=0.012$ ) have significantly higher chance to be misclassified.

#### CONCLUSION

The study reveals there is no collinearity issue with race and tissue density in the dataset and deep learning structure that were used.

#### CLINICAL RELEVANCE/APPLICATION

This can be used as a guide for future model development.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPCA-3

### Preliminary Investigation of the Right Ventricular Scalloping Index as a Novel CMR-derived Marker for Diagnosing Arrhythmogenic Right Ventricular Cardiomyopathy

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Ko Ying Huang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The cardiac magnetic resonance (CMR) evaluation of right ventricular (RV) morphologic abnormalities in patients with arrhythmogenic right ventricular cardiomyopathy (ARVC) is subjective. Here we aimed to develop a novel index, the right ventricular scalloping index (RVSI), to standardize the measurement of RV free wall scalloping and aid in the imaging diagnosis.

#### METHODS AND MATERIALS

We retrospectively included 15 patients with definite ARVC and 45 age- and sex-matched patients with idiopathic right ventricular outflow tract ventricular arrhythmia (RVOT-VA) as controls. The RVSI was measured from cine images on four-chamber view to evaluate its ability to distinguish between ARVC and RVOT-VA patients.

#### RESULTS

The RVSI was significantly higher in the ARVC than RVOT-VA group ( $1.57 \pm 0.22$  vs.  $1.27 \pm 0.07$ ,  $p < 0.001$ ). The RVSI demonstrated high intra- and interobserver reliability (intraclass correlation coefficient, 0.94 and 0.93, respectively). A cut-off value of  $RVSI = 1.38$  provided high sensitivity of 86.7% and high specificity of 95.6%. Moderate linear correlations were found between RVSI and RVEF ( $r = -0.42$ ,  $p < 0.001$ ) as well as between RVSI and RVEDVI ( $r = 0.5$ ,  $p < 0.001$ ). The subgroup analysis revealed a moderate linear correlation between RVSI and RVEDVI ( $r = 0.67$ ,  $p = 0.006$ ) in the ARVC subgroup. In a multivariable analysis, a family history of ARVC or sudden cardiac death (odds ratio, 98.14; 95% confidence interval, 2.34-4116.35;  $p = 0.016$ ) and an  $RVSI = 1.38$  (odds ratio, 145.24; 95% confidence interval, 9.90-2131.10;  $p < 0.001$ ) remained predictive of definite ARVC.

#### CONCLUSION

RVSI is a quantitative method with good performance for distinguishing ARVC and RVOT-VA patients.

#### CLINICAL RELEVANCE/APPLICATION

ARVC is among the major differential diagnoses to be considered in patients with an initial impression of RVOT-VA, image survey with CMR before ablation is recommended to provide a comprehensive assessment of RV morphology, and RVSI is easy and intuitive to measure.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPCA-4

### Regional Variation of Left Ventricular Myocardial T2 Mapping Values and Diagnostic Performance for Active Cardiac Sarcoidosis

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jordan H. Chamberlin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Myocardial tissue characterization with T2 mapping has been shown to aid in diagnosis of cardiac sarcoidosis, but the regional variation and diagnostic performance has not been well evaluated.

#### METHODS AND MATERIALS

2503 patients undergoing 1.5T cardiac MRI from 2017-2022 were queried. 326 patients with biopsy proven extracardiac sarcoidosis were enrolled in this retrospective cohort analysis, of which 110 were found to have complete T2 mapping series. The left ventricle was manually delineated into the 16 corresponding anatomic segments and 7 regions (Basal, mid, apical, anterior, inferior, septal, and lateral) according to the American Heart Association segmentation guidelines. Active cardiac sarcoidosis (aCS) was defined using the 2017 Japanese Circulation Society criteria within 30 days of imaging. Optimal thresholds were calculated using a balanced resampling bootstrapping technique. The optimal thresholds were rounded to the nearest integer for ease of clinical use. Mann-Whitney U Tests were used for comparing continuous distributions.

#### RESULTS

37 (33.6%) patients (mean age 57 years, 65.9% males, 63.4% Black) were found to meet aCS criteria. T2 values across all myocardial regions were found to be significantly higher for patients meeting criteria for aCS ( $P < 0.05$ ). Median regional T2 values in patients with aCS ranged from 48.6 ms (septal) to 50.8 ms (apical) and median regional T2 values in patients without aCS ranged from 47.0 ms (lateral) to 49.5 ms (apical). Utilizing optimized thresholds ( $>50$ ms), the septal myocardium was most specific for active disease (specificity = 0.923). The single region most sensitive for active disease involvement was the inferior segments (sensitivity = 0.630). Using a 50 ms positive threshold for each region, the positive predictive value (PPV) increased proportionally with the addition of each positive region (PPV 1 region  $> 50$ ms, = 0.42, PPV 5 regions = 0.65, PPV 6 regions = 0.88, PPV 7 regions = 1.00). Correspondingly, using a  $< 47$  ms negative threshold, the negative predictive value for ruling out aCS was highest for three segments  $< 47$  ms (NPV = 0.82).

#### CONCLUSION

T2 mapping values vary significantly across the left ventricular myocardium. The best threshold for active disease was found to be  $> 50$  ms, and the best threshold for ruling out active disease was  $< 47$  ms. Elevated regional T2 mapping (especially in the septal and inferior segments) is highly specific for active disease and shows a proportional relationship of myocardial involvement with diagnostic performance.

#### CLINICAL RELEVANCE/APPLICATION

T2 mapping, with attention to regional variation, can help identify patients with active cardiac sarcoidosis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-SPCA-5

### Cardiac Magnetic Resonance Feature-tracking Assessment of Whole-heart Myocardial Mechanics: Prognostic Value for Early Outcomes in Non-ischemic Dilated Cardiomyopathy

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Gryte Galnaitiene, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the prognostic value of whole-heart myocardial strain parameters derived from feature tracking (FT) on cardiac magnetic resonance imaging (CMRI) for early outcomes in patients with nonischemic dilated cardiomyopathy (NIDCM).

#### METHODS AND MATERIALS

This was a single-center prospective study involving 97 patients (mean age  $49.5 \pm 10.1$  years; 69.1% males) with NIDCM. We identified the baseline CMRI-derived whole-heart myocardial mechanical parameters: global longitudinal and circumferential strains of the left ventricle (LVGLS and LVGCS, respectively), global longitudinal strain of the right ventricle (RVGLS), peak longitudinal strain of the left atrium (LA strain) and right atrium (RA strain). The volumes of both ventricles and areas of both atria were also assessed. We evaluated the prognostic impact of the mechanical parameters for early outcomes that were: cardiac death, heart transplantation and hospitalization for worsening heart failure (HF) at 1 year after diagnosis of NIDCM. Logistic regression analysis was used to assess the potential predictors of these early outcomes.

#### RESULTS

The patients were divided into two groups according to the presence of early outcomes. The groups did not differ in mean age and males ( $p > 0.05$ ). The early outcomes were established in 32 patients (3 heart transplantations, 9 cardiac death, and 30 hospitalizations for HF worsening). All patients' left ventricular ejection fraction (LVEF) was severely reduced (mean LVEF  $28.9 \pm 8.9\%$ ) and more decreased in the group with early adverse outcomes ( $23.7 \pm 10.1\%$  vs  $32.9 \pm 10.6\%$ ,  $p < 0.001$ ). Both ventricles and atria were more dilated in the group with early adverse outcomes ( $p < 0.05$ ). Patients without early outcomes had higher LVGLS and RVGLS values ( $-8.2 \pm 4.1$  vs  $-11.7 \pm 4.6$  and  $-12.7 \pm 5.3$  vs  $-16.8 \pm 6.5$ , respectively,  $p < 0.05$ ). The similar tendency was noticed in LA strain and RA strain parameters ( $8.4 \pm 5.0$  vs  $14.6 \pm 4.3$  and  $11.5 \pm 6.9$  vs  $17.1 \pm 8.0$ , respectively,  $p < 0.05$ ). Logistic regression analysis showed that LVGLS was an independent predictor of early adverse outcomes in patients with NIDCM after 1 year ( $p = 0.001$ ).

#### CONCLUSION

LVGLS derived from FT on CMRI can be a significant independent predictor of early adverse outcomes in patients with NIDCM.

#### CLINICAL RELEVANCE/APPLICATION

The mechanics of all parts of the heart in patients with NIDCM were evaluated. It was revealed that LVGLS has an additive prognostic value to predict early adverse outcomes in patients with severely reduced LVEF and NIDCM.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPCA-6

### Evaluation of Myocardial Histological Properties by Pharmacokinetic Analysis Using Golden-angle Radial Sparse Parallel Imaging-volumetric Interpolated Breath-hold Examination (GRASP-VIBE)

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Masaru Shiotani, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Golden-angle radial sparse parallel imaging-volumetric interpolated breath-hold examination (GRASP-VIBE) is a sequence used for dynamic contrast-enhance (DCE) MRI that is robust to motion and enables to evaluate of tissue dynamic contrast analysis. This study examined the feasibility of myocardial perfusion imaging under free-breathing conditions using the GRASP-VIBE method and the possibility of assessing myocardial properties using pharmacokinetic analysis.

#### METHODS AND MATERIALS

Prior to cardiac contrast-enhanced MRI, written informed consent was obtained from all 60 subjects enrolled in the study. Perfusion imaging was performed using GRASP-VIBE for 100 seconds following bolus injection of contrast agent. 3D-image reconstruction was performed with a temporal resolution of 3.0 seconds with liver gate, a breath correction technique using liver tracking. The reconstructed images were visually evaluated for streak and cardiac motion artifacts using a 5-point scale, and the image set with the best visual quality was chosen for pharmacokinetic analysis. The analysis was conducted using a workstation (Syngo Tissue 4D) and involved placing a region of interest (ROI) in the septum of the left ventricular myocardium and calculating the volume transfer constant (K<sub>trans</sub>) using curve fitting with the Tofts model. The myocardial properties were evaluated by pharmacokinetic analysis for the three groups of hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy (DCM), and normal subjects, as diagnosed from clinical information. ROC analysis determined cutoff values for differentiation of these diseases using K<sub>trans</sub>, and sensitivity and specificity were calculated.

#### RESULTS

Among the participants, 7 were diagnosed as normal, 14 as HCM, and 8 as DCM. The K<sub>trans</sub> was significantly lower in the HCM (0.606,  $p=0.0104$ ) and DCM (0.694,  $p=0.0188$ ) groups compared to the normal group (1.299). The area under the curve (AUC) for differentiating HCM from normal myocardium was 0.964, and the sensitivity and specificity were 0.857 and 1.00, respectively, when a cutoff value of 0.816 was used. The AUC for differentiating DCM from normal myocardium was 0.939, and the sensitivity and specificity were 0.875 and 1.00, respectively, when a cutoff value of 0.834 was used.

#### CONCLUSION

GRASP-VIBE is a promising tool for evaluating myocardial perfusion and has the potential to become a new myocardial histological characterization index using pharmacokinetic analysis.

#### CLINICAL RELEVANCE/APPLICATION

GRASP-VIBE can acquire myocardial perfusion images without motion artifacts under free breathing without ECG synchronization. K<sub>trans</sub> might be a new biomarker for assessing myocardial properties.

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## Abstract Archives of the RSNA, 2023

M2-SPCH-1

### Low-field MRI to Visualize Interstitial Lung Disease Yields High Conformity with CT in Assessing Fibrosis Extent

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Nadine Bayerl (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to assess the feasibility of lung imaging using a 0.55 T MRI for visualization of interstitial lung disease (ILD) compared to high-resolution CT (HRCT) as the current standard of reference.

#### METHODS AND MATERIALS

This ongoing prospective clinical trial complied with the Declaration of Helsinki and enrolled 25 consecutive patients so far (mean age  $63 \pm 13$  years; male  $n=15$ ; female  $n=10$ ). Inclusion criteria were confirmed ILD on HRCT and the absence of MRI contraindications. Underlying primary diseases were systemic sclerosis ( $n=16$ ), anti-synthetase syndrome ( $n=3$ ), rheumatoid arthritis ( $n=2$ ), mixed collagenases ( $n=1$ ), systemic lupus erythematosus ( $n=1$ ) and idiopathic pulmonary fibrosis ( $n=2$ ). All patients gave informed written consent. Within the maximum of 30 days, patients underwent conventional HRCT and lung MRI on a 0.55 T scanner. In the latter, two-dimensional turbo-spin-echo (TSE) proton density-weighted sequences (TE/TR=35/2000 milliseconds) with BLADE (periodically rotated overlapping parallel lines with enhanced reconstruction) readout,  $1.25 \times 1.25$  mm<sup>2</sup> in plane-resolution,  $304 \times 304$  matrix and 6 mm slice thickness were acquired in transversal plane for visualization of pulmonary findings. Evaluating the visualization of ILD was performed at five defined levels of the lung by assessing the overall extent of ILD, ground-glass opacity (GGO) and reticulation. Wilcoxon signed-rank tests were performed to evaluate the differences between the paired groups. Significance was assumed for  $p < 0.05$ . Statistical analysis was carried out using GraphPad Prism 9 for macOS, Version 9.4.1 (458).

#### RESULTS

Low-field MRI of the lung allowed an assessment of the overall extent of pulmonary fibrosis comparable to CT (MRI, median=10 %, interquartile range IQR=5-40%; CT, median=15%, IQR=5-40%) with no significant differences between the two modalities. In MRI the extent of reticulation was slightly underestimated compared to CT (MRI, median=5%, IQR=5-18%; CT, median=10%, IQR=5-20%), and the extent of GGO was overestimated (MRI, median=5%, IQR=0-20%; CT, median=5%, IQR=0-10%), both reaching significance ( $p < 0.01$ ). The main limitation of this still ongoing study is the small sample size. Our observations will be substantiated in further studies.

#### CONCLUSION

Our study indicates that low-field MRI of the lung provides a reliable visualization of overall extent of ILD and could be useful for monitoring in follow-up examinations as a radiation-free alternative to HRCT.

#### CLINICAL RELEVANCE/APPLICATION

Patients undergo CT scans up to once a year to monitor the extent of ILD, resulting in repeated radiation exposure. Low-field MRI has the potential to be a promising radiation-free alternative to CT for follow-up.

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## Abstract Archives of the RSNA, 2023

M2-SPCH-2

### **Idiopathic and Infection-triggered Acute Exacerbation of Idiopathic Inflammatory Myopathies-associated Interstitial Lung Disease: Clinical, Radiological Features and Prognosis**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jingping Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Acute exacerbation (AE) of idiopathic inflammatory myopathies-associated interstitial lung disease (IIM-ILD) is a life-threatening event. According to the newly proposed diagnostic criteria for the AE of rheumatic disease-associated interstitial lung disease (RD-ILD), infection is regarded as one of the triggers of AE, and AE could be categorised as idiopathic (I-AE) or infection-triggered (iT-AE). In the present study, we aimed to investigate the differences in the clinical, radiological features and prognosis between I-AE and iT-AE of IIM-ILD patients.

#### **METHODS AND MATERIALS**

We retrospectively analysed 69 patients with AE-IIM-ILD (I-AE (34), iT-AE (35)) in our hospital consecutively between January 2014 and December 2020. Infection was identified as confirmation of bacteria, virus, or fungus in samples obtained from the respiratory tract. The outcome was 1-year all-cause mortality.

#### **RESULTS**

I-AE patients showed higher haemoglobin and PaO<sub>2</sub>/FiO<sub>2</sub> ratio than iT-AE patients ( $P < 0.05$ ), and lower pulse, body temperature, white blood cell (WBC) count, neutrophil percentage (NEU), lower C-reactive protein, erythrocyte sedimentation rate, lactate dehydrogenase, hydroxybutyrate dehydrogenase levels, and lower extent of ground-glass opacities (GGO) on HRCT than iT-AE patients ( $P < 0.05$ ). Multiple logistic regression analysis showed that the combination of NEU and the extent of GGO could help discriminate I-AE from iT-AE patients; the area under the receiver operating characteristic (ROC) curves (AUC) was 0.812 (95%CI 0.711-0.913, Sensitivity 0.714, Specificity 0.735, Accuracy 0.725). There is a significant difference in 1-year all-cause mortality between I-AE and iT-AE patients (mortality: I-AE 17.9%, iT-AE 54.3%; log-rank test,  $P = 0.0023$ ).

#### **CONCLUSION**

Infection-triggered AE-IIM-ILD suffered a poorer prognosis than the idiopathic AE-IIM-ILD. The combination of NEU and the extent of GGO on HRCT could help differentiate between the two groups.

#### **CLINICAL RELEVANCE/APPLICATION**

Distinguishing infection-triggered AE from idiopathic AE of IIM-ILD is essential in clinical practice for providing appropriate treatment. NEU combined with GGO extent on HRCT could help differentiate idiopathic AE from infection-triggered AE of IIM-ILD. Infection-triggered AE-IIM-ILD suffered a poorer prognosis than the idiopathic AE-IIM-ILD.

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## Abstract Archives of the RSNA, 2023

M2-SPCH-3

### Role and Accuracy of MRI in Connective Tissue Disease Related Interstitial Lung Disease

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Surabhi Vyas, MD, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine diagnostic accuracy of MRI with respect to HRCT in connective tissue disease related interstitial lung disease CTD-ILD.

#### METHODS AND MATERIALS

Prospective single-center diagnostic study with sample size of 31 patients of CTD-ILD. Patients underwent HRCT chest and MRI chest on a 1.5 T scanner. PFT and 6-minute-walk-test were done. Warrick-scores and extent-scores were calculated for HRCT and MRI. Warrick score is sum of morphology-score extent-score. Morphology score is sum of scores given for presence/absence of various CT findings with maximum score of 5 for subpleural cyst and minimum score of 1 for ground-glass-opacity, 0 for absence. Extent-score is calculated for each morphology based on number of bronchopulmonary-segments involved, 1 for less than 3, 2 for 4 to 6 and 3 for more than 6 segments. Each MRI sequence was scored independently and combined-MRI-score was also calculated.

#### RESULTS

MRI showed agreement with HRCT for extent of subpleural-line (50%;  $p=0.0015$ ), honeycombing (46.67%;  $p=0.0004$ ), subpleural-cysts (60%;  $p<0.0001$ ) and ground-glass-opacities (50%;  $p=0.003$ ). Best sequences to look for subpleural-line, honeycombing, subpleural-cyst and ground-glass-opacities were STIR (46.67%;  $p=0.0194$ ), 4-minute postcontrast sequence (61.11%;  $p=0.0290$ ), BTFE (50%;  $p=0.0003$ ). Among combined-scores calculated excluding postcontrast sequences, only 1/31 cases had different score than combined-score derived from all 10 sequences (including postcontrast sequences). Ground-glass-opacities were overestimated by MRI (higher scores in 13; lower scores in 2). Combined-MRI-score showed significant correlation with FEV1( $r=0.3484$ ;  $p=0.05$ ), FEV1/FVC( $r=0.4086$ ;  $p=0.02$ ), MEF50( $r=0.4203$ ;  $p=0.03$ ) post-walk test fatigue score(0.4639;  $p=0.01$ ).

#### CONCLUSION

MRI shows moderate, statistically significant, agreement with HRCT and clinical-parameters in morphological and global assessment of ILD extent in CTD patients. Abbreviated MRI protocol for ILD assessment would be T2, STIR, BTFE in axial planes as these sequences show closest correlation with the CT-scores. Post-contrast sequences didn't contribute significantly to global-score. With evolving MRI technology, shorter scan times and longer lifespan of patients, MRI becomes an attractive radiation-free option for serial follow-up of such patients.

#### CLINICAL RELEVANCE/APPLICATION

MRI has the potential to provide a radiation free imaging alternative to CT in follow up of ILD.

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## Abstract Archives of the RSNA, 2023

M2-SPCH-5

### An Explainable Artificial Intelligence to Detect Histopathological UIP Pattern from HRCT Images and Validation of its Ability

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Ryoko Egashira, MD, PhD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH;Speakers Bureau, AstraZeneca PLC;Speakers Bureau, Shionogi & Co, Ltd;Speakers Bureau, KYORIN Holdings, Inc;Speakers Bureau, DAIICHI SANKYO Group;Speakers Bureau, Bayer AG;Speakers Bureau, Otsuka Holdings Co, Ltd;

#### PURPOSE

To create an explainable artificial intelligence that can predict histopathological UIP pattern from HRCT images by machine learning and to validate its ability

#### METHODS AND MATERIALS

233 cases of interstitial lung diseases (ILDs) of mixed etiologies with volumetric CT images were retrospectively identified for this study from an archive with pathologically proven ILDs. The cases were divided into CT-training set for CT-imaging features (n=74), pathology-training set for UIP/non-UIP labels (n=61, UIP: non-UIP=34:27), and a test set (n=98, UIP: non-UIP=60:38). CT-training set cases were selected to include a variety of morphologic patterns and etiologic backgrounds. A custom machine learning model was trained to CT-imaging features. CT-feature extractors for 2D patches from volumetric CT images were created using self-supervised learning. The CT patches with similar features were clustered based on the output features and then pulmonologists/radiologist integrated the radiologically synonymous clusters. Using the integrated clusters as labeled data, deep-learning models to classify the CT findings were created by transfer-learning. A UIP/non-UIP classifier model to classify the cases into UIP or non-UIP by distribution of CT findings in each lung zone using Random Forest. The model was validated using leave-one-out cross validation. Unaware of the labels, two board-certified radiologists classified the test-set cases into UIP/non-UIP pattern according to modified Fleischner's UIP criteria. The validation and test set results were presented as an average of UIP/non-UIP classifier output. The performance of the model was compared with the radiologists' performance.

#### RESULTS

The accuracy and area under curve (AUC) of the model in validation were 71.47%, 0.785, respectively. In the test set, the accuracy, AUC, sensitivity, specificity and F1 score of the model were 78.67%, 0.843, 84.16%, 70%, and 82.88%. The radiologists' accuracy, sensitivity and specificity were 74.49%, 58.3% and 92% in reader A, 68.37%, 48.3% and 92.1% in reader B, respectively.

#### CONCLUSION

The model's performance in predicting pathological UIP pattern in various ILDs was 78.67% in accuracy and 82.88% in F1 score, which was better than the radiologists' performance using modified UIP criteria. While radiologists' performance was excellent in specificity.

#### CLINICAL RELEVANCE/APPLICATION

The detection of histopathological UIP pattern is a key to the prediction of progressive pulmonary fibrosis. There are currently no diagnostic HRCT criteria for UIP pattern other than IPF, this predictive model may be useful.

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## Abstract Archives of the RSNA, 2023

M2-SPCH-6

### Effect of Contrast Enhancement on Diagnosis of Interstitial Lung Abnormalities in Automatic Quantitative CT Measurement

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jaeyeon Choi (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the effect of contrast enhancement on the diagnosis of interstitial lung abnormalities (ILA) in automatic quantitative CT measurement

#### METHODS AND MATERIALS

Patients who underwent preoperative chest CT for lung cancer between April 2017 and December 2020 were retrospectively included. Each examination consisted of a pair of nonenhanced and contrast-enhanced CT scans, and images were analyzed using a commercially available deep learning-based automated quantification software for ILA. According to quantified results based on the definition by the Fleischner Society, patients were divided into normal and ILA groups. The agreement for the diagnosis of ILA was estimated with kappa values. Reproducibility and measurement variability were also estimated using the intra-class correlation coefficient (ICC) and Bland-Altman method.

#### RESULTS

Of the 1199 included patients (mean age, 62.2 years  $\pm$  10.9 [SD]; 595 females), ILA was identified in 46 (3.8%) and 76 (6.3%) on pre- and post-contrast images, respectively. Pre-contrast and post-contrast CT scans showed substantial agreement (weighted Kappa: 0.67) in the diagnosis of ILA. Of the 46 patients diagnosed with ILA on pre-contrast scans, 42 were also diagnosed with ILA on post-contrast scans. Post-contrast images showed a greater extent of total ILA than pre-contrast images (mean percentage, 0.99%  $\pm$  2.2 vs 0.63%  $\pm$  1.6,  $p < 0.0001$ ). Pre- and post-contrast images showed excellent reproducibility for fibrotic ILA (ICC = 0.96), but only fair reproducibility for non-fibrotic ILA (ICC = 0.74). Measurement variability was wider in nonfibrotic ILA than in fibrotic ILA (95% limits of agreement, nonfibrotic: [-2.3, 3.0] vs. fibrotic: [-0.1, 0.1]).

#### CONCLUSION

Contrast enhancement influenced the quantification of ILA with a tendency to overestimate, especially for nonfibrotic ILA.

#### CLINICAL RELEVANCE/APPLICATION

Automatic quantitative assessment for ILA on contrast-enhanced CT images may lead to overdiagnosis of ILA; thus care should be taken in the diagnosis of ILA and subsequent visual assessment may be needed.

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## Abstract Archives of the RSNA, 2023

M2-SPCH-7

### Quantitative CT-based Regional Lung Function and PFT at Baseline Predict One-Year Change of DLCO in Idiopathic Pulmonary Fibrosis

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Wonchul Chung (*Presenter*) Nothing to Disclose

#### PURPOSE

While carbon monoxide lung diffusing capacity (DLCO) test is an important functional measure for idiopathic pulmonary fibrosis (IPF), it is also difficult for patients to conduct. We aimed to predict future DLCO using regional lung function variables computed from quantitative CT (QCT) and baseline pulmonary function test (PFT) variables, via machine learning.

#### METHODS AND MATERIALS

Full inspiratory and full expiratory CTs, demographics, and PFT measurements (spirometry and DLCO) at baseline and DLCO at 1-year follow-up visits were prospectively collected of 45 IPF patients (age=71±5, M:F=39:6) at 5 institutions in South Korea (under IRB approval and with subject consent, using a common dose-reduced QCT protocol). 113 multiscale lung structural and functional features were derived from QCT analysis, using VIDA Vision (Coralville, IA) and in-house software. QCT, demographics, and PFT features significantly correlated with percent predicted DLCO (DLCO%pred) after one year ( $p < 0.05$ , Pearson's correlation) were then used to predict DLCO%pred after one year using XGBoost machine learning algorithm. Model performance was evaluated by  $R^2$  and mean absolute error (MAE).

#### RESULTS

QCT variables had significant correlations with DLCO. Baseline percent predicted DLCO ( $r=0.76$ ;  $p < 0.001$ ), percent predicted forced expiratory volume in the first second (FEV1%pred) ( $r=0.65$ ;  $p < 0.001$ ) and forced vital capacity (FVC%pred) ( $r=0.64$ ;  $p < 0.001$ ), Among QCT variables, regional ventilation index (RRAVC) at whole lobe and Right lower lobe (RLL) ( $r=-0.35$ ,  $-0.13$ ;  $p=0.03$ ,  $0.04$ ), high attenuation area percent (HAA%) at whole lung, left upper lobe (LUL) and left lower lobe (LLL) ( $r=-0.45$ ,  $-0.40$ ,  $-0.39$ ;  $p=0.04$ ,  $0.02$ ,  $0.03$ ) also contributed in predicting future DLCO score. Normalized tracheal wall thickness (WT\*trachea) was also negatively associated with future DLCO ( $r=-0.3$ ;  $p < 0.03$ ). XGBoost model's performance in  $R$ -squared ( $R^2$ ) and mean absolute error (MAE) were 0.73 and 9.01, implying 73% of the total variation and predictions off by 9.01 units from the actual values. Results suggest association of left lung RRAVC, HAA% and tracheal wall thickening with smaller future DLCO in IPF.

#### CONCLUSION

QCT based regional lung structure-function and PFT features can predict DLCO after 1 year via machine learning.

#### CLINICAL RELEVANCE/APPLICATION

Predicting DLCO after 1 year via machine learning provide pathophysiological interpretation of regional changes in lung structure and function in IPF.

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## Abstract Archives of the RSNA, 2023

M2-SPCH-8

### Severe Asthma Patient Treatment Response Evaluation Using Visual and Quantitative Analysis of Chest CT

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Miji Lee, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Visual and quantitative analysis on chest CT for bronchiectasis(BE) score and mucus impaction(MI) extent in patients with severe asthma investigate the correlation with the patient's treatment response.

#### **METHODS AND MATERIALS**

The 34 asthma patients (mean age; 55.1±12.8 years, male;female=40%;60%) who had undergone initial and 1 year follow up inspiration/expiration CT after treatment. Experienced thoracic radiologists independently determined the change of BE score and MI extent. Using Aview software (Coreline Soft), quantitative air-trapping and airway were analyzed at the initial and 10months follow up CT scan. Clinical parameters considered in patient have FEV1 and FEV1/FVC, sputum and blood eosinophils. For statistical analysis, intraclass correlation coefficient and correlation analysis were used.

#### **RESULTS**

In the intraclass correlation coefficient between the two readers, the bronchiectasis(BE) score showed a reliability of 78% and the mucus impaction showed a reliability of 89%. Table 1 shows the greater the BE score and MI extent, the closer the pattern of obstructive lung disease is derived from both readers. MI extent was positive correlated with eosinophils. In the quantitative analysis, FEV1 and FEV1/FVC showed a positive correlation in the normal lung area, but a negative correlation in the case of functional air-trapping with and without emphysema. Quantitatively, when the counted branch segment increases, the PFT result shows a positive correlation, and the Pi10 and wall area measurements show a negative correlation. According to table 2, changes in BE score and MI extent showed a relatively significant correlation with changes in clinical parameters. Only Pi10 showed a negative correlation with PFT, and quantitative normal lung and functional air-trapping changes did not show any correlation.

#### **CONCLUSION**

In patient with asthma, changes in MI extent with treatment have clinical significance rather than the severity of BE score itself. Visual changes in MI extent after treatment of asthma on CT and quantitatively decreased Pi10 correlated with changes in PFT and eosinophilia.

#### **CLINICAL RELEVANCE/APPLICATION**

Through quantitative analysis of airway and visual analysis of mucoid impaction extent, post-treatment response can be evaluated in patients with severe asthma.

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## Abstract Archives of the RSNA, 2023

M2-SPER-1

### Classification of Acute Superior Mesenteric Artery Occlusion on CT using a 3D Machine Learning Model

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Robert J. Harris, PhD (*Presenter*) Scientist, Virtual Radiologic Corporation

#### PURPOSE

Acute superior mesenteric artery (SMA) occlusion is a life-threatening condition that requires immediate diagnosis and treatment. Although our group has previously developed a machine learning 2D model to identify SMA occlusion by analyzing each CT slice individually, it is sometimes not possible to identify an occlusion on a single CT slice. We hypothesized that we could train a machine learning 3D model to identify SMA occlusion on CT with full volumetric context.

#### METHODS AND MATERIALS

Natural language processing (NLP) of radiology CT reports was used retrospectively to identify studies containing SMA occlusion. An axial image series from each of these studies was annotated by a Board Certified radiologist by segmenting the region of occlusion using an in-house brush tool. These segmentations were converted into 3D bounding boxes; 615 annotated volumes were used as positives, and 618 CT volumes with no SMA occlusion were used as negatives in the training dataset. A RetinaNet 3D model using the Medical Open Network for AI (MONAI) framework was implemented for training. The model was applied to a test dataset consisting of 20 negative studies and 59 studies positive for SMA occlusion. The positive studies were cases where the pathology had been missed by the initial reading radiologist (quality assurance cases). Prior to running the RetinaNet 3D model, a separate CT anatomy classification model was run on each series and only slices with abdominal anatomy were kept, to reduce the total image volume inferred by the RetinaNet 3D model. The highest probability from bounding boxes generated by the RetinaNet 3D model was taken as the overall model result for a study.

#### RESULTS

The highest validation accuracy during training was 0.678, at which point the final model was saved. The model achieved an AUC of 0.837 on the test dataset. At a threshold of 0.88, sensitivity was 63.6% with a specificity of 100%, suggesting that over half of missed SMA occlusion cases at our practice would have been caught had this model been in place.

#### CONCLUSION

An artificial intelligence model was trained to identify SMA occlusion on CT imaging. To our knowledge, this is the first use of a machine learning 3D model to identify SMA occlusion on CT images. This model is currently undergoing iterative retraining with false positives and false negatives from prospective data and will be continually updated in preparation for live clinical deployment.

#### CLINICAL RELEVANCE/APPLICATION

SMA occlusions on CT must be timely diagnosed to improve patient outcome and are sometimes missed by radiologists. A 3D model to identify these cases for both worklist prioritization and quality assurance would be highly relevant to improving patient care.

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## Abstract Archives of the RSNA, 2023

M2-SPGI-1

### **A Preliminary Study on the Value of Multi-frequency MR Elastography in Auxiliary Evaluating the Efficacy of Neoadjuvant Chemoradiotherapy for Locally Advanced Rectal Cancer**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Xiao Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the value of multi-frequency magnetic resonance elastography (m-MRE) in auxiliary evaluating the efficacy of neoadjuvant chemoradiotherapy (nCRT) for patients with locally advanced rectal cancer (LARC).

#### **METHODS AND MATERIALS**

From Nov. 2021 to Dec. 2022, 81 patients with rectal cancer were prospectively recruited and after screening by exclusion criteria, 64 patients who underwent radical resection after nCRT were finally enrolled. All patients underwent MRI and rectal elastography examination within 1 week before surgery. Maps of shear-wave speed  $c$  ( $c$ -map) and phase angle of the shear modulus  $f$  ( $f$ -map) were generated and then measured  $c$  and  $f$  values for tumor or rectum wall. According to the collected pathologic ypTN stages and tumor regression grades (TRG), patients were divided into Group1: ypT0-1 (Good response, GR) and ypT2-4 (Poor response, PR) groups, Group2: ypN0 and ypN1-2 groups and Group3: pCR (TRG0) and Non-pCR (TRG1-3) groups. To analyze whether the differences of m-MRE parameters ( $c$ ,  $f$ ,  $c+f$ ) among different groups were statistically significant, and drew ROC curve to analyze the diagnostic efficiency. Compared with T2WI+DWI, to explore whether m-MRE ( $c+f$ ) can show better diagnostic efficacy in distinguishing different groups and to further analyze whether the combination of T2WI+DWI and m-MRE ( $c+f$ ) can achieve higher diagnostic efficacy. To explore whether the combination of T2WI+DWI and m-MRE ( $c+f$ ) could improve the diagnostic accuracy and consistency than that of T2WI+DWI, with pathological results as gold standard.

#### **RESULTS**

Significant differences of  $c$  and  $f$  values were observed in Group 1 and Group 3 ( $P < 0.05$ ), but not in Group 2. m-MRE ( $c$ ,  $f$  and  $c+f$ ) showed good diagnostic efficacy both in Group 1 with AUC values 0.810, 0.736 and 0.853, and Group 3 with AUC values 0.810, 0.736 and 0.853 (all  $P < 0.05$ ). m-MRE ( $c+f$ ) had significantly higher AUC values ( $P < 0.05$ ) than T2WI+DWI in Group 1 and Group 3. Furthermore, the combination of T2WI+DWI and m-MRE ( $c+f$ ) can get higher AUC values ( $P < 0.05$ ) than T2WI+DWI in Group 1 and Group 3 as well. Besides, it could also improve the diagnostic accuracy and consistency than that of T2WI+DWI, with pathological results as gold standard.

#### **CONCLUSION**

m-MRE has a potential auxiliary value in evaluating the efficacy of nCRT for LARC patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Reliable preoperative methods to accurately evaluate tumor regression and identify patients with pCR are significant to LARC patients, which can promote making personalized clinical treatment plans.

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## Abstract Archives of the RSNA, 2023

M2-SPGI-2

### Predicting the Risk of Postoperative Distant Metastasis in Patients with Locally Advanced Rectal Cancer: Using MRI-based Delta-imaging Methods

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Yu Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

To predict the risk of postoperative distant metastases in patients with locally advanced rectal cancer by using delta-imaging features extracted from MRI before and after nCRT.

#### METHODS AND MATERIALS

A total of 213 patients with locally advanced rectal cancer were retrospectively enrolled in Yunnan Cancer Hospital from January 2016 to June 2019. All patients underwent surgical treatment after nCRT and underwent MRI examination before and after nCRT. All patients were followed up for at least 3 years after surgery, except those with postoperative endpoint events. They were randomly divided into training group and verification group (training group n=149, verification group n=64) in a ratio of 7:3, which were used for feature selection and verification respectively. Tumor lesions were delineated layer by layer on T2-weighted imaging (T2-weighted imaging) before and after nCRT, and 3D-slicer software was used for feature extraction. Delta-image omics features are defined as the difference in image omics features before and after nCRT. Using The least absolute shrinkage and selection operator algorithm (LASSO) for feature reduction and extraction, three delta-image omics models were constructed. It includes the Delta-Imagomics model and the combined Delta-imagomics model based on the absolute and relative variation of imagomics features before and after nCRT. Receiver operating characteristic curve (ROC) was used to evaluate the predictive value of the model for DM.

#### RESULTS

A total of 213 patients with LARC were included in this study (42% female and 58% male), with an average age of  $58.50 \pm 12.37$  years and a median follow-up time of 39.8 months. A total of 36 patients (16.9%) developed DM after surgery. 1382 features were extracted from each lesion before and after nCRT. After feature reduction and screening, 7 key features were included in the delta-imaging model based on absolute and relative changes of imaging features before and after nCRT in the training set. In the training set, the area under ROC curve of the absolute and relative variation Delta-Imaging model and the combined Delta-imaging model were 0.77, 0.74 and 0.82, respectively, and the AUC of the corresponding test set were 0.73, 0.70 and 0.84, respectively.

#### CONCLUSION

The combined prediction model based on delta-imaging features of MRI is helpful to predict the risk of distant metastasis after local advanced rectal cancer surgery, and is better than the pure delta-imaging model of absolute and relative changes.

#### CLINICAL RELEVANCE/APPLICATION

To predict the risk of postoperative distant metastases in patients with locally advanced rectal cancer .

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## Abstract Archives of the RSNA, 2023

M2-SPGI-3

### Machine Learning-based Response Assessment in Patients with Rectal Cancer After Neoadjuvant CCRT: Radiomics Analysis for the Assessment of Tumor Regression Grade Using T2-weighted MR Exam

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Yongdae Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We investigated the machine learning model-based radiomics analysis for the assessment of tumor regression grade using T2-weighted MR images in patients with rectal cancer after neoadjuvant chemotherapy-radiation therapy (CRT).

#### METHODS AND MATERIALS

A total of 100 patients with rectal cancer who underwent magnetic resonance (MR) imaging at baseline and after CRT between January 2010 to May 2021 were included. The median age was 64 (31-89) and male was 66% (66/100). All MR scans were acquired with two different 3T scanners (Achieva 3.0T MR system, Philips Healthcare; MAGNETOM Vida, Siemens Healthineers) and included the oblique axial T2-weighted images acquired perpendicular to the long axis of the tumor. Region of interest (ROI) for each cancer lesion was drawn and extracted by a radiologist and 116 radiomics-feature was analyzed using MEDIP software (MEDICAL IP, Seoul, Republic of Korea, [medicalip.com/Medip](http://medicalip.com/Medip)). Treatment responses were evaluated by the radiologist using MR tumor regression grade (mrTRG). Responses were classified into two groups ('good' versus 'poor'); mrTRG 1, 2, and 3 were categorized as 'good', and mrTRG 4 and 5 were categorized as 'poor'. We implemented the 3-principle component analysis (PCA)-ensemble model to predict the response group. Model performance was evaluated by calculating the area under a receiver operating curve (AUROC) for each feature-set, and selected combination of the feature sets.

#### RESULTS

Texture-feature based sets and selected combinations were compared with qualitative mrTRG assessment to identify the significant feature sets in predicting the treatment responses. With the volume feature set (3D), the mean volume change was calculated, and overall 38.55% of volume has decreased. In comparison between the two groups, good response group showed lower baseline tumor volume and larger volume loss at post-CRT MR (50.32%) while poor response group showed larger baseline tumor volume and lesser volume loss at post-CRT MR (29.54%). Of all texture-feature sets and selected combinations of the feature sets, volume feature set (3D) combined with histogram-based contrast feature set (1st order) achieved the largest AUC of 0.79 for differentiating good and poor response.

#### CONCLUSION

Machine learning based radiomics analysis using T2-weighted MR imaging demonstrated feasible diagnostic ability for the response assessment in patients with post CRT rectal cancer. This radiomics analysis enables quantification of tumor volume and texture change.

#### CLINICAL RELEVANCE/APPLICATION

Machine learning based radiomics analysis represents quantitative assessment of treatment response in post-CRT rectal cancer, and can be a useful assistant for treatment response assessment.

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## Abstract Archives of the RSNA, 2023

M2-SPGI-5

### Personalized Weight-Based Dosing of Iodinated Contrast Material: Dose Savings and Effect on Image Quality in Abdominal Computed Tomography (CT)

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Christina Shehata, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Fixed dosing of iodinated contrast material (CM) (i.e., using the same amount of contrast for all patients or based on weight buckets) is a standard practice among many institutions for abdominal CT. This study aims to investigate effects of personalized weight-based dosing (1.14 mL/kg) of CM on saving of contrast and on image quality of abdominal CT.

#### METHODS AND MATERIALS

376 patients who underwent abdominal CT at a large urban academic medical center were included in this study. Each patient had at least two CT of abdomen performed within a one-year interval, with one study using a fixed dose of iodine contrast and the other implementing weight-based dosing. Studies were matched by imaging protocol, peak kilovoltage (kVp), and phase of enhancement. The amount of administered contrast for each study was collected. Attenuation of various organs and structures including portal vein, aorta, inferior vena cava, hepatic veins, liver, and spleen was measured. In addition, noise, contrast-to-noise ratio, and subjective image quality were calculated. Values were compared using paired and unpaired t-test. Sub-analysis based on patients' BMI was also performed.

#### RESULTS

In the fixed-dose protocol, the mean iodine dose was 35 g, compared to 26.2 g and 32.6 g in the weight-based protocol in patients with normal/low weight (BMI = 25) and those with high weight (BMI > 25), respectively. The weight-based protocol also resulted in an average cost reduction of 16.3% with average savings of \$72.58. There were no differences in noise between the two protocols. In patients with high weight, except for the aorta, there were no significant differences in enhancement at the selected ROI between the two contrast protocols. Patients with a normal or low weight with weight-based contrast dosing had lower enhancement ( $p < 0.001$ ), with mean difference in degree of enhancement ranging 7.4-28.1 HU depending on the organ/structure, compared to the studies with a fixed dosing.

#### CONCLUSION

The results of this study demonstrate that a personalized weight-based CM dosing strategy can result in significant saving of contrast. The saving is more pronounced in patients with lower BMI. In patients with higher BMI, the enhancement of abdominal organs was non-inferior to fixed-dosing CTs. Despite the lower degree of enhancement of structure in low-BMI group, as expected with the lower amount of administered iodine, the difference in degree of enhancement was small with no significant effect on subjective perceived image quality.

#### CLINICAL RELEVANCE/APPLICATION

These data support that a weight-based contrast protocol can maintain image quality (especially in larger patients) while improving patient safety and reducing healthcare costs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPGI-7

### Effect of the Body Water and the Body Composition, Calculated by Bioelectrical Impedance Analysis on Contrast-enhanced Dynamic Computed Tomography Images of the Liver

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Takanori Masuda, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To improve its diagnosis on contrast-enhanced dynamic CT (CE-DCT) scans, contrast injection protocol must yield stable arterial contrast enhancement. To investigate how the body-water distribution and the body composition, calculated by bioelectrical impedance analysis (BIA), affect aortic and hepatic enhancement on CE-DCT scans.

#### METHODS AND MATERIALS

This retrospective study was approved by our institutional review board; informed patient consent was waived. Between January 2019 and May 2020, 236 patients with liver cirrhosis underwent CE-DCT before BIA. The CT number (in Hounsfield units, HU) of the abdominal aorta at the celiac artery level on unenhanced scans and during the hepatic arterial phase (HAP) scans was recorded. And, the mean CT number of the hepatic parenchyma of both hepatic lobes at the celiac artery level on unenhanced and portal venous phase (PVP) scans was recorded. We calculated changes in the iodine dose per contrast enhancement (mgI/HU) (IDCE) to evaluate the effect of the patient age and of various constituents of the body composition by performing BIA.

#### RESULTS

The IDCE of the abdominal aorta during HAP was  $121.5 \pm 32.1$  mgI/HU; it was  $698.7 \pm 211.1$  mgI/HU in the hepatic parenchyma during the PVP. Among the parameters used in our BIA, the total body weight (TBW) was the most important factor affecting the IDCE of the liver abdominal aorta on CE-DCT scans acquired during the HAP ( $r = 0.83$ ). The TBW and the skeletal muscle index most strongly affected the IDCE of the hepatic parenchyma on CE-DCT scans obtained during the PVP ( $r = 0.69$ ).

#### CONCLUSION

The TBW had the strongest effect on contrast enhancement. The skeletal muscle index exhibited the strongest correlation with hepatic parenchymal contrast enhancement during the PVP.

#### CLINICAL RELEVANCE/APPLICATION

We found that many body parameters included in BIA affect IDCE on CE-DCT images. Most exhibited a more than moderate correlation with IDCE of vessels and the hepatic parenchyma. It may be a useful index for machine learning to obtain a stable contrast enhancement on CE-DCT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPGI-8

### Effect of the CT Values for Abdominal Aorta and Liver Parenchyma During Contrast Enhancement Dynamic CT with or without the Splenomegaly

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Hiroyuki Ikenaga, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare CT (computed tomography) values for abdominal aorta and liver parenchyma during dynamic contrast-enhanced (CE) CT in cirrhotic patients with and without splenomegaly.

#### METHODS AND MATERIALS

We considered 258 patients (83 males and 46 females for the splenomegaly group, and 83 males and 46 females for the control group) for this study. We measured CT values in the abdominal aorta and hepatic parenchyma during the hepatic arterial (HAP) and portal venous (PVP) phases. The aortic CE at HAP and the hepatic parenchymal CE at PVP were compared between the two groups. For depiction ability, we also calculated the optimal CE rates (>280 HU in the abdominal aorta and >50 HU in the hepatic parenchyma) for each group.

#### RESULTS

The median and range of the CE for all patients with abdominal aorta and liver parenchyma were 273.0 HU (110.9-477.3 HU) and 54.0 HU (19.9-78.6 HU), respectively, in the Splenomegaly (SM) group and 298.9 HU (158.6-494.0 HU) and 54.0 HU (16.5-78.5 HU), respectively, in the non-SM group. In the SM group, the CE for abdominal aorta decreased during the aortic phase for a dynamic CE CT ( $p < 0.05$ ). For the depiction ability, there were significant differences in the rates of optimal CE between both the groups ( $p < 0.05$ ).

#### CONCLUSION

The diagnostic ability and CE for abdominal aorta during the aortic phase exhibited a significant decrease during dynamic CE CT in SM patients.

#### CLINICAL RELEVANCE/APPLICATION

It is necessary to change the injection rates and contrast materials volume during CE CT depending on the presence or absence of SM.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-SPGU-1

### **Fidelity of Iodine and HU Values in a Renal Phantom using a Novel edge-on-irradiated Si-based Photon-Counting Detector CT**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Fides R. Schwartz, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the accuracy of a new edge-on-irradiate silicon-based photon-counting detector CT (Deep Si-PCCT) prototype for quantification of iodine concentration and stability of HU values in moderately and strongly enhancing kidney parenchyma.

#### **METHODS AND MATERIALS**

A phantom that simulates moderately and strongly enhancing kidney parenchyma (at 180 and 240 HU) inside a small patient (23 cm diameter) was scanned using a novel, Deep Si-PCCT prototype. The simulated kidney parenchyma contains an internal dense water-equivalent rod at 60 HU and a rod of 2.2 mg/mL iodine concentration to simulate a proteinaceous, non-enhancing and a mildly enhancing cystic renal lesion. The rods were positioned in the kidney parenchyma in two separate setups, so each rod was imaged within both levels of kidney enhancement. The accuracy and stability of the iodine quantification and HU values were evaluated with repeated ROI measurements of the same size across consecutive slices along the length of the simulated kidney parenchyma and the internal rods. Images were reconstructed with prototype soft tissue kernel at 2.5mm slice thickness without additional denoising.

#### **RESULTS**

The Deep Si-PCCT accurately quantified the iodine concentration in the small rod at  $2.1 \pm 0.02$  and  $2.1 \pm 0.04$  mg/mL (Setup 1 and 2, respectively), and the quantification was stable across the length of the internal rod, with both setups. The water equivalent rod was also quantified correctly, showing iodine concentrations within the standard deviation and HU values of  $58 \pm 0.5$  HU and  $60 \pm 0.9$ . The HU values of moderately and strongly enhancing renal parenchyma were stable across the length of the rod and correlated with the know ground-truth values. The figure also shows images of the first patient with cystic renal lesions scanned on the new Deep Si-PCCT at 120 kVp with 400 mAs and 1 second rotation (axial scan), reconstructed with a standard soft tissue kernel.

#### **CONCLUSION**

The Deep Si-based PCCT is a promising tool for accurate and stable quantification of iodine concentration and measurement of HU values in cystic lesions within moderately and strongly enhancing kidney parenchyma. It has the potential to improve the diagnosis and management of cystic renal lesions.

#### **CLINICAL RELEVANCE/APPLICATION**

The novel Deep Si-based photon-counting detector CT provides, accurate iodine quantification and HU values in kidney parenchyma and cystic lesions, which is crucial for the classification and management of cystic renal lesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPGU-2

### Renal Cyst Pseudoenhancement: Impact of Virtual Monochromatic and Ultra-high-resolution Imaging with Photon-counting Detector CT

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Atsushi Nakamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate whether virtual monochromatic and ultra-high-resolution imaging with photon-counting detector CT (PCD-CD) can overcome renal cyst pseudoenhancement.

#### METHODS AND MATERIALS

This retrospective study included 104 renal cysts in 31 patients (20 men and 11 women, age range, 42 to 91 years; mean age, 71.6 years) who underwent abdominal dynamic contrast-enhanced CT with PCD-CT. Cysts less than 3 mm in diameter and greater than 20 mm in diameter were excluded. Unenhanced and portal venous phase images were reconstructed with 512 and 1024 matrices with slice thicknesses of 0.2, 0.4, 1, and 2 mm, respectively. The 0.2-mm-thick images were reconstructed using polychromatic imaging (T3D) because virtual monochromatic imaging is not applicable to the 0.2-mm-thick images. For the other slice thicknesses, 70 keV virtual monochromatic images were reconstructed. In addition, 512-matrix, 1-mm-thick virtual monochromatic images were reconstructed at 50, 60, 80, and 90 keV. CT values were measured by placing regions of interest on the renal cysts and the attenuation increase from unenhanced to portal venous phase was calculated. The attenuation increases in each image were compared and the frequency of pseudoenhancement (an increase of 10 HU or more) was evaluated.

#### RESULTS

There was no significant difference in attenuation increase between the 512 and 1024 matrix images at any slice thickness ( $P > .05$ ). The attenuation increases were significantly higher for the 0.2-mm-thick T3D images and the 2-mm-thick 70 keV images compared to the 0.4-mm and 1-mm-thick 70 keV images ( $P < .001$ ). The attenuation increase was lower at higher keVs, with significant differences among all keVs ( $P < .001$ ). The frequency of pseudoenhancement was lowest for 90 keV images (13/104, 12.5%), followed by 80 keV images and 0.4-mm-thick 70 keV images (18/104, 17.3%). When only cysts with 10 mm or larger in diameter were included, virtual monochromatic images at 70 keV or higher showed no pseudoenhancement.

#### CONCLUSION

Virtual monochromatic images with PCD-CT can overcome renal cyst enhancement. Thinner slice thicknesses were useful in reducing pseudoenhancement, although 0.2-mm-thick images had a higher frequency of pseudoenhancement due to their polychromatic nature.

#### CLINICAL RELEVANCE/APPLICATION

Virtual monochromatic imaging at 70 keV or higher using photon-counting detector CT shows no pseudoenhancement in renal cysts of 10 mm or larger in diameter and is expected to improve the diagnostic performance of renal masses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPHN-1

### The Prevalence of Malleus-tympanum Synostosis on Ultra-high-resolution CT: A Preliminary Study

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Ning Xu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the prevalence of malleus-tympanum synostosis (MTS) in different individuals via 0.1 mm ultra -high-resolution CT (U-HRCT).

#### METHODS AND MATERIALS

This retrospective study evaluated U-HRCT scans with 0.1 mm thickness of 1587 ears from 1122 subjects from October 2020 to March 2022. MTS presented as a bony connection between the malleus and tympanic wall. MTS was detected in subjects with normal ears, subjects with different types of hearing loss (HL), and subjects with various causes of conductive HL. The prevalence of MTS was calculated and statistically compared between subjects with normal ears and with different types of HL, as well as between subjects with various causes of conductive HL. The correlation between MTS and age or gender was calculated using the Mann-Whitney U test.

#### RESULTS

The prevalence of MTS was 2.8% (16/577), 3.4% (12/352), 7.2% (27/374), and 13.7% (39/284) in subjects with normal, mixed HL, sensorineural HL, and conductive HL ears, respectively. MTS was more common in subjects with HL than in subjects with normal ears ( $p < 0.001$ ), and significant differences were shown between mixed and sensorineural HL groups ( $p_{m-s} = 0.023$ ), between mixed and conductive HL groups ( $p_{m-c} < 0.001$ ), and between sensorineural and conductive HL groups ( $p_{s-c} = 0.006$ ). The prevalence of MTS was 83.9% (52/62), 34.8% (23/66), 12.6% (61/483), 7.5% (8/107), and 6.9% (7/102) in subjects with conductive HL with tympanosclerosis, definite middle ear malformations, otitis media, otosclerosis, and middle ear cholesteatoma, respectively. Besides, MTS was found in 18.8% (6/32) of subjects with unexplained conductive HL, 3 of whom were confirmed as having malleus fixation by surgery. No correlation was shown between MTS and age ( $p = 0.41$ ) or gender ( $p = 0.70$ ) in subjects with normal ears.

#### CONCLUSION

MTS is a new sign that can be clearly visualized on an ultra-high-resolution CT with 0.1 mm thickness. The prevalence of MTS was 2.8% and 7.7% in subjects with normal ears and with HL, respectively. It may be asymptomatic, or may be associated with conductive HL.

#### CLINICAL RELEVANCE/APPLICATION

Malleus-tympanum synostosis (MTS) is a new sign that can be clearly visualized on an ultra-high-resolution CT with 0.1 mm thickness. It is not uncommon and may be asymptomatic or may be associated with conductive HL by resulting in malleus fixation. Moreover, MTS may be the cause of some "idiopathic" conductive HL. Otolologists can use their understanding of MTS to develop new treatment strategies and improve hearing outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPHN-2

### Comparative Study of the Sensitivity of Ultra-high-resolution CT and High-resolution CT in the Diagnosis of Isolated Fenestral Otosclerosis

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Ning Xu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the sensitivity of ultra-high-resolution computed tomography (U-HRCT) and high-resolution computed tomography (HRCT) in the diagnosis of isolated fenestral otosclerosis (IFO).

#### METHODS AND MATERIALS

Eighty-five patients (85 ears) with both clinical and intraoperative diagnosis of IFO were prospectively included between October 2020 and November 2022. Only U-HRCT (0.1mm thickness) was performed for 20 ears, only HRCT (0.67mm thickness) was performed for 45 ears, and both U-HRCT and HRCT were performed for 20 ears. General radiologists and neuroradiologists who were blinded to the clinical and surgical conditions evaluated the images. The sensitivity of U-HRCT and HRCT to detect IFO by the two groups of radiologists were compared.

#### RESULTS

The diagnostic sensitivity of U-HRCT was 100% (40/40 ears) for neuroradiologists and 87.5% (35/40 ears) for general radiologists, which was significantly higher than that of HRCT (89.2% [58/65 ears] for neuroradiologists; 41.5% [27/65 ears] for general radiologists) ( $P=0.042$  and  $P=0.000$ , respectively). When evaluated with HRCT, the sensitivity of general radiologists was significantly lower compared to neuroradiologists ( $P=0.000$ ), while no difference was shown when general radiologists switched to U-HRCT ( $P=0.152$ ). Among the 20 ears that underwent both examinations, 5 ears with  $<1$  mm lesion involving the fissula ante fenestram were shown on U-HRCT, while the sensitivity of HRCT was 40% (2/5 ears) for neuroradiologists, which was significantly lower than that for neuroradiologists to diagnose lesions  $>1$  mm (93.3%, 14/15 ears,  $P=0.032$ ).

#### CONCLUSION

U-HRCT is more sensitive than HRCT in the diagnosis of IFO, and has a significant advantage in the detection of  $< 1$ mm lesions.

#### CLINICAL RELEVANCE/APPLICATION

U-HRCT has a high spatial resolution scale, which can significantly improve the delineation of IFO lesions and improve the ability of general radiologists to detect this disease. It has the potential to be used for screening of patients with suspected otosclerosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPHN-3

### Feasibility of the mDIXON Method for Estimation the Parotid Gland Fat Fraction in Sjögren's Syndrome

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Changwei Ding (*Presenter*) Nothing to Disclose

#### **PURPOSE**

SS characterized by irreversible varying degrees of fat deposition, the objective of this study is to explore the feasibility of estimating fat fraction (FF) in parotid glands with Sjogren's syndrome using the mDIXON method.

#### **METHODS AND MATERIALS**

Conventional MRI and mDIXON-Quant were performed on 62 parotid glands (case group) in 31 SS patients and 62 parotid glands (control group) in 31 healthy volunteers with age and mean body mass index matching. The FF values of the two groups were compared, and the changes of FF values with different degrees of fat deposition were analyzed.

#### **RESULTS**

The FF value of parotid gland in the case group was significantly higher than that in the control group ( $35.7 \pm 15.7$ ,  $28.3 \pm 16.1$ , respectively,  $P=0.008$ ). The FF value in the case group increased gradually from no significant fat deposition in the early stage ( $32.1 \pm 4.8$ ) to significant fat substitution ( $73.0 \pm 4.9$ ).

#### **CONCLUSION**

The FF values obtained by the mDIXON method are a new method that can quantitatively assess the extent of SS parotid gland lesions.

#### **CLINICAL RELEVANCE/APPLICATION**

mDIXON provides a simple and easy clinical method for quantitative assessment of the extent of SS parotid gland lesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPHN-5

### Characterization of Intratumoral Heterogeneity by using Diffusion-relaxation Correlation Spectrum Imaging (DR-CSI) in HNSCC

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Yingwei Wu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the feasibility of diffusion-relaxation correlation spectrum imaging (DR-CSI) in the characterization of microstructural tissue compartments in HNSCC.

#### METHODS AND MATERIALS

Patients suspected with HNSCC who underwent 3-T MRI and surgical resection were prospectively studied. DR-CSI was applied and imaged for primary HNSCC and metastatic lymph nodes in vivo and were co-registered pathological slides. The DR-CSI spectral signal components volume ( $V_A$ ,  $V_B$ ,  $V_C$ ) was identified in accordance with the pathological findings and compared between benign and malignant primary tumors or lymph nodes. A linear model assessed the correlations between ( $V_A$ ,  $V_B$ ,  $V_C$ ) and each component observed in pathological findings. Strength of correlations was evaluated by using Spearman correlation coefficients.

#### RESULTS

Totally 32 subjects (mean age, 45 years  $\pm$  5.6) were evaluated in this study; Basically, three pathological components including epithelial, stroma and vascular areas were accordantly matched with DR-CSI spectral signal components (spectral peaks). Different DR-CSI pattern was observed between HNSCC and benign lesions or metastatic and benign lymph nodes. HNSCC exhibited increased  $V_A$  (HNSCC vs benign,  $0.41 \pm 0.06$  vs  $0.29 \pm 0.06$ ;  $P < 0.01$ ), decreased  $V_C$  ( $0.13 \pm 0.08$  vs  $0.27 \pm 0.09$ ,  $P < 0.01$ ). High malignancy suggested higher  $V_A$  (low- vs high malignancy  $0.36 \pm 0.11$  vs  $0.57 \pm 0.13$ ;  $P < 0.05$ ). In addition, metastatic lymph nodes presented decreased  $V_C$  (metastatic vs benign,  $0.14 \pm 0.08$  vs  $0.19 \pm 0.18$ ;  $P = 0.04$ ).and increased  $V_B$  (metastatic vs benign,  $0.21 \pm 0.08$  vs  $0.14 \pm 0.18$ ;  $P = 0.051$ ).

#### CONCLUSION

Diffusion-relaxation correlation spectrum imaging is feasible to determine the intra-tumoral heterogeneity of HNSCC. The signal components correlate with pathological compartments. Quantitative  $V_A$ ,  $V_B$  and  $V_C$  can be applied to determine malignancy and cervical metastasis.

#### CLINICAL RELEVANCE/APPLICATION

Microstructural MRI has the potential to improve diagnosis and characterization intra-tumoral heterogeneity. DR-CSI has been approved to quantitatively determine various components within the tumor, which is a promising approach for identify intra-tumoral heterogeneity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPHN-7

### Improving Metal Artifact Reduction Methods in Dual-Energy CT for Head and Neck CT Examinations: A Clinical Assessment

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Liu Xing (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the effectiveness of iterative metal artifact reduction (iMAR) technique in reducing dental metallic artifacts during head and neck CT examinations.

#### METHODS AND MATERIALS

Thirty patients with dental prosthesis implants were prospectively collected. Siemens single-source dual-energy CT (SOMATOM Definition Edge CT) was used for examination and the original data were reconstructed respectively in iMAR group (Group A) and conventional iterative reconstruction group (Group B). The CT and SD values of the high density artifacts, low density artifacts, the surrounding soft tissue areas and the same layer of contralateral artifact-free affected areas in the two groups of images were measured respectively. The difference between the two groups was compared by paired t-test. Two senior radiologists used the 5-component table (1~5 points, non-assessable ~ excellent) method to score the metal artifacts removal ability of the two groups. Mann-Whitney U test was used to compare the subjective scores and the consistency of the scores was analyzed by Kappa test.

#### RESULTS

There was no significant difference in CT values at the opposite side of the same layer without artifacts ( $P > 0.05$ ). The CT values in Group A were significantly reduced in the high density artifact area ( $p < 0.05$ ), while significantly increased in the low density artifact area ( $p < 0.05$ ), and were closer to the CT values in the corresponding anatomical areas at the opposite side of the same layer. In terms of image noise, the SD values in each measurement area of Group A's images were lower than those of Group B and were significantly lower in high density areas and low density areas ( $p < 0.05$ ). In terms of subjective score, the results of the two groups of image evaluation were excellent and consistent (Kappa=0.945,  $p < 0.05$ ). The subjective score of Group A was significantly higher than that of the control group, and the subjective score was increased by 2.1 (Group A:  $4.23 \pm 0.32$ , Group B:  $2.11 \pm 0.51$ ;  $P < 0.05$ ).

#### CONCLUSION

The iMAR technique can significantly reduce metal artifacts around dental implants, correct CT values of surrounding tissues, help to accurately observe tissue structures around implants, improve image quality, and has great clinical application value.

#### CLINICAL RELEVANCE/APPLICATION

Compared with conventional iterative reconstruction, it is preferable to use the iMAR technique in head and neck CT examinations as it allows better image quality and helps to accurately observe tissue structures around implants.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPIN-1

### Image Perturbation Analysis to Study the Effect of Motion on CT Radiomic Metrics

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Hesam Setayesh (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the robustness of radiomic metrics in simulated clinically observed ranges of organ motion using an anthropomorphic liver CT phantom with 3D-printed texture inserts.

#### METHODS AND MATERIALS

18 Volumetric CT images of the anthropomorphic liver radiomics phantom with 7 texture inserts were obtained under different imaging conditions varying slice thickness (0.625mm, 1.25mm and 2.5mm), dose (13,86 mGy standard, 40 % dose reduction, and 60 % dose reduction), tube voltage (100 kVp and 120 kVp) and reconstruction algorithms (deep learning image reconstruction algorithm and a hybrid iterative reconstruction algorithm ASiR-V50% one at a time). A circular region of interest (ROI) was manually contoured within a centrally placed texture insert of the phantom. 91 radiomic metrics belonging to 6 different texture families were extracted from the ROI using opensource Pyradiomics software. Subsequently, the same 91 radiomics metrics were extracted using the same ROI co-registered on motion perturbed versions of the original CT images. Specifically, 6 motion conditions: rotation by 5 degrees, rotation by 15 degrees, translation by 2 pixels to the right, translation by 3 pixels to the right, rotation 15 degrees plus translation 2 pixels, and rotation 15 degrees plus translation by 3 pixels were considered. Intraclass correlation (ICC) 2-way-mixed with absolute agreement was used to evaluate radiomics robustness under different imaging and motion conditions.

#### RESULTS

In all imaging conditions, translation by 2 or 3 pixels led to the highest number of radiomic metrics with ICC > 0.8 (indicating high robustness). As opposed to translations, rotation of 15 degrees compared to rotation by 5 degrees showed a significant reduction in robust radiomic metrics, under all imaging conditions ( $p < 0.0001$ ). Rotation followed by translation showed an increase in the number of robust metrics compared to rotation alone, possibly due to the overlap between the modified and the original ROI owing to small movements. Also, despite changes in imaging conditions, the trends in robustness were comparable across the different motion conditions.

#### CONCLUSION

Translation motion amplitudes  $\leq 3$  times the spatial resolution of the image retained the robustness of radiomic metrics on the CT images of anthropomorphic liver phantom. Different radiomic families showed different associations to the simulated motions. However, across different imaging conditions, the trends in robustness were comparable across the different motion conditions.

#### CLINICAL RELEVANCE/APPLICATION

In a clinical situation, understanding the effect of motion and suppressing its effects may support the development of a robust quantitative approach such as radiomics.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-SPIN-2

### Deep Learning is a Promising Tool for Fully Automatic Malignant Lesions Identification and Segmentation in Whole-body [<sup>68</sup>Ga]Ga-PSMA PET/CT Scans

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Joana Castanheira, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This work aims to assess the feasibility and robustness of deep learning-based fully automatic malignant lesion detection and segmentation on whole-body [<sup>68</sup>Ga]Ga-PSMA PET/CT scans.

#### METHODS AND MATERIALS

A dataset of 122 whole-body [<sup>68</sup>Ga]Ga-PSMA-11 PET/CT scans from patients with prostate cancer was used as the training set. These scans were acquired on a Philips Gemini TF16 PET/CT scanner. Two nuclear medicine physicians labeled all lesions suspected of malignancy. Then, a self-adaptive Bayesian classifier was used for semiautomatic lesion segmentation [1]. All segmentations were reviewed and manually rectified if necessary. This set (scans and segmentations) was used to train a fully automatic lesion detection and segmentation 3D U-Net, using the nnU-Net framework [2]. The CT scans were used as a second channel to feed the network. For testing, an independent set containing 39 whole-body [<sup>68</sup>Ga]Ga-PSMA-11 PET/CT scans from prostate cancer patients was randomly selected from our archives. All these scans were performed on a Philips Vereos Digital PET/CT scanner. The gold standard malignant lesions identification and segmentation of the test set were generated as indicated for the training set. The Dice similarity coefficient was used to measure the voxelwise agreement/overlap between the gold standard segmentations and the ones obtained with the trained network.

#### RESULTS

From the 39 test scans included, 32 scans were identified by the physicians as having malignant lesions, and 7 without. The trained network correctly identified all 32 scans with malignant lesions (sensitivity of 100%). From the 7 scans without malignant lesions, the trained network correctly identified 6 (specificity of 86%). Regarding the quality of the segmentation on the 32 scans, the median Dice coefficient was 0.73 (interquartile range [IQR] 0.53-0.82), the sensitivity was 72% (IQR 0.41-0.86), and the predictive positive value was 90% (IQR 0.72-0.99).

#### CONCLUSION

The solution herein described and implemented using deep learning achieved very good results, despite the additional difficulty of segmenting scans acquired on a scanner significantly different from the one used to obtain the train scans. Therefore, fully automatic lesion detection and segmentation on [<sup>68</sup>Ga]Ga-PSMA-11 PET/CT scans using deep learning may be used to help routine clinical work, especially during disease staging and to assess response to therapy. References [1] Constantino et al. J Digit Imaging 2023; [2] Isensee et al. Nature Methods 2021.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning-based fully automatic malignant lesions detection and segmentation on [<sup>68</sup>Ga]Ga-PSMA PET/CT scans is feasible and appears sufficiently robust to be used as an auxiliary tool in the clinics.

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## Abstract Archives of the RSNA, 2023

M2-SPIN-3

### **The CadAIver: Reproducibility Assessment and Novel Normalization Algorithm of Radiomics Features of Vertebral Bone from Different CT Scanners and Protocols**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Riccardo Levi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

1. To quantify the effects of different dose protocols, reconstruction algorithms, fields of view and CT scanners on Radiomics features of the lumbar vertebrae in a cadaveric trunk. 2. To develop a novel normalization algorithm to harmonize Radiomics analyses.

#### **METHODS AND MATERIALS**

We performed a total of 96 CT acquisitions of a cadaveric trunk (80-year old male) on 3 different CT scanners from 2 different vendors, using different kV (80 to 140, with 20 kV steps) and mA (250 to 400, with 50 mA steps). Each acquisition was performed using 2 fields of view (500 and 320 mm) and 2 reconstruction kernels (standard and bone). We also performed a Test-Retest protocol on a single scanner to assess repeatability of features. The lumbar vertebrae were segmented using a convolutional neural network (CNN) with nnU-Net structure and Radiomics features were extracted using pyradiomics library. Intra- and Inter-scanner analyses were assessed using either Analysis of Variance Repeated Measurements (parametric test) or Friedman's Test (non-parametric test) and each radiomics feature was tested using a generalized linear model (GLM) to assess the effects of all the above-mentioned CT acquisition parameters. Moreover, the proposed GLM model was successively employed to standardize radiomics features across different acquisitions, and was compared to the Combat algorithm, using a 10-folds cross-validation (CV) evaluating the R2.

#### **RESULTS**

Variation of KV showed the highest feature modification in intra- and inter-scanner analyses, with the First Order features showing the highest variability (up to 94.4% on Scanner 1). Little or no effect was evident upon mA variation. 100% of shape features on all scanners were found significantly dependent on FOV, and 83% of GLSZM were statistically different between reconstruction kernels. The proposed GLM normalization algorithm obtained a mean R2 across CV higher than 0.90 in 21 Radiomics features (19.6%), whereas Combat normalization algorithm obtained an high R2 value in 1 Radiomics feature (0.90%). Moreover, GLM algorithm was statistically superior in 39 Radiomics features in respect to Combat (which was superior in 16 Radiomics features) in terms of R2.

#### **CONCLUSION**

To our knowledge, this study is the first attempt in describing the effects of CT acquisition parameters on Radiomics features in lumbar vertebrae from cadaveric donor. Current and Voltage affect the Radiomics features in different ways. The developed GLM model was superior to Combat in normalizing radiomics features across all the different CT acquisitions.

#### **CLINICAL RELEVANCE/APPLICATION**

CT radiomics features are to be normalized before multi-scanner studies. The complete dataset and GLM normalization model will be publicly available to foster research in Radiomics.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPIN-4

### Independent Evaluation of the Winning Kits19 Model for Kidney Tumor Segmentation on a Large External Patient Cohort

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Alex G. Raman, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

The fully automatic segmentation of kidney tumors on Computed Tomography (CT) can enable significant advantages in clinical practice including increased accuracy of diagnosis and prognostication of patient outcomes. The Kits19 challenge in 2019 set a baseline for kidney tumor segmentation, with the highest scoring model, nnUNet, receiving a Dice score of 0.85. Herein we seek to evaluate this model on an independent dataset of 694 segmented kidney tumors.

#### METHODS AND MATERIALS

The nnUNet model trained on 210 Kits19 cases was evaluated on a separate institution-specific dataset of 694 total segmented kidney tumor cases, acquired from a diverse range of partner sites. A separate nnUNet model was trained on 555 of the institutional cases and evaluated on both 139 held out cases from the same institution as well as the 210 Kits19 cases. Unfortunately, the KiTS19 90 test cases were not available to evaluate the model trained on institutional data.

#### RESULTS

The nnUNet model trained on the 210 KiTS19 cases received a Dice score of 0.64 when evaluated on the institution specific dataset of 555 cases. The nnUNet trained on the 210 KiTS19 cases also received a Dice score of 0.66 on a held-out test set of 139 institutional cases. In addition, an nnUNet model was trained on these 555 institutional cases and received a Dice score of 0.72 when evaluated on the held-out test set of 139 cases from the same institution. The nnUNet model trained on 555 institutional cases received a Dice score of 0.55 when evaluated on the 210 KiTS19 training cases.

#### CONCLUSION

That the KiTS19 nnUNet model performed significantly worse (0.21 and 0.19 Dice score drops) on the institutional dataset was unexpected, but bears significant implications. Likewise, that the institutional nnUNet model performed significantly worse on the KiTS19 dataset (0.17 Dice score drop) despite being trained on a larger pool of data, reinforces a similar concept. Both models tended to do better on independent data derived from their own respective datasets. This highlights the importance of creating large medical machine learning datasets that incorporate data from a broad range of sources that can capture the data heterogeneity present in distinct patient populations and allow for the creation of generalizable machine learning models.

#### CLINICAL RELEVANCE/APPLICATION

These results also highlight the value of federated learning in a healthcare setting, which can allow for the incorporation of diverse datasets into model training, while maintaining the privacy of patient and institutional health data. Furthermore, these results raise the question of what the true state-of-the-art Dice score is for kidney tumor segmentation and demonstrate the importance of independent model evaluation prior to potential clinical deployment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPIN-5

### Evaluating the Segment Anything Model for MRI Organ Segmentation Using a Simulated Interactive Setup

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Yan Zhuang, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the multi-organ segmentation capabilities of the recently released Segment Anything Model (SAM) as an interactive semi-automated annotation tool for organ segmentation in magnetic resonance (MR) images.

#### METHODS AND MATERIALS

This retrospective study used the publicly available multi-organ MRI dataset, AMOS22, which contains 60 MRI volumes from multiple institutions. The 15 target organs are: liver, spleen, right kidney, left kidney, gallbladder, esophagus, stomach, aorta, inferior vena cava, pancreas, right adrenal gland, left adrenal gland, duodenum, bladder, and prostate/uterus. We extracted 2D slices from each 3D MRI volume and resized images to 512 by 512 pixels, resulting in a total number of 3609 2D images. We evaluated the SAM in a simulated interactive annotation setup. The initial prompt given to SAM was the ground truth bounding box (bbox) with added random jitter. SAM then outputs an initial segmentation mask. In subsequent iterations, SAM takes point-based prompts, as well as all previous prompts and the current segmentation mask, to generate the next refined segmentation mask. This procedure was repeated for 10 iterations to produce the final segmentation. The magnitude of random jitter for the initial bbox is a scaling factor that's uniformly drawn between [0.5,2] for our experiment. The magnitude of random jitter for subsequent point prompts is a translation  $0.2 \cdot R_{\max}$  pixels, where  $R_{\max}$  is the shortest distance between the center and the boundary of a false positive/negative region. The segmentation results of target 15 organs were evaluated against the ground truth masks using the Dice similarity coefficient (DSC) on 2D slices.

#### RESULTS

The mean $\pm$ std DSC for 15 organs after the initial bounding box prompt was  $0.777 \pm 0.049$ . The final mean $\pm$ std DSC after 10 iterative steps was  $0.901 \pm 0.056$ . The best three organs were the right kidney ( $0.954 \pm 0.034$ ), left kidney ( $0.951 \pm 0.028$ ), and spleen ( $0.949 \pm 0.051$ ). The worst three organs were right adrenal gland ( $0.807 \pm 0.113$ ), prostate/uterus ( $0.819 \pm 0.246$ ), and duodenum ( $0.825 \pm 0.156$ ). The mean DSCs increased monotonically with the number of prompts, implying better segmentation results.

#### CONCLUSION

Experimental results demonstrated that after 10 iterations, the SAM model was able to provide reasonable segmentation results for most of the organs in the MR images.

#### CLINICAL RELEVANCE/APPLICATION

The SAM model can potentially reduce radiologists' annotation burden for segmenting MR images to just a few mouse clicks.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPIN-6

### An Automated Quantification Algorithm for Evaluating Total Metabolic Tumor Volume in Patients with FDG-avid Lymphoma using a Deep-learning Model

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Lale Kostakoglu, MD, MPH (*Presenter*) Research Consultant, F. Hoffmann-La Roche Ltd

#### PURPOSE

Total metabolic tumor volume (TMTV) holds promise as a method for quantifying tumor burden in patients with 18F-fluorodeoxyglucose (FDG)-avid lymphoma, but methodological limitations mean that it is rarely used in clinical practice. We developed a deep-learning (DL) model for automatic lesion segmentation and TMTV quantification from FDG-positron emission tomography/computed tomography (FDG-PET/CT) scans. We aimed to evaluate the model and identify factors influencing its performance in patients with diffuse large B-cell lymphoma (DLBCL) or follicular lymphoma (FL).

#### METHODS AND MATERIALS

The DL algorithm (aTMTV) was trained using retrospective trial data from 836 adults with DLBCL. Model testing was performed using an independent retrospective data set including baseline and post-treatment scans from 166 adults with DLBCL and 201 adults with advanced FL collected from two large phase 3 multicenter trials. FDG-PET/CT scans were assessed by expert readers using semiautomated software (mTMTV) and by aTMTV. Pearson's correlation coefficient ( $r$ ) was used to evaluate aTMTV performance versus mTMTV. Bias was assessed using the slope and intercept from a weighted Deming regression. Lesion detection performance was assessed by sensitivity (the proportion of mTMTV-detected lesions identified by aTMTV) and positive predictive value (PPV; the proportion of aTMTV-detected lesions identified by mTMTV).

#### RESULTS

aTMTV quantification highly correlated with mTMTV in the test set ( $n = 367$ ;  $r$ , 0.96 [95% confidence interval (CI): 0.95, 0.96]) for DLBCL and FL. Only moderate bias was detected between aTMTV and mTMTV (slope, 1.06 [95% CI: 1.02, 1.09]; intercept, -0.27 [95% CI: -0.52, -0.03]; mean difference between methods, 0.10 [standard deviation: 1.15]). Agreement between aTMTV and mTMTV was consistent among patients with different demographics and clinical characteristics, and across scans from different PET/CT scanner manufacturers. Overall mean sensitivity and PPV for lesion detection were both  $> 0.8$ . Performance was lower for lesions  $\leq 10$  mL (mean sensitivity, 0.67; mean PPV, 0.72) than for lesions  $> 10$  mL (mean sensitivity and PPV  $> 0.95$ ).

#### CONCLUSION

The model demonstrated good performance and acceptable bias for TMTV measurement in patients with DLBCL or FL. Good generalizability was observed across patient subpopulations and PET/CT scanner manufacturers. Reduced algorithm performance for small lesions ( $\leq 10$  mL) may be the result of higher variability among readers in the determination of small lesions.

#### CLINICAL RELEVANCE/APPLICATION

With further optimization and validation, this model may provide a novel automated approach for lesion segmentation and TMTV quantification to inform the management of patients with FDG-avid lymphoma.

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## Abstract Archives of the RSNA, 2023

M2-SP1R-2

### Unilateral Lung Disease Model Developed using Interventional Radiology Technique

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Hiroshi Kodama, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Standard mouse model of pulmonary fibrosis model has been made by administration of Bleomycin intratracheally or intraperitoneally. The problem of this traditional methods is high mortality rate of more than 50% after Bleomycin administration. Our hypothesis was that unilateral lung disease model established using interventional radiology technique can overcome this limitation, and the feasibility and usefulness of unilateral lung disease was assessed.

#### METHODS AND MATERIALS

After 6-week-old C57BL/6 mice were anesthetized, a 1.7Fr. microcatheter was advanced into trachea using otoscope. Then, 1.0mg/kg of Bleomycin was injected into bilateral lung at trachea (n=13) or unilateral lung (n=14) after advancing the microcatheter to left main bronchus under fluoroscopy. Technical success, %decrease of body weight and survival at day 28 were evaluated. Body weight change and survival were compared between bilateral and unilateral lung disease groups using Mann-Whitney test and log-rank test. Lungs were extracted and evaluated on HE or Masson Trichrome stained specimens.

#### RESULTS

In all mice, bleomycin was successfully injected in bilateral or unilateral lung: Technical success rate was 100%. Body weights decreased 75.7%±14.0% in bilateral lung disease group, and it was significantly improved to 94.1%±11.4% in unilateral lung disease group (p=0.03). Overall survival rate at day 28 was 30.8% and 85.7% in bilateral and unilateral lung disease model, respectively. Survival was significantly better in unilateral lung disease model(p=0.01). On histological evaluation, it is confirmed that collagen deposition was only seen in bleomycin injected lung in unilateral lung disease model.

#### CONCLUSION

Establishing both healthy lung and disease lung in the same individual model using interventional radiology technique was feasible and make it possible to achieve less body weight loss and more favorable survival.

#### CLINICAL RELEVANCE/APPLICATION

Interventional radiology technique helps developing new animal model. Unilateral lung disease mouse model may be useful to analyze the treatment effect to both diseased and normal lung in the same individual.

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## Abstract Archives of the RSNA, 2023

M2-SP1R-3

### Fully Automated Dynamic Frame Rate Adjustment in Digital Subtraction Angiography

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Brendan Crabb, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Digital subtraction angiography (DSA) is a commonly used method for visualizing vasculature throughout the human body. Unfortunately, patient motion can generate artifacts, limiting the diagnostic quality of the images. When motion artifacts are present, image quality can be effectively improved by utilizing higher acquisition frame rates. However, this approach increases radiation dose to both the patient and provider. Moreover, frame rate adjustments are currently performed manually and frequently overlooked. There is a critical need to automatically optimize acquisition frame rates to maximize image quality and limit unnecessary radiation. We aim to develop a fully automated method to adjust frame rates on a series-to-series basis in response to motion artifacts.

#### METHODS AND MATERIALS

DSAs of the cerebral, hepatic, and splenic vasculature were retrospectively collected (n=88 patients, 217 series; frame rate range 1-7 frames per second). The degree of motion artifacts in each DSA was visually scored using a five-grade Likert scale. In addition, image histograms were calculated for each DSA, and the relationship between the standard deviation of pixel intensities and the artifact rating was investigated. A Pearson correlation coefficient with a two-sided p-value was used to quantify the relationship, and the processing time required to analyze each DSA image was recorded.

#### RESULTS

The degree of motion artifacts was strongly associated with the standard deviation of pixel intensities in the image histogram ( $r = 0.78$ ,  $p < 1 \times 10^{-5}$ ). The average processing time required to calculate this metric for a DSA image was 0.008 seconds on a middle-entry PC (Intel Core i5 processor, 8GB RAM).

#### CONCLUSION

The standard deviation of pixel intensities in DSA is significantly associated with the degree of motion artifacts and can be calculated in less than 0.01 seconds. This relationship can be utilized to adjust acquisition frame rates for DSA in a quantifiable, automated, real-time approach.

#### CLINICAL RELEVANCE/APPLICATION

Increasing DSA acquisition frame rates is an effective method to improve image quality when motion artifacts are present, but it also increases the radiation dose. In this study, we present a concept to perform fully automated, real-time frame rate optimizations on a series-to-series basis. This approach will improve image quality when patient motion is present while limiting radiation exposure when high frame rates are unnecessary.

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## Abstract Archives of the RSNA, 2023

M2-SP1R-4

### Impact of a Selective Lens Dose Reduction Protocol in 3D Rotational Angiography on Eye Lens Radiation Exposure in Cerebral Angiography: A Randomized Controlled Trial

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jong-Tae Yoon, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

There is limited research on the radiation exposure to the eye lens during cerebral angiography. A recent study has reported that a simple adjustment of table height during three-dimensional rotational angiography (3D-RA) can significantly reduce the radiation dose to the lens. This study aims to investigate the radiation dose to the eye lens during cerebral angiography and evaluate the effectiveness of a lens dose reduction protocol for 3D-RA in reducing overall lens dose exposure.

#### METHODS AND MATERIALS

A randomized, controlled clinical trial was conducted at a tertiary hospital, with patients undergoing diagnostic cerebral angiography for unruptured intracranial aneurysms. The lens dose reduction protocol in 3D-RA involved raising the table to position the patient's eye lens away from the rotation axis. The radiation dose at the eye lens was estimated by measuring the entrance surface air kerma with photoluminescent glass dosimeter (PLD). The lens doses of 3D-RA and overall examination were analyzed and compared between the two groups. Image quality of the 3D-RA was assessed using quantitative and qualitative methods.

#### RESULTS

A total of 20 participants (mean age, 58 years  $\pm$  9.4 [SD]; 12 men [60%]) were enrolled and randomly assigned to either the conventional group or the lens dose group. The lens dose in 3D-RA was significantly lower in the lens dose group compared to the conventional group (median of 1.1 mGy vs 4.5 mGy,  $P < .001$ ). The total dose was significantly lower in the lens dose reduction group (median of 7.5 mGy vs 10.2 mGy,  $P = .003$ ). In the conventional group, 3D-RA accounted for 46% of the total lens dose, while in the lens dose group, its proportion decreased to 16%. No significant differences were observed in the image quality between the groups.

#### CONCLUSION

The study demonstrated that the lens dose reduction protocol showed significant reduction in the lens dose of the 3D-RA as well as entire cerebral angiography, without compromising image quality.

#### CLINICAL RELEVANCE/APPLICATION

Radiation exposure during neurointerventional procedures is one of the significant issues to consider clinically as lenses have a high radiation sensitivity, and frequent radiation exposure can increase the risk of developing cataracts. Therefore, managing radiation exposure is crucial, and the use of techniques to reduce radiation doses in lenses, as presented in this study, can potentially decrease the likelihood of cataract formation in patients.

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## Abstract Archives of the RSNA, 2023

M2-SPIR-5

### Immunologic Stem Markers of Poorly-differentiated Hepatocellular Carcinoma: Potential Targets for Locoregional NK-cell Based Immunotherapy

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jason Chiang, MD, PhD (*Presenter*) Consultant, Intuitive Surgical, Inc; Equipment support, Johnson & Johnson

#### PURPOSE

Poorly differentiated hepatocellular carcinoma (HCC) is hypothesized to contain immunologic markers of cancer stem cells that elevate the risk for recurrence or progression after locoregional therapy. Natural killer (NK) cells are uniquely able to target cancer stem cells via the innate immune pathway. The goal of this study was to identify cancer stem cell immunologic markers of poorly- vs well-differentiated hepatocellular carcinomas that would make them susceptible to NK-cell based therapy. HCC cell lines of poor- and well-differentiated HCCs were then incubated with naïve and activated NK cells to validate their cytotoxicity profile.

#### METHODS AND MATERIALS

Two HCC tumor cell lines of different grades of differentiation (SNU-423: poorly differentiated; HepG2: well-differentiated) were used to determine immunologic stem cell phenotype and susceptibility to NK cell-mediated cytotoxicity. Flow cytometry was used to evaluate for surface receptor expression of MHC-I, CD-54, CD-44, and PDL-1 after staining with PE-conjugated antibodies. Isotype control antibodies were used to determine non-specific bindings. Freshly isolated NK cells and IL-2 activated NK cells prior to using 4-hr <sup>51</sup>Cr release assay.

#### RESULTS

The poorly differentiated HCC (SNU-423) had significantly higher expression percentage of CD44 ( $P < 0.0001$ ) and much lower expression percentage of MHC-I ( $p = 0.028$ ) and CD-54 ( $P = 0.01$ ), compared to the well-differentiated HCC (HepG2). There was no difference in PDL-1 levels ( $p = 0.70$ ) between the two cell lines. Naïve NK cells and activated NK cells both demonstrated significantly higher targeted killing of the poorly differentiated HCC when compared to the well-differentiated HCC (untreated NK in Snu-423 vs HepG2,  $p = 0.013$ , IL2-treated NK in Snu-423 vs HepG2,  $p < 0.001$ ,). Morphologically, poorly differentiated HCCs exhibited smaller size and proliferated faster when compared to well differentiated HCCs.

#### CONCLUSION

Poorly-differentiated HCCs demonstrated significantly decreased expression of stem cell markers MHC-I, CD-54, and higher expression of CD-44 when compared to well-differentiated HCC. Poorly-differentiated HCCs were subsequently validated to be more susceptible to NK cell therapy. Additional studies in in-vivo HCC models are required to confirm stem profile of poorly differentiated HCCs and their utility as a biomarker for successful NK cell targeting.

#### CLINICAL RELEVANCE/APPLICATION

NK-cell based therapy can potentially be used to augment conventional locoregional therapy options for early- to intermediate-stage HCC. Advances in NK cell activation and expansion will lend itself well to transarterial directed delivery of immunotherapy.

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## Abstract Archives of the RSNA, 2023

M2-SPIR-6

### Evaluating the Potential of ChatGPT's Competency in Interventional Radiology

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Hossam A. Zaki, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

This project investigates ChatGPT's proficiency in Interventional Radiology by evaluating its clinical decision making and performance on a standardized exam.

#### METHODS AND MATERIALS

We utilized ChatGPT, an LLM by Open AI trained on general data, as well as GlassAI, an LLM by Glass Health trained on medical text. Using the American College of Radiology (ACR) Appropriateness Criteria's patient presentations and criteria, we prompted ChatGPT to rank the 3 best interventional procedures, devices, or venous access areas. GlassAI was prompted to provide the best interventional procedures only. Each output was scored out of 3, where 3 is "usually appropriate", 2 is "may be appropriate", 1 is "usually not appropriate", and 0 is not listed. Partial scores were given for non-specific answers. We also used a Self-Assessment Module for Vascular and Interventional Radiology from the ACR published in 2011 to feed non-image based multiple choice questions into ChatGPT. A 1 was given for a correct answer, while a 0 was given for an incorrect answer. Clinical scenarios and exam questions were passed into each LLM twice, to account for stochasticity. The score for the board exam questions were averaged across both runs. Statistical significance was determined using a two-sided student's T-test.

#### RESULTS

ChatGPT achieved a score of 2.38, 2.32, and 3.00 in selecting interventional procedures, devices, and venous access sites, respectively. GlassAI achieved a score of 3.00 in selecting interventional procedures. The difference between the two scores was found to be statistically significant ( $p < 0.05$ ). The average score for the exam was 74.2%.

#### CONCLUSION

This study has demonstrated the potential of LLMs as a valuable tool for IR contexts. Compared to the ACR Appropriateness Criteria, LLMs perform well selecting an interventional procedure when prompted with a specific clinical scenario. GlassAI, a medical-specific model, performed better than ChatGPT, a general model. ChatGPT performed well in predicting interventional devices and venous access sites. ChatGPT performed well on the simulated IR exam.

#### CLINICAL RELEVANCE/APPLICATION

Throughout the study, LLMs consistently exhibited a strong ability to comprehend complex medical scenarios and provide accurate, relevant predictions in interventional radiology areas. Moreover, the use of ChatGPT in a test setting demonstrated its proficiency in answering a wide range of questions. By integrating the model into the decision-making process, we can enhance the efficacy of diagnostic and therapeutic interventions while reducing the cognitive burden on clinicians.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPMK-1

### Thumb Distal Phalangeal Pseudolesion: Imaging Findings and Associations of an Underappreciated Normal Variant that May Mimic Osteolytic Pathology

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Andrew G. Helming, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In daily practice, we often observe a thumb distal phalangeal lucency on routine radiographs which may prompt cross-sectional imaging for further work-up. We hypothesize this represents a "pseudolesion" similar to those at the proximal humerus, radial tuberosity and femoral neck. To our knowledge, this finding has not been described in peer-reviewed literature. We aim to: 1) Describe imaging features of the thumb distal phalangeal pseudolesion (DPPL), 2) record incidence and frequency across age groups, and 3) evaluate associations with underlying diseases.

#### METHODS AND MATERIALS

IRB approved, retrospective review of 450 radiographic exams from 7/1/2021-7/1/2022. Patients divided into 3 age groups: 0-17, mean 12; 18-65, mean 42; 66+, mean 74.5. Each group of 150 cases had 50 hand, wrist, digit exams. Demographics obtained from electronic medical records and cases reviewed on PACS for: DPPL (Likert scale- 0, not present; 1, possible; 2, definite), view-specific conspicuity, location (distal/proximal, radial/ulnar, palmar/dorsal), size, laterality, osteopenia, osteoarthritis (OA) (modified Kellgren-Lawrence), inflammatory arthropathy, periarticular mineralization, and indication.

#### RESULTS

450 patients, 51% female and 49% male, 51% left and 49% right, DPPL present in 23%. Frequency of DPPL varied with age as follows: 68 (45%) seen in >65, 34 (23%) in 18-65, and 3 (2%) in those <18. DPPL located at proximal palmar aspect of thumb distal phalanx in 100%, 97% at ulnar aspect, 3% radial. 2% of patients had inflammatory arthropathy, 21% osteopenia, and 2% peri-articular mineralization. Positive correlations between DPPL presence and patient age, osteopenia, and presence of osteoarthritis, ( $p < 0.001$ ); severity of OA was not correlated. DPPL was not associated with gender or inflammatory arthropathy, and dubiously associated with periarticular mineralization. DPPL frequently seen on frontal and oblique views, infrequently on lateral views. Average size 6.4 x 4.5 mm (CC x TV). DPPL more common on hand and digit radiographs.

#### CONCLUSION

DPPL is common in patients older than 65 and consistently identified at the proximal, palmar-ulnar aspect of the thumb distal phalanx at wrist, hand, and finger/thumb radiography. DPPL is significantly associated with aging, increasing osteopenia, and osteoarthritis, and is unusual in the pediatric population. Anatomically, DPPL may be attributed to radial and ulnar sided basal tubercles bordering a palmar fossa/concavity which is less discrete prior to skeletal maturation.

#### CLINICAL RELEVANCE/APPLICATION

Increasing radiologist awareness of DPPL as a normal variant at the thumb distal phalanx may decrease overcalls of osteolytic bone disease, eliminating unnecessary work-up and alleviating patient anxiety.

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## Abstract Archives of the RSNA, 2023

M2-SPMK-2

### Peripheral Tear of the TFCC: Diagnostic Accuracy of MR Imaging of the Wrist and Diagnostic Performance of the Primary and Secondary Signs

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Youngjun Hur, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of the study was to assess the diagnostic performance value of MRI findings in patients with type 1b triangular fibrocartilage complex (TFCC) tear of the wrist.

#### METHODS AND MATERIALS

In this study, a retrospective enrollment of 78 patients was conducted to examine the diagnostic performance of preoperative MRI examinations in patients with type 1b TFCC tear. Of the enrolled patients, 39 were confirmed to have type 1b TFCC tear through arthroscopy and underwent MRI examination within 180 days before surgery. As the control group, 39 patients were randomly selected from 1157 patients who underwent MRI examination for wrist pain during the same period. Both groups underwent a review of 19 MRI findings by two independent observers, and the correlation between each diagnostic finding and type 1b TFCC tear was assessed using a Chi-square test. The 19 MRI findings comprise 8 primary signs of abnormalities in the distal or proximal lamina, alongside 11 secondary signs suggestive of abnormalities in the surrounding structures.

#### RESULTS

The type 1b TFCC tear group exhibited a significantly greater incidence of 7 primary MRI signs, comprising fiber discontinuity, signal alteration, and retraction of both proximal and distal lamina, as well as scarring of the distal lamina, compared to the control group (all  $p < 0.05$ ). Remarkably, the presence of fiber discontinuity and signal alteration of the distal lamina were higher in the type 1b TFCC tear group (74.3% vs. 38.5%,  $p = 0.003$ , and 87.2% vs. 43.6%,  $p < 0.001$ , respectively), as detected by both observers. In contrast, none of the 11 secondary MRI signs were statistically significant.

#### CONCLUSION

MRI assessment of fiber discontinuity and signal alteration in the distal lamina through MRI examination may provide predictive markers for type 1b TFCC tear. These findings highlight the potential value of MRI as a diagnostic tool for this particular condition.

#### CLINICAL RELEVANCE/APPLICATION

This study holds the potential to identify the diagnostic accuracy of wrist MR imaging, as well as the diagnostic performance of both primary and secondary signs related to type 1b TFCC tear.

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## Abstract Archives of the RSNA, 2023

M2-SPMK-3

### Wrist Instability after Sectioning the Different Components of the Scafolunate Ligament and DCSS using a Cadaveric Model and Evaluated by 4DCT

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Badr Sellami, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To study the effect of sectioning the different components of the SL (scafolunate) ligament-DCSS (dorsal scafolunate septum) in a cadaveric model and assessing dynamic effects with 4DCT.

#### METHODS AND MATERIALS

Five fresh frozen cadaveric specimens were imaged with 4DCT while placed in a custom-made wooden frame before and after introduction of different SL-DCSS lesions. The lesions were created arthroscopically and consisted of VSL (ventral), DSL (dorsal), VSL+DSL, VSL+DSL+partial DCSS, and VSL+DSL+complete DCSS. With CT, dynamic acquisitions were obtained in flexion, extension (F-E), and radial and ulnar (R-U) deviation. Relevant bony structures were semi-automatically segmented. Based on this X; Y; Z graphs were created to analyze the movement of the bones.

#### RESULTS

With VSL sectioning, no SL diastasis occurred. Dorsal tilt increased with VSL sectioning. With DSL sectioning SL diastasis was seen but only in flexion-extension, and not in ulnar-radial deviation. With sectioning of multiple components SL diastasis was observed in all motions. With VSL, DSL, VSL+ DSL tilting in F-E was not concordant with tilting in R-U deviation. When the DCSS was completely sectioned tilting increased significantly in all motions and SL diastasis was most pronounced.

#### CONCLUSION

1. SL diastasis does not occur with VSL lesions, however with DSL lesions it can also not be shown on R-U deviation 2. Except for the most severe injury of all structures (SL+ DCSS) the motion in R-U deviation is not concordant with F-E as would be expected. We believe that the extrinsic ligaments restrain the expected motion. 3. The more components are injured the more SL diastasis and tilting increases. 4. The DCSS plays a very important stabilizing role, and SL instability is most severe when it is injured.

#### CLINICAL RELEVANCE/APPLICATION

Patterns of abnormal scafolunate motion after section of different components can be analyzed on 4D CT, and could predict the underlying injuries. The DCSS (dorsal scafolunate septum) plays an important stabilizing role.

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## Abstract Archives of the RSNA, 2023

M2-SPMK-4

### **Clinical Importance of the Retinacula, Subsheat, Ligament Attachments and Dynamics of the ECU. An US-MRI Study with Anatomical and Histologic Correlation**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Michel O. De Maeseneer, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To perform an US-MR\_anatomical-histological correlation of the extensor carpi ulnaris retinaculae, subsheat, and their attachments to the TFC and carpal ligaments. To review MR and US imaging in 7 patients with abnormal subsheat and ulnar sided TFC tears.

#### **METHODS AND MATERIALS**

Five cadaver specimens (fresh frozen, Thiel, embalmed) were dissected and sectioned at the level of the ECU. US was performed prior to dissection at 4 levels (cubital groove, styloid process, subsheat, carpal insertion). In the 2 dissected specimens (one nl TFC, one major TFC tear) dynamic clips during pro-supination were obtained. US imaging was obtained in consensus by 2 experienced MSK radiologists with a 24 Mhz ultrasound probe. Seven cases of abnormal ECU subsheat on MRI and US from 3 institutions were retrospectively reviewed.

#### **RESULTS**

At the cubital level the ECU is only covered by a thin superficial retinaculum, there is no tight bony or ligament attachment and mobility in pro-supination is very significant. The subsheat starts at the styloid process level, where it connects to the styloid insertion of the TFC. The subsheat is actually a sling of ligamentous bands in continuity with other tendons and extrinsic carpal ligaments (band of Barfred, radiolunotriquetral, intercarpal ligament) Dynamic studies showed a sudden click in pro-supination in the specimens with a major TFC tear, in contrast to the specimens with a normal TFC. All studied cases with abnormal subsheat showed ulnar sided TFC tears.

#### **CONCLUSION**

The ECU retinacula and subsheat are complex, and have not been correctly described in previous anatomical and imaging work. This area is best evaluated on 24 Mhz US as are dynamics of the ECU tendon in pro-supination. There is no subsheat nor tight attachment of the ECU at the cubital level, but tight connections to the extrinsic carpal ligaments distally. In the clinical patients, major abnormality of the subsheat on MR or snapping dislocation of the ECU on US, was associated with ulnar sided TFC tears.

#### **CLINICAL RELEVANCE/APPLICATION**

Understanding the anatomy of the subsheat as described in this work is a requisite to correctly interpret US and MR imaging of this area. Our findings also shed light on the clinical concept of 'ECU dislocation-abnormal ECU motion' Although only limited clinical cases were studied, our findings suggest that subsheat abnormalities and 'abnormal ECU motion' are associated with ulnar sided TFC tears.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPMK-5

### Open Access AI Tools in Clinical Support Roles - An Example of Shoulder Implant Recognition

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Wolfram A. Bosbach, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Uptake of novel artificial intelligence methods into clinical tools is slowed down by multiple factors. One is the lack of access to computing facilities. In this study, we test today's open access resources for performing a musculoskeletal 4-class labeling task.

#### **METHODS AND MATERIALS**

The tools we chose are Google-Chrome as browser, Google-Drive as online repository, Google-Colab as running environment. The model was implemented in Python, specifically Google-TensorFlow. The code was run on a deliberately unbalanced dataset with X-ray images containing implants from four different shoulder implant manufacturers. We applied a fine tuning on the Google-EfficientNet, the dataset was enlarged for training by data augmentation.

#### **RESULTS**

We show that today's available open access resources are suitable for the intended task. Google-EfficientNet can be trained to perform the class labeling. Accuracy and avoidance of overfitting are improved by the data augmentation.

#### **CONCLUSION**

We will make the designed tool available as open access tool on github. Remaining issues today are the data safety and data privacy. Future tools will need to address those if sensitive data is supposed to be processed.

#### **CLINICAL RELEVANCE/APPLICATION**

Identification of unknown implants is only one of the many clinical applications. The relevance of our work is to demonstrate a pilot that uses remotely open access tools for AI work. In the future, support tools could be designed to assist a radiologist in his daily clinical routine.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPMK-6

### Wavelet Decomposition Synthetic Imaging in Metal Artifact Reduction MRI (Magnetic Resonance Imaging) in Patients With Long Bone Tumor Prosthesis

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jiwoo Park, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify the optimal metal artifact reduction sequences (MARS) and to explore solutions to overcome the limitation of existing MARS by using wavelet decomposition.

#### METHODS AND MATERIALS

We assessed a total of 1348 cases of thigh MRI from patients aged  $\geq 18$  years who underwent 3.0T MRI (Philips Healthcare, Best, the Netherlands) at our institution from January 2016 to April 2022. The inclusion criteria were as follows: (1) Bone resection and tumor prosthesis insertion for tumor involvement of the femur (2) MARS were applied to post-operative follow-up MRI; STIR Metal Artifact Reduction for Orthopedic Implants (O-MAR), mDixon O-MAR, STIR O-MAR XD (3) MARS included the coronal T2FS sequence, which allows for viewing the major axis of a long bone tumor prosthesis in a single image and is deemed the most useful for lesion detection (4) Sufficient image quality for assessment. A total of 61 cases (STIR O-MAR: 15 cases, mDixon O-MAR 17cases, STIR O-MAR XD 29 cases) with MR images were included in the final analysis. To assess the metal related signal changes that can affect the diagnostic performance, MR images were assessed by the following parameters: the distinction of anatomic structures and image quality. (1) For the distinction of anatomic structures, (1.1) bony cortex on the outer layer of the long bone with the tumor prosthesis could be well observed (1.2) the range of the muscles showing artifacts in the anterior compartment of thigh muscles surrounding the femur, (2) Regarding image quality, (2.1) center signal void area and (2.2) total artifact area including geometric image distortion, spatial blurring and image noise. The scores for the four parameters assessed for each MARS were summed up (4-20 points). The scores of three sequences were evaluated using the one-way ANOVA and post hoc Tukey Honestly Significant Difference (HSD) test. Wavelet decomposition was applied to O-MAR XD images: a total of 101 conventional sequence-MARS pairs.

#### RESULTS

There were no significant difference in OMAR sequence and mDixon O-MAR sequence ( $P=0.378$ ). However, in subsequent images, wavelet decomposition reduced artifacts caused by blurring, a drawback of OMAR-XD, and there were significantly improved image quality and decreased metal artifact reductions in area ( $P<0.001$ ).

#### CONCLUSION

OMAR or mDIXON OMAR appeared to be more useful than OMAR-XD for assessing 3.0T MRI images of long bone tumor prostheses. Application of the Wavelet decomposition synthetic imaging would aid diagnosis than OMAR-XD in patients with long bone tumor prosthesis.

#### CLINICAL RELEVANCE/APPLICATION

Efforts to reduce metal artifacts in MRI have been ongoing, but assessing postoperative magnetic resonance imaging (MRI) of patients with a long bone tumor prosthesis is still challenging.

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## Abstract Archives of the RSNA, 2023

M2-SPMK-7

### Development of a Fitted Ultrasound Standoff Pad Device

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Mario Russo, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultrasound (US) examinations are ubiquitous diagnostic assessments, reaching nearly 350 scans per 1,000 person-years in the United States. However, US examinations of superficial structures near curved bony prominences, such as the ankle or wrist, can be challenging, often requiring the use of a standoff pad. Unfortunately, a standard standoff pad can be challenging to use due to its bulky size and instability. This is further exacerbated when dynamic maneuvers or procedures are necessary. To address this issue, we have developed initial prototypes of a custom standoff pad adaptor, the FreePad. This exploratory study aims to compare the FreePad to the standard standoff pad and no pad in selected patients undergoing musculoskeletal ultrasound.

#### METHODS AND MATERIALS

We used an operator-centered iterative design approach to create the FreePad. The Form 3 3D-printer was utilized throughout this process to create and test consecutive prototypes. This study was granted IRB approval and utilized patient informed consent. Included were 12 patients who presented to the outpatient radiology clinic for musculoskeletal ultrasound with a focus on superficial structures near anatomic areas of bony eminences (elbow, wrist, hand, ankle and foot). Each patient was examined under three conditions: 1) using US gel with no standoff pad, 2) with a standard standoff pad, and 3) with the FreePad. Each condition was evaluated for: a) duration of examination in seconds and, on a scale of 1 to 5, b) ease of use, c) quality of images, d) patient comfort, and e) diagnostic confidence. Three staff radiologists assessed the diagnostic confidence independently. The criteria results were evaluated using paired sample t-tests.

#### RESULTS

The FreePad was easier to use than both US gel and the standoff pad ( $p=0.03$ ,  $p=0.002$ ). While statistically better than US gel across all other conditions, the FreePad compared to a standoff pad trended towards requiring shorter duration (138 vs 169 sec,  $p=0.09$ ), producing higher quality images (4.5 vs 3.9,  $p=0.08$ ), greater diagnostic confidence (4.4 vs 3.8,  $p=0.08$ ), and increased patient comfort (4.8 vs 4.3,  $p=0.06$ ).

#### CONCLUSION

Use of the FreePad allows for easier scanning of superficial anatomic regions associated with bony eminences. Utilizing a fitted standoff pad device can improve the diagnostic confidence and quality of US images, while significantly enhancing the ease of clinician imaging.

#### CLINICAL RELEVANCE/APPLICATION

The significantly improved ease of imaging using the FreePad is of everyday benefit to MSK radiologists' diagnostic practice and holds even greater promise for improving US-guided procedures in challenging anatomy.

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## Abstract Archives of the RSNA, 2023

M2-SPMK-8

### The Laundry Dilemma: Long or Short Programme to Get Off Calcium Spots

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

David Macia-Suarez, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Long-term comparison of two follow up approaches in performing Ultrasound-guided Percutaneous Irrigation of Calcific Tendinopathy (US-PICT) in the shoulder.

#### METHODS AND MATERIALS

A Cross-sectional study of the evolution of patients undergoing an US-PICT was performed in 2 hospitals, through a Shoulder Pain and Disability Index (SPADI) questionnaire and a clinical survey 5 years after the intervention. The two approaches to assess were: Hospital 1: follow-up by the radiology service a month and a half after the intervention, assessing the need to perform a new US-PICT in case both symptoms and calcification persisted. Hospital 2: the patient was discharged after the intervention, being able to return to the consultation at his own request. In both cases, the same US-PICT (single needle lavage) technique was performed. All patients were informed of their participation in the study and gave their approval through an informed consent document. Authorization was requested and obtained from the regional bioethics committee. At 5 years of the intervention the two approaches were compared using the SPADI questionnaire, a clinical survey and a physical and an US exploration. The SPADI questionnaire consisted of 5 items that assessed pain and 8 items for mobility. The survey consisted of 11 questions that assessed: pain, overall state, mobility and medications compared to before US-PICT. A total of 93 patients were analyzed. 34 from Hospital 1 and 58 from Hospital 2. Statistical analyses were performed using R Statistical Software (v.4.12; Rcore Team 2021), which include a descriptive analysis of the data. Welch test was used in SPADI score means. The Chi-Squared or Fisher test were performed in survey questions.

#### RESULTS

SPADI Score was statistically significant different in the two centers (Hospital 1:  $2.26 \pm 2.18$ ; Hospital 2:  $4.41 \pm 3.01$ ;  $p$ -value  $< 0.001$ ). However, the number of US-PICT was not associated with SPADI Score. Statistically significant differences were found between hospitals in the following aspects of the clinical survey: pain ( $p$ -value = 0.007); mobility compared to healthy ( $p$ -value = 0.001); overall state ( $p$ -value = 0.008). No statistically significant differences were found between the two centers about sex, age, mobility assessment and US features.

#### CONCLUSION

It seems that closer follow-up of patients (Hospital 1 approach) has better objective (SPADI Score) and subjective (clinical survey) long-term outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Performing a close and long follow up of patients after US-PICT allows a better outcome and, therefore, a better clinical state.

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## Abstract Archives of the RSNA, 2023

M2-SPMK-9

### **MRI-guided Retrograde Drilling for Osteochondritis Dissecans of the Talus in Pediatric Patients**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jyri E. Jarvinen (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to evaluate the feasibility, effectivity, and safety of MRI-guided percutaneous retrograde drilling in the treatment of osteochondritis dissecans of the talus (OCDT) in pediatric population.

#### **METHODS AND MATERIALS**

The retrospective study (2010 - 2019) had 27 consecutive pediatric patients (mean age 13 years) with 30 stable, symptomatic OCDT which were unresponsive to conservative treatment. The OCDT were treated using MRI-guided retrograde drilling. They were graded pre- and post-operatively on a validated 5-grade scale (I - V) based on MRI. The procedure's effectivity was assessed by radiological improvement of the OCDT, and by postprocedural questionnaire that was aimed to evaluate pain (Visual Analogue Scale (VAS) 0 - 10) and performance (scale 0 - 10). Also, an evaluation of procedure-associated symptom alleviation was elicited.

#### **RESULTS**

The mean follow-up time was 6.1 (2.4 - 11.4) years. MRI-guided drilling was technically successful in all the cases. No major complications occurred. All the patients were discharged from hospital on the day as the procedure was performed. Mean time interval for follow-up imaging was 4.8 (1 - 12) months. All the OCDT represented grade II - III in pre-operative assessment, and they all remained stable during follow-up. The OCDT grade improved after drilling ( $p = 0.039$ ). Three of grade III OCDT improved to grade I, five of grade III OCDT improved to grade II, and one of grade II OCDT progressed to grade III. The rest of the OCDT remained unchanged. Increased ossification was observed in 39% of the OCDT. The symptoms were significantly alleviated or completely disappeared in 63% of the cases. Preoperative mean VAS and performance was 6.3 (SD 2.0) and 5.2 (SD 2.4), respectively. Both pain (mean change in VAS -3.8, SD 2.6) and performance (mean change 2.6, SD 3.1) were improved significantly ( $p < 0.001$  and  $P = 0.001$ , respectively). Orally administered anti-inflammatory drugs and paracetamol provided satisfactory postprocedural pain relief for 96.7% of the patients.

#### **CONCLUSION**

MRI-guided retrograde drilling of stable OCDT is a feasible, effective, and safe treatment method for pediatric patients.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI-guided retrograde drilling of OCDT provides minimally invasive treatment option for patients who are unresponsive to conservative treatment. It is less invasive compared to surgery and is suitable for outpatient care. Additionally, lack of ionizing radiation makes it considerable treatment choice for pediatric patients.

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## Abstract Archives of the RSNA, 2023

M2-SPMS-1

### STIR Features of Primary Lower Extremity Lymphedema: A Retrospective Analysis of 228 Patients

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

MENGKE LIU (*Presenter*) Nothing to Disclose

#### PURPOSE

The staging of primary lower extremity lymphedema (LEL) is difficult and vital in clinical work. So we investigated the STIR manifestations of primary lower extremity lymphedema (LEL) in different clinical stages.

#### METHODS AND MATERIALS

A retrospective analysis of 228 patients of primary LEL was conducted, all of which underwent MRI examination using a short-time inversion recovery (STIR) sequence. The affected limb MRI manifestation was observed, and patients were divided into stages I, II, and III based on the 2020 International Society of Lymphology (ISL) clinical staging standards. Two radiologists assessed the following characteristics on STIR: the extent of edema, the frequency of MRI manifestations, including dermal thickening (dermal thickness > 2mm), and the morphology of edema in subcutaneous (grid, honeycomb, parallel-lines, banded, crescent, and lymphatic lake). Parallel-lines were thin, 1-2 mm wide, and parallel to the superficial fascia, not forming a network. Grid signs were multiple intertwined lines, up to 3mm wide, with the largest meridian parallel to the superficial fascia and a width-to-length ratio of less than 2/3. Honeycomb signs represented a further thickening of the grid in more than two directions, with a wall thickness greater than 3mm and a width-to-length ratio greater than 2/3. Band sign is an accumulation of fluid on the fascial surface with a strip-like structure observed at the axial level. Crescent sign is a subfascial accumulation observed at the axial level. Lymphatic lake is a large, structureless area of edema located in the subcutaneous soft tissue.

#### RESULTS

The extent of edema was positively correlated with clinical stage, both longitudinally and transversely. When comparing stages, the incidence of dermal thickening in stages II and III were significantly higher than that in stage I. The incidence of parallel-lines in stage I was significantly higher than that in stages II and III. The incidence of grid in stages I and II was significantly higher than that in stage III. The incidence of honeycomb in stages II and III was significantly higher than that in stage I. The incidence of banded sign in stages I and II was significantly higher than that in stage III. The incidence of lymphatic lake and crescent in stage III was significantly higher than that in stages I and II ( $P < 0.05$ ).

#### CONCLUSION

STIR manifestations of primary LEL in different stages have certain characteristics, Parallel line sign is a characteristic sign of stage I, and crescentic sign and lymphatic lake are characteristic signs of stage III. MRI can be an effective auxiliary tool for evaluating the severity of primary LEL.

#### CLINICAL RELEVANCE/APPLICATION

STIR can sensitively diagnose lymphedema and assist in clinical staging.

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## Abstract Archives of the RSNA, 2023

M2-SPNMMI-1

### Virtual Myocardial PET Generated from SPECT-to-PET Translation Model Corrects False High Resting Score in SPECT Due to Photon Attenuation

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Masateru Kawakubo, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Myocardial single photon emission computed tomography (SPECT) is used worldwide for the diagnosis of myocardial ischemia. However, myocardial SPECT with an Anger-type gamma camera has specific artifacts, such as the effect of deep attenuation in the left ventricular inferior wall, that hinder accurate diagnosis. On the other hand, ammonia positron emission tomography (PET) has excellent detector sensitivity and its high-resolution images are considered the gold standard for ischemia diagnosis. We developed an algorithm to generate the virtual PET (vPET) from myocardial SPECT by deep learning network of SPECT-to-PET dataset of the same patient. This research investigates improvement in visual ischemia scoring accuracy of virtual myocardial PET generated by SPECT-to-PET translation (SPT) model.

#### METHODS AND MATERIALS

Fifty-four datasets of N-13 ammonia PET and Tc-99m-methoxyisobutylisonitrile SPECT at stress and resting state were retrospectively analyzed. These myocardial base to apical short-axis image dataset from same patient-to-patient were randomly divided into 34 cases of training datasets (2525 images) and 20 cases of test datasets (1762 images). Summed rest scores (SRS) and summed stress score (SSS) derived from vPET with the SPT model, SPECT, and PET in 20 test cases were blindly and independently assessed and compared among them.

#### RESULTS

SRS of vPET was not differ from those of PET ( $P > 0.999$ ), but those of SPECT was significantly over-estimated than PET ( $P = 0.002$ ) (vPET vs. SPECT vs. PET =  $0.8 \pm 2.0$  vs.  $1.8 \pm 1.5$  vs.  $0.5 \pm 0.4$ ). There were no differences of SSS among vPET, SPECT, and PET (vPET vs. SPECT vs. PET =  $1.5 \pm 2.2$  vs.  $3.4 \pm 3.0$  vs.  $4.1 \pm 5.6$ ).

#### CONCLUSION

Our proposed virtual PET imaging with SPT deep learning model potentially improves visual score based myocardial ischemia diagnosis in SPECT imaging without additional radioisotope injection and the high-cost novel imaging modality. This is the reasonable approach utilizing deep learning because myocardial ischemia diagnosis with standalone SPECT is used worldwide.

#### CLINICAL RELEVANCE/APPLICATION

Virtual PET for correcting attenuation artifact in SPECT is applicable as a low-cost and practical clinical tool which provides powerful auxiliary information for myocardial ischemia diagnosis.

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## Abstract Archives of the RSNA, 2023

M2-SPNMMI-2

### Coronary Artery Bypass Grafting Transiently Improves Myocardial Strain and Myocardial Flow Reserve: An Ammonia PET Study

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Atsushi Yamamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary artery bypass grafting (CABG) is associated with better survival and lower rates of major cardiovascular events in the short and long terms. The patency of bypass grafts has been confirmed using coronary CT angiography; however, the effects of CABG on myocardial strain and microcirculatory functions have not been elucidated. We have made it possible to evaluate left ventricular myocardial strain (LVMS), adapting a feature-tracking technique to electrocardiography-gated high-resolution  $^{13}\text{N}$ -ammonia positron emission tomography (NH<sub>3</sub>-PET). The aim of this study was to evaluate the change of LVMS and myocardial flow reserve (MFR) measured by NH<sub>3</sub>-PET before and after CABG.

#### METHODS AND MATERIALS

Between March 2015 and December 2022, 946 consecutive patients were performed resting and stressed NH<sub>3</sub>-PET because of known or suspected IHD. Patients who underwent NH<sub>3</sub>-PET before and after CABG (mean interval, 6 months) were enrolled. Patients with a transplanted heart, congenital heart disease, adenosine ineffectiveness, or poor imaging were excluded. LVMS was assessed by a feature-tracking technique on the NH<sub>3</sub>-PET cine images of horizontal long-axis slices, and the LVMS ratio (LVMSR) was defined as LVMS at stress divided by that at rest. MFR was calculated using a two-compartment model of the time concentration curve for the first two minutes after ammonia injection. LVMSR and MFR before and after CABG were compared by paired t-test. 11 patients who underwent NH<sub>3</sub>-PET before and after percutaneous coronary intervention (PCI) were analyzed as a comparison group.

#### RESULTS

16 patients who underwent CABG were retrospectively analyzed. LVMSR in the CABG group showed significant improvement with invasive treatment ( $0.99 \pm 0.13$  vs.  $1.15 \pm 0.21$ ,  $p=0.0013$ ). Global MFR increased significantly from baseline to post CABG ( $1.49 \pm 0.42$  vs.  $1.91 \pm 0.51$ ,  $p<0.0001$ ). On the other hand, there was no significant difference in LVMSR before and after PCI ( $1.01 \pm 0.14$  vs.  $1.00 \pm 0.11$ ,  $p=0.87$ ). No significant improvements in global MFR ( $1.83 \pm 0.65$  vs.  $2.12 \pm 0.77$ ,  $p=0.16$ ) were observed in the PCI group.

#### CONCLUSION

CABG transiently improves myocardial strain and MFR significantly. The effect is more pronounced than PCI.

#### CLINICAL RELEVANCE/APPLICATION

This method can reproducibly assess local function before and after revascularization. Furthermore, it has the advantage of detecting ischemia-related wall motion abnormalities, whereas previously only ischemia was evaluated.

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## Abstract Archives of the RSNA, 2023

M2-SPNPM-2

### Radiology Practice Size Distribution Pre- and Post-COVID-19 Pandemic

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Kyle Tegtmeyer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Prior investigations by Rosenkrantz et. al in 2019 have demonstrated a trend of consolidation of radiology groups in the mid-2010s. However, little is known about changes in radiology practice group size and numbers spanning the COVID-19 pandemic. This study seeks to investigate consolidation trends within radiology practice groups before and after the COVID-19 pandemic.

#### METHODS AND MATERIALS

Data on radiologists and their associated practice affiliations were obtained for 2017 and early 2023 from the Physician Compare national database provided by the Centers for Medicare and Medicaid Services. Calculations of unique radiology practice groups and number of unique associated national provider identifier (NPI) numbers associated with each radiology group were performed using R 4.2.2.

#### RESULTS

The number of unique radiologists nationally increased between 2017 and 2023 from 32060 to 34080. Between 2017 and 2023, the number of radiology practices decreased from 3909 to 3455 unique practice entities. The median number of radiologists per practice remained 6 between 2017 and 2023, but the mean practice size increased from 13.9 to 19.0 unique radiologists, indicating a growing skew towards larger groups. The top 10 groups by size increased from including 2411 unique radiologists in 2017 to 3554 unique radiologists in 2023. The top 10 groups by size in 2023 include 3 groups not previously within the top 100 groups by size; the top ranked group by size in 2023 ranked 39th in size in 2017. The number of unique NPI-Practice group pairs has increased from 54,274 in 2017 to 65,664 in 2023; the average radiologist increased billing from under an average of 1.69 to 1.93 distinct practice entities from 2017 to 2023. Analysis by group size demonstrates relative growth in number of radiology practices with >25 radiologists, with a 119% relative increase in number of groups with 100+ radiologists. Geographic analysis demonstrates a relative increase of proportion of groups located within the western census region of approximately 10%, with relative decreases in the remaining regions.

#### CONCLUSION

Consolidation of radiology practice groups has continued through the COVID-19 pandemic from 2017 to 2023, with fewer unique practices and higher average number of radiologists per practice. The greatest growth is seen among practices with 100+ radiologists, highlighting the high degree of consolidation in recent years among the largest groups in the US. At least some of this consolidation appears to be due to greater number of distinct practice entities under which radiologists are billing.

#### CLINICAL RELEVANCE/APPLICATION

Increasing consolidation of radiology practices was seen between 2017 and early 2023, with the largest growth seen in practices with 100 or more radiologists.

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## Abstract Archives of the RSNA, 2023

M2-SPNPM-3

### Reducing Energy Consumption in MRI using Shorter Scan Protocols, Optimized Magnet Cooling Patterns and Deep Learning Sequences: How Low Can We Go

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Saif Afat, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to investigate energy consumption in MRI scanners and identify strategies for improving energy efficiency in radiology departments and practices. We focused on musculoskeletal MRI and assessed the potential savings achievable through optimizing protocols, incorporating deep learning (DL) accelerated acquisitions, and optimizing the cooling system.

#### **METHODS AND MATERIALS**

Energy consumption measurements were performed on three MRI scanners (1.5T Aera, 1.5T Sola, 3T Skyra) in practices in Munich, Germany, between December 2022 and March 2023. Two levels of energy reduction measures, eco protocols and DL accelerated sequences, were implemented and compared to baseline. Analysis was conducted in R and Python to evaluate the average, median, and standard deviations of sequence scan times and energy consumption.

#### **RESULTS**

Our findings showed significant energy savings by optimizing protocol settings alone, with knee imaging achieving a 21% energy consumption reduction and 22% time reduction. Implementing DL technologies led to a 37% energy consumption reduction and a 46% time reduction compared to baseline. Optimizing the magnet cooling strategy resulted in a 23.2% reduction during off-cycles.

#### **CONCLUSION**

Implementing energy-saving strategies, including eco protocols, DL accelerated sequences, and optimized magnet cooling, can significantly reduce energy consumption in MRI scanners without compromising image quality or operational efficiency. Radiology departments and practices should consider adopting these strategies to improve energy efficiency and reduce costs.

#### **CLINICAL RELEVANCE/APPLICATION**

Reducing energy consumption in MRI scanners has environmental, financial, and operational implications for radiology departments and practices. Implementing energy-saving strategies can help address the growing demand for medical devices while reducing energy costs and greenhouse gas emissions.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-SPNR-1

### Multiscale Principal Gradient Alterations in Subcortical-Cortical Connectome as Potential Biomarkers for Memory Impairments in Major Depressive Disorder

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Qian Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

Major depressive disorder (MDD) is associated with functional abnormalities in subcortical networks, which contribute to clinical symptoms and cognitive impairments. This study introduces a new approach, functional gradient mapping, to identify hierarchical organization in subcortical connectivity patterns and evaluate their relationship with cognitive features.

#### METHODS AND MATERIALS

Resting-state fMRI studies were conducted on 145 never-treated first-episode MDD patients and 145 healthy controls (HCs). The voxel-wise gradient distributions of the subcortical-cortical connectome were mapped, and group-averaged gradient values were compared across all subcortical voxels, three main systems (limbic, thalamic, and basal ganglia), structural subregions, and functional subregions related to specific cortical functional networks. The study also assessed the association between significant gradient alterations and neuropsychological functioning.

#### RESULTS

The principal gradient values were organized along a gradual anterior-posterior axis across subcortical structures in MDD patients, which varied across different subcortical systems and subregions relative to HCs. At the system level, principal gradient values were lower in the thalamic and limbic systems but higher in the basal ganglia (BG) striatal system in the MDD group. Within subcortical functional subfields, MDD patients had lower gradient values in all limbic subregions and higher gradient values in thalamic subregions projecting to the frontoparietal network but lower values in other thalamic-subregions. Higher gradient values were observed in BG subregions projecting to FPN and visual networks, but lower gradient values were observed in BG regions projecting to sensorimotor, default mode (DMN), and ventral attention network (VAN). Notably, altered principal gradient values of the thalamic system and the subregion projecting to DMN were positively associated with episodic memory test performance in MDD patients, while the BG region projecting to VAN was negatively linked.

#### CONCLUSION

Multiscale principal gradient alterations of the subcortical-cortical connectome reflected hierarchical disorganization underlying functional segregation in MDD. The interactive associations of thalamic and BG gradient alterations were implicated in subcortical functional connectivity disturbance and episodic memory impairments in MDD patients, revealing an internally differentiated and clinically relevant pattern of subcortical gradient dysfunction in MDD.

#### CLINICAL RELEVANCE/APPLICATION

These findings enhanced our understanding of MDD-related hierarchical pathology and presented potential intervention biomarkers for memory improvements in MDD.

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## Abstract Archives of the RSNA, 2023

M2-SPNR-10

### Volume Reduction in Hippocampal Subregions is Associated with Cognitive Impairment in Patients with Cerebral Small Vessel Disease

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Na Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral small vessel disease (CSVD) is a chronic disease that can lead to mental and psychiatric impairment. As a key brain region for memory and learning, the volume change in the hippocampus may play an important role in cognitive impairment in patients with CSVD, but the specific mechanism is still unknown. The purpose of this article is to compare the volume changes in hippocampal subregions in patients with severe CSVD (CSVD-S), patients with mild CSVD (CSVD-M) and healthy controls (HCs) to investigate the influencing factors of cognitive differences in patients with CSVD.

#### METHODS AND MATERIALS

Sixty-seven CSVD-S patients, 150 CSVD-M patients and 98 healthy controls underwent magnetic resonance imaging (MRI) and cognitive tests. FreeSurfer was used to automatically segment the hippocampus from high-resolution MRI and extract the volume data of 19 subregions. One-way analysis of variance was used to compare the volume differences in hippocampal subregions among the three groups, and the correlation between regions of interest (ROIs) and cognitive test results in the CSVD groups was analyzed. In addition, stepwise regression analysis was performed to correlate the ROIs with multiple risk factors in the CSVD groups.

#### RESULTS

We found significant differences in the volumes of the presubiculum-body, head of granule cell and molecular layer of the dentate gyrus (GC-ML-DG-head), fimbria and hippocampus amygdala transition area (HATA) among the three groups ( $p < 0.003$ , Bonferroni correction), and the volumes of the CSVD-S group were significantly smaller than those of the HC group ( $p < 0.003$ ). Bivariate correlation analysis showed that these four subregions were correlated with the Stroop color-word test (SCWT), and the GC-ML-DG-head and fimbria were also correlated with the Montreal cognitive assessment (MoCA) ( $p < 0.013$ ) in the CSVD groups. Influencing factors of the four subregions included age, gender, smoking, hyperlipidemia and hypertension. Mediation analysis showed that the average volume of the 4 ROIs partially mediated the relationship between drinking and SCWT scores.

#### CONCLUSION

The volume reduction of some hippocampal subregions can aggravate cognitive impairment in patients with CSVD, and the decreased volume of hippocampal subregions was associated with age, gender, smoking, hyperlipidemia and hypertension. The volume of 4 ROIs mediates cognitive function in CSVD patients with drinking.

#### CLINICAL RELEVANCE/APPLICATION

Maintaining good living habits and paying more attention to blood pressure and blood lipids can help to reduce the cognitive impairment caused by CSVD.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPNR-11

### Regional High Iron Deposition on Brain Quantitative Susceptibility Mapping Correlates with Decreased Cognitive Function in End Stage Renal Disease

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Yuan Li (*Presenter*) Nothing to Disclose

#### PURPOSE

The end-stage renal disease (ESRD) patients usually have increased brain iron depositions. This study aimed to quantitatively evaluate the brain iron deposition in patients with ESRD by threshold method of quantitative susceptibility mapping (QSM), and to analyze the correlation between the iron deposition and cognitive function.

#### METHODS AND MATERIALS

Thirty-four ESRD patients and 45 healthy controls (HCs) were prospectively recruited. All subjects were scanned using a 3T MRI to acquire strategically acquired gradient echo (STAGE) sequence. The mean magnetic sensitivity values (MSV) and volume (MSVM, VM) and high iron region (MSVH, VH) of bilateral caudate nucleus (CN), putamen (PUT), globus pallidus (GP), substantia nigra (SN), red nucleus (RN) and dentate nucleus (DN) in both groups were measured manually (Figure 1). All QSM data was compared between groups using analysis of covariance. Neuropsychological examination results were compared between the two groups by two-sample t tests or Mann-Whitney U tests. Partial correlation analysis was used to assess correlations between the MSVH, VH/VM data and cognitive test scores in the ESRD group, with gender, age and education level as covariates. Multiple comparisons of all statistical values were corrected by false discovery rate (FDR). A statistically significant P-value was set at 0.05.

#### RESULTS

Compared with HCs, the MSVM of bilateral PUT, DN and right RN were decreased (Table 1), the VM of all gray matter nuclei were decreased, and the MSVH and VH/VM of bilateral CN, PUT, DN and right SN were increased in ESRD patients ( $P < 0.05$ , FDR corrected)(Figure 2). Patients with ESRD had lower MoCA and DSST scores but higher TMT-A, TMT-B, HAMA, HAMD and BDI-II scores (Table 2). The partial correlation analysis showed that the MSVH of the bilateral RN was negatively correlated with orientation scores (left:  $P = 0.002$ ,  $r = -0.568$ ; right:  $P < 0.001$ ,  $r = -0.651$ )(Figure 3).

#### CONCLUSION

The iron deposition of gray matter nuclei increased as well as volume decreased in ESRD patients. The MSV in high iron areas can better assess the distribution of iron and is related to the cognitive dysfunction.

#### CLINICAL RELEVANCE/APPLICATION

Previous studies were based on the mean MSV of gray matter nuclei in ESRD patients, but since the distribution of iron is uneven, we further divided the gray matter nuclei into high iron area according to the threshold, which can sensitively reflect the abnormal distribution of brain iron and cognitive impairment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPNR-12

### Cerebral Blood Flow Changes in Patients with End Stage Renal Disease: A Study Based on Pseudo-continuous Arterial Spin Labeling

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Yuan Li (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients with end-stage renal disease (ESRD) lead to cerebral hemodynamic instability. This study aimed to quantitatively evaluate the cerebral blood flow (CBF) alteration in patients with ESRD and to analyze the correlation between the CBF with cognitive and clinical indicators.

#### METHODS AND MATERIALS

Thirty-five ESRD patients and 46 healthy controls (HCs) were prospectively recruited. All subjects were scanned using a 3T MRI to acquire pseudo-continuous arterial spin labeling (pCASL) sequence. The relative values of cerebral blood flow (rCBF) of the whole brain was measured using SPM8. All CBF data was compared between groups using analysis of covariance. Neuropsychological examination scores and laboratory indexes were compared between the two groups by two-sample t tests or Mann-Whitney U tests. Partial correlation analysis was used to assess correlations between the CBF data, cognitive test scores and blood biochemical test in the ESRD group, with gender, age and education level as covariates. A statistically significant P-value was set at 0.05.

#### RESULTS

Compared with the HCs, the ESRD group exhibited lower rCBF in the bilateral thalamus and putamen (Figure 1, Table 1)( $P < 0.05$ , FDR corrected). There were significant differences in the levels of RBC, HB, Cre, eGFR, UA and HCY between the two groups (all  $P < 0.05$ ). Patients with ESRD had lower MoCA and DSST scores but higher TMT-A, HAMA, HAMD and BDI-II scores (Table 3). The partial correlation analysis showed that the rCBF of the bilateral thalamus were positively correlated with HCY (left:  $P = 0.010$ ,  $r = 0.449$ ; right:  $P = 0.005$ ,  $r = 0.486$ ), the rCBF of the left putamen was negatively correlated with the MoCA scores ( $P = 0.010$ ,  $r = -0.447$ ), the rCBF of the right thalamus was negatively correlated with the orientation scores ( $P = 0.016$ ,  $r = -0.421$ ), the rCBF of the left putamen was negatively correlated with the delayed recall scores ( $P = 0.002$ ,  $r = -0.528$ ), and the right putamen was negatively correlated with the attention scores ( $P = 0.047$ ,  $r = -0.353$ )(Figure 2).

#### CONCLUSION

The cerebral blood flow in bilateral putamen and thalamus decreased in patients with ESRD, which correlated with HCY level and neurocognitive scores.

#### CLINICAL RELEVANCE/APPLICATION

Patients with ESRD have cerebral hemodynamic imbalances and may suffer from a range of complications. So we used arterial-spin labeling MR imaging to non-invasively and quantitatively evaluate cerebral blood flow changes in patients with ESRD, and analysis the correlation between these changes and cognitive impairment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPNR-13

### Visceral Abdominal Adipose Tissue and Insulin Resistance Respectively Influence Alzheimer's Disease Amyloid Pathology and Neurodegeneration in Midlife

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Mahsa Dolatshahi, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Obesity and adiposity at midlife, evidenced by high body mass index (BMI), are increasingly understood as risk factors for Alzheimer's disease (AD). Importantly, visceral fat is known to be associated with insulin resistance and a proinflammatory state, the mechanisms involved in AD pathology. Herein, we aimed to assess the association between brain MRI volumes as well as amyloid and tau uptake with obesity, insulin resistance, and abdominal adipose tissue in the cognitively normal midlife population.

#### METHODS AND MATERIALS

A total of 34 middle-aged (age:  $51.27 \pm 6.12$  years, BMI:  $32.28 \pm 6.39$  kg/m<sup>2</sup>), cognitively normal participants, underwent bloodwork, brain, and abdominal MRI, as well as amyloid and tau PET scan. Homeostatic Model Assessment for Insulin Resistance (HOMAIR)  $> 1.9$  was used as a measure of insulin resistance. Visceral and subcutaneous adipose tissue (VAT, SAT) were semi-automatically segmented using VOXel Analysis Suite (Voxa). FreeSurfer 7.1.1 was used for the automatic segmentation of cortical and subcortical brain regions using a probabilistic atlas. Dynamic amyloid imaging was performed with a bolus injection of  $\sim 15$  mCi of [<sup>11</sup>C]PiB, followed by a 60-min scan. A single intravenous bolus of between 7.2-10.8 mCi of AV-1451 was administered. Data from the 30-60 minute, and 80-100 minute post-injection window for PiB and AV-1451 were used for the analysis, respectively. The association of brain volumes and PiB and AV-1451 standardized uptake value ratios (SUVRs) within the default mode network areas with BMI and VAT/SAT ratio were assessed using linear regression models.

#### RESULTS

We observed lower right entorhinal white matter volumes in obese participants with insulin resistance compared to metabolically normal non-obese group ( $p=0.004$ ), without any significant difference in PiB or AV-1451 SUVRs. Regression models with sex, age and education as covariates showed a significant positive association between VAT/SAT ratio and left precuneus white matter PiB SUVRs ( $R^2=0.31$ ,  $p=0.005$ ), but no significant associations with AV-1451 SUVRs.

#### CONCLUSION

In our midlife obese sample with insulin resistance, there was lower right entorhinal white matter volume, which is involved in relaying information to the hippocampus. We also demonstrated higher early amyloid pathology in AD-signature areas such as the precuneus in mid-life persons with high VAT/SAT ratio, a marker of visceral obesity.

#### CLINICAL RELEVANCE/APPLICATION

These findings prompt designing interventions targeted at reducing abdominal visceral fat, obesity, and insulin resistance in midlife to prevent against Alzheimer disease pathology and neurodegeneration.

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## Abstract Archives of the RSNA, 2023

M2-SPNR-14

### Utility of Quantifying the Glymphatic System Activity using Diffusion Tensor Image Analysis Along the Perivascular Space (DTI-ALPS) in Mild Cognitive Impairment (MCI), Compared to the Cerebrospinal Fluid (CSF) Biomarker

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Hiroto Takahashi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Identifying early Alzheimer's disease (AD) would offer better disease management. The cerebrospinal fluid (CSF) biomarker is sensitive to neurodegeneration in dementia. Dysfunction of the glymphatic system has been revealed to be associated with various diseases including AD. We evaluated the activity of the glymphatic system in mild cognitive impairment (MCI) with a diffusion-based technique called diffusion tensor image analysis along the perivascular space (DTI-ALPS) to explore the imaging biomarker for assessing early dementia, while comparing the CSF biomarker level.

#### METHODS AND MATERIALS

Sixty-two patients with MCI underwent both CSF measurement and diffusion magnetic resonance imaging at 3T. No hyperintensities in the periventricular white matter were observed in all subjects on T2-weighted images. Based on the CSF p-tau/A $\beta$ 42 ratio value, 33 patients with AD pathology (AD group) were discriminated from 29 patients with non-AD pathology (non-AD group). Diffusivities in the X, Y and Z axes were obtained in the lateral ventricle body plane of all subjects. We assessed the diffusivity along the perivascular spaces, as well as projection fibers and association fibers, respectively in order to acquire the DTI-ALPS index of each hemisphere. The significance of intergroup difference in the DTI-ALPS index was tested using Mann-Whitney's U test. The performance of the DTI-ALPS index to discriminate the groups was assessed using receiver operating characteristic (ROC) analysis. Correlations between the DTI-ALPS index and each CSF amyloid  $\beta$  (A $\beta$ ) 42, phosphorylated tau (p-tau) and total tau (t-tau) value were assessed in all subjects using Pearson's correlation analysis.

#### RESULTS

The DTI-ALPS indices of both hemispheres were higher in the AD group than those of the non-AD group (Right: 1.72/1.59 for AD group/non-AD group; P value was 0.056; Left: 1.61/1.44 for AD group/non-AD group; P value was 0.002, indicating significant intergroup difference). The respective areas under the ROC curve of the DTI-ALPS index of the right/left hemispheres were 0.64/0.73. The DTI-ALPS indices of both hemispheres showed significant correlation with each p-tau value (r: 0.26/0.28 for right/left) and t-tau value (r: 0.28/0.31 for right/left), whereas no significant correlation with the CSFA $\beta$  42 value was identified, in all subjects.

#### CONCLUSION

Impairment of the glymphatic system was more observed in non-AD pathology than in AD pathology in MCI. The DTI-ALPS index might be useful for discriminating early AD from other dementias as well as for measuring neurodegeneration in MCI.

#### CLINICAL RELEVANCE/APPLICATION

Quantifying the activity of the glymphatic system may be a useful biomarker for diagnosing early AD as well as for measuring neurodegeneration in early dementia.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPNR-3

### Evaluate Depression in Parkinson's Disease with a Multi-Flip-Angle and Multi-Echo Gradient Echo Sequence (Multiplex) MRI

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

He Sui, MD,MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Previous multimodal MRI has proven to be a useful imaging approach for both clinical diagnosis and research investigating, however, studies of Parkinson's disease (PD) have focused primarily on motor-related basal ganglia structures and little research has been done on clinical scale indicators. In this experiment, we used multiparametric MRI to detect changes related to non-motor symptoms (NMS) in patients with PD.

#### METHODS AND MATERIALS

We included 37 patients with PD diagnosed by two neurologists from August to December 2021 in our hospital in this retrospective study. Hamilton Depression Scale (HAMD) were used to assess the PD patients. 3D TIWI and Multi-Flip-Angle and Multi-Echo Gradient Echo Sequence (Multiplex) MRI techniques such as T2<sup>\*</sup>-, T1-, PD-mapping and quantitative susceptibility mapping (QSM) were performed using a 3T MR scanner. The regions of interest of the whole brain were depicted according to automatic brain segmentation based on deep learning. The Spearman's rank correlation coefficient was used to analyze the relationship between volume, relaxation value of each brain subregion and NMS related assessment scales

#### RESULTS

Among parkinsonian subjects, we found that left paracentral, precuneus on both sides, and right superior temporal gyrus in MTP-QSM, right frontal pole and left lateral occipital gyrus on MTP-T2<sup>\*</sup> mapping showed correlations with HAMD. Volume of the left superior frontal gyrus, middle frontal gyrus on both sides, left frontalpole, insula on both sides, right middle cingulate gyrus, right entorhinal cortex, right superior temporal gyrus, right middle temporal gyrus and optic chiasm showed negative correlations with HAMD on 3D TIWI images. The indicators in MTP-T1 mapping and PD mapping do not have a clear correlation with HAMD.

#### CONCLUSION

There is a certain degree of correlation between Multiplex MRI and some clinical evaluation indicators related to depression of PD, we suggest the fusion of quantitative multiparametric neuroimaging measures as an effective strategy that could generally cope with early diagnosis of PD.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative multiparametric neuroimaging measures may serve as an effective strategy for non-invasively characterizing the Parkinson's disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPNR-4

### The Impact of Amyloid & Cerebral Small Vascular Disease on Glymphatic Function: A Study Based on Alzheimer's Disease Continuum Participants

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Hui Hong, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Glymphatic dysfunction is a crucial pathway for dementia. Alzheimer's Disease (AD) pathologies co-existing with cerebral small vessel disease (CSVD) is the most common pathogenesis for dementia. We hypothesize that AD pathologies and CSVD could be associated with glymphatic dysfunction, contributing to cognitive impairment.

#### METHODS AND MATERIALS

Participants completed with amyloid PET, diffusion tensor imaging (DTI) and T2FLAIR sequences were included from the Alzheimer's Disease Neuroimaging Initiative (ADNI). White matter hyperintensities (WMH) as the most common CSVD marker was evaluated from T2FLAIR images and represented the burden of CSVD, amyloid PET was used to assess A $\beta$  aggregation in the brain, and DTI-ALPS calculated from DTI reflected glymphatic function. We used correlation analysis to investigate the relationship between WMH burden/A $\beta$  aggregation and DTI-ALPS and the correlations of DTI-ALPS with cognitive domains. Next, mediation analysis was carried out to explore the mediating effects of DTI-ALPS between WMH burden/ A $\beta$  aggregation and cognitive domains.

#### RESULTS

One hundred and thirty-three participants along the AD continuum were included, consisting of 40 CN-, 48 CN+, 26 MCI+, and 19 AD + participants. We found both WMH burden ( $r = -0.432$ ,  $p < 0.001$ ) and whole brain A $\beta$  aggregation ( $r = -0.268$ ,  $p = 0.003$ ) were independently negatively associated with DTI-ALPS. There were no interaction effects of A $\beta$  aggregation and WMH burden on DTI-ALPS ( $\beta = 0.109$ ,  $p = 0.260$ ). DTI-ALPS was positively associated with memory ( $r = 0.470$ ,  $p < 0.001$ ), executive function ( $r = 0.356$ ,  $p < 0.001$ ), visual-spatial function ( $r = 0.241$ ,  $p < 0.040$ ), and language performance ( $r = 0.391$ ,  $p = 0.007$ ). In the mediation analysis, we found that DTI-ALPS mediated the relationship of WMH burden/A $\beta$  with memory, executive and language performance.

#### CONCLUSION

Our study provided evidence that both AD pathology (A $\beta$ ) and CSVD were associated with glymphatic dysfunction, which is further related to cognitive impairment.

#### CLINICAL RELEVANCE/APPLICATION

Our results may provide a theoretical basis for glymphatic function intervention for treating AD.

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## Abstract Archives of the RSNA, 2023

M2-SPNR-5

### **Discordant Hippocampal Atrophy and Cerebral Hypometabolism in Alzheimer's Disease Subjects with Confirmed $\beta$ -amyloid Positivity**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Gavin Yuan, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Hippocampal atrophy on MRI and cerebral hypometabolism on FDG-PET are both widely used biomarkers of Alzheimer's disease (AD). Clinically, hippocampal volumes and FDG-avidity are assessed in comparison to age-matched reference groups, but accuracy of such methods have largely been tested in cohorts without biomarker-confirmed AD. Here, we examined the accuracy of MRI and FDG-PET in amyloid-positive AD, at the single-subject level, and factors that could be associated with structural-metabolic discordance.

#### **METHODS AND MATERIALS**

We included 108 subjects with AD (age 74.5 $\pm$  8.2 years, 59:49 males: females) from the Alzheimer's Disease Neuroimaging Initiative (ADNI), with a positive 18F-florbetapir amyloid PET scan, who underwent FDG-PET and volumetric MRI. 179 amyloid-negative, normal controls (age 75.1 $\pm$  6.9 years, 97:82 males:females) served as the age-matched reference group. Bilateral hippocampal volumes were segmented using  $\beta$ Freerfer v7.1.1, averaged, and normalized by intracranial volume. The same  $\beta$ Freerfer regions were applied to the coregistered FDG-PET and normalized by the pons. A threshold of 1.5 standard deviations below the reference group defined biomarker abnormality (e.g. presence of hippocampal atrophy or cerebral hypometabolism). Two-by-two contingency tables were used to assess concordance/discordance between hippocampal atrophy and hypometabolism. Statistical analyses were performed in STATA 16, and group differences were assessed using the Kruskal-Wallis or Fisher's Exact Tests.

#### **RESULTS**

Hippocampal atrophy correctly classified 40/108 (37%) subjects as AD, whereas precuneus cerebral hypometabolism correctly classified 51/108 (47%) subjects. Structural-metabolic discordance was seen in 47/108 (44%) subjects. Individuals with higher Fazekas scores were less likely to have hippocampal atrophy (OR 0.56,  $p=0.015$ ) or cerebral hypometabolism (OR 0.62,  $p=0.04$ ). Older individuals were less likely to have cerebral hypometabolism (OR 0.93,  $p=0.007$ ). Some subjects without a typical pattern of temporoparietal hypometabolism had significantly decreased FDG avidity in the caudate (5/108) and thalamus (3/108).

#### **CONCLUSION**

Cerebral hypometabolism on FDG-PET and hippocampal atrophy on MRI each detected less than half of the amyloid-confirmed AD subjects. Discordance was high, suggesting that other factors, including age and microvascular disease, could affect the sensitivity of these biomarkers. Notably, the caudate and thalamus were atypical areas of hypometabolism that warrant further investigation.

#### **CLINICAL RELEVANCE/APPLICATION**

Knowing the limitations of clinically used quantitative AD biomarkers is important for appropriate management.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPNR-6

### Defining the Relationship Between Mesial Temporal Atrophy and CSF Biomarkers in Amnesic Mild Cognitive Impairment

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Allison K. Sullivan, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

The NIA-AA research framework introduced a classification scheme to define and stage the pathologic processes leading to Alzheimer's disease (AD) using three groups of biomarkers: biomarkers of  $\beta$ -amyloid deposition, neurofibrillary tangles deposition, and neurodegeneration. Our aim was to evaluate the differences in mesial temporal atrophy rate among amnesic mild cognitive impairment (MCI) patients with normal CSF biomarkers, CSF biomarkers indicating abnormal  $\beta$ -amyloid deposition (A+), and abnormal CSF biomarkers without  $\beta$ -amyloid deposition.

#### METHODS AND MATERIALS

We retrospectively identified 401 elderly patients from the Alzheimer's Disease Neuroimaging Initiative cohort, 243 with a diagnosis of amnesic MCI and 158 cognitively unimpaired (CU). MCI patients were classified into three groups: normal biomarkers ( $n = 46$ ), Alzheimer's continuum (A+,  $n = 144$ ), and non-AD pathologic change (all other biomarker profiles,  $n = 53$ ). Hippocampal (HV) and entorhinal cortex (ERCV) volumes were calculated from brain MRI obtained during the first and second year of study participation. We then evaluated group differences over time using mixed model Analysis of Covariance procedures. Results were considered statistically significant when  $p < 0.05$ .

#### RESULTS

HV and ERCV atrophy rates differed among groups of subjects when controlling for age (HV:  $F = 20.45$ ,  $p < 0.001$ ; ERCV:  $F = 11.86$ ,  $p < 0.001$ ). HV atrophy rate was greatest in the MCI A+ group than all other groups. Worse ERCV atrophy rates were observed in the MCI A+ group than CU elderly individuals and MCI subjects with non-AD pathologic change.

#### CONCLUSION

Mesial temporal atrophy rate is worse in MCI subjects with abnormal  $\beta$ -amyloid deposition (A+) than other MCI individuals.

#### CLINICAL RELEVANCE/APPLICATION

Understanding structural brain differences among patients with different biomarker profiles will enhance the design of clinical trials targeting MCI subjects, especially when MRI markers of neurodegeneration are employed as endpoint.

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## Abstract Archives of the RSNA, 2023

M2-SPNR-7

### PET-based A $\beta$ Quantification and Volumetric Comparisons in A $\beta$ -classified Patients

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Priya Santhanam, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to identify associations between PET-based quantification of amyloid- $\beta$  (A $\beta$ ) and MR brain volumetrics in patients with or without radiological presence of A $\beta$  plaques.

#### METHODS AND MATERIALS

Patients (n=164; mean age=75.1 years) who were clinically identified as having mild cognitive impairment (MCI) and/or Alzheimer's dementia underwent 3T MRI anatomical imaging and PET CT imaging using A $\beta$  binding tracers Amyvid or Vizamy. Neuroradiologist interpretation of PET-imaging allowed patients to be classified as positive (n=89; A $\beta$ +) or negative (n=75; A $\beta$ -) for A $\beta$  presence. NeuroQuant (v3.0) was used to obtain normalized percentile volumes in regions of interest for this patient population (based on previous findings), which were then compared between A $\beta$ + and A $\beta$ - groups. Quantified A $\beta$  tracer in these same regions acquired through newly-available PETQuant (3.0.2) software was also compared between groups. Finally, the statistical association between volumetrics and PET A $\beta$  quantities within regions was assessed via regression modeling.

#### RESULTS

PET-based A $\beta$  quantities were significantly higher in A $\beta$ + patients for bilateral amygdala (p<0.001), entorhinal cortex (p<0.001), hippocampus (left: p=0.001, right: p=0.002), and parahippocampal regions (p<0.001) as compared to A $\beta$ - patients. Additionally, normalized percentile volumes were significantly lower in the A $\beta$ + group for bilateral amygdala (left: p=0.001, right: p=0.005), left hippocampus (p=0.009), and bilateral parahippocampus (left: p=0.003, right: p=0.033). A regression model further identified significant associations between A $\beta$  quantity and volumetric percentile in the left entorhinal cortex (p=0.005), bilateral hippocampus (left: p=0.009, right: p=0.038), and right parahippocampus (p=0.046).

#### CONCLUSION

Decreased volumes and increased A $\beta$  quantities in limbic regions were observed in patients with clinical A $\beta$  positivity. In combination, NeuroQuant and PETQuant metrics provide a useful supplement to radiological examination in patients with MCI or Alzheimer's dementia. Further analysis is needed to determine any predictive value for patient classification and outcomes.

#### CLINICAL RELEVANCE/APPLICATION

A $\beta$  classification in patients with MCI or Alzheimer's dementia can be further informed by quantified metrics of volume and A $\beta$  tracer quantities in limbic regions.

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## Abstract Archives of the RSNA, 2023

M2-SPNR-8

### The Study of Total Load of Imaging Combined with Cognition on Cerebral Small Vessel Disease in High Altitude Areas

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Hai Hua Bao (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral small vessel disease (CSVD) is the most common cerebrovascular disease that can result in disability and cognitive decline in older adults. Owing to the unique environmental conditions, research on cerebral small vessel disease in high altitude areas is limited. The purpose of this study was to investigate whether altitude can affect cognitive function in patients with CSVD, and to evaluate the correlation between total imaging load and cognitive scores.

#### METHODS AND MATERIALS

A total of 56 patients with CSVD who were admitted to the Department of Neurology of the Affiliated Hospital of Qinghai University were included in the study, according to the altitude, it is divided into middle altitude group (1500-2500 meters, n=30) and high altitude group (2500-4500 meters, n=26). Use Prisma 3.0 T magnetic resonance to perform head T1WI, T2WI, T2Flair, DWI, SWI and MRA scans, evaluate CSVD imaging markers and calculate the total load (0-4 points, the severity of the disease is proportional to the score). After the scan, the Cambridge Automated Neuropsychological Test Battery (CANTAB) was used to evaluate the cognitive abilities of all patients, including motor screening task (MOT), reaction time (RTI), rapid visual information processing (RVP), paired association learning (PAL), delayed matching to sample (DMS), spatial working memory (SWM), psychomotor speed, sustained attention, memory ability, and executive function were assessed separately. Data analysis was performed using SPSS 25.0 software.

#### RESULTS

When the total load score was 0 or 1, The high altitude group performed poorly in the DMS test( $P=0.019$ ) and the RIT test( $P=0.024$ ); When the score was 2, there was statistically significant difference between the two groups in DMS ( $P=0.004$ ); when the score was 3 or 4, there was no statistical difference in the test results between the two groups ( $P>0.05$ ). The CSVD total load score was positively correlated with DMSMLAD, DMSMLS, and MOTML ( $r=0.614, 0.727, 0.448$ , all  $P<0.05$ )

#### CONCLUSION

With the increase in altitude, the memory ability and psychomotor speed of CSVD patients decreased more significantly. In addition, with the aggravation of CSVD, memory ability and psychomotor speed will also decrease.

#### CLINICAL RELEVANCE/APPLICATION

Cognitive function decline is more serious in patients with cerebral small vessel disease at high altitude, and it is very important to strengthen early diagnosis and clinical intervention for patients in high altitude areas.

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## Abstract Archives of the RSNA, 2023

M2-SPNR-9

### Brain Cortical Complexity and Subcortical Morphometrics in T2D with Microvascular Complication

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Linqing Fu (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the relationship between the change of cerebral gray matter volume and cognitive function in type 2 diabetes patients with microvascular complication (T2D-C), and to analyze how the change of cerebral gray matter volume and cognitive function are causal links through mediators.

#### METHODS AND MATERIALS

39 normal controls, 39 type 2 diabetes patients without microvascular complication (T2D), and 39 T2D-C patients were recruited for 3D T1weighted imaging (3D T1WI) scanning and neuropsychological scale testing. Voxel-based morphology (VBM) was used to analyze and compare the differences in gray matter volume and neuropsychological scale among the three groups, then the mean gray matter volume of different brain regions between groups was used for partial correlation analysis with the scores of cognitive assessment scales such as Montreal cognitive assessment (MoCA) and biochemical indicators such as HbA1c.

#### RESULTS

With  $p < 0.05$  as the test level of statistical difference, the brain regions with the statistical difference in gray matter volume among the three groups were located in the calcarine, thalamus, left putamen, and left precentral gyrus. Compared with T2D group, the volume of gray matter in the thalamus and left putamen in T2D-C group decreased. Partial correlation analysis showed that the thalamic gray matter volume and left putamen in T2D-C patients were negatively correlated with fasting blood glucose, positively correlated with HOMA2-%B, and negatively correlated with TMT-A score. Mediation analysis found that the direct effect of fasting blood glucose on TMT-A was not significant, but the indirect effect was significant, that is, the gray matter volume of the left putamen played a complete intermediary role in the relationship between fasting blood glucose and TMT-A.

#### CONCLUSION

In T2D-C patients, there are extensive areas of reduced gray matter, and the change in gray matter volume is related to cognitive decline.

#### CLINICAL RELEVANCE/APPLICATION

Early detection of cognitive impairment in T2D patients and targeted intervention can delay the progression of cognitive decline.

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## Abstract Archives of the RSNA, 2023

M2-SPPD-1

### Diffusion and Perfusion Properties of Fetal Brain and Placenta in Fetuses Affected by Intrauterine Growth Restriction (IUGR): A Preliminary IVIM MRI Study

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Roberta Ninkova, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the potential use of Intravoxel Incoherent Motion (IVIM) imaging in the study of microperfusion and microstructural characteristics of fetal brain and placenta in Intrauterine Growth Restriction (IUGR) fetuses, comparing IVIM parameters with those of a healthy control group.

#### METHODS AND MATERIALS

112 pregnancies (30 IUGR; 82 normal) were enrolled. MR examinations were performed at 1.5 T, using a DWI sequence with 10 different b-values (0,10,30,50,75,100,200,400,700,1000 s/mm<sup>2</sup>). For each fetus, specific ROIs were manually placed on fetal and maternal sides of each placenta, and for fetal brain on the following areas: centrum semi-ovale (CSO), frontal and occipital white matter (FWM, OWM), basal ganglia (BG), thalamus (TH), cerebellar hemisphere (CH) and pons. Differences of mean values of perfusion fraction (f), diffusion coefficient (D), and pseudo-diffusion coefficient (D\*) and their correlation with Gestational Age (GA) and Birth Weight (BW) were investigated in both IUGR and control group.

#### RESULTS

We found that in the fetal side of placenta, f allowed to discriminate SGA (Small for Gestational Age) from real FGR (Fetal Growth Restriction) ( $p=0.03$ ), with FGR showing lower values. SGA showed intermediate perfusion pattern in terms of f compared to FGR and healthy controls. A significant positive correlation was found between f and BW in fetal side of IUGR group. Concerning the fetal brain, we found higher D values in supratentorial WM areas compared with the other regions (TH, BG, pons, CH), in both normal and IUGR groups. In particular, higher D values in OWM and pons in IUGR fetuses compared to healthy group. A significant negative correlation between D and GA was found for almost all brain areas in the healthy group and conversely not in the IUGR group.

#### CONCLUSION

Complex interactions between placental and fetal environments ensure normal fetal growth. Impairment of the fetoplacental unit may lead to Intrauterine Growth Restriction (IUGR), which is associated with perinatal morbidity and mortality, and long-term complications, like neurodevelopmental delay. In order to this, the development of new non-invasive examinations, such as fetal MRI, may be helpful in detecting fetal abnormalities and understanding their pathogenesis. Specifically, the IVIM model, may be a novel technique to detect microstructural and microperfusion abnormalities of the placenta and fetal brain that occur in IUGR fetuses.

#### CLINICAL RELEVANCE/APPLICATION

Preliminary results show that IVIM parameters may be potential in vivo biomarkers of IUGR severity, improving prenatal and postnatal diagnosis and management of IUGR fetuses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPPH-1

### Reliability of CT Numbers on Energy Integrating and Deep Silicon Photon Counting Detector CT with Patient Mispositioning

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Aria M. Salyapongse, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

In this study we compared the CT number of six clinically relevant materials on an energy-integrating detector (EID) and deep silicon photon-counting (PCD) CT as an effect of mispositioning for different patient sizes.

#### METHODS AND MATERIALS

We performed three sets of dose-matched scans on a patient size-mimicking phantom with five different water-equivalent diameters (WED) (Mercury Phantom, Gammex). The acquisition modes were: (1) 120 kV single-energy (SE) EID CT, (2) 80/140 kV rapid kV-switching dual-energy (DE) EID CT, and (3) 120 kV deep silicon PCD CT at four positions in the bore: (1) isocenter (0 cm), (2) up 4 cm, (3) up 8 cm, (4) and up 12 cm. Average CT number was calculated for air, water, polystyrene, iodine 10 mg/mL, bone, and polyethylene in (1) 120 kV polychromatic EID, (2) 70 keV monochromatic EID, and (3) 70 keV monochromatic deep silicon PCD images. Trends in CT number with WED for each position were assessed by plotting CT numbers against WED. Slopes were compared using t-tests with multiple comparison adjustment to assess whether trends in CT number with WED were decreased for deep silicon PCD CT relative to EID CT. CT number accuracy was assessed by calculating ideal material CT numbers using the U.S. National Institute of Standards and Technology (NIST) XCOM database toolkit.

#### RESULTS

For air, water, iodine, and bone materials, deep silicon PCD CT had the smallest magnitude slope of CT number over WED for all tested positions. Deep silicon PCD CT slopes are flatter compared with SE EID CT and reached statistical significance for iodine ( $p < .001$ ), and bone ( $p < .001$ ) for all positions, and for air ( $p = .008$ ) and water ( $p = .01$ ) at three positions. Deep silicon PCD CT slopes were flatter compared with DE EID CT and reached statistical significance for air ( $p = .005$ ), water ( $p = .04$ ), and bone ( $p < .001$ ) for all positions, and for iodine ( $p = .04$ ) at three positions. The accuracy of deep silicon PCD CT was higher than either SE or DE EID CT for all materials at all positions except for polystyrene at 12 cm, based on relative root mean square error.

#### CONCLUSION

WED contributes more to CT number change than mispositioning. The change in CT number over WED was smallest for deep silicon PCD CT for air, water, and bone at all tested positions. The CT number accuracy was also closest to the ideal CT number on deep silicon PCD CT for all materials at all positions except polystyrene at 12 cm, compared with SE and DE EID CT.

#### CLINICAL RELEVANCE/APPLICATION

Accurate and stable CT numbers are important for clinical diagnoses, and use of deep silicon PCD CT provides more stable and accurate CT number over patient size and mispositioning compared with SE and DE EID CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPPH-10

### **Dual-Energy CT-based Low Energy Virtual Monoenergetic Imaging of the Lower Extremity Runoff in Patients with Diabetes Mellitus: Impact on Image Quality, Vascular Contrast and Diagnostic Accessibility**

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

#### **PURPOSE**

To evaluate the impact of low energy virtual monoenergetic imaging (VMI)+ dual-energy CT reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of lower extremity arteries in patients with diabetes mellitus.

#### **METHODS AND MATERIALS**

Dual-energy CT angiography scans of lower extremities in patients suffering from diabetes who had undergone clinically indicated dual-energy CT examinations between January 2018 and January 2023 were retrospectively analyzed. Images were reconstructed with standard linear blending (F<sub>0.5</sub>) and low keV VMI+ series were generated from 40 to 100 keV, in an interval of 15 keV. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). A total of five CT number measurements per vessel were performed in the superficial and deep femoral artery, the popliteal artery, proximal anterior and posterior tibial artery as well as the fibular artery. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of lower extremity arteries.

#### **RESULTS**

Our final study cohort consisted of 154 patients (82 males). Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU, 1180.41 ± 45.09; SNR, 29.91 ± 0.99; CNR, 28.60 ± 1.03) followed by 55 keV VMI+ reconstructions; all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard F<sub>0.5</sub> images (HU, 251.32 ± 7.13; SNR: 13.22 ± 0.44; CNR: 10.57 ± 0.39) (p<.0001). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 and 70 keV VMI+ series with a significant difference compared to standard F<sub>0.5</sub> images regarding image quality, vascular contrast and diagnostic assessability of lower extremity arteries (p<.0001).

#### **CONCLUSION**

Low keV VMI+reconstructions at a level of40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of lower extremity arteries in patients with diabetes mellitus compared with standard CT series.

#### **CLINICAL RELEVANCE/APPLICATION**

In patients with diabetes mellitus undergoing dual-energy CT scans of lower extremity arteries, low keV VMI+ CT reconstructions at a level of 40-55 keV should be routinely reconstructed in clinical routine to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-SPPH-11

### Combining K-edge Filtration and Dual-layer CT for Improved Spectral Performance in Pediatric Diagnostics

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Olivia F. Sandvold, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

In pediatric spectral CT, accurate quantitative performance with low radiation doses is imperative. Our study demonstrates the effectiveness of using a combination of a K-edge filter and dual-layer spectral detector to increase the quantification sensitivity of iodine and calcium in pediatric patients.

#### METHODS AND MATERIALS

A polychromatic simulation based on a clinical dual-layer spectral CT (Spectral CT 7500, Philips Healthcare) was used to generate incident spectra at tube voltages of 100 and 120 kVp with radiation exposure of 33 mAs. An optimal K-edge filter material and thickness (holmium 0.15 mm) was selected from other potential filters using the Cramer-Rao lower bound of noise in the iodine domain for a single pencil-beam x-ray projection at the central detector. To model the combination of the K-edge filter and dual-layer CT, the input spectra were filtered and linearly scaled to match the patient dose of the non-filtered cases. The spectra were then applied to noiseless photoelectric and Compton scatter basis projections of three pediatric phantoms containing tissue equivalent inserts (iodine 0.5 mg/mL, iodine 2.0 mg/mL, blood, calcium 50 mg/mL). The phantoms ranged in diameter from 10 to 20 cm. Using fan beam geometry, Poisson noise was added, a material decomposition look-up table approach was used, and filtered back projection reconstruction was performed to generate photo/scatter basis images with realistic noise. To estimate spectral sensitivity, noise was measured for each insert in the photoelectric image, and a corresponding noise ratio relative to K-edge filtered simulations was calculated to compare filtered and non-filtered simulations.

#### RESULTS

At 100 kVp and across all three phantom sizes, the holmium filter and dual-layer CT combination compared to the non-filtered simulation averaged 11% and 10% improvement in photoelectric noise in iodine 0.5 mg/mL and iodine 2.0 mg/mL inserts, respectively. Average filtered noise improvement at 120 kVp was 3% and 5% for the same rods. For the calcium insert, the maximum relative noise improvement was 17% in the 20 cm phantom at 100 kVp. To match non-filtered patient dose, tube exposure was 93 and 85 mAs for 100 and 120 kVp scans.

#### CONCLUSION

Combined holmium K-edge filtration with dual-layer CT increased iodine and calcium sensitivity in pediatric scans at 100 and 120 kVp with radiation exposures within tube capability. This could lead to increased iodine and calcium quantification accuracy and reduced additional non-contrast scans for pediatric patients.

#### CLINICAL RELEVANCE/APPLICATION

The combination of K-edge filtration with dual-layer CT may enhance iodine and calcium quantification accuracy and reduce need for additional non-contrast scans in pediatric diagnostic imaging.

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## Abstract Archives of the RSNA, 2023

M2-SPPH-12

### A Comparative Study of Extracellular Volume Fraction Measured by Spectral CT Between Liver and Pancreas in Patients with Hypertension

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Xiaoming Huang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the correlation between extracellular volume fraction of liver and pancreas measured by spectral CT iodine maps and hypertension-related indicators and to compare their diagnostic value.

#### METHODS AND MATERIALS

166 patients who underwent abdominal spectral CT enhancement scanning were included. They were divided into a normal blood pressure group and a hypertension group according to whether they had hypertension. Then, the hypertension group was further divided into three subgroups according to the systolic and diastolic blood pressure levels. The fECV was calculated by measuring the iodine density (ID) of the liver and abdominal aorta from the iodine maps in equilibrium phase as follows:  $fECV = ID_{\text{hepatic or pancreatic}} \times (100 - Hct) / ID_{\text{abdominal aorta}}$ . One-Way ANOVA analysis was used to compare fECV values among groups. Spearman correlation analysis was used to analyze the correlation between fECV and blood pressure-related indicators, i.e., systolic blood pressure, diastolic blood pressure, pulse pressure. Multiple linear stepwise regression equations were established to obtain the quantitative relationship between fECV and blood pressure-related indicators. ROC curves were used to evaluate the diagnostic performance of hepatic and pancreatic fECV for hypertension.

#### RESULTS

The hepatic fECV ( $36.42 \pm 5.20$ ) and pancreatic fECV ( $36.64 \pm 5.46$ ) of patients with hypertension were significantly higher than those patients with normal blood pressure ( $30.17 \pm 4.12$ ,  $33.45 \pm 3.41$ ) and increased with the enhancement of hypertension level. The fECV of liver and pancreas were positively correlated with SBP ( $r=0.57$ ,  $0.42$ ) and DBP ( $r=0.33$ ,  $0.32$ ). Multiple linear regression analysis showed that SBP entered the equation finally ( $\beta=0.105$ , constant= $18.520$ ;  $\beta=0.119$ , constant= $17.528$ ). The AUC for diagnosing hypertension through hepatic fECV was  $0.830$  (SEN  $61.50\%$ , SPE  $88.00\%$ , cut-off value  $34.16\%$ ) and the AUC for diagnosing hypertension through pancreatic fECV was  $0.663$  (SEN  $53.00\%$ , SPE  $94.70\%$ , cut-off value  $37.93\%$ ). Comparing the two AUCs, the accuracy of hepatic fECV was higher than that of pancreatic fECV and the difference was statistically significant ( $P < 0.05$ ).

#### CONCLUSION

The fECV of liver and pancreas measured by spectral CT iodine maps was related to hypertension-related indicators. SBP was an independent risk factor for elevating both hepatic and pancreatic fECV. The hepatic fECV was more helpful for diagnosing hypertension.

#### CLINICAL RELEVANCE/APPLICATION

The fECV obtained by dual energy spectral examination is a convenient biomarker to assess the liver and pancreas chronic injury. The fECV derived from spectral CT iodine maps had clinical application values for studying the chronic damage of abdominal organs caused by hypertension.

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## Abstract Archives of the RSNA, 2023

M2-SPPH-2

### Imaging Parameters Affecting Stone Detection using Virtual Unenhanced Images at Excretory Phase in Contrast-enhanced Dual-energy CT Urography

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Jianying Li, PhD (*Presenter*) Employee, General Electric Company

#### PURPOSE

To investigate the imaging parameters influencing urinary stone detection rate with virtual unenhanced (VUE) images obtained at the excretory phase (EP) in contrast-enhanced dual-energy CT urography (DECTU).

#### METHODS AND MATERIALS

150 urinary stone patients (mean age:  $47.51 \pm 14.42$  years; males vs females: 101 vs 49) who required triphasic DECTU were analyzed. The true unenhanced (TUE) and VUE images at EP (VUE(EP)) were obtained. Per stone detection rates on the above images were recorded. Stone location, size and CT number on the TUE images were recorded and used in univariate and multivariate logistic regression analyses to investigate imaging factors influencing urinary stone detection rate on VUE(EP) images. In addition, five contrast agents were included in the regression analyses. Thresholds for detecting urinary stone on VUE(EP) images were determined using receiver operating characteristics (ROC) analysis.

#### RESULTS

Three hundred and four stones were detected on TUE images; 217 stones were identified on VUE(EP) images (detection rate, 71.4%). Size (Univariate Multivariate:  $p < 0.001$ ) and CT number (Univariate Multivariate:  $p < 0.001$ ) of the stones were both important factors affecting the detection of stone on the VUE(EP) images (Tab.1). The stone detection rate in the urinary tract was significantly higher than that in the kidney (Univariate Multivariate:  $p < 0.01$ ) (Tab.1 and Fig. 1). However, different contrast agents did not affect the detection rate ( $p = 0.547$ ). The area under ROC curve (AUC) of using size and CT number for detecting stone on the VUE(EP) images was only 0.80 and 0.80, respectively with thresholds for stones with size larger than 3.3 mm and CT number greater than 615 HU being detected. After adding the stone location, the AUC of the three parameters can reach up to 0.88 (Tab.2 and Fig. 2).

#### CONCLUSION

VUE images at EP in DECTU has a relatively low detection rate for urinary stones. Stone location, size and CT number have significant impact on the stone detection rate using VUE(EP) images.

#### CLINICAL RELEVANCE/APPLICATION

VUE images at EP in DECTU are not suitable for detection of urinary stones. Stone location, size and CT number may have an impact on the stone detection rate.

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## Abstract Archives of the RSNA, 2023

M2-SPPH-3

### Mobile Photon-counting Detector CT with MD Plus for Neuroimaging of Patients in Intensive Care Unit

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Junyoung Park (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to evaluate our developed multi-material decomposition method (MD Plus) with mobile PCD-CT for neuroimaging of patients at ICU, and prove the characterization and differentiation of materials between contrast agent and hemorrhage in high-density lesions.

#### METHODS AND MATERIALS

For neuroimaging of patients at ICU, the MD Plus was developed and optimized. All CT scans were performed with the FDA 510(k) cleared mobile PCD-CT (OmniTom Elite). For verification of the accuracy of our MD plus algorithm with the mobile PCD-CT, the experiments were conducted using a multi-energy phantom with various exposure conditions and locations of contrast agent. To prove the material characterization of neuroimaging of patients at ICU, our MD plus algorithm was applied to the patients who underwent mobile PCD-CT. The ability of differentiation between iodine and hemorrhage was evaluated.

#### RESULTS

The results of multi-energy phantom with different exposure showed that there is no critical artifacts on material decomposition maps with various exposure settings. The measured iodine concentrations of each exposure setting were compared to the ground truth. The linear relationships were observed the measured and true iodine concentrations and the coefficient of determinations ( $R^2$ ) for 5, 10, 15, 20 mA were 0.994, 0.995, 0.996, 0.998 respectively. The results of different contrast demonstrated that the material maps were comparable and the difference ratio was 3.644%. The results of neuro-images of patients at ICU demonstrate the key benefits of our MD plus algorithm with mobile PCD-CT: the regions of intracerebral hemorrhage are clearly visible in material decomposition map. Also, the consistent and repeatable ability to show iodine concentration in material map regardless of different patients was proved.

#### CONCLUSION

Our quantitative results of multi-energy phantom verified the accuracy of our MD plus algorithm. In addition, the qualitative results regarding clinical cases of patient at ICU demonstrate that our MD plus algorithm with mobile PCD-CT can separate the contrast agent from the blood accurately. The differentiation of iodine and hemorrhage or acute ischemic stroke can be used in high density lesions after intra-arterial recanalization.

#### CLINICAL RELEVANCE/APPLICATION

The accurate results of MD plus algorithm with mobile PCD-CT can lead to simplified clinical imaging protocols and improved workflow for neuroimaging of critical patients with the risks associated with transportation and life-threatening illness.

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## Abstract Archives of the RSNA, 2023

M2-SPPH-4

### Self-Supervised Deep Learning Methods for Photon Counting CT (PCCT) Denoising without Clean References

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Sen Wang, PhD (*Presenter*) Research support, General Electric Company

#### PURPOSE

To evaluate the performance of self-supervised methods for PCCT image denoising from routine scans, without repeat scans or clean images. These methods include: Noise2Noise (N2N), Noisier2Noise (Nr2N), and Noise2Void (N2V).

#### METHODS AND MATERIALS

For clinical images, clean references are difficult to obtain, as noise is always present. Typically, synthetic low-dose images and full-dose images are used as training input and reference, namely Noise2Full-dose (N2Fd), where the inherent noise correlation degrades the result. Alternatively, several self-supervised learning methods have been proposed. N2N is supposed to be equivalent to Noise2Clean (N2C; trained with clean references). For PCCT scans, binomial selection can be used to create the noise independent pairs required in N2N; Nr2N leverages N2Fd which contains residual noise proportional to the synthetic low-dose noise. Thus, it is possible to cancel the residual noise with careful post-processing. To evaluate their performances, we converted clinical images from the KiTS21 Challenge to water and Ca density maps and simulated PCCT scans using a 120 kVp spectrum and a realistic energy response. For simplicity, the total counts were used to create a grayscale image. The dataset was split into train (211) / validation (30) / test (59) cases (5 slices from each case). A basic U-Net was trained for 90 epochs, minimizing L2 loss. Dose was split evenly using binomial selection for N2N. N2V was also included in our comparison.

#### RESULTS

All methods reduced the original RMSE of the test set from 27.70 HU. Average RMSE in the test set was 12.37 HU for N2N, which was equivalent to that of N2C (12.38 HU). N2Fd, which violates the independence criterion, had suboptimal results (17.82 HU). Nr2N improved the performance of N2Fd to 13.30 HU. N2V (24.37 HU) had the worst performance since CT images violate its requirement of spatially uncorrelated noise. While Nr2N performed well, we found that the performance relies heavily on the convergence of N2Fd. With a limited amount of training data, the convergence of N2Fd might be incomplete, leading to suboptimal results for Nr2N.

#### CONCLUSION

Among the representative self-supervised learning methods, N2N yields the best performance, approaching that of N2C while only requiring routine scans. Nr2N can effectively improve the performance of N2Fd with proper training and post-processing, but is slightly inferior to N2N. Future work will investigate the applicability of N2N to real data, as well as more sophisticated networks and loss functions.

#### CLINICAL RELEVANCE/APPLICATION

We evaluated representative self-supervised learning methods for PCCT image denoising that can use routine scans to train a denoising network without a clean (noiseless) reference.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPPH-5

### Feasibility and Accuracy in Calcium Quantification of the Turbo Flash Mode on a Clinical Photon Counting Detector CT System: A Phantom Study

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Shan Shui Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

The high-pitch scan mode on a first-generation clinical dual-source photon counting detector (PCD) CT system can be used for energy analysis, which is helpful for calcium quantification. However, its performance has not been validated because the high-pitch scan could not obtain the energy spectrum information by the energy-integrating detector dual-source CT. The purpose of this study is to evaluate the feasibility and accuracy of calcium quantification in the high-pitch scan on PCD-CT.

#### METHODS AND MATERIALS

A Gammex<sup>TM</sup> multi-energy CT phantom with three calcium inserts (50, 100, and 300 mg/ml), with and without the elliptical outer layer, was evaluated using a high-pitch (3.2) and regular (0.8) spiral modes on a PCD-CT. Each scan setting was repeated three times with two tube voltages (120 and 140 kVp) and 4 radiation doses (1, 3, 5, and 10 mGy). Calcium maps were generated by adjusting the specific calcium ratio in post-processing and the mean calcium attenuation (CaCT) across three consecutive slices were recorded. Linear regression and Pearson correlation coefficient was implemented for accessing the correlation between CaCT in all scan settings and calcium concentration. The root-mean-squared-error (RSME) was calculated and compared between the high-pitch and regular spiral scans.

#### RESULTS

For all scan settings, the extremely strong correlations between CaCT and calcium concentration were proven by the statistically significant linear regressions (all R-square  $>$ ; 0.99,  $p$   $<$ ; 0.05) and Pearson correlation coefficients (all  $r$   $>$ ; 0.99). The conversion slope ranged from 0.310 to 0.354 mg/mL/HU for the high-pitch scans and from 0.315 to 0.361 mg/mL/HU for the regular spiral scans. The largest RMSE was witnessed in the high-pitch scans of the large phantom at 140 kVp and 1 mGy. The median [interquartile range] RMSE demonstrated similar calcium quantification abilities between the high-pitch and the regular spiral scans (1.25 [0.81; 2.75] versus 0.90 [0.68; 1.50] mg/mL,  $p = 0.152$ ).

#### CONCLUSION

The high-pitch scan mode with full spectral information offers feasible and accurate calcium quantification using the dual-source PCD-CT.

#### CLINICAL RELEVANCE/APPLICATION

Accurate calcium quantification by high-pitch scans on PCD-CT even under ultra-low doses could be promising for bone density screening.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPPH-6

### Decomposition of CT Contrast Agents: Single or Multiple Photon Counting CT Scans? Single or Dual Source PCCT?

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Marc Kachelriess, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

With the beginning of the photon counting CT (PCCT) era, claims are being made that scanning two contrast agents simultaneously is beneficial in terms of dose. Our aim is to quantify the supposed benefit or the possible harm.

#### METHODS AND MATERIALS

PCCT inherently records spectral information. Moreover, the only clinically approved PCCT system, the Naeotom Alpha, is a dual source CT (DSCT): both x-ray tubes can operate at different kV and can utilize different patient-specific prefilters (PSPs), e.g. tin. With PCCT it becomes possible to distinguish more than two materials. Potential applications focus on using two contrast agents, e.g. X=iodine and Y=hafnium. The simultaneous application of two such agents is claimed to be advantageous, e.g. in a way such that the arterial phase of an abdominal acquisition shows X and the venous phase is enhanced by Y. Is this strategy, WXY, with W being the soft tissue, better than two scans W+WX or WX+WY, assuming no patient motion in-between? Or would even three scans, e.g. W+WX+WXY be optimal? To find out, we conducted a study simulating various patient sizes, tube voltages from 70 to 150 kV, four different PSP thicknesses, and all possible bin settings of a photon counting detector to assess the dose-normalized signal-to-noise-ratio (SNRD) of the resulting virtual non-contrast images, and the contrast agent maps of X and Y. No additional noise reduction strategies were applied in order to obtain a fair comparison. Dose penalty (DP) factors are given by the squared ratio of the SNRD values.

#### RESULTS

With just one agent, X=Iodine, doing WX (single source PCCT) instead of W+WX (two scans) yields DP=2.6. Doing WX+WX (DSCT) instead of W+WX yields DP=1.6. With two agents, X=Iodine, Y=Gadolinium, WXY comes with DP=1.5 when compared to WX+WY and with DP=2.0 when compared to W+WX. Surprisingly, WXY+WXY, which can be realized by a DSCT scan, is only slightly (DP=1.25) outperformed by W+WX, which requires two separate scans. By far the best performance is obtained by W+WX+WY and by W+WY+WXY (DP=3.2 if doing WXY instead), which, however, require three scans.

#### CONCLUSION

For the task of providing contrast agent maps, simultaneous contrast agents always come with a penalty in the order of 1.5 to 3.2 which means that the 1.5- to 3.2-fold patient dose is necessary. If motion between two non-simultaneous scans could be perfectly corrected for, patient dose and thus patient risk could be drastically reduced. In particular, if an unenhanced scan (W) is performed in addition to the enhanced scan(s).

#### CLINICAL RELEVANCE/APPLICATION

As long as no motion-compensation between scans can be performed, the currently proposed scan strategies are unavoidable. Once motion can be compensated for, scans should be separated into different contrast enhancement schemes.

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## Abstract Archives of the RSNA, 2023

M2-SPPH-8

### The Accuracy of Monoenergetic Attenuation at High-pitch Scans using A Dual-source Photon-counting Detector CT: A Phantom Study

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Le Qin (*Presenter*) Nothing to Disclose

#### PURPOSE

High-pitch scans performed on a dual-source photon-counting detector CT (PCD-CT) enable reconstructions of virtual monoenergetic imaging at different keV levels. However, the accuracy of monoenergetic attenuation at high-pitch acquisition remains unknown. Thus, the purpose of this study is to evaluate the monoenergetic accuracy of iodine inserts between the regular spiral scan and the high-pitch scan on a first-generation clinical dual-source PCD-CT.

#### METHODS AND MATERIALS

The Gammex<sup>TM</sup> multi-energy CT phantom containing iodine inserts of 2, 5, 10 and 15 mg/mL was scanned on a dual-source PCD-CT, with and without the elliptical outer layer. Two pitch levels (3.2 and 0.8), two tube voltages (120 and 140 kVp) and 4 radiation doses (1, 3, 5 and 10 mGy) were alternated, and each scan setting was repeated three times. The image noise in the background and monoenergetic accuracy of the iodine inserts were evaluated at 40, 70, 100 and 140 keV. The median attenuation errors and absolute attenuation bias were further assessed with linear regression to explore the impact of phantom setup and scan parameters.

#### RESULTS

The background noise increased with lower keV level and radiation doses. The noise levels between high-pitch and regular spiral scans were evidently different for the large phantom at 40 and 70 keV, especially when radiation dose decreased. In the small phantom, the median attenuation errors at 1, 3, 5 and 10 mGy were 5.5 (1.8; 10.5) [median, (25th percentile; 75th percentile)], 5.9 (1.3; 10.6), 6.0 (2.1; 10.1) and 5.7 (2.6; 13.6) HU, respectively. Similarly, the errors were 3.3 (-2.5; 13.9), 4.1 (-1.6; 11.7), 4.1 (-1.0; 11.2) and 4.6 (-1.0; 12.9) HU in the large phantom. At the worst-case scenario, the attenuation bias exceeded 10 HU in 14.6% (7 of 48 measurements for 4 inserts, 4 keV levels and 3 scan repeats) and 29.2% (14 of 48) for the small and large phantom setups, respectively. The linear regression revealed comparable monoenergetic accuracy between high-pitch and regular spiral scans ( $p = 0.332$ ). Compared to the 70 keV, images at 40 keV and 140 keV were associated with statistically significant (6.6 HU and 1.6 HU, both  $p < 0.001$ ) higher attenuation bias.

#### CONCLUSION

The high-pitch scans exhibited similar monoenergetic accuracy with the regular spiral scans, although the attenuations at 40 keV and 140 keV still required careful interpretation.

#### CLINICAL RELEVANCE/APPLICATION

The monoenergetic images with high-pitch scans enabled by the dual-source PCD-CT provide accurate attenuation and could be quantitative used in conditions requiring fast acquisition such as pulmonary embolism, chest pain triad and ruptured cerebral aneurysm.

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## Abstract Archives of the RSNA, 2023

M2-SPPH-9

### Comparison of Iodine Quantification between High-pitch and Regular Spiral Scans using a Dual-source Photon-counting Detector CT: A Phantom Study

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Peng Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

With the advent of the dual source photon-counting detector CT (PCD-CT), material decomposition at high pitch could become a clinical reality and potentially exhibit unprecedented diagnostic value. However, its accuracy has not been validated so far. Thus, the purpose of this study is to investigate the accuracy of iodine quantification in a phantom setup and compare the performance between high-pitch and regular spiral scans based on the first-generation clinical PCD-CT.

#### METHODS AND MATERIALS

Four inserts with known iodine concentrations (2, 5, 10 and 15 mg/mL) were placed in the removable head section of a Gammex<sup>TM</sup> multi-energy CT phantom. The phantom, with and without the elliptical outer layer, was scanned using high-pitch (3.2) and regular (0.8) spiral modes on a dual-source PCD-CT. Two tube voltages (120 and 140 kVp) and 4 radiation doses (1, 3, 5 and 10 mGy) were also alternated, and each scan setting was repeated three times. The mean iodine measurements across three consecutive slices were recorded, and the association between the percentage absolute bias (PAB, normalized to the actual reference) and all scan factors was explored using a linear regression analysis.

#### RESULTS

A total of 96 acquisitions were performed with both phantom setups and all variations of scan parameters. In the small phantom, the PAB ranged from 1.8% to 5.9% and 1.5% to 3.2% for high-pitch and regular spiral acquisitions, respectively, across different radiation doses and tube voltages. The bias appeared more pronounced in the large phantom (4.4% to 8.5% for high-pitch and 2.5% to 6.8% for regular spiral). The linear regression analysis revealed that scan modes, tube voltages and radiation doses were all statistically irrelevant ( $P > 0.05$ ) to the iodine measurement bias. Compared to the phantom with the outer layer, the small phantom was significantly associated ( $p < 0.001$ ) with 7.2% fewer PAB.

#### CONCLUSION

Iodine density can be accurately and reliably quantified with the high-pitch scan mode, whose ability of material decomposition was only recently brought by the advent of the dual-source PCD-CT.

#### CLINICAL RELEVANCE/APPLICATION

High-pitch scans on PCD-CT ensures accurate iodine quantification even in low radiation doses, thus enabling clinical applications which require fast acquisition such as in pediatrics, pulmonary embolism and acute ischemic stroke.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPVA-2

### Assessment of Diagnostic Efficacy of Photon Counting CT Virtual Mono-Energetic Imaging for Abdominal Aortic and Pelvic Vascular Imaging in Patients Prior to Transcatheter Aortic Valve Replacement (TAVR)

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Leona Alizadeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our study aim was to evaluate the diagnostic efficacy of photon counting CT (PCCT) virtual mono-energetic (VMI)+ imaging for low-keV abdominal and pelvic vascular imaging and TAVR planning.

#### METHODS AND MATERIALS

A total of 125 patients (69 male/ 56 female) underwent PCCT imaging pre-TAVR for assessment of the abdominal aorta and pelvic vessels for transfemoral access planning. Virtual mono-energetic images (40 - 120 keV) were generated in 15 keV steps from the spectral post-processing datasets (SPP). For assessment of quantitative image quality, SNR and CNR were calculated from measurements in the infrarenal aorta, common iliac artery, internal iliac artery, external iliac artery, and common femoral artery. Qualitative IQ, diagnostic significance, and vascular contrast were evaluated in a blinded manner by four experienced radiologists, using a 5-point Likert scale with clinically relevant criteria.

#### RESULTS

The highest mean SNR and CNR values of the VMI+ series were found in 40 keV reconstructions (SNR  $32.5 \pm 9.5$  CNR  $33.3 \pm 9.8$ ), followed by the measurements in the 55 keV VMI+ (SNR  $25.0 \pm 8.0$  CNR  $26.3 \pm 7.8$ )( $p < 0.001$ ). SNR and CNR of 40 keV and 55 keV were significantly higher than all other keV levels including standard 120 kV (SNR  $10.7 \pm 3.0$ ; CNR  $26.2 \pm 9.5$ ) ( $p < 0.001$ ). Accordingly, mean HU-values of 40 keV VMI+ reconstructions were significantly higher at  $1401 \pm 18$ , followed by  $748 \pm 14$  for 55 keV reconstructions ( $p < 0.001$ ). The IQ rating using the Likert scale was higher for the virtual mono-energetic images at 55 keV compared to 40 keV ( $4.6 \pm 1.6$  vs.  $3.9 \pm 1.8$ )( $p < 0.001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images series regarding image quality, vascular contrast and diagnostic assessability for the femoral access planning( $p < .0001$ ).

#### CONCLUSION

Our findings suggest that PCCT virtual mono-energetic imaging provides higher SNR and CNR values and better IQ than conventional CT imaging for the abdominal aorta and pelvic vessels at 40 keV. However, for qualitative image quality, 55 keV may be preferred.

#### CLINICAL RELEVANCE/APPLICATION

Choice of the right VMI+ reconstruction, allows for use of the diagnostic quality reserve for potential reduction in contrast agent and radiation dose. Further, low-keV VMI+ PCCT reconstructions with enhanced diagnostic quality for TAVR procedure planning may improve patient safety.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-STCE1

### Science Session (Generative AI)

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 1

#### Sub-Events

#### **M2-STCE1- Large Language Model (LLM) Based Clinical Decision Support (CDSS) Monitoring Pipeline 1**

Felice A. Burn, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

See Presentation

##### **METHODS AND MATERIALS**

See Presentation

##### **RESULTS**

See Presentation

##### **CONCLUSION**

See Presentation

##### **CLINICAL RELEVANCE/APPLICATION**

See Presentation

#### **M2-STCE1- Language guided age-translated generation model to predict incident vertebral fracture 2 using lateral spine X-ray image**

Sang Wouk Cho, MS (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Spine X-ray images contain valuable clinically relevant information, offering insights into the structural integrity of the vertebrae and the presence of fracture. This study aims to generate age-translated X-ray image from language-based diffusion model to predict the incident vertebral fracture (VF) risk.

##### **METHODS AND MATERIALS**

Clinical data and lateral spine X-ray images of patients aged 50 or older who presented to our institution between January 2007 to December 2018 were collected. Incident VF was defined using follow-up X-ray radiographs. A language guided latent diffusion model (LDM) was trained to extract feature maps of morphological structure depending on ages which were used to train another LDM. Two LDMs generated age-translated X-ray images based on the age prompts of incident VF with clinical data. Fracture risk of generated images was calculated using a prevalent VF model and the performance was compared with the Fracture Risk Assessment Tool (FRAX).

##### **RESULTS**

A total of 29,307 lateral spine plain X-ray images from 9,276 patients (mean age 65.7, 66% women) were used to train the language-guided diffusion model. A stratified random sample of 6% (n=555) was selected to predict fracture risk. Over a mean follow-up period of 34.8 months, vertebral fractures occurred in 7.6% of patients (705 out of 9,276 in the whole dataset; 43 out of 512 in the prediction set). In image generation, our model exhibited significantly better image quality and stability with a Peak Signal-to-Noise Ratio (PSNR) of 20.737, compared to a single LDM with PSNR of 15.856 (p<0.001). As generating spine X-ray images, the intermediate feature maps of the LDM model highlighted to spine structure. In the prediction set, generative image-based fracture risk showed higher performance than major osteoporotic fracture risk score

(MOF) and hip fracture risk score (HF) of FRAX in term of c-index (Our 0.703, 95% confidence interval (CI) 0.641 to 0.763; MOF 0.644,95%CI 0.571 to 0.715; HF 0.662, 95%CI 0.587 to 0.735).

## **CONCLUSION**

Our model shows great potential to generate the data-driven morphological changing by age. In addition, generative image-based fracture risk outperformed the FRAX in incident VF prediction in a longitudinal cohort.

## **CLINICAL RELEVANCE/APPLICATION**

We believe that morphological changes in age-translated X-ray images may have better guidance for clinicians to distinguish high risk group of fracture.

## **M2-STCE1-3 Investigation of Implicit Gender Bias in Radiology Fellowship Letters of Recommendation Using Large Language Models**

Batuhan Gundogdu, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To assess and prevent incidents of implicit bias on letters of recommendation (LORs) written for radiology fellowship applicants and analyze such occurrences with respect to the genders of the applicants.

## **METHODS AND MATERIALS**

Perplexity (PPL) conveys a score of a language model's ability to produce a given text. We used the PPL metric as a measure of uniqueness/personalness of a letter of recommendation. In this setting, a more generic and commonly witnessed LOR would yield a low PPL score even if it includes many strong and standout words. In contrast, a personalized letter, possibly describing the specific relationship between the applicant and the writer, would have a high PPL score regardless of the sentiment score. We analyzed 1,036 letters of recommendation from 336 radiology fellowship applications submitted to the University of Chicago. Texts were anonymized, names and other personal entities were replaced with placeholders. We then used a pre-trained Llama 2 large language model (LLM) to calculate average sentence PPL scores for each letter. We compared the distribution of PPL scores with respect to applicant gender with Mann-Whitney U test.

## **RESULTS**

Although there was no significant difference in semantic score (positivity) ( $p>0.5$ ) and letter length ( $p>0.5$ ) between the letters of recommendations of male and female applicants, the PPL scores of LORs written to male applicants were significantly higher than LORs of female applicants ( $p<0.05$ ), indicating more personalized letters for male applicants and more generic letters were written for female applicants.

## **CONCLUSION**

A pattern of more generic and descriptive letters for females, but more personalized and unique letters for males can be an innocent-looking and a subtle implicit bias towards male applicants in radiology careers.

## **CLINICAL RELEVANCE/APPLICATION**

Understanding the differences in the language and content of letters of recommendation for radiology fellowship applicants can help identify areas for improvement in the evaluation process, promoting fair and equitable consideration of all applicants based on their qualifications and potential contributions to the field.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-STCE1-1

### Large Language Model (LLM) Based Clinical Decision Support (CDSS) Monitoring Pipeline

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 1

Felice A. Burn, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

See Presentation

#### **METHODS AND MATERIALS**

See Presentation

#### **RESULTS**

See Presentation

#### **CONCLUSION**

See Presentation

#### **CLINICAL RELEVANCE/APPLICATION**

See Presentation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-STCE1-2

### Language guided age-translated generation model to predict incident vertebral fracture using lateral spine X-ray image

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 1

Sang Wouk Cho, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Spine X-ray images contain valuable clinically relevant information, offering insights into the structural integrity of the vertebrae and the presence of fracture. This study aims to generate age-translated X-ray image from language-based diffusion model to predict the incident vertebral fracture (VF) risk.

#### METHODS AND MATERIALS

Clinical data and lateral spine X-ray images of patients aged 50 or older who presented to our institution between January 2007 to December 2018 were collected. Incident VF was defined using follow-up X-ray radiographs. A language guided latent diffusion model (LDM) was trained to extract feature maps of morphological structure depending on ages which were used to train another LDM. Two LDMs generated age-translated X-ray images based on the age prompts of incident VF with clinical data. Fracture risk of generated images was calculated using a prevalent VF model and the performance was compared with the Fracture Risk Assessment Tool (FRAX).

#### RESULTS

A total of 29,307 lateral spine plain X-ray images from 9,276 patients (mean age 65.7, 66% women) were used to train the language-guided diffusion model. A stratified random sample of 6% (n=555) was selected to predict fracture risk. Over a mean follow-up period of 34.8 months, vertebral fractures occurred in 7.6% of patients (705 out of 9,276 in the whole dataset; 43 out of 512 in the prediction set). In image generation, our model exhibited significantly better image quality and stability with a Peak Signal-to-Noise Ratio (PSNR) of 20.737, compared to a single LDM with PSNR of 15.856 ( $p < 0.001$ ). As generating spine X-ray images, the intermediate feature maps of the LDM model highlighted to spine structure. In the prediction set, generative image-based fracture risk showed higher performance than major osteoporotic fracture risk score (MOF) and hip fracture risk score (HF) of FRAX in term of c-index (Our 0.703, 95% confidence interval (CI) 0.641 to 0.763; MOF 0.644, 95%CI 0.571 to 0.715; HF 0.662, 95%CI 0.587 to 0.735).

#### CONCLUSION

Our model shows great potential to generate the data-driven morphological changing by age. In addition, generative image-based fracture risk outperformed the FRAX in incident VF prediction in a longitudinal cohort.

#### CLINICAL RELEVANCE/APPLICATION

We believe that morphological changes in age-translated X-ray images may have better guidance for clinicians to distinguish high risk group of fracture.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-STCE1-3

### Investigation of Implicit Gender Bias in Radiology Fellowship Letters of Recommendation Using Large Language Models

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 1

Batuhan Gundogdu, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess and prevent incidents of implicit bias on letters of recommendation (LORs) written for radiology fellowship applicants and analyze such occurrences with respect to the genders of the applicants.

#### **METHODS AND MATERIALS**

Perplexity (PPL) conveys a score of a language model's ability to produce a given text. We used the PPL metric as a measure of uniqueness/personalness of a letter of recommendation. In this setting, a more generic and commonly witnessed LOR would yield a low PPL score even if it includes many strong and standout words. In contrast, a personalized letter, possibly describing the specific relationship between the applicant and the writer, would have a high PPL score regardless of the sentiment score. We analyzed 1,036 letters of recommendation from 336 radiology fellowship applications submitted to the University of Chicago. Texts were anonymized, names and other personal entities were replaced with placeholders. We then used a pre-trained Llama 2 large language model (LLM) to calculate average sentence PPL scores for each letter. We compared the distribution of PPL scores with respect to applicant gender with Mann-Whitney U test.

#### **RESULTS**

Although there was no significant difference in semantic score (positivity) ( $p > 0.5$ ) and letter length ( $p > 0.5$ ) between the letters of recommendations of male and female applicants, the PPL scores of LORs written to male applicants were significantly higher than LORs of female applicants ( $p < 0.05$ ), indicating more personalized letters for male applicants and more generic letters were written for female applicants.

#### **CONCLUSION**

A pattern of more generic and descriptive letters for females, but more personalized and unique letters for males can be an innocent-looking and a subtle implicit bias towards male applicants in radiology careers.

#### **CLINICAL RELEVANCE/APPLICATION**

Understanding the differences in the language and content of letters of recommendation for radiology fellowship applicants can help identify areas for improvement in the evaluation process, promoting fair and equitable consideration of all applicants based on their qualifications and potential contributions to the field.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-STCE2

### Science Session (Theranostics)

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 2

#### Sub-Events

#### **M2-STCE2- Hsp90 as a target for novel radiopharmaceuticals in metastatic breast cancer**

1

Marybeth A. Nedrud, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The field of theranostics represents a promising area of research, with most recent advancements seen in prostate cancer with PSMA-based radiopharmaceuticals. The protein Hsp90 is a ubiquitously expressed chaperone protein that functions in cell growth and survival. This protein is upregulated in cancer and associated with poor overall survival, particularly in breast cancer. This work examines if Hsp90-based radiopharmaceuticals maybe useful for the detection and ultimate treatment of metastatic breast cancer.

#### **METHODS AND MATERIALS**

Human normal breast epithelial and breast cancer cell lines were maintained in appropriate growth media per ATCC recommendations. Protein levels were assessed with western blotting and primary antibodies against Hsp90 and GAPDH. Previously developed Hsp90 inhibitors with a tethered Cy5 fluorophore were used in combination with fluorescence microscopy to examine cell labeling. Cell aggressiveness was assessed with a wound healing assay.

#### **RESULTS**

Hsp90 is upregulated in breast cancer cell lines relative to normal epithelium. Furthermore, the protein is translocated to the cell surface in cancer, a phenotype not observed in normal tissue and advantageous for diagnostic and therapeutic targeting. Indeed, small molecule inhibitors of Hsp90 selectively label breast cancer cells *in vitro*. This labeling is dependent upon active Hsp90 binding. The intensity correlates with cell line aggressiveness, as HER2+ and triple negative cell lines with high metastatic potential show the highest degree of labeling by our inhibitor.

#### **CONCLUSION**

Tethered Hsp90-inhibitors selectively label human breast cancer cells *in vitro*. The degree of labeling correlates with metastatic potential, suggesting a role for Hsp90-inhibitor based radiopharmaceuticals for the detection of metastatic breast cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

The field of theranostics shows much promise by using tumor specific protein expression to detect and treat of metastatic disease. Our studies outline a role for the use of Hsp90-inhibitor based radiopharmaceuticals in breast cancer, with future efforts focused on pre-clinical testing of these agents.

#### **M2-STCE2- Detection of senescent cells in pig specimen using a $\beta$ -gal MR imaging agent**

2

Kerem Nernekli, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

During the development of osteoarthritis (OA), joint deterioration gradually occurs due to the secretion of mediators by senescent mesenchymal stromal cells. The purpose of our study was to evaluate if  $\beta$ -gal-responsive gadolinium chelate can detect senescent cells on magnetic resonance imaging (MRI).

#### **METHODS AND MATERIALS**

Senescence was induced in 100 million porcine mesenchymal stem cells (pMSC) with 250 nM doxorubicin and confirmed by a  $\beta$ -galactosidase assay. The cells were co-stained with DAPI and CellEvent<sup>TM</sup> Senescence Green. The relative number of



green-positive senescent cells compared to the total number of DAPI-positive cells was determined for doxorubicin-treated pMSC and untreated control pMSC. The (T1)-relaxation times of increasing concentrations of  $\beta$ -gal-responsive Gd-chelate and  $\beta$ -gal-responsive Gd-chelate plus  $\beta$ -gal enzyme were compared to determine optimal concentration to observe Gd-chelate activation. Next, ten samples of 10 million control cells (n=5) and senescent cells (n=5) were incubated with (0.25 mM)  $\beta$ -gal-responsive Gd-chelate, followed by implantation into 10 cartilage defects of 5 pig knee joints. Cell samples and specimen underwent MRI at 3 Tesla, using a (T1)-weighted fast spin-echo sequence (TR = 700, TE = 12 ms, (80 mm x 40 mm) field of view (FOV)) and a RARE Variable TR (VTR) saturation recovery sequence (TE = 10 ms, TR = 40, 75, 150, 300, 500, 700, 1000, 1500, and 2000 ms, RARE factor = 2, FOV 80 mm x 40 mm). Quantitative measures of senescent and viable cells were compared with a student's t-test.

## RESULTS

Following incubation with doxorubicin, cell samples contained a significantly higher number of  $\beta$ -gal positive pMSC (89%) compared to untreated control samples (11%). Senescent pMSC incubated with 0.625 mM, 0.5 mM, 0.25 mM, and 0.1 mM of  $\beta$ -gal-responsive Gd demonstrated T1-relaxation times of 0.335 ms, 0.605 ms, 0.940 ms, and 1.159 ms without the addition of  $\beta$ -gal as well as 0.290 ms, 0.458 ms, 0.774 ms and 1.037 ms with the addition of beta-gal. The largest difference between T1-relaxation times of samples with and without  $\beta$ -gal activation was noted for a concentration of 0.25 mM Gd. In joint specimens, senescent pMSC implants demonstrated a stronger hyperintense signal on T1-weighted MR images than viable pMSC implants. The T1-relaxation time was  $0.788 \pm 0.22$  ms for senescent cell implants and  $1.03 \pm 0.14$  ms for viable cell implants (p=0.0015).

## CONCLUSION

We demonstrate the feasibility of a  $\beta$ -gal MR imaging agent for MRI detection of senescent cells in joint specimens.

## CLINICAL RELEVANCE/APPLICATION

The  $\beta$ -gal MR imaging agent can enable the detection of senescent cells in arthritic joints and serve as a new imaging biomarker for monitoring the efficacy of senolytic therapies.

## M2-STCE2-3 Detection of senescent cells in a porcine model of osteoarthritis: A pilot study using 18F-PyGal Radiotracer

Kerem Nerekli, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Aging mesenchymal stromal cells release biomolecules that lead to progressive joint damage and osteoarthritis (OA). Our study aimed to evaluate whether 18F-PyGal radiotracer yields senescence-specific positron emission tomography and magnetic resonance imaging (PET-MRI).

## METHODS AND MATERIALS

Senescence was induced in 125 million porcine mesenchymal stem cells (pMSC) with 250Nm doxorubicin and confirmed by a  $\beta$ -galactosidase assay. The cells were co-stained with DAPI and CellEvent<sup>TM</sup> Senescence Green. The relative number of green-positive senescent cells compared to the total number of DAPI-positive cells was determined for doxorubicin-treated pMSC and untreated control pMSC. Triplicate samples of 0.5 million senescent and viable pMSC were incubated with 0.20 uCi of 18F-PyGal tracer for 1 hour, followed by PET imaging. Next, 10 million senescent pMSC (n=12) or viable pMSC (n=12) were implanted into 24 cartilage defects of 12 knee joints of 6 three-month-old Yucatan minipigs (3 males/3 females). 24 hours later, 0.20 uCi of 18F-PyGal was injected intraarticularly. After an uptake time of 60 minutes, all knee joints underwent integrated positron emission tomography (PET, 20-minute acquisition time) and fat-saturated proton density-weighted MRI (fast spin-echo sequence, TR=2500, TE=22 ms) on a clinical PET/MR scanner. The maximum standardized uptake values (SUV<sub>max</sub>) of senescent and viable pMSC were compared with a student's t-test.

## RESULTS

Doxorubicin-induced senescent pMSC demonstrated significantly higher  $\beta$ -gal expression (83%) compared to control viable cells (17 %). Senescent pMSC demonstrated a strong radiotracer signal on PET imaging studies, while viable cells demonstrated little or no radiotracer retention, both in vitro and in vivo. In vitro, the SUV<sub>max</sub> of senescent pMSCs (3074.4 $\pm$ 374.4) was significantly higher compared to the SUV<sub>max</sub> of control pMSCs (1350.23  $\pm$ 191.35; p=0.037). In vivo, the SUV<sub>max</sub> of senescent MSCs (males: 7.55  $\pm$  3.25, females 6.25 $\pm$  1.98) was significantly higher compared to the SUV<sub>max</sub> of viable controls (males: 3.25 $\pm$ 0.90, p=0.031 and females: 1.23 $\pm$  0.58, p=0.0027). Within respective groups of senescent or viable implants, there was no significant difference between the results of male or female pigs. Histology confirmed significantly stronger  $\beta$ -gal staining in senescent cell implants compared to viable cell implants.

## CONCLUSION

18F-PyGal radiotracer accumulates in senescent cells and yields senescence-specific signal on positron PET-MRI scans.

## **CLINICAL RELEVANCE/APPLICATION**

<sup>18</sup>F-PyGal can be used to detect senescent cells on PET/MR images. This can be helpful in studying the role of senescence in the development of OA and provide a quantitative biomarker for monitoring the efficacy of novel therapies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-STCE2-1

### Hsp90 as a target for novel radiopharmaceuticals in metastatic breast cancer

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 2

Marybeth A. Nedrud, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The field of theranostics represents a promising area of research, with most recent advancements seen in prostate cancer with PSMA-based radiopharmaceuticals. The protein Hsp90 is a ubiquitously expressed chaperone protein that functions in cell growth and survival. This protein is upregulated in cancer and associated with poor overall survival, particularly in breast cancer. This work examines if Hsp90-based radiopharmaceuticals maybe useful for the detection and ultimate treatment of metastatic breast cancer.

#### METHODS AND MATERIALS

Human normal breast epithelial and breast cancer cell lines were maintained in appropriate growth media per ATCC recommendations. Protein levels were assessed with western blotting and primary antibodies against Hsp90 and GAPDH. Previously developed Hsp90 inhibitors with a tethered Cy5 fluorophore were used in combination with fluorescence microscopy to examine cell labeling. Cell aggressiveness was assessed with a wound healing assay.

#### RESULTS

Hsp90 is upregulated in breast cancer cell lines relative to normal epithelium. Furthermore, the protein is translocated to the cell surface in cancer, a phenotype not observed in normal tissue and advantageous for diagnostic and therapeutic targeting. Indeed, small molecule inhibitors of Hsp90 selectively label breast cancer cells *in vitro*. This labeling is dependent upon active Hsp90 binding. The intensity correlates with cell line aggressiveness, as HER2+ and triple negative cell lines with high metastatic potential show the highest degree of labeling by our inhibitor.

#### CONCLUSION

Tethered Hsp90-inhibitors selectively label human breast cancer cells *in vitro*. The degree of labeling correlates with metastatic potential, suggesting a role for Hsp90-inhibitor based radiopharmaceuticals for the detection of metastatic breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

The field of theranostics shows much promise by using tumor specific protein expression to detect and treat of metastatic disease. Our studies outline a role for the use of Hsp90-inhibitor based radiopharmaceuticals in breast cancer, with future efforts focused on pre-clinical testing of these agents.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-STCE2-2

### Detection of senescent cells in pig specimen using a $\beta$ -gal MR imaging agent

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 2

Kerem Nernekli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

During the development of osteoarthritis (OA), joint deterioration gradually occurs due to the secretion of mediators by senescent mesenchymal stromal cells. The purpose of our study was to evaluate if  $\beta$ -gal-responsive gadolinium chelate can detect senescent cells on magnetic resonance imaging (MRI).

#### METHODS AND MATERIALS

Senescence was induced in 100 million porcine mesenchymal stem cells (pMSC) with 250 nM doxorubicin and confirmed by a  $\beta$ -galactosidase assay. The cells were co-stained with DAPI and CellEvent™ Senescence Green. The relative number of green-positive senescent cells compared to the total number of DAPI-positive cells was determined for doxorubicin-treated pMSC and untreated control pMSC. The (T1)-relaxation times of increasing concentrations of  $\beta$ -gal-responsive Gd-chelate and  $\beta$ -gal-responsive Gd-chelate plus  $\beta$ -gal enzyme were compared to determine optimal concentration to observe Gd-chelate activation. Next, ten samples of 10 million control cells (n=5) and senescent cells (n=5) were incubated with (0.25 mM)  $\beta$ -gal-responsive Gd-chelate, followed by implantation into 10 cartilage defects of 5 pig knee joints. Cell samples and specimen underwent MRI at 3 Tesla, using a (T1)-weighted fast spin-echo sequence (TR = 700, TE = 12 ms, (80 mm x 40 mm) field of view (FOV)) and a RARE Variable TR (VTR) saturation recovery sequence (TE = 10 ms, TR = 40, 75, 150, 300, 500, 700, 1000, 1500, and 2000 ms, RARE factor = 2, FOV 80 mm x 40 mm). Quantitative measures of senescent and viable cells were compared with a student's t-test.

#### RESULTS

Following incubation with doxorubicin, cell samples contained a significantly higher number of  $\beta$ -gal positive pMSC (89%) compared to untreated control samples (11%). Senescent pMSC incubated with 0.625 mM, 0.5 mM, 0.25 mM, and 0.1 mM of  $\beta$ -gal-responsive Gd demonstrated T1-relaxation times of 0.335 ms, 0.605 ms, 0.940 ms, and 1,159 ms without the addition of  $\beta$ -gal as well as 0.290 ms, 0.458 ms, 0.774 ms and 1.037 ms with the addition of beta-gal. The largest difference between T1-relaxation times of samples with and without  $\beta$ -gal activation was noted for a concentration of 0.25 mM Gd. In joint specimens, senescent pMSC implants demonstrated a stronger hyperintense signal on T1-weighted MR images than viable pMSC implants. The T1-relaxation time was  $0.788 \pm 0.22$  ms for senescent cell implants and  $1.03 \pm 0.14$  ms for viable cell implants ( $p=0.0015$ ).

#### CONCLUSION

We demonstrate the feasibility of a  $\beta$ -gal MR imaging agent for MRI detection of senescent cells in joint specimens.

#### CLINICAL RELEVANCE/APPLICATION

The  $\beta$ -gal MR imaging agent can enable the detection of senescent cells in arthritic joints and serve as a new imaging biomarker for monitoring the efficacy of senolytic therapies.

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## Abstract Archives of the RSNA, 2023

M2-STCE2-3

### Detection of senescent cells in a porcine model of osteoarthritis: A pilot study using 18F-PyGal Radiotracer

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center Theater 2

Kerem Nernekli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Aging mesenchymal stromal cells release biomolecules that lead to progressive joint damage and osteoarthritis (OA). Our study aimed to evaluate whether 18F-PyGal radiotracer yields senescence-specific positron emission tomography and magnetic resonance imaging (PET-MRI).

#### METHODS AND MATERIALS

Senescence was induced in 125 million porcine mesenchymal stem cells (pMSC) with 250Nm doxorubicin and confirmed by a  $\beta$ -galactosidase assay. The cells were co-stained with DAPI and CellEvent™ Senescence Green. The relative number of green-positive senescent cells compared to the total number of DAPI-positive cells was determined for doxorubicin-treated pMSC and untreated control pMSC. Triplicate samples of 0.5 million senescent and viable pMSC were incubated with 0.20 uCi of 18F-PyGal tracer for 1 hour, followed by PET imaging. Next, 10 million senescent pMSC (n=12) or viable pMSC (n=12) were implanted into 24 cartilage defects of 12 knee joints of 6 three-month-old Yucatan minipigs (3 males/3 females). 24 hours later, 0.20 uCi of 18F-PyGal was injected intraarticularly. After an uptake time of 60 minutes, all knee joints underwent integrated positron emission tomography (PET, 20-minute acquisition time) and fat-saturated proton density-weighted MRI (fast spin-echo sequence, TR=2500, TE=22 ms) on a clinical PET/MR scanner. The maximum standardized uptake values (SUVmax) of senescent and viable pMSC were compared with a student's t-test.

#### RESULTS

Doxorubicin-induced senescent pMSC demonstrated significantly higher  $\beta$ -gal expression (83%) compared to control viable cells (17 %). Senescent pMSC demonstrated a strong radiotracer signal on PET imaging studies, while viable cells demonstrated little or no radiotracer retention, both in vitro and in vivo. In vitro, the SUVmax of senescent pMSCs (3074.4±374.4) was significantly higher compared to the SUVmax of control pMSCs (1350.23 ±191.35; p=0.037). In vivo, the SUVmax of senescent MSCs (males: 7.55 ± 3.25, females 6.25± 1.98) was significantly higher compared to the SUVmax of viable controls (males: 3.25±0.90, p=0.031 and females: 1.23± 0.58, p=0.0027). Within respective groups of senescent or viable implants, there was no significant difference between the results of male or female pigs. Histology confirmed significantly stronger  $\beta$ -gal staining in senescent cell implants compared to viable cell implants.

#### CONCLUSION

18F-PyGal radiotracer accumulates in senescent cells and yields senescence-specific signal on positron PET-MRI scans.

#### CLINICAL RELEVANCE/APPLICATION

18F-PyGal can be used to detect senescent cells on PET/MR images. This can be helpful in studying the role of senescence in the development of OA and provide a quantitative biomarker for monitoring the efficacy of novel therapies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSCH03

### Chest Imaging (Vascular)

Monday, Nov. 27 9:30AM - 10:30AM Room: N227B

Carole A. Ridge, FFR(RCSI) (*Moderator*) Nothing to Disclose  
Cristina Fuss, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### M3-SSCH03-1 **Diagnosis of Acute PE with Photon-Counting-Detector CT: Comparison with Energy-Integrating-Detector CT in Daily Routine**

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

#### PURPOSE

To compare the conditions of acute PE detection when energy-integrating-detector CT (EID-CT) is replaced by photon-counting-detector CT (PCD-CT).

#### METHODS AND MATERIALS

The study population included two cohorts of consecutive patients referred for suspicion of acute pulmonary embolism who underwent a chest CT angiographic examination with EID-CT (Somatom Force ; Siemens Healthineers) in Group 1 (n=158) and PCD-CT (Naeotom Alpha ; Siemens Healthineers) in Group 2 (n=172). In Group 1, there were two scanning options depending on the patient respiratory status : (a) a dual-energy protocol when a 6-second apnea was possible (Group 1a ; n=105); (b) a high-pitch, single-energy protocol when the patient was short of breath (Group 1b ; n=53). In Group 2, all patients were scanned with multienergy (collimation:144 x 0.4mm; 120 kVp; pitch: 1.5; IQ level: 80). Standard morphologic imaging consisted of 1-mm thick images (Group 1a : averaged images from both tubes; Group 1b : standard polychromatic images; Group 2 : 70 keV images).

#### RESULTS

In Group 1b : (a) the mean duration of data acquisition was  $0.5 \pm 0.1$  s with a mean CTDIvol of  $6.7 \pm 5.0$  mGy and a median DLP of 168.2 mGy.cm ; (b) all examinations were interpretable down to the subsegmental (n=51 ; 96.2%) or segmental (n=2 ; 3.8%) level. Compared to Group 1a, Group 2 examinations had a significantly (a) shorter mean acquisition time ( $0.9 \pm 0.1$ s vs  $4.0 \pm 0.3$  s ;  $p < 0.001$ ) ; (b) lower mean CTDIvol ( $5.1 \pm 1.9$  mGy vs  $9.5 \pm 2.6$  mGy) and median DLP (169.0 mGy.cm [Q1: 136.0 ; Q3: 215.0] vs 323.4 mGy.cm [Q1: 282.8 ; Q3 : 411.1]) ( $p < 0.001$ ), respectively reduced by 46.3% and 47.7% ; (c) higher proportion of examinations devoid of cardiogenic motion artifacts (n=153 ; 89.0% vs n=30 ; 28.6%) ;  $p < 0.001$ ) with a comparable high rate of examinations interpretable down to the subsegmental level (n=164 ; 95.3% vs n=98 ; 93.3%) ; (d) higher mean level of objective image noise ( $20.3 \pm 6.9$  vs  $17.3 \pm 6.6$  ;  $p < 0.001$ ) with no difference in subjective image noise. Suboptimal arterial enhancement was observed in 5 patients in Group 1a and 6 patients in Group 2, restored on low-energy images in both groups (tube A images in Group 1a ; 50 keV images in Group 2). Acute PE was diagnosed in 16 patients (15%) in Group 1a, 14 patients (26%) in Group 1b and 21 patients (12%) in Group 2. Perfusion images in Group 2 had significantly higher qualitative scores ( $p = 0.047$ ), rated as good to excellent in 158 patients (91.9%) vs 88 patients (83.8%) in Group 1a.

#### CONCLUSION

Compared to EID-CT, high-quality morphologic and perfusion imaging was available in all patients scanned with PCD-CT with a dose reduced by 47.7%.

#### CLINICAL RELEVANCE/APPLICATION

PCD-CT ensures confident depiction of acute PE with spectral imaging available at low radiation dose in all patient categories.

### M3-SSCH03-2 **External Validation of a Deep Learning-Based Model to Detect Pulmonary Embolism on CTPA**

Eline Langius, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the implementation and generalisability of the winning deep learning (DL) model developed by Guanshuo Xu for the RSNA 2020 pulmonary embolism (PE) detection challenge using CT pulmonary angiography (CTPA) scan data of two hospitals.

## METHODS AND MATERIALS

Consecutive CTPA scan data from patients referred to two hospitals for suspected PE was retrospectively analysed by the DL model after successful implementation of the solution code according to the guidelines provided. The first set from hospital A included multidetector CTPA images of 238 patients. The second set from hospital B consisted of 114 patients scanned on a spectral detector CT (SDCT) scanner, which provided paired virtual monochromatic images (VMI). The output of the DL model was compared with a reference standard, which included a consensus reading between at least two experienced cardiothoracic radiologists. Areas under the receiver operating characteristic curve (AUCs) of the algorithm were calculated. Diagnostic measures were obtained by choosing an optimal cut-off value. In the second set, performance of the algorithm on conventional images and VMI was compared.

## RESULTS

According to the reference standard, PE was present in 71 patients (29.8%) in the first dataset and 40 patients (35.1%) in the second dataset. The AUC was 0.96 (95% CI 0.93-0.99) for external validation on the data of hospital A. The AUCs were 0.89 (95% CI 0.82-0.96) and 0.86 (95% CI 0.78-0.95) for external validation on respectively conventional and VMI data from hospital B.

## CONCLUSION

The winning DL model developed for the RSNA 2020 PE detection challenge could be successfully implemented. It showed high diagnostic accuracy on scan data from two hospitals. The lower performance on novel SDCT data suggests that additional training of the DL model on advanced technology may improve generalisability for widespread use in any clinical setting.

## CLINICAL RELEVANCE/APPLICATION

The winning DL model developed for the RSNA 2020 PE detection challenge could be implemented in our hospital, while sustaining high diagnostic performance on conventional CTPA data.

## M3-SSCH03-3 Sex-Specific Differences in Lesion Type and Distribution in Chronic Thromboembolic Pulmonary Hypertension

Marie L. Bambrick, MBBCh (*Presenter*) Nothing to Disclose

## PURPOSE

Registry data suggests females are less likely than males to undergo surgery for chronic thromboembolic pulmonary hypertension (CTEPH) despite a similar proportion of proximal vs distal disease. We hypothesized that sex-specific differences in CTEPH could be elicited with a more detailed analysis of the pulmonary vasculature incorporating lesion location and type.

## METHODS AND MATERIALS

For this single center retrospective review, preoperative computed tomography pulmonary angiography of patients who underwent pulmonary endarterectomy (January 2017 - September 2021) for surgically proven CTEPH were analyzed by a fellowship trained thoracic radiologist. The pulmonary vascular tree was divided into 32 distinct named vessels (3 main, 1 interlobar, 5 lobar, 1 lingular, 2 basal trunks and 20 segmental) and each vessel scored for the presence or absence of chronic thromboembolism. Lesions were classified as either a web, eccentric thickening or occlusion with only the single most obstructive lesion counted per vessel. Subsegmental disease was noted if present when no other lesion was identified in the segmental vessel. Clinical data for each patient was obtained from review of their medical records.

## RESULTS

144 patients were included with 78 (54%) females. Baseline characteristics were similar in females vs males with no significant difference in age (mean 44 vs 41 years,  $p=0.59$ ) or mean pulmonary artery pressure (44 vs 41 mmHg,  $p=0.27$ ). There were 2,679 chronic pulmonary emboli identified in the 4,562 vessels analyzed. Females had fewer vessels involved per case (mean 17 vs 20 vessels,  $p=0.004$ ) and, though diffuse disease was common to both sexes, females had more disease-free pulmonary segments (mean 5.8 vs 3.4 segments,  $p=0.001$ ). Males had an overall greater number of webs, eccentric thickening, and occlusions ( $p=0.006$ , 0.04 and 0.05 respectively). The distribution of lesion type did not significantly vary between sexes at the main ( $p=0.74$ ) or lobar level ( $p=0.14$ ), but significant differences were observed in the segmental ( $p<0.001$ ) and subsegmental vasculature. When no segmental lesion was seen, females had a higher number of subsegmental lesions in those segments ( $p=0.02$ ).



## CONCLUSION

Sex-specific differences exist in chronic pulmonary embolism type and distribution at the segmental and subsegmental level. A higher prevalence of subsegmental disease and a lower burden of chronic PE in females, despite similar hemodynamics, may explain the reported disparity in surgical management.

## CLINICAL RELEVANCE/APPLICATION

Sex-specific differences in CTEPH of lesions at the segmental and subsegmental level may explain reported disparities in the management of chronic thromboembolic pulmonary hypertension.

### M3-SSCH03-4 **Detectability for Peripheral Pulmonary Artery Lesions in Patients with CTEPH: Comparison between Ultra-High-Resolution vs. Conventional CT**

Satoshi Higuchi, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Conventional multidetector CT pulmonary angiography (CTPA), due to its spatial resolution, has been limited to the detection of peripheral steno-occlusive lesions in chronic thromboembolic pulmonary hypertension (CTEPH). This study aims to evaluate the detectability of lesions in segmental and subsegmental pulmonary arteries with CTPA, as identified by invasive selective angiography, between ultra-high-resolution (UHRCT) and conventional CT (cCT) in patients with CTEPH.

## METHODS AND MATERIALS

A total of 24 consecutive patients (age, 70±11 years; 8 men) diagnosed with CTEPH and treated with balloon pulmonary angioplasty (BPA) from 2019 to 2020 were included. Twelve patients underwent CTPA before BPA with cCT (SOMATOM Definition Flash, Siemens Healthineers), and others with UHRCT (Aquilion Precision, Canon Medical Systems). The morphology and location of lesions were evaluated in selective angiography by a cardiologist and in CTPA images by a radiologist. The morphology was classified into 4 types: ringlike stenosis; web; subtotal occlusion; and total occlusion. The definition of segmental and subsegmental branches was determined based on the anatomical feature of the bronchus. Each branch was classified on the CT volume rendering images to avoid differences in perception of the evaluated vessel by each modality. The detection rate of lesions identified by angiography was evaluated between two groups using the chi-square test.  $P < 0.05$  indicated statistical significance.

## RESULTS

For the lesions identified by selective angiography, 80% (44/55) of segmental lesions and 48% (123/256) of subsegmental lesions were detected by cCT, while 98% (42/43) of lesions in segmental arteries and 93% (270/289) of lesions in subsegmental arteries were detected by UHRCT. The detectability of lesions by UHRCT was significantly higher than that by cCT in both of segmental and subsegmental branch (segmental: 98% vs. 80%,  $p = 0.011$  and subsegmental: 93% vs. 48%,  $p < 0.001$ ). There was no interaction by segmental and subsegmental branches ( $p$  for interaction = 0.73). In undetected lesions by CTPA, web lesions accounted for 67% (97/144) in the cCT and 70% (14/20) in the UHRCT, indicating it is the most challenging lesion to detect with CT.

## CONCLUSION

UHRCT demonstrated significantly higher detectability of lesions in segmental and subsegmental pulmonary arteries than conventional CT in patients with CTEPH who were eligible for BPA. By type of lesions, web lesion was the most challenging to detect by CTPA.

## CLINICAL RELEVANCE/APPLICATION

Ultra-high-resolution CT allows to detect lesions in peripheral pulmonary arteries which are the target of BPA more accurately than the conventional CT, helping establishment of the safe and effective BPA for patients with CTEPH.

### M3-SSCH03-5 **Lung Microvasculopathy in CTEPH: Ultra-High-Resolution (UHR) Findings with Photon-Counting CT in 29 Patients**

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

## PURPOSE

To evaluate the morphological characteristics of the most distal divisions of the pulmonary circulation in CTEPH patients with mosaic perfusion.

## METHODS AND MATERIALS

Over a 18-month period, 206 patients with a high-probability of pulmonary hypertension (PH) at echocardiography were referred for chest CT angiography with photon-counting-detector CT. After PH confirmation by right-heart-catheterization in 168 patients, Group 4 PH was diagnosed in 42 patients; 13 patients were excluded (non-CTEPH-pulmonary artery obstruction:  $n = 2$ ; CTEPH without mosaic perfusion ( $n = 9$ ) or lung infection ( $n = 2$ ), leading to a study population of 29 patients scanned



with a collimation of 144 x 0.4mm (n=18) and 120 x 0.2 mm (n=11). Distal lung circulation was assessed in the outer third of the lung parenchyma at the level of the hyper- (zone A) and hypo- (zone B) attenuating areas of mosaic perfusion, after selection of 2 to 3 pairs in different lobes per patient. Two experienced chest radiologists analyzed the size of vascular sections, the presence of PAH-like lesions (i.e., ill-defined micronodules, lobular ground-glass attenuation), capillary and venous lesions seen in PVOD/PCH (septal lines, ground-glass nodules) and systemic-to-pulmonary anastomoses.

## RESULTS

The study population included 15 females and 14 males (mean age : 68.7 ± 12.7 yr ; mean PAPm : 44.4 ± 10.1 mm Hg ; mean PVR : 7.9 ± 3.2 Wood unit) with 3 pairs selected in all but one patient (2 pairs), leading to the analysis of 86 pairs. Significant differences were observed between zones A and B regarding the presence of : (a) dilated distal pulmonary arteries (zone A : n=79 ; 91.9% ; zone B ; n=26 ; 30.23% ; p<0.0001) ; (b) ill-defined micronodules (zone A : n=29 ; 22.09% ; zone B : n=35 ; 40.70% ; p=0.0025) ; (c) lobular ground-glass opacities (zone A : n=2 ; 2.33% ; zone B : n=13 ; 15.12% ; p=0.0045) ; (d) diameter of pulmonary veins (p<0.0001). When dividing the population into two subgroups of patients with a PAPm below (Group A) or above (Group B) the median PAPm value (i.e., 42.5 mm Hg) : (a) the 42 pairs of Group A showed similar differences as those described in the overall study group and a significantly higher frequency of subpleural systemic-to-pulmonary anastomoses (n=21 ; 50% vs 11 ; 26.19% ; p=0.0075) ; (b) in the 41 pairs of Group B, the only significant difference concerned the diameter of distal pulmonary arteries (p<0.0001).

## CONCLUSION

The morphological characteristics of distal pulmonary circulation significantly differed between hyper-and hypo-attenuating areas with a trend toward homogenization of findings in patients with severe PH.

## CLINICAL RELEVANCE/APPLICATION

This study suggests that the high-spatial resolution of PCD-CT has the capability of approaching the complex pathophysiology of small-vessel disease in CTEPH.

## M3- SSCH03-6 Hidden in Plain Sight: Characteristics and Prognostic Value of the Spiral Flap Trajectory in Aortic Dissection

Pablo Francis Schell, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To describe the radiological features of the spiral trajectory (ST) of the flap along the descending thoracic aorta (DTA), a characteristic trait of aortic dissection (AD) on CT angiography (CTA) which has not been thoroughly researched. To find out the association of ST with long-term aortic adverse events (AAE) and create a simple risk evaluation model.

## METHODS AND MATERIALS

A CTA was performed in the subacute phase of AD (<3 months) in all patients discharged after 2008 with a patent false lumen (FL) and no comorbidities (n=105, mean age 58 years, 76 men, 44 type B). The change in the position of the flap on transverse aortic images from the aortic isthmus to the distal abdominal segment was scored in a semiquantitative ordinal scale: ST0 (<45° of rotation), ST1 (45-90°), ST2 (90-180°), ST3 (180-270°), ST4 (270-360°) and ST5 (>360°). Additional scores/measurements performed were maximum aortic diameter, proximal and distal entry tear areas, DTA elongation and tortuosity indices, circumferential FL extent, partial FL thrombosis and arch morphology. Long-term AAE were defined as: DTA aneurysm, elective or emergent aortic surgery and AD-related clinical complications or death. Binomial logistic regression analyses for clinical and radiological parameters related to ST>1 were performed. Sex- and age-adjusted multivariable Cox regression models were compared according to model metrics.

## RESULTS

A spiral flap trajectory (ST>1) was present in 72 participants (69%). The most frequent level after ST0 was ST2 (n=27). There were no differences in proportions between subgroups regarding AD type or the presence of genetic aortic disease (p=0.44 and p=0.08, respectively). Dyslipidemia, gothic arch morphology, DTA diameter and elongation were related to ST>1. Fifty-four participants (51%) had an AAE during follow-up (median 6.02 years, IQR 2.72-9.39). Participants with ST=1 showed a shorter estimated survival time than those with ST0 (6.69 versus 11.6; p=0.01). A sex- and age-adjusted model composed of genetic aortic disease, type B AD and ST=1 allowed for the creation of low- (n=32), intermediate- (n=59) and high-risk (n=14) groups with median survival times of 13.1, 8 and 2.7 years, respectively (Log-rank p<0.0001).

## CONCLUSION

A spiral flap trajectory in aortic dissection, defined as a rotation of the flap >45° along the descending thoracic aorta, is a common and conspicuous finding associated with an increase in the risk of long-term aortic adverse events.

## CLINICAL RELEVANCE/APPLICATION

The spiral flap trajectory is an easily available early marker of risk in AD that does not require complex measurements. Survivors at high risk of aortic adverse events might benefit from earlier surgical treatment.

## Abstract Archives of the RSNA, 2023

M3-SSCH03-1

### Diagnosis of Acute PE with Photon-Counting-Detector CT: Comparison with Energy-Integrating-Detector CT in Daily Routine

Monday, Nov. 27 9:30AM - 10:30AM Room: N227B

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

#### PURPOSE

To compare the conditions of acute PE detection when energy-integrating-detector CT (EID-CT) is replaced by photon-counting-detector CT (PCD-CT).

#### METHODS AND MATERIALS

The study population included two cohorts of consecutive patients referred for suspicion of acute pulmonary embolism who underwent a chest CT angiographic examination with EID-CT (Somatom Force ; Siemens Healthineers) in Group 1 (n=158) and PCD-CT (Naeotom Alpha ; Siemens Healthineers) in Group 2 (n=172). In Group 1, there were two scanning options depending on the patient respiratory status : (a) a dual-energy protocol when a 6-second apnea was possible (Group 1a ; n=105); (b) a high-pitch, single-energy protocol when the patient was short of breath (Group 1b ; n=53). In Group 2, all patients were scanned with multienergy (collimation:144 x 0.4mm; 120 kVp; pitch: 1.5; IQ level: 80). Standard morphologic imaging consisted of 1-mm thick images (Group 1a : averaged images from both tubes; Group 1b : standard polychromatic images; Group 2 : 70 keV images).

#### RESULTS

In Group 1b : (a) the mean duration of data acquisition was  $0.5 \pm 0.1$  s with a mean CTDIvol of  $6.7 \pm 5.0$  mGy and a median DLP of 168.2 mGy.cm ; (b) all examinations were interpretable down to the subsegmental (n=51 ; 96.2%) or segmental (n=2 ; 3.8%) level. Compared to Group 1a, Group 2 examinations had a significantly (a) shorter mean acquisition time ( $0.9 \pm 0.1$ s vs  $4.0 \pm 0.3$  s ;  $p < 0.001$ ) ; (b) lower mean CTDIvol ( $5.1 \pm 1.9$  mGy vs  $9.5 \pm 2.6$  mGy) and median DLP (169.0 mGy.cm [Q1: 136.0 ; Q3: 215.0] vs 323.4 mGy.cm [Q1: 282.8 ; Q3 : 411.1]) ( $p < 0.001$ ), respectively reduced by 46.3% and 47.7% ; (c) higher proportion of examinations devoid of cardiogenic motion artifacts (n=153 ; 89.0% vs n=30 ; 28.6%) ;  $p < 0.001$ ) with a comparable high rate of examinations interpretable down to the subsegmental level (n=164 ; 95.3% vs n=98 ; 93.3%) ; (d) higher mean level of objective image noise ( $20.3 \pm 6.9$  vs  $17.3 \pm 6.6$  ;  $p < 0.001$ ) with no difference in subjective image noise. Suboptimal arterial enhancement was observed in 5 patients in Group 1a and 6 patients in Group 2, restored on low-energy images in both groups (tube A images in Group 1a ; 50 keV images in Group 2). Acute PE was diagnosed in 16 patients (15%) in Group 1a, 14 patients (26%) in Group 1b and 21 patients (12%) in Group 2. Perfusion images in Group 2 had significantly higher qualitative scores ( $p = 0.047$ ), rated as good to excellent in 158 patients (91.9%) vs 88 patients (83.8%) in Group 1a.

#### CONCLUSION

Compared to EID-CT, high-quality morphologic and perfusion imaging was available in all patients scanned with PCD-CT with a dose reduced by 47.7%.

#### CLINICAL RELEVANCE/APPLICATION

PCD-CT ensures confident depiction of acute PE with spectral imaging available at low radiation dose in all patient categories.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSCH03-2

### External Validation of a Deep Learning-Based Model to Detect Pulmonary Embolism on CTPA

Monday, Nov. 27 9:30AM - 10:30AM Room: N227B

Eline Langius, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the implementation and generalisability of the winning deep learning (DL) model developed by Guanshuo Xu for the RSNA 2020 pulmonary embolism (PE) detection challenge using CT pulmonary angiography (CTPA) scan data of two hospitals.

#### METHODS AND MATERIALS

Consecutive CTPA scan data from patients referred to two hospitals for suspected PE was retrospectively analysed by the DL model after successful implementation of the solution code according to the guidelines provided. The first set from hospital A included multidetector CTPA images of 238 patients. The second set from hospital B consisted of 114 patients scanned on a spectral detector CT (SDCT) scanner, which provided paired virtual monochromatic images (VMI). The output of the DL model was compared with a reference standard, which included a consensus reading between at least two experienced cardiothoracic radiologists. Areas under the receiver operating characteristic curve (AUCs) of the algorithm were calculated. Diagnostic measures were obtained by choosing an optimal cut-off value. In the second set, performance of the algorithm on conventional images and VMI was compared.

#### RESULTS

According to the reference standard, PE was present in 71 patients (29.8%) in the first dataset and 40 patients (35.1%) in the second dataset. The AUC was 0.96 (95% CI 0.93-0.99) for external validation on the data of hospital A. The AUCs were 0.89 (95% CI 0.82-0.96) and 0.86 (95% CI 0.78-0.95) for external validation on respectively conventional and VMI data from hospital B.

#### CONCLUSION

The winning DL model developed for the RSNA 2020 PE detection challenge could be successfully implemented. It showed high diagnostic accuracy on scan data from two hospitals. The lower performance on novel SDCT data suggests that additional training of the DL model on advanced technology may improve generalisability for widespread use in any clinical setting.

#### CLINICAL RELEVANCE/APPLICATION

The winning DL model developed for the RSNA 2020 PE detection challenge could be implemented in our hospital, while sustaining high diagnostic performance on conventional CTPA data.

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## Abstract Archives of the RSNA, 2023

M3-SSCH03-3

### Sex-Specific Differences in Lesion Type and Distribution in Chronic Thromboembolic Pulmonary Hypertension

Monday, Nov. 27 9:30AM - 10:30AM Room: N227B

Marie L. Bambrick, MBBCh (*Presenter*) Nothing to Disclose

#### PURPOSE

Registry data suggests females are less likely than males to undergo surgery for chronic thromboembolic pulmonary hypertension (CTEPH) despite a similar proportion of proximal vs distal disease. We hypothesized that sex-specific differences in CTEPH could be elicited with a more detailed analysis of the pulmonary vasculature incorporating lesion location and type.

#### METHODS AND MATERIALS

For this single center retrospective review, preoperative computed tomography pulmonary angiography of patients who underwent pulmonary endarterectomy (January 2017 - September 2021) for surgically proven CTEPH were analyzed by a fellowship trained thoracic radiologist. The pulmonary vascular tree was divided into 32 distinct named vessels (3 main, 1 interlobar, 5 lobar, 1 lingular, 2 basal trunks and 20 segmental) and each vessel scored for the presence or absence of chronic thromboembolism. Lesions were classified as either a web, eccentric thickening or occlusion with only the single most obstructive lesion counted per vessel. Subsegmental disease was noted if present when no other lesion was identified in the segmental vessel. Clinical data for each patient was obtained from review of their medical records.

#### RESULTS

144 patients were included with 78 (54%) females. Baseline characteristics were similar in females vs males with no significant difference in age (mean 44 vs 41 years,  $p=0.59$ ) or mean pulmonary artery pressure (44 vs 41 mmHg,  $p=0.27$ ). There were 2,679 chronic pulmonary emboli identified in the 4,562 vessels analyzed. Females had fewer vessels involved per case (mean 17 vs 20 vessels,  $p=0.004$ ) and, though diffuse disease was common to both sexes, females had more disease-free pulmonary segments (mean 5.8 vs 3.4 segments,  $p=0.001$ ). Males had an overall greater number of webs, eccentric thickening, and occlusions ( $p=0.006$ , 0.04 and 0.05 respectively). The distribution of lesion type did not significantly vary between sexes at the main ( $p=0.74$ ) or lobar level ( $p=0.14$ ), but significant differences were observed in the segmental ( $p<0.001$ ) and subsegmental vasculature. When no segmental lesion was seen, females had a higher number of subsegmental lesions in those segments ( $p=0.02$ ).

#### CONCLUSION

Sex-specific differences exist in chronic pulmonary embolism type and distribution at the segmental and subsegmental level. A higher prevalence of subsegmental disease and a lower burden of chronic PE in females, despite similar hemodynamics, may explain the reported disparity in surgical management.

#### CLINICAL RELEVANCE/APPLICATION

Sex-specific differences in CTEPH of lesions at the segmental and subsegmental level may explain reported disparities in the management of chronic thromboembolic pulmonary hypertension.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSCH03-4

### **Detectability for Peripheral Pulmonary Artery Lesions in Patients with CTEPH: Comparison between Ultra-High-Resolution vs. Conventional CT**

Monday, Nov. 27 9:30AM - 10:30AM Room: N227B

Satoshi Higuchi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Conventional multidetector CT pulmonary angiography (CTPA), due to its spatial resolution, has been limited to the detection of peripheral steno-occlusive lesions in chronic thromboembolic pulmonary hypertension (CTEPH). This study aims to evaluate the detectability of lesions in segmental and subsegmental pulmonary arteries with CTPA, as identified by invasive selective angiography, between ultra-high-resolution (UHRCT) and conventional CT (cCT) in patients with CTEPH.

#### **METHODS AND MATERIALS**

A total of 24 consecutive patients (age,  $70 \pm 11$  years; 8 men) diagnosed with CTEPH and treated with balloon pulmonary angioplasty (BPA) from 2019 to 2020 were included. Twelve patients underwent CTPA before BPA with cCT (SOMATOM Definition Flash, Siemens Healthineers), and others with UHRCT (Aquilion Precision, Canon Medical Systems). The morphology and location of lesions were evaluated in selective angiography by a cardiologist and in CTPA images by a radiologist. The morphology was classified into 4 types: ringlike stenosis; web; subtotal occlusion; and total occlusion. The definition of segmental and subsegmental branches was determined based on the anatomical feature of the bronchus. Each branch was classified on the CT volume rendering images to avoid differences in perception of the evaluated vessel by each modality. The detection rate of lesions identified by angiography was evaluated between two groups using the chi-square test.  $P < 0.05$  indicated statistical significance.

#### **RESULTS**

For the lesions identified by selective angiography, 80% (44/55) of segmental lesions and 48% (123/256) of subsegmental lesions were detected by cCT, while 98% (42/43) of lesions in segmental arteries and 93% (270/289) of lesions in subsegmental arteries were detected by UHRCT. The detectability of lesions by UHRCT was significantly higher than that by cCT in both of segmental and subsegmental branch (segmental: 98% vs. 80%,  $p = 0.011$  and subsegmental: 93% vs. 48%,  $p < 0.001$ ). There was no interaction by segmental and subsegmental branches ( $p$  for interaction = 0.73). In undetected lesions by CTPA, web lesions accounted for 67% (97/144) in the cCT and 70% (14/20) in the UHRCT, indicating it is the most challenging lesion to detect with CT.

#### **CONCLUSION**

UHRCT demonstrated significantly higher detectability of lesions in segmental and subsegmental pulmonary arteries than conventional CT in patients with CTEPH who were eligible for BPA. By type of lesions, web lesion was the most challenging to detect by CTPA.

#### **CLINICAL RELEVANCE/APPLICATION**

Ultra-high-resolution CT allows to detect lesions in peripheral pulmonary arteries which are the target of BPA more accurately than the conventional CT, helping establishment of the safe and effective BPA for patients with CTEPH.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSCH03-5

### Lung Microvasculopathy in CTEPH: Ultra-High-Resolution (UHR) Findings with Photon-Counting CT in 29 Patients

Monday, Nov. 27 9:30AM - 10:30AM Room: N227B

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

#### PURPOSE

To evaluate the morphological characteristics of the most distal divisions of the pulmonary circulation in CTEPH patients with mosaic perfusion.

#### METHODS AND MATERIALS

Over a 18-month period, 206 patients with a high-probability of pulmonary hypertension (PH) at echocardiography were referred for chest CT angiography with photon-counting-detector CT. After PH confirmation by right-heart-catheterization in 168 patients, Group 4 PH was diagnosed in 42 patients ;13 patients were excluded (non-CTEPH-pulmonary artery obstruction : n=2 ; CTEPH without mosaic perfusion (n=9) or lung infection (n=2), leading to a study population of 29 patients scanned with a collimation of 144 x 0.4mm (n=18) and 120 x 0.2 mm (n=11). Distal lung circulation was assessed in the outer third of the lung parenchyma at the level of the hyper- (zone A) and hypo- (zone B) attenuating areas of mosaic perfusion, after selection of 2 to 3 pairs in different lobes per patient. Two experienced chest radiologists analyzed the size of vascular sections, the presence of PAH-like lesions (i.e., ill-defined micronodules, lobular ground-glass attenuation), capillary and venous lesions seen in PVOD/PCH (septal lines, ground-glass nodules) and systemic-to-pulmonary anastomoses.

#### RESULTS

The study population included 15 females and 14 males (mean age :  $68.7 \pm 12.7$  yr ; mean PAPm :  $44.4 \pm 10.1$  mm Hg ; mean PVR :  $7.9 \pm 3.2$  Wood unit) with 3 pairs selected in all but one patient (2 pairs), leading to the analysis of 86 pairs. Significant differences were observed between zones A and B regarding the presence of : (a) dilated distal pulmonary arteries (zone A : n=79 ; 91.9% ; zone B ; n=26 ; 30.23% ;  $p < 0.0001$ ) ; (b) ill-defined micronodules (zone A : n=29 ; 22.09% ; zone B : n=35 ; 40.70% ;  $p = 0.0025$ ) ; (c) lobular ground-glass opacities (zone A : n=2 ; 2.33% ; zone B : n=13 ; 15.12% ;  $p = 0.0045$ ) ; (d) diameter of pulmonary veins ( $p < 0.0001$ ). When dividing the population into two subgroups of patients with a PAPm below (Group A) or above (Group B) the median PAPm value (i.e., 42.5 mm Hg) : (a) the 42 pairs of Group A showed similar differences as those described in the overall study group and a significantly higher frequency of subpleural systemic-to-pulmonary anastomoses (n=21 ; 50% vs 11 ; 26.19% ;  $p = 0.0075$ ) ; (b) in the 41 pairs of Group B, the only significant difference concerned the diameter of distal pulmonary arteries ( $p < 0.0001$ ).

#### CONCLUSION

The morphological characteristics of distal pulmonary circulation significantly differed between hyper-and hypo-attenuating areas with a trend toward homogenization of findings in patients with severe PH.

#### CLINICAL RELEVANCE/APPLICATION

This study suggests that the high-spatial resolution of PCD-CT has the capability of approaching the complex pathophysiology of small-vessel disease in CTEPH.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSCH03-6

### Hidden in Plain Sight: Characteristics and Prognostic Value of the Spiral Flap Trajectory in Aortic Dissection

Monday, Nov. 27 9:30AM - 10:30AM Room: N227B

Pablo Francis Schell, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To describe the radiological features of the spiral trajectory (ST) of the flap along the descending thoracic aorta (DTA), a characteristic trait of aortic dissection (AD) on CT angiography (CTA) which has not been thoroughly researched. To find out the association of ST with long-term aortic adverse events (AAE) and create a simple risk evaluation model.

#### METHODS AND MATERIALS

A CTA was performed in the subacute phase of AD (<3 months) in all patients discharged after 2008 with a patent false lumen (FL) and no comorbidities (n=105, mean age 58 years, 76 men, 44 type B). The change in the position of the flap on transverse aortic images from the aortic isthmus to the distal abdominal segment was scored in a semiquantitative ordinal scale: ST0 (<45° of rotation), ST1 (45-90°), ST2 (90-180°), ST3 (180-270°), ST4 (270-360°) and ST5 (>360°). Additional scores/measurements performed were maximum aortic diameter, proximal and distal entry tear areas, DTA elongation and tortuosity indices, circumferential FL extent, partial FL thrombosis and arch morphology. Long-term AAE were defined as: DTA aneurysm, elective or emergent aortic surgery and AD-related clinical complications or death. Binomial logistic regression analyses for clinical and radiological parameters related to ST>1 were performed. Sex- and age-adjusted multivariable Cox regression models were compared according to model metrics.

#### RESULTS

A spiral flap trajectory (ST>1) was present in 72 participants (69%). The most frequent level after ST0 was ST2 (n=27). There were no differences in proportions between subgroups regarding AD type or the presence of genetic aortic disease (p=0.44 and p=0.08, respectively). Dyslipidemia, gothic arch morphology, DTA diameter and elongation were related to ST>1. Fifty-four participants (51%) had an AAE during follow-up (median 6.02 years, IQR 2.72-9.39). Participants with ST=1 showed a shorter estimated survival time than those with ST0 (6.69 versus 11.6; p=0.01). A sex- and age-adjusted model composed of genetic aortic disease, type B AD and ST=1 allowed for the creation of low- (n=32), intermediate- (n=59) and high-risk (n=14) groups with median survival times of 13.1, 8 and 2.7 years, respectively (Log-rank p<0.0001).

#### CONCLUSION

A spiral flap trajectory in aortic dissection, defined as a rotation of the flap >45° along the descending thoracic aorta, is a common and conspicuous finding associated with an increase in the risk of long-term aortic adverse events.

#### CLINICAL RELEVANCE/APPLICATION

The spiral flap trajectory is an easily available early marker of risk in AD that does not require complex measurements. Survivors at high risk of aortic adverse events might benefit from earlier surgical treatment.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-SSGI05

### Gastrointestinal Imaging (Dual/Multienergy CT Techniques)

Monday, Nov. 27 9:30AM - 10:30AM Room: E350

Ashish R. Khandelwal, MD (*Moderator*) Nothing to Disclose  
Anugayathri Jawahar, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M3-SSGI05-1 Low keV Virtual Monochromatic Images in Abdominal CT Angiography with Photon-counting CT Improve Abdominal Arteries Delineation**

Takashi Ota, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the ability of low keV (50 keV) virtual monochromatic images (VMI) to depict abdominal arteries in abdominal CT angiography (CTA) compared to the 70 keV VMI with photon-counting CT (PCCT).

#### METHODS AND MATERIALS

This retrospective study included 50 consecutive patients who underwent abdominal CTA with a PCCT scanner. After intravenous injection of 600 mgI/kg contrast agent in 25 seconds, CTA was scanned 8 seconds after the abdominal aortic attenuation reached 40 HU. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) in the abdominal aorta (AA), celiac (CeA), superior mesenteric (SMA), renal (RA), and right hepatic artery (RHA) were quantitatively evaluated by region-of-interest analysis on 0.4 mm thickness CT images and compared between 70 keV and 50 keV VMI by paired t-test. Image noise (SD<sub>fat</sub>) was defined as the standard deviation (SD) of CT density for anterior subcutaneous fat. The mean attenuation value of muscles (HU<sub>muscle</sub>) was defined as the CT value of the erector spinae muscles at the same slice and level as that of the CeA. The SNR and the CNR were calculated as follows:  $SNR = HU_{vessel}/SD_{vessel}$ ;  $CNR = (HU_{vessel} - HU_{muscle})/SD_{fat}$ . We created a volume rendering 3D images from the CTA data. We measured the distance from the origin of the CeA to the end of the A8 branch of the RHA to assess how far arterial branches are visualized distally. The software analyzed the vessel route and automatically measured the vessel's length. We compared the length from CeA to A8 at 70 keV VMI with that at 50 keV VMI by using paired t-test.

#### RESULTS

SNR values of 50 keV VMI were significantly higher than those of 70 keV VMI in each artery;  $35.69 \pm 7.52$  vs.  $25.54 \pm 4.34$  for AA,  $21.60 \pm 8.14$  vs.  $18.59 \pm 5.14$  for CeA,  $22.31 \pm 8.18$  vs.  $18.93 \pm 5.58$  for SMA,  $21.38 \pm 8.30$  vs.  $19.11 \pm 5.37$  for RA, and  $13.84 \pm 7.39$  vs.  $12.54 \pm 6.99$  for RHA (all  $p < .05$ ). CNR values of 50 keV VMI were also significantly higher than those of 70 keV VMI in each artery;  $49.29 \pm 15.14$  vs.  $28.42 \pm 7.69$  for AA,  $49.26 \pm 14.44$  vs.  $28.94 \pm 7.71$  for CeA,  $50.45 \pm 15.65$  vs.  $29.70 \pm 8.20$  for SMA,  $50.08 \pm 15.49$  vs.  $29.51 \pm 8.00$  for RA,  $44.73 \pm 14.15$  vs.  $26.62 \pm 7.47$  for RHA (all  $p < .05$ ). The distance between the CeA origin and the A8 end was significantly longer with 50 keV VMI than that with 70 keV VMI:  $192.6 \pm 33.3$  mm with 50 keV VMI and  $180.3 \pm 30.9$  mm with 70 keV VMI ( $p < .001$ ).

#### CONCLUSION

In abdominal CTA with PCCT, the quantitative image quality of 50 keV VMI was better than that of 70 keV VMI. In addition, 3D CTA with 50 keV VMI could depict branches of the RHA more peripherally than that with 70 keV VMI.

#### CLINICAL RELEVANCE/APPLICATION

Low keV virtual monochromatic images have the advantage of delineating arterial branches more peripherally on abdominal CT angiography with photon-counting CT, allowing for a more detailed understanding of the vascular anatomy.



### **M3-SSGI05-2 Ultra-high-resolution Abdominal CT Angiography using Photon-counting CT: A Comparison with Spectral CT Angiography**

Hiromitsu Onishi, MD, PhD (*Presenter*) Research Grant, General Electric Company; Speakers Bureau, General Electric Company

#### **PURPOSE**

A clinical photon-counting (PC) CT scanner can produce images with a minimum slice thickness of 0.2 mm, but for virtual monochromatic images (VMIs), the minimum thickness is limited to 0.4 mm. The purpose of our study was to compare ultra-high-resolution (UHR) abdominal CT angiography (CTA) using 0.2 mm images with spectral CTA using 0.4 mm images in the visualization of arteries at PC CT.

#### **METHODS AND MATERIALS**

This retrospective study included 61 consecutive patients with suspected hepatopancreatobiliary cancer who underwent abdominal CT using a PC CT scanner. For UHR CTA, early arterial phase images after 600 mgI/kg contrast administration were reconstructed with a matrix of 1024×1024, a field of view (FOV) of 205 mm x 205 mm, and a thickness of 0.2 mm (0.2 mm isotropic voxel) using all counted events (termed T3D for PC CT) at 120 kVp. Using the same raw data, 120 kVp T3D and 50 keV VMIs with a 1024 x 1024 matrix, 410 mm x 410 mm FOV, and 0.4 mm thickness (0.4 mm isotropic voxel) were also reconstructed for high-resolution (HR) CTA and 50 keV spectral HR CTA, respectively. Image noise, contrast, and contrast-to-noise ratio (CNR) between hepatic artery and liver parenchyma were measured on maximum intensity projection CTA images and compared using ANOVA. Image quality and visualization of the arteries were also evaluated and compared using the Friedman's test.

#### **RESULTS**

Image noise was significantly higher for UHR CTA ( $16.3 \pm 2.8$  HU) than for HR CTA ( $14.2 \pm 3.5$  HU,  $P < .001$ ) or 50 keV HR CTA ( $13.4 \pm 2.6$  HU,  $P < .001$ ). Contrast and CNR were significantly lower for UHR CTA ( $355 \pm 79$  and  $22.4 \pm 6.9$ , respectively) and HR CTA ( $362 \pm 78$ ,  $26.9 \pm 8.8$ ) than for 50 keV HR CTA ( $770 \pm 164$ ,  $59.6 \pm 18.1$ ,  $P < .001$  for all). In visual assessment, image noise and artifacts were more severe for HR CTA and UHR CTA than for 50 keV HR CTA ( $P < .001$  and  $P < .05$ , respectively). Image sharpness for UHR CTA was significantly superior to HR CTA and 50 keV HR CTA ( $P < .01$  for both). Overall image quality for 50 keV HR CTA was significantly better than for HR CTA and UHR CTA ( $P < .001$  for both). UHR CTA and 50 keV HR CTA showed better delineation of hepatic artery branches than HR CTA ( $P < .001$  for both), and there were no significant differences between UHR CTA and 50 keV HR CTA ( $P = .998$ ).

#### **CONCLUSION**

Although UHR CTA with PC CT has higher spatial resolution, its overall image quality in the abdominal region was inferior to that of 50keV HR CTA with PC CT due to severe image noise and artifacts, and its ability to depict hepatic arteries was almost equal to that of 50keV HR CTA with PC CT.

#### **CLINICAL RELEVANCE/APPLICATION**

When using photon-counting CT, ultra-high-resolution abdominal CT angiography and spectral CT angiography were equally excellent at visualizing small arterial branches, allowing evaluation of detailed vascular anatomy.

### **M3-SSGI05-4 Consistency and Stability of Monoenergetic Attenuation of Photon-counting Detector CT with Various Scanning Settings: A Phantom Study**

Yanzhao Yang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The inconsistency in traditional CT attenuation values acquired from different scanning modes greatly affects the promotion of CT quantitative applications. This study aims to determine the consistency of attenuation value (Hounsfield Unit, HU) acquired on a clinical first-generation dual-source Photon Counting Detector (PCD)-CT system using a phantom system across varies tube voltages and radiation doses.

#### **METHODS AND MATERIALS**

A multi-energy CT phantom containing ten different tissue-simulating inserts with a large elliptical ring was imaged on a dual-source PCD-CT scanner. Each scan setting was repeated three times across three tube voltage (90, 120 and 140kV) with three image quality (IQ) level (80, 145 and 180) respectively. Various tissue inserts were used to characterize the consistency and stability of HUs on monoenergetic images between 50 to 80 keV by intraclass correlation coefficient (ICC) and Bland-Altman plots. Mixed-effected linear regression analysis was implemented for exploring the association between the absolute bias and all scan factors.

## RESULTS

A total of 27 acquisitions were performed with all variations of scan parameters. Image noise increase with the decrease of the monoenergetic level and the increase of the image quality level ( $p < 0.001$ ). Taking the attenuation of inserts in a default abdominal scanning mode (120 kVp with IQ level 145) as a reference, high consistency and stability of HU measurements were observed with different tube voltages and radiation exposure levels with PCD-CT (all ICC  $> 0.99$ ). The mean bias across various tissue insert were all less than 5HU among different acquisition modes and monoenergetic levels. No significant influence on the absolute bias of attenuation was observed across all scanning settings except 90kV with IQ level at 80.

## CONCLUSION

PCD-CT provides stable, repeatable and standardized HUs without influence from different scanning modes for a wide range of radiation doses.

## CLINICAL RELEVANCE/APPLICATION

PCD-CT has potential application value for quantification in different scanning modes, especially at an ultra-low dose level, which could drive the standardization of CT quantification applications.

### M3-SSGI05-6 A Technique to Identify Isoattenuating Gallstones with Dual-Energy CT: an in Vivo Study

Todd C. Soesbe, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop a dual-energy CT method for differentiating isoattenuating gallstones from bile and compare it with previously reported dual-energy CT methods by using a retrospective in vivo reader study.

## METHODS AND MATERIALS

CT scans for 20 isoattenuating gallstone positive and 20 gallstone negative patients were retrospectively collected at two separate institutions. All patients (21 men; mean age, 62; age range, 30-88 years) were scanned with dual-energy CT (IQon, Philips Healthcare) from July 2015 and Oct 2019. Positive and negative stone diagnoses were confirmed with MRCP, ERCP, or US performed within 90 days of CT. Conventional, 40 keV monoenergetic, and effective-Z series were created for each patient. Comparing 2D histograms from all gallstone positive to all gallstone negative patients revealed that isoattenuating stones appear in a separate and unique 2D location. A global ROI around this unique 2D location permitted material differentiation and visual segmentation of isoattenuating stones within the conventional CT series. Thus, two custom series were created for each patient using either Compton and photoelectric attenuation data (segmented-1), or denoised 200 and 40 keV monoenergetic data (segmented-2). Four readers evaluated the presence of isoattenuating stones in each of the five series. Inter-reader agreement was measured by interclass correlation coefficient (ICC), diagnostic performance was evaluated by the mean area under the ROC curve (AUC) estimates, and multi-reader multi-case analysis of variance was used to compare series types.

## RESULTS

For the gallstone positive patients, 20 had gallbladder stones, 1 had cystic duct stones, 3 had common bile duct stones, and 4 had contrast scans. For the gallstone negative patients, 15 had contrast scans. For all patients, the segmented-1 and segmented-2 series provided the highest agreements (ICC = 0.86 and 0.94, respectively) and the highest overall AUC (0.95; 95% confidence interval [CI]: 0.91, 1.00, and 0.94; 95% confidence interval [CI]: 0.89, 1.00, respectively).

## CONCLUSION

Both 2D histogram methods accurately differentiated and segmented isoattenuating gallstones from bile in a single colorized CT series. Our in vivo study results agree with those from a recent ex vivo isoattenuating gallstone study that used a similar 2D histogram method and reader study. Furthermore, the vendor-neutral aspects of our improved in vivo method have the potential to make dual-energy CT the reference standard to evaluate gallstone disease.

## CLINICAL RELEVANCE/APPLICATION

This technique can potentially reduce the need for further gastrointestinal imaging with US or MRI, leading to a reduction in imaging cost, time-to-diagnosis, and risk for patients with cholelithiasis or choledocholithiasis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI05-1

### Low keV Virtual Monochromatic Images in Abdominal CT Angiography with Photon-counting CT Improve Abdominal Arteries Delineation

Monday, Nov. 27 9:30AM - 10:30AM Room: E350

Takashi Ota, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the ability of low keV (50 keV) virtual monochromatic images (VMI) to depict abdominal arteries in abdominal CT angiography (CTA) compared to the 70 keV VMI with photon-counting CT (PCCT).

#### METHODS AND MATERIALS

This retrospective study included 50 consecutive patients who underwent abdominal CTA with a PCCT scanner. After intravenous injection of 600 mgI/kg contrast agent in 25 seconds, CTA was scanned 8 seconds after the abdominal aortic attenuation reached 40 HU. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) in the abdominal aorta (AA), celiac (CeA), superior mesenteric (SMA), renal (RA), and right hepatic artery (RHA) were quantitatively evaluated by region-of-interest analysis on 0.4 mm thickness CT images and compared between 70 keV and 50 keV VMI by paired t-test. Image noise (SD<sub>fat</sub>) was defined as the standard deviation (SD) of CT density for anterior subcutaneous fat. The mean attenuation value of muscles (HU<sub>muscle</sub>) was defined as the CT value of the erector spinae muscles at the same slice and level as that of the CeA. The SNR and the CNR were calculated as follows:  $SNR = HU_{vessel}/SD_{vessel}$ ;  $CNR = (HU_{vessel} - HU_{muscle})/SD_{fat}$ . We created a volume rendering 3D images from the CTA data. We measured the distance from the origin of the CeA to the end of the A8 branch of the RHA to assess how far arterial branches are visualized distally. The software analyzed the vessel route and automatically measured the vessel's length. We compared the length from CeA to A8 at 70 keV VMI with that at 50 keV VMI by using paired t-test.

#### RESULTS

SNR values of 50 keV VMI were significantly higher than those of 70 keV VMI in each artery;  $35.69 \pm 7.52$  vs.  $25.54 \pm 4.34$  for AA,  $21.60 \pm 8.14$  vs.  $18.59 \pm 5.14$  for CeA,  $22.31 \pm 8.18$  vs.  $18.93 \pm 5.58$  for SMA,  $21.38 \pm 8.30$  vs.  $19.11 \pm 5.37$  for RA, and  $13.84 \pm 7.39$  vs.  $12.54 \pm 6.99$  for RHA (all  $p < .05$ ). CNR values of 50 keV VMI were also significantly higher than those of 70 keV VMI in each artery;  $49.29 \pm 15.14$  vs.  $28.42 \pm 7.69$  for AA,  $49.26 \pm 14.44$  vs.  $28.94 \pm 7.71$  for CeA,  $50.45 \pm 15.65$  vs.  $29.70 \pm 8.20$  for SMA,  $50.08 \pm 15.49$  vs.  $29.51 \pm 8.00$  for RA,  $44.73 \pm 14.15$  vs.  $26.62 \pm 7.47$  for RHA (all  $p < .05$ ). The distance between the CeA origin and the A8 end was significantly longer with 50 keV VMI than that with 70 keV VMI:  $192.6 \pm 33.3$  mm with 50 keV VMI and  $180.3 \pm 30.9$  mm with 70 keV VMI ( $p < .001$ ).

#### CONCLUSION

In abdominal CTA with PCCT, the quantitative image quality of 50 keV VMI was better than that of 70 keV VMI. In addition, 3D CTA with 50 keV VMI could depict branches of the RHA more peripherally than that with 70 keV VMI.

#### CLINICAL RELEVANCE/APPLICATION

Low keV virtual monochromatic images have the advantage of delineating arterial branches more peripherally on abdominal CT angiography with photon-counting CT, allowing for a more detailed understanding of the vascular anatomy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI05-2

### Ultra-high-resolution Abdominal CT Angiography using Photon-counting CT: A Comparison with Spectral CT Angiography

Monday, Nov. 27 9:30AM - 10:30AM Room: E350

Hiromitsu Onishi, MD, PhD (*Presenter*) Research Grant, General Electric Company; Speakers Bureau, General Electric Company

#### PURPOSE

A clinical photon-counting (PC) CT scanner can produce images with a minimum slice thickness of 0.2 mm, but for virtual monochromatic images (VMIs), the minimum thickness is limited to 0.4 mm. The purpose of our study was to compare ultra-high-resolution (UHR) abdominal CT angiography (CTA) using 0.2 mm images with spectral CTA using 0.4 mm images in the visualization of arteries at PC CT.

#### METHODS AND MATERIALS

This retrospective study included 61 consecutive patients with suspected hepatopancreatobiliary cancer who underwent abdominal CT using a PC CT scanner. For UHR CTA, early arterial phase images after 600 mgI/kg contrast administration were reconstructed with a matrix of 1024×1024, a field of view (FOV) of 205 mm x 205 mm, and a thickness of 0.2 mm (0.2 mm isotropic voxel) using all counted events (termed T3D for PC CT) at 120 kVp. Using the same raw data, 120 kVp T3D and 50 keV VMIs with a 1024 x 1024 matrix, 410 mm x 410 mm FOV, and 0.4 mm thickness (0.4 mm isotropic voxel) were also reconstructed for high-resolution (HR) CTA and 50 keV spectral HR CTA, respectively. Image noise, contrast, and contrast-to-noise ratio (CNR) between hepatic artery and liver parenchyma were measured on maximum intensity projection CTA images and compared using ANOVA. Image quality and visualization of the arteries were also evaluated and compared using the Friedman's test.

#### RESULTS

Image noise was significantly higher for UHR CTA ( $16.3 \pm 2.8$  HU) than for HR CTA ( $14.2 \pm 3.5$  HU,  $P < .001$ ) or 50 keV HR CTA ( $13.4 \pm 2.6$  HU,  $P < .001$ ). Contrast and CNR were significantly lower for UHR CTA ( $355 \pm 79$  and  $22.4 \pm 6.9$ , respectively) and HR CTA ( $362 \pm 78$ ,  $26.9 \pm 8.8$ ) than for 50 keV HR CTA ( $770 \pm 164$ ,  $59.6 \pm 18.1$ ,  $P < .001$  for all). In visual assessment, image noise and artifacts were more severe for HR CTA and UHR CTA than for 50 keV HR CTA ( $P < .001$  and  $P < .05$ , respectively). Image sharpness for UHR CTA was significantly superior to HR CTA and 50 keV HR CTA ( $P < .01$  for both). Overall image quality for 50 keV HR CTA was significantly better than for HR CTA and UHR CTA ( $P < .001$  for both). UHR CTA and 50 keV HR CTA showed better delineation of hepatic artery branches than HR CTA ( $P < .001$  for both), and there were no significant differences between UHR CTA and 50 keV HR CTA ( $P = .998$ ).

#### CONCLUSION

Although UHR CTA with PC CT has higher spatial resolution, its overall image quality in the abdominal region was inferior to that of 50keV HR CTA with PC CT due to severe image noise and artifacts, and its ability to depict hepatic arteries was almost equal to that of 50keV HR CTA with PC CT.

#### CLINICAL RELEVANCE/APPLICATION

When using photon-counting CT, ultra-high-resolution abdominal CT angiography and spectral CT angiography were equally excellent at visualizing small arterial branches, allowing evaluation of detailed vascular anatomy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI05-4

### **Consistency and Stability of Monoenergetic Attenuation of Photon-counting Detector CT with Various Scanning Settings: A Phantom Study**

Monday, Nov. 27 9:30AM - 10:30AM Room: E350

Yanzhao Yang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The inconsistency in traditional CT attenuation values acquired from different scanning modes greatly affects the promotion of CT quantitative applications. This study aims to determine the consistency of attenuation value (Hounsfield Unit, HU) acquired on a clinical first-generation dual-source Photon Counting Detector (PCD)-CT system using a phantom system across various tube voltages and radiation doses.

#### **METHODS AND MATERIALS**

A multi-energy CT phantom containing ten different tissue-simulating inserts with a large elliptical ring was imaged on a dual-source PCD-CT scanner. Each scan setting was repeated three times across three tube voltage (90, 120 and 140kV) with three image quality (IQ) level (80, 145 and 180) respectively. Various tissue inserts were used to characterize the consistency and stability of HUs on monoenergetic images between 50 to 80 keV by intraclass correlation coefficient (ICC) and Bland-Altman plots. Mixed-effected linear regression analysis was implemented for exploring the association between the absolute bias and all scan factors.

#### **RESULTS**

A total of 27 acquisitions were performed with all variations of scan parameters. Image noise increase with the decrease of the monoenergetic level and the increase of the image quality level ( $p < 0.001$ ). Taking the attenuation of inserts in a default abdominal scanning mode (120 kVp with IQ level 145) as a reference, high consistency and stability of HU measurements were observed with different tube voltages and radiation exposure levels with PCD-CT (all ICC > 0.99). The mean bias across various tissue insert were all less than 5HU among different acquisition modes and monoenergetic levels. No signification influence on the absolute bias of attenuation was observed across all scanning settings except 90kV with IQ level at 80.

#### **CONCLUSION**

PCD-CT provides stable, repeatable and standardized HUs without influence from different scanning modes for a wide range of radiation doses.

#### **CLINICAL RELEVANCE/APPLICATION**

PCD-CT has potential application value for quantification in different scanning modes, especially at an ultra-low dose level, which could drive the standardization of CT quantification applications.

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## Abstract Archives of the RSNA, 2023

M3-SSGI05-6

### A Technique to Identify Isoattenuating Gallstones with Dual-Energy CT: an in Vivo Study

Monday, Nov. 27 9:30AM - 10:30AM Room: E350

Todd C. Soesbe, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a dual-energy CT method for differentiating isoattenuating gallstones from bile and compare it with previously reported dual-energy CT methods by using a retrospective in vivo reader study.

#### METHODS AND MATERIALS

CT scans for 20 isoattenuating gallstone positive and 20 gallstone negative patients were retrospectively collected at two separate institutions. All patients (21 men; mean age, 62; age range, 30-88 years) were scanned with dual-energy CT (IQon, Philips Healthcare) from July 2015 and Oct 2019. Positive and negative stone diagnoses were confirmed with MRCP, ERCP, or US performed within 90 days of CT. Conventional, 40 keV monoenergetic, and effective-Z series were created for each patient. Comparing 2D histograms from all gallstone positive to all gallstone negative patients revealed that isoattenuating stones appear in a separate and unique 2D location. A global ROI around this unique 2D location permitted material differentiation and visual segmentation of isoattenuating stones within the conventional CT series. Thus, two custom series were created for each patient using either Compton and photoelectric attenuation data (segmented-1), or denoised 200 and 40 keV monoenergetic data (segmented-2). Four readers evaluated the presence of isoattenuating stones in each of the five series. Inter-reader agreement was measured by interclass correlation coefficient (ICC), diagnostic performance was evaluated by the mean area under the ROC curve (AUC) estimates, and multi-reader multi-case analysis of variance was used to compare series types.

#### RESULTS

For the gallstone positive patients, 20 had gallbladder stones, 1 had cystic duct stones, 3 had common bile duct stones, and 4 had contrast scans. For the gallstone negative patients, 15 had contrast scans. For all patients, the segmented-1 and segmented-2 series provided the highest agreements (ICC = 0.86 and 0.94, respectively) and the highest overall AUC (0.95; 95% confidence interval [CI]: 0.91, 1.00, and 0.94; 95% confidence interval [CI]: 0.89, 1.00, respectively).

#### CONCLUSION

Both 2D histogram methods accurately differentiated and segmented isoattenuating gallstones from bile in a single colorized CT series. Our in vivo study results agree with those from a recent ex vivo isoattenuating gallstone study that used a similar 2D histogram method and reader study. Furthermore, the vendor-neutral aspects of our improved in vivo method have the potential to make dual-energy CT the reference standard to evaluate gallstone disease.

#### CLINICAL RELEVANCE/APPLICATION

This technique can potentially reduce the need for further gastrointestinal imaging with US or MRI, leading to a reduction in imaging cost, time-to-diagnosis, and risk for patients with cholelithiasis or choledocholithiasis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI06

### Gastrointestinal Imaging (Quantitative Imaging)

Monday, Nov. 27 9:30AM - 10:30AM Room: E352

William B. Hyslop, MD, PhD (*Moderator*) Nothing to Disclose  
David T. Fetzner, MD (*Moderator*) Research support, General Electric Company; Research support, Koninklijke Philips NV; Research support, Siemens AG; Consultant, Koninklijke Philips NV; Advisory Board, Koninklijke Philips NV; Consultant, General Electric Company; Advisory Board, General Electric Company

#### Sub-Events

#### **M3-SSGI06-1 Inter-Exam Reproducibility of Contrast-Enhanced Liver MRI Radiomics Features: Optimization by Tissue-Based Image Normalization and Bias Field Correction**

Bryan A. Blakeney, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Contrast-enhanced MRI is an important imaging modality for evaluating liver pathology. Lack of standardized intensity units and nonuniform signal intensities (bias field) are challenges specific for radiomic analysis of MRI. Reproducibility is an important performance metric of imaging biomarker development. This study evaluates image pre-processing methods for contrast-enhanced liver MRI.

#### **METHODS AND MATERIALS**

This is a single center retrospective study including 19 patients with two multiphase gadoteric acid-enhanced liver MRIs for evaluation of Focal Nodular Hyperplasia (FNH) on Siemens and Philips, 1.5T (n=23) and 3T (15), systems. From 54 patients, exclusion criteria were cancer (24), missing phases (4), and alternative diagnosis (7). The largest FNH was manually segmented, and spherical regions of interests were placed on reference tissues (right and left liver lobes, spleen, subcutaneous fat, vertebral body, paraspinal muscle, and aorta) using 3D Slicer 5.0.3. First and second order radiomics features were calculated with or without N4ITK bias field correction (BFC), on signal intensity normalized to whole image and each reference tissue, using PyRadiomics (custom version based on version 3.0.1) on original pre-contrast, arterial, and hepatobiliary phases and their Laplacian of Gauss and Wavelet transformations. Concordance Correlation Coefficient (CCC) was calculated to measure reproducibility across the two imaging studies. The effect of normalization methods, BFC, and imaging phase on CCC was assessed by multivariable linear regression.

#### **RESULTS**

For each pre-processed exam, 3354 radiomics features were calculated. Normalization of image intensity to right or ipsilateral (to FNH) liver lobe improved mean CCC (0.59 and 0.60 respectively vs 0.43 for no normalization) and was statistically significantly higher ( $p < 0.0001$ ) than any other normalization. BFC independently improved mean CCC overall ( $p < 0.0001$ ) and in pairwise comparison for right or ipsilateral liver vs. non-BFC when averaged over all phases. Right and ipsilateral liver normalization after BFC produced the most radiomic features (1180 and 1172, respectively) meeting lower 95% confidence interval bound for CCC  $> 0.5$ .

#### **CONCLUSION**

Reproducibility of radiomics features in liver is improved by pre-processing with normalization to right or ipsilateral liver lobe and with bias field correction. This study suggests the benefit of standardized MR image processing for radiomic analysis for radiomics-based biomarker development.

#### **CLINICAL RELEVANCE/APPLICATION**

Image pre-processing impacts the reproducibility of radiomics features on contrast-enhanced liver MRI. Standardizing image processing is important for biomarker development using liver MRI radiomics.

#### **M3-SSGI06-2 Liver MRI-Derived Proton Density Fat Fraction: An Image-Derived Phenotype Causally Affects Pan-liver Disease Risk**



MD (*Presenter*) Nothing to Disclose

## PURPOSE

Liver MRI-derived proton density fat fraction (MRI-PDFF) plays an important role in clinical trials. A better understanding of MRI-PDFF associated with pan-liver diseases might support its promotion. To quantify the genetically predicted causal effect of liver MRI-PDFF across the pan-liver disease. To quantify the genetically predicted causal effect of liver MRI-PDFF across the pan-liver disease.

## METHODS AND MATERIALS

This population-based study was mainly derived from summary-level data and 378,436 individual data from UK Biobank and FinnGen. The primary analysis of Mendelian randomization (MR) analysis was conducted using the inverse-variance-weighted method to explore the causal association between genetically determined liver MRI-PDFF and pan-liver disease risk under Bonferroni correction. Logistic regression was performed to validate the association between liver MRI-PDFF PRS and pan-liver disease risk at individual-level data. Mediation analyses were performed using the multivariable MR framework.

## RESULTS

Genetically predicted high liver MRI-PDFF was associated with increased risks of malignant liver neoplasm (odds ratio [OR], 4.52;  $P = 3.28 \times 10^{-9}$ ), alcoholic liver disease (OR, 1.91;  $P = 1.07 \times 10^{-4}$ ), fibrosis and cirrhosis of liver (OR, 3.03;  $P = 1.75 \times 10^{-14}$ ), fibrosis of liver (OR, 3.61;  $P = .002$ ), cirrhosis of liver (OR, 3.77;  $P = 7.37 \times 10^{-9}$ ), nonalcoholic steatohepatitis (OR, 7.66;  $P = 2.86 \times 10^{-8}$ ), and NAFLD (OR, 4.39;  $P = 6.10 \times 10^{-8}$ ), respectively. Additionally, individual-level evidence similarly supported the association described mentioned above based on the liver MRI-PDFF PRS (all  $P < .004$ ). The mediation analysis indicated genetically predicted high-density lipoprotein cholesterol, type 2 diabetes mellitus, and waist-to-hip ratio (25.1%-46.3% mediation effects) were related to the occurrence of fibrosis and cirrhosis of liver, cirrhosis of liver, and NAFLD via liver MRI-PDFF (all  $P < .005$ ).

## CONCLUSION

The study provided evidence that the associations of genetically predicted liver MRI-PDFF with liver health, promoting MRI-PDFF in routine clinical practice.

## CLINICAL RELEVANCE/APPLICATION

The liver MRI-PDFF has a causal association with pan-liver disease risk and is a mediator of metabolic phenotypes, to provide evidence for liver health monitoring.

## M3-SSGI06-3 Results of the Non-invasive Biomarkers of Metabolic Liver Disease NIMBLE study 1.1 on the Reproducibility and Repeatability of US Fat Quantification Techniques in Non-alcoholic Fatty Liver Disease

Arinc Ozturk, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Non-alcoholic fatty liver disease (NAFLD) is the most common cause of liver disease worldwide. Non-invasive liver fat quantification is important for diagnosis and treatment response assessment. Ultrasound-based fat quantification methods include attenuation coefficient (AC), speed of sound (SoS), shear wave dispersion (SWD), controlled attenuation parameter (CAP), Ultrasound derived fat fraction (UDFF), viscosity, and hepatorenal index (HRI). Defining the reproducibility and repeatability of these quantitative biomarkers is relevant for clinical biomarker interpretation and for use as endpoints in clinical trials. The aim of this study was to quantify the inter-vendor reproducibility and operator repeatability and reproducibility of these measures.

## METHODS AND MATERIALS

Prospective two-center study of adults with suspected or established NAFLD stratified by Fibrosis-4 Index (FIB-4). Participants underwent 6 examinations on different ultrasound systems and CAP on two days, each day by a different operator, less than a week apart. Operators and clinical investigators were blinded and a pre-specified scanning order was maintained. Different day/different operator reproducibility coefficient (RDCDDO), same-day/same-operator repeatability coefficient (RCSOSO), and different-scanner reproducibility coefficient (RDCDS) were calculated for each biomarker. RDC reflects the smallest difference between two measurements due to change in underlying steatosis rather than measurement variability; lower is better.

## RESULTS

40 participants (mean age 60 years, 60% female) with low (17), intermediate (15), and high (8) FIB-4 scores were recruited. Mean BMI was 30.9 kg/m<sup>2</sup>. Precision point estimates (RDCDDO, RCSOSO) pooled across manufacturers were: HRI (82.4%, 73.6%), SWD (69.1%, 23.5%), CAP (26%, 21%), UDFF (57.8%, 37.3%), SoS (5%, 5%), AC (26%, 18%) and viscosity (43.2%, 34.1%). RDCDS was 80.8% and 51% for HRI and AC respectively [Table1].



## CONCLUSION

SoS, AC, and CAP were the most reproducible and repeatable fat quantification biomarkers while HRI was the least. Variability across vendors was high. A  $\geq 26\%$  difference in different-day AC or CAP measurements constitutes a true patient change rather than measurement variability. UDF and viscosity demonstrated intermediate performance. SWD was repeatable by the same operator, but less reproducible by different operators. The high variability between vendors means that the results are vendor dependent and not interchangeable.

## CLINICAL RELEVANCE/APPLICATION

Non-invasive US-based steatosis assessment biomarkers are available on many US systems. Understanding expected quantitative biomarker variability guides clinical interpretation and clinical trial utilization.

### M3-SSGI06-4 Development and Validation of Quantitative Clinical Ultrasound Shear Wave Elastography Exam Quality Metrics

Siddhi Hegde, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

Interquartile range (IQR) to median (IQR/M) ratio is the quality metric for vibration controlled transient elastography which has been extrapolated to shear wave elastography (SWE) despite limited evidence. We 1) assess the performance of the existing IQR/M 30% threshold 2) characterize SWE discrimination as a function of IQR/M, and 3) propose body mass index (BMI) and skin to liver capsule distance (SCD) quality indices to predict low-quality (LQ) SWE exams.

## METHODS AND MATERIALS

A single-center retrospective cross-sectional study of adult patients with suspected nonalcoholic fatty liver disease (NAFLD) with non-focal liver biopsy results and US 2D-SWE exams within 1 year was performed. Histopathological fibrosis stage =2 (NASH CRN or Brunt) was considered clinically significant fibrosis (CSF). All pathology slides were reviewed twice by an experienced pathologist to obtain fibrosis decision. A median value of  $< 50$  kilopascals (kPa) from at least 3 SWE measurements constituted a valid case. IQR was calculated using the MS Excel quartile.inc function. IQR/M was reported as a percentage. Receiver operator characteristic (ROC) curves to assess SWE prediction of CSF were plotted for high-quality (HQ) and LQ exams and area under the curve (AUC) was compared by DeLong's test. AUC vs number of included cases under the threshold was assessed across IQR/M thresholds. SCD was manually calculated by trained physicians on the first SWE image. AUCs assessed BMI and SCD prediction of LQ exams.

## RESULTS

546 cases were included (49.4%, n=269 female) with mean (standard deviation) age of 52.1 (12.8) years. 162 (29.7%) cases had CSF. Median SWE predicted CSF with AUC of 0.69 (Odds ratio (OR) 1.06 (95% confidence intervals (CI) 1.04-1.09,  $p < 0.001$ ). At the standard IQR/M threshold of 30%, HQ AUC was 0.80 (OR 1.19, 95% CI 1.12-1.27) with inclusion of 58.6% cases. LQ SWE performed significantly worse (AUC 0.59, DeLong's test  $p < 0.001$ ). At an IQR/M threshold of 20%, HQ AUC was 0.82 (OR 1.42, 95% CI 1.28-1.59) with inclusion of 42.5% cases. At an IQR/M threshold of 60%, HQ AUC was 0.77 (OR 1.16, 95% CI 1.12-1.22) with inclusion of 80.4% cases. BMI and SCD were significant predictors of LQ exams (AUC= 0.6273, 0.7238 respectively, both  $p < 0.001$ ); SCD performance was superior (OR 3.12, 95% CI 2.31-4.29).

## CONCLUSION

Low IQR/M predicts better SWE performance. IQR/M thresholds from 20% - 60% can prioritize accuracy or minimize non-diagnostic exams. The current standard threshold is an acceptable compromise. SCD better predicts LQ exams than BMI. SCD may predict LQ exams without requiring 10 SWE measurements.

## CLINICAL RELEVANCE/APPLICATION

Optimal selection of a quantitative SWE quality threshold will maximize clinical diagnostic performance while minimizing non-diagnostic exams.

### M3-SSGI06-5 AI-SCD: A Deep Learning Approach for Skin-to-Liver Capsule Distance Measurement to Optimize Shear Wave Elastography Performance

Abder-Rahman Ali, MSc, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Increased skin-to-liver capsule distance (SCD) degrades ultrasound shear wave elastography (SWE) measurements due to beam aberration and attenuation. We propose an SCD threshold to predict unreliable SWE exams and develop an artificial intelligence (AI)-measured SCD (AI-SCD) to automate the process.

## METHODS AND MATERIALS

AI-SCD was trained using self-supervised learning (SimCLR) on 17,441 unannotated liver B-mode images, distinct from the cohort below, followed by fine-tuning on 495 radiologist-annotated images using ENet, a supervised learning approach for liver segmentation. The algorithm calculates AI-SCD along the image central axis using a pixel spacing and physical distance conversion factor. We then performed a single-center retrospective cross-sectional study of adult patients with suspected chronic liver disease with non-focal liver biopsy and SWE exams within 1 year. Clinically significant fibrosis (CSF) was considered stage = 2 (or = 3 for Ishak). Cases with SWE median stiffness (MS) <50 kilopascals (kPa) from at least 3 SWE measurements were included. Manual annotated-SCD and AI-SCD were estimated for each case using B-mode images. AUC was calculated for MS predicting CSF before and after stratifying by high and low Manual-SCD and AI-SCD using a threshold of 2.5 cm. AUCs were compared using the DeLong test considering  $p < 0.05$  to be statistically significant.

## RESULTS

1,300 cases (621 women, 48%) with mean age  $50.8 \pm 14.1$  years were analysed. Fatty liver disease (600), viral hepatitis (114), nonspecific (263) and other causes (147) were the causes of liver disease in our dataset. 385 (29.6%) had CSF. Manual SCD (0.6 - 9.2 cm, median 2.0 cm) and AI-SCD (0.89 - 8.6 cm, median 2.03 cm) demonstrated moderate correlation (Pearson's  $r=0.68$ ,  $p < 0.001$ ), minimal bias (0.02 cm) and 95% limits of agreement of -1.05 to 1.09cm. MS was a significant predictor of CSF (AUC = 0.72, odds ratio = 1.085,  $p < 0.001$ ). AUC was higher for low Manual-SCD (988 cases, 76%) than high Manual-SCD (0.77 vs 0.58,  $p < 0.001$ ). AUC was higher for low AI-SCD (989 cases, 76.1%) than high AI-SCD (0.77 vs 0.6,  $p < 0.001$ ).

## CONCLUSION

High SCD reduces SWE exam performance for predicting CSF. AI-SCD can reliably, precisely, and automatically estimate SCD to predict exams that are more likely to be nondiagnostic. This may be useful to select patients who will most benefit from SWE and guide remaining patients to alternate diagnostic strategies like biopsy or magnetic resonance imaging. AI-SCD may also provide a future pathway to automatically optimize SWE acquisition settings to maximize measurement quality.

## CLINICAL RELEVANCE/APPLICATION

Automated SCD calculation may provide a future pathway to automatically optimize SWE acquisition settings to maximize measurement quality.

## M3-SSGI06-6 Co-registration Techniques of MRI Rectum and ex vivo Rectal Whole-Mount Histology: A Feasibility Study

Joao Manoel M. Santos, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Accurate assessment of treatment response requires robust spatial anatomical correlation between histopathology and MRI to create reliable ground-truth labels for training radiomics algorithms. To achieve this, a multimodal radiology-pathology image registration workflow is necessary. This study aims to develop a radiology-pathology co-registration method that enables 1:1 automated spatial mapping between preoperative rectal MRI and ex vivo rectal whole-mount histology (WMH).

## METHODS AND MATERIALS

The study population included 13 patients with rectal adenocarcinoma who underwent neoadjuvant therapy followed by TME from 2018 to 2022, with available WMH and both baseline and post neoadjuvant MRI. A multimodal radiology-pathology image registration workflow was developed. For each patient, 3 axial levels were identified: the center of the tumor bed, one superior and one inferior slice. Using 3 axial levels, the following steps were performed 1) Tumor bed, contours of the internal and external borders of the rectum and 8 corresponding landmarks were manually delineated on T2WI images and corresponding WMH images by a radiologist and a pathologist; 2) Rigid point-based registration of images with automated rescaling was computed via the delineated landmarks, and biomechanically constrained elastic deformable registration was computed from the initial rigid alignment between the annotated internal and external rectal contours to account for differences in MR and WMH rectal distension; 3) Outputs from the multimodal image fusion system were rendered in 3D Slicer to obtain accurate and precise visualization. Dice overlap and modified Hausdorff distance (MHD) of the segmented external, internal, and tumor bed contours were obtained.

## RESULTS

When comparing the rigid point-based registration with deformable image registration, Dice overlap varied from 0.85 to 0.95 mm in the external rectal contour ( $p = 0.0028$ ), and 0.47 to 0.55 mm in the internal contour ( $p = 0.033$ ). MHD, which exhibits the distance to agreement of the delineated MR rectum and histological images, varied from 1.76 to 0.59 mm in the external rectal contour ( $p = 0.008$ ), and 1.67 to 1.23 mm in the internal contour ( $p = 0.01$ ).

## CONCLUSION

This study showed promising results in terms of multimodal image fusion and precise anatomical correlation. Deformable registration significantly improves the internal and external contour agreement over rigid point-based registration.

## **CLINICAL RELEVANCE/APPLICATION**

The clinical impact is related to increasing the accuracy of MRI in assessing treatment response of patients with rectal cancer after neoadjuvant therapy, allowing rectal preservation and thereby improving patients' outcomes and quality of life.

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## Abstract Archives of the RSNA, 2023

M3-SSGI06-1

### Inter-Exam Reproducibility of Contrast-Enhanced Liver MRI Radiomics Features: Optimization by Tissue-Based Image Normalization and Bias Field Correction

Monday, Nov. 27 9:30AM - 10:30AM Room: E352

Bryan A. Blakeney, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast-enhanced MRI is an important imaging modality for evaluating liver pathology. Lack of standardized intensity units and nonuniform signal intensities (bias field) are challenges specific for radiomic analysis of MRI. Reproducibility is an important performance metric of imaging biomarker development. This study evaluates image pre-processing methods for contrast-enhanced liver MRI.

#### METHODS AND MATERIALS

This is a single center retrospective study including 19 patients with two multiphase gadoteric acid-enhanced liver MRIs for evaluation of Focal Nodular Hyperplasia (FNH) on Siemens and Philips, 1.5T (n=23) and 3T (15), systems. From 54 patients, exclusion criteria were cancer (24), missing phases (4), and alternative diagnosis (7). The largest FNH was manually segmented, and spherical regions of interests were placed on reference tissues (right and left liver lobes, spleen, subcutaneous fat, vertebral body, paraspinal muscle, and aorta) using 3D Slicer 5.0.3. First and second order radiomics features were calculated with or without N4ITK bias field correction (BFC), on signal intensity normalized to whole image and each reference tissue, using PyRadiomics (custom version based on version 3.0.1) on original pre-contrast, arterial, and hepatobiliary phases and their Laplacian of Gauss and Wavelet transformations. Concordance Correlation Coefficient (CCC) was calculated to measure reproducibility across the two imaging studies. The effect of normalization methods, BFC, and imaging phase on CCC was assessed by multivariable linear regression.

#### RESULTS

For each pre-processed exam, 3354 radiomics features were calculated. Normalization of image intensity to right or ipsilateral (to FNH) liver lobe improved mean CCC (0.59 and 0.60 respectively vs 0.43 for no normalization) and was statistically significantly higher ( $p < 0.0001$ ) than any other normalization. BFC independently improved mean CCC overall ( $p < 0.0001$ ) and in pairwise comparison for right or ipsilateral liver vs. non-BFC when averaged over all phases. Right and ipsilateral liver normalization after BFC produced the most radiomic features (1180 and 1172, respectively) meeting lower 95% confidence interval bound for CCC  $> 0.5$ .

#### CONCLUSION

Reproducibility of radiomics features in liver is improved by pre-processing with normalization to right or ipsilateral liver lobe and with bias field correction. This study suggests the benefit of standardized MR image processing for radiomic analysis for radiomics-based biomarker development.

#### CLINICAL RELEVANCE/APPLICATION

Image pre-processing impacts the reproducibility of radiomics features on contrast-enhanced liver MRI. Standardizing image processing is important for biomarker development using liver MRI radiomics.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI06-2

### Liver MRI-Derived Proton Density Fat Fraction: An Image-Derived Phenotype Causally Affects Pan-liver Disease Risk

Monday, Nov. 27 9:30AM - 10:30AM Room: E352

Tianyi Xia, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Liver MRI-derived proton density fat fraction (MRI-PDFF) plays an important role in clinical trials. A better understanding of MRI-PDFF associated with pan-liver diseases might support its promotion. To quantify the genetically predicted causal effect of liver MRI-PDFF across the pan-liver disease. To quantify the genetically predicted causal effect of liver MRI-PDFF across the pan-liver disease.

#### METHODS AND MATERIALS

This population-based study was mainly derived from summary-level data and 378,436 individual data from UK Biobank and FinnGen. The primary analysis of Mendelian randomization (MR) analysis was conducted using the inverse-variance-weighted method to explore the causal association between genetically determined liver MRI-PDFF and pan-liver disease risk under Bonferroni correction. Logistic regression was performed to validate the association between liver MRI-PDFF PRS and pan-liver disease risk at individual-level data. Mediation analyses were performed using the multivariable MR framework.

#### RESULTS

Genetically predicted high liver MRI-PDFF was associated with increased risks of malignant liver neoplasm (odds ratio [OR], 4.52;  $P = 3.28 \times 10^{-9}$ ), alcoholic liver disease (OR, 1.91;  $P = 1.07 \times 10^{-4}$ ), fibrosis and cirrhosis of liver (OR, 3.03;  $P = 1.75 \times 10^{-14}$ ), fibrosis of liver (OR, 3.61;  $P = .002$ ), cirrhosis of liver (OR, 3.77;  $P = 7.37 \times 10^{-9}$ ), nonalcoholic steatohepatitis (OR, 7.66;  $P = 2.86 \times 10^{-8}$ ), and NAFLD (OR, 4.39;  $P = 6.10 \times 10^{-8}$ ), respectively. Additionally, individual-level evidence similarly supported the association described mentioned above based on the liver MRI-PDFF PRS (all  $P < .004$ ). The mediation analysis indicated genetically predicted high-density lipoprotein cholesterol, type 2 diabetes mellitus, and waist-to-hip ratio (25.1%-46.3% mediation effects) were related to the occurrence of fibrosis and cirrhosis of liver, cirrhosis of liver, and NAFLD via liver MRI-PDFF (all  $P < .005$ ).

#### CONCLUSION

The study provided evidence that the associations of genetically predicted liver MRI-PDFF with liver health, promoting MRI-PDFF in routine clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

The liver MRI-PDFF has a causal association with pan-liver disease risk and is a mediator of metabolic phenotypes, to provide evidence for liver health monitoring.

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## Abstract Archives of the RSNA, 2023

M3-SSGI06-3

### Results of the Non-invasive Biomarkers of Metabolic Liver Disease NIMBLE study 1.1 on the Reproducibility and Repeatability of US Fat Quantification Techniques in Non-alcoholic Fatty Liver Disease

Monday, Nov. 27 9:30AM - 10:30AM Room: E352

Arinc Ozturk, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Non-alcoholic fatty liver disease (NAFLD) is the most common cause of liver disease worldwide. Non-invasive liver fat quantification is important for diagnosis and treatment response assessment. Ultrasound-based fat quantification methods include attenuation coefficient (AC), speed of sound (SoS), shear wave dispersion (SWD), controlled attenuation parameter (CAP), Ultrasound derived fat fraction (UDFF), viscosity, and hepatorenal index (HRI). Defining the reproducibility and repeatability of these quantitative biomarkers is relevant for clinical biomarker interpretation and for use as endpoints in clinical trials. The aim of this study was to quantify the inter-vendor reproducibility and operator repeatability and reproducibility of these measures.

#### METHODS AND MATERIALS

Prospective two-center study of adults with suspected or established NAFLD stratified by Fibrosis-4 Index (FIB-4). Participants underwent 6 examinations on different ultrasound systems and CAP on two days, each day by a different operator, less than a week apart. Operators and clinical investigators were blinded and a pre-specified scanning order was maintained. Different day/different operator reproducibility coefficient (RDCDDDO), same-day/same-operator repeatability coefficient (RCSDSO), and different-scanner reproducibility coefficient (RDCDS) were calculated for each biomarker. RDC reflects the smallest difference between two measurements due to change in underlying steatosis rather than measurement variability; lower is better.

#### RESULTS

40 participants (mean age 60 years, 60% female) with low (17), intermediate (15), and high (8) FIB-4 scores were recruited. Mean BMI was 30.9 kg/m<sup>2</sup>. Precision point estimates (RDCDDDO, RCSDSO) pooled across manufacturers were: HRI (82.4%, 73.6%), SWD (69.1%, 23.5%), CAP (26%, 21%), UDFF (57.8%, 37.3%), SoS (5%, 5%), AC (26%, 18%) and viscosity (43.2%, 34.1%). RDCDS was 80.8% and 51% for HRI and AC respectively [Table1].

#### CONCLUSION

SoS, AC, and CAP were the most reproducible and repeatable fat quantification biomarkers while HRI was the least. Variability across vendors was high. A  $\geq 26\%$  difference in different-day AC or CAP measurements constitutes a true patient change rather than measurement variability. UDFF and viscosity demonstrated intermediate performance. SWD was repeatable by the same operator, but less reproducible by different operators. The high variability between vendors means that the results are vendor dependent and not interchangeable.

#### CLINICAL RELEVANCE/APPLICATION

Non-invasive US-based steatosis assessment biomarkers are available on many US systems. Understanding expected quantitative biomarker variability guides clinical interpretation and clinical trial utilization.

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## Abstract Archives of the RSNA, 2023

M3-SSGI06-4

### Development and Validation of Quantitative Clinical Ultrasound Shear Wave Elastography Exam Quality Metrics

Monday, Nov. 27 9:30AM - 10:30AM Room: E352

Siddhi Hegde, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Interquartile range (IQR) to median (IQR/M) ratio is the quality metric for vibration controlled transient elastography which has been extrapolated to shear wave elastography (SWE) despite limited evidence. We 1) assess the performance of the existing IQR/M 30% threshold 2) characterize SWE discrimination as a function of IQR/M, and 3) propose body mass index (BMI) and skin to liver capsule distance (SCD) quality indices to predict low-quality (LQ) SWE exams.

#### METHODS AND MATERIALS

A single-center retrospective cross-sectional study of adult patients with suspected nonalcoholic fatty liver disease (NAFLD) with non-focal liver biopsy results and US 2D-SWE exams within 1 year was performed. Histopathological fibrosis stage =2 (NASH CRN or Brunt) was considered clinically significant fibrosis (CSF). All pathology slides were reviewed twice by an experienced pathologist to obtain fibrosis decision. A median value of <50 kilopascals (kPa) from at least 3 SWE measurements constituted a valid case. IQR was calculated using the MS Excel quartile.inc function. IQR/M was reported as a percentage. Receiver operator characteristic (ROC) curves to assess SWE prediction of CSF were plotted for high-quality (HQ) and LQ exams and area under the curve (AUC) was compared by DeLong's test. AUC vs number of included cases under the threshold was assessed across IQR/M thresholds. SCD was manually calculated by trained physicians on the first SWE image. AUCs assessed BMI and SCD prediction of LQ exams.

#### RESULTS

546 cases were included (49.4%, n=269 female) with mean (standard deviation) age of 52.1 (12.8) years. 162 (29.7%) cases had CSF. Median SWE predicted CSF with AUC of 0.69 (Odds ratio (OR) 1.06 (95% confidence intervals (CI) 1.04-1.09,  $p < 0.001$ ). At the standard IQR/M threshold of 30%, HQ AUC was 0.80 (OR 1.19, 95% CI 1.12-1.27) with inclusion of 58.6% cases. LQ SWE performed significantly worse (AUC 0.59, DeLong's test  $p < 0.001$ ). At an IQR/M threshold of 20%, HQ AUC was 0.82 (OR 1.42, 95% CI 1.28-1.59) with inclusion of 42.5% cases. At an IQR/M threshold of 60%, HQ AUC was 0.77 (OR 1.16, 95% CI 1.12-1.22) with inclusion of 80.4% cases. BMI and SCD were significant predictors of LQ exams (AUC= 0.6273, 0.7238 respectively, both  $p < 0.001$ ); SCD performance was superior (OR 3.12, 95% CI 2.31-4.29).

#### CONCLUSION

Low IQR/M predicts better SWE performance. IQR/M thresholds from 20% - 60% can prioritize accuracy or minimize non-diagnostic exams. The current standard threshold is an acceptable compromise. SCD better predicts LQ exams than BMI. SCD may predict LQ exams without requiring 10 SWE measurements.

#### CLINICAL RELEVANCE/APPLICATION

Optimal selection of a quantitative SWE quality threshold will maximize clinical diagnostic performance while minimizing non-diagnostic exams.

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## Abstract Archives of the RSNA, 2023

M3-SSGI06-5

### AI-SCD: A Deep Learning Approach for Skin-to-Liver Capsule Distance Measurement to Optimize Shear Wave Elastography Performance

Monday, Nov. 27 9:30AM - 10:30AM Room: E352

Abder-Rahman Ali, MSc, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Increased skin-to-liver capsule distance (SCD) degrades ultrasound shear wave elastography (SWE) measurements due to beam aberration and attenuation. We propose an SCD threshold to predict unreliable SWE exams and develop an artificial intelligence (AI)-measured SCD (AI-SCD) to automate the process.

#### METHODS AND MATERIALS

AI-SCD was trained using self-supervised learning (SimCLR) on 17,441 unannotated liver B-mode images, distinct from the cohort below, followed by fine-tuning on 495 radiologist-annotated images using ENet, a supervised learning approach for liver segmentation. The algorithm calculates AI-SCD along the image central axis using a pixel spacing and physical distance conversion factor. We then performed a single-center retrospective cross-sectional study of adult patients with suspected chronic liver disease with non-focal liver biopsy and SWE exams within 1 year. Clinically significant fibrosis (CSF) was considered stage = 2 (or = 3 for Ishak). Cases with SWE median stiffness (MS) <50 kilopascals (kPa) from at least 3 SWE measurements were included. Manual annotated-SCD and AI-SCD were estimated for each case using B-mode images. AUC was calculated for MS predicting CSF before and after stratifying by high and low Manual-SCD and AI-SCD using a threshold of 2.5 cm. AUCs were compared using the DeLong test considering  $p < 0.05$  to be statistically significant.

#### RESULTS

1,300 cases (621 women, 48%) with mean age  $50.8 \pm 14.1$  years were analysed. Fatty liver disease (600), viral hepatitis (114), nonspecific (263) and other causes (147) were the causes of liver disease in our dataset. 385 (29.6%) had CSF. Manual SCD (0.6 - 9.2 cm, median 2.0 cm) and AI-SCD (0.89 - 8.6 cm, median 2.03 cm) demonstrated moderate correlation (Pearson's  $r=0.68$ ,  $p < 0.001$ ), minimal bias (0.02 cm) and 95% limits of agreement of -1.05 to 1.09cm. MS was a significant predictor of CSF (AUC = 0.72, odds ratio = 1.085,  $p < 0.001$ ). AUC was higher for low Manual-SCD (988 cases, 76%) than high Manual-SCD (0.77 vs 0.58,  $p < 0.001$ ). AUC was higher for low AI-SCD (989 cases, 76.1%) than high AI-SCD (0.77 vs 0.6,  $p < 0.001$ ).

#### CONCLUSION

High SCD reduces SWE exam performance for predicting CSF. AI-SCD can reliably, precisely, and automatically estimate SCD to predict exams that are more likely to be nondiagnostic. This may be useful to select patients who will most benefit from SWE and guide remaining patients to alternate diagnostic strategies like biopsy or magnetic resonance imaging. AI-SCD may also provide a future pathway to automatically optimize SWE acquisition settings to maximize measurement quality.

#### CLINICAL RELEVANCE/APPLICATION

Automated SCD calculation may provide a future pathway to automatically optimize SWE acquisition settings to maximize measurement quality.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-SSGI06-6

### Co-registration Techniques of MRI Rectum and ex vivo Rectal Whole-Mount Histology: A Feasibility Study

Monday, Nov. 27 9:30AM - 10:30AM Room: E352

Joao Manoel M. Santos, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate assessment of treatment response requires robust spatial anatomical correlation between histopathology and MRI to create reliable ground-truth labels for training radiomics algorithms. To achieve this, a multimodal radiology-pathology image registration workflow is necessary. This study aims to develop a radiology-pathology co-registration method that enables 1:1 automated spatial mapping between preoperative rectal MRI and ex vivo rectal whole-mount histology (WMH).

#### METHODS AND MATERIALS

The study population included 13 patients with rectal adenocarcinoma who underwent neoadjuvant therapy followed by TME from 2018 to 2022, with available WMH and both baseline and post neoadjuvant MRI. A multimodal radiology-pathology image registration workflow was developed. For each patient, 3 axial levels were identified: the center of the tumor bed, one superior and one inferior slice. Using 3 axial levels, the following steps were performed 1) Tumor bed, contours of the internal and external borders of the rectum and 8 corresponding landmarks were manually delineated on T2WI images and corresponding WMH images by a radiologist and a pathologist; 2) Rigid point-based registration of images with automated rescaling was computed via the delineated landmarks, and biomechanically constrained elastic deformable registration was computed from the initial rigid alignment between the annotated internal and external rectal contours to account for differences in MR and WMH rectal distension; 3) Outputs from the multimodal image fusion system were rendered in 3D Slicer to obtain accurate and precise visualization. Dice overlap and modified Hausdorff distance (MHD) of the segmented external, internal, and tumor bed contours were obtained.

#### RESULTS

When comparing the rigid point-based registration with deformable image registration, Dice overlap varied from 0.85 to 0.95 mm in the external rectal contour ( $p = 0.0028$ ), and 0.47 to 0.55 mm in the internal contour ( $p = 0.033$ ). MHD, which exhibits the distance to agreement of the delineated MR rectum and histological images, varied from 1.76 to 0.59 mm in the external rectal contour ( $p = 0.008$ ), and 1.67 to 1.23 mm in the internal contour ( $p = 0.01$ ).

#### CONCLUSION

This study showed promising results in terms of multimodal image fusion and precise anatomical correlation. Deformable registration significantly improves the internal and external contour agreement over rigid point-based registration.

#### CLINICAL RELEVANCE/APPLICATION

The clinical impact is related to increasing the accuracy of MRI in assessing treatment response of patients with rectal cancer after neoadjuvant therapy, allowing rectal preservation and thereby improving patients' outcomes and quality of life.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI07

### Gastrointestinal Imaging (MRI Techniques)

Monday, Nov. 27 9:30AM - 10:30AM Room: E351

Jeanne M. Horowitz, MD (*Moderator*) Nothing to Disclose  
Gaurav Khatri, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### M3-SSGI07-1 Utility of Intracellular Enhanced Technique for Gadoteric Acid-enhanced Hepatobiliary-phase Magnetic Resonance Imaging

Shota Kondo (*Presenter*) Nothing to Disclose

#### PURPOSE

The sensitivity of gadoteric acid-enhanced hepatobiliary-phase (HBP) magnetic resonance imaging (MRI) is high for the detection of liver lesions. However, as gadoteric acid acts as both an extracellular- and hepatocyte-specific contrast agent, signals from the extracellular space may lower the contrast between the lesion and the surrounding hepatic parenchyma. To improve its hepatocyte-specific gadoteric acid enhancement, we developed an intracellular enhancement (ICE) technique that suppresses signals from the extracellular space with a motion-sensitized driven equilibrium pulse. To investigate the clinical applicability of our new technique we compared HBP images acquired with and without the ICE technique.

#### METHODS AND MATERIALS

We subjected 56 patients with suspected neoplastic hepatic lesions to gadoteric acid-enhanced HBP imaging with and without ICE (i+HBP, i-HBP). The images were acquired 10 and 20 min after gadoteric acid injection. A radiologist calculated the signal intensity ratio [(SI ratio) = region of interest (ROI)LIVER/ROI PV], where (ROI)LIVER is the mean SI of the hepatic parenchyma and ROI PV the mean SI at the confluence level of the right and left portal vein. The SI ratio obtained on i-HBP images obtained at 20 min was the reference standard. Superiority and equivalence with a pre-specified margin of 0.2, which is 10% of the mean SI ratio on 20-min i-HBP images, were assessed.

#### RESULTS

The SI ratio of 20-min i+HBP- was superior to 20-min i-HBP images (95% confidence interval (CI), 0.21 - 0.46). The SI ratio of 10-min i+HBP images was not superior, but equivalent (95% CI, -0.20 - -0.02) and the SI ratio of 10-min i-HBP images was neither superior nor equivalent to the 20-min i-HBP images (95% CI, -0.32 to -0.22).

#### CONCLUSION

On gadoteric acid-enhanced MRI scans acquired in the HBP, our ICE technique improved the SI ratio.

#### CLINICAL RELEVANCE/APPLICATION

As our ICE technique improved the SI ratio on HBP images, it may improve lesion detectability and shorten the time required for gadoteric acid-enhanced HBP imaging.

### M3-SSGI07-2 Comparison between Image Quality of Conventional T1-Weighted Image and Deep Learning Based T1-Weighted Image on Gadoteric Acid-Enhanced Liver MRI

Jeong Hee Yoon, MD (*Presenter*) Speaker, Bayer AG; Grant, Koninklijke Philips NV

#### PURPOSE

To compare image quality of T1-weighted image (T1WI) between conventional reconstruction and deep learning (DL)-based T1WI.

## METHODS AND MATERIALS

This prospective study enrolled 54 participants who were scheduled for gadoteric acid-enhanced MRI and signed informed consent. Gadoteric acid-enhanced liver MRI was performed at a 3T scanner (SIGNATM Premier, GE Healthcare). Precontrast, arterial, portal venous, transitional phase and hepatobiliary phases were obtained using commercially available 3D gradient sequence before and after standard dose of contrast media administration (0.025mmol/kg, Primovist or Eovist, Bayer) at a rate of 1 mL/sec. Arterial phases were obtained using MR fluoroscopy technique. Portal, transitional, hepatobiliary phases were obtained 60 sec, 3 min and 20 min after CM administration. Obtained T1WI were additionally reconstructed using DL-based reconstruction algorithm (AIRTm DL, GE Healthcare). Three radiologists independently reviewed the image noise, ringing artifacts, susceptibility artifacts, image texture and overall image quality of precontrast, arterial, portal venous and hepatobiliary phases on a five-point scale. Higher scores indicated less artifact and better image quality.

## RESULTS

A total of 54 participants (male = 38, mean age  $62 \pm 11$  years) were enrolled. DL reconstructed images showed significantly less image noise in all phases (3.31-3.91 on conventional T1WI vs. 3.59-3.86 on DL T1WI,  $P < 0.05$  for all). Ringing artifacts significantly decreased on DL images on all phases (3.71-3.83 on DL T1WI vs. 3.61-3.70 on conventional T1WI,  $P < 0.05$  for all) except precontrast phase ( $3.63 \pm 0.27$  vs.  $3.71 \pm 0.29$ ,  $P > 0.05$ ). No significant differences of susceptibility artifacts were noted between the two ( $P > 0.05$ ) for all phases. Although image texture was significantly plastic on DL images than conventional images in all phases (3.76-3.97 on conventional T1WI vs. 3.14-3.54 on DL T1WI,  $P < 0.05$  for all), overall image quality was significantly higher on DL T1WI (3.70-4.35) than conventional T1WI on all phases (3.35-3.99,  $P < 0.05$  for all).

## CONCLUSION

DL reconstruction algorithm is able to improve the image quality without additional scans on liver MRI.

## CLINICAL RELEVANCE/APPLICATION

DL reconstruction affords better image quality with lower artifacts in acquiring precontrast, arterial, portal venous, transitional phase and hepatobiliary phases on liver MRI.

## M3-SSGI07-3 Efficacy of a Novel Oral Borosilicate Contrast Agent for Gastrointestinal Signal Suppression in MRCP

Matthew S. Carr, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Magnetic resonance cholangiopancreatography (MRCP) is a widely used non-invasive imaging method used to assess pancreaticobiliary diseases. Unfortunately, signal from fluid in the surrounding bowel may degrade evaluation of the biliary tree and pancreatic duct. The use of fasting and other negative oral contrasts (such as fruit juice) show variable clinical efficacy, patient tolerability, and product availability. We sought to evaluate the ability of an experimental dark borosilicate contrast material (DBCM) to reduce intraluminal bowel T2 signal and improve the visualization of pancreaticobiliary structures at MRCP.

## METHODS AND MATERIALS

In this IRB approved study, after standard MRCP protocol, six patients ingested 800 cc of DBCM and imaging was repeated, including coronal T2 weighted and MRCP images. On blinded and randomized data, two radiologists independently measured the intraluminal signal intensity in the stomach, duodenum, and common bile duct (CBD) using circular regions of interest on coronal slab MRCP images. The signal of the stomach and duodenum were normalized to the CBD. Qualitative visualization of the CBD, gallbladder, and pancreatic duct were rated on a 4 point Likert scale (0=not visualized to 4=well-delineated). Data was then analyzed using paired t-tests and inter-reader reliability was evaluated using intraclass correlation coefficients with  $p < 0.05$  denoting significance.

## RESULTS

There was significant decrease in normalized signal intensity measurements by both readers from before (pre) to after oral contrast (post) in the stomach (Reader 1 {R1}: 86.7%,  $p=0.026$ ; Reader 2 {R2}: 81.2%,  $p=0.034$ ) and in the duodenum (R1: 92.6%,  $p < 0.001$ ; R2: 80.1%,  $p < 0.0005$ ). For both readers, scans with DBCM showed significantly improved visualization of the CBD (R1: pre  $3.0 \pm 0.6$  vs. post  $3.8 \pm 0.40$ ,  $p=0.042$ ; R2: pre  $3.0 \pm 0.0$  vs. post  $3.8 \pm 0.4$ ,  $p=0.004$ ) and pancreatic duct (R1: pre  $2.3 \pm 1.0$  vs. post  $3.3 \pm 0.8$ ,  $p=0.012$ ; R2: pre  $2.0 \pm 1.1$  vs. post  $2.8 \pm 1.2$ ,  $p=0.042$ ) but not the gallbladder ( $p > 0.178$ ). There was good to excellent inter-reader reliability for signal intensity measurements in the stomach, duodenum, CBD, and for visibility ratings of the CBD and pancreatic duct ( $r = 0.77$  to  $0.98$ ,  $p < 0.003$ ), but poor for the visibility ratings of the gallbladder ( $r=0.10$ ,  $p=0.78$ ). No serious adverse events were seen in any patient.

## CONCLUSION

Novel DBCM oral contrast significantly decreased signal in the bowel and improved visualization of the CBD and the pancreatic duct relative to the standard MRCP protocol in 6 patient volunteers.

## CLINICAL RELEVANCE/APPLICATION

Use of DBCM significantly improved the anatomic visualization of the pancreatic duct and CBD at MRCP. Larger cohort study of DBCM for delineation of pancreaticobiliary disease is warranted.

### M3-SSGI07-5 **Prospective Evaluation and Comparison Between Resoundant 2D MR-Elastography and 2D/3D MR-Elastography Utilizing the Gravitational Transducer Concept**

Vitali Koch, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate non-invasive diagnostic methods are of utmost importance in nonalcoholic fatty liver disease (NAFLD). Magnetic resonance elastography (MRE) can quantify tissue biomechanics non-invasively and represents a promising technique to assess hepatic fibrosis. Here, we present preliminary results of a prospective study designed to investigate the diagnostic performance of 2D/3D-MRE utilizing the gravitational transducer concept combined with a GRE sequence, in comparison to the current product solution (2D-MRE Resoundant). Furthermore, we investigated the added value of 3D-MRE data when correlating imaging biomarkers with blood markers that reflect liver damage.

#### METHODS AND MATERIALS

Thirty-two participants with different stages of NAFLD were recruited. Patients were examined twice at 60Hz mechanical vibration frequency (Aera, 1.5T, Siemens Healthineers, Germany): firstly, using the Resoundant MRE system (2D-MRE, SE-EPI sequence, 11secs BH) and secondly, using the gravitational transducer approach (2D-MRE and 3D-MRE, GRE sequence, TE=9.2ms [in-phase] and fractional motion encoding at 30mT/m, 14secs BH). While 2D-MRE provides solely the magnitude of the complex shear modulus  $|G^*|$ , 3D-MRE allows for the additional quantification of both real and imaginary parts of  $G^*$ . Data extraction/analysis was performed twice by two experienced readers.

#### RESULTS

Elasticity values originating from 2D-MRE correlated very well between both methods ( $r=0.83$  [95% CI, 0.69 to 0.92],  $p<0.001$ ) with an excellent agreement in Bland-Altman plots. Interrater agreement was excellent ( $\kappa=0.91$ ). 3D-MRE (gravitational) correlated excellently with 2D-MRE (Resoundant) ( $r=0.95$  [95% CI, 0.90 to 0.98],  $p<0.001$ ). However, the Bland-Altman plot showed a clear bias with 2D-MRE overestimating stiffness values. 2D-MRE correlated to GOT in a binary fashion: for  $|G^*|<4\text{kPa}$  we found GOT<30, while for  $|G^*|>4\text{kPa}$  we found GOT>30. 3D-MRE on the contrary demonstrated correlations: for GOT<30 wave attenuation show a clear trend wrt GOT ( $r=-0.27$ ,  $P=0.37$ ), while for GOT>30 viscosity correlated very well to GOT ( $r=0.61$ ,  $P=0.047$ ). Viscosity for GOT<30 just clustered at low values, similarly to attenuation for GOT>30. Interestingly, shear modulus or wave speed did not show any pertinent correlations.

#### CONCLUSION

Gravitational MRE represents a novel and promising method for the non-invasive, accurate, and sensitive characterization of patients with NAFLD. 3D-MRE carries the potential to provide imaging biomarkers that correlate to liver damage.

## CLINICAL RELEVANCE/APPLICATION

Considering the disadvantages of liver biopsy for screening and monitoring of NAFLD, non-invasive methods that accurately assess liver damage represent very attractive alternatives.

### M3-SSGI07-6 **Dual-Frequency 3D Vector Magnetic Resonance Elastography (MRE) Acquisition Efficiency Improvement and Technical Repeatability**

Caixin Qiu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to improve the efficiency of dual-frequency 3D vector MRE image acquisition by analyzing the feasibility and repeatability of the intrinsic 2nd harmonic derived from single-frequency 30Hz MRE data, exploring the causes of technical failure, and validating the alternative forced dual-frequency 3D MRE to improve wave quality and success rate.

#### METHODS AND MATERIALS

We enrolled 80 patients in two cohorts. Cohort One of 66 patients who had single-frequency 30Hz MRE with 6 phase offsets and 60Hz MRE with 3 phase offsets. Cohort Two of 14 subjects with forced dual-frequency (30Hz+60Hz) 3D MRE with 6 phase offsets. Within them, 11 patients had within-day test-retest exams, and 22 patients had one-year follow-up exams, respectively. Image quality was scored by assessing wave penetration depth. Technical failure was defined as no wave or presence of artifacts. The intraclass correlation coefficient (ICC), Bland-Altman plots, and repeatability coefficient (RC) were used to assess measurement agreement and technical repeatability of liver stiffness.

## RESULTS

We achieved a 91% success rate with reliable liver stiffness measurement from the 2nd harmonic of 30Hz data in Cohort One. A successful baseline exam did not necessarily result in another success in the within-day repeated exams or one-year follow-ups (0/11, 5/22 failure rates for within-day and follow-ups, respectively). In successful cases, the Bland-Altman analysis and ICCs demonstrated excellent agreements (all ICCs > 0.90, P < 0.001) in liver stiffness measurement but moderate repeatability from 2nd harmonic of 30Hz data (RC=36.67%). Excellent repeatability from original 60Hz data (RC=11.86%). The quality scores at 2nd harmonic from 30Hz (median: 1, total:101) were significantly lower than those at conventional 60Hz (median: 2, total:140; Z=-4.523, p<0.001). In Cohort Two, most patients had high quality scores at 3 (13/14), and only one patient failed at 60Hz due to massive ascites.

## CONCLUSION

Most 2<sup>nd</sup> harmonic derived from 30Hz MRE data is sufficient for liver stiffness measurement at 60Hz. However, the intrinsic waves generated from system or tissue nonlinearity have suboptimal wave penetration. Consequently, this method has moderate within-day technical repeatability and unpredictable technical failure in repeated exams or follow-ups. Therefore, it is necessary to adopt the alternative forced dual-frequency 3D MRE to reliably improve image quality with shortened acquisition time and enhanced success rate.

## CLINICAL RELEVANCE/APPLICATION

Dual-frequency 3D MRE can acquire data at both 30Hz and 60Hz in one acquisition to improve imaging efficiency with better co-registration and shorter scan time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI07-1

### Utility of Intracellular Enhanced Technique for Gadoteric Acid-enhanced Hepatobiliary-phase Magnetic Resonance Imaging

Monday, Nov. 27 9:30AM - 10:30AM Room: E351

Shota Kondo (*Presenter*) Nothing to Disclose

#### PURPOSE

The sensitivity of gadoteric acid-enhanced hepatobiliary-phase (HBP) magnetic resonance imaging (MRI) is high for the detection of liver lesions. However, as gadoteric acid acts as both an extracellular- and hepatocyte-specific contrast agent, signals from the extracellular space may lower the contrast between the lesion and the surrounding hepatic parenchyma. To improve its hepatocyte-specific gadoteric acid enhancement, we developed an intracellular enhancement (ICE) technique that suppresses signals from the extracellular space with a motion-sensitized driven equilibrium pulse. To investigate the clinical applicability of our new technique we compared HBP images acquired with and without the ICE technique.

#### METHODS AND MATERIALS

We subjected 56 patients with suspected neoplastic hepatic lesions to gadoteric acid-enhanced HBP imaging with and without ICE (i+HBP, i-HBP). The images were acquired 10 and 20 min after gadoteric acid injection. A radiologist calculated the signal intensity ratio [(SI ratio) = region of interest (ROI)LIVER/ROI PV], where (ROI)LIVER is the mean SI of the hepatic parenchyma and ROI PV the mean SI at the confluence level of the right and left portal vein. The SI ratio obtained on i-HBP images obtained at 20 min was the reference standard. Superiority and equivalence with a pre-specified margin of 0.2, which is 10% of the mean SI ratio on 20-min i-HBP images, were assessed.

#### RESULTS

The SI ratio of 20-min i+HBP- was superior to 20-min i-HBP images (95% confidence interval (CI), 0.21 - 0.46). The SI ratio of 10-min i+HBP images was not superior, but equivalent (95% CI, -0.20 - -0.02) and the SI ratio of 10-min i-HBP images was neither superior nor equivalent to the 20-min i-HBP images (95% CI, -0.32 to -0.22).

#### CONCLUSION

On gadoteric acid-enhanced MRI scans acquired in the HBP, our ICE technique improved the SI ratio.

#### CLINICAL RELEVANCE/APPLICATION

As our ICE technique improved the SI ratio on HBP images, it may improve lesion detectability and shorten the time required for gadoteric acid-enhanced HBP imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI07-2

### Comparison between Image Quality of Conventional T1-Weighted Image and Deep Learning Based T1-Weighted Image on Gadoteric Acid-Enhanced Liver MRI

Monday, Nov. 27 9:30AM - 10:30AM Room: E351

Jeong Hee Yoon, MD (*Presenter*) Speaker, Bayer AG; Grant, Koninklijke Philips NV

#### PURPOSE

To compare image quality of T1-weighted image (T1WI) between conventional reconstruction and deep learning (DL)-based T1WI.

#### METHODS AND MATERIALS

This prospective study enrolled 54 participants who were scheduled for gadoteric acid-enhanced MRI and signed informed consent. Gadoteric acid-enhanced liver MRI was performed at a 3T scanner (SIGNATM Premier, GE Healthcare). Precontrast, arterial, portal venous, transitional phase and hepatobiliary phases were obtained using commercially available 3D gradient sequence before and after standard dose of contrast media administration (0.025mmol/kg, Primovist or Eovist, Bayer) at a rate of 1 mL/sec. Arterial phases were obtained using MR fluoroscopy technique. Portal, transitional, hepatobiliary phases were obtained 60 sec, 3 min and 20 min after CM administration. Obtained T1WI were additionally reconstructed using DL-based reconstruction algorithm (AIRTM DL, GE Healthcare). Three radiologists independently reviewed the image noise, ringing artifacts, susceptibility artifacts, image texture and overall image quality of precontrast, arterial, portal venous and hepatobiliary phases on a five-point scale. Higher scores indicated less artifact and better image quality.

#### RESULTS

A total of 54 participants (male = 38, mean age  $62 \pm 11$  years) were enrolled. DL reconstructed images showed significantly less image noise in all phases (3.31-3.91 on conventional T1WI vs. 3.59-3.86 on DL T1WI,  $P < 0.05$  for all). Ringing artifacts significantly decreased on DL images on all phases (3.71-3.83 on DL T1WI vs. 3.61-3.70 on conventional T1WI,  $P < 0.05$  for all) except precontrast phase ( $3.63 \pm 0.27$  vs.  $3.71 \pm 0.29$ ,  $P > 0.05$ ). No significant differences of susceptibility artifacts were noted between the two ( $P > 0.05$ ) for all phases. Although image texture was significantly plastic on DL images than conventional images in all phases (3.76-3.97 on conventional T1WI vs. 3.14-3.54 on DL T1WI,  $P < 0.05$  for all), overall image quality was significantly higher on DL T1WI (3.70-4.35) than conventional T1WI on all phases (3.35-3.99,  $P < 0.05$  for all).

#### CONCLUSION

DL reconstruction algorithm is able to improve the image quality without additional scans on liver MRI.

#### CLINICAL RELEVANCE/APPLICATION

DL reconstruction affords better image quality with lower artifacts in acquiring precontrast, arterial, portal venous, transitional phase and hepatobiliary phases on liver MRI.

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## Abstract Archives of the RSNA, 2023

M3-SSGI07-3

### Efficacy of a Novel Oral Borosilicate Contrast Agent for Gastrointestinal Signal Suppression in MRCP

Monday, Nov. 27 9:30AM - 10:30AM Room: E351

Matthew S. Carr, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic resonance cholangiopancreatography (MRCP) is a widely used non-invasive imaging method used to assess pancreaticobiliary diseases. Unfortunately, signal from fluid in the surrounding bowel may degrade evaluation of the biliary tree and pancreatic duct. The use of fasting and other negative oral contrasts (such as fruit juice) show variable clinical efficacy, patient tolerability, and product availability. We sought to evaluate the ability of an experimental dark borosilicate contrast material (DBCM) to reduce intraluminal bowel T2 signal and improve the visualization of pancreaticobiliary structures at MRCP.

#### METHODS AND MATERIALS

In this IRB approved study, after standard MRCP protocol, six patients ingested 800 cc of DBCM and imaging was repeated, including coronal T2 weighted and MRCP images. On blinded and randomized data, two radiologists independently measured the intraluminal signal intensity in the stomach, duodenum, and common bile duct (CBD) using circular regions of interest on coronal slab MRCP images. The signal of the stomach and duodenum were normalized to the CBD. Qualitative visualization of the CBD, gallbladder, and pancreatic duct were rated on a 4 point Likert scale (0=not visualized to 4=well-delineated). Data was then analyzed using paired t-tests and inter-reader reliability was evaluated using intraclass correlation coefficients with  $p < 0.05$  denoting significance.

#### RESULTS

There was significant decrease in normalized signal intensity measurements by both readers from before (pre) to after oral contrast (post) in the stomach (Reader 1 {R1}: 86.7%,  $p=0.026$ ; Reader 2 {R2}: 81.2%,  $p=0.034$ ) and in the duodenum (R1: 92.6%,  $p < 0.001$ ; R2: 80.1%,  $p < 0.0005$ ). For both readers, scans with DBCM showed significantly improved visualization of the CBD (R1: pre  $3.0 \pm 0.6$  vs. post  $3.8 \pm 0.40$ ,  $p=0.042$ ; R2: pre  $3.0 \pm 0.0$  vs. post  $3.8 \pm 0.4$ ,  $p=0.004$ ) and pancreatic duct (R1: pre  $2.3 \pm 1.0$  vs. post  $3.3 \pm 0.8$ ,  $p=0.012$ ; R2: pre  $2.0 \pm 1.1$  vs. post  $2.8 \pm 1.2$ ,  $p=0.042$ ) but not the gallbladder ( $p > 0.178$ ). There was good to excellent inter-reader reliability for signal intensity measurements in the stomach, duodenum, CBD, and for visibility ratings of the CBD and pancreatic duct ( $r = 0.77$  to  $0.98$ ,  $p < 0.003$ ), but poor for the visibility ratings of the gallbladder ( $r=0.10$ ,  $p=0.78$ ). No serious adverse events were seen in any patient.

#### CONCLUSION

Novel DBCM oral contrast significantly decreased signal in the bowel and improved visualization of the CBD and the pancreatic duct relative to the standard MRCP protocol in 6 patient volunteers.

#### CLINICAL RELEVANCE/APPLICATION

Use of DBCM significantly improved the anatomic visualization of the pancreatic duct and CBD at MRCP. Larger cohort study of DBCM for delineation of pancreaticobiliary disease is warranted.

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## Abstract Archives of the RSNA, 2023

M3-SSGI07-5

### Prospective Evaluation and Comparison Between Resoundant 2D MR-Elastography and 2D/3D MR-Elastography Utilizing the Gravitational Transducer Concept

Monday, Nov. 27 9:30AM - 10:30AM Room: E351

Vitali Koch, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate non-invasive diagnostic methods are of utmost importance in nonalcoholic fatty liver disease (NAFLD). Magnetic resonance elastography (MRE) can quantify tissue biomechanics non-invasively and represents a promising technique to assess hepatic fibrosis. Here, we present preliminary results of a prospective study designed to investigate the diagnostic performance of 2D/3D-MRE utilizing the gravitational transducer concept combined with a GRE sequence, in comparison to the current product solution (2D-MRE Resoundant). Furthermore, we investigated the added value of 3D-MRE data when correlating imaging biomarkers with blood markers that reflect liver damage.

#### METHODS AND MATERIALS

Thirty-two participants with different stages of NAFLD were recruited. Patients were examined twice at 60Hz mechanical vibration frequency (Aera, 1.5T, Siemens Healthineers, Germany): firstly, using the Resoundant MRE system (2D-MRE, SE-EPI sequence, 11secs BH) and secondly, using the gravitational transducer approach (2D-MRE and 3D-MRE, GRE sequence, TE=9.2ms [in-phase] and fractional motion encoding at 30mT/m, 14secs BH). While 2D-MRE provides solely the magnitude of the complex shear modulus  $|G^*|$ , 3D-MRE allows for the additional quantification of both real and imaginary parts of  $G^*$ . Data extraction/analysis was performed twice by two experienced readers.

#### RESULTS

Elasticity values originating from 2D-MRE correlated very well between both methods ( $r=0.83$  [95% CI, 0.69 to 0.92],  $p<0.001$ ) with an excellent agreement in Bland-Altman plots. Interrater agreement was excellent ( $\kappa=0.91$ ). 3D-MRE (gravitational) correlated excellently with 2D-MRE (Resoundant) ( $r=0.95$  [95% CI, 0.90 to 0.98],  $p<0.001$ ). However, the Bland-Altman plot showed a clear bias with 2D-MRE overestimating stiffness values. 2D-MRE correlated to GOT in a binary fashion: for  $|G^*|<4\text{kPa}$  we found  $\text{GOT}<30$ , while for  $|G^*|>4\text{kPa}$  we found  $\text{GOT}>30$ . 3D-MRE on the contrary demonstrated correlations: for  $\text{GOT}<30$  wave attenuation show a clear trend wrt GOT ( $r=-0.27$ ,  $P=0.37$ ), while for  $\text{GOT}>30$  viscosity correlated very well to GOT ( $r=0.61$ ,  $P=0.047$ ). Viscosity for  $\text{GOT}<30$  just clustered at low values, similarly to attenuation for  $\text{GOT}>30$ . Interestingly, shear modulus or wave speed did not show any pertinent correlations.

#### CONCLUSION

Gravitational MRE represents a novel and promising method for the non-invasive, accurate, and sensitive characterization of patients with NAFLD. 3D-MRE carries the potential to provide imaging biomarkers that correlate to liver damage.

#### CLINICAL RELEVANCE/APPLICATION

Considering the disadvantages of liver biopsy for screening and monitoring of NAFLD, non-invasive methods that accurately assess liver damage represent very attractive alternatives.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSGI07-6

### Dual-Frequency 3D Vector Magnetic Resonance Elastography (MRE) Acquisition Efficiency Improvement and Technical Repeatability

Monday, Nov. 27 9:30AM - 10:30AM Room: E351

Caixin Qiu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to improve the efficiency of dual-frequency 3D vector MRE image acquisition by analyzing the feasibility and repeatability of the intrinsic 2nd harmonic derived from single-frequency 30Hz MRE data, exploring the causes of technical failure, and validating the alternative forced dual-frequency 3D MRE to improve wave quality and success rate.

#### METHODS AND MATERIALS

We enrolled 80 patients in two cohorts. Cohort One of 66 patients who had single-frequency 30Hz MRE with 6 phase offsets and 60Hz MRE with 3 phase offsets. Cohort Two of 14 subjects with forced dual-frequency (30Hz+60Hz) 3D MRE with 6 phase offsets. Within them, 11 patients had within-day test-retest exams, and 22 patients had one-year follow-up exams, respectively. Image quality was scored by assessing wave penetration depth. Technical failure was defined as no wave or presence of artifacts. The intraclass correlation coefficient (ICC), Bland-Altman plots, and repeatability coefficient (RC) were used to assess measurement agreement and technical repeatability of liver stiffness.

#### RESULTS

We achieved a 91% success rate with reliable liver stiffness measurement from the 2nd harmonic of 30Hz data in Cohort One. A successful baseline exam did not necessarily result in another success in the within-day repeated exams or one-year follow-ups (0/11, 5/22 failure rates for within-day and follow-ups, respectively). In successful cases, the Bland-Altman analysis and ICCs demonstrated excellent agreements (all ICCs > 0.90,  $P < 0.001$ ) in liver stiffness measurement but moderate repeatability from 2nd harmonic of 30Hz data (RC=36.67%). Excellent repeatability from original 60Hz data (RC=11.86%). The quality scores at 2nd harmonic from 30Hz (median: 1, total:101) were significantly lower than those at conventional 60Hz (median: 2, total:140;  $Z=-4.523$ ,  $p<0.001$ ). In Cohort Two, most patients had high quality scores at 3 (13/14), and only one patient failed at 60Hz due to massive ascites.

#### CONCLUSION

Most 2<sup>nd</sup> harmonic derived from 30Hz MRE data is sufficient for liver stiffness measurement at 60Hz. However, the intrinsic waves generated from system or tissue nonlinearity have suboptimal wave penetration. Consequently, this method has moderate within-day technical repeatability and unpredictable technical failure in repeated exams or follow-ups. Therefore, it is necessary to adopt the alternative forced dual-frequency 3D MRE to reliably improve image quality with shortened acquisition time and enhanced success rate.

#### CLINICAL RELEVANCE/APPLICATION

Dual-frequency 3D MRE can acquire data at both 30Hz and 60Hz in one acquisition to improve imaging efficiency with better co-registration and shorter scan time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSIN02

### Imaging Informatics (Radiology Reporting: AI, NLP, LLM - The Future is Now)

Monday, Nov. 27 9:30AM - 10:30AM Room: S404

Peter A. Harri, MD (*Moderator*) Radiology Advisory Board, Sectra AB  
Jordan D. Perchik, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M3-SSIN02-1 Automated AI Processing, PACS Delivery, and Reporting using a Cloud-based System in a Multihospital Health System**

Neil R. Chaterjee, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The number of artificial intelligence (AI) algorithms both in the literature and available for commercial use has exploded in recent years, but clinical adoption remains limited. One major barrier towards adoption is seamless integration into the clinical workflow. Ideally, AI results would 1) be viewable within the picture archiving and communication system (PACS) and 2) easily inserted into the radiology report. Many companies offer AI solutions that claim to meet these criteria, but these solutions can have limitations such as poor integration with the electronic health record, loss of data control, lack of algorithm transparency, and cost. To meet this need, we developed a cloud-based software layer for automatic image analysis with seamless PACS and reporting engine integration. As a proof-of-concept, we developed an AI algorithm for reporting hepatic steatosis and deployed it in a live clinical environment.

#### METHODS AND MATERIALS

After a study is ended, an HL7 message is sent to the Vendor Neutral Archive (VNA). The VNA instructs PACS to move the study to the AI server hosted on a cloud computing program. The AI server processes the images and outputs 1) image overlays to PACS and 2) summary statistics as Common Data Elements (CDEs) in a DICOM Structured Report (DICOM SR). The DICOM SR is sent to the reporting engine via an HL7 router, permitting the CDEs to be inserted into a report via a macro.

#### RESULTS

All studies with appropriate CT codes were sent to the AI server after it was deployed at our hospital. 701 studies were processed in the first 14 days after deployment. The mean liver attenuation in studies where the liver attenuation algorithm ran was  $57 \pm 36$  HU.

#### CONCLUSION

We developed a cloud-based software solution to automatically run any arbitrary AI algorithm and seamlessly integrate results into PACS and clinical reports, and we demonstrate its use in a real-world clinical environment. This has the potential to significantly decrease the barrier to clinical AI adoption and generate large quantities of AI-processed data for research.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrate the feasibility of implementing a cloud-based software layer for automatic AI analysis with PACS and reporting engine integration. This approach provides an option for institutions to seamlessly integrate AI into their clinical workflows while retaining control over their own data and AI algorithms, which we believe has the potential to increase clinical AI adoption. In our proof-of-concept application of a liver segmentation AI algorithm, this allows for opportunistic screening of hepatic steatosis in every patient that gets an abdominal CT.

#### **M3-SSIN02-2 Identifying High-priority STAT Imaging Studies using Natural Language Processing and Machine Learning Models**

Renaid Kim, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Imaging studies at our institution can be ordered as routine, urgent, or STAT, but further stratification of study urgency is not available. Several prior studies have described how the "STAT" designation is overutilized and misused, further obscuring the actual urgency of an imaging order. All studies from the emergency room, for example, may be designated as STAT even when immediate intervention is not required with positive findings. Additionally, many outpatient studies ordered for routine follow up are ordered STAT. Our purpose was to create an automated system to identify priority STAT imaging studies that would require immediate intervention if positive, thereby avoiding delays in care.

## METHODS AND MATERIALS

Five hundred outpatient imaging studies ordered "STAT" were identified, and their free-text clinical indications were collected. After excluding orders for image-guided procedures and duplicate indications, 351 imaging studies remained in the dataset. For each study, 3 different radiologists evaluated the indication and assigned an integer score between 1 (most likely) and 5 (least likely) based on the likelihood of requiring medical or surgical intervention within 24 hours if positive. A simple majority was used for determining the final score. For studies with interrater score difference =2, a fourth radiologist adjudicated. Boolean features were generated from the free text based on n-grams, with  $1 \leq n \leq 7$ . A total of 15,348 n-grams were created. The dataset was split into 80% training and 20% test sets. To reduce the feature space dimension, the features with a variance less than 0.01 within the training set were removed, resulting in a total of 515 features. The models were trained to detect indications with scores of 1 and 2. Twenty-nine different classification models available in the lazypredict package were utilized.

## RESULTS

The Adaboost classifier achieved the best performance on the test set with the area under the receiver operating characteristic curve (AUROC) of 0.778 and an F1 score of 0.773, followed by the Ridge classifier which achieved an AUROC of 0.736 and an F1 score of 0.731. The perceptron classifier, nu-support vector classifier, and logistic regression models were among the other models that attained an AUROC greater than 0.7.

## CONCLUSION

Machine learning algorithms can use free-text clinical indications to identify studies that should be prioritized to prevent delays in life-saving interventions.

## CLINICAL RELEVANCE/APPLICATION

The STAT indication for imaging studies is often overutilized and misused. An automated, machine learning-driven system for prioritizing studies that could require immediate intervention can help avoid delays in providing life-saving care.

## M3-SSIN02-3 Consensus Based Macros: An Easy Tool to Improve the Quality of Radiology Reports Containing Incidental Imaging Findings

Tianyuan Fu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the potential of using standardized consensus-based macros to improve tracking of actionable incidental findings (AIFs) across a large academic health system and to increase the number of AIFs reports satisfying the 2022 ACR Novel Quality Measure Set

## METHODS AND MATERIALS

Prior to our intervention, there was no structured method for documentation and for tracking the frequency of AIFs at our institution. Standardized system macros were created for pulmonary nodules and liver, gallbladder, pancreas, renal, adrenal, spleen, adnexal, and thyroid lesions and implemented in January 2022. Each macro includes the location of the lesion, one recommended follow-up modality, the time interval for follow-up, and reference to an evidence-based recommendation. Sources for recommendations included the Fleischner Guidelines and ACR Incidental Finding Committee White Papers. A "signature" code was also tagged to each macro option to allow for tracking. The macros were reviewed and approved by a team of academic subspecialty radiologists and regional radiologists in the community. Radiologists and residents were educated on macro usage through demonstrations in faculty meetings, noon conferences, step-by-step instructions on the department intranet homepage, and email communication. Web-based dashboards were generated to illustrate frequency of different types of AIFs over time

## RESULTS

From January to October 2022, 3991 pulmonary nodules (1324 of which required follow-up per guidelines), 205 liver (50), 317 pancreas (317), 306 renal, 13 spleen, and 505 thyroid (204) lesions were tracked using the macros. In a survey of radiologists participating in this initiative, 70% reported using the macros for some, most, or all AIFs, and 84% found the macros easy to adopt. Most found the macros helpful because they helped to save time (62% of respondents) and ensured appropriate and up-to-date follow up according to the most recent societal guidelines (92% of respondents). All respondents indicated they would recommend other faculty and residents use the macros. One of the reported factors which hindered

adoption was that radiologists needed to be reminded that system macros were available for a particular type of AIF. In addition, some found the macros to be wordy or had individual preferences regarding wording

## **CONCLUSION**

Standardized consensus-based macros are easy-to-use tools that support high quality impression statements and can also be potentially used to keep track of AIFs across large health systems

## **CLINICAL RELEVANCE/APPLICATION**

Many AIFs have time and modality specific follow up recommendations based on expert consensus. However, a significant proportion of these do not undergo appropriate follow up according to established guidelines

### **M3-SSIN02-4 Exploring the Potential of Large Language Models ChatGPT and GPT-4 for Data Mining of Radiology CT Reports on Lung Cancer**

Matthias A. Fink, MD, BSc (*Presenter*) Nothing to Disclose

## **PURPOSE**

To demonstrate the feasibility of using the Large Language Models (LLM) ChatGPT and GPT-4 to accurately mine oncological phenotypes from free-text CT reports.

## **METHODS AND MATERIALS**

The latest LLMs can learn in-context and solve new problems through textual prompts in a few- or zero-shot setting. This enables dynamic user interaction and on-the-fly problem-solving without retraining the models. In our retrospective study, we queried our database for free-text radiology CT reports on lung cancer from 09/2021 to 03/2023. Of 445 reports eligible for study inclusion, 25 were used for prompt engineering for LLMs to extract lesion diameters, anatomical locations, and metastatic disease spatial distributions from 420 remaining reports. The output was defined as data frame format in the given prompts. Performance was evaluated against manual measurement extraction and labeling of metastatic sites by four radiologists.

## **RESULTS**

ChatGPT and GPT-4 generated identical outputs with data frames of oncologic follow-up measurements and metastatic sites for all reports (420/420), fed into a rule-based NLP pipeline to match radiologists' ground truth annotations. ChatGPT accurately extracted 84% (2093/2492) of oncologic measurements on a per-lesion basis, while GPT-4 extracted 98.6% (2456/2492;  $P < .001$ ). This resulted in 67% (280/420) accuracy for ChatGPT and 96% (402/420) for GPT-4 in extracting all relevant oncologic measurements on report-level ( $P < .001$ ). ChatGPT identified sites of metastatic disease (12 organs) with 75.9% (73.0, 78.7), 94.1% (93.4, 94.7), and 91.3% (90.6, 92.0) sensitivity, specificity, and accuracy (CI in parentheses), respectively, while GPT-4 identified them with 94.6% (93.0, 96.0), 99.0% (98.7, 99.3), and 98.3% (98.0, 98.6), respectively.

## **CONCLUSION**

Accurate data mining of free-text CT reports using LLMs seems feasible. GPT-4 achieved excellent performance in curating oncological follow-up measurements and identifying spatial patterns of metastatic disease in patients with lung cancer, while ChatGPT had significantly lower performance.

## **CLINICAL RELEVANCE/APPLICATION**

LLMs offer new possibilities for flexible and accurate extraction of cancer phenotypes from radiology reports by using user-defined prompts to dynamically adjust the models' outputs. This provides a potential basis for large-scale labeling, database building, and visual grounding approaches in cross-sectional imaging.

### **M3-SSIN02-5 Natural Language Processing of Oncologic Radiology Reports: Predicting Response and Progression from Free Text Impressions**

Richard Kinh Gian Do, MD, PhD (*Presenter*) Author, RELX;Consultant, General Electric Company;Consultant, Bayer AG;Spouse, Author, Wolters Kluwer nv;Spouse, Committee Member, ALK-Abello A/S;Spouse, Consultant, JDP Therapeutics Inc;Spouse, Consultant, F. Hoffmann-La Roche Ltd

## **PURPOSE**

Radiologists routinely report treatment response and disease progression for cancer patients. This data is increasingly used to build Real World Evidence, to understand how cancer therapies perform in the "Real-World" after their regulatory approval. This study aims to use Natural Language Processing (NLP) to extract progression and response events from radiology reports.

## **METHODS AND MATERIALS**

In this IRB approved HIPAA compliant retrospective study, 3503 consecutive reports over a 4 month period were retrieved if they were prospectively labeled by radiologists with a departmental oncologic response standardized lexicon, which includes multiple categories including progression of disease (PD) and partial response (PR). In this lexicon, no complete response

category is used. A BERT-base-uncased model and tokenizer were used to predict the report response categories of PD and PR. Model performance was measured by accuracy, precision, recall, and F-1 scores, on a training/validation/test set split as 80%/10%/10%.

## RESULTS

772/3503 (22%) reports were labeled with PD, and 385/3503 (11.0%) reports were labeled with PR. Accuracies for the first NLP model created to predict PR were > 99%/97%/95% for training/validation/test sets, respectively. Precision, recall, and F-1 for the PR test set were 98.3%, 90.8%, and 94.4%, respectively. For the PD category, accuracies for the second NLP model were > 99%/96%/98% for training/validation/test sets. Precision, recall, and F-1 for the PD test set were 97.7%/97.7%, and 97.7%, respectively.

## CONCLUSION

In this single institution study, BERT-based NLP can be used to extract progression and response events with high F-1 scores of over 90% when applied to radiology reports with free text impression. Further testing with multi-center reports will be sought next.

## CLINICAL RELEVANCE/APPLICATION

Real World Evidence is increasingly sought by the FDA to assess the performance of cancer therapeutics after regulatory approval. Understanding how cancer drugs perform in the "Real-World" and identifying the subset of patients most likely to benefit from different treatments is essential for the application of personalized medicine. Rapid extraction of progression and response events documented in radiology reports will facilitate this data collection process.

### M3-SSIN02-6 Development of an AI Model to Detect Diagnostic Errors in Radiology using Synthetic Error-Injected Reports

Dabin Min (*Presenter*) Nothing to Disclose

## PURPOSE

Reading radiologic exams is highly complex and prone to diagnostic errors. It is known that the errors occur in 3 to 4% of cases in daily practice and lead to inappropriate or delayed treatment. In this study, we aimed to develop an AI model that can detect most types of diagnostic errors known in the field of radiology.

## METHODS AND MATERIALS

Based on previous research that analyzed the errors in radiology, we developed an Error Generator (EG) that injects diagnostic errors into existing chest x-ray (CXR) reports. Our two board-certified radiologists collaborated to design the process of generating eight types of errors, including underreading (UR), satisfaction of search (SS), faulty reasoning (FR), false-positive findings (FP). We built a transformer-based vision-language model as an Error Detector (ED) and trained it on MIMIC-EG, which consist of 126,439 CXRs from MIMIC-CXR and their corresponding error-injected reports (EIR) generated by EG. We evaluated the binary classification performance of ED on three different datasets: MIMIC-EG (1,494 CXRs), IU-EG (2,994 CXRs), and MIMIC-R (1,494 CXRs). IU-EG is collected from IU-Xray dataset and their corresponding EIRs generated by EG to evaluate our method on unseen data. MIMIC-R consists of the same CXRs as the test split of MIMIC-EG but includes 100 EIRs generated by two radiologist and is used to assess the effectiveness on diagnostic errors made by human experts. To ensure a clinically relevant test setting, we conducted 100 bootstrap samplings in all of our tests, following a 4% error occurrence rate and distribution of error types as reported in related works. For the best possible baseline, we generated errors by swapping original reports with random ones and trained ED only with it (swapED).

## RESULTS

Our method showed performance on MIMIC-R with an AUC of 0.93 (SD=0.02). Furthermore, it exhibited significantly better results than the baseline on all datasets, achieving AUCs of 0.94, 0.88, and 0.93 on MIMIC-EG, IU-EG, and MIMIC-R, respectively, while the swapED yielded 0.77, 0.65, and 0.74, respectively ( $p < 0.001$  for all comparisons). The sensitivity for the four major error types (UR, SS, FP, and FR) in MIMIC-R was 0.82, 0.68, 0.50, and 0.70, respectively, at a specificity of 0.9, while the swapED's was 0.62, 0.44, 0.36, and 0.55, respectively ( $p < 0.001$  for all comparisons).

## CONCLUSION

The AI model trained with synthetic error-injected CXR reports demonstrated effective performance in detecting real-world diagnostic errors.

## CLINICAL RELEVANCE/APPLICATION

The developed model has the potential to be used as a support tool to reduce diagnostic errors, and enhance patient safety.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSIN02-1

### Automated AI Processing, PACS Delivery, and Reporting using a Cloud-based System in a Multihospital Health System

Monday, Nov. 27 9:30AM - 10:30AM Room: S404

Neil R. Chaterjee, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The number of artificial intelligence (AI) algorithms both in the literature and available for commercial use has exploded in recent years, but clinical adoption remains limited. One major barrier towards adoption is seamless integration into the clinical workflow. Ideally, AI results would 1) be viewable within the picture archiving and communication system (PACS) and 2) easily inserted into the radiology report. Many companies offer AI solutions that claim to meet these criteria, but these solutions can have limitations such as poor integration with the electronic health record, loss of data control, lack of algorithm transparency, and cost. To meet this need, we developed a cloud-based software layer for automatic image analysis with seamless PACS and reporting engine integration. As a proof-of-concept, we developed an AI algorithm for reporting hepatic steatosis and deployed it in a live clinical environment.

#### METHODS AND MATERIALS

After a study is ended, an HL7 message is sent to the Vendor Neutral Archive (VNA). The VNA instructs PACS to move the study to the AI server hosted on a cloud computing program. The AI server processes the images and outputs 1) image overlays to PACS and 2) summary statistics as Common Data Elements (CDEs) in a DICOM Structured Report (DICOM SR). The DICOM SR is sent to the reporting engine via an HL7 router, permitting the CDEs to be inserted into a report via a macro.

#### RESULTS

All studies with appropriate CT codes were sent to the AI server after it was deployed at our hospital. 701 studies were processed in the first 14 days after deployment. The mean liver attenuation in studies where the liver attenuation algorithm ran was  $57 \pm 36$  HU.

#### CONCLUSION

We developed a cloud-based software solution to automatically run any arbitrary AI algorithm and seamlessly integrate results into PACS and clinical reports, and we demonstrate its use in a real-world clinical environment. This has the potential to significantly decrease the barrier to clinical AI adoption and generate large quantities of AI-processed data for research.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrate the feasibility of implementing a cloud-based software layer for automatic AI analysis with PACS and reporting engine integration. This approach provides an option for institutions to seamlessly integrate AI into their clinical workflows while retaining control over their own data and AI algorithms, which we believe has the potential to increase clinical AI adoption. In our proof-of-concept application of a liver segmentation AI algorithm, this allows for opportunistic screening of hepatic steatosis in every patient that gets an abdominal CT.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-SSIN02-2

### Identifying High-priority STAT Imaging Studies using Natural Language Processing and Machine Learning Models

Monday, Nov. 27 9:30AM - 10:30AM Room: S404

Renaid Kim, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Imaging studies at our institution can be ordered as routine, urgent, or STAT, but further stratification of study urgency is not available. Several prior studies have described how the "STAT" designation is overutilized and misused, further obscuring the actual urgency of an imaging order. All studies from the emergency room, for example, may be designated as STAT even when immediate intervention is not required with positive findings. Additionally, many outpatient studies ordered for routine follow up are ordered STAT. Our purpose was to create an automated system to identify priority STAT imaging studies that would require immediate intervention if positive, thereby avoiding delays in care.

#### METHODS AND MATERIALS

Five hundred outpatient imaging studies ordered "STAT" were identified, and their free-text clinical indications were collected. After excluding orders for image-guided procedures and duplicate indications, 351 imaging studies remained in the dataset. For each study, 3 different radiologists evaluated the indication and assigned an integer score between 1 (most likely) and 5 (least likely) based on the likelihood of requiring medical or surgical intervention within 24 hours if positive. A simple majority was used for determining the final score. For studies with interrater score difference =2, a fourth radiologist adjudicated. Boolean features were generated from the free text based on n-grams, with  $1 \leq n \leq 7$ . A total of 15,348 n-grams were created. The dataset was split into 80% training and 20% test sets. To reduce the feature space dimension, the features with a variance less than 0.01 within the training set were removed, resulting in a total of 515 features. The models were trained to detect indications with scores of 1 and 2. Twenty-nine different classification models available in the lazypredict package were utilized.

#### RESULTS

The Adaboost classifier achieved the best performance on the test set with the area under the receiver operating characteristic curve (AUROC) of 0.778 and an F1 score of 0.773, followed by the Ridge classifier which achieved an AUROC of 0.736 and an F1 score of 0.731. The perceptron classifier, nu-support vector classifier, and logistic regression models were among the other models that attained an AUROC greater than 0.7.

#### CONCLUSION

Machine learning algorithms can use free-text clinical indications to identify studies that should be prioritized to prevent delays in life-saving interventions.

#### CLINICAL RELEVANCE/APPLICATION

The STAT indication for imaging studies is often overutilized and misused. An automated, machine learning-driven system for prioritizing studies that could require immediate intervention can help avoid delays in providing life-saving care.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-SSIN02-3

### Consensus Based Macros: An Easy Tool to Improve the Quality of Radiology Reports Containing Incidental Imaging Findings

Monday, Nov. 27 9:30AM - 10:30AM Room: S404

Tianyuan Fu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the potential of using standardized consensus-based macros to improve tracking of actionable incidental findings (AIFs) across a large academic health system and to increase the number of AIFs reports satisfying the 2022 ACR Novel Quality Measure Set

#### METHODS AND MATERIALS

Prior to our intervention, there was no structured method for documentation and for tracking the frequency of AIFs at our institution. Standardized system macros were created for pulmonary nodules and liver, gallbladder, pancreas, renal, adrenal, spleen, adnexal, and thyroid lesions and implemented in January 2022. Each macro includes the location of the lesion, one recommended follow-up modality, the time interval for follow-up, and reference to an evidence-based recommendation. Sources for recommendations included the Fleischner Guidelines and ACR Incidental Finding Committee White Papers. A "signature" code was also tagged to each macro option to allow for tracking. The macros were reviewed and approved by a team of academic subspecialty radiologists and regional radiologists in the community. Radiologists and residents were educated on macro usage through demonstrations in faculty meetings, noon conferences, step-by-step instructions on the department intranet homepage, and email communication. Web-based dashboards were generated to illustrate frequency of different types of AIFs over time

#### RESULTS

From January to October 2022, 3991 pulmonary nodules (1324 of which required follow-up per guidelines), 205 liver (50), 317 pancreas (317), 306 renal, 13 spleen, and 505 thyroid (204) lesions were tracked using the macros. In a survey of radiologists participating in this initiative, 70% reported using the macros for some, most, or all AIFs, and 84% found the macros easy to adopt. Most found the macros helpful because they helped to save time (62% of respondents) and ensured appropriate and up-to-date follow up according to the most recent societal guidelines (92% of respondents). All respondents indicated they would recommend other faculty and residents use the macros. One of the reported factors which hindered adoption was that radiologists needed to be reminded that system macros were available for a particular type of AIF. In addition, some found the macros to be wordy or had individual preferences regarding wording

#### CONCLUSION

Standardized consensus-based macros are easy-to-use tools that support high quality impression statements and can also be potentially used to keep track of AIFs across large health systems

#### CLINICAL RELEVANCE/APPLICATION

Many AIFs have time and modality specific follow up recommendations based on expert consensus. However, a significant proportion of these do not undergo appropriate follow up according to established guidelines

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSIN02-4

### Exploring the Potential of Large Language Models ChatGPT and GPT-4 for Data Mining of Radiology CT Reports on Lung Cancer

Monday, Nov. 27 9:30AM - 10:30AM Room: S404

Matthias A. Fink, MD, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate the feasibility of using the Large Language Models (LLM) ChatGPT and GPT-4 to accurately mine oncological phenotypes from free-text CT reports.

#### METHODS AND MATERIALS

The latest LLMs can learn in-context and solve new problems through textual prompts in a few- or zero-shot setting. This enables dynamic user interaction and on-the-fly problem-solving without retraining the models. In our retrospective study, we queried our database for free-text radiology CT reports on lung cancer from 09/2021 to 03/2023. Of 445 reports eligible for study inclusion, 25 were used for prompt engineering for LLMs to extract lesion diameters, anatomical locations, and metastatic disease spatial distributions from 420 remaining reports. The output was defined as data frame format in the given prompts. Performance was evaluated against manual measurement extraction and labeling of metastatic sites by four radiologists.

#### RESULTS

ChatGPT and GPT-4 generated identical outputs with data frames of oncologic follow-up measurements and metastatic sites for all reports (420/420), fed into a rule-based NLP pipeline to match radiologists' ground truth annotations. ChatGPT accurately extracted 84% (2093/2492) of oncologic measurements on a per-lesion basis, while GPT-4 extracted 98.6% (2456/2492;  $P < .001$ ). This resulted in 67% (280/420) accuracy for ChatGPT and 96% (402/420) for GPT-4 in extracting all relevant oncologic measurements on report-level ( $P < .001$ ). ChatGPT identified sites of metastatic disease (12 organs) with 75.9% (73.0, 78.7), 94.1% (93.4, 94.7), and 91.3% (90.6, 92.0) sensitivity, specificity, and accuracy (CI in parentheses), respectively, while GPT-4 identified them with 94.6% (93.0, 96.0), 99.0% (98.7, 99.3), and 98.3% (98.0, 98.6), respectively.

#### CONCLUSION

Accurate data mining of free-text CT reports using LLMs seems feasible. GPT-4 achieved excellent performance in curating oncological follow-up measurements and identifying spatial patterns of metastatic disease in patients with lung cancer, while ChatGPT had significantly lower performance.

#### CLINICAL RELEVANCE/APPLICATION

LLMs offer new possibilities for flexible and accurate extraction of cancer phenotypes from radiology reports by using user-defined prompts to dynamically adjust the models' outputs. This provides a potential basis for large-scale labeling, database building, and visual grounding approaches in cross-sectional imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSIN02-5

### Natural Language Processing of Oncologic Radiology Reports: Predicting Response and Progression from Free Text Impressions

Monday, Nov. 27 9:30AM - 10:30AM Room: S404

Richard Kinh Gian Do, MD, PhD (*Presenter*) Author, RELX;Consultant, General Electric Company;Consultant, Bayer AG;Spouse, Author, Wolters Kluwer nv;Spouse, Committee Member, ALK-Abello A/S;Spouse, Consultant, JDP Therapeutics Inc;Spouse, Consultant, F. Hoffmann-La Roche Ltd

#### PURPOSE

Radiologists routinely report treatment response and disease progression for cancer patients. This data is increasingly used to build Real World Evidence, to understand how cancer therapies perform in the "Real-World" after their regulatory approval. This study aims to use Natural Language Processing (NLP) to extract progression and response events from radiology reports.

#### METHODS AND MATERIALS

In this IRB approved HIPAA compliant retrospective study, 3503 consecutive reports over a 4 month period were retrieved if they were prospectively labeled by radiologists with a departmental oncologic response standardized lexicon, which includes multiple categories including progression of disease (PD) and partial response (PR). In this lexicon, no complete response category is used. A BERT-base-uncased model and tokenizer were used to predict the report response categories of PD and PR. Model performance was measured by accuracy, precision, recall, and F-1 scores, on a training/validation/test set split as 80%/10%/10%.

#### RESULTS

772/3503 (22%) reports were labeled with PD, and 385/3503 (11.0%) reports were labeled with PR. Accuracies for the first NLP model created to predict PR were > 99%/97%/95% for training/validation/test sets, respectively. Precision, recall, and F-1 for the PR test set were 98.3%, 90.8%, and 94.4%, respectively. For the PD category, accuracies for the second NLP model were > 99%/96%/98% for training/validation/test sets. Precision, recall, and F-1 for the PD test set were 97.7%/97.7%, and 97.7%, respectively.

#### CONCLUSION

In this single institution study, BERT-based NLP can be used to extract progression and response events with high F-1 scores of over 90% when applied to radiology reports with free text impression. Further testing with multi-center reports will be sought next.

#### CLINICAL RELEVANCE/APPLICATION

Real World Evidence is increasingly sought by the FDA to assess the performance of cancer therapeutics after regulatory approval. Understanding how cancer drugs perform in the "Real-World" and identifying the subset of patients most likely to benefit from different treatments is essential for the application of personalized medicine. Rapid extraction of progression and response events documented in radiology reports will facilitate this data collection process.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSIN02-6

### Development of an AI Model to Detect Diagnostic Errors in Radiology using Synthetic Error-Injected Reports

Monday, Nov. 27 9:30AM - 10:30AM Room: S404

Dabin Min (*Presenter*) Nothing to Disclose

#### PURPOSE

Reading radiologic exams is highly complex and prone to diagnostic errors. It is known that the errors occur in 3 to 4% of cases in daily practice and lead to inappropriate or delayed treatment. In this study, we aimed to develop an AI model that can detect most types of diagnostic errors known in the field of radiology.

#### METHODS AND MATERIALS

Based on previous research that analyzed the errors in radiology, we developed an Error Generator (EG) that injects diagnostic errors into existing chest x-ray (CXR) reports. Our two board-certified radiologists collaborated to design the process of generating eight types of errors, including underreading (UR), satisfaction of search (SS), faulty reasoning (FR), false-positive findings (FP). We built a transformer-based vision-language model as an Error Detector (ED) and trained it on MIMIC-EG, which consist of 126,439 CXRs from MIMIC-CXR and their corresponding error-injected reports (EIR) generated by EG. We evaluated the binary classification performance of ED on three different datasets: MIMIC-EG (1,494 CXRs), IU-EG (2,994 CXRs), and MIMIC-R (1,494 CXRs). IU-EG is collected from IU-Xray dataset and their corresponding EIRs generated by EG to evaluate our method on unseen data. MIMIC-R consists of the same CXRs as the test split of MIMIC-EG but includes 100 EIRs generated by two radiologist and is used to assess the effectiveness on diagnostic errors made by human experts. To ensure a clinically relevant test setting, we conducted 100 bootstrap samplings in all of our tests, following a 4% error occurrence rate and distribution of error types as reported in related works. For the best possible baseline, we generated errors by swapping original reports with random ones and trained ED only with it (swapED).

#### RESULTS

Our method showed performance on MIMIC-R with an AUC of 0.93 (SD=0.02). Furthermore, it exhibited significantly better results than the baseline on all datasets, achieving AUCs of 0.94, 0.88, and 0.93 on MIMIC-EG, IU-EG, and MIMIC-R, respectively, while the swapED yielded 0.77, 0.65, and 0.74, respectively ( $p < 0.001$  for all comparisons). The sensitivity for the four major error types (UR, SS, FP, and FR) in MIMIC-R was 0.82, 0.68, 0.50, and 0.70, respectively, at a specificity of 0.9, while the swapED's was 0.62, 0.44, 0.36, and 0.55, respectively ( $p < 0.001$  for all comparisons).

#### CONCLUSION

The AI model trained with synthetic error-injected CXR reports demonstrated effective performance in detecting real-world diagnostic errors.

#### CLINICAL RELEVANCE/APPLICATION

The developed model has the potential to be used as a support tool to reduce diagnostic errors, and enhance patient safety.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSNR03

### Neuroradiology (Brain: Neoplasms (Diagnosis and Classification))

Monday, Nov. 27 9:30AM - 10:30AM Room: E353C

Virginia B. Hill, MD (*Moderator*) Medical Science Liaison, Alphabet Inc;;  
Chaitra A. Badve, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M3-SSNR03-1 Radiology Report-guided Prediction of Pediatric Low-grade Neuroepithelial Tumors Genetic Markers using Deep Learning**

Sara Ketabi (*Presenter*) Nothing to Disclose

#### PURPOSE

Pediatric Low-Grade Neuroepithelial Tumor (PLGNT) is one of the most prevalent brain tumors in children. Accurate PLGNT treatment planning requires the identification of the tumor genetic markers, which is typically beyond the purview of radiologists. Nonetheless, the language they use in radiology reports for interpreting brain Magnetic Resonance Imaging (MRI) can potentially be used for diagnosing these genetic markers. In this study, we employ deep learning to investigate the predictive performance of radiology reports in PLGNT genetic marker diagnosis. We also identify important features for each genetic marker from our model to make the predictions more transparent.

#### METHODS AND MATERIALS

This REB-approved retrospective study contains brain MRI reports corresponding to 203 PLGNT patients aged between 5 and 18 diagnosed with BRAF fusion or BRAF V600E mutation, the two most common PLGNT genetic markers. The dataset was divided into training, validation, and test sets using nested 5-fold cross-validation, and Clinical-Longformer, a state-of-the-art language transformer for processing clinical text, was applied to the data. We selected the model with the highest validation Area Under the Receiver Operating Curve (AUC) to detect the most important text features using the gradients of the output class with respect to the input features.

#### RESULTS

Our optimal model achieved a mean test AUC of  $0.864 \pm 0.075$ . This result indicates that radiology reports provide informative descriptions of MR images that enable the model to classify BRAF status with high accuracy. Using the class-wise gradient analysis of the model, "seeding", "sac", "above", "than", "dnet", and "suprasellar" were identified as decisive keywords for predicting BRAF fusion. The top ranking keywords for predicting BRAF V600E mutation include "er", "astrocytoma", "keeping", "oligodendroglioma", "naa", and "above". These are aligned with clinical evidence as tumor location and pathological class have been established as correlated factors with PLGNT BRAF status.

#### CONCLUSION

Although radiologists are not trained to diagnose PLGNT genetic markers, their analysis and description of MR images can significantly aid in genetic marker classification. Moreover, our model's attention scores signify relevant text features such as location information and tumor pathological diagnosis, resulting in reliable and interpretable predictions.

#### CLINICAL RELEVANCE/APPLICATION

Using radiology reports to predict PLGNT genetic markers can reveal important keywords, which are interpretable by radiologists. This can lead to more effective diagnosis and subsequent treatment.

#### **M3-SSNR03-2 MRI Findings in Epstein-Barr Virus-Associated Primary Central Nervous System Lymphoma**

Dario Herran de la Gala, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Epstein-Barr virus (EBV) associated Primary Central Nervous System Lymphoma (PCNSL) is a rare form of extranodal non-Hodgkin lymphoma that is strongly related to immunodeficiency. EBV-associated PCNSL imaging characteristics are described to be different from typical PCNSL. In immunocompromised patients, neurotoxoplasmosis is the main differential diagnosis. The aim of our study was to report the MRI features of a sample of patients with EBV-associated PCNSL with respect to the ones described in the literature for typical PCNSL and neurotoxoplasmosis.

## METHODS AND MATERIALS

We performed a single-center retrospective descriptive study after consulting consecutive patients from a stereotactic brain biopsy database of our adult tertiary medical center. The inclusion criterion was the presence of pathological diagnosis of EBV-associated PCNSL. MRI variables were collected and analyzed: lesion topography, contrast enhancement characteristics, the presence of intralesional hemorrhage, hypercellularity on DWI as well as the evidence of "concentric" and "eccentric" target signs. Two radiologists reviewed all MRI scans in a consensus analysis.

## RESULTS

Forty-one cases of EBV-associated PCNSL were collected. All but 5 patients had immunosuppression. Lesions were unilateral in 39.5% and bilateral in 60.5%. Lesions were multiple in up to 71.8% of cases. Heterogeneous contrast enhancement was present in 78.9% of cases, with 43.5% having ring-like enhancement. Leptomeningeal enhancement was found in 40.5% of cases, and within this group, 62.5% showed perivascular space enhancement. Lesions showed hypercellularity in 67.6% and intralesional hemorrhage in 85.7%. Susceptibility-weighted images (53.0%) and non-enhanced T1-weighted images (24.4%) were the sequences where hemorrhage was most frequently visualized. The "Eccentric target" sign was present in 18.0% of cases and the "concentric target" sign in 15.0% of cases.

## CONCLUSION

The diagnosis of EBV-associated PCNSL is challenging given its rarity. Our sample showed that multiple necrotic and hemorrhagic lesions are the MRI landmarks for EBV-associated PCNSL imaging diagnosis. Hypercellularity, typically seen in PCNSL, was often but inconstantly noticed. "Eccentric" and "concentric" target signs, classically attributed to CNS toxoplasmosis, were found in pathologically proven EBV-associated PCNSL. Neuroradiologists must be aware of this tumor entity, as well as of current MRI limitations in its distinction with neurotoxoplasmosis.

## CLINICAL RELEVANCE/APPLICATION

Radiologist should know EBV-associated PCNSL MRI features and be aware of the possible overlap with neurotoxoplasmosis lesions, one of its main differential diagnoses in immunocompromised patients.

## M3-SSNR03-4 A Comprehensive Analysis of Clinical, Molecular, and Imaging Characteristics of H3 K27- Altered Diffuse Midline Gliomas in Adults

Yongsik Sim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this study was to comprehensively investigate the clinical, molecular, and imaging characteristics of H3 K27-altered diffuse midline glioma (DMG) in adults.

## METHODS AND MATERIALS

Retrospective charts and imaging reviews were performed in 81 adult patients with H3 K27-altered DMG enrolled between 2015 and 2023. The clinical, molecular, imaging, and survival characteristics were analyzed. Cox analyses were performed to determine predictors of overall survival (OS) in H3 K27-altered DMG patients. From available data from the meta-analysis of 1,000 pediatric patients with high-grade glioma and DIPG, 365 pediatric patients (aged < 18 years) with H3 K27-altered DMG were compared with adult patients.

## RESULTS

The median patient age was 42.0 years (range 19.9-75.7 years). All patients (100%) were H3.3 K27-mutant subtype, with frequent p53 expression (32.1%) and ATRX loss (14.3%). The most common location of tumors was thalamus (30.9%), followed by spinal cord (28.4%), non-midline location (17.2%), and medulla (12.3%). The OS of H3 K27-altered DMG adult patients was 30.3 months (IQR 18.1-41.1), longer than H3 K27-altered DMG pediatric patients (30.3 vs. 12.0 months,  $P < 0.001$ ). On multivariable Cox analysis, older age at diagnosis (hazard ratio [HR] = 0.95,  $P < 0.001$ ), spinal cord location (HR = 0.39,  $P = 0.010$ ), and non-gross total resection of nonenhancing tumor (HR = 10.70,  $P = 0.005$ ) were independently associated with better OS.

## CONCLUSION

The current recommendation of testing H3 K27 alteration in midline-located tumors should be questioned. The prognosis of H3 K27-altered DMG in the adult is not discouraging as expected in pediatric counterparts, and promote the reconsideration of aggressive surgery as well as development of clinical trials in this relatively ignored condition.

## CLINICAL RELEVANCE/APPLICATION

This series describes the clinical, molecular, and imaging features of H3 K27-altered DMGs in adults. The prognosis of H3 K27-altered DMG in the adult is not discouraging as expected in pediatric counterparts. Our results suggest reconsideration of aggressive surgery in H3 K27-altered DMG in adults.

### M3-SSNR03-5 **Intra- and Peritumoral Radiomics for Distinguishing Circumscribed and Diffuse Gliomas: A Multicenter Validation Study**

Shuang Li (*Presenter*) Nothing to Disclose

## PURPOSE

Circumscribed astrocytomas (CAGs) are well-circumscribed tumors that have a more solid growth pattern, while diffuse gliomas (DGs) are characterized by invasive growth and infiltration of the brain parenchyma. Accurate preoperative differentiation between CAGs and DGs is essential for treatment planning and prognosis prediction.

## METHODS AND MATERIALS

We retrospectively analyzed MRI data from patients with CAGs and DGs across three institutions. After segmenting the tumor volume of interest (VOI), three VOIs (VOItumor and peritumoral, VOIwhole, and VOIinterface) were obtained that comprised the peritumoral region. Clinical and combined model (incorporating radiomics and clinical features) were also established. To address training dataset imbalance, we employed the Synthetic Minority Oversampling Technique (SMOTE). A 5-fold cross-validation on the training dataset determined the model's hyperparameters, and performance was assessed using receiver operating characteristic curve and precision-recall analysis.

## RESULTS

Finally, 475 patients (DGs:  $n = 338$ , CAGs:  $n = 137$ ) were included in this study. The VOIinterface radiomics model yield the best performance in distinguishing CAGs from DGs, with an AUC of 0.806 and AUPRC of 0.894 in the 5-fold cross-validation set. Using the ANOVA feature selector and SVM classifier, 7 features were selected. The AUC and AUPRC achieved were 0.912 and 0.972 on the internal validation dataset, and 0.897 and 0.930 on the external validation dataset. The combined model using interface radiomics and clinical features improved performance in the external validation set (AUC of 0.94 and PRAUC of 0.959).

## CONCLUSION

Radiomics models incorporating the peritumoral area show increased potential for distinguishing CAGs from DGs compared to intratumoral models. These findings may be promising for evaluating tumor nature before surgery and improving clinical management of glioma patients.

## CLINICAL RELEVANCE/APPLICATION

The application of intra- and peritumoral radiomics for differentiating CAGs and DGs enhances preoperative accuracy, which is vital for customizing treatment plans and anticipating patient outcomes. By including peritumoral radiomics features, clinicians can obtain a more comprehensive insight into the invasive growth patterns of DGs, facilitating better-informed treatment decisions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSNR03-1

### Radiology Report-guided Prediction of Pediatric Low-grade Neuroepithelial Tumors Genetic Markers using Deep Learning

Monday, Nov. 27 9:30AM - 10:30AM Room: E353C

Sara Ketabi (*Presenter*) Nothing to Disclose

#### PURPOSE

Pediatric Low-Grade Neuroepithelial Tumor (PLGNT) is one of the most prevalent brain tumors in children. Accurate PLGNT treatment planning requires the identification of the tumor genetic markers, which is typically beyond the purview of radiologists. Nonetheless, the language they use in radiology reports for interpreting brain Magnetic Resonance Imaging (MRI) can potentially be used for diagnosing these genetic markers. In this study, we employ deep learning to investigate the predictive performance of radiology reports in PLGNT genetic marker diagnosis. We also identify important features for each genetic marker from our model to make the predictions more transparent.

#### METHODS AND MATERIALS

This REB-approved retrospective study contains brain MRI reports corresponding to 203 PLGNT patients aged between 5 and 18 diagnosed with BRAF fusion or BRAF V600E mutation, the two most common PLGNT genetic markers. The dataset was divided into training, validation, and test sets using nested 5-fold cross-validation, and Clinical-Longformer, a state-of-the-art language transformer for processing clinical text, was applied to the data. We selected the model with the highest validation Area Under the Receiver Operating Curve (AUC) to detect the most important text features using the gradients of the output class with respect to the input features.

#### RESULTS

Our optimal model achieved a mean test AUC of  $0.864 \pm 0.075$ . This result indicates that radiology reports provide informative descriptions of MR images that enable the model to classify BRAF status with high accuracy. Using the class-wise gradient analysis of the model, "seeding", "sac", "above", "than", "dnet", and "suprasellar" were identified as decisive keywords for predicting BRAF fusion. The top ranking keywords for predicting BRAF V600E mutation include "er", "astrocytoma", "keeping", "oligodendroglioma", "naa", and "above". These are aligned with clinical evidence as tumor location and pathological class have been established as correlated factors with PLGNT BRAF status.

#### CONCLUSION

Although radiologists are not trained to diagnose PLGNT genetic markers, their analysis and description of MR images can significantly aid in genetic marker classification. Moreover, our model's attention scores signify relevant text features such as location information and tumor pathological diagnosis, resulting in reliable and interpretable predictions.

#### CLINICAL RELEVANCE/APPLICATION

Using radiology reports to predict PLGNT genetic markers can reveal important keywords, which are interpretable by radiologists. This can lead to more effective diagnosis and subsequent treatment.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-SSNR03-2

### MRI Findings in Epstein-Barr Virus-Associated Primary Central Nervous System Lymphoma

Monday, Nov. 27 9:30AM - 10:30AM Room: E353C

Dario Herran de la Gala, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Epstein-Barr virus (EBV) associated Primary Central Nervous System Lymphoma (PCNSL) is a rare form of extranodal non-Hodgkin lymphoma that is strongly related to immunodeficiency. EBV-associated PCNSL imaging characteristics are described to be different from typical PCNSL. In immunocompromised patients, neurotoxoplasmosis is the main differential diagnosis. The aim of our study was to report the MRI features of a sample of patients with EBV-associated PCNSL with respect to the ones described in the literature for typical PCNSL and neurotoxoplasmosis.

#### METHODS AND MATERIALS

We performed a single-center retrospective descriptive study after consulting consecutive patients from a stereotactic brain biopsy database of our adult tertiary medical center. The inclusion criterion was the presence of pathological diagnosis of EBV-associated PCNSL. MRI variables were collected and analyzed: lesion topography, contrast enhancement characteristics, the presence of intralesional hemorrhage, hypercellularity on DWI as well as the evidence of "concentric" and "eccentric" target signs. Two radiologists reviewed all MRI scans in a consensus analysis.

#### RESULTS

Forty-one cases of EBV-associated PCNSL were collected. All but 5 patients had immunosuppression. Lesions were unilateral in 39.5% and bilateral in 60.5%. Lesions were multiple in up to 71.8% of cases. Heterogeneous contrast enhancement was present in 78.9% of cases, with 43.5% having ring-like enhancement. Leptomeningeal enhancement was found in 40.5% of cases, and within this group, 62.5% showed perivascular space enhancement. Lesions showed hypercellularity in 67.6% and intralesional hemorrhage in 85.7%. Susceptibility-weighted images (53.0%) and non-enhanced T1-weighted images (24.4%) were the sequences where hemorrhage was most frequently visualized. The "Eccentric target" sign was present in 18.0% of cases and the "concentric target" sign in 15.0% of cases.

#### CONCLUSION

The diagnosis of EBV-associated PCNSL is challenging given its rarity. Our sample showed that multiple necrotic and hemorrhagic lesions are the MRI landmarks for EBV-associated PCNSL imaging diagnosis. Hypercellularity, typically seen in PCNSL, was often but inconstantly noticed. "Eccentric" and "concentric" target signs, classically attributed to CNS toxoplasmosis, were found in pathologically proven EBV-associated PCNSL. Neuroradiologists must be aware of this tumor entity, as well as of current MRI limitations in its distinction with neurotoxoplasmosis.

#### CLINICAL RELEVANCE/APPLICATION

Radiologist should know EBV-associated PCNSL MRI features and be aware of the possible overlap with neurotoxoplasmosis lesions, one of its main differential diagnoses in immunocompromised patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSNR03-4

### **A Comprehensive Analysis of Clinical, Molecular, and Imaging Characteristics of H3 K27-Altered Diffuse Midline Gliomas in Adults**

Monday, Nov. 27 9:30AM - 10:30AM Room: E353C

Yongsik Sim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study was to comprehensively investigate the clinical, molecular, and imaging characteristics of H3 K27-altered diffuse midline glioma (DMG) in adults.

#### **METHODS AND MATERIALS**

Retrospective charts and imaging reviews were performed in 81 adult patients with H3 K27-altered DMG enrolled between 2015 and 2023. The clinical, molecular, imaging, and survival characteristics were analyzed. Cox analyses were performed to determine predictors of overall survival (OS) in H3 K27-altered DMG patients. From available data from the meta-analysis of 1,000 pediatric patients with high-grade glioma and DIPG, 365 pediatric patients (aged < 18 years) with H3 K27-altered DMG were compared with adult patients.

#### **RESULTS**

The median patient age was 42.0 years (range 19.9-75.7 years). All patients (100%) were H3.3 K27-mutant subtype, with frequent p53 expression (32.1%) and ATRX loss (14.3%). The most common location of tumors was thalamus (30.9%), followed by spinal cord (28.4%), non-midline location (17.2%), and medulla (12.3%). The OS of H3 K27-altered DMG adult patients was 30.3 months (IQR 18.1-41.1), longer than H3 K27-altered DMG pediatric patients (30.3 vs. 12.0 months,  $P < 0.001$ ). On multivariable Cox analysis, older age at diagnosis (hazard ratio [HR] = 0.95,  $P < 0.001$ ), spinal cord location (HR = 0.39,  $P = 0.010$ ), and non-gross total resection of nonenhancing tumor (HR = 10.70,  $P = 0.005$ ) were independently associated with better OS.

#### **CONCLUSION**

The current recommendation of testing H3 K27 alteration in midline-located tumors should be questioned. The prognosis of H3 K27-altered DMG in the adult is not discouraging as expected in pediatric counterparts, and promote the reconsideration of aggressive surgery as well as development of clinical trials in this relatively ignored condition.

#### **CLINICAL RELEVANCE/APPLICATION**

This series describes the clinical, molecular, and imaging features of H3 K27-altered DMGs in adults. The prognosis of H3 K27-altered DMG in the adult is not discouraging as expected in pediatric counterparts. Our results suggest reconsideration of aggressive surgery in H3 K27-altered DMG in adults.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSNR03-5

### **Intra- and Peritumoral Radiomics for Distinguishing Circumscribed and Diffuse Gliomas: A Multicenter Validation Study**

Monday, Nov. 27 9:30AM - 10:30AM Room: E353C

Shuang Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Circumscribed astrocytomas (CAGs) are well-circumscribed tumors that have a more solid growth pattern, while diffuse gliomas (DGs) are characterized by invasive growth and infiltration of the brain parenchyma. Accurate preoperative differentiation between CAGs and DGs is essential for treatment planning and prognosis prediction.

#### **METHODS AND MATERIALS**

We retrospectively analyzed MRI data from patients with CAGs and DGs across three institutions. After segmenting the tumor volume of interest (VOI), three VOIs (VOI<sub>tumor</sub> and peritumoral, VOI<sub>whole</sub>, and VOI<sub>interface</sub>) were obtained that comprised the peritumoral region. Clinical and combined model (incorporating radiomics and clinical features) were also established. To address training dataset imbalance, we employed the Synthetic Minority Oversampling Technique (SMOTE). A 5-fold cross-validation on the training dataset determined the model's hyperparameters, and performance was assessed using receiver operating characteristic curve and precision-recall analysis.

#### **RESULTS**

Finally, 475 patients (DGs:  $n = 338$ , CAGs:  $n = 137$ ) were included in this study. The VOI<sub>interface</sub> radiomics model yield the best performance in distinguishing CAGs from DGs, with an AUC of 0.806 and AUPRC of 0.894 in the 5-fold cross-validation set. Using the ANOVA feature selector and SVM classifier, 7 features were selected. The AUC and AUPRC achieved were 0.912 and 0.972 on the internal validation dataset, and 0.897 and 0.930 on the external validation dataset. The combined model using interface radiomics and clinical features improved performance in the external validation set (AUC of 0.94 and PRAUC of 0.959).

#### **CONCLUSION**

Radiomics models incorporating the peritumoral area show increased potential for distinguishing CAGs from DGs compared to intratumoral models. These findings may be promising for evaluating tumor nature before surgery and improving clinical management of glioma patients.

#### **CLINICAL RELEVANCE/APPLICATION**

The application of intra- and peritumoral radiomics for differentiating CAGs and DGs enhances preoperative accuracy, which is vital for customizing treatment plans and anticipating patient outcomes. By including peritumoral radiomics features, clinicians can obtain a more comprehensive insight into the invasive growth patterns of DGs, facilitating better-informed treatment decisions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSNR04

### Neuroradiology (Brain: Neoplasms (Post-Treatment Evaluation))

Monday, Nov. 27 9:30AM - 10:30AM Room: E353B

Brent D. Weinberg, MD, PhD (*Moderator*) Research Consultant, Canon Medical Systems Corporation  
Gagandeep Singh, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### M3-SSNR04-1 Baseline and Longitudinal Radiologic Assessment of Brain Metastases Treated With Laser Interstitial Thermal Therapy (LITT)

Francesco Sanvito, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify baseline imaging features of brain metastases (BM) predicting lesion progression free survival (PFS-L) after laser interstitial thermal therapy (LITT), and to characterize post-treatment longitudinal volumetric and diffusion imaging changes of long-term responding lesions.

#### METHODS AND MATERIALS

47 BM treated with LITT were retrospectively studied. BM were followed until clinical progression, radiologic progression according to the modified RANO criteria, or censoring. The association between pre-treatment imaging features and PFS-L was assessed with survival analyses. In responding lesions, longitudinal post-LITT volume shrinkage over time was fit to an exponential decay model, and changes in the apparent diffusion coefficient (ADC) were compared between pre-treatment scans, early post-treatment, 1 year follow-up and =2 years follow-up.

#### RESULTS

13 BM progressed after LITT, 17 met radiologic criteria for response after LITT, and 17 were stable at time of censoring. Pre-LITT enhancing volume  $<2.5$  cc ( $p=0.0004$ ) and sphericity  $=0.705$  ( $p=0.0026$ ) predicted longer PFS-L. BM meeting both cutoffs showed a cumulative PFS-L benefit ( $p<0.0001$ ). High sphericity was associated with complete thermal ablation ( $p=0.03$ ), and small volume tended to predict complete ablation ( $p=0.11$ ). Pre-LITT diffusion imaging did not predict PFS-L, while a subset of lesions ( $n=7$ ) with highly perfused hotspots (normalized rCBV  $>2.5$ ) had worse PFS-L ( $p=0.0012$ ). Immediate post-LITT volume was increased compared to pre-LITT ( $p<0.0001$ , median increase 80.3%), and the percentage of volume increase was not a predictor of PFS-L. In 15 out of 17 responding BM (88.2%), post-LITT shrinkage over time was described by an exponential decay ( $R^2$  ranging 0.92-1.0), with half-life ranging 0.3-5.4 months. ADC changes over time were heterogeneous across the 17 responding lesions. Preliminary analyses showed an overall significant ADC decrease immediately after the treatment (median change:  $-128 \times 10^{-6}$  mm<sup>2</sup>/s,  $p=0.03$ ) and a tendency towards a subsequent progressive ADC increase at 1 year (median change compared to post-LITT:  $+114 \times 10^{-6}$  mm<sup>2</sup>/s,  $p=0.37$ ) and at 2 years (median change compared to post-LITT:  $+481 \times 10^{-6}$  mm<sup>2</sup>/s,  $p=0.03$ ).

#### CONCLUSION

Brain metastases with pre-treatment large volume, low sphericity and high perfusion are more at risk of LITT failure. Lesions meeting criteria for response exhibit a characteristic exponential shrinkage over time, and show an overall ADC decrease followed by a long-term increase.

#### CLINICAL RELEVANCE/APPLICATION

Identifying pre-treatment features associated with treatment response aids patient selection for LITT, while characterizing longitudinal changes in responders defines the expected radiologic findings at follow-up.

#### M3-SSNR04-2 A Revised Molecular Recursive Partitioning Analysis using T2-FLAIR-Based Surgical Extent in Patients With Glioblastoma: A Multi-Center Validation Study

Dongyeong Kim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We sought to identify associations of T2-FLAIR based non-enhancing tumor based gross total resection (NE-GTR) among different molecular subgroups of glioblastoma in multi-center validation using molecular-based recursive partitioning analysis for glioblastoma (GBM-molRPA).

## METHODS AND MATERIALS

This multicenter cohort study included a prospective registry cohort and external validation with newly diagnosed glioblastoma patients with confirmed isocitrate dehydrogenase (IDH) and O-6-methylguanine-DNA methyltransferase (MGMT) promoter methylation status. Contrast-enhancing lesion-based GTR (CE-GTR) and NE-GTR were assessed by four neuroradiologists. Associations between the two GTR definitions and overall survival (OS) were evaluated. Two subsets according to IDH mutation, MGMT, and age were further compared for predictive value of OS between CE-GTR and NE-GTR.

## RESULTS

A total of 568 patients were included (216 from prospective set and 352 from external set). NE-GTR achieved better survival stratification than CE-GTR in both prospective and external sets (log-rank test,  $P < .001$ ). In patients with IDH wild-type and positive MGMT methylation status, NE-GTR showed stronger association with OS than CE-GTR (NE-GTR vs. CE-GTR in prospective and external set: HR 0.361 vs. 0.489; HR 0.563 vs. 0.605). Patients aged  $\geq 50$  years with IDH wild-type benefited from reduction of either the NE-GTR or CE-GTR (NE-GTR vs. CE-GTR in prospective and external set: HR 0.220 vs. HR 0.368; HR 0.393 vs. HR 0.352).

## CONCLUSION

NE-GTR provided better outcome stratification than CE-GTR and refined the GBM-molRPA stratification. NE-GTR enhanced long-term survival in patients with IDH wild-type glioblastoma and positive MGMT promoter methylation status.

## CLINICAL RELEVANCE/APPLICATION

The study compared the impact of NE-GTR and CE-GTR on molecular-based recursive partitioning analysis (GBM-molRPA) in patients with newly developed glioblastoma. NE-GTR was found to be more important for patients with IDH wild-type glioblastoma and positive MGMT promoter methylation status. The findings suggest that NE-based GTR improves outcome stratification over CE-based GTR and refines molecular-based RPA stratification.

## M3-SSNR04-3 Whole Brain Spectroscopy Guided Planning of Transducer Arrays for Enhanced Delivery of Tumor Treating Fields in Patients with Glioblastoma

Laiz L. Godoy, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Due to infiltrative nature of glioblastomas (GBMs), an optimal delivery of tumor treating fields (TTFields) requires precise targeting of entire viable tumor. We hypothesize that whole brain spectroscopic imaging (WBSI) derived high-resolution choline/N-acetylaspartate (NAA) maps (voxel size =  $4.3 \times 4.3 \times 5.6 \text{mm}^3$ ) will more accurately delineate the tumor margins and identify a comprehensive target volume for TTFields delivery.

## METHODS AND MATERIALS

Six GBM patients underwent anatomical imaging, and WBSI on a 3T MRI. The processing steps for WBSI data involved field inhomogeneity and eddy current correction, K-space regridding, spatial and Fourier transformation. In each case, quality assurance was evaluated by considering the following metrics: Cramer-Rao lower bounds, line shapes, line width, CSF partial volume contribution, and degree of residual water and lipid signals. The choline/NAA maps, T2-FLAIR images were co-registered to post contrast (PC)-T1 images. One 3D-composite mask was drawn manually on PC-T1 and T2-FLAIR hyperintense tumor abnormalities and labeled as 'tumor mask'. Another mask was drawn on contralateral normal-appearing brain parenchyma by selecting a volume comparable to the tumor size and at the same slice level and was labeled as 'normal mask'. A mean value of choline/NAA was computed from normal mask, and mean + 1 standard deviation of choline/NAA was considered as threshold value. A tumor region corresponding to all voxels that exceeded the threshold choline/NAA value as measured from normal mask (which includes regions beyond contrast-enhancing regions and hyperintense signal abnormality on T2-FLAIR) was considered as "target volume" for TTFields delivery using a modified transducer array layout.

## RESULTS

Quality map analyses revealed that good quality metabolite maps were obtained from all patients. Figure 1 shows choline/NAA map and anatomical images from a representative GBM patient. As evident, an approximately 4 times more viable tumor cells were detected using metabolic maps compared to T2-FLAIR images. Number of voxels encompassing 3D-composite masks drawn on choline/NAA maps were found to be 1.6 to 4 folds higher than those drawn on anatomical images from 6 patients.

## CONCLUSION

Our preliminary results showed that WBSI derived metabolite maps project a more comprehensive representation of tumor's true spatial extent and provide more accurate margins of viable tumor cells for delivering enhanced dose of TTFields.

## CLINICAL RELEVANCE/APPLICATION

Alternative array configuration will allow for enhanced delivery of TTFields dose to all proliferating regions of a GBM, decreasing the rate of local recurrence and improvement in overall survival and the quality of life measures.

### **M3-SSNR04-4 Prospective Longitudinal Analysis of Imaging-based Spatiotemporal Tumor Habitats in Glioblastoma, IDH-wild Type: Implication in Patient Outcome using Multiparametric Physiologic MRI**

Hye Hyeon Moon, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Heterogeneity in glioblastomas is associated with poor outcomes, and physiologic heterogeneity can be quantified with MRI. We analyzed associations between physiologic MRI-based tumor habitats and patient outcome and prospectively validated to predict time-to-progression (TTP) in glioblastoma patients after concurrent chemoradiotherapy (CCRT).

## METHODS AND MATERIALS

We prospectively enrolled 65 patients (mean age,  $57.9 \pm 11.6$  years, 34 women, NCT02613988) with IDH-wild type glioblastoma who underwent CCRT and obtained immediate post-op and 3 serial MRI scans with 3-month interval include diffusion-weighted imaging and dynamic susceptibility contrast imaging. Voxels from cerebral blood volume and apparent diffusion coefficient maps were grouped using k-means clustering into 3 spatial habitats (hypervascular cellular, hypovascular cellular, and nonviable tissue). A discrete habitat risk score was calculated by comparing changes in hypervascular cellular and hypovascular cellular habitats along serial MRI scans (post-op, post-CCRT #1, #2, and #3). The Kaplan-Meier method and Cox regression analysis were used to assess the association between TTP and habitat risk score.

## RESULTS

A cutoff for habitat risk score was increased of hypervascular cellular habitat ( $>0$  voxel) or hypovascular cellular habitat ( $>130$  voxels). The habitat risk score stratified patients according to low, intermediate, and high risk at post-CCRT #1 (mean TTP; 839 vs. 592 vs. 320 days, log-rank test;  $P < .001$ ), post-CCRT #2 (mean TTP; 949 vs. 348 vs. 282 days,  $P < .001$ ), and post-CCRT #3 scans (mean TTP; 950 vs. 487 vs. 343 days,  $P < .001$ ). A Cox regression analysis identified a habitat risk score between post-op and post-CCRT#1 was an independent predictor for TTP (hazard ratio, 4.75; 95% CI, 2.12-10.66,  $P < .001$ ).

## CONCLUSION

The habitat risk score, reflecting spatiotemporal habitats of vascularity and cellularity of tumor, successfully stratified TTP in patients with IDH wild-type glioblastoma. The habitat risk score at immediate post-CCRT imaging can be a useful predictor of early tumor progression and clinical outcomes in patients with post-treatment glioblastoma.

## CLINICAL RELEVANCE/APPLICATION

Spatial heterogeneity in glioblastoma indicates poor prognosis and therapy resistance. Clustering of multiparametric MRI can reflect spatial habitats of post-CCRT glioblastoma. We validated the habitat risk score based on spatiotemporal habitats and associated it with patient outcomes. Increase in habitat risk score at immediate post-CCRT scans was strongly associated with shorter time-to-progression. Our spatiotemporal habitat analysis could be a useful predictor for early tumor progression and clinical outcomes in patients with post-treatment glioblastoma.

### **M3-SSNR04-5 Differentiating Radiation Changes and Leptomeningeal Metastasis in Subependymal Lesion: Added Value of Perfusion MRI to Morphological Features**

Kyu Sung Choi, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate radiation-induced subependymal changes after Stupp protocol in adult-type high-grade diffuse gliomas and differentiate between radiation changes and progression in the evaluation of leptomeningeal disease (LMD)

## METHODS AND MATERIALS

This retrospective study reviewed 79 consecutive diffuse glioma patients (mean age,  $54.9 \pm 13.6$  years, 54 (68.4%) males) with new subependymal enhancement (SE) in the follow-up MRI after gross total resection and concurrent chemoradiation with temozolomide. For differentiating between radiation changes and true progression in SE evaluation, univariate correlation analysis was conducted to identify significant variables among SE interval, genetic mutation including isocitrate dehydrogenase (IDH), and 14 radiomic shape features and relative cerebral blood volume (rCBV). Subsequently, multivariate logistic regression was performed using the significant variables. For added value of rCBV, a log-rank test was conducted

between the multivariate logistic regression models with and without rCBV. The area under the receiver operating characteristic (AUROC) was obtained to assess diagnostic value of significant variables.

## RESULTS

23 out of 79 (21.1%) patients showed first subependymal lesions,  $7.93 \pm 8.18$  months after surgical treatment, and disappeared after  $5.79 \pm 5.75$  months after initial appearance on postoperative MRI. Elongated, small-sized lesions with lower rCBV tended to spontaneously regress: Elongation (odds ratio (OR)=1.22,  $p=0.02$ ), Mean 3D diameters (OR=2.08,  $p=0.01$ ), and rCBV\_p95 (OR=2.07,  $p=0.04$ ). The qualitative evaluation of shape revealed that thin and curvilinear shaped SE tended to regress (OR=0.03,  $p=0.03$ ), showing significant correlation with quantitative shape features ( $r=0.31$ ,  $p=0.005$ ). Shorter SE interval indicates progression (OR=0.90,  $p=0.02$ ) but showed no group difference ( $p=0.08$ ). In sub-centimeter lesions, rCBV showed added value in predicting outcomes ( $R^2=0.550$  vs  $0.658$ ;  $p=0.01$ , log-rank test). Radiation dose showed no significant difference between the progression and regression group ( $73.8 \pm 29.0$  vs  $70.8 \pm 22.6$  Gy,  $p=0.67$ ). IDH mutation status was not significant predictor both logistic regression models ( $p=0.19$ , and  $p=0.08$ ). AUROC for Elongation, Mean 3D diameters, rCBV\_p95, and SE interval was 0.702, 0.802, 0.729, and 0.702, respectively.

## CONCLUSION

Smaller, elongated lesions with lower rCBV are predictive for regression, when differentiating radiation changes from LMD progression in new subependymal enhancement.

## CLINICAL RELEVANCE/APPLICATION

Integrating morphological and perfusional characteristics of subependymal enhancement may help treatment decision-making, which may lead to improved patient outcomes.

## M3-SSNR04-6 Rules-based Volumetric Segmentation of Multiparametric MRI for Response Assessment in Recurrent High-Grade Glioma

Natarajan Raghunand, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Tumor volumetrics can augment imaging response assessment of high-grade glioma (HGG). We present an explainable algorithm to assign brain voxels on multiparametric MRI (mpMRI) to distinct tissue types. Intratumoral tissue type volumes were combined in a multivariable model to predict time-to-progression (TTP) in recurrent HGG (rHGG) treated with hypofractionated reirradiation, bevacizumab, and pembrolizumab ("immunoradiotherapy").

## METHODS AND MATERIALS

In this retrospective study, a rules-based algorithm was developed on calibrated, co-registered mpMRI images from 18 participants presenting a range of pathologic tissue types, including contrast-enhancing tumor (CE), hemorrhage, fluid, non-enhancing tumor (Edema1), and leukoaraiosis (Edema2). Algorithm-computed tissue type volumes were validated by Pearson correlation analysis against ground truth segmentations of enhancing tumor (ET), peritumoral edema (ED), and NCR/NET (necrotic core/non-enhancing tumor) in an external cohort of 235 HGG participants in the BraTS 2020 dataset. In a single-site study of rHGG treated with immunoradiotherapy (NCT02313272, 32 participants, 2015-2019), serial volumes of intratumoral tissue types and the time-on-treatment ( $t_{C1D1}$ ) at each scan date were used to predict TTP. The model was optimized by stepwise variable selection on Akaike Information Criterion with 10-fold cross-validation, and evaluated by its accuracy to predict whether progression would occur within  $n$  ( $=30, 60, \text{ and } 90$ ) days of a given scan date.

## RESULTS

The total study sample comprised 285 participants (rHGG test cohort ages 22-68 years, 65% male). On external validation, there was high correlation of CE with ET ( $R=0.85$ ;  $p<0.001$ ), and High FLAIR (Edema1+Edema2) with ED ( $R=0.87$ ;  $p<0.001$ ), with NET/NCR being moderately correlated with multiple tissue types ( $R=0.22-0.52$ ). A model using per-timepoint  $t_{C1D1}$  and volumes of CE and Fluid was 82.5% accurate for predicting whether progression would occur within 30 days of a given scan date.

## CONCLUSION

Logical rules based on domain knowledge were developed for segmenting brain mpMRI into distinct tissue types. This method is straightforward to implement, easy to understand, and more generalizable than supervised deep learning approaches. A formula for predicting TTP based on time-on-treatment and per-timepoint volumes of CE and Fluid is more explainable than black box deep learning classifiers and suitable for incorporation into the clinical workflow for assessing rHGG.

## CLINICAL RELEVANCE/APPLICATION

Temporal dynamics of intratumoral tissue type volumes can inform a collaborative dialogue between the neuro-oncologist and the neuroradiologist towards improved patient care in rHGG treated with complex multimodality regimens.



## Abstract Archives of the RSNA, 2023

M3-SSNR04-1

### Baseline and Longitudinal Radiologic Assessment of Brain Metastases Treated With Laser Interstitial Thermal Therapy (LITT)

Monday, Nov. 27 9:30AM - 10:30AM Room: E353B

Francesco Sanvito, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify baseline imaging features of brain metastases (BM) predicting lesion progression free survival (PFS-L) after laser interstitial thermal therapy (LITT), and to characterize post-treatment longitudinal volumetric and diffusion imaging changes of long-term responding lesions.

#### METHODS AND MATERIALS

47 BM treated with LITT were retrospectively studied. BM were followed until clinical progression, radiologic progression according to the modified RANO criteria, or censoring. The association between pre-treatment imaging features and PFS-L was assessed with survival analyses. In responding lesions, longitudinal post-LITT volume shrinkage over time was fit to an exponential decay model, and changes in the apparent diffusion coefficient (ADC) were compared between pre-treatment scans, early post-treatment, 1 year follow-up and =2 years follow-up.

#### RESULTS

13 BM progressed after LITT, 17 met radiologic criteria for response after LITT, and 17 were stable at time of censoring. Pre-LITT enhancing volume  $<2.5$  cc ( $p=0.0004$ ) and sphericity  $=0.705$  ( $p=0.0026$ ) predicted longer PFS-L. BM meeting both cutoffs showed a cumulative PFS-L benefit ( $p<0.0001$ ). High sphericity was associated with complete thermal ablation ( $p=0.03$ ), and small volume tended to predict complete ablation ( $p=0.11$ ). Pre-LITT diffusion imaging did not predict PFS-L, while a subset of lesions ( $n=7$ ) with highly perfused hotspots (normalized rCBV  $>2.5$ ) had worse PFS-L ( $p=0.0012$ ). Immediate post-LITT volume was increased compared to pre-LITT ( $p<0.0001$ , median increase 80.3%), and the percentage of volume increase was not a predictor of PFS-L. In 15 out of 17 responding BM (88.2%), post-LITT shrinkage over time was described by an exponential decay ( $R^2$  ranging 0.92-1.0), with half-life ranging 0.3-5.4 months. ADC changes over time were heterogeneous across the 17 responding lesions. Preliminary analyses showed an overall significant ADC decrease immediately after the treatment (median change:  $-128 \times 10^{-6}$  mm<sup>2</sup>/s,  $p=0.03$ ) and a tendency towards a subsequent progressive ADC increase at 1 year (median change compared to post-LITT:  $+114 \times 10^{-6}$  mm<sup>2</sup>/s,  $p=0.37$ ) and at 2 years (median change compared to post-LITT:  $+481 \times 10^{-6}$  mm<sup>2</sup>/s,  $p=0.03$ ).

#### CONCLUSION

Brain metastases with pre-treatment large volume, low sphericity and high perfusion are more at risk of LITT failure. Lesions meeting criteria for response exhibit a characteristic exponential shrinkage over time, and show an overall ADC decrease followed by a long-term increase.

#### CLINICAL RELEVANCE/APPLICATION

Identifying pre-treatment features associated with treatment response aids patient selection for LITT, while characterizing longitudinal changes in responders defines the expected radiologic findings at follow-up.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M3-SSNR04-2

### **A Revised Molecular Recursive Partitioning Analysis using T2-FLAIR-Based Surgical Extent in Patients With Glioblastoma: A Multi-Center Validation Study**

Monday, Nov. 27 9:30AM - 10:30AM Room: E353B

Dongyeong Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We sought to identify associations of T2-FLAIR based non-enhancing tumor based gross total resection (NE-GTR) among different molecular subgroups of glioblastoma in multi-center validation using molecular-based recursive partitioning analysis for glioblastoma (GBM-molRPA).

#### **METHODS AND MATERIALS**

This multicenter cohort study included a prospective registry cohort and external validation with newly diagnosed glioblastoma patients with confirmed isocitrate dehydrogenase (IDH) and O-6-methylguanine-DNA methyltransferase (MGMT) promoter methylation status. Contrast-enhancing lesion-based GTR (CE-GTR) and NE-GTR were assessed by four neuroradiologists. Associations between the two GTR definitions and overall survival (OS) were evaluated. Two subsets according to IDH mutation, MGMT, and age were further compared for predictive value of OS between CE-GTR and NE-GTR.

#### **RESULTS**

A total of 568 patients were included (216 from prospective set and 352 from external set). NE-GTR achieved better survival stratification than CE-GTR in both prospective and external sets (log-rank test,  $P < .001$ ). In patients with IDH wild-type and positive MGMT methylation status, NE-GTR showed stronger association with OS than CE-GTR (NE-GTR vs. CE-GTR in prospective and external set: HR 0.361 vs. 0.489; HR 0.563 vs. 0.605). Patients aged  $\geq 50$  years with IDH wild-type benefited from reduction of either the NE-GTR or CE-GTR (NE-GTR vs. CE-GTR in prospective and external set: HR 0.220 vs. HR 0.368; HR 0.393 vs. HR 0.352).

#### **CONCLUSION**

NE-GTR provided better outcome stratification than CE-GTR and refined the GBM-molRPA stratification. NE-GTR enhanced long-term survival in patients with IDH wild-type glioblastoma and positive MGMT promoter methylation status.

#### **CLINICAL RELEVANCE/APPLICATION**

The study compared the impact of NE-GTR and CE-GTR on molecular-based recursive partitioning analysis (GBM-molRPA) in patients with newly developed glioblastoma. NE-GTR was found to be more important for patients with IDH wild-type glioblastoma and positive MGMT promoter methylation status. The findings suggest that NE-based GTR improves outcome stratification over CE-based GTR and refines molecular-based RPA stratification.

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## Abstract Archives of the RSNA, 2023

M3-SSNR04-3

### Whole Brain Spectroscopy Guided Planning of Transducer Arrays for Enhanced Delivery of Tumor Treating Fields in Patients with Glioblastoma

Monday, Nov. 27 9:30AM - 10:30AM Room: E353B

Laiz L. Godoy, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Due to infiltrative nature of glioblastomas (GBMs), an optimal delivery of tumor treating fields (TTFields) requires precise targeting of entire viable tumor. We hypothesize that whole brain spectroscopic imaging (WBSI) derived high-resolution choline/N-acetylaspartate (NAA) maps (voxel size =  $4.3 \times 4.3 \times 5.6 \text{mm}^3$ ) will more accurately delineate the tumor margins and identify a comprehensive target volume for TTFields delivery.

#### METHODS AND MATERIALS

Six GBM patients underwent anatomical imaging, and WBSI on a 3T MRI. The processing steps for WBSI data involved field inhomogeneity and eddy current correction, K-space regridding, spatial and Fourier transformation. In each case, quality assurance was evaluated by considering the following metrics: Cramer-Rao lower bounds, line shapes, line width, CSF partial volume contribution, and degree of residual water and lipid signals. The choline/NAA maps, T2-FLAIR images were co-registered to post contrast (PC)-T1 images. One 3D-composite mask was drawn manually on PC-T1 and T2-FLAIR hyperintense tumor abnormalities and labeled as 'tumor mask'. Another mask was drawn on contralateral normal-appearing brain parenchyma by selecting a volume comparable to the tumor size and at the same slice level and was labeled as 'normal mask'. A mean value of choline/NAA was computed from normal mask, and mean + 1 standard deviation of choline/NAA was considered as threshold value. A tumor region corresponding to all voxels that exceeded the threshold choline/NAA value as measured from normal mask (which includes regions beyond contrast-enhancing regions and hyperintense signal abnormality on T2-FLAIR) was considered as "target volume" for TTFields delivery using a modified transducer array layout.

#### RESULTS

Quality map analyses revealed that good quality metabolite maps were obtained from all patients. Figure 1 shows choline/NAA map and anatomical images from a representative GBM patient. As evident, an approximately 4 times more viable tumor cells were detected using metabolic maps compared to T2-FLAIR images. Number of voxels encompassing 3D-composite masks drawn on choline/NAA maps were found to be 1.6 to 4 folds higher than those drawn on anatomical images from 6 patients.

#### CONCLUSION

Our preliminary results showed that WBSI derived metabolite maps project a more comprehensive representation of tumor's true spatial extent and provide more accurate margins of viable tumor cells for delivering enhanced dose of TTFields.

#### CLINICAL RELEVANCE/APPLICATION

Alternative array configuration will allow for enhanced delivery of TTFields dose to all proliferating regions of a GBM, decreasing the rate of local recurrence and improvement in overall survival and the quality of life measures.

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## Abstract Archives of the RSNA, 2023

M3-SSNR04-4

### **Prospective Longitudinal Analysis of Imaging-based Spatiotemporal Tumor Habitats in Glioblastoma, IDH-wild Type: Implication in Patient Outcome using Multiparametric Physiologic MRI**

Monday, Nov. 27 9:30AM - 10:30AM Room: E353B

Hye Hyeon Moon, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Heterogeneity in glioblastomas is associated with poor outcomes, and physiologic heterogeneity can be quantified with MRI. We analyzed associations between physiologic MRI-based tumor habitats and patient outcome and prospectively validated to predict time-to-progression (TTP) in glioblastoma patients after concurrent chemoradiotherapy (CCRT).

#### **METHODS AND MATERIALS**

We prospectively enrolled 65 patients (mean age,  $57.9 \pm 11.6$  years, 34 women, NCT02613988) with IDH-wild type glioblastoma who underwent CCRT and obtained immediate post-op and 3 serial MRI scans with 3-month interval include diffusion-weighted imaging and dynamic susceptibility contrast imaging. Voxels from cerebral blood volume and apparent diffusion coefficient maps were grouped using k-means clustering into 3 spatial habitats (hypervascular cellular, hypovascular cellular, and nonviable tissue). A discrete habitat risk score was calculated by comparing changes in hypervascular cellular and hypovascular cellular habitats along serial MRI scans (post-op, post-CCRT #1, #2, and #3). The Kaplan-Meier method and Cox regression analysis were used to assess the association between TTP and habitat risk score.

#### **RESULTS**

A cutoff for habitat risk score was increased of hypervascular cellular habitat ( $>0$  voxel) or hypovascular cellular habitat ( $>130$  voxels). The habitat risk score stratified patients according to low, intermediate, and high risk at post-CCRT #1 (mean TTP; 839 vs. 592 vs. 320 days, log-rank test;  $P < .001$ ), post-CCRT #2 (mean TTP; 949 vs. 348 vs. 282 days,  $P < .001$ ), and post-CCRT #3 scans (mean TTP; 950 vs. 487 vs. 343 days,  $P < .001$ ). A Cox regression analysis identified a habitat risk score between post-op and post-CCRT #1 was an independent predictor for TTP (hazard ratio, 4.75; 95% CI, 2.12-10.66,  $P < .001$ ).

#### **CONCLUSION**

The habitat risk score, reflecting spatiotemporal habitats of vascularity and cellularity of tumor, successfully stratified TTP in patients with IDH wild-type glioblastoma. The habitat risk score at immediate post-CCRT imaging can be a useful predictor of early tumor progression and clinical outcomes in patients with post-treatment glioblastoma.

#### **CLINICAL RELEVANCE/APPLICATION**

Spatial heterogeneity in glioblastoma indicates poor prognosis and therapy resistance. Clustering of multiparametric MRI can reflect spatial habitats of post-CCRT glioblastoma. We validated the habitat risk score based on spatiotemporal habitats and associated it with patient outcomes. Increase in habitat risk score at immediate post-CCRT scans was strongly associated with shorter time-to-progression. Our spatiotemporal habitat analysis could be a useful predictor for early tumor progression and clinical outcomes in patients with post-treatment glioblastoma.

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## Abstract Archives of the RSNA, 2023

M3-SSNR04-5

### Differentiating Radiation Changes and Leptomeningeal Metastasis in Subependymal Lesion: Added Value of Perfusion MRI to Morphological Features

Monday, Nov. 27 9:30AM - 10:30AM Room: E353B

Kyu Sung Choi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate radiation-induced subependymal changes after Stupp protocol in adult-type high-grade diffuse gliomas and differentiate between radiation changes and progression in the evaluation of leptomeningeal disease (LMD)

#### METHODS AND MATERIALS

This retrospective study reviewed 79 consecutive diffuse glioma patients (mean age,  $54.9 \pm 13.6$  years, 54 (68.4%) males) with new subependymal enhancement (SE) in the follow-up MRI after gross total resection and concurrent chemoradiation with temozolomide. For differentiating between radiation changes and true progression in SE evaluation, univariate correlation analysis was conducted to identify significant variables among SE interval, genetic mutation including isocitrate dehydrogenase (IDH), and 14 radiomic shape features and relative cerebral blood volume (rCBV). Subsequently, multivariate logistic regression was performed using the significant variables. For added value of rCBV, a log-rank test was conducted between the multivariate logistic regression models with and without rCBV. The area under the receiver operating characteristic (AUROC) was obtained to assess diagnostic value of significant variables.

#### RESULTS

23 out of 79 (21.1%) patients showed first subependymal lesions,  $7.93 \pm 8.18$  months after surgical treatment, and disappeared after  $5.79 \pm 5.75$  months after initial appearance on postoperative MRI. Elongated, small-sized lesions with lower rCBV tended to spontaneously regress: Elongation (odds ratio (OR)=1.22,  $p=0.02$ ), Mean 3D diameters (OR=2.08,  $p=0.01$ ), and rCBV\_p95 (OR=2.07,  $p=0.04$ ). The qualitative evaluation of shape revealed that thin and curvilinear shaped SE tended to regress (OR=0.03,  $p=0.03$ ), showing significant correlation with quantitative shape features ( $r=0.31$ ,  $p=0.005$ ). Shorter SE interval indicates progression (OR=0.90,  $p=0.02$ ) but showed no group difference ( $p=0.08$ ). In sub-centimeter lesions, rCBV showed added value in predicting outcomes ( $R^2=0.550$  vs  $0.658$ ;  $p=0.01$ , log-rank test). Radiation dose showed no significant difference between the progression and regression group ( $73.8 \pm 29.0$  vs  $70.8 \pm 22.6$  Gy,  $p=0.67$ ). IDH mutation status was not significant predictor both logistic regression models ( $p=0.19$ , and  $p=0.08$ ). AUROC for Elongation, Mean 3D diameters, rCBV\_p95, and SE interval was 0.702, 0.802, 0.729, and 0.702, respectively.

#### CONCLUSION

Smaller, elongated lesions with lower rCBV are predictive for regression, when differentiating radiation changes from LMD progression in new subependymal enhancement.

#### CLINICAL RELEVANCE/APPLICATION

Integrating morphological and perfusional characteristics of subependymal enhancement may help treatment decision-making, which may lead to improved patient outcomes.

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## Abstract Archives of the RSNA, 2023

M3-SSNR04-6

### Rules-based Volumetric Segmentation of Multiparametric MRI for Response Assessment in Recurrent High-Grade Glioma

Monday, Nov. 27 9:30AM - 10:30AM Room: E353B

Natarajan Raghunand, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Tumor volumetrics can augment imaging response assessment of high-grade glioma (HGG). We present an explainable algorithm to assign brain voxels on multiparametric MRI (mpMRI) to distinct tissue types. Intratumoral tissue type volumes were combined in a multivariable model to predict time-to-progression (TTP) in recurrent HGG (rHGG) treated with hypofractionated reirradiation, bevacizumab, and pembrolizumab ("immunoradiotherapy").

#### METHODS AND MATERIALS

In this retrospective study, a rules-based algorithm was developed on calibrated, co-registered mpMRI images from 18 participants presenting a range of pathologic tissue types, including contrast-enhancing tumor (CE), hemorrhage, fluid, non-enhancing tumor (Edema1), and leukoencephalopathy (Edema2). Algorithm-computed tissue type volumes were validated by Pearson correlation analysis against ground truth segmentations of enhancing tumor (ET), peritumoral edema (ED), and NCR/NET (necrotic core/non-enhancing tumor) in an external cohort of 235 HGG participants in the BraTS 2020 dataset. In a single-site study of rHGG treated with immunoradiotherapy (NCT02313272, 32 participants, 2015-2019), serial volumes of intratumoral tissue types and the time-on-treatment ( $t_{C1D1}$ ) at each scan date were used to predict TTP. The model was optimized by stepwise variable selection on Akaike Information Criterion with 10-fold cross-validation, and evaluated by its accuracy to predict whether progression would occur within  $n$  ( $n=30, 60, \text{ and } 90$ ) days of a given scan date.

#### RESULTS

The total study sample comprised 285 participants (rHGG test cohort ages 22-68 years, 65% male). On external validation, there was high correlation of CE with ET ( $R=0.85$ ;  $p<0.001$ ), and High FLAIR (Edema1+Edema2) with ED ( $R=0.87$ ;  $p<0.001$ ), with NET/NCR being moderately correlated with multiple tissue types ( $R=0.22-0.52$ ). A model using per-timepoint  $t_{C1D1}$  and volumes of CE and Fluid was 82.5% accurate for predicting whether progression would occur within 30 days of a given scan date.

#### CONCLUSION

Logical rules based on domain knowledge were developed for segmenting brain mpMRI into distinct tissue types. This method is straightforward to implement, easy to understand, and more generalizable than supervised deep learning approaches. A formula for predicting TTP based on time-on-treatment and per-timepoint volumes of CE and Fluid is more explainable than black box deep learning classifiers and suitable for incorporation into the clinical workflow for assessing rHGG.

#### CLINICAL RELEVANCE/APPLICATION

Temporal dynamics of intratumoral tissue type volumes can inform a collaborative dialogue between the neuro-oncologist and the neuroradiologist towards improved patient care in rHGG treated with complex multimodality regimens.

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## Abstract Archives of the RSNA, 2023

M3-SSPH03

### Physics (CT Image Quality)

Monday, Nov. 27 9:30AM - 10:30AM Room: S405

Adam S. Wang, PhD (*Moderator*) Research support, General Electric Company; Research support, Siemens AG; Research collaboration, Varex Imaging Corporation;

Grace J. Gang, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### M3-SSPH03-1 Detectability of Noise Texture Changes in CT

Luuk J. Oostveen, DIPLPHYS (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### PURPOSE

Noise texture, quantified by the noise power spectrum (NPS), influences lesion detection. In CT it is common to use the average NPS frequency ( $F_{av}$ ) or the peak frequency ( $F_{peak}$ ) as one-parameter NPS descriptors. This study aimed to develop a more complete model of the CT NPS and determine the human-observer detectability of changes in CT NPS.

#### METHODS AND MATERIALS

A model of CT NPS was created based on its ramp dominating the low spatial frequencies and an apodization downslope dominating the higher frequencies. The ramp was quantified by  $F_{peak}$ . The downslope was fitted to a half Gaussian resulting in its sigma ( $s$ ) used as descriptor of the downslope. A two-alternative-forced-choice observer study was performed to determine the detectability of changes in NPS. Five observers were shown three colored noise patches: two containing different realizations of the same colored noise, one of them defined as the reference patch, and one with different  $F_{peak}$  and/or  $s$ . The observer had to identify the patch similar to the reference one. The differences in  $F_{peak}$  and/or  $s$  that still resulted in 80% correct response were determined. As reference, an abdomen-kernel NPS and a chest-kernel NPS were used.  $F_{peak}$  and  $s$  were changed alone and at the same time, resulting in evaluating the differences perceived in 8 directions. An elliptical limiting detectability boundary was fit through the average limiting values from all observers and all directions. For each NPS tested,  $F_{av}$  and the noise texture contrast (Cnt) to the reference NPS was calculated as the integral of the absolute difference of the 2D NPSs. The experiment was repeated with 32 radiologists. However, each radiologist evaluated 1 direction only, with in total 2 radiologists per direction.

#### RESULTS

Changes in  $F_{peak}$  alone are not detectable below a change of 0.2 lp/cm and 0.3 lp/cm for the abdomen and chest NPS, respectively. For  $s$  alone, these values are 0.15 lp/cm and 2 lp/cm, respectively. These thresholds change if the other parameter also changes. However, the Cn needed to make a change detectable is limited ( $< 0.23HU^2$ ) but depends on the parameter being changed and the reference noise texture. As expected, different NPS with the same  $F_{av}$  can be discriminated. No significant difference was found in performance between radiologists and laymen.

#### CONCLUSION

$F_{peak}$  and  $F_{av}$  alone are insufficient to describe noise texture since textures with the same  $F_{peak}$  or  $F_{av}$  can be discriminable. Discrimination of noise texture changes depends on its frequency content. Radiologists do not discriminate noise texture changes better than laymen.

#### CLINICAL RELEVANCE/APPLICATION

For the development of non-linear reconstruction techniques and reconstruction kernels it is important to understand how human observers react to various noise textures.

### M3-SSPH03-2 Lesion Detection Versus Characterization: Patient-data-based Virtual Imaging Trial for Performance Evaluation of Deep Learning CT Noise Reduction

Zhongxing Zhou, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Accurate assessment of image quality for deep learning-based image reconstruction and noise reduction methods (DLIR) is challenging due to its high non-linearity and generalizability concerns. The highly non-linear spatial resolution and noise properties of DLIR may lead to different performance for two important clinical tasks: low-contrast lesion detection vs. characterization. The purpose of this study was to apply a newly developed patient-data-based virtual imaging trial framework to evaluate the performance of a DLIR method for these two tasks.

## METHODS AND MATERIALS

The patient-data-based virtual imaging trial framework consists of 4 steps: (1) lesion- and (2) noise-insertion in projection domain to generate images at different lesion and noise conditions, (3) DLIR processing of all noise realizations, and (4) calculation of index of detectability ( $d'$ ) using a channelized Hotelling observer (CHO). A ResNet-based deep convolutional neural network (DCNN) trained on patient images was evaluated. Lesions in a cylindrical shape (5-mm height, 15-mm diameter) with and without concave boundary were inserted in patient liver images. Ensembles of quarter dose projection data were generated by 600 independent noise realizations for each of the 4 lesion conditions: (1) lesion present (round lesion at -10HU), (2) lesion absent, (3) round lesion at -50HU, and (4) concave lesion at -50HU. For the lesion detection task,  $d'$  was measured using 600 pairs of lesion-present and absent images (conditions 1 and 2). For the lesion characterization task,  $d'$  was calculated using 600 pairs of images with round and concave lesions (conditions 3 and 4). Multiple reconstruction methods were evaluated, including filtered-backprojection (FBP), iterative reconstruction (IR), and the DCNN at 3 settings (weak, medium, and strong).

## RESULTS

DCNN improved  $d'$  for both tasks compared with FBP (detection: 2.24, 2.70, 2.49, 3.04, 3.80; characterization: 1.40, 1.44, 1.45, 1.61, 1.74, for FBP, IR, DCNN-weak, medium, and strong, respectively). However, the improvement of  $d'$  by DCNN over FBP was much lower for the characterization task (4%, 15%, and 24% for the 3 DCNN strengths, respectively) than for the detection task (11%, 36%, and 70%), which can be explained by a stronger blurring effect of DCNN for lesion boundary at higher strength settings.

## CONCLUSION

Using a patient-data-based virtual imaging trial, DLIR was demonstrated to have less performance improvement for a lesion characterization task than for a lesion detection task.

## CLINICAL RELEVANCE/APPLICATION

The reduced performance improvement by DLIR for lesion characterization compared to lesion detection implies that less radiation dose reduction is acceptable for a lesion characterization task.

## M3-SSPH03-3 Impact of Charge-sharing Effects on Noise Variance of Sinogram Projection Data in Photon-counting CT

Chengzhu Zhang, PhD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to introduce a modified estimator for sinogram noise in photon-counting CT that accounts for charge-sharing effects when native detector elements are binned. The new estimator incorporates a calibration constant derived from an air scan to accurately estimate the noise and improve image quality while avoiding repetitive patient scans.

## METHODS AND MATERIALS

We developed a noise variance estimator that accounts for charge-sharing effects in detector binning conditions to estimate sinogram noise variance accurately. The adjusted noise variance is obtained by multiplying the estimated noise variance from the Poisson distribution by a constant  $a$ , i.e.,  $\text{var}(y_i) = a/N_i$ . This constant can be calibrated using an air scan, eliminating the need for repetitive object or patient scans. We used data acquired from an experimental PCD-CT system with a CdTe-based PCD to validate the new model. We studied different detector configurations such as various binning factors, on/off of the anti-charge sharing function, different energy thresholds at 23.42, 26.03, 28.71, 31.45 keV, and different mAs levels.

## RESULTS

We found three key results: First, when the detector is not binned, the Poisson distribution does not need modification, i.e.,  $a=1$ . Second, the modification factor  $a$  increases as the number of binned detectors increases; Particularly,  $a=1.15$  for  $52(\text{slice}) \times 8(\text{axial})$  binning. Third,  $a$  significantly increases when anti-charge sharing is disabled and decreases as the energy threshold moves toward a higher energy end, indicating reduced charge-sharing effects.

## CONCLUSION

Our modified noise variance estimator accurately estimates the noise variance of sinogram projection data.



## CLINICAL RELEVANCE/APPLICATION

The proposed noise variance estimator has significant clinical relevance as it allows for improved measurement of noise properties of photon-counting CT.

### M3-SSPH03-4 **Assessment of 3D Image Quality Variations in the MIDRC Chest CT Database: A Multi-institutional Study of Imaging Systems and Protocols**

Ali Uneri, PhD (*Presenter*) Research Grant, Medtronic plc; Research Grant, Siemens AG; Research Consultant, The Phantom Laboratory; Research Consultant, SpineAlign Medical, Inc

#### PURPOSE

The Medical Imaging and Data Resource Center (MIDRC) database provides a vast collection of CT images in support of data-intensive imaging research. We report rigorous quantitation of image quality (IQ) metrics within the dataset as an important basis for understanding the provenance and IQ variation for such a broad range of scanners and protocols.

#### METHODS AND MATERIALS

Six institutions provided 252 scans using 11 CT scanner models from 4 vendors. An IQ test phantom (20-cm diameter Corgi™, The Phantom Laboratory) was scanned at low (31-38 mAs), medium (63-73 mAs), and high (94-112 mAs) exposure settings and reconstructed with smooth (mediastinum, "med") and sharp ("lung") kernels with standard ("std") (2.5-5 mm) and "thin" (0.5-2.0 mm) slice thickness. Automated analysis software measured contrast-to-noise ratio (CNR), 3D spatial resolution (modulation transfer function [MTF]), and 3D noise power spectrum (NPS) for each scanner and protocol.

#### RESULTS

Slight differences in protocol settings across institutions led to IQ variations, even for the same scanner model. Variations in slice thickness selection affected spatial resolution in the z-direction as captured by the 3D MTF. Convolution kernel selection affected contrast resolution and noise texture in ways that were quantifiably reflected in the CNR and 3D NPS. Across 15 scanners, the interquartile range (IQR) in axial MTF (f50) was 0.43-0.50 mm<sup>-1</sup> for standard and 0.71-0.80 mm<sup>-1</sup> for thin protocols. For lung-std and lung-thin protocols, the IQR in oblique MTF (f50) was 0.24-0.31 mm<sup>-1</sup> and 0.50-0.63 mm<sup>-1</sup>, respectively. Median CNR was 12.7-24.9 for med-std and 12.3-16.1 for med-thin.

#### CONCLUSION

This is the first multi-institutional study to analyze 3D IQ metrics for routine chest CT protocols across the broad range of devices contributing to the MIDRC dataset. Rigorous assessment and understanding of the variability of image characteristics is essential to establishing provenance of the data and is an important step in best utilizing the 100,000+ chest CT images in the database.

## CLINICAL RELEVANCE/APPLICATION

Thorough measurement and quantitation of the image characteristics and their variability can aid the design of machine learning methods and enhance their ability to generalize.

### M3-SSPH03-5 **Measuring Patient-specific and Local Noise Power Spectrum from a Single Photon Counting Detector CT Data Acquisition**

Chengzhu Zhang, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Measuring the noise power spectrum (NPS) in clinical X-ray CT exams is challenging since repeating scans to obtain independent samples under identical experimental conditions would expose patients to high radiation risks. Thus, this study aims to develop a reliable method to estimate patient-specific and pointwise NPS from a single CT acquisition.

#### METHODS AND MATERIALS

We propose a new statistical estimator from raw count data to estimate the noise variance in sinogram projection data. Using this estimator, we develop an analytical reconstruction algorithm to calculate the point-wise covariance between two image voxel locations. A Fourier transform is then applied to obtain the pointwise NPS for a chosen location and the ROI NPS via spatial averaging for every voxel inside the ROI. We validate the method using data from a benchtop photon-counting CT imaging system with a CdTe-based PCD (XC-Hydra FX50, Direct Conversion AB) on various physical phantoms.

#### RESULTS

Our proposed method enables patient-specific NPS measurement for regions of interest at any chosen position and accurately characterizes NPS with detailed spatial structures resulting from image content heterogeneity. Furthermore, the NPS measured using our method exhibits superior quality in terms of variance in measured NPS structures compared to the standard multi-acquisition measurement method. Spatial averaging of the pointwise NPS yields the conventional NPS for local regions of interest.



## CONCLUSION

We developed a new method to estimate patient-specific and local NPS from a single CT acquisition, which enables object-specific NPS measurement and can be used to optimize the imaging system for specific imaging tasks.

## CLINICAL RELEVANCE/APPLICATION

The experimental measured patient-specific local NPS can be used to optimize the imaging system to achieve the desired quantitative performance for specific imaging tasks, which can ultimately improve diagnostic accuracy and reduce patient radiation exposure.

### M3-SSPH03-6 **Impact of Focal Spot selection on Spatial Resolution in Clinical Photon-counting Detector CT**

Kishore Rajendran, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To quantitatively evaluate the impact of focal spot (FS) size of the X-ray tube on spatial resolution in clinical photon-counting detector (PCD) CT.

## METHODS AND MATERIALS

Spatial resolution phantoms - 25  $\mu\text{m}$  diameter tungsten wire and 50  $\mu\text{m}$  thick tungsten foil were scanned on a clinical PCD-CT system (Siemens NAEOTOM Alpha) using the ultra-high-resolution mode (120 x 0.2 mm collimation). Phantom images using two different FS sizes (sUHR - 0.4 x 0.5 mm<sup>2</sup>, UHR - 0.6 x 0.7 mm<sup>2</sup>) were acquired. In-plane and longitudinal resolution were measured using the modulation transfer function (MTF) and section sensitivity profile (SSP). CT images (T3D, 20 to 120 keV) were reconstructed using a sharp (Br89) kernel to quantitatively compare spatial resolution. To demonstrate the impact of FS size on anatomical images, a cadaver knee joint was scanned using the ultra-high-resolution mode with both FS sizes at matched radiation dose (20 mGy) after approval from our institutional biospecimens review board. Morphometric measurements for subchondral trabecular thickness and separation in a representative 3D volume of interest in the lateral femoral condyle were compared between the two FS sizes.

## RESULTS

For in-plane resolution, the cutoff frequency (0% MTF) were comparable (33 cm<sup>-1</sup>) but noticeable differences in 10% MTF values (sUHR: 30.6 cm<sup>-1</sup> vs. UHR: 28.9 cm<sup>-1</sup>) were observed between the two FS sizes. The longitudinal resolution values at 1-mm nominal section thickness were comparable for the two FS sizes with the full-width-at-half-maximum (FWHM) of the SSP at 1.20-1.21 mm. For the 0.2 mm nominal section thickness, the SSP-FWHM was 0.31 mm for sUHR FS and 0.38 mm for the UHR FS. Trabecular morphometry measurements in the cadaveric knee showed a 12.5% difference in mean trabecular thickness and 2.5% difference in mean trabecular separation between sUHR and UHR FS.

## CONCLUSION

Focal spot selection in a clinical PCD-CT system influenced both in-plane and longitudinal spatial resolution, with the smaller FS size yielding higher in-plane and longitudinal spatial resolution. Consequently, quantitative differences in anatomic bone trabecular measurements were observed based on the selected FS size.

## CLINICAL RELEVANCE/APPLICATION

Spatial fidelity of sub-millimeter anatomic structures imaged on PCD-CT can be improved by employing smaller x-ray focal spot, which may benefit quantitative applications relying on high spatial resolution.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSPH03-1

### Detectability of Noise Texture Changes in CT

Monday, Nov. 27 9:30AM - 10:30AM Room: S405

Luuk J. Oostveen, DIPLPHYS (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### PURPOSE

Noise texture, quantified by the noise power spectrum (NPS), influences lesion detection. In CT it is common to use the average NPS frequency ( $F_{av}$ ) or the peak frequency ( $F_{peak}$ ) as one-parameter NPS descriptors. This study aimed to develop a more complete model of the CT NPS and determine the human-observer detectability of changes in CT NPS.

#### METHODS AND MATERIALS

A model of CT NPS was created based on its ramp dominating the low spatial frequencies and an apodization downslope dominating the higher frequencies. The ramp was quantified by  $F_{peak}$ . The downslope was fitted to a half Gaussian resulting in its sigma ( $s$ ) used as descriptor of the downslope. A two-alternative-forced-choice observer study was performed to determine the detectability of changes in NPS. Five observers were shown three colored noise patches: two containing different realizations of the same colored noise, one of them defined as the reference patch, and one with different  $F_{peak}$  and/or  $s$ . The observer had to identify the patch similar to the reference one. The differences in  $F_{peak}$  and/or  $s$  that still resulted in 80% correct response were determined. As reference, an abdomen-kernel NPS and a chest-kernel NPS were used.  $F_{peak}$  and  $s$  were changed alone and at the same time, resulting in evaluating the differences perceived in 8 directions. An elliptical limiting detectability boundary was fit through the average limiting values from all observers and all directions. For each NPS tested,  $F_{av}$  and the noise texture contrast (C<sub>nt</sub>) to the reference NPS was calculated as the integral of the absolute difference of the 2D NPSs. The experiment was repeated with 32 radiologists. However, each radiologist evaluated 1 direction only, with in total 2 radiologists per direction.

#### RESULTS

Changes in  $F_{peak}$  alone are not detectable below a change of 0.2 lp/cm and 0.3 lp/cm for the abdomen and chest NPS, respectively. For  $s$  alone, these values are 0.15 lp/cm and 2 lp/cm, respectively. These thresholds change if the other parameter also changes. However, the C<sub>n</sub> needed to make a change detectable is limited ( $< 0.23HU^2$ ) but depends on the parameter being changed and the reference noise texture. As expected, different NPS with the same  $F_{av}$  can be discriminated. No significant difference was found in performance between radiologists and laymen.

#### CONCLUSION

$F_{peak}$  and  $F_{av}$  alone are insufficient to describe noise texture since textures with the same  $F_{peak}$  or  $F_{av}$  can be discriminable. Discrimination of noise texture changes depends on its frequency content. Radiologists do not discriminate noise texture changes better than laymen.

#### CLINICAL RELEVANCE/APPLICATION

For the development of non-linear reconstruction techniques and reconstruction kernels it is important to understand how human observers react to various noise textures.

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## Abstract Archives of the RSNA, 2023

M3-SSPH03-2

### Lesion Detection Versus Characterization: Patient-data-based Virtual Imaging Trial for Performance Evaluation of Deep Learning CT Noise Reduction

Monday, Nov. 27 9:30AM - 10:30AM Room: S405

Zhongxing Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate assessment of image quality for deep learning-based image reconstruction and noise reduction methods (DLIR) is challenging due to its high non-linearity and generalizability concerns. The highly non-linear spatial resolution and noise properties of DLIR may lead to different performance for two important clinical tasks: low-contrast lesion detection vs. characterization. The purpose of this study was to apply a newly developed patient-data-based virtual imaging trial framework to evaluate the performance of a DLIR method for these two tasks.

#### METHODS AND MATERIALS

The patient-data-based virtual imaging trial framework consists of 4 steps: (1) lesion- and (2) noise-insertion in projection domain to generate images at different lesion and noise conditions, (3) DLIR processing of all noise realizations, and (4) calculation of index of detectability ( $d'$ ) using a channelized Hotelling observer (CHO). A ResNet-based deep convolutional neural network (DCNN) trained on patient images was evaluated. Lesions in a cylindrical shape (5-mm height, 15-mm diameter) with and without concave boundary were inserted in patient liver images. Ensembles of quarter dose projection data were generated by 600 independent noise realizations for each of the 4 lesion conditions: (1) lesion present (round lesion at -10HU), (2) lesion absent, (3) round lesion at -50HU, and (4) concave lesion at -50HU. For the lesion detection task,  $d'$  was measured using 600 pairs of lesion-present and absent images (conditions 1 and 2). For the lesion characterization task,  $d'$  was calculated using 600 pairs of images with round and concave lesions (conditions 3 and 4). Multiple reconstruction methods were evaluated, including filtered-backprojection (FBP), iterative reconstruction (IR), and the DCNN at 3 settings (weak, medium, and strong).

#### RESULTS

DCNN improved  $d'$  for both tasks compared with FBP (detection: 2.24, 2.70, 2.49, 3.04, 3.80; characterization: 1.40, 1.44, 1.45, 1.61, 1.74, for FBP, IR, DCNN-weak, medium, and strong, respectively). However, the improvement of  $d'$  by DCNN over FBP was much lower for the characterization task (4%, 15%, and 24% for the 3 DCNN strengths, respectively) than for the detection task (11%, 36%, and 70%), which can be explained by a stronger blurring effect of DCNN for lesion boundary at higher strength settings.

#### CONCLUSION

Using a patient-data-based virtual imaging trial, DLIR was demonstrated to have less performance improvement for a lesion characterization task than for a lesion detection task.

#### CLINICAL RELEVANCE/APPLICATION

The reduced performance improvement by DLIR for lesion characterization compared to lesion detection implies that less radiation dose reduction is acceptable for a lesion characterization task.

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## Abstract Archives of the RSNA, 2023

M3-SSPH03-3

### Impact of Charge-sharing Effects on Noise Variance of Sinogram Projection Data in Photon-counting CT

Monday, Nov. 27 9:30AM - 10:30AM Room: S405

Chengzhu Zhang, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to introduce a modified estimator for sinogram noise in photon-counting CT that accounts for charge-sharing effects when native detector elements are binned. The new estimator incorporates a calibration constant derived from an air scan to accurately estimate the noise and improve image quality while avoiding repetitive patient scans.

#### METHODS AND MATERIALS

We developed a noise variance estimator that accounts for charge-sharing effects in detector binning conditions to estimate sinogram noise variance accurately. The adjusted noise variance is obtained by multiplying the estimated noise variance from the Poisson distribution by a constant  $a$ , i.e.,  $\text{var}(y_i) = a/N_i$ . This constant can be calibrated using an air scan, eliminating the need for repetitive object or patient scans. We used data acquired from an experimental PCD-CT system with a CdTe-based PCD to validate the new model. We studied different detector configurations such as various binning factors, on/off of the anti-charge sharing function, different energy thresholds at 23.42, 26.03, 28.71, 31.45 keV, and different mAs levels.

#### RESULTS

We found three key results: First, when the detector is not binned, the Poisson distribution does not need modification, i.e.,  $a=1$ . Second, the modification factor  $a$  increases as the number of binned detectors increases; Particularly,  $a=1.15$  for  $52(\text{slice}) \times 8(\text{axial})$  binning. Third,  $a$  significantly increases when anti-charge sharing is disabled and decreases as the energy threshold moves toward a higher energy end, indicating reduced charge-sharing effects.

#### CONCLUSION

Our modified noise variance estimator accurately estimates the noise variance of sinogram projection data.

#### CLINICAL RELEVANCE/APPLICATION

The proposed noise variance estimator has significant clinical relevance as it allows for improved measurement of noise properties of photon-counting CT.

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## Abstract Archives of the RSNA, 2023

M3-SSPH03-4

### Assessment of 3D Image Quality Variations in the MIDRC Chest CT Database: A Multi-institutional Study of Imaging Systems and Protocols

Monday, Nov. 27 9:30AM - 10:30AM Room: S405

Ali Uneri, PhD (*Presenter*) Research Grant, Medtronic plc; Research Grant, Siemens AG; Research Consultant, The Phantom Laboratory; Research Consultant, SpineAlign Medical, Inc

#### PURPOSE

The Medical Imaging and Data Resource Center (MIDRC) database provides a vast collection of CT images in support of data-intensive imaging research. We report rigorous quantitation of image quality (IQ) metrics within the dataset as an important basis for understanding the provenance and IQ variation for such a broad range of scanners and protocols.

#### METHODS AND MATERIALS

Six institutions provided 252 scans using 11 CT scanner models from 4 vendors. An IQ test phantom (20-cm diameter Corgi™, The Phantom Laboratory) was scanned at low (31-38 mAs), medium (63-73 mAs), and high (94-112 mAs) exposure settings and reconstructed with smooth (mediastinum, "med") and sharp ("lung") kernels with standard ("std") (2.5-5 mm) and "thin" (0.5-2.0 mm) slice thickness. Automated analysis software measured contrast-to-noise ratio (CNR), 3D spatial resolution (modulation transfer function [MTF]), and 3D noise power spectrum (NPS) for each scanner and protocol.

#### RESULTS

Slight differences in protocol settings across institutions led to IQ variations, even for the same scanner model. Variations in slice thickness selection affected spatial resolution in the z-direction as captured by the 3D MTF. Convolution kernel selection affected contrast resolution and noise texture in ways that were quantifiably reflected in the CNR and 3D NPS. Across 15 scanners, the interquartile range (IQR) in axial MTF (f50) was 0.43-0.50 mm<sup>-1</sup> for standard and 0.71-0.80 mm<sup>-1</sup> for thin protocols. For lung-std and lung-thin protocols, the IQR in oblique MTF (f50) was 0.24-0.31 mm<sup>-1</sup> and 0.50-0.63 mm<sup>-1</sup>, respectively. Median CNR was 12.7-24.9 for med-std and 12.3-16.1 for med-thin.

#### CONCLUSION

This is the first multi-institutional study to analyze 3D IQ metrics for routine chest CT protocols across the broad range of devices contributing to the MIDRC dataset. Rigorous assessment and understanding of the variability of image characteristics is essential to establishing provenance of the data and is an important step in best utilizing the 100,000+ chest CT images in the database.

#### CLINICAL RELEVANCE/APPLICATION

Thorough measurement and quantitation of the image characteristics and their variability can aid the design of machine learning methods and enhance their ability to generalize.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSPH03-5

### Measuring Patient-specific and Local Noise Power Spectrum from a Single Photon Counting Detector CT Data Acquisition

Monday, Nov. 27 9:30AM - 10:30AM Room: S405

Chengzhu Zhang, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Measuring the noise power spectrum (NPS) in clinical X-ray CT exams is challenging since repeating scans to obtain independent samples under identical experimental conditions would expose patients to high radiation risks. Thus, this study aims to develop a reliable method to estimate patient-specific and pointwise NPS from a single CT acquisition.

#### METHODS AND MATERIALS

We propose a new statistical estimator from raw count data to estimate the noise variance in sinogram projection data. Using this estimator, we develop an analytical reconstruction algorithm to calculate the point-wise covariance between two image voxel locations. A Fourier transform is then applied to obtain the pointwise NPS for a chosen location and the ROI NPS via spatial averaging for every voxel inside the ROI. We validate the method using data from a benchtop photon-counting CT imaging system with a CdTe-based PCD (XC-Hydra FX50, Direct Conversion AB) on various physical phantoms.

#### RESULTS

Our proposed method enables patient-specific NPS measurement for regions of interest at any chosen position and accurately characterizes NPS with detailed spatial structures resulting from image content heterogeneity. Furthermore, the NPS measured using our method exhibits superior quality in terms of variance in measured NPS structures compared to the standard multi-acquisition measurement method. Spatial averaging of the pointwise NPS yields the conventional NPS for local regions of interest.

#### CONCLUSION

We developed a new method to estimate patient-specific and local NPS from a single CT acquisition, which enables object-specific NPS measurement and can be used to optimize the imaging system for specific imaging tasks.

#### CLINICAL RELEVANCE/APPLICATION

The experimental measured patient-specific local NPS can be used to optimize the imaging system to achieve the desired quantitative performance for specific imaging tasks, which can ultimately improve diagnostic accuracy and reduce patient radiation exposure.

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## Abstract Archives of the RSNA, 2023

M3-SSPH03-6

### Impact of Focal Spot selection on Spatial Resolution in Clinical Photon-counting Detector CT

Monday, Nov. 27 9:30AM - 10:30AM Room: S405

Kishore Rajendran, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantitatively evaluate the impact of focal spot (FS) size of the X-ray tube on spatial resolution in clinical photon-counting detector (PCD) CT.

#### METHODS AND MATERIALS

Spatial resolution phantoms - 25  $\mu\text{m}$  diameter tungsten wire and 50  $\mu\text{m}$  thick tungsten foil were scanned on a clinical PCD-CT system (Siemens NAEOTOM Alpha) using the ultra-high-resolution mode (120 x 0.2 mm collimation). Phantom images using two different FS sizes (sUHR - 0.4 x 0.5 mm<sup>2</sup>, UHR - 0.6 x 0.7 mm<sup>2</sup>) were acquired. In-plane and longitudinal resolution were measured using the modulation transfer function (MTF) and section sensitivity profile (SSP). CT images (T3D, 20 to 120 keV) were reconstructed using a sharp (Br89) kernel to quantitatively compare spatial resolution. To demonstrate the impact of FS size on anatomical images, a cadaver knee joint was scanned using the ultra-high-resolution mode with both FS sizes at matched radiation dose (20 mGy) after approval from our institutional biospecimens review board. Morphometric measurements for subchondral trabecular thickness and separation in a representative 3D volume of interest in the lateral femoral condyle were compared between the two FS sizes.

#### RESULTS

For in-plane resolution, the cutoff frequency (0% MTF) were comparable (33 cm<sup>-1</sup>) but noticeable differences in 10% MTF values (sUHR: 30.6 cm<sup>-1</sup> vs. UHR: 28.9 cm<sup>-1</sup>) were observed between the two FS sizes. The longitudinal resolution values at 1-mm nominal section thickness were comparable for the two FS sizes with the full-width-at-half-maximum (FWHM) of the SSP at 1.20-1.21 mm. For the 0.2 mm nominal section thickness, the SSP-FWHM was 0.31 mm for sUHR FS and 0.38 mm for the UHR FS. Trabecular morphometry measurements in the cadaveric knee showed a 12.5% difference in mean trabecular thickness and 2.5% difference in mean trabecular separation between sUHR and UHR FS.

#### CONCLUSION

Focal spot selection in a clinical PCD-CT system influenced both in-plane and longitudinal spatial resolution, with the smaller FS size yielding higher in-plane and longitudinal spatial resolution. Consequently, quantitative differences in anatomic bone trabecular measurements were observed based on the selected FS size.

#### CLINICAL RELEVANCE/APPLICATION

Spatial fidelity of sub-millimeter anatomic structures imaged on PCD-CT can be improved by employing smaller x-ray focal spot, which may benefit quantitative applications relying on high spatial resolution.

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## Abstract Archives of the RSNA, 2023

M3-SSR002

### Radiation Oncology (Gastrointestinal)

Monday, Nov. 27 9:30AM - 10:30AM Room: S501

Meng X. Welliver, MD, PhD (*Moderator*) Advisory Board, NovoCure Ltd; Advisory Board, Eli Lilly and Company  
Tarita O. Thomas, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### M3-SSR002-1 **Dosimetric Evaluation of Synthetic CT Used in Radiation Therapy for MRI Guided Liver SBRT**

Theodore Arsenault, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

We evaluated a deep learning-based synthetic computed tomography (sCT) generation method for magnetic resonance (MR)-only radiation treatment planning (RTP) in liver stereotactic body radiation therapy (SBRT). Conventional RTP workflows combine CT and MR, which can introduce registration errors and cause inefficient clinical workflows, potentially hurting adaptive planning. An MR-only RTP workflow using sCT generated from MR data can address these limitations by offering electron density information that is crucial for dose calculation but unavailable from MR data. We present and validate the clinical potential of a novel deep learning-based sCT generation method.

#### METHODS AND MATERIALS

We developed a conditional generative adversarial network (URcGAN) to generate sCT from MR Dixon images. Thirty-four patients underwent routine FDG-PET/CT and FDG-PET/MR scans. URcGAN was compared to two reference methods: transfer fuzzy clustering with active learning-based classification (TFCALC) and 7-class segmentation (7-Seg). A simulated spherical planning target volume (PTV) (25mm diameter) was drawn in liver segment V. An SBRT plan follows RTOG-1112 protocol using Pinnacle v16.2, delivering 50Gy in 5 fractions. Fluence was copied to sCT images, and dose recalculated for comparison.

#### RESULTS

URcGAN generates sCT in approximately 5 minutes that is of superior quality compared to the two reference methods. Quantitative accuracy of sCT by URcGAN (MAE=51±7 HU and NCC=0.992±0.003) exceeds that by TFCALC (MAE=161±24 and NCC=0.955±0.009) and 7-Seg (MAE=211±19 and NCC=0.93±0.01). For liver SBRT planning, URcGAN achieved passing rates of 95.26%, 99.90%, and 99.96% for gamma criteria of 1%/1mm, 2%/2mm, and 3%/2mm, respectively. Conversely, TFCALC and 7-Seg failed to reach the clinical acceptance rate for any gamma criteria.

#### CONCLUSION

Our study demonstrates that URcGAN is capable of generating sCTs that achieve clinically acceptable dosimetric accuracy for MR-only liver SBRT which was not the case for reference methods. Specifically, the proposed method achieved clinical acceptability of higher than 95% passing rate for all evaluated gamma criteria. Based on our findings, using DCNN for sCT generation may be feasible for MR-only workflow for liver SBRT.

#### CLINICAL RELEVANCE/APPLICATION

Our method of generating sCT from MR images achieves clinically acceptable dosimetric accuracy and enables an MR-only RTP which obviates CT and benefits from MR's superior soft tissue contrast for fast and accurate contouring. Overall, MR-guided liver SBRT using sCT contributes to a more effective and safer treatment outcomes for patients with inoperable liver tumors compared to conventional CT-based RTP.

### M3-SSR002-2 **Combining Intratumoral and Peritumoral Radiomics Features of Different Regions of Interest to Predict Pathological Good Response after Neoadjuvant Ahemoradiotherapy in Locally Advanced Rectal Cancer**

Siyuan Qin (*Presenter*) Nothing to Disclose



## PURPOSE

This study aimed to develop a radiomics model that integrates intratumoral and peritumoral features to predict pathological good response (pGR) to neoadjuvant chemoradiotherapy (nCRT) in patients with locally advanced rectal cancer (LARC). The study also aimed to compare the predictive performance of the model using different combinations of intratumoral and peritumoral regions of interest (ROIs).

## METHODS AND MATERIALS

This retrospective study collected data on patients diagnosed with LARC who underwent nCRT between 2013 and 2021. Patients were divided into training and validation groups at a ratio of 4:1, and five-fold cross-validation was performed to prevent overfitting. Intratumoral ROIs (ROIITU) were segmented on T2-weighted imaging, while peritumoral ROIs were segmented using two methods: ROIPTU\_2mm, ROIPTU\_4mm, and ROIPTU\_6mm, which were obtained by dilating the boundary of ROIITU by 2mm, 4mm, and 6mm, respectively; and ROIMR\_F and ROIMR\_BVLN, which were obtained by segmenting the fat and blood vessels + lymph nodes in the mesorectum. After feature extraction and selection, 11 logistic regression models were established using radiomics features derived from different ROIs or ROI combinations. The average area under the curve (AUC) was used to evaluate the performance of the models.

## RESULTS

The study included a total of 209 patients, consisting of 118 pGR and 91 non-pGR patients. The model that integrated ROIITU and ROIMR\_BVLN features had the highest predictive ability, with an AUC (95% confidence interval) of 0.936 (0.904-0.972) in the training group and 0.859 (0.745-0.974) in the validation group. This model outperformed models that used ROIITU alone (AUC=0.779), ROIMR\_BVLN alone (AUC=0.758), and other models.

## CONCLUSION

Radiomic features of intratumoral and different peritumoral ROIs have predictive value for pGR in LARC patients after nCRT. The model that integrates intratumoral and blood vessels + lymph nodes in the mesorectum features performs the best.

## CLINICAL RELEVANCE/APPLICATION

This study identified, for the first time, the predictive value of radiomics features of different components of the mesorectum in predicting the response to nCRT in LARC patients and established an optimal prediction model by combining intratumoral and peritumoral radiomics features. The optimal prediction model developed in this study may guide clinical decision-making, such as timely surgery or extended resection for patients who are not sensitive to nCRT and conservative treatment or local excision for patients who are sensitive to nCRT.

## M3-SSR002-3 A Dosimetric Comparison of Y-90 Radioembolization and External Beam Radiation Treatment For Liver Cancer

Kajetan Wysoczynski, BS (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this study is to compare the dose distribution and conformity of a liver cancer treatment performed with yttrium-90 (Y-90) microsphere radioembolization and a simulated plan for SBRT for a patient given a medium-sized lesion.

## METHODS AND MATERIALS

In this study, a typical patient with hepatocellular carcinoma (single 155 cc lesion) was treated using Y-90 microspheres with an injected activity of 2.27 GBq. We performed radioembolization dosimetry based on a PET scan acquired 24h post-treatment to measure Y-90 activity, using multiple organ and tumor contours delineated on whole-body CT. We also simulated a five-fraction treatment plan using a conventional SBRT linear accelerator with 5 mm leaf width. We compared dose distributions of the two modalities for several organs based on dose-volume histograms.

## RESULTS

The microsphere treatment delivered a mean dose of 390 Gy to the gross tumor volume and an average of 47 Gy to the liver volume. The five-fraction SBRT plan resulted in a mean tumor dose of 51 Gy and mean liver dose of 11 Gy. It is important to note that 2% of the tumor (D2) received at least 54 Gy in the plan, while Y-90 microspheres delivered 908 Gy at D2 of gross tumor volume. The patient received a 5 Gy lung dose with Y-90, but the SBRT plan predicted 0.36 Gy. This large dose with Y-90 is due to the lung shunt fraction of 14.6% for this patient.

## CONCLUSION

While microspheres can deliver extremely high radiation doses to the tumor in just one administration, SBRT is performed over 5 fractions in the USA. However, Y-90 microspheres deliver more radiation to surrounding lung tissue. Well-vascularized small tumors benefit the most from radioembolization, but dosage to surrounding organs requires analysis with more patients. To better gauge side effects from these very different radiation modalities, biological effective dose calculation will be performed. Other modalities, such as brachytherapy and proton therapy, will be included in further studies.

## CLINICAL RELEVANCE/APPLICATION

Liver cancer is a high-impact area in clinical practice with rising mortality. The most common treatment is resection, but the number of tumors, position, and complex vasculature often prevent surgery. Alternatively, Stereotactic Body Radiation Therapy (SBRT) can provide localized radiation dose with photons produced by a linear accelerator. Y-90 radioembolization is delivered through microspheres injected into the hepatic artery.

### M3-SSRO02-4 **Stereotactic Body Radiation Therapy (SBRT) Induced Lobectomy -- Time-Dependent Analysis of Future Liver Remnant Volume in Unresectable Hepatocellular Carcinoma (HCC)**

Wan Hang K. Chiu, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

Stereotactic Body Radiation Therapy (SBRT) has emerged as an alternate locoregional treatment option in patients with Hepatocellular Carcinoma (HCC) with impressive results. However, little is known whether it can play a bridging role in unresectable HCC due to small future remnant ration (FLR) by inducing liver hypertrophy. In this study, we aim to perform a comprehensive time-dependent analysis of the liver volumes following SBRT.

#### METHODS AND MATERIALS

Between 2019 and 2021, a prospective single arm phase II study (START-FIT) recruited 33 patients with unresectable HCC who underwent transarterial chemoembolization (TACE), followed by SBRT (27.5-40.0 Gy in five fractions) and Avelumab (10 mg/kg). Serial cross-sectional imaging (contrast-enhanced computed tomography, CT or magnetic resonance imaging, MRI) were performed 3-monthly from baseline until disease progression, death or end of study period. The ipsilateral and contralateral liver lobar as well as tumor volumes, FLR and percentage of FLR hypertrophy from baseline (%FLR hypertrophy) were assessed in a dynamic fashion.

#### RESULTS

Ipsilateral lobe atrophy ( $p < 0.0001$ ), contralateral lobe hypertrophy ( $p = 0.0004$ ), tumour reduction ( $p = 0.0056$ ), and FLR hypertrophy ( $p = 0.0001$ ) were observed from 3 months after SBRT. The median %FLR hypertrophy reached around 30% (-13-158) after 12 months, although the fastest increase occurred within the first 3 months and slowly plateau thereafter. Of the 33 recruited patients, 18 (55%) patients were deemed to be amenable to surgical resection over a median follow-up period of 17.2 months (IQR 7.8-25.8).

#### CONCLUSION

SBRT may induce hypertrophy of the contralateral liver lobe while controlling primary tumour and limiting progression.

## CLINICAL RELEVANCE/APPLICATION

Our findings are of particular interest in the providing novel bridge-to-resection technique in patients with small FLR.

### M3-SSRO02-5 **Influence of Skeletal Muscle and Adipose Tissue on Postoperative Complications and Long-Term Prognosis in Colorectal Cancer Patients**

Tong Nie (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to explore the correlation of skeletal muscle and adipose tissue quantified by computed tomography (CT) with postoperative complications and long-term prognosis in colorectal cancer patients after surgical resection.

#### METHODS AND MATERIALS

This retrospective cohort study included 850 patients with colorectal cancer who underwent surgical resection at Wuhan Union Hospital between December 2014 and May 2018. Skeletal muscle and adipose tissue indexes were quantified with CT images at the third lumbar vertebra (L3) levels obtained within three months prior to surgery. Adipose tissue indexes include visceral fat area (VFA), subcutaneous fat area (SFA), and intermuscular fat area (IMFA), while skeletal muscle indexes include skeletal muscle area (SMA) and skeletal muscle radiodensity (SMD). The sex-specific optimal cut-off value for each body composition was defined by using the X-tile software. Logistic and Cox proportional hazards models were used to assess the associations between body composition with postoperative complications and overall survival (OS). Receiver operating characteristic (ROC) analysis was used to estimate the predictive ability of body composition combined with clinical indicators. Finally, decision curve analysis (DCA) and nomograms were used to evaluate the clinical usefulness of the models.

#### RESULTS

A total of 850 patients (492 males and 358 females) were included, the mean (SD) age was 57.8 (11.4) years. Logistic regression analysis indicated that patients with low SMD at the L3 level had higher postoperative complication rate (22.30% vs. 14.63%,  $P = 0.025$ ). Multivariate Cox regression analysis showed that IMFA (HR 1.543, 95% CI 1.060~2.246,  $P = 0.024$ ), SMA (HR 0.657, 95% CI 0.451~0.957,  $P = 0.028$ ) and SMD (HR 0.470, 95% CI 0.300~0.736,  $P = 0.001$ ) at the L3 level were

independent prognostic factors for OS. ROC analyses revealed the predictive accuracy of a combination of body composition and clinical indicators for OS with the area under the ROC curve of 0.823 ( $p < 0.05$ ). DCA demonstrated that the clinico-radiological nomograms were useful for predicting postoperative survival in colorectal cancer patients.

#### **CONCLUSION**

Patients with low SMD at the L3 level had higher postoperative complication rate. High IMFA, low SMD and low SMA at the L3 level were associated with shorter OS. The inclusion of body composition indicators in the prediction model can significantly improve the predictive performance of patient prognosis.

#### **CLINICAL RELEVANCE/APPLICATION**

The combination of CT-quantified body composition and clinical indicators could help physicians to recognize worse survival outcomes in colorectal cancer patients after surgery.

### **M3-SSRO02-6 Evaluation of Lymphatic Metastasis for Patients with Gastric Cancer using Spectral CT Quantitative Parameters**

Zhang Min (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the feasibility of spectral CT quantitative Parameters in distinguishing lymphatic metastasis in patients with gastric cancer.

#### **METHODS AND MATERIALS**

69 patients confirmed of gastric cancer with gastroscopy were preoperatively examined spectral CT and curative gastrectomy. The enrolled patients were divided into two groups according to Gastric Cancer with lymphatic metastasis or not based on postoperative pathology. spectral CT quantitative Parameters, volume iodine content and Slope of energy spectrum curve in both artery and venous phases were calculated. The differences of parameters in two groups were calculated with One-way analysis of variance (ANOVA). A receiver operating characteristic (ROC) analysis was applied to evaluate the diagnostic performance of meaningful spectral CT quantitative parameters.

#### **RESULTS**

Volume iodine content in venous phase of Gastric Cancer with lymphatic metastasis were  $27.89 \pm 0.89$  (100ug/cm<sup>3</sup>), it was  $33.45 \pm 1.37$  (100ug/cm<sup>3</sup>) in Gastric Cancer without lymphatic metastasis group. The above indicator were significantly different between Gastric Cancer with and without lymphatic metastasis groups. ( $p < 0.05$ ) For slope of energy spectrum curve in venous phases, volume iodine content in artery phase and Slope of energy spectrum curve in artery phases, there was no statistically significant difference between two groups. The area under the ROC curve for the diagnosis of lymphatic metastasis of gastric cancer by volume iodine content in venous phases was 0.759 (sensitivity 65.5%; specificity, 82.5%) with the cut-off value of 32.07 (100ug/cm<sup>3</sup>) and 2.41.

#### **CONCLUSION**

Spectrum enhanced CT can accurately evaluate the HER2 positive lymphatic metastasis of gastric cancer with certain quantitative parameters.

#### **CLINICAL RELEVANCE/APPLICATION**

Spectrum enhanced CT quantitative parameters are potential in diagnosing lymphatic metastasis of gastric cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSR002-1

### Dosimetric Evaluation of Synthetic CT Used in Radiation Therapy for MRI Guided Liver SBRT

Monday, Nov. 27 9:30AM - 10:30AM Room: S501

Theodore Arsenault, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

We evaluated a deep learning-based synthetic computed tomography (sCT) generation method for magnetic resonance (MR)-only radiation treatment planning (RTP) in liver stereotactic body radiation therapy (SBRT). Conventional RTP workflows combine CT and MR, which can introduce registration errors and cause inefficient clinical workflows, potentially hurting adaptive planning. An MR-only RTP workflow using sCT generated from MR data can address these limitations by offering electron density information that is crucial for dose calculation but unavailable from MR data. We present and validate the clinical potential of a novel deep learning-based sCT generation method.

#### METHODS AND MATERIALS

We developed a conditional generative adversarial network (URcGAN) to generate sCT from MR Dixon images. Thirty-four patients underwent routine FDG-PET/CT and FDG-PET/MR scans. URcGAN was compared to two reference methods: transfer fuzzy clustering with active learning-based classification (TFCALC) and 7-class segmentation (7-Seg). A simulated spherical planning target volume (PTV) (25mm diameter) was drawn in liver segment V. An SBRT plan follows RTOG-1112 protocol using Pinnacle v16.2, delivering 50Gy in 5 fractions. Fluence was copied to sCT images, and dose recalculated for comparison.

#### RESULTS

URcGAN generates sCT in approximately 5 minutes that is of superior quality compared to the two reference methods. Quantitative accuracy of sCT by URcGAN (MAE=51±7 HU and NCC=0.992±0.003) exceeds that by TFCALC (MAE=161±24 and NCC=0.955±0.009) and 7-Seg (MAE=211±19 and NCC=0.93±0.01). For liver SBRT planning, URcGAN achieved passing rates of 95.26%, 99.90%, and 99.96% for gamma criteria of 1%/1mm, 2%/2mm, and 3%/2mm, respectively. Conversely, TFCALC and 7-Seg failed to reach the clinical acceptance rate for any gamma criteria.

#### CONCLUSION

Our study demonstrates that URcGAN is capable of generating sCTs that achieve clinically acceptable dosimetric accuracy for MR-only liver SBRT which was not the case for reference methods. Specifically, the proposed method achieved clinical acceptability of higher than 95% passing rate for all evaluated gamma criteria. Based on our findings, using DCNN for sCT generation may be feasible for MR-only workflow for liver SBRT.

#### CLINICAL RELEVANCE/APPLICATION

Our method of generating sCT from MR images achieves clinically acceptable dosimetric accuracy and enables an MR-only RTP which obviates CT and benefits from MR's superior soft tissue contrast for fast and accurate contouring. Overall, MR-guided liver SBRT using sCT contributes to a more effective and safer treatment outcomes for patients with inoperable liver tumors compared to conventional CT-based RTP.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSRO02-2

### Combining Intratumoral and Peritumoral Radiomics Features of Different Regions of Interest to Predict Pathological Good Response after Neoadjuvant Chemoradiotherapy in Locally Advanced Rectal Cancer

Monday, Nov. 27 9:30AM - 10:30AM Room: S501

Siyuan Qin (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to develop a radiomics model that integrates intratumoral and peritumoral features to predict pathological good response (pGR) to neoadjuvant chemoradiotherapy (nCRT) in patients with locally advanced rectal cancer (LARC). The study also aimed to compare the predictive performance of the model using different combinations of intratumoral and peritumoral regions of interest (ROIs).

#### METHODS AND MATERIALS

This retrospective study collected data on patients diagnosed with LARC who underwent nCRT between 2013 and 2021. Patients were divided into training and validation groups at a ratio of 4:1, and five-fold cross-validation was performed to prevent overfitting. Intratumoral ROIs (ROIITU) were segmented on T2-weighted imaging, while peritumoral ROIs were segmented using two methods: ROIPTU\_2mm, ROIPTU\_4mm, and ROIPTU\_6mm, which were obtained by dilating the boundary of ROIITU by 2mm, 4mm, and 6mm, respectively; and ROIMR\_F and ROIMR\_BVLN, which were obtained by segmenting the fat and blood vessels + lymph nodes in the mesorectum. After feature extraction and selection, 11 logistic regression models were established using radiomics features derived from different ROIs or ROI combinations. The average area under the curve (AUC) was used to evaluate the performance of the models.

#### RESULTS

The study included a total of 209 patients, consisting of 118 pGR and 91 non-pGR patients. The model that integrated ROIITU and ROIMR\_BVLN features had the highest predictive ability, with an AUC (95% confidence interval) of 0.936 (0.904-0.972) in the training group and 0.859 (0.745-0.974) in the validation group. This model outperformed models that used ROIITU alone (AUC=0.779), ROIMR\_BVLN alone (AUC=0.758), and other models.

#### CONCLUSION

Radiomic features of intratumoral and different peritumoral ROIs have predictive value for pGR in LARC patients after nCRT. The model that integrates intratumoral and blood vessels + lymph nodes in the mesorectum features performs the best.

#### CLINICAL RELEVANCE/APPLICATION

This study identified, for the first time, the predictive value of radiomics features of different components of the mesorectum in predicting the response to nCRT in LARC patients and established an optimal prediction model by combining intratumoral and peritumoral radiomics features. The optimal prediction model developed in this study may guide clinical decision-making, such as timely surgery or extended resection for patients who are not sensitive to nCRT and conservative treatment or local excision for patients who are sensitive to nCRT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-SSR002-3

### A Dosimetric Comparison of Y-90 Radioembolization and External Beam Radiation Treatment For Liver Cancer

Monday, Nov. 27 9:30AM - 10:30AM Room: S501

Kajetan Wysoczynski, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to compare the dose distribution and conformity of a liver cancer treatment performed with yttrium-90 (Y-90) microsphere radioembolization and a simulated plan for SBRT for a patient given a medium-sized lesion.

#### METHODS AND MATERIALS

In this study, a typical patient with hepatocellular carcinoma (single 155 cc lesion) was treated using Y-90 microspheres with an injected activity of 2.27 GBq. We performed radioembolization dosimetry based on a PET scan acquired 24h post-treatment to measure Y-90 activity, using multiple organ and tumor contours delineated on whole-body CT. We also simulated a five-fraction treatment plan using a conventional SBRT linear accelerator with 5 mm leaf width. We compared dose distributions of the two modalities for several organs based on dose-volume histograms.

#### RESULTS

The microsphere treatment delivered a mean dose of 390 Gy to the gross tumor volume and an average of 47 Gy to the liver volume. The five-fraction SBRT plan resulted in a mean tumor dose of 51 Gy and mean liver dose of 11 Gy. It is important to note that 2% of the tumor (D2) received at least 54 Gy in the plan, while Y-90 microspheres delivered 908 Gy at D2 of gross tumor volume. The patient received a 5 Gy lung dose with Y-90, but the SBRT plan predicted 0.36 Gy. This large dose with Y-90 is due to the lung shunt fraction of 14.6% for this patient.

#### CONCLUSION

While microspheres can deliver extremely high radiation doses to the tumor in just one administration, SBRT is performed over 5 fractions in the USA. However, Y-90 microspheres deliver more radiation to surrounding lung tissue. Well-vascularized small tumors benefit the most from radioembolization, but dosage to surrounding organs requires analysis with more patients. To better gauge side effects from these very different radiation modalities, biological effective dose calculation will be performed. Other modalities, such as brachytherapy and proton therapy, will be included in further studies.

#### CLINICAL RELEVANCE/APPLICATION

Liver cancer is a high-impact area in clinical practice with rising mortality. The most common treatment is resection, but the number of tumors, position, and complex vasculature often prevent surgery. Alternatively, Stereotactic Body Radiation Therapy (SBRT) can provide localized radiation dose with photons produced by a linear accelerator. Y-90 radioembolization is delivered through microspheres injected into the hepatic artery.

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## Abstract Archives of the RSNA, 2023

M3-SSR002-4

### **Stereotactic Body Radiation Therapy (SBRT) Induced Lobectomy -- Time-Dependent Analysis of Future Liver Remnant Volume in Unresectable Hepatocellular Carcinoma (HCC)**

Monday, Nov. 27 9:30AM - 10:30AM Room: S501

Wan Hang K. Chiu, FRCR (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Stereotactic Body Radiation Therapy (SBRT) has emerged as an alternate locoregional treatment option in patients with Hepatocellular Carcinoma (HCC) with impressive results. However, little is known whether it can play a bridging role in unresectable HCC due to small future remnant ration (FLR) by inducing liver hypertrophy. In this study, we aim to perform a comprehensive time-dependent analysis of the liver volumes following SBRT.

#### **METHODS AND MATERIALS**

Between 2019 and 2021, a prospective single arm phase II study (START-FIT) recruited 33 patients with unresectable HCC who underwent transarterial chemoembolization (TACE), followed by SBRT (27.5-40.0 Gy in five fractions) and Avelumab (10 mg/kg). Serial cross-sectional imaging (contrast-enhanced computed tomography, CT or magnetic resonance imaging, MRI) were performed 3-monthly from baseline until disease progression, death or end of study period. The ipsilateral and contralateral liver lobar as well as tumor volumes, FLR and percentage of FLR hypertrophy from baseline (%FLR hypertrophy) were assessed in a dynamic fashion.

#### **RESULTS**

Ipsilateral lobe atrophy ( $p < 0.0001$ ), contralateral lobe hypertrophy ( $p = 0.0004$ ), tumour reduction ( $p = 0.0056$ ), and FLR hypertrophy ( $p = 0.0001$ ) were observed from 3 months after SBRT. The median %FLR hypertrophy reached around 30% (-13-158) after 12 months, although the fastest increase occurred within the first 3 months and slowly plateau thereafter. Of the 33 recruited patients, 18 (55%) patients were deemed to be amenable to surgical resection over a median follow-up period of 17.2 months (IQR 7.8-25.8).

#### **CONCLUSION**

SBRT may induce hypertrophy of the contralateral liver lobe while controlling primary tumour and limiting progression.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings are of particular interest in the providing novel bridge-to-resection technique in patients with small FLR.

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## Abstract Archives of the RSNA, 2023

M3-SSR002-5

### Influence of Skeletal Muscle and Adipose Tissue on Postoperative Complications and Long-Term Prognosis in Colorectal Cancer Patients

Monday, Nov. 27 9:30AM - 10:30AM Room: S501

Tong Nie (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to explore the correlation of skeletal muscle and adipose tissue quantified by computed tomography (CT) with postoperative complications and long-term prognosis in colorectal cancer patients after surgical resection.

#### METHODS AND MATERIALS

This retrospective cohort study included 850 patients with colorectal cancer who underwent surgical resection at Wuhan Union Hospital between December 2014 and May 2018. Skeletal muscle and adipose tissue indexes were quantified with CT images at the third lumbar vertebra (L3) levels obtained within three months prior to surgery. Adipose tissue indexes include visceral fat area (VFA), subcutaneous fat area (SFA), and intermuscular fat area (IMFA), while skeletal muscle indexes include skeletal muscle area (SMA) and skeletal muscle radiodensity (SMD). The sex-specific optimal cut-off value for each body composition was defined by using the X-tile software. Logistic and Cox proportional hazards models were used to assess the associations between body composition with postoperative complications and overall survival (OS). Receiver operating characteristic (ROC) analysis was used to estimate the predictive ability of body composition combined with clinical indicators. Finally, decision curve analysis (DCA) and nomograms were used to evaluate the clinical usefulness of the models.

#### RESULTS

A total of 850 patients (492 males and 358 females) were included, the mean (SD) age was 57.8 (11.4) years. Logistic regression analysis indicated that patients with low SMD at the L3 level had higher postoperative complication rate (22.30% vs. 14.63%,  $P=0.025$ ). Multivariate Cox regression analysis showed that IMFA (HR 1.543, 95% CI 1.060~2.246,  $P=0.024$ ), SMA (HR 0.657, 95% CI 0.451~0.957,  $P=0.028$ ) and SMD (HR 0.470, 95% CI 0.300~0.736,  $P=0.001$ ) at the L3 level were independent prognostic factors for OS. ROC analyses revealed the predictive accuracy of a combination of body composition and clinical indicators for OS with the area under the ROC curve of 0.823 ( $p < 0.05$ ). DCA demonstrated that the clinico-radiological nomograms were useful for predicting postoperative survival in colorectal cancer patients.

#### CONCLUSION

Patients with low SMD at the L3 level had higher postoperative complication rate. High IMFA, low SMD and low SMA at the L3 level were associated with shorter OS. The inclusion of body composition indicators in the prediction model can significantly improve the predictive performance of patient prognosis.

#### CLINICAL RELEVANCE/APPLICATION

The combination of CT-quantified body composition and clinical indicators could help physicians to recognize worse survival outcomes in colorectal cancer patients after surgery.

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## Abstract Archives of the RSNA, 2023

M3-SSR002-6

### Evaluation of Lymphatic Metastasis for Patients with Gastric Cancer using Spectral CT Quantitative Parameters

Monday, Nov. 27 9:30AM - 10:30AM Room: S501

Zhang Min (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the feasibility of spectral CT quantitative Parameters in distinguishing lymphatic metastasis in patients with gastric cancer.

#### METHODS AND MATERIALS

69 patients confirmed of gastric cancer with gastroscopy were preoperatively examined spectral CT and curative gastrectomy. The enrolled patients were divided into two groups according to Gastric Cancer with lymphatic metastasis or not based on postoperative pathology. spectral CT quantitative Parameters, volume iodine content and Slope of energy spectrum curve in both artery and venous phases were calculated. The differences of parameters in two groups were calculated with One-way analysis of variance (ANOVA). A receiver operating characteristic (ROC) analysis was applied to evaluate the diagnostic performance of meaningful spectral CT quantitative parameters.

#### RESULTS

Volume iodine content in venous phase of Gastric Cancer with lymphatic metastasis were  $27.89 \pm 0.89$  (100ug/cm<sup>3</sup>), it was  $33.45 \pm 1.37$  (100ug/cm<sup>3</sup>) in Gastric Cancer without lymphatic metastasis group. The above indicator were significantly different between Gastric Cancer with and without lymphatic metastasis groups. ( $p < 0.05$ ) For slope of energy spectrum curve in venous phases, volume iodine content in artery phase and Slope of energy spectrum curve in artery phases, there was no statistically significant difference between two groups. The area under the ROC curve for the diagnosis of lymphatic metastasis of gastric cancer by volume iodine content in venous phases was 0.759 (sensitivity 65.5%; specificity, 82.5%) with the cut-off value of 32.07 (100ug/cm<sup>3</sup>) and 2.41.

#### CONCLUSION

Spectrum enhanced CT can accurately evaluate the HER2 positive lymphatic metastasis of gastric cancer with certain quantitative parameters.

#### CLINICAL RELEVANCE/APPLICATION

Spectrum enhanced CT quantitative parameters are potential in diagnosing lymphatic metastasis of gastric cancer.

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## Abstract Archives of the RSNA, 2023

M3-STCE1

### Science Session (Sustainability in Imaging)

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 1

#### Sub-Events

#### **M3-STCE1- Energy and Greenhouse Gas Emission Savings Associated with Implementation of an Abbreviated Cardiac MRI Protocol**

Fadi Ibrahim, MD, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

MRI is one of the largest contributors to greenhouse gas (GHG) emissions in radiology. Overall energy use is proportional to the scan length. At our center, the standard cardiac MRI protocol was abbreviated in 2020 by moving the cine SSFP acquisitions immediately after GBCA injection. In standard protocols the 10 minutes post-injection was idle prior to initiation of late gadolinium enhancement imaging. Recent studies have demonstrated comparable image quality and diagnostic performance if SSFP images are acquired post-contrast. However, there is no data on associated GHG emissions. In this study we sought to evaluate the impact of implementing this abbreviated cardiac MRI protocol on energy-, cost- and GHG-savings, on per protocol, local and national levels.

#### **METHODS AND MATERIALS**

In this single-center retrospective cross-sectional study, a random selection of adult patients undergoing clinically indicated cardiac MRI between 2019-2020 were included. Exclusion criteria included early termination of the study. Total scan duration was calculated as the difference between DICOM time stamps from the first and last images acquired. Statistical analysis included Wilcoxon rank sum test. Standard and abbreviated protocols were compared with respect to total study duration, energy consumption, GHG emissions, and electricity cost. Energy savings were evaluated based on scanner-specific idle state power. GHG emission savings were calculated as kg CO<sub>2</sub> equivalents (CO<sub>2</sub>e) avoided using the US EPA calculator.

#### **RESULTS**

237 patients were included, 136 with the standard protocol (63% male, mean age 55±16 years) and 101 with the abbreviated protocol (58% male, mean age 49±18 years). Total study duration was shorter for the abbreviated versus standard protocol (37±7 min vs. 45±9 min, p<0.001). The 8 min time savings per study is equivalent to 1.9 kWh energy and 1.3 kg CO<sub>2</sub>e avoided per study. Based on local cardiac MRI volumes, this protocol change resulted in 7043 kWh energy savings, \$1620 in electricity cost savings, and 4,991 kg CO<sub>2</sub>e avoided per year. If extrapolated across the US, implementation of this abbreviated protocol would result in 278,000 kWh in energy-saving, \$55,600 in electricity cost-savings, and 197,014 kg CO<sub>2</sub>e avoided (comparable to 505,054 miles driven by an average gasoline-powered passenger vehicle) per year.

#### **CONCLUSION**

Abbreviated cardiac MRI protocols with a simple change in timing of SSFP acquisitions to minimize idle time and optimize scanner efficiency results in a substantial GHG reduction.

#### **CLINICAL RELEVANCE/APPLICATION**

Abbreviated protocols are often achieved by removing redundant sequences. Here we describe an alternative and complementary approach by optimizing protocol efficiency to achieve energy and GHG emission reductions.

#### **M3-STCE1- Diagnostic and Interventional Use-Phase Greenhouse Gas Emissions in a Hospital-based Medical Imaging Department**

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

## PURPOSE

Health care systems are major contributors to the global climate change crisis, including medical imaging. However, there is limited data on total greenhouse gas (GHG) emissions for both diagnostic and interventional procedures. The purpose of this analysis was to estimate the carbon footprint of use-phase emissions by imaging modality and procedure type in a large multi-site hospital medical imaging department to inform prioritization of sustainability efforts.

## METHODS AND MATERIALS

We performed a cross-sectional analysis of total use-phase GHG emissions for diagnostic and interventional radiology at a large medical imaging department covering 3 hospital systems and 5 hospital sites over 5 years (2018-2022). Five diagnostic modalities including radiography, ultrasound (US), computed tomography (CT), magnetic resonance (MRI) and nuclear medicine (NM) were evaluated along with interventional radiology procedures. Estimates were based on number of exams for each modality or number of interventional procedures and included scanner and equipment electricity use and all consumables and associated waste. The primary outcome was the greenhouse gas footprint, measured in carbon dioxide equivalent (CO<sub>2</sub>e) emissions.

## RESULTS

Across the entire medical imaging department, an average of 616,215 medical imaging tests and procedures were performed each year. Total imaging procedures were lowest in 2020 (538,316) as expected due to the COVID-19 pandemic, but were otherwise similar between years (range in other years, 620,431-642,443). Average total use-phase GHG emissions for all diagnostic and interventional procedures were 3441 metric tons CO<sub>2</sub>e per year, comparable to emissions generated from 766 gas-powered passenger vehicles driven for one year. The highest GHG contributors by exam/procedure were CT (37%, 1273 metric tons CO<sub>2</sub>e) and MRI (36%, 1249 metric tons CO<sub>2</sub>e). GHG emissions related to interventional procedures accounted for 448 metric tons CO<sub>2</sub>e (13% of the total). Despite much higher overall exam volumes for radiography and comparable volumes for US, their relative contributions were much lower (191 metric tons CO<sub>2</sub>e [6%] and 55 metric tons CO<sub>2</sub>e [2%], respectively) due to lower GHG emissions per exam.

## CONCLUSION

In a cross-sectional analysis across a large multi-site medical imaging department, use-phase GHG emissions were substantial with CT and MRI as the largest contributors.

## CLINICAL RELEVANCE/APPLICATION

To our knowledge this is the first report of cross-sectional use-phase emissions data across an entire medical imaging department including both diagnostic and interventional procedures. Given that CT and MRI are associated with highest use-phase emissions, initial sustainability efforts can be targeted to these modalities.

## M3-STCE1- Creation and Impact of a Multidisciplinary Green Radiology Leadership Team

3

Hayley Panet (*Presenter*) Nothing to Disclose

## PURPOSE

Health care contributes over 5% of total global greenhouse gas (GHG) emissions. Within the hospital setting, medical imaging departments are one of the largest contributors. Managing multiple priorities and achieving sustainable outcomes is challenging for leaders across health care organizations. There is currently limited data on the role of multidisciplinary leadership teams in improving sustainability in medical imaging. Therefore, we sought to create a diverse leadership team to evaluate the impact on GHG emissions and waste.

## METHODS AND MATERIALS

We engaged a multidisciplinary group of hospital leaders, physicians, engineers and hospital administrators interested in promoting sustainability. As a first step, a formal Green Radiology Leadership Team structure was established to foster collaboration and outline annual goals. This included formal appointment of a Radiologist and Hospital Administrator to engage members outside the imaging division including environmental engineers. Next, a current state assessment was completed to capture the existing hospital and radiology landscape which included energy consumption, waste generation, and staff engagement. Lastly, we created a blueprint for multidisciplinary collaborations that can be emulated in our groups and practice settings to address sustainability in radiology more broadly.

## RESULTS

The formal appointment of a Radiologist and Hospital Administrator as co-leads has accelerated the engagement and foundational support to sustainability initiatives within the imaging department and across the entire hospital organization. A hospital-wide committee with experts from building services and biomedical engineering was essential to assist with implementing targeted equipment monitoring. A schedule for power supply monitoring was created to track scanner device energy utilization and associated costing. Finally, engaging multidisciplinary staff resulted in increased awareness of GHG emissions and actions that can be taken to reduce them. Funding support was also awarded for multidisciplinary sustainability education and knowledge dissemination activities.

## **CONCLUSION**

Creating a formal leadership structure to develop and promote sustainability in medical imaging departments is critical to engage diverse stakeholders and mobilize teams for success.

## **CLINICAL RELEVANCE/APPLICATION**

All radiology medical imaging departments can leverage their hospital building team expertise and establish a joint governance structure to transfer learnings and facilitate local level improvements. In addition, these learnings can help other medical imaging partner with hospital departments and formulate Green Radiology programs in alignment to overall hospital goals.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-STCE1-1

### Energy and Greenhouse Gas Emission Savings Associated with Implementation of an Abbreviated Cardiac MRI Protocol

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 1

Fadi Ibrahim, MD, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

MRI is one of the largest contributors to greenhouse gas (GHG) emissions in radiology. Overall energy use is proportional to the scan length. At our center, the standard cardiac MRI protocol was abbreviated in 2020 by moving the cine SSFP acquisitions immediately after GBCA injection. In standard protocols the 10 minutes post-injection was idle prior to initiation of late gadolinium enhancement imaging. Recent studies have demonstrated comparable image quality and diagnostic performance if SSFP images are acquired post-contrast. However, there is no data on associated GHG emissions. In this study we sought to evaluate the impact of implementing this abbreviated cardiac MRI protocol on energy-, cost- and GHG-savings, on per protocol, local and national levels.

#### METHODS AND MATERIALS

In this single-center retrospective cross-sectional study, a random selection of adult patients undergoing clinically indicated cardiac MRI between 2019-2020 were included. Exclusion criteria included early termination of the study. Total scan duration was calculated as the difference between DICOM time stamps from the first and last images acquired. Statistical analysis included Wilcoxon rank sum test. Standard and abbreviated protocols were compared with respect to total study duration, energy consumption, GHG emissions, and electricity cost. Energy savings were evaluated based on scanner-specific idle state power. GHG emission savings were calculated as kg CO<sub>2</sub>e equivalents (CO<sub>2</sub>e) avoided using the US EPA calculator.

#### RESULTS

237 patients were included, 136 with the standard protocol (63% male, mean age 55±16 years) and 101 with the abbreviated protocol (58% male, mean age 49±18 years). Total study duration was shorter for the abbreviated versus standard protocol (37±7 min vs. 45±9 min, p<0.001). The 8 min time savings per study is equivalent to 1.9 kWh energy and 1.3 kg CO<sub>2</sub>e avoided per study. Based on local cardiac MRI volumes, this protocol change resulted in 7043 kWh energy savings, \$1620 in electricity cost savings, and 4,991 kg CO<sub>2</sub>e avoided per year. If extrapolated across the US, implementation of this abbreviated protocol would result in 278,000 kWh in energy-saving, \$55,600 in electricity cost-savings, and 197,014 kg CO<sub>2</sub>e avoided (comparable to 505,054 miles driven by an average gasoline-powered passenger vehicle) per year.

#### CONCLUSION

Abbreviated cardiac MRI protocols with a simple change in timing of SSFP acquisitions to minimize idle time and optimize scanner efficiency results in a substantial GHG reduction.

#### CLINICAL RELEVANCE/APPLICATION

Abbreviated protocols are often achieved by removing redundant sequences. Here we describe an alternative and complementary approach by optimizing protocol efficiency to achieve energy and GHG emission reductions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-STCE1-2

### Diagnostic and Interventional Use-Phase Greenhouse Gas Emissions in a Hospital-based Medical Imaging Department

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 1

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

#### PURPOSE

Health care systems are major contributors to the global climate change crisis, including medical imaging. However, there is limited data on total greenhouse gas (GHG) emissions for both diagnostic and interventional procedures. The purpose of this analysis was to estimate the carbon footprint of use-phase emissions by imaging modality and procedure type in a large multi-site hospital medical imaging department to inform prioritization of sustainability efforts.

#### METHODS AND MATERIALS

We performed a cross-sectional analysis of total use-phase GHG emissions for diagnostic and interventional radiology at a large medical imaging department covering 3 hospital systems and 5 hospital sites over 5 years (2018-2022). Five diagnostic modalities including radiography, ultrasound (US), computed tomography (CT), magnetic resonance (MRI) and nuclear medicine (NM) were evaluated along with interventional radiology procedures. Estimates were based on number of exams for each modality or number of interventional procedures and included scanner and equipment electricity use and all consumables and associated waste. The primary outcome was the greenhouse gas footprint, measured in carbon dioxide equivalent (CO<sub>2</sub>e) emissions.

#### RESULTS

Across the entire medical imaging department, an average of 616,215 medical imaging tests and procedures were performed each year. Total imaging procedures were lowest in 2020 (538,316) as expected due to the COVID-19 pandemic, but were otherwise similar between years (range in other years, 620,431-642,443). Average total use-phase GHG emissions for all diagnostic and interventional procedures were 3441 metric tons CO<sub>2</sub>e per year, comparable to emissions generated from 766 gas-powered passenger vehicles driven for one year. The highest GHG contributors by exam/procedure were CT (37%, 1273 metric tons CO<sub>2</sub>e) and MRI (36%, 1249 metric tons CO<sub>2</sub>e). GHG emissions related to interventional procedures accounted for 448 metric tons CO<sub>2</sub>e (13% of the total). Despite much higher overall exam volumes for radiography and comparable volumes for US, their relative contributions were much lower (191 metric tons CO<sub>2</sub>e [6%] and 55 metric tons CO<sub>2</sub>e [2%], respectively) due to lower GHG emissions per exam.

#### CONCLUSION

In a cross-sectional analysis across a large multi-site medical imaging department, use-phase GHG emissions were substantial with CT and MRI as the largest contributors.

#### CLINICAL RELEVANCE/APPLICATION

To our knowledge this is the first report of cross-sectional use-phase emissions data across an entire medical imaging department including both diagnostic and interventional procedures. Given that CT and MRI are associated with highest use-phase emissions, initial sustainability efforts can be targeted to these modalities.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-STCE1-3

### Creation and Impact of a Multidisciplinary Green Radiology Leadership Team

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 1

Hayley Panet (*Presenter*) Nothing to Disclose

#### PURPOSE

Health care contributes over 5% of total global greenhouse gas (GHG) emissions. Within the hospital setting, medical imaging departments are one of the largest contributors. Managing multiple priorities and achieving sustainable outcomes is challenging for leaders across health care organizations. There is currently limited data on the role of multidisciplinary leadership teams in improving sustainability in medical imaging. Therefore, we sought to create a diverse leadership team to evaluate the impact on GHG emissions and waste.

#### METHODS AND MATERIALS

We engaged a multidisciplinary group of hospital leaders, physicians, engineers and hospital administrators interested in promoting sustainability. As a first step, a formal Green Radiology Leadership Team structure was established to foster collaboration and outline annual goals. This included formal appointment of a Radiologist and Hospital Administrator to engage members outside the imaging division including environmental engineers. Next, a current state assessment was completed to capture the existing hospital and radiology landscape which included energy consumption, waste generation, and staff engagement. Lastly, we created a blueprint for multidisciplinary collaborations that can be emulated in our groups and practice settings to address sustainability in radiology more broadly.

#### RESULTS

The formal appointment of a Radiologist and Hospital Administrator as co-leads has accelerated the engagement and foundational support to sustainability initiatives within the imaging department and across the entire hospital organization. A hospital-wide committee with experts from building services and biomedical engineering was essential to assist with implementing targeted equipment monitoring. A schedule for power supply monitoring was created to track scanner device energy utilization and associated costing. Finally, engaging multidisciplinary staff resulted in increased awareness of GHG emissions and actions that can be taken to reduce them. Funding support was also awarded for multidisciplinary sustainability education and knowledge dissemination activities.

#### CONCLUSION

Creating a formal leadership structure to develop and promote sustainability in medical imaging departments is critical to engage diverse stakeholders and mobilize teams for success.

#### CLINICAL RELEVANCE/APPLICATION

All radiology medical imaging departments can leverage their hospital building team expertise and establish a joint governance structure to transfer learnings and facilitate local level improvements. In addition, these learnings can help other medical imaging partner with hospital departments and formulate Green Radiology programs in alignment to overall hospital goals.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-STCE2

### Science Session (Imaging of Immunotherapy)

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 2

#### Sub-Events

#### **M3-STCE2- Early Detection of Trastuzumab Cardiac Toxicity by Cardiac MRI in HER-2 Positive Breast Cancer Patients** 1

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Immunotherapy agents have led to a new era of cancer treatment, yet its side effects management are challenging. One of immunotherapy agents in breast cancer is based on human epidermal growth factor receptor 2 (HER2), as trastuzumab, which has led to increase survival in HER-2 positive breast cancer when used in combination with other chemotherapeutic agents. Trastuzumab is known to cause cardiac toxicity mainly diagnosed by reduced left ventricle systolic function by means of echocardiography and detecting reduced left ventricle ejection fraction (LVEF). This effect is reversible by discontinuation of the drug. In this study our goal is to determine if cardiac MRI feature tracking can predict cardiac toxicity before it became evident on echocardiography.

#### **METHODS AND MATERIALS**

we enrolled 25 patients diagnosed with HER2 positive breast cancer who had normal cardiac function based on their initial echocardiography. As standard of care these patients who were under trastuzumab were studied by echocardiography every 4-6 weeks to detect any decline in LVEF. After two months of treatment cardiac MRI were done in patients who deemed to have normal cardiac function based on their echocardiographic findings. And patients followed by echocardiography for six months. Global longitudinal, Radial and circumferential strain measures were recorded, and these measures were compared to show if they are different among patients who developed cardiac toxicity - based on echocardiography - and those who did not.

#### **RESULTS**

among initial follow up three patients showed decreased LVEF and were excluded from study, of 23 remaining patients eventually five patients showed reduced LVEF. LVGLS and LVGCS measures were significantly lower in two months MRI in these patients than those who did not developed cardiac toxicity.

#### **CONCLUSION**

cardiac MRI feature tracking can potentially be used as an effective screening tool to detect subclinical cardiac toxicity and thus leads to better patient management and possibly reduced cardiac toxicity and improve patients survival.

#### **CLINICAL RELEVANCE/APPLICATION**

Trastuzumab cardiac toxicity is reversible upon drug discontinuation, our results support this idea that cardiac MRI can show cardiac toxicity before it is evident by reduced LVEF.

#### **M3-STCE2- Immunotherapeutic Efficacy in Cardiac Sarcoidosis Treatment Assessed by Cardiac MRI** 2

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cardiac Sarcoidosis treatment is challenging, partly because of delayed diagnosis and chronic course of disease treatment with corticosteroids may lead to several side effects, thus steroid-sparing strategies are desired in this condition, we retrospectively report treatment efficacy in patients who received tocilizumab, infliximab and adalimumab and standard treatment, based on their cardiac MR findings.



## METHODS AND MATERIALS

Fifty patients, with known extra-cardiac sarcoidosis, and suspicious for cardiac sarcoidosis (CS) based on their initial imaging findings were enrolled. 12 patients received tocilizumab, 13 received infliximab and 11 received adalimumab in addition to corticosteroid and methotrexate, 14 patients were under steroid and methotrexate alone. Cardiac function tests as LVEF, RVEF, left ventricle strain analysis and LGE index were recorded in these groups. One-way ANOVA was used to assess for intergroup differences and post hoc test is done thereafter.

## RESULTS

Our study enrolled 50 patients with  $53.3 \pm 16.8$  years old and 33(66%) male treated for cardiac sarcoidosis, three patients who were under infliximab were excluded as they could not tolerate treatment and it was discontinued. Other patients in four groups showed improvement in cardiac function evidenced by increase in LVGLS, LVGCS and LVGRS and decrease in LGE index. One-way ANOVA test showed significant difference in LGE index change between four groups with maximum response in infliximab group. Strain changes were not significantly different between groups.

## CONCLUSION

immunotherapeutic agents are potent supplementary treatments and if used judiciously can improve patient management and outcome in cardiac sarcoidosis, although these treatments have adverse effects that need to be monitored in order to attain better outcomes.

## CLINICAL RELEVANCE/APPLICATION

By use of immunotherapeutic agents, steroid dose needed to control disease can be reduced to minimum and thus increase sarcoidosis patient's quality of life by mitigating steroid side effects.

## M3-STCE2- Deep Learning-based Harmonization of Multisite Pediatric Brain MRI Clinical Trials

3

Abhijeet Parida (*Presenter*) Nothing to Disclose

## PURPOSE

Leveraging the power of machine learning, rare pediatric diseases require multi-institutional collaboration and data. This often leads to inconsistent magnetic resonance imaging (MRI) analyses due to varying image acquisition protocols and quality. This study aims to develop and evaluate a 3D deep-learning framework that can harmonize MR images from multiple sites to enable reproducible data analysis for rare pediatric diseases.

## METHODS AND MATERIALS

We collected 180 T1-weighted MRI scans from three clinical sites using different device manufacturers (GE, Siemens, and Phillips), echo time/relaxation time (10.5/600, 2.5/1900, and 3.8/8.3 ms), and image resolutions (0.41x0.41 mm<sup>2</sup>, 0.82x0.82 mm<sup>2</sup>, and 0.94x0.94 mm<sup>2</sup>). Data from two sites were used to train a branched 3D deep neural style transfer network for harmonizing the differences in paired imaging protocols, while data from the third site were used for independent testing. The network was trained in an unsupervised manner to preserve patient anatomy and harmonize image intensity. The normalized Wasserstein distance (nWD) was employed to quantify the similarity between the intensity histograms and thus assess the quality of intensity harmonization. The relative absolute volume difference (rAVD) of gray matter and white matter, before and after harmonization, was used to assess the preservation of anatomy.

## RESULTS

The intensity harmonization between imaging protocols resulted in an average nWD of  $94.22 \pm 2.01\%$ , and rAVD of  $6.88 \pm 4.71\%$  for the gray matter and  $13.08 \pm 4.67\%$ , for the white matter. A high nWD and a low rAVD value indicate successfully harmonized MRI data from different clinical sites and protocols.

## CONCLUSION

The MRI harmonization algorithm successfully preserved patient anatomy while harmonizing image intensities for data acquired at multiple clinical sites that use different imaging manufacturers and acquisition protocols. This would allow using data from multiple sites to be reliably used for training machine learning models for various clinical outcomes.

## CLINICAL RELEVANCE/APPLICATION

Image harmonization has the potential to facilitate reproducible data analysis for large-scale multi-center clinical trials. Deep learning-based multi-site data harmonization can potentially assist in other areas of medical imaging, where consistent and reliable data analysis is essential for advancing clinical research and improving patient outcomes.

## Abstract Archives of the RSNA, 2023

M3-STCE2-1

### Early Detection of Trastuzumab Cardiac Toxicity by Cardiac MRI in HER-2 Positive Breast Cancer Patients

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 2

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Immunotherapy agents have led to a new era of cancer treatment, yet its side effects management are challenging. One of immunotherapy agents in breast cancer is based on human epidermal growth factor receptor 2 (HER2), as trastuzumab, which has led to increase survival in HER-2 positive breast cancer when used in combination with other chemotherapeutic agents. Trastuzumab is known to cause cardiac toxicity mainly diagnosed by reduced left ventricle systolic function by means of echocardiography and detecting reduced left ventricle ejection fraction (LVEF). This effect is reversible by discontinuation of the drug. In this study our goal is to determine if cardiac MRI feature tracking can predict cardiac toxicity before it became evident on echocardiography.

#### METHODS AND MATERIALS

we enrolled 25 patients diagnosed with HER2 positive breast cancer who had normal cardiac function based on their initial echocardiography. As standard of care these patients who were under trastuzumab were studied by echocardiography every 4-6 weeks to detect any decline in LVEF. After two months of treatment cardiac MRI were done in patients who deemed to have normal cardiac function based on their echocardiographic findings. And patients followed by echocardiography for six months. Global longitudinal, Radial and circumferential strain measures were recorded, and these measures were compared to show if they are different among patients who developed cardiac toxicity - based on echocardiography - and those who did not.

#### RESULTS

among initial follow up three patients showed decreased LVEF and were excluded from study, of 23 remaining patients eventually five patients showed reduced LVEF. LVGLS and LVGCS measures were significantly lower in two months MRI in these patients than those who did not developed cardiac toxicity.

#### CONCLUSION

cardiac MRI feature tracking can potentially be used as an effective screening tool to detect subclinical cardiac toxicity and thus leads to better patient management and possibly reduced cardiac toxicity and improve patients survival.

#### CLINICAL RELEVANCE/APPLICATION

Trastuzumab cardiac toxicity is reversible upon drug discontinuation, our results support this idea that cardiac MRI can show cardiac toxicity before it is evident by reduced LVEF.

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## Abstract Archives of the RSNA, 2023

M3-STCE2-2

### Immunotherapeutic Efficacy in Cardiac Sarcoidosis Treatment Assessed by Cardiac MRI

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 2

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cardiac Sarcoidosis treatment is challenging, partly because of delayed diagnosis and chronic course of disease treatment with corticosteroids may lead to several side effects, thus steroid-sparing strategies are desired in this condition, we retrospectively report treatment efficacy in patients who received tocilizumab, infliximab and adalimumab and standard treatment, based on their cardiac MR findings.

#### METHODS AND MATERIALS

Fifty patients, with known extra-cardiac sarcoidosis, and suspicious for cardiac sarcoidosis (CS) based on their initial imaging findings were enrolled. 12 patient received tocilizumab, 13 received infliximab and 11 received adalimumab in addition to corticosteroid and methotrexate, 14 patients were under steroid and methotrexate alone. Cardiac function tests as LVEF, RVEF, left ventricle strain analysis and LGE index were recorded in these groups. One-way ANOVA was used to assess for intergroup differences and post hoc test is done thereafter.

#### RESULTS

Our study enrolled 50 patients with  $53.3 \pm 16.8$  years old and 33(66%) male treated for cardiac sarcoidosis, three patients who were under infliximab were excluded as they could not tolerate treatment and it was discontinued. Other patients in four groups showed improvement in cardiac function evidenced by increase in LVGLS, LVGCS and LVGRS and decrease in LGE index. One-way ANOVA test showed significant difference in LGE index change between four groups with maximum response in infliximab group. Strain changes were not significantly different between groups.

#### CONCLUSION

immunotherapeutic agents are potent supplementary treatments and if used judiciously can improve patient management and outcome in cardiac sarcoidosis, although these treatments have adverse effects that need to be monitored in order to attain better outcomes.

#### CLINICAL RELEVANCE/APPLICATION

By use of immunotherapeutic agents, steroid dose needed to control disease can be reduced to minimum and thus increase sarcoidosis patient's quality of life by mitigating steroid side effects.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M3-STCE2-3

### Deep Learning-based Harmonization of Multisite Pediatric Brain MRI Clinical Trials

Monday, Nov. 27 10:00AM - 10:30AM Room: Learning Center Theater 2

Abhijeet Parida (*Presenter*) Nothing to Disclose

#### PURPOSE

Leveraging the power of machine learning, rare pediatric diseases require multi-institutional collaboration and data. This often leads to inconsistent magnetic resonance imaging (MRI) analyses due to varying image acquisition protocols and quality. This study aims to develop and evaluate a 3D deep-learning framework that can harmonize MR images from multiple sites to enable reproducible data analysis for rare pediatric diseases.

#### METHODS AND MATERIALS

We collected 180 T1-weighted MRI scans from three clinical sites using different device manufacturers (GE, Siemens, and Phillips), echo time/relaxation time (10.5/600, 2.5/1900, and 3.8/8.3 ms), and image resolutions (0.41x0.41 mm<sup>2</sup>, 0.82x0.82 mm<sup>2</sup>, and 0.94x0.94 mm<sup>2</sup>). Data from two sites were used to train a branched 3D deep neural style transfer network for harmonizing the differences in paired imaging protocols, while data from the third site were used for independent testing. The network was trained in an unsupervised manner to preserve patient anatomy and harmonize image intensity. The normalized Wasserstein distance (nWD) was employed to quantify the similarity between the intensity histograms and thus assess the quality of intensity harmonization. The relative absolute volume difference (rAVD) of gray matter and white matter, before and after harmonization, was used to assess the preservation of anatomy.

#### RESULTS

The intensity harmonization between imaging protocols resulted in an average nWD of 94.22±2.01%, and rAVD of 6.88±4.71% for the gray matter and 13.08±4.67%, for the white matter. A high nWD and a low rAVD value indicate successfully harmonized MRI data from different clinical sites and protocols.

#### CONCLUSION

The MRI harmonization algorithm successfully preserved patient anatomy while harmonizing image intensities for data acquired at multiple clinical sites that use different imaging manufacturers and acquisition protocols. This would allow using data from multiple sites to be reliably used for training machine learning models for various clinical outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Image harmonization has the potential to facilitate reproducible data analysis for large-scale multi-center clinical trials. Deep learning-based multi-site data harmonization can potentially assist in other areas of medical imaging, where consistent and reliable data analysis is essential for advancing clinical research and improving patient outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-SSMK03

### Musculoskeletal Imaging (Metabolic, Quantitative and Functional, Intervention)

Monday, Nov. 27 11:00AM - 12:00PM Room: E450A

Tony T. Wong, MD (*Moderator*) Nothing to Disclose  
Sonali Lala, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### M4-SSMK03-1 Quantitative in Vivo Assessment of Wrist Trabecular Microarchitecture with Photon-counting-detector (PCD) CT

Anika Dutta, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate the feasibility of in vivo trabecular bone quantification in the wrist using photon-counting-detector (PCD) CT in ultra-high-resolution (UHR) mode.

#### METHODS AND MATERIALS

An anthropomorphic wrist phantom was scanned on a peripheral quantitative CT (pQCT) (Extreme II, SCANCO Medical AG) at 68 kV and reconstructed with an 82x82x82  $\mu\text{m}^3$  voxel size. The phantom was also scanned using the UHR mode of a PCD-CT system (Siemens NAEOTOM Alpha) at 120 kV and reconstructed with a Br96 kernel (limiting resolution 125 microns) using quantum iterative reconstruction (strength 3). The voxel size was 117x117x200  $\mu\text{m}^3$ . Additional reconstructions to mimic a state-of-the-art energy integrating detector (EID) were performed (Br76 at 0.4 mm slice thickness) to quantify the improvements in bone quality assessment offered by UHR-PCD-CT. Trabecular morphologic properties for 3 different carpal bones were measured using a semi-automated bone segmentation and quantification framework (BoneJ package, ImageJ, NIH Bethesda MD). The distal radius of 20 patients undergoing clinically indicated wrist CT on the PCD-CT system was retrospectively evaluated by quantitatively extracting metrics of bone volume ratio (BV/TV), trabecular thickness (Tb.Th) and spacing (Tb.Sp), using the same reconstruction settings as the phantom study.

#### RESULTS

Trabecular morphologic indicators from the phantom were overestimated using the EID-CT reconstruction setting (average Tb.Th, 0.97 mm), when compared to the pQCT reference (0.49 mm). UHR-PCD-CT provided a close match (0.47 mm) to the reference, demonstrating accurate trabecular quantification using a whole-body CT system. In the in vivo cohort, BV/TV, Tb.Th and Tb.Sp were significantly lower when using the UHR-PCD-CT reconstruction settings compared to the ones matching EID-CT, with average differences of 43%, 53% and 16%, respectively ( $p < 0.001$ ). Of the three metrics of bone quality, the quantitative assessment of trabecular bone thickness, was shown to benefit the most from the improved spatial resolution offered by PCD-CT.

#### CONCLUSION

This work demonstrates that UHR-PCD-CT can quantitatively assess bone microarchitecture *in vivo*, thus potentially serving as an opportunistic screening tool for osteoporosis. Of the three metrics of bone quality, trabecular bone thickness showed the most benefit from the improved spatial resolution offered by PCD-CT.

#### CLINICAL RELEVANCE/APPLICATION

The UHR capabilities of PCD-CT, combined with its intrinsic spectral properties, may enable an opportunistic comprehensive assessment of bone health at no additional radiation dose.

#### M4-SSMK03-2 Differentiation of Periarticular Mineralized Foci using Dual-energy CT

Jennifer Henneby, MBCh (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate if atomic number (Z) and attenuation levels (HU) at high and low kV values obtained by dual-energy CT can differentiate between types of periarticular mineralized foci.

## METHODS AND MATERIALS

IRB-approved retrospective study. The study included 103 cases where peri-articular mineralized foci were seen on second and third generation dual-source dual-energy CT (Somatom Siemens Flash and Force, Siemens Healthineers). Two musculoskeletal radiologists evaluated the cases and classified them according to the most likely diagnosis based on the radiological appearance and clinical presentation into 3 categories: Carbonate apatite/hydroxyapatite deposition disease (HADD), monosodium urate (MSU) deposition and calcium pyrophosphate dihydrate deposition disease (CPPD). A third MSK radiologist evaluated if initial categorization differed. Three fellows in MSK radiology independently processed the cases with dual-energy CT using the Rho/Z application (Syngo.via, version VB40, Siemens Healthineers). A region of interest (ROI) of at least 1 sq mm was drawn over the dominant focus of mineralization and ROI size and Z and HU values were recorded at high, low and mixed kV energy levels.

## RESULTS

3 groups of cases each were created. Atomic number values for MSU, CPPD, HADD were 7.56 +/- 0.52, 9.16 +/- 0.91 and 10.88 +/- 1.23. An Anova test followed by a post-hoc Tukey's test was performed to assess for specific pairs that had significant difference in their mean Z and HU values at high and low kV. All groups had a significant difference ( $p < 0.001$ ) for Z values. The HADD group compared to the CPPD group and the HADD group compared to the MSU group had a significant difference at high and low kV energy levels. The CPPD group compared to the MSU group did not have a significant difference at high and low kV energy levels.

## CONCLUSION

The Z obtained by the Rho/Z application on DECT is able to differentiate between MSU, CPPD and HADD. The mean HU values at high and low kV values can differentiate between HADD and CPPD and between HADD and MSU.

## CLINICAL RELEVANCE/APPLICATION

Using DECT can narrow the differential diagnosis of peri-articular mineralized foci - reducing the clinical need for joint aspiration and associated risks and also guide treatment in clinical practice.

## M4-SSMK03-4 Development and Validation of a Deep Learning Model for Prediction of Bone Mineral Density and T-score Prediction in Chest X-rays: A Multi-center Study

YOICHI SATO, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Although the number of patients with osteoporosis is increasing worldwide, diagnosis and treatment are presently inadequate. In this study, we developed a deep learning model to predict bone mineral density (BMD) and T-score from chest X-rays, which is one of the most common, easily accessible, and low-cost medical imaging examination methods. In addition to development, we performed external validation to evaluate a deep learning model's reproducibility and generalizability.

## METHODS AND MATERIALS

We trained, validated, and externally tested a deep learning model to predict BMD and T-score from chest X-rays. This retrospective study included consecutively collected results of dual-energy X-ray absorptiometry (DXA) and chest X-ray that had been obtained between 2010 and 2022 from 20 institutions. For the learning labels, we used (1) BMD (g/cm<sup>2</sup>) of the hip and (2) classification of T-score  $\leq -1.0$ ,  $\leq -2.5$  as the threshold. Of these radiographs, 17 institutions were used for training, validation, and internal testing. The 3 other institutions were used for external testing. We trained the deep learning model through ensemble learning of chest X-rays, age, and sex to predict the BMD using regression and T-score for multiclass classification. We assessed the following two metrics to evaluate the performance of the deep learning model in the internal-test dataset and external-test dataset: (1) the correlation coefficient, root mean square error (RMSE) and mean absolute error (MAE) between the predicted and true BMDs and (2) consistency in the T-score between the predicted class and true class.

## RESULTS

This study included 50,064 radiographs from 24,666 patients across 20 institutions. The training and validation dataset comprised 47,150 radiographs (23,151 patients), while the external test dataset included 2,914 radiographs (1,515 patients). The correlation coefficient, RMSE, and MAE for BMD were 0.68, 0.09, and 0.08, respectively. T-score predictions ( $\leq -1.0$ ) showed 79.0% accuracy, 96.6% sensitivity, and 34.1% specificity, while predictions ( $\leq -2.5$ ) demonstrated 79.7% accuracy, 77.1% sensitivity, and 80.4% specificity.

## CONCLUSION

These results suggest that the proposed deep learning model may be suitable for screening patients with osteoporosis by predicting the BMD and T-score from chest X-rays.

## CLINICAL RELEVANCE/APPLICATION

This model may be useful in that it allows screening of osteoporosis patients from chest X-rays, one of the most common and low-cost medical imaging modalities. If this deep learning model becomes available as a medical device, chest X-rays taken in a variety of settings, such as medical examinations, checkups, and hospitals, could be used to screen for osteoporosis.

### M4-SSMK03-5 **Prediction of Osteoporosis Associated Fractures: Evaluation of Dual-Energy CT-derived Metrics of the Lumbar Spine**

Simon S. Martin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the association of dual-energy CT (DECT)-derived bone mineral density (BMD) assessment with the occurrence of osteoporosis-associated fractures in a follow-up period of 2 years.

#### METHODS AND MATERIALS

L1 of 160 patients (77 men, 83 women; mean age, 64.1 years, range, 19-94 years) who underwent dual-source DECT between 01/2016 and 12/2020 was retrospectively analyzed. Cortical HU, trabecular HU, cortical thickness, and phantomless DECT-based bone BMD were obtained from all examinations. Patient files and follow-up images of patients were examined for the occurrence of osteoporosis-associated fractures. Receiver-operating characteristic (ROC) analysis identified AUC values for BMD, HU values and cortical thickness, and logistic regression models were used to evaluate their associations with the occurrence of osteoporosis-associated fractures.

#### RESULTS

ROC curve analysis demonstrated a significantly higher AUC value for DECT-derived BMD compared to cortical HU, trabecular HU and cortical thickness (0.92 vs. 0.67, 0.62 and 0.59, respectively;  $P < .01$ ). Logistic regression models confirmed a significant association of lower DECT-derived BMD with the occurrence of osteoporosis-associated fractures (Odds Ratio, 0.87;  $P < .001$ ), but not of cortical HU, trabecular HU or cortical thickness ( $P > .05$  for all values, respectively).

## CONCLUSION

Dual-energy CT-derived bone mineral density assessment from routine examinations can be used to stratify the risk of sustaining osteoporosis-associated fractures during a follow-up period of 2 years.

## CLINICAL RELEVANCE/APPLICATION

We demonstrate the superiority of dual-energy CT over other methods for opportunistic osteoporosis screening. This information can be used to stratify the risk of patients to sustain fractures and to start patients at risk on osteoporosis treatment without the requirement to perform additional examinations.

### M4-SSMK03-6 **QCT-derived Volumetric Bone Mineral Density in the Evaluation of the Lumbar Spine: Comparison with DXA-based Areal Bone Mineral Density and Trabecular BoneScore**

Stefano Fusco (*Presenter*) Nothing to Disclose

#### PURPOSE

The application of quantitative computed tomography (QCT) to CT scans performed for other clinical reasons can provide valuable information about bone mineral density (BMD) in the setting of opportunistic screening for osteoporosis. We compared volumetric BMD (vBMD) derived from QCT to dual-energy x-ray absorptiometry (DXA)-based parameters such as areal BMD and trabecular bone score (TBS). We also aimed to assess the diagnostic accuracy of these parameters in discriminating between individuals with and without fragility fractures (FFs).

#### METHODS AND MATERIALS

We retrospectively enrolled subjects who underwent both a DXA scan and a non-enhanced chest/abdomen CT scan, with a maximum time lapse of six months between the two examinations. A so-called "asynchronous" calibration was performed on CT images to obtain vBMD values from QCT using QCT PRO v 6.1 software (Mindways Software Inc., Austin, TX). American College of Radiology ranges were used for QCT-vBMD to assign a diagnostic category (normal, osteopenic or osteoporotic status). T-score values were used for DXA diagnosis according to the World Health Organization criteria. TBS values were obtained from DXA on the same areas of BMD analysis. The presence of prevalent fragility fractures (FFs) was assessed at spine, hip and wrist.

## RESULTS

After applying the inclusion and exclusion criteria, our final sample comprised 105 subjects (87 women, mean age  $69 \pm 11$  years). Overall, 49 subjects (46.6%) presented at least one major fragility fracture. QCT diagnosis was as follows: osteoporosis = 59 (56.2%); osteopenia = 36 (34.3%); normal status = 10 (9.5%). DXA diagnosis was: osteoporosis = 25 (23.8%); osteopenia = 35 (33.3%); normal status = 45 (42.9%). A total of 38 subjects (36.2%) showed degraded microarchitecture according to TBS values. A moderate correlation was found between DXA-areal BMD and QCT-vBMD ( $r=0.446$ ) as well as between TBS and vBMD ( $r=0.524$ ), while a good correlation between aBMD and TBS ( $r=0.621$ ) was found. In order to assess the capability of discriminating between subjects with and without FFs, ROC curves were calculated: QCT-vBMD showed the best performance with an AUC of 0.748. On the other hand, AUC for DXA-aBMD was 0.575 and for TBS was 0.650.

## CONCLUSION

Opportunistic QCT evaluation diagnosed a higher prevalence of osteoporosis compared to DXA. vBMD and TBS performed better than DXA-aBMD in discriminating subjects with and without FFs.

## CLINICAL RELEVANCE/APPLICATION

QCT-based opportunistic screening for osteoporosis can partially overcome the limits of DXA, allowing to better identify patients at risk for fragility fractures

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M4-SSMK03-1

### Quantitative in Vivo Assessment of Wrist Trabecular Microarchitecture with Photon-counting-detector (PCD) CT

Monday, Nov. 27 11:00AM - 12:00PM Room: E450A

Anika Dutta, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate the feasibility of in vivo trabecular bone quantification in the wrist using photon-counting-detector (PCD) CT in ultra-high-resolution (UHR) mode.

#### METHODS AND MATERIALS

An anthropomorphic wrist phantom was scanned on a peripheral quantitative CT (pQCT) (Extreme II, SCANCO Medical AG) at 68 kV and reconstructed with an 82x82x82  $\mu\text{m}^3$  voxel size. The phantom was also scanned using the UHR mode of a PCD-CT system (Siemens NAEOTOM Alpha) at 120 kV and reconstructed with a Br96 kernel (limiting resolution 125 microns) using quantum iterative reconstruction (strength 3). The voxel size was 117x117x200  $\mu\text{m}^3$ . Additional reconstructions to mimic a state-of-the-art energy integrating detector (EID) were performed (Br76 at 0.4 mm slice thickness) to quantify the improvements in bone quality assessment offered by UHR-PCD-CT. Trabecular morphologic properties for 3 different carpal bones were measured using a semi-automated bone segmentation and quantification framework (BoneJ package, ImageJ, NIH Bethesda MD). The distal radius of 20 patients undergoing clinically indicated wrist CT on the PCD-CT system was retrospectively evaluated by quantitatively extracting metrics of bone volume ratio (BV/TV), trabecular thickness (Tb.Th) and spacing (Tb.Sp), using the same reconstruction settings as the phantom study.

#### RESULTS

Trabecular morphologic indicators from the phantom were overestimated using the EID-CT reconstruction setting (average Tb.Th, 0.97 mm), when compared to the pQCT reference (0.49 mm). UHR-PCD-CT provided a close match (0.47 mm) to the reference, demonstrating accurate trabecular quantification using a whole-body CT system. In the in vivo cohort, BV/TV, Tb.Th and Tb.Sp were significantly lower when using the UHR-PCD-CT reconstruction settings compared to the ones matching EID-CT, with average differences of 43%, 53% and 16%, respectively ( $p < 0.001$ ). Of the three metrics of bone quality, the quantitative assessment of trabecular bone thickness, was shown to benefit the most from the improved spatial resolution offered by PCD-CT.

#### CONCLUSION

This work demonstrates that UHR-PCD-CT can quantitatively assess bone microarchitecture *in vivo*, thus potentially serving as an opportunistic screening tool for osteoporosis. Of the three metrics of bone quality, trabecular bone thickness showed the most benefit from the improved spatial resolution offered by PCD-CT.

#### CLINICAL RELEVANCE/APPLICATION

The UHR capabilities of PCD-CT, combined with its intrinsic spectral properties, may enable an opportunistic comprehensive assessment of bone health at no additional radiation dose.

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## Abstract Archives of the RSNA, 2023

M4-SSMK03-2

### Differentiation of Periarticular Mineralized Foci using Dual-energy CT

Monday, Nov. 27 11:00AM - 12:00PM Room: E450A

Jennifer Hennebry, MBBCh (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate if atomic number (Z) and attenuation levels (HU) at high and low kV values obtained by dual-energy CT can differentiate between types of periarticular mineralized foci.

#### METHODS AND MATERIALS

IRB-approved retrospective study. The study included 103 cases where peri-articular mineralized foci were seen on second and third generation dual-source dual-energy CT (Somatom Siemens Flash and Force, Siemens Healthineers). Two musculoskeletal radiologists evaluated the cases and classified them according to the most likely diagnosis based on the radiological appearance and clinical presentation into 3 categories: Carbonate apatite/hydroxyapatite deposition disease (HADD), monosodium urate (MSU) deposition and calcium pyrophosphate dihydrate deposition disease (CPPD). A third MSK radiologist evaluated if initial categorization differed. Three fellows in MSK radiology independently processed the cases with dual-energy CT using the Rho/Z application (Syngo.via, version VB40, Siemens Healthineers). A region of interest (ROI) of at least 1 sq mm was drawn over the dominant focus of mineralization and ROI size and Z and HU values were recorded at high, low and mixed kV energy levels.

#### RESULTS

3 groups of cases each were created. Atomic number values for MSU, CPPD, HADD were 7.56 +/- 0.52, 9.16 +/- 0.91 and 10.88 +/- 1.23. An Anova test followed by a post-hoc Tukey's test was performed to assess for specific pairs that had significant difference in their mean Z and HU values at high and low kV. All groups had a significant difference ( $p < 0.001$ ) for Z values. The HADD group compared to the CPPD group and the HADD group compared to the MSU group had a significant difference at high and low kV energy levels. The CPPD group compared to the MSU group did not have a significant difference at high and low kV energy levels.

#### CONCLUSION

The Z obtained by the Rho/Z application on DECT is able to differentiate between MSU, CPPD and HADD. The mean HU values at high and low kV values can differentiate between HADD and CPPD and between HADD and MSU.

#### CLINICAL RELEVANCE/APPLICATION

Using DECT can narrow the differential diagnosis of peri-articular mineralized foci - reducing the clinical need for joint aspiration and associated risks and also guide treatment in clinical practice.

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## Abstract Archives of the RSNA, 2023

M4-SSMK03-4

### Development and Validation of a Deep Learning Model for Prediction of Bone Mineral Density and T-score Prediction in Chest X-rays: A Multi-center Study

Monday, Nov. 27 11:00AM - 12:00PM Room: E450A

YOICHI SATO, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Although the number of patients with osteoporosis is increasing worldwide, diagnosis and treatment are presently inadequate. In this study, we developed a deep learning model to predict bone mineral density (BMD) and T-score from chest X-rays, which is one of the most common, easily accessible, and low-cost medical imaging examination methods. In addition to development, we performed external validation to evaluate a deep learning model's reproducibility and generalizability.

#### METHODS AND MATERIALS

We trained, validated, and externally tested a deep learning model to predict BMD and T-score from chest X-rays. This retrospective study included consecutively collected results of dual-energy X-ray absorptiometry (DXA) and chest X-ray that had been obtained between 2010 and 2022 from 20 institutions. For the learning labels, we used (1) BMD (g/cm<sup>2</sup>) of the hip and (2) classification of T-score = -1.0, -2.5 as the threshold. Of these radiographs, 17 institutions were used for training, validation, and internal testing. The 3 other institutions were used for external testing. We trained the deep learning model through ensemble learning of chest X-rays, age, and sex to predict the BMD using regression and T-score for multiclass classification. We assessed the following two metrics to evaluate the performance of the deep learning model in the internal-test dataset and external-test dataset: (1) the correlation coefficient, root mean square error (RMSE) and mean absolute error (MAE) between the predicted and true BMDs and (2) consistency in the T-score between the predicted class and true class.

#### RESULTS

This study included 50,064 radiographs from 24,666 patients across 20 institutions. The training and validation dataset comprised 47,150 radiographs (23,151 patients), while the external test dataset included 2,914 radiographs (1,515 patients). The correlation coefficient, RMSE, and MAE for BMD were 0.68, 0.09, and 0.08, respectively. T-score predictions ( $\leq -1.0$ ) showed 79.0% accuracy, 96.6% sensitivity, and 34.1% specificity, while predictions ( $\leq -2.5$ ) demonstrated 79.7% accuracy, 77.1% sensitivity, and 80.4% specificity.

#### CONCLUSION

These results suggest that the proposed deep learning model may be suitable for screening patients with osteoporosis by predicting the BMD and T-score from chest X-rays.

#### CLINICAL RELEVANCE/APPLICATION

This model may be useful in that it allows screening of osteoporosis patients from chest X-rays, one of the most common and low-cost medical imaging modalities. If this deep learning model becomes available as a medical device, chest X-rays taken in a variety of settings, such as medical examinations, checkups, and hospitals, could be used to screen for osteoporosis.

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## Abstract Archives of the RSNA, 2023

M4-SSMK03-5

### **Prediction of Osteoporosis Associated Fractures: Evaluation of Dual-Energy CT-derived Metrics of the Lumbar Spine**

Monday, Nov. 27 11:00AM - 12:00PM Room: E450A

Simon S. Martin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the association of dual-energy CT (DECT)-derived bone mineral density (BMD) assessment with the occurrence of osteoporosis-associated fractures in a follow-up period of 2 years.

#### **METHODS AND MATERIALS**

L1 of 160 patients (77 men, 83 women; mean age, 64.1 years, range, 19-94 years) who underwent dual-source DECT between 01/2016 and 12/2020 was retrospectively analyzed. Cortical HU, trabecular HU, cortical thickness, and phantomless DECT-based bone BMD were obtained from all examinations. Patient files and follow-up images of patients were examined for the occurrence of osteoporosis-associated fractures. Receiver-operating characteristic (ROC) analysis identified AUC values for BMD, HU values and cortical thickness, and logistic regression models were used to evaluate their associations with the occurrence of osteoporosis-associated fractures.

#### **RESULTS**

ROC curve analysis demonstrated a significantly higher AUC value for DECT-derived BMD compared to cortical HU, trabecular HU and cortical thickness (0.92 vs. 0.67, 0.62 and 0.59, respectively;  $P < .01$ ). Logistic regression models confirmed a significant association of lower DECT-derived BMD with the occurrence of osteoporosis-associated fractures (Odds Ratio, 0.87;  $P < .001$ ), but not of cortical HU, trabecular HU or cortical thickness ( $P > .05$  for all values, respectively).

#### **CONCLUSION**

Dual-energy CT-derived bone mineral density assessment from routine examinations can be used to stratify the risk of sustaining osteoporosis-associated fractures during a follow-up period of 2 years.

#### **CLINICAL RELEVANCE/APPLICATION**

We demonstrate the superiority of dual-energy CT over other methods for opportunistic osteoporosis screening. This information can be used to stratify the risk of patients to sustain fractures and to start patients at risk on osteoporosis treatment without the requirement to perform additional examinations.

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## Abstract Archives of the RSNA, 2023

M4-SSMK03-6

### **QCT-derived Volumetric Bone Mineral Density in the Evaluation of the Lumbar Spine: Comparison with DXA-based Areal Bone Mineral Density and Trabecular BoneScore**

Monday, Nov. 27 11:00AM - 12:00PM Room: E450A

Stefano Fusco (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The application of quantitative computed tomography (QCT) to CT scans performed for other clinical reasons can provide valuable information about bone mineral density (BMD) in the setting of opportunistic screening for osteoporosis. We compared volumetric BMD (vBMD) derived from QCT to dual-energy x-ray absorptiometry (DXA)-based parameters such as areal BMD and trabecular bone score (TBS). We also aimed to assess the diagnostic accuracy of these parameters in discriminating between individuals with and without fragility fractures (FFs).

#### **METHODS AND MATERIALS**

We retrospectively enrolled subjects who underwent both a DXA scan and a non-enhanced chest/abdomen CT scan, with a maximum time lapse of six months between the two examinations. A so-called "asynchronous" calibration was performed on CT images to obtain vBMD values from QCT using QCT PRO v 6.1 software (Mindways Software Inc., Austin, TX). American College of Radiology ranges were used for QCT-vBMD to assign a diagnostic category (normal, osteopenic or osteoporotic status). T-score values were used for DXA diagnosis according to the World Health Organization criteria. TBS values were obtained from DXA on the same areas of BMD analysis. The presence of prevalent fragility fractures (FFs) was assessed at spine, hip and wrist.

#### **RESULTS**

After applying the inclusion and exclusion criteria, our final sample comprised 105 subjects (87 women, mean age  $69 \pm 11$  years). Overall, 49 subjects (46.6%) presented at least one major fragility fracture. QCT diagnosis was as follows: osteoporosis = 59 (56.2%); osteopenia = 36 (34.3%); normal status = 10 (9.5%). DXA diagnosis was: osteoporosis = 25 (23.8%); osteopenia = 35 (33.3%); normal status = 45 (42.9%). A total of 38 subjects (36.2%) showed degraded microarchitecture according to TBS values. A moderate correlation was found between DXA-areal BMD and QCT-vBMD ( $r=0.446$ ) as well as between TBS and vBMD ( $r=0.524$ ), while a good correlation between aBMD and TBS ( $r=0.621$ ) was found. In order to assess the capability of discriminating between subjects with and without FFs, ROC curves were calculated: QCT-vBMD showed the best performance with an AUC of 0.748. On the other hand, AUC for DXA-aBMD was 0.575 and for TBS was 0.650.

#### **CONCLUSION**

Opportunistic QCT evaluation diagnosed a higher prevalence of osteoporosis compared to DXA. vBMD and TBS performed better than DXA-aBMD in discriminating subjects with and without FFs.

#### **CLINICAL RELEVANCE/APPLICATION**

QCT-based opportunistic screening for osteoporosis can partially overcome the limits of DXA, allowing to better identify patients at risk for fragility fractures

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## Abstract Archives of the RSNA, 2023

M4-SSPH04

### Physics (New Imaging Techniques)

Monday, Nov. 27 11:00AM - 12:00PM Room: S405

James M. Kofler JR, PhD (*Moderator*) Nothing to Disclose  
Ioannis Sechopoulos, PhD (*Moderator*) Research Grant, Siemens AG;Speakers Bureau, Siemens AG;Research Grant, Canon Medical Systems Corporation;Research Grant, Sectra AB;Research Grant, ScreenPoint Medical BV;Research Grant, Volpara Health Technologies Limited

#### Sub-Events

#### **M4-SSPH04-1 Quantification of Coronary Artery Stenosis from Dense Calcifications using Ultra-High-Resolution Photon-Counting-Detector CT**

Emily Koons (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To quantify differences in percent area stenosis in patients with coronary artery calcifications between conventional energy-integrating detector (EID) dual-source CT and ultra-high-resolution (UHR) photon-counting-detector (PCD) dual-source CT.

#### **METHODS AND MATERIALS**

After IRB approval and written informed consent, patients undergoing clinically indicated coronary artery CT angiography were prospectively recruited and scanned first on EID-CT (SOMATOM Force, Siemens) then PCD-CT (NAEOTOM Alpha, Siemens) on the same day. EID-CT was performed following our clinical protocol and images reconstructed using 0.6/0.3 mm slice thickness/increment, Bv40 kernel, 512 matrix size, and ADMIRE strength 4. PCD-CT scans were acquired with a retrospectively-gated UHR spiral technique and 120x0.2mm detector collimation. PCD-CT reconstruction parameters were set based on patient weight to achieve the benefits of UHR mode while addressing increased noise with increased patient size: Bv64 kernel, 0.2/0.1 mm for <70 kg; Bv60 kernel, 0.4/0.2mm for 70-110kg; and Bv60 kernel, 0.6/0.3mm for > 110 kg. All images were reconstructed with iterative reconstruction (QIR) strength 4 and 1024 matrix size at the cardiac phase selected by experienced CT technologists to minimize motion artifact. Percent area stenosis was assessed using commercial software (syngo.via, CT Coronary Vascular Definition, Siemens). For each patient, left main, left anterior descending, right coronary artery, and circumflex were reviewed and the most severe stenosis from dense calcification for each segment was quantified.

#### **RESULTS**

A total of 18 patients were enrolled having a total of 28 coronary artery stenoses. Stenosis grade from EID-CT was substantially reduced in PCD-CT, resulting in an average of 16% (SD=15%) area stenosis reduction. Of 28 lesions, 9 had no change in grade based on CAD-RADS, 5 went from severe to moderate; 8 from moderate to mild; 2 from mild to minimal; 2 from severe to mild, 1 from severe to minimal, and 1 from minimal to mild with use of PCD-CT.

#### **CONCLUSION**

Use of PCD UHR mode decreased percent area stenosis by an average of 16% relative to EID due to decreased blooming and improved resolution, resulting in 18 of 28 stenoses being downgraded in severity.

#### **CLINICAL RELEVANCE/APPLICATION**

Reduced blooming artifact and improved lumen visibility with use of PCD UHR mode potentially allows for more accurate non-invasive assessment of coronary artery disease.

#### **M4-SSPH04-2 Brain Perfusion CT without a CT System**

Shalini Subramanian, MS, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Real-time perfusion imaging is highly desirable for effectively using endovascular thrombectomy (EVT) in treating ischemic stroke; the current standard of care is hindered by the lack of intra-operative perfusion imaging. To address this unmet clinical need, we propose an IPEN (intra-intervention perfusion with no C-arm rotation)-based method using X-ray angiographic (XA) images in the interventional suite.

## METHODS AND MATERIALS

IPEN is built on tomographic theory; wherein an object consists of homogenous regions-of-interest (ROIs) with known shapes. This makes  $N$  x-ray beams in a single projection sufficient to estimate values of  $N$  ROIs. IPEN for brain perfusion assessment comprises 3 steps: (1) create patient-specific brain ROIs from the arterial territory atlas, (2) determine head orientation with respect to XA images, and (3) estimate a dynamic time-enhancement curve (TEC) of ROIs. The proposed algorithm was evaluated by computer simulations using XCAT phantom updated for dynamic CT perfusion. Eight ischemic stroke cases were simulated, each presented thrombus occlusion in one of the 4 arteries—middle cerebral (MCA), anterior cerebral, posterior temporal, and posterior parietal. Intra-arterial contrast enhancement was simulated for each case, and bi-plane XA images were acquired. The scan was repeated 5 times. Using the XA images, IPEN was performed to estimate the TEC values. The accuracy of the estimated TEC was quantitatively assessed against the ground truth using normalized weighted root-mean-square error (RMSE) and linear correlation coefficient ( $R$ ).

## RESULTS

Fig. A shows an XA image with a left MCA occlusion. For this case, ROI-based dynamic contrast-enhanced volumes were generated using estimated and true TEC values. Fig B and Fig C qualitatively show great agreement between the estimated and true values in different brain ROIs, both healthy and ischemic. Quantitatively, the estimated TECs had excellent agreement with the true TECs: the RMSE was as low as  $5.0\% \pm 0.6\%$ , and the  $R$  values ranged 0.85-0.95 ( $P < 0.01$ ) for 8 cases. TECs estimated showed consistent performance for different cases over multiple scans. Overall, IPEN for brain perfusion qualitatively and quantitatively shows excellent performance.

## CONCLUSION

IPEN was performed and evaluated using XA images demonstrating its feasibility in the interventional suite. IPEN for brain perfusion successfully estimated ROI-specific TEC values with high accuracy. Using these estimated TEC, we will be able to calculate reliable brain perfusion indices.

## CLINICAL RELEVANCE/APPLICATION

Real-time perfusion is vital to assess the risk-benefit of EVT before, and success during and after the procedure. In IPEN, using XA images provides volumetric assessment without workflow disruption.

## M4-SSPH04-3 Automated Local Motion Detection and Characterization for X-ray CT

Jiang J. Hsieh, PhD (*Presenter*) Former Employee, General Electric Company

## PURPOSE

Despite major advances in technology, CT images are frequently degraded by patient motion. Motion artifacts are often localized and temporally varying. Most hospitals rely on CT operators to detect motion artifacts, and image quality is highly dependent on the operator's experience. In this paper, an automated algorithm is proposed to detect and characterize motion in local regions.

## METHODS AND MATERIALS

We propose a data consistency metric (CM) derived during the reconstruction process. The CM takes advantage of the fact that around a small object (e.g., a blood vessel) the magnitude of the integrated intensity along a circular path for a single back-projected view is near zero. Therefore, the accumulative intensity difference (AID) is linear over views (AID is the average intensity inside an object ROI subtracting its integrated background intensity). When motion is present, the linear relationship no longer holds. The goodness of fit,  $R^2$ , of the linear regression for AID can be used to quantify the motion. CM is capable of characterizing local motions for each projection. In our previous study, CM was demonstrated for small objects with circular and oval cross-sections. In this paper, we generalize the algorithm to cover objects of arbitrary shapes by defining the object ROI as the minimum enclosing circle.

## RESULTS

Extensive computer simulations were used to demonstrate the efficacy of the proposed approach. We simulated projections of three closed packed cylindrical objects. The combined cylinders form an irregular shaped test object. Under motion-free conditions, CM is not impacted by the presence of nominal noise [ $R^2$  values are in the range of (0.9990, 0.9997)]. When motion is present,  $R^2$  value drops to 0.710 for views with the largest deviation from its nominal position. For further confirmation, we superimposed the simulated projection on a clinical chest scan. The goal is to test the algorithm's robustness in the presence of complex patient anatomies. Consistent results were obtained and  $R^2$  value drops to 0.738 for the worst views with motion.



## CONCLUSION

We developed a local consistency metric to detect and quantify patient motion. The proposed method detects patient motion on a view-by-view basis and characterizes motion over small local regions to address motion inhomogeneity inside patients. The algorithm is capable of generating image quality check for each CT examination and provides a useful guidance for artifact avoidance by identifying projection segments with the least motion.

## CLINICAL RELEVANCE/APPLICATION

We present a method to automatically detect patient motion and guide the operator to minimize image artifacts. The local-motion detection allows an optimal image reconstruction for each anatomical sub-region.

### M4-SSPH04-4 **Combining Coronary CT Angiography, Quantitative Myocardial Blood Flow, and Coronary Flow Reserve Measurement with a Low-Dose Comprehensive Cardiac CT Technique - Validation Versus $^{82}\text{Rb}$ PET**

Logan Hubbard, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The ability of dynamic CT perfusion to assess quantitative myocardial blood flow (mL/min/g) and coronary flow reserve (CFR) is of clinical merit, where its tiered use with coronary CT angiography (CCTA) further improves delineation and risk stratification of focal, diffuse, and microvascular coronary artery disease. Nevertheless, current dynamic CT perfusion techniques remain limited by (1) the high radiation dose characteristic to scanning over multiple cardiac cycles (>5 mSv), and (2) the inaccuracies in myocardial blood flow measurement as compared to quantitative PET. Hence, this work validates an accurate, low-dose comprehensive cardiac CT technique that combines CCTA with a new single-volume CT perfusion approach for quantitative myocardial blood flow and CFR measurement.

#### METHODS AND MATERIALS

Eleven patients with known or suspected coronary artery disease underwent rest and stress (regadenoson 0.4mg IV) imaging with quantitative  $^{82}\text{Rb}$  PET. After which, low-dose comprehensive cardiac CT imaging was performed, consisting of a CCTA protocol, a 10-minute delay, and a subsequent single-volume stress (regadenoson 0.4mg IV) CT protocol. For both protocols, the same triphasic contrast injection (Phase 1: 0.8 mL/kg; Phase 2: 30/70% mix of 0.1 mL/kg; Phase 3: 30mL saline; 5 mL/s) was performed, followed by dynamic bolus tracking with CCTA or stress CT acquisition, respectively. The dynamic bolus tracking, CCTA, and stress CT data were then utilized by a new single-volume CT perfusion approach to derive quantitative rest flow (from the CCTA), stress flow, and CFR measurements, which were compared to corresponding  $^{82}\text{Rb}$  PET measurements through regression, Pearson's correlation ( $r$ ), Lin's concordance correlation (CCC), root-mean-square error (RMSE; accuracy), and root-mean-square deviation (RMSD; precision).

#### RESULTS

Per-vessel flow (QCT) and CFR (CFRCT) measurements were related to corresponding  $^{82}\text{Rb}$  measurements (QPET; CFRPET) by  $QCT = 0.91 QPET + 0.18$  ( $r = 0.95$ ; CCC = 0.94; RMSE = 0.25 mL/min/g; RMSD = 0.23 mL/min/g) and  $CFRCT = 0.91 CFRPET + 0.14$  ( $r = 0.78$ ; CCC = 0.76; RMSE = 0.67; RMSD = 0.66). The median effective dose of the comprehensive cardiac CT technique, consisting of CCTA, quantitative rest and stress flow, and CFR combined, was 2.73 mSv (2.28 - 2.78), while the median effective dose of  $^{82}\text{Rb}$  PET was 3.7 mSv (3.2 - 4.1 mSv).

## CONCLUSION

Accurate, low-dose, quantitative CT myocardial blood flow and CFR measurement combined with CCTA is feasible with a new comprehensive cardiac CT technique.

## CLINICAL RELEVANCE/APPLICATION

Combining CCTA with low-dose, quantitative CT myocardial blood flow and CFR measurement has the potential to improve delineation and risk stratification of focal, diffuse, and microvascular coronary artery disease.

### M4-SSPH04-5 **Dielectrography: A Method for Detection of Human Neurological Disorders using Ultra-Wide-Band (UWB) Microwaves - phantom Design and Benchtop Validation**

Seena Dehkharghani, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Stroke remains the second leading cause of death worldwide. Urgent diagnosis is critical; however, limited access to diagnostic imaging perpetuates immense imbalances in health outcomes, with the WHO estimating two-thirds of the world lacking in basic imaging. We have recently reported the remarkable potential of ultrawide band (UWB) microwaves for stroke detection using artificial neural networks. Prudent design of clinic-ready instrumentation demands rigorous bench validation, however, anatomically realistic test beds for hypothesis testing and validation are lacking. We present an experimental framework and test environment to facilitate development of UWB diagnostic systems for human use.



## METHODS AND MATERIALS

Aqueous and gelatinous head-mimicking dielectric phantoms were fabricated. Blood-mimicking models of varying shapes (e.g., spherical, star) and sizes up to 30 mm were introduced. Realistic human head models were 3D printed and filled with compartment-specific dielectric substrate. Modified antipodal Vivaldi antennas were engineered to support the UWB (0.8-10GHz) and high directivity demands. In house switch matrices were designed to interface to a high-performance vector network analyzer (VNA). Following dielectric calibrations, pilot 8 antenna array was tested with an 8x2 microwave switch matrix for 2-port scattering measurements at variable IF bandwidth (10-100 KHz). A robot navigation system was used for controlled (sub-mm) manipulation of the blood model with a pseudorandom trajectory at 127 positions on a Cartesian grid. Scan time for each location was ~10s. A 2D neural network was trained for classification and localization using the complex values from S-parameter matrices across UWB interrogation. The sensitivity and specificity of the network for multi-class detection and localization error (in mm) were reported.

## RESULTS

Fig 1 demonstrates experimental environment for UWB microwave testing, phantom development, and network performance. High overall sensitivity (>90%) and specificity (100%) for the presence of all hemorrhage classes is shown in the confusion matrix with associated heat map. Median absolute volumetric error for hemorrhage location was <1mm. Maximum operating power remained <3 dBm RMS, well below that of cellular devices. Scaled production costs are projected at \$10-30K for full-form human subject systems.

## CONCLUSION

We present an adaptable bioengineering test bed for hypothesis testing of UWB microwave imaging (MWI). The findings validate the unprecedented potential of low-energy MWI, leveraging advancements in deep neural networks. Human subjects scanning is underway.

## CLINICAL RELEVANCE/APPLICATION

An experimental test bed for development of human UWB MW instruments is introduced.

### M4-SSPH04-6 Simulating Lower-dose Exams in Whole-body Photon-counting-detector CT

Timothy N. Winfree, BS, MS (*Presenter*) Nothing to Disclose

## PURPOSE

To develop and validate a projection domain noise insertion algorithm to simulate lower-dose exams for photon-counting-detector (PCD) CT while avoiding the addition of pulse pileup effects.

## METHODS AND MATERIALS

We developed a projection-domain noise insertion algorithm to simulate lower-dose exams from existing exams performed on a PCD-CT scanner (NAEOTOM Alpha, Siemens). The noise model incorporated the effects of the bowtie filter and automatic exposure control (AEC). A map of the incident number of photons  $N_0(u,v)$  at each detector pixel when no object was in the beam was quantified in terms of noise equivalent quanta (NEQ), which was calculated from the variance in the log normalized projection data of each scan for both low and high threshold energies (T1 and T2). Additionally, projection data were acquired for eight different mAs levels (10, 20, 40, 80, 160, 320, 640, 1280) at 120 kV to investigate the impact of pulse pileup on the linearity of NEQ measurement. The noise insertion algorithm was validated using a 30cm water tank and an anthropomorphic phantom. The 30cm water phantom was scanned using 120kV at 320, 160, and 80 mAs. Starting from the 320 mAs data, lower dose data at 160 mAs and 80 mAs were simulated and compared with the acquired data. Noise Power Spectra (NPS) were calculated to assess the noise texture. An anthropomorphic phantom was scanned using 120 kV at 160, 80 and 40 mAs with AEC on and lower dose data at 80 mAs and 40 mAs were simulated. Noise was measured manually every 20 slices and compared between simulated and acquired images.

## RESULTS

NEQ profiles were linear up until 160 mAs in air scans, after which pulse pileup effects impacted the NEQ profile. To avoid propagating these effects into our noise-inserted images, we acquired the  $N_0$  profile at 20 mAs, and scaled the profile according to the actual mAs used for the scan we are inserting noise into. The NPS curves of simulated low dose images agreed well with that from measured images, differing by a maximum of 5.0%, 6.3%, 4.1%, and 6.1% for half-dose (HD) T1, HD T2, quarter-dose (QD) T1, and QD T2 images, respectively. Noise in the anthropomorphic phantom showed excellent agreement between measured and simulated images, with percent root mean square errors of 5.9%, 5.4%, 5.0%, and 4.6% for QD T1, HD T1, QD T2, and HD T2, respectively.

## CONCLUSION

An accurate noise insertion tool was developed for PCD-CT to synthesize lower dose images from existing exams by taking into account the impact of pulse pileup.

## **CLINICAL RELEVANCE/APPLICATION**

This noise insertion tool enables the generation of lower dose images from existing exams, which can be used to optimize radiation dose in scanning protocols and train deep-learning-based noise reduction algorithms for PCD-CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-SSPH04-1

### Quantification of Coronary Artery Stenosis from Dense Calcifications using Ultra-High-Resolution Photon-Counting-Detector CT

Monday, Nov. 27 11:00AM - 12:00PM Room: S405

Emily Koons (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantify differences in percent area stenosis in patients with coronary artery calcifications between conventional energy-integrating detector (EID) dual-source CT and ultra-high-resolution (UHR) photon-counting-detector (PCD) dual-source CT.

#### METHODS AND MATERIALS

After IRB approval and written informed consent, patients undergoing clinically indicated coronary artery CT angiography were prospectively recruited and scanned first on EID-CT (SOMATOM Force, Siemens) then PCD-CT (NAEOTOM Alpha, Siemens) on the same day. EID-CT was performed following our clinical protocol and images reconstructed using 0.6/0.3 mm slice thickness/increment, Bv40 kernel, 512 matrix size, and ADMIRE strength 4. PCD-CT scans were acquired with a retrospectively-gated UHR spiral technique and 120x0.2mm detector collimation. PCD-CT reconstruction parameters were set based on patient weight to achieve the benefits of UHR mode while addressing increased noise with increased patient size: Bv64 kernel, 0.2/0.1 mm for <70 kg; Bv60 kernel, 0.4/0.2mm for 70-110kg; and Bv60 kernel, 0.6/0.3mm for > 110 kg. All images were reconstructed with iterative reconstruction (QIR) strength 4 and 1024 matrix size at the cardiac phase selected by experienced CT technologists to minimize motion artifact. Percent area stenosis was assessed using commercial software (syngo.via, CT Coronary Vascular Definition, Siemens). For each patient, left main, left anterior descending, right coronary artery, and circumflex were reviewed and the most severe stenosis from dense calcification for each segment was quantified.

#### RESULTS

A total of 18 patients were enrolled having a total of 28 coronary artery stenoses. Stenosis grade from EID-CT was substantially reduced in PCD-CT, resulting in an average of 16% (SD=15%) area stenosis reduction. Of 28 lesions, 9 had no change in grade based on CAD-RADS, 5 went from severe to moderate; 8 from moderate to mild; 2 from mild to minimal; 2 from severe to mild, 1 from severe to minimal, and 1 from minimal to mild with use of PCD-CT.

#### CONCLUSION

Use of PCD UHR mode decreased percent area stenosis by an average of 16% relative to EID due to decreased blooming and improved resolution, resulting in 18 of 28 stenoses being downgraded in severity.

#### CLINICAL RELEVANCE/APPLICATION

Reduced blooming artifact and improved lumen visibility with use of PCD UHR mode potentially allows for more accurate non-invasive assessment of coronary artery disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M4-SSPH04-2

### Brain Perfusion CT without a CT System

Monday, Nov. 27 11:00AM - 12:00PM Room: S405

Shalini Subramanian, MS, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Real-time perfusion imaging is highly desirable for effectively using endovascular thrombectomy (EVT) in treating ischemic stroke; the current standard of care is hindered by the lack of intra-operative perfusion imaging. To address this unmet clinical need, we propose an IPEN (intra-intervention perfusion with no C-arm rotation)-based method using X-ray angiographic (XA) images in the interventional suite.

#### METHODS AND MATERIALS

IPEN is built on tomographic theory; wherein an object consists of homogenous regions-of-interest (ROIs) with known shapes. This makes  $N$  x-ray beams in a single projection sufficient to estimate values of  $N$  ROIs. IPEN for brain perfusion assessment comprises 3 steps: (1) create patient-specific brain ROIs from the arterial territory atlas, (2) determine head orientation with respect to XA images, and (3) estimate a dynamic time-enhancement curve (TEC) of ROIs. The proposed algorithm was evaluated by computer simulations using XCAT phantom updated for dynamic CT perfusion. Eight ischemic stroke cases were simulated, each presented thrombus occlusion in one of the 4 arteries—middle cerebral (MCA), anterior cerebral, posterior temporal, and posterior parietal. Intra-arterial contrast enhancement was simulated for each case, and bi-plane XA images were acquired. The scan was repeated 5 times. Using the XA images, IPEN was performed to estimate the TEC values. The accuracy of the estimated TEC was quantitatively assessed against the ground truth using normalized weighted root-mean-square error (RMSE) and linear correlation coefficient ( $R$ ).

#### RESULTS

Fig. A shows an XA image with a left MCA occlusion. For this case, ROI-based dynamic contrast-enhanced volumes were generated using estimated and true TEC values. Fig B and Fig C qualitatively show great agreement between the estimated and true values in different brain ROIs, both healthy and ischemic. Quantitatively, the estimated TECs had excellent agreement with the true TECs: the RMSE was as low as  $5.0\% \pm 0.6\%$ , and the  $R$  values ranged 0.85-0.95 ( $P < 0.01$ ) for 8 cases. TECs estimated showed consistent performance for different cases over multiple scans. Overall, IPEN for brain perfusion qualitatively and quantitatively shows excellent performance.

#### CONCLUSION

IPEN was performed and evaluated using XA images demonstrating its feasibility in the interventional suite. IPEN for brain perfusion successfully estimated ROI-specific TEC values with high accuracy. Using these estimated TEC, we will be able to calculate reliable brain perfusion indices.

#### CLINICAL RELEVANCE/APPLICATION

Real-time perfusion is vital to assess the risk-benefit of EVT before, and success during and after the procedure. In IPEN, using XA images provides volumetric assessment without workflow disruption.

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## Abstract Archives of the RSNA, 2023

M4-SSPH04-3

### Automated Local Motion Detection and Characterization for X-ray CT

Monday, Nov. 27 11:00AM - 12:00PM Room: S405

Jiang J. Hsieh, PhD (*Presenter*) Former Employee, General Electric Company

#### PURPOSE

Despite major advances in technology, CT images are frequently degraded by patient motion. Motion artifacts are often localized and temporally varying. Most hospitals rely on CT operators to detect motion artifacts, and image quality is highly dependent on the operator's experience. In this paper, an automated algorithm is proposed to detect and characterize motion in local regions.

#### METHODS AND MATERIALS

We propose a data consistency metric (CM) derived during the reconstruction process. The CM takes advantage of the fact that around a small object (e.g., a blood vessel) the magnitude of the integrated intensity along a circular path for a single back-projected view is near zero. Therefore, the accumulative intensity difference (AID) is linear over views (AID is the average intensity inside an object ROI subtracting its integrated background intensity). When motion is present, the linear relationship no longer holds. The goodness of fit,  $R^2$ , of the linear regression for AID can be used to quantify the motion. CM is capable of characterizing local motions for each projection. In our previous study, CM was demonstrated for small objects with circular and oval cross-sections. In this paper, we generalize the algorithm to cover objects of arbitrary shapes by defining the object ROI as the minimum enclosing circle.

#### RESULTS

Extensive computer simulations were used to demonstrate the efficacy of the proposed approach. We simulated projections of three closed packed cylindrical objects. The combined cylinders form an irregular shaped test object. Under motion-free conditions, CM is not impacted by the presence of nominal noise [ $R^2$  values are in the range of (0.9990, 0.9997)]. When motion is present,  $R^2$  value drops to 0.710 for views with the largest deviation from its nominal position. For further confirmation, we superimposed the simulated projection on a clinical chest scan. The goal is to test the algorithm's robustness in the presence of complex patient anatomies. Consistent results were obtained and  $R^2$  value drops to 0.738 for the worst views with motion.

#### CONCLUSION

We developed a local consistency metric to detect and quantify patient motion. The proposed method detects patient motion on a view-by-view basis and characterizes motion over small local regions to address motion inhomogeneity inside patients. The algorithm is capable of generating image quality check for each CT examination and provides a useful guidance for artifact avoidance by identifying projection segments with the least motion.

#### CLINICAL RELEVANCE/APPLICATION

We present a method to automatically detect patient motion and guide the operator to minimize image artifacts. The local-motion detection allows an optimal image reconstruction for each anatomical sub-region.

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## Abstract Archives of the RSNA, 2023

M4-SSPH04-4

### Combining Coronary CT Angiography, Quantitative Myocardial Blood Flow, and Coronary Flow Reserve Measurement with a Low-Dose Comprehensive Cardiac CT Technique - Validation Versus $^{82}\text{Rb}$ PET

Monday, Nov. 27 11:00AM - 12:00PM Room: S405

Logan Hubbard, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The ability of dynamic CT perfusion to assess quantitative myocardial blood flow (mL/min/g) and coronary flow reserve (CFR) is of clinical merit, where its tiered use with coronary CT angiography (CCTA) further improves delineation and risk stratification of focal, diffuse, and microvascular coronary artery disease. Nevertheless, current dynamic CT perfusion techniques remain limited by (1) the high radiation dose characteristic to scanning over multiple cardiac cycles (>5 mSv), and (2) the inaccuracies in myocardial blood flow measurement as compared to quantitative PET. Hence, this work validates an accurate, low-dose comprehensive cardiac CT technique that combines CCTA with a new single-volume CT perfusion approach for quantitative myocardial blood flow and CFR measurement.

#### METHODS AND MATERIALS

Eleven patients with known or suspected coronary artery disease underwent rest and stress (regadenoson 0.4mg IV) imaging with quantitative  $^{82}\text{Rb}$  PET. After which, low-dose comprehensive cardiac CT imaging was performed, consisting of a CCTA protocol, a 10-minute delay, and a subsequent single-volume stress (regadenoson 0.4mg IV) CT protocol. For both protocols, the same triphasic contrast injection (Phase 1: 0.8 mL/kg; Phase 2: 30/70% mix of 0.1 mL/kg; Phase 3: 30mL saline; 5 mL/s) was performed, followed by dynamic bolus tracking with CCTA or stress CT acquisition, respectively. The dynamic bolus tracking, CCTA, and stress CT data were then utilized by a new single-volume CT perfusion approach to derive quantitative rest flow (from the CCTA), stress flow, and CFR measurements, which were compared to corresponding  $^{82}\text{Rb}$  PET measurements through regression, Pearson's correlation ( $r$ ), Lin's concordance correlation (CCC), root-mean-square error (RMSE; accuracy), and root-mean-square deviation (RMSD; precision).

#### RESULTS

Per-vessel flow (QCT) and CFR (CFRCT) measurements were related to corresponding  $^{82}\text{Rb}$  measurements (QPET; CFRPET) by  $QCT = 0.91 QPET + 0.18$  ( $r = 0.95$ ; CCC = 0.94; RMSE = 0.25 mL/min/g; RMSD = 0.23 mL/min/g) and  $CFRCT = 0.91 CFRPET + 0.14$  ( $r = 0.78$ ; CCC = 0.76; RMSE = 0.67; RMSD = 0.66). The median effective dose of the comprehensive cardiac CT technique, consisting of CCTA, quantitative rest and stress flow, and CFR combined, was 2.73 mSv (2.28 - 2.78), while the median effective dose of  $^{82}\text{Rb}$  PET was 3.7 mSv (3.2 - 4.1 mSv).

#### CONCLUSION

Accurate, low-dose, quantitative CT myocardial blood flow and CFR measurement combined with CCTA is feasible with a new comprehensive cardiac CT technique.

#### CLINICAL RELEVANCE/APPLICATION

Combining CCTA with low-dose, quantitative CT myocardial blood flow and CFR measurement has the potential to improve delineation and risk stratification of focal, diffuse, and microvascular coronary artery disease.

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## Abstract Archives of the RSNA, 2023

M4-SSPH04-5

### **Dielectrography: A Method for Detection of Human Neurological Disorders using Ultra-Wide-Band (UWB) Microwaves - phantom Design and Benchtop Validation**

Monday, Nov. 27 11:00AM - 12:00PM Room: S405

Seena Dehkharghani, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Stroke remains the second leading cause of death worldwide. Urgent diagnosis is critical; however, limited access to diagnostic imaging perpetuates immense imbalances in health outcomes, with the WHO estimating two-thirds of the world lacking in basic imaging. We have recently reported the remarkable potential of ultrawide band (UWB) microwaves for stroke detection using artificial neural networks. Prudent design of clinic-ready instrumentation demands rigorous bench validation, however, anatomically realistic test beds for hypothesis testing and validation are lacking. We present an experimental framework and test environment to facilitate development of UWB diagnostic systems for human use.

#### **METHODS AND MATERIALS**

Aqueous and gelatinous head-mimicking dielectric phantoms were fabricated. Blood-mimicking models of varying shapes (e.g., spherical, star) and sizes up to 30 mm were introduced. Realistic human head models were 3D printed and filled with compartment-specific dielectric substrate. Modified antipodal Vivaldi antennas were engineered to support the UWB (0.8-10GHz) and high directivity demands. In house switch matrices were designed to interface to a high-performance vector network analyzer (VNA). Following dielectric calibrations, pilot 8 antenna array was tested with an 8x2 microwave switch matrix for 2-port scattering measurements at variable IF bandwidth (10-100 KHz). A robot navigation system was used for controlled (sub-mm) manipulation of the blood model with a pseudorandom trajectory at 127 positions on a Cartesian grid. Scan time for each location was ~10s. A 2D neural network was trained for classification and localization using the complex values from S-parameter matrices across UWB interrogation. The sensitivity and specificity of the network for multi-class detection and localization error (in mm) were reported.

#### **RESULTS**

Fig 1 demonstrates experimental environment for UWB microwave testing, phantom development, and network performance. High overall sensitivity (>90%) and specificity (100%) for the presence of all hemorrhage classes is shown in the confusion matrix with associated heat map. Median absolute volumetric error for hemorrhage location was <1mm. Maximum operating power remained <3 dBm RMS, well below that of cellular devices. Scaled production costs are projected at \$10-30K for full-form human subject systems.

#### **CONCLUSION**

We present an adaptable bioengineering test bed for hypothesis testing of UWB microwave imaging (MWI). The findings validate the unprecedented potential of low-energy MWI, leveraging advancements in deep neural networks. Human subjects scanning is underway.

#### **CLINICAL RELEVANCE/APPLICATION**

An experimental test bed for development of human UWB MW instruments is introduced.

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## Abstract Archives of the RSNA, 2023

M4-SSPH04-6

### Simulating Lower-dose Exams in Whole-body Photon-counting-detector CT

Monday, Nov. 27 11:00AM - 12:00PM Room: S405

Timothy N. Winfree, BS, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a projection domain noise insertion algorithm to simulate lower-dose exams for photon-counting-detector (PCD) CT while avoiding the addition of pulse pileup effects.

#### METHODS AND MATERIALS

We developed a projection-domain noise insertion algorithm to simulate lower-dose exams from existing exams performed on a PCD-CT scanner (NAEOTOM Alpha, Siemens). The noise model incorporated the effects of the bowtie filter and automatic exposure control (AEC). A map of the incident number of photons  $N_0(u,v)$  at each detector pixel when no object was in the beam was quantified in terms of noise equivalent quanta (NEQ), which was calculated from the variance in the log normalized projection data of each scan for both low and high threshold energies (T1 and T2). Additionally, projection data were acquired for eight different mAs levels (10, 20, 40, 80, 160, 320, 640, 1280) at 120 kV to investigate the impact of pulse pileup on the linearity of NEQ measurement. The noise insertion algorithm was validated using a 30cm water tank and an anthropomorphic phantom. The 30cm water phantom was scanned using 120kV at 320, 160, and 80 mAs. Starting from the 320 mAs data, lower dose data at 160 mAs and 80 mAs were simulated and compared with the acquired data. Noise Power Spectra (NPS) were calculated to assess the noise texture. An anthropomorphic phantom was scanned using 120 kV at 160, 80 and 40 mAs with AEC on and lower dose data at 80 mAs and 40 mAs were simulated. Noise was measured manually every 20 slices and compared between simulated and acquired images.

#### RESULTS

NEQ profiles were linear up until 160 mAs in air scans, after which pulse pileup effects impacted the NEQ profile. To avoid propagating these effects into our noise-inserted images, we acquired the  $N_0$  profile at 20 mAs, and scaled the profile according to the actual mAs used for the scan we are inserting noise into. The NPS curves of simulated low dose images agreed well with that from measured images, differing by a maximum of 5.0%, 6.3%, 4.1%, and 6.1% for half-dose (HD) T1, HD T2, quarter-dose (QD) T1, and QD T2 images, respectively. Noise in the anthropomorphic phantom showed excellent agreement between measured and simulated images, with percent root mean square errors of 5.9%, 5.4%, 5.0%, and 4.6% for QD T1, HD T1, QD T2, and HD T2, respectively.

#### CONCLUSION

An accurate noise insertion tool was developed for PCD-CT to synthesize lower dose images from existing exams by taking into account the impact of pulse pileup.

#### CLINICAL RELEVANCE/APPLICATION

This noise insertion tool enables the generation of lower dose images from existing exams, which can be used to optimize radiation dose in scanning protocols and train deep-learning-based noise reduction algorithms for PCD-CT.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5A-SPBR-1

### Added Value of Contrast-enhanced Digital Mammography (CEDM) in BI-RADS 3 Lesions

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Christofis Charalambous, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our study is to evaluate if our cancer detection rate in our institution for BI-RADS 3 lesions was less than 2%, and to assess if our detection rate could be improved by using contrast-enhanced digital mammography (CEDM).

#### **METHODS AND MATERIALS**

A total of 473 BI-RADS 3 patients depicted on screening mammogram from 2018 to 2020 were collected from our files. All the patients consented to undergo CEDM and biopsy at their next hospital visit. Contrast enhancement intensity categorized as follows: a) Type -1: negative enhancement, b) Type 0: no enhancement c) Type 1: moderate enhancement, d) Type 2: intense enhancement and/or e) Type BE: background enhancement. Pathology results confirmed 473 lesions in total.

#### **RESULTS**

18 (3,81%) out of the 473 lesions were diagnosed as malignant. The mean age of the patients was 56,22 years. On the contrary, 455 (96,89%) lesions were benign. The mean age of these patients was 51,04. Using CEDM's technique data a total of 5 (1,95%) out of 256 lesions with Type -1 and Type 0 enhancement were diagnosed as malignant and 251 (98,05%) were benign. Additionally, a total of 13 (5,99%) out of 217 lesions with any type of enhancement were proved as malignant and 204 (94,01%) were proved as benign. Negative or no enhancement of a BI-RADS 3 lesion at CEM technique shows 1,95% possibility to be malignant, which is 1,86% better than digital mammography alone.

#### **CONCLUSION**

Our study confirms CEDM's added value in BI-RADS 3 lesions evaluation, regarding the positive impact on more accurate staging in the first categorization.

#### **CLINICAL RELEVANCE/APPLICATION**

The use of CEDM on a BI-RADS 3 lesions could potentially predict more accurately benign entities, based on their type of enhancement, and thus play a key role as first line mammography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPBR-2

### **Diagnostic Accuracy of Thoracic Photon-counting Computed Tomography for Locoregional Staging of Breast Cancer: A Prospective Trial**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Jakob Neubauer, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study was to demonstrate the feasibility of complementary locoregional staging of breast cancer in thoracic photon-counting CT (PC-CT) and determine diagnostic performance compared to digital mammography (DM) with MRI as the reference standard.

#### **METHODS AND MATERIALS**

This prospective clinical cohort study included patients with newly diagnosed breast cancer and indication for CT staging of the thorax over a period of 12 months. Patients underwent contrast-enhanced thoracic PC-CT (NAEOTOM Alpha, Siemens Healthineers) and breast MRI in prone position. PC-CT and DM were rated by two independent radiologists regarding the diameter of the largest mass, infiltration of cutis/pectoral muscle/ thoracic wall, number of masses, adjacent DCIS, tumor conspicuity, and diagnostic confidence in a blinded fashion. Reference standard was generated from a consensus reading of MRI by an independent adjudication committee including all histopathological/clinical data. Statistical analysis comprised calculation of Cohen's kappa, Spearman's rho, and pooled measures of diagnostic accuracy.

#### **RESULTS**

Among 32 enrolled female subjects (mean age 59 [SD 13.0]) diagnostic accuracy for T-classification (TNM8thEd.) was higher for PC-CT compared to DM (0.94 vs. 0.50;  $p < 0.01$ ) and the number of detected tumor masses were more strongly correlated with the reference standard compared to DM (0.72 vs. 0.50;  $p < 0.01$ ). Furthermore, sensitivity and specificity for DCIS were higher in PC-CT compared to DM (0.83 and 0.99 vs. 0.25 and 0.80;  $p < 0.04$ ). Average kappa values for inter-reader reliability were higher for PC-CT than DM (mean 0.88 vs. 0.54, respectively;  $p = 0.01$ ).

#### **CONCLUSION**

Locoregional breast cancer staging using contrast-enhanced thoracic PC-CT outperformed digital mammography, with significant improvements in diagnostic accuracy for T-classification, number, and pattern of tumor masses.

#### **CLINICAL RELEVANCE/APPLICATION**

Contrast-enhanced thoracic PC-CT might help provide a more accurate locoregional staging for breast cancer compared to digital mammography.

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## Abstract Archives of the RSNA, 2023

M5A-SPBR-3

### Contrast Enhanced Mammography: Results after 10 Years of Breast Cancer Screening

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Nisim Rahman, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the efficacy of contrast-enhanced mammography (CEM) in detecting breast cancer over a ten-year period in women with intermediate breast cancer risk or dense breasts.

#### METHODS AND MATERIALS

We conducted a retrospective analysis of all CEM examinations performed for screening purposes at our institution between 2012 and 2023. Demographic data, breast density scores, background enhancement, and BI-RADS scores were extracted using rule-based natural language processing (NLP) techniques. Biopsies performed following CEM examinations and their respective pathology results were also identified. Positive CEM results were defined as BI-RADS 3-5 or 0, while negative results were BI-RADS 1-2. BI-RADS scores of CEM and low-energy images (equivalent to 2D-mammography) were compared with biopsy results and imaging follow-up.

#### RESULTS

A total of 5424 CEM screening examinations were performed between the years 2012 and 2023 in 3484 women. The mean age was 54 years, and 18.2% of women (633/3484) had family history of breast cancer. Dense breasts (BI-RADS density score C-D) were observed in 88.3% (3076/3484) of the women, and 34.2% (1193/3484) had background parenchymal enhancement at CEM. A total of 367 biopsies were performed following CEM examinations, and 42 were malignant. CEM detected all cancer cases: sensitivity 100% (42/42), specificity 79.2% (4297/5424), PPV 3.6% (42/1169), NPV 100% (4297/4297). Eight interval cancers were identified during the first-year of follow-up. Of them six with a BI-RADS 0 score at CEM and supplemental MRI recommendation, and two with BI-RADS 3 scores at CEM and six months follow-up. CEM increased the cancer detection rate beyond 2D mammography, with an incremental cancer detection rate of 4/1000 screens.

#### CONCLUSION

CEM increased breast cancer detection rate compared to 2D mammography in women with dense breasts and intermediate breast cancer risk.

#### CLINICAL RELEVANCE/APPLICATION

This ten-year screening cohort supports the implementation of CEM for breast cancer screening in specific populations, including women with intermediate breast cancer risk and dense breasts.

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## Abstract Archives of the RSNA, 2023

M5A-SPBR-4

### Seeing through Contrast: A Dosimetric Comparison of CEM-guided Biopsy and Other Mammography-guided Procedures

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Rodrigo Alcantara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to evaluate the average glandular dose (AGD) of contrast-enhanced mammography (CEM) guidance in comparison with other mammography-guided techniques, including digital stereotactic breast biopsy (SBB) and digital breast tomosynthesis (DBT) guidance. Additionally, we investigate the relationship between AGD and compressed breast thickness (CBT) and estimate the percentage dose due to low-energy (LE) and high-energy (HE) images for routine and interventional CEM.

#### METHODS AND MATERIALS

We performed a retrospective analysis of 163 anonymized mammography-guided interventions, comprising 43 contrast-enhanced mammography (CEM)-guided interventions, all conducted using the same upright mammography unit. Our assessment focused on the overall average glandular dose (AGD) per image acquisition and modality, as well as its dependence on breast thickness. Additionally, we evaluated the AGD differences between low-energy (LE) and high-energy (HE) acquisitions for both CEM approaches.

#### RESULTS

Our study found that the AGD for a single CEM-guided biopsy acquisition (1.48 mGy) was similar to SBB (1.49 mGy) and a single DBT scout (1.55 mGy). The AGD increased with increasing breast thickness for all modalities, with a lower slope for CEM guidance compared to other modalities. Both SBB and CEM require a similar number of images per procedure, while DBT-guided biopsy requires fewer images and offers a lower AGD range. The AGD from a CEM was similar to SBB, even inferior for higher CBT. AGD proportions between LE and HE images are relatively similar for routine and single CEM-guided biopsy image acquisition, with overall dose increase predominantly attributed to LE images across all breast thicknesses.

#### CONCLUSION

Our findings indicate that the radiation dose from CEM guidance during mammography-guided biopsies is within the range commonly achieved for conventional SBB and lower than the values obtained for standard SBB at higher compressed breast thickness. CEM guidance presents great potential to improve the visibility of suspected findings, suggesting it can be a valuable tool for breast interventionism, not only for RC-only findings but also for other indications where increased visibility is required.

#### CLINICAL RELEVANCE/APPLICATION

This study provides important dosimetric information on the safety of CEM-guided biopsy, showing that it is a comparable and effective tool for breast interventionism, with similar radiation dose to other established procedures. Our results highlight the potential benefits of CEM-guidance in improving the visibility of suspected findings and increasing diagnostic accuracy in breast imaging.

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## Abstract Archives of the RSNA, 2023

M5A-SPBR-5

### Uncovering the Unseen: The Potential of CEM for Invasive Lobular Carcinoma Detection

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Rodrigo Alcantara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Invasive lobular carcinoma (ILC) can be challenging to detect due to its slow-growing nature and subtle appearance. The aim of this study was to determine the lesion conspicuity using contrast-enhanced mammography (CEM) and compare the diagnostic performance of CEM and MRI. We also assessed the correlation of the overall lesion size on imaging with the final histopathological report.

#### METHODS AND MATERIALS

We retrospectively selected 94 patients with a histopathological diagnosis of ILC who had undergone preoperative CEM between January 2018 and June 2022 at the Hospital del Mar in Barcelona. We collected data on CEM indication, breast density, background parenchymal enhancement (BPE), multicentricity/multifocality, lesion location, lesion findings on low energy (LE) and recombined (RC) images, lesion conspicuity, and lesion size in LE (mm). We also performed a comparative analysis between CEM and MRI for the 59 cases that had both modalities, and verified the agreement between the measurement of lesions in CEM and the sizes in MRI and the final histologic report.

#### RESULTS

CEM sensitivity in detecting ILC was 98%, and the lesion conspicuity was high in most cases. CEM was not inferior to MRI for ILC evaluation or tumor size assessment, with a positive correlation between CEM and MRI, CEM and histopathology, and MRI and histopathology. The difference between the mean lesion size for CEM and MRI compared to the mean lesion size reported by histopathology was not statically significant.

#### CONCLUSION

Despite ongoing debate about ILC's perceived weaker enhancement on CEM compared to invasive ductal carcinoma, our results showed that CEM can be a valuable alternative to MRI for ILC evaluation, providing a safe, immediately available, and rapid assessment of tumor extent.

#### CLINICAL RELEVANCE/APPLICATION

CEM can be a useful alternative to MRI for the preoperative assessment of patients with ILC. It can also help detect potentially larger tumor sizes than initially expected and aid in making appropriate targeting decisions.

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## Abstract Archives of the RSNA, 2023

M5A-SPBR-6

### Interobserver Agreement between Breast Imagers using the First Version of the BI-RADS CEM Lexicon

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Ambra Santonocito, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to assess the interobserver agreement of the CEM lexicon, which has been introduced as a supplement to the 5th edition of the BI-RADS mammography lexicon.

#### METHODS AND MATERIALS

IRB-approved single center retrospective study. Three breast imaging fellows reviewed 295 lesions in 246 routine clinical breast CEM according to the fifth edition of the BI-RADS lexicon for Mammography and to the first version of the BI-RADS lexicon for CEM. Readers were blinded to patient outcomes, and evaluated breast and lesion features on low energy images (ACR breast density, type of findings, associated architectural distortion), lesion features in recombined images (enhancement findings, lesion conspicuity, mass shape, mass margin, mass internal pattern of enhancement, non-mass distribution, non-mass internal pattern of enhancement, enhancing asymmetry) and also provided a final BI-RADS assessment for both images (MG BI-RADS and CEM BI-RADS assessment). Interobserver agreement was calculated for each evaluated feature using kappa ( $\kappa$ ) statistics.

#### RESULTS

Interobserver agreement for ACR breast density was substantial ( $\kappa = 0.622$ ). Interobserver agreement was moderate to substantial for breast density and findings assessment on both low-energy and recombined images, especially for type of findings ( $\kappa = 0.644$ ) and for enhancement findings ( $\kappa = 0.700$ ). Regarding mass enhancement, there was moderate agreement for shape ( $\kappa = 0.571$ ) and substantial agreement for margins ( $\kappa = 0.603$ ) and internal enhancement ( $\kappa = 0.648$ ). For non-mass enhancement, there was moderate agreement on distribution ( $\kappa = 0.445$ ) and internal enhancement ( $\kappa = 0.518$ ). However, agreement was only fair for asymmetric enhancement's descriptors (homogeneous vs heterogeneous,  $\kappa = 0.313$ ) and MG and CEM BI-RADS assessment ( $\kappa = 0.379$  and  $\kappa = 0.375$ , respectively).

#### CONCLUSION

Moderate and substantial interobserver agreement were demonstrated for breast density and findings assessment on both low-energy and recombined images. There was moderate to substantial agreement on most CEM BI-RADS lesion morphology descriptors, while the agreement was only fair for the descriptors of an enhancing asymmetry.

#### CLINICAL RELEVANCE/APPLICATION

Most of CEM-BIRADS lexicon features allow for an overall high inter-reader agreement, with a lower agreement regarding the descriptors of an enhancing asymmetry and overall BI-RADS assessment.

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## Abstract Archives of the RSNA, 2023

M5A-SPBR-7

### Can Contrast-enhanced Mammography (CEM) Categorize More Accurate B3 Lesions and Reduce Unnecessary Surgical Excisions?

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Christofis Charalambous, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

a) To evaluate the upgrade rates of B3 lesions to malignancy b) To assess if we can get any benefit using CEM to avoid unnecessary open surgical excisions (OSE).

#### METHODS AND MATERIALS

This is a retrospective analysis of CEM examinations that performed in our institution from 2012-2015. The analysis included a total of 1092 CEM examinations. Contrast enhancement intensity was categorized in four categories as follows: a) "-1": negative enhancement, b) "0": no enhancement c) "1": enhancement and d) "BPE": background parenchymal enhancement. In addition to the CEM procedures, 776 core needle biopsies (CNB) were performed. The analysis found that 68 patients returned 71 B3 lesions at the pathology result. As a result, an open surgical excision (OSE) was then performed.

#### RESULTS

Out of the 71 B3 lesions, 16 (22.54%) were atypical ductal hyperplasia (ADH), 2 (2.82%) were flat epithelial atypia (FEA), 14 (19.72%) were lobular neoplasia (LN), 1 (1.41%) was phyllodes tumor (PT), 33 (46.48%) were papillary lesions (PL) and 5 (7.04%) were radial scars (RS). Using CEM's results these lesions were categorized as follows: 59 (83.1%) lesions had any type of enhancement either "1" or "BPE" and 12 (16.9%) of the lesions had "0" enhancement. None of the lesions had "-1" enhancement. After OSE, 18 (25.35%) lesions upgraded their histological result to a malignancy from which 6 (33.33%) were first categorized as ADH, 1 (1.85%) as FEA, 7 (38.88%) as LN, 1 (1.85%) as PT and 3 (16.66%) as PL. None of the radial scars upgraded their histological result. From these 18 lesions, 17 (94.44%) had any type of enhancement and 1 (5.56%) had no enhancement on CEM.

#### CONCLUSION

The findings of this study support the added value of contrast-enhanced mammography (CEM) in the evaluation of B3 lesions, as it can help to categorize these lesions more accurately. Notably, the absence of enhancement in a B3 lesion on CEM has a high negative predictive value, suggesting that it could be a useful tool for reducing the need for open surgical excisions.

#### CLINICAL RELEVANCE/APPLICATION

In our institution, the use of CEM could potentially result in a 16.9% reduction in OSE

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## Abstract Archives of the RSNA, 2023

M5A-SPBR-8

### **Pectoralis Muscle Invasion by Breast Cancer: Can Digital Breast Tomosynthesis Combined with Contrast-enhanced Mammography Improve Diagnostic Confidence**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Olena O. Weaver, MD (*Presenter*) Research Grant, General Electric Company

#### **PURPOSE**

Pectoralis muscle invasion (PMI) by breast cancer (BC) cannot be confidently diagnosed by mammography. Breast MRI is more effective but has limitations. We evaluated a combination of contrast-enhanced mammography (CEM) and digital breast tomosynthesis (DBT) under the same compression for diagnostic accuracy and reader confidence in predicting PMI.

#### **METHODS AND MATERIALS**

Prepectoral cancers (defined as masses adjacent to pectoral muscle with no intervening fat plane) were retrospectively identified in patients with DBT/CEM for BC staging at a single institution. 5 radiologists independently reviewed CEM (low energy (LE) and recombined (RC)) and DBT images of the involved breast in craniocaudal (CC) and mediolateral oblique (MLO) projections, then MRI when available, evaluated predefined radiologic signs of PMI for each image, and graded their diagnostic confidence (Table 1). The ground truth was PMI on surgical pathology (SP). For patients with unavailable SP, or in those post neoadjuvant chemotherapy (NAC) with therapy response and no PMI on SP, radiologists' consensus on muscle and/or fascia enhancement on pre-NAC MRI was used as the ground truth. Measures of diagnostic accuracy, mean radiologist confidence and radiologist agreement for each image type/modality were calculated per radiologic sign, per view and per case.

#### **RESULTS**

Of 145 patients, 9 had prepectoral masses. PMI was present in 3 and absent in 6 cases, with the ground truth based on SP in 3 and on MRI in 6 cases. The range of accuracies for LE was 0.29-0.62 for CC and 0.56-0.67 for MLO. The accuracy of RC was 0.62 for CC and 0.78 for MLO. For CC views the accuracies of LE, RC, and DBT were 0.5, 0.5-0.62, and 0.29-0.5, respectively, with an overall CC DBT/CEM accuracy of 0.62. For MLO views the accuracies of LE, RC, and DBT were 0.67, 0.56-0.78, and 0.67, respectively, with an overall MLO DBT/CEM accuracy of 0.56. Breast MRI had higher per-case diagnostic accuracy than DBT/CEM (1 vs 0.78) with muscle enhancement as the most accurate MRI sign (1.0), followed by fascia enhancement (0.86). On a scale of 1-3, mean radiologist confidence per case was 1.9 for DBT/CEM (1.8-2.3 for LE, 1.6 -2.2 for RC, and 2.1 -2.4 for DBT) with poor agreement (-0.14); vs 2.7 for MRI with moderate to substantial agreement (0.56-0.6).

#### **CONCLUSION**

MRI is superior to DBT/CEM in accuracy and radiologist agreement for PMI. RC images improve the accuracy of non-enhanced images but have the lowest radiologist confidence among all modalities. DBT has lowest accuracy but highest confidence. Absence of SP on treatment-naïve BC and use of MRI as a surrogate limits this study.

#### **CLINICAL RELEVANCE/APPLICATION**

Although RC images marginally improve the accuracy of DBT/CEM for PMI, breast MRI remains the modality of choice for evaluation of prepectoral BC.

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## Abstract Archives of the RSNA, 2023

M5A-SPBR-9

### Can the ROI of Enhancement Predict the Histopathology of a Lesion on CESM

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Tamara D. Suaris, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast-enhanced spectral mammography (CESM) is a rapidly emerging technique for the accurate staging of breast cancer. Can the enhancement levels in CESM be used to predict histology of a lesion?

#### METHODS AND MATERIALS

A retrospective analysis of patients undergoing CESM at St Bartholomew's Hospital, between November 2020 and November 2021, was performed. All lesions confirmed by imaging guided histopathology and had CESM enhancement characteristics analysed. The degree of contrast was quantitatively assessed by measuring the region of interest (ROI) difference between the enhancing lesion and background as a ratio, on both craniocaudal (CC) and mediolateral (ML) views. Statistical analysis was performed to determine whether the percentage signal difference between enhancing lesions and background (%RS) correlated to histopathological results. The %RS calculated for the 3 histological results were compared: invasive and non-invasive cancers and benign lesions.

#### RESULTS

138 lesions were detected, consisting of 73 (52.9%) invasive cancers, 32 (23.2%) non-invasive cancers, and 32 (23.9%) benign lesions. Analysis of enhancement indices showed the following mean % RS: Invasive cancers (ML 1.64%, CC 1.51%), Non-invasive cancers (ML 0.98%, CC 1.02%), Benign lesions (ML 0.75%, CC 0.68%). The enhancement intensity of invasive cancers was significantly higher than that of non-invasive and benign lesions (in both views  $p < 0.01$ ). After the Bonferroni correction, the distribution of %RS in invasive and non-invasive cancers was statistically significant ( $p < 0.01$ , 95%CI -0.01 to 0.003). Similarly for the invasive lesions and benign lesions ( $p < 0.01$ , 95%CI 0.005 to 0.001), while the difference between non-invasive cancer and benign lesions was non statistically significant ( $p = 0.21$ , 95%CI -0.001 to 0.006).

#### CONCLUSION

There is a correlation between the degree of lesion enhancement in CESM among invasive cancers, non-invasive cancers, and benign lesions. Invasive cancers had the stronger enhancement. There is difference in the enhancement between invasive cancer and non-invasive cancers as well as invasive cancers and benign lesions. There is no difference between the non-invasive cancers and benign lesions.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of enhancement levels in CESM is a feasible in the pre-operative assessment of women with breast cancer and can be used to predict histology of a lesion.

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## Abstract Archives of the RSNA, 2023

M5A-SPCA-1

### Improving Dynamic Evaluation of Myocardial Gadolinium Concentration using Elastic Registration for T1 Mapping with Pharmacokinetics Modeling

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yasutoshi Ohta, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Developing a T1 mapping-based pharmacokinetic method to evaluate myocardial gadolinium concentration over time, and enhancing accuracy by optimizing elastic deformation registration

#### METHODS AND MATERIALS

Thirty-five subjects (66 yrs, IQR 65,76) referred for CMR examination were included in this study. In addition to routine examinations, including cine and LGE, Native T1 and dynamic T1 maps (2, 5, 9, and 15 min after contrast administration) were obtained using the MOLLI sequence. T1 maps were obtained at the base, mid, and apex of the left ventricle, and concentration maps without registration were calculated for each imaging time from the native T1map and the post-contrast T1map. Similarly, the concentration maps with elastic registration (ER) for the native T1 maps were calculated from the post-contrast maps as well. The time after contrast administration was calculated for each image in seconds from DICOM tags. Estimated myocardial concentration maps (mM/l) at each imaging time were generated from the parameters obtained from pharmacokinetic analysis using a two-compartment model for each time series concentration map with and without ER. The model fitting accuracy was evaluated by comparing the residuals with and without ER. Myocardium was extracted from each map, the measured myocardial concentration (MC) and the estimated concentration (EC) at the same post-contrast time of MC, and the mean difference ( $\Delta_{\text{mean}}$ ) and standard deviation ( $\Delta_{\text{SD}}$ ) between the MC and EC were measured. Gadolinium concentration of the blood pool was also evaluated for residuals with and without ER.

#### RESULTS

Analyzable dynamic T1 maps were obtained from all subjects. The fitting residuals in the myocardial contrast medium density analysis improved significantly from 0.746 to 0.822 by applying ER ( $p < 0.001$ ). The fitting residuals for the blood pool improved significantly from 0.848 to 0.875 by applying ER ( $p < 0.001$ ). The  $\Delta_{\text{mean}}$  with ER was significantly smaller than without ER: 2min; 0.031 vs. 0.026, 5min; -0.026 vs. -0.022, 9min; -0.025 vs. -0.022, 15min; 0.024 vs. 0.019, (without ER vs. with ER, respectively). The  $\Delta_{\text{SD}}$  was significantly reduced with ER compared to without ER at all imaging times (all; 0.05 vs. 0.03, 2min; 0.05 vs. 0.03, 5min; 0.06 vs. 0.04, 9min; 0.06 vs. 0.04 15min; 0.04 vs. 0.02mM/l) (all,  $p < 0.05$ ).

#### CONCLUSION

Employing elastic deformation registration in dynamic T1 mapping enhanced the accuracy of estimated concentrations derived from myocardial contrast medium pharmacokinetic analysis.

#### CLINICAL RELEVANCE/APPLICATION

The pharmacokinetic approach enables the creation of myocardial gadolinium concentration maps at any given time and the analysis of longitudinal properties such as contrast agent washout in myocardial tissues.

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## Abstract Archives of the RSNA, 2023

M5A-SPCA-3

### Comparison of Myocardial Lesions by Pharmacokinetic Modeling Concentration Maps Over Time and General One-point LGE

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yasutoshi Ohta, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility of detecting myocardial lesions earlier than with conventional LGE timing, as well as to assess the temporal characteristics of these changes, utilizing gadolinium density maps generated from a pharmacokinetic model

#### METHODS AND MATERIALS

Thirty-five subjects (66 yrs, IQR 65,76) referred for CMR examination were included in this study. In addition to routine examinations, including cine and 10 minutes LGE, native T1 and dynamic T1 maps (2, 5, 9, and 15 min after contrast administration) were obtained using the modified Look-Locker inversion recovery sequence. Pharmacokinetic analysis of myocardial and blood pool gadolinium concentrations was performed using a two-compartment model, and predicted concentration maps (mmol/l) at 5, 7, 10, 15, 20, 25, and 30 minutes after contrast were generated from calculated parameters. In cases with positive LGE, the gadolinium concentration of the LGE lesion and remote myocardium, extracellular volume fraction ECV (ECV<sub>les</sub>, ECV<sub>remo</sub>) was calculated at each time point. The contrast ratio between the lesion and the remote myocardium was measured on the density map and LGE images. Changes in these indices at each time point were compared.

#### RESULTS

Hyperenhancement was observed in 20 cases in the LGE image. Lesions were detected at the same sites as LGE in all-time concentration maps. Gadolinium concentrations in the LGE area at each time were 0.48, 0.46, 0.41, 0.34, 0.27, 0.22, and 0.19, showing significant changes, respectively. Contrast concentration in remote myocardium was 0.29, 0.27, 0.24, 0.20, 0.16, 0.13, and 0.11, with significant changes each time. Contrast ratios were 0.25, 0.25, 0.26, 0.35, 0.34, 0.33, and 0.32, with significantly higher values after 15 minutes. The contrast ratio of LGE was 0.61. ECV<sub>les</sub> increased slightly over time to 43%, 45%, 46%, 47%, 47%, 48%, and 50%, but not significantly. ECV<sub>remo</sub> was 26%, 27%, 27%, 27%, 28%, 29%, and 29%, with no significant difference.

#### CONCLUSION

Though the gadolinium density map was inferior to LGE in contrast, lesions were detected at the same sites as LGE after 5 min. Lesion ECV could also be measured without significant change after 5-30 min.

#### CLINICAL RELEVANCE/APPLICATION

The evaluation with density maps can detect lesions as early as LGE after contrast and may allow evaluation of myocardial characteristics using contrast agent kinetic changes in the lesion.

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## Abstract Archives of the RSNA, 2023

M5A-SPCA-4

### **Evaluation of Myocardial Mass Index Effect on Myocardial Function and Adverse Events in Hypertrophic Cardiomyopathic Patients with Normal Left Ventricular Ejection Fraction and Minimal Fibrosis, by Cardiac MRI Strain Analysis: A Prospective Study**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hamid Chalian, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

HCM patients are at risk of developing adverse cardiac events, so an effective risk stratification tool is desirable, strain value measurements by cardiac MRI are reproducible and can show subclinical myocardial deformity, which makes them a potential imaging marker to predict patient's outcome. We evaluated the pattern myocardial strain changes based on myocardial mass index by cardiac MRI in a group of HCM patients with normal left ventricular ejection fraction (LVEF) and low fibrosis.

#### **METHODS AND MATERIALS**

We evaluated cardiac magnetic resonance (CMR) and clinical data of 70 cases, including 50 HCM ( 62 % male) and 20 healthy ( 50% male) subjects. HCM cases inclusion criteria were; normal LVEF with a late gadolinium enhancement (LGE) percentage<10%, exclusion criteria were history of hypertension, valvular heart disease, infiltrative cardiac disorders, ischemic heart disease and renal impairment with estimated glomerular filtration rate (eGFR) less than 30mL/min. follow-up time is set to be 3 years, adverse events are defined as sudden cardiac death, aborted cardiopulmonary resuscitation (CPR), hospitalization because of heart failure or serious arrhythmic events. We clarified between-group differences by ANOVA and post hoc tests. Also Univariate, multivariate Cox regression and Kaplan-Meier analyses revealed the strain pattern differences between patient with favorable and unfavorable prognosis. P value<0.05 was considered significant.

#### **RESULTS**

LV global longitudinal, circumferential, and radial strains (GLS, GCS, and GRS) as well as LV myocardial mass index, were different between the control group and HCM cases (P value < 0.05). Even in HCM patients with normal myocardial mass index strain values were significantly lower than control group. A progressive decline in LVGLS, and LVGCS values were noted along with myocardial mass index increase. LVGLS, LVGCS, and LGE percentage predicted adverse events, and LVGCS was the most potent predictor of adverse events.

#### **CONCLUSION**

Increase in Myocardial mass index, independently cause myocardial contraction abnormalities evident by LV strains impairment despite normal EF and minimal myocardial scar index. CMR parameters, especially CMR feature tracking strain values, could predict adverse events in our study population.

#### **CLINICAL RELEVANCE/APPLICATION**

HCM can result in adverse cardiac events, but many patients are living an uneventful life, thus a screening method in HCM could optimize preventive approaches, strain measurement by CMR are potential imaging markers in this regard.

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## Abstract Archives of the RSNA, 2023

M5A-SPCA-5

### **Differentiating Cardiac Amyloidosis from Hypertrophic Cardiomyopathy using Myocardial Atrial Strains Derived from Cardiac MRI**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Kentaro Ohara (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cardiac amyloidosis (CA) is a curable disease for which early diagnosis and treatment are vital. T1 mapping or late gadolinium enhancement (LGE) is a reliable method to differentiate amyloidosis from hypertrophic cardiomyopathy (HCM). However, there are several limitations to its usage, such as additional image acquisition, differences in T1 values due to equipment and facility, and the need for contrast materials for LGE. Recently, myocardial atrial and ventricular strains derived from magnetic resonance imaging (MRI) were developed to assess myocardial dysfunction in each chamber. This study aimed to evaluate the feasibility of using cardiac atrial or ventricular myocardial strains derived from MRI to differentiate CA from HCM.

#### **METHODS AND MATERIALS**

A total of 27 patients with CA and 76 patients with HCM underwent cardiac MRI; of these, 27 were identified with matched left ventricular ejection fraction (LVEF). The left ventricular strain (LVS), left atrial strain (LAS), right ventricular strain (RVS), and right atrial strain (RAS) were calculated from 4-chamber cine MRI images using a dedicated workstation. The diagnostic performance of CA for HCM was compared using receiver operating characteristic analysis.

#### **RESULTS**

LAS (CA:9.7%, HCM: 15%), RVS (CA:13.1%, HCM: 16%), and RAS (CA:10.4%, HCM: 20%) were significantly lower in the CA group than in the HCM group ( $P < 0.05$ ), whereas LVS showed no significant difference between the two groups (CA, 11%; HCM, 12.4%) ( $P = 0.21$ ). The areas under the curves were LVS, 0.60; LAS, 0.74; RVS, 0.68; and RAS, 0.82. The RAS and LAS showed significantly higher diagnostic performance than the LVS ( $P < 0.05$ ).

#### **CONCLUSION**

Myocardial atrial strain derived from MRI can differentiate CA from HCM with high diagnostic performance. Moreover, it reflects the pathophysiological differences between the two.

#### **CLINICAL RELEVANCE/APPLICATION**

The myocardial atrial strain derived from MRI does not require additional image acquisition or contrast administration. This simple and convenient method could be used to diagnose cardiac amyloidosis.

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## Abstract Archives of the RSNA, 2023

M5A-SPCA-6

### Multimodal Imaging using FDG PET/MR and Adenosine Stress NH<sub>3</sub> PET was Used to Study Patients with Hypertrophic Cardiomyopathy

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Eun-Jung Kong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Previous studies of FDG PET in HCM are lacking, but this modality can explain the inflammatory process that precedes myocardial fibrosis. The aim of the study was to compare regional inflammation by FDG uptake, fibrosis by LGE MRI, and microvascular dysfunction by adenosine stress NH<sub>3</sub> PET in patients with HCM.

#### METHODS AND MATERIALS

Between Jan 2016 and Apr 2018, a total of 25 patients were included in the retrospective study. FDG PET and MRI were simultaneously acquired using an integrated PET/MR scanner, and patients were prepared with a low carbohydrate diet to suppress physiologic myocardial uptake. FDG PET and LGE were analyzed using a 17-segment model, and myocardial flow was analyzed using commercial software (4DM) and compared with FDG PET and LGE.

#### RESULTS

Four patients were excluded due to improper physiologic myocardial suppression (n=1) or combined ischemic heart disease (n=3), leaving 21 patients (16 males, age 59±15 years) in the final analysis. All 21 patients showed abnormal FDG uptake (6.8±3.7 segments) and 20 patients showed LGE (5.7±3.1 segments). Mean stress myocardial blood flow was 1.89±0.59 mL/min/g. FDG uptake and LGE were observed in hypertrophic myocardium and, in some patients, in non-hypertrophic myocardium. Hypertrophic myocardium showed decreased stress myocardial flow compared with non-hypertrophic myocardium. Increased FDG uptake was related to LGE ( $\rho=0.805$ ,  $p<0.001$ ). Of the total 357 segments analyzed, 83.8% showed matched results (102 segments were both positive and 197 segments were both negative). Increased FDG uptake was also related to decreased stress flow ( $\rho=-0.512$ ,  $p=0.043$ ).

#### CONCLUSION

The study found that evaluation of HCM with FDG PET/MR and stress NH<sub>3</sub> PET was useful in evaluating inflammatory changes, fibrosis, and ischemic severity, to explain pathophysiology and to understand disease status. The study also newly found that FDG PET has a correlation with LGE and ischemia, which are known as poor prognostic factors

#### CLINICAL RELEVANCE/APPLICATION

The study also newly found that FDG PET has a correlation with LGE and ischemia, which are known as poor prognostic factors

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## Abstract Archives of the RSNA, 2023

M5A-SPCA-7

### Imaging Features in Female Patients with Wild-type Transthyretin Amyloidosis Cardiomyopathy

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Wild-type transthyretin amyloid cardiomyopathy (ATTRwt-CM) is significantly male-dominated, but there are also female patients. However, sex-related differences in ATTRwt-CM remain unclear. This study aimed to assess imaging features in female patients with ATTRwt-CM.

#### METHODS AND MATERIALS

We retrospectively analyzed 106 consecutive patients who were diagnosed with ATTRwt-CM and evaluated sex-related differences in the imaging features including cardiac MRI and 99mTc-labeled pyrophosphate scintigraphy (99mTc-PYP).

#### RESULTS

Twelve patients (11.3%) were female. These female patients were significantly older at diagnosis ( $75.3 \pm 6.3$  years vs.  $80.6 \pm 4.4$  years;  $p < 0.01$ ). Cardiac MRI-measured left ventricular end-systolic volume was significantly lower ( $44.3 \pm 23.8$  ml vs.  $31.1 \pm 29.3$  ml;  $p < 0.05$ ) and the ejection fraction was significantly higher ( $51.6 \pm 14.1$  % vs.  $62.0 \pm 21.0$  %;  $p < 0.05$ ) in female patients. There was no significant gender difference in left ventricular mass ( $138.4 \pm 48.7$  g vs.  $115.0 \pm 75.7$  g;  $p = 0.26$ ). In T1 mapping, there was no significant difference in native T1 ( $1420.3 \pm 54.0$  ms vs.  $1427.3 \pm 77.5$  ms;  $p = 0.76$ ), but extracellular volume fraction (ECV) was significantly lower ( $56.6 \pm 13.3$  % vs.  $49.4 \pm 15.7$  %;  $p < 0.05$ ) in female patients. No significant difference in myocardial T2 value ( $51.0 \pm 4.5$  ms vs.  $51.0 \pm 3.0$  ms;  $p = 0.97$ ). The mean heart-to-contralateral ratio obtained using 99mTc-PYP was significantly lower in female patients ( $1.95 \pm 0.39$  vs.  $1.63 \pm 0.24$ ;  $p < 0.01$ ).

#### CONCLUSION

Female patients with ATTRwt-CM were predominantly older and had preserved left ventricular ejection fraction, weaker cardiac uptake of the 99mTc-PYP, and lower ECV value compared with male patients. These imaging features may contribute to the underdiagnosis of ATTRwt-CM in female patients.

#### CLINICAL RELEVANCE/APPLICATION

Female patients with ATTRwt-CM have different imaging features than the male counterparts, and we need to recognize these imaging features to avoid underdiagnosing it.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH-1

### Multimodal Classification Model for Gram-Positive and Gram-Negative Bacterial Pneumonia using Imaging and Clinical Features: Improving Antibiotic Treatment Decisions

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Ru Wen (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to develop and validate a classification model that combines imaging features and clinical characteristics to accurately identify patients with Gram-positive and Gram-negative bacterial pneumonia, assisting clinical physicians in empirical antibiotic treatment.

#### METHODS AND MATERIALS

The study included patients with bacterial pneumonia who sought medical care at a tertiary hospital in China between 2010 and 2020. The patients were randomly divided into a training set and a validation set in an 8:2 ratio. The ResNet-18 model was used as the base model, and 512 features were extracted from the maximum lesion layer as deep features. Spearman correlation and mutual information were employed for dimensionality reduction, and the XGBoost model was utilized to construct the imaging model. The GBM model served as the classifier for establishing the clinical model. A logistic regression algorithm was employed to construct an imaging-clinical fusion model based on the individual scores of the imaging model and the clinical model. The classification performance of the clinical model, imaging model, and fusion model was compared using the DeLong test.

#### RESULTS

This study included data from 2423 patients with bacterial pneumonia. Among them, 563 cases were Gram-positive bacterial pneumonia, and 1860 cases were Gram-negative bacterial pneumonia. The imaging model and clinical model had AUCs of 0.719 and 0.827, respectively, in the test set. The fusion model achieved an AUC of 0.884 (95% CI: 0.868-0.898), sensitivity of 0.772, specificity of 0.822, and accuracy of 0.808 in the test set. The DeLong test results demonstrated that the performance of the fusion model was slightly higher than that of the individual imaging or clinical models ( $P < 0.05$ ). Nomogram results of the fusion model showed that clinical scores had the highest weight, and the fusion model exhibited good consistency between predicted probability and expected probability. Decision curve analysis (DCA) confirmed that the fusion model performed well in classifying bacterial pneumonia across most threshold probabilities.

#### CONCLUSION

In this study, we integrated multimodal data including imaging, laboratory tests, and clinical signs to classify gram-positive and gram-negative bacterial pneumonia. Our research demonstrates that the fusion of multiple modalities enhances the classification performance of the model.

#### CLINICAL RELEVANCE/APPLICATION

The fusion model we have developed enables accurate classification of bacterial pneumonia in patients based on CT images, laboratory tests, and clinical signs. It holds significant clinical value in avoiding unnecessary antibiotic usage and provides timely information for guiding clinical decisions and improving patient prognosis.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH-2

### Differentiating Imaging Features of Post Lobectomy Right Middle Lobe Torsion

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Farah Tamizuddin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify differences in imaging features between patients with confirmed right middle lobe (RML) torsion compared to those with suspected RML torsion who did not have torsion.

#### METHODS AND MATERIALS

This retrospective study entailed a search of radiology reports from April 1, 2014 to April 15, 2021, yielding 52 patients with suspected torsion on imaging but ultimately no lobar torsion and 4 with confirmed torsion. This cohort was supplemented by 2 cases identified prior to the search period for a total of 6 confirmed RML torsion cases. Four thoracic radiologists including an adjudicator evaluated chest radiographs (CXR) and computed tomography (CT) exams for multiple imaging signs and features. A resident measured the angle between the RML bronchus and bronchus intermedius on coronal reformats of any CTs performed to exclude or confirm torsion for these patients. Fisher exact and Mann-Whitney tests were used to identify any significant differences in imaging features ( $P < .05$ ).

#### RESULTS

A reversed halo sign was more frequently seen in patients with confirmed torsion ( $P = .001$ ) compared to non-torsion patients (83.3% vs. 0% for 3 readers, including the adjudicator). Torsion patients had a higher percentage of ground-glass opacity (GGO) in the affected lobe compared to non-torsion patients (21.7% vs 13.9% for the adjudicator,  $P = .031$ ). The CT Coronal Bronchial Angle between RML bronchus and bronchus intermedius was larger ( $P = .035$ ) in torsion than non-torsion cases ( $121.3^\circ$  vs  $98.3^\circ$ ). A convex fissure towards the adjacent lobe on CT was more frequent in torsion patients (100% vs 27.3% for the adjudicator,  $P = .009$ ) and increased lobe volume on CT ( $P = .001$ ) occurred more often in confirmed torsion.

#### CONCLUSION

A reversed halo sign, greater proportion of GGO in the affected lobe, larger CT Coronal Bronchial Angle, fissural convexity, and larger lobe volume on CT may aid in early recognition of the rare yet highly significant diagnosis of lobar torsion.

#### CLINICAL RELEVANCE/APPLICATION

This paper is clinically relevant because RML torsion is a potentially life-threatening diagnosis and awareness of imaging signs and features associated with this diagnosis can aid radiologists in suggesting RML torsion earlier and more accurately, thus expediting patient care and optimizing patient outcomes.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH-3

### Frogspawn Sign: Special CT Features for the Diagnosis of Pulmonary Lymphatic Reflux Diseases

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Qi Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the value and the morphologic characteristics of the so-called "frogspawn sign" on high-resolution CT as the special CT feature for the diagnosis of pulmonary lymphedema and lymphatic dilatation caused by pulmonary lymphatic reflux diseases (PLRD). This sign has not been reported in the literature by our knowledge.

#### METHODS AND MATERIALS

We collected 580 patients with clinical and operative proven PLRD in the study, of which 86 cases had frogspawn sign on HRCT and MSCT lymphography. The imaging features of frogspawn sign were retrospectively reviewed by two chest radiologists who reached decisions by consensus. All patients were followed up for HRCT within 3-6 months.

#### RESULTS

The frogspawn sign was seen in 86 (15%) of 580 patients with PLRD, which consisted of diffuse inhomogeneous ground-glass opacity (GGO) with superimposed multiple discontinuous small nodules. The diffuse GGO showed bilateral asymmetrical (100%) and peripheral subpleural or peribronchovascular (14/86, 16%) distribution with predominance in the right middle or lower lung zone. The multiple small nodules appeared round-like or tree-in-bud (22/86, 26%) with 3-6mm in size, central or intrapleural distribution and no continuity or fusion between nodules and nodule-pleura. The spatial distance between the nodules is about 2-4mm. A dynamic changes of this sign was showed in all patients with obvious improvement (32/86, 37%) and aggravation (54/86, 64%) on the follow-up CT.

#### CONCLUSION

The frogspawn sign strongly favors a diagnosis of pulmonary lymphedema and lymphatic dilatation caused by PLRD. This sign is very important for judging the degree of lymphedema and the clinical stage.

#### CLINICAL RELEVANCE/APPLICATION

Pulmonary lymphatic reflux abnormalities are rare disorders characterized by developmental malformation of the bronchial-mediastinal lymph trunk and/or thoracic duct outlet anomaly. The frogspawn sign consisted of diffuse inhomogeneous ground-glass opacity (GGO) with superimposed multiple discontinuous small nodules and strongly favors a diagnosis of pulmonary lymphedema and lymphatic dilatation caused by PLRD.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH-5

### Exploring the Biological Significance of a Robust Radiomic Biomarker of Tumor Heterogeneity in Advanced Non-small Cell Lung Cancer Patients Treated with First-line Immunotherapy

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Andrew W. Chen, BS, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Tumor PD-L1 expression, the accepted predictive biomarker for pembrolizumab (PEMBRO) immunotherapy, is imperfect. We hypothesize that radiomic features, essentially high-throughput descriptors of tumor heterogeneity, can characterize molecular and histopathological tumor subtypes *in vivo*, and enable precision therapy selection.

#### METHODS AND MATERIALS

After IRB approval, a single-center retrospective analysis of pre-treatment CT for stage 4 NSCLC patients (n=342) treated with 1st-line PEMBRO-based therapy Region of interest (ROI) segmentation was performed with ITK-SNAP. Feature extraction on ROIs was performed with the CaPTk toolkit. OPNested Combat mitigated radiomic feature heterogeneity due to differences in contrast enhancement, kernel resolution, and voxel spacing. Clinical variable categories, age, sex, race, ECOG, BMI, smoking status, and tumor histology, were protected during harmonization to prevent removal. Principal component (PC) analysis reduced harmonized feature dimensionality; the first PC was taken as a radiomic signature for histological subtypes (adenocarcinoma, squamous cell, other) and tumor differentiation, using a linear support vector machine (SVM) classifier. For a subset (n=234), a radiomic signature characterized tumor differentiation subtypes (well, moderate, poor). The statistical significance of the radiomic signature's Spearman correlation coefficient (c) for genomic mutational expression categories (negative, positive, unknown) of NSCLC relevant-genes (EGFR, BRAF, ALK, ROS, MET, HER2) and tumor expression of PDL1 was also assessed.

#### RESULTS

The radiomic signature performed patient classification of histological subtype with an accuracy of 81.5% (AUC-0.59), and of tumor differentiation subtypes with an accuracy of 82.3% (AUC-0.62). Statistically significant correlations ( $p < 0.05$ ) were found between the radiomic signature and the following genomic mutational expression categories: ALK (c: 0.88), EGFR (c: 0.87) and ROS (c: 0.62).

#### CONCLUSION

The radiomic signature was shown to have correlations with genes relevant to NSCLC tumor progression and was able to identify tumor subtypes based on their molecular and histopathological characteristics, indicating its biological significance. Our future work involves building a multi-omic predictor (combining radiomic, genomic and clinical information) of progression-free survival to study patient response to PEMBRO-based therapy.

#### CLINICAL RELEVANCE/APPLICATION

The radiomic signature correlated significantly with NSCLC-related genes and identified tumor sub-types based on molecular and histological characteristics. These results help us better understand the biological meaning of radiomic descriptors.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH-6

### Lung Cancer Risk Using Never Smokers' Chest X-Rays: Validation of a Deep Learning-based Model

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Anika Walia (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung cancer is the most common cause of cancer death. In the United States, 10-20% of lung cancers occur in "never-smokers" - those who never smoked cigarettes or smoked fewer than 100 cigarettes in their lifetime. Centers for Medicare and Medicaid Services (CMS) lung cancer screening criteria do not recommend screening never-smokers; however, never-smokers often present with more advanced lung cancer than those who smoke. In this study, we tested whether a deep learning model CXR-Lung-Risk could identify never-smokers at high risk for lung cancer using chest x-rays (CXRs) from the electronic medical record.

#### METHODS AND MATERIALS

The CXR-Lung-Risk model was developed using 147,497 CXRs of 40,643 asymptomatic smokers and never-smokers from the Prostate, Lung, Colorectal, and Ovarian (PLCO) cancer screening trial to predict lung-related mortality risk based on a single CXR image as input. In this study, we externally validated the model in a separate cohort of never-smokers having routine outpatient CXR from 2013-2014. The primary outcome was 6-year incident lung cancer, identified using International Classification of Disease (ICD) codes. Continuous CXR-Lung-Risk scores were converted to low, moderate, and high-risk groups based on externally derived risk thresholds.

#### RESULTS

Of 24,333 patients (mean age  $63.4 \pm 8.21$  years; 44.3% male; 18,880 (80.5%) White, 1,789 (7.6%) Black, 789 (3.7%) Hispanic) included in the study, 32% (7774/24,333) were deemed high risk by CXR-Lung-Risk. 2.5% of the total cohort (616/24,333) developed lung cancer over 6 years of follow-up. CXR-Lung-Risk groups had a graded association with lung cancer risk, with 1.4% (37/2663) in the low-risk group (CXR-Lung-Risk <45), 2.2% (306/13896) in the moderate-risk group (45 < CXR-Lung-Risk < 55), and 3.5% (273/7774) in the high-risk group (CXR-Lung-Risk > 55). After adjusting for age, sex, race, previous lower respiratory tract infection, and prevalent COPD, there was still a 2.1 (95% CI [1.4,3.1];  $p < 0.001$ ) times greater risk of developing lung cancer in the high-risk group compared to low risk.

#### CONCLUSION

Using routine CXRs from the EMR, CXR-Lung-Risk identified never-smokers at high risk of lung cancer, a group in which lung cancer rates are increasing.

#### CLINICAL RELEVANCE/APPLICATION

CXR-Lung-Risk identified never-smokers at high risk of lung cancer, well above the >1.3% 6-year risk threshold where lung cancer screening CT is recommended by National Comprehensive Cancer Network guidelines.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH-7

### Feasibility of Extracellular Volume Fraction Measurement Derived from the Equilibrium Phase Dual-energy CT for Predicting Pathological Grades of Lung Cancer

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hiroaki Nagano, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the diagnostic feasibility of extracellular volume (ECV) fraction measurement using the equilibrium phase dual-energy CT (DECT) for predicting the pathological grade of lung cancer.

#### METHODS AND MATERIALS

This study included 110 patients with lung cancer who underwent preoperative DECT examination and surgical resection. These patients were divided into a low-grade group (G1 and G2) and a high-grade group (G3 and G4) based on their histopathological differentiation. Iodine concentration (IC) and effective atomic number ( $Z_{\text{eff}}$ ) were measured using the equilibrium phases DECT, and ECV fraction was calculated based on IC of the lung cancer and the aorta. DECT parameters and ECV fraction were compared between the pathological grade groups using the Mann-Whitney U test. Receiver-operating characteristic (ROC) curve analysis was performed to evaluate the ability of IC,  $Z_{\text{eff}}$  and ECV fraction to diagnose a high-grade pathological group of lung cancer.

#### RESULTS

IC and  $Z_{\text{eff}}$  during the equilibrium phase and ECV fraction were significantly higher in the low-grade group than in the high-grade group (2.27mg/mL vs. 1.85mg/mL,  $p=0.006$ ; 8.46 vs. 8.29,  $p=0.012$ ; 45.2% vs. 35.0%,  $p<0.001$ ; respectively). The area under the ROC curve values of IC and  $Z_{\text{eff}}$  during the equilibrium phase and of ECV fraction to differentiate high-grade cancers from low-grade cancers were 0.688 (optimal cutoff, 1.80mg/mL; sensitivity, 60.9%; specificity, 73.6%), 0.672 (optimal cutoff, 8.43; sensitivity, 78.3%; specificity, 51.7%) and 0.750 (optimal cutoff, 30.9%; sensitivity, 47.8%; specificity, 94.3%), respectively.

#### CONCLUSION

IC,  $Z_{\text{eff}}$  and ECV fraction measurement using DECT can help predict the pathological grade of lung cancers. ECV fraction showed the best diagnostic performance.

#### CLINICAL RELEVANCE/APPLICATION

ECV fraction derived from the equilibrium phase dual-energy CT provides useful information to predict the pathological grades of lung cancers.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH-8

### Impact of Duration of Diagnostic Workup on Prognosis for Early Lung Cancer: Validation using the NLST and IASLC Databases

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Rowena Yip, PhD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Impact on prognosis of early stage lung cancer due to time delay for follow-up has been quantified in our previous publication using the I-ELCAP database. Here, our goal is to validate our published findings using two independent databases, the National Lung Screening Trial (NLST) and the International Association for the Study of Lung Cancer (IASLC).

#### METHODS AND MATERIALS

Using data collected from the CT arm of the NLST randomized trial (2002-2009) and the IASLC Lung Cancer Staging Project (1999-2010), we determined the size specific 5-year lung cancer (LC)-specific and overall survival rates as surrogates for cure rates. We estimated the change in LC diameter after delays of 90-, 180-, and 365-days using three representative LC volume doubling times (VDTs) of 60(fast), 120(moderate), and 240(slow). We then estimated the decrease in the lung cancer (LC) cure rate resulting from time between CT scans to assess for growth during the diagnostic workup.

#### RESULTS

Using the NLST data for a regression model of the 5-year LC survival rates on LC diameter, the estimated LC cure rate of a 4.0 mm LC with fast (60-day) VDT is 97.4%(95% CI: 97.1%-97.8%) initially, but it would decrease to 96.4%(95% CI: 95.9%-96.8%), 94.9%(95% CI: 94.2%-95.6%) and 89.6%(95% CI: 88.2%-89.6%) after delays of 90, 180, and 365 days, respectively. A 20.0 mm LC with the same VDTs has an initial lower LC cure rate of 87.2%(95% CI: 85.5%-88.9%) initially, and decreases more rapidly to 81.9%(95% CI: 79.4%-84.3%), 74.4%(95%CI:70.9%-77.9%) and 47.8%(95% CI: 40.7%-54.8%) after the same delays of 90, 180, and 365 days. Using the IASLC data for a regression model of the 5-year overall survival rates on LC diameter shows a similar trend.

#### CONCLUSION

Although the average tumor size was larger in these two databases, the average change in LC cure rate per unit increase in tumor size was comparable to our previous results. These findings support our earlier research indicating that the interval between scans required to evaluate the growth of lung nodules has a significant impact on prognosis, particularly for fast-growing and larger cancers. To determine the effectiveness of various management protocols, it is essential to quantify the degree of change in prognosis results caused by this delay.

#### CLINICAL RELEVANCE/APPLICATION

Timely follow-up is crucial for management of lung nodules. Our study shows that delays in CT scans have a significant impact on prognosis, emphasizing the need to quantify this effect for better management protocols.

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## Abstract Archives of the RSNA, 2023

M5A-SPER-1

### **Multicentre Randomised Controlled Trial to Assess the Impact of Online Training on the Diagnostic Performance of Emergency Department Clinicians in Interpreting CT Head Images: The Simulation Training for Emergency Department Imaging 2 (STEDI2) Trial**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Alex Novak (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Delays in reporting of CT scans can impair patient flow in the Emergency Department (ED). Artificial Intelligence led applications are being evaluated to enable ED physicians to interpret CT Head scans, but their baseline interpretation capability is currently unknown. Here we present preliminary results for a trial to measure the accuracy of ED clinicians in interpreting CT head images, determine the impact of an online training simulation, and estimate potential impacts of clinician-led CT head interpretation on patient flow within the Emergency Department

#### **METHODS AND MATERIALS**

A multicentre NIHR Portfolio randomised controlled trial (CPMS: 52221, Clinicaltrials.gov: NCT05427838, ISRCTN: 41484, REC reference: 22/HRA/0743) was undertaken across 6 UK hospitals. Emergency medicine clinicians undertook a blinded baseline online assessment of accuracy in interpreting a dataset of 50 CT Head scans. After completing the baseline assessment, participants were offered an online training package on CT head interpretation, then repeated the assessment and recorded interpretation of up to 30 prospective clinical cases with further assessments repeated at 3 and 6 months. Training and assessment were delivered using the online platform [www.raiqc.com](http://www.raiqc.com). The primary outcome was measured changes in reporting accuracy/sensitivity/specificity as calculated in a pooled analysis. Subgroup analyses included diagnostic performance stratified by clinical role, level of seniority, pathological finding. For prospective clinical interpretations times participant and radiology reporting were recorded and compared.

#### **RESULTS**

From April 2022 until September 2023 206 participants undertook the study. Overall, there was a significant increase in participants' sensitivity (73.3% to 83%) and specificity (65.8% to 89.1%) in detecting the presence of an acute abnormality on the online assessment scans, with a similar increase seen across all pathology subgroups. Overall diagnostic performance for acute abnormality detection remained elevated compared to baseline at six months post training (sensitivity 80.6%, specificity 79.1%).

#### **CONCLUSION**

Online training can be used to significantly improve ED clinicians' ability to interpret CT Head scans.

#### **CLINICAL RELEVANCE/APPLICATION**

Our results demonstrate that dedicated online training can significantly improve the image interpretation accuracy of ED clinicians. Provision of a web-based self-directed simulation-based learning platform is a scalable way of delivering this training to departments with a high staff turnover. Further detailed analysis is ongoing and will provide a detailed basis for comparison with other forthcoming interventions such as AI-assisted image interpretation of CT head scans.

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## Abstract Archives of the RSNA, 2023

M5A-SPER-2

### Inter-modality Data Augmentation and Multi-view Reconstructions from CT to Radiography for the Detection of C-Spine Fractures

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Duncan Ferguson, MD,BSC (*Presenter*) Nothing to Disclose

#### PURPOSE

Cervical spine fractures are a significant cause of morbidity and mortality worldwide. While ACR appropriateness criteria recommend the use of CT over X-ray, access to imaging can be limited in rural areas. The difference in sensitivity between CT and XR has been shown to be 100% and 63% respectively. Delayed diagnosis of C-spine fractures may lead to adverse outcomes. The goal of this project is to develop a model that can be used in areas where there are significant barriers to acquiring CT C-spines. Our objectives are as follows: To develop a method of reconstructing radiographs from CT To train a convolutional neural network using the reconstructed radiographs to detect C-spine fractures, using single and multiple views To assess the use of reconstructed radiographs as a method of data augmentation To test the model on real radiographs on a model trained on reconstructions.

#### METHODS AND MATERIALS

233 non-contrast CT C-spine studies with fracture labels were collected from a publicly available dataset. The dataset was divided into a training/validation (183) and test set (50). Sagittal, coronal, and oblique Average Intensity Projections (AvIPs) were created at a window width and level of 950/400. The EfficientNet V2-S model with pretrained weights was used as the initial model. A single channel model was trained and tested using sagittal AvIPs. Next, oblique AvIPs were added to the training set and the model re-trained. A multichannel model was trained and tested using sagittal and coronal AvIPs. A training and validation set was created using 5-fold cross validation for training of all models. 188 C-spine radiographs with fracture labels from a publicly available dataset were also used to test the two single channel models. The AUROC was plotted and Youden index used to determine the best threshold for prediction. Accuracy, specificity, and sensitivity were calculated for each model.

#### RESULTS

There is improved AUROC with oblique data augmentation using both AvIPs (from 0.60 to 0.65) and true radiographs (0.77 to 0.79) as the test set. Sens/Spec of 0.78/0.70 on true radiographs using the augmented model. The multichannel model performed better than the single channel augmented model (AUROC 0.73)

#### CONCLUSION

Inter-modality augmentation is possible to create a fair C-spine fracture model using 233 CTs. Multichannel model training can be used to optimize radiograph protocols to detect pathology.

#### CLINICAL RELEVANCE/APPLICATION

With improvement, an application in rural communities may result in expedited fracture detection. As well, an inter-modality data augmentation technique would assure preservation of labelling and be a valuable tool to enhance datasets.

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## Abstract Archives of the RSNA, 2023

M5A-SPGI-2

### Evaluation of Contrast Enhanced Photon Counting Computed Tomography Performed in the Inpatient Setting

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Benjamin G. Steyer, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Prior work demonstrating the benefits of photon-counting computed tomography (PCCT) has been performed in controlled research or selective outpatient settings. Given high capital costs of this technology, many scanners will serve general purpose, including application in inpatient settings. Here, we evaluate the performance of a clinical PCCT scanner employed in routine inpatient enhanced abdomen and pelvis imaging and directly compare image quality, image contrast and radiation dose to that of a prior state of the art dual energy CT (DECT) scanner.

#### METHODS AND MATERIALS

In this institutional review board-approved retrospective study, we identified patients ( $n = 35$ ) who had undergone a routine contrast enhanced CT of the abdomen and pelvis on a clinical PCCT scanner (NAEOTOM Alpha, Siemens Healthineers) and who had also undergone a DECT (SOMATOM Force, Siemens Healthineers) within twelve months. The following patient and scan characteristics were recorded: BMI, radiation dose (CTDI<sub>vol</sub>) and contrast volume. For quantitative comparison, we calculated contrast to noise ratio (CNR) and signal to noise ratio (SNR) for organ parenchyma as well as the great vessels for both PCCT and DECT exams.

#### RESULTS

Average BMI of patients undergoing contrast enhanced PCCT was 25.9 (range: 17.1 to 54.7). Average time between contrast enhanced PCCT and DECT was 42 days (range: 4 to 204 days). We observed a 9% decrease in scan dose (CTDI<sub>vol</sub>) in PCCT compared to DECT, 8.7 versus 9.8 mGy respectively ( $p=0.03$ ). Despite reduced dose, calculated CNR and SNR were significantly increased on PCCT versus DECT across all evaluated anatomic structures with the exception of liver, where no significant difference in SNR was observed.

#### CONCLUSION

Our real-world comparison of inpatient contrast enhanced abdomen and pelvis studies on PCCT and DECT indicates decreased radiation exposure (CTDI<sub>vol</sub>) can be achieved on clinical PCCT with increased quantitative metrics of image quality (CNR and SNR). Future planned analysis will focus on rigorous comparison of qualitative and quantitative metrics of image quality utilizing direct comparison of spectral data from both PCCT and DECT.

#### CLINICAL RELEVANCE/APPLICATION

In routine inpatient application, PCCT can provide quantitatively improved image quality compared to DECT at a reduced radiation dose.

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## Abstract Archives of the RSNA, 2023

M5A-SPGI-3

### Low Dose Whole-liver CT Perfusion in Evaluating Residual Viable Tumor Tissue of Hepatocellular Carcinoma after Transcatheter Arterial Chemoembolization

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Liqin Zhao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the value of low dose whole liver CT perfusion (CTP) in evaluating the hemodynamics of residual viable tumor tissue of hepatocellular carcinoma (HCC) treated with transcatheter arterial chemoembolization (TACE).

#### **METHODS AND MATERIALS**

HCC patients treated with TACE were prospectively collected. All patients underwent low dose whole liver perfusion CT examination 4-6 weeks after TACE. Thirty HCC cases with residual tumor viable tissue were selected. The hepatic arterial fraction (HAF, %), capillary surface permeability (PS, ml/min/100g), blood volume (BV, ml/100g) and time to peak (TTP, s) of necrotic tissue (T1), residual viable tumor tissue (T2) and background liver tissue (T3) were obtained using liver tumor perfusion software. Univariate Wilcoxon signed rank was used for the comparison of the above parameters between T2 and T1, T3 groups.

#### **RESULTS**

35 HCC lesions with residual viable tumor tissue were found. The HAF, PS and BV of T2 were higher than those of T1 and T3 ( $P < 0.05$ ); there was no significant difference in TTP between T2 and T1 and T3 ( $P > 0.05$ ).

#### **CONCLUSION**

Low dose whole liver perfusion CT could reflect the hemodynamics of residual viable tumor tissue of HCC treated with TACE.

#### **CLINICAL RELEVANCE/APPLICATION**

It could provide valuable information for the selection of further treatment protocol for HCC patients.

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## Abstract Archives of the RSNA, 2023

M5A-SPGI-4

### **DECT and MRI Indicators for Assessing Iron Overload and the Effectiveness of Iron Overload Therapy in Patients with Primary and Secondary Hemochromatosis**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Anna M. Titova, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Evaluation of MRI, CT parameters after chelation and hemoexfusion therapy in patients with iron overload, identification of the prognostic value of CT indicators in the assessment of moderate and severe iron overload.

#### **METHODS AND MATERIALS**

The design of the study is prospective. The study included the liver scans of 43 patients with hereditary hemochromatosis (HH), secondary transfusion-dependent hemochromatosis (TDH) receiving regular hemotransfusions, iron chelators. We evaluated age, frequency of hemotransfusions, chelating drug used. CT was performed on a Dual Energy computer CT scanner Siemens Somatom Definition 128. 27 patients (62.8%) reached repeated CT. MRI was performed on a Siemens Magnetom Espree high-field scanner with a magnetic field induction of 1.5 T.

#### **RESULTS**

The median age was 34 y.o. [33.00; 53.50] for HH and 52 y.o [36.00; 62.00] for TDH. After therapy in the general group, T2\* values increased by 26%, LIC decreased by 21.2%, DED (dual energy difference)HU 140 and 80 mean by 17.6%, DER (dual energy ratio) HU 140 and 80 mean by 3%, DEI (dual energy index) HU 140 and 80 mean by 92.8%, 80 max by 3%, DEDHU 140 and 80 max by 19%, DERHU 140 and 80 max by 2.5% after therapy. In patients with HH, liver T2\* increased by 4.6 times, LIC decreased by 5.5 times, DEDHU 140 and 80 mean by 35.1%, DERHU 140 and 80 mean by 7.8%, DEIHU 140 and 80 mean by 93.6%, DEDHU 140 and 80 max by 29.3%, DEIHU 140 and 80 max by 21.6%. In patients with TDH, LIC decreased by 18.9%, DEIHU 140 and 80 mean by 92.2%. A value of 80 mean=85.5, 140 mean=71.5, M0.3 mean=76, DEIHU 140 and 80 mean=0.007996 and DEDHU 140 and 80 mean=18.5 predict the probability of severe iron overload.

#### **CONCLUSION**

In patients after chelation therapy and hemoexfusion therapy, MRI and CT indicators decrease. The values of CT 80 mean $\geq$ 85.5, 140 mean $\geq$ 71.5, M0.3 mean $\geq$ 76, DEIHU 140 and 80 mean $\geq$ 0.007996, DEDHU 140 and 80 mean $\geq$ 18.5 can predict LIC values of more than 11 mg/g.

#### **CLINICAL RELEVANCE/APPLICATION**

The threshold of hepatic iron overload which can be diagnosed by measuring CT parameters, mainly with dual-energy scanning, was determined.

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## Abstract Archives of the RSNA, 2023

M5A-SPGI-5

### Shear Wave Elastography and Attenuation Imaging for the Prediction of Risk of Events in Patients with NAFLD

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yudai Fujiwara (*Presenter*) Nothing to Disclose

#### PURPOSE

Common causes of mortality in non-alcoholic fatty liver disease (NAFLD) are cardiovascular events (CVEs), extrahepatic malignancies, and liver-related events (LREs). We aimed to determine the value of fibrosis and steatosis as determined by non-invasive ultrasound-based biomarkers for the prediction of the major events in patients with NAFLD.

#### METHODS AND MATERIALS

During a period 2016-2020, we accumulated a prospective cohort of 279 patients with NAFLD, who underwent shear wave elastography (SWE) together with ultrasound-guided attenuation parameter (UGAP) and liver biopsy within a day, and followed them until December 2022. SWE and UGAP were determined by LOGIQ E9 (GE Healthcare) with a C1-6-D convex probe. The cutoff values of liver stiffness measurements (LSM) by SWE and attenuation coefficient (AC) by UGAP for advanced liver fibrosis stage (F=2) and mild steatosis grade (S=1) were determined by the area under the curve analysis. According to the values, we classified patients into group A (low LSM and low AC), group B (low LSM and high AC), group C (high LSM and high AC), and group D (high LSM and low AC). Cumulative incidence ratio (CIR) of CVE, extrahepatic malignancy or LRE was calculated by Kaplan-Meier analysis and compare among the groups by log-rank test.

#### RESULTS

1) The median LSM values for each stage of liver fibrosis were 6.13 kPa in F0, 6.81 kPa in F1, 8.47 kPa in F3, and 10.23 kPa in F4 ( $p < 0.001$ ). The median AC values for each grade of steatosis were 0.42 dB/cm/MHz in S0, 0.55 dB/cm/MHz in S1, 0.68 dB/cm/MHz in S2, and 0.72 dB/cm/MHz in S3, ( $p < 0.001$ ). 2) 36 patients experienced one or more events during the observation period with a median of 4.1 years. Diabetes mellitus and AC were found to be independently associated with CIR of CVE (8.76%/5 years among all patients). Similarly, LSM was found to be associated with CIR of LRE (5.01%/5 years). 3) CIR of CVE, extrahepatic malignancy or LRE in groups A, B, C, and D was calculated to be 0.0%, 12.8%, 28.5%, and 46.7%, the values of which were significantly different among the groups ( $p < 0.05$ ).

#### CONCLUSION

A combination of ultrasound-based biomarkers LSM and AC determined by 2D SWE and UGAP may be a help for identifying NAFLD patients at a high risk of subsequent life-threatening events.

#### CLINICAL RELEVANCE/APPLICATION

Our prospective cohort study suggested that a combination of SWE and UGAP non-invasively assesses tissue characteristics of NAFLD and contributes to prediction of subsequent major life-threatening events.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPGI-6

### **Multiparametric Quantitative Ultrasound: Assessment of High-risk Steatohepatitis in Patients with Metabolic Dysfunction-associated Fatty Liver Disease**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hong Ding, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Metabolic dysfunction-associated fatty liver disease (MAFLD) affects almost 25% of the adult population worldwide. Early diagnosis and intervention for high-risk steatohepatitis in liver steatosis can prevent disease progression and improve prognosis. Non-invasive detection and quantification are important for the timely management and prevention of the progression of liver steatosis. This study aimed to investigate the clinical value of the predictive model of multiparametric quantitative ultrasound for the non-invasive assessment of high-risk steatohepatitis.

#### **METHODS AND MATERIALS**

The shear wave elastography (SWE), shear wave dispersion (SWD) and attenuation imaging (ATI) examinations were performed on 194 patients with metabolic dysfunction-associated fatty liver disease (MAFLD) who would undergo liver biopsy in Huashan Hospital, Fudan University from June 2021 to September 2022. Based on pathological SAF scoring system, high-risk steatohepatitis is defined as steatohepatitis with greater and clinically significant fibrosis, and a total activity score =4 of steatosis, hepatocyte ballooning and hepatic lobular inflammation. The binary logistic regression was used to identify factors influencing high-risk steatohepatitis. The predictive models were established by using R language. The diagnostic performance for high-risk steatohepatitis was assessed by using the area under curve (AUC), and AUCs were compared by using the Delong test.

#### **RESULTS**

There were 46 cases of high-risk steatohepatitis. Quantitative ultrasound parameters of elastic modulus, dispersion slope and attenuation coefficient, and blood markers including alanine aminotransferase (ALT), aspartate aminotransferase (AST) and high-density lipoprotein cholesterol (HDL-C) were the factors influencing high-risk steatohepatitis (all  $P < 0.05$ ). The AUCs of elastic modulus, dispersion slope, attenuation coefficient, multiparametric ultrasound model, blood markers model and ultrasound combined with blood markers model for diagnosing high-risk steatohepatitis were 0.764, 0.758, 0.634, 0.786, 0.745 and 0.802, respectively. Delong test showed the ultrasound combined with blood markers model had significantly better predictive properties than blood markers model and attenuation coefficient ( $P=0.017$ ,  $P < 0.001$ , respectively).

#### **CONCLUSION**

The combination of multiparametric quantitative ultrasound is useful for the non-invasive diagnosis of high-risk steatohepatitis with positive clinical value.

#### **CLINICAL RELEVANCE/APPLICATION**

This multiparametric quantitative ultrasound is useful for the non-invasive diagnosis of high-risk steatohepatitis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPGI-7

### Contrast Enhanced CT Based Radiomics for Predicting Postoperative Re-bleeding in Cirrhotic Patients

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Xin Yang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility of contrast enhanced CT-based radiomics in predicting postoperative esophagogastric variceal re-bleeding (EGVR) after laparoscopic splenectomy and azygoportal disconnection (LSD) in liver cirrhosis patients with portal hypertension.

#### METHODS AND MATERIALS

Preoperative contrast-enhanced CT examinations of 182 patients receiving LSD were enrolled. Patients were divided into with and without EGVR groups basing one year follow-up. 145 patients were enrolled randomly into training and validation cohorts in the ratio of 7:3, respectively. 37 patients were used in independent testing group. All radiomic features were extracted from CT images of the portal venous phase. Regions of interest (ROIs) were delineated on liver and spleen at the hilum level, respectively. The liver volumes of interest (VOI) and spleen VOI were automatically extracted. The least absolute shrinkage and selection operator (LASSO) regression was used to obtain optimal features from combined ROIs, as well as combined VOIs features, and incorporated into a logistic regression classifier to construct a model. The EGVR predictive performance of radiomics models was evaluated by the area under receiver-operating characteristic curve (AUC).

#### RESULTS

The constructed radiomics models showed good predictive efficacy and outperformed the clinical characteristics models. The best performance of radiomics model was the logistic regression model constructed by 8 features extracted from the ROIs of liver combining with spleen, with AUC of 0.931 and 0.914 for the training and validation group, respectively. An AUC of 0.858 in the independent testing group was obtained.

#### CONCLUSION

Contrast enhanced CT-based radiomics model can predict the risk of EGVR after LSD in patient with cirrhotic portal hypertension.

#### CLINICAL RELEVANCE/APPLICATION

The rate of esophagogastric vein bleeding in patients with cirrhotic portal hypertension is about 30%, with a 20% increase in mortality after six weeks. A 1 year prospectively study showed that the incidence of EGVR in patients after LSD is 13.4%, which is a lethal complication. Therefore, it is necessary to find a convenient way to predict EGVR, and our study provided a non-invasive way for the prediction of re-bleeding after LSD.

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## Abstract Archives of the RSNA, 2023

M5A-SPGI-8

### Non-invasive Liver Fibrosis Assessment with CT-based Iodine-uptake Parameters and Hepatosplenic Volumetric Indices

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Kenichiro Yoshida (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance of iodine uptake parameters and hepatosplenic volumetric indices measured from multiphase hepatic CT to predict liver fibrosis severity in patients who underwent liver resection.

#### METHODS AND MATERIALS

Ninety-one patients with pathologically proven liver fibrosis who underwent multiphase hepatic CT during the portal-venous phase (PVP) and 3-min delayed phase (DP) were included. The hepatic extracellular volume fraction (ECV) was calculated as  $([1 - \text{hematocrit}] \times [\text{hepatic iodine uptake during DP/aortic iodine uptake during DP}] \times 100)$ . The iodine washout rate (IWR) was calculated as  $([\text{hepatic iodine uptake during PVP} - \text{hepatic iodine uptake during DP}]/\text{hepatic iodine uptake during PVP} \times 100)$ . The liver volume (LV) and spleen volume (SV) normalized to body surface area (LV/BSA and SV/BSA, respectively) were quantified on PVP images using a deep learning algorithm. The correlations between the imaging parameters and the pathologic liver fibrosis stages were assessed using Spearman's correlation coefficient. The areas under the receiver operating characteristic curves (AUCs) to predict liver fibrosis severity were calculated for each imaging parameter. Multivariable logistic regression analysis was performed to identify independent predictors for hepatic cirrhosis, and combined diagnostic performance was assessed.

#### RESULTS

Patients with F2-4 ( $n = 37$ ), F3-4 ( $n = 16$ ), and F4 ( $n = 13$ ) showed higher ECV, lower IWR, and higher SV/BSA than those with F0-1 ( $n=54$ ), F0-2 ( $n=75$ ), and F0-3 ( $n=78$ ), respectively (all  $p < 0.05$ ). The highest correlation with fibrosis stages was attained in IWR ( $r = -0.593$ ), followed by SV/BSA ( $r = 0.383$ ), ECV ( $r = 0.381$ ), and LV/BSA ( $r = 0.062$ ). The AUC ranges of ECV, IWR, LV/BSA, and SV/BSA for predicting liver fibrosis severity were 0.667-0.717, 0.843-0.882, 0.507-0.560, and 0.685-0.819, respectively. IWR and SV/BSA were independent predictors of cirrhosis, with combined AUCs of 0.881.

#### CONCLUSION

IWR and SV/BSA can allow better prediction of liver fibrosis severity compared with ECV and LV/BSA in multiphase hepatic CT.

#### CLINICAL RELEVANCE/APPLICATION

IWR and SV/BSA may be served as a non-invasive imaging biomarker for predicting liver fibrosis severity on routine multiphase CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPGU-1

### Feasibility Study of Bone Mineral Metabolism in Chronic Kidney Disease Based on Dual-energy CT

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Wei Huang (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the accuracy of dual-energy CT (DECT) in assessing bone mineral metabolism in patients with chronic kidney disease (CKD) .

#### METHODS AND MATERIALS

The abdominal dual-energy CT images of 53 patients with CKD were retrospectively analyzed, and the images of T12-L4 vertebral bodies were analyzed by decalcification virtual plain scan technology. The images were processed and analyzed using the virtual non-contrast (VNC) software in the Dual-Energy tab of the Syngo Via CT post-processing workstation. The T12 - L4 vertebral body was measured on the median coronal image, the ROI was manually outlined along the outer edge of the vertebral body, and various measurements automatically given by the software were recorded: CT value of calcium (Contrast media, CM), mixed energy image (Mixing ratio of 0.6) CT value (Regular CT value, rCT), calcium concentration (Calcium density, CaD) and fat content percentage (Fat fraction, FF). Pearson correlation analysis was applied to explore the relation between clinical laboratory testing indicators and these parameters.

#### RESULTS

The contrast media, rCT, CaD in the hemodialysis patients were significantly lower than those in early stage CKD (  $p < 0.01$ ). The CM, rCT and CaD values of vertebral body were negatively correlated with Ca ( $r = 0.486, 0.389, 0.598$ , respectively, all  $p < 0.01$ ), There was no correlation between FF and Ca.

#### CONCLUSION

Dual-energy CT VNCA technique may constitute a valid alternative method for quantifying the mineral content and marrow fat composition of bone in the diagnostic assessments of bone mineral metabolism in chronic kidney disease.

#### CLINICAL RELEVANCE/APPLICATION

Using abdominal dual-energy CT images may additionally evaluate bone abnormalities early in CKD patients.

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## Abstract Archives of the RSNA, 2023

M5A-SPGU-2

### Development of a Radiomics Model for CT-based Clear Cell Likelihood Score in Small Solid Renal Masses

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Taekmin Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop an explainable CT radiomics-based model for diagnosing clear cell renal cell carcinoma (ccRCC) among small (= 4 cm) solid renal masses.

#### METHODS AND MATERIALS

This retrospective study included 159 patients (50 women; median age 58 years [IQR 50-65 years]) with pathologically confirmed renal solid masses (= 4 cm). Two radiologists independently evaluated mass-to-cortex ratio and heterogeneity score (on a 5-point Likert scale) in corticomedullary phases, and evaluated a five-tiered CT score for diagnosing ccRCC. Interpretable radiomics model was constructed using the CT radiomics features which were associated with mass-to-cortex ratio (first-order statistics of the mass and renal cortex) and heterogeneity score (first-order statistics and texture features of the mass). Diagnostic performance of diagnosing ccRCC were compared between five-tiered CT score and radiomics model.

#### RESULTS

The masses comprised 52.8% of ccRCC (84/159) and 47.2% (75/159) of other histologic diagnoses. The mass-to-cortex ratio and heterogeneity score were significantly higher in ccRCC than in other diagnoses ( $0.87 \pm 0.18$  vs.  $0.58 \pm 0.21$  and  $4.1 \pm 0.9$  vs.  $2.5 \pm 1.1$ , respectively,  $P < 0.001$  for both). CT score = 4 achieved an AUC of 0.851 with sensitivity, specificity, and PPV of 72.6%, 80%, and 80.2%, respectively. The radiomics-based mass-to-cortex ratio and radiomics-based heterogeneity score obtained intraclass correlation coefficient of 0.89 (95% CI 0.85-0.92) and 0.82 (95% CI 0.76-0.86) compared with the original values, respectively. Diagnostic performance of radiomics model for identifying ccRCC obtained AUC of 0.913, which was superior to that of CT score (difference between areas 0.06,  $P = 0.02$ )

#### CONCLUSION

The CT-based radiomics algorithm, which was constructed using the features correlated with two key parameters, showed good performance of diagnosing ccRCC in small renal masses.

#### CLINICAL RELEVANCE/APPLICATION

CT-based clear cell likelihood score (ccLS) could provide lower cost and greater accessibility for patients, but validation for diagnostic performance and inter-reader agreement are needed. We developed a CT radiomics model for identifying ccRCC, which has a potential to easily apply in clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPGU-3

### Succinate Dehydrogenase-deficient Renal Cell Carcinoma: Characterization of Imaging Features for Precision Diagnosis

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Aditi Chaurasia, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Succinate dehydrogenase-deficient RCC is a rare, newly defined distinct renal cancer subtype under WHO tumor classification, confirmed by immunohistochemistry showing loss of staining of SDHB in tumors. Our aim is to investigate the imaging findings of SDHB-deficient renal tumors to facilitate accurate tumor characterization.

#### METHODS AND MATERIALS

The study included 20 SDH-deficient tumors from 16 patients with pathogenic variations in SDHB gene. Cross-sectional and PET imaging scans from this cohort was retrospectively evaluated by two radiologists and one nuclear medicine specialist. Clinical findings such as demographics, family history, extra-renal findings and metastases were recorded. Tumor imaging characteristics on CT and MRI included were laterality, size, homogeneity, morphology, margins, internal content, T1 and T2 signal intensity, enhancement features, and restricted diffusion.

#### RESULTS

A total of 16 patients (median age 31 years, IQR 19-41, 8 men) were identified with 68.8% of patients having a known family history of SDHB mutation. 81.3% of lesions were solitary and majority were solid (86.7% on CT, 87.5% on MRI) with well-defined margins in >62.5% of lesions, without evidence of internal fat, calcifications, and vascular invasion. On MRI, 87.5% of lesions had T2 intensity equal or more than cortex but less than CSF, and 100% of lesions demonstrated restricted diffusion. 100% of lesions showed enhancement with degree greater than 75% for most lesions on CT and MRI. On PET, all renal masses showed radiotracer uptake (mean SUVmax 31.9, mean SUVmean 7.1). 43.8% of patients demonstrated extra-renal manifestations and 43.8% distant metastasis.

#### CONCLUSION

SDHB-associated RCC is predominantly noted in young patients with no gender predilection. On imaging, SDH-deficient RCC are frequently unilateral, solitary, and solid with well-defined margins demonstrating avid enhancement with variability in enhancement pattern and showing restricted diffusion.

#### CLINICAL RELEVANCE/APPLICATION

The present article is a pilot study to characterize the findings of newly defined SDH-deficient RCC in patients having germline variation in SDHB gene on morphological and PET imaging to aid in early and accurate tumor identification.

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## Abstract Archives of the RSNA, 2023

M5A-SPHN-1

### **Intravoxel Incoherent Motion Diffusion-weighted Imaging in Nasopharyngeal Cancer: Comparison between Turbo Spin-echo and Echo-planar Imaging Techniques**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yuan Liu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the qualitative and quantitative indicators between turbo spin-echo(TSE)-IVIM and echo-planar imaging(EPI)-IVIM in patients with nasopharyngeal cancer.

#### **METHODS AND MATERIALS**

Thirty patients with nasopharyngeal carcinoma underwent a pre-treatment staging MRI examination (Ingenia 3.0T , Philips Healthcare, the Netherlands). The IVIM images were evaluated subjectively and objectively for anatomical structures (nasopharyngeal lesions, turbinate, spinal cord and temporal pole). Subjective evaluation indicators(five-point scale for susceptibility artifacts, geometric distortion, lesion conspicuity and overall image quality) were compared with Wilcoxon signed rank test. Quantitative indicators were compared with paired t-test of signal-to-noise ratio(SNR), contrast-to-noise ratio (CNR), ADC and IVIM-derived parameters. Bland-Altman and coefficient of variance(CV) was performed to analyse reproducibility and robustness between ADC and IVIM-derived parameters of TSE-IVIM and EPI-IVIM.

#### **RESULTS**

TSE-IVIM performed significantly better than EPI-IVIM of the qualitative indicators in nasopharyngeal lesions, turbinate and temporal pole( all  $p < 0.001$ ), while no significant difference in spinal cord(table 1). SNR and CNR of TSE-IVIM were significantly lower than EPI-IVIM in spinal cord and temporal lobe, while no significant difference in the nasopharyngeal lesions and turbinate(table2).  $f$  values of TSE-IVIM showed significant lower than EPI-IVIM in the nasopharyngeal lesions, and ADC and  $D^*$  values of TSE-IVIM showed significant higher than EPI-IVIM in spinal cord (table3). CV of TSE-IVIM mainly showed lower percentage than EPI-IVIM. Bland-Altman analysis showed wide limits of agreement(LoA) in the nasopharyngeal lesions and turbinate(table4,figure1).

#### **CONCLUSION**

For better image subjective scores and no significant lower SNR and CNR, TSE-IVIM performed better image quality and more stable quantitative indicators in the nasopharyngeal lesions and turbinate area, which were more noticeable for magnetic sensitivity artifacts. For the different  $f$  values and wide LoAs between two sequences in the nasopharyngeal lesions , we recommended to use TSE-IVIM on follow-up of patients with nasopharyngeal lesions.

#### **CLINICAL RELEVANCE/APPLICATION**

TSE-IVIM provide better image quality and greatly reduce the susceptibility artifacts and geometric distortion in nasopharynx. TSE-IVIM benefit the accuracy and stability for IVIM-derived parameters. We recommend to use TSE-IVIM on follow-up for nasopharyngeal lesions.

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## Abstract Archives of the RSNA, 2023

M5A-SPHN-2

### Feasibility of Using Multi-frequency Magnetic Resonance Elastography for Evaluating the Parotid Glands In Healthy Volunteers

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Man Ting Tian, MEd (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the feasibility of using multifrequency magnetic resonance elastography (MRE) for evaluating the parotid glands in healthy volunteers.

#### **METHODS AND MATERIALS**

Six healthy volunteers were divided into two groups. Three volunteers had a passive driver placed on the occiput during scanning (occiput group), while the other three had a passive driver placed on the right face (right face group). Both groups underwent multifrequency MRE(60, 90, 120, and 150 Hz) of parotid gland at 3 Tesla. The image quality of the MRE waveforms, elastograms was evaluated.

#### **RESULTS**

In the occiput group, the shear wave propagation from the occiput region to the parotid gland was distant, resulting in significant attenuation and interference. The image quality was higher at 60 Hz, but lower at 90 Hz and 120 Hz. Volunteers could not tolerate the scan at 150 Hz and the scan was terminated. In the right face group, the attenuation and interference of the shear wave propagation were smaller. The image quality was high at all frequencies (60, 90, 120, and 150 Hz). However, because the arrival time of the shear wave in the bilateral parotid gland was different, this group was more suitable for observing the right parotid gland.

#### **CONCLUSION**

The appropriate frequency for the occiput group to evaluate the parotid gland was 60 Hz, while the appropriate frequencies for the right face group were 60 Hz, 90 Hz, 120 Hz, and 150 Hz.

#### **CLINICAL RELEVANCE/APPLICATION**

Multifrequency MRE can be applied to healthy parotid glands, and may be further applied to the study of parotid gland tumors and diffuse lesions such as Sjogren's syndrome in the future.

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## Abstract Archives of the RSNA, 2023

M5A-SPHN-3

### Validation of a Fluorescent MET-Targeting Probe for Assisting Biopsy in OPMDs

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Jingbo Wang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The objective of this study is to investigate the use of a topically applied mesenchymal-epithelial transition factor (MET) targeting probe, cMBP-ICG, in conjunction with near-infrared targeted fluorescent imaging (NIRFI) to improve the accuracy of biopsy site selection for oral potentially malignant disorders (OPMDs). This approach aims to reduce the rate of missed detection of intermediate-high grade dysplasia (IHD) and oral squamous cell carcinoma (OSCC).

#### METHODS AND MATERIALS

The acute toxicological properties of cMBP-ICG were evaluated in mice. The progression of OPMDs to OSCC was simulated in mice treated with 4-NQO and monitored using MRI and NIRFI. Tongue tissue was evaluated for pathological characteristics and MET expression. The detection rate of IHD was compared between NIRFI-assisted and standard biopsy in mice. An exploratory clinical trial involving six subjects with OPMDs evaluated the consistency between NIRFI-assisted and physician-selected biopsy sites using Cohen's kappa statistic.

#### RESULTS

No significant differences were observed in CBC and blood biochemical test results before and after administration of cMBP-ICG. Low-grade dysplasia was present in 62 cases and IHD was present in 34 cases. Carcinoma in situ was present in 21 cases and invasive carcinoma was present in 5 cases. The average signal-to-background ratio and mean fluorescence intensity of neoplasia with higher malignancy than IHD were  $6.3 \pm 2.7$  and  $17.4 \pm 8.9$  arbitrary units, respectively. The mean values of MET-positive area for the four pathological types were  $31.0 \pm 11.9\%$ ,  $57.8 \pm 18.9\%$ ,  $70.4 \pm 13.8\%$ , and  $85.5 \pm 8.4\%$ , respectively. NIRFI-assisted biopsy had a missed detection rate and a detection rate of IHD of  $0.0085 \pm 0.04$  and  $0.66 \pm 0.27$ , respectively, while standard biopsy had a missed detection rate and a detection rate of IHD of  $0.36 \pm 0.2$  and  $0.39 \pm 0.25$ , respectively. There was a statistically significant difference between the two groups ( $P < 0.01$ ). In contrast, there was no statistically significant difference between the two groups in the missed detection rate and detection rate of carcinoma. The OR value related to group assignment was less than 1 for the missed detection rate of IHD and greater than 1 for all detection rates. For the six enrolled patients, NIRFI-assisted biopsy was performed at all sites consistent with experienced clinicians, with a kappa value of 0.39 and a P-value of 0.19.

#### CONCLUSION

Compared to standard biopsy, the use of cMBP-ICG in conjunction with NIRFI may improve the detection of IHD.

#### CLINICAL RELEVANCE/APPLICATION

The NIRF probe cMBP-ICG and NIRF imaging system may provide a non-invasive method for biopsy sampling assistance, potentially changing the clinical protocol for OPMDs, and improving the early diagnosis rate of OSCC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPHN-4

### Development and Validation of Deep Learning Based Automated Detection of Cervical Lymphadenopathy in Patients With Lymphoma for Treatment Response Assessment: A Bi-institutional Feasibility Study

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Ji Su Ko, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To train and evaluate a deep learning (DL) model for the accurate detection and segmentation of abnormal cervical lymph nodes (LN) on head and neck contrast-enhanced CT scans in patients diagnosed with lymphoma and evaluate the clinical utility of the DL model in response assessment.

#### METHODS AND MATERIALS

This retrospective study included patients who underwent CT for abnormal cervical LN and lymphoma assessment between January 2021 and July 2022. Patients were grouped into the development (n=76), internal test 1 (n=27), internal test 2 (n=87), and external test (n=26) cohorts. A 3D SegResNet model was used to train the CT images. The volume change rates of cervical LN across longitudinal CT scans were compared among patients with different treatment outcomes (Stable, response, and progression). Dice similarity coefficient (DSC) and Bland-Altman plot were used to assess the model's segmentation performance and reliability, respectively.

#### RESULTS

No significant differences in baseline clinical characteristics were found across cohorts (age, P=0.55; sex, P=0.13; diagnoses, P=0.06). The mean DSC was  $0.39 \pm 0.2$  with a precision and recall of 60.9% and 57.0%, respectively. Most LN volumes were within the limits of agreement on the Bland-Altman plot. The volume change rates among the three groups differed significantly (progression (n=74), 342.2%; response (n=8), -79.2%; stable (n=5), -8.1%; all P<0.01).

#### CONCLUSION

Our proposed DL segmentation model is reliable for quantifying the cervical LN burden on CT in patients with heterogeneous lymphoma. Longitudinal changes in cervical LN volume, as predicted by the DL model, are useful for treatment response assessment.

#### CLINICAL RELEVANCE/APPLICATION

DL-based auto segmentation model could effectively detect and quantify cervical LN burden in patients with lymphoma across longitudinal CT scans, which could ultimately improve guidance for treatment response assessment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPHN-5

### Deep Learning Based Multi-Modal Segmentation of Oropharyngeal Squamous Cell Carcinoma on CT and MRI Using Self-Configuring nnU-Net

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

DONGJUN LEE, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate deep learning-based segmentation models for oropharyngeal squamous cell carcinoma (OPSCC) using CT and MRI with nnU-Net.

#### METHODS AND MATERIALS

This retrospective study included 91 patients with OPSCC. The patients were grouped into development (n=56), test 1 (n=13), and test 2 (n=22) cohorts. In development cohort, OPSCC was manually segmented on CT, MR, and co-registered CT-MR, which served as ground truth. The multimodal and multichannel input images were then trained using a self-configuring nnU-Net framework. For evaluation metrics, dice similarity coefficient (DSC; 1=perfect and 0=no overlap) and mean Hausdorff distance (HD; near 0=good) were calculated for two test cohorts. Pearson's correlation and Bland-Altman analyses were performed between ground truth and prediction volumes. Kruskal-Wallis tests were performed to compare DSC and HD of the three models.

#### RESULTS

All three models achieved robust segmentation performances with DSC of  $0.64 \pm 0.33$  (CT),  $0.67 \pm 0.27$  (MR), and  $0.65 \pm 0.29$  (CT-MR) in test cohort 1 and  $0.57 \pm 0.31$  (CT),  $0.77 \pm 0.08$  (MR), and  $0.73 \pm 0.18$  (CT-MR) in test cohort 2. No significant differences were found in DSC among the models. HD of CT-MR ( $1.57 \pm 1.06$  mm) and MR models ( $1.36 \pm 0.61$  mm) were significantly lower than that of CT model ( $3.48 \pm 5.0$  mm) ( $P=0.037$  and  $P=0.014$ , respectively). The correlation coefficients between ground truth and prediction volumes for CT, MR, and CT-MR models were 0.88, 0.93, and 0.9, respectively.

#### CONCLUSION

The self-configuring nnU-Net framework yielded a reliable and accurate segmentation of OPSCC on CT and MRI. The multimodal CT-MR model showed promising results for the simultaneous segmentation on CT and MRI.

#### CLINICAL RELEVANCE/APPLICATION

The multimodal segmentation models trained with the nnU-Net framework provided reliable and accurate segmentations of OPSCC on both CT and MR, which can be applied to facilitate clinical staging, radiation therapy planning, and treatment response assessment.

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## Abstract Archives of the RSNA, 2023

M5A-SPHN-6

### Structure-Preserving Image Quality Improvement of Cone Beam CT Using Deep Learning

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Won-Jin Yi, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to increase the image quality and HU accuracy of CBCTs while preserving anatomical structures. We applied contrastive learning-based GAN for unpaired image translation to the quality improvement of CBCT images.

#### METHODS AND MATERIALS

We generate CT-like images from CBCT images using a patchwise contrastive learning-based GAN model. Our model is trained on unpaired CT and CBCT datasets of 30 patients with the novel combination of loss, composed of semantic relation consistency loss, spatially correlative loss, and reconstruction loss. We used a customized feature extractor pretrained on our training dataset to calculate the spatially correlative loss. We evaluate the quality of the images generated by our model in terms of Frechet inception distance (FID), peak signal-to-noise ratio (PSNR), mean absolute error (MAE), and root mean square error (RMSE). Additionally, the structure preservation performance is assessed by the structure score. Furthermore, we performed the ablation study by progressively adding components of the loss to analyze the impact of the various components on the performance.

#### RESULTS

The generated CT-like images by our model are significantly superior to those generated by various baseline models in terms of FID, PSNR, MAE, RMSE, and structure score. The spatially correlative loss and the reconstruction loss in our model provided the complementary benefits of preserving the anatomical structures of the input CBCT images and improving the image quality to be similar to CT images.

#### CONCLUSION

The generated CT-like images by our model were significantly superior to those generated by various baseline models in terms of FID, PSNR, MAE, RMSE, and structure score. We demonstrate that our model provides complementary benefits of preserving the anatomy of the input CBCT images and improving the image quality to be similar to those of CT images.

#### CLINICAL RELEVANCE/APPLICATION

Cone-beam CT (CBCT) is widely used in dental clinics but exhibits limitations in assessing soft tissue pathology because of its lack of contrast resolution and low Hounsfield Units (HU) quantification accuracy. The proposed method considerably enhanced CBCT's quality and HU accuracy while preserving the anatomical structure. We demonstrated that our framework enables detailed visualization of soft tissues and accurate quantification of HU in CBCT. This work could allow for accurate quantification of HU, suggesting the possibility of using CBCT in more clinical situations.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5A-SPHN-7

### Quantitative Pharmacokinetic Parameter $K^{trans}$ Map Assists in Regional Segmentation of Nasopharyngeal Carcinoma in Dynamic Contrast-enhanced Magnetic Resonance Imaging (DCE-MRI)

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Zhou Liu, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate segmentation of nasopharyngeal carcinoma (NPC) lesion areas from dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) facilitates subsequent diagnostic and prognostic workups. Traditionally, anatomical DCE-MRI-based NPC segmentation using deep learning has achieved fair results but still needs further improvement. Hence, we investigate the incremental benefit of incorporating pharmacokinetic parameter maps into anatomical DCE-MR image segmentation tasks by taking advantage of the hemodynamic contrast between NPC and surrounding tissue.

#### METHODS AND MATERIALS

In this paper, a pharmacokinetic parameter  $K^{trans}$  map of NPC is used as prior information and combined with anatomical DCE-MRI data to improve the performance of segmentation models. A novel model, multi-input branch residual U-Net (MBRU-Net), which extracts features from both anatomical DCE-MR images and  $K^{trans}$  maps and fuses them to improve the segmentation performance, is introduced. The effectiveness of the multibranch network is validated by comparing MBRU-Net with deep residual U-Net (ResU-Net) with DCE-MRI +  $K^{trans}$  data. Additionally, different models (U-Net, segmentation network (SegNet), recurrent residual U-Net (R2U-Net), and ResU-Net) are trained with DCE-MRI and DCE-MRI +  $K^{trans}$  data separately and compared to validate the effectiveness of multimodal data using the Dice coefficient (Dice).

#### RESULTS

Our proposed MBRU-Net achieves the best Dice in this study ( $67.39 \pm 15.79\%$ ), higher than ResU-Net's Dice ( $65.57 \pm 17.52$ ) based on DCE-MRI and  $K^{trans}$  data. U-Net, SegNet, R2U-Net, and ResU-Net achieve better results in terms of segmenting tumor regions with DCE-MRI +  $K^{trans}$  data than those of the corresponding models with DCE-MRI data alone, where U-Net has the best performance (DCE-MRI +  $K^{trans}$ : DCE-MRI =  $66.31 \pm 17.80\%$ :  $61.10 \pm 24.14\%$ ).

#### CONCLUSION

It is beneficial to add a pharmacokinetic parametric ( $K^{trans}$ ) map as prior information to the conventional anatomical MRI-based segmentation task, and multibranch network structures perform better than single-branch network structures in terms of NPC segmentation.

#### CLINICAL RELEVANCE/APPLICATION

|  $K^{trans}$  map as a priori information is beneficial for the segmentation of NPC on DCE-MRI, which might facilitate diagnostic and prognostic workup.

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## Abstract Archives of the RSNA, 2023

M5A-SPIN-1

### Comparison of Human and AI-based Medical and Non-medical Segmentation Algorithms

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Matthias F. Froelich, MD (*Presenter*) Consultant, Smart Reporting GmbH; Consultant, Guerbet SA

#### PURPOSE

To evaluate the comparative performance of human and AI-based segmentation, especially in the context of novel algorithms, not trained exclusively on (sectional) imaging data.

#### METHODS AND MATERIALS

A challenging CT slice with suboptimal contrast was selected. Manual segmentation was performed by a radiologist using 3D-Slicer. Automated segmentation algorithms (Total Segmentator fast/standard mode, Segment Anything in four settings) were run on the image. No further adjustment of the segmentation was performed. A total of 7 radiologists (3-11 yrs experience), evaluated the segmentations in blinded approach.

#### RESULTS

Human segmentation took 18:23 min, compared to AI-based approaches which took a maximum of 1:12 min. 5 radiologists (62.5%) identified the human segmentation correctly, which was rated best (> 50% very or somewhat closely correct segmentation). For the AI-based approaches, the Total Segmentator Standard Mode was ranked best (at least moderately closely 100%). The results are summarised in the figure attached.

#### CONCLUSION

AI-based segmentation is significantly faster than human segmentation. In challenging cases with suboptimal contrast, models trained on imaging data exclusively may still be superior to other models.

#### CLINICAL RELEVANCE/APPLICATION

Segmentation is a task that should be performed automatically by AI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPIN-3

### Comparative Analysis of Spectral Characteristics of Monoenergetic CT Reconstructions for Different Kidney Stone Types Scanned on Photon-Counting-CT

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Alexander Hertel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to investigate the potential of using the radiomics profile of different monoenergetic reconstructions of photon-counting CT (PCCT) scans to differentiate various types of kidney stones. The study seeks to explore the relationship between radiomics features and the underlying composition of kidney stones, with the ultimate goal of developing a more accurate and non-invasive approach to diagnose and classify kidney stones. The learning objective of this study is to contribute to the development of a more personalized and precise approach to the diagnosis and treatment of kidney stone disease. The learning objective of this study is to contribute to the development of a more personalized and precise approach to the diagnosis and treatment of kidney stone disease.

#### METHODS AND MATERIALS

Photon-counting CT (PCCT) is a novel imaging technology that has shown great promise in Radiomics analysis, e.g. due to its high feature stability. In this study, we scanned 150 different types of kidney stones, including Xanthine, Brushite, Carbonateapatite, Cystine, and others, using a PCCT. Monoenergetic reconstructions of the scans were created using the Syngo Via software (version VB60A\_HF02) from Siemens in 30 keV steps from 40 to 190 keV. The stones were semi-automatically segmented using the MITK-Workbench software (v2022.10), and radiomics features were then extracted using a Docker container based on Pyradiomics (Version 3.0.1). Statistical analyses, including cluster analyses and the creation of box plots, were performed using R-Statistics (Version 2023.03.0+386) to explore the potential of radiomics for differentiating between different types of kidney stones.

#### RESULTS

In the study it could be shown that especially in the monoenergetic reconstructions with low keV values (40 and 70keV) a differentiation of the different kidney stone types, among other things on the basis of the average HU values, is possible, since these differed significantly depending on the kidney stone type. In contrast, no significant differences were found for the higher keV values.

#### CONCLUSION

Radiomics evaluations of monoenergetic reconstructions with low keV values (40 and 70keV) of photon counting CT scans can help differentiate and characterize renal stones noninvasively, potentially optimizing therapy.

#### CLINICAL RELEVANCE/APPLICATION

Non invasive differentiation of kidney stones to potentially optimize therapy.

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## Abstract Archives of the RSNA, 2023

M5A-SPIN-4

### Dual-Energy CT-derived Imaging Features: Diagnostic and Prognostic Value of Radiomics Features and Iodine Maps in Patients with Mediastinal Masses

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Vitali Koch, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the diagnostic and prognostic value of radiomics features and dual-source dual-energy CT (DECT) based material decomposition in patients with benign and malignant mediastinal masses.

#### METHODS AND MATERIALS

This retrospective study included 90 patients (38 males, mean age  $61 \pm 12$  years) with pathologically confirmed mediastinal masses who underwent contrast-enhanced DECT between 10/2014 and 04/2023. All patients were evaluated by two experienced readers regarding conventional radiomics features, as well as DECT-based texture features including attenuation (HU), iodine density (mg/ml), and fat fraction (%). Data comparisons were performed using analysis of variance (ANOVA) and chi-square statistic tests. Cox regression tests and receiver operating characteristic curve analysis were used to predict outcomes and discriminate between benign and malignant mediastinal masses.

#### RESULTS

Of the 90 mediastinal masses, 28 (31%) were lymphomas, 6 (7%) were mediastinal tumors, and 9 (10%) were thymic carcinomas. Values differed significantly between benign and malignant mediastinal masses regarding DECT-based texture features ( $p < 0.04$ ) and 30 radiomics features ( $p < 0.03$ ). The area under the curve to differentiate between benign and malignant formations was 0.980 (95% CI, 0.893-1.000;  $p < 0.001$ ) for the combination of DECT imaging parameters and radiomics features, yielding a sensitivity of 100% and specificity of 91%. During a follow-up of 60 months (IQR, 52-60 months), the multiparametric approach including radiomics features, DECT parameters, and clinical parameters showed good prognostic power to predict all-cause mortality (c-index = 0.896 [95% CI, 0.802-0.970],  $p = 0.001$ ).

#### CONCLUSION

A multiparametric approach including conventional radiomics features and DECT-based texture features facilitates accurate, non-invasive discrimination between benign and malignant mediastinal masses with high sensitivity and specificity.

#### CLINICAL RELEVANCE/APPLICATION

Early detection of malignant masses is of utmost importance to avoid delays in treatment initiation. Combining radiomics features, DECT-derived imaging parameters, and clinical parameters through computational assessment of texture features has the potential to identify masses with an increased risk of malignancy.

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## Abstract Archives of the RSNA, 2023

M5A-SPIN-5

### **HASKE: A Low-Resource PACS Platform for Improving Diagnostic Imaging Access in Sub-Saharan Africa**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Udunna Anazodo, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The delivery of diagnostic imaging in low-and-middle income countries (LMICs) is challenged by high costs of infrastructure acquisition and shortage of experts, particularly in Sub-Saharan Africa (SSA). One of the main issues accentuating this challenge is the availability of picture archiving and communication systems (PACS) for distribution, archiving and managing of images due to poor availability of quality internet service, high cost of computing infrastructure for hosting and distributing PACS and lack of skilled administrators to effectively maintain the system. Poor access to PACS contributes to poor diagnostic outcomes as the few available radiologists who serve a large population over a vast geographical area, are unable to access images for proper diagnosis. To improve PACS access in resource limited settings, we propose a redistributable PACS platform, HASKE (light in Hausa) accessible to radiologists, physicians, and patients based open-source tools, designed for use in low bandwidth environments and for ease of management.

#### **METHODS AND MATERIALS**

HASKE is designed (Figure 1) to provide a low-resource solution for rapid access to images with standard features for 1) onsite and cloud/remote archiving system, 2) integrated zero footprint DICOM viewer, 3) a straightforward DICOM query interface, 4) mobile phone accessibility, and 5) low maintenance requirements for easy management by non-IT health personnel.

#### **RESULTS**

The pilot open-source PACS tool is currently in use at three imaging facilities in Nigeria will be scaled up to provide a Health Level 7 (HL7) vendor-neutral PACS platform to ensure ease of integration, especially given the nature of medical device procurement in SSA (third party vs. original equipment manufacturers [OEMs]).

#### **CONCLUSION**

The HASKE PACS platform represents a significant step towards improving access to diagnostic imaging in SSA and other resource-limited settings. The platform is designed to overcome prevailing challenges from lost images either through non availability of storage systems or poorly interpreted due to the lack of accessibility to the radiologist. HASKE is designed to help clinicians with limited resources to distribute images better and readily read and share imaging findings to transform disease management in SSA. By utilizing open-source tools, the platform is scalable and affordable, making it accessible to radiologists, physicians, and patients, alike.

#### **CLINICAL RELEVANCE/APPLICATION**

While HASKE address the immediate need for diagnostic image data management, it ultimately will enable health equity and inclusion of resource limited settings in imaging data science and artificial intelligence (AI) solutions, where AI is has the greatest potential to improve local health outcomes.

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## Abstract Archives of the RSNA, 2023

M5A-SPIN-6

### A Platform for Automatically Extracting Imaging Biomarkers from Ischemic and Hemorrhagic Stroke Patients

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Rajat Dhar, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Imaging biomarkers of primary and secondary injury provide critical insights into disease progression and prognosis. Quantifying lesions (infarct or hemorrhage) and associated edema volume can be time-consuming and impractical in large multi-institutional cohorts. We present a cloud-based image repository and computational platform that can archive, analyze, and output multi-dimensional imaging biomarkers from brain CTs of ischemic and hemorrhagic stroke patients.

#### METHODS AND MATERIALS

The Stroke NeuroImaging Phenotype Repository (SNIPR), based on the XNAT platform, has archived serial imaging from large stroke cohorts from multiple institutions. It allows the implementation of image analysis pipelines wrapped in Docker containers. In this study, we deployed containerized pipelines to analyze lesion and edema volume from both ischemic and hemorrhagic (ICH) stroke cohorts. Scans within each imaging session are first classified (using metadata and a deep learning-based classifier), allowing selection of 'axial brain CT' scans which can be processed (incl. DICOM to NIFTI conversion, brain extraction, and normalization), followed by (U-net-based) segmentation of infarct and hemorrhage lesions as well as peri-hematoma edema (in ICH) and displacement of CSF (for both ischemic stroke and ICH). The ratio of hemispheric CSF volumes was calculated in both groups. Net water uptake (NWU) is calculated in the infarct group as the relative density of infarct vs. Mirrored regions. Resulting segmentation masks are stored, while the biomarker results are stored as CSV files and presented as novel data types that can be viewed on a session, subject, or project level. A superimposed view of the lesion and edema/CSF masks over the NCCT image and a summary of the measurements are also held in a PDF.

#### RESULTS

The analysis pipelines were implemented on 2649 CT sessions (ischemia:442 and ICH:2207) from three research centers. Axial brain scans could be found in the majority (74%) of sessions. Pipelines were completed in 1407 (71%), with biomarker extraction, including infarct/hemorrhage volumes, CSF ratio, and NWU. The platform can analyze around 1000 images in a week.

#### CONCLUSION

The study presents a cloud-based image archive and analysis pipeline to calculate biomarkers in axial brain CT. It allows multi-centric collaboration and analyses of thousands of images at a time that would facilitate ongoing stroke research worldwide. The platform will be extended to include more image analysis pipelines useful for stroke research.

#### CLINICAL RELEVANCE/APPLICATION

This platform can assist in quantifying infarction, hemorrhage, and edema in large volumes of serial brain CT scans of ischemic and hemorrhagic stroke patients, facilitating stroke research.

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## Abstract Archives of the RSNA, 2023

M5A-SPIN-7

### Complex Convolutional Neural Networks for Denoising Accelerated Submillimeter Magnetic Susceptibility Brain MRI

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Bryan Quah, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic susceptibility-based imaging using submillimeter isotropic 3D echo-planar imaging (3D-EPI) enables the detection of biomarkers for neurological disorders, such as the central vein sign and paramagnetic rim lesions in multiple sclerosis. Recent developments combining 3D-EPI acquisition with CAIPIRINHA undersampling, have shown to significantly reduce scan times. However, this comes at the cost of a reduced signal-to-noise ratio (SNR) which we address here using a complex denoising deep learning method.

#### METHODS AND MATERIALS

3T brain MRI scans from 52 adults scanned at three imaging sites were used. T2\*-weighted magnitude and phase images were acquired at 650  $\mu\text{m}$  isotropic using 3D-EPI without parallel imaging (Acquisition Time, AT:  $\sim 6$  minutes), and with parallel imaging using CAIPIRINHA at different acceleration factors: R=2, (AT:  $\sim 4$  minutes), R=3 (AT:  $\sim 3$  minutes) and R=4 (AT:  $\sim 2$  minutes). The subjects were divided into 2 datasets: a training set (N=41) for the network to learn the denoising task and a testing set (N=11) to evaluate the model performance. The training set consists of data acquired without CAIPIRINHA while the testing set consists of data acquired with CAIPIRINHA at the 3 acceleration factors. We developed a 2-dimensional convolutional neural network to denoise the complex valued data created from the magnitude and phase 3D-EPI images. Our developed network extends the convolution and rectified linear unit operations to the complex domain. Peak signal-to-noise ratio (PSNR) and structural similarity index measure (SSIM) were calculated before and after denoising.

#### RESULTS

Upon visual inspection, the denoised magnitude and phase images displayed improved image quality while the visibility of brain features and disease-related biomarkers were preserved. The average PSNR values measured across the cohort were increased after denoising at all acceleration factors (+29% for R=2; +34% for R=3; +41% for R=4). Meanwhile, the SSIM values measured remained high for all acceleration factors (mean  $\pm$  SD: 0.959  $\pm$  0.014 for R=2; 0.951  $\pm$  0.021 for R=3; 0.942  $\pm$  0.023 for R=4).

#### CONCLUSION

We developed a complex denoising deep learning approach to efficiently improve the image quality of accelerated submillimeter magnetic susceptibility brain MRI scans. Even at high acceleration factors (R $\geq$ 3), our method was able to restore the significant loss in SNR while maintaining structural details.

#### CLINICAL RELEVANCE/APPLICATION

Our study demonstrates the feasibility of efficiently denoising accelerated magnetic susceptibility brain MRI with complex convolutional neural networks. Our proposed method opens the door for ultra-fast submillimeter SWI and QSM imaging in the clinical setting.

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## Abstract Archives of the RSNA, 2023

M5A-SPIR-1

### Prediction of Response to Treatment and Outcome of Trans-arterial Chemoembolization in Patients with Hepatocellular Carcinoma Using Artificial Intelligence: A Systematic Review Study

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Pedram Keshavarz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study reviews the efficacy of different AI models for prediction of hepatocellular carcinoma treatment response to transarterial chemoembolization (TACE) including the overall survival (OS).

#### METHODS AND MATERIALS

This systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. We conducted a literature search in online databases, including Scopus, Medline (PubMed), Web of Science, Embase, and Google Scholar. The random-effect models were utilized to calculate pool sensitivity, specificity, predictive values, summary receiver operator characteristic (ROC), and area under curve (AUC) based on the "Standards for Reporting Diagnostic accuracy studies" (STARD) guidelines.

#### RESULTS

The systematic review cohort included 21 studies with 4,489 patients. The AI algorithm AUC for predicting HCC response to TACE ranged from 0.32-0.97. Radiomics and non-radiomics feature based models had similar pooled AUCs of 0.76 (95%CI: 0.73-0.79) and 0.75 (95%CI: 0.70-0.80), respectively. Compared to the most widely utilized machine learning methods relying on logistic regression, other AI-based methods such as convolutional neural networks (CNN) and support vector machine (SVM) had AUCs of 0.93 (95%CI 0.84-1.00) and 0.79 (95%CI, 0.77-0.81) respectively. Of all predictive feature models, models combining both CT or MR images with clinical features had higher AUCs of 0.78 (CT+clinical, 95%CI 0.74-0.83) and 0.81 (MR+clinical 95%CI 0.78-0.84) respectively, relative to models based on clinical features alone, AUC 0.67 (95%CI 0.53-0.80).

#### CONCLUSION

AI models showed acceptable performance in prediction of treatment response to TACE and post-TACE OS. CNN method utilizing a combination of cross-sectional images findings and clinical characteristics had superior performance compared to sole clinical features.

#### CLINICAL RELEVANCE/APPLICATION

The prediction of post-TACE, HCC treatment response by AI methods was feasible and significant in all studies. Contributing medical data is vital in improving predictions' confidence and stability, while it can significantly enhance accuracy and reduce the burden on the healthcare systems for investigating all the clinical and radiological features to determine the potential TACE responders. Comprehensive studies are required to introduce a highly accurate and reliable AI prediction model and reduce heterogeneity between outcomes.

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## Abstract Archives of the RSNA, 2023

M5A-SPIR-2

### Predicting Survival of Lung Ablation Patients using Deep Learning-Based Automatic Segmentation and Radiomics Analysis

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hossam A. Zaki, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify radiomic features predictive of survival following image-guided thermal ablation (IGTA) of lung tumors segmented using a deep learning approach.

#### METHODS AND MATERIALS

This HIPAA-compliant study was performed with a waiver for informed consent following institutional review board approval. Between January 1, 2004 and July 14, 2022, adult patients who underwent IGTA for primary and metastatic lung tumors were retrospectively identified. Using pre-procedure CT imaging data, lung zones were automatically segmented using a pre-trained U-Net, which was trained on a large dataset that covers significant visual variability and includes tumors in the segmentation. Following this, we used a U-shaped encoder-decoder transformer architecture (UNETR) to segment lung tumors. The model was trained on lung CT scans with tumor annotations. We then applied the pre-trained model to patients who underwent IGTA. Radiomic features were extracted from the lung segmentations. We utilized features related to the shape of the segmentation, including surface area, volume, and diameter. These radiomic features were then used to predict days-to-death of the patients using a Cox proportional hazards model. Death records were extracted from the electronic medical record and/or obituary data.

#### RESULTS

154 consecutive patients were evaluated (median age, 74.6 years; 46.4% Male). Of these patients, 119 experienced the mortality event, with a mean time to death of 3.6 years (minimum 0.6 years; maximum 14.2 years) following the initial IGTA procedure. Median tumor size was 1.8 cm (minimum 0.6 cm; maximum 5.2 cm), and 138 patients (90%) had primary lung cancer. The initial lung tumor segmentation using UNETR achieved a DICE score of .72, indicating a 72% overlap of the predicted segmentation and the ground-truth. The survivability prediction task using radiomic features achieved a c-index of .69, showing a 69% chance the model will correctly predict which subject has a longer survival time out of a random pair. The most predictive features were flatness and diameter along the row, with a c-index of .57 and .55, respectively. Flatness indicates the elongation of the tumor, while diameter indicates the length in a certain axis, both of which relate to tumor growth patterns.

#### CONCLUSION

Radiomic feature analysis of lung tumors following segmentation by transformer-based UNET may predict long-term survival following image-guided thermal ablation of pulmonary malignancies.

#### CLINICAL RELEVANCE/APPLICATION

The incorporation of a survival prediction model based on radiomics features extracted from pre-procedure CT imaging by a deep learning algorithm may allow interventional radiologists to modify treatment approaches to optimize outcomes for patients.

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## Abstract Archives of the RSNA, 2023

M5A-SPIR-3

### Assessing ChatGPT's Proficiency in Generating Differential Diagnoses Based on Transcribed Vascular and Interventional Radiology Findings

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of specific vascular and interventional radiology (VIR) cases.

#### METHODS AND MATERIALS

A sample of 20 cases specific to VIR imaging were evaluated. Cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

#### RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 85.0% compared to 85.0% ( $p = 0.5$ ) and 30.0% compared to 15.0% ( $p = 0.13$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 60.0% compared to 56.7% ( $p = 0.42$ ). ChatGPT3.5 and ChatGPT4 hallucinated 48.3% versus 13.4% ( $p < 0.00001$ ) of the references provided and generated 1 false statement versus 0 false statements, respectively.

#### CONCLUSION

The two generations of ChatGPT were able to generate a differential diagnosis for prompts containing descriptive radiological findings. The accuracy of top 1 diagnoses matched the expert literature from which the cases originated with reasonable accuracy, with no statistically significant improvement between the 3.5 to the 4<sup>th</sup> generation algorithm. However, responses from both algorithms matched the top 3 diagnoses from the expert literature a minority of the time. The well-known hallucination effect was encountered more commonly in the generation of citations than the generation of factual statements, which improved with the newest algorithm.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) have a large potential to impact clinical and educational medicine. Knowledge of the accuracy and erroneous possibilities of these algorithms will provide a better understanding of the limitations of these new tools.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPIR-4

### Identification of Inferior Vena Cava (IVC) Filters on CT, X-ray and MRI Radiological Reports with a Natural Language Processing (NLP) Based Tool for Management of Clinical Follow Up

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yifan Wang, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Many patients with IVC filters don't get proper follow up and their filters are not removed even when it is not further needed. Many of the patients who are lost to follow up are undergoing other imaging studies in their lifetime with the presence of an IVC filter gets documented in radiological reports. NLP can assist in discovering those patients with IVC filters and help clinicians in monitoring and clinical follow up. The study aims to measure the effectiveness of an NLP solution in discovering IVC filters in radiological reports and explore the role of AI in improving follow up of patients with IVC filters.

#### METHODS AND MATERIALS

Radiological reports of CT, X-ray, and MRI studies from a large academic health system generated between 7/1/2021 and 7/31/2021 were selected for analysis. Follow-up was reviewed up to 20 months after the initial report dates. Radiological reports were analyzed for the presence of mention of an IVC filter using an NLP solution. The NLP positive cases were reviewed to measure: the positive agreement rate of the solution in identifying patients with inferior vena cava (IVC) filter using radiological reports, the number of cases identified that were eligible for IVC removal, the number of cases identified that were eligible for IVC removal and not currently scheduled and the number of IVC removal procedures that resulted from the solution case identification.

#### RESULTS

NLP solution classified 225 reports as positive for the presence of an IVC filter. The positive agreement rate was 99.56% (224/225). On secondary review by 4 clinicians, 164 unique cases were identified. 51.2% (84/164) filters were not placed by IR, and 20.1% (33/164) filters were non-retrievable type. 4.3% (7/164) identified cases had IVC filter related major complications. In 20 months follow up 57.3% (94/164) of the identified cases were eligible for removal at time of the scan, however only 12.8% (12/94) of the filters removed and 87.2% (82/94) of the cases had not been followed or scheduled. Particularly, 45 filters had been present for at least 5 years and 30 out of these 45 filters were eligible for removal.

#### CONCLUSION

The NLP based solution accurately identified patients with IVC filters using the radiological reports. A significant number of the patients that had IVC filters did not have clinical follow up or their filters removed despite eligibility.

#### CLINICAL RELEVANCE/APPLICATION

This is the first report to evaluate the efficacy of IVC filter detection using the commercial product AIDOC. Using radiological reports, NLP has the potential to greatly enhance follow-up management for patients with IVC filters, not only at their home institutions but also for those whose filters were discovered incidentally.

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## Abstract Archives of the RSNA, 2023

M5A-SPIR-5

### Generative Learned Models for Synthesis of Realistic Soft-Tissue Deformable Motion with Controllable Magnitude in Interventional Cone Beam CT

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Alejandro Sisniega, PhD (*Presenter*) Research Grant, Siemens AG; Research Grant, Micro-X Ltd; Research Grant, Izotropic Corporation

#### PURPOSE

Cone-beam CT (CBCT) is a ubiquitous tool for guidance in interventional radiology, yet susceptible to motion artifacts from a combination of quasi-periodic motion and aperiodic, local, motion. Deep autofocus showed potential for compensation of deformable motion but requires large and diverse datasets of motion-corrupted CBCT, paired with the source motion, for training. Reliable simulation of complex motion remains an open challenge. This work reports a generative model for simulation of realistic deformable motion with controllable magnitude, via observation of unpaired, motion-corrupted data.

#### METHODS AND MATERIALS

The generative model receives a motion-free volume as baseline anatomy, and a random perturbation, to synthesize a random, anatomy-aware 4-dimensional motion field. The model implements a variation of the CycleGAN architecture, with spatial transformers coupling the anatomical context to the spatiotemporal motion field. A customized GAN loss was designed to learn an amplitude control code (ACC) yielding controllable motion magnitude, and it was trained in an unsupervised fashion using solely motion-corrupted CBCT volumes. The model was exercised in a proof-of-concept study with (N=144) simulated CBCT including known motion, providing a controlled validation scenario before extension to clinical data. A test set with 594 motion fields was synthesized (9 anatomies, 6 random perturbations, and 11 amplitude control codes).

#### RESULTS

Synthetic motion fields showed magnitude in line with the training set with median amplitude of 26 mm vs 32 mm in training (15 mm vs 17 mm IQR). The spatial distributions of synthetic motion agreed with underlying anatomy, with soft-tissue regions showing large motion distortion with a preference towards anterior parts of the anatomy (median 26 mm) and rigid regions around the spine remaining stationary (median 3.6 mm), in agreement with trends in training data. Variation of the ACC resulted in nearly linear increase in motion amplitude in soft-tissue regions with no significant variation of the spatial distribution. Variation of the random perturbation code resulted in different spatial allocation of motion but no change in magnitude for equivalent control codes.

#### CONCLUSION

Random synthetic motion with anatomically realistic spatial distribution, amplitude, and direction was achieved with a learned generative model via observation of motion-corrupted CBCT. The proof-of-concept study opens the way to application of the model in clinical scenarios.

#### CLINICAL RELEVANCE/APPLICATION

This work presents an unsupervised motion synthesis model able to generate anatomically-realistic motion vector fields, enabling the generation of large training datasets for development of deep autofocus methods.

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## Abstract Archives of the RSNA, 2023

M5A-SPIR-6

### Evaluating Artificial Intelligence for the Diagnosis of Acute PE

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yifan Wang, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Pulmonary embolism (PE) is a severe medical condition, with a high mortality rate if left untreated. A pulmonary embolism response team (PERT) is a multidisciplinary group of providers that provide consultation and care to patients with PE. Artificial Intelligence (AI) has the potential to improve the care provided by a PERT team by notifying members of the team immediately about suspected cases and enabling appropriate therapies to occur in a timely fashion by assisting with the rapid coordination of care amongst a PERT. This study aims to evaluate cases identified by an AI solution across a health system. The health system studied is composed of a main campus (hub) that is capable of performing all current PE therapies and multiple other hospitals (spokes) within the system that can provide limited therapies for PE. This study assesses if AI can correctly identify PE cases of a significant risk stratification and those that may benefit from transfer from a spoke hospital to the hub hospital for additional care.

#### METHODS AND MATERIALS

A retrospective cohort of patients at 3 spoke hospitals undergoing computed tomography pulmonary angiography (CTPA) between 01/2019 -12/2020 was analyzed using an AI solution. A positive finding was defined as the AI solution detecting moderate to large central PE thrombi and a right ventricle to left ventricle (RV/LV) ratio greater than 1.3. CT parameters were obtained from radiological interpretation and data on clinical PERT activation and interventions at each site were obtained by chart review. Metrics measured included the European Society of Cardiology (ESC) PE risk stratification score, PERT consultation, transfer of patients from a spoke-to-hub, and treatment strategy. The findings were compared to historical averages from the hub/main campus.

#### RESULTS

A total of 43 cases from 3,787 CTPA scans were identified by the algorithm, of which 92.5% (37/40) were intermediate-high or high-risk PE based on the ESC risk stratification. Comparing spoke hospitals to the hub hospital, 55% (22/40) vs 100% (133/133) of the identified cases had a PERT consultation and 22% (9/40) versus 70% (93/133) of identified cases received an advanced therapy (catheter or surgical therapies, systemic thrombolytics or mechanical support). Only 5% (2/40) of the identified cases resulted in a spoke-to-hub transfer.

#### CONCLUSION

The use of AI may help optimize the coordination and care of PERT patients by correctly identifying intermediate and high-risk PE cases, those that may require a PERT consultation, and identifying patients who may benefit from transfer to a hub hospital for advanced therapies.

#### CLINICAL RELEVANCE/APPLICATION

AI may have the ability to assist in detection of acute PE and coordination of care amongst clinicians across a health system.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPMK-1

### Quantitative Study of Bone Marrow Edema Due to Acute Fractures with Dual-energy Spectral CT Imaging

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yanan Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the utility of material density and CT attenuation value measurements in dual-energy spectral imaging for differentiating bone marrow edema due to acute bone fractures from the normal bone marrow.

#### METHODS AND MATERIALS

24 patients who presented with acute fractures from November 2017 to March 2018 underwent dual-energy spectral CT imaging on a 16cm wide-detector CT scanner. The virtual monochromatic images and water-calcium material decomposition (MD) images were reconstructed. The monochromatic CT images with color-coded water-calcium MD image overlay were reviewed by two radiologists to identify bone fractures and the associated bone marrow edema. The CT attenuations and water(calcium) concentrations were measured from the CT images and water(calcium) MD images, respectively for bone marrow edema and normal bone marrow. Receiver operator characteristic (ROC) curve analysis was used to determine the diagnostic accuracies of these measurements.

#### RESULTS

The water(calcium) concentrations ( $1040.28 \pm 33.55 \text{mg/cm}^3$ ) in the areas with bone marrow edema were significantly higher than in the normal bone marrow ( $1011.11 \pm 45.83 \text{mg/cm}^3$ ) ( $p < 0.001$ ). The CT attenuation values in the 70keV images were  $210.18 \pm 108.63 \text{HU}$  and  $133.44 \pm 134.06 \text{HU}$  in the areas with bone marrow edema and with normal bone marrow, respectively ( $p < 0.001$ ). The Area under the curve (AUC) for ROC analysis using the water(calcium) concentration was 0.771, significantly higher than the value of 0.719 using the CT attenuation measurement ( $p < 0.05$ ).

#### CONCLUSION

The measurement parameters, especially the water(calcium) concentration measurement in bone marrow obtained in the dual-energy spectral CT imaging, have high accuracy in differentiating bone marrow edema from normal bone marrow.

#### CLINICAL RELEVANCE/APPLICATION

Dual-energy spectral CT imaging provided a novel and accurate method to quantitatively evaluate the bone marrow edema due to acute bone fractures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPMK-2

### **The Use of Monochromatic CT Images Overlaid with Water-calcium Material Decomposition Images in Dual-energy Spectral Imaging for Identifying Bone Marrow Edema Due to Acute Bone**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yanan Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the utility of identifying bone marrow edema due to acute bone fractures using the monochromatic CT images overlaid with color-coded water-calcium material decomposition (MD) images in dual-energy spectral imaging.

#### **METHODS AND MATERIALS**

24 patients who presented with acute bone fractures underwent dual-energy spectral imaging on a 16cm wide-detector CT scanner from November 2017 to March 2018. The virtual monochromatic images and water-calcium MD image pairs were reconstructed. The monochromatic CT images overlaid with color-coded water-calcium images were reviewed by two radiologists, and the fractures and associated bone marrow edema were identified. The CT attenuations and water(calcium) concentrations of the areas with bone marrow edema and with normal bone marrow were measured from the CT images and water(calcium) MD images, respectively. These values were compared with paired t-test. Kappa values were calculated between the two readers on the identification of the areas with and without bone marrow edema.

#### **RESULTS**

There was bone marrow edema associated with every bone fracture and the overlay images had higher confidence and clarity to identify the areas of edema than the CT images alone. The Kappa value was 0.878 between the two readers on the identification of the areas with and without bone marrow edema on color-coded water-calcium images. The water(calcium) concentrations ( $1040.28 \pm 33.55 \text{mg/cm}^3$ ) in the areas with bone marrow edema were significantly higher than in the normal bone marrow area ( $1011.11 \pm 45.83 \text{mg/cm}^3$ ) ( $p < 0.001$ ). The CT attenuation values in the 70keV images were  $210.18 \pm 108.63 \text{HU}$  and  $133.44 \pm 134.06 \text{HU}$  in the areas with and without bone marrow edema, also had a significant difference between the two areas ( $p < 0.001$ ).

#### **CONCLUSION**

The monochromatic CT images overlaid with color-coded water-calcium images in dual-energy spectral CT imaging on a 16cm wide-detector CT is sensitive and quantitative to identify the bone marrow edema due to acute bone fracture.

#### **CLINICAL RELEVANCE/APPLICATION**

The monochromatic CT images overlaid with water-calcium images in spectral CT can provide an alternative to MRI for detecting the bone marrow edema due to acute bone fractures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPMK-3

### Evaluation of Radiosynoviorthesis as a Palliative Treatment in Advanced Arthropathies

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Marta Gallego Verdejo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiosynoviorthesis consists of intra-articular injection of radionuclides to achieve a local therapeutic action in patients with chronic or resistant arthropathies in whom other treatments have failed. This study aims to demonstrate the effectiveness of radiosynoviorthesis in treating chronic synovitis at three levels: clinical, functional, and radiological. Additionally, it will study the safety of the technique.

#### METHODS AND MATERIALS

It is a descriptive and retrospective study with a multidisciplinary approach (radiology, radiophysics and nuclear medicine). The current sample consists of 15 patients referred for treatment with radiosynoviorthesis from various hospitals between 2019 and 2022. However, we expect to expand to 30 patients in the coming months, when the controls will be carried out. Each patient is evaluated before and after treatment using a pain visual analog scale (VAS) from 0 (no pain) to 10 (maximum pain) and a functionality scale depending on the treated articulation. Immediately after the puncture, scintigraphy is performed to assess the adequate distribution of the radionuclide in the joint. Also, an ultrasound control is performed before and approximately 3 months after radiosynoviorthesis.

#### RESULTS

In preliminary results, the mean VAS score lessened from 7.07 before radiosynoviorthesis to 3.47. Similarly, they show an upgrade in the functional scale from 41.47 % to 70.06 % (values expressed as a percentage of the maximum score for each test). In addition, some patients have exhibited an improvement in synovial hyperemia in the ultrasound control, with a reduction in effusion and synovial thickening. Furthermore, it has been confirmed that it is a safe technique, with a low incidence of complications in the treatments performed.

#### CONCLUSION

Radiosynoviorthesis (RSO) is a good treatment for patients with chronic or resistant pathology of the synovial membrane in whom the first lines of treatment have not been effective. It brings improvements at the clinical and functional levels, with a reduction in ultrasound synovitis signs in some patients. It also has a low complication rate, which makes it an effective and safe alternative in the treatment of chronic arthropathies.

#### CLINICAL RELEVANCE/APPLICATION

It is a safe procedure that can bring clinical and functional improvement to patients with limiting arthropathies that can substantially improve their quality of life.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5A-SPMK-4

### Optimizing US-guided Lavage for Rotator Cuff Calcific Tendinitis: The Effect of Corticosteroids Injection Pre vs. Post-procedure

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to determine whether the pre or post-procedure injection of corticosteroids during US-guided lavage of rotator cuff calcific tendinitis affects the outcome.

#### METHODS AND MATERIALS

At our institution, 124 patients with calcific tendinitis of the rotator cuff were treated with US-guided lavage between 2020 and 2021. In 71 patients, a corticosteroid was injected into the subacromial bursa following the lavage (corticosteroid-after group). The remaining 53 patients (corticosteroid-before group) received the injection before undergoing the procedure. Characteristics of calcification were recorded in terms of number, size, location and type according to Gartner and Hayer's classification. Other variables assessed were calcium extracted, number of adverse events and follow-up. Data were analysed using SPSS 25.0 software, and a p-value < 0.05 was considered statistically significant.

#### RESULTS

Both groups showed no significant differences regarding sex ( $p = 0.612$ ) or age ( $p = 0.883$ ). The only reported adverse effect was vasovagal syncope in 7 patients (13.2%) in the corticosteroid-before group and 11 patients (15.5%) in the corticosteroid-after group ( $p = 0.721$ ). The percentage of patients in which a significant amount of calcium was extracted was similar in both groups (54.7% vs 54.9%;  $p = 0.981$ ). The type of calcification was the only factor that showed a statistical association with this outcome (68.5% for type 1 and 2 calcifications; 20% for type 3 calcifications;  $p < 0.01$ ). Finally, the number of patients who required further intervention during follow-up was 23 (43.4%) in the corticosteroid-before group and 41 (57.7%) in the corticosteroid-after group ( $p = 0.943$ ).

#### CONCLUSION

Administration timing of corticosteroid injection before or after calcium deposit removal does not impact treatment outcomes or incidence of adverse effects. Both approaches are equally effective, (however, US guidance should always be recommended to ensure accurate placement and prevent potential complications).

#### CLINICAL RELEVANCE/APPLICATION

The order in which this procedure is performed has been arbitrary, with no comprehensive study conducted on the optimal approach. Our study suggests that patients exhibit similar tolerance levels regardless of the treatment sequence.

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## Abstract Archives of the RSNA, 2023

M5A-SPMK-5

### Intra-articular Injections of the Foot: An Evaluation of Physician Ordering Practices of Ketorolac and Kenalog

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Justin Choi, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Intra-articular steroid injections are widely utilized to provide therapeutic relief and diagnostic evaluation of foot pain. Nonsteroidal anti-inflammatory injectants may offer a safer profile and have been shown to provide similar levels of pain relief as steroids. This study sought to evaluate physician preferences for injection agents for intra-articular foot injections.

#### METHODS AND MATERIALS

An IRB-approved retrospective review was performed using radiology data mining system (Nuance mPower) to identify patients who received intra-articular foot injections from 2011-2023 at a single academic institution. Study participants were eligible if they received an image-guided foot injection and divided into two cohorts: 1) injection with Kenalog and 2) injection with ketorolac. Demographics, BMI, diagnosis, site, agent, pre and post pain scores, treatment history, and ordering provider were recorded. The Visual Analogue Scale was used to collect the pain score. The difference between the pre and post pain scores determined the delta pain score. The Mann-Whitney U test was used to compare the delta pain score between the cohorts. Categorical variables were compared using Pearson's chi-square test.

#### RESULTS

Forty one of the 182 injections were with ketorolac. Eighty four percent of the patients were female and the average age was 65.5 years-old. Fifty percent of patients had a BMI =30. Osteoarthritis was the most common diagnosis for Kenalog and ketorolac injections (95% and 51%, respectively,  $p<0.01$ ) while the tarsometatarsal joints were the most common sites for both cohorts (82% and 37%, respectively,  $p<0.01$ ). Out of the four ordering providers identified, Provider 1 ordered ketorolac for 85% of the injections and Provider 2 ordered Kenalog for 91% of the injections ( $p<0.01$ ). Sixty seven percent of patients who received a kenalog injection and 3% of patients who had ketorolac injections required serial injections ( $p<0.01$ ). Twenty one percent of cohort 1 and 34% of cohort 2 underwent surgery after injections ( $p=0.26$ ). The mean delta scores reported for the Kenalog cohort and ketorolac cohort were -4 and -1, respectively ( $p<0.01$ ).

#### CONCLUSION

There was a clear preference in the type of agent ordered by each provider without a significant difference in post-injection surgical treatment rates. In recent years, there was an increase in usage of ketorolac and for a wider range of injection sites and diagnoses compared to Kenalog. Future studies could quantitate efficacy of intra-articular injections for foot pain by injectant.

#### CLINICAL RELEVANCE/APPLICATION

Ketorolac is a low-cost option for diagnostic and therapeutic intra-articular injections of the foot that offers a safety profile comparable to steroids, without significant differences in outcomes.

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## Abstract Archives of the RSNA, 2023

M5A-SPMK-6

### Quantitative DWI Assessment of Changes in Graft Maturity at 6 and 12 Months after Anterior Cruciate Ligament Reconstruction and Correlation with Clinical Scores

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Feiyuan Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantify the status of graft remodeling using DWI functional MRI at 6 and 12 months after anterior cruciate ligament reconstruction (ACLR) and its correlation with the corresponding clinical function score.

#### METHODS AND MATERIALS

Forty-four patients who underwent ACLR between August 2020 and October 2021 and fifteen volunteers were recruited prospectively. Patients underwent 3.0T conventional MRI and DWI scans in 6 and 12 months after ACLR to measure ADC values of the intra-articular segment graft and its three segments (proximal, middle, and distal). IKDC, Lysholm scores were performed at each time point. Differences between 6 and 12 months postoperatively in ADC changes were compared using the Wilcoxon test. Correlation between ADC values of the intra-articular segment of the graft and clinical scores (IKDC, Lysholm score) in 6 and 12 months was analyzed using the Pearson correlation coefficient.

#### RESULTS

ADC values for the overall intra-articular segment of the ACL graft and its three parts (proximal, middle, and distal) decreased significantly from 6 to 12 months ( $P < 0.05$ ). There was no significant correlation between the ADC values of the grafts and the clinical scores (IKDC, Lysholm scores) at 6 and 12 months postoperatively. The ADC values of the distal segment of the intra-articular segment of the graft were higher than those of the middle and proximal segments at 6 months postoperatively ( $P < 0.05$ ), while the ADC values of the three segments in 12 months were similar.

#### CONCLUSION

The graft continued to mature from 6 months to 12 months after ACLR. The ADC values measured by the graft decreased but were not consistent with clinical function scores, suggesting that DWI and ADC are a finer reflection of changes in graft maturity than clinical scores.

#### CLINICAL RELEVANCE/APPLICATION

DWI can indicate the change of graft maturity and guide the recovery time of ACLR patients after surgery.

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## Abstract Archives of the RSNA, 2023

M5A-SPMK-7

### Metal Suppression Using a New Generation Low-Field MRI; In Vitro Assessment in a Pig Knee Model

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Johanna Luitjens, MD (*Presenter*) Consultant, Smart Reporting

#### PURPOSE

To evaluate the artifact size reduction using a metal artifact correction (SEMAC) sequence at 0.55T and 3T in porcine knee specimens with metal hardware compared to standard sequences. This study aims to assess the feasibility of metal suppression on a novel 0.55T system, to optimize the pulse sequence parameters and to compare them with imaging at 3T as standard of reference.

#### METHODS AND MATERIALS

Steel and titanium screws with 2.2mm diameter were implanted in 12 porcine knee specimens before imaging at 0.55T (Siemens Free.Max) and 3T (Siemens Vida) MRI using turbo spin echo (TSE), view angle tilting (VAT factor 50 and 100), and combined VAT and SEMAC (VAT100+SEMAC) in proton-density (PD) and T2 short TI inversion recovery (STIR) TSE pulse sequences. Sizes of metal artifacts were measured, and the visualization of the bone and cartilage, cruciate ligaments, joint effusion, and growth plate close to the metal artifact as well as the overall image quality, were assessed using a 5-point Likert scale. Wilcoxon-signed-rank tests were performed to determine the differences in image quality between 0.55T and 3T MRI.

#### RESULTS

The size of the metal artifacts for titanium was smaller in normal PD ( $p=0.002$ ), PD VAT100 ( $p=0.019$ ), PD VAT100+SEMAC ( $p=0.01$ ), and T2 STIR VAT50 ( $p=0.04$ ) at 0.55T MRI compared to 3T MRI. For stainless steel screws, almost all sequences showed smaller artifact sizes using 0.55T compared to 3T MRI ( $p<0.001$  for PD, PDVAT50/100, PD VAT100+SEMAC, T2 STIR VAT50/100, T2 STIR VAT100+SEMAC), only in T2 STIR no difference could be found. Close to stainless steel screws, the visualization of the growth plate and the bone was significantly better at 0.55T MRI in all sequences ( $p<0.001$ ). Results from PD with VAT100 and PD VAT100+SEMAC showed better visualization of growth plates close to the titanium screws at 0.55T MR compared to 3T MRI. For all other sequences, the visualization of the growth plates did not differ close to titanium screws between both systems. PD VAT100+SEMAC, PDVAT100, and standard T2 STIR FSE sequences showed better image quality at 0.55T compared to 3T MRI. For all other sequences (PD, PDVAT50, T2 STIR 50/100, TS VAT100+SEMAC), the image quality did not differ between field strengths.

#### CONCLUSION

Our results show that imaging of metal hardware using a novel 0.55T MRI system, in particular, if combined with SEMAC techniques, especially by using factor VAT50, is superior compared to 3T MRI. The visualization of anatomical structures at 0.55T MRI is not inferior compared to 3T MRI.

#### CLINICAL RELEVANCE/APPLICATION

New generation low-field MRI at 0.55T reduces metal artifacts in musculoskeletal imaging, leading to improved visualization of potential hardware complications and thus enhancing patient care.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPMK-8

### Impact of Weight Loss on Knee Joint Synovitis over 48 months and Mediation by Local Subcutaneous Fat: Data from the Osteoarthritis Initiative

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Maximilian T. Loeffler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Synovitis and joint effusion are characteristics of the inflammatory phenotype of osteoarthritis (OA). Weight gain promoted the development of synovitis in a previous study. The purpose of this study was to investigate the effect of weight loss on synovitis progression and to assess whether subcutaneous fat (SCF) around the knee mediates the relationship between weight loss and synovitis progression.

#### METHODS AND MATERIALS

We included 234 overweight and obese participants (BMI  $\geq 25$  kg/m<sup>2</sup>) from the Osteoarthritis Initiative (OAI) with  $>10\%$  weight loss (n=117) or stable overweight ( $<\pm 3\%$  change, n=117) over 48 months matched for age and sex. Effusion-synovitis and Hoffa-synovitis using the MRI Osteoarthritis Knee Score (MOAKS) as well as SCF were assessed in unenhanced MRI studies at baseline and 48 months. Average joint-adjacent SCF (ajSCF) was calculated as the arithmetic mean of medial, lateral, and anterior SCF measurements. Odds-ratios (ORs) for synovitis progression over 48 months ( $=1$  score increase) were calculated in logistic regression models adjusting for age, sex, baseline BMI, Physical Activity Scale for the Elderly (PASE), and baseline SCF measurements. Mediation of the effect of weight loss on synovitis progression by a pathway through local SCF change was assessed.

#### RESULTS

The odds for effusion-synovitis progression decreased with weight loss and ajSCF decrease (OR=0.61 and 0.56 per standard deviation [SD] decrease, 95%-confidence interval [CI] 0.44-0.83 and 0.40-0.79,  $p=0.002$  and  $0.001$ , respectively). In contrast, the odds for Hoffa-synovitis progression increased with weight loss and ajSCF decrease (OR=1.47 and 1.48 per SD decrease, CI 1.05-2.04 and 1.02-2.13,  $p=0.024$  and  $0.038$ , respectively). Decrease in ajSCF mediated 39% of the effect of weight loss on effusion-synovitis progression.

#### CONCLUSION

Effusion-synovitis progression was slowed by weight loss and decrease in local subcutaneous fat. Hoffa-synovitis characterized by fluid in the infrapatellar fat pad increased at the same time, suggesting a decreasing fat pad rather than active synovitis. Decrease in local subcutaneous fat partially mediated the systemic effect of weight loss on synovitis progression.

#### CLINICAL RELEVANCE/APPLICATION

Local subcutaneous fat around the knee that can be easily measured in unenhanced MRI influences the progression of effusion-synovitis. Signal alterations in Hoffa's fat pad are non-specific for synovitis and should be interpreted with caution, particularly, in patients with weight loss.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPMK-9

### Outcomes and Surgical Revision of Meniscus Allograft Transplant

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Timothy McIntyre (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate factors influencing outcomes of meniscal allograft transplant as measured by both patient reported outcomes and complications requiring surgical revision of the meniscus.

#### METHODS AND MATERIALS

Patients undergoing meniscal allograft transplant between 2002 and 2022 at one institution were reviewed. Patient reported outcomes were measured as symptom and function scores via written survey during clinic visits and surgical revision of the meniscus following transplant was recorded. Surgical revision of the transplanted meniscus included meniscectomy, revision transplant, and joint arthroplasty. Univariate and multivariate analyses were performed to evaluate the effect of various prognostic factors on these two outcome measures.

#### RESULTS

81 patients were evaluated (median age 25 years, interquartile range 18-34, 44 patients were men). Patients showed a mean improvement in symptom score post-transplant of  $1.26 \pm 1.84$  ( $p < 0.001$ ). Patients without associated non-meniscal knee injuries showed a symptom improvement of  $2.26 \pm 1.66$  compared to  $0.83 \pm 1.87$  for those with these injuries ( $p = 0.006$ ). Interval time from meniscectomy to transplant was shown to have a spearman correlation coefficient of  $-0.293$  (95% CI  $-0.500$  to  $-0.051$ ,  $p = 0.017$ ) for symptom score improvement and  $-0.247$  (95% CI  $-0.462$  to  $-0.002$ ,  $p = 0.047$ ) for function score improvement. On multivariate analysis, age  $< 25$  years at the time of meniscectomy was found to be associated with increased need for post-transplant revision surgery (OR 0.18, 95% CI 0.03 - 0.96,  $p = 0.045$ ), as was post-transplant reinjury (OR 10.39, 95% CI 2.52 - 42.92,  $p = 0.001$ ).

#### CONCLUSION

Meniscal transplant provides symptomatic improvement for patients, which may be limited by the presence of concomitant non-meniscal injuries and increased time between meniscectomy and transplant. Age  $< 25$  years and reinjury are associated with increased likelihood of revision surgery following transplant, likely due to initial traumatic injury or traumatic reinjury.

#### CLINICAL RELEVANCE/APPLICATION

Meniscal allograft transplant is an increasingly used option for treating meniscal injury to preserve long term function of the knee. Previous studies have varied in choice of outcome measure, failure criteria, and sample size.

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## Abstract Archives of the RSNA, 2023

M5A-SPMS-1

### Quantitative Assessment of Activity in Idiopathic Inflammatory Myopathy by Magnetic Resonance Image Complication (MAGiC)

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Zhaorong Tian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The study explored the feasibility of using Magnetic resonance image compilation (MAGIC) parameters to quantitatively evaluate changes of thigh muscles in idiopathic inflammatory myopathy (IIM), in order to provide a quantitative index for the evaluation of thigh muscle inflammatory activity in IIM. And to investigate the correlation between thigh muscle T1,T2 values and serum creatinine kinase (CK).

#### METHODS AND MATERIALS

Seventy patients with IIM proven by diagnostic criteria were enrolled in the study along with 30 healthy control subjects. According to clinical findings according to the International Myositis Assessment and Clinical Studies Group (IMACS), the 70 patients were divided into an active group (41 cases) and an inactive group (29 cases). All subjects were scanned using a SIGNATM Architect 3.0T MRI scanner by T1WI, FS-T2WI and MAGIC sequence of the thigh muscle. Two radiologists with 10 years of experience in musculoskeletal system diagnosis measured the T1, T2 values of active group, the inactive group, and the healthy control group thigh muscles on the Magic axial image. The T1,T2 values of thigh muscles in the active, inactive, and healthy groups were compared using one-way analysis of variance (ANOVA). Receiver operating characteristic (ROC) curves were used to analyze the diagnostic efficacy of T1,T2 values for activity of idiopathic inflammatory myopathy. A Spearman correlation coefficient model was used to correlate the mean T1,T2 values of thigh muscle with CK.  $P < 0.05$  was considered statistically significant.

#### RESULTS

The T1 values ( $516.11 \pm 82.42$ )ms in the active group of IIM were lower than those in the inactive group ( $794.24 \pm 84.38$ )ms, lower than those in the healthy control group ( $1184.73 \pm 178.23$ )ms, ( $T = -10.693$ ,  $p < 0.001$ ); T2 values of active groups in IIM ( $93.84 \pm 17.15$ )ms, were higher than inactive groups ( $65.07 \pm 9.7$ )ms, higher than those in the healthy control group ( $45.24 \pm 6.7$ )ms, ( $T = -10.013$ ,  $p < 0.001$ ). The areas under the ROC curves (AUCs) of T1,T2 values between the active and inactive groups of IIM,  $0.921$  (95%CI,  $0.846-0.967$ ),  $0.963$  (95%CI,  $0.912-0.993$ ), respectively. The T1,T2 values of thigh muscles in the IIM were positively correlated with CK, and the correlation coefficients ( $r$ ) were  $0.946$ ,  $0.969$  (all  $p < 0.001$ ), respectively.

#### CONCLUSION

MAGIC parameters can be used to quantitatively assess the activity of IIM, but also be used to demonstrate severity of damaged muscles in IIM, and T2 values can serve as a potential biomarker of disease activity. MAGIC provided imaging bases for the clinical diagnosis of IIM.

#### CLINICAL RELEVANCE/APPLICATION

MAGIC parameters can be used to quantitatively assess the activity and severity of damaged muscles of IIM, provided imaging bases for the clinical diagnosis of IIM.

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## Abstract Archives of the RSNA, 2023

M5A-SPNMMI-1

### Association Between Severity of Heart Failure < Myocardial Amyloid Deposition on <sup>99m</sup>Tc pyrophosphate Scintigraph < Echocardiography in Patients with Familial Amyloid Polyneuropathy

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hiroshi Kanaya (*Presenter*) Nothing to Disclose

#### PURPOSE

We investigated the relationship between heart failure severity and myocardial amyloid deposition in patients with familial amyloid polyneuropathy (FAP) using <sup>99m</sup>Tc-pyrophosphate (PYP) scintigraphy and echocardiography.

#### METHODS AND MATERIALS

Subjects were 71 cases diagnosed with FAP by histopathological diagnosis and genetic testing. Ejection fraction (EF), brain natriuretic peptide (BNP), and cardiac troponin T (TnT) were used as indexes of severity of heart failure. Echocardiography and PYP scintigraphy were performed within 3 months of the blood test. In PYP scintigraphy, the heart to contralateral (H/CL) ratio was calculated in planar image. Pearson's correlation coefficient was calculated for the relationship between the index of the severity of heart failure and the H/CL ratio, also echocardiogram index such as interventricular septum thickness in diastole (IVSTd), posterior wall thickness in diastole (PLVWd) and the ratio of mitral velocity to early diastolic velocity of the mitral annulus (E/e').

#### RESULTS

IVSTd, E/e' and H/CL ratio had significant correlation with EF ( $r=-0.36$ ,  $p<0.01$ ,  $r=-0.34$ ,  $p=0.01$ ,  $r=-0.31$ ,  $p=0.01$ , respectively). IVSTd, PLVWd, E/e' and H/CL ratio showed significant correlation with BNP ( $r=0.47$ ;  $p<0.01$ ,  $r=0.52$ ;  $p<0.01$ ,  $r=0.43$ ;  $p=0.01$ ,  $r=0.39$ ;  $p<0.01$ , respectively). IVSTd and PLVWd had significant correlation with TnT ( $r=-0.3$ ;  $p=0.02$ ,  $r=-0.46$ ;  $p<0.01$ , respectively). In addition, in patients with H/CL ratio  $> 1.3$ , H/CL ratio was not significantly correlated with any heart failure index.

#### CONCLUSION

Echocardiographic indices, especially IVSTd, may serve as indices of heart failure, whereas H/CL ratio may not.

#### CLINICAL RELEVANCE/APPLICATION

H/CL ratio on PYP scintigraphy is a useful index for the diagnosis of ATTR-CM, but it may not serve as indices of heart failure.

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## Abstract Archives of the RSNA, 2023

M5A-SPNMMI-2

### Diagnostic Potential of TID Ratio in <sup>13</sup>N-Ammonia PET Imaging: Differentiating INOCA from Multivessel CAD

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Midori Fukuyama, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Adenosine stress <sup>13</sup>N-Ammonia PET (Ammonia PET) is a valuable tool for evaluating both myocardial blood flow reserve (MFR) and cardiac function. It is especially useful for diagnosing multivessel coronary artery disease (Multivessel CAD) by measuring MFR. Ischemia with non-obstructive coronary artery disease (INOCA), one of the chronic coronary syndromes, is increasingly recognized as a risk factor for adverse cardiovascular mortality and outcomes. It is difficult to distinguish between INOCA and Multivessel CAD based on MFR alone because MFR is similarly reduced to less than 2.0 in both. Transient ischemic dilatation (TID) ratio is a useful marker of adverse outcomes on myocardial perfusion imaging in severe and extensive CAD. The usefulness of TID during Ammonia PET in INOCA patients has not been reported. We aimed to evaluate the diagnostic potential of TID ratio and other markers in differentiating INOCA from Multivessel CAD using Ammonia PET.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on 86 patients (47 males, 39 females; median age 73) who underwent rest/ adenosine stress-gated Ammonia PET for known or suspected CAD. Using a commercial-used software program, dynamic scanning measured myocardial blood flow (MBF) and MFR. Patients with global MFR > 2.0 and no evaluation of epicardial coronary artery within three months before or after Ammonia PET were excluded. Seven INOCA patients and 21 Multivessel CAD patients with more than 50% stenosis were included in the final analysis. TID and LV functions were compared between INOCA and Multivessel CAD.

#### RESULTS

No significant differences were detected in rest MBF and MFR between INOCA and Multivessel CAD (1.16 vs. 0.99, 1.52 vs. 1.70, respectively). Although the left ventricular ejection fraction (LVEF) of both INOCA and Multivessel CAD groups were within the normal range, there was a significant difference in rest/ adenosine stress LVEF (78 vs. 65;  $p = 0.008$ , 75 vs. 61;  $p = 0.015$ ). TID was significantly greater in INOCA than in Multivessel CAD (1.29 vs. 1.11;  $p = 0.026$ ). Based on the ROC analysis for identifying INOCA, a TID threshold of 1.22 could predict INOCA (AUC=0.69, sensitivity 95%, specificity 57%, accuracy 85%).

#### CONCLUSION

The TID ratio obtained from adenosine stress Ammonia PET was significantly higher in INOCA patients than in Multivessel CAD patients. Patients with global MFR less than 2.0, TID ratio could be a valuable tool to distinguish INOCA from Multivessel CAD.

#### CLINICAL RELEVANCE/APPLICATION

Transient ischemic dilatation (TID) in rest/ adenosine stress-gated <sup>13</sup>N-Ammonia PET was more significantly observed in Ischemia with non-obstructive coronary artery disease (INOCA) than in Multivessel CAD. TID ratio can assist in distinguishing INOCA from Multivessel CAD.

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## Abstract Archives of the RSNA, 2023

M5A-SPNPM-1

### Flipping Education Right Side Up: A Multiyear Assessment of Flipped Classroom Teaching Versus Traditional Didactic Teaching at Two Academic Institutions

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Michelle Ho, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Traditional radiology education consisting of didactic lectures and workstation readout is associated with poor retention of knowledge. Flipped classroom teaching may be more efficient and effective. At our institution (A), flipped classroom teaching has been used consistently for PGY2 residents on one rotation (FR). While on this rotation, residents are assigned daily teaching topics with pre-recorded lectures followed by in-person discussion of related clinical cases. This forces residents to integrate learned concepts and allows faculty to assess areas of weakness. The purpose of this study is to assess the effectiveness of flipped classroom teaching by comparing resident performance on RadExam for FR compared to other core rotations at Institution A, and to resident performance at another similar institution (B), where flipped classroom is not used.

#### METHODS AND MATERIALS

RadExam scores from 5 different PGY2 level core rotations (body imaging, emergency, musculoskeletal, neuro, and thoracic) were collected at both institutions from 7/1/2018 to 4/30/2020. At Institution A, the flipped classroom teaching model has been used consistently for one of the above core rotations (FR). The other rotations are referred to as traditional rotations (TR) 1 through 4. The rotation names are anonymized for privacy per data use requirement. Exam scores at institution A were compared using one-way ANOVA. Exam scores between institutions A and B were compared using factorial ANOVA. Survey scores for residents' perception of educational value and efficient use of time for above rotations at institution A were also compared.

#### RESULTS

There was significant difference in resident exam scores between rotations at institution A ( $p=0.005$ ) but no difference between the two institutions ( $p=0.7$ ). Residents at institution A performed better on FR than other rotations except for TR4 (Table and Figure). The perceived educational value of FR was higher compared to TR (4.96 vs 4.85,  $p=0.017$ ). No difference was observed in perception of efficient use of time between FR and TR (4.79 vs 4.66,  $p=0.11$ ).

#### CONCLUSION

Flipped classroom teaching is at least as effective as traditional teaching model and it is associated with better resident performance on standardized exams at one institution. It is also associated with higher perceived educational value.

#### CLINICAL RELEVANCE/APPLICATION

Flipped classroom teaching may increase efficiency in teaching while minimizing interruptions in clinical work, and may improve overall competency of radiology residents and their morale.

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## Abstract Archives of the RSNA, 2023

M5A-SPNPM-2

### **Multicriteria Decision Analysis Comparing Gadolinium Based Contrast Agents for Use in Contrast Enhanced Magnetic Resonance Imaging: A Novel Tool in Benefit Risk Assessment**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Robert J. McDonald, MD, PhD (*Presenter*) Consultant, General Electric Company; Research Grant, General Electric Company; Consultant, Bracco Group

#### **PURPOSE**

To compare the benefit-risk balance of all currently available FDA-approved GBCAs using a multicriteria decision analysis (MCDA) model to determine if certain agents provide more favorable benefit-risk balance than others in clinical use.

#### **METHODS AND MATERIALS**

An expert panel developed a MCDA model based on two benefits (relaxivity @ 1.5T and pharmacokinetics) and six safety effects (NSF cases, retained Gd in CNS tissues, and rates of physiologic reactions and mild, moderate, and severe hypersensitivity reactions). After scoring, weighted averages of preference scores for the eight criteria were used to give overall preference values for each GBCA in the MCDA model. The usability of the model was tested using 13 diverse clinical scenarios, 5 of which are detailed below.

#### **RESULTS**

For routine adult patients, and those requiring mitigation of hypersensitivity reactions, preference values were driven by hypersensitivity and physiologic reaction rates: gadodiamide=95, gadopentetate=82, gadobutrol=68, gadoterate=48, gadobenate=34, gadoteridol=4. For patients requiring repeated GBCA doses over a longer timeframe in the detection of subtle/nascent disease preference values were driven by mitigation of Gd tissue retention and relaxivity: gadobenate=73, gadobutrol=55, gadoterate=38, gadodiamide=31, gadoteridol=30, gadopentetate=24. For patients with severely compromised renal function, preference values were driven by mitigation of NSF risk: gadobenate=82, gadoterate=82, gadobutrol=76, gadoteridol=70, gadodiamide=25, gadopentetate=21. For patients requiring hepatobiliary imaging, preference values were driven by pharmacokinetics and relaxivity: gadoxetate=66, gadobenate=44, gadodiamide=35, gadobutrol=29, gadopentetate=29, gadoterate=21, gadoteridol=6.

#### **CONCLUSION**

The benefit-risk profiles for all FDA-approved GBCAs were found to be comparable and all had favorable benefit-risk ratios in many common clinical scenarios. However, depending on patient-centered characteristics and clinical needs, the relative ranking of these benefit-risk ratios varied. MCDA results provide insights in the identification of clinical scenarios/situations where use of specific GBCAs is warranted due to greater clinical benefits or diminished risks of undesirable effects. These results demonstrate the complexity and multimodal mechanisms underlying the clinical decision making necessary in diagnostic imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

Decision analysis models are commonly used by regulatory agencies to compare benefits and risks of similar prescribed agents. MCDA models are helpful in making patient-centered decisions about GBCA use and can optimize clinical decision making and health care delivery in radiology.

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## Abstract Archives of the RSNA, 2023

M5A-SPNPM-3

### Impact Analysis of Primary and Secondary Research in Radiology Journals

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Mohamed K. Ibrahim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Primary and secondary studies are considered the two major research categories. In this study, we examined the scientific and social media impact of primary and secondary publication types in papers published radiological journals during 2010-2020

#### METHODS AND MATERIALS

PubMed publication type tags were used to filter original articles and systematic review and meta-analysis (SR/MA) articles. Clarivate Web of Science was utilized to obtain a list of all radiology journals from the category "Radiology, Nuclear Medicine and Imaging" in Science Citation Index Expanded (SCIE). Automated approach was developed for programmatic extraction of bibliometric and Altmetric yearly citations of each included article using Dimensions API and Altmetric API with Python. Statistical analysis was performed to compare the citation rates between primary and secondary research articles.

#### RESULTS

A total of 96,684 published articles from 2010 to 2020 were identified and their meta-data collected. The mean 2-year citation count following publication year was 5.8 for primary research and 10.2 for SR/MA articles ( $p < 0.001$ ). Between 2010 and 2020, the mean number of citations per SR/MA article was 51.3 compared to 30.5 per primary research article ( $p < 0.001$ ). Mean Altmetric score was 8.2 in SR/MA compared to 3.7 for primary research articles ( $p < 0.001$ ).

#### CONCLUSION

Secondary research studies have been increasing in impact in both academia and social media compared to primary research. Our results highlight the importance and impact of systematic reviews and meta-analysis articles as a scientifically influential study type in radiology.

#### CLINICAL RELEVANCE/APPLICATION

The study focuses on the impact and influence of different types of research publications in radiology, and highlights the increasing importance of systematic reviews and meta-analyses as influential types of research publications. The findings suggest that prioritizing secondary research studies in future research agendas may be valuable. The study also demonstrates the potential of bibliometric and Altmetric analysis in evaluating the impact of scientific research publications, which can provide valuable insights into the impact of research on both academia and the wider public. Overall, this study has implications for researchers, clinicians, and policymakers in radiology and can inform the development of research strategies and priorities in this area.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-1

### **Dynamic Functional Connectivity Alterations Associated with Cognitive Impairment in Patients with Type 2 Diabetes**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Linqing Fu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to explore the change characteristics and differences of dynamic functional connectivity in type 2 diabetes patients with and without mild cognitive impairment by use of resting state functional magnetic resonance imaging (rs-fMRI).

#### **METHODS AND MATERIALS**

The research consisted of 45 healthy controls (HC) and 102 patients with T2 diabetes (T2). The patients with T2 diabetes were split into two groups based on the presence or absence of mild cognitive impairment, named T2-NC group (n=62) and T2-MCI group (n=40) separately. Thirty-nine components were selected by group independent component analysis (ICA) to construct 7 functional networks. Based on the sliding window method and k-means clustering, changes in dynamic functional connectivity between groups were analyzed and characteristic parameters were compared, while the correlations between characteristic parameters and cognitive performance were evaluated.

#### **RESULTS**

The whole cohort showed four kinds of dFC states: strong local connection state (state 1), extensive interconnection state (state 2), sparse connection state (state 3), and strong connection state (state 4). Compared with the control group, fractional time and mean dwell time of state 2 increased in T2 group, fractional time and mean dwell time decreased in state 4 in T2 group, the number of transitions between state 2 and state 4 reduced in T2 group. The changed dFC characteristics were significantly correlated with cognitive ability. When the statistical efficiency is 0.8 and there are 88 samples in each group, significant differences between T2-NC group and T2-MCI group can be observed.

#### **CONCLUSION**

Our findings indicated that the differences in dFC, which were associated with brain functional impairment due to T2D.

#### **CLINICAL RELEVANCE/APPLICATION**

The differences in dFC might be potential biomarkers for predicting the clinical progression, evaluating the cognitive impairment, and further understanding the pathophysiology of T2D.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-11

### **The Alterations of Glymphatic System Function and Choroid Plexus and Their Correlation with Clinical Features in Relapsing Remitting Multiple Sclerosis Patients**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Kong Lina (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the difference in glymphatic system function between relapsing-remitting multiple sclerosis (RRMS) patients versus healthy controls (HCs), and examine the relationship between diffusion along perivascular space (DTI-ALPS) index and choroid plexus (CP) volume or clinical features in RRMS.

#### **METHODS AND MATERIALS**

The ALPS index, the volume of CP in lateral ventricle and the cortical lesions were derived from magnetic resonance imaging (MRI) in 92 RRMS patients and 40 HCs, 23 of 92 RRMS patients were followed up for an average of 6 months to examine the changes in ALPS index and CP volumes.

#### **RESULTS**

RRMS patients had lower ALPS-index and higher volume ratio of CP than HCs. Lower ALPS-index was significantly related to higher ratio of CP volume and cortical lesion volume, and longer disease duration. Higher ratio of CP volume was related to higher cortical lesion volume, and lower MoCA scores in MS. But the ALPS index and CP volume didn't have statistical changes after 6 months of follow-up in 23 patients.

#### **CONCLUSION**

Our findings demonstrated that the impaired glymphatic system function is involved in the inflammatory processing in MS patients and might help us better understand the pathological mechanism of MS.

#### **CLINICAL RELEVANCE/APPLICATION**

The DTI-ALPS index may have unique significance for monitoring MS inflammatory reaction.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-12

### The Diagnostic Value of Dynamic Contrast-enhanced MRI $K^{trans}$ in Diagnosing Neuropsychiatric Systemic Lupus Erythematosus

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Satoru Ide, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Neuropsychiatric systemic lupus erythematosus (NPSLE) is a severe complication of SLE that affects nervous system. Brain MRI findings in SLE often show vascular lesions, but approximately 40% of NPSLE patients have normal MRI findings, which makes diagnosis challenging. The blood-brain barrier (BBB) is crucial for brain microenvironment integrity. However, microvascular disease and neuroinflammatory states can compromise the BBB in NPSLE. Dynamic contrast-enhanced (DCE)-MRI is a promising technique to evaluate BBB permeability, using  $K^{trans}$  as a flow parameter to measure the volume-transfer constant from intravascular to extravascular extracellular space. An increase in  $K^{trans}$  indicates compromised BBB integrity. The purpose of this study is to determine whether the  $K^{trans}$  value is useful for differentiating NPSLE from non-NPSLE.

#### METHODS AND MATERIALS

Forty-seven NPSLE and 55 non-NPSLE patients were recruited. Based on the 1999 ACR classifications, NPSLE patients were classified 43 central nervous system lupus (11 diffuse and 32 focal manifestations) and 4 peripheral nervous system (PNS) lupus. DCE-MRI was performed, and the  $K^{trans}$  map was obtained for all patients. Regions of interest (ROIs) were set in the cerebral cortex, reflecting small vessel disease, as it is a pathological finding of SLE. Manual ROIs were placed on the frontal, temporal, and occipital cortex with reference to T1-weighted images (Figure 1). Subsequently, the  $K^{trans}$  value was measured, and the average of three points value was used for group comparison using Welch's t-test. ROC analysis was performed to analyze the diagnostic accuracy of the  $K^{trans}$  map. All statistics were performed with BellCurve for Excel (Social Survey Research Information Co., Ltd.).

#### RESULTS

The mean value of  $K^{trans}$  (/min) was significantly larger for NPSLE than for non-NPSLE ( $0.88 \pm 0.56$  vs.  $0.26 \pm 0.46$ ,  $p < 0.001$ ) (Figure 2 and 3). The mean value of  $K^{trans}$  was  $1.10 \pm 0.41$  for diffuse manifestation,  $0.86 \pm 0.59$  for focal manifestation,  $0.42 \pm 0.43$  for PNS lupus, respectively. The mean value of  $K^{trans}$  of diffuse manifestation of NPSLE was larger than that of focal manifestation, although there were no significant differences between them due to the small sample size. The ROC analysis showed good diagnostic performance (AUC: 0.832, optimal cut-off points: 0.11 (/min), sensitivity: 71%, specificity: 89%).

#### CONCLUSION

Our study found that  $K^{trans}$  value from DCE-MRI can differentiate between NPSLE and non-NPSLE, and suggests that BBB disruption may contribute to NP syndrome development in NPSLE.

#### CLINICAL RELEVANCE/APPLICATION

The  $K^{trans}$  value derived from DCE-MRI can accurately differentiate between NPSLE and non-NPSLE, indicating that this technique may serve as a new biomarker for SLE.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-13

### Spinal Cord and Brain Atrophy Patterns in NMOSD and MS are Nonrandom and Clinically Relevant

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Tiantian Hua (*Presenter*) Nothing to Disclose

#### PURPOSE

Silent progressive spinal cord and brain atrophies are common findings in neuromyelitis optica spectrum disorder (NMOSD) and multiple sclerosis (MS), but harbor distinct patterns across brain areas leading to inter- and intra-disease heterogeneity, accounting for different physical disability and cognitive decline.

#### METHODS AND MATERIALS

This cohort study used data retrospectively collected from eight neurological centers. Totally, 209 patients with NMOSD, 304 patients with relapsing-remitting MS (RRMS), and 1160 healthy controls (HC) were studied. Non-negative matrix factorization (NMF) was used to determine the atrophy patterns of these two diseases, respectively. Then, the weightings across atrophy patterns were obtained for each individual using a linear regression model by regarding the individual atrophy profile as dependent variables and the NMF-derived atrophy patterns as independent variables. Next, we associated the individual weighting across each atrophy pattern with cognitive profiles scores and expanded disability status scale (EDSS) scores to explore the contribution of each atrophy pattern to the disease manifestations. An additional longitudinal cohort were conducted to validate the stability and progression of these NMF-derived atrophy patterns.

#### RESULTS

Three atrophy patterns were observed in NMOSD: (1) Spinal Cord-Deep Grey Matter (SC-DGM) pattern associated with decreased Brief Visuospatial Memory Test (BVMT), and higher EDSS scores; (2) Frontal-Temporal pattern associated with decreased Mini-Mental State Examination (MMSE) and California Verbal Learning Test (CVLT) scores; and (3) Cerebellum-Brainstem pattern associated with decreased EDSS progression scores. Three atrophy patterns were observed in RRMS: (1) DGM pattern associated with decreased Symbol Digit Modalities Test (SDMT), Paced Auditory Serial Addition Test (PASAT), MMSE, Montreal Cognitive Assessment (MoCA), CVLT and BVMT, and higher EDSS scores; (2) Frontal-Temporal pattern associated with decreased MoCA scores; and (3) Occipital pattern associated with decreased EDSS progression scores. Additionally, the longitudinal cohort validate the stability of atrophy patterns, and formed trajectories of atrophy progression in NMOSD and RRMS.

#### CONCLUSION

These findings suggested spinal and brain atrophy patterns in NMOSD and RRMS occurred largely in a non-random manner and developed (at least partly) according to distinct anatomical patterns. Additionally, these offered categorical perspectives that may facilitate clinical trials of stratifying participants.

#### CLINICAL RELEVANCE/APPLICATION

Atrophy patterns showed stronger associations with cognitive impairment, physical disability, and progression.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-3

### Advanced Imaging in First Episode Psychosis: A Systematic Review

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Riyad Hanafi (*Presenter*) Nothing to Disclose

#### PURPOSE

In addition to ruling out numerous neurological conditions that may have psychiatric manifestations, advanced imaging techniques play a role in identifying imaging biomarkers of psychiatric disorders, selecting patients for optimal treatment, and tracking treatment effects. We performed a systematic review of the literature to determine how advanced imaging in FEP can allow for increasing diagnostic specificity and predicting disease's evolution.

#### METHODS AND MATERIALS

PubMed searches were conducted on December 9, 2022, using combinations of the following predetermined search terms: "first episode psychosis" and "advanced imaging" or "functional MRI", or "resting state MRI" or "spectroscopy" or "ASL" or "DTI" or "diffusion imaging", with filters Clinical Trial, Meta-Analysis and Randomized Controlled Trial.

#### RESULTS

To date, brain imaging studies have shown grey matter deficits, ventricular enlargement and reduced overall brain volume in FEP. Morphology is commonly assessed using T1-weighted volumetric MRI with automated computerized methods. Patients presenting a FEP show a thinning of certain cortical regions notably involved in emotional processing and higher executive functions. Functional MRI (fMRI) is based on the BOLD (Blood Oxygen Level Dependent) contrast, which uses the paramagnetic properties of deoxygenated hemoglobin, during task-activation or resting-state paradigms. Neuronal activity is associated with changes in oxygen consumption and thus in deoxyhemoglobin concentration. Correlations between BOLD signal time series of distant brain regions reflect their functional interactions, allowing for the identification of different functional resting state networks (RSNs).

#### CONCLUSION

In the routine management of a FEP, brain imaging is mainly used to rule out other conditions. In this indication, structural brain MRI is considered the standard examination. In the near future, advanced sequences, particularly functional imaging studies, may allow improved diagnostic specificity, and play a predictive role, in line with the increasing development of personalized medicine.

#### CLINICAL RELEVANCE/APPLICATION

Early treatment of first-episode psychosis (FEP) is one of the major factors that impacts long-term prognosis. Better understanding of FEP pathophysiology, proper patient selection for optimal treatment, and adequate prognostication of disease evolution are real challenges for current research. Besides ruling out some neurological conditions that may have psychiatric manifestations, advanced imaging techniques allow for identifying imaging biomarkers of psychiatric disorders.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-4

### **MRI Volumetric of Limbic System in Burnout Syndrome and Vigilant Attention in a Population with Nocturnal Shifts**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Christian A. Torres Ramirez, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine association between changes in the sleep pattern, burnout syndrome, vigilant attention deficit with structural alterations of the limbic system.

#### **METHODS AND MATERIALS**

39 Volunteer subjects with night shifts underwent a non-contrast brain MRI using a T1 MPRAGE sequence. Brain images were automatically segmented using the VolBrain software. The Maslach Burnout Inventory Index and the test Psychomotor Vigilante Test (PVT) were used to assess the vigilant attention deficit in all patients. The correlation between the volumetric findings with clinical scales were evaluated using Spearman's test. Non-parametric univariate analysis was performed using the Mann-Whitney U test between the volumetric data and burnout syndrome.

#### **RESULTS**

In subjects with burnout syndrome the hippocampal volume was significantly greater than subjects without burnout syndrome ( $p < 0.01$ ). The response time of the PVT test was lower in the subjects with greater volume of the amygdala ( $r = 0.40$ ,  $p = 0.025$ ). Regarding the precision of the test, an inverse correlation was found between the percentage of failed responses with the volume of the hippocampus ( $r = 0.39$ ,  $p = 0.02$ ) and the volume of the amygdala ( $r = 0.49$ ,  $p < 0.01$ ).

#### **CONCLUSION**

Burnout syndrome is associated with a decrease in the volume of the hippocampus. Vigilant attention deficit is associated with changes in the volume of the hippocampus and amygdala.

#### **CLINICAL RELEVANCE/APPLICATION**

The clinical relevance of this work is to use artificial intelligence tools to define brain structural changes on MRI associated with burnout syndrome and vigilance attention that are complementary to clinical evaluation and in the future can will have utility as severity criteria or predictors of complications.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-5

### A Multimodal Imaging Study of Adult-onset Neuronal Intranuclear Inclusion Disease

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Rui Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

In this study, we propose to apply diffusion kurtosis imaging (DKI) to study the microstructural changes in patients with Neuronal intranuclear inclusion disease (NIID) and the relationship with cognitive dysfunction. We also analyze the changes in brain functional connections, hoping to provide a new imaging perspective on the neuropathological mechanism and early diagnosis of this disease.

#### METHODS AND MATERIALS

Our study retrospectively included 12 patients diagnosed with NIID in the Department of Neurology at \*, as well as 20 healthy control subjects matched for age, gender, and education level during the same period. Neuro-psychological assessments, DKI, and RS-fMRI data were collected in our study. Mean kurtosis (MK), axial kurtosis (AK), radial kurtosis (RK), fractional anisotropy (FA), and mean diffusivity (MD) parameters were obtained, and statistical analysis was performed on each DKI parameter of the subjects. We also analyzed the correlation between the DKI parameter values and neuro-psychological scores in brain regions which show significant differences between NIID patients and healthy controls. Finally, based on the ALL 116 template and independent component analysis, we explored changes in brain network functional connectivity in NIID patients.

#### RESULTS

Compared with healthy controls, NIID patients have lower MK and RK values in the thalamus, hippocampus, and left caudate in the gray matter, as well as lower AK values in the thalamus, insula, and left calcarine. In the white matter, FA is reduced in the superior frontal gyrus, corona radiata, corpus callosum splenium, inferior frontal gyrus, and temporal gyrus. While MD is increased in the white matter around the ventricles (FWE-corrected,  $p < 0.05$ ). In NIID patients, there is a positive correlation between the AK value of the left caudate and MoCA results ( $r = 0.770$ ,  $P = 0.015$ ), and a negative correlation between the MD value of the white matter around the ventricles and MoCA results ( $r = -0.678$ ,  $P = 0.045$ ). Additionally, functional connections in multiple brain regions of NIID patients are weakened (NBS correction,  $P_{edge} < 0.05$ ,  $P_{cluster} < 0.05$ , 1000 permutations), with decreased functional connections in the precuneus, angular and frontal\_mid regions of the default mode network (uncorrected,  $P < 0.001$ ,  $cluster > 5$ ).

#### CONCLUSION

NIID patients show changes in the microstructure and functional connections of multiple brain regions. These changes might contribute to the pathological physiology of NIID and serve as potential indicators for monitoring the severity and progression of NIID, which has potential clinical value for early diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

We hope to provide a new imaging perspective on the neuropathological mechanism and early diagnosis of this disease.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-6

### Brain Mechanisms Underlying Emotional Response in Social Pain. Football as a Proxy to Study Fanatism: An fMRI Study

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Francisco Zamorano, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

In this study, we aimed to explore the brain mechanisms underlying positive and negative social stimuli in football fanatics during positive and negative social scenarios and deepen the neural substrate of football-related emotional responses as a proxy of fanaticism.

#### METHODS AND MATERIALS

Forty-three healthy male volunteers who support Chilean football teams were recruited for this fMRI study. Participants were divided into two groups, 22 supporters of the Colo-Colo team and 21 supporters of the Universidad de Chile team. All participants were presented with a compilation of football matches containing 63 goals, and their brain activity was registered in a Siemens 3T SKYRA, during the visual stimulation of score annotations to rivals and from rivals. We also apply a football supporters' fanaticism scale (FSFS) in order to determine the fanaticism level for each participant.

#### RESULTS

The results demonstrate that the brain activity was different when the goals come or go to the most emblematic rival, which we termed the "emotional delta." In the winning scenarios, subcortical activation was observed, specifically in the ventral striatum, caudate, and lentiform nucleus. These areas are important for the reward dopaminergic circuit, inducing pleasure sensations. The mentalizing network was activated for the losing scenario. This mentalizing network strategy could be involved to mitigate the adverse result's pain. Simultaneously, a deactivation was observed at the dACC, which connects the limbic system with the frontal association regions that command normative behavior, decreasing cognitive control and increasing the probability to fall into disruptive or violent behavior. Both, mentalizing network and dACC correlate with FSFS, negatively and positively respectively.

#### CONCLUSION

Football is an excellent social affiliation model, promoting inclusivity, teamwork, community spirit, social change, and personal achievement. Still, the gregarious component could be the reason behind acts of violence and vandalism. Our study provides new inputs for future research on different fanaticism expressions, which is crucial for promoting a more equitable and inclusive society.

#### CLINICAL RELEVANCE/APPLICATION

Social affiliation is a crucial requirement for complex social phenomena. Fanaticism is extreme or excessive devotion or enthusiasm towards a particular cause, belief, or opinion. It often involves blind and unquestioning loyalty to a particular ideology or leader, and a refusal to consider other perspectives or opinions. Fanaticism can lead to intolerance, aggression, and even violence toward those who do not share the same beliefs or views. In this sense, our study proposes a new model for studying complex behaviors like fanaticism.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR-7

### Comparison of fMRI Language Laterality With and Without Sedation in Pediatric Epilepsy

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Elmira Hassanzadeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Functional MRI is an essential component of presurgical language mapping. In clinical settings, young children may be sedated for the MRI with the functional stimuli presented passively. Research has found that sedation changes language activation in healthy adults and children. However, there is limited research comparing sedated and unsedated functional MRI in pediatric epilepsy patients. We compared language activation patterns in children with epilepsy who received sedation for functional MRI to the ones who did not.

#### METHODS AND MATERIALS

We retrospectively identified the patients with focal epilepsy who underwent presurgical functional MRI including Auditory Descriptive Decision Task at our institution from 2014-2022. Patients were divided into sedated and awake groups, based on their sedation status during functional MRI. Auditory Descriptive Decision Task stimuli were presented passively to the sedated group per clinical protocol. We extracted language activation maps contrasted against a control task (reverse speech) in the Frontal and Temporal language regions and calculated separate language laterality indexes for each region. We considered positive laterality indexes as left dominant, negative laterality indexes as right dominant, and absolute laterality indexes less than 0.2 as bilateral. We defined 2 language patterns: typical (i.e., primarily left-sided) and atypical (Fig 1). Typical pattern required at least one left dominant region (either frontal or temporal) and no right dominant region. We then compared the language patterns between the sedated and awake groups.

#### RESULTS

Seventy patients met the inclusion criteria, 25 sedated, and 45 awake (Fig 2). Using the Auditory Descriptive Decision Task paradigm, when adjusted for age, handedness, gender, and laterality of lesion in a weighted logistic regression model, the odds of the atypical pattern were 13.2 times higher in the sedated group compared to the awake group (CI: 2.55-68.41, p-value <0.01).

#### CONCLUSION

Sedation may alter language activation patterns in pediatric epilepsy patients. Language patterns on sedated functional MRI with passive tasks may not represent language networks during wakefulness, sedation may differentially suppress some networks, or require a different task or method of analysis to capture the awake language network.

#### CLINICAL RELEVANCE/APPLICATION

Given the critical surgical implication of these findings, additional studies are needed to better understand how sedation impacts the functional MRI blood oxygenation level-dependent signal. Consistent with current practice, sedated functional MRI should be interpreted with greater caution and requires additional validation as well as research on post-surgical language outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPNR-8

### The Individual Functional Connectome in Pediatric Epilepsy Patients - Does it Add to Presurgical fMRI Brain Mapping

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Radheshyam Stepponat, MD, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Speech is a complex brain function underlying an extended functional and structural neural network. fMRI as part of presurgical evaluation allows the investigation of language lateralization and organization. Nevertheless, conventional fMRI maps just represent a small aspect of the language network. In children, language networks may differ substantially from their general linear model (GLM) -based activation maps as generated by task-based fMRI post-processing. In this study, functional connectivity analysis (FCA) of task-based language fMRI data was compared to the general linear model-based analysis in children undergoing presurgical evaluation for drug resistant epilepsy.

#### METHODS AND MATERIALS

9 patients (5 male, 4 female) between 8 and 16 years with lesional (n=6) and mr-negative epilepsy (n=3), underwent presurgical language evaluation by fMRI. All patients were right-handed. An echo planar imaging (EPI) sequence was used to acquire high temporal resolution (TR=1s) functional images at 3 Tesla. Two task-based fMRI paradigms (verb generation and sentence comprehension) were presented. The CONN-toolbox was used for preprocessing of anatomical and functional data and for creating individual functional connectomes. One experienced pediatric neuroradiologist was blinded to the patients history and reviewed conventionally processed as well as connectome language fMRI data and qualitatively described the activation patterns.

#### RESULTS

Based on GLM-based analysis, 8 out of 9 patients were determined as left-hemispheric language dominant. One patient had a right-hemispheric language dominance in terms of atypical language representation. In the presurgical fMRI activation analysis 3 out of 9 patients showed contralateral activations in the frontal and temporal lobe. In the FCA in 7 out of 9 patients were found significant connectivities to contralateral frontal and temporal lobes at p-uncorrected <0.05. The FCA also demonstrated significant connectivities (p-uncorrected <0.05) to other cortical brain areas in frontal and temporal lobe in all patients, which were not detected in the activation pattern analysis.

#### CONCLUSION

In this study it was shown that functional connectomes deliver more information about the language network. In the FCA a more extended bilateral functional network was found in most patients as compared to presurgical created activation patterns.

#### CLINICAL RELEVANCE/APPLICATION

In order to further understand brain plasticity especially in the presence of brain pathologies, the visualization of functional brain networks and its implementation in clinical setting is essential. Further studies have to show how the information from the FCA can be interpreted in prediction of postoperative speech changes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-SPNR-9

### Causal Association Between Body Mass Index and Neuroimaging Features in Adults

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Han Lv, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

High body mass index (BMI) is associated with negative brain health; however, its causal association remains unclear. This study evaluated the effect of high BMI on neuroimaging features in different age groups and to validated the causal relationship.

#### METHODS AND MATERIALS

This real-world study has been performed based on the KaiLuan Study, a multicenter, long-term follow-up, community-based longitudinal cohort in the adult population since 2006. We modeled the trajectories of BMI during follow-up to evaluate cumulative exposure. Multimodality neuroimaging data have been collected by 3.0T MRI since 2020, which were available for volumetric measurements of the brain structure, white matter hyperintensity (WMH), and skeletonized white matter tract at the voxel-wise level. We performed two-sample Mendelian randomization analysis using genetic data from 681,275 individuals to analyze the causal relationship between BMI and neuroimaging features.

#### RESULTS

In the real-world study, clinical and neuroimaging data were obtained from 1,074 adults (aged 25-83 years). High BMI was found to be associated with a wide range of negative brain health. For adults <45 years, differences in cerebral parenchyma volume between those with BMI > 26.2 kg/m<sup>2</sup> and those with normal BMI corresponded to 12.0 years (95% CI, 3.0 to 20.0) of brain aging. Volumetric results corresponded to -17.9ml (95% CI, -29.8 to -4.5). Differences in WMH were statistically significant for participants >60 years, with 6.0ml (95% CI, 1.5 to 10.5) increased volume. Genetic analysis of 681,275 individuals further indicated causal relationships among high BMI, decreased volume of the cerebral parenchyma and gray matter, and increased fractional anisotropy in projection fibers, further supporting the causal effect of BMI on brain aging and health.

#### CONCLUSION

BMI is causally associated with decreased brain volume and disrupted microstructural integrity in projection fibers. Brain aging is prominent in young adults with high BMI.

#### CLINICAL RELEVANCE/APPLICATION

Controlling BMI has been suggested throughout life, especially for young adults, for protecting brain health.

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## Abstract Archives of the RSNA, 2023

M5A-SPOB-1

### Proposed New MRI Scoring System of Rectosigmoid Endometriosis: Concise Qualitative Assessment with Pathologic Correlation to Guide Operative Planning

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hiroaki Takahashi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Rectosigmoid endometriosis (RSE) manifests as a broad-spectrum of MRI findings ranging from serosal surface disease to deep bowel involvement, a spectrum which impacts the surgical strategy. We propose a new MRI scoring system for RSE that is beneficial in operative planning based on pathologic depth of invasion as it pertains to MRI.

#### METHODS AND MATERIALS

Patients with RSE treated by rectosigmoid surgery from May 2018 to June 2022 were retrieved. Types of surgery were classified into (1) partial thickness resection, (2) discoid resection, and (3) segmental resection, including low anterior resection and sigmoidectomy. Depth of bowel involvement was extracted from pathology reports. Each pre-treatment MRI was scored based on the mutual agreement of two abdominal radiologists. MRI score was defined as follows: (1) score 0: no evidence of RSE, (2) score 1: minimal tethering involving the serosal surface of the rectosigmoid colon, (3) score 2: indeterminate thickening and/or soft tissue involving the rectosigmoid colon without mushroom cap or submucosal involvement, and (4) score 3: definite mushroom cap sign or definite MRI evidence of submucosal involvement. The contingency of surgical strategy and pathological results between different MRI scores (MRI score 2 versus score 3) was assessed by Fisher's exact test with Freeman-Halton extension.  $P < 0.05$  was considered statically significant.

#### RESULTS

Among 89 enrolled patients (median age: 37 [22-57] year old), 3, 10, 34, and 42 patients had MRI score 0, 1, 2, and 3, respectively. All patients with MRI score 0 and 1 underwent partial thickness shaving. When comparing MRI score 2 to MRI score 3, there was a significant difference in patients requiring partial thickness shaving (53% [18/34] vs 7% [3/42]), discoid resection (18% [6/34] vs 7% [3/42]), and segmental resection (29% [10/34] vs 86% [36/42]) ( $p < 0.001$ ). The depth of bowel involvement was extracted from pathology reports in 13 patients with MRI score 2, and 33 patients with MRI score 3. A higher proportion of patients demonstrated greater depth of invasion with MRI score of 3 compared to MRI score of 2 with higher rates of submucosal invasion (52% [17/33] vs 15% [2/13]) and lower rates of muscularis propria invasion (48% [16/33] vs 62% [8/13]), serosal invasion (0% vs 8% [1/13]), and no invasion (0% vs 15% [2/13]) ( $p = 0.001$ ).

#### CONCLUSION

Our MRI scoring system for RSE has good correlation with the pathological spectrum of bowel invasion and is helpful in operative planning.

#### CLINICAL RELEVANCE/APPLICATION

Our MRI scoring system for rectosigmoid endometriosis is a concise and qualitative scale based on suspected depth of bowel wall invasion and correlates with pathology to best guide operative planning.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5A-SPOB-2

### Contrast-enhanced 3D T1-weighted Image with Compressed Sensing and Fast 3D Wheel Technique on Women's Pelvic MRI: Utility for Improving Quality and Acquisition Time as Compared with Conventional Contrast-enhanced 3D T1-weighted Image

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Takahiro Ueda, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the utility of contrast enhanced 3D T1-weighted image with compressed sensing (CS) and wheel encoding order technique (Fast 3D wheel: Fast 3Dw) which is one of the technics for k-space based acceleration technique for improving image quality and acquisition time on women's pelvic MRI as compared with conventional parallel imaging (PI).

#### METHODS AND MATERIALS

24 consecutive female patients with various pelvic diseases underwent contrasted-enhanced 3D T1-weighted image with PI, CS and Fast 3Dw, randomly. Then, all acquisition times were recorded in each patient. For quantitative assessment, SNR of muscle and CR between myometrium and muscle were determined on uterine corpus and cervical level by ROI measurements. For qualitative assessment, two board certified radiologists assessed overall image quality (OIQ), artifact and diagnostic confidence level (DCL) by 5-point scales. Then, each final score was determined as consensus of two readers. To compare the capability for acquisition time reduction, mean acquisition time was compared among all data sets by Tukey's HSD test. To determine quantitative image quality improvement, SNRs and CRs were compared among all methods by Tukey's HSD test. On qualitative image quality evaluations, inter-observer agreement on each data set was assessed by ? statistics followed by ?2 test. Finally, three indexes among all methods by Wilcoxon signed-rank test.

#### RESULTS

Mean acquisition time of CS and Fast 3Dw (CS:  $156.6 \pm 4.8$  sec, Fast 3Dw:  $153.9 \pm 2.7$  sec) were significantly shorter than that of PI (PI:  $313.0 \pm 9.7$  sec,  $p < 0.001$ ). SNR of Fast 3Dw ( $19.3 \pm 0.9$ ) at uterine corpus level were significantly higher than that of PI ( $12.0 \pm 4.2$ ,  $p < 0.05$ ) and CS ( $15.0 \pm 1.4$ ,  $p < 0.05$ ). SNR of Fast 3Dw ( $20.4 \pm 5.5$ ) at uterine cervical level were significantly higher than that of PI ( $15.4 \pm 6.3$ ,  $p < 0.05$ ). There was no significant difference of CR among three methods ( $p > 0.05$ ). All inter-observer agreements were determined as 'moderate' or 'excellent' ( $0.57 < ? < 0.83$ ,  $p < 0.0001$ ). OIQs of CS and Fast 3Dw (CS: median 4, IQR 3-4; Fast 3Dw: median 5, IQR 4-5) were significantly higher than that of PI (median 4, IQR 3-4.75,  $p < 0.05$ ). Artifacts of CS and Fast 3Dw (CS: median 2, IQR 2-3; Fast 3Dw: median 1, IQR 1-2) were significantly lower than that of PI (median 2, IQR 1.25-3,  $p < 0.05$ ). There was no significant difference of DCL among three methods ( $p > 0.05$ ).

#### CONCLUSION

CS and Fast 3Dw are considered as useful for image quality improvement with reducing acquisition time on women's pelvic MRI, when compared with conventional PI.

#### CLINICAL RELEVANCE/APPLICATION

CS and Fast 3Dw are considered as useful for image quality improvement with reducing acquisition time on women's pelvic MRI, when compared with conventional PI.

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## Abstract Archives of the RSNA, 2023

M5A-SPOB-3

### **Pain-free Survival after Percutaneous Image-guided Cryoablation of Extra Peritoneal Endometriosis**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Milan Najdawi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To retrospectively evaluate the pain-free survival of percutaneous image-guided cryoablation of symptomatic extraperitoneal endometriosis (EE).

#### **METHODS AND MATERIALS**

From 2017 to 2022, cryoablation of EE was performed in a single institution for 42 consecutive patients (median age: 37 years [interquartile range: 33 - 39.5]) on a total of 47 lesions. Patient and procedural characteristics were reviewed retrospectively. Tolerance and outcomes in terms of pain and patient's satisfaction were evaluated.

#### **RESULTS**

The mean procedure and hospitalization lengths were 73 minutes [48-94] and 1 day [1-1], respectively; including 67% outpatients. The median follow-up was 13.5 months [1.1-37.7] after cryoablation. The median pain-free survival rates were 93.75% [95% CI, 77.25-98.4] at 6 month, and 82.72% [58.8-93.45] after 12 month, respectively. Pain decreased from a median of 8/10 [7-9] on the visual analogue scale to 0/10 [0-1] at the last follow-up ( $P < 0.0001$ ). The median Patient Global Impression of Change score recorded at last follow-up was 1/7 [1 - 2]. Efficacy rate of cryoablation to avoid secondary surgery was 92.8% (39/42) per patient and 93.6% (44/47) per nodule treated. Four patients (9.5%, 4/42) had adverse event in the days following the procedure, one patient (2%) had a severe adverse event.

#### **CONCLUSION**

Percutaneous cryoablation is safe and effective to significantly reduce pain and obtain local control of extraperitoneal endometriosis.

#### **CLINICAL RELEVANCE/APPLICATION**

Cryoablation provides a minimally invasive alternative to surgery that can achieve local control of the endometriosis and significantly reduce pain. This is important because endometriosis can cause significant pain and can be difficult to treat, often requiring surgery or long-term medical management.

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## Abstract Archives of the RSNA, 2023

M5A-SPPD-1

### CT Angiography for Acute Pediatric Gastrointestinal Hemorrhage: A Search for Best Practices

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Clinton Veselis, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Gastrointestinal bleeding (GIB) in children can be a life-threatening emergency. CT angiogram (CTA) is typically the first-line imaging modality to identify a source and direct further management. When evaluating pediatric patients with GIB; however, no guidelines exist to our knowledge for optimal patient selection and scanning protocols. This project sought to better delineate the best protocols for evaluating GIB in the pediatric patients.

#### METHODS AND MATERIALS

Our work meets criteria for quality improvement and did not constitute human subjects research. We retrospectively reviewed CTA exams performed for GIB at a tertiary care pediatric hospital from 1/23/2018 - 9/6/2022. Exams reported as non-diagnostic were excluded. Patient age and sex were recorded. Number of phases, positive studies, follow-up imaging modality and findings, intervention, and final diagnoses were identified. Phase of CTA with the clearest evidence of GIB was determined in consensus by two pediatric radiologists. Data were evaluated using descriptive statistics.

#### RESULTS

88 CTAs were performed for GIB evaluation in 89 patients [60 males (67%), median age 11.9 years (range 9 months to 28 years)] over the evaluation period. Of 88 exams, 24 (27%) were single-phase, 41 (47%) were dual-phase, 18 (20%) were triple-phase, and 5 (6%) included a fourth phase, 35 (40%) were dual energy, and 2 (2%) were nondiagnostic. Active GIB was identified on 18 exams (20%) with all being most conspicuous during the arterial phase. Further imaging occurred 46 times and included repeat CTA (n=5), Meckel's scan (n=14), tagged red blood cell scan (n=12), and angiography (n=15). 3 patients underwent repeat CTA after an initial negative study; 3 patients were found to be bleeding at subsequent angiography. 8 patients (9%) underwent embolization and 8 (9%) went to surgery. In total 20 (23%) occurrences of GIB were diagnosed in this cohort. Etiologies included vascular malformation, enteroenteric anastomoses, pseudoaneurysm, and a Meckel's diverticulum.

#### CONCLUSION

Among the varied CTA protocols, a majority (77%) of GIB cases were identified in the arterial phase. In this small sample size, bleeding was identified by CTA only in 19% of patients but there was a false negative rate of 18.75%. Further investigation of patient characteristics and a larger cohort may help better define which patients are more likely to have positive findings on imaging.

#### CLINICAL RELEVANCE/APPLICATION

Our data helps to further the clinical data available with regard to the optimal protocoling and patient selection for CT angiography to evaluate for acute gastrointestinal hemorrhage in pediatric patients.

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## Abstract Archives of the RSNA, 2023

M5A-SPPD-2

### The Feasibility of Portal Vein Flow Quantitation in Pediatric Patients using 4D MRI

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Parmede Vakil, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility of time-resolved flow-sensitive four-dimensional (4D) Flow MRI for the quantification of portal venous hemodynamics in a clinical pediatric population.

#### METHODS AND MATERIALS

We retrospectively identified patients who received 4D Flow MRI using a 3T scanner at our institution in the past 1 year. Flow was quantified using Arterys Web-based flow analysis software in three pre-defined anatomic regions in the proximal, mid, and distal portal vein. Maximum velocities and flow volumes were tabulated. Inter-observer variability was assessed using Bland-Altman and regression techniques.

#### RESULTS

15 patients (7 male, mean age 9.6 years, range [2, 17]) received 4D Flow MRI as part of the clinical work up of their underlying gastroenterological disease. Portal venous flow averaged 479 mL/min range [180, 1130] across all study participants. On average, portal flow increased from the proximal (453 mL/min) to the mid (480 mL/min) and distal (505 mL/min) portions. Flow rate correlated moderately with age ( $r = 0.5381$ ,  $p = 0.04$ ). Interobserver agreement was excellent with Bland-Altman analysis showing a mean inter-observer difference of 30 mL/min, a 7% difference, which was not significant on 1-tail t-test ( $p = 0.1$ ) or regression analysis ( $r^2 = 0$ ,  $p = 0.87$ ).

#### CONCLUSION

4D Flow MRI assessment of portal venous flow is feasible in a pediatric population with excellent inter-observer agreement and flow measurements that are in line with literature values provided in quantitative portal flow studies in adults. More studies are required to further characterize the clinical utility of this modality.

#### CLINICAL RELEVANCE/APPLICATION

4D Flow MRI has the capability of providing both anatomic and functional assessment of portal flow and has been validated against US and 2D Flow MRI in adults; however its feasibility in a pediatric population has not been explored.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-1

### **Carotid Artery Assessment in Dual-Source Photon-Counting CT: Impact of Low Energy Virtual Monoenergetic Imaging on Image Quality, Vascular Contrast and Diagnostic Accessibility**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

#### **PURPOSE**

Preliminary dual-energy CT studies have shown that low energy virtual monoenergetic imaging (VMI)+ reconstructions can provide superior image quality compared to standard 120 kV CTA series. The purpose of this study is to evaluate the impact of low energy VMI+ reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of the carotid artery in patients undergoing photon-counting CTA examinations.

#### **METHODS AND MATERIALS**

A total of 122 patients (67 male) who had undergone dual-source photon-counting CTA scans of the carotid artery were retrospectively analyzed in this study. Standard 120 kV CT images and low keV VMI+ series from 40 to 100 keV with an interval of 15 keV were reconstructed. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). CT number measurements were performed in the common, external and internal carotid artery. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of the carotid artery.

#### **RESULTS**

Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU,  $1362 \pm 12$ ; CNR,  $33 \pm 8$ ; SNR,  $34 \pm 9$ ) followed by 55 keV VMI+ reconstructions (HU,  $737 \pm 9$ ; CNR,  $24 \pm 7$ ; SNR,  $26 \pm 7$ ); all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard 120 kV CT series (HU,  $154 \pm 7$ ; CNR,  $16 \pm 4$ ; SNR,  $24 \pm 6$ ) ( $p < .0001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images series regarding image quality, vascular contrast and diagnostic assessability of the carotid artery ( $p < .0001$ ).

#### **CONCLUSION**

Low keV VMI+reconstructions at a level of 40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of the carotid artery compared with standard CT series in photon-counting CTA.

#### **CLINICAL RELEVANCE/APPLICATION**

In patients undergoing photon-counting CTA scans of the carotid artery, low keV VMI+ reconstructions at a level of 40-55 keV should be routinely reconstructed to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-10

### Assessment of Low-dose Chest CT Protocols Prior to Implementation of Lung Cancer Screening Program

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Elena Tonkopi, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate low-dose CT (LDCT) chest protocols prior to implementing a pilot lung cancer screening (LCS) program in the Canadian province of Nova Scotia.

#### METHODS AND MATERIALS

Data were collected from five scanners of a university hospital. Each sample included 20 examinations conducted on average-sized adult patients chosen by image measurement of anterior-posterior (AP) thickness. All scanners were from the same manufacturer installed in 2011-2022. Dose modulation options and iterative reconstruction algorithms were implemented on all machines, and two were dual source (DS) scanners. The volume CT dose index (CTDIvol) and dose-length product (DLP) were collected in each study. The size-specific dose estimate (SSDE) was calculated using the conversion factor for each patient's AP diameter, and the effective dose (ED) was estimated using an anatomy-specific conversion factor for the chest. For quantitative analysis of image quality, CT numbers and image noise in Hounsfield Units (HU) were measured in three regions of interest: tracheal bifurcation, peripheral lung parenchyma, and subcutaneous fat. Signal-to-noise ratio (SNR) values were calculated for each region. Descriptive statistics determined the mean, standard deviation, and median values of obtained data. Protocol differences were determined using a single-factor ANOVA test, with a p-value less than 0.05 denoting statistical significance. The correlation between dose and SNR values was assessed using the Pearson correlation coefficient.

#### RESULTS

The survey included 100 patients with an overall median AP thickness of 25.0 cm demonstrating no significant difference between patient size in each sample ( $p=0.52$ ). Median values of CTDIvol, DLP, and ED ranged from 2.0 to 4.7 mGy, 72.0 to 164 mGy·cm, and 1.0 to 2.3 mSv respectively. The SSDE varied from 2.5 to 5.8 mGy. Differences between the means of the dose distributions from each scanner were statistically significant with higher doses resulting from both DS scanners. A very weak correlation was found between dose and SNR values with the Pearson correlation coefficients of 0.24, -0.09, and -0.15 for trachea, lung, and fat respectively.

#### CONCLUSION

Our study demonstrated up to a 2.3-fold difference in dose resulting from the LDCT examination. Only three of five scanners using this protocol comply with screening requirements. Due to iterative reconstruction, quantitative image quality had a very weak correlation with dose suggesting potential for protocol optimization without degradation of image quality.

#### CLINICAL RELEVANCE/APPLICATION

Canada currently has no organized LCS, however, some provinces are implementing pilot studies. It is crucial to assess the radiation dose and image quality of LDCT protocols before using them for screening

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-11

### Comparison of Photon-Counting-Detector CT and Energy-Integrated-Detector CT for Evaluating Performance Using Tasks Involving Cerebral Small Vessels

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Kazuya Ohashi, PhD, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Detectability index ( $d'$ ) and task transfer function (TTF) are used for evaluating image quality of CT systems. TTF is generally measured using a 30 mm diameter cylindrical phantom. However, it has been reported that this task is not ideal for assessing small vessels, such as those with 1 mm diameter. In this study, we measured TTF using an iodine wire phantom to simulate CT angiography of the cerebral vasculature, and calculated  $d'$  to compare the results of a photon-counting CT system (PCD-CT) and an energy-integrating detector CT system (EID-CT).

#### METHODS AND MATERIALS

We used a cylindrical water phantom with a diameter of 210 mm to simulate X-ray absorption in an adult head. A wire phantom with a 1-mm diameter, 100-mm length was placed in the water phantom as an object for in-plane TTF measurement. Custom-made iodine wire phantoms, 1 mm in diameter, manufactured by Kyoto Kagaku (Kyoto, Japan), and made of the same material equivalent to diluted iodine with a concentration of 12 mg/ml to simulate the anterior choroidal artery. We evaluated the image quality of small blood vessels in polyenergetic imaging and spectral imaging using this phantom. All images were acquired at 120 kVp and dual energy mode using a PCD-CT (NAEOTOM Alpha, Siemens Healthineers, Erlangen, Germany) and a second generation dual source EID-CT (SOMATOM Definition Flash, Siemens Healthineers, Erlangen, Germany). Virtual monoenergetic images (40 keV at spectral imaging) and polyenergetic image were generated, and noise and contrast-dependent spatial resolution were assessed with noise power spectral (NPS) and TTF, respectively. We also computed the detectability index ( $d'$ ) of simulated small vessels.

#### RESULTS

The NPS at 120 kVp was only slightly different between PCD-CT and EID-CT. At 40 keV, PCD-CT had 29 % less noise. The 50 % TTF was 9 % higher for PCD-CT at 120 kVp and 18 % higher at 40 keV. The  $d'$  of PCD-CT was 63 % higher at 120 kVp and 84 % higher at 40 keV.

#### CONCLUSION

The phantom used in this study accurately simulates the adult head with contrasted small vessels, enabling the evaluation of both spectral and polyenergetic images. Our measurements using iodine wire phantoms demonstrated the high performance of PCD-CT in cerebral CT angiography.

#### CLINICAL RELEVANCE/APPLICATION

Our proposed method for measuring  $d'$  would be effective for clarifying the image quality of cerebral CT angiography.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-12

### Clinical Usefulness of the Latest 256-detector CT Scanner with 3D Anti-scatter System and Multi-material Artifact Reduction Algorithm to Reduce Pseudoenhancement of Renal Cysts in Abdominal Contrast-enhanced CT

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Shingo Harashima (*Presenter*) Nothing to Disclose

#### PURPOSE

The latest 256-detector CT scanner (Revolution CT, GE) has been clinically introduced with a focally aligned detector layout and 3D collimator to use 2D grids to reject scatter in the z-direction and angular plates in the third dimension to reduce scatter as well as multi-material artifact reduction (MMAR) algorithm to reduce heel effect and beam-hardening errors in reconstructed images. We assessed clinical usefulness of Revolution CT with the anti-scatter system and MMAR algorithm to reduce pseudoenhancement of renal cysts in abdominal contrast-enhanced CT (CECT).

#### METHODS AND MATERIALS

We included 64 simple renal cysts from 30 patients (16 men; mean age,  $68 \pm 10$  years; mean body mass index [BMI],  $24.9 \pm 4.5$  kg/m<sup>2</sup>) who underwent both the noncontrast CT (NCCT) and CECT at 120 kV with Revolution CT and 76 simple renal cysts from other 30 patients (18 men; mean age,  $65 \pm 12$  years; mean BMI,  $23.2 \pm 3.4$  kg/m<sup>2</sup>) with simple renal cysts who underwent both the NCCT and CECT at 120 kV with a conventional CT scanner (Discovery CT, GE). Each patient underwent helical acquisition of both the NCCT and CECT with iodine load of 600 mgI/kg during the nephrographic phase using our routine parameters including noise index of 10-11 HU (mean CTDIvol:  $6.8 \pm 3.1$  mGy for Revolution CT;  $12.3 \pm 3.0$  mGy, Discovery CT). We reconstructed axial images of slice thickness of 1.25 mm; measured the maximum diameter of the largest cyst on the CECT; and identically placed a region of interest within the cyst to measure the mean CT value on both the NCCT and CECT in each patient. Each renal cyst was classified into one of the following three groups based on the maximum diameter: group A, < 10 mm; group B, = 10 mm to < 20 mm; group C, = 20 mm. Degree of pseudoenhancement of each renal cyst was defined as difference of the mean CT value between CECT and NCCT. Unpaired t test was used to compare the degree of pseudoenhancement between Revolution CT and Discovery CT in the groups A-C.

#### RESULTS

The degree of pseudoenhancement was significantly smaller with Revolution CT than with Discovery CT in the group A ( $0.78 \pm 1.66$  HU [n = 22] vs.  $15.96 \pm 5.95$  HU [n = 28]), the group B ( $1.34 \pm 2.39$  HU [n = 22] vs.  $13.38 \pm 6.47$  HU [n = 26]), and the group C ( $0.39 \pm 1.12$  HU [n = 19] vs.  $6.62 \pm 4.05$  HU [n = 23]) (P < 0.001 for all), as shown in Table. Revolution CT better reduced pseudoenhancement of smaller renal cysts.

#### CONCLUSION

Revolution CT with the anti-scatter system and MMAR algorithm is clinically advantageous for significantly reducing pseudoenhancement of renal cysts in abdominal CECT over a conventional CT scanner.

#### CLINICAL RELEVANCE/APPLICATION

Revolution CT with 3D anti-scatter system and MMAR algorithm is clinically useful to reduce pseudoenhancement of renal cysts and thus improve differentiation between renal cysts and solid masses in abdominal CECT.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-13

### Phantom Study on Radiomic Features in Ultra-High-Resolution CT Imaging: Matrix Size, Radiation Dose, and Reconstruction Algorithms

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Tomoki Maebayashi (*Presenter*) Nothing to Disclose

#### PURPOSE

With the advent of ultra-high-resolution (UHR) CT and photon-counting CT systems, 1024-matrix imaging has achieved clinical viability. These images display enhanced spatial resolution compared to conventional 512-matrix images. However, the impact of matrix size, radiation dose, and reconstruction algorithm on radiomic quantification remains unclear. This phantom study aimed to elucidate the effects of imaging parameters on CT radiomic feature quantification.

#### METHODS AND MATERIALS

3D-printed cylindrical plastic phantom (19 mm diameter) designed for radiomic analysis was fabricated. The phantom contained an array of cavities filled with varying contrast agent concentrations, generating spatial variation in CT values (6 distinct types). These cylindrical phantoms were integrated into a 30x20 cm CT evaluation phantom (Kyoto Kagaku) and imaged using an UHR scanner (Aquilion Precision; Canon). Radiomic analysis was conducted in two dimensions by placing 2.0 cm<sup>2</sup> circular ROI for each of the six phantoms, evaluating 118 features classified as first-order (n=19), shape (n=24), and texture (n=75). Two comparative analyses were performed: a) super-high-resolution (SHR) mode (0.25 mm thickness, 1024 matrix) versus normal-resolution (NR) mode (0.5 mm thickness, 512 matrix) images, utilizing hybrid iterative reconstruction; b) SHR mode images with three tube currents (150 mA, 290 mA, 580 mA) and three reconstruction algorithms (deep learning, hybrid iterative, filtered back projection). A linear mixed-effects model assessed imaging parameter effects on features. A P-value less than 0.05 divided by 118 for Bonferroni correction was considered significant.

#### RESULTS

In 13 (11.0%) of the 118 features, significant disparities arose between measurements from imaging matrices (1024 versus 512 matrix). Neighborhood Gray-Tone Difference Matrix (NGTDM; 20.0%) was primarily affected, followed by Gray-Level Dependence Matrix (GLDM; 14.3%). Examining 1024 matrix images, 35 features (29.7%) exhibited dose-induced measurement alterations. First-order features (73.7%) were most frequently significantly affected, followed by NGTDM (40.0%). No substantial differences were observed in feature measurements related to reconstruction algorithms.

#### CONCLUSION

Significant discrepancies in feature measurements can be discerned when utilizing UHR CT. Approximately 30% of feature measurements using UHR CT images were notably influenced by dose but not by the reconstruction algorithm.

#### CLINICAL RELEVANCE/APPLICATION

Radiomic features derived from CT images using a 1024 matrix deviate from those originating from conventional CT, with measurements dependent on radiation dose while remaining largely unaffected by the reconstruction algorithm.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-2

### Dual-Source Photon-Counting CTA of the Thorax: Impact of Low Energy Virtual Monoenergetic Imaging on Image Quality, Vascular Contrast and Diagnostic Accessibility

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

#### PURPOSE

Preliminary dual-energy CT studies have shown that low energy virtual monoenergetic imaging (VMI)+ reconstructions can provide superior image quality compared to standard 120 kV CTA series. The purpose of this study is to evaluate the impact of low energy VMI+ reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of thoracic arteries in patients undergoing photon-counting CTA examinations.

#### METHODS AND MATERIALS

A total of 120 patients (66 male) who had undergone dual-source photon-counting CTA scans of the thorax were retrospectively analyzed in this study. Standard 120 kV CT images and low keV VMI+ series from 40 to 100 keV with an interval of 15 keV were reconstructed. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). CT number measurements were performed in the ascending and descending aorta, the aortic arch, the common carotid artery, the subclavian artery and the coronaries. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of thoracic arteries.

#### RESULTS

Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU,  $1205 \pm 11$ ; CNR,  $29 \pm 7$ ; SNR,  $30 \pm 9$ ) followed by 55 keV VMI+ reconstructions (HU,  $679 \pm 8$ ; CNR,  $23 \pm 6$ ; SNR,  $24 \pm 7$ ); all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard 120 kV CT series (HU,  $169 \pm 7$ ; CNR,  $19 \pm 5$ ; SNR,  $27 \pm 7$ ) ( $p < .0001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images regarding image quality, vascular contrast and diagnostic assessability of thoracic arteries ( $p < .0001$ ).

#### CONCLUSION

Low keV VMI+reconstructions at a level of 40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of the thoracic arteries compared with standard CT series in photon-counting CTA.

#### CLINICAL RELEVANCE/APPLICATION

In patients undergoing photon-counting CTA scans of the thorax, low keV VMI+ reconstructions at a level of 40-55 keV should be routinely reconstructed to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-4

### Usage of DECT Features and Radiomics for Management of Renal Lesions in Patients with Von Hippel-Lindau

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Von Hippel-Lindau syndrome (VHL) is a rare genetic condition that increases the risk of cancer, particularly clear cell renal cell carcinoma (ccRCC). Patients with VHL mutation are usually placed under active surveillance until the tumor reaches a size of 3cm, after which surgery is advised. This study aims to investigate the potential use of dual-energy CT (DECT) and radiomics in predicting time to 3cm in patients with VHL, providing a more accurate and efficient method of monitoring ccRCC lesions.

#### METHODS AND MATERIALS

This IRB-approved study comprised 71 adult patients (mean age,  $44 \pm 13$  years, 39 males) with histologically proven ccRCCs in patients with VHL germline mutation who underwent contrast-enhanced DECT of the abdomen during their active surveillance period. A total of 134 lesions which were measured  $>1\text{cm}$  and  $<2.5\text{cm}$  on their baseline DECT studies and had a follow-up study reaching 3cm included in our study. We classified the lesions based on their size on baseline images into small (1-1.5cm), medium (1.5-2cm), and large (2-2.5cm). Within each group, we calculated the median time taken for lesions to reach 3cm, enabling us to classify each lesion as either slow-growing or fast-growing. Deidentified low and high kV series of the venous phase of baseline images were imported and processed on the DECT tumor analysis prototype. We semiautomatically segmented all renal lesions to extract DECT and radiomic features. Using a region of interest on the renal cortex, we normalized the iodine concentrations. Data were analyzed with multiple logistic regression and receiver operator characteristic area under the curve (AUC) as the output.

#### RESULTS

In each group, there was no difference in the maximum diameter, volume, and whole area of the lesions growing to 3cm slowly or fast ( $p>0.3$ ). Normalized iodine concentration was significantly higher in lesions that reached 3cm slower than the others ( $p<0.001$ ). Although the necrotic volume of the lesions was higher in those that reached 3cm faster, but it was not statistically significant. With multiple logistic regression, the combination of iodine concentration and normalized iodine concentration was the best subset in predicting lesions reaching 3cm fast (AUC: 0.72, 95% CI: 0.71-0.74). Radiomics were not able to predict time to 3cm based on baseline DECT studies.

#### CONCLUSION

Quantitative iodine parameters of renal lesions derived from the venous phase of DECT studies show potential in predicting the growth of ccRCC lesions and guiding clinical decision-making in patients with VHL.

#### CLINICAL RELEVANCE/APPLICATION

Predicting ccRCC lesion growth in patients with VHL improves care quality, prioritizes monitoring for rapidly growing lesions, and helps minimize unnecessary radiation exposure for slower-growing ones.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-5

### Evaluation of an Experimental Tantalum Oxide Contrast Material for Material Separation from Iodine and Gadolinium using DECT and PCCT

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Yuxin Sun, BS,MSc (*Presenter*) Stockholder, Nextrast, Inc

#### PURPOSE

To evaluate material separation of an experimental tantalum oxide nanoparticle contrast agent (TaCZ) from iodine and gadolinium, using clinical DECT and a prototype deep silicon PCCT scanner.

#### METHODS AND MATERIALS

Vials of the following concentrations of contrast agents: 2.5, 5.0, 10.0 mg iodine/mL (Ultravist, Bayer); 1.2, 1.9, 2.4, 5.8 mg Gd/mL (Multihance, Bracco); 2.0, 2.5, 4.0, 5.0, 6.0, 8.0, 10.0, 12.0 mg Ta/mL (TaCZ, RPI) were scanned in a water-equivalent CT phantom (MECT Phantom, Gammex) on a clinical fast-kV switching DECT scanner (Revolution CT, GE) and a prototype deep silicon PCCT. Paired iodine and water material decomposition (MD) images were generated for both scanners. Also, PCCT bin images were generated (bin A, 44-52 keV; bin B, 52-60 keV; and bin C, 60-80 keV). ROIs were drawn on 10 slices per vial for all image reconstructions to measure average CT attenuation, iodine and water signals. Slopes of iodine versus material concentration graphs were compared for MD images, and higher to lower bin CT number ratios were compared in the bin images.

#### RESULTS

The mean attenuation of 5.0 mg/mL iodine and Ta, and Gd (5.8 mg/mL) at 120 kVp was 129, 130, and 175 HU for DECT, and 119, 130, and 229 HU at 70 keV for PCCT, respectively. Slopes of iodine signal versus elemental concentration for DECT and PCCT are 1.06 and 0.93 for iodine; 0.79 and 0.05 for Gd; and 0.10 and -0.04 for Ta, respectively. For MD iodine maps, a larger slope difference is seen for iodine vs. Ta than for iodine vs. Gd, suggesting better spectral separation of iodine from Ta by DECT and possibly PCCT. At DECT, separation of Ta from Gd appears modest (slope  $\mu = 0.68$ ) but poor for PCCT ( $\mu = 0.08$ ) because both materials are correctly classified as non-iodine by 2-MD. However, in PCCT bin images, Gd signal (K-edge 50.2 keV) is optimized between bins A B with an attenuation ratio of  $\sim 1.38$  between those bins, while Ta signal (K-edge 67.4 keV) is optimized between bins B C with a ratio of  $\sim 1.26$ . Attenuation ratios of other materials, including iodine and water are all = 1.0 for these same bin pairs, indicating promising bin-based material separation of Ta and Gd from iodine and other materials.

#### CONCLUSION

Tantalum provides intense enhancement on par with iodine at 120 kVp. Iodine signal is more readily separated from that of Ta than Gd by DECT material decomposition images, and is slightly more readily separated from that of Ta than Gd by PCCT. When using PCCT bin (non-MD) images, both Gd and Ta signals are readily differentiated from that of iodine, from each other, and from other materials.

#### CLINICAL RELEVANCE/APPLICATION

Experimental TaCZ contrast gives a strong "color" signal that should be readily separated from iodine signal by both DECT and PCCT, and from Gd for PCCT, and may enable future multi-color contrast discrimination.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-6

### Revisiting Noise Variance-mAs Dependence in Photon Counting Detector CT

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Linying Zhan, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

CT noise variance has long been known to be inversely proportional to tube current-time product (mAs), which is essential in clinical CT protocol optimization. With the introduction of photon counting detector CT (PCD-CT), there is an opportunity to provide low-dose CT imaging with high spatial resolution for various clinical tasks. However, the unique technical aspects of PCD-CT, such as pulse pileup and charge-sharing effects, require a new functional dependence on mAs for noise variance.

#### METHODS AND MATERIALS

With the introduction of photon counting detectors (PCDs) in CT imaging, the finite deadtime of the detectors causes the statistical distribution of raw counts to deviate from the ideal Poisson distribution, becoming deadtime-dependent. In this study, a modified Poisson distribution of photon counts for non-paralyzable PCDs was used to derive the post-log sinogram projection data variance. To connect the noise variance of a CT image with the variance of the sinogram data, a cascaded systems analysis was introduced. Additionally, for PCD-CTs with pile-up corrections, a similar analysis was conducted to derive the functional dependence of noise variance on both mAs and deadtime  $t$ . The analytical  $s^2(mA, t)$  models were validated by comparing them with simulation results and experimental data obtained from a CdTe-based PCD-CT system.

#### RESULTS

In PCD-CTs without pile-up corrections, the traditional noise variance of the CT image on mAs is modified by an additional multiplication factor of  $1/(1 + \beta mA t)$  with a numerical constant  $\beta$ . On the other hand, for PCD-CTs with pile-up corrections, the classical noise variance of CT image on mAs is modified by an additional additive factor  $\gamma t$ , where  $\gamma$  is another numerical constant. Compared with simulated PCD-CT noise data with and without pileup corrections, the mean percent errors of the theoretical models are 0.53% (95% limits of agreement: [-8.45%, 9.50%]) and 0.44% (95% limits of agreement: [-8.17%, 9.04%]) respectively. Compared with experimental PCD-CT noise data, the mean percent error of the theoretical model is 0.04% (95% limits of agreement: [-1.30%, 1.38%]).

#### CONCLUSION

In the non-paralyzable counting mode of PCD-CTs, such as those in the existing clinical systems, the dependence of CT image noise on mAs is modified as follows: 1) without pile-up correction,  $\sigma^2$  is altered by a multiplicative factor, and 2) with pulse pile-up correction,  $\sigma^2$  is altered by an additive factor.

#### CLINICAL RELEVANCE/APPLICATION

The novel noise variance-mAs relationships allow one to predict the CT noise variance at different mA levels accurately and provide the needed scientific foundation for clinical protocol optimization of PCD-CT.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-7

### Optimization and Feasibility of Breast Cancer Imaging with Photon-counting CT: A Phantom Study

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Richard W. Ahn, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast enhancement is the most sensitive feature of breast malignancy and forms the basis of cancer detection with either breast MRI or contrast-enhanced mammography. Compared to conventional energy-integrating CT, photon-counting CT (PCCT) offers improved spatial resolution, superior iodine conspicuity, and material differentiation capabilities. The purpose of this study was to evaluate the performance of PCCT for breast cancer imaging using an anthropomorphic phantom.

#### METHODS AND MATERIALS

A spectral mammography phantom (Sun Nuclear) containing 2 sets of simulated lesions with 0.2, 0.5, 1.0, 2.0 mg/mL iodine was placed on top of an anthropomorphic chest phantom (QRM GmbH, 35 cm X 25 cm). Additional iodine rods (Sun Nuclear) with matched iodine concentrations were placed in the center of the chest phantom. The phantom was imaged on a clinical PCCT scanner (NAEOTOM Alpha, Siemens) using a chest protocol in both standard (144X0.4 mm) and ultra-high resolution (UHR: 120X0.2 mm) modes. Images were reconstructed using a quantitative kernel (Qr40) with quantum iterative reconstruction algorithm at a strength of 3 (QIR-3) with two field of views (FOVs): a large FOV of 420 mm X 420 mm containing both mammography phantom and chest phantom, and a small FOV of 224 mm X 224 mm only containing the mammography phantom. All reconstructions were performed with two matrix sizes of 512 and 1024. Threshold-low images (T3D), virtual monoenergetic images (VMIs) at 50, 60, and 70 keV, and iodine maps were generated. Circular ROI were drawn within the breast lesions and iodine rods. Normalized root mean square error (nRMSE) in CT number was calculated for ROI in the lesions compared to the reference iodine rods. Contrast to noise ratio (CNR) and linearity were measured. Circularity of the breast lesions was measured using a local threshold model and MATLAB.

#### RESULTS

CNR was highest at 50 keV for all iodine concentrations and ranged from 8.2 at 2 mg/mL iodine to 1.0 at 0.2 mg/mL. The nRMSE was similar for all configurations and ranged from 0.5-0.7 HU. CT number linearity was excellent for all configurations ( $R^2=1$ ). Circularity of lesions was highest for the large FOV with standard or UHR mode and a 512 matrix size.

#### CONCLUSION

Standard collimation with large FOV and 512 matrix size was optimal for nRMSE, CNR, and circularity measurements. 50 keV VMIs were optimal for breast lesion evaluation due to increased lesion conspicuity and shape fidelity. These phantom results will guide further protocol development to optimize clinical breast imaging on PCCT.

#### CLINICAL RELEVANCE/APPLICATION

PCCT has the potential for improved breast cancer locoregional staging due to greater iodine conspicuity in spectrally derived images and improved resolution compared to prior generations of CT scanners.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-8

### Simultaneous Iodine and Bismuth Dual-contrast CT Enterography with Clinical Photon-counting CT: A Feasibility Phantom Study using Low-concentration Samples

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Afrouz Ataei, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate whether low-concentration iodine and bismuth samples can be visually differentiated and accurately quantified using clinical dual-source photon-counting CT (PCCT).

#### METHODS AND MATERIALS

Four bismuth-barium solutions (0.7, 1.3, 2.5, and 5.1 mg Bi/mL) were prepared by mixing over-the-counter Pepto-Bismol (10.1 mg Bi/mL, Procter Gamble) with a low-density barium sulfate oral suspension (0.1% w/v, NeuLumEX™, E-Z-EM Canada Inc). The 0.7 mg Bi/mL solution corresponded to 30 mL (one dose) of Pepto-Bismol mixed with 500 mL (one bottle) of oral barium suspension. The four bismuth solutions and three iodine rods (1, 2, and 5 mg I/mL, Sun Nuclear) were inserted into three different multi-energy CT phantoms (20, 33, and 40-cm lateral dimension, Sun Nuclear). Each phantom-sample configuration was scanned on a PCCT system (NAEOTOM Alpha, Siemens) at three kV settings (120 kV: [20, 65 keV]; 140 kV: [20, 70 keV]; Sn140 kV: [20, 80 keV], Sn = 0.6-mm tin filter). Radiation dose levels (CTDIvol) were 3, 8, and 12 mGy, respectively. A custom 3-material decomposition method (iodine/bismuth/water) was used to generate iodine, bismuth, and water maps from the PCCT low- and high-energy bin reconstructed images (Qr44, QIR-3, 2.0/1.0 mm slice thickness/increment) for each data acquisition. Volume conservation was incorporated as a physical constraint for the 3-material decomposition method. The mean bismuth and iodine mass concentrations (mg/mL  $\pm$  standard deviation) were measured by placing a circular ROI of  $\sim$ 2.2-cm<sup>2</sup> on each sample. Linear regression analysis was performed to evaluate the correlation between nominal and measured mg/mL values on the iodine and bismuth maps. The root-mean-square-error (RMSE) for iodine, bismuth, and their combination was computed to assess overall quantification accuracy and was compared across all three kV settings and three phantom sizes.

#### RESULTS

All iodine and bismuth samples, including those with the lowest concentrations, were clearly differentiated at all kV settings and phantom sizes. The 140 kV setting (with no additional filter) was found to be the optimal kV across the small, medium, and large phantom sizes, with combined RMSE values of 1.45, 1.91, and 2.00 mg/mL, respectively. Both the iodine and bismuth measured mg/mL values were highly linearly correlated with the nominal mg/mL values ( $R^2 > 0.99$ ) at the optimal 140 kV setting.

#### CONCLUSION

Iodine and bismuth dual-contrast imaging at low-concentration levels can be accurately performed on a clinical PCCT at routine clinical radiation dose levels.

#### CLINICAL RELEVANCE/APPLICATION

Simultaneous imaging and visual segmentation of iodine-enhanced small bowel wall and bismuth containing small bowel lumen may allow for improved diagnosis in CT enterography imaging.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH-9

### Single-energy Low-kV in Energy-integrating Detector CT Versus Low-keV Virtual Monoenergetic Images in Photon-counting Detector CT for Iodine Imaging

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hiroki Kawashima, PhD (*Presenter*) Kyoto kagaku, Research collaboration

#### PURPOSE

To investigate the performance for iodine imaging of low-keV virtual monoenergetic images (VMIs) in photon-counting detector CT (PCD-CT), compared with those of single energy low-kV images in energy-integrating detector CT (EID-CT), using a Fourier-based assessment.

#### METHODS AND MATERIALS

A water-bath phantom with a diameter of 300 mm, which contains two rod-shaped phantoms made of diluted iodine (2 and 12 mg/ml), was scanned using a clinical PCD-CT (SIEMENS, NAEOTOM Alpha) and an EID-CT (SIEMENS, SOMATOM Force) at 15 mGy. A low-kV image was obtained with a tube voltage of 90 kV in EID-CT (EID 90 kV). VMIs at 40 and 64 keV were reconstructed from the scan data obtained with a tube voltage of 120 kV in PCD-CT. The energy level of 40 keV is the lowest keV setting, and 64 keV was the energy level that exhibited the closest CT number to that of EID 90 kV. In PCD-CT, a low energy threshold image with a tube voltage of 90 kV (PCD 90 kV) was also obtained for comparison. The iodine contrast (C) and the task transfer function (TTF) were measured with the rod images; the noise power spectrum (NPS) was measured in the water-only region. The system performance function, including the iodine contrast factor (SPFc2) was defined as  $[C^2 \cdot TTF^2(f)]/NPS(f)$ .

#### RESULTS

The SPFc2 of VMI 40 keV was notably higher than that of EID 90 kV as the spatial frequency increased. The ratios of SPFc2 of VMI 40 keV to EID 90 kV were approximately 1.50 and 2.81 at 0.1 and 0.5 mm<sup>-1</sup>, respectively. The SPFc2 of VMI 64 keV was comparable to or somewhat lower than that of EID 90 kV. In comparison between the same tube voltage, PCD images were superior to EID images, which was consistent with the theoretical advantages of PCD. The ratios of SPFc2 of PCD 90 kV to EID 90 kV were approximately 1.28 and 1.58 at 0.1 and 0.5 mm<sup>-1</sup>, respectively.

#### CONCLUSION

VMI 40 keV in PCD-CT had a higher performance for iodine imaging than the low tube voltage techniques (EID 90 kV and PCD 90 kV), whereas the performance degradation might be unavoidable when the iodine contrast equalized (EID 90 kV versus VMI 64 keV).

#### CLINICAL RELEVANCE/APPLICATION

This study quantitatively demonstrates that PCD-CT has the potential to provide better image quality than EID-CT in a contrast-enhanced CT scan.

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## Abstract Archives of the RSNA, 2023

M5A-SPRO-1

### CT Patterns and Clinical Outcomes of Radiation Pneumonitis in Non-small Cell Lung Cancer Patients

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Hee Kang, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the CT findings of radiation pneumonitis (RP) in non-small cell lung cancer (NSCLC) patients and their relationship with clinical outcomes.

#### METHODS AND MATERIALS

We assessed CT findings and clinical information of 58 patients with NSCLC who underwent radiotherapy as curative treatment. The CT findings were evaluated for the presence and distribution of the parenchymal abnormalities, which were then classified into three patterns: localized pneumonia (LP), cryptogenic organizing pneumonia (COP), and acute interstitial pneumonia (AIP). Radiation technique, gross tumor volume (GTV), radiation (RT) dose, mean lung dose (MLD), and volume of normal lung receiving 20Gy (V20) were also evaluated. Clinical outcome was evaluated on the basis of Common Terminology Criteria for Adverse Events (CTCAE) grade, corticosteroid treatment, admission, and death. Correlations between imaging findings and clinical outcomes were analyzed.

#### RESULTS

Of the total 58 patients, 47 developed RP. Out of 47 patients, 26(55.3%) had symptoms of grade 2 or less, and 2(4.7%) had symptoms of grade 3 or more. RP related death occurred in 11(19.0%) patients. All patients received radiotherapy using the intensity-modulated radiation therapy technique. The mean, median, and range of the radiation-related factors in all patients are as follows; GTV (134.0, 111.5, 6.9-466.4), RT dose (6010.3, 6600.0, 200.0-7000.0), MLD (1437.6, 1465.9, 364.8-2267.5), V20 (24.9, 25.2, 1.1-443.8). The CT findings of RP were ground-glass opacity with reticulation in 46 (97.8%), consolidation in 40 (85.1%), air-bronchogram in 41 (87.2%), traction bronchiectasis in 28 (59.6%), pleural effusion in 19 (40.4%) and necrosis or cavity formation in 4 (8.5%). The most common pattern of RP was LP (n=20, 42.6%) followed by AIP (n=19, 40.4%) and COP (n=8, 17.0%). GTV, MLD and V20 were significantly different between LP, COP, and AIP patterns ( $p<0.05$ ). The presence of underlying pulmonary fibrosis, AIP pattern and CT extent were higher in the patients with higher CTCAE grade than in patients with lower CTCAE grade ( $p<0.05$ ). RT dose, AIP pattern, CT extent were significantly associated with RP-related death ( $p<0.05$ ).

#### CONCLUSION

RP could be classified into LP, COP and AIP in NSCLC patients and GTV, MLD and V20 were significantly different in each pattern. The underlying pulmonary fibrosis, AIP pattern and high extent of RP were associated with poor clinical outcomes.

#### CLINICAL RELEVANCE/APPLICATION

In NSCLC patients undergoing radiotherapy, RP pattern could be classified into LP, COP and AIP, and GTV, MLD and V20 were significantly different in each pattern. Patients with underlying pulmonary fibrosis or those planned for high RT should be closely followed up to improve patient outcomes.

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## Abstract Archives of the RSNA, 2023

M5A-SPVA-1

### High Resolution MRI Based Radiomics for the Assessment of NIILs after CEA of Patients with Carotid Plaques

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Sihan Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to assess the occurrence of fresh ipsilateral ischemic lesions in patients with carotid plaques following carotid endarterectomy.

#### METHODS AND MATERIALS

We retrospectively collected 115 patients from Renmin Hospital of Wuhan University, all of whom presented with at least 70% carotid luminal stenosis as determined by ultrasound angiography or computerized tomography. Prior to undergoing carotid endarterectomy (CEA), all patients underwent high resolution magnetic resonance imaging (hrMRI) using a 3.0T MR750 system (GE Healthcare, USA) equipped with an 8-channel carotid coil (GE Healthcare, USA). The hrMRI protocol consisted of 2D T1WI FSE, PDWI FSE, and 2D T2WI FSE. The hrMRI images were manually segmented using ITK-SNAP, and radiomics features were extracted using pyradiomics. The occurrence of NIILs was confirmed by DWI following CEA. The patients were randomly divided into training and test groups, and a non-invasive model was built using Lasso and multi-variable logistic regression analysis to predict NIILs.

#### RESULTS

Of the total number of patients, 75 were found to have new ipsilateral ischemic lesions (NIILs) following CEA, while 40 did not exhibit any such lesions. Initially, a total of 1175 radiomic features were extracted from T1-weighted images, which were subsequently reduced in dimension to construct a radiomics model to predict NIILs. The area under the curve (AUC) for the radiomics model was 0.864 (95% confidence interval (CI), 0.781-0.947) in the training group and 0.795 (95% CI, 0.646-0.945) in the testing group (Fig. a and b). A clinical model was also built using variables such as sex, age, LDL, HDL, LHR, hypertension, diabetes, IPH (predicted by MRI), and LRNC (predicted by MRI). IPH (OR=42.01) and LRNC (OR=5.11) were incorporated into the clinical model, and a multivariable logistic regression model was constructed by combining radscore, LRNC, and IPH. The model was visualized using a nomogram (Fig. c). The AUC for the combined model was 0.949 (95% CI, 0.906-0.991) in the training group and 0.837 (95% CI, 0.692-0.982) in the testing group. Calibration showed good fitting of the nomogram in both the training and testing groups (Fig. d and e). The nomogram demonstrated the best clinical benefit in the training and testing groups (Fig. f and g).

#### CONCLUSION

The findings of this study illustrate that the occurrence of NIILs in patients with carotid plaques after CEA can be predicted non-invasively using a radiomics model and a combined model.

#### CLINICAL RELEVANCE/APPLICATION

Compared to traditional hrMRI, the combined model, which incorporates radiomics and clinical variables, not only predicts the occurrence of NIILs but also enables personalized treatment for patients.

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## Abstract Archives of the RSNA, 2023

M5A-SPVA-2

### Imaging of the Aorta in Dual-Source Photon-Counting CT: Impact of Low Energy Virtual Monoenergetic Imaging on Image Quality, Vascular Contrast and Diagnostic Assessability

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

#### PURPOSE

Preliminary dual-energy CT studies have shown that low energy virtual monoenergetic imaging (VMI)+ reconstructions can provide superior image quality compared to standard 120 kV CTA series. The purpose of this study is to evaluate the impact of low energy VMI+ reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of the aorta in patients undergoing photon-counting CTA examinations.

#### METHODS AND MATERIALS

A total of 125 patients (69 male) who had undergone dual-source photon-counting CTA scans of the aorta were retrospectively analyzed in this study. Standard 120 kV CT images and low keV VMI+ series from 40 to 100 keV with an interval of 15 keV were reconstructed. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). CT number measurements were performed in the ascending aorta, the aortic arch, the thoracic and infrarenal descending aorta. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of the aorta.

#### RESULTS

Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU,  $1312 \pm 13$ ; CNR,  $32 \pm 8$ ; SNR,  $34 \pm 10$ ) followed by 55 keV VMI+ reconstructions (HU,  $731 \pm 9$ ; CNR,  $24 \pm 6$ ; SNR,  $27 \pm 9$ ); all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard 120 kV CT series (HU,  $160 \pm 8$ ; CNR,  $18 \pm 5$ ; SNR,  $26 \pm 6$ ) ( $p < .0001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images series regarding image quality, vascular contrast and diagnostic assessability of the aorta ( $p < .0001$ ).

#### CONCLUSION

Low keV VMI+reconstructions at a level of 40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of the aorta compared with standard CT series in photon-counting CTA.

#### CLINICAL RELEVANCE/APPLICATION

In patients undergoing photon-counting CTA scans of the aorta, low keV VMI+ reconstructions at a level of 40-55 keV should be routinely reconstructed to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPBR-2

### Is Presence of Enhancement on Contrast-enhanced Mammography (CEM) A Diagnostic Biomarker to Determine the Presence of Malignancy in Suspicious Mammographic Calcifications

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Leyla Zeitouni, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Aim: Calcifications are a regular finding on screening mammograms and considered a potential early sign of breast cancer. However, the majority of calcifications are benign and stereotactic biopsies could be avoided in a large proportion of cases. We assessed whether the presence of a corresponding enhancement on CEM is diagnostic for the presence of malignancy in mammographic calcifications.

#### METHODS AND MATERIALS

Eligible for this retrospective, IRB-approved, single-center study were women recalled due to mammographic BI-RADS 4 calcifications and who received CEM as part of their diagnostic workup between 2020 and 2022 at our institution. CEM protocols followed international recommendations. Two blinded breast fellows (R1, R2) assessed the presence of enhancement corresponding to calcifications on CEM. Reference standard for findings was stereotactic 9G vacuum-assisted breast biopsy or follow up of at least 24 months. For lesions of uncertain malignant potential, surgery was considered. Proportions were compared using the chi-square test.

#### RESULTS

69 women with mammographic calcifications (mean age, range) were included. 17 out of 69 cases (25%) were malignant (13 cases were intraductal and 4 were invasive ductal cancers). In the malignant cases, an enhancement was found in 12/17 (71%, R1) and 15/17 (88%, R2) cases. Seven of 52 (13%) [PB1] benign lesions presented enhancement detected by both readers. The higher enhancement rate in malignant compared to benign calcifications was statistically significant ( $p < 0.001$ , respectively). Non enhancing malignant cases were DCIS cases of varying grades. Enhancing benign cases were intraductal papilloma, adenosis and fibrocystic changes with intraductal epithelial proliferation.

#### CONCLUSION

Enhancement in CEM is diagnostic for the presence of malignancy in mammographic calcifications. The risk of false negative in the absence of enhancement ranged between 1-3 of 10 malignant cases. Benign calcifications can sometimes show enhancement on CEM.

#### CLINICAL RELEVANCE/APPLICATION

CEM identifies pathological enhancement associated with malignant calcification in the majority of the cases, but a significant amount of DCIS may not show enhancement.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPBR-3

### Performance of Node-RADS Scoring System for a Standardized Assessment of Regional Lymph Nodes in Breast Cancer Patients

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Roberto Maroncelli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Current cross-sectional imaging modalities exhibit heterogeneous diagnostic performances for the detection of a lymph node invasion (LNI) in breast cancer (BC) patients. Recently, the Node-RADS score was introduced to provide a standardized comprehensive evaluation of LNI, based on a five-item Likert scale accounting for both size and configuration criteria. In the current study, we hypothesized that the Node-RADS score accurately predicts the LNI and tested its diagnostic performance. The secondary objective focuses on assessing the applicability and feasibility of the score among readers.

#### METHODS AND MATERIALS

We retrospectively reviewed BC patients treated with mastectomy or QUART and lymph node dissection, from January 2020 to January 2023. Patients receiving preoperative systemic chemotherapy were excluded, therefore we included only patients undergoing lymphadenectomy after sentinel node positivity, who refused neoadjuvant therapy (NT) by self-determination and patients who had contraindications to NT. A logistic regression analysis tested the correlation between the Node-RADS score and LNI both at patient and lymph-node level. The ROC curves and the AUC depicted the overall diagnostic performance. In addition, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for different cut-off values (>1, >2, >3, >4).

#### RESULTS

Overall, data from 100 patients were collected. Node-RADS assigned on CT scans and CE-MRI images, was found to independently predict the LNI after an adjusted multivariable regression analysis, both at the patient (OR 3.36, 95%CI 1.68-9.40,  $p=0.004$ ) and lymph node (OR 5.18, 95%CI 3.39-8.64,  $p<0.001$ ) levels. Node-RADS exhibited an AUC of 0.85 and 0.90 at the patient and lymph node levels, respectively. With increasing Node-RADS cut-off values, the specificity and PPV increased from 50.0 to 95.3% and from 50.3 to 80.0%, respectively. Conversely, the sensitivity and NPV decreased from 100 to 40.0% and from 100 to 75.3%, respectively. Excellent inter-reader agreement was found in the classification of LN according to the NODE-RADS MRI score.

#### CONCLUSION

The current study lays the foundation for the introduction of Node-RADS for the regional lymph-node evaluation in BC patients. Interestingly, the Node-RADS score exhibited a moderate-to-high overall accuracy for the identification of LNI, with the possibility of setting different cut-off values according to specific scenarios.

#### CLINICAL RELEVANCE/APPLICATION

Node-RADS has only been validated in prostate and bladder cancer, showing promising results. No previous reports have investigated his role in BC; we want to address this gap. Higher Node-RADS score could be associated with an increased risk of LNI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPBR-4

### Multi-national Validation of A Clinical Image-based AI-risk Model for Individualizing Breast Cancer Screening

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Mikael Eriksson, PhD (*Presenter*) iCAD, Inc

#### PURPOSE

To investigate the predictive performance of a clinically used image-derived AI-based breast cancer risk model in multiple European screening populations.

#### METHODS AND MATERIALS

Four European mammographic screening populations in three countries screened between 2009-2020 for women aged 45-69 was used to perform a nested case-control study. In total, 739 women with incident breast cancers were included together with 7,812 controls matched to cases on year of study-entry. Mammographic features (density, microcalcifications, masses, left-right breast asymmetries of these features) for risk assessment were extracted using AI from full-field digital mammograms. Breast cancer occurrence was assessed after two years of follow-up. Absolute risks of breast cancer were predicted using the risk model from negative mammograms at study-entry. Adjusted Area Under the receiver operating characteristic Curves (aAUC) estimated discriminatory performance and, adjusted risk-ratios estimated the stratification performance of women at high/general risk per the clinical guidelines.

#### RESULTS

The overall aAUC of the AI risk model was 0.72 (95%CI 0.70-0.75), range 0.71 (95%CI 0.67-0.75) to 0.74 (95%CI 0.69-0.78) for breast cancers developed in four screening populations. In the 4.6% of women classified at high risk using the NICE guidelines thresholds, cancers were more likely diagnosed after 2 years follow-up, risk-ratio (RR) 6.7 (95%CI 5.6-8.0), compared with the 71% of women classified at general risk by the model. Similar risk-ratios were observed across tertiles of mammographic density. In the high-risk group, 22% of the 2-year future cancers were diagnosed, and 29% of stage 2 and higher cancers,  $p < 0.01$ .

#### CONCLUSION

The AI risk model showed generalizable discriminatory performances across European populations and, captured ~30% of clinically relevant stage 2 and higher breast cancers in ~5% of high-risk women who were sent home with a negative mammogram. Similar results were seen in fatty and dense breasts. An image-derived AI model is feasible for personalized screening to improve screening outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Image-derived AI risk models for breast cancer have shown high discriminatory performances compared with clinical risk models based on family history and lifestyle factors. However, little is known about their generalizability across different screening settings and clinical feasibility.

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## Abstract Archives of the RSNA, 2023

M5B-SPBR-5

### The Tyrer-Cuzick Risk Model: Is it Effective for All Races?

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Siya Patil, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the predictive value of the Tyrer-Cuzick Version 8 (TC8) Risk Model in a diverse group of patients in an urban medical center. TC scores predict a patient's 10 year and lifetime risk of developing breast cancer.

#### METHODS AND MATERIALS

A retrospective review of breast imaging patients from multiple clinics within a university hospital system from January 1, 2018-November 1, 2022 was conducted. We collected each patient's most recent lifetime TC8 score, self-reported race and ethnicity (Hispanic/Latina), and cancer status. We excluded patients who did not report race or did not have TC8 scores. The final cohort contained 74,181 total patients. Analyses to explore differences in TC8 scores by race and ethnicity were first conducted on the entire sample, and then on 700 patients with breast cancer. Patients not reporting race or ethnicity were excluded from those analyses. Data was analyzed using two sample unpaired, unequal variance t-tests and  $p < 0.05$ .

#### RESULTS

In the total sample ( $n=74,181$ ), mean TC8 risk scores were statistically different between all racial groups and the White reference group. The largest differences were between White and Black (2.4 points,  $p < 0.0001$ , CI 2.23-2.57) and White and "Other" (2.9 points,  $p < 0.0001$ , CI 2.74-3.06). For the breast cancer cohort ( $n=700$ ), Black patients had a mean TC8 score 2.4 points lower than White patients ( $p=0.02$ , CI 0.32-4.4). There was no statistical difference between mean TC8 scores for White vs. Asian or White vs. "Other". Ethnicity did not have a significant impact on TC8 score relationships. For the total group there was a statistical difference between Non-Hispanic (NH)-White and NH-Black (2.7 points,  $p < 0.0001$ , CI 2.53-2.87), consistent with the previous race findings. The Hispanic (H)-Black score was statistically higher than H-White score, however the difference was less than one point. For the breast cancer cohort NH-White had a mean TC8 score 2.2 points greater than NH-Black ( $p=0.045$ , CI 0.41-4.3), and there was no statistical difference between H-White and H-Black scores.

#### CONCLUSION

TC8 scores in Black patients were consistently lower suggesting that TC8 may underestimate Black patients' lifetime breast cancer risk.

#### CLINICAL RELEVANCE/APPLICATION

The TC8 score is an important tool for predicting breast cancer risk. Currently insurance companies only reimburse MRI screening for patients with TC lifetime risk score  $> 20$ . It is possible that some of our patients' risk was underestimated. Specifically, in our cohort 468 Black patients had scores between 17-19 narrowly missing the cutoff. If the 2.2-2.7 point difference was considered those patients may have been advised to pursue MRI screening. We hope our results encourage future research on the appropriateness of TC8 cutoffs for Black patients.

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## Abstract Archives of the RSNA, 2023

M5B-SPBR-6

### Development and Application of a Feature Based Explainable AI Method (XAI) for Trustworthy Breast Cancer Risk Prediction using the Mirai Model

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yao-Kuan Wang, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The Mirai model (Yala, MIT) is a publicly available deep learning (DL) model predicting 1- to 5-year breast cancer risk from digital mammograms. The model prediction relies on features extracted by an encoder that utilizes a convolutional neural network. We hypothesized that understanding the individual features in terms of their receptive fields offers a route to explainable AI (XAI). The purpose of this study was to retrieve and quantify the features captured in the final layer of the encoder for the short-term risk prediction.

#### METHODS AND MATERIALS

The Mirai encoder detects 512 receptive fields in each mammogram and computes one DL feature value for each field. In this study, features were indexed by the order of encoder outputs. Corresponding receptive fields were matched with the annotations in the individual images. Two datasets were used to evaluate localization and discriminatory power of these features for the present lesions: the Cyprus dataset (100 mammograms) with micro-calcification cases and BI-RADS scores, and the CSAW-S dataset (338 mammograms), which is a case collection of malignant masses. Precision scores between the receptive fields and the locations of masses and calcifications were used to identify lesion-specific features with the highest scores. The area under the receiver operating characteristic curve (AUC) for the discriminative power of BI-RADS scores was calculated for the feature values with the highest calcification precision. Other annotated regions studied included the nipple, skin, thick vessels, and axillary lymph nodes.

#### RESULTS

A precision score of 0.81 was found between feature (F) 145 and calcification clusters, while the annotated mass regions had a precision score of 0.80 for F 397. The discriminative ability of the calcification-related feature values for the BI-RADS scores resulted in AUCs of 0.91 and 0.88 for distinguishing suspicious (BI-RADS 4,5) cases from normal (BI-RADS 1,2) and benign (BI-RADS 2) cases, respectively. Other potentially relevant regions had the following feature indexes and precision scores: nipple (F 5, 0.31), skin (F 114, 0.60), thick vessels (F 171, 0.21), and axillary lymph nodes (F 166, 0.26).

#### CONCLUSION

This study provides evidence that risk prediction features in the Mirai model focus on early detection of breast lesions in mammograms, despite not being trained with pixel-wise annotation. The findings provide essential insight into the functionality of short-term breast cancer risk prediction models.

#### CLINICAL RELEVANCE/APPLICATION

It is possible to extract the main features at the core of a short-term breast cancer risk prediction AI algorithm. Increasing AI trustworthiness should encourage the inclusion of this AI algorithm in the clinical decision-making process.

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## Abstract Archives of the RSNA, 2023

M5B-SPBR-7

### Mammographic Density Changes after Neoadjuvant Chemotherapy in Triple-negative Breast Cancer: Association with Treatment and Survival Outcome

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yelim Choi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the associations between mammographic density changes after neoadjuvant chemotherapy (NAC) and treatment and survival outcomes in triple-negative breast cancer (TNBC).

#### METHODS AND MATERIALS

This single center retrospective study evaluated a total of 306 women with TNBC who underwent NAC followed by surgery between 2010 and 2019. Baseline density and density changes after completion of NAC were evaluated both qualitatively and quantitatively. Qualitative breast density (a-d) was evaluated based on the BI-RADS. Quantitative breast density (%) was evaluated using an open-source software (LIBRA) and mediolateral oblique/craniocaudal mammograms of the contralateral breast. Multivariable logistic regression analysis was used to evaluate the association between breast density and pathologic complete response (pCR) according to the menopausal status. Cox proportional hazard regression analysis was used to evaluate the association between breast density and development of (a) contralateral breast cancer and (b) locoregional recurrence and/or distant metastasis.

#### RESULTS

Among 306 women, 93 (30%) achieved pCR, and 71 (23%) had contralateral breast density reduction 10% or greater after NAC. For only premenopausal women (n=177), the contralateral breast density reduction 10% or greater was independently associated with pCR (odds ratio, 2.5; P value=.03). On a median follow-up of 54 months, 10 (3%) women developed contralateral breast cancers, and 68 (22%) women developed locoregional recurrences and/or distant metastases. The contralateral breast density reduction 10% or greater was not associated with the development of contralateral breast cancer (Hazard ratio [HR], 1.3; P value =.78) nor the development of locoregional recurrence and/or distant metastasis (HR, 1.1; P value =.79). Family history of breast cancer was independently associated with the development of contralateral breast cancer (HR, 6.2; P value =.005). The presence of lymphovascular invasion (HR, 2.1; P value=.02), invasive cancer 2cm or greater (HR, 3.9; P value <.001), and lymph node metastasis on the surgical specimen (HR, 2.7; P value =.004) were independently associated with the development of locoregional recurrence and/or distant metastasis. Baseline density was not associated with the treatment and survival outcomes.

#### CONCLUSION

For premenopausal women, contralateral breast density reduction 10% or greater after NAC was independently associated with pCR, although it was not translated to improved outcomes.

#### CLINICAL RELEVANCE/APPLICATION

The contralateral breast density reduction 10% or greater after NAC was associated with achievement of pCR in premenopausal women, however, the density reduction was not translated to improved outcomes.

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## Abstract Archives of the RSNA, 2023

M5B-SPBR-8

### Volumetric Parenchymal Pattern Radiomic Analysis in Digital Breast Tomosynthesis for Breast Cancer Risk Estimation

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Alex A. Nguyen, BS, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

We evaluate the performance of volumetric parenchymal pattern analysis from digital breast tomosynthesis (DBT) versus digital mammography (DM), accounting for conventional risk factors and breast density for breast cancer risk estimation. The rationale is that 3D parenchymal texture analysis with radiomic features may provide information beyond 2D breast density.

#### METHODS AND MATERIALS

We performed a retrospective case-control study in women with concurrent DM and DBT screening (Selenia Dimensions, Hologic Inc.) at our institution from 3/2011-12/2014. Cases were diagnosed with breast cancer within 1-year of screening; controls were confirmed negative or benign at 1-year follow-up, matched on race (Black, White, other/unknown) and age (5-year bins). After exclusions for imaging artifacts, craniocaudal (CC) and mediolateral oblique (MLO) views for 187 cases and 737 controls, in six image formats were assessed: 1) raw DM; 2) processed DM; 3) raw DBT central projection; 4) processed DBT central projection; 5) DBT central reconstructed slice; and 6) 3D DBT reconstructed stack. For cases, we analyzed the breast contralateral to cancer diagnosis and the same breast in matched controls. We extracted 487 radiomic features using a lattice-based approach with the Cancer Imaging Phenomics Toolkit, averaging features for each breast over CC and MLO views. We examined 3 lattice window sizes (6.4, 12.8, and 25.6 mm) and 23 image resampling resolutions (0.075 - 2mm). We performed principal component analysis on the resulting 487 features for each combination of window size and resampled resolution and built conditional logistic regression models to assess the association of the first seven principal components with breast cancer, with models adjusting for age, BMI, and Breast Imaging Reporting and Data System (BI-RADS) density. We calculated the model C-statistic at all window sizes and resolutions (i.e., total of 2304 experimental conditions).

#### RESULTS

Radiomic features from 3D reconstructed DBT scans had on average higher C-statistics across all experimental conditions. A model using only age, BMI, and BI-RADS density had a C-statistic of 0.61. Models using radiomic features plus age, BMI, and BI-RADS density had mean C-statistic of 0.68 (IQR 0.68, 0.69) for reconstructed DBT scans; for all other image types, the mean C-statistic ranged from 0.64 to 0.66.

#### CONCLUSION

3D volumetric breast parenchymal patterns from DBT may improve breast cancer risk estimation beyond markers derived from 2D DM and conventional breast density metrics alone.

#### CLINICAL RELEVANCE/APPLICATION

Fully-automated, 3D parenchymal pattern radiomic analysis is feasible in DBT, and our preliminary evaluation suggests that it may improve breast cancer risk assessment beyond 2D DM measures.

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## Abstract Archives of the RSNA, 2023

M5B-SPBR-9

### **Mammographic Density Assessment: Radiologists, Artificial Intelligence-based Computer-assisted Diagnosis, and Automated Volumetric Measurement**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Su Min Cho, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate breast density assessment using BI-RADS (Breast Imaging Reporting and Data System) breast density category across readers with different levels of experience, artificial intelligence-based computer-assisted diagnosis (AI-CAD) and automated volumetric density measurement program (Volpara®).

#### **METHODS AND MATERIALS**

A total of 1,015 screening mammography were retrospectively reviewed ( $56 \pm 10$  years). Density assessment according to BI-RADS category was performed by four readers with two different levels of experience; experts and general radiologists. Agreements between visually assessed BI-RADS category, AI-CAD (Lunit INSIGHT MMG) and Volpara® were evaluated using weighted kappa statistics.

#### **RESULTS**

Inter-reader agreement between expert and general radiologist was substantial ( $k = 0.65$ ) with a matched rate of 72.8%. The agreement was substantial between the expert or general radiologist and Volpara® ( $k = 0.64 - 0.67$ ) with a matched rate of 72.0% but moderate between expert or general radiologist and AI-CAD ( $k = 0.45 - 0.58$ ) with a matched rate of 56.7 - 67.0%. The agreement between Volpara® and AI-CAD was moderate ( $k = 0.53$ ) with a matched rate of 60.8%.

#### **CONCLUSION**

Density assessment by AI-CAD showed moderate agreement with those of radiologists, while Volpara® showed substantial agreement with radiologists.

#### **CLINICAL RELEVANCE/APPLICATION**

Volpara® presented better agreement with radiologists than AI-CAD with a better matched rate.

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## Abstract Archives of the RSNA, 2023

M5B-SPCA-1

### Can Cardiac CT Alternate Cardiac MRI for Myocardial ECV Quantification in Cardiac Amyloidosis?

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Hidetaka Hayashi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Myocardial extracellular volume (ECV) on CT, a possible alternative to cardiac MRI, has significant practical clinical advantages. However, the consistency between ECVs quantified via CT and MRI in cardiac amyloidosis (CA) has not been fully investigated. Therefore, the current study investigated the application of CT-ECV in CA with MRI-ECV as the reference standard.

#### **METHODS AND MATERIALS**

We retrospectively evaluated 31 patients with CA who underwent cardiac CT and MRI. Pearson correlation analysis was performed to investigate correlations between CT-ECV and MRI-ECV at each segment. In addition, correlations between ECV and clinical parameters were assessed.

#### **RESULTS**

There were no significant differences in terms of the mean global ECVs between CT and MRI ( $51.3\% \pm 10.2\%$  vs  $50.0\% \pm 10.5\%$ ). CT-ECV was strongly correlated with MRI-ECV at the septal ( $r=0.88$ ), lateral ( $r=0.80$ ), and global ( $r=0.87$ ) segments. A strong correlation was also observed at the anterior ( $r=0.77$ ) and inferior ( $r=0.79$ ) segments. In both CT and MRI, the ECV had a weak to strong correlation with high-sensitivity cardiac troponin T level, moderate correlation with global longitudinal strain, and inverse correlation with left ventricular ejection fraction. The septal ECV and global ECV had a slightly higher correlation with the clinical parameters.

#### **CONCLUSION**

Cardiac CT can quantify myocardial ECV and yields results comparable with those obtained using MRI in patients with CA. A significant correlation was also observed between CT-ECV and clinical parameters.

#### **CLINICAL RELEVANCE/APPLICATION**

CT-ECV can be used as an imaging biomarker and alternative to MRI-ECV in patients with CA.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPCA-2

### Clinical Utility of 'Faded Edge Sign' on the Post-contrast T1 Mapping for Diagnosis of Cardiac Amyloidosis

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Eun Ju Chun, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the frequency and potential clinical utility of the 'faded edge sign' on the post-contrast T1 mapping to identify cardiac amyloidosis (CA) among patients with left ventricular hypertrophy (LVH).

#### METHODS AND MATERIALS

We retrospectively enrolled 222 patients with pathologically confirmed LVH (56 CA, 116 hypertrophic cardiomyopathies [HCM], 50 hypertensive heart disease[HHD]) who underwent cardiac MR. The 'faded edge sign' was defined as the boundary between the myocardium and the left ventricular (LV) cavity was unclear and the LV myocardium/cavity signal intensity ratio was between 0.8 and 1.2 on the post-contrast T1 mapping. In diagnosing CA among patients with LVH, we compared the diagnostic accuracy of additional faded edge sign compared to the characteristic late gadolinium enhancement (LGE) pattern (global subendocardial enhancement), native T1 values, and extracellular volume (ECV).

#### RESULTS

The faded edge sign was noted in 40 of 56 patients with CA (71.4%) and 5 of 116 patients with HCM (4.3%) and none of the HHD patients. Mean native T1 value and ECV was the highest in CA, followed by HCM and HHD (1442±81msec vs. 1320±58 msec vs. 1230±32 msec for native T1 value; 41±7% vs. 29±7% vs. 23±2% for ECV;  $p < 0.05$ ). The sensitivity and specificity of faded edge sign for CA was 71.4% and 97.0%, respectively. For the diagnosis of CA, the diagnostic accuracy of the added faded edge sign for the combination of LGE, ECV, and native T1 (AUC 0.931) was higher than that of the combination of LGE+ECV+native T1 (AUC 0.920) or LGE alone (AUC 0.866).

#### CONCLUSION

The 'faded edge sign' on the post-contrast T1 mapping is a simple observation method that is helpful in increasing the ability for diagnosis of CA.

#### CLINICAL RELEVANCE/APPLICATION

In addition to LGE, native T1 and ECV, post-contrast T1 mapping was also helpful for the diagnosis of CA.

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## Abstract Archives of the RSNA, 2023

M5B-SPCA-3

### Prediction of Early Death from Anthracycline-induced Cardiotoxicity using CMR Parameters: An Animal Study

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Nayoung Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to compare cardiac magnetic resonance (CMR) parameters between the early death and survival groups of anthracycline-induced cardiotoxicity rat models, and to identify factors that could predict early death.

#### METHODS AND MATERIALS

We generated 38 Sprague-Dawley cardiotoxicity rat models by injecting doxorubicin (1.0 mg/kg) twice weekly for 12 weeks. We conducted CMR biweekly until 12 weeks, including pre-contrast and post-contrast T1 mapping using a saturation recovery Look-Locker sequence and T2 mapping using a spin echo sequence using a 9.4 T Bruker scanner. Biventricular function, left ventricle (LV) mass, native T1, T2, and ECV (extracellular volume fraction) were measured. The CMR parameters and blood troponin I (TnI) were compared between the early death and survival groups using linear mixed regression analysis.

#### RESULTS

Among 38 rats, seven were excluded because of poor image quality or because they died before CMR at two weeks. Seventeen rats died before 12 weeks, so they were assigned to the early death group: 2 rats surviving for 2 weeks, 2 rats for 4 weeks, 3 rats for 6 weeks, and 3 rats for 8 weeks. Fourteen rats survived until the maximum treating period of 12 weeks and were assigned to the survival group. During the treatment, native T1, T2, and ECV increased, and LVEF (left ventricular ejection fraction) decreased in each group. When the two groups were compared, native T1 showed a significant difference at 8th week, with the early death group showing a higher value than survival group ( $1364.1\text{ms} \pm 75.6$  vs.  $1235.7\text{ms} \pm 60.2$ ,  $P = .01$ ). The ECV exhibited significant differences from 6th week ( $21.7\% \pm 2.4$  in early death group vs.  $18.5\% \pm 2.2$  in the survival group,  $P = .046$ ) through 8th week ( $24.5\% \pm 2.5$  vs.  $20.5\% \pm 2.3$  in survival group;  $P = .022$ ), with the early death group exhibiting significantly higher values. T2 and LVEF showed no significant differences between groups throughout all weeks. TnI levels significantly differed at 8th week ( $7.5\mu\text{g/mL}$  vs.  $0.02\mu\text{g/mL}$ ,  $P = .002$ ). In the survival group, ECV increased significantly between 4 and 6 weeks ( $P = .044$ ), and LVEF decreased significantly between 8 and 12 weeks ( $P = .001$ ). However, native T1 did not show significant week-by-week differences within the survival group. Within the early death group, LVEF decreased significantly between 2 and 4 weeks ( $P = .04$ ), and native T1 and ECV showed a significant increase between 4 and 6 weeks earlier than the survival group ( $P = .007$  and  $.001$ , respectively).

#### CONCLUSION

We have observed the differences in changing patterns in native T1, ECV, T2, and LVEF over the treatment time between the survival and early death groups.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative measurement of native T1 and ECV with CMR may facilitate the prediction of anthracycline-induced cardiotoxicity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPCA-5

### Diagnostic Yield of Cardiac MRI in Patients with Clinically Suspected Myocarditis after COVID-19 Vaccination

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Norain Talib (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate cardiac MRI findings in patients with suspected myocarditis following COVID-19 vaccination in relation to clinical presentation and timing of imaging.

#### METHODS AND MATERIALS

Consecutive adult patients who underwent clinically indicated cardiac MRI for evaluation of suspected myocarditis following mRNA-based COVID-19 vaccination at a single center between June 2021-December 2022 were retrospectively evaluated using the revised 2018 Lake Louise Criteria (LLC). Patients were classified into groups based on presence/absence of T1 criteria (late gadolinium enhancement and/or high T1 map values) and T2 criteria (regional T2-hyperintensity and/or high T2 map values). Clinical information including vaccine history and presenting symptoms were extracted from the health record.

#### RESULTS

89 patients were included, 64% male with mean age  $34 \pm 13$  years; all had received at least one dose of a COVID vaccine (mRNA-1273 in 38% and BNT162b2 in 62%) with median interval between the last dose vaccine dose and cardiac symptoms (chest pain, palpitations or shortness of breath) of 5 days (IQR 1-9). The median interval between last COVID-19 vaccine dose and MRI was 92 days (IQR 31-157). At least one T1 or T2 abnormality on MRI consistent with myocarditis was identified in 42 patients (47%); 25 (28%) met both T1 and T2 criteria on MRI (definite myocarditis); 17 (19%) met T1 criteria but not T2 criteria (possible myocarditis); and 47 (53%) did not meet either T1 or T2 criteria (no myocarditis). None of the patients met T2 criteria but not T1 criteria. The three groups did not differ in age ( $p=0.10$ ), sex ( $p=0.29$ ), vaccine type ( $p=0.24$ ), or left ventricular ejection fraction ( $p=0.53$ ). The interval between last vaccine dose and cardiac MRI was significantly shorter in patients who met both T1 and T2 criteria (28 days, IQR 8-69) compared to those meeting T1 criteria only (110 days, IQR 66-255,  $p<0.001$ ) and those not meeting either T1 or T2 criteria (120 days, IQR 80-252,  $p<0.001$ ). However, the interval between last vaccine dose and MRI did not differ between those meeting T1 criteria only and those not meeting either T1 or T2 criteria ( $p>0.99$ ).

#### CONCLUSION

In a cohort of patients with symptoms concerning for acute myocarditis following COVID-19 vaccination who underwent clinically indicated cardiac MRI, 28% met criteria for definite myocarditis (T1 and T2 abnormal) and 19% met criteria for possible myocarditis (only T1 abnormal). Identification of myocardial edema on cardiac MRI was highly dependent on the timing of imaging after vaccination.

#### CLINICAL RELEVANCE/APPLICATION

Cardiac MRI should be performed as soon as possible after symptom onset in patients with suspected acute myocarditis as the likelihood of detecting myocardial edema drops substantially after a few weeks.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPCA-6

### Diagnostic Accuracy of Cardiac MRI Versus Nuclear Imaging for Cardiac Amyloidosis: A Systematic Review and Meta-Analysis

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

James Roberts, MD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

There is no consensus regarding the relative diagnostic performance of cardiac MRI and nuclear imaging in cardiac amyloidosis. The purpose of this study was to perform a systematic review and meta-analysis to compare the diagnostic accuracy of cardiac MRI and cardiac nuclear imaging for cardiac amyloidosis.

#### METHODS AND MATERIALS

MEDLINE, Ovid Epub, CENTRAL, EMBASE, EMCARE, and Scopus were searched from inception until September 2022. Inclusion criteria included studies that evaluated the diagnostic accuracy of cardiac MRI or cardiac nuclear imaging studies for cardiac amyloidosis in adults. Abstracts and case reports were excluded. Data were independently extracted by two investigators. Summary accuracy metrics were obtained using bivariate random-effects meta-analysis. Meta-regression was used to assess the impact of different covariates. Risk of bias was assessed using the Quality Assessment Tool for Diagnostic Accuracy Studies-2 tool. The study protocol was registered a priori in the International Prospective Register of Systematic Reviews (PROSPERO CRD42022352480).

#### RESULTS

Our search strategy yielded 7322 studies. We screened 2785 studies after excluding duplicates and reviewed the full text of 272 studies. Thirty-nine studies were included (3836 patients, 2331 with cardiac amyloid); 18 studies evaluated cardiac MRI (1553 patients, 968 with cardiac amyloidosis) and 24 evaluated cardiac nuclear imaging (2372 patients, 1401 with cardiac amyloidosis). Only 3 evaluated both MRI and nuclear imaging in the same patients. Overall, combined 99mTc-scintigraphy bone tracers (including 99mTc-DPD, 99mTc-PYP, and 99mTc-HMDP) had higher specificity than LGE on cardiac MRI (96% vs. 85%,  $p < 0.001$ ), with no difference in sensitivity (95% vs. 91%,  $p = 0.88$ ). When the analysis was restricted to studies with endomyocardial biopsy as the reference standard, there was no difference in specificity between modalities (96% vs. 90%,  $p = 0.56$ ). Covariate analysis demonstrated that sensitivity and specificity for nuclear imaging did not differ significantly by quantitative vs. qualitative evaluation. Thirty-seven studies were at risk of bias. There were insufficient studies to pool data on the diagnostic performance of T1 mapping, ECV and PET.

#### CONCLUSION

Nuclear imaging Tc99m bone tracers have higher specificity for cardiac amyloidosis than LGE on cardiac MRI, but similar sensitivity. Limitations including risk of bias and few studies with direct comparison necessitate additional study.

#### CLINICAL RELEVANCE/APPLICATION

Nuclear imaging Tc99m bone tracers are only specific for transthyretin amyloid while MRI detects all types including light chain. Additional studies are needed to determine the relative diagnostic performance in amyloid subtypes.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-SPCH-1

### Modeling Risk of Progression to Lung-RADS 4 from a Benign Lung Cancer Screening CT using Imaging and Clinical Data

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Gunvant R. Chaudhari, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

For patients with benign low-dose chest CTs (LDCTs) with Lung-RADS score = 2, the screening interval is set to one year. To optimize screening intervals, we aim to build a deep learning system to predict risk progression in two years from full volume CT and clinical features.

#### METHODS AND MATERIALS

In this retrospective modeling study, full-volume LDCTs and baseline surveys from the National Lung Screening Trial (NLST) dataset (n=26,722 patients) were accessed to use as training data. A proprietary AI-based system augmented with solid-component segmentations was used to calculate the Lung-RADS 1.1 score for each scan. Baseline LDCTs with Lung-RADS = 2 were selected. For the clinical and demographics data, backward stepwise selection based on p-values was conducted to select the four most predictive features. Then, statistical and deep learning models were trained to predict progression to Lung-RADS 4 in two years. Models were compared based on the AUC-ROC score. To test generalizability, institutional lung screening LDCT and clinical data was collected (n=583 patients). A subset of baseline screenings with corresponding studies in 2 years +/- 4 months were selected. The NLST trained models were evaluated on institutional data.

#### RESULTS

From the NLST dataset, a subset 15,942 baseline LDCT screenings were found to have Lung-RADS = 2, with 1,637 progressing to Lung-RADS 4 (10.3%). Benign Lung-RADS score institutional studies totaled 50 studies, with 7 (14%) progressing to Lung-RADS 4 in two years. After backward stepwise selection on all input features, those that were significantly associated with Lung-RADS 4 progression were average nodule size, largest nodule size, number of nodules, and emphysema diagnosis. Models for predicting progression to Lung-RADS 4 based only on clinical and imaging features had a maximal AUC of 0.667 and 0.750 on the NLST and UCSF holdout data, respectively. Convolutional neural network-based models trained on full volume CTs had an AUC of 0.627 and 0.555 on the NLST and UCSF data, and combined models with clinical features and full-volume CT had a maximal AUC of 0.704 and 0.724.

#### CONCLUSION

This study shows that AI based models can predict future progression to Lung-RADS 4 from clinical features and full-volume CT scan. The full-volume CT based models have limited generalizability to institutional data, likely due to differences in acquisition dates and qualities.

#### CLINICAL RELEVANCE/APPLICATION

Modeling clinical and baseline imaging features that contribute to Lung-RADS 4 progression from a benign baseline LDCT may allow for optimized screening frequency for low-risk patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPCH-2

### AI Assisted Lung Cancer Screening: A Retrospective Multinational Study in the US and Japan

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Atilla P. Kiraly, PhD (*Presenter*) Former Employee, Siemens AG; Employee, Alphabet Inc

#### PURPOSE

To evaluate the impact of an Artificial Intelligence (AI) assistant for lung cancer screening (LCS) on multinational clinical workflows.

#### METHODS AND MATERIALS

We iteratively developed an AI interface via six user experience reader studies. We then conducted two retrospective randomized multi-reader multi-case studies where 627 (141 cancer positive) cases were each read twice (once with and once without AI assistance) by experienced thoracic radiologists (6 US-based or 6 Japan-based), resulting in a total of 7,524 interpretations. Positive cases were defined as imaging studies within two years before a lung cancer diagnosis. Cases without any subsequent cancer diagnosis for at least two years after the imaging study were defined as negative, and enriched for a spectrum of diverse nodules. The studies measured the readers' level of suspicion (LoS, on a 0-100 scale), country-specific screening system scoring categories, and management recommendations. Evaluation metrics included the area under the receiver operating characteristic curve (AUC) for LoS and sensitivity and specificity for recall recommendations.

#### RESULTS

With AI assistance, the radiologists' AUC increased 2.3% (70% to 72%,  $p=0.022$ ) for the US study and 2.3% (93% to 96%,  $p=0.179$ ) for the Japan study. Scoring system specificity for positive screens increased 5.5% (57% to 63%,  $p<0.001$ ) for the US and 6.7% (23% to 30%,  $p<0.001$ ) for the Japan study. No significant drop in sensitivity occurred. Specificity increased 5.8% ( $p<0.001$ ) and 5.4% ( $p<0.001$ ) in the US-based and Japan-based studies for any actionable recommendations, respectively.

#### CONCLUSION

We demonstrate a rigorous randomized study of an AI assistant into real-world-like clinical workflows. Our PACS-integrated AI interface demonstrated improved LCS specificity in both US and Japan-based reader studies, meriting further study in additional international screening environments.

#### CLINICAL RELEVANCE/APPLICATION

We developed a general lung cancer screening AI interface and retrospectively tested it with experienced radiologists on more difficult screening cases under both US-based and Japan-based reading protocols.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPCH-3

### Multi-modality Artificial Intelligence Model Based on CT and Haematoxylin and Erosin (H&E)-stained Slides Images to Predict PD-L1 Status in NSCLC

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Dingpin Huang, MEd (*Presenter*) Nothing to Disclose

#### PURPOSE

Programmed death-ligand 1(PD-L1)expression status is the most important biomarker that has been approved in immunotherapy for lung cancer. However, the gold standard of PD-L1 evaluation based on manual assessment by pathologists, which is influenced by the professional knowledge and experience. The aim of this study is to develop and validate a multi-modality artificial intelligence (AI) model to predict the PD-L1 expression status of lung cancer based on eligible computed tomography (CT) images and haematoxylin and eosin (HE)-stained slides.

#### METHODS AND MATERIALS

We retrospectively analyzed a PD-L1 expression dataset from 227 consecutive eligible lung cancer patients, including chest CT images and whole slide images (WSI) of haematoxylin and eosin(HE)-stained specimen during the corresponding period. The multi-modality AI model integrates CT radiomics and pathological deep learning based on multi-instance learning. The datasets were divided into training, validation, and testing group in a 4:1:1 ratio (n=151,38,38, respectively). Finally, a separate lung cancer immunotherapy cohort (n=47) was used to evaluate the prognostic value of the multi-modality fusion model.

#### RESULTS

The proportion of PD-L1 positive in patients was 55.1%(n=125). The area under the curve (AUC) of fusion model to predict PD-L1 expression status was 0.922, 0.745 and 0.685 in the training, validation and testing group, respectively. The fusion model shows significantly better performance than the single-modality model (AUC=0.781, 0.695, 0.518 for CT radiomics model and AUC=0.93, 0.697, 0.594 for pathological deep learning model in training, validation, testing group, respectively; all  $p < 0.05$ ). Additionally, for the survival cohort, the progression-free survival (PFS) was significantly longer in PD-L1 positive patients predicted by the multi-modality AI model than the negative patients (mean PFS 280 days vs 185 days,  $p < 0.05$ ).

#### CONCLUSION

The multi-modality AI model based on CT and haematoxylin and eosin (H&E)-stained slides images can predict the PD-L1 expression status of lung cancer effectively.

#### CLINICAL RELEVANCE/APPLICATION

Our AI model can assess the PD-L1 expression status of NSCLC automatically, which can avoid subjective bias in manual evaluation and provide more precise assistance for clinical treatment decisions.

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## Abstract Archives of the RSNA, 2023

M5B-SPCH-4

### Comparison of Radiologists' Reports and AI for Detecting Ectasia and Aneurysms of the Thoracic Aorta on LDCT for Lung Cancer Screening: A Multicenter, Multivendor Study of 430 Patients

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Lina Karout, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We assessed the frequency of inconsistent reporting of thoracic aorta ectasia and aneurysm on unenhanced, low-dose CT for lung cancer screening (LCS) and compared the performance of radiologists' reports with an AI algorithm (AIRC, AI Rad Companion, Siemens) for measuring aortic dimensions.

#### METHODS AND MATERIALS

Our IRB-approved and HIPAA-compliant retrospective study included 420 patients (mean age  $66 \pm 7$  years; females: males 157:263) who underwent LCS-LDCT on 10 single and dual-source MDCT scanners at one of the three community and quaternary hospitals. The patients were identified from a commercial radiology report data mining software (mPower, Nuance) with the keywords of "thoracic aorta" "aneurysm" and "ectasia." The negative LDCT-LCS represented consecutive cases over the same period and scanners. We recorded the presence of thoracic aneurysm or ectasia as well as when available the thoracic aorta dimensions from the radiology reports. Separately, thin-section DICOM images (1-1.25mm) were deidentified, exported, and processed with the AIRC to obtain maximum diameter of ascending and descending thoracic aorta. To establish the standard of reference (SOR), a thoracic radiologist independently measured short-axis dimensions of the ascending and descending thoracic aorta. Descriptive statistics and receiver operating characteristics area under the curve were estimated (ROC AUC) with 95% confidence interval.

#### RESULTS

Per SOR, 25/420 patients (5.9%) had ascending thoracic aorta aneurysm ( $\geq 45$  mm), 78/420 (18.6%) had aortic ectasia ( $\geq 40 < 45$  mm), and 18/420 (4.3%) had descending thoracic aorta aneurysm ( $\geq 35$  mm). The respective AUC, sensitivity and specificity of radiology reports were 0.86 (95% CI: 0.75-0.97), 72% and 100% for ascending thoracic aorta aneurysm; 0.66 (95% CI: 0.59-0.74), 35% and 97% for aortic ectasia; and 0.50 (95% CI: 0.36-0.63), 0% and 99% for descending thoracic aneurysm. The corresponding ROC AUCs, sensitivity and specificity for the AI algorithm were 0.99 (95% CI 0.99-1.00), 100% and 99% for ascending thoracic aorta aneurysm; 0.86 (95% CI: 0.81-.091), 82% and 90% for aortic ectasia; and 0.93 (95% CI: 0.87-0.99), 94% and 91% for descending thoracic aneurysm. There was no difference in the performance of AI across different patients' gender, age groups, as well as scanners and hospitals ( $p > 0.1$ ).

#### CONCLUSION

The generalizable AI can improve radiology reporting of ascending and descending thoracic aorta aneurysms on LDCT for lung cancer screening.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists' reports on thoracic aorta ectasia and aneurysm are inconsistent on LDCT; AI can help improve and automate aortic dimensions and help improve reporting accuracy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPCH-5

### Clinical and Imaging Factors Associated with Growth of Subsolid Pulmonary Nodule on CT

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Masha Bondarenko (*Presenter*) Nothing to Disclose

#### PURPOSE

Growth of part solid nodules are predictive of the nodule becoming cancerous along the adenocarcinoma spectrum. We aimed to investigate the clinical significant features that are predictive for growth of part-solid nodules (PSNs) identified by a commercial algorithm and verified by natural language processing (NLP) of radiology reports.

#### METHODS AND MATERIALS

A retrospective study was conducted on patients who underwent chest CT scans between 2015 and 2019 at a single institution. CT scan radiology reports were extracted from mPower to select for patients with subsolid nodules. A commercial algorithm was used on the final dataset to identify nodules with a solid component larger than 6 mm and a non-solid component. The radiology reports were processed using NLP to verify whether the PSNs were growing or not. Clinical and imaging features including age, gender, nodule location, shape, length, margin, lobulation, and pleural traction were evaluated for their predictive value for PSN growth using univariate and multivariate logistic regression analyses.

#### RESULTS

A total of 901 PSNs were included in this study, with 148 of those being growing PSNs. On univariate analysis, lobulated margin ( $p < 0.01$ ), age ( $p < 0.01$ ), and middle lobe ( $p = 0.6$ ) were significantly associated with growing PSNs at a significance level of 0.1. On multivariate analysis, middle lobe (Odds Ratio (OR) [95% Confidence Interval (CI)] = 0.27 [0.12-0.99],  $p = 0.02$ ), age (OR = 1.10 [0.98-1.02],  $p < 0.001$ ), and lobulated margin (OR = 1.53 [2.77-6.50],  $p < 0.001$ ) were significant predictors of growing PSNs.

#### CONCLUSION

In patients with PSNs identified by a commercial algorithm and verified by NLP of radiology reports, higher age, no presence in the right middle lobes, and lobulated margin were independent predictors for fast-growing PSNs. These findings could help identify patients who are at high risk of PSN growth and guide appropriate management decisions. The combination of a commercial algorithm and NLP of radiology reports may be a useful tool for identifying PSNs and monitoring their growth.

#### CLINICAL RELEVANCE/APPLICATION

By identifying adenocarcinoma spectrum nodules at risk for further growth, clinicians can more precisely identify, monitor, and potentially treat high-risk nodules.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPCH-6

### Satellite Modularity as Indicator of Benign Versus Malignant Etiology of Lung Nodules in a Histoplasmosis-endemic Region

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Ryan Staudte, MD, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate if presence of satellite nodularity can distinguish between benign and malignant lung nodules in histoplasmosis-endemic regions. Additionally, to evaluate any other factors that can add confidence in distinguishing between benign and malignant etiology.

#### METHODS AND MATERIALS

An IRB-approved retrospective review was performed of all CT and CTA chest exams from November 2015-2020 containing the phrase "satellite nodule" in the report. Short- and long-axis measurements of both the primary lung nodule and largest satellite nodule were recorded. Data was collected on patient demographics, history of cancer, margins, cavitation, calcification, change in size over time, presence of adjacent bronchovascular bundle nodularity, and tissue diagnosis. Predictive capabilities for demographic and clinical variables were analyzed with logistic regression models to produce odds ratio and area under ROC curve values.

#### RESULTS

346 chest CTs were identified, of which 111 were excluded based on primary nodule size outside the range of 0.6 to 3.0 cm ( $n = 46$ ), undecided final pathology ( $n=12$ ), or insufficient follow-up for diagnosis ( $n=53$ ). Benign primary nodule pathology was found in 201 of 235 patients (86%). Bronchovascular bundle nodularity demonstrated the highest odds of benignity (OR 18.4,  $p<.01$ ) followed by presence of calcification (OR 10.6,  $plt;.01$ ) as single variables. Spiculated margins (OR 0.06,  $plt;.01$ ) and history of metastatic disease or newly diagnosed cancer (OR 0.15,  $plt;.01$ ) were most associated with malignant diagnosis. Bronchovascular nodularity alone demonstrated poor ability to predict the odds of benignity (AUC 0.66,  $plt;.01$ ) but was increased when combined with margin characteristics (AUC 0.82,  $plt;.01$ ) or patient age (AUC 0.80,  $plt;.01$ ). The multivariable combination of margin characteristics and age demonstrated the largest ability to predict the odds of benignity (AUC 0.84,  $plt;.01$ ).

#### CONCLUSION

Approximately 86% of lung nodules with satellite nodules had benign pathology. Spiculated margins followed by clinical history of either new cancer or known metastatic disease were most associated with malignant diagnosis. Bronchovascular bundle nodularity was most associated with benign etiology, more strongly than presence of calcification. Bronchovascular nodularity combined with smooth primary nodule margins or younger patient age, was an excellent predictor of benign diagnosis, possibly permitting less rigorous follow up imaging or further work up.

#### CLINICAL RELEVANCE/APPLICATION

The ability to predict benign etiology of a lung nodule based on the presence of satellite nodularity and bronchovascular bundle nodularity in histoplasmosis endemic regions can direct future follow up recommendations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPER-1

### The Diagnostic Ability of Postmortem CT for the Cause of Natural Death from Out-of-hospital Cardiac Arrest

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yu Nakaki (*Presenter*) Nothing to Disclose

#### PURPOSE

Postmortem CT (PMCT) can help to identify the cause of death. Its diagnostic ability has been reported, however, its findings depend on the corpse and the methodology applied. PMCT cannot diagnose cardiac disease, e.g. myocardial infarction, lethal arrhythmia, and pulmonary thromboembolism, consequently its ability to determine the cause of natural death, especially from out-of-hospital cardiac arrest (OHCA) may be lower than expected. To reveal the current issue of PMCT, we investigated the ability of PMCT to identify the cause of natural death from OHCA.

#### METHODS AND MATERIALS

Between January 2018 and December 2022, we enrolled 306 patients with OHCA who were taken to our hospital and performed non-contrast PMCT. Excluded were 94 patients with unnatural death and 6 patients younger than 18 years. Included were 206 patients (121 males, 85 females; median age 79 years, range 18-104 years) who died a natural death from OHCA. The median interval from death to PMCT was 2.5 hours (range 1 - 28 hours). All were scanned on a 16-row multi-detector CT scanner. The scan parameters were 120 kVp and automated exposure control; the preset noise was 11 Hounsfield units. All images were consensually interpreted by two board-certified radiologists and categorized into diagnostic (PMCT alone was sufficient to determine the cause of death), suggestive (the cause of death was suggested but additional information was needed), and non-diagnostic (the cause of death could not be determined on PMCT images).

#### RESULTS

Of 206 PMCT images, 46 (22.3%) were diagnostic, 16 (7.8%) were suggestive, and 144 (69.9%) were non-diagnostic. Aortic dissection (n=15), aortic aneurysm rupture (n=12), cardiac rupture (n=8), subarachnoid hemorrhage (n=6), cerebral hemorrhage (n=4) and visceral aneurysm rupture (n=1) were diagnosable. In the suggestive group were malignant tumors (n=7), gastrointestinal bleeding/occlusion/perforation (n=7), and 2 other causes.

#### CONCLUSION

As PMCT images were diagnostic or suggestive in only 62 of 206 cases (30.1%) of natural death from OHCA, the diagnostic ability of PMCT must be improved.

#### CLINICAL RELEVANCE/APPLICATION

The low diagnostic ability of PMCT for identifying the cause of natural death from OHCA may require the development of contrast-enhanced- and dual-energy PMCT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPER-2

### **T1 and T2 Signal Appearance of Intracranial Hemorrhage in Post-mortem Magnetic Resonance Imaging**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Wolf-Dieter Zech, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In forensic medicine, age estimation of intracranial hemorrhage can be crucial. Post-mortem MRI (PMMR) can be used as an alternative to autopsy in certain case constellations. In clinical MRI, age estimation of intracranial hemorrhage is based on differing signal behaviors of T1 and T2 over time as hemoglobin passes through different forms before red cell lysis and breakdown into ferritin and hemosiderin. In PMMR, post-mortem phenomena such as putrefaction, autolysis, temperature decrease, and biochemical degradation processes can influence MR signal appearance, particularly at longer post-mortem intervals. So far, it is unknown, if intracranial hemorrhage of different ages appears with the same T1 and T2 signals known in the living and if post-mortem interval alters signal appearance. Therefore, the purpose of this study was to investigate the PMMR T1 and T2 signal behavior of intracranial hemorrhage of different age stages at different post-mortem intervals and to compare it to the known signal behavior in the living.

#### **METHODS AND MATERIALS**

N=200 forensic cases (110 male, 90 female, mean age 54 years) with intracranial hemorrhage due to traumatic injury or natural causes were investigated. Post-mortem interval (time from death to imaging) ranged from 12 h to 21 days. 3 Tesla T1 and T2 weighted unenhanced PMMR of the head was conducted before the autopsy. Age estimation of intracranial hemorrhage (hyperacute: < 12 h, acute: 12-48 h, early subacute: 2-7 d, late subacute: 8 d - 1 month, and chronic: > 1 month) was performed based on autopsy and histology findings as well as medical records. Two observers blinded for autopsy results and medical records evaluated the T1 and T2 signal appearance of intracranial hemorrhage in PMMR. Hemorrhage signal appearances were assigned to the corresponding age estimations. PMMR results were compared to known clinical MRI signal behavior in living patients.

#### **RESULTS**

The following PMMR T1 and T2 signal appearances were observed for different age stages of intracranial hemorrhage: hyperacute: T1 isointense, T2 hyperintense; acute: T1 isointense to hypointense, T2 hypointense; early subacute: T1 hyperintense, T2 hypointense; late subacute: T1 hyperintense, T2 hyperintense; chronic: T1 hypointense, T2 hypointense. The observed signal appearance did not differ from the known signal appearance of living persons. Longer post-mortem intervals of up to 21 days did not significantly alter signal appearance.

#### **CONCLUSION**

In a post-mortem interval of up to 3 weeks, PMMR T1 and T2 signal behavior of intracranial hemorrhage of different age stages are the same as in the living.

#### **CLINICAL RELEVANCE/APPLICATION**

T1 and T2 post-mortem MRI of the head can be used as an alternative to autopsy for age estimation of intracranial hemorrhage.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-SPGI-1

### Gd-EOB-DTPA MRI-based Severity Classification and Prognosis in Fontan-Associated Liver Disease

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Atsushi Yamamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Fontan procedure for congenital single ventricle improves prognosis in childhood but is not a curative treatment. The prognosis in the long-term period after Fontan procedure is extremely poor compared to other congenital heart diseases. This is due to liver injury caused by elevated central venous pressure, which is a feature of the Fontan circulation, and is now attracting attention as Fontan-associated liver disease (FALD). FALD frequently progresses to cirrhosis and develops hepatocellular carcinoma (HCC) despite the young age of the patient. Gd-EOB-DTPA MRI is an effective tool for detecting HCC, but the features of FALD have not been studied. We propose an Gd-EOB-DTPA MRI-based severity classification of FALD and its association with prognosis, including the development of HCC.

#### METHODS AND MATERIALS

Data of Gd-EOB-DTPA MRI for 44 patients (mean age, 25 years; female, 22) after Fontan procedure between January 2010 to April 2023 was retrospectively analyzed. The hepatocyte phase image at 15 minutes after Gd-EOB-DTPA injection was scored semi-qualitatively using the following four points. 1) The extent of low-signal reticular shadows extending from the subhepatic capsule with "reverse lobulation": 0, 1 or 2 points. 2) Liver marginal irregularity: 0 or 1 point. 3) Decreased liver-spleen signal ratio: 0 or 1 point. 4) Atrophy of entire liver: 0 or 1 point. Based on the summed scores, patients were classified as Grade-1 (0 or 1 point), 2 (2 points), 3 (3 points), or 4 (4 points or higher). The endpoint was a composite outcome consisting of HCC, intractable ascites, and heart failure (HF) hospitalization. The event-free survival was analyzed by Kaplan-Meier and log-rank test.

#### RESULTS

There were 11 Grade-1 patients, 18 Grade-2 patients, 8 Grade-3 patients, 7 Grade-4 patients. During a mean follow-up period of 60 months, the composite outcome occurred in 11 patients (6 cases of HCC, 3 cases of intractable ascites, and 2 cases of HF hospitalization). Nine of the 11 patients (82%) were in Grade-3 and 4 groups. Kaplan-Meier analysis revealed that patients with Grade-3 and 4 had significantly poorer prognosis than those with Grade-1 and 2 ( $p < 0.0001$ ).

#### CONCLUSION

Gd-EOB-DTPA MRI could classify the severity and predict prognosis of patients with FALD.

#### CLINICAL RELEVANCE/APPLICATION

This method is not as invasive as liver biopsy and has no sampling errors. It is suitable for surveillance of FALD in young subjects.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGI-2

### Staging Liver Fibrosis in Volunteers and Patients with Nonalcoholic Fatty Liver Disease with Intrinsic Shear Strain Measurement by 4D Phase-contrast MRI

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Amirhosein Baradaran Najar, MSc, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the diagnostic performance of intrinsic shear strain induced by pressure pulse and cardiac motion, measured by phase-contrast MRI, for the detection and staging of liver fibrosis in volunteers and patients with nonalcoholic fatty liver disease using liver biopsy as the reference standard.

#### METHODS AND MATERIALS

This prospective cross-sectional study was institutional review board approved. The study included volunteers and patients with nonalcoholic fatty liver disease undergoing 3T MRI with a quantitative 4D phase contrast sequence with retrospective cardiac gating. The 3D displacement field during eight phases of the cardiac cycle were measured. Automated motion processing and masking techniques were used to extract the hepatic octahedral shear strain (OSS). The reference standard was fibrosis staging by liver biopsy. One-way ANOVA and receiver operating characteristic analyses were performed for normal categorized and dichotomized groups based on hepatic fibrosis stages, including F0 versus = F1, = F1 versus = F2, = F2 versus = F3, and = F3 versus F4. The area under the receiver operating characteristic curve (AUC) was reported for each dichotomization of fibrosis stages.

#### RESULTS

The study included 11 volunteers and 24 patients. Mean values of OSS decreased with higher fibrosis stage, with a mean of  $0.15 \pm 0.08$  (standard deviation) for F0,  $0.12 \pm 0.01$  for F1,  $0.07 \pm 0.01$  for F2,  $0.07 \pm 0.02$  for F3, and  $0.05 \pm 0.03$  for F4. The cardiac-induced strain measurements demonstrated high accuracy in discriminating NASH patients, with  $p < 0.01$  and F score 8.35 from one-way ANOVA and the area under ROC curves (AUC) of 0.87 for F0 vs. = F1, 0.96 for = F1 vs. = F2, 0.90 for = F2 vs. = F3, and 0.90 for = F3 vs. F4.

#### CONCLUSION

The study demonstrated a significant decrease in the liver's OSS with increasing fibrosis stage.

#### CLINICAL RELEVANCE/APPLICATION

The study found that intrinsic shear strain measured by, standard phase-contrast MRI, without the use of any external actuation, has the potential to be a noninvasive diagnostic tool for detection and staging liver fibrosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGI-3

### Depiction of Lymphatic Pathway in Fontan Circulation Using Gd-EOB-DTPA Magnetic Resonance Lymphangiography

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Michinobu Nagao, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Although postoperative mortality rates in congenital single ventricle patients after the Fontan procedure have dramatically improved, the long-term mortality rates have remained high compared to those in patients with other types of congenital heart disease. In the Fontan circulation, congestive liver and lymphatic congestion caused by elevated central venous pressure become permanent, resulting in cirrhosis, refractory ascites, and protein-losing enteropathy. These complications are considered poor prognostic factors as Fontan-associated liver disease (FALD). Gadolinium ethoxybenzyl diethylenetriamine pentaacetic acid (Gd-EOB-DTPA) MRI is expected to detect hepatocellular carcinoma (HCC) that develops in FALD. We attempt to depict abnormal lymphatic pathway in FALD using Gd-EOB-DTPA MRI and propose a classification of their severity.

#### METHODS AND MATERIALS

Fifty-two patients (mean age, 25 years) after Fontan procedure who underwent Gd-EOB-DTPA MRI for evaluation of the FALD were enrolled. MR lymphangiography was scanned using three-dimensional heavily T2-weighted imaging with a 3-tesla scanner 10 minutes after Gd-EOB-DTPA administration. This sequence takes advantage of the T2 shortening effect of Gd-EOB-DTPA to suppress the bile duct and vessel's signals, thereby enhancing the lymphatic pathway. Based on the extent of lymphatic tract involvement in the abdomen, patients were classified into the following three categories; Grade 0: no lymphatic pathway, Grade 1: the presence of lymphatic pathway mainly around the bile duct and liver surface, Grade 2: lymphatic pathway extended from the spine to the inferior vena cava periphery. Refractory ascites, protein-losing enteropathy, development of HCC, and hospitalization for heart failure were used as composite outcomes and contrasted with lymphangiographic findings.

#### RESULTS

In MR lymphangiography, 20 patients were Grade 0, 17 were Grade 1, and 15 were Grade 2. 16 patients had composite outcomes, including 10 with HCC, 4 with refractory ascites, and 2 with heart failure hospitalization. Grade 0 patients had no events (0/20), whereas Grade 1 and Grade 2 patients had the adverse events in 53% (9/17) and 47% (7/15) of patients, respectively.

#### CONCLUSION

A novel technique, MR lymphangiography with Gd-EOB-DTPA, demonstrates the localization and extent of the abnormal lymphatic pathways in Fontan circulation. The lymphangiographic grade is associated with the adverse events in FALD.

#### CLINICAL RELEVANCE/APPLICATION

This MR lymphangiography can be added as one of Gd-EOB-DTPA contrast protocol and does not extend the overall examination time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGI-4

### A Rules-Based Algorithm for Extracting Structured Clinical Data from Liver CT Free-Text Radiology Reports

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Saif Zaman, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

A large proportion of patients throughout the world have undiagnosed liver disease. Given the abundance of data found in radiology reports, they represent an untapped source to study patients with liver disease. Oftentimes it may be arduous to manually sift through patient-level data. As such, validated methods to study these patients and associated radiology reports are needed. Here we present a rules-based algorithm that determines the presence or absence of liver pathologies from unstructured radiology reports for CT liver scans.

#### METHODS AND MATERIALS

Three common diagnosis of liver pathologies were selected for this study, namely focal liver lesions, steatosis and cirrhosis. A data dictionary was created to identify phrases that describe these diagnoses in a radiology report. Data mining and dictionary generation was done by a gastroenterologist treating these liver conditions for more than 20 years at the James A Haley VA Hospital. A random subset of liver CT reports ( $n = 100$ ) of patients with a liver-related complaint were extracted and split into training and testing sets (65 and 35 patients, respectively). Ground truth values for the presence or absence of three liver pathologies were manually annotated, specifically for focal liver lesions, cirrhosis, and steatosis. A rules-based algorithm was leveraged using the two phase sentence analysis for radiology label extraction (SARLE) method: (1) remove phrases and handle negations and (2) link remaining terms to liver pathologies. The algorithm's performance was assessed using accuracy, sensitivity, and specificity.

#### RESULTS

On the test set, the algorithm had an average accuracy across all 3 pathologies of 99.25% (95% CI: 98.76% to 99.65%), sensitivity of 84.21% (68.75% to 93.98%), and specificity of 99.68% (95% CI: 99.25% to 99.89%). Across the 100 patients, the reports of 90 patients were perfectly extracted for all 3 attributes.

#### CONCLUSION

We demonstrate high performance of a rules-based algorithm to extract tabular data information from free text reports of liver CT scans. Our tool performed well in identifying patients with focal liver lesions, steatosis, and cirrhosis, as benchmarked by an expert gastroenterologist.

#### CLINICAL RELEVANCE/APPLICATION

This tool may be useful in developing new machine learning approaches to predict outcomes in liver and other abdominal conditions. Additionally this method may serve as a first step towards identifying the natural language used in radiology reports for future machine learning implementations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGI-5

### Staging of Liver Fibrosis Assessed by Quantification of Hepatic Extracellular Volume Obtained by Dual-energy CT Would be Easier-to-Access than Previous

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Kumi Ozaki, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the validity of 3-min equilibrium-phase CT images compared to 5-min equilibrium-phase images in the quantification of hepatic extracellular volume fraction (ECV) obtained by dual-energy CT.

#### METHODS AND MATERIALS

A total of 80 patients (45 men and 35 women, mean age, 69.3 + 10.4 years) who underwent both 3- and 5-min equilibrium-phase CT images to assess the focal liver lesions, that were suspected of hepatic hemangioma or intrahepatic cholangiocarcinoma between January 2020 and July 2022. The iodine densities of the hepatic parenchyma and aorta were measured and ECV was calculated. Comparisons of value of ECV of each phase, and the relation with fibrosis-4 index (Fib4) and albumin-bilirubin (ALBI) grade were then statistically analyzed.

#### RESULTS

There was no significant difference in value of ECV of 3- and 5-min equilibrium-phase CT images ( $p = 0.056$ ). ECV of 3- and 5-min showed a strong or moderate correlation with ALBI grade (Spearman's  $\rho$ ; 0.763, 0.724, respectively). The correlation with Fib4 was similar to each ECV (Spearman's  $\rho$ ; 0.537, 0.571, respectively).

#### CONCLUSION

ECV value and the correlation with ALBI grade and Fib4 were not significantly different, and ECV of 3-min equilibrium-phase CT images is clinically acceptable.

#### CLINICAL RELEVANCE/APPLICATION

Validity of ECV of 3-min equilibrium-phase CT image can facilitate the prevalence of staging of liver fibrosis assessed by ECV because it can be obtained within routine dynamic contrast examination.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGI-6

### Establishing the Evaluation Model for Liver Cirrhosis Based on CT Radiomics Characteristics of Different Liver Segments

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Liqin Zhao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the performance of evaluating liver cirrhosis by radiomics characteristics of different liver segments in contrast-enhanced CT portal vein phase images.

#### METHODS AND MATERIALS

154 cases with clinically confirmed liver cirrhosis were included in the study group and 150 cases with normal liver findings in the control group. All patients underwent enhanced liver CT on a GE discovery CT 750 HD. The portal phase CT images were selected for analysis, and two radiologists used a commercial radiomics software (Shukun Radiomics V94) to outline different liver segments on the slice of portal vein left branch into four regions of interest (ROI): S1, S2/3, S4 and S7/8; Intraclass correlation coefficient was calculated to test the inter-group consistency. Patients were randomly divided into training set and testing set at a ratio of 7:3, the radiomics characteristics (first-order features, shape features and texture features) of each ROI were extracted. After dimensionality reduction, the radiomics features with the most predictive performance were selected to establish the evaluation model of liver cirrhosis. The area under curve (AUC) was used to evaluate the performance of the model.

#### RESULTS

The two radiologists had good consistency ( $ICC > 0.75$ ). Five, 6, 6 and 6 radiomics features were used for modeling of liver segment S1, S2/3, and S4 and S7/8, respectively. The AUC, accuracy, sensitivity and specificity were 0.948, 0.931, 0.955 and 0.908 in the training set; and 0.928, 0.896, 0.912 and 0.879 in the testing set, respectively for S1; 0.958, 0.924, 0.955 and 0.892 in the training set; and 0.957, 0.881, 0.912 and 0.848 in the testing set, respectively for S2. 0.974, 0.924, 0.940 and 0.908 in the training set; and 0.964, 0.910, 0.941 and 0.879 in the testing set, respectively for S4, and 0.948, 0.908, 0.909 and 0.908 in the training set; and 0.955, 0.910, 0.941 and 0.879 in the testing set, respectively for S7/8

#### CONCLUSION

Good evaluation models of liver cirrhosis may be established using different liver segments, and the model established in the left medial segment gives the highest AUC.

#### CLINICAL RELEVANCE/APPLICATION

Good evaluation models of liver cirrhosis may be established using different liver segments, and the model established in the left medial segment gives the highest AUC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGI-7

### **Prediction of Lymph Node Metastasis of Progressive Gastric Adenocarcinoma Nodes with a Short-Axis Diameter of $\geq 6$ mm**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yang You (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the value of the features of lymph nodes (LN) with a short-axis diameter = 6 mm in prediction of lymph node metastasis (LNM) in advanced gastric adenocarcinoma (GAC) based on dual-energy CT (DECT) radiomics.

#### **METHODS AND MATERIALS**

Data of patients with GAC who underwent radical gastrectomy and LN dissection were retrospectively analyzed. To ensure the correspondence between imaging and pathology, metastatic LNs were only selected from pN3 patients, nonmetastatic LNs were selected from pN0 patients, and the short-axis diameters of the enrolled LNs were all  $\geq 6$  mm. The traditional features of LNs were recorded, including short-axis diameter, long-axis diameter, long-to-short axis ratio, position, shape, density, edge and the degree of enhancement, and univariate and multivariate logistic regression analyses were used to establish a clinical model. Radiomics features at the maximum level of LNs were extracted in venous phase equivalent 120 kV linear fusion images and iodine maps. Intraclass correlation coefficients and the Boruta algorithm were used to screen significant features, and random forest was used to build a radiomics model. The traditional features with statistical significance in univariate analysis and radiomics scores (Rad-score) were included in multivariate logistic regression analysis to construct a combined model. ROC curve and DeLong test were used to evaluate and compare the diagnostic performance of the models. DCA was used to evaluate the clinical benefits of the models.

#### **RESULTS**

This study included 114 metastatic LNs from 45 pN3 patients and 65 nonmetastatic LNs from 28 pN0 patients. The samples were divided into a training set ( $n=125$ ) and a validation set ( $n=54$ ) at a ratio of 7:3. Long-axis diameter and LN shape were independent predictors of LNM and were used to establish the clinical model. 27 screened radiomics features were used to build the radiomics model. LN shape and Rad-score were independent predictors of LNM and were used to construct the combined model. Both the radiomics model (AUC of 0.986 and 0.984) and the combined model (AUC of 0.970 and 0.977) outperformed the clinical model (AUC of 0.772 and 0.820) in predicting LNM in both the training and validation sets. DCA showed superior clinical benefits from the radiomics and combined models.

#### **CONCLUSION**

The models based on LNs DECT radiomics features, or combined traditional features have high diagnostic performance in determining the nature of each LN with a short-axis diameter of  $\geq 6$  mm in advanced GAC.

#### **CLINICAL RELEVANCE/APPLICATION**

The models have important clinical value in the preoperative judgment of N staging, individualized treatment plans and prognosis of patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGI-8

### The Spectral Parameters Measured by Fast kVp Switching Dual-Energy CT: The Association with Ki-67 Expression in Hepatocellular Carcinoma

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Caiyun Li, BMedSc, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the correlation between spectral parameters obtained from contrast-enhanced spectral CT scanning and Ki-67 expression in hepatocellular carcinoma (HCC).

#### METHODS AND MATERIALS

91 HCC patients with hepatitis complicated underwent both pathological examination and two-phase contrast-enhanced CT scanning with spectral imaging mode were included in this study. Then water- and fat-based material decomposition images as well as virtual monochromatic images acquired at energies ranging from 100 to 140 keV were reconstructed. Region of interest (ROI) was placed on the lesion, and water and fat density ( $D_{\text{water}}$ ,  $D_{\text{fat}}$ ), CT values at monochromatic energy images (HU<sub>100-140keV</sub>), as well as effective atomic number were measured. The effective atomic number for lesions was normalized by those for aorta to derive normalized atomic number ( $N_{\text{eff-Z}}$ ). Ki-67 expression level was determined by Ki-67 positivity rate according to immunohistochemistry analysis. Pearson coefficient was used to analyze the correlation between spectral parameters and Ki-67 positivity.

#### RESULTS

The  $N_{\text{eff-Z}}$ , HU<sub>100-140keV</sub>, water and fat density were positively and fairly correlated with the Ki-67 expression, and correlation coefficient  $r$  ( $P$  value), were 0.324 ( $P = 0.002$ ), 0.252-0.358 ( $P = 0.016-0.001$ ), 0.415 ( $P < 0.001$ ) and 0.293 ( $P = 0.005$ ), respectively. Particularly,  $D_{\text{water}}$  showed strongest correlation with Ki-67 expression. Additionally, the correlation between CT value and Ki-67 was enhanced gradually with the increase of monochromatic energy (100keV to 140keV).

#### CONCLUSION

Conclusion: The  $N_{\text{eff-Z}}$ , HU<sub>100-140keV</sub>, water and fat density obtained from spectral scanning on dual-energy CT exhibited positive and fair correlation with Ki-67 expression.

#### CLINICAL RELEVANCE/APPLICATION

Ki-67 was a significant marker for HCC prognosis and clinical decision, however current method to evaluate Ki-67 always needs surgery, which is detrimental for assessing patients who lost surgery chance. Spectral scanning on Dual energy CT provides a new noninvasive method and various parameters to evaluate Ki-67 (indicative of proliferative activity) expression in HCC, which is valuable for clinical diagnosis and treatment.

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## Abstract Archives of the RSNA, 2023

M5B-SPGU-1

### The Additional Value of Pseudocapsule for Clear Cell Likelihood Score v2.0 in Predicting Small Renal Masses: A Multicenter Retrospective Study

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yuwei Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to explore the additional value of pseudocapsule for clear cell likelihood score v2.0 (cCLS v2.0) in diagnosing small renal masses (SRM) and develop a modified clear cell likelihood score (m-cCLS) for predicting malignancy.

#### METHODS AND MATERIALS

In this study, clinical data and MR images of patients with pathologically confirmed solid SRM were retrospectively collected from three academic medical centers between January 1, 2019 and December 31, 2021. All patients were divided into a training group (n = 235), an internal validation group (n = 60), and an external validation group (n = 57). Two junior radiologists independently evaluated whether SRM had pseudocapsule, other MRI features and the cCLS scores according to cCLS v2.0, respectively. Disagreements were resolved by two senior radiologists who reached an agreement. The risk prediction value of pseudocapsules and the cCLS scores in ccRCC and malignant tumors were analyzed using the logistic regression model. M-cCLS was established and calibration curves were drawn to evaluate the consistency of m-cCLS predictions with pathological findings. The diagnostic performance of m-cCLS and cCLS v2.0 was evaluated by drawing ROC and the percentage of ccRCC and malignant tumors in each score was compared using cCLS v2.0 and m-cCLS. The net reclassification index (NRI) and integrated discrimination improvement (IDI) were calculated.

#### RESULTS

352 patients (248 males, 104 females; mean age, 54±12 years) with 358 renal masses were identified. The evaluation results of SRM revealed that pseudocapsule had the additional value for cCLS v2.0 evaluation of ccRCC and malignant tumors ( $P < 0.001$ ). M-cCLS showed a good interobserver agreement in predicting ccRCC and malignant tumors ( $P > 0.05$ ). The diagnostic performance of m-cCLS for ccRCC was comparable to cCLS v2.0 ( $P > 0.05$ ). Compared with cCLS v2.0, the AUC of m-cCLS for diagnosing malignant tumors increased from 0.772 (95%CI: 0.714-0.824), 0.801 (95%CI: 0.680-0.892) and 0.645 (95%CI: 0.507-0.767) to 0.848 (95%CI: 0.796-0.891), 0.887 (95%CI: 0.781-0.953) and 0.716 (95%CI: 0.581-0.827) among three groups, respectively. M-cCLS could achieve the prediction of benign and malignant tumors (the percentage of malignant tumors in m-cCLS 1-5 scores was 19.5%, 31.5%, 72.5%, 91.1%, and 100.0%, respectively). Among three groups, the NRI and IDI of m-cCLS were higher than those of cCLS v2.0.

#### CONCLUSION

Pseudocapsule had the additional value for cCLS v2.0 in the diagnosis of SRM. M-cCLS has great diagnostic performance and improvement for ccRCC and malignant tumors and could predict benign and malignant tumors of SRM.

#### CLINICAL RELEVANCE/APPLICATION

M-cCLS may prove to be a valuable tool for the future non-invasive evaluation of renal tumors.

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## Abstract Archives of the RSNA, 2023

M5B-SPGU-2

### CT-based Potential Predictor for CKD-free Survival after Partial Nephrectomy in Patients with Small RCC

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Seong Min Ahn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate prognostic utility of 3D remaining functional parenchyma (RFP) extracting post-operative kidney CT in predicting chronic kidney disease (CKD)-free survival after partial nephrectomy(PN) in patients with small RCC.

#### METHODS AND MATERIALS

A retrospective analysis was carried out of 331 patients who underwent PN for clear cell RCC (less than 5cm) between September 2006 and September 2020. In order to construct a predictive model for CKD-free survival probability after PN, multivariable Cox regression analysis was carried out adding 3D volume of RFP extracting from the post-operative kidney CT to clinical parameters proven to have an impact on postoperative renal function such as eGFR, age, or perioperative variables.

#### RESULTS

The median age was 53 years, median tumor size was 3.4 cm. A total of 18 patients (5.4%) developed new-onset CKD at a median follow up of 35 months. The CKD-free survival rates at 1, 3, 5 and 7 year were 97.5%, 97.2%, 96.1% and 94.5%, respectively. On univariable Cox regression analysis, age (hazard ratio 1.097,  $P = 0.0001$ ), Charlson Comorbidity Index (hazard ratio 1.728,  $P = 0.0001$ ), hypertension (hazard ratio 4.792,  $P = 0.0017$ ) and Furhmann\_grade (hazard ratio 2.828,  $P = 0.0086$ ) were independent predictors for new-onset CKD. The C-index for CKD-free survival prediction with clinical parameters along was 0.8358. The addition of 3D RFP improved the C-index to 0.8525 ( $p = 0.0405$ ).

#### CONCLUSION

Addition of 3D RFP values to standard clinical factors improves CKD-free survival prediction after PN in patients with small RCC. Using this model, RFP could be a reliable method for preoperative prediction of prognosis in PN.

#### CLINICAL RELEVANCE/APPLICATION

The revised prediction model adding 3D imaging parameters might have an important role in partial nephrectomy decision-making and follow-up plan after surgery in patient with RCC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPGU-3

### Automatic Segmentation of Renal Tumors: A Novel Visualization Approach

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Sophie Bachanek, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish an automatic segmentation algorithm and visualisation method for solid renal tumors that utilizes CT-studies acquired in clinical practice and multireader input.

#### METHODS AND MATERIALS

Renal tumor patients diagnosed 2018-2021 were retrospectively assessed. Inclusion criteria were CT-imaging of renal tumors in corticomedullary or nephrogenic contrast media (CM/NG) phase. Patients with cystic or infiltrative renal tumors and age <18 years were excluded. Manual segmentation of the tumors was performed on all axial CT slices and used for training of a convolutional neural network (UNET). In an independent validation dataset, the accuracy of the UNETs predictions of renal tumor contours was compared to manual segmentations (quantified by DICE score).

#### RESULTS

n=394/n=350 patients in CM/NG phases were included (median age 66 years; 35% female; median tumor diameter 5.4cm). CT-studies from >20 radiological imaging centers were included with different imaging protocols and slice thickness. The UNET was trained on n=316 CM/ n=294 NG contrast phase patients (n=7019 / n=6859 CT images). In the independent validation dataset (n=78 / n=56 patients with 1713 / 1298 CT images), the UNET achieved a DICE score of 0.88 and 0.90 for the corticomedullary and nephrogenic CM phase, respectively. The UNET predictions were visualized using a tile-based approach with color-coding and contour-lines that could be overlaid on CT-images to depict varying levels of prediction confidence.

#### CONCLUSION

A UNET yields a robust automatic delineation of renal tumors on CT-images acquired in clinical routine, irrespective of the contrast media phase. Color-coding and contour-lines can be overlaid on original CT-images to provide visual feedback of UNET segmentations and confidence levels.

#### CLINICAL RELEVANCE/APPLICATION

Automatic renal tumor segmentation using UNETs robustly performs on heterogeneous clinical CT data. Color-coding provides an explainable approach to model predictions and might improve acceptance in clinical practice.

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## Abstract Archives of the RSNA, 2023

M5B-SPHN-2

### Evaluation and Survival Prediction for A Novel Fully Automatic System for Lymph Node Segmentation and Counting in Nasopharyngeal Carcinoma Using Multimodal MRI

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Hui Xie (*Presenter*) Nothing to Disclose

#### PURPOSE

The accurate segmentation and counting of lymph nodes (LNs) is essential for the structured reporting and prognostic diagnosis of nasopharyngeal carcinoma. As such, developing a fully automatic system for accurate LNs segmentation and counting in nasopharyngeal carcinoma patients is of great clinical significance for the accurate prognostic analysis of this disease

#### METHODS AND MATERIALS

First, we proposed a multimodal LNs segmentation model based on T1-weighted, contrast-enhanced T1-weighted, and T2-weighted MRI images, which named NPCnet. We then developed a fully automatic algorithm for LNs counting and combined it with the segmentation model to create a comprehensive system called the Fully Automatic Lymph Node Counting System (AMLNC). The accuracy and practical value of our system were evaluated by comparing its performance metrics (Interclass Correlation Coefficient (ICC) and Bland-Altman plot) with those of detailed MRI assessment (gold standard) and automatic counting using manual delineation (MDAC). Finally, we analyzed the relationship between the LNs count and the prognostic outcomes of the patients, such as Overall Survival (OS), Progression-free Survival (PFS), and Distant Metastasis-free Survival (DMFS)

#### RESULTS

we retrospectively analyzed the data of 995 patients and divided them into training and validation datasets at a ratio of 7:3 for constructing the segmentation model. The mean DICE similarity coefficient in the validation set of 298 cases was 0.771. We selected 20 cases randomly for manual repeat delineation, and there was no statistically significant difference in the mean DICE between automatic segmentation and manual delineation (0.785 vs 0.806,  $p = 0.068$ ). The median (IQR) LNs counts for the gold standard, AMLNC, and MDAC were 3 (2-4.074), 4 (2-4.581), and 4 (2-5.513), respectively. The ICC showed that the AMLNC had good repeatability (0.778 (Gold vs AMLNC), 0.638 (Gold vs MDAC), and 0.739 (AMLNC vs MDAC)). Furthermore, we selected 40 cases randomly for manual reading repeatedly, and the ICC still showed that the AMLNC system had good repeatability (0.805 (Gold vs AMLNC), 0.663 (Gold vs manual MDAC), and 0.672 (Gold vs Gold repeatedly)). The Bland-Altman plot displayed good agreement between the AMLNC and the gold standard. We divided all patients into low (1-4 positive LNs), moderate (5-9), and high (>9) risk groups, and the K-M plots showed a great discriminating ability for OS, PFS, and DMFS using AMLNC

#### CONCLUSION

The AMLNC System in this study demonstrates good repeatability and reliability in its results and clinical survival prediction ability

#### CLINICAL RELEVANCE/APPLICATION

The AMLNC System can be directly used for structured reporting and survival prognosis analysis of nasopharyngeal carcinoma

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPHN-3

### **MRI Radiomics Approach with Deep Transfer Learning for Distinguishing Sinonasal Malignancies: A Preliminary Study Based on Different Machine Learning Algorithms**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Naier Lin, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the diagnostic performance of MRI hand-crafted (HC) radiomics features combined with deep transfer learning (DTL) features in distinguishing between sinonasal squamous cell carcinoma (SCC), adenoid cystic carcinoma (ACC) and non-Hodgkin's Lymphoma (NHL) .

#### **METHODS AND MATERIALS**

This retrospective analysis consisted of 50 patients with sinonasal SCC, 42 patients with NHL and 40 patients with ACC. Patients were allocated to training and testing cohorts randomly at a ratio of 8:2. HC radiomics features and DTL features were extracted from T2-weighted image (T2WI), apparent diffusion coefficient (ADC) and contrast-enhanced T1-weighted image (CE-T1WI). A ResNet50 convolutional neural network (CNN) pretrained model was used for DTL features extracting. The least absolute shrinkage and selection operator (LASSO) regression was applied for feature selection and radiomic signature (radscore) construction. The classification performance for detection of sinonasal SCC, ACC and NHL was compared between seven machine learning (ML) algorithms.

#### **RESULTS**

The radscore included 24 HC radiomics features and 8 DTL features. Algorithm of SVM showed the best performance with the highest accuracy (92.6%) in the testing cohort. ROC analysis indicated that the macro-average AUC and micro-average AUC values of SVM were 0.98 and 0.99. AUCs for diagnosis of ACC, NHL, SCC were 0.99, 0.97 and 1.00, respectively. Besides, KNN and XGBoost algorithms also provided better results with both the macro-average and micro-average AUC values > 0.90.

#### **CONCLUSION**

Three-MRI sequence-based HC radiomics features and DTL features combined with SVM model improved differentiation between sinonasal SCC, NHL and ACC.

#### **CLINICAL RELEVANCE/APPLICATION**

The tumor biological behaviors and therapeutic schedules of SCC, ACC and NHL are different. As a noninvasive and convenient method, the MRI radiomics approach with deep transfer learning represented an opportunity to advance precise prediction for the type of sinonasal malignancies preoperatively and assist in making appropriate treatment and improving the prognosis.

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## Abstract Archives of the RSNA, 2023

M5B-SPHN-4

### Radiomics Analysis for the Prediction of Locoregional Recurrence of Locally Advanced Oropharyngeal Cancer and Hypopharyngeal Cancer

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Te-Chang Wu, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

By radiomic analysis of the postcontrast CT images, this study aimed to predict locoregional recurrence (LR) of locally advanced oropharyngeal cancer (OPC) and hypopharyngeal cancer (HPC), that carry high LR rate >50% and poor overall survival rate <50%.

#### METHODS AND MATERIALS

From two independent cohorts, this retrospective study enrolled 194 patients with stage III-IV OPC or HPC according to the 7th edition of the American Joint Committee on Cancer. These patients were randomly split into a training cohort with 153 cases (80%) and a testing cohort with 39 cases (20%). Only the primary tumor mass was segmented manually for the radiomic analysis. Radiomic features were extracted using PyRadiomics, and then the support vector machine (SVM) was used to build the radiomic model with a 5-fold cross-validation process in the training dataset. For each case, a radiomics score was generated to indicate the probability of LR.

#### RESULTS

Within a follow-up period of 2 years, there were 94 patients with LR assigned in the progression group and 98 patients without LR assigned in the stable group. There was no significant difference in clinical TNM staging, treatment strategies, and common risk factors between these two groups. For the training dataset, the radiomics model to predict LR showed 83.7% accuracy and 0.832 (95% CI: 0.72, 0.87) area under the ROC curve (AUC). For the test dataset, the accuracy and AUC slightly declined to 79.5% and 0.770 (95% CI: 0.64, 0.80), respectively. The sensitivity/specificity of the training and test dataset for LR prediction were 77.6%/ 89.6%, and 66.7%/ 90.5%, respectively.

#### CONCLUSION

The proposed image-based radiomic approach could provide a reliable prediction model of LR in locally advanced OPC and HPC with high accuracy and specificity. Early identification of those prone to post-treatment recurrence would be helpful for appropriate adjustments to treatment strategies and posttreatment surveillance.

#### CLINICAL RELEVANCE/APPLICATION

For locally advanced oropharyngeal and hypopharyngeal cancers with high recurrence rates and poor prognoses, we demonstrated that an image-based radiomic model might potentially identify those prone to post-treatment recurrence with high accuracy and high specificity. Pending the future validation in a large cohort, it is expected to provide an opportunity to make appropriate adjustments to the treatment choices (concurrent chemoradiation therapy vs. surgery with adjuvant treatment), post-treatment imaging interval (6 weeks vs. 12 weeks), chemoradiotherapy treatment protocols, and the patient's rehabilitation plan, psychological support, and social care resource allocation.

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## Abstract Archives of the RSNA, 2023

M5B-SPHN-5

### Assessment of a Commercially Available Artificial Intelligence Algorithm for Risk Stratification of Thyroid Nodules: Diagnostic Performance at a Tertiary Academic Center

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jeffrey R. Ashton, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance of a commercially available, artificial intelligence-based software platform for risk stratification of thyroid nodules on ultrasound (US). This tool was recently FDA approved and no external validation studies have been published to date evaluating its clinical performance.

#### METHODS AND MATERIALS

This retrospective study included all thyroid US examinations containing thyroid nodules over a 1-year period at a large academic medical center. Nodules were included if they had a ground truth diagnosis by: a) surgical pathology, b) fine needle aspiration, or c) three-year follow up US showing stability. The cohort included 650 nodules from 348 patients. An FDA-approved, AI-based software tool (Koios DS Thyroid, Koios Medical) was applied to the images for each nodule. The Koios algorithm generates two primary outputs: 1) ACR TI-RADS nodule descriptors with TI-RADS score and follow up recommendation, and 2) an optional AI adaptor score which can adjust the risk assessment and recommendation based on the overall AI analysis of the images. Four different groups were compared: 1) AI software with AI adaptor enabled, 2) AI software without the AI adaptor, 3) clinical radiology reports (using ACR TI-RADS), and 4) radiology reports combined with AI adaptor score. Diagnostic performance of the final recommendations (FNA or no FNA) was determined based on the ground truth, and comparison between the four groups was made using sensitivity, specificity, and AUROC analysis.

#### RESULTS

Diagnostic performance of the AI algorithm with the AI adaptor tool enabled was similar to the performance of the clinical radiologists (AUC 0.70 for both). The algorithm + adaptor had improved specificity compared to radiologists (0.63 vs 0.43) but decreased sensitivity (0.69 vs 0.81). Without the AI adaptor enabled, performance of the algorithm was slightly worse (AUC 0.65), while the best performance was seen when the radiology interpretation was combined with the AI adaptor (AUC 0.76). When combined with the AI adaptor, radiologist specificity improved from 0.43 to 0.53, resulting in 17% fewer FNA recommendations, with unchanged sensitivity (0.81).

#### CONCLUSION

The Koios DS algorithm demonstrated standalone performance similar to that of radiologists, though with lower sensitivity and higher specificity. Performance was best when radiologist interpretations were combined with the AI adaptor component, which led to improved specificity and a reduction in unnecessary FNA recommendations.

#### CLINICAL RELEVANCE/APPLICATION

AI software can improve thyroid US diagnostic performance and reduce unnecessary procedures. Workflow may also be improved through automated generation of TI-RADS scores, though performance is highest with human input.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPHN-7

### FaBoA: Computed Tomography-based Facial Bone Fracture Analysis Solution

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Hyun-Soo Choi (*Presenter*) Nothing to Disclose

#### PURPOSE

Facial bone fractures must be diagnosed and treated as early as possible to avoid complications and sequelae. Computed Tomography (CT) images are essential for accurate diagnosis and treatment planning, but analyzing these images is time-consuming and requires specialized expertise. While many classification and object detection studies have been conducted to address these issues, their limitations have hindered their widespread clinical use. The ability of classification-based studies to pinpoint the exact location of fractures is limited, while object detection-based research is challenging due to the ambiguity of the shape of a fracture. To address these challenges, we propose a deep learning-based facial bone fracture diagnosis system named FaBoA.

#### METHODS AND MATERIALS

FaBoA was trained on a dataset of 6,294 CT scans with facial bone fractures acquired from January 2009 to March 2020. Experienced expertise manually annotated facial fractures with bounding boxes on all the datasets. Our deep learning model was evaluated on an additional 346 CT scans. We used deep learning-based object detection for the initial detection and class activation-based weakly-supervised segmentation for pixel-wise fine-grained localization.

#### RESULTS

FaBoA achieved sensitivity and specificity were 100% and 84.2%, respectively, for nasal bone fractures. The sensitivity and specificity of all types of facial bone fractures were 81.3% and 70.5%, respectively. Furthermore, FaBoA can visualize fine-grained 3D fractures using the localization technique.

#### CONCLUSION

FaBoA is a reliable and accurate CT-based facial bone fracture analysis solution that has the potential to assist radiologists in the diagnosis and treatment of facial bone fractures, leading to better patient outcomes. The combination of object detection and class-activation-based localization enables FaBoA to accurately detect and classify bone fractures with high sensitivity and specificity. In addition, FaBoA includes not only the diagnosis model but also a user-friendly interface that allows doctors to interact with the solution and access the analysis results easily. FaBoA can also be integrated into radiology workflows to enhance efficiency and reduce interpretation variability. The dataset used in this study, which spans over a decade of CT scans with facial bone fractures, provides a representative sample of real-world clinical cases and enhances the generalizability of the FaBoA model.

#### CLINICAL RELEVANCE/APPLICATION

FaBoA's AI engine and user-friendly interface have the potential to assist in diagnosis, treatment planning, postoperative assessment, and monitoring of facial bone fractures, leading to better patient outcomes and workflow efficiency.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-SPIN-1

### Scaling Temporal and Volumetric Datasets for Tumor Localization Without Per-Pixel Annotations

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To examine whether AI trained using simple annotation strategies can achieve comparable or superior performance to that trained using per-pixel annotations in the context of computer-aided tumor detection.

#### METHODS AND MATERIALS

Two large-scale datasets were retrospectively collected for this study: SUN-SEG consists of 1,106 colonoscopy video clips for polyp detection, in which 49,136 frames are with polyps and 158,690 frames are without polyps. The video clips were split into training (507), validation (126), and test (473) sets. JHH contains 2,426 subjects collected and annotated at Johns Hopkins University for pancreatic tumor detection, where each subject was scanned by contrast-enhanced CT. We randomly split CT scans into training (1,683), validation (420), and test (323) sets. Tumors in both datasets were annotated on a per-pixel basis. We develop a new annotation strategy, simplifying the tumor annotation process to drag and drop (DragDrop). Furthermore, we designed a watershed-based weakly supervised learning method to leverage the DragDrop annotations and accommodate the high-dimensional temporal and volumetric data. Finally, we assessed Sensitivity, Specificity, Precision, and F1-score for tumor detection at both lesion and patient levels.

#### RESULTS

Given a certain annotation budget, our proposed DragDrop strategy improves the sensitivity, specificity, precision, and F1-score at the lesion-level for polyp detection when compared to per-pixel annotation, with improvements from 68% to 71%, 58% to 67%, 43% to 51%, and 54% to 59%, respectively. The patient-level results improve from 75% to 80%, 69% to 79%, 54% to 64%, and 62% to 66%, respectively. For pancreatic tumor detection, the results improve from 61% to 71%, 33% to 42%, 42% to 57%, and 52% to 61%, respectively. The patient-level results improve from 76% to 88%, 70% to 64%, 75% to 74%, and 61% to 73%, respectively. More importantly, for minority patients aged between 75 to 80 and 80 to 85, who only account for 7% and 3% of the JHH test set, our DragDrop improves lesion-level precision from 42% to 61%, and 45% to 60% and improves lesion-level F1-score from 55% to 72% and 59% to 75%.

#### CONCLUSION

Our proposed strategy reduced 87% and 99% annotation efforts for polyp and pancreatic tumor detection, respectively, and achieved a significantly better tumor detection rate than per-pixel annotations given an annotation budget.

#### CLINICAL RELEVANCE/APPLICATION

Simpler annotations demonstrate their advantages in scaling up datasets for tumor localization in comparison with per-pixel annotations. This not only improves accuracy and generalizability but also allows for better representation of underrepresented groups and identifying rare diseases that may be more prevalent in specific populations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIN-2

### Early Prediction of Motor Abnormalities in Very Preterm Infants Using MRI Radiomic Data with a Collaborative Self-Supervised Transformer Model

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Junqi Wang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a collaborative self-supervised learning (Co-SSL) deep learning model for predicting motor abnormalities in preterm infants using MRI radiomic data without large-scale annotated images.

#### METHODS AND MATERIALS

Very preterm infants (gestational age =32 weeks) were enrolled in our institute, and axial T2-weighted MR images were collected on a 3T Philips Ingenia scanner. We processed T2 images using the Developing Human Connectome Project pipeline into 87 regions of interest (ROIs) and the PyRadiomics pipeline to extract 100 radiomic features for each ROI, resulting in a large radiomic feature map (87×100) for each subject. We assessed the motor abnormalities using Bayley III Motor score and dichotomized the infants into low-risk (score>85) vs. high-risk (score=85) groups. We developed a Co-SSL Transformer model for motor abnormalities prediction. Typical self-supervised learning (SSL) defines a pretext task to pretrain a model without using labels, then fine-tunes the model for the downstream real task. In contrast, our Co-SSL strategy uses two collaborative pretext tasks to jointly pretrain the model. Specifically, we first conducted data augmentation on N original subjects by randomly masking radiomic features of ROIs from radiomic feature maps, generating M augmented subjects. We defined two collaborative pretext tasks 1) Reconstruction- to reconstruct the masked radiomic features using the observable ones for all M subjects, and 2) Discrimination- to cluster M augmented subjects into N groups according to N original subjects. Using these two collaborative tasks, we pretrained a Transformer neural network to learn latent features without human labeling, and then fine-tuned this model for our motor abnormality prediction. Performance was assessed by 5-fold cross-validation.

#### RESULTS

A total of 362 subjects were included in this study, out of which only 318 have Bayley III motor scores at 2 years corrected age. Our Co-SSL Transformer achieved a mean (standard deviation [SD]) accuracy of 76.3 (5.1)% and AUC of 0.73 (0.05), outperforming the supervised Transformer [accuracy = 66.6 (5.3)%, AUC=0.64 (0.05)], SimCLR [accuracy=67.3 (5.2)%, AUC=0.65 (0.07)], and Invariant [accuracy=68.3 (4.4)%, AUC=0.67 (0.08)].

#### CONCLUSION

We showed that the proposed model outperformed peer self-supervised ones for early risk stratification of developing motor abnormalities assessed at 2 years corrected age.

#### CLINICAL RELEVANCE/APPLICATION

Very preterm term infants are especially at increased risk of developing motor abnormalities compared to infants who were term born. Our AI strategy enables the early diagnosis of motor abnormalities using brain MRI radiomics without large-scale annotated datasets.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIN-3

### Quantum Kernel Methods Can Improve Binary Classification of COVID-19 Pneumonia on Chest Radiographs

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

John D. Mayfield, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Chest radiography has continued to serve as the workhorse of initial screening and surveillance of patients diagnosed with COVID-19, however, the nonspecific and variable patterns of pneumonia limited diagnostic accuracy as a predictor of disease. Increasingly complex and robust datasets such as COVIDx CXR3 provide enriched training environments for machine learning (ML) models to help clarify diagnosis. However, the stochastic nature of the disease may benefit from emerging technologies that combine ML with quantum computing (QC), known as Quantum machine learning (QML). Here, we evaluate a Quantum Projected Kernel (QPK) method and compare its performance against classical ML methods.

#### METHODS AND MATERIALS

8,000 chest radiographs were randomly selected from the COVIDx-CXR3 database and split 80:20 training:validation set as well as a hold-out testing set of 400 cases. The images underwent dimensionality reduction using UMAP and were encoded into a 11-qubit circuit. Google Cirq's Density Matrix simulator was utilized with realistic noise simulation that is based upon Google's Rainbow quantum processor. Kernel density matrices were optimized in a complex Hilbert space to provide greater separation between classes and then subsequently projected into spatial coordinate space. This processed data was then passed through a linear dense classifier layer where accuracy, f1-score, precision, recall, and sensitivity/specificity were calculated for cross-validation and hold-out testing sets.

#### RESULTS

The model demonstrated an accuracy of 94% [95% CI: 87-95%] with an AUC of 0.94 [95% CI: 82-95%] and f1-score of 0.92. Performance on the holdout testing set yielded 84% accuracy, AUC of 0.83, with an f1-score of 0.84, precision of 81%, recall of 86%, and sensitivity and specificity of 87% and 81%, respectively.

#### CONCLUSION

QPK methods demonstrated promising performance on a diverse database that generalized well to a hold-out testing set. However, further optimization and evaluations are required to assess its performance.

#### CLINICAL RELEVANCE/APPLICATION

QML can provide a quantum advantage to the data to potentially improve robustness compared to classical architectures alone. Given the improved accessibility to cloud-based quantum machines, such approaches may increase productivity and reliability of classification strategies, easing the reliance on larger, more complex models.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIN-4

### Joint Self-supervised and Supervised Contrastive Learning for Multimodal Brain MRI at Term: Towards Predicting Motor Impairments in Infants Born Preterm

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Zhiyuan Li, BS,MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a joint self-supervised and supervised contrastive learning model using multimodal brain MRI at term-equivalent age to predict later motor impairments in infants born preterm.

#### METHODS AND MATERIALS

Data acquisition and pre-processing. This IRB approved study involves a multisite cohort of 297 preterm infants born before 33 weeks gestational age. T2-weighted structural MRI (sMRI), diffusion tensor imaging (DTI), resting-state functional MRI (fMRI), and clinical non-imaging data were collected for each subject. We preprocessed each subject using the Developing Human Connectome Project (dHCP) pipeline to segment the whole brain image into 87 regions of interest (ROIs) for the first three modalities. We further extracted radiomic features, structural connectome, and functional connectome from sMRI, DTI, and fMRI, respectively. Individual subjects underwent motor ability assessment using the Bayley-III Motor subtest at 2 years corrected age. We categorized infants into two groups based on their Motor score (range 40-160): high risk of (scores  $\leq 85$ ) or low risk of motor impairments (scores  $> 85$ ). Joint self-supervised and supervised contrastive learning. Our proposed model is shown in Figure 1. We first designed 5 feature extractors to extract feature embeddings from structural connectome, functional connectome, radiomic features, sMRI images, and clinical non-imaging features, respectively. Next, we pretrained all feature extractors by two pretext contrastive learning tasks, in which the first task was to learn the cross-modality-complementary features by clustering the feature types of an individual patient, and the second task was to learn cross-subject-similarity features by clustering the patient with the same class label. Finally, we fine-tuned the pre-trained network to solve the real task (i.e., risk stratification of motor impairments) in a supervised manner. We evaluated our model using 10-fold cross-validation.

#### RESULTS

Our model achieved an AUC of 0.73, outperforming the Siamese network (AUC=0.65) and Triplet network (AUC=0.68) models. In addition, our model also achieved better prediction performance than the single-modality models, such as the models using DTI (AUC=0.71) or fMRI (AUC=0.70).

#### CONCLUSION

We proposed a novel joint self-supervised and supervised contrastive learning model to predict later motor impairments in very preterm infants using multimodal MRI data. The results showed that our proposed model outperformed peer and single modality models, demonstrating the effectiveness of the designed approach.

#### CLINICAL RELEVANCE/APPLICATION

The proposed model can facilitate deep learning-based applications for multimodal MRI data.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIN-5

### **Towards Patient Consumable Radiology Reports - Improving Content Signal-to-Noise Ratio (SNR) While Converting Medical Jargon to Plain English via GPT-4**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Ghulam Rasool, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

With the increasing complexity of imaging modalities and the trend toward higher-level structured reporting, radiology reports have become equally as complex and lengthier by default; becoming nearly incomprehensible to the average person (patient). Additionally, there are ongoing efforts to produce patient-consumable radiology reporting. However, we believe that improving radiologist report structure and content is a necessary first step to having consistently structured reports for clinician ease of reading. More concise reports with predictable fields in anatomically oriented top-down logical order more effectively convey meaning. We listed and further removed well-known unnecessary words (noise) common in radiologist reports that do not help convey meaning resulting in an easier-to-read objective report (signal). This was followed by prompting the resultant higher Signal-to-Noise Ratio (SNR) phrases to read in plain English.

#### **METHODS AND MATERIALS**

We first prompted GPT 4.0 (Generative Pretraining Transformer) to common radiologist phraseology that consistently slashed report length in half while maintaining content. Removed commonly used unnecessary words including: there is, of the, within the, visualized, measures, approximately, the patient, at this time. Second, we prompted GPT to convert the higher SNR report text to active voice plain English understanding defined by established doctrine, e.g., SEC (Security and Exchange Commission Rule).

#### **RESULTS**

Report content SNR was doubled (total words cut in half) following the removal of unnecessary words while maintaining meaning for physicians in a more inviting/easier-to-read structured format. Following prompting for improved SNR to read in plain English, the report content was explained in a manner for general public understanding. Example GPT input (37 words): "Nonobstructive renal calculus within the left kidney collecting system measuring approximately 0.4 to 0.5 cm in cross-sectional diameter. This renal calculus was present on prior CT, though it has enlarged compared to the previous study". Example GPT output (17 words): "Enlarged non-obstructive kidney stone in left collecting system measuring 0.4-0.5 cm, previously seen on CT." GPT plain English: This report shows that there is a small stone in your left kidney that is not causing a blockage. The stone is growing and has gotten a bit bigger since your last scan.

#### **CONCLUSION**

We show that GPT-4 can significantly increase the SNR of the radiology report for both physicians and for patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Improving report content SNR leveraging GPT helps referring physicians radiologists report readability further converting to plain English completes radiology's service to our patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIN-6

### Quantifying the Technical Challenges and DICOM Metadata Variability in Stroke Machine Learning Data Curation

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Peter Kamel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Data curation is a challenging and often rate-limiting task in machine learning algorithm development. This is compounded by heterogeneity of DICOM metadata labeling and storage conventions, which often makes data curation require extensive preprocessing and manual cleaning. The purpose of this study was to quantify the variability in DICOM metadata labeling conventions and analyze the largest factors limiting data curation for the use case of machine learning on stroke CTs and MRIs.

#### METHODS AND MATERIALS

We evaluated data curation on a set of stroke MRI-CT pairs consisting of DWI sequences from MRI and associated dual energy CT head with 120 kV and 190 keV virtual monochromatic images. From an initial list of 946 patients, we used DICOM queries to find the studies of interest, identify the b1000 DWI images and thick resolution axial 120 kV and 190 keV images, download the images from the PACS, anonymize them, and convert them to NIFTI file format for machine learning. During each step of the process, errors and limitations of data curation were recorded, characterized, and quantified.

#### RESULTS

In the 946 MRI examinations we found 1,122 unique Series Descriptions, of which over 20 were used to identify the DWI sequence, due to varying labeling and storage conventions (Figure 1a). Multiple methods of encoding were used to store the DWI sequence b-value, requiring multiple iterations and regular expression matching to extract the necessary MRI images. Of the initial 946 MRI examination, 24 (2.5%) were missing the appropriate series or unretrievable from the PACS, 2 (0.2%) contained improper or absent b-value encoding, and 32 (3.4%) contained slice increment, geometric, or orientation inconsistencies that prevented image conversion to NIFTI. Similar challenges were encountered with head CT preprocessing and download which contained 18 unique Series Descriptions for the thick-slice axial images. The final yield of MRI-CT pairs that would be useful for our use case was 815, reflecting an approximately 13.8% data loss from the initial list (Figure 1b).

#### CONCLUSION

Technical challenges in DICOM metadata variability pose a significant limitation to machine learning dataset curation. Even with extensive manual correcting, a loss of 10-15% can be expected from an initial list to a curated dataset due to technical factors, which do not include scan or clinical limitations on examinations. Such limitations in dataset curation should be considered at the outset of any machine learning project and accounted for during study design.

#### CLINICAL RELEVANCE/APPLICATION

Machine learning data curation poses significant technical challenges, which need to be accounted for when estimating the yield of an initial data set.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIN-7

Mr

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Muhammad Irfan Khan (*Presenter*) Nothing to Disclose

### PURPOSE

The purpose of this study is to introduce two approaches that leverage multi-armed bandit algorithms to select the most appropriate participants for each round of training in Federated Learning (FL) for brain tumor segmentation. FL is a machine learning approach that enables collaborative training of a model without sharing data. Developing accurate and reliable machine learning models for brain tumor segmentation in federated settings is crucial, and collaborator selection plays a significant role in achieving this goal. However, choosing the most appropriate collaborators for each round of training in Federated Learning (FL) is a challenge. Hence, Reinforcement Learning (RL) algorithms have potential to tackle this challenge.

### METHODS AND MATERIALS

We use RL to evaluate the estimated performance of each collaborator and select the most promising candidates for collaboration. We employ a markov decision process for reward-based selection of collaborators. We measure the estimated performance of each collaborator and the overall performance of the model. Segmentation accuracy and convergence scores are the evaluation metrics used to assess model performances in the OpenFL platform.

### RESULTS

The two proposed approaches (epsilon-greedy and upper confidence bound) effectively select the most promising collaborators for each round of training in FL for brain tumor segmentation. The results show that our approach induces participation of the best candidates leading to better segmentation results. The selected collaborators based on the RL approach showed a higher estimated performance than random selection or the batch-wise collaborator selection. Results indicate a positive correlation between selecting the most appropriate collaborators and the overall performance of the model.

### CONCLUSION

The proposed multi-armed bandit algorithms effectively select the most promising collaborators for each round of training in FL for brain tumor segmentation. The reward-based selection process encourages the participation of the best candidates, leading to better segmentation results and a generalizable model.

### CLINICAL RELEVANCE/APPLICATION

Accurate and reliable machine learning models are essential in clinical settings for early diagnosis and treatment planning. However, after GDPR and HIPAA laws, data privacy concerns limit data sharing, making federated learning a viable approach. This study can lead to better diagnosis and treatment planning for brain tumor patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIR-1

### Prophylactic Internal Iliac Artery Balloon Occlusion in Placenta Accreta Spectrum: Evaluating Efficacy, Risks, and Clinical Implications

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Rui Wang, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to assess the efficacy and risks of prophylactic internal iliac artery balloon occlusion (IIABO) in managing placenta accreta spectrum (PAS) disorders and to discuss the clinical implications of this technique.

#### METHODS AND MATERIALS

We conducted a retrospective analysis of 623 confirmed PAS cases, including placenta accreta, increta, and percreta, between December 2013 and December 2022. Patients were divided into two groups based on whether they received prophylactic IIABO (Balloon Group, n=310) or not (No Balloon Group, n=313). The diagnosis of PAS was based on ultrasonography and verified by MRI when needed. Clinical management, surgical outcomes, complications, and hospitalization-related outcomes were compared between the groups using independent sample t-test, Mann-Whitney U test, or Fisher's exact test, as appropriate.

#### RESULTS

Among 623 confirmed PAS cases, patients were divided into Balloon (n=310) and No Balloon (n=313) groups. The Balloon Group had lower intraoperative bleeding and transfusion, with a significant difference in placenta percreta cases ( $P=0.03$ ), and shorter operation duration for placenta percreta ( $P=0.02$ ). No significant differences were observed in demographics, placenta removal, hysterectomy, or obstetric complications between the groups. Balloon Group had higher rates of arterial injury, thrombosis, and lower extremity ischemia (without statistical differences), as well as higher hospitalization costs ( $P=0.01$ ). Balloon blocking time significantly increased from PA to PI and then to PP ( $P=0.03$ ).

#### CONCLUSION

Prophylactic IIABO can be beneficial in reducing intraoperative bleeding and operation duration in selected PAS cases, particularly placenta percreta. However, the increased vascular complications and costs must be weighed carefully. Further studies should focus on optimizing patient selection and minimizing complications.

#### CLINICAL RELEVANCE/APPLICATION

This study sheds light on the potential benefits and risks of prophylactic internal iliac artery balloon occlusion (IIABO) in managing placenta accreta spectrum (PAS) disorders. While IIABO may be advantageous in specific cases, such as placenta percreta, clinicians must carefully evaluate the associated risks and costs. Future research should focus on refining patient selection and mitigating complications to improve the safety and effectiveness of IIABO in clinical practice.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-SPIR-2

### Time-driven Activity-based Cost Analysis of Uterine Artery embolization

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Nicole H. Kim, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Time-driven activity-based costing (TDABC) is the most accurate costing methodology in healthcare. The aim of this study was to increase cost transparency and uncover potential areas for savings in outpatient uterine artery embolization (UAE) for using TDABC methodology.

#### METHODS AND MATERIALS

We retrospectively reviewed 109 patients who underwent outpatient UAE for fibroids or adenomyosis at a large urban tertiary academic center between January 2020 and December 2022. A process map defined the steps of UAE during a procedure day. Utilization times were captured from electronic health record timestamps and staff interviews using validated techniques. Capacity cost rates were estimated using a combination of institutional data, regional surveys, and manufacturer proxy prices. Costs were calculated using TDABC methodology for personnel, equipment, and consumables. Consumables were further sub-categorized into standard items, vascular devices (eg, needles, sheaths, catheters, wires), embolic agents (trisacryl gelatin particles and/or gelfoam), medications, and other (eg, contrast, closure devices).

#### RESULTS

The mean total cost of UAE was \$4,529 (SD=\$936), the greatest contributor of which was consumables (66%; \$2980 [\$799]), followed by personnel (30%; \$1372 [\$265]) and equipment (4%; \$177 [\$42]). Within consumables, embolic agents accounted for the greatest proportion of costs, accounting for 42% (\$1268 [\$771]), followed by vascular devices (33%; \$980 [\$151]). The cost of embolic agents was highly variable, largely driven by the number of vials (range 1-19) of trisacryl gelatin particles used.

#### CONCLUSION

Consumables accounted for the majority of the total cost of UAE, largely driven by the cost of embolic agents and vascular devices. It is unlikely that improved efficiency in room or personnel time will lead to cost-savings for UAE.

#### CLINICAL RELEVANCE/APPLICATION

Understanding true procedural costs and addressing the high cost of consumable equipment in interventional radiology remains an important obstacle in improving the cost-effectiveness of IR procedures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIR-4

### The Cost of an Interventional Radiology Fellow: Time-driven Activity-based Cost Analysis of Uterine Artery Embolization for Symptomatic Uterine Fibroids

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Nicole H. Kim, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Academic teaching hospitals garner many benefits for undertaking the training of residents and fellows; however, the cost of trainees in the context of clinical care is not well-captured. The aim of this study was to investigate differences in utilization time and total costs between attending alone and attending/fellow cases in patients receiving outpatient uterine artery embolization (UAE) for symptomatic uterine fibroids using time-driven activity-based costing (TDABC) methodology.

#### METHODS AND MATERIALS

We retrospectively reviewed 109 patients who underwent outpatient UAE for fibroids or adenomyosis at a large urban tertiary academic center between January 2020 and December 2022. Using a process map to capture all steps of a single procedure, we gathered utilization times, including pre-procedure care, room time, intra-procedure time, and post-procedure care, from electronic health record timestamps and staff interviews. Capacity cost rates were estimated using validated techniques. Costs were calculated using TDABC methodology for personnel, equipment, and consumables. We analyzed differences in time utilization and costs between procedures performed by an IR attending only (AO) versus an IR attending and IR fellow (AF) using two-sample t-tests, additionally stratifying by time period (July-December vs January-June) to account for trainee experience.

#### RESULTS

Of 109 total cases, 23 (21%) were performed by an attending alone. AO cases had significantly shorter room times (AO vs AF: 141 vs 156 min,  $p=.042$ ) and intra-procedure times (94 vs 110 min,  $p=.009$ ); there were no differences in pre- or post-procedure care times. The mean total cost of AO cases was 12% (\$539) cheaper than AF cases (\$4,103 vs 4,642;  $p=.003$ ). In both AO and AF cases, the greatest contributor of total costs were consumables (70% and 65%, respectively), followed by personnel (27% and 30%). Intra-procedure times were significantly lower for AO cases during July-December (88 vs 114 min,  $p=.024$ ) but not during January-June (99 vs 106 min,  $p=.48$ ).

#### CONCLUSION

The presence of an IR fellow is associated with significantly longer room and intra-procedure times, as well as higher total costs in outpatient UAE. These differences are likely attributable to trainee inexperience during the first half of the fellowship year.

#### CLINICAL RELEVANCE/APPLICATION

Cost of procedures varies depending on practice setting, as well as the presence and experience of a clinical trainee. Understanding true costs is important in determining cost-effectiveness of interventional radiology procedures in different environments.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIR-5

### The Evolving Role of IR in the Management of Cholecystitis

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Tarik Babar, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

(Please review this as an educational exhibit if possible- sorry for the inconvenience!)Teaching Points1. Introduce various innovative interventional radiology (IR) management options for cholecystitis and its complications that impact clinical outcomes2. Review the success of traditional interventions of cholecystitis by IR3. Present a successful example of a standardized multidisciplinary approach for the management of cholecystostomy drains4. Demonstrate successful approaches of management of cholecystitis and its complications through the use of novel IR techniques5. Review high-impact studies regarding IR management of cholecystitis including new, innovative interventions

#### **METHODS AND MATERIALS**

Table of Contents1. Introduction, including epidemiology of cholecystitis and current traditional surgical management options2. Traditional role of IR in the management of non-operative cholecystitis3. Review of existing high-impact studies regarding success of percutaneous cholecystostomy drains4. Indication, technique, and complications of percutaneous cholecystostomy drain5. Standardized management of percutaneous cholecystostomy drains used at our center6. Novel roles for IR in management of cholecystitis7. Indication, technique, and successful cases of percutaneous stone extraction, electrohydraulic lithotripsy (EHL), and laser lithotripsy8. Indication, technique, and successful case of gallbladder cryoablation for chronic cholecystitis9. Review of a high-impact studies regarding novel IR techniques: percutaneous cystic duct interventions for non-operative cholecystitis and percutaneous stone extraction10. Conclusion and summary

#### **RESULTS**

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#### **CONCLUSION**

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Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPIR-7

### **Bacterial Community Analysis of Pyogenic Liver Abscess With or Without Gas Formation by 16S rDNA Sequencing**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yawen Guo (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Gas formation is an important feature of pyogenic liver abscess (PLA). The potential relationship between gas formation bacterial composition in PLA remains unclear. The present study attempts to compare bacterial composition between gas-forming PLA (GFPLA) non-gas-forming PLA (non-GFPLA) to identify factors associated with gas formation in PLA .

#### **METHODS AND MATERIALS**

Clinical data from 331 patients with PLA was collected retrospectively, 16S rDNA sequencing was performed to analyze the bacterial composition of pus samples from 60 consecutive PLA patients. Patients were divided into GFPLA non-GFPLA groups according to the presence or absence of gas on computed tomography (CT). Univariate multivariate logistic analyses were used to identify factors associated with gas formation in PLA.

#### **RESULTS**

Rates of extrahepatic migratory infection (EMI), intensive care unit (ICU) admission mortality were significantly higher in the GFPLA group. 16S rDNA sequencing showed no differences in bacterial community richness diversity between the two groups. Linear discriminant analysis effect size (LEfSe) revealed a higher abundance of *Enterococcus faecium* *Enterobacter cloacae* in the GFPLA group. However, the presence of *Enterococcus faecium* *Enterobacter cloacae* was not associated with the gas formation on multivariate regression analysis. Only the history of digestive system cancer was independently associated with gas formation in PLA .

#### **CONCLUSION**

No relationship was observed between gas formation & bacterial composition in PLA; only the history of digestive system cancer was independently associated with PLA gas formation.

#### **CLINICAL RELEVANCE/APPLICATION**

An increased understanding of the mechanisms underlying PLA gas formation may provide new insights into the clinical phenomenon that patients with gas-forming pyogenic liver abscess (GFPLA) tend to have more severe symptoms increased mortality compared to patients with non-gas-forming PLA (non-GFPLA).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPMK-1

### A Preliminary Study of MRI T2 Mapping Imaging of Knee Cartilage in Type 2 Diabetic

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Fengzi Yao (*Presenter*) Nothing to Disclose

#### PURPOSE

To preliminarily explore the effect of type 2 diabetes mellitus (T2DM) on articular cartilage of knee osteoarthritis (OA) based on MRI T2 mapping sequence.

#### METHODS AND MATERIALS

A total of 52 participants were recruited for MRI T2 mapping sequences. The subjects were divided into experimental group and control group. The experimental group was classified as group A of type 2 diabetic osteoarthritis (T2DM OA), with 32 patients and a total of 61 knees; and the control group was classified as group B of non-diabetic osteoarthritis (NDM OA), with 20 persons and a total of 34 knees. Group A was divided into severe group (Ax1) and mild group (Ax2) according to whether there were diabetes-related complications and basal insulin therapy. According to the course of the disease, = 10 years are classified as Ay1 and > 10 years are classified as Ay2 group. Each subject's cartilage was divided into four regions of interest according to the medial and medial femoral condyle and the medial and medial tibial condyle. The cartilage T2 value for each region of interest is defined as the average of the optimal cartilage display level and the most significant lesion level for each region of interest. The optimal cartilage display layer is selected at the middle level of the articular cartilage on this side; and the most significant lesion area level is selected, from the most serious grade of cartilage lesions. The cartilage T2 value of each region of interest is measured twice and averaged calculated.

#### RESULTS

(1) Compared with the NDM OA group, the T2 value of cartilage in the T2DM OA group was generally increased in the early cartilage grading group. (2) The T2 values of knee cartilage in the severe diabetes group were generally greater than those in the mild group, and the T2 values in the medial femoral condyle and the medial tibial condyle were statistically different ( $p < 0.05$ ). (3) When graded according to the course of the disease, the T2 value of cartilage in the Ay2 group was greater than that in the Ay1 group, and the T2 value of the medial tibial condyle cartilage was statistically different ( $p < 0.05$ ).

#### CONCLUSION

The sequence of MRI T2 mapping is able to help assess knee OA by detecting the T2 value of the knee cartilage. Type 2 diabetes has an impact on knee cartilage degeneration, and the course of diabetes and the condition of blood glucose control are correlated with the degree of knee cartilage degeneration.

#### CLINICAL RELEVANCE/APPLICATION

T2 mapping sequence was used to evaluate the quantitative effect of type 2 diabetes on articular cartilage of knee OA, and to provide evidence for early clinical intervention of T2DM OA.

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## Abstract Archives of the RSNA, 2023

M5B-SPMK-2

### **DISH: The Role of Peripheral Involvement**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Diffuse idiopathic skeletal hyperostosis (DISH) predominantly affects the axial skeleton. However, it can also affect peripheral joints, even prior to spinal involvement. In this study we aim to assess the frequency, distribution and precocity of lower limb joint involvement in these patients.

#### **METHODS AND MATERIALS**

We reviewed chest CT scans of 200 patients, from January 1, 2023 to April 31, 2023, dividing them into two groups: first group of 100 patients aged between 50 and 70 years, and second group of 100 patients older than 70 years. We selected patients with DISH following the criteria of Arlet and Mazière. We then reviewed all previous imaging tests (simple x-Ray, CT and MRI) of the lower extremities stored in our PACS for findings characteristic of DISH and their time of onset.

#### **RESULTS**

We detected 19 DISH patients in the first group (18 men and 1 woman) and 34 in the second (26 men and 8 women). Knee involvement is frequent. Thus, of the 19 patients in the first group, 30% had previous imaging of this joint, and 66% of the cases showed involvement. Of the 34 patients with DISH in the second group, 38% had previous images of the knee, and 53% of them were affected by their disease. In addition, knee involvement was present prior to axial skeletal involvement in 42% of the cases, all of them male. In all patients with knee involvement, the extensor apparatus involvement was in the form of "gull wings".

#### **CONCLUSION**

The involvement of the joints of the lower limb joints in DISH disease is frequent and with typical characteristics that allow the diagnosis to be suspected in the absence of imaging studies of the axial skeleton. In a not negligible percentage of cases, peripheral involvement precedes axial involvement, especially in males. Earlier involvement of the axial skeleton is associated with a higher percentage of peripheral joint involvement.

#### **CLINICAL RELEVANCE/APPLICATION**

We should familiarize ourselves with the characteristics of peripheral involvement in DISH that may even precede spinal disease, as early diagnosis is important for treatment and suspicion of complications.

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## Abstract Archives of the RSNA, 2023

M5B-SPMK-3

### Opportunistic CT-derived Analysis of Fat and Muscle Tissue Composition Predicts Mortality in Patients with Cardiogenic Shock

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Babak Salam (*Presenter*) Nothing to Disclose

#### PURPOSE

Estimation of prognosis in patients presenting with cardiogenic shock (CS) is important to guide clinical decision making. Patients with CS frequently undergo computed tomography (CT) on admission. Aim of this study was to investigate the predictive value of opportunistic CT-derived body composition analysis in CS patients.

#### METHODS AND MATERIALS

Amount and density of fat and muscle tissue were quantified from single-slice CT images at the level of the intervertebral disc space L3/L4 in 152 patients with CS. Multivariable Cox regression and Kaplan-Meier survival analyses were performed to determine the predictive value of opportunistically CT-derived parameters of body composition and compare them with established clinical parameters for risk stratification. The primary endpoint was defined as 30-day mortality.

#### RESULTS

Within the 30-day follow-up, 90/152 (59.2 %) patients died. On univariable analyses, patient age and lactate as clinical prognosticators, as well as skeletal muscle (SM) area, visceral adipose tissue (VAT) area, area of fat tissue in muscle, and inter-muscle fat fraction as imaging biomarkers, were associated with 30-day mortality. On multivariable analyses, lactate (HR 1.10 (CI:1.04-1.17);  $p=0.002$ ) and patient age (HR 1.04 (CI:1.01-1.07),  $p=0.017$ ), as well as visceral adipose tissue (VAT) area (HR 1.004 (CI:1.002-1.007);  $p=0.001$ ) and skeletal muscle (SM) area (HR 0.987 (CI:0.975-0.999);  $p=0.043$ ) remained as independent predictors of 30-day mortality. Kaplan-Meier survival analyses showed significantly increased 30-day mortality in patients with higher VAT area ( $p=0.015$ ) and lower SM area ( $p=0.035$ ).

#### CONCLUSION

CT-derived VAT and SM area are independent predictors of dismal outcomes in CS-patients and have the potential to become a new imaging biomarker, which is available from clinical CT.

#### CLINICAL RELEVANCE/APPLICATION

In this study we propose the use of VAT area and SM area, representing objective measures of patient clinical status, as promising imaging biomarkers for the outcome of patients with CS. The potentially outstanding value of VAT area and SM area is underscored by the fact that, unlike most CS risk scores, they can be rapidly and easily determined using available diagnostic imaging.

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## Abstract Archives of the RSNA, 2023

M5B-SPMK-5

### The Association Between Change of Muscle Quality and Mortality in Patients with Septic Shock

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jiyeon Ha, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the prognostic significance of myosteatorsis in septic shock patients undergoing protocolized bundle therapy in the emergency department.

#### METHODS AND MATERIALS

We conducted a retrospective single center study based on prospectively collected registry of septic shock in adult patients between May 2016 and May 2020. Patients who conducted computed tomography (CT) scan on ED visit day and have prior CT more than 180 days ago were enrolled in this study. Myosteatorsis was defined as sum of low attenuation muscle (LAMA) which represents low quality muscles with fatty infiltration and intermuscular adipose tissue (IMAT) based on CT density of muscle area. Myosteatorsis area difference was calculated between the ED visit day and the prior visit day. An example of body composition measurement is shown in Figure 1. Multivariate logistic regression model was used to evaluate odds ratios (ORs) and 95% confidence intervals (CIs) for 28-day mortality.

#### RESULTS

Of the 569 enrolled patients, the 28-day survival rate was 40.7% and myosteatorsis area was increased in ED visit day compared with the prior visit day in both non-survival and survival group. But the area was more increased in non-survival group (11.5 cm<sup>2</sup> vs. 22.2 cm<sup>2</sup>,  $p < 0.01$ ). Normal attenuation muscle area was more decreased (-20.0 cm<sup>2</sup> vs. -27.6 cm<sup>2</sup>,  $p < 0.01$ ) and LAMA was more increased (10.9 cm<sup>2</sup> vs. 18.8 cm<sup>2</sup>,  $p < 0.01$ ) in non-survival group. The multivariate analysis showed that the decreased SFA and increased myosteatorsis area were independent risk factor for 28-day mortality of septic shock.

#### CONCLUSION

Myosteatorsis area which implies the low quality muscle area was increased in non-survival group of septic shock. Our results revealed the trend of myosteatorsis could be better indicator of septic shock prognosis compared with the single measurement of body composition.

#### CLINICAL RELEVANCE/APPLICATION

The results of the study suggest that monitoring the trend of myosteatorsis could offer valuable insights into the prognosis of septic shock and guide clinical decision-making to enhance patient management.

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## Abstract Archives of the RSNA, 2023

M5B-SPMK-6

### Utilization of AI-aided Osteosarcopenia Measurement on Opportunistic Abdominal CT Scans to Evaluate the Impact of Gastrectomy on Bone Mineral Density

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Hyunseung Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Osteosarcopenia is the co-existence of osteoporosis and sarcopenia, which is closely related with survival outcome in patients with major diseases and elderly patients. In patients treated with gastrectomy, osteoporosis and sarcopenia commonly occurred, but not evaluated routinely in clinical practice. Thus, we applied AI-aided osteosarcopenia measurement methods in opportunistic abdominal CT scans for evaluation of bone mineral density and skeletal muscle area (SMA) in patients treated with gastrectomy.

#### METHODS AND MATERIALS

In fifty two gastric cancer patients (mean age,  $56.2 \pm 11.3$  years) treated with curative gastrectomy, preoperative and 1-year postoperative abdominal CT scans were analyzed for the SMA and BMD. Deep-learning AI techniques were applied to automatically select the L3 vertebrae level, measure the SMA, and place ROI for trabecular attenuation value. Nutritional risk index (NRI) was also calculated based on laboratory results.

#### RESULTS

Between preoperative CT and postoperative CT, all patients showed a decrease in the SMA ( $123 \pm 30$  cm<sup>2</sup> vs.  $113 \pm 28$  cm<sup>2</sup>,  $p=0.08$ ) and the trabecular attenuation values ( $137 \pm 31$  HU vs.  $125 \pm 25$  HU,  $p=0.03$ ). The NRI ( $100 \pm 8$  vs.  $92 \pm 12$ ,  $p<0.001$ ), body weight ( $63 \pm 10$  kg vs.  $57 \pm 9$ ,  $p=0.002$ ) and BMI ( $23 \pm 3$  vs.  $21 \pm 3$ ,  $p=0.001$ ) were also decreased. During the 5-year follow-up record, two patients were identified to show osteoporotic vertebral compression fractures. Both patients showed both osteoporosis and sarcopenia.

#### CONCLUSION

We found that the significant loss of bone mineral density and skeletal muscle mass occurred in patients treated with gastrectomy through AI-aided measurement techniques on opportunistic CT scans.

#### CLINICAL RELEVANCE/APPLICATION

AI-aided measurement of bone mineral density and skeletal muscle area simultaneously is greatly helpful to evaluate osteoporosis and sarcopenia in clinical practice using opportunistic CT scans.

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## Abstract Archives of the RSNA, 2023

M5B-SPMK-7

### Revolutionizing Bariatric Surgery Outcomes: A Radiomics-Based Model to Unveil the Prognostic Power of Preoperative Skeletal Muscle Analysis on Abdominal CT for Metabolic Syndrome Remission

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yoon Jung Lee (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and assess the performance of a CT radiomics-based machine learning predictive model to determine if preoperative skeletal muscle characteristics can predict the remission of metabolic syndrome following bariatric surgery.

#### METHODS AND MATERIALS

Our study population included 79 morbidly obese patients who underwent bariatric surgery and had abdominal and pelvic CT scans preoperatively and one year postoperatively between January 2019 and October 2020. An experienced musculoskeletal radiologist with eight years of experience, unaware of the patients' clinical information, manually outlined regions of interest encompassing the total abdominal muscle area (including psoas, paraspinal, quadratus lumborum, rectus abdominis, transverse abdominis, and internal and external obliques) on every slice throughout the entire extent of the third lumbar vertebra (L3). We extracted radiomics features from preoperative CT images of skeletal muscle and developed a framework for optimal feature selection. To develop our predictive models, we randomly split the complete dataset into 70% for model development and 30% for model validation. To enhance predictive performance, we employed normalization, standardization, and a random search with 5 repeated 5-fold cross-validation for optimization. We utilized three popular algorithms: logistic regression (LR), random forest (RF), and support vector machine (SVM).

#### RESULTS

Feature selection based on absolute correlation (COR) resulted in 43 features with Least Absolute Shrinkage and Selection Operator (LASSO), 35 with Elastic-Net (EN) and 10 with Random Forest (RF). In the cross-validation method, the logistic regression (LR) model achieved the best performance using the COR and RF combination, with train area under the curve (AUC) of 0.774 and test AUC of 0.800. The RF model attained train AUC of 1.000 and test AUC of 0.675 with the COR and RF combination. The SVM model secured train AUC of 0.819 and test AUC of 0.783 using the VIF and RF combination.

#### CONCLUSION

In conclusion, our study demonstrates that the CT radiomics-based machine learning predictive models effectively utilize preoperative skeletal muscle analysis to predict the remission of metabolic syndrome after bariatric surgery. Among the models examined, the logistic regression model with the COR and RF combination yielded the best performance.

#### CLINICAL RELEVANCE/APPLICATION

This study highlights the potential of radiomics and machine learning approaches in personalized preoperative evaluation and prediction of post-bariatric surgery outcomes, ultimately contributing to the advancement of precision medicine in obesity treatment.

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## Abstract Archives of the RSNA, 2023

M5B-SPMK-8

### Deep Learning to Quantify Altered Muscle Status and its Association with Survival in Lung Cancer Screening Eligible Individuals

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Johannes Beat B. Kessler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Skeletal muscle (SM) has been described as an important prognostic factor in patients with cancer or cardiovascular disease. However, its prognostic value in asymptomatic screening eligible individuals at increased risk is not routinely determined on performed CT scans due to limited resources. Thus, we used a 3D deep learning model for fully automatic quantification of SM on routine chest CT and explored its association with survival in heavy smokers participating in a lung cancer screening trial.

#### METHODS AND MATERIALS

A 3D deep learning model was used to estimate SM volume (SMVol) and SM attenuation (SMHU), a known measure of muscle quality, on non-contrast enhanced lung screening chest CTs of 26,144 participants of the National Lung Screening Trial at baseline and on the 1-year follow-up scan (n=52,228). The primary outcome was all-cause mortality. Secondary outcomes were lung cancer and cardiovascular mortality. The association between SMVol and SMHU and outcomes was assessed via multivariable Cox proportional hazards regression at baseline. In addition, the association between muscle wasting (decrease in SMVol or SMHU [ $\geq 20\%$ ]) between the baseline and 1-year follow-up scan and mortality was determined.

#### RESULTS

A total of 1,839 (7%) deaths occurred over a median follow-up of 6.5 years among the 26,144 participants (age  $61.4 \pm 5.0$  years; 40.9% female). At baseline, multivariable Cox regression revealed an independent association between SMVol SMHU and all-cause mortality after adjustment for age, sex, BMI, race, pack years, smoking status, prevalent diabetes or hypertension, prior myocardial infarction, prior stroke (SMVol: HR: 0.43, 95% CI [0.21-0.88];  $p=0.02$ ; SMHU: HR: 0.62, 95% CI [0.57-0.67];  $p<0.001$ ). Individuals with a decrease in SMVol or SMHU  $>20\%$  within one year had a significantly worse survival than those with stable SM measures (HR adjusted for the same risk factors. SMVol: HR 2.10, 95% CI [1.91-2.31],  $p<0.001$ ; SMHU: HR 1.78, 95% CI [1.62-1.95],  $p<0.001$ ). Similar results were obtained for the prediction of lung cancer and cardiovascular mortality.

#### CONCLUSION

Altered muscle status is an independent predictor of survival in a high-risk population of heavy smokers participating in a lung cancer screening trial. Deep learning allows for opportunistic assessment of this currently unused but prognostically relevant information with the potential to guide decision-making and improve personalized prevention.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning-based opportunistic screening of altered muscle status can identify individuals at increased risk of mortality beyond traditional risk factors in a screening setting. Implementation of such methods may provide a solution to inform risk assessment and improve patient management.

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## Abstract Archives of the RSNA, 2023

M5B-SPMK-9

### Ability of Radiofrequency Echographic Multi Spectrometry to Identify Bone Fragility in Subjects with Osteogenesis Imperfecta

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Carla Caffarelli, MEd, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Osteogenesis imperfecta (OI) is a heterogeneous group of heritable bone disease characterized by bone fragility, reduced bone mineral density (BMD), joint laxity, easy bruising, and variable short stature. This study aimed to evaluate the usefulness of the new Radiofrequency Echographic Multi Spectrometry (REMS) technique in the assessment of bone status in subjects with OI.

#### METHODS AND MATERIALS

In a cohort of 35 subjects ( $39.5 \pm 21.2$  years) with OI and in 30 healthy controls we measured BMD at the lumbar spine (LS-BMD), at femoral neck (FN-BMD) and total hip (TH-BMD) using a dual-energy X-ray absorptiometry device; TBS was calculated using TBS iNsight software. Moreover, REMS scans were also carried out at the same axial sites. Moreover, in OI subjects the presence of prior fractures was reported.

#### RESULTS

A total of 85.7% of patients presented with a fracture history. The most common fracture sites were extremity long bones (femur, tibia-fibula and radius-ulna) (70.0%) and at vertebral site (54.3%). BMD evaluated by DXA and REMS technique at all measurement sites were all significantly ( $p < 0.01$ ) lower in subjects suffering from OI than in controls. Dividing OI patients on the bases of Sillence classification, no differences between the BMD-LS values carried out with the DXA technique between OI type I group and OI Type III and IV group. On the contrary, the OI Type III and IV group presented significantly lower values of both TBS and BMD-LS by REMS with respect to patients OI type I ( $p < 0.05$ ) [figure 1]. TBS value presented significant correlations with both BMD-LS by DXA and BMD-LS by REMS technique, however, the better correlation was observed between TBS values and BMD-LS by REMS.

#### CONCLUSION

This preliminary study has shown that REMS appears to be an accurate non-ionizing technology able to assess the bone status in subjects with OI. The attractiveness of the use of REMS for bone measurements in OI patients lies in its lack of ionizing radiation, its ease of use and the portability. In fact, the REMS device can be used directly on patient's bed, and this could represent an excellent method for assessing the bone status even in OI subjects with a recent fracture.

#### CLINICAL RELEVANCE/APPLICATION

This is the first study that has evaluated the usefulness of REMS technology in adult patients with osteogenesis imperfecta. • Finding of a significant correlation between REMS and TBS • REMS could become an important tool able to assess the risk of fragility fractures so helping to overcome the limitations of DXA.

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## Abstract Archives of the RSNA, 2023

M5B-SPMS-1

### Detection and Characterization of Urinary Stone Using Virtual Non-contrast Images Derived from Two Dual-energy CT Scanners: A Phantom Study

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yannan Cheng, BS,BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the feasibility of virtual non-contrast images derived from dual-energy CT (DECT) for urinary stone detection and measurement at different iodine solutions and radiation doses

#### METHODS AND MATERIALS

Twenty-four urinary calcified stones (average size: 1.7-5.8mm) were placed in a custom-made cylindrical phantom filled with water and iodine contrast mixture at different degrees of concentration (0, 7, 13, 22, 30 and 57 mg/mL; CT attenuation value: 0, 200, 350, 600, 800 and 1500HU at 120kVp). Thirty-six scans with three radiation doses (CTDIvol) of 5, 10 and 15mGy at the above six iodine concentrations were performed with rapid tube voltage switching DECT (rsDECT) and dual-layer detector-based CT (dIDECT). True non-contrast images (TNC) and virtual non-contrast images (VNC) were reconstructed. Detection rate and measurement of urinary stones were assessed by two radiologists and statistically compared. Stone detection confidence was also assessed using 4-point grading scale (4: detectable; 3: iodine contrast agents and stones are distinguishable; 2: iodine contrast agents and stones are indistinguishable; 1: not detectable). Stones were considered detected only when the score was greater than 2 points. Size (length and width) and CT attenuation value were performed on the coronal image showing the maximal stone diameter.

#### RESULTS

Most stones were detected on both TNC and VNC images at different iodine concentrations (rsDECT: 91.7%-100%; dIDECT: 95.8%-100%) with detection confidence greater than 2 except VNC1500HU images (rsDECT: 8.3%-20.8%; dIDECT: 33.3%-45.8%) (Tab.1, Fig. 1). There was no statistically significant difference in stone detection rates among different radiation doses. Stone size and attenuation value on VNC images at different iodine concentrations were significantly lower than those of TNC images except the stone width on rsDECT (Tab.2 and 3). As the radiation dose increased, the measurement difference decreased on the VNC images from rsDECT, while not found on the dIDECT (Fig.2).

#### CONCLUSION

VNC images from the two dual-energy CT enabled reliable detection for urinary stone at moderate iodine concentrations (<30mg/mL) with less dependent on radiation dose. Stone size and CT value measurements were underestimated on VNC images.

#### CLINICAL RELEVANCE/APPLICATION

VNC images at different iodine concentrations and radiation doses are feasible to detect and measure urinary stones except higher iodine concentration. It should be noted that stone size and CT value measurements on VNC images were underestimated.

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## Abstract Archives of the RSNA, 2023

M5B-SPNMMI-1

### Deep Learning Reconstruction Enables High SNR at Low Counts in SiPM-based PET/CT Imaging

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

YUYA SHIRAKAWA, BSc (*Presenter*) Research funded, Nihon Medi-Physics Co, Ltd

#### PURPOSE

AiCE-i (Advanced intelligent Clear-IQ Engine-integrated) is an image reconstruction technique designed using deep learning for the Cartesion Prime SiPM-based PET/CT device from Canon. AiCE-i is a denoising reconstruction technique that effectively reduces noise without compromising contrast, leading to stable, high signal-to-noise ratio (SNR) images even with fewer counts contributing to image generation. In this study, we evaluated the relationship between counts and PET image SNR using clinical images with both the conventional method and the new deep learning reconstruction technique.

#### METHODS AND MATERIALS

We analyzed the relationship between liver SNR and counts (True+Scatter) in clinical images of 54 patients who underwent 18F-FDG PET/CT imaging using a SiPM-based PET/CT scanner, Cartesion Prime. The average weight of the patients was  $62.5 \pm 12.5$  kg. All cases underwent at least 4 hours of fasting before PET/CT, and after injection of  $233.3 \pm 51.1$  MBq of 18F-FDG, patients were instructed to rest quietly for 60 minutes. The injected dose per body weight was  $3.6 \pm 0.3$  MBq/kg. Data acquisition started  $60 \pm 7$  minutes after administration, and list-mode acquisition was performed for 5 minutes/bed at the position that included the liver the most (27 cm/bed), followed by 30sec/bed reconstruction from 30 to 300 seconds. The 3D-OSEM method with subset 12, iteration 3, time-of-flight (+), PSF correction (+), and reconstruction using Clear Adaptive Low-Noise Method (CaLM) and AiCE-i were performed. The obtained data were divided into two groups: CaLM and AiCE-i, and statistical analysis was performed using the Kruskal-Wallis test. In the case of significant differences in the multiple comparisons test (Dunn-Bonferroni) for three or more samples, the test was performed. P-values less than 0.05 were considered statistically significant in all analyses.

#### RESULTS

To achieve liver SNR of 10 or higher, which is recommended by the Japanese Society of Nuclear Medicine, a data acquisition time of 120 seconds using CaLM and 30 seconds using AiCE-i was required. In addition, with CaLM, liver SNR increased with increasing counts from 30 to 300 seconds (5.5-16.4,  $r_s=0.98$ ), whereas with AiCE-i, approximately constant liver SNR was obtained from 30 to 300 seconds, which did not correlate with counts (13-16,  $r_s=0.005$ ).

#### CONCLUSION

Using the deep learning reconstruction technique AiCE-i in SiPM-based PET/CT enables stable high liver SNR even with lower counts contributing to image generation, compared to conventional methods.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning reconstruction in SiPM-based PET/CT improves spatial resolution and contrast, allowing high SNR images at low counts, reducing patient burden and radiation exposure.

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## Abstract Archives of the RSNA, 2023

M5B-SPNMMI-2

### Tolerability of Lutetium-177-PSMA-617 in Men with Prostate Cancer and Baseline Cytopenia

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Ahmad Abdelrazek (*Presenter*) Nothing to Disclose

#### PURPOSE

Results from the VISION trial (NCT03511664) led to the approval of lutetium-177 (177Lu)-PSMA-617 for the treatment of metastatic castration-resistant prostate cancer (mCRPC). This trial excluded patients with baseline cytopenias, thus safety in this frequently encountered patient population is unknown. We aimed to use real-world data to describe the tolerability of radioligand therapy in those with poorer bone marrow reserve.

#### METHODS AND MATERIALS

We retrospectively reviewed the records of all patients, who received a first dose of 177Lu-PSMA-617 at Mayo Clinic in the interval of April 26, 2022, to December 1, 2022. Patients were categorized as having poor marrow reserve on the basis of pre-treatment hematologic parameters, including: (1) an anemia cohort with hemoglobin (Hg) less than 9 g/dL, (2) a thrombocytopenia cohort with platelets (Plt) less than  $100 \times 10^9/L$ , (3) a leukopenia cohort with white blood cell count (WBC) less than  $2.5 \times 10^9/L$ , and (4) a multiple cytopenia cohort. These were exclusionary parameters from the VISION trial. Longitudinal laboratory data and clinical outcomes were collected and analyzed using descriptive statistics.

#### RESULTS

At data cutoff, 273 patients had received one or more doses of 177Lu, including 33 (12%) with at least one baseline cytopenia prior to their first cycle of treatment. In total, there were 25 (76%) patients with anemia, 4 (12%) with thrombocytopenia, 2 (6%) with leukopenia, and 2 (6%) with multiple cytopenias at baseline. The median number of cycles received thus far is 4, including 21 (64%) who are still receiving therapy and 12 (36%) who have permanently discontinued treatment. Median longitudinal changes in blood counts for the anemia cohort are presented in Table 1. Reasons for treatment discontinuation include: toxicity (n=5), disease progression (n=4), or death (n=8). Among the 9 patients who stopped 177Lu for toxicity or disease progression, 5 subsequently also died. Dose reductions or treatment delays for worsening myelosuppression were utilized in 8 (24%) and 8 (24%) patients, respectively. Transfusions of packed red blood cells or platelets were required for 26 (78%) patients. A total of 16 (48%) received care in the emergency department or were hospitalized.

#### CONCLUSION

Treatment discontinuation for toxicity was rare among men with mCRPC and baseline cytopenias, while receiving 177Lu; however, these patients have an overall poor prognosis.

#### CLINICAL RELEVANCE/APPLICATION

Patients with initial cytopenia have been excluded originally from the Vision trial and in our study, we found that this group of patients can safely receive 177-PSMA Lutetium.

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## Abstract Archives of the RSNA, 2023

M5B-SPNPM-1

### **Determining the Utility of Augmented Reality Coupled with Diagnostic Medical Sonography: A Potential Workflow Improvement**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Kevin D. Evans, PhD, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To systematically investigate the advantages and challenges related to the workflow implementation of augmented reality (AR) technology, specifically using the Microsoft HoloLens version 2 (HL2) (MediView LLC), paired with a portable ultrasound (US) equipment system.

#### **METHODS AND MATERIALS**

After obtaining IRB approval, multiple data collection methods were employed to assess the utility of AR for US applications. A diverse sample of US users, ranging in experience levels, were invited to participate in a video training session, a hands-on demonstration, and remote instruction while wearing the HL2, connected to a portable US system. The duration of participants' tasks was recorded, both with and without the AR platform. Participants' postures and positions were evaluated using the Rapid Upper Limb Assessment (RULA)<sup>1</sup>, which assesses ergonomic risk factors linked to body positioning and muscle usage. Subjects also completed the System Usability Scale (SUS) (IBM, Armonk, New York), a reliable tool for measuring usability consisting of a 10-item questionnaire. Lastly, participants were invited to share qualitative feedback regarding the AR system evaluation.

#### **RESULTS**

A total of 12 US users provided data during their individual sessions, with and without AR. The time spent on simulated work, both with and without the products, remained consistent, as a group. The RULA scores for the group indicated a lower (better) upper extremity sub-score and a statistically significant lower neck sub-score ( $p < 0.05$ ) when using AR. This suggests a reduced risk of repetitive stress injury when using AR compared to a traditional US examination. Post-test data revealed positive SUS scores, reflecting favorably on both the product and the education and training provided. Participants consistently expressed interest in having access to additional post-processing ultrasound equipment system controls while using the HL2 (i.e., overall gain, power, etc.). Qualitative exit interviews highlighted participants' enthusiasm for incorporating AR systems into their respective clinical workflow.

#### **CONCLUSION**

Although larger studies are necessary to validate these initial findings, this cohort identified numerous opportunities for integrating the AR platforms such as the HL2 and portable ultrasound systems. Preliminary evidence suggests that AR usage may offer occupational health benefits when the workflow includes providing ultrasound guidance.

#### **CLINICAL RELEVANCE/APPLICATION**

Implementation of AR systems for US, have the potential to decrease repetitive stress injuries related to ergonomics in the workplace thereby increasing the productivity and longevity of clinical staff.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-SPNPM-2

### Online Search Trends Correlation with Imaging Volumes for Screening Mammography and Low-Dose Chest CT: A Multicenter Retrospective Five Year Study of 800,000 Examinations

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Public awareness of disease and screening programs increases participation in cancer prevention programs. We assessed the correlation between the online search trends and the volume of clinical requests and scheduling for breast and lung cancer screening with mammography and low-dose CT (LDCT) in multicenter settings of a predominantly urban population.

#### METHODS AND MATERIALS

We first obtained the search interest for the terms "lung cancer" and "lung cancer screening," "breast cancer," and "breast cancer screening" from Google Trends data for the entire United States in the last five years (1st Jan 2018 to 31st Dec 2022). Google trends data are displayed as a linear graph on a scale of 0 to 100, where 100 is the peak popularity, and 0 means insufficient data. The weekly trend data were exported to Microsoft Excel. Next, we queried our radiology report search and analytic engine (Nuance mPower) to obtain data on physician orders for mammography and LDCT examinations per week over the same five years. We then performed a Pearson correlation between the weekly Google trends data and the ordered and performed mammography and LDCT.

#### RESULTS

Over the 260-week study duration, 779,366 mammograms and 43,035 LDCT were performed across the 17 sites. There was a significant correlation between the Google trends for "breast cancer screening" and "lung cancer screening" with the corresponding volume of the ordered ( $r=0.48-0.55$ ) and performed ( $r=0.43-0.55$ ) mammograms and LDCT exams. Upon omission of word "screening," the Google trends for "lung cancer" and "breast cancer" had a much weaker correlation with the volumes of ordered ( $r= -0.07-0.37$ ) and performed ( $r= -0.06-0.23$ ) mammograms and LDCT examinations. Google search spikes during cancer awareness weeks had a stronger correlation with imaging volume surges in breast cancer than for lung cancer.

#### CONCLUSION

Increased interest in "screening" for breast and lung cancer, as reflected in Google trends data, correlates with an increase in the utilization of screening mammography and LDCT.

#### CLINICAL RELEVANCE/APPLICATION

Concerted and sustained online efforts aimed at screening awareness can help enhance the utilization of screening exams and help reduce mortality associated with lung and breast cancer.

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## Abstract Archives of the RSNA, 2023

M5B-SPNPM-3

### Formal Wellness Training of Academic Radiology Leaders Improves Work-Life Conflict

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jay R. Parikh, MD, FRCPC (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the effect of formal leadership training of academic radiology leaders within an academic center on their own burnout and professional fulfillment.

#### METHODS AND MATERIALS

The study cohort were academic radiology leaders within one of the largest academic organizations of academic radiologists within the United States. All academic radiology leaders within the organization were electronically mailed a weblink to a confidential IRB-approved survey in April 2021. The survey included validated questions from the Stanford Professional Fulfillment Index (PFI), values alignment, teamwork, overload, and work family conflict. Academic leaders were invited in May 2021 to participate in instructor-led formal training on leading wellness focusing on 5 core leadership skills - emotional intelligence, self-care, resilience support, demonstrating care, and managing burnout. An identical follow-up survey was electronically mailed 6 months after initial training in November 2021.

#### RESULTS

The overall response rate of academic radiology leaders was 59 % (19/32). For both measures, there was acceptable internal consistency (Cronbach's  $\alpha = 0.63$  for work exhaustion and  $\alpha = 0.90$  for fulfillment). There was statistically significant improvement in work family conflict (3.32 vs 2.86;  $p=0.04$ ). No statistically significant differences were identified for fulfillment, work exhaustion, alignment, work overload and teamwork scores after training.

#### CONCLUSION

Formal instruction in leading wellness improved work-life conflict for academic radiology leaders. There was no significant change in burnout, fulfillment nor organizational alignment of the leaders.

#### CLINICAL RELEVANCE/APPLICATION

Formal instruction in leading wellness raised awareness and improved work-life conflict in academic radiology leaders.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-10

### Advanced MRI Techniques in the Diagnosis of Amyotrophic Lateral Sclerosis (ALS): Morphometry, DTI, ASL Perfusion and BOLD Connectivity

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jose Manuel Hidalgo Gomez De Travecedo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Amyotrophic lateral sclerosis (ALS) is a chronic and progressive neurodegenerative disease characterized by damage to the upper and lower motor neuron, whose diagnosis is currently based on clinical criteria. This study aims to analyze structural and functional MRI parameters in ALS patients to define imaging biomarkers.

#### METHODS AND MATERIALS

An observational cross-sectional study was conducted with a sample of 71 subjects; 34 patients diagnosed with ALS according to El Escorial criteria and 37 age and gender-matched healthy subjects. All participants underwent a basal 3T-MRI including 3D T1WI morphometric sequences, Susceptibility Weighted Imaging (SWI), Diffusion Tensor Imaging (DTI), perfusion Arterial Spin Labeling (ASL) and functional MRI (BOLD), as well as a neuropsychological evaluation. Patients underwent a second MRI and neuropsychological assessment six months later. Post-processing analysis was performed using FreeSurfer, MRTrix, TBSS, BASIL and CONN toolbox software.

#### RESULTS

Morphometric analysis demonstrated greater cortical atrophy in ALS patients, highlighting rolandic regions with left predominance, bilateral amygdala and cerebellum. An association between atrophy and some clinical phenotypes, including cognitive impairment, was found. Greater iron deposition in the rolandic cortex of the patients was quantified by SWI. DTI analysis identified widespread white matter damage in ALS patients, with decreased fractional anisotropy and increased mean diffusivity, in anterior temporal lobe and left frontal lobe. Asymmetric left predominantly disruption of the proximal corticospinal tract (CST), left superior longitudinal fasciculus and frontal aslant tract damage were also notified. Functional connectivity showed foci of motor network impairment in superior and middle frontal gyri and left fusiform gyrus. At six-month reassessment, patients showed an asymmetric progression of the atrophy in rolandic cortex, predominantly right, and cingulate gyrus; further disruption of white matter tracts in frontal and temporal lobes, corpus callosum and CST; and small areas of increased connectivity in motor network and DMN.

#### CONCLUSION

Advanced MRI techniques permit the identification of structural and functional damage in the brain of ALS patients and demonstrate progression of the atrophy over time. Involvement of motor and extra-motor areas was objectified, supporting the relationship between this condition and the group of frontotemporal dementias.

#### CLINICAL RELEVANCE/APPLICATION

ALS is a rare and fatal disease whose diagnosis, based on clinical parameters, is often delayed. Imaging biomarkers through advanced MRI techniques could improve diagnostic accuracy and positively impact healthcare practice.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-11

### Prediction of Conversion to Parkinson's Disease in Individuals with Prodromal Symptoms through a Machine Learning Model using MRI

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Na-Young Shin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Prodromal Parkinson's disease (PD) is the phase during which progressive neurodegenerative pathology is initiated, but motor features necessary for the diagnosis of PD are not yet manifested. Such preclinical nature of prodromal PD leads to the notion that prodromal PD could be considered as being somewhere in between healthy and PD. In this study, we tested the notion by classifying individuals with prodromal PD into those close to healthy and PD respectively and checking plausibility of such distinction.

#### METHODS AND MATERIALS

From the Parkinson's Progression Markers Initiative (<https://www.ppmi-info.org/>), 75 healthy individuals (59.9±11.3 years, 26 women), 132 individuals with PD (60.7±9.2 years, 44 women), and 66 individuals with prodromal PD (62.3±7.6 years, 31 women) for whom structural and diffusion-weighted MRI data were available at the baseline were included. A machine learning model for distinguishing healthy and PD was constructed using the random forests method based on brain structural features in terms of cortical thickness in 62 grey matter regions and fractional anisotropy in 48 white matter regions. The constructed model was externally tested for additional individuals (83 healthy individuals and 130 individuals with PD). Individuals with prodromal PD were divided into healthy-like and PD-like ones by making predictions with the model, while development of PD at follow-ups was assessed for them.

#### RESULTS

For individuals with prodromal PD, motor symptoms as assessed with the Unified Parkinson's Disease Rating Scale Part III was significantly lower than individual with PD. In classifying healthy and PD, the machine learning model showed adequately high performance in cross-validation (accuracy = 91.3%) and external validation (accuracy = 93.8% for healthy individuals and 86.7% for individuals with PD). When the model was applied to individuals with prodromal PD, 40 were classified as PD-like ones while the other 26 were classified as healthy-like ones. Of 26 individuals with prodromal PD who were classified as PD-like ones, 8 (30.8%) converted to PD, while none of those who were classified as healthy-like ones were found to develop PD later ( $p = 0.018$  in Fisher's exact test).

#### CONCLUSION

The externally validated machine learning model for classifying healthy and PD could be used to distinguish healthy-like and PD-like ones among individuals with prodromal PD. Occurrence of all PD converters in PD-like ones suggests that individuals with prodromal PD could be differently positioned on the course of PD development according to their individual risks.

#### CLINICAL RELEVANCE/APPLICATION

Distinguishing PD-like ones from healthy-like ones among individuals with prodromal PD may help to assess the risk of developing PD.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-12

### Quantitative Parameter Mapping of Brain Structure and Components in Parkinson's Disease and Progressive Supranuclear Palsy

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Yuki Matsumoto, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our aim was to simultaneously evaluate changes in brain structure and components, depending on the level of dopamine receptor cells, in Parkinson's disease (PD) and progressive supranuclear palsy (PSP) using the quantitative parameter mapping (QPM) technique. Additionally, we investigated whether there were differences in the quantitative values of proton density, T1, T2\*, and quantitative susceptibility mapping (QSM) between PD and PSP patients.

#### METHODS AND MATERIALS

A total of 44 patients with PD and PSP Richardson syndrome (PSP-RS), all of whom provided informed consent, underwent a 3T MRI brain scan (FUJIFILM Healthcare Corporation) and ioflupane [<sup>123</sup>I] SPECT (DaTscan, SIEMENS Healthcare). In this study, the quantitative values of proton density, T1, T2\*, and QSM images were generated. Additionally a synthetic T1-weighted (T1w) image was computed from the T1 map. FreeSurfer was used to estimate the brain volume, cortical thickness, and local gyrification index (LGI) in each region from the synthetic T1w data of these patients. Furthermore, regions of the left and right substantia nigra and red nucleus were determined by drawing a region of interest (ROI) for each patient. The parcellated results were then compared to the average specific binding ratio (SBR) adjusted by age, or the asymmetry index (AI) in the striatum using Pearson correlation coefficients (*r*). Subsequently, the mean proton density, T1, T2\*, and QSM values of each brain region were measured using the parcellated results so as to investigate the relationship between the average SBR and the mean quantitative values. Finally, the standardized mean difference (SMD) was calculated. For SMD calculations, patients with a SBR<4.5 were included to determine differences between PD and PSP patients.

#### RESULTS

We observed significant positive or negative correlations between the average SBR, cortical thickness, segmented volume, and mean quantitative values (refer to figure). Notably, the right amygdala exhibited the strongest correlation ( $r=0.54$ ), with a volume decrease observed depending on the average SBR. Our results were consistent with previous findings in cases when the correlation was strong.

#### CONCLUSION

Our findings suggested that QPM can simultaneously evaluate changes in brain structure and components related to dopamine receptor cell levels. Moreover, QPM may prove to be a valuable tool for differentiating between PD from PSP in future research.

#### CLINICAL RELEVANCE/APPLICATION

QPM has the ability to simultaneously detect changes in brain structure and components based on dopamine receptor cell levels, all within a short scan time. This makes it a valuable tool that may have clinical applications.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-13

### Cortical and Subcortical Morphological Alterations in Parkinson's Disease Patients with Depression

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Mingrui Qu (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to explore the alteration pattern of cortical thickness and subcortical volume in Parkinson's disease (PD) with depression and their correlation with the severity of the depressive symptom.

#### METHODS AND MATERIALS

PD patients with depression (PDD) (n=42), PD patients without depression (PDND) (n=26) and healthy controls (HC) (n=33) were studied. All subjects underwent a 3D-T1 sequence. FreeSurfer was used to derive measures of cortical thickness and deep grey matter nuclei volume. The FreeSurfer's QDEC was used for cortical thickness analysis and correlation analysis. Multiple comparisons were corrected with Monte Carlo Simulations set at  $P < 0.05$ . ANOVA was applied to compare the subcortical grey matter nuclei volume differences. Age, gender and education were included as covariates.

#### RESULTS

The demographic and clinical data are summarized in Table 1. PDD group showed decreased cortical thickness compared to HC in the bilateral superior frontal gyrus, left middle temporal gyrus, right superior temporal gyrus, right insula, and right bankssts. A lower cortical thickness was observed in PDND group compared to HC in the left superior frontal gyrus, right rostral anterior cingulate and right superior temporal gyrus. PDD group only showed decreased cortical thickness in the right superior temporal gyrus compared to PDND group (Figure 1, Table 2). Cortical thinning correlated with higher HAMD scores in the middle temporal gyrus (Figure 2). In subcortical nuclei, PDD group showed significantly reduced volumes in bilateral hippocampus ( $p < 0.001$ ), bilateral amygdala ( $p = 0.008$ ), left thalamus ( $p < 0.001$ ) and right nucleus accumbens ( $p < 0.001$ ) compared to HC. PDD group showed significantly reduced volumes in left thalamus ( $p = 0.008$ ) and right nucleus accumbens ( $p = 0.001$ ) compared to PDND group. However, the volume of bilateral caudate and putamen ( $p < 0.01$ ) increased significantly compared with HC in the two PD groups (Figure 3).

#### CONCLUSION

Depression has an impact on subcortical nuclei volume and cortical thickness in PD patients. Alterations were found in the frontotemporal regions, thalamus, nucleus accumbens and limbic brain region. Interestingly, this study indicated the volumes of bilateral putamen and caudate increased in the PD group; the effect may be due to a compensatory response to impaired cerebral function in early PD.

#### CLINICAL RELEVANCE/APPLICATION

We explored the alteration pattern of cortical thickness and subcortical nuclei volumes in PDD. Our study implies the distinct effects of the frontotemporal regions, thalamus, nucleus accumbens and limbic brain region on emotional regulation in PD patients. Our results may guide the discovery of neuroimaging markers and underlying mechanisms related to emotional disorders in PD.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-14

### Advanced MRI Neuroimaging Biomarkers in Alzheimer's Disease and Their Association with Liquid Biopsy

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jose Manuel Hidalgo Gomez De Travededo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Alzheimer's disease (AD) is the most frequent cause of age-related dementia, but it is only suspected when clinical cognitive decline appears and, by then, neural damage is already irreversible. The aim of this study is to define MRI biomarkers to improve diagnostic accuracy and to investigate their relationship with the recently described technique of liquid biopsy (LB).

#### METHODS AND MATERIALS

An observational cross-sectional study was conducted with a sample of 150 subjects; 59 patients diagnosed with "dementia due to probable AD" according to NIA-AA criteria and 91 age- and gender-matched healthy subjects. Both groups were drawn from the cohort of a previous neuroepigenetic investigation (iBEAS) carried out in our institution. Participants underwent a 3T MRI including T1WI morphometric sequences, diffusion tensor imaging (DTI) and Arterial Spin Labeling (ASL) perfusion assessment. Post-processing analysis was performed using FreeSurfer, TBSS and BASIL software. iBEAS group had previously identified in LB a series of differentially methylated genes in patients with AD that were proposed as potential biomarkers. In the current project, its association with the alterations detected in MRI was investigated.

#### RESULTS

Morphometric analysis showed a marked cortical atrophy in AD patients, highlighting gray matter loss in medial temporal lobe and thalamus. In addition, certain relationships were demonstrated between clinical and epidemiological variables such as age, sex, time of evolution and score on the Mini Mental State Evaluation and atrophy. DTI revealed damage in corpus callosum and fornix, fronto-parieto-temporal deep white matter and parahippocampal gyri. ASL showed hypoperfusion in dorsolateral prefrontal cortex, inferior parietal and temporal lobe and posterior cingulate/precuneus. In the analysis of the results of the liquid biopsy, patients with differentially methylated IRS-2 and TREM-2 genes presented foci of cortical atrophy in the left frontal, right temporal, and bilateral parietal lobes; and in the lower region of the left cerebellar hemisphere respectively. DTI analysis showed greater disruption of white matter tracts in patients with differentially methylated APOE E4, IRS-2 and TREM-2.

#### CONCLUSION

Advanced MRI permits the identification of structural and perfusion brain damage in AD. The association between differential methylation of some genes studied by LB and the pattern of brain atrophy could open the door to the development of new biomarkers of the disease.

#### CLINICAL RELEVANCE/APPLICATION

AD is a frequent condition whose current diagnosis is mainly clinical and in most cases delayed. Advanced MRI biomarkers and liquid biopsy could improve diagnostic accuracy and positively impact healthcare practice.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-3

### The Accero-Rex-Stent - A Giant Stent For Giant Aneurysms

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Hermann Kraehling, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Until now, the treatment of giant fusiform aneurysms of the posterior circulation has been a disease that is difficult or impossible to treat, mostly due to the lack of availability of a large-format stent. In this multicentre study, we report on the world's first five clinical deployments of the Accero-Rex-Stents (Acandis) for the treatment of fusiform giant aneurysms.

#### **METHODS AND MATERIALS**

The Accero-Rex-Stents are self-expanding, braided, fully radiopaque Nitinol stents. They are available in three different sizes (diameter 7 - 10 mm, length 30 - 60 mm) and intended for implantation in vessels with diameters of 5.5 - 10 mm. The stents were implanted in aneurysm of the posterior circulation.

#### **RESULTS**

Five patients with large fusiform aneurysms of the posterior circulation were treated endovascularly using the Accero-Rex-Stents. There were no major technical complications peri- and post-intervention and the implanted stents showed proper contrast perfusion in all follow-up examinations. A significant remodelling and reduction in the size of the stent-covered aneurysms was already seen in the short-term post-interventional course, no major clinical complications occurred.

#### **CONCLUSION**

The Accero-Rex-Stents were used safely in five patients for the treatment of fusiform aneurysms of the posterior circulation without any technical complications. The treatment options of giant fusiform aneurysms are extended by the Accero-Rex-Stents.

#### **CLINICAL RELEVANCE/APPLICATION**

The treatment options of giant fusiform aneurysms are extended by the Accero-Rex-Stents.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-SPNR-5

### **A Systematic Search and Analysis of Diagnostic Reference Levels (DRLs) in Interventional Neuroradiology (INR)**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Marvin Grech (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to identify whether DRLs for diagnostic and interventional neuroradiology have been previously published and whether any guidelines specify optimal or maximum safe doses for various INR procedures. DRLs are crucial in standardizing practice and may potentially reduce radiation doses during such interventions. In general, INR procedures tend to be associated with high radiation doses both to the patient and operators.

#### **METHODS AND MATERIALS**

An extensive electronic search of the literature was performed using 3 different databases, namely Scopus, Web of Science, and PubMed, without language restrictions. Four main keywords were identified for this search as follows: Dose Area Product (DAP), Fluoroscopy Time (FT), Cumulative Air Kerma (CAK) and Diagnostic Reference Levels (DRLs). The keywords and various synonyms were integrated using the Boolean operators "OR" and "AND". A reference management software was used to import the search results from the 3 databases and the results were scanned for duplicates. Strict inclusion and exclusion criteria were developed, and the abstracts were scanned to check whether the studies met the inclusion criteria. All exclusion and inclusion decisions were documented via the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA).

#### **RESULTS**

The included studies were categorised into 4 main groups: - namely 'Cerebral Angiography', 'Aneurysm Coiling', 'Stroke (Thrombectomy)' and 'AVM/AVF Embolization'. The 3rd Quartile Values for DAP, Air Kerma, Fluoroscopy Time and Image Frames from each of the included studies recorded and tabulated for the 4 categories. Analysis of these values were then performed and screened for significant differences. The authors also sought to identify potential reasons for such discrepancies within the included studies.

#### **CONCLUSION**

To date, few studies have published data regarding DRLs in INR procedures. Guidelines are necessary both for quality control and to reduce procedural radiation doses to "as low as reasonably achievable" as per the "ALARA" principle. This analysis has gathered all the available literature on the matter and may help in future development of standard acceptable doses in INR.

#### **CLINICAL RELEVANCE/APPLICATION**

Identification and analysis of DRLs in INR procedures is essential for subsequent development of recommended radiation doses. Adherence to such recommendations may reduce radiation exposure to "as low as reasonably achievable".

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-7

### Selective Aberrant Alterations in Structural-functional Coupling of Large-scale Brain Networks with Progressive Supranuclear Palsy

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Junyu Qu, BMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

We combined functional and structural connectivity to investigate both global and modular-specific topology changes in the brain following progressive supranuclear palsy (PSP). We also hypothesized that the disruption of connections may lead to structural-functional (S-F) connectivity alterations.

#### METHODS AND MATERIALS

In our study, 51 PSP and 101 healthy control (HC) subjects were enrolled. These participants underwent 3D-T1WI, rs-fMRI, DTI and neuropsychological assessment. Furthermore, two weighted adjacency matrices, representing the structural and functional connectome, were created using the same cortical parcellation. S-F coupling was determined to use the Spearman rank correlation. Then, the intramodular and intermodular connectivity strengths were computed and the graph-theoretic method was used to calculate network topology metric. Finally, we make correlations between clinical scales and S-F coupling.

#### RESULTS

For structural connectivity network (SCN), compared with HCs, the intramodular structural connectome of PSP in subcortical cortex (SC) decreased significantly. The intermodular SCN between SC and the sensorimotor network (SMN) decreased, while the connections between SC and limbic network increased (FDR  $q < 0.001$ ). The characteristic path length ( $L_p$ ) was significantly increased. At the nodal level, these alterations were in SMN, dorsal attention network (DAN), ventral attention network (VAN), frontoparietal network, default mode network (DMN) and SC. For functional connectivity network (FCN), the intramodular functional connectome of PSP in DMN decreased significantly. As the intermodular FCN, DAN-DMN, DAN-SMN, DAN-VAN and DAN-VN decreased (FDR  $q < 0.001$ ). At the global level, the normalized clustering coefficient (?), small worldness ( $s$ ) and  $L_p$  were significantly increased and normalized characteristic path length (?) was decreased. Both PSP and HC groups showed significant correlations in regional S-F connectivity ( $P < 0.05$ ). Besides, we compared regional S-F coupling between PSP and HC by two-sample T-test. We found that PSP increased significantly in visual network (VN), VAN and DMN. Finally, there is no association between S-F coupling and clinical variables.

#### CONCLUSION

The S-F coupling features in PSP are aberrant. These results could contribute to better comprehending the relationships between structural and functional underlying the motor impairments in PSP.

#### CLINICAL RELEVANCE/APPLICATION

Our study discovered increased S-F coupling in PSP, which would indicate the additional breakdown of coherence between brain function and structural connections after brain damage. These findings suggest that functional reorganization occurs along indirect anatomical pathways in PSP.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-8

### Development and Validation of a Deep Learning-based Automatic Brainstem Segmentation and Multi-class Classification Algorithm for Parkinsonian Syndromes using 3D T1-Weighted Images

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Seongken Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a deep learning-based automatic brainstem segmentation and multi-class classification algorithm for parkinsonian syndromes.

#### METHODS AND MATERIALS

The model was developed using 3D T1-weighted brain MR images from subjects that were either cognitively normal or had progressive supranuclear palsy, multiple system atrophy of the cerebellar variant, or Parkinson's disease. We used 2D U-NET for architecture and a multi-view ensemble strategy. The final output was inferred using ensembled probabilities. To assess our segmentation performance using Dice similarity coefficient (DSC), we compared segmentation masks with manual labels in both training and external datasets. We evaluated classification performance based on the regional volumetric measurements obtained from segmentation. The multi-class performance was evaluated using five-fold cross-validation. Three classification models based on support vector machine (SVM), random forest, and XGBoost were trained. We adopted the area under the receiver operating characteristic curve (AUROC) as a representative value of classification performance.

#### RESULTS

In total, 300, 513, 82 eligible patients were recruited as training, internal, and external dataset, respectively. Our model achieved DSC scores of 0.969 and 0.996 in the training and external datasets, respectively, when compared to the manually labeled ground truth masks for the brainstem region. The multi-class classification algorithm using SVM showed higher differentiation performance than the two other approaches. The AUROCs for SVM were  $0.937 \pm 0.022$  ( $\pm$  standard deviation) and 0.914 for internal and external validation, respectively.

#### CONCLUSION

We developed and validated a deep learning model using 3D T1-weighted brain MR images which may allow for fast and accurate differentiation of parkinsonian syndromes.

#### CLINICAL RELEVANCE/APPLICATION

Considering the widespread availability of T1-weighted brain MRI, this automated brainstem segmentation algorithm might be a promising and widely applicable method for the differentiation of parkinsonian syndromes in the clinical practice.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR-9

### Alterations in T1, Proton Density and T2\* Properties of Deep Brain Nuclei in Parkinson's Disease Patients Measured by Synthetic MRI

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jinghan Zhao (*Presenter*) Nothing to Disclose

#### PURPOSE

Combined application of T1, proton density and T2\* map for the differential diagnosis of Parkinson disease (PD) from health controls with the Strategically Acquired Gradient Echo (STAGE) technique.

#### METHODS AND MATERIALS

41 PD patients and 38 volunteers as the control group were prospectively enrolled. Brain MRI examinations, including STAGE, were performed at 3T (Ingenia CX, Philips Healthcare, the Netherlands). T1, proton density and T2\* maps were obtained after post-processing. The nuclei included in this study were caudate nucleus (CN), putamen (PUT), globus pallidus (GP), thalamus (THU), red nucleus (RN), black nucleus (SN) and dentate nucleus (DN). The regions of interest (ROIs) to cover these structures were manually drawn on T1, proton density and T2\* maps by two researchers using SPIN (Signal Processing in NMR, SpinTech, Inc., Bingham Farms, MI, United States), and the mean value within each ROI was measured and recorded. Statistical analysis was performed using SPSS20.0 software, and the normal distribution was tested in each group. Data in accordance with normal distribution were expressed as means  $\pm$  standard deviation, while the others expressed by median (upper and lower quartiles). Independent sample t-test or Mann-Whitney U test (not in accordance with normal distribution) were used to compare the mean values of T1, proton density and T2\* between PD and control group in both hemispheres, and the differences between the left and right were tested by independent sample t-test or Mann-Whitney U test. A P-value  $<0.05$  was considered statistically significant.

#### RESULTS

Compared to the control group, the T1 values of the CN, GP, RN and the proton density values of the CN, PUT, THU, RN were significantly reduced in the PD group, while the T1 values of the DN was increased. ( $P<0.05$ ) (Table 4-5, Figure 1-2). Meanwhile the T2\* value of the SN was significantly reduced and the THU was increased in PD patients. ( $P<0.05$ ) (Table 6, Figure 3). In control group, the T1 values ??of the right THU and DN and the proton density value ??of the right DN were significantly lower than when compared to their counterparts in the left. There was no difference in the T1 proton density and T2\* values between the affected side and the healthy side in the PD group. ( $P<0.05$ ) (Table 1-3, 7-9)

#### CONCLUSION

In summary, we found the alterations of T1, proton density and T2\* values may reflect the microstructural changes of deep brain nuclei.

#### CLINICAL RELEVANCE/APPLICATION

Combined application of T1, proton density and T2\* map for the differential diagnosis of Parkinson disease (PD) from health controls is potentially promising and valuable methods in clinical application.

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## Abstract Archives of the RSNA, 2023

M5B-SPOB-1

### Automatic Detection and Segmentation of Ovarian Epithelial Tumor using a Multitask Model in CT Images

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jing Ren, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

It is of great importance to identify the location and boundary of the ovarian tumors on medical images. The study aimed to develop and validate a multitask model utilizing the 3D nnU-Net framework in multicentric datasets, which can simultaneously complete the tasks of ovarian tumor detection and segmentation.

#### METHODS AND MATERIALS

Multiphase contrast-enhanced CT images from 748 patients who were histologically diagnosed with ovarian epithelial tumors between January 2016 and September 2022 were obtained from two medical centers. The internal dataset from center A consisted of a training set (n=405) and a testing set (n=135), and the external dataset contained 208 patients from center B. The manual annotations of the primary ovarian tumors by two professional radiologists were served as the ground truth of the datasets. The multitask model utilizing the 3D nnU-Net framework was trained for 500 epochs with a loss function that combined binary cross entropy loss and Dice loss. The training procedure involved the 5-fold cross-validation method, and the ensemble prediction was utilized. The segmentation performance was evaluated using the Dice similarity coefficients (DSCs), 95% Hausdorff distance (HD95), and Average Surface Distance (ASD). To evaluate the detection performance of the model, the recall and precision metrics were calculated.

#### RESULTS

The proposed multitask model exhibited good segmentation performance both in the internal and external testing sets, with average DSCs of 91.2% and 85.1%, respectively. The HD95 and ASD of the model were  $17.79 \pm 35.24$  and  $2.86 \pm 7.27$  in the internal testing set, and  $20.99 \pm 31.41$  and  $4.73 \pm 11.73$  in the external testing set. For the task of ovarian tumor detection, the model showed good performance (recall = 95.3% and precision = 72.9%) in the internal dataset, and promising result (recall = 88.7% and precision = 63.4%) in the external dataset.

#### CONCLUSION

The proposed multitask model shows promising in the automatic detection and segmentation of ovarian epithelial tumors.

#### CLINICAL RELEVANCE/APPLICATION

Our proposed multitask model can automatically and accurately complete the tasks of ovarian tumor detection and segmentation, thus avoiding time-consuming and labor-intensive manual operations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPOB-2

### Don't Forget about the Teens! Does Adenomyosis Also Affect Young Girls

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Ana Luiza G. Di Mango, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the difference in prevalence and pattern of adenomyosis between adolescents and reproductive-age adults patients.

#### METHODS AND MATERIALS

In a retrospective study, we evaluated the findings of dedicated pelvic magnetic resonance imaging (MRI) with a medical request of endometriosis/pelvic pain in 192 female patients, of which 96 were adolescents (aged between 11-19 years) and others 96 were reproductive-age adults. Two radiologists independently evaluated the exams. Adenomyosis was defined as the ectopic presence of endometrium as a punctuate high-intensity T2-weighted signal in the junctional zone (JZ) seen in MRI.

#### RESULTS

The prevalence of adenomyosis in adolescents patients was 8.3% (n=8) and in adult patients was 23% (n=22). Superficial adenomyosis was the most prevalent pattern in adolescent patients, with seven cases (87.5%), while only one case (12.5%) had deep adenomyosis with uterine cavity distortion. In adult patients, the most prevalent pattern of adenomyosis involvement was also superficial (n=11, 50%), followed by deep adenomyosis with uterine cavity distortion (n=8, 36.4%) and deep involvement without cavity distortion (n=3, 13.6%).

#### CONCLUSION

Adenomyosis, like in adults patients, is one of the manifestations of endometriosis in adolescents patients, with a difference in prevalence of 14.7% in our study. The most common pattern of involvement in both groups was superficial.

#### CLINICAL RELEVANCE/APPLICATION

The presence of pelvic pain and/or hypermenorrhea in adolescents patients should raise the suspicion of endometriosis, which despite being more common in adult patients, also affects the first group. Early suspicion and diagnosis of adenomyosis can reduce long-term morbidity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPPD-1

### Clinical Value of Virtual Unenhanced CT Images for Children with Hepatic Tumors: CT Measurement and Lesion Detection

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Wei Weian (*Presenter*) Nothing to Disclose

#### PURPOSE

To access the feasibility of multi-material decomposition based virtual unenhanced images (VUE) replacing true non-contrast (TNC) images in the CT follow-up of children with hepatic tumor

#### METHODS AND MATERIALS

This study retrospectively collected 24 children with hepatic tumor who received conventional non-contrast CT scan and sequent dual phase contrast-enhanced spectral CT scans. VUEs were generated at artery phase [VUE(A)] and portal vein phase [VUE(PV)]. Regions of interest were placed on liver parenchyma and tumor site, CT values were measured. The consistency of CT measurement on two-group images were accessed by Pearson analysis and Bland-Altman method. The detection rate of liver tumor lesions was also evaluated with pathologic examination and CT follow-up as standard reference.

#### RESULTS

The 24 children contained 10 with hepatoblastoma, 6 with hemangioma, 5 with focal nodular hyperplasia, 2 with hepatic metastases from neuroblastoma and 1 with lymphomatosis. Including 12 showing hypovascular and 12 cases showing hypervascular. The CT<sub>liver</sub> among three-group images shown no statistical difference (both  $P > 0.05$ ), while CT<sub>tumor</sub> were higher in VUEs than TNC ( $P < 0.05$ ). The CT<sub>liver</sub> and CT<sub>tumor</sub> between VUE(A) and VUE(PV) images exhibited strong positive correlation ( $r_{\text{liver}} = 0.878$ ,  $r_{\text{tumor}} = 0.972$ ,  $p < 0.001$ ). The CT<sub>liver</sub> showed strong correlations between TNC and VUEs [ $r_{\text{VUE(A)}} = 0.787$ ,  $r_{\text{VUE(PV)}} = 0.802$ ,  $p < 0.001$ ]. For CT<sub>tumor</sub>, VUE(PV) showed moderate correlation [ $r_{\text{VUE(PV)}} = 0.497$ ,  $p = 0.014$ ] while VUE(A) showed no correlation ( $r_{\text{VUE(A)}} = 0.394$ ,  $p = 0.057$ ) with TNC, however for hypervascular tumors the CT<sub>tumor</sub> had strong correlation between VUE(A) and TNC ( $r = 0.749$ ,  $p = 0.005$ ). Bland-Altman analysis displayed that the VUE(A) had 6 cases and VUE(PV) had 7 cases where the CT<sub>tumor</sub> bias to TNC larger than 10 HU, therein most had hypervascular lesions. For lesion detection, there were total of 111 lesions, TNC, VUE(A) and VUE(PV) had detection rates of 68.47%, 57.66% and 83.78%, respectively.

#### CONCLUSION

For CT follow-up of children with hepatic tumor, VUE(PV) could replace TNC, VUE(PV) had good correlation with TNC in CT<sub>liver</sub> and CT<sub>tumor</sub>, and VUE(PV) improved tumor lesion display and internal structure announcement.

#### CLINICAL RELEVANCE/APPLICATION

Patients with hepatic tumors need long-term CT follow-up, but children are sensitive to X-ray exposure, excessive radiation may affect growth and development. The CT values measured on the VUE(PV) generated from the enhanced spectral CT data are correlated with that on TNC, and VUE(PV) can improve the lesion detection, so VUE(PV) could replace TNC and reduce the radiation dose of one unenhanced CT scan in the follow-up of children with hepatic tumors.

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## Abstract Archives of the RSNA, 2023

M5B-SPPD-2

### A Comparative Analysis of Clinical and MRI Characteristics of Atypical Teratoid Rhabdoid Tumors and Medulloblastomas of the Posterior Fossa in Pediatric Patients

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Hsinwei Wu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Atypical teratoid rhabdoid tumor (AT/RT) typically presents at a younger age and had a poorer prognosis compared to medulloblastoma. Notwithstanding, these two neoplasms share a considerable degree of neuroimaging overlap and are nearly indistinguishable on MRI. The aim of our study was to discriminate between AT/RT and medulloblastoma through retrospective analysis of their clinical and MRI features, with the ultimate goal of improving treatment strategies and prognostic assessment.

#### METHODS AND MATERIALS

Between 2005 and 2022, a total of 16 patients with histopathologically confirmed AT/RT and 58 patients diagnosed with medulloblastoma were retrospectively enrolled from our institution. We evaluated their clinical data and MRI findings, including lesion signals, intratumoral morphologies, and peritumoral/distal involvement.

#### RESULTS

The age of children diagnosed with AT/RT was younger than that of children with medulloblastoma ( $2.8 \pm 4.9$  [0-17] vs.  $6.6 \pm 4.0$  [0-18],  $P < .001$ ), and the overall survival rate was lower (21.4% vs. 66.7%,  $P = .005$ ). With regards to lesion signals on MRI, AT/RT exhibited a lower ADCmin (cutoff value =  $544.7 \times 10^{-6}$  mm<sup>2</sup>/s, area under the curve [AUC]=0.845,  $P < .001$ ), a lower ADC ratio (cutoff value = .705, AUC=0.860,  $P < .001$ ), and a higher DWI ratio (cutoff value = 1.595, AUC=0.802,  $P < .001$ ) than medulloblastoma. In respect to the intratumoral morphologies, the manifestation of the "tumor central vein sign" was found to be predominantly limited to medulloblastoma while being absent in cases of AT/RT (24/58 [41.4%] vs 1/16 [6.3%],  $P = .008$ ). For the peritumoral invasion detected on T2WI, AT/RT demonstrated a greater propensity for invasion of the brainstem ( $P < .001$ ) and middle cerebellar peduncle ( $P < .001$ ) compared to medulloblastoma.

#### CONCLUSION

MRI findings that include a lower ADC value, greater peritumoral invasion, and the absence of a "tumor central vein sign" have shown promise in distinguishing AT/RT from medulloblastoma. These discernible MRI features, coupled with the comparatively younger age of AT/RT patients, may account for the inferior prognoses observed in this patient population.

#### CLINICAL RELEVANCE/APPLICATION

AT/RT can be distinguished from medulloblastoma based on specific MRI findings, such as a lower ADC value, greater peritumoral invasion, and the absence of the "tumor central vein sign." A combination of these MRI features and the patient's age can improve the accuracy of a pretreatment diagnosis of AT/RT versus medulloblastoma. This improved diagnostic accuracy can help guide treatment strategies and aid in prognostic assessment.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-10

### CT Number Reliability on Energy Integrating and Deep Silicon Photon Counting Detector CT with Patient Size

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Aria M. Salyapongse, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

In this study we compared the CT number of six clinically relevant materials on an energy-integrating detector (EID) and a prototype deep silicon photon-counting detector (PCD) CT as an effect of patient size.

#### METHODS AND MATERIALS

We performed three sets of dose-matched scans on a patient size-mimicking phantom (Mercury Phantom, Gammex), (1) 120 kV single-energy (SE) EID CT, (2) 80/140 kV rapid kV-switching dual-energy (DE) EID CT, and (3) 120 kV deep silicon PCD CT. Average CT number was calculated for air, water, polystyrene, iodine 10 mg/mL, bone, and polyethylene in (1) 120 kV polychromatic EID, (2) 70 keV monochromatic EID, and (3) 70 keV monochromatic deep silicon PCD image volumes. Trends in CT number with patient size were assessed by plotting CT numbers against phantom water equivalent diameter (WED). Slopes were compared using t-tests with multiple comparison adjustment to assess whether trends in CT number with WED were decreased for deep silicon PCD CT relative to EID CT. CT number accuracy was assessed by calculating ideal material CT numbers using the U.S. National Institute of Standards and Technology (NIST) XCOM database toolkit.

#### RESULTS

For all tested materials, deep silicon PCD CT had the smallest magnitude slope of CT number over WED. Deep silicon PCD CT slopes compared with SE EID CT and DE EID CT reached statistical significance for air ( $p = .03$ ,  $p = .007$ ), water ( $p = .02$ ,  $p = .03$ ), iodine 10 mg/mL ( $p < .001$ ,  $p = .04$ ), and bone ( $p < .001$ ,  $p < .001$ ). The accuracy of deep silicon PCD CT was higher than either SE or DE EID CT for all materials based on relative root mean square error. All materials except air had negative slopes for CT number with WED. The slopes for iodine and bone were smallest for deep silicon PCD CT, then DE EID CT, followed by SE EID CT: 20.3, 34.7, 81.5 HU/cm for iodine and 46.9, 113.1, and 186.6 HU/cm for bone, respectively.

#### CONCLUSION

The change in CT number over WED was smallest for deep silicon PCD CT for air, water, iodine 10 mg/mL, and bone. The CT number accuracy was closest to the ideal CT number on deep silicon PCD CT for all materials compared with SE and DE EID CT.

#### CLINICAL RELEVANCE/APPLICATION

Myriad characterizations in clinical radiology rely on accurate and stable CT numbers, use of deep silicon PCD CT could provide more consistent and accurate CT number over patient size and therefore better classification of tissue in clinical radiology.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-11

### Assessing the Efficacy of Multiple Additive Processing in Contrast Enhancement Boost CT Technique for the Diagnosis of Hypervascular Hepatocellular Carcinoma

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Shinji Yabe, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

For accurate diagnosis of hepatocellular carcinoma (HCC) in contrast-enhanced CT (CE-CT), providing better tumor-to-liver contrast is desirable. Recently, it has been demonstrated that a post-processing technique (CE-boost; Canon Medical Systems) can enhance the degree of contrast in CE-CT and facilitate HCC detection. In this technique, an iodine image can be obtained by subtracting the precontrast from the contrast phase image and is added to the contrast phase image with a non-rigid registration and denoising procedure. Despite the potential for further contrast enhancement via an additional additive process, the efficacy of this process remains unexplored. This study aimed to investigate the usefulness of the CE-boost technique with multiple additive processing for the evaluation of hypervascular HCC.

#### METHODS AND MATERIALS

This retrospective study included 21 patients (age,  $74 \pm 8$  years; 13 men) with 31 hypervascular HCCs who underwent multiphase CE-CT. In this study, the late arterial phase (LAP) and portal venous phase (PVP) images were used to evaluate hypervascular HCCs. In the LAP, three types of CE-boost images were created by one to three times additive processing (LAP A1, LAP A2, and LAP A3, respectively). Similarly, three types of CE-boost images were created in the PVP (PVP A1, PVP A2, and PVP A3). Tumor-to-liver contrast-to-noise ratios (CNRs) were calculated in the LAP and PVP and were compared among CE-CT and CE-boost images using the Wilcoxon signed-rank test with Bonferroni correction. Also, the presence or absence of artifacts caused by the CE-boost technique was evaluated using a 3-point scale (1= non-diagnostic, 2= slight artifact, and 3= almost no artifact).

#### RESULTS

The mean size of lesions was  $18.8 \pm 15.5$  mm (range, 8-93 mm). The tumor-to-liver CNR was significantly higher in CE-boost (LAP A3) images ( $7.0 \pm 3.9$ ) than in LAP ( $2.9 \pm 1.9$ ), CE-boost (LAP A1) ( $4.3 \pm 2.5$ ), and CE-boost (LAP A2) images ( $5.8 \pm 3.9$ ) (P<0.01 for all). On the other hand, there were no significant differences in tumor-to-liver CNR among CE-CT and CE-boost images in the PVP (P<0.99 for all). Artifacts due to the CE-boost technique were not noticeable in all CE-boost images and were rated 3.

#### CONCLUSION

The CE-boost technique with multiple additive processing can increase the conspicuity of arterial phase hyperenhancement of hypervascular HCC by improving the tumor-to-liver CNR. In contrast, improvements in tumor-to-liver CNR were not observed in the PVP for washout assessment of hypervascular HCC.

#### CLINICAL RELEVANCE/APPLICATION

CE-boost with multiple additive processing can improve the degree of contrast effect of CE-CT effectively. This technique is especially beneficial in the detection of focal liver lesions that show arterial phase hyperenhancement.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-12

### Low-dose Cerebral Perfusion CT Reconstruction Based on Voxel-level TAC Correction (VTC)

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Zixiang Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

To propose a low-dose cerebral perfusion CT (PCT) image reconstruction method and promote the application of PCT imaging in clinical cerebrovascular diseases (CVD) diagnosis.

#### METHODS AND MATERIALS

A regularized least-squares method with high interpretability based on voxel-level time-attenuation curve (TAC) correction (VTC) is proposed in this study for low-dose PCT image reconstruction. The theory of third-order Hermite interpolation (THI) is applied to voxel-level TAC correction during dynamic images reconstruction. Clinical PCT imaging data is involved for the evaluation of the proposed VTC method, with peak signal-to-noise ratio (PSNR) and structural similarity (SSIM) being the quantitative indexes for imaging performance measurements. Based on the reconstructed PCT images, hemodynamic maps, including cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transition time (MTT), are calculated to validate its ability to restore hemodynamic parameters.

#### RESULTS

Indicated by the PSNR and SSIM values of the low-dose PCT images reconstructed by different methods, the proposed VTC method for low-dose PCT imaging has better performance than several state-of-the-art dynamic CT imaging methods, including the PICCS, ndiNLM, PIDT and NL-T-RPCA methods. Meanwhile, VTC provides the most accurate hemodynamic maps (CBF, CBV and MTT) among all the compared methods.

#### CONCLUSION

The proposed VTC method is capable to reconstruct PCT image with satisfactory image quality under a low-dose PCT scan protocol.

#### CLINICAL RELEVANCE/APPLICATION

The VTC method remarkably reduced the necessary radiational dose for PCT scan. This meaningful for promoting the application of PCT technique in the clinical diagnosis of CVD.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-13

### Photo-realistic Virtual Endoscopy Images for CT Colonography

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Kuuya Shiuchi (*Presenter*) Nothing to Disclose

#### PURPOSE

Algorithms introducing photo-realism to the volume rendering (VR) have been investigated since early 2010s; as a result, some applications for photo-realistic VR (PRVR) have been clinically available. However, there are no applications for photo-realistic virtual endoscopy (PRVE) used for the CT colonography (CTC). An image-based deep-learning technique was proposed for CTC; however, CT-number information is ignored in it and it focused on a different reality. The purpose of this study was to investigate methodologies to achieve the PRVE for CTC and compare images between PRVE and a conventional VE.

#### METHODS AND MATERIALS

To achieve photo-realistic rendering in VE, the rendering calculation of PRVR was modified to suit to a typical viewing field of VE. Unlike the conventional VR for CT, the photo-realistic rendering reflects the CT-number gradient with small fractions in the shading. Thus, the PRVE improves spatial resolution and is less sensitive to the image noise similarly to PRVR. Exploiting this feature, we reconstructed CT images with a high-resolution kernel to improve shape reproducibility of lesions. For the conventional VE (VEc), a standard kernel for abdomen was used. The following parameters were not altered from routine ones: a slice thickness of 1.0 mm, a table position increment of 0.5 mm, and a CT dose index of  $\sim 3.8$  mGy. The averaged rendering time per frame (RT) was measured for consecutive 100 renderings. One radiologist visually evaluated the superiority of PRVE over VEc using a five-point scale (1: worse, 2: somewhat worse, 3: equal, 4: somewhat better, 5: better) for image sharpness, artifact, lesion conspicuity, and gross morphology of ten clinical cases.

#### RESULTS

The RTs of PRVE and VEc were 0.032 and 0.015 s, respectively. The average scores of visual comparisons for image sharpness, artifact, lesion conspicuity, and gross morphology were 5.0, 3.8, 4.1, and 5.0, respectively. The lesions were rendered more clearly with PRVE than with VEc, thanks to the photo-reality enhanced by the high-resolution kernel. Since the CT-number is reflected in the shading more in PRVE than in VEc, residual stools with tagging were able to be easily recognized in the PRVE images.

#### CONCLUSION

The PRVE for CTC exhibited high-quality VE images with better visual evaluations compared to the conventional VE. The PRVE would be effective visualization method for CTC.

#### CLINICAL RELEVANCE/APPLICATION

The PRVE can render lesions in CTC more clearly compared to the VEc. Moreover, it was effective in the fecal tagging because the CT number is more reflected in the PRVE rendering than in VEc rendering.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-2

### Advancing Optimization Strategies for Oncological Abdominal CT Scanning: The i-Violin EU Project Approach Applied to Photon Counting CT

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Gizem Yegin, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To propose CT optimization curves to improve oncological imaging of chest-abdomen CT as worked out in the i-violin EU4Health supported multicenter project for CT Guideline development.

#### METHODS AND MATERIALS

An anthropomorphic abdominal phantom with an extension ring (PTW, Germany) and a length of 17cm was scanned on a Siemens Naeotom Alpha photon-counting CT scanner (Siemens-healthineers, Germany). The phantom contains an in-house designed cylindrical insert placed in the center of it. The first half of the insert contains a collection of low-contrast spheres with sizes of 4, 6, and 8mm diameter (15 of each size) while the second half was background only to provide signal-free segments. CT acquisitions were performed with a large range of scanning parameters and reconstruction settings: tube voltage, CTDI, bowtie filter, reconstruction kernel, iterative reconstruction strength, field of view, matrix size, and slice thickness. An anthropomorphic channelized Hotelling model observer was used to predict the human detectability of the spherical targets. From the percentages of correctly detected spheres of the 3 diameters, the threshold diameter (Dtr) at 62.5% correct was determined via logistic regression (GraphPad Prism, USA), and the 95% CI were estimated via bootstrapping. Optimization curves were realized with all Dtr values for specific parameters, each obtained from all scans with these parameter values.

#### RESULTS

The results of most CT scan parameter combinations were as expected. As an example, a doubled CTDI value corresponds to a significantly lower Dtr ( $p < 0.001$ ). The results allow to compare the relative impact of the CTDI to other parameters. The switch to a smaller field of view, different slice thickness, bowtie filter, and iterative reconstruction strength did not lead to a significantly different low-contrast image quality ( $p > 0.07$ ). The change to 1024x1024 matrix size from 512x512 gave a significant performance increase ( $p = 0.001$ ). Interestingly, despite the use of the same CTDI, for the phantom with an extension ring, the 120 kVp scan outperformed the 90 kVp scan, while this effect was inverted without the ring.

#### CONCLUSION

From this systematic task-based comparison focused on soft tissue performance, it becomes possible to assess the effects of various parameters quantitatively. When completed with reference levels typically used by multiple centers, this approach may facilitate the development of practical guidelines to optimize CT scan protocols.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative and graphical representations of the Dtr values for the different conditions provide a fast approach to measures and parameter settings that would lead to improved soft tissue detection thresholds in abdominal oncological CT.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-3

### Evaluation of Low-contrast Detectability of Abdominal Protocols in Clinical Photon-counting CT

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Jessica D. Flores, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate and clear representation of anatomy is essential in the assessment of pathology in clinical computed tomography (CT). With the introduction of photon-counting CT (PCCT) and more advanced iterative reconstruction (IR) algorithms into clinical practice, there is potential to improve low-contrast detectability in clinical CT protocols. Therefore, this work aimed to assess IR image quality to optimize low-contrast detectability and reduce radiation dose in a clinical abdominal CT protocol.

#### METHODS AND MATERIALS

Data were acquired on a clinical PCCT scanner, Siemens NAEOTOM Alpha. Low contrast detectability was investigated in the CTP 515 low contrast module of the Catphan 600 phantom, which was surrounded by a fat ring to simulate an abdomen and resulted in a water equivalent diameter of 298-mm. Supra-slice contrast rods with a nominal 1.0 % contrast and diameters of 4, 6 and 9 mm were used. A factory abdominal protocol was adjusted to acquire virtual monoenergetic images (VMI) with four tube voltages and two quantum IR (QIR) strengths. VMI were produced at the mean energy of the applied spectrum. The noise power spectrum and task transfer function of each scan protocol was quantified; and detectability index and accuracy for each protocol was also determined using model (in-house non-prewhitening matched filter, NPW) and human observers (in-house 4-alternative forced choice, 4-AFC, scoring with standard deviation, SD), respectively.

#### RESULTS

Preliminary studies with a NPW model observer show that lower doses can be achieved without sacrificing low-contrast detectability of various target sizes when QIR strength is increased in clinical abdominal protocols. For a 6-mm 1% contrast target, detectability may be matched, regardless of tube potential setting, between a protocol using a CTDIvol of 10 mGy and QIR 2; and another protocol using CTDIvol of 5 mGy and QIR 4. Additionally, 4-AFC human observer studies confirm that detectability is relatively unchanged with different tube potential settings when VMI energy levels are selected to match the mean energy of the applied spectrum. For a 6-mm 1% contrast target imaged with a CTDIvol of 10 mGy and QIR 4, tube potential settings of 70, 90, 120, and 140 kVp yielded 4-AFC detective accuracy scores of  $68.3 \pm 2.6\%$ ,  $65.1 \pm 2.7\%$ ,  $63.7 \pm 2.7\%$  and  $60.6 \pm 2.7\%$ , respectively.

#### CONCLUSION

Lower doses can be achieved without sacrificing diagnostic capability and low-contrast detectability in clinical PCCT abdominal protocols when QIR strength is increased and appropriate VMI energies are selected.

#### CLINICAL RELEVANCE/APPLICATION

Comparing various settings in clinical abdominal protocols, this work investigates avenues for optimizing low-contrast detectability in PCCT while also reducing radiation doses.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-4

### Contrast-enhancement Boost Technique on Abdominal-enhanced CT Improves Image Quality of Adamkiewicz Artery

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Huiqing Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the contrast-enhancement boost (CE-Boost) technique on improvement of the image quality of adamkiewicz artery.

#### METHODS AND MATERIALS

109 patients who underwent abdominal-enhanced CT in Aquilion ONE Genesis were retrospectively collected. Images of arterial phase were postprocessed with CE-Boost technique. The arterial phase images (group A) and CE-Boost images (group B) were transferred to vitrea workstation to evaluate the objective and subjective image quality. The CT value and image noise (SD) of descending aorta and erector spinae muscle were measured, and signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. Subjective image quality was analyzed by using a five-point scale to score image quality of adamkiewicz artery.

#### RESULTS

The CT value, SNR, CNR of descending aorta in group A and group B were  $406.2 \pm 104.9$  HU,  $46.1 \pm 13.9$ ,  $46.8 \pm 18.7$  and  $588.9 \pm 157.2$  HU,  $104.6 \pm 48.4$ ,  $120.6 \pm 52.2$ , respectively (all  $P < 0.01$ ). In group A, adamkiewicz artery were observed in 82 patients and observation rate was 75.2% (82/109). In group B, adamkiewicz artery were observed in 97 patients and observation rate was 88.9% (97/109). The image scores of group A (82 cases) and group B (97 cases) were 2 (1.5, 3) and 3 (2, 4), respectively ( $P < 0.01$ ).

#### CONCLUSION

CE-Boost technique can improve the image quality of adamkiewicz artery.

#### CLINICAL RELEVANCE/APPLICATION

CE-Boost technology can improve the visualization of adamkiewicz artery, which is beneficial for understanding spinal cord blood supply and improving the therapeutic effect of diseases of the thoracic aorta and abdominal aorta.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH-5

### Comparison of Imaging Methods for Ultra-high-resolution CT to Delineate Very Small Vessels: Low Tube Voltage Imaging vs. Small Focal Spot Imaging

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Kazuki Ishikawa (*Presenter*) General Electric Company

#### PURPOSE

Imaging techniques with high contrast and spatial resolution are necessary to delineate such as Adamkiewicz. Low-tube-voltage imaging is effective in achieving high contrast, and small-focus imaging is effective in achieving high spatial resolution. Low-tube-voltage imaging requires the use of a large tube current, whereas small-focus imaging is limited by the tube current, which makes it difficult to achieve both low-tube-voltage and small-focus imaging. This study aimed to clarify whether low-tube-voltage imaging or small-focus imaging is superior for delineating blood vessels smaller than 1 mm.

#### METHODS AND MATERIALS

In this study, we used an ultra-high-resolution CT (Aquilion Precision, Canon, Japan) to scan simulated vessel phantoms (DSA2, Kyoto Kagaku, Japan) with diameters of 1 , 0.75 , 0.5 , and 0.25 mm as well as deep learning reconstruction. The imaging conditions were 80 kVp, large focus (0.8 mm× 1.3 mm) and CTDIvol 16.4 mGy for low- tube-voltage imaging and 120 kVp, small focus (0.4 mm × 0.5 mm) and CTDIvol 16 mGy and 29.6 mGy for small-focus imaging. The simulated vessel phantom was filled with a diluted contrast medium to achieve a contrast of approximately 500 HU (high contrast) and 300 HU (low contrast) against the background at 120 kVp. The peak CT values of the simulated vessels and SD of the background were measured for image evaluation, and the signal-to-noise ratio (SNR) was calculated.

#### RESULTS

The SNR of the 1 mm simulated vessel with high contrast dilution contrast media was  $27.75 \pm 0.43$  at low kVp;  $17.74 \pm 0.35$  at small focus 16 mGy;  $22.78 \pm 0.29$  at 29.6 mGy; and  $19.96 \pm 0.45$ ,  $13.16 \pm 0.36$ , and  $22.83 \pm 0.43$  at 0.75 mm, respectively. The values were  $9.07 \pm 0.27$ ,  $7.78 \pm 0.15$  and  $10.75 \pm 0.32$  for 0.5 mm and  $5.52 \pm 0.12$ ,  $6.16 \pm 0.14$ , and  $6.96 \pm 0.13$  for 0.25 mm, respectively. The SNRs of 1 mm simulated vessels with low- contrast diluent were  $19.18 \pm 0.41$  for low kVp;  $12.82 \pm 0.28$  for small focus 16 mGy;  $16.21 \pm 0.27$  for 29.6 mGy; and  $13.3 \pm 0.31$ ,  $8.9 \pm 0.19$ , and  $12.45 \pm 0.26$  for 0.75 mm, respectively. The values were  $7.66 \pm 0.28$ ,  $6.8 \pm 0.23$ , and  $8.41 \pm 0.27$  for 0.5 mm and  $5.52 \pm 0.12$ ,  $6.16 \pm 0.14$ , and  $6.96 \pm 0.13$  for 0.25 mm, respectively.

#### CONCLUSION

In microvascular imaging, low-tube-voltage imaging is effective when a sufficient contrast cannot be obtained, whereas small-focus imaging is effective when a large imaging dose is required.

#### CLINICAL RELEVANCE/APPLICATION

In ultra-high-resolution CT, if the patient is large, rapid injection of a high-density contrast agent and small-focus imaging at 120 kVp can be used to ensure depiction of very small vessels, although the dose will increase. If the patient is small, Low-tube-voltage imaging can be used to ensure the depiction of very small vessels without increased invasiveness of rapid injection of high-density contrast medium.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-SPPH-6

### Radiology Professional Preferences for CT Radiation Dose and Image Quality Monitoring

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Njood Alsaihati, BS, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Existing radiation dose monitoring systems (RDMSs) primarily focus on radiation dose. The purpose of this work was to assess how image quality metrics can be incorporated into these systems taking into consideration the preference of different radiology professionals.

#### METHODS AND MATERIALS

A new RDMS was designed to incorporate image quality assessment alongside radiation dose for clinical performance monitoring in CT. The study investigated how such data should be visualized for effective utilization by radiology professionals. To achieve this, a set of key questions was formulated and answered using various charts, illustrating trends, variations, outliers, comparisons, and inconsistencies in radiation dose and image quality data as oriented by the question. Fifteen such charts were then systematically evaluated by 12 experienced radiology professionals of four radiologists, four technologists/radiographers, and four medical physicists, with a combined professional experience of over 130 years. A Likert scale (very useful = 10, useful = 8, moderately useful = 6, slightly useful = 4, and not useful = 0) was used to assess the usefulness of the charts. To provide additional insights on potential improvements, free-text fields were also enabled. The data were analyzed in terms of average score and deviation per group as well as their individual insights.

#### RESULTS

The system interface overall received an overall average score of 7.8 out of 10.0. Among the 15 charts, the one comparing scanner radiation output with literature and regulatory standards (i.e., diagnostic reference level and achievable dose across patient body habitus), showed the highest variation in scores among professional subgroups. In contrast, the chart representing scanners workload received similar scores across the subgroups. Specific visualizations resonated differently with each professional group, leading to 58 unique suggestions to better inform performance monitoring.

#### CONCLUSION

The study highlighted the importance of including image quality in performance monitoring, regardless of the professional subgroups' preferences. However, we found strong differences across radiology professionals as to what they wish to see visualized.

#### CLINICAL RELEVANCE/APPLICATION

A comprehensive monitoring system that integrates radiation dose with image quality assessment should be tailored to different radiology professionals' roles and responsibilities for best clinical practice in radiology.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPPH-7

### Impact of X-Ray Tube on Image Quality and Conspicuity of Pancreatic Ductal Adenocarcinoma in Pancreatic Protocol Dual-Energy CT

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Tetsuro Kaga, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the image quality and conspicuity of pancreatic ductal adenocarcinoma (PDAC) in dual-energy pancreatic protocol CT between two x-ray tubes mounted in Revolution CT Apex.

#### METHODS AND MATERIALS

Between January 2019 and March 2022, 80 patients underwent dual-energy pancreatic protocol CT using either Performix HDw (old x-ray tube; Group A, n = 41) or Quantix 160 (new x-ray tube; Group B, n = 39) mounted in Revolution CT Apex, respectively. All data were reconstructed at 70- and 40-keV and with medium-strength level of deep-learning image reconstruction. The two groups were compared in terms of CT dose-index volume (CTDIvol), CT numbers of the abdominal aorta, pancreas and PDAC, background noise, and qualitative scores for image noise, overall image quality, and conspicuity of PDAC.

#### RESULTS

The CTDIvol was lower in Group B than in Group A (9.2 mGy vs. 7.9 mGy;  $P < .001$ ). The median CT numbers of all anatomical structures at 70- and 40-keV were comparable between two groups ( $P = .06-.78$ ). The background noise at 70- (14 HU vs. 12 HU;  $P = .046$ ) and 40-keV (30 HU vs. 26 HU;  $P < .001$ ) were lower in Group B than in Group A. Qualitative scores for image noise and overall image quality at 70- and 40-keV and conspicuity of PDAC at 40-keV were higher in Group B than in Group A ( $P < .001-.045$ ).

#### CONCLUSION

In dual-energy pancreatic protocol CT, Revolution CT Apex with Quantix 160 improved qualitative image quality and reduced radiation dose.

#### CLINICAL RELEVANCE/APPLICATION

Even when using the same Revolution CT Apex, the latest x-ray tube of Quantix 160 has clinical impact on the image quality and conspicuity of PDAC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPRO-1

### Prediction of EGFR Mutations in Non-small Cell Lung Cancer Based on Hybrid Radiomics

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Seonhwa Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to predict EGFR gene mutations in non-small cell lung cancer patients based on deep learning and radiomics using CT and clinical characteristics.

#### METHODS AND MATERIALS

A total of 1,917 patients with non-small cell lung cancer were selected as the final study population, who underwent contrast-enhanced CT scans and EGFR gene testing before treatment. Clinical characteristics included gender, family history, height, and weight. The region of interest was segmented from CT images to extract radiomics features and obtain tumor images. The tumor images were used as input data for a CNN model to extract 512 image features, and combined with radiomics features and clinical data to predict EGFR gene mutations. The generalization performance of the model was evaluated using external institutional data.

#### RESULTS

AUROC was used as the performance evaluation metric. The model using tumor images and radiomics features as input data showed an AUROC of 0.67. The model using tumor images, radiomics features, and clinical data showed an AUROC of 0.72.

#### CONCLUSION

This study provides a convenient and non-invasive method for predicting EGFR gene mutations. EGFR gene mutations play a very important role as one of the factors that increase the risk of recurrence in non-small cell lung cancer patients, and can also be used to determine treatment strategies. Therefore, further research is needed to improve the accuracy of the model and address issues related to data collection in the future.

#### CLINICAL RELEVANCE/APPLICATION

EGFR gene mutation is the most commonly observed gene mutation in non-small cell lung cancer patients. EGFR is a signal transduction protein that regulates cell growth and division. When the DNA sequence inside the gene is mutated, the signal transduction pathway works abnormally, causing cancer cells to rapidly proliferate or form tumors. Existing gene mutation tests can only observe a part of the tumor, not the entire tumor, and thus cannot determine the heterogeneity of the entire tumor. In addition, there are technical difficulties and high costs associated with conventional methods, so a non-invasive and convenient test method must be developed to overcome these limitations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPVA-1

### Benefit of Photon-counting CT for Lower Extremity CTA Compared to Conventional Energy-integrating Detector CT

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Safa Hoodeshenas, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of photon-counting detector (PCD) CT on radiologist confidence and visualization of below-knee arteries at lower extremity CT angiography (CTA) compared to conventional energy-integrating detector (EID) CT.

#### METHODS AND MATERIALS

Patients who underwent clinically-indicated lower extremity CTA performed on a commercial PCD CT system (NAETOM Alpha, Siemens), as well as a prior or subsequent lower extremity CTA performed with EID CT were included. PCD-CTA included 0.6 mm slices with sharp kernel (Bv68), whereas EID CTA included 2 mm slices using routine kernel (Bv44), per clinical protocols. Two radiologists independently reviewed the anonymized and randomized CTA exams in separate reading sessions, with each patient's images appearing once per reading session. Readers estimated maximum stenosis grade for each of 7 below-knee arterial segments (popliteal to dorsalis pedis and plantar arteries), noting confidence in stenosis grading (0-100%). Visualization of small vessels was evaluated by counting the number of fibular perforators and grading visualization of fibular perforators, dorsalis pedis and plantar arteries on a 5-point Likert scale (1=worst, 5=best). Image quality metrics (i.e., sharpness, enhancement, and overall image quality) were assessed per patient.

#### RESULTS

25 patients (mean age  $68 \pm 10$  years; M: F=18: 7) underwent CTA runoff using PCD-CT (mean contrast volume:  $120 \pm 14$  cc) and EID-CT (mean contrast volume:  $114 \pm 16$  cc). For both readers, confidence in stenosis grading was significantly higher in PCD-CT for all evaluated arterial segments (e.g., popliteal artery  $92.9 \pm 6$  vs.  $77.3 \pm 14.7$ ;  $p < 0.001$ ; dorsalis pedis artery  $90.6 \pm 6.4$  vs.  $67 \pm 19.5$ ;  $p < 0.001$ ). The number of visualized fibular perforators was significantly higher with PCD-CT ( $8.1 \pm 3$  vs.  $5.4 \pm 2$ ;  $p < 0.001$ ). Visualization of small vessels was rated significantly higher with PCD-CT for all the evaluated small vessels (e.g., plantar arteries:  $4.5 \pm 0.8$  vs.  $3.1 \pm 0.8$ ,  $p < 0.001$ ; fibular perforators,  $p < 0.001$ ; dorsalis pedis,  $p < 0.001$ ). PCD-CT had significantly greater arterial sharpness ( $4.7 \pm 0.5$  vs.  $2.7 \pm 0.9$ ;  $p < 0.001$ ), arterial enhancement ( $4.3 \pm 0.6$  vs.  $3.4 \pm 0.7$ ;  $P < 0.001$ ), and overall image quality ( $4.6 \pm 0.6$  vs.  $3.3 \pm 0.8$ ;  $P < 0.001$ ).

#### CONCLUSION

Lower extremity CTA runoff with PCD-CT and 0.6 mm slices resulted in significantly increased reader confidence in small vessel stenosis grading, a higher number and improved visualization of small arteries, and greater arterial sharpness and enhancement.

#### CLINICAL RELEVANCE/APPLICATION

Thin-slice PCD-CT improved visualization of small calcified below-the-knee vessels, with greater reader confidence and higher number of visualized small vessels.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPVA-2

### Short Segment Linear “Flaps” of the Abdominal Aorta are Not Dissections: Discovery of their Origin via Retrospective Imaging Review

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Amar Shah, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Linear filling defects of the abdominal aorta are often referred to as focal aortic dissection or flaps in radiology reports, triggering concern amongst clinicians for acute aortic syndrome. However, these “flaps” are highly unlikely to represent true intimal-medial dissection flaps given their short segment and often incidental discovery. This retrospective study aims to determine the etiology of linear filling defects of the abdominal aorta utilizing prior contrast-enhanced (CE) imaging.

#### METHODS AND MATERIALS

An IRB-approved, HIPAA compliant retrospective study was performed. Abdomen/pelvis CT reports finalized Jan 2021 through Dec 2022 from two sites of an academic medical center were queried for the terms “focal dissection,” “dissection flap,” “linear filling defect,” and “linear flap”. Duplicate patients were removed. Exclusions based on reports were vessel other than abdominal aorta, thoracoabdominal dissection, no prior CE imaging, and less than 6 months between exams. On imaging review, cases with no change in appearance between exams were excluded. Cases were excluded if medical record review indicated femoral catheter access between imaging exam dates. Imaging review of more recent exam included presence of flap, flap calcification, and qualitative assessment of aortic caliber at the level of flap. Prior exam assessment included evaluation of aortic caliber and aortic findings at the location of subsequent flap.

#### RESULTS

Report query yielded 865 reports and 702 unique patients. After initial exclusion, the imaging of 70 patients was reviewed, of which 40 were excluded for lack of change in imaging appearance of the linear filling defect. 10 patients were excluded for femoral access, yielding a final population of 20 patients. There was a median of 70 months between imaging exams (range 14-230). All aortas were atherosclerotic and 75% (n=15) were ectatic or aneurysmal at the level of flap; on the older exam only 5 aortas were ectatic or aneurysmal. Of 20 cases, mural thrombus or partially ulcerated mural thrombus was present at the flap site in 17, thrombosed PAU in 1, and no corresponding findings in 2.

#### CONCLUSION

Short segment linear filling defects within the abdominal aorta correspond to sites of prior mural thrombus. Mural thrombus has ulcerated or resorbed, leaving behind the luminal surface of the thrombus. Therefore, short segmental filling defects within the abdominal aorta should not be referred to as a dissection flap but rather a remnant of ulcerated and resorbed mural thrombus.

#### CLINICAL RELEVANCE/APPLICATION

Linear filling defects of the abdominal aorta are often reported as focal dissections, but this incorrectly describes their pathophysiology. These filling defects are the remnant surface of ulcerated/resorbed mural thrombus.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5-STCE1

### Science Session (Theranostics and Musculoskeletal)

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center Theater 1

#### Sub-Events

#### **M5-STCE1- Towards A Comprehensive Taxonomy Of Common Errors In Anatomical Structure Segmentation Made By State-Of-The-Art Artificial Intelligence Models**

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The study seeks to identify typical errors in AI-generated CT labeling, fostering a cautious and informed integration of AI technologies in clinical practice and enhancing understanding of associated limitations and challenges.

#### **METHODS AND MATERIALS**

AbdomenAtlas-8K is a curated, high-quality dataset comprising 8,448 CT volumes, was labeled precisely in three weeks. This precision is achieved through the implementation of a human-in-the-loop approach, wherein a radiologist with two years of specialized experience participates. The radiologist's involvement is identifying and revising errors made by the AI model, ensuring that the dataset attains a high level of accuracy and reliability. Typical errors made by the AI model are systematically summarized and subsequently utilized to facilitate further fine-tuning of the AI model. This iterative process aims to continually enhance the performance and efficacy of the AI system, ultimately advancing its capabilities in segmenting anatomical structures in CT imaging. The ITK-SNAP software was used to visualize and analyze the intricate details of CT images.

#### **RESULTS**

The most prevalent labeling errors in the dataset predominantly pertain to the aorta, stomach, and postcava regions. A notable error related to aorta labeling in CT scans involves the inconsistency in delineating which specific parts should be included within the labeled region of the aorta, leading to ambiguous and inaccurate labels. Additionally, we demonstrate a typical error in stomach labeling, wherein the AI model fails to recognize the gastric cavity, resulting in incomplete and inadequate labeling. The postcava labeling exhibits the error of misrecognition of the boundary, leading to imprecise delineation. Most errors in AI CT labeling are attributed to low contrast and high noise in the CT scans, the complexity of the anatomy, and the limited data points available for training. These factors collectively lead to vague organ boundaries and misrecognition, resulting in inaccurate annotations.

#### **CONCLUSION**

Through the implementation of a human-in-the-loop approach, we have effectively compiled a comprehensive taxonomy of prevalent errors encountered in AI-driven systems. Consequently, this approach has improved the efficiency of the overall workflow and ensured a higher level of precision in AI-generated results, ultimately enhancing the reliability and utility of AI-assisted medical imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

These identified errors play a pivotal role in refining the AI model through a targeted human-in-the-loop approach, ultimately aiming to enhance the accuracy and reliability of CT labeling, thereby contributing to improved clinical outcomes and advancing the field of medical imaging.

#### **M5-STCE1- Developing A Novel Continual Learning Strategy To Address The Forgetting Problem For AI Models In Human-In-The-Loop Procedures**

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Devising an effective strategy to tackle the forgetting problem in AI models that continually learn from newly annotated classes (e.g., organs and tumors) while preserving the knowledge of previously learned classes.

## METHODS AND MATERIALS

We leveraged 14 publicly available datasets to train an AI model, each dataset comprising various partially annotated anatomical structures. AI predictions associated with the highest uncertainty were identified and delegated to radiologists for review. A selective group of 12 subjects was chosen from a total of 200, and two radiologists independently revised the AI predictions of four specific organs (namely, aorta, postcava, stomach, and gallbladder) in each selected subject. Primarily, we implemented continual learning strategies during the fine-tuning process. In this context, the pre-trained model was fine-tuned with all revised cases, encapsulating both AI-predicted and human-revised labels. We compared two experimental settings: "Revision-Focused Continual Learning," which involved fine-tuning solely with revised labels from 12 cases, and "All Data Continual Learning," which incorporated fine-tuning with all 200 cases. Additionally, the Multilayer Perceptron (MLP) in our AI model was modified to create organ-based MLP layers, allowing for specific MLP layer updates that corresponded to the revised organs.

## RESULTS

The continual learning strategy proved most successful among various data manipulation methods, leading to improvements in the average dice score of human revised labels (from 81.0%±7.7% to 83.8%±5.8%) while preserving minimal performance degradation in AI predicted labels (90.8%±5.2% to 91.2%±4.9%). The "Revision-Focused Continual Learning" approach resulted in a significant decline in the average dice score of unrevised labels (by 10.4%), while the "All Data Continual Learning" method avoided the forgetting problem but demonstrated limited efficiency in enhancing the average dice score of revised labels (an increase of merely 0.8%).

## CONCLUSION

Incorporating "Revision-Focused" methods during fine-tuning of a pre-trained model can lead to the forgetting problem. Conversely, our novel continual learning strategy effectively mitigates this issue by maintaining the model's original capabilities while assimilating the benefits of newly revised annotations.

## CLINICAL RELEVANCE/APPLICATION

Our proposed fine-tuning strategy enhances diagnostic accuracy and minimizes annotation efforts, thus facilitating long-term learning and promoting trust in the model's decision-making process. This approach fosters continual improvement and the integration of the latest medical knowledge, thereby increasing the model's value in evidence-based healthcare settings.

## M5-STCE1- Common Treatment Strategies for Calcium Hydroxyapatite Deposition Disease: A Cost Effectiveness Analysis

Erin F. Alaia, MD (*Presenter*) Biorez Inc, Consultant

## PURPOSE

To determine the cost-effectiveness of standard treatments for rotator cuff calcium hydroxyapatite deposition disease (HADD).

## METHODS AND MATERIALS

A decision analytic model was created from the perspective of the U.S. Healthcare system over a 1-year time horizon for a 52-year-old female with shoulder pain and radiographic rotator cuff HADD failing conservative management. The model evaluated the incremental cost-effectiveness ratio (ICER) and net monetary benefit (NMB) of standard HADD strategies, including continued conservative management, ultrasound-guided barbotage (UGB), high and low-energy extracorporeal shock wave therapy (ECSW), and surgery. Model input data on cost, probability, and utility were obtained from a comprehensive literature search and expert opinion. The primary effectiveness outcome was quality-adjusted life years (QALY). Costs were estimated in 2022 U.S. dollars. Willingness to pay threshold was set for \$100,000.

## RESULTS

For the base case, UGB was the preferred treatment strategy, with the second highest effectiveness, 0.97 QALY, fourth highest cost, \$2,199.34, and highest NMB (\$95,048.45), with conservative management (0.97 QALY, third highest NMB of 94,688.83) considered a reasonable alternative. High-energy ECSW (0.98 QALY, second highest NMB of 94,805.72) was not cost-effective, having an ICER of \$121,558.90, surpassing the \$100,000/QALY gained willingness-to-pay threshold. Both surgery (second lowest effectiveness, 0.95 QALY, and second lowest NMB of 92,092.46) and low-energy ECSW (lowest effectiveness, 0.92, and lowest NMB of 87,881.20) were dominated and therefore not favored options. One way-sensitivity analysis demonstrated that UGB was favored when the cost was < \$1732.02, or when the probability of success was >76%, while conservative management was favored when the cost was < \$990.34, or when the probability of success was > 76%. Probabilistic sensitivity analysis supported our base case results, with UGB preferred in 43% of simulations, high-energy ECSW in 36%, conservative management in 20%, and low-energy ECSW and surgery in <1%.

## **CONCLUSION**

UGB appears to be the most cost-effective strategy for patients with HADD, while surgery and low-energy ECSW are the least cost-effective. Conservative management can also be considered as a reasonable alternative treatment strategy in the appropriate clinical setting.

## **CLINICAL RELEVANCE/APPLICATION**

Among the common treatment strategies for rotator cuff HADD, ultrasound-guided barbotage appears to be the most cost-effective.

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## Abstract Archives of the RSNA, 2023

M5-STCE1-1

### **Towards A Comprehensive Taxonomy Of Common Errors In Anatomical Structure Segmentation Made By State-Of-The-Art Artificial Intelligence Models**

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center Theater 1

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The study seeks to identify typical errors in AI-generated CT labeling, fostering a cautious and informed integration of AI technologies in clinical practice and enhancing understanding of associated limitations and challenges.

#### **METHODS AND MATERIALS**

AbdomenAtlas-8K is a curated, high-quality dataset comprising 8,448 CT volumes, was labeled precisely in three weeks. This precision is achieved through the implementation of a human-in-the-loop approach, wherein a radiologist with two years of specialized experience participates. The radiologist's involvement is identifying and revising errors made by the AI model, ensuring that the dataset attains a high level of accuracy and reliability. Typical errors made by the AI model are systematically summarized and subsequently utilized to facilitate further fine-tuning of the AI model. This iterative process aims to continually enhance the performance and efficacy of the AI system, ultimately advancing its capabilities in segmenting anatomical structures in CT imaging. The ITK-SNAP software was used to visualize and analyze the intricate details of CT images.

#### **RESULTS**

The most prevalent labeling errors in the dataset predominantly pertain to the aorta, stomach, and postcava regions. A notable error related to aorta labeling in CT scans involves the inconsistency in delineating which specific parts should be included within the labeled region of the aorta, leading to ambiguous and inaccurate labels. Additionally, we demonstrate a typical error in stomach labeling, wherein the AI model fails to recognize the gastric cavity, resulting in incomplete and inadequate labeling. The postcava labeling exhibits the error of misrecognition of the boundary, leading to imprecise delineation. Most errors in AI CT labeling are attributed to low contrast and high noise in the CT scans, the complexity of the anatomy, and the limited data points available for training. These factors collectively lead to vague organ boundaries and misrecognition, resulting in inaccurate annotations.

#### **CONCLUSION**

Through the implementation of a human-in-the-loop approach, we have effectively compiled a comprehensive taxonomy of prevalent errors encountered in AI-driven systems. Consequently, this approach has improved the efficiency of the overall workflow and ensured a higher level of precision in AI-generated results, ultimately enhancing the reliability and utility of AI-assisted medical imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

These identified errors play a pivotal role in refining the AI model through a targeted human-in-the-loop approach, ultimately aiming to enhance the accuracy and reliability of CT labeling, thereby contributing to improved clinical outcomes and advancing the field of medical imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5-STCE1-2

### Developing A Novel Continual Learning Strategy To Address The Forgetting Problem For AI Models In Human-In-The-Loop Procedures

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center Theater 1

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Devising an effective strategy to tackle the forgetting problem in AI models that continually learn from newly annotated classes (e.g., organs and tumors) while preserving the knowledge of previously learned classes.

#### METHODS AND MATERIALS

We leveraged 14 publicly available datasets to train an AI model, each dataset comprising various partially annotated anatomical structures. AI predictions associated with the highest uncertainty were identified and delegated to radiologists for review. A selective group of 12 subjects was chosen from a total of 200, and two radiologists independently revised the AI predictions of four specific organs (namely, aorta, postcava, stomach, and gallbladder) in each selected subject. Primarily, we implemented continual learning strategies during the fine-tuning process. In this context, the pre-trained model was fine-tuned with all revised cases, encapsulating both AI-predicted and human-revised labels. We compared two experimental settings: "Revision-Focused Continual Learning," which involved fine-tuning solely with revised labels from 12 cases, and "All Data Continual Learning," which incorporated fine-tuning with all 200 cases. Additionally, the Multilayer Perceptron (MLP) in our AI model was modified to create organ-based MLP layers, allowing for specific MLP layer updates that corresponded to the revised organs.

#### RESULTS

The continual learning strategy proved most successful among various data manipulation methods, leading to improvements in the average dice score of human revised labels (from  $81.0\% \pm 7.7\%$  to  $83.8\% \pm 5.8\%$ ) while preserving minimal performance degradation in AI predicted labels ( $90.8\% \pm 5.2\%$  to  $91.2\% \pm 4.9\%$ ). The "Revision-Focused Continual Learning" approach resulted in a significant decline in the average dice score of unrevised labels (by 10.4%), while the "All Data Continual Learning" method avoided the forgetting problem but demonstrated limited efficiency in enhancing the average dice score of revised labels (an increase of merely 0.8%).

#### CONCLUSION

Incorporating "Revision-Focused" methods during fine-tuning of a pre-trained model can lead to the forgetting problem. Conversely, our novel continual learning strategy effectively mitigates this issue by maintaining the model's original capabilities while assimilating the benefits of newly revised annotations.

#### CLINICAL RELEVANCE/APPLICATION

Our proposed fine-tuning strategy enhances diagnostic accuracy and minimizes annotation efforts, thus facilitating long-term learning and promoting trust in the model's decision-making process. This approach fosters continual improvement and the integration of the latest medical knowledge, thereby increasing the model's value in evidence-based healthcare settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5-STCE1-3

### Common Treatment Strategies for Calcium Hydroxyapatite Deposition Disease: A Cost Effectiveness Analysis

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center Theater 1

Erin F. Alaia, MD (*Presenter*) Biorez Inc, Consultant

#### PURPOSE

To determine the cost-effectiveness of standard treatments for rotator cuff calcium hydroxyapatite deposition disease (HADD).

#### METHODS AND MATERIALS

A decision analytic model was created from the perspective of the U.S. Healthcare system over a 1-year time horizon for a 52-year-old female with shoulder pain and radiographic rotator cuff HADD failing conservative management. The model evaluated the incremental cost-effectiveness ratio (ICER) and net monetary benefit (NMB) of standard HADD strategies, including continued conservative management, ultrasound-guided barbotage (UGB), high and low-energy extracorporeal shock wave therapy (ECSW), and surgery. Model input data on cost, probability, and utility were obtained from a comprehensive literature search and expert opinion. The primary effectiveness outcome was quality-adjusted life years (QALY). Costs were estimated in 2022 U.S. dollars. Willingness to pay threshold was set for \$100,000.

#### RESULTS

For the base case, UGB was the preferred treatment strategy, with the second highest effectiveness, 0.97 QALY, fourth highest cost, \$2,199.34, and highest NMB (\$95,048.45), with conservative management (0.97 QALY, third highest NMB of 94,688.83) considered a reasonable alternative. High-energy ECSW (0.98 QALY, second highest NMB of 94,805.72) was not cost-effective, having an ICER of \$121,558.90, surpassing the \$100,000/QALY gained willingness-to-pay threshold. Both surgery (second lowest effectiveness, 0.95 QALY, and second lowest NMB of 92,092.46) and low-energy ECSW (lowest effectiveness, 0.92, and lowest NMB of 87,881.20) were dominated and therefore not favored options. One way-sensitivity analysis demonstrated that UGB was favored when the cost was < \$1732.02, or when the probability of success was >76%, while conservative management was favored when the cost was < \$990.34, or when the probability of success was > 76%. Probabilistic sensitivity analysis supported our base case results, with UGB preferred in 43% of simulations, high-energy ECSW in 36%, conservative management in 20%, and low-energy ECSW and surgery in <1%.

#### CONCLUSION

UGB appears to be the most cost-effective strategy for patients with HADD, while surgery and low-energy ECSW are the least cost-effective. Conservative management can also be considered as a reasonable alternative treatment strategy in the appropriate clinical setting.

#### CLINICAL RELEVANCE/APPLICATION

Among the common treatment strategies for rotator cuff HADD, ultrasound-guided barbotage appears to be the most cost-effective.

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## Abstract Archives of the RSNA, 2023

M5-STCE2

### Science Session (Generative AI)

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center Theater 2

#### Sub-Events

#### **M5-STCE2- Explaining an AI classifier as a combination of words: application to breast mass classification** 2

William Lotter, PhD (*Presenter*) Consultant, RadNet, Inc

#### **PURPOSE**

The 'black-box' nature of AI hinders clinical adoption. Common explainability methods highlight image regions that drive an AI's decision. Humans, however, heavily rely on language to convey explanations of not only "where" but "what". We developed a method to explain an AI classifier using common words, and apply it to mass classification on mammograms.

#### **METHODS AND MATERIALS**

Our approach leverages CLIP, a transformer-based model from OpenAI that consists of an image encoder and text encoder that were trained to learn an aligned representation between natural images and text captions (e.g., a picture of a dog is represented similarly to the word "dog"). Using the pre-trained image encoder as input, we train an additional linear layer to classify whether a mass is benign or malignant using CBIS-DDSM, a dataset of ROIs from film mammograms for 1591 masses (48% malignant; 77/23% training/testing). Rather than relying on expert-provided explanations, which adds subjectivity and is often not available, we created a list of general purpose adjectives that encompass visual properties ranging from size to shape. We used the text encoder of CLIP to obtain a representation for each adjective, and then fit a separate linear regression to approximate the benign vs. malignant classifier as a weighted sum of the word representations. Effectively, this approach estimates the image-based task as a combination of words, where the weight for each given word indicates its correlation with malignancy as predicted by the AI classifier.

#### **RESULTS**

The benign vs. malignant classifier achieved an AUC of 0.72, which is similar to top results on CBIS-DDSM. Estimating the image-based classifier using a weighted combination of word representations revealed several words associated with the classifier. Despite not being trained using descriptions of lesions, these words generally align with clinical intuition. For instance, "asymmetric" and "large" are the top words for malignant whereas "round", "symmetric", and "matte" are the top words for benign.

#### **CONCLUSION**

We developed an approach to provide text-based explainability of a vision-based AI classifier. When applied to breast mass classification, the results generally align with clinical intuition, indicating that the AI model may be using similar features as clinicians, though there may be exceptions.

#### **CLINICAL RELEVANCE/APPLICATION**

Explainability is critical for clinical adoption of AI. Our approach uses text to interrogate the features used by an AI model.

#### **M5-STCE2- Transformer-based Multimodal Generative Model - Use-case of Screening Mammogram Reading** 3

Man Luo, PhD, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

While complex deep learning based image processing models have been proposed for automatic reading of mammography images, these models lack interpretability. Efforts have been made to interpret the model's decision through saliency maps or GradCAMs that highlight the model's attention on image region. Often, these interpretability maps may not be well perceived by radiologists. As such, we hypothesize that text-based explanation of a model's attention may be more readily

understandable by humans and therefore may serve as a better explainability tool. Therefore, the purpose of our study was to develop a transformer based multi-modal generative model for automatic interpretation and generation of a text-based explanation of the diagnosis.

## **METHODS AND MATERIALS**

In this IRB approved study, we designed an encoder-decoder model where a multimodal encoder transformed image patches and input text prompt tokens into feature vectors which were concatenated and passed through multiple transformer layers for self-attention based rich feature generation. These features were then passed to a GPT-2 based decoder for textual output generation via cross-attention layers. The model can be directed to produce either diagnosis or explanation for the given image based on input text prompt. We retrospectively extracted 1234 mammography images from Mayo Clinic, balanced in terms of diagnoses (BIRADS0, BIRADS1/2), and subsequently split into training (80%) and test (20%) sets. Left and right breasts were cropped and stitched together side-by-side from CC views of both breasts. Findings section of corresponding radiology reports were extracted to be used as the ground truth explanation while training. State-of-the-art transformer based medical vision-language model, MedViLL was used as baseline for comparison which utilizes attention masking scheme.

## **RESULTS**

Our proposed model achieved high accuracy for both diagnoses (BIRADS 0: 86%, BIRADS 1/2: 94%) compared to the baseline model (BIRADS 0: 75%, BIRADS 1/2: 32%). Generated explanations were evaluated against text sequences from the findings section describing major abnormalities with their characteristics (e.g., 'focal asymmetry'). Model achieved a BLEU score of 0.43 (MedViLL: 0.28) for the most common abnormality (asymmetry).

## **CONCLUSION**

The proposed multi-modal generative model archives high diagnosis accuracy and generates a text-based explanation generation.

## **CLINICAL RELEVANCE/APPLICATION**

This study focuses on automatic reading of screening mammograms. The previous models lack an explanation or easily understandable output. We present a GPT based multimodal model that represents an improvement in model explainability, a crucial factor towards ultimate clinical adoption of AI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5-STCE2-2

### Explaining an AI classifier as a combination of words: application to breast mass classification

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center Theater 2

William Lotter, PhD (*Presenter*) Consultant, RadNet, Inc

#### PURPOSE

The 'black-box' nature of AI hinders clinical adoption. Common explainability methods highlight image regions that drive an AI's decision. Humans, however, heavily rely on language to convey explanations of not only "where" but "what". We developed a method to explain an AI classifier using common words, and apply it to mass classification on mammograms.

#### METHODS AND MATERIALS

Our approach leverages CLIP, a transformer-based model from OpenAI that consists of an image encoder and text encoder that were trained to learn an aligned representation between natural images and text captions (e.g., a picture of a dog is represented similarly to the word "dog"). Using the pre-trained image encoder as input, we train an additional linear layer to classify whether a mass is benign or malignant using CBIS-DDSM, a dataset of ROIs from film mammograms for 1591 masses (48% malignant; 77/23% training/testing). Rather than relying on expert-provided explanations, which adds subjectivity and is often not available, we created a list of general purpose adjectives that encompass visual properties ranging from size to shape. We used the text encoder of CLIP to obtain a representation for each adjective, and then fit a separate linear regression to approximate the benign vs. malignant classifier as a weighted sum of the word representations. Effectively, this approach estimates the image-based task as a combination of words, where the weight for each given word indicates its correlation with malignancy as predicted by the AI classifier.

#### RESULTS

The benign vs. malignant classifier achieved an AUC of 0.72, which is similar to top results on CBIS-DDSM. Estimating the image-based classifier using a weighted combination of word representations revealed several words associated with the classifier. Despite not being trained using descriptions of lesions, these words generally align with clinical intuition. For instance, "asymmetric" and "large" are the top words for malignant whereas "round", "symmetric", and "matte" are the top words for benign.

#### CONCLUSION

We developed an approach to provide text-based explainability of a vision-based AI classifier. When applied to breast mass classification, the results generally align with clinical intuition, indicating that the AI model may be using similar features as clinicians, though there may be exceptions.

#### CLINICAL RELEVANCE/APPLICATION

Explainability is critical for clinical adoption of AI. Our approach uses text to interrogate the features used by an AI model.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5-STCE2-3

### Transformer-based Multimodal Generative Model - Use-case of Screening Mammogram Reading

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center Theater 2

Man Luo, PhD, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

While complex deep learning based image processing models have been proposed for automatic reading of mammography images, these models lack interpretability. Efforts have been made to interpret the model's decision through saliency maps or GradCAMs that highlight the model's attention on image region. Often, these interpretability maps may not be well perceived by radiologists. As such, we hypothesize that text-based explanation of a model's attention may be more readily understandable by humans and therefore may serve as a better explainability tool. Therefore, the purpose of our study was to develop a transformer based multi-modal generative model for automatic interpretation and generation of a text-based explanation of the diagnosis.

#### METHODS AND MATERIALS

In this IRB approved study, we designed an encoder-decoder model where a multimodal encoder transformed image patches and input text prompt tokens into feature vectors which were concatenated and passed through multiple transformer layers for self-attention based rich feature generation. These features were then passed to a GPT-2 based decoder for textual output generation via cross-attention layers. The model can be directed to produce either diagnosis or explanation for the given image based on input text prompt. We retrospectively extracted 1234 mammography images from Mayo Clinic, balanced in terms of diagnoses (BIRADS0, BIRADS1/2), and subsequently split into training (80%) and test (20%) sets. Left and right breasts were cropped and stitched together side-by-side from CC views of both breasts. Findings section of corresponding radiology reports were extracted to be used as the ground truth explanation while training. State-of-the-art transformer based medical vision-language model, MedViLL was used as baseline for comparison which utilizes attention masking scheme.

#### RESULTS

Our proposed model achieved high accuracy for both diagnoses (BIRADS 0: 86%, BIRADS 1/2: 94%) compared to the baseline model (BIRADS 0: 75%, BIRADS 1/2: 32%). Generated explanations were evaluated against text sequences from the findings section describing major abnormalities with their characteristics (e.g., 'focal asymmetry'). Model achieved a BLEU score of 0.43 (MedViLL: 0.28) for the most common abnormality (asymmetry).

#### CONCLUSION

The proposed multi-modal generative model archives high diagnosis accuracy and generates a text-based explanation generation.

#### CLINICAL RELEVANCE/APPLICATION

This study focuses on automatic reading of screening mammograms. The previous models lack an explanation or easily understandable output. We present a GPT based multimodal model that represents an improvement in model explainability, a crucial factor towards ultimate clinical adoption of AI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSCA04

### Cardiac Imaging (Cardiomyopathies and Systemic Diseases )

Monday, Nov. 27 1:30PM - 2:30PM Room: S405

Gautham P. Reddy, MD, MPH (*Moderator*) Nothing to Disclose  
Byoung Wook Choi, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M6-SSCA04-1 Feasibility of the Threshold-based Quantification of Myocardial Fibrosis on Cardiac CT in Nonischemic Dilated Cardiomyopathy**

Nayoung Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility and predictive performance of the threshold-based quantification of MDE on cardiac CT in patients with nonischemic dilated cardiomyopathy (NIDCM).

#### METHODS AND MATERIALS

43 patients (mean age, 59.3 years  $\pm$  17.1 [SD]; 22 women) with NIDCM were prospectively recruited from June 2012 through June 2015 and underwent dual-energy cardiac CT and cardiac MRI. Retrospective image analysis was conducted for conventional CT at 100 kV and 120 kV, and 70-keV monochromatic CT. Myocardial delayed enhancement (MDE) in CT was quantified using 2, 3, and 4-SD techniques and manual quantification. Late gadolinium enhancement (LGE) in MRI was quantified using 5-SD technique. Cox regression analysis was performed to determine the association between variables with the primary outcome, which was defined as a composite of cardiac death, heart transplantation, heart failure hospitalization and appropriate defibrillator therapy.

#### RESULTS

LGE was observed in 29 patients (67%, 29/43) and the mean LGE percentage using 5-SD technique was  $4.1 \pm 3.6\%$ . Manual quantification in all CT sets and 4-SD technique in 70-keV CT yielded excellent degree of interobserver agreement (intraclass correlation coefficient= 0.812, 0.804, and 0.833 for 100 kV, 120 kV, and 70 keV using manual quantification; 0.810 for 70-keV CT using 4-SD technique). The highest degree of agreement with LGE was obtained in 70-keV CT using 4-SD technique (CCC = 0.803), followed by good agreement using manual quantification (CCC = 0.781). From the Bland-Altman plots, 4-SD technique in 70-keV CT showed the smallest bias with the narrowest range of 95% limits of agreement (bias, -0.119; 95% limits of agreement -4.216 to 3.978). During a median follow-up of 1,625 days, a total of 10 (23%, 10/43) patients experienced the primary outcome. In the univariable analysis, LV end-diastolic volume index, LV end-systolic volume index, LV ejection fraction, the presence and extent of myocardial fibrosis were associated with the primary composite outcome. In multivariable analysis, the mean MDE percentage from 70-keV CT with 4-SD technique (adjusted hazard ratio, 1.516; P = .018) was an independent significant predictor along with the mean LGE percentage (adjusted hazard ratio, 1.860; P = .01).

#### CONCLUSION

4-SD technique on 70-keV monochromatic CT yielded comparable results to MRI for quantifying myocardial fibrosis and was an independent predictor of cardiovascular outcome in NIDCM.

#### CLINICAL RELEVANCE/APPLICATION

Myocardial delayed enhancement can be properly quantified using a threshold-based approach in cardiac CT and has prognostic value in predicting adverse cardiac events in patients with NIDCM.

#### **M6-SSCA04-3 Incremental Diagnostic Value of Right Ventricular Strain Analysis in Arrhythmogenic Right Ventricular Cardiomyopathy**

Leyi Zhu (*Presenter*) Nothing to Disclose



## PURPOSE

This study aims to determine if right ventricular strain analysis can be used for the identification of revised Task Force Criteria (rTFC) diagnosed arrhythmogenic right ventricular cardiomyopathy (ARVC) patients, and whether RV strain parameters can discriminate these patients incremental to the existing cardiac magnetic resonance (CMR) criteria, thus improving the diagnostic yield of CMR in ARVC.

## METHODS AND MATERIALS

A total of 74 rTFC diagnosed ARVC patients (37 borderline and 37 definite) were retrospectively enrolled for analysis. Using CMR feature tracking (CMR-FT), we evaluated RV global longitudinal (GLS), circumferential (GCS) and radial strain (GRS) of all participants.

## RESULTS

Compared with controls, patients demonstrated significantly impaired global RV strain in all three directions (all  $p < 0.001$ ). ROC analysis indicated that RV GLS was the strongest discriminator between patients and healthy controls (AUC: 0.92). Using the Youden index, we determined RV GLS = -19.95% as the diagnostic criterion of ARVC patients. In patients with borderline ARVC, there are 17(46%) and 12(32%) participants not fulfilling the existing RV end-diastolic volume index and RV ejection fraction major criterion respectively, of whom 12(71%) and 7(58%), respectively, showed impaired RV GLS. When both conventional criteria and RV GLS were considered together, this new diagnostic method demonstrated an overall diagnostic accuracy of 90% and area under the ROC curve of 0.95.

## CONCLUSION

Our study showed an improved diagnostic accuracy when both CMR-FT derived RV GLS and the existing CMR criteria in rTFC were considered together, especially for those with borderline diagnosis, suggesting the incremental value of strain analysis to the initial assessment of ARVC.

## CLINICAL RELEVANCE/APPLICATION

Cardiovascular MR feature tracking is a clinically applicable method that can sensitively characterize ventricular structural or functional alterations. Our study showed that higher diagnostic accuracy can be reached when both conventional criteria and right ventricular global longitudinal strain are considered together, suggesting that right ventricular strain analysis provides a supplementary method to the initial diagnosis of arrhythmogenic right ventricular cardiomyopathy.

## M6-SSCA04-4 Myocardial Inflammation on Combined Cardiac FDG PET/MRI in Rheumatoid Arthritis

Malcolm Davidson, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

FDG-PET/CT has identified extra-cardiac disease activity and inflammation in patients with rheumatoid arthritis. However, there is limited data on cardiac inflammation and metabolic activity. The purpose of this study was to evaluate the prevalence and correlates of myocardial inflammation in patients with rheumatoid arthritis (RA).

## METHODS AND MATERIALS

In this single center prospective cohort study, adult patients with RA and a control group were recruited for combined cardiac FDG-PET/MRI after diet preparation with a high-fat and low carbohydrate diet for 24 hours plus a minimum 8 hour complete fast prior to FDG-injection. The cardiac MRI protocol included late gadolinium enhanced imaging (LGE), native T1 and T2 mapping, and calculation of extra-cellular volume (ECV). Whole body FDG-uptake was also evaluated to assess for extra-cardiac vascular and articular inflammation. PET analysis included evaluation of SUVmax and cardiac metabolic volume (CMV). Data on disease history, blood biomarkers, and risk factors were evaluated on the same day. RA patients also underwent cardiac CT for calcium scoring within one month of PET/MRI.

## RESULTS

23 patients with RA were included (56% male, mean age  $50 \pm 16$  years) and were compared to 25 controls (56% male, mean age  $50 \pm 16$  years). Focal myocardial FDG-uptake was present in 3 (13%) RA patients (SUVmax 2.2-3.1 and cardiac metabolic volume 1-22cm<sup>2</sup>) but in none of the controls. RA patients with myocardial inflammation were older than those without inflammation ( $66 \pm 11$  years vs.  $47 \pm 15$  years,  $p = 0.03$ ). Sex, disease duration, cardiac risk factors, coronary calcium score and blood biomarkers did not differ significantly between those with and without myocardial inflammation. On cardiac MRI, LGE was more frequent in those with inflammation (67% vs 10%,  $p = 0.02$ ). ECV was significantly higher in RA patients compared to controls ( $26 \pm 2\%$  vs.  $25 \pm 3\%$ ,  $p = 0.02$ ). However, LVEF, native T1, T2 and ECV did not differ significantly between RA patients with and without myocardial inflammation. Myocardial FDG-uptake was not associated with extra-cardiac inflammation in the joints, skeleton or aorta.

## CONCLUSION

Subclinical myocardial inflammation is identified on PET/MRI in a minority of patients with RA, and is associated with increasing age and LGE.

## CLINICAL RELEVANCE/APPLICATION

Future large studies with long-term follow-up are needed to assess whether FDG-uptake in RA patients is associated with arrhythmias and other adverse outcomes and whether anti-inflammatory treatment reduces future event risk.

### M6-SSCA04-5 **Cardiac Magnetic Resonance Assessment of Response to Light-Chain Cardiac Amyloidosis Chemotherapy**

Yubo Guo, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Light-chain cardiac amyloidosis (AL-CA) is a condition that can lead to sudden cardiac death or acute heart failure. Cardiac magnetic resonance (CMR) is a diagnostic tool that provides precise and reproducible information about cardiac structure, function, and tissue characteristics, which may assist in the monitoring of responses to chemotherapy. The purpose of this study is to evaluate the effectiveness of CMR in monitoring responses to chemotherapy among patients with AL-CA.

#### METHODS AND MATERIALS

In this prospective study, we enrolled 111 patients with AL-CA (50.5% male; median age, 54 [interquartile range (IQR), 49-63] years). The patients underwent longitudinal monitoring using biomarkers and contrast-enhanced CMR. At the follow-up visit, patients with AL-CA were categorized based on their hematologic and cardiac responses to chemotherapy.

#### RESULTS

Following chemotherapy, there was a significant increase in right ventricular (RV) longitudinal strain and myocardial T2 ( $P = 0.031$  and  $P = 0.008$ , respectively). Among the groups categorized based on cardiac response, patients with superior responses showed a more significant reduction in native T1 (-25.6 [IQR, -75.0 to 27.0] vs. 14.5 [IQR, -32.0 to 58.8];  $P = 0.047$ ) and extracellular volume (ECV) (-0.020 [IQR, -0.060 to 0.013] vs. 0.020 [IQR, -0.030 to 0.050];  $P = 0.010$ ).

#### CONCLUSION

CMR is an effective tool for monitoring initial changes in patients with AL-CA undergoing chemotherapy, as it provides information on ventricular functional recovery and tissue characterization variation. These findings support the integration of CMR parameters into response assessments, which can lead to more individualized assessments of treatment effectiveness.

## CLINICAL RELEVANCE/APPLICATION

CMR with measurement of ventricle function and myocardial characterization allows non-invasive monitoring of the initial changes following chemotherapy, serial CMR may be a better and more sensitive tool for better characterization of the changes that occur with cardiac response.

### M6-SSCA04-6 **Insights into Cirrhotic Cardiomyopathy: A Cardiac Magnetic Resonance Analysis on the Impact of Liver Cirrhosis on Cardiac Structure and Function**

Jennifer Erley, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of liver cirrhosis on cardiac magnetic resonance (CMR) parameters.

#### METHODS AND MATERIALS

Patients with liver cirrhosis awaiting transplant (free of known cardiovascular diseases) received a CMR exam (3T, Ingenia, Philips), including steady-state free precession sequences and mapping. Cardiac volumes (indexed to the body surface area)/ejection fraction were analyzed and feature tracking was performed (Cvi42, Circle Vascular Imaging). Septal T1 and T2 relaxation times were assessed, and the extracellular volume (ECV) was calculated. Generalized linear models were established, including liver cirrhosis, age, gender, and body mass index.

#### RESULTS

This prospective analysis included 25 patients with liver cirrhosis (56% females, age 51 +/- 2 years) and 25 matched, healthy controls (56% females, age 50 +/- 2 years). The left ventricular (LV) and right ventricular (RV) end-diastolic volume indices (EDVi) were higher (regression coefficient (B)=+9.7 and +3.0 ml/m<sup>2</sup>), while the end-systolic volume indices (ESVi) were lower than in controls (B=-5.3 and -10.1 ml/m<sup>2</sup>), resulting in higher stroke volume indices (SVi) (B=+15.1 and +13.3 ml/m<sup>2</sup>). Also, patients with liver cirrhosis showed a higher LV and RV ejection fraction (EF) (B=+10.5 and +12.2%). The left atrial (LA) EDVi (B=+5.0 ml/m<sup>2</sup>) and ESVi (B=+15.5 ml/m<sup>2</sup>) were higher than in controls, while right atrial (RA) volumes were similar. Native T2 relaxation times were prolonged compared to controls (B=+2.2 ms), while T1 relaxation times and ECV were not significantly different. Global radial strain (GRS) (B=+17.6%) and circumferential strain (GCS) (B=-4.4%) were increased, while longitudinal strain (GLS) was similar to controls.

## **CONCLUSION**

Patients with liver cirrhosis showed cardiac dilatation and a hypercontractile biventricular function, reflected by increased circumferential contractility and myocardial thickening. Also, native T2 relaxation times were prolonged, possibly indicating subtle inflammation or edema.

## **CLINICAL RELEVANCE/APPLICATION**

Individuals with liver cirrhosis show significant differences in cardiac volumes and function. CMR enables further insights into the cardiac abnormalities caused by liver cirrhosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSCA04-1

### Feasibility of the Threshold-based Quantification of Myocardial Fibrosis on Cardiac CT in Nonischemic Dilated Cardiomyopathy

Monday, Nov. 27 1:30PM - 2:30PM Room: S405

Nayoung Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility and predictive performance of the threshold-based quantification of MDE on cardiac CT in patients with nonischemic dilated cardiomyopathy (NIDCM).

#### METHODS AND MATERIALS

43 patients (mean age, 59.3 years  $\pm$  17.1 [SD]; 22 women) with NIDCM were prospectively recruited from June 2012 through June 2015 and underwent dual-energy cardiac CT and cardiac MRI. Retrospective image analysis was conducted for conventional CT at 100 kV and 120 kV, and 70-keV monochromatic CT. Myocardial delayed enhancement (MDE) in CT was quantified using 2, 3, and 4-SD techniques and manual quantification. Late gadolinium enhancement (LGE) in MRI was quantified using 5-SD technique. Cox regression analysis was performed to determine the association between variables with the primary outcome, which was defined as a composite of cardiac death, heart transplantation, heart failure hospitalization and appropriate defibrillator therapy.

#### RESULTS

LGE was observed in 29 patients (67%, 29/43) and the mean LGE percentage using 5-SD technique was  $4.1 \pm 3.6\%$ . Manual quantification in all CT sets and 4-SD technique in 70-keV CT yielded excellent degree of interobserver agreement (intraclass correlation coefficient= 0.812, 0.804, and 0.833 for 100 kV, 120 kV, and 70 keV using manual quantification; 0.810 for 70-keV CT using 4-SD technique). The highest degree of agreement with LGE was obtained in 70-keV CT using 4-SD technique (CCC = 0.803), followed by good agreement using manual quantification (CCC = 0.781). From the Bland-Altman plots, 4-SD technique in 70-keV CT showed the smallest bias with the narrowest range of 95% limits of agreement (bias, -0.119; 95% limits of agreement -4.216 to 3.978). During a median follow-up of 1,625 days, a total of 10 (23%, 10/43) patients experienced the primary outcome. In the univariable analysis, LV end-diastolic volume index, LV end-systolic volume index, LV ejection fraction, the presence and extent of myocardial fibrosis were associated with the primary composite outcome. In multivariable analysis, the mean MDE percentage from 70-keV CT with 4-SD technique (adjusted hazard ratio, 1.516; P = .018) was an independent significant predictor along with the mean LGE percentage (adjusted hazard ratio, 1.860; P = .01).

#### CONCLUSION

4-SD technique on 70-keV monochromatic CT yielded comparable results to MRI for quantifying myocardial fibrosis and was an independent predictor of cardiovascular outcome in NIDCM.

#### CLINICAL RELEVANCE/APPLICATION

Myocardial delayed enhancement can be properly quantified using a threshold-based approach in cardiac CT and has prognostic value in predicting adverse cardiac events in patients with NIDCM.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSCA04-3

### Incremental Diagnostic Value of Right Ventricular Strain Analysis in Arrhythmogenic Right Ventricular Cardiomyopathy

Monday, Nov. 27 1:30PM - 2:30PM Room: S405

Leyi Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to determine if right ventricular strain analysis can be used for the identification of revised Task Force Criteria (rTFC) diagnosed arrhythmogenic right ventricular cardiomyopathy (ARVC) patients, and whether RV strain parameters can discriminate these patients incremental to the existing cardiac magnetic resonance (CMR) criteria, thus improving the diagnostic yield of CMR in ARVC.

#### METHODS AND MATERIALS

A total of 74 rTFC diagnosed ARVC patients (37 borderline and 37 definite) were retrospectively enrolled for analysis. Using CMR feature tracking (CMR-FT), we evaluated RV global longitudinal (GLS), circumferential (GCS) and radial strain (GRS) of all participants.

#### RESULTS

Compared with controls, patients demonstrated significantly impaired global RV strain in all three directions (all  $p < 0.001$ ). ROC analysis indicated that RV GLS was the strongest discriminator between patients and healthy controls (AUC: 0.92). Using the Youden index, we determined RV GLS = -19.95% as the diagnostic criterion of ARVC patients. In patients with borderline ARVC, there are 17(46%) and 12(32%) participants not fulfilling the existing RV end-diastolic volume index and RV ejection fraction major criterion respectively, of whom 12(71%) and 7(58%), respectively, showed impaired RV GLS. When both conventional criteria and RV GLS were considered together, this new diagnostic method demonstrated an overall diagnostic accuracy of 90% and area under the ROC curve of 0.95.

#### CONCLUSION

Our study showed an improved diagnostic accuracy when both CMR-FT derived RV GLS and the existing CMR criteria in rTFC were considered together, especially for those with borderline diagnosis, suggesting the incremental value of strain analysis to the initial assessment of ARVC.

#### CLINICAL RELEVANCE/APPLICATION

Cardiovascular MR feature tracking is a clinically applicable method that can sensitively characterize ventricular structural or functional alterations. Our study showed that higher diagnostic accuracy can be reached when both conventional criteria and right ventricular global longitudinal strain are considered together, suggesting that right ventricular strain analysis provides a supplementary method to the initial diagnosis of arrhythmogenic right ventricular cardiomyopathy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSCA04-4

### Myocardial Inflammation on Combined Cardiac FDG PET/MRI in Rheumatoid Arthritis

Monday, Nov. 27 1:30PM - 2:30PM Room: S405

Malcolm Davidson, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

FDG-PET/CT has identified extra-cardiac disease activity and inflammation in patients with rheumatoid arthritis. However, there is limited data on cardiac inflammation and metabolic activity. The purpose of this study was to evaluate the prevalence and correlates of myocardial inflammation in patients with rheumatoid arthritis (RA).

#### METHODS AND MATERIALS

In this single center prospective cohort study, adult patients with RA and a control group were recruited for combined cardiac FDG-PET/MRI after diet preparation with a high-fat and low carbohydrate diet for 24 hours plus a minimum 8 hour complete fast prior to FDG-injection. The cardiac MRI protocol included late gadolinium enhanced imaging (LGE), native T1 and T2 mapping, and calculation of extra-cellular volume (ECV). Whole body FDG-uptake was also evaluated to assess for extra-cardiac vascular and articular inflammation. PET analysis included evaluation of SUVmax and cardiac metabolic volume (CMV). Data on disease history, blood biomarkers, and risk factors were evaluated on the same day. RA patients also underwent cardiac CT for calcium scoring within one month of PET/MRI.

#### RESULTS

23 patients with RA were included (56% male, mean age  $50 \pm 16$  years) and were compared to 25 controls (56% male, mean age  $50 \pm 16$  years). Focal myocardial FDG-uptake was present in 3 (13%) RA patients (SUVmax 2.2-3.1 and cardiac metabolic volume 1-22cm<sup>2</sup>) but in none of the controls. RA patients with myocardial inflammation were older than those without inflammation ( $66 \pm 11$  years vs.  $47 \pm 15$  years,  $p=0.03$ ). Sex, disease duration, cardiac risk factors, coronary calcium score and blood biomarkers did not differ significantly between those with and without myocardial inflammation. On cardiac MRI, LGE was more frequent in those with inflammation (67% vs 10%,  $p=0.02$ ). ECV was significantly higher in RA patients compared to controls ( $26 \pm 2\%$  vs.  $25 \pm 3\%$ ,  $p=0.02$ ). However, LVEF, native T1, T2 and ECV did not differ significantly between RA patients with and without myocardial inflammation. Myocardial FDG-uptake was not associated with extra-cardiac inflammation in the joints, skeleton or aorta.

#### CONCLUSION

Subclinical myocardial inflammation is identified on PET/MRI in a minority of patients with RA, and is associated with increasing age and LGE.

#### CLINICAL RELEVANCE/APPLICATION

Future large studies with long-term follow-up are needed to assess whether FDG-uptake in RA patients is associated with arrhythmias and other adverse outcomes and whether anti-inflammatory treatment reduces future event risk.

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## Abstract Archives of the RSNA, 2023

M6-SSCA04-5

### Cardiac Magnetic Resonance Assessment of Response to Light-Chain Cardiac Amyloidosis Chemotherapy

Monday, Nov. 27 1:30PM - 2:30PM Room: S405

Yubo Guo, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Light-chain cardiac amyloidosis (AL-CA) is a condition that can lead to sudden cardiac death or acute heart failure. Cardiac magnetic resonance (CMR) is a diagnostic tool that provides precise and reproducible information about cardiac structure, function, and tissue characteristics, which may assist in the monitoring of responses to chemotherapy. The purpose of this study is to evaluate the effectiveness of CMR in monitoring responses to chemotherapy among patients with AL-CA.

#### METHODS AND MATERIALS

In this prospective study, we enrolled 111 patients with AL-CA (50.5% male; median age, 54 [interquartile range (IQR), 49-63] years). The patients underwent longitudinal monitoring using biomarkers and contrast-enhanced CMR. At the follow-up visit, patients with AL-CA were categorized based on their hematologic and cardiac responses to chemotherapy.

#### RESULTS

Following chemotherapy, there was a significant increase in right ventricular (RV) longitudinal strain and myocardial T2 ( $P = 0.031$  and  $P = 0.008$ , respectively). Among the groups categorized based on cardiac response, patients with superior responses showed a more significant reduction in native T1 (-25.6 [IQR, -75.0 to 27.0] vs. 14.5 [IQR, -32.0 to 58.8];  $P = 0.047$ ) and extracellular volume (ECV) (-0.020 [IQR, -0.060 to 0.013] vs. 0.020 [IQR, -0.030 to 0.050];  $P = 0.010$ ).

#### CONCLUSION

CMR is an effective tool for monitoring initial changes in patients with AL-CA undergoing chemotherapy, as it provides information on ventricular functional recovery and tissue characterization variation. These findings support the integration of CMR parameters into response assessments, which can lead to more individualized assessments of treatment effectiveness.

#### CLINICAL RELEVANCE/APPLICATION

CMR with measurement of ventricle function and myocardial characterization allows non-invasive monitoring of the initial changes following chemotherapy, serial CMR may be a better and more sensitive tool for better characterization of the changes that occur with cardiac response.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSCA04-6

### Insights into Cirrhotic Cardiomyopathy: A Cardiac Magnetic Resonance Analysis on the Impact of Liver Cirrhosis on Cardiac Structure and Function

Monday, Nov. 27 1:30PM - 2:30PM Room: S405

Jennifer Erley, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of liver cirrhosis on cardiac magnetic resonance (CMR) parameters.

#### METHODS AND MATERIALS

Patients with liver cirrhosis awaiting transplant (free of known cardiovascular diseases) received a CMR exam (3T, Ingenia, Philips), including steady-state free precession sequences and mapping. Cardiac volumes (indexed to the body surface area)/ejection fraction were analyzed and feature tracking was performed (Cvi42, Circle Vascular Imaging). Septal T1 and T2 relaxation times were assessed, and the extracellular volume (ECV) was calculated. Generalized linear models were established, including liver cirrhosis, age, gender, and body mass index.

#### RESULTS

This prospective analysis included 25 patients with liver cirrhosis (56% females, age 51 +/- 2 years) and 25 matched, healthy controls (56% females, age 50 +/- 2 years). The left ventricular (LV) and right ventricular (RV) end-diastolic volume indices (EDVi) were higher (regression coefficient (B)=+9.7 and +3.0 ml/m<sup>2</sup>), while the end-systolic volume indices (ESVi) were lower than in controls (B=-5.3 and -10.1 ml/m<sup>2</sup>), resulting in higher stroke volume indices (SVi) (B=+15.1 and +13.3 ml/m<sup>2</sup>). Also, patients with liver cirrhosis showed a higher LV and RV ejection fraction (EF) (B=+10.5 and +12.2%). The left atrial (LA) EDVi (B=+5.0 ml/m<sup>2</sup>) and ESVi (B=+15.5 ml/m<sup>2</sup>) were higher than in controls, while right atrial (RA) volumes were similar. Native T2 relaxation times were prolonged compared to controls (B=+2.2 ms), while T1 relaxation times and ECV were not significantly different. Global radial strain (GRS) (B=+17.6%) and circumferential strain (GCS) (B=-4.4%) were increased, while longitudinal strain (GLS) was similar to controls.

#### CONCLUSION

Patients with liver cirrhosis showed cardiac dilatation and a hypercontractile biventricular function, reflected by increased circumferential contractility and myocardial thickening. Also, native T2 relaxation times were prolonged, possibly indicating subtle inflammation or edema.

#### CLINICAL RELEVANCE/APPLICATION

Individuals with liver cirrhosis show significant differences in cardiac volumes and function. CMR enables further insights into the cardiac abnormalities caused by liver cirrhosis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-SSMK04

### Musculoskeletal Imaging (Knee)

Monday, Nov. 27 1:30PM - 2:30PM Room: E353B

William R. Walter, MD (*Moderator*) Nothing to Disclose  
Justin C. Lee, MBBS, FRCR (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M6-SSMK04-1 A Substantial Number of Total Knee Arthroplasty (TKA) Patients Undergo Magnetic Resonance Imaging (MRI) in the Year Prior to Surgery: A Potential Overutilization of Healthcare Resources**

Katelyn E. Rudisill, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Total knee arthroplasty (TKA) is a common procedure for late-stage degenerative changes, a situation for which magnetic resonance imaging (MRI) is typically not considered useful. In an era attempting to contain healthcare expenditures, the rate, timing, and predictors for MRI prior to TKA were assessed in a large, national, administrative dataset.

#### METHODS AND MATERIALS

The 2010 to Q3 2020 MKnee PearlDiver dataset was used to identify patients undergoing TKA for osteoarthritis. Those with lower extremity MRI for knee indications within one year prior to TKA were then defined. Patient age, sex, Elixhauser Comorbidity Index (ECI), region in the country, and insurance plan were characterized. Predictors of having had an MRI were assessed by univariate and multivariate analyses. The costs and timing of the obtained MRIs were also assessed.

#### RESULTS

Of 731,066 TKAs, MRI was obtained within one year prior for 56,180 (7.68%) with 28,963 (51.9%) within the three months of TKA (Figure 1). Independent predictors of having had an MRI included: younger age (odds ratio [OR] 0.74 per decade increase), female sex (OR 1.10), higher ECI (OR 1.15), region of the country (relative to South, Northeast OR 1.08, West OR 1.22, Midwest OR 1.36), and insurance (relative to Medicare, Medicaid OR 1.36 and Commercial OR 1.35) with  $p < 0.0001$  for each. Total cost of MRIs assessed was \$44,686,308.

#### CONCLUSION

Noting that TKA is typically performed for advanced degenerative changes, MRI should rarely be indicated in the preoperative period for this procedure. Nonetheless, the current study found that MRI was performed within the year prior to TKA for 7.68% of the study cohort. In an era striving for evidence-based medicine, the almost \$45 million dollars spent on MRI in the year prior to TKA may represent overutilization.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study suggest that a large number of patients have an MRI of the knee performed in the year prior to TKA. This results in potentially unnecessary healthcare expenditures in excess of almost \$45 million dollars.

#### **M6-SSMK04-2 Platelet-Rich Plasma Therapy for Patellar Tendinopathy: A Randomized Controlled Trial Correlating Clinical Outcome and Novel Imaging Biomarkers**

Rianne A. Van der Heijden, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate whether platelet-rich plasma (PRP) injection shows more pain reduction than dry needling (DN) or sham (SH) in a single-blinded randomized controlled trial (RCT) for patellar tendinopathy (PT). To assess the association between clinical

outcome and quantitative MR and US parameters, single and bi-component Ultrashort-TE (UTE) T2\* and shear wave elastography (SWS), over time.

## **METHODS AND MATERIALS**

Single-blinded RCT with three parallel interventions: PRP, DN and SH. VAS pain score (0-10), VISA-P function score (0-100), UTE MRI and conventional US measures of tendon thickness, hypoechoogenicity, and hyperemia (0-3 grades) and US shear wave speed (SWS) were acquired at 0, 16 and 52-weeks. A sagittal three-dimensional (3D) gradient-echo-based multi-echo UTE-T2\* mapping sequence (3D-Cones, GE Healthcare, WI) was performed utilizing a 3D cone k-space sampling scheme with 16 TEs between 0.003ms and 35ms on a 3.0T scanner (GE Healthcare, WI) using an 8-channel phased-array extremity coil (InVivoFL). Maps of single-component T2\* relaxation time (T2\*single) and the bi-component T2\* parameter fraction of the fast-relaxing macromolecular bound water component (FF) were calculated using in-house developed software. Longitudinal data analysis with subject as a random effect were used to compare between group and within group differences in outcome measures over time. Mixed effects linear regression was used to assess correlations between outcome measures.

## **RESULTS**

29 subjects (83% male, mean age 26.1yrs  $\pm$  5.3) were randomized into the following groups: PRP=9; DN=11; and SH=9. At 52-weeks, all groups demonstrated a significant improvement in pain during activity with the PRP group having the most pain relief (? -5.9 95%CI [-7.8, -3.9]  $p$ <.001). FF significantly increased in all groups (?=0.10-0.11,  $p$ =0.02-0.046), but T2\*single only decreased significantly in the PRP group (?=-8.07,  $p$ =.01). FF and T2\*single were correlated with pain ( $r$ =-0.42,  $p$ =0.003;  $r$ =0.43,  $p$ =0.002). SWS increased significantly only in the PRP group at 52-weeks (?+2.31 95%CI [0.75, 3.88]  $p$ =.003) and SWS was inversely correlated with VAS ( $r$  =-0.52,  $p$ =.009). The correlations between T2\*single and FF, respectively, and SWS were weak and only significant for T2\*single ( $r$ =-0.29,  $p$ =0.046 and  $r$ =0.19,  $p$ =0.18).

## **CONCLUSION**

Our study showed significant pain relief in the PRP group and demonstrated quantitative imaging responsiveness to change over time with US shear-wave elastography and UTE-T2\* parameters, especially with the bi-component parameter  $F_F$ .

## **CLINICAL RELEVANCE/APPLICATION**

UTE-T2\* parameters  $F_F$  and T2\*single as well as US shear-wave elastography may be acceptable adjunctive quantitative measures to assess healing changes in the treated patellar tendon.

## **M6-SSMK04-3 Deep Learning Generated Lower Extremity Radiographic Measurements are Adequate for Quick Assessment of Knee Angular Alignment and Leg Length Determination**

Holden Archer (*Presenter*) Nothing to Disclose

## **PURPOSE**

Angular and longitudinal deformities of leg alignment create excessive stresses across the joints, leading to pain and impaired function. Multiple measurements are used to assess these deformities on anteroposterior (AP) full-length radiographs. An artificial intelligence (AI) software automatically locates anatomical landmarks on AP full-length radiographs and performs 13 measurements to assess knee angular alignment and leg length. The primary aim of this study was to evaluate the agreements in LLD and knee alignment measurements between an AI software and two board-certified radiologists in patients without metal implants. The secondary aim was to assess time savings achieved by AI.

## **METHODS AND MATERIALS**

The measurements assessed in the study were hip-knee-angle (HKA), anatomical-tibiofemoral angle (aTFA), anatomical-mechanical-axis angle (AMA), joint-line-convergence angle (JLCA), mechanical-lateral-proximal-femur-angle (mLPFA), mechanical-lateral-distal-femur-angle (mLDFA), mechanical-medial-proximal-tibia-angle (mMPTA), mechanical-lateral-distal-tibia- angle (mLDTA), femur length, tibia length, full leg length, leg length discrepancy (LLD), and mechanical axis deviation (MAD). These measurements were performed by two musculoskeletal radiologist and the AI software on 164 legs. Intraclass correlation coefficients (ICC) and Bland-Altman analyses were used to assess the AI's performance.

## **RESULTS**

ICC estimates between the AI algorithm and reference standard were excellent (ICC > 0.75) across all 13 variables. The AI software met the predetermined performance targets (maximum allowed differences) for agreement for all variables besides MAD and mLDTA. The mean reading time for the AI algorithm and two readers was 38.3, 435.0, and 625.0 seconds respectively.

## **CONCLUSION**

This study demonstrated that this AI-based software reliably generated measurements for most variables in the study and provided substantial time savings.

## CLINICAL RELEVANCE/APPLICATION

This tool could provide preliminary measurements to clinicians for quick evaluation of the lower extremity. AI-generated measurements could also make a significant difference in rural or remote locations where physicians do not have experience assessing these radiographs.

### M6-SSMK04-4 **Thigh Muscle Volume is Predictive of Total Knee Replacement: Longitudinal Analysis of Data from the Osteoarthritis Initiative**

Upasana U. Bharadwaj, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether higher thigh muscle volume is associated with lower odds of total knee replacement (cases) compared to participants who do not undergo knee replacement (controls).

#### METHODS AND MATERIALS

A total of 134 participants (70 female, age 62.1 [45.0, 79.0] years, BMI 29.9 [22.2, 41.8] kg/m<sup>2</sup>) from the Osteoarthritis Initiative (OAI) cohort who underwent total knee replacement (TKR) of a single knee, excluding bilateral cases, were selected (n=67). Participants who did not undergo TKR were propensity-score matched on age, sex, BMI, Kellgren-Lawrence (KL) grades, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Physical Activity Scale for the Elderly (PASE) as controls (n=67). 3T MRI of the thigh obtained at the time of surgery, 2 years and 4 years before the surgery (if available) were evaluated. A previously trained, accurate (dice score > 0.90 for all muscle groups) deep-learning model for 3D muscle segmentation was used to segment and compute volumes of: extensors, hamstrings, adductors, gracilis, sartorius, and subcutaneous fat. Additional markers such as total muscle volume, normalized volumes (muscle volume / total muscle volume), and extensor-hamstring ratio (extensors volume / hamstrings volume) were derived based on these measurements. Association between thigh muscle volume markers and TKR was assessed using a longitudinal mixed effects logistic regression model; odds ratio (OR) along with 95% confidence intervals for each muscle group (representing overall effect across the 3 timepoints) were computed; a p < 0.05 was considered statistically significant.

#### RESULTS

Normalized thigh muscle volumes were overall associated with TKR (F-statistic=6.36, p<0.001). A higher extensor-hamstring ratio was significantly associated with lower odds of TKR (OR: 0.18 [0.04, 0.58], p=0.005). Higher normalized volumes of hamstrings (OR: 0.93 [0.89, 0.97], p=0.002) and gracilis (OR: 0.92 [0.87, 0.96], p=0.01) were also associated with lower odds of TKR. Adductors (OR: 1.0 [0.99, 1.10]), extensors (OR: 1.02 [0.99, 1.12]), sartorius (OR: 1.05 [0.89, 1.32]), and subcutaneous fat (OR: 0.99 [0.98, 1.01]) as well as absolute muscle volumes did not show significant association with TKR.

#### CONCLUSION

A lower odds ratio of TKR for the extensor-hamstring ratio was found indicating that a stronger extensors group, relative to hamstrings, may lower the risk of TKR. Strong hamstrings, in general, may also lower the risk of TKR.

## CLINICAL RELEVANCE/APPLICATION

These results can potentially inform clinical management; namely, strengthening extensors relative to hamstrings may lower the risk of eventual total knee replacement.

### M6-SSMK04-5 **Frequency of Combined Femoral and Tibial Torsional Deformities on CT of the Lower Leg in Symptomatic Patients with Patellar Instability and Patellar Dislocation**

Till D. Lerch, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Torsional deformities of the lower leg were associated with anterior knee pain, knee osteoarthritis and patellar instability. Increased femoral torsion (FT) and tibial torsion (TT) were associated with patellar instability. Combined torsional deformities might compensate or aggravate each other regarding the influence on patellofemoral kinematics. Therefore, this study aims to determine the prevalence of combined abnormalities in symptomatic patients with patellar instability.

#### METHODS AND MATERIALS

An IRB-approved radiographic retrospective study was performed of 207 consecutive patients with patellar instability. Of them 145 had documented patellar dislocation and 62 had patellar subluxation. All included patients had CT scan of the hip, knee and ankle. FT was measured according to the Murphy method assuming a normal range of 10-25°. Femorotibial rotation (FTR, also called knee torsion) was defined by the angle between the femoral and the tibial posterior condylar lines assuming a normal range of -5 to +5°. TT was measured according to the method described by Waidelich et al (normal range 25-40°).

## **RESULTS**

Mean FT was 29.8°, mean FTR 6.8°, and mean TT 34.2°. Overall, 68% of the patients had FT>25° and 30% had FT>35°. 35% of the patients had FTR>10°, 13% had FTR>15° and 24% had TT>40°. 26% had combined FT>25° and FTR>10°. 9% had no torsional deformity (all three values normal). Whereas 17% had combined FT>25° and TT>40° and 8% had combined FT>35° and TT>40° (torsional malalignment syndrome).

## **CONCLUSION**

In patients with patellar instability, torsional deformities are highly prevalent. The 8-16% with combined increased FT and TT have torsional malalignment syndrome.

In up to 30% of patients with patellar instability, a femoral derotational osteotomy could be evaluated as a potential therapy. 2-5% have combined increased FT, FTR and TT (compensated malalignment) and may be eligible for combined distal femoral and high tibial derotation osteotomy.

## **CLINICAL RELEVANCE/APPLICATION**

Based on the findings of the present study, additional imaging with CT/MRI for torsional analysis is recommended in all patients with patellofemoral disorders to detect combined deformities.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMK04-1

### **A Substantial Number of Total Knee Arthroplasty (TKA) Patients Undergo Magnetic Resonance Imaging (MRI) in the Year Prior to Surgery: A Potential Overutilization of Healthcare Resources**

Monday, Nov. 27 1:30PM - 2:30PM Room: E353B

Katelyn E. Rudisill, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Total knee arthroplasty (TKA) is a common procedure for late-stage degenerative changes, a situation for which magnetic resonance imaging (MRI) is typically not considered useful. In an era attempting to contain healthcare expenditures, the rate, timing, and predictors for MRI prior to TKA were assessed in a large, national, administrative dataset.

#### **METHODS AND MATERIALS**

The 2010 to Q3 2020 MKnee PearlDiver dataset was used to identify patients undergoing TKA for osteoarthritis. Those with lower extremity MRI for knee indications within one year prior to TKA were then defined. Patient age, sex, Elixhauser Comorbidity Index (ECI), region in the country, and insurance plan were characterized. Predictors of having had an MRI were assessed by univariate and multivariate analyses. The costs and timing of the obtained MRIs were also assessed.

#### **RESULTS**

Of 731,066 TKAs, MRI was obtained within one year prior for 56,180 (7.68%) with 28,963 (51.9%) within the three months of TKA (Figure 1). Independent predictors of having had an MRI included: younger age (odds ratio [OR] 0.74 per decade increase), female sex (OR 1.10), higher ECI (OR 1.15), region of the country (relative to South, Northeast OR 1.08, West OR 1.22, Midwest OR 1.36), and insurance (relative to Medicare, Medicaid OR 1.36 and Commercial OR 1.35) with  $p < 0.0001$  for each. Total cost of MRIs assessed was \$44,686,308.

#### **CONCLUSION**

Noting that TKA is typically performed for advanced degenerative changes, MRI should rarely be indicated in the preoperative period for this procedure. Nonetheless, the current study found that MRI was performed within the year prior to TKA for 7.68% of the study cohort. In an era striving for evidence-based medicine, the almost \$45 million dollars spent on MRI in the year prior to TKA may represent overutilization.

#### **CLINICAL RELEVANCE/APPLICATION**

The results of this study suggest that a large number of patients have an MRI of the knee performed in the year prior to TKA. This results in potentially unnecessary healthcare expenditures in excess of almost \$45 million dollars.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMK04-2

### Platelet-Rich Plasma Therapy for Patellar Tendinopathy: A Randomized Controlled Trial Correlating Clinical Outcome and Novel Imaging Biomarkers

Monday, Nov. 27 1:30PM - 2:30PM Room: E353B

Rianne A. Van der Heijden, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate whether platelet-rich plasma (PRP) injection shows more pain reduction than dry needling (DN) or sham (SH) in a single-blinded randomized controlled trial (RCT) for patellar tendinopathy (PT). To assess the association between clinical outcome and quantitative MR and US parameters, single and bi-component Ultrashort-TE (UTE) T2\* and shear wave elastography (SWS), over time.

#### METHODS AND MATERIALS

Single-blinded RCT with three parallel interventions: PRP, DN and SH. VAS pain score (0-10), VISA-P function score (0-100), UTE MRI and conventional US measures of tendon thickness, hypoechogenicity, and hyperemia (0-3 grades) and US shear wave speed (SWS) were acquired at 0, 16 and 52-weeks. A sagittal three-dimensional (3D) gradient-echo-based multi-echo UTE-T2\* mapping sequence (3D-Cones, GE Healthcare, WI) was performed utilizing a 3D cone k-space sampling scheme with 16 TEs between 0.003ms and 35ms on a 3.0T scanner (GE Healthcare, WI) using an 8-channel phased-array extremity coil (InVivoFL). Maps of single-component T2\* relaxation time (T2\*single) and the bi-component T2\* parameter fraction of the fast-relaxing macromolecular bound water component (FF) were calculated using in-house developed software. Longitudinal data analysis with subject as a random effect were used to compare between group and within group differences in outcome measures over time. Mixed effects linear regression was used to assess correlations between outcome measures.

#### RESULTS

29 subjects (83% male, mean age 26.1yrs  $\pm$  5.3) were randomized into the following groups: PRP=9; DN=11; and SH=9. At 52-weeks, all groups demonstrated a significant improvement in pain during activity with the PRP group having the most pain relief (? -5.9 95%CI [-7.8, -3.9]  $p$ <.001). FF significantly increased in all groups (?=0.10-0.11,  $p$ =0.02-0.046), but T2\*single only decreased significantly in the PRP group (?=-8.07,  $p$ =.01). FF and T2\*single were correlated with pain ( $r$ =-0.42,  $p$ =0.003;  $r$ =0.43,  $p$ =0.002). SWS increased significantly only in the PRP group at 52-weeks (?+2.31 95%CI [0.75, 3.88]  $p$ =.003) and SWS was inversely correlated with VAS ( $r$  =-0.52,  $p$ =.009). The correlations between T2\*single and FF, respectively, and SWS were weak and only significant for T2\*single ( $r$ =-0.29,  $p$ =0.046 and  $r$ =0.19,  $p$ =0.18).

#### CONCLUSION

Our study showed significant pain relief in the PRP group and demonstrated quantitative imaging responsiveness to change over time with US shear-wave elastography and UTE-T2\* parameters, especially with the bi-component parameter F<sub>F</sub>.

#### CLINICAL RELEVANCE/APPLICATION

UTE-T2\* parameters FF and T2\*single as well as US shear-wave elastography may be acceptable adjunctive quantitative measures to assess healing changes in the treated patellar tendon.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMK04-3

### Deep Learning Generated Lower Extremity Radiographic Measurements are Adequate for Quick Assessment of Knee Angular Alignment and Leg Length Determination

Monday, Nov. 27 1:30PM - 2:30PM Room: E353B

Holden Archer (*Presenter*) Nothing to Disclose

#### PURPOSE

Angular and longitudinal deformities of leg alignment create excessive stresses across the joints, leading to pain and impaired function. Multiple measurements are used to assess these deformities on anteroposterior (AP) full-length radiographs. An artificial intelligence (AI) software automatically locates anatomical landmarks on AP full-length radiographs and performs 13 measurements to assess knee angular alignment and leg length. The primary aim of this study was to evaluate the agreements in LLD and knee alignment measurements between an AI software and two board-certified radiologists in patients without metal implants. The secondary aim was to assess time savings achieved by AI.

#### METHODS AND MATERIALS

The measurements assessed in the study were hip-knee-angle (HKA), anatomical-tibiofemoral angle (aTFA), anatomical-mechanical-axis angle (AMA), joint-line-convergence angle (JLCA), mechanical-lateral-proximal-femur-angle (mLPFA), mechanical-lateral-distal-femur-angle (mLDFA), mechanical-medial-proximal-tibia-angle (mMPTA), mechanical-lateral-distal-tibia-angle (mLDTA), femur length, tibia length, full leg length, leg length discrepancy (LLD), and mechanical axis deviation (MAD). These measurements were performed by two musculoskeletal radiologist and the AI software on 164 legs. Intraclass correlation coefficients (ICC) and Bland-Altman analyses were used to assess the AI's performance.

#### RESULTS

ICC estimates between the AI algorithm and reference standard were excellent ( $ICC > 0.75$ ) across all 13 variables. The AI software met the predetermined performance targets (maximum allowed differences) for agreement for all variables besides MAD and mLDTA. The mean reading time for the AI algorithm and two readers was 38.3, 435.0, and 625.0 seconds respectively.

#### CONCLUSION

This study demonstrated that this AI-based software reliably generated measurements for most variables in the study and provided substantial time savings.

#### CLINICAL RELEVANCE/APPLICATION

This tool could provide preliminary measurements to clinicians for quick evaluation of the lower extremity. AI-generated measurements could also make a significant difference in rural or remote locations where physicians do not have experience assessing these radiographs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMK04-4

### Thigh Muscle Volume is Predictive of Total Knee Replacement: Longitudinal Analysis of Data from the Osteoarthritis Initiative

Monday, Nov. 27 1:30PM - 2:30PM Room: E353B

Upasana U. Bharadwaj, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether higher thigh muscle volume is associated with lower odds of total knee replacement (cases) compared to participants who do not undergo knee replacement (controls).

#### METHODS AND MATERIALS

A total of 134 participants (70 female, age 62.1 [45.0, 79.0] years, BMI 29.9 [22.2, 41.8] kg/m<sup>2</sup>) from the Osteoarthritis Initiative (OAI) cohort who underwent total knee replacement (TKR) of a single knee, excluding bilateral cases, were selected (n=67). Participants who did not undergo TKR were propensity-score matched on age, sex, BMI, Kellgren-Lawrence (KL) grades, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Physical Activity Scale for the Elderly (PASE) as controls (n=67). 3T MRI of the thigh obtained at the time of surgery, 2 years and 4 years before the surgery (if available) were evaluated. A previously trained, accurate (dice score > 0.90 for all muscle groups) deep-learning model for 3D muscle segmentation was used to segment and compute volumes of: extensors, hamstrings, adductors, gracilis, sartorius, and subcutaneous fat. Additional markers such as total muscle volume, normalized volumes (muscle volume / total muscle volume), and extensor-hamstring ratio (extensors volume / hamstrings volume) were derived based on these measurements. Association between thigh muscle volume markers and TKR was assessed using a longitudinal mixed effects logistic regression model; odds ratio (OR) along with 95% confidence intervals for each muscle group (representing overall effect across the 3 timepoints) were computed; a  $p < 0.05$  was considered statistically significant.

#### RESULTS

Normalized thigh muscle volumes were overall associated with TKR (F-statistic=6.36,  $p < 0.001$ ). A higher extensor-hamstring ratio was significantly associated with lower odds of TKR (OR: 0.18 [0.04, 0.58],  $p = 0.005$ ). Higher normalized volumes of hamstrings (OR: 0.93 [0.89, 0.97],  $p = 0.002$ ) and gracilis (OR: 0.92 [0.87, 0.96],  $p = 0.01$ ) were also associated with lower odds of TKR. Adductors (OR: 1.0 [0.99, 1.10]), extensors (OR: 1.02 [0.99, 1.12]), sartorius (OR: 1.05 [0.89, 1.32]), and subcutaneous fat (OR: 0.99 [0.98, 1.01]) as well as absolute muscle volumes did not show significant association with TKR.

#### CONCLUSION

A lower odds ratio of TKR for the extensor-hamstring ratio was found indicating that a stronger extensors group, relative to hamstrings, may lower the risk of TKR. Strong hamstrings, in general, may also lower the risk of TKR.

#### CLINICAL RELEVANCE/APPLICATION

These results can potentially inform clinical management; namely, strengthening extensors relative to hamstrings may lower the risk of eventual total knee replacement.

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## Abstract Archives of the RSNA, 2023

M6-SSMK04-5

### Frequency of Combined Femoral and Tibial Torsional Deformities on CT of the Lower Leg in Symptomatic Patients with Patellar Instability and Patellar Dislocation

Monday, Nov. 27 1:30PM - 2:30PM Room: E353B

Till D. Lerch, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Torsional deformities of the lower leg were associated with anterior knee pain, knee osteoarthritis and patellar instability. Increased femoral torsion (FT) and tibial torsion (TT) were associated with patellar instability. Combined torsional deformities might compensate or aggravate each other regarding the influence on patellofemoral kinematics. Therefore, this study aims to determine the prevalence of combined abnormalities in symptomatic patients with patellar instability.

#### METHODS AND MATERIALS

An IRB-approved radiographic retrospective study was performed of 207 consecutive patients with patellar instability. Of them 145 had documented patellar dislocation and 62 had patellar subluxation. All included patients had CT scan of the hip, knee and ankle. FT was measured according to the Murphy method assuming a normal range of 10-25°. Femorotibial rotation (FTR, also called knee torsion) was defined by the angle between the femoral and the tibial posterior condylar lines assuming a normal range of -5 to +5°. TT was measured according to the method described by Waidelich et al (normal range 25-40°).

#### RESULTS

Mean FT was 29.8°, mean FTR 6.8°, and mean TT 34.2°. Overall, 68% of the patients had FT>25° and 30% had FT>35°. 35% of the patients had FTR>10°, 13% had FTR>15° and 24% had TT>40°. 26% had combined FT>25° and FTR>10°. 9% had no torsional deformity (all three values normal). Whereas 17% had combined FT>25° and TT>40° and 8% had combined FT>35° and TT>40° (torsional malalignment syndrome).

#### CONCLUSION

In patients with patellar instability, torsional deformities are highly prevalent. The 8-16% with combined increased FT and TT have torsional malalignment syndrome.

In up to 30% of patients with patellar instability, a femoral derotational osteotomy could be evaluated as a potential therapy. 2-5% have combined increased FT, FTR and TT (compensated malalignment) and may be eligible for combined distal femoral and high tibial derotation osteotomy.

#### CLINICAL RELEVANCE/APPLICATION

Based on the findings of the present study, additional imaging with CT/MRI for torsional analysis is recommended in all patients with patellofemoral disorders to detect combined deformities.

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## Abstract Archives of the RSNA, 2023

M6-SSMS01

### Science Session with Keynote: Multisystem (New Horizons in Imaging and Diagnosis of Benign and Malignant Conditions)

Monday, Nov. 27 1:30PM - 2:30PM Room: E350

Margarita V. Revzin, MD, MS (*Moderator*) Nothing to Disclose  
Nariman Nezami, MD (*Moderator*) Consultant, CAPS Medical Ltd

#### Sub-Events

#### **M6-SSMS01-1 Proton Density Fat Fraction Quantification with 6-Point Dixon Technique: Capability for Hematopoietic Ability Assessment and Diagnosis of Aplastic Anemia in the Adults**

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

#### PURPOSE

Whole-body proton density fat fraction (PDFF) imaging is being applied to evaluate the fat content of bone marrow in patients with benign and malignant diseases or osteoporosis. However, no one have evaluated the capability of PDFF for hematopoietic ability. The purpose of this study was to determine the capability of proton density fat fraction quantification (PD-FFQ) with 6-point Dixon technique for hematopoietic ability assessment and diagnosis of aplastic anemia in adults.

#### METHODS AND MATERIALS

Gender and age matched aplastic anemia patients (n=10: aplastic anemia group) and adults without aplastic anemia (n=15: control group) prospectively examined lumbar MRI with PD-FFQ with 6-point Dixon technique at two 3T MR systems (Vantage Centurian, Canon Medical Systems Corporation, Otawara, Japan). To evaluate vertebral bone marrow fat fraction (BMFF) in each subject, region of interests (ROIs) were placed over at vertebrae from L1 to L5, and mean values of each vertebra was recorded. Then, mean, standard deviation (SD) and percentage of coefficient of variation (%CV) of BMFF were determined from all ROI measurements in each patient. To compare each quantitative index between two groups, Student's t-test was performed. To determine the relationship between blood test result and each quantitative index, Pearson's correlation was performed. To compare diagnostic capability for aplastic anemia by all quantitative index as having significant differences between two groups, ROC-based positive test was performed. Then, sensitivity, specificity and accuracy were compared among them.

#### RESULTS

On comparison of two groups, here were significant differences of SD and %CV between aplastic anemia and control groups (SD:  $p=0.02$ , %CV:  $p=0.0008$ ). SD and %CV had significant and negative correlations with number of red blood cell (SD:  $r=-0.43$ ,  $p=0.04$ , %CV:  $r=-0.41$ ,  $p=0.04$ ) and plate count (SD:  $r=-0.43$ ,  $p=0.03$ , %CV:  $r=-0.53$ ,  $p=0.007$ ). When applied feasible threshold value from ROC-based positive tests, specificity of %CV (93.3%) was significantly higher than that of SD (53%,  $p=0.03$ ).

#### CONCLUSION

PD-FFQ with 6-point Dixon technique has a potential for hematopoietic ability assessment and diagnosis of aplastic anemia in adults.

#### CLINICAL RELEVANCE/APPLICATION

PD-FFQ with 6-point Dixon technique has a potential for hematopoietic ability assessment and diagnosis of aplastic anemia in adults.

#### **M6-SSMS01-2 Modification of Lugano Criteria by Pre-Infusion Tumor Kinetics Improves Early Survival Prediction for Lymphoma Patients Under Chimeric Antigen Receptor T-Cell Therapy**

Michael Winkelmann, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Chimeric antigen receptor T-cell therapy (CART) is effective for patients with refractory or relapsed (r/r) lymphoma with prolongation of survival. We aimed to improve the prediction of Lugano criteria for overall survival (OS) at 30-day follow-up (FU1) by including the pre-infusion tumor growth rate (TGRpre-BL) and its early change to 30-day FU1 imaging (TGRpost-BL).

## METHODS AND MATERIALS

Consecutive patients with pre-baseline (pre-BL), baseline (BL) and FU imaging around day 30 with CT or PET/CT before CART were included. TGR was defined as change of Lugano criteria-based tumor burden between pre-BL, BL and FU examinations in relation to days between imaging exams. Overall response and PFS were determined based on Lugano criteria. Proportional Cox regression analysis studied association of TGR with OS. For survival analysis, OS was analyzed using Kaplan-Meier survival curves.

## RESULTS

59 out of 81 patients met the inclusion criteria. At 30-day FU 8 patients (16%) had a CR, 25 patients (42%) a PR, 15 patients (25%) a SD, and 11 patients (19%) a PD according to Lugano criteria. The Median TGRpre-BL was -0.6 mm<sup>2</sup>/d, 24.4 mm<sup>2</sup>/d, -5.1 mm<sup>2</sup>/d, and 18.6 mm<sup>2</sup>/d and the median TGRpost-BL was -16.7 mm<sup>2</sup>/d, -102.0 mm<sup>2</sup>/d, -19.8 mm<sup>2</sup>/d and 8.5 mm<sup>2</sup>/d in CR, PR, SD, and PD patients, respectively. PD patients could be subclassified into a cohort with an increase in TGR (7 of 11 patients [64%], PD TGRpre-to-post-BL INCR) and a cohort with a decrease in TGR (4 of 11 patients [36%], PD TGRpre-to-post-BL DECR) from pre- to post-BL. PD TGRpre-to-post-BL DECR patients exhibited similar OS to patients classified as SD, while PD TGRpre-to-post-BL INCR patients had significantly shorter OS (65 days vs 471 days,  $p < 0.001$ ).

## CONCLUSION

In the context of CART, the additional use of TGRpre-BL and its change to TGRpost-BL determined at 30-day FU1 showed better OS prognostication for patients with Lugano overall progressive than Lugano criteria alone.

## CLINICAL RELEVANCE/APPLICATION

Therefore, this modification of the Lugano classification should be explored as a potential novel imaging biomarker of early response.

## M6-SSMS01-3 Dynamic Monitoring Soft Tissue Healing Via Visualized Gd-Crosslinked Double Network MRI Imaging Microspheres

Tongtong Chen (*Presenter*) Nothing to Disclose

## PURPOSE

Achieving real-time monitoring of scaffold material and regenerated tissue simultaneously using a non-invasive, continuous method.

## METHODS AND MATERIALS

By covalently cross-linking the MRI T1-weighted imaging contrast agent, gadolinium ions, with sodium alginate modified by methacrylic anhydride through an airflow-controlled method, an MRI-ready dual-network cross-linked hydrogel microsphere was fabricated, which simultaneously enables non-invasive real-time monitoring of scaffold material degradation and tissue repair regeneration.

## RESULTS

Relaxation rate experiments showed that the longitudinal relaxation rate of gadolinium alginate microspheres was 33.113 M<sup>-1</sup>s<sup>-1</sup>, which was three times higher than that of the clinical MRI T1-weighted imaging contrast agent gadopentetate glucosamine (Gd-DTPA), and both in vitro and in vivo experiments showed that the T1 signal values of gadolinium alginate microspheres gradually decreased with the degradation of the microspheres ( $R^2=0.95$ ), while in a rat abdominal muscle defect model, the affected The magnetic resonance signal values also showed a linear correlation with the degree of tissue repair in their corresponding histopathological sections in the rat abdominal muscle defect model ( $R^2=0.91$ ). In addition, gadolinium alginate microspheres exhibited good biosafety, with no adverse effects found in vital organs, and the degraded gadolinium ions were eliminated from the body after metabolism by the liver and kidneys.

## CONCLUSION

The dual network cross-linked hydrogel microspheres can use the magnetic resonance signal value to better reflect the in vivo condition of the material while achieving non-invasive real-time monitoring of scaffold material degradation and tissue repair and regeneration.

## CLINICAL RELEVANCE/APPLICATION

Using MRI to monitor the extent of biomaterial degradation and tissue regeneration in a non-invasive manner provides support for further optimization of scaffold materials to match the regenerative process.

### **M6-SSMS01-4 The Value of CT Lymphangiography Combined with $^{99}\text{Tc}^{\text{m}}$ -DX Lymphoscintigraphy in Diagnosing Primary Chylopericardium**

Yimeng Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic value of combined  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy and CT lymphangiography (CTL) in primary chylopericardium.

#### **METHODS AND MATERIALS**

Forty-eight patients diagnosed with primary chylopericardium clinically were retrospectively analyzed, and  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy and CT lymphangiography (CTL) were performed in all patients. According to the  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy results, primary chylopericardium was classified into three types: type I (abnormal radioactive concentration at the angle of the left jugular vein), type II (persistent concentration of contrast in the right jugular angle with or without radiographic concentration in the left jugular angle), and type III (no visualization of the left jugular vein angle or a transient visualization during the examination). The evaluation indexes of CTL include: (1) abnormal distribution of contrast and reflux in the neck, subclavian region, end of thoracic duct, end of right lymphatic duct and axilla, (2) abnormal distribution of contrast in the chest, including deep thorax (anterior mediastinum, aortopulmonary window, peri-tracheal and bronchial, inferior bulge, posterior mediastinum, hilum, peri-bronchial vascular bundle, pericardium, etc.), superficial thorax (intercostal, pleura). CTL characteristics were analyzed between different groups, and  $P < 0.05$  was considered a statistically significant difference.

#### **RESULTS**

Primary chylopericardium in 48 patients showed 12 cases of  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy imaging type I, 14 patients with type II, and 22 patients with type III in 48 patients. The incidence of abnormal distribution of contrast in the pericardial and aortopulmonary windows,  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy group I was greater than group III, and the difference was statistically significant ( $P = 0.008$ ). And the incidence of abnormal distribution of contrast agent in the bilateral cervical or subclavian region was greater in  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy type II than type III ( $P = 0.002$ ).

#### **CONCLUSION**

The  $^{99}\text{Tc}^{\text{m}}$ -DX typing reflects the abnormal of thoracic duct and pericardial effusion in patients with primary chylopericardium, and CTL shows the abnormal systemic lymphatic vessels. The combined application of the two methods is of great value for the localized and qualitative diagnosis of primary chylopericardium.

## CLINICAL RELEVANCE/APPLICATION

To analyze the differences in CTL imaging performance between different  $^{99}\text{Tc}^{\text{m}}$ -DX lymphatic imaging types, so as to explore the diagnostic value of the combined application of the two imaging methods in primary chylopericardium.

### **M6-SSMS01-5 Real-world Experience of an FDA Approved CAR-T Cell Therapy at a Single Institution: Imaging Utilization, Response and Adverse Events Assessment**

Kaustav Bera, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Chimeric antigen receptor (CAR) T-cell immunotherapy has been effective in management of refractory blood cancers but are predominantly used in the clinical trial setting, with wide ranging adverse events. The purpose of this work is to show the real world use of CAR T-cell therapy at a tertiary care cancer center, discussing imaging utilization, findings including response patterns and adverse events including cytokine release syndrome (CRS) and immune effector cell-associated neurotoxicity syndrome (ICANS) to guide management.

#### **METHODS AND MATERIALS**

The retrospective chart review of a cancer registry from 1/2021 to 3/2023 yielded 45 patients who received CAR-T cell infusion. Clinical CRS or ICANS toxicity grade was assessed using American Society for Transplantation and Cellular Therapy, or ASTCT, consensus grading. Demographic and treatment information were obtained. The number and type of inpatient imaging was collected. Response was determined by Deauville score on PET/CT or molecular markers in case of no PET/CT.

#### **RESULTS**

A total of 45 patients with mean age of 62, including 11 women who received CAR T-cells were included. There was one pediatric patient aged 8 with ALL. 84% CAR-T therapies were commercially available ( $n=38$ ) while 7 were locally produced

Anti CD-19 against lymphoma (Fig 1). 62% of the patients had complete response (n=28) as best treatment response, six with partial response, none with stable disease, and 11 (24%) with progressive disease. Amongst responders (n=34), 44% (n=15) progressed with median time to progression being 6 months (Range 2 -19.5 months) while 56% (n=15) had durable response till follow up. 6 patients (13%) died. 33 (73%) and 18 (40%) patients had at least clinical Grade 1 CRS and ICANS respectively. 16 patients experienced both CRS and ICANS. Average length of hospital stay was 23 days. Average number of radiology images while inpatient was 4.2 per patient. Of these the highest modality ordered was CXR with 2.7 CXRs per patient. Meanwhile the commonest neuroimaging study ordered was a head CT with 11 out of 18 patients (61%) with at least Grade 1 ICANS receiving at least one head CT during admission.

#### **CONCLUSION**

CAR-T cell therapy provided durable response in a majority of patients, however complicated by toxicities, mostly in the immediate setting. Imaging plays a crucial role in not only monitoring response to treatment following CAR-T cell therapy but also help in diagnosing toxicities.

#### **CLINICAL RELEVANCE/APPLICATION**

FDA approved CAR-T cell therapy shows remarkable promise in the real-world setting , outside the realm of clinical trials. With their likely increase in use, radiologists will need to educate themselves on the management and toxicity patterns of this therapy in a wide variety of blood cancers.

#### **M6-SSMS01-6 Keynote Speaker: Exploring the Value of Photon-Counting CT in Interventional Radiology and Robotic Surgery**

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMS01-1

### Proton Density Fat Fraction Quantification with 6-Point Dixon Technique: Capability for Hematopoietic Ability Assessment and Diagnosis of Aplastic Anemia in the Adults

Monday, Nov. 27 1:30PM - 2:30PM Room: E350

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

#### PURPOSE

Whole-body proton density fat fraction (PDFF) imaging is being applied to evaluate the fat content of bone marrow in patients with benign and malignant diseases or osteoporosis. However, no one have evaluated the capability of PDFF for hematopoietic ability. The purpose of this study was to determine the capability of proton density fat fraction quantification (PD-FFQ) with 6-point Dixon technique for hematopoietic ability assessment and diagnosis of aplastic anemia in adults.

#### METHODS AND MATERIALS

Gender and age matched aplastic anemia patients (n=10: aplastic anemia group) and adults without aplastic anemia (n=15: control group) prospectively examined lumbar MRI with PD-FFQ with 6-point Dixon technique at two 3T MR systems (Vantage Centurian, Canon Medical Systems Corporation, Otawara, Japan). To evaluate vertebral bone marrow fat fraction (BMFF) in each subject, region of interests (ROIs) were placed over at vertebrae from L1 to L5, and mean values of each vertebra was recorded. Then, mean, standard deviation (SD) and percentage of coefficient of variation (%CV) of BMFF were determined from all ROI measurements in each patient. To compare each quantitative index between two groups, Student's t-test was performed. To determine the relationship between blood test result and each quantitative index, Pearson's correlation was performed. To compare diagnostic capability for aplastic anemia by all quantitative index as having significant differences between two groups, ROC-based positive test was performed. Then, sensitivity, specificity and accuracy were compared among them.

#### RESULTS

On comparison of two groups, here were significant differences of SD and %CV between aplastic anemia and control groups (SD:  $p=0.02$ , %CV:  $p=0.0008$ ). SD and %CV had significant and negative correlations with number of red blood cell (SD:  $r=-0.43$ ,  $p=0.04$ , %CV:  $r=-0.41$ ,  $p=0.04$ ) and plate count (SD:  $r=-0.43$ ,  $p=0.03$ , %CV:  $r=-0.53$ ,  $p=0.007$ ). When applied feasible threshold value from ROC-based positive tests, specificity of %CV (93.3%) was significantly higher than that of SD (53%,  $p=0.03$ ).

#### CONCLUSION

PD-FFQ with 6-point Dixon technique has a potential for hematopoietic ability assessment and diagnosis of aplastic anemia in adults.

#### CLINICAL RELEVANCE/APPLICATION

PD-FFQ with 6-point Dixon technique has a potential for hematopoietic ability assessment and diagnosis of aplastic anemia in adults.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMS01-2

### Modification of Lugano Criteria by Pre-Infusion Tumor Kinetics Improves Early Survival Prediction for Lymphoma Patients Under Chimeric Antigen Receptor T-Cell Therapy

Monday, Nov. 27 1:30PM - 2:30PM Room: E350

Michael Winkelmann, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Chimeric antigen receptor T-cell therapy (CART) is effective for patients with refractory or relapsed (r/r) lymphoma with prolongation of survival. We aimed to improve the prediction of Lugano criteria for overall survival (OS) at 30-day follow-up (FU1) by including the pre-infusion tumor growth rate (TGRpre-BL) and its early change to 30-day FU1 imaging (TGRpost-BL).

#### METHODS AND MATERIALS

Consecutive patients with pre-baseline (pre-BL), baseline (BL) and FU imaging around day 30 with CT or PET/CT before CART were included. TGR was defined as change of Lugano criteria-based tumor burden between pre-BL, BL and FU examinations in relation to days between imaging exams. Overall response and PFS were determined based on Lugano criteria. Proportional Cox regression analysis studied association of TGR with OS. For survival analysis, OS was analyzed using Kaplan-Meier survival curves.

#### RESULTS

59 out of 81 patients met the inclusion criteria. At 30-day FU 8 patients (16%) had a CR, 25 patients (42%) a PR, 15 patients (25%) a SD, and 11 patients (19%) a PD according to Lugano criteria. The Median TGRpre-BL was -0.6 mm<sup>2</sup>/d, 24.4 mm<sup>2</sup>/d, -5.1 mm<sup>2</sup>/d, and 18.6 mm<sup>2</sup>/d and the median TGRpost-BL was -16.7 mm<sup>2</sup>/d, -102.0 mm<sup>2</sup>/d, -19.8 mm<sup>2</sup>/d and 8.5 mm<sup>2</sup>/d in CR, PR, SD, and PD patients, respectively. PD patients could be subclassified into a cohort with an increase in TGR (7 of 11 patients [64%], PD TGRpre-to-post-BL INCR) and a cohort with a decrease in TGR (4 of 11 patients [36%], PD TGRpre-to-post-BL DECR) from pre- to post-BL. PD TGRpre-to-post-BL DECR patients exhibited similar OS to patients classified as SD, while PD TGRpre-to-post-BL INCR patients had significantly shorter OS (65 days vs 471 days, p<0.001).

#### CONCLUSION

In the context of CART, the additional use of TGRpre-BL and its change to TGRpost-BL determined at 30-day FU1 showed better OS prognostication for patients with Lugano overall progressive than Lugano criteria alone.

#### CLINICAL RELEVANCE/APPLICATION

Therefore, this modification of the Lugano classification should be explored as a potential novel imaging biomarker of early response.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMS01-3

### Dynamic Monitoring Soft Tissue Healing Via Visualized Gd-Crosslinked Double Network MRI Imaging Microspheres

Monday, Nov. 27 1:30PM - 2:30PM Room: E350

Tongtong Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

Achieving real-time monitoring of scaffold material and regenerated tissue simultaneously using a non-invasive, continuous method.

#### METHODS AND MATERIALS

By covalently cross-linking the MRI T1-weighted imaging contrast agent, gadolinium ions, with sodium alginate modified by methacrylic anhydride through an airflow-controlled method, an MRI-ready dual-network cross-linked hydrogel microsphere was fabricated, which simultaneously enables non-invasive real-time monitoring of scaffold material degradation and tissue repair regeneration.

#### RESULTS

Relaxation rate experiments showed that the longitudinal relaxation rate of gadolinium alginate microspheres was  $33.113 \text{ M}^{-1}\text{s}^{-1}$ , which was three times higher than that of the clinical MRI T1-weighted imaging contrast agent gadopentetate glucosamine (Gd-DTPA), and both in vitro and in vivo experiments showed that the T1 signal values of gadolinium alginate microspheres gradually decreased with the degradation of the microspheres ( $R^2=0.95$ ), while in a rat abdominal muscle defect model, the affected The magnetic resonance signal values also showed a linear correlation with the degree of tissue repair in their corresponding histopathological sections in the rat abdominal muscle defect model ( $R^2=0.91$ ). In addition, gadolinium alginate microspheres exhibited good biosafety, with no adverse effects found in vital organs, and the degraded gadolinium ions were eliminated from the body after metabolism by the liver and kidneys.

#### CONCLUSION

The dual network cross-linked hydrogel microspheres can use the magnetic resonance signal value to better reflect the in vivo condition of the material while achieving non-invasive real-time monitoring of scaffold material degradation and tissue repair and regeneration.

#### CLINICAL RELEVANCE/APPLICATION

Using MRI to monitor the extent of biomaterial degradation and tissue regeneration in a non-invasive manner provides support for further optimization of scaffold materials to match the regenerative process.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-SSMS01-4

### The Value of CT Lymphangiography Combined with $^{99}\text{Tc}^{\text{m}}$ -DX Lymphoscintigraphy in Diagnosing Primary Chylopericardium

Monday, Nov. 27 1:30PM - 2:30PM Room: E350

Yimeng Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the diagnostic value of combined  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy and CT lymphangiography (CTL) in primary chylopericardium.

#### METHODS AND MATERIALS

Forty-eight patients diagnosed with primary chylopericardium clinically were retrospectively analyzed, and  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy and CT lymphangiography (CTL) were performed in all patients. According to the  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy results, primary chylopericardium was classified into three types: type I (abnormal radioactive concentration at the angle of the left jugular vein), type II (persistent concentration of contrast in the right jugular angle with or without radiographic concentration in the left jugular angle), and type III (no visualization of the left jugular vein angle or a transient visualization during the examination). The evaluation indexes of CTL include: (1) abnormal distribution of contrast and reflux in the neck, subclavian region, end of thoracic duct, end of right lymphatic duct and axilla, (2) abnormal distribution of contrast in the chest, including deep thorax (anterior mediastinum, aortopulmonary window, peri-tracheal and bronchial, inferior bulge, posterior mediastinum, hilum, peri-bronchial vascular bundle, pericardium, etc.), superficial thorax (intercostal, pleura). CTL characteristics were analyzed between different groups, and  $P < 0.05$  was considered a statistically significant difference.

#### RESULTS

Primary chylopericardium in 48 patients showed 12 cases of  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy imaging type I, 14 patients with type II, and 22 patients with type III in 48 patients. The incidence of abnormal distribution of contrast in the pericardial and aortopulmonary windows,  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy group I was greater than group III, and the difference was statistically significant ( $P = 0.008$ ). And the incidence of abnormal distribution of contrast agent in the bilateral cervical or subclavian region was greater in  $^{99}\text{Tc}^{\text{m}}$ -DX lymphoscintigraphy type II than type III ( $P = 0.002$ ).

#### CONCLUSION

The  $^{99}\text{Tc}^{\text{m}}$ -DX typing reflects the abnormal of thoracic duct and pericardial effusion in patients with primary chylopericardium, and CTL shows the abnormal systemic lymphatic vessels. The combined application of the two methods is of great value for the localized and qualitative diagnosis of primary chylopericardium.

#### CLINICAL RELEVANCE/APPLICATION

To analyze the differences in CTL imaging performance between different  $^{99}\text{Tc}^{\text{m}}$ -DX lymphatic imaging types, so as to explore the diagnostic value of the combined application of the two imaging methods in primary chylopericardium.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMS01-5

### Real-world Experience of an FDA Approved CAR-T Cell Therapy at a Single Institution: Imaging Utilization, Response and Adverse Events Assessment

Monday, Nov. 27 1:30PM - 2:30PM Room: E350

Kaustav Bera, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Chimeric antigen receptor (CAR) T-cell immunotherapy has been effective in management of refractory blood cancers but are predominantly used in the clinical trial setting, with wide ranging adverse events. The purpose of this work is to show the real world use of CAR T-cell therapy at a tertiary care cancer center, discussing imaging utilization, findings including response patterns and adverse events including cytokine release syndrome (CRS) and immune effector cell-associated neurotoxicity syndrome (ICANS) to guide management.

#### METHODS AND MATERIALS

The retrospective chart review of a cancer registry from 1/2021 to 3/2023 yielded 45 patients who received CAR-T cell infusion. Clinical CRS or ICANS toxicity grade was assessed using American Society for Transplantation and Cellular Therapy, or ASTCT, consensus grading. Demographic and treatment information were obtained. The number and type of inpatient imaging was collected. Response was determined by Deauville score on PET/CT or molecular markers in case of no PET/CT.

#### RESULTS

A total of 45 patients with mean age of 62, including 11 women who received CAR T-cells were included. There was one pediatric patient aged 8 with ALL. 84% CAR-T therapies were commercially available (n=38) while 7 were locally produced Anti CD-19 against lymphoma (Fig 1). 62% of the patients had complete response (n=28) as best treatment response, six with partial response, none with stable disease, and 11 (24%) with progressive disease. Amongst responders (n=34), 44% (n=15) progressed with median time to progression being 6 months (Range 2 -19.5 months) while 56% (n=15) had durable response till follow up. 6 patients (13%) died. 33 (73%) and 18 (40%) patients had at least clinical Grade 1 CRS and ICANS respectively. 16 patients experienced both CRS and ICANS. Average length of hospital stay was 23 days. Average number of radiology images while inpatient was 4.2 per patient. Of these the highest modality ordered was CXR with 2.7 CXRs per patient. Meanwhile the commonest neuroimaging study ordered was a head CT with 11 out of 18 patients (61%) with at least Grade 1 ICANS receiving at least one head CT during admission.

#### CONCLUSION

CAR-T cell therapy provided durable response in a majority of patients, however complicated by toxicities, mostly in the immediate setting. Imaging plays a crucial role in not only monitoring response to treatment following CAR-T cell therapy but also help in diagnosing toxicities.

#### CLINICAL RELEVANCE/APPLICATION

FDA approved CAR-T cell therapy shows remarkable promise in the real-world setting, outside the realm of clinical trials. With their likely increase in use, radiologists will need to educate themselves on the management and toxicity patterns of this therapy in a wide variety of blood cancers.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSMS01-6

### **Keynote Speaker: Exploring the Value of Photon-Counting CT in Interventional Radiology and Robotic Surgery**

Monday, Nov. 27 1:30PM - 2:30PM Room: E350

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSNPM01

### **Noninterpretive Skills (Beyond Imaging) (Radiology in the Modern Age: AI, Patient Experience, and the Environment)**

Monday, Nov. 27 1:30PM - 2:30PM Room: E351

Nadja Kadom, MD (*Moderator*) Nothing to Disclose  
Kristine S. Burk, MD (*Moderator*) Nothing to Disclose

#### **Sub-Events**

#### **M6-SSNPM01-1 AI-Assisted Lung Nodule Detection: Clinical and Economic Impact Beyond Cancer Screening Programs**

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

#### **PURPOSE**

To appraise the clinical efficacy and economic ramifications of an artificial intelligence (AI)-assisted solution for lung nodule detection and classification in routine clinical settings, where nodules are detected incidentally, by comparing radiologists' performance with and without AI support.

#### **METHODS AND MATERIALS**

A cohort of 130 computed tomography (CT) studies, including 87 with up to five nodules and 43 without nodules, was scrutinized. These studies were screened and collected retrospectively from multiple sites using predefined screening criteria. The ground truth for nodule presence and type was established via super consensus among three expert chest radiologists. LUNGRADS 1.1 category for each of the studies was defined using this GT. A chest radiologist with 15 years of experience initially interpreted studies without AI assistance to categorize the study according to LUNGRADS 1.1, documenting time and accuracy metrics, and subsequently another radiologist with similar experience with AI support, replicated the process. The AI solution used was AVIEW by Coreline Soft. A retrospective modeling approach was employed to gauge the clinical and financial implications, encompassing cost savings and return on investment (ROI) calculations.

#### **RESULTS**

In the absence of AI, the average reading time of 585 minutes. With AI assistance, the reading time diminished to 235 minutes. Statistically significant improvements ( $p < 0.05$ ) were observed with AI-assisted readings. The estimated ROI of 79.5 % for AI implementation considering radiologists' compensation and inference cost for the studies.

#### **CONCLUSION**

The incorporation of AI assistance in lung nodule detection and classification in routine clinical settings beyond lung cancer screening programs yielded notable advancements in radiologists' accuracy and time efficiency, culminating in considerable economic benefits.

#### **CLINICAL RELEVANCE/APPLICATION**

The superior diagnostic performance facilitated by AI assistance has the potential to significantly enhance patient outcomes through the timely identification and judicious management of incidentally detected lung nodules. Moreover, the concomitant economic impact, characterized by optimized resource utilization, substantial cost savings, and an attractive ROI, positions AI as an indispensable asset for healthcare providers in the pursuit of diagnostic excellence in routine clinical settings

#### **M6-SSNPM01-2 Unraveling the Complexities of Elusive Fractures: A Synergistic AI-Radiologist Approach for Enhanced Detection**

Vasanth Venugopal, MD (*Presenter*) Officer, CARPL.AI Inc

## PURPOSE

Missed fractures on imaging studies can lead to delayed treatment and adverse patient outcomes. This study evaluates the performance of an artificial intelligence (AI) system, in detecting commonly missed fractures and explores the potential for synergistic collaboration between AI and radiologists to improve fracture diagnosis.

## METHODS AND MATERIALS

A total of 459 cases, including 215 normals and various types of fractures (scaphoid, radial head, femoral neck, tibial plateau, Lisfranc, and avulsion fractures of the medial and lateral malleoli), were retrospectively extracted from three institutions. The cases were blindly read by two musculoskeletal (MSK) radiologists and analyzed by the AI system (Rayvolve; AZmed, Paris, France). The ground truth was based on clinical confirmation and follow-up studies.

## RESULTS

Among the 126 mismatched cases, the AI system demonstrated a sensitivity of 83.9% and a specificity of 93.5%. In comparison, Radiologist 1 had a sensitivity of 71.7% and a specificity of 92.1%, while Radiologist 2 had a sensitivity of 80.7% and a specificity of 80.9%. The AI system demonstrated a substantial improvement in identifying commonly missed fractures compared to both radiologists. Cohen's Kappa coefficient showed moderate inter-rater agreement between the radiologists ( $k=0.57$ ) and substantial agreement between the AI system and the ground truth ( $k=0.75$ ). In cases where the AI system and at least one radiologist agreed, the sensitivity increased to 87.1% and specificity to 94.7%, demonstrating the potential for improved fracture detection through collaboration.

## CONCLUSION

The AI system outperformed the radiologists in detecting commonly missed fractures, showcasing its potential for improving fracture detection in clinical practice. The statistical analysis suggests that combining the strengths of AI and radiologists through a synergistic model could lead to even better diagnostic performance.

## CLINICAL RELEVANCE/APPLICATION

This study highlights the benefits of incorporating AI into fracture detection workflows and recommends the implementation of a synergistic model. In this model, radiologists and AI systems collaborate in a consensus review process, reevaluating cases where disagreement occurs. This collaboration between AI and radiologists can lead to better patient outcomes by reducing the rate of missed fractures and improving overall diagnostic accuracy.

## M6-SSNPM01-5 Contrast Administration as a Source of Liability: Legal Database Analysis

Jonathan L. Mezrich, MD, JD (*Presenter*) Nothing to Disclose

## PURPOSE

An estimated 50 million CT scans with contrast are performed in the US annually. Use of contrast carries risk of injury and creates duties and expectations on the supervising radiologists. Yet the risk of legal liability when using contrast media is often overlooked. This study seeks to offer legal database evidence demonstrating the risks inherent in contrast utilization and offers suggestions for radiologists to mitigate risk.

## METHODS AND MATERIALS

In order to evaluate the medicolegal implications of contrast administration, searches were performed on two popular online legal data repositories, Verdict Search (American Lawyer Media, NY) and Lexis + (RELX, NY) for contrast related lawsuits against radiologists from 1987-2020. Databases were queried for the terms "Contrast" and "Radiology OR Radiologist"; 486 search results were initially obtained, which were thereafter manually reviewed for relevance and duplication with the end result of 151 distinct published cases.

## RESULTS

Of the 151 cases identified, 45 of these lawsuits involved anaphylaxis, 41 related to contrast extravasation issues, 19 involved acute kidney issues, 8 involved bowel injury, 6 involved development of aspiration pneumonia, 18 involved neurological complications, 4 related to failure to order appropriate studies, with the remaining 10 categorized as miscellaneous/other. Of these 151 cases, 18.5% (26) were resolved by settlement, 51% (77) went to trial, 12% (18) were dismissed without trial, 1.3% (2) were resolved at arbitration and the outcomes of the remainder (28) unknown. Plaintiffs won 26.4% of cases that went to trial with an average judgment award of \$2.9 million. While a majority of settled cases were settled for an undisclosed or confidential amount, the average published settlement amount was approximately \$1 million.

## CONCLUSION

Utilization of contrast media carries real risk of liability, with potential judgment awards in the millions. Radiologists need to be aware of these risks and take steps to mitigate their exposure through adherence to published hospital policies and standards of care. Where possible, artificial intelligence should be incorporated into the process to review medical records for patient allergies, need for premedication, prior reactions or risk factors. Policies which limit a radiologist's discretion to bypass

safeguards may be helpful in certain settings. Finally, bolstering education and use of up to date technology with respect to managing contrast reactions and anaphylaxis in the radiology department setting is recommended.

#### **CLINICAL RELEVANCE/APPLICATION**

This study is relevant to all radiologists and radiology personnel involved in contrast administration, as well as those with an interest in medicolegal implications of imaging.

### **M6- SSNPM01-6 Reducing Residuals of Contrast Agents in Wastewater: Preliminary Results of the GREENWATER Study**

Moreno Zanardo, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The GREENWATER study aims to monitor the amount of iodinated and gadolinium-based contrast agents (ICAs and GBCAs) retrieved from urine collected from outpatients within an hour of administration, in order to assess their potential reduction in hospital wastewater. The study also aims to evaluate the influence of patient age and sex, and the rate of acceptance to participate. The poor retrievability of ICAs and GBCAs in conventional wastewater treatment plants raises concerns about their potential environmental impact. The study provides preliminary data.

#### **METHODS AND MATERIALS**

Following approval from the Ethics Committee, we enrolled outpatients aged 18 years or older in a prospective, observational, single-center study. These patients underwent their scheduled contrast-enhanced examination (either CT or MRI) without any modifications to the standard clinical protocols. We recorded the contrast agent molecule, concentration, dose, and injection rate for each patient, as well as the examination protocol, type, and diagnostic purpose. Following the examination, the usual observation time of around 30 minutes was extended to 45-50 minutes, resulting in a total timespan of 60 minutes after contrast agent administration. During this interval, enrolled patients were asked to provide a urine sample in a container before leaving the hospital.

#### **RESULTS**

After the first 9 months of enrollment, the acceptance rate was 94% (305/325; 95% confidence interval, CI, 94-100%). The median age of the patients was 60 years (interquartile range, IQR, 45-74 years), and 155 of the patients were male (51%). Of the enrolled patients, 150 (49%) underwent MRI and 155 underwent CT. The indications for imaging were cardiac in 138 (45%) patients, neurological in 123 (40%) patients, and other reasons in 44 (14%) patients. The median volume of iodine injected per patient was 22.5 g (IQR 19.0-27.2 g), while the median volume of gadolinium injected per patient was 1.2 mol (IQR 1.0-1.6 mol). The median volume of collected urine was 120 mL (IQR 82-179 mL). The percentage of injected contrast agents (ICAs) recovered from urine was 53% (IQR 36%-87%), while the percentage of GBCAs recovered from urine was 14% (IQR 10%-22%).

#### **CONCLUSION**

The high acceptance rate of 94% among patients suggests that there is a strong interest and awareness among patients for sustainable radiology practices. Analysis of urine samples revealed that more than half of the iodine molecules and only 14% of the gadolinium molecules were recovered.

#### **CLINICAL RELEVANCE/APPLICATION**

The volume of urine collected was sufficient for patient-specific analysis, which could be used to develop a predictive model for the amount of iodine and gadolinium that can be retrieved using this method.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSNPM01-1

### AI-Assisted Lung Nodule Detection: Clinical and Economic Impact Beyond Cancer Screening Programs

Monday, Nov. 27 1:30PM - 2:30PM Room: E351

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

#### PURPOSE

To appraise the clinical efficacy and economic ramifications of an artificial intelligence (AI)-assisted solution for lung nodule detection and classification in routine clinical settings, where nodules are detected incidentally, by comparing radiologists' performance with and without AI support.

#### METHODS AND MATERIALS

A cohort of 130 computed tomography (CT) studies, including 87 with up to five nodules and 43 without nodules, was scrutinized. These studies were screened and collected retrospectively from multiple sites using predefined screening criteria. The ground truth for nodule presence and type was established via super consensus among three expert chest radiologists. LUNGRADS 1.1 category for each of the studies was defined using this GT. A chest radiologist with 15 years of experience initially interpreted studies without AI assistance to categorize the study according to LUNGRADS 1.1, documenting time and accuracy metrics, and subsequently another radiologist with similar experience with AI support, replicated the process. The AI solution used was AVIEW by Coreline Soft. A retrospective modeling approach was employed to gauge the clinical and financial implications, encompassing cost savings and return on investment (ROI) calculations.

#### RESULTS

In the absence of AI, the average reading time of 585 minutes. With AI assistance, the reading time diminished to 235 minutes. Statistically significant improvements ( $p < 0.05$ ) were observed with AI-assisted readings. The estimated ROI of 79.5 % for AI implementation considering radiologists' compensation and inference cost for the studies.

#### CONCLUSION

The incorporation of AI assistance in lung nodule detection and classification in routine clinical settings beyond lung cancer screening programs yielded notable advancements in radiologists' accuracy and time efficiency, culminating in considerable economic benefits.

#### CLINICAL RELEVANCE/APPLICATION

The superior diagnostic performance facilitated by AI assistance has the potential to significantly enhance patient outcomes through the timely identification and judicious management of incidentally detected lung nodules. Moreover, the concomitant economic impact, characterized by optimized resource utilization, substantial cost savings, and an attractive ROI, positions AI as an indispensable asset for healthcare providers in the pursuit of diagnostic excellence in routine clinical settings

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSNPM01-2

### Unraveling the Complexities of Elusive Fractures: A Synergistic AI-Radiologist Approach for Enhanced Detection

Monday, Nov. 27 1:30PM - 2:30PM Room: E351

Vasanth Venugopal, MD (*Presenter*) Officer, CARPL.AI Inc

#### PURPOSE

Missed fractures on imaging studies can lead to delayed treatment and adverse patient outcomes. This study evaluates the performance of an artificial intelligence (AI) system, in detecting commonly missed fractures and explores the potential for synergistic collaboration between AI and radiologists to improve fracture diagnosis.

#### METHODS AND MATERIALS

A total of 459 cases, including 215 normals and various types of fractures (scaphoid, radial head, femoral neck, tibial plateau, Lisfranc, and avulsion fractures of the medial and lateral malleoli), were retrospectively extracted from three institutions. The cases were blindly read by two musculoskeletal (MSK) radiologists and analyzed by the AI system (Rayvolve; AZmed, Paris, France). The ground truth was based on clinical confirmation and follow-up studies.

#### RESULTS

Among the 126 mismatched cases, the AI system demonstrated a sensitivity of 83.9% and a specificity of 93.5%. In comparison, Radiologist 1 had a sensitivity of 71.7% and a specificity of 92.1%, while Radiologist 2 had a sensitivity of 80.7% and a specificity of 80.9%. The AI system demonstrated a substantial improvement in identifying commonly missed fractures compared to both radiologists. Cohen's Kappa coefficient showed moderate inter-rater agreement between the radiologists ( $k=0.57$ ) and substantial agreement between the AI system and the ground truth ( $k=0.75$ ). In cases where the AI system and at least one radiologist agreed, the sensitivity increased to 87.1% and specificity to 94.7%, demonstrating the potential for improved fracture detection through collaboration.

#### CONCLUSION

The AI system outperformed the radiologists in detecting commonly missed fractures, showcasing its potential for improving fracture detection in clinical practice. The statistical analysis suggests that combining the strengths of AI and radiologists through a synergistic model could lead to even better diagnostic performance.

#### CLINICAL RELEVANCE/APPLICATION

This study highlights the benefits of incorporating AI into fracture detection workflows and recommends the implementation of a synergistic model. In this model, radiologists and AI systems collaborate in a consensus review process, reevaluating cases where disagreement occurs. This collaboration between AI and radiologists can lead to better patient outcomes by reducing the rate of missed fractures and improving overall diagnostic accuracy.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-SSNPM01-5

### Contrast Administration as a Source of Liability: Legal Database Analysis

Monday, Nov. 27 1:30PM - 2:30PM Room: E351

Jonathan L. Mezrich, MD, JD (*Presenter*) Nothing to Disclose

#### PURPOSE

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In order to evaluate the medicolegal implications of contrast administration, searches were performed on two popular online legal data repositories, Verdict Search (American Lawyer Media, NY) and Lexis + (RELX, NY) for contrast related lawsuits against radiologists from 1987-2020. Databases were queried for the terms "Contrast" and "Radiology OR Radiologist"; 486 search results were initially obtained, which were thereafter manually reviewed for relevance and duplication with the end result of 151 distinct published cases.

#### RESULTS

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#### CONCLUSION

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#### CLINICAL RELEVANCE/APPLICATION

This study is relevant to all radiologists and radiology personnel involved in contrast administration, as well as those with an interest in medicolegal implications of imaging.

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## Abstract Archives of the RSNA, 2023

M6-SSNPM01-6

### Reducing Residuals of Contrast Agents in Wastewater: Preliminary Results of the GREENWATER Study

Monday, Nov. 27 1:30PM - 2:30PM Room: E351

Moreno Zanardo, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The GREENWATER study aims to monitor the amount of iodinated and gadolinium-based contrast agents (ICAs and GBCAs) retrieved from urine collected from outpatients within an hour of administration, in order to assess their potential reduction in hospital wastewater. The study also aims to evaluate the influence of patient age and sex, and the rate of acceptance to participate. The poor retrievability of ICAs and GBCAs in conventional wastewater treatment plants raises concerns about their potential environmental impact. The study provides preliminary data.

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#### CONCLUSION

The high acceptance rate of 94% among patients suggests that there is a strong interest and awareness among patients for sustainable radiology practices. Analysis of urine samples revealed that more than half of the iodine molecules and only 14% of the gadolinium molecules were recovered.

#### CLINICAL RELEVANCE/APPLICATION

The volume of urine collected was sufficient for patient-specific analysis, which could be used to develop a predictive model for the amount of iodine and gadolinium that can be retrieved using this method.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSVA02

### Vascular Imaging (Abdominal and Neurovascular Imaging)

Monday, Nov. 27 1:30PM - 2:30PM Room: N226

Iain D. Kirkpatrick, MD, FRCPC (*Moderator*) Nothing to Disclose  
Gauri R. Karur, MBBS, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M6-SSVA02-1 Role of CTA Derived Quantitative Imaging Parameters in Bicuspid-Aortic Valve Associated Aortopathy**

Mangun Randhawa, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Bicuspid aortic valve (BAV) is the most common congenital heart abnormality with an 8-9 fold higher rate of aortic complications. Clinical decision-making in patients with BAV-associated aortopathy currently relies on ascending aortic diameter and rate of expansion which need to be followed over time and are imperfect predictors of aortic complications. We investigated the association of CT angiography (CTA)-based quantitative parameters maximum ascending and root aortic diameter and greatest diameter growth. We also compared these baseline imaging parameters in surgically and non-surgically treated patients.

#### METHODS AND MATERIALS

Baseline aortic valve and ascending aortic imaging characteristics from cardiothoracic CTAs performed Jan 2004 - Apr 2020 were retrospectively reviewed for BAV morphology, aortic valve calcium score (AVCS), aortic annulus angle, ascending aorta angle, ascending aortic length, greater curve length (GCL), and maximum root, maximum ascending, and descending diameters. Clinical parameters included height, weight, baseline lipid panel, smoking/substance abuse history, hypertension, statin, beta-blocker or angiotensin receptor blocker therapy, collagen vascular disease, genetic mutations, and family history of aortic aneurysm or dissection. Imaging parameter effects were quantified using generalized linear and logistic modeling.

#### RESULTS

148 BAV patients (51±10 years, 118 males) and 280 CTAs were analyzed. Baseline maximum aortic root and ascending aortic diameter correlated significantly with GCL ( $p < 0.001$ ). In a subset of 121 patients with a follow-up within 2.5 years, 47% underwent surgery and baseline ascending aortic length positively correlated with ascending aortic diameter growth rate ( $p = 0.005$ ) and was predictive of growth  $> 0.7$  mm/year (OR 1.38) per mm length ( $p = 0.006$ ). 90 patients (60.8%) were referred for valve replacement and/or repair of associated aortopathy. In the patients that underwent surgery, baseline AVCS and maximum aortic diameters were higher with a positive correlation ( $p = 0.019, 0.008$ ; OR = 1.000, 1.107;  $\beta = 0.8, 0.6$ ) whereas ascending aortic angle was lower with a negative correlation ( $p = 0.062, OR = 0.972, \beta = -0.4$ ), compared to those without surgery.

#### CONCLUSION

CTA-based quantitative parameters are associated with aortic root and ascending aortic diameter, can predict rate of growth, and may potentially be considered as supplementary tool to differentiate surgically and non-surgically treated patients beyond diameter alone.

#### CLINICAL RELEVANCE/APPLICATION

Adding GCL, ascending aortic length, AVCS and aortic angle may provide additional value beyond diameters in patients with bicuspid aortic valve-associated aortopathy.

#### **M6-SSVA02-2 Contrast-Enhanced Ultrasound (CEUS) for Follow-up after Endovascular Aortic Repair (EVAR): A 12 Year European Single Center Experience**

Johannes Ruebenthaler, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Due to the risk of secondary rupture caused by endoleaks after EVAR, efficient diagnostic follow-up is essential for planning and implementing subsequent therapy. In this retrospective study, the diagnostic accuracy of CEUS was investigated as an alternative examination method to CTA, which is generally accepted as the gold standard but has certain limitations due to its side effect profile.

## METHODS AND MATERIALS

In the present study, data from a total of 241 patients who underwent follow-up examinations after endovascular stent implantation for AAA were collected. A total of 1095 examinations performed with CEUS from January 2005 to October 2017 were identified, of which 300 were compared with concomitant CT examinations.

## RESULTS

A sensitivity of 90.2% and a specificity of 62.4% were calculated regarding the detection of endoleaks, with the examination using CTA considered as the gold standard. There were 110 true positives, 67 false positives, 111 true negatives, and 12 false negatives. In 58% of cases (n=174), the results of the examinations did not differ, in 2% of cases (n=7), only differences in the vessels supplying the aneurysm were detected. 14% of the examinations (n=42) showed differences in the types of endoleaks, and in 26% (n=77), differences in the presence of an endoleak were even recorded.

## CONCLUSION

Significant differences in aneurysm size were demonstrated for different types of endoleaks, which could influence the development of individual follow-up schemes in the future. However, no correlation between aneurysm growth and endoleak classification could be established. Regarding size behavior, all influencing factors were examined in further studies, which need to be verified in a subsequent investigation.

## CLINICAL RELEVANCE/APPLICATION

In summary, the results of this study suggest extensive and promising possibilities. Although CEUS cannot replace CT, this method should be used in addition to CT according to its advantages in follow-up after EVAR. Further prospective studies should build on the findings of this work.

## M6-SSVA02-3 CT Angiography-Based Virtual Portal Venous Pressure Gradient: A Noninvasive Technique for Assessment of Portal Hypertension in Cirrhotic Patients

Shang Wan, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Portal hypertension (PH) is the main consequence of liver cirrhosis, the invasive portal vein pressure gradient (PVPG) measurement remains the most accurate technique for diagnosing PH. This study aimed to validate whether a computed tomography(CT) angiography-based virtual portal vein pressure gradient(vPVPG) can simulate PVPG, as measured during transjugular intrahepatic portosystemic shunt(TIPS) creation, and to see if it could predict PH noninvasively.

## METHODS AND MATERIALS

Ninety-seven patients were included in this retrospective study from March 2019 to July 2022. The patients were divided into a PH group (n=65) and a non-PH group (n=32) based on their PH history. Patients with PH underwent PVPG measurements during TIPS creation, all participants in the two groups underwent CT angiography scans. The three-dimensional model of portal venous system was reconstructed using 3D-slicer software, specifically, the portal vein and its the left (LPV) and right branch (RPV), as well as the superior mesenteric (SMV) and splenic veins (SV). The reconstructed three-dimensional models of the portal venous system were then utilized in the blood flow simulation process, and vPVPG was then computed with this model during the computational fluid dynamics (CFD) analysis.

## RESULTS

In the PH group, the mean PVPG measured was 20.74 mm Hg, with a deviation of 5.19. vPVPG was identified statistically significant for discriminating between the PH (2.4, interquartile ranges(IQR) 1.62-3.04) and non-PH groups (1.03, IQR 0.66-1.41,  $p < 0.001$ ), with an odd ratio (OR) of 7.07 (95% confidence interval(CI): 3.12,16,  $p < 0.001$ ). The receiver operating characteristic (ROC) analysis showed that vPVPG had a satisfactory capability for diagnosing PH, with an area under the curve (AUC) of 0.891 (95% CI 0.828-0.954), an accuracy of 0.825, a sensitivity of 0.813, a specificity of 0.831 when using a cut-off value of 1.157.

## CONCLUSION

We confirmed that the CT-based vPVPG can simulate the invasive PVPG measurement, and may help with the noninvasive diagnosis of portal hypertension in patients with liver cirrhosis.

## **CLINICAL RELEVANCE/APPLICATION**

With the computational fluid dynamics analysis, this study firstly developed a virtual model based on the direct visualization of the portal venous system on CTA images, and this model may allow the noninvasive simulation of PVPG measurement, and it showed good diagnostic performance for portal hypertension in patients with cirrhosis. This technique may have potential to reduce the usage of the invasive PVPG measurement.

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## Abstract Archives of the RSNA, 2023

M6-SSVA02-1

### Role of CTA Derived Quantitative Imaging Parameters in Bicuspid-Aortic Valve Associated Aortopathy

Monday, Nov. 27 1:30PM - 2:30PM Room: N226

Mangun Randhawa, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Bicuspid aortic valve (BAV) is the most common congenital heart abnormality with an 8-9 fold higher rate of aortic complications. Clinical decision-making in patients with BAV-associated aortopathy currently relies on ascending aortic diameter and rate of expansion which need to be followed over time and are imperfect predictors of aortic complications. We investigated the association of CT angiography (CTA)-based quantitative parameters maximum ascending and root aortic diameter and greatest diameter growth. We also compared these baseline imaging parameters in surgically and non-surgically treated patients.

#### METHODS AND MATERIALS

Baseline aortic valve and ascending aortic imaging characteristics from cardiothoracic CTAs performed Jan 2004 - Apr 2020 were retrospectively reviewed for BAV morphology, aortic valve calcium score (AVCS), aortic annulus angle, ascending aorta angle, ascending aortic length, greater curve length (GCL), and maximum root, maximum ascending, and descending diameters. Clinical parameters included height, weight, baseline lipid panel, smoking/substance abuse history, hypertension, statin, beta-blocker or angiotensin receptor blocker therapy, collagen vascular disease, genetic mutations, and family history of aortic aneurysm or dissection. Imaging parameter effects were quantified using generalized linear and logistic modeling.

#### RESULTS

148 BAV patients (51±10 years, 118 males) and 280 CTAs were analyzed. Baseline maximum aortic root and ascending aortic diameter correlated significantly with GCL ( $p < 0.001$ ). In a subset of 121 patients with a follow-up within 2.5 years, 47% underwent surgery and baseline ascending aortic length positively correlated with ascending aortic diameter growth rate ( $p = 0.005$ ) and was predictive of growth  $> 0.7$  mm/year (OR 1.38) per mm length ( $p = 0.006$ ). 90 patients (60.8%) were referred for valve replacement and/or repair of associated aortopathy. In the patients that underwent surgery, baseline AVCS and maximum aortic diameters were higher with a positive correlation ( $p = 0.019, 0.008$ ; OR = 1.000, 1.107;  $\beta = 0.8, 0.6$ ) whereas ascending aortic angle was lower with a negative correlation ( $p = 0.062, OR = 0.972, \beta = -0.4$ ), compared to those without surgery.

#### CONCLUSION

CTA-based quantitative parameters are associated with aortic root and ascending aortic diameter, can predict rate of growth, and may potentially be considered as supplementary tool to differentiate surgically and non-surgically treated patients beyond diameter alone.

#### CLINICAL RELEVANCE/APPLICATION

Adding GCL, ascending aortic length, AVCS and aortic angle may provide additional value beyond diameters in patients with bicuspid aortic valve-associated aortopathy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-SSVA02-2

### **Contrast-Enhanced Ultrasound (CEUS) for Follow-up after Endovascular Aortic Repair (EVAR): A 12 Year European Single Center Experience**

Monday, Nov. 27 1:30PM - 2:30PM Room: N226

Johannes Ruebenthaler, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Due to the risk of secondary rupture caused by endoleaks after EVAR, efficient diagnostic follow-up is essential for planning and implementing subsequent therapy. In this retrospective study, the diagnostic accuracy of CEUS was investigated as an alternative examination method to CTA, which is generally accepted as the gold standard but has certain limitations due to its side effect profile.

#### **METHODS AND MATERIALS**

In the present study, data from a total of 241 patients who underwent follow-up examinations after endovascular stent implantation for AAA were collected. A total of 1095 examinations performed with CEUS from January 2005 to October 2017 were identified, of which 300 were compared with concomitant CT examinations.

#### **RESULTS**

A sensitivity of 90.2% and a specificity of 62.4% were calculated regarding the detection of endoleaks, with the examination using CTA considered as the gold standard. There were 110 true positives, 67 false positives, 111 true negatives, and 12 false negatives. In 58% of cases (n=174), the results of the examinations did not differ, in 2% of cases (n=7), only differences in the vessels supplying the aneurysm were detected. 14% of the examinations (n=42) showed differences in the types of endoleaks, and in 26% (n=77), differences in the presence of an endoleak were even recorded.

#### **CONCLUSION**

Significant differences in aneurysm size were demonstrated for different types of endoleaks, which could influence the development of individual follow-up schemes in the future. However, no correlation between aneurysm growth and endoleak classification could be established. Regarding size behavior, all influencing factors were examined in further studies, which need to be verified in a subsequent investigation.

#### **CLINICAL RELEVANCE/APPLICATION**

In summary, the results of this study suggest extensive and promising possibilities. Although CEUS cannot replace CT, this method should be used in addition to CT according to its advantages in follow-up after EVAR. Further prospective studies should build on the findings of this work.

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## Abstract Archives of the RSNA, 2023

M6-SSVA02-3

### CT Angiography-Based Virtual Portal Venous Pressure Gradient: A Noninvasive Technique for Assessment of Portal Hypertension in Cirrhotic Patients

Monday, Nov. 27 1:30PM - 2:30PM Room: N226

Shang Wan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Portal hypertension (PH) is the main consequence of liver cirrhosis, the invasive portal vein pressure gradient (PVPG) measurement remains the most accurate technique for diagnosing PH. This study aimed to validate whether a computed tomography(CT) angiography-based virtual portal vein pressure gradient(vPVPG) can simulate PVPG, as measured during transjugular intrahepatic portosystemic shunt(TIPS) creation, and to see if it could predict PH noninvasively.

#### METHODS AND MATERIALS

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#### CONCLUSION

We confirmed that the CT-based vPVPG can simulate the invasive PVPG measurement, and may help with the noninvasive diagnosis of portal hypertension in patients with liver cirrhosis.

#### CLINICAL RELEVANCE/APPLICATION

With the computational fluid dynamics analysis, this study firstly developed a virtual model based on the direct visualization of the portal venous system on CTA images, and this model may allow the noninvasive simulation of PVPG measurement, and it showed good diagnostic performance for portal hypertension in patients with cirrhosis. This technique may have potential to reduce the usage of the invasive PVPG measurement.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M6-STCE1

### Science Session (Generative AI)

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 1

#### Sub-Events

#### **M6-STCE1- A comparative analysis of Speech Recognition Pipelines augmented by Large Language Models (LLMs) for Radiology Reporting: A 2023 Update**

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

As radiologists face escalating workloads worldwide, improving the efficiency in reporting is crucial to improve the turnaround time. Artificial Intelligence (AI) augmented speech recognition can decrease dictation errors and assist in accurate report generation, thereby decreasing time needed for post-dictation report correction. Natural Language Processing (NLP) models have attained benchmarking performance for speech-to-text generation tasks for various applications. But radiology reports contain significant out-of-vocabulary words and thus, most NLP models are unable to achieve good performance. Performance of NLPs can be enhanced by augmenting their outputs by Large Language Models (LLMs). In our study, we aim to identify the most efficient end-to-end Dictation-to-Report Pipeline by comparing the performance of a sequential combination of NLP and LLM models for speech recognition and subsequent report generation.

#### **METHODS AND MATERIALS**

200 HRCT Chest dictations (audio clips by 10 dictators) and their corresponding signed final text reports were utilised as inputs and ground truth, respectively. Five NLP models (Whisper V2-Large, DeepSpeech, Word2vec, SparkNLP v4, and AssemblyAI Conformer2) were utilised initially to convert the dictated audio files into free-flowing text and compared. Subsequently, the output of the best-performing NLP model was processed through four LLMs viz. LLAMA (v2 7B), LLAMA (v2 13B), ALPACA, and Falcon 7B. The following metrics viz. Word Error Rate (WER), Sentence Error Rate (SER), Match Error Rate (MER), and average Levenshtein Distance (LD) were used for comparing their performances.

#### **RESULTS**

Five NLP models were applied to generate a preliminary output among which, Whisper with outcomes of WER = 0.153; SER = 0.095; MER = 0.082; LD = 3.25 outperformed other NLP models. Four LLMs were subsequently applied to the output of each of the NLP models to improve these results. Among all combinations, the LLAMA (v2 7B) augmented Whisper NLP pipeline performed the best across all metrics with WER = 0.0306; SER = 0.019; MER = 0.0164; and LD = 0.65. A blinded qualitative comparison of the final output reports by 2 radiologists confirmed Whisper-LLAMA (v2 7B) as the best-performing pipeline.

#### **CONCLUSION**

The combined pipeline of Whisper-LLAMA (v2 7B) shows the best performance for transforming dictations into final radiology reports, with an improvement of 80% in the WER of Whisper's output after augmenting with LLAMA (v2 7B).

#### **CLINICAL RELEVANCE/APPLICATION**

LLM augmented Speech Recognition Pipelines (Whisper-LLAMA v2 7B showing the best performance) significantly improve the accuracy of radiological dictations minimising the need for post-dictation error correction and improving reporting turnaround time.

#### **M6-STCE1- Optimising Large Language Model (LLM) augmented Speech Recognition for Reporting in Radiology: Achieving Near-Zero Error Rates through advanced Prompt Engineering**

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Improving reporting efficiency in radiology is crucial to decrease turnaround times. Artificial Intelligence (AI) augmented speech recognition minimises dictation errors and post-dictation correction time. While Natural Language Processing (NLP)

models show high performance in speech-to-text tasks, the unique language and content of radiology reports poses a challenge. Processing NLP outputs through Large Language Models (LLMs) significantly reduces the error rates and augmenting their performance through prompt engineering further boosts their efficacy. With the aim of achieving near-zero error rates, in our study, we demonstrate staged improvement in the performance of a state-of-the-art Whisper-LLAMA v2 7B speech recognition pipeline through curated specific sequential prompts.

## **METHODS AND MATERIALS**

200 HRCT Chest audio dictations and their corresponding signed final text reports were utilised as inputs and ground truth, respectively to develop a sequential NLP (Whisper V2-Large) and LLM (LLAMA v2 7B) pipeline and baseline performance was recorded. N-grams that appeared more than 50 times in our reports were extracted and used for prompt engineering in three sequential stages by adding the unigram, bigram and trigram terms in the context and prompts. The following performance metrics viz. Word Error Rate (WER), Sentence Error Rate (SER), Match Error Rate (MER), average Levenshtein Distance (LD) and Semantic Similarity (SS) were calculated at each stage.

## **RESULTS**

The baseline Whisper-LLAMA v2 7B showed state-of-the-art performance metrics with WER=0.0306; SER=0.019; MER=0.0164; LD=0.65 and SS=0.898. The application of prompt engineering resulted in significant improvements across all metrics. After the first three stages of prompt engineering, we achieved a WER=0.0183, SER=0.013, MER=0.0094, LD=0.38, and SS=0.986, with no clinically significant errors (confirmed by radiologist), indicating near-perfect accuracy in report generation.

## **CONCLUSION**

Optimization of the Whisper-LLAMA v2 7B pipeline using prompt engineering to include commonly used n-grams in the context and prompts, significantly improves the accuracy of radiological dictations and reduces error rates.

## **CLINICAL RELEVANCE/APPLICATION**

Optimising LLM augmented Speech Recognition pipelines by advanced prompt engineering significantly improves the accuracy of radiological reporting potentially eliminating the need for post-dictation error correction and improving the reporting turnaround time.

## **M6-STCE1- Predicting Complications of Percutaneous Transhepatic Biliary Stenting using Machine Learning: A CT Imaging and Clinical Characteristics-based Approach**

Reza Dehdab, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study aimed to develop a machine learning predictive model using CT imaging features and patient clinical characteristics to assess complications following Percutaneous Transhepatic Biliary Stenting (PTBS) with Self-Expanding Metallic Stents (SEMS) in patients with malignant biliary obstruction. Additionally, the safety and efficacy of PTBS with SEMS as palliative treatment for malignant biliary obstruction were investigated, while enhancing clinical decision-making and risk stratification through machine learning insights.

## **METHODS AND MATERIALS**

The retrospective study involved 320 consecutive patients who underwent PTBS at Namazi Hospital between April 2009 and March 2022. Inclusion criteria encompassed patients aged  $\geq 18$  years with obstructive jaundice due to non-resectable malignant tumors. Feature selection utilized CT imaging features (Length of obstruction, Tumor density, Shape, Bismuth type) and patient clinical characteristics (age, etiology of Biliary Obstruction, diabetes status) through Variance Thresholding and Recursive Feature Elimination (RFE) with cross-validation. Machine learning using logistic regression with a balanced class weight approach was employed for model construction, while standard metrics evaluated model performance.

## **RESULTS**

Among 264 patients with malignant biliary obstruction undergoing PTBS, cholangiocarcinoma (n=156) and pancreatic adenocarcinoma (n=68) were the most common etiologies. The predictive model for post PTBS complications exhibited promising performance. In the training cohort, the model showed sensitivity of 86.5% and specificity of 80.2%, with PPV of 63.8% and NPV of 89.4%. Notably, the model's performance further improved in the validation cohort, with sensitivity of 89.0% and specificity of 85.7%, along with PPV of 71.4% and NPV of 91.2%.

## **CONCLUSION**

The machine learning model demonstrated promise in predicting post PTBS complications for patients with malignant biliary obstruction. With good sensitivity and specificity in both cohorts, the model's use of relevant CT imaging features and patient clinical characteristics could aid clinicians in identifying high-risk patients and optimizing treatment strategies for better outcomes. Further validation and prospective studies will enhance its applicability.

## **CLINICAL RELEVANCE/APPLICATION**

The predictive tool offers potential for clinicians to identify high-risk patients, enabling optimization of treatment plans and interventions for improved patient outcomes and reduced adverse events.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-STCE1-1

### **A comparative analysis of Speech Recognition Pipelines augmented by Large Language Models (LLMs) for Radiology Reporting: A 2023 Update**

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 1

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

As radiologists face escalating workloads worldwide, improving the efficiency in reporting is crucial to improve the turnaround time. Artificial Intelligence (AI) augmented speech recognition can decrease dictation errors and assist in accurate report generation, thereby decreasing time needed for post-dictation report correction. Natural Language Processing (NLP) models have attained benchmarking performance for speech-to-text generation tasks for various applications. But radiology reports contain significant out-of-vocabulary words and thus, most NLP models are unable to achieve good performance. Performance of NLPs can be enhanced by augmenting their outputs by Large Language Models (LLMs). In our study, we aim to identify the most efficient end-to-end Dictation-to-Report Pipeline by comparing the performance of a sequential combination of NLP and LLM models for speech recognition and subsequent report generation.

#### **METHODS AND MATERIALS**

200 HRCT Chest dictations (audio clips by 10 dictators) and their corresponding signed final text reports were utilised as inputs and ground truth, respectively. Five NLP models (Whisper V2-Large, DeepSpeech, Word2vec, SparkNLP v4, and AssemblyAI Conformer2) were utilised initially to convert the dictated audio files into free-flowing text and compared. Subsequently, the output of the best-performing NLP model was processed through four LLMs viz. LLAMA (v2 7B), LLAMA (v2 13B), ALPACA, and Falcon 7B. The following metrics viz. Word Error Rate (WER), Sentence Error Rate (SER), Match Error Rate (MER), and average Levenshtein Distance (LD) were used for comparing their performances.

#### **RESULTS**

Five NLP models were applied to generate a preliminary output among which, Whisper with outcomes of WER = 0.153; SER = 0.095; MER= 0.082; LD = 3.25 outperformed other NLP models. Four LLMs were subsequently applied to the output of each of the NLP models to improve these results. Among all combinations, the LLAMA (v2 7B) augmented Whisper NLP pipeline performed the best across all metrics with WER= 0.0306; SER= 0.019; MER= 0.0164; and LD= 0.65. A blinded qualitative comparison of the final output reports by 2 radiologists confirmed Whisper-LLAMA (v2 7B) as the best-performing pipeline.

#### **CONCLUSION**

The combined pipeline of Whisper-LLAMA (v2 7B) shows the best performance for transforming dictations into final radiology reports, with an improvement of 80% in the WER of Whisper's output after augmenting with LLAMA (v2 7B).

#### **CLINICAL RELEVANCE/APPLICATION**

LLM augmented Speech Recognition Pipelines (Whisper-LLAMA v2 7B showing the best performance) significantly improve the accuracy of radiological dictations minimising the need for post-dictation error correction and improving reporting turnaround time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-STCE1-2

### **Optimising Large Language Model (LLM) augmented Speech Recognition for Reporting in Radiology: Achieving Near-Zero Error Rates through advanced Prompt Engineering**

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 1

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Improving reporting efficiency in radiology is crucial to decrease turnaround times. Artificial Intelligence (AI) augmented speech recognition minimises dictation errors and post-dictation correction time. While Natural Language Processing (NLP) models show high performance in speech-to-text tasks, the unique language and content of radiology reports poses a challenge. Processing NLP outputs through Large Language Models (LLMs) significantly reduces the error rates and augmenting their performance through prompt engineering further boosts their efficacy. With the aim of achieving near-zero error rates, in our study, we demonstrate staged improvement in the performance of a state-of-the-art Whisper-LLAMA v2 7B speech recognition pipeline through curated specific sequential prompts.

#### **METHODS AND MATERIALS**

200 HRCT Chest audio dictations and their corresponding signed final text reports were utilised as inputs and ground truth, respectively to develop a sequential NLP (Whisper V2-Large) and LLM (LLAMA v2 7B) pipeline and baseline performance was recorded. N-grams that appeared more than 50 times in our reports were extracted and used for prompt engineering in three sequential stages by adding the unigram, bigram and trigram terms in the context and prompts. The following performance metrics viz. Word Error Rate (WER), Sentence Error Rate (SER), Match Error Rate (MER), average Levenshtein Distance (LD) and Semantic Similarity (SS) were calculated at each stage.

#### **RESULTS**

The baseline Whisper-LLAMA v2 7B showed state-of-the-art performance metrics with WER=0.0306; SER=0.019; MER=0.0164; LD=0.65 and SS=0.898. The application of prompt engineering resulted in significant improvements across all metrics. After the first three stages of prompt engineering, we achieved a WER=0.0183, SER=0.013, MER=0.0094, LD=0.38, and SS=0.986, with no clinically significant errors (confirmed by radiologist), indicating near-perfect accuracy in report generation.

#### **CONCLUSION**

Optimization of the Whisper-LLAMA v2 7B pipeline using prompt engineering to include commonly used n-grams in the context and prompts, significantly improves the accuracy of radiological dictations and reduces error rates.

#### **CLINICAL RELEVANCE/APPLICATION**

Optimising LLM augmented Speech Recognition pipelines by advanced prompt engineering significantly improves the accuracy of radiological reporting potentially eliminating the need for post-dictation error correction and improving the reporting turnaround time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-STCE1-3

### **Predicting Complications of Percutaneous Transhepatic Biliary Stenting using Machine Learning: A CT Imaging and Clinical Characteristics-based Approach**

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 1

Reza Dehdab, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to develop a machine learning predictive model using CT imaging features and patient clinical characteristics to assess complications following Percutaneous Transhepatic Biliary Stenting (PTBS) with Self-Expanding Metallic Stents (SEMS) in patients with malignant biliary obstruction. Additionally, the safety and efficacy of PTBS with SEMS as palliative treatment for malignant biliary obstruction were investigated, while enhancing clinical decision-making and risk stratification through machine learning insights.

#### **METHODS AND MATERIALS**

The retrospective study involved 320 consecutive patients who underwent PTBS at Namazi Hospital between April 2009 and March 2022. Inclusion criteria encompassed patients aged  $\geq 18$  years with obstructive jaundice due to non-resectable malignant tumors. Feature selection utilized CT imaging features (Length of obstruction, Tumor density, Shape, Bismuth type) and patient clinical characteristics (age, etiology of Biliary Obstruction, diabetes status) through Variance Thresholding and Recursive Feature Elimination (RFE) with cross-validation. Machine learning using logistic regression with a balanced class weight approach was employed for model construction, while standard metrics evaluated model performance.

#### **RESULTS**

Among 264 patients with malignant biliary obstruction undergoing PTBS, cholangiocarcinoma ( $n=156$ ) and pancreatic adenocarcinoma ( $n=68$ ) were the most common etiologies. The predictive model for post PTBS complications exhibited promising performance. In the training cohort, the model showed sensitivity of 86.5% and specificity of 80.2%, with PPV of 63.8% and NPV of 89.4%. Notably, the model's performance further improved in the validation cohort, with sensitivity of 89.0% and specificity of 85.7%, along with PPV of 71.4% and NPV of 91.2%.

#### **CONCLUSION**

The machine learning model demonstrated promise in predicting post PTBS complications for patients with malignant biliary obstruction. With good sensitivity and specificity in both cohorts, the model's use of relevant CT imaging features and patient clinical characteristics could aid clinicians in identifying high-risk patients and optimizing treatment strategies for better outcomes. Further validation and prospective studies will enhance its applicability.

#### **CLINICAL RELEVANCE/APPLICATION**

The predictive tool offers potential for clinicians to identify high-risk patients, enabling optimization of treatment plans and interventions for improved patient outcomes and reduced adverse events.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-STCE2

### Science Session (Theranostics)

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 2

#### Sub-Events

#### **M6-STCE2- Measurement of Tumor Total Diffusion Volume (tDV) of Metastatic Bone Lesions from Prostate Cancer Using Whole-Body MRI(WB-MRI)-Evaluation for Therapeutic Effect-**

Katsuyuki Nakanishi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To measure the total diffusion tumor volume (tDV) of metastatic bone lesions from prostate cancer using whole body MRI(WB-MRI) including whole body diffusion weighted images (DWI) and to research the correlation for serum PSA level and to assess the reliability and reproducibility of our diagnostic methods.

#### **METHODS AND MATERIALS**

17 cases of prostate cancer during various treatment in which WB-MRI was performed twice were retrospectively evaluated. In all patients, serum PSA was measured at the same time of MRI examinations. 3.0T MR scanners were used (Siemens Prisma). The pulse sequences were 1. axial direction of DWI of the level from lower neck and bottom of pelvis. 2. Sagittal direction of T1WI and STIR of total spine 3. Coronal direction of in phase and out of phase of T1WI. In all cases, two radiologists measured tDVs using BD-score (PixSpace, Inc.) which had been developed for calculating ADC value of the lesions and their volume correspond to the tumor automatically by defining the threshold of ADC value. In this study, the threshold was defined as 1.8mm<sup>2</sup>/S. We calculated tDV variation (?tDV) and serum PSA variation (?PSA) before and after therapy in each patient, and examined the relation of ?tDV and ?PSA with Spearman's rank correlation coefficient (rs). Also, the bias between the data of the data of two radiologists was assessed calculating the cross-correlation coefficient.

#### **RESULTS**

In the data of both radiologists, ?tDV and ?PSA were positive correlated strongly by Spearman's rank correlation coefficient (radiologists 1 rs=0.833, p<0.01, radiologist 2 r=0.804, p<0.01). The cross-correlation coefficient of two radiologists was 0.755 (p<0.01).

#### **CONCLUSION**

tDV was proved to be a reliable mark for evaluating the grade of bone metastases from prostate cancer. Using BD score for calculating tDV showed less dispersion between the readers.

#### **CLINICAL RELEVANCE/APPLICATION**

Calculating the disease volume rapidly from WBMRI returns to earth.

#### **M6-STCE2- An evaluation of the performance of AI segmentation of lesions and liver MRI scans: are expert radiology reviews necessary?**

Hildo J. Lamb, MD, PhD (*Presenter*) Consultant, Koninklijke Philips NV

#### **PURPOSE**

Detection and delineation of lesions in the liver is an important radiological task that allows for characterization and informs clinical decision making and surgical planning. This task is very time-consuming and requires expert training. Also, studies have found marked variability in subjective scores of the same lesions between radiologists. Artificial Intelligence (AI) assisted solutions have already shown great promise in reducing variability between readers in liver volumetry [1]. This study evaluates the accuracy of non-expert technicians versus expert radiologists in performing whole liver and liver lesion delineation in the context of colorectal liver metastases resection planning when technicians are assisted using an AI-enabled decision support tool (HepaticaTM).

## METHODS AND MATERIALS

Non-contrast T1w MRI scans from 18 patients with colorectal liver metastasis were retrospectively analyzed. Hepatica™ automatically delineated the whole liver and detected and outlined potential liver lesions. Masks generated by Hepatica™ were provided to three technicians and three radiologists to guide them in finalizing the delineation. Size metrics were automatically measured from the final delineation. Technicians' outputs underwent a second-stage review by a radiographer. Agreement between the mean of technicians+AI and mean of radiologists measuring liver volume and diameter and volume of lesions was assessed using ICC.

## RESULTS

The 41 lesions detected by all radiologists, with volume ranged from 1.3-43.4 ml and diameter from 11.4-51.0 mm, were detected by all technicians. ICC of mean of technicians vs mean of radiologists for liver volume, lesion diameter and lesion volume were 0.999, 0.981 and 0.987, respectively.

## CONCLUSION

The performance of the AI-assisted technicians and expert radiologists was comparable for detection and measurement of liver lesions. These findings suggest that delegating certain time-consuming manual radiologists' tasks to less qualified personnel, can deliver comparable results when supported by AI.

## CLINICAL RELEVANCE/APPLICATION

This shows AI-assisting tools for decision support can enhance the overall efficiency of radiology departments for decision support.

## M6-STCE2-3 **Positron emission tomography (PET) imaging to evaluate in-vivo augmentation of chimeric antigen receptor (CAR)-T cell trafficking following peptide receptor radionuclide therapy (PRRT) in a mouse model of glioblastoma**

Steven Pan, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

Glioblastoma (GBM) is the most aggressive primary malignant brain tumor, and prognosis remains dismal. The development of non-surgical, targeted therapies for GBM is crucial for improving patient outcomes. Chimeric antigen receptor T-cell therapy (CART) has been explored in GBM, however has to date not demonstrated consistent clinical benefit. Prostate-specific membrane antigen (PSMA) is expressed in GBM and thus has potential theranostic applications. Our purpose is to augment CART therapy in a preclinical mouse model of GBM through PSMA-targeted peptide receptor radionuclide therapy (PRRT), and evaluate trafficking of somatostatin-receptor-2 (SSTR2) - expressing CART using somatostatin-analog-PET.

## METHODS AND MATERIALS

Subcutaneous xenografting of a luciferase-expressing PSMA+ GBM tumor line was performed in 7 mice. At 15 weeks post-injection (pi), five animals were treated with 10 million disialoganglioside 2 (GD2, a GBM-specific biomarker) targeting CART cells while two animals served as controls. At week 17 pi, three animals from the treatment group received 1mCi of [Lu177]-PSMA; tumor localization was confirmed using post-treatment Bremsstrahlung single-photon computerized tomography (SPECT). For CART localization, PET was performed with 100uCi of Flourine-18-(18F)-4,7-triazacyclononane-1,4,7-triacetate (NOTA) - octreotide, an SSTR2-binding radiotracer.

## RESULTS

PET at 17 weeks pi demonstrated localization of PET of CART cells to tumor in 2/2 (100%) of animals. Post-PRRT SPECT at 17 weeks pi showed localization of [Lu177]-PSMA to tumor. Subsequent PET at 19 weeks pi, showed CART localization to tumor in (0/1) 0% of CAR-T-only treatment group and persistent tumor localization of CART in (2/3) 75% of the CART+PRRT combination treatment group.

## CONCLUSION

We demonstrate the feasibility of in vivo CART tracking using somatostatin-analog PET, as well as the augmentation of CART cell localization to tumor and systemic expansion following PRRT therapy, whereby tumor killing by targeted radiation enhances additional CART trafficking to tumor. We further provide additional validation for PSMA as a potential theranostic target in GBM. Future studies include evaluation of PRRT with alpha radiation emitters such as Actinium-226 in augmenting CART response.

## CLINICAL RELEVANCE/APPLICATION

This preclinical study demonstrates PRRT augmentation can improve CART localization and trafficking to tumor, while supporting PSMA as an emerging theranostic target in GBM, demonstrating the clinical translational potential of theranostic approaches in GBM.



## Abstract Archives of the RSNA, 2023

M6-STCE2-1

### Measurement of Tumor Total Diffusion Volume (tDV) of Metastatic Bone Lesions from Prostate Cancer Using Whole-Body MRI(WB-MRI)-Evaluation for Therapeutic Effect-

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 2

Katsuyuki Nakanishi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To measure the total diffusion tumor volume (tDV) of metastatic bone lesions from prostate cancer using whole body MRI(WB-MRI) including whole body diffusion weighted images (DWI) and to research the correlation for serum PSA level and to assess the reliability and reproducibility of our diagnostic methods.

#### METHODS AND MATERIALS

17 cases of prostate cancer during various treatment in which WB-MRI was performed twice were retrospectively evaluated. In all patients, serum PSA was measured at the same time of MRI examinations. 3.0T MR scanners were used (Siemens Prisma). The pulse sequences were 1. axial direction of DWI of the level from lower neck and bottom of pelvis. 2. Sagittal direction of T1WI and STIR of total spine 3. Coronal direction of in phase and out of phase of T1WI. In all cases, two radiologists measured tDVs using BD-score (PixSpace. Inc.) which had been developed for calculating ADC value of the lesions and their volume correspond to the tumor automatically by defining the threshold of ADC value. In this study, the threshold was defined as 1.8mm<sup>2</sup>/S. We calculated tDV variation (?tDV) and serum PSA variation (?PSA) before and after therapy in each patient, and examined the relation of ?tDV and ?PSA with Spearman's rank correlation coefficient (rs). Also, the bias between the data of the data of two radiologists was assessed calculating the cross-correlation coefficient.

#### RESULTS

In the data of both radiologists, ?tDV and ?PSA were positive correlated strongly by Spearman's rank correlation coefficient (radiologists 1 rs=0.833, p<0.01, radiologist 2 r=0.804, p<0.01). The cross-correlation coefficient of two radiologists was 0.755 (p<0.01).

#### CONCLUSION

tDV was proved to be a reliable mark for evaluating the grade of bone metastases from prostate cancer. Using BD score for calculating tDV showed less dispersion between the readers.

#### CLINICAL RELEVANCE/APPLICATION

Calculating the disease volume rapidly from WBMRI returns to earth.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-STCE2-2

### **An evaluation of the performance of AI segmentation of lesions and liver MRI scans: are expert radiology reviews necessary?**

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 2

Hildo J. Lamb, MD, PhD (*Presenter*) Consultant, Koninklijke Philips NV

#### **PURPOSE**

Detection and delineation of lesions in the liver is an important radiological task that allows for characterization and informs clinical decision making and surgical planning. This task is very time-consuming and requires expert training. Also, studies have found marked variability in subjective scores of the same lesions between radiologists. Artificial Intelligence (AI) assisted solutions have already shown great promise in reducing variability between readers in liver volumetry [1]. This study evaluates the accuracy of non-expert technicians versus expert radiologists in performing whole liver and liver lesion delineation in the context of colorectal liver metastases resection planning when technicians are assisted using an AI-enabled decision support tool (HepaticaTM).

#### **METHODS AND MATERIALS**

Non-contrast T1w MRI scans from 18 patients with colorectal liver metastasis were retrospectively analyzed. HepaticaTM automatically delineated the whole liver and detected and outlined potential liver lesions. Masks generated by HepaticaTM were provided to three technicians and three radiologists to guide them in finalizing the delineation. Size metrics were automatically measured from the final delineation. Technicians' outputs underwent a second-stage review by a radiographer. Agreement between the mean of technicians+AI and mean of radiologists measuring liver volume and diameter and volume of lesions was assessed using ICC.

#### **RESULTS**

The 41 lesions detected by all radiologists, with volume ranged from 1.3-43.4 ml and diameter from 11.4-51.0 mm, were detected by all technicians. ICC of mean of technicians vs mean of radiologists for liver volume, lesion diameter and lesion volume were 0.999, 0.981 and 0.987, respectively.

#### **CONCLUSION**

The performance of the AI-assisted technicians and expert radiologists was comparable for detection and measurement of liver lesions. These findings suggest that delegating certain time-consuming manual radiologists' tasks to less qualified personnel, can deliver comparable results when supported by AI.

#### **CLINICAL RELEVANCE/APPLICATION**

This shows AI-assisting tools for decision support can enhance the overall efficiency of radiology departments for decision support.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M6-STCE2-3

### **Positron emission tomography (PET) imaging to evaluate in-vivo augmentation of chimeric antigen receptor (CAR)-T cell trafficking following peptide receptor radionuclide therapy (PRRT) in a mouse model of glioblastoma**

Monday, Nov. 27 1:30PM - 2:00PM Room: Learning Center Theater 2

Steven Pan, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Glioblastoma (GBM) is the most aggressive primary malignant brain tumor, and prognosis remains dismal. The development of non-surgical, targeted therapies for GBM is crucial for improving patient outcomes. Chimeric antigen receptor T-cell therapy (CART) has been explored in GBM, however has to date not demonstrated consistent clinical benefit. Prostate-specific membrane antigen (PSMA) is expressed in GBM and thus has potential theranostic applications. Our purpose is to augment CART therapy in a preclinical mouse model of GBM through PSMA-targeted peptide receptor radionuclide therapy (PRRT), and evaluate trafficking of somatostatin-receptor-2 (SSTR2) - expressing CART using somatostatin-analog-PET.

#### **METHODS AND MATERIALS**

Subcutaneous xenografting of a luciferase-expressing PSMA+ GBM tumor line was performed in 7 mice. At 15 weeks post-injection (pi), five animals were treated with 10 million disialoganglioside 2 (GD2, a GBM-specific biomarker) targeting CART cells while two animals served as controls. At week 17 pi, three animals from the treatment group received 1mCi of [Lu177]-PSMA; tumor localization was confirmed using post-treatment Bremsstrahlung single-photon computerized tomography (SPECT). For CART localization, PET was performed with 100uCi of Flourine-18-(18F)-4,7-triazacyclononane-1,4,7-triacetate (NOTA) - octreotide, an SSTR2-binding radiotracer.

#### **RESULTS**

PET at 17 weeks pi demonstrated localization of CART cells to tumor in 2/2 (100%) of animals. Post-PRRT SPECT at 17 weeks pi showed localization of [Lu177]-PSMA to tumor. Subsequent PET at 19 weeks pi, showed CART localization to tumor in (0/1) 0% of CAR-T-only treatment group and persistent tumor localization of CART in (2/3) 75% of the CART+PRRT combination treatment group.

#### **CONCLUSION**

We demonstrate the feasibility of in vivo CART tracking using somatostatin-analog PET, as well as the augmentation of CART cell localization to tumor and systemic expansion following PRRT therapy, whereby tumor killing by targeted radiation enhances additional CART trafficking to tumor. We further provide additional validation for PSMA as a potential theranostic target in GBM. Future studies include evaluation of PRRT with alpha radiation emitters such as Actinium-226 in augmenting CART response.

#### **CLINICAL RELEVANCE/APPLICATION**

This preclinical study demonstrates PRRT augmentation can improve CART localization and trafficking to tumor, while supporting PSMA as an emerging theranostic target in GBM, demonstrating the clinical translational potential of theranostic approaches in GBM.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSCH04

### Chest Imaging (Lung Nodules and Cancer)

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

Jin Mo Goo, MD, PhD (*Moderator*) Research Grant, LG Electronics Inc Research Grant, Coreline Soft, Co, Ltd  
Florian J. Fintelmann, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M7-SSCH04-1 Prognostic Implications of Synchronous Subsolid Nodules in Patients with Resected Subsolid Lung Adenocarcinoma Nodule**

Yura Ahn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the prognostic implications of synchronous subsolid nodules (SSNs) in a large population of patients with resected subsolid lung adenocarcinoma nodules.

#### METHODS AND MATERIALS

Patients who underwent lobectomy or sublobar resection for lung adenocarcinoma manifesting as an SSN and clinical stage IA between January 2010 and December 2017 were retrospectively included. The radiologic features of resected SSN (dominant nodule) and synchronous SSNs were assessed on preoperative CT. The effects of synchronous SSNs on secondary intervention-free survival, time to recurrence, and overall survival were evaluated using Cox proportional hazards regression.

#### RESULTS

Of the 684 included patients (mean age,  $60.9 \pm 9.5$  years, 389 women [56.9%]), 515 (75.3%) had a single SSN and 169 (24.7%) had multiple SSNs. During follow-up (median, 71.8 months), 38 secondary interventions were performed, primarily due to growth of synchronous SSNs (21/24) or metachronous nodules (14/14). Secondary intervention-free survival decreased as the number of synchronous SSNs  $\geq 6$  mm increased ( $P < .001$ ). However, time to recurrence and overall survival were not affected by the synchronous SSNs ( $P = .53$  and  $.65$ , respectively) whereas they were determined by the features of the dominant nodule (solid portion size and histologic subtype, all  $P < .05$ ).

#### CONCLUSION

Synchronous SSNs had no prognostic impact on time to recurrence and overall survival in patients with adenocarcinoma manifesting as SSNs. Therefore, management focusing on the dominant nodule in multiple SSNs is considered appropriate. Because the number of synchronous SSNs  $\geq 6$  mm was associated with secondary intervention-free survival, their presence warrants attention during follow-up.

#### CLINICAL RELEVANCE/APPLICATION

Synchronous subsolid nodules were associated with secondary intervention, not recurrence or overall survival; therefore, the current strategy of dominant nodule-focusing management in multiple subsolid nodules is considered reasonable.

#### **M7-SSCH04-2 Missed Cancer Diagnosis Rate in CT-Guided Core Lung Biopsies with a Histopathologic Finding of Organizing Pneumonia**

Charissa Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the accuracy of CT-guided lung biopsy diagnosis of organizing pneumonia and identify radiologic features present in cases that are later shown to be cancer.

## METHODS AND MATERIALS

This retrospective IRB-approved, HIPAA-compliant study, identified 1314 consecutive patients who underwent CT-guided lung biopsy for suspected lung cancer or metastatic disease between 02/2014 and 04/2022 at a single tertiary referral hospital. A pulmonary pathologist reconfirmed the presence of organizing pneumonia in all samples and no evidence of malignancy. Clinical outcomes were determined through a review of the medical records and included results from follow-up imaging studies and repeat biopsies in cases where they were performed. Chest CTs and/or PET/CTs performed prior to the biopsy were also independently reviewed by a radiologist to determine lesion's radiological features. Descriptive statistics were used.

## RESULTS

In 98/1314 (7.5%) patients, biopsy showed organizing pneumonia with 43 (44%) females, age 55±14 years, median lesion size 2.5cm (IQR 1.7 - 3.5cm). In 10/98 (10%, 95% CI 6-18%) patients with an initial biopsy result of organizing pneumonia, repeat tissue sampling performed median 51 days (IQR 27-115 days) after the first biopsy due to high clinical suspicion for malignancy, demonstrated pulmonary metastases in 5/10 (50%) and primary lung cancers in 5/10 (50%). No imaging or clinical features were associated with a missed diagnosis of malignancy in this cohort.

## CONCLUSION

Organizing pneumonia can mask underlying malignancy in up to 10% of patients undergoing CT-guided biopsy. In this group, no imaging or clinical characteristics were found to be associated with organizing pneumonia that occurred simultaneously with malignancy.

## CLINICAL RELEVANCE/APPLICATION

Organizing pneumonia masks underlying malignancy in up to 10% of cases. Repeat biopsy should be considered in patients with high clinical suspicion of malignancy despite an initial pathology diagnosis of organizing pneumonia.

## M7-SSCH04-3 Venous-Phase Chest CT with Photon-Counting Detector CT (PCD-CT): Comparison with Energy-Integrating-Detector CT (EID-CT) in 76 Patients

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG;Speaker, Siemens AG

## PURPOSE

To investigate the quality of chest PCD-CT examinations acquired at a venous phase in comparison with energy-integrating-detector CT.

## METHODS AND MATERIALS

The study group included 76 oncologic patients fulfilling the following criteria: (a) a PCD-CT examination at a recirculation phase (Naeotom Alpha ; Siemens Healthineers) ; (b) with a prior venous-phase, dual-source, dual-energy CT (DS-DECT) examination (Somatom Force ; Siemens Healthineers) obtained less than 2 years earlier. The scanning parameters included: (a) for PCD-CT (Group 1): collimation:144 x 0.4mm; 120 kVp; pitch: 1.5; IQ level: 180; (b) for DECT (Group 2): collimation: 64 x 0.6mm; tube A (70/80/90 kVp depending on patient morphotype); tube B (Sn150 kVp); pitch: 0.5 - 1. The same injection protocol was used in both groups (120 mL of a 35% contrast agent with a start delay of 70s). Standard morphologic images consisted of 60 keV images (Group 1) and averaged images from both tubes (Group 2).

## RESULTS

The two groups did not differ regarding (a) the quality of opacification of the SVC and upper thoracic veins (good or excellent in >90% of cases in both groups); (b) the level of analyzability of pulmonary arteries (CT angiograms analyzable down to the subsegmental arteries in 86.4% (Group 1) and 81.6% (Group 2) (p=0.60). In Group 1: (a) there was a significant reduction of perivenous beam-hardening artifacts (p=0.005) with artifact-free images and precise analysis of the nodal station 4R in 77.6% of patients (n=59) vs 59.2% of patients (n=45) in Group 2; (b) a significantly lower frequency of cardiac motion artifacts (p=0.009), linked to a shorter median duration of acquisitions (Group 1: 1.2 s ; Group 2: 2.9 s) (p<0.0001). Comparison of objective quality parameters showed higher mean values of CNR in Group 1 (23.13 ± 6.28) compared to Group 2 (20.81±5.73) (p=0005). The level of opacification on standard morphologic images (a) was sufficient for analysis of endo- or perivascular abnormalities on 60 keV images of all patients in Group 1; (b) required analysis of central vessels at a lower energy level (i.e., tube A images) in 18 patients (23.7%) in Group 2; (c) enabling diagnosis of acute PE (Group 1: n=5; Group 2: n=2) and venous thrombi (Group 1: n=14; Group 2: n=8). The median [Q1; Q3] DLP was significantly lower in Group 1 (326.0 [250;413.5] mGy.cm) than in Group 2 (382.0 [325.45; 488.60] mGy.cm) (p<0.0001).

## CONCLUSION

This study shows that venous-phase chest CT using PCD-CT performs better than when using EID-CT in oncology indications.

## CLINICAL RELEVANCE/APPLICATION

Venous-phase PCD-CT provides higher image quality at lower radiation dose than EID-CT in oncologic patients with confident depiction of incidental findings such as acute pulmonary embolism or venous thrombi.

**M7-SSCH04-4 Synergic Prognostic Value of 3D CT-Scan Subcutaneous Fat and Muscle Masses for Immunotherapy-Treated Non-Squamous Cell Lung Cancer**

Pierre Decazes, MD, PhD (*Presenter*) Nothing to Disclose

**PURPOSE**

Survival outcomes are significantly longer in overweight/obese patients (as determined by higher body mass index - BMI) for cancer patients treated with immune checkpoint inhibitors. However, multi-slice determination of body composition from routinely generated CT images may be more informative than simple BMI. Our aim was to explore the prognostic value of 3D anthropometric parameters in a large population of patients treated with immunotherapy.

**METHODS AND MATERIALS**

We retrospectively included 318 patients with advanced non-small cell lung cancer (NSCLC) treated by an immune-checkpoint-inhibitor having a pretreatment 3D thorax-abdomen-pelvis CT scan. Anthropometric parameters were measured three-dimensionally by a deep learning software (Anthropometer3DNet, [www.oncometer3d.com](http://www.oncometer3d.com)) allowing an automatic multi-slice measurement of Lean Body Mass (LBM), Fat Body Mass (FBM), Muscle Body Mass (MBM), Visceral Fat Mass (VFM) and Sub-cutaneous Fat Mass (SFM). Body mass index (BMI) and weight loss (WL) were also retrieved. Receiver operator characteristic (ROC) curve analysis was performed and overall survival (OS) was calculated using Kaplan-Meier curve and Cox regression analysis.

**RESULTS**

In the overall cohort, 1 year survival rate was 0.41 [95% CI: 0.36-0.47] for 182 events and 5 year survival rate was 0.11 [95% CI: 0.08-0.16] for 264 events. In the univariate Kaplan-Meier analysis, prognosis was worse ( $p < 0.01$ ) for patients with low SFM ( $< 4.71$  kg/m<sup>2</sup>), low FBM ( $< 5.04$  kg/m<sup>2</sup>), low VFM ( $< 0.91$  kg/m<sup>2</sup>), low MBM ( $< 6.86$  kg/m<sup>2</sup>), low FBM ( $< 20.52$  kg/m<sup>2</sup>) and low BMI ( $< 26.82$  kg/m<sup>2</sup>). The same parameters were significant in the Cox univariate analysis ( $p < 0.001$ ) and, in the multivariate stepwise Cox analysis, the significant parameters were MBM ( $p < 0.001$ ), SFM (0.019) and WL (0.0004). A KM analysis combining SFM and MBM was able to separate the population in three categories with the worse prognosis for the patients with both low SFM ( $< 4.71$  kg/m<sup>2</sup>) and MBM ( $< 6.86$  kg/m<sup>2</sup>) ( $p < 0.001$ ).

**CONCLUSION**

3D measured low SFM and MBM are significant prognosis factors of NSCLC treated by immune checkpoint inhibitors and can be combined to improve the prognostic value.

**CLINICAL RELEVANCE/APPLICATION**

Determination of body composition may help to better define the prognosis of lung cancers treated with immunotherapy. In the long term, therapeutic adaptation according to body composition could be possible.

**M7-SSCH04-5 Prognostication of Lung Adenocarcinomas Using CT-based Deep Learning of Morphological and Histopathological Features: A Retrospective Dual-institutional Study**

Taehee Lee, MD (*Presenter*) Nothing to Disclose

**PURPOSE**

To develop and validate CT-based deep learning models that learn morphological and histopathological features for lung adenocarcinoma prognostication, and to compare them with a previously developed DL discrete-time survival model.

**METHODS AND MATERIALS**

DL models were trained to simultaneously predict five morphological and histopathological features using preoperative chest CT scans from patients with resected lung adenocarcinomas. The DL score was validated in temporal and external test sets, with freedom from recurrence (FFR) and overall survival (OS) as outcomes. Discrimination was evaluated using the time-dependent area under the receiver operating characteristic curve (TD-AUC) and compared with the DL discrete-time survival model. Multivariable Cox regression analysis was performed, and ablation studies for combinations of target features were conducted.

**RESULTS**

In the temporal test set (640 patients; 331 women; median age, 64 years; interquartile range, 56-70 years), the TD-AUC was 0.79 for 5-year FFR and 0.73 for 5-year OS. In the external test set (846 patients; 459 women; median age, 65 years; interquartile range, 57-72 years), the TD-AUC was 0.71 for 5-year OS, equivalent to the pathologic stage (0.71 vs. 0.71 [ $P = .74$ ]). The prognostic value of the DL score was independent of clinical factors (adjusted per-centage hazard ratio for FFR [temporal test], 1.02 [95% CI: 1.01, 1.03;  $P < .001$ ]; OS [temporal test], 1.01 [95% CI: 1.002, 1.02;  $P = .01$ ]; OS [external test], 1.01 [95% CI: 1.005, 1.02;  $P < .001$ ]). Our model showed a higher TD-AUC than the DL discrete-time survival model, but without statistical significance (2.5-year OS: 0.73 vs. 0.68;  $P = .13$ ). The model predicting all five features demonstrated comparable-to-superior prognostic performance to models predicting fewer features.

## CONCLUSION

The CT-based prognostic score from collective deep learning of morphological and histopathological features successfully predicted survival in lung adenocarcinomas.

## CLINICAL RELEVANCE/APPLICATION

Collective CT-based deep learning of morphological and histopathological features successfully predicted lung adenocarcinoma prognosis, facilitating the selection of surgical modalities and identification of neoadjuvant therapy candidates.

## M7-SSCH04-6 Comparative Performance of Artificial Intelligence (AI) Software for Metastatic Pulmonary Nodules in Oncologic Patients

Albert Hsiao, MD, PhD (*Presenter*) Co-founder, Arterys Inc; Shareholder, Arterys Inc; Co-founder, Vektor.AI; Shareholder, Vektor.AI; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, KA Imaging

## PURPOSE

Pulmonary nodule detection is essential for cancer diagnosis and management. Our study aimed to evaluate the diagnostic performance of AI software for detecting metastatic pulmonary nodules.

## METHODS AND MATERIALS

With IRB approval and waiver of informed consent, we retrospectively reviewed chest CT scans from 167 oncologic patients with pulmonary metastatic disease between October 2022 and January 2023, analyzed with three AI software, ClearRead CT v5.6.3 (Riverain Technologies, Miamisburg, OH), InferRead Lung CT.AI vR12 (Infervision Technology, Philadelphia, PA) and Lung AI (MICA v29.8, Research Model: AMM7; Arterys, Redwood city, CA). We evaluated the overlap between pulmonary nodules reported by AI software, stratified by nodule size, dividing into three groups large ( $>8$  mm), intermediate (6-8 mm), and small ( $\leq 6$  mm). These were then compared against nodules documented by radiologists in clinical reports.

## RESULTS

Infervision presented the most nodules (6355) compared to Arterys (4768) and Riverain (696). Of those presented by Infervision, Arterys presented 42% and Riverain presented 8%. Of those presented by Arterys, Infervision presented 56% and Riverain presented 14%. Of those presented by Riverain, Arterys presented 93% and Infervision presented 72%. A total of 517 nodules were reported by radiologists, of which 22.6% were new, for the remaining, 41.0% had VDT  $\leq 400$  days and 33.5% had VDT  $\leq 200$  days. Of these, Arterys detected 480 (93%), including 258/272 (95%) large, 93/100 (93%) intermediate, and 129/145 (89%) small nodules. Riverain presented 312 (60%), including 194 (71%) large, 59 (59%) intermediate, and 59 (41%) small nodules. Infervision presented 376 (73%), 186 (68%) large, 73 (73%) intermediate and 117 (81%) small nodules.

## CONCLUSION

For oncologic patients with pulmonary metastatic disease, three AI software varied considerably in nodules presented to radiologists. Although Infervision presented the largest number, Arterys detected the greatest proportion of nodules that were incorporated in radiology final reports. Riverain's lower number was due in part to a local implementation limited to display of 5 largest nodules.

## CLINICAL RELEVANCE/APPLICATION

For follow-up of oncologic patients, it may be necessary for AI software to strike a different balance in sensitivity and specificity than in other populations to offer maximal value in the interpretive process. Software implementation is as important as machine learning algorithms for the efficacy of AI in clinical settings.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-SSCH04-1

### Prognostic Implications of Synchronous Subsolid Nodules in Patients with Resected Subsolid Lung Adenocarcinoma Nodule

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

Yura Ahn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the prognostic implications of synchronous subsolid nodules (SSNs) in a large population of patients with resected subsolid lung adenocarcinoma nodules.

#### METHODS AND MATERIALS

Patients who underwent lobectomy or sublobar resection for lung adenocarcinoma manifesting as an SSN and clinical stage IA between January 2010 and December 2017 were retrospectively included. The radiologic features of resected SSN (dominant nodule) and synchronous SSNs were assessed on preoperative CT. The effects of synchronous SSNs on secondary intervention-free survival, time to recurrence, and overall survival were evaluated using Cox proportional hazards regression.

#### RESULTS

Of the 684 included patients (mean age,  $60.9 \pm 9.5$  years, 389 women [56.9%]), 515 (75.3%) had a single SSN and 169 (24.7%) had multiple SSNs. During follow-up (median, 71.8 months), 38 secondary interventions were performed, primarily due to growth of synchronous SSNs (21/24) or metachronous nodules (14/14). Secondary intervention-free survival decreased as the number of synchronous SSNs  $\geq 6$  mm increased ( $P < .001$ ). However, time to recurrence and overall survival were not affected by the synchronous SSNs ( $P = .53$  and  $.65$ , respectively) whereas they were determined by the features of the dominant nodule (solid portion size and histologic subtype, all  $P < .05$ ).

#### CONCLUSION

Synchronous SSNs had no prognostic impact on time to recurrence and overall survival in patients with adenocarcinoma manifesting as SSNs. Therefore, management focusing on the dominant nodule in multiple SSNs is considered appropriate. Because the number of synchronous SSNs  $\geq 6$  mm was associated with secondary intervention-free survival, their presence warrants attention during follow-up.

#### CLINICAL RELEVANCE/APPLICATION

Synchronous subsolid nodules were associated with secondary intervention, not recurrence or overall survival; therefore, the current strategy of dominant nodule-focusing management in multiple subsolid nodules is considered reasonable.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-SSCH04-2

### Missed Cancer Diagnosis Rate in CT-Guided Core Lung Biopsies with a Histopathologic Finding of Organizing Pneumonia

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

Charissa Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the accuracy of CT-guided lung biopsy diagnosis of organizing pneumonia and identify radiologic features present in cases that are later shown to be cancer.

#### METHODS AND MATERIALS

This retrospective IRB-approved, HIPAA-compliant study, identified 1314 consecutive patients who underwent CT-guided lung biopsy for suspected lung cancer or metastatic disease between 02/2014 and 04/2022 at a single tertiary referral hospital. A pulmonary pathologist reconfirmed the presence of organizing pneumonia in all samples and no evidence of malignancy. Clinical outcomes were determined through a review of the medical records and included results from follow-up imaging studies and repeat biopsies in cases where they were performed. Chest CTs and/or PET/CTs performed prior to the biopsy were also independently reviewed by a radiologist to determine lesion's radiological features. Descriptive statistics were used.

#### RESULTS

In 98/1314 (7.5%) patients, biopsy showed organizing pneumonia with 43 (44%) females, age 55±14 years, median lesion size 2.5cm (IQR 1.7 - 3.5cm). In 10/98 (10%, 95% CI 6-18%) patients with an initial biopsy result of organizing pneumonia, repeat tissue sampling performed median 51 days (IQR 27-115 days) after the first biopsy due to high clinical suspicion for malignancy, demonstrated pulmonary metastases in 5/10 (50%) and primary lung cancers in 5/10 (50%). No imaging or clinical features were associated with a missed diagnosis of malignancy in this cohort.

#### CONCLUSION

Organizing pneumonia can mask underlying malignancy in up to 10% of patients undergoing CT-guided biopsy. In this group, no imaging or clinical characteristics were found to be associated with organizing pneumonia that occurred simultaneously with malignancy.

#### CLINICAL RELEVANCE/APPLICATION

Organizing pneumonia masks underlying malignancy in up to 10% of cases. Repeat biopsy should be considered in patients with high clinical suspicion of malignancy despite an initial pathology diagnosis of organizing pneumonia.

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## Abstract Archives of the RSNA, 2023

M7-SSCH04-3

### Venous-Phase Chest CT with Photon-Counting Detector CT (PCD-CT): Comparison with Energy-Integrating-Detector CT (EID-CT) in 76 Patients

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

#### PURPOSE

To investigate the quality of chest PCD-CT examinations acquired at a venous phase in comparison with energy-integrating-detector CT.

#### METHODS AND MATERIALS

The study group included 76 oncologic patients fulfilling the following criteria: (a) a PCD-CT examination at a recirculation phase (Naeotom Alpha ; Siemens Healthineers) ; (b) with a prior venous-phase, dual-source, dual-energy CT (DS-DECT) examination (Somatom Force ; Siemens Healthineers) obtained less than 2 years earlier. The scanning parameters included: (a) for PCD-CT (Group 1): collimation:144 x 0.4mm; 120 kVp; pitch: 1.5; IQ level: 180; (b) for DECT (Group 2): collimation: 64 x 0.6mm; tube A (70/80/90 kVp depending on patient morphotype); tube B (Sn150 kVp); pitch: 0.5 - 1. The same injection protocol was used in both groups (120 mL of a 35% contrast agent with a start delay of 70s). Standard morphologic images consisted of 60 keV images (Group 1) and averaged images from both tubes (Group 2).

#### RESULTS

The two groups did not differ regarding (a) the quality of opacification of the SVC and upper thoracic veins (good or excellent in >90% of cases in both groups); (b) the level of analyzability of pulmonary arteries (CT angiograms analyzable down to the subsegmental arteries in 86.4% (Group 1) and 81.6% (Group 2) ( $p=0.60$ ). In Group 1: (a) there was a significant reduction of perivenous beam-hardening artifacts ( $p=0.005$ ) with artifact-free images and precise analysis of the nodal station 4R in 77.6% of patients ( $n=59$ ) vs 59.2% of patients ( $n=45$ ) in Group 2; (b) a significantly lower frequency of cardiac motion artifacts ( $p=0.009$ ), linked to a shorter median duration of acquisitions (Group 1: 1.2 s ; Group 2: 2.9 s) ( $p<0.0001$ ). Comparison of objective quality parameters showed higher mean values of CNR in Group 1 ( $23.13 \pm 6.28$ ) compared to Group 2 ( $20.81 \pm 5.73$ ) ( $p=0.005$ ). The level of opacification on standard morphologic images (a) was sufficient for analysis of endo- or perivascular abnormalities on 60 keV images of all patients in Group 1; (b) required analysis of central vessels at a lower energy level (i.e., tube A images) in 18 patients (23.7%) in Group 2; (c) enabling diagnosis of acute PE (Group 1:  $n=5$ ; Group 2:  $n=2$ ) and venous thrombi (Group 1:  $n=14$ ; Group 2:  $n=8$ ). The median [Q1; Q3] DLP was significantly lower in Group 1 ( $326.0 [250;413.5]$  mGy.cm) than in Group 2 ( $382.0 [325.45; 488.60]$  mGy.cm) ( $p<0.0001$ ).

#### CONCLUSION

This study shows that venous-phase chest CT using PCD-CT performs better than when using EID-CT in oncology indications.

#### CLINICAL RELEVANCE/APPLICATION

Venous-phase PCD-CT provides higher image quality at lower radiation dose than EID-CT in oncologic patients with confident depiction of incidental findings such as acute pulmonary embolism or venous thrombi.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSCH04-4

### Synergic Prognostic Value of 3D CT-Scan Subcutaneous Fat and Muscle Masses for Immunotherapy-Treated Non-Squamous Cell Lung Cancer

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

Pierre Decazes, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Survival outcomes are significantly longer in overweight/obese patients (as determined by higher body mass index - BMI) for cancer patients treated with immune checkpoint inhibitors. However, multi-slice determination of body composition from routinely generated CT images may be more informative than simple BMI. Our aim was to explore the prognostic value of 3D anthropometric parameters in a large population of patients treated with immunotherapy.

#### METHODS AND MATERIALS

We retrospectively included 318 patients with advanced non-small cell lung cancer (NSCLC) treated by an immune-checkpoint-inhibitor having a pretreatment 3D thorax-abdomen-pelvis CT scan. Anthropometric parameters were measured three-dimensionally by a deep learning software (Anthropometer3DNet, [www.oncometer3d.com](http://www.oncometer3d.com)) allowing an automatic multi-slice measurement of Lean Body Mass (LBM), Fat Body Mass (FBM), Muscle Body Mass (MBM), Visceral Fat Mass (VFM) and Sub-cutaneous Fat Mass (SFM). Body mass index (BMI) and weight loss (WL) were also retrieved. Receiver operator characteristic (ROC) curve analysis was performed and overall survival (OS) was calculated using Kaplan-Meier curve and Cox regression analysis.

#### RESULTS

In the overall cohort, 1 year survival rate was 0.41 [95% CI: 0.36-0.47] for 182 events and 5 year survival rate was 0.11 [95% CI: 0.08-0.16] for 264 events. In the univariate Kaplan-Meier analysis, prognosis was worse ( $p < 0.01$ ) for patients with low SFM ( $< 4.71$  kg/m<sup>2</sup>), low FBM ( $< 5.04$  kg/m<sup>2</sup>), low VFM ( $< 0.91$  kg/m<sup>2</sup>), low MBM ( $< 6.86$  kg/m<sup>2</sup>), low FBM ( $< 20.52$  kg/m<sup>2</sup>) and low BMI ( $< 26.82$  kg/m<sup>2</sup>). The same parameters were significant in the Cox univariate analysis ( $p < 0.001$ ) and, in the multivariate stepwise Cox analysis, the significant parameters were MBM ( $p < 0.001$ ), SFM (0.019) and WL (0.0004). A KM analysis combining SFM and MBM was able to separate the population in three categories with the worse prognostic for the patients with both low SFM ( $< 4.71$  kg/m<sup>2</sup>) and MBM ( $< 6.86$  kg/m<sup>2</sup>) ( $p < 0.001$ ).

#### CONCLUSION

3D measured low SFM and MBM are significant prognosis factors of NSCLC treated by immune checkpoint inhibitors and can be combined to improve the prognostic value.

#### CLINICAL RELEVANCE/APPLICATION

Determination of body composition may help to better define the prognosis of lung cancers treated with immunotherapy. In the long term, therapeutic adaptation according to body composition could be possible.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSCH04-5

### Prognostication of Lung Adenocarcinomas Using CT-based Deep Learning of Morphological and Histopathological Features: A Retrospective Dual-institutional Study

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

Taehee Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate CT-based deep learning models that learn morphological and histopathological features for lung adenocarcinoma prognostication, and to compare them with a previously developed DL discrete-time survival model.

#### METHODS AND MATERIALS

DL models were trained to simultaneously predict five morphological and histopathological features using preoperative chest CT scans from patients with resected lung adenocarcinomas. The DL score was validated in temporal and external test sets, with freedom from recurrence (FFR) and overall survival (OS) as outcomes. Discrimination was evaluated using the time-dependent area under the receiver operating characteristic curve (TD-AUC) and compared with the DL discrete-time survival model. Multivariable Cox regression analysis was performed, and ablation studies for combinations of target features were conducted.

#### RESULTS

In the temporal test set (640 patients; 331 women; median age, 64 years; interquartile range, 56-70 years), the TD-AUC was 0.79 for 5-year FFR and 0.73 for 5-year OS. In the external test set (846 patients; 459 women; median age, 65 years; interquartile range, 57-72 years), the TD-AUC was 0.71 for 5-year OS, equivalent to the pathologic stage (0.71 vs. 0.71 [P=.74]). The prognostic value of the DL score was independent of clinical factors (adjusted per-centage hazard ratio for FFR [temporal test], 1.02 [95% CI: 1.01, 1.03; P<.001]; OS [temporal test], 1.01 [95% CI: 1.002, 1.02; P=.01]; OS [external test], 1.01 [95% CI: 1.005, 1.02; P<.001]). Our model showed a higher TD-AUC than the DL discrete-time survival model, but without statistical significance (2.5-year OS: 0.73 vs. 0.68; P=.13). The model predicting all five features demonstrated comparable-to-superior prognostic performance to models predicting fewer features.

#### CONCLUSION

The CT-based prognostic score from collective deep learning of morphological and histopathological features successfully predicted survival in lung adenocarcinomas.

#### CLINICAL RELEVANCE/APPLICATION

Collective CT-based deep learning of morphological and histopathological features successfully predicted lung adenocarcinoma prognosis, facilitating the selection of surgical modalities and identification of neoadjuvant therapy candidates.

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## Abstract Archives of the RSNA, 2023

M7-SSCH04-6

### Comparative Performance of Artificial Intelligence (AI) Software for Metastatic Pulmonary Nodules in Oncologic Patients

Monday, Nov. 27 3:00PM - 4:00PM Room: E352

Albert Hsiao, MD, PhD (*Presenter*) Co-founder, Arterys Inc; Shareholder, Arterys Inc; Co-founder, Vektor.AI; Shareholder, Vektor.AI; Research Grant, Bayer AG; Research Grant, General Electric Company; Research Grant, KA Imaging

#### PURPOSE

Pulmonary nodule detection is essential for cancer diagnosis and management. Our study aimed to evaluate the diagnostic performance of AI software for detecting metastatic pulmonary nodules.

#### METHODS AND MATERIALS

With IRB approval and waiver of informed consent, we retrospectively reviewed chest CT scans from 167 oncologic patients with pulmonary metastatic disease between October 2022 and January 2023, analyzed with three AI software, ClearRead CT v5.6.3 (Riverain Technologies, Miamisburg, OH), InferRead Lung CT.AI vR12 (Infervision Technology, Philadelphia, PA) and Lung AI (MICA v29.8, Research Model: AMM7; Arterys, Redwood city, CA). We evaluated the overlap between pulmonary nodules reported by AI software, stratified by nodule size, dividing into three groups large ( $\geq 8$  mm), intermediate (6-8 mm), and small ( $\leq 6$  mm). These were then compared against nodules documented by radiologists in clinical reports.

#### RESULTS

Infervision presented the most nodules (6355) compared to Arterys (4768) and Riverain (696). Of those presented by Infervision, Arterys presented 42% and Riverain presented 8%. Of those presented by Arterys, Infervision presented 56% and Riverain presented 14%. Of those presented by Riverain, Arterys presented 93% and Infervision presented 72%. A total of 517 nodules were reported by radiologists, of which 22.6% were new, for the remaining, 41.0% had VDTI $\leq$ 400 days and 33.5% had VDTI $\leq$ 200 days. Of these, Arterys detected 480 (93%), including 258/272 (95%) large, 93/100 (93%) intermediate, and 129/145 (89%) small nodules. Riverain presented 312 (60%), including 194 (71%) large, 59 (59%) intermediate, and 59 (41%) small nodules. Infervision presented 376 (73%), 186 (68%) large, 73 (73%) intermediate and 117 (81%) small nodules.

#### CONCLUSION

For oncologic patients with pulmonary metastatic disease, three AI software varied considerably in nodules presented to radiologists. Although Infervision presented the largest number, Arterys detected the greatest proportion of nodules that were incorporated in radiology final reports. Riverain's lower number was due in part to a local implementation limited to display of 5 largest nodules.

#### CLINICAL RELEVANCE/APPLICATION

For follow-up of oncologic patients, it may be necessary for AI software to strike a different balance in sensitivity and specificity than in other populations to offer maximal value in the interpretive process. Software implementation is as important as machine learning algorithms for the efficacy of AI in clinical settings.

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## Abstract Archives of the RSNA, 2023

M7-SSNMMI03

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Neuroendocrine Imaging)

Monday, Nov. 27 3:00PM - 4:00PM Room: S501

Delphine L. Chen, MD (*Moderator*) Grant, Telix Pharmaceuticals Limited; Speaker, Telix Pharmaceuticals Limited  
Nadine Mallak, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

##### M7-SSNMMI03-1 **Keynote Speaker**

Delphine L. Chen, MD (*Presenter*) Grant, Telix Pharmaceuticals Limited; Speaker, Telix Pharmaceuticals Limited

##### M7-SSNMMI03-2 **Hidden Causes of False Negative Results in Neuroendocrine Tumor Localization Using <sup>68</sup>Ga-DOTATATE PET Imaging**

Arvin Haj-Mirzaian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

PET imaging using radiolabeled somatostatin analogues, including <sup>68</sup>Ga-DOTATATE has shown promising results in diagnosis of neuroendocrine tumors (NETs); however, false-negative (FN) results might occur due to a variety of factors, including tumor size, location, and histological subtypes. In this regard, identifying the hidden causes of FN results of <sup>68</sup>Ga-DOTATATE PET imaging, including genetic changes, might improve the diagnostic accuracy of this imaging method.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on 27 patients who had undergone <sup>68</sup>Ga-DOTATATE scans for suspected NET. Of these, three had negative <sup>68</sup>Ga-DOTATATE scans (11.1%) despite positive pathology reports. To investigate the genetic cause of the FN, whole exome sequencing (WES) was used to evaluate germline and somatic mutations to uncover the possible underlying mechanism of SSTR2 silencing.

#### RESULTS

We observed a significant mutation in SSTR2 in one patient of FN group. Specifically, a C-to-T substitution in the DNA sequence led to an arginine-to-cysteine substitution in the protein sequence of SSTR2. This mutation occurred in the <sup>68</sup>Ga-DOTATATE binding site pocket, which might considerably alter the binding affinity to SSTR2. In the other 26 patients, we observed a high mutation rate in MUC4, DSPP, GP1BA, IRF2BPL, OR2T35, and UBXN1 genes in both positive and negative scans. Further analysis revealed that 243 genes were significantly mutated in the FN group. Pathway analysis of these genes identified significant alterations in DNA repair pathways, such as telomere maintenance, as potential pathways that might directly affect SSTR2 expression. In terms of indirect impact, we found significant mutation in three transcription factors (TFs), including TEAD2, PER1, and HOXA1, that might be involved in regulating SSTR2 expression. Pathway analysis of the genes known to be regulated by these TFs (especially TEAD2), showed that DNA methylation, the translation process, and histone modification are the most significant complexes that probably were altered in FN group. Thus, hypo- or hyper-function of these pathways could result in SSTR2 silencing and instability.

#### CONCLUSION

The findings of this study suggest a new single nucleotide variant in SSTR2 that might cause FN in <sup>68</sup>Ga-DOTATATE PET imaging. Also, we revealed that TFs mutations might be the most prominent cause of SSTR2 downregulation in patients with negative <sup>68</sup>Ga-DOTATATE PET scans.

#### CLINICAL RELEVANCE/APPLICATION

By understanding the underlying mechanisms of SSTR2 silencing, clinicians can optimize therapy regimens based on targeting TFs to improve diagnostic accuracy for NET localization. These findings pave the way for further research and the development of targeted therapies for patients with NETs.

## **M7-SSNMMI03-4 Deep-Learning Enabled Pre-Therapy 68Ga-DOTATATE PET Quantification with Clinical Biomarkers for Prediction of Neuroendocrine Tumors Outcomes**

Azadeh Akhavanallaf, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

The aim of this study is to evaluate quantitative PET metrics on baseline 68Ga-DOTATATE PET/CT combined with pretreatment clinicopathological biomarkers for prediction of treatment effect response, on progression-free survival (PFS) and overall survival (OS) in neuroendocrine tumors (NET).

### **METHODS AND MATERIALS**

seventy patients with well-differentiated NET that received peptide receptor radionuclide therapy (PRRT) with Lu177-DOTATATE, planned as 4 cycles (200 mCi) IV at 8-week intervals, were included. Deep-learning-based segmentation of normal organs was used to generate organ-specific tumor volumes and total-lesion masks from 68Ga-DOTATATE PET images. The tumor metrics evaluated were quantitative lesion-based parameters (SUVmean, SUVmax), and total-tumor burden metrics: Total Lesion Volume (TLV) and Total Lesion Somatostatin Expression (TL-SSE = SUVmean × TLV). In addition, the impact of clinicopathological biomarkers including tumor grade, primary tumor site, and blood biomarkers including Chromogranin A (CgA) and Alkaline Phosphatase (ALP) for prediction of PFS and OS after PRRT were evaluated. Associations between PET quantitative metrics and clinical markers with endpoints OS and PFS were assessed using univariate Kaplan-Meier (KM) analysis, while the significance of the analysis was determined using unpaired t-test statistical analysis.

### **RESULTS**

At the time of analysis, the observed median rate of OS had not yet been reached. While the median rate of PFS was observed at about 27.9 months. In the subgroup analysis we found that OS was proportional to SUVmean, where SUVmean > 15.39 showed a better overall survival (p-val = 0.06). The analysis showed that OS is inversely correlated with TLV, where TLV < 136.21 cm<sup>3</sup> showed a better overall survival (p-val = 0.02). In the subgroup analysis we found that OS is significantly worse in patients with prior systemic treatment (p-val = <0.001). Of the blood biomarkers, OS was inversely proportional to both CgA and ALP, where CgA > 199.5 ng/mL (p-val = 0.02), and ALP > 99.6 U/L (p-val = 0.02) showed significantly worse OS, respectively. Also, likewise, OS analysis, the results showed that PFS is inversely correlated with TLV, where TLV > 119.02 cm<sup>3</sup> showed a strongly worse progression free survival (p-val = 0.05). Similar to OS, of the blood biomarkers, PFS was inversely proportional to both CgA and ALP, where CgA > 269 ng/mL (48%, p-val = 0.001), and ALP > 102 U/L (57%, p-val = 0.04) showed worse PFS, respectively.

### **CONCLUSION**

PET-derived quantitative metrics and biomarkers (i.e. CgA and ALP) are predictive of NET outcomes for both OS and PFS.

### **CLINICAL RELEVANCE/APPLICATION**

patient selection for 177Lu-PRRT

## **M7-SSNMMI03-5 Intra-Subject Heterogeneity of Lesion SUV and SUVR on [68Ga] DOTATATE PET/MRI in Patients with Multiple Meningiomas - Implications for Tumor Biology and Clinical Management**

Se Jung Chris Chang, BA (*Presenter*) Nothing to Disclose

### **PURPOSE**

Meningioma patients commonly present with multiple lesions and have high recurrence rates. Somatostatin receptor 2 (SSTR2)-targeted PET of meningiomas using [68Ga]-DOTATATE PET/MRI and PET/CT has demonstrated substantial clinical benefit. While diagnostic thresholds have been established, there is substantial heterogeneity in avidity of lesions across subjects and standardized uptake value (SUV) does not appear to correlate with WHO grade. Our purpose was to conduct the first study focusing on intra-subject heterogeneity of lesion PET SUV and SUV ratio (SUVR) in patients with multiple meningiomas.

### **METHODS AND MATERIALS**

The study population consisted of patients with multiple meningiomas enrolled on our prospective observational study. Inclusion criteria were ≥3 lesions radiographically compatible with meningioma, at least one of which was pathology-proven. Maximum SUV and SUVR (relative to superior sagittal sinus SUV) were obtained for each lesion. Clinical and demographic data were collected via chart review. Intra-subject lesion heterogeneity was characterized via standard deviation and histogram analyses. ANOVA, Mann-Whitney tests, and linear regressions were performed for statistical analysis. Analyses were repeated following exclusion of 14 patients who received radiotherapy prior to PET.

## RESULTS

47 patients met inclusion criteria. 32/47 (65%) were female; 13/19/9 were WHO grade 1/2/3, respectively. Mean, median, and range of intra-subject SUV and SUVR standard deviations were 9.16, 5.51, 0.40-52.87, and 7.88, 4.16, 0.37-72.43, respectively. There were no significant differences in SUV and SUVR standard deviations between sexes ( $p=0.427$ ;  $p=0.7024$ ) or WHO grades ( $p=0.5049$ ;  $p=0.3634$ ). SUV and SUVR standard deviations did not correlate with age ( $p=0.4271$ ;  $p=0.7024$ )

## CONCLUSION

A wide range of intra-subject lesion SUV and SUVR variability can be seen in our cohort. There were no differences in intra-subject lesion SUV and SUVR variability when stratified by sex or WHO grade. There was also no correlation with age.

## CLINICAL RELEVANCE/APPLICATION

We report wide intra-subject heterogeneity of lesion SUV and SUVR in patients with multiple meningiomas. Our results suggest that new lesions on DOTATATE PET/MRI in a patient should be individually based on published diagnostic thresholds; SUV range of pre-existing lesions does not determine SUV of future lesions. This work may improve clinical interpretation of DOTATATE PET/MRI in patients with meningiomas and improve clinical outcomes.

## M7- **Keynote Speaker**

SSNMMI03-

6

Nadine Mallak, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-SSNMMI03-1

### Keynote Speaker

Monday, Nov. 27 3:00PM - 4:00PM Room: S501

Delphine L. Chen, MD (*Presenter*) Grant, Telix Pharmaceuticals Limited; *Speaker*, Telix Pharmaceuticals Limited

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNMMI03-2

### Hidden Causes of False Negative Results in Neuroendocrine Tumor Localization Using <sup>68</sup>Ga-DOTATATE PET Imaging

Monday, Nov. 27 3:00PM - 4:00PM Room: S501

Arvin Haj-Mirzaian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

PET imaging using radiolabeled somatostatin analogues, including <sup>68</sup>Ga-DOTATATE has shown promising results in diagnosis of neuroendocrine tumors (NETs); however, false-negative (FN) results might occur due to a variety of factors, including tumor size, location, and histological subtypes. In this regard, identifying the hidden causes of FN results of <sup>68</sup>Ga-DOTATATE PET imaging, including genetic changes, might improve the diagnostic accuracy of this imaging method.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on 27 patients who had undergone <sup>68</sup>Ga-DOTATATE scans for suspected NET. Of these, three had negative <sup>68</sup>Ga-DOTATATE scans (11.1%) despite positive pathology reports. To investigate the genetic cause of the FN, whole exome sequencing (WES) was used to evaluate germline and somatic mutations to uncover the possible underlying mechanism of SSTR2 silencing.

#### RESULTS

We observed a significant mutation in SSTR2 in one patient of FN group. Specifically, a C-to-T substitution in the DNA sequence led to an arginine-to-cysteine substitution in the protein sequence of SSTR2. This mutation occurred in the <sup>68</sup>Ga-DOTATATE binding site pocket, which might considerably alter the binding affinity to SSTR2. In the other 26 patients, we observed a high mutation rate in MUC4, DSPP, GP1BA, IRF2BPL, OR2T35, and UBXN1 genes in both positive and negative scans. Further analysis revealed that 243 genes were significantly mutated in the FN group. Pathway analysis of these genes identified significant alterations in DNA repair pathways, such as telomer maintenance, as potential pathways that might directly affect SSTR2 expression. In terms of indirect impact, we found significant mutation in three transcription factors (TFs), including TEAD2, PER1, and HOXA1, that might be involved in regulating SSTR2 expression. Pathway analysis of the genes known to be regulated by these TFs (especially TEAD2), showed that DNA methylation, the translation process, and histone modification are the most significant complexes that probably were altered in FN group. Thus, hypo- or hyper-function of these pathways could result in SSTR2 silencing and instability.

#### CONCLUSION

The findings of this study suggest a new single nucleotide variant in SSTR2 that might cause FN in <sup>68</sup>Ga-DOTATATE PET imaging. Also, we revealed that TFs mutations might be the most prominent cause of SSTR2 downregulation in patients with negative <sup>68</sup>Ga-DOTATATE PET scans.

#### CLINICAL RELEVANCE/APPLICATION

By understanding the underlying mechanisms of SSTR2 silencing, clinicians can optimize therapy regimens based on targeting TFs to improve diagnostic accuracy for NET localization. These findings pave the way for further research and the development of targeted therapies for patients with NETs.

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## Abstract Archives of the RSNA, 2023

M7-SSNMMI03-4

### Deep-Learning Enabled Pre-Therapy 68Ga-DOTATATE PET Quantification with Clinical Biomarkers for Prediction of Neuroendocrine Tumors Outcomes

Monday, Nov. 27 3:00PM - 4:00PM Room: S501

Azadeh Akhavanallaf, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to evaluate quantitative PET metrics on baseline 68Ga-DOTATATE PET/CT combined with pretreatment clinicopathological biomarkers for prediction of treatment effect response, on progression-free survival (PFS) and overall survival (OS) in neuroendocrine tumors (NET).

#### METHODS AND MATERIALS

seventy patients with well-differentiated NET that received peptide receptor radionuclide therapy (PRRT) with Lu177-DOTATATE, planned as 4 cycles (200 mCi) IV at 8-week intervals, were included. Deep-learning-based segmentation of normal organs was used to generate organ-specific tumor volumes and total-lesion masks from 68Ga-DOTATATE PET images. The tumor metrics evaluated were quantitative lesion-based parameters (SUV<sub>mean</sub>, SUV<sub>max</sub>), and total-tumor burden metrics: Total Lesion Volume (TLV) and Total Lesion Somatostatin Expression (TL-SSE = SUV<sub>mean</sub> × TLV). In addition, the impact of clinicopathological biomarkers including tumor grade, primary tumor site, and blood biomarkers including Chromogranin A (CgA) and Alkaline Phosphatase (ALP) for prediction of PFS and OS after PRRT were evaluated. Associations between PET quantitative metrics and clinical markers with endpoints OS and PFS were assessed using univariate Kaplan-Meier (KM) analysis, while the significance of the analysis was determined using unpaired t-test statistical analysis.

#### RESULTS

At the time of analysis, the observed median rate of OS had not yet been reached. While the median rate of PFS was observed at about 27.9 months. In the subgroup analysis we found that OS was proportional to SUV<sub>mean</sub>, where SUV<sub>mean</sub> > 15.39 showed a better overall survival (p-val = 0.06). the analysis showed that OS is inversely correlated with TLV, where TLV < 136.21 cm<sup>3</sup> showed a better overall survival (p-val = 0.02). In the subgroup analysis we found that OS is significantly worse in patients with prior systemic treatment (p-val = <0.001). Of the blood biomarkers, OS was inversely proportional to both CgA and ALP, where CgA > 199.5 ng/mL (p-val = 0.02), and ALP > 99.6 U/L (p-val = 0.02) showed significantly worse OS, respectively. Also, likewise, OS analysis, the results showed that PFS is inversely correlated with TLV, where TLV > 119.02 cm<sup>3</sup> showed a strongly worse progression free survival (p-val = 0.05). Similar to OS, of the blood biomarkers, PFS was inversely proportional to both CgA and ALP, where CgA > 269 ng/mL (48%, p-val = 0.001), and ALP > 102 U/L (57%, p-val = 0.04) showed worse PFS, respectively.

#### CONCLUSION

PET-derived quantitative metrics and biomarkers (i.e. CgA and ALP) are predictive of NET outcomes for both OS and PFS.

#### CLINICAL RELEVANCE/APPLICATION

patient selection for 177Lu-PRRT

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNMMI03-5

### **Intra-Subject Heterogeneity of Lesion SUV and SUVR on [68Ga] DOTATATE PET/MRI in Patients with Multiple Meningiomas - Implications for Tumor Biology and Clinical Management**

Monday, Nov. 27 3:00PM - 4:00PM Room: S501

Se Jung Chris Chang, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Meningioma patients commonly present with multiple lesions and have high recurrence rates. Somatostatin receptor 2 (SSTR2)-targeted PET of meningiomas using [68Ga]-DOTATATE PET/MRI and PET/CT has demonstrated substantial clinical benefit. While diagnostic thresholds have been established, there is substantial heterogeneity in avidity of lesions across subjects and standardized uptake value (SUV) does not appear to correlate with WHO grade. Our purpose was to conduct the first study focusing on intra-subject heterogeneity of lesion PET SUV and SUV ratio (SUVR) in patients with multiple meningiomas.

#### **METHODS AND MATERIALS**

The study population consisted of patients with multiple meningiomas enrolled on our prospective observational study. Inclusion criteria were  $\geq 3$  lesions radiographically compatible with meningioma, at least one of which was pathology-proven. Maximum SUV and SUVR (relative to superior sagittal sinus SUV) were obtained for each lesion. Clinical and demographic data were collected via chart review. Intra-subject lesion heterogeneity was characterized via standard deviation and histogram analyses. ANOVA, Mann-Whitney tests, and linear regressions were performed for statistical analysis. Analyses were repeated following exclusion of 14 patients who received radiotherapy prior to PET.

#### **RESULTS**

47 patients met inclusion criteria. 32/47 (65%) were female; 13/19/9 were WHO grade 1/2/3, respectively. Mean, median, and range of intra-subject SUV and SUVR standard deviations were 9.16, 5.51, 0.40-52.87, and 7.88, 4.16, 0.37-72.43, respectively. There were no significant differences in SUV and SUVR standard deviations between sexes ( $p=0.427$ ;  $p=0.7024$ ) or WHO grades ( $p=0.5049$ ;  $p=0.3634$ ). SUV and SUVR standard deviations did not correlate with age ( $p=0.4271$ ;  $p=0.7024$ )

#### **CONCLUSION**

A wide range of intra-subject lesion SUV and SUVR variability can be seen in our cohort. There were no differences in intra-subject lesion SUV and SUVR variability when stratified by sex or WHO grade. There was also no correlation with age.

#### **CLINICAL RELEVANCE/APPLICATION**

We report wide intra-subject heterogeneity of lesion SUV and SUVR in patients with multiple meningiomas. Our results suggest that new lesions on DOTATATE PET/MRI in a patient should be individually based on published diagnostic thresholds; SUV range of pre-existing lesions does not determine SUV of future lesions. This work may improve clinical interpretation of DOTATATE PET/MRI in patients with meningiomas and improve clinical outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNMMI03-6

### Keynote Speaker

Monday, Nov. 27 3:00PM - 4:00PM Room: S501

Nadine Mallak, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNR05

### Neuroradiology (Brain: Pediatrics and Epilepsy/Movement Disorders)

Monday, Nov. 27 3:00PM - 4:00PM Room: S404

Dann Martin, MD, MS (*Moderator*) Nothing to Disclose  
Elizabeth K. Weidman, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **M7-SSNR05-1 Morning Glory Disc Anomaly - Expanding the MR Phenotype**

Fatemeh Dehghani Firouzabadi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The diagnosis is primarily clinical; imaging corroborates the diagnosis and reveals other associated findings referable to the optic pathway, skull base and intracranial vasculature. We sought to assess the incidence and type of associated optic nerve, chiasm, pituitary and central skull base anomalies in patients with MGDA.

#### **METHODS AND MATERIALS**

We retrospectively searched a radiology database and reviewed medical records for all patients with MGDA at a tertiary children's hospital during the last 10 years. The inclusion criteria for our study cohort were: 1) clinical and radiological diagnosis of MGDA and 2) brain and/or orbit MRI. Imaging was reviewed by two pediatric neuroradiologists.

#### **RESULTS**

Our study cohort consisted of 35 children (M: F=19:16; mean age=4 years, range=2 months-16 years). MGDA involved the right eye in 21, left eye in 11, and both eyes in 3 subjects. MR revealed the following: enlargement of the ipsilateral optic nerve in 16 (46%) patients, asymmetric optic chiasm in 21 (60%) patients with ipsilateral thickening in 19 (54%), and contralaterally small in 3 cases (8%). A persistent craniopharyngeal canal (CPC) was seen in 20 patients (46%) with opposed margins in 13, and 1-3 mm separated margins in 7 subjects. One patient had a ventral off midline cleft of the sphenoid body. Associated pituitary and infundibular anomalies included asymmetric position, angulation, and inferior displacement or a small beak of pituitary tissue projecting into the CPC. Two patients with CPCs had tubular fatty, enhancing pharyngeal lesions and 1 had a sphenoid cephalocele. Steno-occlusive vasculopathy was present in 7 patients. Two patients had ipsilateral anomalous oculomotor nerve origin with enhancement.

#### **CONCLUSION**

We have shown that thickening of the ipsilateral optic nerve and chiasm are frequently associated with MGDA and should not be misdiagnosed as optic glioma.

#### **CLINICAL RELEVANCE/APPLICATION**

MGDA is associated with well described characteristic ocular findings on MR which is primarily obtained to assess for associated vasculopathy and cephalocele. In addition, MGDA is associated with a range of pituitary fossa anomalies from overt cephalocele to persistent CPC with varying degrees of pituitary and infundibular deformity and displacement as well as hamartomatous type lesions.

#### **M7-SSNR05-3 Improved Diagnosis of Autism Spectrum Disorder Patients through Advanced Brain Connectivity Analysis Resting Functional MRI Using Large-scale Augmented Granger Causality (IsAGC)**

Axel Wismueller, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study is to develop and evaluate a novel machine learning technique that utilizes functional MRI (fMRI) to identify individuals with Autism Spectrum Disorder (ASD). The method involves using large-scale Augmented Granger

Causality (IsAGC) to analyze changes in brain connectivity between regions and detect ASD.

## **METHODS AND MATERIALS**

For this study, a subset of 59 resting-state functional MRI (rsfMRI) data sets were obtained from the publicly available Autism Brain Imaging Data Exchange II (ABIDE II) data repository. This subset represents the Longitudinal Sample from the Olin Institute of Living at Hartford Hospital. We utilized the large-scale Augmented Granger Causality (IsAGC) algorithm to calculate directed functional connectivity between brain regions, which uses dimensionality reduction for causal modeling in high-dimensional fMRI time series. We performed a 100-iteration cross-validation approach with a 90%/10% train/test ratio, and we also utilized Kendall's tau rank correlation during feature selection, followed by support vector machine classification. The diagnostic accuracy of IsAGC was evaluated by comparing it with de-confounding partial correlation and the current clinical fMRI analysis standard of cross-correlation (CC) in classifying ASD patients and normal controls. Accuracy, the area under the ROC curve (AUC), and the f1-score were reported to evaluate the performance of IsAGC quantitatively.

## **RESULTS**

As a result, the IsAGC rsfMRI analysis method was found to be the most effective in accurately classifying individuals with Autism Spectrum Disorder (ASD) from healthy subjects, outperforming both partial correlation and clinical standard CC techniques, with an accuracy/AUC/f1 score of 93%/0.90/80%. Therefore, the IsAGC rsfMRI analysis method was determined to be a favorable choice for accurate classification.

## **CONCLUSION**

In conclusion, our results suggest that the IsAGC method is a more effective tool for detecting Autism Spectrum Disorder (ASD) patients through fMRI neuroimaging than conventional CC analysis and partial correlation. We conclude that IsAGC has the capability to identify disease-related changes in brain network connectivity in ASD patients and could serve as a promising diagnostic imaging biomarker for neurologic disease.

## **CLINICAL RELEVANCE/APPLICATION**

The potential value of the IsAGC method as a diagnostic imaging biomarker for neurologic diseases has been demonstrated by its ability to accurately identify changes in fMRI connectivity that can classify patients with Autism Spectrum Disorder (ASD) and healthy controls. This suggests that IsAGC could be a useful tool for diagnosing and studying neurologic diseases.

## **M7-SSNR05-4 Brain MRI Radiomic Features at Term Equivalent Age Enhances Prediction of Neurodevelopmental Outcome in Very Low Birth Weight (VLBW) Preterm Neonates**

Daeun Choi, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate the predictability of region-based radiomics features extracted from T1-weighted, T2-weighted, and fractional anisotropy (FA) images of premature brain MRIs, regarding two different indices of neurodevelopmental outcome: Bayley mental developmental index (MDI) and psychomotor developmental index (PDI).

## **METHODS AND MATERIALS**

This single-center retrospective study included a total of 136 preterm neonates of very low birth weight (VLBW, <1500mg) who underwent brain MRI at term equivalent age and neurodevelopmental assessment at 18-24 months of corrected age. After fully automatic segmentation using the FreeSurfer software, region-based radiomics analysis was done. 14 clinical and 6420 radiomics features were explored for the association with neurodevelopmental delay classified using MDI<85 or PDI<85. Incorporating the best feature sets that were screened out, clinical and combined radiomics-clinical models were developed using logistic regression (LR), random forest (RF), extra-tree, LightGBM, and XGBoost methods. The developed models were temporally validated using another set of 33 preterm neonates. A  $p < 0.05$  was considered significant.

## **RESULTS**

The 136 preterm neonates included 64 cases (based on MDI) and 41 cases (based on PDI) of delayed development, amongst which 34 discrepancies were noted. Of the clinical variables, birth weight, treatment needed retinopathy of prematurity (ROP), within 10th percentile head circumference were significantly associated with neurodevelopmental delay regardless of reference index. Clinical, radiomics, and combined radiomics-clinical predictive models were constructed, in which combination of radiomics features enhanced the predictability of poor neurodevelopmental outcome: prediction of MDI-based poor outcome demonstrated AUCs of 0.87 vs. 0.66 (clinical-only), 0.59 (radiomics-only) and prediction of PDI-based poor outcome demonstrated AUCs of 0.92 vs. 0.89 (clinical-only), 0.76 (radiomics-only). Constructed models were temporally validated using a separate patient set.

## **CONCLUSION**

Combining term equivalent age MRI-based radiomics features with clinical variables enhanced classification performance to predict poor neurodevelopmental outcome.

## CLINICAL RELEVANCE/APPLICATION

Compared with using only clinical variables, combining region-based radiomics features extracted from term equivalent age brain MRIs enhances predictability on poor neurodevelopmental outcome of very preterm neonates. Resultant early identification of high-risk preterm infants enables timely intervention which has been known to be most effective at early postnatal 'critical' periods with brain plasticity.

### M7-SSNR05-5 **The Cortical Hypogyrfication Pattern Associated with Genes in Antipsychotic-Naive First-Episode Schizophrenia**

Xin Gao (*Presenter*) Nothing to Disclose

#### PURPOSE

Schizophrenia is thought to be a neurodevelopmental disease with high genetic heritability. Evidence from neuroimaging studies of schizophrenia has consistently shown widespread cortical local gyrification index (LGI) alterations, possibly reflecting genetic and early developmental factors. The present study aimed to examine the LGI alterations in first-episode antipsychotic-naive schizophrenia and evaluate their relationship with clinical symptoms and the expression profiles of specific risk genes.

#### METHODS AND MATERIALS

The present study enrolled 235 antipsychotic-naive first-episode schizophrenia patients and 214 healthy controls from two datasets. Cortical LGI was extracted from high-resolution T1-weighted images. Partial correlation analysis was evaluated between the LGI and the Positive and Negative Syndrome Scale (PANSS). The expression profiles of six specific gene classes and 232 schizophrenia risk genes were extracted from the Allen Human Brain Atlas (AHBA) database, which contains a standardized microarray gene profile of six healthy postmortem adult brains. Cross-sample correlation was performed between LGI alterations and gene expression. Enrichment analysis and protein-protein interaction (PPI) network analysis were used to annotate the function of associated risk genes.

#### RESULTS

Compared with healthy controls, schizophrenia patients showed lower LGI values in the medial frontal gyrus, superior temporal gyrus, anterior cingulate, and insula. The LGI in the left superior temporal gyrus was negatively associated with PANSS negative symptoms. Nonparametric correlation analysis showed that 3 of 6 gene classes and 83 of 232 risk genes correlated with the hypogyrfication pattern in schizophrenia (FDR-BH correction,  $P < 0.05$ ). PPI network analysis identified a set of hub genes. These identified risk genes were functionally enriched for the development of the central nervous system.

#### CONCLUSION

In summary, the present study provides a set of risk genes possibly associated with the hypogyrfication pattern in antipsychotic-naive first-episode schizophrenia, which could help to unveil the neurobiological underpinnings of cortical impairments in early stage schizophrenia.

## CLINICAL RELEVANCE/APPLICATION

The development-related pathophysiology of schizophrenia

### M7-SSNR05-6 **Neuroimaging Phenotype Variability and Its Correlation to Different Genetic Mutations in NF1 Pediatric Patients**

Monica Schaeubinger, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to explore potential associations among different Neurofibromatosis type 1 (NF1) mutations, brain imaging, and clinical features.

#### METHODS AND MATERIALS

We evaluated the most recent available MRIs from 2000 to 2022 prior to any brain surgery from genetically confirmed pediatric patients with NF1. Two pediatric neuroradiologists evaluated MRIs in consensus, while blinded to specific NF1 gene mutations. Brain imaging patterns were defined as typical (common/expected NF1-related findings) or outliers (unusual features or not described features in the NF1 literature). Demographic and clinical data were collected from the medical record. A geneticist and a pediatric neurologist classified genetic information by mutation type.

#### RESULTS

Of the 129 patients, 34 (26.4%) had atypical imaging particularly noted in cortical malformation including an unusual simplification of the gyri associated with T2/FLAIR hyperintensity of the cortex and subcortical white matter -- NF1 cortical dysmorphology with juxtacortical white matter changes. Genetic mutations were missense mutation (12; 9.3%), inframe deletion/insertion (3; 2.3%), truncating mutation (66; 51.2%), splicing mutation (29; 22.5%), deletions (17; 13.2%), and



others (4; 3.1%). Plexiform neurofibromas were found in 53 (41.1%), optic nerve gliomas 66 (51.2%), moyamoya 8 (6.2%), and brain malformations 6 (4.7%). Clinical characteristics included behavioral/cognitive or developmental disorders (80; 62%), ASD (16; 12.4%), ADHD (45; 34.9%), intellectual disability (9; 6.9%), and learning disorders (38; 29.3%). Notably, 11 (64.7%) patients with deletions had outlier imaging (Fisher's exact p-value for the probability of outlier imaging with deletion compared to non-deletion = 0.004). Pediatric neuroradiologists could identify mutation in most of these, while blinded, by identifying the corticosubcortical signal and morphological abnormality. Correlation with this abnormality did not hold true for other genetic mutations. Clinical genetical associations were noted as increased rates of behavioral/cognitive or developmental disorders (p-value= 0.02) in missense mutation, ASD in splicing mutation (p-value=0.02), ADHD in truncating mutation (p-value= 0.03).

### **CONCLUSION**

Our study revealed a characteristic malformative brain MRI pattern for NF1 patients with genetic deletions. Phenotype-imaging correlations in NF1 can be valuable to inform timely treatment and personalized management.

### **CLINICAL RELEVANCE/APPLICATION**

Our study highlights the importance of phenotype-imaging correlations in NF1. We found that pediatric patients with deletions have a higher likelihood of atypical brain imaging and showed a specific pattern of cortical dysplasia.

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## Abstract Archives of the RSNA, 2023

M7-SSNR05-1

### Morning Glory Disc Anomaly - Expanding the MR Phenotype

Monday, Nov. 27 3:00PM - 4:00PM Room: S404

Fatemeh Dehghani Firouzabadi (*Presenter*) Nothing to Disclose

#### PURPOSE

The diagnosis is primarily clinical; imaging corroborates the diagnosis and reveals other associated findings referable to the optic pathway, skull base and intracranial vasculature. We sought to assess the incidence and type of associated optic nerve, chiasm, pituitary and central skull base anomalies in patients with MGDA.

#### METHODS AND MATERIALS

We retrospectively searched a radiology database and reviewed medical records for all patients with MGDA at a tertiary children's hospital during the last 10 years. The inclusion criteria for our study cohort were: 1) clinical and radiological diagnosis of MGDA and 2) brain and/or orbit MRI. Imaging was reviewed by two pediatric neuroradiologists.

#### RESULTS

Our study cohort consisted of 35 children (M: F=19:16; mean age=4 years, range=2 months-16 years). MGDA involved the right eye in 21, left eye in 11, and both eyes in 3 subjects. MR revealed the following: enlargement of the ipsilateral optic nerve in 16 (46%) patients, asymmetric optic chiasm in 21 (60%) patients with ipsilateral thickening in 19 (54%), and contralaterally small in 3 cases (8%). A persistent craniopharyngeal canal (CPC) was seen in 20 patients (46%) with opposed margins in 13, and 1-3 mm separated margins in 7 subjects. One patient had a ventral off midline cleft of the sphenoid body. Associated pituitary and infundibular anomalies included asymmetric position, angulation, and inferior displacement or a small beak of pituitary tissue projecting into the CPC. Two patients with CPCs had tubular fatty, enhancing pharyngeal lesions and 1 had a sphenoid cephalocele. Steno-occlusive vasculopathy was present in 7 patients. Two patients had ipsilateral anomalous oculomotor nerve origin with enhancement.

#### CONCLUSION

We have shown that thickening of the ipsilateral optic nerve and chiasm are frequently associated with MGDA and should not be misdiagnosed as optic glioma.

#### CLINICAL RELEVANCE/APPLICATION

MGDA is associated with well described characteristic ocular findings on MR which is primarily obtained to assess for associated vasculopathy and cephalocele. In addition, MGDA is associated with a range of pituitary fossa anomalies from overt cephalocele to persistent CPC with varying degrees of pituitary and infundibular deformity and displacement as well as hamartomatous type lesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNR05-3

### Improved Diagnosis of Autism Spectrum Disorder Patients through Advanced Brain Connectivity Analysis Resting Functional MRI Using Large-scale Augmented Granger Causality (IsAGC)

Monday, Nov. 27 3:00PM - 4:00PM Room: S404

Axel Wismueller, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to develop and evaluate a novel machine learning technique that utilizes functional MRI (fMRI) to identify individuals with Autism Spectrum Disorder (ASD). The method involves using large-scale Augmented Granger Causality (IsAGC) to analyze changes in brain connectivity between regions and detect ASD.

#### METHODS AND MATERIALS

For this study, a subset of 59 resting-state functional MRI (rsfMRI) data sets were obtained from the publicly available Autism Brain Imaging Data Exchange II (ABIDE II) data repository. This subset represents the Longitudinal Sample from the Olin Institute of Living at Hartford Hospital. We utilized the large-scale Augmented Granger Causality (IsAGC) algorithm to calculate directed functional connectivity between brain regions, which uses dimensionality reduction for causal modeling in high-dimensional fMRI time series. We performed a 100-iteration cross-validation approach with a 90%/10% train/test ratio, and we also utilized Kendall's tau rank correlation during feature selection, followed by support vector machine classification. The diagnostic accuracy of IsAGC was evaluated by comparing it with de-confounding partial correlation and the current clinical fMRI analysis standard of cross-correlation (CC) in classifying ASD patients and normal controls. Accuracy, the area under the ROC curve (AUC), and the f1-score were reported to evaluate the performance of IsAGC quantitatively.

#### RESULTS

As a result, the IsAGC rsfMRI analysis method was found to be the most effective in accurately classifying individuals with Autism Spectrum Disorder (ASD) from healthy subjects, outperforming both partial correlation and clinical standard CC techniques, with an accuracy/AUC/f1 score of 93%/0.90/80%. Therefore, the IsAGC rsfMRI analysis method was determined to be a favorable choice for accurate classification.

#### CONCLUSION

In conclusion, our results suggest that the IsAGC method is a more effective tool for detecting Autism Spectrum Disorder (ASD) patients through fMRI neuroimaging than conventional CC analysis and partial correlation. We conclude that IsAGC has the capability to identify disease-related changes in brain network connectivity in ASD patients and could serve as a promising diagnostic imaging biomarker for neurologic disease.

#### CLINICAL RELEVANCE/APPLICATION

The potential value of the IsAGC method as a diagnostic imaging biomarker for neurologic diseases has been demonstrated by its ability to accurately identify changes in fMRI connectivity that can classify patients with Autism Spectrum Disorder (ASD) and healthy controls. This suggests that IsAGC could be a useful tool for diagnosing and studying neurologic diseases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNR05-4

### Brain MRI Radiomic Features at Term Equivalent Age Enhances Prediction of Neurodevelopmental Outcome in Very Low Birth Weight (VLBW) Preterm Neonates

Monday, Nov. 27 3:00PM - 4:00PM Room: S404

Daeun Choi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the predictability of region-based radiomics features extracted from T1-weighted, T2-weighted, and fractional anisotropy (FA) images of premature brain MRIs, regarding two different indices of neurodevelopmental outcome: Bayley mental developmental index (MDI) and psychomotor developmental index (PDI).

#### METHODS AND MATERIALS

This single-center retrospective study included a total of 136 preterm neonates of very low birth weight (VLBW, <1500mg) who underwent brain MRI at term equivalent age and neurodevelopmental assessment at 18-24 months of corrected age. After fully automatic segmentation using the FreeSurfer software, region-based radiomics analysis was done. 14 clinical and 6420 radiomics features were explored for the association with neurodevelopmental delay classified using MDI<85 or PDI<85. Incorporating the best feature sets that were screened out, clinical and combined radiomics-clinical models were developed using logistic regression (LR), random forest (RF), extra-tree, LightGBM, and XGBoost methods. The developed models were temporally validated using another set of 33 preterm neonates. A  $p < 0.05$  was considered significant.

#### RESULTS

The 136 preterm neonates included 64 cases (based on MDI) and 41 cases (based on PDI) of delayed development, amongst which 34 discrepancies were noted. Of the clinical variables, birth weight, treatment needed retinopathy of prematurity (ROP), within 10th percentile head circumference were significantly associated with neurodevelopmental delay regardless of reference index. Clinical, radiomics, and combined radiomics-clinical predictive models were constructed, in which combination of radiomics features enhanced the predictability of poor neurodevelopmental outcome: prediction of MDI-based poor outcome demonstrated AUCs of 0.87 vs. 0.66 (clinical-only), 0.59 (radiomics-only) and prediction of PDI-based poor outcome demonstrated AUCs of 0.92 vs. 0.89 (clinical-only), 0.76 (radiomics-only). Constructed models were temporally validated using a separate patient set.

#### CONCLUSION

Combining term equivalent age MRI-based radiomics features with clinical variables enhanced classification performance to predict poor neurodevelopmental outcome.

#### CLINICAL RELEVANCE/APPLICATION

Compared with using only clinical variables, combining region-based radiomics features extracted from term equivalent age brain MRIs enhances predictability on poor neurodevelopmental outcome of very preterm neonates. Resultant early identification of high-risk preterm infants enables timely intervention which has been known to be most effective at early postnatal 'critical' periods with brain plasticity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNR05-5

### The Cortical Hypogyrfication Pattern Associated with Genes in Antipsychotic-Naive First-Episode Schizophrenia

Monday, Nov. 27 3:00PM - 4:00PM Room: S404

Xin Gao (*Presenter*) Nothing to Disclose

#### PURPOSE

Schizophrenia is thought to be a neurodevelopmental disease with high genetic heritability. Evidence from neuroimaging studies of schizophrenia has consistently shown widespread cortical local gyrification index (LGI) alterations, possibly reflecting genetic and early developmental factors. The present study aimed to examine the LGI alterations in first-episode antipsychotic-naive schizophrenia and evaluate their relationship with clinical symptoms and the expression profiles of specific risk genes.

#### METHODS AND MATERIALS

The present study enrolled 235 antipsychotic-naive first-episode schizophrenia patients and 214 healthy controls from two datasets. Cortical LGI was extracted from high-resolution T1-weighted images. Partial correlation analysis was evaluated between the LGI and the Positive and Negative Syndrome Scale (PANSS). The expression profiles of six specific gene classes and 232 schizophrenia risk genes were extracted from the Allen Human Brain Atlas (AHBA) database, which contains a standardized microarray gene profile of six healthy postmortem adult brains. Cross-sample correlation was performed between LGI alterations and gene expression. Enrichment analysis and protein-protein interaction (PPI) network analysis were used to annotate the function of associated risk genes.

#### RESULTS

Compared with healthy controls, schizophrenia patients showed lower LGI values in the medial frontal gyrus, superior temporal gyrus, anterior cingulate, and insula. The LGI in the left superior temporal gyrus was negatively associated with PANSS negative symptoms. Nonparametric correlation analysis showed that 3 of 6 gene classes and 83 of 232 risk genes correlated with the hypogyrfication pattern in schizophrenia (FDR-BH correction,  $P < 0.05$ ). PPI network analysis identified a set of hub genes. These identified risk genes were functionally enriched for the development of the central nervous system.

#### CONCLUSION

In summary, the present study provides a set of risk genes possibly associated with the hypogyrfication pattern in antipsychotic-naive first-episode schizophrenia, which could help to unveil the neurobiological underpinnings of cortical impairments in early stage schizophrenia.

#### CLINICAL RELEVANCE/APPLICATION

The development-related pathophysiology of schizophrenia

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNR05-6

### Neuroimaging Phenotype Variability and Its Correlation to Different Genetic Mutations in NF1 Pediatric Patients

Monday, Nov. 27 3:00PM - 4:00PM Room: S404

Monica Schaeubinger, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to explore potential associations among different Neurofibromatosis type 1 (NF1) mutations, brain imaging, and clinical features.

#### METHODS AND MATERIALS

We evaluated the most recent available MRIs from 2000 to 2022 prior to any brain surgery from genetically confirmed pediatric patients with NF1. Two pediatric neuroradiologists evaluated MRIs in consensus, while blinded to specific NF1 gene mutations. Brain imaging patterns were defined as typical (common/expected NF1-related findings) or outliers (unusual features or not described features in the NF1 literature). Demographic and clinical data were collected from the medical record. A geneticist and a pediatric neurologist classified genetic information by mutation type.

#### RESULTS

Of the 129 patients, 34 (26.4%) had atypical imaging particularly noted in cortical malformation including an unusual simplification of the gyri associated with T2/FLAIR hyperintensity of the cortex and subcortical white matter -- NF1 cortical dysmorphology with juxtacortical white matter changes. Genetic mutations were missense mutation (12; 9.3%), inframe deletion/insertion (3; 2.3%), truncating mutation (66; 51.2%), splicing mutation (29; 22.5%), deletions (17; 13.2%), and others (4; 3.1%). Plexiform neurofibromas were found in 53 (41.1%), optic nerve gliomas 66 (51.2%), moyamoya 8 (6.2%), and brain malformations 6 (4.7%). Clinical characteristics included behavioral/cognitive or developmental disorders (80; 62%), ASD (16; 12.4%), ADHD (45; 34.9%), intellectual disability (9; 6.9%), and learning disorders (38; 29.3%). Notably, 11 (64.7%) patients with deletions had outlier imaging (Fisher's exact p-value for the probability of outlier imaging with deletion compared to non-deletion = 0.004). Pediatric neuroradiologists could identify mutation in most of these, while blinded, by identifying the corticosubcortical signal and morphological abnormality. Correlation with this abnormality did not hold true for other genetic mutations. Clinical genetic associations were noted as increased rates of behavioral/cognitive or developmental disorders (p-value= 0.02) in missense mutation, ASD in splicing mutation (p-value=0.02), ADHD in truncating mutation (p-value= 0.03).

#### CONCLUSION

Our study revealed a characteristic malformative brain MRI pattern for NF1 patients with genetic deletions. Phenotype-imaging correlations in NF1 can be valuable to inform timely treatment and personalized management.

#### CLINICAL RELEVANCE/APPLICATION

Our study highlights the importance of phenotype-imaging correlations in NF1. We found that pediatric patients with deletions have a higher likelihood of atypical brain imaging and showed a specific pattern of cortical dysplasia.

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## Abstract Archives of the RSNA, 2023

M7-SSNR06

### Neuroradiology (Brain: Stroke (Diagnosis and Treatment))

Monday, Nov. 27 3:00PM - 4:00PM Room: S405

Neelu Jain, MD (*Moderator*) Nothing to Disclose  
Vincent M. Timpone, MD (*Moderator*) Research Consultant, iSchemaView, Inc

#### Sub-Events

#### **M7-SSNR06-1 Prediction of Hemorrhagic Transformation after Thrombectomy using Machine Learning of Dual Energy Computed Tomography: Development and Validation Study**

Beomseok Sohn, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate a machine learning model for predicting hemorrhagic transformation after endovascular thrombectomy using dual energy computed tomography.

#### **METHODS AND MATERIALS**

This was a retrospective study from a prospective registry of acute ischemic stroke. Consecutive patients with acute ischemic stroke who underwent endovascular thrombectomy were enrolled in this registry. 3D ResNet was used to extract features from 3D volume data. A fully connected layer was added to the model's final layer for prediction of hemorrhagic transformation. Temporal validation was performed with the test set, which consisted of patients who were admitted after July 2022. The machine learning model's performance was compared with a logistic regression model developed from clinical variables.

#### **RESULTS**

Total of 202 patients were finally included, with 109 (53.9%) patients having hemorrhagic transformation. The machine learning model performed consistently well, showing an average area under the receiver operating characteristic curve of 0.867 (interquartile range, 0.827 - 0.867) upon 5-fold cross validation and area under the receiver operating characteristic curve of 0.911 (95% confidence interval, 0.774 - 1.000) with the test dataset. The logistic regression model of clinical variables showed an area under the receiver operating characteristic curve of 0.705 (95% confidence interval, 0.486 - 0.925) on the test dataset.

#### **CONCLUSION**

A machine learning model was developed and validated for prediction of hemorrhagic transformation after endovascular thrombectomy in patients with acute stroke using dual energy computed tomography.

#### **CLINICAL RELEVANCE/APPLICATION**

This study demonstrated that the use of machine learning models may serve as a supportive tool for prediction of hemorrhagic transformation after mechanical thrombectomy using dual energy computed tomography.

#### **M7-SSNR06-2 Single or Multiphase CTA for Cervical Pseudoocclusion: Does It Matter?**

Mahesh V. Jayaraman, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In patients with Emergent Large Vessel Occlusion (ELVO) who present with a tandem occlusion of both the cervical internal carotid artery (ICA) and an intracranial vessel, it is extremely helpful prior to Endovascular therapy to determine if lack of contrast in the cervical ICA is due to a primary stenotic lesion of the ICA origin, or if it is due to a more distal intracranial occlusion ("pseudo occlusion"). We aimed to determine if multiphase CTA offers an advantage over single phase CTA in detecting carotid pseudo occlusion

## **METHODS AND MATERIALS**

IRB approval was obtained to retrospectively review 59 consecutive patients with acute large vessel occlusion with cervical ICA occlusion and intracranial occlusion. Our current imaging protocol includes multiphase CTA (mCTA) on all patients. Four experienced neuroradiologists reviewed all images, initially only the single-phase images and after a month delay, the images from multiphase CTA; radiologists were blinded to the patient and clinical results. For all scans, they scored the presence or absence of contrast penetration into the proximal ICA, layering of contrast in the cervical ICA, presence of filling of distal cervical ICA (multiphase CTA only), and an overall subjective assessment of whether or not there was a pseudo-occlusion. Angiographic findings from the time of thrombectomy were used as the definitive standard for diagnosis of pseudo-occlusion. Diagnostic accuracy was examined using generalized mixed modeling.

## **RESULTS**

Overall, single phase achieved higher sensitivity than multiple phase ([95%CI] (i.e., 75%, [60.2, 85.5] vs. 53.9% [38.3, 68.9],  $p < .05$ ); no difference was observed for specificity (84.1 vs. 84.2),  $p = .99$ ). Single phase CTA's increased sensitivity is likely from contrast penetration, which had a sensitivity of 75% ([72.4, 77.4]). Single phase CTA's contrast layering and multiphase late venous filling both demonstrated low sensitivities (56% and 50%, respectively) and higher specificities (81% and 70%, respectively).

## **CONCLUSION**

Among various imaging signs, the presence of a contrast layer in the proximal cervical ICA was the most specific, while contrast penetration into the cervical ICA was the most sensitive. Single phase CTA has high sensitivity and specificity for detection of cervical carotid pseudoocclusion. The addition of multiphase CTA did not significantly improve sensitivity or specificity.

## **CLINICAL RELEVANCE/APPLICATION**

For experienced radiologists, multiphase CTA did not result in improved sensitivity or specificity for detection of cervical carotid pseudoocclusion over single phase CTA.

## **M7- SSNR06-3 Posterior Circulation Stroke: Prognostic Value and Predictive Power of Two Evaluation Systems on CT Angiography: BATMAN Score and PC-CS**

Marco De Iuliis, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Posterior circulation strokes are severe clinical events characterized by high rate of morbidity and mortality. The aim of our study is to compare two Computed Tomography Angiography (CTA) systematic scoring systems for intracranial vessels evaluation in posterior ischaemic stroke: the Basilar Artery on Computed Tomography Angiography (BATMAN) score and the Posterior Circulation Collateral Score (PC-CS).

## **METHODS AND MATERIALS**

We performed a bicentric retrospective analysis of 60 patients diagnosed with posterior circulation stroke: 33 patients were from the Center Hospitalier Grenoble Alpes - CHUGA, while 27 from the A.O.U. City of Health and Science, Molinette, Turin. The feasibility of the scoring systems and interobserver agreement were investigated, and the correlation between these scores and prognosis was evaluated.

## **RESULTS**

The time required to apply the score is quite similar between an experienced and a resident reader (90-100s). We found good agreement among observers. These scoring systems correlated well with prognosis at discharge ( $p$ -value: 0.034 for both scores) and prognosis 3 months after discharge (BATMAN score  $p$ -value: 0.0012; PC-CS  $p$ -value: 0.0035). We found no correlation with other scoring systems, such as Thrombolysis In Cerebral Infarction (TICI) score, National Institutes of Health Stroke Scale (NIHSS) classification, and TOAST (Trial of Org 10172 in Acute Stroke Treatment) etiological classification.

## **CONCLUSION**

BATMAN score and PC-CS are feasible and easy to apply, even in the acute setting. These scoring systems express a strong correlation with prognosis, which is meant as MRS at discharge and after 3 months, but the BATMAN correlation rate proved to be higher especially at diagnosis.

## **CLINICAL RELEVANCE/APPLICATION**



Posterior circulation stroke is one of the neurological emergencies still burdened today with a very poor prognosis. Despite recent advances in the treatment of ischemic stroke, there is no consensus supported by clinical trials for the treatment of posterior circulation strokes. In this context, also due to the absence of prognostic scores, the therapeutic decision too often depends only on the experience of the clinicians. Consequently, we decided to analyze two important radiological scores for posterior circulation, the BATMAN and PC-CS scores, in order to determine their predictive power and prognostic value in the emergency setting. Finally, we tested its feasibility and speed of application in experienced and resident readers.

#### **M7-SSNR06-4 Can Radiomics Predict the Stroke Etiology? A Retrospective Study**

Jacobo Porto Alvarez, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the performance of a machine learning model based on radiomics features obtained from non-contrast enhancement CT (NCE-CT), for predicting the TOAST classification of patients with acute ischemic stroke (AIS).

##### **METHODS AND MATERIALS**

This retrospective study includes AIS patients with thrombectomy performed in 2021. The inclusion criteria were: AIS caused by anterior large vessel occlusion, hyperdense clot on NCE-CT, NCE-CT with slices <1 mm, and at least one thrombectomy attempt. The exclusion criteria were: Patients with the NCE-CT and Angio CT performed in another hospital and patients with AIS secondary to other procedures. Finally, 55 patients were selected (29 cardioembolic, 12 atherothrombotic, and 14 indeterminate etiology). Three prediction models were developed: First, the radiomics model with the most significant radiomic features (RF). Second, the clinical model with only clinical data (cardiovascular risk factors and atrial fibrillation). And finally, the combined model with RF and clinical data. The semi-automatic segmentation was performed by a trainee radiologist, under the supervision of interventionalist neuroradiologists, using 3D-Slicer version 5.2.2. The region of interest was the hyperdense clot in NCE-CT. The RF were obtained with 3D-Slicer. The prediction model was performed by using Orange: Data Mining Toolbox in Python, version 3.33.0. The classification models used were Support Vector Machine (SVM), Logistic Regression, Random Forest, Naive Bayes, Neural Network and Gradient Boosting. The evaluation of the three different models was performed with leave-one-out cross-validation. The patients were classified into cardioembolic, atherothrombotic, and undetermined etiology.

##### **RESULTS**

The best results for the combined model was with the Naive Bayes classifier: AUC of 0.935; accuracy of 0.782 and F1 of 0.784. With the radiomics model, the results were: AUC of 0.860; accuracy of 0.709 and F1 of 0.717. In the clinical model, with the same classifier, the results were: AUC of 0.765; accuracy of 0.612, and F1 of 0.624.

##### **CONCLUSION**

The combined model obtained the best results (AUC of 0,935). The radiomics model obtained better results than the clinical model with the same classifier (AUC of 0.860 and 0.765 respectively). NCE-CT-based radiomics could help in the adequate etiology classification of AIS, optimizing secondary prevention treatments.

##### **CLINICAL RELEVANCE/APPLICATION**

The actual way of diagnosis is based on clinical features, radiological images, cardiac images and laboratory data. Radiomics could be an easy tool for helping in the etiology determination of AIS, which plays a crucial role in the therapeutic management of these patients.

#### **M7-SSNR06-6 Fully Automated Detection of Large Vessel Occlusion on Computed Tomography Angiography using Deep Learning**

Chi Kyung Kim (*Presenter*) Nothing to Disclose

##### **PURPOSE**

A few of automated large vessel occlusion (LVO) detecting software has been utilized in clinical settings. However, external evaluations of the software revealed only moderate sensitivity, limiting their applicability. Herein, a fully automated deep learning algorithm for detecting LVO in CT angiography (CTA) was devised and validated.

##### **METHODS AND MATERIALS**

We used 2,051 CTA images of ischemic stroke patients from three Korean university hospitals to train (n = 1,442; 24.6% had LVO) and validate (n = 629; 19.4% had LVO) two deep learning algorithms: 1) vessel segmentation on maximal intensity projection images, and 2) LVO detection using merged vessel segmentation mask. LVO included intracranial internal carotid artery (ICA), M1-middle cerebral artery (MCA), or proximal M2-MCA occlusion. We externally validated the algorithm in 388 ischemic stroke patients (14.4% had LVO) from a multicenter cohort. Using 2,000 stratified bootstrap samples, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) and their 95% confidence intervals were calculated.

## RESULTS

For 1,422 training cases, mean age was  $71.4 \pm 12.3$  and 57% were men. With respect to vessel segmentation performance, dice similarity coefficient between manually segmented and deep learning segmented vessels was  $0.86 \pm 0.45$ . In the internal validation at the threshold of 0.50, area under curve (AUC), sensitivity, specificity, NPV, and PPV was 0.96 (0.93-0.98), 0.80 (0.73-0.88), 0.97 (0.96-0.99), 0.95 (0.94-0.97), and 0.87 (0.82-0.93), respectively; when M2-MCA occlusion was excluded the sensitivity was 0.93 (0.87 - 0.98). In the external validation, corresponding estimates were 0.97 (0.94-0.998), 0.81 (0.70-0.91), 0.99 (0.98-1.00), 0.98 (0.96-0.99), and 0.93 (0.84-1.00), respectively; when M2-MCA occlusion was excluded the sensitivity was 0.95 (0.87 - 1.00). When applied our algorithm in LVO patients with a history of coil embolization (n = 14) and moyamoya disease (n = 7), the algorithm detected LVO in 13 (92.9%) and 6 (85.7%).

## CONCLUSION

We developed fully deep learning-based LVO detection algorithms on CTA. External validation demonstrated robust performance of the algorithm. In addition, the algorithm has the potential to detect LVO in patients with a history of coil embolization and moyamoya disease, for whom previous software was inapplicable.

## CLINICAL RELEVANCE/APPLICATION

A fully deep learning algorithm detecting LVO in CTA can aid less experienced physician. In turn, the algorithm may facilitate early transfer to endovascular treatment capable stroke centers, thereby improving stroke outcomes.

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## Abstract Archives of the RSNA, 2023

M7-SSNR06-1

### **Prediction of Hemorrhagic Transformation after Thrombectomy using Machine Learning of Dual Energy Computed Tomography: Development and Validation Study**

Monday, Nov. 27 3:00PM - 4:00PM Room: S405

Beomseok Sohn, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate a machine learning model for predicting hemorrhagic transformation after endovascular thrombectomy using dual energy computed tomography.

#### **METHODS AND MATERIALS**

This was a retrospective study from a prospective registry of acute ischemic stroke. Consecutive patients with acute ischemic stroke who underwent endovascular thrombectomy were enrolled in this registry. 3D ResNet was used to extract features from 3D volume data. A fully connected layer was added to the model's final layer for prediction of hemorrhagic transformation. Temporal validation was performed with the test set, which consisted of patients who were admitted after July 2022. The machine learning model's performance was compared with a logistic regression model developed from clinical variables.

#### **RESULTS**

Total of 202 patients were finally included, with 109 (53.9%) patients having hemorrhagic transformation. The machine learning model performed consistently well, showing an average area under the receiver operating characteristic curve of 0.867 (interquartile range, 0.827 - 0.867) upon 5-fold cross validation and area under the receiver operating characteristic curve of 0.911 (95% confidence interval, 0.774 - 1.000) with the test dataset. The logistic regression model of clinical variables showed an area under the receiver operating characteristic curve of 0.705 (95% confidence interval, 0.486 - 0.925) on the test dataset.

#### **CONCLUSION**

A machine learning model was developed and validated for prediction of hemorrhagic transformation after endovascular thrombectomy in patients with acute stroke using dual energy computed tomography.

#### **CLINICAL RELEVANCE/APPLICATION**

This study demonstrated that the use of machine learning models may serve as a supportive tool for prediction of hemorrhagic transformation after mechanical thrombectomy using dual energy computed tomography.

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## Abstract Archives of the RSNA, 2023

M7-SSNR06-2

### Single or Multiphase CTA for Cervical Pseudoocclusion: Does It Matter?

Monday, Nov. 27 3:00PM - 4:00PM Room: S405

Mahesh V. Jayaraman, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In patients with Emergent Large Vessel Occlusion (ELVO) who present with a tandem occlusion of both the cervical internal carotid artery (ICA) and an intracranial vessel, it is extremely helpful prior to Endovascular therapy to determine if lack of contrast in the cervical ICA is due to a primary stenotic lesion of the ICA origin, or if it is due to a more distal intracranial occlusion ("pseudo occlusion"). We aimed to determine if multiphase CTA offers an advantage over single phase CTA in detecting carotid pseudo occlusion

#### METHODS AND MATERIALS

IRB approval was obtained to retrospectively review 59 consecutive patients with acute large vessel occlusion with cervical ICA occlusion and intracranial occlusion. Our current imaging protocol includes multiphase CTA (mCTA) on all patients. Four experienced neuroradiologists reviewed all images, initially only the single-phase images and after a month delay, the images from multiphase CTA; radiologists were blinded to the patient and clinical results. For all scans, they scored the presence or absence of contrast penetration into the proximal ICA, layering of contrast in the cervical ICA, presence of filling of distal cervical ICA (multiphase CTA only), and an overall subjective assessment of whether or not there was a pseudo-occlusion. Angiographic findings from the time of thrombectomy were used as the definitive standard for diagnosis of pseudo-occlusion. Diagnostic accuracy was examined using generalized mixed modeling.

#### RESULTS

Overall, single phase achieved higher sensitivity than multiple phase ([95%CI] (i.e., 75%, [60.2, 85.5] vs. 53.9% [38.3, 68.9],  $p < .05$ ); no difference was observed for specificity (84.1 vs. 84.2),  $p = .99$ ). Single phase CTA's increased sensitivity is likely from contrast penetration, which had a sensitivity of 75% ([72.4, 77.4]). Single phase CTA's contrast layering and multiphase late venous filling both demonstrated low sensitivities (56% and 50%, respectively) and higher specificities (81% and 70%, respectively).

#### CONCLUSION

Among various imaging signs, the presence of a contrast layer in the proximal cervical ICA was the most specific, while contrast penetration into the cervical ICA was the most sensitive. Single phase CTA has high sensitivity and specificity for detection of cervical carotid pseudoocclusion. The addition of multiphase CTA did not significantly improve sensitivity or specificity.

#### CLINICAL RELEVANCE/APPLICATION

For experienced radiologists, multiphase CTA did not result in improved sensitivity or specificity for detection of cervical carotid pseudoocclusion over single phase CTA.

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## Abstract Archives of the RSNA, 2023

M7-SSNR06-3

### Posterior Circulation Stroke: Prognostic Value and Predictive Power of Two Evaluation Systems on CT Angiography: BATMAN Score and PC-CS

Monday, Nov. 27 3:00PM - 4:00PM Room: S405

Marco De Iuliis, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Posterior circulation strokes are severe clinical events characterized by high rate of morbidity and mortality. The aim of our study is to compare two Computed Tomography Angiography (CTA) systematic scoring systems for intracranial vessels evaluation in posterior ischaemic stroke: the Basilar Artery on Computed Tomography Angiography (BATMAN) score and the Posterior Circulation Collateral Score (PC-CS).

#### METHODS AND MATERIALS

We performed a bicentric retrospective analysis of 60 patients diagnosed with posterior circulation stroke: 33 patients were from the Center Hospitalier Grenoble Alpes - CHUGA, while 27 from the A.O.U. City of Health and Science, Molinette, Turin. The feasibility of the scoring systems and interobserver agreement were investigated, and the correlation between these scores and prognosis was evaluated.

#### RESULTS

The time required to apply the score is quite similar between an experienced and a resident reader (90-100s). We found good agreement among observers. These scoring systems correlated well with prognosis at discharge (p-value: 0.034 for both scores) and prognosis 3 months after discharge (BATMAN score p-value: 0.0012; PC-CS p-value: 0.0035). We found no correlation with other scoring systems, such as Thrombolysis In Cerebral Infarction (TICI) score, National Institutes of Health Stroke Scale (NIHSS) classification, and TOAST (Trial of Org 10172 in Acute Stroke Treatment) etiological classification.

#### CONCLUSION

BATMAN score and PC-CS are feasible and easy to apply, even in the acute setting. These scoring systems express a strong correlation with prognosis, which is meant as MRS at discharge and after 3 months, but the BATMAN correlation rate proved to be higher especially at diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

Posterior circulation stroke is one of the neurological emergencies still burdened today with a very poor prognosis. Despite recent advances in the treatment of ischemic stroke, there is no consensus supported by clinical trials for the treatment of posterior circulation strokes. In this context, also due to the absence of prognostic scores, the therapeutic decision too often depends only on the experience of the clinicians. Consequently, we decided to analyze two important radiological scores for posterior circulation, the BATMAN and PC-CS scores, in order to determine their predictive power and prognostic value in the emergency setting. Finally, we tested its feasibility and speed of application in experienced and resident readers.

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## Abstract Archives of the RSNA, 2023

M7-SSNR06-4

### Can Radiomics Predict the Stroke Etiology? A Retrospective Study

Monday, Nov. 27 3:00PM - 4:00PM Room: S405

Jacobo Porto Alvarez, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the performance of a machine learning model based on radiomics features obtained from non-contrast enhancement CT (NCE-CT), for predicting the TOAST classification of patients with acute ischemic stroke (AIS).

#### METHODS AND MATERIALS

This retrospective study includes AIS patients with thrombectomy performed in 2021. The inclusion criteria were: AIS caused by anterior large vessel occlusion, hyperdense clot on NCE-CT, NCE-CT with slices <1 mm, and at least one thrombectomy attempt. The exclusion criteria were: Patients with the NCE-CT and Angio CT performed in another hospital and patients with AIS secondary to other procedures. Finally, 55 patients were selected (29 cardioembolic, 12 atherothrombotic, and 14 indeterminate etiology). Three prediction models were developed: First, the radiomics model with the most significant radiomic features (RF). Second, the clinical model with only clinical data (cardiovascular risk factors and atrial fibrillation). And finally, the combined model with RF and clinical data. The semi-automatic segmentation was performed by a trainee radiologist, under the supervision of interventionalist neuroradiologists, using 3D-Slicer version 5.2.2. The region of interest was the hyperdense clot in NCE-CT. The RF were obtained with 3D-Slicer. The prediction model was performed by using Orange: Data Mining Toolbox in Python, version 3.33.0. The classification models used were Support Vector Machine (SVM), Logistic Regression, Random Forest, Naive Bayes, Neural Network and Gradient Boosting. The evaluation of the three different models was performed with leave-one-out cross-validation. The patients were classified into cardioembolic, atherothrombotic, and undetermined etiology.

#### RESULTS

The best results for the combined model was with the Naive Bayes classifier: AUC of 0.935; accuracy of 0.782 and F1 of 0.784. With the radiomics model, the results were: AUC of 0.860; accuracy of 0.709 and F1 of 0.717. In the clinical model, with the same classifier, the results were: AUC of 0.765; accuracy of 0.612, and F1 of 0.624.

#### CONCLUSION

The combined model obtained the best results (AUC of 0,935). The radiomics model obtained better results than the clinical model with the same classifier (AUC of 0.860 and 0.765 respectively). NCE-CT-based radiomics could help in the adequate etiology classification of AIS, optimizing secondary prevention treatments.

#### CLINICAL RELEVANCE/APPLICATION

The actual way of diagnosis is based on clinical features, radiological images, cardiac images and laboratory data. Radiomics could be an easy tool for helping in the etiology determination of AIS, which plays a crucial role in the therapeutic management of these patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSNR06-6

### Fully Automated Detection of Large Vessel Occlusion on Computed Tomography Angiography using Deep Learning

Monday, Nov. 27 3:00PM - 4:00PM Room: S405

Chi Kyung Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

A few of automated large vessel occlusion (LVO) detecting software has been utilized in clinical settings. However, external evaluations of the software revealed only moderate sensitivity, limiting their applicability. Herein, a fully automated deep learning algorithm for detecting LVO in CT angiography (CTA) was devised and validated.

#### METHODS AND MATERIALS

We used 2,051 CTA images of ischemic stroke patients from three Korean university hospitals to train ( $n = 1,442$ ; 24.6% had LVO) and validate ( $n = 629$ ; 19.4% had LVO) two deep learning algorithms: 1) vessel segmentation on maximal intensity projection images, and 2) LVO detection using merged vessel segmentation mask. LVO included intracranial internal carotid artery (ICA), M1-middle cerebral artery (MCA), or proximal M2-MCA occlusion. We externally validated the algorithm in 388 ischemic stroke patients (14.4% had LVO) from a multicenter cohort. Using 2,000 stratified bootstrap samples, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) and their 95% confidence intervals were calculated.

#### RESULTS

For 1,422 training cases, mean age was  $71.4 \pm 12.3$  and 57% were men. With respect to vessel segmentation performance, dice similarity coefficient between manually segmented and deep learning segmented vessels was  $0.86 \pm 0.45$ . In the internal validation at the threshold of 0.50, area under curve (AUC), sensitivity, specificity, NPV, and PPV was 0.96 (0.93-0.98), 0.80 (0.73-0.88), 0.97 (0.96-0.99), 0.95 (0.94-0.97), and 0.87 (0.82-0.93), respectively; when M2-MCA occlusion was excluded the sensitivity was 0.93 (0.87 - 0.98). In the external validation, corresponding estimates were 0.97 (0.94-0.998), 0.81 (0.70-0.91), 0.99 (0.98-1.00), 0.98 (0.96-0.99), and 0.93 (0.84-1.00), respectively; when M2-MCA occlusion was excluded the sensitivity was 0.95 (0.87 - 1.00). When applied our algorithm in LVO patients with a history of coil embolization ( $n = 14$ ) and moyamoya disease ( $n = 7$ ), the algorithm detected LVO in 13 (92.9%) and 6 (85.7%).

#### CONCLUSION

We developed fully deep learning-based LVO detection algorithms on CTA. External validation demonstrated robust performance of the algorithm. In addition, the algorithm has the potential to detect LVO in patients with a history of coil embolization and moyamoya disease, for whom previous software was inapplicable.

#### CLINICAL RELEVANCE/APPLICATION

A fully deep learning algorithm detecting LVO in CTA can aid less experienced physician. In turn, the algorithm may facilitate early transfer to endovascular treatment capable stroke centers, thereby improving stroke outcomes.

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## Abstract Archives of the RSNA, 2023

M7-SSPH05

### Physics (Radiation Dose)

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

Guang-Hong Chen, PhD (*Moderator*) Nothing to Disclose  
Meghan C. Jacobsen, PhD (*Moderator*) Honorarium and Travel, Kyoto Kagaku

#### Sub-Events

### **M7-SSPH05-1 Organ-Aware, Scout-Based Approach for Scout Segmentation and Prospective, Personalized Organ CT Dose Estimation**

Maria Jose Medrano Matamoros, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a multi-task network that simultaneously generates scout-based organ segmentations and anatomically informed predictions of CT radiation dose to organs.

#### METHODS AND MATERIALS

In this IRB-approved, HIPAA compliant, retrospective, single-center study, we propose Organ-Aware Scout-Dose (OA Scout-Dose), a multi-task implementation of the Scout-Net model in which an auxiliary task (scout-based organ segmentation) is used to further optimize the features learned by the primary task (organ-level CT dose estimation). To test feasibility, we assessed the performance of our model in estimating mean doses and segmentation for full body and two organs (lung and liver). Our OA Scout-Dose model followed a U-Net architecture with previously proposed Scout-Net as a backbone to encode the latent features followed by a decoder to generate organ segmentations for lateral and frontal scouts. The reference organ CT doses and segmentations corresponding to adult patients undergoing outpatient contrast-enhanced chest-abdomen-pelvis CT examinations acquired from GE Revolution in single-energy mode were generated by using the publicly available tools MC-GPU (V1.3) and TotalSegmentator. The relative difference between the mean organ doses predicted by Scout-Net and OA Scout-Dose from lateral and frontal scouts and their corresponding ground truths were calculated. Dice scores were also calculated to evaluate the segmentations generated by the auxiliary task.

#### RESULTS

160 CT examinations from 160 adult patients were included for analysis. Their corresponding estimated segmentations and doses were split into training (112) and test (48) sets. The best model was saved on a validation set of 10% from the training set. OA Scout-Dose and Scout-Net models were trained for 200 epochs. L1 and Dice score losses were minimized for primary and auxiliary task. The relative dose differences for lung, liver, and body across the test set decreased from 14.4%, 10.5%, and 5.7% with Scout-Net to 13.4%, 8.9%, and 4.7% with OA Scout-Dose, respectively. Average lung, liver, and body Dice scores were 0.82/0.83, 0.79/0.77, and 0.98/0.99 respectively for lateral/frontal organ segmentations.

#### CONCLUSION

Multi-task implementation of Scout-Net was proposed. Preliminary results demonstrate that OA Scout-Dose has the potential to generate accurate scout-based organ segmentations that allow more anatomically informed organ CT dose prediction from scout images than previously proposed single-task based methods.

#### CLINICAL RELEVANCE/APPLICATION

The proposed method can create personalized organ scout segmentations and prospective CT dose predictions that may be used to optimize radiation dose and image quality.

### **M7-SSPH05-2 Estimation of Organ Doses for Cardiac Catheterizations and Diagnostic Fluoroscopic Procedures Performed in Infants with Congenital Heart Disease**

Jeannette R. Wong-Siegel, MD, MPH (*Presenter*) Nothing to Disclose



## PURPOSE

Children with congenital heart disease (CHD) undergo multiple procedures requiring ionizing radiation (IR) including diagnostic and interventional cardiac catheterizations and other diagnostic fluoroscopic procedures. IR exposure in early childhood may be associated with an increased risk of malignancy with neonates at especially higher risk due to their higher radiosensitivity and longer life expectancy than adults. The magnitude of this exposure and organ-specific risk remains unknown. Here, we describe the organ dose reconstruction and application of these parameters to a sample of procedures obtained in a cohort of neonates with cyanotic CHD requiring early intervention.

## METHODS AND MATERIALS

The National Cancer Institute dosimetry system for radiography and fluoroscopy (NCIRF) was utilized to estimate absolute organ-specific radiation doses (mGy) and total effective dose (mSv). Beam spectra, exposure field configuration, distance from and direction of the X-ray beam, isocenter location, and dose-area-product (DAP, Gy-cm<sup>2</sup>) for each patient were used as input parameters for organ dose calculations collected from a multi-center clinical research collaborative.

## RESULTS

Median frontal and lateral DAP from a sample of ten cardiac catheterizations was 1.57 and 1.19 Gy-cm<sup>2</sup>, respectively. Organ-specific radiation doses were highest for lung from frontal view (8.1 mGy) and breast from lateral view (8.7 mGy) (See Figure). DAP from a sample of 20 diagnostic fluoroscopic procedures was substantially lower, with a median DAP 0.265 Gy-cm<sup>2</sup> for upper gastrointestinal (GI), 0.161 Gy-cm<sup>2</sup> for lower GI, 0.065 Gy-cm<sup>2</sup> for genitourinary (GU), and 0.045 Gy-cm<sup>2</sup> for upper extremity procedures. Organ-specific doses varied by exposure field and were significantly lower (e.g. lung from upper GI (1.09 mGy), lower GI (0.02 mGy), GU (0.004 mGy), and extremity (0.12 mGy)) compared to cardiac catheterizations.

## CONCLUSION

This study is the first to describe organ-specific radiation dose from cardiac catheterizations and diagnostic fluoroscopic studies in a neonatal CHD population, and may help in our understanding of the potential contribution of early childhood IR exposure to future risk of malignancy. In addition, these estimations may also identify specific CHD populations at risk for higher IR exposure secondary to medical management, assist in the development of quality improvement measures to reduce IR exposure, and influence clinical pathway decision-making in this vulnerable and young population.

## CLINICAL RELEVANCE/APPLICATION

NCIRF can estimate patient-specific organ dose from cardiac catheterizations and diagnostic fluoroscopic procedures, which will be critical in the evaluation for risk of future adverse outcomes, such as malignancy.

## M7-SSPH05-3 Multicentric Characterization of Organ-based Tube Current Modulation in Head Computed Tomography: A Dosimetric and Image Quality Study using a Scintillating Fiber Optic Detector

Corentin Desport (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study was to evaluate the efficiency of organ-based tube current modulation (OBTCM) in head CT for different radiology services and manufacturers using a scintillating fiber optic detector.

## METHODS AND MATERIALS

Five CT scanners from four radiology services were evaluated in this study: Siemens Somatom Go Top, GE Revolution CT, GE Revolution Maxima, Canon Aquilion Genesis, and Canon Aquilion Prime. Two head protocols were implemented: a standard and a routine protocol. A scintillating fiber optic detector was placed directly on the gantry to measure the dose reduction rate at 16 angles. Image quality was quantified on a 16-cm CT dose index (CTDI) phantom by measuring the signal-to-noise ratio (SNR) and the standard deviation of the Hounsfield units (HU) of circular regions of interest placed in peripheral regions of the phantom. The NPS (Noise Power Spectrum) was also measured. Values measured were compared on images with and without OBTCM.

## RESULTS

Using the standard protocol, the dose on the anterior part of the patient was reduced by 73.7%, 26.4%, 30.8%, 40.0%, and 10.9% respectively for Siemens Somatom Go Top, GE Revolution CT, GE Revolution Maxima, Canon Aquilion Genesis, and Canon Aquilion Prime using OBTCM. Using the routine protocol, the dose reduction rates measured with OBTCM on the anterior part were up to 73.8%, 31.8%, 21.0%, 58.0%, and 37.2% respectively in Siemens Somatom Go Top, GE Revolution CT, GE Revolution Maxima, Canon Aquilion Genesis, and Canon Aquilion Prime. The dose on the posterior part was unchanged in GE Healthcare and Canon Medical System CT scanners. On the contrary, the dose to the posterior part was increased up to 38.9% and 39.1% in Siemens Somatom Go Top respectively using the standard protocol and the routine protocol. Image noise increased between 2.4 and 10.4% depending on the CT scanner and the ROIs studied. This corresponds to a maximum increase of 0.5 HU. In the same way, the SNR decreased between 2.6 and 9.6% which represents a maximum increase of 2.5

HU. These differences are statistically significant ( $p$ -value  $< 0.05$ ). The study of the NPS shown that the noise texture is unaltered.

## CONCLUSION

OBTCM reduces the dose to the anterior part of patients. In this way, OBTCM reduces the dose to the radiosensitive anterior organs such as the eye lens, thyroid, and breast without reducing substantially image quality.

## CLINICAL RELEVANCE/APPLICATION

Multislice CT is responsible of the main part of the effective collective dose. In this way, manufacturers implemented tools to reduce patient exposure and particularly to reduce the radiosensitive organ exposition. However, these tools can not be evaluated accurately using the dosimetric indicators displayed at the end of each examination serie (CTDI, DLP).

## M7-SSPH05-4 Comparison of Image Quality and Radiation Exposure between Conventional Dose-driven Exposure Control with Contrast-to-noise-ratio-driven Exposure Control as a Function of Source-to-image Distances and Collimations in Abdominal Angiography

Thomas Werncke, MD,DIPLPHYS (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this phantom and animal study was to compare image quality and radiation exposure between detector-dose driven exposure control (DEC) and contrast-to-noise ratio (CNR) driven exposure control (CEC) as a function of source-to-image distance (SID) and collimation.

## METHODS AND MATERIALS

In the phantom study, an iron foil was placed in the isocentre of a stack of polymethylmetacrylate and Al plates simulating a patient-equivalent thickness of 15, 25 and 35cm. Fluoroscopic images were acquired for the DEC with constant detector-dose and CEC with constant CNR using five SIDs between 100 and 130 cm and two collimations (full and collimated field of view 6x6cm). The CNR and radiation exposure were determined and compared. In the animal study, five angiographic scenarios with typical angiographic materials were created in two anaesthetised pigs (AZ 18/2809). Fluoroscopic images were acquired with two SIDs (110, 130cm) and both collimations using the acquisition protocols used in the phantom study. Image quality (IQ) of the images were compared relative to the reference image acquired at SID of 110cm and FFOV by two blinded readers. IQ and radiation dose in terms of air kerma rate were compared using paired t-tests.

## RESULTS

Using DEC, CNR and AKR increased with increasing SID, collimation and patient equivalent thickness. When CEC was used, CNR, showed minor variations with increasing SID, collimation and patient thickness, below physical or regulatory limits. AKR decreased with increasing SID and collimation. Above the limits, CEC showed similar results as compared to those of DEC. In the animal study, IQ ( $p < 0.005$  and AKR  $p = 0.004$ ) increased with higher SID and collimation using DEC. Using CEC, IQ was not significantly different using higher SIDs or collimation while AKR was not significantly different at higher SID but lower using collimation ( $p = 0.012$ ).

## CONCLUSION

Contrary to DEC, CEC allows to maintain the image quality regardless the SID or collimation while the radiation dose to the patient is minimized. Furthermore, CEC could help to achieve the ALARA principle with less interaction of the interventionalist with the angiographic system as compared with DEC.

## CLINICAL RELEVANCE/APPLICATION

A contrast-to-noise ratio driven exposure control optimizes the trade-off between image quality and radiation dose according to the ALARA principle more strictly as the conventional detector-dose driven exposure control, and could lead to a paradigm shift in angiographic imaging geometry.

## M7-SSPH05-5 ChatGPT: What is my Radiation Dose

Jaydev K. Dave, PhD (*Presenter*) Research Grant, Koninklijke Philips NV; Equipment support, Lantheus Medical Imaging; Equipment support, General Electric Company; Research Consultant, Curvebeam LLC; Consultant, Rayscan, Inc.

## PURPOSE

To evaluate responses from ChatGPT (OpenAI, San Francisco, CA) regarding radiation dose questions for common imaging examinations.

## METHODS AND MATERIALS

26 common imaging examinations in the Dose Reference Card published by the American College of Radiology were used in this study and the corresponding radiation dose values were used as reference values. An open-ended prompt was used as an input in ChatGPT asking for radiation dose associated with each of the 26 imaging examinations. Each prompt was entered as

a new session to test the model output independently. Two versions of ChatGPT (February 13, 2023 and March 23, 2023) were used to assess reproducibility. The radiation dose values in the responses were compared with reference values. Other qualitative information in the responses was summarized.

## RESULTS

For the February and March versions, the radiation dose values/ranges provided by ChatGPT agreed with the published reference values in 69% and 65% responses, respectively. The values were under- and over-estimated for 8-12% and 19-23% of the questions. 23-35% of the responses included references to societies/organizations for quoting radiation dose values; however only once was the same reference quoted by the different versions for the same question. Between the 2 versions, identical radiation dose values/ranges were obtained in only 23% of the responses. All responses included factors affecting the radiation dose values. Evaluating qualitative information in the responses revealed that 19% of the combined responses included brief description of the imaging examinations, and 10% of the responses included a note about relatively lower doses due to technological advancements. 48% of the responses stated that benefits outweigh the risk, while 54% of the responses also recommended a benefit/risk consultation with a physician. The radiation dose values were compared to equivalent background radiation in 56% of the responses and to other modalities in 27% of the responses. Strikingly, 33% of the responses included information about cumulative radiation dose due to repeated scans and the risk of developing cancer. Also, while one response for an upper GI study with barium understated the radiation dose value, the other response included misleading information that this study "does not typically involve the use of ionizing radiation".

## CONCLUSION

Review of radiation dose data for common imaging examinations included in ChatGPT responses revealed moderate accuracy (65-69%) and low reproducibility (23%) with both, helpful and misleading information.

## CLINICAL RELEVANCE/APPLICATION

Quantitative and qualitative evaluation of responses pertaining to radiation dose values from ChatGPT highlights gaps in information accessible from a chatbot.

## M7-SSPH05-6 Indication-based Diagnostic Reference Levels for the Most Common CT Indications in Children: Data of an International Registry

Denise Bos, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Computed tomography (CT) is important for diagnostic imaging in pediatric patients, particularly in emergency, but radiation exposure is a concern due to its carcinogenic risk. Radiation doses in CT varies across indications and protocols. Thus, we aim to establish indication-based diagnostic reference levels (DRLs) and achievable doses (ADs) for the most common CT indications in pediatric patients.

## METHODS AND MATERIALS

A comprehensive analysis was performed using CT data from a large international dose registry that included more than 150 facilities from January 1, 2016 to January 1, 2021. ADs and DRLs for the volume-weighted CT-dose index (CTDIvol) and the dose-length product (DLP) were set for the most common CT indications within the registry in children under 18 years. Patients were grouped into five different age groups. CTDIvol calculation referred either to the 16-cm head or 32-cm body phantom. Routine indications in head, chest, and abdomen/pelvis were compared between U.S. and European facilities.

## RESULTS

A total of 108,446 CT examinations from 17 different CT indications in children were included in the analysis. Indications included routine head, trauma head, sinus, temporal bone, facial bones/cranial floor, c-spine, neck, angiography/pulmonary embolism, routine chest, coronary angiography, routine abdomen/pelvis, appendicitis, angiography in abdomen/pelvis, combined chest and abdomen/pelvis (CAP), t-spine, l-spine, and whole body. Sample size of the CT indications varied between 417 (angiography in abdomen/pelvis) and 45,211 examinations (routine head). Radiation dose in terms of ADs and DRLs of DLP and CTDIvol increased mainly significantly with increasing age group ( $p < 0.05$ ). In head scans of 10- to 14-year-old children, DRLs related to DLP varied from 287 mGy\*cm for sinus to 778 mGy\*cm for trauma, in chest from 193 mGy\*cm for coronary angiography to 639 mGy\*cm for routine chest (16-cm head phantom), and in abdomen/pelvis from 334 mGy\*cm for appendicitis to 515 mGy\*cm for routine abdomen/pelvis (16-cm head phantom). U.S. DRLs for CTDIvol and DLP were mainly significantly higher in routine chest and routine abdomen/pelvis than European. For routine head, the differences were inconsistent.

## CONCLUSION

Optimizing radiation dose in pediatric patients is challenging due to variations in dose by age, size, as well as CT indication and protocol. Therefore, we established indication-based diagnostic reference levels for the most common CT indications in children by different age groups using data from a large international dose registry.

## **CLINICAL RELEVANCE/APPLICATION**

Registry data was used to establish diagnostic reference levels and achievable doses for the most common CT indications in pediatric patients.

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## Abstract Archives of the RSNA, 2023

M7-SSPH05-1

### Organ-Aware, Scout-Based Approach for Scout Segmentation and Prospective, Personalized Organ CT Dose Estimation

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

Maria Jose Medrano Matamoros, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a multi-task network that simultaneously generates scout-based organ segmentations and anatomically informed predictions of CT radiation dose to organs.

#### METHODS AND MATERIALS

In this IRB-approved, HIPAA compliant, retrospective, single-center study, we propose Organ-Aware Scout-Dose (OA Scout-Dose), a multi-task implementation of the Scout-Net model in which an auxiliary task (scout-based organ segmentation) is used to further optimize the features learned by the primary task (organ-level CT dose estimation). To test feasibility, we assessed the performance of our model in estimating mean doses and segmentation for full body and two organs (lung and liver). Our OA Scout-Dose model followed a U-Net architecture with previously proposed Scout-Net as a backbone to encode the latent features followed by a decoder to generate organ segmentations for lateral and frontal scouts. The reference organ CT doses and segmentations corresponding to adult patients undergoing outpatient contrast-enhanced chest-abdomen-pelvis CT examinations acquired from GE Revolution in single-energy mode were generated by using the publicly available tools MC-GPU (V1.3) and TotalSegmentator. The relative difference between the mean organ doses predicted by Scout-Net and OA Scout-Dose from lateral and frontal scouts and their corresponding ground truths were calculated. Dice scores were also calculated to evaluate the segmentations generated by the auxiliary task.

#### RESULTS

160 CT examinations from 160 adult patients were included for analysis. Their corresponding estimated segmentations and doses were split into training (112) and test (48) sets. The best model was saved on a validation set of 10% from the training set. OA Scout-Dose and Scout-Net models were trained for 200 epochs. L1 and Dice score losses were minimized for primary and auxiliary task. The relative dose differences for lung, liver, and body across the test set decreased from 14.4%, 10.5%, and 5.7% with Scout-Net to 13.4%, 8.9%, and 4.7% with OA Scout-Dose, respectively. Average lung, liver, and body Dice scores were 0.82/0.83, 0.79/0.77, and 0.98/0.99 respectively for lateral/frontal organ segmentations.

#### CONCLUSION

Multi-task implementation of Scout-Net was proposed. Preliminary results demonstrate that OA Scout-Dose has the potential to generate accurate scout-based organ segmentations that allow more anatomically informed organ CT dose prediction from scout images than previously proposed single-task based methods.

#### CLINICAL RELEVANCE/APPLICATION

The proposed method can create personalized organ scout segmentations and prospective CT dose predictions that may be used to optimize radiation dose and image quality.

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## Abstract Archives of the RSNA, 2023

M7-SSPH05-2

### Estimation of Organ Doses for Cardiac Catheterizations and Diagnostic Fluoroscopic Procedures Performed in Infants with Congenital Heart Disease

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

Jeannette R. Wong-Siegel, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Children with congenital heart disease (CHD) undergo multiple procedures requiring ionizing radiation (IR) including diagnostic and interventional cardiac catheterizations and other diagnostic fluoroscopic procedures. IR exposure in early childhood may be associated with an increased risk of malignancy with neonates at especially higher risk due to their higher radiosensitivity and longer life expectancy than adults. The magnitude of this exposure and organ-specific risk remains unknown. Here, we describe the organ dose reconstruction and application of these parameters to a sample of procedures obtained in a cohort of neonates with cyanotic CHD requiring early intervention.

#### METHODS AND MATERIALS

The National Cancer Institute dosimetry system for radiography and fluoroscopy (NCIRF) was utilized to estimate absolute organ-specific radiation doses (mGy) and total effective dose (mSv). Beam spectra, exposure field configuration, distance from and direction of the X-ray beam, isocenter location, and dose-area-product (DAP, Gy-cm<sup>2</sup>) for each patient were used as input parameters for organ dose calculations collected from a multi-center clinical research collaborative.

#### RESULTS

Median frontal and lateral DAP from a sample of ten cardiac catheterizations was 1.57 and 1.19 Gy-cm<sup>2</sup>, respectively. Organ-specific radiation doses were highest for lung from frontal view (8.1 mGy) and breast from lateral view (8.7 mGy) (See Figure). DAP from a sample of 20 diagnostic fluoroscopic procedures was substantially lower, with a median DAP 0.265 Gy-cm<sup>2</sup> for upper gastrointestinal (GI), 0.161 Gy-cm<sup>2</sup> for lower GI, 0.065 Gy-cm<sup>2</sup> for genitourinary (GU), and 0.045 Gy-cm<sup>2</sup> for upper extremity procedures. Organ-specific doses varied by exposure field and were significantly lower (e.g. lung from upper GI (1.09 mGy), lower GI (0.02 mGy), GU (0.004 mGy), and extremity (0.12 mGy)) compared to cardiac catheterizations.

#### CONCLUSION

This study is the first to describe organ-specific radiation dose from cardiac catheterizations and diagnostic fluoroscopic studies in a neonatal CHD population, and may help in our understanding of the potential contribution of early childhood IR exposure to future risk of malignancy. In addition, these estimations may also identify specific CHD populations at risk for higher IR exposure secondary to medical management, assist in the development of quality improvement measures to reduce IR exposure, and influence clinical pathway decision-making in this vulnerable and young population.

#### CLINICAL RELEVANCE/APPLICATION

NCIRF can estimate patient-specific organ dose from cardiac catheterizations and diagnostic fluoroscopic procedures, which will be critical in the evaluation for risk of future adverse outcomes, such as malignancy.

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## Abstract Archives of the RSNA, 2023

M7-SSPH05-3

### **Multicentric Characterization of Organ-based Tube Current Modulation in Head Computed Tomography: A Dosimetric and Image Quality Study using a Scintillating Fiber Optic Detector**

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

Corentin Desport (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to evaluate the efficiency of organ-based tube current modulation (OBTCM) in head CT for different radiology services and manufacturers using a scintillating fiber optic detector.

#### **METHODS AND MATERIALS**

Five CT scanners from four radiology services were evaluated in this study: Siemens Somatom Go Top, GE Revolution CT, GE Revolution Maxima, Canon Aquilion Genesis, and Canon Aquilion Prime. Two head protocols were implemented: a standard and a routine protocol. A scintillating fiber optic detector was placed directly on the gantry to measure the dose reduction rate at 16 angles. Image quality was quantified on a 16-cm CT dose index (CTDI) phantom by measuring the signal-to-noise ratio (SNR) and the standard deviation of the Hounsfield units (HU) of circular regions of interest placed in peripheral regions of the phantom. The NPS (Noise Power Spectrum) was also measured. Values measured were compared on images with and without OBTCM.

#### **RESULTS**

Using the standard protocol, the dose on the anterior part of the patient was reduced by 73.7%, 26.4%, 30.8%, 40.0%, and 10.9% respectively for Siemens Somatom Go Top, GE Revolution CT, GE Revolution Maxima, Canon Aquilion Genesis, and Canon Aquilion Prime using OBTCM. Using the routine protocol, the dose reduction rates measured with OBTCM on the anterior part were up to 73.8%, 31.8%, 21.0%, 58.0%, and 37.2% respectively in Siemens Somatom Go Top, GE Revolution CT, GE Revolution Maxima, Canon Aquilion Genesis, and Canon Aquilion Prime. The dose on the posterior part was unchanged in GE Healthcare and Canon Medical System CT scanners. On the contrary, the dose to the posterior part was increased up to 38.9% and 39.1% in Siemens Somatom Go Top respectively using the standard protocol and the routine protocol. Image noise increased between 2.4 and 10.4% depending on the CT scanner and the ROIs studied. This corresponds to a maximum increase of 0.5 HU. In the same way, the SNR decreased between 2.6 and 9.6% which represents a maximum increase of 2.5 HU. These differences are statistically significant ( $p$ -value < 0.05). The study of the NPS shown that the noise texture is unaltered.

#### **CONCLUSION**

OBTCM reduces the dose to the anterior part of patients. In this way, OBTCM reduces the dose to the radiosensitive anterior organs such as the eye lens, thyroid, and breast without reducing substantially image quality.

#### **CLINICAL RELEVANCE/APPLICATION**

Multislice CT is responsible of the main part of the effective collective dose. In this way, manufacturers implemented tools to reduce patient exposure and particularly to reduce the radiosensitive organ exposition. However, these tools can not be evaluated accurately using the dosimetric indicators displayed at the end of each examination serie (CTDI, DLP).

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## Abstract Archives of the RSNA, 2023

M7-SSPH05-4

### Comparison of Image Quality and Radiation Exposure between Conventional Dose-driven Exposure Control with Contrast-to-noise-ratio-driven Exposure Control as a Function of Source-to-image Distances and Collimations in Abdominal Angiography

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

Thomas Werncke, MD,DIPLPHYS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this phantom and animal study was to compare image quality and radiation exposure between detector-dose driven exposure control (DEC) and contrast-to-noise ratio (CNR) driven exposure control (CEC) as a function of source-to-image distance (SID) and collimation.

#### METHODS AND MATERIALS

In the phantom study, an iron foil was placed in the isocentre of a stack of polymethylmetacrylate and Al plates simulating a patient-equivalent thickness of 15, 25 and 35cm. Fluoroscopic images were acquired for the DEC with constant detector-dose and CEC with constant CNR using five SIDs between 100 and 130 cm and two collimations (full and collimated field of view 6x6cm). The CNR and radiation exposure were determined and compared. In the animal study, five angiographic scenarios with typical angiographic materials were created in two anaesthetised pigs (AZ 18/2809). Fluoroscopic images were acquired with two SIDs (110, 130cm) and both collimations using the acquisition protocols used in the phantom study. Image quality (IQ) of the images were compared relative to the reference image acquired at SID of 110cm and FFOV by two blinded readers. IQ and radiation dose in terms of air kerma rate were compared using paired t-tests.

#### RESULTS

Using DEC, CNR and AKR increased with increasing SID, collimation and patient equivalent thickness. When CEC was used, CNR, showed minor variations with increasing SID, collimation and patient thickness, below physical or regulatory limits. AKR decreased with increasing SID and collimation. Above the limits, CEC showed similar results as compared to those of DEC. In the animal study, IQ ( $p < 0.005$  and AKR  $p = 0.004$ ) increased with higher SID and collimation using DEC. Using CEC, IQ was not significantly different using higher SIDs or collimation while AKR was not significantly different at higher SID but lower using collimation ( $p = 0.012$ ).

#### CONCLUSION

Contrary to DEC, CEC allows to maintain the image quality regardless the SID or collimation while the radiation dose to the patient is minimized. Furthermore, CEC could help to achieve the ALARA principle with less interaction of the interventionalist with the angiographic system as compared with DEC.

#### CLINICAL RELEVANCE/APPLICATION

A contrast-to-noise ratio driven exposure control optimizes the trade-off between image quality and radiation dose according to the ALARA principle more strictly as the conventional detector-dose driven exposure control, and could lead to a paradigm shift in angiographic imaging geometry.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-SSPH05-5

### ChatGPT: What is my Radiation Dose

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

Jaydev K. Dave, PhD (*Presenter*) Research Grant, Koninklijke Philips NV; Equipment support, Lantheus Medical Imaging; Equipment support, General Electric Company; Research Consultant, Curvebeam LLC; Consultant, Rayscan, Inc.

#### PURPOSE

To evaluate responses from ChatGPT (OpenAI, San Francisco, CA) regarding radiation dose questions for common imaging examinations.

#### METHODS AND MATERIALS

26 common imaging examinations in the Dose Reference Card published by the American College of Radiology were used in this study and the corresponding radiation dose values were used as reference values. An open-ended prompt was used as an input in ChatGPT asking for radiation dose associated with each of the 26 imaging examinations. Each prompt was entered as a new session to test the model output independently. Two versions of ChatGPT (February 13, 2023 and March 23, 2023) were used to assess reproducibility. The radiation dose values in the responses were compared with reference values. Other qualitative information in the responses was summarized.

#### RESULTS

For the February and March versions, the radiation dose values/ranges provided by ChatGPT agreed with the published reference values in 69% and 65% responses, respectively. The values were under- and over-estimated for 8-12% and 19-23% of the questions. 23-35% of the responses included references to societies/organizations for quoting radiation dose values; however only once was the same reference quoted by the different versions for the same question. Between the 2 versions, identical radiation dose values/ranges were obtained in only 23% of the responses. All responses included factors affecting the radiation dose values. Evaluating qualitative information in the responses revealed that 19% of the combined responses included brief description of the imaging examinations, and 10% of the responses included a note about relatively lower doses due to technological advancements. 48% of the responses stated that benefits outweigh the risk, while 54% of the responses also recommended a benefit/risk consultation with a physician. The radiation dose values were compared to equivalent background radiation in 56% of the responses and to other modalities in 27% of the responses. Strikingly, 33% of the responses included information about cumulative radiation dose due to repeated scans and the risk of developing cancer. Also, while one response for an upper GI study with barium understated the radiation dose value, the other response included misleading information that this study "does not typically involve the use of ionizing radiation".

#### CONCLUSION

Review of radiation dose data for common imaging examinations included in ChatGPT responses revealed moderate accuracy (65-69%) and low reproducibility (23%) with both, helpful and misleading information.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative and qualitative evaluation of responses pertaining to radiation dose values from ChatGPT highlights gaps in information accessible from a chatbot.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-SSPH05-6

### Indication-based Diagnostic Reference Levels for the Most Common CT Indications in Children: Data of an International Registry

Monday, Nov. 27 3:00PM - 4:00PM Room: N229

Denise Bos, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Computed tomography (CT) is important for diagnostic imaging in pediatric patients, particularly in emergency, but radiation exposure is a concern due to its carcinogenic risk. Radiation doses in CT varies across indications and protocols. Thus, we aim to establish indication-based diagnostic reference levels (DRLs) and achievable doses (ADs) for the most common CT indications in pediatric patients.

#### METHODS AND MATERIALS

A comprehensive analysis was performed using CT data from a large international dose registry that included more than 150 facilities from January 1, 2016 to January 1, 2021. ADs and DRLs for the volume-weighted CT-dose index (CTDIvol) and the dose-length product (DLP) were set for the most common CT indications within the registry in children under 18 years. Patients were grouped into five different age groups. CTDIvol calculation referred either to the 16-cm head or 32-cm body phantom. Routine indications in head, chest, and abdomen/pelvis were compared between U.S. and European facilities.

#### RESULTS

A total of 108,446 CT examinations from 17 different CT indications in children were included in the analysis. Indications included routine head, trauma head, sinus, temporal bone, facial bones/cranial floor, c-spine, neck, angiography/pulmonary embolism, routine chest, coronary angiography, routine abdomen/pelvis, appendicitis, angiography in abdomen/pelvis, combined chest and abdomen/pelvis (CAP), t-spine, l-spine, and whole body. Sample size of the CT indications varied between 417 (angiography in abdomen/pelvis) and 45,211 examinations (routine head). Radiation dose in terms of ADs and DRLs of DLP and CTDIvol increased mainly significantly with increasing age group ( $p < 0.05$ ). In head scans of 10- to 14-year-old children, DRLs related to DLP varied from 287 mGy\*cm for sinus to 778 mGy\*cm for trauma, in chest from 193 mGy\*cm for coronary angiography to 639 mGy\*cm for routine chest (16-cm head phantom), and in abdomen/pelvis from 334 mGy\*cm for appendicitis to 515 mGy\*cm for routine abdomen/pelvis (16-cm head phantom). U.S. DRLs for CTDIvol and DLP were mainly significantly higher in routine chest and routine abdomen/pelvis than European. For routine head, the differences were inconsistent.

#### CONCLUSION

Optimizing radiation dose in pediatric patients is challenging due to variations in dose by age, size, as well as CT indication and protocol. Therefore, we established indication-based diagnostic reference levels for the most common CT indications in children by different age groups using data from a large international dose registry.

#### CLINICAL RELEVANCE/APPLICATION

Registry data was used to establish diagnostic reference levels and achievable doses for the most common CT indications in pediatric patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-STCE1

### Science Session (Sustainability in Imaging and Imaging of Immunotherapy)

Monday, Nov. 27 2:30PM - 3:00PM Room: Learning Center Theater 1

#### Sub-Events

#### **M7-STCE1- Radiomic features Identifies responders in CAR-T based immunotherapy**

2

Yoganand Balagurunathan, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Diffuse large B-cell lymphoma (DLBCL) is the most common, aggressive disease form of lymphomas with a dismal survival for intermediate grades (5-year survival about 38%). Recent development in chimeric antigen receptor (CAR) T-cell therapy has shown tremendous promise in providing a cure for these patients. We propose to develop Radiomics (quantitative image metric) based biomarker to identify patients that would benefit from engineered cell-based treatments.

#### **METHODS AND MATERIALS**

We identified a cohort of 58 patients with R/R DLBCL, whose largest lesions on the baseline positron emission tomography /computed tomography (PET/CT) imaging were identified along with their anatomical sites related to non-lymphatics. The lesion's co-registered PET imaging was used to converge on a regional boundary to obtain the most active part of the lesion, applying Standardized Uptake Value definition with 41% regional threshold. The lesion regions were characterized using imaging metrics (radiomics) followed by principal component (PC) analysis to reduce the dimensionality in the feature categories (Size, Shape and Texture). These Radiomics metrics along with metabolic tumor volume (MTV) were used both collectively and independently to assess risk to disease progression measured by overall survival using Cox-regression model. We also compared the Radiomic metrics to MTV to identify linear dependency measured by Coefficient of Determination ( $R^2$ ).

#### **RESULTS**

PET scans Shape features (Non lymphatic) had a 21% increased risk to disease progression compared to 15% using MTV, with a CI of [1.0487, 1.417] and [1.04, 1.30] respectively. Patients have a median follow up of 1 year after CAR-T treatment. Shape-PC (Non-Lymph) lesions were not related to MTV (correlation coefficient of 41.8%). Most non lymphatic lesions (top three sites) in our cohort were from lung, bone and liver. Patients with no non- lymphatic lesions were not part of this cohort.

#### **CONCLUSION**

We identified Non-Size based features that are prognostic to patient response to treatment. These metrics provide complementary information to MTV and may serve as a surrogate to treatment response. A secondary validation of these metrics would provide much needed clinical translation.

#### **CLINICAL RELEVANCE/APPLICATION**

Non-size based metrics could be included in the routine clinical practice and improve prognosis/treatment response.

#### **M7-STCE1- Radiology and Sustainability: The Experience of the First Carbon-neutral Hospital in Brazil**

3

Cesar H. Nomura, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To describe the efforts and initiatives of a tertiary hospital in Brazil to achieve carbon neutrality through a comprehensive renewable energy transition.

#### **METHODS AND MATERIALS**

In order to attain carbon neutrality, our institution has made a dedicated commitment to reduce carbon emissions linked to its electricity consumption within the hospital complex. To achieve this goal, we have implemented a strategy to procure International Renewable Energy Certificates (I-RECs), which are globally recognized as a certification standard for renewable

energy sources. Additionally, in our radiology department, we have introduced changes aimed at decreasing unnecessary energy usage of scanners and other equipment.

## **RESULTS**

An institutional diagnosis and Greenhouse Gas (GHG) Emission Inventory revealed that the electricity consumption (Scope 2 of the GHG Protocol) represented 40-45% of total institutional emissions, and the hospital has pledged to reduce its overall emissions by 15% annually. Radiology department was considered an important contributor due to high energy consumption and waste. By acquiring I-REC certificates, our hospital has set a new challenge to become an institution powered by 100% renewable energy. Since then, we have ensured that all energy consumed within our hospital complex is sourced from renewable energy, specifically wind farms located in Brazil. More recently, we have committed to the RACE TO ZERO initiative, reinforcing our promise of cutting at least 50% of emissions by 2030 and achieving net-zero emissions by 2050. Our radiology department was involved in these initiatives through the discussion and implementation of quality improvement initiatives and educational programs on healthcare sustainability.

## **CONCLUSION**

Our institutional experience illustrates the successful implementation of renewable energy solutions as a viable pathway for healthcare institutions to achieve carbon neutrality and contribute to a greener future.

## **CLINICAL RELEVANCE/APPLICATION**

Although the impact of climate crisis is already being felt across the planet, different regions are affected according to their levels of vulnerability and adaptability. The Pan American Health Organization registered that more than half of the 18,000 hospitals in Latin America are located in risky areas for natural disasters, such as floods, earthquakes, or hurricanes. However, less than 1% of these hospitals calculated their carbon footprint and made reduction commitments by the year 2020. Brazil, the country most prone to floods on the continent, only had its first carbon-neutral health institution 3 years ago.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-STCE1-2

### **Radiomic features Identifies responders in CAR-T based immunotherapy**

Monday, Nov. 27 2:30PM - 3:00PM Room: Learning Center Theater 1

Yoganand Balagurunathan, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Diffuse large B-cell lymphoma (DLBCL) is the most common, aggressive disease form of lymphomas with a dismal survival for intermediate grades (5-year survival about 38%). Recent development in chimeric antigen receptor (CAR) T-cell therapy has shown tremendous promise in providing a cure for these patients. We propose to develop Radiomics (quantitative image metric) based biomarker to identify patients that would benefit from engineered cell-based treatments.

#### **METHODS AND MATERIALS**

We identified a cohort of 58 patients with R/R DLBCL, whose largest lesions on the baseline positron emission tomography /computed tomography (PET/CT) imaging were identified along with their anatomical sites related to non-lymphatics. The lesion's co-registered PET imaging was used to converge on a regional boundary to obtain the most active part of the lesion, applying Standardized Uptake Value definition with 41% regional threshold. The lesion regions were characterized using imaging metrics (radiomics) followed by principal component (PC) analysis to reduce the dimensionality in the feature categories (Size, Shape and Texture). These Radiomics metrics along with metabolic tumor volume (MTV) were used both collectively and independently to assess risk to disease progression measured by overall survival using Cox-regression model. We also compared the Radiomic metrics to MTV to identify linear dependency measured by Coefficient of Determination (R<sup>2</sup>).

#### **RESULTS**

PET scans Shape features (Non lymphatic) had a 21% increased risk to disease progression compared to 15% using MTV, with a CI of [1.0487, 1.417] and [1.04, 1.30] respectively. Patients have a median follow up of 1 year after CAR-T treatment. Shape-PC (Non-Lymph) lesions were not related to MTV (correlation coefficient of 41.8%). Most non lymphatic lesions (top three sites) in our cohort were from lung, bone and liver. Patients with no non- lymphatic lesions were not part of this cohort.

#### **CONCLUSION**

We identified Non-Size based features that are prognostic to patient response to treatment. These metrics provide complementary information to MTV and may serve as a surrogate to treatment response. A secondary validation of these metrics would provide much needed clinical translation.

#### **CLINICAL RELEVANCE/APPLICATION**

Non-size based metrics could be included in the routine clinical practice and improve prognosis/treatment response.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-STCE1-3

### Radiology and Sustainability: The Experience of the First Carbon-neutral Hospital in Brazil

Monday, Nov. 27 2:30PM - 3:00PM Room: Learning Center Theater 1

Cesar H. Nomura, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To describe the efforts and initiatives of a tertiary hospital in Brazil to achieve carbon neutrality through a comprehensive renewable energy transition.

#### METHODS AND MATERIALS

In order to attain carbon neutrality, our institution has made a dedicated commitment to reduce carbon emissions linked to its electricity consumption within the hospital complex. To achieve this goal, we have implemented a strategy to procure International Renewable Energy Certificates (I-RECs), which are globally recognized as a certification standard for renewable energy sources. Additionally, in our radiology department, we have introduced changes aimed at decreasing unnecessary energy usage of scanners and other equipment.

#### RESULTS

An institutional diagnosis and Greenhouse Gas (GHG) Emission Inventory revealed that the electricity consumption (Scope 2 of the GHG Protocol) represented 40-45% of total institutional emissions, and the hospital has pledged to reduce its overall emissions by 15% annually. Radiology department was considered an important contributor due to high energy consumption and waste. By acquiring I-REC certificates, our hospital has set a new challenge to become an institution powered by 100% renewable energy. Since then, we have ensured that all energy consumed within our hospital complex is sourced from renewable energy, specifically wind farms located in Brazil. More recently, we have committed to the RACE TO ZERO initiative, reinforcing our promise of cutting at least 50% of emissions by 2030 and achieving net-zero emissions by 2050. Our radiology department was involved in these initiatives through the discussion and implementation of quality improvement initiatives and educational programs on healthcare sustainability.

#### CONCLUSION

Our institutional experience illustrates the successful implementation of renewable energy solutions as a viable pathway for healthcare institutions to achieve carbon neutrality and contribute to a greener future.

#### CLINICAL RELEVANCE/APPLICATION

Although the impact of climate crisis is already being felt across the planet, different regions are affected according to their levels of vulnerability and adaptability. The Pan American Health Organization registered that more than half of the 18,000 hospitals in Latin America are located in risky areas for natural disasters, such as floods, earthquakes, or hurricanes. However, less than 1% of these hospitals calculated their carbon footprint and made reduction commitments by the year 2020. Brazil, the country most prone to floods on the continent, only had its first carbon-neutral health institution 3 years ago.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-STCE2

### Science Session (Generative AI)

Monday, Nov. 27 2:30PM - 3:00PM Room: Learning Center Theater 2

#### Sub-Events

#### **M7-STCE2- MammoGPT: A Large Language model for Mammography-related dialogues** 2

Jie Ma (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recently, large language models (LLMs) in the general domain, such as ChatGPT, have achieved remarkable success in generating human-like responses. However, such large models rarely appear in research in the medical field. To this end, we developed MammoGPT to assist patients with problems related to Mammography's diagnostic reports. MammoGPT has shown extraordinary potential in multi-round interactive dialogues.

#### **METHODS AND MATERIALS**

Our data is collected from three collaborative hospitals at distinct geographical locations using Siemens and Giotto equipment following the ACR standard from 2011 to 2021. A large-scale dataset containing 33,630 mammogram studies with diagnostic reports from 30,495 patients was collected. We set radiologists into two groups, junior and senior, separated by their years of expertise. We recorded 3,753 questions from relevant patients. We used ChatGLM-6B as the initial language model (ILM) to provide three answers to each question, where the diagnostic report served as a prompt for ILM. Junior radiologists corrected the common sense errors inside those answers, if there were any. Then, senior radiologists picked the best answer based on its correctness and professional level for each patient's case. Each training sample consisted of a question (from the patient), a prompt (the diagnostic report), and an answer (picked by the senior radiologist). These samples were then used to train ILM into MammoGPT with a learning rate starting from  $2 \times 10^{-5}$ , a weight decay of 0.1, and a batch size of 12. Eight Nvidia A100 were used for training and two for inference.

#### **RESULTS**

We compare the performance of MammoGPT with three open-source LLMs: Vicuna-13B, ChatGLM-6B, and Llama 2-Chat. Twenty patients were invited to provide their questions and diagnostic reports (prompts). We requested six senior radiologists to evaluate answers generated by each LLM from aspects of correctness, rationality, helpfulness, and professionalism. MammoGPT scored highest on all but rationality, with scores of 90.2, 67.6, 88.0, and 94.6. As for rationality, Llama 2-Chat scored 73.8, with MammoGPT coming second. In particular, MammoGPT showed strong professionalism compared to other LLMs, with a noticeable leading gap of over 15 points.

#### **CONCLUSION**

We present MammoGPT, an LLM that assists patients with questions related to Mammography. This LLM shows a distinctive professional level and proves helpful along with correct answers based on our experiments. With more robust data cleaning, we could train a much improved MammoGPT with stronger rationalism.

#### **CLINICAL RELEVANCE/APPLICATION**

With the continued strain on medical resources worldwide, large models like MammoGPT can enable patients to access professional medical services by consulting from a mobile app.

#### **M7-STCE2- Classification of Alzheimer's Disease Severity from MRI Scans: Vision Transformer versus Convolutional Neural Network Approach** 3

Salil Patel, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Vision transformers (ViTs) are an emerging architecture for medical image analysis. Compared to convolutional neural networks (CNNs), the current dominant approach, ViTs can handle images of arbitrary size and orientation alongside

leveraging long-range dependencies. This study developed a novel ViT to classify Alzheimer's disease presence and severity from MRI scans. The aim was to compare ViTs for this task against an established CNN architecture.

## **METHODS AND MATERIALS**

A custom ViT architecture was compared to a CNN model. The dataset consisted of 15,485 MRI scan slices from the open-access OASIS-1 dataset. The ViT comprised a custom ViT-B16 backbone (21M parameters) and dense output layer. The CNN consisted of four Convolutional Blocks and three Linear Blocks. Images were resized to 128x128 pixels, and one-hot encoded into 4 severity categories. Both models were implemented in TensorFlow/Keras, trained on a V100 GPU with early stopping. The training-test set split was 70:30. 5-fold stratified cross-validation was used and accuracy, precision, recall and F1-score averaged over each fold.

## **RESULTS**

The CNN model achieved an average accuracy of 95.44% over the 5 folds demonstrating high precision (0.94) and recall (0.95), with a weighted F1-score of 0.96. The ViT achieved 98.88% accuracy demonstrating high precision (0.99) and recall (0.98), with a weighted F1-score of 0.99, highlighting its effectiveness in classification.

## **CONCLUSION**

The ViT demonstrated higher accuracy compared to the CNN model for Alzheimer's disease diagnosis and classification using MRI scans, showing the utility of ViTs.

## **CLINICAL RELEVANCE/APPLICATION**

The ability to accurately classify Alzheimer's disease severity from MRI scans could significantly impact diagnostic pathways. Earlier and more accurate detection of Alzheimer's stages can improve patient outcomes and quality of life. This study suggests ViTs may offer advantages over CNNs for dementia classification from MRI neuroimaging.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M7-STCE2-2

### **MammoGPT: A Large Language model for Mammography-related dialogues**

Monday, Nov. 27 2:30PM - 3:00PM Room: Learning Center Theater 2

Jie Ma (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recently, large language models (LLMs) in the general domain, such as ChatGPT, have achieved remarkable success in generating human-like responses. However, such large models rarely appear in research in the medical field. To this end, we developed MammoGPT to assist patients with problems related to Mammography's diagnostic reports. MammoGPT has shown extraordinary potential in multi-round interactive dialogues.

#### **METHODS AND MATERIALS**

Our data is collected from three collaborative hospitals at distinct geographical locations using Siemens and Giotto equipment following the ACR standard from 2011 to 2021. A large-scale dataset containing 33,630 mammogram studies with diagnostic reports from 30,495 patients was collected. We set radiologists into two groups, junior and senior, separated by their years of expertise. We recorded 3,753 questions from relevant patients. We used ChatGLM-6B as the initial language model (ILM) to provide three answers to each question, where the diagnostic report served as a prompt for ILM. Junior radiologists corrected the common sense errors inside those answers, if there were any. Then, senior radiologists picked the best answer based on its correctness and professional level for each patient's case. Each training sample consisted of a question (from the patient), a prompt (the diagnostic report), and an answer (picked by the senior radiologist). These samples were then used to train ILM into MammoGPT with a learning rate starting from  $2 \times 10^{-5}$ , a weight decay of 0.1, and a batch size of 12. Eight Nvidia A100 were used for training and two for inference.

#### **RESULTS**

We compare the performance of MammoGPT with three open-source LLMs: Vicuna-13B, ChatGLM-6B, and Llama 2-Chat. Twenty patients were invited to provide their questions and diagnostic reports (prompts). We requested six senior radiologists to evaluate answers generated by each LLM from aspects of correctness, rationality, helpfulness, and professionalism. MammoGPT scored highest on all but rationality, with scores of 90.2, 67.6, 88.0, and 94.6. As for rationality, Llama 2-Chat scored 73.8, with MammoGPT coming second. In particular, MammoGPT showed strong professionalism compared to other LLMs, with a noticeable leading gap of over 15 points.

#### **CONCLUSION**

We present MammoGPT, an LLM that assists patients with questions related to Mammography. This LLM shows a distinctive professional level and proves helpful along with correct answers based on our experiments. With more robust data cleaning, we could train a much improved MammoGPT with stronger rationalism.

#### **CLINICAL RELEVANCE/APPLICATION**

With the continued strain on medical resources worldwide, large models like MammoGPT can enable patients to access professional medical services by consulting from a mobile app.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M7-STCE2-3

### Classification of Alzheimer's Disease Severity from MRI Scans: Vision Transformer versus Convolutional Neural Network Approach

Monday, Nov. 27 2:30PM - 3:00PM Room: Learning Center Theater 2

Salil Patel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Vision transformers (ViTs) are an emerging architecture for medical image analysis. Compared to convolutional neural networks (CNNs), the current dominant approach, ViTs can handle images of arbitrary size and orientation alongside leveraging long-range dependencies. This study developed a novel ViT to classify Alzheimer's disease presence and severity from MRI scans. The aim was to compare ViTs for this task against an established CNN architecture.

#### METHODS AND MATERIALS

A custom ViT architecture was compared to a CNN model. The dataset consisted of 15,485 MRI scan slices from the open-access OASIS-1 dataset. The ViT comprised a custom ViT-B16 backbone (21M parameters) and dense output layer. The CNN consisted of four Convolutional Blocks and three Linear Blocks. Images were resized to 128x128 pixels, and one-hot encoded into 4 severity categories. Both models were implemented in TensorFlow/Keras, trained on a V100 GPU with early stopping. The training-test set split was 70:30. 5-fold stratified cross-validation was used and accuracy, precision, recall and F1-score averaged over each fold.

#### RESULTS

The CNN model achieved an average accuracy of 95.44% over the 5 folds demonstrating high precision (0.94) and recall (0.95), with a weighted F1-score of 0.96. The ViT achieved 98.88% accuracy demonstrating high precision (0.99) and recall (0.98), with a weighted F1-score of 0.99, highlighting its effectiveness in classification.

#### CONCLUSION

The ViT demonstrated higher accuracy compared to the CNN model for Alzheimer's disease diagnosis and classification using MRI scans, showing the utility of ViTs.

#### CLINICAL RELEVANCE/APPLICATION

The ability to accurately classify Alzheimer's disease severity from MRI scans could significantly impact diagnostic pathways. Earlier and more accurate detection of Alzheimer's stages can improve patient outcomes and quality of life. This study suggests ViTs may offer advantages over CNNs for dementia classification from MRI neuroimaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSBR10

### Breast Imaging (Screening Mammography A to Z)

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450B

Hiroyuki Abe, MD, PhD (*Moderator*) Nothing to Disclose  
Christopher E. Comstock, MD (*Moderator*) Speakers Bureau, Bracco Group; Advisory Board, Guerbet SA; Consultant, Bayer AG; Speaker, Northwest Imaging Forums, Inc  
Alexandra Athanasiou, MD, MSc (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R1-SSBR10-1 Performance Metrics of Screening Digital Breast Tomosynthesis in Post-Lumpectomy Breast Cancer Patients Based on Years Since Diagnosis**

Daniel Do (*Presenter*) Nothing to Disclose

#### **PURPOSE**

There is wide variability in mammographic surveillance protocols after lumpectomy for breast cancer. Some practices recommend diagnostic mammography between 2 and 5 years before returning to annual screening mammography, while others recommend returning immediately to screening or continuing diagnostic mammography indefinitely. The purpose of this study is to determine performance metrics of screening digital breast tomosynthesis (DBT) in post-lumpectomy breast cancer patients based on number of years since diagnosis at a large academic center in which patients return immediately to screening mammography after treatment.

#### **METHODS AND MATERIALS**

Screening DBT exams in post-lumpectomy breast cancer patients from January 1, 2013, to June 30, 2019, were retrospectively reviewed. Performance metrics based on number of years since breast cancer diagnosis were compared using multivariable logistic regression models. Each model was adjusted for age, race, breast density, presence of a prior screening mammogram, and reader. The impact of each of these factors, in addition to time since diagnosis, was examined using generalized estimating equations with an independent correlation matrix, clustering on exams within a single woman.

#### **RESULTS**

Over the study period, 6,695 post-lumpectomy breast cancer patients (mean age 63, range 34-99) underwent 21,773 DBT screening exams. The cancer detection rate (CDR) was 7.7 per 1000 exams, abnormal interpretation rate (AIR) was 6.0% (1,296/21,773), positive predictive value (PPV) 1 was 12.9% (167/1,296), sensitivity was 78.4% (167/213), specificity was 94.8% (20,431/21,560), and false-negative rate (FNR) was 2.1 per 1000 exams. There were no significant differences in CDR, sensitivity, or FNR based on years since diagnosis ( $p > 0.05$ ). For every year since diagnosis, the odds of AIR significantly decreased, PPV1 increased, and specificity increased, holding age, race, breast density, presence of a prior screening mammogram, and reader constant ( $p < 0.001$  to  $p = 0.01$ ). The AIRs were 7.5% (95% CI, 6.4-8.7%) for patients who were diagnosed less than 1 year ago and 5.1% (95% CI, 4.1-6.3%) for those diagnosed 8-9 years ago ( $p = 0.01$ ).

#### **CONCLUSION**

Among 6,695 post-lumpectomy breast cancer patients who underwent 21,773 screening DBT exams, significantly more women were recalled from screening during the initial years after diagnosis compared to subsequent years, but the AIR remained below 10% even in the first year. The CDR did not significantly change based on years since diagnosis.

#### **CLINICAL RELEVANCE/APPLICATION**

These results support our institution's mammographic surveillance protocol for post-lumpectomy breast cancer patients, which is to return immediately to screening mammography, given the acceptably low AIRs.

#### **R1-SSBR10-2 Impact of Prospective Artificial Intelligence (AI) Triage of Screening Mammography/Digital Breast Tomosynthesis (DBT) on Radiologist Recall Rates**

Laura Heacock, MD, MS (*Presenter*) Nothing to Disclose

## **PURPOSE**

Proposed triage-based screening mammography worklists reserve more complex exams for the radiologist and give low-risk exams to standalone AI. The purpose of this study was to prospectively evaluate AI-based triage changes to radiologist recall rate.

## **METHODS AND MATERIALS**

Our IRB-approved study used an AI system trained utilizing model ensembling, with models based on 486,383 FFDM/DBT exams. This model produces a high-specificity threshold score for each breast: extremely low risk (ELR) of breast cancer or not extremely low risk (NELR). From 08/2022-03/2023, eight radiologists (mean experience = 7 yrs, range 2-19 yrs) read from a non-stratified FFDM/DBT screening list (Phase 1). During 04/2023, the same radiologists prospectively batch-read from two lists sorted by AI score: marked as ELR or NELR (Phase 2). Recall rates were compared. Radiologists subjectively rated the Phase 1 vs Phase 2 difficulty and their perception recall rate changes on a 1-5 point Likert scale.

## **RESULTS**

Combined recall rates for both phases were 13.16% (1537/11682); readers recalled 6.2% (268/4325) of ELR exams and 17.25% (1269/7357) of NELR exams. During Phase 1 (no triage), readers interpreted 10,310 screening mammograms (37.9% (3908/10310) ELR, 62.01% (6402/10310) NELR) with average recall rate of 12.9% (1328/10310). Recall rate was 6.32% (247/3908) for ELR and 16.9% (1081/6402) for NELR exams. During Phase 2 (triage), readers interpreted 1,372 screening mammograms (30.4% (417/1372) ELR; 69.6% (955/1372) NELR) with average recall rate of 15.23%. Recall rate decreased to 5.04% (21/417) for ELR and increased to 19.69% (1081/6402) for NELR exams. However, there was no statistical difference in recall rate between phases for ELR exams ( $p=0.33$ ) or NELR exams ( $p=0.08$ ). No statistical difference was observed for ELR or NELR exams for experienced ( $\geq 5$  years,  $p=0.093-0.88$ ) vs inexperienced ( $< 5$  years,  $p=0.218-0.421$ ) readers. Median Likert score for perceived triage list difficulty was 3: "no change compared to Phase 1" (range 2-4). Median Likert score for ELR was 2: "mildly decreased recall rate" (range 1-3) and for NELR was 3.5: "mildly increased recall rate" (range 3-4).

## **CONCLUSION**

Prospective simulated screening mammography triage does not have a significant change in recall rate, despite self-reported perceived increased recalls. Longitudinal investigation of changes to positive predictive values and cancer detection rates is indicated.

## **CLINICAL RELEVANCE/APPLICATION**

Use of standalone AI to read low-risk screening mammograms will likely increase benchmark radiologist recall rates for the remaining complex examinations. However, prospective triage worklists do not appear to cause an additional increase in recall rates compared to routine use of AI.

## **R1- Exploring the Missed: Classifying Interval Breast Cancers in a U.S. Based Screening Population to Unlock the Potential Clinical Utility of AI**

Tiffany Yu, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Recent European studies suggest artificial intelligence (AI) can reduce interval breast cancers. Given different screening practices, we reviewed and classified interval breast cancers to assess AI performance within US screening guidelines. To our knowledge, no comparable US study exists in the era of digital breast tomosynthesis (DBT).

## **METHODS AND MATERIALS**

From a database of Full Field Digital Mammography (FFDM) and DBT screening mammograms acquired from 2010-2019 at a large tertiary care academic center, we identified a subset of interval breast cancers, defined as histopathologic diagnosis within 12 months after a negative screening mammogram. Exclusion criteria were BI-RADS 0, 3, 4, 5, 6; incomplete information; and data errors. Using a semi-informed, case-controlled, blinded approach, 8 fellowship-trained breast radiologists with 3-24 years of experience retrospectively classified the interval cancers as true interval cancer, minimal signs-non-actionable, minimal signs-actionable, technical miss, reading error miss, or occult. Each case was assigned a single classification by consensus. Statistical analysis evaluated associations between case classifications and deep-learning based AI algorithm (Transpara 1.7.1) risk scores, patient factors, tumor characteristics and staging.

## **RESULTS**

From 184,935 screening mammograms (65% FFDM, 35% DBT), we included 150 interval breast cancers in 150 women (age 40-87 years). Nine (6%) were classified as true interval cancers, and of these 44% were flagged by AI; 35 (23%) were minimal signs-non-actionable (71% flagged by AI); 38 (25%) minimal signs-actionable (89% flagged by AI); 7 (5%) missed-technical error (40% flagged by AI); 25 (17%) missed-reading error (94% flagged by AI); and 36 (24%) occult (68% flagged by AI). Women aged 40-49 years were disproportionately affected by occult interval cancers (42%), versus women aged 50

years and older with minimal signs-actionable (27%) ( $p=0.007$ ). Interval cancers were overall associated with ACR breast density C (45%,  $p<0.00$ ). Triple-negative cancers comprised 13% of the sample, with the greatest proportion true interval cancers (25%,  $p=0.003$ ). Most interval cancers were localized (86% TNM stage 0 to 2B,  $p<0.00$ ).

#### **CONCLUSION**

The majority of interval cancers were classified as minimal signs, and both minimal signs and reading error misses had the greatest proportion correctly flagged by AI. Thus, AI can potentially aid in identifying and reducing the interval cancer rate in US-based screening programs.

#### **CLINICAL RELEVANCE/APPLICATION**

Understanding context-specific interval breast cancer classification—in this case US-based screening guidelines—is critical for assessing AI performance on improving screening mammography sensitivity.

#### **R1-SSBR10-4 Beneficial Effect of Repeated Participation in Breast Cancer Screening on Survival**

Robert A. Smith, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The benefit of mammography screening in reducing mortality from breast cancer is established, but less so the benefit of repeated participation at scheduled screening on case survival. The purpose of this study was to investigate the effect of regular attendance to mammography screening.

#### **METHODS AND MATERIALS**

Data on screening history and subsequent survival from 1992 to 2016 were available for 37,079 breast cancer patients in whom 4,564 breast cancer deaths occurred. We obtained data on screening history and subsequent death from breast cancer and extracted data on participation to the five (or fewer) most recent invitations prior to breast cancer diagnosis. Breast cancer incidence data was obtained from the regional oncology centers and breast cancer death data was obtained from the Swedish Cause of Death Register. These data were linked to population screening invitation and attendance data. Formal comparisons of survival with respect to numbers of screens attended utilized Cox proportional hazards regression with time-varying covariates, i.e., cumulative numbers of screens, yielding hazard ratios and 95% confidence intervals.

#### **RESULTS**

Depending on number of invitations, 58-73% participated in all scheduled mammography screening exams, and 73-96% participated in at least one. For those participating in all screening exams, survival rates ranged from 82.7% to 86.9%. For those participating in no screening, survival ranged from 59.1% to 77.6%. In those with five prior invitations to mammography screening, the relative hazard of breast cancer death for those attending all five screens was 0.28 (95% CI 0.25-0.33) compared to women who had participated in none, a 72% reduction in the risk of dying from breast cancer. Even after conservative adjustment for potential self-selection factors, there was a highly significant 66% reduction in hazard, with a hazard ratio of 0.34 (95% CI 0.26-0.43).

#### **CONCLUSION**

We found a greater reduction in the hazard of breast cancer death with increasing number of screening exams attended. In terms of limitations, these results are for case survival, not population mortality, although results are consistent with recent findings of a greater mortality reduction for those who participated in both their most recent scheduled screens. These results indicate that for those who develop breast cancer, regular participation in screening considerably improves the probability of surviving it. The importance of regular attendance in mammography screening should be clearly articulated in breast cancer screening messaging.

#### **CLINICAL RELEVANCE/APPLICATION**

Irregular mammography screening is common. There is a need to stress the importance in regular mammography as a key factor in reducing the risk of breast cancer death.

#### **R1-SSBR10-5 Rates of Advanced Cancers in Digital Breast Tomosynthesis Screening: Association with Screening Interval**

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Increasing early detection of nonlethal breast cancers is the main function of screening. Advanced cancers - characterized by larger size, lymph node involvement, or aggressive molecular subtypes - are those that carry a worse prognosis. Our prior data demonstrated a significant decrease in the rate of advanced cancers with digital breast tomosynthesis (DBT) screening compared with 2D full-field digital mammography (DM). The purpose of this study was to examine how the rate of advanced cancers varied with the DBT screening interval.

## **METHODS AND MATERIALS**

Our detailed database of 1265 cancers (968 invasive) diagnosed over 10 years (2011-2021) of screening with DBT was analyzed. Advanced cancers were defined by TMIST criteria (invasive cancers >2cm, HER2+ or triple negative cancers >1cm, one or more positive axillary lymph nodes, distant organ spread). The rates of advanced compared with non-advanced cancers were assessed by the time interval (in months) from the prior screening mammogram (12-15, 15-18, 18-21, 21-24, 24+ months). Statistical analysis was performed using unpaired T-tests and Chi Square with  $p < 0.05$  considered significant.

## **RESULTS**

Of 968 invasive cancers, 316 (32.7%) were considered advanced. The interval from prior screening for the non-advanced cancers was significantly less (mean 542 days, median 781 days) than for the advanced cancers (mean 634 days, median 890 days) ( $p < 0.02$ ). The rate of advanced cancers showed a trend to increase from 27-28% until 638 days (1.75 years) after which it increased to 35-37%.

## **CONCLUSION**

Advanced cancers occurred with longer intervals from the prior screening. Until 21 months (1.75 years), the rate of advanced cancers was relatively stable at 27-29% after which it increased to 37%. Maintaining a screening interval of less than 2 years could help reduce advanced cancers.

## **CLINICAL RELEVANCE/APPLICATION**

With DBT screening, an interval of less than two years helps reduce the rate of advanced cancers.

## **R1-SSBR10-6 Independent Double Reading in Screening With Digital Breast Tomosynthesis: Effective Investment?**

Stefanie B. Weigel, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

We conducted a randomized controlled trial which revealed significantly raised breast cancer detection by digital breast tomosynthesis with synthetic mammography (DBT+SM) as compared to digital mammography (DM). As independent double reading in mammographic screening aims to increase the diagnostic sensitivity, we investigated in this subanalysis of the trial, whether DBT+SM substantially raises the true-positive proportion of screen-detected breast cancers obtained by a single reading over DM screening.

## **METHODS AND MATERIALS**

From 2018 to 2020, women were randomized 1:1 in 17 screening units ( $n = 49,762$  screened with DBT+SM,  $n = 49,796$  with DM). Results from all independent double readings and for all screen-detected breast cancers, i.e., invasive cancers and ductal carcinoma in situ, were used.

## **RESULTS**

DBT+SM screening diagnosed 416 and DM 306 women with breast cancers. In the DBT+SM arm, 26.9% (112 out of 416) were detected only by one reader and in the DM arm these were 22.2% (68/306), comprising invasive breast cancers [DBT+SM 85/112 (75.9%), DM 46/68 (67.6%)], pT1 cancers [DBT+SM 76/112 (67.9%), DM 38/68 (55.9%)] and non-special type breast cancer [DBT+SM 56/112 (50.0%), DM 31/68 (45.6%)].

## **CONCLUSION**

Comparable to DM screening, and despite a higher diagnostic yield, screening with DBT+SM required still independent double reading to identify a relevant proportion of screen-detected breast cancers that were otherwise not reliably diagnosed.

## **CLINICAL RELEVANCE/APPLICATION**

Independent double reading retains its rationale also in screening with digital breast tomosynthesis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSBR10-1

### Performance Metrics of Screening Digital Breast Tomosynthesis in Post-Lumpectomy Breast Cancer Patients Based on Years Since Diagnosis

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450B

Daniel Do (*Presenter*) Nothing to Disclose

#### PURPOSE

There is wide variability in mammographic surveillance protocols after lumpectomy for breast cancer. Some practices recommend diagnostic mammography between 2 and 5 years before returning to annual screening mammography, while others recommend returning immediately to screening or continuing diagnostic mammography indefinitely. The purpose of this study is to determine performance metrics of screening digital breast tomosynthesis (DBT) in post-lumpectomy breast cancer patients based on number of years since diagnosis at a large academic center in which patients return immediately to screening mammography after treatment.

#### METHODS AND MATERIALS

Screening DBT exams in post-lumpectomy breast cancer patients from January 1, 2013, to June 30, 2019, were retrospectively reviewed. Performance metrics based on number of years since breast cancer diagnosis were compared using multivariable logistic regression models. Each model was adjusted for age, race, breast density, presence of a prior screening mammogram, and reader. The impact of each of these factors, in addition to time since diagnosis, was examined using generalized estimating equations with an independent correlation matrix, clustering on exams within a single woman.

#### RESULTS

Over the study period, 6,695 post-lumpectomy breast cancer patients (mean age 63, range 34-99) underwent 21,773 DBT screening exams. The cancer detection rate (CDR) was 7.7 per 1000 exams, abnormal interpretation rate (AIR) was 6.0% (1,296/21,773), positive predictive value (PPV) was 12.9% (167/1,296), sensitivity was 78.4% (167/213), specificity was 94.8% (20,431/21,560), and false-negative rate (FNR) was 2.1 per 1000 exams. There were no significant differences in CDR, sensitivity, or FNR based on years since diagnosis ( $p > 0.05$ ). For every year since diagnosis, the odds of AIR significantly decreased, PPV increased, and specificity increased, holding age, race, breast density, presence of a prior screening mammogram, and reader constant ( $p < 0.001$  to  $p = 0.01$ ). The AIRs were 7.5% (95% CI, 6.4-8.7%) for patients who were diagnosed less than 1 year ago and 5.1% (95% CI, 4.1-6.3%) for those diagnosed 8-9 years ago ( $p = 0.01$ ).

#### CONCLUSION

Among 6,695 post-lumpectomy breast cancer patients who underwent 21,773 screening DBT exams, significantly more women were recalled from screening during the initial years after diagnosis compared to subsequent years, but the AIR remained below 10% even in the first year. The CDR did not significantly change based on years since diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

These results support our institution's mammographic surveillance protocol for post-lumpectomy breast cancer patients, which is to return immediately to screening mammography, given the acceptably low AIRs.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-SSBR10-2

### Impact of Prospective Artificial Intelligence (AI) Triage of Screening Mammography/Digital Breast Tomosynthesis (DBT) on Radiologist Recall Rates

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450B

Laura Heacock, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Proposed triage-based screening mammography worklists reserve more complex exams for the radiologist and give low-risk exams to standalone AI. The purpose of this study was to prospectively evaluate AI-based triage changes to radiologist recall rate.

#### METHODS AND MATERIALS

Our IRB-approved study used an AI system trained utilizing model ensembling, with models based on 486,383 FFDM/DBT exams. This model produces a high-specificity threshold score for each breast: extremely low risk (ELR) of breast cancer or not extremely low risk (NELR). From 08/2022-03/2023, eight radiologists (mean experience = 7 yrs, range 2-19 yrs) read from a non-stratified FFDM/DBT screening list (Phase 1). During 04/2023, the same radiologists prospectively batch-read from two lists sorted by AI score: marked as ELR or NELR (Phase 2). Recall rates were compared. Radiologists subjectively rated the Phase 1 vs Phase 2 difficulty and their perception recall rate changes on a 1-5 point Likert scale.

#### RESULTS

Combined recall rates for both phases were 13.16% (1537/11682); readers recalled 6.2% (268/4325) of ELR exams and 17.25% (1269/7357) of NELR exams. During Phase 1 (no triage), readers interpreted 10,310 screening mammograms (37.9% (3908/10310) ELR, 62.01% (6402/10310) NELR) with average recall rate of 12.9% (1328/10310). Recall rate was 6.32% (247/3908) for ELR and 16.9% (1081/6402) for NELR exams. During Phase 2 (triage), readers interpreted 1,372 screening mammograms (30.4% (417/1372) ELR; 69.6% (955/1372) NELR) with average recall rate of 15.23%. Recall rate decreased to 5.04% (21/417) for ELR and increased to 19.69% (1081/6402) for NELR exams. However, there was no statistical difference in recall rate between phases for ELR exams ( $p=0.33$ ) or NELR exams ( $p=0.08$ ). No statistical difference was observed for ELR or NELR exams for experienced ( $\geq 5$  years,  $p=0.093-0.88$ ) vs inexperienced ( $< 5$  years,  $p=0.218-0.421$ ) readers. Median Likert score for perceived triage list difficulty was 3: "no change compared to Phase 1" (range 2-4). Median Likert score for ELR was 2: "mildly decreased recall rate" (range 1-3) and for NELR was 3.5: "mildly increased recall rate" (range 3-4).

#### CONCLUSION

Prospective simulated screening mammography triage does not have a significant change in recall rate, despite self-reported perceived increased recalls. Longitudinal investigation of changes to positive predictive values and cancer detection rates is indicated.

#### CLINICAL RELEVANCE/APPLICATION

Use of standalone AI to read low-risk screening mammograms will likely increase benchmark radiologist recall rates for the remaining complex examinations. However, prospective triage worklists do not appear to cause an additional increase in recall rates compared to routine use of AI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-SSBR10-3

### Exploring the Missed: Classifying Interval Breast Cancers in a U.S. Based Screening Population to Unlock the Potential Clinical Utility of AI

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450B

Tiffany Yu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recent European studies suggest artificial intelligence (AI) can reduce interval breast cancers. Given different screening practices, we reviewed and classified interval breast cancers to assess AI performance within US screening guidelines. To our knowledge, no comparable US study exists in the era of digital breast tomosynthesis (DBT).

#### METHODS AND MATERIALS

From a database of Full Field Digital Mammography (FFDM) and DBT screening mammograms acquired from 2010-2019 at a large tertiary care academic center, we identified a subset of interval breast cancers, defined as histopathologic diagnosis within 12 months after a negative screening mammogram. Exclusion criteria were BI-RADS 0, 3, 4, 5, 6; incomplete information; and data errors. Using a semi-informed, case-controlled, blinded approach, 8 fellowship-trained breast radiologists with 3-24 years of experience retrospectively classified the interval cancers as true interval cancer, minimal signs-non-actionable, minimal signs-actionable, technical miss, reading error miss, or occult. Each case was assigned a single classification by consensus. Statistical analysis evaluated associations between case classifications and deep-learning based AI algorithm (Transpara 1.7.1) risk scores, patient factors, tumor characteristics and staging.

#### RESULTS

From 184,935 screening mammograms (65% FFDM, 35% DBT), we included 150 interval breast cancers in 150 women (age 40-87 years). Nine (6%) were classified as true interval cancers, and of these 44% were flagged by AI; 35 (23%) were minimal signs-non-actionable (71% flagged by AI); 38 (25%) minimal signs-actionable (89% flagged by AI); 7 (5%) missed-technical error (40% flagged by AI); 25 (17%) missed-reading error (94% flagged by AI); and 36 (24%) occult (68% flagged by AI). Women aged 40-49 years were disproportionately affected by occult interval cancers (42%), versus women aged 50 years and older with minimal signs-actionable (27%) ( $p=0.007$ ). Interval cancers were overall associated with ACR breast density C (45%,  $p<0.00$ ). Triple-negative cancers comprised 13% of the sample, with the greatest proportion true interval cancers (25%,  $p=0.003$ ). Most interval cancers were localized (86% TNM stage 0 to 2B,  $p<0.00$ ).

#### CONCLUSION

The majority of interval cancers were classified as minimal signs, and both minimal signs and reading error misses had the greatest proportion correctly flagged by AI. Thus, AI can potentially aid in identifying and reducing the interval cancer rate in US-based screening programs.

#### CLINICAL RELEVANCE/APPLICATION

Understanding context-specific interval breast cancer classification—in this case US-based screening guidelines—is critical for assessing AI performance on improving screening mammography sensitivity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSBR10-4

### Beneficial Effect of Repeated Participation in Breast Cancer Screening on Survival

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450B

Robert A. Smith, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The benefit of mammography screening in reducing mortality from breast cancer is established, but less so the benefit of repeated participation at scheduled screening on case survival. The purpose of this study was to investigate the effect of regular attendance to mammography screening.

#### METHODS AND MATERIALS

Data on screening history and subsequent survival from 1992 to 2016 were available for 37,079 breast cancer patients in whom 4,564 breast cancer deaths occurred. We obtained data on screening history and subsequent death from breast cancer and extracted data on participation to the five (or fewer) most recent invitations prior to breast cancer diagnosis. Breast cancer incidence data was obtained from the regional oncology centers and breast cancer death data was obtained from the Swedish Cause of Death Register. These data were linked to population screening invitation and attendance data. Formal comparisons of survival with respect to numbers of screens attended utilized Cox proportional hazards regression with time-varying covariates, i.e., cumulative numbers of screens, yielding hazard ratios and 95% confidence intervals.

#### RESULTS

Depending on number of invitations, 58-73% participated in all scheduled mammography screening exams, and 73-96% participated in at least one. For those participating in all screening exams, survival rates ranged from 82.7% to 86.9%. For those participating in no screening, survival ranged from 59.1% to 77.6%. In those with five prior invitations to mammography screening, the relative hazard of breast cancer death for those attending all five screens was 0.28 (95% CI 0.25-0.33) compared to women who had participated in none, a 72% reduction in the risk of dying from breast cancer. Even after conservative adjustment for potential self-selection factors, there was a highly significant 66% reduction in hazard, with a hazard ratio of 0.34 (95% CI 0.26-0.43).

#### CONCLUSION

We found a greater reduction in the hazard of breast cancer death with increasing number of screening exams attended. In terms of limitations, these results are for case survival, not population mortality, although results are consistent with recent findings of a greater mortality reduction for those who participated in both their most recent scheduled screens. These results indicate that for those who develop breast cancer, regular participation in screening considerably improves the probability of surviving it. The importance of regular attendance in mammography screening should be clearly articulated in breast cancer screening messaging.

#### CLINICAL RELEVANCE/APPLICATION

Irregular mammography screening is common. There is a need to stress the importance in regular mammography as a key factor in reducing the risk of breast cancer death.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSBR10-5

### Rates of Advanced Cancers in Digital Breast Tomosynthesis Screening: Association with Screening Interval

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450B

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Increasing early detection of nonlethal breast cancers is the main function of screening. Advanced cancers - characterized by larger size, lymph node involvement, or aggressive molecular subtypes - are those that carry a worse prognosis. Our prior data demonstrated a significant decrease in the rate of advanced cancers with digital breast tomosynthesis (DBT) screening compared with 2D full-field digital mammography (DM). The purpose of this study was to examine how the rate of advanced cancers varied with the DBT screening interval.

#### METHODS AND MATERIALS

Our detailed database of 1265 cancers (968 invasive) diagnosed over 10 years (2011-2021) of screening with DBT was analyzed. Advanced cancers were defined by TMIST criteria (invasive cancers >2cm, HER2+ or triple negative cancers >1cm, one or more positive axillary lymph nodes, distant organ spread). The rates of advanced compared with non-advanced cancers were assessed by the time interval (in months) from the prior screening mammogram (12-15, 15-18, 18-21, 21-24, 24+ months). Statistical analysis was performed using unpaired T-tests and Chi Square with  $p < 0.05$  considered significant.

#### RESULTS

Of 968 invasive cancers, 316 (32.7%) were considered advanced. The interval from prior screening for the non-advanced cancers was significantly less (mean 542 days, median 781 days) than for the advanced cancers (mean 634 days, median 890 days) ( $p < 0.02$ ). The rate of advanced cancers showed a trend to increase from 27-28% until 638 days (1.75 years) after which it increased to 35-37%.

#### CONCLUSION

Advanced cancers occurred with longer intervals from the prior screening. Until 21 months (1.75 years), the rate of advanced cancers was relatively stable at 27-29% after which it increased to 37%. Maintaining a screening interval of less than 2 years could help reduce advanced cancers.

#### CLINICAL RELEVANCE/APPLICATION

With DBT screening, an interval of less than two years helps reduce the rate of advanced cancers.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSBR10-6

### Independent Double Reading in Screening With Digital Breast Tomosynthesis: Effective Investment?

Thursday, Nov. 30 8:00AM - 9:00AM Room: E450B

Stefanie B. Weigel, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We conducted a randomized controlled trial which revealed significantly raised breast cancer detection by digital breast tomosynthesis with synthetic mammography (DBT+SM) as compared to digital mammography (DM). As independent double reading in mammographic screening aims to increase the diagnostic sensitivity, we investigated in this subanalysis of the trial, whether DBT+SM substantially raises the true-positive proportion of screen-detected breast cancers obtained by a single reading over DM screening.

#### METHODS AND MATERIALS

From 2018 to 2020, women were randomized 1:1 in 17 screening units (n = 49,762 screened with DBT+SM, n = 49,796 with DM). Results from all independent double readings and for all screen-detected breast cancers, i.e., invasive cancers and ductal carcinoma in situ, were used.

#### RESULTS

DBT+SM screening diagnosed 416 and DM 306 women with breast cancers. In the DBT+SM arm, 26.9% (112 out of 416) were detected only by one reader and in the DM arm these were 22.2% (68/306), comprising invasive breast cancers [DBT+SM 85/112 (75.9%), DM 46/68 (67.6%)], pT1 cancers [DBT+SM 76/112 (67.9%), DM 38/68 (55.9%)] and non-special type breast cancer [DBT+SM 56/112 (50.0%), DM 31/68 (45.6%)].

#### CONCLUSION

Comparable to DM screening, and despite a higher diagnostic yield, screening with DBT+SM required still independent double reading to identify a relevant proportion of screen-detected breast cancers that were otherwise not reliably diagnosed.

#### CLINICAL RELEVANCE/APPLICATION

Independent double reading retains its rationale also in screening with digital breast tomosynthesis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSCA09

### Cardiac Imaging (Basic Science)

Thursday, Nov. 30 8:00AM - 9:00AM Room: N226

Michael F. Morris, MD (*Moderator*) Educator, Medtronic plc  
Anna Naumova, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R1-SSCA09-1 Using 7.0 T Cardiac Magnetic Resonance to Quantify Biventricular Changes in Rats under Chronic Hypobaric Hypoxia at High Altitude**

Haotian Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

The hypobaric hypoxia (HH) environments at high altitude cause physiological changes of the cardiovascular system, and the myocardium could be adversely affected. Accordingly, the aim of the present study was to explore the feasibility of using CMR to early and dynamically evaluate biventricular changes under HH environments.

#### METHODS AND MATERIALS

A total of 72 healthy male Sprague-Dawley rats were randomized into the plain control group (P group, n=24) and the high-altitude experimental group (HH group, n=48). Animals of the HH group were exposed to HH environments at Qinghai-Tibet Plateau (altitude: 4250 m), China. According to different HH durations, they were further randomized into three groups (n=16 per group) including 1-month group (HH-1 group), 3-month group (HH-3 group) and 6-month group (HH-6 group). In the meantime, animals of the P group were randomized into three corresponding groups (n=8 per group) including the P-1, P-2 and P-3 groups. At the end of experiment at each time point, biventricular structural and function were measured using 7.0 T CMR and analyzed. Blood tests and myocardial histopathology were performed.

#### RESULTS

The right ventricular global peak longitudinal strain (RVGLS) significantly decreased in the HH-1 group compared with the P-1 group in the first month of adaption ( $-19.92 \pm 1.12\%$  vs.  $22.15 \pm 1.21\%$ ,  $P < 0.05$ ). During the prolonged HH exposure, both the RVGLS, right ventricular global peak circumferential strain (RVGCS) and right ventricular global peak radial strain (RVGRS) significantly decreased in the HH-3 group compared with the P-3 group (RVGLS:  $-17.93 \pm 1.21\%$  vs.  $22.38 \pm 1.09\%$ ,  $P < 0.001$ ; RVGCS:  $-18.73 \pm 0.98\%$  vs.  $20.46 \pm 1.46\%$ ,  $P < 0.05$ ; RVGRS:  $37.09 \pm 1.57\%$  vs.  $40.41 \pm 1.24\%$ ,  $P < 0.05$ ). Further, CMR-derived strain parameters show significant correlation with histopathological findings ( $P < 0.05$ ). Overall, the RV exhibit a trend of higher volume, higher weight and thicker free wall than the control groups. In contrast, the LV has an under-filling conditions which presented as the lower end-diastolic volume (EDV) and end-systolic volume (ESV) than the control groups ( $P < 0.05$ ), with the preserved LVEF and unchanged strain parameters ( $P > 0.05$ ).

#### CONCLUSION

CMR-derived structural and functional parameters allow early and quantitatively evaluate biventricular remodeling during chronic HH exposure and may be used as a diagnostic indicator for the evaluation of myocardial dysfunction under such circumstance.

#### CLINICAL RELEVANCE/APPLICATION

Our experiment demonstrates the feasibility of CMR in evaluation of biventricular changes under chronic HH environments. This has important implications for cardiac management of high-altitude dwellers, especially the immigrants from the plains.

#### **R1-SSCA09-2 Investigating the Therapeutic Efficacy of Magnetically Labeled iPSC-derived Extracellular Vesicles in Myocardial Infarction Treatment**

Guanshu Liu, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The development and use of extracellular vesicles (EVs) -based therapy will greatly benefit from non-invasive MRI methods that can characterize the quantitative, temporal, and ultimate spatial distribution of administered EVs. The goal of this study is to investigate the impact of magnetic labeling on the therapeutic effects of induced pluripotent stem cell (iPSC)-derived EVs in treating injured hearts.

## METHODS AND MATERIALS

iPSC-EVs were isolated from the conditioned medium of iPSCs using commercial size exclusion columns (qEV, iZON) and characterized in accordance with MISEV2018 as described previously<sup>1</sup>. Superparamagnetic iron oxide (SPIO, 5 nm) nanoparticles were conjugated with histidine tags and then encapsulated into EVs by electroporation, followed by Ni-NTA purification. Right after the reperfusion in mouse hearts that undergo a 35-min ligation of the left anterior descending coronary artery (LAD),  $1 \times 10^9$  (measured by NTA) magnetically labeled iPSC-EVs were administered intramyocardially to peri-infarct areas. In vivo cardiac MRI was performed after the injection of EVs using an 11.7T Bruker Biospec MRI scanner to evaluate cardiac function while histological assessment was later performed for infarct size.

## RESULTS

We first optimized the electroporation protocol method to prepare EVs with a high SPIO loading rate and preserved EV characteristics, including size, protein content, RNA content, and immunomodulatory effects on macrophages. The optimized magnetic iPSC-EVs have an MRI detectability of  $\sim 4 \times 10^7$  EVs, providing sufficient sensitivity. The therapeutic evaluation (Fig. 1) shows significantly improved contractile function (32% increase in LVEF,  $P=0.0471$ ), reduced scar size (61% decrease,  $P=0.0059$ ), and increased viable mass (44.5% decrease in midline infarct length,  $P=0.0216$ ) in magneto-EVs-treated IRI mice compared to saline treated mice.

## CONCLUSION

We developed an optimized EV labeling protocol, which allows creation of magnetic iPSC-EVs that can be sensitively detected using in vivo MRI and which have preserved ability to improve cardiac function and reduce infarct size. The therapeutic potential together with the imaging capability enables a theranostic approach for using stem cell-derived EVs to combat ischemic cardiovascular disease. References. 1. Han, Z., et al., *J Extracell Vesicles* 2021, 10 (3), e12054.

## CLINICAL RELEVANCE/APPLICATION

Magnetically labeled, stem cell-derived EVs with well-reserved therapeutic potential is essential to develop MRI-guided EV therapy for treating myocardial infarction in human.

## R1-SSCA09-3 Feasibility of Coronary CT Angiography (CCTA) in Patients with Arbitrary Heart Rate by using the 16cm Wide Body Detector CT under Free Breathing

Xiaohui Li (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the feasibility of 16 wide body detector CT in coronary CT angiography (CCTA) examination with a single cardiac cycle in patients with arbitrary heart rate under free breathing.

## METHODS AND MATERIALS

A total of 200 patients with suspected coronary heart disease were collected and divided into two groups for CCTA: Group A: heart rate < 70 bpm) and Group B: heart rate > 70 bpm). Patients with known renal insufficiency, allergy to contrast iodine, hyperthyreosis, and patients undergoing coronary artery bypass grafting were excluded. The enrolled patients were 194 (group A (n=130 heart rate < 70 bpm), (group B (n=64 heart rate > 70 bpm). All examinations under free breathing were performed on 16cm Wide Body Detector CT (GE Healthcare) by using smart-phase technique for scanning and reconstruction and coronary artery tracking freezing (SSF) technique for coronary artery motion correction. Both groups used the same contrast dose rate of 25 mgI/kg/s. CT value and standard deviation in aortic sinus (AS), right coronary artery, left anterior descending, left circumflex, and pericardial fat were measured. Contrast-to-noise ratio for vessels was calculated. Two experienced Radiologists independently reviewed the image quality by using a 5-point scale (1: nondiagnostic—5: excellent). The image quality and radiation dose of the two groups were compared. The Mann-Whitney test and independent sample t test were used for statistical analysis,  $P < 0.05$  was considered statistically significant.

## RESULTS

There was no difference in sex, age, body mass index (BMI) contrast dose, subjective and quantitative image quality between the two groups (all  $P > 0.05$ ), Group B showed higher mean heart rate ( $80.43 \pm 9.40$ ) than Group A ( $61.00 \pm 6.09$ ), differences were statistically significant ( $P=0.009$ ). The effective radiation dose in group A [ $2.46 \pm 0.74$  mSv] was higher than group B [ $2.09 \pm 0.73$  mSv], differences were statistically significant ( $P=0.000$ ).

## CONCLUSION

This study demonstrated the possibility of CCTA regardless of the patient's heart rate by using the 16cm Wide Body Detector CT under free breathing.

## CLINICAL RELEVANCE/APPLICATION

This study demonstrated the capability of a 16cm z-coverage Computed Tomography (CT) to perform CCTA without any administration of beta-blockers in patients with elevated HR.

### R1-SSCA09-4 **Combining Coronary CT Angiography and Coronary Flow Capacity Measurement with a Low-Dose Comprehensive Cardiac CT Technique - Validation Versus <sup>82</sup>Rb PET**

Logan Hubbard, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

PET-based coronary flow capacity (CFC) measurement, derived from coronary flow reserve (CFR) and quantitative stress flow data, accurately stratifies the functional severity of concurrent focal, diffuse, and microvascular coronary artery disease. Yet, PET CFC measurement lacks relevant morphologic information that only coronary CT angiography (CCTA) can provide. Hence, this work validates an accurate, low-dose comprehensive cardiac CT technique that combines CCTA with a new single-volume CT perfusion approach for quantitative stress flow, CFR, and CFC measurement.

## METHODS AND MATERIALS

Eleven patients with known or suspected coronary disease underwent rest and stress (regadenoson 0.4mg IV) imaging with quantitative <sup>82</sup>Rb PET. After which, low-dose comprehensive cardiac CT imaging was performed, consisting of a CCTA protocol, a 10-minute delay, and a subsequent single-volume stress (regadenoson 0.4mg IV) CT protocol. For both protocols, the same triphasic contrast injection (Phase 1: 0.8 mL/kg; Phase 2: 30/70 mix of 0.1 mL/kg; Phase 3: 30mL saline; 5 mL/s) was performed, followed by dynamic bolus tracking with CCTA or stress CT acquisition, respectively. The dynamic bolus tracking, CCTA, and stress CT data were then utilized by a new single-volume CT perfusion approach to derive quantitative stress flow, CFR, and CFC measurements, which were compared to corresponding <sup>82</sup>Rb PET measurements through t-testing and diagnostic performance analysis.

## RESULTS

Per-vessel CT stress flow and CT CFR measurements were in good agreement with the corresponding <sup>82</sup>Rb PET measurements (stress flow:  $1.95 \pm 0.60$  mL/min/g vs.  $1.88 \pm 0.68$  mL/min/g,  $p = 0.19$ ; CFR:  $2.51 \pm 0.96$  vs.  $2.62 \pm 0.92$ ,  $p = 0.47$ ). For detection of mildly reduced stress flow ( $<1.70$  mL/min/g), mildly reduced CFR ( $<2.70$ ), and mildly reduced CFC (stress  $<1.70$  mL/min/g and CFR  $<2.70$ ), the sensitivity (SN), specificity (SP), positive predictive value (PPV), negative predictive value (NPV), accuracy (AC), and area-under-the-curve (AUC) of the receiver operator characteristic (ROC) were SN = 75%, 88%, 100%; SP = 82%, 53%, 78%; PPV = 80%, 64%, 50%; NPV = 78%, 82%, 100%; AC = 79%, 70%, 82%, AUC = 0.87, 0.85, 0.89. The median effective dose of the comprehensive cardiac CT technique, i.e., CCTA and CFC combined, was 2.73 mSv (2.28 - 2.78), while the median effective dose of <sup>82</sup>Rb PET was 3.7 mSv (3.2 - 4.1 mSv).

## CONCLUSION

A new, low-dose comprehensive cardiac CT technique combines CCTA with CT-based stress flow, CFR, and CFC measurement, with good diagnostic performance as compared to <sup>82</sup>Rb PET.

## CLINICAL RELEVANCE/APPLICATION

Combining CCTA with CT-based coronary flow capacity (CFC) measurement has the potential to improve stratification of patients at risk for major adverse cardiac events.

### R1-SSCA09-5 **Ultra-High Resolution Versus Virtual Non-Calcium Algorithm for Stenosis Evaluation with Photon-Counting CT - Results from a Dynamic Phantom Study**

Emese Zsarnoczay, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this phantom study was to investigate the effect of using ultra-high resolution (UHR) versus virtual non-calcium (VNCa) reconstruction on the accuracy of coronary artery stenosis evaluation in comparison to virtual monoenergetic reconstructions acquired at standard resolution (SR) with photon-counting detector CT (PCD-CT).

## METHODS AND MATERIALS

One vessel phantom (diameter: 4mm) containing solid calcified lesions (25%, 50% stenoses) filled with an analog of iodine and blood inside a thorax phantom attached to a motion simulator was imaged on a PCD-CT system using UHR and SR modes (0.2, 0.6 mm slice thickness, respectively). Images were acquired at heart rates of 60, 80 and 100 beats per minute (bpm),

and UHR (Bv64 kernel, quantum iterative reconstruction (QIR) level 3), SR (55keV, Bv40 kernel, QIR3) and VNCA images (65keV, Qr44 kernel, QIR3) were reconstructed. Percent diameter stenosis (PDS) was measured by three readers.

## **RESULTS**

There was a significant difference between the measured PDS values with UHR vs. SR for the 50% stenosis at all heart rates (all  $P=0.002$ , e.g. at 60bpm UHR:  $51.0\% \pm 1.3$  vs. SR:  $60.3\% \pm 4.9$ ), where UHR measurements were closer to the nominal stenosis, and with VNCA vs. SR (all  $P=0.003$ , e.g. at 60bpm VNCA:  $50.6\% \pm 1.7$  vs. SR:  $60.3\% \pm 4.9$ ) where VNCA measurements were closer to the actual lesion size. For the 50% lesion, no significant difference was found between the measured PDS values for UHR vs. VNCA at all heart rates (all  $P>0.4$ ). For the 25% lesion, there was a significant difference between the measured PDS values with UHR vs. SR at all heart rates (all  $P=0.003$ ), with UHR measurements closer to the actual lesion size, and VNCA vs. SR at 60bpm ( $P=0.002$ ), with VNCA closer to the nominal stenosis. However, there was no difference with VNCA vs. SR at 80bpm ( $P=0.021$ ) and at 100bpm ( $P=0.498$ ). For the 25% lesion, UHR vs. VNCA PDS measurements showed no significant difference at 60 and 80 bpm ( $P=0.212$  and  $P=0.072$ , respectively).

## **CONCLUSION**

This motion phantom study demonstrated improved stenosis quantification accuracy with PCD-CT using either UHR acquisition or VNCA reconstruction techniques up to a heart rate of 80bpm, above which UHR can still provide more accurate stenosis grading compared to SR.

## **CLINICAL RELEVANCE/APPLICATION**

The findings of this phantom study have important implications in accurate stenosis grading. The results support that both VNCA and UHR could improve stenosis grading up to 80bpm.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-SSCA09-1

### Using 7.0 T Cardiac Magnetic Resonance to Quantify Biventricular Changes in Rats under Chronic Hypobaric Hypoxia at High Altitude

Thursday, Nov. 30 8:00AM - 9:00AM Room: N226

Haotian Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

The hypobaric hypoxia (HH) environments at high altitude cause physiological changes of the cardiovascular system, and the myocardium could be adversely affected. Accordingly, the aim of the present study was to explore the feasibility of using CMR to early and dynamically evaluate biventricular changes under HH environments.

#### METHODS AND MATERIALS

A total of 72 healthy male Sprague-Dawley rats were randomized into the plain control group (P group, n=24) and the high-altitude experimental group (HH group, n=48). Animals of the HH group were exposed to HH environments at Qinghai-Tibet Plateau (altitude: 4250 m), China. According to different HH durations, they were further randomized into three groups (n=16 per group) including 1-month group (HH-1 group), 3-month group (HH-3 group) and 6-month group (HH-6 group). In the meantime, animals of the P group were randomized into three corresponding groups (n=8 per group) including the P-1, P-2 and P-3 groups. At the end of experiment at each time point, biventricular structural and function were measured using 7.0 T CMR and analyzed. Blood tests and myocardial histopathology were performed.

#### RESULTS

The right ventricular global peak longitudinal strain (RVGLS) significantly decreased in the HH-1 group compared with the P-1 group in the first month of adaption ( $-19.92 \pm 1.12\%$  vs.  $22.15 \pm 1.21\%$ ,  $P < 0.05$ ). During the prolonged HH exposure, both the RVGLS, right ventricular global peak circumferential strain (RVGCS) and right ventricular global peak radial strain (RVGRS) significantly decreased in the HH-3 group compared with the P-3 group (RVGLS:  $-17.93 \pm 1.21\%$  vs.  $22.38 \pm 1.09\%$ ,  $P < 0.001$ ; RVGCS:  $-18.73 \pm 0.98\%$  vs.  $20.46 \pm 1.46\%$ ,  $P < 0.05$ ; RVGRS:  $37.09 \pm 1.57\%$  vs.  $40.41 \pm 1.24\%$ ,  $P < 0.05$ ). Further, CMR-derived strain parameters show significant correlation with histopathological findings ( $P < 0.05$ ). Overall, the RV exhibit a trend of higher volume, higher weight and thicker free wall than the control groups. In contrast, the LV has an under-filling conditions which presented as the lower end-diastolic volume (EDV) and end-systolic volume (ESV) than the control groups ( $P < 0.05$ ), with the preserved LVEF and unchanged strain parameters ( $P > 0.05$ ).

#### CONCLUSION

CMR-derived structural and functional parameters allow early and quantitatively evaluate biventricular remodeling during chronic HH exposure and may be used as a diagnostic indicator for the evaluation of myocardial dysfunction under such circumstance.

#### CLINICAL RELEVANCE/APPLICATION

Our experiment demonstrates the feasibility of CMR in evaluation of biventricular changes under chronic HH environments. This has important implications for cardiac management of high-altitude dwellers, especially the immigrants from the plains.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSCA09-2

### Investigating the Therapeutic Efficacy of Magnetically Labeled iPSC-derived Extracellular Vesicles in Myocardial Infarction Treatment

Thursday, Nov. 30 8:00AM - 9:00AM Room: N226

Guanshu Liu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The development and use of extracellular vesicles (EVs) -based therapy will greatly benefit from non-invasive MRI methods that can characterize the quantitative, temporal, and ultimate spatial distribution of administered EVs. The goal of this study is to investigate the impact of magnetic labeling on the therapeutic effects of induced pluripotent stem cell (iPSC)-derived EVs in treating injured hearts.

#### METHODS AND MATERIALS

iPSC-EVs were isolated from the conditioned medium of iPSCs using commercial size exclusion columns (qEV, iZON) and characterized in accordance with MISEV2018 as described previously<sup>1</sup>. Superparamagnetic iron oxide (SPIO, 5 nm) nanoparticles were conjugated with histidine tags and then encapsulated into EVs by electroporation, followed by Ni-NTA purification. Right after the reperfusion in mouse hearts that undergo a 35-min ligation of the left anterior descending coronary artery (LAD),  $1 \times 10^9$  (measured by NTA) magnetically labeled iPSC-EVs were administered intramyocardially to peri-infarct areas. In vivo cardiac MRI was performed after the injection of EVs using an 11.7T Bruker Biospec MRI scanner to evaluate cardiac function while histological assessment was later performed for infarct size.

#### RESULTS

We first optimized the electroporation protocol method to prepare EVs with a high SPIO loading rate and preserved EV characteristics, including size, protein content, RNA content, and immunomodulatory effects on macrophages. The optimized magnetic iPSC-EVs have an MRI detectability of  $\sim 4 \times 10^7$  EVs, providing sufficient sensitivity. The therapeutic evaluation (Fig. 1) shows significantly improved contractile function (32% increase in LVEF,  $P=0.0471$ ), reduced scar size (61% decrease,  $P=0.0059$ ), and increased viable mass (44.5% decrease in midline infarct length,  $P=0.0216$ ) in magneto-EVs-treated IRI mice compared to saline treated mice.

#### CONCLUSION

We developed an optimized EV labeling protocol, which allows creation of magnetic iPSC-EVs that can be sensitively detected using in vivo MRI and which have preserved ability to improve cardiac function and reduce infarct size. The therapeutic potential together with the imaging capability enables a theranostic approach for using stem cell-derived EVs to combat ischemic cardiovascular disease. References. 1. Han, Z., et al., *J Extracell Vesicles* 2021, 10 (3), e12054.

#### CLINICAL RELEVANCE/APPLICATION

Magnetically labeled, stem cell-derived EVs with well-reserved therapeutic potential is essential to develop MRI-guided EV therapy for treating myocardial infarction in human.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSCA09-3

### Feasibility of Coronary CT Angiography (CCTA) in Patients with Arbitrary Heart Rate by using the 16cm Wide Body Detector CT under Free Breathing

Thursday, Nov. 30 8:00AM - 9:00AM Room: N226

Xiaohui Li (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility of 16 wide body detector CT in coronary CT angiography (CCTA) examination with a single cardiac cycle in patients with arbitrary heart rate under free breathing.

#### METHODS AND MATERIALS

A total of 200 patients with suspected coronary heart disease were collected and divided into two groups for CCTA: Group A: heart rate < 70 bpm) and Group B: heart rate > 70 bpm). Patients with known renal insufficiency, allergy to contrast iodine, hyperthyroidism, and patients undergoing coronary artery bypass grafting were excluded. The enrolled patients were 194 (group A (n=130 heart rate < 70 bpm), group B (n=64 heart rate > 70 bpm). All examinations under free breathing were performed on 16cm Wide Body Detector CT (GE Healthcare) by using smart-phase technique for scanning and reconstruction and coronary artery tracking freezing (SSF) technique for coronary artery motion correction. Both groups used the same contrast dose rate of 25 mgI/kg/s. CT value and standard deviation in aortic sinus (AS), right coronary artery, left anterior descending, left circumflex, and pericardial fat were measured. Contrast-to-noise ratio for vessels was calculated. Two experienced Radiologists independently reviewed the image quality by using a 5-point scale (1: nondiagnostic—5: excellent). The image quality and radiation dose of the two groups were compared. The Mann-Whitney test and independent sample t test were used for statistical analysis,  $P < 0.05$  was considered statistically significant.

#### RESULTS

There was no difference in sex, age, body mass index (BMI) contrast dose, subjective and quantitative image quality between the two groups (all  $P > 0.05$ ), Group B showed higher mean heart rate ( $80.43 \pm 9.40$ ) than Group A ( $61.00 \pm 6.09$ ), differences were statistically significant ( $P = 0.009$ ). The effective radiation dose in group A [ $2.46 \pm 0.74$  mSv] was higher than group B [ $2.09 \pm 0.73$  mSv], differences were statistically significant ( $P = 0.000$ ).

#### CONCLUSION

This study demonstrated the possibility of CCTA regardless of the patient's heart rate by using the 16cm Wide Body Detector CT under free breathing.

#### CLINICAL RELEVANCE/APPLICATION

This study demonstrated the capability of a 16cm z-coverage Computed Tomography (CT) to perform CCTA without any administration of beta-blockers in patients with elevated HR.

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## Abstract Archives of the RSNA, 2023

R1-SSCA09-4

### Combining Coronary CT Angiography and Coronary Flow Capacity Measurement with a Low-Dose Comprehensive Cardiac CT Technique - Validation Versus $^{82}\text{Rb}$ PET

Thursday, Nov. 30 8:00AM - 9:00AM Room: N226

Logan Hubbard, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

PET-based coronary flow capacity (CFC) measurement, derived from coronary flow reserve (CFR) and quantitative stress flow data, accurately stratifies the functional severity of concurrent focal, diffuse, and microvascular coronary artery disease. Yet, PET CFC measurement lacks relevant morphologic information that only coronary CT angiography (CCTA) can provide. Hence, this work validates an accurate, low-dose comprehensive cardiac CT technique that combines CCTA with a new single-volume CT perfusion approach for quantitative stress flow, CFR, and CFC measurement.

#### METHODS AND MATERIALS

Eleven patients with known or suspected coronary disease underwent rest and stress (regadenoson 0.4mg IV) imaging with quantitative  $^{82}\text{Rb}$  PET. After which, low-dose comprehensive cardiac CT imaging was performed, consisting of a CCTA protocol, a 10-minute delay, and a subsequent single-volume stress (regadenoson 0.4mg IV) CT protocol. For both protocols, the same triphasic contrast injection (Phase 1: 0.8 mL/kg; Phase 2: 30/70 mix of 0.1 mL/kg; Phase 3: 30mL saline; 5 mL/s) was performed, followed by dynamic bolus tracking with CCTA or stress CT acquisition, respectively. The dynamic bolus tracking, CCTA, and stress CT data were then utilized by a new single-volume CT perfusion approach to derive quantitative stress flow, CFR, and CFC measurements, which were compared to corresponding  $^{82}\text{Rb}$  PET measurements through t-testing and diagnostic performance analysis.

#### RESULTS

Per-vessel CT stress flow and CT CFR measurements were in good agreement with the corresponding  $^{82}\text{Rb}$  PET measurements (stress flow:  $1.95 \pm 0.60$  mL/min/g vs.  $1.88 \pm 0.68$  mL/min/g,  $p = 0.19$ ; CFR:  $2.51 \pm 0.96$  vs.  $2.62 \pm 0.92$ ,  $p = 0.47$ ). For detection of mildly reduced stress flow ( $<1.70$  mL/min/g), mildly reduced CFR ( $<2.70$ ), and mildly reduced CFC (stress  $<1.70$  mL/min/g and CFR  $<2.70$ ), the sensitivity (SN), specificity (SP), positive predictive value (PPV), negative predictive value (NPV), accuracy (AC), and area-under-the-curve (AUC) of the receiver operator characteristic (ROC) were SN = 75%, 88%, 100%; SP = 82%, 53%, 78%; PPV = 80%, 64%, 50%; NPV = 78%, 82%, 100%; AC = 79%, 70%, 82%, AUC = 0.87, 0.85, 0.89. The median effective dose of the comprehensive cardiac CT technique, i.e., CCTA and CFC combined, was 2.73 mSv (2.28 - 2.78), while the median effective dose of  $^{82}\text{Rb}$  PET was 3.7 mSv (3.2 - 4.1 mSv).

#### CONCLUSION

A new, low-dose comprehensive cardiac CT technique combines CCTA with CT-based stress flow, CFR, and CFC measurement, with good diagnostic performance as compared to  $^{82}\text{Rb}$  PET.

#### CLINICAL RELEVANCE/APPLICATION

Combining CCTA with CT-based coronary flow capacity (CFC) measurement has the potential to improve stratification of patients at risk for major adverse cardiac events.

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## Abstract Archives of the RSNA, 2023

R1-SSCA09-5

### Ultra-High Resolution Versus Virtual Non-Calcium Algorithm for Stenosis Evaluation with Photon-Counting CT - Results from a Dynamic Phantom Study

Thursday, Nov. 30 8:00AM - 9:00AM Room: N226

Emese Zsarnoczay, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this phantom study was to investigate the effect of using ultra-high resolution (UHR) versus virtual non-calcium (VNCA) reconstruction on the accuracy of coronary artery stenosis evaluation in comparison to virtual monoenergetic reconstructions acquired at standard resolution (SR) with photon-counting detector CT (PCD-CT).

#### METHODS AND MATERIALS

One vessel phantom (diameter: 4mm) containing solid calcified lesions (25%, 50% stenoses) filled with an analog of iodine and blood inside a thorax phantom attached to a motion simulator was imaged on a PCD-CT system using UHR and SR modes (0.2, 0.6 mm slice thickness, respectively). Images were acquired at heart rates of 60, 80 and 100 beats per minute (bpm), and UHR (Bv64 kernel, quantum iterative reconstruction (QIR) level 3), SR (55keV, Bv40 kernel, QIR3) and VNCA images (65keV, Qr44 kernel, QIR3) were reconstructed. Percent diameter stenosis (PDS) was measured by three readers.

#### RESULTS

There was a significant difference between the measured PDS values with UHR vs. SR for the 50% stenosis at all heart rates (all  $P=0.002$ , e.g. at 60bpm UHR:  $51.0\% \pm 1.3$  vs. SR:  $60.3\% \pm 4.9$ ), where UHR measurements were closer to the nominal stenosis, and with VNCA vs. SR (all  $P=0.003$ , e.g. at 60bpm VNCA:  $50.6\% \pm 1.7$  vs. SR:  $60.3\% \pm 4.9$ ) where VNCA measurements were closer to the actual lesion size. For the 50% lesion, no significant difference was found between the measured PDS values for UHR vs. VNCA at all heart rates (all  $P>0.4$ ). For the 25% lesion, there was a significant difference between the measured PDS values with UHR vs. SR at all heart rates (all  $P=0.003$ ), with UHR measurements closer to the actual lesion size, and VNCA vs. SR at 60bpm ( $P=0.002$ ), with VNCA closer to the nominal stenosis. However, there was no difference with VNCA vs. SR at 80bpm ( $P=0.021$ ) and at 100bpm ( $P=0.498$ ). For the 25% lesion, UHR vs. VNCA PDS measurements showed no significant difference at 60 and 80 bpm ( $P=0.212$  and  $P=0.072$ , respectively).

#### CONCLUSION

This motion phantom study demonstrated improved stenosis quantification accuracy with PCD-CT using either UHR acquisition or VNCA reconstruction techniques up to a heart rate of 80bpm, above which UHR can still provide more accurate stenosis grading compared to SR.

#### CLINICAL RELEVANCE/APPLICATION

The findings of this phantom study have important implications in accurate stenosis grading. The results support that both VNCA and UHR could improve stenosis grading up to 80bpm.

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## Abstract Archives of the RSNA, 2023

R1-SSCH09

### Chest Imaging (Radiography: AI and Clinical Applications)

Thursday, Nov. 30 8:00AM - 9:00AM Room: E352

Axel Wismueller, MD, PhD (*Moderator*) Nothing to Disclose  
Emily B. Tsai, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R1-SSCH09-1 Segregating Normal Chest Radiographs from Abnormal Chest Radiographs using DeepTek AI: Retrospective and Prospective Analyses**

Richa Pant (*Presenter*) Nothing to Disclose

#### PURPOSE

An AI model that segregates normal chest radiographs from abnormal chest radiographs can reduce the workload of radiologists and manage the radiology workflow.

#### METHODS AND MATERIALS

17,500 frontal chest radiographs were retrospectively collected from 4 different sites (A, B, C, and D) between April 2020 and November 2022. For sites A and B, associated radiology reports from the PACS were considered the ground truth. Data from sites C and D were annotated by three radiologists, and the annotations made by the most experienced radiologist were considered the ground truth. DeepTek AI was used to process the scans and segregate them as "likely normal" or "suspected abnormal". All "likely normal" scans were reviewed by a human reader, and if any of them were found abnormal, they were sent to an expert reader for final reporting. Additionally, 2049 "likely normal" chest radiographs were randomly sampled from the radiology workflow at a hospital between January and February 2023 for prospective analysis. The associated radiology reports from the PACS were considered the ground truth. All the scans were analyzed using the same method.

#### RESULTS

For the retrospective analysis, the error rate of AI was defined as the percentage of scans that were actually abnormal but predicted as likely normal by AI. The error rate of the human reader was defined as the percentage of scans that were actually abnormal but predicted as normal by the human reader. The reduction in radiology workload, defined by the percentage of scans reported as normal by AI, was calculated at two different thresholds. At threshold 1, AI could segregate 21%, 28%, 31%, and 20% of normal scans from total scans from sites A, B, C, and D with low error rates of 4%, 3%, 1%, and 3%, respectively. At threshold 2, the AI could segregate a higher number of normal scans i.e. 45%, 55%, 63%, and 37% from sites A, B, C, and D at slightly higher error rates of 11%, 6%, 8%, and 8%, respectively. Human readers could segregate 41%, 65%, and 76% of normal scans from total scans from sites A, C, and D at error rates of 11%, 3%, and 11%, respectively. For the prospective analysis, the human reader agreed with the AI result for 95% of scans, and the expert reader found abnormalities in only 1% of the remaining 5% of scans.

#### CONCLUSION

DeepTek AI could effectively segregate normal scans from abnormal scans with high precision, improving the radiology workflow.

#### CLINICAL RELEVANCE/APPLICATION

DeepTek AI was used to segregate normal chest radiographs from abnormal chest radiographs in a retrospective and prospective study. The results demonstrated that DeepTek AI could segregate normal scans from abnormal scans as effectively as a human reader. The approach can be used to optimize the radiology workflow and reduce human fatigue in reporting scans.

#### **R1-SSCH09-3 Leveraging Deep Learning of Chest Radiograph Images Identifies Individuals at High-Risk of Chronic Obstructive Pulmonary Disease**

Saman Doroodgar Jorshery, MD, MPH (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study is to test whether deep learning can identify individuals at high-risk of incident Chronic Obstructive Pulmonary Disease (COPD) over 6 years using outpatient chest x-rays (CXR).

## **METHODS AND MATERIALS**

We previously developed a convolutional neural network (CXR-Lung-Risk) to predict lung-related mortality from CXRs. In this study, we externally validated this tool to predict incident COPD from routine outpatient CXRs. We identified patients with no history of lung cancer, COPD, or emphysema who had a chest radiograph. The primary outcome was incident COPD within 6 years after the CXR. Discrimination was compared to a clinical risk score (TargetCOPD), using area under the receiver operating characteristic curve. Cox proportional hazards survival analysis assessed the association between CXR-Lung-Risk with incident COPD after adjusting for TargetCOPD variables, including age, smoking status, recent dyspnea, and medications. Continuous CXR-Lung-Risk was further categorized in 4 groups (very mild, mild, moderate, high) based on previously published risk thresholds.

## **RESULTS**

We analyzed 10913 patients, with mean age of 62.3 (SD: 6.8), 48.6% male, 18.6% current smoker, with mean TargetCOPD score of 0.14 (SD: 0.12). CXR-Lung-Risk model was significantly and independently associated with incident COPD and added to the predictive value of the TargetCOPD score (6 Years AUC CXR-Lung-Risk + TargetCOPD: [0.72 (95% CI: 0.71-0.74)], vs. 6 Years AUC TargetCOPD alone: [0.66 (95% CI: 0.64-0.67)],  $p < 0.01$ ). We had similar findings with 3 years and 1 year AUC. In comparison with very mild risk group (CXR-Lung-Risk < 60), significantly higher risk of incident COPD was seen in individuals with mild risk group (60 < CXR-Lung-Risk < 65) (aHR: 1.83, 95% CI: 1.47 - 2.27), moderate risk group (65 < CXR-Lung-Risk < 70) (aHR: 2.88, 95% CI: 2.31- 3.60, and high risk group (CXR-Lung-Risk > 70) (aHR: 5.63, 95% CI: 4.48 - 7.08), after adjusting for the aforementioned covariates including chronological age. A similar pattern was observed in subgroup analyses stratified by clinical center.

## **CONCLUSION**

A deep learning model using routine chest x-ray images could identify individuals at high-risk for incident COPD beyond currently used clinical risk factors.

## **CLINICAL RELEVANCE/APPLICATION**

CXR is a widely used imaging modality. Opportunistic screening of existing CXRs using deep learning based model (CXR-Lung-Risk) could help in identifying high-risk individuals and guide COPD prevention.

## **R1- SSCH09-4 Prospective Multi-Site Validation of AI to Detect Tuberculosis and Abnormalities on Screening Chest Radiographs in an HIV Enriched Population in Zambia**

Nsala Sanjase, MBChB (*Presenter*) Nothing to Disclose

## **PURPOSE**

Artificial intelligence (AI) to interpret chest radiographs (CXRs) could function as scalable triage tests for active pulmonary tuberculosis (TB) and as abnormality detectors in resource-constrained settings. In this study, we prospectively evaluated a CXR AI system, including both a TB AI and an CXR abnormality AI, in an HIV enriched population.

## **METHODS AND MATERIALS**

Adults who had symptoms suggestive of TB, were close contacts of TB patients, or were newly diagnosed with HIV were recruited at 3 clinical sites in Zambia (trial NCT05139940). The reference standard for TB status was a positive GeneXpert Ultra assay or sputum Mycobacterium tuberculosis culture, and for CXR abnormality was the presence of a potentially clinically significant imaging finding based on a majority vote of 3 radiologists. The TB AI's scores were dichotomized using two prespecified operating points (OP): a high sensitivity OP based on the WHO target product profile (90% sensitivity, 70% specificity) and a more balanced OP designed to resemble an average radiologist's performance. We tested the TB AI for non-inferiority to 9 radiologists and to the WHO target using a prespecified margin of 5%. We tested the CXR abnormality AI for non-inferiority to a prespecified target (90% sensitivity, 50% specificity).

## **RESULTS**

1,932 patients were enrolled. Of the 1,807 patients with a definitive TB status, 641 (35%) were HIV positive and 190 (11%) were TB positive. The CXRs of 1,923 patients had abnormal status, of which 555 (29%) had CXR abnormalities. The TB AI's AUC was 88% [95%CI 84-91], and the 9 radiologists' sensitivities were comparable to or slightly below the AI at matching specificity. The TB AI's sensitivity and specificity were respectively 87% and 70% at the high-sensitivity OP and 78% and 82% at the balanced OP. At the former OP, the TB AI was non-inferior to the radiologists for sensitivity ( $p < 0.001$ ) but not specificity ( $p = 0.99$ ) and met WHO targets for specificity ( $p < 0.001$ ) but not sensitivity ( $p = 0.17$ ). At the balanced OP, the AI was non-inferior to the radiologists for both sensitivity and specificity ( $p < 0.02$  for both). The CXR abnormality AI's AUC was



97% [95%CI 96-98] with sensitivity and specificity respectively at 97% and 79% at the high-sensitivity OP, meeting the prespecified target ( $p < 0.001$ ).

#### **CONCLUSION**

Both the TB and CXR abnormality AIs demonstrated high performance in an HIV-enriched population. This AI system could help scale cost-effective TB screening and detection of differential diagnoses in settings where radiologists are not available.

#### **CLINICAL RELEVANCE/APPLICATION**

Artificial intelligence can triage for active pulmonary TB with non-inferior performance to radiologists and detect differential diagnoses, indicating potential to aid cost effective TB screening.

#### **R1- SSCH09-5 Investigating Artificial Intelligence Detection of Unreported Radiographic Markers of Osteoporosis on Chest X-Ray**

Jonathan S. Luchs, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Osteoporosis is common in the aging population. The presence of osteopenia and spine wedge fracture on chest X-ray (CXR) are strong indicators of osteoporosis. CXR has the potential to identify patients at high risk of osteoporosis. However, these findings are often underreported due to limited awareness of their importance. AI may be able to characterize patient osteoporosis risk through the detection of these findings. The aim of this study was to process retrospective CXRs to identify osteopenia of the spine and spine wedge fractures that were not reported in the original radiologist report.

#### **METHODS AND MATERIALS**

The dataset consisted of 519 CXRs from patients  $\geq 65$  years, collected from outpatient clinics. CXR images were retrospectively processed by the AI model for the presence/absence of osteopenia and spine wedge fracture. As a comparison, the original radiologist report was manually reviewed for the presence/absence of these findings, with findings considered absent if they were not mentioned in the report. In cases where there was a discrepancy between the model and the report, a radiologist adjudicator evaluated the CXR scan to determine ground truth (GT), i.e., if the finding was overcalled or under called by the AI model/radiologist.

#### **RESULTS**

There was significant variation in reported findings between the AI model and the original report. There were 76 (14.6%) and 58 (11.2%) instances of osteopenia and spine wedge fracture detected by the AI model, compared to 8 (1.5%) and 0 (0.0%) in the report, respectively. AI/report agreement had a Cohen's Kappa of -0.001 for spine fracture and -0.02 for osteopenia, indicating no agreement. In discrepant studies, comparison with the GT indicated that there was predominantly under calling in the original report. 2.2% and 0.0% osteopenia and spine wedge fracture findings were correctly reported, while 97.8% and 100.0% were not indicated in the report. In comparison, the AI model correctly identified 19.0% and 46.2% osteopenia and spine wedge fracture findings, while missing 81.0% and 53.8%, respectively. The AI model had a false positive rate of 0.12 and 0.06 compared to 0.01 and 0.00 in the report.

#### **CONCLUSION**

To date, AI models in medical imaging have typically focused on radiological finding detection to provide direct diagnostic assistance to radiologists. Here we present a study investigating a use-case to enhance patient osteoporosis risk characterisation to improve patient care and management through the detection of unreported findings suggestive of osteoporosis.

#### **CLINICAL RELEVANCE/APPLICATION**

Osteoporosis findings are common on CXR but often not reported. However, these findings have ramifications for billing and revenue capture, pre-emptive treatment and preventing patient morbidity and mortality.

#### **R1- SSCH09-6 Detecting Normals More Safely: Using two Different AI Algorithms to Filter Normal Chest X-Rays and Creating the Complementary Effect of Safety Net**

Sanghyup S. Lee, MD (*Presenter*) Employee, Lunit Inc

#### **PURPOSE**

To evaluate the performance of a normal filtering (NF) AI model developed for autonomous reporting of normal chest radiographs (CXRs) in terms of (a) sensitivity of AI for detecting abnormal CXRs at different levels of clinical significance, (b) proportion of CXRs that can be removed from reporting and (c) combined effect of a commercially available (CA) AI that detects 11 predefined findings from a CXR.



## **METHODS AND MATERIALS**

Three independent retrospective external validation sets composed of frontal (PA and AP) CXRs were consecutively collected from the following sources: PadChest (2016), emergency department (ED) of a UK teaching hospital (Jan 2021) and a random sample from a multicenter health check (HC) institution in South Korea (2021). The reference standard label of normal vs abnormal classification was present in the original report of the Korean dataset. For PadChest and ED, two out of three radiologists yielded a reference standard into the following five categories: Normal, insignificant, borderline abnormal, significant abnormal and critical. Only the last 3 groups were regarded as abnormal for sensitivity analysis. The higher of the two independent levels of significance was selected to ensure conservative analysis. The NF model gives an abnormality score of a CXR as a number between 0 and 1. An independent CA model was applied sequentially after the NF model.

## **RESULTS**

A total of 4,561, 992 and 2,476 patients were included from PadChest, ED and HC datasets (Median age[IQR], male(%), PA/AP; 60y [49-73], 2,068(45.3%), 4,518/43; 68y [50-81], 504(50.8%), 579/413; age, sex unavailable for HC, 2,476/0), with 1,458(32.0%), 73(7.4%) and 2,000(80.8%) cases classified as normal, and 2,120(46.5%), 817(82.4%) and 476(19.2%) cases as abnormal. 22.0% (1,765/8,029) of all CXRs were potentially removed from formal reporting when the NF model threshold was set at 50% specificity. The overall sensitivity was 97.8%(95%CI:97.3-98.3, 3,338/3,413), with individual cohort sensitivities of 98.1%[95%CI:97.4-98.7], 96.8%[95.4-97.9] and 99.6%[98.5-100.0], respectively. Additional 16.7% (4/24) of missed significant/critical abnormal cases were detected by the sequentially run CA model, at the expense of 1.4%(25/1,765) reduction of normally reported cases.

## **CONCLUSION**

A half of all normal frontal CXRs were classified as normal with an average sensitivity of 97.8% for any abnormalities, leading to 22.0% reduction of all frontal CXRs requiring reporting. The complementary effect of the CA model has the potential to act as a safety net for the autonomous NF model.

## **CLINICAL RELEVANCE/APPLICATION**

Normal filtering AI has the potential to reduce the workload of radiologists, while combined use of detection AI may act as a safety net for missed cases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSCH09-1

### Segregating Normal Chest Radiographs from Abnormal Chest Radiographs using DeepTek AI: Retrospective and Prospective Analyses

Thursday, Nov. 30 8:00AM - 9:00AM Room: E352

Richa Pant (*Presenter*) Nothing to Disclose

#### PURPOSE

An AI model that segregates normal chest radiographs from abnormal chest radiographs can reduce the workload of radiologists and manage the radiology workflow.

#### METHODS AND MATERIALS

17,500 frontal chest radiographs were retrospectively collected from 4 different sites (A, B, C, and D) between April 2020 and November 2022. For sites A and B, associated radiology reports from the PACS were considered the ground truth. Data from sites C and D were annotated by three radiologists, and the annotations made by the most experienced radiologist were considered the ground truth. DeepTek AI was used to process the scans and segregate them as "likely normal" or "suspected abnormal". All "likely normal" scans were reviewed by a human reader, and if any of them were found abnormal, they were sent to an expert reader for final reporting. Additionally, 2049 "likely normal" chest radiographs were randomly sampled from the radiology workflow at a hospital between January and February 2023 for prospective analysis. The associated radiology reports from the PACS were considered the ground truth. All the scans were analyzed using the same method.

#### RESULTS

For the retrospective analysis, the error rate of AI was defined as the percentage of scans that were actually abnormal but predicted as likely normal by AI. The error rate of the human reader was defined as the percentage of scans that were actually abnormal but predicted as normal by the human reader. The reduction in radiology workload, defined by the percentage of scans reported as normal by AI, was calculated at two different thresholds. At threshold 1, AI could segregate 21%, 28%, 31%, and 20% of normal scans from total scans from sites A, B, C, and D with low error rates of 4%, 3%, 1%, and 3%, respectively. At threshold 2, the AI could segregate a higher number of normal scans i.e. 45%, 55%, 63%, and 37% from sites A, B, C, and D at slightly higher error rates of 11%, 6%, 8%, and 8%, respectively. Human readers could segregate 41%, 65%, and 76% of normal scans from total scans from sites A, C, and D at error rates of 11%, 3%, and 11%, respectively. For the prospective analysis, the human reader agreed with the AI result for 95% of scans, and the expert reader found abnormalities in only 1% of the remaining 5% of scans.

#### CONCLUSION

DeepTek AI could effectively segregate normal scans from abnormal scans with high precision, improving the radiology workflow.

#### CLINICAL RELEVANCE/APPLICATION

DeepTek AI was used to segregate normal chest radiographs from abnormal chest radiographs in a retrospective and prospective study. The results demonstrated that DeepTek AI could segregate normal scans from abnormal scans as effectively as a human reader. The approach can be used to optimize the radiology workflow and reduce human fatigue in reporting scans.

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## Abstract Archives of the RSNA, 2023

R1-SSCH09-3

### Leveraging Deep Learning of Chest Radiograph Images Identifies Individuals at High-Risk of Chronic Obstructive Pulmonary Disease

Thursday, Nov. 30 8:00AM - 9:00AM Room: E352

Saman Doroodgar Jorshery, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to test whether deep learning can identify individuals at high-risk of incident Chronic Obstructive Pulmonary Disease (COPD) over 6 years using outpatient chest x-rays (CXRs).

#### METHODS AND MATERIALS

We previously developed a convolutional neural network (CXR-Lung-Risk) to predict lung-related mortality from CXRs. In this study, we externally validated this tool to predict incident COPD from routine outpatient CXRs. We identified patients with no history of lung cancer, COPD, or emphysema who had a chest radiograph. The primary outcome was incident COPD within 6 years after the CXR. Discrimination was compared to a clinical risk score (TargetCOPD), using area under the receiver operating characteristic curve. Cox proportional hazards survival analysis assessed the association between CXR-Lung-Risk with incident COPD after adjusting for TargetCOPD variables, including age, smoking status, recent dyspnea, and medications. Continuous CXR-Lung-Risk was further categorized in 4 groups (very mild, mild, moderate, high) based on previously published risk thresholds.

#### RESULTS

We analyzed 10913 patients, with mean age of 62.3 (SD: 6.8), 48.6% male, 18.6% current smoker, with mean TargetCOPD score of 0.14 (SD: 0.12). CXR-Lung-Risk model was significantly and independently associated with incident COPD and added to the predictive value of the TargetCOPD score (6 Years AUC CXR-Lung-Risk + TargetCOPD: [0.72 (95% CI: 0.71-0.74)], vs. 6 Years AUC TargetCOPD alone: [0.66 (95% CI: 0.64-0.67)],  $p < 0.01$ ). We had similar findings with 3 years and 1 year AUC. In comparison with very mild risk group (CXR-Lung-Risk  $< 60$ ), significantly higher risk of incident COPD was seen in individuals with mild risk group ( $60 < \text{CXR-Lung-Risk} < 65$ ) (aHR: 1.83, 95% CI: 1.47 - 2.27), moderate risk group ( $65 < \text{CXR-Lung-Risk} < 70$ ) (aHR: 2.88, 95% CI: 2.31- 3.60, and high risk group (CXR-Lung-Risk  $> 70$ ) (aHR: 5.63, 95% CI: 4.48 - 7.08), after adjusting for the aforementioned covariates including chronological age. A similar pattern was observed in subgroup analyses stratified by clinical center.

#### CONCLUSION

A deep learning model using routine chest x-ray images could identify individuals at high-risk for incident COPD beyond currently used clinical risk factors.

#### CLINICAL RELEVANCE/APPLICATION

CXR is a widely used imaging modality. Opportunistic screening of existing CXRs using deep learning based model (CXR-Lung-Risk) could help in identifying high-risk individuals and guide COPD prevention.

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## Abstract Archives of the RSNA, 2023

R1-SSCH09-4

### Prospective Multi-Site Validation of AI to Detect Tuberculosis and Abnormalities on Screening Chest Radiographs in an HIV Enriched Population in Zambia

Thursday, Nov. 30 8:00AM - 9:00AM Room: E352

Nsala Sanjase, MBChB (*Presenter*) Nothing to Disclose

#### PURPOSE

Artificial intelligence (AI) to interpret chest radiographs (CXR) could function as scalable triage tests for active pulmonary tuberculosis (TB) and as abnormality detectors in resource-constrained settings. In this study, we prospectively evaluated a CXR AI system, including both a TB AI and an CXR abnormality AI, in an HIV enriched population.

#### METHODS AND MATERIALS

Adults who had symptoms suggestive of TB, were close contacts of TB patients, or were newly diagnosed with HIV were recruited at 3 clinical sites in Zambia (trial NCT05139940). The reference standard for TB status was a positive GeneXpert Ultra assay or sputum Mycobacterium tuberculosis culture, and for CXR abnormality was the presence of a potentially clinically significant imaging finding based on a majority vote of 3 radiologists. The TB AI's scores were dichotomized using two prespecified operating points (OP): a high sensitivity OP based on the WHO target product profile (90% sensitivity, 70% specificity) and a more balanced OP designed to resemble an average radiologist's performance. We tested the TB AI for non-inferiority to 9 radiologists and to the WHO target using a prespecified margin of 5%. We tested the CXR abnormality AI for non-inferiority to a prespecified target (90% sensitivity, 50% specificity).

#### RESULTS

1,932 patients were enrolled. Of the 1,807 patients with a definitive TB status, 641 (35%) were HIV positive and 190 (11%) were TB positive. The CXRs of 1,923 patients had abnormal status, of which 555 (29%) had CXR abnormalities. The TB AI's AUC was 88% [95%CI 84-91], and the 9 radiologists' sensitivities were comparable to or slightly below the AI at matching specificity. The TB AI's sensitivity and specificity were respectively 87% and 70% at the high-sensitivity OP and 78% and 82% at the balanced OP. At the former OP, the TB AI was non-inferior to the radiologists for sensitivity ( $p < 0.001$ ) but not specificity ( $p = 0.99$ ) and met WHO targets for specificity ( $p < 0.001$ ) but not sensitivity ( $p = 0.17$ ). At the balanced OP, the AI was non-inferior to the radiologists for both sensitivity and specificity ( $p < 0.02$  for both). The CXR abnormality AI's AUC was 97% [95%CI 96-98] with sensitivity and specificity respectively at 97% and 79% at the high-sensitivity OP, meeting the prespecified target ( $p < 0.001$ ).

#### CONCLUSION

Both the TB and CXR abnormality AIs demonstrated high performance in an HIV-enriched population. This AI system could help scale cost-effective TB screening and detection of differential diagnoses in settings where radiologists are not available.

#### CLINICAL RELEVANCE/APPLICATION

Artificial intelligence can triage for active pulmonary TB with non-inferior performance to radiologists and detect differential diagnoses, indicating potential to aid cost effective TB screening.

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## Abstract Archives of the RSNA, 2023

R1-SSCH09-5

### Investigating Artificial Intelligence Detection of Unreported Radiographic Markers of Osteoporosis on Chest X-Ray

Thursday, Nov. 30 8:00AM - 9:00AM Room: E352

Jonathan S. Luchs, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Osteoporosis is common in the aging population. The presence of osteopenia and spine wedge fracture on chest X-ray (CXR) are strong indicators of osteoporosis. CXR has the potential to identify patients at high risk of osteoporosis. However, these findings are often underreported due to limited awareness of their importance. AI may be able to characterize patient osteoporosis risk through the detection of these findings. The aim of this study was to process retrospective CXRs to identify osteopenia of the spine and spine wedge fractures that were not reported in the original radiologist report.

#### METHODS AND MATERIALS

The dataset consisted of 519 CXRs from patients  $\geq 65$  years, collected from outpatient clinics. CXR images were retrospectively processed by the AI model for the presence/absence of osteopenia and spine wedge fracture. As a comparison, the original radiologist report was manually reviewed for the presence/absence of these findings, with findings considered absent if they were not mentioned in the report. In cases where there was a discrepancy between the model and the report, a radiologist adjudicator evaluated the CXR scan to determine ground truth (GT), i.e., if the finding was overcalled or under called by the AI model/radiologist.

#### RESULTS

There was significant variation in reported findings between the AI model and the original report. There were 76 (14.6%) and 58 (11.2%) instances of osteopenia and spine wedge fracture detected by the AI model, compared to 8 (1.5%) and 0 (0.0%) in the report, respectively. AI/report agreement had a Cohen's Kappa of -0.001 for spine fracture and -0.02 for osteopenia, indicating no agreement. In discrepant studies, comparison with the GT indicated that there was predominantly under calling in the original report. 2.2% and 0.0% osteopenia and spine wedge fracture findings were correctly reported, while 97.8% and 100.0% were not indicated in the report. In comparison, the AI model correctly identified 19.0% and 46.2% osteopenia and spine wedge fracture findings, while missing 81.0% and 53.8%, respectively. The AI model had a false positive rate of 0.12 and 0.06 compared to 0.01 and 0.00 in the report.

#### CONCLUSION

To date, AI models in medical imaging have typically focused on radiological finding detection to provide direct diagnostic assistance to radiologists. Here we present a study investigating a use-case to enhance patient osteoporosis risk characterisation to improve patient care and management through the detection of unreported findings suggestive of osteoporosis.

#### CLINICAL RELEVANCE/APPLICATION

Osteoporosis findings are common on CXR but often not reported. However, these findings have ramifications for billing and revenue capture, pre-emptive treatment and preventing patient morbidity and mortality.

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## Abstract Archives of the RSNA, 2023

R1-SSCH09-6

### **Detecting Normals More Safely: Using two Different AI Algorithms to Filter Normal Chest X-Rays and Creating the Complementary Effect of Safety Net**

Thursday, Nov. 30 8:00AM - 9:00AM Room: E352

Sanghyup S. Lee, MD (*Presenter*) Employee, Lunit Inc

#### **PURPOSE**

To evaluate the performance of a normal filtering (NF) AI model developed for autonomous reporting of normal chest radiographs (CXR) in terms of (a) sensitivity of AI for detecting abnormal CXRs at different levels of clinical significance, (b) proportion of CXRs that can be removed from reporting and (c) combined effect of a commercially available (CA) AI that detects 11 predefined findings from a CXR.

#### **METHODS AND MATERIALS**

Three independent retrospective external validation sets composed of frontal (PA and AP) CXRs were consecutively collected from the following sources: PadChest (2016), emergency department (ED) of a UK teaching hospital (Jan 2021) and a random sample from a multicenter health check (HC) institution in South Korea (2021). The reference standard label of normal vs abnormal classification was present in the original report of the Korean dataset. For PadChest and ED, two out of three radiologists yielded a reference standard into the following five categories: Normal, insignificant, borderline abnormal, significant abnormal and critical. Only the last 3 groups were regarded as abnormal for sensitivity analysis. The higher of the two independent levels of significance was selected to ensure conservative analysis. The NF model gives an abnormality score of a CXR as a number between 0 and 1. An independent CA model was applied sequentially after the NF model.

#### **RESULTS**

A total of 4,561, 992 and 2,476 patients were included from PadChest, ED and HC datasets (Median age[IQR], male(%), PA/AP; 60y [49-73], 2,068(45.3%), 4,518/43; 68y [50-81], 504(50.8%), 579/413; age, sex unavailable for HC, 2,476/0), with 1,458(32.0%), 73(7.4%) and 2,000(80.8%) cases classified as normal, and 2,120(46.5%), 817(82.4%) and 476(19.2%) cases as abnormal. 22.0% (1,765/8,029) of all CXRs were potentially removed from formal reporting when the NF model threshold was set at 50% specificity. The overall sensitivity was 97.8%(95%CI:97.3-98.3, 3,338/3,413), with individual cohort sensitivities of 98.1%[95%CI:97.4-98.7], 96.8%[95.4-97.9] and 99.6%[98.5-100.0], respectively. Additional 16.7% (4/24) of missed significant/critical abnormal cases were detected by the sequentially run CA model, at the expense of 1.4%(25/1,765) reduction of normally reported cases.

#### **CONCLUSION**

A half of all normal frontal CXRs were classified as normal with an average sensitivity of 97.8% for any abnormalities, leading to 22.0% reduction of all frontal CXRs requiring reporting. The complementary effect of the CA model has the potential to act as a safety net for the autonomous NF model.

#### **CLINICAL RELEVANCE/APPLICATION**

Normal filtering AI has the potential to reduce the workload of radiologists, while combined use of detection AI may act as a safety net for missed cases.

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## Abstract Archives of the RSNA, 2023

R1-SSGU06

### Genitourinary Imaging (Advances in Imaging of Genitourinary Cancers)

Thursday, Nov. 30 8:00AM - 9:00AM Room: S501

Satheesh Krishna, MD (*Moderator*) Nothing to Disclose  
Manish Dhyani, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R1-SSGU06-1 Biparametric vs. Multiparametric MRI for Assessing Muscle Invasion in Bladder Urothelial Carcinoma with Variant Histology using the Vesical Imaging-Reporting and Data System: A Multi-institutional Multi-reader Study**

Yuki Arita, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recent studies revealed high accuracy of contrast-free biparametric MRI (bpMRI, including T2-weighted imaging (T2WI) and diffusion-weighted imaging (DWI)) for diagnosing muscle-invasive bladder cancer (MIBC), especially for pure urothelial carcinoma (PUC). However, the diagnostic performance of bpMRI for variant histology urothelial carcinoma (VUC) remains unknown. This study aimed to compare the diagnostic performance of bpMRI and standard multiparametric MRI (mpMRI, including T2WI, DWI, and dynamic contrast-enhanced (DCE)-MRI) for the assessment of muscle layer invasion of VUC.

#### METHODS AND MATERIALS

Multi-institutional retrospective study of 118 treatment-naïve patients with pathologically-proven VUC who underwent bladder mpMRI before transurethral bladder tumor resection between 2010 and 2019. Two sets of images, set 1 (bpMRI) and set 2 (mpMRI), were independently reviewed by three board-certified radiologists according to the vesical imaging-reporting and data system (VI-RADS). Histopathological results were used as reference standard. Receiver operative curve analysis, Z-test, and Wald test were performed to evaluate diagnostic performance.

#### RESULTS

Among the 118 included patients with BC, 66 (55.9%) and 52 (44.1%) were diagnosed with pathologically-confirmed MIBC and non-MIBC, respectively. The AUCs for bpMRI were significantly lower than those for mpMRI for all readers (0.884 vs 0.923/0.873 vs 0.906/0.870 vs 0.902,  $p=0.002/0.002/0.012$  for Reader 1/2/3). With the VI-RADS cut-off score of 4, the sensitivity of bpMRI was significantly lower than that of mpMRI for all readers (66.7% vs 78.8%/66.7% vs 80.3%/65.2% vs 77.3%,  $p=0.005/0.003/0.005$  for Reader 1/2/3). No significant differences were found between bpMRI and mpMRI in terms of specificity for all readers (90.4% vs 92.3%/88.5% vs 88.5%/90.4% vs 88.5%,  $p=0.317/0.99/0.317$  for Reader 1/2/3). With the VI-RADS cut-off score of 3, no significant differences were found between bpMRI and mpMRI in terms of sensitivity for all readers (90.9% vs 92.4%/89.4% vs 90.9%/87.9% vs 90.9%,  $p=0.317/0.317/0.157$  for Reader 1/2/3). The specificity of bpMRI was significantly lower than that of mpMRI for Reader 1 only (71.2% vs 78.8%/71.2% vs 76.9%/71.2% vs 76.9%,  $p=0.046/0.083/0.083$  for Reader 1/2/3).

#### CONCLUSION

The diagnostic performance of contrast-free bpMRI was lower than that of mpMRI in assessing muscle invasion in patients with VUC using VI-RADS. Thus, mpMRI-based is still recommended for assessing muscle invasion in VUC.

#### CLINICAL RELEVANCE/APPLICATION

BpMRI-based VI-RADS reported has diagnostic performance comparable to that of conventional mpMRI-based VI-RADS for PUC. However, according to our results, bpMRI-based VI-RADS may misdiagnose muscle invasion in VUC.

#### **R1-SSGU06-2 Multiparametric Magnetic Resonance Assessment of Tumor Response to Neoadjuvant Immunotherapy in Muscle-invasive Bladder Cancer**

Giorgio Brembilla, MD, PhD (*Presenter*) Nothing to Disclose



## PURPOSE

To investigate the diagnostic performance of multiparametric MRI (mpMRI) of the bladder using VI-RADS and nacVI-RADS criteria in assessing tumour response to neoadjuvant immunotherapy for muscle-invasive bladder cancer (MIBC).

## METHODS AND MATERIALS

116 patients from PURE-01 trial who underwent bladder mpMRI before and after immunotherapy (3 cycles of pembrolizumab) and radical cystectomy (RC) for MIBC were included (n=232 mpMRI scans). All scans were centrally reviewed by an expert radiologist blinded to clinical and histopathological data, to determine pre- and post-therapy VI-RADS and nacVI-RADS scores. The diagnostic accuracy of post-therapy VI-RADS and nacVI-RADS in predicting downstaging (ypT=1N0: primary endpoint) and complete response (ypT0N0; secondary endpoint) at final histopathology after neoadjuvant treatment was assessed. On post-therapy MRI, downstaging was defined as VI-RADS <3 and nacVI-RADS <4; complete response was defined as absence of any residual disease ( "VI-RADS 0"; nac-VI-RADS 1-2). The standard of reference was histopathology of RC specimens.

## RESULTS

Pre-immunotherapy, 21 patients (18.1%) had no measurable disease at MRI, 32 (27.6%) a VI-RADS 1-3 score, 63 (54.3%) had a VI-RADS 4-5 score. Post-immunotherapy, 40 patients (34.5%) had no measurable disease at MRI, 29 (25.0%) a VI-RADS 1-3 score, and 47 (40.5%) had a VI-RADS 4-5 score. At final pathology, 68 (58.6%) showed downstaging and 47 (40.5%) complete response. For downstaging, the sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy of MRI were respectively: 90%, 75%, 72%, 91% and 81% for VI-RADS; 92%, 69%, 68%, 92% and 78% for nacVI-RADS. For complete response: 86%, 64%, 78%, 75% and 77%, for both VI-RADS and nacVI-RADS.

## CONCLUSION

mpMRI of the bladder using VI-RADS and nacVI-RADS scores showed good accuracy in assessing the response of MIBC to neoadjuvant treatment.

## CLINICAL RELEVANCE/APPLICATION

MRI could represent the ideal tool for a non-invasive prediction of MIBC response to neoadjuvant treatments, paving the way to bladder-sparing trials.

## R1-SSGU06-3 Can Differing Growth Rate on Follow up of Incidental Adrenal Nodule Differentiate Adrenal Cortical Carcinomas vs. Pheochromocytomas vs. Adenomas?

May Al Moharb, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Incidental adrenal nodules are commonly encountered. While washout CT is useful when metastasis is suspected, recent literature shows it has no role in the setting of known or concurrent primary extra-adrenal malignancy. When incidental adrenal nodules are encountered, ACR guidelines recommend a follow-up imaging in 1 year. The aim of this research is to estimate the rate of size progression of the three major primary adrenal tumors, namely adrenal adenomas, cortical carcinomas and pheochromocytomas, by distinguishing their rate of size progression.

## METHODS AND MATERIALS

In this IRB approved retrospective study, between the period 2004 - 2021, 154 consecutive patients (86 females and 68 males) with median age of 52.5years (41-63y) with pathologically-proven surgically-resected masses were identified with 56 adrenal cortical carcinomas (ACC), pheochromocytoma and 41 adrenal adenomas were identified. Only cases with a minimum of 2 cross-sectional imaging studies (CTs or MRIs) at two different time points to estimate growth rate (estimated in mm/year) were included. Tumor dimensions were measured both along the gland axis and perpendicular to it. Difference in tumor growth rates, based on duration of available follow-up and baseline size of mass were compared across the three groups.

## RESULTS

Mean growth rates of ACC, pheochromocytoma and adenoma in the entire cohort with at least 3 months between follow-up imaging was 21.7mm/y, 2.6mm/y and 0.4mm/y respectively ( $p<0.001$ ). When subgroup analysis was performed for masses with at least than 6-months and 1-year of follow-up, mean growth rates were 18.7 mm/y, 3.2 mm/y, 0.5mm/y, and 8mm/y, 3.3mm/y, 0.6mm/y respectively for ACC, pheochromocytoma and adenoma ( $p<0.001$ ,  $p<0.001$ ). When only masses with a baseline size of 4 cm or less were analyzed, growth rates were 11.9mm/y, 2.4mm/y and 0.7mm/y for ACC, pheochromocytoma and adenoma ( $p<0.001$ ). However, there was some overlap with some slow-growing ACCs with pheochromocytomas and occasionally with adenomas. Using a threshold of 3mm/y, 10-30% of ACCs would be misdiagnosed as adenoma due to slow growth rates.



## CONCLUSION

On an average, ACCs grow about 5 times faster than pheochromocytomas, and pheochromocytomas grow 5 times faster than adenomas. However, in some cases, especially with baseline sizes less than 4cm, and long follow-up available, growth rates of ACCs overlap with both pheochromocytomas and adenomas.

## CLINICAL RELEVANCE/APPLICATION

Although growth rates of ACCs are higher compared to pheochromocytomas and adenomas, they cannot be relied upon as a single variable to differentiate between incidental adrenal masses.

### R1- SSGU06-4 **Identifying PIRADS 4 Lesions with Positive Predictive Values Similar to PIRADS 5 Lesions on Biparametric Prostate MRI**

Josh B. Moosikasawan, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To determine whether a distinct subset of PIRADS 4 lesions with positive predictive values similar to PIRADS 5 lesions can be identified on biparametric MRI.

## METHODS AND MATERIALS

All biparametric prostate MRIs performed at a single healthcare system over a 15 month period, from July 2021 to December 2022, and interpreted by a single board-certified radiologist with over ten years experience interpreting over 1500 prostate MRIs were identified. Studies with PIRADS 4 lesions were retrospectively reviewed. First, identified lesions were confirmed as PIRADS 4. Then a strategy of inclusion and exclusion was used to identify lesions that can be categorized into a higher suspicion group, "4c". Inclusion criteria included having definite imaging features of focal, homogeneously, circumscribed T2 moderately to markedly hypodensity; while exclusion criteria included any mimicker of prostate cancer, such as pseudolesions in the posterior midline peripheral zone or central gland, or with any other uncertainty that the lesion could represent a cancer. A similar approach was also used to evaluate the PIRADS 5 lesions. Then, radiology-pathology correlation was performed for all the patients with PIRADS 4 and 5 lesions who underwent prostate biopsies. Statistical analysis was performed using Fisher's exact test.

## RESULTS

413 prostate MRIs were identified, with 3 PIRADS 1 (1%), 136 PIRADS 2 (33%), 100 PIRADS 3 (24%), 120 PIRADS 4 (29%), 42 PIRADS 5 (10%), and 12 nondiagnostic (3%). 45 (38%) of the 120 PIRADS 4 were categorized as 4c, while 35 (83%) of the 42 PIRADS 5 were categorized as 5c. 53 out of 75 PIRADS 4, 38 out of 45 PIRADS 4c, 5 out of 7 PIRADS 5, and 25 out of 35 PIRADS 5c underwent biopsies. 35, 5, and 13 of the PIRADS 4; 36, 2, and 0 of the PIRADS 4c; 2, 0, and 3 of the PIRADS 5; and 24, 1, and 0 of the PIRADS 5c had csc, cis, and no evidence of cancer, respectively. The positive predictive values for clinically significant cancer for 4, 4c, and total 4 are 66%, 95%, and 78%, respectively ( $p=0.0016$ ), while those for 5, 5c, and total 5 are 40%, 96%, and 87% ( $p=0.0093$ ).

## CONCLUSION

There is a distinct subset of PIRADS 4 lesions that can be identified on biparametric MRI. These lesions, termed "4c", have positive predictive values similar to those of PIRADS 5 lesions.

## CLINICAL RELEVANCE/APPLICATION

Although MRI have aided in prostate cancer diagnosis including with risk stratification and targeted-biopsies, and have high negative predictive values, false positives have continued to be a limitation. Identifying PIRADS 4c lesions will improve this limitation, and help with patient management and prostate cancer diagnosis. For example, in the context of a negative prostate biopsy of a patient with a PIRADS 4c lesion, it is not unreasonable to consider a repeat biopsy or close clinical followup.

### R1- SSGU06-5 **Is Prostatic Adenocarcinoma with Cribriform Architecture More Difficult to Detect on Prostate MRI**

Mason Belue, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To elucidate the multiparametric MRI (mpMRI) features of cribriform (CBFM)-containing prostate cancers (PCa).

## METHODS AND MATERIALS

Patients who underwent mpMRI, combined 12-core transrectal ultrasound (TRUS) guided systematic (SB) and MRI/US fusion-guided biopsy were retrospectively queried for the presence of CBFM pattern at biopsy. Biopsy cores and lesions were categorized as follows: C0=benign, C1=PCa with no CBFM pattern, C2=PCa with CBFM pattern. Correlation between cancer

core length (CCL) and measured MRI lesion dimension were assessed using a modified Pearson correlation test for clustered data. Differences between the biopsy core groups were assessed with the Wilcoxon-signed rank test with clustering using R.

## **RESULTS**

Between 2015-2022, 131 consecutive patients with CBFM pattern on prostate biopsy and pre-biopsy mpMRI were included. Clinical feature analysis included 1572 systematic biopsy cores (1149 C0, 272 C1, 151 C2) and 736 MRI-targeted biopsy cores (253 C0, 272 C1, 211 C2). Of the 131 patients with confirmed CBFM pathology, targeted biopsy (TBx) alone identified CBFM in 76.3% (100/131) of patients but detected PCa in 97.7% (128/131) patients. SBx biopsy alone detected CBFM in 61.1% (80/131) of patients and PCa in 90.8% (119/131) patients. TBx and SBx had equivalent detection in patients with smaller prostates, however, TBx had superior performance in larger prostates ( $P=0.045$ ). For all lesion groups there was a positive and significant correlation between maximum MRI lesion dimension and CCL (C1 lesions:  $P<0.01$ , C2 lesions:  $P<0.001$ ). There was a significant difference in CCLs between C1 and C2 lesions for T2 scores of 3 and 5 ( $P=0.01$ ,  $P=0.01$  respectively), DWI score of 5 ( $P=0.05$ ), and PI-RADS 5 lesions ( $P=0.01$ ) with C2 lesions having larger CCL despite no significant difference in MRI lesion dimension.

## **CONCLUSION**

Compared to prostate tumors without CBFM features, CBFM is relatively difficult to diagnose on mpMRI, however, most CBFM-containing tumors are visible. Despite having similar MRI lesion dimensions and similar PIRADS scores, CBFM-containing tumors have larger cancer yield on biopsy.

## **CLINICAL RELEVANCE/APPLICATION**

Cancer staging and planning therapeutic interventions is reliant on accurate mpMRI estimation. With CBFM containing lesions having evidence of more inaccurate burden estimation on mpMRI, special considerations should be taken when a biopsy core comes back as being CBFM positive.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSGU06-1

### **Biparametric vs. Multiparametric MRI for Assessing Muscle Invasion in Bladder Urothelial Carcinoma with Variant Histology using the Vesical Imaging-Reporting and Data System: A Multi-institutional Multi-reader Study**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S501

Yuki Arita, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recent studies revealed high accuracy of contrast-free biparametric MRI (bpMRI, including T2-weighted imaging (T2WI) and diffusion-weighted imaging (DWI)) for diagnosing muscle-invasive bladder cancer (MIBC), especially for pure urothelial carcinoma (PUC). However, the diagnostic performance of bpMRI for variant histology urothelial carcinoma (VUC) remains unknown. This study aimed to compare the diagnostic performance of bpMRI and standard multiparametric MRI (mpMRI, including T2WI, DWI, and dynamic contrast-enhanced (DCE)-MRI) for the assessment of muscle layer invasion of VUC.

#### **METHODS AND MATERIALS**

Multi-institutional retrospective study of 118 treatment-naïve patients with pathologically-proven VUC who underwent bladder mpMRI before transurethral bladder tumor resection between 2010 and 2019. Two sets of images, set 1 (bpMRI) and set 2 (mpMRI), were independently reviewed by three board-certified radiologists according to the vesical imaging-reporting and data system (VI-RADS). Histopathological results were used as reference standard. Receiver operative curve analysis, Z-test, and Wald test were performed to evaluate diagnostic performance.

#### **RESULTS**

Among the 118 included patients with BC, 66 (55.9%) and 52 (44.1%) were diagnosed with pathologically-confirmed MIBC and non-MIBC, respectively. The AUCs for bpMRI were significantly lower than those for mpMRI for all readers (0.884 vs 0.923/0.873 vs 0.906/0.870 vs 0.902,  $p=0.002/0.002/0.012$  for Reader 1/2/3). With the VI-RADS cut-off score of 4, the sensitivity of bpMRI was significantly lower than that of mpMRI for all readers (66.7% vs 78.8%/66.7% vs 80.3%/65.2% vs 77.3%,  $p=0.005/0.003/0.005$  for Reader 1/2/3). No significant differences were found between bpMRI and mpMRI in terms of specificity for all readers (90.4% vs 92.3%/88.5% vs 88.5%/90.4% vs 88.5%,  $p=0.317/0.99/0.317$  for Reader 1/2/3). With the VI-RADS cut-off score of 3, no significant differences were found between bpMRI and mpMRI in terms of sensitivity for all readers (90.9% vs 92.4%/89.4% vs 90.9%/87.9% vs 90.9%,  $p=0.317/0.317/0.157$  for Reader 1/2/3). The specificity of bpMRI was significantly lower than that of mpMRI for Reader 1 only (71.2% vs 78.8%/71.2% vs 76.9%/71.2% vs 76.9%,  $p=0.046/0.083/0.083$  for Reader 1/2/3).

#### **CONCLUSION**

The diagnostic performance of contrast-free bpMRI was lower than that of mpMRI in assessing muscle invasion in patients with VUC using VI-RADS. Thus, mpMRI-based is still recommended for assessing muscle invasion in VUC.

#### **CLINICAL RELEVANCE/APPLICATION**

BpMRI-based VI-RADS reported has diagnostic performance comparable to that of conventional mpMRI-based VI-RADS for PUC. However, according to our results, bpMRI-based VI-RADS may misdiagnose muscle invasion in VUC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSGU06-2

### **Multiparametric Magnetic Resonance Assessment of Tumor Response to Neoadjuvant Immunotherapy in Muscle-invasive Bladder Cancer**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S501

Giorgio Brembilla, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic performance of multiparametric MRI (mpMRI) of the bladder using VI-RADS and nacVI-RADS criteria in assessing tumour response to neoadjuvant immunotherapy for muscle-invasive bladder cancer (MIBC).

#### **METHODS AND MATERIALS**

116 patients from PURE-01 trial who underwent bladder mpMRI before and after immunotherapy (3 cycles of pembrolizumab) and radical cystectomy (RC) for MIBC were included (n=232 mpMRI scans). All scans were centrally reviewed by an expert radiologist blinded to clinical and histopathological data, to determine pre- and post-therapy VI-RADS and nacVI-RADS scores. The diagnostic accuracy of post-therapy VI-RADS and nacVI-RADS in predicting downstaging (ypT=1N0: primary endpoint) and complete response (ypT0N0; secondary endpoint) at final histopathology after neoadjuvant treatment was assessed. On post-therapy MRI, downstaging was defined as VI-RADS <3 and nacVI-RADS <4; complete response was defined as absence of any residual disease ("VI-RADS 0"; nac-VI-RADS 1-2). The standard of reference was histopathology of RC specimens.

#### **RESULTS**

Pre-immunotherapy, 21 patients (18.1%) had no measurable disease at MRI, 32 (27.6%) a VI-RADS 1-3 score, 63 (54.3%) had a VI-RADS 4-5 score. Post-immunotherapy, 40 patients (34.5%) had no measurable disease at MRI, 29 (25.0%) a VI-RADS 1-3 score, and 47 (40.5%) had a VI-RADS 4-5 score. At final pathology, 68 (58.6%) showed downstaging and 47 (40.5%) complete response. For downstaging, the sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy of MRI were respectively: 90%, 75%, 72%, 91% and 81% for VI-RADS; 92%, 69%, 68%, 92% and 78% for nacVI-RADS. For complete response: 86%, 64%, 78%, 75% and 77%, for both VI-RADS and nacVI-RADS.

#### **CONCLUSION**

mpMRI of the bladder using VI-RADS and nacVI-RADS scores showed good accuracy in assessing the response of MIBC to neoadjuvant treatment.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI could represent the ideal tool for a non-invasive prediction of MIBC response to neoadjuvant treatments, paving the way to bladder-sparing trials.

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## Abstract Archives of the RSNA, 2023

R1-SSGU06-3

### Can Differing Growth Rate on Follow up of Incidental Adrenal Nodule Differentiate Adrenal Cortical Carcinomas vs. Pheochromocytomas vs. Adenomas?

Thursday, Nov. 30 8:00AM - 9:00AM Room: S501

May Al Moharb, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Incidental adrenal nodules are commonly encountered. While washout CT is useful when metastasis is suspected, recent literature shows it has no role in the setting of known or concurrent primary extra-adrenal malignancy. When incidental adrenal nodules are encountered, ACR guidelines recommend a follow-up imaging in 1 year. The aim of this research is to estimate the rate of size progression of the three major primary adrenal tumors, namely adrenal adenomas, cortical carcinomas and pheochromocytomas, by distinguishing their rate of size progression.

#### METHODS AND MATERIALS

In this IRB approved retrospective study, between the period 2004 - 2021, 154 consecutive patients (86 females and 68 males) with median age of 52.5years (41-63y) with pathologically-proven surgically-resected masses were identified with 56 adrenal cortical carcinomas (ACC), pheochromocytoma and 41 adrenal adenomas were identified. Only cases with a minimum of 2 cross-sectional imaging studies (CTs or MRIs) at two different time points to estimate growth rate (estimated in mm/year) were included. Tumor dimensions were measured both along the gland axis and perpendicular to it. Difference in tumor growth rates, based on duration of available follow-up and baseline size of mass were compared across the three groups.

#### RESULTS

Mean growth rates of ACC, pheochromocytoma and adenoma in the entire cohort with at least 3 months between follow-up imaging was 21.7mm/y, 2.6mm/y and 0.4mm/y respectively ( $p < 0.001$ ). When subgroup analysis was performed for masses with at least 6-months and 1-year of follow-up, mean growth rates were 18.7 mm/y, 3.2 mm/y, 0.5mm/y, and 8mm/y, 3.3mm/y, 0.6mm/y respectively for ACC, pheochromocytoma and adenoma ( $p < 0.001$ ,  $p < 0.001$ ). When only masses with a baseline size of 4 cm or less were analyzed, growth rates were 11.9mm/y, 2.4mm/y and 0.7mm/y for ACC, pheochromocytoma and adenoma ( $p < 0.001$ ). However, there was some overlap with some slow-growing ACCs with pheochromocytomas and occasionally with adenomas. Using a threshold of 3mm/y, 10-30% of ACCs would be misdiagnosed as adenoma due to slow growth rates.

#### CONCLUSION

On an average, ACCs grow about 5 times faster than pheochromocytomas, and pheochromocytomas grow 5 times faster than adenomas. However, in some cases, especially with baseline sizes less than 4cm, and long follow-up available, growth rates of ACCs overlap with both pheochromocytomas and adenomas.

#### CLINICAL RELEVANCE/APPLICATION

Although growth rates of ACCs are higher compared to pheochromocytomas and adenomas, they cannot be relied upon as a single variable to differentiate between incidental adrenal masses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSGU06-4

### Identifying PIRADS 4 Lesions with Positive Predictive Values Similar to PIRADS 5 Lesions on Biparametric Prostate MRI

Thursday, Nov. 30 8:00AM - 9:00AM Room: S501

Josh B. Moosikasawan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine whether a distinct subset of PIRADS 4 lesions with positive predictive values similar to PIRADS 5 lesions can be identified on biparametric MRI.

#### METHODS AND MATERIALS

All biparametric prostate MRIs performed at a single healthcare system over a 15 month period, from July 2021 to December 2022, and interpreted by a single board-certified radiologist with over ten years experience interpreting over 1500 prostate MRIs were identified. Studies with PIRADS 4 lesions were retrospectively reviewed. First, identified lesions were confirmed as PIRADS 4. Then a strategy of inclusion and exclusion was used to identify lesions that can be categorized into a higher suspicion group, "4c". Inclusion criteria included having definite imaging features of focal, homogeneously, circumscribed T2 moderately to markedly hypodensity; while exclusion criteria included any mimicker of prostate cancer, such as pseudolesions in the posterior midline peripheral zone or central gland, or with any other uncertainty that the lesion could represent a cancer. A similar approach was also used to evaluate the PIRADS 5 lesions. Then, radiology-pathology correlation was performed for all the patients with PIRADS 4 and 5 lesions who underwent prostate biopsies. Statistical analysis was performed using Fisher's exact test.

#### RESULTS

413 prostate MRIs were identified, with 3 PIRADS 1 (1%), 136 PIRADS 2 (33%), 100 PIRADS 3 (24%), 120 PIRADS 4 (29%), 42 PIRADS 5 (10%), and 12 nondiagnostic (3%). 45 (38%) of the 120 PIRADS 4 were categorized as 4c, while 35 (83%) of the 42 PIRADS 5 were categorized as 5c. 53 out of 75 PIRADS 4, 38 out of 45 PIRADS 4c, 5 out of 7 PIRADS 5, and 25 out of 35 PIRADS 5c underwent biopsies. 35, 5, and 13 of the PIRADS 4; 36, 2, and 0 of the PIRADS 4c; 2, 0, and 3 of the PIRADS 5; and 24, 1, and 0 of the PIRADS 5c had csc, cis, and no evidence of cancer, respectively. The positive predictive values for clinically significant cancer for 4, 4c, and total 4 are 66%, 95%, and 78%, respectively ( $p=0.0016$ ), while those for 5, 5c, and total 5 are 40%, 96%, and 87% ( $p=0.0093$ ).

#### CONCLUSION

There is a distinct subset of PIRADS 4 lesions that can be identified on biparametric MRI. These lesions, termed "4c", have positive predictive values similar to those of PIRADS 5 lesions.

#### CLINICAL RELEVANCE/APPLICATION

Although MRI have aided in prostate cancer diagnosis including with risk stratification and targeted-biopsies, and have high negative predictive values, false positives have continued to be a limitation. Identifying PIRADS 4c lesions will improve this limitation, and help with patient management and prostate cancer diagnosis. For example, in the context of a negative prostate biopsy of a patient with a PIRADS 4c lesion, it is not unreasonable to consider a repeat biopsy or close clinical followup.

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## Abstract Archives of the RSNA, 2023

R1-SSGU06-5

### Is Prostatic Adenocarcinoma with Cribriform Architecture More Difficult to Detect on Prostate MRI

Thursday, Nov. 30 8:00AM - 9:00AM Room: S501

Mason Belue, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To elucidate the multiparametric MRI (mpMRI) features of cribriform (CBFM)-containing prostate cancers (PCa).

#### METHODS AND MATERIALS

Patients who underwent mpMRI, combined 12-core transrectal ultrasound (TRUS) guided systematic (SB) and MRI/US fusion-guided biopsy were retrospectively queried for the presence of CBFM pattern at biopsy. Biopsy cores and lesions were categorized as follows: C0=benign, C1=PCa with no CBFM pattern, C2=PCa with CBFM pattern. Correlation between cancer core length (CCL) and measured MRI lesion dimension were assessed using a modified Pearson correlation test for clustered data. Differences between the biopsy core groups were assessed with the Wilcoxon-signed rank test with clustering using R.

#### RESULTS

Between 2015-2022, 131 consecutive patients with CBFM pattern on prostate biopsy and pre-biopsy mpMRI were included. Clinical feature analysis included 1572 systematic biopsy cores (1149 C0, 272 C1, 151 C2) and 736 MRI-targeted biopsy cores (253 C0, 272 C1, 211 C2). Of the 131 patients with confirmed CBFM pathology, targeted biopsy (TBx) alone identified CBFM in 76.3% (100/131) of patients but detected PCa in 97.7% (128/131) patients. SBx biopsy alone detected CBFM in 61.1% (80/131) of patients and PCa in 90.8% (119/131) patients. TBx and SBx had equivalent detection in patients with smaller prostates, however, TBx had superior performance in larger prostates ( $P=0.045$ ). For all lesion groups there was a positive and significant correlation between maximum MRI lesion dimension and CCL (C1 lesions:  $P<0.01$ , C2 lesions:  $P<0.001$ ). There was a significant difference in CCLs between C1 and C2 lesions for T2 scores of 3 and 5 ( $P=0.01$ ,  $P=0.01$  respectively), DWI score of 5 ( $P=0.05$ ), and PI-RADS 5 lesions ( $P=0.01$ ) with C2 lesions having larger CCL despite no significant difference in MRI lesion dimension.

#### CONCLUSION

Compared to prostate tumors without CBFM features, CBFM is relatively difficult to diagnose on mpMRI, however, most CBFM-containing tumors are visible. Despite having similar MRI lesion dimensions and similar PIRADS scores, CBFM-containing tumors have larger cancer yield on biopsy.

#### CLINICAL RELEVANCE/APPLICATION

Cancer staging and planning therapeutic interventions is reliant on accurate mpMRI estimation. With CBFM containing lesions having evidence of more inaccurate burden estimation on mpMRI, special considerations should be taken when a biopsy core comes back as being CBFM positive.

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## Abstract Archives of the RSNA, 2023

R1-SSNMMI07

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Pediatrics and General Oncology)

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403A

Helen R. Nadel, MD, FRCPC (*Moderator*) Consultant, ICON plc;;  
Gary A. Ulaner, MD, PhD (*Moderator*) Speaker, Siemens AG; Speaker, Lantheus Holdings; Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd; Research support, Lantheus Holdings; Research support, Novartis AG

#### Sub-Events

##### R1- Keynote Speaker

SSNMMI07-

1

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

##### R1- **[<sup>18</sup>F]FDG PET/MRI in Children Suffering from Lymphoma: Does MRI Contrast Media make a Difference?**

SSNMMI07-

3

Nils M. Bruckmann, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the influence of an MRI contrast agent application on primary and follow-up staging in pediatric patients with newly diagnosed lymphoma using [<sup>18</sup>F]FDG PET/MRI.

#### METHODS AND MATERIALS

From a cohort of 32 children (mean age  $14 \pm 3$ , range 7 - 20 years) with newly diagnosed lymphoma a total of 105 [<sup>18</sup>F]FDG PET/MRI datasets were included for analysis of 2 different reading protocols: (i) PET/MRI-1 comprising unenhanced T2w and/or T1w and diffusion-weighted imaging in combination with a [<sup>18</sup>F]FDG PET dataset (ii) PET/MRI-2 comprising an additional contrast enhanced T1w sequence. All datasets were analyzed by two experienced readers on a patient-based and region-based level according to the revised international pediatric NHL staging system (IPNHLSS). Follow-up and prior examinations as well as histopathology served as reference standard. Differences in staging accuracy were assessed using Wilcoxon and McNemar test.

#### RESULTS

According to the standard of reference active lymphoma was present in 65 of the 105 (62 %) examinations. In patient-based analysis PET/MRI-1 and PET/MRI-2 both determined correct IPNHLSS tumor stage in 90/105 (86 %) children. Region-based analysis correctly identified 119/127 (94 %) lymphoma-affected regions. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy for PET/MRI-1 and PET/MRI-2 reading protocol were 94 %, 97 %, 90 %, 99 %, 97 %, respectively. There were no statistically significant differences between PET/MRI-1 and PET/MRI-2 reading protocol.

#### CONCLUSION

[<sup>18</sup>F]FDG PET/MRI is increasingly accepted for staging of lymphoma patients and the present study further confirms the feasibility and high diagnostic accuracy of it in pediatric lymphoma patients. However, the use of MRI contrast agents in [<sup>18</sup>F]FDG PET/MRI examinations has no additional positive benefit for primary and follow-up staging of pediatric lymphoma patients.

#### CLINICAL RELEVANCE/APPLICATION

[<sup>18</sup>F]FDG PET/MRI is predestined for children suffering from lymphoma and should be considered as the diagnostic of choice. The switch to a contrast agent free [<sup>18</sup>F]FDG PET/MRI protocol should additionally be discussed in all pediatric lymphoma patients.

##### R1- Simultaneous Whole Body 2-[<sup>18</sup>F]FDG-PET/MRI Imaging in Smoldering Multiple Myeloma Assessment

SSNMMI07-



Bastien JAMET (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Whole-body MRI (WB-MRI) is the reference imaging technique in smoldering multiple myeloma (SMM) according to International Myeloma Working Group (IMWG) guidelines in order to find out 2 focal bone lesions (FLs) > 5 mm which is a criterion to initiate therapy. 2-18F-fluorodeoxyglucose positron emission tomography (2-[18F]FDG-PET) usually coupled with computed tomography (CT) also demonstrated an interest in several prospective studies and can be used for the same purpose. Thus, combining these two imaging modalities in one single simultaneous scan in SMM initial workup seems attractive. However, to date, the published data are scarce. In this prospective study, we aimed to explore the diagnostic performance of WB-2-[18F]FDG-PET/MRI imaging in SMM.

#### **METHODS AND MATERIALS**

All patients with SMM at the Nantes University Hospital were prospectively enrolled in this study between May 2021 and March 2023 and underwent WB-2-[18F]FDG-PET/MRI imaging on a 3T Biograph mMR device. Patients were considered as SMM if no myeloma-defining event (MDE: end organ damage attributed to the MM and/or biomarkers of malignancy: clonal bone marrow plasma cell percentage = 60%, involved/uninvolved serum free light chain ratio =100) was present before the WB-2-[18F]FDG-PET/MRI imaging. Diagnostic performance of WB-2-[18F]FDG-PET/MRI imaging, as well as PET and MRI separately for FL and diffuse bone marrow involvement (BMI) detection, were assessed. True positive FL detection was confirmed with follow-up scans. Fisher's exact test was used to assess the differences in detecting FLs and diffuse BMI between PET and MRI.

#### **RESULTS**

70 patients were included in this study for a total of 81 scans. Median age was 66 (31-87). PET detected at least one FL in 6/70 (9%) of patients whereas MRI in 14/70 (20%,  $p < 10^{-3}$ ). PET didn't detect additional patient with FL compared to MRI. In total, WB-2-[18F]FDG-PET/MRI imaging detected at least one FL in 20% of patients. PET detected diffuse BMI in 17/70 (24%) of patients and MRI in 14/70 (20%, NS). Combined PET/MRI assessment allowed diffuse BMI detection in 24/70 (34%) of patients.

#### **CONCLUSION**

MRI was more sensitive than PET for FL detection in SMM. MRI and PET were equally effective for diffuse BMI detection but combined PET/MRI assessment allowed to increase the diffuse BMI detection rate compared to PET and MRI alone.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI should be performed for FL detection in SMM. Combined PET/MRI assessment allowed to increase the diffuse BMI detection rate compared to PET and MRI alone suggesting the two imaging techniques could be complementary. Beyond FL detection, follow-up of these patients will determine if other features extracted from PET or MRI can predict progression to symptomatic MM.

### **R1- 18F-FDG PET/CT Features as Imaging Biomarkers of Outcome and Toxicity in Large-B-cell SSNMMI07-Lymphoma Treated with CAR-T Cell Therapy**

5

Doris Leithner, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Toxicity and disease recurrence or progression after chimeric antigen receptor T (CAR-T) cell therapy in patients with large B cell lymphoma (LBCL) remain clinical challenges and effective quantitative biomarkers are lacking. Our aim was to evaluate whether 18F-FDG PET/CT imaging features can predict the likelihood of response and developing immune toxicity (i.e. cytokine release syndrome [CRS] and neurotoxicity) in LBCL patients treated with CAR-T cell therapy.

#### **METHODS AND MATERIALS**

18F-FDG PET/CT scans performed before CAR-T for LBCL were retrospectively analyzed by a board certified radiologist. Metabolic tumor volume (MTV), SUVmax, and total lesion glycolysis (TLG) were recorded using the PET-CT plugin for FIJI. Response to CAR-T cell therapy was defined according to Lugano criteria. CRS and neurotoxicity were graded according to ASTCT guidelines. Progression-free survival (PFS) and overall survival (OS) were measured from time of CAR-T cell infusion, with PFS events including death, relapse, and disease progression. Association between PET imaging features and outcomes were studied in univariable logistic regression and Cox regression models.

#### **RESULTS**

A total of 181 LBCL patients (median age 65 years) treated with autologous CD19-directed CAR-T (94 axi-cel, 52 tisa-cel, 35 liso-cel) were included. Two time points of evaluation were considered: 1) pre-apheresis scans (n=161; median SUVmax 19, MTV 56, TLG 427), and 2) latest disease evaluation before CAR-T infusion including post-apheresis and post-bridging scans, as well as pre-apheresis scans for patients without additional imaging afterwards (n=181; median SUVmax 15, MTV 44, TLG 333). At the pre-apheresis point, increasing SUVmax, MTV, and TLG were associated with a higher likelihood of non-complete

remission (CR) and grade 2-4 neurotoxicity (P-values 0.003, 0.021, 0.036 and 0.011, 0.04, 0.024, respectively). The same pattern of association was observed when evaluating PET features measured at most recent disease assessment before CAR-T infusion (all P-values <0.001, and 0.033, 0.049, 0.015, respectively). Finally, increasing SUVmax, MTV, and TLG at latest disease assessment were strongly associated with shorter PFS (HR 1.28 [95% CI 1.11-1.48], HR 1.05 [1.03-1.07], HR 1.06 [1.04-1.09], respectively, all P<0.001) and OS (HR 1.33 [95% CI 1.13-1.58], P=0.001; HR 1.05 [1.04-1.07], and HR 1.06 [1.04-1.09], both P<0.001).

#### **CONCLUSION**

Our results demonstrate that quantitative PET imaging features in LBCL may serve as biomarkers for CAR-T cell therapy toxicity and likelihood of treatment failure.

#### **CLINICAL RELEVANCE/APPLICATION**

These findings in one of the largest cohorts of LBCL patients may guide preventive interventions to increase the efficacy and safety of CAR-T cell therapy.

#### **R1- Keynote Speaker**

**SSNMMI07-**

**6**

Gary A. Ulaner, MD, PhD (*Presenter*) Speaker, Siemens AG; Speaker, Lantheus Holdings; Research support, General Electric Company; Research support, F. Hoffmann-La Roche Ltd; Research support, Lantheus Holdings; Research support, Novartis AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSNMMI07-1

### Keynote Speaker

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403A

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSNMMI07-3

### **[<sup>18</sup>F]FDG PET/MRI in Children Suffering from Lymphoma: Does MRI Contrast Media make a Difference?**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403A

Nils M. Bruckmann, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the influence of an MRI contrast agent application on primary and follow-up staging in pediatric patients with newly diagnosed lymphoma using [<sup>18</sup>F]FDG PET/MRI.

#### **METHODS AND MATERIALS**

From a cohort of 32 children (mean age  $14 \pm 3$ , range 7 - 20 years) with newly diagnosed lymphoma a total of 105 [<sup>18</sup>F]FDG PET/MRI datasets were included for analysis of 2 different reading protocols: (i) PET/MRI-1 comprising unenhanced T2w and/or T1w and diffusion-weighted imaging in combination with a [<sup>18</sup>F]FDG PET dataset (ii) PET/MRI-2 comprising an additional contrast enhanced T1w sequence. All datasets were analyzed by two experienced readers on a patient-based and region-based level according to the revised international pediatric NHL staging system (IPNHLSS). Follow-up and prior examinations as well as histopathology served as reference standard. Differences in staging accuracy were assessed using Wilcoxon and McNemar test.

#### **RESULTS**

According to the standard of reference active lymphoma was present in 65 of the 105 (62 %) examinations. In patient-based analysis PET/MRI-1 and PET/MRI-2 both determined correct IPNHLSS tumor stage in 90/105 (86 %) children. Region-based analysis correctly identified 119/127 (94 %) lymphoma-affected regions. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy for PET/MRI-1 and PET/MRI-2 reading protocol were 94 %, 97 %, 90 %, 99 %, 97 %, respectively. There were no statistically significant differences between PET/MRI-1 and PET/MRI-2 reading protocol.

#### **CONCLUSION**

[<sup>18</sup>F]FDG PET/MRI is increasingly accepted for staging of lymphoma patients and the present study further confirms the feasibility and high diagnostic accuracy of it in pediatric lymphoma patients. However, the use of MRI contrast agents in [<sup>18</sup>F]FDG PET/MRI examinations has no additional positive benefit for primary and follow-up staging of pediatric lymphoma patients.

#### **CLINICAL RELEVANCE/APPLICATION**

[<sup>18</sup>F]FDG PET/MRI is predestined for children suffering from lymphoma and should be considered as the diagnostic of choice. The switch to a contrast agent free [<sup>18</sup>F]FDG PET/MRI protocol should additionally be discussed in all pediatric lymphoma patients.

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## Abstract Archives of the RSNA, 2023

R1-SSNMMI07-4

### Simultaneous Whole Body 2-[<sup>18</sup>F]FDG-PET/MRI Imaging in Smoldering Multiple Myeloma Assessment

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403A

Bastien JAMET (*Presenter*) Nothing to Disclose

#### PURPOSE

Whole-body MRI (WB-MRI) is the reference imaging technique in smoldering multiple myeloma (SMM) according to International Myeloma Working Group (IMWG) guidelines in order to find out 2 focal bone lesions (FLs) > 5 mm which is a criterion to initiate therapy. 2-18F-fluorodeoxyglucose positron emission tomography (2-[<sup>18</sup>F]FDG-PET) usually coupled with computed tomography (CT) also demonstrated an interest in several prospective studies and can be used for the same purpose. Thus, combining these two imaging modalities in one single simultaneous scan in SMM initial workup seems attractive. However, to date, the published data are scarce. In this prospective study, we aimed to explore the diagnostic performance of WB-2-[<sup>18</sup>F]FDG-PET/MRI imaging in SMM.

#### METHODS AND MATERIALS

All patients with SMM at the Nantes University Hospital were prospectively enrolled in this study between May 2021 and March 2023 and underwent WB-2-[<sup>18</sup>F]FDG-PET/MRI imaging on a 3T Biograph mMR device. Patients were considered as SMM if no myeloma-defining event (MDE: end organ damage attributed to the MM and/or biomarkers of malignancy: clonal bone marrow plasma cell percentage = 60%, involved/uninvolved serum free light chain ratio = 100) was present before the WB-2-[<sup>18</sup>F]FDG-PET/MRI imaging. Diagnostic performance of WB-2-[<sup>18</sup>F]FDG-PET/MRI imaging, as well as PET and MRI separately for FL and diffuse bone marrow involvement (BMI) detection, were assessed. True positive FL detection was confirmed with follow-up scans. Fisher's exact test was used to assess the differences in detecting FLs and diffuse BMI between PET and MRI.

#### RESULTS

70 patients were included in this study for a total of 81 scans. Median age was 66 (31-87). PET detected at least one FL in 6/70 (9%) of patients whereas MRI in 14/70 (20%,  $p < 10^{-3}$ ). PET didn't detect additional patient with FL compared to MRI. In total, WB-2-[<sup>18</sup>F]FDG-PET/MRI imaging detected at least one FL in 20% of patients. PET detected diffuse BMI in 17/70 (24%) of patients and MRI in 14/70 (20%, NS). Combined PET/MRI assessment allowed diffuse BMI detection in 24/70 (34%) of patients.

#### CONCLUSION

MRI was more sensitive than PET for FL detection in SMM. MRI and PET were equally effective for diffuse BMI detection but combined PET/MRI assessment allowed to increase the diffuse BMI detection rate compared to PET and MRI alone.

#### CLINICAL RELEVANCE/APPLICATION

MRI should be performed for FL detection in SMM. Combined PET/MRI assessment allowed to increase the diffuse BMI detection rate compared to PET and MRI alone suggesting the two imaging techniques could be complementary. Beyond FL detection, follow-up of these patients will determine if other features extracted from PET or MRI can predict progression to symptomatic MM.

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## Abstract Archives of the RSNA, 2023

R1-SSNMMI07-5

### **18F-FDG PET/CT Features as Imaging Biomarkers of Outcome and Toxicity in Large-B-cell Lymphoma Treated with CAR-T Cell Therapy**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403A

Doris Leithner, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Toxicity and disease recurrence or progression after chimeric antigen receptor T (CAR-T) cell therapy in patients with large B cell lymphoma (LBCL) remain clinical challenges and effective quantitative biomarkers are lacking. Our aim was to evaluate whether 18F-FDG PET/CT imaging features can predict the likelihood of response and developing immune toxicity (i.e. cytokine release syndrome [CRS] and neurotoxicity) in LBCL patients treated with CAR-T cell therapy.

#### **METHODS AND MATERIALS**

18F-FDG PET/CT scans performed before CAR-T for LBCL were retrospectively analyzed by a board certified radiologist. Metabolic tumor volume (MTV), SUVmax, and total lesion glycolysis (TLG) were recorded using the PET-CT plugin for FIJI. Response to CAR-T cell therapy was defined according to Lugano criteria. CRS and neurotoxicity were graded according to ASTCT guidelines. Progression-free survival (PFS) and overall survival (OS) were measured from time of CAR-T cell infusion, with PFS events including death, relapse, and disease progression. Association between PET imaging features and outcomes were studied in univariable logistic regression and Cox regression models.

#### **RESULTS**

A total of 181 LBCL patients (median age 65 years) treated with autologous CD19-directed CAR-T (94 axi-cel, 52 tisa-cel, 35 liso-cel) were included. Two time points of evaluation were considered: 1) pre-apheresis scans (n=161; median SUVmax 19, MTV 56, TLG 427), and 2) latest disease evaluation before CAR-T infusion including post-apheresis and post-bridging scans, as well as pre-apheresis scans for patients without additional imaging afterwards (n=181; median SUVmax 15, MTV 44, TLG 333). At the pre-apheresis point, increasing SUVmax, MTV, and TLG were associated with a higher likelihood of non-complete remission (CR) and grade 2-4 neurotoxicity (P-values 0.003, 0.021, 0.036 and 0.011, 0.04, 0.024, respectively). The same pattern of association was observed when evaluating PET features measured at most recent disease assessment before CAR-T infusion (all P-values <0.001, and 0.033, 0.049, 0.015, respectively). Finally, increasing SUVmax, MTV, and TLG at latest disease assessment were strongly associated with shorter PFS (HR 1.28 [95% CI 1.11-1.48], HR 1.05 [1.03-1.07], HR 1.06 [1.04-1.09], respectively, all P<0.001) and OS (HR 1.33 [95% CI 1.13-1.58], P=0.001; HR 1.05 [1.04-1.07], and HR 1.06 [1.04-1.09], both P<0.001).

#### **CONCLUSION**

Our results demonstrate that quantitative PET imaging features in LBCL may serve as biomarkers for CAR-T cell therapy toxicity and likelihood of treatment failure.

#### **CLINICAL RELEVANCE/APPLICATION**

These findings in one of the largest cohorts of LBCL patients may guide preventive interventions to increase the efficacy and safety of CAR-T cell therapy.

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## Abstract Archives of the RSNA, 2023

R1-SSNMMI07-6

### Keynote Speaker

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403A

Gary A. Ulaner, MD,PhD (*Presenter*) Speaker, Siemens AG;Speaker,Lantheus Holdings;Research support, General Electric Company;Research support, F. Hoffmann-La Roche Ltd;Research support, Lantheus Holdings;Research support, Novartis AG

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## Abstract Archives of the RSNA, 2023

R1-SSR004

### Radiation Oncology (Genitourinary and Gynecology)

Thursday, Nov. 30 8:00AM - 9:00AM Room: S502

Anne Rajkumar, MD (*Moderator*) Nothing to Disclose  
Shauna McVorrnan, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R1-SSR004-1 Improving the Prediction of Biochemical Recurrence Free Survival After Radiotherapy Using MRI Radiomics and Hypoxia Gene Signature Information in Patients with Prostate Cancer**

Jim Zhong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of combining prostate MRI radiomic and hypoxia-associated gene signature information to clinical data for predicting biochemical recurrence free survival (BCRFS) after radiotherapy for prostate cancer.

#### METHODS AND MATERIALS

Consecutive patients with biopsy-proven high-grade prostate cancer and pre-treatment MRI who received radiotherapy between 01/12/2007 and 31/08/2013 at two cancer centres were included. All patients had a hypoxia score derived from a 32-gene hypoxia-associated signature (Ragnum signature) obtained from tissue biopsy. Prostate segmentation was performed on axial T2-weighted sequences using RayStation (v9.1). Histogram normalization was applied to the MR images prior to radiomic feature (RF) extraction. PyRadiomics (v3.0.1) was used to extract RFs for analysis. Multivariable Cox proportional hazards models including clinical variables were used to predict BCRFS. The addition of RFs and hypoxia score to the model was evaluated using univariate feature selection. Redundant variables and those highly correlated with tumour volume were removed. Cross-validation and bootstrapping were used to assess final model performance, evaluated with the concordance index (c-index) [confidence intervals presented] and Akaike Information Criterion (AIC).

#### RESULTS

195 patients were included with 97 (49.7%) having hypoxic tumours. The combined clinical-radiomics-hypoxia model and clinical-radiomics model performed equally well (c-index 0.69 [0.64, 0.71]) and outperformed the clinical-only model (c-index of 0.67 [0.62, 0.69]) and clinical-hypoxia model (c-index of 0.68 [0.64, 0.69]). The selected features included age, International Society of Urological Pathology (ISUP) grade, tumour stage, tumour volume, radiotherapy modality and wavelet-derived radiomic features. Comparing the AIC of the clinical model to the combined models, the inclusion of radiomics improved the model ( $p=0.037$ ), whereas the inclusion of hypoxia did not ( $p=0.079$ ), unless it was also combined with the radiomics ( $p=0.030$ ).

#### CONCLUSION

The addition of pre-treatment MRI-derived radiomic features to clinical variables improved the ability to predict BCRFS after prostate radiotherapy with or without the addition of hypoxia gene signature.

#### CLINICAL RELEVANCE/APPLICATION

Integration of MRI-derived radiomics with or without gene-based biomarkers may enable more precise and informative assessment of biochemical recurrence after prostate radiotherapy.

#### **R1-SSR004-2 Novel Quantitative Prostate MRI Predictors of Late Genitourinary Toxicity after Radiation: A Step Forward in Pretherapeutic Risk-stratification**

Joseph Lee, MD, PhD (*Presenter*) Nothing to Disclose



## PURPOSE

Genitourinary toxicity is an important determinant of quality of life after radiation therapy for prostate cancer, with few current identified risk factors. The purpose of our study was to evaluate pretreatment quantitative prostate MRI and clinical characteristics in predicting GU toxicity after RT.

## METHODS AND MATERIALS

In this single institution, retrospective cohort study, we evaluated patients with histologically-confirmed prostate adenocarcinoma and no prior history of pelvic radiation, who underwent MRI within 6 months before completing definitive RT to the prostate from June 2016-January 2023 with follow-up information in our GU toxicity database. MRI measurements included prostatic urethral length (PUL), membranous urethral length, central gland volume, peripheral zone volume, intravesicular prostatic protrusion volume, detrusor muscular ring diameter, and prostatic urethral angle. Clinical data included age, pretreatment American Urology Association (AUA) score, diabetes, anticoagulation, RT modality, hormone use, and pelvic node radiation. GU toxicity was physician scored using Common Terminology Criteria for Adverse Events (CTCAE) with acute (<180 days) and late (>180 days). Multivariable logistic regression models were separately constructed for acute and late grade=2 toxicity. Interrater agreement was assessed using intraclass correlation coefficient (ICC).

## RESULTS

A total of 245 men were included (mean age: 67.1 [SD: 7.5]): 17.0% (40/235) demonstrated acute grade=2 GU toxicity and 21.4% (42/196) grade=2 late toxicity. 11.8% of patients underwent standard fractionated external beam RT, 27.7% hypofractionated EBRT, 42.2% brachytherapy, and 18.4% stereotactic body RT. Only brachytherapy was predictive of acute GU toxicity (OR:2.6 (95%CI: 1.3-5.5), p=0.009). Regardless of RT modality, longer prostatic urethral length increased the odds of late toxicity (OR:2.0 (95%CI: 1.7-7.4, p=0.001) while increasing central gland volume decreased odds of late toxicity (OR: 0.94 (95%CI: 0.90-0.98), p=0.01) with area under the curve (AUC) of model 0.72 (95%CI: 0.65-0.78). No clinical variables were predictive of late toxicity. ICC of prostatic urethral length was excellent at 0.91 (95%CI: 0.88-0.93).

## CONCLUSION

Prostatic urethra length and central gland volumes measured on pretreatment prostate MRI are potential novel independent imaging predictors of late grade≥2 GU toxicity after RT for prostate cancer. Further studies conjunctive with genomic radiosensitivity rather than clinical data or RT modality may optimize a late toxicity prediction model.

## CLINICAL RELEVANCE/APPLICATION

In addition to pretreatment planning and staging, prostate MRI appears promising in the risk-stratification of late GU toxicity.

## R1- SSRO04-3 The Clinical Feasibility of Artificial Intelligence-Guided Deformation of Nodal Contours in Online Cone-beam Adaptive Radiotherapy (OnC-ART) for Cervical Cancer

Ethan Wang, BS (*Presenter*) Nothing to Disclose

## PURPOSE

In cervical cancer patients, online cone-beam CT (CBCT) adaptive radiotherapy (OnC-ART) is a promising EBRT modality that accounts for inter-fractional variation in pelvic anatomy. Lymph node re-contouring for OnC-ART is difficult due to limited visibility of nodes on CBCT. AI-generated influencer structures can guide deformable image registration (AID) of planning CT contours to the day of treatment CBCT, allowing for automated nodal contour generation. In this study, we assessed the clinical acceptability of AID contours and determined when deformation is appropriate.

## METHODS AND MATERIALS

From our ART Registry, we identified 21 cervical cancer patients with 136 total adapted treatment fractions receiving nodal boost along with primary site treatment. For each adaptive patient fraction, clinical tumor volume (CTV) lymph node boost (LNBst) structures were extracted and partitioned into individual nodes. Clinically-delivered contours were classified as the ground truth and compared to unedited AID CTV LNBst contours to assess geometric similarity. AID planning target volume (PTV) LNBst contour coverage of clinical CTV LNBst contours was assessed with a 5mm CTV to PTV margin. For dosimetric assessment, plans generated from AID contours were overlaid on clinical CTV LNBst contours, with coverage evaluated by D100, D95, V100%, and V95%. D100 and D95 were normalized to prescribed doses.

## RESULTS

103 unique AID and clinical CTV LNBst structures were assessed over 649 total occurrences in adaptive treatment fractions, and geometric overlap of the two structures was determined. The median volumetric dice coefficient, false positive dice, false negative dice, and 95% hausdorff distance were 0.655, 0.270, 0.419, and 3.983 mm. AID PTV coverage of clinical CTV LNBst contours exhibited a median FPD of 0. AID PTV-based plan coverage of clinical CTV LNBst structures produced a median normalized D100, normalized D95, V100%, and V95% of 1.001, 1.009, 1, and 1. Specifically, the D95 was greater or equal to the prescribed dose in 75.66% of nodal occurrences. Suboptimal dosimetric coverage was significantly associated (p < .00625) with larger size, higher fraction number, higher intra-fraction nodal count, and daily adapted nodes.

## CONCLUSION

AID contours can produce plans with clinically acceptable nodal coverage, though occasional AID failure mandates manual review of all AID contours. Additional scrutiny of AID nodes is required for OnC-ART later in the treatment cycle and if multiple nodes are targeted in a given patient.

## CLINICAL RELEVANCE/APPLICATION

Our study provides clinicians with the first clinically reported and analyzed use of OnC-ART for nodal boost. Recommendations concerning the accuracy of nodal AID contours in cervical OnC-ART are elucidated.

### **R1- SSRO04-4 CyberKnife Stereotactic Body Radiation Therapy(SBRT)Dose Escalation Prostate Cancer Trial (CK-DESPOT) for Unfavorable Intermediate and High-Risk Prostate Cancer (NCT03822494)**

Anthony Ricco, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Since publication of the FLAME (focal lesion ablative micro boost in prostate cancer) trial, the NCCN guidelines incorporated focal boost for intensity modulated radiation therapy. Limited data has been published for micro boost with SBRT. This phase II clinical trial sought to assess outcomes following simultaneous integrated focal boost during a course SBRT with the CyberKnife system. The primary objective is to assess biochemical disease-free survival and the secondary objective is to assess severe GI and GU toxicity at greater than 6 months follow up (FU).

## METHODS AND MATERIALS

Patients with NCCN unfavorable intermediate or high risk prostate cancer diagnosed within 360 days of enrollment were eligible. MRI and bone scan +/- PSMA PET/CT were required for staging. Patients received ADT, and SBRT was initiated within 2 months of ADT. OAR gel and fiducials were placed. Further criteria included prostate volume <100 cc, no prior pelvic radiation or TURP, AUA score <20, and no nodal or distant metastases. 40 Gy was prescribed to the prostate with PIRADS 4/5 nodule boost to 45-50 Gy. Proximal seminal vesicles received 36.25 Gy. Dose volume constraints were enforced for nearby at-risk organs. Toxicity was evaluated with standardized questionnaires. Biochemical control was determined by the Phoenix definition. Follow-up interval was 1, 3, 6, 12, 18, 24 months and yearly thereafter until year 5.

## RESULTS

Thirty-two men completed SBRT. Median age was 66 years and 84% were Caucasian. Sixty-six percent were stage T1c, 84.4% had a Gleason score of 7 and 56.3% were primary grade 4. Median PSA at baseline was 6.4 and with median 42% cores positive. 84% of men had unfavorable intermediate risk prostate cancer. The median duration of ADT was 6 months. Seventy eight percent received PI-RADS 4/5 simultaneous integrated focal boost. Median follow-up was 1.7 years (range 0.08-4.25). Toxicity was low. AUA scores peaked at 1 month (baseline median=4, 1 month median=10) with decrease close to baseline at 3 months (median=5) and improved at 24/36 months (median=3) and 48 months (median=2). There was no grade 3-5 RTOG acute or late urinary or bowel toxicity. 16 men were followed for 24 months with median PSA of 0 (range 0-0.3), 11 men for 36 months with median PSA of 0 (range 0-0.06) and 6 men for 48 months with median PSA of 0 (range 0-0.05).

## CONCLUSION

Simultaneous integrated focal boost is feasible with SBRT and has been demonstrated in this study to be safe with low toxicity. Biochemical failure has not been seen with short median follow-up.

## CLINICAL RELEVANCE/APPLICATION

This study describes a novel, safe, and low-toxicity radiation protocol for men with intermediate and high-risk prostate cancer demonstrating good quality of life and effective biochemical control at short follow-up.

### **R1- SSRO04-5 Perfusion and Diffusion MRI as a Response Biomarker Following Stereotactic Ablative Body Radiation Therapy of Primary Renal Cell Carcinoma: TROG 13.05 FASTRACK II Trial**

James Korte (*Presenter*) Nothing to Disclose

## PURPOSE

To explore early changes in perfusion and diffusion MRI in primary renal cell carcinoma (RCC) following stereotactic ablative body radiation therapy (SABR) and their correlation with later changes in tumour size on CT.

## METHODS AND MATERIALS

A subset of patients (n=17) from the Trans-Tasman Radiation Oncology Group FASTRACK II prospective multi-centre kidney SABR trial underwent multiparametric MRI. Diffusion weighted imaging (DWI) and dynamic contrast enhanced (DCE) imaging were performed prior to and 3 months post SABR. CT imaging to evaluate tumour volume was performed prior to and following SABR (6, 9, 12, 18, 24, 33 months). Apparent diffusion coefficient maps were calculated from DWI images using a

mono-exponential model. Perfusion metrics were calculated from DCE images with an extended Tofts model and a piecewise linear function. All currently available data was evaluated for correlations between change in MRI metrics and percentage change in tumour volume, relative to baseline, using a Spearman rank correlation ( $r_s$ ) test. Significant correlations ( $p < 0.05$ ) are considered exploratory due to the limited sample size.

## RESULTS

The preliminary analysis includes imaging from three hospitals, with a range of samples for DWI ( $n=6-11$ ) and DCE ( $n=5-9$ ) due to varied attendance, reporting and contraindication to contrast for follow-up imaging. Of the quantitative DCE metrics, median extracellular extravascular volume fraction ( $V_e$ ) was negatively correlated to CT volume changes at 6, 12 and 33 months ( $r_s=-0.31$ ,  $p=0.042$ ;  $r_s=-0.44$ ,  $p=0.049$ ;  $r_s=-0.63$ ,  $p=0.048$ ). The mean of the area under the curve (AUC) and maximum enhancement (ME) were negatively correlated to CT changes at 18 months ( $r_s=-0.81$ ,  $p=0.024$ ;  $r_s=-0.76$ ,  $p=0.048$ ), the mean and median initial rate of enhancement were correlated to CT changes at 9 months ( $r_s=0.90$ ,  $p=0.009$ ;  $r_s=0.76$ ,  $p=0.045$ ), and the median initial rate of washout was correlated to CT volume changes at 9 and 33 months ( $r_s=-0.69$ ,  $p=0.048$ ;  $r_s=-0.76$ ,  $p=0.049$ ). Changes in perfusion, such as AUC and ME, are observed in models of tissue damage and inflammation. Whilst no significant correlations in DWI metrics were observed, the significant  $V_e$  changes are hypothesised to relate to changes in tumour cellularity.

## CONCLUSION

To our knowledge, these are the first multi-centre observations of DWI and DCE metrics as early response biomarkers for renal SABR. Correlation between early changes in DCE metrics and later CT changes are potentially predictive of response but require validation on a larger cohort.

## CLINICAL RELEVANCE/APPLICATION

MRI perfusion metrics may provide an early marker of RCC tumour response to SABR, as compared to later size changes on CT, which could allow early initiation of salvage therapies for radiation resistant tumours.

## R1-SSR004-6 Preliminary Evaluation of Diffusion-weighted MRI and HPV-specific Circulating Tumor DNA Clearance in HPV-positive Cervical Cancer

Meghan C. Jacobsen, PhD (*Presenter*) Honorarium and Travel, Kyoto Kagaku

## PURPOSE

Response to chemoradiotherapy (CRT) in human papillomavirus (HPV)-related cervical cancers correlates with decreases in tumor volume on T2-weighted (T2w) MRI and increases in apparent diffusion coefficient (ADC) from diffusion-weighted imaging (DWI). However, imaging throughout RT is often a poor predictor for recurrence. HPV-specific circulating tumor DNA (ctDNA) is a promising fluid-based biomarker that, along with MRI, may help to better predict long-term patient outcomes based on immunologic response to HPV, as indicated in several trials in HPV-related head and neck cancers.

## METHODS AND MATERIALS

Nine locally advanced cervical cancer patients underwent ctDNA sample collection via cervical swab at baseline and weekly throughout the course of CRT. Clearance of HPV ctDNA was defined as having less than 15 copies/mL plasma by week 3 of RT. Patients also had T2w and DWI MRI at baseline, weeks 2 and 3, and prior to brachytherapy at the end of CRT. Tumors were contoured at each timepoint, and T2w tumor volume normalized to baseline and mean ADC were measured. Volume and ADC in HPV responders and non-responders were compared at each timepoint with a student's t-test.

## RESULTS

Mean ADC increased in both HPV ctDNA responders and non-responders, with the largest differences occurring at baseline ( $1190 \pm 271$   $10^{-6}$   $\text{mm}^2/\text{s}$  and  $995 \pm 156$   $10^{-6}$   $\text{mm}^2/\text{s}$ , respectively,  $p=0.24$ ) and week 2 ( $1285 \pm 100$   $10^{-6}$   $\text{mm}^2/\text{s}$  and  $1138 \pm 74$   $10^{-6}$   $\text{mm}^2/\text{s}$ ,  $p = 0.04$ ). All patients demonstrated volume decreases of at least 53% between baseline and completion of EBRT (range: -53.2% to 99.2%). However, there was no significant difference in normalized tumor volume between patients that did or did not clear HPV ctDNA.

## CONCLUSION

ADC data demonstrated slightly less restricted diffusion during the first two weeks of CRT in patients with favorable HPV ctDNA response. This preliminary analysis demonstrates that HPV ctDNA provides additional complementary data regarding immunologic response that is not fully captured using MR imaging metrics alone, justifying prospective correlative studies and outcomes modeling to accurately predict CRT response in cervical cancer.

## CLINICAL RELEVANCE/APPLICATION

Minimally invasive, fluid-based immune biomarkers such as HPV ctDNA, interpreted in combination with MR imaging findings, may enhance CRT response prediction of cervical cancer early treatment timepoints, thereby informing adaptive CRT strategies.

## Abstract Archives of the RSNA, 2023

R1-SSR004-1

### Improving the Prediction of Biochemical Recurrence Free Survival After Radiotherapy Using MRI Radiomics and Hypoxia Gene Signature Information in Patients with Prostate Cancer

Thursday, Nov. 30 8:00AM - 9:00AM Room: S502

Jim Zhong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of combining prostate MRI radiomic and hypoxia-associated gene signature information to clinical data for predicting biochemical recurrence free survival (BCRFS) after radiotherapy for prostate cancer.

#### METHODS AND MATERIALS

Consecutive patients with biopsy-proven high-grade prostate cancer and pre-treatment MRI who received radiotherapy between 01/12/2007 and 31/08/2013 at two cancer centres were included. All patients had a hypoxia score derived from a 32-gene hypoxia-associated signature (Ragnum signature) obtained from tissue biopsy. Prostate segmentation was performed on axial T2-weighted sequences using RayStation (v9.1). Histogram normalization was applied to the MR images prior to radiomic feature (RF) extraction. PyRadiomics (v3.0.1) was used to extract RFs for analysis. Multivariable Cox proportional hazards models including clinical variables were used to predict BCRFS. The addition of RFs and hypoxia score to the model was evaluated using univariate feature selection. Redundant variables and those highly correlated with tumour volume were removed. Cross-validation and bootstrapping were used to assess final model performance, evaluated with the concordance index (c-index) [confidence intervals presented] and Akaike Information Criterion (AIC).

#### RESULTS

195 patients were included with 97 (49.7%) having hypoxic tumours. The combined clinical-radiomics-hypoxia model and clinical-radiomics model performed equally well (c-index 0.69 [0.64, 0.71]) and outperformed the clinical-only model (c-index of 0.67 [0.62, 0.69]) and clinical-hypoxia model (c-index of 0.68 [0.64, 0.69]). The selected features included age, International Society of Urological Pathology (ISUP) grade, tumour stage, tumour volume, radiotherapy modality and wavelet-derived radiomic features. Comparing the AIC of the clinical model to the combined models, the inclusion of radiomics improved the model ( $p=0.037$ ), whereas the inclusion of hypoxia did not ( $p=0.079$ ), unless it was also combined with the radiomics ( $p=0.030$ ).

#### CONCLUSION

The addition of pre-treatment MRI-derived radiomic features to clinical variables improved the ability to predict BCRFS after prostate radiotherapy with or without the addition of hypoxia gene signature.

#### CLINICAL RELEVANCE/APPLICATION

Integration of MRI-derived radiomics with or without gene-based biomarkers may enable more precise and informative assessment of biochemical recurrence after prostate radiotherapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSR004-2

### Novel Quantitative Prostate MRI Predictors of Late Genitourinary Toxicity after Radiation: A Step Forward in Pretherapeutic Risk-stratification

Thursday, Nov. 30 8:00AM - 9:00AM Room: S502

Joseph Lee, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Genitourinary toxicity is an important determinant of quality of life after radiation therapy for prostate cancer, with few current identified risk factors. The purpose of our study was to evaluate pretreatment quantitative prostate MRI and clinical characteristics in predicting GU toxicity after RT.

#### METHODS AND MATERIALS

In this single institution, retrospective cohort study, we evaluated patients with histologically-confirmed prostate adenocarcinoma and no prior history of pelvic radiation, who underwent MRI within 6 months before completing definitive RT to the prostate from June 2016-January 2023 with follow-up information in our GU toxicity database. MRI measurements included prostatic urethral length (PUL), membranous urethral length, central gland volume, peripheral zone volume, intravesicular prostatic protrusion volume, detrusor muscular ring diameter, and prostatic urethral angle. Clinical data included age, pretreatment American Urology Association (AUA) score, diabetes, anticoagulation, RT modality, hormone use, and pelvic node radiation. GU toxicity was physician scored using Common Terminology Criteria for Adverse Events (CTCAE) with acute (<180 days) and late (>180 days). Multivariable logistic regression models were separately constructed for acute and late grade=2 toxicity. Interrater agreement was assessed using intraclass correlation coefficient (ICC).

#### RESULTS

A total of 245 men were included (mean age: 67.1 [SD: 7.5]): 17.0% (40/235) demonstrated acute grade=2 GU toxicity and 21.4% (42/196) grade=2 late toxicity. 11.8% of patients underwent standard fractionated external beam RT, 27.7% hypofractionated EBRT, 42.2% brachytherapy, and 18.4% stereotactic body RT. Only brachytherapy was predictive of acute GU toxicity (OR:2.6 (95%CI: 1.3-5.5),  $p=0.009$ ). Regardless of RT modality, longer prostatic urethral length increased the odds of late toxicity (OR:2.0 (95%CI: 1.7-7.4,  $p=0.001$ ) while increasing central gland volume decreased odds of late toxicity (OR: 0.94 (95%CI: 0.90-0.98),  $p=0.01$ ) with area under the curve (AUC) of model 0.72 (95%CI: 0.65-0.78). No clinical variables were predictive of late toxicity. ICC of prostatic urethral length was excellent at 0.91 (95%CI: 0.88-0.93).

#### CONCLUSION

Prostatic urethra length and central gland volumes measured on pretreatment prostate MRI are potential novel independent imaging predictors of late grade $\geq$ 2 GU toxicity after RT for prostate cancer. Further studies conjunctive with genomic radiosensitivity rather than clinical data or RT modality may optimize a late toxicity prediction model.

#### CLINICAL RELEVANCE/APPLICATION

In addition to pretreatment planning and staging, prostate MRI appears promising in the risk-stratification of late GU toxicity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSR004-3

### The Clinical Feasibility of Artificial Intelligence-Guided Deformation of Nodal Contours in Online Cone-beam Adaptive Radiotherapy (OnC-ART) for Cervical Cancer

Thursday, Nov. 30 8:00AM - 9:00AM Room: S502

Ethan Wang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

In cervical cancer patients, online cone-beam CT (CBCT) adaptive radiotherapy (OnC-ART) is a promising EBRT modality that accounts for inter-fractional variation in pelvic anatomy. Lymph node re-contouring for OnC-ART is difficult due to limited visibility of nodes on CBCT. AI-generated influencer structures can guide deformable image registration (AID) of planning CT contours to the day of treatment CBCT, allowing for automated nodal contour generation. In this study, we assessed the clinical acceptability of AID contours and determined when deformation is appropriate.

#### METHODS AND MATERIALS

From our ART Registry, we identified 21 cervical cancer patients with 136 total adapted treatment fractions receiving nodal boost along with primary site treatment. For each adaptive patient fraction, clinical tumor volume (CTV) lymph node boost (LNbst) structures were extracted and partitioned into individual nodes. Clinically-delivered contours were classified as the ground truth and compared to unedited AID CTV LNbst contours to assess geometric similarity. AID planning target volume (PTV) LNbst contour coverage of clinical CTV LNbst contours was assessed with a 5mm CTV to PTV margin. For dosimetric assessment, plans generated from AID contours were overlaid on clinical CTV LNbst contours, with coverage evaluated by D100, D95, V100%, and V95%. D100 and D95 were normalized to prescribed doses.

#### RESULTS

103 unique AID and clinical CTV LNbst structures were assessed over 649 total occurrences in adaptive treatment fractions, and geometric overlap of the two structures was determined. The median volumetric dice coefficient, false positive dice, false negative dice, and 95% hausdorff distance were 0.655, 0.270, 0.419, and 3.983 mm. AID PTV coverage of clinical CTV LNbst contours exhibited a median FPD of 0. AID PTV-based plan coverage of clinical CTV LNbst structures produced a median normalized D100, normalized D95, V100%, and V95% of 1.001, 1.009, 1, and 1. Specifically, the D95 was greater or equal to the prescribed dose in 75.66% of nodal occurrences. Suboptimal dosimetric coverage was significantly associated ( $p < .00625$ ) with larger size, higher fraction number, higher intra-fraction nodal count, and daily adapted nodes.

#### CONCLUSION

AID contours can produce plans with clinically acceptable nodal coverage, though occasional AID failure mandates manual review of all AID contours. Additional scrutiny of AID nodes is required for OnC-ART later in the treatment cycle and if multiple nodes are targeted in a given patient.

#### CLINICAL RELEVANCE/APPLICATION

Our study provides clinicians with the first clinically reported and analyzed use of OnC-ART for nodal boost. Recommendations concerning the accuracy of nodal AID contours in cervical OnC-ART are elucidated.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R1-SSR004-4

### **CyberKnife Stereotactic Body Radiation Therapy (SBRT) Dose Escalation Prostate Cancer Trial (CK-DESPOT) for Unfavorable Intermediate and High-Risk Prostate Cancer (NCT03822494)**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S502

Anthony Ricco, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Since publication of the FLAME (focal lesion ablative micro boost in prostate cancer) trial, the NCCN guidelines incorporated focal boost for intensity modulated radiation therapy. Limited data has been published for micro boost with SBRT. This phase II clinical trial sought to assess outcomes following simultaneous integrated focal boost during a course SBRT with the CyberKnife system. The primary objective is to assess biochemical disease-free survival and the secondary objective is to assess severe GI and GU toxicity at greater than 6 months follow up (FU).

#### **METHODS AND MATERIALS**

Patients with NCCN unfavorable intermediate or high risk prostate cancer diagnosed within 360 days of enrollment were eligible. MRI and bone scan +/- PSMA PET/CT were required for staging. Patients received ADT, and SBRT was initiated within 2 months of ADT. OAR gel and fiducials were placed. Further criteria included prostate volume <100 cc, no prior pelvic radiation or TURP, AUA score <20, and no nodal or distant metastases. 40 Gy was prescribed to the prostate with PIRADS 4/5 nodule boost to 45-50 Gy. Proximal seminal vesicles received 36.25 Gy. Dose volume constraints were enforced for nearby at-risk organs. Toxicity was evaluated with standardized questionnaires. Biochemical control was determined by the Phoenix definition. Follow-up interval was 1, 3, 6, 12, 18, 24 months and yearly thereafter until year 5.

#### **RESULTS**

Thirty-two men completed SBRT. Median age was 66 years and 84% were Caucasian. Sixty-six percent were stage T1c, 84.4% had a Gleason score of 7 and 56.3% were primary grade 4. Median PSA at baseline was 6.4 and with median 42% cores positive. 84% of men had unfavorable intermediate risk prostate cancer. The median duration of ADT was 6 months. Seventy eight percent received PI-RADS 4/5 simultaneous integrated focal boost. Median follow-up was 1.7 years (range 0.08-4.25). Toxicity was low. AUA scores peaked at 1 month (baseline median=4, 1 month median=10) with decrease close to baseline at 3 months (median=5) and improved at 24/36 months (median=3) and 48 months (median=2). There was no grade 3-5 RTOG acute or late urinary or bowel toxicity. 16 men were followed for 24 months with median PSA of 0 (range 0-0.3), 11 men for 36 months with median PSA of 0 (range 0-0.06) and 6 men for 48 months with median PSA of 0 (range 0-0.05).

#### **CONCLUSION**

Simultaneous integrated focal boost is feasible with SBRT and has been demonstrated in this study to be safe with low toxicity. Biochemical failure has not been seen with short median follow-up.

#### **CLINICAL RELEVANCE/APPLICATION**

This study describes a novel, safe, and low-toxicity radiation protocol for men with intermediate and high-risk prostate cancer demonstrating good quality of life and effective biochemical control at short follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSR004-5

### Perfusion and Diffusion MRI as a Response Biomarker Following Stereotactic Ablative Body Radiation Therapy of Primary Renal Cell Carcinoma: TROG 13.05 FASTRACK II Trial

Thursday, Nov. 30 8:00AM - 9:00AM Room: S502

James Korte (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore early changes in perfusion and diffusion MRI in primary renal cell carcinoma (RCC) following stereotactic ablative body radiation therapy (SABR) and their correlation with later changes in tumour size on CT.

#### METHODS AND MATERIALS

A subset of patients (n=17) from the Trans-Tasman Radiation Oncology Group FASTRACK II prospective multi-centre kidney SABR trial underwent multiparametric MRI. Diffusion weighted imaging (DWI) and dynamic contrast enhanced (DCE) imaging were performed prior to and 3 months post SABR. CT imaging to evaluate tumour volume was performed prior to and following SABR (6, 9, 12, 18, 24, 33 months). Apparent diffusion coefficient maps were calculated from DWI images using a mono-exponential model. Perfusion metrics were calculated from DCE images with an extended Tofts model and a piecewise linear function. All currently available data was evaluated for correlations between change in MRI metrics and percentage change in tumour volume, relative to baseline, using a Spearman rank correlation (rs) test. Significant correlations ( $p < 0.05$ ) are considered exploratory due to the limited sample size.

#### RESULTS

The preliminary analysis includes imaging from three hospitals, with a range of samples for DWI (n=6-11) and DCE (n=5-9) due to varied attendance, reporting and contraindication to contrast for follow-up imaging. Of the quantitative DCE metrics, median extracellular extravascular volume fraction (Ve) was negatively correlated to CT volume changes at 6, 12 and 33 months ( $rs=-0.31$ ,  $p=0.042$ ;  $rs=-0.44$ ,  $p=0.049$ ;  $rs=-0.63$ ,  $p=0.048$ ). The mean of the area under the curve (AUC) and maximum enhancement (ME) were negatively correlated to CT changes at 18 months ( $rs=-0.81$ ,  $p=0.024$ ;  $rs=-0.76$ ,  $p=0.048$ ), the mean and median initial rate of enhancement were correlated to CT changes at 9 months ( $rs=0.90$ ,  $p=0.009$ ;  $rs=0.76$ ,  $p=0.045$ ), and the median initial rate of washout was correlated to CT volume changes at 9 and 33 months ( $rs=-0.69$ ,  $p=0.048$ ;  $rs=-0.76$ ,  $p=0.049$ ). Changes in perfusion, such as AUC and ME, are observed in models of tissue damage and inflammation. Whilst no significant correlations in DWI metrics were observed, the significant Ve changes are hypothesised to relate to changes in tumour cellularity.

#### CONCLUSION

To our knowledge, these are the first multi-centre observations of DWI and DCE metrics as early response biomarkers for renal SABR. Correlation between early changes in DCE metrics and later CT changes are potentially predictive of response but require validation on a larger cohort.

#### CLINICAL RELEVANCE/APPLICATION

MRI perfusion metrics may provide an early marker of RCC tumour response to SABR, as compared to later size changes on CT, which could allow early initiation of salvage therapies for radiation resistant tumours.

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## Abstract Archives of the RSNA, 2023

R1-SSR004-6

### **Preliminary Evaluation of Diffusion-weighted MRI and HPV-specific Circulating Tumor DNA Clearance in HPV-positive Cervical Cancer**

Thursday, Nov. 30 8:00AM - 9:00AM Room: S502

Meghan C. Jacobsen, PhD (*Presenter*) Honorarium and Travel, Kyoto Kagaku

#### **PURPOSE**

Response to chemoradiotherapy (CRT) in human papillomavirus (HPV)-related cervical cancers correlates with decreases in tumor volume on T2-weighted (T2w) MRI and increases in apparent diffusion coefficient (ADC) from diffusion-weighted imaging (DWI). However, imaging throughout RT is often a poor predictor for recurrence. HPV-specific circulating tumor DNA (ctDNA) is a promising fluid-based biomarker that, along with MRI, may help to better predict long-term patient outcomes based on immunologic response to HPV, as indicated in several trials in HPV-related head and neck cancers.

#### **METHODS AND MATERIALS**

Nine locally advanced cervical cancer patients underwent ctDNA sample collection via cervical swab at baseline and weekly throughout the course of CRT. Clearance of HPV ctDNA was defined as having less than 15 copies/mL plasma by week 3 of RT. Patients also had T2w and DWI MRI at baseline, weeks 2 and 3, and prior to brachytherapy at the end of CRT. Tumors were contoured at each timepoint, and T2w tumor volume normalized to baseline and mean ADC were measured. Volume and ADC in HPV responders and non-responders were compared at each timepoint with a student's t-test.

#### **RESULTS**

Mean ADC increased in both HPV ctDNA responders and non-responders, with the largest differences occurring at baseline ( $1190 \pm 271 \times 10^{-6} \text{ mm}^2/\text{s}$  and  $995 \pm 156 \times 10^{-6} \text{ mm}^2/\text{s}$ , respectively,  $p=0.24$ ) and week 2 ( $1285 \pm 100 \times 10^{-6} \text{ mm}^2/\text{s}$  and  $1138 \pm 74 \times 10^{-6} \text{ mm}^2/\text{s}$ ,  $p = 0.04$ ). All patients demonstrated volume decreases of at least 53% between baseline and completion of EBRT (range: -53.2% to 99.2%). However, there was no significant difference in normalized tumor volume between patients that did or did not clear HPV ctDNA.

#### **CONCLUSION**

ADC data demonstrated slightly less restricted diffusion during the first two weeks of CRT in patients with favorable HPV ctDNA response. This preliminary analysis demonstrates that HPV ctDNA provides additional complementary data regarding immunologic response that is not fully captured using MR imaging metrics alone, justifying prospective correlative studies and outcomes modeling to accurately predict CRT response in cervical cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

Minimally invasive, fluid-based immune biomarkers such as HPV ctDNA, interpreted in combination with MR imaging findings, may enhance CRT response prediction of cervical cancer early treatment timepoints, thereby informing adaptive CRT strategies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSVA04

### Vascular Imaging (Cardiovascular Imaging)

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403B

Phillip M. Young, MD (*Moderator*) Nothing to Disclose  
Camila Urzua Fresno, MD, MSc (*Moderator*) Nothing to Disclose

#### Sub-Events

### R1-SSVA04-2 **Image Quality of Photon-Counting CT Angiographies Depending on Tube Voltage and Collimation Mode in a Continuous Extracorporeal-Perfused Human Cadaveric Model**

Philipp Gruschwitz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the influence of tube voltage and collimation mode on the image quality of CT angiographies (CTA) of femoral arteries using the latest clinical photon-counting detector CT.

#### METHODS AND MATERIALS

CTA of both thighs of 4 body donors were performed using a continuous extracorporeal-perfused human cadaver model with a constant radiation dose (5 mGy) and following tube voltage/collimation combinations a) 120kVp in standard resolution (SR), b) 120kVp in ultrahigh resolution (UHR), c) 140kVp SR. Images were reconstructed with 4 different vascular kernels (Bv40, Bv48, Bv60; Bv76). Intraluminal attenuation and image noise were measured using standardized ROIs. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated as objective image quality parameters. Subjective image quality was assessed by 3 readers using a 7pt Likert scale. Inter-reader agreement was calculated with intraclass correlation coefficient (ICC). Significance was tested using ANOVA ( $p < 0.05$ ).

#### RESULTS

Intraluminal attenuation of 140 kVp scans is significantly lower compared to 120 kVp scans while there are only minor differences between SR/UHR mode ( $383.3 \pm 24.0$  vs.  $421.1 \pm 27.7/404.5 \pm 25.1$  [HU];  $p < 0.001$ ). Image noise increases significantly with sharper kernels independent of the scan setting (120kVp SR:  $8.4 \pm 1.8$  to  $75.4 \pm 16.2$  [HU];  $p < 0.008$ ) and is significantly lower using UHR instead of SR with sharp kernels =Bv60 (Bv76 UHR:  $50.2 \pm 11.7$  vs. SR:  $75.4 \pm 16.2$  [HU];  $p < 0.001$ ). Both SNR and CNR decrease with sharper kernels while the values of 140kVp scans are significantly lower than those of 120kVp scans, regardless of the collimation mode (e.g. CNR: 140kVp Bv49:  $30.1 \pm 2.7$  vs. 120kVp Bv49 SR/UHR:  $33.7 \pm 4.4/33.4 \pm 4.4$ ;  $p < 0.003$ ). Furthermore, the UHR mode is superior to the SR mode in 120 kVp scans when sharp kernels =Bv60 are used (e.g. CNR: Bv60 SR:  $18.4 \pm 4.8$  vs. Bv60 UHR:  $22.7 \pm 5.8$ ;  $p < 0.001$ ). The combination of ultrasharp kernel (Bv76) and UHR was rated the best in subjective assessment (7; IQR 1), followed by 140kVp/120kVp SR Bv76 and 120kVp UHR Bv60 (7; IQR 2). Bv40 kernel were rated the worst, regardless of tube voltage and collimation (5; IQR 1). ICC was moderate (0.73).

#### CONCLUSION

140 kVp scans have a lower objective and subjective image quality compared to 120 kVp scans due to the low iodine contrast. UHR collimation instead of SR at 120 kVp results in improved objective/subjective image quality when using sharp kernels ( $> Bv60$ ), with the added benefit of higher spatial resolution and equivalent postprocessing capabilities.

#### CLINICAL RELEVANCE/APPLICATION

Our study recommends the use of low tube voltages and ultra-high resolution collimation to achieve the best image quality and assessability in CT angiographies using photon-counting CT.

### R1-SSVA04-3 **Algorithmic Performance Consistency Across Patient Demographics and Scanner Manufacturers**

Shirin Salehi (*Presenter*) Nothing to Disclose

## PURPOSE

With increasing use of artificial intelligence in healthcare, there are growing concerns that algorithmic biases may perpetuate existing health inequities. While many published models yield high performance across an aggregate cohort, generalizability across demographics and clinical settings has not yet been explored. In this study, we evaluate real-world performance of an FDA 501k-approved deep learning algorithm for detection of aortic dissection on computed tomography angiography (CTA), with a primary focus on evaluating differences in performance across age, sex, geography, and manufacturer.

## METHODS AND MATERIALS

A total of 1,134 chest and thoracoabdominal CTA exams were included in this study from over 200 U.S. hospitals. Ground-truth classification for presence of aortic dissection was determined through consensus evaluation by three board-certified radiologists. Exams were analyzed using the FDA 501k-approved Viz Aortic Dissection algorithm, developed in collaboration with Avicenna, a deep learning model trained on a representative, diverse cohort across age, sex, disease prevalence, race, and clinical settings. Algorithmic performance was stratified by age (18-40, 40-60, 60+), sex (male, female), geographic region (Continental, Northeast, Pacific, Southeast), and manufacturer (GE Medical Systems, Philips, Siemens, Toshiba). Overall accuracy, sensitivity, specificity, PPV, and NPV were reported. Equalized odds (EO) differences across true positive rates (TPR) and false positive rates (FPR) were used as a measurement of algorithmic fairness across subgroups.

## RESULTS

The algorithm demonstrated high overall accuracy (97%), sensitivity (94%), specificity (97%), PPV (80%) and NPV (99%). Overall mean EO differences across subgroups was 0.031, with individual EO values noted to be small and consistent for age [18-40: 0.0584, 40-60: 0.0294, 60+: 0.0368], sex [M: 0.0227, F: 0.0359], geographic region [Continental: 0.0584, NE: 0.0487, Pacific: 0.0227, SE: 0.0314], and manufacturer [GE: 0.0111, Philips: 0.013, Siemens: 0.0047, Toshiba: 0.0274]. In general, small decreases in TPR or FPR were often balanced by small increases in the complimentary metric for most subgroups.

## CONCLUSION

Overall, small EO differences across all subgroups relative to the aggregate cohort suggest unbiased performance of the deep learning model for aortic dissection detection across a large heterogeneous cohort of CTA exams. Generalizability across demographics and clinical parameters is critical in preventing algorithmic biases and promoting equitable health outcomes.

## CLINICAL RELEVANCE/APPLICATION

A deep learning tool for aortic dissection detection yields no significant biases across all tested subgroups across 200+ US hospitals.

## R1-SSVA04-4 The Role of Multidetector CT Angiography in the Assessment of Disease Activity in Takayasu's Arteritis

Yu Shi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the clinical application value of CTA in evaluating the disease activity of Takayasu arteritis (TA).

## METHODS AND MATERIALS

Sixty-one consecutive patients with TA from January 2010 to December 2021 were included in this study. Demographic and clinical characteristics, acute-phase reactants (APRs) and CTA indicator parameters were recorded. The value of CTA in identifying disease activity was evaluated, using Erythrocyte Sedimentation Rate (ESR) as a reference. A disease activity evaluation model was constructed to compare the benefits of the new model with ESR and Kerr scores by evaluating the consistency index (C-index), the net reclassification index (NRI) and the integrated discriminant index (IDI).

## RESULTS

In total, 29 (47.54%) cases showed active disease. The C-index of ESR to indicate disease activity was 0.778 (95% CI: 0.635, 0.874). The new activity assessment model combining ESR, maximal wall thickness and perivascular fat density (PFD) showed significant improvement in C-index over the ESR method (0.902 vs 0.778,  $P < 0.01$ ; NRI 0.948,  $P < 0.01$ ; and IDI 0.204,  $P < 0.01$ ). In addition, the new model demonstrated a significant superiority over the Kerr score in terms of the C-index (0.902 vs 0.771,  $P < 0.05$ ), NRI (1.142, 95% CI: 0.730, 1.556,  $P < 0.01$ ) and IDI (0.300, 95% CI: 0.187, 0.423,  $P < 0.01$ ).

## CONCLUSION

A novel CTA-based method that involves combining ESR with maximal wall thickness and PFD demonstrated superiority in identifying active TA compared with conventional methods.

## **CLINICAL RELEVANCE/APPLICATION**

1. We first evaluated the value of perivascular fat density in assessing disease activity in patients with TA. 2. Higher values of perivascular fat density were associated with an increased risk of disease activity in TA patients. 3. Combining perivascular fat density, maximal wall thickness and ESR is superior in assessing disease activity in TA patients compared with the Kerr score.  
Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSVA04-2

### Image Quality of Photon-Counting CT Angiographies Depending on Tube Voltage and Collimation Mode in a Continuous Extracorporeal-Perfused Human Cadaveric Model

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403B

Philipp Gruschwitz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the influence of tube voltage and collimation mode on the image quality of CT angiographies (CTA) of femoral arteries using the latest clinical photon-counting detector CT.

#### METHODS AND MATERIALS

CTA of both thighs of 4 body donors were performed using a continuous extracorporeal-perfused human cadaver model with a constant radiation dose (5 mGy) and following tube voltage/collimation combinations a) 120kVp in standard resolution (SR), b) 120kVp in ultrahigh resolution (UHR), c) 140kVp SR. Images were reconstructed with 4 different vascular kernels (Bv40, Bv48, Bv60; Bv76). Intraluminal attenuation and image noise were measured using standardized ROIs. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated as objective image quality parameters. Subjective image quality was assessed by 3 readers using a 7pt Likert scale. Inter-reader agreement was calculated with intraclass correlation coefficient (ICC). Significance was tested using ANOVA ( $p < 0.05$ ).

#### RESULTS

Intraluminal attenuation of 140 kVp scans is significantly lower compared to 120 kVp scans while there are only minor differences between SR/UHR mode ( $383.3 \pm 24.0$  vs.  $421.1 \pm 27.7/404.5 \pm 25.1$  [HU];  $p < 0.001$ ). Image noise increases significantly with sharper kernels independent of the scan setting (120kVp SR:  $8.4 \pm 1.8$  to  $75.4 \pm 16.2$  [HU];  $p < 0.008$ ) and is significantly lower using UHR instead of SR with sharp kernels =Bv60 (Bv76 UHR:  $50.2 \pm 11.7$  vs. SR:  $75.4 \pm 16.2$  [HU];  $p < 0.001$ ). Both SNR and CNR decrease with sharper kernels while the values of 140kVp scans are significantly lower than those of 120kVp scans, regardless of the collimation mode (e.g. CNR: 140kVp Bv49:  $30.1 \pm 2.7$  vs. 120kVp Bv49 SR/UHR:  $33.7 \pm 4.4/33.4 \pm 4.4$ ;  $p < 0.003$ ). Furthermore, the UHR mode is superior to the SR mode in 120 kVp scans when sharp kernels =Bv60 are used (e.g. CNR: Bv60 SR:  $18.4 \pm 4.8$  vs. Bv60 UHR:  $22.7 \pm 5.8$ ;  $p < 0.001$ ). The combination of ultrasharp kernel (Bv76) and UHR was rated the best in subjective assessment (7; IQR 1), followed by 140kVp/120kVp SR Bv76 and 120kVp UHR Bv60 (7; IQR 2). Bv40 kernel were rated the worst, regardless of tube voltage and collimation (5; IQR 1). ICC was moderate (0.73).

#### CONCLUSION

140 kVp scans have a lower objective and subjective image quality compared to 120 kVp scans due to the low iodine contrast. UHR collimation instead of SR at 120 kVp results in improved objective/subjective image quality when using sharp kernels (>Bv60), with the added benefit of higher spatial resolution and equivalent postprocessing capabilities.

#### CLINICAL RELEVANCE/APPLICATION

Our study recommends the use of low tube voltages and ultra-high resolution collimation to achieve the best image quality and assessability in CT angiographies using photon-counting CT.

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## Abstract Archives of the RSNA, 2023

R1-SSVA04-3

### Algorithmic Performance Consistency Across Patient Demographics and Scanner Manufacturers

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403B

Shirin Salehi (*Presenter*) Nothing to Disclose

#### PURPOSE

With increasing use of artificial intelligence in healthcare, there are growing concerns that algorithmic biases may perpetuate existing health inequities. While many published models yield high performance across an aggregate cohort, generalizability across demographics and clinical settings has not yet been explored. In this study, we evaluate real-world performance of an FDA 501k-approved deep learning algorithm for detection of aortic dissection on computed tomography angiography (CTA), with a primary focus on evaluating differences in performance across age, sex, geography, and manufacturer.

#### METHODS AND MATERIALS

A total of 1,134 chest and thoracoabdominal CTA exams were included in this study from over 200 U.S. hospitals. Ground-truth classification for presence of aortic dissection was determined through consensus evaluation by three board-certified radiologists. Exams were analyzed using the FDA 501k-approved Viz Aortic Dissection algorithm, developed in collaboration with Avicenna, a deep learning model trained on a representative, diverse cohort across age, sex, disease prevalence, race, and clinical settings. Algorithmic performance was stratified by age (18-40, 40-60, 60+), sex (male, female), geographic region (Continental, Northeast, Pacific, Southeast), and manufacturer (GE Medical Systems, Philips, Siemens, Toshiba). Overall accuracy, sensitivity, specificity, PPV, and NPV were reported. Equalized odds (EO) differences across true positive rates (TPR) and false positive rates (FPR) were used as a measurement of algorithmic fairness across subgroups.

#### RESULTS

The algorithm demonstrated high overall accuracy (97%), sensitivity (94%), specificity (97%), PPV (80%) and NPV (99%). Overall mean EO differences across subgroups was 0.031, with individual EO values noted to be small and consistent for age [18-40: 0.0584, 40-60: 0.0294, 60+: 0.0368], sex [M: 0.0227, F: 0.0359], geographic region [Continental: 0.0584, NE: 0.0487, Pacific: 0.0227, SE: 0.0314], and manufacturer [GE: 0.0111, Philips: 0.013, Siemens: 0.0047, Toshiba: 0.0274]. In general, small decreases in TPR or FPR were often balanced by small increases in the complimentary metric for most subgroups.

#### CONCLUSION

Overall, small EO differences across all subgroups relative to the aggregate cohort suggest unbiased performance of the deep learning model for aortic dissection detection across a large heterogeneous cohort of CTA exams. Generalizability across demographics and clinical parameters is critical in preventing algorithmic biases and promoting equitable health outcomes.

#### CLINICAL RELEVANCE/APPLICATION

A deep learning tool for aortic dissection detection yields no significant biases across all tested subgroups across 200+ US hospitals.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R1-SSVA04-4

### The Role of Multidetector CT Angiography in the Assessment of Disease Activity in Takayasu's Arteritis

Thursday, Nov. 30 8:00AM - 9:00AM Room: S403B

Yu Shi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the clinical application value of CTA in evaluating the disease activity of Takayasu arteritis (TA).

#### METHODS AND MATERIALS

Sixty-one consecutive patients with TA from January 2010 to December 2021 were included in this study. Demographic and clinical characteristics, acute-phase reactants (APRs) and CTA indicator parameters were recorded. The value of CTA in identifying disease activity was evaluated, using Erythrocyte Sedimentation Rate (ESR) as a reference. A disease activity evaluation model was constructed to compare the benefits of the new model with ESR and Kerr scores by evaluating the consistency index (C-index), the net reclassification index (NRI) and the integrated discriminant index (IDI).

#### RESULTS

In total, 29 (47.54%) cases showed active disease. The C-index of ESR to indicate disease activity was 0.778 (95% CI: 0.635, 0.874). The new activity assessment model combining ESR, maximal wall thickness and perivascular fat density (PFD) showed significant improvement in C-index over the ESR method (0.902 vs 0.778,  $P < 0.01$ ; NRI 0.948,  $P < 0.01$ ; and IDI 0.204,  $P < 0.01$ ). In addition, the new model demonstrated a significant superiority over the Kerr score in terms of the C-index (0.902 vs 0.771,  $P < 0.05$ ), NRI (1.142, 95% CI: 0.730, 1.556,  $P < 0.01$ ) and IDI (0.300, 95% CI: 0.187, 0.423,  $P < 0.01$ ).

#### CONCLUSION

A novel CTA-based method that involves combining ESR with maximal wall thickness and PFD demonstrated superiority in identifying active TA compared with conventional methods.

#### CLINICAL RELEVANCE/APPLICATION

1. We first evaluated the value of perivascular fat density in assessing disease activity in patients with TA. 2. Higher values of perivascular fat density were associated with an increased risk of disease activity in TA patients. 3. Combining perivascular fat density, maximal wall thickness and ESR is superior in assessing disease activity in TA patients compared with the Kerr score.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPBR-2

### **Multiparametric MRI Assessment of Primary Tumor for Predicting Axillary Tumor Burden in Women with Invasive Breast Cancer**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Jin You Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess whether multiparametric MRI features of a primary tumor are associated with axillary lymph node tumor burden in women with invasive breast cancer.

#### **METHODS AND MATERIALS**

This retrospective study evaluated women with invasive breast cancer who underwent 3-T multiparametric breast MRI including diffusion-weighted imaging (DWI) between 2019 and 2020. Two radiologists independently evaluated peritumoral edema and intratumoral necrosis on T2-weighted imaging (T2WI) and measured the mean, minimum, and maximum apparent diffusion coefficient (ADC) values by manually placing regions of interest within the breast tumors. Quantitative kinetic features of breast cancer assessed with computer-aided diagnosis (CAD) and clinical-pathologic characteristics were analyzed. Uni- and multivariable logistic regression was performed to identify predictors of axillary lymph node metastasis or high axillary nodal burden (= 3 positive nodes).

#### **RESULTS**

A total of 242 women (mean age, 54.4 years; age range, 29-86 years) were evaluated. Eighty-three (34.3%) had axillary lymph node metastasis and 39 (16.1%) had high axillary nodal burden by surgical pathologic analysis. On multivariate analysis, predictors of axillary lymph node metastasis were peritumoral edema (Odds ratio [OR]: 4.54; 95% confidence interval [CI]: 2.32, 8.87;  $P < .001$ ), maximum ADC value ( $= 1.207 \times 10^{-3} \text{mm}^2/\text{s}$ ) (OR: 2.60; 95% CI: 1.33, 5.10;  $P = .005$ ), lymphovascular invasion (OR: 5.20; 95% CI: 2.61, 10.35;  $P < .001$ ), and larger tumor size ( $> 2\text{cm}$ ) (OR: 3.17; 95% CI: 1.59, 6.29;  $P < .001$ ). Predictors of high axillary nodal burden were peritumoral edema (OR: 7.39; 95% CI: 2.72, 20.02;  $P = .001$ ), maximum ADC value ( $= 1.045 \times 10^{-3} \text{mm}^2/\text{s}$ ) (OR: 9.74; 95% CI: 3.26, 29.07;  $P < .001$ ), lymphovascular invasion (OR: 8.38; 95% CI: 2.95, 23.75;  $P = .001$ ), and larger tumor size ( $> 2\text{cm}$ ) (OR: 6.08; 95% CI: 1.77, 20.91;  $P = .004$ ). CAD-derived kinetic features of breast cancer did not associate with axillary nodal status. In the subgroup analysis of 192 early-stage breast cancer patients, peritumoral edema (OR: 17.12; 95% CI: 2.02, 144.90;  $P = .009$ ) and lymphovascular invasion (OR: 4.65; 95% CI: 1.01, 21.51;  $P = .049$ ) maintained significance for predicting high axillary nodal burden.

#### **CONCLUSION**

Peritumoral edema on T2WI and maximum ADC value of breast cancer on DWI could be helpful for predicting axillary lymph node tumor burden in women with invasive breast cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

Multiparametric MRI assessment of primary tumor using T2WI and DWI might have predictive value for assessing axillary tumor burden in women with invasive breast cancer.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPBR-3

### **A Radiomic-Clinical Model of Contrast-Enhanced Mammography for Biopsy Outcome Prediction on BI-RADS 4A/4B Patients**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Chang Liu, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In the US over 1 million biopsies are performed annually, with 9.6% diagnostic exams given BI-RADS =4A, most of which are rated as BI-RADS 4A/B. Contrast enhanced mammography (CEM) may improve lesion classification. BI-RADS 4A and 4B patients are particularly challenging for biopsy outcome prediction. The goal of the study is to build machine learning quantitative analysis of CEM to improve breast biopsy outcome prediction.

#### **METHODS AND MATERIALS**

With HIPPA-compliance and IRB-approval, 292 patients (aged 30-86) with 332 included BI-RADS =4A lesions (78 cancers (49 IDC, 14 ILC, 15 DCIS) and 254 benign) underwent pre-biopsy CEM. An experienced radiologist produced Initial BI-RADS based on mammography, tomosynthesis and/or ultrasound, and then CEM-adjusted BI-RADS after CEM interpretation. Logistic regression models for outcome prediction were built using radiomic features of segmented lesions in CEM and four CEM-assessed qualitative clinical descriptors (enhancement, strength of enhancement, kinetics, and background parenchymal enhancement). The area under the receiver operating characteristic curve (AUC) measured model performance. PPV conditioned at 100% sensitivity assessed performance on BI-RADS 4A/B lesions.

#### **RESULTS**

AUC for radiomics was 0.87, clinical descriptors 0.89, and combination 0.92. PPV3 for clinical BI-RADS 4A lesions is 6.9% and model 17.6%. PPV3 of CEM BI-RADS 4A is 5.1% and model 9.1%. PPV3 of clinical BI-RADS 4B is 15.3% and model 25.0%. PPV3 of CEM BI-RADS 4B is 35.9% and model 45.7%. Compared to the radiologist, the model increased 153% (or 63%) and 78% (or 30%) of the PPV for initial clinical BI-RADS 4A (or 4B) patients and CEM-adjusted 4A (or 4B) patients.

#### **CONCLUSION**

Machine learning models of tumor radiomics and clinical descriptors of CEM can substantially increase biopsy outcome prediction accuracy, particularly for the 4A and 4B patients. For 4B patients, the collaboration of radiologists (producing CEM BI-RADS) and our model can largely reduce false positives with a PPV of 45.7%.

#### **CLINICAL RELEVANCE/APPLICATION**

Machine learning analysis and radiologists' clinical assessment of CEM can improve biopsy outcome prediction and their collaboration can gain the highest benefits for the 4A/4B patients.

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## Abstract Archives of the RSNA, 2023

R2-SPBR-4

### **Kinetic Features on DCE-MRI Rather than Glycolytic Phenotype on $^{18}\text{F}$ -FDG PET/CT Predict Recurrence Free Survival in Patients with ER-positive/HER2-negative Early Breast Cancer**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Jiyoung Yoon, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Estrogen receptor (ER)-positive/human epidermal growth factor receptor 2 (HER2)-negative subtype of breast cancer is known to show low F-18 fluorodeoxyglucose ( $^{18}\text{F}$ FDG) uptake on positron emission tomography/computed tomography (PET/CT). The purpose of this study was to evaluate prognostic value of preoperative dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) compared to  $^{18}\text{F}$ FDG PET/CT in patients with ER-positive/HER2-negative early breast cancer.

#### **METHODS AND MATERIALS**

We analyzed data from 145 consecutive women with breast cancer who underwent  $^{18}\text{F}$ FDG PET/CT for initial staging and subsequent surgery between 2008 and 2015. Among them, a total of 118 patients had preoperative DCE-MRI. The clinicopathological variables, computer-aided diagnosis (CAD)-generated kinetic features, apparent diffusion coefficient, and maximum standardized uptake value (SUVmax) were assessed for the risks of recurrence. Hazard ratios (HRs) were estimated from Cox proportional hazards regressions. Recurrence free survival (RFS) curves were estimated using the Kaplan-Meier method and differences in each risk layer were assessed using the log-rank test.

#### **RESULTS**

During the follow up ( $82.25 \pm 22.91$  months), 16 (11.0%) patients experienced recurrence. Peak enhancement (PE)  $>210\%$  (HR 10.70; 95% CI: 1.36-84.51;  $p=0.025$ ), Ki-67  $>6\%$  (HR 5.06; 95% CI: 1.15-22.27;  $p=0.032$ ) and SUVmax  $>6.75$  (HR 4.50; 95% CI: 1.64-12.39;  $p=0.004$ ) were significant factors for RFS on the univariate analysis. On the multivariate analysis, PE  $>210\%$  (HR 9.23; 95% CI: 1.16-73.29;  $p=0.036$ ) was the only significant prognostic factor. On the Kaplan-Meier survival analysis, patients with tumors showing PE  $>210\%$  at preoperative MRI had a significantly poorer 5-year RFS compared to those with PE  $\leq 210\%$  (83.7% and 98.1%, respectively,  $p=0.010$ ).

#### **CONCLUSION**

In patients with early-stage ER-positive/HER2-negative breast cancer, high PE at preoperative DCE-MRI was more effective than  $^{18}\text{F}$ FDG uptake on PET/CT for predicting RFS.

#### **CLINICAL RELEVANCE/APPLICATION**

CAD-generated kinetic information that can be obtained automatically from preoperative breast MRI in routine clinical practice could help stratify which early-stage ER-positive HER2-negative breast cancer to treated with adjuvant chemotherapy.

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## Abstract Archives of the RSNA, 2023

R2-SPBR-5

### **An Innovative Technique using Discrete Multi-Wavelength Near Infra-Red Spectroscopy Diffuse Optical Imaging to Differentiate Breast Lesions in Fast Scans: A Feasibility Study**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Min Jung Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the potential role of newly developed diffuse optical spectroscopic imaging (DOSI) device using discrete multi-wavelength near-infrared spectrum (DMW-NIRS) in fast scans to differentiate breast lesions.

#### **METHODS AND MATERIALS**

The protocol for DOSI using DMW-NIRS in fast scans was approved by the Institutional Review Boards of Severance Hospital; all participants provided informed consent. A total of 62 consecutive women (range, 29-80 years; mean, 49.9 years) with 62 breast lesions (37 malignant, 25 benign) that were biopsied under US guidance were included. A handheld probe consisting of 5 pairs of light-emitting diodes and photodiodes was used, with the lesion location marked according to conventional US findings. Light absorption and scattering were measured with 8 NIR wavelengths. Lesion to normal ratios (L/Ns) of quantitative chromophores (HbO<sub>2</sub>, HHb, THc, StO<sub>2</sub>, Water, Lipid, and TOI) that were calculated in comparison to the contralateral normal breast tissue were assessed. L/Ns of chromophores were compared between the malignancy and benign. Diagnostic performance was calculated for each L/N of chromophores. Subgroup analysis was performed for Breast Imaging Reporting And Data System (BI-RADS) category 4A lesions.

#### **RESULTS**

All L/Ns of chromophores showed significant differences between malignant and benign groups (all  $p < 0.05$ ). Area under receiver operating characteristic curve (AUROC)s of L/Ns of chromophores ranged 0.710-0.901 (all  $p < 0.05$ ), with TOIL/N showing the highest AUROC (0.901; 95% CI: 0.825-0.976). Accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of TOIL/N were 83.9%, 86.5%, 80.0%, 86.5%, and 80.0%, respectively. In subgroup analysis for BI-RADS category 4A lesions, all L/Ns of chromophores, except for Lipid, showed significant differences between malignant and benign groups ( $p < 0.05$ ). AUROCs of L/Ns of chromophores ranged 0.710-0.902 (all  $p$  except for Lipid  $< 0.05$ ), and TOIL/N showed the highest AUROC (0.902; 95% CI: 0.788-1.000). Accuracy, sensitivity, specificity, PPV, and NPV of TOIL/N were 90.6%, 100.0%, 82.4%, 83.3%, and 100.0%, respectively.

#### **CONCLUSION**

L/Ns of chromophores measured by the newly developed DOSI using DMW-NIRS in fast scans showed promise as an adjunct to BI-RADS categorization for distinguishing breast cancers from benign lesions. This new technique also demonstrated similar performance even in subgroup that included only low suspicious lesions.

#### **CLINICAL RELEVANCE/APPLICATION**

New DOSI technique using DMW-NIRS could be a quick, safe, and noninvasive supplemental method to increase diagnostic accuracy. However, it is essential to validate our results with larger patient cohort.

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## Abstract Archives of the RSNA, 2023

R2-SPBR-6

### Comparison of Radiomics-Based Machine-Learning Classifiers for Pretreatment Prediction of Pathologic Complete Response to Neoadjuvant Therapy in Breast Cancer

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Xue Li (*Presenter*) Nothing to Disclose

#### PURPOSE

In recent years, machine learning (ML) classifiers have gradually been used to establish high-performance predictive models for pathological complete response (pCR) in breast cancer after neoadjuvant therapy (NAT). However, few studies have compared the effectiveness of different ML classifiers. This study investigated the ability of radiomics models based on pre- and post-contrast first-phase T1 weighted images (T1WI) to predict breast cancer pCR after NAT and compared the performance of different ML classifiers.

#### METHODS AND MATERIALS

In this retrospective study, 300 patients from the Duke-Breast-Cancer-MRI dataset who underwent neoadjuvant therapy (NAT) were included, including pCR (n=76) and non-pCR (n=224) cases. These patients were randomly divided into training and validation groups at a ratio of 8:2. Radiomics features were extracted from pre- and post-contrast first-phase T1WI images of each patient. The radiomics model was built using features selected through the Spearman correlation analysis and the LASSO algorithm after normalization. SVM, RF, extraTrees, DT, KNN, XGBoost, LightGBM were used as classifiers. ROC curves were used to assess the predictive performance of the radiomics models.

#### RESULTS

Out of the seven classifiers used, the LightGBM classifier performed best in predicting breast cancer pCR, with an AUC of 0.813 in the validation group (95% CI: 0.697-0.928, accuracy 78.3%, sensitivity 46.7%, specificity 100.0%). During subgroup analysis, RF achieved the highest AUC in pCR prediction in luminal breast cancers (0.859, 95% CI: 0.710-1.000, accuracy 85.9%, sensitivity 68.8%, and specificity 83.3%), and DT yielded the highest AUC in pCR prediction in triple negative (TN) breast cancers (0.909, 95% CI: 0.790-1.000, accuracy 88.2%, specificity 81.8%, accuracy 100%).

#### CONCLUSION

Overall, the LightGBM-based radiomics model demonstrated superior performance in predicting breast cancer pCR, while RF and DT displayed promising results in predicting pCR for luminal and TN breast cancers, respectively, during subgroup analysis.

#### CLINICAL RELEVANCE/APPLICATION

pCR after neoadjuvant therapy (NAT) in breast cancer strongly correlates with overall survival. Over the past few years, the value of radiomics in predicting pCR in breast cancer has attracted significant attention, and machine learning algorithms have become a research hotspot. It is widely acknowledged that high-performance machine learning algorithms are essential for establishing radiomics models. Therefore, in our study, we extracted radiomics features based on pre- and first post-contrast T1WI and used seven machine learning classifiers to build prediction models, respectively, and compared their prediction performance.

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## Abstract Archives of the RSNA, 2023

R2-SPBR-7

### Evaluating Mammography Positioning Quality on Digital Screening Mammograms in Large Urban Health Systems - Same as Film?

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Laurie R. Margolies, MD (*Presenter*) Stock options, Nuevozen Corporation Medical Advisory Board, Screenpoint Medical

#### PURPOSE

Mammography positioning quality (MPQ) is critical to detection of breast cancer. Approximately 90% of poor-quality screening mammography images are due to poor positioning. The most common errors on film screen mammography (FSM) reported in the medical literature are inadequate pectoralis major muscle, sagging and poor visualization of posterior tissue. Understanding how positioning errors present themselves on digital mammograms can help tailor quality improvement initiatives. The purpose of this study was to examine MPQ, as defined by American College of Radiology (ACR) criteria, of digital screening mammograms at two US health systems.

#### METHODS AND MATERIALS

Data from two US health systems was collected as part of an international multi-center mammography positioning quality research collaboration (MAMMO.IQ Study). MPQ errors, including exaggeration, portion cut off, posterior tissue missing, nipple not in profile, too high on image receptor (IR), inadequate pectoralis length, sagging, and posterior nipple line (PNL) length difference, were evaluated using artificial intelligence MPQ algorithms applied to screening mammograms acquired between December 2019 and April 2021; associated proportions and rankings of the positioning errors were computed. A total of 221,427 and 318,929 digital mammography images were processed from two health systems. The study was approved by research ethics at the participating sites.

#### RESULTS

175,591 and 290,503 MPQ errors were identified respectively at the centers. The rank order of the eight MPQ errors was nearly identical for the two centers (Wilcoxon Rank Sum Test,  $p=0.645$ ). The three most common MPQ errors, PNL on CC view not within 1 cm of that on MLO view, inadequate pectoralis major muscle, and excessive exaggeration on CC view, accounted for 66% and 72.0% of all MPQ errors at the centers respectively; only inadequate pectoralis major muscle is amongst the reported most common errors on FSM. The two least common errors, breast positioned too high on IR and sagging, accounted for 10.4% and 7.0% of all MPQ errors at the centers respectively.

#### CONCLUSION

MPQ errors on digital mammograms were similarly distributed at the centers, but did not align with the pre-digital era reported findings on film screen mammograms.

#### CLINICAL RELEVANCE/APPLICATION

Knowledge of common MPQ errors can inform technologist teaching efforts. MPQ errors may be affected by equipment used. MPQ assessments may be more reliable by AI than by humans.

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## Abstract Archives of the RSNA, 2023

R2-SPBR-8

### Using Artificial Intelligence to Triage Screening Mammograms after Breast-conserving Therapy

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Jeaneun Park (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to evaluate the clinical usefulness of artificial intelligence (AI) for triaging of screening mammograms after Breast-conserving therapy (BCT).

#### **METHODS AND MATERIALS**

The consecutive mammograms from January to May 2021, conducted in patients who underwent BCT were included. Mammograms were analyzed by dividing into ipsilateral and contralateral breast. Triage was performed in the following three methods. One method was to classify exams as no recall (BI-RADS C1, C2) and recall (C0, C3, C4 or C5) based on the original report by expert radiologists. The commercially available AI for mammography was used for the others. If AI did not detect any abnormality, it was assigned as a no recall, and otherwise as a recall (Standalone AI-triage). For cases classified as recall by AI, one radiologist classified them as recall or no recall in consideration of mammography findings (Decision referral AI-triage). We analyzed cancer detection rate (CDR), recall rate and sensitivity for each method.

#### **RESULTS**

A total of 1190 patients (mean age 56.6 years) were included in the study, with 1221 cases of the ipsilateral and 1135 cases of contralateral breast. In ipsilateral breast, the CDR, recall rate and sensitivity of the original report were 6.5/1000, 3.4%, and 80%. Standalone AI-triage was able to reduce the workload by 77%, while maintaining the same level of CDR and sensitivity. Decision referral AI-triage lowered the recall rate to 2.8%. The CDR, recall rate and sensitivity of the original report were 1.7/1000, 1.9%, and 66.7% in contralateral breast. About 90% of workload could be reduced in standalone AI-triage. In decision referral AI-triage, the CDR, recall rate and sensitivity for were 2.5/1000, 2.0% and 100%.

#### **CONCLUSION**

AI-based triage can contribute to reducing the radiologist's workload without harming sensitivity in the screening mammograms of BCT patients. However, sufficient experience of radiologists is essential to interpret false-positive results, especially in ipsilateral breast after BCT.

#### **CLINICAL RELEVANCE/APPLICATION**

The population undergoing screening after surgery is accumulating, as the number of breast cancer patients increases worldwide. Also, the personal history of breast cancer itself is a sustained long-term risk for future breast cancer. This study investigated the clinical usefulness of AI-based triage to maintain quality even in the screening of patients who underwent BCT, while reducing the radiologist's workload.

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## Abstract Archives of the RSNA, 2023

R2-SPCA-1

### Impact of Diabetes Mellitus on Left Ventricular Deformation in Restrictive Cardiomyopathy Patients Assessed by Cardiac Magnetic Resonance Imaging

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Yue Gao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Diabetes mellitus (DM) is considered a major risk factor for cardiovascular events and increases the risk of worse long-term outcomes in patients with restrictive cardiomyopathy (RCM). We aimed to investigate the impact of comorbid DM on LV deformation in RCM individuals.

#### METHODS AND MATERIALS

Seventy-four RCM patients without DM [RCM (DM-)], 33 with DM [RCM (DM+)], and 75 age- and sex-matched controls who underwent CMR scanning were included. We exclude patients with congenital heart disease and heart failure secondary to other cardiomyopathies or diseases. LV geometry, function, and LV global strains, including peak strain in the radial, circumferential, and longitudinal directions were measured. We evaluated the type of LGE in each RCM patient, which was divided into no-LGE (type 1), local LGE (type 2), and diffuse LGE (type 3). The determinants of reduced LV myocardial strain for all RCM patients were assessed using multivariable linear regression analyses.

#### RESULTS

Compared with normal controls, both RCM (DM-) and RCM (DM+) patients exhibited increased LV end-diastolic and end-systolic volume index and decreased LV ejection fraction. LV global strains progressively declined from the normal controls to two RCM groups. RCM subgroup analysis showed that LV global longitudinal PS was worse in RCM (DM+) group than in RCM (DM-) group ( $p = 0.014$ ). DM was an independent determinant of reduced LV global longitudinal PS in patients with RCM ( $\beta = -0.208$ ,  $p = 0.018$ ). The LGE type was independently associated with a decreased global longitudinal PS ( $\beta = 0.411$ ,  $p < 0.01$ ) in RCM patients.

#### CONCLUSION

DM has an additive deleterious effect on LV function and deformation in RCM patients. The LGE type and DM were found to be associated with reduced LV global longitudinal strain.

#### CLINICAL RELEVANCE/APPLICATION

Diabetes mellitus can aggravate the left ventricular global strain damage in patients with restrictive cardiomyopathy without heart failure, so the control of diabetes mellitus should be strengthened

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPCA-2

### Could Coronary Artery Calcium Score be a Reliable Predictor of Coronary Artery Stenosis in Women?

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Yuval Liberman, MD, MMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary Artery Calcium Score (CACs) has been widely used to predict coronary artery disease (CAD) risk in both men and women. However, due to physiological differences between these two groups, more studies are needed to assess CACS thresholds for suspected CAD in women. This study aims to evaluate the predictability of CACS for determining CAD with  $\geq 50\%$  stenosis in women and to explore the impact of age and CACS threshold selection on its predictive performance.

#### METHODS AND MATERIALS

The study was approved by the hospital IRB. We reviewed all female patients who underwent CCTA for coronary artery disease (CAD) assessment (including CACS) between 01/01/2006 - 12/31/22 in tertiary medical center. CACS was assessed according to Agatston score. SCAS was identified qualitatively on CCTA as  $\geq 50\%$  stenosis using multiplanar curved reconstructions. Correlation between CACS and SCAS was assessed with Pearson correlation. Various CACS cutoff values were used to check the sensitivity and specificity of CACS as predictor for SCAS. Age information was used for multivariate analysis of the accuracy of CACS in predicting SCAS.

#### RESULTS

1378 consecutive female patients ( $62.4 \pm 11.7$  y.o average, min 21, max 93) were included. Average CACS was 194.1 (min 0, max 4130). 381 of the patients had SCAS (27%). Continuous CACS demonstrated a correlation of 0.501 with SCAS. CACS threshold of 100 provided sensitivity of 68.9% and specificity of 88.8%. Increasing the threshold to 400 and 1000 resulted in higher sensitivity (87.3% and 94.8%, respectively) but lower specificity (81.3% and 76.3%, respectively). Optimal performance was achieved with a CACS threshold of 77, providing a sensitivity of 65.5% and specificity of 90.1%. Taking into consideration age and pre/post menopausal age did not statistically improve the results

#### CONCLUSION

Our study demonstrates the potential of CACS as a non-invasive tool for predicting  $\geq 50\%$  coronary stenosis in women. Optimal performance is achieved with a CACS threshold of 77. Further research is needed to identify additional factors that can enhance the predictability of CACS for stenosis in women.

#### CLINICAL RELEVANCE/APPLICATION

Utilizing CACS in women more accurately.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPCA-3

### Coronary Artery Calcium Score (CACS) vs. CAD-RADS Predictability of Positive Cardiac Catheterization in Pre-Solid Organ Transplant Patients: A Comparative Analysis

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Yuval Liberman, MD, MMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The accurate prediction of significant coronary artery stenosis (SCAS) is crucial in the pre-solid organ transplant evaluation process. This study aims to compare the predictability of Coronary Artery Calcium Score (CACS) and CCTA in determining the presence of SCAS (gt;50%) in pre-solid organ transplant patients, as detected by cardiac catheterization (Cath).

#### METHODS AND MATERIALS

This study was IRB approved. All pre-solid organ transplant patients who underwent CCTA for coronary artery disease (CAD) assessment (including CACS) and were sent to Cath between 01/01/2018 - 12/31/22 were reviewed. CACS was assessed according to Agatston score. SCAS was identified as gt;50% stenosis on CCTA. Similarly, Cath was identified as positive if there was a finding of as gt;50% stenosis. Correlation between CACS and Cath was assessed, as well as between CCTA and Cath. CCTA and Various CACS cutoff values were used to create predictors for a positive Cath, which were checked for their sensitivity and specificity.

#### RESULTS

We analyzed data from 72 pre-solid organ transplant patients who underwent CCTA, CACS, and cardiac catheterization (57 males and 15 females). These patients had an average CACS of 709 (min 0, max 7675) and average CCTA of 2.2. The patients had an average age of  $58.2 \pm 9.8$  (min 37, max 71). Our results showed that CACS had a correlation of 0.35 with positive Cath, while CCTA demonstrated a correlation of 0.31. Using CCTA as a binary predictor of positive Cath resulted in a sensitivity of 46% and specificity of 100%. In contrast, CACS yielded a maximum sensitivity of 83.3% (specificity of 68.3%, threshold 2920) and a maximum specificity of 83.3% (sensitivity of 42%, threshold 45).

#### CONCLUSION

The findings suggest that CACS is a better screening tool for eliminating patients without significant stenosis due to its higher specificity, whereas CCTA serves as a better diagnostic tool due to its higher sensitivity. However, it should be noted that both tools demonstrated only moderate correlations with positive catheterization findings, indicating the need for further research to optimize their performance in this patient population.

#### CLINICAL RELEVANCE/APPLICATION

how predictive is calcium score in comparison to ccta of stenosis identified in cath (the gold standard)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPCA-4

### Improving Spatial Resolution at Coronary CT Angiography on Photon-counting Detector CT: A Structured Phantom Study

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Zhou Yu, PhD (*Presenter*) Employee, Canon Medical Systems Corporation

#### PURPOSE

The photon-counting detector CT (PCD-CT) features a semiconductor detector. Due to electrical noise cancellation, its high-density detector element yields high-resolution- and low-noise images. We developed a photon-counting detector CT scanner whose detector is made of CdZnTe. Here we evaluate the spatial resolution of PCD-CT using a structured phantom that simulates coronary CT angiographs (CCTA).

#### METHODS AND MATERIALS

Our structured phantom for CCTA (Fig.1) uses a 3D printer (KEYENCE Agilista-3200). The vessels were filled with iodine contrast medium diluted to 20 mgI/ml; one simulated coronary artery harbored 70% of one simulated stenotic lesion, another a stent graft (Medtronic, BeStent, 3.0 mm × 15 mm). We scanned the phantom on a prototype PCD-CT scanner (Canon Medical Systems) in high-resolution mode. The detector element density was approximately three times that of a conventional CT system. The slice thickness was about 0.2 mm, the tube voltage was 120 kV, and the tube current was 250 mA. For comparison, a conventional energy integrating detector CT (EID-CT; Aquilion ONE GENESIS, Canon Medical Systems) was used; the structured phantom was scanned with a scan protocol that resulted in similar radiation exposure. All images were reconstructed with hybrid iterative reconstruction. To evaluate the image quality of the phantom we measured the noise power spectrum (NPS) as a metric of the noise characteristics and the task-based modulation transfer function (MTF) as a metric of the spatial resolution.

#### RESULTS

The radiation doses (CTDIvol) were approximately 9.5 mGy. The image noise on PCD-CT scans was almost twice as high as on EID-CT scans (SD: 26.8 v.s. 13.8 HU, Fig. 2 left); the spatial resolution was higher with PCD-CT (10%MTF: 1.05 v.s. 0.75 cy/mm, Fig. 2 right) than EID-CT. Comparison of the images shown in Figs. 3 and 4 confirmed the high spatial resolution on PCD-CT images.

#### CONCLUSION

The high-resolution mode on our PCD-CT scanner yields images of fine structures. It is suitable for examining fine structures because it significantly improves spatial resolution, its cost is increased noise.

#### CLINICAL RELEVANCE/APPLICATION

The high-resolution mode of PCD-CT may facilitate a more precise stenosis evaluation and the assessment of the patency of coronary stent grafts at CCTA.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPCA-6

### Deep Learning Image Reconstruction Algorithm and Second-generation Motion Correction Algorithm Improve Dosage Saving and Diagnostic Performance of Coronary CT Angiography with Patients after Percutaneous Coronary

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Wenjie Wu (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the image quality and diagnostic value of low-dose coronary CT angiography (CCTA) with deep learning image reconstruction algorithm (DLIR) and second-generation motion correction algorithm (SSF2) compared with conventional-dose CCTA with high-definition (HD) mode assisted by adaptive statistical iterative reconstruction Veo algorithm (ASIR-V) and first-generation motion correction algorithm (SSF) in coronary in-stent restenosis (ISR).

#### METHODS AND MATERIALS

A total of 105 patients after Percutaneous coronary intervention (PCI) who received CCTA and invasive coronary angiography (ICA) were prospectively collected and randomly divided into two groups: 60 patients in 100kVp low-dose group (LD group) reconstructed with high-grade DLIR (DLIR-H) and second-generation motion correction algorithm (SSF2), and 45 patients in 120kVp conventional-dose group reconstructed with high-definition mode (HD group) assisted by ASIR-V 50% and first-generation motion correction algorithm (SSF1). Radiation dose and contrast media dose, objective image quality including CT value, image noise (SD), signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) for vessels, as well as subjective image quality parameters with Likert 5-level scoring method were assessed. Moreover, based on the ICA results, we compared the diagnostic performance of these two groups at patient level and stent level.

#### RESULTS

With 58.2% radiation dose reduction and 22.5% contrast media reduction, 100kVp LD group assisted with DLIR and SSF2 could achieved even better objective and subjective image quality scores than the 120kVp HD group assisted with HD mode assisted with ASIR-V 50% and SSF. To be specific, SD in AO, LM, LAD, LCX and RCA in LD group was significantly lower than those in HD group (all  $p < 0.05$ ). SNR and CNR in all vessels in LD group were significantly higher than those in HD group (all  $p < 0.05$ ). The subjective image quality scores of the LD group were better than those of the HD group (all  $P < 0.001$ ). The sensitivity, specificity and accuracy of LD group and HD group for diagnosing coronary ISR were 100.0%, 92.1%, 94.2% and 100.0%, 77.9% and 83.8%, respectively, and the number of false positive cases in the DLIR group decreased by 19.2%.

#### CONCLUSION

Compared with conventional-dose CCTA with HD mode assisted by ASIR-V and SSF1, 58.2% dose reduction and 22.5% contrast media reduction CCTA with DLIR and SSF2 could further improve the image quality and diagnostic performance in coronary ISR.

#### CLINICAL RELEVANCE/APPLICATION

It can effectively reduce the radiation dose while improving the quality of CCTA images, and has a high diagnostic efficiency for ISR, which has good clinical application value.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPCH-1

### AI-based Diagnosis of Incidental Pulmonary Embolism (PE) on Contrast-enhanced CT Images: A Multi-center Study

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Roshan Fahimi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Unsuspected, incidental PE on routine, contrast-enhanced chest CT can be overlooked and missed. We performed a standalone, multicenter, external validation study of an AI algorithm for detecting incidental PE on routine contrast-enhanced chest CT.

#### METHODS AND MATERIALS

Our IRB approved study included 432 patients from four hospitals (two quaternary and two community hospitals) with a mean age of  $56 \pm 12$  years and a female-to-male ratio of 248:184. We used a radiology reports database search engine (Nuance mPower) to identify routine contrast-enhanced CT examinations with and without incidental PE. CT images with section thickness  $<1.5$  mm were deidentified and exported from Visage PACS. All CT exams were processed with an AI algorithm (Cina, Compose, Avicenna Inc.) for triage (CE and FDA cleared) and detection of incidental PE on routine contrast enhanced chest CT. We assessed the model performance the area under the curve (AUC) of the receiver operating characteristic (ROC) curve and calculated sensitivity and specificity with SPSS (IBM).

#### RESULTS

The AI algorithm had an overall AUC of 0.86 (95%CI 0.94-0.78) and accuracy of 0.88 for diagnosing incidental PE on routine chest CT. When stratified by sex, the AUC was 0.83 (95%CI 0.95-0.71) for females and 0.92 (95%CI 0.99-0.83) for males. There were no significant inter-institutional variations in model performance across the four sites ( $p>0.1$ ). When stratified by age, the AUC was 0.85 (95%CI 0.98-0.72) for patients  $\leq 60$  years and 0.89 (95%CI 0.98-0.80) for  $> 60$  years, with specificities of 0.91 and 0.93 and sensitivities of 0.80 and 0.87. There were no significant differences among scanners from two main vendors in terms of model AUC, sensitivity, and specificity (GE: 0.85 [95%CI 0.70-0.99], 0.75, 0.96; Siemens: 0.88 [95%CI 0.78-0.98], 0.85, 0.92) ( $p>0.1$ ).

#### CONCLUSION

The assessed AI algorithm was generalizable across different imaging sites, patients gender, age, and scanner vendors for detection of incidental PE on routine contrast-enhanced chest CT.

#### CLINICAL RELEVANCE/APPLICATION

The assessed AI algorithm can help detect incidental PE on routine contrast-enhanced chest CT examination.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPCH-2

### Three-dimensional Growth Mapping in Subacute Type B Aortic Dissection Predicts Long-term Outcomes

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Prabhvir S. Marway, BA, MBBChir (*Presenter*) Nothing to Disclose

#### PURPOSE

Aneurysmal degeneration of the false lumen (FL) is a common complication of Type B aortic dissection (TBAD) often requiring surgical repair. Prophylactic endovascular repair (TEVAR) can prevent FL aneurysm, but early identification of high-risk patients is challenging. Subacute FL growth may predict late adverse events (LAE) but detecting small changes (1-3 mm) is hampered by measurement error. Vascular deformation mapping (VDM) is an emerging CT analysis technique that provides highly accurate 3D maps of aortic growth using routine clinical CTs. We hypothesized that early identification of FL growth by VDM within 3 months post-TBAD can more accurately identify patients at risk of LAE versus standard CT measurements.

#### METHODS AND MATERIALS

We performed a retrospective study (2005-2018) of adult patients with acute, uncomplicated TBAD, with high-quality CT angiograms (CTA) pre-discharge and at 1-3 months post-discharge. Exclusions included: Prior repair of the descending aorta; poor FL enhancement OR complete FL thrombosis. VDM analysis used a multi-step deformable image registration process after semi-automated segmentation. Quantitative growth data from the descending thoracic aorta was extracted from VDM, and 90th percentile radial values were used for analysis. Standard CT measures were collected by expert raters: maximal diameter; proximal tear size; tear distance from the left subclavian artery (LSC). LAE were defined as aneurysmal growth of the dissected aorta >55mm, rupture, and surgical repair of TBAD.

#### RESULTS

Among the 33 patients analyzed, 22 (66%) had LAE. There was no significant difference in follow-up period ( $6.3 \pm 2.7$  vs.  $6.3 \pm 4.0$  years,  $p = 0.99$ ), or time between scans ( $45 \pm 17$  vs.  $46 \pm 29$  days,  $p = 0.88$ ). Based on clinically reported measurements (chart review), there were no significant predictors of LAE by anatomic metrics: maximal diameter ( $42.8 \pm 7.4$  vs.  $39.4 \pm 6.2$ mm,  $p = 0.20$ ), change in maximal TBAD diameter by clinical measurements between scans ( $3.3 \pm 4.2$  vs.  $2.2 \pm 5.3$ mm,  $p = 0.54$ ), and LSC to proximal tear distance ( $51.8 \pm 62.9$  vs.  $41.6 \pm 76.8$ mm,  $p = 0.70$ ). However, VDM identified higher growth in the LAE group compared to the no AE group ( $3.7 \pm 2.8$ mm vs  $1.0 \pm 0.8$ mm,  $p = 0.006$ ). Most (68%) patients in the LAE group had a maximum baseline diameter of = 40mm, compared to 45% in the no AE group ( $p = 0.20$ ).

#### CONCLUSION

3D growth mapping (VDM) using routine CTA images can detect subacute FL growth that is largely missed by clinical CT diameter measurements. Small growth (>2 mm) 1-3 months post-TBAD can identify patients at high risk of late adverse events.

#### CLINICAL RELEVANCE/APPLICATION

Even small aortic growth (>2 mm) can be mapped over a short CT interval using an image analysis technique called VDM, identifying TBAD patients at high risk of late adverse events.

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## Abstract Archives of the RSNA, 2023

R2-SPCH-4

### Real-world Performance of an AI-based Algorithm for Pulmonary Embolism Detection at Several Emergency Departments

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Sarah Quenet, MD (*Presenter*) Employee, Avicenna.ai

#### PURPOSE

The integration of artificial intelligence (AI) in clinical routine allows accurate diagnosis and may ultimately improve patients' outcome of life-threatening conditions such as pulmonary embolism (PE). However, the accuracy needs to be constantly evaluated. This study aims to analyze the real-world performance of an FDA-cleared and CE-marked AI-based software designed to detect PE on chest computed tomography angiograms (CTAs) at a large emergency teleradiology network.

#### METHODS AND MATERIALS

CTAs from patients admitted to several emergency departments (ED) from June 2022 to March 2023 and received by a teleradiology company (Telediag, Lyon, France) for clinical interpretation were retrospectively analyzed. CINA-PE v1.0.3 (Avicenna.AI, La Ciotat, France), an AI-powered algorithm designed to flag acute suspected PEs up to the segmental level, was already integrated into the clinical workflow. Only the scans automatically processed by the device were included in the study. A board-certified senior thoracic radiologist, not blinded to any clinical information, randomly reviewed 5% of the CTAs and their radiological reports, as part of the company's quality control program. The AI-device results were compared to the expert's interpretation, defined as the ground truth. The sensitivity, specificity, PPV and NPV were calculated. Furthermore, the potential causes of false positives (FP) and false negatives (FN) were analyzed.

#### RESULTS

A total of 295 scans (mean age: 66.9 yo  $\pm$  18.5 [SD]; 47.1% male) from 58 ED were reviewed. Among the 34 exams identified as positive for PE by the expert, the device correctly identified 29, yielding a sensitivity of 85.3% [95% CI: 68.9% - 95.1%]. Similarly, 250 out of 261 were correctly identified as negative for PE (specificity of 95.8% [95% CI: 92.6% - 97.9%]). The PPV and NPV were 72.5% and 98.1%, respectively. All the missed PEs (5 FN) were located at the segmental level. The 11 FP had confounding conditions such as bronchiolitis (n=3), pulmonary edema (n=1), lymphadenopathy (n=1), fibrosis (n=1), vena cava artifacts (n=1), overlapping pulmonary vein and artery (n=1), pleuritis (n=1) and unknown (n=2). In addition, the dataset included 2 PEs at the subsegmental level that were considered as negative cases because the algorithm is not intended to detect them.

#### CONCLUSION

The AI-based algorithm, tested on real-world data from several ED, demonstrated high accuracy for PE detection. These results suggest that the integration of AI into daily practice may help optimize the clinical workflow providing a faster and accurate diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

This study provides insight into the high performance of an AI-based algorithm in real clinical routine, tested on heterogeneous data from several clinical sites.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPCH-5

### Unenhanced MR Angiography and V/Q Scan for the Detection of Pulmonary Embolism: Systematic Review and Meta-analysis

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Stephan Altmayer, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our purpose was to conduct an updated meta-analysis to compare the diagnostic performance of unenhanced magnetic resonance angiography (MRA) and ventilation/perfusion (V/Q) scintigraphy in the diagnosis of acute pulmonary embolism (PE).

#### METHODS AND MATERIALS

Systematic searches of PubMed, Embase, Scopus, BVS, Web of Science, and Cochrane databases were conducted through April 2023. The inclusion criteria of our study required the evaluation of the performance of unenhanced MRA and V/Q scintigraphy for the detection of acute pulmonary embolism using computed tomography pulmonary angiography (CTPA) as the reference standard. We excluded studies in which CTPA was performed more than 30 days after the MRA or V/Q scan.

#### RESULTS

A total of 1695 studies were identified through systematic searches, with seven studies meeting inclusion criteria. The results showed that unenhanced MRA had a pooled sensitivity of 0.87 (95% CI 0.82 - 0.91) and specificity of 0.96 (95% CI 0.93 - 0.98), with no statistically significant heterogeneity. The pooled summary receiver operating characteristic (SROC) curve for unenhanced MRA yielded an AUC of 0.92 (95% CI 0.85 - 0.96). On the other hand, V/Q scanning had a pooled sensitivity of 0.81 (95% CI 0.76 - 0.85) and specificity of 0.84 (95% CI 0.74 - 0.91), with statistically significant heterogeneity for both sensitivity and specificity. The selected studies were assessed using the revised QUADAS-2 tool, and all studies were considered to have a relatively low risk of bias.

#### CONCLUSION

Unenhanced MRA has a comparable if not superior diagnostic accuracy compared to V/Q perfusion scan for the detection of pulmonary embolism.

#### CLINICAL RELEVANCE/APPLICATION

Unenhanced MRA for at least similar if not superior diagnostic performance compared to V/Q scan without the need for contrast agents, exposure to radiation, and contraindication in patients with known lung parenchymal abnormality.

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## Abstract Archives of the RSNA, 2023

R2-SPCH-6

### CT-defined Low-skeletal Muscle Mass and Muscle Density are Related with Mortality in Acute Pulmonary Embolism: A Multicenter Analysis

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hans-jonas Meyer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Computed tomography (CT) defined muscle mass can be used as a surrogate parameter for sarcopenia. The present study used thoracic CT to assess pectoralis muscle area and density as an imaging biomarker for prognosis of 30-day mortality in patients with acute pulmonary embolism (PE)

#### METHODS AND MATERIALS

The clinical database was retrospectively screened for patients with thoracic CT in 3 centers. Pectoralis musculature was measured on axial slices of the thoracic CT at the level of T4 of contrast enhanced pulmonary angiography CT. Skeletal muscle area (SMA), skeletal muscle index (SMI), muscle density and gauge were calculated.

#### RESULTS

Overall, 981 patients (440 female, 44.9%) with a mean age of  $63.5 \pm 15.9$  years were included into the study and 144 patients (14.6%) died within the 30-days period. Every pectoral muscle value was higher in survivors compared to non-survivors (exemplarily for SMI  $9.9 \pm 3.5$  cm<sup>2</sup>/m<sup>2</sup> versus  $7.8 \pm 2.6$  cm<sup>2</sup>/m<sup>2</sup>,  $p < 0.001$ ). Moreover, 91 patients were defined as hemodynamically instable (9.3%). Comparable, every pectoral muscle parameter was higher in patients with hemodynamically stable course compared to instable course. Different muscle variables are related to 30-day mortality: SMA, OR = 0.94 (95%CI = (0.92; 0.96),  $p < 0.001$ ); SMI, OR = 0.78 (95%CI = (0.72; 0.84),  $p < 0.001$ ); muscle density, OR = 0.96 (95%CI = (0.94; 0.97),  $p < 0.001$ ); muscle gauge OR = 0.96 (95%CI = (0.94; 0.99),  $p < 0.001$ ). SMI and muscle density were independently associated with 30-days mortality: SMI, OR = 0.81 (95%CI = (0.75; 0.88),  $p < 0.001$ ); muscle density: OR = 0.96 (95%CI = (0.95; 0.98),  $p < 0.001$ ).

#### CONCLUSION

Parameters of the pectoralis musculature are associated with 30-day mortality in patients with acute PE. These findings should lead to an independent validation study and ultimately to the inclusion into clinical routine as a prognostic factor.

#### CLINICAL RELEVANCE/APPLICATION

Pectoralis muscle is a potential important imaging biomarker, which can be easily quantified in clinical routine. There was an association with 30-day mortality in patients with acute PE.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPCH-7

### Improved Quantification and Prognostication of Lung Disease on CT in Pulmonary Hypertension by Combining the Strengths of Deep Learning and Radiologists: A Retrospective Multicentre Study with External Validation

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Krit Dwivedi, BMBS, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Gold standard for Computed Tomography (CT) lung disease quantification is visual assessment by specialist radiologists. Due to overlapping characteristics, distinguishing between Idiopathic Pulmonary Arterial Hypertension (IPAH) and PH associated with Lung Disease (PH-LD) is challenging in patients with 'mild' lung disease. A new IPAH lung disease sub-phenotype has been recently identified. Accurate diagnosis is vital, as therapeutic agents are only indicated in IPAH. CT imaging is routinely performed, but its prognostic impact is not well understood. This retrospective multicentre study deploys an artificial intelligence (AI) model to quantify the prognostic value of CT lung parenchymal patterns in a combined approach with radiological reporting.

#### METHODS AND MATERIALS

521 consecutive IPAH and PH-CLD patients with incident CT imaging between 2001-19 were included from the ASPIRE registry. A DenseNet121 and nnU-net AI model with AUC 0.94 on external testing quantified the percentage of normal lung, ground glass, ground glass with reticulation (GGR), emphysema, honeycombing and fibrosis. Fibrosis severity was scored by sub-specialist radiologists. Multivariate cox regression adjusting for age, sex, WHO function class, pulmonary vascular resistance (PVR) and diffusing capacity of carbon monoxide (DLCO) was performed. Findings were externally validated in 246 patients.

#### RESULTS

AI quantified fibrosis was a significant predictor independent of age, sex, WHO FC, PVR and DLCO in the internal (HR 1.01 per one percentage point,  $p=0.043$ ) and external (HR 1.03,  $p=0.006$ ) cohorts. In sub-group of patients scored by radiologists as having 'no' fibrosis, AI identified minor (1%) fibrosis, which was of prognostic (HR 1.03,  $p=0.004$ ) significance. Adding AI quantified fibrosis to a predictive model of radiologically scored disease and patient demographics significantly improved its predictive strength (c-index 0.763 vs 0.742,  $p=0.038$ ).

#### CONCLUSION

AI quantified parenchymal patterns are prognostic markers for survival, independent of age, sex, WHO function class, disease severity (PVR) and DLCO. This is the largest AI study in this domain and first with external validation (246 patients, 33 centres, 37 scanners). AI is sensitive to minor lung disease, and when used in combination with radiological reporting, provides additional predictive value. These findings have implications for phenotyping, radiological reporting, and therapeutic decisions.

#### CLINICAL RELEVANCE/APPLICATION

This study demonstrates the strength of combining radiological reporting and automated quantitative AI models together to improve patient outcomes. This approach will aid in identifying PH phenotypes and identify new phenotypes based on lung disease severity.

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## Abstract Archives of the RSNA, 2023

R2-SPCH-8

### Artificial Intelligence Algorithms for Incidental Pulmonary Embolism Detection: A Systematic Review and Meta-analysis

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Mohamad Nawras (*Presenter*) Nothing to Disclose

#### PURPOSE

In patients with suspected pulmonary embolism (PE) who undergo chest CT angiogram (CTA), the efficacy of artificial intelligence (AI) algorithms for PE detection has been well established. However, less is known about the use of AI algorithms for detection of incidental PE on imaging ordered for reasons other than suspected PE. The purpose of this study is to evaluate the use of AI algorithms for detection of incidental PE.

#### METHODS AND MATERIALS

We performed a comprehensive literature search using PubMed, Embase, and Web of Science databases from inception to 2/25/2023, for all studies that assess an AI algorithm for detection of incidental PE. Pooled sensitivity, specificity, and the corresponding 95% CI were calculated using the random effect model. Heterogeneity was assessed using the Higgins I<sup>2</sup> index.

#### RESULTS

A total of four studies, including 19,440 CT scans were included in the analysis. The pooled sensitivity of the artificial intelligence algorithms for the detection of incidental PE was 0.839 (95% CI:0.637-0.939, I<sup>2</sup>: 88.23%) and the pooled specificity was 0.999 (95% CI: 0.996-1.000, I<sup>2</sup>: 82.51%).

#### CONCLUSION

Our meta-analysis demonstrated that AI algorithms can detect incidental PEs on CT scans with good sensitivity and excellent specificity. Such algorithms can potentially be used as screening tools or second readers for detection of PEs on non-CTA imaging. Further large-scale studies are necessary to validate our findings.

#### CLINICAL RELEVANCE/APPLICATION

More hospitals are now implementing artificial intelligence and deep learning algorithms to their imaging protocols. It is important to present the overall usefulness of such algorithms as we have done in this study.

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## Abstract Archives of the RSNA, 2023

R2-SPER-1

### Dual-Energy CT for Suspected Scaphoid Fractures: Evaluation of a Clinical Implementation

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Felix C. Muller, MD (*Presenter*) Employee, Siemens AG

#### PURPOSE

In December 2020 we changed the workup of patients with radiographically occult but clinically suspected scaphoid fractures from MRI to dual-energy CT (DECT) using virtual non-calcium images (VNCa). Previous studies have shown similar diagnostic accuracy for MRI and DECT, but we still wanted to investigate if this would lead to overlooked injuries. We also tested a previously proposed threshold level for detection of traumatic bone marrow edema on VNCa images.

#### METHODS AND MATERIALS

Patients were eligible for inclusion if they had received a DECT scan of the wrist with a clinical suspicion of a scaphoid fracture after a radiograph during the first 6 month of implementation. We excluded patients with known scaphoid or other fractures. All patients were scanned on a second or third generation dual-source CT scanner with a tube voltage combination of 80 kV / 140kV or 80kV / 150kV with use of tin filtration. VNCa images were available to the reading on-call radiologists. Definite or possible radius or scaphoid fractures as noted in the radiological report were recorded. We then audited the electronic health record and PACS for any follow up visit or radiological imaging of the wrist for a period of 12 months after the trauma for identification of scaphoid fractures, other fractures or soft tissue injury. Patient with scaphoid or radius fractures were selected for quantitative image analysis compared to patients without as a control group. Areas in the VNCa image above -40HU were color-coded for the automatic detection of fracture associated bone marrow edema.

#### RESULTS

Of 322 identified patients 87 were excluded. Of the 235 included patients (214 adults, 21 Children) 8.5% (20/235) had a scaphoid, 17% (40/235) a radius, and 19.1% (45/235) other fractures. We found no patients with overlooked scaphoid fractures during the follow-up period. Three patients presented with a new wrist trauma and were diagnosed with an avulsion from the scaphoid, a radius fracture and a scapholunate dissociation. Two patients were diagnosed with ulnar collateral ligament injury on clinical follow-up examination. VNCa cutoff of -40HU had a sensitivity and specificity of 100% (95% CI 83%-100%) and 96% (95% CI 79%-100%) for radius fracture and 100% (95% CI 59%-100%) and 92% (95% CI 78%-98%) for scaphoid fracture detection.

#### CONCLUSION

We find no evidence that a DECT based scaphoid fracture workup leads to overlooked scaphoid fracture. VNCa values above -40HU were highly sensitive and specific for the detection of fracture associated bone marrow edema.

#### CLINICAL RELEVANCE/APPLICATION

Implementation of DECT based scaphoid fracture detection is safe and quantitative assessment of virtual non-calcium images can assist radiologists in the detection of radiographically occult fractures.

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## Abstract Archives of the RSNA, 2023

R2-SPGI-1

### Comparison of Split Bolus Dual Energy CT and Multiphase Dual Energy CT in Assessing Vascular Invasion in Patients with Biliary Malignancies: A Randomized Study

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Kondaveeti N. Eswar, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare image quality, definition of vascular invasion and radiation dose of split bolus dual energy CT (DECT) with multiphase DECT in biliary malignancies.

#### METHODS AND MATERIALS

This prospective single centre approved study included 88 patients of gallbladder cancer and hilar cholangiocarcinoma randomized into two groups and scanned on rapid-switching DECT scanner. Patients in group 1 (n=43, mean age: 54.6 years, 12 men) were scanned with multiphase protocol (MPP; arterial, venous, delayed phases in DECT) and those in group 2 (n=45, mean age: 52.6 years, 20 men) with split bolus protocol (SBP; split-bolus, delayed phases in DECT). For both groups, virtual monoenergetic images (VMI) were generated at 50 and 70 keV. Mean attenuation, contrast to noise ratio (CNR) and signal to noise ratio (SNR) of tumor, liver and hepatic vessels were assessed in each phase and VMI and were compared between the two groups along with dose length product and volumetric CT dose index. Two readers independently assessed subjective image quality and vascular invasion (5 point Likert scale) in each phase (MPP and SBP) and inter-reader agreement was compared within groups. Mann Whitney U-test and kappa statistics were used for comparison and  $p < .05$  was considered significant.

#### RESULTS

Arterial phase of group 1 had significantly higher attenuation, CNR and SNR of arteries compared to SBP (for both 50 and 70 keV) of group 2 ( $p < .001$ ). However, venous phase of group 1 had significantly poorer attenuation, CNR and SNR for arteries compared to SBP (both VMI) ( $p < .001$ ). Quantitative parameters for veins and tumor between venous phase (group 1) and SBP (group 2) were comparable. Good-to-strong inter-reader agreement ( $k=0.45$  to  $0.75$ ) for image quality for both protocols was observed. For hepatic arterial invasion, SBP had significantly higher inter-reader agreement ( $k= 0.71$ ) compared to arterial phase of MPP ( $p < .001$ ). For arterial invasion, 32% and 24% of images of group 1 could not be assessed by reader 1 and 2 respectively, compared to 8% and 6%, respectively in group 2 ( $p < .001$ ). Venous invasion was comparable between the two readers. 50 and 70 KeV VMI were comparable for staging of vascular invasion for both readers. MPP had 37% higher radiation dose than SBP ( $p < .001$ ).

#### CONCLUSION

Image quality of SBP is non-inferior to MPP for biliary malignancies. However, SBP showed significantly better inter-observer agreement for arterial invasion indicating better assessment of vascular involvement with significantly lower radiation dose.

#### CLINICAL RELEVANCE/APPLICATION

Biliary malignancies are better defined in venous phase in which arteries are indistinct, making arterial invasion assessment tough. SBP overcomes this by clearly depicting arteries and tumor in same phase for confident assessment.

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## Abstract Archives of the RSNA, 2023

R2-SPGI-3

### Sarcopenia During Neoadjuvant Chemotherapy and its Effect on Survival in Gastroesophageal Adenocarcinomas

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Clarissa Hosse (*Presenter*) Nothing to Disclose

#### PURPOSE

Gastroesophageal adenocarcinomas are one of the most prevalent types of cancer worldwide and their incidence has been increasing over the last few decades. Despite advances in treatment, the survival rate remains low, with less than 30% of patients surviving beyond five years. Patients suffer from dysphagia, weight loss and often present with sarcopenia, a progressive muscle loss associated with both age and cancer. Sarcopenia has been gaining attention as a prognostic factor in cancer, mainly focusing on surgical patients. Its prognostic power for patients who receive multimodal treatment, however, remains unclear. This study aimed to investigate the effect of changes in muscle mass on patients with gastroesophageal adenocarcinomas who received neoadjuvant chemotherapy before surgical resection. The study focused on overall survival (OS), disease-free survival (DFS), and length of stay (LOS) after curative resection as the endpoints.

#### METHODS AND MATERIALS

We collected retrospective data from 146 patients treated between 2010 and 2020. We used a fully automatic "AI body composition analysis software" to measure the lumbar skeletal muscle index (LSMI) on CT scans taken before and after neoadjuvant chemotherapy to evaluate sarcopenia. We defined sarcopenia as LSMI < 38.5 cm<sup>2</sup>/m<sup>2</sup> (female) and < 52.4 cm<sup>2</sup>/m<sup>2</sup> (male). The primary outcome was OS, and the secondary outcomes were DFS and LOS after curative resection. We conducted Kaplan-Meier analyses for survival and tested with Log-Rank.

#### RESULTS

The median OS was 82.13 months (95% CI [64.22 - 10.05]), with 32 recorded deaths (21.9%). The median skeletal muscle loss during neoadjuvant chemotherapy was 2.79%. Although any loss of skeletal muscle during neoadjuvant chemotherapy indicated worse OS, it did not reach statistical significance ( $p = 0.068$ ). LSMI-loss significantly correlated with worse DFS ( $p = 0.028$ ) with a mean of 77.06 months (95% CI [63.03 - 91.09]) without and 47.40 months (95% CI [37.92 - 56.89]) with loss of skeletal muscle mass. It also correlated with LOS ( $p = 0.026$ ) with a median of 12 days (95% CI [11.19 - 12.81]) without and 14 days (95% CI [12.86 - 15.14]) with loss of skeletal muscle mass.

#### CONCLUSION

Patients with gastroesophageal adenocarcinomas undergoing neoadjuvant chemotherapy before surgery are at risk of skeletal muscle loss associated with adverse outcomes. While further studies are needed, loss of skeletal muscle mass during treatment, rather than sarcopenia at any timepoint, has the potential to become a prognostic marker and target for interventions.

#### CLINICAL RELEVANCE/APPLICATION

Using AI body composition analysis techniques to find individual prognostic markers for patients with cancer

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPGI-7

### Evaluation of Programmed Cell Death Ligand 1 Expression in Gastric Cancer by Enhanced CT Parameters

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Min Xu (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to explore the correlation between enhanced CT imaging features and programmed cell death ligand-1(PD-L1) expression status in gastric cancer and to evaluate the predictive value of imaging parameters for immunotherapy biomarkers.

#### METHODS AND MATERIALS

Patients with gastric adenocarcinoma who underwent abdominal CT three stage enhanced scan and PD-L1 immunohistochemical testing before treatment were retrospectively examined. All diagnoses were confirmed by pathology. According to the expression status of PD-L1, they were divided into positive group(CPS $\geq$ 5) and negative group(CPS<5). Baseline CT imaging features were collected. CT value were collected in the unenhanced(U), arterial(A), venous(V), and delayed(D)phases to further calculate the arterial attenuation and venous attenuation with arterial enhancement fraction(AEF). Diagnostic performances of the different variables were evaluated using receiver operating characteristic(ROC) curve.

#### RESULTS

A total of 67patients with gastric adenocarcinoma were included in the study. On abdominal enhancement CT images, the probability of maximum lymph node short diameter $>1$ cm and peak of lesion enhancement occurring in the arterial phase were statistically significant between the two group( $p<0.05$ ); Moreover, the AEF was significantly higher in the positive group than in the negative group( $p<0.05$ ). And the ROC curve analysis showed that the AEF exhibited a high evaluation efficacy [AUC: 0.724(95%CI: 0.602~0.826)]. The combined model had the best diagnostic efficacy[AUC: 0.786(95%CI: 0.669~0.877), sensitivity: 58.33%; specificity: 88.37%].

#### CONCLUSION

There is a correlation between CT imaging features and PD-L1 expression status in gastric cancer, and AEF may help to assess high PD-L1 expression and help to select patients suitable for immunotherapy.

#### CLINICAL RELEVANCE/APPLICATION

To explore the value of CT imaging features in evaluating biomarkers for immunotherapy of gastric.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPGI-8

### MRI-traceable Nanoparticles for Integrin Targeted Liver Fibrosis Detection

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Qihui Hu JR, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To timely detection and intervention of liver fibrosis are crucial for preventing the progression of the liver disease, we designed an integrin  $\beta 3$  targeted nano-platform (cRGD-PLGA/IONP) based on iron oxide nanoparticles (IONPs) for the detection and grading of liver fibrosis.

#### METHODS AND MATERIALS

Preparation of cRGD-PLGA/IONP. The PLGA microcapsules were prepared by the double emulsion process, where superparamagnetic IONPs were introduced into the reaction. cRGD-PLGA/IONP were subsequently characterized by a series of methods. Animal models. C57BL/6 mice received an intraperitoneal injection of 20% CCl<sub>4</sub> (1  $\mu$ g/g) twice weekly for 0, 3, 7, or 11 weeks. MRI protocol. C57BL/6 mice were imaged on a 3.0 T MRI system with animal coils. MR imaging (Discovery 750w, GE Healthcare) was performed at different time points after cRGD-PLGA/IONP, IONP and PBS i.v. injection. Scanning with T2WI and T2 mapping sequences. The T2 and R2 values in various areas of the mice livers at different time points after cRGD-PLGA/IOFA administration were measured and calculated to assess the contrast enhancement.

#### RESULTS

Liver fibrosis induction. Immunofluorescence and Sirius staining confirmed the increased protein expression of integrin  $\beta 3$  subunit in aHSCs and the fibrogenic marker  $\alpha$ -SMA with the time of CCl<sub>4</sub> administration, which indicates the animal model was established successfully (Figure 1). cRGD-PLGA/IONP for MRI detection of liver fibrosis. cRGD-PLGA/IONP group demonstrated a contrast enhancement in R2 to 33.9 s<sup>-1</sup> ( $\Delta$ R2  $\sim$  4.7 s<sup>-1</sup>, an approximate 16.2% increase in the liver area) in the early-stage fibrotic liver (Ishak 1). Compared with the control group (Ishak 0), the significantly increased signal ( $\Delta$ R2) of mice (Ishak 3 and Ishak 5) injected with cRGD-PLGA/IONP were 12.4 (42.5%) and 37.4 (127.9%), and the R2 values were nearly 1.4 and 2.3 times than that of the control group, respectively. (Figure 2a, b). The Fe concentration in mice liver of cRGD-PLGA/IONP group was measured by the inductively coupled plasma-mass spectroscopy. Figure 2c showed that the levels of Fe content in the mice liver were basically consistent with the changes in MRI liver signal values. In contrast, the IONP group did not result in significant signal enhancement at different time points. These results illustrated that cRGD-PLGA/IONP was a highly efficient MRI agent for liver fibrosis diagnosis.

#### CONCLUSION

In conclusion, cRGD-PLGA/IONP could perform MRI visualization detection and grading.

#### CLINICAL RELEVANCE/APPLICATION

Liver fibrosis is the critical stage in developing chronic liver disease (CLD), from simple and reversible injury to irreversible cirrhosis. A novel contrast agent-enhanced MRI detection is a potential new method for diagnosing liver fibrosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPGU-1

### Development and Validation of a Predictive Model Based on Clinical and mpMRI Findings to Reduce Additional Systematic Prostate Biopsy

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Xueqing Cheng (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a predictive model based on clinical features and multiparametric magnetic resonance imaging (mpMRI) to reduce unnecessary systematic biopsies (SB) in biopsy-naïve patients with suspected prostate cancer (PCa).

#### METHODS AND MATERIALS

274 patients who underwent combined cognitive MRI-targeted biopsy (MRTB) with SB were retrospectively enrolled, and temporally be split into development (n = 201) and validation cohorts (n = 73). Multivariable logistic regression analyses were used to determine independent predictors of clinically significant PCa (csPCa) on cognitive MRTB, and the clinical, MRI and combined models were established respectively. Area under the receiver operating characteristic curve (AUC), calibration plots and decision curve analyses were assessed.

#### RESULTS

Prostate imaging data and reporting system (PI-RADS) score, index lesion (IL) on the peripheral zone, age and prostate specific antigen density (PSAD) were independently predictors and included in the combined model. The combined model achieved the best discrimination (AUC: 0.88) as compared to both MRI model incorporated by PI-RADS score, IL level and zone (AUC: 0.86), and clinical model incorporated by age and PSAD (AUC: 0.70). The combined model also showed good calibration and enabled great net benefit on internal and external validation. Applying the combined model as a reference for performing MRTB alone with a cutoff of 60% would reduce 43.8% of additional SB, whilst missing 2.9% csPCa.

#### CONCLUSION

The combined model based on clinical and mpMRI findings improved csPCa prediction and might be useful in making a decision about which patient could safely avoid unnecessary SB in addition to MRTB in biopsy-naïve patients.

#### CLINICAL RELEVANCE/APPLICATION

- Age, PSAD, PI-RADS score and index lesion on the peripheral zone were independently predictors of detecting csPCa by cognitive MRTB.
- The combined model that incorporated clinical and mpMRI findings achieved best discrimination in predicting csPCa, with satisfactory calibration and net benefit in biopsy naïve patients.
- Using the combined model with a cutoff of 60% as an indication of performing MRTB alone would reduce 43.8% of unnecessary SBs, whilst missing 2.9% csPCa.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPHN-2

### The Effects of Improved Position on Image Quality of CT Scanning of Thyroid

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Shuting Liao, MMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

In this study, we explore the effect of the Improved Swimmer's position on computed tomography (CT) image quality of thyroid, on the radiation dose to patients and the detection rate of thyroid micronodules on CT, using GE Revolution Energy Spectrum CT.

#### METHODS AND MATERIALS

Thyroid examinations with spectral CT were compared for Traditional position group (TDN); Swimmer's position group (SWIM) and Improved Swimmer's position group (I-SWIM). We used subjective grades and objective SNRs and CNRs indicators to assess image quality. Potential confounders, such as Body Mass Index (BMI) and the effective diameter of the neck, were assessed. Patients' radiation exposure was measured by the volume CT dose index (CTDIvol), dose-length product (DLP), and the effective dose of the neck (EDN) and thyroid (EDT). We also evaluate the micronodules detection rate on CT images.

#### RESULTS

Subjective and objective evaluation of thyroid CT image quality were significantly improved in the I-SWIM group compared with SWIM group and TDN group ( $p < 0.001$ ). Although there was no statistically significant difference ( $p = 0.109$ ) in BMI, effective neck diameter and radiation dose received between the groups ( $P > 0.05$ ), there was no significant increase in radiation exposure in the modified swimming position group. There was a significant promotion in micronodules detection of thyroid in the I-SWIM group versus SWIM group and TDN group ( $p < 0.001$ ).

#### CONCLUSION

Based on spectral CT, I-SWIM position improved the image quality of thyroid CT without increasing the radiation exposure of the patients, and increased the detection rate of thyroid micronodules on CT.

#### CLINICAL RELEVANCE/APPLICATION

Based on spectral CT, I-SWIM position improved the image quality of thyroid CT without increasing the radiation exposure of the patients, and increased the detection rate of thyroid micronodules on CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPHN-3

### Medium-Term Study Results of Ultrasound-Guided Radiofrequency Ablation for Thyroid Follicular Neoplasm with Low SUV in PET/CT

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

An-Ni Lin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the long-term results of radiofrequency ablation (RFA) of thyroid nodule with cytology of follicular neoplasm with low standard uptake value (SUV) in a positron emission tomography (PET/CT) study.

#### METHODS AND MATERIALS

From January 2018 to January 2021, 40 patients were diagnosed with follicular neoplasm. All patients received ultrasound, fine needle aspiration (FNA) or core needle biopsy (CNB) prior to the treatment. A PET/CT scan was performed in 33 patients prior to treatment. Under local anesthesia, RFA was performed with the use of an RF generator and an 18-gauge internally cooled electrode. Volume changes in nodules on follow-up ultrasonography (US), changes in symptomatic and cosmetic scores, and complications arising during or after RFA were evaluated. Six to twelve months after RFA, all patients received FNA to reevaluate the neoplasm status.

#### RESULTS

Significant volume reductions during follow-up between values prior to RFA and 6 months after RFA ( $7.31 \pm 12.83 \text{ cm}^3$ ,  $p < 0.001$ ) were demonstrated. The respective mean volume reduction ratios at the 6-month and final follow-up were 71.5% and 81.45%. The mean follow-up time was  $2.38 \pm 0.9$  years. One patient presented with vocal cord palsy and another patient presented with ptosis, both of whom recovered after RFA. No post-procedural hypothyroidism occurred in the RFA patients. Pre-RFA thyroglobulin level was significantly positively correlated with the SUVmax value of PET/CT ( $p=0.001$ ).

#### CONCLUSION

RFA is a safe and effective treatment for patients with low-risk follicular neoplasm (SUVmax value  $< 5$ ) in long-term follow-up. It is a viable alternative treatment for patients not suitable or willing to undergo surgery.

#### CLINICAL RELEVANCE/APPLICATION

RFA is a safe and effective treatment option for patients with thyroid follicular neoplasm, specifically those with low SUVmax on PET/CT studies. This treatment can provide significant volume reductions in the nodule and improve symptomatic and cosmetic scores. Additionally, RFA may be a viable alternative to surgery for patients who are not suitable or willing to undergo surgery. Clinicians could consider using RFA as a treatment option in patients with low-risk follicular neoplasm, as it has been demonstrated to have minimal complications and no post-procedural hypothyroidism. Furthermore, clinicians could consider performing PET/CT studies in patients with thyroid nodules to assess their SUVmax value, as it can be a useful predictor of the malignancy rate of thyroid nodule.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPHN-5

### Development and Validation of Radiomics Model Based on Ultrasound Images to Predict Malignancy in Bethesda Category III and IV Thyroid Nodules

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Xiaoxian Li (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to predict malignancy in thyroid nodules with initial fine-needle aspiration (FNA) results of Bethesda category III and IV using a machine learning algorithm.

#### METHODS AND MATERIALS

A total of 266 thyroid nodules (= 1 cm) were included from January 2017 to May 2022 retrospectively. The initial FNA results were Bethesda category III or IV and subsequent pathological diagnoses were obtained. All subjects were divided into a training set and a test set randomly at a ratio of 7:3. One senior and one junior radiologist independently and blindly reviewed the images of the test set and evaluate the nodule features based on the American College of Radiology (ACR) Thyroid Imaging Reporting and Data System (TI-RADS). For each nodule, two grayscale ultrasonography images including one transverse and one longitudinal were selected and segmented. Then radiomics features were extracted and selected using a machine learning algorithm to develop a radiomics model. Univariate and multivariate logistic regression analyses were used to select clinical independent predictors which were used to develop the clinical-radiomics combined model. The receiver operating characteristic (ROC) curves of the radiomics model and combined model were plotted. The AUCs were calculated and compared using DeLong's test.

#### RESULTS

Among the final set, 226 cases were Bethesda III nodules with a malignant rate of 39.4%; 40 cases were Bethesda IV nodules with a malignant rate of 50.0%. The variables included in the clinical-radiomics combined model were nodule size, suspected cervical lymph node metastasis and radiomics probability. In both the training and test sets, the AUC of the combined model was higher than that of the radiomics model (training, 0.823 vs 0.751,  $P = 0.003$ ; test, 0.800 vs 0.749,  $P = 0.040$ ). In the test set, the AUC of the combined model was significantly higher than that of the junior radiologist (0.800 vs 0.658,  $P = 0.029$ ) and no significant difference compared to senior radiologist (0.800 vs 0.760,  $P = 0.550$ ). Moreover, the specificity of the combined model (66.7%) was higher than that of the junior radiologist (44.4%) and senior radiologist (62.2%). There was no significant difference between the AUC of the radiomics model and two radiologists ( $P > 0.05$ ).

#### CONCLUSION

The radiomics model and clinical-radiomics combined model based on grayscale ultrasound images can effectively predict malignancy in Bethesda category III and IV thyroid nodules. The diagnostic performance of the combined model is comparable to that of the senior radiologist and better than that of the junior radiologist.

#### CLINICAL RELEVANCE/APPLICATION

Machine learning algorithm may help in more accurate identification of malignancy in Bethesda category III and IV thyroid nodules for further evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPHN-6

### "Unlocking the Secrets of F-18-FDG PET/CT Thyroid Incidentalomas". A Comprehensive Analysis of Ultrasound and Pathology in a Leading Mexico City Hospital

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Jonahi S. Serrano Heredia (*Presenter*) Nothing to Disclose

#### PURPOSE

Study the prevalence of focal and diffuse thyroid incidentalomas detected by 18-FDG PET/CT. Investigate the relation between SUVmax, ultrasound features, and histopathology to estimate the risk of malignancy in these patients. Estimate a cut-off point of SUVmax to suspect malignancy.

#### METHODS AND MATERIALS

We retrospectively reviewed the reports of 3958 patients in whom 18-FDG-PET/CT scans were performed. Studies in which the presence of thyroid incidentaloma were analyzed. SUVmax and Total lesion glycolysis (3D slicer) values were obtained prospectively. Ultrasound was also prospectively reviewed if available, Fine Needle Aspiration (FNA) and histopathology data were collected. Statistical analysis was made with SPSS 25.

#### RESULTS

The prevalence of thyroid incidentaloma in FDG-PET/CT was 3.2% (130 patients), 98 (2.53%) had focal uptake, and 32 (0.82%) diffuse uptake. 43 patients with focal uptake underwent further workup. The prevalence of focal uptakes was higher in women than in men (33.7% vs 66.3%, OR 1.54, CI 95% 1.0132 - 2.3644). Nodules were classified as benign (N=14) and malignant (N=14) by pathology. The median SUVmax of focal uptakes was 4.50 (1.66-56.24). Malignant lesions had higher SUVmax than Benign (8.25 vs 4.49,  $p=.049$ ). In ultrasound analysis ( $n=43$ ), nodules with the following features had higher SUVmax and malignancy rates: Hypoechoic ( $p=.004$ , SUVmax: 7.28.), taller-than-wide ( $p=.003$ , SUVmax: 8.84), lobulated or irregular margins ( $p=.000008$ , SUVmax: 8.84), punctate echogenic foci ( $p=.039$ , SUVmax: 10.23) and presence of adenopathy ( $p=.037$ , SUVmax: 12.16). A significant difference in SUVmax values among ATA classification was found ( $H=19.27$ ,  $df=4$ ,  $p=.0007$ ). Benign nodules had lower SUVmax values (2.46, 1.86-3.05), while high suspicion nodules had higher SUVmax values (11.62, 4.46-56.24). A cut-off value of 4.880 g/ml SUVmax was used to determine malignancy with a sensitivity of 81% and specificity of 77%.

#### CONCLUSION

Higher SUVmax in PET/CT were consistent with ultrasound features of suspicion and the rate of malignancy. SUVmax values are significantly different among nodules classified according to the ATA guidelines, with benign and low suspicion nodules having lower SUVmax values and high suspicion nodules having higher SUVmax values. A cut-off value of 4.880 g/ml has good sensitivity, and specificity (81% and 77%, respectively). This suggests that SUVmax may be a useful metric for distinguishing between benign and malignant lesions in PET-CT imaging.

#### CLINICAL RELEVANCE/APPLICATION

Up to 3% of PET-CT scans showed a thyroid incidentaloma. It is important to determine which nodules are more likely to be malignant. This study shows SUVmax has a good correlation with ultrasound and pathology for determining malignancy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPHN-7

### Preoperative Localization of Previously Occult Parathyroid Adenomas using Dynamic, Contrast Enhanced Parathyroid MR Imaging

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Jacob Musiol, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Common techniques for preoperative localization of parathyroid adenomas include nuclear medicine parathyroid sestamibi scans with or without SPECT or SPECT-CT, ultrasound, and 4D parathyroid CT with differing levels of success. While not widely utilized, dynamic contrast enhanced parathyroid MRI has also been previously shown to demonstrate parathyroid adenomas with increased sensitivity and specificity when compared to dynamic parathyroid CT. Our interest in dynamic parathyroid MRI began when a patient presented with clinical hyperparathyroidism but occult prior imaging. We tailored a protocol on our clinical use 3 Tesla Siemens magnet using previously published parameters. We subsequently scanned six patients for evaluation of parathyroid adenoma.

#### METHODS AND MATERIALS

Our patient selection included six patients imaged over 18 months with biochemical hyperparathyroidism and elevated serum parathyroid hormone values, but negative prior imaging. Using a clinical Siemens 3T magnet, we performed T1 axial, T2 axial, T2 fat saturated coronal, T1 coronal, T1 axial VIBE pre contrast, and T1 axial VIBE post contrast dynamic sequences. After the administration of gadolinium-based contrast, 11 axial dynamic contrast series were obtained at 11.5 second intervals for a total imaging sequence time of 2 minutes 7 seconds. Additional T1 VIBE post contrast subtraction images were created. All images were submitted to the AGFA PACS, and clinical interpretation was performed by a board certified neuroradiologist.

#### RESULTS

We utilized our protocol to image six patients, all with positive findings on MRI. The lesions identified as positive demonstrated T2 hyperintensity and intense arterial enhancement within the first 30 seconds of contrast injection, followed by delayed washout. The patients were taken to surgery with accurate surgical localization. All six had pathology-proven parathyroid adenomas. The smallest lesion measured 6 mm and the largest lesion measured 14 mm.

#### CONCLUSION

While not widely utilized, dynamic parathyroid MR imaging is a helpful resource for localizing parathyroid adenomas with high sensitivity and specificity. While other modalities such as nuclear medicine parathyroid sestamibi scans or 4D parathyroid CT are more widely available, implementing this dynamic post contrast technique in clinical practice can assist surgeons in preoperative localization, as well as decrease the incidence of exploratory surgery of the neck.

#### CLINICAL RELEVANCE/APPLICATION

Dynamic parathyroid MRI can be readily and easily integrated into routine outpatient imaging protocols for evaluation of parathyroid adenoma. Utilization can improve preoperative surgical localization and improve patient outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIN-1

### Prediction on Lateral Cephalograms of Post Orthognathic Surgery using Graph Convolutional Neural Network and Diffusion Model

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

JiHeon Jeong (*Presenter*) Nothing to Disclose

#### PURPOSE

To generate lateral cephalogram of post orthognathic surgery based on pre-operation lateral cephalogram using a graph convolutional neural net (GCN) and a diffusion model

#### METHODS AND MATERIALS

Among a dataset from nine university hospitals with different types of cephalography machines and radiation exposure protocols, 800 pairs of pre- (T0) and post- (T1) surgery with 12-bit deep grayscale images were selected and registered based on the sella and nasion points. And the dataset was divided into a training set of 700 pairs and a test set of 100 pairs. Landmarks were measured on each image at 41 points using a pre-trained model with an average error of  $0.80 \pm 0.79$  mm. First, a model was trained to predict the movement predictions of each landmark in T1 image by embedding the T0 image and its landmarks using CNN and graph GCN, respectively. To generate T1 images, we used various prompts, including the movement of landmarks based on surgical planning. To ensure more realistic and detailed generation quality using various prompts, an autoencoder using not only a labeled dataset of T0 and T1 but also an unlabeled cephalogram dataset was trained. A diffusion model for image generation in the encoding space was trained with various prompts as conditioning factors. Specifically, T0, and T0's landmarks, and movement predictions were used as prompts.

#### RESULTS

The distances between the landmark points on the images generated by the diffusion model and the T1 images were measured for 100 test images, both with and without various prompts. The diffusion model without prompts had an average error of approximately  $2.33\text{mm} \pm 6.16\text{mm}$  across 30 landmark points, while the diffusion model with prompts had an average error of  $1.76\text{mm} \pm 1.45\text{mm}$ , which was statistically significant based on paired t-test results ( $p < 0.001$ ).

#### CONCLUSION

A diffusion model was trained to generate T1 cephalogram based on T0 images of orthognathic surgery using graph CNN and diffusion model, which lead to better prediction of post-operational cephalogram.

#### CLINICAL RELEVANCE/APPLICATION

This generative model could be used to predict surgical result based on surgery planning and pre-operative cephalogram with landmarks. Therefore, based on this, among various surgical planning options of orthognathic surgery, better outcome could be selected.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIN-2

### Artificial Intelligence (AI) Software for Automated Fracture Detection in Emergency Department: 2-month Experience

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Francesco Pucciarelli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Computer-aided detection tools are routinely used in clinical practice. In recent years, artificial intelligence (AI) is playing an increasing role in medical imaging, aiming at speeding up the workflow and improving human diagnostic performances. The purpose of this study is to evaluate the reliability of an AI software trained to detect fractures on radiographs and to compare its accuracy to radiologists.

#### METHODS AND MATERIALS

This retrospective study included radiographs of patients admitted for trauma to the emergency department of our hospital from May 19 2022 to July 19 2022. Radiographs of each patient were analyzed for the presence of fracture by both radiologists and AI software. For discordant cases a radiologist with 25 years of experience in emergency radiology was considered the ground truth and, when available, CT. Statistical analysis was performed with a dedicated software and accuracy of both radiologist and AI software was collected.

#### RESULTS

Final population consisted of 981 patients, comprising 1360 anatomical districts and 3367 X-ray projections. Concordance between radiologists and AI software was 88.8% (871/981) and discordance was 11.2% (110/981). In discordant cases false positive (FP) were 30 for radiologists vs 76 for AI software; true negative (TN) were 76 vs 30, respectively; true positive (TP) were 3 vs 1 respectively; false negative (FN) were 1 vs 3 respectively. Accuracy was 0.96 for radiologists and 0.91 for AI software (sensitivity 0.99 vs 0.99 and specificity 0.96 vs 0.91 respectively). Positive predictive value (PPV) was 0.92 for radiologist vs 0.81 for AI software; ?negative predictive value (NPV) was equal (0.99). FP for AI software were mainly due to image artifacts, external devices, and immature bone in pediatric patients.

#### CONCLUSION

Radiologists and AI software showed the same sensitivity on fracture detection with a slightly higher specificity for radiologists. NPV was equal. We can conclude that the use of AI software has shown good reliability in ruling out fractures on radiographs.

#### CLINICAL RELEVANCE/APPLICATION

This AI software could be applied to clinical routine to improve the radiologist's confidence in ruling out fractures in the emergency department.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIN-3

### Using Deep Learning to Augment Radiologist Interpretation of Brain MRIs for Alzheimer's Disease

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Vijaya B. Kolachalama (*Presenter*) Nothing to Disclose

#### PURPOSE

Modern machine learning approaches are being developed to assist radiologists in evaluating MRIs for Alzheimer's disease (AD) detection. We sought to determine if a deep learning model can augment neuroradiologist evaluations of MRIs for AD assessment.

#### METHODS AND MATERIALS

We developed a multimodal deep learning framework for dementia assessment that combines MRIs and non-imaging data including demographics, past medical history, neuropsychological testing, and functional assessments [1]. The model was trained on 4,822 participants from the National Alzheimer's Coordinating Center dataset. A subset of cases clinically diagnosed with dementia (n=50) was evaluated by seven neuroradiologists who were asked to differentiate between persons with AD and those with non-Alzheimer's dementia (nADD) using MRI scans and demographic information. We evaluated the model performance against the radiologist assessments and constructed a consensus opinion from the expert ratings and model predictions. [1] Qiu et. al., Nat Commun. 2022 Jun 20;13(1):3404. doi: 10.1038/s41467-022-31037-5

#### RESULTS

Our results showed that combining the radiologist assessments with predictions from our model yielded greater accuracy, sensitivity, specificity, and Matthews correlation coefficient (MCC) in differentiating persons with AD from those with nADD than the assessments made by the neuroradiologists alone. The consensus methods used in this study resulted in an improvement in accuracy from 58% to 64%, in sensitivity from 58% to 64%, in specificity from 60% to 72% , and an increase in the MCC from 0.16 to 0.28.

#### CONCLUSION

Incorporating machine learning model assessments into the consensus radiologist interpretation improved the reliability of AD diagnosis based on brain MRIs, age, and gender.

#### CLINICAL RELEVANCE/APPLICATION

AI-augmented radiologist assessment can improve the diagnostic accuracy of AD diagnosis, leading to more precise and timely treatment, potentially improving patient outcomes.

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## Abstract Archives of the RSNA, 2023

R2-SPIN-4

### Joint Generative and Mixture Data Augmentation for Metastatic Focal Liver Lesion Classification in Abdominal CT Images

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hansang Lee, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Generative data augmentation (DA) using generative adversarial network (GAN) has been successful in improving the learning efficiency of medical image analysis tasks where training data is limited. However, it is prone to mode collapse, where the GAN generates a limited variety of patterns due to inadequate learning of the training data pattern. To overcome this limitation, we propose a novel data augmentation approach that combines generative DA with MixUp-based mixture DA to diversify the pattern of synthetic data. We evaluate the effectiveness of this approach on the classification of metastatic focal liver lesions (FLLs) in abdominal CT images.

#### METHODS AND MATERIALS

Our dataset consists of CT scans from 502 colorectal cancer patients, including 1,290 FLL images with 676 cysts, 130 hemangiomas, and 484 metastases. First, we generated synthetic images by training a StyleGAN model on real training images. We then created new training images by performing MixUp-based linear combinations between synthetic and real training images. The VGG-16 network is then trained using these training images to classify FLLs. To validate the effectiveness of our approach, we compared the accuracy, sensitivity, and specificity of classification results, and analyzed the t-SNE feature distribution to determine whether our approach mitigates mode collapse in generative DA.

#### RESULTS

Generative DA achieved a marginal improvement over the affine DA-based baseline, with 73.2% accuracy compared to 72.3%. Our proposed method achieved 80.8% accuracy and demonstrated a significant enhancement in the sensitivity of cyst and metastasis. In the t-SNE feature distribution, synthetic images generated by generative DA were concentrated around specific locations due to mode collapse, while training images of our method were distributed across the entire class. This outcome confirms that our method can mitigate mode collapse by diversifying the pattern of synthetic images.

#### CONCLUSION

We proposed a novel DA method that combines generative DA with mixture DA to address mode collapse, a major limitation in generative DA. We confirmed that our method diversifies the pattern of synthetic images created by generative DA, mitigating the mode collapse phenomenon and enhancing classification performance in the classification of FLLs in CT images. (This work was supported by the National Research Foundation of Korea Grant funded by the Korea government (No. RS-2023-00207947))

#### CLINICAL RELEVANCE/APPLICATION

Our approach can be applied to a wide range of medical image analysis tasks in which training data is scarce or mode collapse arises during generative DA.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIN-5

### Development of Accurate Automated Organ Segmentation in Pediatric CT Scans: Impacts of Model Pretraining

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Panagiotis Korfiatis, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop a deep learning-based segmentation model for pediatric patients with CT imaging.

#### **METHODS AND MATERIALS**

This study utilized two publicly available datasets: a pediatric dataset with imaging of 359 patients ranging from 5 days to 16 years old, with varying imaging parameters, and a dataset of adult patients consisting of 1204 scans, with annotations of 104 structures. The pediatric dataset comprised 29 organs. In this study we focused on 20 organs. The nnUNet model was trained utilizing the following approach: First, a model was trained using the adult dataset. Then, the weights of the adult model were used to initialize the weights of the pediatric model. The training/validation dataset was comprised of 325 scans, while 34 patients were used for testing. The default nnUNet augmentations were applied in this model excluding mirroring. Finally, the ensemble of the five models from the 5-fold training process was obtained as the final model (Figure 1, supplement).

#### **RESULTS**

Training the model with weight initialization led to performance improvements especially in smaller structures (Figure 1, supplement). The performance of the pretrained nnUNet ranges from 0.57 to 0.97 with the performance of the model being better in larger structures. Smaller structures like the adrenal glands and more complex anatomical structures like the small intestine benefit when pretrained models are utilized.

#### **CONCLUSION**

Leveraging pretrained models to facilitate model training for populations where large datasets that are not widely available can further improve segmentation performance. More advanced training techniques like self-supervised training or data-centric training should also be investigated.

#### **CLINICAL RELEVANCE/APPLICATION**

Image segmentation is the fundamental step in many downstream clinical applications such as quantification and treatment planning, and less attention has been given to solving this problem in pediatric populations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIN-6

### Detection of Progression to Clinically Significant Prostate Cancer Using End-to-End Deep Learning in Sequential MRI

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Christian Roest, MSc (*Presenter*) Grant, Siemens AG

#### PURPOSE

Reading sequential prostate MRI is a difficult task for radiologists. Deep learning (DL) may help detect progression. We explored end-to-end deep learning to compare two sequential MRI scans in detecting progression to clinically significant prostate cancer.

#### METHODS AND MATERIALS

This retrospective study included 714 patients with at least two consecutive biparametric MRI scans of the prostate between 2014 and 2021 (875 follow-up scans). We recorded all PIRADS reported prostate cancer lesions. PI-RADS=3 lesions received MRI-targeted biopsy, and lesions with histopathological grade of ISUP=2 were considered clinically significant (csPCa). All patients were negative for csPCa at the first MRI. Three separate end-to-end DL segmentation approaches were subsequently tested to detect csPCa: 1) a single, current MRI model; 2) a sequential model comparing prior and current MRI 3) model 2 extended with clinical parameters (PSA, PSA density, age, prostate volume). Maximum detected per lesion likelihood in the heatmap was considered the patient-level likelihood for csPCa progression. Receiver-operating characteristic (ROC) curve analysis was used to compare the three DL models at patient level. Lesion level performance was evaluated using free-ROC (FROC) analysis by comparing the area-under-the-FROC-curve (AUFROC) between 0.1 and 2.5 false-positives per patient. Explainable AI was used to create saliency maps, ranking the importance assigned by the model to information in the sequential MRI input. Differences in AUROC and AUFROC were evaluated using DeLong's and bootstrap tests, respectively.

#### RESULTS

The sequential model outperformed the single-scan baseline at lesion-level (AUFROC: 1.45 [1.29–1.61] vs 1.56 [CI 1.40–1.72],  $p < 0.05$ ) and patient-level (AUROC: 72.9% [CI 68.7–77.2%] vs 75.7% [CI 71.6–79.9%],  $p = 0.008$ ). Including differential clinical parameters further improved patient-level performance to 76.1% AUROC (CI 71.6–80.6%). Saliency maps showed significantly higher importance for temporal high b-value sequences, compared to T2W and ADC ( $p < 0.0001$ ).

#### CONCLUSION

Our proposed end-to-end deep learning model can accurately detect progression to csPCa using sequential MRI.

#### CLINICAL RELEVANCE/APPLICATION

Active surveillance is crucial in prostate MRI, and an accurate artificial intelligence tool for detecting progression to clinically significant disease may help to prevent unnecessary biopsies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIR-2

### **GNMT and MMP12 Expression Determines Transarterial Chemoembolization in Hepatocellular Carcinoma**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Tianhao Cong (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Transarterial chemoembolization (TACE) is a first-line treatment for patients with intermediate hepatocellular carcinoma (HCC). It is crucial to accurately identify patients who are effective for TACE and explore their related mechanisms. Our purpose is to determine the key molecular characteristics and related pathways that affect TACE efficacy.

#### **METHODS AND MATERIALS**

Based on microarray datasets and high-throughput sequencing dataset, a TACE-effectiveness model was constructed using logistic regression. Based on external data validation, its accuracy was verified by Kaplan-Meier survival analysis, Principal Component Analysis (PCA), and immunohistochemistry was used to verify the expression level of signature genes. Kyoto Encyclopedia of Genes and Genomes (KEGG) analysis and Cibersort x were used to investigate related mechanisms.

#### **RESULTS**

Three independent cohorts were used, among which GSE104580 was randomly divided into a training set and a validation set at a ratio of 6:4. TACE-effectiveness model was constructed including GNMT and MMP12 through the training set. Our model can effectively distinguish TACE efficient and inefficient patients in the validation set and GSE14520. The OS and DFS of TACE efficient patients were significantly higher than those of TACE inefficient patients. Immunohistochemistry results showed that GNMT was highly expressed in TACE efficient patients, while MMP12 was lowly expressed in TACE efficient patients ( $p < 0.05$ ). MMP12 and GNMT may determine the TACE effectiveness by affecting the metabolic pathway and HIF-1 $\alpha$  signaling pathway.

#### **CONCLUSION**

Our research provides a model that can accurately evaluate the effectiveness of TACE, and MMP12 and GNMT may determine the TACE effectiveness by affecting the metabolic pathway and HIF-1 $\alpha$  signaling pathway.

#### **CLINICAL RELEVANCE/APPLICATION**

Our study provides a basis for individualized accurate medical care for patients with HCC, and provides a novel idea and direction for exploring the mechanism of TACE.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIR-4

### **Efficacy, Mechanism & Safety of Melatonin-loaded on Thermosensitive Nanogels for Rabbit VX2 Tumor Embolization: A Novel Design**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Lei Chen (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the efficacy, mechanism and safety of melatonin loaded on p(N-isopropyl-acrylamide-co-butyl methylacrylate) (PIB-M) in the treatment of rabbit VX2 tumors.

#### **METHODS AND MATERIALS**

In this study, PIB-M was used for tumor embolism. Two types of human hepatoma cell lines (HepG2 and LM3 cells) were used to explore the mechanism by which melatonin prevents the growth and metastasis of cancer cells in vitro. High-performance liquid chromatography was used for pharmacokinetic analysis. A VX2 rabbit tumor model was used to evaluate the efficacy, mechanism and safety of PIB-M in vivo.

#### **RESULTS**

We found that under hypoxic condition, melatonin could inhibit tumor cell proliferation and migration by targeting hypoxia inducible factor-1a (HIF-1a) and vascular endothelial growth factor A (VEGF-A) in vitro. The results of pharmacokinetics in vivo showed that a high concentration of melatonin in the PIB-M group could be maintained in tumor tissue for 72 hours after embolization. In vivo, PIB-M inhibited tumor growth and metastasis in rabbit VX2 tumors by targeting related angiogenic proteins and vascular permeability proteins. The liver and kidney functions were most damaged on the first day but recovered to normal on the seventh day after embolization in the PIB-M group.

#### **CONCLUSION**

PIB-M can effectively inhibit the growth and metastasis of tumor after treatment, and it is safe. This novel method may open avenues for reduced tumor growth and metastasis after embolism, which may be used for treatment for other solid tumors and clinical translation.

#### **CLINICAL RELEVANCE/APPLICATION**

The conclusion of this study may provide a theoretical basis for the use of melatonin in interventional therapy for liver cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIR-5

### Impact of Acute Kidney Injury After Radiofrequency Ablation for Patients with T1a Renal Cell Carcinoma

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hang Jun Cho, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the association between acute kidney injury (AKI) and renal function 1 year after RFA, and whether this relationship is affected by the duration of AKI.

#### **METHODS AND MATERIALS**

We analyzed the data of 393 patients treated by RFA for a single T1aN0M0 renal cell carcinoma. Three outcomes of interest have been defined as follows: (1) recovery of at least 90% of baseline function 1 year after RFA, (2) percentage change of 1 year renal function compared with baseline function, and (3) chronic kidney disease upstaging. AKI was defined according to the RIFLE criteria. The association between AKI and each endpoint of interest was investigated using a regression model after adjusting for common predictors of renal function.

#### **RESULTS**

Total 58 patients (14%) experienced AKI after RFA. The rate of patients recovering 90% of baseline function was lower in the AKI group (20% vs. 51%), while the proportion of patients who had CKD upstaging was significantly higher (40% vs 19%;  $P < 0.0001$ ). At multivariable analysis, AKI was associated with worse renal function 1 year after RFA, regardless of the outcome of interest (all  $p < 0.0001$ ). Longer AKI increases the risk of functional deterioration, especially after the 3rd day of injury. The risk of CKD upstaging for an average patient who had 1-3 versus = 4th day of AKI was 26% (95% CI: 20-32%) versus 67% (95% CI: 45-68%; absolute risk increase of 11%; 95% CI: 7-22%).

#### **CONCLUSION**

AKI negatively affects long-term functional recovery after RFA.

#### **CLINICAL RELEVANCE/APPLICATION**

Monitoring of renal function after RFA for RCC is important for patient management. Through this study, it can be helpful for patient management by identifying the correlation between AKI and changes in renal function after RFA for RCC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPIR-6

### Impact of Clinical Evident Portal Hypertension on Hepatocellular Carcinoma with Transarterial Chemoembolization (CHANCE-CHESS 2301): A Multicenter Cohort Study

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of clinically evident portal hypertension (CEPH) on the prognosis of hepatocellular carcinoma (HCC) patients treated with transarterial chemoembolization (TACE).

#### METHODS AND MATERIALS

A total of 1614 consecutive HCC patients treated with TACE were retrospectively collected from 10 tertiary centers between June 2006 and December 2019. CEPH was defined when at least one following factor was present: 1) esophageal/gastric varices on upper endoscopy or CT imaging, 2) ascites requiring diuretic treatment, 3) splenomegaly (largest diameter on CT >12 cm) with a low platelet count (<100,000/mm<sup>3</sup>). Overall survival (OS) as the study endpoint was analyzed by Kaplan-Meier and Cox regression. Propensity score matching analysis was used to match patients for predetermined prognostic factors. During the following up, portal hypertension-related adverse events were described.

#### RESULTS

Among 1614 patients, 504 (31.2%) were affected by CEPH. Most patients were male (1339, 83.0%) with predominantly etiology of HBV (1167, 72.3%). Before matching, the median OS in CEPH group was 24.5 months (95% confidence interval [CI]: 21.7-28.8) versus 27.3 months (95%CI: 24.9-31.4) (adjusted hazard ratio [HR], 1.22, p = 0.011). After matching, 413 pairs were included. The median OS was also significantly lower in CEPH group (23.4 months [95%CI: 21.6-28.8] vs. 31.7 months [95%CI: 28.0-39.3]; adjusted HR, 1.24, p = 0.022). Subgroup analysis showed that CEPH group had a trend that persisted on lower OS compared to non-CEPH group. Patients with =2 CEPH factors had a significantly worse prognosis than patients with 0 or 1 CEPH factor (p < 0.001). Among them, 25.2%, 5.8%, and 5% of patients developed ascites progression/occurrence, hepatic encephalopathy, and esophageal/gastric variceal bleeding, respectively.

#### CONCLUSION

The presence of CEPH, especially  $\geq 2$  CEPH risk factors, was significantly associated with poor outcomes and should be taken into consideration when managing HCC patients who underwent TACE.

#### CLINICAL RELEVANCE/APPLICATION

The large-sample, real-world study highlights the importance of portal hypertension management by identifying morbidity rate and prognostic impact on clinical decision-making and trial design in HCC patients treated with TACE.

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## Abstract Archives of the RSNA, 2023

R2-SPMK-1

### Assessing the Efficacy of Radiofrequency Ablation and Kyphoplasty for Alleviating Painful Spine Metastases: A Study Using VAS Pain Scale

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Chloe Issa, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the efficacy of pain improvement of radiofrequency ablation (RFA) in conjunction with kyphoplasty in treatment of patients with painful metastatic neoplastic disease to the spine.

#### METHODS AND MATERIALS

Between 3/2019 and 8/2022, a total of 59 kyphoplasty/RFA procedures were performed. The median age of the cohort was 65 years old (range, 41-86) with male-to-female ratio of 0.97. The primary neoplastic disease was as follows: multiple myeloma (n=17, 28.8%), breast cancer (n=15, 25.4%), lung cancer (n=7, 11.9%), prostate cancer (n= 6, 10.2%), lymphoma and colorectal cancer (each n= 3, 5.1%), urothelial carcinoma (n= 2, 3.4%), thyroid cancer, pancreas adenocarcinoma, renal cell carcinoma, and metastatic adenoid cystic carcinoma (each n=1, 3.3%). Pain relief was evaluated by the visual analogue scale (VAS) score before and within 3-months after the procedure. The highest documented VAS pre- and post-procedure was recorded. A P value < 0.05 was considered statistically significant.

#### RESULTS

Technical success was achieved in all patients. The median follow-up was 15 days (IQR, 14-52.5) after the procedure. The median VAS score decreased from 10 (IQR, 8-10) to 2 (IQR, 2-3) within 3 months after procedure ( $p < 0.001$ ). There were no major complications.

#### CONCLUSION

RFA in conjunction with kyphoplasty is safe and provides meaningful clinical improvement in VAS pain scores when measured within 3 months of the procedure.

#### CLINICAL RELEVANCE/APPLICATION

MSK Interventional Radiology - Palliative Spine Intervention

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPMK-3

### Preoperative Imaging Features of Bone Cement Leakage After Percutaneous Vertebroplasty in Kummell's Disease

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hui Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the preoperative imaging features of bone cement leakage after percutaneous vertebroplasty for Kummell's disease.

#### METHODS AND MATERIALS

The clinical, imaging, treatment and follow-up data of patients with Kummell's disease vertebral compression fracture and percutaneous bone cement filled vertebroplasty from January 2016 to January 2022 were analyzed retrospectively. According to whether there was bone cement leakage in postoperative follow-up, they were divided into two groups. The continuous variable data were compared by independent sample t-test or Mann-Whitney U nonparametric rank sum test, and the classified variable data were compared by chi square or Fisher exact chi square; Finally, binary logistic regression was used to explore the independent risk factors of bone cement leakage.

#### RESULTS

A total of 67 cases were included (mean age  $69.63 \pm 9.11$  years, 13 males and 54 females). The injured vertebrae of Kummell's disease were mainly in the thoracolumbar (T5, T6, T7 and T10 were all 1, T8:3, T11:8, T12:19, L1:16, L2:12, L3:1 and L4:4). 38 cases (57%) of bone cement leakage occurred within one month after follow-up, including 24 cases (63%) of intervertebral disc leakage, 11 cases (29%) of soft tissue leakage, 1 case (2.6%) of intravascular leakage, 1 case of intraspinal leakage and 1 case (2.6%) of mixed leakage. The following signs were statistically different between the leakage group and the non leakage group: the degree of X-ray vertebral compression ( $\chi^2=6.278, P=0.043$ ), CT Intravertebral Vacuum Clefts ( $\chi^2=4.899, P=0.025$ ), vertebral cortical discontinuity ( $\chi^2=4.540, P=0.030$ ). Binary logistic regression showed that CT Intravertebral Vacuum Clefts was an independent predictor of bone cement leakage (Odds ratio, OR=3.069, P=0.029).

#### CONCLUSION

The Intravertebral Vacuum Clefts is related to the leakage of bone cement after percutaneous vertebroplasty, which can be used to guide the choice of treatment before operation.

#### CLINICAL RELEVANCE/APPLICATION

The Intravertebral Vacuum Clefts is related to the leakage of bone cement after percutaneous vertebroplasty, which can be used to guide the choice of treatment before operation. The Intravertebral Vacuum Clefts is the preoperative imaging features of bone cement leakage after percutaneous vertebroplasty for Kummell's disease.

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## Abstract Archives of the RSNA, 2023

R2-SPMK-4

### Trabecular Bone Score as an Assessment Tool to Identify the Risk of Vertebral Fractures in SAPHO Syndrome

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Zaizhu Zhang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the clinical utility of TBS evaluation for vertebral fracture (VF) risk assessment in SAPHO patients compared with BMD assessment.

#### METHODS AND MATERIALS

Seventy SAPHO patients [mean age 50.1 (10.7) years, 81% women] were enrolled in this cross-sectional study. TBS and BMD were assessed using dual-energy X-ray absorptiometry. VF of spine were evaluated using whole-spine CT. We compared BMD and TBS results regarding to the presence/absence of VF.

#### RESULTS

Patients with VF had significantly lower BMD, T-score and Z-score of lumbar spine (LS) and TBS values and more frequently presented median-high fracture risk in TBS and abnormal BMD at the three evaluated sites than without. Univariate logistic regression analyses identified lower TBS value ( $<1.23$ ), abnormal BMD of the LS, femoral neck (FN) and total hip (TH) were associated with VF [odds ratio (95% CI): 22.9 (6.1, 85.7), 7.6 (2.4, 23.5), 7.6 (2.4, 23.5), and 10.1 (3.0, 33.8), respectively]. For predicting VF in SAPHO patients. TBS showed the greatest AUC in the ROC curve, with a value of 0.920 compared with 0.777, 0.690 and 0.652 for LS, FN and TH BMD, respectively.

#### CONCLUSION

TBS has a better discriminatory value than BMD for prediction of VF in SAPHO patients.

#### CLINICAL RELEVANCE/APPLICATION

TBS may, therefore, be a useful clinical tool to identify the risk of VF in SAPHO patients.

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## Abstract Archives of the RSNA, 2023

R2-SPMK-5

### Deep Learning Reconstructed T2-weighted Dixon Imaging of the Spine: Impact on Acquisition Time and Image Quality

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Zeynep Berkarda, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the image quality and impact on acquisition time of a novel deep learning based T2 Dixon sequence (T2DL) of the spine.

#### METHODS AND MATERIALS

This prospective, single center study included n=44 consecutive patients with a clinical indication for lumbar MRI at our university radiology department between September 2022 and March 2023. MRI examinations were performed on 1.5-T and 3-T scanners using dedicated spine coils (MAGNETOM Aera and Vida; Siemens Healthcare, Erlangen, Germany). The MR study protocol consisted of our standard clinical protocol, including a T2 standard Dixon sequence (T2std) and the additional T2DL. T2DL acquisition used a conventional sampling pattern with a higher parallel acceleration factor. The individual contrasts acquired for Dixon water-fat separation were then reconstructed using a dedicated research application. After reconstruction of the contrast images from k-space data, a conventional water-fat separation was performed to provide derived water images. Two readers with 6 and 4 years of experience in interpreting MSK imaging, respectively, analyzed the images in a randomized fashion. Overall image quality (OIQ), banding artifacts, artifacts, sharpness, noise, and diagnostic confidence were analyzed using a 5-point Likert scale (from 1 = non-diagnostic to 5 = excellent image quality).

#### RESULTS

Forty-four patients (median age 61.5 years, [IQR: 35.3,67.5], male sex: 39%) were prospectively included. 31 examinations were performed on 1.5-T and 13 examinations on 3-T-scanners. A sequence was successfully acquired in all patients. The total acquisition time of T2DL was 93 seconds at 1.5-T and 86 seconds at 3-T, compared to 235 seconds, and 257 seconds, respectively for T2std (reduction of acquisition time: 60.4% at 1.5-T, and 66.5% at 3-T;  $p < 0.01$ ). OIQ was rated equal for both sequences (mean T2DL  $4.66 \pm 0.61$ , and T2std  $4.61 \pm 0.72$ ;  $p = 0.59$ ). T2DL showed reduced noise levels compared to T2std ( $4.93 \pm 0.26$  versus  $3.84 \pm 0.37$ ;  $p < 0.01$ ). In addition, sharpness was rated to be higher in T2DL ( $4.84 \pm 0.37$  versus  $3.95 \pm 0.53$ ;  $p = 0.01$ ). Although T2DL displayed significantly more banding artifacts ( $4.25 \pm 0.92$  versus  $4.91 \pm 0.29$ ;  $p < 0.01$ ), no impact on readers diagnostic confidence between sequences was noted (T2std:  $4.7 \pm 0.63$ , and T2DL:  $4.8 \pm 0.48$ ;  $p = 0.61$ ). Inter-reader agreement ranged from fair (? for noise: 0.3) to substantial (? for OIQ: 0.8).

#### CONCLUSION

T<sub>2DL</sub> is feasible with image quality comparable to the reference standard while substantially reducing the acquisition time.

#### CLINICAL RELEVANCE/APPLICATION

T2DL may replace standard imaging, while significantly reducing time and cost in MRI of the spine. Further interchangeability analyses seem reasonable to assess the diagnostic performance of the new sequence.

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## Abstract Archives of the RSNA, 2023

R2-SPMK-6

### Diagnostic Delay in Patients with Osteoid Osteoma

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Florian T. Gassert, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the diagnostic delay in patients with osteoid osteoma and to analyze influencing factors.

#### METHODS AND MATERIALS

All patients treated for osteoid osteoma at our tertiary referral center between December 1997 and February 2021 were retrospectively identified (n=302). The diagnosis was verified by an expert panel of radiologists and orthopedic surgeons. Exclusion criteria were post-interventional recurrence, missing data on symptom onset, and if no pretherapeutic CT images were available. Clinical parameters were retrieved from the local clinical information system. CT and MR images were assessed by a senior specialist in musculoskeletal radiology.

#### RESULTS

After all exclusions, we studied 162 patients (mean age,  $24 \pm 11$  years, 115 men). The average diagnostic delay was  $419 \pm 485$  days (median: 275 days; range: 21 - 4503 days). Gender, patient age, presence of nocturnal pain, positive Aspirin test, extent of bone sclerosis, and location of the tumor within bone and relative to joints did not influence diagnostic delay ( $p > .05$ ). It was, however, positively correlated with nidus size ( $r = 0.26$ ;  $p < .001$ ), and shorter with affection of long tubular bones compared to all other sites ( $p = .04$ ). If osteoid osteoma was included in the initial differential diagnoses, diagnostic delay was also shorter ( $p = .007$ ).

#### CONCLUSION

The diagnostic delay in patients with osteoid osteoma is independent from demographics, clinical parameters and most imaging parameters.

#### CLINICAL RELEVANCE/APPLICATION

A long average delay of more than one year suggests low awareness of the disease among physicians. Patients with unclear imaging findings should thus be referred to a specialized musculoskeletal center or an expert in the field should be consulted timely.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPMK-7

### **Differentiation of Bone Metastases from Benign Red Marrow Depositions: Concerns of Conventional MR Imaging**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Jisu Lim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To differentiate bone metastases (BMs) from benign red marrow depositions (BRMs) by qualitative and quantitative analyses of T1-weighted imaging (T1w) and fat-suppressed T2-weighted imaging (T2 FS) and to compare the diagnostic performance of normal muscle and normal bone marrow as internal standards on T2 FS in differentiating BMs and BRMs

#### **METHODS AND MATERIALS**

Seventy-five lesions, including 38 BMs and 37 BRMs, were assessed with T1w and T2 FS. Two radiologists independently evaluated MR images by qualitative (signal intensity [SI] of lesions compared to that of normal muscle [NM] or normal bone marrow [NBM]) and quantitative (parameters of the ROIs in the lesions, including T1 ratio [ratio of T1 SI of lesion to that of NM], T2FMu ratio [ratio of T2 FS SI of lesion to that of NM], and T2FMa ratio [ratio of T2 FS SI of lesion to that of NBM]) analyses. Qualitative and quantitative characteristics of BMs and BRMs were compared. To evaluate the diagnostic utilities of quantitative parameters, ROC curves were analyzed.

#### **RESULTS**

Hyperintensity relative to NM or NBM on T2 FS was more frequent in BMs than in BRMs (100% vs 59.5%~78.4%, respectively;  $p=0.001$ ) but also was present in more than half of BRMs. All quantitative parameters showed a significant difference between BMs and BRMs (T1 ratio, 1.075 vs. 1.227 [ $p=0.002$ ]; T2FMu ratio, 2.094 vs. 1.282 [ $p<0.001$ ]; T2FMa ratio, 3.232 vs. 1.810 [ $p<0.001$ ]). The ROC AUCs of T2FMu and T2FMa ratios were clinically useful (0.781 and 0.841, respectively) and didn't demonstrate statistically significant differences.

#### **CONCLUSION**

The quantitative analysis of T2 FS can be useful in differentiating BMs from BRMs, regardless of whether the reference was NM or NBM.

#### **CLINICAL RELEVANCE/APPLICATION**

Quantitative analysis of conventional T2 FS without additional scanning could be used to differentiate bone metastases from benign red marrow depositions, regardless of whether the comparison reference was normal muscle or normal bone marrow.

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## Abstract Archives of the RSNA, 2023

R2-SPMK-8

### Can Material Density Imaging Improve Detection of Healthy-appearing Bone Metastases at Contrast-enhanced Dual-energy CT?

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hitoshi Takeuchi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Because CT is an imaging modality of choice for oncologic assessment but not sufficiently sensitive to detect bone metastases, sensitive detection of bone metastases by material density imaging is expected at body contrast-enhanced dual-energy CT (ceDECT). We assessed usefulness of water/hydroxyapatite (W/H-DI) and iodine/water density imaging (I/W-DI) to improve detection of healthy-appearing bone metastases at body ceDECT.

#### METHODS AND MATERIALS

From September 2022 through March 2023, two experienced radiologists by consensus included 41 bone metastases that appeared healthy without definite sclerotic/lytic changes or mass formation on virtual monochromatic imaging (VMI) at 70 keV but were diagnosed by MRI, bone scintigraphy/SPECT, and/or FDG-PET/CT from four patients who underwent body ceDECT during the venous phase using a 256-detector DECT scanner (Revolution CT, GE). We reconstructed VMI at 70 keV, W/H-DI, and I/W-DI of slice thickness of 1.25 mm with a deep-learning reconstruction algorithm (TrueFidelity, GE) to place regions of interest within each healthy-appearing bone metastasis and its corresponding non-metastatic area with anatomical symmetry (for a vertebral metastasis, a non-metastatic area in only a little more cranial/caudal vertebra) as reference to measure mean CT value, W/H density, and I/W density, respectively. Paired t test was used to compare the mean CT value, W/H density, and I/W density between the healthy-appearing bone metastases and the reference areas. Receiver operating characteristic (ROC) analysis was adopted to assess diagnostic performance of these parameters to detect healthy-appearing bone metastases.

#### RESULTS

W/H density was significantly higher ( $985.3 \pm 10.9$  mg/mL vs.  $962.9 \pm 10.6$  mg/mL;  $P < 0.001$ ) and I/W density was significantly lower in the metastases than in the reference areas ( $3.4 \pm 1.4$  mg/mL vs.  $3.8 \pm 1.3$  mg/mL;  $P < 0.001$ ), whereas CT value at 70 keV was comparable ( $151.3 \pm 62.8$  HU vs.  $149.1 \pm 60.7$  HU;  $P = 0.429$ ). Area under the ROC curve improved from CT value at 70 keV (0.513) to I/W density (0.595) to W/H density (0.951).

#### CONCLUSION

Material density imaging, particularly W/H-DI, can improve detection of healthy-appearing bone metastases at body ceDECT.

#### CLINICAL RELEVANCE/APPLICATION

As a comprehensive oncologic study, ceDECT with improved detectability of bone metastases by W/H-DI can reduce radiation exposure and/or medical cost and improve patient management by omitting unnecessary further examinations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNMMI-1

### Functional Imaging Metrics in Patients with Metastatic Paraganglioma/pheochromocytoma Treated with Lu-177-dotatate: A Single-center Experience

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Ridvan A. Demirci, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Paragangliomas and pheochromocytomas are rare neuroendocrine tumors for which there is no standard of care for patients that develop metastatic disease. Radioligand therapy in neuroendocrine tumors shows promising results in disease control with minimal adverse events. This study describes our observations of changes in functional imaging metrics relative to time to progression (TTP) with Lu-177-dotatate treatment in patients with metastatic paraganglioma/pheochromocytoma (mPara/Pheo).

#### METHODS AND MATERIALS

Of nine patients with mPara/Pheo treated with four cycles of Lu-177-dotatate, eight patients had both pre-and post-treatment dotatate PET and were included in the image analysis. Total tumor volume (mL, TV) was determined by thresholding all tumor sites with uptake above blood pool activity measured from the left ventricle. SUVmean of the TV and ratio of SUVmean TV to liver (SUVmean T:L ratio) were also measured, and changes between these parameters on pre and post imaging were calculated. Progression was defined as presence of new lesions on post-treatment dotatate PET or by RECIST in those with RECIST measurable disease. TTP was calculated from the date of the 1st cycle.

#### RESULTS

Median age in the cohort was 52 [range 33 to 83], 4 female, with 0 - 1 lines of prior therapy. Median TTP for all patients was 19 [range 4 to 26]. Patients were then divided into two groups, those with progressive disease (N=2, PD) and those with stable disease or partial response (N=6, SD), on initial re-staging scans after the 4th cycle. Median values of TTP were 5 months [range 4 to 6] and 20.5 months [range 13 to 26], respectively. In the two patients in the PD group, TV increased by 103% and 235% from the pre-treatment scan and SUVmean T:L ratio decreased by 8% and 35%. Median change in TV in the SD group was -7.5% [range -43% to +25%]. Two had increased TV, and the remaining four had decreased TV in their post-treatment scans compared to pre-treatment scans. Median SUVmean T:L ratio change was -14.5% [range -52% to +53%].

#### CONCLUSION

Functional imaging metrics, particularly tumor volume, may have predictive power for clinical outcomes in metastatic paraganglioma/pheochromocytoma. Further studies with a larger patient population and correlation with other clinical and biochemical parameters are needed to confirm these results.

#### CLINICAL RELEVANCE/APPLICATION

Functional imaging metrics may serve as an independent biomarker of response in patients with metastatic paraganglioma/pheochromocytoma.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNMMI-2

### The Usefulness of FDG-PET Indexes Including Heterogeneity Parameters in the Prediction of Initial Chemo-radiotherapeutic Effect in Oropharyngeal Cancer

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Shigeki Nagamachi, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

FDG-PET parameters were useful for prediction for the treatment response in various tumors. However, few reports have been analyzed regarding predictivity of FDG-PET indexes particularly heterogeneity indexes for the initial treatment response to chemoradiotherapy in oropharyngeal cancers. The study was done to analyze the predictive capability of various FDG-PET indexes, including heterogeneity parameters such as Entropy, Kurtosis and Skewness for the initial treatment response to chemoradiotherapy.

#### METHODS AND MATERIALS

Sixty-six patients with oropharyngeal cancer were analyzed. Forty patients showed CMR after the initial chemo-radiotherapy. Average age was 63.4, the gender ratio was male 51 and female 15. The case number of each stage were 12 in stage II, 39 in stage III and 15 in stage IV respectively. After the initial therapy, complete remission (CMR) was 48 and partial remission (PMR) was 18 cases based on PERCIST criteria using FDG-PET. The group comparison was done between CMR and PMR group regarding SUVmax, SUVpeak, metabolic tumor volume (MTV) and total lesion glycolysis (TLG). In addition, the values of heterogeneity indexes such as Entropy, Kurtosis and Skewness were also compared. Then under the best cut-off level, the value of positive predictive values (PPV) for CMR were compared among these parameters.

#### RESULTS

Both MTV and TLG values showed significantly lower values in CMR group compared with those in PMR group (9.1 vs. 18.7ml, and 71.9 vs. 157.5g). Other parameters did not show any statistical significance. In the cases with lower TLG (<70g) at baseline, the rate of CMR cases was 100%. Similarly, the cases with lower MTV (<10ml) at base line showed CMR response in 90%. The value of PPV (%) in CMR to the chemo-radiotherapy under the best cut-off values were 100% in TLG, 90% in MTV, 85.7% in SUVmax, 80% in SUVpeak, 69.2% in Entropy, 76.9% in Kurtosis, and 63.6% in Skewness.

#### CONCLUSION

In the prediction of therapeutic response for oropharyngeal cancer, both TLG and MTV were excellent parameters. Among, heterogeneity indexes, Kurtosis seemed to be promising parameter for predicting chemo-radio therapeutic response.

#### CLINICAL RELEVANCE/APPLICATION

In the prediction of chemoradiotherapy for oropharyngeal cancer, the heterogenetic index in particular kurtosis preferably checked in addition to TLG and MTV.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPNPM-1

### Prevalence and Impact of Workplace Sexual Harassment Among Medical Sonographers in the United States

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Sue Y. Yi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the prevalence and impact of workplace sexual harassment experienced by sonographers in the USA with a national survey including both quantitative and qualitative data.

#### METHODS AND MATERIALS

A survey was adapted from multiple existing well validated instruments and distributed anonymously to a convenience sample of medical sonographers via email contacts and sonographer-specific social media pages. Survey data were analyzed to determine respondent demographics, the prevalence of sexual harassment in the last two years, the type and severity of harassment experienced, demographics of perpetrators, personal and institutional responses to such experiences, and the impact of sexual harassment on sonographer physical and mental health and job satisfaction.

#### RESULTS

220 sonographers (82.7% female) participated in the survey. The majority (45%) were aged between 18 and 34 years, and 81% identified as white. The majority (87%) reported experiencing at least one incident of harassment within the last two years. Female respondents experienced higher harassment rates (76%) compared to male respondents (50%,  $p=0.02$ ). The most common forms of harassment were verbal, including suggestive or sexist jokes (69%) and offensive sexist remarks (61%). Perpetrators were predominantly male (78%) and most commonly patients (89%) or their friends/family members (46%). The majority of respondents either ignored the harassing behavior (70%) or treated it like a joke (50%), with only a minority (12%) officially reporting incidents. Of those who reported, 44% were unsatisfied with their institution's response. Among respondents, 34% reported negative impacts of workplace sexual harassment, such as anxiety, depression, sleep loss, or adverse workplace consequences.

#### CONCLUSION

Sexual harassment experienced by sonographers in the workplace is commonplace, and often leads to negative health and career outcomes. Female sonographers are significantly more likely to experience harassment compared to male sonographers, and in a profession where 90% of sonographers are female, it is critical to find systemic methods to prevent harassment behavior and support victims of sexual harassment in the workplace.

#### CLINICAL RELEVANCE/APPLICATION

Sexual harassment is prevalent among sonographers, harming their physical and mental health. Strong institutional policies are critical to curb harassment and lessen its impact.

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## Abstract Archives of the RSNA, 2023

R2-SPNPM-2

### The Shift From Hospital Based Imaging To The Office Setting: A Medicare Analysis from 2013 to 2020

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate trends in productivity for diagnostic radiologists serving the Medicare population, by practice setting.

#### METHODS AND MATERIALS

All imaging interpretation claims from 2013 to 2020 were extracted from the CMS POSPUF Database for Medicare Part B, a national social insurance program providing health insurance for outpatient services for Americans over 65 yrs and disabled. Claims data were merged with CMS data files to determine the year specific total professional component (wRVU) value for each procedure. These values were aggregated for each individual radiologist and stratified by "Place of Service." "Place of service" has two possible values: "Facility" includes hospital affiliated sites, emergency room, or ambulatory surgery center, while "Non-facility" includes private offices and urgent care facilities. Market share of services was defined as the proportion of wRVUs from a given setting divided by wRVUs performed in both settings. Claims were assigned to a US Census region.

#### RESULTS

In 2013, there were 52,179,386 total imaging wRVUs, 63,276,990 (+21.3%) in 2019, and 53,907,670 (-14.8%) in 2020. Facility (hospital) settings accounted for 42,607,520 wRVUs in 2013, 48,578,010 (+14.0%) in 2019, and 40,957,510 (-15.7%) in 2020. Facility market was 81.7% in 2013, 76.8% in 2019, and 76.0% in 2020. Non-facility (office) services accounted for 9,571,866 wRVUs in 2013, 14,698,980 in 2019 (+53.6%), and 12,950,160 (-11.9%). Non-facility market share was 18.3% in 2013, 23.2% in 2019, and 24.0% in 2020. By US region, 2020 total outpatient imaging wRVUs and CAGRs were: South 4,928,295 (+28.1% from 2013), Northeast 3,228,274 (+44.2%), West 2,791,136 (+31.9%), and Midwest 2,002,454 (+46.1%). 2020 wRVU market share of non-facility services by US region was: Northeast 30.5% (+8.7% from 2013), West 29.1% (+3.4%), South 23.6% (+5.5%), and Midwest 15.5% (+4.5%).

#### CONCLUSION

In the Medicare population, the rate of growth of office based imaging wRVUs outpaced growth of hospital settings by 39.4% from 2013 to 2020. Office market share grew by 5.7% nationally, and by 3.4% - 8.7% across US regions. These findings document a shift toward office settings, which are often less subject to peer review, validation, or regulation than are hospital settings. This shift follows several legislative, regulatory and payer efforts to steer patients toward lower cost settings. Further research is advised to ensure appropriate imaging utilization and consistent high quality patient care is provided in non-facility settings.

#### CLINICAL RELEVANCE/APPLICATION

Outpatient imaging services for the US Medicare population have shifted from hospital based to office settings, which are often less expensive, yet also less regulated.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNPM-3

### **The ACR Learning Network Mammography Positioning Improvement Collaborative: Facilitating Local Performance Improvement through Shared Learning**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Sarah M. Pittman, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish and maintain consistent excellent performance in mammography positioning at multiple sites simultaneously by utilizing a structured quality improvement (QI) program within a learning network framework that enables participating sites to develop and implement locally-successful strategies while sharing with and learning from other sites.

#### **METHODS AND MATERIALS**

The Mammography Positioning Improvement Collaborative is led by a physician leader and administrative leader, supported by learning facilitators and an advisory committee comprised of national experts and thought leaders. Sites enter the collaborative by first participating in a structured QI training and project execution program. Sites were selected on the basis of strength of local leadership support, intra-organizational relationships, access to data and analytic support, and experience with QI initiatives. During the QI program, participating sites went through a process of organizing their teams, developing goals, gathering data, evaluating their current state, understanding root causes of problems, and developing and testing solutions. A common process map and an image quality scoring system were established. The impact of the interventions implemented at each site was assessed by tracking the percentage of screening mammograms meeting overall passing criteria over time.

#### **RESULTS**

Six organizations were selected to participate in the first cohort of the collaborative, beginning with participation in the QI program. Run charts from the six sites show that interventions developed and implemented at each site during the program resulted in improvement in the percentage of screening mammograms meeting overall passing criteria, with five of six sites meeting or exceeding the target mean performance of 85% by the end of the QI program. Anticipated variability in progress is observed between sites.

#### **CONCLUSION**

Using a structured QI program within a learning network framework, five of six sites participating in the first cohort of the Mammography Positioning Improvement Collaborative increased the percentage of screening mammograms meeting overall passing criteria from a collaborative mean of 59% to greater than 85%.

#### **CLINICAL RELEVANCE/APPLICATION**

Suboptimal mammography positioning can lead to undetected breast cancer on mammograms. A structured QI program within a learning network framework can facilitate improvement in mammography positioning at multiple sites simultaneously.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-1

### White Matter Lesion Asymmetry: An Indicator of Amyloid PET Positivity in Mild Cognitive Impairment Patients

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hye Weon Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assessing amyloid-positivity in mild cognitive impairment (MCI) patients is crucial as it may indicate a higher risk of developing dementia. This study aims to investigate whether the asymmetry of white matter lesions (WML) on T2-fluid attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI), assessed through artificial intelligence (AI) based hyperintensity segmentation, could potentially serve as an indicator for amyloid positron emission tomography (PET) positivity in patients with MCI.

#### METHODS AND MATERIALS

In this retrospective cohort study, MCI patients who visited a clinical site in South Korea were enrolled. The participants underwent a comprehensive evaluation, including clinical and neuropsychological assessments, brain MRI, and [18F]-Flutemetamol amyloid PET. Our study utilized in-house AI based software for segmenting and separating WML into left and right hemispheres. Using the processed segmentation, we measured individual WML differences through volumetric assessment.

#### RESULTS

A total of 122 subjects were enrolled in the study, with 53 in the amyloid-negative group and 69 in the amyloid-positive group based on amyloid-PET positivity. The two groups were comparable, with no significant differences in age ( $p=0.189$ ), sex ( $p=0.057$ ), education years ( $p=0.411$ ), and MMSE scores ( $p=0.861$ ). However, the amyloid-positive group showed a significantly higher frequency of having an e4 allele of APOE genotype ( $p=0.033$ ) and Clinical Dementia Rating scale ( $p=0.024$ ). The average WML volume differences between hemispheres were significant in the amyloid-negative group ( $p=0.02$ ) but not in the amyloid-positive group ( $p=0.2$ ). Both groups had a larger WML volume in the right hemisphere, which did not differ significantly between the groups.

#### CONCLUSION

Our study results indicate that it is crucial to evaluate the asymmetry of WML rather than the total hyperintensity lesion load in MCI patients, especially in those without amyloid pathology. Therefore, WML asymmetry could be a potential indicator of amyloid positivity in MCI patients.

#### CLINICAL RELEVANCE/APPLICATION

The WML asymmetry could be utilized as an indicator for amyloid PET positivity in MCI patients.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-10

### Impact of an AI Software on the Diagnostic Performance of Radiologists for the Detection of Cerebral Aneurysms on Time of Flight MR-Angiography

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Nils C. Lehnen, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of an AI based software trained to detect cerebral aneurysms on Time-of-Flight MR-Angiographies on the diagnostic performance and reading times of multiple readers with different amounts of experience in diagnostic neuroimaging.

#### METHODS AND MATERIALS

A dataset of 186 MRI studies was evaluated by the different readers for the presence and localization of cerebral aneurysms. First, the reading was done with the support of an AI based software. After a washout period of six weeks, the reading was repeated without the support of the AI software. To document the findings and to measure the reading times, a standardized report was used. The results were compared to the consensus reading of two neuroradiological specialists as a reference standard and sensitivity on patient level and lesion level, specificity on patient level, and false positives per case were calculated.

#### RESULTS

According to the reference standard, there were 54 aneurysms present in the dataset. Six readers took part in the reading with no experience (three medical students), two years experience (resident in neuroradiology), six years experience (fellow neurointerventional radiologist) and twelve years experience (neuroradiology specialist), respectively. Sensitivities on lesion level ranged from 66.7% - 87.0% with AI and 57.7% - 87.0% without AI, sensitivities on patient level ranged from 63.4% - 81.8% with AI and 52.3% - 75.0% without AI. Specificities ranged from 93.7% - 97.2% with AI and 89.4% - 98.6% without AI. False positive findings per case ranged from 0.03 - 0.12 with AI and 0.02 - 0.17 without AI. The differences in diagnostic performance did not reach the level of statistical significance. 4 out of 6 readers showed significantly shorter reading times with the use of AI, while the remaining two readers showed a significant increase in reading times.

#### CONCLUSION

In our retrospective study, we found equivocal results for the diagnostic performance of six different readers for the detection of cerebral aneurysms with and without the use of an AI software. Although we found a tendency towards a better diagnostic performance, these differences were not statistically significant. The majority of readers showed a significant decrease of reading times, but the radiologist and one medical student showed a significant increase of reading times.

#### CLINICAL RELEVANCE/APPLICATION

AI softwares for the detection of pathologies in neuroimaging are increasingly used in the clinical routine. There is a chance that the use of the softwares may improve readers' performances, but radiologists must be aware that with the use of additional softwares, there is a risk of slowing down established workflows without a significant increase in diagnostic performance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNR-11

### **Sensitivity and Specificity of Ischemia Detection on Brain MRIs using a Commercially Available Deep Learning Algorithm in Patients with Suspected Stroke from a Non-comprehensive Stroke Center**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Christian Hedeager Krag, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Several deep learning artificial intelligence (AI) products exist to detect intracerebral pathology in magnetic resonance imaging (MRI). We set out to estimate the ability of a commercially available CE-approved AI product to detect acute brain ischemia on MRI, compared to an experienced Neuroradiologist.

#### **METHODS AND MATERIALS**

We retrospectively included patients from January 2020 based on the following criteria: Age = 18 years, brain MRI due to suspicion of stroke, with onset of symptoms within four weeks prior to the scan. The Neuroradiologist reinterpreted the MRI scans and subclassified ischemic lesions, serving as the reference test. Scans were excluded if artifacts hampered interpretation, or if sequences were missing. The patients were scanned by one of four different MRI models from the same vendor. The first 3/4 of the patients were included consecutively and the remaining patients were included in an enriched manner to increase the size of subgroups of less frequent ischemic lesions. The index test was a CE-approved AI product.

#### **RESULTS**

The final analysis cohort comprised 995 patients (mean age 69 years, 53% female). A case-based analysis for detecting acute or subacute ischemic lesions showed a sensitivity of 89% (95% CI: 85%-91%) and specificity of 90% (95% CI: 87%-92%). In the consecutive cohort only, consisting of 767 patients, we found a sensitivity of 86% (95% CI: 80-90%) and a specificity of 90% (95% CI: 87-92%). The consecutive and enriched cohorts did not differ significantly in sensitivity, nor was there a significant difference in sensitivity or specificity based on sex or age. However, specificity was significantly reduced in cases with DWI artifacts as opposed to those without (77% vs. 91%,  $p < 0.01$ ). Sensitivity increased significantly with lesion size, for fragmented lesions, and for lesions with signs of hemorrhagic transformation. Furthermore, sensitivity varied with the radiological age of the ischemic lesions. For lesions located in multiple anatomical subgroups, sensitivity was 97% (95%CI 94%-99%), while it was 82% (95%CI 77%-87%) for lesions located within one anatomical subgroup, which was significantly different ( $p < 0.001$ ).

#### **CONCLUSION**

The AI product exhibits high sensitivity and specificity in detecting acute ischemic lesions on MRI compared to an experienced Neuroradiologist at our non-comprehensive stroke center. However, upon clinical application of this AI tool, awareness of the reduced sensitivity for detecting smaller ischemic lesions is required.

#### **CLINICAL RELEVANCE/APPLICATION**

Validating AI products that analyze brain scans is essential before clinical application as they can impact patient diagnostics. AI models often decrease accuracy in clinical settings, highlighting the need for validation studies.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-12

### Diagnostic Performance of ChatGPT from Patient History and Imaging Findings in Neuroradiology

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Daisuke Horiuchi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance and utility of Generative Pre-trained Transformer (GPT)-4 based ChatGPT in neuroradiology.

#### METHODS AND MATERIALS

We collected 80 consecutive "Case of the Week" cases in the American Journal of Neuroradiology between October 2021 and April 2023. ChatGPT was provided with patient history and imaging findings for each case and asked to provide a diagnosis. The generated diagnoses were compared with the ground truth to evaluate ChatGPT's diagnostic accuracy rate. Each case was categorized by anatomical location (brain, spine, and head neck). Brain cases were further divided into two groups: the central nervous system (CNS) tumor group and the non-CNS tumor group. The Fisher's exact tests were conducted to compare the diagnostic accuracy rates among the three anatomical locations, as well as between the CNS tumor and the non-CNS tumor groups.

#### RESULTS

ChatGPT's overall diagnostic accuracy rate was 43% (34/80). When categorized by anatomical location, the diagnostic accuracy rates were 40% (24/60) in brain cases, 60% (6/10) in spine cases, and 40% (4/10) in head neck cases. There was no significant difference in the diagnostic accuracy rates among the three anatomical locations ( $p = 0.56$ ). When comparing the CNS tumor and non-CNS tumor groups, the diagnostic accuracy rates were 8% (1/13) in the CNS tumor group, and 49% (23/47) in the non-CNS tumor group. The diagnostic accuracy rate was significantly lower for the CNS tumor group compared to the non-CNS tumor groups ( $p < 0.01$ ).

#### CONCLUSION

This study demonstrates the potential of ChatGPT's diagnostic performance and utility in neuroradiology. ChatGPT can be used without considering anatomical locations in neuroradiology. ChatGPT's diagnostic accuracy may vary depending on the etiology of the diseases, and its diagnostic accuracy is significantly lower in CNS tumors compared to other diseases. Radiologists should understand the potential advantages and limitations of ChatGPT as a diagnostic tool and decision support system.

#### CLINICAL RELEVANCE/APPLICATION

The integration of ChatGPT into neuroradiology practice has the potential to revolutionize the field, improve diagnostic accuracy, and ultimately improve patient outcomes.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-13

### Improved Differentiation of Cavernous Malformation and Acute intraparenchymal Hemorrhage on CT using AI Algorithm

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hwangseon Ju (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to evaluate the utility of an artificial intelligence (AI) algorithm in differentiating between cavernous malformation (CM) and acute intraparenchymal hemorrhage (AIH) on brain computed tomography (CT) images, as the differentiation between these two conditions can be challenging on brain CT and may lead to unnecessary additional studies in clinical practice.

#### METHODS AND MATERIALS

A retrospective, multi-reader, randomized study was conducted to validate the performance of the AI algorithm (SK Inc. CC Medical Insight + Brain Hemorrhage), a commercial software product, in differentiating AIH from CM on brain CT images. CT images of CM and AIH smaller than 3 cm were collected from the electronic database search. The diagnostic performance of the AI algorithm for differentiating CM and AIH was evaluated using the area under the receiver operating characteristics curve (AUC). Six blinded reviewers, including two neuroradiologists, two radiology residents, and two emergency department physicians, evaluated CT images from 288 patients (CM,  $n = 173$ ; AIH,  $n = 115$ ) with and without AI assistance, and the diagnostic performance was compared.

#### RESULTS

The overall AUCs for AI standalone performance in the dataset were 0.93 and 0.92 for slice-wise and patient-wise analyses, respectively. The best diagnostic performance was achieved with a cut-off level of 97.75 % and 97.95 %, sensitivity of 97.1 % and 94.2 %, and specificity of 73.0 % and 73.0 % in slice-wise and patient-wise analyses, respectively. Brain CT interpretation by the reviewers with AI assistance resulted in significantly higher diagnostic accuracy than that without AI assistance (86.92 % vs. 79.86 %,  $p < 0.0001$ ). Radiology residents and emergency department physicians showed significant improvement in the diagnostic accuracy for brain CT interpretation with AI assistance compared to that without AI assistance (84.21 % vs 75.35 %, 80.73 % vs. 72.57 %; respectively, all  $p < 0.05$ ). Neuroradiologists showed a trend of higher diagnostic accuracy with AI assistance in the brain CT interpretation, but with no statistically significant difference (95.83 % vs. 91.67 %).

#### CONCLUSION

The use of AI algorithm can enhance the differentiation of AIH from CM in brain CT interpretation for non-experts in neuroradiology.

#### CLINICAL RELEVANCE/APPLICATION

The AI algorithm can aid in the proper diagnosis and management of patients who present with a hyperdense lesion on brain CT in clinical practice.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-14

### **Battle of the Brains: Exploring the Accuracy of Artificial Intelligence in Detecting Brain Bleeds on CT Scans**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Victor Tang, MBBS, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Artificial intelligence (AI) has the potential to improve the accuracy and speed of diagnosis of acute intracranial haemorrhage (ICH) which can enhance daily radiology practice and reduce diagnostic errors. As the number of commercial AI algorithms increase, radiology departments are met with a choice of which companies to partner with. This study aimed to compare the performance of two different AI algorithms in detection of ICH on CT scans.

#### **METHODS AND MATERIALS**

All technically adequate non-contrast CT brain studies collected over one month were second-read independently by a neuroradiologist to establish a ground truth for the presence of ICH. Two AI algorithms (1 and 2) were then utilized to review these CT studies and assess them for the presence of ICH. The outputs of the AI algorithms were then compared to the ground truth in order to evaluate their diagnostic accuracy and to compare their performance. Repeat CT brains performed on the same patient were included within the study.

#### **RESULTS**

A total of 1241 brain CT scans were performed within the study period, with 1058 scans marked as negative and 183 scans marked as positive for ICH (14% incidence) by the neuroradiologist. The sensitivity and specificity for Algorithm 1 was 86.3% and 97.2%, respectively. Stratifying by location (emergency [ED], inpatient [IP], outpatient [OP]), the sensitivity was 82.6% (ED), 91.1% (IP), 53.8% (OP), the specificity was 97.1% (ED), 97.3% (IP), 91.7% (OP). The sensitivity and specificity for Algorithm 2 was 88.5% and 96.7%, respectively. Stratifying by location, the sensitivity was 87.0% (ED), 91.1% (IP), 69.2% (OP), the specificity was 96.7% (All), 97.2% (ED), 96.0% (IP), 94.4% (OP). Statistical analysis of the data was conducted using a McNemar test. No statistically significant differences between the two algorithms were found at a significance level of 0.05; all cases P-value: 0.913, ED P-value: 1, IP P-value: 0.458, OP P-value: 0.453

#### **CONCLUSION**

Both algorithms demonstrate high diagnostic accuracy with no significant difference. The drop in OP sensitivity could be due to the low sample size (power = .80). AI 2 did provide a differential output for ICH subtypes, however this was not evaluated in this study. Nonetheless, other features of the AI, such as detection of pathologies other than ICH, user interface and cost, will carry more weight in determining which AI solutions to integrate into the departmental workflow.

#### **CLINICAL RELEVANCE/APPLICATION**

The growing number of commercial AI algorithms presents radiology departments with an opportunity of selecting a partnering company, in order to enhance daily practice and reduce diagnostic errors.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-2

### Automatic Brain MRI Segmentation Quality Control for More Reliable Study Outcomes

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Kiril Vadimovic Klein, BSc, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Large-scale (>10,000) retrospective observational studies of quantitative regional brain volume assessment from magnetic resonance imaging (MRI) require automated segmentations (SEG). Segmentation errors on standard clinical data are frequent and hamper results. We seek to mitigate this with automated reliability quantification.

#### METHODS AND MATERIALS

All 35,818 consecutive 3D T1 brain MRI scans acquired for clinical purposes on 24,261 patients in 11 hospitals in the Capital Region of Denmark during 2019 and 2020 were harvested after regulatory waiving of consent. All MRIs were processed and segmented in anatomical brain regions using FAST-AID Brain [DOI:10.48550/arXiv.2208.14360]. A random subset of 4,887 MRIs was manually categorized by a neurologist as with no, minor, and major SEG failure. We fine-tuned a pre-trained 3D residual convolutional neural network (3DResNet) [DOI:10.1038/s41467-019-13163-9] on 3,910 brain MRIs excluding minor SEG failure to predict the SEG failure probability. We compared various scan exclusion (SE) methods, including no SE, manual SE based on major SEG failure (MM1), and manual SE based on any SEG failure (MM2). To examine the automatic approach, we excluded equally many scans with the highest predicted SEG failure probability matching MM1 and MM2, resulting in AM1 and AM2, respectively. We assessed male-female separation using Cohen's d (CD) across age groups for intracranial volume (ICV), hippocampus, cerebellum, and ventricles and computed the minimum sample size per group (MSS) to obtain a power of 0.8 with an alpha of 0.05.

#### RESULTS

On the test set containing no and major SEG failures, we achieved a ROC-AUC of 0.98 and a PR-AUC of 0.99, with a specificity of 0.93 and an accuracy of 0.94 at the 95% sensitivity level. For ICV, both manual and automatic SE methods showed similar separation, with a higher CD for most age groups compared to no SE. Both approaches resulted in a larger average CD for all examined brain regions. The required MSS was significantly reduced, up to five times, compared to no SE.

#### CONCLUSION

Employing a machine learning-based approach for predicting SEG failure probability effectively improves the power of retrospective clinical studies focusing on quantitative regional brain volume assessment. The automatic SE method led to a larger average CD for all examined brain regions and substantially reduced the required MSS, ultimately contributing to more reliable conclusions and improved power in retrospective observational studies.

#### CLINICAL RELEVANCE/APPLICATION

Accurate and reliable quantitative regional brain volumes from MRI are critical for large-scale retrospective observational studies of neurological disorders. We automate quality assurance to increase power and insight.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNR-3

### Advancing the Use of IA in Clinical Practice: Preliminary Outcomes of a Retrospective Clinical Validation Analysis of an AI Volumetric Segmentation Model

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Rafael Maffei Loureiro, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The use of Artificial Intelligence (AI) in radiology presents a potential remedy to the escalating volume of medical exams and the insufficient number of specialists. Nonetheless, most AI applications in radiology have not undergone rigorous clinical validation trials. Such validation is essential to reveal any unforeseen downstream implications of implementing AI models in clinical practice, including sociodemographical factors that could affect the model's performance. Additionally, most volumetric brain segmentation tools were originally designed for Magnetic Resonance Imaging (MRI), which is more expensive, time-consuming, and limited in availability compared to Computed Tomography (CT). To tackle such challenges, we evaluated the reliability and accuracy of an AI model in the volumetric segmentation of the intracranial region and lateral ventricles task, using a retrospective dataset comprised of real-world head CT exams stored in our institution's PACS.

#### METHODS AND MATERIALS

The model is based on an efficient, lightweight U-Net architecture and performs concurrent segmentation in head 3D images of brain and lateral ventricles. For model development, 559 real-world CT images from neonates to adults were used and included typical and atypical cases besides different scanner models, and acquisition settings. For retrospective clinical validation, 167 anonymized exams from February 2021 were chosen. Intracranial and ventricular ground-truth (GT) binary masks were generated using simpleITK and 3D Slicer, respectively and were approved by board-certified neuroradiologists with at least 6 years of experience. Both generation and validation of GT masks were done remotely by using a 3D Slicer Docker web application and a dashboard based on Trame framework. Project approved by the institutional Ethics Committee.

#### RESULTS

Comparison between GT and AI model's masks showed positive results with a mean Hausdorff distance metric and a mean Jaccard similarity index of 10,11 and 0,97, for the intracranial masks, and 13,20 and 0,65 for the ventricle masks, respectively. Intracranial volumes were more homogenous than the ventricles volumes.

#### CONCLUSION

The proposed model demonstrated favorable outcomes by using a pipeline that does not require software installation or data download. Future efforts will focus on advancing the model to a prospective stage by conducting external clinical validation using multicentric real-world data.

#### CLINICAL RELEVANCE/APPLICATION

The model can accurately and efficiently segment CT exams, according to clinical retrospective results. In the future, it might help diagnose patients with greater precision and effectiveness, especially in resource-limited settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNR-4

### **An Experimental Study of Newborn Pigs Based on MRI Histological Analysis: Pathological Control for Predicting Brain Edema Gradation in HIE**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Hefan Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Hypoxic-ischemic encephalopathy is one of the causes of death and severe disability in clinical children. Cerebral edema is the main pathological change affecting the clinical prognosis of HIE. Because the pathology of HIE cannot be obtained, clinical experience is commonly used to determine. Noninvasive and rapid prediction of the degree of cerebral edema is essential for clinical decision-making. To solve the clinical problem, we performed pathological studies by simulating clinical children through HIE animals. According to the pathological changes of brain tissue, the MRI images were divided into mild edema group and severe edema group, so that the microscopic pathological changes corresponded to the abnormal signals of macroscopic images. Then the microscopic pathological changes were associated with the omics model, and finally the omics model with pathological validation was realized to predict the HIE brain edema grade.

#### **METHODS AND MATERIALS**

The HIE model was established by sealing both common carotid arteries and hypoxia in 54 newborn Yorkshire breeding pigs. T2WI and DWI scans were performed at 1 h, 3 h, 6 h, 9 h, 12 h, 16 h, 22 h, and 24 h. At the end of scanning at each time point, a group of neonatal pigs were taken for pathological examination of brain tissue. It provides a biological basis for omics research and explores the biological significance of image-omics. Each sequence manually delineated ROI in the region of interest to extract omics features, and three methods of dimensionality reduction screening features were used to establish the model. The combination of sequences and classifiers with better efficacy was assessed with ROC curves, K-Fold cross-validation, etc.

#### **RESULTS**

Based on the sequence DWI, T2WI, ADC and their combination, the classifiers with better model efficacy were LR, LR, KNN and SVM, and the AUCs were 0.89, 0.86, 0.80 and 0.84, respectively. LR model has the best performance among different classifiers. In the combined sequence and classifier power: the LR classifier training set AUC was 0.88; the validation set AUC was 0.89. Logistic regression classifiers based on DWI images had the best predictive model diagnostic efficacy. Gray level dependent matrix class features and homogeneity class features were found to have more important potential for differentiating brain edema.

#### **CONCLUSION**

1. The logistic regression model based on DWI sequences was effective in identifying HIE brain edema in neonatal pigs. 2. The gray-scale dependent matrix and homogeneity correlation features have the potential to be used as imaging biomarkers to reflect the degree of HIE edema.

#### **CLINICAL RELEVANCE/APPLICATION**

To provide a non-invasive histological prediction model with pathobiological significance for children with clinical HIE.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNR-5

### Deep Learning-based CT to MRI Image Synthesis with Contrastive Loss

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Seungyu Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic Resonance Imaging (MRI) is an essential imaging modality in clinical radiology. However, conventional Positron Emission Tomography (PET) quantitative analysis requires MR images, and it is challenging to utilize PET images alone. Recently, deep learning-based generative models have been widely applied in the medical field, yet attempts to synthesize MRI images from CT scans, which possess higher resolution, are scarce. Moreover, as PET-CT devices are more commonly used than PET-MRI, patients often require multiple scans, leading to increased time and cost. In this study, we introduce a deep learning model utilizing contrastive loss to obtain MRI images from CT scans and demonstrate the feasibility of replacing conventional MRI with synthesized MRI for PET quantitative analysis with <sup>18</sup>F-Florbetaben (FBB) PET imaging.

#### METHODS AND MATERIALS

We used data from 150 patients with brain CT and T1 MRI scans. Among them, 114 were used for training and the remaining 36 for validation. The CT and MRI scans were co-registered using SPM12 and subsequently used for image translation training. We employed a 2D-based Generative Adversarial Network (GAN) model, utilizing four models: pix2pix, cycle-GAN, Dual Contrastive Learning GAN (DCLGAN) and Contrastive Unpaired Translation (CUT). We extracted slices from CT scans, trained the deep learning models to synthesize MRI slices from 256x256 CT slices, and combined the synthesized slices to generate MRI images.

#### RESULTS

We assessed the performance using the Peak Signal-to-Noise Ratio (PSNR), Root Mean Square Error (RMSE), and Structural Similarity Index Measure (SSIM). DCLGAN showed the best performance with a PSNR of 24.13, RMSE of 0.1038, and SSIM of 0.8590. Qualitative evaluation also revealed that DCLGAN accurately predicted structures like basal ganglia and cerebellum, challenging to discern in CT scans. Moreover, we retrospectively compared SUVR evaluation using original MRI and synthesized MRI from 142 patients' FBB-PET scans, obtaining an Intraclass Correlation Coefficient (ICC) of 0.9561, indicating a strong correlation between them.

#### CONCLUSION

Our deep learning model demonstrates the ability to generate high-quality MRI images from CT scans, capturing intricate structures that are difficult to identify in CT images. This research highlights the potential of our approach as a valuable tool when MRI is inaccessible, ensuring continued advancements in medical imaging analysis.

#### CLINICAL RELEVANCE/APPLICATION

Our deep learning model generates high-quality MRI images from CT scans, providing a time- and cost-effective alternative for clinical quantitative analysis, such as SUVR, when MRI is inaccessible.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPNR-7

### Improved Multimodal Diagnosis of Alzheimer's Disease through MRI and PET Image Fusion

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Zeyu Chang (*Presenter*) Nothing to Disclose

#### PURPOSE

Alzheimer's Disease (AD) is a degenerative neurological disorder commonly seen in the ageing population and there is currently no universally accepted automatic diagnostic technique. Previous studies have shown that multimodal analysis can be of great benefit in the diagnosis of AD. In this work, we present two novel multimodal diagnostic models for early detection of AD that utilize fused images from Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET): the 2D dynamic image analysis model and the 3D image analysis model. These models have the potential to improve diagnostic accuracy and facilitate early detection of AD, allowing for timely interventions and better patient outcomes.

#### METHODS AND MATERIALS

Our study utilized a dataset of 394 paired MRI and PET scans from the Alzheimer's Disease Neuroimaging Initiative (ADNI), which included 120 AD, 154 MCI, and 120 Normal Control (NC) scans. We performed multimodal fusion of paired images to create 3D images containing structural and functional information about the brain. We trained two deep learning models for AD diagnosis: a traditional 3D ResNet-18 model and a novel 2D dynamic image analysis model.

#### RESULTS

Based on our experiments, we found that both models performed similarly well in more challenging tasks such as differentiating between AD and MCI (85.75% for the 2D model vs 85.66% for the 3D model) and distinguishing between AD, MCI, and NC (86.88% for the 2D model vs 86.20% for the 3D model). However, the 3D image analysis model showed higher accuracy in relatively simpler tasks such as distinguishing between AD and NC (96.11% for the 3D model vs 99.44% for the 2D model) and between MCI and NC (93.47% for the 3D model vs 98.80% for the 2D model).

#### CONCLUSION

In this study, we have developed two advanced multimodal diagnostic models that offer efficient and accurate early Computer Aided Diagnosis (CAD) of AD and have experimentally demonstrated their effectiveness. Our models outperform existing multimodal diagnostic models using PET images and MRI images as input, in terms of decision-based fusion and image fusion. The proposed models have the potential to assist in early detection and diagnosis of AD, ultimately improving patient outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Our models have significant clinical relevance as they can aid in the early detection and diagnosis of AD, leading to improved patient outcomes. Although the 2D and 3D models perform similarly in some tasks, we recommend the 2D model due to its faster processing time. Our automated approaches have the potential to enhance healthcare professionals' performance and save costs.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-8

### Improved Neurovascular Imaging using Advanced Intelligent Clear-IQ Engine (AiCE)

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Mario Abello Mercado (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the effects of deep-learning image reconstruction on image quality and diagnostic confidence of ultra-high-resolution computed tomography (UHRCT).

#### METHODS AND MATERIALS

In this single-center study, 100 consecutive patients with acute neurological symptoms underwent CT imaging including cranial computed tomography (CCT) and computed tomography angiography (CTA) using an ultra-high resolution CT scanner. CTA images were reconstructed with normal resolution mode (NR-CTA, matrix 512 x 512, slice thickness 0.5 mm) and ultra-high resolution mode (UHR-CTA, matrix 1024 x 1024, slice thickness 0.25 mm) using iterative reconstruction. Additionally, a deep-learning reconstruction algorithm (advanced intelligent clear-IQ engine, AiCE); specifically trained for ultra-high resolution CT-angiography of the brain was utilized to generate a further UHR-CTA datasets (DL-UHR-CTA, matrix 1024 x 1024, slice thickness 0.25 mm). Image quality for all three reconstructions was evaluated visually by two blinded radiologists using a 4-point Likert-scale. Therefore, general (overall image quality, contrast in general, artifacts, diagnostic confidence and image noise) and vessel specific (assessability of proximal, intermediate and subcortical vessels as well as perforators) criteria were assessed. The quantitative features including slope, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), noise, entropy and co-occurrence matrix (COOC) were examined and compared using an in-house tool.

#### RESULTS

Qualitative analysis revealed highest scores for DL-UHR-CTA, followed by UHR-CTA and NR-CTA, whereas DL-UHR-CTA yielded excellent results for all qualitative parameters and was significantly superior to UHR-CTA and NR-CTA (all  $p < 0.001$ ). The quantitative analysis was in line with the qualitative findings with significantly superior results for DL-UHR-CTA (slope:  $p < .01$ , SNR/CNR:  $p = 0.004$ , entropy  $p < .01$ , COOC:  $p < .01$ ).

#### CONCLUSION

Deep-Learning image reconstruction significantly improves image quality of ultra-high resolution neurovascular CT-angiography allowing for higher diagnostic confidence, potentially improving the detection of subtle but oftentimes-significant pathologies.

#### CLINICAL RELEVANCE/APPLICATION

Deep-learning image reconstruction improves the quality of UHR-CTA images, leading to higher diagnostic confidence and potentially aiding in the detection of subtle but clinically significant pathologies.

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## Abstract Archives of the RSNA, 2023

R2-SPNR-9

### **Prediction Model of Vascular Cognitive Impairment Based on MRI White Matter Hyperintensities Radiomics Features in the Elderly Patients with CSVD**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Wei Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish a prediction model of vascular cognitive impairment (VCI) based on white matter hyperintensities(WMH) radiomics feature, in order to guide people at risk of VCI to carry out early intervention and delay the occurrence of VCI or dementia.

#### **METHODS AND MATERIALS**

MRI data of 57 patients with VCI and 169 patients with no cognitive impairment (NCI) were retrospectively analyzed. Patients were randomly divided into training set (n=159) and test set (n=67) in a ratio of 7:3. The images were standardized and WMHs were segmented automatically by using the lesion prediction algorithm in the SPM software package. Two radiologists determined whether there was any error, and if there was any error, ITK-SNAP software was imported for manual delineation. Then features were extracted from the segmented WMHs to select the best image morphological features to build the model. Clinical data and conventional MRI signs were incorporated into the study to build a clinical model, and then the radiomics model was combined with clinical model. The receiver operating characteristic (ROC) curve was plotted and the decision curve analysis (DCA) was performed to evaluate the diagnostic efficacy and clinical application value of each model.

#### **RESULTS**

8 radiomics features were extracted from WMH, and the WMH radiomics model, clinical model and combined model were established respectively. The area under the ROC curve (AUC) of the training sets of the three models were as follows: WMH radiomics model was 0.74(95%CI: 0.66-0.83), clinical model was 0.88(95%CI: 0.81-0.94), combined model was 0.90 (95%CI: 0.84-0.96), The AUC in the test set was 0.75(95%CI:0.62-0.87), 0.81(95%CI: 0.68-0.95) and 0.85 (95%CI: 0.74-0.96), respectively. The combined model has better diagnostic efficacy and a higher clinical net return as assessed by DCA.

#### **CONCLUSION**

The diagnostic efficacy of WMH radiomics combined with clinical model was better than that of WMH radiomics or clinical model. It could provide more sensitive and reliable markers for the early prediction and diagnosis of VCI.

#### **CLINICAL RELEVANCE/APPLICATION**

The model combined WMH radiomics and clinical data had potential clinical application and could provide more sensitive and reliable markers for the early prediction and diagnosis of VCI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPPD-1

### Absorbed Doses in Ovaries During Pediatric Hip Radiography: To Stop Routine Gonadal Shielding and Move Forward

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Kosuke Matsubara, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The National Council on Radiation Protection and Measurements (NCRP) stated that discontinuing routine use of gonad shield is based on our best scientific understanding. To provide data that contributes to our scientific understanding, we evaluated the difference in ovarian dose between the presence and absence of gonad shield and the difference in ovarian dose depending on the shield size and the depth of the positions of the ovaries.

#### METHODS AND MATERIALS

Twenty-five sensitivity-corrected fluorescent glass dosimeters were placed on the cross section at the level of the femoral head of a 1-year-old pediatric phantom to measure absorbed doses with and without a 2-mm-thick lead gonad shield. They were arranged within a depth of 3-9 cm from the body surface and 0-3 cm to the left and right of the body midline. The imaging conditions were as follows: a tube voltage of 50 kV, tube current-time product of 6.3 mAs, a field size of 7×10 cm, and the source-to-image receptor distance of 100 cm. The ovaries were assumed to be 6 cm depth from the body surface and 1.5 cm to the left and right of the body midline. In the Monte Carlo simulation, a voxel phantom was built from CT images of the 1-year-old pediatric phantom, and the absorbed doses in the ovaries were calculated when changing the area covered by the shield to large, medium, and small and when changing the depth of the ovaries to 3-9 cm.

#### RESULTS

Although the gonad shield blocks almost 100% of the primary X-rays, significant values of absorbed doses were observed in the area covered by the shield. There was a tendency for the dose reduction rate to decrease from 75.5-81.6% to 52.8-66.7% at positions covered by the shield with increasing depth from the body surface from 3 to 9 cm. The dose reduction rate ranged from 2.3% to 23.1% at positions not covered by the shield. The average dose reduction rates obtained from measurements and simulations at the assumed positions of the ovaries were 66.2% for measurements and 72.7% for simulations. In the simulation, the dose reduction rate was 80.0-80.1% when the ovaries were completely covered by the shield (large size), but it was 72.4-73.1% and 53.6-55.3% when the ovaries were partially uncovered (medium size) and completely uncovered (small size), respectively.

#### CONCLUSION

When using a gonadal shield, ovarian dose is affected by how deep the ovaries are located from the body surface and whether the locations of ovaries are covered by the shield. Ovarian doses were far below the thresholds for temporary and permanent infertility even without shielding.

#### CLINICAL RELEVANCE/APPLICATION

This study reveals that gonadal shielding does not eliminate a significant number of scattered X-rays produced in the unshielded irradiated areas, supporting the abolition of gonadal shielding in medical practice.

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## Abstract Archives of the RSNA, 2023

R2-SPPH-1

### Skin Dose Estimation Reduces Need for Patient Follow-up

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Determine how reference point air kerma and estimated skin dose are related. Further, determine how use of estimated skin dose could impact patient follow-up.

#### METHODS AND MATERIALS

Reference point air kerma ( $K_{air}$ ) and other demographic information was recorded from 629 patients (669 cases) with  $K_{air}$  above 2Gy. An in-house skin dose ( $D_{skin}$ ) estimation system (DIT Platform) was applied to each case. Dose differences between  $K_{air}$  and  $D_{skin}$  were recorded and summary statistics calculated. Trends against demographics were investigated. Percentage of cases brought below accepted dose thresholds related to skin damage and patient follow-up were determined.

#### RESULTS

Median  $D_{skin}$  estimates were 39.6% lower than  $K_{air}$  [24.9% 25th percentile, 51.1% 75th percentile]. Least squares linear trendline set  $D_{skin}$  as 63.2% of  $K_{air}$  with a  $R^2$  of 0.9. No trend was seen between patient weight and any dose metric. Similarly, difference between  $D_{skin}$  and  $K_{air}$  were not dependent on patient weight. 82.6% of  $K_{air}$  cases between 2 and 3 Gy fell below the erythema limit (2Gy). 40.7% of  $K_{air}$  cases between 3-4 Gy cases, 17.1% of  $K_{air}$  cases between 4-5Gy cases, and 5.6% of  $K_{air}$  cases between 5-6 Gy cases had  $D_{skin} < 2$  Gy. 91.7% of  $K_{air}$  cases between 5-6 Gy cases fell below 5 Gy which is a patient follow-up threshold suggested by several professional societies.

#### CONCLUSION

$K_{air}$  substantially overestimates  $D_{skin}$  in clinical cases. The estimates reduced the number of patients needing follow-up due to possible tissue reactions. When discussing possible skin reactions with patients and physicians the improved estimate reduced the need to discuss more severe skin reactions.

#### CLINICAL RELEVANCE/APPLICATION

The use of skin dose estimation software can decrease the need for patient follow-up and reduce the kinds of possible skin reactions that need to be discussed with patients and referring physicians.

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## Abstract Archives of the RSNA, 2023

R2-SPPH-11

### Image Quality Assessment of Deep Learning Image Reconstruction Combined with Low Radiation Dose in Abdominal CT: A Phantom Study

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Jiewen Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the image quality of deep learning image reconstruction (DLIR) at low and ultra-low dose with filtered back projection (FBP) at clinical dose in abdominal CT.

#### METHODS AND MATERIALS

Ten consecutive scans of Catphan 500/600 phantom were performed on Revolution Apex CT using a clinical dose (20.7mGy), low dose (12.29 mGy), ultra-low dose (6.19 mGy). The acquired images were reconstructed with FBP in the clinical dose group, and reconstructed with medium, high strength DLIR algorithms (DLIR-M, DLIR-H) in the ultra-low dose and low-dose groups. The noise (SD), contrast noise ratio (CNR), low density insert diameter, spatial resolution line pair, noise power spectrum (NPS) and task transfer function (TTF) were measured. Image quality was assessed independently by two radiologists using a 5-point scale. One-way analysis of variance and K-W test were used for statistics. Kappa test was to assess consistency.

#### RESULTS

The values of SD and CNR of DLIR-H images in low-dose and ultra-low dose groups were better than FBP images in the clinical dose group (all  $P < 0.01$ ). Low density inserts diameter and the number of spatial resolution line pair of DLIR-H images in the low-dose group were equivalent to those of FBP images ( $P > 0.05$ ) in the clinical dose group. Compared to the FBP images of the clinical dose group, the image texture of DLIR-M and DLIR-H in the low-dose group and ultra-low dose group were almost unchanged, and the NPS noise of the DLIR-H group in the low-dose group was the lowest (FBP of the clinical dose group:  $f_{peak} = 0.28 \pm 0.01 \text{mm}^{-1}$ ,  $f_{ave} = 0.32 \text{mm}^{-1}$ ,  $NPS_{noise} = 4.44 \pm 0.05 \text{HU}$ ; DLIR(M,H) of the low-dose group:  $f_{peak} = 0.28 \pm 0.01 \text{mm}^{-1}$ ,  $f_{ave} = 0.27 \pm 0.01 \text{mm}^{-1}$ ,  $NPS_{noise} = 3.88 \pm 0.04 \text{HU}$ ; DLIR(M,H) of the ultra-low dose group:  $f_{peak} = 0.27 \text{mm}^{-1}$ ,  $f_{ave} = 0.27 \text{mm}^{-1}$ ,  $NPS_{noise} = 5 \text{HU}$ ); The TTF10% of low contrast target in low-dose and ultra-low dose groups were higher than that of FBP the clinical dose group, while TTF50% were lower in both groups. The subjective score of image quality of DLIR in the ultra-low dose and low-dose groups were not statistically different from that of FBP images in the clinical group ( $P > 0.05$ ). The subjective scores of the two doctors showed good consistency (Kappa = 0.72).

#### CONCLUSION

The DLIR algorithm hardly impacts the image texture, especially the contrast and spatial resolution of the low-dose group are comparable or even better than those of the clinical dose FBP image, and the potential reduction of radiation dose can reach 40%~70%, which provides theoretical basis and scanning parameter selection for clinical abdominal CT imaging.

#### CLINICAL RELEVANCE/APPLICATION

Low-dose DLIR can reduce radiation dose and provide theoretical basis and scan parameter selection for clinical abdominal CT imaging.

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## Abstract Archives of the RSNA, 2023

R2-SPPH-12

### Improving Head CT Image Quality under Low-Dose Scanning Conditions using Deep Learning Image Reconstruction Algorithms

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Chunyu C. Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the potential of deep learning image reconstruction (DLIR) algorithm for improving image quality under low dose scanning conditions

#### METHODS AND MATERIALS

22 inpatients requiring cranial CT reexamination who underwent routine low-dose brain CT scan(120kv200mA) were recruited. All images were reconstructed using filtered backprojection(FBP), ASIR-V at 50% strength (50%ASIR-V), DLIR at low, medium, and high level (DLIR-L, DLIR-M, DLIR-H).The CT values and noise (SD, standard deviation of CT values) of the gray matter (GM) and white matter (WM) at the basal ganglia and centrum semiovale levels were measured at different algorithm groups. The signal-to-noise ratio (SNR) of GM and WM, contrast-to-noise ratio (CNR) between GM and WM, and artifact index (AI) at posterior fossa were calculated. Two radiologists individually performed subjective evaluation of image noise, lesion clarity, overall image quality, and image artifacts using 1-5 scoring system. The consistency between two radiologists was analyzed. The objective and subjective measurements were compared at four algorithm groups.

#### RESULTS

There were no significant differences in the CT values among the different algorithm groups (all  $p > 0.05$ ).In the DLIR groups, as the level of DLIR increased, the SD of GM and WM in the basal ganglia and centrum semiovale, as well as AI, gradually decreased, and while the SNR and CNR gradually increased, compared to FBP and 50% ASIR-V. There were significant statistical differences among the five algorithm groups, with the best performance observed in DLIR-H. (FBP vs DLIR-H, in basal ganglia, SDGM:  $9.45 \pm 2.41$ ,  $3.56 \pm 0.90$ ; SNRGM:  $4.42 \pm 1.27$ ,  $11.47 \pm 2.79$ ; CNR:  $1.23 \pm 0.51$ ,  $2.89 \pm 1.12$ ; AI:  $9.79 \pm 3.69$ ,  $7.22 \pm 2.30$ ; all  $p < 0.01$ ). The subjective evaluation scores in terms of image noise, overall image quality clarity of the lesion, and image artifacts gradually in DLIR (M, H) were higher compare with FBP and 50%ASIR-V, with a significant statistical difference among five algorithm groups(Radiologist1, FBP vs DLIR-H, image noise:  $2.09 \pm 0.53$ ,  $4.14 \pm 0.35$ ; over image quality:  $2.18 \pm 0.40$ ,  $4.00 \pm 0.00$ ; clarity of the lesion:  $2.55 \pm 0.67$ ,  $4.00 \pm 0.31$ ; Image artifacts:  $2.18 \pm 0.59$ ,  $4.05 \pm 0.49$ ; all  $p < 0.01$  ) . Two radiologists showed a good consistency (ICC:0.48-0.75,  $p < 0.01$ ).

#### CONCLUSION

Under low-dose scanning conditions, compared with FBP and 50% ASIR-V, the deep learning optimization scheme has better performance in reducing image noise and artifacts, and subjectively evaluates DLIR-M and DLIR-H as the best post-processing image quality.

#### CLINICAL RELEVANCE/APPLICATION

Compared with FBP and 50% ASIR-V, deep learning image reconstruction algorithms can better improve the quality of head CT images.

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## Abstract Archives of the RSNA, 2023

R2-SPPH-2

### Impact of Model Shape on Peak Skin Dose Estimates

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the impact of patient model shape on peak skin dose calculation

#### **METHODS AND MATERIALS**

100 different human models randomly selected from the Civilian American and European Surface Anthropometry Resource dataset were used as input to a previously validated peak skin dose estimation system. Models were scaled to be the same approximate height as the default stylized phantom. Other Patient dimensions were scaled accordingly. The original phantom had craniocaudal, mediolateral, and anteroposterior dimensions of 173 cm, 39 cm, and 20 cm. The scaled patient models had dimensions of 173 cm,  $89 \pm 7.6$  cm, and  $34.5 \pm 3.4$  cm, respectively. Two positions were chosen for the phantoms: 1) patient models most posterior point aligned with default model's most posterior point and 2) patient model center of mass aligned with default model's center of mass. Beam data from 111 scans with reference point air kerma greater than 2 Gy ( $3.3 \text{ Gy} \pm 2 \text{ Gy}$ ) were applied to each patient model. Summary statistics and skin dose maps were calculated.

#### **RESULTS**

When the posterior of the patient models was aligned with the default model the peak skin dose was  $16\% \pm 0.3\%$  larger than using the default model. When the patient model center of mass was aligned with the default model center of mass the peak skin dose was  $19\% \pm 0.3\%$  larger than the default model.

#### **CONCLUSION**

Patient model substantially impacts final peak skin dose estimates. future work is will refine the existing meshes to better represent a realistic patient on the table.

#### **CLINICAL RELEVANCE/APPLICATION**

Dose estimation software should implement an array of patient models to better approximate the patient on the table to improve peak skin dose estimation.

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## Abstract Archives of the RSNA, 2023

R2-SPPH-3

### Fetal Organ Dose Estimates from the Exposure of Pregnant Women in Fluoroscopy Procedures

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Seth Streitmatter, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the dependence of fetal organ dose on gestational age (GA), beam size and angulation in common fluoroscopy procedures and interventions a pregnant patient may undergo.

#### METHODS AND MATERIALS

Hybrid computational phantoms of pregnant woman at four GAs (10w, 20w, 30w, 38w) were used to assess fetal organ doses by simulating common beam quality (70 kVp, 6.83 mm Al), field size (19 x 19 cm) and projections (LAO 25 CAU 25, LAO 25 CRA 25) used in interventional cardiac procedures. The beam geometry data created for the adult female phantom using NCIRF (National Cancer Institute dosimetry system for Radiography and Fluoroscopy), was translated for dose calculations in MCNP6, a general-purpose Monte Carlo code, and fetal organ doses were assessed.

#### RESULTS

The major organs that the ICRP has assigned tissue weighting factors to were assessed. As the GA increases and the fetus gets closer to the treatment field, the brain (and other fetal organs that are inferior with respect to the mother's thorax) doses decreases (up to 0.39x), while organs that are superior or distributed throughout the fetus (e.g., bone, skin) show increased dose (up to 4.25x). More dramatically, dose increases as the beam becomes more caudally angulated and the fetus is closer to the beam or partially in it; all fetal organ doses were significantly higher for the LAO 25 CAU 25 scenario (up to 5.19x). Bone shows the largest relative increase in dose for GA 10w - 38w in both scenarios. Figure 1 illustrates the dependence of the doses on GA and beam angulation, normalized to organ dose to dose area product (DAP), mGy/mGy·cm<sup>2</sup>.

#### CONCLUSION

For fluoroscopy cases, specifically cardiac/thoracic interventions, differences in GA and beam angulation can have a dramatic effect on fetal organ doses. Using the methods described here provides a higher level of accuracy for fetal organ dose estimates and the interplay between different potential exposure scenarios for pregnant patients than using the older, simple geometric phantoms and the uterus as a surrogate for fetal dose.

#### CLINICAL RELEVANCE/APPLICATION

Examinations that involve an unpredictable duration of fluoroscopy have "substantial risk" potential. The capability to compute more accurate fetal organ doses can provide the patient with more relevant fetal risk assessment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPPH-4

### Evaluation of Different Peak Skin Dose Calculators Using an OSL Dosimeter Array in a Hybrid CT/Angiography Suite

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Megan Glassell, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Fluoroscopically-guided interventional (FGI) procedures can result in high skin doses, potentially in the range where effects such as erythema could occur. Thus, it may be necessary to accurately determine the peak skin dose (PSD) so physicians can predict possible effects and inform the patient. The accuracy of three PSD calculators was evaluated using direct entrance skin dose measurements from optically stimulated luminescent dosimeters (OSLDs).

#### METHODS AND MATERIALS

An array of 286 OSLDs was used to measure entrance skin dose on patients (n=12) undergoing FGI procedures. A previously validated method was used to separate the OSLD dose into CT and fluoroscopy skin dose for patients who were scanned with CT during their procedure. The OSLD with the highest fluoroscopy skin dose was used as the measured PSD. Additionally, an in-house PSD calculator was used to determine the PSD based on information from each patient's RDSR and room-specific correction factors. The PSD values reported from an independent commercial dose tracking software were recorded for each patient. The PSD values from a vendor/system-specific dose tracking software were recorded for each patient.

#### RESULTS

The measured fluoroscopy PSD ranged from 189 mGy to 8,095 mGy for the 12 patients. The results show good agreement between the measured PSD and the PSD from the in-house PSD calculator. The mean percent error was -2% with mean absolute percent error of 10%. There was no statistical difference between the two PSD values ( $p = 0.445$ ). The independent commercial dose tracking software had a mean percent error of -16% with a mean absolute percent error of 21%. There was no statistical difference between the two PSD values ( $p = 0.054$ ). The vendor/system-specific dose tracking software showed the worst agreement between the measured PSD and displayed PSD. The mean percent error was -37% with a mean absolute percent error of 37%. There is a statistically significant difference between the measured PSD and the displayed PSD ( $p = 0.005$ ).

#### CONCLUSION

The in-house PSD calculator that considers parameters from each patient exam and used room-specific correction factors had the best agreement with the measured PSD. The in-house PSD can provide physicians with a relatively more accurate PSD compared to the commercial and vendor dose tracking software.

#### CLINICAL RELEVANCE/APPLICATION

Providing interventional radiologists with an accurate PSD estimation can help them better predict possible skin effects and potentially reduce effects by modifying exam parameters.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPPH-5

### The Feasibility of High-Pitch Spectral CT Monochromatic Imaging in Combination with ASIR-V Technology: A Phantom Study

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Nana Ai (*Presenter*) Nothing to Disclose

#### PURPOSE

To analyse the influence of high-pitch spectral CT monochromatic imaging in combination with pro-adaptive statistical iterative reconstruction-V(ASIR-V) technology on image quality and radiation dose.

#### METHODS AND MATERIALS

A chest phantom was scanned on a revolution energy spectrum CT scanner separately using 0.5s rotation time, 0.992 helical pitch and 0.5s rotation time, 1.531 helical pitch. 70KeV monochromatic images were separately reconstructed at slice thickness of 5mm, meanwhile, the 40% pro-ASIR-V was applied to 70 keV high-pitch monochromatic image. Images of lung window and mediastinal window were separately reconstructed by standard algorithm and sharp algorithm. A total of three sets of images were obtained: routine-pitch/0%ASIR-V group, high-pitch/0%ASIR-V group and high-pitch/40%ASIR-V group. The CT dose index volume (CTDIvol), dose-length product (DLP) and effective dose (ED) were recorded. Standard deviation (SD) of pulmonary parenchyma, soft tissues of chest wall and heart were measured. Subjective image quality of lung window and mediastinal window were assessed by two radiologists in a double blinded and randomized manner using five-point scale (from 5=good image quality, almost no artifacts, clear anatomic details, easy to distinguish to 1=poor image quality, obvious artifacts, indistinct anatomic details, unable to distinguish). The differences between groups for MSD, radiation dose and mean subjective score were done with one-way ANOVA. The interobserver variation between two radiologists were assessed by the kappa statistic.  $P < 0.05$  was considered statistically significant.

#### RESULTS

There was moderate agreement between the two radiologists in rating of subjective image quality ( $K=0.571$ ). Results indicated that the image quality of high-pitch spectral CT monochromatic imaging in combination with 40% pro-ASIR-V were better than routine-pitch or high-pitch in combination with 0%ASIR-V. Effective doses of the routine-pitch group and high-pitch group were 6.84mSv and 5.31mSv. The radiation dose reduction for high-pitch group was 22.37% in comparison with routine-pitch group.

#### CONCLUSION

The use of high-pitch spectral CT monochromatic imaging in combination with pro-ASIR-V resulted in wonderful diagnostic images with lower radiation dose.

#### CLINICAL RELEVANCE/APPLICATION

High-pitch spectral CT monochromatic imaging in combination with ASIR-V may acquire high image quality and low radiation dose.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-SPPH-6

### The Impact of Different Noise Index (NI) on Image Quality of “Three-low” Chest CTA

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Yang C. Chenxiao (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the effect of low tube voltage, low contrast agent dosage and low contrast agent flow rate combined with different NI on the image quality of chest CTA.

#### METHODS AND MATERIALS

This study was randomly divided into two groups: group A (n=20) and group B (n=20). Patients in group A were performed prospective “three-low” chest CTA with following parameters: 100kVp, contrast volume 45ml, contrast flow rate 3.0ml/s, and NI = 12, 14, 16, 18 for subgroup A1, A2, A3 and A4. Group B was control group with routine scanning parameters: 120kVp, contrast volume 60ml, contrast flow rate 4.0ml/s, NI=10. The other scanning sets were same. CT values and SD of the ascending aorta, aortic arch, descending aorta and the same layer of chest wall fat were measured. Then the CNR were calculated. The effective dose (ED = DLP \* 0.014) were also recorded. The subjective image quality of five groups were scored independently by two senior radiologists according to the 5-point system (Five points is the highest and one point is the lowest). More than three points meet the diagnostic criteria.

#### RESULTS

The CT values of experimental group A1, A2, A3, A4 and control group B were  $346.1 \pm 22.1$ ,  $340.7 \pm 13.9$ ,  $344.0 \pm 14.8$ ,  $342.7 \pm 11.8$  and  $406.5 \pm 8.1$  HU, respectively. There were statistical significance between groups A and B ( $P < 0.05$ ) and no statistical significance between group A ( $P > 0.05$ ). The CNR of experimental group A1, A2, A3, A4 and control group B were  $12.9 \pm 2.5$ ,  $15.3 \pm 2.8$ ,  $17.9 \pm 4.1$ ,  $20.0 \pm 2.9$  and  $9.99 \pm 0.99$ , respectively. There was statistical significance between groups ( $P < 0.05$ ). The CNR of experimental group A1, A2, A3, A4 and control group B were  $42.2 \pm 8.3$ ,  $36.1 \pm 5.9$ ,  $32.3 \pm 3.5$ ,  $24.9 \pm 2.8$  and  $53.3 \pm 6.2$ , respectively, There was statistical significance between groups ( $F = 69.6$ ,  $P < 0.05$ ). The effective dose (ED) were  $2.5 \pm 0.24$ ,  $1.41 \pm 0.26$ ,  $1.15 \pm 0.4$ ,  $0.93 \pm 0.08$  and  $5.0 \pm 0.32$ , respectively. The effective dose of each group was statistically significant ( $F = 1076$ ,  $P < 0.01$ ). In subjective statistics, the image scores of experimental group A1, A2, A3, A4 and control group B were  $5.0 \pm 0$ ,  $4.98 \pm 0.14$ ,  $4.17 \pm 0.38$ ,  $3.61 \pm 0.49$  and  $2.63 \pm 0.49$ , respectively. The result from two senior radiologists were high consistency ( $\kappa = 0.65$ ). Only the subjective score of B4 did not meet the diagnostic requirements, and the lowest radiation dose of B3 group was about 77% lower than that of the control group.

#### CONCLUSION

Three low combined with high NI index can reduce the risk of contrast injection and the radiation dose of patients at the same time.

#### CLINICAL RELEVANCE/APPLICATION

To reduce the risk of contrast injection and the radiation dose of patients

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPPH-7

### A Study Related to the Optimal Phase Selection of Virtual Scanning of Spectral Enhanced CT Instead of Conventional Scanning

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Qi Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the optimal phase selection of virtual non-contrast (VNC) technique instead of conventional true non-contrast (TNC) for spectral enhanced CT scanning.

#### METHODS AND MATERIALS

Fifty-seven patients with energy-spectrum-enhanced CT scans of the abdomen were collected, 23 males and 24 females with a mean age of  $55 \pm 12$  years. A spectral CT (Revolution, GE Healthcare, USA) scanner was used, with conventional (non-energy spectral) scanning mode for conventional scanning and gemstone spectral imaging (GSI) abdominal scanning mode for enhanced scanning. The CT scan used spectral mode. The CT values and SD values of the water were measured, and the signal-to-noise ratio (SNR) was calculated. The virtual scanning images were obtained by virtual non-contrast (VNC) technique, and the CT values and SD values of the liver in each phase, and the signal-to-noise ratio (SNR) was calculated. All statistical tests were performed using SPSS version 26.0, and one-way ANOVA was used to compare the differences between CT values, signal-to-noise ratio (SNR), and CT Dose Index (CTDI) of the liver after virtual scanning of the three phases of the spectral enhanced scanning images. For all tests, the level of statistical significance was set at  $P < 0.05$ .

#### RESULTS

The SD and SNR of the liver after after virtual scanning processing of the three phases of the spectral enhanced scanning were statistically significant ( $P < 0.05$ ) compared with those of the conventional scanning. The differences were statistically significant ( $P < 0.05$ ) when comparing the SD values and SNR of the liver between the virtual scanning of the three phases of spectral enhanced scanning. There were significant differences ( $P < 0.05$ ) in the SD values and SNR of the liver between the virtual scanning of the arterial phase and the virtual scanning of the venous and delayed phases, and there were no significant differences ( $P > 0.05$ ) in the SD values and SNR of the liver of the virtual scanning of the venous and delayed phases.

#### CONCLUSION

The image quality of spectral CT virtual scanning was higher than conventional true scanning, the lowest CT Dose Index (CTDI) was in the delayed phase, while the virtual scanning image quality in the delayed phase was better than the virtual scanning image quality in the arterial phase, and they are no difference significantly between the image quality in the portal phase and delayed phase.

#### CLINICAL RELEVANCE/APPLICATION

Spectral CT abdominal enhancement virtual scanning allows for the selection of delayed-period virtual scanning images instead of true scanning, this can reduce the number of scans, decrease radiation dose, and improve image quality.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPPH-8

### **Silver (Ag) X-ray Spectrum Modulation Filter vs. Copper (Cu) X-ray Spectrum Modulation Filter: Capability of Low-Dose CT for Lung Cancer Screening at *In Vitro* and *In Vivo* Studies**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

#### **PURPOSE**

To compare the capability of low-dose CT for lung cancer screening between newly developed silver (Ag) and traditionally applied copper (Cu) x-ray beam spectral modulation filters at in vitro and in vivo studies.

#### **METHODS AND MATERIALS**

A chest CT phantom including simulated ground-glass and part-solid nodules was scanned with a 320-detector row CT with Ag and Cu filters at 0.6, 1.6 and 2.5 mGys and reconstructed with hybrid-type iterative reconstruction (IR) method at in vitro study. Then, 95 patients who underwent low-dose CT lung cancer screening with Ag and Cu filters at same radiation dose level (i.e. 1.6mGy) as well as standard-dose CT examination within 3 months were retrospectively included to in vivo study. At in vivo study, the same reconstruction method was applied. At in vitro study, SNR at each nodule were determined by region of interest (ROI) measurements at all protocols. At each simulated nodule, the probability of nodule was assessed with 5-point visual score by two board-certified chest radiologists. All final scores were determined as consensus of two readers. At in vivo study, SNR of normal lung parenchyma was also determined by ROI measurement at each low-dose CT. Then, the probability of nodule equal to or more than 4 mm in long-axis diameter was also assessed with 5-point scale by same board-certified chest radiologists. Student's t-test was performed to compare SNR of CT data between Ag and Cu filters at in vitro and in vivo studies. At in vitro study, ROC analyses were performed to compare nodule detection capability between Ag and Cu filters on each radiation dose data. At in vivo study, JAFROC analysis was performed to compare nodule detection capability between Ag and Cu filters. Finally, averaged sensitivity (SE) and false-positive/case (FP/case) were compared by McNemar's test and Wilcoxon's signed rank test.

#### **RESULTS**

At in vitro studies, SNR and AUC of Ag filter were significantly higher than those of Cu filter at each radiation dose ( $p < 0.05$ ). At in vivo study, SNR of Ag filter was significantly higher than that of Cu filter ( $p < 0.05$ ). There were no significant differences of averaged figure of merit (FOM) and FP/case of between Ag (FOM=0.92, FP/case=0.24/case) and Cu (FOM=0.91,  $p > 0.05$ ; FP/case=0.24/case,  $p > 0.05$ ) filters. However, averaged sensitivity of low-dose CT with Ag filter (SE=0.88) was significantly higher than that with Cu filter (SE=0.79,  $p < 0.001$ ).

#### **CONCLUSION**

Ag filter can significantly improve image quality and nodule detection capability than Cu filter on low-dose CT screening at *in vitro* and *in vivo* studies.

#### **CLINICAL RELEVANCE/APPLICATION**

Ag filter can significantly improve image quality and nodule detection capability than Cu filter on low-dose CT screening at in vitro and in vivo studies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPPH-9

### Effects of Different Tube Voltages and Different Levels of Hybrid Iterative Reconstruction on the Detection and Characterization of Pulmonary Nodules in Ultra-low-dose Chest CT

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Yue Yao (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the effects of different tube voltages combined with adaptive statistical iterative reconstruction (ASIR-V) algorithms on the detection and characterization of pulmonary nodules by an artificial intelligence software in ultra-low dose chest CT

#### METHODS AND MATERIALS

An anthropomorphic thorax phantom containing 12 spherical simulated nodules served as the reference standard (Diameter: 12, 10, 8, 5 mm; CT value: -800, -630, 100 HU) was scanned at different dose levels with combinations of kVp and tube current: Group A (70kV/30mA:0.11mSv, 100kV/10mA:0.10mSv), Group B (70kV/100mA:0.34mSv, 100kV/30mA:0.32mSV), and Group C (70kV/150mA:0.53, 100kV/50mA:0.51mSV). Scans were repeated 5 times. Four different weights of ASIR-V (0%=FBP, 30%, 50%, 70%) were used to generate images. All images were automatically analyzed using a commercially available artificial intelligence software (Intelligent 4D Imaging System for Chest CT 5.5, YITU Healthcare) and long diameter, short diameter, location and nature of each nodule, and CT and SD values of muscle under each group of conditions were obtained. The detection rate (DR), deformation coefficient (DC) and size measurement deviation percentage (SP) of pulmonary nodules were calculated and compared between groups. The image quality and noise of each group were compared.

#### RESULTS

Under the same ASIR-V weight, the image noise of 70kV was in general lower than that of 100kV group; and noise gradually decreased with the increase of reconstruction weight. Under the same dose level, there was no significant difference in DR of nodules between different kV ( $p>0.05$ ); and DR values in the 70kV group were slightly higher than 100kV at 50%ASIR-V and 70%ASIR-V in Group A, 50%ASIR-V in Group B and 70%ASIR-V in Group C. Higher percentages ASIR-V and 100kV in general had better (lower) DC and SP.

#### CONCLUSION

Detection rates were similar between 70kV and 100kV scans. 70kV had better noise performance under the same ASIR-V percentage, while 100kV and higher ASIR-V percentages were better in preserving the forms of nodules.

#### CLINICAL RELEVANCE/APPLICATION

Under ultra-low radiation dose chest CT, High weight IR is better to balance between nodule detection rate and shape deformation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPRO-1

### Auto-contouring of Brain Metastases for Stereotactic Radiosurgery

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Ho-Hsin Chang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Brain metastases (BMs) are a common complication of cancer and the most common type of brain tumor. Stereotactic radiosurgery (SRS) is a well-established treatment option which allows for the delivery of highly focused radiation allowing for improved sparing of healthy brain tissue when compared to whole-brain radiotherapy leading to better cognitive outcomes after treatment. Highly focused treatments such as SRS require very precise BMs identification and definition. In this study, we train and evaluate the nnUNet's ability to automatically identify and contour BMs for use in radiotherapy planning and treatment assessment.

#### METHODS AND MATERIALS

Post-contrast T1-weighted (T1w+C) MR scans and planning records from 784 SRS patients previously treated at our institution using Gamma Knife SRS were used in this study. Physician-drawn BMs contours were extracted for each patient treatment. T1w+C scans were acquired on the same day of treatment using Philips Ingenia 1.5T scanner using an axial 3D fast spin echo sequence using 1mm slice spacing and  $0.449 \times 0.449 - 1 \times 1$  pixel spacing. This dataset was split into training ( $n=759$ ) and final testing ( $n=25$ ) cohorts. We then trained the nnUNet (Isensee, F., et al. Nature methods, 2021) on 2 NVIDIA TITAN RTX 24GB GPU using 5-fold cross validation with 1000 epochs in each fold. The nnUNet is a self-configuring model that has demonstrated high performance in various automatic contouring tasks. Auto-contouring performance was evaluated using Dice similarity coefficient (DSC) and voxel-wise precision and recall.

#### RESULTS

The 25 test cases had 78 BMs defined by the treating physician at the time of treatment (average volume of  $9.91 \pm 15.28$  cm<sup>3</sup>). 75.6% (59/78) of BMs (average volume of  $8.89 \pm 12.07$  cm<sup>3</sup>) were detected by the trained model resulting in an average DSC of 0.84 ( $\pm 0.11$ ), and voxel-wise precision and recall of 0.87 and 0.85, respectively. The nnUNet did not detect 19 physician-defined BMs (24.4%) (average volume  $1.82 \pm 5.74$  cm<sup>3</sup>) and identified 43 BMs which were not defined at the time of treatment (average volume  $0.98 \pm 3.22$  cm<sup>3</sup>).

#### CONCLUSION

Overall, the trained model shows promise in automatically detecting and contouring BMs. However, the current approach is less accurate in identifying smaller BM volumes. Further work is needed to improve automatic identification and contouring performance for these smaller lesions.

#### CLINICAL RELEVANCE/APPLICATION

Accurate detection and definition of brain metastasis volumes through automated solutions could help standardization of delivered treatments across radiation oncology practices. Furthermore, automation of this process could improve treatment assessment on post-treatment imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-SPVA-1

### Evaluation and Comparison of CT Angiography Image Quality Acquired with Single-Energy Metal Artifact Reduction Algorithm and Deep Learning Reconstruction in Patients after Endovascular Aortic Repair

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Zhiman Lai (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess and compare the image quality of hybrid iterative reconstruction (HIR), deep learning reconstruction (DLR), combination of HIR and single-energy metal artifact reduction (SEMAR) algorithm (HIR+SEMAR), and combination of DLR and SEMAR algorithm (DLR+SEMAR) for computed tomography angiography (CTA) examinations in patients after abdominal aortic (AA) endovascular aortic repair (EVAR).

#### METHODS AND MATERIALS

CTA images of 27 patients (mean age  $\pm$  standard deviation,  $68.7 \pm 8.8$  years, 23 male) were reconstructed using HIR, DLR, HIR+SEMAR, and DLR+SEMAR. CT attenuation, image noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) were measured in muscle, liver, AA distant to stents (region 1 of interest, ROI 1), AA near stents and artifacts (ROI 2), AA near stents but not artifacts (ROI 3), mural thrombus with artifacts, and mural thrombus without artifacts. Data were expressed as median (interquartile distribution) for non-normally distributed data. The subjective visual scores (1 for worst -5 for best) of images were obtained for the following: overall image quality and visibility of surrounding organs, vessels outside the scaffold, and stent thrombosis. These parameters were compared among above four methods.

#### RESULTS

HIR+SEMAR or DLR+SEMAR provided higher Hounsfield unit (HU) values in images with artifacts, while there is no statistically significant attenuation in images without artifacts among four methods. The image noise in HU of images with artifacts was significantly lower in HIR+SEMAR or DLR+SEMAR than in HIR and DLR ( $p < 0.001$ ), while the image noise in HU of images without artifacts was significantly lower in the DLR or DLR+SEMAR group than in the HIR and HIR+SEMAR groups ( $p < 0.0001$ ). For images with stents, SNR and CNR were significantly higher in the HIR+SEMAR [6.110 (4.5, 7.9)] or DLR+SEMAR [6.010 (4.7, 10.5)] group than in the HIR [3.080 (1.9, 4.0)] and DLR [2.860 (1.8, 4.6)] groups (SNR of ROI 2, respectively,  $p < 0.001$ ). But the SNR of liver and muscle were significantly higher in the DLR or DLR+SEMAR group than in the HIR and HIR+SEMAR groups ( $p < 0.0001$ ). The subjective visual scores in the DLR+SEMAR were the highest compared those in the images reconstructed with HIR, DLR and HIR+SEMAR ( $p < 0.0001$ ).

#### CONCLUSION

Compared to HIR, DLR, and HIR+SEMAR, DLR+SEMAR provides superior image quality in terms of quantitative and qualitative parameters, not only markedly reducing metal artifacts but also improving reliably attenuation of soft tissues.

#### CLINICAL RELEVANCE/APPLICATION

The combination of DLR and SEMAR algorithm technique significantly improving CTA image quality not only in the images with metal artifacts but also in those without metal artifacts in patients after EVAR, beneficial for postoperative surveillance.

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## Abstract Archives of the RSNA, 2023

R2-SPVA-2

### Ultra-High-Resolution Photon-Counting Detector CT Angiography of the Lower Limbs

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Dirk Graafen, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Peripheral arterial disease frequently affects the lower limbs, and heavy calcifications may reduce the accuracy of CT-angiography. Photon-counting detector (PCD) CT offers improved image quality for CT angiography, recently demonstrated for coronary artery evaluation. However, no previous study investigated the potential of PCD-CT angiography for the assessment of the lower limbs. Therefore, the aim of this study was to identify the optimal reconstruction parameters for ultra-high-resolution (UHR) PCD-CT angiography of the lower limbs in a phantom and patient study.

#### METHODS AND MATERIALS

Silicone pipes with five different inner diameters (1 to 5 mm) were filled with different iodine concentrations (0, 4.63, 9.25, 18.5, and 37.0 mg I/cm<sup>3</sup>) and scanned in a water container using six different radiation doses (CTDI = 1, 2, 3, 4, 10, and 30 mGy). Virtual monoenergetic images at 55 keV were reconstructed with 0.4 mm isotropic resolution using the quantitative kernels with all ten available sharpness levels (Qr36 to Qr76) combined with the three highest levels of Quantum iterative reconstruction (QIR-2 to QIR-4). Noise levels and sharpness (maximal slope values at the pipe walls) were determined for all reconstructions. Additionally, clinical CT angiographies of 20 patients were reconstructed with a normal (Qr-44), sharp (Qr-60), and ultra-sharp (Qr-72) kernel at QIR2-4. Three raters performed a qualitative analysis of these images with a 5-point Likert scale assessing noise, delineation of plaques and vessel walls, and overall image quality.

#### RESULTS

Increase kernel sharpness led to higher image noise, e.g., for 4 mGy CTDI and QIR-2, noise level was 11 HU for Qr36, 45 HU for Qr60, and 141 HU for Qr76. Maximum slope values increase relevantly until a sharpness level of 60, while higher sharpness levels only yield small additional improvements. QIR clearly decreases noise with higher levels without reducing the maximum slope. Qualitative analysis of the clinical images confirmed these findings. Worse noise scores were given for higher sharpness levels, while no improvement in the delineation of plaques and vessel walls was found between the sharp and ultra-sharp kernel. The sharp kernel (Qr-60) with the highest QIR level (QIR-4) yielded the best overall quality.

#### CONCLUSION

Reconstruction kernels with optimized sharpness level in combination with the highest QIR level yield the best image quality for UHR-PCD-CT angiography of the lower limbs, which is Qr60 for 0.4 mm isotropic voxels with edge lengths of 0.4 mm.

#### CLINICAL RELEVANCE/APPLICATION

Using UHR-PCD-CT angiography with optimized reconstruction parameters might improve diagnostic accuracy and confidence in peripheral artery disease of the lower limbs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-STCE1

### Science Session (Generative AI)

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 1

#### Sub-Events

#### **R2-STCE1-1 Detecting Prior References and Inconsistencies in Follow-up CT Reports using Instruction-tuned Large Language Model : A Multilingual Feasibility Study**

Yisak Kim (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Development of a large language model(LLM)-based model to detect prior references and find inconsistencies in follow-up computational tomography(CT) reports written in Korean and English.

##### **METHODS AND MATERIALS**

We retrospectively searched patients who had visited the department of oncology in 2008 and undergone chest CT. A total of 123,620 chest CT reports from 10,455 patients written in Korean and English between 2001.01.01~2023.06.30 were included. 2,461 reports from 1,310 randomly selected patients were used as a developmental dataset and prior references were manually labeled. Of these, 1,210 cases had no prior reference, and the rest contained one or more prior references. Also, 1,346 reports from 100 randomly selected patients were used as a test dataset. We used KoAlpaca 7B, a fine-tuned version of LLaMA using Korean and English dataset, as a backbone, and performed instruction-tuning with developmental dataset. The performance of the instruction-tuned model was evaluated by manually checking whether the prior reference was accurately detected.

##### **RESULTS**

Our instruction-tuned LLM-based model correctly finds prior reference in 1,280 of 1,346 reports (95.1%). We manually analyzed the missed 66 reports and found that 42 of 66 reports have factual errors in prior reference(e.g. incorrectly write prior CT date as current CT date), so the actual missed rate is about 1.8% (24 of 1,346). From the 1,280 cases where our model correctly found the prior reference, 75 cases were found to have inconsistencies between prior and current reports. We manually evaluated the 75 cases and confirmed that all cases have actual errors such as inconsistent nodule size and incorrect CT exam date.

##### **CONCLUSION**

Our multilingual instruction-tuned LLM-based model could detect the prior references in given reports written in Korean and English, and evaluate whether there are inconsistencies between the prior and current reports. With further instruction-tuning, our LLM-based model has potential to effectively perform various follow-up tasks, such as follow-up history summarization or converting follow-up reports into structured forms.

##### **CLINICAL RELEVANCE/APPLICATION**

The proposed model may assist in finding prior reference in multilingual reports and alarm if there are any inconsistencies between prior and current reports.

#### **R2-STCE1-2 Leveraging GPT-4 for Error Detection on Brain CT Report : A Comparative Study of Different Report Formats and Error Types**

Songsoo Kim, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To assess the capability of GPT-4 in error detection within radiology reports.



## METHODS AND MATERIALS

The data used in this study are 100 synthesized structured brain CT reports as a control group, and 200 brain CT reports randomly sampled from the MIMIC-III database, sourced from Beth Israel Deaconess Medical Center. The following types of errors were defined and applied to the reports: Interpretive error 1a: Substitution of one impression with another, Interpretive error 1b: Omission of most critical impression, Interpretive error 1c: Addition of incorrect impression, Factual error 2a: Discrepancy in the location of the lesion, Factual error 2b: Discrepancy in the numerical measurement. The synthesis of the reports and application of errors were carried out by two board-certified radiologists. Finally we evaluated GPT-4's error detection and correction.

## RESULTS

GPT-4 reviewed 587 reports, including 200 synthesized data (100 with errors, 100 without errors), and 387 MIMIC data (187 with errors, 200 without errors) with average word counts of 125 and 371 respectively. GPT-4 detected and rectified errors in 82% of synthesized cases, but incorrectly revised 10%, and missed 8%. In the MIMIC data, 72% of errors were detected and corrected, 3% were revised incorrectly, and 25% were missed. The error detection performance of GPT-4 exhibited a recall of 0.92 and precision of 0.98 in synthesized data, and a recall of 0.75 and precision of 0.95 in the MIMIC data. The detection rate for Type 1 errors was 75.1%, and 92% on Type 2 errors. Notably, Type 1b detection fell to 18% with over three or more items in the impression on MIMIC-III reports.

## CONCLUSION

GPT-4 demonstrates a remarkable capacity for both error detection and high-quality error revision, suggesting its significant potential within the field of radiology. It performs particularly well in detecting errors in factual information, structured reports, shorter reports, and reports with fewer impressions. However, GPT-4 did not consider it an error even when critical impressions were removed in reports with a large number of impressions, resulting in a significant decrease in performance. This suggests that while GPT-4 excels at understanding sentence structures, it may struggle to accurately assess clinical significance of the impressions.

## CLINICAL RELEVANCE/APPLICATION

GPT-4 has demonstrated strong performance in detecting factual errors, suggesting its potential in identifying small but critical mistakes in radiology report creation. However, given its apparent limitations in assessing clinical significance, its application may be limited in reports with a large number of impressions or lengthy content.

## R2-STCE1-3 Few-Shot Prompting for Labeling Free-Text Radiology Report Using GPT-4

Songsoo Kim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to validate the capability of the GPT-4 in labeling free-text radiology reports leveraging few shot prompting.

## METHODS AND MATERIALS

Materials and Methods: Radiology reports were obtained from the MIMIC-III database, sourced from Beth Israel Deaconess Medical Center, and labeled by two board-certified radiologists. GPT-4 was then assigned three different labeling tasks, employing a "few-shot prompting" strategy, which involved instructing the model using a small set of examples that explicitly demonstrate the task and the expected output, thereby guiding its performance and improving its precision.

## RESULTS

In the multi-label classification of 200 brain CT reports using nine labels (normal, mass, fracture, hemorrhage, vascular, infarct, post-surgical, volume loss, and hydrocephalus), GPT-4 exhibited a general improvement in performance with the use of few-shot prompts, in comparison to zero-shot. Precision increased from 0.803 to 0.957, recall decreased slightly from 0.976 to 0.961, and the F1 score increased from 0.881 to 0.959. For BIRADS category labeling applied to 136 Breast US and 585 mammography cases, the precision increased from 0.824 and 0.847 to 0.831 and 0.845 respectively, the recall increased from 0.803 and 0.821 to 0.831 and 0.824, and the F1 score increased from 0.795 and 0.823 to 0.824 and 0.826. Lastly, for the emergent report labeling for 400 abdomen/pelvis CT cases, accuracy increased from 0.853 to 0.958, precision increased from 0.510 to 0.824, recall increased from 0.820 to 0.918, and the F1 score increased from 0.629 to 0.868.

## CONCLUSION

GPT-4 achieved reliable performance on three different labeling tasks on free-text radiology reports. Specifically, the use of few-shot prompts yielded superior results compared to zero-shot prompts, demonstrating the value of prompt engineering with GPT-4 in radiology applications.

## CLINICAL RELEVANCE/APPLICATION

GPT-4 can be applied to labeling tasks in free-text radiology reports across various modalities and anatomical areas, even in the absence of specific training data. This offers a simpler and more flexible approach compared to traditional NLP methods.

The utility of GPT-4 extends to a wide array of tasks, such as reusing labels for supervised AI model training, aiding in report archiving, and facilitating clinical decision-making, even in situations with scarce data.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-STCE1-1

### **Detecting Prior References and Inconsistencies in Follow-up CT Reports using Instruction-tuned Large Language Model : A Multilingual Feasibility Study**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 1

Yisak Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Development of a large language model(LLM)-based model to detect prior references and find inconsistencies in follow-up computational tomography(CT) reports written in Korean and English.

#### **METHODS AND MATERIALS**

We retrospectively searched patients who had visited the department of oncology in 2008 and undergone chest CT. A total of 123,620 chest CT reports from 10,455 patients written in Korean and English between 2001.01.01~2023.06.30 were included. 2,461 reports from 1,310 randomly selected patients were used as a developmental dataset and prior references were manually labeled. Of these, 1,210 cases had no prior reference, and the rest contained one or more prior references. Also, 1,346 reports from 100 randomly selected patients were used as a test dataset. We used KoAlpaca 7B, a fine-tuned version of LLaMA using Korean and English dataset, as a backbone, and performed instruction-tuning with developmental dataset. The performance of the instruction-tuned model was evaluated by manually checking whether the prior reference was accurately detected.

#### **RESULTS**

Our instruction-tuned LLM-based model correctly finds prior reference in 1,280 of 1,346 reports (95.1%). We manually analyzed the missed 66 reports and found that 42 of 66 reports have factual errors in prior reference(e.g. incorrectly write prior CT date as current CT date), so the actual missed rate is about 1.8% (24 of 1,346). From the 1,280 cases where our model correctly found the prior reference, 75 cases were found to have inconsistencies between prior and current reports. We manually evaluated the 75 cases and confirmed that all cases have actual errors such as inconsistent nodule size and incorrect CT exam date.

#### **CONCLUSION**

Our multilingual instruction-tuned LLM-based model could detect the prior references in given reports written in Korean and English, and evaluate whether there are inconsistencies between the prior and current reports. With further instruction-tuning, our LLM-based model has potential to effectively perform various follow-up tasks, such as follow-up history summarization or converting follow-up reports into structured forms.

#### **CLINICAL RELEVANCE/APPLICATION**

The proposed model may assist in finding prior reference in multilingual reports and alarm if there are any inconsistencies between prior and current reports.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-STCE1-2

### Leveraging GPT-4 for Error Detection on Brain CT Report : A Comparative Study of Different Report Formats and Error Types

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 1

Songsoo Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the capability of GPT-4 in error detection within radiology reports.

#### METHODS AND MATERIALS

The data used in this study are 100 synthesized structured brain CT reports as a control group, and 200 brain CT reports randomly sampled from the MIMIC-III database, sourced from Beth Israel Deaconess Medical Center. The following types of errors were defined and applied to the reports: Interpretive error 1a: Substitution of one impression with another, Interpretive error 1b: Omission of most critical impression, Interpretive error 1c: Addition of incorrect impression, Factual error 2a: Discrepancy in the location of the lesion, Factual error 2b: Discrepancy in the numerical measurement. The synthesis of the reports and application of errors were carried out by two board-certified radiologists. Finally we evaluated GPT-4's error detection and correction.

#### RESULTS

GPT-4 reviewed 587 reports, including 200 synthesized data (100 with errors, 100 without errors), and 387 MIMIC data (187 with errors, 200 without errors) with average word counts of 125 and 371 respectively. GPT-4 detected and rectified errors in 82% of synthesized cases, but incorrectly revised 10%, and missed 8%. In the MIMIC data, 72% of errors were detected and corrected, 3% were revised incorrectly, and 25% were missed. The error detection performance of GPT-4 exhibited a recall of 0.92 and precision of 0.98 in synthesized data, and a recall of 0.75 and precision of 0.95 in the MIMIC data. The detection rate for Type 1 errors was 75.1%, and 92% on Type 2 errors. Notably, Type 1b detection fell to 18% with over three or more items in the impression on MIMIC-III reports.

#### CONCLUSION

GPT-4 demonstrates a remarkable capacity for both error detection and high-quality error revision, suggesting its significant potential within the field of radiology. It performs particularly well in detecting errors in factual information, structured reports, shorter reports, and reports with fewer impressions. However, GPT-4 did not consider it an error even when critical impressions were removed in reports with a large number of impressions, resulting in a significant decrease in performance. This suggests that while GPT-4 excels at understanding sentence structures, it may struggle to accurately assess clinical significance of the impressions.

#### CLINICAL RELEVANCE/APPLICATION

GPT-4 has demonstrated strong performance in detecting factual errors, suggesting its potential in identifying small but critical mistakes in radiology report creation. However, given its apparent limitations in assessing clinical significance, its application may be limited in reports with a large number of impressions or lengthy content.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-STCE1-3

### Few-Shot Prompting for Labeling Free-Text Radiology Report Using GPT-4

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 1

Songsoo Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to validate the capability of the GPT-4 in labeling free-text radiology reports leveraging few shot prompting.

#### METHODS AND MATERIALS

Materials and Methods: Radiology reports were obtained from the MIMIC-III database, sourced from Beth Israel Deaconess Medical Center, and labeled by two board-certified radiologists. GPT-4 was then assigned three different labeling tasks, employing a "few-shot prompting" strategy, which involved instructing the model using a small set of examples that explicitly demonstrate the task and the expected output, thereby guiding its performance and improving its precision.

#### RESULTS

In the multi-label classification of 200 brain CT reports using nine labels (normal, mass, fracture, hemorrhage, vascular, infarct, post-surgical, volume loss, and hydrocephalus), GPT-4 exhibited a general improvement in performance with the use of few-shot prompts, in comparison to zero-shot. Precision increased from 0.803 to 0.957, recall decreased slightly from 0.976 to 0.961, and the F1 score increased from 0.881 to 0.959. For BIRADS category labeling applied to 136 Breast US and 585 mammography cases, the precision increased from 0.824 and 0.847 to 0.831 and 0.845 respectively, the recall increased from 0.803 and 0.821 to 0.831 and 0.824, and the F1 score increased from 0.795 and 0.823 to 0.824 and 0.826. Lastly, for the emergent report labeling for 400 abdomen/pelvis CT cases, accuracy increased from 0.853 to 0.958, precision increased from 0.510 to 0.824, recall increased from 0.820 to 0.918, and the F1 score increased from 0.629 to 0.868.

#### CONCLUSION

GPT-4 achieved reliable performance on three different labeling tasks on free-text radiology reports. Specifically, the use of few-shot prompts yielded superior results compared to zero-shot prompts, demonstrating the value of prompt engineering with GPT-4 in radiology applications.

#### CLINICAL RELEVANCE/APPLICATION

GPT-4 can be applied to labeling tasks in free-text radiology reports across various modalities and anatomical areas, even in the absence of specific training data. This offers a simpler and more flexible approach compared to traditional NLP methods. The utility of GPT-4 extends to a wide array of tasks, such as reusing labels for supervised AI model training, aiding in report archiving, and facilitating clinical decision-making, even in situations with scarce data.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-STCE2

### Science Session (Theranostics)

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 2

#### Sub-Events

### **R2-STCE2-1 The relationship between preoperative Prostate Imaging Reporting and Data System version 2.1 and Gleason score change after radical prostatectomy**

Jiahui Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the relationship between preoperative Prostate Imaging Reporting and Data System version 2.1 (PI-RADS v2.1) and Gleason score (GS) change after radical prostatectomy (RP).

#### **METHODS AND MATERIALS**

The clinical and MRI data of 225 patients with prostate diseases admitted to our hospital from January 2015 to December 2021 were continuously collected. All patients underwent biopsies followed by RP. Univariate and multivariate analyses were performed to analyse the factors influencing GS change after RP. Receiver operating characteristic curve analysis was performed to estimate the area under curve (AUC) for the prediction of GS upgrading to determine the diagnostic performance of preoperative clinical variables and PI-RADS v2.1.

#### **RESULTS**

GS after RP was upgraded in 91 cases, downgraded in 45 cases and consistent in 89 cases. Univariate analysis showed age, the number of positive biopsy cores (No. of PBCs), biopsy GS (bGS) and PI-RADS v2.1 score were factors driving a postoperative GS change (all  $P < 0.05$ ). Further multivariate regression analysis showed that  $\geq 4$  PBCs, bGS of  $< 7$  and PI-RADS v2.1 score of 4-5 were independent predictors of GS upgrading after RP (all  $P < 0.05$ ). The AUCs of No. of PBCs, bGS and PI-RADS v2.1 score were 0.713, 0.637 and 0.611, respectively. The AUC of the model combining three independent predictors was 0.817, which was greater than those of three aforementioned variables alone (all  $P < 0.05$ ).

#### **CONCLUSION**

No. of PBCs, bGS and PI-RADS v2.1 score could help predict preoperative GS upgrading, which could minimise the possibility of prostate cancer undertreatment.

#### **CLINICAL RELEVANCE/APPLICATION**

For prostate cancer patients with the number of positive biopsy cores  $\geq 4$ , biopsy Gleason score of  $< 7$ , and PI-RADS v2.1 score of 4-5, Gleason score is more likely to be upgraded after radical prostatectomy.

### **R2-STCE2-2 Can a Radiomics-Based Diagnostic Tool Predict Cancer-Associated Cachexia in Stage IV Non-Small-Cell Lung Cancer Patients? A Prospective Study Using Plain CT Imaging**

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cancer-associated cachexia (CAC) is a common complication of advanced non-small cell lung cancer (NSCLC) that typically presents as subcutaneous adipose tissue wasting. However, CAC diagnosis can be confounded by factors such as obesity, edema, pleural effusion, and tumor burden. Radiomics holds promise as an important clinical tool for predicting the occurrence of CAC and prognosis in patients with newly diagnosed advanced NSCLC.

#### **METHODS AND MATERIALS**

We retrospectively collected clinical data and non-contrast-enhanced CT images of the abdomen and pelvis from 94 stage IV NSCLC patients. Patients were divided into CAC ( $n=33$ ) and non-CAC ( $n=61$ ) groups based on weight loss greater than 5%

within 6 months of diagnosis and further divided into training and testing cohorts in a 7:3 ratio. A trained deep convolutional neural network were used for automatic 3D segmentation of subcutaneous adipose tissue, followed by the extraction of radiomics features. We used univariate and multivariate logistic regression analysis to identify clinical characteristics with predictive value, and then applied recursive feature elimination for radiomics feature selection. We built a radiomics model using logistic regression and also developed a clinical-radiomics model by integrating radiomics features and independent predictive clinical factors. Each selected radiomics feature is multiplied by its corresponding weight and then weighted sum is calculated to obtain the radiomics score to predict the overall survival.

## RESULTS

There were no significant differences in the volume of the pre-treatment tissue between the CAC ( $2323.11 \pm 1187.44$  cm<sup>3</sup>) and non-CAC groups ( $2949.08 \pm 1365.88$  cm<sup>3</sup>,  $P=0.13$ ). Sex (OR: 0.24; 95% CI: 0.07-0.83;  $P=0.02$ ) and skeletal muscle mass index (OR: 0.94; 95% CI: 0.84-0.99;  $P=0.03$ ) were identified as independent risk factors for CAC, but the corresponding clinical model had poor predictive performance [AUC: 0.75 (95% CI: 0.56-0.93)]. The radiomics model using six features had the best predictive performance for CAC [AUC: 0.83 (95% CI: 0.63-0.97)], and the clinical-radiomics model had similar predictive performance [AUC: 0.87 (95% CI: 0.733-0.937),  $P=0.54$ ]. Patients with higher radiomics scores had significantly shorter overall survival (high radiomics score vs. low radiomics score: 13 months vs. 43 months,  $P<0.001$ ).

## CONCLUSION

Radiomics features extracted from subcutaneous adipose tissue on CT images at initial diagnosis can predict future CAC occurrence and prognosis in stage IV NSCLC patients.

## CLINICAL RELEVANCE/APPLICATION

Radiomics features can predict the future development of CAC, thereby enabling early nutritional intervention to improve the quality of life and survival of patients with advanced cancer.

## R2-STCE2-3 Left atrial myocardial fibrosis assessed with 3D high-resolution LGE-MRI in patients with atrial fibrillation

Leyi Zhu (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the clinical value of three-dimensional (3D) high-resolution late gadolinium enhancement magnetic resonance imaging (LGE-MRI) in accessing left atrial myocardial fibrosis in patients with atrial fibrillation (AF).

## METHODS AND MATERIALS

A total of 35 AF patients referred for hybrid surgical ablation were prospectively enrolled in this study. 3D-LGE-MRI images were acquired by the Siemens 3.0 T machine and analyzed by using ADAS post-processing software independently by two experienced radiologists to obtain parameters such as the area and the area percentage of LGE. Image quality was evaluated by two radiologists. Regional analysis was performed by one radiologist at ten left atrial segments. The Kappa test was used to assess the agreement for scoring image quality, and the interclass correlation coefficient (ICC) was used to evaluate the interobserver agreement of LGE parameters. The parameters of left atrial morphology, area (and area percentage) of LGE, and location of LGE were compared between patients with persistent AF and paroxysmal AF by using the t-test or Mann-Whitney U test.

## RESULTS

Images of 34 patients (97%) were considered of diagnostic value. The scores of the overall image quality and the clarity of the left atrial wall evaluated by two radiologists were ( $2.88 \pm 0.64$ ) points and ( $3.26 \pm 0.75$ ) points (radiologist 1), ( $2.97 \pm 0.58$ ) points and ( $3.24 \pm 0.70$ ) points (radiologist 2), respectively. The corresponding Kappa values were 0.724 and 0.859. Both the area and the area percentage of LGE showed good consistency among observers, and the ICCs were 0.969 and 0.950, respectively. Compared with patients with paroxysmal AF, patients with persistent AF had a higher Utah stage and more severe myocardial fibrosis in the right inferior pulmonary vein antrum and the left atrial septum (all  $P<0.05$ ).

## CONCLUSION

The extent of left atrial fibrosis in patients with persistent AF is more severe than that in patients with paroxysmal AF, with a preferential distribution in the right inferior pulmonary vein antrum and the left atrial septum.

## CLINICAL RELEVANCE/APPLICATION

3D high-resolution LGE-MRI provides a non-invasive way to visualize and quantify left atrial myocardial fibrosis in patients with AF.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-STCE2-1

### The relationship between preoperative Prostate Imaging Reporting and Data System version 2.1 and Gleason score change after radical prostatectomy

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 2

Jiahui Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the relationship between preoperative Prostate Imaging Reporting and Data System version 2.1 (PI-RADS v2.1) and Gleason score (GS) change after radical prostatectomy (RP).

#### METHODS AND MATERIALS

The clinical and MRI data of 225 patients with prostate diseases admitted to our hospital from January 2015 to December 2021 were continuously collected. All patients underwent biopsies followed by RP. Univariate and multivariate analyses were performed to analyse the factors influencing GS change after RP. Receiver operating characteristic curve analysis was performed to estimate the area under curve (AUC) for the prediction of GS upgrading to determine the diagnostic performance of preoperative clinical variables and PI-RADS v2.1.

#### RESULTS

GS after RP was upgraded in 91 cases, downgraded in 45 cases and consistent in 89 cases. Univariate analysis showed age, the number of positive biopsy cores (No. of PBCs), biopsy GS (bGS) and PI-RADS v2.1 score were factors driving a postoperative GS change (all  $P < 0.05$ ). Further multivariate regression analysis showed that =4 PBCs, bGS of <7 and PI-RADS v2.1 score of 4-5 were independent predictors of GS upgrading after RP (all  $P < 0.05$ ). The AUCs of No. of PBCs, bGS and PI-RADS v2.1 score were 0.713, 0.637 and 0.611, respectively. The AUC of the model combining three independent predictors was 0.817, which was greater than those of three aforementioned variables alone (all  $P < 0.05$ ).

#### CONCLUSION

No. of PBCs, bGS and PI-RADS v2.1 score could help predict preoperative GS upgrading, which could minimise the possibility of prostate cancer undertreatment.

#### CLINICAL RELEVANCE/APPLICATION

For prostate cancer patients with the number of positive biopsy cores =4, biopsy Gleason score of <7, and PI-RADS v2.1 score of 4-5, Gleason score is more likely to be upgraded after radical prostatectomy.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R2-STCE2-2

### Can a Radiomics-Based Diagnostic Tool Predict Cancer-Associated Cachexia in Stage IV Non-Small-Cell Lung Cancer Patients? A Prospective Study Using Plain CT Imaging

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 2

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cancer-associated cachexia (CAC) is a common complication of advanced non-small cell lung cancer (NSCLC) that typically presents as subcutaneous adipose tissue wasting. However, CAC diagnosis can be confounded by factors such as obesity, edema, pleural effusion, and tumor burden. Radiomics holds promise as an important clinical tool for predicting the occurrence of CAC and prognosis in patients with newly diagnosed advanced NSCLC.

#### METHODS AND MATERIALS

We retrospectively collected clinical data and non-contrast-enhanced CT images of the abdomen and pelvis from 94 stage IV NSCLC patients. Patients were divided into CAC (n=33) and non-CAC (n=61) groups based on weight loss greater than 5% within 6 months of diagnosis and further divided into training and testing cohorts in a 7:3 ratio. A trained deep convolutional neural network were used for automatic 3D segmentation of subcutaneous adipose tissue, followed by the extraction of radiomics features. We used univariate and multivariate logistic regression analysis to identify clinical characteristics with predictive value, and then applied recursive feature elimination for radiomics feature selection. We built a radiomics model using logistic regression and also developed a clinical-radiomics model by integrating radiomics features and independent predictive clinical factors. Each selected radiomics feature is multiplied by its corresponding weight and then weighted sum is calculated to obtain the radiomics score to predict the overall survival.

#### RESULTS

There were no significant differences in the volume of the pre-treatment tissue between the CAC (2323.11±1187.44 cm<sup>3</sup>) and non-CAC groups (2949.08±1365.88 cm<sup>3</sup>, P=0.13). Sex (OR: 0.24; 95% CI: 0.07-0.83; P=0.02) and skeletal muscle mass index (OR: 0.94; 95% CI: 0.84-0.99; P=0.03) were identified as independent risk factors for CAC, but the corresponding clinical model had poor predictive performance [AUC: 0.75 (95% CI: 0.56-0.93)]. The radiomics model using six features had the best predictive performance for CAC [AUC: 0.83 (95% CI: 0.63-0.97)], and the clinical-radiomics model had similar predictive performance [AUC: 0.87 (95% CI: 0.733-0.937), P=0.54]. Patients with higher radiomics scores had significantly shorter overall survival (high radiomics score vs. low radiomics score: 13 months vs. 43 months, P<0.001).

#### CONCLUSION

Radiomics features extracted from subcutaneous adipose tissue on CT images at initial diagnosis can predict future CAC occurrence and prognosis in stage IV NSCLC patients.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics features can predict the future development of CAC, thereby enabling early nutritional intervention to improve the quality of life and survival of patients with advanced cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-STCE2-3

### Left atrial myocardial fibrosis assessed with 3D high-resolution LGE-MRI in patients with atrial fibrillation

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center Theater 2

Leyi Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the clinical value of three-dimensional (3D) high-resolution late gadolinium enhancement magnetic resonance imaging (LGE-MRI) in accessing left atrial myocardial fibrosis in patients with atrial fibrillation (AF).

#### METHODS AND MATERIALS

A total of 35 AF patients referred for hybrid surgical ablation were prospectively enrolled in this study. 3D-LGE-MRI images were acquired by the Siemens 3.0 T machine and analyzed by using ADAS post-processing software independently by two experienced radiologists to obtain parameters such as the area and the area percentage of LGE. Image quality was evaluated by two radiologists. Regional analysis was performed by one radiologist at ten left atrial segments. The Kappa test was used to assess the agreement for scoring image quality, and the interclass correlation coefficient (ICC) was used to evaluate the interobserver agreement of LGE parameters. The parameters of left atrial morphology, area (and area percentage) of LGE, and location of LGE were compared between patients with persistent AF and paroxysmal AF by using the t-test or Mann-Whitney U test.

#### RESULTS

Images of 34 patients (97%) were considered of diagnostic value. The scores of the overall image quality and the clarity of the left atrial wall evaluated by two radiologists were  $(2.88 \pm 0.64)$  points and  $(3.26 \pm 0.75)$  points (radiologist 1),  $(2.97 \pm 0.58)$  points and  $(3.24 \pm 0.70)$  points (radiologist 2), respectively. The corresponding Kappa values were 0.724 and 0.859. Both the area and the area percentage of LGE showed good consistency among observers, and the ICCs were 0.969 and 0.950, respectively. Compared with patients with paroxysmal AF, patients with persistent AF had a higher Utah stage and more severe myocardial fibrosis in the right inferior pulmonary vein antrum and the left atrial septum (all  $P < 0.05$ ).

#### CONCLUSION

The extent of left atrial fibrosis in patients with persistent AF is more severe than that in patients with paroxysmal AF, with a preferential distribution in the right inferior pulmonary vein antrum and the left atrial septum.

#### CLINICAL RELEVANCE/APPLICATION

3D high-resolution LGE-MRI provides a non-invasive way to visualize and quantify left atrial myocardial fibrosis in patients with AF.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSCA10

### Cardiac Imaging (State of the Art Techniques)

Thursday, Nov. 30 9:30AM - 10:30AM Room: N226

Rozemarijn Vliegenthart, MD, PhD (*Moderator*) Institutional Research Grant, Siemens Healthineers Speaker's Bureau, Siemens Healthineers Speaker's Bureau, Bayer  
Domenico Mastrodicasa, MD (*Moderator*) Stockholder, Segmed, Inc; Consultant, Segmed, Inc

#### Sub-Events

### R3-SSCA10-2 **Ultra-High Resolution Photon-counting Computed Tomography for Coronary Artery Stent Imaging: Image Quality at High-Voltage (140-kVp) and Standard-Voltage (120-kVp)**

Limiao Zou (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to quantitatively evaluate the image quality of photon counting CT (PCCT) on UHR stent imaging at high-voltage (140-kVp) and standard-voltage (120-kVp)

#### METHODS AND MATERIALS

For this in vitro study, a phantom containing six stents of different materials and diameters (2.5-3mm) was scanned with ultra-high resolution (UHR) photon counting CT (PCCT) at 120 kVp and 140 kVp, respectively. Each of the six stents was injected with diluted iodine contrast calibrated to an attenuation of 400HU and placed in an oil-filled container simulating epicardial fat. The UHR images obtained from two voltage were reconstructed using vascular kernels of 10 sharpness levels based on three matrix sizes, using quantum iterative reconstruction (QIR) at a strength level of 3, and a slice thickness of 0.2 mm. The image with a 0.4mm slice thickness and reconstructed with a typical convolution kernel for coronary imaging (BV44) was used as the reference image. The signal-to-noise ratio (SNR), in-stent diameter derived from line profile, sharpness assessed with 10%- 90% edge rise slope (ERS) and stent lumen attenuation increase ratio (SAIR) were evaluated. All measurements are performed automatically by an in-house program with Python (version 3.5) to ensure consistency.

#### RESULTS

No significant differences were found between the standard and high-voltage protocol groups concerning lumen diameter, SNR, ESR, and SAIR. Coronary lumen attenuation and in-stent attenuation of the 120 kVp protocol were significantly higher than those of the 140 kV protocol (all  $p < 0.001$ ). As the kernel sharpness increased across 10 kernels, the SNR decreased and stent sharpness increased at both voltages. The reference image at 0.4mm and bv44 show a significantly higher SNR (6.23 [5.22-8.57] vs 3.77 [2.68-5.88]), lower noise (60.4 [49.1-81.5] vs 113 [74.3-156]) and lower sharpness ( $0.96 \pm 0.34$  vs  $2.11 \pm 0.62$ ) than UHR images.

#### CONCLUSION

UHR mode at 140kV and 120 kVp achieve similar image quality and stent sharpness with a QIR strength of 3. UHR scans and sharp reconstruction kernels on a novel PCCT system significantly increased the sharpness of stent imaging compared with regular scans.

#### CLINICAL RELEVANCE/APPLICATION

The UHR-PCCT with sharp reconstruction kernels allows improved assessment of coronary stent structures.

### R3-SSCA10-3 **Dose-Efficient Ultra-High-Resolution Imaging of Coronary Stents with a CdZnTe-Based Clinical Prototype Photon-Counting Scanner**

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Photon-counting detector (PCD) CT systems have shown great promise in radiation dose reduction, contrast improvement, spectral imaging, and spatial resolution improvement compared to energy-integrating detector (EID) scanners. In this study we evaluated performance of a clinical prototype PCD-CT scanner based on the CdZnTe technology in ultra-high-resolution (UHR) mode to image coronary artery stents at standard and reduced radiation dose.

## METHODS AND MATERIALS

We 3D-printed a series of phantoms mimicking coronary arteries with lumen diameter ( $d$ ) = 3.5 mm. Four coronary artery stents with nominal  $d$  = [2.5-3.5 mm] range were placed inside arteries which were then filled with 35 mg I/mL dilution of iodinated contrast agent. The vessels were placed inside a water tank ( $d$  = 12 cm), which also included calibrated vials of the contrast agent. We scanned the test object with the prototype PCCT scanner and with a commercial EID UHR CT scanner. The detector element sizes at isocenter were  $206 \times 206 \mu\text{m}^2$  and  $250 \times 250 \mu\text{m}^2$  for PCD and EID scanners, respectively. Scan and reconstruction parameters were matched as far as possible within the constraints of the prototype system and included: z-collimation = 4 cm, tube voltage = 120 kVp, exposure = 50, 100, 200 mAs, gantry speed = 1 sec, image matrix size =  $1024 \times 1024$ , in-plane image voxel size =  $195 \times 195 \mu\text{m}^2$ , filtered-backprojection reconstruction algorithm with ultrasharp kernels (EID: FC90, PCD: ramp), slice thickness = 250  $\mu\text{m}$  (EID) and 206  $\mu\text{m}$  (PCD). We measured in-stent lumen diameter, CT number stability, image noise, and contrast-to-noise ratio (CNR), at three dose levels.

## RESULTS

We did not observe a significant difference in lumen measurements between EID and PCD. CT number deviation of water with respect to radiation dose was -0.7 vs 0.5 HU at 100 mAs, and -1.9 vs 1.7 HU at 50 mAs for EID and PCD, respectively. Image noise, measured as standard deviation of 3 cm<sup>2</sup> circular region of interest (ROI) placed in water, was 27.8%, 29.5%, and 28.9% lower for PCD at 200, 100, and 50 mAs, respectively. Iodinated contrast to water CNR was significantly higher for PCD and was improved by 52.9%, 56.5%, and 53.6% at 200, 100, and 50 mAs, respectively.

## CONCLUSION

UHR imaging of coronary stents with a new PCD-CT clinical prototype scanner showed comparable spatial resolution and CT number stability to a UHR EID-CT scanner. Furthermore, PCD-CT showed CNR improvement of up to 56.5% and image noise reduction of up to 29.5%, which translates to 49.7% reduction in radiation dose compared to UHR-EID-CT in noise-matched scans.

## CLINICAL RELEVANCE/APPLICATION

The improved CNR and reduced radiation dose of UHR PCD-CT makes it possible to perform detailed analysis of coronary arteries and in-stent lumen characterization at spatial resolutions of 200  $\mu\text{m}$  and smaller.

## R3-SSCA10-4 Impact of Cardiac Motion and In-vessel Attenuation on Virtual Non-iodine -based Calcium Scoring Using Photon-Counting Detector CT

Tilman S. Emrich, MD (*Presenter*) Speaker, Siemens AG; Travel support, Siemens AG; Advisory Board, Siemens AG

## PURPOSE

Cardiac motion has been shown to affect true non-contrast (TNC)-based coronary artery calcium scoring (CACS). Photon-counting detector (PCD)-CT enables improved spectral separation into several materials, which offers the ability to create virtual non-iodine (VNI) reconstructions based on contrast-enhanced scans. So far, the impact of cardiac motion and contrast media doses has not been assessed for VNI-based CACS. Thus, this study aimed to evaluate the impact of cardiac motion and in-vessel attenuation on CACS using a VNI algorithm on a clinical first-generation PCD-CT and to compare the results to previous virtual non-contrast (VNC) reconstructions.

## METHODS AND MATERIALS

Two artificial vessels with calcifications and different in-vessel attenuations (500 and 800 HU on a standard energy-integrating detector CT at 120 kVp) were scanned on the PCD-CT. Scans were performed at static settings (0 beats per minutes [bpm]) as well as at different heart rates (60, 80, 100 bpm) simulated in a 4-dimensional pattern. VNC and VNI images were reconstructed using a virtual monoenergetic image level of 70keV and quantum iterative reconstruction [QIR] strength level 2. Calcium mass, Agatston scores and cardiac motion susceptibility (CMS)-indices were compared to the physical mass, static scores, as well as between reconstruction, heart rates and attenuations.

## RESULTS

VNI scores significantly decreased with rising heart rates ( $p < 0.01$ ) and showed less underestimation than VNC scores ( $p < 0.001$ ). Only VNI scores were similar to the physical mass at static measurements, and to static scores at 60bpm. Agatston scores using VNI were similar to static scores at 60 and 80 bpm. Standard deviation of CMS-indices was lower for VNI-based than for VNC-based CACS. VNI scores were higher at 500 than 800HU ( $p < 0.001$ ) and higher than VNC scores ( $p < 0.001$ ) with VNI scores at 500 HU showing the lowest deviation from the physical reference.

## CONCLUSION

Cardiac motion and in-vessel attenuation influence VNI-based CACS, but least when calculating Agatston scores, where it outperforms VNC-based CACS.

## CLINICAL RELEVANCE/APPLICATION

VNI-based CACS is more accurate than VNC-based CACS, even at heart rates up to 80 bpm when using Agatston scores. Decreasing scores with increasing in-vessel attenuation have to be taken into account when interpreting VNI-based CACS.

### R3-SSCA10-5 **Image Quality and Radiation dose of Photon-counting CT Coronary Angiography Compared to Energy Integrating CT**

Judith Van Der Bie, MSc (*Presenter*) Institutional support to Erasmus MC from Siemens Healthineers

#### PURPOSE

To objectively assess the image quality of coronary CT angiography (CCTA) with photon-counting CT (PCCT) in comparison with energy-integrating detector (EID) CT for clinically utilized scanning protocols and radiation dose levels.

#### METHODS AND MATERIALS

We retrospectively analysed EID-CT patient scans to obtain the applied tube voltages and corresponding patients' water equivalent diameters. A conical phantom with an iodine insert was scanned on EID-CT using these tube voltages and the relevant phantom diameters. The phantom was subsequently scanned on a PCCT system (NAEOTOM Alpha, Siemens), using a fixed, high tube voltage of 120 kV with CTDIVOL values identical to EID-CT. EID-CT images were reconstructed with slice thickness 0.6 mm, Bv40 kernel and ADMIRE strength 4. PCCT images were reconstructed with slice thickness 0.4 mm, various kernels (Bv40/Bv44/Bv48/Bv56), iterative reconstruction strengths (3/4) and virtual mono-energetic levels (40/45/50/55 keV). Detectability index ( $d'$ ) was used to quantify the visibility of a 3 mm diameter contrast-enhanced artery, accounting for noise, contrast, resolution and human visual perception.

#### RESULTS

Data from 94 patients were included. In medium ( $n=73$ ), large ( $n=17$ ) and extra-large ( $n=4$ ) sized patients, a tube voltage of 70, 80 or 90 kV was applied. For the phantom experiments, water equivalent diameters of 24, 29, and 34 cm were scanned at a CTDIVOL of 3, 6, and 12 mGy. Despite thinner slices in PCCT, noise did not change compared to EID-CT. Contrast in PCCT at the clinically used 55 keV was lower (~15%) for medium and large-sized patients compared to EID-CT. Consequently,  $d'$  for EID-CT was 7%-15% higher than for PCCT with a Bv40 strength 4 kernel. This difference could be mitigated by lowering the keV-level to 40 keV. In extra-large patients, the detectability was up to 24% higher for PCCT than for EID-CT, allowing reconstruction with sharper kernels without a dose penalty.

## CONCLUSION

In extra-large patients, PCCT at 120 kV allows for CCTA at improved spatial resolution without increasing radiation dose or affecting vessel detectability. Due to the reduced image contrast in medium and large-sized patients, i.e. in the vast majority of the population investigated, higher doses are necessary to maintain image quality in high-resolution PCCT. The alternative of using lower mono-energetic levels requires further evaluation in clinical practice.

## CLINICAL RELEVANCE/APPLICATION

PCCT enables improved spatial resolution and advanced spectral data-based post-processing techniques provided that a high tube voltage is utilized. Insights into the impact of 0.4 mm slice thickness, high voltage PCCT on coronary vessel visibility and radiation dose facilitates the justification of this technique.

### R3-SSCA10-6 **Super-Resolution Deep Learning Reconstruction to Improve Image Quality of Coronary CT Angiography**

Nobuo Tomizawa, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to compare subjective and objective image quality in coronary CT angiography using model-based iterative reconstruction (MBIR) and super-resolution deep learning reconstruction (SR-DLR) with reduced radiation dose. The diagnostic performance to detect >50% stenosis on coronary angiography was also compared.

#### METHODS AND MATERIALS

This single-center retrospective study included 52 patients (mean age, 68 years  $\pm$  10 [SD]; 41 men) who underwent coronary CT angiography and subsequent coronary angiography between January and November 2022. MBIR and SR-DLR was used for reconstruction in the first 25 and later 27 patients, respectively. The target SDs to determine the tube current was 22 and 26, respectively. Subjective image quality was evaluated using a four-point quality score (1 = poor, 4 = excellent). Noise at the aortic root and contrast-to-noise ratio (CNR) at the left main trunk were measured. Per-vessel

diameter stenosis was evaluated using a workstation. Diagnostic performance to detect >50% stenosis in coronary angiography was compared by analyzing receiver operating characteristic (ROC) curves.

## **RESULTS**

The mean tube current in the MBIR group was 846 mA  $\pm$  123, which reduced to 788 mA  $\pm$  139 ( $p = 0.04$ ) in the SR-DLR group. Compared to MBIR images, SR-DLR images had less image noise ( $14.6 \pm 1.3$  vs.  $22.7 \pm 4.4$ ,  $p < 0.001$ ) and higher CNR ( $37.0 \pm 8.5$  vs.  $22.1 \pm 4.6$ ,  $p < 0.001$ ). Subjective image quality scores were higher for SR-DLR images with a median of 4 (interquartile range [IQR], 4-4) versus 3 (IQR, 3-4;  $p < 0.001$ ) for MBIR images. The area under the ROC curve to diagnose >50% stenosis on coronary angiography did not differ between the SR-DLR (0.96, 95% CI: 0.92, 0.99) and MBIR (0.96, 95% CI: 0.92, 0.99) groups ( $p = 0.98$ ).

## **CONCLUSION**

The use of SR-DLR with 7% lower tube current than MBIR for reconstruction of coronary CT angiography improved subjective and objective image quality with comparable diagnostic performance in detecting >50% stenosis on coronary angiography.

## **CLINICAL RELEVANCE/APPLICATION**

Compared to MBIR, SR-DLR improves image quality of coronary CT angiography by reducing noise with comparable diagnostic performance, while reducing the tube current by 7%.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSCA10-2

### Ultra-High Resolution Photon-counting Computed Tomography for Coronary Artery Stent Imaging: Image Quality at High-Voltage (140-kVp) and Standard-Voltage (120-kVp)

Thursday, Nov. 30 9:30AM - 10:30AM Room: N226

Limiao Zou (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to quantitatively evaluate the image quality of photon counting CT (PCCT) on UHR stent imaging at high-voltage (140-kVp) and standard-voltage (120-kVp)

#### METHODS AND MATERIALS

For this in vitro study, a phantom containing six stents of different materials and diameters (2.5-3mm) was scanned with ultra-high resolution (UHR) photon counting CT (PCCT) at 120 kVp and 140 kVp, respectively. Each of the six stents was injected with diluted iodine contrast calibrated to an attenuation of 400HU and placed in an oil-filled container simulating epicardial fat. The UHR images obtained from two voltage were reconstructed using vascular kernels of 10 sharpness levels based on three matrix sizes, using quantum iterative reconstruction (QIR) at a strength level of 3, and a slice thickness of 0.2 mm. The image with a 0.4mm slice thickness and reconstructed with a typical convolution kernel for coronary imaging (BV44) was used as the reference image. The signal-to-noise ratio (SNR), in-stent diameter derived from line profile, sharpness assessed with 10%- 90% edge rise slope (ERS) and stent lumen attenuation increase ratio (SAIR) were evaluated. All measurements are performed automatically by an in-house program with Python (version 3.5) to ensure consistency.

#### RESULTS

No significant differences were found between the standard and high-voltage protocol groups concerning lumen diameter, SNR, ESR, and SAIR. Coronary lumen attenuation and in-stent attenuation of the 120 kVp protocol were significantly higher than those of the 140 kV protocol (all  $p < 0.001$ ). As the kernel sharpness increased across 10 kernels, the SNR decreased and stent sharpness increased at both voltages. The reference image at 0.4mm and bv44 show a significantly higher SNR (6.23 [5.22-8.57] vs 3.77 [2.68-5.88]), lower noise (60.4 [49.1-81.5] vs 113 [74.3-156]) and lower sharpness ( $0.96 \pm 0.34$  vs  $2.11 \pm 0.62$ ) than UHR images.

#### CONCLUSION

UHR mode at 140kv and 120 kVp achieve similar image quality and stent sharpness with a QIR strength of 3. UHR scans and sharp reconstruction kernels on a novel PCCT system significantly increased the sharpness of stent imaging compared with regular scans.

#### CLINICAL RELEVANCE/APPLICATION

The UHR-PCCT with sharp reconstruction kernels allows improved assessment of coronary stent structures.

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## Abstract Archives of the RSNA, 2023

R3-SSCA10-3

### Dose-Efficient Ultra-High-Resolution Imaging of Coronary Stents with a CdZnTe-Based Clinical Prototype Photon-Counting Scanner

Thursday, Nov. 30 9:30AM - 10:30AM Room: N226

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detector (PCD) CT systems have shown great promise in radiation dose reduction, contrast improvement, spectral imaging, and spatial resolution improvement compared to energy-integrating detector (EID) scanners. In this study we evaluated performance of a clinical prototype PCD-CT scanner based on the CdZnTe technology in ultra-high-resolution (UHR) mode to image coronary artery stents at standard and reduced radiation dose.

#### METHODS AND MATERIALS

We 3D-printed a series of phantoms mimicking coronary arteries with lumen diameter ( $d$ ) = 3.5 mm. Four coronary artery stents with nominal  $d$  = [2.5-3.5 mm] range were placed inside arteries which were then filled with 35 mg I/mL dilution of iodinated contrast agent. The vessels were placed inside a water tank ( $d$  = 12 cm), which also included calibrated vials of the contrast agent. We scanned the test object with the prototype PCCT scanner and with a commercial EID UHR CT scanner. The detector element sizes at isocenter were  $206 \times 206 \mu\text{m}^2$  and  $250 \times 250 \mu\text{m}^2$  for PCD and EID scanners, respectively. Scan and reconstruction parameters were matched as far as possible within the constraints of the prototype system and included: z-collimation = 4 cm, tube voltage = 120 kVp, exposure = 50, 100, 200 mAs, gantry speed = 1 sec, image matrix size =  $1024 \times 1024$ , in-plane image voxel size =  $195 \times 195 \mu\text{m}^2$ , filtered-backprojection reconstruction algorithm with ultrasharp kernels (EID: FC90, PCD: ramp), slice thickness = 250  $\mu\text{m}$  (EID) and 206  $\mu\text{m}$  (PCD). We measured in-stent lumen diameter, CT number stability, image noise, and contrast-to-noise ratio (CNR), at three dose levels.

#### RESULTS

We did not observe a significant difference in lumen measurements between EID and PCD. CT number deviation of water with respect to radiation dose was -0.7 vs 0.5 HU at 100 mAs, and -1.9 vs 1.7 HU at 50 mAs for EID and PCD, respectively. Image noise, measured as standard deviation of 3 cm<sup>2</sup> circular region of interest (ROI) placed in water, was 27.8%, 29.5%, and 28.9% lower for PCD at 200, 100, and 50 mAs, respectively. Iodinated contrast to water CNR was significantly higher for PCD and was improved by 52.9%, 56.5%, and 53.6% at 200, 100, and 50 mAs, respectively.

#### CONCLUSION

UHR imaging of coronary stents with a new PCD-CT clinical prototype scanner showed comparable spatial resolution and CT number stability to a UHR EID-CT scanner. Furthermore, PCD-CT showed CNR improvement of up to 56.5% and image noise reduction of up to 29.5%, which translates to 49.7% reduction in radiation dose compared to UHR-EID-CT in noise-matched scans.

#### CLINICAL RELEVANCE/APPLICATION

The improved CNR and reduced radiation dose of UHR PCD-CT makes it possible to perform detailed analysis of coronary arteries and in-stent lumen characterization at spatial resolutions of 200  $\mu\text{m}$  and smaller.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSCA10-4

### Impact of Cardiac Motion and In-vessel Attenuation on Virtual Non-iodine -based Calcium Scoring Using Photon-Counting Detector CT

Thursday, Nov. 30 9:30AM - 10:30AM Room: N226

Tilman S. Emrich, MD (*Presenter*) Speaker, Siemens AG; Travel support, Siemens AG; Advisory Board, Siemens AG

#### PURPOSE

Cardiac motion has been shown to affect true non-contrast (TNC)-based coronary artery calcium scoring (CACS). Photon-counting detector (PCD)-CT enables improved spectral separation into several materials, which offers the ability to create virtual non-iodine (VNI) reconstructions based on contrast-enhanced scans. So far, the impact of cardiac motion and contrast media doses has not been assessed for VNI-based CACS. Thus, this study aimed to evaluate the impact of cardiac motion and in-vessel attenuation on CACS using a VNI algorithm on a clinical first-generation PCD-CT and to compare the results to previous virtual non-contrast (VNC) reconstructions.

#### METHODS AND MATERIALS

Two artificial vessels with calcifications and different in-vessel attenuations (500 and 800 HU on a standard energy-integrating detector CT at 120 kVp) were scanned on the PCD-CT. Scans were performed at static settings (0 beats per minutes [bpm]) as well as at different heart rates (60, 80, 100 bpm) simulated in a 4-dimensional pattern. VNC and VNI images were reconstructed using a virtual monoenergetic image level of 70keV and quantum iterative reconstruction [QIR] strength level 2. Calcium mass, Agatston scores and cardiac motion susceptibility (CMS)-indices were compared to the physical mass, static scores, as well as between reconstruction, heart rates and attenuations.

#### RESULTS

VNI scores significantly decreased with rising heart rates ( $p < 0.01$ ) and showed less underestimation than VNC scores ( $p < 0.001$ ). Only VNI scores were similar to the physical mass at static measurements, and to static scores at 60bpm. Agatston scores using VNI were similar to static scores at 60 and 80 bpm. Standard deviation of CMS-indices was lower for VNI-based than for VNC-based CACS. VNI scores were higher at 500 than 800HU ( $p < 0.001$ ) and higher than VNC scores ( $p < 0.001$ ) with VNI scores at 500 HU showing the lowest deviation from the physical reference.

#### CONCLUSION

Cardiac motion and in-vessel attenuation influence VNI-based CACS, but least when calculating Agatston scores, where it outperforms VNC-based CACS.

#### CLINICAL RELEVANCE/APPLICATION

VNI-based CACS is more accurate than VNC-based CACS, even at heart rates up to 80 bpm when using Agatston scores. Decreasing scores with increasing in-vessel attenuation have to be taken into account when interpreting VNI-based CACS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSCA10-5

### Image Quality and Radiation dose of Photon-counting CT Coronary Angiography Compared to Energy Integrating CT

Thursday, Nov. 30 9:30AM - 10:30AM Room: N226

Judith Van Der Bie, MSc (*Presenter*) Institutional support to Erasmus MC from Siemens Healthineers

#### PURPOSE

To objectively assess the image quality of coronary CT angiography (CCTA) with photon-counting CT (PCCT) in comparison with energy-integrating detector (EID) CT for clinically utilized scanning protocols and radiation dose levels.

#### METHODS AND MATERIALS

We retrospectively analysed EID-CT patient scans to obtain the applied tube voltages and corresponding patients' water equivalent diameters. A conical phantom with an iodine insert was scanned on EID-CT using these tube voltages and the relevant phantom diameters. The phantom was subsequently scanned on a PCCT system (NAEOTOM Alpha, Siemens), using a fixed, high tube voltage of 120 kV with CTDIVOL values identical to EID-CT. EID-CT images were reconstructed with slice thickness 0.6 mm, Bv40 kernel and ADMIRE strength 4. PCCT images were reconstructed with slice thickness 0.4 mm, various kernels (Bv40/Bv44/Bv48/Bv56), iterative reconstruction strengths (3/4) and virtual mono-energetic levels (40/45/50/55 keV). Detectability index ( $d'$ ) was used to quantify the visibility of a 3 mm diameter contrast-enhanced artery, accounting for noise, contrast, resolution and human visual perception.

#### RESULTS

Data from 94 patients were included. In medium ( $n=73$ ), large ( $n=17$ ) and extra-large ( $n=4$ ) sized patients, a tube voltage of 70, 80 or 90 kV was applied. For the phantom experiments, water equivalent diameters of 24, 29, and 34 cm were scanned at a CTDIVOL of 3, 6, and 12 mGy. Despite thinner slices in PCCT, noise did not change compared to EID-CT. Contrast in PCCT at the clinically used 55 keV was lower (~15%) for medium and large-sized patients compared to EID-CT. Consequently,  $d'$  for EID-CT was 7%-15% higher than for PCCT with a Bv40 strength 4 kernel. This difference could be mitigated by lowering the keV-level to 40 keV. In extra-large patients, the detectability was up to 24% higher for PCCT than for EID-CT, allowing reconstruction with sharper kernels without a dose penalty.

#### CONCLUSION

In extra-large patients, PCCT at 120 kV allows for CCTA at improved spatial resolution without increasing radiation dose or affecting vessel detectability. Due to the reduced image contrast in medium and large-sized patients, i.e. in the vast majority of the population investigated, higher doses are necessary to maintain image quality in high-resolution PCCT. The alternative of using lower mono-energetic levels requires further evaluation in clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

PCCT enables improved spatial resolution and advanced spectral data-based post-processing techniques provided that a high tube voltage is utilized. Insights into the impact of 0.4 mm slice thickness, high voltage PCCT on coronary vessel visibility and radiation dose facilitates the justification of this technique.

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## Abstract Archives of the RSNA, 2023

R3-SSCA10-6

### Super-Resolution Deep Learning Reconstruction to Improve Image Quality of Coronary CT Angiography

Thursday, Nov. 30 9:30AM - 10:30AM Room: N226

Nobuo Tomizawa, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to compare subjective and objective image quality in coronary CT angiography using model-based iterative reconstruction (MBIR) and super-resolution deep learning reconstruction (SR-DLR) with reduced radiation dose. The diagnostic performance to detect >50% stenosis on coronary angiography was also compared.

#### METHODS AND MATERIALS

This single-center retrospective study included 52 patients (mean age, 68 years  $\pm$  10 [SD]; 41 men) who underwent coronary CT angiography and subsequent coronary angiography between January and November 2022. MBIR and SR-DLR was used for reconstruction in the first 25 and later 27 patients, respectively. The target SDs to determine the tube current was 22 and 26, respectively. Subjective image quality was evaluated using a four-point quality score (1 = poor, 4 = excellent). Noise at the aortic root and contrast-to-noise ratio (CNR) at the left main trunk were measured. Per-vessel diameter stenosis was evaluated using a workstation. Diagnostic performance to detect >50% stenosis in coronary angiography was compared by analyzing receiver operating characteristic (ROC) curves.

#### RESULTS

The mean tube current in the MBIR group was 846 mA  $\pm$  123, which reduced to 788 mA  $\pm$  139 ( $p = 0.04$ ) in the SR-DLR group. Compared to MBIR images, SR-DLR images had less image noise ( $14.6 \pm 1.3$  vs.  $22.7 \pm 4.4$ ,  $p < 0.001$ ) and higher CNR ( $37.0 \pm 8.5$  vs.  $22.1 \pm 4.6$ ,  $p < 0.001$ ). Subjective image quality scores were higher for SR-DLR images with a median of 4 (interquartile range [IQR], 4-4) versus 3 (IQR, 3-4;  $p < 0.001$ ) for MBIR images. The area under the ROC curve to diagnose >50% stenosis on coronary angiography did not differ between the SR-DLR (0.96, 95% CI: 0.92, 0.99) and MBIR (0.96, 95% CI: 0.92, 0.99) groups ( $p = 0.98$ ).

#### CONCLUSION

The use of SR-DLR with 7% lower tube current than MBIR for reconstruction of coronary CT angiography improved subjective and objective image quality with comparable diagnostic performance in detecting >50% stenosis on coronary angiography.

#### CLINICAL RELEVANCE/APPLICATION

Compared to MBIR, SR-DLR improves image quality of coronary CT angiography by reducing noise with comparable diagnostic performance, while reducing the tube current by 7%.

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## Abstract Archives of the RSNA, 2023

R3-SSGI17

### Gastrointestinal Imaging (Ultrasound)

Thursday, Nov. 30 9:30AM - 10:30AM Room: S405

Aya Kamaya, MD (*Moderator*) Royalties, RELX; Research Grant, Canon Medical Systems Corporation  
Hyo-Jin Kang, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **R3-SSGI17-The Reliability and Diagnostic Performance of SRU's 2022 Ultrasound Gallbladder Polyp Management Guidelines for $\geq 7$ mm Polyps**

Bipin P. Nanda, FRCR, MMed (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish the reliability and diagnostic performance of Society of Radiologists in Ultrasound's (SRU) 2022 gallbladder polyp (GBP) management guidelines published in Radiology for polyps of significant size.

#### METHODS AND MATERIALS

All patients who had a  $\geq 7$ mm polyp reported on available ultrasound scans at a specialist center with eventual cholecystectomy over a period of 20 years were included. 2-3 images from the earliest available scan were selected for review by 3 blinded reviewers (1 fellow, 2 staff). Shape (thin stalk/thick stalk/sessile) wall thickening  $\geq 4$ mm were used to classify SRU risk category (SRU-Risk: extremely-low/low/intermediate) and along with size formed the SRU management category (SRU-Manage: No follow-up/Follow/Refer-to-surgeon). Reviewers re-evaluated the images twice with minimum 2 weeks separation. Pathology reports were reviewed by a staff pathologist to classify according to WHO2017 terminology, with outcome for SRU-Risk defined as Malignant polyp including high-grade dysplasia carcinoma in-situ) and outcome for SRU-MC defined as Polyps Requiring Resection (all neoplasms). Intra/Interobserver variability as well as Area Under the Curve ROC (AUC-ROC) performance for SRU risk and management categories were calculated.

#### RESULTS

138 patients (Mean age 53.3, range 20-86, 59 female (42.8%)) with median polyp size 9mm (range 7-45) formed the study cohort. 14/138 (10.1%) and 27/138 (16.6%) of patients had MP and PRR respectively (5 Pyloric gland adenoma, 8 Intracholecystic papillary neoplasm, 12 Carcinoma in-situ/Carcinoma, 2 Mets). Intra-observer variability (SRU-Risk) ranged between minimal to almost perfect (Kappa 0.39-0.92). Interobserver variability (SRU-Risk) ranged between minimal to weak (Kappa 0.29-0.45). The AUC ROC/Sensitivity/Specificity for SRU-Risk vs outcome of Malignant polyp ranged between 0.68-0.70, 78.6-100%, and 32.3%-55.6% for the 3 readers. The AUC ROC/sensitivity/Specificity for SRU management category vs outcome of Polyps Requiring Resection ranged between 0.78-0.80, 92.6-96.3% and 27.0-39.6% for the 3 readers.

#### CONCLUSION

Despite the low interobserver and variable intra-observer agreements, the SRU's 2022 Gallbladder Polyp Guidelines manages to perform with high sensitivity and acceptable specificity for all reviewers for the management of  $>7$ mm GBP.

#### CLINICAL RELEVANCE/APPLICATION

The use of shape and wall thickness criteria in addition to polyp size improves the accuracy of predicting malignancy risk and guiding management decisions for gallbladder polyps. This can aid clinicians in determining which patients require imaging follow-up or surgical intervention.

### **R3-SSGI17-The Role of Multiparametric US in Evaluating Advanced Fibrosis in Patients with Nonalcoholic Fatty Liver Disease: A Global Multicenter Study**

Katsutoshi Sugimoto, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Liver fibrosis is a major prognostic factor in nonalcoholic fatty liver disease (NAFLD), and there is a need for a non-invasive and highly accurate tool to assess advanced fibrosis. In this study, we aimed to develop a highly accurate model for identifying NAFLD patients with advanced fibrosis using multiparametric ultrasound (US).

## METHODS AND MATERIALS

This prospective global multicenter study collected data from seven sites, including 65 biopsy-proven NAFLD patients. Five US markers (shear-wave speed [SWS] in m/s, dispersion slope [DS] in (m/sec)/kHz, attenuation coefficient [AC] in dB/cm/MHz, normalized local variance [NLV], and the echo intensity ratio of liver to kidney [L/K ratio]) were measured using a 2D SWE system (Aplio i800, Canon Medical Systems) immediately before biopsy. The biopsy specimens were scored by expert pathologists from one site. Diagnostic performance was assessed using the area under the receiver operating characteristic curve (AUC) for identifying advanced fibrosis (fibrosis stage = F3), and the best-fit multivariable logistic regression model for identifying patients with advanced fibrosis was determined.

## RESULTS

Sixty-five adults (mean age: 53 years  $\pm$  16 [standard deviation], 32 men) underwent a US examination. Among the five US markers, SWS, NLV, and DS enabled the appropriate identification of advanced fibrosis, with an AUC of 0.886 (95% CI: 0.793, 0.980), 0.805 (95% CI: 0.665, 0.946), and 0.790 (95% CI: 0.614, 0.967), respectively. The most predictive model was combination of SWS and NLV, and its performance was satisfactory, with an AUC of 0.908 (95% CI: 0.802, 1.000).

## CONCLUSION

The combination of SWS and NLV improved the diagnostic performance of identifying NAFLD patients with advanced fibrosis compared to SWS alone. Adding NLV information, which shows the difference between the theoretical (normalized) and real (examined) echo amplitude distribution of the liver, to SWS may facilitate patient management and treatment decisions for physicians.

## CLINICAL RELEVANCE/APPLICATION

The combination of SWS and NLV may help physicians identify NAFLD patients with advanced fibrosis, leading to better management and treatment decisions.

## R3-SSGI17- Combined Elastography for Evaluating Liver Inflammation and Fibrosis in Drug-induced Liver Injury Patients: A Multicenter Biopsy-based Study<sup>3</sup>

Liyun Xue, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We assessed the value of combined elastography (combi-elasto) which combines strain and shear wave imaging in evaluating liver inflammation and fibrosis stages in drug-induced liver injury (DILI) patients.

## METHODS AND MATERIALS

This was a multicenter study that enrolled 345 DILI patients who underwent serological examinations, combi-elasto, then liver biopsy for histological diagnosis of inflammatory grades (G0-4) and liver fibrosis stages (F0-4). The indicators of combi-elasto and clinical indices were used to build diagnostic models. Activity index (A index) and fibrosis index (F index), representing the level of liver inflammation and fibrosis respectively, had been given automatically by combi-elasto and were compared with our model. The indicators of the single elastography method, including the velocity of shear wave ( $V_s$ ) and liver fibrosis index (LFI), were also compared for assessing liver fibrosis. Finally, decision trees were constructed to obtain the most probable grade of liver inflammation and fibrosis separately.

## RESULTS

To assess liver inflammation, the model CECI (=G2) and CECI (=G3) outperformed other models and A index, with the area under the curve (AUC) of 0.87 (0.78-0.97) for =G2 and 0.92 (0.86 - 0.98) for =G3 respectively in the test cohort (all  $p$  lt; 0.05). For evaluating liver fibrosis = F2, the diagnostic performance of CECI (=F2) surpassed LFI (AUC: 0.78 [0.65-0.91] vs. 0.54 [0.38-0.69]) ( $p$  = 0.001), and was equivalent to  $V_s$ , F index and other models ( $p$  gt; 0.05). When diagnosing liver fibrosis = F3, CECI (=F3) was superior to single elastography methods and F index, with an AUC of 0.93 (0.87-0.99) (all  $p$  lt; 0.05).

## CONCLUSION

The diagnostic algorithm based on combin-elasto fills in gaps in noninvasively and accurately assessing liver inflammation and fibrosis of DILI with high reliability.

## CLINICAL RELEVANCE/APPLICATION

We demonstrate that diagnostic models based on combi-elastography noninvasively evaluate the severity of liver inflammation activity and the grade of liver fibrosis in DILI patients. This study offers helpful details to enable clinicians to assess the degree of DILI conveniently and noninvasively.

### **R3-SSGI17- Diagnostic Performance of Sonographic Activity Scores for Adult Terminal Ileal Crohn's Disease Compared to Magnetic Resonance Enterography and Histological Reference Standards: Experience from the Metric Trial**

Shankar Kumar, MBBS, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Intestinal ultrasound (IUS) is increasingly used to diagnose and monitor Crohn's disease (CD). There has been much interest in developing sonographic scores that quantify disease activity, in the hope that more systematic interpretation will improve consistency, aid comparison between consecutive examinations and facilitate treatment response assessment. The Simple Ultrasound Score for Crohn's disease (SUS-CD) and bowel ultrasound score (BUSS) are promising and perform well against colonoscopy. They have been derived and evaluated in single or dual-centre studies using few, highly specialised sonographers, so their performance characteristics in generalised practice are unknown. Whilst mucosal assessment with endoscopic or histological scoring are frequently used as a reference standard for disease activity, they neglect transmural disease, something that is captured by cross-sectional imaging, such as magnetic resonance enterography (MRE). Accordingly, we compared SUS-CD and BUSS against histological and MRE reference standards in a post-hoc analysis of a prospective multicentre, multireader trial.

#### **METHODS AND MATERIALS**

Participants recruited to the METRIC trial were studied, including those with available terminal ileal (TI) biopsies. Sensitivity and specificity of SUS-CD and BUSS for TI CD activity were calculated from the prospective observations of the original METRIC trial sonographers against the histological activity index (HAI) and the simplified magnetic resonance index of activity (sMARIA).

#### **RESULTS**

We included 284 patients (median 31.5 years, IQR 23-46, 54% female) from 8 centres, who underwent IUS and MRE. Of these, 111 patients had available terminal ileal biopsies with HAI scoring within 4 weeks of IUS. IUS was performed by one of 19 practitioners. Against histology, sensitivity and specificity for active disease were 79% (95% CI 69-86%) and 50% (31-69%) for SUS-CD, and 66% (56-75%) and 68% (47-84%) for BUSS, respectively. Compared to sMARIA, the sensitivity and specificity for active CD were 81% (74-86%) and 75% (66-83%) for SUS-CD, and 68% (61-74%) and 85% (76-91%) for BUSS, respectively. The sensitivity of SUS-CD was significantly greater than BUSS against HAI and sMARIA ( $p < 0.001$ ), but its specificity was significantly lower than BUSS against the MRE reference standard ( $p = 0.003$ ).

#### **CONCLUSION**

Our study provides real-world evidence that SUS-CD and BUSS are viable IUS indices that are sensitive and specific for active TI CD, especially when compared to an MRE reference standard.

## CLINICAL RELEVANCE/APPLICATION

More studies like ours in prospective multicentre, multireader settings will facilitate external validation of SUS-CD and BUSS, and establish their suitability for adoption into routine clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSGI17-1

### The Reliability and Diagnostic Performance of SRU's 2022 Ultrasound Gallbladder Polyp Management Guidelines for $\geq 7$ mm Polyps

Thursday, Nov. 30 9:30AM - 10:30AM Room: S405

Bipin P. Nanda, FRCR, MMed (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish the reliability and diagnostic performance of Society of Radiologists in Ultrasound's (SRU) 2022 gallbladder polyp (GBP) management guidelines published in Radiology for polyps of significant size.

#### METHODS AND MATERIALS

All patients who had a  $\geq 7$ mm polyp reported on available ultrasound scans at a specialist center with eventual cholecystectomy over a period of 20 years were included. 2-3 images from the earliest available scan were selected for review by 3 blinded reviewers (1 fellow, 2 staff). Shape (thin stalk/thick stalk/sessile) wall thickening  $\geq 4$ mm were used to classify SRU risk category (SRU-Risk: extremely-low/low/intermediate) and along with size formed the SRU management category (SRU-Manage: No follow-up/Follow/Refer-to-surgeon). Reviewers re-evaluated the images twice with minimum 2 weeks separation. Pathology reports were reviewed by a staff pathologist to classify according to WHO2017 terminology, with outcome for SRU-Risk defined as Malignant polyp including high-grade dysplasia carcinoma in-situ) and outcome for SRU-MC defined as Polyps Requiring Resection (all neoplasms). Intra/Interobserver variability as well as Area Under the Curve ROC (AUC-ROC) performance for SRU risk and management categories were calculated.

#### RESULTS

138 patients (Mean age 53.3, range 20-86, 59 female (42.8%)) with median polyp size 9mm (range 7-45) formed the study cohort. 14/138 (10.1%) and 27/138 (16.6%) of patients had MP and PRR respectively (5 Pyloric gland adenoma, 8 Intracholecystic papillary neoplasm, 12 Carcinoma in-situ/Carcinoma, 2 Mets). Intra-observer variability (SRU-Risk) ranged between minimal to almost perfect (Kappa 0.39-0.92). Interobserver variability (SRU-Risk) ranged between minimal to weak (Kappa 0.29-0.45). The AUC ROC/Sensitivity/Specificity for SRU-Risk vs outcome of Malignant polyp ranged between 0.68-0.70, 78.6-100%, and 32.3%-55.6% for the 3 readers. The AUC ROC/sensitivity/Specificity for SRU management category vs outcome of Polyps Requiring Resection ranged between 0.78-0.80, 92.6-96.3% and 27.0-39.6% for the 3 readers.

#### CONCLUSION

Despite the low interobserver and variable intra-observer agreements, the SRU's 2022 Gallbladder Polyp Guidelines manages to perform with high sensitivity and acceptable specificity for all reviewers for the management of  $>7$ mm GBP.

#### CLINICAL RELEVANCE/APPLICATION

The use of shape and wall thickness criteria in addition to polyp size improves the accuracy of predicting malignancy risk and guiding management decisions for gallbladder polyps. This can aid clinicians in determining which patients require imaging follow-up or surgical intervention.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSGI17-2

### **The Role of Multiparametric US in Evaluating Advanced Fibrosis in Patients with Nonalcoholic Fatty Liver Disease: A Global Multicenter Study**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S405

Katsutoshi Sugimoto, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Liver fibrosis is a major prognostic factor in nonalcoholic fatty liver disease (NAFLD), and there is a need for a non-invasive and highly accurate tool to assess advanced fibrosis. In this study, we aimed to develop a highly accurate model for identifying NAFLD patients with advanced fibrosis using multiparametric ultrasound (US).

#### **METHODS AND MATERIALS**

This prospective global multicenter study collected data from seven sites, including 65 biopsy-proven NAFLD patients. Five US markers (shear-wave speed [SWS] in m/s, dispersion slope [DS] in (m/sec)/kHz, attenuation coefficient [AC] in dB/cm/MHz, normalized local variance [NLV], and the echo intensity ratio of liver to kidney [L/K ratio]) were measured using a 2D SWE system (Aplio i800, Canon Medical Systems) immediately before biopsy. The biopsy specimens were scored by expert pathologists from one site. Diagnostic performance was assessed using the area under the receiver operating characteristic curve (AUC) for identifying advanced fibrosis (fibrosis stage = F3), and the best-fit multivariable logistic regression model for identifying patients with advanced fibrosis was determined.

#### **RESULTS**

Sixty-five adults (mean age: 53 years  $\pm$  16 [standard deviation], 32 men) underwent a US examination. Among the five US markers, SWS, NLV, and DS enabled the appropriate identification of advanced fibrosis, with an AUC of 0.886 (95% CI: 0.793, 0.980), 0.805 (95% CI: 0.665, 0.946), and 0.790 (95% CI: 0.614, 0.967), respectively. The most predictive model was combination of SWS and NLV, and its performance was satisfactory, with an AUC of 0.908 (95% CI: 0.802, 1.000).

#### **CONCLUSION**

The combination of SWS and NLV improved the diagnostic performance of identifying NAFLD patients with advanced fibrosis compared to SWS alone. Adding NLV information, which shows the difference between the theoretical (normalized) and real (examined) echo amplitude distribution of the liver, to SWS may facilitate patient management and treatment decisions for physicians.

#### **CLINICAL RELEVANCE/APPLICATION**

The combination of SWS and NLV may help physicians identify NAFLD patients with advanced fibrosis, leading to better management and treatment decisions.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSGI17-3

### Combined Elastography for Evaluating Liver Inflammation and Fibrosis in Drug-induced Liver Injury Patients: A Multicenter Biopsy-based Study

Thursday, Nov. 30 9:30AM - 10:30AM Room: S405

Liyun Xue, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We assessed the value of combined elastography (combi-elasto) which combines strain and shear wave imaging in evaluating liver inflammation and fibrosis stages in drug-induced liver injury (DILI) patients.

#### METHODS AND MATERIALS

This was a multicenter study that enrolled 345 DILI patients who underwent serological examinations, combi-elasto, then liver biopsy for histological diagnosis of inflammatory grades (G0-4) and liver fibrosis stages (F0-4). The indicators of combi-elasto and clinical indices were used to build diagnostic models. Activity index (A index) and fibrosis index (F index), representing the level of liver inflammation and fibrosis respectively, had been given automatically by combi-elasto and were compared with our model. The indicators of the single elastography method, including the velocity of shear wave ( $V_s$ ) and liver fibrosis index (LFI), were also compared for assessing liver fibrosis. Finally, decision trees were constructed to obtain the most probable grade of liver inflammation and fibrosis separately.

#### RESULTS

To assess liver inflammation, the model CECI (=G2) and CECI (=G3) outperformed other models and A index, with the area under the curve (AUC) of 0.87 (0.78-0.97) for =G2 and 0.92 (0.86 - 0.98) for =G3 respectively in the test cohort (all  $p < 0.05$ ). For evaluating liver fibrosis = F2, the diagnostic performance of CECI (=F2) surpassed LFI (AUC: 0.78 [0.65-0.91] vs. 0.54 [0.38-0.69]) ( $p = 0.001$ ), and was equivalent to  $V_s$ , F index and other models ( $p > 0.05$ ). When diagnosing liver fibrosis = F3, CECI (=F3) was superior to single elastography methods and F index, with an AUC of 0.93 (0.87-0.99) (all  $p < 0.05$ ).

#### CONCLUSION

The diagnostic algorithm based on combin-elasto fills in gaps in noninvasively and accurately assessing liver inflammation and fibrosis of DILI with high reliability.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrate that diagnostic models based on combi-elastography noninvasively evaluate the severity of liver inflammation activity and the grade of liver fibrosis in DILI patients. This study offers helpful details to enable clinicians to assess the degree of DILI conveniently and noninvasively.

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## Abstract Archives of the RSNA, 2023

R3-SSGI17-6

### Diagnostic Performance of Sonographic Activity Scores for Adult Terminal Ileal Crohn's Disease Compared to Magnetic Resonance Enterography and Histological Reference Standards: Experience from the Metric Trial

Thursday, Nov. 30 9:30AM - 10:30AM Room: S405

Shankar Kumar, MBBS, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Intestinal ultrasound (IUS) is increasingly used to diagnose and monitor Crohn's disease (CD). There has been much interest in developing sonographic scores that quantify disease activity, in the hope that more systematic interpretation will improve consistency, aid comparison between consecutive examinations and facilitate treatment response assessment. The Simple Ultrasound Score for Crohn's disease (SUS-CD) and bowel ultrasound score (BUSS) are promising and perform well against colonoscopy. They have been derived and evaluated in single or dual-centre studies using few, highly specialised sonographers, so their performance characteristics in generalised practice are unknown. Whilst mucosal assessment with endoscopic or histological scoring are frequently used as a reference standard for disease activity, they neglect transmural disease, something that is captured by cross-sectional imaging, such as magnetic resonance enterography (MRE). Accordingly, we compared SUS-CD and BUSS against histological and MRE reference standards in a post-hoc analysis of a prospective multicentre, multireader trial.

#### METHODS AND MATERIALS

Participants recruited to the METRIC trial were studied, including those with available terminal ileal (TI) biopsies. Sensitivity and specificity of SUS-CD and BUSS for TI CD activity were calculated from the prospective observations of the original METRIC trial sonographers against the histological activity index (HAI) and the simplified magnetic resonance index of activity (sMARIA).

#### RESULTS

We included 284 patients (median 31.5 years, IQR 23-46, 54% female) from 8 centres, who underwent IUS and MRE. Of these, 111 patients had available terminal ileal biopsies with HAI scoring within 4 weeks of IUS. IUS was performed by one of 19 practitioners. Against histology, sensitivity and specificity for active disease were 79% (95% CI 69-86%) and 50% (31-69%) for SUS-CD, and 66% (56-75%) and 68% (47-84%) for BUSS, respectively. Compared to sMARIA, the sensitivity and specificity for active CD were 81% (74-86%) and 75% (66-83%) for SUS-CD, and 68% (61-74%) and 85% (76-91%) for BUSS, respectively. The sensitivity of SUS-CD was significantly greater than BUSS against HAI and sMARIA ( $p < 0.001$ ), but its specificity was significantly lower than BUSS against the MRE reference standard ( $p = 0.003$ ).

#### CONCLUSION

Our study provides real-world evidence that SUS-CD and BUSS are viable IUS indices that are sensitive and specific for active TI CD, especially when compared to an MRE reference standard.

#### CLINICAL RELEVANCE/APPLICATION

More studies like ours in prospective multicentre, multireader settings will facilitate external validation of SUS-CD and BUSS, and establish their suitability for adoption into routine clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSGI18

### Gastrointestinal Imaging (Focal Liver Disease HCC)

Thursday, Nov. 30 9:30AM - 10:30AM Room: S404

Jeong Min Lee, MD, PhD (*Moderator*) Grant, Bayer AG Grant, Canon Medical Systems Corporation Grant, Koninklijke Philips NV Grant, General Electric Healthcare Grant, Guerbet SA Grant, Samsung Electronics Co, Ltd Grant, Bracco Group Grant, Dongkuk Pharma Grant, Starmed Ltd Grant, RF medical Grant, Siemens AG Speakers, Bayer AG Speakers, Philips Healthcare Speakers, Samsung Medison Speakers, GE Healthcare  
Linda C. Kelahan, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### R3-SSGI18- Can Simplified LI-RADS Table Increase the Sensitivity for Hepatocellular Carcinoma 1 Diagnosis in First-time Patients on Extracellular-Contrast Enhanced MRI

Meng Yin, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our study aimed to evaluate the diagnostic performance of the simplified LR-5 category in the simplified LI-RADS table for HCC on extracellular contrast-enhanced MRI (ECA-MRI).

#### METHODS AND MATERIALS

Patients at high risk for HCC who underwent ECA-MRI were enrolled from four independent centers (Center 1, training and internal testing dataset; Centers 2, 3 and 4, external testing dataset). Two blinded radiologists independently evaluated the imaging features and assigned each observation according to LI-RADS v2018. Five simplified LI-RADS 4 (sLR-4) strategies and one simplified LI-RADS 5 (sLR-5) strategy for the no arterial-phase hyperenhancement (APHE) and three sLR-5 strategies for the non-rim APHE columns were evaluated and finally formed a simplified LI-RADS table in the training dataset. The diagnostic performances of nine strategies and simplified LI-RADS table were compared with LI-RADS v2018 using generalized estimating equations (GEEs). Univariable and multivariable logistic regression analysis was performed to determine significant ancillary features for HCC after adjustment with the GEE model for clustering effects.

#### RESULTS

In total, 1014 patients were included [training dataset, N = 656 (492 patients with 595 observations = 30 mm); testing dataset, including internal cohort N = 195 and external cohort N = 163]. Our simplified LI-RADS table was developed and formed by strategy 6 and strategy III in the training dataset, which had 3 columns and 10 cells. Compared with LR-5 v2018, the sLR-5 had higher sensitivities in the training dataset (79.3% vs. 74.8%,  $P < 0.001$ ), small HCC (sHCC) subgroup training dataset (77.2% vs. 72.0%,  $P < 0.001$ ), and testing dataset (78.2% vs. 73.4%,  $P < 0.001$ ), sHCC subgroup testing dataset (82.0% vs. 73.9%,  $P < 0.001$ ), with similar specificities for HCC in the training dataset (93.6% vs. 94.7%,  $P = 0.156$ ), sHCC subgroup training dataset (92.8% vs. 94.2%,  $P = 0.155$ ) and testing dataset (96.4% vs. 97.1%,  $P = 0.317$ ), sHCC subgroup testing dataset (95.7% vs. 96.7%,  $P = 0.317$ ). Utilizing fat in mass coupled with mild-moderate T2 hyperintensity could provide higher sensitivity (81.6% vs. 79.3% and 74.8%, all  $P < 0.001$ ) for HCC, and had comparable specificity to sLR-5 and LR-5 v2018 (93.2% vs. 93.6% and 94.7%, all  $P > 0.05$ ).

#### CONCLUSION

The simplified LI-RADS table significantly increases sensitivity without reducing specificity for diagnosing HCC on extracellular-contrast enhanced MRI.

#### CLINICAL RELEVANCE/APPLICATION

The LI-RADS algorithms are complex and have limited sensitivity. Our results can reduce the perceived complexity in clinical practice and increase sensitivity without reducing specificity for diagnosing HCC and sHCC on ECA-MRI.

### R3-SSGI18- Contrast-enhanced Ultrasound with Two Different Agents Using LI-RADS for the Diagnosis of 2 HCC: A Multicenter Prospective Study

Zhou, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Contrast-enhanced ultrasound (CEUS) LI-RADS applies only to CEUS examinations performed using pure blood pool agents such as sulfur hexafluoride (SHF), noting that future versions will address Kupffer-cell agents such as perfluorobutane (PFB). Such agents are expected to improve the diagnostic sensitivity for HCC by visualization of a defect in the Kupffer phase (obtained >10 minutes after injection). We aimed to conduct a prospective, multicenter study to validate CEUS LI-RADS for both SHF-enhanced US and PFB-enhanced US, and a modified algorithm that classifies certain observations as LR-5 rather than as LR-4 or LR-M based on Kupffer-phase findings for PFB-enhanced US.

## **METHODS AND MATERIALS**

From June 2021 to December 2021, a total of 375 patients (median age, 56±11 yrs; 318 men, 57 women) at high risk for HCC with 424 observations (345 HCCs, 40 non-HCC malignancies, 39 benign lesions; median size, 37±25 mm) were enrolled in the study. Each participant underwent SHF-enhanced US first and followed by PFB-enhanced US for the diagnosis of HCC on the same day. Diagnostic metrics of CEUS LI-RADS for both SHF-enhanced US and PFB-enhanced US, and a modified algorithm for PFB-enhanced US were calculated. Pairwise comparisons of sensitivity, specificity, and accuracy for the diagnosis of HCC were made among three different algorithms using McNemar's test.

## **RESULTS**

PFB-enhanced US and SHF-enhanced US both using CEUS LI-RADS v2017 showed no significant difference (all  $p > .05$ ) in sensitivity (60% vs 58%), specificity (96% vs 95%), and accuracy (67% vs 65%) for the diagnosis of HCC. The modified algorithm for PFB-enhanced US had significantly increased sensitivity (80% vs 58%,  $p < .001$ ), a nonsignificant decrease in specificity (92% vs 95%,  $p = .73$ ), and significantly increased accuracy (82% vs 65%,  $p < .001$ ) compared with CEUS LI-RADS v2017 for SHF-enhanced US.

## **CONCLUSION**

On basis of CEUS LI-RADS v2017, both SHF-enhanced US and PFB-enhanced US achieved high specificity and relatively low sensitivity for the diagnosis of HCC. When incorporating Kupffer-phase findings, PFB-enhanced US had higher sensitivity without significant loss of specificity.

## **CLINICAL RELEVANCE/APPLICATION**

Expanding contrast-enhanced US toolbox with perfluorobutane may help drive better solutions for clinical problems.

## **R3-SSGI18- Deep Learning MRI-based 3D Quantitative Total Tumor Burden for Subcategorization of Barcelona Clinic Liver Cancer Stage A and B HCC after Surgical Resection**

Hong Wei, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate the potential of MRI-based three-dimensional (3D) quantitative tumor burden in subcategorizing Barcelona Clinic Liver Cancer (BCLC) stage A and B hepatocellular carcinoma (HCC) using fully automated deep learning (DL) segmentation algorithms.

## **METHODS AND MATERIALS**

Consecutive patients with surgically proven HCC classified as BCLC stage A and B who underwent contrast enhanced MRI within 1 month before curative resection between July 2010 and December 2021 were retrospectively recruited. One-dimensional measurements (ie, tumor size and number) were performed independently by two radiologists. For 3D quantitative analysis, total liver volume (cm<sup>3</sup>), total tumor volume (cm<sup>3</sup>), and total tumor burden (TTB, %) were obtained using a fully automated segmentation software. Prognostic factors associated with postsurgical early recurrence were determined by Cox regression analyses with five-fold cross-validation. Survival curves were calculated by the Kaplan-Meier method and compared by the log-rank test. Predictors associated with microvascular invasion (MVI) were identified by logistic regression analyses.

## **RESULTS**

A total of 595 patients (median age, 54 years; interquartile range, 46-62 years; 520 men) were included, with 526 (88.4%) and 69 (11.6%) classified as BCLC stage A and B, respectively. TTB was the dominant predictor of early recurrence, as shown with the largest hazard ratio (HR = 2.2;  $P < .001$ ). Additional predictors of early recurrence included serum AFP level and tumor multiplicity. Using 6.84% as the threshold, TTB stratified patients into 2 risk strata for recurrence-free survival (RFS) in the entire cohort ( $P < .001$ ), BCLC A ( $P < .001$ ) and BCLC B ( $P = .017$ ) patients, respectively. By incorporating TTB into the current BCLC system, a modified BCLC (mBCLC) algorithm was constructed and resulted in a greater differentiation of the early recurrence risk between BCLC A and B patients (differences of 2-year RFS, 27.8% [mBCLC] vs 13.8% [BCLC]). Moreover, TTB was independently associated with MVI, with the largest odds ratio (OR = 2.7;  $P < .001$ ).

## CONCLUSION

TTB derived by using MRI-based fully automated DL segmentation might be a useful predictive biomarker for HCC early recurrence and enabled optimized subcategorization of BCLC A and B patients.

## CLINICAL RELEVANCE/APPLICATION

Our preliminary data provided a promising prospect for fully automated segmentation-derived 3D quantitative tumor burden at MRI in assisting clinical decision makings for HCC. Once validated in large-scale prospective cohorts, this advanced technique is expected to become an increasingly applicable and feasible workflow in routine clinical practice.

## R3-SSGI18-Geographic Disparity in Access to Diagnostic Imaging Services and Liver Cancer Epidemiology: A Case Study in the State of Texas

Courtney Koplyay, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Diagnostic imaging, such as ultrasound (US), CT, and MRI, plays an essential role in the diagnosis of liver cancer. This study's purpose is to assess geographic disparities in the access to diagnostic imaging and the incidence and stage of liver cancer, using Texas as a model state. Identifying counties with disproportionately low imaging utilization and higher rates of advanced-stage liver cancer is vital to guide cancer prevention efforts.

## METHODS AND MATERIALS

The per-county liver cancer incidence and staging (localized vs. metastatic) data were collected between 2015-2019 from the NCI's Surveillance, Epidemiology, and End Results Program (SEER). The annual US, CT, and MRI utilization data, identified by CPT codes, were collected from the Center for Medicare and Medicaid Services (CMS). The per-county number of practicing liver subspecialists, including gastroenterologists and hepatologists, was obtained from the National Provider Identifier (NPI) registry. Each county was classified as urban or rural, according to the 2020 U.S. Census. A geographic analysis of liver cancer incidence, cancer stage, imaging utilization, and subspecialty providers and a logistic regression analysis of cancer stage rate were conducted.

## RESULTS

In Texas, 15,914 new cases of primary liver cancer were reported to the SEER between 2015-2019, with 7,269 (45.7%) reported as localized to the liver. The geographic distribution of liver cancer illustrates the highest incidence around Houston, Dallas-Fort Worth, San Antonio, and Austin. However, incidence rates (per 100,000/year) were higher outside these large cities. The geographic distribution of CPT codes for liver US complete/limited and abdomen CT/MRI with/without contrast indicates a higher utilization of imaging in counties with a higher liver cancer incidence. 11-15% of all liver cancers occurred in counties with poor access to imaging, defined as <10 US or CT/MRI procedures performed per year, and poor access to practicing liver subspecialists. 13% of all liver cancers occurred in counties with a rural-predominant population. The rates of localized stage cancer were approximately 6% higher in urban-predominant counties or those with access to imaging (all  $p < .001$ ).

## CONCLUSION

In Texas, 11-15% of all liver cancers occurred in counties with poor access to diagnostic imaging. Geographic disparities exist in access to imaging and cancer stage at diagnosis. However, access to diagnostic imaging was associated with only a 6% improvement in the cancer stage.

## CLINICAL RELEVANCE/APPLICATION

Counties with poor access to imaging had slightly higher rates of metastatic liver cancer. The small effect size suggests imaging-based screening services are underutilized or ineffective in counties with access to imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSGI18-1

### Can Simplified LI-RADS Table Increase the Sensitivity for Hepatocellular Carcinoma Diagnosis in First-time Patients on Extracellular-Contrast Enhanced MRI

Thursday, Nov. 30 9:30AM - 10:30AM Room: S404

Meng Yin, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our study aimed to evaluate the diagnostic performance of the simplified LR-5 category in the simplified LI-RADS table for HCC on extracellular contrast-enhanced MRI (ECA-MRI).

#### METHODS AND MATERIALS

Patients at high risk for HCC who underwent ECA-MRI were enrolled from four independent centers (Center 1, training and internal testing dataset; Centers 2, 3 and 4, external testing dataset). Two blinded radiologists independently evaluated the imaging features and assigned each observation according to LI-RADS v2018. Five simplified LI-RADS 4 (sLR-4) strategies and one simplified LI-RADS 5 (sLR-5) strategy for the no arterial-phase hyperenhancement (APHE) and three sLR-5 strategies for the non-rim APHE columns were evaluated and finally formed a simplified LI-RADS table in the training dataset. The diagnostic performances of nine strategies and simplified LI-RADS table were compared with LI-RADS v2018 using generalized estimating equations (GEEs). Univariable and multivariable logistic regression analysis was performed to determine significant ancillary features for HCC after adjustment with the GEE model for clustering effects.

#### RESULTS

In total, 1014 patients were included [training dataset, N = 656 (492 patients with 595 observations = 30 mm); testing dataset, including internal cohort N = 195 and external cohort N = 163]. Our simplified LI-RADS table was developed and formed by strategy 6 and strategy III in the training dataset, which had 3 columns and 10 cells. Compared with LR-5 v2018, the sLR-5 had higher sensitivities in the training dataset (79.3% vs. 74.8%,  $P < 0.001$ ), small HCC (sHCC) subgroup training dataset (77.2% vs. 72.0%,  $P < 0.001$ ), and testing dataset (78.2% vs. 73.4%,  $P < 0.001$ ), sHCC subgroup testing dataset (82.0% vs. 73.9%,  $P < 0.001$ ), with similar specificities for HCC in the training dataset (93.6% vs. 94.7%,  $P = 0.156$ ), sHCC subgroup training dataset (92.8% vs. 94.2%,  $P = 0.155$ ) and testing dataset (96.4% vs. 97.1%,  $P = 0.317$ ), sHCC subgroup testing dataset (95.7% vs. 96.7%,  $P = 0.317$ ). Utilizing fat in mass coupled with mild-moderate T2 hyperintensity could provide higher sensitivity (81.6% vs. 79.3% and 74.8%, all  $P < 0.001$ ) for HCC, and had comparable specificity to sLR-5 and LR-5 v2018 (93.2% vs. 93.6% and 94.7%, all  $P > 0.05$ ).

#### CONCLUSION

The simplified LI-RADS table significantly increases sensitivity without reducing specificity for diagnosing HCC on extracellular-contrast enhanced MRI.

#### CLINICAL RELEVANCE/APPLICATION

The LI-RADS algorithms are complex and have limited sensitivity. Our results can reduce the perceived complexity in clinical practice and increase sensitivity without reducing specificity for diagnosing HCC and sHCC on ECA-MRI.

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## Abstract Archives of the RSNA, 2023

R3-SSGI18-2

### **Contrast-enhanced Ultrasound with Two Different Agents Using LI-RADS for the Diagnosis of HCC: A Multicenter Prospective Study**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S404

Jianhua Zhou, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Contrast-enhanced ultrasound (CEUS) LI-RADS applies only to CEUS examinations performed using pure blood pool agents such as sulfur hexafluoride (SHF), noting that future versions will address Kupffer-cell agents such as perfluorobutane (PFB). Such agents are expected to improve the diagnostic sensitivity for HCC by visualization of a defect in the Kupffer phase (obtained >10 minutes after injection). We aimed to conduct a prospective, multicenter study to validate CEUS LI-RADS for both SHF-enhanced US and PFB-enhanced US, and a modified algorithm that classifies certain observations as LR-5 rather than as LR-4 or LR-M based on Kupffer-phase findings for PFB-enhanced US.

#### **METHODS AND MATERIALS**

From June 2021 to December 2021, a total of 375 patients (median age, 56±11 yrs; 318 men, 57 women) at high risk for HCC with 424 observations (345 HCCs, 40 non-HCC malignancies, 39 benign lesions; median size, 37±25 mm) were enrolled in the study. Each participant underwent SHF-enhanced US first and followed by PFB-enhanced US for the diagnosis of HCC on the same day. Diagnostic metrics of CEUS LI-RADS for both SHF-enhanced US and PFB-enhanced US, and a modified algorithm for PFB-enhanced US were calculated. Pairwise comparisons of sensitivity, specificity, and accuracy for the diagnosis of HCC were made among three different algorithms using McNemar's test.

#### **RESULTS**

PFB-enhanced US and SHF-enhanced US both using CEUS LI-RADS v2017 showed no significant difference (all  $p > .05$ ) in sensitivity (60% vs 58%), specificity (96% vs 95%), and accuracy (67% vs 65%) for the diagnosis of HCC. The modified algorithm for PFB-enhanced US had significantly increased sensitivity (80% vs 58%,  $p < .001$ ), a nonsignificant decrease in specificity (92% vs 95%,  $p = .73$ ), and significantly increased accuracy (82% vs 65%,  $p < .001$ ) compared with CEUS LI-RADS v2017 for SHF-enhanced US.

#### **CONCLUSION**

On basis of CEUS LI-RADS v2017, both SHF-enhanced US and PFB-enhanced US achieved high specificity and relatively low sensitivity for the diagnosis of HCC. When incorporating Kupffer-phase findings, PFB-enhanced US had higher sensitivity without significant loss of specificity.

#### **CLINICAL RELEVANCE/APPLICATION**

Expanding contrast-enhanced US toolbox with perfluorobutane may help drive better solutions for clinical problems.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSGI18-5

### Deep Learning MRI-based 3D Quantitative Total Tumor Burden for Subcategorization of Barcelona Clinic Liver Cancer Stage A and B HCC after Surgical Resection

Thursday, Nov. 30 9:30AM - 10:30AM Room: S404

Hong Wei, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the potential of MRI-based three-dimensional (3D) quantitative tumor burden in subcategorizing Barcelona Clinic Liver Cancer (BCLC) stage A and B hepatocellular carcinoma (HCC) using fully automated deep learning (DL) segmentation algorithms.

#### METHODS AND MATERIALS

Consecutive patients with surgically proven HCC classified as BCLC stage A and B who underwent contrast enhanced MRI within 1 month before curative resection between July 2010 and December 2021 were retrospectively recruited. One-dimensional measurements (ie, tumor size and number) were performed independently by two radiologists. For 3D quantitative analysis, total liver volume (cm<sup>3</sup>), total tumor volume (cm<sup>3</sup>), and total tumor burden (TTB, %) were obtained using a fully automated segmentation software. Prognostic factors associated with postsurgical early recurrence were determined by Cox regression analyses with five-fold cross-validation. Survival curves were calculated by the Kaplan-Meier method and compared by the log-rank test. Predictors associated with microvascular invasion (MVI) were identified by logistic regression analyses.

#### RESULTS

A total of 595 patients (median age, 54 years; interquartile range, 46-62 years; 520 men) were included, with 526 (88.4%) and 69 (11.6%) classified as BCLC stage A and B, respectively. TTB was the dominant predictor of early recurrence, as shown with the largest hazard ratio (HR = 2.2; P < .001). Additional predictors of early recurrence included serum AFP level and tumor multiplicity. Using 6.84% as the threshold, TTB stratified patients into 2 risk strata for recurrence-free survival (RFS) in the entire cohort (P < .001), BCLC A (P < .001) and BCLC B (P = .017) patients, respectively. By incorporating TTB into the current BCLC system, a modified BCLC (mBCLC) algorithm was constructed and resulted in a greater differentiation of the early recurrence risk between BCLC A and B patients (differences of 2-year RFS, 27.8% [mBCLC] vs 13.8% [BCLC]). Moreover, TTB was independently associated with MVI, with the largest odds ratio (OR = 2.7; P < .001).

#### CONCLUSION

TTB derived by using MRI-based fully automated DL segmentation might be a useful predictive biomarker for HCC early recurrence and enabled optimized subcategorization of BCLC A and B patients.

#### CLINICAL RELEVANCE/APPLICATION

Our preliminary data provided a promising prospect for fully automated segmentation-derived 3D quantitative tumor burden at MRI in assisting clinical decision makings for HCC. Once validated in large-scale prospective cohorts, this advanced technique is expected to become an increasingly applicable and feasible workflow in routine clinical practice.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSGI18-6

### Geographic Disparity in Access to Diagnostic Imaging Services and Liver Cancer Epidemiology: A Case Study in the State of Texas

Thursday, Nov. 30 9:30AM - 10:30AM Room: S404

Courtney Kopyay, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Diagnostic imaging, such as ultrasound (US), CT, and MRI, plays an essential role in the diagnosis of liver cancer. This study's purpose is to assess geographic disparities in the access to diagnostic imaging and the incidence and stage of liver cancer, using Texas as a model state. Identifying counties with disproportionately low imaging utilization and higher rates of advanced-stage liver cancer is vital to guide cancer prevention efforts.

#### METHODS AND MATERIALS

The per-county liver cancer incidence and staging (localized vs. metastatic) data were collected between 2015-2019 from the NCI's Surveillance, Epidemiology, and End Results Program (SEER). The annual US, CT, and MRI utilization data, identified by CPT codes, were collected from the Center for Medicare and Medicaid Services (CMS). The per-county number of practicing liver subspecialists, including gastroenterologists and hepatologists, was obtained from the National Provider Identifier (NPI) registry. Each county was classified as urban or rural, according to the 2020 U.S. Census. A geographic analysis of liver cancer incidence, cancer stage, imaging utilization, and subspecialty providers and a logistic regression analysis of cancer stage rate were conducted.

#### RESULTS

In Texas, 15,914 new cases of primary liver cancer were reported to the SEER between 2015-2019, with 7,269 (45.7%) reported as localized to the liver. The geographic distribution of liver cancer illustrates the highest incidence around Houston, Dallas-Fort Worth, San Antonio, and Austin. However, incidence rates (per 100,000/year) were higher outside these large cities. The geographic distribution of CPT codes for liver US complete/limited and abdomen CT/MRI with/without contrast indicates a higher utilization of imaging in counties with a higher liver cancer incidence. 11-15% of all liver cancers occurred in counties with poor access to imaging, defined as <10 US or CT/MRI procedures performed per year, and poor access to practicing liver subspecialists. 13% of all liver cancers occurred in counties with a rural-predominant population. The rates of localized stage cancer were approximately 6% higher in urban-predominant counties or those with access to imaging (all  $p < .001$ ).

#### CONCLUSION

In Texas, 11-15% of all liver cancers occurred in counties with poor access to diagnostic imaging. Geographic disparities exist in access to imaging and cancer stage at diagnosis. However, access to diagnostic imaging was associated with only a 6% improvement in the cancer stage.

#### CLINICAL RELEVANCE/APPLICATION

Counties with poor access to imaging had slightly higher rates of metastatic liver cancer. The small effect size suggests imaging-based screening services are underutilized or ineffective in counties with access to imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSHN03

### Science Session with Keynote: Head and Neck Imaging (Thyroid Nodules and Thyroid Cancer Imaging)

Thursday, Nov. 30 9:30AM - 10:30AM Room: S501

Kim Learned, MD (*Moderator*) Nothing to Disclose

Jaime Wicks, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### R3-SSHN03-1 **Diagnostic Value of Contrast-Enhanced Ultrasonography Alone and Adjusted for ACR-TIRADS in Differentiating Benign and Malignant Thyroid Nodules Compared To Histological Diagnosis: Preliminary Results from a Single-Center Prospective Study**

Alessandra d. Borges, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assess the diagnostic value of contrast-enhanced ultrasound (CEUS) by evaluating independent qualitative imaging characteristics in differentiating between benign and malignant thyroid nodules compared to histological diagnosis, and whether CEUS complements ACR-TIRADS classification

#### METHODS AND MATERIALS

Between August 2022 and March 2023, 53 patients with thyroid nodules referred for surgical treatment were evaluated with final diagnosis confirmed by histopathological results. Exclusion criteria were age under eighteen and contraindication to CEUS (SonoVue-Bracco). This study was approved by the ethics committee. Gray-scale sonography: Each patient had up to two nodules evaluated according to ACR-TIRADS. CEUS: 2.4 mL bolus of SonoVue was injected for each nodule and scanned in a dual-frame contrast-enhanced mode for 3 minutes. Qualitative features were evaluated in arterial phase (up to 60 seconds) including margin (whether well-defined or not), area of enhancement (corresponding to 0-25%, 25-50%, 50-75%, or 75-100% of the total area of the nodule), degree of enhancement (higher, lower or equal to thyroid parenchyma), contrast arrival time (before, after, or at the same time as thyroid parenchyma), and type of enhancement (homogeneous, heterogeneous, ring enhancement, or no enhancement). Wash-out was also evaluated (present or absent), with the time at which the washout begins. All qualitative patterns were adjusted for ACR-TIRADS classification. Variables were described as n (%) or median and interquartile range. The association between CEUS findings and nodule malignancy was analyzed using generalized estimating equations with a binomial link function and an independent correlation structure

#### RESULTS

A total of 71 nodules were examined of which 37 (52.1%) were malignant and 34 (47.8%) benign. CEUS was able to differentiate between benign and malignant thyroid nodules based on four statistically significant features. Benign nodules exhibited a ring enhancement pattern, whereas malignant nodules tended to have undefined margins, an irregular shape, and the presence of washout. After adjusting for ACR-TIRADS classification, those four features remained statistically significant

#### CONCLUSION

CEUS improves the accuracy of ultrasound in distinguishing thyroid nodules by identifying features predictive of malignancy, such as undefined margins, irregular shape, and wash-out, while ring enhancement is associated with benign nodules

#### CLINICAL RELEVANCE/APPLICATION

Ultrasound's diagnostic accuracy in distinguishing thyroid nodules can be enhanced by incorporating SonoVue contrast potentially reducing the need for unnecessary surgeries, leading to improved patient outcomes

### R3-SSHN03-2 **Modified ACR TI-RADS and Modified AI TI-RADS for Thyroid Nodules: A Multicenter Retrospective Study**

Xiaoxian Li (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to explore the optimal fine-needle aspiration (FNA) size threshold in the American College of Radiology (ACR) Thyroid Imaging Reporting and Data System (TI-RADS) and artificial intelligence (AI) TI-RADS, as well as revise the stratification criteria in AI TI-RADS.

## METHODS AND MATERIALS

A total of 2596 thyroid nodules (in 2511 patients) were included at six hospitals from January 2017 to September 2021 retrospectively. Two experienced radiologists independently and blindly reviewed all images and evaluate the nodule features based on ACR TI-RADS. Images would be reassessed by an expert when disagreement existed. The FNA thresholds in ACR TI-RADS, AI TI-RADS, and the revised version of AI TI-RADS (6-point nodules were upgraded from TR4 to TR5) were adjusted to form five new versions, respectively. Version 1 was TR3 = 2.5 cm and TR4 = 2.0 cm, version 2 was TR3 no FNA and TR4 = 1.5 cm, version 3 was TR3 no FNA and TR4 = 2.0 cm, version 4 was TR3 no FNA and TR4 = 2.5 cm, version 5 was TR3 no FNA and TR4 = 3.0 cm. The diagnostic performance and unnecessary FNA rate (UFR) of each new version were calculated and compared with the original ACR TI-RADS. The version with the best diagnostic efficacy was selected as the final modified version, provided that there was no significant decrease in sensitivity.

## RESULTS

The modified criteria for mACR TI-RADS were as follows: (1) TR3 nodules were not recommended for FNA; (2) FNA threshold for TR4 increased to 2.5 cm. The modified criteria for mAI TI-RADS were as follows: (1) 6-point nodules were upgraded from TR4 to TR5; (2) TR3 nodules were not recommended for FNA; (3) FNA threshold for TR4 increased to 2.5 cm. Compared with original ACR TI-RADS, mACR TI-RADS yielded higher specificity (72.8% vs 46.4%,  $P < 0.001$ ), accuracy (74.2% vs 51.0%,  $P < 0.001$ ), AUC (0.800 vs 0.695,  $P < 0.001$ ) and lower UFR (24.5% vs 48.3%,  $P < 0.001$ ) although the sensitivity was slightly decreased without significant difference (87.3% vs 92.7%,  $P = 0.057$ ). Compared with original ACR TI-RADS, mAI TI-RADS yielded higher specificity (73.1% vs 46.4%,  $P < 0.001$ ), accuracy (74.7% vs 51.0%,  $P < 0.001$ ), AUC (0.808 vs 0.695,  $P < 0.001$ ) and lower UFR (24.2% vs 48.3%,  $P < 0.001$ ) although the sensitivity was slightly decreased without significant difference (88.5% vs 92.7%,  $P = 0.057$ ). There was no significant difference between mACR TI-RADS and mAI TI-RADS in the diagnostic performance and UFR.

## CONCLUSION

Compared with original ACR TI-RADS, the mACR TI-RADS and mAI TI-RADS based on stratification rule and FNA threshold adjustments can significantly improve the specificity and accuracy without sacrificing sensitivity.

## CLINICAL RELEVANCE/APPLICATION

With great diagnostic efficacy and utility, the mACR TI-RADS and mAI TI-RADS are expected to become the revision of TI-RADS in the future.

## R3-SSHN03-3 Ultrasound for Predicting Progression on Active Surveillance of Papillary Thyroid Microcarcinoma

Ji Ye Lee, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Patients at low-risk for papillary thyroid microcarcinomas (PTMC) undergo US examination as part of active surveillance (AS). The purpose of this study was to determine if US features can predict tumor progression in patients at low risk for PTMC undergoing AS.

## METHODS AND MATERIALS

This prospective study enrolled 1,177 patients with PTMC from three hospitals between June 2016 and January 2021. Participants were self-assigned to either immediate surgery or AS and those with  $\geq 2$  US examinations were included in the analysis. Tumor progression was defined by the following criteria: size enlargement, new extrathyroidal extension, or new lymph node metastasis (LNM). Multivariable Cox regression analysis was used to assess the association of clinical and US features with overall tumor progression and specific tumor progression criteria. Tumor progression rate was compared between participants stratified by tumor progression criteria.

## RESULTS

Among 699 participants, 68 (mean age,  $49 \pm 12$ ) showed tumor progression (mean follow-up,  $41.4 \pm 16.0$ ). Overall tumor progression was associated with the imaging features US-diffuse thyroid disease (US-DTD) (hazard ratio [HR], 2.3; 95% CI: 1.4, 3.7;  $P = .001$ ) and intratumoral vascularity (HR, 1.7 [95% CI: 1.0, 3.0];  $P = .004$ ) and the patient characteristics of male sex (HR, 2.8 [95% CI: 1.7, 4.6];  $P < .001$ ), age  $< 30$  years (HR, 2.9 [95% CI: 1.2, 6.8];  $P = .001$ ), and baseline thyroid-stimulating hormone  $= 7$   $\mu\text{U/mL}$  (HR, 6.9 [95% CI: 2.7, 17.4];  $P = .001$ ). Patients with US-DTD (14.2%,  $P = .003$ ), intratumoral vascularity (14.1%,  $P = .04$ ), or both (20.8%,  $P = .003$ ) showed higher progression rates than patients without these features (6.0%).

## CONCLUSION

Presence of US-DTD and intratumoral vascularity were associated with an increased risk of tumor progression in patients with PTMC under AS.

## CLINICAL RELEVANCE/APPLICATION

Our study have clinical relevance because it provides prognostic value of US from a prospectively designed multicenter cohort.

### R3-SSHN03-4 **Perfluorobutane-enhanced US-guided Fine-needle Aspiration to Improve the Diagnosis of Small Lateral Cervical Metastatic Lymph Nodes of Papillary Thyroid Carcinoma**

Guanying Wang (*Presenter*) Nothing to Disclose

## PURPOSE

The correct diagnosis of metastatic small lateral cervical lymph nodes (short diameter =8mm) of papillary thyroid carcinoma (PTC) preoperatively is important, which affects the surgical strategy. Ultrasound-guided fine-needle aspiration cytology (FNAC) combined with the measurement of thyroglobulin in FNA washout fluid (FNA-Tg) has been widely recognized as an effective tool for the diagnosis of lymph nodes (LNs) before surgery. Our prospective study (DOI: 10.1145/radiol.221465) indicated that contrast-enhanced US (CEUS) with perfluorobutane could improve the diagnostic accuracy of small lateral LNs in PTC. The purpose of this retrospective cohort study is to evaluate the impact of CEUS in guiding fine-needle aspiration (FNA) of lateral cervical LNs in PTC.

## METHODS AND MATERIALS

In this retrospective study, consecutive patients who had undergone FNAC and FNA-Tg for small lateral cervical LNs from a single center from October 2020 to October 2021 were included, all of which were confirmed PTC. The patients were divided into two groups based on whether US or CEUS-guided FNA. Patients who underwent CEUS-guided FNA (CEUS group) were matched with those who underwent US-guided FNA (US group) according to size and suspicious features of US. The reference standards were surgical histologic assessment and follow-up. The receiver operating characteristic curve was drawn to compare the diagnostic accuracy of two groups after the PSM.

## RESULTS

A total of 284 consecutive patients [median age, 36;  $\pm 11$ [SD]; 202 women] were enrolled in this study, including 161 in US group and 118 in CEUS group, and 5 patients underwent both US-guided and CEUS-guided FNA within two weeks. Of 279 patients, 70 patient pairs were matched. In the CEUS group versus the US group, the rate of metastatic LNs was 56% (39/70) versus 54% (31/70), and the number of suspicious features was (mean [SD], 2.7[1.0]) versus (mean [SD], 2.6[1.3]). After PSM, the CEUS group showed better diagnostic accuracy in FNA-Tg (AUC: 0.96 vs. 0.80;  $P < 0.01$ ) and in the combination of FNAC and FNA-Tg (AUC: 0.95 vs. 0.83;  $P = 0.018$ ). Five patients had undergone US-guided FNA, and the results of FNA were benign. But the results were changed for changing the target LNs or target zones within LNs mentioned by CEUS. The results of FNA indicated metastasis and were confirmed by surgery.

## CONCLUSION

Perfluorobutane-enhanced US-guided FNA had a better diagnostic performance for small cervical lateral metastatic LNs of PTC, especially for choosing the most representative LNs.

## CLINICAL RELEVANCE/APPLICATION

CEUS-guided FNA improves diagnostic accuracy for small cervical lateral metastatic LNs, which might be helpful for surgical decisions.

### R3-SSHN03-5 **The Role of Repeated Biopsy in Thyroid Nodules with Atypia of Undetermined Significance with Architectural Atypia on Core-needle Biopsy**

Hye Hyeon Moon, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to evaluate the utility of repeat biopsy in atypia of undetermined significance with architectural atypia (AUS-A) nodules on core-needle biopsy (CNB).

## METHODS AND MATERIALS

A retrospective study including patients with CNB categorized as AUS-A between 2013 and 2015. The demographic data, results of the subsequent biopsies, and ultrasound (US) images of the patients were evaluated. The risk of malignancy (ROM) of nodules according to number of CNBs and number of AUS-A diagnoses was compared. Demographic and US features were compared to determine the predictive features for malignancy.

## RESULTS

Of 1003 thyroid nodules with AUS-A on CNB, 289 (28.8%) underwent surgery and 120 nodules were deemed malignant upon histopathology, yielding a final malignancy rate of 12-41.5%. Repeat CNB was performed in 248 nodules (24.7%) and reclassified into categories II, AUS-A, AUS with nuclear atypia (AUS-N), IV, V, VI in 30.2%, 52.8%, 5.2%, 10.5%, 0.4%, and 0.8% of nodules. The ROM for nodules diagnosed with one and two or more AUS-A results were 39.3% and 45.7% respectively (P=.708). Among the US features, solid composition, irregular margins, microcalcifications, and high suspicion on the US risk stratification system were associated with malignancy (P < .005).

## CONCLUSION

The ROM of AUS-A nodule on CNB was high as 12-41.5%. Repeat CNB did not enhance the identification of malignancy. US features may be a better guide for the decision of either surveillance or diagnostic surgery.

## CLINICAL RELEVANCE/APPLICATION

The use of core needle biopsy (CNB) for the diagnosis of thyroid nodules is increasing, but the role of repeat biopsy in indeterminate lesions identified by CNB has not been investigated. In particular, atypia of undetermined significance (AUS) nodules shows a significant difference in malignancy risk depending on the presence or absence of nuclear atypia. This study is the first to investigate the usefulness of repeat CNB for AUS nodules with architectural atypia but without nuclear atypia. AUS with architectural atypia nodules show a substantial risk of malignancy. Repeat biopsy does not improve the detection of malignancy, while US features may serve as a better guide for risk stratification, enabling the optimized management of these nodules. Currently, there is no standard guideline for managing AUS nodules after CNB, and we propose that our findings can be used to develop future management strategies.

## R3- **Keynote Speaker** SSH03-6

Kim Learned, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

R3-SSHN03-1

### **Diagnostic Value of Contrast-Enhanced Ultrasonography Alone and Adjusted for ACR-TIRADS in Differentiating Benign and Malignant Thyroid Nodules Compared To Histological Diagnosis: Preliminary Results from a Single-Center Prospective Study**

Thursday, Nov. 30 9:30AM - 10:30AM Room: S501

Alessandra d. Borges, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Assess the diagnostic value of contrast-enhanced ultrasound (CEUS) by evaluating independent qualitative imaging characteristics in differentiating between benign and malignant thyroid nodules compared to histological diagnosis, and whether CEUS complements ACR-TIRADS classification

#### **METHODS AND MATERIALS**

Between August 2022 and March 2023, 53 patients with thyroid nodules referred for surgical treatment were evaluated with final diagnosis confirmed by histopathological results. Exclusion criteria were age under eighteen and contraindication to CEUS (SonoVue-Bracco). This study was approved by the ethics committee. Gray-scale sonography: Each patient had up to two nodules evaluated according to ACR-TIRADS. CEUS: 2.4 mL bolus of SonoVue was injected for each nodule and scanned in a dual-frame contrast-enhanced mode for 3 minutes. Qualitative features were evaluated in arterial phase (up to 60 seconds) including margin (whether well-defined or not), area of enhancement (corresponding to 0-25%, 25-50%, 50-75%, or 75-100% of the total area of the nodule), degree of enhancement (higher, lower or equal to thyroid parenchyma), contrast arrival time (before, after, or at the same time as thyroid parenchyma), and type of enhancement (homogeneous, heterogeneous, ring enhancement, or no enhancement). Wash-out was also evaluated (present or absent), with the time at which the washout begins. All qualitative patterns were adjusted for ACR-TIRADS classification. Variables were described as n (%) or median and interquartile range. The association between CEUS findings and nodule malignancy was analyzed using generalized estimating equations with a binomial link function and an independent correlation structure

#### **RESULTS**

A total of 71 nodules were examined of which 37 (52.1%) were malignant and 34 (47.8%) benign. CEUS was able to differentiate between benign and malignant thyroid nodules based on four statistically significant features. Benign nodules exhibited a ring enhancement pattern, whereas malignant nodules tended to have undefined margins, an irregular shape, and the presence of washout. After adjusting for ACR-TIRADS classification, those four features remained statistically significant

#### **CONCLUSION**

CEUS improves the accuracy of ultrasound in distinguishing thyroid nodules by identifying features predictive of malignancy, such as undefined margins, irregular shape, and wash-out, while ring enhancement is associated with benign nodules

#### **CLINICAL RELEVANCE/APPLICATION**

Ultrasound's diagnostic accuracy in distinguishing thyroid nodules can be enhanced by incorporating SonoVue contrast potentially reducing the need for unnecessary surgeries, leading to improved patient outcomes

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSHN03-2

### Modified ACR TI-RADS and Modified AI TI-RADS for Thyroid Nodules: A Multicenter Retrospective Study

Thursday, Nov. 30 9:30AM - 10:30AM Room: S501

Xiaoxian Li (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to explore the optimal fine-needle aspiration (FNA) size threshold in the American College of Radiology (ACR) Thyroid Imaging Reporting and Data System (TI-RADS) and artificial intelligence (AI) TI-RADS, as well as revise the stratification criteria in AI TI-RADS.

#### METHODS AND MATERIALS

A total of 2596 thyroid nodules (in 2511 patients) were included at six hospitals from January 2017 to September 2021 retrospectively. Two experienced radiologists independently and blindly reviewed all images and evaluate the nodule features based on ACR TI-RADS. Images would be reassessed by an expert when disagreement existed. The FNA thresholds in ACR TI-RADS, AI TI-RADS, and the revised version of AI TI-RADS (6-point nodules were upgraded from TR4 to TR5) were adjusted to form five new versions, respectively. Version 1 was TR3 = 2.5 cm and TR4 = 2.0 cm, version 2 was TR3 no FNA and TR4 = 1.5 cm, version 3 was TR3 no FNA and TR4 = 2.0 cm, version 4 was TR3 no FNA and TR4 = 2.5 cm, version 5 was TR3 no FNA and TR4 = 3.0 cm. The diagnostic performance and unnecessary FNA rate (UFR) of each new version were calculated and compared with the original ACR TI-RADS. The version with the best diagnostic efficacy was selected as the final modified version, provided that there was no significant decrease in sensitivity.

#### RESULTS

The modified criteria for mACR TI-RADS were as follows: (1) TR3 nodules were not recommended for FNA; (2) FNA threshold for TR4 increased to 2.5 cm. The modified criteria for mAI TI-RADS were as follows: (1) 6-point nodules were upgraded from TR4 to TR5; (2) TR3 nodules were not recommended for FNA; (3) FNA threshold for TR4 increased to 2.5 cm. Compared with original ACR TI-RADS, mACR TI-RADS yielded higher specificity (72.8% vs 46.4%,  $P < 0.001$ ), accuracy (74.2% vs 51.0%,  $P < 0.001$ ), AUC (0.800 vs 0.695,  $P < 0.001$ ) and lower UFR (24.5% vs 48.3%,  $P < 0.001$ ) although the sensitivity was slightly decreased without significant difference (87.3% vs 92.7%,  $P = 0.057$ ). Compared with original ACR TI-RADS, mAI TI-RADS yielded higher specificity (73.1% vs 46.4%,  $P < 0.001$ ), accuracy (74.7% vs 51.0%,  $P < 0.001$ ), AUC (0.808 vs 0.695,  $P < 0.001$ ) and lower UFR (24.2% vs 48.3%,  $P < 0.001$ ) although the sensitivity was slightly decreased without significant difference (88.5% vs 92.7%,  $P = 0.057$ ). There was no significant difference between mACR TI-RADS and mAI TI-RADS in the diagnostic performance and UFR.

#### CONCLUSION

Compared with original ACR TI-RADS, the mACR TI-RADS and mAI TI-RADS based on stratification rule and FNA threshold adjustments can significantly improve the specificity and accuracy without sacrificing sensitivity.

#### CLINICAL RELEVANCE/APPLICATION

With great diagnostic efficacy and utility, the mACR TI-RADS and mAI TI-RADS are expected to become the revision of TI-RADS in the future.

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## Abstract Archives of the RSNA, 2023

R3-SSHN03-3

### Ultrasound for Predicting Progression on Active Surveillance of Papillary Thyroid Microcarcinoma

Thursday, Nov. 30 9:30AM - 10:30AM Room: S501

Ji Ye Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients at low-risk for papillary thyroid microcarcinomas (PTMC) undergo US examination as part of active surveillance (AS). The purpose of this study was to determine if US features can predict tumor progression in patients at low risk for PTMC undergoing AS.

#### METHODS AND MATERIALS

This prospective study enrolled 1,177 patients with PTMC from three hospitals between June 2016 and January 2021. Participants were self-assigned to either immediate surgery or AS and those with  $\geq 2$  US examinations were included in the analysis. Tumor progression was defined by the following criteria: size enlargement, new extrathyroidal extension, or new lymph node metastasis (LNM). Multivariable Cox regression analysis was used to assess the association of clinical and US features with overall tumor progression and specific tumor progression criteria. Tumor progression rate was compared between participants stratified by tumor progression criteria.

#### RESULTS

Among 699 participants, 68 (mean age,  $49 \pm 12$ ) showed tumor progression (mean follow-up,  $41.4 \pm 16.0$ ). Overall tumor progression was associated with the imaging features US-diffuse thyroid disease (US-DTD) (hazard ratio [HR], 2.3; 95% CI: 1.4, 3.7;  $P = .001$ ) and intratumoral vascularity (HR, 1.7 [95% CI: 1.0, 3.0];  $P = .004$ ) and the patient characteristics of male sex (HR, 2.8 [95% CI: 1.7, 4.6];  $P < .001$ ), age  $< 30$  years (HR, 2.9 [95% CI: 1.2, 6.8];  $P = .001$ ), and baseline thyroid-stimulating hormone  $\geq 7$   $\mu\text{U/mL}$  (HR, 6.9 [95% CI: 2.7, 17.4];  $P = .001$ ). Patients with US-DTD (14.2%,  $P = .003$ ), intratumoral vascularity (14.1%,  $P = .04$ ), or both (20.8%,  $P = .003$ ) showed higher progression rates than patients without these features (6.0%).

#### CONCLUSION

Presence of US-DTD and intratumoral vascularity were associated with an increased risk of tumor progression in patients with PTMC under AS.

#### CLINICAL RELEVANCE/APPLICATION

Our study has clinical relevance because it provides prognostic value of US from a prospectively designed multicenter cohort.

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## Abstract Archives of the RSNA, 2023

R3-SSHN03-4

### Perfluorobutane-enhanced US-guided Fine-needle Aspiration to Improve the Diagnosis of Small Lateral Cervical Metastatic Lymph Nodes of Papillary Thyroid Carcinoma

Thursday, Nov. 30 9:30AM - 10:30AM Room: S501

Guanying Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

The correct diagnosis of metastatic small lateral cervical lymph nodes (short diameter =8mm) of papillary thyroid carcinoma (PTC) preoperatively is important, which affects the surgical strategy. Ultrasound-guided fine-needle aspiration cytology (FNAC) combined with the measurement of thyroglobulin in FNA washout fluid (FNA-Tg) has been widely recognized as an effective tool for the diagnosis of lymph nodes (LNs) before surgery. Our prospective study (DOI: 10.1145/radiol.221465) indicated that contrast-enhanced US (CEUS) with perfluorobutane could improve the diagnostic accuracy of small lateral LNs in PTC. The purpose of this retrospective cohort study is to evaluate the impact of CEUS in guiding fine-needle aspiration (FNA) of lateral cervical LNs in PTC.

#### METHODS AND MATERIALS

In this retrospective study, consecutive patients who had undergone FNAC and FNA-Tg for small lateral cervical LNs from a single center from October 2020 to October 2021 were included, all of which were confirmed PTC. The patients were divided into two groups based on whether US or CEUS-guided FNA. Patients who underwent CEUS-guided FNA (CEUS group) were matched with those who underwent US-guided FNA (US group) according to size and suspicious features of US. The reference standards were surgical histologic assessment and follow-up. The receiver operating characteristic curve was drawn to compare the diagnostic accuracy of two groups after the PSM.

#### RESULTS

A total of 284 consecutive patients [median age, 36;  $\pm 11$ [SD]; 202 women] were enrolled in this study, including 161 in US group and 118 in CEUS group, and 5 patients underwent both US-guided and CEUS-guided FNA within two weeks. Of 279 patients, 70 patient pairs were matched. In the CEUS group versus the US group, the rate of metastatic LNs was 56% (39/70) versus 54% (31/70), and the number of suspicious features was (mean [SD], 2.7[1.0]) versus (mean [SD], 2.6[1.3]). After PSM, the CEUS group showed better diagnostic accuracy in FNA-Tg (AUC: 0.96 vs. 0.80;  $P < 0.01$ ) and in the combination of FNAC and FNA-Tg (AUC: 0.95 vs. 0.83;  $P = 0.018$ ). Five patients had undergone US-guided FNA, and the results of FNA were benign. But the results were changed for changing the target LNs or target zones within LNs mentioned by CEUS. The results of FNA indicated metastasis and were confirmed by surgery.

#### CONCLUSION

Perfluorobutane-enhanced US-guided FNA had a better diagnostic performance for small cervical lateral metastatic LNs of PTC, especially for choosing the most representative LNs.

#### CLINICAL RELEVANCE/APPLICATION

CEUS-guided FNA improves diagnostic accuracy for small cervical lateral metastatic LNs, which might be helpful for surgical decisions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSHN03-5

### The Role of Repeated Biopsy in Thyroid Nodules with Atypia of Undetermined Significance with Architectural Atypia on Core-needle Biopsy

Thursday, Nov. 30 9:30AM - 10:30AM Room: S501

Hye Hyeon Moon, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to evaluate the utility of repeat biopsy in atypia of undetermined significance with architectural atypia (AUS-A) nodules on core-needle biopsy (CNB).

#### METHODS AND MATERIALS

A retrospective study including patients with CNB categorized as AUS-A between 2013 and 2015. The demographic data, results of the subsequent biopsies, and ultrasound (US) images of the patients were evaluated. The risk of malignancy (ROM) of nodules according to number of CNBs and number of AUS-A diagnoses was compared. Demographic and US features were compared to determine the predictive features for malignancy.

#### RESULTS

Of 1003 thyroid nodules with AUS-A on CNB, 289 (28.8%) underwent surgery and 120 nodules were deemed malignant upon histopathology, yielding a final malignancy rate of 12-41.5%. Repeat CNB was performed in 248 nodules (24.7%) and reclassified into categories II, AUS-A, AUS with nuclear atypia (AUS-N), IV, V, VI in 30.2%, 52.8%, 5.2%, 10.5%, 0.4%, and 0.8% of nodules. The ROM for nodules diagnosed with one and two or more AUS-A results were 39.3% and 45.7% respectively ( $P=.708$ ). Among the US features, solid composition, irregular margins, microcalcifications, and high suspicion on the US risk stratification system were associated with malignancy ( $P < .005$ ).

#### CONCLUSION

The ROM of AUS-A nodule on CNB was high as 12-41.5%. Repeat CNB did not enhance the identification of malignancy. US features may be a better guide for the decision of either surveillance or diagnostic surgery.

#### CLINICAL RELEVANCE/APPLICATION

The use of core needle biopsy (CNB) for the diagnosis of thyroid nodules is increasing, but the role of repeat biopsy in indeterminate lesions identified by CNB has not been investigated. In particular, atypia of undetermined significance (AUS) nodules shows a significant difference in malignancy risk depending on the presence or absence of nuclear atypia. This study is the first to investigate the usefulness of repeat CNB for AUS nodules with architectural atypia but without nuclear atypia. AUS with architectural atypia nodules show a substantial risk of malignancy. Repeat biopsy does not improve the detection of malignancy, while US features may serve as a better guide for risk stratification, enabling the optimized management of these nodules. Currently, there is no standard guideline for managing AUS nodules after CNB, and we propose that our findings can be used to develop future management strategies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSHN03-6

### Keynote Speaker

Thursday, Nov. 30 9:30AM - 10:30AM Room: S501

Kim Learned, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSIN07

### Imaging Informatics (Recent Advances in Artificial Intelligence for Images)

Thursday, Nov. 30 9:30AM - 10:30AM Room: N227B

Paul H. Yi, MD (*Moderator*) Consultant, FH Orthopedics SAS; Consultant, BunkerHill Health  
Krishna Nand Keshava Murthy, PhD, MSc (*Moderator*) Nothing to Disclose

#### Sub-Events

### R3-SSIN07- "AI Localism": Calibrating Performance of AI Algorithm for Intracranial Hemorrhage Detection to Local Conditions using Conformal Uncertainty Quantification<sup>1</sup>

Stuart R. Pomerantz, MD (*Presenter*) Support, General Electric Company

#### PURPOSE

AI algorithms often fail to meet performance claims in actual clinical implementation due to local patient and disease variances from initial training/testing. Without a systematic statistical approach, heuristic attempts at determining appropriate probability threshold adjustments can be beyond the capabilities of radiologists at initial algorithm adoption, much less to adapt as conditions change. We present a novel method for calibrating AI algorithm performance to local conditions by applying Conformal Uncertainty Quantification techniques on an Intracranial Hemorrhage (ICH) CT Detection algorithm previously developed at our institution. By providing rigorous and mathematically provable guarantees for high accuracy on the local population, this method can improve confidence in AI system reliability across diverse settings.

#### METHODS AND MATERIALS

To minimize typical ROC tradeoffs, our methodology optimizes both PPV and NPV by allowing abstention on cases for which the model has high uncertainty, as determined by a Conformal Prediction statistical analysis using a hold-out set of recent cases for ex-post-facto calibration. If the locally-derived calibration set is representative of future data, then appropriate high and low thresholds can be calculated to achieve formal guarantees for the PPV and/or NPV desired by the use-case requirements of a given implementation. Conformal methodology was applied to results of our ICH Detection algorithm on consecutive CT exams (9122 exams over recent 6 month period ) compared to ground-truth from AI-naïve final reports. A deep learning feature extractor was used on the array of per-image probabilities of each case with decision-tree training for probabilistic binary classification.

#### RESULTS

Conformal uncertainty quantification effectively calibrated the AI model to a set of patients several years removed in time from the initial algorithm training, enabling high-confidence PPV and NPV compared to a model that cannot perform abstention. The calibrated model provides a formal PPV guarantee of at least 85% and NPV of at least 95%. with only 7% of data points abstained. By standard ROC analysis , an NPV of 95% would yield PPV of 50% (Fig 1).

#### CONCLUSION

Conformal uncertainty quantification provides a straightforward non-heuristic approach to calibrating an AI algorithm's performance to local conditions, enhancing prediction confidence, promising better decision-making and risk management in one own's setting.

#### CLINICAL RELEVANCE/APPLICATION

Conformal uncertainty quantification can be easily applied to a wide range of AI models improving practicality and reliability of algorithm implementation across diverse settings, time periods and use-case targets in the radiology workflow pipeline.

### R3-SSIN07-MedVisGPT: Human-AI Collaborative Diagnosis for Medical Imaging<sup>2</sup>

Xingxin He (*Presenter*) Nothing to Disclose

## PURPOSE

To enhance diagnostic efficiency, a Human-AI interactive diagnosis approach is proposed, allowing for seamless engagement between the two entities.

## METHODS AND MATERIALS

A dataset of knee radiographs and associated reports for cases with anterior cruciate ligament (ACL) tears and control knees was collected retrospectively from the Research Patient Data Registry (RPDR) database at Massachusetts General Brigham (MGB) between 2001 and 2022. The cases include 10,000 individuals with confirmed isolated ACL tears on MRI and no prior ACL reconstruction, while the control group consists of 16,000 individuals with MRI confirmation of no ligament tears or fractures. All radiographs included AP and lateral views and were collected from patients above the age of 14. We built and trained an interactive approach named Medical Visual Generative Pre-Trained Transformer (MedVisGPT) to assist and combine efforts with humans in interpreting radiological images. MedVisGPT can accept and receive multiple medical images from a single patient, which emphasizes and fuses vital diagnostic features across all given imaging data. MedVisGPT can describe medical images, interact with healthcare professionals, suggest diagnoses, give medical suggestions, and generate formal reports efficiently by engaging in natural and professional conversations with humans. MedVisGPT is locally trained and deployed, thus can perform these tasks while maintaining the privacy and confidentiality of patient data.

## RESULTS

To demonstrate our MedVisGPT, here, we provided knee X-ray images of different views from two patients (a control case and a case with ACL) to our MedVisGPT and ask it the following questions: 1. Describe the given X-ray images briefly. 2. Provide the impression of the X-rays. 3. Provide the rationale behind your task. 4. Provide a report in a formal format. For the ACL case, we additionally asked questions to require suggestions: Is it an ACL? So does it need further MRI to confirm? MedVisGPT properly answered each question regarding the given images, gave MRI recommendation for the suspicious case, and summarized the context during chatting to generate a complete report in a professional format (see the left in the figure for the control case, the right for the case with ACL.). The entire process takes less than one minute, which tremendously reduces the workload of human radiologists in diagnosing medical images.

## CONCLUSION

Our MedVisChat can suggest diagnoses, provide medical suggestions, and produce detailed medical reports in seconds by engaging in natural and professional conversations with humans.

## CLINICAL RELEVANCE/APPLICATION

MedVisChat can enhance diagnostic efficiency and automated medical report generation, resulting in reduced time and labor costs.

## R3-SSIN07-Enhancing the Trustworthiness of Deep Learning Tools for Clinical Applications: A Comprehensive Pipeline with Model Explainability, Uncertainty Quantification, and Outlier Detection Applied to Implant Detection on Radiographs

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

Confident deployment of deep learning (DL) models in clinical settings necessitates trustworthiness, which includes the ability to explain predictions, report uncertainty levels, and identify outlier input data (out-of-distribution). Detecting total hip arthroplasty (THA) implants on plain radiographs is crucial for facilitating revision THA, but existing DL models lack trustworthiness for clinical deployment. In this work, we present THA-AID, a trustworthy DL tool for automated implant detection, to demonstrate our proposed pipeline for DL trustworthiness.

## METHODS AND MATERIALS

We built a 5-fold cross-validation DL classifier to recognize 28 implants in input hip radiographs. We trained it on 244,248 AP, lateral, and oblique images obtained from 13,375 THA patients (2000-2022). Our trustworthiness pipeline consisted of 1) integrated gradient maps for model explainability, 2) a Mondrian Cross-conformal Predictor (MCCP) for uncertainty quantification that enabled the model to predict more than one label on challenging radiographs, and 3) a framework to detect data outliers, warning users if input image features or MCCP predictions deviate from 95% of the training data (possible outlier). The latter prevented the model from making predictions for out-of-distribution input data. Our pipeline is thoroughly evaluated on held-out internal and external test sets and six medical and non-medical out-of-domain datasets, including ImageNet, RadImageNet, chest X-ray, knee-radiograph, pre-operative hip, and post-operative hip datasets with unseen implants. We also compare our tool's baseline performance with two board-certified orthopedic surgeons.

## RESULTS

Accuracy [F1-scores] were 98.9% [0.99] and 98.0% [0.98], with an MCCP coverage [efficiency] of 99.7% [93.7%] and 97% [69.8%] on the internal and external test sets, respectively. Coverage denoted the fraction of prediction sets with true labels, and efficiency denoted the fraction of prediction sets with a single label. THA-AID achieved 97.5% accuracy compared to the

best surgeon accuracy of 87% on 200 test images. It also identified 100% of data from out-of-domain datasets. Eliminating 39.7% of the most outlier external data improved the external set's accuracy, coverage, and efficiency to 1.0.

## **CONCLUSION**

We developed THA-AID, a clinically trustworthy DL model that surpasses all previously reported models in baseline performance and exemplifies a pipeline for making DL models trustworthy.

## **CLINICAL RELEVANCE/APPLICATION**

THA-AID is a strong candidate for clinical deployment in radiologic and orthopedic surgery applications. The trustworthiness pipeline exemplified in THA-AID can be easily applied to existing DL models without altering their architecture or training regime.

## **R3-SSIN07-Concurrent Classification and Out-of-Distribution Detection of Radiologic Images: A 4 Generative Approach**

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

## **PURPOSE**

Out-of-distribution (OOD) detection is crucial in medical imaging deep learning as it helps identify samples that come from a distribution different from the training data. Deep learning models may perform poorly on data from a different distribution without alerting the user. OOD detection algorithms can identify such situations and notify users of potential errors, allowing them to reassess the diagnosis before making a final decision. Unlike other methods, we propose a joint generation-classification scheme to detect pneumothorax and OOD images that relies on perceptual differences rather than spurious features.

## **METHODS AND MATERIALS**

To obtain a representative set of features, we used a variational autoencoder (VAE) with 1024 features to recreate images of 256x256 pixels. We fed the latent features to a classifier and co-trained it to detect the presence or absence of pneumothorax (Figure 1). The classifier's inputs are features condensed by the VAE, forcing the latent space to capture information required for classification and image restoration. We used the CheXpert dataset as our training and validation set (n=72,053; 80%:20% respectively) and tested our model on the SIIM-ACR dataset (n=11,582). We also trained a vanilla EfficientNet-B4 model for comparison. To quantify the distribution of images, we calculated the average cosine similarity of each image with the training set images. We set a threshold of 1% based on the training set, meaning that if an image has a lower similarity than the first percentile of training set samples, it is considered OOD. This approach allows us to see image-level statistics compared to existing population-level approaches. To test our OOD detection algorithm, we used a pediatric chest x-ray dataset (n=5,856).

## **RESULTS**

Our model achieved an AUROC of 0.79 in detecting pneumothorax on the validation set and 0.78 on the test set. These values were 0.81 and 0.79 for the validation and test sets, respectively, when evaluating the vanilla classifier. On the validation set, 1% of the images were flagged as OOD, while 6.1% of the SIIM-ACR test set was characterized as OOD. This number was 48.9% for the pediatric chest x-ray dataset.

## **CONCLUSION**

Our combined generation-classification scheme can be used to detect OOD samples without significantly degrading the performance of the classification model.

## **CLINICAL RELEVANCE/APPLICATION**

In healthcare settings, OOD images can come from different scanners or populations, causing the model's performance to degrade and reducing its generalizability. This means that model cannot be trustworthy in those situations. Adding a layer of OOD detection ensures that patients receive accurate and reliable diagnoses while maintaining trust in AI systems.

## **R3-SSIN07-Reproducibility of Deep Learning Algorithms Developed for Medical Imaging Analysis: A 5 Systematic Review**

Shahriar Faghani, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Since 2000, there have been more than 8,000 publications on radiology artificial intelligence (AI). AI breakthroughs allow complex tasks to be automated and even performed beyond human capabilities. However, the lack of details on the methods and algorithm code undercuts its scientific value. Many science subfields have recently faced a reproducibility crisis, eroding trust in processes and results and influencing the rise in retractions of scientific papers. For the same reasons, conducting research in deep learning also requires reproducibility. Three criteria need to be met for a study to be truly reproducible: technically reproducible, statistically reproducible, and conceptually reproducible. Although several valuable manuscript

checklists for AI in medical imaging exist, they are not focused specifically on reproducibility. In this study, we conducted a systematic review of recently published papers in the field of deep learning to evaluate if the description of their methodology could allow the reproducibility of their findings.

## **METHODS AND MATERIALS**

We focused on the Journal of Digital Imaging (JDI), a specialized journal that publishes papers on AI and medical imaging. We used the keyword "Deep Learning" and collected the articles published between January 2020 to January 2022. We screened all the articles and included the ones which reported the development of a deep learning tool in medical imaging. We extracted the reported details about the dataset, data handling steps, data splitting, model details, and performance metrics of each included article based on a checklist developed by several experts in the fields of AI and medical imaging to assess the three mentioned reproducibility criteria.

## **RESULTS**

We found 148 articles. 80 were included after screening for articles that reported developing a deep learning model for medical image analysis. Five studies have made their code publicly available, and thirty-five studies have utilized publicly available datasets. We provided figures to show the ratio and absolute count of reported items from included studies.

## **CONCLUSION**

According to our cross-sectional study, in JDI publications on DL in medical imaging, authors infrequently report the key elements of their study to make it reproducible.

## **CLINICAL RELEVANCE/APPLICATION**

This systematic review emphasizes the importance of a reproducibility checklist for deep learning algorithms developed for medical imaging analysis to have practical clinical applications. The study suggests that researchers should present comprehensive descriptions of their methodology and share their code and datasets publicly, as these steps can enhance the scientific value and reliability of AI-based medical imaging research.

## **R3-SSIN07-Robust and General Phase Recognition on Multi-Phase Contrast-Enhanced CT Scans**

6

Ling Zhang (*Presenter*) Nothing to Disclose

## **PURPOSE**

Most previous CT phase recognition methods only work on a specific scan area (e.g., chest, upper abdomen) and are not evaluated in external hospitals. This work aims to develop an efficient and robust method for CT phase recognition across scan areas and hospitals.

## **METHODS AND MATERIALS**

Our model is a clinical prior knowledge-guided classification framework that extracts the features of pre-defined points of interest (POIs) located by self-supervised anatomical embedding (SAM) algorithm and captures the relationship between POIs via self-attention mechanism. The global average pooling is applied to all POI tokens to give classification probabilities for noncontrast, arterial, venous, and delay. We trained the model using a self-collected large-scale multi-center dataset with 9,876 CT scans of 2,130 patients from three hospitals, covering various scan areas from chest to lower abdomen. The phase labels were manually annotated by three radiologists from three hospitals. The internal test set consists of 2,437 scans of 535 patients from the same three hospitals. The external test sets include datasets from three different external hospitals, including an abdominal CT dataset (ExtAbd) with 7,413 scans of 1,606 patients, and two chest CT datasets (ExtChest1, ExtChest2) with 3,886 scans of 445 patients and 568 scans of 147 patients, respectively.

## **RESULTS**

On the internal test set, our model achieved a mean F1 score of 96.8% , outperforming DICOM tags (77.5 %) and the state-of-the-art 2D based deep learning approach (95.9%) and vanilla POI based method (89.4%). Specifically for each phase, our model surpassed the 2D approach by F1 score margins of 0.6%, 0.4%, 1.1%, and 1.5% for noncontrast, arterial, venous, and delay, respectively. When evaluated on external test sets, our model maintained a stable performance advantage. We reported a substantially higher mean F1 score (93.5%) on ExtAbd dataset compared with the 2D (70.0%) and vanilla POI based approach (75.2%), and showed slightly better performance on ExtChest1 and ExtChest2 datasets (96.8% and 95.8%) than the 2D (94.3% and 93.9% ) and vanilla POI based approach (94.5% and 85.0% ).

## **CONCLUSION**

The proposed model could identify phases in both chest and abdominal CT scans with better accuracy and superior generalization ability in comparison to DICOM tags and state-of-the-art deep learning approaches.

## **CLINICAL RELEVANCE/APPLICATION**

The developed deep learning method promises a practical automated tool for laborious data curation when faced with large-scale, real-world data, thus helping scale up research for subsequent CT image analysis. In addition, it enables the

widespread deployment of fully-automated AI-based applications for downstream clinical tasks, e.g., screening, diagnosis, and prognosis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSIN07-1

### "AI Localism": Calibrating Performance of AI Algorithm for Intracranial Hemorrhage Detection to Local Conditions using Conformal Uncertainty Quantification

Thursday, Nov. 30 9:30AM - 10:30AM Room: N227B

Stuart R. Pomerantz, MD (*Presenter*) Support, General Electric Company

#### PURPOSE

AI algorithms often fail to meet performance claims in actual clinical implementation due to local patient and disease variances from initial training/testing. Without a systematic statistical approach, heuristic attempts at determining appropriate probability threshold adjustments can be beyond the capabilities of radiologists at initial algorithm adoption, much less to adapt as conditions change. We present a novel method for calibrating AI algorithm performance to local conditions by applying Conformal Uncertainty Quantification techniques on an Intracranial Hemorrhage (ICH) CT Detection algorithm previously developed at our institution. By providing rigorous and mathematically provable guarantees for high accuracy on the local population, this method can improve confidence in AI system reliability across diverse settings.

#### METHODS AND MATERIALS

To minimize typical ROC tradeoffs, our methodology optimizes both PPV and NPV by allowing abstention on cases for which the model has high uncertainty, as determined by a Conformal Prediction statistical analysis using a hold-out set of recent cases for ex-post-facto calibration. If the locally-derived calibration set is representative of future data, then appropriate high and low thresholds can be calculated to achieve formal guarantees for the PPV and/or NPV desired by the use-case requirements of a given implementation. Conformal methodology was applied to results of our ICH Detection algorithm on consecutive CT exams (9122 exams over recent 6 month period ) compared to ground-truth from AI-naïve final reports. A deep learning feature extractor was used on the array of per-image probabilities of each case with decision-tree training for probabilistic binary classification.

#### RESULTS

Conformal uncertainty quantification effectively calibrated the AI model to a set of patients several years removed in time from the initial algorithm training, enabling high-confidence PPV and NPV compared to a model that cannot perform abstention. The calibrated model provides a formal PPV guarantee of at least 85% and NPV of at least 95%. with only 7% of data points abstained. By standard ROC analysis , an NPV of 95% would yield PPV of 50% (Fig 1).

#### CONCLUSION

Conformal uncertainty quantification provides a straightforward non-heuristic approach to calibrating an AI algorithm's performance to local conditions, enhancing prediction confidence, promising better decision-making and risk management in one own's setting.

#### CLINICAL RELEVANCE/APPLICATION

Conformal uncertainty quantification can be easily applied to a wide range of AI models improving practicality and reliability of algorithm implementation across diverse settings, time periods and use-case targets in the radiology workflow pipeline.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSIN07-2

### MedVisGPT: Human-AI Collaborative Diagnosis for Medical Imaging

Thursday, Nov. 30 9:30AM - 10:30AM Room: N227B

Xingxin He (*Presenter*) Nothing to Disclose

#### PURPOSE

To enhance diagnostic efficiency, a Human-AI interactive diagnosis approach is proposed, allowing for seamless engagement between the two entities.

#### METHODS AND MATERIALS

A dataset of knee radiographs and associated reports for cases with anterior cruciate ligament (ACL) tears and control knees was collected retrospectively from the Research Patient Data Registry (RPDR) database at Massachusetts General Brigham (MGB) between 2001 and 2022. The cases include 10,000 individuals with confirmed isolated ACL tears on MRI and no prior ACL reconstruction, while the control group consists of 16,000 individuals with MRI confirmation of no ligament tears or fractures. All radiographs included AP and lateral views and were collected from patients above the age of 14. We built and trained an interactive approach named Medical Visual Generative Pre-Trained Transformer (MedVisGPT) to assist and combine efforts with humans in interpreting radiological images. MedVisGPT can accept and receive multiple medical images from a single patient, which emphasizes and fuses vital diagnostic features across all given imaging data. MedVisGPT can describe medical images, interact with healthcare professionals, suggest diagnoses, give medical suggestions, and generate formal reports efficiently by engaging in natural and professional conversations with humans. MedVisGPT is locally trained and deployed, thus can perform these tasks while maintaining the privacy and confidentiality of patient data.

#### RESULTS

To demonstrate our MedVisGPT, here, we provided knee X-ray images of different views from two patients (a control case and a case with ACL) to our MedVisGPT and ask it the following questions: 1. Describe the given X-ray images briefly. 2. Provide the impression of the X-rays. 3. Provide the rationale behind your task. 4. Provide a report in a formal format. For the ACL case, we additionally asked questions to require suggestions: Is it an ACL? So does it need further MRI to confirm? MedVisGPT properly answered each question regarding the given images, gave MRI recommendation for the suspicious case, and summarized the context during chatting to generate a complete report in a professional format (see the left in the figure for the control case, the right for the case with ACL.). The entire process takes less than one minute, which tremendously reduces the workload of human radiologists in diagnosing medical images.

#### CONCLUSION

Our MedVisChat can suggest diagnoses, provide medical suggestions, and produce detailed medical reports in seconds by engaging in natural and professional conversations with humans.

#### CLINICAL RELEVANCE/APPLICATION

MedVisChat can enhance diagnostic efficiency and automated medical report generation, resulting in reduced time and labor costs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSIN07-3

### Enhancing the Trustworthiness of Deep Learning Tools for Clinical Applications: A Comprehensive Pipeline with Model Explainability, Uncertainty Quantification, and Outlier Detection Applied to Implant Detection on Radiographs

Thursday, Nov. 30 9:30AM - 10:30AM Room: N227B

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Confident deployment of deep learning (DL) models in clinical settings necessitates trustworthiness, which includes the ability to explain predictions, report uncertainty levels, and identify outlier input data (out-of-distribution). Detecting total hip arthroplasty (THA) implants on plain radiographs is crucial for facilitating revision THA, but existing DL models lack trustworthiness for clinical deployment. In this work, we present THA-AID, a trustworthy DL tool for automated implant detection, to demonstrate our proposed pipeline for DL trustworthiness.

#### METHODS AND MATERIALS

We built a 5-fold cross-validation DL classifier to recognize 28 implants in input hip radiographs. We trained it on 244,248 AP, lateral, and oblique images obtained from 13,375 THA patients (2000-2022). Our trustworthiness pipeline consisted of 1) integrated gradient maps for model explainability, 2) a Mondrian Cross-conformal Predictor (MCCP) for uncertainty quantification that enabled the model to predict more than one label on challenging radiographs, and 3) a framework to detect data outliers, warning users if input image features or MCCP predictions deviate from 95% of the training data (possible outlier). The latter prevented the model from making predictions for out-of-distribution input data. Our pipeline is thoroughly evaluated on held-out internal and external test sets and six medical and non-medical out-of-domain datasets, including ImageNet, RadImageNet, chest X-ray, knee-radiograph, pre-operative hip, and post-operative hip datasets with unseen implants. We also compare our tool's baseline performance with two board-certified orthopedic surgeons.

#### RESULTS

Accuracy [F1-scores] were 98.9% [0.99] and 98.0% [0.98], with an MCCP coverage [efficiency] of 99.7% [93.7%] and 97% [69.8%] on the internal and external test sets, respectively. Coverage denoted the fraction of prediction sets with true labels, and efficiency denoted the fraction of prediction sets with a single label. THA-AID achieved 97.5% accuracy compared to the best surgeon accuracy of 87% on 200 test images. It also identified 100% of data from out-of-domain datasets. Eliminating 39.7% of the most outlier external data improved the external set's accuracy, coverage, and efficiency to 1.0.

#### CONCLUSION

We developed THA-AID, a clinically trustworthy DL model that surpasses all previously reported models in baseline performance and exemplifies a pipeline for making DL models trustworthy.

#### CLINICAL RELEVANCE/APPLICATION

THA-AID is a strong candidate for clinical deployment in radiologic and orthopedic surgery applications. The trustworthiness pipeline exemplified in THA-AID can be easily applied to existing DL models without altering their architecture or training regime.

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## Abstract Archives of the RSNA, 2023

R3-SSIN07-4

### Concurrent Classification and Out-of-Distribution Detection of Radiologic Images: A Generative Approach

Thursday, Nov. 30 9:30AM - 10:30AM Room: N227B

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Out-of-distribution (OOD) detection is crucial in medical imaging deep learning as it helps identify samples that come from a distribution different from the training data. Deep learning models may perform poorly on data from a different distribution without alerting the user. OOD detection algorithms can identify such situations and notify users of potential errors, allowing them to reassess the diagnosis before making a final decision. Unlike other methods, we propose a joint generation-classification scheme to detect pneumothorax and OOD images that relies on perceptual differences rather than spurious features.

#### METHODS AND MATERIALS

To obtain a representative set of features, we used a variational autoencoder (VAE) with 1024 features to recreate images of 256x256 pixels. We fed the latent features to a classifier and co-trained it to detect the presence or absence of pneumothorax (Figure 1). The classifier's inputs are features condensed by the VAE, forcing the latent space to capture information required for classification and image restoration. We used the CheXpert dataset as our training and validation set (n=72,053; 80%:20% respectively) and tested our model on the SIIM-ACR dataset (n=11,582). We also trained a vanilla EfficientNet-B4 model for comparison. To quantify the distribution of images, we calculated the average cosine similarity of each image with the training set images. We set a threshold of 1% based on the training set, meaning that if an image has a lower similarity than the first percentile of training set samples, it is considered OOD. This approach allows us to see image-level statistics compared to existing population-level approaches. To test our OOD detection algorithm, we used a pediatric chest x-ray dataset (n=5,856).

#### RESULTS

Our model achieved an AUROC of 0.79 in detecting pneumothorax on the validation set and 0.78 on the test set. These values were 0.81 and 0.79 for the validation and test sets, respectively, when evaluating the vanilla classifier. On the validation set, 1% of the images were flagged as OOD, while 6.1% of the SIIM-ACR test set was characterized as OOD. This number was 48.9% for the pediatric chest x-ray dataset.

#### CONCLUSION

Our combined generation-classification scheme can be used to detect OOD samples without significantly degrading the performance of the classification model.

#### CLINICAL RELEVANCE/APPLICATION

In healthcare settings, OOD images can come from different scanners or populations, causing the model's performance to degrade and reducing its generalizability. This means that model cannot be trustworthy in those situations. Adding a layer of OOD detection ensures that patients receive accurate and reliable diagnoses while maintaining trust in AI systems.

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## Abstract Archives of the RSNA, 2023

R3-SSIN07-5

### Reproducibility of Deep Learning Algorithms Developed for Medical Imaging Analysis: A Systematic Review

Thursday, Nov. 30 9:30AM - 10:30AM Room: N227B

Shahriar Faghani, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Since 2000, there have been more than 8,000 publications on radiology artificial intelligence (AI). AI breakthroughs allow complex tasks to be automated and even performed beyond human capabilities. However, the lack of details on the methods and algorithm code undercuts its scientific value. Many science subfields have recently faced a reproducibility crisis, eroding trust in processes and results and influencing the rise in retractions of scientific papers. For the same reasons, conducting research in deep learning also requires reproducibility. Three criteria need to be met for a study to be truly reproducible: technically reproducible, statistically reproducible, and conceptually reproducible. Although several valuable manuscript checklists for AI in medical imaging exist, they are not focused specifically on reproducibility. In this study, we conducted a systematic review of recently published papers in the field of deep learning to evaluate if the description of their methodology could allow the reproducibility of their findings.

#### METHODS AND MATERIALS

We focused on the Journal of Digital Imaging (JDI), a specialized journal that publishes papers on AI and medical imaging. We used the keyword "Deep Learning" and collected the articles published between January 2020 to January 2022. We screened all the articles and included the ones which reported the development of a deep learning tool in medical imaging. We extracted the reported details about the dataset, data handling steps, data splitting, model details, and performance metrics of each included article based on a checklist developed by several experts in the fields of AI and medical imaging to assess the three mentioned reproducibility criteria.

#### RESULTS

We found 148 articles. 80 were included after screening for articles that reported developing a deep learning model for medical image analysis. Five studies have made their code publicly available, and thirty-five studies have utilized publicly available datasets. We provided figures to show the ratio and absolute count of reported items from included studies.

#### CONCLUSION

According to our cross-sectional study, in JDI publications on DL in medical imaging, authors infrequently report the key elements of their study to make it reproducible.

#### CLINICAL RELEVANCE/APPLICATION

This systematic review emphasizes the importance of a reproducibility checklist for deep learning algorithms developed for medical imaging analysis to have practical clinical applications. The study suggests that researchers should present comprehensive descriptions of their methodology and share their code and datasets publicly, as these steps can enhance the scientific value and reliability of AI-based medical imaging research.

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## Abstract Archives of the RSNA, 2023

R3-SSIN07-6

### Robust and General Phase Recognition on Multi-Phase Contrast-Enhanced CT Scans

Thursday, Nov. 30 9:30AM - 10:30AM Room: N227B

Ling Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

Most previous CT phase recognition methods only work on a specific scan area (e.g., chest, upper abdomen) and are not evaluated in external hospitals. This work aims to develop an efficient and robust method for CT phase recognition across scan areas and hospitals.

#### METHODS AND MATERIALS

Our model is a clinical prior knowledge-guided classification framework that extracts the features of pre-defined points of interest (POIs) located by self-supervised anatomical embedding (SAM) algorithm and captures the relationship between POIs via self-attention mechanism. The global average pooling is applied to all POI tokens to give classification probabilities for noncontrast, arterial, venous, and delay. We trained the model using a self-collected large-scale multi-center dataset with 9,876 CT scans of 2,130 patients from three hospitals, covering various scan areas from chest to lower abdomen. The phase labels were manually annotated by three radiologists from three hospitals. The internal test set consists of 2,437 scans of 535 patients from the same three hospitals. The external test sets include datasets from three different external hospitals, including an abdominal CT dataset (ExtAbd) with 7,413 scans of 1,606 patients, and two chest CT datasets (ExtChest1, ExtChest2) with 3,886 scans of 445 patients and 568 scans of 147 patients, respectively.

#### RESULTS

On the internal test set, our model achieved a mean F1 score of 96.8% , outperforming DICOM tags (77.5 %) and the state-of-the-art 2D based deep learning approach (95.9%) and vanilla POI based method (89.4%). Specifically for each phase, our model surpassed the 2D approach by F1 score margins of 0.6%, 0.4%, 1.1%, and 1.5% for noncontrast, arterial, venous, and delay, respectively. When evaluated on external test sets, our model maintained a stable performance advantage. We reported a substantially higher mean F1 score (93.5%) on ExtAbd dataset compared with the 2D (70.0%) and vanilla POI based approach (75.2%), and showed slightly better performance on ExtChest1 and ExtChest2 datasets (96.8% and 95.8%) than the 2D (94.3% and 93.9% ) and vanilla POI based approach (94.5% and 85.0% ).

#### CONCLUSION

The proposed model could identify phases in both chest and abdominal CT scans with better accuracy and superior generalization ability in comparison to DICOM tags and state-of-the-art deep learning approaches.

#### CLINICAL RELEVANCE/APPLICATION

The developed deep learning method promises a practical automated tool for laborious data curation when faced with large-scale, real-world data, thus helping scale up research for subsequent CT image analysis. In addition, it enables the widespread deployment of fully-automated AI-based applications for downstream clinical tasks, e.g., screening, diagnosis, and prognosis.

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## Abstract Archives of the RSNA, 2023

R3-SSMK11

### Musculoskeletal Imaging (Tumors of Bone and Soft Tissue)

Thursday, Nov. 30 9:30AM - 10:30AM Room: N228

Mihra S. Taljanovic, MD, PhD (*Moderator*) Nothing to Disclose  
Corey K. Ho, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R3-SSMK11-1 Development of a Spectral Multiparameter Model for Differentiating Bone Islands and Bone Metastases on Detector-based Spectral CT**

Yuhan Zhou, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance of a spectral multiparameter model for differentiating bone islands (BIs) and bone metastases (OBMs) based on dual-layer detector spectral CT (DLCT).

#### METHODS AND MATERIALS

This retrospective study collected 80 patients who underwent DLCT chest and abdominal multi-phase scans in a routine scanning protocol. Record the total CT dose index (DLP), dose length product (CTDI) and effective radiation dose (ED) of both the plain scan and multi-phase contrast-enhanced scan phases. Spectral data were post-processed to obtain conventional images (CI), effective atomic number (Z-eff) and electron density (DE) maps, virtual non-calcium images (VNCa), and the slope of the X-ray attenuation curve ( $\mu$ HU) on plain phase CT images. Differences in various spectral quantitative parameters between BIs and OBMs were evaluated by t-test. Logistic regression was used to evaluate the predictive probability of spectral multi-parameters for BIs and OBMs, and a spectral multi-parameter model was established. The receiver operating characteristic curves (ROC) and area under the curve (AUC) were employed to evaluate the diagnostic performance of the spectral multiparametric model in comparison to single-parameter model.

#### RESULTS

There were significant differences in conventional CT value, Z-eff, ED, and  $\mu$ HU between the BIs and OBMs groups for distinguish BIs from OBMs ( $P < 0.001$ ). The spectral multi-parameter model had the highest discriminative power for differentiating BIs from OBMs (AUC=0.931), while CT value (AUC=0.92) and each spectral parameter (Z-eff: AUC=0.888; ED: AUC=0.84;  $\mu$ HU: AUC=0.888) also showed good independent predictive performance. Compared to multiphase contrast-enhanced scans, the radiation dose during the plain phase is significantly reduced ( $p < 0.001$ ).

#### CONCLUSION

The spectral multi-parameter model, derive from plain phase images, demonstrates a higher discriminative diagnostic performance in differentiating BIs from OBMs compared to conventional CT and single spectral parameter, without necessitating additional radiation exposure.

#### CLINICAL RELEVANCE/APPLICATION

It is crucial to establish whether a sclerotic lesion is a bone island or osteoblastic bone metastasis to determine treatment strategy, particularly with atypical image findings. Detector-based spectral CT offers a valuable multiparametric approach for clinical assessment, obviating the need for supplementary scanning protocols and additional radiation exposure. The development of an optimized model holds the potential to offer enhanced imaging support for the early clinical diagnosis, treatment strategy formulation, and prognosis prediction of osteoblastic metastases.

#### **R3-SSMK11-2 Monitoring the Plexiform/Diffuse Neurofibromas that Progress to MPNST**

Sarah Attia, BS (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this study is to evaluate a consecutive series of neurofibromatosis (NF) type I patients, who have had at least one whole body (WB) MRI to investigate the frequency of plexiform neurofibromas (pNF) and diffuse neurofibromas (dNF) and the incidence of malignant peripheral nerve sheath tumors (MPNST). Our hypothesis was that MPNSTs arise de novo, more commonly than in pNF or dNF.

## METHODS AND MATERIALS

In this retrospective cross-sectional IRB approved study at a tertiary care institute, electronic medical records were searched for NF1 patients who had undergone at least one WB-MRI screening between the years 2015 to 2023. A consecutive series of 83 patients with known NF1 were screened for MPNST using anatomic STIR, diffusion-weighted, and pre- and post-contrast T1W 3D imaging as a standard protocol. A MSK fellowship-trained radiologist evaluated all scans and the lesions were categorized as discrete lesions, pNF, dNF, and MPNST using the previously-described imaging criteria. Histopathology served as the reference standard for benign and malignant lesions. Descriptive statistics were derived.

## RESULTS

Among the 83 patients analyzed, 53 (64%) were women and 30 were men (36%) of ages (37+/-14.43). 33 had positive family history of NF1 and genetic studies. All had good quality imaging studies without motion degradation. All patients had discrete cutaneous-subcutaneous lesions of variable sizes. 6/83 (7%) had dNF, 20/83 (24%) had plexiform neurofibromas, 29/83 (35%) had both dNF and pNF, and 28/83 (34%) had neither. The dNF and pNF showed variable distribution in the torso. 8/83 patients had 9 total MPNSTs in variable locations throughout the body including liver and lung. Only 1/9 MPNST developed in the chest area, 4 years after WBMRI with underlying pNF along the right bronchial tree (fig. 1). 37.5% of patients with MPNST died within 5 years of pathologic diagnosis.

## CONCLUSION

Our results demonstrate that MPNSTs arise with about 11% frequency in NF1 patients and 11% MPNSTs arise in the setting of a pNF. None arise in dNF.

## CLINICAL RELEVANCE/APPLICATION

Plexiform and diffuse NF do not significantly predispose to MPNSTs in the setting of NF1, which otherwise are fatal tumors in at least of 37.5% of cases within 5 years of the diagnosis.

## R3- Explainable Multimodal Radiomics Based Risk Model to Predict Involvement of Post-Surgical Tissue Margin in Soft Tissue Sarcoma

Ehsan Alipour, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

Soft tissue sarcomas (STSs) are a rare group of cancer that usually require precise surgical resection to achieve local control. The involvement of post-surgical tissue margin is a critical factor in determining the success of the surgery and the likelihood of recurrence. In this study, we present a multimodal radiomics-based risk model to predict the involvement of post-surgical tissue margin in STS using pretreatment MRI radiomics.

## METHODS AND MATERIALS

A retrospective cohort of patients with STS, pretreatment MRI imaging, and post resection pathology margin information was identified. In addition, clinical information including patient's age, biologic sex, tumor location, and pre-excision tumor grading was extracted. Tumor regions on pre-treatment MRI images were segmented by a musculoskeletal radiologist with over 10 years of experience on 4 sequences including fat suppressed T2, fat suppressed T1 before and after intravenous contrast, and T1-weighted images. 104 original radiomics features were extracted using the Pyradiomics package for each sequence. These features were pooled together with the clinical and demographic data mentioned before. Margin information was extracted from pathology reports. Data was divided into training and testing sets using a 0.8, 0.2 ratio. A XGBoost model was trained to classify patients. Random search with 5-fold cross validation was used to find the best model parameters. The model was calibrated based on actual probabilities in the train set and the best threshold for model prediction was identified by the Youden index. The final model was tested on the hold-out test set. Shapley values were used to assess feature importance for the model.

## RESULTS

A cohort of 199 patients with soft tissue sarcoma that had pretreatment MRI imaging and post resection pathology margin information were identified. There were 70 female and 129 male patients. The average age at diagnosis was 54 years. Out of these, 149 STSs had a clear tissue margin. Our best performing model achieved a ROC-AUC of 0.73 (Figure 1a) on the hold-out test set reaching a sensitivity of 60% and specificity of 73% using the threshold suggested by the Youden index. The negative predictive value of the model was 85% (Figure 1b). The final model only used 10 of the input features. Most important features were original shape sphericity of the T1AC image and tumor's maximum 2D diameter. (Figure 1c)



## CONCLUSION

Our multimodal radiomics-based risk model shows promising results in predicting the involvement of post-surgical tissue margin in STS.

## CLINICAL RELEVANCE/APPLICATION

Radiomics-based model predicts involvement of post-surgical margin in STS using MRI and clinical data. The model can be used to flag high risk patients and plan surgery accordingly.

### R3-SSMK11-4 **Risk Factors for Recurrences and Metastases of Soft Tissue Sarcomas Derived from Routine Clinical MRI**

Sam Sedaghat, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

There is a lack of studies evaluating potential risk factors for recurrences and metastases of soft tissue sarcomas (STS). Therefore, this multicenter study investigates potential imaging and non-imaging risk factors for recurrences and metastasis of STS derived during routine MRI examination.

#### METHODS AND MATERIALS

285 patients with histologically proven primary STS were included in this IRB-approved multicenter study. Patients with liposarcoma, angiosarcoma and retroperitoneal sarcoma were excluded. The following imaging risk factors were derived from standard clinical MRI sequences: configuration, infiltration, heterogeneity, and size of primary STS. Additionally, histological subtype, tumor grade (according to FNCLCC), resection status, previous occurrence of a recurrence, and location were evaluated as non-imaging risk factors. All potential risk factors were investigated for recurrences and metastases separately. 1.5 Tesla MRI systems from three different vendors were used for imaging.

#### RESULTS

The most common STS was pleomorphic sarcoma, followed by myxofibrosarcoma and synovial sarcoma. The mean age of the patients was 54,6 years. 46,3% of the patients were female. For metastasis, the tumor grade ( $p = 0.001$ ), the resection status ( $p=0.008$ ) and the occurrence of a previous recurrence ( $p<0.001$ ) were significant non-imaging risk factors. From the imaging side, configuration ( $p=0.033$ ) and infiltration ( $p=0.029$ ) of the primary tumor were the only significant risk factors for metastases. For recurrences, the only significant risk factor was the tumor location ( $p=0.029$ ). All other risk factors showed no significant results regarding metastases and recurrences. There was no imaging risk factor for recurrences.

## CONCLUSION

Configuration and infiltrative behavior of the primary STS, as well as tumor grade, resection status, and previous occurrence of a recurrence presented as potential risk factors for metastases. Our findings can help radiologists inside and outside of large sarcoma centers to evaluate the potential risk for later metastases of STS during routine MRI examinations. However, there was no potential imaging-related risk factor for the occurrence of STS recurrences.

## CLINICAL RELEVANCE/APPLICATION

There is an urgent need for reliable risk stratification for STS-related metastases and recurrences. MRI examination of primary STS is often performed outside large sarcoma centers, leading to insufficient patient data for risk analysis. Our study can help radiologists and non-radiologists to evaluate the risk of later metastases by just reviewing tumor-related data during routine MRI examination.

### R3-SSMK11-5 **Attention-based Deep Learning Model for the Segmentation and Classification of Pelvic and Sacral Tumors on Routine MRI**

Ping Yin (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop an attention-based two stage deep learning (DL) model for the segmentation and classification of benign and malignant pelvic and sacral tumors (PSTs) based on routine magnetic resonance imaging (MRI) and clinical characteristics.

#### METHODS AND MATERIALS

549 patients with PSTs at our hospital were retrospectively used for model building and internal test. An additional 105 PSTs patients were used for the prospective test set. Based on multi-sequence MRI (T1-W, T2-W, DWI, CET1-W), physician's labeling, segmentation model, and clinical features, we compared the effects of six classification models. Three radiologists compared diagnostic performance with the model. The performance of different models was assessed using the area under the curve (AUC) and accuracy (ACC) values.

## RESULTS

In total, 654 patients were enrolled in this study, including 160 benign tumors and 494 malignant tumors. We found significant statistical differences in terms of age, sex, tumor size, and tumor location between patients with benign and malignant tumors ( $P < 0.01$ ). DeLong-test between AUCs showed that the classification effect based on model segmentation (model 3) was significantly better than that based on whole-map classification (model 1;  $P = 0.01$ ) and a doctor's rough segmentation annotation classification (model 2;  $P = 0.02$ ) in the internal test set. The model based on plain MR images (without CET1-w) obtained an ACC comparable to that of the enhanced model (with CET1-w) ( $P > 0.05$ ). The fusion of imaging and clinical information further improved the efficiency and robustness of the algorithm. Our highest scoring model (model 6) achieved mean Dice score of 0.758 for segmentations, 0.823 AUC, 0.776 ACC, 0.827 sensitivity, and 0.657 specificity for classifications in the internal test set, and 0.836 AUC, 0.781 ACC, 0.825 sensitivity, and 0.640 specificity in the prospective test set. The model's ACC was comparable to that of senior residents (ACC of 0.819 and 0.771;  $P > 0.05$ ) and junior attending physician (ACC of 0.79;  $P > 0.05$ ). However, the diagnosing time of DL model (2.1 seconds) is significantly shorter than physicians (average time 4.32 minutes) ( $P < 0.01$ ).

## CONCLUSION

Our attention-based two stage DL model allowed the accurate segmentation and classification of benign and malignant PSTs without enhanced MRI and may thus facilitate diagnosis.

## CLINICAL RELEVANCE/APPLICATION

Our model only needs to input the original image to give diagnostic suggestions, which can not only reduce the misdiagnosis rates but also greatly improve diagnostic efficiency.

## R3- SSMK11-6 X-rays Radiomics-based Machine Learning Classification of Atypical Cartilaginous Tumor and High-grade Chondrosarcoma of Long Bones

Salvatore Gitto, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Atypical cartilaginous tumor (ACT) and high-grade chondrosarcoma (CS) of long bones are respectively managed with curettage/watchful waiting and wide resection. Preoperatively, imaging diagnosis can be challenging due to interobserver variability and biopsy suffers from sampling errors. Our aim was to determine diagnostic performance of X-rays radiomics-based machine learning for classification of ACT and CS of long bones.

## METHODS AND MATERIALS

118 patients (71 women; median age: 56 years) with surgically treated and histology-proven cartilaginous bone tumors were retrospectively included at a tertiary bone sarcoma center. Based on temporal criteria (date of surgery), the dataset was split into training and independent test cohorts for model tuning and independent testing on unseen data, respectively. The training and independent test cohorts consisted of 95 (65 ACT; 30 CS) and 23 (17 ACT; 6 CS) patients, respectively. Segmentation was manually performed by drawing an oval-shaped region of interest including the lesion on preoperative frontal view X-rays. MRI was available and used for identification of lesion margins in all patients before X-rays image segmentation. After preprocessing consisting of resampling to isotropic pixel and intensity discretization, radiomic features (morphology, intensity-based statistics, intensity histogram and texture) were extracted. Dimensionality reduction included stability, variance and inter-correlation analyses. Class balancing was performed in the training cohort (CS oversampled to  $n=65$ ). Thus, a machine-learning classifier (Support Vector Machine) was automatically tuned on the training cohort using nested 10-fold cross-validation and tested on the independent test cohort. Mann-Whitney U test was performed to verify feature significance in differentiating ACT from CS. Bonferroni-adjusted  $p$ -value  $< 0.005$  indicated statistical significance.

## RESULTS

Five radiomic features (2 morphology and 3 texture) passed dimensionality reduction ( $p < 0.005$ ). After tuning on the training cohort (AUC=0.78), the machine-learning classifier had 83% accuracy, 83% sensitivity and 82% specificity in identifying the lesions in the independent test cohort, respectively.

## CONCLUSION

Machine learning showed high accuracy in classifying ACT and CS of long bones based on preoperative X-rays radiomic features.

## CLINICAL RELEVANCE/APPLICATION

Radiomics-based machine learning is an objective method, using X-rays images only, that may be used in the management of cartilaginous bone lesions by accurately differentiating between ACT and CS.

## Abstract Archives of the RSNA, 2023

R3-SSMK11-1

### Development of a Spectral Multiparameter Model for Differentiating Bone Islands and Bone Metastases on Detector-based Spectral CT

Thursday, Nov. 30 9:30AM - 10:30AM Room: N228

Yuhan Zhou, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance of a spectral multiparameter model for differentiating bone islands (BIs) and bone metastases (OBMs) based on dual-layer detector spectral CT (DLCT).

#### METHODS AND MATERIALS

This retrospective study collected 80 patients who underwent DLCT chest and abdominal multi-phase scans in a routine scanning protocol. Record the total CT dose index (DLP), dose length product (CTDI) and effective radiation dose (ED) of both the plain scan and multi-phase contrast-enhanced scan phases. Spectral data were post-processed to obtain conventional images (CI), effective atomic number (Z-eff) and electron density (DE) maps, virtual non-calcium images (VNCa), and the slope of the X-ray attenuation curve ( $\mu$ HU) on plain phase CT images. Differences in various spectral quantitative parameters between BIs and OBMs were evaluated by t-test. Logistic regression was used to evaluate the predictive probability of spectral multi-parameters for BIs and OBMs, and a spectral multi-parameter model was established. The receiver operating characteristic curves (ROC) and area under the curve (AUC) were employed to evaluate the diagnostic performance of the spectral multiparametric model in comparison to single-parameter model.

#### RESULTS

There were significant differences in conventional CT value, Z-eff, ED, and  $\mu$ HU between the BIs and OBMs groups for distinguish BIs from OBMs ( $P < 0.001$ ). The spectral multi-parameter model had the highest discriminative power for differentiating BIs from OBMs (AUC=0.931), while CT value (AUC=0.92) and each spectral parameter (Z-eff: AUC=0.888; ED: AUC=0.84;  $\mu$ HU: AUC=0.888) also showed good independent predictive performance. Compared to multiphase contrast-enhanced scans, the radiation dose during the plain phase is significantly reduced ( $p < 0.001$ ).

#### CONCLUSION

The spectral multi-parameter model, derive from plain phase images, demonstrates a higher discriminative diagnostic performance in differentiating BIs from OBMs compared to conventional CT and single spectral parameter, without necessitating additional radiation exposure.

#### CLINICAL RELEVANCE/APPLICATION

It is crucial to establish whether a sclerotic lesion is a bone island or osteoblastic bone metastasis to determine treatment strategy, particularly with atypical image findings. Detector-based spectral CT offers a valuable multiparametric approach for clinical assessment, obviating the need for supplementary scanning protocols and additional radiation exposure. The development of an optimized model holds the potential to offer enhanced imaging support for the early clinical diagnosis, treatment strategy formulation, and prognosis prediction of osteoblastic metastases.

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## Abstract Archives of the RSNA, 2023

R3-SSMK11-2

### Monitoring the Plexiform/Diffuse Neurofibromas that Progress to MPNST

Thursday, Nov. 30 9:30AM - 10:30AM Room: N228

Sarah Attia, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to evaluate a consecutive series of neurofibromatosis (NF) type I patients, who have had at least one whole body (WB) MRI to investigate the frequency of plexiform neurofibromas (pNF) and diffuse neurofibromas (dNF) and the incidence of malignant peripheral nerve sheath tumors (MPNST). Our hypothesis was that MPNSTs arise de novo, more commonly than in pNF or dNF.

#### METHODS AND MATERIALS

In this retrospective cross-sectional IRB approved study at a tertiary care institute, electronic medical records were searched for NF1 patients who had undergone at least one WB-MRI screening between the years 2015 to 2023. A consecutive series of 83 patients with known NF1 were screened for MPNST using anatomic STIR, diffusion-weighted, and pre- and post-contrast T1W 3D imaging as a standard protocol. A MSK fellowship-trained radiologist evaluated all scans and the lesions were categorized as discrete lesions, pNF, dNF, and MPNST using the previously-described imaging criteria. Histopathology served as the reference standard for benign and malignant lesions. Descriptive statistics were derived.

#### RESULTS

Among the 83 patients analyzed, 53 (64%) were women and 30 were men (36%) of ages (37+/-14.43). 33 had positive family history of NF1 and genetic studies. All had good quality imaging studies without motion degradation. All patients had discrete cutaneous-subcutaneous lesions of variable sizes. 6/83 (7%) had dNF, 20/83 (24%) had plexiform neurofibromas, 29/83 (35%) had both dNF and pNF, and 28/83 (34%) had neither. The dNF and pNF showed variable distribution in the torso. 8/83 patients had 9 total MPNSTs in variable locations throughout the body including liver and lung. Only 1/9 MPNST developed in the chest area, 4 years after WBMRI with underlying pNF along the right bronchial tree (fig. 1). 37.5% of patients with MPNST died within 5 years of pathologic diagnosis.

#### CONCLUSION

Our results demonstrate that MPNSTs arise with about 11% frequency in NF1 patients and 11% MPNSTs arise in the setting of a pNF. None arise in dNF.

#### CLINICAL RELEVANCE/APPLICATION

Plexiform and diffuse NF do not significantly predispose to MPNSTs in the setting of NF1, which otherwise are fatal tumors in at least of 37.5% of cases within 5 years of the diagnosis.

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## Abstract Archives of the RSNA, 2023

R3-SSMK11-3

### Explainable Multimodal Radiomics Based Risk Model to Predict Involvement of Post-Surgical Tissue Margin in Soft Tissue Sarcoma

Thursday, Nov. 30 9:30AM - 10:30AM Room: N228

Ehsan Alipour, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Soft tissue sarcomas (STSs) are a rare group of cancer that usually require precise surgical resection to achieve local control. The involvement of post-surgical tissue margin is a critical factor in determining the success of the surgery and the likelihood of recurrence. In this study, we present a multimodal radiomics-based risk model to predict the involvement of post-surgical tissue margin in STS using pretreatment MRI radiomics.

#### METHODS AND MATERIALS

A retrospective cohort of patients with STS, pretreatment MRI imaging, and post resection pathology margin information was identified. In addition, clinical information including patient's age, biologic sex, tumor location, and pre-excision tumor grading was extracted. Tumor regions on pre-treatment MRI images were segmented by a musculoskeletal radiologist with over 10 years of experience on 4 sequences including fat suppressed T2, fat suppressed T1 before and after intravenous contrast, and T1-weighted images. 104 original radiomics features were extracted using the Pyradiomics package for each sequence. These features were pooled together with the clinical and demographic data mentioned before. Margin information was extracted from pathology reports. Data was divided into training and testing sets using a 0.8, 0.2 ratio. A XGBoost model was trained to classify patients. Random search with 5-fold cross validation was used to find the best model parameters. The model was calibrated based on actual probabilities in the train set and the best threshold for model prediction was identified by the Youden index. The final model was tested on the hold-out test set. Shapley values were used to assess feature importance for the model.

#### RESULTS

A cohort of 199 patients with soft tissue sarcoma that had pretreatment MRI imaging and post resection pathology margin information were identified. There were 70 female and 129 male patients. The average age at diagnosis was 54 years. Out of these, 149 STSs had a clear tissue margin. Our best performing model achieved a ROC-AUC of 0.73 (Figure 1a) on the hold-out test set reaching a sensitivity of 60% and specificity of 73% using the threshold suggested by the Youden index. The negative predictive value of the model was 85% (Figure 1b). The final model only used 10 of the input features. Most important features were original shape sphericity of the T1AC image and tumor's maximum 2D diameter. (Figure 1c)

#### CONCLUSION

Our multimodal radiomics-based risk model shows promising results in predicting the involvement of post-surgical tissue margin in STS.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics-based model predicts involvement of post-surgical margin in STS using MRI and clinical data. The model can be used to flag high risk patients and plan surgery accordingly.

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## Abstract Archives of the RSNA, 2023

R3-SSMK11-4

### **Risk Factors for Recurrences and Metastases of Soft Tissue Sarcomas Derived from Routine Clinical MRI**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N228

Sam Sedaghat, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

There is a lack of studies evaluating potential risk factors for recurrences and metastases of soft tissue sarcomas (STS). Therefore, this multicenter study investigates potential imaging and non-imaging risk factors for recurrences and metastasis of STS derived during routine MRI examination.

#### **METHODS AND MATERIALS**

285 patients with histologically proven primary STS were included in this IRB-approved multicenter study. Patients with liposarcoma, angiosarcoma and retroperitoneal sarcoma were excluded. The following imaging risk factors were derived from standard clinical MRI sequences: configuration, infiltration, heterogeneity, and size of primary STS. Additionally, histological subtype, tumor grade (according to FNCLCC), resection status, previous occurrence of a recurrence, and location were evaluated as non-imaging risk factors. All potential risk factors were investigated for recurrences and metastases separately. 1.5 Tesla MRI systems from three different vendors were used for imaging.

#### **RESULTS**

The most common STS was pleomorphic sarcoma, followed by myxofibrosarcoma and synovial sarcoma. The mean age of the patients was 54,6 years. 46,3% of the patients were female. For metastasis, the tumor grade ( $p = 0.001$ ), the resection status ( $p=0.008$ ) and the occurrence of a previous recurrence ( $p<0.001$ ) were significant non-imaging risk factors. From the imaging side, configuration ( $p=0.033$ ) and infiltration ( $p=0.029$ ) of the primary tumor were the only significant risk factors for metastases. For recurrences, the only significant risk factor was the tumor location ( $p=0.029$ ). All other risk factors showed no significant results regarding metastases and recurrences. There was no imaging risk factor for recurrences.

#### **CONCLUSION**

Configuration and infiltrative behavior of the primary STS, as well as tumor grade, resection status, and previous occurrence of a recurrence presented as potential risk factors for metastases. Our findings can help radiologists inside and outside of large sarcoma centers to evaluate the potential risk for later metastases of STS during routine MRI examinations. However, there was no potential imaging-related risk factor for the occurrence of STS recurrences.

#### **CLINICAL RELEVANCE/APPLICATION**

There is an urgent need for reliable risk stratification for STS-related metastases and recurrences. MRI examination of primary STS is often performed outside large sarcoma centers, leading to insufficient patient data for risk analysis. Our study can help radiologists and non-radiologists to evaluate the risk of later metastases by just reviewing tumor-related data during routine MRI examination.

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## Abstract Archives of the RSNA, 2023

R3-SSMK11-5

### Attention-based Deep Learning Model for the Segmentation and Classification of Pelvic and Sacral Tumors on Routine MRI

Thursday, Nov. 30 9:30AM - 10:30AM Room: N228

Ping Yin (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop an attention-based two stage deep learning (DL) model for the segmentation and classification of benign and malignant pelvic and sacral tumors (PSTs) based on routine magnetic resonance imaging (MRI) and clinical characteristics.

#### METHODS AND MATERIALS

549 patients with PSTs at our hospital were retrospectively used for model building and internal test. An additional 105 PSTs patients were used for the prospective test set. Based on multi-sequence MRI (T1-W, T2-W, DWI, CET1-W), physician's labeling, segmentation model, and clinical features, we compared the effects of six classification models. Three radiologists compared diagnostic performance with the model. The performance of different models was assessed using the area under the curve (AUC) and accuracy (ACC) values.

#### RESULTS

In total, 654 patients were enrolled in this study, including 160 benign tumors and 494 malignant tumors. We found significant statistical differences in terms of age, sex, tumor size, and tumor location between patients with benign and malignant tumors ( $P < 0.01$ ). Delong-test between AUCs showed that the classification effect based on model segmentation (model 3) was significantly better than that based on whole-map classification (model 1;  $P = 0.01$ ) and a doctor's rough segmentation annotation classification (model 2;  $P = 0.02$ ) in the internal test set. The model based on plain MR images (without CET1-w) obtained an ACC comparable to that of the enhanced model (with CET1-w) ( $P > 0.05$ ). The fusion of imaging and clinical information further improved the efficiency and robustness of the algorithm. Our highest scoring model (model 6) achieved mean Dice score of 0.758 for segmentations, 0.823 AUC, 0.776 ACC, 0.827 sensitivity, and 0.657 specificity for classifications in the internal test set, and 0.836 AUC, 0.781 ACC, 0.825 sensitivity, and 0.640 specificity in the prospective test set. The model's ACC was comparable to that of senior residents (ACC of 0.819 and 0.771;  $P > 0.05$ ) and junior attending physician (ACC of 0.79;  $P > 0.05$ ). However, the diagnosing time of DL model (2.1 seconds) is significantly shorter than physicians (average time 4.32 minutes) ( $P < 0.01$ ).

#### CONCLUSION

Our attention-based two stage DL model allowed the accurate segmentation and classification of benign and malignant PSTs without enhanced MRI and may thus facilitate diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

Our model only needs to input the original image to give diagnostic suggestions, which can not only reduce the misdiagnosis rates but also greatly improve diagnostic efficiency.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSMK11-6

### **X-rays Radiomics-based Machine Learning Classification of Atypical Cartilaginous Tumor and High-grade Chondrosarcoma of Long Bones**

Thursday, Nov. 30 9:30AM - 10:30AM Room: N228

Salvatore Gitto, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Atypical cartilaginous tumor (ACT) and high-grade chondrosarcoma (CS) of long bones are respectively managed with curettage/watchful waiting and wide resection. Preoperatively, imaging diagnosis can be challenging due to interobserver variability and biopsy suffers from sampling errors. Our aim was to determine diagnostic performance of X-rays radiomics-based machine learning for classification of ACT and CS of long bones.

#### **METHODS AND MATERIALS**

118 patients (71 women; median age: 56 years) with surgically treated and histology-proven cartilaginous bone tumors were retrospectively included at a tertiary bone sarcoma center. Based on temporal criteria (date of surgery), the dataset was split into training and independent test cohorts for model tuning and independent testing on unseen data, respectively. The training and independent test cohorts consisted of 95 (65 ACT; 30 CS) and 23 (17 ACT; 6 CS) patients, respectively. Segmentation was manually performed by drawing an oval-shaped region of interest including the lesion on preoperative frontal view X-rays. MRI was available and used for identification of lesion margins in all patients before X-rays image segmentation. After preprocessing consisting of resampling to isotropic pixel and intensity discretization, radiomic features (morphology, intensity-based statistics, intensity histogram and texture) were extracted. Dimensionality reduction included stability, variance and inter-correlation analyses. Class balancing was performed in the training cohort (CS oversampled to n=65). Thus, a machine-learning classifier (Support Vector Machine) was automatically tuned on the training cohort using nested 10-fold cross-validation and tested on the independent test cohort. Mann-Whitney U test was performed to verify feature significance in differentiating ACT from CS. Bonferroni-adjusted p-value < 0.005 indicated statistical significance.

#### **RESULTS**

Five radiomic features (2 morphology and 3 texture) passed dimensionality reduction ( $p < 0.005$ ). After tuning on the training cohort (AUC=0.78), the machine-learning classifier had 83% accuracy, 83% sensitivity and 82% specificity in identifying the lesions in the independent test cohort, respectively.

#### **CONCLUSION**

Machine learning showed high accuracy in classifying ACT and CS of long bones based on preoperative X-rays radiomic features.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiomics-based machine learning is an objective method, using X-rays images only, that may be used in the management of cartilaginous bone lesions by accurately differentiating between ACT and CS.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSNR14

### Neuroradiology (Brain: Cognition and Memory)

Thursday, Nov. 30 9:30AM - 10:30AM Room: S401

Vahe M. Zohrabian, MD (*Moderator*) Nothing to Disclose  
Atin Saha, MD, MS (*Moderator*) Nothing to Disclose

#### Sub-Events

### R3-SSNR14-1 Characterization of Increased Brain Iron Deposition Associated With Motor Dysfunction in Cerebral Small Vessel Disease Patients With Mild Cognitive Impairment

Kelly Gillen, PhD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to compare the difference in brain iron deposition in the gray matter nuclei of the basal ganglia between cerebral small vessel disease (CSVD) patients with mild cognitive impairment (CSVD-MCI), CSVD patients without MCI (CSVD-no MCI) and healthy individuals using quantitative susceptibility mapping (QSM), as well as the correlation between brain iron deposition and motor dysfunction.

#### METHODS AND MATERIALS

Seventy-four CSVD-MCI patients, seventy-nine CSVD-no MCI patients and fifty-five healthy controls (HCs) were enrolled in this research. All subjects received cognitive, motor and Hospital Anxiety and Depression Scale (HADS) assessments. Brain QSM maps were calculated from multiecho GRE data using morphology-enabled dipole inversion with an automatic uniform cerebrospinal fluid zero reference algorithm (MEDI+0). ITK-SNAP was used by neuroradiologists to measure the susceptibility values reflecting the iron content in the regions of interest. A multiple linear regression analysis was performed to explore independent influencing factors of magnetic susceptibility. Correlation and mediation analyses between brain iron deposition and motor function were investigated.

#### RESULTS

There were significant differences in susceptibility values between the neostriatum including putamen and caudate nucleus among the three groups. The susceptibility values of the above regions in the CSVD-MCI group were higher than those in the CSVD-no MCI and HC groups. Stepwise multivariate linear regression analysis revealed that diabetes was the factor affecting iron deposition in the neostriatum in CSVD-MCI patients, and age was the factor affecting iron deposition in the neostriatum in CSVD-no MCI patients. In particular, anxiety showed significant mediation effects in the prediction of motor dysfunction with iron deposition in the left putamen in CSVD patients. Moreover, correlation analysis revealed that the susceptibility value of the left neostriatum was positively correlated with the five-repetition sit-to-stand test (5R-STST) time in CSVD patients.

#### CONCLUSION

The higher susceptibility value of CSVD-MCI patients with cognitive and motor dysfunction suggested a higher brain iron deposition burden, which may be a quantitative imaging marker to predict dementia.

#### CLINICAL RELEVANCE/APPLICATION

CSVD is the main cause of stroke and cognitive impairment, which seriously affects people's quality of life. In this study, the higher brain iron deposition burden may be a quantitative imaging marker to predict dementia.

### R3-SSNR14-2 Regional Brain Iron Correlate with Transcriptional and Cellular Signatures in Alzheimer's Disease

Jixin Luan, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to examine alterations in Alzheimer's disease (AD) patients' brain iron accumulation using quantitative susceptibility mapping (QSM), and applied an integrative imaging transcriptomics approach to identify transcriptional and cellular correlates of these changes.

## METHODS AND MATERIALS

Participants included 30 AD patients and 26 age- and sex-matched healthy controls (HCs). All participants underwent QSM on a 3.0T MRI scanner. Regional microarray expression data were obtained from 6 postmortem brains provided by the Allen Human Brain Atlas (AHBA). We used the abagen toolbox to process and map the transcriptomic data from the Desikan-Killiany Atlas. To examine the association between the healthy brain transcriptome and region QSM in AD, we used partial least square regression (PLS). We then used all genes in PLS1+ and PLS1- to conduct further bioinformatics analyses investigating whether these genes map to common and relevant biological pathways. We also investigated whether our PLS1+ and PLS1- subsets of genes were particularly enriched for genes of specific brain cell types. In our study, we used a spin-based method to correct for potential confounding effects of spatial autocorrelation.

## RESULTS

Compared with healthy controls, AD patients exhibited increased QSM, primarily in left caudate ( $P < 0.05$ ). The first PLS component (PLS1) explained the highest proportion of QSM changes (31.50%) and did so above chance ( $P_{boot} = 0.001$ ). Notably, we found that the PLS1 weighted gene expression map was spatially correlated with the case-control QSM t-map (Pearson's  $r = 0.48$ ,  $p_{spin} < 0.05$ ). Using gene ontological (GO) analyses with the PLS1- gene list, we found enrichment for a number of GO terms-biological pathways broadly mapping to the ion channel activity. We found that upweighted genes were significantly associated with microglia (MG), while downweighted genes were significantly associated with glutamatergic neurons (GLU).

## CONCLUSION

Our findings bridge levels to connect genes, biological pathways, and cell classes to in vivo imaging correlates of AD, particularly the processes involving iron accumulation.

## CLINICAL RELEVANCE/APPLICATION

This study provides insight into the cellular and molecular changes associated with AD, and the use of quantitative susceptibility mapping and imaging transcriptomics to identify the relationship between brain iron accumulation and AD may lead to the development of novel diagnostic and therapeutic strategies for the disease.

## R3-SSNR14-3 Health Care Disparities in Outpatient Imaging for Cognitive Impairment

Joshua Wibecan, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Alzheimer's Disease and other dementias disproportionately affect African American and Hispanic patients compared to White patients. However, these groups are less likely to have a diagnosis and are diagnosed at a later stage. Imaging is a critical component for the work-up of cognitive impairment (CI) and is ideally performed with MRI. The purpose of this project is to examine if there are differences in the age at which imaging is obtained or the modality selected for evaluation of CI between racial groups at our safety net academic medical center.

## METHODS AND MATERIALS

This IRB exempt retrospective study used Philips Performance Bridge to identify all outpatient CT Head, CTA Head, and MRI brain examinations performed for CI at our safety net academic medical center between 3/1/2018 and 2/28/2022 ( $n = 1699$ ). Patient self-identified race was obtained from the hospital Clinical Data Warehouse. Racial groups included Black/African American (AA) ( $n=697$ ), White (WH) ( $n=377$ ), Hispanic or Latino (HI) ( $n=275$ ), and other groups collapsed into an Other (OT) group ( $n=275$ ). Average age at imaging and percentage undergoing MRI were calculated for each group. Statistical analysis for age at imaging was performed with Kruskal-Wallis followed by Steel-Dwass method and percentage undergoing MRI was evaluated by Chi-square followed by groupwise Chi-square corrected for multiple comparisons with Bonferroni correction.

## RESULTS

There was a significant difference in average age at imaging for CI amongst the groups ( $p < 0.0001$ ) with AA patients (average age  $\pm$  95% confidence interval,  $72.5 \pm 0.91$  years) getting imaged significantly later than WH ( $67.8 \pm 1.4$  years), HI ( $66.5 \pm 1.6$ ), and OT ( $66.7 \pm 1.6$ ) patients ( $p < 0.0001$  for AA vs all other groups), but there were no significant differences between the other groups in the average age at imaging (WH vs HI  $p=0.532$ , WH vs OT  $p=0.6987$ , and HI vs OT  $p=0.99$ ). There was a significant difference in the percentage undergoing MRI for CI amongst the groups ( $p < 0.0001$ ) with a lower percentage of AA patients (50.9%) undergoing MRI compared to WH (60.0%), HI (67.0%), and OT (68.2%) patients ( $p < 0.05$  for AA vs all other groups), but there were no significant differences between the percentage of other groups undergoing MRI for CI (WH vs HI  $p=0.411$ , WH vs OT  $p=0.12$ , and HI vs OT  $p=0.80$ ).

## CONCLUSION

Self-identified Black / African American patients were imaged for cognitive impairment at an older age and were less frequently imaged for cognitive impairment with MRI. Further work is needed to understand these racial disparities and reduce barriers to obtain ideal imaging for Black / African American patients.

## CLINICAL RELEVANCE/APPLICATION

Delays in obtaining imaging and obtaining suboptimal imaging may contribute to racial disparities in diagnosis of dementia.

### R3-SSNR14-4 **Degeneration of the Cholinergic System in Objective Subtle Cognitive Decline Individuals**

Hui Hong, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Objective subtle cognitive decline (Obj-SCD) is considered a preclinical stage of Alzheimer's disease (AD). While previous research has suggested that degeneration of the cholinergic system is an early pathophysiological event in the AD continuum, it remains unclear whether it is also involved in Obj-SCD. The study will examine changes in the cholinergic system, including alterations in the volume of the cholinergic nucleus basalis of Meynert (NBM) and the integrity of cholinergic pathways in individuals with Obj-SCD, both cross-sectionally and longitudinally.

## METHODS AND MATERIALS

Neuropsychological evaluations, amyloid PET, and MRI scans were performed on a total of 41 Obj-SCD participants and 61 healthy controls (HC) from the Alzheimer's Disease Neuroimaging Initiative. NBM segmentation and cholinergic pathways tracking were conducted at baseline, 12-, 24-, and 48-month follow-ups. The baseline and 4-year rate of change in NBM volume and cholinergic pathways mean diffusivity (MD) were compared in the entire sample and amyloid stratified (+/-) subsample. Further linear regression models were used to estimate the association between cholinergic indices and amyloid and vascular pathologies.

## RESULTS

After controlling for age, sex, APOE genotype, and total intracranial volume, Obj-SCD individuals exhibited declined NBM volume and increased medial pathway MD compared to HC at baseline, with no significant difference in the lateral pathway. Similar results were also found in Obj-SCD+ individuals. Notably, an increase in medial pathway MD was seen in Obj-SCD- individuals compared to HC-. Results from the longitudinal analysis indicated that both the normalized NBM volume and cholinergic pathways MD decreased over time. In particular, the longitudinal decline in normalized NBM volume was steeper over time in Obj-SCD+ individuals than HC-. Additionally, normalized NBM volume was associated with both A $\beta$  aggregation and white matter hyperintensities (WMH) burden, whereas cholinergic pathways MD correlated with WMH burden.

## CONCLUSION

The findings of this study suggest that the degeneration of the cholinergic system is a significant contributor to cognitive impairment during the preclinical stage of Alzheimer's disease, which underscores the importance of targeting this system in early therapeutic interventions. Additionally, the study suggests that amyloid and vascular pathologies have distinct effects on the atrophy of NBM and the reduced integrity of cholinergic pathways in the early stages of AD.

## CLINICAL RELEVANCE/APPLICATION

These results have implications for the development of novel therapeutic strategies that target these pathologies and potentially delay the onset or slow the progression of cognitive decline in AD.

### R3-SSNR14-5 **Characterization of Brain Alterations Related to Cognitive Performance in Patients with Heart Failure: A Simultaneous PET/MR Study**

Chong Zheng (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to phenotype the cerebral alterations in patients with heart failure (HF) in correlation to cognitive performance, by mapping cerebral blood flow (CBF), structural and metabolic status using integrated PET/MR.

## METHODS AND MATERIALS

Forty-six HF patients caused by ischemic heart disease and 32 age- and sex-matched healthy volunteers were included. The participants underwent an integrated 18F-fluorodeoxyglucose (FDG) cerebral PET/MR scan, followed by cardiac MR. The normalized grey matter volume (GMV) images, normalized CBF images, normalized PET standardized uptake value ratio (SUVR) images, and cardiac MR parameters were obtained. Cardiac serum laboratory tests and neuropsychological scores were also collected. Voxel-wise analysis was used to evaluate alterations in brain CBF, metabolism and structure in the HF patients. Associations among brain alterations, cardiac markers, and cognitive performance in HF patients were explored by correlation analysis.

## RESULTS

Compared with normal controls, HF patients showed significant cognitive decline, regional brain hypometabolism in bilateral calcarine cortex, caudate nucleus, thalamus, hippocampus, precuneus, posterior cingulate cortex, lingual and olfactory cortex, and GMV reduction in bilateral thalamus and hippocampus. Reduced CBF appeared in multiple sites in HF over controls, with principally lower flow in frontal lobe, thalamus, cingulate cortex, and cerebellum. SUVR of the hypometabolic brain regions was correlated with cognitive performance, end-diastolic volume, stroke volume, cardiac output, and left ventricular mass. GMV of the atrophic regions was correlated with NT-ProBNP and stroke volume.

## CONCLUSION

Our findings suggest that HF patients experience impairments in brain metabolism, CBF, and grey matter structure in cognition-related brain regions. Stroke volume plays a critical role in the association between cerebral alterations and cognitive decline, indicating that chronic systemic hypoperfusion may be a major cause of cognitive impairment in HF patients.

## CLINICAL RELEVANCE/APPLICATION

Our results suggest that cardiac dysfunction in HF patients may lead to reduced systemic perfusion, which further induce chronic cerebral hypoperfusion, metabolic and structural brain changes, and eventually cognitive impairment.

### R3- **Decreased Cerebral Volumes Correlate with Cognitive Impairment in Thrombotic SSNR14-6 Thrombocytopenic Purpura**

Kevin Chen, BA (*Presenter*) Nothing to Disclose

## PURPOSE

Immune thrombotic thrombocytopenic purpura (iTTP) is a rare, life-threatening condition characterized by acute episodes of microvascular thrombosis throughout the body including the brain, most frequently resulting in small cerebral infarcts. In remission, cognitive symptoms remain prevalent and silent cerebral infarction is common. The purpose of this study is to evaluate brain volume changes in iTTP patients and their association with neurocognitive deficits.

## METHODS AND MATERIALS

Between September 2020 and November 2022, 33 adult patients with iTTP during disease remission (characterized by ADAMTS13 activity <10% during an acute episode) were prospectively enrolled and underwent a research brain MRI (3D T1-weighted MPRAGE) and neurocognitive testing (NIH ToolBox). Brain morphometry was obtained using NeuroQuant™ which reported volumes as an age/sex-matched percentile normalized to the general population. Fully-corrected T scores from the NIH ToolBox Cognition battery were used to compute individual and composite scores, adjusting for age, sex, race, and educational attainment. One-sample Wilcoxon tests were used to identify significant differences compared to a theoretical median of the 50th percentile. Spearman two-tailed tests were used to assess the significance and strength of correlations between brain volumes and NIH scores. Statistical significance was set at  $\alpha = 0.05$ .

## RESULTS

33 patients (8 M / 25 F) with mean age of 46 years (range 22 - 76) were included in the analysis. All analyzed brain regions except for cerebellum were significantly decreased in volume compared to a theoretical median of the 50th percentile (all  $P < 0.05$ ). Total composite NIH ToolBox scores positively correlated (all  $P < 0.05$ ) with the normalized volumes for total cortical gray matter ( $R = 0.43$ ), as well as parietal ( $R = 0.43$ ), occipital ( $R = 0.44$ ), and temporal lobes ( $R = 0.36$ ).

## CONCLUSION

Patients with iTTP exhibit global cortical and regional cerebral volume loss compared to age and sex matched general population. Cerebral volumes are significantly correlated with neurocognitive scores, particularly in the parietal, occipital, and temporal lobes. Ongoing follow-up with brain MRI and volumetric analysis may provide utility in monitoring these patients and guiding neurocognitive therapy.

## CLINICAL RELEVANCE/APPLICATION

iTTP patients in remission have diminished cerebral volumes compared to normative data and suffer from a greater prevalence of persistent cognitive impairments. Brain volume measures using MRI may provide a quantitative surrogate marker for neurocognitive dysfunction in these patients and potentially guide therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR14-1

### Characterization of Increased Brain Iron Deposition Associated With Motor Dysfunction in Cerebral Small Vessel Disease Patients With Mild Cognitive Impairment

Thursday, Nov. 30 9:30AM - 10:30AM Room: S401

Kelly Gillen, PhD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to compare the difference in brain iron deposition in the gray matter nuclei of the basal ganglia between cerebral small vessel disease (CSVD) patients with mild cognitive impairment (CSVD-MCI), CSVD patients without MCI (CSVD-no MCI) and healthy individuals using quantitative susceptibility mapping (QSM), as well as the correlation between brain iron deposition and motor dysfunction.

#### METHODS AND MATERIALS

Seventy-four CSVD-MCI patients, seventy-nine CSVD-no MCI patients and fifty-five healthy controls (HCs) were enrolled in this research. All subjects received cognitive, motor and Hospital Anxiety and Depression Scale (HADS) assessments. Brain QSM maps were calculated from multiecho GRE data using morphology-enabled dipole inversion with an automatic uniform cerebrospinal fluid zero reference algorithm (MEDI+0). ITK-SNAP was used by neuroradiologists to measure the susceptibility values reflecting the iron content in the regions of interest. A multiple linear regression analysis was performed to explore independent influencing factors of magnetic susceptibility. Correlation and mediation analyses between brain iron deposition and motor function were investigated.

#### RESULTS

There were significant differences in susceptibility values between the neostriatum including putamen and caudate nucleus among the three groups. The susceptibility values of the above regions in the CSVD-MCI group were higher than those in the CSVD-no MCI and HC groups. Stepwise multivariate linear regression analysis revealed that diabetes was the factor affecting iron deposition in the neostriatum in CSVD-MCI patients, and age was the factor affecting iron deposition in the neostriatum in CSVD-no MCI patients. In particular, anxiety showed significant mediation effects in the prediction of motor dysfunction with iron deposition in the left putamen in CSVD patients. Moreover, correlation analysis revealed that the susceptibility value of the left neostriatum was positively correlated with the five-repetition sit-to-stand test (5R-STST) time in CSVD patients.

#### CONCLUSION

The higher susceptibility value of CSVD-MCI patients with cognitive and motor dysfunction suggested a higher brain iron deposition burden, which may be a quantitative imaging marker to predict dementia.

#### CLINICAL RELEVANCE/APPLICATION

CSVD is the main cause of stroke and cognitive impairment, which seriously affects people's quality of life. In this study, the higher brain iron deposition burden may be a quantitative imaging marker to predict dementia.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR14-2

### Regional Brain Iron Correlate with Transcriptional and Cellular Signatures in Alzheimer's Disease

Thursday, Nov. 30 9:30AM - 10:30AM Room: S401

Jixin Luan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to examine alterations in Alzheimer's disease (AD) patients' brain iron accumulation using quantitative susceptibility mapping (QSM), and applied an integrative imaging transcriptomics approach to identify transcriptional and cellular correlates of these changes.

#### METHODS AND MATERIALS

Participants included 30 AD patients and 26 age- and sex-matched healthy controls (HCs). All participants underwent QSM on a 3.0T MRI scanner. Regional microarray expression data were obtained from 6 postmortem brains provided by the Allen Human Brain Atlas (AHBA). We used the abagen toolbox to process and map the transcriptomic data from the Desikan-Killiany Atlas. To examine the association between the healthy brain transcriptome and region QSM in AD, we used partial least square regression (PLS). We then used all genes in PLS1+ and PLS1- to conduct further bioinformatics analyses investigating whether these genes map to common and relevant biological pathways. We also investigated whether our PLS1+ and PLS1- subsets of genes were particularly enriched for genes of specific brain cell types. In our study, we used a spin-based method to correct for potential confounding effects of spatial autocorrelation.

#### RESULTS

Compared with healthy controls, AD patients exhibited increased QSM, primarily in left caudate ( $P < 0.05$ ). The first PLS component (PLS1) explained the highest proportion of QSM changes (31.50%) and did so above chance ( $P_{boot} = 0.001$ ). Notably, we found that the PLS1 weighted gene expression map was spatially correlated with the case-control QSM t-map (Pearson's  $r = 0.48$ ,  $p_{spin} < 0.05$ ). Using gene ontological (GO) analyses with the PLS1- gene list, we found enrichment for a number of GO terms-biological pathways broadly mapping to the ion channel activity. We found that upweighted genes were significantly associated with microglia (MG), while downweighted genes were significantly associated with glutamatergic neurons (GLU).

#### CONCLUSION

Our findings bridge levels to connect genes, biological pathways, and cell classes to in vivo imaging correlates of AD, particularly the processes involving iron accumulation.

#### CLINICAL RELEVANCE/APPLICATION

This study provides insight into the cellular and molecular changes associated with AD, and the use of quantitative susceptibility mapping and imaging transcriptomics to identify the relationship between brain iron accumulation and AD may lead to the development of novel diagnostic and therapeutic strategies for the disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR14-3

### Health Care Disparities in Outpatient Imaging for Cognitive Impairment

Thursday, Nov. 30 9:30AM - 10:30AM Room: S401

Joshua Wibecan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Alzheimer's Disease and other dementias disproportionately affect African American and Hispanic patients compared to White patients. However, these groups are less likely to have a diagnosis and are diagnosed at a later stage. Imaging is a critical component for the work-up of cognitive impairment (CI) and is ideally performed with MRI. The purpose of this project is to examine if there are differences in the age at which imaging is obtained or the modality selected for evaluation of CI between racial groups at our safety net academic medical center.

#### METHODS AND MATERIALS

This IRB exempt retrospective study used Philips Performance Bridge to identify all outpatient CT Head, CTA Head, and MRI brain examinations performed for CI at our safety net academic medical center between 3/1/2018 and 2/28/2022 (n = 1699). Patient self-identified race was obtained from the hospital Clinical Data Warehouse. Racial groups included Black/African American (AA) (n=697), White (WH) (n=377), Hispanic or Latino (HI) (n=275), and other groups collapsed into an Other (OT) group (n=275). Average age at imaging and percentage undergoing MRI were calculated for each group. Statistical analysis for age at imaging was performed with Kruskal-Wallis followed by Steel-Dwass method and percentage undergoing MRI was evaluated by Chi-square followed by groupwise Chi-square corrected for multiple comparisons with Bonferroni correction.

#### RESULTS

There was a significant difference in average age at imaging for CI amongst the groups ( $p < 0.0001$ ) with AA patients (average age  $\pm$  95% confidence interval,  $72.5 \pm 0.91$  years) getting imaged significantly later than WH ( $67.8 \pm 1.4$  years), HI ( $66.5 \pm 1.6$ ), and OT ( $66.7 \pm 1.6$ ) patients ( $p < 0.0001$  for AA vs all other groups), but there were no significant differences between the other groups in the average age at imaging (WH vs HI  $p = 0.532$ , WH vs OT  $p = 0.6987$ , and HI vs OT  $p = 0.99$ ). There was a significant difference in the percentage undergoing MRI for CI amongst the groups ( $p < 0.0001$ ) with a lower percentage of AA patients (50.9%) undergoing MRI compared to WH (60.0%), HI (67.0%), and OT (68.2%) patients ( $p < 0.05$  for AA vs all other groups), but there were no significant differences between the percentage of other groups undergoing MRI for CI (WH vs HI  $p = 0.411$ , WH vs OT  $p = 0.12$ , and HI vs OT  $p = 0.80$ ).

#### CONCLUSION

Self-identified Black / African American patients were imaged for cognitive impairment at an older age and were less frequently imaged for cognitive impairment with MRI. Further work is needed to understand these racial disparities and reduce barriers to obtain ideal imaging for Black / African American patients.

#### CLINICAL RELEVANCE/APPLICATION

Delays in obtaining imaging and obtaining suboptimal imaging may contribute to racial disparities in diagnosis of dementia.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSNR14-4

### Degeneration of the Cholinergic System in Objective Subtle Cognitive Decline Individuals

Thursday, Nov. 30 9:30AM - 10:30AM Room: S401

Hui Hong, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Objective subtle cognitive decline (Obj-SCD) is considered a preclinical stage of Alzheimer's disease (AD). While previous research has suggested that degeneration of the cholinergic system is an early pathophysiological event in the AD continuum, it remains unclear whether it is also involved in Obj-SCD. The study will examine changes in the cholinergic system, including alterations in the volume of the cholinergic nucleus basalis of Meynert (NBM) and the integrity of cholinergic pathways in individuals with Obj-SCD, both cross-sectionally and longitudinally.

#### METHODS AND MATERIALS

Neuropsychological evaluations, amyloid PET, and MRI scans were performed on a total of 41 Obj-SCD participants and 61 healthy controls (HC) from the Alzheimer's Disease Neuroimaging Initiative. NBM segmentation and cholinergic pathways tracking were conducted at baseline, 12-, 24-, and 48-month follow-ups. The baseline and 4-year rate of change in NBM volume and cholinergic pathways mean diffusivity (MD) were compared in the entire sample and amyloid stratified (+/-) subsample. Further linear regression models were used to estimate the association between cholinergic indices and amyloid and vascular pathologies.

#### RESULTS

After controlling for age, sex, APOE genotype, and total intracranial volume, Obj-SCD individuals exhibited declined NBM volume and increased medial pathway MD compared to HC at baseline, with no significant difference in the lateral pathway. Similar results were also found in Obj-SCD+ individuals. Notably, an increase in medial pathway MD was seen in Obj-SCD- individuals compared to HC-. Results from the longitudinal analysis indicated that both the normalized NBM volume and cholinergic pathways MD decreased over time. In particular, the longitudinal decline in normalized NBM volume was steeper over time in Obj-SCD+ individuals than HC-. Additionally, normalized NBM volume was associated with both A $\beta$  aggregation and white matter hyperintensities (WMH) burden, whereas cholinergic pathways MD correlated with WMH burden.

#### CONCLUSION

The findings of this study suggest that the degeneration of the cholinergic system is a significant contributor to cognitive impairment during the preclinical stage of Alzheimer's disease, which underscores the importance of targeting this system in early therapeutic interventions. Additionally, the study suggests that amyloid and vascular pathologies have distinct effects on the atrophy of NBM and the reduced integrity of cholinergic pathways in the early stages of AD.

#### CLINICAL RELEVANCE/APPLICATION

These results have implications for the development of novel therapeutic strategies that target these pathologies and potentially delay the onset or slow the progression of cognitive decline in AD.

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## Abstract Archives of the RSNA, 2023

R3-SSNR14-5

### Characterization of Brain Alterations Related to Cognitive Performance in Patients with Heart Failure: A Simultaneous PET/MR Study

Thursday, Nov. 30 9:30AM - 10:30AM Room: S401

Chong Zheng (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to phenotype the cerebral alterations in patients with heart failure (HF) in correlation to cognitive performance, by mapping cerebral blood flow (CBF), structural and metabolic status using integrated PET/MR.

#### METHODS AND MATERIALS

Forty-six HF patients caused by ischemic heart disease and 32 age- and sex-matched healthy volunteers were included. The participants underwent an integrated 18F-fluorodeoxyglucose (FDG) cerebral PET/MR scan, followed by cardiac MR. The normalized grey matter volume (GMV) images, normalized CBF images, normalized PET standardized uptake value ratio (SUVR) images, and cardiac MR parameters were obtained. Cardiac serum laboratory tests and neuropsychological scores were also collected. Voxel-wise analysis was used to evaluate alterations in brain CBF, metabolism and structure in the HF patients. Associations among brain alterations, cardiac markers, and cognitive performance in HF patients were explored by correlation analysis.

#### RESULTS

Compared with normal controls, HF patients showed significant cognitive decline, regional brain hypometabolism in bilateral calcarine cortex, caudate nucleus, thalamus, hippocampus, precuneus, posterior cingulate cortex, lingual and olfactory cortex, and GMV reduction in bilateral thalamus and hippocampus. Reduced CBF appeared in multiple sites in HF over controls, with principally lower flow in frontal lobe, thalamus, cingulate cortex, and cerebellum. SUVR of the hypometabolic brain regions was correlated with cognitive performance, end-diastolic volume, stroke volume, cardiac output, and left ventricular mass. GMV of the atrophic regions was correlated with NT-ProBNP and stroke volume.

#### CONCLUSION

Our findings suggest that HF patients experience impairments in brain metabolism, CBF, and grey matter structure in cognition-related brain regions. Stroke volume plays a critical role in the association between cerebral alterations and cognitive decline, indicating that chronic systemic hypoperfusion may be a major cause of cognitive impairment in HF patients.

#### CLINICAL RELEVANCE/APPLICATION

Our results suggest that cardiac dysfunction in HF patients may lead to reduced systemic perfusion, which further induce chronic cerebral hypoperfusion, metabolic and structural brain changes, and eventually cognitive impairment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR14-6

### Decreased Cerebral Volumes Correlate with Cognitive Impairment in Thrombotic Thrombocytopenic Purpura

Thursday, Nov. 30 9:30AM - 10:30AM Room: S401

Kevin Chen, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Immune thrombotic thrombocytopenic purpura (iTTP) is a rare, life-threatening condition characterized by acute episodes of microvascular thrombosis throughout the body including the brain, most frequently resulting in small cerebral infarcts. In remission, cognitive symptoms remain prevalent and silent cerebral infarction is common. The purpose of this study is to evaluate brain volume changes in iTTP patients and their association with neurocognitive deficits.

#### METHODS AND MATERIALS

Between September 2020 and November 2022, 33 adult patients with iTTP during disease remission (characterized by ADAMTS13 activity <10% during an acute episode) were prospectively enrolled and underwent a research brain MRI (3D T1-weighted MPRAGE) and neurocognitive testing (NIH ToolBox). Brain morphometry was obtained using NeuroQuant™ which reported volumes as an age/sex-matched percentile normalized to the general population. Fully-corrected T scores from the NIH ToolBox Cognition battery were used to compute individual and composite scores, adjusting for age, sex, race, and educational attainment. One-sample Wilcoxon tests were used to identify significant differences compared to a theoretical median of the 50th percentile. Spearman two-tailed tests were used to assess the significance and strength of correlations between brain volumes and NIH scores. Statistical significance was set at  $\alpha = 0.05$ .

#### RESULTS

33 patients (8 M / 25 F) with mean age of 46 years (range 22 - 76) were included in the analysis. All analyzed brain regions except for cerebellum were significantly decreased in volume compared to a theoretical median of the 50th percentile (all  $P < 0.05$ ). Total composite NIH ToolBox scores positively correlated (all  $P < 0.05$ ) with the normalized volumes for total cortical gray matter ( $R = 0.43$ ), as well as parietal ( $R = 0.43$ ), occipital ( $R = 0.44$ ), and temporal lobes ( $R = 0.36$ ).

#### CONCLUSION

Patients with iTTP exhibit global cortical and regional cerebral volume loss compared to age and sex matched general population. Cerebral volumes are significantly correlated with neurocognitive scores, particularly in the parietal, occipital, and temporal lobes. Ongoing follow-up with brain MRI and volumetric analysis may provide utility in monitoring these patients and guiding neurocognitive therapy.

#### CLINICAL RELEVANCE/APPLICATION

iTTP patients in remission have diminished cerebral volumes compared to normative data and suffer from a greater prevalence of persistent cognitive impairments. Brain volume measures using MRI may provide a quantitative surrogate marker for neurocognitive dysfunction in these patients and potentially guide therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR15

### Neuroradiology (Techniques and Methods: AI for Image Interpretation)

Thursday, Nov. 30 9:30AM - 10:30AM Room: S402

Nancy Pham, MD (*Moderator*) Nothing to Disclose  
Tyler Richards, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### R3-SSNR15-1 **Multiclass Pediatric Low-Grade Neuroepithelial Tumor Molecular Subtype Identification with Bi-institutional Apparent Diffusion Coefficient MRIs and Machine Learning**

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Pediatric Low-Grade Neuroepithelial Tumor (PLGNT) is the most common type of brain tumor in children, and thus, imaging-based pipelines for PLGNT molecular subtype identification are needed. Radiomics-based machine learning (ML) models are shown to be capable of classifying BRAF Fusion and BRAF V600E Mutation. In this study, we conduct a multiclass and bi-institutional classification using Apparent Diffusion Coefficient (ADC) MRI scans.

#### METHODS AND MATERIALS

Our REB-approved retrospective study included 252 children. The local hospital dataset consisted of brain MRIs (ADC) of patients with BRAF fusion (n=114), BRAF V600E mutation (n=36), and other molecular subtypes (n=79), while the external dataset included patients with BRAF fusion (n=18) and BRAF V600E mutation (n=5) only. Tumor segmentations were provided by a pediatric neuroradiology fellow and verified by a senior pediatric neuroradiologist, and PyRadiomics was used for extracting the radiomics features. We created 18 radiomics datasets using 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), and 6 image normalization methods (NoNormalization, MinMax, ZScore, Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient). We used Random Forests as the classifiers. For each radiomics dataset, we repeated the experiment with different data splits and model random states 100 times (1800 tests) and calculated the Area Under Receiver Operating Characteristic Curve (AUC). We trained and evaluated our models with and without clinical variables including age, sex (binary), and tumor location (binary; supra- and infratentorial).

#### RESULTS

Overall, using the combination of radiomics and clinical variables, the average one-vs-the-rest AUC was 0.762 with 95% CI [0.756, 0.768]. Using only the clinical variables, we achieved an average test AUC of 0.670 and radiomics alone resulted in AUC of 0.746. The difference between the performance levels when radiomics and clinical variables were combined was statistically significant (p-value 0.00019). We achieved lower AUCs with non-normalized images (mean AUC 0.734) and higher AUCs with histogram equalization (mean AUC 0.771).

#### CONCLUSION

Our bi-institutional study shows radiomics-based ML models trained on ADC-extracted features differentiate BRAF fusion, V600E mutation, and other molecular subtypes of PLGNT with high diagnostic accuracies. We showed combining clinical variables and radiomics improves such models.

#### CLINICAL RELEVANCE/APPLICATION

The success of treatment planning for PLGNT is conditioned on subtype identification, for which our machine learning models are demonstrated to be effective and reliable.

### R3-SSNR15-2 **Retrospective Detection of Missed Intracranial Aneurysms on Computed Tomography Angiography Using a Commercial Deep Learning Algorithm**

Tamer Sobeh, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The early identification of intracranial aneurysms (IAs) enables risk stratification and the timely initiation of optimal management. The increasing workload for radiologists to detect IAs, particularly incidental cases in the non-subarachnoid hemorrhage setting, underscores the need for high-performance computer-assisted diagnosis tools to improve efficiency and increase sensitivity. This study aimed to evaluate the effectiveness of a commercial deep learning algorithm in retrospectively detecting missed IAs on computed tomography angiography (CTA) and identifying patients with missed high-risk aneurysms for follow-up.

## METHODS AND MATERIALS

During the period between February 18, 2020, and July 31, 2022, head CTA studies were collected at our institution. A deep learning algorithm using natural language processing (NLP) was applied to identify radiological reports negative for an aneurysm and applied convolutional neural networks to the corresponding imaging data to identify missed aneurysms. For concordant cases, the ground truth was assumed. Cases that were negative by report and positive by the algorithm were reviewed by three board-certified neuroradiologists, one diagnostic and two interventional for consensus-based ground truth.

## RESULTS

A total of 2,617 head CTA studies were analyzed. The prevalence of IAs was 4.7% (123/2,617). The algorithm flagged 34 cases as suspected missed aneurysms. The majority 67% (23/34) of these cases were determined to be true positive aneurysms by a minimum of two out of three neuroradiologists, resulting in a 23.0% (23/100) enhanced detection rate or 0.88% (23/2,617) out of all the head CTA studies conducted during the study period. The missed aneurysms in this study were predominantly small-sized, with the majority located in the anterior circulation. The common features of these lesions that led to missed detection were their small size and poor visibility.

## CONCLUSION

This study demonstrates the potential of deep learning systems as a secondary reader in identifying missed intracranial aneurysms, some of which could be clinically significant.

## CLINICAL RELEVANCE/APPLICATION

A commercially available artificial intelligence algorithm for intracranial aneurysms may be beneficial in detecting additional aneurysms in 8.8 out of every 1000 patients who undergo a head CTA.

## R3-SSNR15-3 Systematic Review and Meta-Analysis of 3D CNN Methodologies in the Classification of Intracranial Hemorrhage on Head CT

Ling Ling Chan, MBBS, FRCR (*Presenter*) Nothing to Disclose

## PURPOSE

To perform a systematic review and meta-analysis of 3D convolutional neuronal network (CNN) models to detect and classify intracranial haemorrhage (ICH) on head CT.

## METHODS AND MATERIALS

We performed a comprehensive search of the published literature with PubMed, Embase, Scopus, and Web of Science database for articles which utilized AI in detecting the presence and types of ICH on 3D non-contrast head CT in accordance with the PRISMA 2020 checklist criteria. Our initial database search found 320 articles published from 1 January 2018 to 15 June 2022. After removal of duplicates, 221 were screened by five investigators based on their titles and abstracts. 105 potentially pertinent articles were evaluated further for full-text screening, of which 12 were enrolled ultimately (Figure 1).

## RESULTS

3D CNN models have pooled sensitivity of 0.956 (95%CI 0.934-0.971) and specificity of 0.955 (95%CI 0.937-0.968) with overall AUC of 0.982. Models tested on prospective datasets showed higher specificity (0.972, 95%CI 0.958-0.981) than those on retrospective datasets (0.941, 95%CI 0.935-0.946;  $p=0.0003$ ). There was no significant difference in pooled sensitivity between models tested on prospective (0.969, 95%CI 0.935-0.985) and retrospective datasets (0.946, 95%CI 0.919-0.964;  $p=0.201$ ). Models which were trained with spatial labels had slightly higher specificity (0.970, 95%CI 0.956-0.979) than those without spatial labels (0.948, 95%CI 0.922-0.965;  $p=0.0502$ ). There was no significant difference in pooled sensitivity between models tested trained with spatial labels (0.965, 95%CI 0.937-0.980) and without (0.951, 95%CI 0.920-0.971;  $p=0.418$ ). There was no significant difference in pooled sensitivity and specificity between models trained on consecutive (sens: 0.952, 95% 0.910-0.975; spec: 0.954, 95%CI 0.930-0.970) and non-consecutive (sens: 0.956, 95%CI 0.935-0.970 [ $p=0.878$ ]; spec: 0.956, 95%CI 0.926-0.974 [ $p=0.817$ ]) datasets.

## CONCLUSION

3D CNN models have excellent sensitivity and specificity to detect and classify ICH on head CT; pooled sensitivity was higher in specificity for models tested on prospective than retrospective datasets.

## CLINICAL RELEVANCE/APPLICATION

3D CNN models on head CT exhibited great potential to be used as a first line screening tool in Emergency Department for automated ICH detection and classification.

### R3-SSNR15-4 **The Test Retest Variability and Robustness Evaluations of Automated Magnetic Resonance Parkinsonism Index in Aging Related Neurodegenerative Diseases**

Ling Ling Chan, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

The Magnetic Resonance Parkinsonism Index [MRPI=(pons area/midbrain area)×(middle cerebellar peduncle width/superior cerebellar peduncle width)] is an imaging marker that is able to discriminate atypical parkinsonian disorders such as progressive supranuclear palsy from idiopathic Parkinson's disease (PD). A fast registration-based method was developed to automatically calculate MRPI to overcome the time-consuming manual estimation of MRPI. We aimed to examine the reproducibility of automated MRPI derived from 3D T1W imaging using different MRI systems, understand its changes in mild cognitive impairment (MCI) and Alzheimer's dementia (AD), and compare the variability between automatic and manual MRPI in PD.

#### METHODS AND MATERIALS

T1-weighted images from four datasets were processed to yield automated MRPI and related measures using MorphoBox segmentation research application (Fig. A) as follows: (i) Alzheimer's Disease Neuroimaging Initiative (ADNI) 1, including subjects with same-day repeated 1.5T MRI scans, to examine within-subject reproducibility; (ii) ADNI 2/GO 3T MRI, to compare within-subject automated MRPI changes between back-to-back accelerated with GRAPPA parallel imaging technique and unaccelerated T1W data; (iii) longitudinal 1.5/3T MRI of case-control PD cohorts acquired at our institution, used to test diagnostic ability of automated MRPI to track PD progression, and compare the coefficient of variance (CV) between automated and manual MRPI measurements performed by two raters. Cross-sectional and longitudinal/pairwise comparisons of MRPI were evaluated with two-sample t-test and paired t-test, respectively.

#### RESULTS

Automated MRPI measures were highly reproducible, without significant changes between repeated scans within subjects with(out) image acceleration. There were no MRPI differences in subjects of any of the healthy/MCI/AD/PD groups, and no longitudinal changes in healthy/PD groups over 6 or 10 years. Less variability was seen in automated MRPI compared to manual MRPI (Fig. B). CV of automated MRPI measures were smaller for 3T T1 compared to 1.5T data (Fig. CD).

#### CONCLUSION

The automated MRPI algorithm is reproducible and robust, especially on 3T scans acquired with higher resolution, and showed less variability than manual measures between raters. Parallel imaging can be used without detrimental effect to automated MRPI.

## CLINICAL RELEVANCE/APPLICATION

Automated MRPI is reliable across different MRI systems, ageing cohorts and time-points, but performing better on 3T data, with potential for use as quick tools to facilitate radiological screening.

### R3-SSNR15-5 **Impact of an Artificial Intelligence Assist Tool on CT Brain Report Time: A Mixed Methods Evaluation of Report Time Across a Large Teleradiology Service**

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

#### PURPOSE

Non contrast CT brain (NCCTB) is commonly reported in teleradiology, requiring much radiologist time, and with many factors contributing to reporting time. This analysis evaluates the impact of an AI algorithm, accounting for other known factors, on radiologist reporting time of NCCTB within a large teleradiology service.

#### METHODS AND MATERIALS

A commercial comprehensive AI tool, detecting 130 findings on NCCTB, was deployed across a large Australian teleradiology service. Initially, the AI was deployed in the background to confirm successful technical deployment, with AI findings not made available to radiologists, followed by full launch where all radiologists were provided access to AI findings and the tool was adopted as standard practice. Deidentified details of reporting radiologist, study ID, AI findings, AI access per case, series count and system reporting timestamps were retrospectively collected across both periods for all standalone NCCTB reported between Feb 2022 and Jan 2023. Reporting time was defined as the time between the "image-opened" and "dictation-end" timestamps. Data analysis was restricted to studies reported by radiologists whom reported a minimum of 50 studies with and without AI assistance. A linear mixed effects model was performed with reporting clinician as a random effect and reporting time as dependent variable, with a log-transform applied to estimate percent change in independent

fixed variables. Time of day (in or out of hours), number of priority findings, worklist triage (critical, urgent or routine), series count and whether AI predictions were accessed, were evaluated as fixed effects.

## RESULTS

A total of 18,550 studies reported by 30 radiologists were included in the analysis. Use of the AI and reporting out of hours was associated with an 8.5% and 7.1% reduction in reporting time respectively.

## CONCLUSION

While the results of this analysis are limited to a small number of radiologists reporting solely in teleradiology, this analysis demonstrates that reporting time is influenced by a variety of factors. Reasonable efficiency gains in teleradiology reporting time were observed through the deployment of a comprehensive AI algorithm as standard practice, warranting further exploration of its impact on cost efficiency or other clinical workflow indicators, and in larger radiologist groups.

## CLINICAL RELEVANCE/APPLICATION

Even accounting for known factors which affect report time, the availability of a comprehensive AI tool to assist detection of findings has a striking association with reduced time to report non contrast CT brain cases, indicating high likelihood of improved clinical efficiency in the real world, teleradiology setting.

## R3-SSNR15-6 Comparing DSC with ASL for Differentiating Residual and Recurrent Glioblastoma from Post-Treatment Changes with Deep Learning

Louis Gagnon, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Multimodal MRI is used for the evaluation of tumor burden in glioblastoma (GBM) patients after surgical resection, radiation, and chemotherapy. Despite technological advances, it remains difficult to distinguish between residual/recurrent tumor and treatment-related changes (1,2). Perfusion MR methods can be used to better differentiate these two entities (3). Here, we compared the performance of Dynamic Susceptibility Contrast (DSC) and Arterial Spin Labeling (ASL) perfusion MRI to differentiate recurrent tumor from treatment-related changes using a Deep Learning segmentation model in post-operative glioblastoma MRI.

## METHODS AND MATERIALS

A cohort of 107 GBM patients with both DSC and ASL sequences were identified from January 2018 to December 2022 at UC San Diego Health. 138 post-operative scans were manually segmented for enhancing and non-enhancing cellular tumor volume by a neuroradiologist. A subset of 50 out of the 138 scans had histological diagnosis from biopsy. Segmentations were performed based on extensive chart review and longitudinal imaging using T1, T1 contrast-enhanced (T1ce), fluid-attenuated inversion recovery (FLAIR), Restriction Spectrum Imaging (RSI) multi-shell diffusion sequence, DSC and ASL. We then trained a nnU-Net neural network to segment cellular tumor using 98 randomly selected cases. The deep learning model was subsequently tested on the 40 remaining cases (13 negative, 27 positive) from unique patients. Different combinations of the model inputs (T1, T1ce, FLAIR, RSI, DSC, ASL) were tested and the performance of each model was assessed using segmentation metrics (Dice score and Hausdorff distance (HD95)) and from the area under the curve (AUC) of the receiver operating characteristic (ROC) curve.

## RESULTS

The mean Dice score and HD95 obtained across the test set were similar for DSC and ASL ( $p=0.28$  and  $p=0.07$ , paired t-test). The AUC of the ROC curve was higher for DSC compared to when no perfusion was used (0.90 vs 0.86) and this difference was statically significant ( $p<0.05$ ,  $n=10000$  random permutation test). The AUC of the ROC curve for ASL was not statistically different compared to when no perfusion method was used (0.85 vs 0.86,  $p= 0.21$ ).

## CONCLUSION

Our preliminary results show that DSC improved the detection while ASL did not. These findings re-demonstrate the importance of including a DSC perfusion method in brain tumor MRI protocol. Future work will include a 5-fold cross validation to improve statistical power.

## CLINICAL RELEVANCE/APPLICATION

MRI perfusion has been shown to improve the detection of recurring tumor in post-operative Glioblastoma MRI. We compared the performance of two perfusion methods (DSC and ASL) when used together with Deep Learning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR15-1

### Multiclass Pediatric Low-Grade Neuroepithelial Tumor Molecular Subtype Identification with Bi-institutional Apparent Diffusion Coefficient MRIs and Machine Learning

Thursday, Nov. 30 9:30AM - 10:30AM Room: S402

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Pediatric Low-Grade Neuroepithelial Tumor (PLGNT) is the most common type of brain tumor in children, and thus, imaging-based pipelines for PLGNT molecular subtype identification are needed. Radiomics-based machine learning (ML) models are shown to be capable of classifying BRAF Fusion and BRAF V600E Mutation. In this study, we conduct a multiclass and bi-institutional classification using Apparent Diffusion Coefficient (ADC) MRI scans.

#### METHODS AND MATERIALS

Our REB-approved retrospective study included 252 children. The local hospital dataset consisted of brain MRIs (ADC) of patients with BRAF fusion ( $n=114$ ), BRAF V600E mutation ( $n=36$ ), and other molecular subtypes ( $n=79$ ), while the external dataset included patients with BRAF fusion ( $n=18$ ) and BRAF V600E mutation ( $n=5$ ) only. Tumor segmentations were provided by a pediatric neuroradiology fellow and verified by a senior pediatric neuroradiologist, and PyRadiomics was used for extracting the radiomics features. We created 18 radiomics datasets using 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), and 6 image normalization methods (NoNormalization, MinMax, ZScore, Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient). We used Random Forests as the classifiers. For each radiomics dataset, we repeated the experiment with different data splits and model random states 100 times (1800 tests) and calculated the Area Under Receiver Operating Characteristic Curve (AUC). We trained and evaluated our models with and without clinical variables including age, sex (binary), and tumor location (binary; supra- and infratentorial).

#### RESULTS

Overall, using the combination of radiomics and clinical variables, the average one-vs-the-rest AUC was 0.762 with 95% CI [0.756, 0.768]. Using only the clinical variables, we achieved an average test AUC of 0.670 and radiomics alone resulted in AUC of 0.746. The difference between the performance levels when radiomics and clinical variables were combined was statistically significant ( $p$ -value 0.00019). We achieved lower AUCs with non-normalized images (mean AUC 0.734) and higher AUCs with histogram equalization (mean AUC 0.771).

#### CONCLUSION

Our bi-institutional study shows radiomics-based ML models trained on ADC-extracted features differentiate BRAF fusion, V600E mutation, and other molecular subtypes of PLGNT with high diagnostic accuracies. We showed combining clinical variables and radiomics improves such models.

#### CLINICAL RELEVANCE/APPLICATION

The success of treatment planning for PLGNT is conditioned on subtype identification, for which our machine learning models are demonstrated to be effective and reliable.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSNR15-2

### Retrospective Detection of Missed Intracranial Aneurysms on Computed Tomography Angiography Using a Commercial Deep Learning Algorithm

Thursday, Nov. 30 9:30AM - 10:30AM Room: S402

Tamer Sobeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The early identification of intracranial aneurysms (IAs) enables risk stratification and the timely initiation of optimal management. The increasing workload for radiologists to detect IAs, particularly incidental cases in the non-subarachnoid hemorrhage setting, underscores the need for high-performance computer-assisted diagnosis tools to improve efficiency and increase sensitivity. This study aimed to evaluate the effectiveness of a commercial deep learning algorithm in retrospectively detecting missed IAs on computed tomography angiography (CTA) and identifying patients with missed high-risk aneurysms for follow-up.

#### METHODS AND MATERIALS

During the period between February 18, 2020, and July 31, 2022, head CTA studies were collected at our institution. A deep learning algorithm using natural language processing (NLP) was applied to identify radiological reports negative for an aneurysm and applied convolutional neural networks to the corresponding imaging data to identify missed aneurysms. For concordant cases, the ground truth was assumed. Cases that were negative by report and positive by the algorithm were reviewed by three board-certified neuroradiologists, one diagnostic and two interventional for consensus-based ground truth.

#### RESULTS

A total of 2,617 head CTA studies were analyzed. The prevalence of IAs was 4.7% (123/2,617). The algorithm flagged 34 cases as suspected missed aneurysms. The majority 67% (23/34) of these cases were determined to be true positive aneurysms by a minimum of two out of three neuroradiologists, resulting in a 23.0% (23/100) enhanced detection rate or 0.88% (23/2,617) out of all the head CTA studies conducted during the study period. The missed aneurysms in this study were predominantly small-sized, with the majority located in the anterior circulation. The common features of these lesions that led to missed detection were their small size and poor visibility.

#### CONCLUSION

This study demonstrates the potential of deep learning systems as a secondary reader in identifying missed intracranial aneurysms, some of which could be clinically significant.

#### CLINICAL RELEVANCE/APPLICATION

A commercially available artificial intelligence algorithm for intracranial aneurysms may be beneficial in detecting additional aneurysms in 8.8 out of every 1000 patients who undergo a head CTA.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSNR15-3

### Systematic Review and Meta-Analysis of 3D CNN Methodologies in the Classification of Intracranial Hemorrhage on Head CT

Thursday, Nov. 30 9:30AM - 10:30AM Room: S402

Ling Ling Chan, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

To perform a systematic review and meta-analysis of 3D convolutional neuronal network (CNN) models to detect and classify intracranial haemorrhage (ICH) on head CT.

#### METHODS AND MATERIALS

We performed a comprehensive search of the published literature with PubMed, Embase, Scopus, and Web of Science database for articles which utilized AI in detecting the presence and types of ICH on 3D non-contrast head CT in accordance with the PRISMA 2020 checklist criteria. Our initial database search found 320 articles published from 1 January 2018 to 15 June 2022. After removal of duplicates, 221 were screened by five investigators based on their titles and abstracts. 105 potentially pertinent articles were evaluated further for full-text screening, of which 12 were enrolled ultimately (Figure 1).

#### RESULTS

3D CNN models have pooled sensitivity of 0.956 (95%CI 0.934-0.971) and specificity of 0.955 (95%CI 0.937-0.968) with overall AUC of 0.982. Models tested on prospective datasets showed higher specificity (0.972, 95%CI 0.958-0.981) than those on retrospective datasets (0.941, 95%CI 0.935-0.946;  $p=0.0003$ ). There was no significant difference in pooled sensitivity between models tested on prospective (0.969, 95%CI 0.935-0.985) and retrospective datasets (0.946, 95%CI 0.919-0.964;  $p=0.201$ ). Models which were trained with spatial labels had slightly higher specificity (0.970, 95%CI 0.956-0.979) than those without spatial labels (0.948, 95%CI 0.922-0.965;  $p=0.0502$ ). There was no significant difference in pooled sensitivity between models tested trained with spatial labels (0.965, 95%CI 0.937-0.980) and without (0.951, 95%CI 0.920-0.971;  $p=0.418$ ). There was no significant difference in pooled sensitivity and specificity between models trained on consecutive (sens: 0.952, 95% 0.910-0.975; spec: 0.954, 95%CI 0.930-0.970) and non-consecutive (sens: 0.956, 95%CI 0.935-0.970 [ $p=0.878$ ]; spec: 0.956, 95%CI 0.926-0.974 [ $p=0.817$ ]) datasets.

#### CONCLUSION

3D CNN models have excellent sensitivity and specificity to detect and classify ICH on head CT; pooled sensitivity was higher in specificity for models tested on prospective than retrospective datasets.

#### CLINICAL RELEVANCE/APPLICATION

3D CNN models on head CT exhibited great potential to be used as a first line screening tool in Emergency Department for automated ICH detection and classification.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR15-4

### The Test Retest Variability and Robustness Evaluations of Automated Magnetic Resonance Parkinsonism Index in Aging Related Neurodegenerative Diseases

Thursday, Nov. 30 9:30AM - 10:30AM Room: S402

Ling Ling Chan, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

The Magnetic Resonance Parkinsonism Index [MRPI=(pons area/midbrain area)×(middle cerebellar peduncle width/superior cerebellar peduncle width)] is an imaging marker that is able to discriminate atypical parkinsonian disorders such as progressive supranuclear palsy from idiopathic Parkinson's disease (PD). A fast registration-based method was developed to automatically calculate MRPI to overcome the time-consuming manual estimation of MRPI. We aimed to examine the reproducibility of automated MRPI derived from 3D T1W imaging using different MRI systems, understand its changes in mild cognitive impairment (MCI) and Alzheimer's dementia (AD), and compare the variability between automatic and manual MRPI in PD.

#### METHODS AND MATERIALS

T1-weighted images from four datasets were processed to yield automated MRPI and related measures using MorphoBox segmentation research application (Fig. A) as follows: (i) Alzheimer's Disease Neuroimaging Initiative (ADNI) 1, including subjects with same-day repeated 1.5T MRI scans, to examine within-subject reproducibility; (ii) ADNI 2/GO 3T MRI, to compare within-subject automated MRPI changes between back-to-back accelerated with GRAPPA parallel imaging technique and unaccelerated T1W data; (iii) longitudinal 1.5/3T MRI of case-control PD cohorts acquired at our institution, used to test diagnostic ability of automated MRPI to track PD progression, and compare the coefficient of variance (CV) between automated and manual MRPI measurements performed by two raters. Cross-sectional and longitudinal/pairwise comparisons of MRPI were evaluated with two-sample t-test and paired t-test, respectively.

#### RESULTS

Automated MRPI measures were highly reproducible, without significant changes between repeated scans within subjects with(out) image acceleration. There were no MRPI differences in subjects of any of the healthy/MCI/AD/PD groups, and no longitudinal changes in healthy/PD groups over 6 or 10 years. Less variability was seen in automated MRPI compared to manual MRPI (Fig. B). CV of automated MRPI measures were smaller for 3T T1 compared to 1.5T data (Fig. CD).

#### CONCLUSION

The automated MRPI algorithm is reproducible and robust, especially on 3T scans acquired with higher resolution, and showed less variability than manual measures between raters. Parallel imaging can be used without detrimental effect to automated MRPI.

#### CLINICAL RELEVANCE/APPLICATION

Automated MRPI is reliable across different MRI systems, ageing cohorts and time-points, but performing better on 3T data, with potential for use as quick tools to facilitate radiological screening.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR15-5

### Impact of an Artificial Intelligence Assist Tool on CT Brain Report Time: A Mixed Methods Evaluation of Report Time Across a Large Teleradiology Service

Thursday, Nov. 30 9:30AM - 10:30AM Room: S402

Catherine M. Jones, MBBS (*Presenter*) Researcher, Annalise-AI Pty Ltd

#### PURPOSE

Non contrast CT brain (NCCTB) is commonly reported in teleradiology, requiring much radiologist time, and with many factors contributing to reporting time. This analysis evaluates the impact of an AI algorithm, accounting for other known factors, on radiologist reporting time of NCCTB within a large teleradiology service.

#### METHODS AND MATERIALS

A commercial comprehensive AI tool, detecting 130 findings on NCCTB, was deployed across a large Australian teleradiology service. Initially, the AI was deployed in the background to confirm successful technical deployment, with AI findings not made available to radiologists, followed by full launch where all radiologists were provided access to AI findings and the tool was adopted as standard practice. Deidentified details of reporting radiologist, study ID, AI findings, AI access per case, series count and system reporting timestamps were retrospectively collected across both periods for all standalone NCCTB reported between Feb 2022 and Jan 2023. Reporting time was defined as the time between the "image-opened" and "dictation-end" timestamps. Data analysis was restricted to studies reported by radiologists whom reported a minimum of 50 studies with and without AI assistance. A linear mixed effects model was performed with reporting clinician as a random effect and reporting time as dependent variable, with a log-transform applied to estimate percent change in independent fixed variables. Time of day (in or out of hours), number of priority findings, worklist triage (critical, urgent or routine), series count and whether AI predictions were accessed, were evaluated as fixed effects.

#### RESULTS

A total of 18,550 studies reported by 30 radiologists were included in the analysis. Use of the AI and reporting out of hours was associated with an 8.5% and 7.1% reduction in reporting time respectively.

#### CONCLUSION

While the results of this analysis are limited to a small number of radiologists reporting solely in teleradiology, this analysis demonstrates that reporting time is influenced by a variety of factors. Reasonable efficiency gains in teleradiology reporting time were observed through the deployment of a comprehensive AI algorithm as standard practice, warranting further exploration of its impact on cost efficiency or other clinical workflow indicators, and in larger radiologist groups.

#### CLINICAL RELEVANCE/APPLICATION

Even accounting for known factors which affect report time, the availability of a comprehensive AI tool to assist detection of findings has a striking association with reduced time to report non contrast CT brain cases, indicating high likelihood of improved clinical efficiency in the real world, teleradiology setting.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSNR15-6

### Comparing DSC with ASL for Differentiating Residual and Recurrent Glioblastoma from Post-Treatment Changes with Deep Learning

Thursday, Nov. 30 9:30AM - 10:30AM Room: S402

Louis Gagnon, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Multimodal MRI is used for the evaluation of tumor burden in glioblastoma (GBM) patients after surgical resection, radiation, and chemotherapy. Despite technological advances, it remains difficult to distinguish between residual/recurrent tumor and treatment-related changes (1,2). Perfusion MR methods can be used to better differentiate these two entities (3). Here, we compared the performance of Dynamic Susceptibility Contrast (DSC) and Arterial Spin Labeling (ASL) perfusion MRI to differentiate recurrent tumor from treatment-related changes using a Deep Learning segmentation model in post-operative glioblastoma MRI.

#### METHODS AND MATERIALS

A cohort of 107 GBM patients with both DSC and ASL sequences were identified from January 2018 to December 2022 at UC San Diego Health. 138 post-operative scans were manually segmented for enhancing and non-enhancing cellular tumor volume by a neuroradiologist. A subset of 50 out of the 138 scans had histological diagnosis from biopsy. Segmentations were performed based on extensive chart review and longitudinal imaging using T1, T1 contrast-enhanced (T1ce), fluid-attenuated inversion recovery (FLAIR), Restriction Spectrum Imaging (RSI) multi-shell diffusion sequence, DSC and ASL. We then trained a nnU-Net neural network to segment cellular tumor using 98 randomly selected cases. The deep learning model was subsequently tested on the 40 remaining cases (13 negative, 27 positive) from unique patients. Different combinations of the model inputs (T1, T1ce, FLAIR, RSI, DSC, ASL) were tested and the performance of each model was assessed using segmentation metrics (Dice score and Hausdorff distance (HD95)) and from the area under the curve (AUC) of the receiver operating characteristic (ROC) curve.

#### RESULTS

The mean Dice score and HD95 obtained across the test set were similar for DSC and ASL ( $p=0.28$  and  $p=0.07$ , paired t-test). The AUC of the ROC curve was higher for DSC compared to when no perfusion was used (0.90 vs 0.86) and this difference was statically significant ( $p<0.05$ ,  $n=10000$  random permutation test). The AUC of the ROC curve for ASL was not statistically different compared to when no perfusion method was used (0.85 vs 0.86,  $p= 0.21$ ).

#### CONCLUSION

Our preliminary results show that DSC improved the detection while ASL did not. These findings re-demonstrate the importance of including a DSC perfusion method in brain tumor MRI protocol. Future work will include a 5-fold cross validation to improve statistical power.

#### CLINICAL RELEVANCE/APPLICATION

MRI perfusion has been shown to improve the detection of recurring tumor in post-operative Glioblastoma MRI. We compared the performance of two perfusion methods (DSC and ASL) when used together with Deep Learning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH13

### Physics (Ultra-high Resolution CT)

Thursday, Nov. 30 9:30AM - 10:30AM Room: E352

Emil Y. Sidky, BS, PhD (*Moderator*) Nothing to Disclose

Peter B. Noel, PhD (*Moderator*) Research Grant, Siemens AG; Research Grant, Koninklijke Philips NV; Speakers Bureau, Koninklijke Philips NV; Advisory Board, Koninklijke Philips NV; Speakers Bureau, Canon Medical Systems Corporation; Advisory Board, Canon Medical Systems Corporation

#### Sub-Events

### R3-SSPH13-1 **Ultra-High-Resolution K-Edge Imaging for Guidance of Micro-Robots in Brain Surgery: A Feasibility Study using Deep-Silicon Photon-Counting CT**

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detectors (PCD) CT has been demonstrated to enhance spatial resolution up to 150  $\mu\text{m}$ , improve image contrast, reduce radiation exposure, and differentiate 3 or more materials through K-edge imaging. These potential benefits could be useful for guiding micro-robots and surgical tools during minimally invasive brain surgery. Si-based PCDs, equipped with 8 adjustable energy thresholds, could potentially detect K-edge of materials used in fabrication of surgical tools including neodymium (Nd), tungsten (W), and gold (Au). The aim of this study is to explore the feasibility of using K-edge imaging to detect micro-robot components in the human head.

#### METHODS AND MATERIALS

We previously developed a micro-driller robot that is propelled by a cubic Nd magnet (K-edge = 43.5 keV) with 250  $\mu\text{m}$ -sides and equipped with a 1 mm-long 3D printed drill bit. Static and rotating magnetic fields are used to control the direction and rotation of the robot. We investigate incorporating a second K-edge material, such as W (K-edge = 69.5 keV), to detect its orientation and position under PCD-guidance. We configure the W and Nd components of the robot at various distances ranging from 0 to 1 mm in increments of 125  $\mu\text{m}$  within a 3D-printed structure. The samples are then placed inside a human skull filled with ballistic gel. The skull phantom is scanned on a clinical prototype deep-Si PCD-CT scanner with 8 adjustable energy bins, in axial mode. Scan parameters include: 120 kVp, 300 mAs, axial mode, 0.5 s rotation time, and 4 cm z-collimation. Virtual monoenergetic images, iodine density maps, and water maps are reconstructed using a filtered-backprojection algorithm with a prototype sharp kernel (10% MTF = 21.2 lp/cm). Image voxel size is 117  $\mu\text{m}$  x 117  $\mu\text{m}$  x 417  $\mu\text{m}$ .

#### RESULTS

Nd and W components of the microrobot are easily distinguishable in images. Nd exhibits higher contrast in low-energy VMIs and in iodine density maps (due to the proximity of its K-edge energy to that of iodine). Conversely, W appears more pronounced in the water maps. The presence of metal artifacts due to other metallic parts does not affect detection of the robotic components.

#### CONCLUSION

Ultra-high-resolution K-edge imaging enabled by deep-Si photon-counting CT can distinguish different components of a microrobot inside a human head phantom. The technology shows promise to enable precision image-guided robotic surgery. This is a phantom study on a prototype scanner and no denoising or dose-reduction algorithms are used.

#### CLINICAL RELEVANCE/APPLICATION

Deep-Si photon-counting CT enables accurate localization and separation of microrobot components and shows great promise in precision image-guided robotic surgery applications.

### R3-SSPH13-2 **Deep-Learning-based Noise Reduction Framework for Ultra-High-Resolution Photon-Counting-Detector Cardiac CT**

Chang, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ultra-high-resolution (UHR) photon-counting-detector (PCD) CT improves cardiac image resolution but also substantially increases image noise, hampering its adoption in clinical practice. This study develops a dedicated deep-learning-based denoising framework using scanner-reconstructed images to reduce noise while maintaining high spatial resolution.

#### **METHODS AND MATERIALS**

Coronary CT angiography (CTA) exams acquired with the UHR mode on a PCD-CT (NAEOTOM Alpha, Siemens Healthcare) were included in this study. The 120 kV low-energy threshold images (named T3D on the scanner) were reconstructed using both filtered back projection (FBP) and iterative reconstruction (IR) algorithms with strength 4 (QIR4), 0.2 mm slice thickness, referred to as T3DFBP\_thin and T3DIR\_thin, respectively. Subtracting T3DIR\_thin from T3DFBP\_thin generated noise-only images, referred to as T3Dnoise\_thin. Another set of IR images with a thicker slice (0.6 mm) was reconstructed as a low-noise reference (T3DIR\_thick). U-Net architecture convolutional neural network (CNN) was constructed using mean square error loss, with inputs generated by a weighted summation of noise-only and reference patches (T3DIR\_thick + a \* T3Dnoise\_thin) obtained from 5 adjacent slices. CNN was trained using center slice patch of T3DIR\_thick as label, and denoising strength was controlled by weighting factor a. The denoising performance of resulting kernel-dedicated CNN was evaluated on thin FBP images with various sharp kernels (from Bv68 to Bv76), and in images containing dense calcification and stents. Image quality was also compared with that of commercial IR.

#### **RESULTS**

The proposed CNN significantly reduces noise (90% relative to FBP, 56% relative to IR), while maintaining high resolution and a natural noise texture without patchiness. At matched (clinically acceptable) noise levels, CNN allowed using a much sharper kernel (Bv72) than that of IR (Bv48), resulting in reduced blooming artifacts and improved spatial resolution in patients with dense calcification or stent, with a more accurate assessment of the lumen. Example cases with CNN showed a reduction in % lumen stenosis from 67 to 56% in a patient with dense calcification, and an increase in lumen diameter from 2.88 to 3.50 mm for a patient with coronary artery stent.

#### **CONCLUSION**

The proposed CNN framework utilizes scanner-reconstructed UHR PCD-CT images to achieve substantial noise reduction while maintaining high-resolution details in challenging coronary CTA cases with dense calcifications and stents.

#### **CLINICAL RELEVANCE/APPLICATION**

Improved UHR PCD cardiac CT image quality is beneficial for improving visualization and assessment of patients with dense calcifications and/or coronary stents.

### **R3- SSPH13-3 Pushing the Limits of Spatial Resolution in Clinical Photon-counting-detector (PCD) CT using a Dedicated High-resolution Convolutional Neural Network (HR-CNN)**

Zhongxing Zhou, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

PCD-CT can achieve ultra-high spatial resolution (up to 40 lp/cm). However, the resolution in some patient exams is limited by pixel size and far below the system limit; e.g., for a reconstruction field of view (FOV) of 400 mm and a 1024 matrix, typical of a body exam, the pixel size of 0.4 mm corresponds to a Nyquist frequency of only 12.5 lp/cm. To achieve higher spatial resolution, smaller pixels are needed, which increases image noise. The purpose of this study was to develop a dedicated high-resolution noise reduction method to push the limits of spatial resolution in routine CT exams.

#### **METHODS AND MATERIALS**

A dedicated high-resolution deep convolutional neural network (HR-CNN) was developed to reduce noise for PCD-CT. The sharpest quantitative kernel (Qr89) and pixel size of 0.15 mm (150-mm FOV and 1024 matrix) were used to fully utilize the high spatial resolution. The HR-CNN was trained using patient exams acquired with ultra-high-resolution mode and reconstructed with both filtered back-projection (FBP) and iterative reconstruction (IR). The thin-slice (0.2 mm) FBP and IR images were subtracted to generate primarily noise-only images, which were scaled and superimposed on the thick-slice (0.4mm) IR images (training target) to generate CNN training inputs. Spatial decoupling with a random pixel translation was applied to each noise-only image for data augmentation. The impact of FOV, kernel, and denoising on spatial resolution was studied using bar-pattern phantoms and a pilot study including 5 patients with interstitial lung diseases. Two thoracic radiologists evaluated 4 different FOV/reconstruction conditions: (1) FOV-410/Qr56-IR, (2) FOV-410/Qr89-IR, (3) FOV-150/Qr89-IR, (4) FOV-150/Qr89-HR-CNN in terms of overall image quality, resolution, and preference order.

#### **RESULTS**

With a FOV of 410 mm, the sharp kernel Qr89 can display bar-patterns only up to 14 lp/cm, not much higher than the routine lung kernel Qr56. With a FOV of 150 mm, Qr89-HR-CNN could display bar patterns as high as 20-22 lp/cm, higher than those

in the training target (Qr89-IR, 18-20 lp/cm). For patient cases, both radiologists ranked the FOV150 images with HR-CNN the highest in overall diagnostic quality, spatial resolution, and preference. The HR-CNN reduced the noise in patients' images by  $93.0 \pm 0.6\%$  and  $44.9 \pm 5.3\%$  in comparison with original FBP and IR (strength 4) images, respectively.

#### **CONCLUSION**

The proposed HR-CNN denoising method, along with small pixel size, increases the limit of spatial resolution in routine CT exams.

#### **CLINICAL RELEVANCE/APPLICATION**

Spatial resolution of PCD-CT is not fully utilized in routine practice. Our proposed HR-CNN may extend resolution toward the system limit, which is beneficial in diagnosis of many diseases such as interstitial lung disease.

### **R3-SSPH13-4 Super Resolution CBCT Imaging with a Dual-Layer Flat-Panel Detector**

Yongshuai Ge, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To overcome the intrinsic bottleneck of signal readout speed, spatial resolution and energy separation in conventional single-layer flat panel detector (FPD) based CBCT imaging, an innovative super resolution dual-energy CBCT (DE-CBCT) imaging method, named as suRi, is developed with the dual-layer FPD.

#### **METHODS AND MATERIALS**

In suRi, sub-pixel (half pixel in this study) shifted binning is utilized between the two detector layers to double the spatial sampling rate of the dual-layer FPD during signal acquisition. By doing so, high spatial resolution CBCT imaging can be achieved while at high signal readout speed (large detector binning rate). In addition, a penalized likelihood material decomposition algorithm is developed to directly reconstruct the high resolution material bases from the obtained dual-energy CBCT projections. Experiments are conducted with physical phantoms and biological specimen to validate the performance of the proposed suRi CBCT imaging technique.

#### **RESULTS**

At the same signal readout speed (detector binning level), experimental results demonstrate that the proposed suRi method can improve the image spatial resolution by over 45% compared with the conventional dual-layer FPD based DE-CBCT imaging. Moreover, accurate basis images with high spatial resolution can be directly reconstructed from such dual-energy projections acquired by suRi.

#### **CONCLUSION**

A super resolution DE-CBCT imaging method is proposed for dual-layer FPD.

#### **CLINICAL RELEVANCE/APPLICATION**

This proposed suRi method would enable high resolution "spatial-temporal-spectral" CBCT imaging in future. As a consequence, the imaging performance of the current medical CBCT imaging systems, for example, the C-Arm systems, would be greatly enhanced.

### **R3-SSPH13-5 Spectral Ultra-High-Resolution Coronary CT Angiography with a Prototype Deep-Silicon Photon-Counting CT Scanner: Initial Results in a Dynamic Phantom**

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Photon-counting detectors (PCD) show significant promise for enhancing the diagnostic value and image quality of CT scans. PCD-CT offers several benefits, including radiation reduction, spectral information, and improved spatial resolution. Edge-on-irradiated deep-Si PCD has the potential to provide better combined spectral and spatial resolution compared to the current CdTe and CdZnTe PCDs. It may improve characterization of coronary arteries by reducing blooming artifacts and providing virtual monoenergetic images (VMIs). Here we investigate the utility of deep-Si PCD-CT in coronary CT angiography in a dynamic phantom and evaluate the effects of cardiac motion on image quality.

#### **METHODS AND MATERIALS**

We fabricated several 3D-printed vessels mimicking coronary arteries with diameter ( $d$ ) = 1-3 mm. 4 CoCr alloy coronary stents are placed inside the vessels, filled with iodine-based or gadolinium-based contrast agents (IBCA, GBCA), and attached to a dynamic cardiac motion phantom. Different concentrations of IBCA and water are also included. We operate the phantom at 60 bpm and at rest (0 bpm). Scans are performed at 120 kVp and 425 mA, using 8 energy thresholds, 0.35s rotation, and prospective ECG-gating at 70% of R-R. VMIs (70 keV) are reconstructed using a cardiac half-scan filtered-backprojection algorithm with a prototype high resolution kernel (10% MTF at 21.2 lp/cm) at  $146 \times 146 \times 420 \mu\text{m}^3$  voxel size. We measure CT numbers in 12 regions of interest (ROIs) with diameters of 1-5mm. Effective spatial resolution (blooming) is measured as



in-stent lumen diameter (N = 36), free lumen diameter (N = 36), and stent strut thickness (N = 72) through matched line profiles. All comparisons are performed by Wilcoxon signed rank test with  $p < 0.05$  considered statistically significant.

## RESULTS

We observe no significant difference in CT numbers between 0 and 60 bpm scans. Median 0- vs 60-bpm in-stent lumen measurements are not significantly different: stent 1: 2.07 vs 2.08 ( $p > 0.47$ ), stent 2: 1.76 vs 1.76 ( $p > 0.78$ ), stent 3: 2.06 vs 2.06 ( $p > 0.95$ ), stent#4: 1.83 vs 1.90 ( $p > 0.14$ ), all measured in mm. Similarly, the difference in free lumen measurements is not significant. Median 0- vs 60-bpm stent strut thicknesses are 428-580  $\mu\text{m}$  vs 421-569  $\mu\text{m}$ .

## CONCLUSION

We demonstrated the potential of spectral ultra-high-resolution coronary CT angiography enabled by deep-Si PCD-CT. No degradation in CT number accuracy or spatial resolution due to cardiac motion was found. This was a limited phantom experiment on a prototype scanner that is under active development. More detailed studies at higher heart rates are warranted.

## CLINICAL RELEVANCE/APPLICATION

Reducing blooming artifact in coronary angiography with spectral deep-Si PCD leads to improved stent, plaque, and lumen visualization.

## R3-SSPH13-6 Simultaneous Ultra-high Resolution Multi-energy Cardiac Imaging in a Dual-source Photon Counting CT

Elisabeth Shanblatt, PhD (*Presenter*) Employee, Siemens AG

## PURPOSE

To assess a new research acquisition mode for simultaneous ultra-high resolution and multi-energy (UHR-ME) cardiac imaging available in a clinical dual-source photon-counting-detector (PCD) CT system.

## METHODS AND MATERIALS

A research-only, dual-source, cardiac scan mode (96 x 0.2 mm collimation) that combines UHR and multi-energy imaging was used for phantom and patient scans. A 35 cm abdomen multi-energy phantom containing several inserts of different iodine concentrations (2, 5, 10, and 15 mg/cc) was scanned on the PCD-CT. Images were reconstructed with a quantitative Qr44 kernel, iterative reconstruction (IR) level 4, and 0.6 mm slices. Iodine CT number accuracy across virtual monoenergetic image (VMI) energy levels was measured. Iodine concentration and virtual noncontrast (VNC) CT numbers were evaluated for 5 mm slices. The modulation transfer function (MTF) and slice sensitivity profile (SSP) were measured with Br89 and 0.2 mm slices on a 25- $\mu\text{m}$  tungsten wire and a 25- $\mu\text{m}$  gold foil respectively to determine the axial and longitudinal spatial resolutions and were compared to the UHR-only cardiac mode. Under IRB approval, patients with coronary CTA exams were prospectively scanned with this mode. UHR and various multi-energy series were reconstructed: VMI (50, 70, and 100 keV), virtual calcium removal (VCR), virtual noniodine (VNI) to separate iodine and calcium, iodine map, and VNC. The multi-energy series were reconstructed with the minimum slice thickness of 0.4 mm and UHR images were reconstructed with 0.2 mm slices.

## RESULTS

The UHR-ME mode produced VMIs with a mean CT number error of 5.9% and iodine concentration root-mean-squared-error of 0.75 mg/cc. The MTF cutoff frequency was 33  $\text{cm}^{-1}$  for both the UHR and UHR-ME modes. The SSP FWHM was 0.38 mm for UHR-ME and 0.39 mm for UHR (nominally 0.2 mm). The UHR reconstruction (20-120 keV) showed sharp images and clear delineation of coronary arteries and the calcified plaque. The 50 keV VMI showed enhanced iodine contrast and improved CNR while the 100 keV VMI demonstrated reduced blooming artifact from the calcified plaque. The VCR images removed calcified plaque and retained iodinated-lumen, while VNI removed iodine and retained calcified plaque which could potentially be used for calcium quantification.

## CONCLUSION

The UHR-ME cardiac mode simultaneously provides quantitatively accurate spectral information and ultra-high resolution images. Initial patient images showed complementary information from the UHR and various multi-energy images.

## CLINICAL RELEVANCE/APPLICATION

The combination UHR-ME mode provides both spectral information and high spatial resolution, while maintaining 66 ms temporal resolution to allow a more comprehensive cardiac imaging examination from a single PCD-CT scan.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-SSPH13-1

### Ultra-High-Resolution K-Edge Imaging for Guidance of Micro-Robots in Brain Surgery: A Feasibility Study using Deep-Silicon Photon-Counting CT

Thursday, Nov. 30 9:30AM - 10:30AM Room: E352

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detectors (PCD) CT has been demonstrated to enhance spatial resolution up to 150  $\mu\text{m}$ , improve image contrast, reduce radiation exposure, and differentiate 3 or more materials through K-edge imaging. These potential benefits could be useful for guiding micro-robots and surgical tools during minimally invasive brain surgery. Si-based PCDs, equipped with 8 adjustable energy thresholds, could potentially detect K-edge of materials used in fabrication of surgical tools including neodymium (Nd), tungsten (W), and gold (Au). The aim of this study is to explore the feasibility of using K-edge imaging to detect micro-robot components in the human head.

#### METHODS AND MATERIALS

We previously developed a micro-driller robot that is propelled by a cubic Nd magnet (K-edge = 43.5 keV) with 250  $\mu\text{m}$ -sides and equipped with a 1 mm-long 3D printed drill bit. Static and rotating magnetic fields are used to control the direction and rotation of the robot. We investigate incorporating a second K-edge material, such as W (K-edge = 69.5 keV), to detect its orientation and position under PCD-guidance. We configure the W and Nd components of the robot at various distances ranging from 0 to 1 mm in increments of 125  $\mu\text{m}$  within a 3D-printed structure. The samples are then placed inside a human skull filled with ballistic gel. The skull phantom is scanned on a clinical prototype deep-Si PCD-CT scanner with 8 adjustable energy bins, in axial mode. Scan parameters include: 120 kVp, 300 mAs, axial mode, 0.5 s rotation time, and 4 cm z-collimation. Virtual monoenergetic images, iodine density maps, and water maps are reconstructed using a filtered-backprojection algorithm with a prototype sharp kernel (10% MTF = 21.2 lp/cm). Image voxel size is 117  $\mu\text{m}$  x 117  $\mu\text{m}$  x 417  $\mu\text{m}$ .

#### RESULTS

Nd and W components of the microrobot are easily distinguishable in images. Nd exhibits higher contrast in low-energy VMIs and in iodine density maps (due to the proximity of its K-edge energy to that of iodine). Conversely, W appears more pronounced in the water maps. The presence of metal artifacts due to other metallic parts does not affect detection of the robotic components.

#### CONCLUSION

Ultra-high-resolution K-edge imaging enabled by deep-Si photon-counting CT can distinguish different components of a microrobot inside a human head phantom. The technology shows promise to enable precision image-guided robotic surgery. This is a phantom study on a prototype scanner and no denoising or dose-reduction algorithms are used.

#### CLINICAL RELEVANCE/APPLICATION

Deep-Si photon-counting CT enables accurate localization and separation of microrobot components and shows great promise in precision image-guided robotic surgery applications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH13-2

### Deep-Learning-based Noise Reduction Framework for Ultra-High-Resolution Photon-Counting-Detector Cardiac CT

Thursday, Nov. 30 9:30AM - 10:30AM Room: E352

Shaojie Chang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultra-high-resolution (UHR) photon-counting-detector (PCD) CT improves cardiac image resolution but also substantially increases image noise, hampering its adoption in clinical practice. This study develops a dedicated deep-learning-based denoising framework using scanner-reconstructed images to reduce noise while maintaining high spatial resolution.

#### METHODS AND MATERIALS

Coronary CT angiography (CTA) exams acquired with the UHR mode on a PCD-CT (NAEOTOM Alpha, Siemens Healthcare) were included in this study. The 120 kV low-energy threshold images (named T3D on the scanner) were reconstructed using both filtered back projection (FBP) and iterative reconstruction (IR) algorithms with strength 4 (QIR4), 0.2 mm slice thickness, referred to as T3DFBP\_thin and T3DIR\_thin, respectively. Subtracting T3DIR\_thin from T3DFBP\_thin generated noise-only images, referred to as T3Dnoise\_thin. Another set of IR images with a thicker slice (0.6 mm) was reconstructed as a low-noise reference (T3DIR\_thick). U-Net architecture convolutional neural network (CNN) was constructed using mean square error loss, with inputs generated by a weighted summation of noise-only and reference patches (T3DIR\_thick + a \* T3Dnoise\_thin) obtained from 5 adjacent slices. CNN was trained using center slice patch of T3DIR\_thick as label, and denoising strength was controlled by weighting factor a. The denoising performance of resulting kernel-dedicated CNN was evaluated on thin FBP images with various sharp kernels (from Bv68 to Bv76), and in images containing dense calcification and stents. Image quality was also compared with that of commercial IR.

#### RESULTS

The proposed CNN significantly reduces noise (90% relative to FBP, 56% relative to IR), while maintaining high resolution and a natural noise texture without patchiness. At matched (clinically acceptable) noise levels, CNN allowed using a much sharper kernel (Bv72) than that of IR (Bv48), resulting in reduced blooming artifacts and improved spatial resolution in patients with dense calcification or stent, with a more accurate assessment of the lumen. Example cases with CNN showed a reduction in % lumen stenosis from 67 to 56% in a patient with dense calcification, and an increase in lumen diameter from 2.88 to 3.50 mm for a patient with coronary artery stent.

#### CONCLUSION

The proposed CNN framework utilizes scanner-reconstructed UHR PCD-CT images to achieve substantial noise reduction while maintaining high-resolution details in challenging coronary CTA cases with dense calcifications and stents.

#### CLINICAL RELEVANCE/APPLICATION

Improved UHR PCD cardiac CT image quality is beneficial for improving visualization and assessment of patients with dense calcifications and/or coronary stents.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH13-3

### Pushing the Limits of Spatial Resolution in Clinical Photon-counting-detector (PCD) CT using a Dedicated High-resolution Convolutional Neural Network (HR-CNN)

Thursday, Nov. 30 9:30AM - 10:30AM Room: E352

Zhongxing Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

PCD-CT can achieve ultra-high spatial resolution (up to 40 lp/cm). However, the resolution in some patient exams is limited by pixel size and far below the system limit; e.g., for a reconstruction field of view (FOV) of 400 mm and a 1024 matrix, typical of a body exam, the pixel size of 0.4 mm corresponds to a Nyquist frequency of only 12.5 lp/cm. To achieve higher spatial resolution, smaller pixels are needed, which increases image noise. The purpose of this study was to develop a dedicated high-resolution noise reduction method to push the limits of spatial resolution in routine CT exams.

#### METHODS AND MATERIALS

A dedicated high-resolution deep convolutional neural network (HR-CNN) was developed to reduce noise for PCD-CT. The sharpest quantitative kernel (Qr89) and pixel size of 0.15 mm (150-mm FOV and 1024 matrix) were used to fully utilize the high spatial resolution. The HR-CNN was trained using patient exams acquired with ultra-high-resolution mode and reconstructed with both filtered back-projection (FBP) and iterative reconstruction (IR). The thin-slice (0.2 mm) FBP and IR images were subtracted to generate primarily noise-only images, which were scaled and superimposed on the thick-slice (0.4mm) IR images (training target) to generate CNN training inputs. Spatial decoupling with a random pixel translation was applied to each noise-only image for data augmentation. The impact of FOV, kernel, and denoising on spatial resolution was studied using bar-pattern phantoms and a pilot study including 5 patients with interstitial lung diseases. Two thoracic radiologists evaluated 4 different FOV/reconstruction conditions: (1) FOV-410/Qr56-IR, (2) FOV-410/Qr89-IR, (3) FOV-150/Qr89-IR, (4) FOV-150/Qr89-HR-CNN in terms of overall image quality, resolution, and preference order.

#### RESULTS

With a FOV of 410 mm, the sharp kernel Qr89 can display bar-patterns only up to 14 lp/cm, not much higher than the routine lung kernel Qr56. With a FOV of 150 mm, Qr89-HR-CNN could display bar patterns as high as 20-22 lp/cm, higher than those in the training target (Qr89-IR, 18-20 lp/cm). For patient cases, both radiologists ranked the FOV150 images with HR-CNN the highest in overall diagnostic quality, spatial resolution, and preference. The HR-CNN reduced the noise in patients' images by  $93.0 \pm 0.6\%$  and  $44.9 \pm 5.3\%$  in comparison with original FBP and IR (strength 4) images, respectively.

#### CONCLUSION

The proposed HR-CNN denoising method, along with small pixel size, increases the limit of spatial resolution in routine CT exams.

#### CLINICAL RELEVANCE/APPLICATION

Spatial resolution of PCD-CT is not fully utilized in routine practice. Our proposed HR-CNN may extend resolution toward the system limit, which is beneficial in diagnosis of many diseases such as interstitial lung disease.

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## Abstract Archives of the RSNA, 2023

R3-SSPH13-4

### Super Resolution CBCT Imaging with a Dual-Layer Flat-Panel Detector

Thursday, Nov. 30 9:30AM - 10:30AM Room: E352

Yongshuai Ge, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To overcome the intrinsic bottleneck of signal readout speed, spatial resolution and energy separation in conventional single-layer flat panel detector (FPD) based CBCT imaging, an innovative super resolution dual-energy CBCT (DE-CBCT) imaging method, named as suRi, is developed with the dual-layer FPD.

#### METHODS AND MATERIALS

In suRi, sub-pixel (half pixel in this study) shifted binning is utilized between the two detector layers to double the spatial sampling rate of the dual-layer FPD during signal acquisition. By doing so, high spatial resolution CBCT imaging can be achieved while at high signal readout speed (large detector binning rate). In addition, a penalized likelihood material decomposition algorithm is developed to directly reconstruct the high resolution material bases from the obtained dual-energy CBCT projections. Experiments are conducted with physical phantoms and biological specimen to validate the performance of the proposed suRi CBCT imaging technique.

#### RESULTS

At the same signal readout speed (detector binning level), experimental results demonstrate that the proposed suRi method can improve the image spatial resolution by over 45% compared with the conventional dual-layer FPD based DE-CBCT imaging. Moreover, accurate basis images with high spatial resolution can be directly reconstructed from such dual-energy projections acquired by suRi.

#### CONCLUSION

A super resolution DE-CBCT imaging method is proposed for dual-layer FPD.

#### CLINICAL RELEVANCE/APPLICATION

This proposed suRi method would enable high resolution "spatial-temporal-spectral" CBCT imaging in future. As a consequence, the imaging performance of the current medical CBCT imaging systems, for example, the C-Arm systems, would be greatly enhanced.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH13-5

### Spectral Ultra-High-Resolution Coronary CT Angiography with a Prototype Deep-Silicon Photon-Counting CT Scanner: Initial Results in a Dynamic Phantom

Thursday, Nov. 30 9:30AM - 10:30AM Room: E352

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detectors (PCD) show significant promise for enhancing the diagnostic value and image quality of CT scans. PCD-CT offers several benefits, including radiation reduction, spectral information, and improved spatial resolution. Edge-on-irradiated deep-Si PCD has the potential to provide better combined spectral and spatial resolution compared to the current CdTe and CdZnTe PCDs. It may improve characterization of coronary arteries by reducing blooming artifacts and providing virtual monoenergetic images (VMIs). Here we investigate the utility of deep-Si PCD-CT in coronary CT angiography in a dynamic phantom and evaluate the effects of cardiac motion on image quality.

#### METHODS AND MATERIALS

We fabricated several 3D-printed vessels mimicking coronary arteries with diameter ( $d$ ) = 1-3 mm. 4 CoCr alloy coronary stents are placed inside the vessels, filled with iodine-based or gadolinium-based contrast agents (IBCA, GBCA), and attached to a dynamic cardiac motion phantom. Different concentrations of IBCA and water are also included. We operate the phantom at 60 bpm and at rest (0 bpm). Scans are performed at 120 kVp and 425 mA, using 8 energy thresholds, 0.35s rotation, and prospective ECG-gating at 70% of R-R. VMIs (70 keV) are reconstructed using a cardiac half-scan filtered-backprojection algorithm with a prototype high resolution kernel (10% MTF at 21.2 lp/cm) at  $146 \times 146 \times 420 \mu\text{m}^3$  voxel size. We measure CT numbers in 12 regions of interest (ROIs) with diameters of 1-5mm. Effective spatial resolution (blooming) is measured as in-stent lumen diameter ( $N = 36$ ), free lumen diameter ( $N = 36$ ), and stent strut thickness ( $N = 72$ ) through matched line profiles. All comparisons are performed by Wilcoxon signed rank test with  $p < 0.05$  considered statistically significant.

#### RESULTS

We observe no significant difference in CT numbers between 0 and 60 bpm scans. Median 0- vs 60-bpm in-stent lumen measurements are not significantly different: stent 1: 2.07 vs 2.08 ( $p > 0.47$ ), stent 2: 1.76 vs 1.76 ( $p > 0.78$ ), stent 3: 2.06 vs 2.06 ( $p > 0.95$ ), stent#4: 1.83 vs 1.90 ( $p > 0.14$ ), all measured in mm. Similarly, the difference in free lumen measurements is not significant. Median 0- vs 60-bpm stent strut thicknesses are 428-580  $\mu\text{m}$  vs 421-569  $\mu\text{m}$ .

#### CONCLUSION

We demonstrated the potential of spectral ultra-high-resolution coronary CT angiography enabled by deep-Si PCD-CT. No degradation in CT number accuracy or spatial resolution due to cardiac motion was found. This was a limited phantom experiment on a prototype scanner that is under active development. More detailed studies at higher heart rates are warranted.

#### CLINICAL RELEVANCE/APPLICATION

Reducing blooming artifact in coronary angiography with spectral deep-Si PCD leads to improved stent, plaque, and lumen visualization.

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## Abstract Archives of the RSNA, 2023

R3-SSPH13-6

### Simultaneous Ultra-high Resolution Multi-energy Cardiac Imaging in a Dual-source Photon Counting CT

Thursday, Nov. 30 9:30AM - 10:30AM Room: E352

Elisabeth Shanblatt, PhD (*Presenter*) Employee, Siemens AG

#### PURPOSE

To assess a new research acquisition mode for simultaneous ultra-high resolution and multi-energy (UHR-ME) cardiac imaging available in a clinical dual-source photon-counting-detector (PCD) CT system.

#### METHODS AND MATERIALS

A research-only, dual-source, cardiac scan mode (96 x 0.2 mm collimation) that combines UHR and multi-energy imaging was used for phantom and patient scans. A 35 cm abdomen multi-energy phantom containing several inserts of different iodine concentrations (2, 5, 10, and 15 mg/cc) was scanned on the PCD-CT. Images were reconstructed with a quantitative Qr44 kernel, iterative reconstruction (IR) level 4, and 0.6 mm slices. Iodine CT number accuracy across virtual monoenergetic image (VMI) energy levels was measured. Iodine concentration and virtual noncontrast (VNC) CT numbers were evaluated for 5 mm slices. The modulation transfer function (MTF) and slice sensitivity profile (SSP) were measured with Br89 and 0.2 mm slices on a 25-um tungsten wire and a 25-um gold foil respectively to determine the axial and longitudinal spatial resolutions and were compared to the UHR-only cardiac mode. Under IRB approval, patients with coronary CTA exams were prospectively scanned with this mode. UHR and various multi-energy series were reconstructed: VMI (50, 70, and 100 keV), virtual calcium removal (VCR), virtual noniodine (VNI) to separate iodine and calcium, iodine map, and VNC. The multi-energy series were reconstructed with the minimum slice thickness of 0.4 mm and UHR images were reconstructed with 0.2 mm slices.

#### RESULTS

The UHR-ME mode produced VMIs with a mean CT number error of 5.9% and iodine concentration root-mean-squared-error of 0.75 mg/cc. The MTF cutoff frequency was 33 cm<sup>-1</sup> for both the UHR and UHR-ME modes. The SSP FWHM was 0.38 mm for UHR-ME and 0.39 mm for UHR (nominally 0.2 mm). The UHR reconstruction (20-120 keV) showed sharp images and clear delineation of coronary arteries and the calcified plaque. The 50 keV VMI showed enhanced iodine contrast and improved CNR while the 100 keV VMI demonstrated reduced blooming artifact from the calcified plaque. The VCR images removed calcified plaque and retained iodinated-lumen, while VNI removed iodine and retained calcified plaque which could potentially be used for calcium quantification.

#### CONCLUSION

The UHR-ME cardiac mode simultaneously provides quantitatively accurate spectral information and ultra-high resolution images. Initial patient images showed complementary information from the UHR and various multi-energy images.

#### CLINICAL RELEVANCE/APPLICATION

The combination UHR-ME mode provides both spectral information and high spatial resolution, while maintaining 66 ms temporal resolution to allow a more comprehensive cardiac imaging examination from a single PCD-CT scan.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH14

### Physics (Image-Guided Interventions and Therapy)

Thursday, Nov. 30 9:30AM - 10:30AM Room: E350

Michael Speidel, PhD (*Moderator*) Institutional research agreement, Siemens AG  
Zhihua Qi, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### R3-SSPH14-1 Diffusion Tensor Imaging Tractography of the Facial Nerve in Patients with Cerebellopontine Angle Tumors

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Preserving the facial nerve during surgery of cerebellopontine angle tumor is challenging because of the unpredictable location and morphologic changes in the facial nerve. Therefore, imaging to visualize preoperatively the facial nerve could help surgeons to plan the surgery and to prevent nerve injuries during the interventions. In the present prospective study, we attempted to characterize preoperatively the FN and its relations with cerebellopontine angle tumor in order to correlate the preoperative DTT image with the intraoperative findings during cerebellopontine angle tumor surgery. On the other hand, we aimed to explore the appropriate DTT tracing parameters and to observe the clinical effect of the surgery on the facial nerve.

#### METHODS AND MATERIALS

The 15 enrolled patients had cerebellopontine angle tumors and were submitted to a surgical resection in the Neurosurgery Department of between February 2018 and July 2022. At the same time, they underwent preoperative MRI and DTI-DTT with a medium FA of 0.14 and 1 ROI. The imaging series were processed obtaining 3D representations of nerve-tumor relations. The location determined by radiology was known by the surgeon who, afterwards, informed of the intrasurgical findings.

#### RESULTS

Preoperative visualization of the facial nerve using DTT was successful in all 15 patients. Facial nerve was located on the anterior-middle third of the cerebellopontine angle tumors in 9 patients, anterior-superior third in 5 patients and anterior-inferior third in 1 patient. Moreover, the correlation between the DTT and intraoperative findings of the FN was 100%. FN function remained the same degree before and after surgery in 8 patients. 1 patient improved his functionality meanwhile the others worsened

#### CONCLUSION

Preoperative facial nerve tractography reconstruction showed a high correlation with intraoperative findings. Preoperative tractography information regarding facial nerve position and its cisternal course is valuable information and could help the surgeon in increasing the safety of the procedure during cerebellopontine angle tumor surgery.

#### CLINICAL RELEVANCE/APPLICATION

Facial nerve anatomic structure was preserved in all patients during surgery. At 6 months follow-up, 66.66% of patients had a facial nerve normal function or a mild dysfunction.

### R3-SSPH14-2 MRI-guided, Pancreas-targeted siRNA Therapy to Inhibit NP1 Expression in Pancreatic Beta-cells

Guanshu Liu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Selective gene inhibition by siRNA therapeutics promises the prevention and treatment of diabetes. Herein we aimed to develop a new MRI-guided siRNA delivery system for targeted gene therapy of the pancreas.

## METHODS AND MATERIALS

Nanoformulations of liposome-polycation-DNA (LPD) was employed to deliver siRNA to target neuronal pentraxin 1, a protein produced by pancreatic  $\beta$ -cells under hyperglycemic conditions, and its knockdown was shown effectively preserving normal glucose homeostasis, insulin levels, and body weight similar to controls in mouse models of diabetes. To obtain  $\beta$ -cell-targeting, LPD was modified with exendin-4, an agonist of glucagon-like peptide 1 receptor (GLP-1R) highly expressed on the  $\beta$ -cell surface<sup>1-2</sup>. All animal studies were approved by our institutional ACUC. Randomly selected mice received iv injection of 100  $\mu$ L Gd-DTPA labeled exendin-4 LPD or control LPD (4 mg lipid per mouse, n=3 in each group). Mice were then imaged before, 2 hours, and 48 hours after the LPD injection. MRI images were acquired using an 11.7 T Bruker scanner as described previously<sup>3</sup>. Quantitative T1 maps were acquired using a saturation recovery RARE-VTR sequence with an effective TE= 14 ms (RARE factor= 8) and 8 TR times varying from 100 ms to 5000 ms. The collected data were processed to estimate the T1 (or  $R1=1/T1$ ) pixel-by-pixel using Matlab.

## RESULTS

We investigated the MRI detectability of the iv-injected LPD in the mouse pancreas. At 48 hours post-injection, the T1w images showed noticeable hyperintense (Figure 1b), indicative of the accumulation of LPD in these areas. To quantify the uptake of LPD, we also acquired the T1 maps (Figure 1c), on which a large portion of the pancreas showed elevated R1 relaxation rates. Compared to mice in the control group, there were negligible R1 changes at 2 hours post-injection, which was increased to  $43 \pm 18\%$  higher than the control mouse in 48 hours. Immunofluorescence images of pancreatic sections confirmed the accumulation of LPD in islet cells (Figure 1e).

## CONCLUSION

Our preliminary results clearly demonstrated the ability of MRI to guide the siRNA delivery using LPD, which may serve as a platform technology for optimizing the formulation of nanoparticles for the maximized efficiency of targeted delivery. Reference: 1. Wang, P., et al., *Diabetes* 2014, 63 (5), 1465-1474. 2. Tasyurek, M. H., et al., *Expert Rev Mol Med* 2014,16, e7. 3. Chen, Z., et al., *Quant Imaging Med Surg* 2019, 9 (9), 1579-1591.

## CLINICAL RELEVANCE/APPLICATION

The nanotheranostic system to be developed may ultimately provide a new, effective approach to reverse the disease progression of diabetes in which MRI guidance can significantly improve the success rate of gene therapy.

## R3-SSPH14-3 Digital Pulse-Driven 160 kV X-ray Source Using CNTs for Radiation Therapy

Hanna Lee (*Presenter*) Nothing to Disclose

## PURPOSE

The demand for minimizing X-ray exposure to patients and medical personnel during medical X-ray imaging procedures used for disease diagnosis is on the rise. The traditional X-ray source used is an analog method that emits thermal electrons by heating a filament. These sources utilized in medical applications requires a penetrating power of approximately 20 to 150 kV or more. To enable immediate control of medical devices with low dose, it is imperative to develop a new type of digital X-ray tube that can overcome the limitations of the traditional analog method. Reflecting these points, this study aimed to develop a 160 kV X-ray source based on carbon nanotubes (CNTs), with digital control of X-ray energy and dose.

## METHODS AND MATERIALS

The X-ray source was composed of a cathode that generated electrons, a gate that controlled the current in the CNT, an anode that the electrons reached, and a window that emitted X-rays. A gate relay operated in pulse mode, and another relay controlled the pulse time to generate X-rays. A timer was set on the anode to control the application time of high voltage. The digital control of the CNT-based X-ray source and the emitted dose were confirmed by varying the voltage, duty, and frequency applied to the anode. The response of cells was studied by irradiating the cells with various.

## RESULTS

The voltage-current graph confirmed the field emission characteristics of the CNT-based X-ray source. Furthermore, an increase in duty cycle from 10 to 100% and frequency from 1 to 30 Hz at 160 kV resulted in an increase in emitted dose and dose rate. For instance, when the anode voltage was set to 160 kV at a duty cycle of 50% and a frequency of 10 Hz, a dose of 337.9  $\mu$ Gy and a dose rate of 73.9  $\mu$ Gy/s were emitted within 4.5 seconds.

## CONCLUSION

In this study, we developed a 160 kV radiation source using CNT for field emission. We also demonstrated that high-speed digital drive-in pulse units with instantaneous on-off is possible, which is difficult to implement with conventional hot cathode X-ray tubes. The high-speed digital driving method can reduce the risk of users being exposed to unnecessary residual doses. Additionally, by adjusting the duty cycle and frequency using the CNT-based 160kV X-ray tube, it has been confirmed that the energy and dose of the X-rays can be precisely controlled. In the future, it is expected that finer digital control will be possible by applying semiconductors such as MOSFET and IGBT. This technology has potential for application in orthovoltage radiation therapy.



## CLINICAL RELEVANCE/APPLICATION

We exposed the cells to radiation using a 160 kV digital X-ray tube based on CNTs and examined their response. We anticipate that the developed tube can be further utilized and developed for application in orthovoltage radiation therapy.

### **R3-SSPH14-4 Monte Carlo-based Dosimetry of Fluoroscopy and Cone-Beam CT Imaging Studies for Yttrium-90 Radioembolization Patients**

Terrance Moretti, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Internal organ dosimetry has not been well-studied for numerous interventional fluoroscopy procedures. A particularly vulnerable population for deterministic effects from these interventions are yttrium-90 microsphere patients. Lung absorbed doses in these patients may be nearing thresholds for pneumonitis due to the radioembolization procedure alone. When imaging doses are also considered a threshold for effects may be crossed. Other organs may also be at risk for radiation-induced detriment.

#### **METHODS AND MATERIALS**

A previously validated Monte Carlo model of an interventional imaging suite used in these procedures was available for implementation in PHITS. CT image data was received for ten patients who received Y90 radioembolization within the past 5 years. The patient CT data was converted directly to a PHITS readable format by the DICOM2PHITS program. Dose coefficients to relevant organs were calculated with binned RDSR data for these interventions provided relevant kVp, filtration, table height, beam angulation, and collimated field area data. Simulations were run with these parameters, and dose coefficients per unit dose to the reference point were tabulated on a per-voxel basis. Irradiation dose data from the RDSR files were combined with these dose coefficients to obtain total doses for relevant organs from both mapping and administration interventions. Simulations included contributions from fluoroscopy, digital acquisitions, and CBCT, which was modelled as a 200-degree arc (180 degrees plus the fan angle) beginning at 120 degrees RAO and centered at isocenter with a radius of the source-to-isocenter distance.

#### **RESULTS**

Both the planning procedures and administration procedures were considered, and their contributions were summed. Patient-specific doses for multiple organs, including the liver, heart, and lungs were assessed. Dose-volume histograms were created for the sections of these organs contained in the CT volume.

#### **CONCLUSION**

The MC model was suitable for simulating procedures of this type and can be extended beyond Y90 radioembolization patients. Peak skin dose may also be evaluated and compared against dose tracking software. The scan range of the CT's used in this study was limited, thus limiting accuracy of doses organs partially or fully outside the scan range, such as the lungs.

## CLINICAL RELEVANCE/APPLICATION

Implementing this model may help explain clinical cases of radiation pneumonitis in patients near but below the threshold for effect calculated from the microspheres. The system is adaptable to other types of procedures as well.

### **R3-SSPH14-5 Evaluation of Advanced Dosimetry in Transarterial Radioembolization of Hepatocellular Carcinoma with Yttrium-90 Microspheres**

Karin Knesaurek, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our work is to investigate the relationships between tumor (T) and normal tissue (N) absorbed dose in relation with the clinical outcomes in hepatocellular carcinoma (HCC) treated with Yttrium-90 (Y-90) microspheres.

#### **METHODS AND MATERIALS**

In a prospective study, after transarterial radioembolization of HCC with Y-90 microspheres, 58 patients (10 female:48 male, mean age  $67.3 \pm 8.2$  y) were imaged on a four-ring, time-of-flight (TOF), PET/CT system. For localization of the Y-90 microspheres and attenuation correction of PET images, the low dose, non-diagnostic CT images from PET/CT were used. Images were acquired for 15 min. The reconstruction matrix size was 200x200x75 mm and voxel size 4.07x4.07x3.00 mm. Local deposition method was used for dosimetry calculations. For each patient, volume-of-interest (VOI) for whole liver and tumor(s) was manually created and a program automatically created normal tissue VOI. At a month post treatment and subsequently every three months after Y-90 treatment, mRECIST criteria done on MRI were used to assess response.

## RESULTS

For 58 patients, the mean liver, tumor and normal tissue doses (mean  $\pm$  SD) were  $52.70 \pm 23.46$  Gy,  $719.91 \pm 804.62$  Gy and  $46.85 \pm 20.89$  Gy respectively. Among these patients, 37 showed complete response (CR), 9 showed partial response (PR), 1 showed stable disease (SD) and 11 showed progression of disease (PD). Overall response rate (ORR), which is defined as the proportion of patients who have a complete or partial response to therapy was 79%, and for these patients the mean T was  $857.75 \pm 846.32$  Gy and for patients with PD, the mean T was significantly lower  $208.16 \pm 202.55$  Gy. The mean liver and normal tissue doses were similar; for PR+CR patients, liver and normal tissue doses were  $51.86 \pm 22.55$  Gy and  $45.75 \pm 20.56$  Gy, respectively and for PD patients the same values were  $56.38 \pm 28.83$  Gy and  $51.06 \pm 23.60$  Gy, respectively.

## CONCLUSION

Although the number of PD cases was limited and partial volume effect was not considered, our data shows that patients with partial and complete response (PR+CR) have a statistically higher ( $P = 0.0001$ ) tumor dose than those with progression of disease.

## CLINICAL RELEVANCE/APPLICATION

Using personalized and image-based dosimetry can improve the clinical outcomes in HCC treated with Y-90 microspheres.

### R3-SSPH14-6 **A Quantitative CBCT Pipeline for Improving the Robustness of Radiomics Features Extracted from CBCT Images in Image Guided Radiation Therapy**

Farhang Bayat, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Radiomics in CBCT-guided radiation therapy has potential for aiding in treatment response assessment. However, robustness of radiomics models is a primary concern due to inaccuracies and noise in CBCT imaging. To address this challenge, a novel quantitative CBCT approach (qCBCT) was developed to improve robustness of radiomics features extracted from CBCT images used during radiation therapy procedures.

## METHODS AND MATERIALS

qCBCT framework employs a pipeline of methods to address scattered radiation, beam hardening, image lag, and noise in CBCT. To evaluate the repeatability and reproducibility of CBCT radiomics features, two electron density phantoms, identical in composition but different in size, were scanned using the qCBCT framework and the clinical CBCT by using identical linac-mounted CBCT scan protocols. A third set of data was acquired using Multi Detector CT (MDCT). Regression models were developed to correlate radiomics features between the small and large phantoms in MDCT images, serving as the gold standard. Subsequently deviations of radiomics features extracted from qCBCT and clinical CBCT images were evaluated with respect to the regression model as a measure of robustness.

## RESULTS

Of 90 features tested, 28 passed initial robustness tests in MDCT images. Compared to clinical CBCT, qCBCT reduced deviations from the gold standard model by a factor of 14 for intensity and 180 for texture features. Variability in qCBCT radiomics features was not statistically significant when compared to MDCT except for 8 features. Whereas 24 out of 28 radiomics features in Clinical CBCT exhibited statically significant variations when compared to MDCT.

## CONCLUSION

By providing higher CT number accuracy and lower noise, qCBCT can substantially improve the robustness of both intensity and texture-based features in CBCT images, which in turn can enhance radiomics modeling, thereby improving applicability of radiomics in treatment response assessments in image guided radiation therapy.

## CLINICAL RELEVANCE/APPLICATION

A novel CBCT imaging method is presented which improves robustness of radiomics features extracted from CBCT images in image guided radiation therapy. This work could potentially help with predicting tumor response and normal tissue toxicity during the course of radiation therapy by utilizing daily localization CBCT images.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH14-1

### Diffusion Tensor Imaging Tractography of the Facial Nerve in Patients with Cerebellopontine Angle Tumors

Thursday, Nov. 30 9:30AM - 10:30AM Room: E350

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Preserving the facial nerve during surgery of cerebellopontine angle tumor is challenging because of the unpredictable location and morphologic changes in the facial nerve. Therefore, imaging to visualize preoperatively the facial nerve could help surgeons to plan the surgery and to prevent nerve injuries during the interventions. In the present prospective study, we attempted to characterize preoperatively the FN and its relations with cerebellopontine angle tumor in order to correlate the preoperative DTT image with the intraoperative findings during cerebellopontine angle tumor surgery. On the other hand, we aimed to explore the appropriate DTT tracing parameters and to observe the clinical effect of the surgery on the facial nerve.

#### METHODS AND MATERIALS

The 15 enrolled patients had cerebellopontine angle tumors and were submitted to a surgical resection in the Neurosurgery Department of between February 2018 and July 2022. At the same time, they underwent preoperative MRI and DTI-DTT with a medium FA of 0.14 and 1 ROI. The imaging series were processed obtaining 3D representations of nerve-tumor relations. The location determined by radiology was known by the surgeon who, afterwards, informed of the intrasurgical findings.

#### RESULTS

Preoperative visualization of the facial nerve using DTT was successful in all 15 patients. Facial nerve was located on the anterior-middle third of the cerebellopontine angle tumors in 9 patients, anterior-superior third in 5 patients and anterior-inferior third in 1 patient. Moreover, the correlation between the DTT and intraoperative findings of the FN was 100%. FN function remained the same degree before and after surgery in 8 patients. 1 patient improved his functionality meanwhile the others worsened

#### CONCLUSION

Preoperative facial nerve tractography reconstruction showed a high correlation with intraoperative findings. Preoperative tractography information regarding facial nerve position and its cisternal course is valuable information and could help the surgeon in increasing the safety of the procedure during cerebellopontine angle tumor surgery.

#### CLINICAL RELEVANCE/APPLICATION

Facial nerve anatomic structure was preserved in all patients during surgery. At 6 months follow-up, 66.66% of patients had a facial nerve normal function or a mild dysfunction.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH14-2

### **MRI-guided, Pancreas-targeted siRNA Therapy to Inhibit NP1 Expression in Pancreatic Beta-cells**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E350

Guanshu Liu, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Selective gene inhibition by siRNA therapeutics promises the prevention and treatment of diabetes. Herein we aimed to develop a new MRI-guided siRNA delivery system for targeted gene therapy of the pancreas.

#### **METHODS AND MATERIALS**

Nanoformulations of liposome-polycation-DNA (LPD) was employed to deliver siRNA to target neuronal pentraxin 1, a protein produced by pancreatic  $\beta$ -cells under hyperglycemic conditions, and its knockdown was shown effectively preserving normal glucose homeostasis, insulin levels, and body weight similar to controls in mouse models of diabetes. To obtain  $\beta$ -cell-targeting, LPD was modified with exendin-4, an agonist of glucagon-like peptide 1 receptor (GLP-1R) highly expressed on the  $\beta$ -cell surface<sup>1-2</sup>. All animal studies were approved by our institutional ACUC. Randomly selected mice received iv injection of 100  $\mu$ L Gd-DTPA labeled exendin-4 LPD or control LPD (4 mg lipid per mouse, n=3 in each group). Mice were then imaged before, 2 hours, and 48 hours after the LPD injection. MRI images were acquired using an 11.7 T Bruker scanner as described previously<sup>3</sup>. Quantitative T1 maps were acquired using a saturation recovery RARE-VTR sequence with an effective TE= 14 ms (RARE factor= 8) and 8 TR times varying from 100 ms to 5000 ms. The collected data were processed to estimate the T1 (or  $R1=1/T1$ ) pixel-by-pixel using Matlab.

#### **RESULTS**

We investigated the MRI detectability of the iv-injected LPD in the mouse pancreas. At 48 hours post-injection, the T1w images showed noticeable hyperintense (Figure 1b), indicative of the accumulation of LPD in these areas. To quantify the uptake of LPD, we also acquired the T1 maps (Figure 1c), on which a large portion of the pancreas showed elevated R1 relaxation rates. Compared to mice in the control group, there were negligible R1 changes at 2 hours post-injection, which was increased to  $43 \pm 18\%$  higher than the control mouse in 48 hours. Immunofluorescence images of pancreatic sections confirmed the accumulation of LPD in islet cells (Figure 1e).

#### **CONCLUSION**

Our preliminary results clearly demonstrated the ability of MRI to guide the siRNA delivery using LPD, which may serve as a platform technology for optimizing the formulation of nanoparticles for the maximized efficiency of targeted delivery. Reference: 1. Wang, P., et al., *Diabetes* 2014, 63 (5), 1465-1474. 2. Tasyurek, M. H., et al., *Expert Rev Mol Med* 2014,16, e7. 3. Chen, Z., et al., *Quant Imaging Med Surg* 2019, 9 (9), 1579-1591.

#### **CLINICAL RELEVANCE/APPLICATION**

The nanotheranostic system to be developed may ultimately provide a new, effective approach to reverse the disease progression of diabetes in which MRI guidance can significantly improve the success rate of gene therapy.

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## Abstract Archives of the RSNA, 2023

R3-SSPH14-3

### Digital Pulse-Driven 160 kV X-ray Source Using CNTs for Radiation Therapy

Thursday, Nov. 30 9:30AM - 10:30AM Room: E350

Hanna Lee (*Presenter*) Nothing to Disclose

#### PURPOSE

The demand for minimizing X-ray exposure to patients and medical personnel during medical X-ray imaging procedures used for disease diagnosis is on the rise. The traditional X-ray source used is an analog method that emits thermal electrons by heating a filament. These sources utilized in medical applications requires a penetrating power of approximately 20 to 150 kV or more. To enable immediate control of medical devices with low dose, it is imperative to develop a new type of digital X-ray tube that can overcome the limitations of the traditional analog method. Reflecting these points, this study aimed to develop a 160 kV X-ray source based on carbon nanotubes (CNTs), with digital control of X-ray energy and dose.

#### METHODS AND MATERIALS

The X-ray source was composed of a cathode that generated electrons, a gate that controlled the current in the CNT, an anode that the electrons reached, and a window that emitted X-rays. A gate relay operated in pulse mode, and another relay controlled the pulse time to generate X-rays. A timer was set on the anode to control the application time of high voltage. The digital control of the CNT-based X-ray source and the emitted dose were confirmed by varying the voltage, duty, and frequency applied to the anode. The response of cells was studied by irradiating the cells with various.

#### RESULTS

The voltage-current graph confirmed the field emission characteristics of the CNT-based X-ray source. Furthermore, an increase in duty cycle from 10 to 100% and frequency from 1 to 30 Hz at 160 kV resulted in an increase in emitted dose and dose rate. For instance, when the anode voltage was set to 160 kV at a duty cycle of 50% and a frequency of 10 Hz, a dose of 337.9 uGy and a dose rate of 73.9 uGy/s were emitted within 4.5 seconds.

#### CONCLUSION

In this study, we developed a 160 kV radiation source using CNT for field emission. We also demonstrated that high-speed digital drive-in pulse units with instantaneous on-off is possible, which is difficult to implement with conventional hot cathode X-ray tubes. The high-speed digital driving method can reduce the risk of users being exposed to unnecessary residual doses. Additionally, by adjusting the duty cycle and frequency using the CNT-based 160kV X-ray tube, it has been confirmed that the energy and dose of the X-rays can be precisely controlled. In the future, it is expected that finer digital control will be possible by applying semiconductors such as MOSFET and IGBT. This technology has potential for application in orthovoltage radiation therapy.

#### CLINICAL RELEVANCE/APPLICATION

We exposed the cells to radiation using a 160 kV digital X-ray tube based on CNTs and examined their response. We anticipate that the developed tube can be further utilized and developed for application in orthovoltage radiation therapy.

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## Abstract Archives of the RSNA, 2023

R3-SSPH14-4

### Monte Carlo-based Dosimetry of Fluoroscopy and Cone-Beam CT Imaging Studies for Yttrium-90 Radioembolization Patients

Thursday, Nov. 30 9:30AM - 10:30AM Room: E350

Terrance Moretti, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Internal organ dosimetry has not been well-studied for numerous interventional fluoroscopy procedures. A particularly vulnerable population for deterministic effects from these interventions are yttrium-90 microsphere patients. Lung absorbed doses in these patients may be nearing thresholds for pneumonitis due to the radioembolization procedure alone. When imaging doses are also considered a threshold for effects may be crossed. Other organs may also be at risk for radiation-induced detriment.

#### METHODS AND MATERIALS

A previously validated Monte Carlo model of an interventional imaging suite used in these procedures was available for implementation in PHITS. CT image data was received for ten patients who received Y90 radioembolization within the past 5 years. The patient CT data was converted directly to a PHITS readable format by the DICOM2PHITS program. Dose coefficients to relevant organs were calculated with binned RDSR data for these interventions provided relevant kVp, filtration, table height, beam angulation, and collimated field area data. Simulations were run with these parameters, and dose coefficients per unit dose to the reference point were tabulated on a per-voxel basis. Irradiation dose data from the RDSR files were combined with these dose coefficients to obtain total doses for relevant organs from both mapping and administration interventions. Simulations included contributions from fluoroscopy, digital acquisitions, and CBCT, which was modelled as a 200-degree arc (180 degrees plus the fan angle) beginning at 120 degrees RAO and centered at isocenter with a radius of the source-to-isocenter distance.

#### RESULTS

Both the planning procedures and administration procedures were considered, and their contributions were summed. Patient-specific doses for multiple organs, including the liver, heart, and lungs were assessed. Dose-volume histograms were created for the sections of these organs contained in the CT volume.

#### CONCLUSION

The MC model was suitable for simulating procedures of this type and can be extended beyond Y90 radioembolization patients. Peak skin dose may also be evaluated and compared against dose tracking software. The scan range of the CT's used in this study was limited, thus limiting accuracy of doses organs partially or fully outside the scan range, such as the lungs.

#### CLINICAL RELEVANCE/APPLICATION

Implementing this model may help explain clinical cases of radiation pneumonitis in patients near but below the threshold for effect calculated from the microspheres. The system is adaptable to other types of procedures as well.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH14-5

### Evaluation of Advanced Dosimetry in Transarterial Radioembolization of Hepatocellular Carcinoma with Yttrium-90 Microspheres

Thursday, Nov. 30 9:30AM - 10:30AM Room: E350

Karin Knesaurek, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of our work is to investigate the relationships between tumor (T) and normal tissue (N) absorbed dose in relation with the clinical outcomes in hepatocellular carcinoma (HCC) treated with Yttrium-90 (Y-90) microspheres.

#### METHODS AND MATERIALS

In a prospective study, after transarterial radioembolization of HCC with Y-90 microspheres, 58 patients (10 female:48 male, mean age 67.3±8.2y) were imaged on a four-ring, time-of-flight (TOF), PET/CT system. For localization of the Y-90 microspheres and attenuation correction of PET images, the low dose, non-diagnostic CT images from PET/CT were used. Images were acquired for 15 min. The reconstruction matrix size was 200x200x75 mm and voxel size 4.07x4.07x3.00 mm. Local deposition method was used for dosimetry calculations. For each patient, volume-of-interest (VOI) for whole liver and tumor(s) was manually created and a program automatically created normal tissue VOI. At a month post treatment and subsequently every three months after Y-90 treatment, mRECIST criteria done on MRI were used to assess response.

#### RESULTS

For 58 patients, the mean liver, tumor and normal tissue doses (mean ± SD) were 52.70±23.46 Gy, 719.91±804.62 Gy and 46.85±20.89 Gy respectively. Among these patients, 37 showed complete response (CR), 9 showed partial response (PR), 1 showed stable disease (SD) and 11 showed progression of disease (PD). Overall response rate (ORR), which is defined as the proportion of patients who have a complete or partial response to therapy was 79%, and for these patients the mean T was 857.75±846.32 Gy and for patients with PD, the mean T was significantly lower 208.16±202.55 Gy. The mean liver and normal tissue doses were similar; for PR+CR patients, liver and normal tissue doses were 51.86±22.55 Gy and 45.75±20.56 Gy, respectively and for PD patients the same values were 56.38±28.83 Gy and 51.06±23.60 Gy, respectively.

#### CONCLUSION

Although the number of PD cases was limited and partial volume effect was not considered, our data shows that patients with partial and complete response (PR+CR) have a statistically higher ( $P = 0.0001$ ) tumor dose than those with progression of disease.

#### CLINICAL RELEVANCE/APPLICATION

Using personalized and image-based dosimetry can improve the clinical outcomes in HCC treated with Y-90 microspheres.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-SSPH14-6

### **A Quantitative CBCT Pipeline for Improving the Robustness of Radiomics Features Extracted from CBCT Images in Image Guided Radiation Therapy**

Thursday, Nov. 30 9:30AM - 10:30AM Room: E350

Farhang Bayat, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiomics in CBCT-guided radiation therapy has potential for aiding in treatment response assessment. However, robustness of radiomics models is a primary concern due to inaccuracies and noise in CBCT imaging. To address this challenge, a novel quantitative CBCT approach (qCBCT) was developed to improve robustness of radiomics features extracted from CBCT images used during radiation therapy procedures.

#### **METHODS AND MATERIALS**

qCBCT framework employs a pipeline of methods to address scattered radiation, beam hardening, image lag, and noise in CBCT. To evaluate the repeatability and reproducibility of CBCT radiomics features, two electron density phantoms, identical in composition but different in size, were scanned using the qCBCT framework and the clinical CBCT by using identical linac-mounted CBCT scan protocols. A third set of data was acquired using Multi Detector CT (MDCT). Regression models were developed to correlate radiomics features between the small and large phantoms in MDCT images, serving as the gold standard. Subsequently deviations of radiomics features extracted from qCBCT and clinical CBCT images were evaluated with respect to the regression model as a measure of robustness.

#### **RESULTS**

Of 90 features tested, 28 passed initial robustness tests in MDCT images. Compared to clinical CBCT, qCBCT reduced deviations from the gold standard model by a factor of 14 for intensity and 180 for texture features. Variability in qCBCT radiomics features was not statistically significant when compared to MDCT except for 8 features. Whereas 24 out of 28 radiomics features in Clinical CBCT exhibited statically significant variations when compared to MDCT.

#### **CONCLUSION**

By providing higher CT number accuracy and lower noise, qCBCT can substantially improve the robustness of both intensity and texture-based features in CBCT images, which in turn can enhance radiomics modeling, thereby improving applicability of radiomics in treatment response assessments in image guided radiation therapy.

#### **CLINICAL RELEVANCE/APPLICATION**

A novel CBCT imaging method is presented which improves robustness of radiomics features extracted from CBCT images in image guided radiation therapy. This work could potentially help with predicting tumor response and normal tissue toxicity during the course of radiation therapy by utilizing daily localization CBCT images.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-STCE1

### Science Session (Sustainability in Imaging)

Thursday, Nov. 30 10:00AM - 10:30AM Room: Learning Center Theater 1

#### Sub-Events

### R3-STCE1-1 MRI Load Profile Characterization Across Scanner Manufacturers and Field Strengths - Opportunities for Energy Efficiency Improvements

Kim Trenbath, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiology plays a vital role in patient care, but a reliance on energy-intensive imaging equipment leads to significant greenhouse gas emissions. MRI scanners can consume up to 80% of their total energy during times when there is not active patient imaging. Characterizing MRI average power and time to enter low-power mode across scanning protocols can identify energy efficiency opportunities.

#### METHODS AND MATERIALS

A current monitoring device was installed for three continuous weeks in July 2023 on four different MRI systems including: two 3T scanners (manufacturer 1 "M1\_3T" and M2\_3T), one 1.5T scanner (M1\_1.5T), and one low-field strength (M3\_lowT) scanner. Power was calculated for all systems using the reference (three or single phase) voltage of the machine and a calculated or vendor-provided power factor. The average power in low-power mode and ready-to-scan mode was quantified for all four systems. For M1\_3T, scanner log data was available and used to determine: the time for the scanner to enter low-power mode following an exam, and the average energy consumed per exam. An energy efficiency simulation was performed whereby M1\_3T was entered into lower-power mode 10 minutes after each scan to project energy and cost savings.

#### RESULTS

The average power for low-power mode was 12.7 kW, 10.7 kW, 12.2 kW, and 8.6 W for M1\_3T, M2\_3T, M1\_1.5T, and M3\_lowT, respectively. The average power for ready-to-scan mode was 16.2 kW, 20.7 kW, and 123.4 W for M1\_3T, M2\_3T, M1\_1.5T, and M3\_lowT. The M1\_3T scanner's most energy intensive exam was the brain with and without contrast protocol (19.6 kWh). The lowest was the L-spine without contrast protocol (10.5 kWh). M1\_3T entered low-power mode after only 48% of exams. The time to enter low-power mode was an average of 15.6 minutes  $\pm$  3.7 minutes. The energy efficiency simulation resulted in the scanner entering low-power mode after 81% of the exams and saved on average 1.6 kWh per exam. These savings nationally amount to 25,679 MTCO<sub>2</sub> and 9.6 million USD per year (40 million scans per year, 0.15 USD per kWh and 0.879 lbs of CO<sub>2</sub> per kWh).

#### CONCLUSION

Preliminary results indicate a range of different average power characteristics across scanner manufacturers and field strengths during times when there is no active patient imaging. The time to enter low-power mode varies substantially for the M1\_3T scanner providing an area for potential improvements in energy efficiency.

#### CLINICAL RELEVANCE/APPLICATION

Radiology's energy-intensive equipment leads to significant GHG emissions with potential clinical implications. Characterizing MRI load profiles across various systems is crucial for identifying energy efficiency opportunities.

### R3-STCE1-2 Contrasting Carbon Emissions of Two Machine Learning Training Approaches: From Scratch Versus Pretrained Models

Vasanth Venugopal, MD (*Presenter*) Officer, CARPL.AI Inc

#### PURPOSE

The primary focus of this empirical study is to conduct a thorough comparative analysis of carbon emissions associated with two distinct model training methodologies. The first methodology involves constructing a model de novo without reliance on

any foundational model, while the second methodology employs a pre-trained model, which has its origins in the ImageNet dataset.

## **METHODS AND MATERIALS**

An open-source dataset released by the Royal Australian and New Zealand College of Radiologists (RANZCR), comprising of 30,000 X-ray images, was used for this study. These images were meticulously annotated through a rigorous process. The primary approach involved the construction, iterative training, and optimization of a ResNet 200D architectural model through backpropagation to augment its classification performance. The entire process was conducted on an NVIDIA RTX 3080 GPU and completed in an estimated timeframe of 48 hours. The peak GPU usage during the training was observed to be 95%, with a power consumption of 320 watts. The alternative method employed a pre-trained ResNet-200d model, originally trained using the ImageNet dataset for a variety of image classification tasks. This pre-trained model was fine-tuned on the catheter dataset, tailoring it specifically for catheter classification. The fine-tuning process, conducted on the same NVIDIA RTX 3080 GPU, was completed in a mere 8 hours. The peak GPU usage during fine-tuning was recorded at 60%, with a power consumption of 250 watts. The carbon emissions were calculated using the equation: Carbon Emission (kg CO<sub>2</sub>e) = Power Consumption (kW) \* Training Time (hours) \* Carbon Emission Factor (kg CO<sub>2</sub>e/kWh). Based on the power consumption and training time, the primary approach emitted approximately 7680 KG of CO<sub>2</sub> while the secondary approach emitted around 1000 KG of CO<sub>2</sub>.

## **RESULTS**

The first model achieved an AUC score of 0.832, and the CO<sub>2</sub> emission was calculated to be 7680 KG. The second model achieved a higher AUC score of 0.934, with significantly lower CO<sub>2</sub> emissions of approximately 1000 KG.

## **CONCLUSION**

We demonstrate a significant (87%) reduction in the carbon emissions for AI model training while using a foundation model without loss of performance.

## **CLINICAL RELEVANCE/APPLICATION**

While it is commonplace knowledge that using foundational models reduces power consumption and hence carbon emission, the extent of such reduction in the context of radiology AI model training was not calculated before.

## **R3-STCE1-3 Sustainable Radiology Education: The Impact of RSNA Radiology Podcast on Radiology Journal Article Impact Including Downloads, Citations, and Altmetric Scores**

Mark Wang, BSc (*Presenter*) Nothing to Disclose

## **PURPOSE**

Environmental sustainability is a critically important topic, including within medical education. Traditional methods of knowledge dissemination include conferences and print journals, both of which have significant environmental impacts. Podcasts have a low environmental impact and have surged in popularity as a way to educate and inform, including within medicine. Our goal is to assess the effect of Radiology podcasts on the impact of Radiology articles.

## **METHODS AND MATERIALS**

All articles published in the print version of Radiology from January 2021 to December 2022 were reviewed. Editorials and cases were excluded. Articles presented on Radiology podcasts and their journal category were included in the podcast group. Articles published within the same category of the same issue were used as matched controls. Google Scholar citations, Dimension citations, Altmetric Attention Scores (AAS), and downloads were gathered. A Mann-Whitney U-test was used to compare the medians. T-tests could not be performed because the data was non-parametric.

## **RESULTS**

There were 88 articles in the podcast group (P) and 378 articles in the matched-control group (MC). Original Research made up most of the articles (P=77.3%, MC=91.0%), followed by Reviews and Commentary (P=20.5%, MC=7.9%), and then Communications (P=2.3%, MC=0.8%). The mean number of Google Scholar citations (P=26, MC=16), Dimension citations (P=22, MC=14), AAS (P=131, M=27), and downloads (P=12,206, MC=3,536) were higher in the podcast group. The podcast group had a significantly higher median number of Google Scholar citations (P=15, MC=10, p=0.01), Dimension citations (P=12, MC=9, p=0.01), AAS (P=43, MC=10, p<0.001), and downloads (P=4336, MC=2124, p<0.001). Further data breakdown will also be presented.

## **CONCLUSION**

Articles featured on the podcast had a greater impact across all categories evaluated. This suggests that podcasts can be an effective method of disseminating and amplifying research in a sustainable manner.

## **CLINICAL RELEVANCE/APPLICATION**

Podcasts are an effective, efficient, and low-carbon footprint method of disseminating and amplifying the knowledge contained in Radiology journal articles.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-STCE1-1

### **MRI Load Profile Characterization Across Scanner Manufacturers and Field Strengths - Opportunities for Energy Efficiency Improvements**

Thursday, Nov. 30 10:00AM - 10:30AM Room: Learning Center Theater 1

Kim Trenbath, PhD, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiology plays a vital role in patient care, but a reliance on energy-intensive imaging equipment leads to significant greenhouse gas emissions. MRI scanners can consume up to 80% of their total energy during times when there is not active patient imaging. Characterizing MRI average power and time to enter low-power mode across scanning protocols can identify energy efficiency opportunities.

#### **METHODS AND MATERIALS**

A current monitoring device was installed for three continuous weeks in July 2023 on four different MRI systems including: two 3T scanners (manufacturer 1 "M1\_3T" and M2\_3T), one 1.5T scanner (M1\_1.5T), and one low-field strength (M3\_lowT) scanner. Power was calculated for all systems using the reference (three or single phase) voltage of the machine and a calculated or vendor-provided power factor. The average power in low-power mode and ready-to-scan mode was quantified for all four systems. For M1\_3T, scanner log data was available and used to determine: the time for the scanner to enter low-power mode following an exam, and the average energy consumed per exam. An energy efficiency simulation was performed whereby M1\_3T was entered into lower-power mode 10 minutes after each scan to project energy and cost savings.

#### **RESULTS**

The average power for low-power mode was 12.7 kW, 10.7 kW, 12.2 kW, and 8.6 W for M1\_3T, M2\_3T, M1\_1.5T, and M3\_lowT, respectively. The average power for ready-to-scan mode was 16.2 kW, 20.7 kW, and 123.4 W for M1\_3T, M2\_3T, M1\_1.5T, and M3\_lowT. The M1\_3T scanner's most energy intensive exam was the brain with and without contrast protocol (19.6 kWh). The lowest was the L-spine without contrast protocol (10.5 kWh). M1\_3T entered low-power mode after only 48% of exams. The time to enter low-power mode was an average of 15.6 minutes  $\pm$  3.7 minutes. The energy efficiency simulation resulted in the scanner entering low-power mode after 81% of the exams and saved on average 1.6 kWh per exam. These savings nationally amount to 25,679 MTCO<sub>2</sub> and 9.6 million USD per year (40 million scans per year, 0.15 USD per kWh and 0.879 lbs of CO<sub>2</sub> per kWh).

#### **CONCLUSION**

Preliminary results indicate a range of different average power characteristics across scanner manufacturers and field strengths during times when there is no active patient imaging. The time to enter low-power mode varies substantially for the M1\_3T scanner providing an area for potential improvements in energy efficiency.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiology's energy-intensive equipment leads to significant GHG emissions with potential clinical implications. Characterizing MRI load profiles across various systems is crucial for identifying energy efficiency opportunities.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-STCE1-2

### Contrasting Carbon Emissions of Two Machine Learning Training Approaches: From Scratch Versus Pretrained Models

Thursday, Nov. 30 10:00AM - 10:30AM Room: Learning Center Theater 1

Vasanth Venugopal, MD (*Presenter*) Officer, CARPL.AI Inc

#### PURPOSE

The primary focus of this empirical study is to conduct a thorough comparative analysis of carbon emissions associated with two distinct model training methodologies. The first methodology involves constructing a model de novo without reliance on any foundational model, while the second methodology employs a pre-trained model, which has its origins in the ImageNet dataset.

#### METHODS AND MATERIALS

An open-source dataset released by the Royal Australian and New Zealand College of Radiologists (RANZCR), comprising of 30,000 X-ray images, was used for this study. These images were meticulously annotated through a rigorous process. The primary approach involved the construction, iterative training, and optimization of a ResNet 200D architectural model through backpropagation to augment its classification performance. The entire process was conducted on an NVIDIA RTX 3080 GPU and completed in an estimated timeframe of 48 hours. The peak GPU usage during the training was observed to be 95%, with a power consumption of 320 watts. The alternative method employed a pre-trained ResNet-200d model, originally trained using the ImageNet dataset for a variety of image classification tasks. This pre-trained model was fine-tuned on the catheter dataset, tailoring it specifically for catheter classification. The fine-tuning process, conducted on the same NVIDIA RTX 3080 GPU, was completed in a mere 8 hours. The peak GPU usage during fine-tuning was recorded at 60%, with a power consumption of 250 watts. The carbon emissions were calculated using the equation: Carbon Emission (kg CO<sub>2</sub>e) = Power Consumption (kW) \* Training Time (hours) \* Carbon Emission Factor (kg CO<sub>2</sub>e/kWh). Based on the power consumption and training time, the primary approach emitted approximately 7680 KG of CO<sub>2</sub> while the secondary approach emitted around 1000 KG of CO<sub>2</sub>.

#### RESULTS

The first model achieved an AUC score of 0.832, and the CO<sub>2</sub> emission was calculated to be 7680 KG. The second model achieved a higher AUC score of 0.934, with significantly lower CO<sub>2</sub> emissions of approximately 1000 KG.

#### CONCLUSION

We demonstrate a significant (87%) reduction in the carbon emissions for AI model training while using a foundation model without loss of performance.

#### CLINICAL RELEVANCE/APPLICATION

While it is commonplace knowledge that using foundational models reduces power consumption and hence carbon emission, the extent of such reduction in the context of radiology AI model training was not calculated before.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-STCE1-3

### **Sustainable Radiology Education: The Impact of RSNA Radiology Podcast on Radiology Journal Article Impact Including Downloads, Citations, and Altimetric Scores**

Thursday, Nov. 30 10:00AM - 10:30AM Room: Learning Center Theater 1

Mark Wang, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Environmental sustainability is a critically important topic, including within medical education. Traditional methods of knowledge dissemination include conferences and print journals, both of which have significant environmental impacts. Podcasts have a low environmental impact and have surged in popularity as a way to educate and inform, including within medicine. Our goal is to assess the effect of Radiology podcasts on the impact of Radiology articles.

#### **METHODS AND MATERIALS**

All articles published in the print version of Radiology from January 2021 to December 2022 were reviewed. Editorials and cases were excluded. Articles presented on Radiology podcasts and their journal category were included in the podcast group. Articles published within the same category of the same issue were used as matched controls. Google Scholar citations, Dimension citations, Altimetric Attention Scores (AAS), and downloads were gathered. A Mann-Whitney U-test was used to compare the medians. T-tests could not be performed because the data was non-parametric.

#### **RESULTS**

There were 88 articles in the podcast group (P) and 378 articles in the matched-control group (MC). Original Research made up most of the articles (P=77.3%, MC=91.0%), followed by Reviews and Commentary (P=20.5%, MC=7.9%), and then Communications (P=2.3%, MC=0.8%). The mean number of Google Scholar citations (P=26, MC=16), Dimension citations (P=22, MC=14), AAS (P=131, M=27), and downloads (P=12,206, MC=3,536) were higher in the podcast group. The podcast group had a significantly higher median number of Google Scholar citations (P=15, MC=10,  $p=0.01$ ), Dimension citations (P=12, MC=9,  $p=0.01$ ), AAS (P=43, MC=10,  $p<0.001$ ), and downloads (P=4336, MC=2124,  $p<0.001$ ). Further data breakdown will also be presented.

#### **CONCLUSION**

Articles featured on the podcast had a greater impact across all categories evaluated. This suggests that podcasts can be an effective method of disseminating and amplifying research in a sustainable manner.

#### **CLINICAL RELEVANCE/APPLICATION**

Podcasts are an effective, efficient, and low-carbon footprint method of disseminating and amplifying the knowledge contained in Radiology journal articles.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-STCE2

### Science Session (Imaging of Immunotherapy)

Thursday, Nov. 30 10:00AM - 10:30AM Room: Learning Center Theater 2

#### Sub-Events

#### **R3-STCE2-1 Diagnostic accuracy of Imaging findings in the detection of lymph node metastasis in patients with Head and neck cancer**

Gadupudi Vignesh I, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The objective of this retrospective study was to evaluate the precision of radiological imaging methods, such as CT, MRI, and USG, in identifying lymph node metastasis among individuals diagnosed with head and neck cancer.

#### **METHODS AND MATERIALS**

A total of 1412 patients with head and neck cancers who underwent pre-operative imaging at our tertiary cancer institute between January 2020- 2023 were included. Two experienced radiologists blinded to the histopathology results independently reviewed the imaging findings. They classified the nodes at each level as benign, indeterminate, suspicious for metastasis, and metastatic. The number and level of metastatic lymph nodes and the presence or absence of extranodal extension were compared to the histopathological findings. The primary histopathological subtype and degree of differentiation were also recorded. The information gathered was analyzed using IBM SPSS Statistics. Frequency analysis and percentage analysis were used to describe the data. For each modality and level, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated.

#### **RESULTS**

CT, MRI, and USG had high diagnostic accuracy: CT (82.4%), MRI (81.1%), and USG (82.4%). All modalities showed high sensitivity (CT: 92.8%, MRI: 89.4%, USG: 89.5%) and negative predictive value (CT: 84.8%, MRI: 85.5%, USG: 88.8%). Sensitivity, specificity, PPV, and NPV varied by level, with the highest values in level V (MRI: 99.4% sensitivity, 99% specificity). Highest specificity and PPV were found for level II (USG had specificity of 46.1% and PPV of 54%). In indeterminate nodes, 85% were negative for metastases and 15% were positive. Additional imaging or sampling may help avoid overdiagnosis in such cases. For assessing extranodal extension (ENE), combined imaging sensitivity-38.5%, specificity-92.7%, PPV-16.8%, and NPV-97.5%.

#### **CONCLUSION**

Accurate pre-operative staging is crucial due to ENE's impact on disease upstaging and treatment considerations. Imaging showed high accuracy, sensitivity, and NPV in detecting lymph node metastases and extranodal extension in head and neck malignancies, indicating their value in predicting absence of lymph node metastasis and reducing unnecessary neck dissections. Imaging specificity and PPV were relatively lower, urging re-examining criteria for metastatic nodes. The content, quality, and effective communication of imaging findings to treating physicians are essential for optimal patient care.

#### **CLINICAL RELEVANCE/APPLICATION**

Hence Radiologist should be aware of the characteristics in predicting absence of lymph node metastasis and thereby reducing unnecessary neck dissections.

#### **R3-STCE2-3 Beyond the Spectrum:A Novel Imaging Response in Triple-Negative Breast Cancer Patients Undergoing Preoperative Immuno-chemotherapy**

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to investigate and characterize a novel imaging phenomenon, transient focal enhancement (TFE), observed in breast cancer patients undergoing preoperative immunotherapy plus chemotherapy.

## **METHODS AND MATERIALS**

The study was conducted as part of a prospective single-arm, open-label, monocentric phase II trial, enrolling 39 treatment-naive non-metastatic triple negative breast cancer (TNBC) patients. Breast MRI scans were performed before and during treatment cycles. Two experienced radiologists independently reviewed the MRI images and recorded various imaging features, including the amount of breast fibroglandular tissue (FGT), background parenchymal enhancement (BPE), primary tumor morphology. Transient focal enhancement (TFE), which was defined as a distinct and localized area of enhancement within the breast tissue outside the tumor, measuring greater than 5mm in size, during the treatment course, which subsequently exhibited reduction or disappearance on follow-up imaging, was recorded and depicted. Statistical analysis was performed to assess the association between TFE and clinical or imaging factors using chi-square or Fisher's exact tests for categorical variables, t-tests for continuous variables, and the Cochran-Armitage trend test for correlation with FGT classification. The significance level was set at  $p < 0.05$ .

## **RESULTS**

Among the study cohort, 51.3% of patients exhibited TFE on breast MRI. TFE demonstrated specific morphological features, such as an oval shape, circumscribed margins, and homogeneous enhancement. There was a significant association between TFE and FGT classification. The presence of TFE alone did not correlate with the overall treatment response. Notably, TFE with a longest diameter greater than 10mm showed a statistically significant association with a higher likelihood of achieving a pathological complete response (pCR).

## **CONCLUSION**

This prospective study identified and characterized TFE as a unique imaging response pattern in TNBC patients undergoing preoperative immuno-chemotherapy. TFE demonstrated specific morphological features and was significantly associated with FGT classification. While the presence of TFE alone did not correlate with overall response, the presence of larger TFE lesions was indicative of a higher probability of achieving a pCR.

## **CLINICAL RELEVANCE/APPLICATION**

The identification of TFE as an imaging biomarker for treatment response in TNBC patients undergoing preoperative immuno-chemotherapy has clinical implications. Monitoring TFE during the treatment course can potentially aid in treatment decision-making and may serve as an early predictor of treatment response.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R3-STCE2-1

### Diagnostic accuracy of Imaging findings in the detection of lymph node metastasis in patients with Head and neck cancer

Thursday, Nov. 30 10:00AM - 10:30AM Room: Learning Center Theater 2

Gadupudi Vignesh I, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The objective of this retrospective study was to evaluate the precision of radiological imaging methods, such as CT, MRI, and USG, in identifying lymph node metastasis among individuals diagnosed with head and neck cancer.

#### METHODS AND MATERIALS

A total of 1412 patients with head and neck cancers who underwent pre-operative imaging at our tertiary cancer institute between January 2020- 2023 were included. Two experienced radiologists blinded to the histopathology results independently reviewed the imaging findings. They classified the nodes at each level as benign, indeterminate, suspicious for metastasis, and metastatic. The number and level of metastatic lymph nodes and the presence or absence of extranodal extension were compared to the histopathological findings. The primary histopathological subtype and degree of differentiation were also recorded. The information gathered was analyzed using IBM SPSS Statistics. Frequency analysis and percentage analysis were used to describe the data. For each modality and level, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated.

#### RESULTS

CT, MRI, and USG had high diagnostic accuracy: CT (82.4%), MRI (81.1%), and USG (82.4%). All modalities showed high sensitivity (CT: 92.8%, MRI: 89.4%, USG: 89.5%) and negative predictive value (CT: 84.8%, MRI: 85.5%, USG: 88.8%). Sensitivity, specificity, PPV, and NPV varied by level, with the highest values in level V (MRI: 99.4% sensitivity, 99% specificity). Highest specificity and PPV were found for level II (USG had specificity of 46.1% and PPV of 54%). In indeterminate nodes, 85% were negative for metastases and 15% were positive. Additional imaging or sampling may help avoid overdiagnosis in such cases. For assessing extranodal extension (ENE), combined imaging sensitivity-38.5%, specificity-92.7%, PPV-16.8%, and NPV-97.5%.

#### CONCLUSION

Accurate pre-operative staging is crucial due to ENE's impact on disease upstaging and treatment considerations. Imaging showed high accuracy, sensitivity, and NPV in detecting lymph node metastases and extranodal extension in head and neck malignancies, indicating their value in predicting absence of lymph node metastasis and reducing unnecessary neck dissections. Imaging specificity and PPV were relatively lower, urging re-examining criteria for metastatic nodes. The content, quality, and effective communication of imaging findings to treating physicians are essential for optimal patient care.

#### CLINICAL RELEVANCE/APPLICATION

Hence Radiologist should be aware of the characteristics in predicting absence of lymph node metastasis and thereby reducing unnecessary neck dissections.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R3-STCE2-3

### **Beyond the Spectrum: A Novel Imaging Response in Triple-Negative Breast Cancer Patients Undergoing Preoperative Immuno-chemotherapy**

Thursday, Nov. 30 10:00AM - 10:30AM Room: Learning Center Theater 2

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to investigate and characterize a novel imaging phenomenon, transient focal enhancement (TFE), observed in breast cancer patients undergoing preoperative immunotherapy plus chemotherapy.

#### **METHODS AND MATERIALS**

The study was conducted as part of a prospective single-arm, open-label, monocentric phase II trial, enrolling 39 treatment-naïve non-metastatic triple negative breast cancer (TNBC) patients. Breast MRI scans were performed before and during treatment cycles. Two experienced radiologists independently reviewed the MRI images and recorded various imaging features, including the amount of breast fibroglandular tissue (FGT), background parenchymal enhancement (BPE), primary tumor morphology. Transient focal enhancement (TFE), which was defined as a distinct and localized area of enhancement within the breast tissue outside the tumor, measuring greater than 5mm in size, during the treatment course, which subsequently exhibited reduction or disappearance on follow-up imaging, was recorded and depicted. Statistical analysis was performed to assess the association between TFE and clinical or imaging factors using chi-square or Fisher's exact tests for categorical variables, t-tests for continuous variables, and the Cochran-Armitage trend test for correlation with FGT classification. The significance level was set at  $p < 0.05$ .

#### **RESULTS**

Among the study cohort, 51.3% of patients exhibited TFE on breast MRI. TFE demonstrated specific morphological features, such as an oval shape, circumscribed margins, and homogeneous enhancement. There was a significant association between TFE and FGT classification. The presence of TFE alone did not correlate with the overall treatment response. Notably, TFE with a longest diameter greater than 10mm showed a statistically significant association with a higher likelihood of achieving a pathological complete response (pCR).

#### **CONCLUSION**

This prospective study identified and characterized TFE as a unique imaging response pattern in TNBC patients undergoing preoperative immuno-chemotherapy. TFE demonstrated specific morphological features and was significantly associated with FGT classification. While the presence of TFE alone did not correlate with overall response, the presence of larger TFE lesions was indicative of a higher probability of achieving a pCR.

#### **CLINICAL RELEVANCE/APPLICATION**

The identification of TFE as an imaging biomarker for treatment response in TNBC patients undergoing preoperative immuno-chemotherapy has clinical implications. Monitoring TFE during the treatment course can potentially aid in treatment decision-making and may serve as an early predictor of treatment response.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-SSCH10

### Science Session with Keynote: Chest Imaging (MR and Radionomics)

Thursday, Nov. 30 11:00AM - 12:00PM Room: S405

Yoshiharu Ohno, MD, PhD (*Moderator*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology  
Jonathan A. Liu, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R4-SSCH10-1 Longitudinal Morpho-Functional MRI for the Management of Incidental Pulmonary Nodules in Patients with COPD - A Nationwide Multicenter Trial**

Lin Zhu, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the capability to accurately diagnose and predict the long-term outcome of incidental pulmonary nodules in heavy smokers by morpho-functional chest magnetic resonance imaging (MRI) in multicenter trial research.

#### **METHODS AND MATERIALS**

Patients who participate in the two rounds of same-day MRI and low-dose computed tomography (LDCT) scan or have histopathological proofs after their first exam at 16 centers in the nationwide multicenter trial were included. The accuracy of MRI in predicting lung cancer in high-risk patients was verified by histopathological results and compared with LDCT, and compared the consistency of MRI and CT in judging the outcome of nodules through two rounds of imaging follow-up. MRI Parsimonious and fuller multivariable logistic-regression models based on MRI were constructed based on the consensual LDCT results as the standard of reference.

#### **RESULTS**

249 patients were analyzed in the present study out of 567 patients after their first round exam, of which, 8 patients (13 nodules) with histopathological proofs after the first round of imaging. MRI has similar detection accuracy of LDCT for patients with malignant nodules (36.4% vs. 33.4%) and revealed a substantial inter-method agreement with LDCT on the long-term outcome judgment of incidental nodules based on two rounds of imaging assessment( $\kappa=0.78-0.80$ ). Our MRI full model showed significant improvement in the predictive accuracy of incidental nodule progression than the parsimonious model (AUC 0.91 vs. 0.81,  $P<0.05$ ), and has no difference compared with the LDCT model ( $P=0.45$ ), suggesting that the MRI full model which associated sociodemographic, clinical and characteristics based on the MRI imaging has the similar potential as LDCT on incidental pulmonary nodules diagnosis and progression prediction in patients with high risk.

#### **CONCLUSION**

MRI plays a promising role in evaluating incidental nodules and predicting their long-term outcome in heavy smokers, which may contribute to radiation management and public health improvement.

#### **CLINICAL RELEVANCE/APPLICATION**

Our data suggest MRI has satisfactory discrimination of patients with malignant lung nodules compared with LDCT and has equivalent prediction efficiency of the cancerous probability of incidental nodules of patients with COPD if simultaneously considering sociodemographic and clinical variables. The implementation of our nodule risk-prediction models based on MRI is expected to reduce the radiation of follow-up CTs, and improve clinical and public health practice.

#### **R4-SSCH10-2 CT Based Deep Learning Radiomics Biomarker for PD L1 Expression in Non Small Cell Lung Cancer**

Jingshan Gong, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop and validate CT-based deep learning radiomics signature for predicting programmed cell death ligand 1 (PD-L1) expression in non-small cell lung cancers (NSCLCs).

## METHODS AND MATERIALS

Two hundreds and fifty-nine consecutive patients with pathological confirmed NSCLCs were retrospectively enrolled and randomly divided into a training cohort and a validation cohort at a ratio of 7:3. The univariate and multivariate analysis were used to build clinical model. Radiomics features and deep learning features were extracted from preoperative non-contrast CT images. Least absolute shrinkage and selection operator regression (LASSO) was implemented to select the features with strong association with PD-L1 expression. Radiomics score (Rad-score) and deep learning radiomics score (DLR-score) for each patient were calculated through linear combination of the selected features and coefficients. Predictive performance for PD-L1 expression was evaluated via area under the curve (AUC) of receiver operating characteristic (ROC).

## RESULTS

The clinical model based on gender and Cytokeratin 19 fragment obtained an AUC of 0.705 (95% CI: 0.611-0.799) for PD-L1 in the training cohort and 0.644 (95% CI: 0.525-0.763) in test cohort for PD-L1 expression. Three radiomics features and twenty-one deep learning features were selected by LASSO regression. AUCs of Rad-score for PD-L1 expression were 0.786 (95%CI: 0.699-0.874) and 0.702 (95%CI: 0.538-0.866) in the training cohort and validation cohort, respectively. AUCs of DLR-score for PD-L1 expression were 0.983 (95%CI: 0.970-0.997) and 0.942 (95%CI: 0.898-0.986) in the training cohort and validation cohort, respectively. AUCs of deep radiomics signature were higher than those of rad-score and clinical model with statistical significance.

## CONCLUSION

The CT-based deep learning radiomics signature could achieve clinical acceptable predictive performance for PD-L1 expression, which showed potential to be a surrogate imaging biomarker or a complement of immunohistochemistry assessment.

## CLINICAL RELEVANCE/APPLICATION

In this study, the DLR- score, derived from preoperation CT images through deep transfer learning, showed a clinical acceptable predictive performance for PD-L1 expression in patients with NSCLCs. Clinical translation of DLR-score could facilitate selection of patients who would be benefit for immune checkpoint inhibitors therapy noninvasively.

## R4-SSCH10-3 Radiomics Derived Phenotypes Predict Response to Durvalumab Immunotherapy for Non-Small Cell Lung Cancer

Andrew W. Chen, BS, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the prognostic value of radiomic phenotypes for immunotherapy outcomes in combination with other clinical variables for patients with advanced NSCLC treated with durvalumab, an anti PD-1 immune checkpoint inhibitor.

## METHODS AND MATERIALS

After IRB approval, patients with advanced NSCLC (n=117) treated at our institution with durvalumab with pre- (n=117) and post-treatment (n=79) CT scans were identified. Radiomic features were extracted using the cancer imaging phenomics toolkit (CapTk) from segmented tumor volumes. Radiomic feature heterogeneity from batch effects of convolution kernel, contrast enhancement, manufacturer and slice thickness were harmonized using a nested ComBat approach. We used the Anderson-Darling test to determine if any radiomic features continued to be influenced by batch effects after harmonization; those identified were dropped for survival analysis. Phenotypes were separately generated from pre- and post-treatment radiomic features, and longitudinal (delta) features were estimated from pre- and post-treatment images. The prognostic value of the radiomic phenotypes alone and in combination with clinical variables were analyzed with Cox proportional-hazards models. The discriminatory power of the Cox proportional-hazard models was reported with a c-statistic. Kaplan-Meier curves and log-rank tests were used in assessing the Cox proportional-hazards model's ability in separating patients based on hazard score for overall survival (OS).

## RESULTS

The Cox model using only clinical variables had a c-statistic=0.64 and a log-rank p=0.0024. The model from post-treatment radiomic phenotypes, combined with clinical variables, had the best performance predicting OS (c-statistic=0.73, log-rank p=0.0024). The model generated from pre-treatment radiomic phenotypes combined with clinical variables performed better than clinical variables alone (c-statistic=0.65, log-rank p=0.028). Post-treatment radiomic phenotypes alone could stratify patients for OS (log-rank p=0.0055) but had equivalent c-statistic to clinical variables alone.

## CONCLUSION

Radiomic phenotypes derived from post-treatment CT scans show great promise in predicting patient response to immunotherapy with durvalumab. There is also potential for therapy prediction using pre-treatment radiomic features which should be further explored in a larger study.

## CLINICAL RELEVANCE/APPLICATION

PD-L1 expression level is important for predicting PD-1/PDL1 inhibitor response, including durvalumab, however has significant limitations; novel predictive biomarkers are urgently sought. CT radiomic phenotypes may serve as complementary predictive biomarkers to provide precision NSCLC therapeutic decision-making.

### R4- SSCH10-4 **Keynote Speaker**

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

### R4- SSCH10-5 **Visualized Quantitative Evaluation of Regional Ventilation and Perfusion in Patients with COPD using MRI Phase-Resolved Functional Lung Imaging (PREFUL)**

Lin Zhu, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the clinical value of phase-resolved functional lung imaging (PREFUL) in diagnosing and regional specificity assessment of ventilation and perfusion status of chronic obstructive pulmonary disease (COPD) patients of different severity.

## METHODS AND MATERIALS

8 healthy volunteers, 10 patients with COPD (2 as GOLD1, 3 as GOLD2, 3 as GOLD3, and 2 as GOLD4) underwent MRI using 3D PREFUL under free breathing at 3.0 T (Free-breathing 1H MRI acquisition, no contrast agent administration). All images were sorted to reconstruct full cardiac and respiratory cycles using a sine model. The PREFUL postprocessing method was used for the extraction of dynamic perfusion and ventilation parameters. Mean ventilation and perfusion maps, ventilation flow-volume loops (FVL) correlation, ventilation defect percentage (VDP), perfusion defect percentage (QDP), map of ventilation/perfusion defects (V/Q defects), and matched defect percentage on both perfusion and ventilation maps (VQM) were calculated.

## RESULTS

Compared to the homogenous ventilation and perfusion maps of healthy volunteers, COPD patients showed significant heterogeneity. The mean ventilation and perfusion percentage in COPD patients were significantly lower than the healthy volunteers ( $P < 0.01$ ), while the FVL is statistically higher in COPD patients ( $P < 0.01$ ). The ventilation map showed regional differences in visual agreement with emphysema on CT and all 3D PREFUL-derived ventilation parameters correlated with FEV1 and FEV1/FVC in the patients with COPD (all  $P < 0.05$ ). Besides, our data showed a trend of correlation between different GOLD grades and VDP ( $P < 0.05$ ) in the COPD patients, but no significant difference in QDP among groups. Compared to patients with low-grade COPD (GOLD 1-2), severe COPD (GOLD 3-4) had higher VQM which indicated a better consistency of regional defect in ventilation and perfusion maps ( $P < 0.01$ ).

## CONCLUSION

MRI PREFUL plays a promising role in evaluating the severity of COPD and visually predicting regional ventilation and perfusion defect in 3D lung imaging.

## CLINICAL RELEVANCE/APPLICATION

This study shows the feasibility of the PREFUL postprocessing method to gain quantitative information regarding visual regional lung perfusion and ventilation without the need for contrast agents and breath holding, which will be advantageous for future clinical translation.

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## Abstract Archives of the RSNA, 2023

R4-SSCH10-1

### Longitudinal Morpho-Functional MRI for the Management of Incidental Pulmonary Nodules in Patients with COPD - A Nationwide Multicenter Trial

Thursday, Nov. 30 11:00AM - 12:00PM Room: S405

Lin Zhu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the capability to accurately diagnose and predict the long-term outcome of incidental pulmonary nodules in heavy smokers by morpho-functional chest magnetic resonance imaging (MRI) in multicenter trial research.

#### METHODS AND MATERIALS

Patients who participate in the two rounds of same-day MRI and low-dose computed tomography (LDCT) scan or have histopathological proofs after their first exam at 16 centers in the nationwide multicenter trial were included. The accuracy of MRI in predicting lung cancer in high-risk patients was verified by histopathological results and compared with LDCT, and compared the consistency of MRI and CT in judging the outcome of nodules through two rounds of imaging follow-up. MRI Parsimonious and fuller multivariable logistic-regression models based on MRI were constructed based on the consensual LDCT results as the standard of reference.

#### RESULTS

249 patients were analyzed in the present study out of 567 patients after their first round exam, of which, 8 patients (13 nodules) with histopathological proofs after the first round of imaging. MRI has similar detection accuracy of LDCT for patients with malignant nodules (36.4% vs. 33.4%) and revealed a substantial inter-method agreement with LDCT on the long-term outcome judgment of incidental nodules based on two rounds of imaging assessment( $\kappa=0.78-0.80$ ). Our MRI full model showed significant improvement in the predictive accuracy of incidental nodule progression than the parsimonious model (AUC 0.91 vs. 0.81,  $P<0.05$ ), and has no difference compared with the LDCT model ( $P=0.45$ ), suggesting that the MRI full model which associated sociodemographic, clinical and characteristics based on the MRI imaging has the similar potential as LDCT on incidental pulmonary nodules diagnosis and progression prediction in patients with high risk.

#### CONCLUSION

MRI plays a promising role in evaluating incidental nodules and predicting their long-term outcome in heavy smokers, which may contribute to radiation management and public health improvement.

#### CLINICAL RELEVANCE/APPLICATION

Our data suggest MRI has satisfactory discrimination of patients with malignant lung nodules compared with LDCT and has equivalent prediction efficiency of the cancerous probability of incidental nodules of patients with COPD if simultaneously considering sociodemographic and clinical variables. The implementation of our nodule risk-prediction models based on MRI is expected to reduce the radiation of follow-up CTs, and improve clinical and public health practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-SSCH10-2

### CT Based Deep Learning Radiomics Biomarker for PD L1 Expression in Non Small Cell Lung Cancer

Thursday, Nov. 30 11:00AM - 12:00PM Room: S405

Jingshan Gong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate CT-based deep learning radiomics signature for predicting programmed cell death ligand 1 (PD-L1) expression in non-small cell lung cancers (NSCLCs).

#### METHODS AND MATERIALS

Two hundreds and fifty-nine consecutive patients with pathological confirmed NSCLCs were retrospectively enrolled and randomly divided into a training cohort and a validation cohort at a ratio of 7:3. The univariate and multivariate analysis were used to build clinical model. Radiomics features and deep learning features were extracted from preoperative non-contrast CT images. Least absolute shrinkage and selection operator regression (LASSO) was implemented to select the features with strong association with PD-L1 expression. Radiomics score (Rad-score) and deep learning radiomics score (DLR-score) for each patient were calculated through linear combination of the selected features and coefficients. Predictive performance for PD-L1 expression was evaluated via area under the curve (AUC) of receiver operating characteristic (ROC).

#### RESULTS

The clinical model based on gender and Cytokeratin 19 fragment obtained an AUC of 0.705 (95% CI: 0.611-0.799) for PD-L1 in the training cohort and 0.644 (95% CI: 0.525-0.763) in test cohort for PD-L1 expression. Three radiomics features and twenty-one deep learning features were selected by LASSO regression. AUCs of Rad-score for PD-L1 expression were 0.786 (95%CI: 0.699-0.874) and 0.702 (95%CI: 0.538-0.866) in the training cohort and validation cohort, respectively. AUCs of DLR-score for PD-L1 expression were 0.983 (95%CI: 0.970-0.997) and 0.942 (95%CI: 0.898-0.986) in the training cohort and validation cohort, respectively. AUCs of deep radiomics signature were higher than those of rad-score and clinical model with statistical significance.

#### CONCLUSION

The CT-based deep learning radiomics signature could achieve clinical acceptable predictive performance for PD-L1 expression, which showed potential to be a surrogate imaging biomarker or a complement of immunohistochemistry assessment..

#### CLINICAL RELEVANCE/APPLICATION

In this study, the DLR- score, derived from preoperation CT images through deep transfer learning, showed a clinical acceptable predictive performance for PD-L1 expression in patients with NSCLCs. Clinical translation of DLR-score could facilitate selection of patients who would be benefit for immune checkpoint inhibitors therapy noninvasively.

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## Abstract Archives of the RSNA, 2023

R4-SSCH10-3

### Radiomics Derived Phenotypes Predict Response to Durvalumab Immunotherapy for Non-Small Cell Lung Cancer

Thursday, Nov. 30 11:00AM - 12:00PM Room: S405

Andrew W. Chen, BS, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the prognostic value of radiomic phenotypes for immunotherapy outcomes in combination with other clinical variables for patients with advanced NSCLC treated with durvalumab, an anti PD-1 immune checkpoint inhibitor.

#### METHODS AND MATERIALS

After IRB approval, patients with advanced NSCLC (n=117) treated at our institution with durvalumab with pre- (n=117) and post-treatment (n=79) CT scans were identified. Radiomic features were extracted using the cancer imaging phenomics toolkit (CapTk) from segmented tumor volumes. Radiomic feature heterogeneity from batch effects of convolution kernel, contrast enhancement, manufacturer and slice thickness were harmonized using a nested ComBat approach. We used the Anderson-Darling test to determine if any radiomic features continued to be influenced by batch effects after harmonization; those identified were dropped for survival analysis. Phenotypes were separately generated from pre- and post-treatment radiomic features, and longitudinal (delta) features were estimated from pre- and post-treatment images. The prognostic value of the radiomic phenotypes alone and in combination with clinical variables were analyzed with Cox proportional-hazards models. The discriminatory power of the Cox proportional-hazard models was reported with a c-statistic. Kaplan-Meier curves and log-rank tests were used in assessing the Cox proportional-hazards model's ability in separating patients based on hazard score for overall survival (OS).

#### RESULTS

The Cox model using only clinical variables had a c-statistic=0.64 and a log-rank p=0.0024. The model from post-treatment radiomic phenotypes, combined with clinical variables, had the best performance predicting OS (c-statistic=0.73, log-rank p=0.0024). The model generated from pre-treatment radiomic phenotypes combined with clinical variables performed better than clinical variables alone (c-statistic=0.65, log-rank p=0.028). Post-treatment radiomic phenotypes alone could stratify patients for OS (log-rank p=0.0055) but had equivalent c-statistic to clinical variables alone.

#### CONCLUSION

Radiomic phenotypes derived from post-treatment CT scans show great promise in predicting patient response to immunotherapy with durvalumab. There is also potential for therapy prediction using pre-treatment radiomic features which should be further explored in a larger study.

#### CLINICAL RELEVANCE/APPLICATION

PD-L1 expression level is important for predicting PD-1/PDL1 inhibitor response, including durvalumab, however has significant limitations; novel predictive biomarkers are urgently sought. CT radiomic phenotypes may serve as complementary predictive biomarkers to provide precision NSCLC therapeutic decision-making.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R4-SSCH10-4

### Keynote Speaker

Thursday, Nov. 30 11:00AM - 12:00PM Room: S405

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R4-SSCH10-5

### Visualized Quantitative Evaluation of Regional Ventilation and Perfusion in Patients with COPD using MRI Phase-Resolved Functional Lung Imaging (PREFUL)

Thursday, Nov. 30 11:00AM - 12:00PM Room: S405

Lin Zhu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the clinical value of phase-resolved functional lung imaging (PREFUL) in diagnosing and regional specificity assessment of ventilation and perfusion status of chronic obstructive pulmonary disease (COPD) patients of different severity.

#### METHODS AND MATERIALS

8 healthy volunteers, 10 patients with COPD (2 as GOLD1, 3 as GOLD2, 3 as GOLD3, and 2 as GOLD4) underwent MRI using 3D PREFUL under free breathing at 3.0 T (Free-breathing 1H MRI acquisition, no contrast agent administration). All images were sorted to reconstruct full cardiac and respiratory cycles using a sine model. The PREFUL postprocessing method was used for the extraction of dynamic perfusion and ventilation parameters. Mean ventilation and perfusion maps, ventilation flow-volume loops (FVL) correlation, ventilation defect percentage (VDP), perfusion defect percentage (QDP), map of ventilation/perfusion defects (V/Q defects), and matched defect percentage on both perfusion and ventilation maps (VQM) were calculated.

#### RESULTS

Compared to the homogenous ventilation and perfusion maps of healthy volunteers, COPD patients showed significant heterogeneity. The mean ventilation and perfusion percentage in COPD patients were significantly lower than the healthy volunteers ( $P < 0.01$ ), while the FVL is statistically higher in COPD patients ( $P < 0.01$ ). The ventilation map showed regional differences in visual agreement with emphysema on CT and all 3D PREFUL-derived ventilation parameters correlated with FEV1 and FEV1/FVC in the patients with COPD (all  $P < 0.05$ ). Besides, our data showed a trend of correlation between different GOLD grades and VDP ( $P < 0.05$ ) in the COPD patients, but no significant difference in QDP among groups. Compared to patients with low-grade COPD (GOLD 1-2), severe COPD (GOLD 3-4) had higher VQM which indicated a better consistency of regional defect in ventilation and perfusion maps ( $P < 0.01$ ).

#### CONCLUSION

MRI PREFUL plays a promising role in evaluating the severity of COPD and visually predicting regional ventilation and perfusion defect in 3D lung imaging.

#### CLINICAL RELEVANCE/APPLICATION

This study shows the feasibility of the PREFUL postprocessing method to gain quantitative information regarding visual regional lung perfusion and ventilation without the need for contrast agents and breath holding, which will be advantageous for future clinical translation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPBR-1

### Optimizing Double Reading in Screening Mammography through Pairing Strategies Explored by Modelled Radiologists' Assessments

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Jessie Gommers, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiologists' performance characteristics vary, yet the pairing of radiologists for the double reading of screening mammography is done randomly or out of convenience. No attempts have been made to prospectively optimise the pairing of radiologists for improved screening performance. We aim to investigate whether the optimal set of pairs of radiologists can be achieved by using modelled radiologist performance characteristics for pairing.

#### METHODS AND MATERIALS

Our retrospective study was performed with datasets from breast cancer screening programs in Sweden (2008-2015), England (2012-2014), and Norway (2004-2018). Logistic regression models with reader and case effects, for positive and negative screening examinations separately, were used to model radiologists' screening assessments. Screening programs with different pairing strategies, including the pairing of readers with 1) opposite or 2) similar true-positive rates (TPR) and/or false-positive rates (FPR), were simulated. Group performances of the different pairing strategies were compared against those of the random pairing strategies, with positive assessments defined by either reader flagging a case as abnormal. Bootstrap resampling ( $n=1,000$ ) was used to obtain 95% confidence intervals.

#### RESULTS

The final study sample consisted of 3,191,955 screening examinations, 936,621 from Sweden, 435,281 from England, and 1,820,053 from Norway. The logistic-regression models adequately predicted individual (Pearson correlations  $> 0.95$ ) reader performance. Within the simulations, pairing similar readers reduced what they were similar in and pairing opposite readers increased what they were opposite in. The pairing strategies involving readers with similar FPR resulted in significantly lower FPR outcomes (Sweden: 4.50%, England: 5.51%, Norway: 8.03%), compared to the random pairing strategies (Sweden: 4.74%, England: 5.76%, Norway: 8.30%), while the TPR did not change significantly. All other pairing strategies performed equally or worse than random pairing.

#### CONCLUSION

There was no pairing strategy that increased TPR and at the same time decreased FPR. However, according to our pairing rule, pairing readers with similar FPR performance characteristics may result in a reduced FPR with no significant reduction in TPR. Pairing readers with similar FPR characteristics may be helpful to reduce the number of examinations sent to consensus or arbitration. Additional studies are needed to explore the effect of consensus and arbitration.

#### CLINICAL RELEVANCE/APPLICATION

Pairing readers with similar FPR might result in reduced FPR while not significantly reducing TPR, potentially reducing workload. Future studies are needed to explore what happens after consensus/arbitration.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPBR-2

### Comparison of Contrast-Enhanced Spectral Mammography and Digital Mammography in Detecting Breast Cancer: A Systematic Review and Meta-Analysis

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate and compare the diagnostic accuracy of digital mammography (DM) and contrast-enhanced spectral mammography (CESM) in breast cancer detection, through a systematic review and meta-analysis.

#### METHODS AND MATERIALS

A comprehensive literature search was conducted using PubMed, Web of Science, Scopus, and Google Scholar up to February 15, 2023. Bivariate modeling was employed to obtain pooled diagnostic accuracy metrics (sensitivity, specificity, DOR, PPV, and NPV) of CESM and DM. Summary ROC curves were used for comparison.

#### RESULTS

The systematic review incorporated twenty-four studies based on our eligibility criteria. However, we excluded four studies from the meta-analysis due to incomplete contingency tables. The meta-analysis ultimately included twenty studies, consisting of 3830 breast lesions. Among these, 17 studies focused on diagnostic purposes, two were dedicated to screening and one study aimed at preoperative assessment. For breast cancer detection, CESM demonstrated significantly higher sensitivity (0.948, 95% CI: 0.917-0.968) and better specificity (0.732, 95% CI: 0.626-0.816) than DM (sensitivity: 0.815, 95% CI: 0.731-0.877; specificity: 0.576, 95% CI: 0.415-0.723). The diagnostic odds ratio for CESM (50.4, 95% CI: 35.5-69.5) was notably superior to DM (6.12, 95% CI: 3.4-10.2).

#### CONCLUSION

CESM exhibits superior diagnostic performance compared to DM in breast cancer detection. Clinicians should consider CESM as an alternative or complementary imaging modality to DM.

#### CLINICAL RELEVANCE/APPLICATION

CESM offers improved diagnostic accuracy in breast cancer diagnosis of patients retrieved from screening, making it a valuable alternative or complement to DM in specific clinical situations, including dense breast tissue and inconclusive imaging cases, while considering its drawbacks.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPBR-5

### Optimizing Lesion Detection in Digital Breast Tomosynthesis: A Phantom Study Investigating Angular Range Across Varied Breast Density and Thickness

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Hee Jeong Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the optimal angular range (AR) for digital breast tomosynthesis (DBT) systems that provides the highest detectability of breast lesions across various breast densities and thicknesses.

#### METHODS AND MATERIALS

The Modular DBT phantom (Model 165SI; Gammex Inc, WI, USA) composed of tissue-equivalent adipose and glandular modules and a module embedded with test objects of speckles, masses, and fibers was used to generate ten modular combinations simulating different breast thicknesses and densities, as well as different lesion locations. A prototype DBT system (KERI, Gyeonggi-do, Korea) with a W/AI target/filter combination operating at ARs of  $\pm 7.5^\circ$  ( $AR\pm 7.5^\circ$ ),  $12.5^\circ$  ( $AR\pm 12.5^\circ$ ),  $\pm 19^\circ$  ( $AR\pm 19^\circ$ ), and  $\pm 25^\circ$  ( $AR\pm 25^\circ$ ) was used to acquire 11 low-dose projection images of each combination. Image datasets were acquired three times under the same conditions. Three blinded radiologists independently assessed lesion detectability on the reconstructed images according to the 2018 ACR Digital Mammography Quality Control Manual. Their scores were averaged and compared using linear mixed models with combination and reader as random intercepts.

#### RESULTS

The  $AR\pm 12.5^\circ$  provided the highest overall lesion detectability across all breast combinations. Speckles were best detected with  $AR\pm 7.5^\circ$  or  $AR\pm 12.5^\circ$  in all breast combinations, with no significant difference between them. However, speckle detectability was significantly lower when using the  $AR\pm 19^\circ$  or  $AR\pm 25^\circ$  ( $P = .014$  for thin fatty,  $0.026$  for thick fatty, and  $< .001$  for dense breasts). The optimal AR for mass detection was  $AR\pm 19^\circ$  for thin breasts and  $AR\pm 25^\circ$  for thick breasts. Specifically, for thin fatty breasts,  $AR\pm 19^\circ$  significantly outperformed the other ranges ( $P = .042$ ), while for thick dense breasts,  $AR\pm 25^\circ$  significantly outperformed the others ( $P = .025$ ). Although the optimal AR for fiber detectability varied among the breast combinations,  $AR\pm 25^\circ$  provided the lowest detectability among the four ARs in all combinations ( $P = .013$  for thin fatty,  $.026$  for thin dense and thick fatty,  $.004$  for thick dense breasts).

#### CONCLUSION

The optimal AR for overall lesion detectability was the  $AR_{\pm 12.5^\circ}$  in all breast densities and thicknesses. However, for speckle and mass detection, narrower and wider ARs may be necessary, respectively.

#### CLINICAL RELEVANCE/APPLICATION

While current DBT systems generally employ a single AR, using various ARs may enhance the lesion detectability for patients with different breast densities and thicknesses, as well as different lesion types of interest.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPBR-6

### Diagnosis of Lesions Presenting as Architectural Distortion on DBT: Malignancy Rate Related to Accompanied Features, Ultrasound Findings, and BI-RADS Density

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Jiejie Zhou, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate diagnosis of architectural distortion (AD) on DBT is challenging, and usually ultrasound (US) is performed to provide additional information. This study aims to: (1) compare the diagnosis in cases associated with nodular density and microcalcifications; (2) compare the diagnosis in cases with and without corresponding suspicious findings on US; (3) evaluate the malignancy rate in cases with different BI-RADS density backgrounds.

#### METHODS AND MATERIALS

A total of 471 cases were included, 265 malignant and 206 benign, which were all pathologically confirmed. The DBT images were reviewed to identify the suspicious areas showing architectural distortion, and to determine whether the lesion was accompanied by nodular density or microcalcifications. The US reports were reviewed to determine whether there were suspicious findings corresponding to the detected AD. The malignancy rate in each DBT BI-RADS category, with or without accompanied nodule density, microcalcifications, US findings, and in different density backgrounds were analyzed.

#### RESULTS

Malignant rate in DBT BI-RADS 5, 4C, 4B, 4A, and 2-3 groups were 100%, 86%, 57%, 37%, and 19%, respectively (Table 1). For cases accompanied by nodular density, microcalcifications, and without any features, the malignancy rate was 91%, 69% and 38%, respectively. Of 471 cases, 315 showed the corresponding abnormality on US, and the malignancy rate was 72%. In 156 cases without corresponding US findings, the malignancy rate was much lower at 24% ( $P < 0.00001$ , Table 2). The malignancy rate in patients who had BI-RADS density category A+B was significantly higher (48/64, 75%) than in those who had category C+D (217/407, 53%,  $p=0.0011$ ). When using DBT BI-RADS =4A as the cutoff, 252/265 (95%) malignancies were correctly diagnosed by DBT, and 13 cases were misdiagnosed; but 9 of them could be correctly diagnosed by the supplement US. In the benign group, 54/206 (26%) were correctly diagnosed as DBT BI-RADS 2 or 3. When US was considered, 35 false positive lesions showed US BI-RADS 2-3 and they might be spared of biopsy.

#### CONCLUSION

AD lesions on DBT accompanied by nodule density had a higher malignant rate than those with microcalcifications, and the malignant rate was the lowest for those without any accompanied features. Cases with corresponding US abnormalities had a much higher malignancy rate than those without. Lastly, AD detected in fatty breasts had a higher malignancy rate, presumably due to the more clearly revealed features in a clean background.

#### CLINICAL RELEVANCE/APPLICATION

Diagnosis of lesions presenting as architectural distortion on DBT can be improved with more understanding of associated features and tissue backgrounds, as well as the corresponding findings by using the supplementary ultrasound.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPBR-7

### Diagnosis of Architectural Distortion on Digital Breast Tomosynthesis Using Radiomics and Deep Learning

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Yang Zhang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The objective of this study is to develop diagnostic models for patients showing architectural distortion in Digital Breast Tomosynthesis (DBT) images using two Artificial Intelligence (AI) techniques: radiomics and deep learning.

#### METHODS AND MATERIALS

A retrospective review identified a total of 506 cases. The initial 298 cases were utilized for training, while the remaining 208 cases were allocated for independent testing. The training set includes 175 malignant and 123 benign cases. The architectural distortion areas on craniocaudal (CC) and mediolateral oblique (MLO) views were manually defined as for radiomics analysis. Features were extracted using PyRadiomics, followed by the application of the support vector machine (SVM) to select significant features and construct the classification model. Deep learning employed the ResNet50 algorithm, producing binary outputs for malignancy and benignity. The Gradient-weighted Class Activation Mapping (Grad-CAM) method was used to identify suspicious regions. Malignancy probabilities were utilized to create ROC curves. The model was further applied to a testing dataset consisting of 208 cases, including 122 malignant cases and 96 benign cases for independent testing.

#### RESULTS

The radiomics model, created using combined CC+MLO features, resulted in an AUC of 0.82, sensitivity of 0.78, specificity of 0.68, and accuracy of 0.74. Using only CC features, the AUC was 0.77. The deep-learning model generated an AUC of 0.61, significantly lower than all radiomics models ( $p < 0.01$ ), likely due to the utilization of the entire image as input. The Grad-CAM method effectively localized architectural distortion areas. In the testing dataset, the radiomics model, built using combined CC+MLO features, yielded an AUC of 0.8, sensitivity of 0.82, specificity of 0.76, and accuracy of 0.74. When only CC features were used, the AUC was 0.74. The deep-learning model generated an AUC of 0.57.

#### CONCLUSION

Radiomics models demonstrate satisfactory diagnostic accuracy, and high specificity within the benign group can help prevent unnecessary biopsies. Deep learning can be employed to localize architectural distortion areas, potentially offering an automated method for ROI delineation. The validation results on the testing dataset further confirm the reliability of the radiomics model in real-world scenarios.

#### CLINICAL RELEVANCE/APPLICATION

This study demonstrates the promising potential of radiomics models in accurately diagnosing architectural distortion in DBT. Additionally, the study suggests that deep learning can effectively localize areas of architectural distortion, which could aid in the development of a fully automated computer-aided diagnosis system for breast cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPBR-8

### How Long Does It Take to Read a Mammogram? Investigating the Reading Time of Digital Breast Tomosynthesis Compared to 2D Mammography

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Yan Chen, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Digital breast tomosynthesis (DBT) can increase cancer detection and reduce recall rates compared to 2D full-field digital mammography (FFDM) alone. We analysed DBT reading times in a national screening program, compared to FFDM, to investigate the impact of DBT implementation on reading times in double reading, high-volume breast screening programmes.

#### METHODS AND MATERIALS

Reading time data were recorded as part of the PROSPECTS Trial, a prospective randomised trial comparing DBT plus FFDM or synthetic 2D mammography (S2D) to FFDM alone, in the UK National Health Service (NHS) breast screening programme, from January 2019 to February 2023. The time to report DBT+FFDM or DBT+S2D and FFDM alone was calculated per case and reading times were compared between modalities. Reporting times were also compared between readers from different professional groups - radiologists and radiographers (i.e. technologists); and with years of DBT reading. The effect of experience using DBT in the screening setting on reporting time was investigated.

#### RESULTS

Following exclusions, 48 readers reported 1,242 FFDM clinics (34,210 FFDM cases) and 973 DBT clinics (13,983 DBT cases). DBT reading time was doubled compared to FFDM ( $2.09 \pm 0.64$  minutes vs.  $0.98 \pm 0.30$  minutes, respectively;  $p < .001$ ), and DBT+S2D reading was longer than DBT+FFDM ( $2.24 \pm 0.62$  minutes vs.  $2.04 \pm 0.46$  minutes, respectively;  $p = .006$ ). No significant difference was identified in reporting time between radiologists and radiographer readers ( $2.06 \pm 0.71$  minutes vs.  $2.14 \pm 0.46$  minutes, respectively;  $p = .71$ ). Readers with five or more years of experience reading DBT were quicker at reading DBT than those with less than five years' experience ( $1.86 \pm 0.56$  minutes vs.  $2.37 \pm 0.65$  minutes;  $p = .008$ ), and DBT reading time significantly improved after 6-months of accrued screening experience ( $p = .01$ ).

#### CONCLUSION

DBT reading required greater time compared to FFDM, yet relatively short exposure with DBT in the screening setting (6-months) improved reporting time.

#### CLINICAL RELEVANCE/APPLICATION

In double reading, high-volume breast screening programmes, caution needs to be exercised when considering DBT as a standard screening tool to prevent overwhelming screening workloads in high-volume screening programmes.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5A-SPCA-1

### Ultra-High Spatial Resolution of Photon Counting Detector Coronary CT Angiographies Minimize Overestimation Bias Compared to Invasive Reference

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Moritz C. Halfmann, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultra-high resolution coronary CT angiographies (UHR-CCTA) from Photon counting detector (PCD)-CT have recently been proven feasible in a patient population. However, data comparing it to quantitative coronary angiography as the clinical reference standard for stenosis assessment, is still missing. Therefore, it was the aim of the study to compare stenosis measurements of UHR-CCTA to QCA.

#### METHODS AND MATERIALS

For this retrospective study, the institutional database was searched for patients who had undergone UHR-CCTA for the assessment of coronary artery disease (CAD) and had a clinically indicated coronary angiography within 30 days from CCTA. Exclusion criteria were the chronic total occlusion (CTO) of a coronary artery as well as the presence of coronary stents prior to CCTA. This resulted in a total of 39 patients with 83 coronary stenoses. CCTA images were reconstructed with slice thicknesses of 0.6, 0.4 and 0.2 (UHR) mm using the vascular reconstruction kernels Bv44 (0.6/0.4mm) or Bv64 (0.2mm). Stenoses were assessed on all slice thicknesses by two cardiovascular radiologists and on QCA by two cardiologists. Measurements were compared using univariate analysis of variance with post-hoc testing and Bland-Altman plots.

#### RESULTS

Mean degrees of coronary stenosis continuously decreased with decreasing slice thicknesses ( $61.3 \pm 13.7\%$  vs.  $53.8 \pm 15.4\%$  vs.  $46.4 \pm 14.8\%$ , all  $p=0.001$ ). Both the 0.6 and the 0.4mm reconstructions showed significant differences between UHR-CCTA and QCA ( $44.1 \pm 15.1\%$ ,  $p<0.001$  and  $p=0.004$  respectively), while the 0.2mm reconstructions did not ( $p=0.428$ ). Bland Altman analysis revealed significant bias between 0.6mm (mean bias 17.6, limits of agreement -14.6 to 48.8) and 0.4mm (9.8, -24.0 to 43.6) reconstructions and QCA, respectively. UHR-CCTA reconstructions did not show a significant bias (2.1, -27.2 to 31.4) but the spread was broader than for QCA.

#### CONCLUSION

UHR-CCTA reconstructions minimized overestimation bias of coronary stenosis measurements in comparison to the clinical reference standard of QCA.

#### CLINICAL RELEVANCE/APPLICATION

Reduced overestimation bias from UHR-CCTA reconstructions can obviate the need for unnecessary referral for follow-up imaging including invasive coronary angiography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPCA-3

### Virtual Monoenergetic Reconstructions from Photon-Counting Detector CT Influence Coronary Stenosis Quantification: Comparison Between Coronary CT, Coronary and Invasive Coronary Angiography

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Elias Wolf (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the influence of virtual monoenergetic image (VMI) reconstructions on the accuracy of coronary artery stenosis measurements on a clinical dual-source photon-counting detector computed tomography (PCD-CT) system in a dynamic phantom, and in a patient cohort with invasive correlation.

#### METHODS AND MATERIALS

A rod phantom with two custom-built vessels (4mm diameter) and two different stenoses grades (50% and 25%) was mounted into an anthropomorphic thorax phantom and heartbeats were simulated with 10 different beats per minute (bpm), between 50 bpm and 80 bpm. In addition, 33 patients (26 (78.8%) male, mean age  $71.3 \pm 9.0$  years) who underwent coronary CT angiography (CCTA) and invasive coronary angiography as part of their clinical work-up for suspected coronary artery disease were retrospectively identified from the clinical database. A total of 9 different VMI levels from 40-140 keV were reconstructed with a slice thickness of 0.4 mm, Qr40 Kernel, and QIR strength level of 3 on a PCD-CT system. Reconstruction parameters for the phantom were matched with those of the clinical patient cohort. Percent diameter stenosis (PDS) measurements were compared to either the manufacturers data sheet (phantom) or quantitative coronary angiography (QCA) measurements (clinical cohort) as a ground truth.

#### RESULTS

Variation of VMI reconstructions lead to significantly different stenosis measurements in the phantom and patients (e.g., mean PDS in patients:  $68.3\% \pm 9.6$  at 40 keV vs  $53.0\% \pm 9.7$  at 140 keV,  $p < 0.0001$ ). Across the entire range of artificial heart ranges, the phantom study indicated 100 keV (bias: -0.4%, limit of agreement (LoA): -4.5/3.7) for the 50% and 90 keV (bias: 1.4%, LoA, -1.9/4-8) for the 25% stenosis as an ideal VMI level with the least deviation to the reference stenoses. The tissue quality of the plaque (calcified, mixed, or soft) determined the ideal VMI level in the study group. For the in-vivo comparison to QCA as reference, 100 keV (bias: 17.2%, LoA, -1.2/35.7) for calcified, 140 keV (bias: 5.0%, LoA, -24.5/34.4) for mixed and 40 keV (bias: -0.5%, LoA, -21.5/20.5) for soft plaques led to the best agreements.

#### CONCLUSION

VMI reconstructions have the potential to improve the accuracy of coronary CT angiography (CCTA) for the quantification of different stenoses types.

#### CLINICAL RELEVANCE/APPLICATION

VMI reconstructions can help overcome current limitations of CCTA due to calcium blooming thereby help reduce bias in stenosis quantification compared to QCA.

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## Abstract Archives of the RSNA, 2023

R5A-SPCA-6

### Quantification and Detection of Calcium Using Multimodal Fusion Approach

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Paddy Raghav, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Calcium detection and quantification from computed tomography (CT) scans of the heart is an important tool for the early diagnosis of coronary artery disease (CAD). However, manual identification of calcium can be time-consuming and subject to inter- and intra-observer variability. The majority of current clinical solutions to identify and quantify coronary artery calcium score are semi automatic and are developed for unenhanced ECG gated Cardiac CT scan. The proposed method uses a multimodal fusion based approach, is automatic and precisely quantifies and classifies calcium in different arteries.

#### METHODS AND MATERIALS

We developed a multimodal fusion based approach that utilizes both Cardiac CT and Chest CT. The core of it is a in-house developed segmentation model that segments heart and calcium. One major challenge we faced was due to the variability in scan resolution, orientation, and heart size across different patients. To address this, we normalized the scans to fit a scaled coordinate system. To detect calcium deposits, an intensity threshold was applied to filter out the areas of the scan with higher calcium density, followed by connected-components labeling to identify the connected legions of calcium. To classify calcium deposits based on their location within the heart, a likelihood model based on spatial features and location was built. This helped to determine the probability that a given calcium deposit belongs to a specific region of the heart.

#### RESULTS

The solution was tested on 200 cardiac patients and 1000 chest patients. The Pearson correlation coefficient between the reference actual and the computed predictive scores on the test set show a high level of correlation (0.84;  $p < 0.001$ ) and high limits of agreement in Bland-Altman plot. The proposed method correctly classifies the risk group in 75.2% of the cases and classifies the subjects in the same group. For the presence/absence of coronary artery calcifications, the deep learning model achieved a sensitivity of 90 % and a specificity of 94 %.

#### CONCLUSION

Fully automated deep learning-based calcium quantification on cardiac-CTs shows good correlation compared to reference standards. Automating this process may reduce evaluation time and potentially optimize clinical calcium scoring.

#### CLINICAL RELEVANCE/APPLICATION

AI-powered calcium detection has the potential to improve the accuracy, efficiency, and consistency of heart disease diagnosis, ultimately leading to better patient outcomes. By analyzing data from multiple imaging modalities, AI algorithms can identify patterns and correlations that may be missed by a single imaging modality. This can help clinicians to identify patients at high risk for future cardiovascular events and take preventative measures to reduce that risk.

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## Abstract Archives of the RSNA, 2023

R5A-SPCH-1

### Positional Effects on Cardiopulmonary Function Measured by 4D-Flow and 3D-cine MRI with Blanket-Like Coil

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Ryogo Enoki, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Hemodynamic changes caused by positional changes are known in patients with heart failure or pregnant women, but clinically applicable noninvasive testing methods have not been well established. This study aims to assess the feasibility of assessing cardiac function and collecting normal values for pulmonary blood flow measurements by changing body position.

#### METHODS AND MATERIALS

CMR imaging was performed on 10 healthy volunteers who gave consent for imaging using a 3T MRI and a blanket-like coil; 3D cine was performed using the Hyperkat acceleration in the horizontal section, and 4D flow using Hyperkat was performed to measure the flow of the mediastinal region. These images were taken in the supine, right lateral recumbent, and left lateral recumbent positions. A questionnaire was obtained from the participants regarding imaging in different positions. The left and right ventricular volume parameters (end-diastolic volume, end-systolic volume, and ejection fraction) were then calculated from the 3D cine. 4D flow data were used to measure the flow volume(ml/heartbeat) of the Aorta, main pulmonary artery (PA), right PA, left PA, SVC, and IVC, respectively. Differences in each flow volume between body positions were compared.

#### RESULTS

Positional changes did not significantly alter right or left ventricular volumetric parameters. Flow volume did not change with position in Aorta (74 ml, 76 ml, 75 ml) and main PA (81 ml, 71 ml, 83 ml). Right PA (36 ml, 42 ml, 27 ml) increased in the right lateral position and significantly decreased in the left lateral position compared with the supine position ( $P=0.09$ ,  $0.02$ , respectively). Left PA (32 ml, 21 ml, 44 ml) significantly decreased in the right lateral position and significantly increased in the left lateral position ( $p=0.02$ ,  $0.01$ , respectively). Blood flow in SVC (21 ml, 24 ml, 19 ml) and IVC (42 ml, 33 ml, 39 ml) was not significantly different by position. The proportion of right/left distribution of pulmonary flow was 0.53 in the supine position, 0.67 in the right recumbent position, and 0.39 in the left recumbent position, showing significant differences between positions ( $p<0.01$ ). The total imaging time for cine and 4D flow was approximately 30 minutes, including positional changes.

#### CONCLUSION

4D flow and cine imaging with a blanket-like coil had clinically applicable imaging times. Cardiac function in healthy volunteers did not differ by positioning, but the left or right pulmonary blood flow increased on the gravity side.

#### CLINICAL RELEVANCE/APPLICATION

The measurement of hemodynamic changes due to positional differences can be performed noninvasively, enabling the evaluation of pathological conditions such as heart failure patients.

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## Abstract Archives of the RSNA, 2023

R5A-SPCH-2

### Radiologist and Surgical Agreement in Classification of Chronic Thromboembolic Pulmonary Hypertension (CTEPH)

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Lewis D. Hahn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Determine agreement between radiologists (rads) and surgeons in localizing level of disease in CTEPH and determine factors that affect agreement.

#### METHODS AND MATERIALS

6 rads (3 local and 3 external) localized CTEPH level on CTPA on consecutive patients who underwent pulmonary thromboendarterectomy (PTE) surgery at a leading CTEPH surgical center from 1/7/21-10/22/22. Rads graded the level of most proximal disease in the left and right PAs using a locally developed surgical level classification: level 1= disease in main PA; level 2= disease distal to level 1 to segmental ostia; level 3=segmental disease; level 4=subsegmental disease; level 0=no disease. 10 cases were used for training. The time between CTPA and surgery, minimum slice thickness of CTPA, and number of positive CTEPH cases each radiologist read/year was recorded. Excluded patients (number in parenthesis) included those w/o CTPA study (30), time between CTPA and surgery was >180 days (110), slice thickness was >3mm (2), study was not CTPA protocol (4), path diagnosis of PA sarcoma (4), presence of acute PE (4), patients<18 y/o (3). Surgical notes were reviewed to determine surgical level of disease. Weighted kappa and multivariate analysis were performed.

#### RESULTS

330 patients had PTE over 22 months. After 157 exclusions +10 training cases, rads reviewed 163 CTPAs. Agreement was substantial ( $\kappa=0.62-0.77$ ) between all rads except for moderate agreement between rads 2 and 4 and rads 4 and 5. Agreement between reader 1 and surgical level was substantial ( $\kappa=0.724$ ) and moderate for readers 2-6 ( $\kappa$  range 0.49-0.58). Agreement was significantly better with less time between CTPA and PTE ( $p=0.006$ ) with <50% agreement when CTPA>118 days old. Agreement between rads and surgery for proximal (level 1+2) disease did not change with slice thickness. There was a significant drop with distal (level 3+4) disease in studies with slice thickness =1mm ( $\kappa$  range 0.06-0.327) vs thickness<1mm ( $\kappa$  range 0.34-0.6) ( $p=0.03$ ). No difference was seen between rads agreement and CTEPH level or laterality. Reader experience was marginally correlated with surgical agreement.

#### CONCLUSION

Using this CTEPH surgical classification system, agreement between rads was substantial and was moderate to substantial between rads and surgeons. Slice thickness <1mm must be used to accurately localize segmental and subsegmental disease. Agreement decreased as time between CTPA and surgery increased.

#### CLINICAL RELEVANCE/APPLICATION

There is a high level of agreement between rads and surgeons for grading CTEPH. Slice thickness <1mm should be used as experienced surgeons can treat distal disease. Given evolution of disease, patients with studies >4 months old could undergo repeat CTPA prior to PTE to more accurately localize disease for surgeons.

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## Abstract Archives of the RSNA, 2023

R5A-SPCH-3

### Monitoring Changes in Lung Perfusion of Patients with Acute Pulmonary Embolism under Therapy Using Free Breathing Arterial-spin Labeling (ASL-)MRI: Preliminary Results of an Ongoing Study

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Max Munz (*Presenter*) Nothing to Disclose

#### PURPOSE

Organ perfusion can be imaged non-invasively with ASL-MRI. The aim of this study was to evaluate changes of lung perfusion in patients with acute pulmonary embolism (PE) under therapy using ASL-MRI.

#### METHODS AND MATERIALS

Between 11/2020 and 12/2022, 15 patients (median/min/max 55/24/90 y/o, 9f) with PE before and after treatment initiation (min/max/mean/median 5/243/165/174 days in-between) were examined by ASL-MRI under free breathing in a prospective study. The study was approved by the local ethic committee and all patients gave written informed consent. Initially, patients were treated with heparin (n=9), alteplase and heparin (n=1) or oral anticoagulation (n=5). One patient additionally underwent catheter-directed embolectomy. After the initial therapy patients were treated with Rivaroxaban (n=5), Apixaban (n=8) or low molecular weight heparin (n=2). The examinations were performed on a 1.5T MRI. Pulmonary perfusion was assessed using free-breathing ECG-triggered pseudo-continuous ASL-MRI. The pulmonary trunk was labeled during systole, and images were acquired during diastole of the subsequent cardiac cycle. Additionally, multisection coronal, balanced steady-state-free-precession imaging was carried out. The proportion of perfusion deficit caused by pulmonary embolism was categorized for each lung lobe: I) 0-25 %, II) 26-50 %, III) 51-75 %, IV) >75 %

#### RESULTS

Before treatment, perfusion deficits caused by PE were found in all patients in 59 lobes: I) n=5, II) n=10, III) n=17, IV) n=27. At follow-up imaging, perfusion deficits were found in 25 lobes of 8 patients: I) n=7, II) n=8, III) n=6, IV) n=4. Improved lung perfusion was seen in all patients. Perfusion deficits resolved completely in 7/15 patients.

#### CONCLUSION

This is the first study using ASL-MRI to evaluate changes of lung perfusion during and after therapy of patients with PE. After therapy, improvements of lung perfusion were seen in all patients. However, in some patients, persistent perfusion deficits could be observed.

#### CLINICAL RELEVANCE/APPLICATION

The clinical relevance of these findings needs to be evaluated in future studies. Nonetheless, ASL-MRI might be useful to monitor non-invasively the treatment effects in patients with PE.

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## Abstract Archives of the RSNA, 2023

R5A-SPCH-4

### Assessment of Missed Incidental Pulmonary Embolisms on Chest CT with an AI-algorithm

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Vera Inka Josephin Graeve, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Pulmonary embolism (PE) is the third most frequent cause of cardiovascular related death and occurs in 1 of 1000 patients in the European population. In symptomatic patients a CT angiography reveals a detection rate of more than 95%, while the diagnostic performance for occlusions of pulmonary arteries massively decreases in CT scans, performed due to other reasons than suspected PE. A recent study estimates, that radiologists diagnose nearly as much of those incidental pulmonary embolisms (iPE) than they miss. The aim of this study was a retrospective assessment of iPE missed by radiologists on chest CT with an artificial intelligence (AI) algorithm including prevalence, anatomic distribution pattern and daytime of diagnosis of the CT scans.

#### METHODS AND MATERIALS

This IRB approved, retrospective single center study included 1965 chest CT scans acquired during venous or arterial contrast, performed due to other reasons than suspected PE, analyzed by an FDA-approved AI algorithm for diagnosing iPE (Aidoc Medical). The appearance of iPEs, their location and the studytime were retrieved from the radiological reports and compared to all positive findings of the AI algorithm, verified by an experienced radiologist, serving as the gold standard. For statistical analysis SPSS was used (Version 28, 2021).

#### RESULTS

Of the 1966 cases 63 suspicious iPEs were displayed by the AI of which 42 were true iPEs (Sensitivity 95%, Specificity 99%). Prevalence of iPE was 2,4%, while half of the positive cases were missed by radiologists (PPV: 66%; NPV: 99%). In nearly 76% (16/21) the retrospectively identified missed iPEs were allocated in the right lower lobe, while the non-missed iPEs showed a nonspecific distribution affecting all lung segments. Most of the reports which missed an iPE were generated between 1:00 and 5:00pm (57%).

#### CONCLUSION

Nearly 50% of cases with iPE were missed by radiologists, which indicates the need for a robust AI solution. Secondly, this study can pave the way for a better understanding of iPEs with regard to their anatomic distribution pattern and different external influences in order to prevent future misdiagnosis.

#### CLINICAL RELEVANCE/APPLICATION

This study illustrates the poor diagnostic performance of radiologists diagnosing iPEs, focussing on their anatomic distribution and additional external influences that may cause misdiagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPCH-5

### Effects of Model-based Iterative Reconstruction Algorithm and Contrast Enhancement Boost Postprocessing Technique on the Pulmonary CT Angiography: A Evaluation of Image Quality for Obese Patients

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Mei Ye (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether model-based iterative reconstruction [forward projected model-based IR solution (FIRST)] algorithm and contrast-enhancement-boost (CE-Boost) technique can improve the image quality in pulmonary CT angiography (CTA) for obese patients.

#### METHODS AND MATERIALS

This prospective study was conducted on 100 consecutive patients who underwent pulmonary CTA for suspected pulmonary embolism (PE). Patients whose body mass index (BMI) exceeded 25 (group 1) were performed with conventional hybrid iterative reconstruction [adaptive iterative dose reduction 3D (AIDR 3D)], FIRST, and CE-Boost. Non-obese patients (BMI < 25, group 2) was subjected to AIDR 3D, considering as reference standard. CT numbers, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and image noise were quantitatively assessed by pulmonary arteries. Two chest radiologists independently reviewed the CT images (5, best; 1, worst) by four subjective characteristics including noise, visibility of pulmonary artery, overall image quality and diagnostic confidence. The Mann-Whitney U test and Independent Samples t-test were used for statistical analysis.

#### RESULTS

Group 1 FIRST images had significantly lower image noise compared with group 2 AIDR 3D images ( $p < 0.05$ ), while group 1 CE-Boost and AIDR 3D images were inferior to group 2 AIDR 3D images regarding to image noise. Both CE-Boost images and FIRST images showed higher SNR and CNR than group 2 AIDR 3D images (all  $p < 0.05$ ). When compared with group 2 AIDR 3D, group 1 AIDR 3D exhibits lower subjective scores, whereas group 1 FIRST and CE-Boost had markedly higher scores (all  $p < 0.05$ ). A major increase in diagnostic confidence was observed after the addition of FIRST or CE-Boost (all  $p < 0.05$ ).

#### CONCLUSION

The postprocessing technique CE-Boost and FIRST reconstruction algorithm can both improve overall image quality and diagnostic confidence of pulmonary CTA in obese patients.

#### CLINICAL RELEVANCE/APPLICATION

High-quality pulmonary CTA image provided by CE-Boost or FIRST enables a better visualization of the main pulmonary artery and its branch vessels. This may enable early diagnosis of PE and reduce exposure dose in obese patients.

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## Abstract Archives of the RSNA, 2023

R5A-SPCH-6

### Efficacy of Lung Dynamic CT Perfusion in Patients with Pulmonary Hypertension

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Takuya Yokota (*Presenter*) Nothing to Disclose

#### PURPOSE

We developed lung dynamic CT perfusion (LCTP) that can evaluate absolute lung blood flow. The purpose of this study was to investigate the incremental diagnostic value of LCTP over CT pulmonary angiography (CTPA) for detecting perfusion defect with perfusion scintigraphy.

#### METHODS AND MATERIALS

This retrospective single-center study included 23 patients (mean age, 61 years  $\pm$  16 [SD]; 15 women) who were suspected of pulmonary hypertension underwent LCTP and perfusion scintigraphy from January 2021 to March 2023. LCTP data was obtained by electrocardiogram-gated axial scan targeted at systolic phase using a 320-row CT. The acquisition was performed separately in the upper and the lower lung fields, and these data were combined for analysis. Deconvolution method was used to calculate the blood flow of the lungs using a workstation. The phase in which the pulmonary artery was most contrasted during LCTP scan was selected to reconstruct CTPA. Six regions of interest were placed in each lobe to calculate quantitative perfusion ratio. Diagnostic performance of CTPA and CTPA plus quantitative perfusion ratio was compared to detect perfusion defect with perfusion scintigraphy. The analysis was performed for each lobe (right upper, right middle, right lower, left upper, left lingula, and left lower lobe).

#### RESULTS

Of the 138 lobes, 86 lobes (62%) showed perfusion defects on scintigraphy. Adding LCTP to CTPA increased sensitivity from 29.1% (95% CI: 20, 40%) to 95.3% (95% CI: 89, 99%;  $p < 0.001$ ) and accuracy from 54.3% (95% CI: 46, 63%) to 92.7% (95% CI: 87, 96%;  $p < 0.001$ ) while maintaining specificity (96.2% [95% CI: 87, 100%] vs. 88% [95% CI: 77, 96%];  $p = 0.13$ ). The area under the receiver operating characteristics curve increased from 0.63 (95% CI: 0.57, 0.68) to 0.96 (95% CI: 0.94, 0.99;  $p < 0.001$ ) when LCTP was included. The mean radiation dose and contrast medium amount was 5.1 mSv  $\pm$  1.3 and 78 ml  $\pm$  15, respectively.

#### CONCLUSION

Adding LCTP to CTPA improves the diagnostic performance to detect perfusion defect in perfusion scintigraphy by increasing sensitivity.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative evaluation of pulmonary blood flow using dynamic lung CT perfusion enables accurate diagnosis compared to CT pulmonary angiography alone with acceptable radiation and contrast medium dose.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPCH-7

### The Effects of Age on Lung Structure Parameters in Healthy People by Low-dose Computed Tomography

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Anqi Liu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This article mainly focuses on the associations of lung structure parameters in healthy people with age. We quantified these changes by indicators derived from LDCT such as lung volumes, pulmonary vascular volumes and fractal dimensions, artery diameters, etc.

#### METHODS AND MATERIALS

1500 participants aged 20-69 years (mean age, 45±14 years; 51.4% men) with normal chest imaging manifestations were included in this study. The MPAd (main pulmonary artery diameter) at the bifurcation of the pulmonary artery and the AAd (ascending aorta diameter) at the same level in cross section were measured. We calculated the ratio PA by dividing MPAd by AAd. The lung volumes and pulmonary vascular volumes (small, middle, large vessels/arteries/veins) were computed by 3-dimensional(3D) reconstructions using LDCT images of the study population, and vessel fractal dimensions, normalized lung volumes (divided by body surface area) and normalized pulmonary vascular volumes (divided by total lung volume) were calculated.

#### RESULTS

We chose the young group (20-44-year-old group) as a reference, the MPAd of middle-aged group (45-59-year-old group,  $\beta=1.040$ ,  $p<0.001$ ) and old group (60-69-year-old group,  $\beta=1.778$ ,  $p<0.001$ ) increased compared to the young group after being adjusted for bias, so did AAd. Increasing total and right lung volumes were associated with age-based groups, the same phenomenon was observed when normalized by BSA, but the left lung volume ( $\beta=0.036$ ,  $p=0.215$ ) and normalized left lung volume ( $\beta=0.010$ ,  $p=0.546$ ) did not show statistically significant increase between the old and young groups. We found statistical differences ( $P<0.05$ ) of vascular volumes between the 3 age-based groups, but there was no association of vascular volumes in the 3 groups after adjustment. The normalized pulmonary vascular volumes except normalized pulmonary large artery and venous volumes presented lower levels comparing the middle-aged and old groups with young group. Vessel fractal dimensions have no associations with age. The 90th percentile cutoff values of MPAd were 27.63, 28.80 and 29.60mm, AAd were 32.28, 37.11 and 40.06mm, ratio PA were 0.97, 0.90, 0.86 for young group, middle-aged group and old group respectively.

#### CONCLUSION

MPAd, AAd, total and right lung volumes increased when compared the old and middle-aged people to young people, while the normalized pulmonary vascular volumes except normalized pulmonary large artery and venous volumes presented lower levels comparing the old and middle-aged people with young people.

#### CLINICAL RELEVANCE/APPLICATION

Changes in LDCT-related lung structure parameters with age may provide normal reference values for healthy people in different age stage, which can also be potential markers of lung aging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPER-1

### **Necessity of Whole Body CT in Trauma Patients After Vehicle Accidents - Predictive Parameters for a Negative CT Examination**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Daniel Ginzburg (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To rule out serious findings in trauma patients, immediate CT imaging poses a major aspect in the Advanced Trauma Life Support scheme. In order to assess the necessity for whole body CT in patients after a vehicle accident a detailed analysis of this patient group is required. We aimed to identify patients after vehicle accidents that do not benefit from CT imaging in regard to the chest and abdomen.

#### **METHODS AND MATERIALS**

In this retrospective study, all patients that received a trauma CT in our emergency department after vehicle accidents between 03/2017 and 08/2019 were evaluated regarding trauma mechanisms as well as initial clinical assessment including the extended Focused assessment with sonography for Trauma (eFAST). Inclusion criteria were: vehicle accident, CT scan of the chest and abdomen and GCS = 13.

#### **RESULTS**

348/2525 patients (13.8 %) met the inclusion criteria. 151/348 patients (43.4 %) had an unremarkable physical examination according the ATLS scheme and a negative eFAST exam. 90/151 patients (59.6 %) had no injuries on CT, while the remaining 61 patients (40.4%) had only minor to moderate trunk injuries (Abbreviated injury scale - AIS < 3) not necessarily requiring CT evaluation (e.g. non-dislocated rib or sternal fractures). None of these patients required surgery, and apart from adjusted pain treatment, no changes were made to the therapeutic regimen based on the CT results. Of 197/348 (56.6%) patients with abnormal findings on physical examination and/or eFAST, 75 (38.1%) had severe trunk injuries (AIS = 3) requiring immediate clinical intervention on subsequent CT; 103 patients (52.3%) had mild/medium injuries (AIS < 3) and 19 patients (9.6%) had no trauma-related injuries.

#### **CONCLUSION**

While CT examinations remain an essential diagnostic pillar for the assessment of severely injured trauma patients, the indication for performing such examinations in patients with a GCS  $\geq$  13 without abnormalities on physical examination or eFAST could be approached in a more individualized way. These patients rarely benefit from a trauma CT scan in terms of adjusting their treatment regimen.

#### **CLINICAL RELEVANCE/APPLICATION**

With vehicle accidents being one of the most frequent causes of death especially in younger patients below the age of 45 the correct diagnostics and treatment of this patient group is of major clinical significance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPGI-1

### **Pancreatic Volume Changes in Patients with Immunotherapy-induced Acute Pancreatitis and Diabetes Mellitus Type 3c**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Hiroaki Takahashi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Immune check-point inhibitors (ICI) therapy causes immune-related pancreatic injury (irPI) resulting in acute pancreatitis (AP) or glandular dysfunction including insulin-requiring diabetes mellitus type 3c (DM-3c). We investigated the chronological pancreatic volume changes in patients with ICI-associated AP and DM-3c.

#### **METHODS AND MATERIALS**

Patients treated with ICI therapy (pembrolizumab, ipilimumab or nivolumab) who developed ICI-associated AP or DM-3c from 2015 to 2019 at 3 centers in our network were included. CT or PET/CT examinations in each of following periods were reviewed: (1) Pre-treatment scans (prior to ICI administration), (2) pre-diagnostic scans (after ICI administration and prior to irPI diagnosis), (3) early post-diagnostic scans (0-90 days after irPI diagnosis), (4) midterm post-diagnostic scans (91-360 days after irPI diagnosis), and (5) late post-diagnostic scans (>360 days after irPI diagnosis). Each exam was anonymized and segmented by an experienced abdominal radiologist. The mean pancreatic volume was used as the representative value if multiple examinations were performed in each period. Normalized pancreatic volume (NPV) is calculated by the ratio of pancreatic volume in each period to that in the pre-diagnostic scan. Mann-Whitney U test was used to compute NPV statistical differences with  $P < 0.05$  considered statically significant.

#### **RESULTS**

Among 30 enrolled patients (12 males, 18 females, mean age: 63 [37-90] year-old), 21 patients developed AP and 9 patients developed DM-3c. No patient had concurrent AP and DM-3c diagnosis. The median duration from ICI administration to irPI diagnosis was 131 days (12-715 days) in patients with AP and 146 days (28-685 days) in patients with DM-3c. NPV (pre-treatment; pre-diagnostic; early post-diagnostic; midterm post-diagnostic; late post-diagnostic) was 1.05 (n=14, p=0.53); 1 (n = 21); 1.22 (n=19, p=0.41); 0.71 (n=12, p=0.04); 0.53 (n=5, p=0.14) in patients with AP and 0.80 (n=7, p=0.20); 1 (n=9); 0.71 (n=8, p=0.01); 0.62 (n=8, p < 0.001); 0.73 (n=5, p=0.01) in patients with DM-3c.

#### **CONCLUSION**

The pancreas shows increase in volume after ICI administration in patients with AP and DM-3c, but at different timing. Increase is seen prior to DM-3c diagnosis, and within 0-90 days after AP diagnosis. Pancreas volume decreases in 91- days after the diagnosis of DM-3c or AP and persists after 1 year. The degree of pancreatic atrophy is more severe in AP than DM-3c.

#### **CLINICAL RELEVANCE/APPLICATION**

CT pancreatic volumetry is a useful tool to assess irPI. Pancreatic volume loss could suggest previous irPI events. Pancreatic volume increase could suggest the future risk of ICI-associated DM-3c and recent AP events.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPGI-2

### Time Dependency and Risk Factors of Splanchnic Vein Thrombosis Development in the Early Phase of Acute Pancreatitis: A Systematic Review and Meta-analysis

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Ruben Z. Borbely, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Splanchnic vein thrombosis (SVT) is a local complication of acute pancreatitis (AP) that may lead to subsequent complications such as portal hypertension, gastrointestinal bleeding, and mesenteric ischemia. Our aim was to analyze the temporal progression and contributing risk factors of SVT occurrence during the early phase of AP.

#### METHODS AND MATERIALS

We conducted a systematic search in four medical databases (Embase, MEDLINE via PubMed, Scopus, and CENTRAL) on October 27, 2022. Inclusion criteria were studies using appropriate radiological modalities to identify SVT in adult patients with AP, present data on early phase AP, and offer accurate information on the imaging timing. Exclusion criteria were studies with patients having malignant disease or recent surgical history. We used a random effects model, we calculated SVT-affected patient proportions, with 95% confidence intervals (CI), and conducted subgroup analyses. The study protocol was prospectively registered in the PROSPERO database.

#### RESULTS

Our analysis included 14 studies encompassing 1,951 patients. We found that the proportion of patients who developed SVT during the early phase of AP (within 12 days post-symptom onset) was 0.13 (CI 0.08-0.22). SVT incidence was lowest at 0.05 (CI 0.02-0.15) within 0-3 days, increasing almost five-fold to 0.23 (CI 0.1-0.46) between 3-11 days. Factors influencing SVT occurrence included etiology (alcoholic 0.31 (CI 0.13-0.58), biliary 0.12 (CI 0.04-0.3),  $p=0.03$ ), and pancreatic necrosis (absent 0.09 (CI 0.06-0.15), under 50% 0.29 (CI 0.22-0.37), over 50% 0.46 (CI 0.36-0.56),  $p=0.01$ ). The proportions of distinct venous combinations affected by thrombosis included splenic vein (SV) 0.48 (CI 0.35-0.61), portal vein (PV) 0.28 (CI 0.18-0.42), superior mesenteric vein (SMV) 0.14 (CI 0.08-0.25), SV and PV 0.09 (CI 0.05-0.19), SV and SMV 0.06 (CI 0.02-0.14), PV and SMV 0.13 (CI 0.06-0.27), all three veins 0.1 (CI 0.05-0.19),  $p=0.01$ .

#### CONCLUSION

One in six patients develops SVT in the early phase of AP. Alcoholic etiology and pancreatic necrosis increase the risk of SVT. In addition, this risk seems to increase with the duration of AP. The affected veins, in descending order, are the SV, PV, SMV, and combinations thereof.

#### CLINICAL RELEVANCE/APPLICATION

Imaging should target high-risk patients and take into account the time-dependent nature of SVT incidence. Furthermore, when reporting, radiologists should have an increased suspicion of SVT if they observe pancreatic necrosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPGI-4

### Preoperative Assessment of Peripheral Vascular Invasion of Pancreatic Ductal Adenocarcinoma Based on High-resolution MRI

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Xiaoqi Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

Preoperative imaging determination of vascular invasion is important for surgical resectability of pancreatic ductal adenocarcinoma (PDAC). The purpose of this study is to compare diagnostic accuracy of PDAC vascular invasion between high-resolution MRI (HR-MRI), conventional MRI (non-HR-MRI) and CT, and clarify the applicable diagnostic criteria for MRI and CT.

#### METHODS AND MATERIALS

Pathologically proved PDAC with preoperative HR-MRI (79 cases, 58 with CT) and non-HR-MRI (77 cases, 59 with CT) from 2014 to 2022 were retrospectively collected. Vascular invasion was confirmed by surgical exploration and pathology. The degree of tumor-vascular contact, vessel narrowing and contour irregularity were reviewed respectively. Diagnostic criteria 1 (C1) is the presence of all three characteristics, and criteria 2 (C2) if any one of them is present. The diagnosis efficacy of different examination methods and different criteria was evaluated and compared.

#### RESULTS

HR-MRI showed satisfying performance in assessing vascular invasion (AUC: 0.87-0.92), especially better sensitivity (0.79-0.86 vs 0.40-0.79) compared with non-HR-MRI and CT. HR-MRI was superior to non-HR-MRI, but evenly matched to C2 assessed CT. C2 was superior to C1 in CT evaluation (0.85 vs 0.79,  $P=0.03$ ). C1 was superior to C2 in venous assessment by HR-MRI (0.90 vs 0.87,  $P=0.04$ ) and arterial assessment by non-HR-MRI (0.69 vs 0.68,  $P=0.04$ ). Combining C1 assessed HR-MRI and C2 assessed CT yielded the best performance, significantly better than CT alone (0.96 vs 0.86,  $P=0.04$ ).

#### CONCLUSION

HR-MRI can provide more accurate assessment of PDAC vascular invasion than conventional MRI. C1 may be more applicable to MRI assessment, while C2 may be more applicable to CT. The combination of HR-MRI and CT outperformed CT alone and should be the recommended preoperative examination option.

#### CLINICAL RELEVANCE/APPLICATION

HR-MRI provides vital information for the assessment of PDAC vascular invasion and may contribute to the operative decision making. Combined C1 assessed HR-MRI and C2 assessed CT showed the best efficacy and is the preferred preoperative examination option for PDAC.

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## Abstract Archives of the RSNA, 2023

R5A-SPGI-5

### Multivariate Quantitative Ultrasound Approach for the Assessment of Hepatic Steatosis in Chronic Liver Disease

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Hidekatsu Kuroda (*Presenter*) Nothing to Disclose

#### PURPOSE

There is a need for a non-invasive, widely available, and highly accurate tool for assessing hepatic steatosis considering the global increase in the incidence of non-alcoholic fatty liver disease. This study focused on the acoustic properties of the integrated backscatter coefficient (IBSC) and signal-to-noise ratio (SNR) in addition to the ultrasound-guided attenuation parameter (UGAP). We attempted to construct a highly accurate model for the prediction of  $\geq 5\%$  steatosis in chronic liver disease (CLD) using a multivariate quantitative ultrasound approach.

#### METHODS AND MATERIALS

This prospective multicenter study enrolled 582 patients with CLD between February 2020 and April 2021, who were grouped into steatosis ( $n=364$ ) and non-steatosis ( $n=218$ ) groups using magnetic resonance imaging proton density fat fraction (MRI-PDFF) values as a reference. Four models were created to compute the prediction equation for steatosis: Model 1 (UGAP alone), Model 2 (UGAP + IBSC), Model 3 (UGAP + SNR), and Model 4 (UGAP + IBSC + SNR). Receiver operating characteristic (ROC) analysis, category-free net reclassification improvement (cf-NRI), and integrated discrimination improvement (IDI) were used to examine the optimal model.

#### RESULTS

The areas under the ROC curve for steatosis diagnosis in Models 1, 2, 3, and 4 were 0.923, 0.931, 0.953, and 0.959, respectively. Internal validation using the bootstrap method yielded a C-index of 0.923, 0.930, 0.952, and 0.958, respectively; Models 3 and 4 demonstrated statistically significant discriminative power over the other models ( $p<.001$ ) (95% confidence interval: 0.431-0.753,  $p<.001$ ). The cf-NRI and IDI were 0.592 (95% confidence interval: 0.431-0.753,  $p<.001$ ) and 0.019 (95% confidence interval: 0.005-0.031,  $p<.01$ ), indicating higher discriminative performance of Model 4 compared to Model 3.

#### CONCLUSION

The multivariate quantitative ultrasound approach focused on the acoustic properties of UGAP, IBSC, and SNR is a promising method for assessing  $\geq 5\%$  steatosis in CLD.

#### CLINICAL RELEVANCE/APPLICATION

We developed a predictive formula using multiple quantitative ultrasound parameters to diagnose  $\geq 5\%$  steatosis in CLD with high discrimination and calibration power. The three quantitative ultrasound parameters, namely ultrasound-guided attenuation parameter, integrated backscatter coefficient, and signal-to-noise ratio, strongly correlated with steatosis in CLD. The procedure also demonstrated the potential to diagnose and quantify hepatic steatosis, with an AUROC of 0.959 (95% confidence interval: 0.944, 0.973) using the multiple quantitative ultrasound model.

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## Abstract Archives of the RSNA, 2023

R5A-SPGI-6

### **Diagnostic Accuracy of Computed Tomography (CT) for Detection of Hepatic Steatosis: A Systematic Review and Meta-analysis**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Maryam Haghshomar, MD, MA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

CT is a widely accessible imaging method and has an important role for opportunistic diagnosis of fatty liver. Its accuracy and performance however have been inconsistent in various studies and no clear criteria have been established by the societies. Our objective is to conduct a comprehensive review and meta-analysis to assess the diagnostic accuracy of CT in detection of steatosis.

#### **METHODS AND MATERIALS**

We searched through PUBMED, Embase, and Scopus databases between September 1977 to March 2023. We included studies evaluating diagnostic accuracy, such as sensitivity or specificity, cross-tabulations, or correlations of noncontrast CT (NCCT), contrast-enhanced (CECT), and dual-energy CT (DECT) in detecting fatty liver using either biopsy, proton-density fat fraction, or standard imaging as the reference standard.

#### **RESULTS**

Thirty-six (4432 participants) studies were included. CT is a reliable method for detecting mild and moderate/severe fatty liver, with sensitivity/specificity of 80.2%/90% for NCCT, 82.3%/96.1%, for CECT, and 83.2%/90% for DECT. Additionally, the area under the curve of diagnostic accuracy for NCCT, CECT, and DECT were 0.891, 0.901, and 0.917, respectively. Stratifying by multiple clinically relevant characteristics did not eliminate the statistical heterogeneity. The heterogeneity was most prominent for DECT and CECT. The threshold range for diagnosing fatty liver was a liver attenuation < 38.5-58 HU, a liver minus spleen attenuation of < -19 to -10.1 HU, and a liver-to-spleen attenuation ratio < 0.89 to 1.2.

#### **CONCLUSION**

NCCT, CECT, and DECT are reliable methods for screening fatty liver in clinical settings. They can detect mild/moderate to severe fatty liver with high reliability and accuracy. It is important to remain cautious when interpreting these findings as there was significant heterogeneity observed, particularly for DECT and CECT.

#### **CLINICAL RELEVANCE/APPLICATION**

CT is a major modality for opportunistic detection of hepatic steatosis. Results of this meta-analysis explores the performance of CT for this task and discuss the threshold values for diagnosis of steatosis.

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## Abstract Archives of the RSNA, 2023

R5A-SPGI-7

### The Application Value of FLIS Combined with T2\* Mapping in Preoperative Liver Function Assessment of sHCC

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Shao Peng Li II, DO (*Presenter*) Nothing to Disclose

#### PURPOSE

Using the 15 minutes indocyanine green retention rate (ICG R-15) as the reference standard, the diagnostic value of FLIS combined with T2\* mapping for preoperative assessment of liver reserve function in sHCC were compared with T1 mapping.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on 60 patients with sHCC who had preoperative imaging findings from July 2020 to March 2023. All patients underwent Gd-EOB-DTPA-enhanced MRI, including pre-injection (T1-pre) mapping, post-injection (T1-post) 20 min mapping, and T2\* mapping. The ROIs were selected at the same location and measurements were taken to calculate R2\* values, pre-injection (T1-pre), post-injection (T1-20 min) T1 relaxation times and calculated the T1 relaxation time reduction rate (T1-pre - T1-20 min / T1-pre). Three features of the hepatobiliary phase were assessed: normal liver parenchyma, biliary system and portal vein signal intensity, and FLIS was calculated. All patients underwent a ICG retention test and were divided into three groups (29 patients in group 1 <10%, 19 patients in group 2 10%-20% and 12 patients in group 3 =20%). The differences between the normal liver R2\* values, FLIS and T1 relaxation time reduction rates between the three groups were statistically analysed.

#### RESULTS

The reduction rates of T1 relaxation time, R2\* values, FLIS between the 3 groups were (76.56±1.00)%, (62.12± (1.25)%, (53.19±2.25)% vs (39.75±2.57) Hz, (45.39±1.83) Hz, (55.41±2.34) Hz vs (4.90±0.90), (3.68±0.82) (1.58±0.79), the differences were statistically significant (P<0.01), R2\* values were negatively correlated with liver function grade, FLIS and T1 relaxation time reduction rate were positively correlated with liver function grade, Spearman's correlation coefficient Rs were -0.921, 0.821, 0.981. The area under the R2\* value, FLIS and T1 relaxation time reduction rate ROC were 0.883, 0.825 and 0.914 between group 1 and 2, and 0.867, 0.8 and 0.869 between groups 2 and 3. The T1 relaxation time reduction rate was the most efficient diagnostic between the 3 groups, followed by R2\* value and FLIS respectively, and the combined diagnostic efficacy of the two increased (0.945, 0.935).

#### CONCLUSION

The FLIS and T2\* mapping can accurately assess the liver reserve function of patients with sHCC preoperatively, and their combined diagnostic efficacy is higher than the T1 relaxation time reduction rate.

#### CLINICAL RELEVANCE/APPLICATION

The combined diagnostic efficacy of FLIS and T2\* mapping is higher than the T1 relaxation time reduction rate. And it can shorten scanning time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPGI-8

### Quantitative liver function analysis using T1 mapping on gadoxetic acid-enhanced MR imaging; the application of Dixon-based fat correction in look-locker inversion recovery sequence

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Ye Rin Hwang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the role of T1 map-derived quantitative imaging parameters for the assessment of liver function, and the impact of fat correction of T1 mapping on gadoxetic acid-enhanced MR imaging

#### METHODS AND MATERIALS

A total of 228 patients with normal liver, chronic liver disease and liver cirrhosis who underwent 3T gadoxetic acid-enhanced MR including Dixon-based fat corrected look-locker inversion recovery (LLIR) sequence were included. Two readers measured pre- and postcontrast T1 relaxation times (preT1 and postT1) on conventional and water map T1 in two sessions with 2-week interval. The averaged preT1, postT1 values, changes between pre- and postcontrast T1liver ( $\Delta T1$ ), and adjusted postcontrast T1liver ( $\text{postcontrast T1liver} - \text{T1spleen} / \text{T1spleen}$ ) for both conventional T1 and water map T1, were analyzed for assessment of clinical indices of liver function and hepatic enhancement grade on hepatobiliary phase (HBP). Liver fat fraction (FF) was calculated on MR-based proton density fat fraction (PDFF) map and correlation of T1 map-derived parameters with fat fraction were assessed. With the FF cut-off 6.4%, T1 map-derived parameters were compared between fatty liver and non-fatty liver groups. Multivariate linear regression (MLR) analyses were performed to determine significant variables for T1 value. Reproducibility of T1 values were also assessed.

#### RESULTS

The inter-reader and intra-reader reproducibility showed near-perfect agreement (ICC 0.929-0.999). 68 subjects were included in fatty liver (FL) group (29.8%, 68/228; mean FF for FL group  $10.77\% \pm 4.92$  vs. non-fatty liver (NFL) group  $2.75\% \pm 1.33$ ). The water map preT1 was lower than preT1 in FL group, and showed significant difference between FL group and NFL group ( $669.4 \pm 274.21$  vs.  $760.67 \pm 207.05$ ,  $p = 0.015$ ). The correlation of preT1 ( $r = 0.232$ ,  $p = 0.0005$ ) and  $\Delta T1$  ( $r = 0.263$ ,  $p = 0.0001$ ) with FF were significant, however water map preT1 ( $r = -0.109$ ,  $p = 0.106$ ) and water map  $\Delta T1$  ( $r = 0.039$ ,  $p = 0.569$ ) showed no correlation with FF. With MLR analysis, albumin, total bilirubin, HBP enhancement grade, FF and  $R^2$  value were significantly associated with T1 map-derived parameters (preT1, postT1,  $\Delta T1$ , and adjusted postT1). For the same T1 map-derived parameters measured on water map, the effect of FF was eliminated while HBP enhancement grade, albumin, and  $R^2$  value were persistently significant factors.

#### CONCLUSION

T1 mapping on water map using Dixon-based fat corrected LLIR sequence can estimate liver function effectively free from the influence of hepatic steatosis.

#### CLINICAL RELEVANCE/APPLICATION

With the fat corrected water map T1, T1 mapping of liver can be a useful and noninvasive imaging biomarker for the assessment of liver function regardless of hepatic steatosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPGU-1

### Comparing the Diagnostic Performance of Biparametric with Multiparametric MRI using PI-RADS version 2.1 for Clinically Significant Prostate Cancer

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Danping Zhuang (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic performance of multiparametric MRI (mpMRI) with biparametric MRI (bpMRI) for clinically significant prostate cancer (csPCa) based on the Prostate Imaging Reporting and Data System (PI-RADS) version 2.1.

#### METHODS AND MATERIALS

1939 patients underwent prostate MRI from January 2019 to December 2021. This study finally enrolled 597 patients with 616 lesions who underwent mp-MRI (T2WI, DWI and DCE) before MRI/transrectal ultrasound fusion-targeted biopsy. All lesions were classified as 249 lesions in peripheral zone (PZ) with 81 csPCa and 367 lesions in transition zone (TZ) with 67 csPCa. We scored the lesions on the image according to the site of targeted biopsy using the PI-RADS v2.1 standard with blinding to PSA value and pathology results. There were four weeks in between reading sessions for bpMRI and mpMRI. On bpMRI, the overall category of lesions in PZ was determined solely based on the DWI category. The overall category of lesion in TZ was the same between bpMRI and mpMRI. A Student's t-test and a Mann-Whitney U test were employed to compare continuous variables. When using a cutoff of PI-RADS category =4, the ROC curves for bpMRI and mpMRI in the diagnosis of csPCa were drawn to calculate AUC values.

#### RESULTS

Patients with csPCa had higher PSA levels and PSAD values, but lower prostate volumes, and being older, compared to those with non-csPCa ( $P < 0.001$ ). The AUCs of bpMRI and mpMRI in PZ for the diagnosis of csPCa were 0.901 and 0.891, respectively ( $P > 0.05$ ). However, mpMRI had higher sensitivity (93.8%) but lower specificity (76.2%) compared to bpMRI (sensitivity: 74.1%; specificity: 89.9%). The same trend was observed in PZ+TZ lesions. In PZ, significantly fewer lesions were assigned to category 3 in mpMRI than in bpMRI due to some lesions with category 3 in bpMRI were up-scored to category 4 in mpMRI. For PZ, if biopsy had been performed in patients with PI-RADS categories 4 and 5, mpMRI detected 39 additional patients who needed biopsy compared to bpMRI and identified 16 cases of csPCa.

#### CONCLUSION

Both bpMRI and mpMRI using PI-RADS v2.1 exhibited similar diagnostic performance in diagnosing csPCa, yet mpMRI might decrease the probability of missing csPCa cases.

#### CLINICAL RELEVANCE/APPLICATION

Compared to mpMRI, bpMRI offers several advantages including contrast-free imaging, shorter scanning time, and lower costs. However, the application value of bpMRI in diverse clinical scenarios needs to be further researched. Our study demonstrated that mpMRI had the advantage of reducing the probability of missing csPCa cases.

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## Abstract Archives of the RSNA, 2023

R5A-SPGU-2

### Combined Real-time Elastography and Contrast-enhanced Ultrasound for the Detection of Clinically Significant Prostate Cancer

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Yunkai Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic performance of combined real-time elastography (RTE) and contrast enhanced ultrasound (CEUS) for the detection of clinically significant prostate cancer (csPCa).

#### **METHODS AND MATERIALS**

This prospective study was approved by the local ethics committee. Between November 2019 and December 2022, 286 patients scheduled for prostate biopsy underwent RTE and CEUS evaluation before biopsy procedure. Men with suspicious lesions on RTE (defined as reproducible stiffness lesion) or CEUS (defined as increased focal contrast enhancement) underwent targeted biopsy (TB) in conjunction with systematic biopsy (SB). Men with negative RTE and CEUS underwent SB alone. The primary outcome was the detection of csPCa (Grade Group = 2) in correlation with the biopsy results.

#### **RESULTS**

Among the 286 patients (median age, 67 years) enrolled in this study, mpUS identified suspicious lesion(s) in 204 patients. The biopsy histopathology confirmed the diagnosis of prostate cancer in 146 patients, including 110 patients with csPCa. The csPCa detection rate was 28% (80/286) for CEUS-TB, 26% (74/286) for RTE-TB and 25% (72/286) for SB ( $P = 0.73$ ). The combination of CEUS-TB and RTE-TB could achieve a csPCa detection rate of 34% (101/286), significant higher than that of SB ( $P=0.02$ )

#### **CONCLUSION**

Combined CEUS-TB and RTE-TB could achieved significantly higher csPCa detection rate than SB alone.

#### **CLINICAL RELEVANCE/APPLICATION**

Combined CEUS-TB and RTE-TB could improve csPCa detection than either individual US and SB alone.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPHN-1

### The Added Values of Dynamic Contrast-enhanced Ultrasound in Diagnosis of Small Thyroid Nodules ( $\leq 10\text{mm}$ )

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Yun-Lin Huang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the potential added values of dynamic contrast-enhanced ultrasound (DCE-US) for the diagnosis of small solid thyroid nodules.

#### METHODS AND MATERIALS

This bi-center prospective study was approved by the institutional review board and it was performed between January 2020 and October 2020. B-mode ultrasound and contrast-enhanced ultrasound (CEUS) images were obtained for solid thyroid nodules ( $= 1.0\text{ cm}$ ) confirmed by pathological results. The CEUS time-intensity curves (TICs) of thyroid nodules and surrounding parenchyma were created by VueBox® software (Bracco, Italy). The quantitative parameters of CEUS were analyzed after curve fitting. The weighted kappa statistic ( $\kappa$ ) was performed to assess the interobserver agreement and consistency between the diagnosis of CEUS and DCE-US. The diagnostic performance of CEUS and DCE-US was evaluated and compared.

#### RESULTS

Totally, 79 thyroid nodules in 79 consecutive patients (55 women; median age: 41 years) were enrolled; 70.9 % (56/79) were malignant and 29.1 % (23/79) were benign nodules. Hypoenhancement during the arterial phase of CEUS was associated with malignant nodules ( $P < 0.001$ ), with an AUC of 0.705, sensitivity of 71.4 %, and specificity of 69.6 %. The peak enhancement (PE), wash-in rate (WiR), and wash-out rate (WoR) of quantitative parameters of DCE-US in malignancies were significantly lower than those in benign nodules ( $P < 0.05$ ). For detecting malignant small solid thyroid nodules ( $= 1.0\text{ cm}$ ), the AUCs of PE, WiR, and WoR were 0.642 (sensitivity 65.2 %, specificity 67.9 %), 0.643 (sensitivity 43.5 %, specificity 91.1 %), and 0.667 (sensitivity 69.6 %, specificity 69.6 %), respectively. Comparing the quantitative parameters between small solid thyroid nodules and surrounding normal thyroid parenchyma, the PE, wash-in area under the curve, WiR, wash-in perfusion index, wash-out AUC, wash-in and wash-out AUC, and WoR of the nodules were significantly lower than those of normal thyroid tissue ( $P < 0.05$ ). A total of 20.3 % (16/79) nodules showed iso-enhancement during the arterial phase of CEUS, and the median PE ratio of surrounding tissue and thyroid nodules was 1.70 (IQR 1.33 - 1.89).

#### CONCLUSION

DCE-US using VueBox® perfusion analysis could provide added values for differential diagnosis of small solid thyroid nodules. VueBox® is a helpful tool for the evaluation of dynamic microvascularization of lesions.

#### CLINICAL RELEVANCE/APPLICATION

This bi-center prospective study highlights the practicality of DCE-US using VueBox® perfusion analysis for the evaluation of dynamic microvascularization of thyroid nodules and differential diagnosis of small solid thyroid nodules.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPHN-2

### The Value of Deep Learning Reconstruction Algorithms Combined with Organ Dose Modulation Techniques to Improve Thyroid CT Scan Image Quality and Reduce Radiation Dose

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Ren-feng LV (*Presenter*) Nothing to Disclose

#### PURPOSE

Study the deep learning reconstruction (DLIR) algorithm combined with organ dose modulation (ODM) technology to improve the quality of thyroid CT scan images and reduce the radiation dose value.

#### METHODS AND MATERIALS

Using APEX CT, 36 patients with thyroid examination in our hospital were scanned and divided into non-ODM (N-ODM) and ODM groups according to whether the ODM technique was used or not, with 18 cases in each group. According to the different reconstruction algorithms, the two groups respectively reconstructed 2.5 mm images using adaptive statistical iterative reconstruction (ASIR-V, 30%) and deep learning reconstruction (DLIR). Scan start position is 14 cm below the plane of the thyroid cartilage, the ODM area contains a fixed length of 5 cm of the thyroid. At the level of maximum thyroid display in the transectional position, the CT values and noise (SD) of the thyroid and muscle in the same layer were recorded, the contrast noise ratio (CNR) and radiation dose (ED) were calculated, the image quality was evaluated subjectively by two imaging physicians using a 5-point scale.

#### RESULTS

There was no statistical difference in CT values of thyroid and muscle tissue in the four groups ( $P > 0.05$ ). The SD, CNR and image quality subjective scores of the N-ODM-DLIR and ODM-DLIR groups were better than the N-ODM-ASIR and ODM-ASIR groups (all  $P < 0.05$ ), the overall image noise of DLIR group is significantly better than that of ASIR group, which can provide a clear image of the neck hierarchy. The radiation dose reduction was about 23% in the ODM group compared to the N-ODM group ( $2.20 \pm 0.07$  vs.  $2.89 \pm 0.04$ ,  $t = 35.04$ ,  $P < 0.05$ ).

#### CONCLUSION

In thyroid CT scans, using the DLIR reconstruction algorithm can significantly improve the image quality, combined with the ODM technique effectively reduces the radiation dose.

#### CLINICAL RELEVANCE/APPLICATION

During thyroid scan, because the thickness of the X-axis of the human neck and shoulder is much greater than the Y-axis, the adaptive statistical iterative reconstruction algorithm can not improve the noise of the lower neck scan image well, while the DLIR algorithm can effectively suppress the noise. The thyroid is a highly sensitive tissue organ, ODM technology can conduct low-dose imaging of thyroid area in the process of scanning, combined with DLIR algorithm can improve the image quality.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPHN-4

### Evaluation of Ultrasound Characteristics of Two Topical Hemostatic Agents after Thyroid Surgery

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Vincenzo Dolcetti (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of the study is to describe the ultrasound appearance of topical hemostatics after thyroidectomy, in order to recognize their main features to avoid diagnostic errors and pitfalls.

#### **METHODS AND MATERIALS**

We enrolled 84 patients who underwent hemithyroidectomy or total thyroidectomy and treated with two types of topical hemostats, 49 with an absorbable hemostat of oxidized regenerated cellulose (Oxitamp®) and 35 with a fibrin glue-based hemostat (Tisseel®). All patients were examined with B-mode ultrasound to evaluate post-surgical changes and the presence or absence of residual swab at the level of the thyroid lodge in each patient. A regression analysis was performed for positive cases correlating the size of the residual swab with the time elapsed since surgery

#### **RESULTS**

In 39 patients of the first group (approximately 80%) was detected a haemostatic residue which could potentially be confused with a native gland residue, or with cancer recurrence in oncological patients. No residue was detected in patients in the second group. The main ultrasound characteristics of the swab were analyzed and arranged according to predefined patterns, providing suggestions to recognize it and avoid wrong diagnoses. A part of the group of patients with tampon residue was re-evaluated after 6-12 months, ensuring that the swab remained for months after the maximum resorption time declared by the manufacturer. The regression analysis showed a weak not statistically significant correlation between time elapsed from surgery and the size of the residue.

#### **CONCLUSION**

Since the two materials showed the same efficacy in post surgical hemostasis, the fibrin glue pad is more favorable in the ultrasound follow-up because it creates reduced surgical outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

It is important to know and recognize the ultrasound characteristics of oxidized cellulose based hemostats in order to reduce the number of diagnostic errors and the inappropriate diagnostic investigations.

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## Abstract Archives of the RSNA, 2023

R5A-SPHN-6

### Utility of Repeat FNA for Benign Thyroid Nodules

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Sam Afshari, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

For a large portion of patients with suspicious thyroid nodules, fine-needle aspiration (FNA) yields a benign diagnosis. There is a paucity of data to help determine which of these patients require a repeat FNA. The primary aim of this study is to evaluate the incidence of malignancy from repeat FNA of thyroid nodules in patients with initially benign pathology. Additionally, we assess if there are any demographic indicators or image features that may predict a need for repeat biopsy.

#### METHODS AND MATERIALS

We retroactively identified patients who underwent more than one thyroid FNA at our institution between May 2010 and September 2022. From this cohort, we found 383 patients who underwent a total of 791 biopsies. Of these, 110 nodules had a cytopathologic diagnosis of Benign Follicular Nodule (BFN) based on the Bethesda System at the time of initial FNA. 38 of the 110 had a corresponding second biopsy of the same nodule on a later date. Demographic variables and pertinent risk factors were recorded. Associated TI-RADS descriptors, TI-RADS score, and size of the nodules were documented for each biopsy when available.

#### RESULTS

Of the 38 biopsies that were initially benign and underwent repeat biopsy, 36 were confirmed as benign (94.7%) on repeat biopsy. One nodule had a non-diagnostic sample on repeat biopsy and was lost to follow-up (2.6%). Only one nodule was ultimately diagnosed as malignant (2.6%). The mean age (SD) at time of first biopsy was 51.2 (16.1) years. Initial cytopathology from repeat FNA identified 30 BFN (79%), 6 atypical follicular cells of undetermined significance (AFCUS) (15.8%), 1 follicular neoplasm (2.6%) and 1 nondiagnostic (2.6%). Of the six biopsies that were classified as AFCUS, three underwent Afirma genomic sequencing and were determined to be benign (50%). One of the three AFCUS nodules that did not undergo Afirma was surgically removed and identified as a micropapillary thyroid carcinoma. The nodule that was classified as a follicular neoplasm on repeat FNA was diagnosed as an adenomatous hyperplastic nodule on surgical pathologic examination. The mean time (SD) between first and second FNA was 69.6 (40.6) months. Mean increase in nodule size was 0.46 cm between initial and repeat biopsy.

#### CONCLUSION

In this retrospective study of patients who underwent a repeat FNA of thyroid nodule initially categorized as benign on initial FNA, only 1 of 38 patients (2.6%) was found to have malignant pathology on final diagnosis. The single nodule with initial benign cytology subsequently found to be malignant had no interval increase in size.

#### CLINICAL RELEVANCE/APPLICATION

Our data suggest a low risk of malignancy for thyroid nodules biopsied based on TI-RADS recommendations, suggesting that re-biopsy of nodules with benign cytology is likely unnecessary.

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## Abstract Archives of the RSNA, 2023

R5A-SPIN-1

### A New Automatic AI Tool for MR Urography Functional Analysis in Children

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Luca Basso, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic resonance urography (MRU) is a technique used to evaluate urinary tract abnormalities in children, with the advantage of being noninvasive and allowing both morphologic and functional assessments. Currently, MRU analysis is usually performed with semiautomated software that typically requires manual segmentation of the kidney and pelvis and other time-consuming interactions. In recent years, artificial intelligence (AI) techniques have been used in various domains to solve segmentation, classification, diagnosis tasks. In this work, we propose a deep learning-based approach to automate the functional analysis of the MRU. The proposed approach is integrated into a commercial web viewer (DicomVision) so that it can be used easily included into the clinical routine.

#### METHODS AND MATERIALS

The developed pipeline first employs an Attention U-Net for automatic segmentation of the kidneys and pelvis on morphological MR and then an image registration process to align the segmentations on functional MR. Morphological and functional MR scans are navigable and analyzable on the web viewer along with the automatic segmentations provided by the pipeline. The web viewer allows the automatic segmentations to be edited manually if necessary. Finally, functional analysis is automatically performed by considering the entire 3D anatomy of the kidneys and pelvis, thus assessing the functioning of the renal system in its entirety. The results produced by the analysis, that include excretion curves and split renal functions (with volumetric, area under the curve (AUC), and Rutland Patlack methods) together with derived parameters, are presented in an automatically generated report within the web viewer.

#### RESULTS

The automatic segmentation of morphological MR has been tested on 107 patients using cross validation, achieving a Dice Score of  $0.87 \pm 0.15$  and  $0.91 \pm 0.11$  for left and right kidney, and a Dice Score of  $0.75 \pm 0.24$  and  $0.71 \pm 0.25$  for the left and right pelvis respectively. The registration process, used to align the morphologic segmentations on functional MRU scans, produced functional segmentations that did not require manual retouching in 74% of cases.

#### CONCLUSION

Our analyses demonstrate that the automated web viewer enables rapid and comprehensive analysis of children's MRUs. In particular, the use of such software reduces the time required for segmentation and enables functional analysis on the entire 3D anatomical structure of the kidneys and pelvis.

#### CLINICAL RELEVANCE/APPLICATION

This AI tool for MRU performs faster and better for functional evaluation of SRF and opens the door assessment of new quantitative parameters for obstructive and non-obstructive pathologies which can be useful for surgical planning.

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## Abstract Archives of the RSNA, 2023

R5A-SPIN-2

### Generative Adversarial Networks for Brain MRI Synthesis: Impact of Training Set Size on Clinical Applications

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Gian Marco Conte, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To test the impact of training set size on generative adversarial networks (GANs) trained to synthesize brain MRI sequences.

#### METHODS AND MATERIALS

We previously trained two GANs to generate pre-contrast T1 from post-contrast T1 (T1 model) and FLAIR from T2 (FLAIR model) sequences (baseline models). The reference models were trained on 135 from the BraTS 2017 dataset. Here, we trained the same models using 1251 subjects from the BraTS 2021 dataset using the same architecture and hyperparameters from the original model: a batch size of 1, learning rate  $2 \times 10^{-4}$ , Adam optimizer, cross-entropy, and L1 loss. We trained two versions of the updated models: one stopped at an early checkpoint (early models) and one after 50 epochs (late models). We tested all models on a dataset of newly diagnosed 487 IDH-wt gliomas (Fig.1 A, B). The generated T1 and FLAIR sequences were compared with the original MRIs using the structural similarity index (SSI) and mean squared error (MSE). To assess the practical impact of using synthetic data, we simulated scenarios where either the T1, FLAIR, or both were missing and used their synthetic version as inputs of a segmentation model (HD-GLIO) with the original post-contrast T1 and T2. We compared the segmentations obtained in all scenarios using the dice similarity coefficient (DSC) for the contrast-enhancing area, non-enhancing area, and the whole lesion (Fig. 1B, C). We used Friedman and Dunn's test to compare the DSC scores and correct for multiple comparisons.

#### RESULTS

The median SSI on the test set for the generated T1 were .957, .947, and .947 and the median MSE were .006, .014, and .008 for the baseline, early, and late models. For the generated FLAIR, the median SSI were .924, .908, and .915 and the median MSE were .016, .016, and .019 for the baseline, early, and late models. The range DSC on the test set for the baseline, early and late models were .655 - .953, .420 - .952, and .610 - .952 (Fig. 1D). Overall, the baseline and late models did not show any statistically significant differences in DSC, but both performed significantly better than the early models.

#### CONCLUSION

Generative models trained on a relatively small cohort performed similarly to those trained on a cohort 10 times larger. Overall, synthesizing FLAIR is more challenging than T1; consequently, segmentation of the contrast-enhancing areas is more robust to the use of synthetic data.

#### CLINICAL RELEVANCE/APPLICATION

Incomplete MRI exams reduce the possibility of applying AI models in practice. We show that GANs can generate missing MRIs with relatively low data, making them a viable option for rare diseases or institutions with limited computing resources.

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## Abstract Archives of the RSNA, 2023

R5A-SPIN-3

### Clinical Validation Study of Machine Learning Algorithms for Liver Transplant Planning Including Vessel Segmentation

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Beck Olson (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate volumetric measurements have been shown to improve the outcome of liver transplant operations for both donor and recipient. [1] Preparation involves the segmentation of the donor liver in order to ensure acceptable tissue volume to support a good outcome for both the donor and the recipient. Ideally, vasculature would be excluded from these measurements however this process can take up to 1 hour for a highly trained specialist. A reliable, automated machine learning model was developed in order to significantly reduce the time required for generating this vital data.

#### METHODS AND MATERIALS

Materials: 35 retrospective liver donor venous phase CT images were collected from historical records in order to train the initial model. Three rounds of evaluation were performed by three separate readers with 10 patients each round. Between rounds the model was re-trained with all previous results. The final model had a total training set of 64 images. Methods: A 3D CNN (NVIDIA Clara segresnet [2, 4-5]) was trained using 44 retrospective cases. Training labels for the right lobe, left lobe and vessels were extracted from venous phase CT images using the EDDA [3] software package by an expert analyst. The model performance was compared to segmentations performed by two readers, one novice to liver segmentation and the other a highly trained specialist in liver segmentation. All 3 results were uploaded to an XNAT [6] server for review. Clinicians performed a blinded review of all 3 segmentations for quality using the OHIF plugin [7].

#### RESULTS

The final model was trained using a total of 44 retrospective and 20 prospective clinical cases showing mean dice scores of 0.96 for the right lobe, 0.930 for the left lobe, and 0.725 for the vessels. Three metrics commonly used in liver transplant planning including graft weight to recipient weight ratio (GWRW), future liver remnant (FLR), and graft volume to standard liver volume ratio (GVSTL) were calculated and compared between the ML result and the expert assuming the right lobe as the graft. The median difference between the expert and ML for GWRW was 2% with a mean of 4.5%  $\pm$  0.1%, for FLR the median difference was 7% with an average of 12%  $\pm$  0.2%, and for GVSTL the median difference was 6% with an average of 8%  $\pm$  0.2%.

#### CONCLUSION

The presented machine learning model for liver donor segmentation was able to efficiently provide accurate estimates for liver volumetrics in order to support surgical planning.

#### CLINICAL RELEVANCE/APPLICATION

Accurate volumetrics are critical for predicting outcome in liver donor transplant cases. A CNN was trained to quickly and automatically segment the right and left lobes excluding vessels for liver donor transplant surgery planning.

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## Abstract Archives of the RSNA, 2023

R5A-SPIN-4

### Evaluating ChatGPT as an Adjunct for Radiologic Decision-Making

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Arya S. Rao (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate ChatGPT's capacity for clinical decision support in radiology via the identification of appropriate imaging services for two important clinical presentations: breast cancer screening and breast pain.

#### METHODS AND MATERIALS

We compared ChatGPT's responses to the American College of Radiology (ACR) Appropriateness Criteria for breast pain and breast cancer screening. Our prompt formats included an open-ended (OE) format, where ChatGPT was asked to provide the single most appropriate imaging procedure, and a select all that apply (SATA) format, where ChatGPT was given a list of imaging modalities to assess. Scoring criteria evaluated whether proposed imaging modalities were in accordance with ACR guidelines. Three replicate entries were conducted for each prompt, and the average of these was used to determine final scores.

#### RESULTS

ChatGPT achieved an average OE score of 1.83 (out of 2) and a SATA average percentage correct of 88.9% for breast cancer screening prompts, and an average OE score of 1.125 (out of 2) and a SATA average percentage correct of 58.3% for breast pain prompts.

#### CONCLUSION

ChatGPT achieves moderate accuracy in identifying appropriateness of common imaging modalities for breast cancer screening and breast pain. Our results demonstrate the feasibility of using ChatGPT for radiologic decision making.

#### CLINICAL RELEVANCE/APPLICATION

Our pilot study of the use of ChatGPT in radiology demonstrates the potential to improve clinical workflows and responsible use of radiology services. Potential use cases include triage and imaging resource allocation.

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## Abstract Archives of the RSNA, 2023

R5A-SPIN-5

### Modified Turing Test Unveiled: AI-Generated Radiology Editorials Compete with Human Expertise

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to assess the performance of AI-generated editorials in comparison to human-written editorials in the field of radiology, examining various dimensions including ease of comprehension, English proficiency, technical knowledge and expertise, persuasiveness and convincingness of arguments, and consistency of content.

#### METHODS AND MATERIALS

16 human-written editorials were collected from eight radiology journals, including AJNR, Radiology, AJR, Academic Radiology, Journal of Neurointerventional Surgery, Stroke, JACR, and Clinical Neuroradiology, with two editorials authored by the same person from each journal. GPT-4.0 was used to generate corresponding AI-written editorials based on the topics provided. A total of 32 editorials were reviewed by five different reviewers, four of whom were editorial board members of AJNR, and one was an editor at The Neuroradiology Journal. The reviewers scored the texts using a 1-5 scale for the aforementioned dimensions. They were blinded to the origin of the texts, and the AI-generated and human-written editorials were presented in separate batches, ensuring that the counterparts were not assessed within the same batch. The Mann-Whitney U test was employed to compare the performance of the texts, and Fleiss's kappa was used to assess inter-rater reliability.

#### RESULTS

The analysis revealed no statistically significant differences between AI-generated and human-written editorials in any of the assessed dimensions. In terms of ease of comprehension, English proficiency, technical knowledge and expertise, persuasiveness and convincingness of arguments, and consistency of content, AI-generated texts performed similarly to human-written texts. Fleiss's kappa results indicated low inter-rater agreement in scoring the editorials based on the provided scoring criteria. Reviewers' accuracies in identifying AI-generated vs. human-written texts were 14/32, 27/32, 25/32, 30/32, and 7/32, respectively.

#### CONCLUSION

AI-generated editorials, as exemplified by GPT-4.0, demonstrate comparable performance to human-written editorials. Reviewers had a hard time differentiating the texts highlighting the challenge faced by even expert reviewers in differentiating the editorials. These findings suggest that AI-generated texts may be on par with human-written texts in terms of the evaluated qualities.

#### CLINICAL RELEVANCE/APPLICATION

The use of AI-generated content in radiology journals could potentially augment editorial writing, enhance the efficiency of content generation, and contribute to the growing body of literature in the field. Further research and development of AI systems may lead to improved capabilities and applications within the radiology community and beyond.

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## Abstract Archives of the RSNA, 2023

R5A-SPIN-6

### Data Mining with Natural Language Processing on Radiology Chest X-Ray Reports

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Michael Welsh, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiology reports are a rich source of diagnostic information. Structured reports particularly lend themselves to data mining and artificial intelligence (AI). However, even structured reporting templates demonstrate inconsistent formatting and large variability in terminology, which hinders large-scale text analysis. We developed an AI system, based on natural language processing (NLP) methods, that extracts the fields from reports and can be used to identify relevant features on an image, such as an endotracheal tube.

#### METHODS AND MATERIALS

In this retrospective, IRB-approved study, 1492 pediatric chest radiographs with corresponding radiology reports were obtained at our institution from 2014 to 2019. Two pediatric radiologists labeled the 1492 images based on the presence/absence of metallic hardware, endotracheal tubes, tracheostomy tubes, and the number of lines and tubes, documented in the database software REDCap. Patient demographics were directly extracted from the DICOM header information. The labeled images were then used to train an AI system (train/valid/test splits of 60%/20%/20%), using NLP and supervised machine learning algorithms (scikit-learn v1.1.3) to automatically parse text data and predict the presence of hardware.

#### RESULTS

The AI system was able to determine the presence of metallic hardware, tubes, and the number of lines and tubes using only a few sections of the report (notably the "history", "impression", and "finding" sections). The balanced accuracy of the system is more than 90% (type-I error of 5% and power of 80%) in most classification tasks by using the appropriate fields.

#### CONCLUSION

We utilized NLP to reliably and automatically label images for the presence of lines and tubes, using radiology reports. The proposed system can be adapted for other external devices and has significant utility for identifying objects on the image, with important implications for image quality and patient safety.

#### CLINICAL RELEVANCE/APPLICATION

The proposed system uses radiology reports to identify labeled structures on clinical images. This reduces time-consuming annotation efforts for radiology research and accelerates AI development.

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## Abstract Archives of the RSNA, 2023

R5A-SPIR-1

### Intra-arterial CT Perfusion is Feasible During Liver-directed Therapy Procedures

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Rajesh P. Shah, MD (*Presenter*) Research support, Merit Medical Systems, Inc; Consultant, Intuitive Surgical, Inc; Consultant, F. Hoffmann-La Roche Ltd; Research support, Lucence Health; Consultant, Histosonics, Inc; Consultant, Artio Medical, Inc

#### PURPOSE

To determine feasibility and baseline statistics of intra-arterial CT perfusion during Interventional Radiology (IR) liver-directed therapy procedures.

#### METHODS AND MATERIALS

This was a prospective observational study approved by the local institutional review board. Nine patients undergoing intra-arterial therapy (IAT) for hepatocellular carcinoma (HCC) without treatment in the prior year were enrolled. Subjects underwent injection of a 50% dilution of Iohexol 300 mgI/mL from either the celiac artery at 3 mL/sec for a total volume of 24 mL for conventional hepatic arterial anatomy, or from the superior mesenteric artery (SMA) for replaced anatomy at a rate of 5 mL/sec for a total volume of 40 mL to account for flow into mesenteric vessels. Perfusion scanning was performed continuously for 11 sec, then every 2 sec to a total scan time of 40 sec to capture arterial, portal venous, and washout phases at 100 kV and 60 mA. Radiation dose was recorded. A region of interest (ROI) was drawn on the common hepatic artery, portal vein, spleen (celiac injection) or small bowel (SMA injection), and non-tumor liver by a single Radiologist. Arterial blood flow (AF), portal venous blood flow (PVF), and perfusion index (PI) were calculated from an ROI drawn on a single index tumor 1.5 cm or larger in size without prior treatment. Descriptive statistics were calculated. The Wilcoxon Rank-Sum test was used to determine the significance of peripheral vs. central tumor and any prior treatment (more than 1 year prior) on perfusion values. Analysis of Variance was used to determine impact of tumor segment on perfusion values. A p-value < 0.05 was considered significant. A Pearson Correlation coefficient was calculated to determine impact of tumor size.

#### RESULTS

All 9 patients successfully underwent perfusion CT. Celiac artery injection occurred in 7 patients, while 2 patients had injection via SMA. Median (IQR) radiation dose was 525.3 (524.4-528.6) mGy·cm. Mean (Range) index tumor diameter was 2.46 (1.5-4.5) cm. Index tumors were distributed in segments 2, 5, 7, and 8 (2 subjects each) as well as segment 4 tumor in 1 subject. Three tumors were central while 6 were peripheral. Median (IQR) AF, PVF, and PI were 509.9 (389.6-524), 291.1 (71-859.4), 58.3 (41.9-87.6) mL/min/100 mL, respectively. Treatment more than 1 year prior, tumor segment, and peripheral location of tumor were not significant for perfusion values ( $p > 0.05$ ). Higher AF was strongly correlated with larger tumor ( $r = 0.6$ ).

#### CONCLUSION

Intra-arterial perfusion CT is feasible during IAT for HCC. A wide range of AF and PVF is seen in HCC and these values can provide a baseline for evaluating dosing of IAT such as radioembolization.

#### CLINICAL RELEVANCE/APPLICATION

CT perfusion of HCC is feasible and may help better personalize IR treatments.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPIR-2

### **A Surprising Effect of Metformin Plus Transarterial Chemoembolization on Hepatocellular Carcinoma Patients with Type II Diabetes**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Linxia Wu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Diabetes is common in the patients with hepatocellular carcinoma (HCC) and can lead to poor prognosis for these patients. Metformin is a hypoglycemic drug with anti-tumor effects. Whether metformin can have a positive effect on HCC patients receiving interventional embolization (transarterial chemoembolization, TACE) is still unclear. The study was conducted to explore the effect of metformin plus TACE on HCC patients with type II diabetes.

#### **METHODS AND MATERIALS**

From January 2014 to June 2021, 385 consecutive HCC patients with type II diabetes from three medical centers were retrospectively reviewed. All of them received TACE, and 216 patients received metformin. Propensity Score Matching (PSM) was used to reduce selective bias. Competing risk model was used to reduce the influence of deaths caused by other factors (not cancer) on the results.

#### **RESULTS**

The median overall survival (mOS) (35 months, 95%CI: 28-44 months vs 20 months, 95%CI: 16-24 months;  $P < 0.001$ ) and median progression-free survival (mPFS) (11 months, 95%CI: 10-14 months vs 8 months, 95%CI: 6-11 months;  $P < 0.001$ ) for patients with metformin were longer than those without metformin before PSM. Similar results were presented after PSM. The multivariate regression analysis presented that metformin could reduce mortality risk of patients (HR: 0.56, 95%CI: 0.44-0.71;  $P < 0.001$ ) and tumor progression risk (HR: 0.67, 95%CI: 0.53-0.84;  $P < 0.001$ ) before PSM. The subgroup analysis showed that patients with BCLC stage A, BCLC stage B, BCLC stage C, Child-Pugh A and Child-Pugh B who received metformin could receive survival benefits from metformin. After excluding the influence of deaths caused by other factors (such as heart disease, diabetes, etc), metformin could still reduce mortality risk of patients and tumor progression risk. The adverse events evaluation was based on the NCI-CTCAE 5.0. The results showed metformin did not increase severe adverse events (grade III or grade IV).

#### **CONCLUSION**

Metformin might bring survival benefits for HCC patients with type II diabetes who received TACE. Metformin could achieve the effect of "killing two birds with one stone" for these patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Metformin has been proved to have anti-cancer effects in preliminary studies. However, there are few clinical studies on metformin against cancer. We included 385 patients from three medical centers to conduct the study to explore the effect of metformin on hepatocellular carcinoma patients with TACE. Our results presented metformin could prolong the survival of patients, which could provide new evidence for clinical decision for HCC patients with type II diabetes.

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## Abstract Archives of the RSNA, 2023

R5A-SPIR-5

### Development of PLGA-loaded Ticagrelor Magnetic Microspheres: Towards Prevention of Post PCI Thrombosis

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Kunkun Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

After percutaneous coronary intervention (PCI), dual antiplatelet therapy (DAPT) was required to prevent thrombosis. Systemic DAPT may increase the bleeding risk, especially in populations at high risk of bleeding. Moreover, patients who require non-cardiac surgery during DAPT, have to make decision between postpone surgery and discontinue medication. The aim of this study was to develop PLGA-Fe<sub>3</sub>O<sub>4</sub>-Ticagrelor microspheres (PFTm), which were local infused to aortic wall for local antiplatelet therapy.

#### METHODS AND MATERIALS

We designed and prepared PLGA loaded with ticagrelor magnetic microspheres by improved emulsified solvent evaporation method. For in vitro study, the morphology, relaxation rate, drug release rate, encapsulation efficiency, and biocompatibility of PFTm were evaluated. For animal experiment, twenty Japanese rabbits were divided into four groups, including local PFTm therapy group, systemic PFTm therapy group, non-therapy control group, and healthy control group. The last two groups shared one group of animals. The first three groups underwent balloon injury for the abdominal aorta. The first group received balloon PFTm infusion immediately after the injury, while the second group received intravenous PFTm. The other two groups did not receive treatment. MR T2WI was performed pre-operation and post-operation at day0, day2 and day3 to detect PFTm distribution. Then, the targeted aorta was harvest for pathological.

#### RESULTS

The characterization of PFTm showed that it was spherical. The size of the PFTm was  $930.5 \pm 134$  nm, with SPAN=0.35. The overall size of the PFTm was uniform. The drug encapsulation efficiency of the PFTm was  $82\% \pm 2\%$ , the release rate of ticagrelor from the microspheres reached 90% within 96 hours. The  $r^2$  of the PFTm was 332.0 mm<sup>-1</sup> s<sup>-1</sup>. The PFTm were nontoxic for the cells by CCK-8. Twenty rabbits (3~4kg) were used. All rabbits were successfully established aorta injury model, in which the first two animals in the local PFTm therapy group were found intramural hematoma during PFTm infusion, resulting in animal death. The results of animal experiments showed that PFTm was infused into aortic wall with no thrombus detected in the local PFTm therapy group. The thrombosis area in the systemic PFTm therapy group was significantly smaller than that in the non-therapy control group ( $0.37 \pm 0.04$  mm<sup>2</sup> vs  $0.58 \pm 0.03$  mm<sup>2</sup>,  $P < 0.0001$ ).

#### CONCLUSION

PFTm was successfully developed, which can effectively inhibit thrombosis. This study provides a new concept of local infusion for prevention of thrombosis after PCI.

#### CLINICAL RELEVANCE/APPLICATION

The study validated new concept for local antiplatelet therapy after PCI, which may decrease systemic risk of bleeding and provide chance for non-cardiac surgery during anticoagulation therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPIR-6

### Single vs Double Lumen Ports Placements: Infection and Complication Rates

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Konrad Kozlowski, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Port-a-cath (subcutaneous port) placements are implanted intravascular ports that allow for easy venous access. With the rise in port placements performed by Interventional Radiologists (IR), it is important to determine whether there are differences in infection and complication rates between double and single lumen ports.

#### METHODS AND MATERIALS

We retrospectively analyzed 1582 port placements and removals during a 2-year period (April 2019-March 2021) at the University of Miami(UM) Health System. Patients were grouped by single and double lumen port subgroups and information on infection (bacteremia/port site infection), malfunctions (fibrin sheath, thrombosis, catheter malposition, extravasation), wound dehiscence, and hematoma rates were collected. Chi-square and Fisher t-test analyses were performed on the data in IBM SPSS 2022.

#### RESULTS

On average, patient age was 58.7 years, BMI 27 kg/m, with 616 port placements in males (38.9%) and 966 in females (61.1%). We identified 684 single lumen (43.2%) and 898 double lumen port placements (56.8%). Double lumen ports sustained bacteremia at a significantly higher rate than single lumen ports (3.5% vs 1.2%,  $p= 0.005$ ), with the most common causes of bacteremia being *S. Aureus* (65%), *E. Faecalis* (16.1%), and *E. Coli* (12.9%). Moreover, double lumen ports experienced significantly higher rates of fibrin sheath (2.5% vs 0.4%,  $p= 0.002$ ), catheter tip malposition (1.3% vs 0%,  $p=0.002$ ), and thrombosis (1.2% vs 0%,  $p= 0.007$ ) compared to single lumen ports. Furthermore, double lumen ports encountered more wound dehiscence ( $n= 8$  vs 2), port site infections ( $n=12$  vs 5), extravasation ( $n=4$  vs 1), and hematoma ( $n=4$  vs 1) compared to single lumen ports, although these differences were not statistically significant.

#### CONCLUSION

This study found significantly higher rates of infectious complications and malfunctions of double lumen ports compared to single lumen ports, suggesting that structural differences inherent to double lumen ports may be conducive to bacterial growth and catheter malfunction.

#### CLINICAL RELEVANCE/APPLICATION

These results indicate that oncologists and their IR colleagues may consider placing single lumen ports if clinically feasible, however future studies are still needed to determine clinical significance. Limitations of this study include retrospective nature and potential loss of patient follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPMK-1

### Dual Energy CT-derived Effective Atomic Number and Electron Density for Differentiation of Bone Tumors: Initial Experience

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Tomohito Hasegawa (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine whether dual-energy CT parameters including electron density (ED) and effective atomic number ( $Z_{\text{eff}}$ ) could be quantitative imaging markers for differentiating benign from malignant bone tumors.

#### METHODS AND MATERIALS

Fifty-eight patients (34 males and 24 females, age range from 9 to 86 years) with histopathologically proven osteolytic bone tumor who underwent spectral detector CT scan were included in this retrospective study. Images of the conventional CT value (CT<sub>conv</sub>, HU), electron density relative to water (ED, %), and  $Z_{\text{eff}}$  (AU) were obtained. Regions-of-interest were manually placed on the largest cross-section of tumor avoiding calcification to obtain the mean parametric values. Histopathologically, the tumors were divided into two groups: benign and intermediate malignant tumor (n=14), malignant tumor (n=44). Mann-Whitney U test was used to compare the DECT parameters between two groups. ROC curve analysis was used to assess the discriminative abilities of the DECT parameters.

#### RESULTS

The mean  $Z_{\text{eff}}$  of benign and intermediate malignant tumors was significantly higher than that of malignant tumors ( $7.47 \pm 0.11$  vs  $7.38 \pm 0.12$ ,  $p=0.011$ ), whereas the mean CT<sub>conv</sub> and ED showed no significant difference between the two groups ( $44.28 \pm 7.00$  vs  $41.89 \pm 11.92$ ,  $p=0.490$  and  $103.54\% \pm 0.66$  vs  $103.60\% \pm 0.92$ ,  $p=0.637$ ). The AUC for  $Z_{\text{eff}}$  was 0.727, with a sensitivity of 72.73%, specificity of 64.29% and accuracy of 70.69% (cut off, < 7.44).

#### CONCLUSION

The mean  $Z_{\text{eff}}$  may be helpful in differentiating benign and intermediate malignant bone tumors from malignant tumors. Their difference in  $Z_{\text{eff}}$  may reflect differences in elemental composition which are inaccessible with conventional CT.

#### CLINICAL RELEVANCE/APPLICATION

The mean  $Z_{\text{eff}}$  may be helpful in differentiating benign and intermediate malignant bone tumors from malignant tumors.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPMK-2

### A New Approach to Detect Rib Metastases Using Deep Learning with Hounsfield Unit-augmentation

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Misato Sone, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

With the recent developments of cancer treatments, the number of patients with bone metastases is increasing. CT can well define cortical destruction in bone metastases due to its high spatial resolution. However, detection of bone metastases on CT is challenging for radiologist because of the three types of metastases (osteoblastic, osteolytic, and mixed) to evaluate. Hounsfield Unit (HU)-augmentation, using multiple HU windows in the HU normalization is available for deep learning (DL) algorithm. Thus, HU-augmentation using the appropriate CT values for the three types of bone metastases has the potential to improve detection accuracy. This study aimed to investigate whether the accuracy of the DL algorithm for detecting rib metastases on CT can be improved by HU-augmentation method.

#### METHODS AND MATERIALS

All images of bone metastases were obtained retrospectively from the clinical databases of a single institution between April 2011 and September 2019. Delayed phase axial images of contrast-enhanced CT with soft tissue kernel reconstruction were used. Both training and validation datasets, ground truth labels were established using bounding boxes by two radiologists. After manually extracting thoracic region from the torso CT, faster region-based convolutional neural network is utilized for rib metastasis detection. HU augmentation was performed with three HU windows; osteoblastic (WW 700 HU/WL 450 HU), osteolytic (WW 900 HU/WL 200 HU), and mixed (WW 1300 HU/WL 80 HU), in both training and testing phase. Training and evaluation of DL were performed by 5-fold cross validation. The mean Average Precision (mAP), F-measure, precision, and recall were calculated and compared with and without HU-augmentation.

#### RESULTS

A total of 4218 positive slice images in 159 patients with rib metastases (mean age, 62±11 years; 78 male) were used for model development and test. Primary lesion of 159 patients were following; 47 were breast, 46 were lungs, 17 were prostate, and 49 were other origins. The mAP and F-measure with HU-augmentation were 0.609 and 0.591, compared with 0.553 and 0.571 without HU-augmentation. The precision and recall with HU-augmentation were 0.741 and 0.492, compared with 0.667 and 0.503 without HU-augmentation.

#### CONCLUSION

HU-augmentation improved DL algorithm to detect rib metastases on CT.

#### CLINICAL RELEVANCE/APPLICATION

This study reveals that HU-augmentation using the appropriate CT values for the three types of bone metastases (osteoblastic, osteolytic, and mixed) improves the detection accuracy of rib metastases.

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## Abstract Archives of the RSNA, 2023

R5A-SPMK-3

### Retrospective Validation of the Birmingham Atypical Cartilage Tumor Imaging Protocol (BACTIP) in a Single US Tertiary Care Center

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Sonja Opper, DO (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to retrospectively validate the Birmingham Atypical Cartilage Tumor Imaging Protocol (BACTIP) in a US tertiary care center. This study will provide the necessary groundwork for prospective validation in real-time patients.

#### METHODS AND MATERIALS

Institutional review board approval was obtained. A keyword search within our institutional PACS for the words chondroid, enchondroma and chondrosarcoma in the text of MRI reports from 2014 - 2022. Lesions in the proximal humerus, distal femur, and proximal tibia of adults were included in the study. Lesions were categorized into 1 of 7 BACTIP categories based on size and presence/absence of endosteal scalloping. Rate of malignancy for each BACTIP category was calculated and based on follow up protocol, evaluation of delayed diagnosis was recorded.

#### RESULTS

The PACS keyword search resulted in 305 patients that met inclusion criteria. Preliminary results are below: Of these 305 MRI exams, 75% had no additional MRI exams and clinically presumed benign enchondromas. The remaining 25% of patients had 1 or more follow up MRI exam(s). The length of time between MRI exams varied widely from 2 months to 8 years. BACTIP Type IA (47% of lesions, 2% biopsy rate), IB (20%, 3%), IC (10%, 18%), IIA (6%, 0%), IIB (4%, 28%), IIC (11%, 32%), and III (2%, 100%), respectively. Biopsy rate increased with BACTIP category. Type IA and IB lesions had a malignancy rate of 0%. Malignancy rate for type IC was 33%, and 50% for IIB. Type IIC lesions had a 50% malignancy rate. Type III has a biopsy rate of 100% and malignancy rate of 75%. Malignancy rate increased with BACTIP category.

#### CONCLUSION

Retrospective validation of the BACTIP in a single US tertiary care center showed similar results to those reported by Davies et al in 2019. There were no cases where the application of BACTIP would have led to a delayed diagnosis. The BACTIP would serve as a conservative and appropriate imaging follow-up guideline for patients with central cartilage tumors around the shoulder and knee joint.

#### CLINICAL RELEVANCE/APPLICATION

Central cartilage tumors are common incidental lesions around knee and shoulder joints. Differentiation of low grade chondroid lesions, such as enchondroma from low grade chondrosarcoma, is often difficult even on MRI given pathologic and radiologic similarities. The BACTIP was introduced in UK literature in 2019 and provides a guide to initial assessment, diagnosis, and imaging follow-up plan for incidental indeterminate central cartilage tumors (Fig 1). This imaging protocol was retrospectively validated in an article published by Davies et al in 2019. However, this protocol has not been widely accepted and has not been validated in the US population.

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## Abstract Archives of the RSNA, 2023

R5A-SPMK-4

### Iodine Quantification in Bone Marrow Using Photon-counting Detector CT: A Phantom Study

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Tatsuhito Yamamoto (*Presenter*) Nothing to Disclose

#### PURPOSE

Detecting intertrabecular bone metastases, which replace bone marrow without destroying the bony structures, is a challenging task to diagnose on CT. Photon-counting detector CT (PCD-CT) enables a simultaneous multi-energy acquisition that offers further qualitative and quantitative information in a single scan. This study aimed to investigate the accuracy of iodine quantification using a PCD-CT and to assess the feasibility of measuring iodine concentrations in the tissue that has penetrated into the bone.

#### METHODS AND MATERIALS

A bone marrow phantom was constructed using cellulated calcium sulfate plaster that was impregnated with iodinated contrast medium at various concentrations (0, 0.75, 1.5, 3, 6, 12, 24, 48, and 96 mgI/mL). Images were acquired using a PCD-CT scanner (NAEOTOM Alfa, SIEMENS, Germany) with a detector size of 0.2 mm and a tube voltage of 120 kVp. The acquired images were reconstructed with a 1-mm thickness using a Qr40 kernel. The CT numbers and calculated iodine quantification values were measured by placing circular regions-of-interest (ROIs, approximately 10 cm<sup>2</sup>) on the iodine maps and quantification maps, respectively, at the top, middle, and bottom of each phantom. Statistical analysis was performed using a two-way ANOVA. P-values less than 0.05 considered as statistically significant.

#### RESULTS

The CT values (mean  $\pm$  SD) for each ROI on the iodine maps of the phantom were as follows: 553  $\pm$  24, 532  $\pm$  20, 504  $\pm$  24, 587  $\pm$  23, 554  $\pm$  14, 708  $\pm$  20, 738  $\pm$  4.4, 1130  $\pm$  17, and 1450  $\pm$  200 H.U. at iodine concentrations of 0, 0.75, 1.5, 3, 6, 12, 24, 48, and 96 mgI/mL, respectively. The quantified iodine values for the phantom were 16.4 $\pm$ 0.90, 16.2 $\pm$ 1.1, 16.3 $\pm$ 0.82, 17.1 $\pm$ 0.57, 19.3 $\pm$ 0.49, 22.3 $\pm$ 0.54, 26.5 $\pm$ 0.047, 36.6 $\pm$ 0.12, and 49.9 $\pm$ 3.6mg/mL, respectively. There were significant differences in either CT values on the iodine maps or quantified iodine values between phantoms with iodine concentrations greater than or equal to 6 mg/mL ( $P < 0.05$ ). However, there were no differences between phantoms with other iodine concentrations.

#### CONCLUSION

There was a correlation between iodine concentrations and both the CT values on the iodine map and the iodine quantification values in higher iodine solutions, but no clear difference was observed in lower iodine solutions when compared to the iodine quantification values in the water-impregnated bone phantom. The iodine value was overestimated in the phantom without iodine, and appropriate correction would be necessary when applied to clinical cases.

#### CLINICAL RELEVANCE/APPLICATION

PCD-CT has the potential to detect intertrabecular bone metastases that may not be visible on conventional CT scans and evaluate their vascularity.

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## Abstract Archives of the RSNA, 2023

R5A-SPMK-5

### Is Semi-automatic Segmentation with Quantitative Analysis of Whole-body DWI-MRI Images a Feasible Parameter for Assessing Treatment Response in Multiple Myeloma Patients?

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To study the feasibility of quantitative whole-body diffusion-weighted MRI (DWI) analysis using a semi-automatic segmentation technique for the assessment of treatment response in patients with multiple myeloma.

#### METHODS AND MATERIALS

34 patients with multiple myeloma underwent whole-body MRI at our center. Images were acquired and reported according to MY-RADs (Myeloma Response Assessment and Diagnosis System) guidelines. Patients were classified as responders or non-responders according to their MRI- Response Assessment Category (RAC) and the response category given following the International Myeloma Working Group (IMWG) criteria, considering the latter one as the gold standard. Quantitative analysis of DWI images of each MRI was performed after semi-automated segmentation. Data analysis was performed with SPSS 25.0 software (Chi-square and Student's t-tests). Two-tailed p-values were used for all statistical evaluations and a p-value < 0.05 was considered statistically significant.

#### RESULTS

13 patients (38.2%) did not respond to treatment according to IMWG response criteria. They showed no statistically significant differences in total diffusion volume (tDV: 240.82 cm<sup>3</sup> vs. 196.08 cm<sup>3</sup>; p = 0.507) or mean global apparent diffusion coefficient (gADC: 694.92 x 10<sup>-6</sup> mm<sup>2</sup>/s vs. 779.4 x 10<sup>-6</sup> mm<sup>2</sup>/s; p = 0.123) in quantitative analysis of DWI before and after treatment, respectively. Among the remaining 21 responding patients (61.8%), tDV significantly decreased (214.93 cm<sup>3</sup> vs 111.41 cm<sup>3</sup>; p = 0.01) and gADC significantly increased (738.82 x 10<sup>-6</sup> mm<sup>2</sup>/s vs 1126.29 x 10<sup>-6</sup> mm<sup>2</sup>/s; p = 0.002) after treatment. Furthermore, the percentage of high ADC values (=1400 x 10<sup>-6</sup> mm<sup>2</sup>/s) of tDV was higher in responder patients after treatment (36.57 %) than in non-responders (7.8 %), with significant differences (p < 0.001).

#### CONCLUSION

Total diffusion volume (tDV) and global apparent diffusion coefficient (gADC) may be feasible parameters for assessing treatment response in patients with multiple myeloma.

#### CLINICAL RELEVANCE/APPLICATION

The utilization of novel imaging techniques for the follow-up and monitoring of multiple myeloma treatment represents a rapidly expanding field, which has the potential to provide dependable data and enhance the precision of radiological reports.

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## Abstract Archives of the RSNA, 2023

R5A-SPMK-6

### Measurement of Tumor Total Diffusion Volume (tDV) of Metastatic Bone Lesions from Prostate Cancer Using Whole-Body MRI(WB-MRI)-Evaluation for Therapeutic Effect

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Katsuyuki Nakanishi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To measure the total diffusion tumor volume (tDV) of metastatic bone lesions from prostate cancer using whole body MRI(WB-MRI) including whole body diffusion weighted images (DWI) and to research the correlation for serum PSA level and to assess the reliability and reproducibility of our diagnostic methods.

#### METHODS AND MATERIALS

Nine cases of prostate cancer during various treatment in which WB-MRI was performed twice were retrospectively evaluated. In all patients, serum PSA was measured at the same time of MRI examinations. 3.0T MR scanners were used (Siemens Prisma). The pulse sequences were 1. axial direction of DWI of the level from lower neck and bottom of pelvis. 2. Sagittal direction of T1WI and STIR of total spine 3. Coronal direction of in phase and out of phase of T1WI. In all cases, two radiologists measured tDVs using BD-score (PixSpace. Inc.) which had been developed for calculating ADC value of the lesions and their volume correspond to the tumor automatically by defining the threshold of ADC value. In this study, the threshold was defined as 1.8mm<sup>2</sup>/S. We calculated tDV variation (?tDV) and serum PSA variation (?PSA) before and after therapy in each patient, and examined the relation of ?tDV and ?PSA with Spearman's rank correlation coefficient (rs). Also, the bias between the data of the data of two radiologists was assessed calculating the cross-correlation coefficient.

#### RESULTS

In the data of both radiologists, ?tDV and ?PSA were positive correlated strongly by Spearman's rank correlation coefficient (radiologists 1 r=0.99, p=0.000002, radiologist 2 r=0.88, p=0.002). The cross-correlation coefficient of two radiologists was 0.98 (p=0.000002).

#### CONCLUSION

tDV was proved to be a reliable mark for evaluating the grade of bone metastases from prostate cancer. Using BD score for calculating tDV showed less dispersion between the readers.

#### CLINICAL RELEVANCE/APPLICATION

Calculating the disease volume rapidly from WBMRI returns to earth.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5A-SPMK-8

### Diagnostic Performance of Magnetic Resonance Imaging for Detecting Meniscal Ramp Lesions in Patients with Anterior Cruciate Ligament Tears. A Meta-analysis

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Seong Jong Yun, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The clinical importance of meniscal ramp lesions in patients with anterior cruciate ligament (ACL) tear has emerged as a major issue. However, the diagnostic accuracy of magnetic resonance imaging (MRI) for detecting ramp lesions has a wide range. This meta-analysis was aim to meta-analyze the diagnostic performance of MRI for diagnosing ramp lesion in patients with ACL tear

#### METHODS AND MATERIALS

Literature search of PubMed, EMBASE, and the Cochrane Library was performed based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines. Diagnostic performance studies using MRI as the index test and arthroscopy as the reference standard for ramp lesion were included. Bivariate and hierarchical summary receiver operating characteristic modeling was used to evaluate the diagnostic performance. We performed meta-regression analyses for potential sources of heterogeneity.

#### RESULTS

Nine studies from eight articles (883 patients with ACL tear) were included. The summary sensitivity, summary specificity, and area under the hierarchical summary receiver operating characteristic (AUC) for ramp lesion were 0.71 (95% confidence interval [CI], 0.59-0.81) and 0.94 (95% CI, 0.88-0.97), and 0.90 (95% CI, 0.87-0.92), respectively. Among the potential covariates, magnet strength ( $P<0.01$ ), patients' knee position ( $P=0.04$ ), and MRI interpreter ( $P=0.04$ ) were associated with heterogeneity in terms of sensitivity, whereas, magnet strength ( $P=0.03$ ) was associated with heterogeneity in terms of specificity.

#### CONCLUSION

MRI demonstrated moderate sensitivity and excellent specificity for diagnosing ramp lesion. For increase sensitivity, use of 3T MRI with the patients' knee in the neutral position (about 30° flexion), and the involvement of musculoskeletal radiologist for MRI interpretation may be needed.

#### CLINICAL RELEVANCE/APPLICATION

We recommend routine arthroscopic assessment for the presence of ramp lesion, although it was not suspected on MRI.

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## Abstract Archives of the RSNA, 2023

R5A-SPMS-1

### Functional and Structural Brain Alterations in Patients Recovered from COVID-19 with Anosmia

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Francisco Zamorano, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate functional and morphological brain alterations in recovered COVID-19 patients.

#### METHODS AND MATERIALS

72 recovered COVID-19 patients (33 females, mean age 42, range [18-66]; 38 with anosmia during infection; 29 hospitalized because of respiratory symptoms) were asked to resolve a Reversal Learning Task (RLT) while their brain activity was measured with fMRI. Images were acquired with a 3T Siemens Skyra scanner. Neuropsychological alterations were assessed with Addenbrooke II and INECO tests. In the RLT, the participants had to choose between two options that were presented with different probabilities of obtaining reinforcement (0.8 vs 0.2 and 0.7 vs 0.3). Through trial and error, participants were able to learn the most advantageous option. After a certain number of repetitions, the probabilities associated with each option could be reversed, and the subject had to learn the new association. Behavior was modeled using a Rescorla-Wagner learning algorithm and Cumulative Prospect Theory. This model uses a learning rate that updates the subjective probability of being rewarded and a multiplicative approach to calculate the expected utility of each option. Brain activity associated with the decision-making period was analyzed with FSL in regard to the expected utility, controlled by reaction time as a proxy of difficulty. Cortical thickness was analyzed with Freesurfer using HCP pipeline and SurfStat from Matlab.

#### RESULTS

There was a decrease of activity in several prefrontal and subcortical regions in those patients that had anosmia, regardless of the severity of respiratory symptoms. There was cortical thinning in the left superior frontal gyrus in those patients that had anosmia, regardless of the severity of respiratory symptoms. This indicates that recovered COVID-19 patients that presented anosmia during the infection have functional and structural brain alterations.

#### CONCLUSION

Our results suggest that anosmia can be used as a marker of brain alterations in patients recovered from COVID-19. It could be important to follow the track of these patients in order to investigate possible long term consequences of COVID-19 on the nervous system.

#### CLINICAL RELEVANCE/APPLICATION

While COVID-19 primarily affects the respiratory system, the brain can also be involved. Increasing evidence indicates that recovered patients present neuropsychiatric alterations and thinning of certain cerebral cortex areas, especially those connected to the primary olfactory cortex. Given this background it is highly relevant to evaluate the possibility of alterations at the brain level in recovered COVID-19 patients, which, as we find, seem to extend to other regions.

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## Abstract Archives of the RSNA, 2023

R5A-SPNMMI-1

### First Application of Novel Human Granzyme B Imaging Agent in a Humanized Melanoma Mouse Model Treated with Immune Checkpoint Inhibitor Therapy

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Priska Summer, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We have previously shown that granzyme B (GZB) PET imaging can determine treatment response in cancer immunotherapy. This study evaluates whether a novel human granzyme B imaging agent CYT-200 (Cytosite) labeled with  $^{68}\text{Ga}$  can be used as a reliable, non-invasive biomarker of intra-tumoral GZB levels and efficacy immune checkpoint inhibitor therapy in vivo.

#### METHODS AND MATERIALS

All animal studies were approved and conducted according to the IACUC guidelines. Naïve NSG mice received human untransduced T cells intravenously for immune reconstitution 14 days prior to subcutaneous implantation of human melanoma cells (G361) into the left shoulders. Mice received three intraperitoneal doses of pembrolizumab (200  $\mu\text{g}$ ) and anti-CTLA-4 (100  $\mu\text{g}$ ) combined, administered in three days intervals, starting from when the tumors reached  $336\pm 38$  mm<sup>3</sup>. PET imaging was performed prior to treatment initiation (baseline), such as on days 4, 7, and 14 after the first treatment dose. Tumor-bearing mice were injected with  $4.6\pm 0.30$  MBq of CYT-200 labeled with  $^{68}\text{Ga}$  60 $\pm$ 5 min prior to PET image acquisition. Intra-tumoral T-cell activity was measured by tumor-to-blood ratio (TBR), calculated by the standard uptake values (SUVs) of the tumors normalized against the heart blood pool. Treatment response was assessed by tumor growth measurements over 30 days after tumor implantation.

#### RESULTS

PET imaging on day 4 after treatment initiation showed the highest TBR compared to the baseline ( $3.08\pm 0.98$  vs.  $1.22\pm 0.48$ ) with a gradual decrease of the TBRs on day 7 ( $2.76\pm 1.85$ ) and 14 ( $1.91\pm 0.23$ ). A combination of pembrolizumab and anti-CTLA-4 therapy decreased tumor size on days 4 and 7 after treatment initiation ( $336\pm 38$  mm<sup>3</sup> vs.  $154\pm 31$  mm<sup>3</sup> and  $131\pm 129$  mm<sup>3</sup>, respectively). However, tumor growth resumed 12 days after treatment initiation ( $181\pm 112$  mm<sup>3</sup>), correlating with the reduced T-cell activity shown by declining CYT-200 PET uptake values.

#### CONCLUSION

These preliminary results demonstrate that the novel human granzyme B PET imaging agent CYT-200 labeled with  $^{68}\text{Ga}$  can detect intra-tumoral T-cell activity associated with tumor-killing following immune checkpoint inhibitor therapy in a humanized mouse model for melanoma.

#### CLINICAL RELEVANCE/APPLICATION

Granzyme B PET imaging is a tool for monitoring response to immunotherapy in melanoma patients, which could lead to more effective treatment decisions and improved patient outcomes.

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## Abstract Archives of the RSNA, 2023

R5A-SPNMMI-2

### **Incidental Detection of Focal F-18 FDG Uptake in the Prostate of Oncologic Patients with Application of Logistic Classification**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Kyung Hoon Hwang, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Although prostate cancer has been refocused in the field of nuclear medicine with the advent of FDA-approved PSMA-targeted PET imaging radiopharmaceuticals, however, F-18 FDG still remains the most used drug in oncologic PET imaging. This retrospective study was to assess the incidentally observed focal prostate F-18 FDG uptake in non-prostate cancer patients, and to apply Logistic classification to improve the diagnostic accuracy.

#### **METHODS AND MATERIALS**

The reports of F-18 FDG PET/CT performed in non-prostate male cancer patients at our hospital were retrospectively reviewed to identify unexpectedly observed suspicious focal prostate uptake. Among them, those with final histopathological reports of the corresponding FDG uptake sites were included in this study. The focal uptakes were classified as malignant or benign according to the histopathological reports. SUV parameters such as SUVmax, SUVpeak, MTV of each focal uptake was measured, and compared between malignant and benign lesions. Logistic classification was applied to the SUV parameters using R software to improve the diagnostic accuracy. Statistical significance was set at  $p < 0.05$ .

#### **RESULTS**

About half of the focal uptakes were malignant. Among the calculated FDG parameters, maximum SUV differentiated malignant from benign lesions with the best accuracy. Application of Logistic classification didn't improve the diagnostic accuracy.

#### **CONCLUSION**

About half of the incidental focal prostate F-18 FDG uptake was proved to be malignant. This finding could justify the application of PET imaging to cancer patients and subjects at high risk of developing cancer. A further study with a larger number of subjects and more dedicated machine Learning algorithms might be warranted.

#### **CLINICAL RELEVANCE/APPLICATION**

Authors investigated the clinical significance of incidental prostate FDG uptake and the usefulness of application of machine Learning algorithm such as Logistic classification in the diagnostic accuracy.

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## Abstract Archives of the RSNA, 2023

R5A-SPNPM-1

### **Sterile Gown and Drape, and Bouffant Cap for Thyroid FNA: Preventing Infections or Producing Unnecessary Medical Waste**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Scott Tseng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ultrasound-guided fine needle aspiration is a very low-risk procedure. Despite this, there remains great variability with extensive protective equipment use. Given the inherent monetary and environmental costs of protective equipment, this study aims to assess the difference in infection rate when conducted with full versus limited (without bouffant/cap, sterile gown, and full body sterile drape) protective equipment use.

#### **METHODS AND MATERIALS**

A total of 310 consecutive patients were retrospectively reviewed for thyroid fine needle aspirations at the main hospital and outpatient clinic site from December 1, 2020 to May 15, 2022. The hospital site operated with full protective equipment (bouffant, sterile gown, sterile gloves, and full body sterile drape), and the outpatient site operated with limited (sterile gloves, limited sterile paper drape) protective equipment. Two patients were excluded as no procedure was performed. Review for signs of infection within 30 days of procedure was performed using medical records blindly to the degree of protective equipment utilization. Descriptive statistics and confidence intervals were provided to compare the two groups.

#### **RESULTS**

No infections were identified in either group, with 0/230 (0%, 95CI% 0 - 2%) in the full protective equipment group vs. 0/78 (0%, 95CI% 0 - 6%) in the limited protective equipment group. There was no statistically significant difference in infection rate between full and limited protective equipment use in thyroid fine needle aspiration (FNA) in the included 308 procedures with 95% confidence interval of -6% - 2%. Two patients out of 230 (0.9%) in the full protective equipment group developed mild allergic reaction to topical antiseptic. The 78 procedures with limited protective equipment represents a saving of at least 70,590 grams of carbon dioxide equivalents compared to full protective equipment procedures.

#### **CONCLUSION**

Decreasing the extent of protective equipment does not impact the infection rate for thyroid FNA. Given the inherent costs involved in the procurement and waste of protective equipment, reducing protective equipment use is warranted to reduce both the monetary and environmental impacts of waste.

#### **CLINICAL RELEVANCE/APPLICATION**

Using limited protective equipment (sterile gloves and limited drape) for thyroid FNA does not increase infection rate as compared to full protective set, while saving significant grams of carbon dioxide equivalents.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPNPM-2

### Dual Energy CT: Less is More

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Caterina Di Manna, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the reduction of iodinated contrast agent and radiation dose using Dual Source Dual Energy CT, maintaining the same image quality.

#### METHODS AND MATERIALS

This single-center randomized prospective study enrolled 121 oncologic patients who underwent the first CT exam acquired with a single energy (SE) 128-slice CT (LightSpeed VCT) and the subsequent using a Dual Source Dual Energy CT (Somatom Force) (DSDECT). In the first exam, was administered a dose of contrast agent (CA) (Iomeron 350) of 0.7mg of iodine per kg of lean body mass (LBM). In the second exam with DSDECT the dose of CA was reduced to 0.5mg of iodine per kg of LBM. The mean value of CA administered to patients were compared between the two exams. The difference in radiation dose between the two exams was considered as secondary outcome. Quantitative image analysis was performed considering enhancement of porta, liver parenchima and aorta, and noise metrics. Image quality was evaluated considering visual perception of enhancement, noise, and artifacts based on a 5-point Likert scale.

#### RESULTS

The mean CA dose administered to patients in the first exam (SE) was 105.4ml ( $\pm 13.19$ ), with a mean iodine dose of 36.91g ( $\pm 4.62$ ); in the second control (DE), an average of 81.23ml of CA ( $\pm 14.68$ ) was administered, with an average iodine dose of 28.53g ( $\pm 5.20$ ). Qualitative analysis demonstrated comparable image quality in scans with DECT. Our study also demonstrated a reduction in the average radiation dose delivered to the patient by 36% using DECT.

#### CONCLUSION

Our study confirms the advantages of DSDECT in the follow-up of oncologic patients. Using DSDECT it is possible to reduce the amount of iodinated CA by 30% and radiation dose by 36% maintaining the same image quality.

#### CLINICAL RELEVANCE/APPLICATION

Dual Energy CT is a promising technique to evaluate oncologic patients using a reduced amount of contrast media and radiation dose. These advantages are crucial in patients which, due to their pathology, frequently undergo a follow-up CT scans.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPNR-1

### Prediction of Future Dementia for MCI Patients from Neuroimaging and Other Multimodal Data Using a Novel Machine Learning Framework

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Andrew Cirincione, MS, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Prediction of future dementia for patients with mild cognitive impairment (MCI) is a significant clinical goal, so that the identified cases can benefit from available treatments. Currently, the clinical standard for diagnosing dementia utilizes neuroradiological findings from multimodal imaging modalities such as MRI and PET scans, as well as cognitive tests and biomarkers like tau and amyloid uptake levels in cerebrospinal fluid. However, efficiently and objectively analyzing these complex and disparate data can be difficult in clinical settings, contributing to high rates of underdiagnosis or misdiagnosis of dementia at early stages. Machine learning (ML) offers a potentially more efficient and objective methodology to predict future dementia for MCI patients from these multimodal data.

#### METHODS AND MATERIALS

We recently developed Ensemble Integration (EI), an ML framework designed to advance predictive modeling from multimodal data by leveraging complementarity among the data modalities (Li et al, *Bioinformatics Advances*, 2022). In this work, we assessed EI's ability to predict the future development of dementia among MCI patients using processed T1-weighted MRI imaging and other multimodal data from The Alzheimer's Disease Prediction of Longitudinal Evolution (TADPOLE) challenge (Marinescu et al, *Predictive Intelligence in Medicine*, 2019). Specifically, we developed an EI-based predictive model of dementia from data of 672 MCI patients collected at their first visit (baseline), and rigorously evaluated this model and benchmark methods from two separate test sets.

#### RESULTS

For predicting the future development of dementia among MCI patients, the EI-based model performed better on the two test sets (AUROC=0.77/0.78, sensitivity=0.71/0.75, specificity=0.74/0.75) than commonly used XGBoost (AUROC=0.66/0.67, sensitivity=0.59/0.63, specificity=0.73/0.71) and deep learning (AUROC=0.63/0.64, sensitivity=0.78/0.62, specificity=0.41/0.55) approaches. Among the most predictive features in this EI model were MRI-derived measurements of the white matter volume of the thalamus, a region associated with dementia (Aggleton et al, *Brain*, 2016; Ryan et al, *Brain*, 2013).

#### CONCLUSION

EI is an effective framework for predicting if an MCI patient will develop dementia in the future from neuroimaging and other multimodal data collected at baseline. EI identified several neuroimaging features associated with progression to dementia that may have gone unidentified using traditional statistical methods.

#### CLINICAL RELEVANCE/APPLICATION

By integrating neuroimaging and other multimodal data using an effective method like Ensemble Integration, it is possible to accurately predict the development of future dementia among MCI patients.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-11

### Performance of Dual-Layer Spectral Detector CT in Identifying Early Ischemic Changes in Acute Ischemic Stroke Patients

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Keiichi Honda (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to evaluate the efficacy of spectral imaging using computed tomography (CT) equipped with a dual-layer detector for diagnosing acute ischemic stroke.

#### METHODS AND MATERIALS

We retrospectively analyzed CT spectral images of 26 regions in 15 patients diagnosed with acute ischemic stroke. We performed non-contrast brain CT using dual-layer detector CT non-contrast brain MRI on the same day. We compared the conventional CT values, relative electron density (ED), effective atomic number (Zeff) of the ischemic stroke region the contralateral normal region. We used the Mann-Whitney U test to compare each imaging parameter in the ischemic region the normal region. Receiver operating characteristic (ROC) analysis was conducted to determine the area under the ROC curve (AUC) for the differentiation of acute ischemic stroke.

#### RESULTS

The CT value ( $28.2 \pm 3.93$  HU vs.  $33.4 \pm 2.34$  HU,  $P < 0.001$ ) the ED ( $102.43 \pm 0.411$  vs.  $102.95 \pm 0.170$ ,  $P < 0.001$ ) showed a significant difference between the ischemic stroke region the contralateral normal region. There was no significant difference in Zeff ( $7.357 \pm 0.0465$  vs.  $7.365 \pm 0.0365$ ,  $P = 0.47$ ). The AUC for the diagnosis of acute ischemic stroke using conventional CT, ED, and Zeff were 0.846, 0.904, and 0.615, respectively. With an optimal threshold of ED of 102.65, the sensitivity, specificity, PPV, NPV, and accuracy of differentiation of acute ischemic stroke were 80.8%, 100%, 100%, 83.9%, and 90.4%, respectively.

#### CONCLUSION

Our results suggest that electron density images derived from dual-layer detector CT can improve the detection of acute ischemic stroke compared to conventional non-contrast CT imaging.

#### CLINICAL RELEVANCE/APPLICATION

Improved discrimination of early ischemic changes region with electron density images, as compared to conventional images, is expected to lead to easier CT diagnosis of acute ischemic stroke.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-13

### Neurotransmitters Release in the Brain Extracellular Space Following Neuronal Excitation can be Tracked by Tracer-based MRI

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Yuanyuan Li (*Presenter*) Nothing to Disclose

#### PURPOSE

The interstitial fluid (ISF) within the brain extracellular space (ECS) is a direct microscopic environment in which brain cells survive and function, however, the dynamic modulatory processes that occur in the ECS upon stimulation, as well as their underlying mechanisms, have not been elucidated. Given the potentially important capacity of tracer-based magnetic resonance imaging (MRI) in visualizing the drainage of ISF in brain ECS and analyzing the diffusion characteristics of ECS in the deep brain, it is pertinent to explore the underlying biophysical mechanisms.

#### METHODS AND MATERIALS

In the present study, by using an algorithm-optimized tracer-based MRI and DECS-Mapping techniques, we quantitatively measured the dynamic biophysical parameters of the brain ECS structure and ISF drainage in the thalamus following neuronal excitation in an electric pain stimulation rat model. Immunofluorescence assays and western blot were used to confirm the morphological basis for structural changes in ECS. Additionally, the release and distribution of neurotransmitters were mapped at different time-points following pain stimuli by using mass spectrometry imaging (MSI). The same examinations were performed in an aquaporin-4 (AQP4) gene knockout rat model to explore the roles of AQP4 in regulating ECS structure and ISF drainage.

#### RESULTS

Significantly decreased diffusion coefficient (DECS) and volume fraction ( $\alpha$ ) of the brain ECS were found in the thalamus caused by neuronal excitation, accompanied with the slowdown of ISF drainage. The morphological basis for structural changes in ECS was local spatial deformation of astrocyte foot processes. An AQP4 knockout rats model was used in which the changes of the ECS structure were reversed and found that the slowed DECS and ISF drainage persisted. Meanwhile, the dynamic changes of DECS were found to be synchronized with the release and elimination processes for neurotransmitters following neuronal excitation.

#### CONCLUSION

In conclusion, tracer-based MRI represents a promising technique to reflect neuronal activity, the down-regulation of ISF drainage following neuronal excitation is caused by the restricted diffusion in the brain ECS, and  $D_{ECS}$  might be used to track the neurotransmitters release following neuronal activities in the deep brain.

#### CLINICAL RELEVANCE/APPLICATION

Tracer-based MRI represents a promising technique to reflect neuronal activity. Brain ECS and ISF drainage within it will become a new target for monitoring neural network excitation, which will open up new research avenues for understanding the physiology and pathology of central nervous system diseases.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-2

### Investigating ChatGPT's Capability to Generate Differential Diagnoses from Transcribed Radiological Findings in Neurological Imaging

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of neuroradiology cases.

#### METHODS AND MATERIALS

A sample of 32 neuroradiology cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

#### RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 37.5% compared to 56.3% ( $p=0.065$ ) and 9.4% compared to 15.6% ( $p = 0.23$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 44.3% compared to 52.5% ( $p=0.25$ ). ChatGPT3.5 and ChatGPT4 hallucinated 36.5% versus 12.2% ( $p=0.012$ ) of the references provided and generated 7 total false statements versus 3 total false statements, respectively.

#### CONCLUSION

The ChatGPT algorithms were able to produce a differential diagnosis for prompts containing descriptive radiological findings. The responses matched the expert literature from which the cases originated a minority of the time, though a non-statistically significant improvement was made in the accuracy categories from 3.5 to the 4th generation algorithm. The renowned hallucination effect appeared more frequently in generated citations compared to algorithm-produced statements, with both showing improvement in the latest generation.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) hold significant potential to influence both clinical and educational aspects of medicine. Familiarity with the precision and potential errors of these algorithms can offer a deeper insight into the constraints of these emerging tools.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-3

### Deep-Learning Augmented Contrast Enhancement Improves the Detection of Cerebral Vessel Occlusions in CT-Angiography of Acute Stroke Patients

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Sebastian Steinmetz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To examine the impact of deep-learning augmented contrast enhancement on diagnostic performance of poorly contrasted computed tomography angiography (CTA) in acute stroke.

#### METHODS AND MATERIALS

This retrospective single center study included patients with suspected ischemic stroke who underwent comprehensive CT imaging including cranial computed tomography (CCT), whole brain volume perfusion CT (VPCT) and computed tomography angiography (CTA) and had poorly contrasted CTA (defined as  $<350\text{HU}$  in the proximal MCA) between 01/2021 and 12/2022. 58/102 patients had vascular occlusion with correlate in perfusion. All CTA datasets were reconstructed conventionally using iterative reconstruction (conventional CTA, cCTA) and additionally using an AI-powered Augmented Contrast Enhancing tool (ClariACE, ClariPi, Seoul South Korea), which is a pre-trained deep learning model allowing selective boosting of contrast agent components in CT images (enhanced CTA, eCTA). The quantitative features including slope, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), noise, entropy and density values were examined by software and were calculated standardized and compared. Datasets were then evaluated by two blinded radiologists, who applied 4-point-Likert-scales to general and vessel specific measures of both cCTA and eCTA datasets (overall image quality, overall contrast, artifacts, diagnostic confidence, image noise, assessability of proximal, intermediate and subcortical vessels). Furthermore, readers evaluated both datasets for presence / absence of cerebral vessel occlusions with VPCT serving as reference standard for calculating sensitivity and specificity.

#### RESULTS

This study included 102 patients (mean age= $67.69\pm 13.18\text{y}$ ; 32 women). Objective image evaluation revealed an increase in iodine contrast by ca. 100%. eCTA revealed significantly higher subjective contrast, diagnostic confidence and overall image quality ( $p<.001$ ). Both readers achieved significantly improved sensitivity with eCTA as compared to cCTA (Reader 1: 55/58 [95%; 95%-CI: 85.62% to 98.92%] vs. 48/58 [83%; 95%-CI: 70.57% to 91.41%]; Reader 2: 53/58 [91%; 95%-CI: 81.02.% to 97.14%] vs. 46/58 [79%; 95%-CI: 66.65% to 88.83%]). Reader 1 yielded no false positive findings on cCTA or eCTA (specificity 44/44 [100%; 95%-CI: 91.96% to 100%]), reader 2 yielded no false positive findings on cCTA and 1 false positive on eCTA (reader 2: 43/44 [98%; 95%-CI: 87.98% to 99.94%]).

#### CONCLUSION

Deep-learning augmented contrast enhancements significantly increases image quality and diagnostic performance of poorly contrasted CTA.

#### CLINICAL RELEVANCE/APPLICATION

Enabling faster and more accurate care for stroke patients.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-4

### Use of a Computer-based Program to Classify Injuries from the Upper Cervical Spine According to AO Spine Classification

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

David E. Timaran Montenegro, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

AO classification is a detailed, laborious, and challenging standardized assessment to describe imaging findings of UCST. To improve efficiency reducing assessment time, a computerized program was developed to determine AO Classification from standardized imaging report system from Cervical Spine Imaging CT and MRI called, PAUCI: Program for Analysis of Upper Cervical Injury.

#### METHODS AND MATERIALS

The computer program utilizes a series of 44 dichotomic questions based on the presence or absence of imaging findings. Initially, registration of lesions was performed retrospectively by two neuroradiologist after consensus was achieved. Then, the database was reviewed by PAUCI and a third blinded neuroradiologist to determine AO classification. Statistical analysis included calculation of agreement coefficients between the neuroradiologist assessment and AO classification according to anatomic level and severity type of injuries.

#### RESULTS

Initially, 170 subjects with UCST were included in our study and registered in the database. All patients showed lesions in the upper cervical spine on CT or MRI. Among them, 70 subjects were randomized to be assessed by the third blinded evaluator and PAUCI. Second-order agreement coefficients indicated that PAUCI and the neuroradiologist demonstrated a statistically significant degree of agreement regarding AO injury level (Level I: AC2 0.886, Level II: AC2 0.874, Level III: 0.675;  $P > |Z|$  (p value)  $< 0.0001$  for all). There was also significant agreement regarding AO injury severity at each level (Type A: 0.980; Type B: 0.864 Type C: 0.639;  $P > |Z| < 0.001$  for Type A and B and 0.0064 for Type C).

#### CONCLUSION

AO classification for the upper cervical spine injury determined by PAUCI and neuroradiologist demonstrated a statistically significant degree of agreement. Stronger agreement was identified with lesions occurring at the anatomic Level I. More modest agreement was found with lesions at Level III with severity type C. PAUCI represents an opportunity to determine AO classification efficiently and accurately from cervical spine imaging in cases of upper cervical spine injury.

#### CLINICAL RELEVANCE/APPLICATION

Detailed description of imaging findings in patients with upper cervical spine trauma using a standardized system is needed to assess prognosis and outcomes. Currently, AO spine is a reliable classification system. Main limitations include difficulty and time consumption in busy real life practice. Computerized systems can help to expedite the process to classify lesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPNR-5

### Correlation of Brain Stiffness Measured Using Virtual MR Elastography Based on DWI with Enlarged Perivascular Space

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Miran Han, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Enlarged perivascular spaces (EPVS) have been known to be associated with various degenerative disease. However, since they were also frequently observed in healthy population, it is not clear how severe EPVS burden can be considered pathologic. Therefore, we investigated the relationship EPVS and brain stiffness which is also considered as biomarker of neurodegenerative disease, using the virtual magnetic resonance elastography (vMRE). That is a non-invasive and novel technique based on diffusion weighted imaging (DWI)

#### METHODS AND MATERIALS

We retrospectively reviewed healthy adults who performed MR imaging for routine medical examination from March 2021 to June 2022. EPVS were rated on visual grading [grade 0, 1, 2, 3, 4 for 0, 1-10, 11-20, 21-40, >40 EPVS at centrum semiovale (CSO) and basal ganglia (BG) of either hemisphere]. We excluded patients who had high SI at white mater (> Fazekas scale 1), EPVS at BG > grade 1, hypertension, cardiovascular disease, and diabetes to minimize the effect of confounding factors. We randomly selected age matched patients according EPVS grade at CSO. Shifted apparent diffusion coefficient was calculated from DWI ( $b=200$  and  $1500\text{sec}/\text{mm}^2$ ) and converted to DWI-based virtual shear modulus ( $\mu$ ). Brain stiffness was measured in centrum semiovale area, but also in whole brain. Multiple comparison test were performed for evaluating relationship between EPVS grade and brain stiffness.

#### RESULTS

Finally 248 patients (50 patient for grade 0, 1, 2, 3 and 48 patients for 4, 107 female, 141 male) were included. There were no differences in brain volume between EPSV groups ( $P = 0.109$ ), the virtual shear modulus ( $\mu$ ) decreased not only in CSO but also in whole brain, as the EPSV grade increased ( $P < 0.001$ ). In post hoc analysis, there is no significant differences of brain stiffness between G0 and G1 ( $P = 0.939$  for CSO,  $P = 0.984$  for total brain), G2 and G3 ( $P = 0.893$  for CSO,  $P = 0.418$  for total brain). When the EPVS was re-graded as normal (G0-1), mild (G2-3) and high (G4), the change of brain stiffness parameters were significant according to EPSV grade (Normal vs Mild,  $P = 0.001$ ; Mild vs High,  $P = 0.015$  for CSO and  $P = 0.001$ ;  $P = 0.016$  for total brain).

#### CONCLUSION

The higher degree of EPVS at CSO presented lower value of brain stiffness parameter. The rating system of EPVS needs to be revised in consideration of clinical impact.

#### CLINICAL RELEVANCE/APPLICATION

The enlarged perivascular space showed negative correlation with brain stiffness measured using virtual MR elastography, new rating system of EPVS based on brain stiffness could be suggested.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-6

### Harmonized Tract Based Spatial Statistics (TBSS) with Multiple Diffusion Models of the Alzheimer's Disease Connectome Project (ADCP)

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

John W. Roberts, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Alzheimer's Disease (AD) has been mainly thought of as a disease involving gray matter changes. Gray matter atrophy is observed primarily in fronto-temporal regions, but less is known about the disruptions to white matter. This study investigates disruptions to white matter in the AD continuum (cognitive unimpaired (CU) or healthy controls (HCs); cognitive impaired (CI) - Mild Cognitive Impairment (MCI) and AD) using diffusion tensor imaging (DTI) and multi-tissue neurite and orientation dispersion and density imaging (mtNODDI) models of the multi-shell connectome diffusion MRI (ms-dMRI) data from the Alzheimer's Disease Connectome Project (ADCP).

#### METHODS AND MATERIALS

Data from 121 participants (Cognitive Unimpaired (26 M, 43 F) mean age 67 +/- 7.2; Cognitive Impaired (31 M, 21 F) mean age 73.2 +/- 8.8) in the ADCP with ms-dMRI were pre-processed using DESIGNER processing guidelines using tools implemented in FSL, ANTS, and MRtrix3. TBSS pre-processing was performed, and parametric ComBat data harmonization was applied to the skeletonized data for the DTI and mtNODDI parameters. The effects of cognitive impairment on these parameters were statistically evaluated using permutation testing and threshold free cluster enhancement with family wise error corrected threshold of  $p < 0.05$ , controlling for age and sex.

#### RESULTS

Analysis of DTI and NODDI measures revealed significant differences in mtCSF (partial volume fraction of cerebrospinal fluid), mtODI (orientation dispersion index of neurites), and mtVFEXTRA (partial volume fraction of extracellular free water) between CI and CU individuals. Specifically, CI individuals had higher mtVFEXTRA (1 cluster) and mtODI (6 clusters), and lower mtCSF (1 cluster) and mtODI (1 cluster) than CU individuals. All results are statistically significant with family-wise error corrected p-values with an a level of 0.05.

#### CONCLUSION

Cognitively impaired individuals were found to have decreased axonal coherence in the brainstem and surrounding cerebellar regions as well as in frontal lobe sub gyral white matter, suggesting increased neurodegeneration in these regions. Conversely, cognitively impaired individuals were found to have reduced extracellular fluid in cerebral white matter and decreased tissue complexity in the gray matter of the posterior corona radiata. Further research is needed to replicate and extend these findings and investigate potential confounding factors.

#### CLINICAL RELEVANCE/APPLICATION

Neurite complexity tends to decrease in the posterior white matter and increase in the brainstem and sub gyral frontal white matter in cognitively impaired individuals on the AD continuum.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-7

### **Pretreatment MR-Based Radiomics in Patients With Glioblastoma: A Systematic Review and Meta-Analysis of Prognostic Endpoints**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Su Jeong Yang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recent studies have shown promise of MR-based radiomics in predicting the survival of patients with untreated glioblastoma. This study aimed to comprehensively collate evidence to assess the prognostic value of radiomics in glioblastoma.

#### **METHODS AND MATERIALS**

PubMed-MEDLINE, Embase, and Web of Science were searched to find original articles investigating the prognostic value of MR-based radiomics in glioblastoma published up to March 6, 2022. Concordance indexes (C-indexes) and Cox proportional hazards ratios (HRs) of overall survival (OS) and progression-free survival (PFS) were pooled via random-effects modeling. For studies aimed at classifying long-term and short-term PFS, a hierarchical regression model was used to calculate pooled sensitivity and specificity. Between-study heterogeneity was assessed using the Higgin inconsistency index (I<sup>2</sup>). Subgroup regression analysis was performed to find potential factors contributing to heterogeneity. Publication bias was assessed via funnel plots and the Egger test.

#### **RESULTS**

Among 596 abstracts, 17 studies were included. Respective pooled C-indexes and HRs for OS were 0.65 (95% confidence interval [CI], 0.58-0.72) and 2.88 (95% CI, 2.28-3.64), whereas those for PFS were 0.61 (95% CI, 0.55-0.66) and 2.78 (95% CI, 1.91-4.03). Among 4 studies that predicted short-term PFS, the pooled sensitivity and specificity were 0.77 (95% CI, 0.58-0.89) and 0.60 (95% CI, 0.45-0.73), respectively. There was a substantial between-study heterogeneity among studies with the survival endpoint of OS C-index (n=9, I<sup>2</sup>=83.8%). Publication bias was not observed overall.

#### **CONCLUSION**

Pretreatment MR-based radiomics provided modest prognostic value in both OS and PFS in patients with glioblastoma.

#### **CLINICAL RELEVANCE/APPLICATION**

Pretreatment MR-based radiomics provided modest prognostic value in patients with glioblastoma with pooled C-indexes for overall survival and progression-free survival as 0.65 and 0.61, respectively.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-8

### Imaging Findings of IIH: The Value of MRI in Predicting the Presence of Disease

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Zachary Miles (*Presenter*) Nothing to Disclose

#### PURPOSE

Idiopathic intracranial hypertension (IIH) is a condition characterized by an increase in cerebrospinal fluid (CSF) with a lack of identifiable structural cause or etiology. This condition is expected to rise in incidence along with an increase in obesity in the coming years. Brain imaging has been successfully used to identify this disease with specific findings prompting further evaluation. We believe that MR imaging findings can predict the presence of IIH and we attempted to reproduce and reinforce existing knowledge in the literature.

#### METHODS AND MATERIALS

This study was a retrospective data analysis of MRI imaging reports completed during the calendar year 2020 at John Peter Smith hospital. Any MRI report including the phrase "Idiopathic intracranial hypertension" was reviewed and patients with a lumbar puncture confirming the diagnosis of IIH were included. The study sample was 64 IIH cases and 41 normal MRI brains as a control. All cases were deidentified and randomized. These MRI studies were reviewed by three different neuroradiologists who were blinded to the diagnoses. The presence or absence of four imaging findings was noted—empty pituitary sella, posterior globe flattening, bilateral transverse sinus stenosis, and enlarged optic nerve sheaths. Inter-rater reliability (IRR) was analyzed as well as Odds Ratios for each finding using a generalized linear mixed model.

#### RESULTS

Our results demonstrated substantial and almost perfect agreement amongst radiologists when identifying empty pituitary sella, enlarged optic nerve sheaths, and posterior globe flattening (IRR value  $>0.6$ ). However, there was only moderate agreement amongst radiologists when assessing bilateral transverse sinus stenosis (IRR value 0.569). Odds ratios for each imaging finding were statistically significant ( $p$  value  $<.0001$ ). Posterior globe flattening had the highest odds ratio and was never seen in controls.

#### CONCLUSION

Our results reinforce existing evidence that specific MR imaging findings can predict the presence of IIH. A limitation to this study was the lack of vascular imaging such as MR Venography, which is likely responsible for the low IRR in identifying bilateral transverse sinus stenosis. A future study could look at CT or MR venography alone or combined with these findings to predict the presence of IIH.

#### CLINICAL RELEVANCE/APPLICATION

As the incidence of IIH increases in the population, it is increasingly important to recognize MR findings which predict the presence of this disease. In addition, vascular imaging should be included in the diagnostic workup of IIH.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR-9

### Reduction of Injected Volume of Intravenous Contrast Media for Brain CT: Problem or Opportunity

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Goni Merhav (*Presenter*) Nothing to Disclose

#### PURPOSE

This study investigates whether reducing the volume of intravenous iodinated contrast material injected during brain computed tomography (CT) provides reliable and accurate enhanced imaging without compromising diagnostic accuracy.

#### METHODS AND MATERIALS

In this prospective IRB approved study of 102 consecutive patients all of whom received informed consent, enhanced brain CT was done for indications such as headache and dizziness. 47 patients then received a reduced dose of 60 ml of Omnipaque 350 iv, while the control group of 55 patients received the usual 80 cc of Omnipaque 350 iv as suggested on the package insert. All CTs were done on a Siemens Somatom Definition Flash scanner or Siemens Somatom AS 64 with the same parameters: 100kV, 300-400 mA, 3 mm slice thickness, 12/3200 window width, data collection diameter 500. Three neuroradiologists blinded to the amount of injected contrast material rated the CT scans for image quality and lesion detection using a 5-point Likert scale. Readings were controlled for age and gender. Visibility of six anatomic structures was recorded by each reader. Inter-rater reliability was tested using intra class correlation (ICC, two-way random effect model, single rater, agreement) based on the 95% confidence interval of ICC estimates. Multiple linear regression was used to predict overall diagnostic accuracy.

#### RESULTS

Readers' ratings had a high intra class correlation coefficient (ICC) value of 0.873 (CI 95% 0.831-0.908). No significant demographic or clinical differences were noted between the two groups. The 80cc group had significantly higher enhancement ratings compared to the 60cc group for six anatomical structures. However the mean difference scores between the study group and the control group for the six items were less than 0.5 ( $p < 0.001$ ).

#### CONCLUSION

The rankings of the raters for both the test and control groups did not differ significantly. Therefore, the overall diagnostic quality did not show a clinically significant difference between the two groups. The potential advantages of reduced contrast volume include shortened scan duration, lower radiation exposure, lower risk of adverse effects such as contrast induced nephropathy or cardiac failure, and cost minimization. Conservation of iodinated contrast media is a timely concern given the recent global shortage of iodinated contrast material in the year 2022.

#### CLINICAL RELEVANCE/APPLICATION

Reduced IV contrast volume for brain CT yields accurate imaging, may reduce adverse effects (nephropathy or cardiac failure), is cost minimizing, has shorter scan times, and mitigates future supply chain contrast shortages.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPPD-1

### Developing an Evidenced-Based Pediatric Pituitary Magnetic Resonance Imaging Protocol: How We Did It

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Michael Nance, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a protocol to facilitate appropriate intravenous contrast use based on various pediatric pituitary imaging indications.

#### METHODS AND MATERIALS

A retrospective review of pediatric pituitary MRI protocols at Children's Healthcare of Atlanta was performed from July 2021 to June 2022 using the Empower database and review of patient records. Information for ordering specialty, imaging indication, and MRI protocol including the use of Gadolinium (Gd) were obtained. A comprehensive systematic and manual literature search was performed. PubMed MESH search criteria: (pediatrics OR child) AND magnetic resonance imaging AND (sella OR pituitary OR hypophysis), and patient age from newborn (birth-1 month) to adolescent (13-18 years). Included articles informed the magnetic resonance imaging technique for: precocious puberty, hypopituitarism, septo-optic dysplasia, Sellar mass, diabetes insipidus and pituitary adenoma. The systematic search resulted in 1,778 citations which yielded 57 articles after screening inclusion/exclusion criteria. Manual search contributed an additional 18 articles.

#### RESULTS

From July 2021 to June 2022, a total of 375 studies were performed (235 female, 140 male) with an age range of 6 weeks to 20 years (mean 10.7 years). The most frequent imaging indications were growth hormone deficiency (GHD) (44.1%) followed by precocious puberty (33.2%). Other indications included adenoma (13.1%) and pituitary mass (9.6%). Ordering provider specialty was predominantly endocrinology (70.9%). A total of 284 studies were ordered with Gd (75%). Based on indication, there was substantial institutional variance in the use of Gd. Adenoma (96% with Gd), GHD (59% with Gd), mass (75% with Gd), and precocious puberty (90% with Gd). Preliminary review of the literature also showed variation with included references describing Gd use in 93.3% (28/30) for pituitary mass, 50% (13/26) for hypopituitary/GHD, and 80% (4/5) for precocious puberty.

#### CONCLUSION

Standardized pediatric pituitary imaging protocols are not widely available potentially causing variance in the diagnostic efficacy. We demonstrate that there is substantial intra-institutional variance in the use of Gd based on pediatric pituitary imaging indication at a single institution quaternary children's hospital. We developed imaging protocol recommendations for each pituitary imaging indication based on our literature review. This will be presented to our endocrinologists for review and modifications to meet our local practice demands.

#### CLINICAL RELEVANCE/APPLICATION

We developed an institutional evidenced based pediatric pituitary imaging protocol to inform the appropriate use of Gd contrast for diagnostic efficacy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPPH-1

### Comparison of Scan Protocols with Different Automatic Exposure Control Software Using Water Equivalent Diameter Calculated from CT Images

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Hsiang-Chi Kuo, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study evaluated the patient dose and size difference when translating clinical scan protocols from one CT scanner to a new PETCT scanner with different automatic exposure control (AEC) software.

#### METHODS AND MATERIALS

Reference clinical protocols were built on a Philips big bore scanner (P) using 3D DOM version of Dose Right (DR) for AEC with different DR levels at various anatomical sites. These protocols were translated to a new Siemens Biograph V600 PETCT scanner (S) which utilizing CareDose 4D as AEC to modulate mAs in different strength from very weak to very strong with different Quality Reference mAs (Q. RefmAs). The average CareDose strength was applied. The RefmAs of the RT protocols from S were used with minor edits. An anthropomorphic phantom, wrapped with 0 and 5 cm bolus, was scanned using thorax and abdomen protocols at S and P scanners. The cross-sectional size of the phantom on the CT image was calculated as the water equivalent diameter (wED) based on the method described in AAPM TG 220 report. The CTDIvol for each slice was extracted from the DICOM header. The wED, and the CTDIvol data from each scanned protocol were statistically analyzed using the Spearman coefficient to determine the correlation. 85 patient scans on both scanners were compared to the CTDIvol as a function of wED across scanners and anatomical locations.

#### RESULTS

In phantom images' analysis, the P scanner using DR showed a higher correlation to wED ( $>0.83$  vs.  $<0.8$ ) than the S scanner, which applied RefmAs. Comparing the statistical results among protocols from both scanners, the subgroup of the scans from the same scanner (DR=17 vs. DR=21 vs. DR=25; Thorax Q. RefmAs=160 vs. Abdomen Q. RefmAs=250) showed a strong correlation (0.98). The scan results from different scanners (S vs. P) showed a weaker ( $<0.83$ ) correlation. Comparing patient scans, the images of the S scanner demonstrated a significantly higher exposure variance with wED and a sharper CTDIvol increase at wED between 25-30 cm resulting in a higher scanning dose with the pre-estimated patient size larger than ~28 cm. P scanner had a maximum exposure limit so that CTDIvol could be kept below 27.6 mGy in the body site. S scanner did not limit maximum exposure from software such that the CTDIvol exposure could be more than 40 mGy, and in the case when scanned with the hand positioned on the chest, the CTDIvol could be more than 60 mGy.

#### CONCLUSION

This study highlights that assessing CTDI vs. wED can be a practical approach to evaluating clinical scan protocols for different AEC software and scan protocols.

#### CLINICAL RELEVANCE/APPLICATION

Translating CT scan protocols.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPPH-10

### Patient-specific Analysis of Organ Doses and Image Quality in Abdominal Single Energy and Dual Energy CT Examinations

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Keisuke Fujii, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aims of this study are to evaluate organ doses for individual patients in abdominal CT examinations with conventional 120 kV single energy CT (SECT) and 80/135 kV dual energy CT (DECT), and to compare organ doses and image quality of the CT images in DECT scans with them in SECT scans.

#### METHODS AND MATERIALS

Monte Carlo (MC) simulations for each voxelized phantom of 40 adult normal weight and overweight patients undergoing abdominal CT examinations with Aquilion Precision as a SECT scanner and Aquilion ONE / PRISM Edition as a DECT scanner (Canon Medical Systems) were performed by inputting the CT images, descriptions of each CT scanner, and scanning parameters including our estimated tube current modulation profiles into MC simulation software ImpactMC (Advanced Breast CT, GmbH). Region of interests (ROI) of seven radiosensitive organs (thyroid, lung, esophagus, breast, liver, stomach, and bladder) were set on the simulated dose distribution images, and organ doses for each organ were calculated as average doses within each organ ROI. Next, we evaluated image quality of abdominal CT images from SECT scans and 70 keV virtual monochromatic images (VMI) images from DECT scans, which were reconstructed with deep learning reconstruction algorithms. We set ROIs on liver region of plain SECT and VMI images, applied moving average filters in the ROI, and evaluated apparent noise (which showed the correlation with the subjective recognition of image noise on CT images) from standard deviation of the mean CT values for each filter size. Image contrast was calculated as differences between CT values of aorta at the early phase and those of liver region on plain SECT and VMI images, and contrast-to-noise ratio (CNR) was also calculated as the ratio of the contrast and apparent noise of each image.

#### RESULTS

Organ doses for liver and stomach within scan range of normal and overweight patients in abdominal SECT scans were 22-32 mGy while the organ doses for the patients in abdominal DECT scans were 16-21 mGy. Apparent noise of the VMI images obtained from DECT scans was approximately 30% lower than that of SECT images, and contrast of the VMI images was approximately 30% higher than that of SECT images. From these results, CNR of the VMI images was approximately 2 times higher than that of SECT images.

#### CONCLUSION

DECT examinations allows for the reduction of organ doses for organs within scan range by approximately 30% compared to conventional SECT examinations, and VMI images obtained from DECT scans also provides higher signal detectability than SECT images.

#### CLINICAL RELEVANCE/APPLICATION

DECT examinations can be performed with lower radiation doses than conventional SECT examinations, and VMI images obtained from DECT scans can provide higher signal detectability than SECT images.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH-11

### Ultra-low Dose CT Imaging with a Denoising AI model in Body Composition Analysis

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Hooney D. Min, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Body composition analysis (BCA) is a crucial clinical application. CT is regarded as the gold standard for BCA, but DEXA is more common due to lower radiation exposure. This study evaluated the feasibility of using an ultra-low dose CT protocol with a denoising AI model to reduce radiation exposure without compromising reliability.

#### METHODS AND MATERIALS

A prospective study of 100 subjects (26 males and 74 females, aged 23-62 years, mean BMI:  $23.2 \pm 3.25$  kg/m<sup>2</sup>) was conducted. Participants underwent a standard dose CT scan (120 mAs, 120 kVp, 0.066 mSv) and were randomly assigned a second CT scan with varying doses: 1) standard dose: 0.066 mSv, 2) half dose: 0.034 mSv, 3) quarter dose: 0.018 mSv, 4) ultra-low dose: 0.007 mSv. All effective doses included a scout view, obtained with a tin filter. Ultra-low dose CT used 10mAs, the lowest achievable on CT. CT scans captured a single 5 mm slice thickness axial image at the third lumbar spine. Standard dose CT scans were reconstructed using the Filtered Back Projection (FBP) method. Low dose CT images were reconstructed using the FBP method and a denoising AI model. CT scans were segmented using a commercially available software to obtain areas relevant to BCA (muscle, subcutaneous fat, and visceral fat). Intraclass correlation was used to compare BCA area values from low dose CT images to that of standard dose CTs. Muscle area was further divided into normal attenuation muscle (NAM) and low attenuation muscle (LAM). Wilcoxon signed rank test was used to compare NAM and LAM values from low dose CT images to that of standard dose CTs.

#### RESULTS

Body composition parameters (muscle, subcutaneous fat, and visceral fat) from low dose CT scans (even without denoising) demonstrated high agreement with standard-dose CT scans, with intraclass correlation coefficients exceeding 0.95. Total muscle area was uniform across doses, but when divided into NAM and LAM, NAM was underestimated and LAM was overestimated as CT dose became lower. NAM and LAM values differed significantly in low-dose CTs compared to standard-dose CTs. The denoising AI model decreased the differences in NAM and LAM area at half-dose CTs ( $p > 0.05$ ).

#### CONCLUSION

Ultra-low dose CT provided accurate BCA without added radiation exposure, even without AI denoising. A denoising AI model enhanced the accuracy in differentiating LAM and NAM in low dose CT scans.

#### CLINICAL RELEVANCE/APPLICATION

Ultra-low dose CT imaging (0.007 mSv) offers accurate and safe BCA with a lower effective dose than a single DEXA scan (0.013 mSv), suggesting better BCA without additional radiation exposure.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH-12

### Improved Detectability of Low Contrast Objects with Deep Learning-based Denoising on Legacy CT Machine: A 10-Reader Phantom study

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Jisu Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to assess the detectability of low-contrast objects through a human reader test by comparing denoised images obtained from a legacy CT machine with those acquired from a recent CT machine. Additionally, the study compares the low contrast detectability of the original and denoised images obtained from the legacy CT machine.

#### METHODS AND MATERIALS

A Catphan® low-contrast phantom module was used for evaluation, with an added soft tissue-mimicking ring, resulting in a total phantom diameter of 30 cm (simulating adult body size). Images were acquired using a legacy CT machine (Philips Brilliance 64) set to 12mGy and a recent CT machine (Siemens Force) set to 32mGy. The images were reconstructed using the Filtered Back Projection (FBP) method. A vendor-agnostic deep learning-based denoising model was employed to process the images from the legacy CT machine. Based on the sample size calculation using a non-inferiority test with a non-inferiority margin of 0.05 in the area under the curve (AUC), 10 human readers and 100 images were required for each setting (denoised and original 12mGy images on legacy CT, and original 32mGy images on recent CT), resulting in a total of 300 images being tested. Of the 100 images, 50 were set to include a 15 mm object with a contrast of 10 HU, and 50 were set to not include. Ten radiologists with varying years of experience evaluated the images using a 5-point Likert scale for the presence of the object, and AUC values were calculated for each setting. A non-inferiority test was performed to compare denoised images with images obtained from the recent CT. An additional superiority test was performed between denoised and original FBP images acquired from the legacy CT.

#### RESULTS

The AUC for the original FBP image from the legacy CT was 0.895, while the denoised image from the same machine had an AUC of 0.988. The recent CT had an AUC of 0.993. The low-contrast detectability of denoised FBP images from the legacy CT was found to be non-inferior to the FBP images obtained from the recent CT ( $p < 0.01$ ). Furthermore, denoised FBP images exhibited superior low-contrast detectability compared to the original FBP images acquired from the legacy CT ( $p < 0.01$ ).

#### CONCLUSION

The deep learning-based denoising model significantly improved low-contrast detectability on legacy CT and was non-inferior to images obtained from recent CT.

#### CLINICAL RELEVANCE/APPLICATION

The application of this vendor-agnostic denoising model may offer a potential solution to improve the detectability of low-contrast objects in clinical settings that still use legacy CT machines.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH-2

### Agreement of Size-specific Dose Prediction and Site-specific Diagnostic Reference Level in Adult Abdominal CT Examinations

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Shengwen Deng, PHD (*Presenter*) Nothing to Disclose

#### PURPOSE

CT doses range across population can be predicted prospectively with size-specific phantoms or reviewed in dose monitoring software, but the agreement between the two methods lack large population confirmation<sup>1</sup>. We aimed to compare predicted size-specific dose to reported values across multiple vendors in our hospital system, and also, to develop strategies to convert between size-specific prediction with Mercury phantom and retrospective site-specific local diagnostic reference level.

#### METHODS AND MATERIALS

The overall study design was illustrated (Fig a). Diagnostic reference levels across academic hospitals (n=9) and community sites (n=13) in the past 3 years were quantified with quantile summary of CTDIvol for different BMI groups (n>30 per group), using de-identified meta-data from dose monitoring software (DoseTrack, Sectra, Fig b), retrospectively. Patient sizes (water equivalent diameter, Dw) in Mercury 4.0 phantom were converted to BMI with a reported equation<sup>2</sup>, with an assumed error of 10%. The phantom was scanned using clinical abdomen protocols with identical tube current modulation settings (reference mAs, DRI or CareDose Index, n=11). Phantom CTDIvol and Dw were calculated with imQuest<sup>3</sup>. The distributions of CTDIvol for different patient sizes from DoseTrack were compared with phantom-acquired CTDIvol data.

#### RESULTS

Retrospective DRLs across hospitals (academic vs community) and vendors (Philips vs Siemens) were shown (Fig c,d), generally agree within BMI groups. Phantom scans with same protocols had lower CTDIvol across all patient sizes compared to local DRL. For Siemens, considerable agreement of median CTDIvol between predicted and reported was identified (3.4 ±1.8% for academic, 5.3 ±1.8% for community). For Philips, maximum CTDIvol predicted was close to DRL reported median CTDIvol (9.1 ± 5.7% for academic, 6.9 ±5.4% for community).

#### CONCLUSION

Size-specific CTDIvol estimated with Mercury phantom has considerable agreement with actual dose range of respective BMI population, with conversion of BMI and Dw. It is feasible to use size-specific phantom to estimate retrospective site-specific dose distribution, with proper optimization for different vendors and protocols.

#### CLINICAL RELEVANCE/APPLICATION

Estimating CT dose range prospectively is crucial for imaging protocol optimization. Our findings suggest it is feasible to predict population patient-size-specific CTDIvol for tube-current modulated protocols using size-specific phantom.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH-3

### Application of Deep Learning Image Reconstruction Algorithm to Reduce Radiation Dose in Brain CT Perfusion

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Fang Wang, PhD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To improve the improvement of deep learning image reconstruction (DLIR) algorithm in CT perfusion (CTP) in suspected acute stroke.

#### METHODS AND MATERIALS

Patients with suspected acute ischemic stroke were selected for CTP imaging. Scanning tube voltage was 80 kV and low dose current was set at 50 mA. Image reconstruction of low-dose scan data was performed using hybrid iterative reconstruction-40% (ASiR-V) and DLIR intensity (medium and high), respectively. Perfusion parameters were reconstructed for three sequential images: cerebral blood flow (CBF), brain volume (CBV) and mean passage time (MTT). Comparing the differences in parameter means and correlation of the 3 sequences. Objective evaluation and subjective evaluation (integral system) Image quality: objective evaluation mainly measures the CT value and noise of the lateral ventricle and middle cerebral artery during the peak period, calculates the signal-to-noise ratio (SNR) and contrast noise ratio (CNR); measurement data are expressed in the form of "median  $\pm$  quartile", and the objective score of the peak images of the three groups are compared. Differences between groups were compared by Friedman test and pairwise comparisons by Wilcoxon signed rank test with bonferroni correction, and  $P < 0.05$  was considered statistically significant.

#### RESULTS

40% CBF and CBV differences for sir-v, DLIR-M in frontal, temporal, occipital and basal ganglia ( $36.5 \pm 12.3$  vs  $30.2 \pm 7.8$  vs  $33.6 \pm 9.4$ ,  $p < 0.001$ )( $2.5 \pm 0.4$  vs  $1.8 \pm 0.3$  vs  $2.1 \pm 0.5$ ,  $p < 0.001$ ), And the mean CBF and CBV in order from large to small: 40% Air-v > DLIR-H > DLIR-M, Pairwise comparisons were statistically different ( $P < 0.05$ ). The three perfusion parameters of the DLIR sequence were correlated with 40% AIDS-v ( $P < 0.05$ ), and the CBF and CBV values (R values) for the 40% AR-v were higher (0.84,0.66) than the DLIR-M sequence (0.50,0.61). SD values in DLIR-M and DLIR-H arteries were lower than 40% Asia-v ( $P < 0.001$ ), with the highest SNR and CNR in the DLIR-H sequence ( $p < 0.001$ ).

#### CONCLUSION

DLIR-H can significantly improve the peak period image quality of low-dose cerebral CTP arteries, and the reconstructed perfusion parameters are better correlated with 40% Asia-v.

#### CLINICAL RELEVANCE/APPLICATION

The DLIR reconstruction algorithm can improve the image quality of arterial vessels during the peak period without affecting the accuracy of perfusion parameters, and further validate that the reconstruction algorithm of DLIR-H is more suitable for intracranial vessels.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH-5

### Clinical Value of Deep Learning Image Reconstruction in the Diagnosis of Pulmonary Nodule in Ultra-low Dose Chest CT

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Zheng Zhijuan (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the image quality, lung nodule detectability and accuracy of quantitative analysis of deep learning image reconstruction (DLIR) and adaptive statistical iterative reconstruction-Veo (ASIR-V) in Ultra-low dose (ULD) CT for helping large-scale lung cancer screening in clinical.

#### METHODS AND MATERIALS

102 patients required lung examination who underwent simultaneously non-contrast ULD CT and standard chest CT scan were included in this prospective study. Standard chest CT was reference standard using ASIR-V at 50% strength (50%ASIR-V). They are divided into two groups: ULD CT scanning were divided into two groups: ULD-CT (UL-A group, n= 46, 100 kVp and 50mA) using 50%ASIR-V and DLIR at high level (DLIR-H); ULD-CT (UL-B group, n = 56, 100 kVp and 30 mA) using 50%ASIR-V and DLIR-H. Radiologists detected and measured nodules. The size, maximum layer area, volume, maximum floor area, 3D long diameter, CT value and standard deviation (SD) of nodules were measured. The signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were to calculate. Two experienced radiologists were subjectively scored image quality and special morphological signs of partial pulmonary nodules using a 5-point method. The Difference between ULD and reference images were compared.

#### RESULTS

304 nodules in 294 (96.71%) for UL-A group (50%ASIR-V and DLIR-H), 297 nodules in 280 (94.28%) for UL-B group (50%ASIR-V and DLIR-H) were detected. The detection rate of solid nodules of 99.59%, pure ground glass nodules of 84.48%, and partial solid nodules of 100% for UL-A group, and the detection rate of solid nodules of 97.19%, pure ground glass nodules of 78.26% and partial solid nodules of 100% for UL-B group, respectively, with the same performance observed at different nodule types between 50%ASIR and DLIR. There were no differences in the size, CT value, SD, total volume, maximum layer area, and 3D long diameter of pure ground glass nodules and solid nodules and SNR in low-dose and standard-dose images for UL-A and UL-B group ( $p>0.05$ ). The DLIR-H images had significantly higher CNR of nodules, lower lung tissue noise than ASIR-V% images for UL-A and LU-B group (all  $P < 0.001$ ). There was no difference in the subjective score of overall image quality between ASIR-V and DLIR-H for UL-A and UL-B group ( $p>0.05$ ).

#### CONCLUSION

Compared with ASIR-V, DLIR-H can significantly improve image quality. The lung lesion measurements in ULD CT scan images based on DLIR reconstruction have high correlation and low difference with CT images of standard dose.

#### CLINICAL RELEVANCE/APPLICATION

DLIR can reduce the noise of CT images and provide high image quality. Low-dose chest CT combined with DLIR is conducive to the wide clinical application under the condition of greatly reducing radiation dose.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH-6

### Impact of the Third Generation and Deep Learning Iterative Reconstructions on Spatial Resolution with Dual energy CT-Dependency on Contrast and Dose

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Yifang Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The effects of third generation and deep learning iterative reconstruction (ASIR-V and DLIR) are non-linear. The degree of the impact may depend on the lesion contrast and radiation dose. The objective of this study was to quantify this impact in the context of spatial resolution versus noise reduction.

#### METHODS AND MATERIALS

An anthropomorphic liver phantom was used. The liver contains various lesions of different contrast and shapes. The phantom was scanned using a GE Revolution CT at the dual-energy mode with CTDIvol of 14 mGy and 5.6 mGy (slice thickness 2.5 mm). ASIR-V from 0 to 100% and DLIR low, medium, and high were applied to images reconstructed using 70 keV. Thin rectangular regions of interest (ROI of 3 pixels width) were drawn across the boundary of the selected lesions and the horizontal profiles were obtained. The average slopes of the profiles were used as a metric delineating the lesion edge sharpness (a surrogate for spatial resolution). Meanwhile, the contrast-to-noise ratio (CNR) and noise suppression ratio (NSR), defined as the noise divided by noise at ASIR-V 0 of each lesion were also measured at both doses. For each lesion, the normalized edge sharpness was defined as the profile slope divided by the slope at ASIR-V 0 and CTDIvol of 14 mGy.

#### RESULTS

The lesion edge sharpness was found significantly reduced at low dose (5.6 mGy). The application of ASIR-V and DLIR further reduced the sharpness albeit improving CNR, but DLIR enhanced the sharpness as compared with higher ASIR-V fractions (above 70%) with improved NSR. Furthermore, the effect of ASIR-V and DLIR depends on the contrast itself: the lower the contrast is, the more blurred the edge is. For the contrast higher than 70 HU, the edge blurring is much less. In addition, the noise suppression was also contrast dependent with the biggest suppression at lowest contrast.

#### CONCLUSION

The degree of spatial resolution loss was found to be dependent on the lesion contrast and radiation dose for a given ASIR-V fraction or DLIR strength. The noise suppression also increases as the contrast decreases. DLIR enhances the sharpness as compared with higher ASIR-V fractions (above 70%) with improved NSR.

#### CLINICAL RELEVANCE/APPLICATION

Assist adequate use of iterative reconstructions for low contrast lesions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPPH-7

### Assessment of Semi-automatic Whole-body Fat Quantification Using Ultra Low Dose CT Using Iterative and Artificial Intelligence-based Reconstruction in an In-vivo Swine Model: An Intra Individual Analysis

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Josephine Berger (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the stability of semi-automatic body fat quantification in real low-dose swine CT scans using iterative and AI-based reconstruction.

#### METHODS AND MATERIALS

Ten sedated swines received CT scans with fixed tube voltage and tube-current on the same 3rd generation dual-source scanner. Consecutive scans with reduced mAs to 50%, 25%, 10%, and 5% were performed. All scans were reconstructed using iterative reconstruction strength 2 (IR2) and a novel AI-based reconstruction algorithm (AIR), resulting in 10 datasets per swine. 100% IR2 served as the reference standard. Whole-body fat tissue volume was measured using threshold-based semi-automated segmentation (-200 HU to -40 HU). Total body fat volume, mean HU values and noise (standard deviation of HU) were extracted and compared via adequately corrected mixed-effects analysis.

#### RESULTS

The volumetric segmentations were stable down to 25% ( $p=0.104$ ) using IR2 and down to 5% with AIR. Compared to the reference standard, mixed effects analysis showed stable CT values in both groups down to 10% mAs but significant HU bias at 5% IR2 ( $p<0.001$ ), while AIR results were still stable ( $p=0.136$ ). Both datasets had significantly increased image noise at lower radiation doses. Interestingly, 25% AIR produced similar noise to 100% IR2.

#### CONCLUSION

Body fat volume analysis is possible down to 25% radiation dose using conventional iterative reconstruction, although there is significantly higher image noise. AI-based reconstruction mitigates this limitation at the same dose level by enabling comparable noise levels to 100% IR2. Furthermore, AI-based reconstruction preserves CT values and volumetric results better than iterative reconstruction at only 5% mAs.

#### CLINICAL RELEVANCE/APPLICATION

In conclusion, our study strongly suggests that by employing AI-based reconstruction, accurate semi-automated quantification of adipose tissue volume can be accomplished with minimal radiation exposure to the patient, thus further empowering CT as a valuable tool in body composition analysis.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH-8

### Impact of the Tube Start Angle on Patient Dose in Single and Dual Source Spiral CT

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Edith Baader (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the radiation dose in single source CT (SSCT) and dual source CT (DSCT) scans as a function of tube start angle and spiral pitch value to identify the dose reduction potential by selecting the optimal start angle.

#### METHODS AND MATERIALS

Previous studies have shown that dose to certain radiosensitive organs in spiral CT scans could substantially be reduced by optimizing the tube start angle [MedPhys 36: 5654-5664, 2009][MedPhys 38(6):3177-85, 2011]. This applies particularly to small peripheral organs. This study investigates the impact of the tube start angle on the effective dose as a measure of the overall radiation risk. Furthermore, in addition to SSCT systems with constant tube current (noTCM) as in the previous studies, also today's standard tube current modulation minimizing the mAs-product (mAsTCM) and DSCT systems were considered. Using Monte Carlo simulations, dose values for different tube positions with an angular increment of 10° and a longitudinal increment of 5 mm were simulated in the thorax region of six adult patients based on clinical CT data. The thorax region was chosen as short scan times and thus high pitch values are particularly relevant in this body region; in total, dose simulations were performed over a scan range of 35 cm with a collimation of 38.4 mm. From the resulting dose distributions, organ doses and effective dose were determined as a function of tube angle and longitudinal position. Using these per view dose data, the individual organ doses, as well as the total effective dose, were determined for spiral scans with (mAsTCM) and without (noTCM) tube current modulation with pitch values ranging from  $p=0.5$  to 1.5 for SSCT and up to  $p=3.0$  for DSCT. The dose reduction of the optimal start angle relative to the worst start angle in terms of dose was determined.

#### RESULTS

Dose reductions for single organs are highly organ-specific. While the tube start angle affects the lung dose less than 5%, higher variations occur e.g. for the dose to the thyroid gland and the stomach. The impact of mAsTCM depends on the organ and the pitch value; however, the dose reductions are in the same order of magnitude. For the effective dose, dose reductions of up to 7% for SSCT and up to 20% for DSCT can be achieved in particular for high pitch values when selecting the optimal start angle for the simulated patients.

#### CONCLUSION

Variation of the tube start angle in spiral scans exhibit substantial differences in radiation dose for high pitch values. Vendors should provide a method to automatically select the optimal scan start angle to minimize patient risk.

#### CLINICAL RELEVANCE/APPLICATION

By controlling the start angle in spiral scans, radiation dose to various organs and effective dose and thus patient risk can be significantly reduced.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPPH-9

### Fetal Doses in the Most Frequent Diagnostic Radiology Procedures in a Pregnant Patient: Results of In-phantom Measurements

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Vjekoslav Kopacin, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Emergencies during pregnancy do happen! Cardio/cerebrovascular, urologic, GI emergencies and trauma can be singled out. The medical team may be in doubt when choosing proper diagnostic imaging that uses ionizing radiation, potentially causing a delay in diagnosis and treatment. The purpose of this research was to experimentally measure the dose to the fetus during diagnostic imaging and fluoroscopy-guided minimally invasive procedure on a newly developed, anthropomorphic phantom of a pregnant female.

#### METHODS AND MATERIALS

A Tena phantom, representing a pregnant female in 2nd trimester, was scanned with imaging modalities that use ionizing radiation (Figure 1). Appropriate protocols for probable clinical emergencies in pregnant females were used: NC CT and CTA in stroke protocol, DSA in ischemic stroke endovascular treatment, PA CTA, trauma CT, abdomen/pelvis NC CT, abdominal radiography and fluoroscopy in nephrostomy placement. RPL dosimeters were placed in the fetal head and body, placenta and adjacent structures of interest, and experimental measurements were performed.

#### RESULTS

The highest measured doses in the fetal head and body were recorded in the trauma CT and abdomen/pelvis NC CT. 34,7 mGy and 23,7 mGy were measured in the head, and 32,5 mGy and 19,6 mGy in the body. In all other scanning protocols, the dose to the fetal head and body did not exceed 2 mGy.

#### CONCLUSION

For most imaging scenarios, measured fetal doses were below 2 mGy except in scanning protocols where the fetus was in the field of direct ionizing radiation. The highest measured dose to the fetal head of 34,7 mGy in the performed WBCT was below 50 mGy and well below the 100 mGy recommended by the ICRP above which the deterministic effects on the developing fetus rise. The measured fetal doses for all clinical scenarios are consistent with published data.

It should be kept in mind that the fetus in a developed phantom is with its head faced cranially. As fetuses in 2<sup>nd</sup> trimester are freely movable in the uterus, in a different position, measured doses could be even lower. The research has limitations as it can be seen as a case report. Patient-specific physical phantoms and computational models are time-consuming and matching anthropomorphic physical phantoms to the size and location of the fetus within the maternal body is almost impossible. This is the reason why faster methods are used for fetal dose estimation in clinical practice. Such methods usually use typical doses from references or use one of a number of available dosimetry software.

#### CLINICAL RELEVANCE/APPLICATION

Although there have been guidelines that state how it is possible to carry out imaging diagnostics based on ionizing radiation in pregnant women, their application may still cause anxiety to some radiologists.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPVA-1

### The Application Value of Black Blood Imaging Based on CT Flexible Subtraction Technology in Carotid Artery

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Tao Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

The CT black blood images may potentially offer more insightful information. In this study, we utilized MR vessel wall imaging of carotid arteries as a gold standard to investigate the improvement effect of carotid soft plaque image quality in CT black blood images.

#### METHODS AND MATERIALS

After carotid artery CT angiography (CTA) examination, the images underwent reverse flexible contrast enhancement and CE-BOOST technology to achieve CT black blood. The study was divided into four groups, with Group A being the cervical artery CTA examination group, Group B being the CTA delayed scan group, Group C being the CT black blood group with image reconstruction after 4 minutes and 30 seconds of delay, and Group D being the MR vascular wall imaging group. The subjective evaluation score was 5 points, analyzing multiple dimensions such as the lumen display's clarity, the vessel wall's sharpness, and the presence of plaques. The objective scoring was conducted on the neck artery CTA images, CTA delayed scanning group, and CT black-blood group. The evaluation was based on the SD value of the cervical artery plaque lesion adjacent to the sternocleidomastoid muscle,  $CNR = \frac{CT_{lumen} - CT_{sternocleidomastoid\ muscle}}{SD_{sternocleidomastoid\ muscle}}$ , and  $SNR = \frac{CT_{lumen}}{SD_{lumen}}$ . We conducted the one-way ANOVA, the non-parametric test and Kappa analysis for subjective evaluation score, with  $p < 0.05$  indicating a statistically significant difference.

#### RESULTS

The study included a total of 20 patients, of whom 12 were male and 8 were female, with an average age of 63 years. The differences in BMI (23.3 vs. 23.5 vs. 24.0) were not statistically significant ( $p < 0.05$ ). Objective scoring: in the comparison between groups A, B, and C, group A showed advantages in CNR ( $88.64 \pm 30.14$  vs.  $3.74 \pm 3.85$  vs.  $-50.25 \pm 15.44$ ,  $p = 0.000$ ) and in SNR ( $61.27 \pm 27.60$  vs.  $6.99 \pm 3.91$  vs.  $-19.50 \pm 6.91$ ,  $p = 0.000$ ); there was no statistically significant difference in SD values ( $5.29 \pm 1.34$  vs.  $5.28 \pm 2.36$  vs.  $3.96 \pm 1.24$ ,  $p = 0.487$ ). Subjective scoring: group D > group C > group A > group B, (4.8 vs. 4.3 vs. 4 vs. 3.6,  $p = 0.025$ ).

#### CONCLUSION

Flexible contrast-enhanced cervical artery CT black blood imaging has a high diagnostic value with a transparent vessel wall and plaque morphology display. Its diagnostic value is superior to conventional CTA scans. Therefore, we recommend adding a delayed scan with flexible contrast-enhanced CT black blood imaging during cervical artery CTA scanning.

#### CLINICAL RELEVANCE/APPLICATION

The CT black-blood imaging technology of the carotid arteries enables clear visualization of the anatomy and structure of the vessel wall, overcoming the limitations of traditional carotid CTA. Compared with MR vascular wall imaging, CT black-blood imaging of the carotid arteries also has good diagnostic value.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPVA-2

### Performance of an Artificial Intelligence Algorithm for Quantifying the Maximum Thoracic Aortic Diameter in Patients with Aortic Pathologies

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Nicola Fink, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Given the high mortality associated with acute aortic events, early detection and appropriate monitoring of aortic dilatation and aneurysm are crucial. However, accurate follow-up CT measurements remain tedious and time-consuming. In this context, artificial intelligence (AI) reduces missed findings and inter-/intra-reader variability. However, most studies evaluated this at predefined landmarks only, which may not necessarily correspond to the largest diameter. This study aimed to assess the performance of a deep neural network (DNN)-based algorithm in quantifying aortic diameters at the most dilated location in a heterogeneous population.

#### METHODS AND MATERIALS

A total of 100 patients (67.2 [56.0-73.4] years; 60.0% male) with thoracic aortic dilatation/aneurysm were scanned according to institutional CT protocols. Nearly two third of the included patients (n=62) had pathologic findings of the thoracic aorta due to prior repair (n=29 surgical; n=17 endovascular; n=10 both) and/or aortic dissection (n=42). Segmentation and measurements of the thoracic ascending (AA) and descending Aorta (DA) were performed on non- and contrast-enhanced CT scans using a combination of multiple DNN models which were previously trained on 1582 CT datasets. All measurements were compared to manual measurements performed by two radiologists, overall as well as in the following subgroups: 1) AA vs. DA; 2) non-obese vs. obese patients (BMI=30kg/m<sup>2</sup>); 3) patients without vs. with aortic repair; 4) patients without vs. with aortic dissection.

#### RESULTS

Mean AI-based automated and manual diameters significantly differed (non-contrast: 40.9mm [37.3-48.2] vs. 42.9mm [38.9-50.0],  $p<0.001$ ; contrast-enhanced: 40.9mm [37.3-48.2] vs. 40.3mm [36.6-46.9],  $p<0.01$ ) but showed excellent correlation and agreement ( $r>0.85$ ;  $ICC>0.9$ ). Depending on the subgroup, automated and manual values were similar in the AA but significantly different in the DA ( $p<0.001$ ), similar in obese but significantly different in non-obese patients ( $p<0.01$ ), and similar in patient without aortic repair or dissection but significantly different in patients with such pathological conditions of the aorta ( $p<0.001$ ). However, in all subgroups automated diameters showed strong correlation and excellent agreement with corresponding manual values ( $r>0.84$ ;  $ICC>0.9$ ).

#### CONCLUSION

This DNN-based algorithm enables accurate automated assessment of the largest aortic diameter in a heterogeneous patient population with various aortic pathologies.

#### CLINICAL RELEVANCE/APPLICATION

By showing high agreement with manual measurements, this algorithm offers the possibility to support radiologists in clinical practice, thus increasing efficiency, with good results even in a heterogeneous population.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPBR-1

### Comparison of Advanced Breast Cancers by Ethnicity: Digital Breast Tomosynthesis versus Digital Mammography

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Increasing early detection of nonlethal breast cancers is the main function of screening. Advanced cancers - characterized by larger size, lymph node involvement, or aggressive molecular subtypes - are those that carry a worse prognosis. Our prior data demonstrated a significant decrease in the rate of advanced cancers with digital breast tomosynthesis (DBT) screening compared with 2D full-field digital mammography (DM). The purpose of this study was to examine how the rate of advanced cancers varied with patient race/ethnicity.

#### METHODS AND MATERIALS

Our detailed database of 1407 breast cancers (142 DM, 1265 DBT) was analyzed over 13 years (DM 2008-2011, DBT 2011-2021) of screening with DBT was analyzed. Advanced cancers were defined by TMIST criteria (invasive cancers >2cm, HER2+ or triple negative cancers >1cm, one or more positive axillary lymph nodes, distant organ spread). The rates of advanced compared with non-advanced cancers were assessed by patient race/ethnicity. Statistical analysis was performed using unpaired T-tests and Chi Square with  $p < 0.05$  considered significant.

#### RESULTS

Of 1265 DBT cancers, race/ethnicity data was available in 1246 (98.5%) and was as follows: 935 (75%) White, 177 (14%) Black, 73 (6%) Hispanic, 28 (2%) Asian, 33 (3%) other. Of 968 invasive cancers, the ethnicity data was available in 952 (98.3%): 732 (77%) White, 129 (14%) Black, 45 (5%) Hispanic, 18 (2%) Asian, 28 (3%) other. Of the 968 invasive cancers, 316 (32.6%) were considered advanced. The rate of advanced to non-advanced invasive cancers was not significantly different by ethnic group, although it trended higher among Black and Asian patients: White 230/732 (31.4%), Black 47/129 (36.4%), Hispanic 14/45 (31.1%), Asian 7/18 (38.9%), Other 8/28 (28.6%). Similarly for the DM cohort, no significant differences were noted in the rates of advanced cancers between ethnic groups: White 23/58 (39%), Black 9/15 (60%), Hispanic 3/9 (33%), Asian 1/3 (33%), other 7/14/(50%). However, when comparing the rates between DBT and DM, significant reduction was noted in the White and Black groups: White 31.1% vs 39% and Black 36.4% vs 60%, DBT vs DM respectively ( $p < 0.07$ ).

#### CONCLUSION

With DBT, advanced cancers rates varied slightly among ethnic groups but overall was not significantly different. However, when compared to DM screening, advanced cancers were significantly reduced in the White and Black populations.

#### CLINICAL RELEVANCE/APPLICATION

Screening with DBT helps reduce advanced cancers, particularly in the White and Black/African American populations.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5B-SPBR-3

### Breast Ultrasound Optimization Training for Radiology Residents Utilizing an Interactive Online Module

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Rebecca T. Sivarajah, MD (*Presenter*) Spouse, Medical Director, AstraZeneca PLC

#### PURPOSE

The primary goal of the project was to create an interactive online learning module to teach breast ultrasound optimization to radiology residents and then assess whether the learning module was effective at teaching these concepts to radiology residents.

#### METHODS AND MATERIALS

An on-line interactive module teaching concepts of breast ultrasound optimization was created by the lead author utilizing Articulate Storyline 3 Software. The on-line module included navigational toolbars, clickable parameters, and real breast ultrasound examples illustrating concepts of breast ultrasound optimization. Residents were assigned an anonymous study identification number. Participating radiology residents first filled out an on-line questionnaire asking them to rate their subjective breast ultrasound optimization knowledge. They then completed an on-line pre-test consisting of 24 multiple choice questions. Then, participants engaged in the interactive online training module. After completing the online training module, participants completed an online post-test (same questions as the pre-test). They also then completed a questionnaire rating new subjective breast ultrasound optimization knowledge and a questionnaire rating the effectiveness of the training module.

#### RESULTS

Overall pre-test mean test scores were 54.4 +/- 4.4% and overall post-test mean scores were 78.9 +/- 3.4%. The mean score significantly improved between the pre-test and post-test by 24.4% (95% CI: [14.2%, 34.6%], P=0.0002). The mean subjective knowledge score significantly improved between the pre-test and post-test by 1.4 (95% CI: [0.9,1.9], P less than 0.0001). Subjective satisfaction with the effectiveness of the module was high: 4.4 +/- 0.2 out of 5.

#### CONCLUSION

This study suggested that an interactive online module could be effective at teaching concepts of breast ultrasound optimization to radiology residents and that learners found it to be a useful activity.

#### CLINICAL RELEVANCE/APPLICATION

A breast ultrasound must be properly optimized to avoid errors in interpretation and management. Therefore, radiologists who perform breast ultrasound exams must be proficient at recognizing suboptimal images and be familiar with techniques used to optimize the breast ultrasound image. However, there is no formal program to teach these skills to radiology residents at our institution. In addition, it can be difficult to cover all of the detailed concepts of breast ultrasound optimization during a busy clinical day when scanning time and faculty teaching time can be limited. Online interactive modules can be helpful to teach such concepts allowing flexibility of learning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPBR-5

### Comparison of Automated Breast Ultrasound and Hand-held Breast Ultrasound in Preoperative Evaluation of Early-stage Breast Cancer: A Multicenter Prospective Study

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Ji Soo Choi, MD,PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare automatic breast ultrasound (ABUS) and hand-held breast ultrasound (HHUS) as an adjunct to full-field digital mammography (FFDM) for the preoperative evaluation of local tumor extent in women with newly diagnosed early-stage breast cancers

#### METHODS AND MATERIALS

This multicenter prospective study included consecutive women with early-stage breast cancers (clinical Tis, T1-2/N0) treated by surgery who had undergone ABUS and HHUS adjunct to FFDM for preoperative local tumor staging between Oct 2019 and Apr 2021. Radiologists independently sought the index cancer and additional ipsilateral and contralateral cancers using ABUS plus FFDM (ABUS/DM) or HHUS plus FFDM (HHUS/DM). Pathologic diagnoses of all suspected lesions were used as reference standards. Sensitivity and specificity obtained for ABUS/DM and HHUS/DM were compared. Noninferiority of ABUS/DM was assessed in sensitivity at a margin of 5%.

#### RESULTS

A total of 659 women (mean age, 50.5 years  $\pm$  9 [SD]) were included in the study. Seventy-nine women (12.0%, 79/659) exhibited additional cancers: 64 additional ipsilateral cancers (51 multifocal and 13 multicentric) and 15 contralateral cancers. For index cancers, both ABUS/DM and HHUS/DM showed sensitivities of 100%. ABUS/DM showed non-inferior sensitivity to HHUS/DM for additional ipsilateral cancers (71.9% [46/64] vs. 75.0% [48/64];  $P=0.617$ ) and higher sensitivity than HHUS/DM for contralateral cancers (86.7% [13/15] vs. 60.0% [9/15];  $P=0.046$ ). Specificities were not significantly different between ABUS/DM and HHUS/DM for both additional ipsilateral cancers (97.7% [581/595] vs. 97.0% [577/595];  $P=0.317$ ) and contralateral cancers (97.8% [630/644] vs. 98.3% [633/644];  $P=0.467$ ).

#### CONCLUSION

ABUS/DM showed non-inferior sensitivity to HHUS/DM with similar specificity in diagnosing additional ipsilateral and contralateral breast cancers in women with early-stage breast cancers. Thus, ABUS may be used as an alternative to HHUS as a preoperative staging tool for early-stage breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

There is limited literature on ABUS for preoperative evaluation of newly diagnosed breast cancer patients. ABUS may be used as an alternative to HHUS as a preoperative staging tool for early-stage breast cancer, for whom preoperative axillary US is not essential.

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## Abstract Archives of the RSNA, 2023

R5B-SPBR-6

### Using Artificial Intelligence To Assess The Risk Of Malignancy In Breast Lesions Identified On Second-Look Ultrasound

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Rachel M. Cruz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the results of an artificial intelligence (AI) algorithm-based software for predicting the risk of malignancy in breast lesions identified on second-look ultrasound.

#### METHODS AND MATERIALS

This was a retrospective and single-center study, approved by the Institutional Review Board, which evaluated 628 second-look ultrasound examinations performed between January and December 2022 at a reference cancer center. 486 cases were excluded because they did not have prior magnetic resonance imaging (MRI) or biopsy performed in the same institution, or because no corresponding lesion was found on second-look ultrasound. MRI and ultrasound features were classified according to the BI-RADS lexicon criteria. Subsequently, the images were analyzed using Koios DS Breast software (Koios Medical, USA). The software results were divided into: benign or probably benign (BIRADS 2/3), low or intermediate suspicion (BIRADS 4A/4B), high suspicion or probably malignant (BIRADS 4C/5). The histopathological result was considered the gold standard.

#### RESULTS

164 lesions from 142 patients were included. The mean age of the patients was 48 years (21-78 years) and the mean mass size on ultrasound was 17 mm (3-70 mm). At MRI, 25 lesions (15.2%) were classified as BIRADS 3, 120 (78.0%) as BIRADS 4, and 11 (6.7%) as BIRADS 5. At ultrasound, there were 93 masses (56.1%) and 72 non-mass findings (43.9%), of which 15 lesions (9.1%) were classified as BIRADS 3, 141 (86.0%) as BIRADS 4, and 8 (4.9%) as BIRADS 5. Analysis using the software classified 23 lesions (14.0%) as BIRADS 2/3, 113 (68.9%) as BIRADS 4A/4B, and 28 (17.1%) as BIRADS 4C/5. Core needle biopsy was performed in 129 (78.7%) and vacuum-assisted biopsy in 35 (21.3%), which yielded 131 (79.9%) benign histologic findings (24 with associated atypia) and 33 (20.1%) malignant results. None of the lesions classified as BIRADS 2/3 using the software were malignant, while 2 lesions classified as BIRADS 3 on MRI and 1 lesion classified as BIRADS 3 on ultrasound were malignant. The predictive positive value (PPV) of lesions classified as BIRADS 4A/4B and BIRADS 4C/5 by the software were 17.7% and 46.4%, respectively.

#### CONCLUSION

The AI software demonstrated high sensitivity to predict the risk of malignancy in lesions identified on second-look ultrasound, contributing to a more accurate indication of percutaneous biopsies. It can be used to avoid unnecessary biopsies in lesions classified as benign or probably benign (BIRADS 2/3).

#### CLINICAL RELEVANCE/APPLICATION

AI can be used to predict the risk of malignancy in lesions identified on second-look ultrasound, and to avoid unnecessary biopsies.

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## Abstract Archives of the RSNA, 2023

R5B-SPBR-7

### Multimodal Artificial Intelligence (AI) in Diagnostic Imaging: Added Value of Breast Ultrasound (US) in Symptomatic Patients

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Beatriu Reig, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to explore the accuracy of US alone, full-field digital mammography (FFDM) and/or digital breast tomosynthesis (DBT) alone, and multimodal AI in the diagnostic evaluation of the symptomatic patient.

#### METHODS AND MATERIALS

In this retrospective and IRB-approved study, our IRB-approved multimodal AI system included full-field digital mammography (FFDM), digital breast tomosynthesis (DBT) and hand-held breast ultrasound (US) examinations performed 2010-2020, with 1,964,416 exams in 324,978 patients. We used a patient-based training/validation/testing split of 60%/10%/30%. Our test set consisted of 1371 women (1490 exams) who underwent both diagnostic FFDM or FFDM/DBT with targeted ultrasound for a symptomatic indication (pain, palpable area of concern, nipple discharge). Accuracy of the AI system was evaluated for malignancy for DBT/FFDM alone, US alone, and multimodal AI by calculating AUROC, sensitivity, specificity, PPV and NPV. Cancer types (pathology-confirmed with 120 days of the imaging) detected by DBT/FFDM alone, US alone, and multimodal AI were compared. We dichotomized AI's probabilistic predictions into biopsy vs. no biopsy decisions by matching the clinical biopsy rates. Specificity was therefore standardized across categories.

#### RESULTS

Of 1,371 patients who underwent same day diagnostic FFDM/DBT and US (average age 54.4, standard deviation 11.63), the AI model AUROC for breast cancer detection was 0.956 for multimodal AI, 0.864 for FFDM/DBT only, and 0.944 for US only. Sensitivity was 89.2% (58/65 cancers) for multimodal, 60% (39/65) for FFDM/DBT only, and 84.6% (55/65) for US only. 61.6% (845/1371) of women had dense breasts. For women with dense breasts, AUROC was 0.98 for multimodal, 0.848 for FFDM/DBT only, and 0.963 for US only, with sensitivity of 92.7% (38/41), 58.5% (24/41) and 92.7% (38/41). For women with non-dense breasts, AUROC was 0.919 for multimodal, 0.895 for FFDM/DBT only, and 0.900 for US only, with sensitivity of 83.3% (20/24), 62.5% (15/24) and 70.8% (17/24). 4.61% (3/65) cancers were in women under 40. For women under 40, multimodal AUC=0.982, FFDM/DBT AUC=0.894, US=0.994.

#### CONCLUSION

A multimodal AI system showed higher performance for breast cancer detection in symptomatic diagnostic evaluations than FFDM/DBT or US models, including women with both dense and non-dense breasts. An US-only model outperformed other models for women < 40.

#### CLINICAL RELEVANCE/APPLICATION

Diagnostic workup in symptomatic patients often requires both mammography and ultrasound. Use of multimodal AI in the diagnostic breast cancer setting improves cancer detection regardless of breast density.

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## Abstract Archives of the RSNA, 2023

R5B-SPBR-8

### Comparison of Screening Recall Rates When Automated Breast Ultrasound is Coupled or Uncoupled with Screening Mammogram

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Daniela E. Wermuth, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the screening recall rates (RR) for women with dense breast tissue who underwent automated breast ultrasound (ABUS) either as a coupled exam following same day screening mammogram or at a future date within the one-year screening interval.

#### METHODS AND MATERIALS

This single-institution retrospective review included women aged 35-90 with heterogeneously dense or extremely dense breast tissue who had a screening mammogram from June 2016 to June 2021 and an ABUS within the one-year screening interval. The RR for patients who underwent screening mammogram coupled with ABUS on the same day were compared to the RR for those who had screening mammogram followed by ABUS 1-364 days later. Cancer detection rates (CDR) between the two groups were also compared.

#### RESULTS

A total of 5,813 screening mammograms were performed on patients who met inclusion criteria. The study population RR was 2.5% (147/5,813) for mammogram and 4.3% (249/5,813) for ABUS, with a CDR of 5.3/1,000 (31/ 5,813). Of the 5,813 patients, same day ABUS was performed on 3,347 (58%) and 2,466 (42%) underwent ABUS 1-364 days following mammogram. The combined RR for the coupled screening mammogram and ABUS group was 5.9% (196/3,347) with 3.1% (105/3,347) RR on mammogram, 3.4% (114/3,347) RR on ABUS, and CDR of 4.2/1,000 (14/3,347). For mammogram and ABUS performed independently, the mammogram RR was 1.7% (42/2466) and the ABUS RR was 5.5% (135/2466), with a CDR of 6.9/1,000 (17/2,466). There was a statistically significant difference in the combined RR of coupled mammogram and ABUS compared to mammogram performed independent of ABUS ( $p < 0.0001$ ), between coupled and uncoupled mammogram ( $p = 0.0008$ ), and between coupled and uncoupled ABUS ( $p = 0.0002$ ). There was no statistically significant difference in CDR between the coupled and uncoupled groups ( $p = 0.2223$ ).

#### CONCLUSION

Mammogram and ABUS interpreted as a same day, coupled exam increases both the individual mammogram RR and the combined mammogram/ABUS RR. Conversely, the ABUS RR is lower when ABUS is interpreted as a coupled exam compared to ABUS uncoupled from mammography. There is no statistically significant difference in CDR when ABUS is coupled or uncoupled with screening mammogram.

#### CLINICAL RELEVANCE/APPLICATION

This study supports scheduling of ABUS according to patient preference or optimal practice workflow as there is no overall screening outcomes benefit to preferential scheduling of ABUS as a coupled or uncoupled exam.

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## Abstract Archives of the RSNA, 2023

R5B-SPCA-1

### Simultaneous Single-breathhold Cardiac T1, T2, T2\*, and Fat Fraction Mapping with Rosette MR Fingerprinting

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Evan Cummings (*Presenter*) Nothing to Disclose

#### PURPOSE

In this work, we present a method for mapping cardiac T1, T2, T2\*, and fat fraction during a single breathhold acquisition. Quantitative MRI can be used to diagnose and evaluate a wide range of cardiac pathologies: T1 mapping for myocarditis, myocardial infarction, and myocardial amyloidosis<sup>1</sup>; T2 mapping for myocardial edema injury<sup>1</sup>; T2\* mapping for iron deposition<sup>2</sup>; and fat fraction mapping to determine fat content of the myocardium<sup>3</sup>. MR Fingerprinting (MRF) is a method for rapidly measuring multiple tissue properties, including T1 and T2<sup>4,5</sup>. MRF data can be collected along a rosette trajectory<sup>6</sup>, a multi-echo trajectory which has previously been used in cardiac applications to map T2\*<sup>7</sup> and fat fraction<sup>8</sup>. In this work, MRF with the rosette trajectory is extended to enable T1, T2, T2\*, and fat fraction mapping in a single breathhold.

#### METHODS AND MATERIALS

A healthy volunteer was scanned on a 1.5T MAGNETOM Sola (Siemens Healthineers, Erlangen, Germany) using a breathhold 15 heartbeat ECG-triggered sequence with the following parameters: TR=20.41 ms, TE=0.84 ms, variable flip angles up to 20°, 1.6x1.6x8mm voxel size, 300x300 mm<sup>2</sup> FOV, with multiple inversion and T2 preparation pulses. Data were acquired with a 23 lobe rosette with an 18.5 ms readout and 0.8 ms echo spacing. Images were reconstructed using an iterative approach with a cluster-based sparsity regularizer. T1 and T2 values were mapped using pattern matching<sup>4</sup>, T2\* values were calculated by fitting decay curves along the rosette echo images<sup>7</sup>, and fat fraction was extracted using Hierarchical IDEAL<sup>9</sup>. The technique was validated in phantoms for accuracy. Volunteer reference T1, T2, and T2\* maps were collected using Siemens Myomaps sequences.

#### RESULTS

Mean myocardial measurements were: T1= 1137±102 ms, T2= 44.5±7.8 ms, T2\*= 22.4±5.0 ms, PDFF= 3.6±3.7%. Rosette MRF T1 values are higher than published MOLLI T1 values<sup>10</sup>, and T2 values are lower than published T2-prep bSSFP values<sup>11</sup>, similar to prior MRF studies<sup>5,8</sup>. T2\* and PDFF values agree with published literature<sup>3,4</sup>.

#### CONCLUSION

Rosette MRF can be used to simultaneously map T<sub>1</sub>, T<sub>2</sub>, T<sub>2</sub>\*, and fat fraction in the heart in a single-breathhold acquisition.

References: 1. Messroghli DR et al. *JCMR* 2017 2. Triadyaksa P et al. *JMRI* 2020 3. Ng ACT et al. *Circ Cardiovasc Imaging* 2018 4. Ma D et al. *Nature* 2013 5. Hamilton J et al. *MRM* 2017 6. Noll D *IEEE Trans Med Imaging* 1997 7. Bush AM et al. *JMRI* 2020 8. Liu Y et al. *Front Cardiovasc Med* 2022 9. Tsao J Jiang Y. *MRM* 2013 10. Dabir D et al. *JCMR* 2014 11. Hanson CA et al. *Radiology* 2020

#### CLINICAL RELEVANCE/APPLICATION

We present a method for mapping cardiac T1, T2, T2\*, and fat fraction in a single breathhold acquisition with the aim of reducing patient scan times while providing comprehensive quantitative information for myocardial assessment.

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## Abstract Archives of the RSNA, 2023

R5B-SPCA-2

### To Investigate the Enhancement Effect Between High and Low Concentration Contrast Medium in Coronary Computed Tomography Angiography (CCTA).

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Wenbin Liang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the enhancement effect between high and low concentration contrast medium in coronary computed tomography angiography (CCTA)

#### METHODS AND MATERIALS

A total of 163 patients suspected of coronary disease (CAD) were randomly assigned into two groups with different contrast concentrations, 25mgI/kg/s injection rate for 10s. A high concentration contrast medium (Iomeprol, 400mgI/ml) was used in group A (n=85), while a lower concentration one (Iohexol, 350mgI/ml,) was used in group B (n=78). All patients were scanned with free breathing with a fixed tube voltage of 100 kVp, smart mA with tube current range from 320 to 720 mA. 50% adaptive statistical iterative reconstruction (ASIR-V50%) was used for the pre-scan dose adjustment and post-scan reconstruction. All CT images were reviewed in randomized order by two experienced radiologists blinded to scan and contrast protocol. Both quantitative measurements including CT value, standard deviation (SD, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR)) and subjective scores (1-5) were obtained and compared between the two groups.

#### RESULTS

There was no significant difference in gender, age, body mass index (BMI), heart rate and radiation dose between the 2 groups (all P value >0.05). Both quantitative measurements (CT value, SD,SNR and CNR) and subjective scores were also similar between the two groups (P>0.05). However, there were statistically significant difference in contrast medium dosage and flow rate between the two groups (P value was 0.000 and 0.001, respectively).The low concentration contrast medium group had statistically higher in contrast medium dosage and flow rate than the high concentration contrast medium group [43.34±8.35 vs 49.01±8.50ml;4.2±0.7vs 4.6±0.5](P value was 0.000 and 0.001, respectively).

#### CONCLUSION

Under the premise of maintaining the same contrast agent injection scheme, there is no significant difference in image quality and radiation dose between high and low contrast agents with different concentrations, but under the condition of constant total iodine, high concentration contrast agent can achieve a relatively low injection rate.

#### CLINICAL RELEVANCE/APPLICATION

High concentration contrast agent but with low injection rate can applied in coronary computed tomography angiography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPCA-3

### Zero-Contrast Imaging for the Assessment of Transcatheter Aortic Valve Implantation in Candidates with Renal Dysfunction

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Candidates for transcatheter aortic valve implantation (TAVI) are currently evaluated using computed tomography angiography and invasive cardiac catheterization as an essential part of case selection and pre-procedure interventional planning. However, both imaging methods utilize iodinated agents, which may cause contrast-induced nephropathy, particularly in patients with baseline renal dysfunction. This study aimed to describe a zero-contrast imaging protocol for pre-TAVI evaluation in patients with advanced renal impairment.

#### METHODS AND MATERIALS

The pre-TAVI zero-contrast scheme consisted of the following multi-modality combinations: 1) gadolinium-free magnetic resonance imaging (three-dimensional navigator-echo with electrocardiogram-gated steady-state free-precession series); 2) iodinated-free multislice computed tomography electrocardiogram-gated; 3) lower limb arterial duplex scan ultrasound; and 4) transesophageal echocardiography. Ultimately, TAVI was performed for those deemed good candidates, and contrast was allowed during the intervention; however, operators were strongly advised to utilize the least volume possible of iodinated agents. This pilot survey included ten patients with symptomatic aortic stenosis and renal dysfunction who underwent zero-contrast multi-modality imaging.

#### RESULTS

All the patients ultimately underwent TAVI. The intervention was successful in all cases, without = moderate residual aortic regurgitation, prosthesis embolization, annulus rupture, major vascular complications, stroke, or death during index hospitalization. The creatinine clearance remained stable throughout the observation period (baseline:  $26.85 \pm 12.55$  ml/min; after multi-modality imaging:  $26.76 \pm 11.51$  ml/min; post-TAVI at discharge:  $29.84 \pm 13.98$  ml/min;  $p=0.3$  all).

#### CONCLUSION

The proposed contrast-free imaging protocol appears to be a promising clinical tool for pre-TAVI evaluation in patients with severe renal dysfunction.

#### CLINICAL RELEVANCE/APPLICATION

Chronic renal dysfunction is common in individuals with aortic stenosis and is often challenging for the evaluation of TAVI candidates. The occurrence of acute kidney injury (AKI) following pre-TAVI evaluation using methods based on angiographic contrast has been largely underreported, but everyday practice and common sense indicate that it is a major clinical issue. In this context, we developed a zero-contrast diagnostic routine for patients with severe aortic stenosis and renal dysfunction who are considered for TAVI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5B-SPCA-4

### Feasibility, Image Quality and Radiation Dose Evaluation of Coronary CT Angiography (CCTA) in Patients with Arrhythmia by Using the 16cm Wide Detector CT

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Wenbin Liang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility, image quality and radiation dose of a 16cm wide detector CT for coronary CT angiography (CCTA) within single cardiac cycle in patients with arrhythmia.

#### METHODS AND MATERIALS

A total of 70 patients with suspected coronary heart disease underwent CCTA were divided into two groups for analysis: Group A (n=35, arrhythmia) and Group B (n=35, sinus rhythm). All examinations were performed under free breathing on a 16cm wide detector CT (GE Healthcare) by using the SmartPhase technique for scanning and reconstruction and SSF technique for coronary artery motion correction. Both groups used the same contrast dose rate of 25 mgI/kg/s. CT value and standard deviation in aortic sinus (AS), right coronary artery, left anterior descending, left circumflex and pericardial fat were measured. Contrast-to-noise ratio for vessels was calculated. Two experienced Radiologists independently reviewed the image quality by using a 5-point scale[1] (1: nondiagnostic and 5: excellent). Image quality and radiation dose of the two groups were compared. The Mann-Whitney test and independent sample t test were used for statistical analysis,  $P < 0.05$  was considered statistically significant.

#### RESULTS

There was no difference in contrast dose, radiation dose, quantitative and qualitative image quality[1] between the two patient groups (all  $p > 0.05$ ). The arrhythmia group had statistically higher heart rate and higher heart variation than the sinus rhythm group [ $84.77 \pm 35.02$  vs.  $67.80 \pm 12.53$  beats/min] ( $P = 0.009$ ). The effective radiation dose in the arrhythmia group [ $(2.86 \pm 1.07)$  mSv] was higher than that in the sinus rhythm group [ $(2.22 \pm 0.64)$  mSv] which was statistically significant ( $P = 0.004$ ).

#### CONCLUSION

CCTA is feasible in arrhythmia patients by using 16cm wide detector CT providing good image quality, but requires slightly higher radiation dose compared with that of sinus rhythm patients.

#### CLINICAL RELEVANCE/APPLICATION

CCTA is feasible in atrial fibrillation patients using a new generation 256-MDCT providing good image quality and low radiation dose in this challenging population

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPCA-6

### Improved Detection of Subendocardial Infarction using Synthetic Double Inversion Late Gadolinium Enhancement

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Jong Eun Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

A novel imaging technique called Synthetic double inversion LGE using T1 mapping has been developed. This study aimed to increase the conspicuity of the enhanced region in patients with MI, particularly those with subendocardial infarction by nulling the signal of normal myocardium and blood cavity.

#### METHODS AND MATERIALS

To validate the proposed method, phantom experiment was conducted using a commercial phantom (T1 MES) that mimics nine different T1 values of myocardium and blood pre- and post- enhanced at 1.5T and 3T environment. Synthetic LGE that is generated using the post T1 map allows for the nulling of signal intensity from single tissue with a specific T1 value, depending on the inversion time (TI). The proposed method employs two numerical inversion pulses, which null 2 types of tissues. For the evaluation of our method, 30 cases of MRI study from patients with subendocardial infarction were retrospectively collected, which included T1 maps and LGE images. We generated synthetic LGE for each patient using mathematical equation and nullified the signal from normal myocardium and blood cavity. This can increase contrast with infarct myocardium in MI patients as intended in this study.

#### RESULTS

In the phantom experiment, proposed method generated a synthetic LGE that accurately nullified the signal from the regions corresponding to the two selected T1 values. This result demonstrated the effectiveness of our approach. In the in-vivo experiment, the result showed significantly higher contrast compared to conventional LGE. The proposed method demonstrated significantly higher contrast ratios for remote/enhanced and blood/enhanced regions, with values of  $2.59E-05$  and  $2.07E-05$ , respectively, compared to conventional LGE with values of 0.06 and 0.91. This represents an increase in contrast of over 400-fold for blood cavity and 23-fold for remote regions compared to conventional LGE.

#### CONCLUSION

Using synthetic double inversion LGE, contrast enhancement was observed in subendocardial infarction, with improved conspicuity compared to conventional LGE. This technique nulling healthy myocardium and blood cavity can improve detection of myocardial infarction.

#### CLINICAL RELEVANCE/APPLICATION

This study proposes a new imaging technique, Synthetic double inversion LGE, to overcome the challenges in identifying subendocardial infarction using conventional LGE. This technique has shown promising results in nulling normal myocardium and blood cavity, which can improve the contrast with infarct myocardium in MI patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPCH-1

### Free-Breathing Ultra-High-Pitch Pulmonary Angiography by Means of Photon-Counting Detector CT for Diagnosis of Acute Pulmonary Embolism

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Pauline Pannenbecker, MD, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess image quality (IQ) and required radiation dose of an ultra-high-pitch CT pulmonary angiography (CTPA) protocol with a low contrast medium (CM) dose in free-breathing technique for diagnosis of acute pulmonary embolism (PE) using a clinical photon-counting detector (PCD) CT scanner in comparison to a matched conventional energy-integrating detector (EID) based Single-Energy CTPA protocol.

#### METHODS AND MATERIALS

51 CTPAs performed on a clinical PCD CT (Naeotom Alpha, Siemens Healthcare GmbH) were prospectively compared to 51 CTPAs performed on a 3rd generation Dual-Source EID CT (Somatom Force, Siemens Healthcare GmbH). All CTPAs were acquired with an ultra-high-pitch CTPA scan protocol in free-breathing technique (matched parameters: 40ml CM, flow rate 4ml/sec, pitch 3.2) at 140 kV (PCD) and 70-100 kV (EID). Based on spectral CTPAs acquired on the PCD scanner, iodine-distribution maps were reconstructed. As ultra-high-pitch EID CTPA could only be performed in Single-Energy mode due to technical limitations, reconstruction of iodine-maps was not possible in this subgroup. For evaluation of objective IQ, CT attenuation within pulmonary arteries, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were compared. To assess subjective IQ, three readers rated CTPAs (at 60 keV using virtual monoenergetic imaging for PCD and at standard reconstruction for EID) and iodine-maps based on a four-point scale. For radiation dose analysis, effective dose (ED), CTDIvol, dose length product, and size-specific dose estimates were compared.

#### RESULTS

CT attenuation was higher within all pulmonary vessels in the PCD-group (all  $p < 0.05$ ). While CNR and SNR were higher in the lobar pulmonary arteries in PCD CTPAs ( $p < 0.05$ ), they were similar within the pulmonary trunk ( $p > 0.05$ ). Subjective IQ of PCD scans was rated best by all three reviewers (excellent or good IQ in 96.1% of PCD CTPAs vs. 50.9% of EID CTPAs, ICC = 0.795). All evaluated radiation dose parameters were lower in the PCD group, as is exemplified with a mean ED of 1.33 ( $\pm 0.47$ ) mSv vs. 1.80 ( $\pm 0.82$ ) mSv (PCD vs. EID; all  $p < 0.05$ ).

#### CONCLUSION

Ultra-high-pitch CTPA acquisition in free-breathing technique with PCD CT allows for superior objective and subjective image quality with reduced radiation dose, while providing full spectral assessability. Moreover, in this protocol setting, PCD CTPA enables reconstruction of color-coded iodine-distribution maps, offering additional functional information compared to matched ultra-high-pitch EID CTPA.

#### CLINICAL RELEVANCE/APPLICATION

In PCD CT, pulmonary arteries can be fully spectrally assessed despite ultra-high-pitch settings, overcoming the need for breath-holds in the context of pulmonary embolism where dys- and tachypnea are common symptoms.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPCH-2

### Prediction of the Treatment of Pulmonary Embolism using CT Texture Analysis

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Ki Yeol K. Lee, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the utility of computed tomography texture analysis (CTTA) parameters in predicting the treatment outcome in pulmonary thromboembolism (PTE).

#### METHODS AND MATERIALS

We evaluated 88 patients diagnosed with PTE on whom chest computed tomography (CT) for detecting PTE was performed. Texture analysis was performed on the acute PTE detected on chest CT. Using the software, the groups in which PTE disappeared and remained after treatment were compared. The mean, standard deviation (SD), entropy, mean of positive pixels (MPP), skewness, and kurtosis of parameters on the spatial scaling factor (SSF) 2-6 were compared between the groups. The gray-level co-occurrence matrix (GLCM) texture features were used for SSF 0 images.

#### RESULTS

PTE disappeared after treatment in 51 patients, whereas it remained in 37 patients. Entropy was significantly different in SSF 3,4,5,6 ( $p < 0.05$ ). The mean and MPP on SSF 0 and the SD on SSF 4,5,6 were also significantly different ( $p < 0.05$ ). Other parameters, such as the mean, standard deviation, MPP, skewness, and kurtosis, on other SSFs were not significantly different. Among the GLCM parameters, several parameters such as joint energy and entropy, perimeter, area, and long and short axis were significantly different ( $p < 0.05$ ).

#### CONCLUSION

CTTA allows the prediction of whether the PTE will dissolve or remain after treatment. The mean and MPP on non-filtered images, entropy, and SD values on highly filtered SSFs had the best performance in predicting the anticoagulation treatment effects. The results suggest that several parameters of GLCM texture features can be used to predict anticoagulation treatment effects.

#### CLINICAL RELEVANCE/APPLICATION

CTTA can be used to predict whether PTE will dissolve or remain in the patient after treatment.

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## Abstract Archives of the RSNA, 2023

R5B-SPCH-3

### Impact of an AI Based Triage and Prioritization Solution for Incidental Pulmonary Embolism Findings on Contrast CT in an Outpatient Setting

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Seyedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To measure the impact of a computer aided triage and prioritization AI solution for patients with incidental pulmonary embolism (iPE) undergoing CT scan of the chest and/or abdomen.

#### METHODS AND MATERIALS

Cases from a large academic health system were collected from the outpatient setting between April 2022 and April 2023. A wait time metric was calculated for AI-notified cases with suspected positive iPE findings and compared to negative non-AI-notified cases. Wait time was defined as the difference between the time of study acquisition completion to the time a radiologist opens the case for dictation. The median wait times were calculated for the AI-notified and non-AI-notified cases. A Mood's median test was used to test for statistical significance.

#### RESULTS

A total of 28,914 CT contrast examinations that included the lungs (12,564 chest/abdo/pelvis and 16,350 chest only) were collected. The AI solution provided suspected positive prioritization notifications (AI-notified) on 269 cases (87 chest/abdo/pelvis and 182 chest only). The median wait time was 86 minutes (AI-notified) compared to 242 minutes (non-AI-notified). The observed median wait time reduction was 64.4% (156 minutes,  $p$ -value<0.001). The median wait time was 76 minutes (AI-notified) compared to 461 minutes (non-AI-notified) and 87 minutes (AI-notified) compared to 172 minutes (non-AI-notified) for chest/abdo/pelvis and chest only cases respectively. The chest/abdo/pelvis subcohort had the largest observed median wait time reduction (83.5%, 385 minutes,  $p$ -value<0.001) compared to chest only cases (50.6%, 85 minutes,  $p$ -value: 0.009).

#### CONCLUSION

A computer aided triage and prioritization AI solution decreased wait times for contrast CT examinations with suspected iPE potentially saving hours of diagnosis delays in the outpatient setting.

#### CLINICAL RELEVANCE/APPLICATION

Using an AI solution to prioritize radiologist interpretation of CT scans with iPE findings decreases wait time. Time saved has the potential to prioritize diagnosis and facilitate earlier treatment initiation.

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## Abstract Archives of the RSNA, 2023

R5B-SPCH-5

### Impact of the Recent Global Iodinated Contrast Agent Shortage on Observed Positivity Rate for Pulmonary Embolism in CT Pulmonary Angiograms at a Major US Healthcare System

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Axel Wismueller, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantitatively track the impact of the recent global shortage of iodinated contrast agents on observed Pulmonary Embolism (PE) positivity rate in CT Pulmonary Angiogram (CTPA) exams using AI-based image analysis at a major US healthcare system.

#### METHODS AND MATERIALS

Using software of a commercial AI-based image analysis vendor (Aidoc Medical, Tel Aviv, Israel), we analyzed daily volumes and PE positivity rates for a total of 2,407 Computed Tomography Pulmonary Angiogram (CTPA) exams before and during the recent contrast agent shortage (both comprising 04/01/2022 through 07/01/2022). For comparison with a non-contrast CT exam type, we analyzed daily volumes and positivity rates for Intracranial Hemorrhage (ICH) on 10,843 non-contrast head CT exams during the same time period. Specifically, we compared two observational periods, namely (i) a pre-shortage control period from 04/14/22 through 05/05/2022, and (ii) a contrast shortage period from 05/21/2022 through 06/11/2022. Percentage change metrics of case volumes and positivity rates for PE and ICH were calculated, where we report relative changes with regard to a baseline measurement period from 04/01/2022 through 04/14/2022. The two observational periods were compared for statistically significant differences using Welch's unequal variances t-test.

#### RESULTS

Case volumes of contrast-enhanced CTPA exams dropped from baseline during the contrast agent shortage period by  $42.88\% \pm 20.22\%$  while PE positivity rates increased by  $47.8\% \pm 13.7\%$ , where statistical differences between observational periods were highly significant ( $p < 10^{-4}$ ). For comparison, non-contrast head CT volumes dropped by only  $7.55\% \pm 2.98\%$ , and ICH positivity rates increased by only  $12.5\% \pm 1.87\%$ , with no significant difference between pre-shortage and shortage observational periods ( $p > 0.05$ ).

#### CONCLUSION

Our results suggest a significant increase of PE positivity rate in CTPA exams at significantly decreased CTPA total exam volumes during the observed global contrast agent shortage period, while non-contrast head CT exam volumes and ICH positivity rates remained essentially stable. Our observations can be explained by more restrictive ordering patterns for CTPA studies during the acute contrast agent shortage period, limiting access to such exams only to patients with high clinical pre-test probability.

#### CLINICAL RELEVANCE/APPLICATION

Using AI-based image analysis can quantify effects of unexpected healthcare challenges on critical radiology findings, such as for pulmonary embolism during the observed global contrast agent shortage.

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## Abstract Archives of the RSNA, 2023

R5B-SPCH-6

### Diagnostic Ability for the Presence and Severity of Pulmonary Hypertension on Super-high-resolution Non-enhanced Chest Computed Tomography

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Yukihiro Nagatani, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the detectability of pulmonary hypertension (PH) and the predictability of its severity by cross-sectional vessel area (CSA) on super-high-resolution (SHR) non-enhanced chest computed tomography (CT)

#### METHODS AND MATERIALS

Thirty patients including 11 patients diagnosed as PH, 9 patients with connective tissue disease (CTD) associated interstitial pneumonia (CTD-IP) without PH and 10 age-matched controls, underwent UHR non-enhanced chest CT. Mean pulmonary arterial pressure (PAP) were measured at right heart catheterization performed within 1 month of the chest CT examination date for the 11 PH patients. Image data were obtained using iterative reconstruction algorithm with normal-resolution simulation (NRsim) mode (512×512 matrix size, 0.5-mm slice thickness), and using deep-learning-based reconstruction algorithm with SHR mode (1024×1024 matrix size, 0.25-mm slice thickness). By using binary images with the optimal threshold of -720 HU at three predefined trans-axial levels including aortic arch, tracheal bifurcation and right proximal pulmonary vein, average vessel dimension (AVD) and the percentage of the total CSA for the lung field area (%CSA) for dimensions of less than 0.5, 0.5 to 1, 1 to 2 and 2 to 5 mm<sup>2</sup> were quantified for CT data both at NRsim and SHR mode. AVD and %CSA were compared among PH, CTD-IP and age-matched controls with Kruskal-Wallis test, and correlated with mean PAP for PH with Spearman's rank coefficient.

#### RESULTS

On CT images at SHR mode, AVD for dimensions of less than 0.5 mm<sup>2</sup> for PH (0.226±0.008 mm<sup>2</sup>) were smaller as compared with those for CTD-IP (0.239±0.008 mm<sup>2</sup>) and age-matched controls (0.245±0.004 mm<sup>2</sup>). ( $p < 0.01$ ) AVD for dimensions of 1 to 2 mm<sup>2</sup> correlated negatively with mean PAP ( $r = -0.67$ ,  $p = 0.048$ ). In contrast, on CT images at NRsim mode, although %CSA for dimensions of less than 0.5 mm<sup>2</sup> correlated positively with mean PAP ( $r = 0.71$ ,  $p = 0.032$ ), the %CSA for PH (0.61±0.38%) was larger than that for CTD-IP (0.53±0.30%) and comparable to that for age-matched controls (0.60±0.25%).

#### CONCLUSION

AVD for dimensions of less than 2 mm<sup>2</sup> at SHR mode on non-enhanced chest CT images has the potential to indicate the presence and severity of PH.

#### CLINICAL RELEVANCE/APPLICATION

Quantification of pulmonary smaller peripheral vessels of less than 2 mm<sup>2</sup> depicted at SHR mode may be useful for direct assessment of peripheral arterial remodeling in PH.

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## Abstract Archives of the RSNA, 2023

R5B-SPCH-7

### **Dual-Layer Dual-Energy CT-Derived Pulmonary Perfusion for the Differentiation of Acute Pulmonary Embolism and Chronic Thromboembolic Pulmonary Hypertension**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Roman J. Gertz, MD (*Presenter*) Institutional research contract, Koninklijke Philips NV

#### **PURPOSE**

To assess the ability of dual-layer dual-energy computed tomography (dILECT)-derived pulmonary perfusion maps to differentiate between acute pulmonary embolism (PE) and chronic thromboembolic pulmonary hypertension (CTEPH).

#### **METHODS AND MATERIALS**

57 patients with acute PE, 52 patients with CTEPH and 22 controls, all of whom underwent CT pulmonary angiography on a dILECT were included in this retrospective study. Normal and malperfused areas of lung parenchyma were semiautomatically contoured using iodine density overlay maps (IDOs). First order histogram features of normal and malperfused lung tissue were extracted. Iodine density (ID) was normalized to the mean pulmonary artery (MPA) and the left atrium (LA). Group differences were analyzed using the t-test and the Mann-Whitney U test. The data was split into training and validation sets to assess the diagnostic accuracy of the derived histogram features using the area under the receiver operating characteristic curve (AUC).

#### **RESULTS**

In acute PE, normal perfused lung areas revealed a higher mean and peak iodine uptake normalized to the MPA than in CTEPH (both  $p < 0.001$ ). After normalizing mean ID in perfusion defects to the LA, patients with acute PE revealed a reduced average perfusion (ID<sub>mean,LA</sub>) compared to both CTEPH patients and controls ( $p < 0.001$  for both). ID<sub>mean,LA</sub> allowed for a differentiation between acute PE and CTEPH with moderate accuracy (AUC: 0.72, sensitivity 74%, specificity 64%), resulting in a PPV and NPV for CTEPH of 64% and 70%.

#### **CONCLUSION**

dILECT enables quantification and characterization of pulmonary perfusion patterns in acute PE and CTEPH, enabling the differentiation between the two diseases.

#### **CLINICAL RELEVANCE/APPLICATION**

The identified parameters yield the potential to enable more timely identification of patients with chronic thromboembolic pulmonary hypertension.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5B-SPER-1

### Disentangling the Knot: Our Experience with Ultrasound Assisted Manual Testicular Detorsion in the Radiology Department

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Mauricio J. Fernandez, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Testicular torsion (TT) is an emergency. Prompt diagnosis and management are key to preserve the testicle. Our objective is to show our experience with intravaginal TT sonographic diagnosis and ultrasound (US) assisted manual detorsion (MD).

#### METHODS AND MATERIALS

A prospective, randomized, controlled trial over an 8-year period with a total of 108 patients diagnosed with TT. Mean age was 14 years, age range 1-48 years. US was performed in 106 patients (98%). Testicular flow was absent in 73 (69%), diminish in 27 (25%), normal in 6 (6%). Torsion of the cord was documented in 103 patients (97,2%) and not demonstrated in 3 (2,8%). In the first group of 59 patients, 57 underwent surgery following sonographic diagnosis of TT and 2 went directly to surgery. In the second group, 49 patients underwent US assisted MD attempt immediately after sonographic TT confirmation and posterior surgery. MD is attempted following US TT confirmation, explaining the procedure and obtaining consent. It is performed with US assistance and without sedation or analgesia thus enabling clinical monitoring and expediting the procedure. US assisted MD was performed by 14 staff radiologist, 1 pediatric surgeon and 8 radiology residents under staff supervision.

#### RESULTS

In the first group, testicular echotexture was preserved in 33 (58%) and altered in 24 (42%). 15 orchiectomies were performed (25,4%) and 44 (76,4%) testicles were fixated including 4 that showed later atrophy (9%). 1 of the patients that did not undergo US exam turned out to be a false positive. 4 underwent spontaneous detorsion while performing the US. 2 patients had inguinal torsion. 1 patient with Asperger syndrome barely cooperated with the diagnostic US exam. In the second group, testicular echotexture was preserved in 44 (89,8%) and altered in 5 (10,2%). MD achieved testicular reperfusion and symptoms relief in 42 patients (85,7% success rate). 1 orchiectomy was performed (2%) and 48 testicles were fixated including 2 that showed later atrophy (4%). There were no complications related to US assisted MD.

#### CONCLUSION

US confirms the diagnosis of TT, evaluates pre-detorsion testicular viability, assists MD and verifies restoration of testicular flow. MD is a non-invasive, simple, feasible, quick, safe and effective maneuver that improves testicular viability by immediately restoring testicular flow if successful, relieves patient's symptoms and improves his comfort and facilitates posterior surgery.

#### CLINICAL RELEVANCE/APPLICATION

Sonographic diagnosis of TT and US assisted MD adds value to the radiologist role in this emergency clinical setting performing a medical act that is both diagnostic and therapeutic.

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## Abstract Archives of the RSNA, 2023

R5B-SPGI-1

### Measurement of Spleen Volume Using CT Images with Deep Learning Segmentation: Definition of Normal Spleen and Splenomegaly

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Kotaro Fujita, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and evaluate a fully automated algorithm for segmenting the spleen and to establish thresholds for splenomegaly from CT.

#### METHODS AND MATERIALS

The dataset used to develop this deep learning software on Python consisted of anonymized non-contrast CT images of the abdomen of 138 patients provided by PSP Inc. These 138 images were divided into a training set, a validation set, and a test set. A Bayesian 3D U-Net was trained on the labeled spleen data. The initial study cohort consisted of generally healthy, asymptomatic adult outpatients who were potential renal donors, liver donors, scheduled to undergo CT colonography or abdominal CT for physical examination between April 2011 and April 2022, at a single medical center. A subanalysis was conducted prior to the clinical study. One hundred and twenty patients were randomly selected from the clinical study population. Multiple regression analysis was used to evaluate the relationship between demographic and clinical data and spleen capacity data.

#### RESULTS

The final sample consisted of 2554 asymptomatic adult outpatients (mean age  $\pm$  standard deviation, 65.0  $\pm$  15.3 years, including 1736 men and 821 women). The mean height  $\pm$  standard deviation of the patients was 162.1  $\pm$  9.4 cm, and the mean weight of the patients was 62.3  $\pm$  13.7 kg. The deep learning tool was used to successfully segment the spleen in all scans. The mean standardized spleen volume  $\pm$  standard deviation was 123.2  $\pm$  59.2 mL, showing a normal distribution. Patient weight was the major determinant of spleen volume and demonstrated a linear relationship. From this result, a linear weight-based upper limit of normal spleen threshold volume was derived: splenomegaly = 1.87  $\times$  weight (kg) + 124.67 mL. In the subset of 100 patients, the median difference in spleen volume between the deep learning tool and the manual method was 2.3%: mean Dice score was 0.95 (0.72-0.97).

#### CONCLUSION

Weight-based thresholds for objective normal spleen and splenomegaly were derived from a spleen volume database using CT images, based on deep learning.

#### CLINICAL RELEVANCE/APPLICATION

Splenomegaly is defined as an abnormal enlargement of the spleen resulting from various clinical conditions such as infections, hematologic diseases, congestion, autoimmune diseases or tumors. Splenomegaly is often a diagnostic entry point for various background diseases, and accurate detection of splenomegaly is clinically important. The purpose of our study is to establish the normal distribution of splenic volume in healthy adults using automated organ segmentation techniques on abdominal CT images. Furthermore, this data will be used to establish a potential threshold for splenomegaly.

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## Abstract Archives of the RSNA, 2023

R5B-SPGI-2

### Imaging Practices and Clinical Outcomes Following Suboptimal Visualization Score on Hepatocellular Carcinoma Ultrasound Screening

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Seoiyoung Ahn, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

The Ultrasound Liver Imaging Reporting and Data Systems (US LI-RADS) provides standardized terminology and reporting of ultrasound (US) screening for hepatocellular carcinoma (HCC). However, limited data exists on the clinical relevance of US LI-RADS suboptimal visualization scores of B/C. The aim of this study is to identify predictors of suboptimal visualization on HCC US screening and investigate follow-up imaging practices and clinical outcomes.

#### METHODS AND MATERIALS

Retrospective analysis was performed on patients who underwent initial HCC US screening from 2017-2021. Clinical factors, including demographics, body mass index (BMI), laboratory findings, hepatitis/cirrhosis status, surgical pathology, initial US and follow-up imaging, diagnosis of HCC/cirrhosis, and liver transplant, were collected. Multivariable analysis was performed to determine predictors for suboptimal (B/C) visualization on HCC US screening. Chi-square test and independent t-test were performed to compare follow-up imaging practices and clinical outcomes between scores of A and B/C. Only patients with US LI-RADS visualization scores were included.

#### RESULTS

Of 396 patients, 56% (221/396) had a score of A, while 44% (175/396) had suboptimal scores of B/C. Multivariable analysis revealed that BMI (OR:1.05, 95% CI:1.01-1.09,  $p=0.01$ , per 1 score increase) and cirrhosis (OR:2.64, 95% CI:1.11-6.27,  $p=0.027$ ) predicted suboptimal visualization. Further analysis showed that 42.53% (94/221) of the patients with a score of A had follow-up imaging, compared to 45.71% (80/175) with scores of B/C. The mean time to follow-up imaging was not significantly different. However, US was more frequently performed in patients with a score of A (65.96% vs. 43.75%,  $p=0.003$ ), while CT was performed more frequently among patients with scores of B/C (23.40% vs. 38.75%,  $p=0.028$ ). Clinically, liver transplant was more common within one year from initial US among patients with scores of B/C (13.75% vs. 9.57%,  $p=0.0284$ ), while subsequent diagnosis of HCC/cirrhosis after the initial US was not significantly different.

#### CONCLUSION

Our findings suggest that patients with suboptimal visualization scores of B/C on initial HCC US screening were followed at similar intervals as those with a score of A. However, patients with scores of B/C underwent CT follow-up and liver transplant more frequently than those with a score of A. This study highlights the need for establishing recommendations for imaging and clinical management following suboptimal visualization on HCC US screening.

#### CLINICAL RELEVANCE/APPLICATION

Suboptimal visualization scores on initial HCC US screening impact follow-up imaging and clinical outcomes, and thus standardized recommendations are warranted for optimal care.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPGI-3

### Effect of Liver Fibrosis on the Correlation between US-ATI and MRI-PDFF

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Riwa Kishimoto, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

With the increasing number of liver diseases caused by obesity and metabolic syndrome, the assessment of fatty liver by ultrasound attenuation imaging (ATI) is widely used clinically. It has been reported that ATI correlates well with MRI-derived proton density fat fraction (PDFF). On the other hand, the influence of liver fibrosis on ATI has been discussed. In the present study, we investigated whether the degree of fibrosis affects the correlation between ATI and MRI-PDFF when divided into high and low fibrosis groups using shear wave speed (SWS) and Fib-4 index.

#### METHODS AND MATERIALS

Seventy-four patients with ultrasound (US) and MR examinations performed within two weeks were included. Canon Medical Systems Aplio i800 with an i8CX1 probe was used, and SWS and ATI were obtained simultaneously using an advanced SWE application. After at least 4 hours of fasting, five measurements were taken with a right intercostal procedure avoiding large blood vessels at neutral breathing during a breath hold. MRI was performed using a Philips Achieva 1.5T, and the m-Dixon method was used. ROI of about 10 mm diameter was placed in the center of the right lobe, same as US. The correlation between ATI value and MRI-PDFF was investigated. To evaluate the effect of fibrosis, the patients were divided into two groups using SWS and Fib-4 index, which is considered highly likely to be associated with fibrosis: those with SWS = 1.6 m/s and those with SWS <1.6 m/s, and those with Fib-4 index = 2.67 and < 2.67. The analysis of covariance (ANCOVA) was performed.

#### RESULTS

Fifty-five patients were included, excluding those due to low reliability whose interquartile range (IQR)/median of SWS and ATI was over 0.3. The correlation between ATI value and MRI-PDFF of the liver was good,  $R=0.74$ . In a study in which the patients were divided by SWS and Fib-4 index, the correlation coefficients were similar: 0.78 for the high SWS group and 0.74 for the low SWS group, and 0.74 for the high Fib-4 index group and 0.77 for the low Fib-4 index group, respectively. The degree of liver fibrosis did not significantly affect the correlation between ATI and MRI-PDFF using ANCOVA.

#### CONCLUSION

We hypothesized that the correlation between ATI and MRI-PDFF would be worse in cases with liver fibrosis, but no difference was found in the study divided into high and low fibrosis groups using SWS and Fib-4 index. The correlation was good in both groups with  $R > 0.7$ , and fibrosis had no confounding effect.

#### CLINICAL RELEVANCE/APPLICATION

The degree of liver fibrosis did not significantly affect the correlation between ATI and MRI-PDFF.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPGI-4

### Shear Wave Elastography Assessment of the Spleen Before and After Transjugular Intrahepatic Portosystemic Shunt (TIPS)

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Robert Turner, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Transjugular intrahepatic portosystemic shunt (TIPS) creation is an effective intervention to minimize complications of portal hypertension. However, periodic surveillance of TIPS is required to detect asymptomatic shunt stenosis or occlusion. Spleen shear wave elastography (SWE) has previously been shown to correlation with portal pressure, therefore it may be a surrogate marker for surveillance of TIPS patency. The goal of this study was to evaluate the changes in splenic stiffness using SWE immediately before and after TIPS placement, to determine how acute changes in portal pressure effect the spleen.

#### METHODS AND MATERIALS

This prospective cohort study included adult patients with portal hypertension who underwent nonemergent TIPS creation at a single institution from 10/31/2017 - 5/20/2021. Individuals were excluded if they had a prior splenectomy. Patients were evaluated with spleen SWE immediately before and after TIPS placement. Spleen length was measured by ultrasound in each individual during the pre-TIPS scan. Paired t-test analysis was performed to compare median splenic stiffness before and after the procedure and spleen length between patient groups.

#### RESULTS

Thirty patients were enrolled with a mean age of 58 years (SD=14.8). There was a decrease in median spleen shear wave velocity (SSWV) in 70% of patients following TIPS creation ( $p=0.03$ , binomial 95% CI=54% - 86%). The average decrease in SSWV after TIPS creation was 0.21 m/sec ( $p=0.01$ , 95% CI=0.38 - 0.05). Spleen length trended higher in patients who showed a decrease in SSWV (mean=16.2 cm, SD=2.99) compared to those who had an increase in SSWV (mean=15.3 cm, SD=2.51), though this difference was not statistically significant ( $p=0.43$ ).

#### CONCLUSION

There was a statistically significant decrease in SSWV immediately after TIPS placement, indicating that spleen stiffness is acutely affected by changes in portal pressure. Spleen SWE may be a useful tool in longitudinal surveillance of TIPS patency, using the patient as a self-control.

#### CLINICAL RELEVANCE/APPLICATION

Spleen shear wave elastography may be a complementary, non-invasive tool for monitoring TIPS patency and portal hypertension complications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPGI-5

### US-LIRADS: Outcomes of Category 1B and 1C Examinations on Multiphase CT/MRI

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Tyler Sevco, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to evaluate the outcomes of ultrasound (US) LI-RADS category US-1B and US-1C examinations performed for hepatocellular carcinoma (HCC) screening and surveillance on the basis of subsequently performed multiphase MRI or CT.

#### METHODS AND MATERIALS

In this retrospective analysis, 211 patients at high risk for HCC (127 men and 84 women; mean [±SD] age, 59.8 ±13.1 years) underwent screening liver US between June 2019 and September 2022 and were assigned US-1B (111 patients) or US-1C (100 patients) on a prospective clinical basis using the US-LIRADS algorithm. The results of follow-up imaging studies were analyzed.

#### RESULTS

US visualization scores were assigned as B (52.6% [111/211]) and C (47.4% [100/211]). The most common reasons for US-1B and 1C visualization scores included overlying bowel gas (52.6% [111/211]), parenchymal heterogeneity/echogenicity (26.5% [56/211]), and body habitus/poor acoustic window (10.0% [21/211]). Follow-up US for ongoing HCC screening was available for 57.8% (122/211) of patients. On follow-up US, 98.4% of patients remained US-LIRADS category 1 (120/122), 0.8% were category 2 (1/122), and 0.8% were category 3 (1/122). Subsequently-performed multiphase contrast-enhanced MRI or CT was available for 38.3% (81/211) of patients including 43.0% (43/100) of 1B patients and 34.2% (38/111) of 1C patients with a time interval between screening US and CT/MR of 287.9 ± 265.5 days. Multiphase CT or MRI results for patients with US-1B and US-1C visualization scores included no abnormality at CT or MRI (70.3% [57/81]), a benign lesion (6.2% [5/81]), a LI-RADS category 3 (LR-3) observation (16.0% [13/81]), a LI-RADS category 4 or 5 (LR-4 or LR-5) observation (5.0% [4/81]), and an LR-M observation (2.5% [2/81]). Within the US-1B cohort, an LR-4 or LR-5 observation was seen in 4.6% (2/43) and an LR-M observation was seen in 2.3% (1/43). In the US-1C cohort, an LR-4 or LR-5 observation was seen in 2.6% (1/38) and an LR-M observation was seen in 5.3% (2/38). The incidence of probable or definite HCC on CT/MR for US-1B or US-1C examinations was 5.0% (4/81) and for any malignancy was 7.4% (6/81).

#### CONCLUSION

In the HCC screening population, approximately 5% of US-1B and US-1C examinations have probable or definite HCC and 7.4% have malignant findings on multiphase CT or MR. Despite this, only 38.3% of patients with US-1B or US-1C examinations underwent multiphase CT or MRI, meaning that the majority of clinical providers are currently opting for continued ultrasound surveillance despite limited liver visualization.

#### CLINICAL RELEVANCE/APPLICATION

Patients in the HCC screening population with US-1B or US-1C examinations due to suboptimal liver visualization may benefit from further evaluation with multiphase CT or MRI.

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## Abstract Archives of the RSNA, 2023

R5B-SPGI-6

### Repeatability and Reproducibility of Multi-parametric Ultrasound in Liver Assessment

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Reinhard I. Kubale, MD (*Presenter*) Research Consultant, Siemens AG

#### PURPOSE

Quantitative ultrasound-based techniques, such as ultrasound derived fat fraction (UDFF) and point shear wave elastography (pSWE), have become promising noninvasive tools for evaluating liver fibrosis and steatosis. However, the repeatability and reproducibility of these techniques remain critical factors for their broader clinical adoption. This study aims to assess the sonographer reproducibility and measurement repeatability of UDFF and pSWE in liver assessment within a cohort of 31 subjects.

#### METHODS AND MATERIALS

Three experienced sonographers performed five acquisitions each on the subjects' livers using the Siemens Sequoia ultrasound system. The intraclass correlation coefficients (ICCs) and Bland-Altman analysis were employed to evaluate the repeatability within each sonographer and the reproducibility across the sonographers for both UDFF and pSWE measurements.

#### RESULTS

The results demonstrated good sonographer reproducibility and measurement repeatability for both UDFF and pSWE. The ICC for UDFF repeatability ranged from 0.97 (95% CI: 0.95-0.98) to 0.99 (95% CI: 0.98-1.0), while the ICC for pSWE repeatability ranged from 0.94 (95% CI: 0.89-0.97) to 0.96 (95% CI: 0.93-0.98). Additionally, the ICC for sonographer reproducibility was 0.93 (95% CI: 0.88-0.96) for UDFF and 0.62 (95% CI: 0.43-0.77) for pSWE. Bland-Altman analysis revealed a mean difference of 0 % for UDFF and 0 m/s for pSWE, indicating no bias between the sonographers, and the limits of agreement were within  $\pm 3.51\%$  for UDFF and  $\pm 0.2$  m/s for pSWE, demonstrating acceptable agreement.

#### CONCLUSION

These findings support the repeatability and reproducibility of UDFF and pSWE measurements in liver assessment, highlighting their potential as reliable tools for noninvasive liver fibrosis and steatosis evaluation. Further research is warranted to optimize measurement protocols and investigate their performance in various clinical settings.

#### CLINICAL RELEVANCE/APPLICATION

This study demonstrates that ultrasound-derived fat fraction (UDFF) and point shear wave elastography (pSWE) show good repeatability and reproducibility for assessing liver fibrosis and steatosis, making them promising noninvasive tools in clinical settings. The high intraclass correlation coefficients and Bland-Altman analysis results support their reliability across different sonographers, highlighting the potential for these techniques to be adopted more widely in liver assessment. Future research should focus on optimizing measurement protocols and evaluating their performance across various clinical contexts to further solidify their clinical utility.

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## Abstract Archives of the RSNA, 2023

R5B-SPGI-7

### Ultrasound Point Shear Wave Elastography is Feasible Across All Ages to Evaluate for Sinusoidal Obstruction Syndrome after Hematopoietic Stem Cell Transplantation

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Kelly R. Dietz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Veno-occlusive disease or sinusoidal obstruction syndrome (VOD/SOS) is a known potential complication of HCT and usually involves the liver. Hepatic VOD is characterized by damage to blood vessels in the liver and surrounding liver cells, with significant associated morbidity. Ultrasound point shear wave elastography (PSWE) is an imaging technique that has high sensitivity and specificity in detecting tissue stiffness, which is hypothesized to increase in VOD/SOS. A prospective, observational pilot study was performed to evaluate the feasibility and value of shear wave elastography (SWE) in the diagnosis of hepatic VOD/SOS after hematopoietic cell transplantation (HCT).

#### METHODS AND MATERIALS

Pediatric and adult patients undergoing autologous or allogeneic HCT at a single academic institution, and who received myeloablative conditioning were consented to participate in this study. Pre-transplant liver and other organ evaluation was performed. Post-transplant evaluation and SWE imaging was performed on all subjects at day +5, day +10, day +14, day +21, day +100.

#### RESULTS

A total of 42 patients were enrolled in the study, of which 62% were males with median age of 15 years (range: 1-50 years). Underlying malignancy was the primary indication for HCT in 73% of patients.; 95% underwent an allogeneic HCT with a median age of participation of 15 years (range: 1-50 years). No patients were diagnosed with VOD and there was no statistical significance in the median liver stiffness before and after engraftment (1.4 (1.1-2.6) vs. 1.4 (1.2-2) m/sec;  $p=0.81$ ). Trends were observed by ultrasound during the course of observation including hepatic enlargement, gallbladder wall thickening and sludge, alterations in portal and hepatic venous flow, and the development of ascites, all despite the lack of VOD diagnosis.

#### CONCLUSION

PSWE is feasible in children and adults to assess the flow dynamics in hepatic and portal vasculature. Further studies need to be performed to evaluate its utility in diagnosis of VOD/SOS and assessing the therapeutic response.

#### CLINICAL RELEVANCE/APPLICATION

Performing point shear wave elastography is feasible across all ages. Though there were no VOD/SOS cases, this study successfully demonstrates the radiologic changes in hepato-portal venous flow changes and organ changes after HSCT.

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## Abstract Archives of the RSNA, 2023

R5B-SPGU-1

### Estimation of Renal Function Using Iodine Maps in Dual-energy Spectral Computed Tomography Urography: A Feasibility and Accuracy Study

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Shigeng Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the feasibility of measuring glomerular filtration rate (GFR) using iodine maps in dual-energy spectral computed tomography urography (DEsCTU).

#### METHODS AND MATERIALS

One hundred and eighty patients with renal tumors referred for DEsCTU were prospectively enrolled. The DEsCTU protocol included non-contrast, nephrographic, and excretory phase imaging. The CT-derived GFR was calculated separately using the above 3-phase iodine maps (CT-GFRiodine) and 120 kVp-like images (CT-GFR120kvp). CT-GFRiodine and CT-GFR120kvp were compared with estimated GFR (eGFR) using paired t-test, correlation analysis, and Bland-Altman plots. The receiver operating characteristic (ROC) curves were used to test the renal function diagnostic performance with CT-GFR120kvp and CT-GFRiodine.

#### RESULTS

There were 100 patients with normal renal function and 80 patients with decreased renal function. The difference between eGFR ( $91.71 \pm 14.17 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ) as reference standard and CT-GFRiodine ( $93.42 \pm 14.04 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ) was not statistically significant, showing excellent correlation ( $r=0.88$ ,  $P<0.001$ ) and agreement ( $\pm 15.65 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ,  $P=0.091$ ). The correlation between eGFR and CT-GFR120kvp ( $84.71 \pm 21.76 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ) was poor ( $r=0.58$ ,  $P<0.001$ ), and the agreement was poor ( $\pm 45.75 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ,  $P=0.004$ ). The CT-GFRiodine had the largest area under the curve (AUC) for distinguishing between normal and decreased renal function (AUC=0.974).

#### CONCLUSION

The GFR can be calculated accurately using iodine maps in DEsCTU.

#### CLINICAL RELEVANCE/APPLICATION

This study explored the potential information of iodine maps in DEsCTU and demonstrated that DEsCT could be a non-invasive and reliable one-stop-shop imaging technique for evaluating both the urinary tract morphology and renal function, thereby providing more quantitative parameters for clinical practice and bringing more benefits to patients.

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## Abstract Archives of the RSNA, 2023

R5B-SPGU-2

### AI-based Urinary Calculi Detection, Localization, and Quantification on Abdomen-pelvis CT: A Multicenter, International Internal Testing and External Validation Study

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Parisa Kaviani, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Detection and localization of urinary calculi have a crucial role in patient management and in choosing the best course of therapy. Therefore, we performed a multicenter, international study to assess the performance of an AI algorithm for urinary calculi detection, localization, and quantification on abdomen-pelvis CT.

#### METHODS AND MATERIALS

Our retrospective IRB-approved study included 980 patients (mean age  $60 \pm 14$  years; M:F 509:471) who underwent non-contrast abdomen-pelvis CT for the evaluation of suspected urinary calculi at one of the 8 hospitals (4 sites in India, n=451 patients; 4 in the US, n=529 patients). The training (n>1000 CT) and internal testing data (n=451 CT) belonged came from the Indian sites while the US sites contributed data for the external model validation. Patients with surgical clips, stent, and metal related artifacts were excluded. All CT exams were reviewed by one of the three radiologists from India and US, and separately processed with Urologiq AI algorithm (Biocliq Technologies PVY LTD, India) to obtain information on the size of urinary calculi (n= 451) as well as to determine the urinary calculi presence and location, and hydronephrosis/hydronephroureter presence/severity (n=980). Deidentified DICOM images were imported to a secure platform CARING Analytics platform (CARPL) for ground truthing. The sensitivity, specificity, and area under the curve of receiver operating characteristics (ROC-AUC) were estimated to assess the AI model performance.

#### RESULTS

Our AI algorithm was able to detect the presence of urinary calculi with sensitivities, specificities, and AUCs of 97.3%, 94.2%, 0.958 (internal testing data) and 100%, 100%, 0.958 (external validation set), respectively. Likewise, the AI model differentiated the location of the renal calculi with sensitivities, specificities, and AUCs of 100%, 69.2%-99.6%, and 0.700 - 0.996 (internal testing data) and 92.9%-100%, 75.5%-100%, and 0.79-1 (external validation data) at different locations including (renal, ureteric, bladder levels), respectively. There was a strong correlation of 0.941-0.963 between AI and radiologist measured stone dimensions ( $p < 0.001$ ) with a <5% differences between the two measures.

#### CONCLUSION

The assessed AI algorithm was generalizable and accurate for detection, localization, and quantification of urinary calculi in both internal testing and external validation sites.

#### CLINICAL RELEVANCE/APPLICATION

The assessed AI model can help improve reporting accuracy and efficiency of abdominal-pelvis CT examinations for kidney stones.

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## Abstract Archives of the RSNA, 2023

R5B-SPHN-1

### **New Strategies in the Diagnosis of Thyroid Nodule: TI-RADS Risk Stratification Systems Versus Computer Aided Diagnosis Software**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Vincenzo Dolcetti (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare thyroid nodules evaluation of a expert radiologist (based on ACR-TIRADS classification) to the CAD System S-Detect, in a cohort of patients who performed FNAC.

#### **METHODS AND MATERIALS**

140 patients with an age range of 34 to 78 years with one and no more than three thyroid nodules were enrolled prospectively. The B-mode ultrasound evaluation of the nodule was integrated by a CAD System S-detect evaluation on each patient, and the two were put in comparison with cytology as gold standard. The exclusion criteria were the presence of cystic or mixed predominantly cystic (fluid >50%) lesions, and nodules smaller than 5 mm. All nodules were characterized in terms of size, shape, margins, composition, echogenicity, presence of calcifications or punctate echogenic foci and extrathyroidal extension. Afterward, the S-Detect software was used to automatically determine the shape, composition, echogenicity, and margins of the same nodule.

#### **RESULTS**

At the cytological examination, 102 benign and 38 malignant nodules were identified. At the B mode evaluation, 99 benign nodules (TIRADS 2/3) and 41 malignant nodules (TIRADS 4/5) were identified with a sensitivity of 98%, a specificity of 93%, a positive predictive value of 97% and a negative predictive value of 97%. The S-Detect software identified 97 benign and 43 malignant nodules, with a sensitivity of 97%, a specificity of 92%, a PPV of 95%, a NPV of 95%. A high agreement (>95%) was therefore demonstrated between the evaluation of thyroid nodules performed by the radiologist at the B-mode US using the ACR-TIRADS classification system and the automatic CAD classification provided by the S-Detect software.

#### **CONCLUSION**

ACR-TIRADS shows high agreement with the S-Detect and both show high agreement with cytology results.

#### **CLINICAL RELEVANCE/APPLICATION**

S-Detect is a viable tool for the characterization of thyroid nodules and it has a potential role as a teaching or support tool for the less experienced operators.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPHN-2

### Preoperative Diagnosis of Cervical Lymph Node Metastasis in Patients with Thyroid Cancer: Integrative Analysis of CT Imaging Features Based on US

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Meesun Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultrasound (US) is widely used as a primary imaging modality for the evaluation of cervical lymph node (LN) metastasis in thyroid cancer, but its diagnostic accuracy is limited. Computer tomography (CT) is often employed as a complementary modality, but there is no clear consensus on how to integrate the findings from the two modalities. We conducted a study to evaluate the concordance between suspicious imaging features observed on US and CT and to determine the clinical significance of concordant and discordant cases.

#### METHODS AND MATERIALS

This retrospective study included consecutive thyroid cancer patients who underwent US, CT examinations, and LN biopsy before surgery between December 2006 and June 2015. We analyzed US and CT images of LNs based on the lexicons of the Korean Society of Thyroid Radiology risk stratification system on a node-by-node basis. The concordance rate was calculated by matching US hyperechogenicity/abnormal vascularity with CT strong/ heterogeneous enhancement, US cystic changes vs. CT cystic changes, and US echogenic foci with CT calcifications. The malignancy rate of LNs was further compared according to the presence of specific suspicious features on US with their concordance with CT features.

#### RESULTS

A total of 277 cervical LNs (228 patients, mean age  $47.4 \pm 13.6$  years, female 73.2%) were analyzed, with 53.1% of them were metastatic. The positive concordance rate of suspicious features between US and CT were generally high (US hyperechogenicity vs. CT strong/heterogeneous enhancement, 89.1%; US abnormal vascularity vs. CT strong/heterogeneous enhancement, 86.4%; US cystic changes vs. CT cystic change, 70.6%; US large echogenic foci vs. CT macrocalcification, 87.0%), except for punctate echogenic foci (PEF) (vs. CT microcalcification, 6.5%). Positive concordant cases of US hyperechogenicity/abnormal vascularity showed higher malignancy risk (93.5%) than that of discordant cases (41.2%,  $P < .001$ ). The presence of cystic change or EF on US indicated a high risk of malignancy (82.6-95.8%), irrespective of presence of corresponding CT features.

#### CONCLUSION

Suspicious imaging features of cervical LNs observed on US and CT were generally concordant, except for PEF. Heterogeneous or strong enhancement features of CT reinforces the diagnostic significance of hyperechogenicity or abnormal vascularity on US. However, when cystic changes or echogenic foci are observed on US, malignancy should be suspected regardless of CT findings.

#### CLINICAL RELEVANCE/APPLICATION

An integrative evaluation of the suspicious features with both US and CT can enhance the diagnostic ability for detecting cervical lymph node metastasis in thyroid cancer patients.

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## Abstract Archives of the RSNA, 2023

R5B-SPHN-3

### Evaluating the Diagnostic Performance of a Deep Learning Model for Detecting Thyroid Nodule Malignancy: An Expert Evaluation Study

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Sanaz Vahdati, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Thyroid cancer is the most common endocrine malignancy. Ultrasound is the primary imaging modality for evaluating thyroid nodules. Based on the radiologist's assessment, further management, including fine needle aspiration, which is an invasive and costly procedure, may be requested. Thyroid nodule assessment relies on the expertise of radiologists and is subjective to an intrareader agreement. In recent years many deep-learning applications have been developed for thyroid nodule characterization. However, the evaluation of the deep learning model's performance in real-world radiology settings has been limited. In the current work, we aim to evaluate the performance of our previously developed model for thyroid nodule classification into benign and malignant with a radiologist using the American College of Radiology Thyroid Imaging Reporting and Data Systems scoring (TIRAD).

#### METHODS AND MATERIALS

The proposed model was trained on the ultrasound images of thyroid nodules from 983 patients with confirmed diagnostic reports from 2008 to 2018. 81 cases were held out as a testing set, and the rest of the data was used for training purposes. One radiologist with more than ten years of experience in ultrasound imaging evaluated the same images of the test set based on the TIRAD scoring system. The radiologist's thyroid nodule evaluation was recorded while the radiologist was blinded regarding the model's prediction and final pathological diagnosis of the patients.

#### RESULTS

The whole pipeline from the developed model reached an AUROC of 0.84 (CI 95%: 0.75-0.91) with sensitivity and specificity of 84% and 63%, respectively. The TIRAD evaluation of the test set had a sensitivity of 76% and specificity of 34% which was comparably lower than the model's prediction (p-value=0.003). A comparison of our model's performance with ground truth and the TIRAD score based on an expert radiologist's evaluation was analyzed. In 28% of the cases, the model predicted benign nodules as benign with TIRAD >3 reports from an expert radiologist. In 19% of cases, our model predicted benign nodules with TIRAD =3 as benign, and in 33% of cases, our model predicted malignant nodules correctly with the TIRAD >3. In addition, our model predicted no nodule as malignant, while the nodule had a benign biopsy report with a TIRAD =3.

#### CONCLUSION

We demonstrate the potential diagnostic performance of the deep learning model by comparison of its predictions with TIRAD scores from an expert radiologist.

#### CLINICAL RELEVANCE/APPLICATION

Thyroid nodule assessment in ultrasound is subjective to inter and intra-reader agreement. Our deep learning model can provide further assistance to radiologists for thyroid nodule evaluation.

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## Abstract Archives of the RSNA, 2023

R5B-SPHN-4

### Real-World Costs Associated with Incidental Thyroid Nodule Workup at an Academic Medical Center

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Brandon K.K. Fields, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Incidental thyroid nodules (ITN) are a frequent finding on cross-sectional imaging, occurring in up to 18% of CT neck studies with a malignancy rate of up to 11% in the reported literature. The rising incidence of thyroid cancer in the United States, due largely to low-risk papillary thyroid cancers detected as ITNs, has been termed an “epidemic of overdiagnosis”. ITN workup, including thyroid ultrasound, labs, and biopsy, may therefore cause resource burden on the healthcare system with questionable clinical benefit. The purpose of our study was to prospectively quantify the cumulative financial burden of ITN workup within a single hospital system using real-world data.

#### METHODS AND MATERIALS

Starting in August 2022, all ITNs discovered on CT and MR studies that include the neck at a single hospital system were flagged using a key phrase within the radiology report. The patient’s age, nodule size, nodule characteristics, and results of any further tests including thyroid labs, thyroid ultrasound, ultrasound-guided fine needle aspiration, and thyroidectomy, were recorded. The cost of thyroid labs, thyroid ultrasound, ultrasound-guided fine needle aspiration, and thyroidectomy was estimated using national 2023 Medicare reimbursement rates for each test.

#### RESULTS

From August 2022 to April 2023, ITNs were found on imaging studies including the neck of 355 patients. The overall incidence of thyroid nodules in a representative selection of studies was 4.0%. Further workup was recommended in 130 of 355 patients based on American College of Radiology guidelines. Fifty of 130 patients underwent laboratory testing with TSH, total T4, free T4, and/or free T3 assays. Thus far, 28 ultrasounds and six fine needle aspiration biopsies have been performed. Of the six biopsies, only one showed malignancy and that patient has not yet undergone surgical workup. One patient underwent right partial thyroidectomy for an indeterminate ultrasound result; final surgical pathology was benign and the patient is currently euthyroid. The total cost of thyroid nodule workup thus far has been \$5,780.96 for one malignancy diagnosed. Assuming the patient with diagnosed malignancy in our cohort undergoes a partial thyroidectomy and remains euthyroid, the total cost for one malignancy diagnosed and treated will be \$6,499.37.

#### CONCLUSION

In this single center prospective cohort study, the total cost of thyroid nodule workup from August 2022 to April 2023 was \$5,780 for one malignancy diagnosed, and \$6,499 for one malignancy diagnosed and treated.

#### CLINICAL RELEVANCE/APPLICATION

Incidental thyroid nodule (ITN) workups cause financial burden on a healthcare system with questionable clinical benefit. Quantifying this financial burden is an important step toward cost-effective healthcare.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPIN-1

### Using a Large Language Model for Identifying Findings in Chest X-ray Reports

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Pritam Mukherjee, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate Vicuna-13B, a publicly available large language model (LLM), on the task of identifying chest x-ray reports that are positive for a set of findings.

#### METHODS AND MATERIALS

This retrospective study used 25,596 chest x-ray reports from 2797 patients (M: 1,557 (56%), median age: 47, IQR: [32, 58]), corresponding to the test set of the publicly available NIH Chest X-Ray dataset. For the 13 Chexpert findings (atelectasis, cardiomegaly, consolidation, edema, enlarged cardiomeastinum, fracture, lung lesion, lung opacity, pleural effusion, pleural other, pneumonia, pneumothorax, and support devices) we considered the following multi-label binary classification task: the class label for a finding is True if the report contains a positive mention of the finding, and False otherwise. The LLM we chose is Vicuna-13B, a finetuned version of the LLaMA foundation model. We used a rule-based interactive prompting strategy, where each step is a natural language question in English. To avoid randomness in outputs, we set the "temperature" hyperparameter to 0. Since "gold label" radiologist annotations for the large dataset were not available, our primary goal was to assess the agreement of Vicuna's outputs with two popular and state-of-the-art labelers - a rule-based NLP tool Chexpert, and a deep learning model ChexBert - using the Fleiss' kappa statistic performed in a pairwise manner. A subset of 100 reports was manually annotated by a senior radiologist with more than 25 years of experience according to the Chexpert labeling rules. Receiver operating characteristics (ROC) analysis was performed using the radiologist annotations as the reference to assess the reliability of Chexpert, ChexBert and Vicuna.

#### RESULTS

Chexpert and ChexBert showed very high agreement with one another with a kappa value of 0.84 for the NIH dataset. Vicuna showed moderate agreement, with kappa values of 0.54 ( $P < .001$ ) vs Chexpert and 0.56 ( $P < .001$ ) vs ChexBert. When compared to radiologist annotations for 100 reports, Vicuna outperformed ChexBert on 4/11 findings (atelectasis, consolidation, enlarged cardiomeastinum, and pleural other), and Chexpert on 5/11 findings (atelectasis, cardiomegaly, enlarged cardiomeastinum, and pleural other); the mean AUROC over 13 labels was 0.85 for all models.

#### CONCLUSION

LLMs such as Vicuna present promising alternatives to custom-built NLP or deep learning tools for analyzing radiology reports. Vicuna showed satisfactory performance on our task - without any additional training or finetuning.

#### CLINICAL RELEVANCE/APPLICATION

Vicuna can be run locally without risking patient privacy and can accurately determine the presence or absence of findings in reports without the need for any training or custom NLP rules.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPIN-2

### Performance Evaluation and Return on Investment Estimation of a High-Sensitivity Normal-Abnormal Chest X-ray Classifier for Enhanced Clinical Workflow

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Shraddha Mittal (*Presenter*) Employee, CARPL.ai Pvt Ltd

#### PURPOSE

To evaluate the performance of a high-sensitivity normal-abnormal chest X-ray classifier, in improving the clinical workflow through efficient batching of normal and abnormal cases.

#### METHODS AND MATERIALS

The IRB-approved study used an enriched retrospective dataset consisting of 2405 normal cases and 2356 abnormal cases. The abnormal cases included clinically significant findings including but not limited to consolidation, nodule, cavitation, pleural effusion, pneumothorax, pneumoperitoneum, cardiomegaly, and rib fractures. These studies were evaluated using ChestLink by Oxipit.ai to classify the chest X-rays into normal and abnormal categories. The algorithm was orchestrated and the inferencing results were analyzed on the CARPL.AI platform.

#### RESULTS

The AI classifier identified 1859 normal and 2902 abnormal cases, with 12 false negatives and 568 false positives. The calculated sensitivity (recall or true positive rate) of ChestLink is 99.49%, and its specificity (true negative rate) is 76.38%. The positive predictive value (PPV) is 80.77%, while the negative predictive value (NPV) is 99.35%. In the existing workflow with a 30% time reduction for normal cases, the ROI is 26.4%. In the auto-batch workflow, where radiologists take 10 seconds to approve normal cases, the return on Investment (ROI) increases to 180.6%.

#### CONCLUSION

AI solutions can effectively improve the clinical workflow by batching normal and abnormal cases, allowing for the prioritization of abnormal cases for radiologists' review. This minimizes the time spent on normal cases and ensures faster diagnosis and treatment of patients with chest abnormalities. The low false-negative rate further emphasizes its potential to reduce missed abnormal cases, leading to improved patient outcomes. It also demonstrates a positive ROI in both scenarios, significantly improving the efficiency of radiology departments, especially in the auto-batch workflow.

#### CLINICAL RELEVANCE/APPLICATION

Implementing ChestLink can lead to faster diagnosis and reporting for patients, while reducing radiologists' workload by optimizing their time spent on normal cases. The auto-batch workflow further enhances these benefits, making it a valuable solution for radiology departments seeking to increase productivity and efficiency.

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## Abstract Archives of the RSNA, 2023

R5B-SPIN-3

### Development and Clinical Validation of a Radiological Impression Summarization System with Large Language Models

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Adrian Serapio (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and clinically validate a large language model that automatically generates impressions to summarize radiology reports.

#### METHODS AND MATERIALS

This retrospective model development study included 204,540 consecutively collected CT, MRI, US, and PET radiology reports from January 2021 to December 2021 from a single academic institution. We devised a text summarization task using a T5 large language model pretrained on the C4 dataset to generate the impression section from the clinical history, comparison, and findings sections of the radiology reports. Repetitive, non-informative phrases such as "No wet reading was provided for this report" and "The above findings have been communicated to the referring physician" were removed from the reports to improve model performance. The Recall-Oriented Understudy for Gisting Evaluation (ROUGE) score, a standard metric for measuring the quality of summaries, was used to evaluate model performance, and a five-reader performance study was conducted to validate clinical utility derived from impression generation. For each of sixty reports, readers were presented with either the report or model-generated impressions and were asked to edit the impression. Impressions were rated for their clinical accuracy, grammatical accuracy, stylistic quality, with the edit distance between their edited impression and the original impression, and time taken to edit also recorded.

#### RESULTS

On a UCSF general test dataset composed of 19,710 reports, the model achieved average ROUGE-1, ROUGE-2, and ROUGE-L scores of 54.05, 36.94, and 46.92. For the reader performance study, the model achieved mean ratings of 3.6/4, 3.9/4, and 3.4/4 for clinical accuracy, grammatical accuracy, and stylistic quality respectively and a mean edit distance and edit time of 11.75 words and 18.79 seconds respectively, of a similar performance to the radiologist baseline. The reader performance study demonstrated a moderate level of interexpert agreement (ICC: 0.57).

#### CONCLUSION

Using the clinical history and findings section of a radiology report, large language models can automatically generate radiological impressions with clinical accuracy, stylistic quality, and grammatical accuracy.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrate that a large language model can be used to automatically generate excellent quality radiologic impressions, which could potentially improve report quality and workflow efficiency.

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## Abstract Archives of the RSNA, 2023

R5B-SPIN-4

### Evaluation of A Natural Language Processing Model for Automated Protocolling of CT/MRI Requisitions

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Jia Cheng Yao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assess the accuracy of a natural language processing (NLP) model for automatically protocolling CT and MRI requisitions.

#### METHODS AND MATERIALS

Image requisitions of all CT/MRIs performed between January 2018-September 2022 at our institution were extracted from the Electronic Medical Record. A total of 234,193 records were obtained containing study requisition text, patient location (outpatient, emergency, inpatient), WTIS triage priority (P1-P4) and selected protocol. Studies were excluded if they did not include a priority or standardized protocol, or were for an interventional radiology procedure ( $n = 10,150$ ). A total of 224,043 studies were included, with 569 unique protocols (140 CT and 429 MRI). Studies were stratified by triage priority, then randomly split into training, validation and test datasets based on a 80-10-10% split. Data was pre-processed (lower casing, punctuation removal, stop-word removal, lemmatization) using standard techniques. Two independent pre-trained Bidirectional Encoder Representations from Transformers (BERT) models for study protocol and triage priority were fine-tuned using the training dataset based on the optimal hyperparameters (batch size = 10, learning-rate  $3e-4$ ) for 5 epochs. Results were analyzed for precision/recall and accuracy, with sub-analysis based on patient location and imaging modality.

#### RESULTS

For study protocol, weighted-mean F1-score, precision and recall were 0.813, 0.848 and 0.792, respectively. Overall accuracy was 0.848 (Top-3 accuracy 0.960, Top-5 accuracy 0.973). Stratified by location, accuracy for outpatient (OP), emergency department (ED), and inpatient (IP) studies were 0.832, 0.987 and 0.856, respectively. Accuracy for CT and MRI were 0.899 and 0.762, respectively. Micro-averaged one-vs-rest (OvR) area under the curve (AUC) was 0.998. For study protocol, weighted-mean F1-score, precision and recall were 0.847, 0.845 and 0.849, respectively. Priority 1 studies demonstrated high F1, precision and recall, 0.952, 0.948 and 0.956, respectively. Overall accuracy was 0.849 (Top-2 accuracy 0.982). Stratified by location, accuracy for OP, ED, and IP studies were 0.832, 0.987 and 0.856, respectively. Accuracy for CT and MRI were 0.831 and 0.881, respectively. Micro-averaged OVR AUC was 0.974.

#### CONCLUSION

Natural language processing models are a feasible solution for automated protocolling of CT/MRI requisitions.

#### CLINICAL RELEVANCE/APPLICATION

Applications include workflow optimization, protocol suggestion and study flagging. Given a relative lack of protocol standardization, automated methods also provide opportunities for standardization between institutions and radiologists.

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## Abstract Archives of the RSNA, 2023

R5B-SPIN-5

### Lifelike Pixel Print Phantoms for Clinical Evaluation of a Deep Learning CT Reconstruction Algorithm

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Jessica Y. Im, BEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep learning CT reconstruction (DLR) has become increasingly popular as a method of improving image quality and reducing radiation exposure. Due to their nonlinear nature, these algorithms exhibit object-dependent resolution and noise performance. Therefore, traditional phantoms, which lack tissue morphology, in combination with image quality metrics, such as contrast-to-noise ratio (CNR), have become inadequate indicators of clinical imaging performance. In this study, we propose to utilize lifelike 3D-printed PixelPrint lung phantoms to evaluate DLR performance over a wide range of radiation doses.

#### METHODS AND MATERIALS

A lung phantom generated from a patient chest CT with ground glass opacities (GGO) was fabricated using PixelPrint technology. The phantom was scanned with a conventional CT (Incisive CT, Philips Healthcare) at five radiation dose levels (CTDIvol 4.4, 5.6, 9.8, 14.4, 17.0 mGy). At each radiation dose, three scans were acquired, and each was reconstructed with filtered back projection (FBP), iterative reconstruction at one level (iDose4, Level 3), and AI-enabled DLR (Precise Image (PI)) at five levels (Sharper, Sharp, Standard, Smooth, Smoother). Noise and CNR were calculated for each radiation dose and reconstruction technique. With FBP at 17.0 mGy as the reference, structural similarity index measure (SSIM), multi-scale SSIM (MS SSIM), root mean square error (RMSE), and standard deviation (SD) of difference images were also calculated. A two-sample t-test with Bonferroni post hoc test was then performed to evaluate the performance of each dose and reconstruction combination in comparison to the reference for each metric.

#### RESULTS

The PixelPrint phantom produced clinically realistic images. iDose4 and DLR demonstrated superior performance at lower radiation doses compared to FBP across all metrics. To match or exceed the performance of the reference for every metric, iDose4 and varying levels of DLR required 9.8 mGy and between 4.4 and 9.8 mGy, respectively. These doses corresponded to dose reductions of 42% for iDose4 and 42% to 75% for DLR.

#### CONCLUSION

DLR has been shown to reduce radiation dose compared to FBP without compromising diagnostic image quality, surpassing the dose reduction achieved through iterative reconstruction. PixelPrint phantoms offer a valuable option for evaluating non-linear and object-dependent reconstruction algorithms, including various flavors of DLR.

#### CLINICAL RELEVANCE/APPLICATION

The use of PixelPrint in evaluating novel CT technologies offers a more realistic testing environment compared to traditional phantoms. This, in turn, promotes the translation of new technologies, such as DLR, into clinical practice.

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## Abstract Archives of the RSNA, 2023

R5B-SPIN-6

### **Evaluation of Segmentation Performance using Multiple Reference Standards for Accurate Orbital Bone Modeling in Cranio-maxillofacial Surgery: Based on MSDA-Net Deep Learning Segmentation**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Min Jin Lee, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Accurate segmentation and modeling of orbital bone on facial CT images are essential for creating customized bone templates in craniomaxillofacial surgery. This study proposes MSDA-Net, a segmentation algorithm that considers varying characteristics of orbital bone in terms of intensity and thickness, and evaluates its performance using reference standards generated through manual labeling by observers and label combination methods.

#### **METHODS AND MATERIALS**

A dataset of 355 facial CT images was divided into 228 training, 56 validation, and 71 test sets. MSDA-Net includes multiscale hierarchy module that considers various bone thicknesses and dual-attention module that focuses on meaningful features of thin bone. Three reference standards were obtained from observers, including a neurosurgeon with over 15 years of experience and two senior medical students. Three additional reference standards were generated using label combination methods, such as label fusion, majority voting, and the STAPLE algorithm. Segmentation performance was evaluated using six reference standards, with the evaluation ROI divided into three regions: whole orbital bone, medial wall, and orbital floor.

#### **RESULTS**

The proposed method outperformed with a DSC of over 89.75% for whole orbital bone and DSCs of 74.38% and 81.42% for the medial wall and orbital floor, respectively. However, differences in reference standards generated by observers and label combination methods resulted in varying levels of precision and recall. Observer 1 tended to generate thick labels, resulting in high precision, while Observers 2 and 3 produced relatively thin labels, leading to high recall values. Label fusion tended to generate thick labels, resulting in high precision, while majority voting and STAPLE generated similar reference standards with high recall. No significant difference in all segmentation measurements was observed between majority voting and STAPLE using the reference standards.

#### **CONCLUSION**

MSDA-Net provides accurate segmentation results by considering varying thickness and intensity of the orbital bone. Our study emphasizes the importance of using multiple reference standards to evaluate segmentation algorithms for structures prone to inter-observer variability. (This research was supported by a grant from the Korea Health Technology R&D Project through the Korea Health Industry Development Institute, funded by the Ministry of Health & Welfare (HI22C1496))

#### **CLINICAL RELEVANCE/APPLICATION**

Our study can assist in creating customized implants and surgical guides for reconstructing fractured or defective bones and establish reference standards for evaluating automatic segmentation algorithms.

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## Abstract Archives of the RSNA, 2023

R5B-SPIN-7

### Evaluating the Reliability of ChatGPT as a Tool for Imaging Test Referral: A Comparative Study with a Clinical Decision Support System

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Shani Rosen (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to investigate the feasibility of using Chat Generative Pre-trained Transformer (ChatGPT) to provide accurate imaging referrals for clinical use, as compared to the existing ESR iGuide system. With the continuous evolution and advancement of technology, Artificial Intelligence (AI) is increasingly being used to make diagnosis and decisions, including suggesting the most appropriate imaging referrals. This study aims to explore whether ChatGPT can provide equally or more accurate imaging referrals compared to the ESR iGuide. By evaluating the accuracy and effectiveness of ChatGPT, this study can contribute to the development of AI-based tools for clinical decision-making and potentially improve patient outcomes.

#### METHODS AND MATERIALS

A comparative study was conducted in a tertiary hospital. Data was collected from 97 consecutive cases that were admitted to the emergency department with abdominal complaints. We compared the imaging test referral recommendations suggested by the ESR iGuide and the ChatGPT and analyzed cases of disagreement. In addition, we selected cases where ChatGPT recommended a Chest Abdominal Pelvis (CAP) CT (n=66), and asked four specialists to grade the appropriateness of the referral.

#### RESULTS

ChatGPT recommendations were consistent with the recommendations provided by the ESR iGuide. No statistical differences were found between the appropriateness of referrals by age or gender. Using a sub-analysis CAP cases, high agreement between ChatGPT and the specialists was found. Cases of disagreement (12.4%) were further analyzed and presented themes of vague recommendations such as "it would be advisable" and "this would help to rule out".

#### CONCLUSION

ChatGPT's ability to guide the selection of appropriate tests may be comparable to some degree with the ESR iGuide. Features such as the clinical, ethical, and regulatory implications are still warranted and need to be addressed prior to clinical implementation. Further studies are needed to confirm these findings.

#### CLINICAL RELEVANCE/APPLICATION

The article explores the potential of using advanced language models, such as ChatGPT, in healthcare as a CDS for selecting appropriate imaging tests. Using ChatGPT can improve the efficiency of the decision-making process

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## Abstract Archives of the RSNA, 2023

R5B-SPIR-1

### Image-guided Intratumoral Radiofrequency Hyperthermia-Enhanced Herpes Simplex Virus Thymidine Kinase Gene Therapy of Non-Small Cell Lung Cancer: The Underlying Molecular Mechanisms

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Hui Zheng, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To validate the feasibility of image-guided interventional radiofrequency hyperthermia (RFH)-enhanced direct suicide gene therapy of orthotopic non-small cell lung cancer (NSCLC) and the underlying molecular mechanisms.

#### METHODS AND MATERIALS

This study included (a) in vitro experiments to prove the principle of the concept of "RFH-enhanced killing efficacy of Herpes Simplex Virus Thymidine Kinase (HSV-TK) /ganciclovir (GCV) gene therapy" on NSCLC cells, which was confirmed by confocal microscopy, MTS assay and apoptosis analysis; (b) in vivo experiments to validate the feasibility of the new interventional oncology technique, "image-guided intratumoral RFH-enhanced local HSV-TK/GCV gene therapy of NSCLC " by using a multifunctional perfusion-thermal RFH electrode for the rat models of orthotopic lung cancer; and (c) to investigate the related biomolecular mechanisms through three potential pathways, including apoptosis, heat shock protein and immunomodulatory. Both in-vitro and in-vivo experiments were divided into four study groups (n=6/group) with different treatments: (1) combination therapy of RFH+ HSV-TK/GCV; (2) RFH alone at 42°C for 30 min; (3) gene therapy with HSV-TK/GCV; and (4) control with saline.

#### RESULTS

In in-vitro experiments, bioluminescence optical imaging of cells confirmed that the relative photon signal intensity in the combination therapy group was significantly lower than those in the other three groups ( $p<0.001$ ). Confocal microscopy and MTS assay also demonstrated significant decrease in cell viability in combination therapy group, compared with other three groups ( $p<0.001$ ). Flow cytometry showed remarkably increased apoptosis in the combination therapy group ( $p<0.01$ ). In in-vivo experiments, follow-up bioluminescence imaging demonstrates a significantly lower relative photon signal intensity of tumors in the combination therapy group than in the other groups ( $p<0.05$ ). Immunohistochemical staining revealed the significantly decreased expression of Bcl-2 ( $p<0.01$ ), and significantly increased expression of Bax ( $p<0.05$ ) and Caspase-3 ( $p<0.01$ ) in the combination therapy group. Immunohistochemical staining also displayed the up-regulation of HSP-70 ( $p<0.01$ ), IL-2 ( $p<0.01$ ) and CD94 ( $p<0.01$ ) in combination therapy.

#### CONCLUSION

This study validated the feasibility of image-guided interventional RFH-enhanced direct suicide gene therapy of orthotopic NSCLC, which is activated through the mechanisms of augmenting Bax/Bcl-2/caspase-3-dependent apoptosis and the HSP-70/IL-2 depended anti-tumor immunity regulation pathway.

#### CLINICAL RELEVANCE/APPLICATION

This study has established ground works for developing a new interventional oncology therapy to effectively manage NSCLC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPIR-3

### Outcomes of Percutaneous Transluminal Angioplasty and/or Stenting (PTAS) as Treatment for Transplant Renal Artery Stenosis (TRAS)

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Dhane F. Stomp, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The objective of this study was to investigate the efficacy of percutaneous transluminal angioplasty and/or stenting (PTAS) for treatment of transplant renal artery stenosis (TRAS).

#### METHODS AND MATERIALS

This single-center, retrospective study analyzed a total of 91 patients with TRAS (median age = 61; 62.46% male and 37.36% female) who underwent 114 PTAS procedures between August 2013 and March 2020. We manually measured renal artery stenosis diameters from pre- and post-intervention angiographic images in the picture archiving and communication system (PACS) for each procedure. Technical success was defined as the ability to successfully dilate the stenosis with angioplasty and/or stent without significant residual stenosis. Baseline and post-intervention peak systolic velocities (PSV) [cm/s] and serum creatinine levels [mg/dL] at regular intervals for at least 24 months were recorded. Baseline and post-intervention results were compared using a two-sided paired samples T-test, with statistical significance defined by a p-value < 0.05.

#### RESULTS

Regardless of intervention type, primary technical success was notably high (96.70%). The most performed procedure was stenting (75.44%). Angioplasty alone resulted in a higher reintervention rate compared to stenting (44.44% vs. 20.55%;  $p = 0.037$ ). Serum creatinine was measured for a median of 12 months; PSV was measured for a median of 6 months. There was a statistically significant reduction in PSV up to 12 months (mean reduction 233 cm/s;  $p < 0.001$ ). There was also a significant reduction in creatinine from baseline to nadir (mean reduction 0.84 mg/dL;  $p < 0.001$ ), achieved at a median of 4 months. The reduction in PSV did not correlate with the reduction in creatinine (Pearson correlation coefficient = 0.33;  $p = 0.79$ ). Fourteen (12.28%) procedural complications occurred, including six minor (e.g., perinephric hematoma, puncture site hematoma, stent kinking) and eight major complications (e.g., dissection, pseudoaneurysm, thromboembolism). Four deaths occurred during the study period, none of which were attributed to study interventions (SIR adverse event class E-F).

#### CONCLUSION

PTAS is an effective, safe treatment for TRAS with a high rate of technical success. A higher reintervention rate was seen with angioplasty alone compared to stenting. Following PTAS, there was a statistically significant reduction in both PSV at 12 months and serum creatinine to nadir. No permanent adverse sequelae or death resulted from any procedure.

#### CLINICAL RELEVANCE/APPLICATION

Percutaneous transluminal angioplasty and/or stenting (PTAS) may serve as a safe, effective treatment option for patients with transplant renal artery stenosis (TRAS), which is procedurally and clinically applicable.

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## Abstract Archives of the RSNA, 2023

R5B-SPIR-4

### New Method of Knee OA Treatment with Intra Genicular Artery Injection of Mesenchymal Stem Cells

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Maedeh Rouzbahani (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to evaluate the role of intra-arterial mesenchymal cell injection in the management of knee osteoarthritis.

#### METHODS AND MATERIALS

After IRB and the ethics committee's approval, 30 patients with moderate knee osteoarthritis (OA) were treated. All patients had an MRI prior the procedure confirming the OA. After accessing the contralateral femoral artery, the genicular artery leading to the vascular blush was catheterized. The solution of mesenchymal stem cells(70 million allogenic cells) was then injected in the vessel. All the patients were admitted for one day following the procedure. MRI of the knee is planned in all patients at one month. WOMAC scores were obtained before and weekly after the intervention.

#### RESULTS

Technical success rate was 100%. 30 patients have completed clinical, and imaging follow up at one month. They were divided to four age groups and their womac score results recorded in 4 weeks as described below:A) Womac Score for age>55 (n=16) : "32.63" reduced to "7.69"B) Womac Score for age<=55 (n=14): "25.14" reduced to "3.36"C) Womac Score for weight>70 (n=17): "27.76 reduced to 5.47"D) Womac Score for weight<=70 (n=13): "30.92 reduced to 5.92" The average WOMAC score before the intervention, was about (25.14 - 32.63), and it dropped to about (7.69 - 3.36) on one month. This reduction on mean WOMAC numbers is statistically significant. Patient symptoms improved significantly. MRIs of the knee have demonstrated a significant regeneration of the affected cartilage and the subchondral lesions.

#### CONCLUSION

This preliminary study is promising demonstrating that intra-Genicular artery injection of mesenchymal Stem Cells not only improves clinical symptoms, but also results in early cartilage regeneration. In addition to pain improvement and cartilage regeneration, MRI Pictures demonstrate that in some patients subchondral changes improved significantly

#### CLINICAL RELEVANCE/APPLICATION

new method to pain management for OA patients.

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## Abstract Archives of the RSNA, 2023

R5B-SPIR-5

### All-payer Utilization of Arterial and Venous Thrombectomy for VTE in the United States

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Stephanie McNamara, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

An estimated one million venous thromboembolism (VTE) events occur annually in the U.S. and the use of thrombectomy to treat VTE is becoming increasingly common. Here, we assess utilization trends of arterial and venous thrombectomy to treat VTE for commercial and Medicare beneficiaries between 2017 and 2021.

#### METHODS AND MATERIALS

A claims search was performed through the Standard Analytical File (SAF) and claims clearinghouse databases to collect utilization data for arterial and venous thrombectomy across commercial and Medicare payers between January 2017 and December 2021 using Common Procedural Terminology (CPT codes). Thrombectomy CPT codes (37184-37188) were cross-referenced against ICD-10 codes for venous thromboembolism (VTE). Cross-referencing with COVID-19 ICD-10 codes was performed for 2020 and 2021 data. Claim counts and percentages were tabulated, and p-values calculated using chi square in GraphPad Prism.

#### RESULTS

Between January 2017 to December 2021, 79,925 claims for arterial and venous thrombectomy to treat VTE were identified. There was a 125% 5-year increase in total claims. Although there were significantly more venous thrombectomy (VT) claims than arterial thrombectomy (AT) (64,258 vs. 15,667,  $p < 0.001$ ), a greater 5-year increase in AT claims was observed compared to VT (5.5- vs. 1.8-fold). AT was more often billed through commercial insurers (62.1%) than Medicare (37.9%) ( $p < 0.001$ ) with the opposite true of VT (53.2% Medicare, 46.8% commercial,  $p < 0.001$ ). Interventional Radiology (IR) performed significantly more AT and VT procedures across all payers from 2017 to 2021 (IR: 46.7%, all cardiology: 23.1%, all surgery: 4.2%, vascular surgery: 25.9%,  $p < 0.001$ ). However, cardiology subspecialties saw a greater rise in AT and VT across all payers from 2017 to 2021 compared to IR (AT: 6.6- vs. 6.0-fold, VT: 2.6- vs. 1.5-fold). The Midwest and Southeast had the highest utilization of AT and VT regardless of payer. In COVID-19 patients, AT claims in 2021 were 3-fold higher than in 2020 (393 vs. 135 claims,  $p < 0.001$ ) irrespective of payer. Top ICD-10 codes associated with AT and VT were "pulmonary embolism without acute cor pulmonale" (61% of AT) and "embolism/thrombosis of iliac/femoral/popliteal veins" (49% of VT), respectively.

#### CONCLUSION

From 2017 to 2021, the number of claims for arterial or venous thrombectomy to treat VTE across all payers increased significantly. While a majority of these were VT, a greater rise in the number of AT claims was observed. IR performed more AT and VT procedures than any other specialty over this 5-year period.

#### CLINICAL RELEVANCE/APPLICATION

The use of thrombectomy to treat VTE is growing rapidly. Nonetheless, it remains a small percentage of total VTEs occurring nationally each year.

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## Abstract Archives of the RSNA, 2023

R5B-SPIR-6

### **The Benefit of Filtered Blood Reperfusion in Suction Thrombectomy of Submassive Pulmonary Embolism**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Ryan Bitar, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Catheter-directed suction thrombectomy has emerged as a major tool for reducing right heart strain in the management high-intermediate risk pulmonary embolism (PE); however, suction thrombectomy presents a potential concern for significant blood loss during clot aspiration. The purpose of this study is to assess the benefit and safety of utilizing a blood reperfusion filtration device (BRFD) during thrombectomy which is able to filter and return aspirated blood in an attempt to minimize blood loss.

#### **METHODS AND MATERIALS**

A single-institution retrospective cohort study was conducted on patients who underwent suction thrombectomy from 2018-2022. Patients were categorized into cohorts based on the use versus nonuse of a BRFD. Inclusion criteria involved adult patients with submassive PE (either imaging and/or biomarkers indicative of right heart strain) who underwent suction thrombectomy. Patients with massive PE, preceding cardiac arrest, or contraindication to anti-coagulation were excluded. Critical data points included age, gender, pre-procedural vitals and labs, procedural change in pulmonary arterial pressure (PAP), immediate post-procedural vitals and labs, admission length, blood transfusions, and 30-day post-procedural complications.

#### **RESULTS**

50 patients were recruited for each cohort. No significant difference in patient demographics, preprocedural vitals or labs, pre-procedural PAP, or thrombectomy-related decrease in PAP was observed. Post-procedural decrease in heart rate was -12.4 bpm in the non-BRFD cohort versus -20.6 bpm in the BRFD cohort ( $p = 0.039$ ). 24-hour post-procedural complete blood count demonstrated a significantly increased drop in hemoglobin in the non-BRFD cohort (-2.54g/dL) in comparison to the BRFD cohort (-1.54g/dL) ( $p=0.00004$ ). Of note 24-hour post-procedural platelets, white blood cells, creatinine, and potassium did not demonstrate a significant change between the two cohorts. 20% of the non-BRFD cohort and 4% of the BRFD cohort required blood transfusions ( $p= 0.028$ ). No significant difference was observed in days of admission or number of complications between the two cohorts.

#### **CONCLUSION**

The results of this study indicate that using a BRFD is a safe means of minimizing blood loss during suction thrombectomy, as evidenced by an attenuated drop in hemoglobin and a reduction in blood transfusions. Of note, the study poses limitations intrinsic to that of a low-power single-institution retrospective cohort study.

#### **CLINICAL RELEVANCE/APPLICATION**

Employment of a BRFD during suction thrombectomy should be considered as a beneficial tool for decreasing the risk of post-procedural anemia and the need for potential transfusions, improving patient energy/recovery and sparing precious blood products.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPMK-1

### Are Isolated Ulnar Fractures a True Marker for Intimate Partner Violence?

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Tammy Sung, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

What is the prevalence of confirmed or high risk for intimate partner violence (IPV) among adult women with isolated ulnar shaft fractures within a large integrated health system? Are there injury or sociodemographic characteristics associated with IPV in patients with isolated ulnar fractures?

#### METHODS AND MATERIALS

Adult women, age 18 to 65, with ulnar fractures from 2016 through 2021 were identified through electronic health record (EHR) query. Patients were categorized into two groups, one with isolated ulnar fractures and another with fractures of both the radius and ulna. Sociodemographic and clinical data, referral data, reported mechanism of injury and IPV documentation were collected. IPV stratification into four groups: confirmed IPV, high risk for IPV, low risk for IPV and not IPV based on ICD 9/10, internal IPV diagnosis codes and clinical chart review. Radiographs of isolated ulnar fracture group were evaluated for fracture side, location, pattern and displacement.

#### RESULTS

29% of 148 patients with isolated ulnar fractures were high risk or confirmed IPV, compared to 10% of the 147 patients who had non-isolated ulnar fractures ( $p < .01$ ). 95% of patients had formal documentation of screening within their EHR and 9% at time of fracture presentation. Within isolated ulna fracture group, confirmed or high-risk for IPV was associated with reported mechanism of injury of assault (37% versus 1%;  $P < .01$ ) but not other injury characteristics. Confirmed or high-risk for IPV was associated with previously reported IPV correlates of alcohol abuse history (30% versus 15%,  $p = .04$ ), depression history (42% versus 15%,  $p < .01$ ), and anxiety history (42% versus 22%,  $p = .01$ ). Increased number of prior documented emergency visits (median 2.0; interquartile range 0.0-6.0 versus median 0.0; interquartile range 0.0-1.0;  $p < .01$ ) was also associated with confirmed or high-risk for IPV.

#### CONCLUSION

Prevalence of confirmed or high-risk IPV in isolated ulnar fracture patients was significantly higher than those with non-isolated ulnar fractures. Frequent emergency department visits, alcohol abuse history and psychiatric history would favor IPV etiology.

#### CLINICAL RELEVANCE/APPLICATION

IPV is a global public health emergency which is challenging to diagnose. Prior research reported up to a third of 62 adult female patients with isolated ulnar fractures at three Level 1 trauma centers in urban setting may be associated with IPV. We found that 29% of adult female patients with this fracture identified in outpatient, urgent care, and emergency settings across a large multicenter health system had confirmed or were high risk for IPV. Our research supports isolated ulnar fracture as a true marker for IPV and highlights the importance of IPV screening at time of fracture evaluation.

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## Abstract Archives of the RSNA, 2023

R5B-SPMK-2

### Association Between Pelvic Bone CT-Derived Body Composition and Patient Outcomes in Older Adults With Proximal Femur Fracture

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Taeran Ahn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the association between pelvic bone computed tomography (CT)-derived body composition and patient outcomes in older adult patients who underwent surgery for proximal femur fractures.

#### METHODS AND MATERIALS

We retrospectively identified consecutive patients aged  $\geq 65$  years who underwent pelvic bone CT and subsequent surgery for proximal femur fractures between July 2018 and September 2021. Eight CT metrics were calculated from the cross-sectional area and attenuation of the subcutaneous fat and muscle, including the thigh subcutaneous fat (TSF) index, TSF attenuation, thigh muscle (TM) index, TM attenuation, gluteus maximus (GM) index, GM attenuation, gluteus medius and minimus (Gmm) index, and Gmm attenuation. The patients were dichotomized using the median value of each metric. Multivariable Cox regression and logistic regression models were used to determine the association between CT metrics with overall survival (OS) and postsurgical intensive care unit (ICU) admission, respectively.

#### RESULTS

A total of 372 patients (median age, 80.5 years; interquartile range, 76.0-85.0 years; 285 females) were included. TSF attenuation above the median (adjusted hazard ratio [HR], 2.39; 95% confidence interval [CI], 1.41-4.05), GM index below the median (adjusted HR, 2.63; 95% CI, 1.33-5.26), and Gmm index below the median (adjusted HR, 2.33; 95% CI, 1.12-4.55) were independently associated with shorter OS. TSF index (adjusted odds ratio [OR], 6.67; 95% CI, 3.13-14.29), GM index (adjusted OR, 3.45; 95% CI, 1.49-7.69), GM attenuation (adjusted OR, 2.33; 95% CI, 1.02-5.56), Gmm index (adjusted OR, 2.70; 95% CI, 1.22-5.88), and Gmm attenuation (adjusted OR, 2.22; 95% CI, 1.01-5.00) below the median were independently associated with ICU admission.

#### CONCLUSION

In older adult patients who underwent surgery for proximal femur fracture, low muscle indices of the GM and gluteus medius/minimus obtained from their cross-sectional areas on preoperative pelvic bone CT were significant prognostic markers for predicting high mortality and postsurgical ICU admission.

#### CLINICAL RELEVANCE/APPLICATION

CT metrics of the gluteus muscle group and subcutaneous fat can be utilized as risk stratification factors in elderly patients with proximal femur fractures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPMK-4

### Prediction of Histopathological Subtypes of Dermatofibrosarcoma Protuberans Based on MRI Radiomics Machine Learning Model

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Siyu Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish a diagnostic model for classic DFSP and FS-DFSP image information to explore the feasibility of predicting DFSP histological subtypes.

#### METHODS AND MATERIALS

53 DFSPs were retrospectively included in this study: 9 subjects with FS-DFSP and 44 subjects with classic DFSP. Their T1WI and FS-T2WI images constituted the primary dataset used to train multiple machine learning algorithms for constructing DFSP histological subtype prediction model. The subjects were randomly divided into training group and testing group. The training group was used for machine learning and the testing group was used to evaluate the training model. All patients were scanned using a 3.0T MR scanner. ROIs were manually delineated by open-source software on each slice of the T1WI and FS-T2WI images by one musculoskeletal radiologist with 5 years of professional experience, and each ROI segmentation was tested by another radiologist with 10 years of experience. LASSO was used to select features from preoperative imaging data. The prediction models of RF and KNN classifiers were constructed on T1WI and FS-T2WI respectively by using the extracted imaging features. The prognostic performance was assessed in training cohort and testing cohort by means of AUC, sensitivity, specificity and accuracy.

#### RESULTS

15 imaging features were selected by using LASSO algorithm. The AUC of RF based on T1WI was 0.902; sensitivity, 91.2%; specificity, 89.2%; and accuracy, 90.4%. The AUC of RF based on FS-T2WI was 0.913; sensitivity, 90.7%; specificity, 91.1%; and accuracy, 88.9%. The AUC of KNN based on T1WI was 0.798; sensitivity, 88.7%; specificity, 89.7%; and accuracy, 80.1%. The AUC of KNN based on FS-T2WI was 0.815; sensitivity, 83.5%; specificity, 86.3%; and accuracy, 82.1%.

#### CONCLUSION

This study puts forward for the first time the application of radiomics to distinguish the histopathological subtypes of DFSP, which provides a new and effective assistant diagnostic method for recognizing DFSP variants. The non-invasive machine learning method based on T1WI and FS-T2WI imaging is potential prognostic tool by distinguishing different levels of DFSP pathological subtypes before operation to improve the treatment strategy.

#### CLINICAL RELEVANCE/APPLICATION

DFSP is a rare low to intermediate grade soft tissue sarcoma of skin, but the FS-DFSP is a clearly malignant pathological subtype. The identification of malignant pathological subtypes by radiomics plays an important role preoperatively. The non-invasive machine learning method based on T1WI and FS-T2WI imaging is potential prognostic tool by distinguishing different levels of DFSP pathological subtypes before operation in this study to provide a new idea for the diagnosis and treatment of DFSP.

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## Abstract Archives of the RSNA, 2023

R5B-SPMK-5

### **Radiomics Signature on Magnetic Resonance Imaging: A Feasible Imaging Biomarker for Prediction of the Histopathological Grade of Soft Tissue Sarcomas**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Lei Xu, DC (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiomics analysis is more comprehensive and reliable to better provide the features of tumor characteristics and heterogeneity. It is important to identify the pathologic grade of soft tissue sarcomas before receiving treatment. Thus, we aimed to build a radiomics signature on the basis of magnetic resonance imaging and evaluate its ability for preoperatively identifying the grade of Soft tissue sarcoma (STS).

#### **METHODS AND MATERIALS**

99 patients (55 low grade STS and 44 high grade STS) were at random segmented into a training cohort (39 low grade STS and 31 high grade STS) and a validation cohort (16 low grade STS and 13 high grade STS) with a portion of 7:3. T2 with fat saturation and T1 with fat saturation and gadolinium contrast images were used to extract radiomics features. Radiomics signature was developed by the least absolute shrinkage and selection operator (LASSO) logistic regression model. The receiver that operated characteristics curve (ROC) analysis was used to assess radiomics signature's prediction performance.

#### **RESULTS**

A radiomics was developed by 8 radiomics features achieved favorable predictive efficacy. High-grade STS showed higher radiomics score than low-grade STS in both groups. An excellent prediction performance was indicated by the radiomics signature in both groups. The training cohorts and validation cohorts had an area under curves (AUCs) of 0.888 and 0.861, respectively.

#### **CONCLUSION**

A radiomics signature on the basis of MRI images could help identification the grade of STS, which could help guide clinical treatment strategies

#### **CLINICAL RELEVANCE/APPLICATION**

In this study, we build a radiomics signature on the basis of magnetic resonance imaging and evaluate its ability for preoperatively identifying the grade of Soft tissue sarcoma (STS). We found that the radiomics signature on the basis of MRI images could help identification the grade of STS, which could help guide clinical treatment strategies.

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## Abstract Archives of the RSNA, 2023

R5B-SPMK-6

### Shear Wave Elastography in Benign vs Malignant Fatty Tumors

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Ilyan Mezinskiy Kushnerev, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Lipomas are the most frequent soft tissue tumors of the general population, but they are not always easy to differentiate from liposarcomas. The goal of the study was to assess if shear wave elastography (SWE) could help differentiate malignant and benign iso/hyperechoic lipomatous lesions.

#### METHODS AND MATERIALS

We retrospectively review patients with fatty lesions that underwent percutaneous core needle biopsy in a University Hospital during 2021. All patients underwent ultrasonography followed by SWE to measure elasticity in kPa before biopsy. We compared benign and malignant tumors. The biopsy findings and, in some cases, the surgical-specimen histology were used as gold-standard.

#### RESULTS

We included 27 patients with lipomatous lesions, 22 with benign (16 lipomas, 3 spindle cell lipomas and 3 hibernomas) and 5 with malignant tumours (well differentiated liposarcomas). Malignant fatty lesions had significantly higher mean (19.07 (6.1-53.6) vs 46.86 (20.6-78.8);  $p=0.006$ ), max (74.4 (36.2-102.7) vs 33.69 (6.4-110.4);  $p=0.013$ ) and Standard Deviation (16.86 (9.8-24.3) vs 7.6 (0.5-25.2)  $p=0.008$ ) elasticity values compared to benign ones. Differences between benign subgroups do not achieve statistical significance.

#### CONCLUSION

SWE had good specificity and sensitivity for separating benign from malignant soft-tissue lipomatous masses, while differentiation between benign subgroups was not possible. Malignant lesions were stiffer and had more heterogeneous elasticity values than their benign counterparts.

#### CLINICAL RELEVANCE/APPLICATION

The primary objective of this study is to enhance the comfort of patients by reducing the time taken to arrive at a diagnosis and minimizing the need for unnecessary biopsies. This is a critical consideration because biopsies can be invasive, uncomfortable, and carry a risk of complications. Moreover, unnecessary biopsies can result in increased healthcare costs and undue stress for patients. By increasing the speed and accuracy of diagnosis, SWE has the potential to significantly improve patient outcomes and reduce healthcare costs.

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## Abstract Archives of the RSNA, 2023

R5B-SPMK-7

### Feasibility of Dual-layer Spectral CT Histogram Analyses for Differentiation Between Benign and Malignant Myxoid Soft Tissue Tumors: A Preliminary Study

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Tomohito Hasegawa (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the usefulness of electron density (ED) and effective atomic number (Z<sub>eff</sub>) for differentiation between benign and malignant myxoid soft tissue tumors.

#### METHODS AND MATERIALS

Twenty-two consecutive patients (mean age 60.5 years) with pathologically proven soft tissue tumors including 11 benign myxoid soft tissue tumors (BMSTTs) and 11 malignant myxoid soft tissue tumors (MMSTTs) were retrospectively analyzed. For all patients, preoperative dual-energy CT examination was performed using a dual-layer spectral detector CT scanner between February 2018 and March 2023. ROIs were drawn to fill the solid parts within each tumor avoiding calcified areas, and placed onto exactly the same locations in the images of Z<sub>eff</sub>, ED and conventional CT (120 KeV, CTconv). The histogram indices (the mean, skewness, kurtosis and 10th, 25th, 50th, 75th, and 90th percentiles) of the CTconv, Z<sub>eff</sub>, and ED values were compared between BMSTTs and MMSTTs using the Mann-Whitney U test. ROC curve analysis was carried out to assess the ability of each index to differentiate MMSTTs from BMSTTs. Sensitivity and specificity were calculated with a threshold criterion that would maximize the average of sensitivity and specificity by the largest Youden's index.

#### RESULTS

The skewness of ED was significantly lower in MMSTTs ( $-0.11 \pm 1.32$ ) than in BMSTTs ( $0.73 \pm 0.49$ ) ( $P = 0.013$ ), while no significant difference was shown in any other parameters. The area under the ROC curve for diagnosing MMSTTs was 0.81 for ED skewness. With a cut-off value of 0.62, the sensitivity and specificity to predict MMSTTs were 90.91% and 72.73%.

#### CONCLUSION

The skewness of ED may be useful in differentiating MMSTT from BMSTT.

#### CLINICAL RELEVANCE/APPLICATION

Histogram analysis of dual-energy CT parameters, especially skewness of electron density may be useful in differentiating malignant from benign myxoid soft tissue tumors.

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## Abstract Archives of the RSNA, 2023

R5B-SPMK-8

### The Diagnostic Role of Ultrasound in Merkel Cell Carcinoma: Our Experience

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Merkel cell carcinoma (MCC) is a rare and very aggressive type of skin cancer (<1% of all cutaneous malignancies), predominantly affecting old and/or immunosuppressed patients. Our purpose is to describe and illustrate the main sonographic features of this tumor.

#### METHODS AND MATERIALS

We retrospectively reviewed the images of MCC diagnosed in our institution during the last 10 years. We evaluated the demographic and clinical characteristics of the patients, the gray-scale and color Doppler sonographic findings of the lesions, and the locoregional lymph node involvement.

#### RESULTS

Ultrasound images of 8 patients were available, 6 women and 2 men with ages between 69 and 94 years. All but one of the tumors were in photoexposed areas. 7 patients debuted with a fast-growing nodular dermal lesion. In those 7 patients who clinically showed a cutaneous nodule, ultrasonographically the tumors were dermohypodermal, hypoechoic, non-encapsulated, with infiltrative margins through the relatively homogeneous subcutaneous septa, and with extensive vascularization that respects the architecture of the cutaneous plexuses. In 4 of the tumors, there was a "sandwich" pattern with an area of elongated dermal involvement and a parallel zone deep in the subcutaneous cellular tissue connected by infiltrated interlobular septa. Locoregional adenopathies and in-transit metastases were detected in almost half of the patients at the time of diagnosis.

#### CONCLUSION

Ultrasound is the imaging test of choice in the evaluation of cutaneous and superficial tumors. Despite its rarity, the presence of a dermohypodermal tumor with infiltrating borders through the lobular septa, high vascularization, relatively respected architecture and particularly, the appearance of a "sandwich" pattern, should make us include MCC in the differential diagnosis and force us to study on the spot the locoregional adenopathies and possible in-transit metastases.

#### CLINICAL RELEVANCE/APPLICATION

Recognizing the sonographic findings described above is of great importance to suggest the diagnosis of this rare entity, as well as to perform the locoregional extension study in the same exploration. All this means a considerable clinical benefit, since it allows an early management of this condition.

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## Abstract Archives of the RSNA, 2023

R5B-SPNMMI-1

### Dynamic Multi-phase $^{18}\text{F}$ -NaF PET/MRI in Pediatrics

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Kip E. Guja, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Skeletal imaging with  $^{18}\text{F}$ -NaF offers improved imaging characteristics and biodistribution compared to conventional bone scintigraphy with  $^{99\text{m}}\text{Tc}$  methylene diphosphonate (MDP) and hydroxydiphosphonate (HDP) but is typically acquired in a single delayed phase. Early blood pool phase imaging plays a vital role in pediatric skeletal scintigraphy due to its ability to reveal evidence of hyperemia, inflammation, marrow infiltration, and soft tissue abnormalities. Here we report an initial pilot study combining the superior imaging characteristics of NaF PET and the increased sensitivity of blood pool phase imaging by performing dynamic multiphase  $^{18}\text{F}$ -NaF PET/MRI in pediatric patients.

#### METHODS AND MATERIALS

Dynamic PET images were acquired in a single bed position focused on the area of clinical concern using fast list-mode starting just after injection of the radiopharmaceutical for a duration of 10 minutes. This was followed by standard delayed phase acquisition for the second portion of the exam. Dynamic blood pool phase images were reconstructed at 2.5 minutes per frame for a total of 10 minutes. Additional static blood pool phase images were reconstructed using the entire first 10 minutes of the exam. For the MRI component of the dynamic phase, zero echo time (ZTE) proton-density weighted MRI images were acquired.

#### RESULTS

In this prospective pilot study, a total of eight  $^{18}\text{F}$ -NaF PET/MRI examinations were performed on seven pediatric patients, ranging from 5 years old to 20 years old. Four of the exams were performed with traditional single delayed phase imaging only and four were acquired with dynamic and static early blood pool phase imaging in addition to the standard whole body delayed phase. Diagnoses included osteomyelitis, mastoiditis, CRMO, and one indeterminate lesion with subsequently improved after conservative therapy with NSAIDs.

#### CONCLUSION

Dynamic early blood pool phase  $^{18}\text{F}$ -NaF pediatric PET/MRI can improve imaging evaluation of children with skeletal complaints by combining the superior imaging characteristics of  $^{18}\text{F}$ -NaF PET with the added sensitivity of blood pool phase images and superior contrast with reduced radiation exposure of MRI. Further studies in larger cohorts of pediatric patients with a variety of skeletal pathologies are needed.

#### CLINICAL RELEVANCE/APPLICATION

Skeletal scintigraphy is one of the most common indications for pediatric radionuclide imaging. Combining the strengths of  $^{18}\text{F}$ -NaF PET with dynamic early blood pool imaging in PET/MRI offers unique and important benefits in evaluating children with skeletal complaints.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPNPM-1

### Increased Adverse Iodine Contrast Agent Reactions and Resistance to Epinephrine in the Setting of Beta-blocker Therapy: A Multi-Institutional Analysis of 209,482 Patients

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Brittany Q. Dang, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Adverse allergic reactions to iodine contrast agents are not common but can result in urticaria, nausea, vomiting, and potentially anaphylaxis. Beta-blockers, however, are a widely used class of medications that have been associated with an increased risk and severity of anaphylactic reactions. The purpose of this research is to investigate the relationship between beta blockers and adverse iodinated contrast agent reactions and response to epinephrine.

#### METHODS AND MATERIALS

The TriNetX research network provides access to de-identified medical record information for more than 111 million patients in 76 large healthcare organizations and was used for this study. Two patient cohorts were created. Beta-blocker utilization was identified by any of the following medication names and codes: acebutolol (149), atenolol (1202), bisoprolol (19484), metoprolol (6918), nadolol (7226), nebivolol (31555), and propranolol (8787). Contrast exposure was identified by ioxilan (27793), iopromide (27781), ioversol (27792), iopamidol (5966), and iohexol (5956). Both cohorts had exposure to one of the contrast agents at the time of a CT of the chest (CPT code 71260). One group was simultaneously on treatment with a beta blocker, while the other group was excluded from them. The cohorts were balanced for age, race, gender, and ethnicity by propensity score matching via the greedy nearest neighbor algorithm, resulting in 104,741 patients in each arm. They were then evaluated for subsequent ICD-10 code for "adverse effect of diagnostic agents" (T50.8X5), and medication codes for "use of epinephrine" (3992), and "use of glucagon" (4832).

#### RESULTS

Patients on beta blockers were 2.3 times more likely to have an adverse reaction to iodinated contrast agents (RR 2.3, 95% CI (1.65,3.29), p-value <0.0001). They were also 50% more likely to require treatment with epinephrine (RR 1.49, 95% CI (1.43,1.56), p-value <0.0001) and 2.6 times more likely to require treatment with glucagon (RR 2.6, 95% CI (2.43,2.7), p-value <0.0001).

#### CONCLUSION

The results from this large global data set support the idea that beta blockers increase the risk of allergic reactions to substances such as iodinated contrast agents and are associated with a reduced response to epinephrine. With the increasing use of beta blockers and iodine contrast agents, awareness of the potential adverse reactions and resistance to epinephrine is important.

#### CLINICAL RELEVANCE/APPLICATION

The current research is significant because understanding the increased risk of adverse reactions to iodine contrast agents and resistance to epinephrine in the setting of beta blockers will lead to improved safety of evaluation and treatment for patients requiring radiologic imaging with contrast.

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## Abstract Archives of the RSNA, 2023

R5B-SPNPM-2

### How Many "Lives" Does a Radiologist Save in a Career? A Modeling Analysis and Estimation

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Alexander Kuehne, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Medical imaging has unquestionably revolutionized medical care over the past century. Due to radiologists playing a supportive role in the care of a large number of patients, our total impact is difficult to quantify. The purpose of this analysis is to estimate the total value, in Quality Adjusted Life Years (QALYs) and average "lives" saved during the course of a usual career in radiology.

#### METHODS AND MATERIALS

We use figures from recent literature to calculate a point estimate as well as plausible ranges for the value of radiologic work over the course of a usual career. Input parameters include the average of a career (30 years), studies read per year (9671-12,669), annual work RVUs (9,264), total/work RVU ratio (1.97), cost per RVU (\$32.41), cost-effectiveness and willingness-to-pay for QALYs in the US (50-200K/QALY), average age of the US population (39), and remaining QALYs for the average person (~35). Deterministic and probabilistic sensitivity analyses were performed to assess plausible ranges and the sensitivity of health utility impact from the career in radiology. Results are reported in 2021 US Dollars.

#### RESULTS

The average radiologist is expected to provide health services with estimated value of \$18 million during the course of their career, reporting on the order of 300K-400K examinations (impacting at most as many patients). When the average cost-effectiveness of imaging is \$50,000/QALY, a radiologist is expected to provide 355 QALYs during a career or "save" the equivalent QALYs remaining in ~10 average lives. A pessimistic estimation, based on a higher proportion of low-value care (lower cost-effectiveness), could reduce the health utility impact by approximately 75%. Deterministic and probabilistic sensitivity analyses recapitulate the major findings, and emphasize that the health utility consequences of radiologic practice is highly dependent on the cost-effectiveness of imaging.

#### CONCLUSION

Radiologists provide a large volume of clinical care during the course of a career, impacting hundreds of thousands of patients. The total sum of our impact however, is highly sensitivity to health system variables, most importantly, the cost-effectiveness of radiologic imaging. Efforts to advance both value-based care could have an outsized effect on the utility of radiologic practice as a whole.

#### CLINICAL RELEVANCE/APPLICATION

Due to radiologists playing a supportive role in the care of a large number of patients, our total impact is difficult to quantify. Further knowledge and analysis of various system wide factors and, the sensitivity of radiology to these variables, can raise awareness of our overall impact on the US health system and potentially point towards ways of further value-basis analysis of radiologic imaging cares.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-1

### Independent Component Analysis vs. Block Design: A Comparison of Methods for Sedated Language Mapping in Pediatric Epilepsy

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Elmira Hassanzadeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Passive task-based fMRI under anesthesia is done for presurgical language mapping in pediatric epilepsy patients who cannot complete an awake study. In our previous study, using standard block design task paradigm-based analysis methods, we observed more atypical language patterns in task fMRI under anesthesia compared to wakefulness. We hypothesize that due to the effect sedation has on the brain, unconstrained data driven methods of analyses may be more likely to reveal the language network.

#### METHODS AND MATERIALS

We retrospectively identified patients with focal epilepsy who underwent presurgical functional MRI under anesthesia, including Auditory Descriptive Decision Task paradigm at our institution from 2014-2022. We used two methods to extract language activation maps: 1) paradigm-based block design general linear model (GLM), and 2) data-driven independent component analysis (ICA). A laterality index (LI) was calculated separately in the Frontal and Temporal language regions of interest (ROI). We considered positive laterality indexes as left dominant, negative laterality indexes as right dominant, and absolute laterality indexes less than 0.2 as bilateral. We defined 2 language patterns: typical (i.e., primarily left-sided) and atypical (Fig 1a).

#### RESULTS

Twenty-four patients, mean age 7 years old (SD=3.2), 36% female, met the inclusion criteria and were analyzed. Figure 1 (b-d) shows LI distribution in each ROI based on the analysis method. The language pattern of 16% of the patients is categorized as typical with GLM, compared to 69% with ICA. There is a significant positive correlation between the Frontal and Temporal LI with the ICA (pearson  $r = 0.44$ ,  $P=0.03$ ) compared to GLM (pearson  $r = 0.3$ ,  $P=0.15$ ). There is a significant negative correlation of Temporal LI between the two methods. This is manifested as more left-dominant (typical) patterns with ICA. There is no correlation between the Frontal LIs between the two methods.

#### CONCLUSION

In this fMRI dataset under anesthesia, ICA analysis demonstrates a stronger expected correlation of the frontal and temporal laterality indexes. ICA may be a useful analysis method for sedated scans. However, the possibility of an increased typical pattern with ICA needs further analysis with larger samples.

#### CLINICAL RELEVANCE/APPLICATION

Prior research indicates that anesthesia impacts bold signal of Frontal brain regions disproportionately when compared to Temporal brain regions, which exhibit more robust signal under sedation. The presurgical pattern derived from passive task-based fMRI under anesthesia requires caution in interpretation and further data driven analysis method may improve accuracy of language pattern assignment.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-10

### Deep Learning Enhances Reliability of Dynamic Contrast-Enhanced MRI in Diffuse Gliomas: Bypassing Post-processing and Providing Uncertainty Maps

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Youngwook Lyoo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To propose a deep learning-based probabilistic model for directly estimating and reliably generating pharmacokinetic (PK) parameter maps from dynamic contrast-enhanced (DCE)-MRI, bypassing the limitations of low reliability due to irreproducible arterial input functions (AIFs), and incorporating uncertainty maps.

#### METHODS AND MATERIALS

From Apr 2010 to Feb 2018, we retrospectively enrolled 341 consecutive patients (mean age, 55±15 years; 202 (59.2%) male) with adult-type diffuse gliomas, who underwent preoperative DCE-MRI. We developed a neural network model combining a temporal convolutional network and a probabilistic U-net to estimate PK maps directly without using the AIF. Structural Similarity Index Measure (SSIM) between generated and ground truth (GT) maps was calculated for quantitative validation of map generation. The reliability of the PK parametric maps was evaluated by comparing the intraclass correlation coefficient (ICC) of two Ktrans, Vp, and Ve measurement, averaged for tumor subregions-of-interest, obtained twice independently, using: 1) conventional PK map generation using commercial software; 2) generated PK maps from the neural network model. For clinical validation, Area Under the Receiver Operating Characteristic Curve (AUROC) was obtained for differentiating WHO grade (low- vs high-grade) and IDH mutation.

#### RESULTS

Generated Ktrans, Vp, Ve maps showed high SSIM (0.949±0.02, 0.746±0.021, 0.745±0.023) compared to the GT maps, respectively. The ICC of PK maps was significantly higher in generated PK maps compared to the conventional approach: 0.984 vs 0.119, p<0.001 for ktrans, 0.994 vs 0.465, p<0.001 for Ve, 0.984 vs 0.563, p<0.001 for Vp. In the IDH-mutation prediction and glioma grading, PK values of enhancing tumor portion obtained from generated and GT maps was comparable in AUROC: 1) Ktrans, 0.844 vs 0.836 (p=0.78); Vp, 0.846 vs 0.846 (p=0.97); and Ve, 0.837 vs 0.826 (p=0.76) for IDH prediction; and 2) Ktrans, 0.892 vs 0.872 (p=0.58); Vp, 0.908 vs 0.875 (p=0.51); and Ve, 0.910 vs 0.863 (p=0.39) for glioma grading.

#### CONCLUSION

PK maps generated from DCE-MRI using a deep learning-based probabilistic model showed improved reliability without compromising diagnostic performance in glioma grading.

#### CLINICAL RELEVANCE/APPLICATION

Quick generation of PK maps from DCE-MRI bypassing post-processing using deep-learning with improved reliability may accelerate the application of DCE-MRI to clinical practice, benefiting treatment response monitoring in diffuse gliomas.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPNR-11

### Correlations of Computational Modeling of Interstitial Fluid Pressure and Velocity with IDH1 Expression and Ki-67 Level in Glioblastoma

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Jianan Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

The immunohistochemistry features of glioblastoma have important influence on its occurrence and prognosis. This study aimed to explore correlation of computational modeling of interstitial fluid pressure (IFP) and velocity (IFV) based on dynamic contrast enhanced (DCE)-MRI with IDH1 expression and Ki-67 level in glioblastoma.

#### METHODS AND MATERIALS

Patients diagnosed as glioblastoma between 2020 and 2021 were included. All patients underwent examination before surgery in a 3.0T MR scanner (uMR770, United Imaging Healthcare). DCE-MRI (transverse T1-weighted spoiled gradient-echo sequence, 100 time-points, temporal resolution 2.5s) were performed before, during and after the injection of contrast agent (gadodiamide injection, 0.2mL/kg, 3.5mL/s). IDH1 expression and Ki-67 level were evaluated by immunohistochemistry of tumor samples after surgery. The permeability parameters were calculated from extended-Tofts model. Volume-of-interests were delineated manually including the whole tumor on late DCE images. The partial differential equation of IFP and IFV was formulated from the continuity equation and solved in MATLAB. All modeling parameters were decided according to foreknowledge from previous studies. Spearman's test was used to assess the relationship between IFP and IFV indicators (mean, standard deviation, kurtosis, skewness) and immunohistochemistry markers. Significance criteria was  $P < 0.05$  for all statistic results.

#### RESULTS

Thirty-four patients were included (mean age  $57.2 \pm 10.4$ , 17 females). IFP and IFV mappings were obtained for each patient. The IDH1 expression was negatively correlated with IFP<sub>mean</sub> ( $P=0.031$ ,  $r=-0.382$ ), IFP<sub>kurtosis</sub> ( $P=0.031$ ,  $r=-0.383$ ) and IFV<sub>mean</sub> ( $P=0.038$ ,  $r=-0.369$ ) and positively correlated with the IFP<sub>skewness</sub> ( $P=0.023$ ,  $r=0.402$ ). Ki-67 level was negatively correlated with IFV<sub>kurtosis</sub> ( $P=0.042$ ,  $r=-0.351$ ). No significance was found in other statistic results.

#### CONCLUSION

Computational modeling of IFP and IFV based on DCE-MRI has significant correlation with IDH1 expression and Ki-67 level of glioblastoma.

#### CLINICAL RELEVANCE/APPLICATION

This study found that computational modeled IFP were associated with the expression of IDH1 in glioblastoma. IFP is closely associated with tumor permeability, and could be affected by the microvascular properties within the tumor. Compared with IDH mutant, IDH wild-type glioma has faster tumor cell proliferation, richer neovascularization and higher permeability. Ki-67 reflects the proliferation of tumor cells and can be used to distinguish low-grade glioma from high-grade glioma. Therefore, IFP indicators have potential significance in predicting the molecular classification, tumor recurrence and prognosis of glioma.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-12

### Usefulness of Perfusion Imaging with Super-selective pCASL for Meningioma

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Takashi Katsube (*Presenter*) Nothing to Disclose

#### PURPOSE

Identification of meningioma's feeding arteries and brain invasion is important for transcatheter arterial tumor embolization (TAE) or tumor resection. Super-selective pseudo-continuous arterial spin labeling (SS-ASL) is capable of selectively labeling the major arteries in the neck and noninvasively assessing the perfusion area of that artery. The purpose of this study is to investigate whether SS-ASL can identify the feeding arteries of meningioma and determine the presence or absence of meningioma brain invasion.

#### METHODS AND MATERIALS

The subjects were 19 patients (18 women and a man, mean age 64.6) who had SS-ASL of MRI and angiography and were pathologically diagnosed meningioma. The average major axis of the tumors on MRI is 37.7mm (15-58 mm). SS-ASL was selectively labeled for an external carotid artery, an internal carotid artery, or bilateral vertebral arteries, respectively, and two to five SS-ASL images were taken in each case, with different arteries selected depending on the localization of the tumor. Two observers separately identified the feeding arteries of meningioma by SS-ASL and compared them to angiography to assess their accuracy. Also, increased perfusion in the region of the tumor bordering the brain parenchyma on SS-ASL with selected internal carotid or vertebral arteries was considered as having brain invasion, and the findings was compared with surgical and pathological findings. The image quality of SS-ASL was evaluated on a 4-point scale (grade 1-4).

#### RESULTS

One case in which the feeding artery could not be clearly identified on angiography was deleted, resulting in 18 cases being evaluated. In 16 cases (88.9%) for observer 1 and 15 cases (83.3%) for observer 2, the feeding arteries noted on SS-ASL were consistent with the angiographic findings. Surgery and pathology were able to correctly determine the presence or absence of brain invasion of meningioma in 14 cases, with 3 cases showing brain invasion. And 10 cases (71.4%) were correctly evaluated by SS-ASL. All 7 cases judged as no brain invasion by SS-ASL had no brain invasion. A total of 61 SS-ASL images were obtained in 18 cases. The images graded 3 or 4, which can be judged as good, were 55 (90.2%) for observer 1 and 52 (85.2%) for observer 2.

#### CONCLUSION

SS-ASL is expected as a non-invasive method for estimating the feeding arteries of meningioma and may be useful for surgical information and TAE decisions.

#### CLINICAL RELEVANCE/APPLICATION

SS-ASL can noninvasively assess blood flow in intracranial lesions. The ability to identify the distribution of blood flow in meningioma with SS-ASL provides useful information for angiography and surgery.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-13

### Spinal CSF Outflow using Spin Labeling MRI

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Mitsue Miyazaki, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

In comparison to the brain, the mechanisms of intrinsic CSF spinal outflow are ones that remain to be unclear. The purpose of this research work is to investigate the location of CSF spinal outflow using novel MRI non-contrast, spin-labelling of endogenous CSF.

#### METHODS AND MATERIALS

Seven healthy subjects were imaged using a clinical 3 Tesla MR imager with a 16-channel spine coil. Coronal T2-weighted 2D fluid attenuated inversion recovery (FLAIR) and coronal T2-weighted 3D centric ky-kz single-shot FSE (cSSFSE) were used to locate the lumbar regions of the spinal canal, while axial T2-weighted imaging was used to locate a spin-labeling, time-spatial labeling inversion pulse (Time-SLIP). To prevent blood contamination, an effective TE ( $TE_{eff}$ ) of 300 ms was used in the Time-SLIP experiments.

#### RESULTS

Using non-invasive, non-contrast techniques, we demonstrate both proximal to distal and cranial to caudal flow gradients, with the highest level of CSF flow along the L3 and L4 nerve roots. Interestingly, the slowest outflow was in ROI 1 and 2 (L1) which also demonstrating overall increased Time - to - Peak (TTP) relative to L2-4.

#### CONCLUSION

Our work is the first to validate the use of non-invasive, non-contrast MR techniques to identify and quantify intrinsic CSF spinal outflow metrics. Our quantitative results demonstrate high CSF outflow along the lumbar nerve roots as the first direct visualization of dispersed CSF egress from the nerve root sheaths into the adjacent paraspinal space.

#### CLINICAL RELEVANCE/APPLICATION

New avenue for spinal CSF flow study, with implications for intrathecal drug design/delivery, identifying flow abnormalities related to CSF issues, and as biomarker for neuropathy/radiculopathy.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-2

### Does Resting-state fMRI have the Potential for Presurgical Functional Mapping?

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Ruchi Sharma, MS, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

In research, the potential of resting state has been explored for several decades, however, task-based functional MRI (tb-fMRI) is the status quo for presurgical planning where eloquent functional networks of the brain such as language and movement are mapped. But, reliable tb-fMRI mapping requires task compliance whereas resting-state fMRI (rs-fMRI), which utilises the inherent synchronisation of fMRI BOLD signals between brain areas, enables this mapping even in sleep/anaesthesia conditions. Further, several functional networks can be mapped at once. To leverage the capabilities of rs-fMRI in clinical settings, a comparison of the two is crucial. The purpose of this study was to compare rs-fMRI and tb-fMRI.

#### METHODS AND MATERIALS

The raw rs-fMRI data and partially pre-processed tb-fMRI data (n=75 language, n=80 motor) from a healthy cohort were obtained from HCP dataset. After relevant pre-processing steps including artefact correction, skull-stripping, and denoising. Independent component analysis was performed on the rs-fMRI time series using standardized reproducible pipelines in Python. The components were compared with functional atlases - Schaefer (sensory-motor) and SENSEAAS (language) using Dice coefficients, and the component with the largest coefficient was chosen for subsequent analyses. For tb-fMRI, cluster-based z-statistic maps were generated at a significance level of  $p=0.05$  using a threshold of  $z = 3.69$  using the FSL toolbox. Following this, four metrics were computed- sensitivity and specificity of rs-fMRI with respect to tb-fMRI (masked with an average of both to avoid null voxels), concordance of lateralization (left, right, bilateral) between rs-fMRI and tb-fMRI, the distance between the centre of mass (COM) of peak clusters in rs-fMRI and tb-fMRI, and product of group-averaged tb-fMRI and rs-fMRI maps.

#### RESULTS

The tb-fMRI produced more lateralized activations than rs-fMRI. The concordance between the lateralization side indicated by rs-fMRI to that by tb-fMRI was 36 % for the language network.

#### CONCLUSION

The sensitivity and specificity values were in an acceptable range. The distance between rs-fMRI and tb-fMRI COMs as well as lateralisation concordance were similar to previous studies on tumours. The product of rs-fMRI and tb-fMRI maps indicate good topographic concordance. Taken together, the results reflect that rs-fMRI is comparable to tb-fMRI but doesn't have a very high concordance, likely reflecting the unique activations captured by rs-fMRI.

#### CLINICAL RELEVANCE/APPLICATION

Pre-surgical planning based on rs-fMRI can be used for patients non-compliant with tb-fMRI such as comatose, paralyzed, cognitively challenged, claustrophobic, etc.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-3

### ABC/2 and Ice Cream Cone Method for Volumetric Assessment of Vestibular Schwannomas: Reliability of These Methods

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Nader Ashraf, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Vestibular schwannomas are three-dimensional tumors that cannot be accurately assessed with linear measurements or simple volume calculations. Volumetric analysis, using software that segments images, provides a more robust tool for measuring tumor volume, growth rate, and volumetric change. However, this software is not widely accessible and can be time-consuming. As a result, volume-estimating formulas such as ABC/2 and ice cream cone have become popular. This study aimed to evaluate the accuracy of volume estimation using these formulas compared to manual segmentation, using magnetic resonance imaging (MRI).

#### METHODS AND MATERIALS

The study analyzed 46 cases of unilateral vestibular schwannomas confirmed by pathology and examined using MRI. Volumetric analysis was conducted using a 3-D, T1-weighted, magnetization-prepared rapid gradient echo (MPRAGE) sequence with manual image segmentation. Two-dimensional metrics were used to calculate tumor volume using ABC/2 ( $AP \cdot ML \cdot CC / 2$ ) and ice cream cone formulas. The largest anteroposterior (AP) and craniocaudal (CC) dimensions were compared for each tumor. Differences greater than 10% between these dimensions were used to assess the difference between the lesions. Unpaired t-tests were used to analyze the results, with significance set at  $p < 0.05$ .

#### RESULTS

Of the 46 patients, 34 (74%) had intracanalicular and cisternal components, while 10 (22%) had only intracanalicular component. The comparison of volume estimation was done on a subgroup of 31 patients. The mean tumor volumes obtained by manual segmentation, ABC/2, and ice cream cone methods were 1244.41 ( $\pm 982.35$ ) mm<sup>3</sup>, 1557.23 ( $\pm 1484.05$ ) mm<sup>3</sup>, and 1043.64 ( $\pm 891.13$ ) mm<sup>3</sup>, respectively. There was no statistically significant difference between ABC/2 and manual segmentation ( $p=0.16$ ), ice cream cone and manual segmentation ( $p=0.20$ ), and ABC/2 and ice cream cone ( $p=0.52$ ) measurements. Of the tumors, 26 (57%) had longer AP dimensions, while 6 (13%) had longer CC dimensions.

#### CONCLUSION

Linear measurement applications such as the ABC/2 and ice cream cone methods can serve as substitutes for calculating tumor volumes, given their ease of use and accessibility. However, the ABC/2 formula tends to overestimate the tumor volume, while the ice cream cone formula tends to underestimate it. Furthermore, while the majority of vestibular schwannomas are ovoid, 13% of tumors grow predominantly in a CC fashion, which may result in preferential trigeminal nerve involvement.

#### CLINICAL RELEVANCE/APPLICATION

The ABC/2 and ice cream cone formulas are reliable and time-efficient alternatives to manual segmentation for accurately estimating the volume of vestibular schwannomas.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-4

### Applying ChatGPT to Predict Imaging Modalities Given Neuroradiological Patient Presentation

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Lleyem Nazario-Johnson, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this project is to explore the ability of large language models (LLMs) to predict the best neuroradiologic imaging modality given specific clinical presentations. In addition, we seek to determine if LLMs can outperform an experienced neuroradiologist in this regard.

#### METHODS AND MATERIALS

We utilized ChatGPT, an LLM built by Open AI that is trained on general data, as well as GlassAI, an LLM built by Glass Health that is trained on medical text. We prompted ChatGPT to rank the three best neuroimaging modalities, while taking the best responses from GlassAI and the neuroradiologist. We compared the responses to the American College of Radiology (ACR) Appropriateness Criteria for 147 conditions under the Neurologic Panel. Clinical scenarios were passed into each LLM twice, to account for stochasticity. Each output was scored out of 3, where 3 is "usually appropriate", 2 is "may be appropriate", 1 is "usually not appropriate", and 0 is not listed. Partial scores were given for non-specific answers. Scores were averaged across neurological topics. Statistical significance was determined using a two-sided student's T-test.

#### RESULTS

ChatGPT achieved a score of 1.75 with a standard deviation of .81, while GlassAI achieved a score of 1.83 with a standard deviation of .81 across all neurological clinical scenarios. The difference between them was not found to be statistically significant ( $p > .05$ ). The neuroradiologist achieved a score of 2.19, with the difference of the scores being statistically significant when compared to LLMs ( $p < .05$ ). ChatGPT was also found to be the more inconsistent of the two LLMs, with the score difference between both outputs being statistically significant ( $p < .01$ ). It was also found that the score between different ranks outputted by ChatGPT was statistically significant ( $p < .001$  for each).

#### CONCLUSION

LLMs perform well selecting an appropriate neuroradiologic imaging procedure when prompted with a specific clinical scenario. ChatGPT, a general model, performed the same as GlassAI, a medical-specific model, suggesting that with medical text training, ChatGPT could significantly improve its function in this application. LLMs did not outperform an experienced neuroradiologist, indicating the need for their continued improvement in the medical context.

#### CLINICAL RELEVANCE/APPLICATION

LLMs such as ChatGPT and GlassAI are able to comprehensively analyze large volumes of patient data and provide practitioners with accurate and reliable recommendations. This ability can improve diagnostic accuracy, reduce unnecessary testing and radiation exposure, and ultimately improve patient outcomes. Though LLMs do not yet outperform a neuroradiologist, our investigation indicates a proof of concept for their clinical implementation.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-5

### Photon-counting Detector CT Could Visualize Brachial Plexus: A New Method to Evaluate Nervous System

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Masahiro Nakashima, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

MRI is widely used to evaluate brachial plexus, however, it is often difficult to visualize it because of field inhomogeneity and anatomical complexity. Recent advent of photon-counting detector CT (PCD-CT) could provide the higher spatial resolution with better tissue characterization. The purpose of this study was to investigate the optimal reconstruction function of the PCD-CT to maximize the quality of imaging for it.

#### METHODS AND MATERIALS

This retrospective study included patients who underwent neck PCD-CT for screening between March 1 and April 3, 2023 in our institution. Patients with radiological abnormalities, such as masses and postoperative cervical spine, were excluded. To evaluate the appropriate reconstruction function (kernel), the signal-to-noise ratio (SNR) was quantitatively compared in eight different kernels for each patient while other parameters, including matrix size (512×512mm), degree of iterative reconstruction (QIR2), and slice thickness (0.4mm), were fixed. Radiation dose levels were CTDIvol 11.0-13.8mGy. The kernels of quantitative regular (Qr) series from Qr40 to Qr72 (Qr40, Qr44, Qr48, Qr56, Qr60, Qr64, Qr68, and Qr72), the standard kernel for quantitative evaluation, were used. The SNR was measured on a reconstructed 1mm-thick coronal section image by setting six regions of interest (ROIs) with 3 mm<sup>2</sup> on each of the bilateral C5-C7 nerves, and the average and standard deviations (SDs) of the SNRs were calculated. All the ROIs within each subject were copied and pasted to the images with different kernels to ensure locational accuracy. The SNR was measured by a board-certified neuroradiologist with 8 years of experience. Statistical analyses were performed with the Friedman test, and the Wilcoxon signed-rank test.

#### RESULTS

Ten subjects (5 males and 5 females; median 73 [range65-78]years) were evaluated. The SNR (mean±SD) was 3.39±1.30, 2.93±0.96, 2.66±0.95, 2.05±0.72, 1.74±0.59, 1.44±0.48, 1.14±0.37, 1.14±0.37, for Qr40, Qr44, Qr48, Qr56, Qr60, Qr64, Qr68, and Qr72, respectively. The SNRs exhibited a constant decrease with each increase in the Qr number. The SNRs were significantly different ( $P<0.05$ ) between any of the two groups, except for Qr68 vs Qr72. The kernel with the smaller Qr number demonstrated a better SNR in the evaluation of the brachial plexus.

#### CONCLUSION

On PCD-CT, the kernel with a smaller Qr number was more suitable to evaluate the brachial plexus. Qr40, in particular, was found to have the highest SNR and was seemed to be clinically useful.

#### CLINICAL RELEVANCE/APPLICATION

While MRI has been the mainstay for the evaluation of the brachial plexus, the heterogeneity of magnetic fields hampers image evaluation. PCD-CT, with its improved tissue resolution, may help in the assessment of the brachial plexus.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-6

### Large-scale Granger Causality (IsGC) for Identifying Autism Spectrum Disorder Patients Using Functional MRI - A Multivariate Brain Connectivity Analysis

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Ali Vosoughi (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to create and test a new machine-learning approach for identifying individuals with Autism Spectrum Disorder (ASD). This approach uses large-scale Granger Causality (IsGC) to analyze differences in connectivity seen in resting-state functional MRI (rsfMRI).

#### METHODS AND MATERIALS

We have selected a subset of 59 rsfMRI data sets from ASD patients and healthy controls from the Olin Institute of Living at Hartford Hospital. This subset is part of the publicly available preprocessed Autism Brain Imaging Data Exchange II (ABIDE II) data repository and specifically represents the Longitudinal Sample. To calculate directed functional connectivity between brain regions, we used the large-scale Granger Causality (IsGC) algorithm. This algorithm has recently been developed and leverages dimensionality reduction for causal modeling in high-dimensional fMRI time series. We applied a 100-iteration cross-validation approach with a 90%/10% train/test ratio. During the feature selection process, Kendall's tau rank correlation was used, followed by support vector machine classification. To evaluate the diagnostic accuracy of IsGC in classifying ASD patients and normal controls, we compared its performance with both a deconfounding partial correlation and the current clinical fMRI analysis standard of cross-correlation (CC). We reported accuracy, area under the ROC curve (AUC), and f1-score to quantitatively evaluate the performance of IsGC.

#### RESULTS

The IsGC rsfMRI analysis method demonstrated superior performance compared to both the partial correlation and clinical standard CC techniques in classifying ASD patients from healthy subjects. With an accuracy/AUC/f1 score of 97.9%/1.0/96.4% for IsGC, 75.4%/0.79/60.5% for partial correlation, and 80.1%/0.85/66.8% for CC, respectively, it is suggested that the IsGC rsfMRI analysis method is a favored choice for accurate classification.

#### CONCLUSION

Our results demonstrate that IsGC significantly enhances the diagnostic accuracy of identifying patients with ASD from rsfMRI neuroimaging. Based on our findings, we conclude that IsGC is better equipped to capture disease-related changes in brain network connectivity in ASD patients compared to both conventional CC analysis and partial correlation.

#### CLINICAL RELEVANCE/APPLICATION

The IsGC method successfully classifies Autism Spectrum Disorder (ASD) patients and controls through identifying key changes in fMRI connectivity, clearly demonstrating its potential usefulness as a novel diagnostic imaging biomarker for neurologic disease.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-7

### Adaptive Changes of Hypoxia Exposure in Normal Adults at High Altitude and Comparison of Brain Structure and Function between Insomnia and Non Insomnia by f-MRI

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Mingguang Yang (*Presenter*) Nothing to Disclose

#### PURPOSE

To observe the brain adaptation changes in normal adults after exposure to hypoxia at high altitude and the differences in brain structure and function in patients with secondary insomnia

#### METHODS AND MATERIALS

26 subjects of aid workers in Tibet were prospectively enrolled, and high-resolution three-dimensional T1-weighted structural images and resting state functional magnetic resonance imaging (rs-fMRI) were collected. MRI scans were taken as baseline data before admission to Tibet. Six months after emigration to Tibet, 26 subjects were divided into insomnia group (8 cases) and non-insomnia group (18 cases) according to Pittsburgh Sleep Quality Index (PSQI), and MRI scanning was performed again. Based on voxel morphology (VBM), local consistency (ReHo), low-frequency amplitude ratio (fALFF), and degree center (DC), 26 subjects were analyzed before and after entering Tibet, and the insomnia and non insomnia groups were analyzed respectively.

#### RESULTS

Compared with the pre Tibet group, the gray matter volume (GMV) atrophy of 26 subjects in the post Tibet group was located in the middle frontal gyrus, parahippocampal gyrus and right parietal inferior marginal angular gyrus, with significant differences ( $P < 0.01$ ). The ReHo value between pre Tibet and post Tibet groups were statistically significant ( $P < 0.01$ ). The brain area with increased ReHo value was located in the right cerebellar hemisphere. The fALFF values between the pre Tibet and post Tibet groups were statistically significant ( $P < 0.01$ ). The brain regions with increased fALFF values were located in the left lingual gyrus, the left middle temporal gyrus, and the cortex around the left talate fissure; The fALFF value between the insomnia group and the non insomnia group was statistically significant ( $P < 0.01$ ). The brain area with increased fALFF value was located in the left posterior cingulate gyrus. The DC value between the insomnia group and the non insomnia group was statistically significant ( $P < 0.01$ ). The brain area with reduced DC value was located in the left orbital superior frontal gyrus.

#### CONCLUSION

The structure and function of several brain regions were changed in normal adults after migrating to high altitude and secondary insomnia.

#### CLINICAL RELEVANCE/APPLICATION

In this study, people exposed to low oxygen in high altitude areas were tracked, and the brain function and morphology were compared with insomnia and non-insomnia after migration to high altitude areas and before and after their own migration, and multiple brain regions with abnormal brain structure and function were found

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-8

### Brain Image Reconstruction using Deep Learning CT Image Quality

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Michaela Cellina (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the image quality of brain computed tomography (CT) images reconstructed with deep learning-based image reconstruction, Advanced intelligent Clear-IQ Engine (AiCE), and Iterative Reconstructions (AIDR3D)

#### METHODS AND MATERIALS

150 consecutive patients underwent unenhanced brain CT scans with the following acquisition parameters: 120 kV, 50 mAs, slice thickness 0.5 mm, rotation time 1.5 sec, field of view, 250 mm; matrix, 512 × 512. Each dataset was reconstructed with AIDR3D and AiCE at 1 mm thickness and 1 mm increment. All images were evaluated using a dedicated PACS system. Image quality on a 4-point scale (excellent, good, sufficient, poor quality), gray matter-white matter differentiation, and anatomical detail (based on the visualization of basal ganglia, internal and external capsule) were independently assessed by two experienced readers. Interobserver agreement was assessed. Posterior fossa artifact index, the contrast to noise ratio (CNR) basal ganglia and the background image noise were evaluated.

#### RESULTS

No significant difference was observed in image quality ( $p=0.06$ ). The gray matter-white matter differentiation was higher in AiCE reconstructions ( $p=0.003$ ), as well as the anatomical detail ( $p=0.04$ ). Image noise and artifact index of the posterior cranial fossa were significantly lower in images reconstructed with AiCE ( $p=0.003$ , and  $=0.005$ ) respectively. CNR was higher in deep learning based reconstruction ( $p=0.004$ ).

#### CONCLUSION

In brain CT, deep learning based reconstructions allow significant reduction of noise and artifacts and better subjective image quality compared with iterative reconstructions.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning based reconstructions improve image quality when compared to iterative reconstruction: this fact may allow the reduction of CT acquisition parameters and radiation exposure in CT protocols.

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## Abstract Archives of the RSNA, 2023

R5B-SPNR-9

### Reduction of Posterior Fossa Artifacts using Spectral Monoenergetic CT Images

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Helena Mellander (*Presenter*) Nothing to Disclose

#### PURPOSE

The radiological evaluation of the posterior fossa in conventional brain computed tomography (CT) is often interfered by beam hardening artifacts. Dual energy CT has been increasingly evaluated regarding for example reduction of metal artifacts and general image quality. Artifact reduction that could improve the assessment of the posterior fossa would be of great value since the symptoms of pathology may be non-specific such as headache, nausea, vertigo and ataxia. Patients could receive suboptimal level of care or incorrect treatment if not correctly diagnosed or while awaiting further work-up. The purpose of this study was to evaluate posterior fossa artifacts in virtual monoenergetic images (VMIs) compared to conventional CT images.

#### METHODS AND MATERIALS

We included consecutive exams from adult (over 18 years) patients at our center who had undergone non-contrast spectral brain CT and whose exam was assessed as normal (e.g. no findings of ischemia, expansivities or hemorrhages). Regions of interest (ROIs) were drawn in predefined areas in posterior fossa grey matter (GM) and white matter (WM), in the interpetrous part of pons and in reference supratentorial GM and WM. Mean Hounsfield values and standard deviation (SD, considered image noise) were noted for the conventional images (CIs) and retrieved in spectral diagrams for monoenergetic series at 40-200 keV. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. The SD of the ROI in interpetrous pons was considered PFAI (posterior fossa artifact index). Visual assessment was performed by independent review by neuroradiologists blinded to reconstruction details.

#### RESULTS

In the objective part of the study 188 patients were included and of them, forty consecutive patients were included in the subjective part. SNR was significantly higher compared to CIs in VMIs at 50 keV and higher for all measure points and CNR was higher in VMIs from 40 to 80 keV compared to CIs (Figure 1). Compared to CIs, mean image noise was lower for cerebellar WM in VMIs at and above 50 keV and for cerebellar GM the noise values were significantly lower in VMIs at and above 60 keV. The PFAI was significantly lower in VMIs above 50 keV compared to in CIs. VMIs at 60 keV received the highest visual assessment scores regarding overall image quality and artifact severity (higher scores indicating less artifacts) in the interpetrous pons.

#### CONCLUSION

Our results indicate that VMIs may improve objective and subjective image quality and artifact severity in the posterior fossa.

#### CLINICAL RELEVANCE/APPLICATION

CT is the most used neuroradiological imaging modality in clinical routine care. Improving the diagnostic strengths of the images regarding posterior fossa pathology could have a direct impact for the patient outcome.

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## Abstract Archives of the RSNA, 2023

R5B-SPPH-1

### Clinical Comparison of Commercial Dosimetry Software Platforms for Y-90 Radioembolization Treatment

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Judy R. James, PHD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patient dosimetry is an evolving field for therapy procedures in Nuclear Medicine. Post imaging dosimetry verification is gaining importance to validate prescribed dose with delivered dose in tumor and normal tissues. In Yttrium-90 (Y-90) radioembolization, specific targeted amounts of Y-90 radiation (Gy) is prescribed to preferentially destroy the cancerous cells. Different approaches to clinical dosimetry in NM have been proposed, with planar and SPECT images. Aim of this study was to compare clinically available dosimetry softwares to evaluate patient liver tumor dose following Y90 Treatment and the associated challenges with the software calculations.

#### METHODS AND MATERIALS

Dosimetry analysis was performed on a patient that received Y-90 treatment to the right anterior lobe with a prescribed dose of 301 Gy. The lung shunt fraction was at 2.7%. SPECT/CT was acquired following Y-90 administration on two separate gamma cameras: GE CZT and Philips Bright view (BV) and quantitative SPECT images were reconstructed. Following the required segmentations of the liver and tumor, the maximum absorbed dose to the hottest area of the tumor was obtained and compared using 3 dosimetry software platforms: 1) MIM Y90 Sure Plan<sup>TM</sup>, 2) HERMES Voxel dosimetry<sup>TM</sup> and 3) Simplicity<sup>TM</sup>.

#### RESULTS

Variability was observed in steps leading to computation and calculation of the absorbed radiation dose. The three platforms required a post Y-90 reconstructed SPECT, CT, and the administered dose. In addition, the needs for a) MIM lung shunt fraction (LSF), b) HERMES: duration between administration and scan time; c) Simplicity a pre Y-90 planning CT or MR and LSF. Segmentation and contouring workflow variability was also observed. MIM has a streamlined workflow for contouring and calculating the maximum dose compared to HERMES and Simplicity. Maximum reported doses were: a) MIM: 522.4 Gy with 95% of tumor: 496.28 Gy (CZT) and 196.04 Gy with 95% of tumor: 186.24 Gy (BV); b) HERMES: 184.27 Gy (CZT) and 200.44 Gy (BV); c) Simplicity: 433.7 Gy (CZT) and 574.2 Gy (BV), where the true prescribed dose was 301 Gy. The doses computed by the three software had >20% deviation from the actual prescribed dose.

#### CONCLUSION

Initial results of a dosimetry software comparison provided evidence that variability exists in the calculation of absorbed dose estimates on SPECT/CT images.

#### CLINICAL RELEVANCE/APPLICATION

Absorbed dose calculation in Y-90 radioembolization treatments are feasible clinically. However, dosimetry still faces challenges of standardization among different calculation platforms, imaging scanners, dose calculation models, and target area segmentation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPPH-10

### Radiation Effect Measurement in Brain Tumor using MR-based Conductivity Imaging

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Hyun Chul Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The ionizing radiation produces ions inside the human body that can kill cancerous tissues by damaging DNA directly or creating charged particles that damage DNA. MR-based electrical conductivity imaging is a sensitive technique for evaluating the response of normal tissues immediately after irradiation, but it is necessary to verify responses of cancer tissues to become a reliable tool for evaluating therapeutic effects in clinical practice. In this study, we used MR-based electrical conductivity imaging to evaluate the responses of irradiated and non-irradiated tissues during the peri-irradiation period in mouse brain tumors.

#### METHODS AND MATERIALS

For intracranial tumors, C6 glioma cells were injected into the right caudate-putamen of 14 Balb/c nude mice for in vivo imaging. Tumor growth was confirmed on MR images using a 9.4T MRI 2 weeks after tumor cell inoculation. The mice were divided into an irradiated group (n = 7) and a non-irradiated group (n = 7). In the irradiated group, the mean dose rate was 0.98 Gy/min, and the field size was 5 × 30 cm under a Co-60 gamma-ray irradiation unit. Imaging experiments were performed before and at 0, 1, 2, 3, 7, and 10 days after irradiation in both groups. For electrical conductivity imaging, a multi-echo spin-echo pulse sequence was applied to obtain a B1 map, which was used to calculate high-frequency conductivity images.

#### RESULTS

Figure 1 shows full time-course MR and electrical conductivity images of tumor with and without irradiation. Morphology of tumor region in MR images showed a similar pattern over time in both groups. However, conductivity images showed clear contrast changes between the two groups over time. In line graphs, the percentage change of the normal region with irradiation increased by 27.2% up to 2 days and then decreased to 12.4%. The change of the normal region without irradiation was not observed. Meanwhile, the change of the tumor region with irradiation increased by 61.1% up to 3 days and then decreased to 52.9%. The change of the tumor region without irradiation was not observed until 3 days after irradiation, but increased to 23.2% at 10 days after.

#### CONCLUSION

Conductivity image provides information on cellularity and amounts of electrolytes in tissues, it shows potential as a tool for quantifying therapeutic effects of radiation on tumor.

#### CLINICAL RELEVANCE/APPLICATION

The goal of radiation therapy in cancers is to maximize suppression of local tumors and minimize side effects on normal tissue. MR-based electrical conductivity imaging showed potential as a tool with high sensitivity for measuring and evaluating tissue response after irradiation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPPH-12

### Evaluation of the Feasibility of Injectable Lipiodol and Tissue Glue Fiducial Markers for CyberKnife Tracking

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Xianzhi Deng (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate combinations of lipiodol and tissue glue using phantom and rabbit models, for feasibility in computed tomography (CT) image quality and image recognition of the Cyberknife system.

#### METHODS AND MATERIALS

The gold and lipiodol fiducial markers were inserted into tissue-equivalent phantom. CT was performed to assess images in terms of contrast to noise ratio (CNR), signal to noise ratio (SNR), and streak index (SI). To investigate the performance of combination of lipiodol and tissue glue, a study is conducted in the spine phantom which was placed in such a way that the lipiodol fiducial marker was overlapped with the bone in TLS. CT values, deformation, displacement, and diffusion of lipiodol fiducial markers were evaluated one week after injected into the livers of six rabbit models. Tracking accuracy of the gold fiducial markers and the lipiodol fiducial markers were analyzed and compared.

#### RESULTS

The phantom shows that the fiducial markers in each group could be seen clearly visible on the CT scans. Compared to lipiodol fiducial markers, gold fiducial markers had a greater SI and poorer CNR and SNR. Groups of lipiodol fiducial markers overlapped with the spine can be identified and successfully tracked. Both the pairing tolerance and uncertainty values did not exceed the systematic threshold. There were no adverse reactions such as rupture, necrosis and infection were observed in the injection site. Over the course of a week, the volume of lipiodol glue fiducial marker decreased by 30% while CT value stayed above 1000 HU. The registration translation deviation of gold fiducial markers tracking was lower than that of lipiodol glue fiducial markers tracking in supero-inferior, left-right and antero-posterior directions ( $Z = -2.276$ ,  $-10.226$ ,  $Z = -6.378$ ,  $P < 0.05$ ).

#### CONCLUSION

Fiducial markers composed of a combination of lipiodol and tissue glue were well visualized in a phantom on CT and produce less artifact than the gold fiducials. Lipiodol fiducial markers were successfully recognized and tracked using the Cyberknife Xsight-Lung tracking system in rabbit models.

#### CLINICAL RELEVANCE/APPLICATION

Compared with solid markers, combinations of lipiodol and tissue glue possess the following advantages: ? it can be injected through the liver via a thinner needle, reducing the risk of pain and complications during puncture. ? The corresponding volume can be injected according to the size of the tumor, especially the tracking method combined with Cyberknife only needs one injection, which can reduce the number of punctures and simplify the process. ? The visibility of the markers on the imaging device can be adjusted by changing the ratio of lipiodol to tissue glue.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPPH-2

### Clinical and Radiation Risk Across One Million Patients in Computed Tomography: Influence of Age, Size, and Race

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Francesco Ria, DMP (*Presenter*) Metis Health Analytics

#### PURPOSE

We recently developed a mathematical model to balance radiation risk and clinical risk, namely the risk of misdiagnosis due to insufficient image quality. In this work, we applied this model to a population of one million CT imaging cases to evaluate the risk stratification with different ages, sexes, and races.

#### METHODS AND MATERIALS

The demographics were informed by literature and census information simulating a clinical liver cancer population. The Total Risk (TR) was calculated as the linear combination of radiation risk and clinical risk. The model included factors for the radiation burden for different age and sex; the prevalence of the disease; the false positive rate; the expected life-expectancy loss for an incorrect diagnosis for different ages, sex, and race; and a typical false positive rate of 5%. It was assumed that each case received an average radiologist interpretative performance of 0.75 AUC for a hypothetical lesion without any changes in radiation dose beyond routine practice. We further, for each patient, simulated 2,000 imaging conditions with CTDIvol varying from 0.1 and 200 mGy with 0.1 mGy increments. Per each CTDIvol value, the anticipated AUC was calculated by applying the established asymptotic relationships between CTDIvol and image quality. The AUC distribution was then used to calculate the theoretical minimum total risk (TRmin) per each patient.

#### RESULTS

For the routine practice, the median theoretical total risk was estimated to be 0.058 deaths per 100 patients (range: 0.002 - 0.154) comprising of the median radiation risk of 0.009 (range: 0.001 - 0.069), and of the median clinical risk of 0.049 (range:  $7.0 \times 10^{-5}$  - 0.094). Considering the varying scanner output conditions, the median TRmin was 0.054 deaths per 100 patients for White male patients, 0.054 for Blacks, 0.057 for Hispanics, and 0.065 for Asians. For female patients, the median TRmin values were 0.049, 0.056, 0.054, and 0.061 deaths per 100 patients, respectively.

#### CONCLUSION

For each demographic condition, the clinical risk was found to largely outweigh the radiation risk by at least 500%. Total risk showed different stratifications with patient age and race.

#### CLINICAL RELEVANCE/APPLICATION

To optimize CT conditions for specific patients and/or population, both radiation risk and clinical risks should be accounted together with demographic information. We demonstrated a methodology that allows a complete depiction of total risk in CT, considering radiation and clinical risks at comparable units, and patient demographic.

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## Abstract Archives of the RSNA, 2023

R5B-SPPH-3

### Attenuation Correction for Total-body Positron Emission Tomography by Exploiting Anatomical Priors

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Wenbo Li (*Presenter*) Nothing to Disclose

#### PURPOSE

During positron emission tomography (PET) scanning, additional computed tomography (CT) imaging is utilized to provide attenuation coefficient maps to achieve more precise quantification on PET images. However, this not only exposes patients to extra doses of ionizing radiation but also makes attenuation correction (AC) difficult for PET/MR or PET-only scanners. Recently, many efforts have been applied to address this issue but the majority of these methods have been implemented on specific anatomical tissue, ignoring the structural differences among various human body sites.

#### METHODS AND MATERIALS

Experiments were performed on total-body scans of 20 patients that contained paired NAC PET and AC PET images of different sites, including the head and neck, chest, abdomen, pelvis, and extremities. Considering the anatomical disparities, we utilized the cycle-consistent generative adversarial network (Cycle GAN) as a foundation and modified its discriminator to differentiate between the authenticity of the input and its corresponding anatomy. In addition, the training process included the integration of a discriminative loss that relied on anatomical structures to enhance the quality of the generated AC PET images.

#### RESULTS

The results showed that our method yielded superior quantification outcomes with a peak signal-to-noise ratio (PSNR) of  $38.02 \pm 5.52$  dB and a structural similarity index (SSIM) of  $0.96 \pm 0.05$ . Compared to nonattenuation-corrected PET (NAC PET) images ( $33.30 \pm 12.35$  dB,  $0.84 \pm 0.552$ ), our method resulted in a 14% increase in both PSNR and SSIM, indicating its effectiveness in converting NAC PET images into AC PET images.

#### CONCLUSION

Our work accounts for differences in the anatomy of various human body sites and applies this information as a priori knowledge in the generation of AC PET images from NAC PET images. By incorporating prior factors, we achieved remarkable quantitative results, as evidenced by significant improvements in both PSNR and SSIM metrics compared to NAC PET images in different body sites.

#### CLINICAL RELEVANCE/APPLICATION

Considering anatomical prior information, our work utilizes deep learning techniques to generate AC PET images directly from NAC PET images, bypassing the PET reconstruction step, which facilitates attenuation correction of PET images in PET/MR or PET-alone scanners.

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## Abstract Archives of the RSNA, 2023

R5B-SPPH-4

### Performance Evaluation of a Super Resolution Deep Learning Reconstruction Algorithm for Chest CT

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Patrik Rogalla, MD, MBA (*Presenter*) Institutional Research Grant, Canon Medical Systems Corporation; Institutional Research Grant, KA Imaging

#### PURPOSE

To evaluate the effect of Super Resolution Deep Learning Reconstruction (SR-DLR) using 1024 matrix on image quality in chest CT compared to standard-of-care reconstruction methods.

#### METHODS AND MATERIALS

A DCNN-based Super Resolution Deep Learning Reconstruction (SR-DLR) model was developed for lung imaging. For training, standard-dose image data acquired using an ultra-high resolution CT scanner (Canon Aquilion Precision) served as target and low-dose image data from the normal resolution mode served as input. Projection data from 31 standard-of-care CT acquisitions (Canon Aquilion ONE PRISM) of the chest were reconstructed with 3 different methods: Hybrid iterative reconstruction (AIDR-3D for lung and body) at 512 matrix (series I), deep learning reconstruction (AiCE, lung and body algorithm) at 512 matrix (series II), and SR-DLR (lung algorithm) at 1024 matrix (series III), all at 3 mm slice thickness with 2.5 mm spacing. Images were also reconstructed using SR-DLR at 1024 matrix and 0.5 mm slice thickness (series IV). All 4 series, synchronized and without annotation, were reviewed in both window settings by 3 chest radiologists blinded to technical details on a 4K monitor with a 4x2 hanging protocol for the following categories on a scale of 1-5: lung resolution; soft tissue contrast; noise texture/level (lung, tissue), artifact (lung, tissue); overall image quality (lung, tissue). Forced ranking of the overall diagnostic confidence was also recorded (1 = highest, 4 = lowest). Image noise (SD) was measured in tissue and air.

#### RESULTS

P values refer to series I vs III and I vs IV. The mean rating of series I-IV was 3.1/3.7/4.2/4.7 for lung resolution (both  $p < 0.001$ ); 3.2/4.1/4.1/3.5 for tissue contrast ( $p < 0.001$ ,  $p = 0.002$ ); 3.0/3.8/4.4/4.7 for lung noise (both  $p < 0.001$ ); 3.0/4.2/4.2/3.5 for tissue noise (both  $p < 0.001$ ); 4.3/4.3/4.4/4.4 for lung artifacts ( $p = 0.06$ ,  $p = 0.03$ ); 4.2/4.4/4.3/4.2 for tissue artifacts ( $p = 0.25$ ,  $p = 0.79$ ); 3.1/3.8/4.3/4.7 for overall image quality lung (both  $p < 0.001$ ) and 3.1/4.1/4.0/3.5 for overall image quality tissue (both  $p < 0.001$ ); the mean overall diagnostic confidence ranking was 3.9/2.8/2.1/1.1 for lung (both  $p < 0.001$ ) and 3.5/1.8/1.9/2.7 (both  $p < 0.001$ ) for tissue, respectively. For series I vs IV, mean image noise in tissue was 17.4/17.5 HU ( $p = 0.97$ ) and 45.9/12.5 in air ( $p < 0.001$ ).

#### CONCLUSION

The SR-DLR using a 1024 matrix provides superior clinical image quality in chest CT; SR-DLR thin slices are overall preferred for lung parenchyma. SR-DLR holds promise to eliminate the need for separate reconstructions for the lung parenchyma and soft tissues.

#### CLINICAL RELEVANCE/APPLICATION

The SR-DLR outperforms current clinical standard-of-care reconstructions and may contribute to improving the diagnostic value of chest CT

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPPH-5

### **K-RCPS: Uncertainty Quantification for Diffusion Models via Conformal Prediction and Conformal Risk Control in CT Denoising**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Jacopo Teneggi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Diffusion models can generate varied and high-quality samples. It is paramount to estimate the uncertainty of these models when used for inverse problems in medical imaging (e.g., CT denoising). We propose a novel uncertainty quantification procedure to construct pixel-wise intervals that provably contain future samples as well as the ground-truth image while minimizing the mean interval length.

#### **METHODS AND MATERIALS**

A diffusion denoising model was trained and validated on the AbdomenCT-1K dataset comprising 1,112 CT scans (170,000 images) from 12 different medical centers. Uncertainty quantification was carried out on random subsets of 640 images not shown during training. Every image in the subset was perturbed with isotropic Gaussian noise (std=0.4) and the diffusion model was used to reconstruct 128 noiseless samples (81,920 total images). We compute the pixel-wise calibrated quantiles over the samples to guarantee that with probability at least 80% every pixel in a new sample from the diffusion model on the same noisy observation will be contained in its respective interval. We then conformalize the intervals such that with probability greater than 90% no more than 5% of the pixel in the ground-truth high-quality image will fall outside of the intervals on future, unseen noisy observations. We propose a novel convex optimization extension of the original Risk Controlling Prediction Sets (RCPS) procedure, K-RCPS, that provably minimizes the mean interval length. We compare with existing uncertainty quantification approaches in terms of guarantees provided and mean interval length over 20 draws of the 640 images.

#### **RESULTS**

K-RCPS provides the shortest mean interval length ( $0.1391 \pm 0.0025$ ) compared to quantile regression ( $0.3522 \pm 0.0085$ ), naïve (i.e., not calibrated) empirical quantiles ( $0.1401 \pm 0.0024$ ), and the existing RCPS procedure ( $0.1614 \pm 0.0020$ ). K-RCPS is currently the only high-dimensional uncertainty quantification approach that guarantees both coverage of future samples on the same noisy observation and risk control on future observations.

#### **CONCLUSION**

Conformal prediction and conformal risk control can be deployed for diffusion models in CT denoising to construct uncertainty intervals that provide finite-sample and distribution-free guarantees on the generated noiseless images. K-RCPS provably minimizes the mean interval length, and it consistently outperforms existing methods.

#### **CLINICAL RELEVANCE/APPLICATION**

Statistically valid uncertainty quantification techniques build radiologists' confidence in diffusion models used for inverse problems in medical imaging.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5B-SPPH-6

### Comparing Machine Learning Algorithms for Predictive Radiomic Features of Tumor Response after Pancreatic SBRT

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Amit Jethanandani, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Pancreatic cancer is a debilitating malignancy with a short life expectancy. While pancreatic SBRT has shown robust tumor control, identifying patients that respond to SBRT remains challenging. The aim of this study was to compare ML algorithms for prediction of pancreatic tumor response utilizing radiomic features extracted from MR-guided SBRT set-up imaging. We also evaluated whether static radiomic features (e.g. obtained at first SBRT fraction) differed in this predictive potential compared to delta radiomic features (e.g. net change in features between SBRT fractions 1-2 and 1-3)

#### METHODS AND MATERIALS

58 pancreatic cancer patients treated with MR-guided SBRT at our institution were analyzed. Gross tumor volumes were delineated on daily set-up MRIs prior to each fraction. Patients were treated to the pancreas at a dose of 35-50 Gy in 5 fractions. Tumor response was defined using TRG-CAP for patients who underwent resection. For patients who remained unresectable post-SBRT, tumor response was determined with RECIST v.1.1 criteria on imaging at 1-3 months. MRI scans were normalized in signal intensity and 39 texture features were extracted. Features were ranked by predictive importance using RF, LASSO, and MRMR algorithms. Top 1-4 importance features from each model were analyzed using logistic regression to determine predictive performance. Logistic regression was used to obtain the area under the curve (AUC) and the Akaike information criterion (AIC) in order to compare models.

#### RESULTS

For the static feature model, an MRMR algorithm of the top 2 importance features outperformed other approaches (AUC: 0.656; AIC: 55.12). For the first delta radiomics model (fractions 1-2), an RF model of the top 3 importance features demonstrated the best performance (AUC: 0.681; AIC: 52.1). For the second delta radiomics model (fractions 1-3), LASSO - using the top importance feature only - demonstrated the best performance (AUC: 0.603; AIC: 53.76).

#### CONCLUSION

Leveraging an RF algorithm to rank delta radiomic features from SBRT fractions 1-2 demonstrated the best prediction of pancreatic tumor response.

#### CLINICAL RELEVANCE/APPLICATION

Radiomic features of pancreatic tumors may contain predictive information about local control following MR-guided SBRT. These features could be used to personalize adaptive approaches to SBRT by identifying non-responders prior to completion of treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPPH-7

### Technical Performance Comparison of Super Resolution Deep Learning Reconstruction Algorithm on a Wide Area, Conventional Energy-Integrating Detector vs Conventional Reconstruction Algorithms on a Photon-Counting Computed Tomography System

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Kirsten Lee Boedeker, PhD (*Presenter*) Employee, Canon Medical Systems Corporation

#### PURPOSE

The purpose of this work is to systematically compare fundamental image quality between data reconstructed with a Super Resolution Deep Learning Reconstruction (SR-DLR) algorithm acquired on a wide volume, energy-integrating detector (EID) Computed Tomography (CT) system vs data reconstructed with Hybrid Iterative Reconstruction (HIR), as well as Filtered Backprojection (FBP), acquired on a Photon-Counting CT System (PCCT) in standard resolution mode.

#### METHODS AND MATERIALS

A Catphan<sup>TM</sup> embedded in a 25-35cm body ellipse was scanned at six dose levels from 1.9mGy-19.7mGy on a wide volume EID as well as on a CZT-based PCCT in standard resolution mode (Canon Medical Systems Corporation, Otawara, Japan). Images generated from the EID system were reconstructed with FBP and an SR-DLR for cardiac to a 512 matrix and 1024 matrix. Two clinically realistic fields of view (FOV), 180mm and 360mm, were evaluated. Counting images from the PCCT were generated based on total counts registered over five energy bins and reconstructed with HIR cardiac kernels. Resolution was assessed via task-dependent Modulation Transfer Function (MTF) for three contrast levels. Noise was assessed by measuring the standard deviation (SD) and Noise Power Spectrum (NPS). Noise Equivalent Quanta (NEQ) and Low Contrast Detectability (LCD) were also assessed.

#### RESULTS

For FBP, PCCT exceeded the spatial resolution of EID. However, the spatial resolution for SR-DLR with both a 512 and 1024 matrix on the EID system exceeded that of both conventional reconstruction algorithms on PCCT for all contrasts, by up to 5lp/cm at the 10% of the MTF, except at the lowest dose/contrast combinations. For FBP, PCCT decreased noise at low dose relative to EID. SR-DLR had lower noise magnitude, by 20-45%, than FBP and HIR on PCCT for all conditions. Both HIR on PCCT and SR-DLR on EID have noise shifted to lower frequencies, although with 1024 matrix the higher frequency content increases. NEQ is significantly greater for SR DLR for all conditions, leading to better LCD.

#### CONCLUSION

While PCCT provides benefit over EID when reconstructed with equivalent reconstruction algorithms, SR-DLR improves EID image quality above that of PCCT in standard resolution mode with HIR and FBP.

#### CLINICAL RELEVANCE/APPLICATION

SR-DLR using both 512 and 1024 matrix sizes leads to significant image quality benefits in spatial resolution and noise relative to conventional reconstruction algorithms on EID CT and PCCT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPPH-8

### Evaluation of Regularized Model-Based Cone-Beam Computed Tomography Image Reconstruction for Image-Guided Radiation Therapy: A Phantom Study

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Shih-Chi Lin, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study investigates the potential improvement in Cone-Beam Computed Tomography (CBCT) image quality for adaptive image-guided radiotherapy (IGRT) planning using regularized model-based image reconstruction methods. We evaluate maximum likelihood proximity gradient algorithms using higher-order total variation (PGA-ML-HOTV) and tight framelets (TF) regularization to improve CBCT image quality over conventional image reconstruction methods.

#### METHODS AND MATERIALS

The Tomographic Iterative GPU-based Reconstruction toolbox (TIGRE) was used for projection processing, code development, and image reconstruction. The filtered back-projection algorithm (FDK), with scatter correction and a ramp filter, was used as the baseline (BL) due to the similarity to the vendors' algorithm. PGA-ML (HOTV/TF) and row-action maximum likelihood algorithm (RAMLA; for comparison) were implemented using a Poisson noise model without scatter correction. These reconstructions were initialized with an FDK and a uniform image using 50, 100, 150, and 200 iterations. A Catphan phantom was scanned using CBCT Head Protocol on a Varian TrueBeam LINAC. Image quality was evaluated using the square root of the area under the 2D noise power spectrum curve (NPS<sub>2D</sub>), contrast (?HU), contrast-to-noise ratio (CNR), target transfer function value at 50% and 10% (TTF-50 and -10), and a model observer with eye filter detectability index (DI) of the -138 HU, 12.2-mm diameter polystyrene plug.

#### RESULTS

PGA-ML performances with HOTV and TF were indistinguishable. The highest performance improvement over BL was seen using PGA-ML with 150 iterations initialized with FDK. In this case, NPS<sub>2D</sub>, ?HU, TTF, CNR, and DI improved by 15%, 12%, 51-52%, 4%, and 21%, respectively. It was noted that there is a trade-off in image quality with this method. Specifically, images initialized with a uniform image and 200 iterations had better NPS<sub>2D</sub>, CNR, and DI by 56-57%, 82-83%, and 111-112%, respectively. When initializing with an FDK image, ?HU decreased by 12%, but CNR increased (4%) due to lower noise. ?HU declined with increased iterations. ?HU and TTF improved with increasing iterations with a uniform image, while NPS<sub>2D</sub> and DI worsened, outperforming FDK. CNR increased initially but decreased beyond 150 iterations due to increased noise.

#### CONCLUSION

The study demonstrates that regularized model-based image reconstruction methods can provide better image quality than FDK with optimized iteration and penalty settings and thus enhance target delineation during adaptive IGRT. Task-based performance assessment of these methods is necessary to enable integration into CBCT-based adaptive radiotherapy.

#### CLINICAL RELEVANCE/APPLICATION

CBCT quality is important for CBCT-based adaptive IGRT planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPVA-2

### **Spectral CT Monochromatic Imaging With Metal Artifact Reductions In Assessment Of Stent Lumen In Portal Venography After TIPS: A Retrospective Study**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Xingpeng Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the clinical value of spectral CT monochromatic imaging with metal artifact reductions in assessment of stent lumen in portal venography after transjugular intrahepatic portosystemic shunt (TIPS).

#### **METHODS AND MATERIALS**

Twenty-seven patients with TIPS for portal hypertension were performed spectral CT portal venography (CTPV) in our study. All raw data were reconstructed as 120 kVp-like imaging, and 6 groups of monochromatic imaging from 45 keV to 70 keV with 5 keV as an interval, respectively. Four slices CTPV images were evaluated, including main portal vein, proximal, middle and distant level of stent. Objective indexes for portal vein and stent included artifact index (AI), signal intensity (SI), standard deviation (SD), signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). Subjective indexes were assessed by two radiologists with 5-point scale separately. Patients with portal vein thromboses were recorded, and statistical analyses were analyzed.

#### **RESULTS**

According to Child-Pugh staging in all 27 patients, 3 were classified into grade A, 14 were grade B, and 10 were grade C. For objective indexes in portal vein and stent lumen, all SI, SNR and CNR decreased with the increase of keV (all  $P < 0.01$ ), and 45 keV demonstrates the highest SI, SD, SNR and CNR. The enhancement of portal vein and stent lumen were higher than 200 HU only in 45, 50, 55 and 60 keV, and there is no statistical significance for all indexes between 70 keV and 120 kVp-like group (all  $P > 0.05$ ). With MARs technique, AI decreased significantly for all 45 to 70 keV images. For subjective indexes, 60 keV group manifested best image quality scores and diagnostic confidence among all 7 groups. 1 stent thrombosis was detected in TIPS with CTPV, including 7 patients with portal vein cavernous transformation.

#### **CONCLUSION**

Combined with subjective and objective assessments of image quality, spectral CT monochromatic imaging at 60 keV with MARs technique increased SI, SNR, CNR in assessment of TIPS stent lumen and portal vein for liver cirrhosis, which is feasible in evaluation of stent lumen and portal vein after TIPS.

#### **CLINICAL RELEVANCE/APPLICATION**

Spectral CT monochromatic imaging at 60 keV with MARs technique demonstrated feasibility in evaluation of stent lumen and portal vein after TIPS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5-STCE1

### Science Session (Theranostics)

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center Theater 1

#### Sub-Events

### **R5-STCE1-1 A multimodal deep learning network for non-invasive prediction of the hepatic decompensation risk in compensated cirrhotic people: a multicenter cohort study**

Yuxiang Lai (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Assessing the risk of portal hypertension (PHT)-related decompensation aids the prophylactic strategy to improve prognosis of the compensated cirrhotic population. Hence, we aimed to develop a multimodal artificial intelligence decompensation prediction system (AIDE) to predict the hepatic decompensation risk non-invasively.

#### **METHODS AND MATERIALS**

1,045 compensated cirrhotic patients from seven tertiary medical centers who underwent baseline contrast-enhanced CT imaging were enrolled with a median follow-up of 33 months. A total of 615 patients from the first five centers were treated as the training and validation cohorts, while 430 from other two centers comprised the external test cohort. AIDE's performance was evaluated using concordance index (C-index) and time-dependent area under the curve (tAUC). The risk stratification performance was assessed by Kaplan-Meier analysis and compared with the Baveno VII performance. AIDE employed two separate pipelines to process multimodal data, with one dedicated to image data and the other to clinical data. Additionally, AIDE included three stages: liver and spleen segmentation with ResUNet, prognostic feature extraction and fusion with ResNet and MLP, and decompensation risk prediction with Cox (Proportional Hazards) Regression.

#### **RESULTS**

In the external test cohort, AIDE achieved a C-index of 0.84 (95% confidence interval (CI): 0.80 - 0.87) and a 3-year tAUC of 0.87 (0.83 - 0.92), outperformed the conventional models. The 3-year decompensation rates were 1% (3/230), 25% (47/188), and 59% (23/39) in the low-, moderate-, and high- risk groups, respectively ( $p < 0.05$ ). AIDE reduced the proportion of patients in the grey zone of Baveno VII by 63% and achieved an AUC of 0.82 (0.76 - 0.89) for CSPH diagnosis; the PHT progression mechanisms might be captured by the AIDE.

#### **CONCLUSION**

AIDE effectively mined and fused decompensated-relevant image-type and context-type information to optimize the prediction and grading of the risk of first hepatic decompensation in patients with compensated cirrhosis. It can help guide the prophylactic strategies when HVPG/LSM are not available.

#### **CLINICAL RELEVANCE/APPLICATION**

AIDE could help determine the precise prophylactic and therapeutic interventions for patients with compensated cirrhosis to prevent the occurrence of decompensating events, as the model can identify low-, moderate-, and high-risk patients, which is correlated closely with baseline CSPH status. Low-risk patients may not require non-selective beta-blockers (NSBB) treatment. Moderate-risk patients need further assessment for HVPG, LSM, or high-risk varices to determine PHT severity and treatment necessity. High-risk patients should receive endoscopic evaluation and prophylactic treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5-STCE1-1

### **A multimodal deep learning network for non-invasive prediction of the hepatic decompensation risk in compensated cirrhotic people: a multicenter cohort study**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center Theater 1

Yuxiang Lai (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Assessing the risk of portal hypertension (PHT)-related decompensation aids the prophylactic strategy to improve prognosis of the compensated cirrhotic population. Hence, we aimed to develop a multimodal artificial intelligence decompensation prediction system (AIDE) to predict the hepatic decompensation risk non-invasively.

#### **METHODS AND MATERIALS**

1,045 compensated cirrhotic patients from seven tertiary medical centers who underwent baseline contrast-enhanced CT imaging were enrolled with a median follow-up of 33 months. A total of 615 patients from the first five centers were treated as the training and validation cohorts, while 430 from other two centers comprised the external test cohort. AIDE's performance was evaluated using concordance index (C-index) and time-dependent area under the curve (tAUC). The risk stratification performance was assessed by Kaplan-Meier analysis and compared with the Baveno VII performance. AIDE employed two separate pipelines to process multimodal data, with one dedicated to image data and the other to clinical data. Additionally, AIDE included three stages: liver and spleen segmentation with ResUNet, prognostic feature extraction and fusion with ResNet and MLP, and decompensation risk prediction with Cox (Proportional Hazards) Regression.

#### **RESULTS**

In the external test cohort, AIDE achieved a C-index of 0.84 (95% confidence interval (CI): 0.80 - 0.87) and a 3-year tAUC of 0.87 (0.83 - 0.92), outperformed the conventional models. The 3-year decompensation rates were 1% (3/230), 25% (47/188), and 59% (23/39) in the low-, moderate-, and high- risk groups, respectively ( $p < 0.05$ ). AIDE reduced the proportion of patients in the grey zone of Baveno VII by 63% and achieved an AUC of 0.82 (0.76 - 0.89) for CSPH diagnosis; the PHT progression mechanisms might be captured by the AIDE.

#### **CONCLUSION**

AIDE effectively mined and fused decompensated-relevant image-type and context-type information to optimize the prediction and grading of the risk of first hepatic decompensation in patients with compensated cirrhosis. It can help guide the prophylactic strategies when HVPG/LSM are not available.

#### **CLINICAL RELEVANCE/APPLICATION**

AIDE could help determine the precise prophylactic and therapeutic interventions for patients with compensated cirrhosis to prevent the occurrence of decompensating events, as the model can identify low-, moderate-, and high-risk patients, which is correlated closely with baseline CSPH status. Low-risk patients may not require non-selective beta-blockers (NSBB) treatment. Moderate-risk patients need further assessment for HVPG, LSM, or high-risk varices to determine PHT severity and treatment necessity. High-risk patients should receive endoscopic evaluation and prophylactic treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5-STCE2

### Science Session (Generative AI)

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center Theater 2

#### Sub-Events

#### **R5-STCE2-1 Towards Automated Procedural Registry for Interventional Oncology: Feasibility of Using GPT-4 to Extract Critical Diagnostic Imaging Report Findings**

Alexander Shieh, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

This work assessed the feasibility of using the large language model (LLM) GPT-4 to extract critical procedure-specific findings, including disease progression, type of progression and change in lesion size, from cancer surveillance CT reports in patients who underwent percutaneous thermal ablation for liver tumors without further training. This tool could help construct large-scale procedural registries, which are crucial for establishing evidence and automated quality control for novel interventions.

##### **METHODS AND MATERIALS**

To ensure the safety of protected health information and abide by current state and institutional regulations, we created 24 synthetic reports for our experiments. These reports resembled the structure and wording of 60 reports from 12 consecutive patients in our liver ablation registry during 2021 to 2022, yet they used fictional patient history, lesion size and location. Incidental findings were injected with the help of GPT-4 to make these synthetic reports more realistic. We designed a prompt for GPT-4 to extract "progression finding", "progression type" and "size or change in size" from the reports. The "progression type" is defined as one of the following: local tumor progression (LTP), intrahepatic progression other than local tumor progression (IHP minus LTP), and extrahepatic progression (EHP)

##### **RESULTS**

The 24 virtual reports included 70 total progression findings (10 LTP, 30 IHP minus LTP, 30 EHP). The precision and recall for all progression findings were 0.92 and 0.96. GPT-4 retrieved all LTPs correctly, with precision and recall both 1.0. For IHP minus LTP the precision was 0.97, while recall was 0.93. As for EHP, the precision was 0.82 and the recall was 0.93.

##### **CONCLUSION**

GPT-4 achieved good performance for extracting cancer progression findings from diagnostic imaging reports without further training. Detecting EHP may be harder for GPT-4 compared to detecting IHP. Further evaluation is needed for images of different modality (e.g. PET/CT and MRI) and for different pathologies.

##### **CLINICAL RELEVANCE/APPLICATION**

Extracting procedure-specific cancer progression patterns across multiple organ systems in heavily treated patients is challenging. With the volume rapidly growing, additional reviewing of all images for research and quality control purposes may not be feasible. The original reports of these scans already contain rich information and can be used to flag sentinel scans for elective review to extract procedure specific outcomes. However, these reports may not be structured in favor of the current research protocol. The proposed text-based method could overcome this barrier and be adopted to build procedure specific registries, allowing radiologists to identify and review critical scans more efficiently.

#### **R5-STCE2-3 Machine learning approaches to CT and MRI protocol assignment: comparison of foundation and fine-tuned large language models with a conventional classifier.**

Timothy Sotman, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Imaging protocol assignment for CT and MRI studies is critical for high quality radiology care. Correct determination of specialized protocols requires time and expertise. Machine learning (ML) techniques in natural language processing (NLP)

may be used to automate this process. This study sought to compare the performance of a conventional ML classifier and large language models (LLM) in protocol assignment.

## **METHODS AND MATERIALS**

Protocols assigned to CT and MRI exams during routine clinical care were extracted for all exams between April 2022 and April 2023. The free text protocols were mapped to 189 standardized protocol classes using pattern matching and manual review to produce a dataset of 68,610 exams and protocols. The dataset was normalized using the Natural Language Toolkit Python package and vectorized using the term frequency-inverse document frequency vectorizer from the scikit-learn Python package. A classification model was trained on 80% of the dataset using a stochastic gradient descent classifier from scikit-learn. The model was evaluated on 20% of the data withheld as a test set. The text-bison-001 large language model from Google PaLM 2 was fine-tuned by providing 9839 prompts containing examination code, type, and indication and example responses containing the correct protocol assignment. Each class was represented by at least 20 examples. The model was evaluated with 100 prompts withheld from training. The performance of the foundation GPT-4 model via the Azure OpenAI Service was evaluated using 100 prompts providing a list of protocol classes to select from along with the examination type and clinical indication. Class weighted F1 scores were calculated for each model.

## **RESULTS**

The classifier demonstrated an F1 score of 0.898. The fine-tuned PaLM 2 model demonstrated an F1 score of 0.861. Foundation GPT-4 without any additional fine-tuning demonstrated an F1 score of 0.718. The models performed worse for protocols that appeared infrequently in the training set due to class imbalance.

## **CONCLUSION**

Imaging protocol assignment is a multilabel classification problem that can be approached using several ML techniques. A fine-tuned LLM performed similarly well in this task to a bespoke classifier trained on a much larger dataset. A foundation LLM also performed reasonably well without any additional information about our institutional protocols. These results suggest that a further fine-tuned large language model may achieve expert level performance. Fine-tuning and evaluation of LLMs with larger data sets is ongoing.

## **CLINICAL RELEVANCE/APPLICATION**

Correct imaging protocol assignment is critical for optimal patient care as CT and MRI protocols are highly tailored to address the clinical question at hand.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5-STCE2-1

### **Towards Automated Procedural Registry for Interventional Oncology: Feasibility of Using GPT-4 to Extract Critical Diagnostic Imaging Report Findings**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center Theater 2

Alexander Shieh, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This work assessed the feasibility of using the large language model (LLM) GPT-4 to extract critical procedure-specific findings, including disease progression, type of progression and change in lesion size, from cancer surveillance CT reports in patients who underwent percutaneous thermal ablation for liver tumors without further training. This tool could help construct large-scale procedural registries, which are crucial for establishing evidence and automated quality control for novel interventions.

#### **METHODS AND MATERIALS**

To ensure the safety of protected health information and abide by current state and institutional regulations, we created 24 synthetic reports for our experiments. These reports resembled the structure and wording of 60 reports from 12 consecutive patients in our liver ablation registry during 2021 to 2022, yet they used fictional patient history, lesion size and location. Incidental findings were injected with the help of GPT-4 to make these synthetic reports more realistic. We designed a prompt for GPT-4 to extract "progression finding", "progression type" and "size or change in size" from the reports. The "progression type" is defined as one of the following: local tumor progression (LTP), intrahepatic progression other than local tumor progression (IHP minus LTP), and extrahepatic progression (EHP)

#### **RESULTS**

The 24 virtual reports included 70 total progression findings (10 LTP, 30 IHP minus LTP, 30 EHP). The precision and recall for all progression findings were 0.92 and 0.96. GPT-4 retrieved all LTPs correctly, with precision and recall both 1.0. For IHP minus LTP the precision was 0.97, while recall was 0.93. As for EHP, the precision was 0.82 and the recall was 0.93.

#### **CONCLUSION**

GPT-4 achieved good performance for extracting cancer progression findings from diagnostic imaging reports without further training. Detecting EHP may be harder for GPT-4 compared to detecting IHP. Further evaluation is needed for images of different modality (e.g. PET/CT and MRI) and for different pathologies.

#### **CLINICAL RELEVANCE/APPLICATION**

Extracting procedure-specific cancer progression patterns across multiple organ systems in heavily treated patients is challenging. With the volume rapidly growing, additional reviewing of all images for research and quality control purposes may not be feasible. The original reports of these scans already contain rich information and can be used to flag sentinel scans for elective review to extract procedure specific outcomes. However, these reports may not be structured in favor of the current research protocol. The proposed text-based method could overcome this barrier and be adopted to build procedure specific registries, allowing radiologists to identify and review critical scans more efficiently.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5-STCE2-3

### Machine learning approaches to CT and MRI protocol assignment: comparison of foundation and fine-tuned large language models with a conventional classifier.

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center Theater 2

Timothy Sotman, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Imaging protocol assignment for CT and MRI studies is critical for high quality radiology care. Correct determination of specialized protocols requires time and expertise. Machine learning (ML) techniques in natural language processing (NLP) may be used to automate this process. This study sought to compare the performance of a conventional ML classifier and large language models (LLM) in protocol assignment.

#### METHODS AND MATERIALS

Protocols assigned to CT and MRI exams during routine clinical care were extracted for all exams between April 2022 and April 2023. The free text protocols were mapped to 189 standardized protocol classes using pattern matching and manual review to produce a dataset of 68,610 exams and protocols. The dataset was normalized using the Natural Language Toolkit Python package and vectorized using the term frequency-inverse document frequency vectorizer from the scikit-learn Python package. A classification model was trained on 80% of the dataset using a stochastic gradient descent classifier from scikit-learn. The model was evaluated on 20% of the data withheld as a test set. The text-bison-001 large language model from Google PaLM 2 was fine-tuned by providing 9839 prompts containing examination code, type, and indication and example responses containing the correct protocol assignment. Each class was represented by at least 20 examples. The model was evaluated with 100 prompts withheld from training. The performance of the foundation GPT-4 model via the Azure OpenAI Service was evaluated using 100 prompts providing a list of protocol classes to select from along with the examination type and clinical indication. Class weighted F1 scores were calculated for each model.

#### RESULTS

The classifier demonstrated an F1 score of 0.898. The fine-tuned PaLM 2 model demonstrated an F1 score of 0.861. Foundation GPT-4 without any additional fine-tuning demonstrated an F1 score of 0.718. The models performed worse for protocols that appeared infrequently in the training set due to class imbalance.

#### CONCLUSION

Imaging protocol assignment is a multilabel classification problem that can be approached using several ML techniques. A fine-tuned LLM performed similarly well in this task to a bespoke classifier trained on a much larger dataset. A foundation LLM also performed reasonably well without any additional information about our institutional protocols. These results suggest that a further fine-tuned large language model may achieve expert level performance. Fine-tuning and evaluation of LLMs with larger data sets is ongoing.

#### CLINICAL RELEVANCE/APPLICATION

Correct imaging protocol assignment is critical for optimal patient care as CT and MRI protocols are highly tailored to address the clinical question at hand.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSBR11

### Science Session with Keynote: Breast Imaging (Advanced Applications in Breast Imaging)

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450B

Ellen B. Mendelson, MD, MA (*Moderator*) Medical Advisory Board, Seno Medical Instruments, Inc; Medical Advisory Board, Delphinus Medical Technologies, Inc  
Cherie M. Kuzmiak, DO (*Moderator*) Nothing to Disclose  
Savannah C. Partridge, PhD (*Moderator*) Research Grant, General Electric Company; Research support, Koninklijke Philips NV; Consultant, Guerbet SA

#### Sub-Events

#### **R6-SSBR11-1 Supplemental Optoacoustic Imaging of Breast Masses: A Cost-Effectiveness Analysis**

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Optoacoustic Ultrasound (OA/US) is a novel imaging method that utilizes tissue's intrinsic contrast to demonstrate real-time oxygenation and can be co-registered with gray-scale ultrasound (US). Prior prospective trials demonstrated that OA/US significantly improves diagnostic specificity with a slight decrease in sensitivity when used as a supplemental technique to US alone. In our study, we aimed to evaluate the cost-effectiveness of using OA/US versus US to differentiate benign and malignant breast masses in a diagnostic setting.

#### METHODS AND MATERIALS

We created a decision-tree model based on potential diagnostic results to compare the cost-effectiveness of OA/US and US from the perspective of the U.S. Healthcare system. We utilized diagnostic test performance parameters from the PIONEER-01 (NCT01943916) and the MAESTRO (NCT02364388) clinical trials and cost parameters (USD) from the Truven Health MarketScan® Databases. Utility (quality-adjusted life in years, QALY) assumptions were made following published patient-reported outcomes. Diagnostic outcomes were designed as true positive, true negative, false positive, and false negative to represent certain relations between health states and related costs. Cost effectiveness was calculated through incremental cost-effectiveness ratio (USD per QALY gain, ICER) and net monetary benefit (USD, NMB) calculations. One-way and two-way deterministic and probabilistic sensitivity analyses were performed to determine the significance of variation in input parameters. A willingness-to-pay (WTP) threshold of \$100,000 per QALY gain was used for the study. All analyses were performed using TreeAge Pro Healthcare 2022 (Williamstown, MA).

#### RESULTS

OA/US had a total cost of \$1,784.58 and 0.80 QALYs in the base case, whereas US had a total cost of \$2,018.84 and 0.79 QALYs. The incremental NMB for OA/US was \$1,452.86, and the ICER was -\$19,223.77 per QALY, indicating that OA/US was more cost-effective than US. Tornado analysis revealed the greatest sensitivity to variation in the disutility caused by biopsy and follow-up visits, followed by the cost of OA/US and US, respectively. The estimated variation in input parameters for the analyzed ranges did not produce an ICER higher than the \$100,000/QALY WTP threshold. According to probabilistic sensitivity analysis, OA/US was the better strategy in 100% of 10,000 iterations.

#### CONCLUSION

OA/US is more cost-effective than US for evaluating breast masses. It can reduce costs while improving patients' quality of life, primarily by reducing false-positive results with consequent benign biopsies.

#### CLINICAL RELEVANCE/APPLICATION

Evaluating breast masses with OA/US in a diagnostic setting is economically feasible and can increase patients' quality of life.

#### **R6-SSBR11-2 Photon-counting CT for the Diagnosis of Degenerative Changes and Rupture of Silicone Breast Implants: A Comprehensive Evaluation of Diagnostic Accuracy and Imaging Features**

Jakob Neubauer, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study was to evaluate the diagnostic accuracy of photon-counting CT (PC-CT) in detecting degenerative changes and rupture of silicone breast implants. Accurate detection and diagnosis of these complications are important for appropriate clinical management.

## **METHODS AND MATERIALS**

Over a period of one year, we prospectively included all patients with silicone breast implants who received thoracic PC-CT (NAEOTOM Alpha, Siemens Healthineers) and breast MRI. Monoenergetic reconstructions and material decomposition reconstructions were obtained. Two radiologists (5 and 10 years of experience in breast imaging) independently evaluated the images for the presence of folds of the membrane, peri-implant fluid collections and silicone collections, intra-implant fluid, keyhole and linguini sign, and capsular calcifications. The reference standard was a consensus reading by two radiologists (11 and 25 years of experience in breast imaging) of all imaging examinations. Cohen's kappa for inter-rater reliability and pooled measures for diagnostic accuracy were calculated.

## **RESULTS**

We included 19 patients with 31 implants and found that the diagnostic accuracy of PC-CT was high for detecting peri-implant silicone collections, the linguini sign, intra-implant fluid, the keyhole sign, capsular calcifications, and folds of the membrane, with accuracy values ranging from 0.91 to 0.99. Also, sensitivities ranged from 0.88-0.99 and specificities from 0.75-0.99. Inter-rater reliability was observed to be nearly perfect ( $\kappa > 0.80$ ) for all imaging features, with the exception of peri-implant fluid collections where inter-rater reliability was determined to be fair (0.39).

## **CONCLUSION**

We found PC-CT to be highly accurate in detecting various signs of degenerative changes and rupture of silicone breast implants.

## **CLINICAL RELEVANCE/APPLICATION**

Our findings suggest that PC-CT could be a feasible imaging modality for the evaluation of implant ruptures.

## **R6-SSBR11-3 A Radiomics Approach Based on Machine Learning in Distinguishing Benign and Malignant Breast Lesions Using T2 Weighted and Diffusion Weighted Imaging: A Multicenter Study**

Yulu Liu (*Presenter*) Nothing to Disclose

## **PURPOSE**

Breast Magnetic Resonance Imaging (BMRI) has been recommended as supplemental screening tool of breast cancer by international guidelines, but its long examination time and use of contrast material remains to be concerned. Thus, the purpose of this study is to develop an unenhanced radiomics model using machine learning techniques based on T2W and DW sequences to identify benign and malignant breast lesions.

## **METHODS AND MATERIALS**

A total of 1760 patients were enrolled in this multicenter study to develop, validate and test a radiomics model. 1293 continuous patients were randomly divided into two groups at a ratio of 6:4 for model construction. (training cohort,  $n=775$ ; validation cohort,  $n=518$ ). After MR image segmentation, feature extraction and selection, we used the machine learning Gaussian Process (GP), Support Vector Machine (SVM) and Logistic algorithm to differentiate breast cancer. Afterwards, models' diagnostic performance was tested on three independent testing cohorts (internal retrospective test,  $n=167$ ; internal perspective test,  $n=188$ ; external retrospective test,  $n=112$ ). Model performance was evaluated using AUC to compare with the model combining Postcontrast Phase I images, and the diagnosis of radiologists. Subgroup analysis was performed to assess the performance in different categories, including lesion types (mass and no-mass), background parenchymal enhancement (minimal, mild, moderate, and marked), age ( $\geq 50$  and  $< 50$ ), and pathological types of malignancy.

## **RESULTS**

The unenhanced model performed best based on GP classifier (AUC, training: 0.893, validation: 0.848), and showed favorable prediction in testing cohorts (AUCs, 0.818-0.840). The AUC values for unenhanced model were not statistically different from the combined model ( $p > 0.05$ ). There was no significant difference in performance between the unenhanced model with two readers ( $p > 0.05$ ). The unenhanced model demonstrated favorable performance in diagnosing tumors with different lesion types, background parenchymal enhancement, and ages. The model performed worst in identifying ductal carcinoma in situ, whereas showed favorable competence in identifying other types of malignancies ( $p=0.0054$ ).

## **CONCLUSION**

The model utilizing the unenhanced sequences based on T2WI and DWI, has displayed excellent diagnostic accuracy, comparable to radiologists. These findings indicate that our model could potentially help the screening of breast cancer in the future.

## CLINICAL RELEVANCE/APPLICATION

Our study showed that a machine learning unenhanced radiomics model using T2WI and DWI is effective in distinguishing breast lesions, which suggests this approach could potentially assist in screening of breast cancers in the future.

### R6-SSBR11-4 **Assessment of Nonmass Lesions Detected by Screening Breast US: A Multicenter Study**

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To analyze US features of non-mass lesions (NMLs) detected by screening US and determine the predictive features. In addition, to investigate application of classification system for validating screening US detected NMLs.

#### METHODS AND MATERIALS

This retrospective, multicenter study included 993 asymptomatic women who were referred for screening US. Eligible women had NMLs detected at US. Three radiologists interpreted and assessed the final Breast Imaging Reporting and Data System (BI-RADS) category. Univariable and multivariable logistic regression was used to identify independent clinical and imaging factors associated with malignancy. We applied the classification system and calculated the positive predictive value for biopsy recommendations (PPV2) and conversion rate of BI-RADS 4A to 3 category. Inter-reader agreements between readers were analyzed with weighted kappa values.

#### RESULTS

Among 993 patients (mean age  $49.7 \pm 8.6$  years, range, 30-80 years) with 993 NMLs, 885 (89.1%) were benign, 29 (2.9%) were high risk lesion, and 79 (8.0%) were malignant lesions. The mean size of malignant NMLs was significantly larger than benign NMLs ( $2.6 \pm 1.1$  vs  $1.9 \pm 0.8$  cm,  $P < .001$ ). In the multivariable analysis, mixed echogenicity (OR, 4.95;  $P < .001$ ), segmental distribution (OR, 5.52;  $P < .001$ ), presence of calcification (OR, 22.87;  $P < .001$ ), presence of posterior shadowing (OR, 7.22;  $P < .001$ ) and size on US (OR, 1.56;  $P = .009$ ) were independent factors associated with malignant NMLs. The presence of multiple small cysts was not negatively associated with malignant NMLs (OR, 0.59;  $P = .290$ ). Among the features showing statistical significance on multivariable analysis, presence of calcification showed PPV of 44.3%, segmental distribution (PPV of 22.9%), presence of posterior shadowing (PPV of 21.8%) and mixed echogenicity (PPV of 16.5%). Utilizing the classification system showed PPV2 of 16.7% (95% CI: 13.6, 20.3) and conversion rate of BI-RADS 4A to 3 were 42.8% (reader 1 and reader 2) and 40.0% (reader 3). Inter-observer agreement for NMLs was excellent with kappa values ranging from 0.83 to 0.90.

#### CONCLUSION

When breast NMLs are detected on screening US, suspicious malignant US features may be applicable for diagnosing clinically occult malignant NMLs.

## CLINICAL RELEVANCE/APPLICATION

No prior study has investigated US features of NMLs detected on screening US. Our study provides data regarding US features that may improve the utility of screening US in asymptomatic women in accurate diagnosis of NML.

### R6-SSBR11-5 **Keynote Speaker: Potential Role of Breast DWI in Breast Cancer Screening and Diagnosis**

Savannah C. Partridge, PhD (*Presenter*) Research Grant, General Electric Company; Research support, Koninklijke Philips NV; Consultant, Guerbet SA

### R6-SSBR11-6 **Different Downstream Outcomes After Consensus Discussion Related to Which Readers, AI or Radiologist, Flagged the Screening Mammography as Abnormal - In the Prospective Interventional Screentrustcad Trial**

Karin Dembrower, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

ScreenTrustCAD (NCT04778670) was the first prospective interventional study of AI in population-based breast cancer screening with a total of 55,581 women included. Based on a paired-reader design, it was found that in a double-reading and consensus workflow, AI plus one reader achieved superior cancer detection to two readers, without increasing recalls. The purpose of the current sub-study was to analyze differences in consensus recall decisions depending on whether AI or radiologists had initially flagged the exam as abnormal.

#### METHODS AND MATERIALS

The current study was performed within the ScreenTrustCAD trial, which employed an index test of paired reading between two human readers and Lunit INSIGHT MMG (AI). The three readers of each exam were blinded to the reads of others. An exam flagged by any reader was forwarded to the consensus discussion. In this sub-study, women who reported lumps at

time of screening were excluded since AI did not consider that information. For each combination of readers who flagged the exam, we calculated the proportion of recalled women, cancers detected and positive predictive value (PPV).

## **RESULTS**

There were 55,581 women included in the ScreenTrustCAD trial with 269 women diagnosed with breast cancer. After excluding women reporting a lump, there were 53,865 women overall, of whom 238 with breast cancer. In total, 5515 exams were flagged for consensus discussion, of which AI, reader 1 and reader 2 each flagged 3014 (55%), 2255 (41%) and 2424 (44%) respectively. 1358 (2.47%) women were recalled, of whom 238 (17.5%) were diagnosed with breast cancer and 1120 (82.5%) were not. Among 2501 consensus cases which had not been flagged by AI (but by one or two radiologists), the consensus discussion decided to recall 626 (25%) and for 21 (0.8%) cancer was detected, resulting in 3.4% PPV. Among 3014 consensus cases which had been flagged by AI (and zero to two radiologists), the consensus discussion decided to recall 732 (24%) and for 217 (7.2%) cancer was detected, resulting in 29% PPV. See Figure 1 for further breakdown of results.

## **CONCLUSION**

For the exams that the radiologists in the consensus discussion decided to recall, the PPV for exams previously flagged by AI, compared to those only flagged by radiologists, was nearly 10 times higher.

## **CLINICAL RELEVANCE/APPLICATION**

Radiologists involved in the consensus discussions in screening mammography should be made aware of their bias of overcalling non-AI-flagged exams and possibly undercalling AI-flagged exams. The consensus discussion may need to be re-designed for optimal use of AI reads.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSBR11-1

### Supplemental Optoacoustic Imaging of Breast Masses: A Cost-Effectiveness Analysis

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450B

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Optoacoustic Ultrasound (OA/US) is a novel imaging method that utilizes tissue's intrinsic contrast to demonstrate real-time oxygenation and can be co-registered with gray-scale ultrasound (US). Prior prospective trials demonstrated that OA/US significantly improves diagnostic specificity with a slight decrease in sensitivity when used as a supplemental technique to US alone. In our study, we aimed to evaluate the cost-effectiveness of using OA/US versus US to differentiate benign and malignant breast masses in a diagnostic setting.

#### METHODS AND MATERIALS

We created a decision-tree model based on potential diagnostic results to compare the cost-effectiveness of OA/US and US from the perspective of the U.S. Healthcare system. We utilized diagnostic test performance parameters from the PIONEER-01 (NCT01943916) and the MAESTRO (NCT02364388) clinical trials and cost parameters (USD) from the Truven Health MarketScan® Databases. Utility (quality-adjusted life in years, QALY) assumptions were made following published patient-reported outcomes. Diagnostic outcomes were designed as true positive, true negative, false positive, and false negative to represent certain relations between health states and related costs. Cost effectiveness was calculated through incremental cost-effectiveness ratio (USD per QALY gain, ICER) and net monetary benefit (USD, NMB) calculations. One-way and two-way deterministic and probabilistic sensitivity analyses were performed to determine the significance of variation in input parameters. A willingness-to-pay (WTP) threshold of \$100,000 per QALY gain was used for the study. All analyses were performed using TreeAge Pro Healthcare 2022 (Williamstown, MA).

#### RESULTS

OA/US had a total cost of \$1,784.58 and 0.80 QALYs in the base case, whereas US had a total cost of \$2,018.84 and 0.79 QALYs. The incremental NMB for OA/US was \$1,452.86, and the ICER was -\$19,223.77 per QALY, indicating that OA/US was more cost-effective than US. Tornado analysis revealed the greatest sensitivity to variation in the disutility caused by biopsy and follow-up visits, followed by the cost of OA/US and US, respectively. The estimated variation in input parameters for the analyzed ranges did not produce an ICER higher than the \$100,000/QALY WTP threshold. According to probabilistic sensitivity analysis, OA/US was the better strategy in 100% of 10,000 iterations.

#### CONCLUSION

OA/US is more cost-effective than US for evaluating breast masses. It can reduce costs while improving patients' quality of life, primarily by reducing false-positive results with consequent benign biopsies.

#### CLINICAL RELEVANCE/APPLICATION

Evaluating breast masses with OA/US in a diagnostic setting is economically feasible and can increase patients' quality of life.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R6-SSBR11-2

### **Photon-counting CT for the Diagnosis of Degenerative Changes and Rupture of Silicone Breast Implants: A Comprehensive Evaluation of Diagnostic Accuracy and Imaging Features**

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450B

Jakob Neubauer, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to evaluate the diagnostic accuracy of photon-counting CT (PC-CT) in detecting degenerative changes and rupture of silicone breast implants. Accurate detection and diagnosis of these complications are important for appropriate clinical management.

#### **METHODS AND MATERIALS**

Over a period of one year, we prospectively included all patients with silicone breast implants who received thoracic PC-CT (NAEOTOM Alpha, Siemens Healthineers) and breast MRI. Monoenergetic reconstructions and material decomposition reconstructions were obtained. Two radiologists (5 and 10 years of experience in breast imaging) independently evaluated the images for the presence of folds of the membrane, peri-implant fluid collections and silicone collections, intra-implant fluid, keyhole and linguini sign, and capsular calcifications. The reference standard was a consensus reading by two radiologists (11 and 25 years of experience in breast imaging) of all imaging examinations. Cohen's kappa for inter-rater reliability and pooled measures for diagnostic accuracy were calculated.

#### **RESULTS**

We included 19 patients with 31 implants and found that the diagnostic accuracy of PC-CT was high for detecting peri-implant silicone collections, the linguini sign, intra-implant fluid, the keyhole sign, capsular calcifications, and folds of the membrane, with accuracy values ranging from 0.91 to 0.99. Also, sensitivities ranged from 0.88-0.99 and specificities from 0.75-0.99. Inter-rater reliability was observed to be nearly perfect ( $\kappa > 0.80$ ) for all imaging features, with the exception of peri-implant fluid collections where inter-rater reliability was determined to be fair (0.39).

#### **CONCLUSION**

We found PC-CT to be highly accurate in detecting various signs of degenerative changes and rupture of silicone breast implants.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings suggest that PC-CT could be a feasible imaging modality for the evaluation of implant ruptures.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R6-SSBR11-3

### **A Radiomics Approach Based on Machine Learning in Distinguishing Benign and Malignant Breast Lesions Using T2 Weighted and Diffusion Weighted Imaging: A Multicenter Study**

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450B

Yulu Liu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Breast Magnetic Resonance Imaging (BMRI) has been recommended as supplemental screening tool of breast cancer by international guidelines, but its long examination time and use of contrast material remains to be concerned. Thus, the purpose of this study is to develop an unenhanced radiomics model using machine learning techniques based on T2W and DW sequences to identify benign and malignant breast lesions.

#### **METHODS AND MATERIALS**

A total of 1760 patients were enrolled in this multicenter study to develop, validate and test a radiomics model. 1293 continuous patients were randomly divided into two groups at a ratio of 6:4 for model construction. (training cohort, n=775; validation cohort, n=518). After MR image segmentation, feature extraction and selection, we used the machine learning Gaussian Process (GP), Support Vector Machine (SVM) and Logistic algorithm to differentiate breast cancer. Afterwards, models' diagnostic performance was tested on three independent testing cohorts (internal retrospective test, n=167; internal perspective test, n=188; external retrospective test, n=112). Model performance was evaluated using AUC to compare with the model combining Postcontrast Phase I images, and the diagnosis of radiologists. Subgroup analysis was performed to assess the performance in different categories, including lesion types (mass and no-mass), background parenchymal enhancement (minimal, mild, moderate, and marked), age ( $\geq 50$  and  $< 50$ ), and pathological types of malignancy.

#### **RESULTS**

The unenhanced model performed best based on GP classifier (AUC, training: 0.893, validation: 0.848), and showed favorable prediction in testing cohorts (AUCs, 0.818-0.840). The AUC values for unenhanced model were not statistically different from the combined model ( $p > 0.05$ ). There was no significant difference in performance between the unenhanced model with two readers ( $p > 0.05$ ). The unenhanced model demonstrated favorable performance in diagnosing tumors with different lesion types, background parenchymal enhancement, and ages. The model performed worst in identifying ductal carcinoma in situ, whereas showed favorable competence in identifying other types of malignancies ( $p = 0.0054$ ).

#### **CONCLUSION**

The model utilizing the unenhanced sequences based on T2WI and DWI, has displayed excellent diagnostic accuracy, comparable to radiologists. These findings indicate that our model could potentially help the screening of breast cancer in the future.

#### **CLINICAL RELEVANCE/APPLICATION**

Our study showed that a machine learning unenhanced radiomics model using T2WI and DWI is effective in distinguishing breast lesions, which suggests this approach could potentially assist in screening of breast cancers in the future.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSBR11-4

### Assessment of Nonmass Lesions Detected by Screening Breast US: A Multicenter Study

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450B

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To analyze US features of non-mass lesions (NMLs) detected by screening US and determine the predictive features. In addition, to investigate application of classification system for validating screening US detected NMLs.

#### METHODS AND MATERIALS

This retrospective, multicenter study included 993 asymptomatic women who were referred for screening US. Eligible women had NMLs detected at US. Three radiologists interpreted and assessed the final Breast Imaging Reporting and Data System (BI-RADS) category. Univariable and multivariable logistic regression was used to identify independent clinical and imaging factors associated with malignancy. We applied the classification system and calculated the positive predictive value for biopsy recommendations (PPV2) and conversion rate of BI-RADS 4A to 3 category. Inter-reader agreements between readers were analyzed with weighted kappa values.

#### RESULTS

Among 993 patients (mean age  $49.7 \pm 8.6$  years, range, 30-80 years) with 993 NMLs, 885 (89.1%) were benign, 29 (2.9%) were high risk lesion, and 79 (8.0%) were malignant lesions. The mean size of malignant NMLs was significantly larger than benign NMLs ( $2.6 \pm 1.1$  vs  $1.9 \pm 0.8$  cm,  $P < .001$ ). In the multivariable analysis, mixed echogenicity (OR, 4.95;  $P < .001$ ), segmental distribution (OR, 5.52;  $P < .001$ ), presence of calcification (OR, 22.87;  $P < .001$ ), presence of posterior shadowing (OR, 7.22;  $P < .001$ ) and size on US (OR, 1.56;  $P = .009$ ) were independent factors associated with malignant NMLs. The presence of multiple small cysts was not negatively associated with malignant NMLs (OR, 0.59;  $P = .290$ ). Among the features showing statistical significance on multivariable analysis, presence of calcification showed PPV of 44.3%, segmental distribution (PPV of 22.9%), presence of posterior shadowing (PPV of 21.8%) and mixed echogenicity (PPV of 16.5%). Utilizing the classification system showed PPV2 of 16.7% (95% CI: 13.6, 20.3) and conversion rate of BI-RADS 4A to 3 were 42.8% (reader 1 and reader 2) and 40.0% (reader 3). Inter-observer agreement for NMLs was excellent with kappa values ranging from 0.83 to 0.90.

#### CONCLUSION

When breast NMLs are detected on screening US, suspicious malignant US features may be applicable for diagnosing clinically occult malignant NMLs.

#### CLINICAL RELEVANCE/APPLICATION

No prior study has investigated US features of NMLs detected on screening US. Our study provides data regarding US features that may improve the utility of screening US in asymptomatic women in accurate diagnosis of NML.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSBR11-5

### **Keynote Speaker: Potential Role of Breast DWI in Breast Cancer Screening and Diagnosis**

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450B

Savannah C. Partridge, PhD (*Presenter*) Research Grant, General Electric Company; Research support, Koninklijke Philips NV; Consultant, Guerbet SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSBR11-6

### Different Downstream Outcomes After Consensus Discussion Related to Which Readers, AI or Radiologist, Flagged the Screening Mammography as Abnormal - In the Prospective Interventional ScreenTrustcad Trial

Thursday, Nov. 30 1:30PM - 2:30PM Room: E450B

Karin Dembrower, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

ScreenTrustCAD (NCT04778670) was the first prospective interventional study of AI in population-based breast cancer screening with a total of 55,581 women included. Based on a paired-reader design, it was found that in a double-reading and consensus workflow, AI plus one reader achieved superior cancer detection to two readers, without increasing recalls. The purpose of the current sub-study was to analyze differences in consensus recall decisions depending on whether AI or radiologists had initially flagged the exam as abnormal.

#### METHODS AND MATERIALS

The current study was performed within the ScreenTrustCAD trial, which employed an index test of paired reading between two human readers and Lunit INSIGHT MMG (AI). The three readers of each exam were blinded to the reads of others. An exam flagged by any reader was forwarded to the consensus discussion. In this sub-study, women who reported lumps at time of screening were excluded since AI did not consider that information. For each combination of readers who flagged the exam, we calculated the proportion of recalled women, cancers detected and positive predictive value (PPV).

#### RESULTS

There were 55,581 women included in the ScreenTrustCAD trial with 269 women diagnosed with breast cancer. After excluding women reporting a lump, there were 53,865 women overall, of whom 238 with breast cancer. In total, 5515 exams were flagged for consensus discussion, of which AI, reader 1 and reader 2 each flagged 3014 (55%), 2255 (41%) and 2424 (44%) respectively. 1358 (2.47%) women were recalled, of whom 238 (17.5%) were diagnosed with breast cancer and 1120 (82.5%) were not. Among 2501 consensus cases which had not been flagged by AI (but by one or two radiologists), the consensus discussion decided to recall 626 (25%) and for 21 (0.8%) cancer was detected, resulting in 3.4% PPV. Among 3014 consensus cases which had been flagged by AI (and zero to two radiologists), the consensus discussion decided to recall 732 (24%) and for 217 (7.2%) cancer was detected, resulting in 29% PPV. See Figure 1 for further breakdown of results.

#### CONCLUSION

For the exams that the radiologists in the consensus discussion decided to recall, the PPV for exams previously flagged by AI, compared to those only flagged by radiologists, was nearly 10 times higher.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists involved in the consensus discussions in screening mammography should be made aware of their bias of overcalling non-AI-flagged exams and possibly undercalling AI-flagged exams. The consensus discussion may need to be re-designed for optimal use of AI reads.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSCA11

### Cardiac Imaging (Advanced Imaging in Congenital and Inherited Diseases)

Thursday, Nov. 30 1:30PM - 2:30PM Room: N226

Hildo J. Lamb, MD, PhD (*Moderator*) Consultant, Koninklijke Philips NV  
Cristina Fuss, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **R6-SSCA11-1 Ventricular Interdependence in Repaired Tetralogy of Fallot Patients with Right Ventricular Heart Failure**

Li Jiang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Individuals with repaired tetralogy of Fallot (rTOF) are still at high risk for worsening cardiac function, and understanding the underlying pathophysiological mechanism is important for exploring disease progression and management options. This study aims to investigate ventricular interdependence in rTOF patients prior to and following right ventricular (RV) heart failure.

#### METHODS AND MATERIALS

118 rTOF patients and 34 controls that underwent cardiac magnetic resonance (CMR) analyses were retrospectively analyzed, with rTOF patients being further subdivided into those with preserved RV function ( $n = 54$ ) and those that experienced RV heart failure ( $n = 64$ ). CMR-derived feature tracking techniques were used to assess RV, left ventricular (LV) and septal strain. Interventricular interdependence in different patient subgroups was analyzed through the use of correlation and multivariate backward linear regression models.

#### RESULTS

Progressive reductions in RV, LV and septal strain were evident from controls, through patients with preserved RV function, to patients with RV heart failure ( $P < 0.01$ ), but LV and septal longitudinal strain increased slightly in patients with preserved RV function relative to controls ( $P > 0.05$ ). Correlations between LV and RV strain were found to gradually change with RV function, and were the closest in rTOF patients with RV heart failure ( $r = |-0.270| - 0.506$ , all  $P < 0.05$ ). Correlations between RV volume and septal strain is nonlinear with different disease state. Subsequent multivariate analyses revealed the RV longitudinal strain is independently correlated with LV strain in three directions in rTOF patients with RV heart failure (Radial  $-0.70 [-1.33, -0.06]$ ,  $P = 0.032$ ; Circumferential  $0.44 [0.17, 0.72]$ ,  $P = 0.002$ , Longitudinal  $0.54 [0.26, 0.81]$ ,  $P < 0.001$ ).

#### CONCLUSION

Our study indicates the nonlinear effect of RV volume load on septal deformation with different disease state and RV functionality in rTOF patients, and emphasizes the effect of RV on LV deformation is greatest when RV function decreased significantly.

#### CLINICAL RELEVANCE/APPLICATION

This research preliminarily describes that RV-LV interdependencies varies and LV adaptation to RV dysfunction in rTOF patients, and non-invasively analyzes the interventricular physiological association, offering a valuable foundation for further studies exploring disease progression and the mechanisms underlying interventricular interaction in this patient population.

#### **R6-SSCA11-3 Assessment of Global Longitudinal Strain in the Human Fetus using Feature-Tracking MRI and Doppler Ultrasound Gating**

Bjoern Schoennagel, MD (*Presenter*) Co-founder, North Medical GmbH; Stockholder, North Medical GmbH

## PURPOSE

To evaluate the feasibility of Feature-Tracking MRI (FT-MRI) for the assessment of global longitudinal strain (GLS) of the left (LV) and right ventricle (RV) using cardiac Doppler ultrasound gating in human fetuses.

## METHODS AND MATERIALS

This retrospective study included 47 human fetuses (gestational age: 28+3 - 37+6 weeks) with or without congenital heart disease (CHD) who underwent fetal cardiac MRI at 3T. The local ethics committee approved the study and pregnant women gave written informed consent prior to MR examination. Fetal cardiac MRI was performed using Doppler ultrasound (SmartSync, northh medical, Germany) for gating of a cine balanced steady-state free-precession sequence (FOV 246 x 246 mm<sup>2</sup>, matrix size 164 x160, slices 12, slice thickness 5 mm, slice gap -1 mm, TR 4.1 ms, TE 2.0 ms, FA = 60°, echo train length 9, shot duration 36.7 ms). GLS of the LV and RV was derived from four-chamber views and determined by manual delineation of endo- and epicardial contours on end-diastolic images followed by automated propagation using dedicated feature-tracking software (Segment, Medviso, Sweden). GLS between healthy fetuses and fetuses with CHD were compared by Student's t-Test (level of significance = 0.05).

## RESULTS

GLS of 38/47 fetuses (81 %) was successfully analyzed. 21 fetuses had known CHD (e.g. Coarctation, Ebstein anomaly, Tetralogy of Fallot) and 17 were healthy. Nine fetuses were excluded due to reduced image quality or misregistration of myocardial wall motion by the feature-tracking software. One fetus had univentricular left heart, so determination of RV GLS was not possible in this case. Mean LV GLS of all 38 fetuses was -14.5 % (SD ± 6.7 %) and mean RV GLS was -11.9 % (SD ± 5.8). Fetuses with CHD revealed significantly reduced LV GLS (-11.7 % vs. -17.8 %,  $p < 0.004$ ) and RV GLS (-9.3 % vs. -15.2 %,  $p < 0.001$ ) when compared to healthy fetuses.

## CONCLUSION

Our study revealed significantly reduced LV and RV GLS values for fetuses with CHD compared to healthy fetuses. FT-MRI using Doppler ultrasound gating in the human fetus provides a new quantitative approach for evaluation of fetal cardiac function and may serve as a new tool to improve the understanding of fetal cardiac function.

## CLINICAL RELEVANCE/APPLICATION

FT-MRI using Doppler ultrasound gating warrants further quantitative investigation to assess fetal cardiac function.

## R6-SSCA11-5 Aortic Diameters in Marfan Syndrome: Intraindividual Comparison of Transthoracic Echocardiography (TTE) and 3D Modified Relaxation-Enhanced Angiography without Contrast and Triggering (REACT)

Carsten H. Gietzen, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the measurement of aortic diameters using a novel flow-independent MR-Angiography (3D modified Relaxation-Enhanced Angiography without Contrast and Triggering (modified REACT)) and transthoracic echocardiography (TTE) in Marfan syndrome (MFS) patients.

## METHODS AND MATERIALS

This was a retrospective, single-center study that included 46 examinations of 32 MFS patients (mean age 37.5 ± 11.3 years, 17 women, no prior aortic surgery) who received TTE and REACT (ECG- and respiratory-triggering, Compressed SENSE 9, 1.5 T) of the thoracic aorta (January 2018 - April 2022). Aortic diameters (sinuses of Valsalva (SV), sinotubular junction (STJ), and ascending aorta (AoA)) were independently measured by two radiologists (inner-edge, using multiplanar reconstruction) in REACT and two cardiologists in TTE (leading-edge). Intraclass correlation coefficient (ICC), Pearson correlation coefficient (r), Bland-Altman analyses, and t-test were employed to assess agreement between imaging modalities and observers.

## RESULTS

The mean time between TTE and modified REACT was 28 ± 45 days. Modified REACT yielded an average total acquisition time of 05:06 min ± 02:47 min. Interobserver correlation at the SV, STJ, and AoA were excellent for REACT (ICC=0.98-0.99) and TTE (ICC=0.90-0.97). There was no significant difference between REACT and TTE for diameters determined at the SV (39.6 ± 3.8 mm vs. 39.2 ± 3.2 mm;  $r=0.78$ ,  $p=0.26$ ) and the STJ (35.3 ± 4.7 mm vs. 35.2 ± 4.5 mm;  $r=0.87$ ,  $p=0.552$ ). AoA diameters measured by REACT were smaller than in TTE (30.6 ± 5.3 mm vs. 34.3 ± 5.3 mm;  $r=0.74$ ,  $p<0.01$ ).

## CONCLUSION

There was a strong correlation between REACT and TTE at all levels of measurement. At the AoA, diameters were significantly larger using TTE. This difference is mostly due to different heights of measurements since AoA measurements were measured closer to the aortic valve in TTE due to the limited field of view whereas in REACT, measurement of the AoA is performed at the level of the bifurcation of the pulmonary trunk.

## CLINICAL RELEVANCE/APPLICATION

Given its fast acquisition time and strong agreement with TTE, modified REACT represents an attractive and fast technique to depict the thoracic aorta in Marfan syndrome patients. Patients who receive repetitive aortic imaging throughout their lives may benefit from this technique free of gadolinium contrast.

### **R6-SSCA11-6 Monitoring Marfan Syndrome and Related Disorders: Updated 2022 ACC/AHA Guideline Improves Concordance between TTE and CT but Relevant Measurements Differences Remain Frequent**

Nick Lasse Beetz, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Patients with Marfan syndrome and related syndromes require repetitive aortic imaging with TTE and CT being most widely used. Aortic measurements should provide high accuracy as in patients with progressive aortic enlargement of as little as > 2 mm surgical aortic repair is usually recommended. However, there is few scientific evidence as to which imaging modality should be performed in this young patient population. Recently, the 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease was published. This study aims at comparing the updated imaging recommendations.

## METHODS AND MATERIALS

In this retrospective study we included 137 patients diagnosed with Marfan syndrome. All patients underwent TTE and ECG-triggered CT. Aortic diameter measurement at the aortic sinus and the ascending aorta were taken - first, according to the old 2010 ACC/AHA guideline (TTE: inner edge to inner edge, CT: external diameter), and second, according to the new 2022 ACC/AHA guideline (TTE: leading edge to leading edge, CT: internal diameter). Differences between the two methods for measuring aortic diameters were compared using Bland-Altman plots. The acceptable clinical limit of agreement for the difference between the two methods was predefined as < +/-2 millimeters.

## RESULTS

Using the updated 2022 ACC/AHA guideline the frequency of measurement differences outside the acceptable clinical agreement limit of difference was significantly reduced from 49% to 26% for the aortic sinus and from 41% to 29% for the ascending aorta. The systematic measurement error (bias) decreased from -0.3 mm for the aortic sinus and +1.1 mm for the ascending aorta using the new 2022 guideline, compared to a bias of -2.7 mm for the aortic sinus and +1.2 mm for the ascending aorta using the old 2010 guideline.

## CONCLUSION

For the first time this study shows that the updated imaging recommendations of the 2022 ACC/AHA can improve the concordance between ECG-triggered CT and TTE measurements in patients with Marfan syndrome who require accurate monitoring to prevent life-threatening aortic dissection and rupture. Unfortunately, the frequency of measurement differences between CT and TTE outside the acceptable clinical agreement limit of difference remains high.

## CLINICAL RELEVANCE/APPLICATION

Highly accurate measurement of aortic diameters in patients at risk for fatal aortic rupture and dissection is warranted. Although the updated 2022 guidelines shows improved concordance between the different imaging modalities, there is still a high frequency of measurement differences > 2 mm, which may lead to relevant clinical implications regarding aortic repair. Therefore, the risk of repetitive radiation exposure by the clinically accepted "gold-standard" ECG-triggered CT can be justified.

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## Abstract Archives of the RSNA, 2023

R6-SSCA11-1

### Ventricular Interdependence in Repaired Tetralogy of Fallot Patients with Right Ventricular Heart Failure

Thursday, Nov. 30 1:30PM - 2:30PM Room: N226

Li Jiang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Individuals with repaired tetralogy of Fallot (rTOF) are still at high risk for worsening cardiac function, and understanding the underlying pathophysiological mechanism is important for exploring disease progression and management options. This study aims to investigate ventricular interdependence in rTOF patients prior to and following right ventricular (RV) heart failure.

#### METHODS AND MATERIALS

118 rTOF patients and 34 controls that underwent cardiac magnetic resonance (CMR) analyses were retrospectively analyzed, with rTOF patients being further subdivided into those with preserved RV function ( $n = 54$ ) and those that experienced RV heart failure ( $n = 64$ ). CMR-derived feature tracking techniques were used to assess RV, left ventricular (LV) and septal strain. Interventricular interdependence in different patient subgroups was analyzed through the use of correlation and multivariate backward linear regression models.

#### RESULTS

Progressive reductions in RV, LV and septal strain were evident from controls, through patients with preserved RV function, to patients with RV heart failure ( $P < 0.01$ ), but LV and septal longitudinal strain increased slightly in patients with preserved RV function relative to controls ( $P > 0.05$ ). Correlations between LV and RV strain were found to gradually change with RV function, and were the closest in rTOF patients with RV heart failure ( $r = |-0.270| - 0.506$ , all  $P < 0.05$ ). Correlations between RV volume and septal strain is nonlinear with different disease state. Subsequent multivariate analyses revealed the RV longitudinal strain is independently correlated with LV strain in three directions in rTOF patients with RV heart failure (Radial  $-0.70$  [ $-1.33, -0.06$ ],  $P = 0.032$ ; Circumferential  $0.44$  [ $0.17, 0.72$ ],  $P = 0.002$ , Longitudinal  $0.54$  [ $0.26, 0.81$ ],  $P < 0.001$ ).

#### CONCLUSION

Our study indicates the nonlinear effect of RV volume load on septal deformation with different disease state and RV functionality in rTOF patients, and emphasizes the effect of RV on LV deformation is greatest when RV function decreased significantly.

#### CLINICAL RELEVANCE/APPLICATION

This research preliminarily describes that RV-LV interdependencies varies and LV adaptation to RV dysfunction in rTOF patients, and non-invasively analyzes the interventricular physiological association, offering a valuable foundation for further studies exploring disease progression and the mechanisms underlying interventricular interaction in this patient population.

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## Abstract Archives of the RSNA, 2023

R6-SSCA11-3

### Assessment of Global Longitudinal Strain in the Human Fetus using Feature-Tracking MRI and Doppler Ultrasound Gating

Thursday, Nov. 30 1:30PM - 2:30PM Room: N226

Bjoern Schoennagel, MD (*Presenter*) Co-founder, North Medical GmbH; Stockholder, North Medical GmbH

#### PURPOSE

To evaluate the feasibility of Feature-Tracking MRI (FT-MRI) for the assessment of global longitudinal strain (GLS) of the left (LV) and right ventricle (RV) using cardiac Doppler ultrasound gating in human fetuses.

#### METHODS AND MATERIALS

This retrospective study included 47 human fetuses (gestational age: 28+3 - 37+6 weeks) with or without congenital heart disease (CHD) who underwent fetal cardiac MRI at 3T. The local ethics committee approved the study and pregnant women gave written informed consent prior to MR examination. Fetal cardiac MRI was performed using Doppler ultrasound (SmartSync, northh medical, Germany) for gating of a cine balanced steady-state free-precession sequence (FOV 246 x 246 mm<sup>2</sup>, matrix size 164 x 160, slices 12, slice thickness 5 mm, slice gap -1 mm, TR 4.1 ms, TE 2.0 ms, FA = 60°, echo train length 9, shot duration 36.7 ms). GLS of the LV and RV was derived from four-chamber views and determined by manual delineation of endo- and epicardial contours on end-diastolic images followed by automated propagation using dedicated feature-tracking software (Segment, Medviso, Sweden). GLS between healthy fetuses and fetuses with CHD were compared by Student's t-Test (level of significance = 0.05).

#### RESULTS

GLS of 38/47 fetuses (81 %) was successfully analyzed. 21 fetuses had known CHD (e.g. Coarctation, Ebstein anomaly, Tetralogy of Fallot) and 17 were healthy. Nine fetuses were excluded due to reduced image quality or misregistration of myocardial wall motion by the feature-tracking software. One fetus had univentricular left heart, so determination of RV GLS was not possible in this case. Mean LV GLS of all 38 fetuses was -14.5 % (SD ± 6.7 %) and mean RV GLS was -11.9 % (SD ± 5.8). Fetuses with CHD revealed significantly reduced LV GLS (-11.7 % vs. -17.8 %,  $p < 0.004$ ) and RV GLS (-9.3 % vs. -15.2 %,  $p < 0.001$ ) when compared to healthy fetuses.

#### CONCLUSION

Our study revealed significantly reduced LV and RV GLS values for fetuses with CHD compared to healthy fetuses. FT-MRI using Doppler ultrasound gating in the human fetus provides a new quantitative approach for evaluation of fetal cardiac function and may serve as a new tool to improve the understanding of fetal cardiac function.

#### CLINICAL RELEVANCE/APPLICATION

FT-MRI using Doppler ultrasound gating warrants further quantitative investigation to assess fetal cardiac function.

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## Abstract Archives of the RSNA, 2023

R6-SSCA11-5

### **Aortic Diameters in Marfan Syndrome: Intraindividual Comparison of Transthoracic Echocardiography (TTE) and 3D Modified Relaxation-Enhanced Angiography without Contrast and Triggering (REACT)**

Thursday, Nov. 30 1:30PM - 2:30PM Room: N226

Carsten H. Gietzen, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the measurement of aortic diameters using a novel flow-independent MR-Angiography (3D modified Relaxation-Enhanced Angiography without Contrast and Triggering (modified REACT)) and transthoracic echocardiography (TTE) in Marfan syndrome (MFS) patients.

#### **METHODS AND MATERIALS**

This was a retrospective, single-center study that included 46 examinations of 32 MFS patients (mean age  $37.5 \pm 11.3$  years, 17 women, no prior aortic surgery) who received TTE and REACT (ECG- and respiratory-triggering, Compressed SENSE 9, 1.5 T) of the thoracic aorta (January 2018 - April 2022). Aortic diameters (sinuses of Valsalva (SV), sinotubular junction (STJ), and ascending aorta (AoA)) were independently measured by two radiologists (inner-edge, using multiplanar reconstruction) in REACT and two cardiologists in TTE (leading-edge). Intraclass correlation coefficient (ICC), Pearson correlation coefficient (r), Bland-Altman analyses, and t-test were employed to assess agreement between imaging modalities and observers.

#### **RESULTS**

The mean time between TTE and modified REACT was  $28 \pm 45$  days. Modified REACT yielded an average total acquisition time of  $05:06 \text{ min} \pm 02:47 \text{ min}$ . Interobserver correlation at the SV, STJ, and AoA were excellent for REACT (ICC=0.98-0.99) and TTE (ICC=0.90-0.97). There was no significant difference between REACT and TTE for diameters determined at the SV ( $39.6 \pm 3.8 \text{ mm}$  vs.  $39.2 \pm 3.2 \text{ mm}$ ;  $r=0.78$ ,  $p=0.26$ ) and the STJ ( $35.3 \pm 4.7 \text{ mm}$  vs.  $35.2 \pm 4.5 \text{ mm}$ ;  $r=0.87$ ,  $p=0.552$ ). AoA diameters measured by REACT were smaller than in TTE ( $30.6 \pm 5.3 \text{ mm}$  vs.  $34.3 \pm 5.3 \text{ mm}$ ;  $r=0.74$ ,  $p<0.01$ ).

#### **CONCLUSION**

There was a strong correlation between REACT and TTE at all levels of measurement. At the AoA, diameters were significantly larger using TTE. This difference is mostly due to different heights of measurements since AoA measurements were measured closer to the aortic valve in TTE due to the limited field of view whereas in REACT, measurement of the AoA is performed at the level of the bifurcation of the pulmonary trunk.

#### **CLINICAL RELEVANCE/APPLICATION**

Given its fast acquisition time and strong agreement with TTE, modified REACT represents an attractive and fast technique to depict the thoracic aorta in Marfan syndrome patients. Patients who receive repetitive aortic imaging throughout their lives may benefit from this technique free of gadolinium contrast.

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## Abstract Archives of the RSNA, 2023

R6-SSCA11-6

### Monitoring Marfan Syndrome and Related Disorders: Updated 2022 ACC/AHA Guideline Improves Concordance between TTE and CT but Relevant Measurements Differences Remain Frequent

Thursday, Nov. 30 1:30PM - 2:30PM Room: N226

Nick Lasse Beetz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients with Marfan syndrome and related syndromes require repetitive aortic imaging with TTE and CT being most widely used. Aortic measurements should provide high accuracy as in patients with progressive aortic enlargement of as little as > 2 mm surgical aortic repair is usually recommended. However, there is few scientific evidence as to which imaging modality should be performed in this young patient population. Recently, the 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease was published. This study aims at comparing the updated imaging recommendations.

#### METHODS AND MATERIALS

In this retrospective study we included 137 patients diagnosed with Marfan syndrome. All patients underwent TTE and ECG-triggered CT. Aortic diameter measurement at the aortic sinus and the ascending aorta were taken - first, according to the old 2010 ACC/AHA guideline (TTE: inner edge to inner edge, CT: external diameter), and second, according to the new 2022 ACC/AHA guideline (TTE: leading edge to leading edge, CT: internal diameter). Differences between the two methods for measuring aortic diameters were compared using Bland-Altman plots. The acceptable clinical limit of agreement for the difference between the two methods was predefined as < +/-2 millimeters.

#### RESULTS

Using the updated 2022 ACC/AHA guideline the frequency of measurement differences outside the acceptable clinical agreement limit of difference was significantly reduced from 49% to 26% for the aortic sinus and from 41% to 29% for the ascending aorta. The systematic measurement error (bias) decreased from -0.3 mm for the aortic sinus and +1.1 mm for the ascending aorta using the new 2022 guideline, compared to a bias of -2.7 mm for the aortic sinus and +1.2 mm for the ascending aorta using the old 2010 guideline.

#### CONCLUSION

For the first time this study shows that the updated imaging recommendations of the 2022 ACC/AHA can improve the concordance between ECG-triggered CT and TTE measurements in patients with Marfan syndrome who require accurate monitoring to prevent life-threatening aortic dissection and rupture. Unfortunately, the frequency of measurement differences between CT and TTE outside the acceptable clinical agreement limit of difference remains high.

#### CLINICAL RELEVANCE/APPLICATION

Highly accurate measurement of aortic diameters in patients at risk for fatal aortic rupture and dissection is warranted. Although the updated 2022 guidelines shows improved concordance between the different imaging modalities, there is still a high frequency of measurement differences > 2 mm, which may lead to relevant clinical implications regarding aortic repair. Therefore, the risk of repetitive radiation exposure by the clinically accepted "gold-standard" ECG-triggered CT can be justified.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGI19

### Gastrointestinal Imaging (Diffuse Liver Disease)

Thursday, Nov. 30 1:30PM - 2:30PM Room: E352

Sudhakar K. Venkatesh, MD, FRCR (*Moderator*) Nothing to Disclose  
Benjamin Mervak, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **R6-SSGI19- Noninvasive Quantification of Hepatic Steatosis using Ultrasound-derived Fat Fraction with MRI-derived Proton Density Fat Fraction as the Reference Standard (CHESS 2303): A Multicenter Prospective Study**

Yi Dong, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To prospectively assess the role of ultrasound-derived fat fraction (UDFF) in the detection of hepatic steatosis using MRI-derived proton density fat fraction (PDFF) as the reference standard.

#### METHODS AND MATERIALS

Participants with or suspected of having nonalcoholic fatty liver disease (NAFLD) were prospectively recruited by an international multicenter between January 2023 to April 2023. All participants underwent UDFF and MRI-derived PDFF measurements on the same day. Demographic, clinical, and laboratory data were gathered. An MRI-derived PDFF cutoff of 5% was used for the definition of NAFLD. The correlation between UDFF (%) and MRI-derived PDFF (%) was calculated using the Pearson correlation coefficient. The area under the receiver operating characteristic curve (AUC) was calculated to assess the accuracy of UDFF in the diagnosis of hepatic steatosis.

#### RESULTS

A total of 113 participants were included: 46.0% (52/113) were male, mean age was 45 years  $\pm$  12 (SD); mean body mass index was 25.5 kg/m<sup>2</sup>  $\pm$  4.2 (SD); median alanine aminotransferase was 21.0 IU/L (IQR: 15.3, 34.8), median aspartate aminotransferase was 20.0 IU/L (IQR: 16.0, 27.0), median albumin was 4.6 md/dL (IQR: 4.3, 4.9), median total bilirubin was 1.1 md/dL (IQR: 0.8, 1.4), median prothrombin time international normalized ratio was 1.0 (IQR: 0.9, 1.0), and median platelet was 227.0  $\times$  10<sup>9</sup>/L (IQR: 188.0, 258.8). Overall, 34.5% (39/113) had type 2 diabetes mellitus, and 67.3% (76/113) had NAFLD (MRI-derived PDFF of 5% or more). The median UDFF was 9.2% (IQR: 4.8, 15.2). The Pearson correlation coefficient between UDFF and MRI-derived PDFF was good ( $r = 0.764$ ,  $P < 0.001$ ). Using MRI-derived PDFF as a reference, UDFF had good accuracy for the diagnosis of NAFLD (AUC was 0.865 [95% CI: 0.797, 0.932], with a sensitivity of 67.1%, and a specificity of 89.2%). The interobserver agreement of UDFF was excellent (ICC = 0.948,  $P < 0.001$ ). The intraobserver agreement of UDFF was excellent (ICC = 0.904-0.969,  $P < 0.001$ ).

#### CONCLUSION

The UDFF was useful for assessing hepatic steatosis when using MRI-derived PDFF as the reference standard.

#### CLINICAL RELEVANCE/APPLICATION

This multicenter prospective study highlights the practicality of ultrasound-derived fat fraction as a potential alternative tool for magnetic resonance imaging for detecting nonalcoholic fatty liver disease.

### **R6-SSGI19- Disease Progression and Tissue Inhomogeneity affect Fibrosis Staging Discordance between Hepatic MRE and Liver Biopsy in Nonalcoholic Fatty Liver Disease**

Yiyang Sheng (*Presenter*) Nothing to Disclose

## PURPOSE

In this study, our objective is to investigate the hypothesis that discrepancies between MR elastography (MRE) based fibrosis staging and biopsy staging may be linked to the heterogeneity of liver tissue that develops during chronic liver diseases (CLD) and is associated with other histopathological characteristics.

## METHODS AND MATERIALS

In this retrospective study, we analyzed 3D vector MRE exams from 175 individual patients with diagnosed nonalcoholic fatty liver disease (NAFLD) who underwent MRE and liver biopsy exams between Oct. 2015 and Oct. 2021 (227 total data sets). First, we determined the MRE diagnostic stage using the Youden Index, and calculated the discordance between MRE and biopsy-based fibrosis stages. Then, we performed feature extraction on pixel-wise liver stiffness (LS) measurements, including histogram-based distribution features and position-based shape features (129 total features). Next, we employed multivariate logistic regression with lasso regularization and correlation analysis to identify independent features contributing to the discordance in fibrosis staging. Finally, we examined the associations between inhomogeneity features and NAFLD progression, as assessed by MRI-assessed proton-density fat fraction (PDFF) and MRE-assessed mean LS.

## RESULTS

The top six features impacting the discordance in fibrosis staging, ordered from high to low normalized impact, were ballooning, PDFF, sex, maximum 2D diameter, gray-level run length matrix (GLRLM) run variance, and minimum LS. Using logistic regression that incorporated these six features, we were able to differentiate discordant cases with an overall accuracy of 0.83, based on a train-to-test ratio of 7:3. We observed that elevated ballooning grade, increased PDFF, male sex, and high minimum LS were associated with increased values of pixel-wise high-rank features metrics (maximum 2D diameter, GLRLM run variance). Steatosis and ballooning may be the primary drivers in more discordant cases, while pixel-wise high-rank features metrics might represent secondary factors related to these primary drivers.

## CONCLUSION

This study highlights that ballooning and steatosis (PDFF) are the two most significant factors leading to discordant readings between MRE and biopsy in fibrosis staging. The discordance may stem from subjective histologic staging influenced by steatosis and ballooning, or it could result from histogram and position-related inhomogeneity caused by these primary factors.

## CLINICAL RELEVANCE/APPLICATION

Findings highlight the importance of factors like PDFF, ballooning in NAFLD diagnosis monitoring. MRE is a reliable substitute of biopsy in cases with mild steatosis and ballooning, serving as a high-value screening tool.

## R6-SSGI19- Three-Dimensional MR Elastography Identifies Portal Hypertension in Cirrhosis: A Prospective Multicenter Study

Yu Shi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop a non-invasive multivariate models based on Three-dimensional MR elastography (3D-MRE) to determine portal hypertension (PH), particularly to diagnose clinically significant portal hypertension (CSPH, HVPG>10mmHg) and severe portal hypertension (SPH, HVPG>12mmHg), using HVPG as the gold standard.

## METHODS AND MATERIALS

This prospective, multicenter study enrolled patients with cirrhosis scheduled for HVPG, and who intended to undergo MR imaging (including 3D-MRE and diffusion-, T1-, and T2-weighted imaging) before the HVPG procedure. A total of 57 patients were recruited from five institutions. Multiple viscoelastic parameters of the liver and spleen, as well as shear stiffness (SS) ratios and subtraction values, were evaluated independently by two radiologists. Univariable and multivariable linear regression analyses were conducted to assess the associations between mechanical parameters and HVPG. Univariable and multivariable logistic regression analyses were used to predict CSPH and SPH, respectively.

## RESULTS

HVPG showed the strongest positive correlation with splenic SS at 60Hz ( $r = 0.785$ ;  $P < .001$ ), followed by hepatic SS at 30Hz ( $r = 0.631$ ;  $P < .001$ ), splenic SS at 30Hz ( $r = 0.612$ ;  $P < .001$ ), hepatic SS at 60Hz ( $r = 0.547$ ;  $P < .001$ ). Multivariable linear regression analysis showed splenic SS at 60Hz ( $\beta = 1.017$ ; 95% CI: 0.71, 1.325;  $P < .001$ ), liver SS ratio ( $\beta = -2.359$ ; 95% CI: -4.477, -0.241;  $P = .03$ ), and liver stiffness difference ( $\beta = 1.169$ ; 95% CI: 0.251, 2.087;  $P = .001$ ) was the independent factors determining HVPG. Approximately 56.5% of the total variability in HVPG was explained by these 3 variables (adjusted  $R^2 = 0.565$ ). Logistic regression analysis showed splenic SS at 60Hz (OR = 2.217 [95% CI: 1.292, 3.803];  $P = 0.004$ ) and liver SS at 30Hz (OR = 6.211 [95% CI: 1.218, 31.669];  $P = 0.028$ ) were independently associated with CSPH, establishing a model with excellent performance in diagnosing CSPH (area under the receiver operating characteristic curve [AUC], 0.975 [95% CI: 0.79, 0.99]). As for SPH, it showed splenic SS at 60Hz (OR = 1.65 [95%

CI:1.25,2.16]; P = .001) were independently associated with HVPG, also with better performance (AUC, 0.969 [95% CI: 0.81, 0.98]).

## **CONCLUSION**

3D-MRE with dual frequencies is a very promising method in both predicting HVPG and diagnosing the presence CSPH and SPH. Splenic stiffness at 60Hz, combining liver stiffness ratio (60Hz/30Hz) and differences (60Hz-30Hz), was the independent parameters associating HVPG.

## **CLINICAL RELEVANCE/APPLICATION**

3D-MRE is a non-invasive, rapid, and highly accurate tool for predicting PH. This indicates that the use of 3D-MR elastography can provide more personalized evaluation and better medical experience for patients with cirrhosis.

## **R6-SSGI19- Practical Application of Multivendor MRI-based R2\* Mapping for Liver Iron Quantification at 1.5T and 3.0T**

Gregory Simchick, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To determine the practical applicability of MRI vendor-provided R2\* maps for liver iron concentration (LIC) quantification.

## **METHODS AND MATERIALS**

In this prospective study, participants with suspected iron overload were recruited at four academic medical centers. Each participant underwent MRI of the liver at 1.5T and 3.0T using clinical MRI systems from one of three vendors (GE Healthcare, Philips Healthcare, and Siemens Healthineers). At each field strength, 3D multiecho gradient echo data were acquired for R2\* mapping. A standardized 2D multiecho single spin-echo acquisition was performed at 1.5T to obtain reference LIC measurements using an FDA-approved LIC estimation algorithm (FerriScan, Resonance Health). Recent multicenter, multivendor R2\* versus LIC linear calibrations with wide dynamic LIC ranges have been published (i.e., MCMV calibrations). However, the MCMV calibrations were derived using a non-commercial, centralized R2\* reconstruction, and their applicability with vendor-provided R2\* maps remains unknown. R2\* ranges of agreement comparing the centralized and vendor reconstructions were determined by evaluating coefficient of variation as a function of vendor R2\* range. Within the determined R2\* ranges of agreement, R2\*-LIC linear calibrations were derived for each site, field strength, and reconstruction. Calibrations were compared using F tests and multiple comparison testing.

## **RESULTS**

207 participants (mean age  $37.6 \pm 19.6$  [SD] years; 117 male and 90 female) were recruited. R2\* ranges of agreement were determined with upper limits of approximately 500, 375, and 330 s<sup>-1</sup> (corresponding to LICs of approximately 12.9, 9.6, and 8.4 mg/g [Fe/dry tissue]) for the GE, Philips, and Siemens reconstructions, respectively, at 1.5T and approximately 700 and 800 s<sup>-1</sup> (corresponding to LICs of approximately 9.4 and 10.8 mg/g) for GE and Philips, respectively, at 3.0T. Within the R2\* ranges of agreement, no significant differences were observed in the R2\*-LIC calibrations when comparing across all sites and reconstructions ( $p = 0.06$ ) or when comparing the calibrations pairwise ( $p = 0.24$ ). Joint (including all sites) vendor R2\*-LIC calibrations ( $LIC = 0.0256 R2^* - 0.02$  mg/g and  $LIC = 0.0137 R2^* + 0.06$  mg/g at 1.5T and 3.0T, respectively) agreed with the MCMV calibrations.

## **CONCLUSION**

R2\* measurements obtained from vendor-provided R2\* maps can be reliably and practically used with the published MCMV calibrations to quantify LIC less than approximately 8.4-12.9 mg/g [Fe/dry tissue].

## **CLINICAL RELEVANCE/APPLICATION**

This work may facilitate widespread clinical dissemination of R2\*-based LIC quantification over a range of LIC values that cover the optimal range for chelation therapy, thereby reducing the need to perform liver biopsy.

## **R6-SSGI19- Identification of Super-high-risk Group for Developing Hepatocellular Carcinoma in Ultrasound Surveillance**

Yeun-Yoon Kim, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To develop and validate a model to predict super-high-risk group of incident hepatocellular carcinoma (HCC) in patients with chronic hepatitis B or C under ultrasound (US) surveillance who are potentially eligible for surveillance with alternative imaging modality.

## **METHODS AND MATERIALS**

This retrospective study included 17,557 treatment-naïve patients with chronic hepatitis B or C from three institutions who underwent US surveillance for HCC between 2005 and 2015. All patients were in Child-Pugh class A, and aged 40 to 75 years.

For model establishment, 11,311 patients from one institution were identified, and randomly assigned to development (n = 7,918) or internal validation (n = 3,393) datasets. In the development dataset, clinical characteristics and US features (presence of cirrhosis, fatty liver, splenomegaly, ascites and cirrhotic nodules) were recorded based on the review of electronic medical chart. Significant factors were identified by multivariable Cox regression analysis, and the prediction model was established. The model performance was compared to existing HCC development risk models in validation dataset (n = 3,393) and test dataset from two other institutions (n = 6,246).

## **RESULTS**

The 5-year cumulative incidence rates of HCC were 7.6%, 7.4% and 4.3% in the development, validation, and external test datasets, respectively. Multivariable Cox regression revealed that age, sex, diabetes mellitus, serum albumin and alanine aminotransferase levels, platelet counts, cirrhotic parenchymal echotexture on US, and multiple cirrhotic nodules on US were independently associated with HCC risk. Using a cut-off for annual HCC incidence rate of 2.5% or higher, the 5-year cumulative HCC incidence rates in the validation and external test datasets were 24.1% and 15.5%, respectively. The Uno concordance index was significantly higher than those of aMAP, THRI, ADDRESS-HCC, Velazquez score index, and modified PAGE-B in the validation dataset (0.747 vs. 0.686, 0.662, 0.584, 0.582, and 0.668, respectively; all P <0.001) and external test dataset (0.791 vs. 0.740, 0.668, 0.658, 0.650, and 0.740, respectively; all P <0.001).

## **CONCLUSION**

Our model integrating clinical and surveillance US features was useful to discriminate the super-high-risk group for HCC in chronic hepatitis B or C, and showed superior performance than previously reported risk scoring systems. Alternative surveillance imaging modality may be considered in the super-high-risk group to facilitate early detection of HCC.

## **CLINICAL RELEVANCE/APPLICATION**

Given that the use of alternative imaging modality is limited in HCC surveillance, our prediction model would help focus on super-high-risk group for developing HCC, and potentially individualize surveillance imaging modality.

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## Abstract Archives of the RSNA, 2023

R6-SSGI19-1

### Noninvasive Quantification of Hepatic Steatosis using Ultrasound-derived Fat Fraction with MRI-derived Proton Density Fat Fraction as the Reference Standard (CHESS 2303): A Multicenter Prospective Study

Thursday, Nov. 30 1:30PM - 2:30PM Room: E352

Yi Dong, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To prospectively assess the role of ultrasound-derived fat fraction (UDFF) in the detection of hepatic steatosis using MRI-derived proton density fat fraction (PDFF) as the reference standard.

#### METHODS AND MATERIALS

Participants with or suspected of having nonalcoholic fatty liver disease (NAFLD) were prospectively recruited by an international multicenter between January 2023 to April 2023. All participants underwent UDFF and MRI-derived PDFF measurements on the same day. Demographic, clinical, and laboratory data were gathered. An MRI-derived PDFF cutoff of 5 % was used for the definition of NAFLD. The correlation between UDFF (%) and MRI-derived PDFF (%) was calculated using the Pearson correlation coefficient. The area under the receiver operating characteristic curve (AUC) was calculated to assess the accuracy of UDFF in the diagnosis of hepatic steatosis.

#### RESULTS

A total of 113 participants were included: 46.0 % (52/113) were male, mean age was 45 years  $\pm$  12 (SD); mean body mass index was 25.5 kg/m<sup>2</sup>  $\pm$  4.2 (SD); median alanine aminotransferase was 21.0 IU/L (IQR: 15.3, 34.8), median aspartate aminotransferase was 20.0 IU/L (IQR: 16.0, 27.0), median albumin was 4.6 md/dL (IQR: 4.3, 4.9), median total bilirubin was 1.1 md/dL (IQR: 0.8, 1.4), median prothrombin time international normalized ratio was 1.0 (IQR: 0.9, 1.0), and median platelet was 227.0 $\times$ 10<sup>9</sup>/L (IQR: 188.0, 258.8). Overall, 34.5 % (39/113) had type 2 diabetes mellitus, and 67.3 % (76/113) had NAFLD (MRI-derived PDFF of 5% or more). The median UDFF was 9.2 % (IQR: 4.8, 15.2). The Pearson correlation coefficient between UDFF and MRI-derived PDFF was good ( $r = 0.764$ ,  $P < 0.001$ ). Using MRI-derived PDFF as a reference, UDFF had good accuracy for the diagnosis of NAFLD (AUC was 0.865 [95 % CI: 0.797, 0.932], with a sensitivity of 67.1 %, and a specificity of 89.2 %). The interobserver agreement of UDFF was excellent (ICC = 0.948,  $P < 0.001$ ). The intraobserver agreement of UDFF was excellent (ICC = 0.904-0.969,  $P < 0.001$ ).

#### CONCLUSION

The UDFF was useful for assessing hepatic steatosis when using MRI-derived PDFF as the reference standard.

#### CLINICAL RELEVANCE/APPLICATION

This multicenter prospective study highlights the practicality of ultrasound-derived fat fraction as a potential alternative tool for magnetic resonance imaging for detecting nonalcoholic fatty liver disease.

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## Abstract Archives of the RSNA, 2023

R6-SSGI19-2

### **Disease Progression and Tissue Inhomogeneity affect Fibrosis Staging Discordance between Hepatic MRE and Liver Biopsy in Nonalcoholic Fatty Liver Disease**

Thursday, Nov. 30 1:30PM - 2:30PM Room: E352

Yiyang Sheng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In this study, our objective is to investigate the hypothesis that discrepancies between MR elastography (MRE) based fibrosis staging and biopsy staging may be linked to the heterogeneity of liver tissue that develops during chronic liver diseases (CLD) and is associated with other histopathological characteristics.

#### **METHODS AND MATERIALS**

In this retrospective study, we analyzed 3D vector MRE exams from 175 individual patients with diagnosed nonalcoholic fatty liver disease (NAFLD) who underwent MRE and liver biopsy exams between Oct.2015 and Oct. 2021 (227 total data sets). First, we determined the MRE diagnostic stage using the Youden Index, and calculated the discordance between MRE and biopsy-based fibrosis stages. Then, we performed feature extraction on pixel-wise liver stiffness (LS) measurements, including histogram-based distribution features and position-based shape features(129 total features).. Next, we employed multivariate logistic regression with lasso regularization and correlation analysis to identify independent features contributing to the discordance in fibrosis staging. Finally, we examined the associations between inhomogeneity features and NAFLD progression, as assessed by MRI-assessed proton-density fat fraction (PDFF) and MRE-assessed mean LS.

#### **RESULTS**

The top six features impacting the discordance in fibrosis staging, ordered from high to low normalized impact, were ballooning, PDFF, sex, maximum 2D diameter, gray-level run length matrix (GLRLM) run variance, and minimum LS. Using logistic regression that incorporated these six features, we were able to differentiate discordant cases with an overall accuracy of 0.83, based on a train-to-test ratio of 7:3. We observed that elevated ballooning grade, increased PDFF, male sex, and high minimum LS were associated with increased values of pixel-wise high-rank features metrics (maximum 2D diameter, GLRLM run variance). Steatosis and ballooning may be the primary drivers in more discordant cases, while pixel-wise high-rank features metrics might represent secondary factors related to these primary drivers.

#### **CONCLUSION**

This study highlights that ballooning and steatosis (PDFF) are the two most significant factors leading to discordant readings between MRE and biopsy in fibrosis staging. The discordance may stem from subjective histologic staging influenced by steatosis and ballooning, or it could result from histogram and position-related inhomogeneity caused by these primary factors.

#### **CLINICAL RELEVANCE/APPLICATION**

Findings highlight the importance of factors like PDFF, ballooning in NAFLD diagnosis monitoring. MRE is a reliable substitute of biopsy in cases with mild steatosis and ballooning, serving as a high-value screening tool.

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## Abstract Archives of the RSNA, 2023

R6-SSGI19-4

### Three-Dimensional MR Elastography Identifies Portal Hypertension in Cirrhosis: A Prospective Multicenter Study

Thursday, Nov. 30 1:30PM - 2:30PM Room: E352

Yu Shi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a non-invasive multivariate models based on Three-dimensional MR elastography (3D-MRE) to determine portal hypertension (PH), particularly to diagnose clinically significant portal hypertension (CSPH, HVPG>10mmHg) and severe portal hypertension (SPH, HVPG>12mmHg), using HVPG as the gold standard.

#### METHODS AND MATERIALS

This prospective, multicenter study enrolled patients with cirrhosis scheduled for HVPG, and who intended to undergo MR imaging (including 3D-MRE and diffusion-, T1-, and T2-weighted imaging) before the HVPG procedure. A total of 57 patients were recruited from five institutions. Multiple viscoelastic parameters of the liver and spleen, as well as shear stiffness (SS) ratios and subtraction values, were evaluated independently by two radiologists. Univariable and multivariable linear regression analyses were conducted to assess the associations between mechanical parameters and HVPG. Univariable and multivariable logistic regression analyses were used to predict CSPH and SPH, respectively.

#### RESULTS

HVPG showed the strongest positive correlation with splenic SS at 60Hz ( $r = 0.785$ ;  $P < .001$ ), followed by hepatic SS at 30Hz ( $r = 0.631$ ;  $P < .001$ ), splenic SS at 30Hz ( $r = 0.612$ ;  $P < .001$ ), hepatic SS at 60Hz ( $r = 0.547$ ;  $P < .001$ ). Multivariable linear regression analysis showed splenic SS at 60Hz ( $\beta = 1.017$ ; 95% CI: 0.71, 1.325;  $P < .001$ ), liver SS ratio ( $\beta = -2.359$ ; 95% CI: -4.477, -0.241;  $P = .03$ ), and liver stiffness difference ( $\beta = 1.169$ ; 95% CI: 0.251, 2.087;  $P = .001$ ) was the independent factors determining HVPG. Approximately 56.5% of the total variability in HVPG was explained by these 3 variables (adjusted  $R^2 = 0.565$ ). Logistic regression analysis showed splenic SS at 60Hz (OR = 2.217 [95% CI: 1.292, 3.803];  $P = 0.004$ ) and liver SS at 30Hz (OR = 6.211 [95% CI: 1.218, 31.669];  $P = 0.028$ ) were independently associated with CSPH, establishing a model with excellent performance in diagnosing CSPH (area under the receiver operating characteristic curve [AUC], 0.975 [95% CI: 0.79, 0.99]). As for SPH, it showed splenic SS at 60Hz (OR = 1.65 [95% CI: 1.25, 2.16];  $P = .001$ ) were independently associated with HVPG, also with better performance (AUC, 0.969 [95% CI: 0.81, 0.98]).

#### CONCLUSION

3D-MRE with dual frequencies is a very promising method in both predicting HVPG and diagnosing the presence CSPH and SPH. Splenic stiffness at 60Hz, combining liver stiffness ratio (60Hz/30Hz) and differences (60Hz-30Hz), was the independent parameters associating HVPG.

#### CLINICAL RELEVANCE/APPLICATION

3D-MRE is a non-invasive, rapid, and highly accurate tool for predicting PH. This indicates that the use of 3D-MR elastography can provide more personalized evaluation and better medical experience for patients with cirrhosis.

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## Abstract Archives of the RSNA, 2023

R6-SSGI19-5

### Practical Application of Multivendor MRI-based R2\* Mapping for Liver Iron Quantification at 1.5T and 3.0T

Thursday, Nov. 30 1:30PM - 2:30PM Room: E352

Gregory Simchick, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the practical applicability of MRI vendor-provided R2\* maps for liver iron concentration (LIC) quantification.

#### METHODS AND MATERIALS

In this prospective study, participants with suspected iron overload were recruited at four academic medical centers. Each participant underwent MRI of the liver at 1.5T and 3.0T using clinical MRI systems from one of three vendors (GE Healthcare, Philips Healthcare, and Siemens Healthineers). At each field strength, 3D multiecho gradient echo data were acquired for R2\* mapping. A standardized 2D multiecho single spin-echo acquisition was performed at 1.5T to obtain reference LIC measurements using an FDA-approved LIC estimation algorithm (FerriScan, Resonance Health). Recent multicenter, multivendor R2\* versus LIC linear calibrations with wide dynamic LIC ranges have been published (i.e., MCMV calibrations). However, the MCMV calibrations were derived using a non-commercial, centralized R2\* reconstruction, and their applicability with vendor-provided R2\* maps remains unknown. R2\* ranges of agreement comparing the centralized and vendor reconstructions were determined by evaluating coefficient of variation as a function of vendor R2\* range. Within the determined R2\* ranges of agreement, R2\*-LIC linear calibrations were derived for each site, field strength, and reconstruction. Calibrations were compared using F tests and multiple comparison testing.

#### RESULTS

207 participants (mean age  $37.6 \pm 19.6$  [SD] years; 117 male and 90 female) were recruited. R2\* ranges of agreement were determined with upper limits of approximately 500, 375, and 330 s<sup>-1</sup> (corresponding to LICs of approximately 12.9, 9.6, and 8.4 mg/g [Fe/dry tissue]) for the GE, Philips, and Siemens reconstructions, respectively, at 1.5T and approximately 700 and 800 s<sup>-1</sup> (corresponding to LICs of approximately 9.4 and 10.8 mg/g) for GE and Philips, respectively, at 3.0T. Within the R2\* ranges of agreement, no significant differences were observed in the R2\*-LIC calibrations when comparing across all sites and reconstructions ( $p = 0.06$ ) or when comparing the calibrations pairwise ( $p = 0.24$ ). Joint (including all sites) vendor R2\*-LIC calibrations ( $LIC = 0.0256 R2^* - 0.02$  mg/g and  $LIC = 0.0137 R2^* + 0.06$  mg/g at 1.5T and 3.0T, respectively) agreed with the MCMV calibrations.

#### CONCLUSION

R2\* measurements obtained from vendor-provided R2\* maps can be reliably and practically used with the published MCMV calibrations to quantify LIC less than approximately 8.4-12.9 mg/g [Fe/dry tissue].

#### CLINICAL RELEVANCE/APPLICATION

This work may facilitate widespread clinical dissemination of R2\*-based LIC quantification over a range of LIC values that cover the optimal range for chelation therapy, thereby reducing the need to perform liver biopsy.

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## Abstract Archives of the RSNA, 2023

R6-SSGI19-6

### Identification of Super-high-risk Group for Developing Hepatocellular Carcinoma in Ultrasound Surveillance

Thursday, Nov. 30 1:30PM - 2:30PM Room: E352

Yeun-Yoon Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a model to predict super-high-risk group of incident hepatocellular carcinoma (HCC) in patients with chronic hepatitis B or C under ultrasound (US) surveillance who are potentially eligible for surveillance with alternative imaging modality.

#### METHODS AND MATERIALS

This retrospective study included 17,557 treatment-naïve patients with chronic hepatitis B or C from three institutions who underwent US surveillance for HCC between 2005 and 2015. All patients were in Child-Pugh class A, and aged 40 to 75 years. For model establishment, 11,311 patients from one institution were identified, and randomly assigned to development (n = 7,918) or internal validation (n = 3,393) datasets. In the development dataset, clinical characteristics and US features (presence of cirrhosis, fatty liver, splenomegaly, ascites and cirrhotic nodules) were recorded based on the review of electronic medical chart. Significant factors were identified by multivariable Cox regression analysis, and the prediction model was established. The model performance was compared to existing HCC development risk models in validation dataset (n = 3,393) and test dataset from two other institutions (n = 6,246).

#### RESULTS

The 5-year cumulative incidence rates of HCC were 7.6%, 7.4% and 4.3% in the development, validation, and external test datasets, respectively. Multivariable Cox regression revealed that age, sex, diabetes mellitus, serum albumin and alanine aminotransferase levels, platelet counts, cirrhotic parenchymal echotexture on US, and multiple cirrhotic nodules on US were independently associated with HCC risk. Using a cut-off for annual HCC incidence rate of 2.5% or higher, the 5-year cumulative HCC incidence rates in the validation and external test datasets were 24.1% and 15.5%, respectively. The Uno concordance index was significantly higher than those of aMAP, THRI, ADDRESS-HCC, Velazquez score index, and modified PAGE-B in the validation dataset (0.747 vs. 0.686, 0.662, 0.584, 0.582, and 0.668, respectively; all P <0.001) and external test dataset (0.791 vs. 0.740, 0.668, 0.658, 0.650, and 0.740, respectively; all P <0.001).

#### CONCLUSION

Our model integrating clinical and surveillance US features was useful to discriminate the super-high-risk group for HCC in chronic hepatitis B or C, and showed superior performance than previously reported risk scoring systems. Alternative surveillance imaging modality may be considered in the super-high-risk group to facilitate early detection of HCC.

#### CLINICAL RELEVANCE/APPLICATION

Given that the use of alternative imaging modality is limited in HCC surveillance, our prediction model would help focus on super-high-risk group for developing HCC, and potentially individualize surveillance imaging modality.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGI20

### Gastrointestinal Imaging (Bowel)

Thursday, Nov. 30 1:30PM - 2:30PM Room: E351

Nancy A. Hammond, MD (*Moderator*) Nothing to Disclose  
Kevin J. Chang, MD (*Moderator*) Speaker, RELX; Speaker, Koninklijke Philips NV

#### Sub-Events

### **R6-SSGI20- Income, Racial/Ethnic, and Urbanicity Differences for Screening CT Colonography Use 1 Among Medicare Beneficiaries**

Eric W. Christensen, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Colorectal cancer (CRC) screening is associated with reduced mortality, yet almost one-third of the U.S. population is not current with CRC screening guidelines. These guidelines include various screening strategies, with multiple options being provided to increase the adherence to these guidelines. Of these screening strategies, the Centers for Medicare and Medicaid Services provides reimbursement for all except CT colonography (CTC). Given these reimbursement differences, the purpose is to examine the association of income, racial/ethnic, and urbanicity differences in the use of CTC relative to other CRC screening strategies.

#### METHODS AND MATERIALS

This was a multiyear (January 2011 to December 2020) retrospective study of individuals aged 45-85 years with Medicare fee-for-service insurance. Data were obtained using a 5% research identifiable sample of all Medicare fee-for-service beneficiaries. Income, racial/ethnic, and urbanicity differences for screening CTC use were assessed with multivariable logistic regression and adjusted for sex, age, race/ethnicity, Charlson comorbidity index, year, and related conditions. Like logistic regressions models were estimated for other CRC screening strategies.

#### RESULTS

Between 2011 and 2020, there were 10,027,439 beneficiary years (mean age, 69.8 +/- 8.2 [SD]). The odds ratio (OR) of beneficiaries residing in communities with a per capita income of \$100,000 or more having a screening CTC was 6.06 (95%CI: 3.96, 9.27) compared with those residing in communities with a per capita income of less than \$25,000. The like odds for other CRC screening strategies were 1.35 (95%CI: 1.30, 1.39) for optical colonoscopy, 1.01 (95%CI: 0.67, 1.54) for sigmoidoscopy, 1.44 (95%CI: 1.42, 1.46) for guaiac fecal-occult blood test/fecal immunochemical test, and 1.32 (95%CI: 1.26, 1.37) for stool DNA..

#### CONCLUSION

While higher income was associated with higher odds for most screening strategies, the positive income effect was many orders of magnitude larger for screening CTC. The lack of reimbursement for screening CTC may be associated with income-based access differences.

#### CLINICAL RELEVANCE/APPLICATION

Among the CRC screening strategies, optical colonoscopy offers higher detection sensitivity and allows for lesion biopsy or resection, but it is the most invasive, which for some individuals, may hinder compliance with the CRC screening guidelines. Hence, while optical colonoscopy is the gold standard, if some individuals are reluctant to undergo it due to its invasiveness, the need for anesthesia, or risk of complications, reimbursement for CTC may be beneficial if it increases compliance with screening guidelines.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGI20-1

### Income, Racial/Ethnic, and Urbanicity Differences for Screening CT Colonography Use Among Medicare Beneficiaries

Thursday, Nov. 30 1:30PM - 2:30PM Room: E351

Eric W. Christensen, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Colorectal cancer (CRC) screening is associated with reduced mortality, yet almost one-third of the U.S. population is not current with CRC screening guidelines. These guidelines include various screening strategies, with multiple options being provided to increase the adherence to these guidelines. Of these screening strategies, the Centers for Medicare and Medicaid Services provides reimbursement for all except CT colonography (CTC). Given these reimbursement differences, the purpose is to examine the association of income, racial/ethnic, and urbanicity differences in the use of CTC relative to other CRC screening strategies.

#### METHODS AND MATERIALS

This was a multiyear (January 2011 to December 2020) retrospective study of individuals aged 45-85 years with Medicare fee-for-service insurance. Data were obtained using a 5% research identifiable sample of all Medicare fee-for-service beneficiaries. Income, racial/ethnic, and urbanicity differences for screening CTC use were assessed with multivariable logistic regression and adjusted for sex, age, race/ethnicity, Charlson comorbidity index, year, and related conditions. Like logistic regressions models were estimated for other CRC screening strategies.

#### RESULTS

Between 2011 and 2020, there were 10,027,439 beneficiary years (mean age, 69.8 +/- 8.2 [SD]). The odds ratio (OR) of beneficiaries residing in communities with a per capita income of \$100,000 or more having a screening CTC was 6.06 (95%CI: 3.96, 9.27) compared with those residing in communities with a per capita income of less than \$25,000. The like odds for other CRC screening strategies were 1.35 (95%CI: 1.30, 1.39) for optical colonoscopy, 1.01 (95%CI: 0.67, 1.54) for sigmoidoscopy, 1.44 (95%CI: 1.42, 1.46) for guaiac fecal-occult blood test/fecal immunochemical test, and 1.32 (95%CI: 1.26, 1.37) for stool DNA..

#### CONCLUSION

While higher income was associated with higher odds for most screening strategies, the positive income effect was many orders of magnitude larger for screening CTC. The lack of reimbursement for screening CTC may be associated with income-based access differences.

#### CLINICAL RELEVANCE/APPLICATION

Among the CRC screening strategies, optical colonoscopy offers higher detection sensitivity and allows for lesion biopsy or resection, but it is the most invasive, which for some individuals, may hinder compliance with the CRC screening guidelines. Hence, while optical colonoscopy is the gold standard, if some individuals are reluctant to undergo it due to its invasiveness, the need for anesthesia, or risk of complications, reimbursement for CTC may be beneficial if it increases compliance with screening guidelines.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGU07

### Genitourinary Imaging (Emerging AI Applications in Genitourinary Imaging)

Thursday, Nov. 30 1:30PM - 2:30PM Room: S502

Ashkan A. Malayeri, MD (*Moderator*) Nothing to Disclose  
Bhavik N. Patel, MD, MBA (*Moderator*) Nothing to Disclose

#### Sub-Events

#### R6-SSGU07-1 **Spatial Characterization of Multiparametric MRI Performance using a Standardized Prostate Segmentation Model**

Sohaib Naim, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to evaluate the performance of multiparametric MRI (mpMRI) to accurately detect clinically significant prostate cancer (csPCa) lesions through spatial characterization across different regions within the prostate gland.

#### METHODS AND MATERIALS

Our HIPAA-compliant, IRB-approved study group consisted of 1,143 consecutive men at our single institution that underwent mpMRI prior to radical prostatectomy between 2010 and 2022. Genitourinary (GU) radiologists and GU pathologists performed matching workflows with the prostate sector map model to identify true positive (TP), false negative (FN), and false positive (FP) lesions for all subjects. All TP, FN, and FP lesions were used to illustrate cancer prevalence (CP), detection rate (DR), and positive predictive values (PPV), each of which was sorted within a standardized prostate segmentation model, the prostate sector map. Using a weighted chi-square test we correlated statistical differences for DR and PPV for sectors established within the transition zone (TZ) vs. peripheral zone (PZ), anterior vs. posterior, base-gland (Base) vs. mid-gland (Mid) vs. apex-gland (Apex), and left vs. right prostate.

#### RESULTS

Our findings are presented across different sector regions for both DR and PPV. From our 1,143 subject cohort, we identified 2,152 PCa lesions, of which 1060 were csPCa lesions. We analyzed differences by stratifying laterality, anterior vs. posterior, and Base, Mid, and Apex levels within TZ and PZ. Our statistical findings show a significantly lower DR for the anterior vs. posterior regions (67.3% vs. 75.6%;  $p < 0.001$ ) for PZ sectors as well as right vs. left hemispheres (69.4% vs. 75.7%;  $p < 0.05$ ) for TZ sectors. We also identify a significantly lower DR in the Apex region vs. Base and Mid regions (71.5%;  $p < 0.01$ ). For our statistical findings with lower PPV values, we observe a significantly lower PPV for TZ vs. PZ sectors (75.8% vs. 82.4%;  $p < 0.001$ ) and the Base region vs. Mid and Apex regions (77.1%;  $p < 0.01$ ) for PZ sectors. These findings inform us how underdiagnosis occurs for lesions within anterior and Apex regions for PZ sectors, and often overdiagnoses occur for lesions which classify under PZ sectors in the Base region.

#### CONCLUSION

From 1,143 subjects, we identified significantly lower DRs for lesions in the anterior and apex regions of the prostate within PZ, along with significantly lower PPVs in the base prostate region and TZ compared to PZ. These findings, indicate that further attention to these locations would better resolve these shortcomings and benefit PCa diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

Spatial-based mpMRI performance in detecting lesions can improve the identification of prostate cancer and reduce the need for biopsies in at-risk men.

#### R6-SSGU07-2 **Equivalence of nnU-Net Based and Manual T-index for Assessing Surgical Difficulty in Patients with Small Renal Mass**

Dongkyu An, MD (*Presenter*) Nothing to Disclose



## PURPOSE

We proposed a novel nephrometry index called T-index for small renal mass based on three-dimensional topology, which represents the degree of intraparenchymal extension and peripherality of the renal cell carcinoma (RCC). Despite the usefulness of the novel nephrometry index predicting the difficulty of the partial nephrectomy (PNx), some opinions suggested that it might be difficult to apply clinically due to the time-consuming manual segmentation process of extracting the values. To overcome this limitation, we aimed to demonstrate the equivalent performance of the automatically extracted T-index based on nnU-Net, a deep-learning based segmentation program, compared to the manually extracted one.

## METHODS AND MATERIALS

This retrospective, single-center study included 215 patients who underwent PNx for clear cell RCC (less than 5cm) between September 2007 and December 2019. Then, 125 cases were sorted as a training set for nnU-Net to label the kidney, tumor and renal sinus. The rest of 90 cases were sorted as a test set for the automatic segmentation. T-index was calculated by adding up the reciprocals of the distances from all points on the tumor-parenchyma and tumor-sinus (if tumor invades renal sinus) interface to renal sinus. The intraclass correlation coefficient between manually (mT-index) and automatically extracted T-index (auT-index) was measured. Spearman's correlation and logistic regression were used to analyze the efficacy of T-index.

## RESULTS

The mean±SD of mT-index and auT-index for the 90 patients in the test set was 117.30±101.24 and 105.23±95.71 (1/mm), respectively. T-index showed an excellent intraclass correlation coefficient (0.970, 95% confidence interval 0.928-0.985) regardless of its extracting methods. Also, T-index showed a significant correlation with perioperative factors reflecting surgical difficulty, regardless of the extracting methods: immediate postoperative creatinine difference (mT-index  $r=0.343$ ;  $p=0.001$ , auT-index  $r=0.331$ ;  $p=0.0015$ ) and warm ischemia time (mT-index  $r=0.615$ ;  $p<0.001$ , auT-index  $r=0.624$ ;  $p<0.001$ ). In the entire patient population, the T-index significantly predicted the immediate post-operative complications compared to preexisting nephrometry indices, and these results were consistent with our previous study.

## CONCLUSION

auT-index extracted from the nnU-Net based segmentation showed an excellent correlation and equivalent performance of predicting surgical difficulty and post-operative complications in PNx compared to the manually extracted one.

## CLINICAL RELEVANCE/APPLICATION

Using an automatically extracted T-index could be a reliable method for preoperative prediction of prognosis in PNx without requiring labor-intensive manual processes by experts.

## R6-SSGU07-4 Deep Learning based on ResNet-18 for Intelligent Classification of PI-RADS 3 Lesions

Liang Wang (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the intelligent classification and prediction efficacy of deep learning model for benign prostate lesions, non-clinically significant prostate cancer (non-csPCa) and clinically significant prostate cancer (csPCa) in PI-RADS 3 lesions.

## METHODS AND MATERIALS

From January 2015 to December 2021, lesions diagnosed with PI-RADS 3 by multi-parametric MRI or bi-parametric MRI were retrospectively included. They were classified as benign, non-csPCa, and csPCa according to the pathologic results of biopsy, transurethral resection or radical prostatectomy specimens. T2WI images of the lesions were saved in JPEG format and were divided into a training set and a test set according to 8:2. The preprocessing of the training set included scaling, clipping, image enhancement, tensor conversion and normalization. The preprocessing of the test set included scaling, clipping, tensor conversion and normalization. ResNet-18 architecture was used for model training, and all layers were trained. The GPU used was Tesla T4 and the computing device architecture version was v11.2. All statistical analyses were performed using Python open-source libraries such as numpy, pandas, matplotlib, seaborn, plotly requests, tqdm, opencv-python, pillow, wandb, etc. The trained model was saved as pth file and evaluated in the test set. The receiver operating curve was used to evaluate the predictive effectiveness of the model. t-NSE was used for image semantic feature visualization. The class activation mapping was used to visualize the area focused by the model.

## RESULTS

A total of 428 benign prostate lesion images, 158 non-csPCa images and 273 csPCa images were included. 685 images were used for training and 169 images for testing. The best accuracy of the model in test set was 0.787. The precision in predicting benign prostate disease, non-csPCa and csPCa were 0.882, 0.681 and 0.851, and the area under ROC curve were 0.875, 0.89 and 0.929, respectively. Semantic feature analysis shows strong classification separability between csPCa and benign diseases. The class activation map shows that the deep learning model can focus on the area of the prostate or the location of PI-RADS 3 lesions.



## CONCLUSION

Deep learning model based on ResNet-18 architecture can realize intelligent classification of PI-RADS 3 lesions.

## CLINICAL RELEVANCE/APPLICATION

Deep learning based on ResNet-18 network provides a new method and basis for accurately classifying ambiguous PI-RADS 3 lesions and is helpful for formulating management strategies for PI-RADS 3 lesions.

### R6-SSGU07-5 **Using 3D Swin UnetR Architecture and 3D Hinge Forest Architecture for Automatically Segmenting all Subtypes of Renal Cell Masses, Kidney, and Cysts on MRI**

Pouria Yazdian, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study explores the potential of convolutional neural networks (CNN) for automating renal cell carcinoma (RCC) mass, cyst, and healthy kidney tissue segmentation, addressing the time-consuming manual segmentation process traditionally performed by expert radiologists.

## METHODS AND MATERIALS

We utilized a retrospectively maintained dataset consisting of 326 patients, 1034 complex masses (approximately three tumors per kidney), and 2171 cysts. All patients underwent an MRI between 2015 and 2021, with surgically removed tumors being pathologically confirmed. Lesions were manually segmented using ITK-SNAP on the excretory phase of MRI and co-registered on all other contrast-enhanced T1 sequences (pre-, arterial, and venous). The patient population was randomly divided into training (65%), testing (25%), and validation (10%) groups, stratified by tumor count, pathology, tumor volume, and kidney size. We trained ten benchmark models using 3D SwinUNETR and a differentiable decision forest, Hinge Forest, to segment lesions and kidney tissue, evaluating their performance with the Dice Similarity Coefficient (DSC) score.

## RESULTS

The best 3D Swin UnetR models achieved DSC scores of 0.81 for AML, 0.89 for chromophobe, 0.54 for ccRCC, 0.48 for HLRCC, 0.77 for hybrid, 0.71 for oncocytoma, 0.76 for papillary, 0.94 for kidney, and 0.48 for cysts. Overall performance of all the 10 benchmarked test sets was  $0.55 \pm 0.21$  for Swin UnetR tumor segmentation. The best 3D HF model scored 0.65 for AML, 0.72 for chromophobe, 0.50 for ccRCC, 0.46 for HLRCC, 0.65 for hybrid, 0.72 for oncocytoma, 0.65 for papillary, 0.92 for kidney, and 0.4 for cysts. Overall performance of all the 10 benchmarked test sets was  $0.51 \pm 0.8$  tumor segmentation.

## CONCLUSION

Advanced CNN architectures, such as 3D SwinUNET and hinge forest, show promise for automating renal mass subtypes, cyst, and kidney tissue segmentation on MRI. The 3D SwinUNET outperformed the 3D HF model, potentially reducing radiologist workload and enhancing diagnostic accuracy. Future research should refine these models, investigate their clinical application, and externally validate them for improving patient care.

## CLINICAL RELEVANCE/APPLICATION

This study highlights the potential of advanced CNN architectures to revolutionize renal cancer diagnosis by automating RCC subtype, cyst, and kidney tissue segmentation on MRI, potentially reducing radiologist workload, improving diagnostic accuracy, and facilitating efficient treatment planning.

### R6-SSGU07-6 **A Multicenter Validation of Prediction Uncertainty to Triage Patients for Prostate Cancer AI Diagnosis**

Stefan J. Fransen, MSc (*Presenter*) Grant, Siemens AG; Grant, Health~Holland

## PURPOSE

AI prediction uncertainty can identify cases at risk of AI failure, enabling reliable automatic AI triaging. This study validates an uncertainty-based triage for prostate cancer patients, to improve diagnostic accuracy of AI and improve the clinical workflow.

## METHODS AND MATERIALS

A multi-center dataset of patients undergoing MRI triage for prostate cancer and an existing state-of-the-art AI algorithm for prostate cancer detection was used. The algorithm was previously trained on 7756 prostate bpMRI examinations (T2, ADC, and high b-value DWI) from Institute A (Siemens scanner) and provides 15 heatmaps with voxel-level likelihoods of malignant tissues (PIRADS=4). The trained algorithm was used to predict 561 unseen cases from Institute B (Philips scanner) and 200 unseen cases from Institute C (Siemens scanner). The variability in patient-level likelihood scores was used to measure prediction uncertainty. Predictions with a low variability were considered certain whereas predictions with a high variability were considered uncertain, at risk of AI failure. Multiple splits (20%, 40%, 60%, and 80%) were used to make certain and uncertain groups. The ability of AI to triage patients was assessed by comparing the AUROC of certain cases with

uncertain cases. Furthermore, a comparison was made with the radiologist by comparing the true positive rate (TPR) of certain cases and the TPR of the radiologist at the false positive rate (FPR) operating point of the radiologist. Statistical significance was assessed by using DeLong's test.

## **RESULTS**

AUROC of AI prediction was significantly higher for certain cases compared to uncertain cases, in both test sets up to 40% AI diagnosis ( $p < 0.05$ ). The highest AI performance was achieved by only selecting the 20% most certain cases (0.85 AUROC Institute B, 0.97 AUROC Institute C), indicating that AI prediction with a high level of certainty is more reliable. Compared to the overall radiologist performance, the AI can predict with a higher sensitivity in 20% of the cases from institute B (0.96 vs. 0.87 TPR at 0.45 FPR) and 60% of the cases from institute C (0.98 vs. 0.96 TPR at 0.22 FPR).

## **CONCLUSION**

Prediction uncertainty can triage patients for which AI diagnosis is reliable and identify patients at risk of AI failure in external test sets including other MRI vendors. This technique could improve the clinical workflow by implementing AI diagnosis for cases with high certainty, while only redirecting patients at risk of AI failure to a radiologist worklist for reporting.

## **CLINICAL RELEVANCE/APPLICATION**

AI detection for prostate cancer approaches expert-level performance, making automatic patient triaging possible. Using AI prediction uncertainty enables a reliable selection of patients fit for AI diagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGU07-1

### Spatial Characterization of Multiparametric MRI Performance using a Standardized Prostate Segmentation Model

Thursday, Nov. 30 1:30PM - 2:30PM Room: S502

Sohaib Naim, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to evaluate the performance of multiparametric MRI (mpMRI) to accurately detect clinically significant prostate cancer (csPCa) lesions through spatial characterization across different regions within the prostate gland.

#### METHODS AND MATERIALS

Our HIPAA-compliant, IRB-approved study group consisted of 1,143 consecutive men at our single institution that underwent mpMRI prior to radical prostatectomy between 2010 and 2022. Genitourinary (GU) radiologists and GU pathologists performed matching workflows with the prostate sector map model to identify true positive (TP), false negative (FN), and false positive (FP) lesions for all subjects. All TP, FN, and FP lesions were used to illustrate cancer prevalence (CP), detection rate (DR), and positive predictive values (PPV), each of which was sorted within a standardized prostate segmentation model, the prostate sector map. Using a weighted chi-square test we correlated statistical differences for DR and PPV for sectors established within the transition zone (TZ) vs. peripheral zone (PZ), anterior vs. posterior, base-gland (Base) vs. mid-gland (Mid) vs. apex-gland (Apex), and left vs. right prostate.

#### RESULTS

Our findings are presented across different sector regions for both DR and PPV. From our 1,143 subject cohort, we identified 2,152 PCa lesions, of which 1060 were csPCa lesions. We analyzed differences by stratifying laterality, anterior vs. posterior, and Base, Mid, and Apex levels within TZ and PZ. Our statistical findings show a significantly lower DR for the anterior vs. posterior regions (67.3% vs. 75.6%;  $p < 0.001$ ) for PZ sectors as well as right vs. left hemispheres (69.4% vs. 75.7%;  $p < 0.05$ ) for TZ sectors. We also identify a significantly lower DR in the Apex region vs. Base and Mid regions (71.5%;  $p < 0.01$ ). For our statistical findings with lower PPV values, we observe a significantly lower PPV for TZ vs. PZ sectors (75.8% vs. 82.4%;  $p < 0.001$ ) and the Base region vs. Mid and Apex regions (77.1%;  $p < 0.01$ ) for PZ sectors. These findings inform us how underdiagnosis occurs for lesions within anterior and Apex regions for PZ sectors, and often overdiagnoses occur for lesions which classify under PZ sectors in the Base region.

#### CONCLUSION

From 1,143 subjects, we identified significantly lower DRs for lesions in the anterior and apex regions of the prostate within PZ, along with significantly lower PPVs in the base prostate region and TZ compared to PZ. These findings, indicate that further attention to these locations would better resolve these shortcomings and benefit PCa diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

Spatial-based mpMRI performance in detecting lesions can improve the identification of prostate cancer and reduce the need for biopsies in at-risk men.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGU07-2

### Equivalence of nnU-Net Based and Manual T-index for Assessing Surgical Difficulty in Patients with Small Renal Mass

Thursday, Nov. 30 1:30PM - 2:30PM Room: S502

Dongkyu An, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We proposed a novel nephrometry index called T-index for small renal mass based on three-dimensional topology, which represents the degree of intraparenchymal extension and peripherality of the renal cell carcinoma (RCC). Despite the usefulness of the novel nephrometry index predicting the difficulty of the partial nephrectomy (PNx), some opinions suggested that it might be difficult to apply clinically due to the time-consuming manual segmentation process of extracting the values. To overcome this limitation, we aimed to demonstrate the equivalent performance of the automatically extracted T-index based on nnU-Net, a deep-learning based segmentation program, compared to the manually extracted one.

#### METHODS AND MATERIALS

This retrospective, single-center study included 215 patients who underwent PNx for clear cell RCC (less than 5cm) between September 2007 and December 2019. Then, 125 cases were sorted as a training set for nnU-Net to label the kidney, tumor and renal sinus. The rest of 90 cases were sorted as a test set for the automatic segmentation. T-index was calculated by adding up the reciprocals of the distances from all points on the tumor-parenchyma and tumor-sinus (if tumor invades renal sinus) interface to renal sinus. The intraclass correlation coefficient between manually (mT-index) and automatically extracted T-index (auT-index) was measured. Spearman's correlation and logistic regression were used to analyze the efficacy of T-index.

#### RESULTS

The mean±SD of mT-index and auT-index for the 90 patients in the test set was 117.30±101.24 and 105.23±95.71 (1/mm), respectively. T-index showed an excellent intraclass correlation coefficient (0.970, 95% confidence interval 0.928-0.985) regardless of its extracting methods. Also, T-index showed a significant correlation with perioperative factors reflecting surgical difficulty, regardless of the extracting methods: immediate postoperative creatinine difference (mT-index  $r=0.343$ ;  $p=0.001$ , auT-index  $r=0.331$ ;  $p=0.0015$ ) and warm ischemia time (mT-index  $r=0.615$ ;  $p<0.001$ , auT-index  $r=0.624$ ;  $p<0.001$ ). In the entire patient population, the T-index significantly predicted the immediate post-operative complications compared to preexisting nephrometry indices, and these results were consistent with our previous study.

#### CONCLUSION

auT-index extracted from the nnU-Net based segmentation showed an excellent correlation and equivalent performance of predicting surgical difficulty and post-operative complications in PNx compared to the manually extracted one.

#### CLINICAL RELEVANCE/APPLICATION

Using an automatically extracted T-index could be a reliable method for preoperative prediction of prognosis in PNx without requiring labor-intensive manual processes by experts.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGU07-4

### Deep Learning based on ResNet-18 for Intelligent Classification of PI-RADS 3 Lesions

Thursday, Nov. 30 1:30PM - 2:30PM Room: S502

Liang Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the intelligent classification and prediction efficacy of deep learning model for benign prostate lesions, non-clinically significant prostate cancer (non-csPCa) and clinically significant prostate cancer (csPCa) in PI-RADS 3 lesions.

#### METHODS AND MATERIALS

From January 2015 to December 2021, lesions diagnosed with PI-RADS 3 by multi-parametric MRI or bi-parametric MRI were retrospectively included. They were classified as benign, non-csPCa, and csPCa according to the pathologic results of biopsy, transurethral resection or radical prostatectomy specimens. T2WI images of the lesions were saved in JPEG format and were divided into a training set and a test set according to 8:2. The preprocessing of the training set included scaling, clipping, image enhancement, tensor conversion and normalization. The preprocessing of the test set included scaling, clipping, tensor conversion and normalization. ResNet-18 architecture was used for model training, and all layers were trained. The GPU used was Tesla T4 and the computing device architecture version was v11.2. All statistical analyses were performed using Python open-source libraries such as numpy, pandas, matplotlib, seaborn, plotly requests, tqdm, opencv-python, pillow, wandb, etc. The trained model was saved as pth file and evaluated in the test set. The receiver operating curve was used to evaluate the predictive effectiveness of the model. t-NSE was used for image semantic feature visualization. The class activation mapping was used to visualize the area focused by the model.

#### RESULTS

A total of 428 benign prostate lesion images, 158 non-csPCa images and 273 csPCa images were included. 685 images were used for training and 169 images for testing. The best accuracy of the model in test set was 0.787. The precision in predicting benign prostate disease, non-csPCa and csPCa were 0.882, 0.681 and 0.851, and the area under ROC curve were 0.875, 0.89 and 0.929, respectively. Semantic feature analysis shows strong classification separability between csPCa and benign diseases. The class activation map shows that the deep learning model can focus on the area of the prostate or the location of PI-RADS 3 lesions.

#### CONCLUSION

Deep learning model based on ResNet-18 architecture can realize intelligent classification of PI-RADS 3 lesions.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning based on ResNet-18 network provides a new method and basis for accurately classifying ambiguous PI-RADS 3 lesions and is helpful for formulating management strategies for PI-RADS 3 lesions.

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## Abstract Archives of the RSNA, 2023

R6-SSGU07-5

### Using 3D Swin UnetR Architecture and 3D Hinge Forest Architecture for Automatically Segmenting all Subtypes of Renal Cell Masses, Kidney, and Cysts on MRI

Thursday, Nov. 30 1:30PM - 2:30PM Room: S502

Pouria Yazdian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study explores the potential of convolutional neural networks (CNN) for automating renal cell carcinoma (RCC) mass, cyst, and healthy kidney tissue segmentation, addressing the time-consuming manual segmentation process traditionally performed by expert radiologists.

#### METHODS AND MATERIALS

We utilized a retrospectively maintained dataset consisting of 326 patients, 1034 complex masses (approximately three tumors per kidney), and 2171 cysts. All patients underwent an MRI between 2015 and 2021, with surgically removed tumors being pathologically confirmed. Lesions were manually segmented using ITK-SNAP on the excretory phase of MRI and co-registered on all other contrast-enhanced T1 sequences (pre-, arterial, and venous). The patient population was randomly divided into training (65%), testing (25%), and validation (10%) groups, stratified by tumor count, pathology, tumor volume, and kidney size. We trained ten benchmark models using 3D SwinUNETR and a differentiable decision forest, Hinge Forest, to segment lesions and kidney tissue, evaluating their performance with the Dice Similarity Coefficient (DSC) score.

#### RESULTS

The best 3D Swin UnetR models achieved DSC scores of 0.81 for AML, 0.89 for chromophobe, 0.54 for ccRCC, 0.48 for HLRCC, 0.77 for hybrid, 0.71 for oncocytoma, 0.76 for papillary, 0.94 for kidney, and 0.48 for cysts. Overall performance of all the 10 benchmarked test sets was  $0.55 \pm 0.21$  for Swin UnetR tumor segmentation. The best 3D HF model scored 0.65 for AML, 0.72 for chromophobe, 0.50 for ccRCC, 0.46 for HLRCC, 0.65 for hybrid, 0.72 for oncocytoma, 0.65 for papillary, 0.92 for kidney, and 0.4 for cysts. Overall performance of all the 10 benchmarked test sets was  $0.51 \pm 0.8$  tumor segmentation.

#### CONCLUSION

Advanced CNN architectures, such as 3D SwinUNET and hinge forest, show promise for automating renal mass subtypes, cyst, and kidney tissue segmentation on MRI. The 3D SwinUNET outperformed the 3D HF model, potentially reducing radiologist workload and enhancing diagnostic accuracy. Future research should refine these models, investigate their clinical application, and externally validate them for improving patient care.

#### CLINICAL RELEVANCE/APPLICATION

This study highlights the potential of advanced CNN architectures to revolutionize renal cancer diagnosis by automating RCC subtype, cyst, and kidney tissue segmentation on MRI, potentially reducing radiologist workload, improving diagnostic accuracy, and facilitating efficient treatment planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSGU07-6

### A Multicenter Validation of Prediction Uncertainty to Triage Patients for Prostate Cancer AI Diagnosis

Thursday, Nov. 30 1:30PM - 2:30PM Room: S502

Stefan J. Fransen, MSc (*Presenter*) Grant, Siemens AG; Grant, Health~Holland

#### PURPOSE

AI prediction uncertainty can identify cases at risk of AI failure, enabling reliable automatic AI triaging. This study validates an uncertainty-based triage for prostate cancer patients, to improve diagnostic accuracy of AI and improve the clinical workflow.

#### METHODS AND MATERIALS

A multi-center dataset of patients undergoing MRI triage for prostate cancer and an existing state-of-the-art AI algorithm for prostate cancer detection was used. The algorithm was previously trained on 7756 prostate bpMRI examinations (T2, ADC, and high b-value DWI) from Institute A (Siemens scanner) and provides 15 heatmaps with voxel-level likelihoods of malignant tissues (PIRADS=4). The trained algorithm was used to predict 561 unseen cases from Institute B (Philips scanner) and 200 unseen cases from Institute C (Siemens scanner). The variability in patient-level likelihood scores was used to measure prediction uncertainty. Predictions with a low variability were considered certain whereas predictions with a high variability were considered uncertain, at risk of AI failure. Multiple splits (20%, 40%, 60%, and 80%) were used to make certain and uncertain groups. The ability of AI to triage patients was assessed by comparing the AUROC of certain cases with uncertain cases. Furthermore, a comparison was made with the radiologist by comparing the true positive rate (TPR) of certain cases and the TPR of the radiologist at the false positive rate (FPR) operating point of the radiologist. Statistical significance was assessed by using DeLong's test.

#### RESULTS

AUROC of AI prediction was significantly higher for certain cases compared to uncertain cases, in both test sets up to 40% AI diagnosis ( $p < 0.05$ ). The highest AI performance was achieved by only selecting the 20% most certain cases (0.85 AUROC Institute B, 0.97 AUROC Institute C), indicating that AI prediction with a high level of certainty is more reliable. Compared to the overall radiologist performance, the AI can predict with a higher sensitivity in 20% of the cases from institute B (0.96 vs. 0.87 TPR at 0.45 FPR) and 60% of the cases from institute C (0.98 vs. 0.96 TPR at 0.22 FPR).

#### CONCLUSION

Prediction uncertainty can triage patients for which AI diagnosis is reliable and identify patients at risk of AI failure in external test sets including other MRI vendors. This technique could improve the clinical workflow by implementing AI diagnosis for cases with high certainty, while only redirecting patients at risk of AI failure to a radiologist worklist for reporting.

#### CLINICAL RELEVANCE/APPLICATION

AI detection for prostate cancer approaches expert-level performance, making automatic patient triaging possible. Using AI prediction uncertainty enables a reliable selection of patients fit for AI diagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSMK12

### Musculoskeletal Imaging (Elbow, Forearm, Wrist and Hand)

Thursday, Nov. 30 1:30PM - 2:30PM Room: N228

Rosemary J. Klecker, MD (*Moderator*) Nothing to Disclose  
Hamza Alizai, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### R6-SSMK12-1 **High Frequency Ultrasound in Assessment of Nail Psoriasis and Onychomycosis: A Comparative Study**

Chhavi Gupta, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Differentiation between psoriatic onychopathy and onychomycosis is a diagnostic challenge. The differentiation is critical as both these entities have long term prognostic and clinical implications and encompass long-course therapies. Currently, differentiation is based on clinical and histopathological examination like biopsies (wherein they share common features) and fungal culture. The special stains may not be readily available and are costly. Ultrasound (USG), a low cost, non-invasive and readily available modality has been used for evaluation of nail unit in recent studies, where changes in nail structure have been observed. This study compares the nail USG features in psoriasis and onychomycosis.

#### METHODS AND MATERIALS

After ethical clearance and informed consent, 185 dystrophic nails with psoriasis (105) and onychomycosis (82) were enrolled. 30 control nail units were examined. The opposite side nail served as control in focal disease and age and sex matched control was assessed in global disease. USG examination of the nail unit was performed using high frequency linear transducer (3-16 MHz). Qualitative examination of nail plate, ventral and dorsal nail plate contours, nail bed, nail matrix, extensor tendon, enthesi and distal interphalangeal joint (DIP) was performed. The quantitative parameters recorded were thickening of nail plate, nail bed, nail matrix and extensor tendon. Colour and power doppler was used to assess the vascularity of nail bed and DIP joint.

#### RESULTS

Both psoriasis and onychomycosis showed increased nail plate and nail bed thickness with wavy nail plate contour. The nail matrix thickness was significantly more in psoriatic nails of the hand ( $3.54 \pm 0.75$  vs  $3.17 \pm 0.63$ ;  $p=0.0086$ ) compared to onychomycosis. Psoriatic nails had increased thickness of extensor tendon ( $0.81 \pm 0.25$  vs  $0.54 \pm 0.12$ ;  $p=0.0001$  in hands,  $0.75 \pm 0.19$  vs  $0.55 \pm 0.13$ ;  $p=0.0001$  in feet;  $1.17 \pm 0.33$  vs  $0.7 \pm 0.16$ ;  $p=0.001$  in great toe) viz a viz onychomycosis. Psoriatic nails had a higher associated presence of DIP enthesopathies such as enthesophytes (20.4 vs 2.4 %;  $p=0.0002$ ); bony erosions (7.8 vs 1.2%;  $p=0.039$ ); raised enthesi vascularity (54.3 vs 1.2%;  $p=0.00001$ ) and raised nail bed vascularity (13.6 vs 4.9%;  $p=0.046$ ) compared to onychomycotic counterparts. The interplate space was preserved more commonly in psoriasis viz a viz onychomycosis (23.3 vs 11%;  $p=0.029$ ).

#### CONCLUSION

Nail USG emerged as a useful non-invasive technique for differentiating psoriatic and onychomycotic nails.

#### CLINICAL RELEVANCE/APPLICATION

USG can aid in differentiating nail psoriasis and onychomycosis which is a diagnostic challenge clinically and after biopsy. Its easy availability, low cost, ability to image multiple nails repeatedly makes it a lucrative modality.

#### R6-SSMK12-2 **Diagnostic Value of Hand Ultrasound in Early Detection of Rheumatoid Arthritis**

Mahyar Daskareh, MD (*Presenter*) Nothing to Disclose



## PURPOSE

Rheumatoid arthritis (RA) is now considered to be a multistep process and a continuum of disease, rather than a distinct phenotype. In this study, we aimed to investigate the diagnostic value and predictive role of hand ultrasound (US) in the early stages of RA and to identify the characteristics that contribute to predicting the development of clinical RA in the long-term follow up.

## METHODS AND MATERIALS

Patients complaining of non-traumatic pain in their hand joints who did not meet the ACE-EULAR 2010 criteria for RA diagnosis were recruited and followed for 24 months. After initial clinical and laboratory examinations, we evaluated the hands' joints and tendons using greyscale and power doppler US techniques. Supervised machine learning (ML) methods were implemented to identify the characteristics that have high value in predicting future RA development.

## RESULTS

Of the 326 patients, 123 (37.7%) progressed to clinical RA. Laboratory parameters, including WBC (OR:1.23, 95%CI: 1.02-1.50, P=0.035), RF (OR:1.08, 95%CI: 1.04-1.12, P=<0.0001), and Anti CCP (OR:1.04, 95%CI: 1.02-1.07, P=0.002) were the strongest independent predictors of RA progression. Additionally, baseline greyscale US findings, such as radiocarpal synovial thickening (OR: 39.8, 95%CI: 15.86-100.20, P=<0.0001), PIP synovitis, (OR: 68, 95%CI: 12.62-365.91, P=<0.0001), MCP synovitis (OR: 39, 95%CI: 3.34-454.1, P=0.003), and wrist effusion (OR:12.56, 95%CI: 2.22-70.95, P=0.004) were significantly associated with developing RA. ML results suggested that the best model with the highest F1-score was the random forest with 80 trees, and radiocarpal synovial thickening, MCP and PIP synovitis in addition to RF, and anti-CCP were the most important predictive features.

## CONCLUSION

Our study suggests that US examination is a sensitive method for detecting and predicting clinical RA at early stages and can facilitate treatment decision-makings in earlier course of the disease. Radiocarpal synovial thickening, PIP, and MCP synovitis at baseline were the most valuable predictors for RA development when added to clinical and laboratory evaluations.

## CLINICAL RELEVANCE/APPLICATION

Using ultrasound to evaluate and predict the risk of clinical RA during pre-clinical phases could help with the early initiation of management strategies and improve patients' prognosis.

## R6-SSMK12-4 Fast Elbow MRI with Deep Learning Reconstruction: Assessment of Image Quality and Visualization of Anatomy Compared to Standard Imaging

Sebastian Werner (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study was to evaluate a deep learning (DL) reconstruction for turbo spin echo (TSE) sequences of the elbow regarding image quality and visualization of anatomy.

## METHODS AND MATERIALS

Between October 2020 and June 2021, seventeen participants (8 patients, 9 healthy subjects; mean age: 43±16 [20-70] years, 8 men) were prospectively included in this study. Each patient underwent two examinations: standard MRI, including TSE sequences reconstructed with a generalized autocalibrating partial parallel acquisition reconstruction (TSES), and prospectively undersampled TSE sequences reconstructed with a DL reconstruction (TSEDL). The images were evaluated concerning image quality, noise, edge sharpness, artifacts, diagnostic confidence, and delineation of anatomical structures using a 5-point Likert scale.

## RESULTS

Image quality was significantly improved in TSEDL (4.35, IQR 4-5) compared to TSES (3.76, IQR 3-4, p=0.008). Moreover, TSEDL showed decreased noise (4.29, IQR 3.5-5) compared to TSES (3.35, IQR 3-4, p=0.004). Ratings for delineation of anatomical structures, artifacts, edge sharpness, and diagnostic confidence did not differ significantly between TSEDL and TSES (p > 0.05). Inter- and intra-reader agreement was substantial to almost perfect (?=0.628-0.904). Using DL, the acquisition time could be reduced by more than 35% compared to TSES.

## CONCLUSION

TSE<sub>DL</sub> provided improved image quality and decreased noise while receiving equal ratings for edge sharpness, artifacts, delineation of anatomical structures, and diagnostic confidence compared to TSE<sub>S</sub>.

## CLINICAL RELEVANCE/APPLICATION

Providing more than a 35% reduction of acquisition time, TSEDL may be clinically relevant for elbow imaging due to increased patient comfort and higher patient throughput.

## **R6-SSMK12-5 Clinical and Radiological Predictors of Delayed Union or Non-Union of Scaphoid Fractures**

Gianluca Folco, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

The purpose of our study was to review the role of different clinical and radiological variables from X-ray images of the hand in patients with scaphoid fractures on potential delayed union or non-union.

### **METHODS AND MATERIALS**

We retrospectively reviewed all patients who underwent at least one X-ray examination of the hand at our institution for a scaphoid fracture, excluding those who were referred for surgical treatment. Patients' clinical variable such as age and sex, and radiological data such as fracture dislocation, site on the scaphoid bone, articular involvement and side were collected, to then construct a multivariate model to predict delayed union or non-union of said fractures.

### **RESULTS**

Our final population was composed by 105 patients, 75 (71%) of whom males, with a median age of 39 years (interquartile range, 27-63 years). Overall, 26 (25%) patients developed a delayed union or non-union of their scaphoid fracture. At multiple regression, fracture displacement ( $p < 0.001$ ), and patients' age ( $p = 0.046$ ) and sex ( $p = 0.038$ ) yielded a significant impact on delayed union or non-union, with an overall R-squared of 0.479 for such predictive model. Site fracture on the scaphoid bone displayed a borderline significance on delayed union or non-union rates ( $p = 0.079$ ).

### **CONCLUSION**

A higher age, male sex, fracture dislocation or fracture sites different than the middle third of the scaphoid bone are predictors of higher rates of delayed union or non-union of scaphoid fractures.

### **CLINICAL RELEVANCE/APPLICATION**

Such data could be considered when planning clinical pathways for patients presenting with scaphoid fractures.

## **R6-SSMK12-6 MRI Findings in the Elbow Among Pediatric Baseball Players Based on Skeletal Maturity**

Vandan Patel, BS (*Presenter*) Nothing to Disclose

### **PURPOSE**

To characterize the spectrum of MRI findings in the elbow among youth baseball players with respect to regional skeletal maturity and surgical intervention.

### **METHODS AND MATERIALS**

This IRB-approved, HIPAA-compliant retrospective study analyzed consecutive baseball players (<18 years), who underwent elbow MRI at our free-standing children's hospital in the past 11 years (2010-2021). Two radiologists reviewed each examination independently to categorize regional skeletal maturity and findings within the medial, lateral, and posterior elbow. Findings were compared between maturation groups and logistic regression models were used to identify predictors of surgery.

### **RESULTS**

This study group of 136 children (115 boys, 21 girls) included 89 skeletally immature ( $12.7 \pm 2.3$  years) and 47 skeletally mature children ( $16.2 \pm 1.0$  years,  $p < 0.01$ ). Kappa coefficient ranged 0.64-0.96 and percent agreement ranged 86%-99%. Elbow effusion (27% vs 9%,  $p = 0.02$ ), medial epicondyle marrow edema (52% vs 15%,  $p < 0.01$ ), avulsion fractures (19% vs 2%,  $p = 0.01$ ), and osteochondritis dissecans (OCD, 24% vs 6%,  $p = 0.02$ ) were significantly more common among skeletally immature children whereas sublime tubercle marrow edema (10% vs 47%,  $p < 0.01$ ) and triceps tendinosis (19% vs 38%,  $p = 0.03$ ) were more common among skeletally mature children. Presence of intra-articular body (OR=22.8, 95% CI 2.2-466.8,  $p = 0.02$ ) and OCD (OR=6.6, 95% CI 1.6-29.3,  $p = 0.01$ ) were independent predictors for surgery.

### **CONCLUSION**

Differential patterns of MRI findings were observed in the elbow in our study group of symptomatic pediatric baseball players, which correlated with regional skeletal maturity. The presence of intra-articular body and OCD, but not skeletal maturity, were independent predictors of surgery.

### **CLINICAL RELEVANCE/APPLICATION**

With increasing sports participation and prevalence of elbow injuries among youth baseball players, a comprehensive assessment of various sites of stress in the context of functional anatomy and regional skeletal maturity can improve

diagnostic accuracy, ensure timely intervention, and reduce long-term morbidity.  
Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSMK12-1

### High Frequency Ultrasound in Assessment of Nail Psoriasis and Onychomycosis: A Comparative Study

Thursday, Nov. 30 1:30PM - 2:30PM Room: N228

Chhavi Gupta, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Differentiation between psoriatic onychopathy and onychomycosis is a diagnostic challenge. The differentiation is critical as both these entities have long term prognostic and clinical implications and encompass long-course therapies. Currently, differentiation is based on clinical and histopathological examination like biopsies (wherein they share common features) and fungal culture. The special stains may not be readily available and are costly. Ultrasound (USG), a low cost, non-invasive and readily available modality has been used for evaluation of nail unit in recent studies, where changes in nail structure have been observed. This study compares the nail USG features in psoriasis and onychomycosis.

#### METHODS AND MATERIALS

After ethical clearance and informed consent, 185 dystrophic nails with psoriasis (105) and onychomycosis (82) were enrolled. 30 control nail units were examined. The opposite side nail served as control in focal disease and age and sex matched control was assessed in global disease. USG examination of the nail unit was performed using high frequency linear transducer (3-16 MHz). Qualitative examination of nail plate, ventral and dorsal nail plate contours, nail bed, nail matrix, extensor tendon, enthesis and distal interphalangeal joint (DIP) was performed. The quantitative parameters recorded were thickening of nail plate, nail bed, nail matrix and extensor tendon. Colour and power doppler was used to assess the vascularity of nail bed and DIP joint.

#### RESULTS

Both psoriasis and onychomycosis showed increased nail plate and nail bed thickness with wavy nail plate contour. The nail matrix thickness was significantly more in psoriatic nails of the hand ( $3.54 \pm 0.75$  vs  $3.17 \pm 0.63$ ;  $p=0.0086$ ) compared to onychomycosis. Psoriatic nails had increased thickness of extensor tendon ( $0.81 \pm 0.25$  vs  $0.54 \pm 0.12$ ;  $p=0.0001$  in hands,  $0.75 \pm 0.19$  vs  $0.55 \pm 0.13$ ;  $p=0.0001$  in feet;  $1.17 \pm 0.33$  vs  $0.7 \pm 0.16$ ;  $p=0.001$  in great toe) viz a viz onychomycosis. Psoriatic nails had a higher associated presence of DIP enthesopathies such as enthesophytes (20.4 vs 2.4 %;  $p=0.0002$ ); bony erosions (7.8 vs 1.2%;  $p=0.039$ ); raised enthesis vascularity (54.3 vs 1.2%;  $p=0.00001$ ) and raised nail bed vascularity (13.6 vs 4.9%;  $p=0.046$ ) compared to onychomycotic counterparts. The interplate space was preserved more commonly in psoriasis viz a viz onychomycosis (23.3 vs 11%;  $p=0.029$ ).

#### CONCLUSION

Nail USG emerged as a useful non-invasive technique for differentiating psoriatic and onychomycotic nails.

#### CLINICAL RELEVANCE/APPLICATION

USG can aid in differentiating nail psoriasis and onychomycosis which is a diagnostic challenge clinically and after biopsy. Its easy availability, low cost, ability to image multiple nails repeatedly makes it a lucrative modality.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSMK12-2

### Diagnostic Value of Hand Ultrasound in Early Detection of Rheumatoid Arthritis

Thursday, Nov. 30 1:30PM - 2:30PM Room: N228

Mahyar Daskareh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Rheumatoid arthritis (RA) is now considered to be a multistep process and a continuum of disease, rather than a distinct phenotype. In this study, we aimed to investigate the diagnostic value and predictive role of hand ultrasound (US) in the early stages of RA and to identify the characteristics that contribute to predicting the development of clinical RA in the long-term follow up.

#### METHODS AND MATERIALS

Patients complaining of non-traumatic pain in their hand joints who did not meet the ACE-EULAR 2010 criteria for RA diagnosis were recruited and followed for 24 months. After initial clinical and laboratory examinations, we evaluated the hands' joints and tendons using greyscale and power doppler US techniques. Supervised machine learning (ML) methods were implemented to identify the characteristics that have high value in predicting future RA development.

#### RESULTS

Of the 326 patients, 123 (37.7%) progressed to clinical RA. Laboratory parameters, including WBC (OR:1.23, 95%CI: 1.02-1.50, P=0.035), RF (OR:1.08, 95%CI: 1.04-1.12, P=<0.0001), and Anti CCP (OR:1.04, 95%CI: 1.02-1.07, P=0.002) were the strongest independent predictors of RA progression. Additionally, baseline greyscale US findings, such as radiocarpal synovial thickening (OR: 39.8, 95%CI: 15.86-100.20, P=<0.0001), PIP synovitis, (OR: 68, 95%CI: 12.62-365.91, P=<0.0001), MCV synovitis (OR: 39, 95%CI: 3.34-454.1, P=0.003), and wrist effusion (OR:12.56, 95%CI: 2.22-70.95, P=0.004) were significantly associated with developing RA. ML results suggested that the best model with the highest F1-score was the random forest with 80 trees, and radiocarpal synovial thickening, MCP and PIP synovitis in addition to RF, and anti-CCP were the most important predictive features.

#### CONCLUSION

Our study suggests that US examination is a sensitive method for detecting and predicting clinical RA at early stages and can facilitate treatment decision-makings in earlier course of the disease. Radiocarpal synovial thickening, PIP, and MCV synovitis at baseline were the most valuable predictors for RA development when added to clinical and laboratory evaluations.

#### CLINICAL RELEVANCE/APPLICATION

Using ultrasound to evaluate and predict the risk of clinical RA during pre-clinical phases could help with the early initiation of management strategies and improve patients' prognosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSMK12-4

### Fast Elbow MRI with Deep Learning Reconstruction: Assessment of Image Quality and Visualization of Anatomy Compared to Standard Imaging

Thursday, Nov. 30 1:30PM - 2:30PM Room: N228

Sebastian Werner (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate a deep learning (DL) reconstruction for turbo spin echo (TSE) sequences of the elbow regarding image quality and visualization of anatomy.

#### METHODS AND MATERIALS

Between October 2020 and June 2021, seventeen participants (8 patients, 9 healthy subjects; mean age:  $43 \pm 16$  [20-70] years, 8 men) were prospectively included in this study. Each patient underwent two examinations: standard MRI, including TSE sequences reconstructed with a generalized autocalibrating partial parallel acquisition reconstruction (TSES), and prospectively undersampled TSE sequences reconstructed with a DL reconstruction (TSEDL). The images were evaluated concerning image quality, noise, edge sharpness, artifacts, diagnostic confidence, and delineation of anatomical structures using a 5-point Likert scale.

#### RESULTS

Image quality was significantly improved in TSEDL (4.35, IQR 4-5) compared to TSES (3.76, IQR 3-4,  $p=0.008$ ). Moreover, TSEDL showed decreased noise (4.29, IQR 3.5-5) compared to TSES (3.35, IQR 3-4,  $p=0.004$ ). Ratings for delineation of anatomical structures, artifacts, edge sharpness, and diagnostic confidence did not differ significantly between TSEDL and TSES ( $p > 0.05$ ). Inter- and intra-reader agreement was substantial to almost perfect ( $\kappa=0.628-0.904$ ). Using DL, the acquisition time could be reduced by more than 35% compared to TSES.

#### CONCLUSION

TSE<sub>DL</sub> provided improved image quality and decreased noise while receiving equal ratings for edge sharpness, artifacts, delineation of anatomical structures, and diagnostic confidence compared to TSE<sub>S</sub>.

#### CLINICAL RELEVANCE/APPLICATION

Providing more than a 35% reduction of acquisition time, TSEDL may be clinically relevant for elbow imaging due to increased patient comfort and higher patient throughput.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSMK12-5

### Clinical and Radiological Predictors of Delayed Union or Non-Union of Scaphoid Fractures

Thursday, Nov. 30 1:30PM - 2:30PM Room: N228

Gianluca Folco, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of our study was to review the role of different clinical and radiological variables from X-ray images of the hand in patients with scaphoid fractures on potential delayed union or non-union.

#### METHODS AND MATERIALS

We retrospectively reviewed all patients who underwent at least one X-ray examination of the hand at our institution for a scaphoid fracture, excluding those who were referred for surgical treatment. Patients' clinical variable such as age and sex, and radiological data such as fracture dislocation, site on the scaphoid bone, articular involvement and side were collected, to then construct a multivariate model to predict delayed union or non-union of said fractures.

#### RESULTS

Our final population was composed by 105 patients, 75 (71%) of whom males, with a median age of 39 years (interquartile range, 27-63 years). Overall, 26 (25%) patients developed a delayed union or non-union of their scaphoid fracture. At multiple regression, fracture displacement ( $p < 0.001$ ), and patients' age ( $p = 0.046$ ) and sex ( $p = 0.038$ ) yielded a significant impact on delayed union or non-union, with an overall R-squared of 0.479 for such predictive model. Site fracture on the scaphoid bone displayed a borderline significance on delayed union or non-union rates ( $p = 0.079$ ).

#### CONCLUSION

A higher age, male sex, fracture dislocation or fracture sites different than the middle third of the scaphoid bone are predictors of higher rates of delayed union or non-union of scaphoid fractures.

#### CLINICAL RELEVANCE/APPLICATION

Such data could be considered when planning clinical pathways for patients presenting with scaphoid fractures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSMK12-6

### MRI Findings in the Elbow Among Pediatric Baseball Players Based on Skeletal Maturity

Thursday, Nov. 30 1:30PM - 2:30PM Room: N228

Vandan Patel, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To characterize the spectrum of MRI findings in the elbow among youth baseball players with respect to regional skeletal maturity and surgical intervention.

#### METHODS AND MATERIALS

This IRB-approved, HIPAA-compliant retrospective study analyzed consecutive baseball players (<18 years), who underwent elbow MRI at our free-standing children's hospital in the past 11 years (2010-2021). Two radiologists reviewed each examination independently to categorize regional skeletal maturity and findings within the medial, lateral, and posterior elbow. Findings were compared between maturation groups and logistic regression models were used to identify predictors of surgery.

#### RESULTS

This study group of 136 children (115 boys, 21 girls) included 89 skeletally immature (12.7±2.3 years) and 47 skeletally mature children (16.2±1.0 years,  $p<0.01$ ). Kappa coefficient ranged 0.64-0.96 and percent agreement ranged 86%-99%. Elbow effusion (27% vs 9%,  $p=0.02$ ), medial epicondyle marrow edema (52% vs 15%,  $p<0.01$ ), avulsion fractures (19% vs 2%,  $p=0.01$ ), and osteochondritis dissecans (OCD, 24% vs 6%,  $p=0.02$ ) were significantly more common among skeletally immature children whereas sublime tubercle marrow edema (10% vs 47%,  $p<0.01$ ) and triceps tendinosis (19% vs 38%,  $p=0.03$ ) were more common among skeletally mature children. Presence of intra-articular body (OR=22.8, 95% CI 2.2-466.8,  $p=0.02$ ) and OCD (OR=6.6, 95% CI 1.6-29.3,  $p=0.01$ ) were independent predictors for surgery.

#### CONCLUSION

Differential patterns of MRI findings were observed in the elbow in our study group of symptomatic pediatric baseball players, which correlated with regional skeletal maturity. The presence of intra-articular body and OCD, but not skeletal maturity, were independent predictors of surgery.

#### CLINICAL RELEVANCE/APPLICATION

With increasing sports participation and prevalence of elbow injuries among youth baseball players, a comprehensive assessment of various sites of stress in the context of functional anatomy and regional skeletal maturity can improve diagnostic accuracy, ensure timely intervention, and reduce long-term morbidity.

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## Abstract Archives of the RSNA, 2023

R6-SSNMMI08

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Prostate Cancer Therapy)

Thursday, Nov. 30 1:30PM - 2:30PM Room: S403A

Don C. Yoo, MD (*Moderator*) Consultant, Konica Minolta, Inc  
Phillip H. Kuo, MD, PhD (*Moderator*) Consultant, Konica Minolta, Inc; Consultant, Amgen Inc; Consultant, Blue Earth Diagnostics Ltd; Research Grant, Blue Earth Diagnostics Ltd; Consultant, Novartis AG; Speaker, Novartis AG; Consultant, Chimerix, Inc; Consultant, Fusion Pharmaceuticals Inc; Consultant, Bayer AG; Consultant, General Electric Company; Speaker, General Electric Company; Research Grant, General Electric Company; Speaker, Digital Science Press, Inc; Consultant, Radionetics; Former Employee, Konica Minolta, Inc

#### Sub-Events

#### **R6-SSNMMI08-1 Lesion Based Dosimetric Analysis of Response to 177Lu-Psma Therapy in McRpc Patients**

**1** Surekha Yadav, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To perform lesion-based dosimetry to evaluate the tumor dose absorbed per lesion and to evaluate the relation between the absorbed tumor dose and the response to RLT.

#### METHODS AND MATERIALS

25 patients with progressive mCRPC who presented for RLT therapy were consecutively sampled for inclusion in this retrospective study. Semi-quantitative analysis of 24-hour post-treatment SPECT was performed using MRT Dosimetry Software (MIM Software Inc., Cleveland, US) after cycle 1 (C1) and cycle 2 (C2). Lesion segmentation used a 42% threshold. The change in the absorbed dose of a lesion from C1 to C2 was evaluated to assess the response:  $\text{Response} = 1 - \frac{\text{Mean Absorbed dose C1} - \text{Mean Absorbed dose C2}}{\text{Mean Absorbed dose C1}}$

#### RESULTS

103 lesions evaluated at two time points. The decrease in the average radiation absorbed dose was 41%. Out of the 21 patients, 10 (47%) achieved a PSA50 response after C2. Responders who achieved PSA50 showed a significantly higher decrease in average absorbed dose as compared to the patients who did not achieve a PSA50 (54.32% in PSA50 versus 28.9% in non-PSA50,  $p=0.0047$ ). There was no difference in baseline absorbed dose between the two groups (5.7 Gray in PSA50 versus 3.9 Gray in non-PSA50,  $p=0.1678$ ). Skeletal lesions in the responders showed a decrease of 55%, while nodal lesions showed a decrease of 51%. Non-responders who did not achieve PSA50 concurrently showed a lower decrease in average absorbed dose from C1 to C2 for both the skeletal (26%) as well as the nodal lesions (40%).

#### CONCLUSION

Patients demonstrating a higher decrease in absorbed dose are more likely to have a PSA50 response after C2, although there was no relationship between baseline absorbed dose and PSA response.

#### CLINICAL RELEVANCE/APPLICATION

Lesion based dosimetry will potentially lead to optimal disease control by targeting high radiation doses to patient who need it, while reducing radiation toxicity and delaying therapy resistance in others.

#### **R6-SSNMMI08-2 AI-based Prediction of Treatment Response in Patients with Metastatic Castration-resistant Prostate Cancer using <sup>18</sup>F-DCFpYl PSMA PET/CT**

Andrew F. Voter (*Presenter*) Nothing to Disclose

## PURPOSE

Despite widespread adoption of prostate-specific membrane antigen (PSMA) PET/CT imaging for prostate cancer, prognostication of patient outcomes remains challenging. The primary goal of this work was to evaluate the feasibility of a deep learning (DL) model to identify patients at risk for progression based on baseline PSMA PET imaging.

## METHODS AND MATERIALS

PSMA-PET/CT scans of 128 patients (Age 71.7±8.4years, PSA 19.4±42.7) with metastatic castration-resistant prostate cancer (mCRPC) on the index PSMA PET/CT scans were used for the training set. A total of 1624 PSMA-avid foci suspicious for malignancy were labeled and reassessed on follow-up PSMA PET/CT or other imaging modalities. Lesions were classified as either progressive or non-progressive based on increased radiotracer avidity or greater than 2mm size increase. A deep multi-modal fusion 3D convolutional neural network (CNN) based on the index PSMA PET/CT was trained to predict lesion-wise treatment response on follow up imaging. The model was validated using an independent test set comprising 105 lesions from 19 patients (Age 72.2±7.1 years, PSA 18.5±16.1). Then, patient-wise CNN features were obtained by averaging lesion-wise CNN features, and a random survival forest model was trained to predict PFS. Then, patients were stratified into low-versus high-risk groups by Kaplan Meier analysis and the log rank test.

## RESULTS

The model based on PET/CT achieved an accuracy of 0.819, AUC of 0.615, F1-score of 0.899, precision of 0.838 and recall of 0.970 in classifying lesions as progressive versus non-progression. The time to event survival analysis yielded a C index of 0.61. Our algorithm was able to identify a high-risk population in the testing set with significantly reduced median survival (26.1 months) relative to the remaining population (57.4 months, P=0.04).

## CONCLUSION

We developed a DL model to predict lesion and patient-level treatment response using PSMA PET/CT scans. Our DL model was able to identify mCRPC patients at high risk for progression. Further studies are warranted to determine the clinical implications of our deep learning model.

## CLINICAL RELEVANCE/APPLICATION

PSMA PET/CT is an invaluable tool for the management of mCRPC. We demonstrated its value in prognostication by stratifying patient outcomes and identifying a high risk subgroup of patients who may benefit from focused care or alternative therapies.

## R6-SSNMMI08-3 Salvage Radiotherapy Guidance with <sup>18</sup>F-Fluciclovine PET/CT and <sup>68</sup>Ga-PSMA PET/CT in Patients with Biochemical Recurrence Postprostatectomy: A Planned Secondary Endpoint from a Randomized Trial

Olayinka A. Abiodun-Ojo, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the impact of 18F-fluciclovine and 68Ga-PSMA PET on salvage radiotherapy (RT) management decisions in patients with biochemical recurrence after radical prostatectomy.

## METHODS AND MATERIALS

Prospectively enrolled men with rise in prostate-specific antigen (PSA) postprostatectomy were randomized in an intention-to-treat clinical trial to PET/CT imaging with 18F-fluciclovine (arm A) or 68Ga-PSMA with 20 mg Lasix unless contraindicated (arm B), to guide treatment planning. Initial RT decisions based on conventional imaging and clinicopathologic findings were compared with final RT decisions based on PET findings: extrapelvic nodal/bone uptake - no RT; pelvic nodal uptake - RT to prostate bed+pelvis; no uptake or prostate bed only uptake - RT to prostate bed. Clopper-Pearson binomial method was used to determine the significance of decision changes.

## RESULTS

6/140 patients withdrew from the trial before PET scanning. Of the remaining 134 patients, 65 (median PSA 0.28 ng/mL) received 18F-fluciclovine PET and 69 (median PSA 0.35 ng/mL) received 68Ga-PSMA PET. Patient-based analysis showed a significantly higher positivity rate for prostate cancer recurrence with 18F-fluciclovine (95.4%) than 68Ga-PSMA (60.9%; p<0.001). Local recurrence was detected on 18F-fluciclovine in 72.3% and on 68Ga-PSMA in 37.7% (p<0.001). Positivity rates on 18F-fluciclovine and 68Ga-PSMA were comparable for pelvic lymph node recurrence and extrapelvic metastases (Table 1). Overall RT decision change was 30.7% in arm A vs 42.0% in arm B. 5/65 (7.7%) in arm A and 8/69 (11.6%) patients in arm B had the decision to offer radiotherapy withdrawn due to extrapelvic uptake on PET. Among patients with final decision to receive RT, treatment fields were changed in 15/60 (25.0%) in arm A vs 21/61 (34.4%) in arm B. 1/60 (1.7%) in arm A vs 2/61 (3.3%) in arm B had field increased from prostate bed only to prostate bed and pelvis, while 14/60 (23.3%) in arm A vs 19/61 (31.1%) in arm B had field reduced from RT to prostate bed and pelvis to prostate bed only. Changes in the decision to offer RT, treatment fields, and overall RT decisions were statistically significant for arms A B.

## CONCLUSION

We report significantly higher positivity rates on <sup>18</sup>F-fluciclovine than <sup>68</sup>Ga-PSMA PET for whole body and local recurrence. <sup>18</sup>F-fluciclovine and <sup>68</sup>Ga-PSMA had significant impact on salvage radiotherapy management decisions in postprostatectomy patients with recurrent prostate cancer. Further analysis to determine the effect of management decision change on failure-free survival is ongoing.

## CLINICAL RELEVANCE/APPLICATION

<sup>18</sup>F-fluciclovine and <sup>68</sup>Ga-PSMA significantly influenced radiotherapy management decisions in prostate cancer patients with biochemical recurrence postprostatectomy.

## R6-SSNMMI08- Early Adverse Events, Emergency Room Visits and Hospitalizations After PSMA Based RLT: A Retrospective Analysis from Real World Theranostics Practice

Ahmad Abdelrazek (*Presenter*) Nothing to Disclose

## PURPOSE

Lutetium-177-PSMA (Lu-PSMA) is an effective treatment for metastatic castration-resistant prostate cancer (mCRPC) patients, even though the immediate side effects that can occur during or right after treatment administration are not heavily investigated. Herein, we aimed to report on all adverse events occurring during or shortly after treatment.

## METHODS AND MATERIALS

We reviewed 185 patients between April and November 2022. The primary goal of our study is to outline the early side effects reported in the clinical notes, and the secondary goal is to report the emergency room visits and hospitalizations within 30 days following a Lu-PSMA administration. We investigated independent variables in univariable and multivariable logistic regression analyses

## RESULTS

The median (IQR) age at the time of the first Lu-PSMA cycle was 70 years (67-76), with a median (IQR) PSA of 11.8 ng/ml (2.3-76.4) and an Eastern Cooperative Oncology Group (ECOG) performance status of 0,1,2,3 was 114 (61.6%) 59 (31.9%) 10 (5.4%) 2 (1.1%), respectively. At the time of the first Lu-PSMA cycle, 123 (66.5%) patients had lymph node metastasis, 164 (88.6%) had bone metastasis, and 54 (32.4%) had visceral metastasis, as detected by <sup>68</sup>Ga or <sup>18</sup>F PSMA-targeted PET/CT. Among known side effects attributed to Lu-PSMA, the most observed during or shortly after therapy were gastrointestinal in origin, including nausea 36 (19.5%), vomiting 36 (19.5%), abdominal pain 17 (9.2%), constipation 16 (8.6%), and diarrhea 9 (4.9%). Other adverse effects included fatigue 54 (29.2%), decreased appetite 15 (8.1%), unintentional weight loss 10 (5.4%), and dry mouth 9 (4.9%). In all, 16 (8.6%) patients had visited the emergency room after receiving Lu-PSMA. Out of those 16 patients, 2 (1.1%) patients were due to anemia and thrombocytopenia, 2 (1.1%) patients had pneumonia, pleural effusion, and acute respiratory failure, 2 (1.1%) patients were due to abdominal pain and vomiting, 2 (1.1%) patients presented with sepsis and septic shock, and one (0.5%) patient was due to intestinal obstruction and perforated appendicitis. Additionally, 2 (1.1%) patients were hospitalized, one (0.5%) due to severe anemia, and the other one (0.5%) due to pathological spinal fracture. A high ECOG performance score was associated with an increased number of emergency department visits ( $p= 0.017$ ) and hospital admissions ( $p= 0.007$ )

## CONCLUSION

Mild to moderate short-term side effects secondary to treatment with Lu-PSMA are not uncommon, but most patients can be managed in an outpatient setting

## CLINICAL RELEVANCE/APPLICATION

In the current era of treatment of metastatic castrate-resistant prostate cancer with <sup>177</sup>-PSMA Lutetium, we gave the physicians a broad view of the common side effects that we faced from real-world data

## R6-SSNMMI08- Keynote Speaker

5

Phillip H. Kuo, MD, PhD (*Presenter*) Consultant, Konica Minolta, Inc; Consultant, Amgen Inc; Consultant, Blue Earth Diagnostics Ltd; Research Grant, Blue Earth Diagnostics Ltd; Consultant, Novartis AG; Speaker, Novartis AG; Consultant, Chimerix, Inc; Consultant, Fusion Pharmaceuticals Inc; Consultant, Bayer AG; Consultant, General Electric Company; Speaker, General Electric Company; Research Grant, General Electric Company; Speaker, Digital Science Press, Inc; Consultant, Radionetics; Former Employee, Konica Minolta, Inc

## R6-SSNMMI08- Keynote Speaker

6

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

## Abstract Archives of the RSNA, 2023

R6-SSNMMI08-1

### Lesion Based Dosimetric Analysis of Response to 177Lu-Psma Therapy in mCRpc Patients

Thursday, Nov. 30 1:30PM - 2:30PM Room: S403A

Surekha Yadav, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To perform lesion-based dosimetry to evaluate the tumor dose absorbed per lesion and to evaluate the relation between the absorbed tumor dose and the response to RLT.

#### METHODS AND MATERIALS

25 patients with progressive mCRPC who presented for RLT therapy were consecutively sampled for inclusion in this retrospective study. Semi-quantitative analysis of 24-hour post-treatment SPECT was performed using MRT Dosimetry Software (MIM Software Inc., Cleveland, US) after cycle 1 (C1) and cycle 2 (C2). Lesion segmentation used a 42% threshold. The change in the absorbed dose of a lesion from C1 to C2 was evaluated to assess the response:  $\text{Response} = 1 - \frac{\text{Mean Absorbed dose C2} - \text{Mean Absorbed dose C1}}{\text{Mean Absorbed dose C1}}$

#### RESULTS

103 lesions evaluated at two time points. The decrease in the average radiation absorbed dose was 41%. Out of the 21 patients, 10 (47%) achieved a PSA50 response after C2. Responders who achieved PSA50 showed a significantly higher decrease in average absorbed dose as compared to the patients who did not achieve a PSA50 (54.32% in PSA50 versus 28.9% in non-PSA50,  $p=0.0047$ ). There was no difference in baseline absorbed dose between the two groups (5.7 Gray in PSA50 versus 3.9 Gray in non-PSA50,  $p=0.1678$ ). Skeletal lesions in the responders showed a decrease of 55%, while nodal lesions showed a decrease of 51%. Non-responders who did not achieve PSA50 concurrently showed a lower decrease in average absorbed dose from C1 to C2 for both the skeletal (26%) as well as the nodal lesions (40%).

#### CONCLUSION

Patients demonstrating a higher decrease in absorbed dose are more likely to have a PSA50 response after C2, although there was no relationship between baseline absorbed dose and PSA response.

#### CLINICAL RELEVANCE/APPLICATION

Lesion based dosimetry will potentially lead to optimal disease control by targeting high radiation doses to patient who need it, while reducing radiation toxicity and delaying therapy resistance in others.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSNMMI08-2

### AI-based Prediction of Treatment Response in Patients with Metastatic Castration-resistant Prostate Cancer using $^{18}\text{F}$ -DCFPyL PSMA PET/CT

Thursday, Nov. 30 1:30PM - 2:30PM Room: S403A

Andrew F. Voter (*Presenter*) Nothing to Disclose

#### PURPOSE

Despite widespread adoption of prostate-specific membrane antigen (PSMA) PET/CT imaging for prostate cancer, prognostication of patient outcomes remains challenging. The primary goal of this work was to evaluate the feasibility of a deep learning (DL) model to identify patients at risk for progression based on baseline PSMA PET imaging.

#### METHODS AND MATERIALS

PSMA-PET/CT scans of 128 patients (Age  $71.7 \pm 8.4$  years, PSA  $19.4 \pm 42.7$ ) with metastatic castration-resistant prostate cancer (mCRPC) on the index PSMA PET/CT scans were used for the training set. A total of 1624 PSMA-avid foci suspicious for malignancy were labeled and reassessed on follow-up PSMA PET/CT or other imaging modalities. Lesions were classified as either progressive or non-progressive based on increased radiotracer avidity or greater than 2mm size increase. A deep multi-modal fusion 3D convolutional neural network (CNN) based on the index PSMA PET/CT was trained to predict lesion-wise treatment response on follow up imaging. The model was validated using an independent test set comprising 105 lesions from 19 patients (Age  $72.2 \pm 7.1$  years, PSA  $18.5 \pm 16.1$ ). Then, patient-wise CNN features were obtained by averaging lesion-wise CNN features, and a random survival forest model was trained to predict PFS. Then, patients were stratified into low-versus high-risk groups by Kaplan Meier analysis and the log rank test.

#### RESULTS

The model based on PET/CT achieved an accuracy of 0.819, AUC of 0.615, F1-score of 0.899, precision of 0.838 and recall of 0.970 in classifying lesions as progressive versus non-progression. The time to event survival analysis yielded a C index of 0.61. Our algorithm was able to identify a high-risk population in the testing set with significantly reduced median survival (26.1 months) relative to the remaining population (57.4 months,  $P=0.04$ ).

#### CONCLUSION

We developed a DL model to predict lesion and patient-level treatment response using PSMA PET/CT scans. Our DL model was able to identify mCRPC patients at high risk for progression. Further studies are warranted to determine the clinical implications of our deep learning model.

#### CLINICAL RELEVANCE/APPLICATION

PSMA PET/CT is an invaluable tool for the management of mCRPC. We demonstrated its value in prognostication by stratifying patient outcomes and identifying a high risk subgroup of patients who may benefit from focused care or alternative therapies.

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## Abstract Archives of the RSNA, 2023

R6-SSNMMI08-3

### Salvage Radiotherapy Guidance with <sup>18</sup>F-Fluciclovine PET/CT and <sup>68</sup>Ga-PSMA PET/CT in Patients with Biochemical Recurrence Postprostatectomy: A Planned Secondary Endpoint from a Randomized Trial

Thursday, Nov. 30 1:30PM - 2:30PM Room: S403A

Olayinka A. Abiodun-Ojo, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the impact of <sup>18</sup>F-fluciclovine and <sup>68</sup>Ga-PSMA PET on salvage radiotherapy (RT) management decisions in patients with biochemical recurrence after radical prostatectomy.

#### METHODS AND MATERIALS

Prospectively enrolled men with rise in prostate-specific antigen (PSA) postprostatectomy were randomized in an intention-to-treat clinical trial to PET/CT imaging with <sup>18</sup>F-fluciclovine (arm A) or <sup>68</sup>Ga-PSMA with 20 mg Lasix unless contraindicated (arm B), to guide treatment planning. Initial RT decisions based on conventional imaging and clinicopathologic findings were compared with final RT decisions based on PET findings: extrapelvic nodal/bone uptake - no RT; pelvic nodal uptake - RT to prostate bed+pelvis; no uptake or prostate bed only uptake - RT to prostate bed. Clopper-Pearson binomial method was used to determine the significance of decision changes.

#### RESULTS

6/140 patients withdrew from the trial before PET scanning. Of the remaining 134 patients, 65 (median PSA 0.28 ng/mL) received <sup>18</sup>F-fluciclovine PET and 69 (median PSA 0.35 ng/mL) received <sup>68</sup>Ga-PSMA PET. Patient-based analysis showed a significantly higher positivity rate for prostate cancer recurrence with <sup>18</sup>F-fluciclovine (95.4%) than <sup>68</sup>Ga-PSMA (60.9%;  $p < 0.001$ ). Local recurrence was detected on <sup>18</sup>F-fluciclovine in 72.3% and on <sup>68</sup>Ga-PSMA in 37.7% ( $p < 0.001$ ). Positivity rates on <sup>18</sup>F-fluciclovine and <sup>68</sup>Ga-PSMA were comparable for pelvic lymph node recurrence and extrapelvic metastases (Table 1). Overall RT decision change was 30.7% in arm A vs 42.0% in arm B. 5/65 (7.7%) in arm A and 8/69 (11.6%) patients in arm B had the decision to offer radiotherapy withdrawn due to extrapelvic uptake on PET. Among patients with final decision to receive RT, treatment fields were changed in 15/60 (25.0%) in arm A vs 21/61 (34.4%) in arm B. 1/60 (1.7%) in arm A vs 2/61 (3.3%) in arm B had field increased from prostate bed only to prostate bed and pelvis, while 14/60 (23.3%) in arm A vs 19/61 (31.1%) in arm B had field reduced from RT to prostate bed and pelvis to prostate bed only. Changes in the decision to offer RT, treatment fields, and overall RT decisions were statistically significant for arms A B.

#### CONCLUSION

We report significantly higher positivity rates on <sup>18</sup>F-fluciclovine than <sup>68</sup>Ga-PSMA PET for whole body and local recurrence. <sup>18</sup>F-fluciclovine and <sup>68</sup>Ga-PSMA had significant impact on salvage radiotherapy management decisions in postprostatectomy patients with recurrent prostate cancer. Further analysis to determine the effect of management decision change on failure-free survival is ongoing.

#### CLINICAL RELEVANCE/APPLICATION

<sup>18</sup>F-fluciclovine and <sup>68</sup>Ga-PSMA significantly influenced radiotherapy management decisions in prostate cancer patients with biochemical recurrence postprostatectomy.

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## Abstract Archives of the RSNA, 2023

R6-SSNMMI08-4

### Early Adverse Events, Emergency Room Visits and Hospitalizations After PSMA Based RLT: A Retrospective Analysis from Real World Theranostics Practice

Thursday, Nov. 30 1:30PM - 2:30PM Room: S403A

Ahmad Abdelrazek (*Presenter*) Nothing to Disclose

#### PURPOSE

Lutetium-177-PSMA (Lu-PSMA) is an effective treatment for metastatic castration-resistant prostate cancer (mCRPC) patients, even though the immediate side effects that can occur during or right after treatment administration are not heavily investigated. Herein, we aimed to report on all adverse events occurring during or shortly after treatment.

#### METHODS AND MATERIALS

We reviewed 185 patients between April and November 2022. The primary goal of our study is to outline the early side effects reported in the clinical notes, and the secondary goal is to report the emergency room visits and hospitalizations within 30 days following a Lu-PSMA administration. We investigated independent variables in univariable and multivariable logistic regression analyses

#### RESULTS

The median (IQR) age at the time of the first Lu-PSMA cycle was 70 years (67-76), with a median (IQR) PSA of 11.8 ng/ml (2.3-76.4) and an Eastern Cooperative Oncology Group (ECOG) performance status of 0,1,2,3 was 114 (61.6%) 59 (31.9%) 10 (5.4%) 2 (1.1%), respectively. At the time of the first Lu-PSMA cycle, 123 (66.5%) patients had lymph node metastasis, 164 (88.6%) had bone metastasis, and 54 (32.4%) had visceral metastasis, as detected by 68Ga or 18F PSMA-targeted PET/CT. Among known side effects attributed to Lu-PSMA, the most observed during or shortly after therapy were gastrointestinal in origin, including nausea 36 (19.5%), vomiting 36 (19.5%), abdominal pain 17 (9.2%), constipation 16 (8.6%), and diarrhea 9 (4.9%). Other adverse effects included fatigue 54 (29.2%), decreased appetite 15 (8.1%), unintentional weight loss 10 (5.4%), and dry mouth 9 (4.9%). In all, 16 (8.6%) patients had visited the emergency room after receiving Lu-PSMA. Out of those 16 patients, 2 (1.1%) patients were due to anemia and thrombocytopenia, 2 (1.1%) patients had pneumonia, pleural effusion, and acute respiratory failure, 2 (1.1%) patients were due to abdominal pain and vomiting, 2 (1.1%) patients presented with sepsis and septic shock, and one (0.5%) patient was due to intestinal obstruction and perforated appendicitis. Additionally, 2 (1.1%) patients were hospitalized, one (0.5%) due to severe anemia, and the other one (0.5%) due to pathological spinal fracture. A high ECOG performance score was associated with an increased number of emergency department visits ( $p= 0.017$ ) and hospital admissions ( $p= 0.007$ )

#### CONCLUSION

Mild to moderate short-term side effects secondary to treatment with Lu-PSMA are not uncommon, but most patients can be managed in an outpatient setting

#### CLINICAL RELEVANCE/APPLICATION

In the current era of treatment of metastatic castrate-resistant prostate cancer with 177-PSMA Lutetium, we gave the physicians a broad view of the common side effects that we faced from real-world data

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## Abstract Archives of the RSNA, 2023

R6-SSNMMI08-5

### Keynote Speaker

Thursday, Nov. 30 1:30PM - 2:30PM Room: S403A

Phillip H. Kuo, MD, PhD (*Presenter*) Consultant, Konica Minolta, Inc;Consultant, Amgen Inc;Consultant, Blue Earth Diagnostics Ltd;Research Grant, Blue Earth Diagnostics Ltd;Consultant, Novartis AG;Speaker, Novartis AG;Consultant, Chimerix, Inc;Consultant, Fusion Pharmaceuticals Inc;Consultant, Bayer AG;Consultant, General Electric Company;Speaker, General Electric Company;Research Grant, General Electric Company;Speaker, Digital Science Press, Inc;Consultant, Radionetics;Former Employee, Konica Minolta, Inc

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## Abstract Archives of the RSNA, 2023

R6-SSNMMI08-6

### Keynote Speaker

Thursday, Nov. 30 1:30PM - 2:30PM Room: S403A

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSNR16

### Neuroradiology (Brain: Trauma)

Thursday, Nov. 30 1:30PM - 2:30PM Room: N229

Hediyeh Baradaran, MD, MS (*Moderator*) Nothing to Disclose  
Mariza Clement, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **R6-SSNR16-1 Increased Relative Risk of Delayed Hemorrhage in Patients Taking Anticoagulant and Antiplatelet Medications with Concurrent Aspirin Therapy: Clinical Recommendations Based on Five Year Retrospective Analysis in a Large Health System**

Warren Chang, MD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

The incidence of delayed posttraumatic intracranial hemorrhage (DH) in patients on anticoagulant (AC) and antiplatelet (AP) medications, including direct oral anticoagulants (DOACs) is not well defined, especially in patients taking AC/AP agents with concurrent aspirin. Studies have reported disparate results with 1-10% risk of DH and 0-3% mortality and few examined risk of concurrent aspirin. We seek to provide guidelines for clinical management for patients taking AC/AP agents with or without aspirin in the ED (Emergency Department) setting.

#### METHODS AND MATERIALS

1642 patients taking AP and AC agents presenting to network EDs from 2017-2023 with head trauma were included. Repeat CT scans were recommended for patients taking AP/AC medications that had head trauma. Repeat CTs were typically performed within 24 hours (average follow-up was 21 hours and 99% were within 3 days). Average time to DH was 20 hours. Patients with repeat exams were included if their initial CT was read as negative and there was no trauma between the scans. All positive cases were reviewed by two board certified neuroradiologists. Patients were excluded if hemorrhage (ICH) was retrospectively identified on the initial examination. Cases were reclassified as negative if ICH on the follow-up CT was thought to be absent or artifactual. Cases were positive if the initial CT was considered negative and the follow-up CT demonstrated new ICH.

#### RESULTS

There was 1.88% overall incidence (31 cases) of DH and 0.4% overall mortality (6 patients). Patients taking concurrent aspirin had increased risk of DH (RR 5.2, 3.8% vs 0.8%,  $p < 0.001$ ). The group of patients taking warfarin or AP agents demonstrated higher rate of DH (3.6% compared to 0.7%, RR 5.1,  $p < 0.01$ ) and higher mortality (0.9% compared to 0.0%) compared to the DOAC group. There was increased risk in the warfarin/AP group both with and without aspirin therapy (6.0% vs 1.7% with aspirin, 1.5% vs 0.2% without aspirin). Patients taking DOACs had markedly increased risk of DH while taking concurrent aspirin (1.7% vs 0.16%, RR 10.8,  $p < 0.01$ ).

#### CONCLUSION

The risk of DH was increased in patients taking aspirin in addition to AC/AP medications (3.9%, 1 per 26 scans). Repeat imaging should be obtained for patients with head trauma taking AC/AP agents along with aspirin. Repeat examination should be strongly considered on patients taking warfarin or AP agents even without aspirin given moderate risk (1.5% 1/66 scans). Patients taking DOACs alone have low risk of DH (0.16%, 1 / 603 scans) and repeat imaging can be deferred unless patients have external signs of trauma or a dangerous mechanism of injury.

#### CLINICAL RELEVANCE/APPLICATION

Patients taking both AC/AP medications and aspirin have high relative risk of DH and repeat CT scan to evaluate for DH is recommended.

### **R6-SSNR16-2 Soccer Heading Over 2 Years is Associated with Change in Frontal White Matter Microstructure That Varies by Exposure Magnitude**

Lipton, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Repetitive head impacts (RHI) in soccer have been associated with adverse cognitive and neuroimaging outcomes in cross-sectional studies. However, few have reported on the longitudinal effects of soccer RHI on neuroimaging and cognitive performance. The objective of this study was to assess the association of soccer heading over two years with change in brain microstructure and cognitive performance in adult amateur players (n=148, mean age 26.7 years, 25.6% female).

## METHODS AND MATERIALS

Two-year heading exposure was categorized as low (0-556 total headers), moderate (564-1,512 total headers), or high (1,538-23,462 total headers) using the HeadCount-12m questionnaire. Diffusion tensor imaging (3T, 32 encoding directions, b=800 s/mm<sup>2</sup>, 2mm<sup>3</sup> isotropic resolution), neurite orientation dispersion and density imaging (same parameters as above except three shells instead of one: 6 directions at b = 300 s/mm<sup>2</sup>, 32 at b = 800 s/mm<sup>2</sup>, and 60 at b = 2,000 s/mm<sup>2</sup>), and the Cogstate battery were acquired at the initial study visit and two years later. Mixed-effects models accounted for age, concussion history, sex, and education. Significant findings survived false discovery rate of 0.05 (actual p-values 0.001-0.004).

## RESULTS

The high heading exposure group, over two years, demonstrated an increase of mean diffusivity (MD), radial diffusivity (RD), and axial diffusivity (AD) in frontal WM regions, and a decrease of orientation-dispersion index (ODI) in the right superior frontal white matter and superior corona radiata. Low and moderate heading was associated with a decrease of MD, RD, and AD, and increase of ODI over the same period. High heading was associated with decline of verbal learning performance over two years, whereas low and moderate heading exposure was associated with improvement in verbal learning, but these findings did not reach statistical significance.

## CONCLUSION

These results suggest greater heading exposure over two years is associated with adverse effects on white matter microstructure in young adult amateur soccer players. Our results are suggestive of a subclinical effect, given the sub-significant pattern of verbal learning changes. Larger longitudinal studies in diverse cohorts are needed to determine the potential for adverse microstructural and functional change over the longer term to better guide intervention and policy.

## CLINICAL RELEVANCE/APPLICATION

Decline of brain microstructure over 2 years in soccer players who head at high levels, with trends toward decline of cognitive performance, suggests potential subclinical injury, which could affect long-term brain health.

## R6-SSNR16-3 Functional Connectivity Changes Observed Using Resting-State Functional Magnetic Resonance Imaging Following Mild Traumatic Brain Injury: A Systematic Review

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Mild traumatic brain injury (mTBI) remains a relatively common diagnosis that nevertheless often poses diagnostic and therapeutic challenges. Advanced neuroimaging has been used to great effect over the last decade to characterize post-mTBI neurological changes. In particular, a large number of studies have investigated resting-state functional MRI changes following mTBI, across a diverse set of brain areas and time periods, using a variety of methods. We performed a systematic review to summarize common and discordant findings among the literature.

## METHODS AND MATERIALS

This study was performed as per PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Diagnostic Test Accuracy) guidelines. Five databases ("PubMed," "Embase," "Cochrane Central," "Scopus," "Web of Science") were searched for research published since 2010. The search strategy used keywords of "functional magnetic resonance imaging" and "mild traumatic brain injury" as well as related terms. All results were screened at the abstract and title level by four reviewers according to predefined inclusion and exclusion criteria. Two reviewers performed full-text data screening and extraction. The following categories were extracted: article characteristics, cohort demographics, MRI technical parameters, data processing, statistical analysis, and data characteristics.

## RESULTS

Data extraction was performed for 66 studies. On average, these studies included 41.2 subjects (average age 36.6 years, 48% females) in the mTBI group and 32.6 (average age 36.6 years, 45% females) in the control group. The most common analysis method was seed-to-voxel (n=25) followed by independent component analysis (ICA, n=19). 62 studies used 3T tesla MRI scanners. The whole brain (n=28) was the most common subject of analysis followed by the default mode network (n=23). Inconsistent patterns of functional connectivity changes were reported, even when the same method was used to study the same region or network.

## CONCLUSION

Although studies of functional connectivity changes following mTBI have similar patient demographics among mTBI and control groups, there is significant heterogeneity in reported analysis methods, regions and networks of interest, and reported functional connectivity changes.

## CLINICAL RELEVANCE/APPLICATION

We provide a systematic review of the diverse literature regarding functional connectivity changes, observed via resting-state functional MRI, following mild traumatic brain injury. We hope the results highlight unsettled questions and guide further investigation.

### R6-SSNR16-4 **Adverse Association of Soccer Heading with Verbal Learning is Mediated by Microstructure of the Orbitofrontal Gray Matter-White Matter Interface**

Joan Song (*Presenter*) Nothing to Disclose

#### PURPOSE

Repetitive head impacts (RHI) from soccer heading are an integral part of the sport. High RHI exposure is associated with worse verbal learning (VL). Adverse associations of RHI with white matter (WM) microstructure have also been identified using diffusion tensor MRI (DTI). The orbitofrontal region and the gray matter (GM) - WM interface (GWI) are known predilection sites for head impact shear force trauma, but DTI investigations have been restricted to deeper WM regions. Moreover, studies have not yet tested the causal role of imaging findings in the pathway from RHI exposure to worse cognitive function. We tested the mediating role of orbitofrontal GWI microstructure in a known association of RHI with worse VL. We hypothesized the natural sharp transition from high WM fractional anisotropy (FA) to low GM FA is attenuated as a function of RHI and this attenuation mediates the association of RHI with VL.

#### METHODS AND MATERIALS

We analyzed RHI (12-month heading from HeadCount, a validated instrument), DTI (3.0T; 32 directions; b=800; voxel size 2mm<sup>3</sup>) and VL (International Shopping List) from 353 amateur soccer players (18-53, 27% female). To overcome limitations (e.g., misregistration and partial volume effects) we interrogated the transition from low GM FA to high WM FA by computing the slope of FA orthogonal to the GWI (defined by FreeSurfer) over the entire orbitofrontal region, as follows: we binned all orbitofrontal voxels by distance to the GWI and computed average FA within each bin. Average FA was plotted vs. distance to the GWI and fit to a 7th order polynomial. FA slope across the GWI is defined as the maximum slope magnitude of the polynomial fit. To test mediation by GWI microstructure, we fitted linear models to test the associations of (1) RHI with VL, (2) RHI with FA slope and (3) RHI and FA slope with VL, with age and sex as covariates. Mediation by FA slope was calculated as the product of RHI effect size in model (2) and FA slope effect size in model (3). Mediation significance was tested using the Sobel test.

#### RESULTS

We confirmed an association of higher RHI with worse VL ( $p=0.0305$ ). High RHI was associated with lower orbitofrontal GWI FA slope ( $p=0.00745$ ). The orbitofrontal GWI FA slope was a significant mediator ( $p=0.0186$ ) of the association of higher RHI with worse VL.

## CONCLUSION

GWI microstructure integrity in the orbitofrontal region, as quantified by FA slope, mediates the association of RHI with VL. These results support a mechanistic role for juxtacortical white matter in adverse associations of soccer RHI with worse cognitive performance.

## CLINICAL RELEVANCE/APPLICATION

GWI microstructure findings support a causal role in the adverse association of RHI with cognitive performance and may serve as a complementary biomarker of trauma-related brain pathology.

### R6-SSNR16-5 **Identification of Subarachnoid Lymphatic-Like Membranes in Patients with Severe Head Trauma**

Toshiteru Miyasaka, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recently, subarachnoid lymphatic-like membranes (SLYMs) have been identified, and subarachnoid space (SAS) is subdivided into outer SAS and inner SAS. A traumatic brain injury could bring physical rupture of SLYMs, altering CSF flow patterns. Therefore, we investigated how much abnormal outer SAS is found in severe head trauma patients.

## METHODS AND MATERIALS

Of 63 patients hospitalized for severe head trauma between April 1, 2021, and March 31, 2023, 48 patients were analyzed retrospectively, excluding three patients with significant artifacts and 12 patients who did not have T2-weighted images. The mean age of the patients was 55.6 years (8-89 years), with 18 females and 30 males. The mean GCS on admission was 9.4 points, and the head MRI was taken between 1 and 26 days, averaging 9.4 days after admission. Of the 48 patients, T2WI was taken in transverse and coronal sections except for two patients whose T2WI was taken only in a transverse section, and susceptibility weighted image (SWI) was taken in all patients. On T2WI, membrane-like structures that appear to be accompanied by superficial veins in SAS were assumed to be SLYMs. For patients with disproportionately enlarged outer SAS in the fornix, its thickness was observed in T2WI transverse and coronal sections on the left and right sides, respectively. The thickest part of the outer SAS was measured. MRI, including SWI, was also examined concerning abnormal findings in the brain parenchyma, such as cerebral contusions and diffuse axonal injury (DAI).

## RESULTS

Disproportionate fluid retention of outer SAS was found in 29 unilateral fornices of 18 patients (37.5%). The mean thickness was 5 mm, with a standard deviation of 1.87. Subdural hematomas were found in 13 unilateral fornices of 10 patients (20.8%), and SLYMs could not be identified. Of the 18 patients with abnormal outer SAS, 13 (72.2%) had either cerebral contusion or DAI, or both, and 2 (11.1%) had fat emboli. Thirty patients with no identifiable outer SAS had a cerebral contusion, DAI, or both in 21 patients (70%).

## CONCLUSION

Outer SAS was identified in a low frequency of patients with severe head trauma. There was no correlation between the presence of abnormal outer SAS and cerebral contusion or DAI. 2 patients, a small number, but both patients with fat emboli had abnormal outer SAS. The limitation of this study is that it is challenging to distinguish SLYMs from subdural hematomas.

## CLINICAL RELEVANCE/APPLICATION

The rupture of SLYMs could be associated with the prolonged suppression of glymphatic flow and heightened risk of Alzheimer's disease after traumatic brain injury. It is essential to identify SLYMs by imaging.

## R6-SSNR16-6 Quantitative Volumetry of Ventricles in Association to Clinical Assessment in MTBI

Thomas Knoblauch, MS (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to investigate trends in ventricular volume in patients with mild traumatic brain injury (mTBI) and explore clinical associations.

## METHODS AND MATERIALS

We conducted a chart review of clinical and radiological data for a diverse group of 540 patients ( $42 \pm 15$  years; 229 male) with diagnosed mTBI, excluding those with prior head injury or neurological comorbidities. We documented loss of consciousness (LOC) at the time of injury and recorded occurrence and improvement of seven clinical mTBI symptoms (i.e., headache, balance difficulties, cognitive impairment, fatigue, anxiety, depression, and emotional lability) on a survival timeline. A brain MRI protocol with a 3.0T MR scanner sequencing T1, T2, FLAIR, gradient echo imaging, susceptibility weighted imaging, diffusion tensor imaging (DTI), dynamic whole brain perfusion, and functional MRI was performed on each patient. A 3D T1-weighted image (0.93mm x 0.93mm x 1.2mm) was subsequently analyzed using NeuroQuant V.3 software to provide normative percentile volume of ventricles (NPVV) and normalized value of ventricles volume to the intracranial volume (VV). MRI normalcy was defined by the absence of atypical white matter hyperintensities, hippocampal atrophy or asymmetry, abnormal fractional anisotropy in DTI, MR perfusion anomaly, and atypical auditory functional MRI during a word listening task. We conducted t-tests and a machine learning analysis using the random forest algorithm to examine the association between NPVV, VV, and clinical and demographic measures, including age, sex, MRI normalcy, LOC, occurrence and improvement of seven mTBI symptoms, time of examination of the symptoms, time until first reported improvement of any symptoms, and time of MRI scan.

## RESULTS

Female patients had greater NPVV ( $P < 0.0073$ ). The only clinical measure significantly associated with NPVV was MRI normalcy ( $P < 0.00041$ ), with patients with abnormal MRI having significantly larger ventricle volume than those with normal MRI. As expected, age was the top feature ranked by the random forest in the prediction of the VV (%IncMSE = 57.1 and %IncNodePurity = 83.4). The MRI normalcy was ranked second by the random forest regarding '%IncMSE' for the prediction of the VV.

## CONCLUSION

Our study suggests that increased ventricular volumes may be reflective of the underlying neuropathology of disparate imaging abnormalities in head trauma and relate to the associated atrophy of these processes.

## **CLINICAL RELEVANCE/APPLICATION**

This study provides insights into potential diagnostic and clinical applications of quantitative ventricular volume assessment in mTBI. Quantitative volumetric software may assist radiologic interpretation and offer value to the imaging assessment of mTBI subjects.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSNR16-1

### Increased Relative Risk of Delayed Hemorrhage in Patients Taking Anticoagulant and Antiplatelet Medications with Concurrent Aspirin Therapy: Clinical Recommendations Based on Five Year Retrospective Analysis in a Large Health System

Thursday, Nov. 30 1:30PM - 2:30PM Room: N229

Warren Chang, MD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

The incidence of delayed posttraumatic intracranial hemorrhage (DH) in patients on anticoagulant (AC) and antiplatelet (AP) medications, including direct oral anticoagulants (DOACs) is not well defined, especially in patients taking AC/AP agents with concurrent aspirin. Studies have reported disparate results with 1-10% risk of DH and 0-3% mortality and few examined risk of concurrent aspirin. We seek to provide guidelines for clinical management for patients taking AC/AP agents with or without aspirin in the ED (Emergency Department) setting.

#### METHODS AND MATERIALS

1642 patients taking AP and AC agents presenting to network EDs from 2017-2023 with head trauma were included. Repeat CT scans were recommended for patients taking AP/AC medications that had head trauma. Repeat CTs were typically performed within 24 hours (average follow-up was 21 hours and 99% were within 3 days). Average time to DH was 20 hours. Patients with repeat exams were included if their initial CT was read as negative and there was no trauma between the scans. All positive cases were reviewed by two board certified neuroradiologists. Patients were excluded if hemorrhage (ICH) was retrospectively identified on the initial examination. Cases were reclassified as negative if ICH on the follow-up CT was thought to be absent or artifactual. Cases were positive if the initial CT was considered negative and the follow-up CT demonstrated new ICH.

#### RESULTS

There was 1.88% overall incidence (31 cases) of DH and 0.4% overall mortality (6 patients). Patients taking concurrent aspirin had increased risk of DH (RR 5.2, 3.8% vs 0.8%,  $p < 0.001$ ). The group of patients taking warfarin or AP agents demonstrated higher rate of DH (3.6% compared to 0.7%, RR 5.1,  $p < 0.01$ ) and higher mortality (0.9% compared to 0.0%) compared to the DOAC group. There was increased risk in the warfarin/AP group both with and without aspirin therapy (6.0% vs 1.7% with aspirin, 1.5% vs 0.2% without aspirin). Patients taking DOACs had markedly increased risk of DH while taking concurrent aspirin (1.7% vs 0.16%, RR 10.8,  $p < 0.01$ ).

#### CONCLUSION

The risk of DH was increased in patients taking aspirin in addition to AC/AP medications (3.9%, 1 per 26 scans). Repeat imaging should be obtained for patients with head trauma taking AC/AP agents along with aspirin. Repeat examination should be strongly considered on patients taking warfarin or AP agents even without aspirin given moderate risk (1.5% 1/66 scans). Patients taking DOACs alone have low risk of DH (0.16%, 1 / 603 scans) and repeat imaging can be deferred unless patients have external signs of trauma or a dangerous mechanism of injury.

#### CLINICAL RELEVANCE/APPLICATION

Patients taking both AC/AP medications and aspirin have high relative risk of DH and repeat CT scan to evaluate for DH is recommended.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSNR16-2

### Soccer Heading Over 2 Years is Associated with Change in Frontal White Matter Microstructure That Varies by Exposure Magnitude

Thursday, Nov. 30 1:30PM - 2:30PM Room: N229

Michael L. Lipton, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Repetitive head impacts (RHI) in soccer have been associated with adverse cognitive and neuroimaging outcomes in cross-sectional studies. However, few have reported on the longitudinal effects of soccer RHI on neuroimaging and cognitive performance. The objective of this study was to assess the association of soccer heading over two years with change in brain microstructure and cognitive performance in adult amateur players (n=148, mean age 26.7 years, 25.6% female).

#### METHODS AND MATERIALS

Two-year heading exposure was categorized as low (0-556 total headers), moderate (564-1,512 total headers), or high (1,538-23,462 total headers) using the HeadCount-12m questionnaire. Diffusion tensor imaging (3T, 32 encoding directions, b=800 s/mm<sup>2</sup>, 2mm<sup>3</sup> isotropic resolution), neurite orientation dispersion and density imaging (same parameters as above except three shells instead of one: 6 directions at b = 300 s/mm<sup>2</sup>, 32 at b = 800 s/mm<sup>2</sup>, and 60 at b = 2,000 s/mm<sup>2</sup>), and the Cogstate battery were acquired at the initial study visit and two years later. Mixed-effects models accounted for age, concussion history, sex, and education. Significant findings survived false discovery rate of 0.05 (actual p-values 0.001-0.004).

#### RESULTS

The high heading exposure group, over two years, demonstrated an increase of mean diffusivity (MD), radial diffusivity (RD), and axial diffusivity (AD) in frontal WM regions, and a decrease of orientation-dispersion index (ODI) in the right superior frontal white matter and superior corona radiata. Low and moderate heading was associated with a decrease of MD, RD, and AD, and increase of ODI over the same period. High heading was associated with decline of verbal learning performance over two years, whereas low and moderate heading exposure was associated with improvement in verbal learning, but these findings did not reach statistical significance.

#### CONCLUSION

These results suggest greater heading exposure over two years is associated with adverse effects on white matter microstructure in young adult amateur soccer players. Our results are suggestive of a subclinical effect, given the sub-significant pattern of verbal learning changes. Larger longitudinal studies in diverse cohorts are needed to determine the potential for adverse microstructural and functional change over the longer term to better guide intervention and policy.

#### CLINICAL RELEVANCE/APPLICATION

Decline of brain microstructure over 2 years in soccer players who head at high levels, with trends toward decline of cognitive performance, suggests potential subclinical injury, which could affect long-term brain health.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R6-SSNR16-3

### Functional Connectivity Changes Observed Using Resting-State Functional Magnetic Resonance Imaging Following Mild Traumatic Brain Injury: A Systematic Review

Thursday, Nov. 30 1:30PM - 2:30PM Room: N229

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Mild traumatic brain injury (mTBI) remains a relatively common diagnosis that nevertheless often poses diagnostic and therapeutic challenges. Advanced neuroimaging has been used to great effect over the last decade to characterize post-mTBI neurological changes. In particular, a large number of studies have investigated resting-state functional MRI changes following mTBI, across a diverse set of brain areas and time periods, using a variety of methods. We performed a systematic review to summarize common and discordant findings among the literature.

#### METHODS AND MATERIALS

This study was performed as per PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Diagnostic Test Accuracy) guidelines. Five databases ("PubMed," "Embase," "Cochrane Central," "Scopus," "Web of Science") were searched for research published since 2010. The search strategy used keywords of "functional magnetic resonance imaging" and "mild traumatic brain injury" as well as related terms. All results were screened at the abstract and title level by four reviewers according to predefined inclusion and exclusion criteria. Two reviewers performed full-text data screening and extraction. The following categories were extracted: article characteristics, cohort demographics, MRI technical parameters, data processing, statistical analysis, and data characteristics.

#### RESULTS

Data extraction was performed for 66 studies. On average, these studies included 41.2 subjects (average age 36.6 years, 48% females) in the mTBI group and 32.6 (average age 36.6 years, 45% females) in the control group. The most common analysis method was seed-to-voxel (n=25) followed by independent component analysis (ICA, n=19). 62 studies used 3T tesla MRI scanners. The whole brain (n=28) was the most common subject of analysis followed by the default mode network (n=23). Inconsistent patterns of functional connectivity changes were reported, even when the same method was used to study the same region or network.

#### CONCLUSION

Although studies of functional connectivity changes following mTBI have similar patient demographics among mTBI and control groups, there is significant heterogeneity in reported analysis methods, regions and networks of interest, and reported functional connectivity changes.

#### CLINICAL RELEVANCE/APPLICATION

We provide a systematic review of the diverse literature regarding functional connectivity changes, observed via resting-state functional MRI, following mild traumatic brain injury. We hope the results highlight unsettled questions and guide further investigation.

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## Abstract Archives of the RSNA, 2023

R6-SSNR16-4

### Adverse Association of Soccer Heading with Verbal Learning is Mediated by Microstructure of the Orbitofrontal Gray Matter-White Matter Interface

Thursday, Nov. 30 1:30PM - 2:30PM Room: N229

Joan Song (*Presenter*) Nothing to Disclose

#### PURPOSE

Repetitive head impacts (RHI) from soccer heading are an integral part of the sport. High RHI exposure is associated with worse verbal learning (VL). Adverse associations of RHI with white matter (WM) microstructure have also been identified using diffusion tensor MRI (DTI). The orbitofrontal region and the gray matter (GM) - WM interface (GWI) are known predilection sites for head impact shear force trauma, but DTI investigations have been restricted to deeper WM regions. Moreover, studies have not yet tested the causal role of imaging findings in the pathway from RHI exposure to worse cognitive function. We tested the mediating role of orbitofrontal GWI microstructure in a known association of RHI with worse VL. We hypothesized the natural sharp transition from high WM fractional anisotropy (FA) to low GM FA is attenuated as a function of RHI and this attenuation mediates the association of RHI with VL.

#### METHODS AND MATERIALS

We analyzed RHI (12-month heading from HeadCount, a validated instrument), DTI (3.0T; 32 directions; b=800; voxel size 2mm<sup>3</sup>) and VL (International Shopping List) from 353 amateur soccer players (18-53, 27% female). To overcome limitations (e.g., misregistration and partial volume effects) we interrogated the transition from low GM FA to high WM FA by computing the slope of FA orthogonal to the GWI (defined by FreeSurfer) over the entire orbitofrontal region, as follows: we binned all orbitofrontal voxels by distance to the GWI and computed average FA within each bin. Average FA was plotted vs. distance to the GWI and fit to a 7th order polynomial. FA slope across the GWI is defined as the maximum slope magnitude of the polynomial fit. To test mediation by GWI microstructure, we fitted linear models to test the associations of (1) RHI with VL, (2) RHI with FA slope and (3) RHI and FA slope with VL, with age and sex as covariates. Mediation by FA slope was calculated as the product of RHI effect size in model (2) and FA slope effect size in model (3). Mediation significance was tested using the Sobel test.

#### RESULTS

We confirmed an association of higher RHI with worse VL ( $p=0.0305$ ). High RHI was associated with lower orbitofrontal GWI FA slope ( $p= 0.00745$ ). The orbitofrontal GWI FA slope was a significant mediator ( $p= 0.0186$ ) of the association of higher RHI with worse VL.

#### CONCLUSION

GWI microstructure integrity in the orbitofrontal region, as quantified by FA slope, mediates the association of RHI with VL. These results support a mechanistic role for juxtacortical white matter in adverse associations of soccer RHI with worse cognitive performance.

#### CLINICAL RELEVANCE/APPLICATION

GWI microstructure findings support a causal role in the adverse association of RHI with cognitive performance and may serve as a complementary biomarker of trauma-related brain pathology.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSNR16-5

### Identification of Subarachnoid Lymphatic-Like Membranes in Patients with Severe Head Trauma

Thursday, Nov. 30 1:30PM - 2:30PM Room: N229

Toshiteru Miyasaka, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recently, subarachnoid lymphatic-like membranes (SLYMs) have been identified, and subarachnoid space (SAS) is subdivided into outer SAS and inner SAS. A traumatic brain injury could bring physical rupture of SLYMs, altering CSF flow patterns. Therefore, we investigated how much abnormal outer SAS is found in severe head trauma patients.

#### METHODS AND MATERIALS

Of 63 patients hospitalized for severe head trauma between April 1, 2021, and March 31, 2023, 48 patients were analyzed retrospectively, excluding three patients with significant artifacts and 12 patients who did not have T2-weighted images. The mean age of the patients was 55.6 years (8-89 years), with 18 females and 30 males. The mean GCS on admission was 9.4 points, and the head MRI was taken between 1 and 26 days, averaging 9.4 days after admission. Of the 48 patients, T2WI was taken in transverse and coronal sections except for two patients whose T2WI was taken only in a transverse section, and susceptibility weighted image (SWI) was taken in all patients. On T2WI, membrane-like structures that appear to be accompanied by superficial veins in SAS were assumed to be SLYMs. For patients with disproportionately enlarged outer SAS in the fornix, its thickness was observed in T2WI transverse and coronal sections on the left and right sides, respectively. The thickest part of the outer SAS was measured. MRI, including SWI, was also examined concerning abnormal findings in the brain parenchyma, such as cerebral contusions and diffuse axonal injury (DAI).

#### RESULTS

Disproportionate fluid retention of outer SAS was found in 29 unilateral fornices of 18 patients (37.5%). The mean thickness was 5 mm, with a standard deviation of 1.87. Subdural hematomas were found in 13 unilateral fornices of 10 patients (20.8%), and SLYMs could not be identified. Of the 18 patients with abnormal outer SAS, 13 (72.2%) had either cerebral contusion or DAI, or both, and 2 (11.1%) had fat emboli. Thirty patients with no identifiable outer SAS had a cerebral contusion, DAI, or both in 21 patients (70%).

#### CONCLUSION

Outer SAS was identified in a low frequency of patients with severe head trauma. There was no correlation between the presence of abnormal outer SAS and cerebral contusion or DAI. 2 patients, a small number, but both patients with fat emboli had abnormal outer SAS. The limitation of this study is that it is challenging to distinguish SLYMs from subdural hematomas.

#### CLINICAL RELEVANCE/APPLICATION

The rupture of SLYMs could be associated with the prolonged suppression of glymphatic flow and heightened risk of Alzheimer's disease after traumatic brain injury. It is essential to identify SLYMs by imaging.

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## Abstract Archives of the RSNA, 2023

R6-SSNR16-6

### Quantitative Volumetry of Ventricles in Association to Clinical Assessment in MTBI

Thursday, Nov. 30 1:30PM - 2:30PM Room: N229

Thomas Knoblauch, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to investigate trends in ventricular volume in patients with mild traumatic brain injury (mTBI) and explore clinical associations.

#### METHODS AND MATERIALS

We conducted a chart review of clinical and radiological data for a diverse group of 540 patients ( $42 \pm 15$  years; 229 male) with diagnosed mTBI, excluding those with prior head injury or neurological comorbidities. We documented loss of consciousness (LOC) at the time of injury and recorded occurrence and improvement of seven clinical mTBI symptoms (i.e., headache, balance difficulties, cognitive impairment, fatigue, anxiety, depression, and emotional lability) on a survival timeline. A brain MRI protocol with a 3.0T MR scanner sequencing T1, T2, FLAIR, gradient echo imaging, susceptibility weighted imaging, diffusion tensor imaging (DTI), dynamic whole brain perfusion, and functional MRI was performed on each patient. A 3D T1-weighted image (0.93mm x 0.93mm x 1.2mm) was subsequently analyzed using NeuroQuant V.3 software to provide normative percentile volume of ventricles (NPVV) and normalized value of ventricles volume to the intracranial volume (VV). MRI normalcy was defined by the absence of atypical white matter hyperintensities, hippocampal atrophy or asymmetry, abnormal fractional anisotropy in DTI, MR perfusion anomaly, and atypical auditory functional MRI during a word listening task. We conducted t-tests and a machine learning analysis using the random forest algorithm to examine the association between NPVV, VV, and clinical and demographic measures, including age, sex, MRI normalcy, LOC, occurrence and improvement of seven mTBI symptoms, time of examination of the symptoms, time until first reported improvement of any symptoms, and time of MRI scan.

#### RESULTS

Female patients had greater NPVV ( $P < 0.0073$ ). The only clinical measure significantly associated with NPVV was MRI normalcy ( $P < 0.00041$ ), with patients with abnormal MRI having significantly larger ventricle volume than those with normal MRI. As expected, age was the top feature ranked by the random forest in the prediction of the VV (%IncMSE = 57.1 and %IncNodePurity = 83.4). The MRI normalcy was ranked second by the random forest regarding '%IncMSE' for the prediction of the VV.

#### CONCLUSION

Our study suggests that increased ventricular volumes may be reflective of the underlying neuropathology of disparate imaging abnormalities in head trauma and relate to the associated atrophy of these processes.

#### CLINICAL RELEVANCE/APPLICATION

This study provides insights into potential diagnostic and clinical applications of quantitative ventricular volume assessment in mTBI. Quantitative volumetric software may assist radiologic interpretation and offer value to the imaging assessment of mTBI subjects.

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## Abstract Archives of the RSNA, 2023

R6-SSPD05

### Pediatric Imaging (Chest, Cardiac and Fetal)

Thursday, Nov. 30 1:30PM - 2:30PM Room: N230B

Teresa Victoria, MD, PhD (*Moderator*) Nothing to Disclose  
LaDonna J. Malone, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### R6-SSPD05-1 Neonatal Pulmonary MRI at Term-Equivalent Age for Defining Bronchopulmonary Dysplasia Severity and Its Relationship with Short-Term Respiratory Outcomes

Francesco Rizzetto, MD (*Presenter*) Travel support, Bracco Group

#### PURPOSE

This retrospective study aims to evaluate the potential of neonatal pulmonary magnetic resonance imaging (MRI), using commercially available sequences, to identify and quantify lung parenchymal injury associated with bronchopulmonary dysplasia (BPD) and predict short-term respiratory outcomes.

#### METHODS AND MATERIALS

Pulmonary MRI, using turbo spin echo and gradient echo sequences during natural sleep, was performed in premature infants, including infants with and without a clinical diagnosis of BPD. Lung MRIs were scored independently by two pediatric radiologists and one 4th year radiology resident, using the modified Ochiai scoring system and a new proposed score, the Bronchopulmonary Dysplasia Magnetic Resonance Index (BPDMRI), based on four hyperaeration (hyperexpansion, emphysema, cysts, mosaic pattern) and four parenchymal variables (triangular subpleural opacities, fibrous stripes and bands, edema and atelectasis, distortion of bronchovascular bundles). Both the modified Ochiai score and the BPDMRI were correlated with two short-term respiratory outcomes: the length of mechanical ventilation and the length of any respiratory support until discharge. The BPDMRI was also compared with the clinical definition of BPD between the severity groups. Intra- and inter-reader reproducibility of the BPDMRI were calculated.

#### RESULTS

The study included 25 premature infants (9 no-BPD and 16 BPD subjects). Pulmonary MRI showed a wide variety in appearance of pulmonary parenchyma among BPD patients and revealed significant structural differences across the range of MRI scores. Both the modified Ochiai score and the BPDMRI resulted positively correlated to the length of mechanical ventilation ( $r = 0.828$ ,  $p < 0.001$ ;  $r = 0.900$ ,  $p < 0.001$ ) and the length of any respiratory support until discharge ( $r = 0.897$ ,  $p < 0.001$ ;  $r = 0.953$ ,  $p < 0.001$ ). In the severe disease group, the length of respiratory support showed a smaller IQR when related with the BPDMRI rather than when related with the clinical definition. The BPDMRI had almost perfect intra-reader reproducibility and good inter-reader reproducibility.

#### CONCLUSION

Pulmonary MRI identified and objectively quantified lung parenchymal abnormalities associated with BPD, showing a strong correlation with the length of mechanical ventilation and the length of any respiratory support until discharge.

#### CLINICAL RELEVANCE/APPLICATION

Lung MRI may help identify infants with more serious disease and likely at greater risk for respiratory morbidities better than the severity stratification based on the clinical definition, proving its potential to contribute to a new definition of BPD based on the underlying pulmonary pathology and to predict short-term respiratory outcomes.

### R6-SSPD05-2 Assessment of 3D Hemi-Diaphragmatic Motion via Free-Breathing Dynamic MRI in Pediatric Thoracic Insufficiency Syndrome

Mahdie Hosseini, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Thoracic insufficiency syndrome (TIS) is a condition that affects respiratory function due to spinal and thoracic deformities in pediatric subjects. When progressive deformities limit lung development, reconstructive surgery is performed to promote growth. We present a novel method for the analysis of the 3D motion of each hemi-diaphragm (HD) surface via free-breathing thoracic dynamic magnetic resonance imaging (dMRI) toward understanding lung function, evaluating the effect of surgical intervention, and long-term follow up.

## METHODS AND MATERIALS

In a study of 49 children with TIS who underwent VEPTR surgery and 150 healthy children, we constructed 4D dMRI images from free-breathing dMRI acquisitions and manually delineated the diaphragm at end-expiration (EE) and end-inspiration (EI) time points. We automatically selected 25 points uniformly on each HD surface, obtained their velocities based on their inferior-superior displacements between the EE and EI time points, and derived mean velocities in 13 homologous regions for each HD surface to provide a measure of regional 3D HD motion. We compared between the motion of right HD (RHD) and left HD (LHD) in homologous regions in normal subjects and patients and before and after operation for patients via a paired T-test.

## RESULTS

The normal group comprised of 49.4% males and 50.6% females, while the TIS group had 55.1% males and 44.9% females. The mean age was  $11.7 \pm 3.6$  years for the normal group and  $3.5 \pm 3.5$  and  $5.9 \pm 3.6$  years for the pre-op and post-op TIS subjects, respectively. In the normal group, the RHD exhibited a statistically significantly higher velocity compared to its homologous regions in LHD, and the posterior regions showed higher velocity than other regions in both RHD and LHD. In the TIS group, the velocities were generally significantly lower than in normal subjects, although the velocities generally increased post-operatively, particularly in RHD in posterior, central, and medial regions with statistical significance.

## CONCLUSION

It is feasible to quantify the regional motion of the 3D diaphragm surface in normal subjects and TIS patients via free-breathing dMRI. Using this method, regional motion of the 3D HD surface can be assessed in comparison to normal subjects to study TIS and its corrective surgery.

## CLINICAL RELEVANCE/APPLICATION

The proposed free-breathing 4D dynamic MRI method can be used to quantify the motion of the individual 3D hemi-diaphragm surface to assess deviation from normal and alteration due to corrective surgery in TIS.

## R6-SSPD05-3 Right Atrial Remodeling In Pediatric Patients with Repaired of Tetralogy of Fallot: A CMR Study

Rong-Zhen Ouyang, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to evaluate the RA remodeling and atrioventricular interaction in young pediatric patients with repaired tetralogy of Fallot (rTOF) using cardiovascular magnetic resonance imaging (CMR).

## METHODS AND MATERIALS

A total of 146 consecutive pediatric patients with rTOF & 9;(Table 1) who underwent clinically indicated CMR were included and 56 normal controls were recruited as control group according to the inclusion and exclusion criteria. On routine two and four chamber cine images, right atrial (RA) maximum volume (Vmax), passive volume (Vpac), and minimum volume (Vmin) as well as the corresponding ejection fraction (EF), including RA total EF, passive EF, and booster EF, were measured (Figure 1A). CMR biplane feature tracking of RA was performed to derive RA strain, including total strain (es), passive strain (ee) and active strain (ea), and the corresponding strain rate (SRs, SRe, SRa) (Figure 1B). Right atrioventricular coupling index (RAVCI) was & 9;defined for each participant by the ratio between RA volume and RV volume at end-diastole. GLS, GRS and FAC of RA were also derived from CMR feature tracking. Transthoracic echocardiography was performed on the same day to determine right ventricular (RV) diastolic function.

## RESULTS

Patients with rTOF had higher RA volume and lower reservoir, conduit and booster function as well as GLS, GCS and FAC, compared to controls (Table 2). Patients with RV diastolic dysfunction (DD) had larger RA size and lower partial function than patients without RV DD (Table 3). RA Vmax, Vpac and Vmin index were all negatively associated with RA reservoir and conduit function (Figure 1C). RA volumetric data was positively associated with RV end-diastolic volume index (EDVi) and RV end-systolic volume index (ESVi) (Figure 1D). RA SRs and SRa were positively correlated with RV ESVi. The association of parameters between RV diastolic function and RA function were also found. RAVCI increased while LACVI decreased in patients with rTOF. LA Vmax, SV and function were lower in patients than in controls (Table 2).

## CONCLUSION

RA three phasic structure and function demonstrated earlier remodeling than RV diastolic and systolic function impairment. There was atrioventricular interaction between RA and RV and atrial interaction between RA and LA. RA evaluation is clinically important in the management of patients with rTOF.

## CLINICAL RELEVANCE/APPLICATION

This study comprehensively assessed RA structure and function remodeling using CMR in patient with rTOF. RA three phasic volume increased while function impaired, which were prior to remodeling of RV and associated with RV and LA function, highlighting a need for CMR assessment of RA remodeling.

## R6-SSPD05-4 Myocardial Native T1 Mapping in Children with Kawasaki Disease: Correlation with Disease Phase and Coronary Artery Dilation

Shengkun Peng, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To assess myocardial abnormalities using native T1 mapping based on cardiac magnetic resonance (CMR) and investigate their relationship with disease phase and coronary artery (CA) dilation in children with Kawasaki disease (KD).

### METHODS AND MATERIALS

Fifty-eight KD patients in the acute phase group (within 40 days of onset), 72 KD patients in the chronic phase group (onset >40 days, and 40 age- and sex-matched normal controls underwent a 3.0 T CMR examination. Each phase group was subdivided by Coronary Artery (CA) dilation. Z-score of >2 was defined as coronary artery dilation (CA dilation). In the CA dilation group, CA dilation was further stratified (subgroup: mid- to large-size aneurysms,  $2 < Z\text{-score} < 5$ , dilation only and/or small aneurysm Z-score = 5.0). Global, regional (base, middle, and apex), and segments (territory of CA dilation) native T1 values in 16 American Heart Association segmentation were measured and compared among groups.

### RESULTS

The global T1 value of KD patients in acute phase was the highest, followed by that of patients in chronic phase, and the global T1 value of controls was the lowest ( $1404.32 \pm 71.28$  vs  $1376.96 \pm 64.72$  vs  $1304.31 \pm 62.10$  ms,  $P < 0.01$ ). No significant difference in global and segmental native T1 values were observed between KD patients with and without CA dilation in acute and chronic phase, respectively (all  $P > 0.05$ ). No correlation was found between the Z-score and native T1 values of the corresponding coronary territories both in the acute and chronic phase (all  $P > 0.05$ ). Only in the chronic phase, global and segmental (territory of CA) T1 values of KD patients with mid- to large-size aneurysms were higher than that of dilation-only to small aneurysms. After adjusting for clinical characteristics, the multivariate analysis demonstrated that disease phase and age were associated with global T1 in KD patients ( $\beta = -0.223$ ,  $P = 0.007$ ;  $\beta = -0.346$ ,  $P = 0.001$ , model  $R^2 = 0.146$ ). Compared to controls, ROC curves showed the optimal cutoff value of global T1 value was 1369.53 ms (AUC 0.857) in the acute phase and 1344.32 ms (AUC 0.795) in the chronic phase.

## CONCLUSION

Native T1 mapping can quantitatively assess myocardial abnormalities in KD. Myocardial damage in KD patients exists in both acute and chronic phases, and is more severe in the acute phase. Native T1-quantified myocardial injury exists independently of CA dilation in the acute phase.

## CLINICAL RELEVANCE/APPLICATION

Based on these findings, the understanding of the pathogenesis of KD can be further improved.

## R6-SSPD05-5 Evolution of Diffusivity and Anisotropy in the Fetal Brain in the Second and Third Trimesters

Camilo A. Calixto, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Evaluate changes in fractional anisotropy (FA) and mean diffusivity (MD) in the cortical plate (CP) and subcortical white matter (scWM) of fetuses between 23 and 36 weeks of gestational age (GA).

### METHODS AND MATERIALS

Women aged 18-45 years with normal pregnancies were prospectively recruited. Subjects underwent 3T fetal MRI. We acquired DTI using 12 directions and b-values of 0 and 500 s/mm<sup>2</sup>. Each subject had 2-8 acquisitions along orthogonal planes, and data were reconstructed using a motion-tracked slice-to-volume registration algorithm. We used a spatiotemporal DTI atlas of fetal brain as a template for automatic segmentation. This template included labels for CP and scWM, parcellated to pre-frontal, posterior parietal, temporal, and occipital lobes, and motor and sensory cortex. We propagated labels to individual fetuses using a tensor-based registration algorithm and multiple-template-based fusion of probabilistic segmentations (STAPLE). Different models were fitted, and based on the Akaike information criterion, FA was evaluated using



an exponential model and MD using a quadratic one. For each model, we defined a point of change. For FA, this point was set where there was a decrease of less than 2% in two consecutive weeks; for MD, it was the parabola's vertex. Confidence intervals for these estimates were obtained via bootstrapping. We examined differences between hemispheres using a t-test over the bootstrapped samples.

## RESULTS

We included 44 fetuses with median GA of 32.1 weeks (IQR; 30.1, 34.4). FA in all CP and scWM parcellations followed an exponential decay trend. The scWM parcellations of frontal and temporal lobe, cingulum, and sensory cortex had a point of slow decay in FA before 36 weeks of GA. The sensory cortex had the earliest point of slow decay at 32.7 weeks. None of the CP parcellations had a point of slow decay in FA in our study period. We only found differences in points of slow decay between left and right hemispheres in the sensory cortex, cingulum, and temporal lobe scWM parcellations. MD in all CP and scWM parcellation followed a downward opened parabolic trend. Most ROIs showed a peak of MD between 27 and 29 weeks of GA. The sensory cortex had the earliest peak in both CP and aWM. We only found differences in change points between the left and right hemispheres in the motor cortex and cingulum CP parcellations.

## CONCLUSION

Our work utilized motion-corrected DTI to perform the first non-invasive evaluation of microstructural development of the CP and scWM in live fetuses. FA in the CP and scWM follows exponential decay, while MD in the CP and scWM has a parabolic trend.

## CLINICAL RELEVANCE/APPLICATION

These data provide insights into cytoarchitectonic changes at this critical period in human life and could enable earlier detection of abnormalities.

## R6-SSPD05-6 A New Quantitative Approach for Prenatal Diagnosis of Esophageal Atresia on Fetal MRI

Yukiko Michishita, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the diagnostic accuracy of a quantitative index for esophageal atresia (EA), and to calculate cutoff values for fetal MRI to distinguish fetuses with EA from those without, identified by a distended pharynx.

## METHODS AND MATERIALS

From our radiology database, we extracted 32 fetuses diagnosed with suspected EA from radiology reports over the past 20 years. Of these, 20 cases, excluding 12 cases in which esophageal atresia was ruled out after birth, were included [mean GA wks; 33 (range: 29-36), Gross EA classification; type C (n=17) and A (n=3)]. Similarly, 47 fetuses diagnosed as normal on the radiology report were selected for comparison [mean GA wks; 32 (range: 25-38)]. As a conventional qualitative diagnosis, the presence or absence of an esophageal pouch (EP) was determined. The anteroposterior diameters of the pharynx (P) and upper cervical spinal canal (SC) were measured and the P/SC ratio was calculated as a quantitative indicator. Two radiologists performed both evaluations independently based on sagittal images obtained using a bSSFP or SSTSE. We calculated sensitivity and specificity as indicators of the diagnostic performance. The mean P/SC ratio calculated by the two raters was used to compare the P/SC ratio between fetuses with/without EA. The optimal cutoff point of the P/SC ratio, suggesting EA, was analyzed by ROC-AUC, and was subjected to 2000 bootstrap resamples for internal validation. Inter-rater reliability was confirmed by k coefficient for EP and ICC for P/SC ratio. P-values less than 0.05 were considered statistically significant.

## RESULTS

The sensitivity and specificity for EP were 90.0% and 98.9%. The median P/SC ratio in fetuses with EA was 1.2 (IQR: 1.0-1.3) and those without EA was 0.9 (IQR: 0.8-1.1), and the P/SC ratio was significantly higher in fetuses with EA. Estimated cutoff value for EA in our data was 1.1. Analysis of the internal validation cohort yielded the best diagnostic P/SC ratio of 1.1 with AUC of 0.85 (95%CI; 0.73-0.95), sensitivity and specificity of 79.9% and 83.9%, respectively. K coefficient of EP, ICC(2,1) of P/SC ratio was 0.89, 0.95 (95%CI, 0.92-0.97).

## CONCLUSION

Addition of the objective P/SC ratio to the subjective findings (EP) could improve the diagnostic performance of fetal MRI for EA.

## CLINICAL RELEVANCE/APPLICATION

Esophageal pouch is the only direct sign of esophageal atresia, but cannot always be seen. Adding the P/SC ratio, a new quantitative index, to conventional qualitative assessment may improve the fetal diagnosis of esophageal atresia.



## Abstract Archives of the RSNA, 2023

R6-SSPD05-1

### Neonatal Pulmonary MRI at Term-Equivalent Age for Defining Bronchopulmonary Dysplasia Severity and Its Relationship with Short-Term Respiratory Outcomes

Thursday, Nov. 30 1:30PM - 2:30PM Room: N230B

Francesco Rizzetto, MD (*Presenter*) Travel support, Bracco Group

#### PURPOSE

This retrospective study aims to evaluate the potential of neonatal pulmonary magnetic resonance imaging (MRI), using commercially available sequences, to identify and quantify lung parenchymal injury associated with bronchopulmonary dysplasia (BPD) and predict short-term respiratory outcomes.

#### METHODS AND MATERIALS

Pulmonary MRI, using turbo spin echo and gradient echo sequences during natural sleep, was performed in premature infants, including infants with and without a clinical diagnosis of BPD. Lung MRIs were scored independently by two pediatric radiologists and one 4th year radiology resident, using the modified Ochiai scoring system and a new proposed score, the Bronchopulmonary Dysplasia Magnetic Resonance Index (BPDMRI), based on four hyperaeration (hyperexpansion, emphysema, cysts, mosaic pattern) and four parenchymal variables (triangular subpleural opacities, fibrous stripes and bands, edema and atelectasis, distortion of bronchovascular bundles). Both the modified Ochiai score and the BPDMRI were correlated with two short-term respiratory outcomes: the length of mechanical ventilation and the length of any respiratory support until discharge. The BPDMRI was also compared with the clinical definition of BPD between the severity groups. Intra- and inter-reader reproducibility of the BPDMRI were calculated.

#### RESULTS

The study included 25 premature infants (9 no-BPD and 16 BPD subjects). Pulmonary MRI showed a wide variety in appearance of pulmonary parenchyma among BPD patients and revealed significant structural differences across the range of MRI scores. Both the modified Ochiai score and the BPDMRI resulted positively correlated to the length of mechanical ventilation ( $r = 0.828$ ,  $p < 0.001$ ;  $r = 0.900$ ,  $p < 0.001$ ) and the length of any respiratory support until discharge ( $r = 0.897$ ,  $p < 0.001$ ;  $r = 0.953$ ,  $p < 0.001$ ). In the severe disease group, the length of respiratory support showed a smaller IQR when related with the BPDMRI rather than when related with the clinical definition. The BPDMRI had almost perfect intra-reader reproducibility and good inter-reader reproducibility.

#### CONCLUSION

Pulmonary MRI identified and objectively quantified lung parenchymal abnormalities associated with BPD, showing a strong correlation with the length of mechanical ventilation and the length of any respiratory support until discharge.

#### CLINICAL RELEVANCE/APPLICATION

Lung MRI may help identify infants with more serious disease and likely at greater risk for respiratory morbidities better than the severity stratification based on the clinical definition, proving its potential to contribute to a new definition of BPD based on the underlying pulmonary pathology and to predict short-term respiratory outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSPD05-2

### Assessment of 3D Hemi-Diaphragmatic Motion via Free-Breathing Dynamic MRI in Pediatric Thoracic Insufficiency Syndrome

Thursday, Nov. 30 1:30PM - 2:30PM Room: N230B

Mahdie Hosseini, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Thoracic insufficiency syndrome (TIS) is a condition that affects respiratory function due to spinal and thoracic deformities in pediatric subjects. When progressive deformities limit lung development, reconstructive surgery is performed to promote growth. We present a novel method for the analysis of the 3D motion of each hemi-diaphragm (HD) surface via free-breathing thoracic dynamic magnetic resonance imaging (dMRI) toward understanding lung function, evaluating the effect of surgical intervention, and long-term follow up.

#### METHODS AND MATERIALS

In a study of 49 children with TIS who underwent VEPTR surgery and 150 healthy children, we constructed 4D dMRI images from free-breathing dMRI acquisitions and manually delineated the diaphragm at end-expiration (EE) and end-inspiration (EI) time points. We automatically selected 25 points uniformly on each HD surface, obtained their velocities based on their inferior-superior displacements between the EE and EI time points, and derived mean velocities in 13 homologous regions for each HD surface to provide a measure of regional 3D HD motion. We compared between the motion of right HD (RHD) and left HD (LHD) in homologous regions in normal subjects and patients and before and after operation for patients via a paired T-test.

#### RESULTS

The normal group comprised of 49.4% males and 50.6% females, while the TIS group had 55.1% males and 44.9% females. The mean age was  $11.7 \pm 3.6$  years for the normal group and  $3.5 \pm 3.5$  and  $5.9 \pm 3.6$  years for the pre-op and post-op TIS subjects, respectively. In the normal group, the RHD exhibited a statistically significantly higher velocity compared to its homologous regions in LHD, and the posterior regions showed higher velocity than other regions in both RHD and LHD. In the TIS group, the velocities were generally significantly lower than in normal subjects, although the velocities generally increased post-operatively, particularly in RHD in posterior, central, and medial regions with statistical significance.

#### CONCLUSION

It is feasible to quantify the regional motion of the 3D diaphragm surface in normal subjects and TIS patients via free-breathing dMRI. Using this method, regional motion of the 3D HD surface can be assessed in comparison to normal subjects to study TIS and its corrective surgery.

#### CLINICAL RELEVANCE/APPLICATION

The proposed free-breathing 4D dynamic MRI method can be used to quantify the motion of the individual 3D hemi-diaphragm surface to assess deviation from normal and alteration due to corrective surgery in TIS.

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## Abstract Archives of the RSNA, 2023

R6-SSPD05-3

### Right Atrial Remodeling In Pediatric Patients with Repaired of Tetralogy of Fallot: A CMR Study

Thursday, Nov. 30 1:30PM - 2:30PM Room: N230B

Rong-Zhen Ouyang, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to evaluate the RA remodeling and atrioventricular interaction in young pediatric patients with repaired tetralogy of Fallot (rTOF) using cardiovascular magnetic resonance imaging (CMR).

#### METHODS AND MATERIALS

A total of 146 consecutive pediatric patients with rTOF & 9;(Table 1) who underwent clinically indicated CMR were included and 56 normal controls were recruited as control group according to the inclusion and exclusion criteria. On routine two and four chamber cine images, right atrial (RA) maximum volume (Vmax), passive volume (Vpac), and minimum volume (Vmin) as well as the corresponding ejection fraction (EF), including RA total EF, passive EF, and booster EF, were measured (Figure 1A). CMR biplane feature tracking of RA was performed to derive RA strain, including total strain (es), passive strain (ee) and active strain (ea), and the corresponding strain rate (SRs, SRe, SRa) (Figure 1B). Right atrioventricular coupling index (RAVCI) was & 9;defined for each participant by the ratio between RA volume and RV volume at end-diastole. GLS, GRS and FAC of RA were also derived from CMR feature tracking. Transthoracic echocardiography was performed on the same day to determine right ventricular (RV) diastolic function.

#### RESULTS

Patients with rTOF had higher RA volume and lower reservoir, conduit and booster function as well as GLS, GCS and FAC, compared to controls (Table 2). Patients with RV diastolic dysfunction (DD) had larger RA size and lower partial function than patients without RV DD (Table 3). RA Vmax, Vpac and Vmin index were all negatively associated with RA reservoir and conduit function (Figure 1C). RA volumetric data was positively associated with RV end-diastolic volume index (EDVi) and RV end-systolic volume index (ESVi) (Figure 1D). RA SRs and SRa were positively correlated with RV ESVi. The association of parameters between RV diastolic function and RA function were also found. RAVCI increased while LACVI decreased in patients with rTOF. LA Vmax, SV and function were lower in patients than in controls (Table 2).

#### CONCLUSION

RA three phasic structure and function demonstrated earlier remodeling than RV diastolic and systolic function impairment. There was atrioventricular interaction between RA and RV and atrial interaction between RA and LA. RA evaluation is clinically important in the management of patients with rTOF.

#### CLINICAL RELEVANCE/APPLICATION

This study comprehensively assessed RA structure and function remodeling using CMR in patient with rTOF. RA three phasic volume increased while function impaired, which were prior to remodeling of RV and associated with RV and LA function, highlighting a need for CMR assessment of RA remodeling.

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## Abstract Archives of the RSNA, 2023

R6-SSPD05-4

### Myocardial Native T1 Mapping in Children with Kawasaki Disease: Correlation with Disease Phase and Coronary Artery Dilation

Thursday, Nov. 30 1:30PM - 2:30PM Room: N230B

Shengkun Peng, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess myocardial abnormalities using native T1 mapping based on cardiac magnetic resonance (CMR) and investigate their relationship with disease phase and coronary artery (CA) dilation in children with Kawasaki disease (KD).

#### METHODS AND MATERIALS

Fifty-eight KD patients in the acute phase group (within 40 days of onset), 72 KD patients in the chronic phase group (onset>40 days, and 40 age- and sex-matched normal controls underwent a 3.0 T CMR examination. Each phase group was subdivided by Coronary Artery(CA)dilation. Z-score of >2 was defined as coronary artery dilation (CA dilation). In the CA dilation group, CA dilation was further stratified (subgroup: mid- to large-size aneurysms, $2 < Z\text{-score} < 5$ , dilation only and/or small aneurysm  $Z\text{-score} = 5.0$ ). Global, regional (base, middle, and apex), and segments (territory of CA dilation) native T1 values in 16 American Heart Association segmentation were measured and compared among groups.

#### RESULTS

The global T1 value of KD patients in acute phase was the highest, followed by that of patients in chronic phase, and the global T1 value of controls was the lowest ( $1404.32 \pm 71.28$  vs  $1376.96 \pm 64.72$  vs  $1304.31 \pm 62.10$ ms,  $P < 0.01$ ). No significant difference in global and segmental native T1 values were observed between KD patients with and without CA dilation in acute and chronic phase, respectively (all  $P > 0.05$ ). No correlation was found between the Z-score and native T1 values of the corresponding coronary territories both in the acute and chronic phase (all  $P > 0.05$ ). Only in the chronic phase, global and segmental(territory of CA)T1 values of KD patients with mid- to large-size aneurysms were higher than that of dilation-only to small aneurysms. After adjusting for clinical characteristics, the multivariate analysis demonstrated that disease phase and age were associated with global T1 in KD patients ( $\beta = -0.223$ ,  $P = 0.007$ ;  $\beta = -0.346$ ,  $P = 0.001$ , model  $R^2 = 0.146$ ). Compared to controls, ROC curves showed the optimal cutoff value of global T1 value was 1369.53 ms (AUC 0.857) in the acute phase and 1344.32 ms (AUC 0.795) in the chronic phase.

#### CONCLUSION

Native T1 mapping can quantitatively assess myocardial abnormalities in KD. Myocardial damage in KD patients exists in both acute and chronic phases, and is more severe in the acute phase. Native T1-quantified myocardial injury exists independently of CA dilation in the acute phase.

#### CLINICAL RELEVANCE/APPLICATION

Based on these findings, the understanding of the pathogenesis of KD can be further improved.

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## Abstract Archives of the RSNA, 2023

R6-SSPD05-5

### Evolution of Diffusivity and Anisotropy in the Fetal Brain in the Second and Third Trimesters

Thursday, Nov. 30 1:30PM - 2:30PM Room: N230B

Camilo A. Calixto, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Evaluate changes in fractional anisotropy (FA) and mean diffusivity (MD) in the cortical plate (CP) and subcortical white matter (scWM) of fetuses between 23 and 36 weeks of gestational age (GA).

#### METHODS AND MATERIALS

Women aged 18-45 years with normal pregnancies were prospectively recruited. Subjects underwent 3T fetal MRI. We acquired DTI using 12 directions and b-values of 0 and 500 s/mm<sup>2</sup>. Each subject had 2-8 acquisitions along orthogonal planes, and data were reconstructed using a motion-tracked slice-to-volume registration algorithm. We used a spatiotemporal DTI atlas of fetal brain as a template for automatic segmentation. This template included labels for CP and scWM, parcellated to pre-frontal, posterior parietal, temporal, and occipital lobes, and motor and sensory cortex. We propagated labels to individual fetuses using a tensor-based registration algorithm and multiple-template-based fusion of probabilistic segmentations (STAPLE). Different models were fitted, and based on the Akaike information criterion, FA was evaluated using an exponential model and MD using a quadratic one. For each model, we defined a point of change. For FA, this point was set where there was a decrease of less than 2% in two consecutive weeks; for MD, it was the parabola's vertex. Confidence intervals for these estimates were obtained via bootstrapping. We examined differences between hemispheres using a t-test over the bootstrapped samples.

#### RESULTS

We included 44 fetuses with median GA of 32.1 weeks (IQR; 30.1, 34.4). FA in all CP and scWM parcellations followed an exponential decay trend. The scWM parcellations of frontal and temporal lobe, cingulum, and sensory cortex had a point of slow decay in FA before 36 weeks of GA. The sensory cortex had the earliest point of slow decay at 32.7 weeks. None of the CP parcellations had a point of slow decay in FA in our study period. We only found differences in points of slow decay between left and right hemispheres in the sensory cortex, cingulum, and temporal lobe scWM parcellations. MD in all CP and scWM parcellation followed a downward opened parabolic trend. Most ROIs showed a peak of MD between 27 and 29 weeks of GA. The sensory cortex had the earliest peak in both CP and scWM. We only found differences in change points between the left and right hemispheres in the motor cortex and cingulum CP parcellations.

#### CONCLUSION

Our work utilized motion-corrected DTI to perform the first non-invasive evaluation of microstructural development of the CP and scWM in live fetuses. FA in the CP and scWM follows exponential decay, while MD in the CP and scWM has a parabolic trend.

#### CLINICAL RELEVANCE/APPLICATION

These data provide insights into cytoarchitectonic changes at this critical period in human life and could enable earlier detection of abnormalities.

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## Abstract Archives of the RSNA, 2023

R6-SSPD05-6

### A New Quantitative Approach for Prenatal Diagnosis of Esophageal Atresia on Fetal MRI

Thursday, Nov. 30 1:30PM - 2:30PM Room: N230B

Yukiko Michishita, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic accuracy of a quantitative index for esophageal atresia (EA), and to calculate cutoff values for fetal MRI to distinguish fetuses with EA from those without, identified by a distended pharynx.

#### METHODS AND MATERIALS

From our radiology database, we extracted 32 fetuses diagnosed with suspected EA from radiology reports over the past 20 years. Of these, 20 cases, excluding 12 cases in which esophageal atresia was ruled out after birth, were included [mean GA wks; 33 (range: 29-36), Gross EA classification; type C (n=17) and A (n=3)]. Similarly, 47 fetuses diagnosed as normal on the radiology report were selected for comparison [mean GA wks; 32 (range: 25-38)]. As a conventional qualitative diagnosis, the presence or absence of an esophageal pouch (EP) was determined. The anteroposterior diameters of the pharynx (P) and upper cervical spinal canal (SC) were measured and the P/SC ratio was calculated as a quantitative indicator. Two radiologists performed both evaluations independently based on sagittal images obtained using a bSSFP or SSTSE. We calculated sensitivity and specificity as indicators of the diagnostic performance. The mean P/SC ratio calculated by the two raters was used to compare the P/SC ratio between fetuses with/without EA. The optimal cutoff point of the P/SC ratio, suggesting EA, was analyzed by ROC-AUC, and was subjected to 2000 bootstrap resamples for internal validation. Inter-rater reliability was confirmed by k coefficient for EP and ICC for P/SC ratio. P-values less than 0.05 were considered statistically significant.

#### RESULTS

The sensitivity and specificity for EP were 90.0% and 98.9%. The median P/SC ratio in fetuses with EA was 1.2 (IQR: 1.0-1.3) and those without EA was 0.9 (IQR: 0.8-1.1), and the P/SC ratio was significantly higher in fetuses with EA. Estimated cutoff value for EA in our data was 1.1. Analysis of the internal validation cohort yielded the best diagnostic P/SC ratio of 1.1 with AUC of 0.85 (95%CI; 0.73-0.95), sensitivity and specificity of 79.9% and 83.9%, respectively. K coefficient of EP, ICC(2,1) of P/SC ratio was 0.89, 0.95 (95%CI, 0.92-0.97).

#### CONCLUSION

Addition of the objective P/SC ratio to the subjective findings (EP) could improve the diagnostic performance of fetal MRI for EA.

#### CLINICAL RELEVANCE/APPLICATION

Esophageal pouch is the only direct sign of esophageal atresia, but cannot always be seen. Adding the P/SC ratio, a new quantitative index, to conventional qualitative assessment may improve the fetal diagnosis of esophageal atresia.

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## Abstract Archives of the RSNA, 2023

R6-SSPH15

### Physics (Novel CT Systems and Methods)

Thursday, Nov. 30 1:30PM - 2:30PM Room: S501

Xiaochuan Pan, PhD (*Moderator*) Founder, XP Imaging, LLC; Shareholder, XP Imaging, LLC; Founder, XPIM, LLC; Shareholder, XPIM, LLC; Founder, Clarix Imaging Corp; Shareholder, Clarix Imaging Corp  
Scott Hsieh, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### R6-SSPH15-1 Cone-beam CT Imaging of Knee Fractures with a Super Short Scan

Dell P. Dunn, MD (*Presenter*) Research Grant, Samsung Electronics Co, Ltd;

#### PURPOSE

Cone-beam CT with flat panel detector is playing an increasingly important role in radiology. To get complete data for theoretically exact image reconstruction, the X-ray source trajectory must be non-planar and the detector wide enough to avoid transaxial data truncation. In practice, such conditions are very constraining: acquiring data on a circular arc is much easier, and data truncation cannot always be avoided depending on scanned anatomy and detector size. Ideally, the circular arc would at least cover 180 degrees plus the fan angle subtended by the region-of-interest, thereby defining a short scan. If the arc length is shorter, the data is only partially complete for theoretically exact reconstruction in the plane of the trajectory. We aim to show that such a super short scan with truncated projection data scan can nevertheless be of strong diagnostic value for knee imaging.

#### METHODS AND MATERIALS

23 patients referred from the Emergency Department with high suspicion for knee fracture were evaluated with super short scans and conventional radiographs (CR). All data were acquired on a twin-robotic X-ray system (Siemens Healthineers, Germany). The geometry of the system limits the scan angle for lying knee acquisitions to 171 degrees, and the data is transaxially truncated as the knee of interest is covered in each view while the other knee moves in and out of the field-of-view during the scan. The data was analyzed in a retrospective study with three radiologists of 1, 4, and 12 years of experience. They rated the 23 sets of images from the super short scans in terms of diagnostic value for inspection of both osseous structures and soft tissue (including effusion, a sign of fracture). They also provided confidence levels for detection of a tibial plateau fracture, of which 5 were present based on an adjudicating reader panel and review of medical records.

#### RESULTS

On a scale of 1 to 4 corresponding to "inadequate, somewhat adequate, adequate, more than adequate", the reader-averaged score of diagnostic value was  $3.39 \pm 0.06$  for inspection of osseous structures and  $3.32 \pm 0.09$  for soft tissue. Reader average AUC for detection of a tibial plateau fracture was 0.96 (80% confidence interval: [0.85, 0.99]), while AUC for detection of a tibial plateau fracture from CR was 0.8 (80% CI: [0.67, 0.89]). Given our paired study design, the difference was statistically significant with a p value of 0.056.

#### CONCLUSION

Despite inherent cone-beam and limited angle artifacts, super short scans of cone-beam data can be of high diagnostic value for evaluation for fracture in the knee.

#### CLINICAL RELEVANCE/APPLICATION

Advanced developments in cone-beam imaging have strong potential to improve patient healthcare through early detection of fractures otherwise missed on conventional radiographs.

### R6-SSPH15-2 The New Kid on the Block: Comparison Between Dynamic Digital Radiography (DDR) with Perfusion Assessment and CT Pulmonary Angiography (CTPA) in Evaluation of Suspected Pulmonary Thromboembolism



Anmol Dhawan, MBBS, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate the findings of dynamic digital radiography (DDR) in patients with suspected pulmonary thromboembolism (PTE) and compare them with findings of CT pulmonary angiography (CTPA) in patients with suspected PTE; and to define the role of DDR in patients with suspected or proven PTE.

## **METHODS AND MATERIALS**

Study design: Prospective analytical study. Population: Patients referred to the radiology department for a CTPA study to rule out PTE. Sample size: 24 (currently ongoing). Exclusion criteria: unstable and intubated patients. Equipment used: Shimadzu RadSpeed Pro Radiography System with Konica-Minolta DDR technology, Philips Incisive Pro 128-slice MDCT machine.

## **RESULTS**

This is an interim analysis of an ongoing pilot study. We currently have a comparison of 24 patients who underwent both CT pulmonary angiography (CTPA) and dynamic digital radiography (DDR) studies for evaluation of suspected pulmonary thromboembolism (PTE). We have used both qualitative and quantitative assessment of lung perfusion as provided by the DDR system. The primary quantitative parameter that we have used for assessment is the difference in the percentage share of total perfusion between both lungs, and correlating it with the presence or absence of thromboembolism on a CTPA study. In the interim analysis of our study, we have found a greater mean difference in inter-lung perfusion in patients with PTE (21%) than in patients without PTE (13%). However, a larger sample size is required to determine true statistical significance.

## **CONCLUSION**

To our knowledge, this is the first study comparing dynamic digital radiography (DDR) and CT pulmonary angiography for the assessment of pulmonary thromboembolism (PTE). So far in our study, DDR has shown promising results in evaluation of lung perfusion in patients with suspected pulmonary thromboembolism and may have a role in ruling out PTE and following up patients being treated for PTE. However, a larger sample size is required to determine true statistical significance.

## **CLINICAL RELEVANCE/APPLICATION**

Pulmonary thromboembolism (PTE) is an important cause of mortality in today's world. CT pulmonary angiography (CTPA) remains the gold standard for evaluation of these patients. However, it does have drawbacks such as requirement of intravenous iodinated contrast, significant radiation exposure and higher cost. Dynamic digital radiography (DDR) with perfusion assessment is an upcoming modality to evaluate patients with suspected PTE, and it offers a promising use in circumstances precluding the use of CTPA or for follow-up of patients, limiting exposure to ionizing radiation and iodinated contrast as well as saving cost.

## **R6-SSPH15-3 Quantification of Thoracic Duct Lymphatic Flow using Dynamic Contrast Enhanced CT Lymphangiography**

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

## **PURPOSE**

The thoracic duct is the largest lymphatic vessel in the human body and is responsible for draining lymphatic fluid from the lower limbs, abdomen, and thorax. The flow rate of lymphatic fluid through the thoracic duct is an important diagnostic parameter for a variety of medical conditions, including lymphedema, protein losing enteropathy, and heart failure. Currently, there is no reliable method for measuring the thoracic duct lymphatic flow rate. The purpose of this study was to develop and validate a non-invasive method for quantifying the thoracic duct lymphatic flow rate using dynamic contrast enhanced CT lymphangiography.

## **METHODS AND MATERIALS**

Initially an ultrasound flow probe was surgically implanted on the thoracic duct and used as the reference standard. Angiotensin II was infused in a subset of animals to increase the lymphatic flow rate. CT lymphangiography was acquired at 100 kV and 200 mA using a fast-pitched helical scan mode covering the entire thoracic duct following water-soluble iodinated contrast injection into bilateral inguinal lymph nodes. Specifically, two helical scans, acquired at the base and peak contrast enhancement of the thoracic duct, were used to measure CT lymphatic flow rate. Both first pass analysis and thresholding techniques for lymphatic flow measurement using dynamic contrast enhanced CT lymphangiography were validated. CT lymphatic flow measurements were compared to the reference flow probe measurements using regression, root-mean-square error (RMSE) and root-mean-square deviation (RMSD) analysis.

## **RESULTS**

Eleven swine (10 male; mean weight, 43.6±2.6 kg) were evaluated with 71 dynamic CT acquisitions. The lymphatic flow measurement using a first pass analysis (QFPA) and thresholding (QTHR) techniques were related to the reference flow measurements (QREF) by  $QFPA=1.01QREF+0.02$ ,  $r=0.98$ ,  $RMSE=0.13$  mL/min and  $RMSD=0.36$  mL/min and  $QTHR=0.84QREF+0.40$ ,  $r=0.87$ ,  $RMSE=0.28$  mL/min and  $RMSD=0.34$  mL/min.



## CONCLUSION

The study results showed that the first pass analysis and thresholding techniques could be used to accurately quantify lymphatic flow rate using dynamic contrast-enhanced CT lymphangiography. These techniques can potentially be used to noninvasively assess lymphatic flow rate in different disease states affecting the lymphatic system, including lymphedema, protein losing enteropathy, and heart failure.

## CLINICAL RELEVANCE/APPLICATION

This study can potentially provide important information about the flow rate of the thoracic duct in patients with suspected lymphatic abnormalities. The non-invasive method we develop for quantifying the thoracic duct lymphatic flow rate will have significant clinical implications for the diagnosis and treatment of lymphatic disorders.

## R6-SSPH15-4 Spectral Breast Computed Tomography (CT) Based on a CdTe Photon-counting Detector: Quantitative Contrast Imaging

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

### PURPOSE

To investigate the feasibility of iodine contrast quantification using dual-energy material decomposition with a dedicated cone beam breast Computed Tomography (CT) system based on a CdTe photon-counting detector in a postmortem breast study.

### METHODS AND MATERIALS

This study was performed with a prototype bench-top breast CT system, consisting of a tungsten target x-ray tube, a rotational platform controlled by a high precision stepper motor, and a prototype CdTe photon-counting 2D array detector. The CdTe energy-resolved detector has a pixel pitch of 75  $\mu\text{m}$  and a matrix size of 2070 by 514. The photon-counting detector has two energy thresholds, which can be used to acquire low and high energy images simultaneously within a single scan. Iodine contrast quantification is achieved through dual-energy material decomposition based on experimental phantom calibrations. Liquid iodine solutions of various iodine concentrations were used in the calibration. A non-linear fitting function was used to determine the iodine decomposition coefficients based on the phantom calibrations. Solid iodine disks, with concentrations ranging from 2 to 20 mg/ml, were inserted into postmortem breast for a validation study. The breast was shaped into a cylindrical shape, approximately 12 cm in diameter, and was imaged using 70 kVp and 114 mAs. The average glandular dose at this setting was estimated to be approximately 6 mGy based on a previously developed breast CT dose simulation package. Iodine signals from the low and high energy images were measured and used to derive the iodine concentrations using the iodine decomposition coefficients obtained in the calibration.

### RESULTS

The measured iodine concentrations from dual-energy material decomposition showed a good linear correlation with the known values (Pearson's  $R = 0.99$ ). The slope and the intercept from the linear fitting were derived to be 1.03 and -0.59 mg/ml, respectively. The root-mean-square (RMS) error and the standard error of estimate (SEE) were determined to be 0.97 mg/ml and 0.89 mg/ml.

## CONCLUSION

The results from this study show the feasibility of accurate iodine quantification in breast contrast imaging using the proposed CdTe photon-counting breast CT at a dose level equivalent to that of a standard two-view mammography.

## CLINICAL RELEVANCE/APPLICATION

The capability of iodine quantification in breast contrast imaging at a clinically relevant dose level with breast CT can significantly improve the predictive power of malignancy in breast cancer diagnosis.

## R6-SSPH15-5 Assessment of Diagnostic Quality of a Low-dose Dynamic CT Myocardial Perfusion Technique in a High-Fat Diet Swine Animal Model

Alireza Shojazadeh, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The purpose of this study was to evaluate the capability of a low-dose single-volume myocardial CT perfusion technique to assess changes in myocardial perfusion and coronary flow reserve (CFR) over the duration of a high-fat diet in a swine animal model.

### METHODS AND MATERIALS

Ten Swine (39.2 kg  $\pm$  11.0) fed a high-fat diet (HFD) between May 2022 and February 2023 were imaged using a 320-slice CT scanner under rest and stress (IV adenosine: 240  $\mu\text{g}/\text{mg}/\text{kg}/\text{min}$ ) conditions at 3, 4, 4.3, 4.7, 4.8 and 5.8 months of HFD. Twenty pairs of repeated CT measurements were made with approximately 10-minute delay between each acquisition under rest and stress conditions. Peripheral injection of contrast (0.5 mL/kg; 370 mgI/mL) and a diluted contrast/saline chaser (0.5

mL/kg; 30:70 contrast/saline) at 5 mL/s was followed by bolus tracking and a single volume scan acquired at the peak of the aortic enhancement (100kVp, 200 mA). Following image acquisition, myocardium segmentation was performed, and a first pass analysis model was used to derive perfusion in mL/min/g using the bolus-tracking and single volume scan data. Subsequently, rest and stress perfusion measurements were used for CFR computation. All volume scans were used for rest perfusion measurement (PREST), and sixteen volume scans were available for stress perfusion measurement (PSTRESS) and CFR computation. Correlation between the HFD duration and changes in both stress-induced myocardial perfusion and CFR were assessed via regression analysis. The CT dose index for the volume scans was also determined.

## RESULTS

Starting at 3 months following HFD, stress-induced myocardial perfusion measurements (PSTRESS) and CFR were correlated to HFD duration (T), as follows:  $PSTRESS = -0.19T + 2.35$  ( $r = -0.99$ ) and  $CFR = -0.25T + 3.04$  ( $r = -0.96$ ). The first (P1) and second (P2) single-volume CT perfusion measurements were related by  $P2 = 0.97 P1 + 0.05$  ( $r = 0.99$ , RMSE = 0.03 mL/min/g). The average CT dose index of the technique was only 7.4 mGy.

## CONCLUSION

A strong negative correlation was found between high-fat diet time duration and both CFR and stress-induced myocardial perfusion measurements using the low-dose single-volume myocardial CT perfusion technique. This technique can potentially assess myocardial perfusion and CFR for early diagnosis of coronary artery disease.

## CLINICAL RELEVANCE/APPLICATION

This low-dose dynamic CT perfusion technique can potentially allow for efficient treatment planning and preventive care as it allows can provide accurate, low-dose physiologic assessment of coronary artery disease.

## R6- SSPH15-6 Impact of a Novel Silicon-based Photon-counting CT Prototype on Plaque Burden, Plaque Composition and Blooming: An ex Vivo Phantom Study

Emma Verelst, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

To characterize vascular plaques with a silicon-based photon-counting CT prototype (Si-PCCT) in comparison with a conventional energy-integrating detector CT (EIDCT) system.

## METHODS AND MATERIALS

Ethical approval was obtained for the use of three human resected and formol-fixed arteries (carotid, femoral and iliac), which were centrally embedded in a cylindrical phantom ( $d = 20$  cm) filled with a 2% agar-water mixture. In one sample (iliac artery), a stainless steel covered stent (Atrium Advanta V12, Atrium Medical Corporation) was introduced. The arteries were filled with an iodine-based contrast solution (15 mg/mL with 0.9% saline). Helical scans were acquired using a prototype Si-PCCT and a conventional EIDCT system (Revolution CT, GE Healthcare) at similar scans parameters (120 kV, 40 mm collimation, 0.9 pitch, 1 s rotation and 17 mGy CTDIvol). Images were reconstructed with a bone kernel and ASIR0, a 15 cm field-of-view (FOV) and a slice thickness of 0.42 mm (Si-PCCT) and 0.63 mm (EIDCT). The plaques were characterized by evaluation of 1) plaque area, 2) area-based plaque burden, and 3) calcified plaque region, i.e. the area with CT-values  $> 1000$  HU. In addition, to evaluate the appearance of the plaque-stent interface, 4) blooming artefacts were quantified as the ratio between inner and outer stent diameter. Differences between Si-PCCT and EIDCT were tested using a paired sample t-test.

## RESULTS

On average, Si-PCCT resulted in 50% smaller plaque areas ( $p = 0.001$ ), a 9.6% reduction in plaque burden ( $p = 0.005$ ), and a 25.7% increase of heavily calcified regions ( $HU > 1000$ ) within plaques ( $p < 0.001$ ), when compared to EIDCT. The evaluation of the stented sample resulted in an average blooming reduction of 27.3% (Si-PCCT:  $34.6\% \pm 2\%$ ; EIDCT:  $61.9\% \pm 6\%$ ;  $p < 0.001$ ).

## CONCLUSION

This study demonstrated an improved spatial resolution of a novel Si-PCCT prototype for the characterization of plaques, based on plaque area, plaque burden, plaque composition and blooming, when compared to EIDCT.

## CLINICAL RELEVANCE/APPLICATION

EIDCT is prone to blooming and beam hardening artefacts, compromising plaque characterization. This study evaluated the impact of a Si-PCCT prototype on plaque characterization using an ex vivo vascular phantom.

## Abstract Archives of the RSNA, 2023

R6-SSPH15-1

### Cone-beam CT Imaging of Knee Fractures with a Super Short Scan

Thursday, Nov. 30 1:30PM - 2:30PM Room: S501

Dell P. Dunn, MD (*Presenter*) Research Grant, Samsung Electronics Co, Ltd;

#### PURPOSE

Cone-beam CT with flat panel detector is playing an increasingly important role in radiology. To get complete data for theoretically exact image reconstruction, the X-ray source trajectory must be non-planar and the detector wide enough to avoid transaxial data truncation. In practice, such conditions are very constraining: acquiring data on a circular arc is much easier, and data truncation cannot always be avoided depending on scanned anatomy and detector size. Ideally, the circular arc would at least cover 180 degrees plus the fan angle subtended by the region-of-interest, thereby defining a short scan. If the arc length is shorter, the data is only partially complete for theoretically exact reconstruction in the plane of the trajectory. We aim to show that such a super short scan with truncated projection data scan can nevertheless be of strong diagnostic value for knee imaging.

#### METHODS AND MATERIALS

23 patients referred from the Emergency Department with high suspicion for knee fracture were evaluated with super short scans and conventional radiographs (CR). All data were acquired on a twin-robotic X-ray system (Siemens Healthineers, Germany). The geometry of the system limits the scan angle for lying knee acquisitions to 171 degrees, and the data is transaxially truncated as the knee of interest is covered in each view while the other knee moves in and out of the field-of-view during the scan. The data was analyzed in a retrospective study with three radiologists of 1, 4, and 12 years of experience. They rated the 23 sets of images from the super short scans in terms of diagnostic value for inspection of both osseous structures and soft tissue (including effusion, a sign of fracture). They also provided confidence levels for detection of a tibial plateau fracture, of which 5 were present based on an adjudicating reader panel and review of medical records.

#### RESULTS

On a scale of 1 to 4 corresponding to "inadequate, somewhat adequate, adequate, more than adequate", the reader-averaged score of diagnostic value was  $3.39 \pm 0.06$  for inspection of osseous structures and  $3.32 \pm 0.09$  for soft tissue. Reader average AUC for detection of a tibial plateau fracture was 0.96 (80% confidence interval: [0.85, 0.99]), while AUC for detection of a tibial plateau fracture from CR was 0.8 (80% CI: [0.67,0.89]). Given our paired study design, the difference was statistically significant with a p value of 0.056.

#### CONCLUSION

Despite inherent cone-beam and limited angle artifacts, super short scans of cone-beam data can be of high diagnostic value for evaluation for fracture in the knee.

#### CLINICAL RELEVANCE/APPLICATION

Advanced developments in cone-beam imaging have strong potential to improve patient healthcare through early detection of fractures otherwise missed on conventional radiographs.

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## Abstract Archives of the RSNA, 2023

R6-SSPH15-2

### **The New Kid on the Block: Comparison Between Dynamic Digital Radiography (DDR) with Perfusion Assessment and CT Pulmonary Angiography (CTPA) in Evaluation of Suspected Pulmonary Thromboembolism**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S501

Anmol Dhawan, MBBS, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the findings of dynamic digital radiography (DDR) in patients with suspected pulmonary thromboembolism (PTE) and compare them with findings of CT pulmonary angiography (CTPA) in patients with suspected PTE; and to define the role of DDR in patients with suspected or proven PTE.

#### **METHODS AND MATERIALS**

Study design: Prospective analytical study. Population: Patients referred to the radiology department for a CTPA study to rule out PTE. Sample size: 24 (currently ongoing). Exclusion criteria: unstable and intubated patients. Equipment used: Shimadzu RadSpeed Pro Radiography System with Konica-Minolta DDR technology, Philips Incisive Pro 128-slice MDCT machine.

#### **RESULTS**

This is an interim analysis of an ongoing pilot study. We currently have a comparison of 24 patients who underwent both CT pulmonary angiography (CTPA) and dynamic digital radiography (DDR) studies for evaluation of suspected pulmonary thromboembolism (PTE). We have used both qualitative and quantitative assessment of lung perfusion as provided by the DDR system. The primary quantitative parameter that we have used for assessment is the difference in the percentage share of total perfusion between both lungs, and correlating it with the presence or absence of thromboembolism on a CTPA study. In the interim analysis of our study, we have found a greater mean difference in inter-lung perfusion in patients with PTE (21%) than in patients without PTE (13%). However, a larger sample size is required to determine true statistical significance.

#### **CONCLUSION**

To our knowledge, this is the first study comparing dynamic digital radiography (DDR) and CT pulmonary angiography for the assessment of pulmonary thromboembolism (PTE). So far in our study, DDR has shown promising results in evaluation of lung perfusion in patients with suspected pulmonary thromboembolism and may have a role in ruling out PTE and following up patients being treated for PTE. However, a larger sample size is required to determine true statistical significance.

#### **CLINICAL RELEVANCE/APPLICATION**

Pulmonary thromboembolism (PTE) is an important cause of mortality in today's world. CT pulmonary angiography (CTPA) remains the gold standard for evaluation of these patients. However, it does have drawbacks such as requirement of intravenous iodinated contrast, significant radiation exposure and higher cost. Dynamic digital radiography (DDR) with perfusion assessment is an upcoming modality to evaluate patients with suspected PTE, and it offers a promising use in circumstances precluding the use of CTPA or for follow-up of patients, limiting exposure to ionizing radiation and iodinated contrast as well as saving cost.

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## Abstract Archives of the RSNA, 2023

R6-SSPH15-3

### Quantification of Thoracic Duct Lymphatic Flow using Dynamic Contrast Enhanced CT Lymphangiography

Thursday, Nov. 30 1:30PM - 2:30PM Room: S501

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### PURPOSE

The thoracic duct is the largest lymphatic vessel in the human body and is responsible for draining lymphatic fluid from the lower limbs, abdomen, and thorax. The flow rate of lymphatic fluid through the thoracic duct is an important diagnostic parameter for a variety of medical conditions, including lymphedema, protein losing enteropathy, and heart failure. Currently, there is no reliable method for measuring the thoracic duct lymphatic flow rate. The purpose of this study was to develop and validate a non-invasive method for quantifying the thoracic duct lymphatic flow rate using dynamic contrast enhanced CT lymphangiography.

#### METHODS AND MATERIALS

Initially an ultrasound flow probe was surgically implanted on the thoracic duct and used as the reference standard. Angiotensin II was infused in a subset of animals to increase the lymphatic flow rate. CT lymphangiography was acquired at 100 kV and 200 mA using a fast-pitched helical scan mode covering the entire thoracic duct following water-soluble iodinated contrast injection into bilateral inguinal lymph nodes. Specifically, two helical scans, acquired at the base and peak contrast enhancement of the thoracic duct, were used to measure CT lymphatic flow rate. Both first pass analysis and thresholding techniques for lymphatic flow measurement using dynamic contrast enhanced CT lymphangiography were validated. CT lymphatic flow measurements were compared to the reference flow probe measurements using regression, root-mean-square error (RMSE) and root-mean-square deviation (RMSD) analysis.

#### RESULTS

Eleven swine (10 male; mean weight, 43.6±2.6 kg) were evaluated with 71 dynamic CT acquisitions. The lymphatic flow measurement using a first pass analysis (QFPA) and thresholding (QTHR) techniques were related to the reference flow measurements (QREF) by  $QFPA=1.01QREF+0.02$ ,  $r=0.98$ ,  $RMSE=0.13$  mL/min and  $RMSD=0.36$  mL/min and  $QTHR=0.84QREF+0.40$ ,  $r=0.87$ ,  $RMSE=0.28$  mL/min and  $RMSD=0.34$  mL/min.

#### CONCLUSION

The study results showed that the first pass analysis and thresholding techniques could be used to accurately quantify lymphatic flow rate using dynamic contrast-enhanced CT lymphangiography. These techniques can potentially be used to noninvasively assess lymphatic flow rate in different disease states affecting the lymphatic system, including lymphedema, protein losing enteropathy, and heart failure.

#### CLINICAL RELEVANCE/APPLICATION

This study can potentially provide important information about the flow rate of the thoracic duct in patients with suspected lymphatic abnormalities. The non-invasive method we develop for quantifying the thoracic duct lymphatic flow rate will have significant clinical implications for the diagnosis and treatment of lymphatic disorders.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-SSPH15-4

### **Spectral Breast Computed Tomography (CT) Based on a CdTe Photon-counting Detector: Quantitative Contrast Imaging**

Thursday, Nov. 30 1:30PM - 2:30PM Room: S501

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### **PURPOSE**

To investigate the feasibility of iodine contrast quantification using dual-energy material decomposition with a dedicated cone beam breast Computed Tomography (CT) system based on a CdTe photon-counting detector in a postmortem breast study.

#### **METHODS AND MATERIALS**

This study was performed with a prototype bench-top breast CT system, consisting of a tungsten target x-ray tube, a rotational platform controlled by a high precision stepper motor, and a prototype CdTe photon-counting 2D array detector. The CdTe energy-resolved detector has a pixel pitch of 75  $\mu\text{m}$  and a matrix size of 2070 by 514. The photon-counting detector has two energy thresholds, which can be used to acquire low and high energy images simultaneously within a single scan. Iodine contrast quantification is achieved through dual-energy material decomposition based on experimental phantom calibrations. Liquid iodine solutions of various iodine concentrations were used in the calibration. A non-linear fitting function was used to determine the iodine decomposition coefficients based on the phantom calibrations. Solid iodine disks, with concentrations ranging from 2 to 20 mg/ml, were inserted into postmortem breast for a validation study. The breast was shaped into a cylindrical shape, approximately 12 cm in diameter, and was imaged using 70 kVp and 114 mAs. The average glandular dose at this setting was estimated to be approximately 6 mGy based on a previously developed breast CT dose simulation package. Iodine signals from the low and high energy images were measured and used to derive the iodine concentrations using the iodine decomposition coefficients obtained in the calibration.

#### **RESULTS**

The measured iodine concentrations from dual-energy material decomposition showed a good linear correlation with the known values (Pearson's  $R = 0.99$ ). The slope and the intercept from the linear fitting were derived to be 1.03 and -0.59 mg/ml, respectively. The root-mean-square (RMS) error and the standard error of estimate (SEE) were determined to be 0.97 mg/ml and 0.89 mg/ml.

#### **CONCLUSION**

The results from this study show the feasibility of accurate iodine quantification in breast contrast imaging using the proposed CdTe photon-counting breast CT at a dose level equivalent to that of a standard two-view mammography.

#### **CLINICAL RELEVANCE/APPLICATION**

The capability of iodine quantification in breast contrast imaging at a clinically relevant dose level with breast CT can significantly improve the predictive power of malignancy in breast cancer diagnosis.

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## Abstract Archives of the RSNA, 2023

R6-SSPH15-5

### Assessment of Diagnostic Quality of a Low-dose Dynamic CT Myocardial Perfusion Technique in a High-Fat Diet Swine Animal Model

Thursday, Nov. 30 1:30PM - 2:30PM Room: S501

Alireza Shojazadeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the capability of a low-dose single-volume myocardial CT perfusion technique to assess changes in myocardial perfusion and coronary flow reserve (CFR) over the duration of a high-fat diet in a swine animal model.

#### METHODS AND MATERIALS

Ten Swine (39.2 kg  $\pm$  11.0) fed a high-fat diet (HFD) between May 2022 and February 2023 were imaged using a 320-slice CT scanner under rest and stress (IV adenosine: 240  $\mu$ g/mg/kg/min) conditions at 3, 4, 4.3, 4.7, 4.8 and 5.8 months of HFD. Twenty pairs of repeated CT measurements were made with approximately 10-minute delay between each acquisition under rest and stress conditions. Peripheral injection of contrast (0.5 mL/kg; 370 mgI/mL) and a diluted contrast/saline chaser (0.5 mL/kg; 30:70 contrast/saline) at 5 mL/s was followed by bolus tracking and a single volume scan acquired at the peak of the aortic enhancement (100kVp, 200 mA). Following image acquisition, myocardium segmentation was performed, and a first pass analysis model was used to derive perfusion in mL/min/g using the bolus-tracking and single volume scan data. Subsequently, rest and stress perfusion measurements were used for CFR computation. All volume scans were used for rest perfusion measurement (PREST), and sixteen volume scans were available for stress perfusion measurement (PSTRESS) and CFR computation. Correlation between the HFD duration and changes in both stress-induced myocardial perfusion and CFR were assessed via regression analysis. The CT dose index for the volume scans was also determined.

#### RESULTS

Starting at 3 months following HFD, stress-induced myocardial perfusion measurements (PSTRESS) and CFR were correlated to HFD duration (T), as follows:  $PSTRESS = -0.19T + 2.35$  ( $r = -0.99$ ) and  $CFR = -0.25T + 3.04$  ( $r = -0.96$ ). The first (P1) and second (P2) single-volume CT perfusion measurements were related by  $P2 = 0.97 P1 + 0.05$  ( $r = 0.99$ , RMSE = 0.03 mL/min/g). The average CT dose index of the technique was only 7.4 mGy.

#### CONCLUSION

A strong negative correlation was found between high-fat diet time duration and both CFR and stress-induced myocardial perfusion measurements using the low-dose single-volume myocardial CT perfusion technique. This technique can potentially assess myocardial perfusion and CFR for early diagnosis of coronary artery disease.

#### CLINICAL RELEVANCE/APPLICATION

This low-dose dynamic CT perfusion technique can potentially allow for efficient treatment planning and preventive care as it allows can provide accurate, low-dose physiologic assessment of coronary artery disease.

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## Abstract Archives of the RSNA, 2023

R6-SSPH15-6

### Impact of a Novel Silicon-based Photon-counting CT Prototype on Plaque Burden, Plaque Composition and Blooming: An ex Vivo Phantom Study

Thursday, Nov. 30 1:30PM - 2:30PM Room: S501

Emma Verelst, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To characterize vascular plaques with a silicon-based photon-counting CT prototype (Si-PCCT) in comparison with a conventional energy-integrating detector CT (EIDCT) system.

#### METHODS AND MATERIALS

Ethical approval was obtained for the use of three human resected and formol-fixated arteries (carotid, femoral and iliac), which were centrally embedded in a cylindrical phantom (d = 20 cm) filled with a 2% agar-water mixture. In one sample (iliac artery), a stainless steel covered stent (Atrium Advanta V12, Atrium Medical Corporation) was introduced. The arteries were filled with an iodine-based contrast solution (15 mg/mL with 0.9% saline). Helical scans were acquired using a prototype Si-PCCT and a conventional EIDCT system (Revolution CT, GE Healthcare) at similar scans parameters (120 kV, 40 mm collimation, 0.9 pitch, 1 s rotation and 17 mGy CTDIvol). Images were reconstructed with a bone kernel and ASIR0, a 15 cm field-of-view (FOV) and a slice thickness of 0.42 mm (Si-PCCT) and 0.63 mm (EIDCT). The plaques were characterized by evaluation of 1) plaque area, 2) area-based plaque burden, and 3) calcified plaque region, i.e. the area with CT-values > 1000 HU. In addition, to evaluate the appearance of the plaque-stent interface, 4) blooming artefacts were quantified as the ratio between inner and outer stent diameter. Differences between Si-PCCT and EIDCT were tested using a paired sample t-test.

#### RESULTS

On average, Si-PCCT resulted in 50% smaller plaque areas ( $p = 0.001$ ), a 9.6% reduction in plaque burden ( $p = 0.005$ ), and a 25.7% increase of heavily calcified regions (HU > 1000) within plaques ( $p < 0.001$ ), when compared to EIDCT. The evaluation of the stented sample resulted in an average blooming reduction of 27.3% (Si-PCCT: 34.6%  $\pm$  2%; EIDCT: 61.9%  $\pm$  6%;  $p < 0.001$ ).

#### CONCLUSION

This study demonstrated an improved spatial resolution of a novel Si-PCCT prototype for the characterization of plaques, based on plaque area, plaque burden, plaque composition and blooming, when compared to EIDCT.

#### CLINICAL RELEVANCE/APPLICATION

EIDCT is prone to blooming and beam hardening artefacts, compromising plaque characterization. This study evaluated the impact of a Si-PCCT prototype on plaque characterization using an ex vivo vascular phantom.

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## Abstract Archives of the RSNA, 2023

R6-STCE1

### Science Session (Generative AI)

Thursday, Nov. 30 1:30PM - 2:00PM Room: Learning Center Theater 1

#### Sub-Events

### R6-STCE1-1 PromptWise: Introducing Prompt Engineering Paradigm for Enhanced Patient-Large Language Model Interactions Towards Medical Education

Satvik Tripathi (*Presenter*) Nothing to Disclose

#### PURPOSE

Large language models (LLMs) have recently become popular for general-purpose use and are helpful for various tasks, including patient support. In this study, we present the PromptWise (Prompt engineering for Well-structured, Interactive, and Supportive Education) paradigm to focus on the applications of LLMs specifically in patient education, and explore how prompt engineering can improve patient interactions with LLMs for medical education. By crafting specific and context-rich prompts, patients can receive more accurate and relevant information, enhancing their understanding of medical conditions and facilitating better decision-making.

#### METHODS AND MATERIALS

Our study focuses on the development of a prompt engineering guideline (PromptWise) and the assessment of 25 paired radiology prompt scenarios. The PromptWise guidelines were derived through input from medical experts, a literature review, and iterative refinement. Each scenario featured a pair of prompts asking the same radiology-related query, with one prompt constructed following our PromptWise guidelines and the other not. Scenarios were focused on medical education and not clinical decision-making. Patient education aims to empower patients to be more involved in their condition or diagnosis by helping them make more informed decisions regarding their health. The responses generated by the LLM (OpenAI's GPT3.5) were recorded systematically for each pair. This data collection process facilitates a comprehensive analysis of the LLM's performance based on the varying prompt quality and development.

#### RESULTS

We developed six key pointers for the PromptWise guidelines and assessed them using 25 paired radiology prompt scenarios. The results demonstrate the tangible impact of prompt engineering on patient-LLM interactions. Prompts following our guidelines yielded accurate and relevant responses from the LLM (GPT3.5). In contrast, inconsistent prompts, which lacked essential details, led to inaccurate or irrelevant responses. The findings underline the potential of prompt engineering to enhance patient education and improve medical decision-making.

#### CONCLUSION

PromptWise will transform patient-LLM interactions by crafting specific, context-rich prompts; patients can receive accurate and relevant information, leading to an improved understanding of medical conditions, better decision-making, and increased patient empowerment. Well-structured prompts also reduce the risk of misinformation, support medical professionals, and offer tailored healthcare guidance.

#### CLINICAL RELEVANCE/APPLICATION

PromptWise guidelines will enable patients to access information, bridge knowledge gaps efficiently, and actively participate in their healthcare.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-STCE1-1

### **PromptWise: Introducing Prompt Engineering Paradigm for Enhanced Patient-Large Language Model Interactions Towards Medical Education**

Thursday, Nov. 30 1:30PM - 2:00PM Room: Learning Center Theater 1

Satvik Tripathi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Large language models (LLMs) have recently become popular for general-purpose use and are helpful for various tasks, including patient support. In this study, we present the PromptWise (Prompt engineering for Well-structured, Interactive, and Supportive Education) paradigm to focus on the applications of LLMs specifically in patient education, and explore how prompt engineering can improve patient interactions with LLMs for medical education. By crafting specific and context-rich prompts, patients can receive more accurate and relevant information, enhancing their understanding of medical conditions and facilitating better decision-making.

#### **METHODS AND MATERIALS**

Our study focuses on the development of a prompt engineering guideline (PromptWise) and the assessment of 25 paired radiology prompt scenarios. The PromptWise guidelines were derived through input from medical experts, a literature review, and iterative refinement. Each scenario featured a pair of prompts asking the same radiology-related query, with one prompt constructed following our PromptWise guidelines and the other not. Scenarios were focused on medical education and not clinical decision-making. Patient education aims to empower patients to be more involved in their condition or diagnosis by helping them make more informed decisions regarding their health. The responses generated by the LLM (OpenAI's GPT3.5) were recorded systematically for each pair. This data collection process facilitates a comprehensive analysis of the LLM's performance based on the varying prompt quality and development.

#### **RESULTS**

We developed six key pointers for the PromptWise guidelines and assessed them using 25 paired radiology prompt scenarios. The results demonstrate the tangible impact of prompt engineering on patient-LLM interactions. Prompts following our guidelines yielded accurate and relevant responses from the LLM (GPT3.5). In contrast, inconsistent prompts, which lacked essential details, led to inaccurate or irrelevant responses. The findings underline the potential of prompt engineering to enhance patient education and improve medical decision-making.

#### **CONCLUSION**

PromptWise will transform patient-LLM interactions by crafting specific, context-rich prompts; patients can receive accurate and relevant information, leading to an improved understanding of medical conditions, better decision-making, and increased patient empowerment. Well-structured prompts also reduce the risk of misinformation, support medical professionals, and offer tailored healthcare guidance.

#### **CLINICAL RELEVANCE/APPLICATION**

PromptWise guidelines will enable patients to access information, bridge knowledge gaps efficiently, and actively participate in their healthcare.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R6-STCE2

### Science Session (Sustainability in Imaging)

Thursday, Nov. 30 1:30PM - 2:00PM Room: Learning Center Theater 2

#### Sub-Events

#### R6-STCE2-1 Artificial Intelligence Enabled Acceleration Reduces the Carbon Footprint of MRI

Sean A. Woolen, MD, MS (*Presenter*) Research Grant, Siemens AG; Investigator, Siemens AG

##### PURPOSE

Deep learning (DL) powered MRI acceleration algorithms enable practices to reduce scanning time while reducing noise, keeping the same resolution, and preserving image quality. Our objective was to assess the potential energy, cost, and carbon savings resulting from DL acceleration.

##### METHODS AND MATERIALS

In this retrospective evaluation, an MRI was equipped with a power meter (1-Hz sampling rate). A phantom was scanned using traditional acquisition and a single vendor technique for DL acceleration for MRI head, cervical spine, and knee. Power measurement logs were extracted for exams. Data were segmented into individual sequences and total sequence energy consumption. Energy, time, cost (assuming a mean cost of \$0.14 per kilowatt hour), and carbon savings were calculated for the DL acceleration model. The projected annual savings were calculated using current procedure terminology codes for 2022 studies at a single institution. Data were summarized using descriptive statistics.

##### RESULTS

The standard protocol energy and duration for active scanning ranged from 5.3-9.3 kWh and 9.3-13.8 min. Compared to the standard protocols, DL acceleration reduced active scan time for brain MRI by 3.9 min (-41.8%), cervical spine MRI by 6.3 min (-45.7%), and knee MRI by 8.2 min (-66.3%). The decreased time resulted in 36.4% to 67.7% lower energy consumption between the protocols, translating to MRI exam savings ranging from 2.0-6.3 kWh, \$0.28-\$0.88, and 1.4-4.5 kilograms of carbon dioxide equivalent (Kg CO<sub>2</sub>eq). Applying these results to our institution's annual imaging volume, DL acceleration would save 31,362 kWh, \$4,391, and 22,226 Kg CO<sub>2</sub>eq for brain MRI; 9,240 kWh, \$1,294, and 6,548 Kg CO<sub>2</sub>eq for cervical spine MRI; and 7,812 kWh, \$1,094, and 5,536 Kg CO<sub>2</sub> eq for knee MRI.

##### CONCLUSION

Accelerated protocols using DL acceleration can result in more sustainable, energy-efficient, faster and lower cost MRI.

##### CLINICAL RELEVANCE/APPLICATION

It is crucial for radiologists and scientists to understand how deep learning acceleration can serve to mitigate energy consumption in medical imaging. This data will help institutions make informed decisions regarding Radiology operations and develop strategies to maximize the positive contributions of new acceleration methods.

#### R6-STCE2-2 Abbreviated MRI for Hepatocellular Carcinoma Screening Reduces Carbon Footprint

Sean A. Woolen, MD, MS (*Presenter*) Research Grant, Siemens AG; Investigator, Siemens AG

##### PURPOSE

Abbreviated MRI for hepatocellular carcinoma (HCC) screening enables practices to reduce scanning time while maintaining high sensitivity and specificity for early-stage cancer. We aimed to assess the potential energy, cost, time, and carbon savings resulting from an abbreviated MRI HCC screening exam with dynamic extracellular gadolinium-based contrast media.

##### METHODS AND MATERIALS

This is an IRB-approved retrospective single-center energy and time study. Inclusion criteria were hepatocellular carcinoma screening patients with an MRI. Exclusion criteria were studies with MRCP, Eovist, or pelvic imaging and incomplete studies.

Ten prospective observations were performed to determine differences between HCC screening exams. MRIs were equipped with a power meter (1-Hz sampling rate). Power measurement logs were extracted for a phantom and five patient exams for the abbreviated and full HCC screening protocol. Energy, time, cost (assuming a mean cost of \$0.14 per kilowatt hour), and carbon savings were calculated for the abbreviated HCC screening protocol. Exam duration for the larger dataset from November 2019 to June 2021 was extracted for 318 abbreviated MRIs and 169 full MRI screening studies. DICOM header data of total times were extracted using Quantivly. Mean full and abbreviated protocol times were assessed with a Welch's t-test. Energy data were summarized using descriptive statistics.

## **RESULTS**

The process map revealed the only differences between the full and abbreviated MRI exams were the study duration and energy consumption. The duration for the abbreviated protocol was 12.0 min +/- 4.3 min, compared with 29.7 +/- 8.8 min (mean +/- SD) for the full protocol (difference, 17.7 min; P < 0.0001). The study durations for the power-metered exams were similar to the times extracted from the DICOM files. The decreased study duration from the abbreviated protocol resulted in a 60.6% decrease in energy consumption, translating to MRI exam savings of 7.7 kWh, \$1.08, and 5.5 Kg CO<sub>2</sub>eq. Applying these results to the 318 abbreviated exams performed from Nov 2019 to June 2021 at our institution estimates a saving of 2,448.6 kWh, \$343.44, and 1,749 Kg CO<sub>2</sub>eq compared to the full protocol.

## **CONCLUSION**

Abbreviated protocols for hepatocellular screening can result in more sustainable, energy-efficient, faster, and lower-cost MRI. The amount of energy savings is nearly identical to time savings.

## **CLINICAL RELEVANCE/APPLICATION**

Radiology policymakers must understand the benefits of abbreviated versus full protocol for hepatocellular screening. This data will help institutions make informed decisions to optimize their radiology operations and policies.

## **R6-STCE2-3 Comparison of the carbon footprint of CT and wide-angle tomosynthesis**

Alan H. Zhao, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

Carbon emissions are a significant contributor to global climate changes. As a result, there is a need for a low carbon footprint, efficacious imaging method. The wide-angle carbon nanotube x-ray enabled stationary digital chest tomosynthesis system has unique traits that may make it a more sustainable and energy efficient imaging modality than computerized tomography (CT).

## **METHODS AND MATERIALS**

We reviewed the power usage of CT from multiple studies and compared them to our measured power usage of our wide-angle tomosynthesis system.

## **RESULTS**

A 2020 Swiss study found that a CT scanner that scanned 7904 patients over 1 year found that the CT scanner used 26226 kWh in total (active + idle/off time). This is comparable to 5 Swiss households of 4 people. Each scan required 3.32 kWh or 1.4 kg of CO<sub>2</sub> emissions equivalent. A 2022 Australian study found similar results, with each scan requiring 3.72 kWh or 1.6 kg of CO<sub>2</sub> emissions equivalent (active + idle/off time). For the wide-angle tomosynthesis system, each scan requires 0.005 kWh during active scan time or 0.002 kg of CO<sub>2</sub> emissions equivalent. Assuming an annual CT scan load of 7904 patients, the wide-angle tomosynthesis system requires 1000 kWh (active + idle/off time).

## **CONCLUSION**

For each active scan, the wide-angle tomosynthesis system requires 4% electricity. Using an average of 3.52 kWh per CT scan of the two studies and assuming an annual CT scan load of 7904 patients, the total CO<sub>2</sub> emissions equivalent saved is comparable to 2.4 years of an average gasoline-powered car. Alternatively, it is equivalent to the carbon sequestered by 13 acres of forest in one year. These energy savings are due to the fact that the wide-angle tomosynthesis system requires much less electricity and therefore has a lower carbon footprint than CT. To maximize imaging acquisition speed, CT machines are often placed in standby for hours at a time, increasing their electricity demands, especially as gantry rotation is maintained. The wide-angle tomosynthesis system does not require these high load standby periods and can be utilized to replace CT scans when clinically appropriate, such as lung nodule screening, calcium scoring and fracture evaluation.

## **CLINICAL RELEVANCE/APPLICATION**

Given the need to reduce carbon emissions, low carbon footprint imaging methods are necessary. The stationary digital tomosynthesis system has a lower carbon footprint than that of CT.

## Abstract Archives of the RSNA, 2023

R6-STCE2-1

### Artificial Intelligence Enabled Acceleration Reduces the Carbon Footprint of MRI

Thursday, Nov. 30 1:30PM - 2:00PM Room: Learning Center Theater 2

Sean A. Woolen, MD, MS (*Presenter*) Research Grant, Siemens AG; Investigator, Siemens AG

#### PURPOSE

Deep learning (DL) powered MRI acceleration algorithms enable practices to reduce scanning time while reducing noise, keeping the same resolution, and preserving image quality. Our objective was to assess the potential energy, cost, and carbon savings resulting from DL acceleration.

#### METHODS AND MATERIALS

In this retrospective evaluation, an MRI was equipped with a power meter (1-Hz sampling rate). A phantom was scanned using traditional acquisition and a single vendor technique for DL acceleration for MRI head, cervical spine, and knee. Power measurement logs were extracted for exams. Data were segmented into individual sequences and total sequence energy consumption. Energy, time, cost (assuming a mean cost of \$0.14 per kilowatt hour), and carbon savings were calculated for the DL acceleration model. The projected annual savings were calculated using current procedure terminology codes for 2022 studies at a single institution. Data were summarized using descriptive statistics.

#### RESULTS

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#### CONCLUSION

Accelerated protocols using DL acceleration can result in more sustainable, energy-efficient, faster and lower cost MRI.

#### CLINICAL RELEVANCE/APPLICATION

It is crucial for radiologists and scientists to understand how deep learning acceleration can serve to mitigate energy consumption in medical imaging. This data will help institutions make informed decisions regarding Radiology operations and develop strategies to maximize the positive contributions of new acceleration methods.

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## Abstract Archives of the RSNA, 2023

R6-STCE2-2

### Abbreviated MRI for Hepatocellular Carcinoma Screening Reduces Carbon Footprint

Thursday, Nov. 30 1:30PM - 2:00PM Room: Learning Center Theater 2

Sean A. Woolen, MD, MS (*Presenter*) Research Grant, Siemens AG; Investigator, Siemens AG

#### PURPOSE

Abbreviated MRI for hepatocellular carcinoma (HCC) screening enables practices to reduce scanning time while maintaining high sensitivity and specificity for early-stage cancer. We aimed to assess the potential energy, cost, time, and carbon savings resulting from an abbreviated MRI HCC screening exam with dynamic extracellular gadolinium-based contrast media.

#### METHODS AND MATERIALS

This is an IRB-approved retrospective single-center energy and time study. Inclusion criteria were hepatocellular carcinoma screening patients with an MRI. Exclusion criteria were studies with MRCP, Eovist, or pelvic imaging and incomplete studies. Ten prospective observations were performed to determine differences between HCC screening exams. MRIs were equipped with a power meter (1-Hz sampling rate). Power measurement logs were extracted for a phantom and five patient exams for the abbreviated and full HCC screening protocol. Energy, time, cost (assuming a mean cost of \$0.14 per kilowatt hour), and carbon savings were calculated for the abbreviated HCC screening protocol. Exam duration for the larger dataset from November 2019 to June 2021 was extracted for 318 abbreviated MRIs and 169 full MRI screening studies. DICOM header data of total times were extracted using Quantivly. Mean full and abbreviated protocol times were assessed with a Welch's t-test. Energy data were summarized using descriptive statistics.

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#### CONCLUSION

Abbreviated protocols for hepatocellular screening can result in more sustainable, energy-efficient, faster, and lower-cost MRI. The amount of energy savings is nearly identical to time savings.

#### CLINICAL RELEVANCE/APPLICATION

Radiology policymakers must understand the benefits of abbreviated versus full protocol for hepatocellular screening. This data will help institutions make informed decisions to optimize their radiology operations and policies.

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## Abstract Archives of the RSNA, 2023

R6-STCE2-3

### Comparison of the carbon footprint of CT and wide-angle tomosynthesis

Thursday, Nov. 30 1:30PM - 2:00PM Room: Learning Center Theater 2

Alan H. Zhao, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Carbon emissions are a significant contributor to global climate changes. As a result, there is a need for a low carbon footprint, efficacious imaging method. The wide-angle carbon nanotube x-ray enabled stationary digital chest tomosynthesis system has unique traits that may make it a more sustainable and energy efficient imaging modality than computerized tomography (CT).

#### METHODS AND MATERIALS

We reviewed the power usage of CT from multiple studies and compared them to our measured power usage of our wide-angle tomosynthesis system.

#### RESULTS

A 2020 Swiss study found that a CT scanner that scanned 7904 patients over 1 year found that the CT scanner used 26226 kWh in total (active + idle/off time). This is comparable to 5 Swiss households of 4 people. Each scan required 3.32 kWh or 1.4 kg of CO<sub>2</sub> emissions equivalent. A 2022 Australian study found similar results, with each scan requiring 3.72 kWh or 1.6 kg of CO<sub>2</sub> emissions equivalent (active + idle/off time). For the wide-angle tomosynthesis system, each scan requires 0.005 kWh during active scan time or 0.002 kg of CO<sub>2</sub> emissions equivalent. Assuming an annual CT scan load of 7904 patients, the wide-angle tomosynthesis system requires 1000 kWh (active + idle/off time).

#### CONCLUSION

For each active scan, the wide-angle tomosynthesis system requires 4% electricity. Using an average of 3.52 kWh per CT scan of the two studies and assuming an annual CT scan load of 7904 patients, the total CO<sub>2</sub> emissions equivalent saved is comparable to 2.4 years of an average gasoline-powered car. Alternatively, it is equivalent to the carbon sequestered by 13 acres of forest in one year. These energy savings are due to the fact that the wide-angle tomosynthesis system requires much less electricity and therefore has a lower carbon footprint than CT. To maximize imaging acquisition speed, CT machines are often placed in standby for hours at a time, increasing their electricity demands, especially as gantry rotation is maintained. The wide-angle tomosynthesis system does not require these high load standby periods and can be utilized to replace CT scans when clinically appropriate, such as lung nodule screening, calcium scoring and fracture evaluation.

#### CLINICAL RELEVANCE/APPLICATION

Given the need to reduce carbon emissions, low carbon footprint imaging methods are necessary. The stationary digital tomosynthesis system has a lower carbon footprint than that of CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-STCE1

### Science Session (Theranostics)

Thursday, Nov. 30 2:30PM - 3:00PM Room: Learning Center Theater 1

#### Sub-Events

### R7-STCE1-3 Deciphering the Disruption of Abnormal Functional Gradient Distribution and Brain Network Connectivity Decoupling in Spinocerebellar Ataxia Type 3

Heiko Meyer (*Presenter*) Employee, Siemens AG

#### PURPOSE

Purpose: To explore the functional and structural connectivity changes in the cerebellum and cerebrum in spinocerebellar ataxia type 3 (SCA3) patients,<sup>1</sup> using a novel gradient-based resting-state functional connectivity (FC) analysis approach and to examine their relationships with clinical factors as well as to identify potential therapeutic targets and theoretical foundations for SCA3 intervention

#### METHODS AND MATERIALS

We recruited 51 SCA3 patients and 59 healthy controls who underwent T1-MPRAGE, resting-state fMRI and diffusion tensor imaging (DTI) examination. We computed the FC gradients in the cerebellum and cerebrum to map the functional hierarchy from sensorimotor to supramodal regions. We also performed coupling analysis of FC and structural connectivity (SC) among regions of interest (ROIs) in the brain. We then correlated the quantitative values of ROIs with clinical variables such as CAG repeats, disease duration, ataxia scales, and cognitive tests.

#### RESULTS

SCA3 patients showed compression of the primary sensory-motor and supramodal gradient, indicating a loss of functional differentiation and integration in the cerebellum and cerebrum. They also exhibited disruption in the coupling of FC and SC, suggesting impaired communication between brain regions. Moreover, we found that FC gradient values in right calcarine were negatively associated with CAG repeats, ataxia severity, and cognitive impairment; FC values in left cerebellum crus I and right cerebellum crus II were positively associated with disease duration and verbal memory.

#### CONCLUSION

These findings propose a possible mechanism involving gradient abnormalities that explains the co-occurrence and interaction of low-level and high-level functional abnormalities in SCA3. On the other hand, the clarification of the pathophysiological significance of connectivity abnormalities in SCA3 hinges on a more comprehensive comprehension of how network architecture shapes and restricts functional processes.

#### CLINICAL RELEVANCE/APPLICATION

Our findings suggest that FC gradient analysis is a potential biomarker for SCA3 diagnosis and treatment evaluation.

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## Abstract Archives of the RSNA, 2023

R7-STCE1-3

### **Deciphering the Disruption of Abnormal Functional Gradient Distribution and Brain Network Connectivity Decoupling in Spinocerebellar Ataxia Type 3**

Thursday, Nov. 30 2:30PM - 3:00PM Room: Learning Center Theater 1

Heiko Meyer (*Presenter*) Employee, Siemens AG

#### **PURPOSE**

Purpose: To explore the functional and structural connectivity changes in the cerebellum and cerebrum in spinocerebellar ataxia type 3 (SCA3) patients, using a novel gradient-based resting-state functional connectivity (FC) analysis approach and to examine their relationships with clinical factors as well as to identify potential therapeutic targets and theoretical foundations for SCA3 intervention

#### **METHODS AND MATERIALS**

We recruited 51 SCA3 patients and 59 healthy controls who underwent T1-MPRAGE, resting-state fMRI and diffusion tensor imaging (DTI) examination. We computed the FC gradients in the cerebellum and cerebrum to map the functional hierarchy from sensorimotor to supramodal regions. We also performed coupling analysis of FC and structural connectivity (SC) among regions of interest (ROIs) in the brain. We then correlated the quantitative values of ROIs with clinical variables such as CAG repeats, disease duration, ataxia scales, and cognitive tests.

#### **RESULTS**

SCA3 patients showed compression of the primary sensory-motor and supramodal gradient, indicating a loss of functional differentiation and integration in the cerebellum and cerebrum. They also exhibited disruption in the coupling of FC and SC, suggesting impaired communication between brain regions. Moreover, we found that FC gradient values in right calcarine were negatively associated with CAG repeats, ataxia severity, and cognitive impairment; FC values in left cerebellum crus I and right cerebellum crus II were positively associated with disease duration and verbal memory.

#### **CONCLUSION**

These findings propose a possible mechanism involving gradient abnormalities that explains the co-occurrence and interaction of low-level and high-level functional abnormalities in SCA3. On the other hand, the clarification of the pathophysiological significance of connectivity abnormalities in SCA3 hinges on a more comprehensive comprehension of how network architecture shapes and restricts functional processes.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings suggest that FC gradient analysis is a potential biomarker for SCA3 diagnosis and treatment evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-STCE2

### Science Session (Generative AI)

Thursday, Nov. 30 2:30PM - 3:00PM Room: Learning Center Theater 2

#### Sub-Events

#### R7-STCE2-1 Large language model improves detection of negated expressions in radiology reports

Yvonne Su, BA (*Presenter*) Nothing to Disclose

##### PURPOSE

Named-entity recognition (NER) and negation detection are crucial to extract structured information from unstructured text. The extracted information can provide meaningful insights for clinical decision-making, patient care, and medical research. Large Language Models (LLMs), such as the Bidirectional Encoder Representations from Transformers (BERT), may improve understanding of text. This study compared the ability of a rule-based NLP system and an LLM—both trained for the medical domain—to correctly detect negated concepts in radiology reports.

##### METHODS AND MATERIALS

This HIPAA-compliant, IRB-approved study used a convenience sample of 1000 consecutive de-identified radiology reports from a large U.S.-based academic health system. Duplicate reports were excluded to yield the study cohort of 984 reports. The rule-based medspaCy system was applied to identify terms in the report text corpus from RadLex, the Unified Medical Language System (UMLS), and the Radiology Gamuts Ontology. An LLM, the Clinical Assertion and Negation Classification BERT (CAN-BERT), had been trained using MIMIC III and patient data from the i2b2/VA challenge. We compared medspaCy and CAN-BERT to detect negations of the identified entities. Power analysis determined a sample size of 382 pairs to achieve  $\alpha=0.05$ ,  $\beta=0.8$  for McNemar's test; based on 15% negated terms, 2800 randomly selected terms were annotated manually as affirmative or negative. The two models were compared with ground-truth annotations using McNemar's test. Precision, recall, and F1 were computed.

##### RESULTS

Of the 2800 terms, 387 (13.8%) were negated. For negation detection, medspaCy attained recall of 0.795, precision of 0.356, and F1 of 0.492. CAN-BERT achieved recall of 0.785, precision of 0.768, and F1 of 0.777. Although the models' recall was not significantly different, CAN-BERT had significantly better precision ( $\chi^2 = 304.64$ ;  $p < 0.001$ ).

##### CONCLUSION

The CAN-BERT LLM detected negated terms in radiology reports with high precision and recall; its precision significantly exceeded that of a rule-based system.

##### CLINICAL RELEVANCE/APPLICATION

Detection of negated expressions is crucial to accurately annotate radiology reports to: (1) improve training of image-based AI models and (2) enable discovery of causal relationships among diseases and findings in radiology reports.

#### R7-STCE2-2 Glioblastoma Monitoring using GPT-4 for Summarization of Radiological Reports

Robert Terzis, MD (*Presenter*) Nothing to Disclose

##### PURPOSE

Disease monitoring in patients with glioblastoma typically involves numerous consecutive cranial MRI scans, making the longitudinal evaluation of these patients a complex and resource-intensive task. The advent of large language models (LLMs) presents an opportunity to facilitate physician support by summarizing radiological results and disease tracking data. The purpose of this study was to evaluate this possibility, particularly focusing on the capacity of LLMs to extract meaningful information from complex textual input.

## METHODS AND MATERIALS

We retrospectively included 225 MRI examinations from 45 patients with biopsy-confirmed glioblastoma who were treated at our institution. The large language model, GPT-4, was supplied with the five most recent MRI reports, including clinical information in text form. The model's task was to synthesize the disease course, present the current state, and produce the R-code for a suitable graphic representation. Summaries generated by GPT-4 were evaluated by two experts in neuro-oncology with >20 and >8 years of experience, respectively. The evaluation categories included: (1) accuracy and logical-semantic representation, determined by assessing four distinct items on a binomial scale of "yes" or "no"; (2) overall quality; and (3) utility in patient monitoring and clinical decision-making, assessed using a 5-point Likert scale, with higher scores indicating more favorable results.

## RESULTS

The summaries derived from GPT-4 aligned with expert consensus about the disease course 86.7% of the time. GPT-4's disease course summaries received a median score of 4 in terms of quality and were perceived to have a median utility score of 3.

## CONCLUSION

GPT-4 efficiently summarized the course of the disease and pinpointed essential events with considerable accuracy, quality, and relevant usefulness for treating physicians.

## CLINICAL RELEVANCE/APPLICATION

Our results underline the potential of large language models for radiological and medical workflow optimization.

## R7-STCE2-3 Adapting Large Language Models for Personalized Impression Generation in PET reports: Expert Evaluation

Xin Tie, MS (*Presenter*) Nothing to Disclose

## PURPOSE

While large language models (LLMs) have been used in generating impressions for X-ray, CT, and MRI reports, adapting them for whole-body PET reports introduces new challenges: (1) the lengthy and complex PET findings, and (2) the necessity for impressions to be tailored to each physician's reporting style. In this study, we evaluated the performance of an LLM in generating personalized impressions for PET reports and identified remaining performance gaps.

## METHODS AND MATERIALS

In previous work, we developed a PEGASUS-based LLM on a corpus of 37,590 whole-body PET reports. The model, trained to generate impressions in the styles of different dictating physicians, outperformed 11 other state-of-the-art LLMs, including LLaMA and GPT2. In this work, we performed a reader study to evaluate different aspects of the model's performance. Three nuclear medicine physicians independently reviewed a total of 72 PET reports along with model-generated impressions. Each physician assessed 12 impressions originally dictated by themselves and generated in their own style, and 12 impressions dictated by other physicians; readers were blinded to dictating physicians during this assessment. These impressions were evaluated on 6 quality dimensions (3-point scale) and an overall utility score (5-point scale). The quality categories comprised (1) unnecessary additions; (2) important omissions; (3) factual correctness; (4) clarity and organization; (5) appropriate interpretations; and (6) valid recommendations for patient management. The overall utility score gauged the extent of changes needed to render an impression suitable for clinical use.

## RESULTS

When physicians reviewed their own reports, 72% (26/36) of the PEGASUS-generated impressions were clinically acceptable with minor or no changes and none received the lowest possible score, with a mean utility score of 4.08 out of 5. This score was significantly lower than the mean utility score (4.75) of clinical impressions originally dictated by the physicians themselves. The discrepancy was primarily attributed to "factual correctness" (Clinical vs. LLM: 2.97 vs. 2.58), "interpretations" (2.94 vs. 2.78), and "recommendations" (3.00 vs. 2.69). However, the physicians favored LLM impressions generated in their own style over the impressions dictated by other physicians.

## CONCLUSION

Our model produced clinically-useful and personalized PET impressions. However, model-generated impressions fell short in terms of factual accuracy, interpretation, and providing recommendations.

## CLINICAL RELEVANCE/APPLICATION

LLMs could expedite PET reporting by automatically drafting impressions based on the findings. The identified challenges provide directions for future research efforts.

## Abstract Archives of the RSNA, 2023

R7-STCE2-1

### Large language model improves detection of negated expressions in radiology reports

Thursday, Nov. 30 2:30PM - 3:00PM Room: Learning Center Theater 2

Yvonne Su, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Named-entity recognition (NER) and negation detection are crucial to extract structured information from unstructured text. The extracted information can provide meaningful insights for clinical decision-making, patient care, and medical research. Large Language Models (LLMs), such as the Bidirectional Encoder Representations from Transformers (BERT), may improve understanding of text. This study compared the ability of a rule-based NLP system and an LLM—both trained for the medical domain—to correctly detect negated concepts in radiology reports.

#### METHODS AND MATERIALS

This HIPAA-compliant, IRB-approved study used a convenience sample of 1000 consecutive de-identified radiology reports from a large U.S.-based academic health system. Duplicate reports were excluded to yield the study cohort of 984 reports. The rule-based medspaCy system was applied to identify terms in the report text corpus from RadLex, the Unified Medical Language System (UMLS), and the Radiology Gamuts Ontology. An LLM, the Clinical Assertion and Negation Classification BERT (CAN-BERT), had been trained using MIMIC III and patient data from the i2b2/VA challenge. We compared medspaCy and CAN-BERT to detect negations of the identified entities. Power analysis determined a sample size of 382 pairs to achieve  $\alpha=0.05$ ,  $\beta=0.8$  for McNemar's test; based on 15% negated terms, 2800 randomly selected terms were annotated manually as affirmative or negative. The two models were compared with ground-truth annotations using McNemar's test. Precision, recall, and F1 were computed.

#### RESULTS

Of the 2800 terms, 387 (13.8%) were negated. For negation detection, medspaCy attained recall of 0.795, precision of 0.356, and F1 of 0.492. CAN-BERT achieved recall of 0.785, precision of 0.768, and F1 of 0.777. Although the models' recall was not significantly different, CAN-BERT had significantly better precision ( $\chi^2 = 304.64$ ;  $p < 0.001$ ).

#### CONCLUSION

The CAN-BERT LLM detected negated terms in radiology reports with high precision and recall; its precision significantly exceeded that of a rule-based system.

#### CLINICAL RELEVANCE/APPLICATION

Detection of negated expressions is crucial to accurately annotate radiology reports to: (1) improve training of image-based AI models and (2) enable discovery of causal relationships among diseases and findings in radiology reports.

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## Abstract Archives of the RSNA, 2023

R7-STCE2-2

### Glioblastoma Monitoring using GPT-4 for Summarization of Radiological Reports

Thursday, Nov. 30 2:30PM - 3:00PM Room: Learning Center Theater 2

Robert Terzis, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Disease monitoring in patients with glioblastoma typically involves numerous consecutive cranial MRI scans, making the longitudinal evaluation of these patients a complex and resource-intensive task. The advent of large language models (LLMs) presents an opportunity to facilitate physician support by summarizing radiological results and disease tracking data. The purpose of this study was to evaluate this possibility, particularly focusing on the capacity of LLMs to extract meaningful information from complex textual input.

#### METHODS AND MATERIALS

We retrospectively included 225 MRI examinations from 45 patients with biopsy-confirmed glioblastoma who were treated at our institution. The large language model, GPT-4, was supplied with the five most recent MRI reports, including clinical information in text form. The model's task was to synthesize the disease course, present the current state, and produce the R-code for a suitable graphic representation. Summaries generated by GPT-4 were evaluated by two experts in neuro-oncology with >20 and >8 years of experience, respectively. The evaluation categories included: (1) accuracy and logical-semantic representation, determined by assessing four distinct items on a binomial scale of "yes" or "no"; (2) overall quality; and (3) utility in patient monitoring and clinical decision-making, assessed using a 5-point Likert scale, with higher scores indicating more favorable results.

#### RESULTS

The summaries derived from GPT-4 aligned with expert consensus about the disease course 86.7% of the time. GPT-4's disease course summaries received a median score of 4 in terms of quality and were perceived to have a median utility score of 3.

#### CONCLUSION

GPT-4 efficiently summarized the course of the disease and pinpointed essential events with considerable accuracy, quality, and relevant usefulness for treating physicians.

#### CLINICAL RELEVANCE/APPLICATION

Our results underline the potential of large language models for radiological and medical workflow optimization.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R7-STCE2-3

### Adapting Large Language Models for Personalized Impression Generation in PET reports: Expert Evaluation

Thursday, Nov. 30 2:30PM - 3:00PM Room: Learning Center Theater 2

Xin Tie, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

While large language models (LLMs) have been used in generating impressions for X-ray, CT, and MRI reports, adapting them for whole-body PET reports introduces new challenges: (1) the lengthy and complex PET findings, and (2) the necessity for impressions to be tailored to each physician's reporting style. In this study, we evaluated the performance of an LLM in generating personalized impressions for PET reports and identified remaining performance gaps.

#### METHODS AND MATERIALS

In previous work, we developed a PEGASUS-based LLM on a corpus of 37,590 whole-body PET reports. The model, trained to generate impressions in the styles of different dictating physicians, outperformed 11 other state-of-the-art LLMs, including LLaMA and GPT2. In this work, we performed a reader study to evaluate different aspects of the model's performance. Three nuclear medicine physicians independently reviewed a total of 72 PET reports along with model-generated impressions. Each physician assessed 12 impressions originally dictated by themselves and generated in their own style, and 12 impressions dictated by other physicians; readers were blinded to dictating physicians during this assessment. These impressions were evaluated on 6 quality dimensions (3-point scale) and an overall utility score (5-point scale). The quality categories comprised (1) unnecessary additions; (2) important omissions; (3) factual correctness; (4) clarity and organization; (5) appropriate interpretations; and (6) valid recommendations for patient management. The overall utility score gauged the extent of changes needed to render an impression suitable for clinical use.

#### RESULTS

When physicians reviewed their own reports, 72% (26/36) of the PEGASUS-generated impressions were clinically acceptable with minor or no changes and none received the lowest possible score, with a mean utility score of 4.08 out of 5. This score was significantly lower than the mean utility score (4.75) of clinical impressions originally dictated by the physicians themselves. The discrepancy was primarily attributed to "factual correctness" (Clinical vs. LLM: 2.97 vs. 2.58), "interpretations" (2.94 vs. 2.78), and "recommendations" (3.00 vs. 2.69). However, the physicians favored LLM impressions generated in their own style over the impressions dictated by other physicians.

#### CONCLUSION

Our model produced clinically-useful and personalized PET impressions. However, model-generated impressions fell short in terms of factual accuracy, interpretation, and providing recommendations.

#### CLINICAL RELEVANCE/APPLICATION

LLMs could expedite PET reporting by automatically drafting impressions based on the findings. The identified challenges provide directions for future research efforts.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSCH01

### Chest Imaging (Chest CT: Photon Counting and Dose Reduction)

Sunday, Nov. 26 9:00AM - 10:00AM Room: S401

Anastasia Oikonomou, MD, PhD (*Moderator*) Nothing to Disclose  
Fides R. Schwartz, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### S1-SSCH01-Radiological-Histological Correlation on Photon-Counting-Detector CT Using Cadaveric Human Lungs: Nodule and Airway Analysis<sup>1</sup>

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the performance of photon-counting-detector CT (PCD-CT) to evaluate nodules and airways (bronchioles and bronchi) compared with energy-integrating-detector CT (EID-CT) using cadaveric human lungs.

#### METHODS AND MATERIALS

Image data of 20 cadaveric lungs were acquired by both EID-CT and PCD-CT at radiation dose with a noise level equivalent to the diagnostic reference level image (CTDIvol: 9.0mGy). EID-CT images were reconstructed with 512 matrix and 0.6-mm thickness. PCD-CT images were reconstructed with two settings; PCD-512: same as C-CT; PCD-1024: 1024 matrix and 0.2-mm thickness. Two specimens per lung were obtained and examined using hematoxylin and eosin stains. The CT images were evaluated for nodules and airways on a 5-point scale comparing with histology (1=Not identifiable, 2=Barely identifiable, 3=Identifiable, but difficult to assess detail, 4=Partially consistent with histology, 5=Nearly consistent with histology). For identifiable nodules, the error rates were calculated as the absolute difference between the diameters on CT and the true diameters on histology divided by the true diameters. Objective noise in the lung parenchyma was evaluated by measuring standard deviation. The Wilcoxon signed-rank test with Bonferroni correction was used for statistical analyses.

#### RESULTS

In total, 70 nodules (median 1195  $\mu\text{m}$ , range 235 - 8803  $\mu\text{m}$ ) and 91 airways (median 855  $\mu\text{m}$ , range 204 - 3324  $\mu\text{m}$ ) in 40 specimens were evaluated. In terms of nodules, PCD-1024, PCD-512, and EID-CT scored significantly higher in that order (EID-CT,  $2.6 \pm 1.1$ ; PCD-512,  $2.8 \pm 1.1$ ; PCD-1024,  $3.7 \pm 1.4$ ; all  $p < 0.002$ ). The error rate on PCD-1024 tended to be lower than the others, but there was no significant difference (EID-CT,  $0.17 \pm 0.12$ ; PCD-512,  $0.18 \pm 0.16$ ; PCD-1024,  $0.14 \pm 0.11$ ; all  $p > 0.05$ ). In terms of airways, PCD-1024, PCD-512, and EID-CT scored significantly higher in that order (EID-CT,  $1.8 \pm 1.3$ ; PCD-512,  $2.0 \pm 1.4$ ; PCD-1024,  $2.6 \pm 1.7$ ; all  $p < 0.005$ ). Objective noise was significantly larger for PCD-1024, EID-CT and PCD-512 in that order (EID-CT,  $37 \pm 5\text{HU}$ ; PCD-512,  $27 \pm 5\text{HU}$ ; PCD-1024,  $44 \pm 7\text{H}$ ; all  $p < 0.001$ ).

#### CONCLUSION

This study histologically confirmed that PCD-CT images outperformed EID-CT in the assessment of nodules and airways, especially in the high-resolution setting with 1024 matrix and 0.2-mm thickness.

#### CLINICAL RELEVANCE/APPLICATION

PCD-CT is suitable for the assessment of nodules and airways in detail and has the potential to evaluate submillimeter nodules and bronchioles.

### S1-SSCH01-Photon Counting CT in the Chest: Improvements in Contrast-to-Noise Ratio and Radiation Dose Compared to Energy Integrating CT<sup>2</sup>

Pooyan Khalighinejad, MD (*Presenter*) Nothing to Disclose



## PURPOSE

To evaluate the use of Photon Counting Detector CT (PCD-CT) for dose-to-noise ratio and radiation dose improvements in chest CT imaging. This study compares PCD-CT to Energy Integrating Detector CT (EID-CT) by measuring radiation dose, image noise, and contrast-to-noise ratios (CNR) for four vital chest anatomy structures within the same patient cohort.

## METHODS AND MATERIALS

In this institutional review board (IRB)-approved, single-center, multi-vendor study 30 consecutive patients referred for routine chest CT underwent PCD-CT (NAEOTOM Alpha, Siemens) and had a previous EID-CT within the last two years. EID-CT systems included GE Optima CT660 and Revolution EVO (n = 17), Siemens SOMATOM Force (n = 6), Canon Aquilion (n = 6), and Philips IQon (n = 1). PCD-CT scans used 120 kVp, automated exposure control (AEC), 0.8 pitch, and 0.25 s rotation time; with images reconstructed using 2-mm thick slices at 60 keV (Br44 kernel, QIR 3). EID-CT scans followed standard clinical protocols with 100-120 kVp based on BMI and AEC; with images reconstructed using 2-mm or 2.5-mm thick slices and manufacturer-recommended kernels. A radiology resident measured CT numbers at three non-consecutive levels in the 1) right lung, 2) aorta, 3) pulmonary artery, 4) thyroid, 5) right latissimus dorsi, and 6) mediastinal fat. All regions of interest (ROIs) were approximately 1-cm<sup>2</sup> in area. The CT dose index volume (CTDIvol) and dose length product (DLP) were recorded for each scan. Image noise was defined as the standard deviation of CT numbers within the mediastinal fat. CNR was calculated as the difference between the mean CT number at each anatomical site and the latissimus dorsi muscle mean CT number, divided by image noise.

## RESULTS

The 30 patients included 15 females and 15 males with mean age of 61 years (range: 30-81 years) and mean BMI of 26.5 kg/m<sup>2</sup>. The median interval between the PCD-CT and EID-CT scans was 123 days (range: 38-425 days). Mean CTDIvol and DLP values were significantly smaller in PCD-CT as compared with EID-CT (P < 0.01 and P < 0.05, respectively). Image noise and CNR in the lung parenchyma were not significantly different. CNR in the aorta, pulmonary artery, and thyroid were significantly higher in PCD-CT compared to EID-CT (P < 0.001, P < 0.05, and P < 0.001, respectively).

## CONCLUSION

These findings reveal that PCD-CT significantly enhances the CNR of vascular and iodine-rich structures in chest CT while using a lower radiation dose compared to EID-CT.

## CLINICAL RELEVANCE/APPLICATION

Photon counting detector CT (PCD-CT) is an innovative technology that delivers enhanced contrast-to-noise ratio (CNR) of vital chest structures with reduced radiation exposure.

## S1-SSCH01-Super-High-Resolution Chest Imaging using CZT-Based Photon Counting CT: Performance Characterization and First Clinical Trial

Keiichi Nomura, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Recently, first clinical studies of CZT-based photon counting detector CT (CZT-PCD-CT) has started in Japan. Due to its small detector pixel design, CZT-PCD-CT provides super-high-resolution (SHR) imaging mode, and has potential to improve diagnostic quality for CT chest imaging. Deep learning reconstruction can also be used together with SHR mode to reduce the noise in high resolution imaging. This study aims to 1) quantify resolution benefits of the CZT-PCD-CT SHR mode in comparison to normal resolution mode (NR); 2) evaluate clinical image quality and potential clinical benefits of SHR mode in chest imaging.

## METHODS AND MATERIALS

The prototype CZT-PCD-CT is built based on a Aquilion Precision system (Canon Medical Systems, Japan). The beam coverage of the CZT-PCD-CT system is 40 mm. Catphan600 (The Phantom Laboratory, U.S) and patient scans were acquired in helical mode at 120 kVp, 250 mA (9.7 mGy), 0.5s rotation and pitch factor 0.8. The focal spot size is 0.4 mm\*0.5 mm. NR images were reconstructed using a 512-matrix size, and a hybrid-iterative reconstruction (Hybrid-IR). SHR images were reconstructed using a 1024-matrix size, and both Hybrid-IR and deep learning reconstruction method (DLR). The image thickness is 1.2 mm, lung kernel was used for all images. Visual evaluation and profile measurements are performed on Catphan with slit modules, and task-based transfer functions (TTF) are measured using Teflon module. Clinical chest images were assessed for NR and SHR image noise (SD) and anatomical structures in the lung fields.

## RESULTS

Slit profiles were visible up to 10 lp/cm in NR, 12 lp/cm in SHR and 12 lp/cm in SHR with DLR. TTF value at 10% was NR 1.1, SHR1.5 and SHR with DLR 2.5 cycles/mm. From the clinical images, the image noise levels of SHR and NR are acceptable for diagnostic tasks. The SHR mode with DLR shows the lowest noise level in all three methods (SD was 52.6 HU for NR, 73.4 HU for SHR and 45.5 HU for SHR with DLR). For chest imaging, ground glass opacity and bronchioles are better defined, and chest wall undershoot artifacts are significantly reduced in SHR images.



## CONCLUSION

The CZT-PCD-CT with super-high-resolution imaging mode has significantly improved spatial resolution and has potential in improving diagnostic accuracy for chest imaging.

## CLINICAL RELEVANCE/APPLICATION

The high-resolution images in the SHR mode of CZT-PCD-CT contribute to improved diagnostic performance in chest imaging.

## S1-SSCH01-Ultra-High-Resolution Spectral Characterization of Lung Airways with Deep-Silicon Photon-Counting CT: A Phantom Study

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

CT scanners with photon-counting detectors (PCDs) show significant potential for enhancing diagnostic value and image quality. Potential advantages of PCD-CT include reduced radiation exposure, always-on spectral capability, and spatial resolution of 150  $\mu\text{m}$  or better. A recently developed technology, edge-on-irradiated deep-Si PCD, has the potential to provide improved simultaneous spectral and spatial resolution compared to current CdTe/CdZnTe PCDs, which exhibit reduced energy resolution due to K-escape fluorescence and charge-sharing. Higher combined spatial and spectral resolution could improve visualization of small lung airways by resolving these in task-optimal virtual monoenergetic images (VMIs). This study aims to explore the benefits of deep-Si PCD-CT in chest CT for evaluating the airway walls and lumens.

## METHODS AND MATERIALS

We 3D-print seven airway models with different inner-wall diameters (0.75-2 mm) and wall thicknesses (0.75-1 mm) which are placed inside a 20 cm-diameter phantom filled with ballistic gel. We scan the phantom on a clinical prototype deep-Si PCD-CT scanner with the following parameters: 120 kVp, 300 mAs, 8 energy thresholds, 1 s rotation time. VMIs at 40, 70, and 140 keV are reconstructed using a filtered-backprojection algorithm with a prototype sharp kernel (10% modulation transfer function cutoff at 21.2 lp/cm) with  $125 \times 125 \times 417 \mu\text{m}^3$  voxel size. We measure airway lumen diameter and wall thickness through a series of line profiles ( $N = 63$ ), and contrast-to-noise ratio (CNR) between airway wall and air in the VMIs. The Wilcoxon signed rank test is used for all comparisons with  $p < 0.05$  being considered statistically significant.

## RESULTS

CNR is significantly lower for 40 keV images compared to 70 and 140 keV, with medians of 16.1, 19.8, and 20.1, respectively. The 70 keV images show significantly more accurate estimation of airway wall thickness (error 19-110  $\mu\text{m}$ ) and lumen diameter (error 30-105  $\mu\text{m}$ ) compared to the 40 keV and 140 keV images.

## CONCLUSION

Ultra-high-resolution (UHR) spectral imaging of the lung airways with deep-Si PCD realized subpixel ( $< 150 \mu\text{m}$ ) accuracy in measuring airway lumen and wall thickness in 70 keV VMIs. This is a small phantom study on a prototype scanner without any denoising algorithms applied. Additional algorithms may further improve the CNR and accuracy of airway measurements.

## CLINICAL RELEVANCE/APPLICATION

UHR PCD-CT improves visualization of small lung airways, and the spectral information used to generate VMIs can be utilized to maximize the CNR between airway walls and the lumen. The combined UHR VMI information may help improve characterization of changes in airways which may be of value in monitoring the treatment of diseases such as cystic fibrosis.

## S1-SSCH01-Investigating the Small Pixel Effect in Ultra-High-Resolution Photon-Counting CT of the Lung

Henner Huflage, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate potential benefits in image quality and radiation dose of ultra-high resolution (UHR) collimation over standard macro mode in ultra-low-dose photon-counting detector CT (PCD-CT) of the lung.

## METHODS AND MATERIALS

Six cadaveric specimens were examined with 5 dose settings using tin prefiltration, each with UHR ( $120 \times 0.2 \text{ mm}$ ) and standard collimation ( $144 \times 0.4 \text{ mm}$ ), with a first-generation PCD-CT scanner. Image quality was evaluated quantitatively by noise comparisons in the trachea and both main bronchi. Additionally, 16 readers (14 radiologists and 2 internal medicine physicians) independently completed a browser-based pairwise forced-choice comparison task for assessment of subjective image quality. Kendall's rank coefficient ( $W$ ) was calculated to assess interrater agreement, and Pearson's correlation coefficient ( $r$ ) was used to analyse the relationship between noise measurements and image quality rankings.

## RESULTS

Across all dose levels, image noise in UHR mode was lower than in macro mode for scan protocols matched by CTDIvol ( $p < 0.001$ ). UHR examinations exhibited noise levels comparable to the next higher dose setting in macro mode ( $p = 0.275$ ). Subjective ranking of protocols based on 5760 pairwise tests showed high interrater agreement ( $W = 0.99$ ;  $p = 0.001$ ) with UHR mode being preferred by readers in the majority of comparisons. Irrespective of scan mode, a substantial indirect correlation was observed between image noise and subjective image quality ranking ( $r = -0.97$ ;  $p < 0.001$ ).

## CONCLUSION

In PCD-CT of the lung, UHR collimation reduces image noise considerably over macro mode with standard collimation. This so-called "small pixel effect" allows for superior image quality in ultra-low-dose examinations with associated considerable potential for radiation dose reduction.

## CLINICAL RELEVANCE/APPLICATION

Exploiting the small pixel effect in UHR lung imaging by means of PCD-CT allows for both superior image quality and considerable radiation dose reduction.

## S1-SSCH01-Deep Learning Reconstruction vs. Hybrid-Type Iterative Reconstruction: Capability for Image Quality Improvement and Lung Finding Evaluation on Standard-, Reduced- and Ultra-Low-Dose High-Definition CTs

Daisuke Takenaka, MD (*Presenter*) Canon Medical Systems Corporation

## PURPOSE

High definition CTs (HDCTs) with and without a photon counting system have been clinically applied, although image noise for thinner section thickness is one of the drawbacks on HDCT. Moreover, deep learning reconstruction (DLR) has been introduced and compared with iterative reconstruction (IR) methods. The purpose of this study was to compare the capabilities of DLR for image quality improvement and lung finding evaluation with those of hybrid-type IR for standard-, reduced- and ultra-low dose CTs (SDCT, RDCT and ULDC) obtained with HDCT in patients with various pulmonary diseases.

## METHODS AND MATERIALS

Forty patients with various pulmonary diseases underwent SDCT (CT dose index volume  $<CTDIvol>$ : mean $\pm$ standard deviation,  $9.0 \pm 1.8$  mGy), RDCT ( $CTDIvol$ :  $1.7 \pm 0.2$  mGy) and ULDC ( $CTDIvol$ :  $0.8 \pm 0.1$  mGy) at a HDCT. All CT data set were then reconstructed at 0.25, 0.5 and 1mm section thicknesses with  $512 \times 512$  or  $1024 \times 1024$  matrixes by hybrid-type IR and DLR. SNR of lung parenchyma was assessed by ROI measurement. Probabilities of presence of major lung finding were independently evaluated by 5-point scoring system by two board-certified chest radiologists for each CT data set. SNR and detection performance of each lung finding were then compared between DLR and hybrid-type IR by paired t-tests and ROC analyses for all CT data at each section thickness. Inter-observer agreement for each lung finding was evaluated by  $\kappa$  statistics followed by  $\chi^2$  test.

## RESULTS

SNR of DLR was significantly higher than that of hybrid-type IR on each CT data ( $p < 0.0001$ ). Assessments of all findings except consolidation and nodules or masses, areas under the curve (AUCs) for ULDC with IR for each section thickness ( $0.91 = AUC = 0.97$ ) were significantly smaller than those of all CT data with DLR ( $0.97 = AUC = 1$ ,  $p < 0.05$ ) and the SDCT with hybrid-type IR ( $0.98 = AUC = 1$ ,  $p < 0.05$ ). All inter-observer agreements were determined to be substantial or almost perfect ( $0.72 = \kappa = 0.93$ ,  $p < 0.0001$ ).

## CONCLUSION

DLR is potentially more effective for image quality improvement and lung finding evaluation than hybrid-type IR on all radiation dose CTs obtained at HDCT in patients with a variety of pulmonary diseases.

## CLINICAL RELEVANCE/APPLICATION

DLR is potentially more effective for image quality improvement and lung finding evaluation than hybrid-type IR on all radiation dose CTs obtained at HDCT in patients with various pulmonary diseases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSCH01-1

### **Radiological-Histological Correlation on Photon-Counting-Detector CT Using Cadaveric Human Lungs: Nodule and Airway Analysis**

Sunday, Nov. 26 9:00AM - 10:00AM Room: S401

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the performance of photon-counting-detector CT (PCD-CT) to evaluate nodules and airways (bronchioles and bronchi) compared with energy-integrating-detector CT (EID-CT) using cadaveric human lungs.

#### **METHODS AND MATERIALS**

Image data of 20 cadaveric lungs were acquired by both EID-CT and PCD-CT at radiation dose with a noise level equivalent to the diagnostic reference level image (CTDIvol: 9.0mGy). EID-CT images were reconstructed with 512 matrix and 0.6-mm thickness. PCD-CT images were reconstructed with two settings; PCD-512: same as C-CT; PCD-1024: 1024 matrix and 0.2-mm thickness. Two specimens per lung were obtained and examined using hematoxylin and eosin stains. The CT images were evaluated for nodules and airways on a 5-point scale comparing with histology (1=Not identifiable, 2=Barely identifiable, 3=Identifiable, but difficult to assess detail, 4=Partially consistent with histology, 5=Nearly consistent with histology). For identifiable nodules, the error rates were calculated as the absolute difference between the diameters on CT and the true diameters on histology divided by the true diameters. Objective noise in the lung parenchyma was evaluated by measuring standard deviation. The Wilcoxon signed-rank test with Bonferroni correction was used for statistical analyses.

#### **RESULTS**

In total, 70 nodules (median 1195  $\mu$ m, range 235 - 8803  $\mu$ m) and 91 airways (median 855  $\mu$ m, range 204 - 3324  $\mu$ m) in 40 specimens were evaluated. In terms of nodules, PCD-1024, PCD-512, and EID-CT scored significantly higher in that order (EID-CT, 2.6 $\pm$ 1.1; PCD-512, 2.8 $\pm$ 1.1; PCD-1024, 3.7 $\pm$ 1.4; all  $p$ <0.002). The error rate on PCD-1024 tended to be lower than the others, but there was no significant difference (EID-CT, 0.17 $\pm$ 0.12; PCD-512, 0.18 $\pm$ 0.16; PCD-1024, 0.14 $\pm$ 0.11; all  $p$ >0.05). In terms of airways, PCD-1024, PCD-512, and EID-CT scored significantly higher in that order (EID-CT, 1.8 $\pm$ 1.3; PCD-512, 2.0 $\pm$ 1.4; PCD-1024, 2.6 $\pm$ 1.7; all  $p$ <0.005). Objective noise was significantly larger for PCD-1024, EID-CT and PCD-512 in that order (EID-CT, 37 $\pm$ 5HU; PCD-512, 27 $\pm$ 5HU; PCD-1024, 44 $\pm$ 7H; all  $p$  <0.001).

#### **CONCLUSION**

This study histologically confirmed that PCD-CT images outperformed EID-CT in the assessment of nodules and airways, especially in the high-resolution setting with 1024 matrix and 0.2-mm thickness.

#### **CLINICAL RELEVANCE/APPLICATION**

PCD-CT is suitable for the assessment of nodules and airways in detail and has the potential to evaluate submillimeter nodules and bronchioles.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSCH01-2

### Photon Counting CT in the Chest: Improvements in Contrast-to-Noise Ratio and Radiation Dose Compared to Energy Integrating CT

Sunday, Nov. 26 9:00AM - 10:00AM Room: S401

Pooyan Khalighinejad, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the use of Photon Counting Detector CT (PCD-CT) for dose-to-noise ratio and radiation dose improvements in chest CT imaging. This study compares PCD-CT to Energy Integrating Detector CT (EID-CT) by measuring radiation dose, image noise, and contrast-to-noise ratios (CNR) for four vital chest anatomy structures within the same patient cohort.

#### METHODS AND MATERIALS

In this institutional review board (IRB)-approved, single-center, multi-vendor study 30 consecutive patients referred for routine chest CT underwent PCD-CT (NAEOTOM Alpha, Siemens) and had a previous EID-CT within the last two years. EID-CT systems included GE Optima CT660 and Revolution EVO ( $n = 17$ ), Siemens SOMATOM Force ( $n = 6$ ), Canon Aquilion ( $n = 6$ ), and Philips IQon ( $n = 1$ ). PCD-CT scans used 120 kVp, automated exposure control (AEC), 0.8 pitch, and 0.25 s rotation time; with images reconstructed using 2-mm thick slices at 60 keV (Br44 kernel, QIR 3). EID-CT scans followed standard clinical protocols with 100-120 kVp based on BMI and AEC; with images reconstructed using 2-mm or 2.5-mm thick slices and manufacturer-recommended kernels. A radiology resident measured CT numbers at three non-consecutive levels in the 1) right lung, 2) aorta, 3) pulmonary artery, 4) thyroid, 5) right latissimus dorsi, and 6) mediastinal fat. All regions of interest (ROIs) were approximately 1-cm<sup>2</sup> in area. The CT dose index volume (CTDIvol) and dose length product (DLP) were recorded for each scan. Image noise was defined as the standard deviation of CT numbers within the mediastinal fat. CNR was calculated as the difference between the mean CT number at each anatomical site and the latissimus dorsi muscle mean CT number, divided by image noise.

#### RESULTS

The 30 patients included 15 females and 15 males with mean age of 61 years (range: 30-81 years) and mean BMI of 26.5 kg/m<sup>2</sup>. The median interval between the PCD-CT and EID-CT scans was 123 days (range: 38-425 days). Mean CTDIvol and DLP values were significantly smaller in PCD-CT as compared with EID-CT ( $P < 0.01$  and  $P < 0.05$ , respectively). Image noise and CNR in the lung parenchyma were not significantly different. CNR in the aorta, pulmonary artery, and thyroid were significantly higher in PCD-CT compared to EID-CT ( $P < 0.001$ ,  $P < 0.05$ , and  $P < 0.001$ , respectively).

#### CONCLUSION

These findings reveal that PCD-CT significantly enhances the CNR of vascular and iodine-rich structures in chest CT while using a lower radiation dose compared to EID-CT.

#### CLINICAL RELEVANCE/APPLICATION

Photon counting detector CT (PCD-CT) is an innovative technology that delivers enhanced contrast-to-noise ratio (CNR) of vital chest structures with reduced radiation exposure.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSCH01-3

### Super-High-Resolution Chest Imaging using CZT-Based Photon Counting CT: Performance Characterization and First Clinical Trial

Sunday, Nov. 26 9:00AM - 10:00AM Room: S401

Keiichi Nomura, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recently, first clinical studies of CZT-based photon counting detector CT (CZT-PCD-CT) has started in Japan. Due to its small detector pixel design, CZT-PCD-CT provides super-high-resolution (SHR) imaging mode, and has potential to improve diagnostic quality for CT chest imaging. Deep learning reconstruction can also be used together with SHR mode to reduce the noise in high resolution imaging. This study aims to 1) quantify resolution benefits of the CZT-PCD-CT SHR mode in comparison to normal resolution mode (NR); 2) evaluate clinical image quality and potential clinical benefits of SHR mode in chest imaging.

#### METHODS AND MATERIALS

The prototype CZT-PCD-CT is built based on a Aquilion Precision system (Canon Medical Systems, Japan). The beam coverage of the CZT-PCD-CT system is 40 mm. Catphan600 (The Phantom Laboratory, U.S) and patient scans were acquired in helical mode at 120 kVp, 250 mA (9.7 mGy), 0.5s rotation and pitch factor 0.8. The focal spot size is 0.4 mm\*0.5 mm. NR images were reconstructed using a 512-matrix size, and a hybrid-iterative reconstruction (Hybrid-IR). SHR images were reconstructed using a 1024-matrix size, and both Hybrid-IR and deep learning reconstruction method (DLR). The image thickness is 1.2 mm, lung kernel was used for all images. Visual evaluation and profile measurements are performed on Catphan with slit modules, and task-based transfer functions (TTF) are measured using Teflon module. Clinical chest images were assessed for NR and SHR image noise (SD) and anatomical structures in the lung fields.

#### RESULTS

Slit profiles were visible up to 10 lp/cm in NR, 12 lp/cm in SHR and 12 lp/cm in SHR with DLR. TTF value at 10% was NR 1.1, SHR 1.5 and SHR with DLR 2.5 cycles/mm. From the clinical images, the image noise levels of SHR and NR are acceptable for diagnostic tasks. The SHR mode with DLR shows the lowest noise level in all three methods (SD was 52.6 HU for NR, 73.4 HU for SHR and 45.5 HU for SHR with DLR). For chest imaging, ground glass opacity and bronchioles are better defined, and chest wall undershoot artifacts are significantly reduced in SHR images.

#### CONCLUSION

The CZT-PCD-CT with super-high-resolution imaging mode has significantly improved spatial resolution and has potential in improving diagnostic accuracy for chest imaging.

#### CLINICAL RELEVANCE/APPLICATION

The high-resolution images in the SHR mode of CZT-PCD-CT contribute to improved diagnostic performance in chest imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSCH01-4

### Ultra-High-Resolution Spectral Characterization of Lung Airways with Deep-Silicon Photon-Counting CT: A Phantom Study

Sunday, Nov. 26 9:00AM - 10:00AM Room: S401

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

CT scanners with photon-counting detectors (PCDs) show significant potential for enhancing diagnostic value and image quality. Potential advantages of PCD-CT include reduced radiation exposure, always-on spectral capability, and spatial resolution of 150  $\mu\text{m}$  or better. A recently developed technology, edge-on-irradiated deep-Si PCD, has the potential to provide improved simultaneous spectral and spatial resolution compared to current CdTe/CdZnTe PCDs, which exhibit reduced energy resolution due to K-escape fluorescence and charge-sharing. Higher combined spatial and spectral resolution could improve visualization of small lung airways by resolving these in task-optimal virtual monoenergetic images (VMIs). This study aims to explore the benefits of deep-Si PCD-CT in chest CT for evaluating the airway walls and lumens.

#### METHODS AND MATERIALS

We 3D-print seven airway models with different inner-wall diameters (0.75-2 mm) and wall thicknesses (0.75-1 mm) which are placed inside a 20 cm-diameter phantom filled with ballistic gel. We scan the phantom on a clinical prototype deep-Si PCD-CT scanner with the following parameters: 120 kVp, 300 mAs, 8 energy thresholds, 1 s rotation time. VMIs at 40, 70, and 140 keV are reconstructed using a filtered-backprojection algorithm with a prototype sharp kernel (10% modulation transfer function cutoff at 21.2 lp/cm) with  $125 \times 125 \times 417 \mu\text{m}^3$  voxel size. We measure airway lumen diameter and wall thickness through a series of line profiles ( $N = 63$ ), and contrast-to-noise ratio (CNR) between airway wall and air in the VMIs. The Wilcoxon signed rank test is used for all comparisons with  $p < 0.05$  being considered statistically significant.

#### RESULTS

CNR is significantly lower for 40 keV images compared to 70 and 140 keV, with medians of 16.1, 19.8, and 20.1, respectively. The 70 keV images show significantly more accurate estimation of airway wall thickness (error 19-110  $\mu\text{m}$ ) and lumen diameter (error 30-105  $\mu\text{m}$ ) compared to the 40 keV and 140 keV images.

#### CONCLUSION

Ultra-high-resolution (UHR) spectral imaging of the lung airways with deep-Si PCD realized subpixel ( $< 150 \mu\text{m}$ ) accuracy in measuring airway lumen and wall thickness in 70 keV VMIs. This is a small phantom study on a prototype scanner without any denoising algorithms applied. Additional algorithms may further improve the CNR and accuracy of airway measurements.

#### CLINICAL RELEVANCE/APPLICATION

UHR PCD-CT improves visualization of small lung airways, and the spectral information used to generate VMIs can be utilized to maximize the CNR between airway walls and the lumen. The combined UHR VMI information may help improve characterization of changes in airways which may be of value in monitoring the treatment of diseases such as cystic fibrosis.

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## Abstract Archives of the RSNA, 2023

S1-SSCH01-5

### Investigating the Small Pixel Effect in Ultra-High-Resolution Photon-Counting CT of the Lung

Sunday, Nov. 26 9:00AM - 10:00AM Room: S401

Henner Huflage, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate potential benefits in image quality and radiation dose of ultra-high resolution (UHR) collimation over standard macro mode in ultra-low-dose photon-counting detector CT (PCD-CT) of the lung.

#### METHODS AND MATERIALS

Six cadaveric specimens were examined with 5 dose settings using tin prefiltration, each with UHR (120 x 0.2 mm) and standard collimation (144 x 0.4 mm), with a first-generation PCD-CT scanner. Image quality was evaluated quantitatively by noise comparisons in the trachea and both main bronchi. Additionally, 16 readers (14 radiologists and 2 internal medicine physicians) independently completed a browser-based pairwise forced-choice comparison task for assessment of subjective image quality. Kendall's rank coefficient (W) was calculated to assess interrater agreement, and Pearson's correlation coefficient (r) was used to analyse the relationship between noise measurements and image quality rankings.

#### RESULTS

Across all dose levels, image noise in UHR mode was lower than in macro mode for scan protocols matched by CTDIvol ( $p < 0.001$ ). UHR examinations exhibited noise levels comparable to the next higher dose setting in macro mode ( $p = 0.275$ ). Subjective ranking of protocols based on 5760 pairwise tests showed high interrater agreement ( $W = 0.99$ ;  $p = 0.001$ ) with UHR mode being preferred by readers in the majority of comparisons. Irrespective of scan mode, a substantial indirect correlation was observed between image noise and subjective image quality ranking ( $r = -0.97$ ;  $p < 0.001$ ).

#### CONCLUSION

In PCD-CT of the lung, UHR collimation reduces image noise considerably over macro mode with standard collimation. This so-called "small pixel effect" allows for superior image quality in ultra-low-dose examinations with associated considerable potential for radiation dose reduction.

#### CLINICAL RELEVANCE/APPLICATION

Exploiting the small pixel effect in UHR lung imaging by means of PCD-CT allows for both superior image quality and considerable radiation dose reduction.

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## Abstract Archives of the RSNA, 2023

S1-SSCH01-6

### Deep Learning Reconstruction vs. Hybrid-Type Iterative Reconstruction: Capability for Image Quality Improvement and Lung Finding Evaluation on Standard-, Reduced- and Ultra-Low-Dose High-Definition CTs

Sunday, Nov. 26 9:00AM - 10:00AM Room: S401

Daisuke Takenaka, MD (*Presenter*) Canon Medical Systems Corporation

#### PURPOSE

High definition CTs (HDCTs) with and without a photon counting system have been clinically applied, although image noise for thinner section thickness is one of the drawbacks on HDCT. Moreover, deep learning reconstruction (DLR) has been introduced and compared with iterative reconstruction (IR) methods. The purpose of this study was to compare the capabilities of DLR for image quality improvement and lung finding evaluation with those of hybrid-type IR for standard-, reduced- and ultra-low dose CTs (SDCT, RDCT and ULDC) obtained with HDCT in patients with various pulmonary diseases.

#### METHODS AND MATERIALS

Forty patients with various pulmonary diseases underwent SDCT (CT dose index volume <CTDIvol>: mean±standard deviation, 9.0±1.8mGy), RDCT (CTDIvol: 1.7±0.2mGy) and ULDC (CTDIvol: 0.8±0.1mGy) at a HDCT. All CT data set were then reconstructed at 0.25, 0.5 and 1mm section thicknesses with 512×512 or 1024×1024 matrixes by hybrid-type IR and DLR. SNR of lung parenchyma was assessed by ROI measurement. Probabilities of presence of major lung finding were independently evaluated by 5-point scoring system by two board-certified chest radiologists for each CT data set. SNR and detection performance of each lung finding were then compared between DLR and hybrid-type IR by paired t-tests and ROC analyses for all CT data at each section thickness. Inter-observer agreement for each lung finding was evaluated by ? statistics followed by ?2 test.

#### RESULTS

SNR of DLR was significantly higher than that of hybrid-type IR on each CT data ( $p<0.0001$ ). Assessments of all findings except consolidation and nodules or masses, areas under the curve (AUCs) for ULDC with IR for each section thickness (0.91=AUC=0.97) were significantly smaller than those of all CT data with DLR (0.97=AUC=1,  $p<0.05$ ) and the SDCT with hybrid-type IR (0.98=AUC=1,  $p<0.05$ ). All inter-observer agreements were determined to be substantial or almost perfect (0.72=?=0.93,  $p<0.0001$ ).

#### CONCLUSION

DLR is potentially more effective for image quality improvement and lung finding evaluation than hybrid-type IR on all radiation dose CTs obtained at HDCT in patients with a variety of pulmonary diseases.

#### CLINICAL RELEVANCE/APPLICATION

DLR is potentially more effective for image quality improvement and lung finding evaluation than hybrid-type IR on all radiation dose CTs obtained at HDCT in patients with various pulmonary diseases.

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## Abstract Archives of the RSNA, 2023

S1-SSGU01

### Genitourinary Imaging (AI for Detection and Characterization of Genitourinary Cancers)

Sunday, Nov. 26 9:00AM - 10:00AM Room: S404

Baris Turkbey, MD (*Moderator*) Nothing to Disclose  
Jessica G. Fried, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### S1-SSGU01-2 Evaluation of a Cascaded Deep Learning-Based Algorithm for Prostate Lesion Detection on Biparametric MRI

Yue Lin, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate a deep learning-based AI algorithm for intraprostatic lesion detection and segmentation and to compare its performance with radiologist and biopsy results.

#### METHODS AND MATERIALS

This retrospective study included consecutive participants who were imaged with mpMRI and subsequently received MRI/ultrasound fusion-guided targeted and systematic biopsy from April 2019 to September 2022. All lesions were prospectively evaluated using PI-RADSv2.1. A previously developed deep learning-based AI algorithm was evaluated, the algorithm inputs included biparametric MRI sequences and the outputs included prostate organ and intraprostatic lesion segmentations. Algorithm performance was compared to a radiologist at both lesion- and participant-level using sensitivity, positive predictive value (PPV), false discovery rate (FDR), and Dice similarity coefficient (DSC). Gleason Grade Groups 2 and higher were considered as clinically significant prostate cancer. The algorithm performance was also examined using the histopathological outcomes, and the Wald test was used to compare the performance of the algorithm and the radiologist for cancer detection.

#### RESULTS

A total of 658 participants (median age, 67 years; interquartile range, 61-71 years) with 1029 MRI visible lesions were evaluated. On participant-level analysis using the radiologist as ground truth, the detection sensitivity of the AI was 93% (519/559; 95% confidence interval [CI]: 90, 95), PPV was 88% (519/594; 95% CI: 85, 90), and FDR was 13% (75/594; 95% CI: 10, 15). Mean number of false positive lesions per participant was 0.61 (range 0-3). DSC for lesion segmentation was 0.34. On histopathologic analysis, the algorithm identified 96% (282/294; 95% CI: 94, 98) of all participants with clinically significant prostate cancer versus 98% (287/294; 95% CI: 96, 99) identified by the radiologist ( $P = 0.23$ ). The algorithm detected 84% (103/122), 96% (152/159), 96% (47/49), 95% (38/40), and 98% (45/46) of participants with Gleason Grade Groups of 1, 2, 3, 4, and 5 lesions, respectively.

#### CONCLUSION

Validation of AI algorithms in clinical scenarios is critical for their translation, demonstrated here in a fully automated cascaded deep learning-based AI algorithm which can detect lesions suspicious for cancer on MRI with a reasonable performance comparable to a well-trained radiologist. Moreover, it was able to reliably predict clinically significant lesions on histopathology.

#### CLINICAL RELEVANCE/APPLICATION

A deep-learning AI can detect prostate cancer with radiologist-like performance on MRI and reliably predict clinically significant lesions on histopathology, which may aid in prostate cancer detection and reduce interpretation variability.

#### S1-SSGU01-3 Multiple Centre External Validation of an AI Solution for Prostate Cancer Diagnostic Imaging

Francesco Giganti, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Clinical translation of AI solutions for detection of clinically significant prostate cancer (csPCa) has been limited by the lack of validation on multi-centre datasets including multiple MRI scanners, vendors, field strengths and imaging protocols. Here, we evaluate the ability of an AI solution to generalise to real-world external validation data including blinded validation on an unseen site.

## METHODS AND MATERIALS

AI-based software was developed using PROSTATEx and retrospective data from five sites (794 patients, 34% csPCa). The software was evaluated on a blinded external validation set (252 patients - 42 per site, 31% csPCa, 9% with prior negative biopsy) of multiparametric (mpMRI) data obtained from six sites; one site was unseen during development, and data from other sites was from later time periods than the development set. This external data included six scanner models from two vendors, with different field strengths (1.5T/3.0T) and acquisition protocols. The software automatically outputs scores intended to identify Gleason score (GS)=3+4 csPCa per-patient. csPCa was confirmed by biopsy (GS=3+4 / PI-RADS =3), with PI-RADS 1/2 patients that did not receive a biopsy assumed negative. Exclusion criteria included quality issues such as severe motion and metal prostheses, active surveillance, prior prostate or bladder surgery or treatment including brachytherapy, TURP, prostatectomy, ablation, HIFU/focal therapy, or water vapour therapy. Performance was evaluated using ROC analysis, with 95% confidence intervals estimated by bootstrapping.

## RESULTS

For selecting patients for biopsy, the AI identified patients with csPCa with sensitivity 94% (95% CI 88-99%), specificity 57% (49-64%), NPV 95% (90-99%), and AUC 0.85 (0.80-0.90) using mpMRI data from the blinded external validation set. Comparing between sites, the AUC ranged from 0.70-0.98, with a pooled AUC of  $0.86 \pm 0.11$ . On the unseen site, the AUC was 0.95 (0.87-1.00). Reporting radiologists had per-patient sensitivity 99% (95% CI 96-100%) due to the assumed ground truth, specificity 73% (67-80%), NPV 99% (98-100%), and AUC 0.95 (0.92-0.97). In a 2019 Cochrane meta-analysis of 12 major studies (37% csPCa), radiologists identified patients with GS=3+4 csPCa with sensitivity 86% and specificity 42%.

## CONCLUSION

The proposed AI solution shows comparable performance to radiologists in major expert studies, on a large real-world, multi-centre, external validation dataset with different cs scanners, vendors, field strengths and imaging protocols.

## CLINICAL RELEVANCE/APPLICATION

AI could support prostate cancer detection in clinical practice, generalises to multiple sites, scanners and imaging protocols, and is robust to novel data.

## S1-SSGU01-5 Discerning Benign and Malignant T1a Renal Mass in CT Images using an End-to-end Deep Learning based Pipeline

Aakanksha Rana, PhD, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to evaluate the effectiveness of an end-to-end deep learning-based pipeline that can be used to assist physicians in pre-operatively diagnosing the malignancy of T1a renal masses. The pipeline functions by taking a preoperative CT scan as input, localizing the tumor region by segmenting it, and predicting the probability of malignancy in a fully automated fashion without requiring manual intervention.

## METHODS AND MATERIALS

This T1a-focused retrospective study was performed on 289 kidney cancer cases where malignancy was confirmed by histopathology; consisting of 224 malignant (82% clear cell, 9% papillary, 5% chromophobe, 1% multilocular, 1% tubulocystic) and 65 benign (51% oncocytoma, 13% angiomyolipoma, 3% mest, and 32% simple cysts). This T1a group was selected from a larger cohort of 697 RCC patients of all stages, collected from multiple centers in United States and Europe which were a part of a private and two publicly available datasets (Kidney Tumor Segmentation Challenge and TCGA-KIRC). Data from 289 T1a patients were used to train and validate the deep learning-based pipeline. A cascade of convolutional neural networks (CNNs) is used to segment the tumor for localization, and classify the segmented tumor region as benign or malignant. Validation metrics included dice scores for precise localization, and accuracy and area under the curve for malignancy at optimal output data cutoff values.

## RESULTS

A total of 289 patients with T1a RCC (224 malignant and 65 benign, median age 48 years; (12-79 years), 59% male and 41% female) were used to train and validate the pipeline following a five-fold cross validation process. The deep learning pipeline used a split of 80:20 for defining training and validation sets, respectively. For the first localization stage, a segmentation dice score of 0.83 was achieved. Then, for classification stage, an average area under the curve of 0.87 was observed with an accuracy of 0.82, a specificity of 0.81 (58 out of 65 patients) and sensitivity of 0.89 (180 out of 224 patients).

## **CONCLUSION**

An end-to-end "Localize-to-Classify" convolutional neural network-based framework demonstrates potential in the differentiation of T1a renal masses as benign or malignant using pre-op CT scans.

## **CLINICAL RELEVANCE/APPLICATION**

T1a Renal Cell Carcinoma (RCC) is the earliest stage of kidney cancer accounting for approximately 40% of kidney cancer cases in the United States. The diagnosis of T1a RCC is difficult due to its small size ( $\leq 40\text{mm}$ ), often resulting in over- or under-treatment of patients. Prior studies using tumors up to 70mm reported that radiologists could only correctly diagnose half of the malignant tumors pre-operatively.

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## Abstract Archives of the RSNA, 2023

S1-SSGU01-2

### Evaluation of a Cascaded Deep Learning-Based Algorithm for Prostate Lesion Detection on Biparametric MRI

Sunday, Nov. 26 9:00AM - 10:00AM Room: S404

Yue Lin, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate a deep learning-based AI algorithm for intraprostatic lesion detection and segmentation and to compare its performance with radiologist and biopsy results.

#### METHODS AND MATERIALS

This retrospective study included consecutive participants who were imaged with mpMRI and subsequently received MRI/ultrasound fusion-guided targeted and systematic biopsy from April 2019 to September 2022. All lesions were prospectively evaluated using PI-RADSv2.1. A previously developed deep learning-based AI algorithm was evaluated, the algorithm inputs included biparametric MRI sequences and the outputs included prostate organ and intraprostatic lesion segmentations. Algorithm performance was compared to a radiologist at both lesion- and participant-level using sensitivity, positive predictive value (PPV), false discovery rate (FDR), and Dice similarity coefficient (DSC). Gleason Grade Groups 2 and higher were considered as clinically significant prostate cancer. The algorithm performance was also examined using the histopathological outcomes, and the Wald test was used to compare the performance of the algorithm and the radiologist for cancer detection.

#### RESULTS

A total of 658 participants (median age, 67 years; interquartile range, 61-71 years) with 1029 MRI visible lesions were evaluated. On participant-level analysis using the radiologist as ground truth, the detection sensitivity of the AI was 93% (519/559; 95% confidence interval [CI]: 90, 95), PPV was 88% (519/594; 95% CI: 85, 90), and FDR was 13% (75/594; 95% CI: 10, 15). Mean number of false positive lesions per participant was 0.61 (range 0-3). DSC for lesion segmentation was 0.34. On histopathologic analysis, the algorithm identified 96% (282/294; 95% CI: 94, 98) of all participants with clinically significant prostate cancer versus 98% (287/294; 95% CI: 96, 99) identified by the radiologist ( $P = 0.23$ ). The algorithm detected 84% (103/122), 96% (152/159), 96% (47/49), 95% (38/40), and 98% (45/46) of participants with Gleason Grade Groups of 1, 2, 3, 4, and 5 lesions, respectively.

#### CONCLUSION

Validation of AI algorithms in clinical scenarios is critical for their translation, demonstrated here in a fully automated cascaded deep learning-based AI algorithm which can detect lesions suspicious for cancer on MRI with a reasonable performance comparable to a well-trained radiologist. Moreover, it was able to reliably predict clinically significant lesions on histopathology.

#### CLINICAL RELEVANCE/APPLICATION

A deep-learning AI can detect prostate cancer with radiologist-like performance on MRI and reliably predict clinically significant lesions on histopathology, which may aid in prostate cancer detection and reduce interpretation variability.

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## Abstract Archives of the RSNA, 2023

S1-SSGU01-3

### Multiple Centre External Validation of an AI Solution for Prostate Cancer Diagnostic Imaging

Sunday, Nov. 26 9:00AM - 10:00AM Room: S404

Francesco Giganti, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Clinical translation of AI solutions for detection of clinically significant prostate cancer (csPCa) has been limited by the lack of validation on multi-centre datasets including multiple MRI scanners, vendors, field strengths and imaging protocols. Here, we evaluate the ability of an AI solution to generalise to real-world external validation data including blinded validation on an unseen site.

#### METHODS AND MATERIALS

AI-based software was developed using PROSTATEx and retrospective data from five sites (794 patients, 34% csPCa). The software was evaluated on a blinded external validation set (252 patients - 42 per site, 31% csPCa, 9% with prior negative biopsy) of multiparametric (mpMRI) data obtained from six sites; one site was unseen during development, and data from other sites was from later time periods than the development set. This external data included six scanner models from two vendors, with different field strengths (1.5T/3.0T) and acquisition protocols. The software automatically outputs scores intended to identify Gleason score (GS)=3+4 csPCa per-patient. csPCa was confirmed by biopsy (GS=3+4 / PI-RADS =3), with PI-RADS 1/2 patients that did not receive a biopsy assumed negative. Exclusion criteria included quality issues such as severe motion and metal prostheses, active surveillance, prior prostate or bladder surgery or treatment including brachytherapy, TURP, prostatectomy, ablation, HIFU/focal therapy, or water vapour therapy. Performance was evaluated using ROC analysis, with 95% confidence intervals estimated by bootstrapping.

#### RESULTS

For selecting patients for biopsy, the AI identified patients with csPCa with sensitivity 94% (95% CI 88-99%), specificity 57% (49-64%), NPV 95% (90-99%), and AUC 0.85 (0.80-0.90) using mpMRI data from the blinded external validation set. Comparing between sites, the AUC ranged from 0.70-0.98, with a pooled AUC of  $0.86 \pm 0.11$ . On the unseen site, the AUC was 0.95 (0.87-1.00). Reporting radiologists had per-patient sensitivity 99% (95% CI 96-100%) due to the assumed ground truth, specificity 73% (67-80%), NPV 99% (98-100%), and AUC 0.95 (0.92-0.97). In a 2019 Cochrane meta-analysis of 12 major studies (37% csPCa), radiologists identified patients with GS=3+4 csPCa with sensitivity 86% and specificity 42%.

#### CONCLUSION

The proposed AI solution shows comparable performance to radiologists in major expert studies, on a large real-world, multi-centre, external validation dataset with different scanners, vendors, field strengths and imaging protocols.

#### CLINICAL RELEVANCE/APPLICATION

AI could support prostate cancer detection in clinical practice, generalises to multiple sites, scanners and imaging protocols, and is robust to novel data.

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## Abstract Archives of the RSNA, 2023

S1-SSGU01-5

### Discerning Benign and Malignant T1a Renal Mass in CT Images using an End-to-end Deep Learning based Pipeline

Sunday, Nov. 26 9:00AM - 10:00AM Room: S404

Aakanksha Rana, PhD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to evaluate the effectiveness of an end-to-end deep learning-based pipeline that can be used to assist physicians in pre-operatively diagnosing the malignancy of T1a renal masses. The pipeline functions by taking a preoperative CT scan as input, localizing the tumor region by segmenting it, and predicting the probability of malignancy in a fully automated fashion without requiring manual intervention.

#### METHODS AND MATERIALS

This T1a-focused retrospective study was performed on 289 kidney cancer cases where malignancy was confirmed by histopathology; consisting of 224 malignant (82% clear cell, 9% papillary, 5% chromophobe, 1% multilocular, 1% tubulocystic) and 65 benign (51% oncocytoma, 13% angiomyolipoma, 3% mest, and 32% simple cysts). This T1a group was selected from a larger cohort of 697 RCC patients of all stages, collected from multiple centers in United States and Europe which were a part of a private and two publicly available datasets (Kidney Tumor Segmentation Challenge and TCGA-KIRC). Data from 289 T1a patients were used to train and validate the deep learning-based pipeline. A cascade of convolutional neural networks (CNNs) is used to segment the tumor for localization, and classify the segmented tumor region as benign or malignant. Validation metrics included dice scores for precise localization, and accuracy and area under the curve for malignancy at optimal output data cutoff values.

#### RESULTS

A total of 289 patients with T1a RCC (224 malignant and 65 benign, median age 48 years; (12-79 years), 59% male and 41% female) were used to train and validate the pipeline following a five-fold cross validation process. The deep learning pipeline used a split of 80:20 for defining training and validation sets, respectively. For the first localization stage, a segmentation dice score of 0.83 was achieved. Then, for classification stage, an average area under the curve of 0.87 was observed with an accuracy of 0.82, a specificity of 0.81 (58 out of 65 patients) and sensitivity of 0.89 (180 out of 224 patients).

#### CONCLUSION

An end-to-end "Localize-to-Classify" convolutional neural network-based framework demonstrates potential in the differentiation of T1a renal masses as benign or malignant using pre-op CT scans.

#### CLINICAL RELEVANCE/APPLICATION

T1a Renal Cell Carcinoma (RCC) is the earliest stage of kidney cancer accounting for approximately 40% of kidney cancer cases in the United States. The diagnosis of T1a RCC is difficult due to its small size (= 40mm), often resulting in over- or under-treatment of patients. Prior studies using tumors up to 70mm reported that radiologists could only correctly diagnose half of the malignant tumors pre-operatively.

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## Abstract Archives of the RSNA, 2023

S1-SSHNO1

### Science Session with Keynote: Head and Neck Imaging (Advanced Techniques in Head and Neck Imaging)

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353B

Sara G. Tedla, MD (*Moderator*) Nothing to Disclose  
Noriyuki Fujima, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### S1-SSHNO1-1 Oral Cavity Ultrasonography: Our Preliminary Experience

Vittorio Patane' (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultra-high Frequency Ultrasound (UHFUS) is a recent-evolving technique used to study oral lesions. This study aims to assess potential role of intraoral UHFUS in evaluating parameters such as Tumor Thickness (TT) and Depth of Invasion (DOI) in Oral Squamous Cell Carcinoma (OSCC).

#### METHODS AND MATERIALS

Twelve patients, aged 48 to 74 years, presenting with oral cavity, gum, or tongue lesions between January 2022 and April 2023 suspected of having OSCC were examined by a skilled examiner using intraoral UHFUS prior to surgery. Subsequently, an anatomopathological examination was performed. UHFUS features were then compared to the histological findings.

#### RESULTS

Ten patients were diagnosed with several oral pathologies including infiltrating squamous carcinoma, fibrous dysplasia, candidiasis, squamous carcinoma, and post-traumatic fibroma. Ultrasonographic assessment revealed hypoechoic structures with irregular, stellate borders and increased vascularity around the infiltrating squamous mucosal and submucosal regions in cases of infiltrating squamous carcinoma. Candidiasis with ulceration appeared as a hyper-echoic gap with frayed margins and heterogeneous submucosal involvement. Sublingual fibroma presented as an isoechoic esophytic lesion with well-defined margins. All lesions were pathologically confirmed except for a recurrent lesion involving the posterior gingival angle and both the soft and hard palate regions. The study found a positive correlation between UHFUS measurements and histology for both TT and DOI, although UHFUS slightly overestimated the latter. The site of the lesion did not significantly affect echogenicity or vascularization.

#### CONCLUSION

Emerging as a non-invasive method, UHFUS has proven useful for investigating both endo- and exophytic lesions within the oral cavity. The main limitation lies in the inability to image lesions located in the posterior aspect of the hard palate or soft palate. Our preliminary experience, although limited in samplesize, has demonstrated consistent correspondence between UHFUS and pathological anatomy. These findings highlight the potential of UHFUS as a valuable technique for evaluating oral lesions and offer guidance for its inclusion within diagnostic and surgical management protocols. In conclusion, intraoral UHFUS has presented promising potential for OSCC due to its significant correlation with histology.

#### CLINICAL RELEVANCE/APPLICATION

These findings highlight the potential of UHFUS as a valuable technique for evaluating oral lesions and offer guidance for its inclusion within diagnostic and surgical management protocols. In conclusion, intraoral UHFUS has presented promising potential for OSCC due to its significant correlation with histology.

### S1-SSHNO1-3 An AI-driven end-to-end Segmentation Tool for Extraocular Muscles Affecting Thyroid Eye Disease (TED)

Vikash Gupta, PhD, MS (*Presenter*) Nothing to Disclose



## PURPOSE

Thyroid Eye Disease (TED), also known as Graves' ophthalmopathy or orbitopathy, is a condition that affects patients with autoimmune hyperthyroidism. It is caused by the activation of orbital fibroblasts by thyroid autoantibodies leading to their proliferation, differentiation, and the deposition of glycosaminoglycans, ultimately leading to varying degrees of enlargement of the extraocular muscles and an increase in orbital fat. The resulting symptoms of TED can include exophthalmos, lagophthalmos, diplopia, and periorbital edema as well as compressive optic neuropathy which can lead to permanent blindness. We developed a system for automated segmentation of 10 non-osseous structures in the orbit for the purpose of longitudinal morphological monitoring as the disease progresses or responds to treatment.

## METHODS AND MATERIALS

We identified neuroradiologist-verified CT scans of normal orbits (n=32) and 10 orbits affected by TED (n=32). Orbital structures (globe, optic nerve, fat, lacrimal gland, and 6 extraocular muscles) were manually segmented on each orbit by trained raters using ITKSnap. For binary segmentation, a 3D-UNet-based method (5 encoding layers of 16, 32, 62, 128, and 256 channels and 5 decoding layers of matching channels) was used. First, the relevant image quadrant (top-left or top-right depending on the eye) was cropped and the images were resized to a size of 256, 256, and 96 slices. A binary image was created from each of the 10 labels. The model was trained 2000 epochs using 44 training and 10 validation image-label pairs; a separate segmentation model was employed for each label. Testing was performed on 10 new image-label pairs, and performance was quantified using the dice coefficient.

## RESULTS

Dice scores for each label were: globe 0.913, optic nerve 0.729, medial rectus 0.606, inferior rectus 0.693, lateral rectus 0.586, superior rectus 0.670, superior oblique 0.488, inferior oblique 0.512, fat 0.820, lacrimal gland 0.416.

## CONCLUSION

This is one of the first attempts to study the segmentation of the orbital tissues in the setting of TED. The ability to automatically segment these structures will facilitate large-scale statistical analyses of the individual compartment shapes and volumes to detect early TED, its progression, and/or its response to therapy.

## CLINICAL RELEVANCE/APPLICATION

Segmenting the aforementioned muscles is a labor-intensive task, which prevents large-scale morphological statistical study in this domain. An automated end-to-end process will help in evaluating the effects of therapy in long-term patient care.

## S1-SSHN01-4 Two Heterogeneous Growth and Prognosis Patterns of Metastatic Cervical Lymph Node Among Nasopharyngeal Carcinoma: Is it True that the Bigger the Lymph Node the Worse the Prognosis

Shuqi Li, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Anti-tumor immunity and metastatic ability are presented in metastatic cervical lymph node (mCLN) simultaneously. However, for patients with nasopharyngeal carcinoma (NPC), there is currently no simple and feasible radiological indicator that can distinguish the dominant effect of mCLN, making it difficult to guide further management. Here, we investigated the cervical lymph node-to-primary tumor ratio of the maximum diameter (maxCLN/maxPT) in indicating prognostic value and growth patterns for mCLN among NPC patients.

## METHODS AND MATERIALS

Totally 866 non-metastatic NPC patients with N1-N3 staging were retrospectively included from two centers. Scatter plot with polynomial fitting curve, Kaplan-Meier survival analysis and multivariable Cox proportional hazard model with or without interaction effect were carried out to analyze the association between maxCLN and maxPT and their dominant prognostic value in OS. Three methods including receiver operating characteristic curve, restricted cubic spline and maximally selected rank statistics were used to calculate the cutoff value of maxCLN/maxPT. Random matched-pair analysis was used to analyze the treatment outcomes. A violin plot with Chi-square test was used to show the difference of Ki-67 expressions between the two groups from biopsy samples of primary tumor and mCLN.

## RESULTS

The maxCLN was not an independent prognostic factor in OS among NPC until considering the interaction item of maxCLN/maxPT (HR: 0.14, 95% CI: 0.04-0.46, P=0.001). With the optimal cutoff value of 0.8 for maxCLN/maxPT, which was proved by three kinds of methods, patients were divided into two groups: the 5-year OS of CLN-protect group (maxCLN/maxPT=0.8) was better than those of CLN-damage group (maxCLN/maxPT<0.8) (all P and adjusted P<0.05). Better 5-year OS was achieved for CLN-protect group treated with additional induction chemotherapy comparing to concurrent chemoradiotherapy alone (82.6% vs. 93.3%, P and adjusted P<0.05). The maxCLN/maxPT indicated two types of growth patterns: the maxCLN grew faster than maxPT in CLN-protect group, which is opposite in CLN-damage group. The



expression of Ki-67 in mCLN was lower in CLN-protect group than those in CLN-damage group, supporting the favorable prognosis of maxCLN/maxPT.

## **CONCLUSION**

With the cutoff of 0.8, maxCLN/maxPT, which is a positive prognostic indicator and IC-sensitive marker, enable the identification for two types of growth patterns and prognostic value for mCLN among patients with NPC.

## **CLINICAL RELEVANCE/APPLICATION**

The introduction of maxCLN/maxPT reveals interaction association between mCLN and primary tumor, and visualizes intrinsic tumor activity. It provides a novel tool for accurate prognostic prediction among NPC patients with mCLN.

## **S1-SSHN01-5 A Comparative Analysis of Two Machine Learning-Based Diagnostic Patterns with Thyroid Imaging Reporting and Data System for Thyroid Nodules: Diagnostic Performance and Unnecessary Biopsy Rate**

Chong-Ke Zhao, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The risk stratification system of the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) for thyroid nodules is affected by low diagnostic specificity. Machine learning (ML) methods can optimize the diagnostic performance in medical image analysis. However, it is unknown which ML-based diagnostic pattern is more effective in improving diagnostic performance for thyroid nodules and reducing nodule biopsies. Therefore, we compared ML-assisted visual approaches and radiomics approaches with ACR TI-RADS in diagnostic performance and unnecessary fine-needle aspiration biopsy (FNAB) rate for thyroid nodules.

## **METHODS AND MATERIALS**

This retrospective study evaluated a data set of ultrasound(US) and shear wave elastography (SWE) images in patients with biopsy-proven thyroid nodules ( $\geq 1$  cm) from the Hospital A (743 nodules in 720 patients from September 2017 to January 2019) and an independent test data set from the Hospital B (106 nodules in 102 patients from February 2019 to April 2019). Six US features and five SWE parameters from the radiologists' interpretation were used for building the ML-assisted visual approaches. The radiomics features extracted from the US and SWE images were used with ML methods for developing the radiomics approaches. The diagnostic performance for differentiating thyroid nodules and the unnecessary FNAB rate of the ML-assisted visual approaches and the radiomics approaches were compared with ACR TI-RADS.

## **RESULTS**

The ML-assisted US visual approach had the best diagnostic performance than the US radiomics approach and ACR TI-RADS (area under the curve [AUC]: 0.900 vs. 0.789 vs. 0.689 for the validation data set, 0.917 vs. 0.770 vs. 0.681 for the test data set). After adding SWE, the ML-assisted visual approach had a better diagnostic performance than US alone (AUC: 0.951 vs. 0.900 for the validation data set, 0.953 vs. 0.917 for the test data set). When applying the ML-assisted US+SWE visual approach, the unnecessary FNAB rate decreased from 30.0% to 4.5% in the validation data set and from 37.7% to 4.7% in the test data set in comparison to ACR TI-RADS.

## **CONCLUSION**

The ML-assisted dual modalities visual approach can assist radiologists to diagnose thyroid nodules more effectively and considerably reduce the unnecessary FNAB rate in the clinical management of thyroid nodules.

## **CLINICAL RELEVANCE/APPLICATION**

The application of the ML-assisted dual modalities visual approach can improve diagnostic for thyroid nodules and meaningful reduction in unnecessary FNAB rate of thyroid nodules. The ML method has significant potential for enhancing the ability of radiologists to determine the optimal clinical management of thyroid nodules.

## **S1-SSHN01-6 Keynote Speaker**

Noriyuki Fujima, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSHN01-1

### Oral Cavity Ultrasonography: Our Preliminary Experience

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353B

Vittorio Patane' (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultra-high Frequency Ultrasound (UHFUS) is a recent-evolving technique used to study oral lesions. This study aims to assess potential role of intraoral UHFUS in evaluating parameters such as Tumor Thickness (TT) and Depth of Invasion (DOI) in Oral Squamous Cell Carcinoma (OSCC).

#### METHODS AND MATERIALS

Twelve patients, aged 48 to 74 years, presenting with oral cavity, gum, or tongue lesions between January 2022 and April 2023 suspected of having OSCC were examined by a skilled examiner using intraoral UHFUS prior to surgery. Subsequently, an anatomopathological examination was performed. UHFUS features were then compared to the histological findings.

#### RESULTS

Ten patients were diagnosed with several oral pathologies including infiltrating squamous carcinoma, fibrous dysplasia, candidiasis, squamous carcinoma, and post-traumatic fibroma. Ultrasonographic assessment revealed hypoechoic structures with irregular, stellate borders and increased vascularity around the infiltrating squamous mucosal and submucosal regions in cases of infiltrating squamous carcinoma. Candidiasis with ulceration appeared as a hyper-echoic gap with frayed margins and heterogeneous submucosal involvement. Sublingual fibroma presented as an isoechoic esophytic lesion with well-defined margins. All lesions were pathologically confirmed except for a recurrent lesion involving the posterior gingival angle and both the soft and hard palate regions. The study found a positive correlation between UHFUS measurements and histology for both TT and DOI, although UHFUS slightly overestimated the latter. The site of the lesion did not significantly affect echogenicity or vascularization.

#### CONCLUSION

Emerging as a non-invasive method, UHFUS has proven useful for investigating both endo- and exophytic lesions within the oral cavity. The main limitation lies in the inability to image lesions located in the posterior aspect of the hard palate or soft palate. Our preliminary experience, although limited in sample size, has demonstrated consistent correspondence between UHFUS and pathological anatomy. These findings highlight the potential of UHFUS as a valuable technique for evaluating oral lesions and offering guidance for its inclusion within diagnostic and surgical management protocols. In conclusion, intraoral UHFUS has presented promising potential for OSCC due to its significant correlation with histology.

#### CLINICAL RELEVANCE/APPLICATION

These findings highlight the potential of UHFUS as a valuable technique for evaluating oral lesions and offering guidance for its inclusion within diagnostic and surgical management protocols. In conclusion, intraoral UHFUS has presented promising potential for OSCC due to its significant correlation with histology.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSHN01-3

### An AI-driven end-to-end Segmentation Tool for Extraocular Muscles Affecting Thyroid Eye Disease (TED)

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353B

Vikash Gupta, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Thyroid Eye Disease (TED), also known as Graves' ophthalmopathy or orbitopathy, is a condition that affects patients with autoimmune hyperthyroidism. It is caused by the activation of orbital fibroblasts by thyroid autoantibodies leading to their proliferation, differentiation, and the deposition of glycosaminoglycans, ultimately leading to varying degrees of enlargement of the extraocular muscles and an increase in orbital fat. The resulting symptoms of TED can include exophthalmos, lagophthalmos, diplopia, and periorbital edema as well as compressive optic neuropathy which can lead to permanent blindness. We developed a system for automated segmentation of 10 non-osseous structures in the orbit for the purpose of longitudinal morphological monitoring as the disease progresses or responds to treatment.

#### METHODS AND MATERIALS

We identified neuroradiologist-verified CT scans of normal orbits ( $n=32$ ) and 10 orbits affected by TED ( $n=32$ ). Orbital structures (globe, optic nerve, fat, lacrimal gland, and 6 extraocular muscles) were manually segmented on each orbit by trained raters using ITKSnap. For binary segmentation, a 3D-UNet-based method (5 encoding layers of 16, 32, 62, 128, and 256 channels and 5 decoding layers of matching channels) was used. First, the relevant image quadrant (top-left or top-right depending on the eye) was cropped and the images were resized to a size of 256, 256, and 96 slices. A binary image was created from each of the 10 labels. The model was trained 2000 epochs using 44 training and 10 validation image-label pairs; a separate segmentation model was employed for each label. Testing was performed on 10 new image-label pairs, and performance was quantified using the dice coefficient.

#### RESULTS

Dice scores for each label were: globe 0.913, optic nerve 0.729, medial rectus 0.606, inferior rectus 0.693, lateral rectus 0.586, superior rectus 0.670, superior oblique 0.488, inferior oblique 0.512, fat 0.820, lacrimal gland 0.416.

#### CONCLUSION

This is one of the first attempts to study the segmentation of the orbital tissues in the setting of TED. The ability to automatically segment these structures will facilitate large-scale statistical analyses of the individual compartment shapes and volumes to detect early TED, its progression, and/or its response to therapy.

#### CLINICAL RELEVANCE/APPLICATION

Segmenting the aforementioned muscles is a labor-intensive task, which prevents large-scale morphological statistical study in this domain. An automated end-to-end process will help in evaluating the effects of therapy in long-term patient care.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSHN01-4

### Two Heterogeneous Growth and Prognosis Patterns of Metastatic Cervical Lymph Node Among Nasopharyngeal Carcinoma: Is it True that the Bigger the Lymph Node the Worse the Prognosis

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353B

Shuqi Li, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Anti-tumor immunity and metastatic ability are presented in metastatic cervical lymph node (mCLN) simultaneously. However, for patients with nasopharyngeal carcinoma (NPC), there is currently no simple and feasible radiological indicator that can distinguish the dominant effect of mCLN, making it difficult to guide further management. Here, we investigated the cervical lymph node-to-primary tumor ratio of the maximum diameter (maxCLN/maxPT) in indicating prognostic value and growth patterns for mCLN among NPC patients.

#### METHODS AND MATERIALS

Totally 866 non-metastatic NPC patients with N1-N3 staging were retrospectively included from two centers. Scatter plot with polynomial fitting curve, Kaplan-Meier survival analysis and multivariable Cox proportional hazard model with or without interaction effect were carried out to analyze the association between maxCLN and maxPT and their dominant prognostic value in OS. Three methods including receiver operating characteristic curve, restricted cubic spline and maximally selected rank statistics were used to calculate the cutoff value of maxCLN/maxPT. Random matched-pair analysis was used to analyze the treatment outcomes. A violin plot with Chi-square test was used to show the difference of Ki-67 expressions between the two groups from biopsy samples of primary tumor and mCLN.

#### RESULTS

The maxCLN was not an independent prognostic factor in OS among NPC until considering the interaction item of maxCLN/maxPT (HR: 0.14, 95% CI: 0.04-0.46,  $P=0.001$ ). With the optimal cutoff value of 0.8 for maxCLN/maxPT, which was proved by three kinds of methods, patients were divided into two groups: the 5-year OS of CLN-protect group (maxCLN/maxPT $\geq$ 0.8) was better than those of CLN-damage group (maxCLN/maxPT $<$ 0.8) (all  $P$  and adjusted  $P<0.05$ ). Better 5-year OS was achieved for CLN-protect group treated with additional induction chemotherapy comparing to concurrent chemoradiotherapy alone (82.6% vs. 93.3%,  $P$  and adjusted  $P<0.05$ ). The maxCLN/maxPT indicated two types of growth patterns: the maxCLN grew faster than maxPT in CLN-protect group, which is opposite in CLN-damage group. The expression of Ki-67 in mCLN was lower in CLN-protect group than those in CLN-damage group, supporting the favorable prognosis of maxCLN/maxPT.

#### CONCLUSION

With the cutoff of 0.8, maxCLN/maxPT, which is a positive prognostic indicator and IC-sensitive marker, enable the identification for two types of growth patterns and prognostic value for mCLN among patients with NPC.

#### CLINICAL RELEVANCE/APPLICATION

The introduction of maxCLN/maxPT reveals interaction association between mCLN and primary tumor, and visualizes intrinsic tumor activity. It provides a novel tool for accurate prognostic prediction among NPC patients with mCLN.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSHN01-5

### **A Comparative Analysis of Two Machine Learning-Based Diagnostic Patterns with Thyroid Imaging Reporting and Data System for Thyroid Nodules: Diagnostic Performance and Unnecessary Biopsy Rate**

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353B

Chong-Ke Zhao, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The risk stratification system of the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS) for thyroid nodules is affected by low diagnostic specificity. Machine learning (ML) methods can optimize the diagnostic performance in medical image analysis. However, it is unknown which ML-based diagnostic pattern is more effective in improving diagnostic performance for thyroid nodules and reducing nodule biopsies. Therefore, we compared ML-assisted visual approaches and radiomics approaches with ACR TI-RADS in diagnostic performance and unnecessary fine-needle aspiration biopsy (FNAB) rate for thyroid nodules.

#### **METHODS AND MATERIALS**

This retrospective study evaluated a data set of ultrasound (US) and shear wave elastography (SWE) images in patients with biopsy-proven thyroid nodules ( $\geq 1$  cm) from the Hospital A (743 nodules in 720 patients from September 2017 to January 2019) and an independent test data set from the Hospital B (106 nodules in 102 patients from February 2019 to April 2019). Six US features and five SWE parameters from the radiologists' interpretation were used for building the ML-assisted visual approaches. The radiomics features extracted from the US and SWE images were used with ML methods for developing the radiomics approaches. The diagnostic performance for differentiating thyroid nodules and the unnecessary FNAB rate of the ML-assisted visual approaches and the radiomics approaches were compared with ACR TI-RADS.

#### **RESULTS**

The ML-assisted US visual approach had the best diagnostic performance than the US radiomics approach and ACR TI-RADS (area under the curve [AUC]: 0.900 vs. 0.789 vs. 0.689 for the validation data set, 0.917 vs. 0.770 vs. 0.681 for the test data set). After adding SWE, the ML-assisted visual approach had a better diagnostic performance than US alone (AUC: 0.951 vs. 0.900 for the validation data set, 0.953 vs. 0.917 for the test data set). When applying the ML-assisted US+SWE visual approach, the unnecessary FNAB rate decreased from 30.0% to 4.5% in the validation data set and from 37.7% to 4.7% in the test data set in comparison to ACR TI-RADS.

#### **CONCLUSION**

The ML-assisted dual modalities visual approach can assist radiologists to diagnose thyroid nodules more effectively and considerably reduce the unnecessary FNAB rate in the clinical management of thyroid nodules.

#### **CLINICAL RELEVANCE/APPLICATION**

The application of the ML-assisted dual modalities visual approach can improve diagnostic for thyroid nodules and meaningful reduction in unnecessary FNAB rate of thyroid nodules. The ML method has significant potential for enhancing the ability of radiologists to determine the optimal clinical management of thyroid nodules.

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## Abstract Archives of the RSNA, 2023

S1-SSHN01-6

### Keynote Speaker

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353B

Noriyuki Fujima, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSNMMI01

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Prostate Cancer Imaging)

Sunday, Nov. 26 9:00AM - 10:00AM Room: E350

Terence Z. Wong, MD, PhD (*Moderator*) Consultant, General Electric Company  
Don C. Yoo, MD (*Moderator*) Consultant, Konica Minolta, Inc

#### Sub-Events

##### S1-SSNMMI01-1 **Keynote Speaker**

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

##### S1-SSNMMI01-2 **Keynote Speaker**

Terence Z. Wong, MD, PhD (*Presenter*) Consultant, General Electric Company

##### S1-SSNMMI01-3 **Final Analysis of a Prospective, Single-center, Phase II/III Imaging Trial of <sup>68</sup>Ga-RM2 PET/MRI in Patients with Biochemical Recurrence of Prostate Cancer**

Heying Duan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The recent NCCN guideline has included prostate-specific membrane antigen (PSMA)-targeted PET for the detection of biochemical recurrent (BCR) prostate cancer (PC). However, up to 10% of PC do not express PSMA, and given the high intratumor heterogeneity, targeting a single tumor characteristic might not be sufficient to reflect full extent of disease. Gastrin releasing peptide receptors (GRPR) have shown to be overexpressed in PC and can be targeted with <sup>68</sup>Ga-RM2. In this study, we evaluated the diagnostic performance of <sup>68</sup>Ga-RM2 PET/MRI in BCR PC.

#### METHODS AND MATERIALS

This prospective, single-center, open-label, single-arm, phase II/III trial was performed at Stanford University. Patients =18 years with Karnofsky performance =50, rising PSA =0.2 ng/mL after prostatectomy, or =2 ng/mL above nadir after radiotherapy, and non-contributory conventional imaging (negative CT and/or bone scan) were eligible. The primary outcome was to assess diagnostic performance of <sup>68</sup>Ga-RM2 PET/MRI vs MRI alone. Each PET scan was interpreted by three independent masked readers using a standardized evaluation criteria. This study is registered with ClinicalTrials.gov NCT02624518 and is complete.

#### RESULTS

Between December 12, 2015 and July 27, 2021, 209 patients were screened for eligibility, of whom 100 were included. The primary endpoint was met; <sup>68</sup>Ga-RM2 PET/MRI showed significantly higher detection rates than MRI alone (143 vs 96 lesions, respectively; P<0.001) and sensitivity (85.2%; 95% CI 75.6, 92.1 vs 49.4%; 95% CI 38.1, 60.7, respectively; P<0.001) while specificity was comparably high (100.0%; 95% CI 82.4, 100.0 vs 94.7%; 95% CI 74.0, 99.9, respectively; P=0.303).

#### CONCLUSION

<sup>68</sup>Ga-RM2 PET/MRI showed better diagnostic performance than MRI alone in BCR PC with significantly higher detection rates, sensitivity, and accuracy. Therefore, <sup>68</sup>Ga-RM2 PET should be considered in BCR PC patients in aiding disease detection and management decision. Further prospective comparative studies with PSMA-targeted PET are needed to gain a better understanding of GRPR and PSMA expression patterns in BCR PC.

#### CLINICAL RELEVANCE/APPLICATION

The collective findings of this comparative imaging trial and other published studies provide compelling evidence that <sup>68</sup>Ga-RM2 PET/MRI not only outperforms conventional imaging with MRI but also shows higher reliability and number of lesions

detected which could potentially affect subsequent patient management. Thus, GRPR-targeted PET imaging is a valuable tool in the imaging armamentarium of prostate cancer at biochemical recurrence.

## **S1-SSNMMI01-4 Correlation between PSMA PET/CT and Prostate MRI in Newly Diagnosed Prostate Cancer**

Sean Gharai, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To compare prostate cancer mpMRI PIRADS score with 68Gallium Gozetotide Prostate Specific Membrane Antigen (68Ga PSMA) PET/CT lesion uptake in newly diagnosed prostate cancer. 68Ga PSMA PET/CT which was approved by the FDA for use in detection of metastatic disease in patients with castrate-resistant prostate cancer, has primarily been used to evaluate disease involvement following initial treatment with surgery or radiation therapy. To our knowledge, there are few studies directly comparing the correlation between 68Ga PSMA PET/CT and prostate MRI in newly diagnosed prostate cancer prior to definitive treatment. We aim to evaluate the complementary role of these studies in this patient group.

### **METHODS AND MATERIALS**

15 newly diagnosed biopsy proven prostate cancer patients who underwent prostate MRI with and without contrast and 68Ga PSMA PET/CT are included in our retrospective analysis. All patients underwent prostate MRI, followed by 68Ga PSMA PET/CT. After injection of 68Ga PSMA, emission and transmission scans of the whole body from the head to mid-thigh as well as a low-dose spiral CT scan from the lower head to mid-thigh for anatomical localization were obtained. The maximum standardized uptake values (SUVmax) were calculated using the patient's body weight and injected dose. The lesion's PIRADS score and zonal location was correlated with 68Ga PSMA lesion location and SUVmax.

### **RESULTS**

One patient was diagnosed with a PIRADS 3 lesion, six patients with a PIRADS 4 lesion, and eight patients with a PIRADS 5 lesion. SUVmax values ranged from 3.3 to 29.9. The prostate zonal location of the 68Ga PSMA and mpMRI lesions were concordant in 14 of 15 patients. Out of these 14 patients, 12 had a relatively high lesion SUVmax (6.2-29.9) and a high PIRADS score (4 or 5). In the remaining two patients, one had a relatively low SUVmax (3.3) and low PIRADS score (3) and one had high SUVmax (22.7) and low PIRADS score (3).

### **CONCLUSION**

Our findings demonstrate correlation between SUVmax of lesions on 68Ga PSMA PET/CT and corresponding PIRADS score on MRI in newly diagnosed prostate cancer patients. Further studies with higher sample sizes are warranted to establish a statistically significant relationship between the degree of uptake and PIRADS score. Based on our findings, future investigation of the correlation between SUVmax, PIRADS score, and pathologic Gleason score may aid in treatment planning.

### **CLINICAL RELEVANCE/APPLICATION**

68Ga PSMA PET/CT and prostate MRI may be complementary in both initial diagnosis and therapy planning, including guiding radiation where it may be the appropriate therapeutic approach.

## **S1-SSNMMI01-5 Comparison of the Pattern of Local Prostate Cancer Recurrence on <sup>68</sup>Ga-PSMA PET/CT Versus <sup>18</sup>F-fluciclovine PET/CT in Post-prostatectomy, Pre-radiotherapy Patients: Analysis of a Randomized Controlled Trial**

Ismahel Lawal, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Local recurrence in the prostate bed region (PBR) is the earliest and commonest form of prostate cancer (PCa) recurrence. We investigated the detection rate and pattern of local recurrence of prostate cancer (PCa) on 68Ga-PSMA PET/CT versus 18F-fluciclovine PET/CT in post-prostatectomy patients to see if the differences in the excretory patterns of these tracers influence lesion detection in the prostate bed region (PBR).

### **METHODS AND MATERIALS**

We evaluated PET/CT images of patients recruited into a phase 2 trial that randomized post-prostatectomy patients with detectable PSA to imaging with either 68Ga-PSMA PET/CT with 20 mg furosemide at radiotracer injection or routine 18F-fluciclovine PET/CT for guiding salvage radiotherapy decision. Two experienced Nuclear Medicine Physicians read the scans independently. We identified patients with PBR recurrence and categorized the sites of recurrence as (i) vesicourethral anastomotic (VUA) site, (ii) seminal vesicle lateral resection margin region (SVLR), (ii) retrovesical (RV) region, and (iv) other regions, including recurrence in the urethral, bladder and rectal walls. We compared the pattern of recurrent lesions seen on 68Ga-PSMA PET/CT versus 18F-fluciclovine PET/CT using Chi-square test.



## RESULTS

Sixty-nine and 66 patients completed 68Ga-PSMA PET/CT and 18F-fluciclovine PET/CT, respectively. Median PSA was not different between the 68Ga-PSMA arm and 18F-fluciclovine arms [0.39 (IQR=0.19 - 1.13) ng/mL and 0.28 (IQR=0.13 - 0.79) ng/mL, respectively,  $p=0.276$ ]. 18F-fluciclovine PET/CT detected more PBR recurrence than 68Ga-PSMA PET/CT (87.88% versus 37.68%,  $p<0.001$ ). Among the 26 patients with PBR recurrence on 68Ga-PSMA PET/CT, 35 recurrent lesions were detected versus 58 patients with 104 PBR lesions detected on 18F-fluciclovine. Fourteen VUA lesions were detected on 68Ga-PSMA PET/CT and 52 on 18F-fluciclovine PET/CT,  $p<0.001$ . Twelve SVLR lesions were detected on 68Ga-PSMA versus 40 on 18F-fluciclovine,  $p=0.081$ . One recurrent lesion was seen each on 68Ga-PSMA PET/CT and 18F-fluciclovine PET/CT in the RV region. Eight recurrent lesions at other sites were seen on 68Ga-PSMA PET/CT versus 11 on 18F-fluciclovine PET/CT,  $p=0.361$ .

## CONCLUSION

<sup>18</sup>F-fluciclovine PET/CT has a higher detection rate at the VUA post-prostatectomy compared to <sup>68</sup>Ga-PSMA, despite the use of furosemide with <sup>68</sup>Ga-PSMA. Differences in detection rate at other prostate bed sites did not reach statistical significance.

## CLINICAL RELEVANCE/APPLICATION

18F-fluciclovine PET/CT for PCa recurrence improves lesion detection at the vesicourethral anastomosis versus 68Ga-PSMA with furosemide likely due to lower bladder activity, allowing better visualization of bladder contiguous structures.

## S1- SSNMMI01- Improvement of Gleason Grading Prediction in Prostate Cancer Stratification for Radical Prostatectomy: A Machine Learning- based Theranostic Multi-omics Study

Jing Ning, MD (Presenter) Nothing to Disclose

## PURPOSE

We aim to improve the predictive performance of the whole mount Gleason grading in prostate cancer for a smart and better stratification for radical prostatectomy by deploying a high-throughput machine learning model to merge multiple omics.

## METHODS AND MATERIALS

**Study Design** A total of 146 patients with histologically confirmed prostate cancer were enrolled in this study, all of whom underwent 68Ga-PSMA-11 PET/MR scans before radical prostatectomy between May 2014 to April 2020 in the nuclear medicine department of our hospital. After the surgery, all patients were followed up until 1st December 2022. **Radiomics Data Acquisition** Volumes of Interest (VOIs) were delineated 68Ga-PSMA-11 PET/MR images on Hermes, from whom radiomics features were computed using the PyRadiomics. **Genomics Data Acquisition** DNA was isolated from FFPE samples of radical prostatectomy. Whole exome sequencing (WES) analysis was conducted. Functional pathway states were quantified using multiple established in silico tools. **Clinical endpoints** were defined as BCR status and death status. **Pathomics Data Acquisition** Tissue microarray were constructed from RP specimens and immunohistochemical analysis was performed on 2-5- $\mu$ m-thick sections from FFPE samples. PSMA, AR, Ki-67, PSA, FASN, IL6ST, CDK2, CD3, STAT3, NKX3.1, TBb have already been selected as potential biomarkers and stained in TMA slides. **ML-based Data Integration** We established 5 ML-based models including KNN, RF, SVM, IGR, and XGB. These ML algorithms were applied to the integration of clinical parameters, radiomics data, genomics data and pathomics data. The classification results were validated using 100-fold Monte Carlo cross-validation.

## RESULTS

The AUC, ACC, SNS, SPC, PPV and NPV of 5 ML-based approaches were respectively calculated and the resulting RF classification algorithm gave the best performance with 0.87, 0.78, 0.83, 0.72, 0.80, 0.80. Compared to needle biopsy, the performance of machine learning algorithm to predict Gleason grading is better. The specificity, positive predictive value, accuracy and the area under curve were elevated by 18% (0.61 vs 0.72), 7% (0.75 vs 0.80), 1% (0.77 vs 0.78) and 11% (0.75 vs 0.87) respectively while the sensitivity and negative predictive value were decreased by 7% (0.89 vs 0.83) and 1% (0.81 vs 0.80).

## CONCLUSION

Our findings suggest that our multi-omics machine learning model has the better performance for the prediction of Gleason grading than the current clinical baseline, which potentially facilitate the clinical decision-making and personalized management of prostate cancer.

## CLINICAL RELEVANCE/APPLICATION

To facilitate precise prostate cancer patient stratification for radical prostatectomy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSNMMI01-1

### Keynote Speaker

Sunday, Nov. 26 9:00AM - 10:00AM Room: E350

Don C. Yoo, MD (*Presenter*) Consultant, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSNMMI01-2

### Keynote Speaker

Sunday, Nov. 26 9:00AM - 10:00AM Room: E350

Terence Z. Wong, MD, PhD (*Presenter*) Consultant, General Electric Company

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSNMMI01-3

### Final Analysis of a Prospective, Single-center, Phase II/III Imaging Trial of <sup>68</sup>Ga-RM2 PET/MRI in Patients with Biochemical Recurrence of Prostate Cancer

Sunday, Nov. 26 9:00AM - 10:00AM Room: E350

Heying Duan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The recent NCCN guideline has included prostate-specific membrane antigen (PSMA)-targeted PET for the detection of biochemical recurrent (BCR) prostate cancer (PC). However, up to 10% of PC do not express PSMA, and given the high intratumor heterogeneity, targeting a single tumor characteristic might not be sufficient to reflect full extent of disease. Gastrin releasing peptide receptors (GRPR) have shown to be overexpressed in PC and can be targeted with <sup>68</sup>Ga-RM2. In this study, we evaluated the diagnostic performance of <sup>68</sup>Ga-RM2 PET/MRI in BCR PC.

#### METHODS AND MATERIALS

This prospective, single-center, open-label, single-arm, phase II/III trial was performed at Stanford University. Patients =18 years with Karnofsky performance =50, rising PSA =0.2 ng/mL after prostatectomy, or =2 ng/mL above nadir after radiotherapy, and non-contributory conventional imaging (negative CT and/or bone scan) were eligible. The primary outcome was to assess diagnostic performance of <sup>68</sup>Ga-RM2 PET/MRI vs MRI alone. Each PET scan was interpreted by three independent masked readers using a standardized evaluation criteria. This study is registered with ClinicalTrials.gov NCT02624518 and is complete.

#### RESULTS

Between December 12, 2015 and July 27, 2021, 209 patients were screened for eligibility, of whom 100 were included. The primary endpoint was met; <sup>68</sup>Ga-RM2 PET/MRI showed significantly higher detection rates than MRI alone (143 vs 96 lesions, respectively;  $P<0.001$ ) and sensitivity (85.2%; 95% CI 75.6, 92.1 vs 49.4%; 95% CI 38.1, 60.7, respectively;  $P<0.001$ ) while specificity was comparably high (100.0%; 95% CI 82.4, 100.0 vs 94.7%; 95% CI 74.0, 99.9, respectively;  $P=0.303$ ).

#### CONCLUSION

<sup>68</sup>Ga-RM2 PET/MRI showed better diagnostic performance than MRI alone in BCR PC with significantly higher detection rates, sensitivity, and accuracy. Therefore, <sup>68</sup>Ga-RM2 PET should be considered in BCR PC patients in aiding disease detection and management decision. Further prospective comparative studies with PSMA-targeted PET are needed to gain a better understanding of GRPR and PSMA expression patterns in BCR PC.

#### CLINICAL RELEVANCE/APPLICATION

The collective findings of this comparative imaging trial and other published studies provide compelling evidence that <sup>68</sup>Ga-RM2 PET/MRI not only outperforms conventional imaging with MRI but also shows higher reliability and number of lesions detected which could potentially affect subsequent patient management. Thus, GRPR-targeted PET imaging is a valuable tool in the imaging armamentarium of prostate cancer at biochemical recurrence.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSNMMI01-4

### Correlation between PSMA PET/CT and Prostate MRI in Newly Diagnosed Prostate Cancer

Sunday, Nov. 26 9:00AM - 10:00AM Room: E350

Sean Gharai, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare prostate cancer mpMRI PIRADS score with 68Gallium Gozetotide Prostate Specific Membrane Antigen (68Ga PSMA) PET/CT lesion uptake in newly diagnosed prostate cancer. 68Ga PSMA PET/CT which was approved by the FDA for use in detection of metastatic disease in patients with castrate-resistant prostate cancer, has primarily been used to evaluate disease involvement following initial treatment with surgery or radiation therapy. To our knowledge, there are few studies directly comparing the correlation between 68Ga PSMA PET/CT and prostate MRI in newly diagnosed prostate cancer prior to definitive treatment. We aim to evaluate the complementary role of these studies in this patient group.

#### METHODS AND MATERIALS

15 newly diagnosed biopsy proven prostate cancer patients who underwent prostate MRI with and without contrast and 68Ga PSMA PET/CT are included in our retrospective analysis. All patients underwent prostate MRI, followed by 68Ga PSMA PET/CT. After injection of 68Ga PSMA, emission and transmission scans of the whole body from the head to mid-thigh as well as a low-dose spiral CT scan from the lower head to mid-thigh for anatomical localization were obtained. The maximum standardized uptake values (SUVmax) were calculated using the patient's body weight and injected dose. The lesion's PIRADS score and zonal location was correlated with 68Ga PSMA lesion location and SUVmax.

#### RESULTS

One patient was diagnosed with a PIRADS 3 lesion, six patients with a PIRADS 4 lesion, and eight patients with a PIRADS 5 lesion. SUVmax values ranged from 3.3 to 29.9. The prostate zonal location of the 68Ga PSMA and mpMRI lesions were concordant in 14 of 15 patients. Out of these 14 patients, 12 had a relatively high lesion SUVmax (6.2-29.9) and a high PIRADS score (4 or 5). In the remaining two patients, one had a relatively low SUVmax (3.3) and low PIRADS score (3) and one had high SUVmax (22.7) and low PIRADS score (3).

#### CONCLUSION

Our findings demonstrate correlation between SUVmax of lesions on 68Ga PSMA PET/CT and corresponding PIRADS score on MRI in newly diagnosed prostate cancer patients. Further studies with higher sample sizes are warranted to establish a statistically significant relationship between the degree of uptake and PIRADS score. Based on our findings, future investigation of the correlation between SUVmax, PIRADS score, and pathologic Gleason score may aid in treatment planning.

#### CLINICAL RELEVANCE/APPLICATION

68Ga PSMA PET/CT and prostate MRI may be complementary in both initial diagnosis and therapy planning, including guiding radiation where it may be the appropriate therapeutic approach.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSNMMI01-5

### Comparison of the Pattern of Local Prostate Cancer Recurrence on $^{68}\text{Ga}$ -PSMA PET/CT Versus $^{18}\text{F}$ -fluciclovine PET/CT in Post-prostatectomy, Pre-radiotherapy Patients: Analysis of a Randomized Controlled Trial

Sunday, Nov. 26 9:00AM - 10:00AM Room: E350

Ismaheel Lawal, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Local recurrence in the prostate bed region (PBR) is the earliest and commonest form of prostate cancer (PCa) recurrence. We investigated the detection rate and pattern of local recurrence of prostate cancer (PCa) on  $^{68}\text{Ga}$ -PSMA PET/CT versus  $^{18}\text{F}$ -fluciclovine PET/CT in post-prostatectomy patients to see if the differences in the excretory patterns of these tracers influence lesion detection in the prostate bed region (PBR).

#### METHODS AND MATERIALS

We evaluated PET/CT images of patients recruited into a phase 2 trial that randomized post-prostatectomy patients with detectable PSA to imaging with either  $^{68}\text{Ga}$ -PSMA PET/CT with 20 mg furosemide at radiotracer injection or routine  $^{18}\text{F}$ -fluciclovine PET/CT for guiding salvage radiotherapy decision. Two experienced Nuclear Medicine Physicians read the scans independently. We identified patients with PBR recurrence and categorized the sites of recurrence as (i) vesicourethral anastomotic (VUA) site, (ii) seminal vesicle lateral resection margin region (SVLR), (ii) retrovesical (RV) region, and (iv) other regions, including recurrence in the urethral, bladder and rectal walls. We compared the pattern of recurrent lesions seen on  $^{68}\text{Ga}$ -PSMA PET/CT versus  $^{18}\text{F}$ -fluciclovine PET/CT using Chi-square test.

#### RESULTS

Sixty-nine and 66 patients completed  $^{68}\text{Ga}$ -PSMA PET/CT and  $^{18}\text{F}$ -fluciclovine PET/CT, respectively. Median PSA was not different between the  $^{68}\text{Ga}$ -PSMA arm and  $^{18}\text{F}$ -fluciclovine arms [0.39 (IQR=0.19 - 1.13) ng/mL and 0.28 (IQR=0.13 - 0.79) ng/mL, respectively,  $p=0.276$ ].  $^{18}\text{F}$ -fluciclovine PET/CT detected more PBR recurrence than  $^{68}\text{Ga}$ -PSMA PET/CT (87.88% versus 37.68%,  $p<0.001$ ). Among the 26 patients with PBR recurrence on  $^{68}\text{Ga}$ -PSMA PET/CT, 35 recurrent lesions were detected versus 58 patients with 104 PBR lesions detected on  $^{18}\text{F}$ -fluciclovine. Fourteen VUA lesions were detected on  $^{68}\text{Ga}$ -PSMA PET/CT and 52 on  $^{18}\text{F}$ -fluciclovine PET/CT,  $p<0.001$ . Twelve SVLR lesions were detected on  $^{68}\text{Ga}$ -PSMA versus 40 on  $^{18}\text{F}$ -fluciclovine,  $p=0.081$ . One recurrent lesion was seen each on  $^{68}\text{Ga}$ -PSMA PET/CT and  $^{18}\text{F}$ -fluciclovine PET/CT in the RV region. Eight recurrent lesions at other sites were seen on  $^{68}\text{Ga}$ -PSMA PET/CT versus 11 on  $^{18}\text{F}$ -fluciclovine PET/CT,  $p=0.361$ .

#### CONCLUSION

$^{18}\text{F}$ -fluciclovine PET/CT has a higher detection rate at the VUA post-prostatectomy compared to  $^{68}\text{Ga}$ -PSMA, despite the use of furosemide with  $^{68}\text{Ga}$ -PSMA. Differences in detection rate at other prostate bed sites did not reach statistical significance.

#### CLINICAL RELEVANCE/APPLICATION

$^{18}\text{F}$ -fluciclovine PET/CT for PCa recurrence improves lesion detection at the vesicourethral anastomosis versus  $^{68}\text{Ga}$ -PSMA with furosemide likely due to lower bladder activity, allowing better visualization of bladder contiguous structures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSNMMI01-6

### Improvement of Gleason Grading Prediction in Prostate Cancer Stratification for Radical Prostatectomy: A Machine Learning- based Theranostic Multi-omics Study

Sunday, Nov. 26 9:00AM - 10:00AM Room: E350

Jing Ning, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to improve the predictive performance of the whole mount Gleason grading in prostate cancer for a smart and better stratification for radical prostatectomy by deploying a high-throughput machine learning model to merge multiple omics.

#### METHODS AND MATERIALS

**Study Design**A total of 146 patients with histologically confirmed prostate cancer were enrolled in this study, all of whom underwent 68Ga-PSMA-11 PET/MR scans before radical prostatectomy between May 2014 to April 2020 in the nuclear medicine department of our hospital. After the surgery, all patients were followed up until 1st December 2022. **Radiomics Data Acquisition** Volumes of Interest (VOIs) were delineated 68Ga-PSMA-11 PET/MR images on Hermes, from whom radiomics features were computed using the PyRadiomics. **Genomics Data Acquisition** DNA was isolated from FFPE samples of radical prostatectomy. Whole exome sequencing (WES) analysis was conducted. Functional pathway states were quantified using multiple established in silico tools. **Clinical endpoints** were defined as BCR status and death status. **Pathomics Data Acquisition** Tissue microarray were constructed from RP specimens and immunohistochemical analysis was performed on 2-5- $\mu$ m-thick sections from FFPE samples. PSMA, AR, Ki-67, PSA, FASN, IL6ST, CDK2, CD3, STAT3, NKX3.1, TBb have already been selected as potential biomarkers and stained in TMA slides. **ML-based Data Integration** We established 5 ML-based models including KNN, RF, SVM, IGR, and XGB. These ML algorithms were applied to the integration of clinical parameters, radiomics data, genomics data and pathomics data. The classification results were validated using 100-fold Monte Carlo cross-validation.

#### RESULTS

The AUC, ACC, SNS, SPC, PPV and NPV of 5 ML-based approaches were respectively calculated and the resulting RF classification algorithm gave the best performance with 0.87, 0.78, 0.83, 0.72, 0.80, 0.80. Compared to needle biopsy, the performance of machine learning algorithm to predict Gleason grading is better. The specificity, positive predictive value, accuracy and the area under curve were elevated by 18% (0.61 vs 0.72), 7% (0.75 vs 0.80), 1% (0.77 vs 0.78) and 11% (0.75 vs 0.87) respectively while the sensitivity and negative predictive value were decreased by 7% (0.89 vs 0.83) and 1% (0.81 vs 0.80).

#### CONCLUSION

Our findings suggest that our multi-omics machine learning model has the better performance for the prediction of Gleason grading than the current clinical baseline, which potentially facilitate the clinical decision-making and personalized management of prostate cancer.

#### CLINICAL RELEVANCE/APPLICATION

To facilitate precise prostate cancer patient stratification for radical prostatectomy.

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## Abstract Archives of the RSNA, 2023

S1-SSPH01

### Physics (Photon Counting Detector CT I)

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353C

Cynthia H. McCollough, PhD (*Moderator*) Research Grant, Siemens AG  
Ke Li, PhD (*Moderator*) Research Consultant, Pulmera Inc.

#### Sub-Events

#### S1-SSPH01-1 Scatter Estimation and Correction in Photon Counting Detector CT

Ran Zhang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Scattered radiation in multi-row detector CT (MDCT) and cone-beam CT (CBCT) can lead to image artifacts, contrast reduction, and quantification errors. Multi-row photon counting detector CT (PCD-CT) is a promising technology that can potentially improve clinical CT imaging. This work aimed to develop a real-time and effective method for scatter estimation and correction using the energy-discriminating capability of PCD-CT.

#### METHODS AND MATERIALS

Monte Carlo simulations and experimental measurements were conducted to investigate the impact of energy thresholds on the scatter-to-primary ratio (SPR) in PCD-CT. A benchtop PCD-CT system with a 120 kVp spectrum and 4-cm z-coverage was utilized. The energy threshold of the PCD (T) was changed from 40 keV to 110 keV, creating a low-energy bin [20 keV, T] and a high-energy bin [T, 120 keV]. The SPR in low-energy and high-energy bins was measured as a function of the energy threshold. A novel data acquisition mode called MoHi-PoLo was proposed, which combines a quasi-Monochromatic High-energy bin and a Polychromatic Low-energy bin. A scatter correction method was then proposed to leverage the benefits of the MoHi-PoLo acquisition. Physical phantom experiments were conducted to demonstrate the effectiveness and robustness of the proposed method.

#### RESULTS

The SPR measurements showed that 1) high-energy bin data in PCD-CT always have a lower SPR compared to the corresponding low-energy bin data; 2) the SPR of the high-energy bin decreased significantly as the energy threshold increased; and 3) when the energy threshold approached the maximum keV of the spectrum, MoHi bin data was nearly free of scatter artifacts. Moreover, MoHi bin data was effective in estimating and correcting scatter in the PoLo bin.

#### CONCLUSION

Scatter decreases significantly in higher energy bins of PCD-CT. By utilizing the energy-discriminating capability offered by PCD-CT, the proposed MoHi-PoLo data acquisition scheme provides a new opportunity to address the scatter problem in CT.

#### CLINICAL RELEVANCE/APPLICATION

Scatter has a significant impact on the accuracy of HU number and material quantification. A real-time and low-cost scatter correction method can benefit many applications in interventional radiology and radiation therapy.

#### S1-SSPH01-2 Quantitative Knee Imaging using High-resolution Photon-counting Detector CT

Kishore Rajendran, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate the feasibility of simultaneous, quantitative cartilage and subchondral bone imaging using ultra-high-resolution (UHR) multi-energy photon-counting detector (PCD) CT.



## METHODS AND MATERIALS

After approval from our institutional review board, four cadaveric knees were scanned on a clinical PCD-CT system (Siemens NAEOTOM Alpha) using the UHR collimation (120 x 0.2 mm) at 120 kV, 20 mGy CTDIvol mimicking the routine knee arthrography protocol used in our clinical practice. A 50 mL bolus of 50-75% diluted anionic iodine contrast (Conray, Guerbet LLC) was injected into the intraarticular space under sonographic guidance approximately 10 minutes prior to CT acquisition. UHR PCD-CT images (0.2-mm thickness, "T3D" images using 20-120 keV, Br96 kernel with cutoff frequency at 40 lp/cm), and low- and high-energy threshold images (0.4 mm thickness, 20-120 keV and 65-120 keV, Qr76 kernel with cutoff frequency at 28 lp/cm) were reconstructed for trabecular bone morphometry and quantitative iodine decomposition, respectively. A material decomposition algorithm was applied to the Qr76 images to quantify iodine diffusion in the articular cartilage, while the UHR Br96 images were used to quantify trabecular thickness (Tb.Th), spacing (Tb.Sp) and bone volume fraction (BV/TV) in distal femur and proximal tibia of each knee. Additionally, a multi-energy CT phantom (Gammex, Sun Nuclear, WI) containing iodine at 2, 5, 10, 15 mg/cc was scanned on the PCD-CT system to assess iodine quantification accuracy using root-mean-squared-error (RMSE).

## RESULTS

Iodine decomposition in the articular cartilage showed contrast diffusion up to 15 mg/mL in the superficial zone and between 0 and 5 mg/mL in the deep zone. Bone morphometry measurements showed Tb.Th ranging from 0.43 to 0.54 mm, Tb.Sp ranging from 1.14 to 2.95 mm, and BV/TV ranging from 0.12 to 0.2. The RMSE for iodine quantification was 0.19 mg/cc in the multi-energy phantom.

## CONCLUSION

The UHR mode of the PCD-CT system facilitates simultaneous assessment of bone trabecular architecture and iodine quantification in intraarticular cartilage of the knee joint from a single arthrographic exam.

## CLINICAL RELEVANCE/APPLICATION

Contrast diffusion in cartilage, and trabecular microarchitecture are crucial markers of overall joint health relevant to diagnosis and management of osteoarthritis.

## S1- SSPH01-3 High z-axis Resolution Imaging using CZT Based Photon Counting CT: Quantitative Study and First Clinical Trial

Saeko Mochinaga, RT (*Presenter*) Nothing to Disclose

## PURPOSE

First clinical studies have been performed on CZT-based photon counting CT (CZT-PCD-CT). Due to its small detector pixel design, CZT-PCD-CT can provide super high-resolution (SHR) mode with 0.2mm slice thickness. Its z-axis resolution stands out from conventional scintillator-based CT systems. This study aims to characterize z-resolution improvements of CZT-PCD-CT using phantom studies and explore its potential clinical benefits in thoracic and spine imaging.

## METHODS AND MATERIALS

The prototype CZT-PCD-CT is built based on a Aquilion Precision system (Canon Medical Systems, Japan). The beam coverage of the system is 40 mm, and the focus size is 0.4\*0.5 mm. To evaluate z-axis resolution, comb-shaped phantom of 0.3, 0.4, 0.5, 0.6 mm intervals were scanned with helical-mode, 120 kVp, 100 mA, 0.5 s/rotation, pitch factor of 0.8. Normal resolution (NR) and SHR images were reconstructed with standard kernel with filtered back projection. NR images were 512-matrix size and 0.6 mm slice thickness, and SHR images were 1024-matrix size and 0.2 mm slice thickness. Coronal NR and SHR images of the comb phantom were obtained for the visibility evaluation and profile measurement. In addition, the visibility of bone and lung structures and the image noise (noise SD) was evaluated with sagittal images of the thoracic spine and coronal images of the lung. These clinical images were reconstructed using NR mode with hybrid-iterative reconstruction and SHR mode with hybrid-iterative reconstruction and deep learning reconstruction (DLR).

## RESULTS

For the comb phantom images, 0.3 mm gap on the SHR images was visible while gap of 0.5 mm or less on the NR images was not visible. Cortical and cancellous bone on sagittal images of the thoracic spine was more sharply delineated in SHR images. The noise SD of the intervertebral disc was 10.2 HU for the NR images, 13.1 HU for the SHR images with IR, and 11.1 HU for the SHR images with DLR. The interlobar pleura, bronchioles, and ground glass opacity on the coronal lung images were also more visible on the SHR images. The noise SD of the lung field was 52.6 HU for the NR images, 73.4 HU for the SHR images with IR, and 45.5 HU for the SHR images with DLR. These results showed that SHR images has higher Z-axis spatial resolution than NR images, and improved image quality of CT images obtained with multi planar reconstruction.

## CONCLUSION

SHR provides higher Z-axis spatial resolution and MPR images with higher sharpness compared to NR. Furthermore, DLR algorithm is expected to maintain resolution and further reduce noise.

## CLINICAL RELEVANCE/APPLICATION

Z-axis spatial resolution is important for the evaluation of sharpness MPR images, and the SHR modes of PCD-CT contribute to the improvement of the image quality of MPR images.

### **S1-SSPH01-4 Initial Investigation of Metal Artifact Reduction Performance on a Prototype Deep Silicon Based Photon Counting CT System**

Jonathan L. Troville, PhD (*Presenter*) Research support, Canon Medical Systems Corporation

#### **PURPOSE**

To compare the efficacy of metal artifact reduction using a prototype deep silicon based photon counting CT system with energy-integrating detector (EID) CT.

#### **METHODS AND MATERIALS**

A prototype deep silicon based photon counting CT scanner and an EID CT scanner (GE Discovery CT750 HD) were used to acquire images of a surgical screw. The screw was placed in a 20 cm-diameter water bath. 140 keV virtual monochromatic images were acquired with the deep silicon prototype at 120 kV, 290 mA, 0.5 second rotation time, and 0.417 mm slice thickness. 140 kV polychromatic and 140 keV virtual monochromatic images were acquired on the EID scanner at 140 kV/80 mA/1 second rotation time/0.625 mm slice thickness, and 80-140 kV/260 mA/0.8 seconds rotation time/0.625 mm slice thickness respectively. All images were reconstructed at 100 mm reconstruction diameter. ROIs were manually placed over the regions containing the largest magnitude hypo and hyper dense artifacts for each scan mode. Additionally, ROIs were placed over water background regions approximately 20 mm from the center of the surgical screw. HU values averaged over the background ROIs, standard deviations of the averages, and integral uniformity of background ROI values were compared between acquisition types.

#### **RESULTS**

Deep silicon photon counting images exhibited the smallest magnitude hyper/hypo dense artifacts with values of 130/-194 HU, compared to 367/-305 and 332/-451 HU for polychromatic and GSI scan types, respectively. The background water range of average HU values was -20.81 to 16.42 (SD: 17.53), -78.48 to 14.94 (SD: 50.77), and -132.7 to 20.67 (SD: 79.59) for deep silicon, polychromatic, and GSI modes respectively.

#### **CONCLUSION**

This study indicates that deep silicon photon counting outperforms polychromatic and dual energy for reduction of metal artifacts of a surgical screw model. Deep silicon provided better reduction of artifact near the surgical screw, and in regions further away from the screw.

## CLINICAL RELEVANCE/APPLICATION

Visualization near the surface of surgical screws is important to assess for screw loosening and infection but is impeded by artifact which was less severe with deep silicon photon counting compared to energy integrating and dual energy CT.

### **S1-SSPH01-5 Universal 120 kV Dual-Source Ultra-High Pitch Protocol on the Emerging Photon Counting CT System for Pediatric Abdomen of All Sizes: A Phantom Investigation**

Wei Zhou, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To test the hypothesis if a universal 120 kV ultra-high pitch and virtual monoenergetic image (VMI) on photon counting CT (PCCT) can provide equivalent or better quality for pediatric abdominal imaging, regardless of size, compared to single kV energy-integrating CT (EICT).

#### **METHODS AND MATERIALS**

3 iodine (2, 5, 10 mgI/cc) and 1 solid water inserts were attached to phantoms of variable sizes (Dw of 11.7, 17.3, 19.2, 32cm), simulating abdomen of a newborn, 5-year-old, 10-year-old, and adult size pediatric patients. Each phantom setting was scanned on a EICT (Siemens Drive) using clinical size specific kV (e.g. 80kV for newborn, 120kV for adult size), pitch 3 abdomen protocol. The CTDIvol of each phantom was determined by clinical CareDose on, while all scans were later performed with fixed mA and matched to pre-determined CTDIvol on EICT. Each phantom was then scanned on a PCCT (Siemens Alpha) using 120kV, pitch 3, and CTDI values matched to EICT scans. VMIs were generated from PCCT scans between 40 and 80keV with a 5keV interval. Reconstructions were matched between PCCT and EICT. Image noise was measured as standard deviation of solid water. Iodine CNR was measured as 10mgI/cc vs. water. NPS was measured in uniform phantom regions. Image quality metrics were compared between PCCT VMIs and EICT.

## RESULTS

The noise level of PCCT VMIs decreases with increased keV while CNR decreases with increased keV. The noise level (HU) of PCCT VMIs at 65keV ( $7.8\pm 0.9$ ) for newborn, 70keV ( $8.8\pm 1.1$ ) for 5 years, 55keV ( $12.0\pm 0.8$ ) for 10 years, and 65keV ( $15.8\pm 1.8$ ) for adult size are comparable or lower than ( $P<0.05$ , T-Test) corresponding EICT acquisitions with size specific kV (newborn:  $7.8\pm 0.8$ , 5 years:  $7.6\pm 1.0$ , 10 years:  $12.2\pm 0.7$ , adult size:  $15.3\pm 1.5$ ). The CNR of PCCT VMI at 50keV ( $51.1\pm 10.2$ ) for newborn, 55keV ( $42.5\pm 3.8$ ) for 5 years, 70keV ( $27.5\pm 1.0$ ) for 10 years, and 80keV ( $14.1\pm 1.4$ ) for adult size is comparable or higher than ( $P<0.05$ ) EICT acquisitions with size specific kV (newborn:  $55.8\pm 5.4$ , 5 years:  $40.6\pm 6.2$ , 10 years:  $25.4\pm 0.7$ , adult size:  $13.4\pm 1.4$ ). The peak noise frequency (mm<sup>-1</sup>) of PCCT VMIs at 65 or 70keV (newborn: 0.18, 5 years: 0.15, 10 years: 0.19, adult size: 0.16) is almost identical to EICT images (newborn: 0.18, 5 years: 0.15, 10 years: 0.19, adult size: 0.17).

## CONCLUSION

Compared to size specific kV EICT, PCCT 120kV and post-processed VMIs can provide equivalent or better quality for pediatric abdominal CT, regardless of patient size.

## CLINICAL RELEVANCE/APPLICATION

Our findings provide the first evidence that all (contrast or non-contrast) pediatric abdominal CT can be scanned by a universal ultra-fast protocol on PCCT, which reduces complexity of pediatric CT protocols to accommodate diverse patient sizes while avoiding sub-optimal acquisition parameters based on size.

## S1- SSPH01-6 Simultaneous Multi-energy High-pitch CT Pulmonary Angiography using a Dual-source Photon-counting-detector CT: A Phantom Experiment

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

A dual-source CT system can be operated in a high pitch (3.2) helical mode (FLASH) to provide a temporal resolution as fast as 66 milliseconds, which is beneficial to reduce motion artifacts in CT pulmonary angiography (CTPA). A dual-source CT can also be operated in a multi-energy (ME) mode (including dual-energy) to provide pulmonary perfused blood volume (PBV) information, beneficial in the evaluation of pulmonary embolism (PE). Currently, no energy-integrating detector (EID) CT can perform ME acquisition at a temporal resolution as fast as in the high-pitch scan mode. The purpose of this phantom study is to evaluate the ability of a dual-source photon-counting-detector (PCD) CT to perform simultaneous ME and high-pitch imaging for CTPA.

## METHODS AND MATERIALS

Two plastic tubes filled with iodine solution were made to mimic two different shapes of emboli in a pulmonary vessel. These tubes, along with 3 solid iodine samples at various concentrations (5, 10 and 15 mg/mL), were placed on a motion arm to mimic the motion of vessels during breathing (20 and 30 rpm). These were scanned inside a semi-anthropomorphic chest phantom (25x35 cm) on both a clinical dual-source PCD-CT (Naeotom Alpha, Siemens) and a dual-source EID CT (Force, Siemens) without and with motion of the vascular PE phantom, each scan repeated twice. EID-CT scans were performed separately using both ME and high pitch modes. PCD scans were performed using the ME high-pitch mode. Iodine maps were generated from the ME scans, and iodine concentrations measured centrally inside each sample.

## RESULTS

When there was no motion, measured iodine concentrations agreed well with the ground truth for both EID-CT at ME mode and PCD-CT (EID:  $5.4\pm 0.5$ ,  $10.3\pm 0.6$ ,  $15.6\pm 0.8$  mg/mL; PCD:  $5.1\pm 0.2$ ,  $10.6\pm 0.6$ ,  $15.3\pm 0.3$  mg/ml, for the 3 iodine samples, respectively). When there was motion, EID-CT at ME mode suffered from significant artifacts on the two tubes mimicking PEs and distortions on the 3 iodine samples. The measured iodine concentrations on PCD-CT were more stable than on EID-CT at ME mode (Range of percent error: EID: [-13.0%, 6.4%] and [-22.2%, 20.4%]; PCD: [-0.9%, 3.9%] and [0.9%, 5.9%] for 20 and 30 rpm, respectively). Although EID-CT at high-pitch mode has the same temporal resolution as PCD-CT, it does not provide spectral information for iodine quantification.

## CONCLUSION

The combined ME and high-pitch acquisition mode in dual-source PCD-CT enables simultaneous accurate iodine quantification and high-pitch motion-free imaging of pulmonary arteries and emboli.

## CLINICAL RELEVANCE/APPLICATION

ME high-pitch PCD-CT may improve detection of pulmonary emboli over EID-CT by providing images with reduced motion artifacts and improved accuracy for iodine quantification.

## Abstract Archives of the RSNA, 2023

S1-SSPH01-1

### Scatter Estimation and Correction in Photon Counting Detector CT

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353C

Ran Zhang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Scattered radiation in multi-row detector CT (MDCT) and cone-beam CT (CBCT) can lead to image artifacts, contrast reduction, and quantification errors. Multi-row photon counting detector CT (PCD-CT) is a promising technology that can potentially improve clinical CT imaging. This work aimed to develop a real-time and effective method for scatter estimation and correction using the energy-discriminating capability of PCD-CT.

#### METHODS AND MATERIALS

Monte Carlo simulations and experimental measurements were conducted to investigate the impact of energy thresholds on the scatter-to-primary ratio (SPR) in PCD-CT. A benchtop PCD-CT system with a 120 kVp spectrum and 4-cm z-coverage was utilized. The energy threshold of the PCD (T) was changed from 40 keV to 110 keV, creating a low-energy bin [20 keV, T] and a high-energy bin [T, 120 keV]. The SPR in low-energy and high-energy bins was measured as a function of the energy threshold. A novel data acquisition mode called MoHi-PoLo was proposed, which combines a quasi-Monochromatic High-energy bin and a Polychromatic Low-energy bin. A scatter correction method was then proposed to leverage the benefits of the MoHi-PoLo acquisition. Physical phantom experiments were conducted to demonstrate the effectiveness and robustness of the proposed method.

#### RESULTS

The SPR measurements showed that 1) high-energy bin data in PCD-CT always have a lower SPR compared to the corresponding low-energy bin data; 2) the SPR of the high-energy bin decreased significantly as the energy threshold increased; and 3) when the energy threshold approached the maximum keV of the spectrum, MoHi bin data was nearly free of scatter artifacts. Moreover, MoHi bin data was effective in estimating and correcting scatter in the PoLo bin.

#### CONCLUSION

Scatter decreases significantly in higher energy bins of PCD-CT. By utilizing the energy-discriminating capability offered by PCD-CT, the proposed MoHi-PoLo data acquisition scheme provides a new opportunity to address the scatter problem in CT.

#### CLINICAL RELEVANCE/APPLICATION

Scatter has a significant impact on the accuracy of HU number and material quantification. A real-time and low-cost scatter correction method can benefit many applications in interventional radiology and radiation therapy.

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## Abstract Archives of the RSNA, 2023

S1-SSPH01-2

### Quantitative Knee Imaging using High-resolution Photon-counting Detector CT

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353C

Kishore Rajendran, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate the feasibility of simultaneous, quantitative cartilage and subchondral bone imaging using ultra-high-resolution (UHR) multi-energy photon-counting detector (PCD) CT.

#### METHODS AND MATERIALS

After approval from our institutional review board, four cadaveric knees were scanned on a clinical PCD-CT system (Siemens NAEOTOM Alpha) using the UHR collimation (120 x 0.2 mm) at 120 kV, 20 mGy CTDIvol mimicking the routine knee arthrography protocol used in our clinical practice. A 50 mL bolus of 50-75% diluted anionic iodine contrast (Conray, Guerbet LLC) was injected into the intraarticular space under sonographic guidance approximately 10 minutes prior to CT acquisition. UHR PCD-CT images (0.2-mm thickness, "T3D" images using 20-120 keV, Br96 kernel with cutoff frequency at 40 lp/cm), and low- and high-energy threshold images (0.4 mm thickness, 20-120 keV and 65-120 keV, Qr76 kernel with cutoff frequency at 28 lp/cm) were reconstructed for trabecular bone morphometry and quantitative iodine decomposition, respectively. A material decomposition algorithm was applied to the Qr76 images to quantify iodine diffusion in the articular cartilage, while the UHR Br96 images were used to quantify trabecular thickness (Tb.Th), spacing (Tb.Sp) and bone volume fraction (BV/TV) in distal femur and proximal tibia of each knee. Additionally, a multi-energy CT phantom (Gammex, Sun Nuclear, WI) containing iodine at 2, 5, 10, 15 mg/cc was scanned on the PCD-CT system to assess iodine quantification accuracy using root-mean-squared-error (RMSE).

#### RESULTS

Iodine decomposition in the articular cartilage showed contrast diffusion up to 15 mg/mL in the superficial zone and between 0 and 5 mg/mL in the deep zone. Bone morphometry measurements showed Tb.Th ranging from 0.43 to 0.54 mm, Tb.Sp ranging from 1.14 to 2.95 mm, and BV/TV ranging from 0.12 to 0.2. The RMSE for iodine quantification was 0.19 mg/cc in the multi-energy phantom.

#### CONCLUSION

The UHR mode of the PCD-CT system facilitates simultaneous assessment of bone trabecular architecture and iodine quantification in intraarticular cartilage of the knee joint from a single arthrographic exam.

#### CLINICAL RELEVANCE/APPLICATION

Contrast diffusion in cartilage, and trabecular microarchitecture are crucial markers of overall joint health relevant to diagnosis and management of osteoarthritis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSPH01-3

### High z-axis Resolution Imaging using CZT Based Photon Counting CT: Quantitative Study and First Clinical Trial

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353C

Saeko Mochinaga, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

First clinical studies have been performed on CZT-based photon counting CT (CZT-PCD-CT). Due to its small detector pixel design, CZT-PCD-CT can provide super high-resolution (SHR) mode with 0.2mm slice thickness. Its z-axis resolution stands out from conventional scintillator-based CT systems. This study aims to characterize z-resolution improvements of CZT-PCD-CT using phantom studies and explore its potential clinical benefits in thoracic and spine imaging.

#### METHODS AND MATERIALS

The prototype CZT-PCD-CT is built based on a Aquilion Precision system (Canon Medical Systems, Japan). The beam coverage of the system is 40 mm, and the focus size is 0.4\*0.5 mm. To evaluation z-axis resolution, comb-shaped phantom of 0.3, 0.4, 0.5, 0.6 mm intervals were scanned with helical-mode, 120 kVp, 100 mA, 0.5 s/rotation, pitch factor of 0.8. Normal resolution (NR) and SHR images were reconstructed with standard kernel with filtered back projection. NR images were 512-matrix size and 0.6 mm slice thickness, and SHR images were 1024-matrix size and 0.2 mm slice thickness. Coronal NR and SHR images of the comb phantom were obtained for the visibility evaluation and profile measurement. In addition, the visibility of bone and lung structures and the image noise (noise SD) was evaluated with sagittal images of the thoracic spine and coronal images of the lung. These clinical images were reconstructed using NR mode with hybrid-iterative reconstruction and SHR mode with hybrid-iterative reconstruction and deep learning reconstruction (DLR).

#### RESULTS

For the comb phantom images, 0.3 mm gap on the SHR images was visible while gap of 0.5 mm or less on the NR images was not visible. Cortical and cancellous bone on sagittal images of the thoracic spine was more sharply delineated in SHR images. The noise SD of the intervertebral disc was 10.2 HU for the NR images, 13.1 HU for the SHR images with IR, and 11.1 HU for the SHR images with DLR. The interlobar pleura, bronchioles, and ground glass opacity on the coronal lung images were also more visible on the SHR images. The noise SD of the lung field was 52.6 HU for the NR images, 73.4 HU for the SHR images with IR, and 45.5 HU for the SHR images with DLR. These results showed that SHR images has higher Z-axis spatial resolution than NR images, and improved image quality of CT images obtained with multi planar reconstruction.

#### CONCLUSION

SHR provides higher Z-axis spatial resolution and MPR images with higher sharpness compared to NR. Furthermore, DLR algorithm is expected to maintain resolution and further reduce noise.

#### CLINICAL RELEVANCE/APPLICATION

Z-axis spatial resolution is important for the evaluation of sharpness MPR images, and the SHR modes of PCD-CT contribute to the improvement of the image quality of MPR images.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-SSPH01-4

### Initial Investigation of Metal Artifact Reduction Performance on a Prototype Deep Silicon Based Photon Counting CT System

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353C

Jonathan L. Troville, PhD (*Presenter*) Research support, Canon Medical Systems Corporation

#### PURPOSE

To compare the efficacy of metal artifact reduction using a prototype deep silicon based photon counting CT system with energy-integrating detector (EID) CT.

#### METHODS AND MATERIALS

A prototype deep silicon based photon counting CT scanner and an EID CT scanner (GE Discovery CT750 HD) were used to acquire images of a surgical screw. The screw was placed in a 20 cm-diameter water bath. 140 keV virtual monochromatic images were acquired with the deep silicon prototype at 120 kV, 290 mA, 0.5 second rotation time, and 0.417 mm slice thickness. 140 kV polychromatic and 140 keV virtual monochromatic images were acquired on the EID scanner at 140 kV/80 mA/1 second rotation time/0.625 mm slice thickness, and 80-140 kV/260 mA/0.8 seconds rotation time/0.625 mm slice thickness respectively. All images were reconstructed at 100 mm reconstruction diameter. ROIs were manually placed over the regions containing the largest magnitude hypo and hyper dense artifacts for each scan mode. Additionally, ROIs were placed over water background regions approximately 20 mm from the center of the surgical screw. HU values averaged over the background ROIs, standard deviations of the averages, and integral uniformity of background ROI values were compared between acquisition types.

#### RESULTS

Deep silicon photon counting images exhibited the smallest magnitude hyper/hypo dense artifacts with values of 130/-194 HU, compared to 367/-305 and 332/-451 HU for polychromatic and GSI scan types, respectively. The background water range of average HU values was -20.81 to 16.42 (SD: 17.53), -78.48 to 14.94 (SD: 50.77), and -132.7 to 20.67 (SD: 79.59) for deep silicon, polychromatic, and GSI modes respectively.

#### CONCLUSION

This study indicates that deep silicon photon counting outperforms polychromatic and dual energy for reduction of metal artifacts of a surgical screw model. Deep silicon provided better reduction of artifact near the surgical screw, and in regions further away from the screw.

#### CLINICAL RELEVANCE/APPLICATION

Visualization near the surface of surgical screws is important to assess for screw loosening and infection but is impeded by artifact which was less severe with deep silicon photon counting compared to energy integrating and dual energy CT.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-SSPH01-5

### Universal 120 kV Dual-Source Ultra-High Pitch Protocol on the Emerging Photon Counting CT System for Pediatric Abdomen of All Sizes: A Phantom Investigation

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353C

Wei Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To test the hypothesis if a universal 120 kV ultra-high pitch and virtual monoenergetic image (VMI) on photon counting CT (PCCT) can provide equivalent or better quality for pediatric abdominal imaging, regardless of size, compared to single kV energy-integrating CT (EICT).

#### METHODS AND MATERIALS

3 iodine (2, 5, 10 mgI/cc) and 1 solid water inserts were attached to phantoms of variable sizes (Dw of 11.7, 17.3, 19.2, 32cm), simulating abdomen of a newborn, 5-year-old, 10-year-old, and adult size pediatric patients. Each phantom setting was scanned on a EICT (Siemens Drive) using clinical size specific kV (e.g. 80kV for newborn, 120kV for adult size), pitch 3 abdomen protocol. The CTDIvol of each phantom was determined by clinical CareDose on, while all scans were later performed with fixed mA and matched to pre-determined CTDIvol on EICT. Each phantom was then scanned on a PCCT (Siemens Alpha) using 120kV, pitch 3, and CTDI values matched to EICT scans. VMIs were generated from PCCT scans between 40 and 80keV with a 5keV interval. Reconstructions were matched between PCCT and EICT. Image noise was measured as standard deviation of solid water. Iodine CNR was measured as 10mgI/cc vs. water. NPS was measured in uniform phantom regions. Image quality metrics were compared between PCCT VMIs and EICT.

#### RESULTS

The noise level of PCCT VMIs decreases with increased keV while CNR decreases with increased keV. The noise level (HU) of PCCT VMIs at 65keV ( $7.8 \pm 0.9$ ) for newborn, 70keV ( $8.8 \pm 1.1$ ) for 5 years, 55keV ( $12.0 \pm 0.8$ ) for 10 years, and 65keV ( $15.8 \pm 1.8$ ) for adult size are comparable or lower than ( $P < 0.05$ , T-Test) corresponding EICT acquisitions with size specific kV (newborn:  $7.8 \pm 0.8$ , 5 years:  $7.6 \pm 1.0$ , 10 years:  $12.2 \pm 0.7$ , adult size:  $15.3 \pm 1.5$ ). The CNR of PCCT VMI at 50keV ( $51.1 \pm 10.2$ ) for newborn, 55keV ( $42.5 \pm 3.8$ ) for 5 years, 70keV ( $27.5 \pm 1.0$ ) for 10 years, and 80keV ( $14.1 \pm 1.4$ ) for adult size is comparable or higher than ( $P < 0.05$ ) EICT acquisitions with size specific kV (newborn:  $55.8 \pm 5.4$ , 5 years:  $40.6 \pm 6.2$ , 10 years:  $25.4 \pm 0.7$ , adult size:  $13.4 \pm 1.4$ ). The peak noise frequency (mm<sup>-1</sup>) of PCCT VMIs at 65 or 70keV (newborn: 0.18, 5 years: 0.15, 10 years: 0.19, adult size: 0.16) is almost identical to EICT images (newborn: 0.18, 5 years: 0.15, 10 years: 0.19, adult size: 0.17).

#### CONCLUSION

Compared to size specific kV EICT, PCCT 120kV and post-processed VMIs can provide equivalent or better quality for pediatric abdominal CT, regardless of patient size.

#### CLINICAL RELEVANCE/APPLICATION

Our findings provide the first evidence that all (contrast or non-contrast) pediatric abdominal CT can be scanned by a universal ultra-fast protocol on PCCT, which reduces complexity of pediatric CT protocols to accommodate diverse patient sizes while avoiding sub-optimal acquisition parameters based on size.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S1-SSPH01-6

### Simultaneous Multi-energy High-pitch CT Pulmonary Angiography using a Dual-source Photon-counting-detector CT: A Phantom Experiment

Sunday, Nov. 26 9:00AM - 10:00AM Room: E353C

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

A dual-source CT system can be operated in a high pitch (3.2) helical mode (FLASH) to provide a temporal resolution as fast as 66 milliseconds, which is beneficial to reduce motion artifacts in CT pulmonary angiography (CTPA). A dual-source CT can also be operated in a multi-energy (ME) mode (including dual-energy) to provide pulmonary perfused blood volume (PBV) information, beneficial in the evaluation of pulmonary embolism (PE). Currently, no energy-integrating detector (EID) CT can perform ME acquisition at a temporal resolution as fast as in the high-pitch scan mode. The purpose of this phantom study is to evaluate the ability of a dual-source photon-counting-detector (PCD) CT to perform simultaneous ME and high-pitch imaging for CTPA.

#### METHODS AND MATERIALS

Two plastic tubes filled with iodine solution were made to mimic two different shapes of emboli in a pulmonary vessel. These tubes, along with 3 solid iodine samples at various concentrations (5, 10 and 15 mg/mL), were placed on a motion arm to mimic the motion of vessels during breathing (20 and 30 rpm). These were scanned inside a semi-anthropomorphic chest phantom (25x35 cm) on both a clinical dual-source PCD-CT (Naeotom Alpha, Siemens) and a dual-source EID CT (Force, Siemens) without and with motion of the vascular PE phantom, each scan repeated twice. EID-CT scans were performed separately using both ME and high pitch modes. PCD scans were performed using the ME high-pitch mode. Iodine maps were generated from the ME scans, and iodine concentrations measured centrally inside each sample.

#### RESULTS

When there was no motion, measured iodine concentrations agreed well with the ground truth for both EID-CT at ME mode and PCD-CT (EID:  $5.4 \pm 0.5$ ,  $10.3 \pm 0.6$ ,  $15.6 \pm 0.8$  mg/mL; PCD:  $5.1 \pm 0.2$ ,  $10.6 \pm 0.6$ ,  $15.3 \pm 0.3$  mg/ml, for the 3 iodine samples, respectively). When there was motion, EID-CT at ME mode suffered from significant artifacts on the two tubes mimicking PEs and distortions on the 3 iodine samples. The measured iodine concentrations on PCD-CT were more stable than on EID-CT at ME mode (Range of percent error: EID: [-13.0%, 6.4%] and [-22.2%, 20.4%]; PCD: [-0.9%, 3.9%] and [0.9%, 5.9%] for 20 and 30 rpm, respectively. Although EID-CT at high-pitch mode has the same temporal resolution as PCD-CT, it does not provide spectral information for iodine quantification.

#### CONCLUSION

The combined ME and high-pitch acquisition mode in dual-source PCD-CT enables simultaneous accurate iodine quantification and high-pitch motion-free imaging of pulmonary arteries and emboli.

#### CLINICAL RELEVANCE/APPLICATION

ME high-pitch PCD-CT may improve detection of pulmonary emboli over EID-CT by providing images with reduced motion artifacts and improved accuracy for iodine quantification.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-STCE1

### Science Session (Generative AI)

Sunday, Nov. 26 9:30AM - 10:00AM Room: Learning Center Theater 1

#### Sub-Events

### S1-STCE1-1 Virtual Reality and AI Chatbot Improve Radiology On-Call Training

Yusuf Alibrahim, BMedSc, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This research project aims to evaluate the use of artificial intelligence (AI) chatbot tools when integrated in a virtual reality (VR) setting to teach radiology on call topics to radiology residents.

#### METHODS AND MATERIALS

Three first year radiology residents in Guyana are enrolled in an 8 week radiology course. Each resident was provided with a VR headset. Before the sessions, the residents completed an assessment related to the topics to be taught that week. In the sessions, the residents and the preceptor, a senior resident from the University of Toronto, join a shared room in the application. The sessions start with a presentation about the topics followed by cases with scrollable CT images and 3D reconstructions. This is followed by a discussion where each resident utilizes the conversational AI chatbot to gather information about a topic and teach it to other residents. After each session, the residents repeated the assessment and completed a survey rating their subjective experience of the sessions in VR and the AI chatbot.

#### RESULTS

The preliminary findings of our study showed that residents were able to see the imaging findings in VR and interact with others in a seamless fashion. The residents noted that there is minimal chance of distractions in VR and that the 3D reconstructions helped to quickly identify the pathologies. Further data is being collected with regards to integrating imaging findings of specific cases to the AI chatbot, accuracy of the information, and realism of chatting with the AI chatbot compared to people. Additional data about the seamless interaction with the AI chatbot and using voice recognition compared to traditional methods of typing to search are being collected. There were technical challenges in the earlier sessions with minor undesirable physical effects (nausea, headache, etc.) but those eventually improved with improvement in VR controls, session timing, and improvements in the application through updates.

#### CONCLUSION

These findings suggest that the use of AI and VR-based training are promising for teaching radiology on call topics to radiology residents. The integration of AI into VR leads to synergistic results with a more immersive and interactive learning experience than traditional methods, such as lectures or textbooks. Furthermore, the 3D reconstructions of CT scans are especially helpful in VR due to the sense of depth and scale provided by this modality.

#### CLINICAL RELEVANCE/APPLICATION

Artificial intelligence and VR-based training could be used to develop new and accessible ways of teaching a variety of radiology topics in a seamless and cost-effective way. This could be especially useful in supporting radiology education remotely in regions which lack local radiology expertise.

### S1-STCE1-2 Generation of Radiology Report's Impression from Findings' description on Pediatric Abdomen Ultrasound

Dana Alkhulaifat, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Training and validation of artificial intelligence (AI) models require annotated data. Annotation is challenging due to the need for well-defined search criteria (e.g., inclusion and exclusion), domain-specific knowledge and expertise, budget, and time. Additionally, since establishing well-defined annotation rules poses numerous challenges, manually curated datasets can be

subjective and inconsistent. Natural language processing has demonstrated utility in the identification of diagnoses from radiology reports. These reports could also be used to annotate images, thereby improving the speed and accuracy of data curation for model building. In this research, we trained an AI model to generate an impression from the findings section on pediatric ultrasound reports. We examined whether a generative deep learning (DL) model can construct an accurate impression from findings similar to a radiologist in pediatric ultrasound reports.

## **METHODS AND MATERIALS**

After receiving IRB exemption, a total of 16891 reports of pediatric complete abdominal ultrasound were obtained from our institution (51% female, 47% male, 2% unknown), from 2015 to 2022 (age range (0, 43 years), mean of 7y8m, std of 6y4m). The findings and impression sections of each report were extracted. The dataset was divided into (60%, 20%, 20%) for the training, validation, and testing of a generative DL model, respectively. Recall-Oriented Understudy for Gisting Evaluation (Rouge) 1, 2, L, and Lsum were used as performance metrics. Three outcomes were established to measure the interpretability performance: "human impression is more complete", "human and machine impressions are similar", and "model impression is more complete." These outcomes were assigned to 300 random reports from the test dataset and results were computed and declared with 95% confidence level.

## **RESULTS**

The Rouge 1, 2, L, and Lsum metrics were (0.61, 0.49, 0.57, 0.6) (0.52, 0.38, 0.48, 0.5) on the train and validation datasets, and (0.51, 0.37, 0.46, 0.49) on the blind test dataset. The average completeness scores of the generated impressions were (36.6%, 59.7%, 3.7%) which indicates that 63.4% of generated impressions are similar or better than human impressions with confidence interval of (0.5857, 0.6943). Table 1 demonstrates an example of a radiologist's impression and an AI-generated impression.

## **CONCLUSION**

The Rouge and human scores indicate that a generative DL model fine-tuned on the reports of pediatric complete abdominal ultrasounds can be a valuable and time-saving tool for annotating datasets for the purpose of building AI models in radiology.

## **CLINICAL RELEVANCE/APPLICATION**

The utilization of radiology reports to annotate images improves the speed and accuracy of large dataset curation for model building.

## **S1-STCE1-3 Impact of an AI-Based Workflow in Interpretation of Chest Radiographs**

Charu Arora, MBBS, MBA (*Presenter*) Nothing to Disclose

## **PURPOSE**

To assess the impact of an artificial intelligence (AI) based radiology tool on the efficiency and accuracy of radiologists with varying experience in interpreting chest radiographs.

## **METHODS AND MATERIALS**

50 normal chest radiographs (CXR) confirmed by a panel of United States board certified radiologists were given blinded for interpretation to 11 radiologists with 1 to 17 years of experience (mean + SD: 3.8 + 4.7, median: 3) Radiographs were randomised into two groups, one interpreted unaided (U) and one aided by an AI tool (A). Radiologists were asked to (a) create a brief report (in group A, the artificial intelligence tool created a report which could be edited), (b) classify the CXR as normal or abnormal, (c) if abnormal, make a management decision based on a standardised protocol (critical attention, follow-up, no follow-up), (d) indicate confidence in their interpretation on a 10 point scale. Sensitivity, false positivity rate (FPR), turnaround time (TAT) from the time the study was opened to the time the report was submitted and reader confidence were calculated.

## **RESULTS**

275 reads each were received in groups U and A. Mean sensitivity in U was 64% and A was 85.4% ( $p < 0.001$ ). FPR reduced by 0.21 ( $p < 0.001$ ) in A as compared to U. Percent reduction in FPR was highest for less experienced readers (62.2%) as compared to more experienced readers (57.5%). 47 (17%) and 20 (7%) were recommended follow up while 5 (2%) and 1 (0.4%) were classified as critical in groups U and A respectively. Median TAT was 39 and 18 seconds respectively in groups U and A. Mean confidence of readers in classifying cases as normal increased by 25% in group A as compared to group U.

## **CONCLUSION**

An AI-based tool can improve sensitivity, TAT, and reader confidence while also reducing FPR. The improvement is more significant in less experienced readers. This is part of a larger multi-reader multi-case (MRMC) study including normal and abnormal radiographs which will be completed and presented by November 2023.

## **CLINICAL RELEVANCE/APPLICATION**

AI tools have a significant impact on radiologist efficiency and accuracy in interpretation of chest radiographs which may be more evident in less experienced radiologists. The full effect of this needs further evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-STCE1-1

### Virtual Reality and AI Chatbot Improve Radiology On-Call Training

Sunday, Nov. 26 9:30AM - 10:00AM Room: Learning Center Theater 1

Yusuf Alibrahim, BMedSc, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This research project aims to evaluate the use of artificial intelligence (AI) chatbot tools when integrated in a virtual reality (VR) setting to teach radiology on call topics to radiology residents.

#### METHODS AND MATERIALS

Three first year radiology residents in Guyana are enrolled in an 8 week radiology course. Each resident was provided with a VR headset. Before the sessions, the residents completed an assessment related to the topics to be taught that week. In the sessions, the residents and the preceptor, a senior resident from the University of Toronto, join a shared room in the application. The sessions start with a presentation about the topics followed by cases with scrollable CT images and 3D reconstructions. This is followed by a discussion where each resident utilizes the conversational AI chatbot to gather information about a topic and teach it to other residents. After each session, the residents repeated the assessment and completed a survey rating their subjective experience of the sessions in VR and the AI chatbot.

#### RESULTS

The preliminary findings of our study showed that residents were able to see the imaging findings in VR and interact with others in a seamless fashion. The residents noted that there is minimal chance of distractions in VR and that the 3D reconstructions helped to quickly identify the pathologies. Further data is being collected with regards to integrating imaging findings of specific cases to the AI chatbot, accuracy of the information, and realism of chatting with the AI chatbot compared to people. Additional data about the seamless interaction with the AI chatbot and using voice recognition compared to traditional methods of typing to search are being collected. There were technical challenges in the earlier sessions with minor undesirable physical effects (nausea, headache, etc.) but those eventually improved with improvement in VR controls, session timing, and improvements in the application through updates.

#### CONCLUSION

These findings suggest that the use of AI and VR-based training are promising for teaching radiology on call topics to radiology residents. The integration of AI into VR leads to synergistic results with a more immersive and interactive learning experience than traditional methods, such as lectures or textbooks. Furthermore, the 3D reconstructions of CT scans are especially helpful in VR due to the sense of depth and scale provided by this modality.

#### CLINICAL RELEVANCE/APPLICATION

Artificial intelligence and VR-based training could be used to develop new and accessible ways of teaching a variety of radiology topics in a seamless and cost-effective way. This could be especially useful in supporting radiology education remotely in regions which lack local radiology expertise.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-STCE1-2

### Generation of Radiology Report's Impression from Findings' description on Pediatric Abdomen Ultrasound

Sunday, Nov. 26 9:30AM - 10:00AM Room: Learning Center Theater 1

Dana Alkhulaifat, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Training and validation of artificial intelligence (AI) models require annotated data. Annotation is challenging due to the need for well-defined search criteria (e.g., inclusion and exclusion), domain-specific knowledge and expertise, budget, and time. Additionally, since establishing well-defined annotation rules poses numerous challenges, manually curated datasets can be subjective and inconsistent. Natural language processing has demonstrated utility in the identification of diagnoses from radiology reports. These reports could also be used to annotate images, thereby improving the speed and accuracy of data curation for model building. In this research, we trained an AI model to generate an impression from the findings section on pediatric ultrasound reports. We examined whether a generative deep learning (DL) model can construct an accurate impression from findings similar to a radiologist in pediatric ultrasound reports.

#### METHODS AND MATERIALS

After receiving IRB exemption, a total of 16891 reports of pediatric complete abdominal ultrasound were obtained from our institution (51% female, 47% male, 2% unknown), from 2015 to 2022 (age range (0, 43 years), mean of 7y8m, std of 6y4m). The findings and impression sections of each report were extracted. The dataset was divided into (60%, 20%, 20%) for the training, validation, and testing of a generative DL model, respectively. Recall-Oriented Understudy for Gisting Evaluation (Rouge) 1, 2, L, and Lsum were used as performance metrics. Three outcomes were established to measure the interpretability performance: "human impression is more complete", "human and machine impressions are similar", and "model impression is more complete." These outcomes were assigned to 300 random reports from the test dataset and results were computed and declared with 95% confidence level.

#### RESULTS

The Rouge 1, 2, L, and Lsum metrics were (0.61, 0.49, 0.57, 0.6) (0.52, 0.38, 0.48, 0.5) on the train and validation datasets, and (0.51, 0.37, 0.46, 0.49) on the blind test dataset. The average completeness scores of the generated impressions were (36.6%, 59.7%, 3.7%) which indicates that 63.4% of generated impressions are similar or better than human impressions with confidence interval of (0.5857, 0.6943). Table 1 demonstrates an example of a radiologist's impression and an AI-generated impression.

#### CONCLUSION

The Rouge and human scores indicate that a generative DL model fine-tuned on the reports of pediatric complete abdominal ultrasounds can be a valuable and time-saving tool for annotating datasets for the purpose of building AI models in radiology.

#### CLINICAL RELEVANCE/APPLICATION

The utilization of radiology reports to annotate images improves the speed and accuracy of large dataset curation for model building.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-STCE1-3

### Impact of an AI-Based Workflow in Interpretation of Chest Radiographs

Sunday, Nov. 26 9:30AM - 10:00AM Room: Learning Center Theater 1

Charu Arora, MBBS, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the impact of an artificial intelligence (AI) based radiology tool on the efficiency and accuracy of radiologists with varying experience in interpreting chest radiographs.

#### METHODS AND MATERIALS

50 normal chest radiographs (CXR) confirmed by a panel of United States board certified radiologists were given blinded for interpretation to 11 radiologists with 1 to 17 years of experience (mean + SD: 3.8 + 4.7, median: 3) Radiographs were randomised into two groups, one interpreted unaided (U) and one aided by an AI tool (A). Radiologists were asked to (a) create a brief report (in group A, the artificial intelligence tool created a report which could be edited), (b) classify the CXR as normal or abnormal, (c) if abnormal, make a management decision based on a standardised protocol (critical attention, follow-up, no follow-up), (d) indicate confidence in their interpretation on a 10 point scale. Sensitivity, false positivity rate (FPR), turnaround time (TAT) from the time the study was opened to the time the report was submitted and reader confidence were calculated.

#### RESULTS

275 reads each were received in groups U and A. Mean sensitivity in U was 64% and A was 85.4% ( $p < 0.001$ ). FPR reduced by 0.21 ( $p < 0.001$ ) in A as compared to U. Percent reduction in FPR was highest for less experienced readers (62.2%) as compared to more experienced readers (57.5%). 47 (17%) and 20 (7%) were recommended follow up while 5 (2%) and 1 (0.4%) were classified as critical in groups U and A respectively. Median TAT was 39 and 18 seconds respectively in groups U and A. Mean confidence of readers in classifying cases as normal increased by 25% in group A as compared to group U.

#### CONCLUSION

An AI-based tool can improve sensitivity, TAT, and reader confidence while also reducing FPR. The improvement is more significant in less experienced readers. This is part of a larger multi-reader multi-case (MRMC) study including normal and abnormal radiographs which will be completed and presented by November 2023.

#### CLINICAL RELEVANCE/APPLICATION

AI tools have a significant impact on radiologist efficiency and accuracy in interpretation of chest radiographs which may be more evident in less experienced radiologists. The full effect of this needs further evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-STCE2

### Science Session (Theranostics)

Sunday, Nov. 26 9:30AM - 10:00AM Room: Learning Center Theater 2

#### Sub-Events

### **S1-STCE2-2 Assessment of a Syndecan-1 targeted theranostic nanoparticle for improved detection and treatment of pancreatic cancer**

Lacey R. McNally, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Pancreatic cancer is a recalcitrant cancer that is both difficult to detect at early stage and generally resistant to standard of care therapy. As such, we have developed a tumor-targeted nanoparticle that has the capability to serve as a contrast agent or to deliver a therapeutic agent to block the autophagic survival mechanism. We synthesized a tumor-targeted nanoparticle to IGF1-R via syndecan-1 peptide to deliver dye or echinomycin for detection and treatment of pancreatic cancer.

#### **METHODS AND MATERIALS**

Using microwave chemistry, we synthesized a Syndecan-1 peptide and conjugated it to a 100 nm liposome using standard techniques. We loaded either IR-800 dye or echinomycin, an antibiotic, into the nanoparticle to facilitate tumor detection and treatment. In vitro testing of nanoformulated echinomycin and mechanism of action were assessed. Syndecan-1 targeted theranostic nanoparticles were iv injected into orthotopic pancreatic (S2VP10 or S2013) xenografts. Biodistribution and efficacy were tracked using Multispectral Optoacoustic Tomography or bioluminescence imaging.

#### **RESULTS**

In vivo, biodistribution of syndecan-1-targeted nanoparticles indicated preferential uptake in orthotopic pancreatic tumors (S2VP10 or S2CP9) compared to the liver and kidney (S2VP10  $p = 0.0016$ ,  $p = 0.00004$  and S2CP9  $p = 0.0009$ ,  $p = 0.0001$ ). Syndecan-1 targeted nanodelivered echinomycin resulted in significant survival increases compared to gemcitabine (S2VP10  $p = 0.0003$ , S2CP9  $p = 0.0017$ ) or echinomycin only (S2VP10  $p = 0.0096$ , S2CP9  $p = 0.0073$ ). The mechanism of action of echinomycin treatment demonstrated autophagic cell death based upon high levels of LC3-II among other autophagy markers, but without hallmarks of apoptosis, e.g., caspase activation and chromatin fragmentation, or necrosis, e.g., plasma membrane degradation and chromatin condensation/degrading.

#### **CONCLUSION**

We demonstrate that actively targeted nanodelivery of echinomycin results in autophagic cell death in pancreatic and potentially other high-autophagy, apoptosis-resistant tumors. Collectively, these findings support syndecan-1-targeted delivery of echinomycin and dysregulation of autophagy to induce cell death in pancreatic cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

Neither improved detection or neoadjuvant treatment of pancreatic cancer have substantially changed in decades. Our theranostic nanoparticle demonstrates both successful detection via MSOT and treatment via blocking of autophagy. As this treatment targets non-apoptosis pathways, it has the potential to translate into clinical trials as a complementary therapy.

### **S1-STCE2-3 Leveraging serial quantitative imaging for treatment response monitoring and dosimetry of <sup>177</sup>Lu-PSMA-617 therapy**

Catherine Meyer, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

While <sup>177</sup>Lu-PSMA-617 is a promising treatment option for metastatic castration-resistant prostate cancer, not all patients respond equally to treatment. <sup>177</sup>Lu SPECT/CT imaging offers an opportunity to assess response dynamics while the therapy



is ongoing. In this work, we evaluate the value of baseline and interim  $^{177}\text{Lu}$  SPECT/CT imaging after cycles 1 and 3 of treatment. We also report patient-specific dosimetry based on serial SPECT/CT imaging following the first cycle of therapy.

## **METHODS AND MATERIALS**

To date, 23 patients (age  $\pm$  SD,  $72 \pm 7.9$ ) underwent quantitative SPECT/CT imaging from vertex to mid-thighs 24h following administration of the 1st and 3rd cycles of  $^{177}\text{Lu}$ -PSMA-617. Total tumor burden (TTB) was evaluated on the initial PET and cycles 1 and 3 SPECT scans using an SUV threshold of 3 with removal of physiologic uptake. TTB was assessed longitudinally and correlated to PSA values and clinical measures. Additionally, dosimetry was performed retrospectively based on SPECT/CT at 4 time points (4h, 24h, 48h, 72h) in 5 patients selected predominantly for concerns of exceeding dose limits with the standard administered activity. Normal organs were segmented using a neural-network algorithm and manual contouring. Tumor lesions were segmented using a patient-specific SUV threshold. Image and dosimetry analysis were performed using commercial software to generate 3D voxelized dose maps.

## **RESULTS**

Three representative patients were included in this preliminary retrospective analysis exhibiting response, progression, and a mixed response. In all cases, the TTB volume kinetics were well-correlated with serum PSA values and clinical measures. Dosimetry in 5 patients revealed tolerable mean doses to the kidneys, parotid glands, and bone marrow of  $3.5 \pm 1.8$  Gy,  $1.5 \pm 1.0$  Gy, and  $0.2 \pm 0.06$  Gy, respectively. However, in one patient with a single kidney, the mean kidney dose was 5.2 Gy, indicating a possible cumulative 6 cycle dose exceeding the commonly used 23 Gy tolerance dose limit. In total, 46 lesions were contoured with an overall mean tumor dose of  $5.6 \pm 4.4$  Gy.

## **CONCLUSION**

Post-therapy SPECT/CT images provide a quantitative metric by which response can be systematically measured and early detection of progression confirmed. Voxelized dosimetry for a patient with a single kidney revealed a kidney dose possibly contraindicating the standard activity dosing regimen, as well as a high degree of heterogeneity in tumor doses across all patients.

## **CLINICAL RELEVANCE/APPLICATION**

This work demonstrates the added value of serial SPECT/CT imaging throughout the course of  $^{177}\text{Lu}$ -PSMA-617 treatment for earlier response detection and dose estimation. Post-therapy imaging may provide additional imaging biomarkers and absorbed doses may predict treatment efficacy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S1-STCE2-2

### Assessment of a Syndecan-1 targeted theranostic nanoparticle for improved detection and treatment of pancreatic cancer

Sunday, Nov. 26 9:30AM - 10:00AM Room: Learning Center Theater 2

Lacey R. McNally, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Pancreatic cancer is a recalcitrant cancer that is both difficult to detect at early stage and generally resistant to standard of care therapy. As such, we have developed a tumor-targeted nanoparticle that has the capability to serve as a contrast agent or to deliver a therapeutic agent to block the autophagic survival mechanism. We synthesized a tumor-targeted nanoparticle to IGF1-R via syndecan-1 peptide to deliver dye or echinomycin for detection and treatment of pancreatic cancer.

#### METHODS AND MATERIALS

Using microwave chemistry, we synthesized a Syndecan-1 peptide and conjugated it to a 100 nm liposome using standard techniques. We loaded either IR-800 dye or echinomycin, an antibiotic, into the nanoparticle to facilitate tumor detection and treatment. In vitro testing of nanoformulated echinomycin and mechanism of action were assessed. Syndecan-1 targeted theranostic nanoparticles were iv injected into orthotopic pancreatic (S2VP10 or S2013) xenografts. Biodistribution and efficacy were tracked using Multispectral Optoacoustic Tomography or bioluminescence imaging.

#### RESULTS

In vivo, biodistribution of syndecan-1-targeted nanoparticles indicated preferential uptake in orthotopic pancreatic tumors (S2VP10 or S2CP9) compared to the liver and kidney (S2VP10  $p = 0.0016$ ,  $p = 0.00004$  and S2CP9  $p = 0.0009$ ,  $p = 0.0001$ ). Syndecan-1 targeted nanodelivered echinomycin resulted in significant survival increases compared to gemcitabine (S2VP10  $p = 0.0003$ , S2CP9  $p = 0.0017$ ) or echinomycin only (S2VP10  $p = 0.0096$ , S2CP9  $p = 0.0073$ ). The mechanism of action of echinomycin treatment demonstrated autophagic cell death based upon high levels of LC3-II among other autophagy markers, but without hallmarks of apoptosis, e.g., caspase activation and chromatin fragmentation, or necrosis, e.g., plasma membrane degradation and chromatin condensation/degrading.

#### CONCLUSION

We demonstrate that actively targeted nanodelivery of echinomycin results in autophagic cell death in pancreatic and potentially other high-autophagy, apoptosis-resistant tumors. Collectively, these findings support syndecan-1-targeted delivery of echinomycin and dysregulation of autophagy to induce cell death in pancreatic cancer.

#### CLINICAL RELEVANCE/APPLICATION

Neither improved detection or neoadjuvant treatment of pancreatic cancer have substantially changed in decades. Our theranostic nanoparticle demonstrates both successful detection via MSOT and treatment via blocking of autophagy. As this treatment targets non-apoptosis pathways, it has the potential to translate into clinical trials as a complementary therapy.

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## Abstract Archives of the RSNA, 2023

S1-STCE2-3

### Leveraging serial quantitative imaging for treatment response monitoring and dosimetry of <sup>177</sup>Lu-PSMA-617 therapy

Sunday, Nov. 26 9:30AM - 10:00AM Room: Learning Center Theater 2

Catherine Meyer, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

While <sup>177</sup>Lu-PSMA-617 is a promising treatment option for metastatic castration-resistant prostate cancer, not all patients respond equally to treatment. <sup>177</sup>Lu SPECT/CT imaging offers an opportunity to assess response dynamics while the therapy is ongoing. In this work, we evaluate the value of baseline and interim <sup>177</sup>Lu SPECT/CT imaging after cycles 1 and 3 of treatment. We also report patient-specific dosimetry based on serial SPECT/CT imaging following the first cycle of therapy.

#### METHODS AND MATERIALS

To date, 23 patients (age  $\pm$  SD, 72  $\pm$  7.9) underwent quantitative SPECT/CT imaging from vertex to mid-thighs 24h following administration of the 1st and 3rd cycles of <sup>177</sup>Lu-PSMA-617. Total tumor burden (TTB) was evaluated on the initial PET and cycles 1 and 3 SPECT scans using an SUV threshold of 3 with removal of physiologic uptake. TTB was assessed longitudinally and correlated to PSA values and clinical measures. Additionally, dosimetry was performed retrospectively based on SPECT/CT at 4 time points (4h, 24h, 48h, 72h) in 5 patients selected predominantly for concerns of exceeding dose limits with the standard administered activity. Normal organs were segmented using a neural-network algorithm and manual contouring. Tumor lesions were segmented using a patient-specific SUV threshold. Image and dosimetry analysis were performed using commercial software to generate 3D voxelized dose maps.

#### RESULTS

Three representative patients were included in this preliminary retrospective analysis exhibiting response, progression, and a mixed response. In all cases, the TTB volume kinetics were well-correlated with serum PSA values and clinical measures. Dosimetry in 5 patients revealed tolerable mean doses to the kidneys, parotid glands, and bone marrow of 3.5  $\pm$  1.8 Gy, 1.5  $\pm$  1.0 Gy, and 0.2  $\pm$  0.06 Gy, respectively. However, in one patient with a single kidney, the mean kidney dose was 5.2 Gy, indicating a possible cumulative 6 cycle dose exceeding the commonly used 23 Gy tolerance dose limit. In total, 46 lesions were contoured with an overall mean tumor dose of 5.6  $\pm$  4.4 Gy.

#### CONCLUSION

Post-therapy SPECT/CT images provide a quantitative metric by which response can be systematically measured and early detection of progression confirmed. Voxelized dosimetry for a patient with a single kidney revealed a kidney dose possibly contraindicating the standard activity dosing regimen, as well as a high degree of heterogeneity in tumor doses across all patients.

#### CLINICAL RELEVANCE/APPLICATION

This work demonstrates the added value of serial SPECT/CT imaging throughout the course of <sup>177</sup>Lu-PSMA-617 treatment for earlier response detection and dose estimation. Post-therapy imaging may provide additional imaging biomarkers and absorbed doses may predict treatment efficacy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSBR01

### Breast Imaging (Breast MRI and Developing Techniques)

Sunday, Nov. 26 10:30AM - 11:30AM Room: S401

Katja Pinker-Domenig, MD, PhD (*Moderator*) Speakers Bureau, European Society of Breast Imaging; Speakers Bureau, Siemens AG; Speakers Bureau, IDKD; Speakers Bureau, Canon Medical Systems Corporation; Consultant, F. Hoffmann-La Roche Ltd; Consultant, Merantix Healthcare; Consultant, AURA Health  
Mami Iima, MD, PhD (*Moderator*) Nothing to Disclose  
Almir Bitencourt, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### S2-SSBR01-The Optimal Timepoint for Lesion Evaluation in Ultrafast DCE MRI: Correlation With Background Parenchymal Enhancement and Lesion Characteristics

Masako Y. Kataoka, MD, PhD (*Presenter*) Speaker, Siemens AG Speaker, Bayer AG Speaker, Devicor Medical Products, Inc Speaker, Guerbet SA

#### PURPOSE

Ultrafast Dynamic contrast MRI (UF-DCE MRI) scan multiple frames of images just after contrast agent injection, visualizing lesions before background parenchymal enhancement (BPE) appears. Knowing the optimal time frame of the lesion evaluation helps in interpretation and improvement of the UF-DCE protocol. Thus, we aimed to investigate the optimal timing for lesion evaluation on UF-DCE MRI in relation to BPE and lesion characteristics.

#### METHODS AND MATERIALS

We retrospectively analyzed patients who underwent UF-DCE MRI in our hospital from 2018 to 2021, and had at least one target enhanced lesion suspected of malignancy. Those with post neoadjuvant chemotherapy and poor image quality were excluded. 3T-MRI (Prisma, Siemens, Erlangen) with a 18-ch breast coil was used. The UF-DCE protocol used a 3D gradient-echo VIBE with compressed sensing. Gadobutrol was injected at 2 ml/s. UF-DCE MRI (from 15 sec before to 60 sec after contrast injection, 2 sec preparation time followed by 3.65 sec/frame x 20 frames) were obtained. Axial subtracted MIP images (2nd -20th frames) were computed. An experienced breast radiologist evaluated the serial MIP images and evaluated conspicuity (score 1-5, 5 as best) and the first and last frames of optimal timing. The frame number is used as a proxy to time (sec) from the contrast injection. BPE and lesion size were also recorded. Wilcoxon rank-sum test was used for comparison.

#### RESULTS

In total 419 patients (mean age 56) were included (with 402 patients with timing information) The first and the last frames of optimal timing was the 12.6 and 19.6 (31 sec and 57 sec after contrast injection respectively). For those with marked BPE (n = 59), the first and the last frames of optimal timing was the 12.0 and 18.5 frames (29 and 53 sec) and significantly earlier than those with non-marked BPE (12.7 and 19.7,  $p=0.009$  and  $p<0.0001$  respectively). For those with a lesion size > 20mm (n=195), the first frame of optimal timing was the 12.4 frame (30 sec), slightly earlier than those with a smaller lesion (12.8,  $p=0.029$ ). For benign lesions (n=66), the first frame of optimal timing was significantly later than malignant lesions (n=336) (13.4 vs 12.4, 34 vs 30 sec,  $P=0.0003$ ). Conspicuity score was higher in invasive carcinoma (n=296) than non-invasive carcinoma and benign lesions (score 4.8 vs 3.7  $p<0.0001$ )

#### CONCLUSION

Optimal timing of breast lesion evaluation on UF-DCE MRI can be earlier for those with marked BPE and later for benign disease / smaller lesions. Conspicuity is excellent for invasive carcinoma.

#### CLINICAL RELEVANCE/APPLICATION

The current data helps in interpreting various breast lesions on UF-DCE MRI. Information of optimal timing can be used to develop simpler and more efficient UF-DCE MRI protocol focusing on best timing for lesion evaluation.

## **S2-SSBR01-Voxelwise Mapping of DCE-MRI Time-Intensity-Curve Profiles Enables Visualizing and Quantifying Hemodynamic Heterogeneity in Breast Lesions**

Zhou Liu, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To propose a novel model-free data-driven approach based on the voxelwise mapping of DCE-MRI time-intensity-curve (TIC) profiles for quantifying and visualizing hemodynamic heterogeneity and to validate its potential clinical applications.

### **METHODS AND MATERIALS**

From December 2018 to July 2022, 259 patients with 325 pathologically confirmed breast lesions who underwent breast DCE-MRI were retrospectively enrolled. Based on the manually segmented breast lesions, the TIC of each voxel within the 3D whole lesion was classified into 19 subtypes based on wash-in rate (nonenhanced, slow, medium, and fast), wash-out enhancement (persistent, plateau, and decline), and wash-out stability (steady and unsteady), and the composition ratio of these 19 subtypes for each lesion was calculated as a new feature set (Type-19). Compared with the three-type TIC classification and semiquantitative parameters, Type-19 features were used to build a machine learning model to differentiate lesion malignancy and classify histologic grades, proliferation status, and molecular subtypes.

### **RESULTS**

The Type-19 feature-based model significantly outperformed models based on the three-type TIC method and semiquantitative parameters both in distinguishing lesion malignancy (AUC = 0.875 vs. 0.831,  $P = 0.01$  and 0.875 vs. 0.804,  $P = 0.03$ ), predicting tumor proliferation status (AUC = 0.890 vs. 0.548,  $P = 0.006$  and 0.890 vs. 0.596,  $P = 0.020$ ), and classifying molecular subtypes (AUC = 0.697 vs. 0.548,  $P = 0.009$  and 0.697 vs. 0.534,  $P < 0.001$ ), but not in predicting histologic grades ( $P = 0.820$  and 0.970).

### **CONCLUSION**

In addition to conventional methods, the proposed computational approach provides another novel model-free data-driven approach to quantify and visualize hemodynamic heterogeneity.

### **CLINICAL RELEVANCE/APPLICATION**

Voxelwise intra-lesion mapping of TIC profiles allows for visualization of hemodynamic heterogeneity and its composition ratio for differentiation of malignant and benign breast lesions.

## **S2-SSBR01-Super-resolution Deep-learning K-space-to-image Reconstruction in Diffusion-weighted Breast MRI at 3.0 Tesla**

Stephanie Sauer, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Diffusion-weighted imaging (DWI) in breast MRI is time-consuming and often associated with suboptimal spatial resolution. This study investigated a k-space-to-image reconstruction approach for scan time reduction and a deep-learning based interpolation-algorithm for improved spatial resolution in single-shot echo planar imaging for breast DWI at 3.0 Tesla.

### **METHODS AND MATERIALS**

A total of 133 women (age  $49.7 \pm 12.1$  years) who received multiparametric breast MRI including DWI between November 2022 and January 2023 were enrolled. The acquired DWI raw data (standard DWI) was retrospectively processed using deep-learning image reconstruction (DL-DWI) and an additional interpolation algorithm referred to as "super resolution" (SRDL-DWI). All datasets included b values of 800  $\text{s/mm}^2$ , 1600  $\text{s/mm}^2$  (calculated), and ADC maps. Overall image quality was ranked by three blinded readers, while SNR and ADC values were compared. To quantify structural variations caused by image quality alterations, we employed a range of quantitative similarity and error metrics.

### **RESULTS**

Compared to standard DWI, both DL- and SRDL-DWI allowed for a 39% reduction in simulated scan time (5:26 vs. 3:20 min). Highest image quality rankings were assigned to SRDL-DWI (all  $p < 0.001$ ). Interreader agreement was good, indicated by an ICC of 0.780 (95% confidence interval 0.758-0.801;  $p < 0.001$ ). Irrespective of b value, both standard and DL-DWI produced superior SNR compared to interpolated SRDL-DWI in the pectoral muscle (all  $p = 0.050$ ) and fibroglandular tissue (all  $p < 0.001$ ), while no significant difference was ascertained between the two standard-resolution DWI datasets (all  $p > 0.999$ ). ADC values in fibroglandular tissue were higher in SRDL-DWI (+0.5%) and DL-DWI (+3.4%) compared to standard DWI (both  $p = 0.001$ ). Structural similarity index metrics (SSIM = 0.86) revealed high concordance between the undersampled reconstructions (with and without super resolution) and the acquired standard DWI images for all b values. Accordingly, calculation of error metrics (NRMSE = 0.05, SMAPE = 0.02, LOGAC = 0.04) supported the assumption of low voxel-wise error. Of note, similarity was highest and error metrics were lowest for b values of 800  $\text{s/mm}^2$ .

## CONCLUSION

Deep-learning based k-space-to-image reconstruction reduced simulated scan time by 39% without influencing structural similarity in breast DWI at 3.0 Tesla. Additionally employing a SRDL interpolation algorithm allows for subjective improvement of image quality.

## CLINICAL RELEVANCE/APPLICATION

DWI constitutes a promising technique for non-contrast breast MRI, e.g., for screening purposes. The assessed deep-learning approaches facilitate a significant reduction of acquisition time without compromising image quality.

## S2-SSBR01-Diffusion-Weighted MRI for Breast Cancer Screening in High-Risk Women: Analysis of First 4 Year Outcome for Invasive and In Situ Cancer Detection

Hee Jung Shin, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Interest in unenhanced magnetic resonance imaging (MRI) screening for breast cancer is growing due to concerns about gadolinium deposition in the brain and the high cost of contrast-enhanced MRI. The purpose of this study was to analyze the outcomes of the data obtained during the first year of enrollment in DWIST (Diffusion-Weighted Magnetic Resonance Imaging Screening Trial; <https://ClinicalTrials.gov, NCT03835897>), which is a prospective, multicenter, intraindividual comparative cohort study designed to compare the performance of mammography, ultrasonography, dynamic contrast-enhanced (DCE) MRI, and diffusion-weighted (DW) MRI screening in women at high risk of developing breast cancer.

### METHODS AND MATERIALS

A total of 1046 women with BRCA mutation or family history of breast cancer and lifetime risk = 20% underwent the first-year breast screenings with digital mammography, ultrasonography, DCE MRI, and DW MRI (b=0, 800, 1200 sec/mm<sup>2</sup> and ADC map) at 3.0 T. Images are independently interpreted by trained radiologists at each institution. As for the interim results, pathology served as the reference standard. Each image modality and their combination was compared in terms of invasive and in situ cancer detection.

### RESULTS

In the first year, a total of 39 cancers (3.7%, 39/1046) were detected, with one of them being an interval cancer. Among them, 28 (72%) were invasive cancers, and 11 (28%) were in situ cancers. Overall cancer detection rate (CDR) was 43.6% (95% confidence interval, 29.3%-59.0%) on mammography, 59.0% (95% CI, 43.4%-72.9%) on US, 74.4% (95% CI, 58.9%-85.4%) on DW-MRI, and 92.3% (95% CI, 79.7%-97.3%) on DCE-MRI. CDR of invasive cancer was 53.6% (95% CI, 35.8%-70.5%) on mammography, 67.9% (95% CI, 49.3%-82.1%) on US, 82.1% (95% CI, 64.4%-92.1%) on DW-MRI, and 92.9% (95% CI, 77.4%-98.0%) on DCE-MRI, whereas CDR of in situ cancer was 18.2% (95% CI, 5.1%-47.7%) on mammography, 36.4% (95% CI, 15.2%-64.6%) on US, 54.5% (95% CI, 28.0%-78.7%) on DW-MRI, and 90.9% (95% CI, 62.3%-98.4%) on DCE-MRI. Cancer detection rate of combined mammography and DW-MRI was 85.7% (95% CI, 68.5%-94.3%) for invasive cancer and 63.6% (95% CI, 35.4%-84.8%) for in situ cancer.

### CONCLUSION

DW-MRI showed a higher invasive and in situ cancer detection rate than mammography and ultrasound, but a lower one than DCE-MRI.

### CLINICAL RELEVANCE/APPLICATION

DW-MRI is expected to be used as a supplemental screening tool to mammography, which has shown higher performance compared to ultrasound.

## S2-SSBR01-Reduced Acquisition Time of Deep-Learning Accelerated T2-Weighted Breast MR Imaging at 6 3T With Super-Resolution: A Prospective Study on Image Quality

Caroline Wilpert, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The study aimed to compare a deep-learning accelerated T2-weighted Dixon sequence with super resolution (DL-T2) to a standard T2-weighted Dixon sequence (T2) for breast MRI with evaluation of overall image quality features in intra-individual comparison.

### METHODS AND MATERIALS

Prospective monocentric pseudo-anonymized study on 140 women (mean age 52 years  $\pm$  14 SD [range:24-82]) who underwent 3T breast MRI with a standard breast imaging protocol and a novel DL reconstructed T2-weighted research application sequence with doubled acceleration factor (4 vs. 2), reduced phase resolution (53%vs.100%) and identical spatial resolution of 0.6 x 0.6 x 3.0 mm. The signal-to-noise ratio (SNR) was employed for quantitative analysis. Two

radiologists rated the image data for qualitative analysis (image quality, noise, anatomic subregions, artifacts, conspicuity of 85 cystic lesions) with intra-individual comparisons and 5-point Likert-Scales (1 = non-diagnostic to 5 = excellent).

## **RESULTS**

The mean acquisition time was 01:50 min for DL-T2 compared to 04:29 min for T2 ( $p < 0.001$ ). There was a significant difference in SNR in DL-T2 and T2 ( $51 \pm 26$  vs.  $40 \pm 19$ ,  $p < 0.001$ ). Image quality was significantly higher in DL-T2 with excellent quality in 127/140 vs. 5/140 cases for conventional T2 ( $p < 0.001$ ). Good image quality (Likert = 4) was reported in 12/140 cases for DL-T2 vs. 113/140 cases for T2 ( $p < 0.001$ ). A higher assessability of all anatomic regions was noted in DL-T2 ( $p < 0.001$ ) with the exception of the image quality of bone marrow, which was better in T2 ( $4.9 \pm 0.3$  vs.  $4.1 \pm 0.2$ ,  $p < 0.001$ ). Conspicuity of cysts was rated higher in DL-T2 ( $p < 0.001$ ). No additional artifacts were observed in DL-T2.

## **CONCLUSION**

DL-T2 for breast imaging results in a reduction of acquisition time of 59 % compared to standard T2 with improved SNR, image quality and conspicuity of cystic lesions compared to standard T2.

## **CLINICAL RELEVANCE/APPLICATION**

Application of DL-T2 may improve cost- and time-effectiveness of breast MR protocols with advantage of improved image quality. To analyse diagnostic accuracy is aim of future studies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSBR01-1

### The Optimal Timepoint for Lesion Evaluation in Ultrafast DCE MRI: Correlation With Background Parenchymal Enhancement and Lesion Characteristics

Sunday, Nov. 26 10:30AM - 11:30AM Room: S401

Masako Y. Kataoka, MD, PhD (*Presenter*) Speaker, Siemens AG Speaker, Bayer AG Speaker, Devicor Medical Products, Inc Speaker, Guerbet SA

#### PURPOSE

Ultrafast Dynamic contrast MRI (UF-DCE MRI) scan multiple frames of images just after contrast agent injection, visualizing lesions before background parenchymal enhancement (BPE) appears. Knowing the optimal time frame of the lesion evaluation helps in interpretation and improvement of the UF-DCE protocol. Thus, we aimed to investigate the optimal timing for lesion evaluation on UF-DCE MRI in relation to BPE and lesion characteristics.

#### METHODS AND MATERIALS

We retrospectively analyzed patients who underwent UF-DCE MRI in our hospital from 2018 to 2021, and had at least one target enhanced lesion suspected of malignancy. Those with post neoadjuvant chemotherapy and poor image quality were excluded. 3T-MRI (Prisma, Siemens, Erlangen) with a 18-ch breast coil was used. The UF-DCE protocol used a 3D gradient-echo VIBE with compressed sensing. Gadobutrol was injected at 2 ml/s. UF-DCE MRI (from 15 sec before to 60 sec after contrast injection, 2 sec preparation time followed by 3.65 sec/frame x 20 frames) were obtained. Axial subtracted MIP images (2nd -20th frames) were computed. An experienced breast radiologist evaluated the serial MIP images and evaluated conspicuity (score 1-5, 5 as best) and the first and last frames of optimal timing. The frame number is used as a proxy to time (sec) from the contrast injection. BPE and lesion size were also recorded. Wilcoxon rank-sum test was used for comparison.

#### RESULTS

In total 419 patients (mean age 56) were included (with 402 patients with timing information) The first and the last frames of optimal timing was the 12.6 and 19.6 (31 sec and 57 sec after contrast injection respectively). For those with marked BPE (n = 59), the first and the last frames of optimal timing was the 12.0 and 18.5 frames (29 and 53 sec) and significantly earlier than those with non-marked BPE (12.7 and 19.7, p=0.009 and p<0.0001 respectively). For those with a lesion size > 20mm (n=195), the first frame of optimal timing was the 12.4 frame (30 sec), slightly earlier than those with a smaller lesion (12.8, p=0.029). For benign lesions (n=66), the first frame of optimal timing was significantly later than malignant lesions (n=336) (13.4 vs 12.4, 34 vs 30 sec, P=0.0003). Conspicuity score was higher in invasive carcinoma (n=296) than non-invasive carcinoma and benign lesions (score 4.8 vs 3.7 p<0.0001)

#### CONCLUSION

Optimal timing of breast lesion evaluation on UF-DCE MRI can be earlier for those with marked BPE and later for benign disease / smaller lesions. Conspicuity is excellent for invasive carcinoma.

#### CLINICAL RELEVANCE/APPLICATION

The current data helps in interpreting various breast lesions on UF-DCE MRI. Information of optimal timing can be used to develop simpler and more efficient UF-DCE MRI protocol focusing on best timing for lesion evaluation.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-SSBR01-2

### Voxelwise Mapping of DCE-MRI Time-Intensity-Curve Profiles Enables Visualizing and Quantifying Hemodynamic Heterogeneity in Breast Lesions

Sunday, Nov. 26 10:30AM - 11:30AM Room: S401

Zhou Liu, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To propose a novel model-free data-driven approach based on the voxelwise mapping of DCE-MRI time-intensity-curve (TIC) profiles for quantifying and visualizing hemodynamic heterogeneity and to validate its potential clinical applications.

#### METHODS AND MATERIALS

From December 2018 to July 2022, 259 patients with 325 pathologically confirmed breast lesions who underwent breast DCE-MRI were retrospectively enrolled. Based on the manually segmented breast lesions, the TIC of each voxel within the 3D whole lesion was classified into 19 subtypes based on wash-in rate (nonenhanced, slow, medium, and fast), wash-out enhancement (persistent, plateau, and decline), and wash-out stability (steady and unsteady), and the composition ratio of these 19 subtypes for each lesion was calculated as a new feature set (Type-19). Compared with the three-type TIC classification and semiquantitative parameters, Type-19 features were used to build a machine learning model to differentiate lesion malignancy and classify histologic grades, proliferation status, and molecular subtypes.

#### RESULTS

The Type-19 feature-based model significantly outperformed models based on the three-type TIC method and semiquantitative parameters both in distinguishing lesion malignancy (AUC = 0.875 vs. 0.831,  $P = 0.01$  and 0.875 vs. 0.804,  $P = 0.03$ ), predicting tumor proliferation status (AUC = 0.890 vs. 0.548,  $P = 0.006$  and 0.890 vs. 0.596,  $P = 0.020$ ), and classifying molecular subtypes (AUC = 0.697 vs. 0.548,  $P = 0.009$  and 0.697 vs. 0.534,  $P < 0.001$ ), but not in predicting histologic grades ( $P = 0.820$  and 0.970).

#### CONCLUSION

In addition to conventional methods, the proposed computational approach provides another novel model-free data-driven approach to quantify and visualize hemodynamic heterogeneity.

#### CLINICAL RELEVANCE/APPLICATION

Voxelwise intra-lesion mapping of TIC profiles allows for visualization of hemodynamic heterogeneity and its composition ratio for differentiation of malignant and benign breast lesions.

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## Abstract Archives of the RSNA, 2023

S2-SSBR01-3

### Super-resolution Deep-learning K-space-to-image Reconstruction in Diffusion-weighted Breast MRI at 3.0 Tesla

Sunday, Nov. 26 10:30AM - 11:30AM Room: S401

Stephanie Sauer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Diffusion-weighted imaging (DWI) in breast MRI is time-consuming and often associated with suboptimal spatial resolution. This study investigated a k-space-to-image reconstruction approach for scan time reduction and a deep-learning based interpolation-algorithm for improved spatial resolution in single-shot echo planar imaging for breast DWI at 3.0 Tesla.

#### METHODS AND MATERIALS

A total of 133 women (age  $49.7 \pm 12.1$  years) who received multiparametric breast MRI including DWI between November 2022 und January 2023 were enrolled. The acquired DWI raw data (standard DWI) was retrospectively processed using deep-learning image reconstruction (DL-DWI) and an additional interpolation algorithm referred to as "super resolution" (SRDL-DWI). All datasets included b values of 800 s/mm<sup>2</sup>, 1600 s/mm<sup>2</sup> (calculated), and ADC maps. Overall image quality was ranked by three blinded readers, while SNR and ADC values were compared. To quantify structural variations caused by image quality alterations, we employed a range of quantitative similarity and error metrics.

#### RESULTS

Compared to standard DWI, both DL- and SRDL-DWI allowed for a 39% reduction in simulated scan time (5:26 vs. 3:20 min). Highest image quality rankings were assigned to SRDL-DWI (all  $p < 0.001$ ). Interreader agreement was good, indicated by an ICC of 0.780 (95% confidence interval 0.758-0.801;  $p < 0.001$ ). Irrespective of b value, both standard and DL-DWI produced superior SNR compared to interpolated SRDL-DWI in the pectoral muscle (all  $p = 0.050$ ) and fibroglandular tissue (all  $p < 0.001$ ), while no significant difference was ascertained between the two standard-resolution DWI datasets (all  $p > 0.999$ ). ADC values in fibroglandular tissue were higher in SRDL-DWI (+0.5%) and DL-DWI (+3.4%) compared to standard DWI (both  $p = 0.001$ ). Structural similarity index metrics (SSIM = 0.86) revealed high concordance between the undersampled reconstructions (with and without super resolution) and the acquired standard DWI images for all b values. Accordingly, calculation of error metrics (NRMSE = 0.05, SMAPE = 0.02, LOGAC = 0.04) supported the assumption of low voxel-wise error. Of note, similarity was highest and error metrics were lowest for b values of 800 s/mm<sup>2</sup>.

#### CONCLUSION

Deep-learning based k-space-to-image reconstruction reduced simulated scan time by 39% without influencing structural similarity in breast DWI at 3.0 Tesla. Additionally employing a SRDL interpolation algorithm allows for subjective improvement of image quality.

#### CLINICAL RELEVANCE/APPLICATION

DWI constitutes a promising technique for non-contrast breast MRI, e.g., for screening purposes. The assessed deep-learning approaches facilitate a significant reduction of acquisition time without compromising image quality.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSBR01-4

### Diffusion-Weighted MRI for Breast Cancer Screening in High-Risk Women: Analysis of First Year Outcome for Invasive and In Situ Cancer Detection

Sunday, Nov. 26 10:30AM - 11:30AM Room: S401

Hee Jung Shin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Interest in unenhanced magnetic resonance imaging (MRI) screening for breast cancer is growing due to concerns about gadolinium deposition in the brain and the high cost of contrast-enhanced MRI. The purpose of this study was to analyze the outcomes of the data obtained during the first year of enrollment in DWIST (Diffusion-Weighted Magnetic Resonance Imaging Screening Trial; <https://ClinicalTrials.gov, NCT03835897>), which is a prospective, multicenter, intraindividual comparative cohort study designed to compare the performance of mammography, ultrasonography, dynamic contrast-enhanced (DCE) MRI, and diffusion-weighted (DW) MRI screening in women at high risk of developing breast cancer.

#### METHODS AND MATERIALS

A total of 1046 women with BRCA mutation or family history of breast cancer and lifetime risk = 20% underwent the first-year breast screenings with digital mammography, ultrasonography, DCE MRI, and DW MRI ( $b=0$ , 800, 1200 sec/mm<sup>2</sup> and ADC map) at 3.0 T. Images are independently interpreted by trained radiologists at each institution. As for the interim results, pathology served as the reference standard. Each image modality and their combination was compared in terms of invasive and in situ cancer detection.

#### RESULTS

In the first year, a total of 39 cancers (3.7%, 39/1046) were detected, with one of them being an interval cancer. Among them, 28 (72%) were invasive cancers, and 11 (28%) were in situ cancers. Overall cancer detection rate (CDR) was 43.6% (95% confidence interval, 29.3%-59.0%) on mammography, 59.0% (95% CI, 43.4%-72.9%) on US, 74.4% (95% CI, 58.9%-85.4%) on DW-MRI, and 92.3% (95% CI, 79.7%-97.3%) on DCE-MRI. CDR of invasive cancer was 53.6% (95% CI, 35.8%-70.5%) on mammography, 67.9% (95% CI, 49.3%-82.1%) on US, 82.1% (95% CI, 64.4%-92.1%) on DW-MRI, and 92.9% (95% CI, 77.4%-98.0%) on DCE-MRI, whereas CDR of in situ cancer was 18.2% (95% CI, 5.1%-47.7%) on mammography, 36.4% (95% CI, 15.2%-64.6%) on US, 54.5% (95% CI, 28.0%-78.7%) on DW-MRI, and 90.9% (95% CI, 62.3%-98.4%) on DCE-MRI. Cancer detection rate of combined mammography and DW-MRI was 85.7% (95% CI, 68.5%-94.3%) for invasive cancer and 63.6% (95% CI, 35.4%-84.8%) for in situ cancer.

#### CONCLUSION

DW-MRI showed a higher invasive and in situ cancer detection rate than mammography and ultrasound, but a lower one than DCE-MRI.

#### CLINICAL RELEVANCE/APPLICATION

DW-MRI is expected to be used as a supplemental screening tool to mammography, which has shown higher performance compared to ultrasound.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSBR01-6

### Reduced Acquisition Time of Deep-Learning Accelerated T2-Weighted Breast MR Imaging at 3T With Super-Resolution: A Prospective Study on Image Quality

Sunday, Nov. 26 10:30AM - 11:30AM Room: S401

Caroline Wilpert, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The study aimed to compare a deep-learning accelerated T2-weighted Dixon sequence with super resolution (DL-T2) to a standard T2-weighted Dixon sequence (T2) for breast MRI with evaluation of overall image quality features in intra-individual comparison.

#### METHODS AND MATERIALS

Prospective monocentric pseudo-anonymized study on 140 women (mean age 52 years  $\pm$  14 SD [range:24-82]) who underwent 3T breast MRI with a standard breast imaging protocol and a novel DL reconstructed T2-weighted research application sequence with doubled acceleration factor (4 vs. 2), reduced phase resolution (53%vs.100%) and identical spatial resolution of 0.6 x 0.6 x 3.0 mm. The signal-to-noise ratio (SNR) was employed for quantitative analysis. Two radiologists rated the image data for qualitative analysis (image quality, noise, anatomic subregions, artifacts, conspicuity of 85 cystic lesions) with intra-individual comparisons and 5-point Likert-Scales (1 = non-diagnostic to 5 = excellent).

#### RESULTS

The mean acquisition time was 01:50 min for DL-T2 compared to 04:29 min for T2 ( $p < 0.001$ ). There was a significant difference in SNR in DL-T2 and T2 ( $51 \pm 26$  vs.  $40 \pm 19$ ,  $p < 0.001$ ). Image quality was significantly higher in DL-T2 with excellent quality in 127/140 vs. 5/140 cases for conventional T2 ( $p < 0.001$ ). Good image quality (Likert = 4) was reported in 12/140 cases for DL-T2 vs.113/140 cases for T2 ( $p < 0.001$ ). A higher assessability of all anatomic regions was noted in DL-T2 ( $p < 0.001$ ) with the exception of the image quality of bone marrow, which was better in T2 ( $4.9 \pm 0.3$  vs.  $4.1 \pm 0.2$ ,  $p < 0.001$ ). Conspicuity of cysts was rated higher in DL-T2 ( $p < 0.001$ ). No additional artifacts were observed in DL-T2.

#### CONCLUSION

DL-T2 for breast imaging results in a reduction of acquisition time of 59 % compared to standard T2 with improved SNR, image quality and conspicuity of cystic lesions compared to standard T2.

#### CLINICAL RELEVANCE/APPLICATION

Application of DL-T2 may improve cost- and time-effectiveness of breast MR protocols with advantage of improved image quality. To analyse diagnostic accuracy is aim of future studies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSCA01

### Cardiac Imaging (Artificial Intelligence Applications)

Sunday, Nov. 26 10:30AM - 11:30AM Room: N228

Prachi P. Agarwal, MD (*Moderator*) Nothing to Disclose

Albert Hsiao, MD, PhD (*Moderator*) Co-founder, Arterys Inc;Shareholder, Arterys Inc;Co-founder, Vektor.AI;Shareholder, Vektor.AI;Research Grant, Bayer AG;Research Grant, General Electric Company;Research Grant, KA Imaging

#### Sub-Events

### S2-SSCA01-Opportunistic Screening for Cardiomegaly on Chest or Abdominal CT using Fully Automated AI

Steven A. Rothenberg, MD (*Presenter*) Founder, Empower Therapeutics Inc ;Member, Translation Holdings LLC;Consultant, Radiostics LLC

#### PURPOSE

To validate the accuracy of a fully-automated artificial intelligence (AI) algorithm designed to opportunistically screen for cardiomegaly on routine chest or abdomen CT exams to predict future major cardiovascular disease (CVD) events.

#### METHODS AND MATERIALS

The heart and inner chest were manually segmented on a multi-institutional set of chest and abdominal CT exams without or with IV contrast (N=1200 routine and 300 with difficult technical and clinical features). A fully-automated AI algorithm (AI Cardiomegaly v0.9) was developed to quantify the area-based cardiothoracic ratio (CTR). For this single-center retrospective clinical validation study, the AI algorithm was run on 13,387 consecutive routine chest or abdominal CT exams from January 1 to June 30, 2016. The CTR (adjusted for age and gender) was statistically associated with the time of first major CVD event derived from a search of the electronic medical records for relevant ICD10 and CPT codes.

#### RESULTS

The cohort included 52% females with 65% white, 30% black, and 5% other/unknown. Mean age was 55.3. Mean BMI was 29.2. Compared to the lowest 50th percentile for the CTR, the top 10th percentile (with cardiomegaly) had increased risk of 2.3x for arrhythmia (HR: 2.3, 95%CI: 1.2-1.5, p<.001), 2.4x for valvular heart disease (HR: 2.4, 95%CI: 2.1-2.9, p<.001), 3.0x for heart failure (HR: 3.0, 95%CI: 2.5-3.6, p<.001), 4.9x for coronary event (HR: 4.9, 95%CI: 4.2-5.7, p<.001), 2.0x for stroke (HR: 2.0, 95%CI: 1.7-2.5, p<.001), and 1.7x for death (HR: 1.7, 95%CI: 1.5-1.9, p<.001).

#### CONCLUSION

A fully-automated AI algorithm designed to opportunistically screen for cardiomegaly on routine chest or abdomen CT exams was highly predictive of future major CVD events.

#### CLINICAL RELEVANCE/APPLICATION

The heart is imaged in 40 million annual chest and abdominal CT exams in the U.S., and unmanaged cardiomegaly is present in approximately 2 million of these patients. Opportunistic screening for cardiomegaly on routine chest and abdominal CT scans adds no patient cost or radiation and can be followed by appropriate care coordination and management that has the potential to markedly reduce the public health burden of CVD.

### S2-SSCA01-Ultra-High-Resolution Photon-Counting-Detector Coronary CT Angiography Using a Dedicated Denoising Convolutional Neural Network for Patients with Dense Calcifications and Stents

Shaojie Chang, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Patients with stents or dense calcifications pose considerable challenges to coronary CT angiography (cCTA) due to blooming artifacts. Ultra-high-resolution (UHR) photon-counting-detector (PCD) CT offers superior spatial resolution for cardiac imaging but significantly increases image noise. This study aims to develop a deep convolution neural network (CNN) for UHR PCD-CT to improve the quality of cCTA for patients with stent and dense calcification.

## METHODS AND MATERIALS

With IRB approval, a CNN was trained on clinical cCTA exams to reduce noise, and subsequently tested on a cohort (n=31; 26 male; mean age 74.2) of challenging coronary CTA cases including dense calcifications (24) and stents (7). All exams were performed using the UHR mode on a dual source PCD-CT (NAEOTOM Alpha, Siemens Healthcare). Images were reconstructed using both filtered back projection (FBP) and iterative reconstruction algorithms with strength 4 (QIR4), 0.2 mm slice thickness, a clinical routine kernel (Bv48), and a sharp kernel (Bv72). The trained CNN was applied to the 0.2 mm FBP images with Bv72 kernel. For each of the 31 testing cases, three blinded image series (Bv48-QIR4, Bv72-QIR4, and Bv72-CNN) were displayed side-by-side in a randomized order and reviewed by an experienced cardiac radiologist. The reader was asked to use a 5-point Likert score for overall image quality (1-nondiagnostic, 2-questionably/barely diagnostic for lumen evaluation, 3-fair/reasonable image quality but diagnostic for lumen evaluation, 4-good image quality, fully diagnostic for lumen evaluation, 5-excellent image quality, fully diagnostic), rate their confidence level on a scale of 1-100 (1 being not confident, and 100 being very confident), assess the degree of stenosis and provide the overall CAD-RADS score.

## RESULTS

The trained CNN substantially reduced image noise by approximately 50% compared to that of QIR images, making the noise of Bv72 images similar to that of Bv48 QIR images. The overall image quality for Bv72-CNN ( $4.22 \pm 0.56$ ) was significantly ( $p < 0.002$ ) higher than Bv48-QIR4 ( $3.96 \pm 0.41$ ) and Bv72-QIR4 ( $2.35 \pm 0.55$ ). CNN significantly improved mean reader confidence in stenosis assessment (Bv72-CNN/Bv48-QIR4/Bv72-QIR4: 94.1/92.3/82.4,  $p < 0.002$ ). For the overall CAD-RADS score, two studies deemed as non-diagnostic using the Bv72 kernel were scored and became diagnostic after applying the CNN denoising.

## CONCLUSION

The UHR PCD-CT combined with a CNN denoising effectively enhanced the diagnostic image quality and improved reader confidence in stenosis assessment.

## CLINICAL RELEVANCE/APPLICATION

The proposed CNN has the potential to improve diagnostic quality and reader confidence and promote clinical adoption of UHR PCD-CT by substantially reducing image noise.

## S2-SSCA01-Deep Learning Analysis of Cardiac Volumetry and Function with Real-Time MRI

5

Amin Mahmoodi, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Electrocardiogram (ECG)-gated cine steady-state free-precession (SSFP) is the standard pulse sequence for assessment of ventricular volumetry and function in cardiac MRI. Yet, it's susceptible to respiratory motion, and it's sensitive to arrhythmia because it does not image a physiological heartbeat but collages snapshots from multiple beats. Real-time (RT) SSFP without ECG-gating has potential for assessing ventricular function, but is challenging to use clinically due to the need for manual identification of cardiac phase across multiple slices and heartbeats. We propose a deep learning strategy to automate phase and slice detection to enable volumetry from RT-SSFP.

## METHODS AND MATERIALS

Short-axis (SAX) cine SSFP images from 241 cardiac MRI exams were spatially and temporally downsampled to simulate RT SSFP to train two Xception-style convolutional neural networks (CNNs). Data were split 80/10/10 into training/validation/test to 1) provide end-diastolic (ED) and end-systolic (ES) phase estimation and 2) classify cardiac slices as atrial, ventricular, or apical. Both CNNs were evaluated for accuracy and recall for ED and ES phase and slice location. CNNs were then applied to RT SSFP acquisitions from 11 patients, for whom RT-SSFP was acquired as part of routine clinical care. CNNs were combined to generate pseudo-cine SSFP series from RT SSFP between detected ED-ED intervals, and compared against cine SSFP for ventricular volumetry measured with clinical cardiac MRI software (Cardio AI [version 29.8.3] Arterys, Redwood Shores, CA). Statistics include Pearson correlation and Bland-Altman.

## RESULTS

The phase estimation CNN detected ED and ES phases with accuracy of 91% and 88%, and recall of 0.82 and 0.74. The slice classification CNN achieved accuracy of 93-97%, and recall of 0.86-0.96. There was strong correlation between ventricular volumes obtained from RT SSFP and paired cine SSFP for ED ( $r=0.98$ ) and ES ( $r=0.97$ ). RT-SSFP slightly underestimated EDV ( $-8.80\text{mL}$ , LOA  $\pm 27.64\text{mL}$ ) and overestimated ESV ( $13.36\text{mL}$ , LOA  $\pm 25.59\text{mL}$ ). There was a lower correlation of calculated ejection fraction ( $r=0.68$ ) between RT-SSFP and cine SSFP.

## CONCLUSION

CNNs are capable of inferring cardiac phase and slice location from RT SSFP to enable measurements of cardiac volumetry, which were comparable to cine SSFP. Future improvements of RT SSFP may improve reliability of this method for quantification of cardiac function.

## CLINICAL RELEVANCE/APPLICATION

Deep learning algorithms may enable measurement of cardiac function from RT SSFP, which is less susceptible to motion and artifacts than traditional cine SSFP. This may enable more reliable cardiac MRI for patients with arrhythmia or who are unable to breath-hold.

## S2-SSCA01-Harnessing Deep Learning to Identify Type 2 Diabetes from Frontal Chest Radiographs: A 6 Prospective Study with External Validation

Ayis T. Pyrros, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to explore the efficacy of a deep learning (DL) model, developed using a combination of ambulatory chest radiographs (CXRs) and electronic health records (EHRs), for the opportunistic detection of type 2 diabetes (T2D) from a prospective cohort.

## METHODS AND MATERIALS

In this IRB-approved study, we utilized a dataset of 271,065 CXRs from 160,244 unique patients, obtained between 2010 to 2021. The multi-task DL model was built using PyTorch and ResNet34, and trained on the following variables: age, BMI, HbA1c (%), diabetes status, and select comorbidities (CHF, cardiac arrhythmias, morbid obesity, COPD, and vascular disease) extracted from the EHR. Ground truth labels for diabetes were based on ICD10 and HbA1c data. The model's discriminatory ability was assessed with area under the receiver operating characteristic curve (ROC AUC) in prospective and external cohorts. For comparison, we developed logistic regression (LR) models that used only EHR data. To understand the model's decision-making process, CXR occlusion maps were generated and an autoencoder technique was employed.

## RESULTS

Our DL model, using only CXR data, predicted prevalent T2D in a 7-month (2022) prospective cohort of 9,943 patients, 5,641 females (57%), with an average age of 54.04 years (SD=18.17). The model achieved an AUC of 0.84 (95% CI: 0.83, 0.85), surpassing the EHR-based LR model with an AUC of 0.79 (95% CI: 0.77, 0.80;  $P < 0.001$ ). The DL model consistently outperformed the LR model: 0.85 vs. 0.74 for poorly controlled T2D patients, 0.89 vs. 0.77 for T2D patients with BMI<25 (ages 35-70), and 0.80 vs. 0.74 for T2D patients with BMI=25 (ages 35-70), all with  $P < 0.001$ . External validation at a geographically distinct institution (n=5,026) yielded a AUC of 0.77 (95% CI: 0.75, 0.78). In the prospective cohort, our model identified 1,381 (14%) patients as high-risk for T2D who were previously undiagnosed, suggesting screening opportunities. This included 147 individuals who would not meet criteria for T2D screening (BMI<25). Using explainable AI techniques, we found correlations between specific adiposity features and high DL scores.

## CONCLUSION

Our study showcases a DL model's ability, trained on CXRs and EHR data, to predict T2D. Outperforming a traditional LR model, it illustrates the advantage of using imaging data in disease prediction. Importantly, the model identified numerous high-risk, previously undiagnosed individuals, offering enhanced opportunities for early detection and intervention.

## CLINICAL RELEVANCE/APPLICATION

DL methods can utilize common CXRs for opportunistic disease screening, potentially improving healthcare outcomes, particularly as T2D, a major cardiovascular risk factor, can be identified through this approach.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-SSCA01-3

### Opportunistic Screening for Cardiomegaly on Chest or Abdominal CT using Fully Automated AI

Sunday, Nov. 26 10:30AM - 11:30AM Room: N228

Steven A. Rothenberg, MD (*Presenter*) Founder, Empower Therapeutics Inc ;Member, Translation Holdings LLC;Consultant, Radiostics LLC

#### PURPOSE

To validate the accuracy of a fully-automated artificial intelligence (AI) algorithm designed to opportunistically screen for cardiomegaly on routine chest or abdomen CT exams to predict future major cardiovascular disease (CVD) events.

#### METHODS AND MATERIALS

The heart and inner chest were manually segmented on a multi-institutional set of chest and abdominal CT exams without or with IV contrast (N=1200 routine and 300 with difficult technical and clinical features). A fully-automated AI algorithm (AI Cardiomegaly v0.9) was developed to quantify the area-based cardiothoracic ratio (CTR). For this single-center retrospective clinical validation study, the AI algorithm was run on 13,387 consecutive routine chest or abdominal CT exams from January 1 to June 30, 2016. The CTR (adjusted for age and gender) was statistically associated with the time of first major CVD event derived from a search of the electronic medical records for relevant ICD10 and CPT codes.

#### RESULTS

The cohort included 52% females with 65% white, 30% black, and 5% other/unknown. Mean age was 55.3. Mean BMI was 29.2. Compared to the lowest 50th percentile for the CTR, the top 10th percentile (with cardiomegaly) had increased risk of 2.3x for arrhythmia (HR: 2.3, 95%CI: 1.2-1.5,  $p < .001$ ), 2.4x for valvular heart disease (HR: 2.4, 95%CI: 2.1-2.9,  $p < .001$ ), 3.0x for heart failure (HR: 3.0, 95%CI: 2.5-3.6,  $p < .001$ ), 4.9x for coronary event (HR: 4.9, 95%CI: 4.2-5.7,  $p < .001$ ), 2.0x for stroke (HR: 2.0, 95%CI: 1.7-2.5,  $p < .001$ ), and 1.7x for death (HR: 1.7, 95%CI: 1.5-1.9,  $p < .001$ ).

#### CONCLUSION

A fully-automated AI algorithm designed to opportunistically screen for cardiomegaly on routine chest or abdomen CT exams was highly predictive of future major CVD events.

#### CLINICAL RELEVANCE/APPLICATION

The heart is imaged in 40 million annual chest and abdominal CT exams in the U.S., and unmanaged cardiomegaly is present in approximately 2 million of these patients. Opportunistic screening for cardiomegaly on routine chest and abdominal CT scans adds no patient cost or radiation and can be followed by appropriate care coordination and management that has the potential to markedly reduce the public health burden of CVD.

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## Abstract Archives of the RSNA, 2023

S2-SSCA01-4

### Ultra-High-Resolution Photon-Counting-Detector Coronary CT Angiography Using a Dedicated Denoising Convolutional Neural Network for Patients with Dense Calcifications and Stents

Sunday, Nov. 26 10:30AM - 11:30AM Room: N228

Shaojie Chang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients with stents or dense calcifications pose considerable challenges to coronary CT angiography (cCTA) due to blooming artifacts. Ultra-high-resolution (UHR) photon-counting-detector (PCD) CT offers superior spatial resolution for cardiac imaging but significantly increases image noise. This study aims to develop a deep convolution neural network (CNN) for UHR PCD-CT to improve the quality of cCTA for patients with stent and dense calcification.

#### METHODS AND MATERIALS

With IRB approval, a CNN was trained on clinical cCTA exams to reduce noise, and subsequently tested on a cohort ( $n=31$ ; 26 male; mean age 74.2) of challenging coronary CTA cases including dense calcifications (24) and stents (7). All exams were performed using the UHR mode on a dual source PCD-CT (NAEOTOM Alpha, Siemens Healthcare). Images were reconstructed using both filtered back projection (FBP) and iterative reconstruction algorithms with strength 4 (QIR4), 0.2 mm slice thickness, a clinical routine kernel (Bv48), and a sharp kernel (Bv72). The trained CNN was applied to the 0.2 mm FBP images with Bv72 kernel. For each of the 31 testing cases, three blinded image series (Bv48-QIR4, Bv72-QIR4, and Bv72-CNN) were displayed side-by-side in a randomized order and reviewed by an experienced cardiac radiologist. The reader was asked to use a 5-point Likert score for overall image quality (1-nondiagnostic, 2-questionably/barely diagnostic for lumen evaluation, 3-fair/reasonable image quality but diagnostic for lumen evaluation, 4-good image quality, fully diagnostic for lumen evaluation, 5-excellent image quality, fully diagnostic), rate their confidence level on a scale of 1-100 (1 being not confident, and 100 being very confident), assess the degree of stenosis and provide the overall CAD-RADS score.

#### RESULTS

The trained CNN substantially reduced image noise by approximately 50% compared to that of QIR images, making the noise of Bv72 images similar to that of Bv48 QIR images. The overall image quality for Bv72-CNN ( $4.22\pm 0.56$ ) was significantly ( $p<0.002$ ) higher than Bv48-QIR4 ( $3.96\pm 0.41$ ) and Bv72-QIR4 ( $2.35\pm 0.55$ ). CNN significantly improved mean reader confidence in stenosis assessment (Bv72-CNN/Bv48-QIR4/Bv72-QIR4: 94.1/92.3/82.4,  $p < 0.002$ ). For the overall CAD-RADS score, two studies deemed as non-diagnostic using the Bv72 kernel were scored and became diagnostic after applying the CNN denoising.

#### CONCLUSION

The UHR PCD-CT combined with a CNN denoising effectively enhanced the diagnostic image quality and improved reader confidence in stenosis assessment.

#### CLINICAL RELEVANCE/APPLICATION

The proposed CNN has the potential to improve diagnostic quality and reader confidence and promote clinical adoption of UHR PCD-CT by substantially reducing image noise.

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## Abstract Archives of the RSNA, 2023

S2-SSCA01-5

### Deep Learning Analysis of Cardiac Volumetry and Function with Real-Time MRI

Sunday, Nov. 26 10:30AM - 11:30AM Room: N228

Amin Mahmoodi, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Electrocardiogram (ECG)-gated cine steady-state free-precession (SSFP) is the standard pulse sequence for assessment of ventricular volumetry and function in cardiac MRI. Yet, it's susceptible to respiratory motion, and it's sensitive to arrhythmia because it does not image a physiological heartbeat but collages snapshots from multiple beats. Real-time (RT) SSFP without ECG-gating has potential for assessing ventricular function, but is challenging to use clinically due to the need for manual identification of cardiac phase across multiple slices and heartbeats. We propose a deep learning strategy to automate phase and slice detection to enable volumetry from RT-SSFP.

#### METHODS AND MATERIALS

Short-axis (SAX) cine SSFP images from 241 cardiac MRI exams were spatially and temporally downsampled to simulate RT SSFP to train two Xception-style convolutional neural networks (CNNs). Data were split 80/10/10 into training/validation/test to 1) provide end-diastolic (ED) and end-systolic (ES) phase estimation and 2) classify cardiac slices as atrial, ventricular, or apical. Both CNNs were evaluated for accuracy and recall for ED and ES phase and slice location. CNNs were then applied to RT SSFP acquisitions from 11 patients, for whom RT-SSFP was acquired as part of routine clinical care. CNNs were combined to generate pseudo-cine SSFP series from RT SSFP between detected ED-ED intervals, and compared against cine SSFP for ventricular volumetry measured with clinical cardiac MRI software (Cardio AI [version 29.8.3] Arterys, Redwood Shores, CA). Statistics include Pearson correlation and Bland-Altman.

#### RESULTS

The phase estimation CNN detected ED and ES phases with accuracy of 91% and 88%, and recall of 0.82 and 0.74. The slice classification CNN achieved accuracy of 93-97%, and recall of 0.86-0.96. There was strong correlation between ventricular volumes obtained from RT SSFP and paired cine SSFP for ED ( $r=0.98$ ) and ES ( $r=0.97$ ). RT-SSFP slightly underestimated EDV (-8.80mL, LOA  $\pm 27.64$ mL) and overestimated ESV (13.36mL, LOA  $\pm 25.59$ mL). There was a lower correlation of calculated ejection fraction ( $r=0.68$ ) between RT-SSFP and cine SSFP.

#### CONCLUSION

CNNs are capable of inferring cardiac phase and slice location from RT SSFP to enable measurements of cardiac volumetry, which were comparable to cine SSFP. Future improvements of RT SSFP may improve reliability of this method for quantification of cardiac function.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning algorithms may enable measurement of cardiac function from RT SSFP, which is less susceptible to motion and artifacts than traditional cine SSFP. This may enable more reliable cardiac MRI for patients with arrhythmia or who are unable to breath-hold.

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## Abstract Archives of the RSNA, 2023

S2-SSCA01-6

### Harnessing Deep Learning to Identify Type 2 Diabetes from Frontal Chest Radiographs: A Prospective Study with External Validation

Sunday, Nov. 26 10:30AM - 11:30AM Room: N228

Ayis T. Pyrros, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to explore the efficacy of a deep learning (DL) model, developed using a combination of ambulatory chest radiographs (CXRs) and electronic health records (EHRs), for the opportunistic detection of type 2 diabetes (T2D) from a prospective cohort.

#### METHODS AND MATERIALS

In this IRB-approved study, we utilized a dataset of 271,065 CXRs from 160,244 unique patients, obtained between 2010 to 2021. The multi-task DL model was built using PyTorch and ResNet34, and trained on the following variables: age, BMI, HbA1c (%), diabetes status, and select comorbidities (CHF, cardiac arrhythmias, morbid obesity, COPD, and vascular disease) extracted from the EHR. Ground truth labels for diabetes were based on ICD10 and HbA1c data. The model's discriminatory ability was assessed with area under the receiver operating characteristic curve (ROC AUC) in prospective and external cohorts. For comparison, we developed logistic regression (LR) models that used only EHR data. To understand the model's decision-making process, CXR occlusion maps were generated and an autoencoder technique was employed.

#### RESULTS

Our DL model, using only CXR data, predicted prevalent T2D in a 7-month (2022) prospective cohort of 9,943 patients, 5,641 females (57%), with an average age of 54.04 years (SD=18.17). The model achieved an AUC of 0.84 (95% CI: 0.83, 0.85), surpassing the EHR-based LR model with an AUC of 0.79 (95% CI: 0.77, 0.80;  $P < 0.001$ ). The DL model consistently outperformed the LR model: 0.85 vs. 0.74 for poorly controlled T2D patients, 0.89 vs. 0.77 for T2D patients with BMI<25 (ages 35-70), and 0.80 vs. 0.74 for T2D patients with BMI=25 (ages 35-70), all with  $P < 0.001$ . External validation at a geographically distinct institution (n=5,026) yielded a AUC of 0.77 (95% CI: 0.75, 0.78). In the prospective cohort, our model identified 1,381 (14%) patients as high-risk for T2D who were previously undiagnosed, suggesting screening opportunities. This included 147 individuals who would not meet criteria for T2D screening (BMI<25). Using explainable AI techniques, we found correlations between specific adiposity features and high DL scores.

#### CONCLUSION

Our study showcases a DL model's ability, trained on CXRs and EHR data, to predict T2D. Outperforming a traditional LR model, it illustrates the advantage of using imaging data in disease prediction. Importantly, the model identified numerous high-risk, previously undiagnosed individuals, offering enhanced opportunities for early detection and intervention.

#### CLINICAL RELEVANCE/APPLICATION

DL methods can utilize common CXRs for opportunistic disease screening, potentially improving healthcare outcomes, particularly as T2D, a major cardiovascular risk factor, can be identified through this approach.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSGI01

### Gastrointestinal Imaging (Focal Liver Disease (Non HCC))

Sunday, Nov. 26 10:30AM - 11:30AM Room: S405

Woo Kyoung Jeong, MD, PhD (*Moderator*) Nothing to Disclose  
Alessandro Furlan, MD, MMM (*Moderator*) Royalties, RELX; Research support, Endra, Inc; Consultant, Bracco Group

#### Sub-Events

#### S2-SSGI01- Abbreviated Liver MRI with Gd-EOB-DTPA ( Eovist ) Compared to Complete MRI for Follow up of Colorectal Liver Metastases

Maria El Homsy, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare between abbreviated liver MRI and complete liver MRI for assessment of response in patients with colorectal liver metastases.

#### METHODS AND MATERIALS

This retrospective IRB approved study included consecutive patients with colorectal liver metastases between 1/1/2012 and 12/3/2021 on chemotherapy with at least one follow up MRI performed with Gd-EOB-DTPA (Eovist). A baseline MRI was designated by the study coordinator and a follow-up MRI was chosen and separated into two sets of images: a complete MRI with all sequences and an abbreviated MRI (AMRI) including Coronal and axial hepatobiliary phase, axial DWI and coronal T2W. 7 readers reviewed the sets of images with a month break in between to assess RECIST1.1 response and detection of new lesions. To assess interrater agreement (3 readers read each follow-up), Fleiss kappa was computed for variables with 2 levels and Light's averaged pairwise kappa was computed for variables with > 2 levels. To assess intra-rater agreement, simple kappa was computed for variables with 2 levels and weighted kappa was computed for variables with >2 levels.

#### RESULTS

195 patients (135M/60F, median 54y) were included. There was substantial intra-reader agreement for RECIST 1.1 response (Kappa between 0.66-0.89) and for detection of new lesions (Kappa between 0.63-0.81). There was substantial inter-reader agreement for RECIST1.1 response using complete MRI and AMRI with kappa = 0.68 [0.61, 0.74] and 0.72 [0.65, 0.78] respectively. There was moderate inter-reader agreement for detection of new lesion using complete MRI and AMRI with kappa of 0.49 [0.36, 0.64] and 0.56 [0.42, 0.71] respectively.

#### CONCLUSION

Inter-reader agreement between complete and abbreviated MRI was substantial for RECIST1.1 response assessment, thus AMRI can be considered as substitute for follow-up of patients with colorectal liver metastases.

#### CLINICAL RELEVANCE/APPLICATION

AMRI may be considered as an adequate substitute to a complete MRI liver for patients with colorectal liver metastases when the goal is to assess treatment response in the liver. The potential benefit of AMRI is reduced scan time for the patient, increased patient throughput, and decreased interpretation time for the radiologist.

#### S2-SSGI01- Predicting the Chemotherapeutic Response of Colorectal Cancer Liver Metastasis using Shear-Wave Elastography

Jae Seok Bae, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the prognostic role of shear-wave velocity (SWV) value for predicting chemotherapeutic response and progression-free survival (PFS) in patients with colorectal cancer liver metastases (CRLMs).

## METHODS AND MATERIALS

In this prospective, single-center study, participants with CRLM who were scheduled to undergo chemotherapy were enrolled between May 2018 and June 2021. SWV value measurements by using shear-wave elastography were performed at the CRLM before and after starting chemotherapy. Based on the Response Evaluation Criteria in Solid Tumors, the chemotherapeutic response of the participants was categorized into two categories: responders including complete remission and partial remission, and nonresponders including stable disease and progressive disease. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the performance of changes in SWV values in predicting the chemotherapeutic response of CRLM. In addition, Cox proportional hazard model was used to identify variables associated with PFS.

## RESULTS

In total, 67 participants (40 men; mean age, 62.3 years  $\pm$  10.1) were enrolled, of which 34 were responders and 33 were nonresponders. The area under the ROC curve, sensitivity, and negative predictive value of SWV value in predicting nonresponders were 0.840, 97.0%, and 95.2%, respectively, with a cutoff value of 13% decrease. The change in SWV value was also independently associated with PFS (hazard ratio, 1.020) as well as being a nonresponder and number of CRLM=5.

## CONCLUSION

The change in SWV values measured after chemotherapy demonstrated a meaningful diagnostic performance to predict nonresponders in patients with CRLM. The change in SWV value was also independently associated with PFS.

## CLINICAL RELEVANCE/APPLICATION

In patients with CRLM, ARFI elastography performed early in the course of chemotherapy may help in the selection of chemotherapy regimen by predicting chemo-responsiveness of CRLM.

## S2-SSGI01- Efficacy of Contrast Enhanced Ultrasound Compared to Hepatobiliary MRI for Differentiation of FNH and Hepatic Adenoma: Preliminary Results of Prospective Clinical Trial (NCT03652636)

Jordan K. Swensson, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Focal nodular hyperplasia (FNH) and hepatic adenoma (HA) are hepatic lesions that occur in similar patient demographics but have markedly different risks and treatments. Because of overlapping morphologic and enhancement features, they are often difficult to differentiate on routine ultrasound, CT, or MR imaging. MR imaging with hepatobiliary agents such as gadoxetate disodium (Eovist/Primovist) utilizes physiologic and anatomic differences in FNH and HA uptake and biliary excretion of contrast to distinguish between these two entities and is the standard imaging approach with published accuracies of >90%. However, MRI may be time consuming, expensive, and at times poorly tolerated. This study presents preliminary data from a prospective clinical trial designed to evaluate if contrast enhanced ultrasound (CEUS) can be used to differentiate FNH from HA with similar accuracy compared to hepatobiliary agent MRI.

## METHODS AND MATERIALS

38 patients with lesions consistent with FNH or HA on hepatobiliary agent MRI within the previous 12 months were identified and consented. 7 chose to withdraw without any intervention, leaving 31 patients to undergo a one-time prospective CEUS of up to two hepatic lesions. Limited grayscale and post contrast sonographic images were obtained following intravenous administration of 2 mL sulfur hexafluoride lipid-type A microspheres (Lumason) per lesion for a total of 47 separate lesions. Images were anonymized and two blinded radiologists provided a diagnosis of FNH or HA for each individual lesion.

## RESULTS

A total of 29 female and 2 male patients were included in the analysis, with average age of 37 years and average body mass index of 32.3. A total of 21 FNH and 26 HA were characterized by MRI then evaluated with CEUS. For all 47 lesions, the two readers demonstrated sensitivity and specificity for FNH of 66.7% / 76.9% and 66.7% / 92.3% with overall accuracy of 72.3% and 80.8%. For lesions greater than or equal to 2 cm in size (12 FNH, 16 HA) the two readers demonstrated sensitivity and specificity for FNH of 75.0% / 100% and 91.4% / 89.3%, each with an overall accuracy of 89.3%. Kappa score for interobserver variability was 0.28 for all lesions and 0.71 for lesions greater than or equal to 2 cm in size.

## CONCLUSION

Contrast enhanced ultrasound demonstrates a high degree of accuracy compared to hepatobiliary agent MRI in differentiating FNH from HA lesions that are greater than 2 cm in size, with moderate inter-observer agreement. Smaller lesions are less reliably differentiated using CEUS.

## CLINICAL RELEVANCE/APPLICATION

Contrast enhanced ultrasound has utility in differentiating FNH from hepatic adenomas, with accuracy approaching that of hepatobiliary agent MRI for lesions greater than 2cm in size.



## Abstract Archives of the RSNA, 2023

S2-SSGI01-4

### Abbreviated Liver MRI with Gd-EOB-DTPA ( Eovist ) Compared to Complete MRI for Follow up of Colorectal Liver Metastases

Sunday, Nov. 26 10:30AM - 11:30AM Room: S405

Maria El Homsy, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare between abbreviated liver MRI and complete liver MRI for assessment of response in patients with colorectal liver metastases.

#### METHODS AND MATERIALS

This retrospective IRB approved study included consecutive patients with colorectal liver metastases between 1/1/2012 and 12/3/2021 on chemotherapy with at least one follow up MRI performed with Gd-EOB-DTPA (Eovist). A baseline MRI was designated by the study coordinator and a follow-up MRI was chosen and separated into two sets of images: a complete MRI with all sequences and an abbreviated MRI (AMRI) including Coronal and axial hepatobiliary phase, axial DWI and coronal T2W. 7 readers reviewed the sets of images with a month break in between to assess RECIST1.1 response and detection of new lesions. To assess interrater agreement (3 readers read each follow-up), Fleiss kappa was computed for variables with 2 levels and Light's averaged pairwise kappa was computed for variables with > 2 levels. To assess intra-rater agreement, simple kappa was computed for variables with 2 levels and weighted kappa was computed for variables with >2 levels.

#### RESULTS

195 patients (135M/60F, median 54y) were included. There was substantial intra-reader agreement for RECIST 1.1 response (Kappa between 0.66-0.89) and for detection of new lesions (Kappa between 0.63-0.81). There was substantial inter-reader agreement for RECIST1.1 response using complete MRI and AMRI with kappa = 0.68 [0.61, 0.74] and 0.72 [0.65, 0.78] respectively. There was moderate inter-reader agreement for detection of new lesion using complete MRI and AMRI with kappa of 0.49 [0.36, 0.64] and 0.56 [0.42, 0.71] respectively.

#### CONCLUSION

Inter-reader agreement between complete and abbreviated MRI was substantial for RECIST1.1 response assessment, thus AMRI can be considered as substitute for follow-up of patients with colorectal liver metastases.

#### CLINICAL RELEVANCE/APPLICATION

AMRI may be considered as an adequate substitute to a complete MRI liver for patients with colorectal liver metastases when the goal is to assess treatment response in the liver. The potential benefit of AMRI is reduced scan time for the patient, increased patient throughput, and decreased interpretation time for the radiologist.

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## Abstract Archives of the RSNA, 2023

S2-SSGI01-5

### **Predicting the Chemotherapeutic Response of Colorectal Cancer Liver Metastasis using Shear-Wave Elastography**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S405

Jae Seok Bae, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the prognostic role of shear-wave velocity (SWV) value for predicting chemotherapeutic response and progression-free survival (PFS) in patients with colorectal cancer liver metastases (CRLMs).

#### **METHODS AND MATERIALS**

In this prospective, single-center study, participants with CRLM who were scheduled to undergo chemotherapy were enrolled between May 2018 and June 2021. SWV value measurements by using shear-wave elastography were performed at the CRLM before and after starting chemotherapy. Based on the Response Evaluation Criteria in Solid Tumors, the chemotherapeutic response of the participants was categorized into two categories: responders including complete remission and partial remission, and nonresponders including stable disease and progressive disease. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the performance of changes in SWV values in predicting the chemotherapeutic response of CRLM. In addition, Cox proportional hazard model was used to identify variables associated with PFS.

#### **RESULTS**

In total, 67 participants (40 men; mean age, 62.3 years  $\pm$  10.1) were enrolled, of which 34 were responders and 33 were nonresponders. The area under the ROC curve, sensitivity, and negative predictive value of SWV value in predicting nonresponders were 0.840, 97.0%, and 95.2%, respectively, with a cutoff value of 13% decrease. The change in SWV value was also independently associated with PFS (hazard ratio, 1.020) as well as being a nonresponder and number of CRLM=5.

#### **CONCLUSION**

The change in SWV values measured after chemotherapy demonstrated a meaningful diagnostic performance to predict nonresponders in patients with CRLM. The change in SWV value was also independently associated with PFS.

#### **CLINICAL RELEVANCE/APPLICATION**

In patients with CRLM, ARFI elastography performed early in the course of chemotherapy may help in the selection of chemotherapy regimen by predicting chemo-responsiveness of CRLM.

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## Abstract Archives of the RSNA, 2023

S2-SSGI01-6

### **Efficacy of Contrast Enhanced Ultrasound Compared to Hepatobiliary MRI for Differentiation of FNH and Hepatic Adenoma: Preliminary Results of Prospective Clinical Trial (NCT03652636)**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S405

Jordan K. Swensson, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Focal nodular hyperplasia (FNH) and hepatic adenoma (HA) are hepatic lesions that occur in similar patient demographics but have markedly different risks and treatments. Because of overlapping morphologic and enhancement features, they are often difficult to differentiate on routine ultrasound, CT, or MR imaging. MR imaging with hepatobiliary agents such as gadoxetate disodium (Eovist/Primovist) utilizes physiologic and anatomic differences in FNH and HA uptake and biliary excretion of contrast to distinguish between these two entities and is the standard imaging approach with published accuracies of >90%. However, MRI may be time consuming, expensive, and at times poorly tolerated. This study presents preliminary data from a prospective clinical trial designed to evaluate if contrast enhanced ultrasound (CEUS) can be used to differentiate FNH from HA with similar accuracy compared to hepatobiliary agent MRI.

#### **METHODS AND MATERIALS**

38 patients with lesions consistent with FNH or HA on hepatobiliary agent MRI within the previous 12 months were identified and consented. 7 chose to withdraw without any intervention, leaving 31 patients to undergo a one-time prospective CEUS of up to two hepatic lesions. Limited grayscale and post contrast sonographic images were obtained following intravenous administration of 2 mL sulfur hexafluoride lipid-type A microspheres (Lumason) per lesion for a total of 47 separate lesions. Images were anonymized and two blinded radiologists provided a diagnosis of FNH or HA for each individual lesion.

#### **RESULTS**

A total of 29 female and 2 male patients were included in the analysis, with average age of 37 years and average body mass index of 32.3. A total of 21 FNH and 26 HA were characterized by MRI then evaluated with CEUS. For all 47 lesions, the two readers demonstrated sensitivity and specificity for FNH of 66.7% / 76.9% and 66.7% / 92.3% with overall accuracy of 72.3% and 80.8%. For lesions greater than or equal to 2 cm in size (12 FNH, 16 HA) the two readers demonstrated sensitivity and specificity for FNH of 75.0% / 100% and 91.4% / 89.3%, each with an overall accuracy of 89.3%. Kappa score for interobserver variability was 0.28 for all lesions and 0.71 for lesions greater than or equal to 2 cm in size.

#### **CONCLUSION**

Contrast enhanced ultrasound demonstrates a high degree of accuracy compared to hepatobiliary agent MRI in differentiating FNH from HA lesions that are greater than 2 cm in size, with moderate inter-observer agreement. Smaller lesions are less reliably differentiated using CEUS.

#### **CLINICAL RELEVANCE/APPLICATION**

Contrast enhanced ultrasound has utility in differentiating FNH from hepatic adenomas, with accuracy approaching that of hepatobiliary agent MRI for lesions greater than 2cm in size.

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## Abstract Archives of the RSNA, 2023

S2-SSGI02

### Gastrointestinal Imaging (CT Techniques and Dose Reduction)

Sunday, Nov. 26 10:30AM - 11:30AM Room: S404

Benjamin M. Yeh, MD (*Moderator*) Grant, Koninklijke Philips NV; Grant, General Electric Company; Consultant, Canon Medical Systems Corporation; Speaker, Canon Medical Systems Corporation; Royalties, Oxford University Press; Shareholder, Nextrast, Inc; Board Member, Nextrast, Inc  
Yong Eun Chung, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **S2-SSGI02- Image Quality of Abdominal Photon-Counting CT with Reduced Contrast Media Dose: Evaluation of Reduced Contrast Media Protocols during the COVID-19 Pandemic Supply Shortage**

Yannik Christian Layer, MD (*Presenter*) Research grant by Siemens Healthcare

#### PURPOSE

Due to iodinated contrast media supply shortages caused by the COVID-19 pandemic in summer 2022, patients received reduced CT contrast media doses (CMD) at our institute. Aim of this study was to assess the impact of CMD reduction on diagnostic quality of photon-counting detector CT (PCD-CT) and energy-integrating detector CT (EID-CT).

#### METHODS AND MATERIALS

Clinical CT scans of the abdominal region acquired in portal venous phase between June and July 2022 on a PCD-CT were included and virtual monoenergetic images (VMI) with 50, 60 and 70 keV reconstructed. CT scans performed on an EID-CT were analyzed for comparison. Diagnostic quality and contrast intensity were rated by two radiologists using a 5-point Likert grading scale qualitatively. Additionally, the blinded readers had to assign the CT scans to reduced or regular CMD. For quantitative assessment regions-of-interest (ROIs) were placed in defined segments of the abdominal aorta, the inferior vena cava, the portal vein, liver, spleen, kidneys and muscular tissue. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated for each organ.

#### RESULTS

Overall 158 CT scans (100% CMD: 75; 70% CMD: 24; 50% CMD: 42) performed on a PCD-CT and 68 examinations (100% CMD: 57; 50% CMD: 11) on an EID-CT were analyzed. Overall diagnostic quality scored 5 (5-5) for PCD-CT with standard CMD (PCD-CT 50% CMD: 4 (4-5); EID-CT 100%: 4 (4-5); EID-CT 50% CMD: 3 (2-3)) and contrast intensity scored 5 (4-5) (PCD-CT 50% CMD: 4 (3-4); EID-CT 100% CMD: 4 (4-4.75); EID-CT 50% CMD: 2.5 (1-3)). For PCD-CT 71.69% of the examinations with reduced CMD were assigned 100% CMD by the readers (Reader 1: 71.08%; Reader 2: 72.29%), for EID-CT 9.09% (Reader 1: 0%; Reader 2: 18.18%). Averaged for all measurements SNR for 50% CMD was reduced by 19% in PCD-CT (EID-CT 34%) and CNR by 48% (EID-CT 56%). VMI at 50 keV increased SNR averaged for all measurements at 50% CMD by 72% and CNR by 153%.

#### CONCLUSION

Diagnostic interpretability of photon-counting detector computed tomography examinations with reduction of up to 50% CMD is maintained. PCD-CT deducted scans with 70% CMD were often not recognized as CMD reduced scans. Compared to EID-CT less decline in SNR and CNR is observed for CMD reduced PCD-CT images. Reducing CMD by 30% on PCD-CT does not decrease overall objective image quality and is therefore recommended for abdominal CT. By reconstruction of low-keV images for example at 50 keV, a significant increase in SNR and CNR can be achieved, which even exceeds the effects of the CMD reduction.

#### CLINICAL RELEVANCE/APPLICATION

The study demonstrates the potential of contrast media reduction of PCD-CT in clinical routine. This can benefit patients with renal impairment, for example, and reduce negative effects of iodinated contrast media on the environment.

## **S2-SSGI02- Benefits of Photon Counting CT for Liver Lesion Detection Compared to Conventional Scanners: A Pilot Reader Study Using Virtual Imaging Trials**

Benjamin Wildman-Tobriner, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Photon counting CT (PCCT) has potential for increased spatial resolution and decreased noise compared to traditional energy integrating CT (EICT). The purpose of this study was to compare PCCT to EICT for detection of liver lesions, particularly for challenging conditions: small lesions or larger patients.

### **METHODS AND MATERIALS**

A virtual imaging trial framework was employed using human models and scanner-specific, validated CT simulators. 25 anthropomorphic virtual phantoms (BMI from 20.0-38.8 kg/m<sup>2</sup>) were included, and between 1-6 liver lesions were inserted into each phantom. The lesions' size and contrast ranged from 0.4-1.5 cm, and 51-95 HU, respectively. The phantoms were then scanned, modeling commercial PCCT (Alpha) and EICT (Flash) scanners (Siemens) under a variety of acquisition and clinical reconstruction settings (CTDI<sub>vol</sub> of 1.5 6.0 mGy, reconstruction kernels of Br36/Br32, Br40/Br40, Br56/Br54). Ultimately 100 scans were produced. All scans were then independently evaluated by 3 subspecialty-trained abdominal radiologists using a web-based platform for image viewing and grading. Readers marked all identifiable liver lesions in each scan, assigned a confidence rating (0-100) for every detected lesion, and gave an overall image quality score (range 0-100). Reader detection of liver lesions was compared to the known ground truth of the inserted lesions, and performance metrics (sensitivity and precision) and image quality scores were evaluated across all imaging conditions.

### **RESULTS**

Mean sensitivity across all readers for lesion detection at 6 mGy was 91.8% for PCCT and 87.7% for EICT (p=0.05). At the lower dose of 1.5 mGy, mean sensitivities were 80.8% and 75.6% for PCCT and EICT, respectively (p=0.03). For lesions <1.0 cm at 1.5 mGy, sensitivity on PCCT was 84.9% compared to 73.5% for EICT (p=0.01). Precision between PCCT and EICT was not significantly different, and the overall image quality scores averaged 52.9 for PCCT and 48.3 for EICT.

### **CONCLUSION**

Detection of liver lesions was improved using a photon counting CT platform compared to a traditional energy integrating CT system. This performance increase was more pronounced at lower doses and for smaller lesions.

### **CLINICAL RELEVANCE/APPLICATION**

Detection of small liver lesions such as early metastasis is crucial for accurate staging and surgical planning. Our study suggests that photon counting CT may improve detection of small lesions compared to traditional scanners.

## **S2-SSGI02- Comparison of Image Quality of Abdominal CT Examinations and Virtual Noncontrast Images Between Photon-Counting and Energy-Integrating Detector CT**

Ludovica Lofino, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To compare image quality of portal venous phase (PVP) abdominal CT examinations and virtual non-contrast (VNC) images between photon-counting CT (PCCT) and energy-integrating Detector CT (EID).

### **METHODS AND MATERIALS**

In this HIPAA compliant, IRB-approved, retrospective study, multi-phase CT scans from one commercially available PCCT (NAEOTOM Alpha, Siemens Healthineers) and two EID dual-source dual-energy CT systems (SOMATOM Definition Flash and SOMATOM Force, Siemens Healthineers) were retrieved. A total of 45 BMI-matched patients (21 women, 24 men; mean age 58.5 ± 15.3 years, range 19-81 years; mean BMI 29.0 ± 6.8 kg/m<sup>2</sup>, range 13-47 kg/m<sup>2</sup>) were included: 15 for PCCT and 15 for each EID system. In vivo image quality parameters (MTFF<sub>10</sub>, noise magnitude, Fav, Fpeak, NPSf<sub>10</sub>) were measured and compared between PCCT and EID for standard PVP and VNC images. A subset analysis was also performed in the overweight patient population (BMI>25 kg/m<sup>2</sup>). CTDI<sub>vol</sub> values were recorded for the three scanners. Because scanner tube current modulation adapts to patient size, radiation dose was compared among scanners accounting for BMI using a figure of merit: FOM=1/(BMI\*lnCTDI<sub>vol</sub>). A five-point scale (1=best and 5=worst) was used to assess reader perception of noise, visibility of small structures, and overall image quality.

### **RESULTS**

Compared to the two EID systems, PCCT yielded significantly improved resolution and noise magnitude for both PVP (MTFF<sub>10</sub> = 0.55 ± 0.08 for PCCT vs. 0.50 ± 0.04 and 0.49 ± 0.03 for Flash and Force, P=0.02; noise = 9.76 ± 3.10 vs. 15.35 ± 4.14 and 10.70 ± 1.34, P=0.02) and VNC images (MTFF<sub>10</sub> = 0.56 ± 0.01 for PCCT vs. 0.51 ± 0.05 and 0.51 ± 0.03 for Flash and Force, P=0.02; noise = 9.59 ± 2.77 vs. 13.90 ± 3.57 and 10.83 ± 2.83, P=0.02). A similar statistically significant trend was confirmed in the smaller subset of overweight patients. Our FOM analysis suggests that, for equal radiation exposure levels

and comparable patient size, PCCT yields 20% noise reduction compared to the two EID systems, with 18% reduction in overweight patients. Reader's perceived image noise was significantly lower for PCCT compared to EID for both PVP ( $1.85 \pm 0.88$  vs.  $2.60 \pm 0.88$  and  $2.70 \pm 0.80$ ) and VNC images ( $1.95 \pm 0.83$  vs.  $3.0 \pm 0.97$  and  $2.90 \pm 0.85$ ). Of note, overall image quality improved significantly for PCCT compared to EID ( $1.35 \pm 0.67$  vs.  $2.60 \pm 0.82$  and  $2.45 \pm 0.69$  for PVP and  $1.50 \pm 0.67$  vs  $2.85 \pm 0.81$  and  $2.55 \pm 0.60$  for VNC).

## **CONCLUSION**

Compared to conventional EID systems, PCCT yields significantly lower radiation dose along with improved image quality on PVP and VNC images of abdominal CT examinations.

## **CLINICAL RELEVANCE/APPLICATION**

PCCT has a lower radiation dose compared to EID CT, with better image quality parameters and lower noise magnitude.

## **S2-SSGI02- Deep-learning CT Reconstruction in the Abdomen: A Systematic Review and Meta-Analysis** **4**

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Deep-learning image reconstruction (DLR) provides a unique opportunity to overcome current reconstruction modalities' restrictions. We conducted this systematic review of the literature and meta analysis to evaluate the two most common commercially available deep learning algorithms for CT reconstruction in abdominal imaging and determine their effectiveness.

## **METHODS AND MATERIALS**

We used PubMed, Scopus, Embase, and Web of Science to conduct systematic searches for studies assessing the most common commercially available deep learning CT reconstruction algorithms: True Fidelity (TF) and Advanced intelligent Clear-IQ Engine (AiCE) in the abdomen of human participants.

## **RESULTS**

Forty-four articles fulfilled inclusion criteria. 32 studies evaluated TF and 12 studies assessed AiCE. DLR algorithms produced images with significantly less noise (22-57.3% less than IR) but preserved a desirable noise texture with increased contrast-to-noise ratios and improved lesion detectability on conventional CT. These improvements with DLR were similarly noted in dual-energy CT which was only assessed for a single vendor. Reported radiation reduction potential was 35.1-78.5%. Nine studies assessed observer performance with the two dedicated liver lesion studies being performed on the same vendor reconstruction (TF). These two studies indicate preserved low contrast liver lesion detection (>5mm) at CTDIvol 6.8 mGy (BMI 23.5 kg/m<sup>2</sup>) to 12.2 mGy (BMI 29 kg/m<sup>2</sup>). If smaller lesion detection and improved lesion characterization is needed, a CTDIvol of 13.6 mGy - 34.9 mGy is needed in a normal weight to obese population. Mild signal loss and blurring have been reported at high DLR reconstruction strengths.

## **CONCLUSION**

Deep learning reconstructions significantly improve image quality in CT of the abdomen. Assessment of other dose levels and clinical indications is necessary. Careful choice of radiation dose levels is necessary, particularly for small liver lesion assessment.

## **CLINICAL RELEVANCE/APPLICATION**

The use of DLR reconstruction techniques could lead to more accurate diagnosis and treatment planning, while also reducing the risks associated with radiation exposure during CT imaging. However, careful selection of appropriate radiation doses is necessary to avoid signal loss and blurring at high DLR reconstruction strengths.

## **S2-SSGI02- AI-aided Contrast Augmentation of Abdominal-Pelvis CT Examinations: Multi-site, External** **5 Validation Study of Impact on Hepatic Lesions, Vessels, and Parenchyma**

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Liver lesions can be difficult to detect and assess on abdomen-pelvis CT due to their low contrast and high noise in the liver parenchyma. We assessed the qualitative and quantitative effect of AI-aided, iodine-related contrast augmentation of abdominal-pelvis CT examinations on hepatic lesions, vessels, and parenchyma.

## **METHODS AND MATERIALS**

The study received IRB approval with the waiver of informed consent. Our study included 100 contrast-enhanced abdomen-pelvis CT exams from 100 adult patients (mean age 59 +/- 14 years, M:F 48:52 ) who were imaged to evaluate primary or metastatic liver lesions. The thin-section deidentified DICOM images were exported offline from PACS and processed with an AI algorithm (ClariACE, ClariPi, South Korea) for selective iodine-related contrast augmentation in CT images. The algorithm

allows users to set their preferred contrast augmentation intensity (fixed at 0.70 for the study purpose) and simultaneous image denoising (fixed at 0.20). We performed a side-by-side comparison of baseline (CT-B) and contrast augmentation (CT-CA) images for liver lesion conspicuity, detection, image noise, and artifacts. We also measured attenuation values on CT-B and CT-CA in abdominal fat, gall bladder, muscles, liver parenchyma, liver lesion, common hepatic artery, and right portal vein. Data were assessed using paired t-test and Wilcoxon rank sum test with a corrected p-value of < 0.0125 for statistical significance.

## RESULTS

There was a significant subjective improvement in hepatic and vascular enhancement as well as in the image noise on CT-CA versus CT-B images. There were no major artifacts on CT-CA images. Most CT exams had between 1-20 liver lesions with improved lesion conspicuity on CT-CA images compared to CTB. Likewise, there was a significant increase in HU values of liver, liver vessels, and liver lesions on CT-CA (HU increase of 15-80 HU,  $p < 0.001$ ), without any change in CT numbers of abdominal fat, muscles, and gall bladder (0-2 HU change;  $p > 0.9$ ).

## CONCLUSION

The AI-aided, iodine-related contrast augmentation of abdominal-pelvis CT examinations resulted in improvement in liver lesion conspicuity and quantitative lesion and vascular enhancement.

## CLINICAL RELEVANCE/APPLICATION

AI-aided, iodine-related contrast augmentation can help improve lesion detection and evaluation while denoising the CT images.

## S2-SSGI02- Super-High-Resolution Abdominal Imaging using CZT based Photon Counting CT with Deep Learning Reconstruction: Quantitative Study and First Clinical Impression

Ken Hirayama (*Presenter*) Nothing to Disclose

## PURPOSE

Recently, first clinical studies of CZT-based photon counting detector CT (CZT-PCD-CT) has started in Japan. Due to its small pixel design, CZT-PCD-CT can generate super-high-resolution (SHR) image and has potential to improve the diagnostic quality of abdominal imaging. To mitigate the noise in SHR imaging, a deep learning based reconstruction can also be applied in SHR mode. In this study, we aim to 1) quantify the resolution benefits of the CZT-PCD-CT for abdominal imaging in comparison to normal resolution mode (NR); 2) evaluate diagnostic image quality with patient scan and explore potential clinical benefits of SHR mode in abdominal imaging.

## METHODS AND MATERIALS

The prototype CZT-PCD-CT is built based on a Aquilion Precision system (Canon Medical Systems, Japan). The beam coverage of the CZT-PCD-CT system is 40 mm, and the focal spot size is 0.4 mm\*0.5 mm. Catphan600 (The Phantom Laboratory, U.S) and patients were scanned in helical mode at 120 kVp, 250 mA (9.7 mGy), 0.5 s rotation and pitch factor 0.8. NR images were reconstructed using a 512-matrix size, and a hybrid-iterative reconstruction (Hybrid-IR). SHR images were reconstructed using a 1024-matrix size with both Hybrid-IR and deep learning reconstruction (DLR). The image thickness is 1.2 mm, and standard kernel was used for all images. Visual evaluation and profile measurement are performed on Catphan with slit modules, task-based transfer functions (TTF) were measured at Polystyrene module. Clinical abdomen images were assessed for NR and SHR image noise (SD) and anatomical structures in the upper abdomen.

## RESULTS

Slit profiles were visible up to 8 lp/cm in NR, 10 lp/cm in SHR and 10 lp/cm in SHR with DLR. 10% TTF values were 0.7 cycles/mm for NR images, 1.0 cycles/mm for SHR images with IR, and 0.9 cycles/mm for SHR images with DLR. Spatial resolution with SHR mode was higher compared to NR mode. For abdominal NR and SHR images, the image noise levels were acceptable for diagnostic tasks. The noise SD was 10.2 HU for NR images, 13.1 HU for SHR images with IR and 11.1 HU for SHR images with DLR, and the SHR images with DLR showed low noise level with high spatial resolution. Pancreatic duct and vessels were more visible and blooming artifacts from calcification were significantly reduced on SHR images.

## CONCLUSION

The CZT PCD-CT with super-high-resolution imaging mode offers significant improvements in spatial resolution and has potential in improving diagnostic quality of abdominal imaging.

## CLINICAL RELEVANCE/APPLICATION

The high-resolution images in the SHR mode of CZT-PCD-CT contribute improved diagnostic performance in abdominal imaging.

## Abstract Archives of the RSNA, 2023

S2-SSGI02-1

### Image Quality of Abdominal Photon-Counting CT with Reduced Contrast Media Dose: Evaluation of Reduced Contrast Media Protocols during the COVID-19 Pandemic Supply Shortage

Sunday, Nov. 26 10:30AM - 11:30AM Room: S404

Yannik Christian Layer, MD (*Presenter*) Research grant by Siemens Healthcare

#### PURPOSE

Due to iodinated contrast media supply shortages caused by the COVID-19 pandemic in summer 2022, patients received reduced CT contrast media doses (CMD) at our institute. Aim of this study was to assess the impact of CMD reduction on diagnostic quality of photon-counting detector CT (PCD-CT) and energy-integrating detector CT (EID-CT).

#### METHODS AND MATERIALS

Clinical CT scans of the abdominal region acquired in portal venous phase between June and July 2022 on a PCD-CT were included and virtual monoenergetic images (VMI) with 50, 60 and 70 keV reconstructed. CT scans performed on an EID-CT were analyzed for comparison. Diagnostic quality and contrast intensity were rated by two radiologists using a 5-point Likert grading scale qualitatively. Additionally, the blinded readers had to assign the CT scans to reduced or regular CMD. For quantitative assessment regions-of-interest (ROIs) were placed in defined segments of the abdominal aorta, the inferior vena cava, the portal vein, liver, spleen, kidneys and muscular tissue. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated for each organ.

#### RESULTS

Overall 158 CT scans (100% CMD: 75; 70% CMD: 24; 50% CMD: 42) performed on a PCD-CT and 68 examinations (100% CMD: 57; 50% CMD: 11) on an EID-CT were analyzed. Overall diagnostic quality scored 5 (5-5) for PCD-CT with standard CMD (PCD-CT 50% CMD: 4 (4-5); EID-CT 100%: 4 (4-5); EID-CT 50% CMD: 3 (2-3)) and contrast intensity scored 5 (4-5) (PCD-CT 50% CMD: 4 (3-4); EID-CT 100% CMD: 4 (4-4.75); EID-CT 50% CMD: 2.5 (1-3)). For PCD-CT 71.69% of the examinations with reduced CMD were assigned 100% CMD by the readers (Reader 1: 71.08%; Reader 2: 72.29%), for EID-CT 9.09% (Reader 1: 0%; Reader 2: 18.18%). Averaged for all measurements SNR for 50% CMD was reduced by 19% in PCD-CT (EID-CT 34%) and CNR by 48% (EID-CT 56%). VMI at 50 keV increased SNR averaged for all measurements at 50% CMD by 72% and CNR by 153%.

#### CONCLUSION

Diagnostic interpretability of photon-counting detector computed tomography examinations with reduction of up to 50% CMD is maintained. PCD-CT deducted scans with 70% CMD were often not recognized as CMD reduced scans. Compared to EID-CT less decline in SNR and CNR is observed for CMD reduced PCD-CT images. Reducing CMD by 30% on PCD-CT does not decrease overall objective image quality and is therefore recommended for abdominal CT. By reconstruction of low-keV images for example at 50 keV, a significant increase in SNR and CNR can be achieved, which even exceeds the effects of the CMD reduction.

#### CLINICAL RELEVANCE/APPLICATION

The study demonstrates the potential of contrast media reduction of PCD-CT in clinical routine. This can benefit patients with renal impairment, for example, and reduce negative effects of iodinated contrast media on the environment.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-SSGI02-2

### Benefits of Photon Counting CT for Liver Lesion Detection Compared to Conventional Scanners: A Pilot Reader Study Using Virtual Imaging Trials

Sunday, Nov. 26 10:30AM - 11:30AM Room: S404

Benjamin Wildman-Tobriner, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon counting CT (PCCT) has potential for increased spatial resolution and decreased noise compared to traditional energy integrating CT (EICT). The purpose of this study was to compare PCCT to EICT for detection of liver lesions, particularly for challenging conditions: small lesions or larger patients.

#### METHODS AND MATERIALS

A virtual imaging trial framework was employed using human models and scanner-specific, validated CT simulators. 25 anthropomorphic virtual phantoms (BMI from 20.0-38.8 kg/m<sup>2</sup>) were included, and between 1-6 liver lesions were inserted into each phantom. The lesions' size and contrast ranged from 0.4-1.5 cm, and 51-95 HU, respectively. The phantoms were then scanned, modeling commercial PCCT (Alpha) and EICT (Flash) scanners (Siemens) under a variety of acquisition and clinical reconstruction settings (CTDI<sub>vol</sub> of 1.5 6.0 mGy, reconstruction kernels of Br36/Br32, Br40/Br40, Br56/Br54). Ultimately 100 scans were produced. All scans were then independently evaluated by 3 subspecialty-trained abdominal radiologists using a web-based platform for image viewing and grading. Readers marked all identifiable liver lesions in each scan, assigned a confidence rating (0-100) for every detected lesion, and gave an overall image quality score (range 0-100). Reader detection of liver lesions was compared to the known ground truth of the inserted lesions, and performance metrics (sensitivity and precision) and image quality scores were evaluated across all imaging conditions.

#### RESULTS

Mean sensitivity across all readers for lesion detection at 6 mGy was 91.8% for PCCT and 87.7% for EICT ( $p=0.05$ ). At the lower dose of 1.5 mGy, mean sensitivities were 80.8% and 75.6% for PCCT and EICT, respectively ( $p=0.03$ ). For lesions <1.0 cm at 1.5 mGy, sensitivity on PCCT was 84.9% compared to 73.5% for EICT ( $p=0.01$ ). Precision between PCCT and EICT was not significantly different, and the overall image quality scores averaged 52.9 for PCCT and 48.3 for EICT.

#### CONCLUSION

Detection of liver lesions was improved using a photon counting CT platform compared to a traditional energy integrating CT system. This performance increase was more pronounced at lower doses and for smaller lesions.

#### CLINICAL RELEVANCE/APPLICATION

Detection of small liver lesions such as early metastasis is crucial for accurate staging and surgical planning. Our study suggests that photon counting CT may improve detection of small lesions compared to traditional scanners.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSGI02-3

### Comparison of Image Quality of Abdominal CT Examinations and Virtual Noncontrast Images Between Photon-Counting and Energy-Integrating Detector CT

Sunday, Nov. 26 10:30AM - 11:30AM Room: S404

Ludovica Lofino, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare image quality of portal venous phase (PVP) abdominal CT examinations and virtual non-contrast (VNC) images between photon-counting CT (PCCT) and energy-integrating Detector CT (EID).

#### METHODS AND MATERIALS

In this HIPAA compliant, IRB-approved, retrospective study, multi-phase CT scans from one commercially available PCCT (NAEOTOM Alpha, Siemens Healthineers) and two EID dual-source dual-energy CT systems (SOMATOM Definition Flash and SOMATOM Force, Siemens Healthineers) were retrieved. A total of 45 BMI-matched patients (21 women, 24 men; mean age  $58.5 \pm 15.3$  years, range 19-81 years; mean BMI  $29.0 \pm 6.8$  kg/m<sup>2</sup>, range 13-47 kg/m<sup>2</sup>) were included: 15 for PCCT and 15 for each EID system. In vivo image quality parameters (MTF<sub>f10</sub>, noise magnitude, Fav, Fpeak, NPS<sub>f10</sub>) were measured and compared between PCCT and EID for standard PVP and VNC images. A subset analysis was also performed in the overweight patient population (BMI > 25 kg/m<sup>2</sup>). CTDI<sub>vol</sub> values were recorded for the three scanners. Because scanner tube current modulation adapts to patient size, radiation dose was compared among scanners accounting for BMI using a figure of merit:  $FOM = 1 / (BMI * \ln CTDI_{vol})$ . A five-point scale (1=best and 5=worst) was used to assess reader perception of noise, visibility of small structures, and overall image quality.

#### RESULTS

Compared to the two EID systems, PCCT yielded significantly improved resolution and noise magnitude for both PVP (MTF<sub>f10</sub> =  $0.55 \pm 0.08$  for PCCT vs.  $0.50 \pm 0.04$  and  $0.49 \pm 0.03$  for Flash and Force,  $P=0.02$ ; noise =  $9.76 \pm 3.10$  vs.  $15.35 \pm 4.14$  and  $10.70 \pm 1.34$ ,  $P=0.02$ ) and VNC images (MTF<sub>f10</sub> =  $0.56 \pm 0.01$  for PCCT vs.  $0.51 \pm 0.05$  and  $0.51 \pm 0.03$  for Flash and Force,  $P=0.02$ ; noise =  $9.59 \pm 2.77$  vs.  $13.90 \pm 3.57$  and  $10.83 \pm 2.83$ ,  $P=0.02$ ). A similar statistically significant trend was confirmed in the smaller subset of overweight patients. Our FOM analysis suggests that, for equal radiation exposure levels and comparable patient size, PCCT yields 20% noise reduction compared to the two EID systems, with 18% reduction in overweight patients. Reader's perceived image noise was significantly lower for PCCT compared to EID for both PVP ( $1.85 \pm 0.88$  vs.  $2.60 \pm 0.88$  and  $2.70 \pm 0.80$ ) and VNC images ( $1.95 \pm 0.83$  vs.  $3.0 \pm 0.97$  and  $2.90 \pm 0.85$ ). Of note, overall image quality improved significantly for PCCT compared to EID ( $1.35 \pm 0.67$  vs.  $2.60 \pm 0.82$  and  $2.45 \pm 0.69$  for PVP and  $1.50 \pm 0.67$  vs  $2.85 \pm 0.81$  and  $2.55 \pm 0.60$  for VNC).

#### CONCLUSION

Compared to conventional EID systems, PCCT yields significantly lower radiation dose along with improved image quality on PVP and VNC images of abdominal CT examinations.

#### CLINICAL RELEVANCE/APPLICATION

PCCT has a lower radiation dose compared to EID CT, with better image quality parameters and lower noise magnitude.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-SSGI02-4

### Deep-learning CT Reconstruction in the Abdomen: A Systematic Review and Meta-Analysis

Sunday, Nov. 26 10:30AM - 11:30AM Room: S404

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep-learning image reconstruction (DLR) provides a unique opportunity to overcome current reconstruction modalities' restrictions. We conducted this systematic review of the literature and meta analysis to evaluate the two most common commercially available deep learning algorithms for CT reconstruction in abdominal imaging and determine their effectiveness.

#### METHODS AND MATERIALS

We used PubMed, Scopus, Embase, and Web of Science to conduct systematic searches for studies assessing the most common commercially available deep learning CT reconstruction algorithms: True Fidelity (TF) and Advanced intelligent Clear-IQ Engine (AiCE) in the abdomen of human participants.

#### RESULTS

Forty-four articles fulfilled inclusion criteria. 32 studies evaluated TF and 12 studies assessed AiCE. DLR algorithms produced images with significantly less noise (22-57.3% less than IR) but preserved a desirable noise texture with increased contrast-to-noise ratios and improved lesion detectability on conventional CT. These improvements with DLR were similarly noted in dual-energy CT which was only assessed for a single vendor. Reported radiation reduction potential was 35.1-78.5%. Nine studies assessed observer performance with the two dedicated liver lesion studies being performed on the same vendor reconstruction (TF). These two studies indicate preserved low contrast liver lesion detection (>5mm) at CTDIvol 6.8 mGy (BMI 23.5 kg/m<sup>2</sup>) to 12.2 mGy (BMI 29 kg/m<sup>2</sup>). If smaller lesion detection and improved lesion characterization is needed, a CTDIvol of 13.6 mGy - 34.9 mGy is needed in a normal weight to obese population. Mild signal loss and blurring have been reported at high DLR reconstruction strengths.

#### CONCLUSION

Deep learning reconstructions significantly improve image quality in CT of the abdomen. Assessment of other dose levels and clinical indications is necessary. Careful choice of radiation dose levels is necessary, particularly for small liver lesion assessment.

#### CLINICAL RELEVANCE/APPLICATION

The use of DLR reconstruction techniques could lead to more accurate diagnosis and treatment planning, while also reducing the risks associated with radiation exposure during CT imaging. However, careful selection of appropriate radiation doses is necessary to avoid signal loss and blurring at high DLR reconstruction strengths.

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## Abstract Archives of the RSNA, 2023

S2-SSGI02-5

### AI-aided Contrast Augmentation of Abdominal-Pelvis CT Examinations: Multi-site, External Validation Study of Impact on Hepatic Lesions, Vessels, and Parenchyma

Sunday, Nov. 26 10:30AM - 11:30AM Room: S404

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Liver lesions can be difficult to detect and assess on abdomen-pelvis CT due to their low contrast and high noise in the liver parenchyma. We assessed the qualitative and quantitative effect of AI-aided, iodine-related contrast augmentation of abdominal-pelvis CT examinations on hepatic lesions, vessels, and parenchyma.

#### METHODS AND MATERIALS

The study received IRB approval with the waiver of informed consent. Our study included 100 contrast-enhanced abdomen-pelvis CT exams from 100 adult patients (mean age 59 +/- 14 years, M:F 48:52 ) who were imaged to evaluate primary or metastatic liver lesions. The thin-section deidentified DICOM images were exported offline from PACS and processed with an AI algorithm (ClariACE, Claripi, South Korea) for selective iodine-related contrast augmentation in CT images. The algorithm allows users to set their preferred contrast augmentation intensity (fixed at 0.70 for the study purpose) and simultaneous image denoising (fixed at 0.20). We performed a side-by-side comparison of baseline (CT-B) and contrast augmentation (CT-CA) images for liver lesion conspicuity, detection, image noise, and artifacts. We also measured attenuation values on CT-B and CT-CA in abdominal fat, gall bladder, muscles, liver parenchyma, liver lesion, common hepatic artery, and right portal vein. Data were assessed using paired t-test and Wilcoxon rank sum test with a corrected p-value of < 0.0125 for statistical significance.

#### RESULTS

There was a significant subjective improvement in hepatic and vascular enhancement as well as in the image noise on CT-CA versus CT-B images. There were no major artifacts on CT-CA images. Most CT exams had between 1-20 liver lesions with improved lesion conspicuity on CT-CA images compared to CTB. Likewise, there was a significant increase in HU values of liver, liver vessels, and liver lesions on CT-CA (HU increase of 15-80 HU,  $p < 0.001$ ), without any change in CT numbers of abdominal fat, muscles, and gall bladder (0-2 HU change;  $p > 0.9$ ).

#### CONCLUSION

The AI-aided, iodine-related contrast augmentation of abdominal-pelvis CT examinations resulted in improvement in liver lesion conspicuity and quantitative lesion and vascular enhancement.

#### CLINICAL RELEVANCE/APPLICATION

AI-aided, iodine-related contrast augmentation can help improve lesion detection and evaluation while denoising the CT images.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSGI02-6

### Super-High-Resolution Abdominal Imaging using CZT based Photon Counting CT with Deep Learning Reconstruction: Quantitative Study and First Clinical Impression

Sunday, Nov. 26 10:30AM - 11:30AM Room: S404

Ken Hirayama (*Presenter*) Nothing to Disclose

#### PURPOSE

Recently, first clinical studies of CZT-based photon counting detector CT (CZT-PCD-CT) has started in Japan. Due to its small pixel design, CZT-PCD-CT can generate super-high-resolution (SHR) image and has potential to improve the diagnostic quality of abdominal imaging. To mitigate the noise in SHR imaging, a deep learning based reconstruction can also be applied in SHR mode. In this study, we aim to 1) quantify the resolution benefits of the CZT-PCD-CT for abdominal imaging in comparison to normal resolution mode (NR); 2) evaluate diagnostic image quality with patient scan and explore potential clinical benefits of SHR mode in abdominal imaging.

#### METHODS AND MATERIALS

The prototype CZT-PCD-CT is built based on a Aquilion Precision system (Canon Medical Systems, Japan). The beam coverage of the CZT-PCD-CT system is 40 mm, and the focal spot size is 0.4 mm\*0.5 mm. Catphan600 (The Phantom Laboratory, U.S) and patients were scanned in helical mode at 120 kVp, 250 mA (9.7 mGy), 0.5 s rotation and pitch factor 0.8. NR images were reconstructed using a 512-matrix size, and a hybrid-iterative reconstruction (Hybrid-IR). SHR images were reconstructed using a 1024-matrix size with both Hybrid-IR and deep learning reconstruction (DLR). The image thickness is 1.2 mm, and standard kernel was used for all images. Visual evaluation and profile measurement are performed on Catphan with slit modules, task-based transfer functions (TTF) were measured at Polystyrene module. Clinical abdomen images were assessed for NR and SHR image noise (SD) and anatomical structures in the upper abdomen.

#### RESULTS

Slit profiles were visible up to 8 lp/cm in NR, 10 lp/cm in SHR and 10 lp/cm in SHR with DLR. 10% TTF values were 0.7 cycles/mm for NR images, 1.0 cycles/mm for SHR images with IR, and 0.9 cycles/mm for SHR images with DLR. Spatial resolution with SHR mode was higher compared to NR mode. For abdominal NR and SHR images, the image noise levels were acceptable for diagnostic tasks. The noise SD was 10.2 HU for NR images, 13.1 HU for SHR images with IR and 11.1 HU for SHR images with DLR, and the SHR images with DLR showed low noise level with high spatial resolution. Pancreatic duct and vessels were more visible and blooming artifacts from calcification were significantly reduced on SHR images.

#### CONCLUSION

The CZT PCD-CT with super-high-resolution imaging mode offers significant improvements in spatial resolution and has potential in improving diagnostic quality of abdominal imaging.

#### CLINICAL RELEVANCE/APPLICATION

The high-resolution images in the SHR mode of CZT-PCD-CT contribute improved diagnostic performance in abdominal imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSPD01

### Science Session with Keynote: Pediatric Imaging (Neuroradiology/Head and Neck)

Sunday, Nov. 26 10:30AM - 11:30AM Room: N226

Nolan R. Altman, MD (*Moderator*) Nothing to Disclose  
Elysa Widjaja, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

##### S2-SSPD01-Keynote Speaker

5

Elysa Widjaja, MD, PhD (*Presenter*) Nothing to Disclose

##### S2-SSPD01-AI-Thyroid: Pilot Results for Evaluating Thyroid Malignancy in Children

6

Eun Ju Ha, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Although less common in children compared to adults, thyroid cancer represents the most common pediatric endocrine malignancy. Prior studies have shown feasibility of AI models for predicting malignant thyroid nodules in the adult population. Studies on AI model performance and validation on the pediatric population are presently lacking. Here, we examine applicability of AI in the evaluation of thyroid nodules in children.

#### METHODS AND MATERIALS

Pediatric cohorts (N = 123; mean age,  $15.4 \pm 2.4$  years; 99 female) who obtained ultrasound (US) for thyroid nodule(s) and had histological confirmation were retrospectively identified from two independent institutions (Ajou University Medical Center, South Korea; Stanford Lucile Packard Children's Hospital, USA). AI-Thyroid, a deep learning model for identifying malignant thyroid nodules and learned on adult population, was tested on the pediatric cohorts on the following scenarios: (a) scenario 1: nodules, with axial US images; (b) scenario 2, nodules, with longitudinal US images; and (c) scenario 3, nodules, with both axial and longitudinal US images together. Model performance was compared against blinded expert radiologist performance using the American College of Radiology-, American Thyroid Association-, and Korean-Thyroid Imaging Reporting and Data Systems (TIRADSs) interpretation.

#### RESULTS

A total of 150 thyroid nodules were analyzed, 44 (29.3%) comprising malignant nodules. Based on the radiologists' TIRADSs interpretation, the sensitivity and specificity were 86.4-93.2% and 45.3-78.3%, respectively. Using AI-Thyroid, the area under the receiver operating characteristic (AUROC), sensitivity, and specificity were: (a) scenario 1: 0.894, 72.7%, and 86.7%; (b) scenario 2: 0.927, 77.3%, and 89.5%; (c) scenario 3: 0.904, 86.4%, and 79.1%. The AUROC did not differ significantly between the pediatric cohorts from the two institutions ( $p = 0.410$ ).

#### CONCLUSION

We present high performance of AI-Thyroid on the pediatric population. Future investigations could include additional approaches to optimizing AI-Thyroid tailored to pediatric population, such as transfer learning from adult population, fine-tuning on pediatric cohorts, and, image synthesis, as well as implications of AI as an adjunct tool alongside tissue sampling in the ENT clinics.

#### CLINICAL RELEVANCE/APPLICATION

1. The diagnostic performances of the adult-based AI model were acceptable in the pediatric population. 2. It is necessary to optimize AI-Thyroid tailored to pediatric population, such as transfer learning from adult population, fine-tuning on pediatric cohorts, and, image synthesis, as well as implications of AI as an adjunct tool alongside tissue sampling in the ENT clinics.

## Abstract Archives of the RSNA, 2023

S2-SSPD01-5

### Keynote Speaker

Sunday, Nov. 26 10:30AM - 11:30AM Room: N226

Elysa Widjaja, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSPD01-6

### AI-Thyroid: Pilot Results for Evaluating Thyroid Malignancy in Children

Sunday, Nov. 26 10:30AM - 11:30AM Room: N226

Eun Ju Ha, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Although less common in children compared to adults, thyroid cancer represents the most common pediatric endocrine malignancy. Prior studies have shown feasibility of AI models for predicting malignant thyroid nodules in the adult population. Studies on AI model performance and validation on the pediatric population are presently lacking. Here, we examine applicability of AI in the evaluation of thyroid nodules in children.

#### METHODS AND MATERIALS

Pediatric cohorts (N = 123; mean age,  $15.4 \pm 2.4$  years; 99 female) who obtained ultrasound (US) for thyroid nodule(s) and had histological confirmation were retrospectively identified from two independent institutions (Ajou University Medical Center, South Korea; Stanford Lucile Packard Children's Hospital, USA). AI-Thyroid, a deep learning model for identifying malignant thyroid nodules and learned on adult population, was tested on the pediatric cohorts on the following scenarios: (a) scenario 1: nodules, with axial US images; (b) scenario 2, nodules, with longitudinal US images; and (c) scenario 3, nodules, with both axial and longitudinal US images together. Model performance was compared against blinded expert radiologist performance using the American College of Radiology-, American Thyroid Association-, and Korean-Thyroid Imaging Reporting and Data Systems (TIRADSs) interpretation.

#### RESULTS

A total of 150 thyroid nodules were analyzed, 44 (29.3%) comprising malignant nodules. Based on the radiologists' TIRADSs interpretation, the sensitivity and specificity were 86.4-93.2% and 45.3-78.3%, respectively. Using AI-Thyroid, the area under the receiver operating characteristic (AUROC), sensitivity, and specificity were: (a) scenario 1: 0.894, 72.7%, and 86.7%; (b) scenario 2: 0.927, 77.3%, and 89.5%; (c) scenario 3: 0.904, 86.4%, and 79.1%. The AUROC did not differ significantly between the pediatric cohorts from the two institutions ( $p = 0.410$ ).

#### CONCLUSION

We present high performance of AI-Thyroid on the pediatric population. Future investigations could include additional approaches to optimizing AI-Thyroid tailored to pediatric population, such as transfer learning from adult population, fine-tuning on pediatric cohorts, and, image synthesis, as well as implications of AI as an adjunct tool alongside tissue sampling in the ENT clinics.

#### CLINICAL RELEVANCE/APPLICATION

1. The diagnostic performances of the adult-based AI model were acceptable in the pediatric population. 2. It is necessary to optimize AI-Thyroid tailored to pediatric population, such as transfer learning from adult population, fine-tuning on pediatric cohorts, and, image synthesis, as well as implications of AI as an adjunct tool alongside tissue sampling in the ENT clinics.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSR001

### Radiation Oncology (Head and Neck)

Sunday, Nov. 26 10:30AM - 11:30AM Room: S402

Simon S. Lo, MBChB (*Moderator*) Committee member, Elekta AB  
Sung Kim, MD (*Moderator*) Consultant, Nanobiotix

#### Sub-Events

### S2-SSR001-3 **Graph-Based Spatially-Aware Radiomics Improves Prediction of Locoregional Recurrence in Radiotherapy-Treated Head and Neck Squamous Cell Carcinoma**

Joseph Bae, MS, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Most radiomic analyses calculate a single number for each feature studied. Each of these values captures the global expression of a single textural component within a region of interest (ROI), but cannot holistically represent the spatial distribution of that feature (i.e. pixel or voxel-wise values). Nonetheless, radiomic analysis has been largely successful in numerous contexts and has been applied to multiple tasks including the prediction of treatment response to radiotherapy (RT) in head and neck squamous cell carcinoma (HNSCC). HNSCC treated via RT results in locoregional recurrence (LR) in up to 30% of cases, which can result in negative outcomes for patients. Here we propose a novel method leveraging computational graphs to more thoroughly exploit the spatial expression of radiomic features from pre-treatment CT to improve LR prediction for RT-treated HNSCC.

#### METHODS AND MATERIALS

A de-identified dataset containing 492 HNSCC patient CTs and RT structures was identified from the Cancer Imaging Archive. 70 patients experienced LR. Voxel-wise radiomic features were extracted from each CT from within RT gross target volume (GTV) ROIs. Supervoxel clustering was used to segment ROIs within GTVs into 50 subregions. Computational graphs were built by creating 50 nodes with each containing radiomic feature expression from one GTV subregion. Edges were created between nodes by calculating the Euclidean distance between mean radiomic feature values of each pair of nodes, thereby capturing the relationship in radiomic expression between each pair of subregions. One graph was created for each image studied. A graph attention neural network (GAT) was trained for the LR prediction task. 80% of the data was randomly used for training and the remaining for testing. Comparisons were made with a previously published radiomic signature and standard clinical predictors including patient age, smoking history, sex, and tumor stage.

#### RESULTS

Graph radiomics resulted in an AUC of 0.775, a sensitivity of 83.8% and a specificity of 55.6% on the test set, outperforming both clinical (AUC=0.520, sensitivity=81.5%, specificity=29.4%) and traditional radiomic (AUC=0.495, sensitivity=65.5%, specificity=41.2%) approaches.

#### CONCLUSION

Graph radiomics more effectively leverages information contained in voxel-level radiomic feature expression, improving LR prediction for HNSCC patients. Graph radiomics may expand the potential for radiomic analysis of medical imaging datasets complementary to deep learning analyses.

#### CLINICAL RELEVANCE/APPLICATION

The prediction of LR for HNSCC patients from pre-treatment imaging might inform alternative or more aggressive treatment paradigms for at-risk patients, hopefully improving patient outcomes and quality of life.

### S2-SSR001-4 **Structured Reporting and Deep Learning to Reduce Miss Rate of Radiation-Induced Temporal Lobe Injury on MRI of Patients With Nasopharyngeal Carcinoma**

Linmei Zhao (*Presenter*) Nothing to Disclose

## PURPOSE

To develop a structured report (SR) and deep learning (DL) model for the reduction of miss rate of radiation-induced temporal lobe injury (RTLTI) on magnetic resonance imaging (MRI) of patients with nasopharyngeal carcinoma (NPC).

## METHODS AND MATERIALS

A total of 2043 NPC patients from four academic centers in China were included. All patients underwent radiotherapy and follow-up MRIs. RTLTI was diagnosed if any of white matter finger-like lesions, contrast-enhanced lesions, cysts, or hemorrhages appeared in the index (N) and follow-up MRI images (N+1) but no lesion on prior MRI(N-1). The index MRI, defined as the one in which the temporal lobe findings that meet the diagnostic criteria for RTLTI first appeared, was reviewed blindly by two radiologists (L.Z and Y.Z) using the original report (OR) and SR. A DL model based on the Efficient Net B4 architecture was trained for RTLTI classification. A cohort of 476 patients (293 non-RTLTI and 183 RTLTI) from one hospital was divided into training and testing set at a ratio of 8:2. Then, the model was externally tested on MRI scans of 1567 patients (1353 non-RTLTI and 214 RTLTI) from 3 other hospitals. Model performance was evaluated by accuracy, area under the receiver operator curve (AUC), sensitivity, and specificity. Images were evaluated again by two radiologists (L.Z and Y.Z) using the output of the DL model as a reference. Performance was evaluated by calculating the miss rates, accuracy, specificity, and sensitivity for radiologists using OR (OR), radiologist using SR (SR), DL model alone (Artificial intelligence [AI]) and radiologists with DL assistance (AI-assisted).

## RESULTS

The miss rates of RTLTI for OR, SR, AI and AI-assisted were 46.3% (99 of 214), 26.6% (57 of 214), 9.8% (21 of 214) and 7.5% (16 of 214), respectively. Figure 1 demonstrates the performance of the four approaches in classifying RTLTI. Compared with OR, radiologists assisted by SR had significantly improved diagnostic accuracy (95.5% vs. 93.7%,  $P=0.002$ ) and sensitivity (73.6% vs. 53.7%,  $P<0.001$ ). The AI model outperformed SR in sensitivity (90.3 vs. 53.7%,  $P<0.001$ ), but accuracy or specificity were not improved. Assisted with the AI model, the radiologists achieved a higher accuracy (by 1.5%,  $P<0.001$ ) and specificity (by 1.3%,  $P<0.001$ ).

## CONCLUSION

The implementation of SR and AI improved radiologist performance in detecting RTLTI on conventional MRI. Moreover, the AI model outperformed radiologists using SR in RTLTI detection.

## CLINICAL RELEVANCE/APPLICATION

Our study plays an important role in promoting the integration of SR and AI into routine clinical workflow to assist radiologists in the early diagnosis of RTLTI, improving diagnostic capabilities and health outcomes

## S2-SSR001-5 Radiomics Approaches for Predicting Non-iodine-Avid Status of Lung Metastases in Patients With Differentiated Thyroid Cancer Based on CT: A Prospective, Observational Study

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Identifying non-iodine-avid status of lung metastases (LMs) in time is crucial to avoid radioactive I131 treatment for patients with differentiated thyroid cancer (DTC) who will not benefit from it. In this study, we speculated that vivid radiomics features and deep learning features of routine chest CT scans may reflect different tumor heterogeneity between noniodine-avid and iodine-avid LMs. To evaluate this hypothesis, different radiomics models were built with machine learning, deep learning and novel integration of radiomics features and deep learning features to discriminate non-iodine-avid LMs from iodine-avid LMs in patients with DTC.

## METHODS AND MATERIALS

Models were built in 1445 pretreated LMs of 270 consecutive DTC patients with pretreated initially diagnosed LMs who underwent both chest CT and diagnostic radioiodine whole-body scanning between January 2010 and December 2019 in A Cancer Hospital. Integration models based on machine learning were built with selected radiomics features and deep learning features and compared with classic machine learning models (Random Forest, K-Nearest Neighbor, Logistic Regression, and Support Vector Machine), or deep learning models to predict non-iodine-avid status of lung metastases. To validate these radiomics approaches prospectively, we recruited 244 consecutive patients with 876 LMs between January 2020 to October 2022.

## RESULTS

Among all the machine learning models, the Support Vector Machine showed the best discrimination, with a 0.815 area under the curve (AUC), a 0.754 sensitivity and a 0.730 specificity. The deep learning model reached a 0.869 AUC, a 0.794 sensitivity and a 0.798 specificity. All the integration models were significantly better than classic machine learning or deep learning alone, with the best AUC of 0.904, sensitivity of 0.812, specificity of 0.823.



## CONCLUSION

Radiomics features and deep learning features of routine chest CT scans can reflect different tumor heterogeneity between noniodine-avid and iodine-avid LMs. Specially, we found that the novel integration models combining traditional radiomics features and deep learning features could further improve the prediction ability comparing with classic machine learning or deep learning alone. Our study highlights a possible role of radiomics approaches from routine chest CT as a noninvasive, less radioactive and cost-effective way to evaluate iodine-avid status of LMs in DTC.

## CLINICAL RELEVANCE/APPLICATION

Radiomics approaches based on routine chest CT scans can predict iodine-avid status of LMs in patients with DTC and aid in treatment strategy in advance before radioactive I131 therapy, noninvasively and less radioactively.

## S2-SSR001-6 Assessment of Skin Changes and Recovery Following Radiotherapy Using High Frequency Ultrasound

Vittorio Patane' (*Presenter*) Nothing to Disclose

## PURPOSE

Radiation therapy (RT) results as an effective and safe treatment for cutaneous non-melanoma skin cancer (NMSC). Although surgery is the gold standard, in cases of inoperability or patient choice RT is used for radical intent; in high-risk disease, RT in adjuvant setting is preferred. In the case of positive margins, the indication for RT remains undisputed; for other risk factors (PNI invasion, T3, G3 degree of differentiation), the indication for adjuvant therapy remains at the discretion of the radiation oncologist, as the adverse effects could be greater than the benefit. HFUS (US ultra-high frequency, 48MHZ) as the latest generation ultrasound that allows, thanks to the use of high frequency ultrasound, to study the skin accurately and reliably, compared to the traditional ultrasound (10-20MHZ). It allows to have greater detail of the skin layers from the epidermis to the hypodermis, to better characterize the thickness and size of skin oncological lesions. Aims: The aim of this study is to evaluate skin structures after RT treatment clinically and with HFUS to record adverse effects and grade of severities and eventually studying disease recurrences that would not be clinically evident.

## METHODS AND MATERIALS

Between July 2022 to April 2023, we enrolled 20 patients (pts) who underwent RT to evaluate toxicities clinically and with HFUS. 13 patients had the histological diagnosis of Squamous cell carcinoma (cSCC), while 7 had a diagnosis of Basal cell carcinoma (BCC); 10 pts performed RT for radical purpose, the remaining 10 received adjuvant RT treatment. Follow-up (fup) was performed every 3 months after the end of RT by clinical examination and HFUS.

## RESULTS

At the first fup, at 3 months after the end of RT, 4 patients presented erythema G1 according to CTCAE toxicity scale. Only 1 patient had erythema G1 at the 2nd fup at 6 months after treatment. Remaining patients had no acute toxicities in fup at 3/6/9 months. HFUS showed alterations in the echogenicity of the skin layers, most evident immediately after radiotherapy treatment. The most frequently documented lesions were bands and areolas of hypoechogenicity in the radiotreated area which showed a slight increase in the vascular signal on Color Doppler, especially in more superficial layers of the skin, in agreement with the clinical findings of dyschromia and erythema in the treated area. In all cases after 3-month, we documented the restitutio ad integrum of the treated skin region.

## CONCLUSION

RT for NMSC is confirmed as a safe and well-tolerated treatment clinically and by ultrasound evaluation, both in the radical and adjuvant modality.

## CLINICAL RELEVANCE/APPLICATION

Resulting minimal toxicities, RT should always be considered in the case of adjuvant therapy in the treatment of high-risk of NMSC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSR001-3

### Graph-Based Spatially-Aware Radiomics Improves Prediction of Locoregional Recurrence in Radiotherapy-Treated Head and Neck Squamous Cell Carcinoma

Sunday, Nov. 26 10:30AM - 11:30AM Room: S402

Joseph Bae, MS, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Most radiomic analyses calculate a single number for each feature studied. Each of these values captures the global expression of a single textural component within a region of interest (ROI), but cannot holistically represent the spatial distribution of that feature (i.e. pixel or voxel-wise values). Nonetheless, radiomic analysis has been largely successful in numerous contexts and has been applied to multiple tasks including the prediction of treatment response to radiotherapy (RT) in head and neck squamous cell carcinoma (HNSCC). HNSCC treated via RT results in locoregional recurrence (LR) in up to 30% of cases, which can result in negative outcomes for patients. Here we propose a novel method leveraging computational graphs to more thoroughly exploit the spatial expression of radiomic features from pre-treatment CT to improve LR prediction for RT-treated HNSCC.

#### METHODS AND MATERIALS

A de-identified dataset containing 492 HNSCC patient CTs and RT structures was identified from the Cancer Imaging Archive. 70 patients experienced LR. Voxel-wise radiomic features were extracted from each CT from within RT gross target volume (GTV) ROIs. Supervoxel clustering was used to segment ROIs within GTVs into 50 subregions. Computational graphs were built by creating 50 nodes with each containing radiomic feature expression from one GTV subregion. Edges were created between nodes by calculating the Euclidean distance between mean radiomic feature values of each pair of nodes, thereby capturing the relationship in radiomic expression between each pair of subregions. One graph was created for each image studied. A graph attention neural network (GAT) was trained for the LR prediction task. 80% of the data was randomly used for training and the remaining for testing. Comparisons were made with a previously published radiomic signature and standard clinical predictors including patient age, smoking history, sex, and tumor stage.

#### RESULTS

Graph radiomics resulted in an AUC of 0.775, a sensitivity of 83.8% and a specificity of 55.6% on the test set, outperforming both clinical (AUC=0.520, sensitivity=81.5%, specificity=29.4%) and traditional radiomic (AUC=0.495, sensitivity=65.5%, specificity=41.2%) approaches.

#### CONCLUSION

Graph radiomics more effectively leverages information contained in voxel-level radiomic feature expression, improving LR prediction for HNSCC patients. Graph radiomics may expand the potential for radiomic analysis of medical imaging datasets complementary to deep learning analyses.

#### CLINICAL RELEVANCE/APPLICATION

The prediction of LR for HNSCC patients from pre-treatment imaging might inform alternative or more aggressive treatment paradigms for at-risk patients, hopefully improving patient outcomes and quality of life.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSR001-4

### Structured Reporting and Deep Learning to Reduce Miss Rate of Radiation-Induced Temporal Lobe Injury on MRI of Patients With Nasopharyngeal Carcinoma

Sunday, Nov. 26 10:30AM - 11:30AM Room: S402

Linmei Zhao (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a structured report (SR) and deep learning (DL) model for the reduction of miss rate of radiation-induced temporal lobe injury (RTLI) on magnetic resonance imaging (MRI) of patients with nasopharyngeal carcinoma (NPC).

#### METHODS AND MATERIALS

A total of 2043 NPC patients from four academic centers in China were included. All patients underwent radiotherapy and follow-up MRIs. RTLI was diagnosed if any of white matter finger-like lesions, contrast-enhanced lesions, cysts, or hemorrhages appeared in the index (N) and follow-up MRI images (N+1) but no lesion on prior MRI(N-1). The index MRI, defined as the one in which the temporal lobe findings that meet the diagnostic criteria for RTLI first appeared, was reviewed blindly by two radiologists (L.Z and Y.Z) using the original report (OR) and SR. A DL model based on the Efficient Net B4 architecture was trained for RTLI classification. A cohort of 476 patients (293 non-RTLI and 183 RTLI) from one hospital was divided into training and testing set at a ratio of 8:2. Then, the model was externally tested on MRI scans of 1567 patients (1353 non-RTLI and 214 RTLI) from 3 other hospitals. Model performance was evaluated by accuracy, area under the receiver operator curve (AUC), sensitivity, and specificity. Images were evaluated again by two radiologists (L.Z and Y.Z) using the output of the DL model as a reference. Performance was evaluated by calculating the miss rates, accuracy, specificity, and sensitivity for radiologists using OR (OR), radiologist using SR (SR), DL model alone (Artificial intelligence [AI]) and radiologists with DL assistance (AI-assisted).

#### RESULTS

The miss rates of RTLI for OR, SR, AI and AI-assisted were 46.3% (99 of 214), 26.6% (57 of 214), 9.8% (21 of 214) and 7.5% (16 of 214), respectively. Figure 1 demonstrates the performance of the four approaches in classifying RTLI. Compared with OR, radiologists assisted by SR had significantly improved diagnostic accuracy (95.5% vs. 93.7%,  $P=0.002$ ) and sensitivity (73.6% vs. 53.7%,  $P<0.001$ ). The AI model outperformed SR in sensitivity (90.3 vs. 53.7%,  $P<0.001$ ), but accuracy or specificity were not improved. Assisted with the AI model, the radiologists achieved a higher accuracy (by 1.5%,  $P<0.001$ ) and specificity (by 1.3%,  $P<0.001$ ).

#### CONCLUSION

The implementation of SR and AI improved radiologist performance in detecting RTLI on conventional MRI. Moreover, the AI model outperformed radiologists using SR in RTLI detection.

#### CLINICAL RELEVANCE/APPLICATION

Our study plays an important role in promoting the integration of SR and AI into routine clinical workflow to assist radiologists in the early diagnosis of RTLI, improving diagnostic capabilities and health outcomes

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSR001-5

### **Radiomics Approaches for Predicting Non-iodine-Avid Status of Lung Metastases in Patients With Differentiated Thyroid Cancer Based on CT: A Prospective, Observational Study**

Sunday, Nov. 26 10:30AM - 11:30AM Room: S402

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Identifying non-iodine-avid status of lung metastases (LMs) in time is crucial to avoid radioactive I131 treatment for patients with differentiated thyroid cancer (DTC) who will not benefit from it. In this study, we speculated that vivid radiomics features and deep learning features of routine chest CT scans may reflect different tumor heterogeneity between noniodine-avid and iodine-avid LMs. To evaluate this hypothesis, different radiomics models were built with machine learning, deep learning and novel integration of radiomics features and deep learning features to discriminate non-iodine-avid LMs from iodine-avid LMs in patients with DTC.

#### **METHODS AND MATERIALS**

Models were built in 1445 pretreated LMs of 270 consecutive DTC patients with pretreated initially diagnosed LMs who underwent both chest CT and diagnostic radioiodine whole-body scanning between January 2010 and December 2019 in A Cancer Hospital. Integration models based on machine learning were built with selected radiomics features and deep learning features and compared with classic machine learning models (Random Forest, K-Nearest Neighbor, Logistic Regression, and Support Vector Machine), or deep learning models to predict non-iodine-avid status of lung metastases. To validate these radiomics approaches prospectively, we recruited 244 consecutive patients with 876 LMs between January 2020 to October 2022.

#### **RESULTS**

Among all the machine learning models, the Support Vector Machine showed the best discrimination, with a 0.815 area under the curve (AUC), a 0.754 sensitivity and a 0.730 specificity. The deep learning model reached a 0.869 AUC, a 0.794 sensitivity and a 0.798 specificity. All the integration models were significantly better than classic machine learning or deep learning alone, with the best AUC of 0.904, sensitivity of 0.812, specificity of 0.823.

#### **CONCLUSION**

Radiomics features and deep learning features of routine chest CT scans can reflect different tumor heterogeneity between noniodine-avid and iodine-avid LMs. Specially, we found that the novel integration models combining traditional radiomics features and deep learning features could further improve the prediction ability comparing with classic machine learning or deep learning alone. Our study highlights a possible role of radiomics approaches from routine chest CT as a noninvasive, less radioactive and cost-effective way to evaluate iodine-avid status of LMs in DTC.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiomics approaches based on routine chest CT scans can predict iodine-avid status of LMs in patients with DTC and aid in treatment strategy in advance before radioactive I131 therapy, noninvasively and less radioactively.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-SSR001-6

### Assessment of Skin Changes and Recovery Following Radiotherapy Using High Frequency Ultrasound

Sunday, Nov. 26 10:30AM - 11:30AM Room: S402

Vittorio Patane' (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiation therapy (RT) results as an effective and safe treatment for cutaneous non-melanoma skin cancer (NMSC). Although surgery is the gold standard, in cases of inoperability or patient choice RT is used for radical intent; in high-risk disease, RT in adjuvant setting is preferred. In the case of positive margins, the indication for RT remains undisputed; for other risk factors (PNI invasion, T3, G3 degree of differentiation), the indication for adjuvant therapy remains at the discretion of the radiation oncologist, as the adverse effects could be greater than the benefit. HFUS (US ultra-high frequency, 48MHZ) as the latest generation ultrasound that allows, thanks to the use of high frequency ultrasound, to study the skin accurately and reliably, compared to the traditional ultrasound (10-20MHZ). It allows to have greater detail of the skin layers from the epidermis to the hypodermis, to better characterize the thickness and size of skin oncological lesions. Aims: The aim of this study is to evaluate skin structures after RT treatment clinically and with HFUS to record adverse effects and grade of severities and eventually studying disease recurrences that would not be clinically evident.

#### METHODS AND MATERIALS

Between July 2022 to April 2023, we enrolled 20 patients (pts) who underwent RT to evaluate toxicities clinically and with HFUS. 13 patients had the histological diagnosis of Squamous cell carcinoma (cSCC), while 7 had a diagnosis of Basal cell carcinoma (BCC); 10 pts performed RT for radical purpose, the remaining 10 received adjuvant RT treatment. Follow-up (fup) was performed every 3 months after the end of RT by clinical examination and HFUS.

#### RESULTS

At the first fup, at 3 months after the end of RT, 4 patients presented erythema G1 according to CTCAE toxicity scale. Only 1 patient had erythema G1 at the 2nd fup at 6 months after treatment. Remaining patients had no acute toxicities in fup at 3/6/9 months. HFUS showed alterations in the echogenicity of the skin layers, most evident immediately after radiotherapy treatment. The most frequently documented lesions were bands and areolas of hypoechogenicity in the radiotreated area which showed a slight increase in the vascular signal on Color Doppler, especially in more superficial layers of the skin, in agreement with the clinical findings of dyschromia and erythema in the treated area. In all cases after 3-month, we documented the restitutio ad integrum of the treated skin region.

#### CONCLUSION

RT for NMSC is confirmed as a safe and well-tolerated treatment clinically and by ultrasound evaluation, both in the radical and adjuvant modality.

#### CLINICAL RELEVANCE/APPLICATION

Resulting minimal toxicities, RT should always be considered in the case of adjuvant therapy in the treatment of high-risk of NMSC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-STCE1

### Science Session (Sustainability in Imaging)

Sunday, Nov. 26 10:30AM - 11:00AM Room: Learning Center Theater 1

#### Sub-Events

#### **S2-STCE1-2 Energy and greenhouse gas emission savings from power down of CT scanners in non-operational hours in a large regional practice**

Maura J. Brown, MD, FRCPC (*Presenter*) Synthesis Health Inc - research collaboration, no financial relationship at this time (Nov 2022).

#### **PURPOSE**

To assess the clinical practicality of placing CT scanners in low power mode our group gathered CT scanner use data from practice settings over a multi-hospital region serving 3.1 million people. Using vendor provided energy use data, we modeled energy, cost and greenhouse gas (GHG) savings which could be obtained switching to a lower power mode without impact on patient care

#### **METHODS AND MATERIALS**

CT scanner usage data was pulled from the RIS systems of four healthcare organizations. Exclusion criteria included lack of a practical low power mode or lack of data from the manufacturer regarding power consumption. Scanners were classified based on clinical usage pattern: "Low-use" scanners are minimally used outside standard daytime hours. "Medium-use" scanners are staffed and always available, however usage is less than one scan every two hours outside of daytime hours. "Heavy-use" scanners are in use 24 hours a day with no opportunity to lower power consumption level. For low- and medium-use scanners, we model energy savings during a 6-hour period from 7 pm to 1 am (evening) or 1 am to 7 am (night):  $E = P(6 \text{ hours} - nt)$  Where  $P$  = difference in power consumption between stand-by and lower power modes,  $n$  = the average number of scans done in the time period, and  $t$  is time estimate the scanner will be out of sleep mode when one patient is scanned ( $t = 25$  minutes). A 12-hour daytime period (7 am to 7 pm) was considered on weekends in addition to evening/night

#### **RESULTS**

Of the 37 CT scanners, 20 were excluded. Of the 17 eligible scanners 7 were low-use, 5 medium-use and 5 heavy-use. In total, for the 12 scanners in low-use and medium-use clinical settings, the energy savings are 251,022 kWh/year if all were switched to lower power mode when not in use, equivalent to 456,042 miles driven in a gasoline powered car and US \$30,876 saved in electricity costs. The heavy-use scanners were in use greater than one scan every two hours 24 hours per day, therefore switching to lower power mode for energy savings was not performed

#### **CONCLUSION**

Placing CT scanners in lower power mode in non-operational hours in low-use and medium-use clinical settings results in substantial energy and GHG savings

#### **CLINICAL RELEVANCE/APPLICATION**

Results of this modeling study suggest that efforts should be targeted to switching CT scanners to lower power mode outside standard daytime hours in low-use and medium-use clinical settings

#### **S2-STCE1-3 Exposing Sustainable Imaging Strategies: The Role of Practitioners in Reducing Carbon Footprint**

Diana E. Carver, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Diagnostic radiology is a crucial component of medicine and must be "decarbonized" for public health and safety. Healthcare emits an estimated 4.4% of global greenhouse gases (GHG) and 8.5% of the US's total GHGs. The climate crisis requires

coordinated action from everyone, including radiologists and healthcare systems. This study estimates emissions associated with a radiology department in an academic medical center and aims to identify and implement interventions to reduce environmental impact by focusing on rescan rates.

## **METHODS AND MATERIALS**

This study is part of a collaboration between a major radiology equipment manufacturer and a large academic medical center in the southeastern US that sees more than 2.6M patients annually. The manufacturer makes radiology equipment such as MR, CT, X-ray, and US; software; and provides sustainability program services. Our scope included 14 pieces of radiology equipment, performing an average 15,000 exams per month with 24-hr operations. We performed an ISO14040-based Life Cycle Assessment, including capital equipment manufacturing and distribution, consumable and durable supplies, energy use, staff and patient commuting, laundering and supply reprocessing, equipment refurbishment, and waste disposal. Using the electronic medical record, we assessed rescan rates by modality and anatomy, in addition to turnover and flow rates.

## **RESULTS**

Initial results from one month of data show rescan rates vary by modality, with an average exam per patient ranging from 1 to 1.78. CT showed the highest average number of exams per patient, followed by X-Ray, US, and MR. Total energy consumption of 4 CTs over one month was 7263 kWh, resulting in an estimated 3744 kg CO<sub>2</sub>e. Annual total emissions could reach up to 44,927 kg CO<sub>2</sub>e. Energy consumption was 74% of the total CO<sub>2</sub>e related to the life cycle emissions of the equipment. Based on energy consumption alone, CO<sub>2</sub>e was estimated to be 0.6 kg CO<sub>2</sub>e per exam. Reducing repeat scans from 1.78 to 1 exam per patient could lead to 78% less energy consumption and emissions, assuming the repeated scans do not have a clinical indication.

## **CONCLUSION**

Reducing unnecessary or repeated scans provides substantial GHG emission reductions and improves health equity. Several factors impact the rescan rate, including procedure and disease type, technical errors, staff expertise, and operational factors. Technology innovations, such as AI, can perform scans faster and reduce rescans of MR and CT images when patients are moving. Optimal utilization of equipment may reduce per-scan or per-patient GHGs but may increase cumulative GHGs.

## **CLINICAL RELEVANCE/APPLICATION**

Health system policies for decarbonized energy sources can reduce GHGs in an aging patient population and growing demand for medical imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-STCE1-2

### Energy and greenhouse gas emission savings from power down of CT scanners in non-operational hours in a large regional practice

Sunday, Nov. 26 10:30AM - 11:00AM Room: Learning Center Theater 1

Maura J. Brown, MD, FRCPC (*Presenter*) Synthesis Health Inc - research collaboration, no financial relationship at this time (Nov 2022).

#### PURPOSE

To assess the clinical practicality of placing CT scanners in low power mode our group gathered CT scanner use data from practice settings over a multi-hospital region serving 3.1 million people. Using vendor provided energy use data, we modeled energy, cost and greenhouse gas (GHG) savings which could be obtained switching to a lower power mode without impact on patient care

#### METHODS AND MATERIALS

CT scanner usage data was pulled from the RIS systems of four healthcare organizations. Exclusion criteria included lack of a practical low power mode or lack of data from the manufacturer regarding power consumption. Scanners were classified based on clinical usage pattern: "Low-use" scanners are minimally used outside standard daytime hours. "Medium-use" scanners are staffed and always available, however usage is less than one scan every two hours outside of daytime hours. "Heavy-use" scanners are in use 24 hours a day with no opportunity to lower power consumption level. For low- and medium-use scanners, we model energy savings during a 6-hour period from 7 pm to 1 am (evening) or 1 am to 7 am (night):  $E = P(6 \text{ hours} - nt)$  Where  $P$  = difference in power consumption between stand-by and lower power modes,  $n$  = the average number of scans done in the time period, and  $t$  is time estimate the scanner will be out of sleep mode when one patient is scanned ( $t = 25$  minutes). A 12-hour daytime period (7 am to 7 pm) was considered on weekends in addition to evening/night

#### RESULTS

Of the 37 CT scanners, 20 were excluded. Of the 17 eligible scanners 7 were low-use, 5 medium-use and 5 heavy-use. In total, for the 12 scanners in low-use and medium-use clinical settings, the energy savings are 251,022 kWh/year if all were switched to lower power mode when not in use, equivalent to 456,042 miles driven in a gasoline powered car and US \$30,876 saved in electricity costs. The heavy-use scanners were in use greater than one scan every two hours 24 hours per day, therefore switching to lower power mode for energy savings was not performed

#### CONCLUSION

Placing CT scanners in lower power mode in non-operational hours in low-use and medium-use clinical settings results in substantial energy and GHG savings

#### CLINICAL RELEVANCE/APPLICATION

Results of this modeling study suggest that efforts should be targeted to switching CT scanners to lower power mode outside standard daytime hours in low-use and medium-use clinical settings

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S2-STCE1-3

### Exposing Sustainable Imaging Strategies: The Role of Practitioners in Reducing Carbon Footprint

Sunday, Nov. 26 10:30AM - 11:00AM Room: Learning Center Theater 1

Diana E. Carver, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Diagnostic radiology is a crucial component of medicine and must be “decarbonized” for public health and safety. Healthcare emits an estimated 4.4% of global greenhouse gases (GHG) and 8.5% of the US’s total GHGs. The climate crisis requires coordinated action from everyone, including radiologists and healthcare systems. This study estimates emissions associated with a radiology department in an academic medical center and aims to identify and implement interventions to reduce environmental impact by focusing on rescan rates.

#### METHODS AND MATERIALS

This study is part of a collaboration between a major radiology equipment manufacturer and a large academic medical center in the southeastern US that sees more than 2.6M patients annually. The manufacturer makes radiology equipment such as MR, CT, X-ray, and US; software; and provides sustainability program services. Our scope included 14 pieces of radiology equipment, performing an average 15,000 exams per month with 24-hr operations. We performed an ISO14040-based Life Cycle Assessment, including capital equipment manufacturing and distribution, consumable and durable supplies, energy use, staff and patient commuting, laundering and supply reprocessing, equipment refurbishment, and waste disposal. Using the electronic medical record, we assessed rescan rates by modality and anatomy, in addition to turnover and flow rates.

#### RESULTS

Initial results from one month of data show rescan rates vary by modality, with an average exam per patient ranging from 1 to 1.78. CT showed the highest average number of exams per patient, followed by X-Ray, US, and MR. Total energy consumption of 4 CTs over one month was 7263 kWh, resulting in an estimated 3744 kg CO<sub>2</sub>e. Annual total emissions could reach up to 44,927 kg CO<sub>2</sub>e. Energy consumption was 74% of the total CO<sub>2</sub>e related to the life cycle emissions of the equipment. Based on energy consumption alone, CO<sub>2</sub>e was estimated to be 0.6 kg CO<sub>2</sub>e per exam. Reducing repeat scans from 1.78 to 1 exam per patient could lead to 78% less energy consumption and emissions, assuming the repeated scans do not have a clinical indication.

#### CONCLUSION

Reducing unnecessary or repeated scans provides substantial GHG emission reductions and improves health equity. Several factors impact the rescan rate, including procedure and disease type, technical errors, staff expertise, and operational factors. Technology innovations, such as AI, can perform scans faster and reduce rescans of MR and CT images when patients are moving. Optimal utilization of equipment may reduce per-scan or per-patient GHGs but may increase cumulative GHGs.

#### CLINICAL RELEVANCE/APPLICATION

Health system policies for decarbonized energy sources can reduce GHGs in an aging patient population and growing demand for medical imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-STCE2

### Science Session (Imaging of Immunotherapy)

Sunday, Nov. 26 10:30AM - 11:00AM Room: Learning Center Theater 2

#### Sub-Events

#### **S2-STCE2-1 Combo or mono-immunotherapy in patients with metastatic MSI colorectal cancer: The role of radiologists in clinical decision-making.**

Remy Barbe, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The goal is to determine the response to mono vs combo immunotherapy for patients with metastatic microsatellite instability colorectal cancer (MSI mCRC), using quantitative imaging features from baseline CT-scans and clinical factors.

#### **METHODS AND MATERIALS**

This retrospective study included a training cohort of 105 patients and a validation cohort of 45 patients treated either with a single immunotherapy (mono) or a combination of immunotherapies (combo). Chest-abdomen-pelvis baseline CT-scans were collected and annotated by 6 radiologists. Annotations were made manually in 2D on the axial plane slice where the tumor was largest. Total tumor volume (TTV) was computed by summing the approximate volume of each lesion. Reproducibility was assessed using Intra-correlation coefficient (ICC2k) on 10 patients. Cox models were used to predict overall survival (OS). Progression free survival (PFS) was evaluated. Recursive feature elimination (RFE) was used to reduce the number of variables using bootstrap and the concordance-index. A cutoff was selected for each continuous feature and a risk score was built using Hazard ratios. The final model was modified to exclude the type of treatment (mono-combo).

#### **RESULTS**

In total, 2258 lesions were annotated. ICC2k was equal to 0.95, 0.91 and 0.88 for TTV, number of lesions and number of metastatic sites. Of the 14 variables studied, 4 were selected after the RFE: age, presence of peritoneal carcinomatosis (PC), number of lesions and TTV. Type of treatment was excluded from the feature selection process. The cutoffs for TTV, number of lesions and age were 73cm<sup>3</sup>, 20 lesions and 60 years old. The log HR for TTV, number of lesions, age and PC were 1.13, 0.96, 0.91 and 0.38 and the cutoff of the risk score was 1.36. Patients with a low risk score had similar OS and PFS independently of treatment, while those with a high score had significantly worse OS and PFS if treated with monotherapy (HR=3.68, p=0.006 and HR=5.68, p<0.001 respectively). In the validation cohort, a significant difference in PFS was observed for the high score population (HR=8.487, p=0.046).

#### **CONCLUSION**

Total tumor volume combined with number of lesions and presence of peritoneal carcinomatosis could guide immunotherapy treatment for MSI mCRC. This score would allow radiologists to identify patients who will benefit from combo immunotherapy, thus limiting drug-overuse and its increased risk of serious adverse effects. TTV had the highest HR, highlighting the value of calculating total tumor burden in selected cases.

#### **CLINICAL RELEVANCE/APPLICATION**

Imaging is able to identify criteria that may play a role in therapeutic decision-making in patients with mCRC MSI, identifying those who benefit from combo-immunotherapy, enabling personalized treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S2-STCE2-1

### **Combo or mono-immunotherapy in patients with metastatic MSI colorectal cancer: The role of radiologists in clinical decision-making.**

Sunday, Nov. 26 10:30AM - 11:00AM Room: Learning Center Theater 2

Remy Barbe, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The goal is to determine the response to mono vs combo immunotherapy for patients with metastatic microsatellite instability colorectal cancer (MSI mCRC), using quantitative imaging features from baseline CT-scans and clinical factors.

#### **METHODS AND MATERIALS**

This retrospective study included a training cohort of 105 patients and a validation cohort of 45 patients treated either with a single immunotherapy (mono) or a combination of immunotherapies (combo). Chest-abdomen-pelvis baseline CT-scans were collected and annotated by 6 radiologists. Annotations were made manually in 2D on the axial plane slice where the tumor was largest. Total tumor volume (TTV) was computed by summing the approximate volume of each lesion. Reproducibility was assessed using Intra-correlation coefficient (ICC2k) on 10 patients. Cox models were used to predict overall survival (OS). Progression free survival (PFS) was evaluated. Recursive feature elimination (RFE) was used to reduce the number of variables using bootstrap and the concordance-index. A cutoff was selected for each continuous feature and a risk score was built using Hazard ratios. The final model was modified to exclude the type of treatment (mono-combo).

#### **RESULTS**

In total, 2258 lesions were annotated. ICC2k was equal to 0.95, 0.91 and 0.88 for TTV, number of lesions and number of metastatic sites. Of the 14 variables studied, 4 were selected after the RFE: age, presence of peritoneal carcinomatosis (PC), number of lesions and TTV. Type of treatment was excluded from the feature selection process. The cutoffs for TTV, number of lesions and age were 73cm<sup>3</sup>, 20 lesions and 60 years old. The log HR for TTV, number of lesions, age and PC were 1.13, 0.96, 0.91 and 0.38 and the cutoff of the risk score was 1.36. Patients with a low risk score had similar OS and PFS independently of treatment, while those with a high score had significantly worse OS and PFS if treated with monotherapy (HR=3.68, p=0.006 and HR=5.68, p<0.001 respectively). In the validation cohort, a significant difference in PFS was observed for the high score population (HR=8.487, p=0.046).

#### **CONCLUSION**

Total tumor volume combined with number of lesions and presence of peritoneal carcinomatosis could guide immunotherapy treatment for MSI mCRC. This score would allow radiologists to identify patients who will benefit from combo immunotherapy, thus limiting drug-overuse and its increased risk of serious adverse effects. TTV had the highest HR, highlighting the value of calculating total tumor burden in selected cases.

#### **CLINICAL RELEVANCE/APPLICATION**

Imaging is able to identify criteria that may play a role in therapeutic decision-making in patients with mCRC MSI, identifying those who benefit from combo-immunotherapy, enabling personalized treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-1

### Performance of an Artificial Intelligence System on Screening Breast Tomosynthesis Cases

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Roger S. Yang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the performance of artificial intelligence (AI) on screening tomosynthesis mammograms

#### METHODS AND MATERIALS

This retrospective study included 28,278 DBT screening exams and the subsequent BIRADS 0 workups, consecutively collected from February to July 2022 from multiple outpatient imaging centers within a private practice. The screening exams (Hologic) were evaluated by 36 MQSA radiologists and scored according to the Breast Imaging Reporting and Data Classification System (BIRADS). BIRADS 0 cases were recalled for additional evaluation and potential biopsy. All DBT screening exams were analyzed by an AI system (Transpara 1.7.1, ScreenPoint Medical), which assigned an exam score between 1-10 indicating an increasing likelihood of malignancy. The positive predictive value (PPV) of radiologists and the performance of the AI system were evaluated.

#### RESULTS

Out of 28,278 screening exams, 4170 exams were labeled as BIRADS 0, resulting in a recall rate of 14.75%. Of the 4,170 patients recalled, 3,531 returned to one of our facilities for diagnostic imaging. There were 581 diagnostic exams labeled as BIRADS 4-5 and recommended for biopsy. Biopsy results were available for 335 cases at the time of analysis, revealing 70 biopsy-proven cancers. A BIRADS-0 rating corresponded to a PPV of 3.4%. A BIRADS 4-5 rating based on DBT and subsequent workup yielded a PPV of 20.9%. AI identified 92.9% of cancers (65/70) with an exam score between 8 and 10, 84.3% of cancers (59/70) were flagged with the highest AI score of 10.

#### CONCLUSION

AI score 8-10 has a strong predictive value for cancer. This system can be used to aid radiologists when evaluating screening mammograms.

#### CLINICAL RELEVANCE/APPLICATION

An AI tool that reliably indicates the probability of malignancy on the initial mammogram could serve as clinical decision support reducing biopsy and recall rates and increasing cancer detection rates.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-2

### Improving Video-Based Ultrasound Diagnostic Performance for Breast Cancer to Expert-Level Using Deep Learning: A Retrospective, Multicenter, Diagnostic Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Fajin Dong JR, MD,MD (*Presenter*) Nothing to Disclose

#### PURPOSE

we aim to propose and validate a new automated deep learning framework based on standard video recordings of ultrasound examination.

#### METHODS AND MATERIALS

We designed a video-based framework for breast screening cineclips and integrated three classic AI models, DenseNet121, MobileNet, and Xception as backbones. For comparison, image-based framework is also constructed using the same three backbones with physician selected images, since image-based diagnosis is the current standard practice. In total, 3907 patients from two major medical centers were enrolled between July 2015 and January 2022. Both images and videos of the patients are utilized to train and evaluate models, including retrospective real-world data and prospective test data. Cineclip model tests, image model tests, and reader studies with human experts are performed on both retrospective and prospective data.

#### RESULTS

The accuracy of cineclip models is 87.40 to 92.59%, exceeding the accuracy of 76.00 to 85.60% achieved by all physicians with 7 to 10 years of experience in reader studies. In both real-world and prospective tests, cineclip models surpass image models among all evaluation metrics, including accuracy (87.40-92.59% vs. 80.80-85.83%), sensitivity (86.00-93.33% vs. 80.00-91.07%), specificity (83.10-92.00% vs. 78.87-86.67%), F1 (0.876-0.927 vs. 0.807-0.861) and AUROC (Area under Receiver Operating Characteristic Curve, 0.926-0.962 vs. 0.843-0.936). The difference in AUROC between cineclip models and image models with DenseNet121 and Xception backbone is statistically significant in real-world test under significance level ( $p=0.049$  for DenseNet backbone, and  $p=0.008$  for Xception backbone).

#### CONCLUSION

Cineclip models can achieve higher accuracy along with better robustness than image-based models, outperforming human experts. Our video-based AI framework might better aid breast cancer diagnosis and alleviate the scarcity of experienced physicians.

#### CLINICAL RELEVANCE/APPLICATION

Ultrasound is one of the most widely used methods for breast cancer screening. However, its popularity is prohibited by its high operator dependence and the scarcity of skilled ultrasound specialists. This study can reduce the skill requirement and inter-operator variations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-3

### Deep Learning-Based MRI Model to Predict Pathologic Complete Response After Neoadjuvant Chemotherapy in HER2-Positive and Triple-Negative Breast Cancer

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Sooyeon Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

There are limited studies on the prediction of pathologic complete response (pCR) after neoadjuvant chemotherapy (NAC) using deep learning technique. We aimed to develop a deep learning-based MRI model to predict pCR in women with human epidermal growth factor receptor 2 (HER2)-positive or triple-negative breast cancers.

#### METHODS AND MATERIALS

In this IRB-approved single center retrospective study, a total of 852 women (mean age $\pm$ standard deviation, 51 $\pm$ 10 years old) with HER2-positive or triple negative breast cancer who underwent NAC followed by surgery between 2017 and 2021 were included. They were divided into a training set (n=724) and a validation set (n=128) in a ratio of 8.5:1.5. Post-NAC dynamic contrast-enhanced (DCE)-MRI data (subtraction images of the 1st, 3rd, and 5th dynamic phase) and clinical data (age, clinical T stage, clinical N stage, estrogen receptor, progesterone receptor, HER2, Ki-67, histologic grade, histologic type, and initial MRI size) were collected. pCR was defined as the absence of both invasive and in-situ residuals in the breast in the surgical specimen. For each woman, tumor bed or residual enhancing lesions on post-NAC MRI were annotated using the three rectangular region-of-interests for the initial, intermediate (center), and endpoints, respectively. After pre-processing, the deep learning models were developed using 3D ResNet 50 architecture, 5-fold cross validation, and Python 3.6. Clinical data model, each phase model of DCE-MRI, and the combined model were developed, and each performance was evaluated using an area under the receiver operating characteristics curve (AUC). DeLong method was used to compare AUCs.

#### RESULTS

The AUCs of the 1st, 3rd, and 5th dynamic MRI model were 0.63, 0.70, and 0.67, respectively. Compared to the 3rd dynamic MRI model with the highest AUC value of 0.70, the combined MRI model obtained from all dynamic images showed a lower AUC value of 0.66 albeit without statistical significance (0.70 vs 0.66, P=0.09). The AUC of the clinical data model was 0.57. The combined model of the clinical data and all dynamic MR images showed an AUC value of 0.65, which was significantly lower than that of the 3rd dynamic MRI model (0.65 vs 0.70, P=0.02).

#### CONCLUSION

The deep learning model based on the 3<sup>rd</sup> dynamic phase of DCE-MRI showed the best performance in predicting pCR in women with HER2-positive or triple-negative breast cancers.

#### CLINICAL RELEVANCE/APPLICATION

Our deep-learning based MRI model demonstrates the potential to predict pCR in women with HER2-positive or triple-negative breast cancer. This information, after careful validation in further studies, can be utilized in a prospective trial to omit breast cancer surgery for women with a high possibility of pCR.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-4

### Combining with Convolution Neural Network and Graph Convolution Network for Predicting Axillary Lymph Node Metastasis in Breast Cancer Based on DCE-MRI: A Multicenter Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yi Dai, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to develop a deep learning model combining convolution neural network (CNN) and graph convolution network (GCN) based on dynamic contrast-enhanced (DCE)-MRI for predicting axillary nodal status in breast cancer as well as to explore the biological mechanism by employing gene analysis of RNA-sequencing data.

#### METHODS AND MATERIALS

A total of 935 patients with breast cancer who underwent preoperative DCE-MRI from four institutes were retrospectively analyzed. 742, 83 and 110 patients were grouped into the training, internal test and independent external test sets, respectively. The regions of interest of the breast lesions were cropped manually by two radiologists. Three conventional CNNs, namely, 3D ResNet, 3D-Xception and HRNet (high-resolution Net) were used as the backbone architecture for axillary lymph node (ALN) metastasis identification based on the tumor, ALN, and combined tumor-ALN regions on the images. The feature maps obtained by CNNs are globally pooled and fused with the spatial structure features obtained by high resolution GCN. RNA-sequencing data from 11 patients were used to explore the underlying biological basis of the AI prediction. To select the most powerful CNN or CNN-GCN model for ALN-metastasis prediction, the performance of three CNN models and three CNN-GCN models was compared with area under the receiver operating characteristic (ROC) curve (AUC), accuracy, sensitivity and specificity. The performance of these models was compared with radiomics models, the Memorial Sloan-Kettering Cancer Center (MSKCC) model, and three radiologists.

#### RESULTS

The optimal HRNet-GCN\_tumor+ALN model, achieved an AUC of 0.873 in the internal test cohort, as well as an AUC of 0.870 in the external test cohort, which was better than the best performing radiomics model (logistic regression, AUC: 0.790) and MSKCC model (AUC: 0.752). Additionally, with the assistance of HRNet-GCN\_tumor+ALN, the radiologists' performance was improved (external test cohort,  $P < 0.05$ ). In the biological basis exploration, the high-risk group was associated with the downregulation of pathways mediating tumor proliferation and the promotion of anti-tumor immune cell infiltration in the microenvironment.

#### CONCLUSION

The proposed GCN-CNN fusion deep learning model could effectively predict ALN status preoperatively in breast cancer patients.

#### CLINICAL RELEVANCE/APPLICATION

This study successfully demonstrated a CNN-GCN model base on DCE-MRI, which could non-invasively and preoperatively predict ALN metastasis of breast cancer with high accuracy. This model may assist and guide for radiologists to make more precise evaluation of ALN status.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-5

### Patient Race Impacts the Screening Mammogram False Positive Rate of a Commercially Available AI Algorithm

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Derek L. Nguyen, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate a commercially available AI algorithm's ability to accurately interpret negative screening mammograms and the impact of patient demographics on its performance.

#### METHODS AND MATERIALS

This retrospective cohort study identified 27,681 negative screening tomosynthesis mammograms from our academic institution from 1/1/16 to 12/31/19. All patients had two years of follow up without a diagnosis of atypia or malignancy. Patients with prior breast surgery or implant augmentation were excluded. A subset of unique patients was randomly selected to provide a broad distribution of race/ethnicity. This final cohort was interpreted by an FDA approved, commercially available AI algorithm (ProFound AI 3.0, iCAD, Inc) which was trained prior to the study using an enriched multi-vendor screening population dataset from at least 20 institutions. The algorithm generated case and risk scores for each mammogram. Per vendor, case scores > 49 (range 0-100) have a high certainty for malignancy and risk scores > 0.8 (range 0-1) are at high-risk for developing a malignancy on the subsequent screening mammogram (1-year cancer risk). Patient demographics (age, race/ethnicity, and breast density) were compared with case and risk scores using bivariate and multivariate logistic regression.

#### RESULTS

4855 unique patients (median age: 54 years [46-63]) were included. The false positive rate for case and risk scores was 17% (816/4855) and 5% (240/4855), respectively. Every patient demographic was significantly associated with patients' case and risk scores on bivariate analysis,  $p < 0.001$ . On multivariate analysis, Black patients were significantly more likely (OR: 1.45, 95% CI 1.19-1.77) to have case scores > 49 compared to White patients. Asian patients were significantly less likely (OR: 0.68, 95% CI 0.54-0.86) to have case scores > 49 when compared to White patients. Breast density did not influence case scores after adjusting for age and race. On multivariate analysis, only Black patients were significantly more likely (OR: 1.46, 95% CI 1.05-2.03) to have risk scores > 0.8 compared to White patients. Increased breast density was associated with risk scores > 0.8 (fatty - reference; scattered - OR: 1.99, 95% CI 1.33-3.05; heterogeneous - OR: 2.00, 95% CI 1.25-3.55; extremely - OR: 2.80, 95% CI 1.26-5.84).

#### CONCLUSION

Patient race influenced the performance of a commercially available AI algorithm analyzing negative screening mammograms. False positive rates for suspicious case and risk scores were 17% and 5%, respectively.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware that the performance of FDA approved, commercially available AI software will vary by patient demographics and efforts to train on diverse datasets are needed.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3A-SPBR-6

### AI for Diffusion-Weighted Breast MRI

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Dimitrios Bounias, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Diffusion-weighted imaging (DWI) is a rapidly emerging MRI technique in oncologic breast imaging that requires no contrast agent administration, rendering it an attractive potential future supplement or even alternative to mammography and dynamic contrast-enhanced MRI. Artificial intelligence (AI) has the potential to assist radiological decisions on this emerging MR technique, facilitating a quicker adoption into clinical routine. In this work, we utilized nnDetection, a state-of-the-art self-configuring Retina U-Net based object detection model, with certain breast cancer-specific extensions to create a robust model trained on a large dataset of unenhanced breast MRI acquisitions.

#### METHODS AND MATERIALS

The IRB approved study included n=818 patients. Histopathologically proven malignant lesions accounted for n=618 lesions in n=268 patients. All patients underwent a clinically indicated multiparametric breast 3T MRI examination, including a multi-b-value DWI acquisition (50,750,1500). The nnDetection AI model was trained with the following extensions: (i) Apparent Diffusion Coefficient (ADC) as additional input, (ii) random bias field, random spike, and random ghosting augmentations, (iii) a size-balanced data loader to ensure that the fewer large lesions were given an equal chance to be picked in a mini-batch and (iv) replacement of the loss function with a size-adjusted focal loss, that increases as false positive predictions get smaller or as true positive predictions get larger. This adapted loss function prioritizes finding the primary lesion while disincentivizing small indeterminate false positives. The Area Under the Receiver Operating Characteristic (AUROC) was used as the metric for patient-level performance in 5-fold cross-validation.

#### RESULTS

The nnDetection AI model was able to achieve an AUROC of 0.88 using only the abbreviated unenhanced DWI MRI acquisition, and compares favorably against multireader performance metrics reported for mammography ((i)0.81, (ii) 0.87, (iii) 0.81). The model was also able to achieve 0.70 FROC (Free-response Receiver Operating Characteristic) for primary lesions, indicating a relevant localization ability.

#### CONCLUSION

This study shows that AI has the ability to complement the assessment of breast MRI in abbreviated unenhanced examinations based on DWI, even before radiologists are involved in the diagnostic process.

#### CLINICAL RELEVANCE/APPLICATION

This work supports personalization in breast cancer screening by enabling radiologists to use advanced imaging techniques such as abbreviated diffusion-weighted imaging (DWI), potentially supplementing the diagnostic toolbox.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-7

### Risk-aware AI for Lesion Detection and Characterization in Breast MRI

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Dimitrios Bounias, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

AI methods for medical object detection revolve around discovering and rating structures of potential relevance to the patient. Performance is commonly calculated with Free-response Receiver Operating Characteristic (FROC) analysis, which calculates sensitivity at predefined thresholds of false positives (FPs) per case. FROC weighs all lesions equally, but in practice not all lesions might be considered as having identical instantaneous impact for the further clinical pathway of a patient, revealing a risk imbalance. Here we describe the development and evaluation of such a risk-aware model for breast cancer using diffusion-weighted imaging (DWI) MR acquisitions.

#### METHODS AND MATERIALS

For this IRB approved study we used a dataset with  $n=818$  women undergoing clinically indicated 3T breast MRI including multi-b-value DWI (50,750,1500), containing  $n=618$  histopathologically verified malignant lesions in  $n=268$  patients. The risk function was calculated using reported 15-year breast cancer mortality based on lesion size, from a multi-year study involving  $n=819,647$  patients from Sopik et al, 2018. A risk-adjusted adaptation of FROC (raFROC) is proposed, where true positive predictions and ground truth samples are weighted by the associated risk. FPs are weighted by  $1/\text{risk}$ , due to the desire to minimize unneeded biopsies and the lower value of low risk lesions. To accommodate for the metric, we also propose a risk-adjusted focal loss (raFocal) that applies similar weighting. A focal loss and a raFocal model were trained using 5-fold cross validation. Evaluation took place using traditional methods and raFROC.

#### RESULTS

The risk-aware (raFocal) model improved both the AUROC (Area Under the Receiver Operating Characteristic curve) and AP (Average Precision) patient-level performance (AUROC/AP 0.86/0.77) compared to the standard "focal" model (0.84/0.70). The proposed raFROC portrays a difference (focal 0.60, raFocal 0.65) between the models across all FP thresholds, being able to better mirror patient-level improvement. In contrast, a lesser difference was present for regular FROC (focal 0.50, raFocal 0.52), appearing only in lower thresholds.

#### CONCLUSION

This work showcases a first step for risk-aware AI model training and validation in medical object detection. Accounting for clinical risk and outcome is very important in medical diagnosis, as it allows balancing the trade off between FP findings and missing pathologies, significantly influencing the clinical outcome of the individual patient.

#### CLINICAL RELEVANCE/APPLICATION

This work showcases how to incorporate risk into the training and evaluation of object detection models for breast cancer screening, which previously considered all lesions equal, bringing AI closer to clinical needs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-8

### Chat GPT: How Far Has It Gone Yet?

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Marcela C. Lauer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Chat GPT is an artificial intelligence (AI) language model trained on a dataset of human language, making it capable of understanding and generating complex sentences and paragraphs, including medical literature. The objective of this study is to analyze Chat GPT's accuracy and reproducibility in answering questions about breast radiology.

#### METHODS AND MATERIALS

Questions were gathered from nationally regarded professional societies, as well as elaborated from breast radiologists with over 15 years of experience. We formulated 10 questions that were answered by medical residents (12 from the 1st/2nd year and 12 from the 3rd/4th year) and 12 professionals specialized in breast imaging. All questions had only one correct answer. The alternatives included the options of "more than one alternative is correct" and "all alternatives are incorrect", for the cases in which Chat GPT could not provide one correct answer for the question. Reproducibility was determined by asking the model each question ten times from at least 5 different devices in at least 3 different locations.

#### RESULTS

The mean average of the residents in the 1st and 2nd years was 40% of correct answers, for 3rd and 4th years residents it was 60%, for breast imaging specialists it was 80% and the average of correct responses by Chat GPT-4 was 45%, and varied from 30% to 60% correct answers. Chat-GPT did not demonstrate an increasing or decreasing pattern of number of correct answers thought time that would allow us to infer that it was learning through the questions. Concerning reproducibility, Chat GPT answered the same item in all 10 attempts for only 4 questions.

#### CONCLUSION

ChatGPT could provide accurate responses in 45% of questions related to breast imaging, which is more than a 1st or 2nd year radiology resident but less than a 3rd or 4th year resident. Although it is expected that it will evolve over time, we could not state that in our study. We encourage future studies to further examine how trustworthy are the information provided by it and to analyze if this technology will continue evolving over time, as we hope this technology may improve education for medical doctors, and even patient's outcomes and quality of life.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT is an AI language model launched in November 2022, trained on a dataset covering a broad range of topics, including the medical literature. Discussion regarding the potential of ChatGPT in all fields of academia is ongoing, and its applicability is under investigation. Although there is one study that tests how Chat GPT would answer questions about screening breast cancer recommendations (Haver et. al), there are currently no studies examining Chat GPT's applicability as a learning tool for professionals consult.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR-9

### **Preliminary Interim Analysis of AI-STREAM (Artificial Intelligence for Breast Cancer Screening in Mammography): A Prospective Multicenter Study Design in Korea Using AI-based CADe/x**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yun Woo Chang, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study is to compare the diagnostic accuracy of radiologists with and without the use of AI-based CADe/x in mammography reading for breast cancer screening of Korean women with average breast cancer risk.

#### **METHODS AND MATERIALS**

Total of 24,601 participants were enrolled between February 2021 and December 2022 at six study sites in Korea. The mammograms were read by breast imaging radiologist (BR) without using AI-based CADe/x through single reading, and results were recorded on the study platform (BEST image). Then, the radiologists reviewed the mammograms with the assistance of AI-based CADe/x and recorded the results on the study platform based on the radiologist's decision after considering both with and without AI-based CADe/x. These BR were experts in breast imaging at an academic hospital for over ten years. If a recall was required, further diagnostic workup was conducted to confirm the cancer detected on screening. In the simulation study, the same participants' mammograms were read by general radiologists (GR) in the same setting of the reading process, without and with use of AI-based CADe/x. GR are radiologists not specializing in breast imaging. The diagnostic accuracy of GR and BR, with or without the use of AI-based CADe/x was compared with AI-based CADe/x for mammography reading for breast cancer screening.

#### **RESULTS**

By the end of patient enrollment, breast cancer was confirmed in 131 patients. GR without AI found 86 cancers, GR with AI found 110 cancers, BR without AI found 110 cancers, and BR with AI found 124 cancers. When a 10% cutoff was applied to AI, it detected 118 cancers. Stand-alone AI-based CADe/x detected significantly higher cancer detection than GR without AI. AI detected slightly more cancer than BR without AI or GR with AI, but there was no statistical significance. BR with AI had the highest cancer detection rate compared with AI stand-alone, BR without AI, or GR with AI, but there was no statistical significance. There was no difference between GR and AI in the recall, but recall in BR was significantly lower.

#### **CONCLUSION**

AI-based CAD e/x could be helpful for radiologists with less experience in mammography reading. BR with AI had the highest accuracy in cancer detection and a lower recall rate compared with other situations. This is a preliminary interim analysis of the prospective study as cancer registry data will be available at least 26 months after the year of interest.

#### **CLINICAL RELEVANCE/APPLICATION**

This prospective multicenter cohort study aims to generate real-world evidence to compare the diagnostic accuracy of radiologists with and without AI-based CADe/x in mammography reading for breast cancer screening.

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## Abstract Archives of the RSNA, 2023

S3A-SPCA-1

### Total Cardiac Volume Segmentation Model for Pediatric Heart Transplant Donors and Patients using Transfer Learning

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Elanchezhian Somasundaram, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop an optimized model to predict total cardiac volumes (TCV) in donors and pediatric heart transplant patients using transfer learning techniques on pretrained models predicting individual heart segments.

#### METHODS AND MATERIALS

An internal, clinical chest computed tomography (CT) dataset (n=275), consisting of non-contrast and contrast-enhanced exams, was included for the study. 251 exams were used for model training while 27 were retained for model testing. TCV was segmented as part of clinical workflow using Mimics (Materialize NV, Leuven, Belgium). Additionally, heart chamber segments from a large public dataset (n= 866) curated by the University Hospital Radiology Department (Basel, Switzerland) was included for transfer learning. A dynamic U-net (DynUNET) architecture within the MONAI framework was first pre-trained on the public dataset for 100 epochs, using a 0.8/0.2 split for training/validation respectively, and then trained on the internal TCV dataset. Another DynUNET model was trained only on the internal TCV dataset. Experiment tracking and hyperparameter search tools were used to find the training parameters that produced the best validation dice score. Both models were tested on the internal test dataset (n=27) as well as 20 adult, chest CT scans from multiple institutions, shared by UNOS (United Network for Organ Sharing) through a formal research agreement. UNOS exams were segmented for TCV using 3D Slicer. Relative volume error (RVE) and Dice coefficients (DSC) were calculated for model performance evaluation and comparison.

#### RESULTS

The most optimal DynUNET model trained with pre-trained weights had an initial learning rate of 0.0005 with an exponential learning rate scheduler and an Adam optimizer. The mean ( $\pm$  standard deviation) RVE and DSC was 3.3 ( $\pm$  3.0%) and 0.95 ( $\pm$  0.02) respectively for the internal dataset and 6.9 ( $\pm$  10%) and 0.90 ( $\pm$  0.10) respectively for the UNOS dataset. The most optimal DynUNET model trained only on the internal TCV dataset had an initial learning rate of 0.003 using a cosine learning rate scheduler and Adam optimizer. The mean ( $\pm$  standard deviation) RVE and DSC was 5.3 ( $\pm$  5.5%) and 0.93 ( $\pm$  0.02) respectively for the internal dataset and 11 ( $\pm$  16%) and 0.87 ( $\pm$  0.15) for the UNOS dataset.

#### CONCLUSION

Transfer learning using pre-trained weights from a large public dataset improved model performance for prediction of TCV in an internal clinical dataset as well as a set from UNOS, where exams span various institutions, scanner manufacturers, and protocols.

#### CLINICAL RELEVANCE/APPLICATION

Total cardiac volume (TCV) is an important metric for recipient-donor organ matching for organ transplantation. A clinically deployable, optimized deep learning TCV segmentation model is useful for such organ size matching.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPCA-2

### Comparison of Prognostic Value Between CAD-RADS 1.0 and CAD-RADS 2.0 Evaluated by Convolutional Neural Networks Based CCTA

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Zengfa Huang (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of the present study was to investigate the prognostic value of the novel coronary artery disease reporting and data system (CAD-RADS) 2.0 compared with CAD-RADS 1.0 in patients with suspected CAD evaluated by convolutional neural networks (CNN) based coronary computed tomography angiography (CCTA).

#### METHODS AND MATERIALS

A total of 2131 consecutive inpatients with suspected CAD were evaluated by CCTA for CAD-RADS 1.0 and CAD-RADS 2.0 classifications. Kaplan-Meier and multivariate Cox models were used to estimate major adverse cardiovascular events (MACE) inclusive of all-cause mortality or myocardial infarction (MI). The C-statistic was used to assess the discriminatory ability of the two classifications.

#### RESULTS

In total, 94 (5.2%) MACE occurred over the median follow-up of 45.25 months (interquartile range 43.53 to 46.63 months). The annualized MACE rate was 0.014 (95% CI: 0.011-0.017). Kaplan-Meier survival curves indicated that the Coronary Artery Disease Reporting and Data System (CAD-RADS) classification, segment involvement score (SIS) grade, and Computed Tomography Fractional Flow Reserve (CT-FFR) classification were all significantly associated with the increase in the cumulative MACE (all  $P < 0.001$ ). CAD-RADS classification, SIS grade, and CT-FFR classification were significantly associated with endpoint in univariate and multivariate Cox analysis. CAD-RADS 2.0 showed a further incremental increase in the prognostic value in predicting MACE (c-statistic 0.702, 95% CI: 0.641-0.763,  $P = 0.047$ ), compared with CAD-RADS 1.0.

#### CONCLUSION

The novel CAD-RADS 2.0 evaluated by CNN-based CCTA showed higher prognostic value of MACE than CAD-RADS 1.0 in patients with suspected CAD.

#### CLINICAL RELEVANCE/APPLICATION

The novel CAD-RADS 2.0 evaluated by CNN-based CCTA showed good performance for predicting major adverse cardiac events (MACE) in patients with suspected CAD and may serve as a non-invasive imaging marker for risk stratification in future clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPCA-3

### Diagnostic Utility of Artificial Intelligence in Detecting Coronary Artery Disease on CT Coronary Calcium Score Using Manual Calcium Scoring as Reference Standard- A Meta-Analysis

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Sarah Agnes Mary R. Lim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The amount of coronary artery calcification is said to be a strong and independent predictor of coronary heart disease events. Calcium scoring is a non-invasive procedure wherein calcifications within the coronary arteries are quantified and this is interpreted by trained radiologists. However, this is known to be tedious and time-consuming. Artificial intelligence (AI) is now being used as an adjunct tool in cardiovascular imaging. "Machine learning or deep-learning algorithm is a subset of AI that utilizes algorithms to combine voluminous data comprising clinical information and coronary anatomical variables for optimal prediction of major adverse cardiac events" (Wang, 2019). The aim of this study is to determine the accuracy of AI in detecting coronary artery disease on CT coronary calcium score using manual counting as reference standard.

#### METHODS AND MATERIALS

We searched PUBMED, Google Scholar for studies on AI in detecting CT coronary calcium using manual counting as the reference standard. Pooled sensitivity, specificity, positive and negative likelihood ratios were calculated. Two investigators (ISB and SRL) independently extracted the data.

#### RESULTS

Out of 45 articles, three (3) were included in the study. A total of 769 calcium score procedures were included in the analysis. Overall pooled sensitivity of 0.952 (CI=95%, 0.926-0.970), pooled specificity of 0.949 (CI=95%, 0.921-0.970), positive likelihood ratio of 12.1 (CI=95%, 2.304-63.636) and negative likelihood ratio of 0.055 (CI=95%, 0.036-0.084).

#### CONCLUSION

Deep learning A.I. on coronary artery calcium score can be used to detect coronary artery disease. Further study to compare utility of machine learning with deep learning using manual counting as reference standard.

#### CLINICAL RELEVANCE/APPLICATION

Artificial intelligence is now used in a myriad of applications not only in medicine but also in daily life. AI has a potential to improve the workflow in radiology through automation of CT coronary calcium score determination, a task which is known to be time-consuming. If A.I. may be used in the clinical setting, more people may be screened for coronary artery disease in a given amount of time. This may also help in improving the efficiency of radiologists.

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## Abstract Archives of the RSNA, 2023

S3A-SPCA-4

### Accuracy of Machine Learning Algorithms for Calcium Scores on Chest Computed Tomography: A Systematic Review and Meta-analysis

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Pedro A. Pereira, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic accuracy of artificial intelligence (AI) algorithms for quantifying coronary artery calcium (CAC) on chest computed tomography (CT) images.

#### METHODS AND MATERIALS

PubMed, EMBASE, and Cochrane Central databases were systematically searched for studies published up to April 1st. Studies were included if they compared ML-derived calcium score categories (Agatston score) with expert manual analysis in gated and non-gated studies. The main outcome was the percentage of agreement between automatic and manual analyses of the Agatston score categories. We also calculated the rates of the underestimated and overestimated categories using automatic analysis. Heterogeneity was examined using  $I^2$  statistics. A random effects model was used to perform the meta-analysis. The study protocol was registered a priori in the International Prospective Register of Systematic Reviews (Prospero Protocol CRD42023407318).

#### RESULTS

A total of 23 studies comprising 9788 subjects with gated CT and 4967 with non-gated CT were included. The mean age of the sample was 58.9 years. The percentage of Agatston score agreement between automatic and manual analyses for gated studies was 93.1% (95% CI, 90.8-94.8%). Automatic analysis overestimated the Agatston category by 4.2% (95% CI, 2.8-6.2%) and underestimated it by 2.3% (95% CI, 1.8-2.9%). The percentage agreement for non-gated studies was 79.8% (95%CI, 68.0-88.0%). Automatic models overestimated or underestimated the Agatston category by 10% (95%CI, 4.7-20.0%) and 5% (95%CI, 2.1-11.1%), respectively. Significant heterogeneity was observed in the analyzed outcomes ( $I^2 > 50\%$ ).

#### CONCLUSION

Our findings demonstrate a high degree of agreement in calcium score analysis using machine learning algorithms, particularly in gated studies.

#### CLINICAL RELEVANCE/APPLICATION

The use of AI algorithms could improve CT interpretation workflow, offering automatic quantification coronary calcium with high accuracy to both cardiac-gated and non-cardiac-gated chest CTs.

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## Abstract Archives of the RSNA, 2023

S3A-SPCA-5

### Deep Learning-Based Measurement of Left Atrial Volume on Calcium Scoring CT: Observations in the Dallas Heart Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Fernando U. Kay, MD, PhD (*Presenter*) Research Grant, Edwards Lifesciences Corporation

#### PURPOSE

Coronary calcium scoring CT (CAC-CT) imaging data is currently underutilized. Left atrial (LA) enlargement is associated with atrial arrhythmias and stroke. In this study, we aimed to evaluate the accuracy of an AI-based segmentation algorithm for estimating LA volumes on CAC-CT and compare the results with other clinical variables in the Dallas Heart Study phase 2 (DHS2).

#### METHODS AND MATERIALS

Participants with both CAC-CT and cardiac MRI (CMRI) were eligible for inclusion. We developed a 3D Unet Deep Learning model using a semi-supervised approach with nested cross-validation. A cardiac imager created reference cardiac chamber segmentation on CAC-CT for 70 randomly selected participants, using epicardial margins. This initial model generated synthetic segmentations in 1,931 additional scans, which were utilized for model refinement. LA volume was derived using Pyradiomics. In 749 participants, maximum LA volume was independently assessed on CMRI via the biplane method. Clinical variables were collected for analysis. We included a subset of 735 participants without prior events for a Kaplan-Meier analysis of incident atrial fibrillation, stroke, or transient ischemic attack.

#### RESULTS

The segmentation model achieved a Dice score of  $0.93 \pm 0.01$  (mean  $\pm$  SD) when compared to manual segmentation. The cohort consisted of 445 females and 304 males with a median age of 50 years (IQR: 43 - 57). The intraclass correlation coefficient between CAC-CT-derived LA volume and maximum LA volume on CMRI was 0.67 (95% CI: 0.63 - 0.71). CAC-CT LA volume had an AUC curve of 0.82 (95% CI: 0.78 - 0.86) for detecting participants in the 4th quartile of maximum LA volume on CMRI. In multivariable linear analysis, CAC-CT LA volume indexed to BSA was significantly associated with male sex (Beta coefficient: 1.6\*\*), age (0.3\*\*\*), smoking habit (-0.7\*), and hypertension (2.9\*\*\*) (P: \* $<0.1$ , \*\* $<0.05$ , \*\*\* $<0.01$ ). The 4th percentile of indexed LA volume on CAC-CT was associated with incident composite events (N = 15) during follow-up when compared to the 1st-3rd percentiles (P = 0.01).

#### CONCLUSION

We developed a segmentation model capable of extracting LA volume from CAC-CT, demonstrating moderate correlation with LA maximum values derived from CMRI. This CAC-CT biomarker was significantly associated with clinical variables, including incident atrial fibrillation and cerebrovascular events in the DHS2.

#### CLINICAL RELEVANCE/APPLICATION

AI-derived segmentation algorithms have the potential to enhance the extraction of LA volume from CAC-CT, enabling more comprehensive risk stratification beyond traditional calcium scoring.

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## Abstract Archives of the RSNA, 2023

S3A-SPCA-7

### Right Ventricular Strain and Abnormal Muscle Formation on Cardiac CT: To Identify Pulmonary Hypertension in Repaired Tetralogy of Fallot

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yamato Shimomiya (*Presenter*) Employee, Ziosoft, Inc

#### PURPOSE

In the long-term period of repaired tetralogy of Fallot (TOF), right ventricular (RV) volume augmentation due to pulmonary regurgitation is frequent, and right heart failure due to its aggravation is prognostic. Transcatheter pulmonary valve implantation (TPVI) is becoming increasingly popular as a minimally invasive treatment, but it must be carefully indicated in cases of RV pressure overload. We used multi-phase cardiac CT to assess RV volumetry, strain, and morphology to identify pulmonary hypertension in patients with repaired TOF scheduled for TPVI.

#### METHODS AND MATERIALS

Forty-four patients with repaired TOF scheduled for TPVI were enrolled to undergo cardiac CT, MRI, and right heart catheterization. Pulmonary hypertension (PH) was defined as a mean pulmonary artery pressure of 25 mmHg or greater by right heart catheterization. CT-RV strain was calculated using ECG-gated CT data with motion coherence image processing. The association of PH with RV strain and abnormal muscle bundles in the right ventricular outflow tract on cardiac CT was evaluated. Additionally, RV volumetry was compared between cardiac cine MRI and CT.

#### RESULTS

Eleven of the 44 patients had PH. CT-RV strain was significantly lower patients with PH than those without PH ( $-8.7 \pm 1.6$  % vs.  $-11.3 \pm 2.33$  %;  $p < 0.001$ ). Receiver-operating-characteristic curve analysis revealed that with optimal RV strain  $-10.4$  %, patients with PH can be diagnosed with an area under the curve 0.97, sensitivity 100%, and specificity 89%. The frequency of formation of abnormal muscle bundles in the RV outflow tract was significantly greater in patients with PH (7/11, 64%) than in patients without PH (11/33, 35%). RV volumes calculated from CT and MRI showed a strong positive correlation, but CT tended to increase volume more than MRI (RV-EDVi: CT vs. MRI,  $176.2 \pm 47.9$  ml/m<sup>2</sup> vs.  $147.0 \pm 42.1$  ml/m<sup>2</sup>; Pearson  $r = 0.90$ ; RV-ESVi: CT vs. MR:  $98.7 \pm 36.9$  ml/m<sup>2</sup> vs.  $79.8 \pm 28.4$  ml/m<sup>2</sup>; Pearson  $r = 0.91$ ).

#### CONCLUSION

The reduction of RV strain and the presence of abnormal muscle bundles in the RV outflow tract obtained from multi-phase CT indicate PH in repaired TOF and should make one cautious about the indication for TPVI.

#### CLINICAL RELEVANCE/APPLICATION

Cardiac CT provides not only accurate anatomical information from the RV to the pulmonary artery, but also noninvasive evaluation of pulmonary hypertension.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPCH-1

### Assessment of Solitary Pulmonary Nodules Using Dual-layer Spectral Detector Computed Tomography

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ko Tsepang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

With lung cancer being the most common malignancy diagnosed worldwide, differentiating between malignant solitary pulmonary nodules (SPNs) and other lung diseases remained a substantial challenge. The aim of this study was to examine the usefulness of Dual-layer Spectral Detector Computed Tomography in solitary pulmonary nodule (SPN) assessment.

#### METHODS AND MATERIALS

Between September 2021 and December 2022, dual-layer spectral images of 71 patients confirmed by pathology were retrospectively analyzed in the venous phase. Patients were classified into the malignant group and the benign group. The iodine concentration (IC) values of the SPN, normalized IC of the SPN to aorta/pulmonary artery/pulmonary vein (NICa/NICpa/NICpv), CT values of 40 keV (HU40keV) and 80keV (HU80keV) monochromatic images, and the slope of spectral HU curve were calculated and compared between the benign and malignant groups. ROC curve analysis was performed to assess the diagnostic performance of the above parameters.

#### RESULTS

IC, NICpa, HU40keV, and slope HU had significantly higher values in the malignant group than in the benign group (all  $P < 0.05$  in Mann-Whitney U test). Iodine density (AUC = 0.78) of 1.74 mg/ml yielded a sensitivity of 95% and a specificity of 57%. Slope HU (AUC = 0.79) of 2.9 yielded a sensitivity of 95% and a specificity of 57%.

#### CONCLUSION

Both virtual monochromatic images and iodine concentration maps prove to be highly useful in differentiating benign and malignant pulmonary nodules.

#### CLINICAL RELEVANCE/APPLICATION

Dual-layer Spectral Detector Computed Tomography can help to differentiate benign from malignant SPNs.

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## Abstract Archives of the RSNA, 2023

S3A-SPCH-3

### Combination of Clinical and Spectral CT Parameters for Predicting Lymphovascular Invasion in N0 Stage Non-small Cell Lung Cancer

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Liangna Deng (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the predictive value of spectral CT quantitative parameters for lymphovascular invasion in N0 stage non-small cell lung cancer, a diagnostic model was constructed and visualized as a nomogram to assist clinical preoperative treatment decisions.

#### METHODS AND MATERIALS

107 patients with N0 stage non-small cell lung cancer underwent spectral CT before surgery and were divided into two groups: positive group and negative group. Clinical baseline characteristics included age, gender, biochemical markers, serum tumor markers and Immunohistochemical markers. Imaging features included lobe location, tumor boundary, lobulation sign, spiculation, bubblelike lucency, air bronchogram, vascular convergence and pleural retraction. A radiologist delineated the regions of interest on the layer of maximum tumor diameter and the nearest upper and lower layers in axial enhanced images and calculated the average value. Monoenergetic CT value, effective atomic number (Eff-Z), iodine concentration (IC) of tumor and artery were acquired to calculate normalized iodine concentration (NIC,  $NIC = IC_{tumor} / IC_{artery}$ ).  $\chi^2$  test, t-test and U test were used for calculated differences between groups. Then, least absolute shrinkage and selection operator (LASSO) regression and multivariate logistic regression were used to select the most discriminating features, build a predictive model and visualize the model as a nomogram. ROC curves, calibration curves and decision curves analysis (DCA) were used to evaluate prediction performance and clinical utility.

#### RESULTS

41 patients had lymphovascular invasion in 107 N0 stage non-small cell lung cancer patients. The gender, TIF-1 and lymphocyte count differed between the two groups ( $P < 0.05$ ). After feature selection, the six variables included 70keV, 90keV and Eff-Z in the dual phase were screened by LASSO regression to construct the nomogram. The AUC of the clinical-spectral CT model were 0.93 (95%CI: 0.88~0.98). The sensitivity and specificity were 0.89 and 0.88, respectively. The model showed good calibration, and the DCA demonstrated that the model has a higher net benefit than the best single variable.

#### CONCLUSION

There were differences in gender, TIF-1 and lymphocyte count and spectral CT parameters in lymphovascular invasion status. The nomogram based on Clinical characteristics and 70keV, 90keV and Eff-Z in the dual phase is helpful for the preoperative determination of lymphovascular invasion status in non-small cell lung cancer.

#### CLINICAL RELEVANCE/APPLICATION

The nomogram is helpful for the preoperative determination of lymphovascular invasion status in N0 stage non-small cell lung cancer, which can assist in clinical preoperative decision-making and patient risk stratification.

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## Abstract Archives of the RSNA, 2023

S3A-SPCH-5

### Quantitative Lung and Lobar Perfusion from Dual-source, Dual-energy CTPA in Chronic Thromboembolic Pulmonary Hypertension and Acute Pulmonary Embolism

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Jacob V. Hansen, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the differences in quantitative lung and lobar perfusion metrics between patients with chronic thromboembolic pulmonary hypertension (CTEPH) and acute pulmonary embolism (PE).

#### METHODS AND MATERIALS

Under IRB approval, 162 adult patients (>21 years) diagnosed with acute PE or CTEPH were scanned clinically using dual-source, dual-energy CT (Siemens SOMATOM Flash) pulmonary angiography (DE-CTPA) between 2019 and 2023. De-identified, thin-section DE-CTPA images from 81 PE patients (M:F 45:36; median age 69 years [60; 76]) and 81 CTEPH patients (M:F 46:35; median age 71 [61; 78]) were processed using the automated, machine-learning based eXamine DE Lung Isolation software (Siemens Healthineers) to obtain quantitative lung and lobar perfusion data. Clinical data was retrieved from electronic patient journals. Statistical analysis was performed using R (RStudio) with Mann-Whitney U test (individual perfusion parameters), PERMANOVA (for multivariate comparison) and multiple logistic regression (for correlation between perfusion parameters and clinical data and biomarkers).

#### RESULTS

Whole lung blood volume was lower ( $p < 0.001$ ) in PE patients (median 3399 mL [2554, 4284]) than in CTEPH patients (median 4094 mL [3397, 4818]). The same was observed at single lung and lobar level (figure 1A). The multivariate comparison encompassing all perfusion variables (figure 1A-C) showed a difference between the two groups ( $F = 6.15$ ,  $Pr > (F) = 0.004$ ) after testing for homogeneity of variance. We found poor correlation ( $r < 0.3$ ) between perfusion parameters and right heart catheterization parameters, 6-minute walking distance, and tricuspid annular plane systolic excursion (TAPSE) in CTEPH patients as well as with TAPSE, mean arterial blood pressure, and saturation in PE patients. In CTEPH, right upper lobe contrast uptake (CU), left upper lobe volume and CU, and left and lower lobe contrast concentration (CC) predicted whether patients had high ( $> 4$  L/min) cardiac output (CO) ( $p = 0.01 - 0.03$ ).

#### CONCLUSION

Lung and lobar perfusion are lower in patients with acute PE than patients with CTEPH as highlighted by differences in DECT-derived pulmonary blood volume parameters. This might be explained by the differences between an acute, decompensated disease phenotype and a chronic, compensated disease phenotype. Perfusion parameters correlate poorly with hemodynamic and clinical parameters in both diseases, but might predict severity.

#### CLINICAL RELEVANCE/APPLICATION

Fully automatic estimation of quantitative pulmonary perfusion from dual-source, dual-energy CTPA can help assess differences in patients CTEPH and PE.

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## Abstract Archives of the RSNA, 2023

S3A-SPCH-6

### Application Value of Spectral CT Multi-Parameter Imaging in the Detection of Emboli and Assessment of Thrombus Burden in Acute Pulmonary Embolism

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Weimeng Cao (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to investigate the efficacy of spectral CT multi-parameter (Spectral Based Image) imaging compared to regular CT (rCT) imaging in the detection of emboli and assessment of thrombus burden in acute pulmonary embolism (PE).

#### METHODS AND MATERIALS

102 suspected pulmonary embolism (PE) patients who underwent dual-layer spectral CT (DLCT) pulmonary angiography (CTPA) were prospectively enrolled. Spectral data were reconstructed into conventional images (CI), iodine density maps (ID), effective atomic number (Zeff) maps, and ID-Zeff fusion maps (ID-Zeff). The detection rate of acute PE in each group was evaluated, and the diagnostic efficiency for PE was assessed using receiver operating characteristic (ROC) curves and area under the curve (AUC) for each type of image. The diagnostic efficiency for PE was evaluated separately in pulmonary lobes and main pulmonary arteries, pulmonary segmental arteries, and subsegmental pulmonary arteries. In diagnosed acute PE patients, the total number of thrombi and the number of thrombi detected in three level of pulmonary artery were counted, and the thrombus burden was compared among groups using the Qanadli (Q) score. Independent sample t-tests and chi-square tests were used for quantitative and qualitative data, respectively.

#### RESULTS

Among the 102 suspected PE patients, a total of 63 cases were diagnosed based on imaging, laboratory tests, and clinical data. Among them, the CI, ID, Zeff, and ID-Zeff respectively diagnosed 53, 55, 60, and 60 cases. The ID-Zeff image (AUC: 0.989, sensitivity: 97%, specificity: 100%) significantly improved the detection rate of PE compared to the CI image (AUC: 0.892, sensitivity: 84%, specificity: 94%). The total number of thrombi detected by the CI image and each spectral image group in each three level of pulmonary artery were as follows: CI (172, 25, 75, 72), ID (217, 25, 82, 100), Zeff (222, 25, 85, 112), and ID-Z-eff (230, 25, 85, 120). The Q scores for each spectral image group were as follows: CI (15.64±5.28), ID (19.25±6.42), Zeff (19.87±6.86), and ID-Zeff (20.46±6.6). The Q scores in each spectral image group were statistically significant compared to the CI group ( $p < 0.001$ ).

#### CONCLUSION

DLCT multi-parameter ID-Zeff maps exhibit better detection rates and thrombus detecting efficacy in PE compared to CI images, especially in subsegmental PE. Additionally, the ID-Zeff map provides more accurate Q scores.

#### CLINICAL RELEVANCE/APPLICATION

ID-Zeff imaging can use the wedge-shaped perfusion defect region to detect subsegmental and micro thrombi, significantly improving the detection efficacy of peripheral micro emboli in PE. This provides more accurate imaging data for the precise assessment of thrombus burden, risk stratification, and prognosis prediction.

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## Abstract Archives of the RSNA, 2023

S3A-SPCH-7

### CT-based Automated Measure of Vertebral Fracture Associates with COPD Severity, Sex and Age in Smokers

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Syed Ahmed Nadeem, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Osteoporosis is a major comorbidity of chronic obstructive pulmonary disease (COPD) contributing to high prevalence of vertebral compression fractures (VCF). Alteration in spine morphology due to VCF reduces rib-cage mobility and chest space, hinders lung expansion and function, and adversely impacts mobility, quality of life, and clinical outcomes. This retrospective study examines the association of VCF with COPD severity, sex, and age using a CT-based automated method.

#### METHODS AND MATERIALS

Twelve thoracic and the first lumbar vertebrae were automatically segmented and labeled from chest CT scans using a previously validated deep learning-based method. Following the Genant's principle, an automated VCF assessment method was developed and applied to individual vertebral volume. Inspiratory or total lung capacity chest CT scans from the Iowa cohort of the Genetic Epidemiology of COPD (COPDGene) study at baseline visits were used. Four COPD severity groups were defined—(1) preserved lung function (GOLD 0), (2) mild COPD (PRISm and GOLD 1), (3) moderate COPD (GOLD 2), and (4) severe COPD (GOLD 3 and 4). A generalized linear model of the VCF count with age, sex, height, weight, smoking history, and COPD severity was developed.

#### RESULTS

Study participants (n=1221; age (mean±SD): 59.29±8.98 years; 581 female) in the preserved lung function and mild, moderate, and severe COPD groups had 0.61±1.27, 0.66±1.37, 0.85±1.53, and 1.03±1.75 VCF counts, respectively. As compared to the preserved lung function group, moderate and severe COPD were associated with significantly higher VCF counts (p=0.047 and p=0.00048, respectively), while the observed higher VCF counts in mild COPD were not significant (p=0.084). Females (p<0.0001) were associated with lower VCF counts. Aging was positively correlated with the VCF count (p<0.0001).

#### CONCLUSION

A CT-based automated measure of VCF is presented, and its association with COPD severity, sex, and age is demonstrated. Automation of the CT-based method will facilitate its application to nationwide repositories chest CT scans exploring associations of demographic, lifestyle, and clinical factors on osteoporosis and VCF and their impacts in COPD and other lung diseases.

#### CLINICAL RELEVANCE/APPLICATION

The new method offers CT-based automated quantification of VCF, which may be useful to investigate the osteoporosis comorbidity in COPD and its impact on lung function and clinical outcomes.

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## Abstract Archives of the RSNA, 2023

S3A-SPCH-8

### Deep Neural Network to Detect Emphysema on Chest Radiographs.

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Seowoo Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Chronic obstructive lung disease (COPD) remains underdiagnosed globally, and chest radiographs are typically obtained for patients with respiratory symptoms. This study aimed to develop a deep neural network to detect emphysema on chest radiographs.

#### METHODS AND MATERIALS

We retrospectively collected chest radiographs and CT scans between 2009 and 2020 from patients with emphysema, as identified in CT reports, at a single tertiary referral center for the model development. The emphysema index was calculated from the CT scans and dichotomized at a cutoff of 10% to determine the presence of CT-defined emphysema. A U-Net-based deep neural network was trained to predict CT-defined emphysema on chest radiographs. Chest radiographs were processed to generate three-channel images, consisting of a native chest radiograph, a segmented lung image, and a pulmonary vessel map. Lung segmentation and pulmonary vessel map extraction guided the model to focus on anatomical structures relevant to emphysema pathophysiology. The diagnostic performance of the model was evaluated using the area under the receiver operating characteristic curve (AUC) in the temporally separated internal test set and two external test sets. The prognostic value of model-defined emphysema on chest radiographs for overall survival was assessed using a Cox proportional hazards model in an independent internal set of patients with COPD.

#### RESULTS

A total of 2,579 chest radiographs and 11,284 chest computed tomography (CT) scans from 9,192 adult patients were included in the training. The deep neural network achieved AUCs of 0.90, 0.90, and 0.87 in the internal test set (n=184), external test set 1 (n=491) and external test set 2 (n=559), respectively. In an independent internal set (n=4,919), survival analysis demonstrated that the presence of emphysema, as predicted by the deep learning model, was associated with worse overall survival on multivariable analysis (adjusted hazard ratio: 1.3; 95% confidence interval: 1.2-1.5;  $P < .01$ ).

#### CONCLUSION

The deep neural network accurately detected emphysema presence on chest radiographs.

#### CLINICAL RELEVANCE/APPLICATION

The deep neural network can help overcome the global underdiagnosis of COPD using chest radiographs.

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## Abstract Archives of the RSNA, 2023

S3A-SPER-1

### Detection of Pooled Intracavitary Torso Hemorrhage on CT with Deep Learning

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Nathan Sarkar, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Internal hemorrhage caused by traumatic injury is a potentially life-threatening condition requiring rapid treatment. Hemorrhage accounts for 30-40% of all trauma-related deaths, and approximately 50,000 people die from trauma-related hemorrhage in the US annually. WBCT reports are time consuming, and automated algorithms that detect hemorrhage could be used for early notification, however to our knowledge, no such methods have been described. We develop and test DL algorithms for detection of three forms of pooled hemorrhage at CT- hemothorax, hemoperitoneum, and pelvic hematoma.

#### METHODS AND MATERIALS

Three datasets of patients with hemothorax (n=77), hemoperitoneum (n=150), and pelvic hematoma (n=253) served as positive cases for each feature and 373 negative WBCT scans were used as controls in three separate experiments using a ResNeXt-101 architecture with fully connected layer pre-trained on ImageNet. Positive slices were identified using existing label masks. All scans were resampled to a uniform slice thickness of 1.5 mm, and pre-processed using an abdominal/mediastinal window [HU -175, 250]. Data augmentation was performed using rotation, translation, scaling, and shear transformations. 3 consecutive slices were used as input. Training, validation, and testing was conducted using a 70:10:20 split of the data. Models were trained on an NVIDIA Titan RTX graphics card with 24GB memory. Decision thresholds were optimized for high sensitivity for this screening task. If a single slice was determined to be positive for a given feature, the patient was predicted to be positive. Performance was measured using standard accuracy metrics. Grad-CAM saliency maps were used for explainability.

#### RESULTS

Patient level accuracies in the test sets were as follows: 1. For pelvic hematoma (test n=125 CTs), accuracy, precision (PPV), recall (sensitivity), and NPV were 97%, 93%, 100%, and 100%, respectively. 2. For hemoperitoneum (n=105), these were 97%, 97%, 93%, and 97%, and 3. For hemothorax (n=90), these were 99%, 94%, 100%, and 100%. Hemoperitoneum was the only feature with false negatives and both occurred at low segmented volumes (18 and 23 mL). Saliency maps showed that attention corresponded with areas of pooled blood.

#### CONCLUSION

Our models were highly accurate and could be used to accelerate the activation of life-saving treatment protocols in patients at risk for exsanguination.

#### CLINICAL RELEVANCE/APPLICATION

In future work, these classification algorithms can be scaled to larger datasets and included in a pipeline with segmentation algorithms to serve combined early notification (CADt) and precision medicine (CADx) purposes, thus reducing time to diagnosis and assisting with surgical decision-making in positive patients.

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## Abstract Archives of the RSNA, 2023

S3A-SPGI-1

### **Predictive Value of a Radiomics Nomogram Model Based on Contrast-enhanced Computed Tomography for KIT Exon 9 Gene Mutation in Gastrointestinal Stromal Tumors**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yuze Wei (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish and validate a radiomics nomogram model for predicting the KIT exon 9 mutation status of gastrointestinal stromal tumors (GISTs) before surgery.

#### **METHODS AND MATERIALS**

All imaging and clinicopathological data of 87 patients diagnosed with pathologically confirmed GISTs were retrospectively collected and randomly assigned to the training set ( $n = 60$ ) and test set ( $n = 27$ ) at a ratio of 7:3. Based on contrast-enhanced CT (CE-CT) arterial and venous period images, the region of interest (ROI) of the tumors were manually drawn layer by layer, and the radiomics features were extracted. The ICC (intra-class correlation coefficient) was used to test the consistency between observers and least absolute shrinkage and selection operator regression (LASSO) was used to further screen the features. The nomogram of integrated radiomics score (Rad-Score) and clinical risk factors (extra-gastric location and distant metastasis) was drawn on the basis of multivariate logistic regression. The area under the receiver operating characteristic curve (AUC) and the correction curve were used to evaluate the predictive efficiency of the nomogram, and the clinical benefits that the decision curve evaluation model might bring to patients.

#### **RESULTS**

The AUC, sensitivity, specificity, and accuracy in the nomogram model were 0.902 (95% confidence interval [CI]: 0.798-0.964), 85.7%, 86.9%, and 91.7% for the training group, and 0.907 (95% CI: 0.732-0.984), 77.8%, 94.4%, and 88.9% for the test group.

#### **CONCLUSION**

The radiomics nomogram model based on CE-CT can effectively predict the KIT exon 9 mutation status of GISTs and may be used for selective gene analysis in the future, which is of great significance for the accurate treatment of GISTs.

#### **CLINICAL RELEVANCE/APPLICATION**

Our models show that radiomics has great potential for predicting GIST gene mutations, which may enable clinicians to optimize clinical decisions in patients with GIST.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPGI-3

### Identification of Macrotrabecular-massive Hepatocellular Carcinoma (MTM-HCC) using Gadoteric Acid-enhanced MRI and User-friendly Radiomics Analysis Suite

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Jongjin Yoon, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiomics analysis is often challenging for radiologists due to time-consuming pre-processing, tumor segmentation, and complex analysis. The purpose of this study was to attempt to develop a radiomics model for identifying macrotrabecular-massive HCCs (MTM-HCCs) using radiomics analysis suite that provides semi-automatic segmentation and user-friendly analysis tools, and to compare the model's performance to that of conventional radiomics analysis.

#### METHODS AND MATERIALS

We enrolled 3 independent cohorts from 2 tertiary care centers. The 3 cohorts consisted of a total of 464 patients who underwent gadoteric acid-enhanced MRI and surgical resection for treatment-naïve single HCCs between December 2007 and December 2014. Independent review of histopathology by two pathologists was performed for each cohort. The arterial phase images were semi-automatically segmented by reviewer 1 (faculty radiologist) in training set, and by reviewer 1, reviewer 2 (resident radiologist), and reviewer 3 (research assistant) in validation cohorts. Inter-observer agreement was evaluated using intraclass correlation coefficient (ICC). A commercial radiomics suite (syngo.via, Siemens Healthineers) was used to calculate and analyze 1,234 radiomics features. Additionally, the same radiomics features were analyzed using conventional radiomics analysis method. Area under a receiver operating characteristic curve (AUROC) was the performance metric.

#### RESULTS

ICC values in internal and external validation sets mostly exhibited excellent agreement. The training cohort AUROC for the radiomics suite random forest model was 0.72 for reviewer 1. The internal validation cohort AUROC values were 0.63, 0.71, and 0.73, while external validation set values were 0.72, 0.75, and 0.73 for reviewer 1, 2, and 3, respectively. The radiomics suite model demonstrated comparable or superior AUROC values compared to conventional techniques. In the pooled internal and external validation cohort (n=250), the predicted MTM-HCC by radiomics suite was significantly associated with frequent early recurrence and extrahepatic metastasis, and poor overall survival for all reviewers ( $P < 0.05$  for all)

#### CONCLUSION

We developed radiomics models to classify histopathologic subtypes of HCCs using a user-friendly radiomics suite. The models' diagnostic performance was comparable to conventional methods and consistent across varying user experience levels. The model showed potential in predicting prognostic factors in a pooled validation cohort.

#### CLINICAL RELEVANCE/APPLICATION

This simple, user-friendly approach of developing radiomics models is expected to make radiomics more accessible to radiologists and facilitate real-world application.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPGI-5

### Deep Learning of Two- Dimensional Shear Wave Elastography for Assessment of Clinically Significant Portal Hypertension

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Youngseo Cho, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to make a deep-learning model of 2D-shear wave elastography (SWE) images to detect clinically significant portal hypertension (CSPH) [DL-CSPH] using long short-term memory (LSTM) architecture, and to compare the diagnostic performance with conventional diagnostic method.

#### METHODS AND MATERIALS

A retrospective study was conducted using 2D-SWE image data collected in a single center, and the subject were divided into training (n=168) and test (n=113) sets. CSPH was diagnosed by hepatic venous pressure gradient measurement. With the training set, the DL-CSPH model using convolution neural network (CNN) and long short-term memory (LSTM) architecture of the 2D-SWE measurement image was derived. Especially, sequential order of liver stiffness (LS) measurement was applied into the LSTM model and compared with the LSTM model with random selection. As a conventional diagnostic method, the cut-off value of LS was calculated via a receiver operating curve analysis in the training set and applied the cut-off value in the test set.

#### RESULTS

In the prediction of CSPH using the deep-learning model, the LSTM model with sequential order showed better performance than the CNN model (sensitivity: 94.3% VS 85.7%, specificity: 86.1% VS 79.1%, accuracy: 91.2% VS 83.2%, AUC: 0.824 VS 0.902). The difference in AUC value was statistically significant. (P=0.03) Although the DL-CSPH model in sequential order performed better in predicting CSPH compared to the LS or APRI cutoff values, this difference was not statistically significant (P=0.53, 0.19, respectively). However, the DL-CSPH model in sequential order exhibited a significant improvement over FIB4 in predicting CSPH (P=0.01).

#### CONCLUSION

DL-CSPH model in sequential order demonstrates excellent overall performance in predicting CSPH.

#### CLINICAL RELEVANCE/APPLICATION

The DL-CSPH model has practical value as it enables non-invasive, automated monitoring of portal pressure in patients with chronic liver disease in a robust and reproducible manner.

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## Abstract Archives of the RSNA, 2023

S3A-SPGI-6

### Identification of a Radiomic Signature to Predict the Risk of Hepatocellular Carcinoma in Cirrhotic Patients

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Olimpia Bazzini (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients with cirrhosis are at increased risk of Hepatocellular Carcinoma (HCC); currently, clinical and radiological scores for an accurate early prediction of the development of HCC are lacking. The study aims to assess if radiomics can assist in accurately identifying cirrhotic patients at risk of HCC.

#### METHODS AND MATERIALS

98 patients (M:F=64:34; mean age 67 years  $\pm$ 9,81) were included in this retrospective monocentric study. Two groups were identified: group (a) with 49 patients (M:F=31:18; mean age 67,4 years  $\pm$ 9,12) who had a baseline CT with radiological signs of cirrhosis, without evidence of HCC in follow-up CT (LI-RADS 1-3); group (b) with 49 patients (M:F=33:16; mean age 67,5 years  $\pm$ 10,5) who had a baseline CT with radiological signs of cirrhosis and evidence of HCC in one follow-up CT scan (LI-RADS 4/5). Four radiologists (3 years of experience) provided complete liver segmentations, manually drawing volumes of interest (VOI) on non-enhanced baseline CT scans. 851 radiomic features (RF) were extracted from each VOI. Redundant RF (Spearman correlation coefficient = 0.99) were removed. The dataset was split into train:test set (70%:30%). Decision Tree classification algorithm and a 3-fold cross-validation were performed on train dataset to explore different cost complexity parameters to set the best pruning. The final model was validated on the test set in terms of accuracy, sensibility, sensitivity, precision, areas under the receiver operating characteristic (ROC) curve and under the precision-recall curve (PRC).

#### RESULTS

The tree-based model included the "wavelet-LLH\_glcm\_DifferenceAverage" RF, classifying patients as positive when higher than 0.97. The final model predicted the risk of developing HCC with an accuracy, sensitivity, specificity and precision of 0.73, 0.93, 0.56, and 0.65, respectively. Areas under ROC curve and PRC were 0.74 and 0.81.

#### CONCLUSION

A radiomic model identified a RF for stratification of cirrhotic patients at risk of developing HCC, showing high sensitivity. To increase the specificity of the model, we aim to integrate this radiomic approach with clinical and radiological parameters.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics can non-invasively predict the development of HCC in cirrhotic patients and may assist clinicians in creating a tailored monitoring path for each patient.

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## Abstract Archives of the RSNA, 2023

S3A-SPGI-7

### Added Value of Diffusion-weighted MR Imaging in the Diagnosis of Cholangiocarcinoma Recurrence

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Keiichiro Yamada, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the added value of magnetic resonance (MR) imaging including diffusion-weighted imaging (DWI) in the diagnostic performance of contrast-enhanced computed tomography (CECT) for diagnosis of cholangiocarcinoma recurrence.

#### METHODS AND MATERIALS

Thirty-three consecutive patients who underwent follow-up CECT and MR imaging after cholangiocarcinoma resection were included: 20 with recurrence and 13 without recurrence. Two observers independently reviewed CECT and subsequently reviewed combined CECT and MR imaging including DWI (b value, 1000 s/mm<sup>2</sup>). A five-point scale rating for the likelihood of cholangiocarcinoma recurrence was assessed. Both observers reviewed each image set twice. Diagnostic performance (receiver operating characteristic [ROC] curve analysis), accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were evaluated. To evaluate the intra-observer and inter-observer agreement with regard to the correct diagnosis of recurrence, kappa statistics were used.

#### RESULTS

For both observers, diagnostic performance (area under curve [AUC] of ROC) improved after additional review of MR imaging including DWI; AUC improved from 0.614 to 0.918 ( $P < 0.01$ ) in the first reading session of Observer A, and from 0.820 to 0.928 ( $P = 0.20$ ) in the second reading session of Observer A, from 0.566 to 0.858 ( $P < 0.01$ ) in the first reading session of Observer B, from 0.753 to 0.930 ( $P < 0.01$ ) in the second reading session of Observer B. Diagnostic accuracy, sensitivity, specificity, PPV, and NPV were higher than CECT alone in the first reading session of Observer A and both reading session of Observer B. Intra-observer agreement of confidence levels improved after the addition of MR imaging: kappa value improved from 0.423 to 0.636 for Observer A, from 0.199 to 0.479 for Observer B. Inter-observer agreement of confidence levels also improved after the addition of MR images: kappa value improved from 0.093 to 0.230 for the first reading session, from 0.140 to 0.460 for the second reading session.

#### CONCLUSION

The addition of MR imaging including DWI to CECT, improves the detection of cholangiocarcinoma recurrence when compared with CECT alone.

#### CLINICAL RELEVANCE/APPLICATION

The addition of MR imaging including DWI to CECT, helps to detect early-stage resectable recurrence lesions of cholangiocarcinoma.

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## Abstract Archives of the RSNA, 2023

S3A-SPGI-8

### To Predict Hepatic Decompensation Status using Computed Tomography-Based Radiomics Signature with the Body Composition Model

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yashbir Singh, PhD, MEng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to investigate the potential value of computational radiomics in predicting hepatic decompensation using body-composition model in the patients with Primary Sclerosing Cholangitis (PSC), a chronic cholestatic liver disease that can lead to hepatic decompensation.

#### **METHODS AND MATERIALS**

A total of 220 patients diagnosed with PSC and with an available abdomen CT acquired during the portal venous phase were included in the study. We used an in-house developed U-Net model that assesses body composition using the subcutaneous adipose tissue (SAT), skeletal muscle (SKM), visceral adipose tissue (VAT), and intermuscular adipose tissue (IMAT). The PyRadiomics library was used to extract radiomic features on the region of interest (ROI) created by the body composition model. Out of 100 radiomics features, 23 features were identified to be significant using statistical analysis (t-test). We aimed to develop a classification model using radiomics features based on a traditional machine learning approach (random forest classification).

#### **RESULTS**

The machine learning model achieved a prediction accuracy of 97% in the validation set, which was evaluated in terms of the AUC. This study is a first step in this proof-of-concept application of combining Radiomics Signature and the Body Composition Model with imaging data and the model was designed to predict short-term outcomes.

#### **CONCLUSION**

The study revealed the potential for prognostic features for hepatic decompensation patients in PSC and provided hidden information that may help in discovering new differentiating imaging features. This methodological approach may also have the potential for detecting other PSC-related complications such as cholangiocarcinoma and applications in other chronic liver diseases such as non-alcoholic fatty liver disease.

#### **CLINICAL RELEVANCE/APPLICATION**

The use of radiomics with Body composition model in predicting hepatic decompensation in PSC patients may aid in early detection and intervention. The approach may also be useful in detecting other complications associated with PSC and other chronic liver diseases, thereby contributing to better clinical management and improved patient outcomes.

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## Abstract Archives of the RSNA, 2023

S3A-SPGU-1

### Prediction of Bladder Cancer Based on Biparametric MRI Radiomics: Comparison with Traditional MRI

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Li Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare biparametric (bp) MRI radiomics signatures and traditional MRI model for the preoperative prediction of bladder cancer (BCa) grade.

#### METHODS AND MATERIALS

This retrospective study included 255 consecutive patients with pathologically confirmed 113 low-grade and 142 high-grade BCa who underwent preoperative MRI, including T2-weighted imaging (T2WI) and apparent diffusion coefficient (ADC). The traditional MRI nomogram model was developed using univariate and multivariate logistic regression by the mean apparent diffusion coefficient (mADC), vesical imaging reporting and data system (VI-RADS) scoring, tumor size and number of tumors. Volumes of interest were manually drawn on T2WI and ADC maps by two radiologists. Using ANOVA, correlation and LASSO methods to select features. Then, a logistic regression (LR) classifier was used to develop the radiomics signatures in the training set and assessed in the validation set. Receiver operating characteristic (ROC) analysis was used to compare the diagnostic abilities of the radiomics and traditional MRI models by the DeLong test. Finally, decision curve analysis (DCA) was performed by estimating the clinical usefulness of the two models in both the training and validation sets.

#### RESULTS

The areas under the ROC curves (AUCs) of the traditional MRI model were 0.841 in the training cohort and 0.806 in the validation cohort. The AUCs of the three groups of radiomics model [ADC, T2WI, bp-MRI (ADC and T2WI)]-based logistic regression analysis algorithms were 0.888, 0.875 and 0.899 in the training cohort and 0.863, 0.805 and 0.867 in the validation cohort, respectively. The combined radiomics model achieved higher AUCs than the traditional MRI model and was compared using the DeLong test ( $P = 0.026$  and  $0.023$  in the training and validation cohorts, respectively). DCA indicated that the radiomics model had higher net benefits than the traditional MRI model.

#### CONCLUSION

The bp-MRI radiomics model may be helpful for distinguishing high-grade and low-grade BCa and outperformed the traditional MRI model. Multicenter validation is needed to acquire high-level evidence for its clinical application.

#### CLINICAL RELEVANCE/APPLICATION

Our study shows that the bp-MRI radiomics model presented superior diagnostic performance to the traditional MRI model. This may assist doctors in obtaining the preoperative histological grading of the tumor, which is convenient for determining the treatment strategy for BCa.

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## Abstract Archives of the RSNA, 2023

S3A-SPGU-2

### Comparison of Single-shot EPI, Multi-shot EPI, and Reduced Field-of-view in Bladder DWI at 3.0 T

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Tsutomu Tamada, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the image quality of single-shot echo-planar diffusion-weighted imaging (SS-EPI DWI), multi-shot EPI DWI (MS-EPI DWI), and reduced field-of-view DWI (rFOV DWI) in bladder cancer and their diagnostic ability for muscle invasion.

#### METHODS AND MATERIALS

Seventy-three patients who had a multiparametric MRI including SS-EPI DWI, MS-EPI DWI, and rFOV DWI as a preoperative examination for bladder cancer between August 2020 and February 2023 were included in the study. Qualitative image quality was evaluated by three radiologists. Regarding the SS-EPI DWI, MS-EPI DWI, and rFOV DWI, the three items of distortion, wall clarity, and lesion conspicuity were graded in four stages: 1: poor, 2: fair, 3: good, and 4: excellent. Quantitative image quality assessment was performed by a radiologist. The signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and signal intensity ratio (SIR) were used as measures of quantitative evaluation. The control was set to the iliopsoas muscle. Three radiologists assessed the presence of muscle invasion of bladder cancer using Vesical Imaging-Reporting and Data System. Clinical information and pathology results were not known to the readers. The Wilcoxon matched pairs signed ranks test was used to compare qualitative and quantitative scores. The McNemar test and ROC analysis were used to compare diagnostic performance. A p-value < 0.05 was considered significant.

#### RESULTS

The qualitative scores for distortion were MS-EPI DWI (2.95 to 3.42), rFOV DWI (2.74 to 3.18), and SS-EPI DWI (2.33 to 3.00) in descending order, with significant differences for all combinations. The wall clarity scores were MS-EPI DWI (3.00 to 3.34), SS-EPI DWI (2.86 to 3.16), and rFOV DWI (2.44 to 2.86) in descending order, and the three readers were in agreement, with significant differences between rFOV DWI and the other two types of DWI. Quantitative evaluation showed no significant difference in SNR and CNR between each test. SIR was higher for MS-EPI DWI (average, 10.5; SD, 4.4), rFOV DWI (average, 6.5; SD, 2.1), and SS-EPI DWI (average, 5.6; SD, 1.5), in that order, with significant differences between each DWI. The diagnostic performance of muscle invasion was good for all DWIs. AUC values were 0.83 to 0.88 for SS-EPI DWI, 0.85 to 0.90 for MS-EPI DWI, and 0.83 to 0.93 for rFOV DWI. There was no significant difference between sequences.

#### CONCLUSION

MS-EPI DWI and rFOV DWI reduced image distortion and MS-EPI DWI improved bladder wall visibility compared to SS-EPI DWI, but did not contribute to improve diagnostic performance of muscle layer invasion.

#### CLINICAL RELEVANCE/APPLICATION

If distortion or bladder wall obscuration is seen on SS-EPI DWI during examination, additional MS-EPI DWI can improve image quality.

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## Abstract Archives of the RSNA, 2023

S3A-SPHN-1

### **Osteogenesis Imperfecta: Implications of Using Micro-CT for Visualizing Developmental Variation in the Middle and Inner Ear of OIM Mice**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Dallin Judd (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our research is to visualize and document anatomic variation in the ears of mice bred to have the Type III OI genetic variant in order to better understand the cause of OI-related hearing loss.

#### **METHODS AND MATERIALS**

3D models of the middle and inner ears were created from micro-CT scans that also employed two new contrast-enhanced methods to visualize the cochlea and middle ear (malleus, incus, and stapes). All CT scanning were done using the new Small Animal Imaging Facility (SAIF). The scan resolution was approximately 20 $\mu$ m. The studied WT and OIM mouse samples include three time points intended to capture a developmental sequence: 0-day-old (WT=20, OIM=29), 7-day-old (WT=23, OIM=23), and 14-day-old mice (WT=22, OIM=18). The visualization software Avizo was then used to digitally segment the bone of the inner ear and middle ear.

#### **RESULTS**

In OIM inner ears, the surrounding otic capsule tended to be more demineralized, exhibiting lower threshold values than WT. This contrasts with WT specimens, where the ossified bone was more distinct from the hollow space of the inner ear. Intrusions in the vestibule were observed in both the 2D slices and the reconstructed 3D models of the OIM inner ears. Comparison of volumes for the right OI and WT inner ears and left OI and WT inner ears indicated statistically significant differences between the genotypes.?

#### **CONCLUSION**

Bony intrusions observed in the vestibules of OIM mice may negatively affect fluid movement within the semicircular canals and vestibule (utricle and saccule), possibly altering the balancing and body positioning abilities of OI mice. This is ongoing research employing additional contrast enhanced CT (CE-CT) methods to visualize not only the bony labyrinths, but also soft tissue, including muscle and cartilage. In addition, more age-points are currently being collected with the aim of elucidating the pathogenesis of osteogenesis imperfecta during different stages of ear development.

#### **CLINICAL RELEVANCE/APPLICATION**

This research uses micro-CT imaging designed to capture a developmental sequence, giving us the potential to elucidate how and when the bony intrusions are impacting surrounding structures. Insight into this anatomical damage may help disambiguate the OI-related pathology, including the distinction between sensorineural vs. mixed hearing loss, unilateral vs. bilateral pathology, and the asymmetric nature of the disease in the ear. Upon completion, this research will demonstrate the efficacy of using these new imaging approaches for studying minute structures of the ear and may markedly advance our understanding of the pathogenesis of OI-related hearing loss.

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## Abstract Archives of the RSNA, 2023

S3A-SPHN-2

### **Magnetic Resonance Neurography of Peripheral Trigeminal Nerves: Correlation of Sunderland Class of Nerve Injury on Imaging versus Clinical Neurosensory Testing and its Diagnostic Efficacy**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Shuda Xia (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Iatrogenic or traumatic injuries to the peripheral trigeminal nerve (PTN) can cause loss of sensation and neuropathic pain in the face and oral cavity. Clinical neurosensory testing (NST) is currently the reference standard for diagnosis but is less reliable within the first 3 months following injury and cannot precisely identify the location of the nerve injury. MR neurography (MRN) has been studied for PTN injury diagnosis but with small sample sizes. The aim of this cross-sectional study was to evaluate the correlation between Sunderland class of nerve injury on MRN and NST and obtain diagnostic efficacy with surgical findings as reference standard.

#### **METHODS AND MATERIALS**

An Institutional Review Board approved this retrospective cross-sectional study of adult patients of all genders with suspected injury of PTN who had both clinical NST by an experienced oral maxillofacial surgeon and MRN interpreted by an expert radiologist. A total of 297 patient records with a chief complaint of PTN neuralgia were identified from the university database. All patient charts were reviewed to identify Sunderland injury class on NST and MRN, previous surgeries, whether surgery was performed after the MRN, and surgical outcomes. Of the cohort, 87 patients had both NST injury grade and Sunderland class injury in their records, and 45 of these patients had surgery. Pearson correlation was obtained and the accuracy of NST and MRI was obtained with surgical and histopathology findings as reference standards. Cohen's weighted Kappa was also calculated.

#### **RESULTS**

There were 20 men and 67 women with an age range of 15 to 81 years. Most (69/87, 79%) injuries resulted from tooth extractions and implants. On MRN, there were no class I injuries, 26 class II injuries, 26 class III injuries, 26 class IV injuries, and 9 class V injuries. There was a very strong positive correlation between injury grade on MRN and the NST injury class ( $p < .001$ ). There were substantial agreements between NST, MRN, and surgical findings.

#### **CONCLUSION**

The results of this study confirm that MRN adequately provides the injury grade better than NST with improved diagnostic accuracy.

#### **CLINICAL RELEVANCE/APPLICATION**

Prompt non-invasive and accurate diagnostic evaluation of suspected PTN injury is critical for successful management. MRN provides the needed pre-operative information on injury grade and its anatomic localization.

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## Abstract Archives of the RSNA, 2023

S3A-SPHN-3

### Relationship Between MRI and Clinical Findings of Anatomic Risk Factors in Adult Patients Affected by Obstructive Sleep Apnea/hypopnea Syndrome (OSAHS)

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Maria Paola Belfiore (*Presenter*) Nothing to Disclose

#### PURPOSE

Identify specific anatomical abnormalities associated with Obstructive Sleep Apnea/hypopnea syndrome (OSAHS), and establish a correlation between the pathological condition and the anatomical changes and enhance treatment planning for future management

#### METHODS AND MATERIALS

This case-control study conducted in 2022 investigated the potential of MRI in identifying the causes of upper airway obstruction in OSAHS patients. The study included 30 participants diagnosed with OSAHS and 16 healthy subjects enrolled as a control group, matched for gender, age, height, and weight. All participants underwent MRI examination of the cervical maxillofacial district in the bore of the same 1.5 T magnet. MRI exams revealed significant differences in the upper airway volume, midsagittal nasopharyngeal antero-posterior distance, axial CSA of the nasopharyngeal airway, midsagittal tongue area, soft palatal length, midsagittal soft palatal area, and axial volume of the right and left parapharyngeal adipose tissue in patients with OSAHS compared to controls. Furthermore, the study analyzed the correlation between cephalometric and anatomical measurements and OSAHS severity.

#### RESULTS

The results showed a significant association between the severity of OSAHS and soft palate length, soft palate area, Hyoid-Sella distance, and Hyoid-Nasion distance. Soft palate length was closely associated with Hyoid-Sella distance, Hyoid-Nasion distance, and tongue area. The study also evaluated the facial skeletal structure, showing significant differences in intermandibular distance, mandibular depth, and the position of both the maxilla and mandible between the two groups.

#### CONCLUSION

Multiple soft tissue and skeletal structures surrounding the upper airways may contribute to the symptoms and clinical severity of OSAHS; in some cases, they may even play a dominant role. MRI has enormous potential in evaluating the three compartments of obstruction: air lumen, soft tissues, and facial skeleton.

#### CLINICAL RELEVANCE/APPLICATION

This study highlights the potential of MRI in identifying the causes of upper airway obstruction in adult OSAHS patients. While polysomnography remains the gold standard for OSAHS diagnosis, MRI can offer a valuable alternative method for evaluating the craniomaxillofacial morpho-volumetric characteristics contributing to airway size reduction. This information can assist in determining the most appropriate therapeutic approach and surgical intervention, ultimately improving OSAHS patient outcomes.

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## Abstract Archives of the RSNA, 2023

S3A-SPHN-4

### Cochlea-carotid Dehiscence: An Underappreciated Condition

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Charles Tandler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cochlea-carotid artery dehiscence (CCD) is the erosion of the bony plate between the cochlea and the petrous segment of the internal carotid artery. In one study of 1,000 temporal bones, there is a histologic prevalence of cochlea-carotid artery dehiscence of 7.7%. It has been reported to be associated with pulsatile tinnitus, conductive hearing loss, sensorineural hearing loss, vertigo, and other otologic disorders. However, the clinical significance of cochlea-carotid artery dehiscence is unknown. Other than a small number of case reports, no large-scale study investigates the radiographic prevalence of CCD and its clinical significance. This study hopes to highlight its clinical significance by retrospectively reviewing a large volume of temporal bone computed tomography (CT) exams and patients' symptoms.

#### METHODS AND MATERIALS

This retrospective single-center cross-sectional study was conducted after the institution's IRB approved the study. Consecutive 1,000 patients (2,000 ears) who underwent CT temporal bones were reviewed. CT images were obtained with 0.625 mm thick and 0.3 mm reconstruction interval. First, a radiology resident reviewed all exams for possible CCD. Then, selected cases were reviewed by two board-certified neuroradiologists independently. The discrepancy was resolved by consensus. Possible CCD ears were divided into three categories: 1) dehiscence, 2) thinning/possible dehiscence, and 3) no dehiscence. The location of the dehiscence or thinning/possible dehiscence was recorded. The results were correlated with clinical findings. Duplicated exams and age less than 18 years old were excluded.

#### RESULTS

Thirteen temporal bones with CCD were identified in twelve patients, including one patient with bilateral CCD (8 men, 4 women, age: 36-78). The basal turn was affected in eleven ears, and the apical turn was affected in two ears. One patient had progressive sensorineural hearing loss of high frequency of the affected ear. Another patient had bilateral hearing loss, more profound in the affected ear, with episodic dizziness. One patient had no documented otological finding in the chart. Other patients did not have symptoms that might be associated with CCD.

#### CONCLUSION

CCD is a rare condition, as reported in the literature. Its clinical significance is still unknown, although pulsatile tinnitus, conductive hearing loss, sensorineural hearing loss, vertigo, and other otologic disorders have been reported in the literature.

#### CLINICAL RELEVANCE/APPLICATION

CCD is a rare condition as reported in the literature. Its clinical significance is still unknown, although pulsatile tinnitus, conductive hearing loss, sensorineural hearing loss, vertigo, and other otologic disorders have been reported.

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## Abstract Archives of the RSNA, 2023

S3A-SPHN-5

### Combining Virtual Monoenergetic Imaging and Iterative Metal Artifact Reduction in Photon-counting CT of Patients with Dental Implants

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Theresa Sophie Patzer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Virtual monoenergetic imaging (VMI) and iterative metal artifact reduction (MAR) are established techniques in energy-integrating detector (EID) CT. The artifact suppressing effect of both approaches is not thoroughly investigated in photon-counting detector (PCD) CT. This study aims to evaluate the potential of VMI, MAR, and combinations thereof in PCD-CT for metal artifact reduction in patients with dental implants.

#### METHODS AND MATERIALS

In 50 patients with dental implants (25 women; mean age  $62 \pm 9.92$  years), conventional 120 kVp imaging (T3D), VMI, T3DMAR and VMIMAR were compared. VMI datasets were reconstructed at 40, 70, 110, 150 and 190 keV. Objective image quality was assessed by ROI-based measurements of attenuation and respective standard deviations in the most hyper- and hypodense artifacts, as well as in artifact-impaired soft tissue of the mouth floor. Three readers evaluated artifact extent and soft tissue interpretability separately on a five-point scale. The introduction of new artifacts and/or overcorrection of pre-existing artifacts was assessed subjectively.

#### RESULTS

MAR substantially reduced hyperdense and hypodense artifacts (T3D 1305.0/-1418.4 HU; T3DMAR 103.2/-46.9 HU), soft tissue impairment (T3D 106.7 HU; T3DMAR 39.7 HU) and image noise (T3D 16.9 HU; T3DMAR 5.2 HU) compared to non-MAR datasets (all  $p=0.001$ ). While VMIMAR =150 keV did not enhance artifact reduction over T3DMAR objectively (all  $p=0.081$ ), VMIMAR =110 keV received superior subjective ratings (all  $p=0.023$ ). Without MAR, VMI displayed no measurable artifact extent reduction (all  $p=0.186$ ). However, VMI =110 keV reduced soft tissue impairment over T3D (all  $p=0.009$ ). VMI facilitated no significant denoising over T3D with or without MAR (all  $p=0.366$ ). VMIMAR =110 keV resulted in less overcorrection than T3DMAR (all  $p=0.001$ ).

#### CONCLUSION

While VMI alone presented only minimal metal artifact reduction potential, post-processing using MAR enabled a substantial reduction of hyperdense and hypodense artifacts. The combination of both provided a considerable benefit in subjective artifact reduction compared to MAR alone.

#### CLINICAL RELEVANCE/APPLICATION

Combining iterative MAR with VMI represents a potent tool for maxillofacial PCD-CT with dental implants achieving substantial artifact reduction. Thus, these approaches allow for improved image quality, improving delicate detection and evaluation of oral pathologies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPHN-7

### Application of parotid gland ASL and T2 mapping MRI in Sjögren's syndrome

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Zhang Gaozhengbo, MA (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to explore the application value of ASL and T2 mapping techniques in the assessment and early diagnosis of parotid gland injury in Sjögren's syndrome(SS) patients.

#### METHODS AND MATERIALS

This study prospectively included 54 first-time confirmed SS patients and 30 healthy volunteers from a tertiary hospital from August 2021 to October 2022. Non parametric Mann Whitney U test was used to compare various parameters between SS patients and healthy volunteers. LSD test was used to compare the differences in parameters between adjacent MRI morphological grading. Spearman rank correlation test was used to analyze the correlation between parotid gland MRI morphological grading and various parameters of SS patients. The combination of logistic regression and receiver operating characteristics is used to evaluate the diagnostic efficacy of various parameters and their combination in distinguishing healthy volunteers from early SS patients and all SS patients.

#### RESULTS

The parotid gland BF of all SS patients and 0-3 grade SS patients was higher than that of healthy volunteers. There was no statistically significant difference in BF between grade 4 SS patients and healthy volunteers. The T2 value and standard deviation of T2 value in the parotid gland of all SS patients and 0-4 grade SS patients were higher than those of healthy volunteers. The morphological grading of parotid gland MRI (0-3 grades) showed a strong positive correlation with BF ( $r=0.785$ ,  $P<0.001$ ), a moderate positive correlation with T2 value ( $r=0.547$ ,  $P<0.001$ ), and a moderate positive correlation with T2 standard deviation ( $r=0.622$ ,  $P<0.001$ ). The area under the curve of BF is 0.813; The AUC of T2 value is 0.810; The AUC of T2 standard deviation is 0.649. The AUC of the combined diagnosis of BF, T2 value, and T2 value standard deviation is 0.842. The diagnostic efficacy of BF, T2 value, and combined diagnosis is higher than the T2 value standard deviation, while the diagnostic efficacy of combined diagnosis is higher than BF or T2 value.

#### CONCLUSION

The BF, T2 values, and standard deviation of T2 values of the parotid gland can distinguish between healthy volunteers and SS patients, reflecting the corresponding changes in the parotid gland of SS patients at different stages. The combination of the three can improve diagnostic efficiency. ASL technology and T2 mapping technology have certain significance in the evaluation and early diagnosis of parotid gland injury in SS patients, and are important supplementary tools for routine MRI diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

ASL technology and T2 mapping technology have certain significance in the evaluation and early diagnosis of parotid gland injury in SS patients, and are important supplementary tools for routine MRI diagnosis.

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## Abstract Archives of the RSNA, 2023

S3A-SPIN-2

### Development of a Three-Dimensional Expression Method for Ultrasound Images Using Mixed Reality Head-Mounted Displays

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Do Hyung Lee (*Presenter*) Nothing to Disclose

#### PURPOSE

This research aimed to develop a real-time three-dimensional (3D) expression of ultrasound images in mixed reality (MR) space to enhance the intuitiveness and understanding of ultrasound images, and to compare its performance with conventional two-dimensional (2D) ultrasound.

#### METHODS AND MATERIALS

An MR ultrasound system was developed using the Microsoft HoloLens 2™ MR head-mounted display (HMD), incorporating a 3D camera for SLAM (Simultaneous Localization and Mapping) of the ultrasound transducer. Technical performance was evaluated for MR 2D and MR 3D ultrasound modalities. User evaluation involved 20 healthcare workers (10 medical doctors (MD) group, and 10 non-MD group; 4 nurses, and 6 radiology technicians) who assessed elapsed time, target object position identification score (both of horizontal and vertical position), and shape identification score for every three modalities: 1) conventional 2D ultrasound, 2) MR 2D ultrasound, and 3) MR 3D ultrasound. For each correct identification of the position and shape for a single target object, a score of 1 point was given. The user satisfaction assessment was also conducted regarding the intuitiveness of shape recognition, location recognition, and ease of use in the 3D accumulation process on a scale of 5.

#### RESULTS

User evaluation revealed no significant difference in elapsed time, and position identification among the three modalities. Shape identification score was significantly improved with MR 3D ultrasound compared to conventional 2D and MR 2D ultrasound (conventional 2D:  $1.05 \pm 0.76$  [average  $\pm$  standard deviation], MR 2D:  $1.30 \pm 1.13$ , MR 3D:  $3.00 \pm 0.00$ ,  $p < 0.001$ ). All evaluators identified the correct shapes of all target objects, eliminating differences between groups in using MR 3D ultrasound. User satisfaction score in the intuitiveness of shape identification with MR 3D ultrasound was as high as  $4.85 \pm 0.37$ .

#### CONCLUSION

Incorporating 2D ultrasound into the MR space and expressing it in three dimensions through a user-driven 3D accumulation process were both technically feasible to implement. Moreover, the MR 3D ultrasound display was superior to both conventional 2D and MR 2D ultrasound in discerning the shape of the target object, providing a more intuitive visualization.

#### CLINICAL RELEVANCE/APPLICATION

HoloLens offers the function for multiple users to simultaneously share the same MR space, which can be implemented when several users are each wearing their own HoloLens device. By employing the technology developed in this study to reconstruct and display the images as 3D MR, it is expected to facilitate sharing of examination contents and promote intuitive understanding among patients with limited anatomical knowledge and clinical support staff.

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## Abstract Archives of the RSNA, 2023

S3A-SPIN-3

### A Novel 18F-FDG-PET Based Signature for Non-Small Cell Lung Cancer Prognostication

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Mitchell Chen, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a novel 18F-fluorodeoxyglucose-positron emission tomography (FDG-PET) radiomics predictive model combined with metabolic hotspot to centroid (HOC) metric for patient prognostication in non-small cell lung cancer (NSCLC).

#### METHODS AND MATERIALS

Pre-therapy FDG-PET scans from 301 NSCLC patients (age:  $69.1 \pm 9.8$ , male: female (M: F) = 183:118) were acquired between July 2009 and November 2018 and included as the training data. Independent external FDG-PET data were acquired from five centers ( $n = 257$ ) and used for model validation. Two board-certified clinical radiologists with 8 and 13 years of professional experience segmented the primary tumor using metabolic tumor volume 40% (MTV40) threshold. Additional regions of interests (ROI) were acquired from the peri-tumoral penumbra as annular shells of 1cm in thickness, and from the background lung parenchyma as spheres of 3cm in diameter. Following pre-processing, radiomics features compliant with the Image Biomarker Standardization Initiative (IBSI) were extracted using PyRadiomics from each ROI, normalized and aggregated to form a feature space. Non-reproducible features with an inter-class correlation (ICC) of less than 0.8 were excluded. Cox regression with elastic net regularization was performed to develop a radiomics model with patients' 3-year overall survival as the response vector. Using multivariable regression, this was combined with a novel PET metric developed based on the clonal driver mutation theory of cancer growth, namely the FDG HOC distance, to develop a composite radiomics predictive vector (RPV). Model performance for disease prognostication was tested by stratifying the patients into a high and low risk group using k-means clustering based on RPV.

#### RESULTS

In all external testing cohorts, statistically significant stratification of the patients into high and low risk groups was achieved using RPV ( $p$ -value  $< 0.05$ ).

#### CONCLUSION

A model developed based on PET radiomics and HOC can achieve patient prognostication in NSCLC. Comparing to models based on CT or PET radiomics alone, this novel signature captures explainable information on tumour growth, and demonstrates a role of the latter for predicting patient survival in NSCLC.

#### CLINICAL RELEVANCE/APPLICATION

Imaging-based metrics such as FDG-PET radiomics and HOC offer a non-invasive way of assessing neoplasms at the time of diagnosis. This can aid in clinical decision making, particularly in cases where tissue sampling is challenging or shows inconclusive results. The information presented by these measurements can additionally give insight into tumor composition and metabolism, thereby advancing an understanding of cancer biology that is not otherwise achievable in vivo.

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## Abstract Archives of the RSNA, 2023

S3A-SPIN-4

### AI-assisted Volumetric Segmentation for Metastases in Follow-up CT Scans: A Multi-institutional Reader Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Alessa Hering, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

AI-assisted techniques for lesion registration and segmentation have the potential to make CT-based tumor follow-up assessment faster and less reader-dependent. However, empirical evidence on the advantages of AI assistance for lymph node and soft tissue metastases in follow-up CT scans is lacking. Therefore, the aim of this study was to assess the efficiency, quality and inter-reader variability of an AI-assisted workflow for volumetric segmentation of lymph node and soft tissue metastases in follow-up CT scans. Three hypotheses were tested: (H1) Assessment time for follow-up lesion segmentation is reduced using an AI-assisted workflow. (H2) The quality of the AI-assisted segmentation is non-inferior to the quality of fully manual segmentation. (H3) The inter-reader variability of the resulting segmentations is reduced with AI assistance.

#### METHODS AND MATERIALS

This multi-institutional reader study retrospectively analyzed 126 lymph nodes and 135 soft tissue metastases from 55 patients diagnosed with stage IV melanoma. Given segmentations of these lesions on the baseline scan, three experienced readers from two institutions performed both AI-assisted and manual segmentations on the follow-up scans. The results were then statistically analyzed and compared to a manual segmentation reference standard to assess the quality and accuracy of the AI-assisted workflow.

#### RESULTS

AI-assisted segmentation reduced user interaction time significantly by a third (222s vs 336s per patient), achieved similar Dice scores (0.80-0.84 vs 0.81-0.82) and decreased inter-reader variability (median Dice 0.85-1.0 vs 0.80-0.82), compared to manual segmentation. In over 50% of the segmentation propositions within the AI-assisted workflow, two radiologists accepted the results without any further corrections.

#### CONCLUSION

AI-assisted segmentation reduced user interaction time significantly by a third, achieved similar Dice scores and decreased inter-reader variability, compared to manual segmentation. In over 50% of the segmentation propositions within the AI-assisted workflow, two radiologists accepted the results without any further corrections.

#### CLINICAL RELEVANCE/APPLICATION

AI-assisted lesion segmentation makes accurate quantification of volumetric tumor growth and other characteristics feasible in clinical routine, enabling earlier and better response assessment.

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## Abstract Archives of the RSNA, 2023

S3A-SPIN-5

### Graph-Theoretic Automatic Lesion Tracking and Detection of Patterns of Lesion Changes in Longitudinal CT Studies

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Leo Joskowicz, PhD (*Presenter*) Officer, HighRAD Ltd

#### PURPOSE

To evaluate the performance of a novel generic method for tracking individual lesion changes and detecting patterns in liver and lung metastatic lesions in longitudinal CT.

#### METHODS AND MATERIALS

We define seven individual lesion change classes: new, disappeared, unique, lone, merged, split, and complex lesion and five lesion change patterns: single, linear, merged, split, and complex pattern to summarize the evolution of lesions over time. The method automatically computes the lesion matchings, the labels of the changes in individual lesions, and the patterns of the lesion changes. It uses a graph-based technique where lesions are vertices and edges are pairings of matched lesions. The inputs are the scans and the organ and lesion segmentations in each scan. It performs pairwise deformable registration of consecutive scans, organs and lesion segmentations, matches overlapping lesions, and computes the changes from the resulting graph. The method was evaluated on lung and liver metastases datasets with 83 scans from 19 patients (mean  $126 \pm 81$  days apart) and 77 scans from 19 patients (mean  $109 \pm 93$  days apart). Ground truth manual lesion segmentations, matchings and changes classification were obtained by an expert radiologist.

#### RESULTS

The lung and liver metastases overall individual lesion change class accuracy is 97% and 87%. The patterns of lesion changes were identified with an accuracy of 94% and 80%. The highlighting of unusual lesion labels and lesion change patterns helped the radiologist find missed lesions (57 lungs, 52 liver) and wrongly annotated lesions (1 lungs, 18 liver), accounting for 4.9% and 8.7% of the original ground-truth lesions.

#### CONCLUSION

Our method accurately classifies changes in individual lesion and reliably identifies patterns of lesion changes in liver and lung longitudinal CT studies.

#### CLINICAL RELEVANCE/APPLICATION

Automatic lesion change classification and pattern detection in longitudinal CT studies may improve the accuracy and efficiency of radiological interpretation and disease status evaluation.

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## Abstract Archives of the RSNA, 2023

S3A-SPIN-6

### Accurate Coverage Assessment in MRI using Deep Learning-Based Landmark Detection

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ryan Chamberlain, PhD (*Presenter*) Employee, ImBio, LLC

#### PURPOSE

This study aims to develop a deep learning-based MRI coverage detection model. By introducing key points to define coverage, using self-supervised learning to overcome annotation challenges, the model addresses crucial coverage detection obstacles and promotes patient-centered care.

#### METHODS AND MATERIALS

**Datasets:** We used three datasets for train and evaluate the model: Lumbar Spine Open dataset1 (464 T1 and T2-weighted lumbar spine MRI images); IXI MRA dataset2 (nearly 600 MR images from healthy subjects); and TubeTK MRA dataset (100 T1-weighted MRA images from healthy patients). No manual annotations of key points needed. **Model:** Adapted from Frueh et al.'s paper<sup>3</sup>, we employed the Template Matching Network (TMN) with separate feature encoders for the source image and augmented extracted patch. The stacked feature vectors feed into three fully connected layers, the localizer. We added a detector branch for coverage detection, sharing the localizer's architecture, but yielding binary results (Figure). **Augmentation:** Techniques include affine transformation, gamma adjustment, and Gaussian blurring. Images and patches are cropped before resizing to the model's input size of 224x224, ensuring flexible image scope and dynamic image/patch size ratios, enhancing model robustness and adaptability. **Training:** Loss functions comprise log negative likelihood loss for the localizer and cross-entropy loss for the detector, using multi-purpose optimization. StepLR manages learning rate scheduling, and early stopping ensures an efficient training strategy.

#### RESULTS

We evaluated our deep learning-based coverage detection model in spine and MRA scenarios. The spine model demonstrated a 4.84mm mean distance in localizing key points, and correctly identified vertebral levels in 55% of cross subject test cases. The model achieved an F1 score of 0.799 in detecting coverage in partial lumbar spine images. The MRA model achieved a 6.65mm mean distance in localization, and qualitatively identified correct locations in two randomly selected cross subject images (see figure).

#### CONCLUSION

Our coverage detection model exhibits strong performance in spine imaging and MRA studies, with promising results in localizing random or manually labeled key points as well as detecting coverage in partial images.

#### CLINICAL RELEVANCE/APPLICATION

By ensuring accurate coverage of relevant anatomical structures, our deep learning-based model has the potential to reduce repeat imaging and patient revisits, conserving resources and minimizing risks for patients. By automating the coverage assessment process, the model alleviates the burden on clinicians to manually review images. This innovation ultimately boosts efficiency, and promotes better patient care.

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## Abstract Archives of the RSNA, 2023

S3A-SPIN-7

### Discrimination of the Pulmonary Nodules Using the Chest CT Image Features by Homology Method

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Akira Sato, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The degree of lung adenocarcinoma (LAc) invasion is important in determining treatment strategy, but it is not revealed until the pathological diagnosis at surgical treatment. So, we developed a method to determine it from preoperative CT images, but it is also necessary to discriminate the lesion of LAc from normal tissues. Homology is one of the topological concepts and quantifies contact. Homology-based image analysis (HA) can explain the reason for inference based on mathematics. So, we have aimed to discriminate LAc and normal tissues in CT image based on HA.

#### METHODS AND MATERIALS

This study uses chest CT images of patients with LAc. Fifty ROIs (regions of interest) were created for each LAc lesion, lung field (no lesion), blood vessels in the lung field, bronchi, and ribs. Next, binarized images were created while varying the CT value. The Betti numbers ( $b_0$ ,  $b_1$ : the number of isolated areas and holes) in the ROI were measured and normalized with the area of ROI. These indices were used as imaging features and compared using Mann-Whitney U test. The relationship between HU and imaging features was plotted as a homology profile. Moreover, we developed a binary classification model based on the support vector machine (SVM) that classifies the ROI for LAc or normal tissue, and five-fold cross-validation was used.

#### RESULTS

U test showed that each normal tissue significantly differed for nodules ( $p < 0.05$ ). The performances of SVM-based model are as follows (mean  $\pm$  SD). The discrimination between lung fields and LAc had an accuracy of  $1.00 \pm 0.00$  and area under the ROC curve (AUROC) of  $1.00 \pm 0.00$ , while the discrimination between ribs and LAc had an accuracy of  $0.99 \pm 0.01$  and AUROC  $1.00 \pm 0.00$  were the best results. For the best discrimination between blood vessels and LAc, an accuracy of  $0.91 \pm 0.03$  and AUROC of  $0.97 \pm 0.01$  were obtained, while for the discrimination between bronchi and LAc, an accuracy of  $0.97 \pm 0.01$  and AUROC  $1.00 \pm 0.00$ .

#### CONCLUSION

The results suggest that it is possible to extract image features for each tissue by using HA, and that the classification model using those features can classify with excellent performance. Therefore, we will discriminate the ROIs obtained from the automatic contouring technique using the multi-classification model in the future. In conclusion, we succeeded in discriminating the ROI obtained from chest CT images for LAc and normal tissues using the SVM-based model that discriminates the image features by HA.

#### CLINICAL RELEVANCE/APPLICATION

We will develop the hybrid model, including this proposed model and our developed model that classifies the invasiveness degree of LAc on preoperative CT images. The hybrid model may not only help in early diagnosis and predicting prognosis but also lead to the discovery of novel valuable indices.

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## Abstract Archives of the RSNA, 2023

S3A-SPIR-1

### Comparison of Micro Flow Imaging and Contrast Enhanced Ultrasound in Microwave Ablation of Benign Thyroid Nodules

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Min Zhuang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the application value of micro-flow imaging (MFI) in microwave ablation (MWA) of thyroid nodules by comparing it with contrast-enhanced ultrasound (CEUS).

#### METHODS AND MATERIALS

From January 2020 to March 2022, 50 patients with 55 thyroid nodules who underwent MWA in the ultrasound department of our hospital were included. According to the different ablation evaluation methods, they were divided into the CEUS group and the MFI group. Before the operation, CEUS and MFI were used to evaluate the consistency of blood flow inside the nodule. Immediately after ablation, CEUS or MFI was used to evaluate whether the ablation was complete. Follow-up was conducted at 1, 3, and 6 months after the operation and every 6 months thereafter to record the diameter and volume of the nodule, CEUS and MFI were used to evaluate the suspected recurrent nodules.

#### RESULTS

There was no significant difference between MFI and CEUS in assessing the internal blood flow of nodules ( $P > 0.05$ ), and the consistency between them was very strong (kappa value = 0.81). All nodules showed complete ablation. At 1, 3, 6, and 12 months after the operation, the VRR in the CEUS group was 41%, 61%, 78%, and 89% respectively, and in the MFI group was 41%, 55%, 71%, and 83% respectively, there was no significant statistical difference between the two groups ( $p > 0.05$ ). No serious complications occurred after the operation.

#### CONCLUSION

The application effect of MFI in MWA of benign thyroid nodules is consistent with CEUS, and when CEUS cannot be used or unconditionally to use, MFI can be an alternative.

#### CLINICAL RELEVANCE/APPLICATION

CEUS can sensitively display the micro blood perfusion in tissues and can be used to differentiate benign and malignant tumors, it plays an essential role in the whole ablation process, which can determine the ablation area before ablation and evaluate the therapeutic effect after ablation. However, CEUS is an invasive and expensive examination, and not suitable for patients with severe cardiopulmonary dysfunction or hypersensitivity to ultrasound contrast agents. Explore a new, non-invasive way to evaluate the efficacy of thyroid nodule ablation will not only help to reduce the cost of patients. Micro-flow imaging (MFI) is a new ultrasound technology that can eliminate tissue motion artifacts while maintaining sensitivity to low-speed blood flow signals by using effective algorithms to visualize microvascular, it has the advantages of being non-invasive, fast, and convenient. In recent years, MFI has gradually been widely used in clinical practice. There are only a few studies on the application of MFI in the thermal ablation process of thyroid nodules. This paper aims to further study the application value of MFI in the MWA process of thyroid nodules by comparing it with CEUS.

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## Abstract Archives of the RSNA, 2023

S3A-SPIR-2

### Reperfusion of Pulmonary Arteriovenous Malformations Treated by Catheter Embolization

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Guenther K. Schneider, MD, PhD (*Presenter*) Research Grant, Siemens AG;Speakers Bureau, Siemens AG;Speakers Bureau, Bracco Group;Research Grant, Bracco Group

#### PURPOSE

339 patients with HHT (Osler disease) underwent screening for manifestation of the disease in the brain, the lung and the liver by one CE MRI study. In 144 patients at least one pulmonary AVM was found and catheter embolization using platinum coils or vascular plugs was performed with initial complete occlusion of the PAVM. However, especially in the lung reperfusion may occur due to reopening of the treated vessel itself or newly developed collateral vessels. The aim of our study was to evaluate patients post treatment of pulmonary AVM's for possible reperfusion.

#### METHODS AND MATERIALS

Of 144 patients with previous treatment of PAVMs 117 patients underwent follow-up studies to detect reperfused PAVM by CE MRA. The mean follow-up period was 4 yrs and 8 month. For follow-up a time-resolved MRA was used with injection of a small CM bolus (0.025 mmol/kg BW MultiHance, Bracco). The temporal resolution of the sequence was < 3 sec/dataset with a total number of 72 slices. Thereafter a high resolution CE MRA (0.075 mmol/kg BW MultiHance) was performed. Images were evaluated regarding enhancement of the AVM and if detected, time of enhancement of the draining vein.

#### RESULTS

In 77 of 117 patients no reperfusion in follow-up studies was found. In 35 patients reperfusion of the treated vessel and in 5 patients reperfusion of the PAVM was detected due to collateral vessels supplying the PAVM. In one patient reperfusion occurred due to systemic arterial supply from collaterals arising from the intercostal arteries. The mean time between embolization and detection of reperfusion in patients treated at our department was 6 years. 36 of 40 patients with reperfused PAVM were confirmed by DSA and underwent reembolization. In 4 cases supplying vessels were < 2mm and only further follow-up studies were performed. Reperfusion was detected both after coil embolization and implantation of Amplatzer vascular plug 4. The mean diameter of reperfused vessels was 4.6 mm (SD 1.4).

#### CONCLUSION

Reperfusion of initially completely occluded PAVMs might even occur after longer time intervals thus regular follow-up studies are mandatory. CE MR-Angiography can reliably depict reperfusion of PAVM and evaluation of the enhancement kinetics of the draining vein was helpful to distinguish between retrograde filling, filling of the still dilated draining vein via normal lung tissue and reperfusion by reopening of shunt vessels or new collateral supply.

#### CLINICAL RELEVANCE/APPLICATION

Reperfusion of embolized PAVM can occur in up to 35 percent of patients and early detection is mandatory to avoid complications e.g. stroke. Dynamic CE MRA directly depicts early enhancement of the draining vein as a sign of reperfusion and thus can give important additional information not gained in conventional acquisitions or CT.

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## Abstract Archives of the RSNA, 2023

S3A-SPIR-3

### Comparative Prospective Analysis of Digital Variance Angiography and Digital Subtraction Angiography in Prostatic Artery Embolization: A Potential Solution for Radiation Dose Reduction

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Leona Alizadeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Prostatic Artery Embolization (PAE) is a complex vascular intervention that requires the use of X-ray angiography imaging with high doses of radiation and iodinated contrast agent. The purpose of this study was to compare the performance of Digital Variance Angiography (DVA) with standard Digital Subtraction Angiography (DSA) in PAE and to evaluate the potential of DVA to reduce radiation exposure and contrast agent use.

#### METHODS AND MATERIALS

A prospective observational study was conducted on 26 patients (mean age 72, SD 14.6, range 49-89) in two groups (n=13): Group 1: standard CARE imaging protocol and Group 2: reduced detector dose and image quality pre-settings. All patients underwent PAE at our institution between January and December 2022. The study included a total of 107 acquisitions, from which DSA and DVA images were generated from the same raw series. The Contrast-to-Noise Ratio (CNR) values were calculated, and the image quality was assessed by four experienced readers using a 5-grade-Likert-scale in a randomized blinded survey. Radiation dose data was evaluated by assessment of dose-area-product (DAP) reference point air-kerma (RP), fluoroscopy times and image frames.

#### RESULTS

The DVA images provided significantly higher CNR values compared to DSA images, with a median CNR of  $32.2 \pm 9.5$  in Group 1 and  $24.8 \pm 9.9$  for Group 2 vs.  $8.1 \pm 11.1$  for Group 1 DSA and  $7.3 \pm 9.3$  for Group 2 DSA,  $p < 0.001$ . Furthermore, the DVA images received significantly higher Likert scores compared to DSA images, with a median (IQR) value of 4.52 (4-5) for Group 1 DVA 4.12 (3-5) for Group 2 and 3.24 (3-4) for Group 1 DSA and 2.9 (2-4) for Group 2,  $p < 0.001$ . Mean radiation burden in Group 1 was significantly higher by -49% / -45% with a DAP  $17.85 \mu\text{Gy} \cdot \text{m}^2 / \text{frame}$  and RP 0.89 / frame compared to Group 2 with a DAP  $9.62 \mu\text{Gy} \cdot \text{m}^2 / \text{frame}$  and RP 0.49 / frame ( $p < 0.001$ ).

#### CONCLUSION

The results of this study demonstrate that DVA has significantly higher CNR compared to DSA for both Groups in PAE procedures. The use of DVA could potentially provide a quality reserve that can be utilized for significant reduction of radiation exposure and iodinated contrast agent in PAE, up to 50-70% without compromising image quality. This may have a significant impact on patient safety during complex procedures such as PAE.

#### CLINICAL RELEVANCE/APPLICATION

The implementation of DVA in PAE can significantly reduce radiation exposure, which is a critical factor for improving patient safety during complex vascular interventions. These findings suggest that DVA should be considered as an alternative to DSA in PAE and other similar procedures that require high-quality imaging while minimizing the risk of radiation exposure and potentially also contrast agent use.

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## Abstract Archives of the RSNA, 2023

S3A-SPIR-4

### Quantitative MRI-based Volumetric Analysis of Percutaneous Sclerotherapy Outcomes in Peripheral Extremity Venous Malformations

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Amanda Laguna, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To study the changes in MRI radiomic features occurring in peripheral venous malformations (VMs) after treatment using percutaneous sclerotherapy (PS).

#### METHODS AND MATERIALS

Our vascular anomalies database was searched for patients with peripheral extremity VMs who were treated by image-guided PS and had completed their treatment plan, and clinical and imaging follow-up between 2005-2022. VMs were manually segmented on pre- and post-treatment T2-weighted (T2-WI) MRI using 3D Slicer software to assess changes in lesion volume and signal intensity (SI). To account for signal parameter differences between pre- and post-treatment T2-WI, the post-treatment T2-WI MRI signal was re-scaled to the pre-treatment T2-WI volume using a simple histogram matching algorithm, which allowed for precise and true calculation of SI change after PS. Therapeutic response was categorized as 0=worse or unchanged, and 1=improvement based on clinical evolution after treatment. Clinical outcome assessment was also scored on a 7-point scale, ranging from -3 (worst) to +3 (maximum improvement), based on patient's perception of symptom improvement. Spearman's rank correlation coefficient (?) and Paired t-test were used for statistical analysis.

#### RESULTS

Eighty-one patients (mean age: 20±14 years; 47 females) with upper (23 lesions) and lower (58) extremity VMs underwent 125 PS treatments (range: 1-6). Different sclerosants were used: alcohol (52 sessions), bleomycin (38), and sotradecol (35). Most patients (77) reported clinical improvement following PS, including mild (8 patients), moderate (22), and significant (47) improvement. The mean change in lesion volume was  $-7.9 \pm 24.6 \text{ cm}^3$  ( $P=.005$ ) and in mean SI was  $-123.1 \pm 162.9$  ( $P<.001$ ). Overall, there was a significant correlation between change in lesion volume and treatment response ( $r=-.3$ ,  $P=.004$ ). On subgroup analysis, SI change correlated with clinical outcomes of VMs treated in one session ( $n=51$ ;  $r=-.3$ ,  $P=.01$ ), and VMs treated with bleomycin ( $n=22$ ;  $r=-.4$ ,  $P=.04$ ). While lesion volume change correlated with clinical outcomes of pediatric patients ( $n=50$ ;  $r=-.3$ ,  $P=.03$ ), VMs treated with sotradecol ( $n=17$ ;  $r=-.5$ ,  $P=.02$ ), and VMs located in the foot ( $n=10$ ;  $r=-.6$ ,  $P=.04$ ).

#### CONCLUSION

MRI radiomic features including lesion volume and signal intensity correlate with the clinical outcomes for peripheral VMs treated using PS.

#### CLINICAL RELEVANCE/APPLICATION

This study is first to investigate the relationship between signal intensity change of VMs and clinical outcome after PS. The study represents first step for application of complex, comprehensive radiomics in vascular malformations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPIR-5

### **Efficacy of 50% Acetic Acid Sclerotherapy for Treatment of Simple Renal Cysts - Comparison of 5-Minutes Dwell time Technique and 3-Minutes Dwell Time Technique**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

INKEON YEO, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare long term follow-up treatment results of single-session sclerotherapy for renal cyst using 50% acetic acid 3-minute dwell technique with those using 50% acetic acid 5-minute dwell technique.

#### **METHODS AND MATERIALS**

Total 101 simple renal cysts of 97 patients (M:F = 43:54, mean age -  $63 \pm 12.8$  years) underwent single-session 50% acetic acid sclerotherapy using less than 5 minutes (35 cysts, Group I) or 3 minutes (66 cysts, Group II) dwell technique in our institution. An acetic acid volume corresponding to a 5 ~ 40% (mean percentage- 13%) of the aspirated cyst volume was injected into the cysts and removed in less than 5 minutes or 3 minutes with position changes. Follow-up examination was performed using ultrasound or CT images at 3 to 6-months intervals for a minimum of 1 year. All patients were retrospectively reviewed on the therapeutic response and complications. The response was classified as either complete remission (volume reduction, = 95%), partial remission (volume reduction, 50-95%), or failure (volume reduction, = 50%).

#### **RESULTS**

In 97 simple renal cysts, complete remission on follow-up was observed in 22 of 35 cysts (62.9%) in group I and 46 of 66 cysts (69.7%) in group II. The partial remission on follow-up was observed in 11 of 35 cysts (37.1%) in group I and 20 of 66 cysts (30.3%) in group II. There was no failure in both groups. There were no statistically significant differences in the complete remission and partial remission between the two groups. There was mild post procedure complication in 25 patients, but no major procedure related complication.

#### **CONCLUSION**

Single-session 50% acetic acid sclerotherapy for the treatment of simple renal cysts using less than 3 minutes dwell technique is an effective and safe therapeutic option for simple renal cyst. 50% acetic acid sclerotherapy with a 3 minutes dwell time, using a volume of about 10% of the aspirated volume, is sufficient for satisfactory results of simple renal cyst sclerotherapy when compared with 50% acetic acid sclerotherapy using 5 minutes dwell time.

#### **CLINICAL RELEVANCE/APPLICATION**

50% acetic acid sclerotherapy show higher complete remission rate than any other ethanol one session sclerotherapy and, also show acetic acid sclerotherapy with 3 minute dwell time is sufficient for complete remission of renal cysts.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPIR-6

### Quantification and Analysis of Radiation Dose from Fluoroscopically Guided Prostate Artery Embolization Procedures

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Rasha S. Makkia, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantify patient radiation exposure during PAE and provide radiometric data to inform clinical decision-making regarding the radiation-related deterministic and stochastic risks versus the relative benefits of PAE.

#### METHODS AND MATERIALS

121 PAE procedures were performed between 2018 and 2021 at Yale New Haven Hospital, CT. The collected patient data followed an IRB-approved protocol, including age, height, body weight, and metal implants or contrast in the bladder during the procedure. Dosimetric data included total procedure time, total fluoroscopy time, Cumulative-Air-Kerma (CAK), Kerma-Area-Product (KAP) from fluoroscopy, and total KAP. These dosimetric data were analyzed using Radimetrics software (Bayer HealthCare, NJ). As a surrogate for stochastic risk, the effective dose from each PAE was computed by multiplying the total KAP using a conversion factor of  $0.11\text{mSv.Gy}^{-1}\text{.cm}^{-2}$  derived from values in published literature. PAE effective doses were then compared to abdominal-pelvic CT exams for patients who had individual abdominal-pelvic CTs. The CT effective dose was calculated by multiplying the DLP using the standard conversion factor of  $0.015\text{mSv.Gy}^{-1}\text{.cm}^{-1}$ . To account for patient size, for each patient, a ratio was derived between the effective dose from PAE and that from abdominal-pelvic CT. To examine the likelihood of deterministic effects, peak skin dose (PSD) calculations were performed for PAE patients with a CAK greater than 3Gy using an in-house Matlab algorithm (MathWorks, MA).

#### RESULTS

The average PAE procedure and fluoroscopy took 150 minutes and 37.1 minutes, accordingly. KAP and CAK had a mean value of  $280\text{Gy.cm}^2$ , and  $2.145\text{Gy}$ . The average effective dose from PAE fluoroscopy was 30.8 mSv and the effective dose from CT was 9.1mSv. The average ratio was 4.1; however, patients with CTs had a higher average PAE dose than patients without CTs due to greater use of CBCT, DSA, and larger field sizes in earlier patients. PSD was calculated for any PAE exam with a CAK greater than 3Gy. 12 exams had a CAK between 3 and 4Gy, 6 had a CAK between 4 and 5Gy and only 2 had a CAK greater than 5Gy. The maximum PSD calculations were 4Gy and 4.1Gy. There were no deterministic complications reported within 90 days after PAE.

#### CONCLUSION

This quantification data helps provide a standard for which clinicians can draw accurate judgments regarding the risks of PAE and can provide a standard for interventionalists to compare their own procedural radiation dosages during PAE.

#### CLINICAL RELEVANCE/APPLICATION

Benign prostatic hyperplasia is a worldwide health problem that significantly impacts men's quality of life. When radiation safety guidelines are followed, it offers effective treatment with a low risk of deterministic or stochastic radiation-related injuries.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPMK-1

### Shear Wave Elastosonography Applied to Synovitis: A Preliminary Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Salvatore Marsico (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to evaluate the utility of shear wave elastosonography (SWE) to identify synovitis in patients who had a history of arthritis within the diagnosis of a defined rheumatological disease.

#### METHODS AND MATERIALS

We performed a B-mode and SWE (US) to a total number of 58 participants divided in 2 groups: group 1 included 29 patients with confirmed active wrist and/or hand synovitis; group 2 included 29 healthy volunteers without suspicion of synovitis. In a subset of patients (n=8), the joint count and the rest of the disease evaluation were performed to the elastosonography to study the correlation between the clinical and radiological findings.

#### RESULTS

The difference in both the mean maximum kPa value and the average joint kPa value was statistically significant between cases and controls: maximum kPa value cases  $38.14 \pm 35.08$  kPa, controls  $4.72 \pm 5.93$  kPa; average joint value cases  $29.77 \pm 26.07$ , controls  $4.17 \pm 5.22$ . The most frequent place to find joint effusion in both cases and controls was the dorsal radiocarpal joint: 41.4% of controls, mean kPa value of  $7.66 \pm 5.39$  kPa, 58.6% of cases, mean kPa value  $40.61 \pm 40.76$  kPa (p-value 0.004). kPa values correlated with disease activity measurements in the 8 patients clinically evaluated at the moment of the SWE.

#### CONCLUSION

SWE is a promising technique that may have a role in the diagnosis and assessment of synovial inflammatory activity.

#### CLINICAL RELEVANCE/APPLICATION

New semiquantitative ultrasound technique in the diagnosis and in monitoring of therapy of synovitis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPMK-2

### Zero Time-to-Echo Imaging of the Hand and Wrist in Patients with Rheumatoid Arthritis: Comparison with Radiography and Conventional MRI using CT as Gold Standard

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Jun Tsukamoto, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Zero echo time (ZTE) imaging has been developed to detect signals from the objects with extremely short T2\* value, and this sequence can generate CT-like images from MRI after gray-scale inversion. The aim of this study is to compare ZTE imaging with radiography for the detection of hand and wrist bone erosions in patients with rheumatoid arthritis (RA), using CT as the reference method.

#### METHODS AND MATERIALS

The study was approved by the local ethics committee, and written consent was obtained from all patients. From December 2022 to April 2023, nine consecutive patients with RA were included in this prospective study. They underwent radiography, MRI at 3T (conventional T1-weighted and fat-suppressed T2-weighted imaging, and ZTE imaging), and CT of the bilateral hand and wrist on within 2 weeks. MRI evaluation was performed according to the Outcome Measures in Rheumatology Clinical Trials (OMERACT) recommendations. Two certificated radiologists evaluated the images from the three imaging modalities. Bone erosion on images was independently reviewed by the 2 certificated radiologists with a four-point scale (0; normal, 1; discrete erosion, 2; less than 50% of the joint surface, 3; more than 50% of the joint surface). The images were evaluated for bone erosion in 25 sites in each finger and wrist, including the distal radius, the distal ulna, the 8 carpal bones, the first through fifth bases of metacarpal bones, and the proximal and distal aspects of first through fifth metacarpophalangeal joints. One experienced musculoskeletal radiologist performed the CT evaluation and set the findings as gold standard.

#### RESULTS

With CT as the reference method for bone erosions, the sensitivity and specificity of plain radiography, conventional MRI, and ZTE were 51.6/95.3%, 71.1/90.4%, and 93.8/96.3%, respectively. Overall diagnostic performance was significantly better at ZTE than at radiography and conventional MRI images ( $P < .01$ ). Interobserver agreement on bone erosion assessment was excellent for ZTE imaging ( $\kappa$  value of 0.815) but was not excellent for radiography ( $\kappa$  value of 0.496) and conventional MRI ( $\kappa$  value of 0.648).

#### CONCLUSION

Zero time-to-echo imaging can provide reliable bone erosion assessment in RA patients.

#### CLINICAL RELEVANCE/APPLICATION

Zero time-to-echo imaging is superior to plain radiography and almost comparable to CT for the detection of bone erosion in RA patients. It can be readily incorporated into the clinical workflow in addition to conventional MRI.

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## Abstract Archives of the RSNA, 2023

S3A-SPMK-3

### Ultra-high-resolution Photon-counting Detector CT Arthrography of the Ankle: A Feasibility Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Karsten S. Luetkens, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assessing the stability of chondral lesions represents a crucial diagnostic imaging task in musculoskeletal imaging, as chondral delamination and subchondral pathologies may not be visible in direct arthroscopy but impact therapeutic concepts. This study was designed to investigate the image quality of ultra-high-resolution ankle arthrography employing photon-counting detector CT.

#### METHODS AND MATERIALS

A board-certified radiologist with nine years of experience in musculoskeletal imaging performed bilateral ankle arthrographies in all four cadaveric specimens using ultrasound for guidance. Bilateral arthrograms were acquired in four cadaveric specimens with full-dose (10 mGy) and low-dose (3 mGy) scan protocols. Three convolution kernels with different spatial frequencies were utilized for image reconstruction (?50; Br98: 39.0, Br84: 22.6, Br76: 16.5 lp/cm). Seven radiologists subjectively assessed image quality regarding the depiction of bone, hyaline cartilage, and ligaments. Additional quantitative assessment comprised the measurement of noise and computation of contrast-to-noise ratios (CNR).

#### RESULTS

While optimal depiction of bone tissue was achieved with the ultra-sharp Br98 kernel ( $p=0.043$ ), visualization of cartilage improved with lower modulation transfer functions at each dose level ( $p=0.014$ ). Interrater reliability was good to excellent for all assessed tissues (intraclass correlation coefficient = 0.805). Noise levels in subcutaneous fat decreased with reduced spatial frequency ( $p<0.001$ ). Notably, low-dose Br76 matched CNR of full-dose Br84 ( $p>0.999$ ) and superseded Br98 ( $p<0.001$ ) in all tissues. No dose-dependent difference was ascertained for any of the tissues with Br98 ( $p > 0.999$ ).

#### CONCLUSION

Based on the reported results, photon-counting detector CT arthrography of the ankle with ultra-high-resolution collimation offers stellar image quality and tissue assessability. While bone depiction was found to be superior in combination with an ultra-sharp convolution kernel, soft tissue evaluation benefited from employing lower spatial frequency.

#### CLINICAL RELEVANCE/APPLICATION

Photon-counting detector CT arthrography is feasible and allows for depicting even minute anatomy at low radiation dose. The inherent advantages regarding imaging of thin layers of hyaline cartilage ought to be pursued further.

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## Abstract Archives of the RSNA, 2023

S3A-SPMK-6

### Frequency of Peroneal Compartment Pathology in a Large Series of Ankle MRIs from a Tertiary Care County US Hospital: Imaging-based Epidemiological Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Muhammad R. Akram, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Peroneal compartment pathology is a frequently misdiagnosed finding or underdiagnosed as simple ankle ligament sprains in patients presenting to the healthcare system with ankle injuries. High-resolution magnetic resonance imaging allows timely identification of these injuries for outlining appropriate treatment. However, these lesions have been studied in only a few small case series, convenient samples, or review articles. The aim of this study was to elucidate the frequency of peroneal compartment pathology in a large series of patients presenting for ankle MRIs with ankle pain and/or injury in our tertiary care county system with the hypothesis that peroneal lesions are a frequent finding.

#### METHODS AND MATERIALS

A consecutive series of 373 patients with suspected ankle internal derangement at a tertiary care county hospital (ages 13-87 years, all genders) were included. All had undergone 3 Tesla ankle MR imaging with standardized institutional MR imaging protocols. The structured reports were data-mined, and all scans were re-reviewed by a fellowship-trained musculoskeletal radiologist. Any scans performed for tumors or infections were excluded. The scans were re-analyzed for peroneal longus (PL) and peroneal brevis (PB) tenosynovitis and tendinopathy using previously described criteria for pathology in the literature. Descriptive statistics were performed.

#### RESULTS

There were 404 MRIs from 373 patients, with 292 MRIs (72.3%) from 267 females and 112 MRIs (27.7%) from 106 males. Only 98 (24.3%) MRIs had normal peroneal compartments, and 306 MRIs (75.7%) had ankles with peroneal findings. There were 51 (12.6%) cases of PB tenosynovitis, 57 (14.1%) cases of PL tenosynovitis, 148 (36.6%) cases of PB tendinopathy, 239 (59.2%) cases of PL tendinopathy, 95 (23.5%) partial PB tendon tears, 8 (2.0%) partial PL tendon tears, 2 (0.5%) complete PB tendon tears, and 1 (0.2%) complete PL tendon tear. Peroneal longus tendinopathy was the most common finding.

#### CONCLUSION

Peroneal compartment pathology is frequent on high-resolution 3T ankle MRIs performed for internal derangements.

#### CLINICAL RELEVANCE/APPLICATION

The ankle MRI reader should pay close attention to peroneal compartment lesions while evaluating for ankle derangement, as these lesions are frequent.

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## Abstract Archives of the RSNA, 2023

S3A-SPMK-7

### Clinical Application of a Deep Learning Model for Osteoporosis Screening using Chest X-rays Taken During Lung Cancer Screening

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

YOICHI SATO, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The number of patients suffering from age-related osteoporosis is increasing worldwide. In Japan, osteoporosis screening is conducted in municipalities throughout the country for early detection and treatment, but the screening uptake rate remains at around 5%. To address this issue, we developed a deep learning model to test for osteoporosis from chest X-rays as a new screening method. In Japan, approximately 40 million people undergo lung cancer screening annually, which includes chest X-rays. We focused on this point and conducted a demonstration experiment, believing that it would be possible to screen a large number of citizens for osteoporosis by simultaneously assessing osteoporosis using chest X-rays taken during lung cancer screening.

#### METHODS AND MATERIALS

The demonstration was conducted in a medium-sized city in Japan with a population of 80,000 from Apr 2022 to Apr 2023. In this city, a medical association was contracted by the local government to conduct lung cancer screening. The examinees had chest X-rays taken at 25 clinics in the city. The chest X-rays are then sent to the medical association's health checkup center for secondary reading. We installed an AI algorithm at the center and performed AI analysis on the chest X-rays of the examinees who had given their consent in advance. The examinees who were found to be in need of further examination (YAM<80%) visited an orthopedic hospital in the city and underwent a bone density test using the DEXA method. Based on the examination and test results, medication was started for those examinees who needed therapeutic intervention. The study obtained the number of people who underwent lung cancer screening, the number of people who consented to AI analysis, the number of people who required inspection, the number of people who visited orthopaedic clinics, and the number of people diagnosed and treated for osteoporosis.

#### RESULTS

5,290 patients underwent lung cancer screening. Of these, 3,324 patients consented to AI analysis, excluding those already undergoing osteoporosis treatment. Of these, 1,848 patients required further examination. After examination and DEXA, 497 patients were diagnosed with osteoporosis, and treatment was initiated.

#### CONCLUSION

The study suggested the usefulness of screening for osteoporosis using chest X-rays taken during lung cancer screening.

#### CLINICAL RELEVANCE/APPLICATION

The conventional osteoporosis screening examined 185 individuals yearly. By utilizing chest radiographs for screening, 3,324 people could be screened, roughly 18 times more. This method detected about 497 osteoporosis patients, enabling treatment initiation. It's estimated that this approach could prevent 16 hip fractures and reduce medical and nursing care costs by about 29 million yen.

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## Abstract Archives of the RSNA, 2023

S3A-SPMK-8

### Application of a Deep Learning Algorithm in Detection of Hardware Complications for the Post-Operative Hip

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Jin Rong Tan, MD, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

The most common mechanical failure in the internal fixation of trochanteric hip fractures is the cutout of the sliding screw through the femoral head, with the incidence ranging from 0 to 16.5%. Radiography remains the mainstay for evaluation, both in the immediate postoperative period and at long-term follow-up. The clinical and radiological progression of hardware complications including cutout is often insidious, and can be missed especially in limited resource settings. There is relatively limited literature on the application of deep learning to assess hardware complications on radiographs. Hence, we aim to evaluate the performance of a deep convolutional neural network (DCNN) in detecting and localising implant cutout on plain frontal pelvic radiographs.

#### METHODS AND MATERIALS

A DCNN was developed using 32,152 pelvic radiographs containing fixation hardware acquired from the emergency department and orthopaedic clinics between January 2016 and December 2020, of which 24,114 and 8,038 were allocated for training (75%) and validation (25%) sets respectively. Presence of cutout was defined as protrusion of the fixation hardware beyond the cortical margins. To determine ground truth labels (cutout present or absent), all radiographs were individually read by 2 board-certified consultant musculoskeletal subspecialty radiologists blinded to the accompanying radiology reports. In doubtful cases, the accompanying report and all imaging performed in the following 6 months were reviewed. Final decision was made by consensus between the 2 musculoskeletal radiologists. Algorithm performance was evaluated with a hold-out test dataset of 8,039 radiographs of which 53 (0.66%) were positive for cutout. The authors also used the visualization algorithm gradient-weighted class activation mapping (Grad-CAM) to assess localization accuracy.

#### RESULTS

The algorithm achieved an accuracy of 99.5%, a sensitivity of 83%, a specificity of 99.6%, and an AUC of 0.992 for identifying implant cutout. The visualization algorithm showed an accuracy of 25%. Of the 44 true positive cases accurately predicted, there were 11 (25%) instances where the model correctly identified an activation site.

#### CONCLUSION

A DCNN can detect implant cutout on PXR with a high accuracy and might assist clinicians to assess the presence of post-operative hardware complications including implant cutout. However, the visualization algorithm is unable to accurately localize the site of cutout; this is work in progress at time of abstract submission

#### CLINICAL RELEVANCE/APPLICATION

A DCNN can detect implant cutout on PXR with a high accuracy and might assist clinicians to assess the presence of post-operative hardware complications including implant cutout.

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## Abstract Archives of the RSNA, 2023

S3A-SPMS-1

### Metabolic Outcomes of Aging and Obesity: A Longitudinal Study of the Dallas Heart Study Cohort

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Parker Davis, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to examine the metabolic risk factors in the longitudinal Dallas Heart Study (DHS) cohort. The baseline exam (DHS1) was conducted in 1999-2000, and the current 3rd phase exam (DHS3) has been enrolling since 2020.

#### METHODS AND MATERIALS

Subjects underwent a multi-2D axial T2-weighted spin-echo abdominal MRI (10mm axial section) in DHS1 on Philips 1.5T Intera at the baseline exam and a 3D volumetric T1-weighted gradient-echo whole-body MRI (5mm axial section) in DHS3 on Siemens 3T Prisma. Based on the DHS1 data, manual fat segmentation was previously completed on a single slice at L2-L3 measuring subcutaneous (SAT) and visceral (VAT) cross-sectional areas. On the DHS3 images, fat segmentations were performed on the same slice location corresponding with the subject's DHS1 segmentation. Changes in the segmented SAT and VAT areas between DHS1 and DHS3 were calculated. Subjects' height, weight, and serum laboratory values (lipids, cholesterol, glucose, and insulin) were collected for DHS1 and -3 exams, from which metabolic syndrome (MetS) risk factors were recorded (waist circumference  $\geq 88$ in for women,  $\geq 102$ in for men; blood pressure  $\geq 130/85$ ; LDL  $\geq 130$ ; HDL  $\leq 50$  for women,  $\leq 40$  for men; total cholesterol  $\geq 200$ ; triglycerides  $\geq 150$ ; fasting glucose  $\geq 100$ ; HOMA-IR  $\geq 2.73$ ) for both time points, and metabolic health was categorized as unhealthy ( $\geq 3$  risk factors) or healthy ( $\leq 3$  risk factors). The association between metabolic health and abdominal adiposity (SAT and VAT) was assessed using logistic regression, adjusting for age and sex as covariates.

#### RESULTS

192 subjects from the original DHS1 cohort have thus far returned for DHS3 examination. The median age of this interim cohort is 64 years (43 years at baseline). Over the 21 years, the median weight gain was +3.2 [interquartile range, -3.3, +9.3]kg, BMI gain +1.3 [-0.6, +3.6]kg/m<sup>2</sup>, SAT change +82 [18, 154]cm<sup>2</sup>, VAT change +33 [-9, +69]cm<sup>2</sup>. The prevalence of MetS increased from 53.6% to 63.3%, with 53.9% of previously metabolically healthy subjects becoming metabolically unhealthy in the interim, whereas 29.1% of previously metabolically unhealthy subjects became metabolically healthy. After adjustment for age and sex, VAT, but not SAT, was consistently associated with MetS over 20 years of aging. Gain in VAT was also associated with interval development of MetS in previously metabolically healthy subjects.

#### CONCLUSION

Visceral fat, rather than subcutaneous fat, is consistently associated with MetS through aging, and the gain in visceral fat is associated with the development of MetS.

#### CLINICAL RELEVANCE/APPLICATION

Our preliminary finding in this 20-year longitudinal cohort further strengthens the evidence that visceral fat is implicated in metabolic health.

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## Abstract Archives of the RSNA, 2023

S3A-SPNMMI-2

### Clinical Impact of Digital PET/CT Compared to Conventional PET/CT in Patients with Malignant Tumor for Initial Staging

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Naoto Kawaguchi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Digital PET/CT (dPET) systems have improved the detection of small lesions by increasing spatial and temporal resolution and have the potential to allow for accurate staging in patients with malignant tumor. The purpose of this study is to compare <sup>18</sup>F-fluorodeoxyglucose (FDG) uptake of lesions and the diagnostic performance for initial disease staging of the dPET with conventional PET/CT (cPET).

#### METHODS AND MATERIALS

Between April and August 2020, 60 patients (mean age, 66±13 years; 31 males) with malignant tumors underwent a single FDG injection and both dPET and conventional cPET with a randomized scan order. We measured the maximum standardized uptake values (SUVmax) in up to 5 FDG-positive lesions per patients and compared them between the two scanners. Furthermore, two experienced readers independently diagnosed the initial disease staging using the TNM score (The eighth edition of the Union for International Cancer Control) or Lugano classification on both PET imaging. Cases of inconsistency between the two readers were finally determined by the third experienced reader. The final staging results for the two PET modalities were compared with the pathological diagnosis. The institutional ethics committee approved this study protocol in accordance with the ethical guidelines of the Declaration of Helsinki, and all patients provided informed consent.

#### RESULTS

One hundred and twenty-three lesions were analyzed. 14 lesions could only be measured only with dPET. In the remaining 109 lesions, SUVmax was significantly higher on the dPET compared to the cPET (12.0±7.8 vs. 8.5±7.0, p<0.01). Especially in 36 lesions less than 10 mm in diameter, the SUVmax with the dPET was higher in all lesions. 8 of the 60 cases showed differences in staging between the two PET modalities. dPET detected new lymph node metastases in five cases and bone metastasis in one case compared to cPET, four were true positives and two were false positives. Otherwise, the N-factor was changed in two cases on dPET compared to cPET, but one was true negative, and one could not be judged pathologically.

#### CONCLUSION

Our study showed that the dPET can better detect small lesions compared to cPET. dPET can have an impact on the diagnosis of metastasis in the initial staging of malignant tumor compared to cPET.

#### CLINICAL RELEVANCE/APPLICATION

New digital PET/CT can have a big impact on the diagnosis of metastasis in the initial staging of malignant tumor.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNPM-1

### **Increasing Cost-effectiveness of CT-based Mobile Stroke Units in Germany: A Model-based Economic Analysis**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Johann S. Rink, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To analyze the design of Computed Tomography (CT) based Mobile Stroke Unit (MSU) programs and operating modes in order to identify major determinants and cut-offs that help improve cost-effectiveness and enable large-scale implementation of MSUs.

#### **METHODS AND MATERIALS**

Costs of different possible operating modes, varying operating hours including weekend and non-weekend coverage, and personnel were simulated for the German healthcare system. Ischemic stroke incidence, circadian distribution, rates of alternative diagnoses and stroke mimics were included as well as missed cases to model case coverage and patient-level costs in acute stroke care. Based on internationally reported stroke outcomes, a 5-year Markov-Model was used to analyze cost-effectiveness outcomes for varying catchment zone populations.

#### **RESULTS**

For a catchment zone of 400,000 inhabitants, the 7-day/16-hour MSU coverage resulted in the lowest cost of MSU deployment per ischemic stroke (USD 5,667) whereas the 7-day/24-hour model caused the highest costs (USD 8,285). Comparing stroke care delivered by MSU to regular emergency medical services, MSU achieved an incremental 0.06 quality-adjusted life years (QALY) on average, with an incremental cost-effectiveness ratio of USD 37,348 per QALY. Sensitivity analyses revealed that a catchment zone population below 400,000 inhabitants together with the effect of missing stroke cases at dispatch significantly increased patient-level costs of MSU care.

#### **CONCLUSION**

When setting up prospective MSU programs, cost-effectiveness can be addressed by taking into account major determinants of MSU operation: For the German healthcare system, the catchment zone should cover at least 400,000 inhabitants and operating modes should include weekend coverage and 12 to 16 hour daytime coverage. Measures to reduce the rate of missed strokes are advised.

#### **CLINICAL RELEVANCE/APPLICATION**

The economic evaluation of MSU programs aiming at identifying major determinants and thresholds could optimize efficient resource allocation and maximize MSU cost-effectiveness.

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## Abstract Archives of the RSNA, 2023

S3A-SPNPM-2

### Economic Impact in the MRI Department using Artificial Intelligence in MRI Acquisitions

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Patricia M. Carrascosa, MD, PhD (*Presenter*) Speakers Bureau, General Electric Company

#### PURPOSE

The objective of this work is to project the economic impact of the use of Artificial Intelligence (AI) in an MRI scanner of our institution that has a high demand of scheduled studies between 8 AM to 8 PM. We previously performed an optimization of protocols and validated the new algorithm with AI in terms of image quality and diagnostic accuracy versus conventional studies determining the new time duration of the studies.

#### METHODS AND MATERIALS

During one month we worked with AI system (AIR Recon DL, GE) in two 3T MRI scanners (Signa Architect; GE) in order to obtain the best sequences in terms of image quality, signal to noise and time duration of the studies. After finishing that phase we performed a research comparing the new length time for the sequences and agenda times for each study type, image quality and diagnostic accuracy between two experienced observers to analyzed AI and conventional studies of the same patient respectively. Results have shown no differences regarding diagnosis and image quality but with a significant reduction in scanning times. With that information we will project the economic impact of using AI system in the two scanners per month. The time reduction of the studies varied according to the region. We calculated according to the normal distribution of studies the total minutes regarding each type, we projected the new duration time applying AI, the gained difference in minutes and the additional studies that could be carried out. We calculated the increment in the percentage regarding the number of studies performed in the same time range and also in relation to the total number of patients.

#### RESULTS

The most required studies at our centers were selected for the projection (knee, spine and brain MRI scans). Both scanning times and the assigned agenda time were reduced significantly using AI. The mean scan time without AI technology was 10.3 minutes, while using AI technology was 5.7 minutes. The mean assigned agenda time without AI technology was 16.6 minutes, while using AI technology was 10 minutes. The time reduction in the projected studies allowed to be able to perform a 638,5 more studies in both scanners in the same time that only 1111 were done. This corresponds to an increment of 57,64% .The global impact regarding the total scanners production would be a 36,6%.

#### CONCLUSION

AI in MR is an excellent opportunity to increment the number of studies in centers with high demand and delayed accessibility .In this projection selecting only the more frequent studies required we could project an increment of 35 % in our monthly billing.

#### CLINICAL RELEVANCE/APPLICATION

Artificial intelligence in MRI scan opens new horizons in terms of image quality, patients experience and cost effectiveness of the MRI department

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNPM-3

### Testing the Ability of ChatGPT to Generate Differential Diagnoses from Transcribed Radiological Findings in Chest and Cardiac Imaging

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of specific chest and cardiac radiology cases.

#### METHODS AND MATERIALS

A sample of 52 cases from adult and pediatric chest and cardiac imaging were evaluated. Cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

#### RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 57.7% compared to 69.2% ( $p=0.11$ ) and 11.5% compared to 15.4% ( $p=0.28$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 48.1% compared to 55.8% ( $p=0.21$ ). ChatGPT3.5 and ChatGPT4 hallucinated 34.2% versus 9.6% ( $p=0.001$ ) of the references provided and generated 10 total false statements versus 4 total false statements, respectively.

#### CONCLUSION

The two generations of ChatGPT were able to generate a differential diagnosis for prompts containing descriptive radiological findings. The contents of these responses matched the expert literature from which the cases originated a minority of the time, though a non-statistically significant improvement was made in the accuracy categories from 3.5 to the 4th generation algorithm. The well-known hallucination effect was encountered more commonly in citations produced than in statements made by the algorithm, both of which improved with the newest generation.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) have a large potential to impact clinical and educational medicine. Knowledge of the accuracy and erroneous possibilities of these algorithms will provide a better understanding of the limitations of these new tools.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNR-1

### Causal Associations of Genetically Determined Tinnitus with Neuroimaging Traits: Evidence from a Mendelian Randomization Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Jing Sun, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Potential reverse causality and unmeasured confounding factors are common biases in previous studies of the relationship between tinnitus and neuroanatomical features. Additionally, the causal association between neuroimaging features and the presence of tinnitus is unclear. The aim of this study was to investigate the causal role of tinnitus in the alteration of brain volumetric measures using Mendelian randomization (MR).

#### METHODS AND MATERIALS

Summary-level data from a genome-wide association study (GWAS) of tinnitus were derived from the UK Biobank ( $n = 117,882$ ). GWAS summary statistics for total brain volume, white and gray matter volume and cerebrospinal fluid volume were also obtained ( $n = 33,224$ ). A bidirectional MR analysis was performed to investigate the causal relationship between tinnitus and neuroanatomical features.

#### RESULTS

Genetic susceptibility to tinnitus was causally associated with increased white matter volume (odds ratio [OR] = 2.36, 95% confidence interval [CI] 1.03-5.39,  $p = 0.04$ ) and total brain volume (OR = 2.39, 95% CI 1.05-5.46,  $p = 0.04$ ) but inversely associated with cerebrospinal fluid volume (OR = 0.36, 95% CI 0.16-0.83,  $p = 0.02$ ). However, no causal effect of total brain volume, white matter volume, gray matter volume, or cerebrospinal fluid volume on the presence of tinnitus was detected in the reverse MR study.

#### CONCLUSION

The genetically predicted risk of tinnitus was causally associated with higher white matter volume and total brain volume, independent of any confounding factors, while neuroanatomical features were not causally associated with the presence of tinnitus. Our findings provide evidence supporting the hypothesis that tinnitus has a neurodevelopmental origin at the genetic level.

#### CLINICAL RELEVANCE/APPLICATION

Our findings provide evidence supporting the hypothesis that tinnitus has a neurodevelopmental origin at the genetic level, further elucidating the underlying pathophysiological mechanisms of tinnitus-related brain anatomical impairment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNR-10

### Improving Image Quality of Skull Base with Volume High Definition Reconstruction in a Wide-detector CT System

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yanan Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the image quality improvement for the skull base with a volume high definition (VHD) reconstruction algorithm on a 16cm wide-detector 256-row CT.

#### METHODS AND MATERIALS

Prospectively enrolled 40 adults (Group 1) for non-enhanced head CT on a 16cm wide-detector 256-row Revolution CT scanner. The CT numbers and their standard deviation (SD) of Medulla Oblongata, cerebellum, brain stem, basal frontal lobe and centrum ovale (used as background) were measured to calculate signal to noise ratio (SNR) and artifact index (AI):  $AI = \sqrt{SD^2(ROI) - SD^2(\text{centrum ovale})}$ . These values were compared with those of 40 adults in Group 2 who underwent a non-enhanced head CT on a 64-row VCT. All subjects were scanned with a protocol of 120 kVp, and 1.0s rotation time. The tube currents were adjusted to have similar CT dose index (CTDI) for the two systems.

#### RESULTS

There was no statistical difference in the age, thickness of occipital tuberosity, anteroposterior or trans diameters between the two groups. Compared with 64-row CT, the image noise (in HU) with the 256-row CT was reduced by 27% ( $4.39 \pm 0.68$  vs.  $6.00 \pm 1.10$ ) at the Medulla Oblongata, 24% ( $4.48 \pm 0.51$  vs.  $5.86 \pm 0.57$ ) at cerebellum, 33% ( $4.14 \pm 0.51$  vs.  $6.17 \pm 0.74$ ) at brain stem, 39% ( $3.84 \pm 0.58$  vs.  $6.30 \pm 1.19$ ) at the basal frontal lobe and 28% ( $3.16 \pm 0.37$  vs.  $4.36 \pm 0.42$ ) at centrum ovale. This resulted in an increase of 43%, 42%, 76% and 65% in SNR in the four regions, respectively. In addition, the artifacts index was significantly reduced with 256-row CT by 25% ( $2.95 \pm 0.95$  vs.  $3.93 \pm 1.61$ ) at Medulla Oblongata, 20% ( $3.05 \pm 0.93$  vs.  $3.83 \pm 0.88$ ) at cerebellum, 40% ( $2.54 \pm 0.92$  vs.  $4.26 \pm 1.14$ ) at brain stem, and 54% ( $2.00 \pm 1.14$  vs.  $4.33 \pm 1.83$ ) at the basal frontal lobe.

#### CONCLUSION

The CT image quality of the skull base in terms of noise and artifacts was significantly improved on a 256-row wide-detector CT with VHD reconstruction algorithm, compared with a 64-row system at similar radiation dose.

#### CLINICAL RELEVANCE/APPLICATION

Improved images of the skull base can be obtained on a wide-detector CT with VHD to overcome physical challenges such as cone beam and scattering, when keeping similar dose to 64-row CT.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3A-SPNR-11

### Geniculate Ganglion Diverticulum: A Novel MRI Finding in Patient with Idiopathic Intracranial Hypertension

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ahmed Abdelmonem, MD, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

While patients with idiopathic intracranial hypertension (IIH) typically present with headache and/or visual disturbance, pulse-synchronous tinnitus (PST) and hearing loss can be the primary manifestations of this condition in a group of patients. The correct diagnosis for this group can be delayed. Although several MRI signs have been previously described to be associated with IIH, none have been proven to have a high positive predictive value (PPV). In this study, we tested the hypothesis that the presence of the geniculate ganglion diverticulum (GD) is a novel marker for the detection of IIH.

#### METHODS AND MATERIALS

This is an IRB-approved single institution retrospective observational study. Brain MRI exams of patients referred by Otolaryngology division over the period of 10 years were reviewed. 400 MRI exams fulfilling inclusion and exclusion criteria were screened for presence of GD by two Neuroradiology fellows independently. In cases of discrepancy in image interpretation, an agreement was reached by reviewing images jointly. A matched control group of cases without GD was compiled. Brain MRI studies of all patients in this study were reviewed for presence of an "empty" sella appearance (ES), a known MRI sign of IIH. Electronic medical records of patients in this study were reviewed for presence of clinical manifestations of IIH. Receiver operator characteristic (ROC) curves were generated to estimate accuracy of each covariate in diagnosing IIH. Area under each ROC curve (AUC) was calculated to identify an accurate prognostic covariate. Statistical analysis was done using R programming language V 4.2.2.

#### RESULTS

GD was visualized in MRI exams of 41 patients. GD was not present in the MRI exams of 359 patients. 61 patients were randomly selected from group of 359 patients that did not have GD. A total of 102 patients were included in this study. Studied groups had no significant differences in terms of age, gender, and BMI. GD and ES have a statistically significant correlation with IIH (P-value: < 0.001). There was no correlation between PST and GD (P-value: 0.83). Presence of unilateral or bilateral GD has a similar correlation with IIH (P-value: < 0.001). AUC based on GD for predicting IIH was 0.84 (0.79- 0.89) and based on ES was 0.93 (0.89- 0.96). Negative predictive value of both GD and ES for IIH was 100%. PPV of GD for IIH was 31% and this value for ES was 52%.

#### CONCLUSION

There was a statistically significant correlation between the presence of GD and the presence of IIH. There was no statistically significant correlation between the presence of GD and the presence of PST.

#### CLINICAL RELEVANCE/APPLICATION

The presence of GD should raise the possibility of IIH, particularly in patients presenting with otologic manifestations such as PST and low-frequency hearing loss.

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## Abstract Archives of the RSNA, 2023

S3A-SPNR-13

### Treatment Response Prediction in Major Depressive Disorder using Brain Magnetic Resonance Imaging: A Systematic Review and Meta-analysis

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Fenghua Long (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantify the value of brain magnetic resonance imaging (MRI) in predicting major depressive disorder (MDD) treatment efficacy and to assess performance variations among interventions and biomarkers.

#### METHODS AND MATERIALS

We searched eligible studies in PubMed, Embase, Web of Science, and Science Direct databases before March 22, 2023, using keywords "depress\*", "major depress\*", "MDD", "treatment outcome", "remission", "response", and "MRI". Information including individuals as responders/remitters or non-responders/non-remitters, sensitivity, and specificity were extracted. Logarithm of diagnostic odds ratios [log(DOR)] was summarized, and forest plot was drawn. Sensitivity and specificity were conducted using Reitsma's random effect model. Area under curve (AUC) of summary receiver operating characteristic (SROC) curve was calculated. We conducted Deek's funnel plot asymmetry test to evaluate impact of publication bias. Subgroup analyses were conducted based on MRI modalities (structural MRI [sMRI], resting-state functional MRI [rs-fMRI], task-based fMRI [tb-fMRI]) and interventions (antidepressant and electroconvulsive therapy [ECT]). Antidepressants were subdivided into selective serotonin reuptake inhibitors (SSRI) and mixed medication groups. Meta-regression was conducted among subgroups.

#### RESULTS

We included 44 studies with 2623 MDD participants. Overall, the SROC AUC was 0.875, sensitivity was 77.1%, specificity was 74.1%, and log(DOR) was 2.381. Deek's test indicated a negative correlation between effective sample size and log(DOR) ( $P = 0.008$ ). Rs-fMRI subgroup had higher predictive performance (79.3% sensitivity, 78.2% specificity, AUC 0.891) than tb-fMRI subgroup (74.9% sensitivity, 68.9% specificity, AUC 0.854) in terms of specificity in predicting treatment efficacy ( $P = 0.01$ ). No significant difference was found between sMRI and other modalities. No significant predicting differences were found in antidepressants and ECT, or among ECT, SSRI, and mixed group. Brain biomarkers located in limbic system and frontal were more frequently revealed contributing to prediction in antidepressant subgroup, such as functional connectivity between amygdala and anterior cingulate cortex, while those for ECT were often located in limbic system.

#### CONCLUSION

Brain MRI has potential to predict MDD treatment efficacy, with rs-fMRI showing higher predictive performance. No significant difference were found between different interventions, but brain biomarkers located in limbic system and frontal lobe may provide clinical relevance.

#### CLINICAL RELEVANCE/APPLICATION

Brain MRI biomarkers can predict treatment efficacy of MDD, reducing the financial burden, time of trial, and poor prognosis for patients.

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## Abstract Archives of the RSNA, 2023

S3A-SPNR-14

### Comparative Analysis of Normative Brain Structural Volumes Between Singapore (SG) and Caucasian Population

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Chi Long Ho, MD, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

Structural brain volumes vary due to differences in age, gender [males(M), females(F)], geographical location and ethnicity. Currently, MNI is most widely used brain template but it is limited to young/healthy Western population and not representative of other populations. We aim to compare differences between SG Chinese and Caucasian (Cau) brain volumes to address the need for age, gender-and-ethnicity-specific brain templates for accurate stereotactic standardization across structural brains from different individuals. Our aim is also to build a brain volumetry database for SG Chinese population (for now), which is currently lacking in Singapore.

#### METHODS AND MATERIALS

Retrospective T1W MPRAGE brain (N:248) gathered from Parkinson's Progression Markers Initiative (PPMI-Caucasian) database and SG data (N:360) obtained from Sengkang General Hospital. FastSurfer (v2.0.4) used for brain segmentation into 21 regions (some left and right regions combined); brain volumes were normalized using total intracranial volume. Subjects divided into 5 age-groups: 31-40, 41-50, 51-60, 61-70, 71-80 years. If > 2 outliers were present, subjects were removed while the rest of outliers imputed with median (age-and-gender-matched). Wilcoxon tests (Bonferroni corrected) used for comparisons between SG and Cau.

#### RESULTS

In 41-50 age-group, SG(M) have significantly greater cerebral white-matter than Cau(M), but the reversed is true for lateral ventricular volumes, while SG(F) have greater thalamus than Cau(F). SG(M+F) 51-60 age-group have significantly greater 3rd ventricle while SG(M) 71-80 age-group have greater inferior lateral ventricle and CSF compared to Cau(M). In SG 41-50 age-group, M have significantly smaller caudate, pallidum, sub-cortical gray matter, cortex, cerebellum white matter, corpus callosum, cerebellum cortex, total gray matter, hippocampus, putamen, and thalamus than F. In SG 51-60 age-group, M have significantly greater 3rd ventricles than F while reversed is true for cerebellum white matter. In SG 71-80 age-group, M have significantly smaller caudate than F.

#### CONCLUSION

There are differences in brain structure/volumes between SG and Cau across ages and gender. Building an age, gender-and-population-specific brain volumetry database is paramount to ensure accurate comparison and greater accuracy during brain registration, especially if comparison to neurological diseased states has to be made.

#### CLINICAL RELEVANCE/APPLICATION

Normative brain volumetry database for specific age-group, gender and ethnicity ensures reliable differentiation of healthy from neurological diseased brains for early diagnosis and interventions.

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## Abstract Archives of the RSNA, 2023

S3A-SPNR-2

### Brain Functional Connectivity Alterations in the Depressed Adolescents with Suicide Behaviors

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Wei Peng (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate abnormalities of brain functional connectivity (FC) in both gray matter (GM) and white matter (WM) of depressed adolescents with suicide behaviors.

#### METHODS AND MATERIALS

Participants included 38 depressed adolescents with suicide behaviors (SA) and 28 healthy control (HC) subjects. FC differences in both gray and white matters between the two groups were identified at whole brain level with FDR corrected, based on resting-state blood oxygenation level-dependent signals. Correlation analyses were further conducted to explore the relationships between FCs and cognitive ability reflected by Wisconsin card sorting test.

#### RESULTS

Age and gender were well matched between two groups (SA mean age =14.8, HC mean age =15.0; 6males and 32 females in SA, 8 males and 20 females in HC). Compared to HC, SA group presented lower FCs in left orbitofrontal area-middle cerebellar peduncle (GM10WM22,  $t=5.43$ ), left orbitofrontal area-right superior cerebellar peduncle (GM10WM45,  $t=5.28$ ), left orbitofrontal area-right corticospinal tract (GM10WM48,  $t=5.18$ ), left ventral posterior cingulate cortex-left sagittal stratum (GM18GM13,  $t=4.47$ ), right ventral posterior cingulate cortex-left sagittal stratum (GM65WM13,  $t=4.55$ ), right associative visual cortex-left sagittal stratum (GM69WM13,  $t=3.57$ ), right primary visual cortex-left sagittal stratum (GM71WM13,  $t=4.79$ ), right superior temporal gyrus-left internal capsule (GM66WM8,  $t=4.00$ ), left middle temporal gyrus-left superior corona radiata (GM16WM10,  $t=6.91$ ), right anterior prefrontal cortex-right tapetum (GM73WM28,  $t=3.56$ ), left cingulate gyrus-right tapetum (WM15WM28,  $t=3.47$ ), and left orbitofrontal area-right tapetum (GM10WM28,  $t=4.95$ ). Correlation analyses further revealed that, FCs in GM18WM13 and GM65WM13 were positively associated with the percentage of correct response and negatively correlated with the perseverative response; FC in GM18WM13 was negatively associated with the percentage of perseverative errors; FC in GM71WM13 was positively associated with the percentage of correct response, and negatively associated with the perseverative response and the percentage of perseverative errors; FC in GM69WM13 was negatively correlated with the perseverative response and the percentage of perseverative errors.

#### CONCLUSION

This study identified reduced FCs in essential brain areas of depressed adolescents with suicide behaviors, mainly located in the default mode network and visual network, which was related with impaired cognition.

#### CLINICAL RELEVANCE/APPLICATION

The findings suggested the pathophysiology of suicide behaviors in depressed adolescents and might imply targeted brain areas for future treatment of suicide.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNR-3

### Concurrent Structural and Perfusion Changes in the Brain in Migraineurs with Patent Foramen Ovale: A Perfusion Functional Magnetic Resonance Imaging Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Xiangcao Li, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the structural and perfusion alterations in the brain and their neural mechanisms in migraineurs with patent foramen ovale (PFO) by jointly applying magnetic resonance imaging in both structural and perfusion modalities.

#### METHODS AND MATERIALS

Participants included migraineurs with PFO (n=20) and healthy controls (n=28), matched for age and gender. MRI data acquisition for all subjects was performed on a GE Discovery MR750W 3.0T. Scans were performed during the interictal period of headache attacks in patients. The scanned sequences included T1 Flair, T2 Flair, T2 Propeller, 3D T1 Bravo, 3D pcASL sequences. Magnetic resonance image preprocessing and statistical analysis were performed on SPM8, SPM12, CAT12 in MATLAB 2018b. CAT12 and BrainNetViewer software were used to present the results.

#### RESULTS

1. There was no statistical difference between the two groups of subjects in terms of gender and age composition ( $P > 0.05$ ). 2. VBM analysis was performed using total intracranial volume (TIV), gender, and age as covariates. The gray matter density was found to be reduced in the midbrain and the precuneus in the left inferior temporal gyrus, left middle temporal gyrus, left middle occipital gyrus, left lingual gyrus, left inferior occipital gyrus, and left hippocampus in the patient group ( $P > 0.05$ ). 3. SBM analysis was performed using age and gender as covariates. The depth of the sulcus in the insula, superior temporal gyrus, inferior frontal gyrus triangle, temporal pole, lateral prefrontal cortex, internal olfactory cortex, lingual gyrus, hippocampal gyrus, and talar parietal gyrus was found to be reduced in the patient group. The gyrification was reduced in the lateral occipital lobe, superior parietal lobule, cuneus, and precuneus ( $P > 0.05$ ). Comparisons between CBF groups were made using age and sex as covariates. CBF values were found to be elevated in the cerebellum as well as in the left perirhinal cortex, left lingual gyrus, and right lingual gyrus in the patient group. CBF values were decreased in the right middle frontal gyrus, right superior temporal gyrus, and right insula ( $P > 0.05$ ).

#### CONCLUSION

Migraineurs with PFO were found to have multiple eigenvalue changes in brain structure and perfusion, and the brain regions with two or more eigenvalue changes were mainly located in the temporal lobe, frontal lobe, occipital lobe, insula, cuneus, precuneus, and cerebellum. It is suggested that subsequent studies could focus on observing the relevant brain regions.

#### CLINICAL RELEVANCE/APPLICATION

This study lays the foundation for the pathological mechanism of the disease and the discovery of relevant imaging markers. It provides a basis for further research on the relatively specific brain mechanisms as well as the treatment of migraineurs with PFO.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNR-6

### Schizophrenia and Gray Matter Heterotopia in the Frontal Lobe: A Finding with Hitherto Little Attention Despite Nowadays High Resolution 3D MR Imaging

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Christophe Arendt, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Only a handful of cases with gray matter heterotopia (GMH) in schizophrenia are described in the literature from the late '90s through MRI. Yet, postmortem studies detected heterotopic neurons in the white matter (WM) more frequently. The aim was to demonstrate their prevalence using images with higher spatial resolution than before.

#### METHODS AND MATERIALS

Inpatients with schizophrenia and an institutional MRI were included in this retrospective study, and consecutive data sets of non-schizophrenic persons served as controls. Two independent radiologists, trained for neuroimaging and blinded to any clinical information, evaluated 3D T1-weighted gradient echo sequences (1 mm<sup>3</sup> voxel size; 1.5 and 3.0 T) to look for GMH. Number and location (periventricular/deeper WM; frontal, parietal, temporal or occipital) of GMH were assessed. Presence of periventricular cysts (PVC), enlarged caves of the septum pellucidum (ECSP), dysgenesis of the corpus callosum (DCC), focal cortical dysplasia (FCD) and polymicrogyria (PMG) were noted, if present. A consensus for cases with disagreements was made in a second read. Fisher's exact and Pearson's  $\chi^2$  test were used to test for differences and relationships, respectively.

#### RESULTS

From 01/2013 till 07/2021, MR scans of 214 cases (mean age, 42 yrs; 69% males) and 141 controls (mean age, 46 yrs; 50% males) were analyzed. There was a prevalence of 2.8% (n=6/214) of GMH in the patient cohort versus 0% in non-schizophrenic persons (p=0.046). All seven lesions were located in the frontal lobe; two of them on both sides in one patient and two patients with GMH in the deeper and not in the periventricular WM. Another finding that was found solely in the patient cohort was the presence of PVC (n=3/214, 1.4%; p=0.218). ECSP were detected in both groups (n=6/214, 2.8% vs. n=4/141, 2.8%; p=0.613). Raters did not detect DCC, FCD or PMG in both cohorts. There were no relationships between GMH and PVC ( $\chi^2=0.052$ ; p=0.950), GMH and ECSP ( $\chi^2=0.177$ ; p=0.841), and PVC and ECSP ( $\chi^2=0.088$ ; p=0.918). No associations between GMH and baseline characteristics or pre-existing conditions could be made.

#### CONCLUSION

GMH in schizophrenia were found more frequently than expected, as indicated by a prevalence of 2.8%, which might be due to the nowadays higher resolution of structural MRI. All lesions were found in the frontal lobe and even in the deeper WM. Other findings were PVC and ECSP, the latter being also present in controls with almost the same frequency. Interestingly, there were no associations between GMH and epilepsy.

#### CLINICAL RELEVANCE/APPLICATION

High resolution 3D T1-weighting detected GMH in 2.8% of schizophrenic patients. These findings may inform personalized approaches to intervention such as in treatment-resistance despite good compliance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNR-7

### Multiclass Radiomics-based Models for Pediatric Low-Grade Neuroepithelial Tumors Molecular Subtype Identification Based on Open-Radiomics Protocol

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Pediatric Low-Grade Neuroepithelial Tumor (PLGNT) is the most common type of brain tumor in children, and radiomics-based machine learning (ML) models have been shown to be effective for classifying BRAF fusion and BRAF V600E mutation PLGNT molecular subtypes. We investigate the effect of MRI sequence, image normalization, and radiomics extraction hyperparameters using the Open-Radiomics protocol to provide reproducible results.

#### METHODS AND MATERIALS

Our REB-approved retrospectively acquired study cohort consisted of 339 children with PLGNT including 143 with BRAF fusion, 71 with BRAF V600E mutation, and 125 tumors with other molecular subtypes. MRI sequences included Fluid-Attenuated Inversion Recovery (FLAIR), T1-weighted (T1), gadolinium-based contrast agent (GBCA) enhanced T1-weighted (T1CE), and T2-weighted (T2) sequences images. Tumor segmentations were provided by a pediatric neuroradiology fellow and verified by a senior pediatric neuroradiologist. PyRadiomics was used for extracting the radiomics features from the regions of interest. We created 72 radiomics datasets using a combination of 4 sequences, 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), and 6 image normalization methods (NoNormalization, MinMax, ZScore, Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient). We used Random Forest classifiers. For each radiomics dataset, we repeated the train-validation-test (60/20/20) experiment with different data splits and model random states 100 times (7200 tests) and calculated the Area Under ROC Curve (AUC).

#### RESULTS

We achieved a test AUC of 0.880 with 95% Confidence Interval (CI) [0.879, 0.882] for BRAF fusion vs BRAF V600E mutation binary classification. The highest average test performance for a specific dataset was achieved using MinMax normalization and binWidth of 25 on T1CE (AUC: 0.890). For 3-class classification, the average one-vs-the-rest (OvR) AUC was 0.789 with 95% CI [0.786, 0.792]. The top-performing dataset was ZScore, binWidth 15, FLAIR, with an average test AUC of 0.816. Unlike binWidth and image normalization, different imaging sequences resulted in statistically significant differences in AUC in both binary and multiclass scenarios.

#### CONCLUSION

Among the four imaging sequences in the dataset, T1CE was the best for separating BRAF fusion from V600E mutation. However, radiomic features extracted from FLAIR images outperformed other sequences at differentiating BRAF fusion and mutation from the other subtypes.

#### CLINICAL RELEVANCE/APPLICATION

Identification of the molecular subtype of PLGNT is important for treatment planning. Our comprehensive approach ensures that we capture best-performing and reproducible models.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPNR-8

### Multiclass Radiomics-based Machine Learning Models for Medulloblastoma Molecular Subtype Identification

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Medulloblastoma (MB) is an aggressive brain tumor in children and qualitative MR imaging features including tumor location within the cerebellum have been shown to differentiate MB subtypes. We develop radiomics-based machine learning (ML) models using MRI Fluid-Attenuated Inversion Recovery (FLAIR) images to classify four MB molecular subtypes (WNT, SHH, group 3, group 4). We follow the Open-Radiomics protocol to achieve reproducible results.

#### METHODS AND MATERIALS

Our REB-approved and retrospective study includes 104 pediatric patients with an age range of 1 to 17.2 years (mean age  $7.8 \pm 3.95$  years, 71 males, 68%). Tumor segmentations were provided by two pediatric neuroradiologists. PyRadiomics was used for extracting the radiomics features from the regions of interest (ROIs). The four MB molecular subgroups were identified based on next-generation sequencing panels, fluorescence in situ hybridization, and specialized testing (including RNA methylation array and DNA methylation array). The dataset included 44, 28, 20, and 12 cases of the WNT, SHH, group 3, and group 4 subgroups, respectively. We created 18 radiomics datasets using 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), and 6 image normalization methods (NoNormalization, MinMax, ZScore, Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient). We used Random Forests as classifiers. For each radiomics dataset, we repeated the experiment with different data splits and model random state 100 times (1800 tests) and calculated the Area Under Receiver Operating Characteristic Curve (AUC).

#### RESULTS

When classifying group 3 versus all other subgroups, we achieved an overall test AUC of 0.619 with 95% confidence interval (CI) [0.607, 0.631]. On 4-class classification, the average one-vs-the-rest AUC was 0.703 with 95% CI [0.690, 0.716]. The top-performing dataset was ZScore with binWidth 25, where we achieved average test AUC of 0.750. Analyzing per-class AUCs on the top-performing setting, the highest performance was noted for SHH vs others, where we achieved an average test AUC of 0.845. We also observed significantly higher AUC for group 3 vs others when switched to multiclass classification (0.668).

#### CONCLUSION

Performance of radiomics-based ML models for identifying MB subtypes using MR images depends on the subtype, how the model is trained, and how the image is normalized. Our results show ZScore is the best image normalization technique and multiclass classification can improve per-class performance of the models.

#### CLINICAL RELEVANCE/APPLICATION

Pretherapeutic identification of MB subtype is important for treatment planning for which we train and evaluate reproducible machine learning models.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3A-SPNR-9

### Nodal Properties of Resting-State Brain Functional Network in Childhood and Adolescence

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yu Tian (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to describe and compare the characteristics of changes in the nodal properties of brain functional networks during childhood and adolescence, revealing the developmental trajectories of different brain structures during development.

#### METHODS AND MATERIALS

In this study, 42 healthy volunteers aged 6-18 years were right-handed primary and middle school students were recruited, and the subgroup analysis included children (6-12 years,  $n = 19$ ) and adolescents (13-18 years,  $n = 23$ ). Resting-state functional magnetic resonance imaging (fMRI) data were collected using a 3.0T MRI scanner. The topological properties of the functional brain network were analyzed using graph theory.

#### RESULTS

Compared with the children group, the nodal efficiency of the superior frontal gyrus, middle frontal gyrus, left dorsolateral fusiform gyrus, and other brain regions in the adolescent group was significantly increased ( $P < 0.05$ , FDR correction) and positively correlated with age. The degree of centrality of the superior frontal gyrus, bilateral inferior frontal gyrus operculum, left medioventral fusiform gyrus, and other brain regions increased significantly ( $P < 0.05$ , FDR correction) and were positively correlated with age. The degree of centrality of the left dorsolateral fusiform gyrus, left rostral cuneus gyrus, and right medial superior occipital gyrus was significantly reduced ( $P < 0.05$ , FDR correction) and negatively correlated with age. The nodal shortest paths in the superior frontal gyrus, left ventrolateral fusiform gyrus, right superior parietal lobule, and other brain regions were significantly reduced ( $P < 0.05$ , FDR correction) and negatively correlated with age.

#### CONCLUSION

The transmission efficiency of the brain core network gradually increased, and the subnetwork function gradually improved in children and adolescents with age. the functional development of each brain area in the occipital visual cortex was uneven and internally functionally differentiated.

#### CLINICAL RELEVANCE/APPLICATION

Changes in the topological properties of brain functional network nodes during childhood and adolescence can provide more detailed and intuitive information on the rules of brain development. We believe that our study makes a significant contribution to the literature because it provides evidence-based findings that clinicians and healthcare providers can adopt in actual clinical settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPOB-1

### Value Addition of Subspecialty Trained Experienced Readers for O-RADS MRI Scoring and Guiding Management for Patients with Adnexal Mass Referred to Gynecology Oncology Multidisciplinary Rounds in a Tertiary Center

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ankush Jajodia, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assess the diagnostic accuracy, interobserver variability, and common lexical errors of the ACR O-RADS scoring system in staff radiologists with less experience and non-fellowship trained.

#### METHODS AND MATERIALS

Patients with an adnexal mass on standard post-contrast pelvic MRI and referred after initial interpretation by a staff radiologist (R3-lacking experience and fellowship experience) to gynec-oncology rounds in a tertiary center. Two fellowship-trained radiologists with different experience levels, R2 (2 years) and R1 (10 years), assigned O-RADS MRI scores independently. Diagnostic accuracies (ROC curve analysis) and agreement between readers were analyzed for each reader. Scores 4 and 5 were assigned malignant. R1 independently assigned misclassification if a malignant lesion scored = 3, a benign lesion scored = 4, or a non-adnexal mass was incorrectly categorized as benign or malignant.

#### RESULTS

Twelve malignant and 36 benign lesions included in the study were assigned O-RADS MRI score malignant (4,5) and benign (1,2,3) in 10 (20.8%) and 38 (79.2%), 15 (31.2%) and 33 (68.8%) and 45 (93.7%) and 3 (6.3%) by R1, R2, and R3 respectively. MR O-RADS score (4,5) associated with malignancy with diagnostic efficacy and areas under the curve values of 0.942 (95 % CI, 0.834-0.989), 0.579 (95 % CI, 0.428-0.720), and 0.553 (95 % CI, 0.403-0.697) obtained for readers R1, R2, and R3 respectively, with statistically significantly different between R1-R2 and R2-R3. Two and eleven lesions were incorrectly classified as benign by R1 and R3 readers. Inter-observer agreement interpretation obtained k values was fair between all readers; 0.435 (95 % CI, 0.224-0.646) for R1-R2, 0.441 (95 % CI, 0.238-0.645) for R2-R3, and 0.440 (95 % CI, 0.192-0.687) for R2-R3 respectively. There were nine correct upgrades and seven correct downgrades to malignant and benign categories by experienced R1 readers. Misclassification in nonexperienced readers was due to misinterpretation of solid tissue (n=14), incorrect interpretation of diffusion images (n=10), and incorrect interpretation of non-dynamic contrast enhancement (n=7).

#### CONCLUSION

Additional interpretation by experienced readers provides incremental diagnostic accuracies in the MR O-RADS score.

#### CLINICAL RELEVANCE/APPLICATION

Experienced readers correctly upgraded 18% malignant lesions with fair inter-observer agreement among readers with various experiences, although the diagnostic accuracies were significantly different between readers. Unnecessary biopsy was avoided in 14.5% by correct downgrading by experienced readers. Incorrect classification of 16% of lesions by experienced readers potentially highlights need to simplify the existing scoring system.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPOB-2

### Accuracy of the Characterization of Adnexal Masses, Indeterminate at Ultrasonography, Using a Magnetic Resonance Imaging (MRI) Protocol without Contrast: External Validation of the Non-contrast MRI Adnex Score in a Multicentre setting

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Camilla Panico, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The characterization of adnexal masses is critical to guide appropriate patient management. Up to 20% of adnexal masses remain uncharacterized after ultrasound and MRI is needed. The O-RADS MRI score relies on gadolinium-based contrast; however, avoiding contrast is sometimes preferable due to logistical and patient factors. A recent study proposed an alternative (Non-contrast MRI Adnex Score -NCMAS). The purpose of our study is to show the preliminary data of a multicentric prospective evaluation of the NCMAS in characterizing the adnexal masses.

#### METHODS AND MATERIALS

A multicenter observational prospective study has been set up including 16 standing Italian Centers. NCMAS is the Index Test; its aim is to predict the malignancy of the ovarian lesions on the basis of a NCMAS. The score is based on 5 categories. Two radiologists for each center (one senior and one junior) read the images, blinded to the clinical information of the patients except for age. The diagnostic end-point (absence/presence of the malignant tumor) is verified through histopathology after surgery or through radiological follow-up at 12 months. The diagnostic accuracy of NCMAS is evaluated by measuring sensitivity, specificity, positive and negative predictive values, and ROC curve with area under the curve (AUC). To measure agreement between senior and junior radiologist Kappa statistics is performed. This preliminary analysis includes 45 patients representing about 15% of the total patients to be recruited.

#### RESULTS

Fifteen out of the 45 patients were classified as malignant using the NCMAS. Comparing these diagnoses with the gold standard we found: sensitivity of 85.71% (95% Conf. Int. 66.13%-98.22%), specificity of 90.32% (Conf. Int. 78,58%-97.96%), positive predictive value of 80% (Conf. Int. 59.54%-95.67%), negative predictive value 93.33% (Conf. Int: 52.78%-99.18%). The malignant lesions correctly classified were 88.89% (Conf. Int. 77.78%-96.29%). The AUC was 88.02% (Conf. Int. 77.14%-98.90%). As to the comparison between senior and junior radiologists, for a diagnosis of a malignant lesion, the agreement was 90.24%, with a Kappa statistic of 0.79 (Conf. Int. 0.59-0.985).

#### CONCLUSION

The performance of NCMAS score was externally and prospectively confirmed. Even if found in about 15% of the total calculated sample size, the results are promising. If confirmed, the use of NCMAS may add an important tool in clinical practice when contrast imaging cannot be used for logistic or patient factors.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study may represent a confident support to the clinical use of non-contrast MRI in diagnosing adnexal masses, undetermined at ultrasonography

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## Abstract Archives of the RSNA, 2023

S3A-SPPD-1

### Cardiac Computed Tomography Angiography with and without Bolus Tracking Methods in Infants with Congenital Heart Disease

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Takayuki Yoshiura, BA, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Cardiac computed tomography angiography (CCTA) is useful in congenital heart disease (CHD) diagnosis and plays a major role in treatment. The bolus tracking (BT) methods can accurately predict the optimal scan delay that reflects the hemodynamics of the individual, but the drawback is the increased radiation dose due to pre-monitoring scans. This study aimed to compare the radiation dose, vascular CT number, and image quality of CCTA with and without BT methods for infants with CHD.

#### METHODS AND MATERIALS

This study retrospectively studied 72 consecutive patients with suspected CHD who underwent infant CCTA from December 2017 to April 2022, divided into groups with and without BT methods, in our information system. All scans were performed using a 64-detector row CT scanner (Lightspeed VCT; GE Healthcare, Milwaukee, Wisconsin) with the following parameters: rotation: 0.4 s, helical pitch: 1.375, slice thickness: 0.625 mm, tube voltage: 80 kVp, and automatic tube current modulation with a noise index of 40, iterative reconstruction (IR, blending of 30% of ASIR with FBP) algorithms under the standard kernel/filter reconstruction. Volume CT dose index (CTDI<sub>vol</sub>) and dose length product (DLP) were recorded for all CT scanning, and an effective dose was obtained using conversion factors. The CT number of the ascending aorta (AO) and pulmonary artery (PA), image noise of muscle tissue, and contrast-to-noise ratio (CNR) were measured and calculated.

#### RESULTS

The median values in the groups with and without BT were 2.20 mGy vs. 0.44 mGy for CTDI<sub>vol</sub>, 8.10 mGy·cm vs. 6.20 mGy·cm for DLP, and 0.66 mSv vs. 0.51 mSv for effective dose. The mean values in the groups with and without BT were 471.2 Hounsfield units (HU) and 515.6 HU for AO and 463.2 HU and 512.5 HU for PA, respectively. The mean image noise was 17.3 HU and 17.0 HU in the groups with and without BT ( $p = 0.76$ ), and the mean CNR was 23.9 and 26.5 in both groups ( $p = 0.21$ ).

#### CONCLUSION

CCTA for infants with CHD without BT methods can reduce the radiation dose while maintaining the CT enhancement of the vessels and image quality compared to CCTA with BT methods.

#### CLINICAL RELEVANCE/APPLICATION

CCTA for infants with CHD can ensure good image quality and reduce radiation dose without using the BT method.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-1

### Improved Single-Shot GRASE with Flyback Variable Density Sampling and Deep Neural-Network

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Zheng Zhong, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To enable highly accelerated (12X) single shot gradient and spin echo (ss-GRASE) sequence without appreciable image artifacts by incorporating flyback variable density sampling coupled to a deep neural network.

#### METHODS AND MATERIALS

**SS-GRASE with flyback variable density sampling:**The sequence diagram was shown in Figure A, where a 3-fold acceleration was achieved using three gradient echoes after each refocusing pulse. This was coupled with variable density sampling for a total of 12-fold acceleration. To minimize phase inconsistency among the gradient echoes, flyback acquisition was employed with three echoes each grouped into different regions of the k-space.**Data Acquisition:**With IRB approval, images were acquired using ss-GRASE on phantom and human brains on a GE 3T Premier scanner. Key sequence parameters were: TR/TE=300/100ms, slice thickness=3mm, FOV=28cm<sup>2</sup>, matrix=256×224, slices=30 to 40, parallel imaging factor=3. A total of 90 slices of phantom and 320 slices of the human brain were acquired. The experiment was repeated using variable density sampling SSFSE with the same parameters except for TR=700ms.**Image Reconstruction:**The acquired data from both ss-GRASE and SSFSE was reconstructed using the parallel imaging compressive sensing (PICS) algorithm provided by BART and fed into the neural network as input and output, respectively. A U-Net architecture was tailored to further remove artifacts from PICS reconstruction. The U-Net consists of a downsampling encoder and an upsampling decoder network with a mirrored and reversed encoder structure (Figure B). The network was trained on an NVIDIA Titan Xp 16GB graphics card. To avoid overfitting, weight-decay (0.01) and random rotation for data augmentation were applied. Adam optimizer was used with a learning rate of 0.0005 for 1000 epochs guided by MSE loss until convergence.

#### RESULTS

The second column of Figure C illustrates the artifacts of PICS reconstruction arising from the phase inconsistency of the three gradient echoes in ss-GRASE. The artifacts can be largely removed using the deep neural network, as evidenced by the improved image quality from both phantom and human brain images (third column).

#### CONCLUSION

The performance of the ss-GRASE sequence was substantially improved with a combination of flyback variable density sampling and a deep neural network. The deep neural network enables reduction of the artifacts which PICS reconstruction fails to address in ss-GRASE.

#### CLINICAL RELEVANCE/APPLICATION

The proposed approach of ss-GRASE enables improved acquisition speed (300ms/slice) and less SAR issue as compared to conventional SSFSE, implying further applications of the technique in freezing motion such as bowel imaging, and SAR-sensitive situations such as pediatric imaging.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-10

### Unpaired MR-CT Translation using Diffusion Model and Cross-modality Structure Extractor

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Junghyun Roh, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

For the breast cancer patients after surgery, MRI scans are required to identify the surgical site and determine the treatment plan, but radiotherapy planning requires extra CT scans. By developing the deep learning model to synthesize CT from MRI images, physicians can reduce the time consumption and do treatment efficiently. Since a dataset containing paired MR and CT images with registration is difficult to be retrieved because of anatomical changes, unpaired MR-CT translation is the key to solve this problem. However, due to the information difference within MRI and CT, unpaired translation across the modalities is still a hard task to be done. In this paper, we propose a novel structure using a cycle-structured diffusion model and an extra algorithm for structure preservation.

#### METHODS AND MATERIALS

The dataset we used is composed of 2D MRI (T2) and CT scans of the patients who underwent partial resection for breast cancer or did radiation therapy. Train set is composed of 3,606 MR scans and 2,770 CT scans from 62 patients, and 543 pairs of MRI and CT from 15 patients were used for test. The proposed model is composed of two generators: Diffusive and Non-Diffusive. Non-diffusive generator  $G'$  is used to make a reference for the diffusive generator  $G$ . Using the image  $G'(x)$  and noisy input  $x_t$ , the diffusive generator focuses on learning the target domain's structure and reconstructing the input image  $x$ . The Modality independent neighborhood descriptor (MIND) algorithm extracts the structural information using the similarity among adjacent patches. This descriptor makes a similar output for the same object regardless of its modality, so it can guide the unsupervised model to keep the structure. We compared our model's result with other unsupervised translation models by quantitative metrics: MSE, PSNR, and SSIM.

#### RESULTS

By the metrics, we can know that our proposed model generates the most similar result with ground truth for both sides: MR to CT and CT to MR. The resulting image shows that the diffusive generator contributed well to build realistic images. Also, the MIND loss helped to solve the structure deformation problem, especially in CT to MR conversion.

#### CONCLUSION

In this study, we showed bidirectional MR-CT unpaired translation functionality can be raised by adapting a diffusive generator as translation model. In addition, the proposed loss function in this paper can help maintain the structural information and compensate for the essential problem of unpaired translation.

#### CLINICAL RELEVANCE/APPLICATION

The synthetic CT image generated by the proposed model and MRI can be used for dose calculation in radiation treatment planning for breast cancer. This method can help physicians to reduce the time consumption and establish precise treatment regions.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-11

### The Superiority of Low-kV Renal Triphasic-enhanced CT with Deep Learning Image Reconstruction in Patient Care over the Conventional Enhanced CT Exam

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Xiaobo Ding, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether the deep learning image reconstruction (DLIR) can provide more patient care through the reduction of radiation dose and contrast agent volume for renal enhanced CT exam.

#### METHODS AND MATERIALS

148 patients suspicious of renal lesion were included, 118 patients in the DLIR group and 30 in the conventional enhanced CT (CECT) group. The parameters for DLIR group: rotation speed of 0.5 s, collimation of 128×0.625 mm, pitch of 0.992:1, 50% ASIR-V, noise index (NI) of 9, automatic current modulation, standard kernel, 100 kV and mA range of 100-550 in the arterial phase (AP) and excretion phase (EP) and 120 kV and mA range of 150-500 in the parenchymal phase (PP); retrospective algorithm of DLIR. The volume and injection rate of contrast agent (320 mgI/ml) were 0.9 ml/kg and 3 ml/s. In CECT group: 120 kV, 281 mAs, collimation of 128×0.625 mm, pitch of 0.914:1, level 3 of iDose4, standard(B) filter for all phases. The volume and injection rate of contrast agent (320 mgI/ml) were 1.2 ml/kg and 2.7 ml/s. CT values and standard deviation (SD) of cortex, medulla, subcutaneous adipose tissue (SAT) on AP, parenchyma, pelvis and psoas muscle (PM) and SAT on PP, middle calyx (MC), upper ureter and middle ureter on EP were measured to calculate signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). SD of SAT was lower in DLIR group, compared to CECT (9.08 vs. 11.11,  $p<0.001$ ). No differences in subjective scores were observed between two groups.

#### RESULTS

There was no difference in BMI between two groups (24.4 vs. 23.4,  $p>0.05$ ). CTDI, DLP and contrast agent volume of DLIR group were significantly lower than those of CECT group (23.7 vs. 70.8 mGy,  $p<0.001$ ; 744.1 vs. 2197.4 mGy[[Unsupported Character - Symbol Font #158;]]cm,  $p<0.001$ ; 62.4 vs. 77.8 ml,  $p<0.001$ ). SNR of parenchyma and upper ureter and CNR of cortex to medulla in DLIR group were significantly higher than those in CECT group (10.83 vs. 7.52; 19.45 vs. 7.12; 11.83 vs. 6.59;  $p<0.001$  each). The SD of SAT was lower in DLIR group, compared to CECT (9.08 vs. 11.11,  $p<0.001$ ). No differences in subjective scores were observed between two groups.

#### CONCLUSION

Low-kV enhanced CT exam combined with DLIR algorithm is a feasible method for better patient care, compared to conventional enhanced CT exam.

#### CLINICAL RELEVANCE/APPLICATION

The scan speed is faster and image quality is better for the deep learning algorithm of low-dose renal three-phase scan of GE revolution 256 row CT than that of conventional renal three-phase scan of Philips 128 row CT, which could significantly reduce the radiation dose and contrast agent dosage of patients, and reduce the burden of liver and kidney of patients.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-12

### Performance of an Artificial Intelligence-Based Real-time System for Breast Positioning Evaluation and Image Quality Control in Mammography

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ying Guo (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the effectiveness of an artificial intelligence (AI) system for automated assessment of breast positioning and image quality in mammography.

#### METHODS AND MATERIALS

Assessment of breast positioning and image quality was performed by AI system and by two radiographers on 360 images of 90 women. Nine image quality criteria evaluating the appearance of the nipple, breast rotation, pectoral muscle, inframammary fold, pectoral nipple line, shoulder overlap shadow, abdominal skin, contralateral breast and foreign body were used for craniocaudal and mediolateral-oblique views. Image quality of cases were also evaluated with the standards of Mammography Quality Standards Act (MQSA) as grade "adequate" or "inadequate". Intraclass correlation and Cohen's kappa coefficient ( $\kappa$ ) were used to investigate the correlation and agreement between the radiographer's assessments and AI. The performance of the AI system was evaluated using accuracy, sensitivity, and specificity.

#### RESULTS

The AI algorithm demonstrated high accuracy in distinguishing between adequate and inadequate images, with an overall accuracy of 93%, sensitivity of 94% and specificity of 92%. In terms of breast positioning, the AUC of poor imaging quality prediction by AI system according to incomplete gland, incomplete pectoralis muscle, over or insufficient exposure was (0.903 vs 0.937 vs 0.982). Overall accuracy of AI system was 0.958. Inter-observer agreement for breast positioning assessment indicating substantial agreement between the radiographers and AI system ( $\kappa=0.75$ ). A substantial to almost perfect agreement was observed between the radiographers and AI on the nipple in profile ( $\kappa = 0.93$ ) and contralateral breast criterion ( $\kappa = 0.82$ ). We observed a slight to moderate agreement for the other criteria ( $\kappa = 0.55-0.79$ ).

#### CONCLUSION

The AI algorithm demonstrated high accuracy in distinguishing between high and low-quality images and detecting suboptimal breast positioning in mammography. The results showed a high level of agreement between the AI system and the radiographers.

#### CLINICAL RELEVANCE/APPLICATION

The high accuracy, sensitivity, and specificity of an AI system for quality control in mammography suggest its potential as a valuable tool for radiologists and technologists in the clinical setting, particularly in low-resource areas where access to experienced radiologists may be limited.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-13

### Artificial Intelligence-based Triage of Breast Cancer Screening Mammograms in a Swiss Region: Possible Impact of AI Region's Score Cutoff on Radiologist Workload

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Federica Zanca, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify the optimal region's score cutoff when using an artificial intelligence (AI) cancer-detection software to triage negative screening examinations into a one-click reporting radiologist work stream, e.g. reader validation of the AI negative result.

#### METHODS AND MATERIALS

This prospective multi-center simulation study aims at collecting about 10000 exams from a Swiss screening program. Preliminary data includes 3 months of screening mammograms. AI cancer-detection software (Transpara, Screenpoint Medical, v1.7.1) was used as a concurrent reading to detect potential abnormalities, for all exams collected. The software computes a region score for every marked area (soft tissue lesions and microcalcifications), indicating the likelihood of cancer on a scale from 0-98. Higher scores represent a higher likelihood of cancer. Based on these AI prediction scores, various cutoff points for the highest region score at the exam level (42, 49, 60, 74) were evaluated as thresholds to potentially channel women to the one-click reporting work stream. The different cutoff points were assessed in terms of missed abnormalities. Mean, median and variance of the AI scores were calculated. Data were also stratified per lesion type and breast density.

#### RESULTS

500 exams were examined, of which 12 were recalled for further examination (recall rate: 2.4%). Of these, 4 did not return, 5 were benign and 3 were diagnosed as cancer (biopsy proven), resulting in a 0.6% cancer incidence over one screening interval of 2 years. The mean, median and variance of AI scores were, respectively, 13, 0 and 564. There were respectively 0,1,2 and 2 missed cancers in case an AI score cutoff of 42, 49, 60 and 74 was used, corresponding to 0%, 0.2%, 0.4% and 0.4% of all screen-detected cancers in the population. The cutoffs of 42/49/60/74 correspond to 79%/87%/93%/99% of the workload. More data collection and stratification per lesion type and breast density is ongoing.

#### CONCLUSION

Preliminary data suggests that a cutoff score of 42 would allow triaging breast cancer screening mammograms with a 99.9% negative predicted value (NPV) into a one-click reporting.

#### CLINICAL RELEVANCE/APPLICATION

Using commercial AI software to triage mammogram workflow based on a 99.9% NPV could reduce radiologist workload by 78%.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-2

### Development of a Machine Learning Algorithm for Fat-free Mass Estimation: Application to Personalized Contrast Injection in Computed Tomography

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Natalie Heracleous, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Using fat-free mass (FFM) to personalize i.v. contrast volume injection enables reproducible target liver enhancement. However, measuring FFM requires expensive equipment and is time-consuming, limiting its applicability in clinical practice. This study aims at developing a Machine Learning (ML) model to accurately estimate the patient FFM.

#### METHODS AND MATERIALS

Previously collected abdominal CT data from 689 adult patients referred for liver lesion characterization or cancer follow-up was used (11 centers, different CT vendors, 2018-2022). This dataset includes various patient characteristics and measurements such as age, gender, weight, height, Body Mass Index (BMI), Size Specific Dose Estimate (SSDE), and FFM measured with Bioelectrical Impedancemeter (ground truth (GT)). A multivariate linear regression model was developed for FFM estimation. The correlations of the investigated variables with measured FFM were studied, and the most correlating variables were retained in the final model. The data was divided into training and test sets following the 80/20 rule and were validated using the K-fold technique. The model's performance was evaluated against the GT using Mean Absolute Percentage Error (MAPE), Root Mean Squared Error (RMSE) and R-squared. Our algorithm was also benchmarked against models already existing in the literature by comparing the distributions of the relative differences between theoretical and measured FFM values when applied to our data.

#### RESULTS

Preliminary results show a very good performance in predicting the FFM for our patient data sample. The cross-validation results showed the model to be robust for the typical patient profiles in our clinical settings. Specifically, the model showed low MAPE (0.033 +/- 0.003), high R2 (0.91 +/- 0.02) and relatively low standard deviation of residuals RMSE (2.13 +/- 0.23).

#### CONCLUSION

Our model can reliably and efficiently estimate the patient FFM to personalize i.v. contrast volume in adult abdominal CT examinations, reducing the time required for its measurement and avoiding the need for expensive equipment.

#### CLINICAL RELEVANCE/APPLICATION

The ability to accurately estimate FFM enables effortless personalization of contrast volume injection for a reproducible liver enhancement in clinical practice.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-3

### Evaluation of Unsupervised Low-dose Digital Breast Tomosynthesis Denoising using Cycle-consistent Generative Adversarial Network

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Tsutomu Gomi, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to evaluate the image quality improvement in digital breast tomosynthesis (DBT) with unsupervised cycle-consistent generative adversarial networks (cycle-GANs) during pre-reconstruction processing under low radiation exposure.

#### METHODS AND MATERIALS

The cycle-GAN pre-reconstruction manipulation with filtered back projection (FBP) was compared with and without relative GAN techniques (unsupervised image-to-image translation: UNIT and supervised image-to-image translation: pix2pix). The peak signal-to-noise ratio (PSNR), mean square error (MSE), structural similarity (SSIM), and detectability index ( $d'$ ) in the in-focus plane and artifact spread function (ASF) in the longitudinal direction using a phantom (training; BR3D [model 020, CIRS Inc.], testing; DBT quality control [model 021, CIRS Inc.] and TOR-MAM [Leeds Test Objects Inc.]) at various radiation doses (automatic exposure control reference dose: 1.36 mGy: approximately 50% reduction of reference dose: 0.66 mGy; approximately 75% reduction of reference dose: 0.31 mGy) were used to compare noise reduction and preserved contrast rates.

#### RESULTS

PSNR and MSE were similar to the references with cycle-GAN at 75% and pix2pix at 50% radiation dose reductions of reference, respectively (PSNR: cycle-GAN: 25.19 and 25.81, UNIT: 23.81 and 18.68, pix2pix: 26.46 and 25.92, without GAN (w/o-GAN): 26.03 and 24.07; MSE: cycle-GAN: 0.003 and 0.002, UNIT: 0.004 and 0.013, pix2pix: 0.002 and 0.002, w/o-GAN: 0.002 and 0.003, at 50% and 75% reduced radiation dose, respectively). The SSIM of the images generated by the cycle-GAN model at a 50% reduced radiation dose was similar to that of the reference images acquired at full radiation dose (cycle-GAN: 0.66 and 0.64, UNIT: 0.62 and 0.59, pix2pix: 0.64 and 0.62, w/o-GAN: 0.61 and 0.50 at 50% and 75% reduced radiation dose, respectively).  $d'$  was similar to the reference in cycle-GAN and pix2pix at 50% radiation dose reduction of reference (reference: 2.79, cycle-GAN: 2.80 and 2.71, UNIT: 2.64 and 2.46, pix2pix: 2.82, and 2.58, w/o-GAN: 2.73 and 1.89 at 50% and 75% reduced radiation dose, respectively). ASF revealed a similar distribution (symmetry) to the reference, except for pix2pix. Pix2pix spread the distribution and became asymmetric.

#### CONCLUSION

This phantom experiment revealed the highest usefulness of cycle-GAN in low-dose conditions considering the image quality in the in-focus plane and longitudinal direction, as well as a 50% reduction in the reference.

#### CLINICAL RELEVANCE/APPLICATION

The cycle-GAN pre-reconstruction manipulation with FBP can significantly reduce noise with preserved contrast and radiation dose reduction in clinical practice.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-4

### MRI Image Generation from CT Images for Cerebral Ischemic Stroke Patients Using Deep Learning

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Zhihua LI (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral ischemic stroke is a leading cause of death and disability worldwide, and timely diagnosis and treatment are crucial for improving patient outcomes. Computed tomography (CT) and magnetic resonance imaging (MRI) are both widely used imaging modalities for diagnosing stroke. However, CT is often the first choice due to its accessibility and speed, while MR provides higher sensitivity and specificity. This study aims to investigate the feasibility of converting CT images of cerebral ischemic stroke patients to MRI using deep learning techniques.

#### METHODS AND MATERIALS

The proposed method utilizes a Cycle Generative Adversarial Network (Cycle-GAN) raised by Jun et al. to learn the mapping between the two modalities and generate synthetic MRI from CT scans. We have added a new attribute to the network, based on the observation that stroke lesions are highly discernible on MR images. The dataset used in this study consists of CT and MR images from 120 patients at Longgang Central Hospital of Shenzhen. Only the MRI input contains attribute information, where the presence or absence of lesions is encoded as one-hot codes. To address the challenge of detecting lesions in CT images and improve the network's feature extraction capabilities, we adjusted the window width and center of the original CT image to 60 and 35, respectively.

#### RESULTS

Experimental results demonstrate that the proposed approach can effectively generate high-quality MRI from CT scans, achieving a peak signal-to-noise ratio (PSNR) of 24.4 dB and a structural similarity index (SSIM) of 0.78. Furthermore, our method outperforms existing image-to-image translation methods in terms of visual quality and quantitative evaluation metrics.

#### CONCLUSION

Deep learning has shown promising results in extracting subtle lesion features from CT images, although the outcomes may differ from those of the original MRI. Nonetheless, the algorithm can still provide valuable insights to medical professionals. While some progress has been made in this area, there is still significant room for improvement. Future research will focus on refining the algorithm and conducting comparative studies with related algorithms.

#### CLINICAL RELEVANCE/APPLICATION

Timely diagnosis of Cerebral ischemic stroke is critical. However, traditional MRI scans are time-consuming, while CT imaging is widely available. By using deep learning to convert CT images to MRI, medical professionals can diagnose the condition more quickly and develop appropriate treatment plans.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPPH-5

### Semi-Automatic Segmentation of Thymic Epithelial Tumors using U-Net

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Nathan S. Lay, PhD (*Presenter*) Inventor, ScanMed

#### PURPOSE

Volumetric analysis of thymic epithelial lesions can be more informative than RECIST for oncologic follow up but requires laborious segmentation with low reproducibility when done manually. To propose and quantify performance of a U-Net artificial intelligence (AI) model for segmenting thymic epithelial tumors in CT scans with user-provided 3D regions-of-interest.

#### METHODS AND MATERIALS

A consecutive cohort comprised of 85 CT scans from 60 thymoma patients (mean age: 55 range: 32-75) was queried from a single institution database. Thymic tumors in the thorax were then manually segmented slice-by-slice on axial CT images by trainees or volunteers under the supervision of an expert cardiothoracic radiologist. The cohort was then partitioned into training and validation sets containing 63 CT scans from 45 patients and 22 CT scans from 15 patients respectively. A 2D U-Net was then trained on cropped image slices from 141 tumors over 1000 epochs. Performance was measured using the arithmetic mean and standard deviation of Dice similarity coefficient (DSC) over 3D manual segmentation masks of the whole image. DSC produces a similarity score ranging from 0 to 1 with 1 being a perfect match.

#### RESULTS

U-Net model snapshots were validated every 10 epochs on cropped image slices coming from 49 validation tumors. The method achieved a peak overall validation Dice similarity coefficient of 0.59 +/- 0.17. This corresponds to validation tumor DSCs of 0.60 +/- 0.09 for thymoma lesions located in the lung parenchyma, 0.68 +/- 0.14 for pleural and 0.57 +/- 0.19 for mediastinal thymoma lesions.

#### CONCLUSION

The current DSC results of our U-net AI model show promise for volumetric analysis of thymic tumors. Thymic tumors present a complicated and often unnoticed appearance in CT and a larger dataset is likely to produce a more generalizable and performant U-Net model over our current results.

#### CLINICAL RELEVANCE/APPLICATION

Thymic tumor progression is currently tracked using RECIST v1.1. RECIST is used because it is simple and reproducible, but it is not suitable for some types of pleural thymic tumors. Automatic volumetric analysis can be simple, reproducible and accurate for all thymic tumors.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-6

### Reproducibility of a Deep Learning COVID-19 Classification Model Based on Image Acquisition Dates and Data Resampling

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Mena Shenouda, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the impact of (1) image acquisition date and (2) data resampling, which was performed to create new training and test sets, on the ability of a deep learning (DL) model to predict COVID-19 diagnosis from chest radiographs (CXRs).

#### METHODS AND MATERIALS

A DL model using the DenseNet-121 architecture was trained on an original dataset of 9860 COVID+/- patients (disease prevalence: 15.5%) from a single institution. The model was validated on a more current cohort of 5893 patients (disease prevalence: 12.4%) from the same institution but achieved significantly lower performance as evaluated using area under the receiver operating characteristic curve (AUC). To investigate this performance discrepancy, this work (1) compared the International Classification of Diseases 10 (ICD-10) codes between the original dataset and current test set, (2) limited the image acquisition date range of the current test set to that of the original and compared COVID severity scores and age, and (3) retrained the model using a resampling of the original dataset to evaluate whether the original results were due to a statistical anomaly. No training was performed using the current test set.

#### RESULTS

The original dataset and current test set shared the same top-three ICD-10 codes: (1) screening for other viral disease, (2) age-related osteoporosis, and (3) unspecified osteoarthritis. COVID severity scores of patients with images obtained during the overlap of dates between the test sets failed to achieve a significant difference ( $p=0.06$ ); however, the DL prediction scores indicated more "obvious" cases within the original test set, thus correctly labeling a greater portion of true-positive and true-negative CXRs. There was a significant difference ( $p<0.001$ ) between cohort age, with the current test set having a larger mean ( $57.9 \text{ years} \pm 18.3$ ) than the original dataset ( $54.7 \text{ years} \pm 18.9$ ). Lastly, retraining the model by resampling the original dataset resulted in an AUC value [95% CI] of 0.71 [0.67, 0.74], significantly lower than the original AUC value of 0.76 [0.73, 0.79]. Importantly, the AUC value of the current test set was no longer statistically less than the AUC value obtained with this resampled original dataset ( $p=0.11$ ).

#### CONCLUSION

This work examined potential factors that may impact model performance. Resampling the dataset resulted in significantly lower performance, which may explain how different partitions of a dataset (or an entirely new dataset) may yield variable performance.

#### CLINICAL RELEVANCE/APPLICATION

With the rise of DL use in medical applications, interpretability of models is essential for proper deployment, ensuring an understanding of how various factors may impact model performance and that results are comprehensible.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-7

### Model Calibration by Temperature Scaling of a U-Net Deep Learning Model Trained for the Segmentation of Mesothelioma Tumor: A Pilot Study

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Mena Shenouda, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To produce calibrated pixel-wise label probabilities in the task of mesothelioma segmentation, which will ensure proper generation of probability maps.

#### METHODS AND MATERIALS

Temperature scaling (TS) is a post-processing probability calibration method to be used for multi-class classification. For medical image semantic segmentation tasks, the two classes would be "disease" or "no disease." TS estimates a single scalar parameter temperature  $T > 0$ , using the logit  $z_i$  vector as input, where  $i$  is the  $i$ -th image. The temperature is typically optimized only on the validation images and using the negative log-likelihood cost function, as was performed in this work. The calculated temperature "softens" the output of the last activation layer with  $T > 1$  reducing model confidence (i.e., probability predictions),  $T = 1$  indicating no change to the original probability, and  $T < 1$  increasing model confidence. The temperature was calculated for four separate validation sets: left or right hemithorax displaying either tumor only or tumor plus effusion. For the left hemithorax, 275 sections displayed tumor only, and 97 sections displayed tumor plus effusion. For the right hemithorax, 216 sections displayed tumor only, and 101 sections displayed tumor plus effusion.

#### RESULTS

The calculated temperatures for tumor only on the left hemithorax, tumor plus effusion on the left hemithorax, tumor only on the right hemithorax, and tumor plus effusion on the right hemithorax were  $T = 3.7, 3.4, 2.3, 2.1$ , respectively. All temperature values were greater than unity, which demonstrated the model's overconfidence prior to calibration.

#### CONCLUSION

This work demonstrated the overconfidence of the initial model, as all temperatures were greater than one. This finding is consistent with the literature, since modern neural networks have been reported to be overconfident in their predictions. With a correctly calibrated model, accurate probability maps can be generated, thus streamlining automation of the mesothelioma segmentation task.

#### CLINICAL RELEVANCE/APPLICATION

Due to the widespread use of neural networks for medical image classification and segmentation tasks, there is a need to ensure that model outputs are properly calibrated so that the resulting probabilities are indicative of the model's true confidence.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-8

### Adaptive Multimodality Medical Image Translation with Total-Body PET

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Yuxi Jin (*Presenter*) Nothing to Disclose

#### PURPOSE

To dynamically generate specified modality images from nonattenuation-corrected PET images according to user requirements.

#### METHODS AND MATERIALS

To dynamically translate nonattenuation corrected (NAC) PET images to user-specified modality images, we embed a switch layer after each skip connection in the decoder of UNet. The switch layer learns the scale and offset parameters by two fully connected layers from the switch code. The switch codes are 001/010/100 for attenuation corrected (AC) PET/CT/MRI, respectively, and are coded by one-hot coding. The proposed model can adaptively output the specified modality image by normalizing the input features into the specified modality with the scale and offset parameters. A total of 119 patients scanned with the uEXPLORER scanner and 225 patients scanned with the uPMR scanner were retrospectively enrolled. We selected 13 patient cases as an external validation set for quantitative analysis, and the remaining 108 PET/CT cases and 215 PET/MR cases were used as experimental data to train the proposed network. To better train the proposed model, we mix and slice these data along the axial orientation to obtain two-dimensional images. After excluding 6547 slices for negative samples, we obtained 104286 slice samples in total. We randomly select 83429 samples for training, 10428 samples for validation, and 10429 samples for testing. The quantitative performance is evaluated by PSNR, MAE, and SSIM. The qualitative performance is measured by the error map between the model output and the ground truth.

#### RESULTS

Our results achieved small quantification errors (low bias), good image quality (high PSNR), and high similarity (high SSIM) in the different body regions. All modal translation results have a similar appearance as the ground truth. Qualitative and quantitative analyses demonstrated the outstanding performance of the proposed model.

#### CONCLUSION

We design a novel deep learning model to realize adaptatively multimodality translation. This work can complete one-to-many modality translation, including direct PET attenuation correction (NAC-AC), CT synthesis (PET-CT), and MRI synthesis (PET-MRI). The simulated multimodality images have small qualification errors, good image quality, and high image similarity, which demonstrates that the proposed method is a promising tool in preclinical research, such as tumor contouring, anatomical localization, and dose calculation of radiotherapy.

#### CLINICAL RELEVANCE/APPLICATION

The proposed adaptive multimodality medical image translation model can provide more comprehensive and integrated image information, aiding doctors in better understanding a patient's physical condition and making more accurate diagnoses and treatment plans.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH-9

### Large Language Model (LLM) Passes the Radiology Physics Quiz

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Shakthi K. Ramasamy, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

With the recent advances in natural language processing, large language models (LLMs) such as GPT-4 have become increasingly powerful in their ability to understand and generate natural language. This study aims to assess the knowledge quiz-taking capacity of GPT-4 and GPT-3.5 for the Radiology Physics quiz.

#### METHODS AND MATERIALS

An IRB approval is not required. The study was conducted on a set of 62 multiple-choice questions compiled from the Radiology Core Physics App, which is used by radiology residents for their board preparations, and the sample questions for the Diagnostic, Nuclear, and Therapeutic content of the Initial Certification for Medical Physics from the American Board of Radiology (ABR) ([theabr.org](http://theabr.org)) website. Image-based questions were excluded from the study due to the limitations of the current GPT models. The questions were typed into the prompt of [chat.openai.com](https://chat.openai.com) models GPT-4 (subscription required) and GPT-3.5 (freely available to the public). The answers were correlated with the respective answer keys. The performance of the models was evaluated for a passing score of 75%. The performance of GPT-4 vs GPT-3.5 was compared using a two-proportion z-test.

#### RESULTS

GPT-4 and GPT-3.5 took the Radiology Physics quiz, with GPT-4 achieving a success rate of 79% (49 correct) and GPT-3.5 achieving a success rate of 55% (34 correct). A two-proportion z-test was conducted to compare the performances of the two models. The calculated z-score is approximately 2.863, and the p-value is approximately 0.0042. Since the p-value (0.0042) is less than the significance level of 0.05, there is a statistically significant difference between the performances of GPT-4 and GPT-3.5 on the Radiology Physics quiz.

#### CONCLUSION

The results indicate a significant difference between the performances of GPT-4 and GPT-3.5 on the Radiology Physics quiz. GPT-4 demonstrated a higher success rate, scoring above the passing score. GPT-3.5 had a notably lower success rate, indicating that the newer GPT-4 model has improved knowledge and understanding of radiology core physics compared to its predecessor.

#### CLINICAL RELEVANCE/APPLICATION

The performance of GPT-4 in the Radiology Physics quiz highlights the potential application of large language models in medical education and training. GPT-4 could be a valuable resource for radiology residents, medical physicists, and other healthcare professionals seeking to enhance their understanding of radiology core physics principles. Additionally, the significant improvement in performance between GPT-3.5 and GPT-4 demonstrates the rapid advancements in natural language processing, indicating a promising future for LLMs in the medical field.

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## Abstract Archives of the RSNA, 2023

S3A-SPRO-1

### Ten-Year Experience of 5-Fraction Lung Stereotactic Body Radiotherapy (SBRT) for Biopsy-Proven Non-Small Cell Lung Carcinoma (NSCLC)

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

John M. Watkins, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Describe the local control (LC) and correlative clinicopathologic prognostic factors in patients treated with 5-fraction lung SBRT for biopsy-proven NSCLC.

#### METHODS AND MATERIALS

Intradepartmental quality assurance database of SBRT patients was utilized to identify patients with biopsy-proven NSCLC treated with 5-fraction SBRT at a single institution. Overall survival (OS), disease-free survival (DFS), and LC were measured from SBRT completion to last clinical follow-up or death (with DFS/LC backdated to last clinical follow-up if death occurred more than 3 months after last imaging). Regression analyses were performed on clinical (age, gender, race, tobacco use), radiographic (maximal tumor dimension, T-stage), pathologic (histology), and treatment (target coverage by dose, frequency of SBRT, SBRT start to completion) factors for association with LC. Kaplan-Meier method was employed for survival estimation.

#### RESULTS

Between 2011-2021, 107 patients were identified for inclusion in the present analysis. There were 112 total NSCLC targets, 60 (54%) being adenocarcinoma. Median age at the time of treatment was 75 years old (range, 38-93). Median SBRT dose was 5000 cGy (4500-6000 cGy) delivered over a median treatment time of 9 days (4-45). Median maximal internal target volume (ITV) dose (D 0.1 cc) was 6554 cGy (4497-7660), with median ITV receiving 5000 cGy (V50) and 5500 cGy (V55) of 100% (0-100%) and 98.8% (0-100%), respectively. Median planning target volume (PTV) V50 and V55 were 96.6% (0-100%) and 67.4% (0-99.7%), respectively. At median follow-up of 21 months (1-139), 75 (70%) patients had died. Median survivor follow-up was 39 months (7-139) with an estimated 3-year overall survival of 42.6% (32.6-52.6%). Forty-three patients experienced disease recurrence, of whom 8 had local failures (4 biopsy-proven). Estimated 3-year local control was 86.2% (76.2-96.2%). Univariate analysis of factors associated with LC identified only ITV V50 and PTV V50 as being significantly associated with LC. Estimated 3-year LC for ITV V50 > 98% versus < 98% was 88% and 79%, respectively. Estimated 3-year LC for PTV V50 > 95% versus < 95% was 91% and 75%, respectively.

#### CONCLUSION

ITV V50 and PTV V50 were the most strongly associated factors with LC after 5-fraction lung SBRT in the present population.

#### CLINICAL RELEVANCE/APPLICATION

SBRT for early-stage NSCLC is an excellent option for inoperable patients or those who decline lobectomy. The present study demonstrates the importance of minimum target coverage on local control in a large population with mature follow-up.

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## Abstract Archives of the RSNA, 2023

S3A-SPVA-1

### **Perivascular Fat Attenuation on CT Angiography is a Biomarker to Identify the Inflammation of Culprit Plaques in Internal Carotid Atherosclerosis**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ziyu Tian (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Our study aimed to evaluate the value of FAI as a tool for measuring plaque inflammation and identifying culprit plaques in internal carotid atherosclerosis.

#### **METHODS AND MATERIALS**

We analysed patients with internal carotid atherosclerosis who underwent neck CTA examination. The culprit plaque group and nonculprit plaque group were divided based on the clinical diagnosis. We compared the CTA characteristics, and baseline data between the two groups, as well as the FAI at the maximum stenosis, nonstenosis site and the whole ICA. A receiver operating characteristic (ROC) curve was used to determine the diagnostic accuracy of FAI for classifying culprit plaques in patients with bilateral ICA atherosclerotic stenosis.

#### **RESULTS**

In total, 101 and 94 patients were included in the culprit plaque (mean age, 64.78 years  $\pm$ 8.17; 84 men) and nonculprit plaque groups, respectively (mean age, 66.72 years  $\pm$ 7.51; 80 men). In the nonculprit plaque group, the perivascular FAI around the maximum stenosis site and around the whole ICA were lower than those in the culprit plaque group ( $P < 0.05$ ). In patients with bilateral extracranial ICA stenosis, ROC analysis of atherosclerotic stenosis in combination with FAI performed well in predicting the culprit plaque (AUC=0.863,  $P < 0.001$ ).

#### **CONCLUSION**

The perivascular FAI may be useful in identifying inflammation and the culprit plaque from ICA atherosclerosis and provides a new monitoring method for risk stratification.

#### **CLINICAL RELEVANCE/APPLICATION**

To our best knowledge, we first use the novel biomarker perivascular FAI to measure plaque inflammation and identify culprit plaques in internal carotid atherosclerosis. Our study first demonstrated that patients in the culprit plaque group had a higher level of perivascular inflammation measured by FAI than those in the nonculprit group. The noninvasive measurement of FAI can be used to evaluate and identify the local inflammation of culprit plaques in the ICA, which may help to monitor the inflammation progression of atherosclerotic plaques. Furthermore, FAI at the maximum stenosis site combined with stenosis can noninvasively predict the ICA culprit plaques, which enables the recognition of stroke risk patients and guides targeted treatments.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPVA-2

### Dark Blood Computed Tomography Angiography Combined with Deep Learning Reconstruction for Thickened Carotid Artery Wall Imaging in Takayasu Arteritis Patients

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Tong Su, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the capability of a newly developed dark-blood CTA imaging, combined with deep learning reconstruction (DLR), to visualize the thickened carotid artery wall of Takayasu arteritis (TAK) patients, compared with conventional CTA images.

#### METHODS AND MATERIALS

This prospective study continuously recruited fifty-three patients with TAK who underwent neck CTA scans. All acquisitions were performed with a 320 row-detector CT scanner (Aquilion ONE Genesis Edition). Arterial and Delayed phase images were reconstructed using HIR (Adaptive Iterative Dose Reduction [AIDR] 3D) and DLR (Advanced Intelligent Clear-IQ Engine [AiCE]). Afterward, these two groups of images processed with a dedicated software (SURESubtraction) to generate dark-blood images. Therefore, four groups of images were produced for analysis: Delayed-HIR, Delayed-DLR, Dark-blood-HIR, Dark-blood-DLR. Qualitative parameters, including overall image quality, vessel wall visualization ability, and diagnostic confidence index, were rated by two radiologists independently according to a five-point scale. Quantitative parameters, including SNR of vessel wall, CNR between the vessel wall and lumen, were computed and compared. The vessel wall thickness of thickened common carotid artery was measured and the inter-rater variability was evaluated.

#### RESULTS

The qualitative scores of overall image quality presented Delayed-DLR was superior to Delayed-HIR and Dark-blood-DLR was superior to Dark-blood-HIR (all  $p < 0.001$ ). CTA images processed with dark-blood technique presented higher qualitative scores in terms of vascular wall display ability and diagnostic confidence index, superior to conventional CTA images (all  $p < 0.001$ ). For brachiocephalic trunk, bilateral subclavian arteries and common carotid arteries, the SNRs and the CNR of Dark-blood-DLR images were significantly higher than those of Dark-blood-HIR images. And for bilateral common carotid arteries, the CNR of DLR presented higher quantitative scores than HIR for both delayed and dark-blood phases (all  $p < 0.001$ ). CTA images processed with dark-blood technique presented higher quantitative scores superior to conventional CTA images (all  $p < 0.001$ ). The average vessel wall thickness of carotid arteries measured on dark-blood phases were thicker than delayed phases (all  $p < 0.001$ ). And the highest ICC value between two raters was obtained on Dark-blood-DLR image (ICC 0.958).

#### CONCLUSION

Compared to HIR, dark blood method combined with DLR reconstruction improved CTA image quality, and enhanced the visualization of thickened vessel wall of TAK patients.

#### CLINICAL RELEVANCE/APPLICATION

Dark blood method combined with DLR reconstruction is conducive to rapid and accurate measurement of vessel wall thickness.

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## Abstract Archives of the RSNA, 2023

S3B-SPBR-1

### Evaluation of a Deep-Learning Based Software Tool to Automatically Detect and Quantify Breast Arterial Calcifications on Digital Mammography

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Bilel Ben Jedidia (*Presenter*) Nothing to Disclose

#### PURPOSE

Breast arterial calcification (BAC) has been identified as an independent cardiovascular risk factor but is not routinely documented in mammography reports, partially because manually scoring by radiologists can be time-consuming. The aim of this study was to evaluate an artificial intelligence (AI) software that automatically detects and quantifies BAC.

#### METHODS AND MATERIALS

Women who underwent both 2D mammography and thoracic CT from 2009 to 2018 were retrospectively included in this single-center study. A deep learning based software (iCAD, Nashua, NH, USA) was used to automatically detect and quantify BAC with a 0 to 10 point BAC AI score. Results were compared with a previously described BAC manual score based on radiologists' visual quantification of BAC on the mammogram. Coronary Artery Calcium (CAC) score was manually evaluated using a 12-point scale on CT. Diagnostic performance of marked BAC AI score (defined as a BAC AI score = 5) for the detection of marked CAC (CAC score = 4) was analyzed. R software version 4.0.2 was used to perform the analysis.

#### RESULTS

502 women (mean age: 62 years  $\pm$  16) were included. BAC AI score was highly correlated with BAC manual score (Spearman's correlation 0.83,  $p < 0.01$ ). Marked BAC AI score for the detection of marked CAC had a sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 32.7%, 96.1%, 71.2%, 83.1% and 81.9%, respectively. Marked BAC AI score was associated with marked CAC with an adjusted odds ratio of 12.139, (95% CI 11.92-12.35,  $p < 0.001$ ).

#### CONCLUSION

Automatic BAC AI score shows a very strong correlation to manual BAC scoring. Marked BAC AI score is associated with marked CAC (CAC score  $\geq 4$ ).

#### CLINICAL RELEVANCE/APPLICATION

Automatic BAC AI score could be a useful tool to promote the integration of BAC in the mammography report and improve awareness of a woman's cardiovascular risk status.

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## Abstract Archives of the RSNA, 2023

S3B-SPBR-2

### Comparison of Supplemental Screening with Artificial Intelligence and Breast Ultrasound in Women with Dense Breast

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Whether using artificial intelligence (AI) system for screening mammography in women with dense breasts can replace supplemental breast ultrasound (US) is not well known. This study aimed to assess the value of supplemental US and AI with screening mammography in women with dense breasts.

#### METHODS AND MATERIALS

A retrospective database search identified consecutive asymptomatic women who underwent digital mammography (DM) and supplemental screening US between January 2017 and December 2018. AI software was applied for mammography, and four-view heat maps with a representative abnormality score per breast were evaluated. A BI-RADS category =3 on US and maximum abnormality score =10 on AI were considered positive results. The cancer detection rate (CDR) per 1000 examinations, sensitivity, specificity, and abnormal interpretation rate (AIR) were estimated and compared.

#### RESULTS

Among 5708 women (mean age±standard deviation: 52.4±7.9), 33 cancers (13 ductal carcinoma in situ and 20 invasive carcinoma) were found. DM alone showed CDR of 2.8 (16/5708; 95% CI: 1.7, 4.5), sensitivity of 48.5% (16/33; 95% CI: 32.5, 64.8), specificity of 94.3% (5350/5675; 95% CI: 93.6, 94.9) and AIR of 6.0% (341/5708; 95% CI: 5.4, 6.6). DM combined with AI showed a CDR of 3.2 per 1000 examinations (18/5708; 95% CI: 1.9, 4.9), sensitivity of 54.5% (18/33; 95% CI: 38.0, 70.2), specificity of 95.3% (5409/5675; 95% CI: 94.7, 95.8) and AIR of 5.0% (284/5708; 95% CI: 4.4, 5.6). DM combined with US yielded a CDR of 5.3 per 1000 examinations (30/5708; 95% CI: 3.6, 7.5), sensitivity of 90.9% (95% CI: 30/33; 95% CI: 76.4, 96.9), specificity of 77.6% (4401/5675; 95% CI: 76.5, 78.6), and AIR of 22% (1304/5708; 95% CI: 21, 24). CDR and sensitivity of DM with supplemental US were significantly higher than that of DM alone ( $P < .001$ ), but with higher AIR and lower specificity ( $P < .001$ ). DM with AI showed higher specificity ( $P = .001$ ) with lower AIR ( $P = .002$ ) than DM alone, however with comparable CDR and sensitivity ( $P = .157$ ). AI correctly identified one invasive lobular cancer missed by DM and US. US alone detected additional 10 cancers, of which 90% were stage 0 ( $n=4$ ) and stage I ( $n=5$ ) invasive cancers, all node negative.

#### CONCLUSION

DM with supplemental US showed higher cancer detection ability than with supplemental AI in women with dense breasts. Supplemental US detected additional early-stage cancers in women with dense breasts without AI recall.

#### CLINICAL RELEVANCE/APPLICATION

The combined use of digital mammography with artificial intelligence cannot replace supplemental breast US in women with dense breasts yet.

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## Abstract Archives of the RSNA, 2023

S3B-SPBR-3

### **Bias-Free Artificial Intelligence: Developing a Deep Learning Algorithm for Diverse Racial Populations in Breast Cancer Diagnosis**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Dogan S. Polat, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to develop a deep learning (DL) algorithm to facilitate automated diagnosis of breast cancer using mammography.

#### **METHODS AND MATERIALS**

The algorithm was trained on a total of 136,172 mammograms that includes an isolated partition of Optimam (n=103472), DDSM (n=2812), and multiple single and multi-institution datasets across southeast Asia, Africa, South America, and Europe (n=29888). The algorithm was then tested on 9304 cases [Optimam (n=8980) and independent blinded single institution (n=324)]. Cancers comprised 34.7% (n=3226) of 9304 mammograms (23.6% invasive, 8.7% DCIS and 2.5% unknown types), while 65.3% (n=6078) were benign/negative. Race was stratified into five categories: white (n=6943, 74.6%), Asian (n=555, 6%), black (n=411, 4.4%), other (n=235, 2.5%), and unavailable/withheld (n=1160, 12.5%). Chi-square tests compared categorical variables, while t-tests and ANOVA compared area under the curve (AUC) of the model for different groups and means. ROC curves are compared in pairwise manner using pROC library in R.

#### **RESULTS**

Mean patient age was 61.1 (SD±7.7). While lesion type information either was not available or negative for 5604 (60.2%) patients, 2544(27.3%) presented as soft tissue abnormality and 1156 (12.4%) as calcifications. The algorithm achieved AUC of 0.91, 0.95 sensitivity, 0.55 specificity, 0.92 negative predictive value (NPV) and 0.66 positive predictive value (PPV). When stratified by lesion type, the algorithm performed better in characterizing soft tissue lesions [compared to calcification and other lesion types with following parameters AUC, sensitivity, specificity, NPV and PPV: 0.87, 0.9, 0.59, 0.48, 0.93 vs 0.71, 0.8, 0.49, 0.55, 0.76, 0.71 (p<0.001)]. Similarly, better diagnostic performance was achieved in detecting invasive cancer than DCIS (AUC 0.87 vs. 0.72, p<0.001), and cancer size >20mm vs <5mm (AUC 0.87 vs 0.77, respectively p<0.001). Performance was comparable across racial groups with the following AUC, sensitivity, specificity, NPV, and PPV: White (0.90, 0.86, 0.76, 0.92, 0.63), Black (0.92, 0.89, 0.75, 0.96, 0.54), Asian (0.89, 0.86, 0.75, 0.94, 0.54), Other (0.91, 0.85, 0.82, 0.95, 0.59), and Unknown (0.90, 0.90, 0.75, 0.82, 0.86). All racial groups were compared to global AUC and found no significant difference (p=1 for each).

#### **CONCLUSION**

The algorithm's performance on datasets comprising diverse racial populations is comparable to that of breast radiologists, tested on datasets that include cases representative of real-world clinical settings.

#### **CLINICAL RELEVANCE/APPLICATION**

The mammography DL algorithm showed high diagnostic performance across diverse datasets, comparable to US screening benchmarks, promising for large-scale screening triaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPBR-4

### Simulating Synthetic Post-contrast Breast MRI from Single Pre-contrast MRI Sequence Using Deep Learning Model

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility of deep learning model for simulated post-contrast T1-weighted breast MR images generated using single pre-contrast MR image in patients with breast cancer. In addition, to validate the deep model network implemented with five pre-contrast sequences including T2-weighted and diffusion-weighted imaging.

#### METHODS AND MATERIALS

In this retrospective study, 363 women with breast cancer and contrast-enhanced breast MRI were identified between June 2019 and December 2019 at a single academic institution. An Extra-Dimensional U-net with visual geometry group was developed to simulate T1-weighted post-contrast images from single pre-contrast T1-weighted images. A total of 330 cases were used for the training set and 24 cases were used for validation set. In addition, we externally validated the deep learning model using five pre-contrast sequences (T1-weighted non-fat suppressed [FS], T1-weighted FS, T2-weighted FS, apparent diffusion coefficient, and diffusion-weighted imaging) [[https://github.com/ecalabr/breast\\_simulated\\_gad](https://github.com/ecalabr/breast_simulated_gad)]. Performance was evaluated qualitatively regarding lesion visibility and five point scale (5: excellent, 4: good, 3: acceptable, 2: poor and 1: unacceptable), and also quantitatively with metrics including peak signal to noise ratio (PSNR) and SSIM (structural similarity index).

#### RESULTS

The validation set of 24 MRI examinations in 24 women (mean age, 56 years; range, 43-73 years) were evaluated. There were 23 invasive ductal carcinoma, 1 ductal carcinoma in situ; 19 masses and 1 non-mass, 4 mass with nonmass lesions (mean size, 2.2cm; range, 1.1-7.0cm). With our model, 63% (15/24) were visible and were rated 50% (12/24) good or excellent or acceptable and 50% (12/24) unacceptable or poor. In comparison, with the open-source deep model, 70% (17/24) lesions were visible and rated 46% (11/24) good or excellent or acceptable, and 54% (13/24) unacceptable or poor. With our developed model, simulated post-contrast T1-weighted breast MR images showed PSNR of 27.10 and SSIM of 0.87.

#### CONCLUSION

Our developed model using single pre-contrast T1-weighted imaging is capable of producing the simulated post-contrast MR image, and is comparable to outcomes using suggested deep learning model.

#### CLINICAL RELEVANCE/APPLICATION

There is increasing need for non-contrast breast MRI for cancer detection due to gadolinium retention and more accessibility of breast MRI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3B-SPBR-5

### Machine Learning-based Texture Analysis of Axillary LNs Using 3-T MRI for Predicting LN Metastasis in Breast Cancer

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Na Lae Eun, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to determine whether texture analysis for 3-T magnetic resonance imaging (MRI) in axillary lymph nodes (LNs) can predict LN metastasis in breast cancer.

#### METHODS AND MATERIALS

This retrospective study included 204 patients who underwent breast and axillary surgery for breast cancer between March 2022 and December 2022. We assessed common features of axillary LNs, including clinicopathologic features and MRI assessment by radiologists, as well as texture features of axillary LNs on contrast-enhanced T1-weighted images using commercial software based on PyRadiomics. The index LN was determined as the LN with the largest cortical thickness. Logistic regression with feature selection was used to reduce the dimensionality of the data (14 clinicopathologic and 869 texture features). Using the selected features, we trained an XGBoost classifier to build common, radiomics, and combined common and radiomics models for predicting LN metastasis. The diagnostic performance of predictive models for LN metastasis was compared by using generalized estimating equation analysis.

#### RESULTS

Of the 204 women, 47 (23%) were diagnosed with LN metastases. The XGBoost classifier with common features, including clinicopathologic and MRI assessment, showed the lowest diagnostic performance (accuracy and area under the receiver operating characteristic curve [AUC], 73.81% and 0.846). The radiomics and combined common and radiomics model with the XGBoost classifier showed better diagnostic performance than that of the analysis of common features alone (accuracy and AUC, 90.48% and 0.939, 90.48% and 0.939 vs. 73.81% and 0.846,  $p < 0.05$ ). In addition, the combined common and radiomics model showed a positive predictive value of 100% for predicting LN metastasis.

#### CONCLUSION

Texture analysis using an XGBoost classifier for axillary LNs on 3-T MRI may be a useful tool in predicting LN metastasis in patients with breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

Machine learning-based texture analysis of axillary LNs using 3T-MRI can help predict axillary LN metastasis and potentially de-escalate axillary surgery in patients with breast cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPBR-6

### Artificial Intelligence Helps General Radiologists and Breast Imaging Specialists Find Challenging-to-Detect Cancers

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Bryan Haslam, PhD (*Presenter*) Employee, RadNet, Inc

#### PURPOSE

There is growing evidence that AI helps radiologists detect more breast cancers in screening mammography. However, there has been little explanation of how AI helps radiologists with varying levels of specialty. Here, we investigated how AI for DBT helps general radiologists and breast imaging specialists detect breast cancer lesions with varying degrees of how challenging the cancers are to detect.

#### METHODS AND MATERIALS

Following an IRB approved protocol, a reader study was conducted to evaluate the interpretative performance of 18 radiologists including 9 general radiologists and 9 breast imaging specialists. Each reader read 240 retrospectively collected DBT screening exams (100 cancers and 140 non-cancers) once with and once without the aid of AI. General radiologists' and breast imaging specialists' performance, as measured by AUC, were examined with vs without AI. Additionally, cancer exams were sorted by degree of difficulty in two different ways. First, the cancer exams were grouped by the BIRADS assessment given at the time of original clinical interpretation: a) recalled cancers (n = 67) were those given a BIRADS 0 and b) non-recalled cancers (n = 33) were those given a BIRADS 1 or 2. The non-recalled exams are considered more difficult given that these are the clinically "missed" exams where the interpreting radiologist at the time of exam acquisition deemed there were no suspicious findings for a recall. Second, the cancer exams were subdivided into a) harder (n = 16), b) medium (n = 11) and c) easier (n = 73) cancer cases based on the proportion of the readers in the study that recalled the exam when reading without the aid of AI (< 50% recalled, 50% to 75% recalled, and > 75% recalled, respectively).

#### RESULTS

Overall, both general radiologists (AUC increase of 0.075) and breast imaging specialists (AUC increase of 0.050) demonstrated improved performance when reading with AI than without AI. Across both methods of sorting the cancer exams by difficulty, there were greater improvements with AI when radiologists interpreted more challenging (AUC increase for non-recalled: 0.100, harder: 0.176 and medium: 0.110) than less challenging cancers (recalled: 0.040 and easier: 0.027). The largest boost in performance was observed for general radiologists on the harder cancers with an AUC improvement of 0.186.

#### CONCLUSION

AI helped both general radiologists and breast imaging specialists improve cancer detection performance overall and to a greater extent for the more challenging cancer cases.

#### CLINICAL RELEVANCE/APPLICATION

AI for screening DBT helps radiologists with varying levels of specialty, especially on difficult to detect cancers that would likely go undetected until a future exam, suggesting that AI may help detect these cancers earlier.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPBR-7

### Examining the Potential of ChatGPT to Derive Differential Diagnoses from Transcribed Radiological Findings in Breast and Ultrasound Imaging

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of breast and ultrasound radiology cases.

#### METHODS AND MATERIALS

A sample of 25 breast and ultrasound imaging cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

#### RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 32% compared to 40% ( $p=0.28$ ) and 8.0% compared to 12.0% ( $p = 0.32$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 38.9% compared to 45.2% ( $p=0.33$ ). ChatGPT3.5 and ChatGPT4 hallucinated 32.0% versus 8.0% ( $p=0.017$ ) of the references provided and generated 6 total false statements versus 2 total false statements, respectively.

#### CONCLUSION

The ChatGPT algorithms were able to produce a differential diagnosis for prompts containing descriptive radiological findings. The responses matched the expert literature from which the cases originated a minority of the time, though a non-statistically significant improvement was made in the accuracy categories from 3.5 to the 4th generation algorithm. The renowned hallucination effect appeared more frequently in generated citations compared to algorithm-produced statements, with both showing improvement in the latest generation.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) possess considerable potential to transform clinical and educational medicine. Awareness of their accuracy and potential for mistakes will contribute to a more comprehensive understanding of the limitations of such new tools.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPBR-8

### Improving Artificial Intelligence (AI) Risk Assessment with Multiple Imaging Modalities and Prior Imaging Data

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Eliana Goldberg, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to evaluate the efficacy of multimodal AI algorithms (full field digital mammography (FFDM)/digital breast tomosynthesis (DBT), breast ultrasound (US) and prior imaging) into breast cancer risk assessment models

#### METHODS AND MATERIALS

Our IRB-approved research utilized a multimodal AI system trained on a dataset of FFDM, DBT, and US exams. These exams were conducted between 2010 and 2020, involving 1,964,416 exams on 324,978 patients. We used a patient-based 60-10-30 split for training/validation/testing. The testing dataset comprised FFDM/DBT/US from patients not included in the training/validation sets, with histopathology/imaging stability as reference standard. The AI risk model was designed to predict cancer risk at multiple time points: 1 year, 3 years, 5 years, and 10 years based on imaging alone. We compared the model's AUROC, sensitivity, and specificity for each risk assessment interval. We also compared 10-year risk assessments to Tyrer-Cuzick (TC) scores.

#### RESULTS

On a test set of 29,845 patients (average age 59.1, standard deviation 11.09, 74,024 exams), 3.05% (910/29845) were diagnosed with breast cancer within 10 years. The AI model achieved AUROC for breast cancer risk assessment as follows: 0.888 (1 year), 0.804 (3 years), 0.770 (5 years), and 0.760 (10 years). Sensitivity was 71.5% (1 year), 52.3% (3 years), 44.0% (5 years), and 40.7% (10 years). For women with dense breasts, AI model AUROC was 0.876 (1 year), 0.779 (3 years), 0.750 (5 years), and 0.739 (10 years). Sensitivity was 69.8% (1 year), 50% (3 years), 42.7% (5 years), and 39.8% (10 years). For women with non-dense breasts, model AUROC was 0.896 (1 year), 0.822 (3 years), 0.781 (5 years), and 0.774 (10 years). Sensitivity was 72.2% (1 year), 52.8% (3 years), 43.1% (5 years), and 39.5% (10 years). Specificity was held constant at 90% for model binarization thresholds. On a random subset of 134 patients with cancer and non-cancer patients, model AUROC was 0.826 (10 years), while TC scores was 0.644 (10 years). When patients were binarized into high or low risk, AI was more informative than was TC. For example, patients who were assessed as TC high risk but AI low risk had a low incidence of cancer (18.9%; 7/37), whereas patients who were assessed as TC low risk and AI high risk had a high incidence of cancer (89.1%; 33/37).

#### CONCLUSION

Multimodal breast cancer risk assessment based on FFDM/DBT, US imaging and prior examinations outperforms standardized risk cancer assessment.

#### CLINICAL RELEVANCE/APPLICATION

Integrating multiple imaging modalities and prior imaging into AI breast cancer risk assessment models enhances performance, enabling the development of a personalized, data-driven, and evolving screening schedule based on an individual's risk profile over time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPBR-9

### Self-Supervised Pretrained Vision Transformers for Breast Ultrasound Classification

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

George Zhou, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Develop a deep learning model for automated breast ultrasound classification. For computer vision tasks such as this one, convolutional neural networks (CNN) have been the gold standard. Here we study the application of Vision Transformers (ViT) for breast ultrasound classification. Specifically, we examine how the performance of ViT can be improved with self-supervised pretraining.

#### METHODS AND MATERIALS

A total of 647 breast ultrasound images were collected. A label of either benign or malignant was given to each image by radiologists. Malignant cases were validated with histopathologic results from subsequent fine needle aspiration biopsies. The final dataset included 437 benign and 210 malignant US images (PMID: 31867417). The ViT explored in this study consists of 12 transformer encoder layers with 12 multi-attention heads. First the images are tokenized into patches. The patches are linearly projected and combined with positional encodings before input into the sequence of transformer encoders. We study three pretraining paradigms: random weight initialization, supervised pretraining on ImageNet, and self-supervised pretraining on ImageNet. In supervised learning, annotated labels are used during pretraining. In self-supervised learning, representations are learned without any explicit labels; instead, supervisory signals are derived from the data itself. After the models are pretrained, one fully connected layer is added on top of each model and trained to perform binary classification.

#### RESULTS

We evaluate our models using five-fold cross validation. The ViT with random weight initialization achieves an AuROC of  $0.67 \pm 0.08$ . The supervised pretrained ViT achieves an AuROC of  $0.88 \pm 0.04$ . The self-supervised pretrained ViT achieves an AuROC of  $0.92 \pm 0.02$ . Visualization of the self-attention heat maps show that the self-supervised ViT can learn semantic segmentation information without any explicit segmentation masks.

#### CONCLUSION

We show that self-supervised pretraining offers a performance boost compared to supervised pretraining ViT for breast ultrasound classification. Overall, our results show that with the advances being made in deep learning, it may be worthwhile to renew the discussion on the role of ultrasound in screening for breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

In the context of breast cancer screening, mammography is the gold standard. Breast ultrasound, despite being widely available and posing no radiation risk, is limited by a high rate of false positives, operator dependency, and a growing shortage of (breast) radiologists. However, advances in deep learning can potentially mitigate these limitations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCA-1

### Inferior Left Atrial Diverticulum Communicating with the Right Atrium or Inferior Vena Cava: CT and Clinical Features

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Hae Jin Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

Interatrial communications in atypical locations are found at CT. However, information on imaging findings of atypical or nonseptal communications between two cardiac atria has not been known to dates. The purpose of this study was to evaluate the prevalence, location, size and morphological characteristics of left trial (LA) diverticula communicated with right atrium on cardiac CT.

#### METHODS AND MATERIALS

This retrospective study included 222 consecutive patients who underwent cardiac computed tomography and showed incidental inferior LA diverticula (ILAD). The prevalence, number, size, morphological characteristics and location of ILAD communicating with the right atrium or inferior vena cava were analyzed. Shunts were defined as anatomical defects between the two structures with or without visible contrast flow or attenuation step up.

#### RESULTS

The prevalence of ILAD with shunt was 9.9% (22/222) among ILADs. Shapes of ILAD with shunt were tubular (n = 12, 54.5%), saccular (n = 8, 36.3%), and network-like appearance (n = 2, 9.1%). Mean ostial diameter of ILAD and mean size of shunt were 6.4 mm, 4.9 mm, respectively. Of the 22 patients, 7 (31.8%) had two or more shunts.

#### CONCLUSION

Cardiac CT helps to detect a new type of interatrial communications which can mimic classical atrial septal defects. Although their clinical significance remains unclear, radiologists should be aware of them and report their findings.

#### CLINICAL RELEVANCE/APPLICATION

Our study is the first study to visually assess the category using ECG gated cardiac CT for LA diverticulum with shunt to RA.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCA-2

### Cardiac CT-derived Global and Regional Epicardial Adipose Tissue Contributes to Atrial Fibrillation in Patients without Left Atrial Myopathy as Defined by Endocardial Voltage Mapping

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Aqeel Umar, MBCh (*Presenter*) Nothing to Disclose

#### PURPOSE

Atrial myopathy contributes to the pathogenesis of atrial fibrillation (AF), but many AF patients have no obvious atrial myopathy. Epicardial adipose tissue (EAT) has recently been shown to be greater in AF patients than those without AF. Our aim was to assess the relationship of EAT in AF patients with/without atrial myopathy defined by endocardial voltage mapping.

#### METHODS AND MATERIALS

75 AF patients with cardiac CT prior to pulmonary vein ablation were prospectively enrolled. Left atrial (LA) endocardial voltage mapping was performed in all patients. Left atrial myopathy was defined as the sum of all low voltage ( $<0.5\text{mV}$ ) areas (LVA) exceeding 5% of total LA surface area. AF patients were assigned to either LVA- ( $<5\%$  LVA) or LVA+ ( $\geq 5\%$  LVA) groups. 48 age-, sex- and BMI-matched patients without AF and structural heart disease/coronary artery disease, who had undergone cardiac CT, were identified as a control group. Total, LA and right atrial (RA) EAT were quantified on CT using fat density thresholding ( $-195$  to  $-30$  HU) after segmenting areas of interest using standard 3D post-processing software. Differences between groups were assessed using one-way ANOVA and relationships were assessed using correlation analysis. Inter-observer variability of EAT analysis was assessed with correlation analysis and Coefficient of Variance (CV) using random subset of 35 AF patients.

#### RESULTS

LVA- patients ( $n=50$ ; 6% f) were younger than LVA+ patients ( $n=25$ ; 44% f). BMI correlated with total EAT (Spearman  $r$  0.50;  $p<.01$ ), LA EAT ( $r$  0.47;  $p<.01$ ) and RA EAT ( $r$  0.41;  $p<.01$ ) in AF patients and similarly in controls. Between LVA+ and LVA- AF patients, there was no significant difference for total EAT ( $89.1\pm 41.1\text{cm}^3$  vs  $83.5\pm 31.1\text{cm}^3$ ;  $P=.5$ ), LA EAT ( $9.9\pm 5.8\text{cm}^3$  vs  $8.9\pm 3.5\text{cm}^3$ ;  $P=.6$ ) and RA EAT ( $7.4\pm 3.8\text{cm}^3$  vs  $7.5\pm 3.1\text{cm}^3$ ;  $P=.9$ ). Compared to controls, LVA- patients had greater total EAT ( $80.1\pm 29.3\text{cm}^3$  vs  $56.5\pm 22.1\text{cm}^3$ ;  $p<.001$ ), greater LA EAT ( $8.9\pm 3.5\text{cm}^3$  vs  $4.5\pm 1.9\text{cm}^3$ ;  $p<.001$ ) and greater RA EAT ( $7.5\pm 3.1\text{cm}^3$  vs  $4.9\pm 2.0\text{cm}^3$ ;  $p<.001$ ). There was good agreement for total EAT ( $r=0.99$ ), LA EAT ( $r=0.98$ ) and RA EAT ( $r=0.98$ ) between observers (all  $p<.001$ ) with CV of 3.5%, 6.4% and 6.2% respectively.

#### CONCLUSION

EAT does not differ between AF patient with or without LA myopathy, but EAT is significantly greater among AF patients without LA myopathy compared to controls without AF. These findings suggest that EAT may contribute to the pathogenesis of AF even in the absence of LA myopathy. Strategies to monitor and reduce EAT may help to improve rhythm control in these patients.

#### CLINICAL RELEVANCE/APPLICATION

Increased EAT volume may play an important role in AF pathogenesis in patients without LA myopathy; further studies should analyse the effect of EAT reducing treatment and downstream effects on AF incidence.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCA-3

### **Metabolic Syndrome is Associated with Impaired Left Atrial and Left Ventricular Deformation and Abnormal Atrioventricular Interaction in Patients with Myocardial Infarction**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Jing Liu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Metabolic syndrome (MetS) is a cluster of cardiovascular risk factors that predicts poor short- or long-term outcomes in patients with myocardial infarction (MI). However, the potential mechanisms influencing prognosis are still unclear. Thus, this study aimed to determine the effect of MetS on left atrial (LA) and left ventricular (LV) deformation and abnormal atrioventricular interactions in MI patients.

#### **METHODS AND MATERIALS**

A total of 181 MI patients, including 119 without MetS (MI [MetS-]) and 62 with MetS (MI [MetS+]), and 58 controls who underwent 3.0 T cardiac magnetic resonance (CMR) were included. LA ejection fraction [LAEF] and deformation indices (reservoir, conduit, and booster pump function) and LV deformation parameter (global peak radial, circumferential, and longitudinal strain [PS]) based on CMR three-dimensional feature tracking were measured and compared among groups. Correlations of MetS and LV deformation and geometry with LA functional indices were assessed by multivariable linear regression analysis.

#### **RESULTS**

LA reservoir function (total EF and total strain) and conduit function (passive strain) and LV deformation parameters (radial, circumferential, and longitudinal PS) significantly decreased from the control group, through the MI (MetS-), to MI (MetS+) group (all  $P < 0.05$ ). Compared with controls, the booster pump function (active EF and active strain) was decreased in the MI (MetS+) group (all  $P < 0.05$ ) but preserved in the MI (MetS-) group. Furthermore, multivariate linear regression demonstrated that MetS was independently associated with total and active LAEF, total and passive strain ( $\beta = -0.172$  to  $-0.200$ , all  $P < 0.05$ ) in MI patients; LA reservoir and conduit function were independently associated with LV circumferential PS ( $\beta = 0.230$  to  $0.394$ , all  $P < 0.05$ ) and longitudinal PS ( $\beta = 0.189$  to  $0.354$ , all  $P < 0.05$ ), LA passive strain and strain rate were independently associated with LV mass ( $\beta = -0.178$  and  $-0.298$ , all  $P < 0.05$ ).

#### **CONCLUSION**

Coexisting MetS may exacerbate the adverse effects of MI on LA and LV dysfunction. LV circumferential and longitudinal PS are stable predictors of LA three-phasic function; LV hypertrophy is independently associated with LA conduit function.

#### **CLINICAL RELEVANCE/APPLICATION**

These results suggest that metabolic disorders may be important in managing patients with myocardial infarction.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3B-SPCA-4

### **MRI Evaluation by T1 Mapping of the Post Myocardial Infarction Left Ventricular Thrombus**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Samer Abi Khalil, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The objective of this study is to evaluate the post myocardial infarction left ventricular thrombus on cardiac MRI by measuring its T1 mapping value, thus to determine the age of thrombus.

#### **METHODS AND MATERIALS**

This observational retrospective study was performed on all patients scheduled for 3.0 Tesla cardiac MRI post myocardial infarction on our institution from January 2015 to December 2022. 35 patients with a left ventricular thrombus that may be measurable on T1 mapping sequence were included. They were separated in two groups depending on the period of time between the infarct and the MRI - less than three months: group A; more than three months: group B. T1 mapping value was measured for all thrombi.

#### **RESULTS**

T1 of thrombi was  $1098 \pm 61$  ms in group A and  $1316 \pm 75$  ms in group B,  $p < 10^{-4}$ . T1 of the myocardium was  $1224 \pm 73$  ms in group A and  $1254 \pm 48$  ms in group B,  $p = 0.139$ . T1 of the blood pool was  $1934 \pm 137$  ms in group A and  $2008 \pm 124$  ms in group B,  $p = 0.135$ .

#### **CONCLUSION**

Recent thrombi had shorter mapping T1 than old thrombi.

#### **CLINICAL RELEVANCE/APPLICATION**

This method represents a new approach for the age and the maturity of left ventricular thrombus. It provides complementary information for the recommendations of imaging control and anticoagulation therapy.

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## Abstract Archives of the RSNA, 2023

S3B-SPCA-5

### STEMI Patients: Who Gets What Imaging

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Alex Zhang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Our study aims to determine if hospital and patient characteristics affect what type of imaging modality ST elevated myocardial infarction (STEMI) patients receive.

#### METHODS AND MATERIALS

The National Emergency Department Sample (NEDS) database was retrospectively queried for patients with a primary diagnosis of STEMI. Logistic regression was used to determine the likelihood of receiving ultrasound and fluoroscopy based cardiac imaging with respect to hospital characteristics such as region, teaching status, and trauma level designations. We also looked at patient characteristics including hypertension, hyperlipidemia, and tobacco usage.

#### RESULTS

Of the 175,700 patients with a primary diagnosis of STEMI, most were white (74.1%), seen at a non-trauma hospital (49.7%), and insured through medicare (44.8%). Female patients were less likely to get fluoroscopy imaging (OR: .927, 95%CI .871 - .987) than male patients. Black patients were also less likely to get fluoroscopy imaging relative to white patients (OR: .711, 95%CI .583 - .869). Patients with private insurance and patients at teaching hospitals were more likely to get fluoroscopy relative to medicare patients (OR: 1.211, 95%CI 1.069 -1.371) and patients at non teaching hospitals (OR: 1.563, 95%CI 1.133 - 2.155). Patients at trauma hospitals level 1-3 were more likely to get fluoroscopic cardiac imaging compared to non trauma hospitals: Level 1 (OR: 1.593, 95%CI 1.022 - 2.486), Level 2 (OR: 2.489??, 95%CI 1.813 - 3.417), Level 3 (OR: 2.216 95%CI 1.544 - 3.180) Patients with private insurance were more likely to get ultrasound cardiac imaging compared to medicare patients (OR: 1.165, 95%CI 1.025 - 1.325). Trauma level had no effect on patients receiving ultrasound cardiac imaging compared to non trauma: Level 1 (OR: 1.548, 95%CI 0.856 - 2.801), Level 2 (OR: 1.548, 95%CI 0.796 - 2.266), Level 3 (OR: 0.941 95%CI .559 - 1.583)

#### CONCLUSION

We found that females and black patients are less likely to receive fluoroscopy imaging relative to male and white patients, respectively. While ongoing gender and race disparities may play a role in these findings, further studies are needed to fully elucidate this relationship. Additionally, private insurance beneficiaries are more likely to get imaged with fluoroscopy. Proximity to hospitals with imaging capabilities and better access to resources may play a role in our findings

#### CLINICAL RELEVANCE/APPLICATION

Hospitals and clinicians need to re-evaluate their imaging algorithm for black and female patients. We also found that type of insurance and teaching hospital drastically affects likelihood of receiving fluoroscopy. These findings indicate a deeper health inequality that hospitals and physicians should address together in order to make healthcare more equitable

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCA-6

### STEMI Patients: Can Imaging Predict Cost of Stay and Mortality?

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Alex Zhang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Our study aims to determine if imaging modality can predict cost of stay and mortality in patients who have a primary diagnosis of ST elevated myocardial infarction (STEMI).

#### METHODS AND MATERIALS

The national emergency department sample (NEDS) database was retrospectively queried for patients who had a primary diagnosis of STEMI. A multivariate linear regression model was used to account for key clinical covariates including age, sex, race, insurance status, income quartile, teaching status, trauma level, and cardiac risk factors such as tobacco use, coronary artery disease, and hyperlipidemia to determine cost associated with cardiac imaging. Primary outcomes focused on cost associated with use of CT, MRI, fluoroscopy, and ultrasound. A secondary analysis, with the same multivariate model, was performed to determine if certain imaging corresponded to increased odds of death.

#### RESULTS

Of the 175,700 patients, in our analysis, that presented to the emergency department with a primary diagnosis of a STEMI, most were female (69.3%), white (74.1%), and had a median income in the 1st quartile (29.4%). There was increased cost associated with all cardiac imaging modalities (relative to patients who did not receive an imaging modality); fluoroscopy (B: 27,630, 95%CI 15,748-39,311), CT (B: 32,757, 95%CI 4,036-61,478), MRI (B: 397,766 380980-414,751), x-ray (24,740, 95%CI 6,426-43,055) and ultrasound (B: 25,492, 95%CI 14,150-36,834). Patients who got imaging with ultrasound (OR: 0.76, 95%CI 0.64-0.90) or fluoroscopy (OR: 0.45 95%CI 0.39-0.53) were less likely to die relative to patients who did not get imaged by those modalities. There was no difference in death rate in patients who were imaged with X-ray (OR:0.79, 95%CI 0.47-1.35) or CT scan (OR: 0.62, 95%CI 0.37-0.1.04).

#### CONCLUSION

STEMI patients who get imaging pay significantly more than patients who do not get imaging. However, the use of x-ray or CT scan imaging does not necessarily lead to better outcomes, as shown in the death rates we have found. Each imaging modality is found to increase cost of stay in the tens of thousands of dollars, with MRI, being the exception, increasing cost of stay by hundreds of thousands of dollars.

#### CLINICAL RELEVANCE/APPLICATION

Hospitals and clinicians should be encouraged to rethink what type of imaging they order for STEMI patients. Our study shows that CT and X-ray do not decrease mortality rate, while increasing cost of stay for patients by tens of thousands of dollars.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCA-7

### Diagnostic Accuracy of Dynamic Stress CT Myocardial Perfusion with Regadenoson for the Detection of Hemodynamically Significant Coronary Artery Disease

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Cesar Urtasun Iriarte I, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the diagnostic performance of dynamic stress CT myocardial perfusion imaging (CT-MPI) in combination with coronary CT angiography (CCTA) to accurately identify hemodynamically significant coronary artery disease (CAD) compared to the gold standard (invasive coronary angiography, ICA; and invasive fractional flow reserve, iFFR).

#### METHODS AND MATERIALS

Between December 2019 and February 2023, 141 patients with suspected or known CAD underwent CCTA and dynamic stress CT-MPI employing regadenoson as stressor. The presence of hemodynamically significant coronary lesions was determined by CCTA (CAD-RADS=3) and CT-MPI (myocardial blood flow relative to remote myocardium <0.85) compared to CCTA alone, using angiographic severity and a iFFR of =0.80 as reference.

#### RESULTS

A total of 141 patients (113 males, mean 64.8±10.1 years old, 24 with prior stent implantation) were evaluated. CCTA and CT-MPI were positive in 67 (47.5%) and 50 (35.5%) patients, respectively. 43 patients (32 males, 65.6±11.1 years old; 93.3% with CAD-RADS =3) who underwent ICA were retained for the statistical analysis. Compared to ICA, the patient-based analysis of CCTA showed a sensitivity of 100%; specificity of 50%, negative predictive value (NPV) of 100% and a positive predictive value (PPV) of 92.5%. The approach comprising CCTA and dynamic stress CT-MPI increased the specificity (97.4%) and PPV (97.4%). The accuracy of the combination of the anatomical and functional techniques was also higher (97.7% vs 93%). Receiver operating curve (ROC) analysis showed improved discrimination accuracy for the combination of CCTA and CT-MPI (0.92; CI 0.74-1; p=0.001) compared with CCTA alone (0.75; CI 0.49-1; p=0.052).

#### CONCLUSION

Dynamic stress CT-MPI with regadenoson offers incremental diagnostic value over CCTA alone for the detection of hemodynamically significant CAD.

#### CLINICAL RELEVANCE/APPLICATION

Dynamic stress CT-MPI is an easy-to-perform diagnostic examination technique which increases the specificity and diagnostic accuracy of CCTA alone for the detection of hemodynamically significant CAD.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCH-1

### Quantitative Analysis for Bronchiectasis using Artificial Intelligence-based Bronchial Tapering Ratio in Patients with Chronic Obstructive Pulmonary Disease

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Hyejin Park (*Presenter*) Nothing to Disclose

#### PURPOSE

Bronchiectasis (BE) is associated with loss of lung function and increased morbidity and mortality. CT is the standard method used to assess bronchiectasis but current imaging methods are limited in assessing the extent of bronchiectasis on CT scans. This study aimed to automatically quantify the extent of bronchiectasis based on an artificial intelligence (AI)-based analysis of bronchial tapering ratio on chest CT and assess the association of quantified bronchiectasis score and exacerbations in patients with chronic obstructive pulmonary disease (COPD).

#### METHODS AND MATERIALS

We analyzed the longitudinal cohort data of COPD patients from the Korean Obstructive Lung Disease (KOLD) cohort. The bronchiectasis score accounting the extent of abnormal tapering of inner lumen compared with the proximal airway (bronchial tapering ratio = 1.1, a measure of airway dilatation) in each patients on chest CT scans was analyzed. Quantified bronchiectasis score was correlated with visual analysis by two thoracic radiologists. Multivariable logistic analysis was performed to assess the association between the bronchiectasis score and pulmonary exacerbations on follow-up adjusted by demographics, pulmonary functional measure, and airway CT parameters.

#### RESULTS

Total 337 patients (median age, 66 years; 328 men [97%]) were included. Among the 337 patients, 210 (62%) had a history of a least one exacerbation. Bronchiectasis was present based on visual analysis in 148 (43.9%) patients and bronchiectasis score significantly increased as extent of bronchiectasis on visual analysis increased ( $P = .02$ ). During a median 5-year follow-up, the bronchiectasis score was a significant independent predictor of acute exacerbation (adjusted odds ratio [OR], 1.12 [95%CI: 1.03-1.22];  $P = .007$ ) along with wall area percentage on CT (OR, 1.03 [1.01-1.06];  $P = 0.02$ ) and forced expiratory volume in 1 s (OR, 0.98 [0.97-0.99];  $P = 0.002$ ) in multivariable analysis.

#### CONCLUSION

In COPD, artificial intelligence-based CT measures of bronchiectasis based on bronchial tapering ratio were significant predictors for acute exacerbation.

#### CLINICAL RELEVANCE/APPLICATION

Evaluation of extent of bronchiectasis on chest CT using artificial intelligence-based bronchial tapering ratio were reliable and automatically quantified extent of bronchiectasis on CT had prognostic implications for COPD exacerbations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCH-2

### **Lymphatic Bubble Sign in Lung and Mediastinum: Special CT Feature for the Diagnosis of Pulmonary Lymphatic Malformation with Lymphatic-airway Leakage**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

MENGKE LIU (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the special CT feature of lymphatic bubble sign (LBS) on HRCT for the diagnosis of pulmonary lymphatic malformation (PLM) with lymphatic-airway or alveolar leakage.

#### **METHODS AND MATERIALS**

Eight hundred and ten patients diagnosed as PPL were collected in this retrospective study from January of 2006 to December of 2022, of which 62 cases with chylous phlegm and plastic bronchitis showed LBS in lung and/or mediastinum on HRCT or CT lymphography. The imaging features of LBS were blinded reviewed by two chest radiologists respectively, including the position, size, quantity, morphology, and dynamic changes of bubbles. All patients were followed up for HRCT within 1-6 months.

#### **RESULTS**

LBS was seen in 62 (7.7%) of 810 patients with PPL, which was located in pulmonary interstitium in 30 cases, paraloobar-fissure with thickening in 5 and mediastinal fat area in 12, both in 20 patients. ALL the LBS manifested multiple lesions, no wall or thin wall and round-like with smooth edges with a size of 3-10mm. A dynamic changes of this sign was showed in all patients with obvious improvement in 56 cases, aggravation 6 and recurrent occurrence in 25 patients on the 1-6 months follow-up CT. In addition, similar lesions were showed in chest wall, ribs and pleural cavity, respectively. The associated-accompanying lesions include ground glass opacity, interlobular septal thickening, tree-in-bud, chylothorax, chylo-pericardium and mediastinal opacity. All the lesions is not related to thoracic puncture drainage or direct lymphangiography, but patients often have long-term medical history of dyspnea and chronic cough.

#### **CONCLUSION**

This sign indicates the formation of lymphatic and airway leaks in the lungs, with chylous leakage leading to chylous pneumonia and plastic bronchitis. However, the air in the airway pours back into the lymphatic vessels due to pressure changes and other reasons, forming the LBS. Chest CT has important value in displaying this sign and helps to determine PLMs and chylous leakage and providing strong evidence for clinical treatment.

#### **CLINICAL RELEVANCE/APPLICATION**

LBS strongly favors a diagnosis of pulmonary lymphedema and lymphatic dilatation with lymphatic-airway or alveolar leakage and plastic bronchitis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCH-3

### Template Matching Method for Accurate Quantification of Cystic Tissue Volume in CT Scans of Diffuse Cystic Lung Disease

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Katie J. Noonan, BEng, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Diffuse Cystic Lung Disease (DCLD) is a broad term used to describe rare lung diseases characterised by the presence of air-filled cysts within the parenchyma of the lungs. Due to their relative scarcity and visual similarity to more prevalent diseases such as emphysema, DCLDs are frequently mis-diagnosed, leading to significantly worse clinical outcomes and a higher burden on the healthcare system. Our research presents a method which accurately identifies cystic regions within DCLD CT scans, achieving a similar standard to expert defined manually annotated cases. Furthermore, the method quantifies cystic tissue volume in the sample, providing a reliable and efficient means of assessment.

#### METHODS AND MATERIALS

Template matching methods involve the extraction of image features, such as shape, texture and colour, and correlates them with a pre-defined image template to identify regions of interest. In the context of a Lymphangioliomyomatosis CT scan, circular regions of low attenuation that exhibit high correlation to a black circle template were isolated and defined as potential cystic regions. The detected regions were then compared with related manually annotated cases which had previously outlined the presence of cystic regions as identified by an expert radiologist.

#### RESULTS

The method's performance was evaluated by comparing its results with that of the manual annotations of an expert radiologist. The assessment yielded a Dice Similarity Coefficient of 86%, Precision of 79%, Specificity of 99% and an F1 Score of 88%.

#### CONCLUSION

The high correlation observed between the template matching method and the manually annotated cases outlines the potential of semi-automated feature extraction methods as a faster and less labour-intensive method to quantifying cystic tissue volume across numerous cases. By computing the ratio between cystic and lung tissue volume, this method provides a reliable means of assessing the overall health of lung tissue. The use of such methods has broad implications in clinical settings, where accurate and efficient evaluation of numerous cases is essential.

#### CLINICAL RELEVANCE/APPLICATION

The semi-automated method outlined identifies cystic regions comparably to expert radiologists, allowing development of a lung health score based on cystic/lung tissue volume ratio.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCH-4

### Clinical Course and Risk Factors for Development and Progression of Interstitial Lung Disease in Primary Sjögren's Syndrome

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Eunseo Lee (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the long-term course and prognostic factors of patients with primary Sjögren syndrome-associated interstitial lung disease (pSS-ILD).

#### METHODS AND MATERIALS

This single-center, retrospective study included 120 pSS patients who underwent at least two high-resolution computed tomography (HRCT) scans between March 2013 and February 2021. Clinical symptoms, laboratory data, HRCT findings, and pulmonary function test results were collected. HRCT were scored blindly by two expert thoracic radiologists: extent of ground glass opacities (GGO), fine/coarse reticulations, and honeycombing, and coarseness score of fibrosis.

#### RESULTS

In patients with pSS without ILD at baseline (n=81), no development of ILD was found on follow-up (median, 2.8 years). In patients with pSS-ILD (n=39), total disease extent, extent of coarse reticulation, and traction bronchiectasis increased on HRCT, whereas the extent of GGO decreased at follow-up (median, 3.2 years) (each  $p < 0.001$ ). In progressive group of pSS-ILD (n=19/39, 48.7%), the extent of coarse reticulation and coarseness score of fibrosis were increased at follow-up ( $p < 0.05$ ). Multivariate logistic regression analysis showed that LDH (OR, 1.012) and diffusing capacity for carbon monoxide (OR, 0.922) were independent risk factors for pSS-ILD at baseline. Usual interstitial pneumonia (UIP) pattern on CT (OR, 15.237) and follow-up duration (OR, 1.403) were independent risk factors for disease progression in patients with pSS-ILD. In response to glucocorticoid and/or immunosuppressants, GGO decreased, whereas the extent of fibrosis increased even after treatment.

#### CONCLUSION

In pSS patients with no ILD during baseline evaluation, no newly developed ILD was identified during follow-up over two years. Progression occurred in approximately half of the pSS-ILD patients with slow gradual deterioration. UIP pattern on CT and follow-up duration were independent risk factors for progression of pSS-ILD.

#### CLINICAL RELEVANCE/APPLICATION

HRCT is a crucial modality for determining the progression of lung fibrosis in patients with pSS, in addition to the initial screening evaluation for ILD.

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## Abstract Archives of the RSNA, 2023

S3B-SPCH-5

### Chest Radiography, Computed Tomography and Magnetic Resonance in Evaluation of Pulmonary Sarcoidosis in Assessment of Disease Progression and Comparison with Pulmonary Function Tests

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Stephan Altmayer, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare radiography, high resolution computed tomography (HRCT), and magnetic resonance imaging (MRI) in the assessment of disease progression in pulmonary sarcoidosis in comparison to pulmonary function tests.

#### METHODS AND MATERIALS

In this prospective study of 77 adults diagnosed with sarcoidosis, all subjects underwent baseline pulmonary function testing, chest radiography, HRCT and MRI. Chest radiographs were categorized using the Siltzbach classification system. HRCT and MRI were scored using the Scleroderma Lung Study I system. Pulmonary function was reassessed after 12 months, with progressive disease defined by  $\geq 5\%$  reduction of forced vital capacity (FVC). Differences in median imaging scores were assessed with Student's t-test and Wilcoxon rank-sum test. Correlation between imaging and pulmonary function was investigated using Pearson's and Spearman's rank correlation coefficients. FVC decline was the gold standard on multivariate analysis used to calculate the odds ratios (OR) for progression of disease predicted by imaging, with score thresholds determined by maximum Youden's index. The area under the curve (AUC) of the receiver operating characteristic plot was calculated for each imaging modality.

#### RESULTS

There is a strong correlation between chest radiography and MRI ( $r=0.649$ ,  $P < 0.001$ ), and CT and MRI scores ( $r=0.851$ ,  $P < 0.05$ ). CT and MRI scores correlated with FVC (MRI:  $r = -0.584$ ,  $P < 0.001$ ; CT:  $r = -0.308$ ,  $P = 0.049$ ) and diffusing capacity of the lung for carbon monoxide (MRI:  $r = -0.564$ ,  $P = 0.004$ ; CT  $r = -0.216$ ,  $P = 0.017$ ). The AUCs for Radiography, MRI and CT scores were 0.70 (0.49-0.85), 0.51 (0.32-0.75), and 0.76 (0.56-0.90), respectively. Multivariate analysis demonstrated significant prediction of progressive disease by CT (OR = 1.236,  $p = 0.044$ ) and MRI (OR = 1.594,  $p = 0.021$ ).

#### CONCLUSION

MRI may be a viable alternative to HRCT in lung assessment and prediction of disease progression in patients with pulmonary sarcoidosis.

#### CLINICAL RELEVANCE/APPLICATION

MRI may be a viable tool for the assessment of disease progression in patients with pulmonary sarcoidosis, although further studies are necessary to validate this tool.

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## Abstract Archives of the RSNA, 2023

S3B-SPCH-6

### To Evaluate the Role of the F FDG PET CT in the Idiopathic Pulmonary Fibrosis and Diffuse Parenchymal Lung Disease

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Sikandar M. Shaikh, DMRD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the role of the (18)F-FDG PET/CT in patients with idiopathic pulmonary fibrosis (IPF) and diffuse parenchymal lung disease (DPLD).

#### METHODS AND MATERIALS

Seventy-two patients (62 men and 10 women; mean age +/- SD, 68.7 +/- 9.4 y) with IPF (n = 36) or other forms of DPLD (n = 36) were advised whole body PET/CT and also high-resolution CT (HRCT), which were acquired simultaneously. 18 F FDG was done after injecting the radiotracer and whole-body PET-CT was done after 60 minutes of FDG administration. The amount of the uptake in the pulmonary (18)F-FDG metabolism was quantified as a standardized uptake value (SUV(max)). Along with this scan the HRCT lung was done for each patient and further analysis of the various HRCT patterns of parenchymal involvement as ground-glass opacities or reticulation/honeycombing. Along with this the patients underwent a global health assessment and pulmonary function tests.

#### RESULTS

The pulmonary uptake metabolism in 72 of 72 patients was evaluated. The parenchymal pattern of the HRCT is seen as the maximal (18)F-FDG metabolism which was seen predominantly in ground-glass (14/72), reticulation/honeycombing (52/72), and mixed (6/72). The mean SUV(max) in patients with ground-glass and mixed patterns was 2.0 +/- 0.4, and in reticulation/honeycombing it was 3.0 +/- 1.0 (Mann-Whitney U test, P = 0.007). The mean SUV(max) in patients with IPF was 2.9 +/- 1.1, and in other DPLD it was 2.7 +/- 0.9 (Mann-Whitney U test, P = 0.862). The mean mediastinal lymph node SUV(max) (2.7 +/- 1.3) correlated with pulmonary SUV(max) (r = 0.63, P < 0.001). Pulmonary (18)F-FDG uptake correlated with the global health score (r = 0.50, P = 0.004), forced vital capacity (r = 0.41, P = 0.014), and transfer factor (r = 0.37, P = 0.042).

#### CONCLUSION

The increased pulmonary (18)F-FDG metabolism is seen in all the patients with IPF and also other forms of DPLD was observed. Pulmonary (18)F-FDG uptake shows significant changes in the measurements of health and lung physiology in these patients. The analysis showed that the (18)F-FDG metabolism is higher at the site of maximal uptake which corresponds to the areas of reticulation/honeycombing on the HRCT scans other than with ground-glass patterns.

#### CLINICAL RELEVANCE/APPLICATION

The role of the Whole body PET-CT is important in various forms of ILD and other pathologies in the chest

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCH-7

### Predictors of Progressive Pulmonary Fibrosis: A Radiologic-Pathologic Correlation Study

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Hyeong Ryun Cho, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Progressive pulmonary fibrosis (PPF), which is treatable with anti-fibrotic therapy, is defined as interstitial lung disease (ILD) other than idiopathic pulmonary fibrosis (IPF) that manifests progressive features regardless of standard management. This study evaluates the radiologic-pathologic correlations of PPF and identifies predictors associated with disease progression and survival.

#### METHODS AND MATERIALS

Between January 2004 and December 2020, 75 patients diagnosed with ILD other than IPF who underwent surgical lung biopsy were retrospectively included. Three chest radiologists reviewed chest computed tomography (CT) features and fibrosis extent on baseline and follow-up CT, and patients were subdivided into PPF and non-PPF based on progression. Two pathologists reviewed cases for pathologic features and the presence of usual interstitial pneumonia (UIP). Overall and progression-free survival were calculated using the Kaplan-Meier method, and the Cox proportional hazard method was used to examine predictors for progressive pulmonary fibrosis and survival.

#### RESULTS

Regarding radiologic-pathologic correlations, when the pathologic UIP pattern was present in the specimen, it was associated with radiologic honeycombing, traction bronchiectasis, and reticulation ( $p < 0.001$ ). Progression was seen in 42.7% (32/75) of non-IPF ILD patients, with a median progression time of 44 months. Radiologic traction bronchiectasis was identified as the only predictive factor of PPF on the multivariate Cox-proportional hazard method (hazard ratio [HR], 6.54;  $p = 0.003$ ). PPF (HR, 3.96;  $p = 0.013$ ) and advanced age (HR, 1.13,  $p < 0.001$ ) were associated with an increased risk of death in non-IPF ILD patients. The median survival time of PPF was 120 months.

#### CONCLUSION

A radiologic pattern of traction bronchiectasis was a predictor of PPF, while PPF and advanced age were risk factors for low survival in non-IPF ILD patients.

#### CLINICAL RELEVANCE/APPLICATION

Recognition of traction bronchiectasis is crucial for predicting PPF in patients with non-IPF ILD, emphasizing the importance of timely initiation of anti-fibrotic therapy in improving patient outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPCH-8

### **Granulomatous and Lymphocytic Interstitial Lung Disease in Common Variable Immunodeficiency: CT Findings and Association with Pulmonary Function Tests**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Nicholas Landini, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Common Variable Immunodeficiency (CVID) may be complicated by Granulomatous and Lymphocytic Interstitial Lung Disease (GL-ILD). GL-ILD includes a wide spectrum of ILD abnormalities, worsening CVID prognosis. We aimed to characterize chest Computed Tomography (CT) findings of GL-ILD, in comparison with CVID patients without GL-ILD, and their association with PFT worsening.

#### **METHODS AND MATERIALS**

Patients with CVID followed from 2018 to 2021 were retrospectively evaluated. Inclusion criteria were: GL-ILD diagnosis, CT and PFT performed within one week. Patients on GL-ILD therapy or with the clinical suspicion of infection were excluded. Age and sex matched non GL-ILD subjects were searched. CT findings, evaluated in consensus by two chest radiologists, were: bronchiectasis, bronchial wall thickening, mucous plugs, tree in bud, mosaic perfusion, small nodules ( $\leq 10$ mm) and big nodules (multiple  $\geq 3$ ), consolidation, ground glass opacities (GGO), reticulation, fibrotic ILD, cavitation/necrosis and bands. Small nodules main distribution (centrilobular, perilymphatic or random) was noted. CT abnormalities were assessed in upper, lower fields and whole lungs, describing disease predominance. Presence of enlarged nodes (axis  $\geq 10$  mm), pleural or pericardial effusion was also assessed. Fisher exact test was computed, assessing Odds Ratios (OR) for GL-ILD against non GL-ILD. A significant p-value was set as  $\leq 0.05$ , with Bonferroni correction for the following PFT: TLC, FEV1, FVC and DLCO, % predicted.

#### **RESULTS**

38 GL-ILD subjects and 38 controls were identified. Most common GL-ILD CT findings in GL-ILD ( $\geq 50\%$  patients) were: bronchiectasis, multiple non-perilymphatic small nodules, GGO, consolidations, bands and enlarged nodes. The disease was usually predominant in lower fields (92%). Bronchiectasis, GGO, reticulations, fibrosis and bands were more frequent in lower fields. GGO was associated with TLC worsening, reticulation with all PFT worsening, fibrotic ILD with DLCO (p-value  $\leq 0.0125$ ). Considering whole lungs analysis, small nodules, consolidations, reticulations and fibrosis had an OR  $\geq 10$  in identifying GL-ILD versus non GL-ILD patients.

#### **CONCLUSION**

GL-ILD usually manifests with bronchiectasis, non-perilymphatic nodules, GGO, consolidations, bands and enlarged mediastinal lymph nodes, with a lower field predominance. Reticulation is the main CT finding associated with functional worsening. Small nodules, consolidations, reticulations and fibrotic ILD are highly suggestive of GL-ILD in CVID subjects.

#### **CLINICAL RELEVANCE/APPLICATION**

These results provide CT characteristics of GL-ILD that may be helpful in the diagnosis of a such polymorphic disease, verifying their relationships with PFT worsening

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPER-1

### Self-Supervised Machine Learning to Triage Acute Chest Syndrome in Pediatric Patients with SCD

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Syed M. Anwar, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Children with sickle cell disease (SCD) are at a high risk of poor outcome if they develop pneumonia or acute chest syndrome (ACS). We have developed a machine learning model for ACS prediction using chest radiographs (CXR), hence triaging children for treatment presented to the emergency department.

#### METHODS AND MATERIALS

We performed a retrospective analysis of children with SCD who had a CXR performed at an urban pediatric emergency department between July 2015 and March 2023. A query of our clinical registry identified 1,115 pediatric SCD patients with "likely ACS" (n=601) or "likely not ACS" (n=514), based on diagnosis code and disposition. We manually reviewed the radiologist impression for each CXR and excluded 28.4% (n=171) of patients in the "likely ACS" group and 5.1% (n=26) of patients initially labeled "likely not ACS". A pre-trained, self-supervised machine learning model was fine-tuned using manually reviewed CXR impressions to predict ACS in future radiographic images. Our deep learning model used a vision transformer and was pre-trained on 400,000 CXRs from publicly available data. The model and was earlier tested on other clinical conditions such as covid-19, age, and sex prediction. We report machine learning inference time and the time required to complete the radiologic assessment, reporting timing for both daytime and overnight studies because an attending radiologist is available to review new studies during daytime and evening hours but only reviews images overnight if they are paged directly with a question.

#### RESULTS

The average accuracy of our ACS prediction model was 0.85 with sensitivity of 0.77, specificity of 0.91, and AUC of 0.89. Machine learning inference time was 0.0068 (median) seconds (IQR:0.0065-0.0072) running on machine with NVIDIA RTX A5000 GPU with half-precision (FP16). Daytime studies, completed between 06:00 and 22:00 h, were read by a radiologist within 55.0 (median) minutes (IQR:23.0-115.0). Overnight studies, completed between 22:00 and 06:00 h, were read within 401.5 (median) minutes (IQR:245.25-535.75).

#### CONCLUSION

The model for ACS prediction from CXR has the potential to identify high risk SCD patients in the emergency department in a timely manner with clinically acceptable performance. Our inference time is real-time, allowing for prediction of ACS as soon as a CXR is recorded in the PACS.

#### CLINICAL RELEVANCE/APPLICATION

ACS is associated with mortality and severe morbidity in children with SCD and requires rapid recognition and intervention. At our single site, real-time machine learning prediction has the greatest potential to expedite diagnosis during overnight hours.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPGI-1

### Clinical and Imaging Features of Focal Intrahepatic Biliary Stricture Visualized Only as Duct Dilatation

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Byoungje Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The percentage of patients with precursor lesions or malignancy due to focal intrahepatic stricture (FIHS) without radiographically demonstrable bile duct abnormality, visualized only as duct dilatation, is currently unknown. Moreover, it is unknown whether there is a variable to differentiate malignant or precursor lesions from non-precursor benign lesions. Therefore, we studied the proportion of patients with FIHSs that were precursor lesions or malignancies. Additionally, we evaluated the clinical variables and MRI features that may discriminate between non-premalignant benign and premalignant/malignant FIHSs.

#### METHODS AND MATERIALS

This retrospective study assessed patients who underwent surgery for FIHS between January 2010 and March 2022. The number and proportion of non-precursor benign lesions, precursors, and malignancies were calculated. Clinical variables and MRI features were compared between non-premalignant benign and premalignant/malignant FIHSs using independent t-tests and chi-square tests for continuous and categorical variables, respectively.

#### RESULTS

Twenty-five patients with confirmed histopathological diagnoses were identified. The study included 13 men (52.0%) and 12 women (48.0%). The median age of all the patients at the first imaging diagnosis was 65 years (range, 43-78 years). Of the 25 FIHS patients, 9 (36%) were diagnosed with cholangiocarcinoma and 6 (24%) were diagnosed with precursor lesions. Among the precursor lesions, five were intraductal papillary neoplasms of the bile duct, and one was biliary intraepithelial neoplasia. Therefore, 15 (60%) had malignant or precursor lesions, and 10 (40%) were diagnosed with non-precursor benign lesions. None of the clinical variables and imaging features used for analysis showed a statistically significant difference between the non-premalignant benign and premalignant/malignant FIHS groups ( $p < .05$ ).

#### CONCLUSION

More than half of FIHSs were malignant or precursor lesions. There were no predictive values for the clinical and imaging parameters. Therefore, a more active strategy for the diagnosis and follow-up imaging should be considered.

#### CLINICAL RELEVANCE/APPLICATION

Patients with FIHS require active treatment including surgical treatment and careful imaging follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPGI-2

### **MRI Screening with Machine Learning-supported Post-processing and Genetics of Multiple Biliary Hamartomas**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Philipp Schindler, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Multiple biliary hamartomas (MBH), also known as "von Meyenburg complexes", are benign and asymptomatic malformations of dilated bile ducts embedded in fibrous stroma, usually smaller than 10 mm. A detailed knowledge of these malformative cystic-like lesions is crucial because they may be misdiagnosed as malignant. The aim of this study was to investigate the feasibility of magnetic resonance imaging (MRI) screening for the detection of MBH with machine learning-supported post-processing and to explore the genetic characteristics of this rare condition.

#### **METHODS AND MATERIALS**

Five consecutive patients with MBH were prospectively enrolled in this study. All patients underwent high-resolution (3.0 Tesla) contrast-enhanced hepatobiliary MRI and magnetic resonance cholangiopancreatography (MRCP) at baseline to provide a structured report of imaging features of MBH and at 12-month follow-up to exclude progression. A pipeline of 3D k-means clustering based image segmentation was used for detection of cystic-like lesions. Eccentricity was calculated to identify round and oval objects in the cluster and to exclude the biliary tree. Customized next-generation sequencing (NGS) was used to identify the underlying genetic cause of MBH.

#### **RESULTS**

Baseline MRI showed innumerable small hepatic cystic lesions without contrast enhancement, even in the hepato-biliary phase, and without communication with the biliary tree, allowing the diagnosis of MBH. K-means clustering based image segmentation was feasible for annotation of MBH. Total liver lesion volume remained stable over time (mean volume: 104.8 ml; mean proportion of total liver volume: 8.1%). All patients had a heterozygous missense, truncating, or frameshift mutation in the polycystic kidney and hepatic disease 1 (PKHD1) gene encoding the multidomain integral membrane protein fibrocystin.

#### **CONCLUSION**

This preliminary data suggests that machine learning-augmented MRI screening can be used for quantification of MBH. The genetic analysis revealed a potential association between multiple biliary hamartomas and mutations in the PKHD1 gene. These findings provide important insights into the diagnosis of this rare condition.

#### **CLINICAL RELEVANCE/APPLICATION**

Knowledge of MRI findings and genetics of MBH is helpful for a prompt and correct diagnosis, avoiding unnecessary invasive procedures and/or an excessive number of radiological investigations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPGI-3

### A Comparison of the Diagnostic Accuracies of Ultrasound and CT in 82 Proven Cases of Acute Cholecystitis

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Joshua Thurgood (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the efficacies of US imaging vs CT imaging in the diagnosis of acute cholecystitis in aiming to improve the diagnosis and treatment of patients with acute cholecystitis.

#### METHODS AND MATERIALS

We retrospectively collected data on 100 patients with suspected acute cholecystitis and 100 control patients with studies occurring between 3/1/2015 and 3/31/2020. Of the 100 suspected acute cholecystitis patients, 50 had US imaging and 50 had CT imaging done. To be included as a proven case of acute cholecystitis, cases were then screened for cholecystectomy. Due to this, 7 US subjects and 11 CT subjects were removed as they did not undergo cholecystectomy or were treated via a different method. In the control group, 50 patients had US imaging and 50 had CT imaging. All studies were then reviewed by three radiologists of differing experience levels. The data from each reviewer was then combined and tabulated. One reviewer also tabulated data for patients that had both US and CT studies done, which amounted to 47 of the patients with confirmed acute cholecystitis.

#### RESULTS

The sensitivity of CT for diagnosing acute cholecystitis was greater than the sensitivity of US, with these being 66.67% and 53.49% respectively. The negative predictive value of CT was also greater than that of US, which were 75.93% and 64.91% respectively. There were no false positives by any of the reviewers, so the specificities and positive predictive values were 100% for both CT and US modalities. Among the 47 patients who had both US and CT studies done, 24 had both positive US and CT for acute cholecystitis, 9 patients had a positive CT and negative US, 4 patients had a positive US and negative CT, and 10 patients had both negative US and CT studies.

#### CONCLUSION

CT was significantly more sensitive and had a higher negative predictive value than US. However, both modalities had lower sensitivities and negative predictive values than what is found in the literature. All three reviewers performed better on CT than US with two performing significantly better with sensitivities improving by 20.63% and 15.98% respectively. The results of our study showed significantly higher performance using CT imaging over US imaging when evaluating for acute cholecystitis. However, we still suggest US as our first imaging test in patients with suspected AC. If the US is negative, CT should be performed. If the CT is negative and there is still strong clinical suspicion for AC, a HIDA scan should be done.

#### CLINICAL RELEVANCE/APPLICATION

The research being conducted is significant because time to treatment of acute cholecystitis is most often imaging dependent and understanding the relative efficacies of the two most common initial imaging modalities will lead to increased efficiency and time to treatment of these patients.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3B-SPGI-4

### Ultra-high-resolution Drip-infusion CT Cholangiography with Deep Learning-based Reconstruction: Comparison with Normal-resolution Simulation

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Atsushi Nakamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the image quality and bile duct delineation of drip-infusion CT cholangiography (DIC-CT) using an ultra-high-resolution CT (UHR CT) with a 1024 x 1024 matrix combined with a deep learning-based reconstruction algorithm in comparison with simulated normal-resolution (NR) images.

#### METHODS AND MATERIALS

Twenty-five potential liver transplant donors (13 men and 12 women, age range, 21 to 61 years; mean age, 36.3 years) who underwent DIC-CT using the super-high-resolution (SHR) mode of a UHR CT scanner for preoperative evaluation were included in this retrospective study. SHR images were reconstructed with a 1024 x 1024 matrix and 0.25-mm slice thickness using a deep learning-based reconstruction algorithm. Simulated NR images were reconstructed from the same raw data with a 512 x 512 matrix and 0.5-mm slice thickness using a hybrid iterative reconstruction algorithm. Maximum CT value and contrast-to-noise ratio (CNR) of the common bile duct were compared between SHR and NR images using the paired t-test. Two radiologists independently reviewed the maximum intensity projection images and graded the image quality for delineation of the peripheral bile ducts, image sharpness, image noise, and the overall image quality using a 5-point scale, and the results were compared using the Wilcoxon signed-rank test.

#### RESULTS

The maximum CT number of the common bile duct was significantly higher on SHR images than on NR images ( $451.6 \pm 65.0$  vs.  $382.5 \pm 67.4$ ,  $P < .001$ ). CNR was significantly lower on SHR images than on NR images ( $19.8 \pm 4.0$  vs.  $38.9 \pm 12.4$ ,  $P < .001$ ). In qualitative analysis, NR scored significantly higher (i.e. less noise) than SHR for noise ( $4.0 \pm 0.2$  and  $4.1 \pm 0.3$  vs.  $2.0 \pm 0.2$  and  $1.9 \pm 0.3$ ,  $P < .001$ ), whereas SHR scored significantly higher for peripheral bile duct delineation ( $3.6 \pm 0.8$  and  $3.8 \pm 0.5$  vs.  $2.4 \pm 0.8$  and  $2.2 \pm 0.5$ ,  $P < .01$ ), sharpness ( $3.8 \pm 0.6$  and  $3.9 \pm 0.7$  vs.  $2.2 \pm 0.6$  and  $2.1 \pm 0.7$ ,  $P < .001$ ), and overall image quality ( $4.0 \pm 0.6$  and  $3.6 \pm 0.8$  vs.  $2.0 \pm 0.6$  and  $2.4 \pm 0.8$ ,  $P < .01$ ) for both readers.

#### CONCLUSION

UHR CT combined with a deep learning-based reconstruction provided drip-infusion CT cholangiography images with higher spatial resolution and improved the delineation of the peripheral bile duct, despite increased image noise and decreased CNR.

#### CLINICAL RELEVANCE/APPLICATION

Ultra-high-resolution CT combined with a deep learning-based reconstruction provides high-quality drip-infusion CT cholangiography and improves peripheral bile duct delineation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPGI-5

### Breath-hold 3D Gradient- and Spin-echo (GRASE) MRCP Compared to Compressed-sensing Highly Accelerated Respiratory-triggered Technique

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Nobuyuki Kawai, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate breath-hold 3D gradient- and spin-echo (GRASE) MRCP compared to respiratory-triggered 3D turbo spin-echo (TSE) MRCP highly accelerated with the compressed sensing-sensitivity encoding (C SENSE).

#### METHODS AND MATERIALS

Fifty-eight consecutive patients (30 men, 28 women, mean age 67.2 years) with suspicious having pancreaticobiliary diseases underwent MRCP on a 3-T clinical scanner. All patients underwent breath-hold 3D GRASE MRCP with sensitivity encoding (SENSE) (BH-MRCP; SENSE factor, 2) and respiratory-triggered 3D TSE MRCP highly accelerated with the C SENSE (RT-MRCP; C SENSE factor, 11.6) in a random order. For quantitative image analyses, signal intensity (SI) of biliary ducts and main pancreatic duct (MPD), peribiliary ductal tissue, and peripancreatic ductal tissue were measured. The relative duct-to-periductal contrast ratios (RCs) of each pancreaticobiliary segments were calculated as  $(SI_{duct} - SI_{periduct}) / (SI_{duct} + SI_{periduct})$ , respectively. For qualitative image analyses, two radiologists coincidentally graded conspicuity of biliary ducts, MPD, and pancreatic cystic lesion, and overall image quality between the two sequences using a five-point rating scale. Artifacts were also graded using a four-point rating scale.

#### RESULTS

Mean acquisition times in BH-MRCP and RT-MRCP sequence were 23 and 29 seconds, respectively. RCs of all three segments of MPD in BH-MRCP were slightly lower than those in RT-MRCP ( $P = 0.002$ ). Conspicuity of central and peripheral segments of right and left hepatic duct, cystic duct, and common bile duct in BH-MRCP were significantly higher than those in RT-MRCP ( $P = 0.015$ ). Conspicuity of MPD and pancreatic cystic lesion was comparable between the two sequences. Overall image quality in BH-MRCP was significantly higher than that in RT-MRCP ( $P = 0.038$ ). In BH-MRCP, the number of scans with the poor or non-diagnostic image quality (score = 2) in overall image quality was decreased compared with that in RT-MRCP [3.4% (2/58) vs. 8.6% (5/58),  $P = 0.242$ ].

#### CONCLUSION

BH-MRCP provided better image quality and a reduced number of poor or non-diagnostic images compared to RT-MRCP.

#### CLINICAL RELEVANCE/APPLICATION

Breath-hold 3D gradient- and spin-echo MRCP provided better image quality compared to respiratory-triggered 3D turbo spin echo MRCP highly accelerated with the compressed sensing-sensitivity encoding.

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## Abstract Archives of the RSNA, 2023

S3B-SPGI-7

### Ultra-High Resolution T2-weighted PROPELLER MRI of the Rectum with Deep Learning Reconstruction: Assessment of the Image Quality and Diagnostic Performance

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Takahiro Tsuboyama, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the impact of ultra-high resolution acquisition with a slice thickness of 1.2 mm and deep learning reconstruction (DLR) on the image quality and diagnostic performance of T2-weighted periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER) images for rectal cancer.

#### METHODS AND MATERIALS

This prospective study included 34 patients who underwent MRI for the assessment of pretreatment or post-chemoradiotherapy rectal cancer. Written informed consent was obtained. The following four types of axial T2-weighted PROPELLER imaging perpendicular to the tumor were obtained: a slice thickness of 3 mm with conventional reconstruction (3-CR) and DLR (3-DLR), and a slice thickness of 1.2 mm with CR (1.2-CR) and DLR (1.2-DLR). Three radiologists independently evaluated the image quality and assessed the extramural tumor spread, extramural venous invasion (EMVI), lymph node metastasis, and response to chemoradiotherapy if applicable by using a 5-point scoring system. The image quality was compared with Friedman's test. Agreement of the scores obtained with the four types of PROPELLER imaging was assessed by the intraclass correlation coefficient. The diagnostic performance by the three readers were compared with Friedman's test in 22 patients who underwent surgery after MRI.

#### RESULTS

In the image quality assessment, 1.2-DLR yielded significantly the best sharpness, rectal and tumor conspicuity, and overall image quality ( $P < 0.05$ ) for all readers. In the diagnostic performance, perfect agreement (ICC value  $> 0.80$ ) was not seen among the four PROPELLER images in all readers regarding extramural tumor spread, EMVI, and complete response. For the diagnosis of extramural tumor spread, specificity and accuracy were significantly lower with 3-DLR (mean, 0.64 and 0.74) and 1.2-DLR (mean, 0.58 and 0.74) than with 3-CR (mean, 0.75 and 0.79) and 1.2-CR (mean, 0.78 and 0.83) ( $P < 0.05$ ). For the diagnosis of venous invasion, sensitivity and accuracy were significantly higher with 1.2-CR (mean, 0.42 and 0.67) and 1.2-DLR (mean, 0.55 and 0.71) than with 3-CR (mean, 0.30 and 0.59) and 3-DLR (mean, 0.36 and 0.56) ( $P < 0.05$ ). There were no significant differences in the diagnostic accuracies of lymph node metastases and complete response.

#### CONCLUSION

Ultra-high resolution PROPELLER T2-weighted MRI using DLR could provide high image quality and accurate detection of venous invasion although it increased false-positive diagnoses of extramural tumor extension.

#### CLINICAL RELEVANCE/APPLICATION

Although DLR can provide thin-slice T2-weighted PROPELLER MRI with high image quality, extramural tumor spread should be carefully interpreted because DLR may increase false-positive results.

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## Abstract Archives of the RSNA, 2023

S3B-SPGI-8

### Deep Learning Segmentation and Radiomics for Automatic Identification and Activity Assessment of CTE Lesions in Crohn's Disease

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yankun Gao (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this paper is to develop a deep learning automatic segmentation model for the segmentation of Crohn's Disease (CD) lesions in CTE images. Additionally, the radiomics features extracted from the segmented CD lesions will be analyzed, and multiple machine learning classifiers will be built to distinguish CD activity.

#### METHODS AND MATERIALS

This retrospective study includes two sets of CTE image data (segmentation dataset and classification dataset). The CD lesions in the segmentation dataset were manually segmented by radiologists, and a deep learning automatic segmentation model based on nnU-Net neural network was developed. The CTE images in the classification dataset were processed using the automatic segmentation model to obtain segmentation results and extract radiomics features. The most optimal features were then selected to build five machine learning classifiers to distinguish CD activity. The performance of the automatic segmentation model was evaluated using the Dice similarity coefficient (DSC), while the performance of the machine learning classifier was evaluated using the area under the curve (AUC), sensitivity, specificity and accuracy.

#### RESULTS

The segmentation dataset consisted of 84 CTE examinations of CD patients (60 males) and the classification dataset included a total of 193 CTE examinations of CD patients (136 males). The deep learning segmentation model achieved a DSC value of 0.824 on the testing set. Among the five machine learning classifiers, the Logistic Regression (LR) model showed the highest classification performance in the testing set, with an AUC, sensitivity, specificity and accuracy of 0.862, 0.697, 0.840 and 0.759, respectively.

#### CONCLUSION

Our study demonstrates that a deep learning segmentation model based on the nnU-Net neural network can accurately segment CD lesions in CTE images and build a machine learning classifier to distinguish CD activity based on the extracted radiomics features. This approach can help clinicians assess the severity of patient's disease with greater accuracy.

#### CLINICAL RELEVANCE/APPLICATION

Helps radiologists aid in diagnosis and improve diagnostic efficiency, which in turn helps clinicians assess a patient's condition and provide an idea for the next step in treatment.

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## Abstract Archives of the RSNA, 2023

S3B-SPGU-2

### Predicting Renal Allograft Dysfunction using Shear-wave Dispersion Slope

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Taekmin Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the role of shear-wave dispersion slope for predicting renal allograft dysfunction.

#### METHODS AND MATERIALS

We retrospectively reviewed 126 kidney transplant recipients (median age 57 years [interquartile range 47-62 years], 60 women) who underwent kidney biopsy for allograft evaluation from November 2022 to February 2023. All patients underwent shear-wave elastography (SWE) examination just before biopsy, and parenchymal stiffness and dispersion slope were obtained in cortex. To reduce subject-to-subject variations, we performed SWE in renal sinus fat for reference tissue. Clinical and pathologic factors related to renal stiffness and dispersion slope were evaluated by multivariable linear regression analysis. We conducted univariate and multivariate analysis to predict acute rejection using imaging parameters including SWE. Diagnostic performance of significant parameters in detecting acute rejection was evaluated by area under the receiver operating curve (AUC) values.

#### RESULTS

Acute rejection was found in 31 out of 126 (24.6%) of the patients. The median cortex-to-sinus stiffness ratio (SR) did not differ between the patients with acute rejection and without rejection (1.21 vs. 1.20,  $P=0.47$ ), while median cortex-to-sinus dispersion slope ratio (DSR) was higher in patients with acute rejection than in those without rejection (1.4 vs. 1.21,  $P<0.01$ ). Grade of interstitial fibrosis and tubular atrophy (IFTA) was the only determinant factor for both SR (coefficient, 0.13 per grade;  $P<0.01$ ) and DSR (coefficient, 0.10 per grade,  $P=0.01$ ). In multivariate analysis, mean resistive index (OR 1.06, 95% CI 1.02-1.15,  $P<0.01$ ) and DSR (OR 18.3, 95% CI 3.3-101.6,  $P<0.001$ ) were independent factors for predicting acute rejection. The AUC of resistive index, DSR, and combined two parameters were 0.64, 0.68, and 0.74, respectively.

#### CONCLUSION

Shear-wave dispersion slope obtained at SWE may be helpful for identifying renal allograft dysfunction.

#### CLINICAL RELEVANCE/APPLICATION

Shear-wave dispersion slope, which reflects the viscosity of tissue, might be used as a reliable noninvasive imaging modality that can help differentiate acute dysfunction from stable graft.

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## Abstract Archives of the RSNA, 2023

S3B-SPHN-1

### Fluoroscopic Function in Cone-beam CT Provides Video Fluorographic Swallowing Study

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yukihiro Iida, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Videofluoroscopic swallowing study (VFSS) is a gold-standard radiological examination for dysphagic patients. Usually, VFSS is performed using whole-body x-ray fluoroscopic unit. This prevents oral radiologists without a whole-body x-ray fluoroscopic unit from performing VFSS. Recently, a cone-beam CT unit equipped with x-ray fluoroscopy has been put into practical use. In this study, we evaluated the cone-beam CT unit's fluoroscopic function whether it is suitable for VFSS.

#### METHODS AND MATERIALS

A cone-beam CT unit for maxillofacial region (VGi evo Evolved 3D Imaging, NewTom, Inc.) was used to take fluoroscopic images. The temporal resolution was 20 and 15 frames per second. The tube current was fixed at 3 mA and tube voltage at 110 kV. The contrast and gamma values of the images were adjusted to clearly observe. First, a phantom modeled living body was subjected. A 4 mm diameter tube was attached to the inside of the phantom and a 40w/v% barium solution (Barytgen HD, FUSHIMI Pharmaceutical Co., Ltd.) was through. Two 2 mm diameter iron balls were also attached to the pharynx of the phantom. One was on the epiglottic valley, and one on the piriform sinus. Then, two healthy adults with no history of dysphagia were subjected. Saliva (with no contrast media), a 40w/v% barium solution, a paste with barium solution (Fruche, House Foods Corp.), and a gelatin jelly with barium solution (Jelly Ace, House Foods Corp.) were used as test foods. Two subjects swallowed a spoonful or 3 ml of each test food. The subject's VFSS images were evaluated using the checking items in the VFSS guideline of the Japanese Society of Dysphagia Rehabilitation.

#### RESULTS

The image of barium solution passed through the tube and 2 mm iron balls were clear observed in the phantom's VFSS images. Swallowing movements without contrast medium allowed clear observation of the anatomical structures these were tongue, pharynx, soft palate, and others. All target evaluation items including the movement of the test food into the epiglottic valley, the piriform sinus, and the esophagus could be observed. The VFSS image of the phantom and two subjects were clear observed in both 20 and 15 frames per second.

#### CONCLUSION

Although there are restrictions on the body position of the subject, a cone-beam CT unit equipped with x-ray fluoroscopy could be applied for practical VFSS examination. It allows the oral radiologists to perform VFSS in minimal clinics. Then, the accurate diagnosis of swallowing function, treatment effects, and the progress of recovery of swallowing function will be possible.

#### CLINICAL RELEVANCE/APPLICATION

This method allows performing VFSS in minimal clinics. The accurate diagnosis of swallowing function, treatment effects, and the progress of recovery of swallowing function will be possible.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPHN-4

### Application of Multidimensional Diffusion MRI in Nasopharyngeal Carcinoma: An Exploratory Cross-sectional Study

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yingying Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the potential of multidimensional diffusion MRI (Mdd-MRI) in assessing the microscopic diffusion characteristics of nasopharyngeal carcinoma (NPC) and explore its potential application in diagnosing and differentiating tumor pathological subtypes and TNM stage, as well as determining Epstein-Barr virus (EBV) infection status.

#### METHODS AND MATERIALS

Sixty-six patients with histologically-confirmed NPC were included in the study. Mdd-MRI was performed with multiple b values to obtain five microscopic diffusion metrics: anisotropic mean kurtosis (MKa), isotropic mean kurtosis (MKi), total mean kurtosis (MKt), and microscopic fractional anisotropy ( $\mu$ FA). For comparison with macroscopic diffusion characteristics, apparent diffusion coefficient (ADC) was obtained through conventional diffusion weighted imaging sequence. Diffusion-related measurements were compared using student t test between NPC tissue and normal nasopharyngeal tissue, among different histopathology, TNM stage, and EBV infection status. Spearman correlation analysis was performed between diffusion-related measurements and T stage.  $P < 0.05$  (two-tailed) indicates significant difference.

#### RESULTS

Significant difference was found in ADC between tumor tissue and normal nasopharyngeal tissue ( $P = 6.023e-11$ ). Microscopic metrics and ADC showed significant differences among different primary tumor stages (T1-T4) and a significant correlation with T stage ( $\mu$ FA:  $\rho = 0.52$ ,  $P = 0.00001$ ; MKa:  $\rho = 0.38$ ,  $P = 0.002$ ; MKi:  $\rho = 0.27$ ,  $P = 0.03$ ; MKt:  $\rho = 0.32$ ,  $P = 0.009$  and ADC:  $\rho = -0.36$ ,  $P = 0.003$ ). However, no significant differences were observed in other subgroups, including histopathology, N stage, and M stage, and EBV infection status (all  $P > 0.05$ ).

#### CONCLUSION

Mdd-MRI is a valuable tool for assessing the microscopic diffusion characteristics of NPC. However, it has limited value in diagnosing NPC, differentiating tumor pathological subtypes, N stage, and M stage, and predicting EBV infection status.

#### CLINICAL RELEVANCE/APPLICATION

Mdd-MRI can be a useful technique in assessing the microscopic diffusion characteristics of NPC, providing insights into tumor heterogeneity from a novel diffusion perspective.

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## Abstract Archives of the RSNA, 2023

S3B-SPHN-5

### Demonstrating the Facial Nerve in the Parotid Gland using 3 Dimension Fast Field Echo Imaging

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yihua Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the performance of three-dimension fast field echo imaging (T2WI-3D-FFE) in displaying the intraparotid facial nerve (IFN) and localizing the tumor.

#### METHODS AND MATERIALS

Seventy-nine patients with parotid tumors who underwent T2WI-3D-FFE were retrospectively enrolled (Table 1). The T2WI-3D-FFE images were reconstructed with curvilinear planar reconstruction (CPR) by two radiologists independently. The identification certainty of IFN was scored with an arbitrary scale of 0-3. The tumor locations were categorized as deep or superficial on the basis of direct and 2 indirect methods (the facial nerve line (FNL) and retromandibular vein (RMVL)). Surgical localization was considered as the criterion standard. The diagnostic accuracy, sensitivity and specificity for localizing parotid lesions using each method were calculated and compared using the McNemar tests.

#### RESULTS

The main trunk, temporofacial division, and cervicofacial division of IFN were visualized in 100%, 52% and 46% of patients, respectively on the reconstructed T2WI-3D-FFE images. The diagnostic accuracy, sensitivity, specificity, positive predictive value, and negative predictive value for localizing deep lobe lesions using direct method were 96.2%, 88.9%, 91.7%, 80%, 98.6%, respectively. These findings were significantly higher than FNL and RMVL in sensitivity ( $P < 0.05$ ). The relationship between the tumor and the main trunk of the facial nerve was correctly predicted in 93.67% (74/79) of images (Table 3).

#### CONCLUSION

T2WI-3D-FFE can provide detailed morphological information on the nerve relative to adjacent structures preoperatively.

#### CLINICAL RELEVANCE/APPLICATION

Intraparotid facial nerve (IFN) imaging is a clinical challenge in MRI that it is difficult to differentiate parotid gland tumors from facial nerve on conventional MRI. It is great demand to develop new diagnostic technology to accurately display peripheral nerve and tumor for avoiding intraoperative injury.

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## Abstract Archives of the RSNA, 2023

S3B-SPIN-1

### Multi-parametric MRI Brain Tumor Diagnosis with Memorizing Transformer

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yiqing Shen (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep learning has been widely utilized in MRI diagnosis. Among them, transformers have gained increasing popularity due to their ability to handle multiple modalities. However, its application has been hindered because acquiring large-scale multimodal MR data is expensive and time-consuming. To narrow the gap, we designed a transformer architecture with external memory, which memorizes the attention from the historical training process to reduce the reliance on large-scale dataset.

#### METHODS AND MATERIALS

During training, the external memory stores a paired query and value from each attention head. Importantly, this design is efficient and does not incur any additional computation cost. During inference, the cached memory is used to enhance local attention through K nearest neighbor lookup. This improves the overall performance of the model. We implemented this external memory design on an 8-layer vision transformer with 8 attention heads in each layer and the dimension of the tokens were set to 256, but it can be incorporated into any transformer-based model (Fig. a). Evaluations were performed on a dataset of 147 brain post-treatment malignant glioma cases, each of which included five MRI sequences, T1-weighted (T1w), T2-weighted (T2w), fluid-attenuated inversion recovery (FLAIR), gadolinium-enhanced T1w (GdT1w), and amide proton transfer-weighted (APTw) MR images, for classifying treatment effect and tumor recurrence. For each scan, the 3D APTw MRI protocol provided 15 slices, so all volumetric MR images had 15 instances. Each instance included T1w, T2w, FLAIR, GdT1w, and APTw images with the matrix shape of 5 (sequences)  $\times$  256 (pixels)  $\times$  256 (pixels). A proportion of 80% on the case-level was split as the training set (n=118) and the remaining 20% as the test set.

#### RESULTS

The baseline was the ViT without external memory. Our method achieved an AUC of 0.848 ( $p < 0.001$ ), which improves 5.15% of the plain ViT's AUC of 0.806 ( $p < 0.001$ ). The accuracy is 0.779, the precision is 0.625, the sensitivity is 0.818, the specificity is 0.818 and the F1-score is 0.709 (Fig. b).

#### CONCLUSION

In this work, we propose a memorizing transformer for the small-scale multi-parametric MR image analysis. The method stores the attention in the training process and applies them to the inference stage with KNN lookup, which thus costs no extra GPU run-in memory. The method can increase the plain transformer AUC by 5.15%, which confirms the effectiveness of our method.

#### CLINICAL RELEVANCE/APPLICATION

We propose a memorizing transformer for the small-scale multi-parametric MR image analysis that can increase the plain transformer AUC.

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## Abstract Archives of the RSNA, 2023

S3B-SPIN-2

### Consistent and Efficient Image Segmentation in the German Nationwide RACOON Consortium

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Bianca C. Lassen-Schmidt, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Multi-center studies, including large cohorts, require software tools that ensure consistent and efficient segmentation of image data. In the RACOON project, all German university hospitals jointly work with identical software systems. Here we analyze the segmentation tool of the first RACOON trial retrospectively and discuss the requirements for such a tool.

#### METHODS AND MATERIALS

In this study, a cohort of 14,023 patients (47% female, mean age 54.6 years, mean BMI 23.4) from 36 German university hospitals was collected and evaluated by radiologists. The datasets included chest CT with 22 different disease groups. Of the total cohort, 20% (2394 datasets) were randomly selected and processed using the segmentation and annotation toolkit SATORI. This client-server application is highly configurable and was utilized to provide a guided lung segmentation workflow, including automated segmentation of the lungs, lung lobes, and ground glass opacities. Additionally, other anatomical structures and pathologies could be manually or semi-automatically segmented.

#### RESULTS

The overall performance of SATORI was evaluated by 35 radiologists with varying levels of experience using the tool, ranging from 1 (less use) to 5 (frequent use) on a Likert scale of 1 (poor) to 5 (excellent). The mean overall performance rating for SATORI was 2.7. Analysis of the ratings from the different user groups, based on their intensity of use (IoU), revealed that 5/5/6/8/10 radiologists with an IoU 1/2/3/4/5 rated the performance as 1.8/2.2/2.3/2.9/3.4, respectively. A Wilcoxon rank sum test was performed to compare the ratings between inexperienced (IoU 1-3) and experienced (IoU 4-5) readers, and a difference was found ( $P = 0.01$ ). Seven radiologists reported occasional freezing or slowness as the reason for a negative rating.

#### CONCLUSION

SATORI showed promise in achieving consistent image segmentation in the RACOON project. Users with more experience rated it higher, likely due to a learning effect. SATORI is being prepared for three more RACOON studies, with improvements to usability and network connection logging to address occasional freezing. Future enhancements include individual worklists for readers and a review tool for communication between reader and reviewer. Three key requirements for segmentation software in large multi-center studies to ensure consistent and efficient image segmentation are guided workflows, simultaneous use by multiple users, and highly automatic segmentation tools. "Funded by „NUM 2.0“ (FKZ: 01KX2121)".

#### CLINICAL RELEVANCE/APPLICATION

Multi-center studies provide heterogeneous data, more readers, and enough data for studies with rare pathologies. Nonetheless, segmentation software needs to meet specific requirements.

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## Abstract Archives of the RSNA, 2023

S3B-SPIN-3

### Clinical Study of Low Radiation Dose Combined with Deep Learning Image Reconstruction Algorithm for Detection of Liver Metastases

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Nana Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim was to investigate whether low radiation doses combined with DLIR algorithms improve liver image quality and liver metastasis detection compared with ASiR-V algorithms.

#### METHODS AND MATERIALS

195 patients with suspected liver lesions who needed abdominal enhanced CT scans were collected. Conventional radiation dose examination (tube current of 400 mA) was performed during the first venous phase and low radiation dose examination (200 mA or 120 mA) was performed during the second venous phase. Patients were divided into a 50% radiation dose reduction group and a 70% radiation dose reduction group according to the different tube currents at the second venous phase. All images were reconstructed with ASiR-V50%, DLIR-L, DLIR-M and DLIR-H. Quantitative parameters including subcutaneous fat noise, CT values and SNR of liver, pancreas, portal vein and muscle, and contrast-noise ratio of liver metastases were compared with one way ANOVA test. Qualitative parameters including image quality, noise, contrast, lesion conspicuity, and diagnostic confidence score were compared with Kruskal-Wallis H test. The number and size of liver metastases detected by the ASiR-V50% algorithm at standard radiation doses were used as a reference standard, and the detection rates of liver metastases of different sizes were calculated for each algorithm under low radiation dose conditions.

#### RESULTS

Objective evaluation: The noise and SNR of ASiR-V50% at standard dose were comparable to DLIR-M at 50% lower dose and 70% lower dose, while DLIR-H at 50% lower dose and 70% lower dose had lower noise and higher SNR and CNR. Subjective evaluation: Compared with the ASiR-V50% of standard dose, both DLIR-M and DLIR-H with 50% reduced dose could maintain the image quality, and DLIR-M and DLIR-H with 70% reduced dose had reduced image quality but still met the diagnostic requirements with a subjective score >3. Lesion detection rate: The lesion detection rates for ASiR-V50%, DLIR-L, DLIR-M, and DLIR-H at 50% lower doses were 90.2%, 89.2%, 91.4%, and 89.9%, respectively. All algorithms were able to detect all lesions larger than 1 cm. The lesion detection rates were 69.4%, 70.5%, 73.3%, and 71.3% for ASiR-V50%, DLIR-L, DLIR-M, and DLIR-H at 70% lower doses, respectively.

#### CONCLUSION

Compared to ASiR-V50%, DLIR can improve the objective and subjective image quality, as well as lesion conspicuity and diagnostic confidence of liver metastases. DLIR can maintain or improve image quality at 50% radiation dose reduction while preserving the detection of liver metastases larger than 1 cm.

#### CLINICAL RELEVANCE/APPLICATION

DLIR can maintain or improve image quality at 50% radiation dose reduction while preserving the detection of liver metastases larger than 1 cm.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPIN-5

### **Prediction of T2DM using MRI Fat Fraction Maps of Ectopic Fat Deposition, Abdominal Wall Muscle Fat and Bone Marrow Adipose Tissue**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Qi An (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our study was to quantitatively assess the abdominal wall muscle adipose tissue (AMAT) and bone marrow adipose tissue (BMAT) content and ectopic adipose deposition in patients with Type 2 diabetes mellitus (T2DM) by MRI fat fraction maps to explore independent risk factors that can predict T2DM.

#### **METHODS AND MATERIALS**

A total of 345 participants who underwent 1.5 T or 3.0 T MRI examination of upper abdomen were included in our study. The MRI images of all patients included IDEAL-IQ or mDixon Quant sequence. The fat fraction (FF) and area of visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), AMAT were obtained at the level of the L1 and L2 vertebral bodies by Image J (National Institutes of Health, USA), and the FF and area of BMAT were automatically calculated at the level of the T12 and L1 vertebral bodies by the software where the mean of BMAT were computed. The hepatic fat fraction (HFF) and pancreatic fat fraction (PFF) were semi-automatically measured by Smart ROI on the post-processing platform (Intellispace Portal, ISP, Philips, Holland). The binary Logistic regression analysis and receiver operating characteristic (ROC) curve were used to evaluate the predictive ability of independent risk factors for T2DM.

#### **RESULTS**

VAT area, VAT FF, HFF, PFF, BMAT FF, AMAT area and AMAT FF of the T2DM group were higher than the non-T2DM group and SAT FF was lower ( $P < 0.05$ ). However there was no statistically significant difference in SAT area of two groups ( $P > 0.05$ ). The binary logistic regression model analysis showed that SAT FF, VAT area and PFF were independent risk factors for T2DM, and OR values were 0.920, 1.007 and 1.073, respectively. The ROC curve showed that area under the curve (AUC) values of SAT FF, VAT area and PFF were 0.609, 0.681 and 0.786 respectively, and the sensitivity were 0.441, 0.676 and 0.750 respectively, and the specificity were 0.798, 0.625 and 0.773. The AUC values predicted by SAT FF combined with VAT area and PFF for T2DM were 0.787, with the sensitivity of 0.853 and the specificity of 0.661. The differences of AUC values were compared by Delong test, and the results showed that the AUC values of PFF and their combination were higher than those of SAT FF and VAT area ( $P < 0.05$ ).

#### **CONCLUSION**

In this study, we found that SAT FF, VAT area and PFF are independent risk factors for T2DM, and PFF is a better predictor of T2DM than SAT FF and VAT area.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings further deepened our understanding of the relationship among ectopic fat deposition, AMAT and BMAT. In addition, we found that PFF is a better independent risk factor for T2DM, so quantitative evaluation of PFF fat content in patients with T2DM by non-invasive MRI fat maps can better predict and evaluate the occurrence, progress and prognosis of T2DM.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPIN-6

### Cardiac CT to MR Image Conversion Using Generative Diffusion Models

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Albert S. Song, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether 1) a generative diffusion model, trained exclusively with cardiac MRI data, could be used to perform intermodality image conversion from cardiac CTA to cine SSFP MRI and 2) if these synthesized SSFP images can be used as inputs for other MRI-specific CNNs.

#### METHODS AND MATERIALS

With HIPAA compliance and IRB approval, we retrospectively collected 222 cardiac MRIs to train a diffusion model to synthesize SSFP images from image edges. MRI exams were split 70/15/15 for training, validation, and testing. To evaluate cross-modality image conversion, we retrospectively identified an additional 30 patients who underwent both cardiac CTA and MRI within  $7 \pm 8$  months, between 4/2020 and 3/2023 (age  $47 \pm 20$  years, 13 male). The diffusion CNN was used to synthesize SSFP images from CTA. To show that synthesized SSFP images are superior inputs for MRI-specific CNNs, we used an existing MRI-trained 2D UNet to segment the synthetic SSFP and source CTA images and compared them against manual segmentations. Cardiac volumes were then compared between synthetic and real cine SSFP images. Statistical analyses included comparison of segmentation overlap using Dice and comparison of cardiac volumetry using Pearson correlation and paired t-test with a type I error threshold of 0.05.

#### RESULTS

For the following results, segmentation Dice scores are presented in order of epicardium, myocardium, and endocardium. For short axis CTA images, median Dice was 0.900 (IQR:0.844-0.932), 0.689 (0.597-0.752), and 0.906 (0.853-0.938), respectively. For synthesized-SSFP images, median Dice was 0.926 (IQR: 0.893 - 0.945), 0.757 (0.682 - 0.812), and 0.920 (0.866 - 0.948), respectively. Mean Dice scores were significantly higher for synthetic SSFP images relative to CTA images ( $p < 0.001$  for each task, paired t-test). Volumetric measurements from synthesized and real SSFP images correlated well for EDV ( $r=0.77$ ), ESV ( $r=0.83$ ), and EF ( $r=0.88$ ).

#### CONCLUSION

Diffusion models can be used to perform intermodality image conversion, including synthesizing SSFP images from CTA. Volumetric measurements of cardiac function using synthetic SSFP images generated from cardiac CTA correlated well with direct measurements from cardiac MRI.

#### CLINICAL RELEVANCE/APPLICATION

Diffusion models may enable intermodality image conversion to facilitate cross-modality image quantification, segmentation, and comparison for cardiac CTA and MRI.

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## Abstract Archives of the RSNA, 2023

S3B-SPIN-7

### AI Enhancement: Emulating Radiologists' Approach for Automated Contrast Phase Detection in Abdominal CT Scans

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Eduardo P. Reis, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The accurate determination of contrast phases in abdominal CT scans is essential for the deployment of downstream artificial intelligence (AI) applications and reliable quantification of imaging biomarkers. DICOM tags are often used to identify contrast phases, but they can be unreliable. To address this challenge, we present an image-based AI algorithm that emulates how radiologists visually assess the enhancement patterns of key anatomical structures to determine the contrast phase. Our goal is to enhance the reliability and generalizability of contrast phase detection, independent of DICOM tags, and to facilitate its integration into clinical workflows by open sourcing the tool through an easy-to-use AI pipeline.

#### METHODS AND MATERIALS

We obtained 739 abdominal CT exams, and included 1545 axial series, split into a 1183 and 362 for training and testing. Each patient's data was exclusively allocated to one set. The series were labeled as non-contrast, arterial, venous, or delayed using the "Series Description" DICOM tag. A radiologist reviewed each series to confirm or correct labels. Key anatomical structures, such as aorta, portal vein, inferior vena cava, renal parenchyma, and renal pelvis, were segmented using our open-source AI toolbox and radiomic features were extracted. An Extreme Gradient Boosting (XGBoost) classifier was trained to classify CT images into four contrast phases. The performance was evaluated using accuracy, sensitivity, specificity and F1 scores on internal and external validation datasets. External validation was performed on 209 scans (582 series) from "VinDr-Multiphase CT", a publicly available dataset that included non-contrast, arterial and venous scans.

#### RESULTS

In internal validation, we achieved an overall accuracy of 92% and F1 scores of 97% for non-contrast, 79% for arterial, 92% for venous, and 95% for delayed phases. In external validation, we achieved an accuracy of 89%, and F1 scores of 97% for non-contrast, 87% for arterial, and 81% for venous phases. The performance improvement of the arterial class on external validation shows generalization capability despite limited training examples for this class. The algorithm was made publicly available through an open-source platform.

#### CONCLUSION

The proposed AI-based algorithm accurately detects contrast phases in abdominal CT scans independent of DICOM tags. The successful external validation demonstrates the algorithm's generalizability and robustness.

#### CLINICAL RELEVANCE/APPLICATION

Contrast detection is crucial for deploying AI methods and ensuring the reliability of quantitative imaging biomarkers. The proposed algorithm serves as a valuable tool for enhancing AI applicability in medical imaging, allowing integration with other AI algorithms.

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## Abstract Archives of the RSNA, 2023

S3B-SPIR-1

### Shear Wave Elastography Evaluates the Efficacy of Microwave Ablation on Thyroid Nodules

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Shishi Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

As a minimally invasive technique, percutaneous microwave ablation (MWA) has been applied as an alternative to thyroid surgery for benign thyroid nodules. Coagulation necrosis occurs and stiffness changes in thyroid tissue after ablation. Shear wave elastography (SWE) has been used to differentiate the malignant thyroid from benign nodules. But it has seldom been applied to monitor the change of thyroid nodules after ablation. The study aimed to investigate the efficacy of MWA on thyroid nodules and the effect of stiffness on the efficacy of MWA.

#### METHODS AND MATERIALS

Sixty-seven thyroid nodules treated with MWA were included between June 2021 and April 2023. All nodules were pathologically confirmed benign, and the maximum diameter was within 3 cm. SWE was performed to quantify the stiffness of nodules. The size, volume, volume reduction rate (VRR), and stiffness value of thyroid nodules were recorded before and at one, three, and six months after ablation. Thyroid nodules are classified as hard nodules or soft nodules according to the value of SWE. Compare the VRR between hard and soft nodules during post-ablation follow-up.

#### RESULTS

All nodules were completely ablated, and no complications occurred. The VRR of thyroid nodules gradually increased after ablation, and the VRR at one, three, and six months after ablation were 52.3% [interquartile range (IQR): 35.6-74.1%], 57.6% (IQR: 37.2-78.4%), and 74.9% (IQR: 50.4-90.2%), respectively ( $P < 0.05$ ). The study showed that the stiffness of the nodules increased post-ablation compared with pre-ablation ( $P < 0.05$ ). The stiffness value peaked one month after ablation and then gradually decreased ( $P < 0.05$ ). The mean of SWE before ablation, and at one, three, and six months after ablation were  $36.7 \pm 9.5$  KPa,  $76.5 \pm 10.2$  KPa,  $62.8 \pm 11.4$  KPa, and  $46.9 \pm 9.5$  KPa, respectively ( $P < 0.05$ ). Compared with soft nodules, hard nodules have a lower VRR after ablation ( $P < 0.05$ ).

#### CONCLUSION

SWE is a noninvasive, sensitive and repeatable technique which can be applied to evaluate the efficacy of MWA of thyroid nodules and postoperative follow-up.

#### CLINICAL RELEVANCE/APPLICATION

SWE has been used for noninvasive and quantitative evaluation of the efficacy of MWA on thyroid nodules and postoperative follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPIR-2

### The Role of Contrast-enhanced Ultrasound in the Biopsies of Peripheral Pulmonary Lesions: A Retrospective Multicenter Study by using Propensity Score Analysis

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Xue-Yan Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the performance of conventional US and contrast-enhanced US (CEUS) as guiding tools in percutaneous transthoracic needle biopsy (PTNB) and evaluate the role of CEUS in PTNB for peripheral pulmonary lesions (PPLs).

#### METHODS AND MATERIALS

Patients with PPLs who received PTNB between 2017 and 2022 were retrospectively enrolled at four medical centers. According to whether pre-biopsy CEUS was performed, patients were divided into CEUS and US groups. The sampling success rate and the diagnostic accuracy of PTNB stratified by lesion size were analyzed. One-to-one propensity score-matching (PSM) analysis was performed using the nearest-neighbor matching method.

#### RESULTS

A total of 1027 lesions were analyzed: there were 634 in US group (mean age, 59 years  $\pm$  13 [standard deviation], 413 men) and 393 in CEUS group (mean age, 61 years  $\pm$  13 [standard deviation], 270 men). The CEUS group produced more acceptable samples than the US group (98.2% vs. 95.7%,  $p = .03$ ) and improved diagnostic accuracy (96.9% vs. 94.2%,  $p = .042$ ), and sensitivity (96.9% vs. 94.0%,  $p = .03$ ). PSM and stratified analyses ( $n = 358$  per group) indicated that the sample success rate (99.0% vs. 95.7%,  $p = .04$ ) and diagnostic accuracy (98.5% vs. 92.9%,  $p = .006$ ) of the CEUS group was higher than that of the US group for 2-7cm PPLs but not for lesions larger than 7cm (sample success rate: 96.9% vs. 97.1%,  $p = .93$ ; diagnostic accuracy: 95.0% vs. 99.0%,  $p = .08$ ).

#### CONCLUSION

CEUS-guided PTNB has a higher sampling success rate and diagnostic accuracy than US in 2-7cm PPLs. For PPLs larger than 7cm, consistent diagnostic accuracy can be achieved by well-trained biopsy operators whether using US or CEUS as the guide tool.

#### CLINICAL RELEVANCE/APPLICATION

This study aims to investigate the role of CEUS in guiding PTNB of PPLs. The findings of this study can provide a detailed reference for selecting biopsy imaging guidance with a stratification criterion.

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## Abstract Archives of the RSNA, 2023

S3B-SPIR-3

### Comparison Between Percutaneous Transthoracic Co-axial Needle CT-guided Biopsy and Transbronchial Lung Biopsy for the Diagnosis of Persistent Pulmonary Consolidation

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Juan Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to compare the diagnostic yield and the complication rate between percutaneous transthoracic CT-guided co-axial needle biopsy (PTCNB) and transbronchial lung biopsy (TBLB) in persistent pulmonary consolidation.

#### METHODS AND MATERIALS

From January 1, 2016 to December 31, 2020, we have retrospectively enrolled a total of 155 consecutive patients with persistent pulmonary consolidation who underwent both TBLB and PTCNB. The diagnostic accuracy, specificity, sensitivity and complication rate of the two biopsy methods for persistent lung consolidation has been compared. According to histopathological and microbiological analysis, the results of biopsy specimens were categorized as follows: malignant, specific benign, non-specific benign and non-diagnostic. The final diagnosis was established by surgical resection or clinicoradiological follow-up for at least 12 months following biopsy. Diagnostic yield of PTCNB/TBLB was defined as the percentage of the true diagnosis from biopsy as malignant and specific benign lesions.

#### RESULTS

According to the standard reference, the final biopsy diagnoses of 11 cases were confirmed true malignant based on the surgical resections, the remaining were confirmed by clinical and imaging follow-up for at least 12 months. The overall diagnostic accuracy, sensitivity and specificity of PTCNB for malignant diagnosis were 91.61%, 72.34% and 100%, whereas of TBLB were 87.74%, 59.57% and 100%. At the same time, the overall diagnostic accuracy, sensitivity and specificity of PTCNB for specific benign diagnosis were 84.25%, 64.71% and 100%, whereas of TBLB were 63.23%, 16.18% and 100%. The diagnostic yield of PTCNB and TBLB were 50.32% and 25.16% respectively. For the TBLB-based negative cases, PTCNB provided a definite diagnostic yield of 37.93%. There were 45(45/155, 29.03%), 22(22/155, 14.19%) and 13(13/155, 8.39%) patients who experienced pneumothorax, intrapulmonary hemorrhage and hemoptysis respectively in PTCNB, while there were only 5(5/155, 3.22%) cases of mild intraprocedural bleeding occurring in TBLB.

#### CONCLUSION

PTCNB is an effective and safe modality, associated with higher diagnostic yield and better diagnostic accuracy compared to TBLB for persistent consolidation, especially as the complementary method for TBLB-based negative lung lesions.

#### CLINICAL RELEVANCE/APPLICATION

In this study, we compared the diagnostic yield and the complication rate between percutaneous transthoracic CT-guided coaxial needle biopsy (PTCNB) and transbronchial lung biopsy (TBLB) of persistent pulmonary consolidation. Clinical physicians may choose appropriate biopsy method according to our study.

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## Abstract Archives of the RSNA, 2023

S3B-SPIR-4

### **PI3K $\delta$ Inhibitor PI-3065 Induces Apoptosis in Hepatocellular Carcinoma Cells by Targeting Survivin**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yuze Wei (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Hepatocellular carcinoma (HCC) is one of the most common malignant tumors worldwide, and its clinical treatment remains challenging. The development of new treatment regimens is important for effective HCC treatment. This research design to explore the anti-tumor function of PI3K  $\delta$  inhibitor PI-3065 on HCC and its potential mechanism.

#### **METHODS AND MATERIALS**

CCK8 and flow cytometry were used to determine the activity of HCC cells treated with PI-3065. Apoptosis of HCC cells treated with PI-3065 were evaluated by hoechst staining and western blot. Mitochondrial staining and extraction were used to detect the mitochondrial state of HCC cells. SK-HEP-1 cells effectively transfected with survivin siRNA and plasmid overexpressed with survivin were treated with PI-3065, and then the apoptosis level of cells was evaluated by hoechst staining and western blot. The effects of PI-3065 on migration and colony formation of HCC cells were evaluated by wound-healing assay and colony formation assay. SK-HEP-1-derived xenograft tumor model in nude mice were constructed and administered by intragastric administration for 14 days. The control group were given the same dose of placebo. At the end point, the anti-hepatoma activity of PI-3065 in vivo was evaluated according to the volume, weight and protein changes of transplanted tumor.

#### **RESULTS**

We found that PI-3065 dose- and time-dependently reduced HCC cell viability and induced apoptosis while posing no obvious apoptotic toxicity in normal liver cells. Further mechanistic analysis showed that PI-3065 induced apoptosis mainly by inhibiting survivin protein expression, decreasing mitochondrial membrane potential, and promoting cytochrome C release. Simultaneously, PI-3065 markedly suppressed the colony formation, migration, and epithelial-mesenchymal transition abilities of HCC cells. Furthermore, transplantation of nude mice with HCC tumors showed that PI-3065 inhibits HCC tumor growth in vivo by targeting survivin.

#### **CONCLUSION**

PI-3065 specifically inhibited survivin expression and exerted anti-HCC activity in vivo and in vitro, suggesting that it may serve as an effective antitumor drug for HCC treatment, which warrants further study.

#### **CLINICAL RELEVANCE/APPLICATION**

In this study, we confirmed for the first time that PI-3065 can exert anti-HCC activity by inducing cell apoptosis in vivo and in vitro, which indicated that PI-3065 has great potential in clinical practice. Further studies have confirmed that PI-3065 has no toxicity to normal hepatocytes, and its safety and efficacy may provide a new choice for the treatment of HCC patients.

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## Abstract Archives of the RSNA, 2023

S3B-SPIR-5

### **Sono-activated Oxygen/Sulfate Dual-Radical Nanotherapy for Combined Cancer Suppression & Infected Wound Repair**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Xiaohui Qiao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore an all-in-one therapy for cooperatively fighting cancer, infection and boosting wound repair for patients with advanced superficial cancers or after surgical intervention to avoid multiple drug abuse and resultant adverse effects.

#### **METHODS AND MATERIALS**

The ultrasound-activated nanosensitizer PHMP was dexterously designed for combined therapy of cancer and infected wound based on oxygen/sulfate dual-radical nanotherapy. Firstly, the *in vitro* cancer cell killing action was proved using CCK-8 assay and fluorescence staining after the cells being treated with PHMP + US. Then, the *in vitro* migration promoting and bacteriostatic action was assessed through scratch test and detecting the bacteria viability respectively. Finally, the *in vivo* tumor-suppressive effect and repair function to the infected skin defect of PHMP + US was evaluated by constructing the subcutaneous melanoma and full thickness *S. aureus* infected skin wound model, and then monitoring tumor size, wound area as well as analyzing histological characteristics.

#### **RESULTS**

In the PHMP + US group, the descended cell viability and apparent cell death were observed, and the narrower scratch gap and fewer bacterial colonies were displayed. Simultaneously, the tumors undergoing PHMP + US disposal exhibited poor growth, distinct cell apoptosis and lower proliferation ability. In addition, the infected wounds in the PHMP + US group healed the fastest and demonstrated well-organized collagen fiber and skin structure.

#### **CONCLUSION**

The *in vitro* and *in vivo* results suggests that US-activated PHMP can effectively inhibit tumor and promote infected wound repair.

#### **CLINICAL RELEVANCE/APPLICATION**

This study highlights the overall treatment of later stage or postoperative cancers accompanied by infectious wounds with a single US-activated multifunctional intervention which bypasses the side effects of polypharmacy and systemic administration of anticancer drugs/antibiotics. Such a conception delves the maximum capacity of each member and meanwhile reduces the harm to the minimum, which is of vast prospect in clinical transformation.

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## Abstract Archives of the RSNA, 2023

S3B-SPIR-6

### Elucidation of the Microvascular Embolization Effects of Imipenem/Cilastatin; Evaluation at the Level of Microvessels using Monochromatic X-ray in Vivo Study

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Hiroki Nakamura (*Presenter*) Nothing to Disclose

#### PURPOSE

To elucidate the characteristics of Imipenem/Cilastatin (IPM/CS) as an embolic material in vivo.

#### METHODS AND MATERIALS

Three healthy Japanese white rabbits (approximately 3 kg each) were used. A portion of one ear of each rabbit was injected subcutaneously with picibanil (0.5 KE) to create an inflammation-induced model. High spatial resolution microangiography was performed using monochromatic X-rays extracted from synchrotron radiation facility (Super Photon ring-8; SPring-8). Under anesthesia, an elastomer needle (26 G) was placed in the intermediate branch of the auricular artery, and pre-embolization angiography was performed. Then, embolization was performed from the intermediate branch of the auricular artery using a mixture of IPM/CS (0.2 g) and non-ionic contrast agent (2 ml). Angiography was performed during embolization, and at 3, 10, 20, 30, 40, 50, 60, 70, 80, and 90 minutes after embolization. The embolized vascular diameter was evaluated from the images during embolization, and the recanalization time was defined as after embolization time of "total artery area of post embolization / total artery area of pre embolization  $\times$  100" was  $\geq$ 100 %. ROIs were set in both normal (n=3) and inflammation-induced (n=3) sites, and comparisons were made between the two groups.

#### RESULTS

The mean diameter of the embolized vessels immediately after embolization was  $267 \pm 58.35 \mu\text{m}$ , with a range of 174-363  $\mu\text{m}$ . In the follow-up observations after embolization, the normal vessels recanalized at an average of 70 minutes (case1: 101% on 70 min later, case2: 100% on 90 min later and case3: 101% on 50min later). In contrast, the vessels in the inflammation-induced areas did not show recanalization during the 90 minutes observation period.

#### CONCLUSION

The characteristics of IPM/CS as an embolic material in vivo were elucidated. In vivo, much larger vessels are embolized than the actual particle size. It was also suggested that the embolization effect duration might differ between normal and inflammation-induced areas.

#### CLINICAL RELEVANCE/APPLICATION

The analgesic effect of IPM/CS embolization for pain associated with chronic arthritis has been clinically confirmed, and it may potentially become a basic data for the development of new embolic materials as alternatives to IPM/CS.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK-1

### Feasibility Study on Classification of Meniscus Damage Based on MRI Radiomics

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Hongxing Fan (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the value of machine learning(ML)models based on MRI radiomics features in predicting the degree of meniscus injury.

#### METHODS AND MATERIALS

MRI images of 732 knee menisci were retrospective analyzed. The menisci were randomly divided into a training group (n=512) and a validation group (n=220) at a ratio of 7:3. Radiomic features were extracted from the sagittal and coronal proton density-weighted fat suppression images. The Minimum redundancy maximum relevance (mRMR) and least absolute shrinkage and selection operator (LASSO) were used for data dimension reduction and feature selection. Then, based on the optimal features, we constructed a four-category classification model with different ML methods, and its diagnostic performance was quantified by the the area under the receiver operating characteristic curve (AUC).

#### RESULTS

Eighteen significant radiomic features (10 from sagittal and 8 from coronal images) were selected for model construction. The Macro AUC of support vector machine, logistic regression, Gaussian process, random forest, quadratic discriminant analysis and Bagging decision tree model were 0.876, 0.871, 0.870, 0.869, 0.868 and 0.868, respectively. The best-performing models for each lesion grade were: random forest for normal meniscus (AUC=0.948), logistic regression for grade 1 meniscus injury (AUC=0.833), Bagging decision tree for grade 2 (AUC=0.805) and random forest (AUC=0.902) for grade 3 meniscus injury.

#### CONCLUSION

The ML models based on MRI radiomics features can accurately assess the type of meniscal injury.

#### CLINICAL RELEVANCE/APPLICATION

By accurately assessing the type of meniscal injury, ML can enhance the reliability and reproducibility of the diagnosis and help radiologists make clinical decisions.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK-2

### Enhancing Patient-Centered Radiology Reports with Generative Artificial Intelligence: Adding Value to Radiology Reporting

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Jiwoo Park, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the efficacy of AI-generated radiology reports in terms of report processing and providing high-quality, easily understandable reports that can address patient questions and to estimate the accuracy and artificial hallucination of AI-generated radiology reports.

#### METHODS AND MATERIALS

A total of 100 spine MRI reports were retrieved from our hospital database, all of which had been approved by fellowship-trained board-certified radiologists with 6 to 18 years of experience. To ensure compliance with HIPAA regulations, all reports were deidentified by removing unique identifying information. Using generative AI, AI-generated radiology reports were then produced by inputting the original reports into a new session without any prior questions having been posed. The reports were generated in four formats: (1) structured reports, (2) summary reports, (3) recommendations, and (4) patient-friendly reports. To evaluate the quality and accuracy of the AI-generated reports, they were compared with the original reports by a panel of radiologists in terms of: (1) the quality of the structured report, (2) the quality of the summary, (3) the concordance of the recommendations with those made by the radiologists, (4) the compatibility of the patient-friendly reports, and (5) the occurrence of artificial hallucinations. Two radiologists conducted qualitative and quantitative studies, independently (five-point scale).

#### RESULTS

The scoring of the AI-generated radiology reports were  $4.95 \pm 0.24$  for structured report and  $4.69 \pm 0.67$  for summary. The agreements of radiologist recommendations and generative-AI recommendations was 95.96% (score  $4.88 \pm 0.54$ ). The compatibility for patient-friendly reports was 83 % (score  $4.71 \pm 0.71$ ). There were 3% artificial hallucinations in patient-friendly reports. This amounted to 3.6 times higher prevalence of easy understandable for the generative-AI powered patient friendly reports ( $P < .001$ ).

#### CONCLUSION

Generative AI was employed to reproduce radiology reports in various useful formats. The potential benefits of using AI assistants to generate these reports include improved report quality, greater efficiency in radiology workflows for producing structured reports, summaries, and recommendations, and a move toward patient-centered radiology.

#### CLINICAL RELEVANCE/APPLICATION

The use of large language model in radiology reports can have a significant impact on the quality and efficiency of radiology workflows. By producing high-quality, easily understandable reports that can address patient questions, AI-generated reports can improve patient care and satisfaction, moving towards patient-centered radiology, which places a greater emphasis on meeting the needs and expectations of patients.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK-3

### Performance of Deep Learning based Vertebral Compression Fracture Detection Algorithm in Patients with Acute and Chronic Fractures

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Jemyoung LEE, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Although deep learning algorithms (DL) show promising detecting lesions, the robustness of DL in detecting vertebral compression fractures (VCFs) in patients with acute and chronic fractures was less well known. Therefore, the aim of this study was to investigate the robustness of a DL for detecting VCFs in patients with acute and chronic fractures.

#### METHODS AND MATERIALS

We included 178 patient CT cases (excluding those who underwent surgery with cement or screw) diagnosed with VCF at a tertiary medical center (KUMC, Seoul). Each vertebra's reference standard was established by two radiologists. A total of 1200 vertebral bodies (VBs) were labeled for use in the evaluation of which 1000 VBs were normal, 104 chronic and 171 acute. We utilized a deep learning-based quantitative spine analysis program (ClariVCF, ClariPi Inc., Seoul) in which the vertebral body was segmented automatically by using a pre-trained CNN model followed by measurement of vertebral heights at anterior, middle, and posterior portions of each vertebra. Vertebral height loss was then calculated by measuring the ratio of height at the anterior or middle portion to that of the posterior portion. In addition, a formula was used to compare the vertebral heights between the consecutive vertebra above and below. We evaluated the detection performance of DL for acute and chronic VCFs with sensitivity and specificity by using a criterion of 20% height loss ratio according to the Genant classification.

#### RESULTS

The detection performance of DL for the chronic VCFs was shown to be 94.23% (87.87-97.85%, 95% CI) in sensitivity and 86.91% (84.65-88.94%, 95% CI) in specificity. The performance was reduced for acute VCFs (N=171) to 78.95% (72.07-84.80%, 95% CI) in sensitivity and 86.91% (84.65-88.94%, 95% CI) in specificity. For the overall dataset, which included both acute and chronic VCFs, the sensitivity was 84.56% (79.71-88.64%, 95% CI) and the specificity was 86.91% (84.65-88.94%, 95% CI).

#### CONCLUSION

The deep learning-based VCFs detection algorithm was more sensitive in detecting chronic VCFs than acute VCFs. However, the specificity remained unchanged for both chronic and acute.

#### CLINICAL RELEVANCE/APPLICATION

It might be necessary to take cortical disruption or cortical step-off into account for acute VCFs, where some vertebral height loss might not be noticeable. This demonstrates the necessity for techniques other than height loss measurement. Additionally, a unique height loss measurement approach is necessary for each spinal location while taking into account the physiologic wedging of each vertebral level in order to prevent false positive results.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPMK-4

### Describing the Effects of IV Contrast on CT Abdominal Body Composition Biomarkers

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Alexander D. Weston, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Automated measures of body composition from abdominal CT images are becoming more common to quantify frailty, obesity, and to predict disease outcomes. However, measures may be biased by the presence of intravenous (IV) contrast, possibly leading to prior studies avoiding reporting skeletal muscle density measurements (e.g., Magudia 2021, Radiology). We evaluated the effect of IV contrast phase on six biomarkers of abdominal body composition.

#### METHODS AND MATERIALS

We randomly sampled 244 persons with 258 abdominal CT radiologic exams (479 series) from a cohort representative of the general population. Series were manually annotated for IV contrast phase (noncontrast, arterial, venous, delayed, or nephrographic). We applied a deep-learning model to segment abdominal body composition centered at the L3 transverse process (previously validated mean Dice scores for subcutaneous fat area 0.98, visceral fat area 0.94, muscle area 0.96, and bone area 0.98). Muscle and bone density were defined as mean Hounsfield units (HU) of the segmented tissues. All available CT series were segmented and multiple acceptable series acquired at different IV contrast phases were used to calculate the difference in each body composition biomarker relative to the noncontrast CT series. Values are reported in scatter plots and significance was assessed using 2-sided paired-sample t-tests.

#### RESULTS

Based on manual review, 256/258 CT studies (99%) had one or more series with acceptable quality for body composition analysis and 95/256 studies (37%) had a noncontrast series for comparison. Skeletal muscle density measurements were higher in venous phase versus noncontrast (difference of 5.9HU, 95% CI: 4.72 - 7.15HU) and delayed phase versus noncontrast (difference of 8.5HU, 95% CI: 7.35 - 9.69HU), significant after Bonferroni correction. Vertebral bone density measurements were higher in venous phase versus noncontrast (difference of 8.2HU, 95% CI: 4.9 - 11.5HU) and delayed phase versus noncontrast (difference of 11.5HU, 95% CI: 7.5 - 15.6). No significant differences were observed between arterial phase versus noncontrast series.

#### CONCLUSION

Skeletal muscle density and vertebral bone density measurements on abdomen CT are slightly higher in the presence of IV contrast.

#### CLINICAL RELEVANCE/APPLICATION

A correction factor may be needed to account for IV contrast phase when measuring skeletal muscle density and vertebral bone density biomarkers in CT-based body composition analysis.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK-5

### **Distal Radius Fracture: Competent Radiology Reports Generated by ChatGPT Integrating RSNA Template Items and AO Classifier**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Wolfram A. Bosbach, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

While demand for radiology imaging grows worldwide, novel information technology tools promise an increase of reporting quality and as well quantity. Text report drafting tools are part of this development.

#### **METHODS AND MATERIALS**

In the present study, cases of distal radius fracture are defined. Command files for the writing of a report following a template of the Radiological Society of North America (RSNA) and Arbeitsgemeinschaft Osteosynthese (AO) are given to the natural language processing tool ChatGPT.

#### **RESULTS**

An overall high appraisal of ChatGPT radiology reports is obtained in an assessment by human radiologists. ChatGPT is able to adjust output files in response to minor changes in input command files. Shortcomings are the dealing with technical terminology and medical interpretation of findings.

#### **CONCLUSION**

In the future, text drafting tools might well support the clinical work of radiologists. ChatGPT is seen by us as a substantial step forward toward that aim.

#### **CLINICAL RELEVANCE/APPLICATION**

The amount of clinical imaging is growing because of reasons such as demographics and more complex imaging modalities. Tools which draft a text report allow the radiologist to increase output efficiency and to focus time on patient pathology.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK-6

### The Value of Incorporating Additional Carpal Tunnel Sequences in the Hand MRI for Patients Presenting with Trigger Finger Symptoms

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

NA YOUNG LEE (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the prevalence of carpal tunnel syndrome (CTS) in trigger finger patients and identify the MRI criteria necessary for its diagnosis, particularly in cases requiring surgical intervention by obtaining additional two sequence MRI of the carpal tunnel.

#### METHODS AND MATERIALS

Fifty-five hands in 49 patients underwent MRI for evaluation of trigger finger prior to surgery. The dataset included variables such as age, sex, patients' symptoms, and measurements of median nerve signal intensity (SI) and shape, cross-sectional area of the median nerve (MNA), and retinacular bowing. Patients who underwent carpal tunnel release were classified as having severe CTS. The statistical analysis of these factors was conducted using a suite of methods including the independent Student's t-test, Chi-square test, and logistic regression. ROC curves were also drawn to evaluate the precision of CTS diagnosis and to predict severe CTS.

#### RESULTS

A total of 22 hands underwent carpal tunnel release surgery for CTS with concomitant pulley release for trigger finger. The incidence of severe CTS in patients with trigger finger was observed to be 40%. One third of patients diagnosed with severe CTS exhibit the classical symptoms associated with CTS, including tingling sensations in their fingers. However, the remaining patients present with symptoms primarily related to trigger finger, such as pain in the fingers. Statistically significant differences were observed between patients with trigger finger and severe CTS, and those with trigger finger only groups, in relation to several key factors, including MNA, median nerve SI and shape, and retinacular bowing at the outlet ( $p < 0.001 \sim 0.005$ ). Among these factors, only MNA of proximal to inlet level (MNA-pi) and increased median nerve SI with nerve fascicle swelling exhibited a positive correlation with odds ratio of 1.657. Further analysis of ROC curves demonstrated a sensitivity, specificity, and accuracy of MNA-pi  $> 15 \text{ mm}^2$  of 77.27%, 72.73%, and 84.5%, and MNA of distal to outlet (MNA-do)  $> 13 \text{ mm}^2$  of 81.82%, 75.76%, and 84.8%.

#### CONCLUSION

MRI is a highly accurate diagnostic modality for detecting severe CTS, which often requires surgical intervention.

#### CLINICAL RELEVANCE/APPLICATION

Incorporating two additional sequences of MRI of the carpal tunnel with hand MRI for preoperative evaluation of trigger finger has the potential to aid in the detection of severe CTS and in facilitating optimal surgical planning.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK-7

### Usefulness of the Floating Fat Sign in the Extensor Tendon Sheath for Predicting Extensor Pollicis Longus Tendon Rupture in Distal Radius Fracture

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Bo Mi Chung, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the usefulness of the floating fat sign for predicting extensor pollicis longus (EPL) rupture in distal radius fracture (DRF).

#### **METHODS AND MATERIALS**

This retrospective study included patients with DRF, consisting of the EPL rupture ( $n = 9$ ) and non-rupture ( $n = 340$ ) groups. The floating fat sign was visually graded on a semi-quantitative Likert scale (0 to 2) for the second and third extensor compartments separately. The presence of bone fragment, Lister's tubercle fracture type, fracture gap, and presence of intra-articular fracture were assessed. Fisher's exact test was conducted to assess the correlation between the floating fat sign and EPL rupture. Univariate and multivariate analyses were performed, followed by ROC curve analysis.

#### **RESULTS**

The sum of floating fat sign scores of the second and third compartments was significantly correlated with the odds of EPL rupture ( $p = 0.001$ ). Male sex, conservative treatment, floating fat sign score of the second and third extensor compartments, and sum of floating fat sign scores of the second and third extensor compartments were significant variables associated with EPL rupture. The floating fat sign in the third compartment was an independent predictive indicator for EPL rupture ( $p = 0.002$ ). ROC curve analysis revealed that the AUC was the highest (0.835) for the multivariate model, followed by the univariate model of the sum of floating fat sign scores of the second and third compartments.

#### **CONCLUSION**

The floating fat sign in DRF could be a predictive indicator for EPL rupture.

#### **CLINICAL RELEVANCE/APPLICATION**

The presence of the floating fat sign in distal radius fracture may assist in predicting the risk of extensor pollicis longus tendon rupture, which could aid in developing a treatment plan or providing warning of potential tendon rupture.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK-8

### Investigation of Buffer Thickness for Reducing Artifacts from the Table in Computed Tomography Examinations During the Extremities Three-Dimensional Imaging

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yoshiki Kamihoriuchi (*Presenter*) Nothing to Disclose

#### PURPOSE

If the hand is directly positioned on the computed tomography (CT) table mat, it is often difficult to separate the hand from the CT table mat due to artefacts from the CT table mat at the three-dimensional (3D) imaging. The objective of this investigation was to determine the optimal thickness of the buffer material utilized for 3D imaging, to alleviate artifact generation consequent to hand separation from the CT table mat.

#### METHODS AND MATERIALS

The wrist phantom was placed on a CT table mat. Styrofoam and medical non-woven gauze were used as buffers, and 10 scans were acquired each with no buffer (none), one piece of gauze (gauze) and 1, 2, 3, 4 and 5 mm of Styrofoam. The scan parameter was following (tube voltage 135 kV, tube current 100 mA, rotation time 1.0 second, helical pitch 0.637, slice thickness 1.0 mm, field of view 150). For the 3D image, we utilized images with a reconstruction interval of 0.5 mm and reconstructed them using three different bone functions (FC30 AIDR3D mild: FC30, Aice Bone mild: BM, and Aice Bone standard: BS). Three regions of interest (ROIs) were set up within an identical image section, both in the absence of buffer and with a 5 mm Styrofoam buffer. Subsequently, profile curves were measured and the maximum CT values at the phantom edge were compared. A comparative analysis of the full-width at half-maximum (FWHM) was conducted among three scenarios: no buffer, gauze, and 1 mm buffer. Visualization scores were evaluated at three levels to assess the degree of artifacts caused by the CT table mat during 3D image creation.

#### RESULTS

The results obtained indicate statistically significant differences between the scenarios without buffer and with gauze, gauze and 1 mm buffer for all cases. In terms of the maximum CT values at the phantom edges, the following comparisons were made: FC30 (none: 340 (229-348) HU, 5 mm: 289 (282-295) HU), BM (none: 446 (358-451) HU, 5 mm: 380 (366-387) HU), and BS (none: 269 (227-275) HU, 5 mm: 219 (215-222) HU) ( $p < 0.05$  for all). Furthermore, the full-width at half-maximum (FWHM) was analyzed for FC30 (gauze: 0.77 (0.71-0.85) mm, 1 mm: 1.08 (1.07-1.18) mm), Bone Mild (gauze: 0.72 (0.63-0.81) mm, 1 mm: 1.00 (0.99-1.08) mm), and Bone Standard (gauze: 0.77 (0.71-0.85) mm, 1 mm: 1.08 (1.07-1.18) mm) ( $p < 0.05$  for all).

#### CONCLUSION

By inserting a buffer material with a thickness of at least 1mm between the hand and the CT table mat at creating 3D imaging, the separation of the hand and the CT table mat can be achieved easier for regardless of the conditions.

#### CLINICAL RELEVANCE/APPLICATION

It was confirmed that using a buffer material of 1 mm or more can significantly reduce the effects of artifacts from the CT table mat, which can improve the quality of 3D imaging of the hand and increase flexibility in positioning.

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## Abstract Archives of the RSNA, 2023

S3B-SPMS-1

### **STIR-based Volume Measurement Methods for Staging Primary Lower Extremity Lymphedema: A Single-center Study of Asymmetric Volume Difference**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

MENGKE LIU (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The staging of lower extremity lymphedema (LEL) is hard in clinical work. The perfect soft tissue contrast of Short Term Inversion Recovery (STIR) sequence of MRI enables quantitatively assess the clinical staging of primary LEL. This study aims to explore the clinical value of MRI-based asymmetric volume measurement in the clinical staging of primary LEL.

#### **METHODS AND MATERIALS**

92 patients with unilateral primary LEL underwent Short Term Inversion Recovery (STIR) sequence of MRI. The volume of the middle calf was calculated using the clinical dermatome method (VCl). Two radiologists measure the total volume (V), musculoskeletal volume (VM), and subcutaneous volume (VS) in the middle calves on MRI. The difference between the affected and unaffected calf regarding V (DV) and VS (DVS) was obtained. DV and DVS were defined as asymmetric volume difference. The volume of the middle calf (Vcl) and difference in volume (DVcl) were calculated using the clinical circumferential method. The relationship between asymmetric volume difference and clinical staging was evaluated. Interobserver consistency was assessed through intraclass correlation coefficient (ICC). Volume comparisons were performed using one-way analysis of variance (ANOVA) analysis or Kruskal-Wallis test among three groups. Spearman's correlation analysis was used to assess volume and clinical stage correlation. The receiver operating characteristic (ROC) curve was drawn to assess the value of asymmetric volume difference for clinical staging.

#### **RESULTS**

The asymmetric volume difference was statistically significant in stage I compared to stages II and III ( $p < 0.05$ ). The asymmetric volume difference (DV:  $r = 0.753$ ; DVS:  $r = 0.759$ ) correlated more with the clinical stage than the affected Vcl ( $r = 0.581$ ), V ( $r = 0.628$ ), VS ( $r = 0.743$ ) and DVcl ( $r = 0.718$ ). The area under ROC curve (AUC) for identifying the clinical stage by the asymmetric volume difference was greater than that for the affected Vcl, V, VS and DVcl, with DVS (AUC=0.951) having the highest area under the curve to distinguish between stages I and II.

#### **CONCLUSION**

STIR-based asymmetric volume difference can be used as an adjunctive measure for clinical staging of LEL with good reproducibility, and DVS could be the best indicator for differentiating between stages I and II.

#### **CLINICAL RELEVANCE/APPLICATION**

STIR can quantitatively assess the severity of primary lower extremity lymphedema, facilitating clinical decision making and improving prognosis.

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## Abstract Archives of the RSNA, 2023

S3B-SPNMMI-1

### PSMA PET/CT for Localization of Prostate Cancer after Focal Therapy

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Mahbod Jafarvand, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

PSMA-ligand PET has become the first-line imaging tool for staging and re-staging patients with prostate cancer. However its role in patients with prostate cancer who underwent focal therapy (HIFU, irreversible electroporation, photodynamic therapy, cryoablation, and laser therapy) is still unknown. In this study, we aimed to investigate the diagnostic performances of PSMA PET/CT to detect and localize biochemical recurrence after focal therapy.

#### METHODS AND MATERIALS

This was a retrospective single center study. Patients with the following inclusion criteria were included: focal treatment for prostate cancer, 68Ga-PSMA-11 PET with contrast enhanced CT performed for biochemical recurrence, and no therapy between focal therapy and PET. Three independent blinded readers performed the PET image analysis and a per-region (T, N, M1a, M1b, M1c) centralized majority rule was applied (positivity rate). Inter-reader agreement of the positivity rates was calculated with Fleiss' kappa. In a sub-cohort of patients with a MRI and biopsy performed within 3 months of PSMA PET, diagnostic accuracy was evaluated on a per-patient and per-segment analysis on standard WB +60 min and the delayed +90 min pelvic images. A single radiologist blinded to PSMA and pathology performed MRI interpretation. Twelve prostatic segments were defined, and for every segment, suspicion for recurrence was assessed.

#### RESULTS

Of the 3329 patients with either a PSMA PET scan or focal therapy performed at UCLA, 100 patients met the inclusion criteria. PSMA-PET positivity rate per majority rule was 85/100 (85%) for prostate, 17/100 (17%) for pelvic lymph nodes and 20/100 (20%) for distant metastases. The inter-reader agreement for positivity rate by region was moderate ( $\kappa=0.5$ ). 29 patients had MRI and post-therapy biopsy data available. In these, Per-patient analysis showed a sensitivity of 92% for PSMA and 88% for MRI. Per-segment analysis performed on 297 validated segments resulted in a sensitivity, specificity, positive predictive value and negative predictive value of 53%, 90%, 74% and 78% for PSMA at +60 min, 55%, 92%, 79% and 79% for PSMA at +90 min and 29%, 92%, 72% and 65% for MRI ( $p<0.01$ ), respectively. All Patients with PSMA SUV<sub>max</sub> = 10 had GG =3 disease.

#### CONCLUSION

In this retrospective study of 100 patients treated with focal treatment for prostate cancer the PSMA-PET positivity rate was 85% for prostate. The sensitivity per-segment was 55% on delayed +90 min pelvic PSMA PET vs 29% for MRI with a similar specificity of 92%. results suggest that PSMA PET/CT has potential for localization of recurrent prostate cancer after focal therapy.

#### CLINICAL RELEVANCE/APPLICATION

PSMA PET appears promising for localization of biochemical recurrence after focal therapy.

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## Abstract Archives of the RSNA, 2023

S3B-SPNMMI-2

### Manufacturing Iodine-loaded Polymeric Microcapsules: Proof-of-Concept for Theranostics in Peritoneal Carcinomatosis

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Nils Grosse Hokamp, MD, PhD (*Presenter*) Research Grant, Koninklijke Philips NV; Speakers Bureau, Koninklijke Philips NV; Consultant, Bristol-Myers Squibb Company

#### PURPOSE

Peritoneal carcinomatosis refers to shedding of tumor cells to the peritoneal cavity and often is indicative of incurable and/or end stage disease. Treatment options at this advanced stage include hyperthermic intraperitoneal chemotherapy (HIPEC) alongside cytoreductive surgery. Aiming for continuous chemotherapeutic delivery options, this study intended to provide proof-of-concept of polymeric microcapsules that allow incorporation of chemotherapeutic agents and that are furthermore loaded with iodine in order to allow in-vivo tracing using computed tomography.

#### METHODS AND MATERIALS

For synthesis a solvent-emulsion evaporation technique has been used. Hydrophobic iodinated oils (e.g. Lipiodol) were used as inner phase of the capsule. A biodegradable polymer [poly(lactic-co-glycolic acid), PGLA] was used as outer shell material. A fluorescent dye was added for direct visualisation. Incorporation of hydrophilic drugs, was shown with an aqueous iodinated compound (iohexol), using a water-oil-water emulsion process. Light/fluorescence microscopy, UV/Vis spectroscopy and size distribution using a Coulter Counter were conducted in addition to spectral detector CT based quantification of iodine content (SDCT).

#### RESULTS

The synthesis yielded polymeric capsules containing CT-imageable iodinated compounds with tuneable diameter. The obtained particle diameters were in the range of 0.1 - 15  $\mu\text{m}$ . Iodide concentration was further quantified using UV/vis spectroscopy. Here, Iodine to polymer ratio varied between 23 to 125 mg I/g corresponding to 0.01 to 0.03  $\mu\text{g}$  I/capsule; similar results were obtained using SDCT. In addition cytostatic drugs could be incorporated into the particles.

#### CONCLUSION

Controlled formation of iodine-loaded polymeric microcapsules can be achieved. The capsules can be visualized using SDCT which furthermore allows for quantification of their iodine content (consistent with UV/vis-based measurements as standard of reference). Furthermore, cytotoxic drugs can be incorporated into these particles.

#### CLINICAL RELEVANCE/APPLICATION

The described syntheses provide proof-of-concept for in-vivo traceable and quantifiable microcapsules. Attempts to alter longevity of these systems might allow for a continuous therapy of peritoneal carcinomatosis. Alternatively, advanced manufacturing might allow for targeted drug delivery, e.g. by incorporating receptors into the outer shell.

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## Abstract Archives of the RSNA, 2023

S3B-SPNPM-1

### **Disability, an Often-Overlooked Aspect of Equity, Diversity, and Inclusion Among Radiology Departments in Canada and the United States**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Ali Abbas, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Despite nearly a quarter of Canadians and Americans reported to be living with a disability, persons with disabilities continue to face both structural and cultural barriers with respect to careers in medicine. Equity, diversity, and inclusivity (EDI) statements can act as a first step in deconstruction of these cultural barriers. However, when compared to other EDI initiatives focused on gender, race, and ethnicity, persons with disabilities receive little attention.

#### **METHODS AND MATERIALS**

We conducted a cross-sectional analysis of all radiology residency program websites in Canada and the United States (US). Data was collected from each radiology department website including the presence or absence of an EDI statement or page; if present, we determined whether mention was made of persons with disabilities.

#### **RESULTS**

We reviewed the websites of 16 Canadian and 181 US radiology residency programs. Seven (44%) Canadian institutions had an EDI statement, with one (14%) mentioning persons with disabilities. In the US, 103 (57%) institutions had an EDI statement, with 42 (41%) mentioning persons with disabilities.

#### **CONCLUSION**

There were a significant proportion of radiology departments without EDI statements on their websites and an even smaller proportion that acknowledged persons with disabilities. Persons with disabilities are underrepresented in the medical profession and are often left out of radiology department EDI statements. This population faces many barriers to careers in medicine, underscoring the importance of physical and cultural accommodations.

#### **CLINICAL RELEVANCE/APPLICATION**

Patients with disabilities often report that healthcare providers lack understanding of their condition; thus, inclusion of persons with disabilities among the physician workforce may result in improved patient care. In recent years, there has been an increase in recruitment of medical students with disabilities. Therefore, it is important that post-graduate medical training programs implement the changes necessary to welcome and accommodate these individuals. An institution's public commitment to EDI, and specifically to patients and providers with disabilities, is central to implementing inclusive change going forward.

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## Abstract Archives of the RSNA, 2023

S3B-SPNPM-2

### Gender-specific Differences in Aspired Academic Qualification and Perceived Research Opportunities: Excerpts from a Nationwide German Survey

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Isabel Molwitz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess gender-specific differences in aspired academic qualifications and perceived research opportunities.

#### METHODS AND MATERIALS

Questionnaires were sent to radiologists of different career levels via the German Roentgen Society, the European Society of Radiology's Radiological Trainee Forum, the Radiological Society of North America's Resident and Fellow Committee, and manually to 4500 radiologists of the largest German hospitals. Statistical analyses were conducted with age-adjusted regression analyses only for participants from Germany, as international responses were scarce.

#### RESULTS

Of 510 radiologists with German affiliations (female: 237, 46%, mean age 42 ±10 years) men were four times more likely to have a higher academic degree (PD, habilitation) than women (odds ratio 4.39 [95%-confidence interval 2.22-8.67]) and twice as likely to pursue such a degree (2.87 [1.47-5.61]). Stated reasons to pursue further academic qualification (PD) more frequently found among male participants were: to be eligible for a position as leading physician (2.56 [1.07-6.15]) and a research interest (2.36 [1.0-5.57]). There were no gender differences in motivations occurring from an interest in teaching (1.86 [0.84-4.14]), the wish for more opportunities (1.62 [0.73-3.59]), or a higher independency (0.95 [0.44-2.05]). Most male (84%) and female (74%) radiologists were satisfied with possibilities of congress participation. The odds for dissatisfaction were slightly smaller among men than among women (0.62 [0.39-0.98]). Among both genders, dissatisfaction was high concerning time off clinical duties for research purposes (women: 64%, men 57%; 0.69 [0.41-1.16]). Most female respondents (51%) were dissatisfied with options to be involved in research projects, while most men (61%) were satisfied with them. Differences between both genders were not significant (0.60 [0.35-1.01]). Likewise, dissatisfaction with possibilities to develop their own projects and apply for funding was slightly higher among women (48% vs. 40%) but differences not of statistical significance (0.77 [0.45-1.35]).

#### CONCLUSION

Among German radiologists, men pursue academic qualification more frequently, with eligibility for a position as leading physician being a gender-specific motivational difference. Dissatisfaction with research opportunities tend to be higher among women.

#### CLINICAL RELEVANCE/APPLICATION

To achieve gender equality in science and among leading academic positions, it is essential to understand differences in motivation and integration in research among male and female radiologists. Women may want more support than currently provided, in terms of integration into research projects, developing their own projects, and applying for funding.

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## Abstract Archives of the RSNA, 2023

S3B-SPNPM-3

### Gender Representation in Radiology Practices in the United States

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Elizabeth H. Dibble, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate gender representation in radiology practices in the United States

#### METHODS AND MATERIALS

The ACR Human Resources Commission fielded the 2022 Workforce Survey 11/2022-12/2022. The sample drew from the ACR members (35,601), non-members (12,551), and RBMA members (1,482). Structured closed-end questions were used, consistent with earlier surveys. Responses were group practice deduplicated and weighted and compared to 2021 survey results.

#### RESULTS

524 fully qualified (decision-maker) respondents completed the survey: 77% male and 20% female. 1278 partially qualified respondents completed it: 65% male, 29% female, and .002% nonbinary. Significantly fewer partially qualified respondents preferred not to self-report gender in 2022 vs 2021 (5% vs 8%,  $p=0.0046$ ). 325 respondents answered questions about practice size and gender composition. The median number of non-practice-leader radiologists per practice was 15 (interquartile range (IQR) 7,30); full-time 13 (IQR 6,24), part-time 2 (IQR 0,5). The median number of practice-leader radiologists was 4 (IQR 1,7); full-time 4 (IQR 2,7), part-time 0 (IQR 0,0). These numbers were not different from 2021 ( $p>0.05$ ). Of full-time non-practice-leader radiologists per practice, the median number of females age  $<40=0$  (IQR 0, 1),  $40-65=1$  (IQR 0, 3), and  $>65=0$  (IQR 0,0); the median number of males age  $<40=2$  (IQR 0,4),  $40-65=6$  (IQR 3,12), and  $66+=0$  (IQR 0,1). The mean number of non-practice-leader radiologists increased slightly from 2021 to 2022 across all ages and represented genders, although this did not reach significance ( $p>0.05$ ). Of full-time practice-leader radiologists, the median number of females age  $<40=0$  (IQR 0, 0),  $40-65=0$  (IQR 0,1), and  $66+=0$  (IQR 0,0); the median number of males age  $<40=0$  (IQR 0,0),  $40-65=3$  (IQR 1,5), and  $66+=0$  (IQR 0,0). The mean number of practice-leader females increased slightly across all age groups from 2021 to 2022. The mean number of practice-leader males increased for age  $<40$  ( $p=0.0458$ ), decreased for  $40-65$  ( $p>0.05$ ), and increased for  $66+$  ( $p>0.05$ ). The mean and median number of radiologists identifying as nonbinary was 0 for all queries.

#### CONCLUSION

Female and nonbinary radiologists are underrepresented in radiology practices. Significantly fewer respondents in 2022 preferred not to self-report gender compared to 2021. The median number of female and nonbinary radiologist practice leaders is 0. The mean number of female practice leaders increased slightly across all age groups from 2021 to 2022, although this did not reach significance.

#### CLINICAL RELEVANCE/APPLICATION

Female and nonbinary radiologists are underrepresented in US radiology practices in both leadership and non-leadership roles.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-1

### Association of Body Mass Index and Waist Circumference with Multimodal Magnetic Resonance Imaging Indicators of Brain Health in 9- to 10-year-olds in the US

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Simone Kaltenhauser, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the relationship of pre-adolescents' Body Mass Index (BMI) and waist circumference (WC) with magnetic resonance imaging (MRI) indicators of brain health (cortical morphometry, resting-state functional connectivity, white matter (WM) micro- and cytostructure) over two years.

#### METHODS AND MATERIALS

We retrieved baseline and two-year follow-up clinical and neuroimaging information of a sociodemographic diverse cohort of 11,878 9- to 10-year-olds enrolled in the Adolescent Brain Cognitive Development (ABCD) study across 21 centers in the US. Inclusion required absence of neurodevelopmental/psychiatric diagnoses and traumatic brain injury. T1- and T2-weighted structural MRI, diffusion tensor imaging, resting-state functional MRI, and restriction spectrum imaging were quantified in a region-of-interest based approach. At both time points, cross-sectional linear regression determined the association of BMI/WC with fractional anisotropy (FA), neurite density (ND), cortical thickness and resting-state functional connectivity, after correction for age, gender, puberty, race/ethnicity, handedness, socioeconomic status and scanner device. In longitudinal analyses, multivariate regression was used to examine associations of baseline BMI with interval changes in neuroimaging metrics.

#### RESULTS

At baseline, 4,576 children (48.3% female) at an average age of 10.0 years (7.6 months) were included. 1,567 enrollees aged 12.0 years (7.7 months) had complete follow-up. At both point in time analyses, higher BMI/WC were associated with pervasive bilateral reductions of FA ( $P < .001$ ) as well as ND ( $P < .03$ ). With higher BMI/WC, especially prefrontal cortical thickness was reduced in both hemispheres ( $P < .04$ ). We found predominantly negative associations of BMI/WC with intra- and inter-network functional coupling of salience and cingulo-opercular networks ( $P < .005$ ). Over a mean follow-up period of 23.8 (1.6) months, we observed overall interval cortical thinning and increase in averaged FA and ND. Higher BMI at baseline was associated with lower interval increment in FA and ND of several commissural, projection and association WM tracts as well as reduced interval cortical thinning of prefrontal regions.

#### CONCLUSION

Higher BMI and waist circumference among children are associated with reduced WM micro- and cytostructural integrity, cortical thickness, and functional connectivity. Our longitudinal analysis suggests contribution of higher BMI to hindered interval development of WM micro- and cytostructure and cortex morphology.

#### CLINICAL RELEVANCE/APPLICATION

Our findings highlight the neurodevelopmental implications of pre-adolescents' higher weight and point to the need for early targeting of brain health indicators.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPNR-10

### Spatiotemporal Discoordination of Brain Spontaneous Activity in Major Depression Disorder

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Qunjun Liang (*Presenter*) Nothing to Disclose

#### PURPOSE

Major depressive disorder (MDD) is a world-wide debilitating mental illness. Despite extensive research, the pathogenesis of MDD remains unknown. Spatiotemporal psychopathology (STPP) posits that the symptoms of MDD arise from aberrant spatiotemporal experiences in a patient's inner world, which may be reflected by their brain spontaneous activity. In the present study, we aim at determining the spatiotemporal discoordination of MDD patient's brain spontaneous activity using fMRI.

#### METHODS AND MATERIALS

91 MDD and 91 demography-matched HC were recruited in this study. The fMRI data were preprocessed via fMRIPrep and the timeseries were extracted over Schaefer400 parcels. Spatiotemporal topology (SPT) of the brain activity was measured by the Euclidean distance of each pair of parcels in a 3-dimension coordinate composed by two functional gradients (Margulies et al., 2016) and time delay (Mitra et al., 2014). SPT was then averaged across Yeo's 7 network atlas, resulting in 7 intra- and 21 inter-network SPT. Repeated measures ANOVA was performed to test the mean difference of the SPTs between MDD and HC. A machine learning approach was employed to investigate the efficacy of SPT in discerning between HC and individuals with MDD.

#### RESULTS

A significant difference in network-specific features between MDD and HC was found ( $F(27, 5040) = 2.9, p < .001$ ). Simple-effect test identified four inter-network SPT that showed a significant group effect, including control-somatomotor distance ( $F = 7.3, p = .007$ ), salience-dorsal attention distance ( $F = 11.1, p < .001$ ), salience-visual distance ( $F = 19.2, p < .001$ ), and somatomotor-visual distance ( $F = 19.2, p < .001$ ). The logistic model yielded an accuracy of 0.73 in predicting the group label, and the ROC curve showed an AUC value of 0.86.

#### CONCLUSION

SPT may reflect the homeostatic fluctuation of neuronal activity in the brain, and it is a theoretical-driven measure inspired by STPP. The significant difference in SPT were found in the visual and somatomotor network. The machine learning approach demonstrated the effectiveness of SPT features in differentiating between individuals with MDD and HC. While SPT topology presents theoretical validity and potential clinical value, it is no more than a general evaluation of the current state of the brain. As a result, the precise interpretation of its magnitude and direction is not yet apparent.

#### CLINICAL RELEVANCE/APPLICATION

In the long run, SPT topology may serve as an important reference index in diagnosing MDD using low-cost fMRI scans. In addition, SPT topology could potentially function as a prognostic marker for MDD intervention. However, in its current stage, its main value lies in fundamental research, such as enhancing our understanding of the neural abnormalities of MDD.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-11

### **Mild Cognitive Impairment in Non-alcoholic Fatty Liver Disease is Associated with Abnormal Resting-state Functional Connectivity Between the Default Mode Network and Regions within the Reward System**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Jie Li, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Mild cognitive impairment (MCI) is commonly seen in patients with nonalcoholic fatty liver disease (NAFLD), but the neural mechanisms have not been elucidated. In this study, we used resting-state fMRI (RS-fMRI) to investigate the characteristics of spontaneous neural activity in NAFLD patients with MCI.

#### **METHODS AND MATERIALS**

A total of 74 NAFLD patients and 62 demographic-matched healthy controls (HC) were enrolled. According to the Montreal Cognitive Assessment (MoCA) score, the patients were divided into two groups: 43 patients with MCI\_NAFLD and 31 patients with nonMCI\_NAFLD. All participants underwent 3.0T RS-fMRI scan and neurocognitive psychological assessment, and patients underwent liver MRI proton density fat fraction (PDFF) and blood biochemical indexes measurement. DPABI software was used to process the RS-fMRI data and obtain the whole brain amplitude of low-frequency fluctuations (ALFF) map. One-way analysis of covariance and post-hoc tests were used to compare the differences in ALFF maps among the three groups. The abnormal regions were selected as the regions of interest (ROI) to compare the differences in whole-brain seed-based functional connectivity (FC) between the two patient groups, and the correlation between abnormal FC values and clinical variables was analyzed.

#### **RESULTS**

Compared with nonMCI\_NAFLD patients, MCI\_NAFLD patients had reduced ALFF values in the right cerebellum and right cuneus, and increased ALFF values in the left posterior cingulate gyrus (PCC), and the ALFF values in these different regions were significantly correlated with MoCA scores. Compared with nonMCI\_NAFLD patients, MCI\_NAFLD patients had enhanced FC between the left PCC and the left lingual gyrus, left parahippocampal gyrus, left medial orbitofrontal gyrus, left middle frontal gyrus, left postcentral gyrus and right postcentral gyrus, and reduced FC between the left PCC and the left insula and right supplementary motor area. Among them, the FC values between the left PCC and the regions related to the reward system were correlated with cognitive function, emotional symptoms, PDFF values and insulin function in NAFLD patients. In particular, the ALFF values of the PCC completely mediated the correlation between the FC values between the PCC and the orbitofrontal cortex and MoCA scores.

#### **CONCLUSION**

The development of cognitive impairment in patients with NAFLD may be closely related to the dysfunction of the default mode network and dopamine pathway, in which visceral fat accumulation and insulin dysfunction also play a crucial role.

#### **CLINICAL RELEVANCE/APPLICATION**

These special neuroanatomical abnormalities may help to shed light on the underlying pathophysiology and manifestations of MCI in patients with NAFLD.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-12

### Altered Functional Connectivity of Olfactory Neural Circuits in Subjective Cognitive Decline under Odor Stimulation

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yajing Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

Olfactory involvement is an early feature of Alzheimer's disease. The purpose of this study was to investigate the functional connectivity(FC) changes of olfactory neural circuits in subjective cognitive decline (SCD) in olfactory task fMRI under specific odor stimulation.

#### METHODS AND MATERIALS

A total 56 normal controls(NC) and 57 SCD were included.All subjects were tested with cognitive scale, olfactory behavior assessment, and olfactory task fMRI. The FC difference of olfactory neural circuits between the two groups was analyzed by the method of generalized psychophysiological interaction (gPPI).

#### RESULTS

There was no significant difference in olfactory behavior between the two groups. In olfactory task-fMRI with specific odor stimulation, the FC from bilateral POCs to the right parahippocampal area in the SCD group was significantly reduced; while the FC from the right hippocampus to the right frontal lobe was significantly enhanced. The connectivities from bilateral POCs to the right parahippocampal area, the right parahippocampal, and the right hippocampal were significantly positively correlated with the memory cognitive threshold; the connectivities from bilateral POCs to the right parahippocampal area, the right parahippocampal, and the right fusiform gyrus were significantly positively correlated with the global cognitive function.

#### CONCLUSION

The olfactory behavior reflects the comprehensive performance of the olfactory function, while the olfactory task-fMRI reflects the FC of the olfactory neural circuits. The results of this study indicate that although the olfactory behavior of SCD is at a normal level, the FC of olfactory neural circuits(POC-hippocampus-frontal lobe) has changed.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study suggest that the FC changes of olfactory nerve circuits in SCD subjects under specific odor stimulation conditions, and the correlation between the connectivity of olfactory nerve circuits and the global cognitive function and memory function, prove that the FC changes of olfactory nerve circuits in SCD patients may be used as an early identification marker of high AD risk.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-14

### Altered Hippocampal Intra-networks in Mild Cognitive Impairment: A Structural MRI Study in a General Elderly Japanese Population

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Sera Kasai (*Presenter*) Nothing to Disclose

#### PURPOSE

Although altered networks inside the hippocampus (hippocampal intra-networks) have been observed in dementia, the evaluation of hippocampal intra-networks using MRI is challenging. We employed conventional structural imaging and incident component analysis (ICA) to investigate the structural covariance of the hippocampal intra-networks. To our knowledge, there have been no population-based studies with large sample sizes to assess the association between MCI status and hippocampal intra-network connectivity. Our aim was to assess whether individuals with MCI have altered hippocampal intra-network connectivity as measured using source-based morphometry (SBM) that is a type of structural network when compared with cognitively normal older adults (CNOA).

#### METHODS AND MATERIALS

This was a cross-sectional study of 2122 residents who participated in a population-based prospective study of cerebro- and cardiovascular diseases and dementia in a large population of older Japanese individuals with 3T MRI (median age 69 years, 60.9% female). The participants were divided into 218 patients with MCI and 1904 cognitively normal older adults (CNOA). By employing 3D T1-weighted imaging and ICA, we extracted the structural covariance intra-networks in the hippocampus.

#### RESULTS

The ICA extracted 16 intra-networks from the hippocampal structural images, which were divided into two bilateral networks and 14 ipsilateral networks. Of the 16 intra-networks, four (one bilateral network and three ipsilateral networks) were significant predictors of MCI from the CNOA after adjusting for age, sex, education, disease history, and hippocampal volume/total intracranial volume ratio (Figure) ( $p < 0.01$ ). In addition, the networks predicted MCI independent of hippocampal volume ( $p < 0.01$ ), although hippocampal volume was also a predictor of MCI ( $p < 0.01$ ).

#### CONCLUSION

In this population-based study with a large sample size, we extracted four MCI-related hippocampal intra-networks based on SBM, which can be estimated using conventional structural imaging with 3T MRI. These hippocampal intra-networks predicted MCI independently of hippocampal volume, suggesting the altered networks may reflect a different pathology from that of brain atrophy.

#### CLINICAL RELEVANCE/APPLICATION

By using conventional structural imaging and ICA, we found that the relationship between hippocampal intra-networks and MCI was independent from the hippocampal volume. This method provides additional information for understanding cognitive impairment.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-3

### Clinical Quantitative Brain MRI: Quantifying Age-related Changes in Tissue Volume

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Artem Kaliaev, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The volumes of the brain and substructures change continuously throughout the human lifespan. Establishing normal development patterns can be useful for detecting abnormal developmental pathways by comparison. Our goal is to study the pattern of normal brain development for the general population of our hospital as stratified by sex using the high geometrical accuracy and precision of turbo spin echo-based quantitative MRI.

#### METHODS AND MATERIALS

This retrospective single-center cross-sectional study was conducted on healthy, ethnically diverse patients with normal brain imaging. The institution's IRB approved the study, and participants were imaged by 3.0-T MRI. Dual-echo turbo spin echo (DE-TSE; PD/T2-weighted) and single-echo turbo spin echo (SE-TSE; T1-weighted) images were used for the MRI parameter calculation. The image processing pipeline (IPP) consisted of a qMRI-based segmentation process that was programmed with Python (version 3.8.11) and the Anaconda Navigator (version 2.2.4). The IPP required a Fiji-based preparation step (version 2.1.1) to edit intracranial matter (ICM), which includes the in toto brain tissue and cerebrospinal fluid (CSF). Then, the IPP was applied consecutively for all subjects' MRIs. Finally, the mean volume for the ICM, brain, white matter (WM), gray matter (GM), and CSF were calculated. Statistical significance and Pearson correlation methods were used for the statistical analysis.

#### RESULTS

A total of 277 patients (146 females) with normal brain radiological reports were included in this study leading to 7 decadal age groups. The ICM, brain, GM, and CSF and CSF ventricles volumes were significantly different between the age groups ( $p$ -value 0.019,  $<0.001$ ,  $<0.001$ ,  $<0.001$ ,  $<0.001$  respectively). There was a significant negative association between age and the ICM, brain, and GM volumes ( $p$ -value 0.008,  $<0.001$ , and  $<0.001$ , respectively), while there was a significant positive association between age and CSF and CSF ventricles volume ( $p$ -value  $<0.001$  and  $<0.001$ ). Furthermore, the significant correlation between ICM, brain, GM, and CSF, CSF ventricle volumes, and age groups was different for male and female cohorts (0.028 and  $<0.001$ s, respectively).

#### CONCLUSION

In an ethnically diverse cohort of 277 patients without neurological findings, we find that the volume of total GM decreases with age and appears to be largely replaced by CSF as the WM volume stays constant after twenty years of age.

#### CLINICAL RELEVANCE/APPLICATION

Clinical quantitative brain MRI is a valuable tool for quantifying age-related changes in brain tissue volume, characteristic of normal development, which can aid in early diagnosis and monitoring of age-related neurodegenerative diseases.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-4

### Evaluation of Brain Stiffness Change According to Brain Development using Virtual MR Elastography Based on DWI

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

You Na Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Viscoelastic property of brain have been demonstrated to be affected by aging and various neurological disease. Based on the knowledge that measured mechanical properties of brain reflect the microstructure composition and organization of neural tissue, magnetic resonance elastography (MRE) parameters representing mechanical properties can be a potential imaging marker for brain development. However, conventional MRE acquisition has been limited in children due to its invasive property and long scan time. The virtual MRE (vMRE) is a non-invasive and novel technique to measure tissue mechanical property based on diffusion weighted imaging (DWI). The purpose of this study was to evaluate change of brain stiffness according to brain development in children and young adults using vMRE.

#### METHODS AND MATERIALS

We retrospectively reviewed 247 children and young adults (6 months~30 years, 119 females, 128 males) without structural brain abnormality. Shifted apparent diffusion coefficient was calculated from DWI ( $b=200$  and  $1500\text{sec}/\text{mm}^2$ ) and converted to DWI-based virtual shear modulus ( $\mu$ ). Brain stiffness was measured in whole brain and thirteen brain regions; cerebrum, cerebral gray/white matter, basal ganglia, thalamus, frontal/ parietal/temporal/occipital lobe, cerebellum, middle cerebellar peduncle, hippocampus, amygdala. Multiple comparison test and linear regression were conducted to investigate changes in brain stiffness according to brain development.

#### RESULTS

Sexual dimorphism was not observed in any brain region. The virtual shear modulus ( $\mu$ ) of whole brain increased until the age of 16 years and then reached plateau. The DWI based mechanical property parameter of whole brain was increased 1.15% per year ( $R^2=0.642$ ,  $P < 0.001$ ) until 16-year-old. The change of brain stiffness according to brain development showed regional differences. Changes of brain stiffness showed the earliest plateau (8-year-old) in cerebral gray matter and continued to increase in the basal ganglia until 30-year-old. Although steepest increase in occipital lobe (1.85% increase/year,  $R^2=0.659$ ,  $P < 0.001$ ), there was no significant difference in pattern of stiffness change according to brain lobar area.

#### CONCLUSION

DWI-based brain stiffness parameters increased with brain development in pediatrics period with differences by region.

#### CLINICAL RELEVANCE/APPLICATION

DWI-based brain stiffness parameters increased with brain development until 16-year-old and reached plateau. The change of stiffness showed different pattern across the regions.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-6

### Comparing the Clinical Utility of Linear Versus Volumetric MRI in Enlarged Vestibular Aqueduct Syndrome Patients

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Amit Gupta, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Presently CT is established method (Cincinnati criteria) for diagnosis of EVAS. Recently studies showed that linear measurement on MR are similar to CT in terms of confidence of diagnosis and correlation with audiometric data. The purpose of this study was to confirm validity of linear MR measurements and explore role of volumetric MRI measurements in predicting the hearing outcomes in patients with EVAS.

#### METHODS AND MATERIALS

A retrospective study design was used including 30 patients that fit the inclusion criteria for a total of 46 ears. Linear measurements were made using the vestibular aqueduct (VA) midpoint and VA opercular widths for determination of EVAS. Semiautomatic volumetric measurements were calculated from all slices containing both the VA and endolymphatic sac (VA-ELS) using MIM Software Platform (MIM Software Inc.). Air and bone conduction data was collected from medical records. Univariate and multivariate analyses were performed to assess for a correlation between volumetric measurements and audiometric hearing outcomes.

#### RESULTS

Of the study population, 16 patients demonstrated bilateral EVA (53.3%). Average VA volume estimated by volumetric MRI analysis was 0.19 mm<sup>3</sup>; sd = 0.17 mm<sup>3</sup>. Volumetric MRI measurements significantly correlated to both midpoint length and operculum size for EVAS diagnosis. Univariate analysis and multivariate analyses adjusting for age, race, and gender did not reveal significant correlations between volumetric MRI measurements and audiometric hearing outcomes. Midpoint size and operculum size correlated only weakly with low frequency bone conduction hearing outcomes.

#### CONCLUSION

These results suggests an excellent correlation between the liner and volumetric measurements for diagnosis of EVAS, however, with an unclear role for both MRI measurements in the predicting hearing outcomes. In our study, neither linear nor volumetric measurements showed strong correlations with audiometric hearing data.

#### CLINICAL RELEVANCE/APPLICATION

Given the 3D structure of the VA-ELS, volumetric measurements may improve MRI diagnostic utility in EVAS. This study warrants further research into the relationship VA-ELS structure and hearing outcomes, and questions the previously published results on this topic.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-7

### A Normative Model of the Brain from the Adult Colombian Population

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Jon Duque-Grajales, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

The brain changes throughout life. There is an increasing interest in development of normative models based on anatomical brain features, which are related to the genetics of the population (Elliott et al. *Nature*, 2018). However, the normative models published so far have been mostly based on European descent population (Bethlehem et al. *Nature*, 2022, Rutherford et al. *Elife*, 2022). Here, we propose a normative model of brain aging in a Colombian adult population based on their brain volumes.

#### METHODS AND MATERIALS

2256 healthy participants (age range: 18 - 80 years; 1058 females) were selected based on their radiological report in a retrospective cross-sectional study. This study was approved by the institution's ethical committee. Brain anatomical T1w MR were processed using FSL (V.5) (Smith et al. *Neuroimage*, 2004). The preprocessing included tissue segmentation and subcortical structures extraction. Additionally, we aggregate all the volumes in a new parameter, the delta age, defined as the deviation of the predicted age by a multiple linear model between the age and the volume of all brain structures. Participants with volumes above or below five mean absolute deviations from the mean population for the same sex were discarded. Six different models were evaluated as normative models based on their standardized mean squared error (SMSE) derived from a random five-fold cross-validation: centiles, locally estimated scatterplot smoothing (LOESS), Gaussian process (GP), generalized additive models of location shape and scale (GAMLSS) and linear quantile regression (quant).

#### RESULTS

We derived one normative model per sex due to gender differences in 7 out of the 10 brain structures analyzed ( $p < 0.05$ ). Besides the GP model, all models had similar SMSE values for every structure (SMSE range, female: 0.684 - 1.136, male: 0.698 - 1.165). However, the LOESS model showed a consistent minimum SMSE across structures, having the best performance with the delta age.

#### CONCLUSION

The LOESS model provided a consistent minimum SMSE across all brain structures. Nevertheless, the use of a composed metric aggregating the volumes from all brain structures, the delta age, outperformed the performance of the model on individual brain structures. Therefore, we propose a normative model of brain aging in a Colombian adult population based on a LOESS model in terms of the delta age, that could be evaluated on a larger dataset.

#### CLINICAL RELEVANCE/APPLICATION

We derived a normative model of brain aging in a Colombian adult population based on the brain volume of different structures, providing a reference of brain aging which could highlight deviations from it in neurodegenerative and mental disorders.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-8

### Can fMRI be Used to Develop Neuroimaging Biomarkers for the Risk of Developing Schizophrenia? A fMRI Study Investigating Neural Context-adaptation in Visual Perception, Object Categorization, and Reward Processing Across the Schizotypy Spectrum

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Anna O. Giarratana, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Schizophrenia can be understood to exist on a spectrum; from non-clinical individuals with higher levels of schizotypal personality traits to patients with schizophrenia. Studying schizotypy in non-clinical populations can be extremely informative, given that schizotypy is positively correlated with an increased liability for the eventual development of a schizophrenia spectrum disorder. By studying schizotypy, researchers may be able to detect biomarkers for early detection of psychosis and identify brain regions that may be targets for treatment. Our lab previously found using fMRI, that neural adaptation to reward range is impaired in both healthy individuals with stronger schizotypal personality traits and in patients with schizophrenia. However, it remained unclear whether these deficits are limited to the reward domain, or extend to other domains as well. To this end, we undertook the larger fMRI study described here.

#### METHODS AND MATERIALS

We recruited 98 participants who scored within the top 10%, bottom 10%, and middle 20% of the schizotypy scale as assessed by the Schizotypal personality questionnaire - brief revised (BPQ-BRU). Participants underwent three different tasks while in the fMRI. We investigated reward processing, utilizing a variant of the Monetary Incentive Delay task previously used in our lab. We investigated visual processing, using a task previously used in a collaborators lab based on the concept of surround suppression. Finally, we investigated object categorization, using a novel face-house identification task we developed for this purpose.

#### RESULTS

We find that participants exhibit neural adaptation in the context of reward, visual processing, and object categorization. However, while our previous studies showed that reward range adaptation is impaired in individuals with higher schizotypy, we find no such deficit in visual processing or object categorization.

#### CONCLUSION

Our findings suggest that the inability of those on the schizophrenia spectrum to adapt to the range seen in reward tasks does not generalize to the visual domain. These results may indicate that the deficits seen are specific to the dopamine reward pathways of the brain.

#### CLINICAL RELEVANCE/APPLICATION

These findings highlight reward adaptation as a possible functional neuroimaging biomarker, and a potential target for future studies to investigate interventions (i.e. behavioral interventions or brain stimulation) in an effort to decrease progression along the schizophrenia spectrum.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR-9

### Multi-site rTMS Combined with Cognitive Training Modulates Effective Connectivity in Patients with Alzheimer's Disease

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yuan-Yuan Qin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Alzheimer's disease (AD) is an irreversible neurodegenerative disorder with recent understanding as a disconnection syndrome. As pharmacotherapy for AD is currently limited, attention has been paid to non-drug adjuvant interventions such as repetitive transcranial magnetic stimulation (rTMS). Multi-site rTMS associated with cognitive training (rTMS-COG) therapy has been shown to be probably effective for AD patients at early-stage. rTMS has been approved to be able to modulate local activity in a remote area that is functionally connected to cortical stimulation targets. However, the causal interactions between the stimulation targets and other brain regions has yet to be explored. The purpose of this study is to investigate the effective connectivity (EC) changes after multi-site rTMS-COG therapy.

#### METHODS AND MATERIALS

Written informed consent of all participants were obtained according to the declaration of Helsinki before enrollment. 10Hz rTMS over left dorsal lateral prefrontal cortex (DLPFC) and lateral temporal lobe (LTL) were delivered for 4 weeks with COG. AD patients were divided into real (real rTMS+COG, n=11) or sham (sham rTMS+COG, n=8) group to undergo neuropsychological assessment, resting-state fMRI and 3D brain structural imaging before (T0), immediately at the end of (T4), and 4 weeks after treatment (T8). A 2x3 factorial design with "time" as within-subject factor (3 levels: T0, T4, T8) and "group" as between-subject factor (2 levels) were used to investigate the EC changes related to stimulation targets on the rest of brain, as well as the causal interactions among 7 resting state networks based on granger causality analysis (GCA).

#### RESULTS

At voxel-level, the EC changes from left DLPFC out to left inferior parietal lobe and left superior frontal gyrus, as well as from left LTL out to left orbital frontal cortex had significant group x time interaction effect. At network level, significant interaction effect has been identified on the EC increment from limbic network out to default mode network. The EC decrease at voxel level and EC increase at network level were all associated with better functioning in the ability of daily living and cognition.

#### CONCLUSION

Multi-site rTMS combined with cognitive training could modulate effective connectivity in patients with AD, doing better for the ability of daily living and cognitive function. Due to the longitudinal design, the sample size is limited. Further multi-center cohort study was further needed to validate our pilot study.

#### CLINICAL RELEVANCE/APPLICATION

This study provides a novel explanation for the neurobiological mechanisms of multisite rTMS-COG therapy in AD patients and further shed light on the direction of targeted brain network modulation in future.

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## Abstract Archives of the RSNA, 2023

S3B-SPOB-1

### **Risk of Malignancy in Ovarian-Adnexal Imaging Reporting & Data System (O-RADS) Ultrasound (US) version 2022 Score 2 Unilocular and Bilocular, Smooth Ovarian Cysts Without Solid Components**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Luyao Shen, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ovarian-Adnexal Imaging Reporting Data System (O-RADS) Ultrasound (US) version 2022 (v2022) downgraded smooth bilocular cysts without solid components <10 cm to the O-RADS US 2 with a lower expected risk of malignancy (ROM) of <1% based on results from IOTA5 trial (Timmerman et al. JAMA Oncol. 2023;9(2):225-233). We aim to assess the ROM of unilocular and bilocular, smooth cysts without solid components <10 cm in a non-selected patient population presenting to academic radiology departments in the United States.

#### **METHODS AND MATERIALS**

In this IRB-approved, retrospective study from 6 institutions, pelvic US over 5 years were consecutively reviewed to include exams with ovarian cystic lesions. Lesions without surgical, imaging, or clinical follow-up were excluded. Malignant lesions were diagnosed by histopathology, and benignity determined by histopathology, diagnostic on CT/MRI, resolution, decreased size >10%, or stability by imaging or normal clinical exam >2 years. Investigators blinded to the final outcome recorded imaging features and scores per the O-RADS US. Mann-Whitney and Fisher's exact tests were performed (two-tailed  $p < 0.05$  significant).

#### **RESULTS**

Of 14302 pelvic US reviewed, 913 patients had cystic ovarian lesions. Of those, 319 patients with 337 cystic lesions with smooth walls and septations without solid components <10 cm were included. The median age was 45 years (interquartile range 35-53), and there were 212 (66%) pre-menopausal and 107 (34%) post-menopausal patients. There were 292 unilocular cysts (275 patients) and 45 bilocular cysts (45 patients). Differences in patient age, menstrual status, and lesion size were not statistically significant between the 2 groups ( $p=0.633$ ,  $0.865$ , and  $0.845$ , respectively). The ROM was 0.3% (1/292) for unilocular cysts and 2% (1/45) for bilocular cysts. ROM was not statistically significant between the 2 groups ( $p=0.250$ ). The 2 malignant tumors (1 unilocular, premenopausal patient, and 1 bilocular cyst, postmenopausal patient) were both borderline serous tumors.

#### **CONCLUSION**

A 2% ROM was noted with bilocular cysts in our cohort, which is higher than expected range for O-RADS US v2022 score 2 (<1%). ROM difference between unilocular and bilocular, smooth ovarian cysts without solid components <10 cm is not statistically different. Further investigations in a larger cohort should be undertaken to confirm these initial results.

#### **CLINICAL RELEVANCE/APPLICATION**

In bilocular, smooth cysts without solid components, measuring less than 10 cm, the ROM is greater than the O-RADS US v2022 expected range of <1%. Borderline tumors can have this morphology. Our results suggest further investigation in a larger cohort is needed to help determine the appropriate risk categorization for bilocular cysts.

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## Abstract Archives of the RSNA, 2023

S3B-SPOB-2

### Ovarian-Adnexal Reporting and Data System (O-RADS) MRI Score Effects of DWI and ADC Values

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Marco Gennarini (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study is to evaluate the potential of integrating diffusion-weighted imaging (DWI) and quantitative assessment of apparent diffusion coefficient (ADC) into the O-RADS MRI system for prognostic purposes. Subsequently, to evaluate the validity and reproducibility of this approach among operators with different levels of experience in female pelvic imaging and to identify any correlations between the histology of malignant lesions and ADC values.

#### METHODS AND MATERIALS

The study included 173 patients with 213 indeterminate masses in the adnexa that underwent MRI examination between January 2015 and June 2022. 140 patients with 172 masses met the inclusion criteria, which required them to be over 18 years old, have undergone a standard MRI exam, have no acute symptoms, and have had subsequent surgery with histopathological examination or stable follow-up for at least one year. Two radiologists with 4 and 1 year of experience in female pelvic imaging, respectively, blindly evaluated all masses according to the O-RADS MRI score system. To perform a quantitative analysis, a circular ROI was placed on the ADC map obtained from single-exponential DWI. If the lesion had multiple solid components, 4 to 6 ROIs were placed, and the ROI with the lowest ADC value was recorded. Lesions without enhanced solid tissue, with fluid, adipose, blood or fibrotic content, were considered benign (O-RADS 2) and excluded.

#### RESULTS

The study showed excellent agreement between the two radiologists in classifying adnexal masses according to the O-RADS MRI score system ( $K = 0.936$ ; 95% CI). Two ROC curves were used to determine the best cut-off value for the ADC between O-RADS MRI categories 3-4 and 4-5, which allowed for some masses to be upgraded or downgraded compared to their original classification. The AUC for O-RADS MRI scores 3 and 4 was 0.951, with an optimal ADC cut-off value of  $1.411 \times 10^{-3}$  mm<sup>2</sup>/sec. Three adnexal masses originally classified as O-RADS MRI score 3 were upgraded to score 4, and four lesions with an ROI ADC  $> 1.411 \times 10^{-3}$  mm<sup>2</sup>/sec were downgraded to score 3. All 30 adnexal lesions classified as O-RADS MRI score 5 remained in that category. The AUC for O-RADS MRI scores 4 and 5 was 0.630, with an optimal ADC cut-off value of  $0.849 \times 10^{-3}$  mm<sup>2</sup>/sec. Twenty-two adnexal masses originally classified as O-RADS MRI score 4 were upgraded to score 5, and 36 adnexal lesions, in accordance with TIC type 2, remained in O-RADS MRI score 4. There was a significant correlation between ADC values and the histotype of ovarian carcinoma ( $p$  value  $< 0.001$ ).

#### CONCLUSION

Our research reveals how DWI and ADC values can provide valuable prognostic information for the O-RADS MRI classification, leading to improved standardization and characterization of adnexal masses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPOB-3

### Comparison of O-RADS and Simple Rules Ultrasound Classifications to Predict Adnexal Malignancy

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Andrew Nanapragasam, FRCPC, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

This study compares performance of US O-RADS (version 2022) and Simple Rules (SR) criteria in a cohort of asymptomatic pathology-proven adnexal masses and evaluates O-RADS and SR inter-observer agreement in a subset of patients.

#### METHODS AND MATERIALS

We conducted retrospective analysis in consecutive patients who underwent surgical resection between January 2008 and December 2018 at two adult university hospitals. US cine clips were available for all examinations. One experienced radiologist, blinded to diagnosis, categorized all US imaging by O-RADS and SR criteria. SR assessment assigned the following features as benign: unilocular/multilocular cyst with uniform thin septa irrespective of cyst content/size; cystic or solid mass with attenuating component; cystic mass with <3 mm nodule(s) or completely calcified nodule(s). Malignant features included: non-attenuating solid mass; cystic mass with non-attenuating nodule, nodule(s) =3 mm; multilocular cysts with septa too close to be distinctly seen. A subset of cohort was randomly selected and reviewed by two blinded radiologists with fewer years of experience. Chi-square testing was used for comparison of ratios, and Kappa statistic for inter-observer agreement.

#### RESULTS

791 adnexal masses in 762 patients were assessed, aged 18-92 ( $44 \pm 15$ ); 628 benign, 49 LMP, 114 malignant, measuring 1 to 39 cm ( $7.9 \text{ cm} \pm 4.2$ ). O-RADS categories were 2 (n=309), 3 (n=165), 4 (n=181), 5 (n=136) with malignant rates of 0.3%, 3%, 25%, and 82% respectively. Application of simple rules criteria identified 561 masses as benign and 230 as malignant. Combining O-RADS 4 and 5 categories as being malignant, sensitivity, specificity, NPV, PPV, and accuracy to detect invasive/LMP masses were 96% (CI:92-99%), 75% (CI:71-78%), 99% (CI:97-100%), 49% (CI:44-55%), and 79% (CI:76-82%). Corresponding results for SR were 96% (CI:91-98%), 89% (CI:85-91%), 99% (CI:98-100%), 68% (CI:61-74%), and 90% (CI:87-92%) with specificity, PPV, accuracy of SR being statistically significantly higher than O-RADS ( $p < 0.0001$ ). Inter-observer agreement between the three readers were 0.89, 0.91, and 0.93 for SR benign versus malignant categories and 0.71, 0.75, and 0.75 for O-RADS 2/3 from O-RADS 4/5.

#### CONCLUSION

Adnexal mass ultrasound assessment with SR performs significantly better than O-RADS classification for specificity, PPV, and accuracy with similarly high sensitivity and NPV. High inter-observer agreement was found with both SR and O-RADS.

#### CLINICAL RELEVANCE/APPLICATION

US risk stratification by experienced radiologists using SR criteria outperforms O-RADS and can result in a better triaging of patients to gynecologists versus gynecologists by predicting a more precise rate of malignancy.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3B-SPPD-2

### Automated Reconstruction and Segmentation of High-isotropic-resolution Fetal Brain MRI Data for Quantitative Brain Morphological Analysis

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Haoxiang Li (*Presenter*) Nothing to Disclose

#### PURPOSE

Fetal MRI has gained increasing importance in prenatal diagnosis because of its superior soft tissue contrast. To compensate for fetal and maternal motion and limited spatial resolution, two-dimensional (2D) images are acquired across each anatomical direction. In this study, we develop and present an automated pipeline that reconstructs a high-isotropic-resolution fetal brain volume from three 2D thick-slice images and segments it into multiple brain structures using state-of-the-art MR image analysis methods. The accuracy of the pipeline is validated by evaluating the correlation between brain structure volumes and gestational age.

#### METHODS AND MATERIALS

Sixty pregnant women with normal fetal brain, aged between 20 to 36 weeks of gestation, were enrolled with informed written consent and IRB approval to obtain T2-weighted images along axial, coronal, and sagittal directions using a turbo spin echo (TSE) sequence. The NiftyMIC method was employed to perform slice-to-volume motion correction and reconstruct a single fetal brain volume at 0.8 mm isotropic spatial resolution from the three 2D TSE images. The reconstruction process included brain masking, bias-field correction, volumetric reconstruction in each subject's native space, and transformation to the template space. A deep learning-based segmentation neural network named FetalBrainParcellation was then utilized to segment each high-resolution brain volume into eight brain structures, including cortical grey matter, deep grey matter, white matter, corpus callosum, brainstem, cerebellum, intra-axial cerebrospinal fluid (CSF), and extra-axial CSF. Finally, the Pearson correlation coefficient between the volume of each brain structure and the gestational age was computed.

#### RESULTS

The quality of reconstruction and segmentation results of all 60 subjects were visually confirmed by two expert pediatric radiologists. The volume of each brain structure was highly ( $r > 0.9$  for five structures,  $r > 0.8$  for seven structures) and significantly ( $p < 0.001$ ) correlated with the gestational age, which was consistent with previous studies.

#### CONCLUSION

This study introduced a pipeline that automatically reconstructed and segmented fetal brain volumes and validated its robustness and accuracy for quantitative morphological analysis of normal fetal brains.

#### CLINICAL RELEVANCE/APPLICATION

The automated pipeline developed for reconstructing and segmenting fetal brain MRI data provides a novel tool for quantitative morphological analysis of fetal brains, which can aid in diagnosis and prognosis. Further research will assess its validity for fetal brains with pathologies and explore its potential clinical applications.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-1

### Evaluating ChatGPT's Performance on a Radiology-physics Question Set

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Jaydev K. Dave, PhD (*Presenter*) Research Grant, Koninklijke Philips NV; Equipment support, Lantheus Medical Imaging; Equipment support, General Electric Company; Research Consultant, Curvebeam LLC; Consultant, Rayscan, Inc.

#### PURPOSE

Recent reports have evaluated ChatGPT's (OpenAI, San Francisco, CA) performance on several standardized examinations. The purpose of this work was to evaluate the performance of this text-based AI language model on a radiology-physics question set.

#### METHODS AND MATERIALS

A radiology-physics question set with 135 questions (RAPHEX, Radiological and Medical Physics Society of New York) was used to assess ChatGPT's performance. All questions were in the multiple-choice format with single correct answer and three to four distractors. The questions covered different imaging modalities, and included questions with images ( $n = 27$ ), calculations ( $n = 36$ ), and regulatory limits/accreditation requirements ( $n = 17$ ). Freely available, March 23, 2023 version of ChatGPT was used in this study. The questions were entered in multiple choice format with the stem and the options into the chat dialogue box. The responses were evaluated and scored. The justification provided in the ChatGPT responses was also reviewed for correctness.

#### RESULTS

Out of 27 image-based question, there were 8 questions in which interpretation of images was required and given that images are not accepted as input in ChatGPT, there were no responses for these questions. Thus, these 8 questions were not considered in the scoring. Other image-based questions either included description of artifacts/image content in the question stem or images with tabulated data. For these questions, responses were provided by ChatGPT and so these were included for assessment. From the 127 questions included in the analysis, correct responses/explanation were obtained for 79 (62.2%). For 2 questions the correct responses were obtained; however, the justification was incorrect. Evaluating the proportion of correct responses as a function of question type revealed that correct responses were obtained for 63.2% of the questions with images (12/19), 50.0% of the questions that involved calculations (18/36), and 35.3% of the questions involving regulatory limits/accreditation requirements (6/17). Modality-wise, the proportion of correct cases was 88% for radiography, 50% for mammography, 36% for fluoroscopy, 60% for computed tomography, 83% for ultrasound, 67% for magnetic resonance imaging, 43% for nuclear medicine, and 72% for fundamental questions including safety and radiobiology.

#### CONCLUSION

Leaving aside questions that rely on image interpretation, ChatGPT scored 62.2% on a radiology-physics question set covering different modalities and question categories. Image-interpretation questions remain unanswered.

#### CLINICAL RELEVANCE/APPLICATION

Analyzing the performance of chatbots will help target evaluation criteria for maintenance of certification/online longitudinal assessment.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-10

### Opportunistic Osteoporosis Screening with Bone Mineral Density Estimation on Computed Tomography using Multi-View Semi-Supervised Learning

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Heng Guo, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Computed tomography (CT) scans, which are widely used for other indications, can provide added-value for osteoporosis screening. We propose a novel method for estimating bone mineral density (BMD) using routine CT scans.

#### METHODS AND MATERIALS

We proposed DeepBMD that consists of automatic spine vertebrae instance segmentation and BMD regression in this work. Patients who underwent both a routine CT and a Dual-energy X-ray Absorptiometry (DXA) examination within one month between December 2020 and December 2022 were retrospectively included. This led to 3,586 CT scans (81% chest CT, 19% abdomen CT) and 3,805 DXA results with lumbar BMD values (L1 - L4). After excluding scans with low quality, metal implants and bone fractures, a dataset of 2,633 CT-DXA pairs in patient-level were obtained. An automated vertebrae instance segmentation tool was developed to distinguish vertebrae with DXA gold-standard or not. Finally, we got 4,889 vertebrae with DXA gold-standard, and 30,400 not. The paired dataset was randomly split into 60%, 10%, and 30% for training, validation, and testing. We developed a multi-view semi-supervised learning framework for BMD regression. Specifically, 3D and 2.5D vertebrae patches were extracted under different augmentation parameters. A hybrid network consisting of a CNN and a Vision Transformer was used to extract features. For vertebrae without gold-standard, pseudo BMDs would be generated. An experienced clinical expert specialized in orthopedics checked the vertebrae identification results. The Pearson correlation coefficient, sensitivity, specificity, area under receiver operating characteristics (AUC) are reported.

#### RESULTS

There are 1,005 osteoporotic patients (group A) and 1,628 non-osteoporotic patients (group B) in our dataset. Females account for 68.6% in group A and 48.6% in group B. The average ages of group A and group B are 65.56( $\pm$ 8.59) and 62.17( $\pm$ 9.12). For vertebrae identification, DeepBMD achieves a success rate of 98.7%, indicating that it is robust and reliable. DeepBMD achieves a great correlation coefficient of 0.909 on the testing set. According to the literature that a T-score of less than or equal to -2.5 is considered to be osteoporotic, DeepBMD achieves a sensitivity of 0.87, specificity of 0.90, and AUC of 0.96 for osteoporosis screening.

#### CONCLUSION

The predictions of the proposed algorithm exhibit a strong correlation with DXA and can facilitate opportunistic osteoporosis screening.

#### CLINICAL RELEVANCE/APPLICATION

Using routine CT for BMD estimation can provide the added-value for opportunistic osteoporosis screening. Beyond evaluating BMD in the lumbar vertebrae, our method can also assess the thoracic vertebrae, providing patients with a more comprehensive evaluation of their spine health.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-11

### Development of a TOPAS Monte Carlo Model of a C-arm Cone Beam CT (CBCT) for Organ Dose Estimation

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Nina McWilliams, BSc, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

C-arm cone beam computed tomography (CBCT) used in an interventional radiology (IR) setting provides the radiologist with cross sectional images to assist in performing and verifying a radiological intervention. To accurately estimate the radiation dose to the patient, knowledge of the doses delivered to major radiosensitive organs is required. However, the current approaches for CBCT dosimetry are still under development. Replication of system specific complexities such as automatic exposure control (AEC), rotational geometries, beam hardening and scatter contributions make the simulation and estimation of CBCT radiation doses challenging. The main aim of this research was to develop a novel TOPAS Monte Carlo (MC) dosimetry model of a C-arm CBCT incorporating AEC, and validate it with measurements using an anthropomorphic phantom.

#### METHODS AND MATERIALS

A MC model of a Siemens Artis Q C-arm CBCT system [Siemens, Erlangen, Germany] was developed in TOPAS, version 3.9. A TOPAS extension to incorporate AEC functionality was implemented into the MC model. The system's energy spectrum, CBCT rotational parameters, system geometry and tube filtration were simulated according to manufacturer specifications. Experimental data was obtained using the Body CBCT protocol and a physical CIRS ATOM® adult female anthropomorphic phantom. Verification of the dose distribution and AEC functionality of the MC model was carried out using thermoluminescent dosimeters (TLDs) placed in the tissue-equivalent organ sections of the phantom mimicking patient organs. Measured doses were compared with MC simulated doses for different sites within the phantom acquisitions.

#### RESULTS

This study presents details of the development of a novel AEC module in TOPAS MC simulations for incorporation into a C-arm CBCT MC model. The AEC module, the first of its kind, will shortly be released for public use in TOPAS. The CBCT MC model has been applied to abdominal acquisition protocols in IR and validated through anthropomorphic phantom dose distributions and organ dose measurements.

#### CONCLUSION

A novel AEC module has been successfully developed in TOPAS which can be easily incorporated into other imaging application models that employ such dose modulation. The MC model allows for a more realistic dosimetry estimation, advancing the current CBCT dosimetry approaches.

#### CLINICAL RELEVANCE/APPLICATION

Few studies have documented radiation doses from C-arm CBCT exposures in adults. The novel AEC module developed in this research, and its validation using an anthropomorphic phantom, is a step towards personalised dosimetry in CBCT.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-12

### Development of an Ultra-high-Resolution Dental Cone-beam CT System

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Riku Koda (*Presenter*) Nothing to Disclose

#### PURPOSE

The dental cone-beam computed tomography (DCBCT) systems have been clinically used since early 2000s. They provide detailed images that can help dentists diagnose and plan treatment for different dental conditions. The spatial resolutions of DCBCTs are generally higher than those of multi-slice CT systems; however, the spatial frequency limits evaluated by 5% modulation transfer function (5%MTF) are approximately 2 mm<sup>-1</sup> and those are not necessarily sufficient for observing micro structural abnormalities in oral region. This study aimed to develop a new DCBCT (DCBCT<sub>new</sub>) that achieves a 5%MTF significantly higher than that of conventional DCBCT (DCBCT<sub>c</sub>) without increasing the radiation dose.

#### METHODS AND MATERIALS

A contact geometry, in which the X-ray detector is close to the object, for reducing the focus penumbra was adopted in this system. Furthermore, since the dentition is generally located anteriorly in the head, a half scan orbit was used to prevent collisions between the occipital region and the detector. The scan duration was 6.5 s; during that, projection data with 520 views were obtained using a CsI-based detector with 1488 × 660 pixels. The pixel size at the iso-center was 0.081 mm. For the DCBCT<sub>new</sub> and a DCBCT<sub>c</sub>, MTFs were measured from images obtained by scanning a copper wire with a diameter of 0.1 mm. The radiation dose of DCBCT<sub>new</sub> was measured according to the standard method for the weighted CT dose index (CTDI<sub>w</sub>); then, the effective dose was estimated from the result. An oral region in an anthropomorphic head phantom was scanned using both DCBCT<sub>new</sub> and DCBCT<sub>c</sub>.

#### RESULTS

The 5%MTF of DCBCT<sub>new</sub> was 3.80 mm<sup>-1</sup>, which was more than twice that of DCBCT<sub>c</sub> (1.65 mm<sup>-1</sup>). The estimated effective dose of DCBCT<sub>new</sub> was 0.084 mSv which was significantly lower than reported ones (around 0.2 mSv) of the DCBCT<sub>c</sub>. The phantom images of DCBCT<sub>new</sub> were remarkably sharper and clearer compared to those of DCBCT<sub>c</sub>.

#### CONCLUSION

The developed DCBCT presented significantly higher spatial resolution and more suitable dental CT images to observe micro structures with a lower radiation dose, compared to a conventional DCBCT.

#### CLINICAL RELEVANCE/APPLICATION

The developed DCBCT was able to provide high-resolution images with low dose scanning. This result suggested that there are sufficient rooms to improve the image quality of current clinical DCBCT systems.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-13

### A Dose Based Method to Optimize Virtual Monoenergetic Cone-beam Computed Tomography Imaging Parameters for Image-guided Radiotherapy

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Hyejoo Kang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to optimize Virtual Monoenergetic (VM) cone-beam computed tomography (CBCT) protocols for Image Guided Radiation Therapy (IGRT) as functions of exposure and single frame acquisition rate while minimizing patient imaging dose.

#### METHODS AND MATERIALS

First, 7 CBCT sets acquired at 80 kVp and 140 kVp with various exposures and frame rates were used to determine the average normalized Air Kerma ( $K_{air}$ ) per exposure (mAs) for the X-ray Imaging (XI) system of a Truebeam linac (Varian Medical System, CA) with a calibrated 0.6cc air Kerma Farmer chamber. Then, 6 combined dual (80 and 140 kVp) energy CBCT protocols were optimized, ensuring that their estimated cumulative  $K_{air}$  resulted in a lower imaging dose than  $K_{air}$  of the default 140 kVp-Pelvis CBCT protocol ( $K_{air} = 133$  mGy). VM-CBCT projection images of a Catphan 604 (Phantomlab, NY) at specific energies were generated from DE-CBCT, and then were reconstructed using the Feldkamp-Davis-Kress (FDK) algorithm within an open-source TIGRE toolbox. The quality of VM-CBCT images at 50 keV were evaluated using quantitative metrics such as Hounsfield units (HU), contrast-to-noise ratios (CNR), and noise-level using in-house scripts.

#### RESULTS

The average difference between estimated and measured cumulative  $K_{air}$  for all combined DE-CBCT protocols was  $2.2 \pm 2.1\%$ . Qualitative evaluation of VM-CBCT images at 50 keV showed comparable image quality between those with high- and low- $K_{air}$ . The HU of 20% bone material in the all low- $K_{air}$  VM-CBCT with were within 35 HU of the theoretical value of 298 HU. Additionally, the CNR and noise level between high- and low-  $K_{air}$  VM-CBCT images were within 1.6 ( $16.0 \pm 0.9$ ) and 3 HU ( $19.3 \pm 1.0$  HU) respectively.

#### CONCLUSION

The proposed method of optimizing DE-CBCT acquisition parameters based on  $K_{air}$  provides imaging dose estimate within 3%. VM-CBCT generated from optimized DE-CBCT with reduced  $K_{air}$  showed comparable image quality to VM-CBCT generated from the highest  $K_{air}$  DE-CBCT based on both qualitative and quantitative assessments. Ongoing research aims to explore the impact of further reducing the framerates in CBCT acquisition and evaluating the use of iterative reconstruction to determine imaging parameters with reduced imaging dose while maintaining image quality for clinical applications.

#### CLINICAL RELEVANCE/APPLICATION

VM-CBCT has shown promise in improving visualization of soft tissues compared to standard CBCT. However, the increased imaging dose associated with VM-CBCT remains a concern. We propose to determine imaging parameters using air Kerma measurement-based approaches of optimizing DE-CBCT imaging parameters. This approach has the potential to substantially reduce imaging dose for VM-CBCT without deteriorating image quality for clinical applications.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-2

### Adaptive Deep Learning MR Image Enhancement for Flexible Rapid MR Protocol Design

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Zechen Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep Learning (DL) based image enhancement approaches can restore the image quality for accelerated Magnetic Resonance (MR) scans. However, a single DL model might not allow flexible MR protocol setup to achieve higher acceleration and resolution. In this work, we propose a Proximal Gradient Descent based unrolled Network (PGDNet) that can adaptively resolve different levels of noise amplification and image blurring. Preliminary performance evaluations were compared with traditional DL methods on various acquisition tasks.

#### METHODS AND MATERIALS

PGDNet (Fig. A, PGDNet) incorporates the image degradation model into the image restoration process to jointly estimate the degradation kernel and the high quality image, which maintains the data consistency with the acquired image while performing adaptive image enhancement. 356 MR acquisitions with paired fully sampled and undersampled (i.e. fewer number of phase encodings [NPE] or signal averages [NSA]) images were collected for training (#pairs for reduced NPE: 101, #pairs for reduced NSA: 193, #pairs for both: 18) and testing (#pairs for reduced NPE: 11, #pairs for reduced NSA: 29, #pairs for both: 4). Three different models were trained: 1) Enhanced Deep Residual Networks (EDSR) (Fig. A, EDSR) trained with all data pairs; 2) EDSR model fine-tuned with the reduced NPE data pairs as the super-resolution expert (SRE) model; 3) PGDNet trained with all data pairs. Quantitative PSNR and SSIM metrics were used to evaluate the accuracy of the model outputs on 3 acquisition tasks.

#### RESULTS

In denoising tasks (Fig. B, reduced NSA scans), PGDNet can better preserve small structures, and prevent over-smoothing, particularly the trabecular bone textures in MSK cases. In deblurring tasks (Fig. B, reduced NPE scans), PGDNet can still achieve similar/superior performance compared to the EDSR SRE model, and show improved structural consistency with the reference image. Compared to EDSR and EDSR SRE, PGDNet demonstrates its adaptation and robustness in the joint denoising and deblurring tasks (Fig. B, scans with reduced NSA and NPE). Quantitative measurements also supported the qualitative assessment.

#### CONCLUSION

By explicitly leveraging the image degradation model, PGDNet outperforms the conventional DL methods in various acquisition tasks, particularly filling the gaps in acquisitions with both reduced NPE and NSA. This allows more flexible MR protocol design to achieve highly accelerated clinical exams or improved image quality for clinical diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

DL based image enhancement methods supporting different types of fast MR acquisitions allow more flexible rapid protocol design to achieve more efficient clinical workflow or improved image quality for clinical diagnosis.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-4

### Assessing Racial and Age-Related Fairness in Chest X-Ray Classification Algorithms

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yonghan Ting, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

Evaluate bias in two commercial (AI1, AI2) and one academic (AI3) chest x-ray classification algorithms. Estimate the fairness of these algorithms for different age and racial groups using the Aequitas package.

#### METHODS AND MATERIALS

- 500 anonymized chest x-rays were collected from patients aged above 18, across 6 races at an academic hospital center in Singapore.
- Ground truth was established by an experienced radiologist.
- X-rays were analyzed by two commercial and one academic CXR classification model for normal-abnormal classification on the CARPL.AI platform
- Aequitas package preloaded on this platform was used to evaluate algorithm performance on metadata classes, including age group and race, with reference groups selected based on the majority population characteristics.
- False negative rate (FNR) metric was used to calculate inter-class scores of bias.

#### RESULTS

- For age, AI1 showed FNR disparity for patients aged 48-99; AI2 showed FNR disparity for patients aged 19-31 and 48-99; AI3 showed FNR disparity across all age groups.
- For race, at a 60% disparity intolerance, FNR parity was observed for Chinese and Indian populations in AI1 and AI2, respectively; AI3 demonstrated FNR parity for Chinese and Malay groups.

#### CONCLUSION

The study found the AI algorithms to have racial parity but at a reduced tolerance range. Both algorithms showed a certain degree of FNR disparity for certain age groups. We propose including bias evaluation as a core component of every AI solutions' validation pipeline.

#### CLINICAL RELEVANCE/APPLICATION

By identifying disparities in the performance of these algorithms across different age groups and racial backgrounds, our findings can inform clinicians, healthcare institutions, and algorithm developers about the limitations and potential risks associated with the current AI-based diagnostic tools.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-5

### Improving Reconstruction in Accelerated MRI via Transferable Deep Learning

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Yuxiang Zhou, PHD (*Presenter*) Nothing to Disclose

#### PURPOSE

The objective of this study is to develop an attentive feature refinement-based transfer learning approach for vendor transfer in medical image, which will allow any pre-trained model to transfer knowledge across domains and adapt to novel domains with relatively limited datasets.

#### METHODS AND MATERIALS

Variational Feedback Network (VFN) was adopted as the base architecture to conduct and evaluate the effectiveness of our proposed transfer learning strategy. We extend the transfer learning capability of VFN beyond existing transfer learning methods (i.e., pretrained weights finetuning) by selecting pretrained features that benefit reconstruction quality. To enable knowledge transfer from the source dataset to refine target tasks, we exploit the high-level features of reconstructions from VFN network. To refine the subsampled k-space, we propose a feature extraction and refinement (FER) module. We use more than 400 T1-weighted MRI ACR phantom images collected from MAGNETOM Skyra 3.0T (SIEMENS Healthcare) and Discovery 750W 3.0T (General Electric HealthCare) scanners as our two domains and analyze the transfer in both directions.

#### RESULTS

The images were reconstructed with an acceleration factor of 4. Five AI models were development in this studied and tested on GE phantom dataset. The first model was trained with SIEMENS ACR data (400 samples) using the basic VFN network. The second model was trained with GE ACR data (100 samples) using the basic VFN network. The third model was trained with SIEMENS + GE ACR data (500 samples) using the basic VFN network. The fourth model was trained based model 1 but fine-tuned with GE dataset without feature supervision. The fifth model was trained based model 1 but fine-tuned with GE dataset with a feature extractor. The reconstruction quality is compared across implicit and explicit transfer learning methods. The testing results for GE 5 dataset of PSNR are 35.7 +/- 13.05, 43.73 +/- 15.6, 44.16 +/- 13.06, 42.61 +/- 13.76, 44.72 +/- 16.38, and SSIM 0.9024 +/- 0.12, 0.9718 +/- 0.06, 0.9806 +/- 0.03, 0.9631 +/- 0.08, 0.9893 +/- 0.09 for the above 5 models.

#### CONCLUSION

Our study indicates that the reconstruction quality by using our newly developed feature refinement-based transfer learning is significantly better than these reconstructed with conventional Variational Feedback Network (VFN) with limited datasets.

#### CLINICAL RELEVANCE/APPLICATION

This study established and tested a new DL model of feature refinement-based transfer learning with strong ability to handle data heterogeneity and variability at speeding up MRI scans up to 4~8 times faster. This method will be able to shorten clinical MRI scan time for improved patient experience and reduced cost while maintaining the quality for diagnosis.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH-6

### Viability of an AI-enabled 0.5T Scanner to Improve MR Access

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Arjun Narula, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Access to MRI is known to have improved clinical outcomes. However, it is limited to high economic regions due to high cost, lack of infrastructure and unavailability of skilled labor. Lower field strength MRI along with lower gradient and RF specifications will reduce cost and infrastructure requirements. However, image quality from these derated systems have historically not been sufficient for clinical use. Recent developments in image acquisition and reconstruction with artificial intelligence (AI) could enable improvement of quality of images obtained from such systems to make it clinically viable. This abstract tests the hypothesis that an AI-enabled 0.5T system with low gradient and RF power would provide clinically sufficient information compared to a conventional 1.5T clinical scanner.

#### METHODS AND MATERIALS

Routine brain and cervical spine exams were collected from 197 patients (1188 series in total) on 0.5T, low gradient and low RF AI-enabled scanner with custom made 14-channel HNU coil. The same patients were also scanned on a commercial 1.5T scanner. The scan duration of the 0.5T AI-enabled scanner was comparable to the clinical scanner and at the most less than 2 times the clinical scanner's scan duration. Comparisons were made to study the clinical sufficiency for diagnosis of the AI-enabled 0.5T scanner images to those obtained from 1.5T scanner by at least 4 radiologists from a pool of 10 global radiologists. The radiologists rated the images on a Likert scale between 1 and 9 (1: clinically useless, 5: diagnostic quality, 9: better than reference).

#### RESULTS

The 0.5T scans were rated on an average as  $6.11 \pm 1.2$ ; significantly above diagnostic quality 5 ( $p < 1e-4$ ). On a subset of the data, conventional (non-AI) reconstructed images were compared with AI-reconstructed images. AI reconstruction significantly improved ( $p < 1e-14$ ) the rating average by  $2 \pm 0.96$  points on the Likert scale. Only a total of 81 series out of 1188 obtained an average rating below 5 (diagnostic) and were mostly due to motion artefacts. The rest were due to poor acquisition parameter choices in the early phase of the study.

#### CONCLUSION

This study has shown that AI-based image quality improvement can enable head and c-spine images from a 0.5T system to be diagnostically sufficient. Further assessment on other anatomies and additional AI methods for acceleration is required.

#### CLINICAL RELEVANCE/APPLICATION

AI-enabled low-field systems can provide diagnostic image quality similar to clinically accepted 1.5T scanners and has good potential to help improve access of MRI to underprivileged regions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPPH-7

### Improving Juxta-vascular Pulmonary Nodule Detection Capability Using a Deep Learning-based AI Detection System in Low-dose Computed Tomography (LDCT)

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Fang Wang, PhD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the performance of a deep learning computer aided diagnostic (CAD) system to improve detection rate for juxta-vascular pulmonary nodules in LDCT.

#### METHODS AND MATERIALS

104 healthy patients who underwent low-dose chest CT screening using a 256slice wide-detector CT (Revolution, GE Healthcare) were enrolled. Protocols were adjusted so that effective dose was set to approximately 1.5 mSv. All DICOM images were sent to a deep learning (DL) computer aided diagnostic system (InferRead CT Lung Research, Infervision) for automatic pulmonary nodule detection. Three methods were used to read the images. Method A: Independent reading of axial images by two radiologists to detect juxta-vascular pulmonary nodule (JVPN) reaching consensus. Method B: DL assisted reading result was analyzed by radiologists to judge whether they were JVPN. Method C: Based on method B results, radiologists read the films by combining the axial images. The total number and locations of nodules for each patient detected in each method were recorded. Two senior chief radiologists' consensus readings were used as the gold standard nodules. The detection rate and false positive rate of each method were calculated respectively.

#### RESULTS

216 JVPNs were confirmed as gold standard. In method A, 158 nodules were detected, among which 156 were true positive JVPNs; in method B, 215 nodules were detected, among which 190 were true positive JVPNs; In method C, 212 nodules were detected, among which 208 were true JVPNs. In method C, the detection rate of all JVPNs was 96.29% which was higher than that in method A and B (72.22% and 87.96). The false positive rate for juxta-vascular pulmonary nodules detected by method C (4%) was significantly lower than that by method A (12%) and B (24%).

#### CONCLUSION

The screening method of image reading combined with DL-CAD results interpreted by radiologists significantly improves the detection rate and reduce false positive rate of juxta-vascular pulmonary nodules in LDCT screening.

#### CLINICAL RELEVANCE/APPLICATION

Reading combined with DL-CAD results interpreted by radiologists can improve the detection efficiency of juxta-vascular pulmonary nodules which could be used as a preferred method for LDCT screening of pulmonary nodules in high risk patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPPH-8

### **Towards a Fully Autonomous Artificial Intelligence Volume-rendered Segmentation Workflow for CT Angiography of the Thoracic Aorta**

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Ahmed S. Negm, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Three-dimensional (3D) surface rendering enables global qualitative assessment of aortic anatomy. Generating a surface model for 3D visualization requires time-consuming manual or semi-automated segmentation, taking an average of 32 minutes per case at our institution. This amounts to 2.74 FTE of 3D lab technologist time. To decrease manual effort, we developed a deep learning model to automate aortic segmentation and 3D surface model creation from CTA images, integrating an artificial intelligence (AI)-assisted workflow into the clinical practice. We then compared the visual quality of AI-assisted and fully automated surface renderings of the thoracic aorta.

#### **METHODS AND MATERIALS**

An AI model was trained on 304 manually created segmentation maps created for clinical purposes at our institution. Processing time for the AI model was 6 minutes with GPU acceleration. In this IRB-approved study, we retrospectively analyzed the visual quality of 25 3D surface renderings for CTAs acquired at a single center. Twenty-five sets of renderings were then blindly assessed by two experienced cardiovascular radiologists, comparing deep learning segmentations to those that had been manually adjusted by an experienced 3D lab technologist. Comparisons were made using a 5-point Likert scale and covered multiple anatomic features as well as overall quality.

#### **RESULTS**

The renderings based on the AI-only segmentations were assessed to be equivalent to the AI-corrected renderings ( $p \geq 0.19$ ) across all anatomic regions except for the coronary arteries ( $p = 0.06$ ), which favored the AI-corrected results. The coronary arteries are not consistently segmented across all exams, which may have caused the model to underperform in these features. The overall reader agreement was very good (Gwet AC1 = 0.68).

#### **CONCLUSION**

Fully automated AI-based segmentation of the thoracic aorta produces 3D renderings of equal quality compared to the existing manual process, which may allow for significant time savings by fully automating 3D postprocessing.

#### **CLINICAL RELEVANCE/APPLICATION**

An AI-only workflow yielded similar image quality for thoracic aorta segmentation indicating the potential to fully automate thoracic aortic CTA post-processing.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPPH-9

### Validation of the QuCAD Evaluation Tool to Quantify Wait-Time-Savings from a Computer-Aided Triage and Notification (CADt) Device

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Berkman Sahiner, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This work validates our queueing theory-based QuCAD evaluation tool designed to quantify the wait-time savings that a computer-aided triage and notification (CADt) device may bring to chest CT and chest CT angiography (CTA) pulmonary embolism (PE) STAT cases from a tertiary academic medical center.

#### METHODS AND MATERIALS

To validate the QuCAD evaluation tool, we retrospectively retrieved clinical reader timestamp data to characterize radiologists' work queue via the number of readers, image inter-arrival time to the PACS, and radiologists' effective reading time. The effective reading time of each radiologist was defined as the time between the opening of two consecutive readings. An exponential curve is fit to the distributions of inter-arrival times and effective reading times. We compared the wait-time savings predicted by QuCAD with the mean difference in clinical turnaround time from data before and after CADt adoption. Turnaround time is defined as the time from when an image entered the PACS to when the first review is completed by a radiologist. We stratified this comparison by cases arriving between 8am and 5pm (day shift) and those between 5pm and 8am (night shift).

#### RESULTS

Between 2019 and 2022, 9,864 chest CT/CTA PE STAT cases were reviewed by 70+ radiologists. On average, 2 to 3 readers reviewed images at a given timepoint. The overall case arrival rate was 0.327/min, and the mean effective reading times were 20.1 min for positive PE studies and 14.9 min for negative PE cases. When having 2, 3, and 4 radiologists reviewing images, QuCAD predicts wait-time-savings for positive PE cases to be 14.9 min [95% CI: 13.3, 16.8], 1.27 min [1.00, 1.54], and 0.25 min [0.16, 0.33] respectively. From positive clinical PE cases, the mean difference in turnaround time before and after the use of CADt is 22.9 min during day shift hours. During night shift hours, the mean turnaround time difference drops to 8.26 min.

#### CONCLUSION

Using 4 years of workflow data from a tertiary academic medical center, this study successfully validated the QuCAD tool designed to quantify potential wait-time-savings a CADt can bring to positive findings. Despite a large variability in clinical workflow, wait-time saving predictions from QuCAD estimates align with the turnaround time reduction from the clinical data.

#### CLINICAL RELEVANCE/APPLICATION

CADt devices use artificial intelligence (AI) to process patient images and prioritize cases with suspected findings. Previous work developed an evaluation tool (QuCAD) that quantifies the time-saving benefits via queueing theory. This study validated QuCAD using timestamp data from a real clinic. QuCAD is now publicly available for evaluating the time-saving benefits of CADt devices.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPVA-1

### Improving Image Quality of Blood Vessels through Deep Learning-Based Denoising and Enhancement Method Based on Low-Energy DSA

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Ruizhi Hou (*Presenter*) Nothing to Disclose

#### PURPOSE

This work investigates the feasibility and efficacy of a novel approach that combines low-energy digital subtraction angiography (DSA) images with a new denoising and enhancement framework for improving the image quality of blood vessels while reducing ionizing radiation during surgical procedures.

#### METHODS AND MATERIALS

Between December 2021 and December 2022, 140 patients participated in a retrospective study on DSA intervention therapy for cerebral arteries, renal arteries, coronary arteries, and lower limb arteries. The study had IRB approval and waived written consent. These patients were randomly divided into training, validation, and test sets, with 98, 14, and 28 patients, respectively. The denoising and enhancement network framework consisted of a noise estimator, a denoising network, and a refinement network. The network was trained using only the noisy DSA image for joint denoising and enhancement. An ROI measuring 256 x 256 was placed over the arterial angiography region, with the non-angiographic region serving as the background. Measurements of pixel values and standard deviation were taken for the artery, and the signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated for the ROI region. The image quality was assessed using the Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index Measure (SSIM). Images obtained through low-energy transmission with deep learning-based denoising and enhancement were assigned to the prediction group, while images obtained through normal-energy X-ray fluoroscopy were assigned to the ground truth group for objective evaluations.

#### RESULTS

Effective use of deep learning techniques can reduce image noise and increase CNR and SNR. Low-energy DSA, when combined with denoising and enhancement network (PSNR:  $40.72 \pm 2.85$ dB; SSIM:  $0.9370 \pm 0.0440$ ; SNR:  $34.86 \pm 3.46$ ; CNR:  $5.10 \pm 4.48$ ), proves to be superior to low-energy DSA (PSNR:  $26.05 \pm 0.03$ dB; SSIM:  $0.3770 \pm 0.0436$ ; SNR:  $20.71 \pm 1.19$ ; CNR:  $2.37 \pm 2.56$ ); A single image of 1024 x 1024 with a processing speed can be achieved in 0.051 seconds.

#### CONCLUSION

Low-energy DSA combined with deep learning denoising and enhancement techniques can enhance the contrast between arteries and surrounding tissues, optimize the quality of arterial images, reduce noise, and maintain real-time efficiency.

#### CLINICAL RELEVANCE/APPLICATION

Combining low-energy DSA with deep learning denoising and enhancement techniques can effectively reduce noise and enhance the shape of displayed arteries in real time, providing valuable assistance for various interventional procedures in clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPVA-2

### Quantitative Analysis of Lower Extremity Muscle Features Measured from Computed Tomography Angiography for Diagnosis of Peripheral Arterial Disease

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Ge Hu (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore whether lower extremity muscle features can be used for the diagnosis of peripheral arterial disease (PAD).

#### METHODS AND MATERIALS

Data of patients with PAD who visited our hospital between July 2016 and September 2020 were retrospectively collected. Two radiologists evaluated PAD severity on digital subtraction angiography (DSA) and computed tomography angiography (CTA) images using the runoff score. With the DSA score as reference standard, the patients were divided into two groups: mild PAD (DSA score = 7) vs. severe PAD (DSA score > 7). After segmenting lower extremity muscles from CTA images, 95 features were extracted for: univariable analysis, logistic regression model (LRM) analysis, and sub-dataset analysis (to verify whether PAD diagnosis can be realized through only part of the lower leg images).

#### RESULTS

A total of 56 patients ( $69 \pm 11$  years; 38 men) with 56 lower legs were enrolled in this study. The lower leg muscles of the mild PAD group (36 patients) showed higher CT values (44.6 vs. 39.5,  $P < 0.001$ ) with smaller dispersion (35.6 vs. 41.0,  $P < 0.001$ ) than those in the severe PAD group (20 patients). The area under the curve (AUC) of the CTA score, LRM-I (model constructed with muscle features), and LRM-II (model constructed with muscle features and CTA score) for PAD diagnosis were 0.81, 0.84, and 0.89, respectively. The highest diagnostic performance was observed in the image subset of the middle and inferior segments of the lower extremity (LRM-I, 0.83; LRM-II, 0.90).

#### CONCLUSION

Lower extremity muscle features can be used for PAD diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of lower extremity muscle features can be a useful supplement to the current clinical imaging diagnosis methods of PAD and compensate for the limitations of vascular stenosis diagnosis from the perspective of muscle ischemia evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-STCE1

### Science Session (Theranostics)

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 1

#### Sub-Events

### S3-STCE1-1 The Feasibility of Endovascular Management of Acute Stroke with a Large Ischemic Territory: A Meta-Analysis and Markov Cost-Effectiveness Analysis

Assala Aslan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Mechanical thrombectomy (MT) for acute ischemic stroke is generally avoided when the expected infarction is large (defined as ASPECT score of  $< 5$ ). However, three recent trials including RESCUE-Japan, SELECT2, and ANGEL-ASPECT, showed that patients with large cerebral infarctions had better functional outcomes, measured as modified Rankin Scale (mRS) score of 0-3 at 90 days, with MT as compared to best medical management (BMM) alone. In this study we performed a meta-analysis of these trials comparing MT vs. BMM for treatment of acute ischemic stroke with large infarction territory, and then analyzed the cost-effectiveness associated with those treatments.

#### METHODS AND MATERIALS

A meta-analysis of the RESCUE-Japan, SELECT2, and ANGEL-ASPECT trials was conducted using R Studio. Statistical analysis employed the Weighted Average Normal (WAN) method for calculating mean differences from medians in continuous variables and the Risk Ratio (RR) for categorical variables. TreeAge software was used to construct a cost-effectiveness analysis model comparing MT vs. BMM in the treatment of ischemic stroke with large infarction territory.

#### RESULTS

In the meta-analysis, MT was associated with a significant reduction in mRS with a mean difference (MD) across all studies of  $-0.55$  ( $P < 0.0001$ , 95% CI:  $-0.78 - -0.33$ ) indicating better functional outcomes compared to BMM (Figure 1). In the base-case analysis using a timeline of 10 years, MT and BMM alone were found to have a total gain of 2.54 QALY and 1.82 QALY, respectively. MT was also associated with a lower total cost of \$248,525, compared to \$265,456 with BMM alone (Figure 2). MT had a total incremental effectiveness of 0.72 QALY when compared with BMM alone, with an incremental cost-effectiveness ratio of \$-23,535.

#### CONCLUSION

This study shows that, besides having a better functional outcome at 90-day follow-up, MT was more cost-effective compared to BMM, when accounting for healthcare cost associated with treatment outcome.

#### CLINICAL RELEVANCE/APPLICATION

In this meta-analysis, we found that mechanical thrombectomy (MT) had superior functional outcomes measure as mRS of 0-3 at 90-days, compared to best medical management (BMM) for treatment of AIS with low ASPECT score ( $< 6$ ). Additionally, using Markov model and projection over 10 years period, MT was also found to be more cost effective than BMM, and was associated with lower better healthcare costs on the long term.

### S3-STCE1-2 Design and Creation of a 3D Printed Realistic Anthropomorphic Kidney Phantom for Theranostics (Lutetium-177) Dosimetry

Sara Belko, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Lutetium-177 prostate-specific membrane antigen-617 ( $^{177}\text{Lu}$ -PSMA-617) is a radioligand theranostic that delivers beta-particle radiation to PSMA-expressing cells in metastatic castration-resistant prostate cancer. [1]  $^{177}\text{Lu}$ -PSMA-617 has been shown to accumulate in the kidneys which can lead to possible injury thus is an organ of interest to monitor during treatment. [1] To ensure proper dosimetry, phantoms of a known activity can be used to assess imaging partial-volume



errors. [2] Previous studies have used multipart spherical and ellipsoidal models to represent a kidney. These models can be time consuming to make and do not account for artifacts from organic curvature of the kidney and quantifying two kidneys adjacently. The purpose of this project was to design and three dimensional (3D) print a realistic anthropomorphic model with right and left kidneys with two compartments (medulla and cortex).

#### **METHODS AND MATERIALS**

Left and right kidneys without pathology were segmented from a deidentified CT scan using Materialize MIMICs (version 25.0). Kidney segmentation allowed for more organic realistic shapes and curvatures. The parts were pulled into Materialize 3-Matic (version 17.0) for computer aided design (CAD). CAD modifications included: Hollowing and creating an inner chamber resulting in a 67% volume cortical (outer) chamber and 31% volume medulla (inner) chamber, [3] Creation of luer ports to be used with one way valves to inject water and <sup>177</sup>Lu-PSMA-617 into the chambers, A peg and base system to allow the kidneys to be positioned in their natural anatomic positions when being scanned and immersed in water. The kidneys were printed using stereolithography (SLA) on a FormLabs 3B printer ([www.formlabs.com](http://www.formlabs.com)). Each multi-chambered kidney was printed individually as one piece in FormLabs clear resin ([www.formlabs.com](http://www.formlabs.com)). The models were post-processed in isopropyl alcohol, cured, and finished according to the instructions for use published by the material manufacturer. The positioning base was printed in white polylactic acid using fused deposition modeling (FDM) on a Ultimaker S5 printer (<https://ultimaker.com/>). It was printed at 100% infill to ensure it would not float when submerged.

#### **RESULTS**

A water tight anthropomorphic phantom with 2-chamber left and right kidneys was developed and tested with <sup>177</sup>Lu-PSMA-617. The material cost of the model was 82 dollars.

#### **CONCLUSION**

A low-cost, easily printable, realistic kidney model was developed to be used for theranostic dosimetry or calibration. Dosimetry studies will be published in the future.

#### **CLINICAL RELEVANCE/APPLICATION**

3D printing allows for the creation of low-cost, anthropomorphic phantoms that can be used to calculate radiation dosimetry in theranostics.

### **S3-STCE1-3 A radiomics approach to noninvasively predict PD-1 expression and prognosis in patients with HCC treated with sorafenib after surgery**

Feng Che, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the impact of preoperative contrast-enhanced CT-based radiomics model on PD-1 status prediction in hepatocellular carcinoma (HCC) patients.

#### **METHODS AND MATERIALS**

The study included 105 HCC patients (training cohort: 72; validation cohort: 33) who underwent preoperative contrast-enhanced CT and received systemic sorafenib treatment after surgery. Radiomics score was built for each patient and was integrated with independent clinicoradiologic predictors into the radiomics model using multivariable logistic regression analysis.

#### **RESULTS**

Seventeen radiomics features were finally selected to construct the radiomics score. In multivariate analysis, serum creatine and peritumoral enhancement were significant independent factors for PD-1 expression prediction. The radiomics model integrated radiomics signature with serum creatine and peritumoral enhancement showed good discriminative performance (AUC of 0.897 and 0.794 in the training and validation cohort). Overall survival (OS) was significantly different between the radiomics-predicted PD-1-positive and PD-1-negative groups (OS: 29.66 months, CI:16.03-44.40 vs. 31.04 months, CI: 17.10-44.07, P<0.001). Radiomics-predicted PD-1 was an independent predictor of OS of patients treated with sorafenib after surgery. (Hazard ratio [HR]: 1.61 [1.23-2.1], P<0.001).

#### **CONCLUSION**

The proposed model based on radiomic signature helps to evaluate PD-1 status of HCC patients and may be used for evaluating patients most likely to benefit from sorafenib as a potentially combination therapy regimen with immune checkpoint therapies.

#### **CLINICAL RELEVANCE/APPLICATION**

PD-1 was an independent predictor of overall survival of patients treated with sorafenib after surgery. A contrast-enhanced CT radiomics model was built and showed satisfactory value for preoperative prediction of PD-1 in HCC patients. The radiomics features may provide a promising opportunity to improve clinical decision support for patients with immunotherapeutic approaches.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-STCE1-1

### The Feasibility of Endovascular Management of Acute Stroke with a Large Ischemic Territory: A Meta-Analysis and Markov Cost-Effectiveness Analysis

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 1

Assala Aslan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Mechanical thrombectomy (MT) for acute ischemic stroke is generally avoided when the expected infarction is large (defined as ASPECT score of  $< 5$ ). However, three recent trials including RESCUE-Japan, SELECT2, and ANGEL-ASPECT, showed that patients with large cerebral infarctions had better functional outcomes, measured as modified Rankin Scale (mRS) score of 0-3 at 90 days, with MT as compared to best medical management (BMM) alone. In this study we performed a meta-analysis of these trials comparing MT vs. BMM for treatment of acute ischemic stroke with large infarction territory, and then analyzed the cost-effectiveness associated with those treatments.

#### METHODS AND MATERIALS

A meta-analysis of the RESCUE-Japan, SELECT2, and ANGEL-ASPECT trials was conducted using R Studio. Statistical analysis employed the Weighted Average Normal (WAN) method for calculating mean differences from medians in continuous variables and the Risk Ratio (RR) for categorical variables. TreeAge software was used to construct a cost-effectiveness analysis model comparing MT vs. BMM in the treatment of ischemic stroke with large infarction territory.

#### RESULTS

In the meta-analysis, MT was associated with a significant reduction in mRS with a mean difference (MD) across all studies of  $-0.55$  ( $P < 0.0001$ , 95% CI:  $-0.78 - -0.33$ ) indicating better functional outcomes compared to BMM (Figure 1). In the base-case analysis using a timeline of 10 years, MT and BMM alone were found to have a total gain of 2.54 QALY and 1.82 QALY, respectively. MT was also associated with a lower total cost of \$248,525, compared to \$265,456 with BMM alone (Figure 2). MT had a total incremental effectiveness of 0.72 QALY when compared with BMM alone, with an incremental cost-effectiveness ratio of \$-23,535.

#### CONCLUSION

This study shows that, besides having a better functional outcome at 90-day follow-up, MT was more cost-effective compared to BMM, when accounting for healthcare cost associated with treatment outcome.

#### CLINICAL RELEVANCE/APPLICATION

In this meta-analysis, we found that mechanical thrombectomy (MT) had superior functional outcomes measure as mRS of 0-3 at 90-days, compared to best medical management (BMM) for treatment of AIS with low ASPECT score ( $< 6$ ). Additionally, using Markov model and projection over 10 years period, MT was also found to be more cost effective than BMM, and was associated with lower better healthcare costs on the long term.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-STCE1-2

### Design and Creation of a 3D Printed Realistic Anthropomorphic Kidney Phantom for Theranostics (Lutetium-177) Dosimetry

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 1

Sara Belko, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Lutetium-177 prostate-specific membrane antigen-617 ( $^{177}\text{Lu}$ -PSMA-617) is a radioligand theranostic that delivers beta-particle radiation to PSMA-expressing cells in metastatic castration-resistant prostate cancer. [1]  $^{177}\text{Lu}$ -PSMA-617 has been shown to accumulate in the kidneys which can lead to possible injury thus is an organ of interest to monitor during treatment. [1] To ensure proper dosimetry, phantoms of a known activity can be used to assess imaging partial-volume errors. [2] Previous studies have used multipart spherical and ellipsoidal models to represent a kidney. These models can be time consuming to make and do not account for artifacts from organic curvature of the kidney and quantifying two kidneys adjacently. The purpose of this project was to design and three dimensional (3D) print a realistic anthropomorphic model with right and left kidneys with two compartments (medulla and cortex).

#### METHODS AND MATERIALS

Left and right kidneys without pathology were segmented from a deidentified CT scan using Materialize MIMICs (version 25.0). Kidney segmentation allowed for more organic realistic shapes and curvatures. The parts were pulled into Materialize 3-Matic (version 17.0) for computer aided design (CAD). CAD modifications included: Hollowing and creating an inner chamber resulting in a 67% volume cortical (outer) chamber and 31% volume medulla (inner) chamber, [3] Creation of luer ports to be used with one way valves to inject water and  $^{177}\text{Lu}$ -PSMA-617 into the chambers, A peg and base system to allow the kidneys to be positioned in their natural anatomic positions when being scanned and immersed in water. The kidneys were printed using stereolithography (SLA) on a FormLabs 3B printer ([www.formlabs.com](http://www.formlabs.com)). Each multi-chambered kidney was printed individually as one piece in FormLabs clear resin ([www.formlabs.com](http://www.formlabs.com)). The models were post-processed in isopropyl alcohol, cured, and finished according to the instructions for use published by the material manufacturer. The positioning base was printed in white polylactic acid using fused deposition modeling (FDM) on a Ultimaker S5 printer (<https://ultimaker.com/>). It was printed at 100% infill to ensure it would not float when submerged.

#### RESULTS

A water tight anthropomorphic phantom with 2-chamber left and right kidneys was developed and tested with  $^{177}\text{Lu}$ -PSMA-617. The material cost of the model was 82 dollars.

#### CONCLUSION

A low-cost, easily printable, realistic kidney model was developed to be used for theranostic dosimetry or calibration. Dosimetry studies will be published in the future.

#### CLINICAL RELEVANCE/APPLICATION

3D printing allows for the creation of low-cost, anthropomorphic phantoms that can be used to calculate radiation dosimetry in theranostics.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-STCE1-3

### **A radiomics approach to noninvasively predict PD-1 expression and prognosis in patients with HCC treated with sorafenib after surgery**

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 1

Feng Che, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the impact of preoperative contrast-enhanced CT-based radiomics model on PD-1 status prediction in hepatocellular carcinoma (HCC) patients.

#### **METHODS AND MATERIALS**

The study included 105 HCC patients (training cohort: 72; validation cohort: 33) who underwent preoperative contrast-enhanced CT and received systemic sorafenib treatment after surgery. Radiomics score was built for each patient and was integrated with independent clinicoradiologic predictors into the radiomics model using multivariable logistic regression analysis.

#### **RESULTS**

Seventeen radiomics features were finally selected to construct the radiomics score. In multivariate analysis, serum creatine and peritumoral enhancement were significant independent factors for PD-1 expression prediction. The radiomics model integrated radiomics signature with serum creatine and peritumoral enhancement showed good discriminative performance (AUC of 0.897 and 0.794 in the training and validation cohort). Overall survival (OS) was significantly different between the radiomics-predicted PD-1-positive and PD-1-negative groups (OS: 29.66 months, CI:16.03-44.40 vs. 31.04 months, CI: 17.10-44.07,  $P < 0.001$ ). Radiomics-predicted PD-1 was an independent predictor of OS of patients treated with sorafenib after surgery. (Hazard ratio [HR]: 1.61 [1.23-2.1],  $P < 0.001$ ).

#### **CONCLUSION**

The proposed model based on radiomic signature helps to evaluate PD-1 status of HCC patients and may be used for evaluating patients most likely to benefit from sorafenib as a potentially combination therapy regimen with immune checkpoint therapies.

#### **CLINICAL RELEVANCE/APPLICATION**

PD-1 was an independent predictor of overall survival of patients treated with sorafenib after surgery. A contrast-enhanced CT radiomics model was built and showed satisfactory value for preoperative prediction of PD-1 in HCC patients. The radiomics features may provide a promising opportunity to improve clinical decision support for patients with immunotherapeutic approaches.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-STCE2

### Science Session (Generative AI)

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 2

#### Sub-Events

### S3-STCE2-1 Evaluation of ChatGPT-Generated Pamphlets for Common Interventional Radiology Procedures

Soheil Kooraki, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to evaluate the accuracy and reliability of educational patient pamphlets created by ChatGPT, a large AI language model, for common interventional radiology (IR) procedures.

#### METHODS AND MATERIALS

Twenty frequently performed IR procedures were selected, and five users were tasked to independently request ChatGPT to generate educational patient pamphlets for each procedure using identical commands. Subsequently, two independent radiologists assessed the quality and accuracy of the pamphlets. The review focused on identifying potential errors, inaccuracies, the consistency of pamphlets.

#### RESULTS

The review of the pamphlets revealed that 25% (25/100) of generated pamphlets contained errors, with a total number of 31 identified errors. The most common errors were related to the omission of information regarding sedation for the procedure (9/31), pre-procedural preparation details (5/31), procedural steps for Y-90 radioembolization (3/31), and precautionary measures for the procedure (3/31). There were inter-user structural variations in the pamphlets created for each IR procedure.

#### CONCLUSION

Although the study showed promising results for ChatGPT-generated educational patient pamphlets, the pamphlets were not entirely accurate and were prone to errors and inter-user structural variabilities.

#### CLINICAL RELEVANCE/APPLICATION

Future advancements and refinements in AI language models could potentially improve their utility in creating reliable educational medical content, but human supervision and expert validation are still necessary to ensure accuracy and patient safety.

### S3-STCE2-2 ChatGPT vs. Hybrid NLP/Rule Based Algorithm for Determination of Referral Specialty from Right Upper Quadrant Ultrasound Reports

Jacob L. Kraus, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Artificial intelligence (AI) tools can be used to identify clinically significant findings in radiology reports and help providers by suggesting referral services based on them. The aim of this study is to evaluate and compare the abilities Chat GPT and a hybrid Natural Language Processing (NLP)/rule-based algorithm in the determination of appropriate specialty referral for patients based on right upper quadrant (RUQ) ultrasound reports.

#### METHODS AND MATERIALS

300 RUQ reports were randomly collected from March 23 to April 4, 2023 from an academic tertiary level 1000+ bedded hospital. Reports were manually de-identified of any PHI, labeled for clinically significant findings (CSF) and interpreted in order to determine need for follow-up and, if necessary, specialty referral. Labeling and interpretation were done under the

guidance of a board-certified radiology attending. Both Chat GPT and a hybrid NLP/rule-based algorithm were then prompted with the reports and asked to determine whether patients required follow up based on findings, the reason for that determination, and what specialty the patient should be referred to. As the hybrid algorithm can only determine the need for specialty referral to one of 4 services (hepatobiliary, urology, primary care and gynecology), Chat GPT was prompted with that same constraint. Responses were then analyzed for their ability to determine what specialty a patient would need referral to if any at all. The set of true referrals used as the ground truth only included correct referrals for combinations of CSFs that were used to create the rule set of the hybrid algorithm.

## RESULTS

ChatGPT's recall achieved a precision of 54.37%, a recall of 76.54%, an F1 Score of 63.58%, and an accuracy of 74.69%. The hybrid algorithm achieved a precision of 96.31%, a recall of 70.66%, an F1 Score of 81.51%, and an accuracy of 90.78%.

## CONCLUSION

: When prompted with rule-based constraints ChatGPT's precision, accuracy and F1 score were limited when compared to our hybrid algorithm. This is in part could be due to an affirmative bias which resulted in a significantly higher number of false positives from ChatGPT (167 vs. 7). Our hybrid model's low false positive was likely due to its integrated rule set which constrained referral generation to a smaller set of CSF combinations. ChatGPT's recall was slightly higher than that of our hybrid algorithm which may be due to its zero shot learning capabilities which allow it to classify samples from classes not trained on.

## CLINICAL RELEVANCE/APPLICATION

Comparing the ability of an internally constructed hybrid NLP/rule-based model to Chat GPT in the determination of appropriate follow up specialty from right upper quadrant ultrasound radiology reports.

### S3-STCE2-3 ChatGPT for Determination of Need for Follow Up from Right Upper Quadrant Ultrasound Reports

Jacob L. Kraus, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Patient follow-up is a key component of patient care. In radiology, coordinating patient follow-up from imaging report findings is challenging because of the multiple communication systems and steps between the imaging report findings and patient follow-up. The increase in volume of imaging that has occurred in the past decade also contributes to the challenge of coordinating patient follow-up. This study aimed to determine the viability of using Chat GPT, a generative AI, to binarily determine whether or not a patient requires follow-up based on findings in their right upper quadrant ultrasound reports.

## METHODS AND MATERIALS

300 RUQ reports were randomly collected from March 23 to April 4, 2023, from an academic tertiary level 1000+ bedded hospital. Reports were manually de-identified of any PHI. Reports were then labeled as clinically significant findings and interpreted in order to determine the need for follow-up and, if necessary, specialty referral. A total of 23 groups of clinically significant findings were identified. Labeling and interpretation were done under the guidance of a board-certified radiology attending. Chat GPT was then prompted with the reports and asked to determine whether or not patients required follow up based on findings, the reason for that determination, and what specialty the patient should be referred to. Chat GPT responses were then labeled in the context of the previous questions. Chat GPT's determination of need for follow up was then compared to the true need for follow up.

## RESULTS

234 out 300 reports necessitated follow up after manual interpretation. ChatGPT determined that 223 of the 300 reports necessitated follow up. Recall was 90.6%, precision was 95.07%, accuracy was 89%, and F1 Score was 92.78 %.

## CONCLUSION

ChatGPT achieved a recall of 90.6%, precision of 95.07%, accuracy was 89%, and an F1 Score of 92.78%. ChatGPT could provide a method of automatically labelling reports that would alert providers when their patients imaging requires follow up and could be expanded to take into urgency of specific findings. The limits of this study include a lack of specificity in prompting, interpreter bias, site specific practice patterns lending importance to certain findings, as well site-specific reporting norms. Additionally, limitations of generative AI technologies such as a lack of training data in specific areas, mislabeled training data, non-structured responses, and bias may also play a role.

## CLINICAL RELEVANCE/APPLICATION

Evaluation of ChatGPT's ability to determine need for follow up from right upper quadrant ultrasound radiology reports.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-STCE2-1

### Evaluation of ChatGPT-Generated Pamphlets for Common Interventional Radiology Procedures

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 2

Soheil Kooraki, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to evaluate the accuracy and reliability of educational patient pamphlets created by ChatGPT, a large AI language model, for common interventional radiology (IR) procedures.

#### **METHODS AND MATERIALS**

Twenty frequently performed IR procedures were selected, and five users were tasked to independently request ChatGPT to generate educational patient pamphlets for each procedure using identical commands. Subsequently, two independent radiologists assessed the quality and accuracy of the pamphlets. The review focused on identifying potential errors, inaccuracies, the consistency of pamphlets.

#### **RESULTS**

The review of the pamphlets revealed that 25% (25/100) of generated pamphlets contained errors, with a total number of 31 identified errors. The most common errors were related to the omission of information regarding sedation for the procedure (9/31), pre-procedural preparation details (5/31), procedural steps for Y-90 radioembolization (3/31), and precautionary measures for the procedure (3/31). There were inter-user structural variations in the pamphlets created for each IR procedure.

#### **CONCLUSION**

Although the study showed promising results for ChatGPT-generated educational patient pamphlets, the pamphlets were not entirely accurate and were prone to errors and inter-user structural variabilities.

#### **CLINICAL RELEVANCE/APPLICATION**

Future advancements and refinements in AI language models could potentially improve their utility in creating reliable educational medical content, but human supervision and expert validation are still necessary to ensure accuracy and patient safety.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3-STCE2-2

### ChatGPT vs. Hybrid NLP/Rule Based Algorithm for Determination of Referral Specialty from Right Upper Quadrant Ultrasound Reports

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 2

Jacob L. Kraus, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Artificial intelligence (AI) tools can be used to identify clinically significant findings in radiology reports and help providers by suggesting referral services based on them. The aim of this study is to evaluate and compare the abilities Chat GPT and a hybrid Natural Language Processing (NLP)/rule-based algorithm in the determination of appropriate specialty referral for patients based on right upper quadrant (RUQ) ultrasound reports.

#### METHODS AND MATERIALS

300 RUQ reports were randomly collected from March 23 to April 4, 2023 from an academic tertiary level 1000+ bedded hospital. Reports were manually de-identified of any PHI, labeled for clinically significant findings (CSF) and interpreted in order to determine need for follow-up and, if necessary, specialty referral. Labeling and interpretation were done under the guidance of a board-certified radiology attending. Both Chat GPT and a hybrid NLP/rule-based algorithm were then prompted with the reports and asked to determine whether patients required follow up based on findings, the reason for that determination, and what specialty the patient should be referred to. As the hybrid algorithm can only determine the need for specialty referral to one of 4 services (hepatobiliary, urology, primary care and gynecology), Chat GPT was prompted with that same constraint. Responses were then analyzed for their ability to determine what specialty a patient would need referral to if any at all. The set of true referrals used as the ground truth only included correct referrals for combinations of CSFs that were used to create the rule set of the hybrid algorithm.

#### RESULTS

ChatGPT's recall achieved a precision of 54.37%, a recall of 76.54%, an F1 Score of 63.58%, and an accuracy of 74.69%. The hybrid algorithm achieved a precision of 96.31%, a recall of 70.66%, an F1 Score of 81.51%, and an accuracy of 90.78%.

#### CONCLUSION

: When prompted with rule-based constraints ChatGPT's precision, accuracy and F1 score were limited when compared to our hybrid algorithm. This is in part could be due to an affirmative bias which resulted in a significantly higher number of false positives from ChatGPT (167 vs. 7). Our hybrid model's low false positive was likely due to its integrated rule set which constrained referral generation to a smaller set of CSF combinations. ChatGPT's recall was slightly higher than that of our hybrid algorithm which may be due to its zero shot learning capabilities which allow it to classify samples from classes not trained on.

#### CLINICAL RELEVANCE/APPLICATION

Comparing the ability of an internally constructed hybrid NLP/rule-based model to Chat GPT in the determination of appropriate follow up specialty from right upper quadrant ultrasound radiology reports.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3-STCE2-3

### ChatGPT for Determination of Need for Follow Up from Right Upper Quadrant Ultrasound Reports

Sunday, Nov. 26 12:00PM - 12:30PM Room: Learning Center Theater 2

Jacob L. Kraus, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patient follow-up is a key component of patient care. In radiology, coordinating patient follow-up from imaging report findings is challenging because of the multiple communication systems and steps between the imaging report findings and patient follow-up. The increase in volume of imaging that has occurred in the past decade also contributes to the challenge of coordinating patient follow-up. This study aimed to determine the viability of using Chat GPT, a generative AI, to binarily determine whether or not a patient requires follow-up based on findings in their right upper quadrant ultrasound reports.

#### METHODS AND MATERIALS

300 RUQ reports were randomly collected from March 23 to April 4, 2023, from an academic tertiary level 1000+ bedded hospital. Reports were manually de-identified of any PHI. Reports were then labeled as clinically significant findings and interpreted in order to determine the need for follow-up and, if necessary, specialty referral. A total of 23 groups of clinically significant findings were identified. Labeling and interpretation were done under the guidance of a board-certified radiology attending. Chat GPT was then prompted with the reports and asked to determine whether or not patients required follow up based on findings, the reason for that determination, and what specialty the patient should be referred to. Chat GPT responses were then labeled in the context of the previous questions. Chat GPT's determination of need for follow up was then compared to the true need for follow up.

#### RESULTS

234 out 300 reports necessitated follow up after manual interpretation. ChatGPT determined that 223 of the 300 reports necessitated follow up. Recall was 90.6%, precision was 95.07%, accuracy was 89%, and F1 Score was 92.78 %.

#### CONCLUSION

ChatGPT achieved a recall of 90.6%, precision of 95.07%, accuracy was 89%, and an F1 Score of 92.78%. ChatGPT could provide a method of automatically labelling reports that would alert providers when their patients imaging requires follow up and could be expanded to take into urgency of specific findings. The limits of this study include a lack of specificity in prompting, interpreter bias, site specific practice patterns lending importance to certain findings, as well site-specific reporting norms. Additionally, limitations of generative AI technologies such as a lack of training data in specific areas, mislabeled training data, non-structured responses, and bias may also play a role.

#### CLINICAL RELEVANCE/APPLICATION

Evaluation of ChatGPT's ability to determine need for follow up from right upper quadrant ultrasound radiology reports.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSCH02

### Chest Imaging (Lung Cancer Screening)

Sunday, Nov. 26 1:00PM - 2:00PM Room: N228

Patricia J. Mergo, MD (*Moderator*) Nothing to Disclose  
Mark M. Hammer, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **S4-SSCH02-Successful Improvement in Lung Screening Enrollment for Women Undergoing Breast 1 Screening: The CALM Study (Coordinate A Lung Screening with Mammography)**

Kim L. Sandler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung cancer has been the leading cause of cancer-related mortality in women for decades. Lung cancer screening saves lives through the early detection of lung cancer, yet uptake remains low. Mammography is well utilized with 70% of eligible women reporting having a mammogram in the past two years. We devised a study to investigate if screening mammography can be used as an opportunity to increase lung screening among women.

#### METHODS AND MATERIALS

Women undergoing screening mammography from November 2019 to December 2022 were included from two geographically unique academic hospitals (Sites A and B). Site A is a centralized lung screening program in the Southeast and Site B is a hybrid program in the Northeast. Electronic health records were reviewed to determine lung screening eligibility based on USPSTF recommendations. Researchers then notified patients directly or through their healthcare providers of their lung screening eligibility. Women previously enrolled in lung screening were excluded. The overall number of individuals screened at each site was recorded and compared to site-specific pre-intervention enrollment rates utilizing an interrupted time series with a flexible model specified for the historical data. Two months (March and April 2020) were excluded due to COVID-19 clinical shutdown.

#### RESULTS

The records of 32,165 mammography participants during the study period were reviewed, identifying 1,569 individuals eligible for LCS of whom 1,089 (69%) had not previously enrolled. At Site A, the total number of screenings significantly increased at 12 months compared to the number predicted from pre-intervention data ( $p = 0.011$ ). At Site B, a non-significant increase in screenings was found ( $p = 0.278$ ). Site B intervention effect may have been attenuated due to prolonged operational effects of the pandemic which did not occur at Site A.

#### CONCLUSION

Targeted outreach to patients and providers in the CALM study resulted in improved enrollment in lung screening. These outreach strategies can be customized to different program structures, as represented by the centralized and hybrid programs included in this initiative. Radiology practices are uniquely positioned to use this intervention to improve enrollment as all patients were seen for both mammography and low-dose CT.

#### CLINICAL RELEVANCE/APPLICATION

The intervention strategies utilized in the CALM study improved screening enrollment for women. Radiologists can apply this approach to combat historically poor lung screening rates and save lives through the early detection of lung cancer.

### **S4-SSCH02-Lung Cancer Screening Trends after Introducing the New 2021 US Preventive Services 2 Taskforce (USPSTF)**

Valeria Pena-Trujillo, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To describe the impact of the 2021-USPSTF lung cancer screening guidelines eligibility-criteria expansion on the clinical and sociodemographic characteristics of the targeted population

## METHODS AND MATERIALS

In this retrospective study, the imaging database of a large academic multisite center was assessed to identify all patients who underwent a clinically-indicated baseline lung CT from 4/2021-12/2022 as part of our lung cancer screening program. Collected data included sociodemographic (sex, race, ethnic group, language, zip code) and clinical characteristics (smoking status, LungRads Score [LRS], other interstitial lung diseases, etc.). Patients' zip codes were used to estimate median household income by pairing them with IRS data. Distances between the patient's residence and exam site were calculated as a straight line between zip codes. The collected cohort included individuals eligible under the 2013-USPSTF guidelines and newly eligible patients under the expanded recommendations. As a nonoverlapping group to the 2013-USPSTF, the characteristics of the 2021-USPSTF cohort were assessed and compared. Sociodemographic and clinical variables between both cohorts were compared using nonparametric tests for continuous variables and X<sup>2</sup>-tests for categorical variables

## RESULTS

From 7720 patients, 2301 baseline screening CTs were included for further analysis (1539 old recommendations; 727 expanded recommendations) after excluding follow-ups and non-eligible patients under USPSTF. Female patients represented 45.87% and 48% of the old vs. new guidelines cohorts, respectively. Mean age at screening was 64 vs. 57 years old ( $p=0.001$ ). No other statistically significant differences in sociodemographic variables were found. As expected, the number of packs-year was significantly lower (42.3 vs. 29.4;  $p<0.001$ ) in the revised recommendations. In addition, both cohorts had several significant differences ( $p=0.0172$ ) in terms of LRS; we found that patients screened under new guidelines had a lower proportion of LRS 3 (9.4 vs. 8%) and 4 (8 vs. 5.2%), and a higher proportion of LRS 1 (11.1 vs. 12.5%) and 2 (71.3 vs. 74.3%). For LRS 4, there was a higher proportion of 4B/X in the 2013-USPSTF (26.02 vs. 23.68%; 18.7 vs. 5.26%). We also found fewer Smodifiers in the new guideline's cohort (51.7 vs. 38%;  $p<0.01$ )

## CONCLUSION

The expansion of current guidelines may promote earlier detection of smoking-related lung malignancies. Future studies may reveal differences in gender or sociodemographic variables

## CLINICAL RELEVANCE/APPLICATION

Our results suggest that the eligibility-criteria expansion of the new USPSTF lung cancer screening guidelines may promote earlier detection of smoking-related lung malignancies

## S4-SSCH02-Association between Altered Subcutaneous Adipose Tissue and Survival in a High-Risk Population of Heavy Smokers Participating in Lung Cancer Screening

Fabian Bernhard Pallasch, MD (*Presenter*) Nothing to Disclose

## PURPOSE

There is increasing evidence that body composition portraits prognostic relevance in cancer and cardiometabolic disease. While most studies focus on changes in muscle status, little is known about the role of adipose tissue, especially in a screening setting. Here, we used a deep learning model for fully automatic 3D quantification of subcutaneous adipose tissue (SAT) on chest CTs and investigated its association with mortality in a high-risk population of heavy smokers participating in lung cancer screening.

## METHODS AND MATERIALS

We used a 3D deep learning model to segment SAT on lung screening non-contrast enhanced chest CTs of 26,144 individuals participating in the National Lung Screening Trial at baseline and after one year follow-up ( $n=52,228$  scans). For analysis, SAT volume (SATvol) and SAT density (SATHU) as a measure of SAT quality were quantified. The primary outcome was all-cause mortality. Additional outcomes were lung cancer and cardiovascular mortality. Multivariable Cox proportional hazards regression was used to assess the association between SATvol as well as SATHU and mortality at baseline and a decrease in SATvol and SATHU ( $=10\%$ ) within one year and mortality.

## RESULTS

Among 26,144 individuals (age  $61.4 \pm 5.0$  years; 40.9% female) a total of 1,839 (7%) deaths occurred over a median follow-up of 6.5 years. At baseline, only SATHU was independently associated with all-cause mortality after multivariable adjustment for clinical risk factors (age, sex, race, smoking status, pack years, prevalent hypertension, diabetes, and past stroke or myocardial infarction; HR: 1.07, 95% CI [1.02-1.12];  $p = 0.003$ ). Individuals with a decline in SATvol or SATHU  $=10\%$  over a period of one year, had a significantly worse outcome compared to those with stable SATvol or SATHU (hazard ratios adjusted for the same risk factors SATvol: HR 1.94, 95% CI [1.77-2.13],  $p<0.001$ ; SATHU: HR 3.1, 95% CI [2.79-3.44],  $p<0.001$ ). Similar associations were found for lung cancer and cardiovascular mortality as outcome of interest.

## CONCLUSION

A deep learning model can automatically quantify altered SAT on chest CT in an opportunistic fashion.  $SAT_{HU}$  at baseline and a decrease in  $SAT_{vol}$  or  $SAT_{HU}$  within one year are independently associated with mortality in lung cancer screening eligible heavy smokers beyond clinical risk factors, which may help to improve personalized risk assessment and prevention.

## CLINICAL RELEVANCE/APPLICATION

Our results show that automated methods can provide a fast and low-cost solution to identify high-risk individuals participating in lung cancer screening. This can accelerate clinical implementation to guide management and improve population health.

### S4-SSCH02-Large Language Models and Lung Cancer: A Comparative Study on the Appropriateness of Artificial Intelligence Statements

Amir A. Rahsepar, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The recent release of large language models (LLMs) for public use, such as ChatGPT and Google Bard, has opened up a multitude of potential benefits as well as challenges. To evaluate and compare the accuracy and relevance of responses generated by ChatGPT and Google Bard to non-expert questions related to lung cancer prevention, screening, and terminology commonly used in radiology reports based on the recommendation of Lung Imaging Reporting and Data System (Lung-RADS) v2022 from American College of Radiology and Fleischner society.

#### METHODS AND MATERIALS

Forty exactly the same questions were created and presented to ChatGPT and Google Bard by three different authors of this paper. Each answer was reviewed by two radiologists for accuracy. Responses were scored as correct, partially correct, incorrect, or unanswered. Consistency was also evaluated among the answers provided by ChatGPT and Google Bard. Here, consistency was defined as the agreement between the three answers provided by either ChatGPT or Google Bard, regardless of whether the concept conveyed was correct or incorrect.

#### RESULTS

ChatGPT answered all questions. Out of 120 answers, 85 (70.8%) were correct, 14 (11.7%) were partially correct, and 21 (17.5%) were incorrect. Google Bard did not answer 23 (19.1%) questions. Among the 97 questions answered by Google Bard, 62 (51.7%) were correct, 11 (9.2%) were partially correct, and 24 (20%) were incorrect. We found that ChatGPT's answers were consistent 36 out of 40 times (90%), while Google Bard's answers were consistent 23 out of 40 times (57.5%).

## CONCLUSION

Although the use of artificial intelligence offers new possibilities in fields like medicine, it also presents challenges that must be carefully reviewed by experts to prevent undue burden on patients and healthcare workers.

## CLINICAL RELEVANCE/APPLICATION

It is essential that LLM developers be aware of the complexity of healthcare decision-making and implement serious guardrails for all healthcare-related interactions.

### S4-SSCH02-Rate of Benign Surgeries in an Academic CT Lung Cancer Screening Program

Raquelle H. El Alam, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Screening with low dose computed tomography (CT) can reduce lung cancer related death at the expense of unavoidable false positive results. The purpose of this study is to measure the rate of surgery for benign nodules and evaluate characteristics of those nodules.

#### METHODS AND MATERIALS

In this study, we evaluated patients in the Lung Cancer Screening (LCS) program across a large tertiary healthcare network from 5/2015 through 10/2021 who underwent surgical resection for a lung nodule. We reviewed the pathology reports and subsequent follow-up to establish whether the nodule was benign or malignant, and only benign nodules were included for this study. Imaging characteristics of the nodules were evaluated by a radiology fellow, and we recorded Lung-RADS category, nodule status (baseline, stable, new, growing), FDG uptake on PET/CT, and calculated the risk from the Brock model.

## RESULTS

During the study period, a total of 21366 LCS CT was performed in 9050 patients, and 260 patients underwent surgical resection. Review of the pathology results revealed: 220 lung cancer (85%), 2 other malignancies (1%), and 38 benign findings (15%). Pathology of the benign nodules was as follows: 12 with scarring/fibrosis, 5 with benign neoplasms, 14 with infection/inflammation, and 7 with other diagnoses. Lung-RADS category was as follows: 4 (11%) Lung-RADS 2, 2 (5%) Lung-Rad 3, 11 (29%) Lung-RADS 4A, 13 (34%) Lung-RADS 4B, and 8 (21%) Lung-RADS 4X. The size of the nodules ranged from 4 to 41 mm with a median of 13 mm. 2 (5%) were ground glass, 10 (26%) were part-solid, and 26 (68%) were solid. FDG-PET/CT was performed in 19 out of 38 cases, of which: 2 (11%) had no uptake, 10 (53%) had mild uptake, 3 (16%) had moderate uptake, and 4 (21%) had intense uptake. Risk assessment by Brock calculator revealed that 9 (24) had <5% (very low) risk; 27 (71%) had 5-65% (low-intermediate) risk, and 2 (5%) had >65% (high) risk.

## CONCLUSION

Surgical resection of benign nodules is unavoidable despite application of Lung-RADS guidelines in a modern screening program, with approximately 15% of surgeries being performed for benign lesions.

## CLINICAL RELEVANCE/APPLICATION

Surgeries for benign pulmonary nodules are an inevitable part of a lung cancer screening program due to overlap between the appearance of benign and malignant pulmonary nodules.

## S4-SSCH02-Improving the Readability of Patient-Facing Information about Lung Cancer using Large Language Models: ChatGPT, GPT-4 and Bard

Hana L. Haver, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Access to information remains a modifiable contributor to disparities in lung cancer screening. With the increasing attention towards using large language models in generating health information has shown early promise, little has been reported about the capability of these models to improve readability of health information and its accessibility to the general public. Here, we assessed how 3 large language models (LLM): ChatGPT, GPT-4 and Bard, perform in summarizing and simplifying health information about lung cancer prevention and screening.

## METHODS AND MATERIALS

We evaluated the readability of answers to common questions about lung cancer prevention and screening that were generated by ChatGPT. We then asked ChatGPT, GPT-4 and Bard to simplify this answer set, and assessed the simplified answers for language complexity (Flesch Reading Ease) and readability on 5 established scales: Flesch-Kincaid Grade Level, Gunning-Fog Index, Coleman-Liau Index, Automated Readability Index, and Simple Measure of Gobbledygook. Complexity score of 60 and greater and readability score of grade 8 and below was considered adequate for an average audience. Statistical analysis utilized paired t-testing between readability scores from the original and simplified answers for each model. Simplified answers were blindly rated for clinical appropriateness by 3 fellowship-trained cardiothoracic radiologists.

## RESULTS

The baseline answers to questions generated by ChatGPT in response to questions related to lung cancer had an overall mean language complexity of 49.7 and an overall mean readability of grade 12.6. Following simplification of these answers by ChatGPT, GPT-4 and Bard, the overall mean language complexity and readability were found to be improved when each was compared to the score of the original text (Figure 1). Upon blinded assessment of clinical appropriateness of the simplified answers, our board-certified cardiothoracic radiologists determined that they were clinically appropriate 84% (ChatGPT), 79% (GPT-4) and 95% (Bard) of the time.

## CONCLUSION

Lung cancer information provided by ChatGPT is complex and difficult to read. LLM's including ChatGPT, GPT-4 and Bard demonstrate the capability to simplify the language of lung cancer information to a level more accessible for the general public, though the non-trivial number of inappropriate or inconsistent answers of the simplified content imply that further study is required.

## CLINICAL RELEVANCE/APPLICATION

ChatGPT generates responses to questions about lung cancer that are difficult to read. ChatGPT, GPT-4 and Bard can be used to simplify this texts with varying degrees of clinical appropriateness, indicating early potential to improve access to health information for the average audience.

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## Abstract Archives of the RSNA, 2023

S4-SSCH02-1

### Successful Improvement in Lung Screening Enrollment for Women Undergoing Breast Screening: The CALM Study (Coordinate A Lung Screening with Mammography)

Sunday, Nov. 26 1:00PM - 2:00PM Room: N228

Kim L. Sandler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung cancer has been the leading cause of cancer-related mortality in women for decades. Lung cancer screening saves lives through the early detection of lung cancer, yet uptake remains low. Mammography is well utilized with 70% of eligible women reporting having a mammogram in the past two years. We devised a study to investigate if screening mammography can be used as an opportunity to increase lung screening among women.

#### METHODS AND MATERIALS

Women undergoing screening mammography from November 2019 to December 2022 were included from two geographically unique academic hospitals (Sites A and B). Site A is a centralized lung screening program in the Southeast and Site B is a hybrid program in the Northeast. Electronic health records were reviewed to determine lung screening eligibility based on USPSTF recommendations. Researchers then notified patients directly or through their healthcare providers of their lung screening eligibility. Women previously enrolled in lung screening were excluded. The overall number of individuals screened at each site was recorded and compared to site-specific pre-intervention enrollment rates utilizing an interrupted time series with a flexible model specified for the historical data. Two months (March and April 2020) were excluded due to COVID-19 clinical shutdown.

#### RESULTS

The records of 32,165 mammography participants during the study period were reviewed, identifying 1,569 individuals eligible for LCS of whom 1,089 (69%) had not previously enrolled. At Site A, the total number of screenings significantly increased at 12 months compared to the number predicted from pre-intervention data ( $p = 0.011$ ). At Site B, a non-significant increase in screenings was found ( $p = 0.278$ ). Site B intervention effect may have been attenuated due to prolonged operational effects of the pandemic which did not occur at Site A.

#### CONCLUSION

Targeted outreach to patients and providers in the CALM study resulted in improved enrollment in lung screening. These outreach strategies can be customized to different program structures, as represented by the centralized and hybrid programs included in this initiative. Radiology practices are uniquely positioned to use this intervention to improve enrollment as all patients were seen for both mammography and low-dose CT.

#### CLINICAL RELEVANCE/APPLICATION

The intervention strategies utilized in the CALM study improved screening enrollment for women. Radiologists can apply this approach to combat historically poor lung screening rates and save lives through the early detection of lung cancer.

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## Abstract Archives of the RSNA, 2023

S4-SSCH02-2

### Lung Cancer Screening Trends after Introducing the New 2021 US Preventive Services Taskforce (USPSTF)

Sunday, Nov. 26 1:00PM - 2:00PM Room: N228

Valeria Pena-Trujillo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To describe the impact of the 2021-USPSTF lung cancer screening guidelines eligibility-criteria expansion on the clinical and sociodemographic characteristics of the targeted population

#### METHODS AND MATERIALS

In this retrospective study, the imaging database of a large academic multisite center was assessed to identify all patients who underwent a clinically-indicated baseline lung CT from 4/2021-12/2022 as part of our lung cancer screening program. Collected data included sociodemographic (sex, race, ethnic group, language, zip code) and clinical characteristics (smoking status, LungRads Score [LRS], other interstitial lung diseases, etc.). Patients' zip codes were used to estimate median household income by pairing them with IRS data. Distances between the patient's residence and exam site were calculated as a straight line between zip codes. The collected cohort included individuals eligible under the 2013-USPSTF guidelines and newly eligible patients under the expanded recommendations. As a nonoverlapping group to the 2013-USPSTF, the characteristics of the 2021-USPSTF cohort were assessed and compared. Sociodemographic and clinical variables between both cohorts were compared using nonparametric tests for continuous variables and X<sup>2</sup>-tests for categorical variables

#### RESULTS

From 7720 patients, 2301 baseline screening CTs were included for further analysis (1539 old recommendations; 727 expanded recommendations) after excluding follow-ups and non-eligible patients under USPSTF. Female patients represented 45.87% and 48% of the old vs. new guidelines cohorts, respectively. Mean age at screening was 64 vs. 57 years old ( $p=0.001$ ). No other statistically significant differences in sociodemographic variables were found. As expected, the number of packs-year was significantly lower (42.3 vs. 29.4;  $p<0.001$ ) in the revised recommendations. In addition, both cohorts had several significant differences ( $p=0.0172$ ) in terms of LRS; we found that patients screened under new guidelines had a lower proportion of LRS 3 (9.4 vs. 8%) and 4 (8 vs. 5.2%), and a higher proportion of LRS 1 (11.1 vs. 12.5%) and 2 (71.3 vs. 74.3%). For LRS 4, there was a higher proportion of 4B/X in the 2013-USPSTF (26.02 vs. 23.68%; 18.7 vs. 5.26%). We also found fewer Smodifiers in the new guideline's cohort (51.7 vs. 38%;  $p<0.01$ )

#### CONCLUSION

The expansion of current guidelines may promote earlier detection of smoking-related lung malignancies. Future studies may reveal differences in gender or sociodemographic variables

#### CLINICAL RELEVANCE/APPLICATION

Our results suggest that the eligibility-criteria expansion of the new USPSTF lung cancer screening guidelines may promote earlier detection of smoking-related lung malignancies

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## Abstract Archives of the RSNA, 2023

S4-SSCH02-3

### Association between Altered Subcutaneous Adipose Tissue and Survival in a High-Risk Population of Heavy Smokers Participating in Lung Cancer Screening

Sunday, Nov. 26 1:00PM - 2:00PM Room: N228

Fabian Bernhard Pallasch, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

There is increasing evidence that body composition portraits prognostic relevance in cancer and cardiometabolic disease. While most studies focus on changes in muscle status, little is known about the role of adipose tissue, especially in a screening setting. Here, we used a deep learning model for fully automatic 3D quantification of subcutaneous adipose tissue (SAT) on chest CTs and investigated its association with mortality in a high-risk population of heavy smokers participating in lung cancer screening.

#### METHODS AND MATERIALS

We used a 3D deep learning model to segment SAT on lung screening non-contrast enhanced chest CTs of 26,144 individuals participating in the National Lung Screening Trial at baseline and after one year follow-up (n=52,228 scans). For analysis, SAT volume (SATvol) and SAT density (SATHU) as a measure of SAT quality were quantified. The primary outcome was all-cause mortality. Additional outcomes were lung cancer and cardiovascular mortality. Multivariable Cox proportional hazards regression was used to assess the association between SATvol as well as SATHU and mortality at baseline and a decrease in SATvol and SATHU (=10%) within one year and mortality.

#### RESULTS

Among 26,144 individuals (age  $61.4 \pm 5.0$  years; 40.9% female) a total of 1,839 (7%) deaths occurred over a median follow-up of 6.5 years. At baseline, only SATHU was independently associated with all-cause mortality after multivariable adjustment for clinical risk factors (age, sex, race, smoking status, pack years, prevalent hypertension, diabetes, and past stroke or myocardial infarction; HR: 1.07, 95% CI [1.02-1.12];  $p = 0.003$ ). Individuals with a decline in SATvol or SATHU =10% over a period of one year, had a significantly worse outcome compared to those with stable SATvol or SATHU (hazard ratios adjusted for the same risk factors SATvol: HR 1.94, 95% CI [1.77-2.13],  $p < 0.001$ ; SATHU: HR 3.1, 95% CI [2.79-3.44],  $p < 0.001$ ). Similar associations were found for lung cancer and cardiovascular mortality as outcome of interest.

#### CONCLUSION

A deep learning model can automatically quantify altered SAT on chest CT in an opportunistic fashion. SAT<sub>HU</sub> at baseline and a decrease in SAT<sub>vol</sub> or SAT<sub>HU</sub> within one year are independently associated with mortality in lung cancer screening eligible heavy smokers beyond clinical risk factors, which may help to improve personalized risk assessment and prevention.

#### CLINICAL RELEVANCE/APPLICATION

Our results show that automated methods can provide a fast and low-cost solution to identify high-risk individuals participating in lung cancer screening. This can accelerate clinical implementation to guide management and improve population health.

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## Abstract Archives of the RSNA, 2023

S4-SSCH02-4

### Large Language Models and Lung Cancer: A Comparative Study on the Appropriateness of Artificial Intelligence Statements

Sunday, Nov. 26 1:00PM - 2:00PM Room: N228

Amir A. Rahsepar, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The recent release of large language models (LLMs) for public use, such as ChatGPT and Google Bard, has opened up a multitude of potential benefits as well as challenges. To evaluate and compare the accuracy and relevance of responses generated by ChatGPT and Google Bard to non-expert questions related to lung cancer prevention, screening, and terminology commonly used in radiology reports based on the recommendation of Lung Imaging Reporting and Data System (Lung-RADS) v2022 from American College of Radiology and Fleischner society.

#### METHODS AND MATERIALS

Forty exactly the same questions were created and presented to ChatGPT and Google Bard by three different authors of this paper. Each answer was reviewed by two radiologists for accuracy. Responses were scored as correct, partially correct, incorrect, or unanswered. Consistency was also evaluated among the answers provided by ChatGPT and Google Bard. Here, consistency was defined as the agreement between the three answers provided by either ChatGPT or Google Bard, regardless of whether the concept conveyed was correct or incorrect.

#### RESULTS

ChatGPT answered all questions. Out of 120 answers, 85 (70.8%) were correct, 14 (11.7%) were partially correct, and 21 (17.5%) were incorrect. Google Bard did not answer 23 (19.1%) questions. Among the 97 questions answered by Google Bard, 62 (51.7%) were correct, 11 (9.2%) were partially correct, and 24 (20%) were incorrect. We found that ChatGPT's answers were consistent 36 out of 40 times (90%), while Google Bard's answers were consistent 23 out of 40 times (57.5%).

#### CONCLUSION

Although the use of artificial intelligence offers new possibilities in fields like medicine, it also presents challenges that must be carefully reviewed by experts to prevent undue burden on patients and healthcare workers.

#### CLINICAL RELEVANCE/APPLICATION

It is essential that LLM developers be aware of the complexity of healthcare decision-making and implement serious guardrails for all healthcare-related interactions.

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## Abstract Archives of the RSNA, 2023

S4-SSCH02-5

### Rate of Benign Surgeries in an Academic CT Lung Cancer Screening Program

Sunday, Nov. 26 1:00PM - 2:00PM Room: N228

Raquelle H. El Alam, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Screening with low dose computed tomography (CT) can reduce lung cancer related death at the expense of unavoidable false positive results. The purpose of this study is to measure the rate of surgery for benign nodules and evaluate characteristics of those nodules.

#### METHODS AND MATERIALS

In this study, we evaluated patients in the Lung Cancer Screening (LCS) program across a large tertiary healthcare network from 5/2015 through 10/2021 who underwent surgical resection for a lung nodule. We reviewed the pathology reports and subsequent follow-up to establish whether the nodule was benign or malignant, and only benign nodules were included for this study. Imaging characteristics of the nodules were evaluated by a radiology fellow, and we recorded Lung-RADS category, nodule status (baseline, stable, new, growing), FDG uptake on PET/CT, and calculated the risk from the Brock model.

#### RESULTS

During the study period, a total of 21366 LCS CT was performed in 9050 patients, and 260 patients underwent surgical resection. Review of the pathology results revealed: 220 lung cancer (85%), 2 other malignancies (1%), and 38 benign findings (15%). Pathology of the benign nodules was as follows: 12 with scarring/fibrosis, 5 with benign neoplasms, 14 with infection/inflammation, and 7 with other diagnoses. Lung-RADS category was as follows: 4 (11%) Lung-RADS 2, 2 (5%) Lung-Rad 3, 11 (29%) Lung-RADS 4A, 13 (34%) Lung-RADS 4B, and 8 (21%) Lung-RADS 4X. The size of the nodules ranged from 4 to 41 mm with a median of 13 mm. 2 (5%) were ground glass, 10 (26%) were part-solid, and 26 (68%) were solid. FDG-PET/CT was performed in 19 out of 38 cases, of which: 2 (11%) had no uptake, 10 (53%) had mild uptake, 3 (16%) had moderate uptake, and 4 (21%) had intense uptake. Risk assessment by Brock calculator revealed that 9 (24) had <5% (very low) risk; 27 (71%) had 5-65% (low-intermediate) risk, and 2 (5%) had >65% (high) risk.

#### CONCLUSION

Surgical resection of benign nodules is unavoidable despite application of Lung-RADS guidelines in a modern screening program, with approximately 15% of surgeries being performed for benign lesions.

#### CLINICAL RELEVANCE/APPLICATION

Surgeries for benign pulmonary nodules are an inevitable part of a lung cancer screening program due to overlap between the appearance of benign and malignant pulmonary nodules.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSCH02-6

### Improving the Readability of Patient-Facing Information about Lung Cancer using Large Language Models: ChatGPT, GPT-4 and Bard

Sunday, Nov. 26 1:00PM - 2:00PM Room: N228

Hana L. Haver, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Access to information remains a modifiable contributor to disparities in lung cancer screening. With the increasing attention towards using large language models in generating health information has shown early promise, little has been reported about the capability of these models to improve readability of health information and its accessibility to the general public. Here, we assessed how 3 large language models (LLM): ChatGPT, GPT-4 and Bard, perform in summarizing and simplifying health information about lung cancer prevention and screening.

#### METHODS AND MATERIALS

We evaluated the readability of answers to common questions about lung cancer prevention and screening that were generated by ChatGPT. We then asked ChatGPT, GPT-4 and Bard to simplify this answer set, and assessed the simplified answers for language complexity (Flesch Reading Ease) and readability on 5 established scales: Flesch-Kincaid Grade Level, Gunning-Fog Index, Coleman-Liau Index, Automated Readability Index, and Simple Measure of Gobbledygook. Complexity score of 60 and greater and readability score of grade 8 and below was considered adequate for an average audience. Statistical analysis utilized paired t-testing between readability scores from the original and simplified answers for each model. Simplified answers were blindly rated for clinical appropriateness by 3 fellowship-trained cardiothoracic radiologists.

#### RESULTS

The baseline answers to questions generated by ChatGPT in response to questions related to lung cancer had an overall mean language complexity of 49.7 and an overall mean readability of grade 12.6. Following simplification of these answers by ChatGPT, GPT-4 and Bard, the overall mean language complexity and readability were found to be improved when each was compared to the score of the original text (Figure 1). Upon blinded assessment of clinical appropriateness of the simplified answers, our board-certified cardiothoracic radiologists determined that they were clinically appropriate 84% (ChatGPT), 79% (GPT-4) and 95% (Bard) of the time.

#### CONCLUSION

Lung cancer information provided by ChatGPT is complex and difficult to read. LLM's including ChatGPT, GPT-4 and Bard demonstrate the capability to simplify the language of lung cancer information to a level more accessible for the general public, though the non-trivial number of inappropriate or inconsistent answers of the simplified content imply that further study is required.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT generates responses to questions about lung cancer that are difficult to read. ChatGPT, GPT-4 and Bard can be used to simplify this texts with varying degrees of clinical appropriateness, indicating early potential to improve access to health information for the average audience.

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## Abstract Archives of the RSNA, 2023

S4-SSIN01

### Imaging Informatics (Advances in Image Segmentation and 3D Printing)

Sunday, Nov. 26 1:00PM - 2:00PM Room: S401

Ayis T. Pyrros, MD (*Moderator*) Nothing to Disclose  
Fides R. Schwartz, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### S4-SSIN01- TotalSegmentator: Robust Segmentation of 104 Anatomical Structures on CT Data

1

Martin Segeroth (*Presenter*) Nothing to Disclose

#### PURPOSE

To present a deep-learning segmentation model that can automatically segment all major anatomical structures in body CT images. An easy-to-use model that shows robust performance on any clinical data would enable radiological studies using large sample sizes and increase the impact of radiologic examinations.

#### METHODS AND MATERIALS

In 1204 CT examinations, we segmented 104 anatomical structures (27 organs, 59 bones, 10 muscles, 8 vessels) covering many relevant structures for use cases such as organ volumetry, disease characterization, and surgical or radiotherapy planning. The CT images were randomly sampled from the University Hospital Basel PACS consisting of routine clinical studies and thus represent a real-world dataset (different ages, pathologies, scanners, body parts, sequences, and sites). 57 subjects were used for validation and 65 as test datasets. We trained a nnU-Net segmentation algorithm on this dataset and calculated Dice similarity coefficients (Dice) to evaluate the model's performance. The trained algorithm was applied to a second dataset of an aging study with 4004 whole-body polytrauma CTs acquired between 2011 and 2020 to investigate volume and density age dependent changes.

#### RESULTS

The test set was randomly sampled thus the data demonstrates variability caused by different scanners and protocols. Since the test set includes a wide range of clinical data, it also exhibits some pathologies. Nevertheless, our model demonstrated a high Dice (0.943, CI: 0.938 - 0.947) on the test set. Our model significantly outperformed other publicly available segmentation models (Dice 0.932 versus 0.871,  $p < 0.001$ ). On patients with major pathologies (e.g. large hernia or kidney transplant) the model generated robust results. In our aging study, we found significant correlations between age and volume/mean attenuation for a variety of organ groups (e.g. aorta volume [ $r = 0.62$ ;  $p < 0.001$ ], mean attenuation of the hips [ $r = -0.60$ ;  $p < 0.001$ ], mean attenuation of the autochthonous dorsal musculature [ $r = -0.72$ ;  $p < 0.001$ ]) and volume of iliopsoas or kidneys).

#### CONCLUSION

Our segmentation model is (1) publicly available (<https://github.com/wasserth/TotalSegmentator>) including training data (<https://doi.org/10.5281/zenodo.6802613>); (2) easy to use ([www.totalsegmentator.com](http://www.totalsegmentator.com)); (3) segments most anatomically relevant structures in the entire body; and (4) works robustly in any clinical setting.

#### CLINICAL RELEVANCE/APPLICATION

The model enables any researcher / clinician to perform robust and accurate segmentation of 104 anatomical structures. This may accelerate radiological research and finally improve radiological reports.

#### S4-SSIN01- AbdomenAtlas-8K: Human-in-the-Loop Annotating Eight Anatomical Structures for 8,448 Three-Dimensional Computed Tomography Volumes in Three Weeks

2

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Segmenting anatomical structures can facilitate precise robotic surgery, personalized treatment planning, and improved patient outcomes, but it is a highly cumbersome and time-intensive process. We seek to expedite this process using an efficient human-in-the-loop approach.

## METHODS AND MATERIALS

We first pre-trained an AI model on 14 publicly available datasets using the partial labels provided by each dataset. The model was then used to generate pseudo labels of 8,448 three-dimensional CT volumes for segmenting eight critical structures in the abdominal region, including the spleen, liver, kidneys, stomach, gallbladder, pancreas, aorta, and IVC. The quality of the pseudo labels was assessed by inconsistency, uncertainty, and overlapping measurements. The integration of these three measurements resulted in a list that prioritized the CT volumes and regions in the volume that required medical professionals to review and revise the pseudo labels. The revised labels were used to fine-tune the model. This process was repeated until the professionals confirmed that the highest-priority CT volumes on the list did not require further revision. From the human-in-the-loop approach, we summarized a taxonomy of common errors made by AI and medical professionals, which minimized the duplication in human revision and improved the efficiency of continuous refinement of AI models and organ annotations. A commercial software called Pair was used by the medical professional for revising the annotations. Finally, the professional confirmed the annotation of all the CT volumes by visual inspection.

## RESULTS

AbdomenAtlas-8K is a high-quality dataset consisting of 8,448 CT volumes with eight anatomical structures annotated in detail. 99% of the annotations were generated by AI algorithms and the remaining 1% by a medical professional. We demonstrated high sensitivity and precision (0.78 and 0.83, respectively) in detecting AI errors, highlighting the efficiency of human revisions.

## CONCLUSION

Our human-in-the-loop approach can significantly reduce annotation effort while maintaining high-quality annotations. With this approach, we have annotated 8,448 CT scans within three weeks. The annotations were of superior quality, ensuring precision and dependability in segmenting critical abdominal structures.

## CLINICAL RELEVANCE/APPLICATION

AbdomenAtlas-8K will be made publicly available to advance medical research, providing doctors, researchers, patients, and students with a comprehensive understanding of human anatomy and facilitating early cancer detection. It will enable researchers to identify abnormalities associated with various diseases and provide insights into imaging characteristics of cancer, diabetes, and heart disease.

## S4-SSIN01- Efficient Segmentation using Diffusion Model Support

3

Veit Sandfort, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Segmentation is a cornerstone of cardiovascular image analysis. Manual labeling of CT angiographic (CTA) images is prohibitively tedious, time-consuming, and expensive for 3D/4D data. Diffusion models (DMs) for image generation have recently made tremendous progress. DMs are based on multi-step addition of noise and learned denoising to generate synthetic samples. This can be used to extract semantically meaningful features from medical images. We aimed to evaluate the performance of a diffusion model supported Unet (DM-Unet) for CT segmentation compared to a standard U-net in the task of completing partial manual segmentations of cardiovascular structures.

## METHODS AND MATERIALS

A DM was trained in an unsupervised fashion on 2D slices from 1,800 chest CTAs. 44 CTAs were fully segmented with the labels ascending aorta (AA), left atrium (LA), left ventricle (LV), left atrial appendage (LAA), right atrium (RA), right ventricle (RV), papillary muscle, and LV myocardium (Myo). As baseline, a standard-Unet was trained on a small number ( $n=50$  and  $n=100$ ) of randomly selected slices of the 44 CTs to predict the remainder of the segmentations. Strong data augmentation (rotation, flip, crop, noise) was used. For the DM-Unet, we used the pretrained DM to extract internal network activations, automatically selected the 64 most meaningful features with a gradient boosting method, and trained a Unet on the extracted feature maps of randomly selected slices ( $n=50$  and  $n=100$ ) to predict the remainder of the segmentations. Performance was evaluated using dice coefficient. Statistical significance was tested using paired Wilcoxon test.

## RESULTS

The DM-Unet showed significantly higher performance compared to the standard U-net ( $p < 0.0001$  for all tested features). The difference in performance was higher when fewer training samples were used (train slices  $n=50$  compare to  $n=100$ , see figure). Subjectively, the DM-Unet also resulted in visually more consistent segmentations. The inability of the standard Unet to delineate the boundary between RA and RV with very sparse training data is striking.

## CONCLUSION

Standard Unets are unable to achieve acceptable performance in the setting of very few manual annotations. Diffusion models trained in unsupervised fashion can successfully support standard-Unets leading to significantly improved segmentation efficiency and enabling significant labor and cost reductions for segmentation tasks.

## CLINICAL RELEVANCE/APPLICATION

Manual segmentations are required for a variety of image quantification tasks in clinical radiology and research. Decreasing the manual effort for segmentation would be highly desirable.

### S4-SSIN01- Optimization of STL Generation for Patient-Specific 3D Printed Models

4

Maxwell B. Lohss, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

3D printing at the point-of-care requires accurate recreation of a patient's anatomy. Despite the development of advanced software platforms, conversion of a segmented image into a surface mesh (STL) can be a complex, poorly-optimized process that often requires manual correction. To improve the efficiency and accuracy of the mesh creation process, we evaluated and optimized settings for 3D printing computed tomography (CT) imaging of cam-type femoroacetabular impingement (FAI) using Mimics Medical 25.0.

#### METHODS AND MATERIALS

CT images of 5 femurs with cam-type FAI were segmented by an experienced engineer and validated by a board-certified radiologist to create anatomical reference meshes. STL mesh contours were manually adjusted across the model to maximize accuracy and mesh quality. The image mask was converted to meshes using the Low, Medium, High, and Optimal presets settings in Mimics. 3D deviation analyses comparing each mesh to the reference were performed with Geomagic Control 2014. Models were evaluated for mesh irregularities including non-manifold edges, self-intersections, highly creased edges, spikes, and holes. Starting with the Optimal preset, 40 different meshes were created by modifying the smooth factor (SF) and smoothing iteration (SI) settings from 0.3-1 and 1-20 respectively. Meshes were identified that showed an average root mean square deviation (RMSD) below 0.20 mm and a mesh that had a similar surface quality to the reference. These meshes were further evaluated using planar deviation analyses formatted around the femoral neck axis to assess error at the most clinically relevant portion of the model around the cam deformity.

#### RESULTS

The Low, Medium, High, and Optimal settings showed an average RMSD of 1.63 mm, 0.72 mm, 0.44 mm, and 0.26 mm, respectively. The number of mesh irregularities normalized to the number of mesh triangles were 0.138, 0.159, 0.132, and 0.365, respectively, and 0.021 for the reference. Custom meshes with SF > 0.9 and SI = 20 had an average RMSD of 0.20 mm with a similar number of mesh irregularities normalized to mesh triangles compared to the reference (Cohen's d < 0.80). The planar deviation analyses performed in the region of the cam deformity showed an RMSD of 0.07 mm.

## CONCLUSION

Predefined settings in Mimics can create meshes that are error-prone and of poor quality. Optimizing the pre-defined smoothing parameters in mesh conversion with SF > 0.9 and SI = 20 produces a mesh that retains the anatomical detail and surface quality of a mesh that was manually corrected and smoothed.

## CLINICAL RELEVANCE/APPLICATION

Our analysis identified optimal parameters for converting femur image segmentation to surface meshes with high mesh quality while maintaining accuracy.

### S4-SSIN01- What is the Optimal Number of Readers needed to Establish a Reference Standard for AI Segmentation Algorithms? Insights from a Prostate MRI Segmentation Study Involving Multiple Readers

5

Sebastien Moliere, MD,BMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Developing reliable and accurate automatic segmentation algorithms for organs requires a reference standard established by multiple readers. This study aims to determine the ideal number of readers necessary to establish a reference standard by quantifying the inter-observer variability of manual prostate contour segmentation.

#### METHODS AND MATERIALS

Seven radiologists with various experience independently performed a manual segmentation of the prostate contour (whole-gland (WG) and transition zone (TZ)) on 40 MRI. To quantify inter-observer variability, a comparative analysis of the delineations was performed using standard metrics (Dice, Hausdorff and volume-based metrics), and impact of the number of



raters (from 2 to 7) on variability using two measurement strategies - pairwise metrics and metrics with respect to a reference segmentation - was evaluated.

## RESULTS

The average segmentation Dice score (DSC) for pairwise comparison of 2 readers was 0.919 (WG) / 0.876 (TZ). The interquartile range of the DSC decreased rapidly with the number of readers, with the smallest range (0.002 (WG) / 0.0037 (TZ)) observed for 6 raters. The minimum variability was often found for three readers using consensus methods, with STAPLE resulting in a DSC of 0.96 (WG) and 0.94 (TZ), and interquartile range being minimal for 3 raters.

## CONCLUSION

The number of readers has a significant impact on inter-reader variability. Variability has often been found to be minimal for 3 raters, or 3 raters represent a tipping point in the variability evolution, with both pairwise-based metrics or metrics with respect to a reference.

## CLINICAL RELEVANCE/APPLICATION

Three readers may be an ideal number to consider for consensual references in developing automatic segmentation algorithms for prostate contour segmentation, as it minimizes inter-observer variability.

## S4-SSIN01- Large Language-Image Model for Multi-Organ Segmentation and Cancer Detection from 6 Computed Tomography

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the feasibility of using language-image models for the automated segmentation of 25 abdominal organs and the detection of six types of tumors in CT scans originating from various hospitals, institutes, and countries.

## METHODS AND MATERIALS

We proposed the CLIP-Driven Universal Model, which incorporates text embedding learned from Contrastive Language-Image Pre-training (CLIP) into segmentation models. This CLIP label encoding captures anatomical relationships, enabling the model to learn structured feature embedding and segment 25 organs and six types of tumors. As illustrated in the figure, our Universal Model consists of a text branch and a vision branch. The Universal Model was developed using an assembly of 14 public datasets, encompassing a total of 3,410 CT scans for training. We then evaluated its generalizability and transferability on 117 external CT scans from two external datasets, i.e., 3D-IRCADb and TotalSegmentator. In addition to public datasets, the Universal Model was independently evaluated on a large-scale dataset from Johns Hopkins Hospital, comprising 5,038 CT scans with 21 annotated organs, to investigate extensibility to novel classes. Dice Similarity Coefficient (DSC) and Normalized Surface Distance (NSD) were evaluated for organ/tumor segmentation; Sensitivity and Specificity were evaluated for tumor detection.

## RESULTS

We rank first on the Medical Segmentation Decathlon (MSD) public leaderboard and achieve state-of-the-art results on Beyond The Cranial Vault (BTCV). Six critical anatomical structures can be segmented by AI with a similar variance to two human experts. Furthermore, the Universal Model is computationally more efficient (6x faster) than previous dataset-specific models, generalizes better to CT scans from three different hospitals, and exhibits superior transfer learning performance on novel classes and image analysis tasks.

## CONCLUSION

The proposed CLIP-Driven Universal Model, integrating image representation with language, possessed remarkable efficiency, generalizability, transferability, and extensibility in organ segmentation and tumor detection.

## CLINICAL RELEVANCE/APPLICATION

The ability to segment organs and detect tumors in CT scans through our AI algorithms will provide direct assistance to radiologists in a cooperative manner by combining the best of human and AI expertise. The high-performing AI can facilitate the creation of large datasets that are significantly larger than current medical datasets, thus promoting larger-scale studies for early cancer detection in real-world settings.

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## Abstract Archives of the RSNA, 2023

S4-SSIN01-1

### TotalSegmentator: Robust Segmentation of 104 Anatomical Structures on CT Data

Sunday, Nov. 26 1:00PM - 2:00PM Room: S401

Martin Segeroth (*Presenter*) Nothing to Disclose

#### PURPOSE

To present a deep-learning segmentation model that can automatically segment all major anatomical structures in body CT images. An easy-to-use model that shows robust performance on any clinical data would enable radiological studies using large sample sizes and increase the impact of radiologic examinations.

#### METHODS AND MATERIALS

In 1204 CT examinations, we segmented 104 anatomical structures (27 organs, 59 bones, 10 muscles, 8 vessels) covering many relevant structures for use cases such as organ volumetry, disease characterization, and surgical or radiotherapy planning. The CT images were randomly sampled from the University Hospital Basel PACS consisting of routine clinical studies and thus represent a real-world dataset (different ages, pathologies, scanners, body parts, sequences, and sites). 57 subjects were used for validation and 65 as test datasets. We trained a nnU-Net segmentation algorithm on this dataset and calculated Dice similarity coefficients (Dice) to evaluate the model's performance. The trained algorithm was applied to a second dataset of an aging study with 4004 whole-body polytrauma CTs acquired between 2011 and 2020 to investigate volume and density age dependent changes.

#### RESULTS

The test set was randomly sampled thus the data demonstrates variability caused by different scanners and protocols. Since the test set includes a wide range of clinical data, it also exhibits some pathologies. Nevertheless, our model demonstrated a high Dice (0.943, CI: 0.938 - 0.947) on the test set. Our model significantly outperformed other publicly available segmentation models (Dice 0.932 versus 0.871,  $p < 0.001$ ). On patients with major pathologies (e.g. large hernia or kidney transplant) the model generated robust results. In our aging study, we found significant correlations between age and volume/mean attenuation for a variety of organ groups (e.g. aorta volume [ $r = 0.62$ ;  $p < 0.001$ ], mean attenuation of the hips [ $r = -0.60$ ;  $p < 0.001$ ], mean attenuation of the autochthonous dorsal musculature [ $r = -0.72$ ;  $p < 0.001$ ]) and volume of iliopsoas or kidneys).

#### CONCLUSION

Our segmentation model is (1) publicly available (<https://github.com/wasserth/TotalSegmentator>) including training data (<https://doi.org/10.5281/zenodo.6802613>); (2) easy to use ([www.totalsegmentator.com](http://www.totalsegmentator.com)); (3) segments most anatomically relevant structures in the entire body; and (4) works robustly in any clinical setting.

#### CLINICAL RELEVANCE/APPLICATION

The model enables any researcher / clinician to perform robust and accurate segmentation of 104 anatomical structures. This may accelerate radiological research and finally improve radiological reports.

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## Abstract Archives of the RSNA, 2023

S4-SSIN01-2

### **AbdomenAtlas-8K: Human-in-the-Loop Annotating Eight Anatomical Structures for 8,448 Three-Dimensional Computed Tomography Volumes in Three Weeks**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S401

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Segmenting anatomical structures can facilitate precise robotic surgery, personalized treatment planning, and improved patient outcomes, but it is a highly cumbersome and time-intensive process. We seek to expedite this process using an efficient human-in-the-loop approach.

#### **METHODS AND MATERIALS**

We first pre-trained an AI model on 14 publicly available datasets using the partial labels provided by each dataset. The model was then used to generate pseudo labels of 8,448 three-dimensional CT volumes for segmenting eight critical structures in the abdominal region, including the spleen, liver, kidneys, stomach, gallbladder, pancreas, aorta, and IVC. The quality of the pseudo labels was assessed by inconsistency, uncertainty, and overlapping measurements. The integration of these three measurements resulted in a list that prioritized the CT volumes and regions in the volume that required medical professionals to review and revise the pseudo labels. The revised labels were used to fine-tune the model. This process was repeated until the professionals confirmed that the highest-priority CT volumes on the list did not require further revision. From the human-in-the-loop approach, we summarized a taxonomy of common errors made by AI and medical professionals, which minimized the duplication in human revision and improved the efficiency of continuous refinement of AI models and organ annotations. A commercial software called Pair was used by the medical professional for revising the annotations. Finally, the professional confirmed the annotation of all the CT volumes by visual inspection.

#### **RESULTS**

AbdomenAtlas-8K is a high-quality dataset consisting of 8,448 CT volumes with eight anatomical structures annotated in detail. 99% of the annotations were generated by AI algorithms and the remaining 1% by a medical professional. We demonstrated high sensitivity and precision (0.78 and 0.83, respectively) in detecting AI errors, highlighting the efficiency of human revisions.

#### **CONCLUSION**

Our human-in-the-loop approach can significantly reduce annotation effort while maintaining high-quality annotations. With this approach, we have annotated 8,448 CT scans within three weeks. The annotations were of superior quality, ensuring precision and dependability in segmenting critical abdominal structures.

#### **CLINICAL RELEVANCE/APPLICATION**

AbdomenAtlas-8K will be made publicly available to advance medical research, providing doctors, researchers, patients, and students with a comprehensive understanding of human anatomy and facilitating early cancer detection. It will enable researchers to identify abnormalities associated with various diseases and provide insights into imaging characteristics of cancer, diabetes, and heart disease.

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## Abstract Archives of the RSNA, 2023

S4-SSIN01-3

### Efficient Segmentation using Diffusion Model Support

Sunday, Nov. 26 1:00PM - 2:00PM Room: S401

Veit Sandfort, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Segmentation is a cornerstone of cardiovascular image analysis. Manual labeling of CT angiographic (CTA) images is prohibitively tedious, time-consuming, and expensive for 3D/4D data. Diffusion models (DMs) for image generation have recently made tremendous progress. DMs are based on multi-step addition of noise and learned denoising to generate synthetic samples. This can be used to extract semantically meaningful features from medical images. We aimed to evaluate the performance of a diffusion model supported Unet (DM-Unet) for CT segmentation compared to a standard U-net in the task of completing partial manual segmentations of cardiovascular structures.

#### METHODS AND MATERIALS

A DM was trained in an unsupervised fashion on 2D slices from 1,800 chest CTAs. 44 CTAs were fully segmented with the labels ascending aorta (AA), left atrium (LA), left ventricle (LV), left atrial appendage (LAA), right atrium (RA), right ventricle (RV), papillary muscle, and LV myocardium (Myo). As baseline, a standard-Unet was trained on a small number ( $n=50$  and  $n=100$ ) of randomly selected slices of the 44 CTs to predict the remainder of the segmentations. Strong data augmentation (rotation, flip, crop, noise) was used. For the DM-Unet, we used the pretrained DM to extract internal network activations, automatically selected the 64 most meaningful features with a gradient boosting method, and trained a Unet on the extracted feature maps of randomly selected slices ( $n=50$  and  $n=100$ ) to predict the remainder of the segmentations. Performance was evaluated using dice coefficient. Statistical significance was tested using paired Wilcoxon test.

#### RESULTS

The DM-Unet showed significantly higher performance compared to the standard U-net ( $p < 0.0001$  for all tested features). The difference in performance was higher when fewer training samples were used (train slices  $n=50$  compare to  $n=100$ , see figure). Subjectively, the DM-Unet also resulted in visually more consistent segmentations. The inability of the standard Unet to delineate the boundary between RA and RV with very sparse training data is striking.

#### CONCLUSION

Standard Unets are unable to achieve acceptable performance in the setting of very few manual annotations. Diffusion models trained in unsupervised fashion can successfully support standard-Unets leading to significantly improved segmentation efficiency and enabling significant labor and cost reductions for segmentation tasks.

#### CLINICAL RELEVANCE/APPLICATION

Manual segmentations are required for a variety of image quantification tasks in clinical radiology and research. Decreasing the manual effort for segmentation would be highly desirable.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSIN01-4

### Optimization of STL Generation for Patient-Specific 3D Printed Models

Sunday, Nov. 26 1:00PM - 2:00PM Room: S401

Maxwell B. Lohss, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

3D printing at the point-of-care requires accurate recreation of a patient's anatomy. Despite the development of advanced software platforms, conversion of a segmented image into a surface mesh (STL) can be a complex, poorly-optimized process that often requires manual correction. To improve the efficiency and accuracy of the mesh creation process, we evaluated and optimized settings for 3D printing computed tomography (CT) imaging of cam-type femoroacetabular impingement (FAI) using Mimics Medical 25.0.

#### METHODS AND MATERIALS

CT images of 5 femurs with cam-type FAI were segmented by an experienced engineer and validated by a board-certified radiologist to create anatomical reference meshes. STL mesh contours were manually adjusted across the model to maximize accuracy and mesh quality. The image mask was converted to meshes using the Low, Medium, High, and Optimal presets settings in Mimics. 3D deviation analyses comparing each mesh to the reference were performed with Geomagic Control 2014. Models were evaluated for mesh irregularities including non-manifold edges, self-intersections, highly creased edges, spikes, and holes. Starting with the Optimal preset, 40 different meshes were created by modifying the smooth factor (SF) and smoothing iteration (SI) settings from 0.3-1 and 1-20 respectively. Meshes were identified that showed an average root mean square deviation (RMSD) below 0.20 mm and a mesh that had a similar surface quality to the reference. These meshes were further evaluated using planar deviation analyses formatted around the femoral neck axis to assess error at the most clinically relevant portion of the model around the cam deformity.

#### RESULTS

The Low, Medium, High, and Optimal settings showed an average RMSD of 1.63 mm, 0.72 mm, 0.44 mm, and 0.26 mm, respectively. The number of mesh irregularities normalized to the number of mesh triangles were 0.138, 0.159, 0.132, and 0.365, respectively, and 0.021 for the reference. Custom meshes with SF > 0.9 and SI = 20 had an average RMSD of 0.20 mm with a similar number of mesh irregularities normalized to mesh triangles compared to the reference (Cohen's d < 0.80). The planar deviation analyses performed in the region of the cam deformity showed an RMSD of 0.07 mm.

#### CONCLUSION

Predefined settings in Mimics can create meshes that are error-prone and of poor quality. Optimizing the pre-defined smoothing parameters in mesh conversion with SF > 0.9 and SI = 20 produces a mesh that retains the anatomical detail and surface quality of a mesh that was manually corrected and smoothed.

#### CLINICAL RELEVANCE/APPLICATION

Our analysis identified optimal parameters for converting femur image segmentation to surface meshes with high mesh quality while maintaining accuracy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSIN01-5

### **What is the Optimal Number of Readers needed to Establish a Reference Standard for AI Segmentation Algorithms? Insights from a Prostate MRI Segmentation Study Involving Multiple Readers**

Sunday, Nov. 26 1:00PM - 2:00PM Room: S401

Sebastien Moliere, MD,BMedSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Developing reliable and accurate automatic segmentation algorithms for organs requires a reference standard established by multiple readers. This study aims to determine the ideal number of readers necessary to establish a reference standard by quantifying the inter-observer variability of manual prostate contour segmentation.

#### **METHODS AND MATERIALS**

Seven radiologists with various experience independently performed a manual segmentation of the prostate contour (whole-gland (WG) and transition zone (TZ)) on 40 MRI. To quantify inter-observer variability, a comparative analysis of the delineations was performed using standard metrics (Dice, Hausdorff and volume-based metrics), and impact of the number of raters (from 2 to 7) on variability using two measurement strategies - pairwise metrics and metrics with respect to a reference segmentation - was evaluated.

#### **RESULTS**

The average segmentation Dice score (DSC) for pairwise comparison of 2 readers was 0.919 (WG) / 0.876 (TZ). The interquartile range of the DSC decreased rapidly with the number of readers, with the smallest range (0.002 (WG) / 0.0037 (TZ)) observed for 6 raters. The minimum variability was often found for three readers using consensus methods, with STAPLE resulting in a DSC of 0.96 (WG) and 0.94 (TZ), and interquartile range being minimal for 3 raters.

#### **CONCLUSION**

The number of readers has a significant impact on inter-reader variability. Variability has often been found to be minimal for 3 raters, or 3 raters represent a tipping point in the variability evolution, with both pairwise-based metrics or metrics with respect to a reference.

#### **CLINICAL RELEVANCE/APPLICATION**

Three readers may be an ideal number to consider for consensual references in developing automatic segmentation algorithms for prostate contour segmentation, as it minimizes inter-observer variability.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSIN01-6

### Large Language-Image Model for Multi-Organ Segmentation and Cancer Detection from Computed Tomography

Sunday, Nov. 26 1:00PM - 2:00PM Room: S401

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility of using language-image models for the automated segmentation of 25 abdominal organs and the detection of six types of tumors in CT scans originating from various hospitals, institutes, and countries.

#### METHODS AND MATERIALS

We proposed the CLIP-Driven Universal Model, which incorporates text embedding learned from Contrastive Language-Image Pre-training (CLIP) into segmentation models. This CLIP label encoding captures anatomical relationships, enabling the model to learn structured feature embedding and segment 25 organs and six types of tumors. As illustrated in the figure, our Universal Model consists of a text branch and a vision branch. The Universal Model was developed using an assembly of 14 public datasets, encompassing a total of 3,410 CT scans for training. We then evaluated its generalizability and transferability on 117 external CT scans from two external datasets, i.e., 3D-IRCADb and TotalSegmentator. In addition to public datasets, the Universal Model was independently evaluated on a large-scale dataset from Johns Hopkins Hospital, comprising 5,038 CT scans with 21 annotated organs, to investigate extensibility to novel classes. Dice Similarity Coefficient (DSC) and Normalized Surface Distance (NSD) were evaluated for organ/tumor segmentation; Sensitivity and Specificity were evaluated for tumor detection.

#### RESULTS

We rank first on the Medical Segmentation Decathlon (MSD) public leaderboard and achieve state-of-the-art results on Beyond The Cranial Vault (BTCV). Six critical anatomical structures can be segmented by AI with a similar variance to two human experts. Furthermore, the Universal Model is computationally more efficient (6x faster) than previous dataset-specific models, generalizes better to CT scans from three different hospitals, and exhibits superior transfer learning performance on novel classes and image analysis tasks.

#### CONCLUSION

The proposed CLIP-Driven Universal Model, integrating image representation with language, possessed remarkable efficiency, generalizability, transferability, and extensibility in organ segmentation and tumor detection.

#### CLINICAL RELEVANCE/APPLICATION

The ability to segment organs and detect tumors in CT scans through our AI algorithms will provide direct assistance to radiologists in a cooperative manner by combining the best of human and AI expertise. The high-performing AI can facilitate the creation of large datasets that are significantly larger than current medical datasets, thus promoting larger-scale studies for early cancer detection in real-world settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSMK01

### Musculoskeletal Imaging (Shoulder)

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353B

Richard J. Hughes, FRCR (*Moderator*) Nothing to Disclose  
Navid Faraji, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### S4-SSMK01-1 **Fat Fractions of the Rotator Cuff Muscles Acquired with Two-point Dixon MRI: Predicting Outcome after Arthroscopic Rotator Cuff Repair**

Georg C. Feuerriegel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to quantify and compare intramuscular fat fraction (FF) and muscle volume between patients with failed and intact rotator cuff (RC) repair as well as a control group with conservative treatment to define reliable FF cut-off values for predicting the outcome of RC repair.

#### METHODS AND MATERIALS

In this retrospective study patients with full-thickness RC tears who received MRI before and after arthroscopic RC repair including a two-point Dixon sequence between July 2016 and December 2022 were screened for eligibility. Patients with re-tear of one or more RC tendons diagnosed on MRI (Sugaya IV and V) were enrolled into the study and matched for age, gender, BMI, and MRI time interval to patients with intact RC repair (Sugaya I and II). A third group with conservatively treated RC tears was included as reference and also matched to the failed RC repair group. Two radiologists analyzed morphological features including the size and location of RC tears (Cofield) as well as the integrity of the RC after repair (Sugaya). Furthermore, the tendon retraction (Patte) and fatty infiltration (Goutallier) were assessed. Quantitative FFs were calculated from the two-point Dixon sequence and the RC muscles were segmented semi-automatically to calculate the FF and volume for each muscle. ROC curves were used to determine the FF cut-off values which best predict RC re-tears. Mann-Whitney U and Wilcoxon Signed-Rank tests were used to assess the differences between groups.

#### RESULTS

In total 136 patients were enrolled, consisting of three groups: 41 (22%) patients had a failed RC repair (mean age  $58 \pm 7$  years, 16 women), 50 (27%) patients matched into the intact RC repair group and 45 patients were matched into the conservative treatment group. The mean time interval between baseline and follow-up MRI was  $17.0 \pm 2.7$  months. Preoperative FF was significantly higher in the failed repair group for all RC muscles compared to the intact repair group and the conservative treatment group ( $p < 0.05$ ). ROC curves showed reliable preoperative FF cut-off values for predicting re-tears at 6.0% for the SSP muscle (0.83 AUC), 7.4% for the ISP muscle (AUC 0.82) and 8.3% for the SSC muscle (0.94 AUC). Compared to the intact repair group a significant decrease in muscle volume was seen in the failed repair group for all muscles (SSP:  $P = 0.035$ , ISP:  $P = 0.023$ , SSC:  $P = 0.018$ ).

#### CONCLUSION

Preoperative quantitative FF calculated from two-point Dixon MRI can be used to predict the risk of re-tear after arthroscopic RC repair with reliable cut-off values between 6% and 8.3%.

#### CLINICAL RELEVANCE/APPLICATION

Muscle fatty infiltration is a predictor of successful RC repair and reliable cut-off values for FF might improve preoperative screening and risk assessment in patients with full-thickness RC tears.

#### S4-SSMK01-2 **US-guided Percutaneous Irrigation of Extra-shoulder Calcific Tendinopathy**

Domenico Albano (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the efficacy and safety of ultrasound-guided percutaneous irrigation of calcific tendinopathy (US-PICT) applied out of the shoulder comparing its effectiveness to US-PICT of the rotator cuff.

## METHODS AND MATERIALS

Patients subjected to US-PICT for extra-shoulder calcific tendinitis (Case Group) were compared to those subjected to US-PICT of the rotator cuff (Control Group). We had pre-procedure VAS pain score, 1-month and 3-month VAS of patients of the Case Group, pre-procedure and 3-month VAS of patients of the Control Group.

## RESULTS

The Case Group consisted of 41 patients (27 women; mean age: 45±9 years): 26 gluteus medius, 5 patellar tendon, 3 rectus femoris, 2 gluteus maximus, 2 extensor digitorum, 1 extensor carpi radialis longus, 1 ilio-tibial band, 1 peroneus longus. The Control Group included 41 patients (27 women; mean age: 47±11 years). No complications were observed in both Groups. We used 9-cm needles in 31/41 patients of the Case Group (76%) with deeply located calcifications within the gluteus medius, rectus femoris and gluteus maximus tendons, while 3-cm needles have been used in the remaining 10 patients. The mean pre-procedure VAS of the Case Group was 8.8±0.7 with a significant ( $P<0.001$ ) drop at 1 month (4.5±0.6) and 3 months (3.6±0.6). The mean pre-procedure VAS of the Control Group was 8±1.4 and dropped to 3.1±1.6 after 3 months ( $P<0.001$ ). Post-treatment VAS at 3 months was not significantly different between two Groups ( $p=0.134$ ). Similarly, the decrease of VAS from baseline to three months was not significantly different between the two Groups ( $p=0.264$ ).

## CONCLUSION

US-PICT is a safe and effective procedure that can be used out of the shoulder.

## CLINICAL RELEVANCE/APPLICATION

This study demonstrated the safety and effectiveness of US-PICT as a valuable therapeutic option for extra-shoulder calcific tendinitis, with similar clinical outcome to the same procedure performed in the rotator cuff. The technique must be adapted in some deeply located calcifications by means of the use of different needles and by thoroughly planning the access point for the procedure.

## S4- SSMK01-3 Shoulder Pain in Breast Cancer Patients: How Much Do We Need to Worry about Metastases

Rosa E. Ochoa Albiztegui, MD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

To determine the frequency of metastatic disease as the cause for shoulder pain in patients with breast cancer.

## METHODS AND MATERIALS

This is a single-center IRB approved retrospective study. Patients with breast cancer who were referred for MRI of the shoulder [subsequently: "MRI"] due to pain from January 2012 to December 2021 were reviewed. Additionally, 420 FDG PET-CT and 857 CT examinations within 1 year prior to MRI were reviewed to ascertain whether patients had known metastases. Descriptive statistics are presented as counts and % of the total n.

## RESULTS

We included  $n = 639$  patients. Mean patient age was 60 years old (range 29-96 years). On average the first patient MRI was 3 years after breast cancer diagnosis. Fifty-seven patients (9%) had osseous metastases; of these, 47 (7%) patients had only osseous metastases and 10 (2%) patients additionally had other metastases. In their first MRI, there were 54 patients (8.5%) with osseous metastases. Out of 77 patients with multiple MRIs, only 3 developed osseous metastases on subsequent MRIs (3.8%). In patients with bone metastasis on MRI, 40 patients (70%) had already known bone metastasis from prior imaging. On the other hand, 155 patients with prior imaging and no bone metastases, none had metastases on MRI. Only in 14 patients (2.2%), the initial diagnosis of a bone metastasis was made in MRI, and none of these patients had prior imaging. There were 23 patients with soft-tissue metastasis on MRI, but only in 6 cases (0.9%) metastasis were not known from prior imaging.

## CONCLUSION

Shoulder pain is not associated with bone or soft tissue metastasis in most patients with breast cancer. None of the patients in our cohort without bone metastasis on prior CT or PET/CT had a shoulder metastasis on MRI.

## CLINICAL RELEVANCE/APPLICATION

Patients with shoulder pain and recent CT or PET-CT negative for bone metastasis are unlikely to present metastatic disease on shoulder MRI. IV contrast may not be necessary due to low probability of metastatic disease. Breast cancer patients with shoulder pain may benefit from an optimized assessment of anatomical structures to investigate other causes of pain.



#### **S4-SSMK01-4 T2 Quantification and Synthetic T2-weighted Images Derived from GRAPPATINI for Evaluation of Shoulder Joint: Comparison to Conventional T2-weighted MRI**

Seung Yun Lee, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

GRAPPATINI can provide accelerated acquisition of T2 map and subsequent generation of synthetic T2-weighted image (T2WI). We evaluated the diagnostic equivalence of synthetic T2WI derived from GRAPPATINI compared with conventional T2WI in the shoulder joint, and the correlation of T2 value from GRAPPATINI for glenoid cartilage evaluation.

##### **METHODS AND MATERIALS**

Consecutive patients with shoulder pain were recruited retrospectively from November 2022 to January 2023. We acquired conventional fat-saturated (fs) T2WI, and T2 map and subsequent synthetic fs-T2WI derived from the GRAPPATINI of the shoulder joint. The diagnostic equivalence was evaluated in terms of image quality and lesion detectability by comparing conventional and synthetic fs-T2WI. The image quality was assessed by the relative signal-to-noise ratio (rSNR) and relative contrast-to-noise ratio (rCNR) measurements using fluid, muscle, cartilage, and tendon. The lesion detectability was evaluated by four radiologists, by measuring 5-point ordinal scores for the likelihood of pathologic change in the supraspinatus tendon (SST) and superior labrum. Also, the T2 values were measured from the T2 map of GRAPPATINI by selecting four regions of interest at each quadrant of glenoid fossa cartilage. Statistical analysis was performed with Wilcoxon signed rank test for image quality analysis and interchangeability test for lesion detectability analysis, respectively. Also, the difference of estimated T2 value depending on cartilage degeneration was evaluated by Student t-test, with the reference of cartilage finding on conventional fs-T2WI.

##### **RESULTS**

23 patients were included (20 females, median age = 62). In the image quality assessment, the rSNR showed statistically significant difference in cartilage ( $p=0.037$ ) and tendon ( $p=0.007$ ), and rCNR showed no significant difference between conventional and synthetic fs-T2WI. Regarding the lesion detectability, conventional and synthetic fs-T2WI were clinically interchangeable for evaluating pathologic change in SST and superior labrum (upper limits of 95% confidence intervals of differences between rates of agreement = 3.7% in SST and = 2.7% in labrum). Estimated T2 values of GRAPPATINI showed statistical differences between the groups of normal and degenerative cartilage findings ( $p=0.006$ ).

##### **CONCLUSION**

T2 map and synthetic T2WI acquired from GRAPPATINI were determined to be of diagnostic equivalence with the conventional T2WI and can be used for clinical assessment of shoulder joint pathology.

##### **CLINICAL RELEVANCE/APPLICATION**

T2 quantification and subsequent synthetic T2WI derived by GRAPPATINI can be acquired simultaneously with reduced scan time and applied for the detection of degenerative change and cartilage evaluation.

#### **S4-SSMK01-5 Accelerated 2-3-Minute Multi-echo Ultra-short Echo Time (mecho UTE) using Conjugate Gradient SENSE (CG-SENSE) Reconstruction**

Hung P. Do, PhD, MSc (*Presenter*) Employee, Canon Medical Systems Corporation

##### **PURPOSE**

Multi-echo Ultra-short Echo-Time (mecho UTE) allows visualizations and quantitative assessment of short T2\* tissues (tendon, ligament, meniscus, bone, etc.), which are invisible (i.e., signal void) in routine clinical images (Figure 0). Currently, mecho UTE with gridding, a traditional reconstruction method for non-Cartesian, often takes ~5-6 min scan time. This study aimed to accelerate the current mecho UTE using Conjugate Gradient SENSE (CG-SENSE) reconstruction (Pruessmann et. al.).

##### **METHODS AND MATERIALS**

Data Collection: Experiments were performed on healthy volunteers under an approved IRB using a 3T MRI scanner. Mecho UTE sequence parameters are shown in Table 1. Reference 5min UTE as well as prospectively accelerated 3min and 2min UTE scans were acquired. Three datasets were reconstructed with both Gridding and CG-SENSE. Data Analysis: Subtraction (2nd echo was subtracted from 1st echo) images were generated for visualization of short T2\* tissues. Logarithmic inversion (Wiesinger et. al.) of the first echo ( $TE1 = 0.096ms$ ) yields CT-like images. Mono-exponential fitting of mecho UTE data was used to generate T2\* map. Full-Width at Half-Maximum (FWHM) was calculated to assess the sharpness of CG-SENSE and Gridding.

##### **RESULTS**

Figure 1 shows the first echo ( $TE1 = 96$  micro-seconds) images of three datasets with CG-SENSE and Gridding. Figures 2 3 show subtraction images ( $TE1 - TE2$ ), which allow visualization of short T2\* tissues and CT-like images generated via

logarithmic inversion, respectively. Shoulder tendons (arrow) and bone, which are invisible in conventional imaging, are better delineated. CG-SENSE enables sharper images compared to Gridding. Additionally, 2min CG-SENSE image shows higher image quality than the current standard 5min mecho UTE with Gridding. Figure 4 shows T2\* maps generated from mono-exponential fitting. T2\* values measured from a small region of interest (ROI) on the shoulder tendon (arrow) are similar in all reconstructions and approximately ~7ms, which is in the range reported in the literature for tendons (Juras et. al. Qiao et. al.). Figures 5 6 show feature profiles and FWHM. CG-SENSE shows smaller FWHMs, which means sharper images compared to Gridding.

#### **CONCLUSION**

The feasibility of accelerated 2-3 min mecho UTE using CG-SENSE was demonstrated. Compared to the current standard (5min UTE with Gridding), the accelerated mecho UTE provides sharper images with similar quantitative T2\*.

#### **CLINICAL RELEVANCE/APPLICATION**

CG-SENSE allows 2-3 min mecho UTE, which provides visualization and quantification of short T2\* tissues, which are invisible in routine clinical MRI. This may enable the widespread adoption of mecho UTE into the clinical settings.

#### **S4-SSMK01-6 Accelerated MRI-Acquisition using Deep-Learning Image Reconstruction and Edge Sharpening, and Standard Acquisition Protocol in Evaluating Patients after Rotator Cuff Repair: A Comparison**

Roy P. Marcus, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the diagnostic performance of accelerated MRI acquisition with deep-learning reconstruction and edge sharpening in patients after rotator cuff repair.

#### **METHODS AND MATERIALS**

This prospective study was approved by the local IRB. Unenhanced MRI scans of the operated shoulder were performed on 116 patients using a 3 Tesla (T) scanner (MAGNETOM Prisma, Siemens Healthineers). Standard and accelerated protocols were used during the same scanning session acquiring three sequences in coronal plane (TIRM, PD TSE and PD FS), two sequences in sagittal plane (TIRM and T1 TSE) and one sequence in axial plane (PD FS) with a slice thickness of 3 mm each. The acquisition times and artifacts of the standard and the accelerated protocols were recorded. Two experienced radiologists, blinded to the acquisition protocol, evaluated postsurgical changes of the tendons as per Sugaya classification (1: sufficient thickness, 2: sufficient thickness with partial high intensity, 3: insufficient thickness, 4: minor discontinuity, 5: major discontinuity).

#### **RESULTS**

Inter-rater and intra-rater reliabilities of the evaluated 207 operated tendons were almost perfect ( $\kappa = 0.824 - 0.863$ ). The accelerated protocol reduced the acquisition time by 80% (3.7 minutes [2.5 - 6.3] vs. 18.4 minutes [17 - 33.7] for accelerated vs. standard protocol,  $p < 0.001$ ). A total of four intra-rater disagreements were observed (2%) due to motion artifact in the standard acquisition or slightly different acquisition planes. No motion artifact was recorded during the accelerated protocol.

#### **CONCLUSION**

Accelerated MRI acquisition with -deep-learning reconstruction and edge sharpening significantly shortens the acquisition time while allowing a reliable evaluation of the shoulder after rotator cuff repair.

#### **CLINICAL RELEVANCE/APPLICATION**

Accelerated MRI protocols significantly reduced scanning time. Metal artifacts after rotator cuff repair do not impair the image quality or the dependability of the examination.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSMK01-1

### **Fat Fractions of the Rotator Cuff Muscles Acquired with Two-point Dixon MRI: Predicting Outcome after Arthroscopic Rotator Cuff Repair**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353B

Georg C. Feuerriegel, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to quantify and compare intramuscular fat fraction (FF) and muscle volume between patients with failed and intact rotator cuff (RC) repair as well as a control group with conservative treatment to define reliable FF cut-off values for predicting the outcome of RC repair.

#### **METHODS AND MATERIALS**

In this retrospective study patients with full-thickness RC tears who received MRI before and after arthroscopic RC repair including a two-point Dixon sequence between July 2016 and December 2022 were screened for eligibility. Patients with re-tear of one or more RC tendons diagnosed on MRI (Sugaya IV and V) were enrolled into the study and matched for age, gender, BMI, and MRI time interval to patients with intact RC repair (Sugaya I and II). A third group with conservatively treated RC tears was included as reference and also matched to the failed RC repair group. Two radiologists analyzed morphological features including the size and location of RC tears (Cofield) as well as the integrity of the RC after repair (Sugaya). Furthermore, the tendon retraction (Patte) and fatty infiltration (Goutallier) were assessed. Quantitative FFs were calculated from the two-point Dixon sequence and the RC muscles were segmented semi-automatically to calculate the FF and volume for each muscle. ROC curves were used to determine the FF cut-off values which best predict RC re-tears. Mann-Whitney U and Wilcoxon Signed-Rank tests were used to assess the differences between groups.

#### **RESULTS**

In total 136 patients were enrolled, consisting of three groups: 41 (22%) patients had a failed RC repair (mean age  $58 \pm 7$  years, 16 women), 50 (27%) patients matched into the intact RC repair group and 45 patients were matched into the conservative treatment group. The mean time interval between baseline and follow-up MRI was  $17.0 \pm 2.7$  months. Preoperative FF was significantly higher in the failed repair group for all RC muscles compared to the intact repair group and the conservative treatment group ( $p < 0.05$ ). ROC curves showed reliable preoperative FF cut-off values for predicting re-tears at 6.0% for the SSP muscle (0.83 AUC), 7.4% for the ISP muscle (AUC 0.82) and 8.3% for the SSC muscle (0.94 AUC). Compared to the intact repair group a significant decrease in muscle volume was seen in the failed repair group for all muscles (SSP:  $P = 0.035$ , ISP:  $P = 0.023$ , SSC:  $P = 0.018$ ).

#### **CONCLUSION**

Preoperative quantitative FF calculated from two-point Dixon MRI can be used to predict the risk of re-tear after arthroscopic RC repair with reliable cut-off values between 6% and 8.3%.

#### **CLINICAL RELEVANCE/APPLICATION**

Muscle fatty infiltration is a predictor of successful RC repair and reliable cut-off values for FF might improve preoperative screening and risk assessment in patients with full-thickness RC tears.

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## Abstract Archives of the RSNA, 2023

S4-SSMK01-2

### US-guided Percutaneous Irrigation of Extra-shoulder Calcific Tendinopathy

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353B

Domenico Albano (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the efficacy and safety of ultrasound-guided percutaneous irrigation of calcific tendinopathy (US-PICT) applied out of the shoulder comparing its effectiveness to US-PICT of the rotator cuff.

#### METHODS AND MATERIALS

Patients subjected to US-PICT for extra-shoulder calcific tendinitis (Case Group) were compared to those subjected to US-PICT of the rotator cuff (Control Group). We had pre-procedure VAS pain score, 1-month and 3-month VAS of patients of the Case Group, pre-procedure and 3-month VAS of patients of the Control Group.

#### RESULTS

The Case Group consisted of 41 patients (27 women; mean age: 45±9 years): 26 gluteus medius, 5 patellar tendon, 3 rectus femoris, 2 gluteus maximus, 2 extensor digitorum, 1 extensor carpi radialis longus, 1 ilio-tibial band, 1 peroneus longus. The Control Group included 41 patients (27 women; mean age: 47±11 years). No complications were observed in both Groups. We used 9-cm needles in 31/41 patients of the Case Group (76%) with deeply located calcifications within the gluteus medius, rectus femoris and gluteus maximus tendons, while 3-cm needles have been used in the remaining 10 patients. The mean pre-procedure VAS of the Case Group was 8.8±0.7 with a significant ( $P<0.001$ ) drop at 1 month (4.5±0.6) and 3 months (3.6±0.6). The mean pre-procedure VAS of the Control Group was 8±1.4 and dropped to 3.1±1.6 after 3 months ( $P<0.001$ ). Post-treatment VAS at 3 months was not significantly different between two Groups ( $p=0.134$ ). Similarly, the decrease of VAS from baseline to three months was not significantly different between the two Groups ( $p=0.264$ ).

#### CONCLUSION

US-PICT is a safe and effective procedure that can be used out of the shoulder.

#### CLINICAL RELEVANCE/APPLICATION

This study demonstrated the safety and effectiveness of US-PICT as a valuable therapeutic option for extra-shoulder calcific tendinitis, with similar clinical outcome to the same procedure performed in the rotator cuff. The technique must be adapted in some deeply located calcifications by means of the use of different needles and by thoroughly planning the access point for the procedure.

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## Abstract Archives of the RSNA, 2023

S4-SSMK01-3

### Shoulder Pain in Breast Cancer Patients: How Much Do We Need to Worry about Metastases

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353B

Rosa E. Ochoa Albiztegui, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the frequency of metastatic disease as the cause for shoulder pain in patients with breast cancer.

#### METHODS AND MATERIALS

This is a single-center IRB approved retrospective study. Patients with breast cancer who were referred for MRI of the shoulder [subsequently: "MRI"] due to pain from January 2012 to December 2021 were reviewed. Additionally, 420 FDG PET-CT and 857 CT examinations within 1 year prior to MRI were reviewed to ascertain whether patients had known metastases. Descriptive statistics are presented as counts and % of the total n.

#### RESULTS

We included n = 639 patients. Mean patient age was 60 years old (range 29-96 years). On average the first patient MRI was 3 years after breast cancer diagnosis. Fifty-seven patients (9%) had osseous metastases; of these, 47 (7%) patients had only osseous metastases and 10 (2%) patients additionally had other metastases. In their first MRI, there were 54 patients (8.5%) with osseous metastases. Out of 77 patients with multiple MRIs, only 3 developed osseous metastases on subsequent MRIs (3.8%). In patients with bone metastasis on MRI, 40 patients (70%) had already known bone metastasis from prior imaging. On the other hand, 155 patients with prior imaging and no bone metastases, none had metastases on MRI. Only in 14 patients (2.2%), the initial diagnosis of a bone metastasis was made in MRI, and none of these patients had prior imaging. There were 23 patients with soft-tissue metastasis on MRI, but only in 6 cases (0.9%) metastasis were not known from prior imaging.

#### CONCLUSION

Shoulder pain is not associated with bone or soft tissue metastasis in most patients with breast cancer. None of the patients in our cohort without bone metastasis on prior CT or PET/CT had a shoulder metastasis on MRI.

#### CLINICAL RELEVANCE/APPLICATION

Patients with shoulder pain and recent CT or PET-CT negative for bone metastasis are unlikely to present metastatic disease on shoulder MRI. IV contrast may not be necessary due to low probability of metastatic disease. Breast cancer patients with shoulder pain may benefit from an optimized assessment of anatomical structures to investigate other causes of pain.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSMK01-4

### **T2 Quantification and Synthetic T2-weighted Images Derived from GRAPPATINI for Evaluation of Shoulder Joint: Comparison to Conventional T2-weighted MRI**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353B

Seung Yun Lee, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

GRAPPATINI can provide accelerated acquisition of T2 map and subsequent generation of synthetic T2-weighted image (T2WI). We evaluated the diagnostic equivalence of synthetic T2WI derived from GRAPPATINI compared with conventional T2WI in the shoulder joint, and the correlation of T2 value from GRAPPATINI for glenoid cartilage evaluation.

#### **METHODS AND MATERIALS**

Consecutive patients with shoulder pain were recruited retrospectively from November 2022 to January 2023. We acquired conventional fat-saturated (fs) T2WI, and T2 map and subsequent synthetic fs-T2WI derived from the GRAPPATINI of the shoulder joint. The diagnostic equivalence was evaluated in terms of image quality and lesion detectability by comparing conventional and synthetic fs-T2WI. The image quality was assessed by the relative signal-to-noise ratio (rSNR) and relative contrast-to-noise ratio (rCNR) measurements using fluid, muscle, cartilage, and tendon. The lesion detectability was evaluated by four radiologists, by measuring 5-point ordinal scores for the likelihood of pathologic change in the supraspinatus tendon (SST) and superior labrum. Also, the T2 values were measured from the T2 map of GRAPPATINI by selecting four regions of interest at each quadrant of glenoid fossa cartilage. Statistical analysis was performed with Wilcoxon signed rank test for image quality analysis and interchangeability test for lesion detectability analysis, respectively. Also, the difference of estimated T2 value depending on cartilage degeneration was evaluated by Student t-test, with the reference of cartilage finding on conventional fs-T2WI.

#### **RESULTS**

23 patients were included (20 females, median age = 62). In the image quality assessment, the rSNR showed statistically significant difference in cartilage ( $p=0.037$ ) and tendon ( $p=0.007$ ), and rCNR showed no significant difference between conventional and synthetic fs-T2WI. Regarding the lesion detectability, conventional and synthetic fs-T2WI were clinically interchangeable for evaluating pathologic change in SST and superior labrum (upper limits of 95% confidence intervals of differences between rates of agreement = 3.7% in SST and = 2.7% in labrum). Estimated T2 values of GRAPPATINI showed statistical differences between the groups of normal and degenerative cartilage findings ( $p=0.006$ ).

#### **CONCLUSION**

T2 map and synthetic T2WI acquired from GRAPPATINI were determined to be of diagnostic equivalence with the conventional T2WI and can be used for clinical assessment of shoulder joint pathology.

#### **CLINICAL RELEVANCE/APPLICATION**

T2 quantification and subsequent synthetic T2WI derived by GRAPPATINI can be acquired simultaneously with reduced scan time and applied for the detection of degenerative change and cartilage evaluation.

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## Abstract Archives of the RSNA, 2023

S4-SSMK01-5

### Accelerated 2-3-Minute Multi-echo Ultra-short Echo Time (mecho UTE) using Conjugate Gradient SENSE (CG-SENSE) Reconstruction

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353B

Hung P. Do, PhD, MSc (*Presenter*) Employee, Canon Medical Systems Corporation

#### PURPOSE

Multi-echo Ultra-short Echo-Time (mecho UTE) allows visualizations and quantitative assessment of short T2\* tissues (tendon, ligament, meniscus, bone, etc.), which are invisible (i.e., signal void) in routine clinical images (Figure 0). Currently, mecho UTE with gridding, a traditional reconstruction method for non-Cartesian, often takes ~5-6 min scan time. This study aimed to accelerate the current mecho UTE using Conjugate Gradient SENSE (CG-SENSE) reconstruction (Pruessmann et. al.).

#### METHODS AND MATERIALS

Data Collection: Experiments were performed on healthy volunteers under an approved IRB using a 3T MRI scanner. Mecho UTE sequence parameters are shown in Table 1. Reference 5min UTE as well as prospectively accelerated 3min and 2min UTE scans were acquired. Three datasets were reconstructed with both Gridding and CG-SENSE. Data Analysis: Subtraction (2nd echo was subtracted from 1st echo) images were generated for visualization of short T2\* tissues. Logarithmic inversion (Wiesinger et. al.) of the first echo (TE1 = 0.096ms) yields CT-like images. Mono-exponential fitting of mecho UTE data was used to generate T2\* map. Full-Width at Half-Maximum (FWHM) was calculated to assess the sharpness of CG-SENSE and Gridding.

#### RESULTS

Figure 1 shows the first echo (TE1 = 96 micro-seconds) images of three datasets with CG-SENSE and Gridding. Figures 2 3 show subtraction images (TE1 - TE2), which allow visualization of short T2\* tissues and CT-like images generated via logarithmic inversion, respectively. Shoulder tendons (arrow) and bone, which are invisible in conventional imaging, are better delineated. CG-SENSE enables sharper images compared to Gridding. Additionally, 2min CG-SENSE image shows higher image quality than the current standard 5min mecho UTE with Gridding. Figure 4 shows T2\* maps generated from mono-exponential fitting. T2\* values measured from a small region of interest (ROI) on the shoulder tendon (arrow) are similar in all reconstructions and approximately ~7ms, which is in the range reported in the literature for tendons (Juras et. al. Qiao et. al.). Figures 5 6 show feature profiles and FWHM. CG-SENSE shows smaller FWHMs, which means sharper images compared to Gridding.

#### CONCLUSION

The feasibility of accelerated 2-3 min mecho UTE using CG-SENSE was demonstrated. Compared to the current standard (5min UTE with Gridding), the accelerated mecho UTE provides sharper images with similar quantitative T2\*.

#### CLINICAL RELEVANCE/APPLICATION

CG-SENSE allows 2-3 min mecho UTE, which provides visualization and quantification of short T2\* tissues, which are invisible in routine clinical MRI. This may enable the widespread adoption of mecho UTE into the clinical settings.

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## Abstract Archives of the RSNA, 2023

S4-SSMK01-6

### Accelerated MRI-Acquisition using Deep-Learning Image Reconstruction and Edge Sharpening, and Standard Acquisition Protocol in Evaluating Patients after Rotator Cuff Repair: A Comparison

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353B

Roy P. Marcus, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the diagnostic performance of accelerated MRI acquisition with deep-learning reconstruction and edge sharpening in patients after rotator cuff repair.

#### METHODS AND MATERIALS

This prospective study was approved by the local IRB. Unenhanced MRI scans of the operated shoulder were performed on 116 patients using a 3 Tesla (T) scanner (MAGNETOM Prisma, Siemens Healthineers). Standard and accelerated protocols were used during the same scanning session acquiring three sequences in coronal plane (TIRM, PD TSE and PD FS), two sequences in sagittal plane (TIRM and T1 TSE) and one sequence in axial plane (PD FS) with a slice thickness of 3 mm each. The acquisition times and artifacts of the standard and the accelerated protocols were recorded. Two experienced radiologists, blinded to the acquisition protocol, evaluated postsurgical changes of the tendons as per Sugaya classification (1: sufficient thickness, 2: sufficient thickness with partial high intensity, 3: insufficient thickness, 4: minor discontinuity, 5: major discontinuity).

#### RESULTS

Inter-rater and intra-rater reliabilities of the evaluated 207 operated tendons were almost perfect ( $\kappa = 0.824 - 0.863$ ). The accelerated protocol reduced the acquisition time by 80% (3.7 minutes [2.5 - 6.3] vs. 18.4 minutes [17 - 33.7] for accelerated vs. standard protocol,  $p < 0.001$ ). A total of four intra-rater disagreements were observed (2%) due to motion artifact in the standard acquisition or slightly different acquisition planes. No motion artifact was recorded during the accelerated protocol.

#### CONCLUSION

Accelerated MRI acquisition with deep-learning reconstruction and edge sharpening significantly shortens the acquisition time while allowing a reliable evaluation of the shoulder after rotator cuff repair.

#### CLINICAL RELEVANCE/APPLICATION

Accelerated MRI protocols significantly reduced scanning time. Metal artifacts after rotator cuff repair do not impair the image quality or the dependability of the examination.

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## Abstract Archives of the RSNA, 2023

S4-SSMK02

### Musculoskeletal Imaging (Pelvis and Hip)

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353C

Amy M. Oliveira, MD (*Moderator*) Nothing to Disclose  
Tatiane C. Rodrigues, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **S4-SSMK02-2 Employing Generative AI to Visualize Ideal Total Hip Arthroplasty and Conduct Patient-Specific Surgical Templating on Plain Radiographs**

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Total hip arthroplasty (THA) templating involves manual measurements and 2D implant renderings on preoperative radiographs. While a tedious process, optimal templating improves surgical efficiency and reduces complications by visualizing desirable surgical outcomes and anticipating challenges. This study introduces THA-Net, a deep learning (DL) algorithm that simulates postoperative THA radiographs with a single preoperative pelvis input, generating predictions unconditionally (algorithm selects implants) or conditionally (surgeon selects implants). We hypothesized that THA-Net would produce images as valid and realistic as actual radiographs while needing no or minimal surgeon inputs.

#### METHODS AND MATERIALS

THA-Net utilizes a pretrained YOLO-v5 model to crop the hip joint from an input preoperative pelvis radiograph and then employs a classifier-free conditional diffusion model for inpainting THA implants and generating realistic postoperative radiographs. The diffusion model offers two modes: 1) automated, requiring only the input radiograph, and 2) hardware-aware, allowing user-specified components. Trained on 356,305 radiographs from 14,357 patients (2000-2022), the model was conditioned on the 2-year complication outcomes and acetabular inclination angles available for the training data to ensure optimal implant selection/positioning and consider complication risk minimization during inference. Two orthopedic surgeons blindly assessed the surgical validity and realism of 100 real and 100 synthetic postoperative radiographs. Synthetic radiographs were also assessed against software-based criteria.

#### RESULTS

The surgical validity of synthetic postoperative radiographs (THA-Net output) was significantly higher than real ones (mean difference: 0.8 and 1.1 points on a 10-point Likert scale for automated and hardware-aware generations, respectively;  $p < 0.001$ ). Blinded expert reviews couldn't differentiate real and synthetic radiographs regarding realism. Synthetic radiographs were rated as realistic as their real counterparts in 95% of hardware-aware and 98% of automated generations. They exhibited excellent validity and realism when analyzed using validated software.

#### CONCLUSION

We developed a DL-based next-generation THA templating tool to generate synthetic postoperative radiographs with highly valid and realistic surgical execution.

#### CLINICAL RELEVANCE/APPLICATION

As a standalone technology, this tool enables patient-specific surgical planning and identifies the optimal postoperative target. Further refinement of this tool may allow it to interface with robotics, navigation, and AR/VR technologies to achieve desirable surgical execution while reducing dependence on 3D imaging data.

#### **S4-SSMK02-3 Hip MRI: Patients with Hip Dysplasia can Present with Femoral Version Deformities and with Combined Acetabular and Femoral Version Deformities**

Till D. Lerch, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Frequency of abnormal femoral torsion (FT) is unclear for patients with hip dysplasia. Increased FT was associated with hip dysplasia but only few studies investigated the true FT. The purpose of this study was to investigate frequency of increased or decreased FT or acetabular version (AV) and combined version on preoperative MRI of patients with hip dysplasia.

## METHODS AND MATERIALS

A retrospective comparative study that involved 419 hips of symptomatic patients with hip dysplasia undergoing periacetabular osteotomy was performed. Mean age was 28 years, 88% were female patients and mean preoperative LCE angle was 11°. All patients had FT > 25°. Preoperative MRI was performed for all patients in clinical routine for evaluation of cartilage and labrum lesions and for dGEMRIC. Preoperative hip MRI was evaluated for assessment of FT, AV and combined version on axial T1-weighted images. Combined version equals the sum of FT and AV. FT was measured by one radiology resident with 5 years of experience in musculoskeletal imaging according to the Reikeras method. Field of view of the CT scan and MRI included pelvis and knee.

## RESULTS

Mean FT of 419 hips was 16° (-20-57°), and mean central AV was 19° (3-35°) and mean combined version was 35° (-8-78°). 44% of hips had FT between 10-25°, 24% had FT > 25° and 32% had FT < 10°. FT > 35° was found in 6% and FT < 0° was found in 8%. The combination of normal FV and AV was present in 36%, while 19% have increased FT > 25° and normal AV and 27% have decreased FT < 10° and normal AV. Decreased combined version < 20° was present in 12%, increased combined version > 50° was present in 14%.

## CONCLUSION

One third of patients with hip dysplasia have normal FT combined with normal AV. Almost a third of patients have decreased FV < 10°, while 23% have increased FT > 25°. Patients with hip dysplasia can exhibit combined deformities. This is important for preoperative planning of hip preservation surgery (periacetabular osteotomy or femoral derotation osteotomy).

## CLINICAL RELEVANCE/APPLICATION

Preoperative hip MRI allows assessment of FT and detection of deformities of FT such as increased or decreased FT for patients with hip dysplasia and hip pain.

## S4-SSMK02-4 Low Dose Photon Counting Computed Tomography of the Pelvis with Tin Filter and Denoising: How Low Can We Go

Roy P. Marcus, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the quality of images of the pelvis using a Photon Counting Computed Tomography (PCCT) at ultra-low dose.

## METHODS AND MATERIALS

Images were acquired on a standard pelvis phantom using a clinical PCCT (NAEOTOM Alpha, Siemens Healthineers) and an energy integrating Computed Tomography (EID) (SOMATOM Edge Plus, Siemens Healthineers) at 100 kV with tin filter and at varying radiation doses (CTDI 1.5, 1, 0.75, 0.5, 0.25, 0.1, 0.05 mGy). Two-millimeter axial images were reconstructed using a smooth soft tissue (B40) and a bone kernel. In addition, the PCCT bone reconstructions were denoised using a clinical DICOM-based denoising tool (ClariCT.AI, ClariPi). Two radiologists, blinded of either the modality or dose, evaluated the images; settings and radiation exposure were equivalent to the ones used in clinical practice. In addition to SNR measurements, delineation of the cortical and cancellous bone, as well as artifacts and overall image quality were assessed using a 5 point Likert-scale (1 = extremely bad, 5 = excellent). An average of a Likert Score > 3 was considered clinically satisfactory.

## RESULTS

SNR measured in PCCT images was significantly higher than in EID images ( $p < 0.001$ ). Denoising contributed to an additional SNR increase in PCCT images ( $p < 0.001$ ). Inter-rater reliability was excellent to almost perfect ( $\kappa = 0.87 - 1$ ). Photon starvation artifacts were observed only in EID at 0.05 mGy. Acquisitions = 0.25 mGy on the PCCT and = 0.5 mGy on the EID were diagnostically valid. With additional denoising, the PCCT can produce pelvic scans with a good image quality at already 0.1 mGy.

## CONCLUSION

CT of the pelvic structures can be obtained on PCCT combined with a denoising software at significantly lower radiation exposure, while preserving image quality.

## CLINICAL RELEVANCE/APPLICATION

The use of ultra-low dose PCCT and denoising software generate CT scans of the pelvis at a radiation exposure lower than conventional radiographs.

### S4-SSMK02-5 **Disparities in DEXA Scan Utilization Varies Across Racial/Ethnic Groups Prior to and After Hip Fractures**

Katelyn E. Rudisill, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Geriatric hip fractures are common and important sentinel events regarding bone health. While dual X-ray absorptiometry (DEXA) scans are a standard method for determining bone density, differences in use among various race/ethnic groups around the time of hip fracture may reveal disparities within the healthcare system. The current study aimed to evaluate for racial/ethnic variations in DEXA scan utilization among a cohort of geriatric hip fracture patients.

#### METHODS AND MATERIALS

The 2014 to 2016 Medicare Standard Analytic Files (SAF) PearlDiver dataset was used to identify geriatric patients sustaining hip fractures. From that cohort, those who had a DEXA scan prior to or following their fracture were defined, and patient age, sex, Elixhauser Comorbidity Index (ECI), race/ethnicity, and income (based on zip code) were characterized. Demographic factors of patients who did and did not receive a DEXA scan before or after hip fracture were compared with univariate and multivariate analyses. Predictive factors for receiving a DEXA scan were determined.

#### RESULTS

Of 58,099 hip fracture patients, 19.8% had a DEXA scan before fracture, and 3.9% of those who did not receive a pre-fracture DEXA scan had a scan following their fracture. Of the study cohort, 91.0% identified as white and 9.0% as non-white (Native American, Black, Hispanic, Asian, or Other). Prior to hip fracture, 20.3% of White patients had a DEXA scan, compared to 14.7% of Asians, 14.4% of Hispanics, 14.0% of Blacks, 10.7% of Native Americans, and 16.4% of "Other" patients. Controlling for patient age, sex, ECI, and income, compared to white patients, all non-white patients were at lesser odds of having a DEXA scan performed before hip fracture (Native American odds ratio [OR] 0.39, Black OR 0.59, Hispanic OR 0.64, Asian OR 0.69, and other OR 0.77,  $p < 0.0001$  for all except other,  $p = 0.0262$ ). Following hip fracture, Black OR 0.66 ( $p$ -value = 0.0021), Hispanic OR 0.57 ( $p$ -value = 0.0251), and other OR 0.75 ( $p$ -value = 0.024) patients were also at lesser odds of having a DEXA scan.

#### CONCLUSION

Using a large Medicare dataset, controlling for patient age, sex, ECI, and income marker, the current study revealed disparities in DEXA scan utilization across race/ethnic groups before and after presenting with a fragility hip fracture. Identifying such disparities highlights the need for improved medical access and care in this at-risk hip fracture population.

## CLINICAL RELEVANCE/APPLICATION

DEXA scan utilization identifies patients with low bone densities, and early detection can prevent individuals from developing a hip fragility fracture. Varying use of DEXA scans for different racial/ethnic groups highlights disparities in the healthcare system - which may negatively impact care outcomes among disadvantaged groups.

### S4-SSMK02-6 **Radiographic Assessment of the Pubic Symphysis in Elite Male Adolescent Football Players: Development and Reliability of the Maturing Adolescent Pubic Symphysis (MAPS) Classification**

David Hanff, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The pubic symphysis is susceptible to growth related injuries long after the adolescent growth spurt. The late age of ossification of the pubic symphysis was recently demonstrated using advanced imaging. Our study describes the radiographic maturation of the pubic symphysis on pelvic radiographs in adolescent football players and introduces the Maturing Adolescent Pubic Symphysis classification (MAPS classification).

#### METHODS AND MATERIALS

Anteroposterior pelvic radiographs of 105 healthy adolescent male football players between 12 and 24 years old were used to develop the classification system. The radiological scoring of the symphyseal joint was developed over five rounds. The final MAPS classification items were scored in random order by two experienced raters, blinded to the age of the participant and to each other's scoring. The inter- and intra-rater reliability were examined using weighted kappa (?).

## RESULTS

We developed a classification system with descriptive definitions and an accompanying pictorial atlas. The symphyseal joint was divided into three regions: the superior corners, and the upper and lower regions of the joint line. The superior corners are classified as rounded, squared or beaked. The upper region of the joint line: round or straight. The lower region of the joint line: straight, diagonal, or "in between". Inter-rater reliability was substantial to almost perfect: superior region:  $\kappa = 0.70$  (95% CI 0.60 - 0.79), upper region of the joint line:  $\kappa = 0.89$  (95% CI 0.86 - 0.92), lower region of the joint line:  $\kappa = 0.65$  (95% CI 0.55 - 0.75). The intra-observe reliability showed similar results.

## CONCLUSION

The Maturing Adolescent Pubic Symphysis classification (MAPS-classification) is a reliable descriptive classification of the radiographic maturation of the pubic symphysis joint in athletic males. Maturation starts at the superior corner, creating a squared edge. The joint line then gradually ossifies - from superior to inferior. The stages can provide a basis for understanding in clinical practice and will allow future research in this field.

## CLINICAL RELEVANCE/APPLICATION

This study raises awareness to all health professionals that many radiographic findings at the pubic symphysis represent non-complete ossification rather than pathology. The maturation process can still be ongoing at 23 years old in males. This also suggests that pubic-related groin pain could be linked to maturation until a relatively high age.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSMK02-2

### Employing Generative AI to Visualize Ideal Total Hip Arthroplasty and Conduct Patient-Specific Surgical Templating on Plain Radiographs

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353C

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Total hip arthroplasty (THA) templating involves manual measurements and 2D implant renderings on preoperative radiographs. While a tedious process, optimal templating improves surgical efficiency and reduces complications by visualizing desirable surgical outcomes and anticipating challenges. This study introduces THA-Net, a deep learning (DL) algorithm that simulates postoperative THA radiographs with a single preoperative pelvis input, generating predictions unconditionally (algorithm selects implants) or conditionally (surgeon selects implants). We hypothesized that THA-Net would produce images as valid and realistic as actual radiographs while needing no or minimal surgeon inputs.

#### METHODS AND MATERIALS

THA-Net utilizes a pretrained YOLO-v5 model to crop the hip joint from an input preoperative pelvis radiograph and then employs a classifier-free conditional diffusion model for inpainting THA implants and generating realistic postoperative radiographs. The diffusion model offers two modes: 1) automated, requiring only the input radiograph, and 2) hardware-aware, allowing user-specified components. Trained on 356,305 radiographs from 14,357 patients (2000-2022), the model was conditioned on the 2-year complication outcomes and acetabular inclination angles available for the training data to ensure optimal implant selection/positioning and consider complication risk minimization during inference. Two orthopedic surgeons blindly assessed the surgical validity and realism of 100 real and 100 synthetic postoperative radiographs. Synthetic radiographs were also assessed against software-based criteria.

#### RESULTS

The surgical validity of synthetic postoperative radiographs (THA-Net output) was significantly higher than real ones (mean difference: 0.8 and 1.1 points on a 10-point Likert scale for automated and hardware-aware generations, respectively;  $p < 0.001$ ). Blinded expert reviews couldn't differentiate real and synthetic radiographs regarding realism. Synthetic radiographs were rated as realistic as their real counterparts in 95% of hardware-aware and 98% of automated generations. They exhibited excellent validity and realism when analyzed using validated software.

#### CONCLUSION

We developed a DL-based next-generation THA templating tool to generate synthetic postoperative radiographs with highly valid and realistic surgical execution.

#### CLINICAL RELEVANCE/APPLICATION

As a standalone technology, this tool enables patient-specific surgical planning and identifies the optimal postoperative target. Further refinement of this tool may allow it to interface with robotics, navigation, and AR/VR technologies to achieve desirable surgical execution while reducing dependence on 3D imaging data.

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## Abstract Archives of the RSNA, 2023

S4-SSMK02-3

### **Hip MRI: Patients with Hip Dysplasia can Present with Femoral Version Deformities and with Combined Acetabular and Femoral Version Deformities**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353C

Till D. Lerch, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Frequency of abnormal femoral torsion(FT) is unclear for patients with hip dysplasia. Increased FT was associated with hip dysplasia but only few studies investigated the true FT. The purpose of this study was to investigate frequency of increased or decreased FT or acetabular version (AV) and combined version on preoperative MRI of patients with hip dysplasia.

#### **METHODS AND MATERIALS**

A retrospective comparative study that involved 419 hips of symptomatic patients with hip dysplasia undergoing periacetabular osteotomy was performed. Mean age was 28 years, 88% were female patients and mean preoperative LCE angle was 11°. All patients had FT>25°. Preoperative MRI was performed for all patients in clinical routine for evaluation of cartilage and labrum lesions and for dGEMRIC. Preoperative hip MRI was evaluated for assessment of FT, AV and combined version on axial T1-weighted images. Combined version equals the sum of FT and AV. FT was measured by one radiology resident with 5 years of experience in musculoskeletal imaging according to the Reikeras method. Field of view of the CT scan and MRI included pelvis and knee.

#### **RESULTS**

Mean FT of 419 hips was 16° (-20-57°), and mean central AV was 19° (3-35°) and mean combined version was 35° (-8-78°).44% of hips had FT between 10-25°, 24% had FT>25° and 32% had FT<10°. FT>35° was found in 6% and FT<0° was found in 8%. The combination of normal FV and AV was present in 36%, while 19% have increased FT>25° and normal AV and 27% have decreased FT<10° and normal AV. Decreased combined version<20° was present in 12%, increased combined version>50° was present in 14%.

#### **CONCLUSION**

One third of patients with hip dysplasia have normal FT combined with normal AV. Almost a third of patients have decreased FV<10°, while 23% have increased FT>25°. Patients with hip dysplasia can exhibit combined deformities. This is important for preoperative planning of hip preservation surgery (periacetabular osteotomy or femoral derotation osteotomy).

#### **CLINICAL RELEVANCE/APPLICATION**

Preoperative hip MRI allows assessment of FT and detection of deformities of FT such as increased or decreased FT for patients with hip dysplasia and hip pain.

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## Abstract Archives of the RSNA, 2023

S4-SSMK02-4

### Low Dose Photon Counting Computed Tomography of the Pelvis with Tin Filter and Denoising: How Low Can We Go

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353C

Roy P. Marcus, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the quality of images of the pelvis using a Photon Counting Computed Tomography (PCCT) at ultra-low dose.

#### METHODS AND MATERIALS

Images were acquired on a standard pelvis phantom using a clinical PCCT (NAEOTOM Alpha, Siemens Healthineers) and an energy integrating Computed Tomography (EID) (SOMATOM Edge Plus, Siemens Healthineers) at 100 kV with tin filter and at varying radiation doses (CTDI 1.5, 1, 0.75, 0.5, 0.25, 0.1, 0.05 mGy). Two-millimeter axial images were reconstructed using a smooth soft tissue (B40) and a bone kernel. In addition, the PCCT bone reconstructions were denoised using a clinical DICOM-based denoising tool (ClariCT.AI, ClariPi). Two radiologists, blinded of either the modality or dose, evaluated the images; settings and radiation exposure were equivalent to the ones used in clinical practice. In addition to SNR measurements, delineation of the cortical and cancellous bone, as well as artifacts and overall image quality were assessed using a 5 point Likert-scale (1 = extremely bad, 5 = excellent). An average of a Likert Score >3 was considered clinically satisfactory.

#### RESULTS

SNR measured in PCCT images was significantly higher than in EID images ( $p < 0.001$ ). Denoising contributed to an additional SNR increase in PCCT images ( $p < 0.001$ ). Inter-rater reliability was excellent to almost perfect ( $\kappa = 0.87 - 1$ ). Photon starvation artifacts were observed only in EID at 0.05 mGy. Acquisitions =0.25 mGy on the PCCT and =0.5 mGy on the EID were diagnostically valid. With additional denoising, the PCCT can produce pelvic scans with a good image quality at already 0.1 mGy.

#### CONCLUSION

CT of the pelvic structures can be obtained on PCCT combined with a denoising software at significantly lower radiation exposure, while preserving image quality.

#### CLINICAL RELEVANCE/APPLICATION

The use of ultra-low dose PCCT and denoising software generate CT scans of the pelvis at a radiation exposure lower than conventional radiographs.

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## Abstract Archives of the RSNA, 2023

S4-SSMK02-5

### Disparities in DEXA Scan Utilization Varies Across Racial/Ethnic Groups Prior to and After Hip Fractures

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353C

Katelyn E. Rudisill, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Geriatric hip fractures are common and important sentinel events regarding bone health. While dual X-ray absorptiometry (DEXA) scans are a standard method for determining bone density, differences in use among various race/ethnic groups around the time of hip fracture may reveal disparities within the healthcare system. The current study aimed to evaluate for racial/ethnic variations in DEXA scan utilization among a cohort of geriatric hip fracture patients.

#### METHODS AND MATERIALS

The 2014 to 2016 Medicare Standard Analytic Files (SAF) PearlDiver dataset was used to identify geriatric patients sustaining hip fractures. From that cohort, those who had a DEXA scan prior to or following their fracture were defined, and patient age, sex, Elixhauser Comorbidity Index (ECI), race/ethnicity, and income (based on zip code) were characterized. Demographic factors of patients who did and did not receive a DEXA scan before or after hip fracture were compared with univariate and multivariate analyses. Predictive factors for receiving a DEXA scan were determined.

#### RESULTS

Of 58,099 hip fracture patients, 19.8% had a DEXA scan before fracture, and 3.9% of those who did not receive a pre-fracture DEXA scan had a scan following their fracture. Of the study cohort, 91.0% identified as white and 9.0% as non-white (Native American, Black, Hispanic, Asian, or Other). Prior to hip fracture, 20.3% of White patients had a DEXA scan, compared to 14.7% of Asians, 14.4% of Hispanics, 14.0% of Blacks, 10.7% of Native Americans, and 16.4% of "Other" patients. Controlling for patient age, sex, ECI, and income, compared to white patients, all non-white patients were at lesser odds of having a DEXA scan performed before hip fracture (Native American odds ratio [OR] 0.39, Black OR 0.59, Hispanic OR 0.64, Asian OR 0.69, and other OR 0.77,  $p < 0.0001$  for all except other,  $p = 0.0262$ ). Following hip fracture, Black OR 0.66 ( $p$ -value = 0.0021), Hispanic OR 0.57 ( $p$ -value = 0.0251), and other OR 0.75 ( $p$ -value = 0.024) patients were also at lesser odds of having a DEXA scan.

#### CONCLUSION

Using a large Medicare dataset, controlling for patient age, sex, ECI, and income marker, the current study revealed disparities in DEXA scan utilization across race/ethnic groups before and after presenting with a fragility hip fracture. Identifying such disparities highlights the need for improved medical access and care in this at-risk hip fracture population.

#### CLINICAL RELEVANCE/APPLICATION

DEXA scan utilization identifies patients with low bone densities, and early detection can prevent individuals from developing a hip fragility fracture. Varying use of DEXA scans for different racial/ethnic groups highlights disparities in the healthcare system - which may negatively impact care outcomes among disadvantaged groups.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-SSMK02-6

### **Radiographic Assessment of the Pubic Symphysis in Elite Male Adolescent Football Players: Development and Reliability of the Maturing Adolescent Pubic Symphysis (MAPS) Classification**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E353C

David Hanff, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The pubic symphysis is susceptible to growth related injuries long after the adolescent growth spurt. The late age of ossification of the pubic symphysis was recently demonstrated using advanced imaging. Our study describes the radiographic maturation of the pubic symphysis on pelvic radiographs in adolescent football players and introduces the Maturing Adolescent Pubic Symphysis classification (MAPS classification).

#### **METHODS AND MATERIALS**

Anteroposterior pelvic radiographs of 105 healthy adolescent male football players between 12 and 24 years old were used to develop the classification system. The radiological scoring of the symphyseal joint was developed over five rounds. The final MAPS classification items were scored in random order by two experienced raters, blinded to the age of the participant and to each other's scoring. The inter- and intra-rater reliability were examined using weighted kappa (?).

#### **RESULTS**

We developed a classification system with descriptive definitions and an accompanying pictorial atlas. The symphyseal joint was divided into three regions: the superior corners, and the upper and lower regions of the joint line. The superior corners are classified as rounded, squared or beaked. The upper region of the joint line: round or straight. The lower region of the joint line: straight, diagonal, or "in between". Inter-rater reliability was substantial to almost perfect: superior region:  $\kappa = 0.70$  (95% CI 0.60 - 0.79), upper region of the joint line:  $\kappa = 0.89$  (95% CI 0.86 - 0.92), lower region of the joint line:  $\kappa = 0.65$  (95% CI 0.55 - 0.75). The intra-observe reliability showed similar results.

#### **CONCLUSION**

The Maturing Adolescent Pubic Symphysis classification (MAPS-classification) is a reliable descriptive classification of the radiographic maturation of the pubic symphysis joint in athletic males. Maturation starts at the superior corner, creating a squared edge. The joint line then gradually ossifies - from superior to inferior. The stages can provide a basis for understanding in clinical practice and will allow future research in this field.

#### **CLINICAL RELEVANCE/APPLICATION**

This study raises awareness to all health professionals that many radiographic findings at the pubic symphysis represent non-complete ossification rather than pathology. The maturation process can still be ongoing at 23 years old in males. This also suggests that pubic-related groin pain could be linked to maturation until a relatively high age.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR01

### Neuroradiology (Brain: Infectious, Inflammatory, and Metabolic Disorders)

Sunday, Nov. 26 1:00PM - 2:00PM Room: E351

Susana Calle, MD (*Moderator*) Nothing to Disclose  
Ichiro Ikuta, MD, MMedSc (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **S4-SSNR01-1 Progressive Reduction in Basal Ganglia Explains and Predicts Cerebral Structural Alteration in Type 2 Diabetes Mellitus**

Minchul Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Type 2 diabetes is consistently reported to be associated with reduced gray matter, mainly in the cortical-striatal-limbic networks. However, little is known about how the progression of diabetes affects cerebral gray matter. We investigate gray matter alterations according to diabetes progression and the causal relationship to the whole brain.

#### **METHODS AND MATERIALS**

Among 1121 participants who attended health screenings, 543 age- and sex-matched participants were enrolled and divided among the nondiabetes, prediabetes, and diabetes groups according to their glycosylated hemoglobin (HbA1c) levels. Voxel-based morphometry using a linear trend model was performed to reveal brain regions associated with disease progression. The Granger causal network of structural covariance was used to assess the causal relationships of brain structural alterations according to disease progression. Multivariable pattern analysis was applied for the stage-specific predictions of hyperglycemia.

#### **RESULTS**

With diabetes progression, a linear trend of gray matter volume reduction in the basal ganglia ( $P < 0.05$ , FWER corrected) was detected, which caused a reduction in bilateral temporal gyri, frontal pole, parahippocampus, and bilateral posterior cingulate/precuneus volumes. In addition, the gray matter pattern of the basal ganglia could predict patients with diabetes (accuracy 60.12%,  $p = 0.002$ ).

#### **CONCLUSION**

The basal ganglia is the area of the brain with progressive gray matter reduction that is associated with diabetes progression. The reduced volume in the basal ganglia causes widespread, networkwise gray matter volume reductions throughout diabetes progression. These findings indicate that the basal ganglia play a key role in diabetes by affecting the cortical-striatal-limbic network.

#### **CLINICAL RELEVANCE/APPLICATION**

We demonstrated that the basal ganglia is the area of stepwise gray matter reduction according to diabetes progression. The reduced volume in the basal ganglia causes widespread, networkwise gray matter reduction over diabetes progression. To interpret the result, we propose a basal ganglia initiation and networkwise propagation model of hyperglycemia affecting the brain. These findings indicate that the basal ganglia play a key role in type 2 diabetes by affecting the cortical-striatal-limbic network.

#### **S4-SSNR01-3 Network Connectivity Anomalies in Limbic-predominant Age-related TDP-43 Encephalopathy Neuropathological Change (LATE-NC)**

Mahir Tazwar, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Limbic-predominant age-related TDP-43 encephalopathy neuropathological change (LATE-NC) is a common neurodegenerative pathology in the brain of older adults and is associated with accelerated cognitive impairment. The anatomical distribution of LATE-NC typically involves the amygdala, hippocampus, and other subcortical, temporal, and frontal lobe regions. But its impact on the structural integrity of this network of regions remains unknown. In this study, we tested the hypothesis that LATE-NC is associated with abnormalities in graph theoretic measures of structural connectivity in the network of regions known to be involved in LATE-NC.

## METHODS AND MATERIALS

This study included 148 deceased older adults participating in Rush Memory and Aging Project and Religious Orders Study. Ex-vivo diffusion tensor imaging (DTI) scans were acquired on 3T scanners, followed by detailed neuropathologic examination by a board-certified neuropathologist. Fractional anisotropy (FA) maps derived from DTI scans were used to define region-to-region structural connectivity in a network of 19 regions known to be involved in LATE-NC using graph theory-based network measures. General linear models were used to investigate the association of global and local graph measures with LATE-NC stages, controlling for other neuropathologies (Alzheimer's disease, Lewy bodies, arteriolosclerosis, atherosclerosis, cerebral amyloid angiopathy, gross and microscopic infarcts), demographics (age at death, sex, education), total white matter hyperintensity volume, postmortem intervals, and scanner variables. Statistical significance was set at  $p < 0.05$ .

## RESULTS

Linear regression revealed that greater LATE-NC stage was associated with increased characteristic path length and with lower values of the remaining global network measures ( $p < 0.05$ ). LATE-NC was also associated with lower local efficiency, increased nodal path length, lower nodal strength, and lower clustering coefficient in 74%, 79%, 32%, and 63% of the nodes, respectively ( $p < 0.05$ ). Finally, LATE-NC was associated with both greater (in 21% of nodes) and lower (in 16% of nodes) eigenvector centrality, and with both greater and lower betweenness centrality in 21% of nodes, respectively ( $p < 0.05$ ).

## CONCLUSION

Using graph theory and a hypothesis-driven approach, we found significant degradation of structural integrity in white matter of the network of regions affected by LATE-NC.

## CLINICAL RELEVANCE/APPLICATION

These findings may shed light on the effects of LATE-NC on brain connectivity, and in combination with other imaging and clinical information, may aid towards the development of tools for in-vivo detection of this devastating neuropathology.

## S4-SSNR01-4 Cerebral Microstructural Alterations in Post-Covid-Condition are Related to Cognitive Impairment, Olfactory Dysfunction and Fatigue

Alexander Rau, MD (*Presenter*) Nothing to Disclose

## PURPOSE

In the aftermath of the Corona Virus Disease 2019 (COVID-19), approximately 10-25% of patients developed a "Post-COVID-condition" (PCC) which is characterized, among other symptoms, by neurocognitive deficits, disturbed olfaction and fatigue. However, the pathophysiological basis of this condition is poorly understood. Diffusion microstructure imaging (DMI) is a promising approach to fill this gap, as it detects even small volume shifts between microstructural compartments of a neural tissue model.

## METHODS AND MATERIALS

Prospective cross-sectional study of  $n=89$  patients with PCC who received DMI. DMI parameters were read for the whole gray matter and tested for association with clinical data. To reveal the spatial distribution of microstructural alterations, we carried out voxel-wise group comparisons with threshold-free cluster enhancement and FWE-correction after adjustment for age and sex.

## RESULTS

Due to PCC-symptoms, 53% of patients could not return to the previous level of independence/employment. The cognitive performance measured by the MoCA-test was impaired in 41% (26, IQR [4] points,  $< 26/30$  is cut-off value). The olfactory performance was impaired in 73% (9, IQR [4] items identified,  $< 11/12$  is cut-off value). The WEIMuS questionnaire indicated fatigue in 78% (43, IQR [17] points,  $> 33/68$  is cut-off value). PCC patients were compared to matched healthy controls (healthy non-COVID, HNC;  $n = 47$ ) and controls that passed COVID-19 without developing a PCC (unimpaired post-COVID, UPC;  $n = 38$ ). Analysis of whole-brain DMI-data revealed a volume-shift from the extraneurite compartment (V-extra) into the free water fraction (V-CSF) for the gray matter that was positively associated with the severity of initial COVID-19 infection ( $P = 0.004$ ). To further determine microstructural correlates of PCC-associated symptoms after COVID-19, voxel-based associations of V-extra with clinical scores were performed. Here, symptom-specific networks emerged that were significantly correlated with impaired MoCA- or olfactory-performance and fatigue.

## CONCLUSION

In summary, DMI revealed long-lasting microstructural changes after COVID-19 infection with different patterns in patients with and without PCC. Expression of PCC-symptoms was associated with affection of specific cerebral networks, suggesting a pathophysiological basis of this syndrome.

## CLINICAL RELEVANCE/APPLICATION

Due to the high prevalence of PCC, our findings are of high relevance as they allow for an insight into the pathophysiology of neurological symptoms.

### **S4-SSNR01-5 Enlarged Choroid Plexus Related to Iron Rim Lesions and Deep Gray Matter Atrophy in Relapsing-Remitting Multiple Sclerosis**

Li Yongmei, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the association between choroid plexus (CP) volume and brain lesions load, especially iron rim lesions (IRLs) load and atrophy in multiple sclerosis (MS), and its relationship with clinical characteristics.

## METHODS AND MATERIALS

3.0 T brain MRI images were acquired from 99 relapsing-remitting MS (RRMS) and 60 healthy controls (HCs) to obtain the volumes of CP, whole brain and lesions. Volumes were expressed as a ratio of intracranial volume. Expanded Disability Status Scale (EDSS), Montreal Cognitive Assessment (MoCA) and Symbol Digit Modalities Test (SDMT) were used to assess the severity of disability and cognitive function. Student's t-test and Multivariable regression analyses were performed to evaluate the difference of CP volumes between RRMS and HC and the association between CP volume and lesions load, brain volumes and clinical scale scores in RRMS.

## RESULTS

CP volume was 30% larger in patients with RRMS than HCs ( $p < 0.001$ ) and was 20% larger in patients with IRLs than those without IRLs ( $p = 0.007$ ). Moreover, the larger CP volume was related to greater white matter lesions (WMLs) volume in the whole RRMS ( $r = 0.46$ ,  $p < 0.001$ ). Further analysis in patients with IRLs showed a positive correlation between CP volume and WMLs volume ( $r = 0.45$ ,  $p = 0.003$ ), and IRLs volume ( $r = 0.51$ ,  $p < 0.001$ ). Meanwhile, enlarged CP was related to lower volumes in the whole brain ( $r = -0.30$ ,  $p = 0.006$ ), deep gray matter ( $r = -0.51$ ,  $p < 0.001$ ) and most regional deep gray matter nuclei (except amygdala), but no correlation with cortical lesions or cortex volume (both  $p > 0.05$ ). In addition, CP volume was significantly higher in patients with cognitive impairment than those with cognitive preservation by MoCA scores ( $p = 0.011$ ); the larger CP volume was associated with higher EDSS scores ( $r = 0.25$ ;  $p = 0.014$ ) and lower SDMT Z scores in RRMS ( $r = -0.26$ ;  $p = 0.014$ ).

## CONCLUSION

The enlargement of CP in RRMS had close correlations with inflammatory lesions, especially IRLs and deep gray matter atrophy, but not the cortex. Meanwhile, the larger CP volume was associated with higher disability and lower cognitive scores. CP volume may be a surrogate imaging marker for MS disease activity.

## CLINICAL RELEVANCE/APPLICATION

CP is considered to be linked to inflammation of MS, but its connection with markers of inflammation in vivo in MS is unclear, the markers such as lesions load and brain atrophy, particularly the WMLs edge surrounded by an iron rim, termed as IRLs. Our study provides an essential imaging basis for exploring the pathophysiological mechanism of CP involved in the brain inflammatory and neurodegeneration.

### **S4-SSNR01-6 A Folate Receptor-Targeted Nanoparticle Contrast Agent Enables Molecular MRI of Neuroinflammation in Mouse Models of Amyloid and Tau Pathology**

Andrew A. Badachhape, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Neuroinflammation frequently accompanies worsening pathogenesis and cognitive decline in neurodegenerative conditions such as Alzheimer's disease (AD). An MRI contrast agent capable of visualizing neuroinflammation would be highly desirable due to widespread use of MRI in the context of neurological disorders. Folate receptor  $\beta$ , a marker of the pro-inflammatory phenotype, is expressed on microglia and may serve as a potential imaging target. In this work, we investigated a liposomal, folate-targeted nanoparticle contrast agent coupled with gadolinium for molecular MRI of neuroinflammation in mouse models of AD that develop amyloid and tau pathology.

## **METHODS AND MATERIALS**

In vivo studies were performed in P301S mice, a model of tau pathology and APP/PSEN1 mice, a model of amyloid pathology. Transgenic mice and wild-type (WT), control littermates (n=6/genotype, 24 total) underwent baseline, pre-contrast MRI using T1-weighted spin echo sequences with 160 um in-plane resolution and 1.2 mm slice thickness. Delayed MRI was performed 4 days after systemic administration of a high T1 relaxivity folate-targeted liposomal-Gd contrast agent (0.15 mmol Gd/kg). Animals were euthanized after the final imaging session for microscopic analysis of the brain. Signal changes between pre-contrast and post-contrast MRI were determined in target regions of the brain.

## **RESULTS**

Transgenic mice demonstrated signal enhancement in post-contrast T1w-MRI compared to baseline scans. In comparison, WT control mice did not show signal enhancement. APP/PSEN1 transgenic mice exhibited greater relative enhancement (+5.9%,  $p < 0.005$ ) than P301S mice (3.9%,  $p < 0.05$ ). Immunofluorescence analysis demonstrated higher levels of activated microglia in brains of transgenic mice compared to WT control mice.

## **CONCLUSION**

A folate receptor  $\beta$ -targeted liposomal-Gd contrast agent enables *in vivo* MRI of neuroinflammation in mouse models of Alzheimer's disease.

## **CLINICAL RELEVANCE/APPLICATION**

Targeted imaging agents could play an important role in monitoring of Alzheimer's disease progression leading to cognitive decline and evaluation of therapies that target neuroinflammation.

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## Abstract Archives of the RSNA, 2023

S4-SSNR01-1

### Progressive Reduction in Basal Ganglia Explains and Predicts Cerebral Structural Alteration in Type 2 Diabetes Mellitus

Sunday, Nov. 26 1:00PM - 2:00PM Room: E351

Minchul Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Type 2 diabetes is consistently reported to be associated with reduced gray matter, mainly in the cortical-striatal-limbic networks. However, little is known about how the progression of diabetes affects cerebral gray matter. We investigate gray matter alterations according to diabetes progression and the causal relationship to the whole brain.

#### METHODS AND MATERIALS

Among 1121 participants who attended health screenings, 543 age- and sex-matched participants were enrolled and divided among the nondiabetes, prediabetes, and diabetes groups according to their glycosylated hemoglobin (HbA1c) levels. Voxel-based morphometry using a linear trend model was performed to reveal brain regions associated with disease progression. The Granger causal network of structural covariance was used to assess the causal relationships of brain structural alterations according to disease progression. Multivariable pattern analysis was applied for the stage-specific predictions of hyperglycemia.

#### RESULTS

With diabetes progression, a linear trend of gray matter volume reduction in the basal ganglia ( $P < 0.05$ , FWER corrected) was detected, which caused a reduction in bilateral temporal gyri, frontal pole, parahippocampus, and bilateral posterior cingulate/precuneus volumes. In addition, the gray matter pattern of the basal ganglia could predict patients with diabetes (accuracy 60.12%,  $p = 0.002$ ).

#### CONCLUSION

The basal ganglia is the area of the brain with progressive gray matter reduction that is associated with diabetes progression. The reduced volume in the basal ganglia causes widespread, networkwise gray matter volume reductions throughout diabetes progression. These findings indicate that the basal ganglia play a key role in diabetes by affecting the cortical-striatal-limbic network.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrated that the basal ganglia is the area of stepwise gray matter reduction according to diabetes progression. The reduced volume in the basal ganglia causes widespread, networkwise gray matter reduction over diabetes progression. To interpret the result, we propose a basal ganglia initiation and networkwise propagation model of hyperglycemia affecting the brain. These findings indicate that the basal ganglia play a key role in type 2 diabetes by affecting the cortical-striatal-limbic network.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR01-3

### Network Connectivity Anomalies in Limbic-predominant Age-related TDP-43 Encephalopathy Neuropathological Change (LATE-NC)

Sunday, Nov. 26 1:00PM - 2:00PM Room: E351

Mahir Tazwar, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Limbic-predominant age-related TDP-43 encephalopathy neuropathological change (LATE-NC) is a common neurodegenerative pathology in the brain of older adults and is associated with accelerated cognitive impairment. The anatomical distribution of LATE-NC typically involves the amygdala, hippocampus, and other subcortical, temporal, and frontal lobe regions. But its impact on the structural integrity of this network of regions remains unknown. In this study, we tested the hypothesis that LATE-NC is associated with abnormalities in graph theoretic measures of structural connectivity in the network of regions known to be involved in LATE-NC.

#### METHODS AND MATERIALS

This study included 148 deceased older adults participating in Rush Memory and Aging Project and Religious Orders Study. Ex-vivo diffusion tensor imaging (DTI) scans were acquired on 3T scanners, followed by detailed neuropathologic examination by a board-certified neuropathologist. Fractional anisotropy (FA) maps derived from DTI scans were used to define region-to-region structural connectivity in a network of 19 regions known to be involved in LATE-NC using graph theory-based network measures. General linear models were used to investigate the association of global and local graph measures with LATE-NC stages, controlling for other neuropathologies (Alzheimer's disease, Lewy bodies, arteriolosclerosis, atherosclerosis, cerebral amyloid angiopathy, gross and microscopic infarcts), demographics (age at death, sex, education), total white matter hyperintensity volume, postmortem intervals, and scanner variables. Statistical significance was set at  $p < 0.05$ .

#### RESULTS

Linear regression revealed that greater LATE-NC stage was associated with increased characteristic path length and with lower values of the remaining global network measures ( $p < 0.05$ ). LATE-NC was also associated with lower local efficiency, increased nodal path length, lower nodal strength, and lower clustering coefficient in 74%, 79%, 32%, and 63% of the nodes, respectively ( $p < 0.05$ ). Finally, LATE-NC was associated with both greater (in 21% of nodes) and lower (in 16% of nodes) eigenvector centrality, and with both greater and lower betweenness centrality in 21% of nodes, respectively ( $p < 0.05$ ).

#### CONCLUSION

Using graph theory and a hypothesis-driven approach, we found significant degradation of structural integrity in white matter of the network of regions affected by LATE-NC.

#### CLINICAL RELEVANCE/APPLICATION

These findings may shed light on the effects of LATE-NC on brain connectivity, and in combination with other imaging and clinical information, may aid towards the development of tools for in-vivo detection of this devastating neuropathology.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR01-4

### **Cerebral Microstructural Alterations in Post-Covid-Condition are Related to Cognitive Impairment, Olfactory Dysfunction and Fatigue**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E351

Alexander Rau, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In the aftermath of the Corona Virus Disease 2019 (COVID-19), approximately 10-25% of patients developed a "Post-COVID-condition" (PCC) which is characterized, among other symptoms, by neurocognitive deficits, disturbed olfaction and fatigue. However, the pathophysiological basis of this condition is poorly understood. Diffusion microstructure imaging (DMI) is a promising approach to fill this gap, as it detects even small volume shifts between microstructural compartments of a neural tissue model.

#### **METHODS AND MATERIALS**

Prospective cross-sectional study of n=89 patients with PCC who received DMI. DMI parameters were read for the whole gray matter and tested for association with clinical data. To reveal the spatial distribution of microstructural alterations, we carried out voxel-wise group comparisons with threshold-free cluster enhancement and FWE-correction after adjustment for age and sex.

#### **RESULTS**

Due to PCC-symptoms, 53% of patients could not return to the previous level of independence/employment. The cognitive performance measured by the MoCA-test was impaired in 41% (26, IQR [4] points, < 26/30 is cut-off value). The olfactory performance was impaired in 73% (9, IQR [4] items identified, < 11/12 is cut-off value). The WEIMuS questionnaire indicated fatigue in 78% (43, IQR [17] points, > 33/68 is cut-off value). PCC patients were compared to matched healthy controls (healthy non-COVID, HNC; n = 47) and controls that passed COVID-19 without developing a PCC (unimpaired post-COVID, UPC; n = 38). Analysis of whole-brain DMI-data revealed a volume-shift from the extraneurite compartment (V-extra) into the free water fraction (V-CSF) for the gray matter that was positively associated with the severity of initial COVID-19 infection (P = 0.004). To further determine microstructural correlates of PCC-associated symptoms after COVID-19, voxel-based associations of V-extra with clinical scores were performed. Here, symptom-specific networks emerged that were significantly correlated with impaired MoCA- or olfactory-performance and fatigue.

#### **CONCLUSION**

In summary, DMI revealed long-lasting microstructural changes after COVID-19 infection with different patterns in patients with and without PCC. Expression of PCC-symptoms was associated with affection of specific cerebral networks, suggesting a pathophysiological basis of this syndrome.

#### **CLINICAL RELEVANCE/APPLICATION**

Due to the high prevalence of PCC, our findings are of high relevance as they allow for an insight into the pathophysiology of neurological symptoms.

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## Abstract Archives of the RSNA, 2023

S4-SSNR01-5

### Enlarged Choroid Plexus Related to Iron Rim Lesions and Deep Gray Matter Atrophy in Relapsing-Remitting Multiple Sclerosis

Sunday, Nov. 26 1:00PM - 2:00PM Room: E351

Li Yongmei, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the association between choroid plexus (CP) volume and brain lesions load, especially iron rim lesions (IRLs) load and atrophy in multiple sclerosis (MS), and its relationship with clinical characteristics.

#### METHODS AND MATERIALS

3.0 T brain MRI images were acquired from 99 relapsing-remitting MS (RRMS) and 60 healthy controls (HCs) to obtain the volumes of CP, whole brain and lesions. Volumes were expressed as a ratio of intracranial volume. Expanded Disability Status Scale (EDSS), Montreal Cognitive Assessment (MoCA) and Symbol Digit Modalities Test (SDMT) were used to assess the severity of disability and cognitive function. Student's t-test and Multivariable regression analyses were performed to evaluate the difference of CP volumes between RRMS and HC and the association between CP volume and lesions load, brain volumes and clinical scale scores in RRMS.

#### RESULTS

CP volume was 30% larger in patients with RRMS than HCs ( $p < 0.001$ ) and was 20% larger in patients with IRLs than those without IRLs ( $p = 0.007$ ). Moreover, the larger CP volume was related to greater white matter lesions (WMLs) volume in the whole RRMS ( $r = 0.46$ ,  $p < 0.001$ ), Further analysis in patients with IRLs showed a positive correlation between CP volume and WMLs volume ( $r = 0.45$ ,  $p = 0.003$ ), and IRLs volume ( $r = 0.51$ ,  $p < 0.001$ ). Meanwhile, enlarged CP was related to lower volumes in the whole brain ( $r = -0.30$ ,  $p = 0.006$ ), deep gray matter ( $r = -0.51$ ,  $p < 0.001$ ) and most regional deep gray matter nuclei (except amygdala), but no correlation with cortical lesions or cortex volume (both  $p > 0.05$ ). In addition, CP volume was significantly higher in patients with cognitive impairment than those with cognitive preservation by MoCA scores ( $p = 0.011$ ); the larger CP volume was associated with higher EDSS scores ( $r = 0.25$ ;  $p = 0.014$ ) and lower SDMT Z scores in RRMS ( $r = -0.26$ ;  $p = 0.014$ ).

#### CONCLUSION

The enlargement of CP in RRMS had close correlations with inflammatory lesions, especially IRLs and deep gray matter atrophy, but not the cortex. Meanwhile, the larger CP volume was associated with higher disability and lower cognitive scores. CP volume may be a surrogate imaging marker for MS disease activity.

#### CLINICAL RELEVANCE/APPLICATION

CP is considered to be linked to inflammation of MS, but its connection with markers of inflammation in vivo in MS is unclear, the markers such as lesions load and brain atrophy, particularly the WMLs edge surrounded by an iron rim, termed as IRLs. Our study provides an essential imaging basis for exploring the pathophysiological mechanism of CP involved in the brain inflammatory and neurodegeneration.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR01-6

### **A Folate Receptor-Targeted Nanoparticle Contrast Agent Enables Molecular MRI of Neuroinflammation in Mouse Models of Amyloid and Tau Pathology**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E351

Andrew A. Badachhape, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Neuroinflammation frequently accompanies worsening pathogenesis and cognitive decline in neurodegenerative conditions such as Alzheimer's disease (AD). An MRI contrast agent capable of visualizing neuroinflammation would be highly desirable due to widespread use of MRI in the context of neurological disorders. Folate receptor  $\beta$ , a marker of the pro-inflammatory phenotype, is expressed on microglia and may serve as a potential imaging target. In this work, we investigated a liposomal, folate-targeted nanoparticle contrast agent coupled with gadolinium for molecular MRI of neuroinflammation in mouse models of AD that develop amyloid and tau pathology.

#### **METHODS AND MATERIALS**

In vivo studies were performed in P301S mice, a model of tau pathology and APP/PSEN1 mice, a model of amyloid pathology. Transgenic mice and wild-type (WT), control littermates (n=6/genotype, 24 total) underwent baseline, pre-contrast MRI using T1-weighted spin echo sequences with 160  $\mu$ m in-plane resolution and 1.2 mm slice thickness. Delayed MRI was performed 4 days after systemic administration of a high T1 relaxivity folate-targeted liposomal-Gd contrast agent (0.15 mmol Gd/kg). Animals were euthanized after the final imaging session for microscopic analysis of the brain. Signal changes between pre-contrast and post-contrast MRI were determined in target regions of the brain.

#### **RESULTS**

Transgenic mice demonstrated signal enhancement in post-contrast T1w-MRI compared to baseline scans. In comparison, WT control mice did not show signal enhancement. APP/PSEN1 transgenic mice exhibited greater relative enhancement (+5.9%,  $p < 0.005$ ) than P301S mice (3.9%,  $p < 0.05$ ). Immunofluorescence analysis demonstrated higher levels of activated microglia in brains of transgenic mice compared to WT control mice.

#### **CONCLUSION**

A folate receptor  $\beta$ -targeted liposomal-Gd contrast agent enables *in vivo* MRI of neuroinflammation in mouse models of Alzheimer's disease.

#### **CLINICAL RELEVANCE/APPLICATION**

Targeted imaging agents could play an important role in monitoring of Alzheimer's disease progression leading to cognitive decline and evaluation of therapies that target neuroinflammation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR02

### Science Session with Keynote: Neuroradiology (Brain: Movement Disorders)

Sunday, Nov. 26 1:00PM - 2:00PM Room: E352

Noah N. Chasen, MD (*Moderator*) Nothing to Disclose

Sara G. Tedla, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **S4-SSNR02-1 Higher Intracranial Volumes but Lower White Matter Volumes in Parkinson Patients Compared to Controls: An MRI-Based Volumetric Analysis With Deep-Learning Segmentation**

Nikhil Gupta (*Presenter*) Nothing to Disclose

#### PURPOSE

Parkinson's disease (PD) has been associated with morphological changes in subcortical volumes. These volumes are highly dependent on covariates such as age, gender and intracranial volume (ICV). This study evaluates the ability of MRI volumetric analysis based on a deep learning segmentation to characterize volumetric abnormalities in patients with PD compared to controls, considering potential effects of covariates.

#### METHODS AND MATERIALS

100 patients with PD and 100 controls with 3DT1-weighted MR images were randomly selected from the available PPMI database. NeuroShield (InMed Prognostics), a deep learning-based brain MRI segmentation algorithm, was used for automated segmentation and computation of several brain volumes: ICV, white matter (WM) volume, gray matter (GM) volume along with volumes of deep gray matter (dGM) structures. Comparison of computed volumes between PD and control subjects was done using univariate and multivariate linear regression analysis adjusting by covariates.

#### RESULTS

There were no significant between-group differences in GM or dGM volumes, adjusting or not by covariates. Interestingly, ICV was significantly higher in PD patients compared to controls (univariate p-value = 0.01). Gender-specific analysis revealed this difference was significant in males only (univariate p-value = 0.002, Fig. 1A). WM volume, on the contrary, was found to be significantly lower in PD patients compared to controls (multivariate p-value adjusting for covariates = 0.03). This was significant in males only (multivariate p-value adjusting for covariates = 0.02, Fig. 1B).

#### CONCLUSION

PD male patients were shown to have larger ICV compared to controls, a finding little reported in the literature possibly related to genetic factors or compensatory mechanisms to early brain damage. These results also suggest WM atrophy in those patients. Further studies are needed to better understand underlying mechanisms of these gender-specific volumetric abnormalities.

#### CLINICAL RELEVANCE/APPLICATION

As ICV can be significantly higher in PD patients compared to controls it is key to accurately measure and consider ICV in volumetric analysis of PD patients.

#### **S4-SSNR02-2 Keynote Speaker**

Nancy Pham, MD (*Presenter*) Nothing to Disclose

#### **S4-SSNR02-4 Choroid Plexus Volume, Dopaminergic Degeneration, and Motor Prognosis in Parkinson's Disease**

Chae Jung Park, MD (*Presenter*) Nothing to Disclose

## PURPOSE

There is increasing evidence that the choroid plexus (CP) is involved in the clearance of harmful metabolites from the brain, as a part of the glymphatic system. This study aimed to investigate the association between CP volume (CPV) and longitudinal motor outcomes in patients with Parkinson's disease (PD).

## METHODS AND MATERIALS

This retrospective study evaluated patients with drug-naïve, early stage PD who underwent dopamine transporter (DAT) scanning and high-resolution 3-tesla T1-weighted structural magnetic resonance imaging. All patients showed a decrease in DAT availability in the posterior putamen. The CP volume of each patient was automatically segmented, and the ratio to intracranial volume was used in subsequent analyses. The relationship between CP volume and baseline Unified Parkinson's Disease Rating Scale Part III (UPDRS-III) scores was assessed using multivariate linear regression. We performed Cox regression and linear mixed model analyses to assess longitudinal motor outcomes (i.e., development of levodopa-induced dyskinesia [LID], wearing-off, or freezing-of-gait [FOG] and longitudinal increases in the dose of dopaminergic medications) according to CP volume.

## RESULTS

A total of 322 drug-naïve, early stage PD patients (mean age,  $64.14 \pm 9.72$  [SD] years; 170 females) were included. CP volume was positively associated with the UPDRS-III score after adjusting for age at symptom onset, sex, disease duration, body mass index, and white matter high signal intensity volumes. The Cox regression model showed that baseline CP volume did not significantly affect the development of LID (hazard ratio [HR] = 1.202,  $P = 0.402$ ) and wearing-off (HR = 1.278,  $P = 0.218$ ), however, a larger CP volume was associated with the future development of FOG (HR = 1.539,  $P = 0.027$ ) after adjusting for covariates. Further, a more rapid increase in dopaminergic medication in the linear mixed model (CP volume  $\times$  time,  $P = 0.037$ ).

## CONCLUSION

These findings suggest that CP volume has the potential to serve as a biomarker for baseline and longitudinal motor disabilities in patients with PD.

## CLINICAL RELEVANCE/APPLICATION

Choroid plexus volume was associated with higher baseline UPDRS-III, a higher risk of developing freezing-of-gait, and more rapid increases in dopaminergic medications over time in patients with Parkinson's disease. These findings suggest that a choroid plexus volume is associated with parkinsonian motor deficits at initial assessment, as well as poor outcomes with respect to the progression of motor disabilities during the follow-up. The choroid plexus volume, which can be easily and automatically obtained from MRI, has the potential to serve as a biomarker for baseline and longitudinal motor disabilities in Parkinson's disease patients.

## S4-SSNR02-6 Detection and Classification of Parkinson's Disease From Dat Scans Using Machine Learning: A Systematic Review of 8,364 Patients

Faranak Ebrahimian Sadabad, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Parkinson's disease (PD) is the second most common neurodegenerative disorder that affects daily quality of life, and early diagnosis is crucial for proper treatment. Dopamine Transporter Single-photon Emission Computed Tomography (DaTscan) is widely used for clinical diagnosis. To improve PD diagnosis accuracy, Machine Learning (ML) and Deep learning (DL) methods, such as convolutional neural networks (CNNs) and support vector machines (SVMs), Artificial neural network (ANN) and Dense Convolutional Network (Dense NET), are being applied to improve PD diagnosis accuracy. The purpose of this study is to review the current state of using ML methods for PD diagnosis with DaTscans

## METHODS AND MATERIALS

Systematic searches were done through PubMed, Scopus, Web of Science, PPMI, and IEEE. Overall, we found 271 articles that were screened, and data were abstracted by 6 observers. The sensitivity, specificity, and accuracy of different algorithms and methods were reported.

## RESULTS

8364 PD subjects and 3524 healthy controls (HCs) across 27 studies were included. DL was used in 10 studies and classical ML was used in 15 studies. The remaining 2 studies applied transfer learning approaches combined with deep learning. The most commonly used algorithms of deep and machine learning were convolutional neural networks (CNNs) and support vector machines (SVMs), respectively. 7 studies employed DaTscan as the imaging modality, 13 utilized other SPECT tracers, and 7 applied a combination of the two. Ultimately, a total of 25, 24, 25, and 13 studies among the included records reported sensitivity, specificity, accuracy, and AUC, respectively, which led to a median sensitivity of 96.42% (range: 78.13% - 100%), a median specificity of 95.01% (range: 38.89% - 100%), a median accuracy of 95.20% (range: 64% - 99.20%), and a median AUC of 0.98 (range: 0.76 - 0.99).

## **CONCLUSION**

To the best of our knowledge, this is the first systematic review that compares different methods for the diagnosis of PD. Detailed analyses like correlation to disease stages and progression are currently being explored.

## **CLINICAL RELEVANCE/APPLICATION**

Overall, ML and DL have high sensitivity and specificity in the detection of Parkinson's disease by DaT scans.  
Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR02-1

### Higher Intracranial Volumes but Lower White Matter Volumes in Parkinson Patients Compared to Controls: An MRI-Based Volumetric Analysis With Deep-Learning Segmentation

Sunday, Nov. 26 1:00PM - 2:00PM Room: E352

Nikhil Gupta (*Presenter*) Nothing to Disclose

#### PURPOSE

Parkinson's disease (PD) has been associated with morphological changes in subcortical volumes. These volumes are highly dependent on covariates such as age, gender and intracranial volume (ICV). This study evaluates the ability of MRI volumetric analysis based on a deep learning segmentation to characterize volumetric abnormalities in patients with PD compared to controls, considering potential effects of covariates.

#### METHODS AND MATERIALS

100 patients with PD and 100 controls with 3DT1-weighted MR images were randomly selected from the available PPMI database. NeuroShield (InMed Prognostics), a deep learning-based brain MRI segmentation algorithm, was used for automated segmentation and computation of several brain volumes: ICV, white matter (WM) volume, gray matter (GM) volume along with volumes of deep gray matter (dGM) structures. Comparison of computed volumes between PD and control subjects was done using univariate and multivariate linear regression analysis adjusting by covariates.

#### RESULTS

There were no significant between-group differences in GM or dGM volumes, adjusting or not by covariates. Interestingly, ICV was significantly higher in PD patients compared to controls (univariate p-value = 0.01). Gender-specific analysis revealed this difference was significant in males only (univariate p-value = 0.002, Fig. 1A). WM volume, on the contrary, was found to be significantly lower in PD patients compared to controls (multivariate p-value adjusting for covariates = 0.03). This was significant in males only (multivariate p-value adjusting for covariates = 0.02, Fig. 1B).

#### CONCLUSION

PD male patients were shown to have larger ICV compared to controls, a finding little reported in the literature possibly related to genetic factors or compensatory mechanisms to early brain damage. These results also suggest WM atrophy in those patients. Further studies are needed to better understand underlying mechanisms of these gender-specific volumetric abnormalities.

#### CLINICAL RELEVANCE/APPLICATION

As ICV can be significantly higher in PD patients compared to controls it is key to accurately measure and consider ICV in volumetric analysis of PD patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR02-2

### Keynote Speaker

Sunday, Nov. 26 1:00PM - 2:00PM Room: E352

Nancy Pham, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSNR02-4

### Choroid Plexus Volume, Dopaminergic Degeneration, and Motor Prognosis in Parkinson's Disease

Sunday, Nov. 26 1:00PM - 2:00PM Room: E352

Chae Jung Park, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

There is increasing evidence that the choroid plexus (CP) is involved in the clearance of harmful metabolites from the brain, as a part of the lymphatic system. This study aimed to investigate the association between CP volume (CPV) and longitudinal motor outcomes in patients with Parkinson's disease (PD).

#### METHODS AND MATERIALS

This retrospective study evaluated patients with drug-naïve, early stage PD who underwent dopamine transporter (DAT) scanning and high-resolution 3-tesla T1-weighted structural magnetic resonance imaging. All patients showed a decrease in DAT availability in the posterior putamen. The CP volume of each patient was automatically segmented, and the ratio to intracranial volume was used in subsequent analyses. The relationship between CP volume and baseline Unified Parkinson's Disease Rating Scale Part III (UPDRS-III) scores was assessed using multivariate linear regression. We performed Cox regression and linear mixed model analyses to assess longitudinal motor outcomes (i.e., development of levodopa-induced dyskinesia [LID], wearing-off, or freezing-of-gait [FOG] and longitudinal increases in the dose of dopaminergic medications) according to CP volume.

#### RESULTS

A total of 322 drug-naïve, early stage PD patients (mean age,  $64.14 \pm 9.72$  [SD] years; 170 females) were included. CP volume was positively associated with the UPDRS-III score after adjusting for age at symptom onset, sex, disease duration, body mass index, and white matter high signal intensity volumes. The Cox regression model showed that baseline CP volume did not significantly affect the development of LID (hazard ratio [HR] = 1.202,  $P = 0.402$ ) and wearing-off (HR = 1.278,  $P = 0.218$ ), however, a larger CP volume was associated with the future development of FOG (HR = 1.539,  $P = 0.027$ ) after adjusting for covariates. Further, a more rapid increase in dopaminergic medication in the linear mixed model (CP volume  $\times$  time,  $P = 0.037$ ).

#### CONCLUSION

These findings suggest that CP volume has the potential to serve as a biomarker for baseline and longitudinal motor disabilities in patients with PD.

#### CLINICAL RELEVANCE/APPLICATION

Choroid plexus volume was associated with higher baseline UPDRS-III, a higher risk of developing freezing-of-gait, and more rapid increases in dopaminergic medications over time in patients with Parkinson's disease. These findings suggest that a choroid plexus volume is associated with parkinsonian motor deficits at initial assessment, as well as poor outcomes with respect to the progression of motor disabilities during the follow-up. The choroid plexus volume, which can be easily and automatically obtained from MRI, has the potential to serve as a biomarker for baseline and longitudinal motor disabilities in Parkinson's disease patients.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-SSNR02-6

### **Detection and Classification of Parkinson's Disease From DaT Scans Using Machine Learning: A Systematic Review of 8,364 Patients**

Sunday, Nov. 26 1:00PM - 2:00PM Room: E352

Faranak Ebrahimian Sadabad, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Parkinson's disease (PD) is the second most common neurodegenerative disorder that affects daily quality of life, and early diagnosis is crucial for proper treatment. Dopamine Transporter Single-photon Emission Computed Tomography (DaTscan) is widely used for clinical diagnosis. To improve PD diagnosis accuracy, Machine Learning (ML) and Deep learning (DL) methods, such as convolutional neural networks (CNNs) and support vector machines (SVMs), Artificial neural network (ANN) and Dense Convolutional Network (Dense NET), are being applied to improve PD diagnosis accuracy. The purpose of this study is to review the current state of using ML methods for PD diagnosis with DaTscans

#### **METHODS AND MATERIALS**

Systematic searches were done through PubMed, Scopus, Web of Science, PPMI, and IEEE. Overall, we found 271 articles that were screened, and data were abstracted by 6 observers. The sensitivity, specificity, and accuracy of different algorithms and methods were reported.

#### **RESULTS**

8364 PD subjects and 3524 healthy controls (HCs) across 27 studies were included. DL was used in 10 studies and classical ML was used in 15 studies. The remaining 2 studies applied transfer learning approaches combined with deep learning. The most commonly used algorithms of deep and machine learning were convolutional neural networks (CNNs) and support vector machines (SVMs), respectively. 7 studies employed DaTscan as the imaging modality, 13 utilized other SPECT tracers, and 7 applied a combination of the two. Ultimately, a total of 25, 24, 25, and 13 studies among the included records reported sensitivity, specificity, accuracy, and AUC, respectively, which led to a median sensitivity of 96.42% (range: 78.13% - 100%), a median specificity of 95.01% (range: 38.89% - 100%), a median accuracy of 95.20% (range: 64% - 99.20%), and a median AUC of 0.98 (range: 0.76 - 0.99).

#### **CONCLUSION**

To the best of our knowledge, this is the first systematic review that compares different methods for the diagnosis of PD. Detailed analyses like correlation to disease stages and progression are currently being explored.

#### **CLINICAL RELEVANCE/APPLICATION**

Overall, ML and DL have high sensitivity and specificity in the detection of Parkinson's disease by DaT scans.

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## Abstract Archives of the RSNA, 2023

S4-SSPH02

### Physics (Diagnostic X-ray)

Sunday, Nov. 26 1:00PM - 2:00PM Room: N227B

Srinivasan Vedantham, PhD (*Moderator*) Research collaboration, Koning Corporation Research collaboration, General Electric Company

Wei Zhao, PhD (*Moderator*) Research support, Siemens AG

#### Sub-Events

### S4-SSPH02-1 Ex-Vivo Assessment of Multi-Contrast X-ray Imaging for the Diagnosis of Lung Cancer

Dan Bushe, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung cancer remains the leading cause of cancer-related mortality worldwide. Early detection and accurate diagnosis of lung cancers are crucial for improving patient outcomes. Chest X-ray radiography has the potential to provide a powerful low-dose screening tool to enable the early detection of lung cancers. However, the X-ray absorption contrast mechanism is poorly suited for the detection of small, low-density lung nodules during the early stages of lung cancer. Recently, grating-based multi-contrast X-ray imaging has emerged as a promising approach to overcome the limitations of conventional X-ray radiography by offering the dark-field imaging capacity to probe the microstructures of the lungs and generate contrast when the tissue-to-air ratio of the alveolar-air interfaces is changed. The purpose of this study is to evaluate the potential for multi-contrast imaging using a human-compatible prototype system to detect lung cancers.

#### METHODS AND MATERIALS

An ex-vivo swine lung was injected with 0.5 mL to 1 mL of a 3% agar gel solution at depths of 1 to 3 cm to simulate five pulmonary nodules. Following confirmation of the location and formation of each nodule with CT (Fig. 1A), the lung specimen was imaged on a novel multi-contrast chest X-ray imaging system. Multi-contrast images (simultaneous absorption and dark-field contrast) were acquired in a single scanning acquisition at 70 kVp with an estimated effective dose of 0.23 mSv. Contrast and contrast-to-noise ratio (CNR) measurements were made for each of the five nodules by placing regions of interest over the five nodules and in a homogenous background region of the upper right lung.

#### RESULTS

The mean HU of the injected nodules was  $-9 \pm 18$  HU,  $24 \pm 48$  HU,  $-19 \pm 23$  HU,  $-18 \pm 49$ , and  $-14 \pm 8$  HU. Absorption, dark-field, differential phase, and three novel absorption-dark field fusion images of the healthy and diseased lung specimens are presented in Fig. 1B. The absorption-normalized dark-field signal provided the highest contrast level across all five lesions. The dark field CNR was improved when compared to the absorption CNR for four out of the five nodules, with the greatest improvement being a 3.73 factor increase in CNR.

#### CONCLUSION

The incorporation of the additional information generated from a single multi-contrast acquisition can be leveraged to improve the detection and confirmation of lesions when compared to conventional chest radiography. The dark field provided an increase in CNR in four out of the five lesions when compared to the absorption CNR.

#### CLINICAL RELEVANCE/APPLICATION

The integration of the additional information provided by X-ray dark-field imaging in clinical practice has the potential to improve the detection of lung cancers and ultimately improve patient outcomes.

### S4-SSPH02-2 Breast Density and Radiation Exposure in Screening with Digital Breast Tomosynthesis: A Subanalysis of the Randomized TOSYMA Trial

Walter Heindel, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The randomized TOSYMA trial showed that digital breast tomosynthesis plus synthesized mammography (DBT+SM) detects significantly higher rates of invasive breast cancers than digital mammography (DM); this was particularly pronounced in women with dense breasts. On the other hand, DBT is known to operate with higher average glandular doses (AGD) of radiation than DM. In the present subanalysis of TOSYMA, we evaluated how the average glandular doses (AGD) applied with DBT+SM or DM, respectively, related to the density of examined breast.

## METHODS AND MATERIALS

From 2018 to 2020, TOSYMA, a multicentric, multivendor randomised controlled screening trial, recruited 99,689 women aged 50 to 69 years. The trial was embedded in the routine German Mammography-Screening Program. In this study, the median AGD, and the women's age and breast thickness were compared per study arm and across the breast density categories A (fatty), B (scattered), C (heterogeneously dense), or D (extremely dense). Mean AGD levels were modeled in multivariable regression models using breast density and study arm as predictor variables and breast thickness and age group as confounder variables.

## RESULTS

The analyses included 196,622 (DBT+SM) and 197,037 (DM) exposures. Women's age and breast thickness decreased markedly and similarly in both trial arms from category A to D ( $p < .001$ ). Overall, the AGD was higher in the DBT+SM than in the DM group (+ 0.94 mGy,  $p < .001$ ). However, while the median AGD applied in the DM screening arm changed only slightly with rising breast density (from 1.36 mGy (A) to 1.33 mGy (D), i.e., by -2.9%), the median AGD applied in DBT+SM decreased from 2.22 mGy in density group A to 1.73 mGy in category D, a difference of -22.0%. Multivariable regression analyses revealed that the decline of the applied radiation dose in women with higher breast density was specific to the DBT+SM screening arm (interaction term  $p < .001$ ) and not explained by women's age or breast thickness.

## CONCLUSION

This study confirms that the median AGD is generally higher in DBT+SM than in DM screening. Remarkably, however, the median AGD decreased significantly with increasing breast density only in the DBT+SM, but not in the DM arm.

## CLINICAL RELEVANCE/APPLICATION

This finding should be appraised against the previous evidence from TOSYMA that DBT+SM screening detects substantially more invasive cancers in dense breasts than DM. The presented data seem to indicate that this asset of DBT+SM is achieved with a relatively low radiation dose.

## S4-SSPH02-3 ACR Dose Index Registry for Digital Radiography: Developing Adult Dose Index Benchmarks

Xiang Li, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

In 2021, the American College of Radiology (ACR) dose index registry (DIR) launched a new pilot project in digital radiography (DR). An important goal was to develop national benchmarks for the dose indices used in DR. The purpose of this abstract was to report the first set of benchmarks for adult patients based on two years of pilot project data.

## METHODS AND MATERIALS

The pilot project included 7 institutions, which configured some of their DR devices to submit Radiation Dose Structured Reports to the ACR. A comprehensive exam mapping system was developed to map different local exam descriptions to the same ACR Common IDs. Each Common ID represented one type of radiographic procedure (e.g., 4002472 XRAY, abdomen). All event-level dose-index values from the participating institutions over a two-year period (2021 and 2022) were recorded. The recorded dose indices included the exposure index (EI), exposure index target (EIT), and deviation index (DI) defined by the IEC 62-494 standard as well as the kerma-area product (KAP). First, facility-level statistics were calculated using the event-level data from each facility. For example, "EI median" and "DI standard deviation" were used to describe the central tendency and the dispersion of the EI data from a given facility. Registry statistics (quartiles) were then calculated from the facility-level results.

## RESULTS

41 ACR Common ID procedures had sufficient event counts to allow registry statistics to be generated for adult patients, among which 15 procedures had more than 20,000 events each. For these high-volume procedures, the "registry EI median" ranged from 190 for chest to 1281 for unilateral hand. In general, central body work (chest, abdomen, and spine) had lower median EI values than extremity exams (elbow, hand, wrist, tibia/fibula and foot). The "registry DI standard deviation" ranged from 1.3 for unilateral hand to 3.1 for cervical spine. The "registry KAP median" ranged range 0.15 for unilateral wrist to 24.6 for lumbar spine (unit: dGy-cm<sup>2</sup>). Finally, the "registry KAP Interquartile Range" ranged from 0.09 for unilateral wrist to 31.5 for lumbar spine.

## CONCLUSION

Using two years of pilot project data, we established the first set of national benchmarks for DR dose indices. Individual facilities can benchmark their local performance against these national values and make data-driven decisions for quality improvement. Increased participation in DIR DR across the US will improve generalizability of future benchmarks.

## CLINICAL RELEVANCE/APPLICATION

The ACR Dose Index Registry for Digital Radiography will enable participants to benchmark their dose indices performance data against national values.

### S4-SSPH02-4 **Dependence of Reported Exposure Index Values on Vendor Algorithm: An Anthropomorphic Phantom Study**

Kathleen A. Scilla, MS (*Presenter*) Nothing to Disclose

## PURPOSE

IEC 62494-1 defined a standardized Exposure Index (EI) for radiography but left methods for determining the relevant image region and value of interest (VOI) when computing EI to vendor discretion. The aim of this study was to investigate the impact of vendor algorithm for VOI on EI.

## METHODS AND MATERIALS

Four anthropomorphic phantoms (hand, foot, head, and thorax) were imaged on ten radiographic units (one fixed and one mobile from five different manufacturers). Manual techniques for each setup were set to achieve a specified half value layer and unattenuated detector air kerma ( $K_{ref}$ ) at a specified source-to-image distance. Exam tags investigated were PA Hand and Wrist (setup 1); LAT Foot and Ankle (setup 2); LAT Skull (setup 3); AP Chest (setup 4); and AP T-Spine, Upper Ribs, and Lower Ribs (setup 5). For each exam tag (e), three images of the phantom were taken for each of three field sizes (f) - 8"x10", 10"x12", and 14"x17"- and EI was recorded. EI values were corrected for detector EI accuracy and differences in measured air kerma and  $K_{ref}$  for each setup, and the mean corrected EI value for each unit (k) at a given e and f was calculated ( $E_{Ie,f,k}$ ). Then the median  $E_{Ie,f,k}$  across f was determined ( $E_{Ie,med,k}$ ) and compared to the median across all k ( $E_{Ie,med,all}$ ).

## RESULTS

Three units failed to correctly detect the radiation field for AP Chest exams for 8"x10", and  $E_{Ie,f,k}$  nearly doubled when electronic collimation was manually adjusted on the images to the correct area. Use of 14"x17" increased  $E_{Ie,f,k}$  by 111% (hand/wrist) relative to 8"x10" for one unit, while others maintained  $E_{Ie,f,k}$  to within 16%. Field size had a moderate impact on  $E_{Ie,f,k}$  for head, foot and thorax phantoms, resulting in variations of -21% to 57% for the same e and k. Variations of -40% to 276% were observed in  $E_{Ie,f,k}$  for the thorax phantom for the same f and k for vendors A and D. Differences in  $E_{Ie,f,k}$  were negligible between exam tags with hand and foot phantoms. Vendor algorithm resulted in differences up to 70% between  $E_{Ie,med,k}$  and  $E_{Ie,med,all}$  ( $\%E_{Ie,med,all}$ ).  $E_{Ie,med,k}$  for vendor A was 2-58% lower than  $E_{Ie,med,all}$ , whereas vendor E was 1-25% higher.  $\%E_{Ie,med,k}$  for vendor D ranged from -66% to 70%.

## CONCLUSION

Proper collimation reduces variability in EI. Results indicate fundamental differences in vendor determination of VOI, making it difficult to compare EI between vendors despite a standardized EI definition.

## CLINICAL RELEVANCE/APPLICATION

Vendor-specific algorithms for identifying VOI impact displayed EI. Care should be taken when comparing dose statistics between different systems and target EI likely need to be vendor specific.

### S4-SSPH02-5 **A Monte Carlo Framework to Explore Novel X-ray Spectrum Optimization Strategies using Alternative Patient and Operator Dose Metrics in Interventional Radiology**

Rodrigo T. Massera, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Increased energies can be used to limit skin dose in interventional radiology (IR), however this can adversely affect patient and operator organ doses. This work implements a Monte Carlo (MC) framework for x-ray spectrum optimization of (IR) systems using alternative dose metrics, such as an averaged patient dose from phantom model ( $D_p$ ), dose at the patient center using the same model ( $D_c$ ) and operator effective dose ( $D_{eff}$ ).

## METHODS AND MATERIALS

The PENELOPE /penEasy(2020) MC code was used to simulate IR procedures with a C-arm system in an IR suite. System components included the x-ray tube, spectral filter, patient table, x-ray detector and antiscatter grid. The operator was modelled using an ORNL anthropomorphic phantom modified to include some missing organs of interest for dosimetry. A

cylinder composed of a homogenous body-tissue mixture with varying diameter and length was used to represent patients. Personal protective equipment (PPE) (lead aprons, eyeglasses, ceiling and table shields) was modelled to quantify its impact on staff doses. The dose metrics were calculated for x-ray spectra covering 40 kVp to 120 kVp, with Cu additional filtration between 0 and 0.9 mm. Image quality was quantified using signal difference-to-noise difference (SDNR) between a 1 x 1 cm<sup>2</sup> region at the center of the detector, with and without a 0.2 mm thick iron object placed inside the phantom. The FOM was defined as  $SDNR^2/D$ , where D is one of the dose metrics.

## RESULTS

At patient thicknesses of 10 cm and 40 cm, optimal tube potential increased from 50 kVp to 77 kVp using an FOM based on D<sub>p</sub>, and from 44 kVp to 55 kVp for an FOM utilizing D<sub>c</sub>. Switching to an FOM calculated using operator dose D<sub>eff</sub> gave slightly lower optimal potentials, namely 46 kVp and 65 kVp, for 10 cm and 40 cm, respectively. These low x-ray energies result from assuming an ideal x-ray tube, while in practice x-ray tube power limits these settings. The optimal tube potential for D<sub>p</sub> is within the 90% maximum FOM for the D<sub>eff</sub>. When all PPE is used, a reduction in D<sub>eff</sub> of 95% could be achieved compared to no PPE, when averaged over a large selection of scenarios. Adding 0.2 mm Cu filtration, and using the optimal kVp at each thickness can reduce D<sub>p</sub> or D<sub>eff</sub> by approximately 30%.

## CONCLUSION

In general, lower energies should be selected when optimizing to average patient dose, center dose and operator dose, compared to patient entrance dose. Optimal dose scenarios for a chosen metrics will depend on available x-ray tube power. Personal protective equipment remains the most effective means of limiting operator dose.

## CLINICAL RELEVANCE/APPLICATION

The flexibility afforded by the MC framework allows optimization of IR systems for alternative dose metrics such as averaged patient dose, dose at the patient center and effective dose of the operator.

### S4-SSPH02-6 **Opportunistic Bone Mineral Density Quantification from Single-shot Dual-energy Radiography using a Triple-layer Flat Panel Detector**

Stephen Z. Liu, BS (*Presenter*) Nothing to Disclose

## PURPOSE

The recently introduced triple-layer flat panel detector (FPD) enables single-shot dual-energy (DE) radiography. We investigate its application in opportunistic bone mineral density (BMD) screening from lumbar spine radiographs using kernel-based scatter correction and optimization-based material decomposition.

## METHODS AND MATERIALS

The triple-layer FPD was deployed as a retrofit on an Ysio Max (Siemens Healthineers) digital radiography system. Posterior-anterior single-shot DE radiographs of an anthropomorphic lumbar spine phantom were obtained in a contact scan configuration using 180.6 cm source-detector distance, a 13:1 vertical Pb/Al anti-scatter grid, and x-ray tube settings of 121 kV (+1.5 mm Al) and 6.2 mAs. Full (43 cm) and half (21 cm) axial collimation settings were compared. Scatter in each detector layer was estimated by a kernel-based approach; kernel parameters were calibrated from a Monte Carlo simulation of a digital cadaver phantom different from the phantom used in the experiments. Projection-domain decomposition with a beam-hardening model was applied to scatter-subtracted three-layer data to obtain water and CaHA pathlengths. Areal BMD (aBMD) of L1, L3 and L4 vertebrae were calculated from the CaHA imaging and compared to reference derived from a CT scan of the phantom.

## RESULTS

Despite the anti-scatter grid, the kernel-estimated scatter-to-primary ratios (SPRs) behind the vertebrae were high in all three FPD layers, e.g., ~120% for L4 in the top layer radiograph at 21 cm collimation and ~156% at 43 cm collimation. Due to relatively poor spectral separation between layers, uncorrected scatter leads to substantial underestimation of BMD at both collimations (>110% error for L1, L3 and L4). With scatter correction, errors are reduced to ~100%-43% and ~2%-45% for narrow and wide collimated scans, respectively, depending on the vertebra.

## CONCLUSION

Opportunistic BMD screening by single-shot DE radiography with the emerging triple-layer FPDs may be feasible using the proposed algorithmic scatter correction and model-based projection-domain decomposition. Ongoing work investigated the reproducibility of this approach to change imaging conditions.

## CLINICAL RELEVANCE/APPLICATION

The study investigates the feasibility of applying a novel, single-exposure dual-energy radiographic detector technology in opportunistic screening for bone mineral density loss.

## Abstract Archives of the RSNA, 2023

S4-SSPH02-1

### Ex-Vivo Assessment of Multi-Contrast X-ray Imaging for the Diagnosis of Lung Cancer

Sunday, Nov. 26 1:00PM - 2:00PM Room: N227B

Dan Bushe, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung cancer remains the leading cause of cancer-related mortality worldwide. Early detection and accurate diagnosis of lung cancers are crucial for improving patient outcomes. Chest X-ray radiography has the potential to provide a powerful low-dose screening tool to enable the early detection of lung cancers. However, the X-ray absorption contrast mechanism is poorly suited for the detection of small, low-density lung nodules during the early stages of lung cancer. Recently, grating-based multi-contrast X-ray imaging has emerged as a promising approach to overcome the limitations of conventional X-ray radiography by offering the dark-field imaging capacity to probe the microstructures of the lungs and generate contrast when the tissue-to-air ratio of the alveolar-air interfaces is changed. The purpose of this study is to evaluate the potential for multi-contrast imaging using a human-compatible prototype system to detect lung cancers.

#### METHODS AND MATERIALS

An ex-vivo swine lung was injected with 0.5 mL to 1 mL of a 3% agar gel solution at depths of 1 to 3 cm to simulate five pulmonary nodules. Following confirmation of the location and formation of each nodule with CT (Fig. 1A), the lung specimen was imaged on a novel multi-contrast chest X-ray imaging system. Multi-contrast images (simultaneous absorption and dark-field contrast) were acquired in a single scanning acquisition at 70 kVp with an estimated effective dose of 0.23 mSv. Contrast and contrast-to-noise ratio (CNR) measurements were made for each of the five nodules by placing regions of interest over the five nodules and in a homogenous background region of the upper right lung.

#### RESULTS

The mean HU of the injected nodules was  $-9 \pm 18$  HU,  $24 \pm 48$  HU,  $-19 \pm 23$  HU,  $-18 \pm 49$ , and  $-14 \pm 8$  HU. Absorption, dark-field, differential phase, and three novel absorption-dark field fusion images of the healthy and diseased lung specimens are presented in Fig. 1B. The absorption-normalized dark-field signal provided the highest contrast level across all five lesions. The dark field CNR was improved when compared to the absorption CNR for four out of the five nodules, with the greatest improvement being a 3.73 factor increase in CNR.

#### CONCLUSION

The incorporation of the additional information generated from a single multi-contrast acquisition can be leveraged to improve the detection and confirmation of lesions when compared to conventional chest radiography. The dark field provided an increase in CNR in four out of the five lesions when compared to the absorption CNR.

#### CLINICAL RELEVANCE/APPLICATION

The integration of the additional information provided by X-ray dark-field imaging in clinical practice has the potential to improve the detection of lung cancers and ultimately improve patient outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-SSPH02-2

### Breast Density and Radiation Exposure in Screening with Digital Breast Tomosynthesis: A Subanalysis of the Randomized TOSYMA Trial

Sunday, Nov. 26 1:00PM - 2:00PM Room: N227B

Walter Heindel, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The randomized TOSYMA trial showed that digital breast tomosynthesis plus synthesized mammography (DBT+SM) detects significantly higher rates of invasive breast cancers than digital mammography (DM); this was particularly pronounced in women with dense breasts. On the other hand, DBT is known to operate with higher average glandular doses (AGD) of radiation than DM. In the present subanalysis of TOSYMA, we evaluated how the average glandular doses (AGD) applied with DBT+SM or DM, respectively, related to the density of examined breast.

#### METHODS AND MATERIALS

From 2018 to 2020, TOSYMA, a multicentric, multivendor randomised controlled screening trial, recruited 99,689 women aged 50 to 69 years. The trial was embedded in the routine German Mammography-Screening Program. In this study, the median AGD, and the women's age and breast thickness were compared per study arm and across the breast density categories A (fatty), B (scattered), C (heterogeneously dense), or D (extremely dense). Mean AGD levels were modeled in multivariable regression models using breast density and study arm as predictor variables and breast thickness and age group as confounder variables.

#### RESULTS

The analyses included 196,622 (DBT+SM) and 197,037 (DM) exposures. Women's age and breast thickness decreased markedly and similarly in both trial arms from category A to D ( $p < .001$ ). Overall, the AGD was higher in the DBT+SM than in the DM group (+ 0.94 mGy,  $p < .001$ ). However, while the median AGD applied in the DM screening arm changed only slightly with rising breast density (from 1.36 mGy (A) to 1.33 mGy (D), i.e., by -2.9%), the median AGD applied in DBT+SM decreased from 2.22 mGy in density group A to 1.73 mGy in category D, a difference of -22.0%. Multivariable regression analyses revealed that the decline of the applied radiation dose in women with higher breast density was specific to the DBT+SM screening arm (interaction term  $p < .001$ ) and not explained by women's age or breast thickness.

#### CONCLUSION

This study confirms that the median AGD is generally higher in DBT+SM than in DM screening. Remarkably, however, the median AGD decreased significantly with increasing breast density only in the DBT+SM, but not in the DM arm.

#### CLINICAL RELEVANCE/APPLICATION

This finding should be appraised against the previous evidence from TOSYMA that DBT+SM screening detects substantially more invasive cancers in dense breasts than DM. The presented data seem to indicate that this asset of DBT+SM is achieved with a relatively low radiation dose.

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## Abstract Archives of the RSNA, 2023

S4-SSPH02-3

### ACR Dose Index Registry for Digital Radiography: Developing Adult Dose Index Benchmarks

Sunday, Nov. 26 1:00PM - 2:00PM Room: N227B

Xiang Li, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

In 2021, the American College of Radiology (ACR) dose index registry (DIR) launched a new pilot project in digital radiography (DR). An important goal was to develop national benchmarks for the dose indices used in DR. The purpose of this abstract was to report the first set of benchmarks for adult patients based on two years of pilot project data.

#### METHODS AND MATERIALS

The pilot project included 7 institutions, which configured some of their DR devices to submit Radiation Dose Structured Reports to the ACR. A comprehensive exam mapping system was developed to map different local exam descriptions to the same ACR Common IDs. Each Common ID represented one type of radiographic procedure (e.g., 4002472 XRAY, abdomen). All event-level dose-index values from the participating institutions over a two-year period (2021 and 2022) were recorded. The recorded dose indices included the exposure index (EI), exposure index target (EIT), and deviation index (DI) defined by the IEC 62-494 standard as well as the kerma-area product (KAP). First, facility-level statistics were calculated using the event-level data from each facility. For example, "EI median" and "DI standard deviation" were used to describe the central tendency and the dispersion of the EI data from a given facility. Registry statistics (quartiles) were then calculated from the facility-level results.

#### RESULTS

41 ACR Common ID procedures had sufficient event counts to allow registry statistics to be generated for adult patients, among which 15 procedures had more than 20,000 events each. For these high-volume procedures, the "registry EI median" ranged from 190 for chest to 1281 for unilateral hand. In general, central body work (chest, abdomen, and spine) had lower median EI values than extremity exams (elbow, hand, wrist, tibia/fibula and foot). The "registry DI standard deviation" ranged from 1.3 for unilateral hand to 3.1 for cervical spine. The "registry KAP median" ranged from 0.15 for unilateral wrist to 24.6 for lumbar spine (unit: dGy-cm<sup>2</sup>). Finally, the "registry KAP Interquartile Range" ranged from 0.09 for unilateral wrist to 31.5 for lumbar spine.

#### CONCLUSION

Using two years of pilot project data, we established the first set of national benchmarks for DR dose indices. Individual facilities can benchmark their local performance against these national values and make data-driven decisions for quality improvement. Increased participation in DIR DR across the US will improve generalizability of future benchmarks.

#### CLINICAL RELEVANCE/APPLICATION

The ACR Dose Index Registry for Digital Radiography will enable participants to benchmark their dose indices performance data against national values.

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## Abstract Archives of the RSNA, 2023

S4-SSPH02-4

### Dependence of Reported Exposure Index Values on Vendor Algorithm: An Anthropomorphic Phantom Study

Sunday, Nov. 26 1:00PM - 2:00PM Room: N227B

Kathleen A. Scilla, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

IEC 62494-1 defined a standardized Exposure Index (EI) for radiography but left methods for determining the relevant image region and value of interest (VOI) when computing EI to vendor discretion. The aim of this study was to investigate the impact of vendor algorithm for VOI on EI.

#### METHODS AND MATERIALS

Four anthropomorphic phantoms (hand, foot, head, and thorax) were imaged on ten radiographic units (one fixed and one mobile from five different manufacturers). Manual techniques for each setup were set to achieve a specified half value layer and unattenuated detector air kerma ( $K_{ref}$ ) at a specified source-to-image distance. Exam tags investigated were PA Hand and Wrist (setup 1); LAT Foot and Ankle (setup 2); LAT Skull (setup 3); AP Chest (setup 4); and AP T-Spine, Upper Ribs, and Lower Ribs (setup 5). For each exam tag (e), three images of the phantom were taken for each of three field sizes (f) - 8"x10", 10"x12", and 14"x17"- and EI was recorded. EI values were corrected for detector EI accuracy and differences in measured air kerma and  $K_{ref}$  for each setup, and the mean corrected EI value for each unit (k) at a given e and f was calculated ( $E_{Ie,f,k}$ ). Then the median  $E_{Ie,f,k}$  across f was determined ( $E_{Ie,med,k}$ ) and compared to the median across all k ( $E_{Ie,med,all}$ ).

#### RESULTS

Three units failed to correctly detect the radiation field for AP Chest exams for 8"x10", and  $E_{Ie,f,k}$  nearly doubled when electronic collimation was manually adjusted on the images to the correct area. Use of 14"x17" increased  $E_{Ie,f,k}$  by 111% (hand/wrist) relative to 8"x10" for one unit, while others maintained  $E_{Ie,f,k}$  to within 16%. Field size had a moderate impact on  $E_{Ie,f,k}$  for head, foot and thorax phantoms, resulting in variations of -21% to 57% for the same e and k. Variations of -40% to 276% were observed in  $E_{Ie,f,k}$  for the thorax phantom for the same f and k for vendors A and D. Differences in  $E_{Ie,f,k}$  were negligible between exam tags with hand and foot phantoms. Vendor algorithm resulted in differences up to 70% between  $E_{Ie,med,k}$  and  $E_{Ie,med,all}$  ( $\%E_{Ie,med,all}$ ).  $E_{Ie,med,k}$  for vendor A was 2-58% lower than  $E_{Ie,med,all}$ , whereas vendor E was 1-25% higher.  $\%E_{Ie,med,k}$  for vendor D ranged from -66% to 70%.

#### CONCLUSION

Proper collimation reduces variability in EI. Results indicate fundamental differences in vendor determination of VOI, making it difficult to compare EI between vendors despite a standardized EI definition.

#### CLINICAL RELEVANCE/APPLICATION

Vendor-specific algorithms for identifying VOI impact displayed EI. Care should be taken when comparing dose statistics between different systems and target EI likely need to be vendor specific.

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## Abstract Archives of the RSNA, 2023

S4-SSPH02-5

### A Monte Carlo Framework to Explore Novel X-ray Spectrum Optimization Strategies using Alternative Patient and Operator Dose Metrics in Interventional Radiology

Sunday, Nov. 26 1:00PM - 2:00PM Room: N227B

Rodrigo T. Massera, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Increased energies can be used to limit skin dose in interventional radiology (IR), however this can adversely affect patient and operator organ doses. This work implements a Monte Carlo (MC) framework for x-ray spectrum optimization of (IR) systems using alternative dose metrics, such as an averaged patient dose from phantom model ( $D_p$ ), dose at the patient center using the same model ( $D_c$ ) and operator effective dose ( $D_{eff}$ ).

#### METHODS AND MATERIALS

The PENELOPE /penEasy(2020) MC code was used to simulate IR procedures with a C-arm system in an IR suite. System components included the x-ray tube, spectral filter, patient table, x-ray detector and antiscatter grid. The operator was modelled using an ORNL anthropomorphic phantom modified to include some missing organs of interest for dosimetry. A cylinder composed of a homogenous body-tissue mixture with varying diameter and length was used to represent patients. Personal protective equipment (PPE) (lead aprons, eyeglasses, ceiling and table shields) was modelled to quantify its impact on staff doses. The dose metrics were calculated for x-ray spectra covering 40 kVp to 120 kVp, with Cu additional filtration between 0 and 0.9 mm. Image quality was quantified using signal difference-to-noise difference (SDNR) between a  $1 \times 1 \text{ cm}^2$  region at the center of the detector, with and without a 0.2 mm thick iron object placed inside the phantom. The FOM was defined as  $SDNR^2/D$ , where D is one of the dose metrics.

#### RESULTS

At patient thicknesses of 10 cm and 40 cm, optimal tube potential increased from 50 kVp to 77 kVp using an FOM based on  $D_p$ , and from 44 kVp to 55 kVp for an FOM utilizing  $D_c$ . Switching to an FOM calculated using operator dose  $D_{eff}$  gave slightly lower optimal potentials, namely 46 kVp and 65 kVp, for 10 cm and 40 cm, respectively. These low x-ray energies result from assuming an ideal x-ray tube, while in practice x-ray tube power limits these settings. The optimal tube potential for  $D_p$  is within the 90% maximum FOM for the  $D_{eff}$ . When all PPE is used, a reduction in  $D_{eff}$  of 95% could be achieved compared to no PPE, when averaged over a large selection of scenarios. Adding 0.2 mm Cu filtration, and using the optimal kVp at each thickness can reduce  $D_p$  or  $D_{eff}$  by approximately 30%.

#### CONCLUSION

In general, lower energies should be selected when optimizing to average patient dose, center dose and operator dose, compared to patient entrance dose. Optimal dose scenarios for a chosen metrics will depend on available x-ray tube power. Personal protective equipment remains the most effective means of limiting operator dose.

#### CLINICAL RELEVANCE/APPLICATION

The flexibility afforded by the MC framework allows optimization of IR systems for alternative dose metrics such as averaged patient dose, dose at the patient center and effective dose of the operator.

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## Abstract Archives of the RSNA, 2023

S4-SSPH02-6

### Opportunistic Bone Mineral Density Quantification from Single-shot Dual-energy Radiography using a Triple-layer Flat Panel Detector

Sunday, Nov. 26 1:00PM - 2:00PM Room: N227B

Stephen Z. Liu, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The recently introduced triple-layer flat panel detector (FPD) enables single-shot dual-energy (DE) radiography. We investigate its application in opportunistic bone mineral density (BMD) screening from lumbar spine radiographs using kernel-based scatter correction and optimization-based material decomposition.

#### METHODS AND MATERIALS

The triple-layer FPD was deployed as a retrofit on an Ysio Max (Siemens Healthineers) digital radiography system. Posterior-anterior single-shot DE radiographs of an anthropomorphic lumbar spine phantom were obtained in a contact scan configuration using 180.6 cm source-detector distance, a 13:1 vertical Pb/Al anti-scatter grid, and x-ray tube settings of 121 kV (+1.5 mm Al) and 6.2 mAs. Full (43 cm) and half (21 cm) axial collimation settings were compared. Scatter in each detector layer was estimated by a kernel-based approach; kernel parameters were calibrated from a Monte Carlo simulation of a digital cadaver phantom different from the phantom used in the experiments. Projection-domain decomposition with a beam-hardening model was applied to scatter-subtracted three-layer data to obtain water and CaHA pathlengths. Areal BMD (aBMD) of L1, L3 and L4 vertebrae were calculated from the CaHA imaging and compared to reference derived from a CT scan of the phantom.

#### RESULTS

Despite the anti-scatter grid, the kernel-estimated scatter-to-primary ratios (SPRs) behind the vertebrae were high in all three FPD layers, e.g., ~120% for L4 in the top layer radiograph at 21 cm collimation and ~156% at 43 cm collimation. Due to relatively poor spectral separation between layers, uncorrected scatter leads to substantial underestimation of BMD at both collimations (>110% error for L1, L3 and L4). With scatter correction, errors are reduced to ~100%-43% and ~2%-45% for narrow and wide collimated scans, respectively, depending on the vertebra.

#### CONCLUSION

Opportunistic BMD screening by single-shot DE radiography with the emerging triple-layer FPDs may be feasible using the proposed algorithmic scatter correction and model-based projection-domain decomposition. Ongoing work investigated the reproducibility of this approach to change imaging conditions.

#### CLINICAL RELEVANCE/APPLICATION

The study investigates the feasibility of applying a novel, single-exposure dual-energy radiographic detector technology in opportunistic screening for bone mineral density loss.

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## Abstract Archives of the RSNA, 2023

S4-SSVA01

### Vascular Imaging (Aortic Imaging)

Sunday, Nov. 26 1:00PM - 2:00PM Room: N226

James Roberts, MD, MSc (*Moderator*) Nothing to Disclose  
Kaitlin Marquis, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### S4-SSVA01-Deep Learning-Based Radiomics of CTA to Predict Adverse Events After Initial Endovascular Repair for Acute Uncomplicated Stanford Type B Aortic Dissection<sup>1</sup>

Xuefang Lu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients undergoing thoracic endovascular aortic repair (TEVAR) with acute uncomplicated Stanford type B aortic dissection (uTBAD) are associated with a high rate of postoperative adverse events (AE). To develop a prediction model using deep learning-based radiomics features of computed tomography angiography (CTA) and clinical features to predict AE of acute uTBAD after initial TEVAR.

#### METHODS AND MATERIALS

A retrospective study of 232 patients between January 2015 and January 2022 undergoing TEVAR with acute uTBAD was conducted. The three-dimensional (3D) deep convolutional neural network (CNN) was used to automatically recognize and segment CTA images and obtain the required general radiomic features. Analysis of Variance and the Least Absolute Shrinkage and Selection Operation algorithms were implemented for feature selection and radiomics score building. The radiomics score (Rad-Score) and clinical factors were incorporated in a nomogram using the multivariable logistic regression analysis. The Hosmer-Lemeshow test was used to check the calibration of models. The Kaplan-Meier curve was used to stratify the risk of patients.

#### RESULTS

The Rad-Score incorporation with platelet and C-reactive protein showed moderate improvement in the efficiency with an AUC of 0.82 (95% CI, 0.74-0.89) in the training cohort and AUC of 0.72 (95% CI, 0.57-0.86) in inter-validation cohort. The specific performance of the combined model was shown AUC of 0.77(95%CI,0.66-0.88) in the independent validation cohort collected in 2020 and 2021, the accuracy of 0.72, precision of 0.65, sensitivity of 0.85, specificity of 0.62. The Hosmer-Lemeshow test was statistically significant in the combined model ( $t_{\text{training}}=0.15$ ,  $t_{\text{inter-validation}}=0.19$ ,  $t_{\text{independent validation}}=0.18$ ,  $p>0.05$ ). The Kaplan-Meier curve confirmed that patients with low-risk Rad-scores tended to have better survival.

#### CONCLUSION

The combination of deep learning-based radiomics of CTA and clinical indicators can predict AE after initial TEVAR in acute uTBAD patients. The nomogram was verified to be clinically useful. It is expected to provide early warning of patients' prognosis during follow-up examinations.

#### CLINICAL RELEVANCE/APPLICATION

The combination of image morphological and clinical indicators can predict acute uTBAD patients with high risk of AE after initial TEVAR. The Rad-Score incorporation with clinical factors with an AUC of 0.82 (95% CI, 0.74-0.89) in the training cohort, AUC of 0.72 (95% CI, 0.57-0.86) in the inter-validation cohort, and AUC of 0.77(95%CI,0.66-0.88) in the independent validation cohort. The nomogram was verified to be clinically useful. It is expected to provide early warning of patients' prognosis during follow-up examinations.

### S4-SSVA01-Possible Impact of the Revised 2022 ACC Aha Aortic Disease Guideline on the Management of "High-Risk Uncomplicated" Type B Aortic Dissection<sup>2</sup>

Malgorzata Polacin, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The role of preventive thoracic endovascular aortic repair (TEVAR) in patients with uncomplicated type B aortic dissection (uTBAD) is a matter of debate. The updated 2022 ACC/AHA aortic disease guideline acknowledges the existence of a "high-risk (HR)" subcategory of uTBAD, with the assignment of a class 2B consideration for TEVAR. We explore the frequency of HR imaging features in a retrospective cohort of patients with uTBAD and compare the actual frequency of interventions with the rate of interventions that could have been considered according to the updated 2022 guideline.

## **METHODS AND MATERIALS**

We retrospectively analyzed 86 consecutive patients (mean age  $49 \pm 17$  years) with acute TBAD between 2013 and 2017. Out of 86 patients 26 were classified as complicated TBAD at the time of the event, based on organ/limb ischemia (n=20) or impending aortic rupture (n=4). 60 patients were classified as initially uTBAD at the time of the event. Baseline and follow-up CTs were reviewed by two cardiovascular radiologists (8 and 25 years of experience). Patients were reclassified according to the 2022 guideline into uTBAD and the new HR-uTBAD category, if at least one high-risk imaging feature was present. The rate of patients who could have been considered for intervention was compared to the actual intervention rate.

## **RESULTS**

Out of 60 patients originally classified as uTBAD, 48 demonstrated at least one HR imaging feature enumerated in the 2022 guideline at baseline (initial aortic diameter of  $>40$  mm, false lumen diameter  $>22$  mm, entry tear diameter  $>10$  mm, entry tear at the lesser aortic curvature, radiographic-only malperfusion, hemorrhagic pleural effusion), and additional 7 patients demonstrated a high-risk feature within 2 years (aortic growth  $>5$  mm in sequential imaging), resulting in a total of 55 HR-uTBAD out of the original 60 uTBAD. Within 2 years, only 15 of 60 uTBADs required intervention for late complications (12 with aortic growth, 2 with branch vessel occlusion, 1 with impending rupture). From 60 patients classified as HR uTBAD 40 had no late complications. If the presence of HR imaging features had been used to guide preemptive TEVAR in acute TBAD, the rate of interventions would have increased from 30% (cTBAD only) to 94% (cTBAD and HR-uTBAD).

## **CONCLUSION**

Applying the recently introduced "high-risk" subcategory of uTBAD in the updated 2022 guideline, more than 90% of all uTBADs would have qualified as HR-uTBAD and would be eligible for preemptive TEVAR, although secondary complications occurred in only 25% of patients.

## **CLINICAL RELEVANCE/APPLICATION**

This updated guideline will significantly influence cardiovascular radiologists and their reports with the potential need for structured reporting of HR features when diagnosing patients with acute TBAD.

## **S4-SSVA01-Quantification of Abdominal Aortic Aneurysm Strain Using MR Feature Tracking: Accuracy and Association with Progression Rate**

Huiming Dong, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Abdominal Aortic Aneurysm (AAA) management, primarily determined by maximum aneurysm diameter and growth rate, fails to preempt many catastrophic ruptures. Aortic wall strain may provide additional insight into risk of progression. MR feature tracking (FT) measures myocardial tissue strain from standard cine steady-state free precession (SSFP) MR images. This study aimed to (1) assess the accuracy of AAA wall circumferential strain by MR FT (MR Strain) using an in silico approach, and (2) investigate its relationship with recent AAA progression in patients under surveillance.

## **METHODS AND MATERIALS**

MR strain was measured using a work-in-progress FT software package. Accuracy of MR strain was assessed against the ground-truth strain in 54 synthetic cine MRIs created from finite element model (FEM) simulation of a patient's abdomen using a range of aortic pulse pressures, tissue motions, luminal signal intensity variations and image noise. Association of in vivo MR strain with progression was assessed in 25 consecutive AAA patients that had a prior MRI or CT study within  $>6$  months and  $\leq 2$  years from which maximum diameter (Dmax) growth rate was quantified. Pulse-gated cine bSSFP imaging was acquired at the level of the AAA and the normal caliber aorta, proximal to the aneurysm. Univariate and multivariate regression were used to associate growth rate with clinical variables, Dmax and peak circumferential MR strain across the cardiac cycle. Two independent readers measured MR strain to assess interoperator variability.

## **RESULTS**

In silico, bias and limits of agreement (LoA) of MR strain were  $0.48 \pm 0.42\%$ , with a correlation slope of 0.963 to ground-truth. In vivo, MR strain was significantly lower in AAA ( $1.2 \pm 0.6\%$ ) than the non-aneurysmal aorta ( $2.4 \pm 1.7\%$ ; Wilcoxon sign-rank test  $P < .001$ ). In univariate analyses Dmax (regression coefficient = 0.087,  $P < .001$ ) and peak strain (regression coefficient = -1.563,  $P < .001$ ) significantly associated with growth rate while diabetes, hypertension and current smoking nearly reached significance. MR strain remained an independent predictor of growth rate (regression coefficient = -0.904,

P=.014) after controlling for Dmax. MR strain was highly reproducible (bias±LoA: 0.03±0.31%, intraclass correlation coefficient: 97.8%, coefficient of variation: 7.14%).

#### **CONCLUSION**

MR feature tracking can reliably measure AAA wall circumferential strain and is associated with recent growth rate independent of aneurysm diameter.

#### **CLINICAL RELEVANCE/APPLICATION**

MR strain of AAA may reflect the underlying dynamic degenerative remodeling of elastin fibers and shifting of the mechanical load to the much stiffer collagen, offering improved AAA risk stratification.

### **S4-SSVA01-Predictors of Late Adverse Events in Patients with Surgically Managed Type I Aortic Dissection**

Hyejin Park (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate and find predictors of adverse events in patients with AD type I using early postoperative CT after ascending aorta replacement.

#### **METHODS AND MATERIALS**

From January 2011 to December 2017, 103 consecutive patients (55.43±13.94 years, men 49.5%) who underwent ascending aorta replacement due to AD type I and have available early postoperative CT within 3 months were included. Primary outcome was AD-related adverse events that defined as AD-related death and 2<sup>nd</sup> aorta operation due to AD associated aortic aneurysm or impending rupture. Secondary outcome was annual growth rate of the aorta. Postoperative CT exams were evaluated to determine the location and size of primary intimal tear, multi-level maximum diameter of the aorta, and false lumen status. Univariate and multivariable cox regression analyses were performed to find predictors that associated with AD-related adverse events.

#### **RESULTS**

Of all, 24 (23.3%) patients presented AD-related adverse events. Marfan syndrome, initial maximum diameter at multi-level of the aorta, and primary intimal tear size (=10 mm) were independently associated with adverse events in univariate cox regression analysis. In multivariable cox regression analysis, Marfan syndrome (HR [hazard ratio], 15.33; 95% confidence interval [CI], 5.37-43.74; P<0.001), maximal aorta diameter =40 mm (HR, 4.90; 95% CI, 1.93-12.40; P<0.001), and multiple intimal tears =3 (HR, 7.12; 95% CI, 2.68-18.92; P<0.001) were significant factors associated with AD-related adverse events.

#### **CONCLUSION**

Maximal aortic diameter ≥40 mm and multiple intimal tears on early postoperative CT will help to identify patients with high risk of adverse events in whom more aggressive management would be necessary.

#### **CLINICAL RELEVANCE/APPLICATION**

Early postoperative CT findings can identify patients with high risk of adverse events, and careful follow-up with preventive intervention can be considered in those with high risk findings.

### **S4-SSVA01-Recurrent Aortic Dissection: Imaging and Clinical Outcomes**

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Apichaya Sriprachyakul, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To describe the frequency, risk factors, radiologic findings and clinical outcome of recurrent aortic dissection (AD) compared with initial aortic dissection.

#### **METHODS AND MATERIALS**

The initial CT angiograms and all follow-up imaging studies of 445 consecutive patients with acute aortic syndrome (AAS) were retrospectively reviewed by 2 cardiovascular radiologists, and patients with acute aortic dissection were identified. Follow-up CT angiograms were assessed to determine recurrent AD. The demographics and risk factors were collected. CT scans at initial and recurrent ADs were evaluated for involved aortic segment (same, different, or overlapping segments), involved lumen (true, false or both lumens), and aneurysm formation. Associations between radiologic findings and mortality were evaluated using chi-squared or Fisher exact tests. Mortality rate was calculated. Prognostic factors were analyzed by log-rank test and Cox proportional hazards modelling.

## RESULTS

We identified 276 initial ADs (196 men, mean age 60 years, range 23-95 years) and 24 recurrent ADs (20 men, mean age 55 years, range 23-81 years). Patients with recurrent AD were younger than patients experiencing a first AD (52±15 versus 60±15 years; P=0.008). The Marfan syndrome was significantly more common in recurrent AD (21% versus 7%; P=0.004). The recurrent AD involved the same (previously dissected) or a different (previously non-dissected) aortic segments in 43% and 39%, respectively. If a recurrent AD affected the same segment (n=10), the new dissection delaminated the already thinned, previously dissected outer wall of the false lumen in 6, and dissected the former true-lumen wall in 4. The involved aortic segment, involved lumen, and aneurysm formation in recurrent AD were not associated with mortality (P=0.679, 0.470, and 0.539 respectively). Patients with recurrent AD had a higher mortality rate at 1 year than in patients with initial AD (25.2% and 13.6%). Recurrent AD (HR =1.87; 95% CI 0.79-4.46; P=0.155) was positively associated with 1-year mortality but was not a statically significant predictor.

## CONCLUSION

Among patients with aortic dissection, 8 % present with recurrent AD. Recurrent AD is strongly associated with Marfan syndrome and younger age. Although a recurrent AD in the same segment can further delaminate an already thinned aortic wall, radiologic features were not significantly associated with mortality in this study. Recurrent AD was not significantly associated with early mortality.

## CLINICAL RELEVANCE/APPLICATION

Recurrent AD is considered a rare but grave late complication of AD, particularly if it affects a previously dissected aortic segment; early mortality is similar, however, most patients survive into their next chronic phase of the disease.

## S4-SSVA01-Clinical Evaluation of Non-contrast-Enhanced QISS Magnetic Resonance Angiography as Follow-up Examination Modality for the Evaluation of Aneurysms and Their Endoleaks After Abdominal Endovascular Aneurysm Repair

Karim Mostafa, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Clinical evaluation of non-contrast-enhanced QISS magnetic resonance angiography in its ability to diagnose and monitor endoleaks and aneurysm diameters after abdominal endovascular aneurysm repair (EVAR) in direct comparison to contrast-enhanced computed tomography angiography (CE-CTA).

## METHODS AND MATERIALS

Our study included 20 patients (17 male, median age 79.8 years) who underwent radial QISS-MRA and CE-CTA after non-fenestrated infrarenal EVAR at their first follow-up examination. Two radiologists evaluated datasets from both techniques for each patient concerning presence of endoleaks, types of endoleaks, aneurysm diameters and image quality.

## RESULTS

Compared to CE-CTA, all endoleaks after abdominal EVAR were detected and classified correctly on QISS-MRA. The interobserver agreement between CE-CTA and QISS-MRA was almost perfect, except for type 2 endoleaks, where agreement was substantial. Intermodal aneurysm diameter measurements correlate "very strongly" for both observers. All results were statistically significant. Hyperdense imaging artefacts in CE-CTA cause aneurysm diameter measurements to be inaccurate by up to 1 cm. These artifacts were not present in QISS-MRA. Also, QISS-MRA seems to be more sensitive in detecting type II endoleaks. Some type II endoleaks could only be detected in QISS-MRA but not in CE-CTA, which was most likely due to low-flow endoleak-characteristics.

## CONCLUSION

QISS-MRA is a contrast agent free technique for diagnosing and monitoring all types of endoleaks and aneurysms in patients after abdominal EVAR. It provides information about specific clinical questions concerning aneurysm size as well as presence and types of endoleaks without exposure to radiation and contrast agents.

## CLINICAL RELEVANCE/APPLICATION

After implantation of an aortic prosthesis, patients will undergo a contrast-enhanced CT examination to then be stratified to risk groups. For low- and intermediate risk patients, aneurysm monitoring is recommended with ultrasound. In cases where ultrasound is not feasible due to its known limitations, CT diagnostics will be necessary with the side effect of radiation and contrast media exposure. In this scenario, QISS magnetic resonance angiography constitutes a radiation- and contrast free imaging modality that can answer specific clinical questions concerning aneurysm diameter and presence of endoleaks. In all patients after EVAR, a follow-up CT examination is recommended five years after prosthesis implantation. Here, QISS magnetic resonance angiography can be implemented as well, as it can provide necessary information about the aneurysm and its endoleaks with the advantage of avoidance radiation and contrast media exposure.



## Abstract Archives of the RSNA, 2023

S4-SSVA01-1

### Deep Learning-Based Radiomics of CTA to Predict Adverse Events After Initial Endovascular Repair for Acute Uncomplicated Stanford Type B Aortic Dissection

Sunday, Nov. 26 1:00PM - 2:00PM Room: N226

Xuefang Lu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients undergoing thoracic endovascular aortic repair (TEVAR) with acute uncomplicated Stanford type B aortic dissection (uTBAD) are associated with a high rate of postoperative adverse events (AE). To develop a prediction model using deep learning-based radiomics features of computed tomography angiography (CTA) and clinical features to predict AE of acute uTBAD after initial TEVAR.

#### METHODS AND MATERIALS

A retrospective study of 232 patients between January 2015 and January 2022 undergoing TEVAR with acute uTBAD was conducted. The three-dimensional (3D) deep convolutional neural network (CNN) was used to automatically recognize and segment CTA images and obtain the required general radiomic features. Analysis of Variance and the Least Absolute Shrinkage and Section Operation algorithms were implemented for feature selection and radiomics score building. The radiomics score (Rad-Score) and clinical factors were incorporated in a nomogram using the multivariable logistic regression analysis. The Hosmer-Lemeshow test was used to check the calibration of models. The Kaplan-Meier curve was used to stratify the risk of patients.

#### RESULTS

The Rad-Score incorporation with platelet and C-reactive protein showed moderate improvement in the efficiency with an AUC of 0.82 (95% CI, 0.74-0.89) in the training cohort and AUC of 0.72 (95% CI, 0.57-0.86) in inter-validation cohort. The specific performance of the combined model was shown AUC of 0.77(95%CI,0.66-0.88) in the independent validation cohort collected in 2020 and 2021, the accuracy of 0.72, precision of 0.65, sensitivity of 0.85, specificity of 0.62. The Hosmer-Lemeshow test was statistically significant in the combined model ( $t_{\text{training}}=0.15$ ,  $t_{\text{inter-validation}}=0.19$ ,  $t_{\text{independent validation}}=0.18$ ,  $p>0.05$ ). The Kaplan-Meier curve confirmed that patients with low-risk Rad-scores tended to have better survival.

#### CONCLUSION

The combination of deep learning-based radiomics of CTA and clinical indicators can predict AE after initial TEVAR in acute uTBAD patients. The nomogram was verified to be clinically useful. It is expected to provide early warning of patients' prognosis during follow-up examinations.

#### CLINICAL RELEVANCE/APPLICATION

The combination of image morphological and clinical indicators can predict acute uTBAD patients with high risk of AE after initial TEVAR. The Rad-Score incorporation with clinical factors with an AUC of 0.82 (95% CI, 0.74-0.89) in the training cohort, AUC of 0.72 (95% CI, 0.57-0.86) in the inter-validation cohort, and AUC of 0.77(95%CI,0.66-0.88) in the independent validation cohort. The nomogram was verified to be clinically useful. It is expected to provide early warning of patients' prognosis during follow-up examinations.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-SSVA01-2

### Possible Impact of the Revised 2022 ACC Aha Aortic Disease Guideline on the Management of "High-Risk Uncomplicated" Type B Aortic Dissection

Sunday, Nov. 26 1:00PM - 2:00PM Room: N226

Malgorzata Polacin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The role of preventive thoracic endovascular aortic repair (TEVAR) in patients with uncomplicated type B aortic dissection (uTBAD) is a matter of debate. The updated 2022 ACC/AHA aortic disease guideline acknowledges the existence of a "high-risk (HR)" subcategory of uTBAD, with the assignment of a class 2B consideration for TEVAR. We explore the frequency of HR imaging features in a retrospective cohort of patients with uTBAD and compare the actual frequency of interventions with the rate of interventions that could have been considered according to the updated 2022 guideline.

#### METHODS AND MATERIALS

We retrospectively analyzed 86 consecutive patients (mean age 49 ±17 years) with acute TBAD between 2013 and 2017. Out of 86 patients 26 were classified as complicated TBAD at the time of the event, based on organ/limb ischemia (n=20) or impending aortic rupture (n=4). 60 patients were classified as initially uTBAD at the time of the event. Baseline and follow-up CTs were reviewed by two cardiovascular radiologists (8 and 25 years of experience). Patients were reclassified according to the 2022 guideline into uTBAD and the new HR-uTBAD category, if at least one high-risk imaging feature was present. The rate of patients who could have been considered for intervention was compared to the actual intervention rate.

#### RESULTS

Out of 60 patients originally classified as uTBAD, 48 demonstrated at least one HR imaging feature enumerated in the 2022 guideline at baseline (initial aortic diameter of >40 mm, false lumen diameter >22 mm, entry tear diameter >10 mm, entry tear at the lesser aortic curvature, radiographic-only malperfusion, hemorrhagic pleural effusion), and additional 7 patients demonstrated a high-risk feature within 2 years (aortic growth >5 mm in sequential imaging), resulting in a total of 55 HR-uTBAD out of the original 60 uTBAD. Within 2 years, only 15 of 60 uTBADs required intervention for late complications (12 with aortic growth, 2 with branch vessel occlusion, 1 with impending rupture). From 60 patients classified as HR uTBAD 40 had no late complications. If the presence of HR imaging features had been used to guide preemptive TEVAR in acute TBAD, the rate of interventions would have increased from 30% (cTBAD only) to 94% (cTBAD and HR-uTBAD).

#### CONCLUSION

Applying the recently introduced "high-risk" subcategory of uTBAD in the updated 2022 guideline, more than 90% of all uTBADs would have qualified as HR-uTBAD and would be eligible for preemptive TEVAR, although secondary complications occurred in only 25% of patients.

#### CLINICAL RELEVANCE/APPLICATION

This updated guideline will significantly influence cardiovascular radiologists and their reports with the potential need for structured reporting of HR features when diagnosing patients with acute TBAD.

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## Abstract Archives of the RSNA, 2023

S4-SSVA01-3

### Quantification of Abdominal Aortic Aneurysm Strain Using MR Feature Tracking: Accuracy and Association with Progression Rate

Sunday, Nov. 26 1:00PM - 2:00PM Room: N226

Huiming Dong, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Abdominal Aortic Aneurysm (AAA) management, primarily determined by maximum aneurysm diameter and growth rate, fails to preempt many catastrophic ruptures. Aortic wall strain may provide additional insight into risk of progression. MR feature tracking (FT) measures myocardial tissue strain from standard cine steady-state free precession (SSFP) MR images. This study aimed to (1) assess the accuracy of AAA wall circumferential strain by MR FT (MR Strain) using an in silico approach, and (2) investigate its relationship with recent AAA progression in patients under surveillance.

#### METHODS AND MATERIALS

MR strain was measured using a work-in-progress FT software package. Accuracy of MR strain was assessed against the ground-truth strain in 54 synthetic cine MRIs created from finite element model (FEM) simulation of a patient's abdomen using a range of aortic pulse pressures, tissue motions, luminal signal intensity variations and image noise. Association of in vivo MR strain with progression was assessed in 25 consecutive AAA patients that had a prior MRI or CT study within >6 months and ≤2 years from which maximum diameter (Dmax) growth rate was quantified. Pulse-gated cine bSSFP imaging was acquired at the level of the AAA and the normal caliber aorta, proximal to the aneurysm. Univariate and multivariate regression were used to associate growth rate with clinical variables, Dmax and peak circumferential MR strain across the cardiac cycle. Two independent readers measured MR strain to assess interoperator variability.

#### RESULTS

In silico, bias and limits of agreement (LoA) of MR strain were  $0.48 \pm 0.42\%$ , with a correlation slope of 0.963 to ground-truth. In vivo, MR strain was significantly lower in AAA ( $1.2 \pm 0.6\%$ ) than the non-aneurysmal aorta ( $2.4 \pm 1.7\%$ ; Wilcoxon sign-rank test  $P < .001$ ). In univariate analyses Dmax (regression coefficient = 0.087,  $P < .001$ ) and peak strain (regression coefficient = -1.563,  $P < .001$ ) significantly associated with growth rate while diabetes, hypertension and current smoking nearly reached significance. MR strain remained an independent predictor of growth rate (regression coefficient = -0.904,  $P = .014$ ) after controlling for Dmax. MR strain was highly reproducible (bias ± LoA:  $0.03 \pm 0.31\%$ , intraclass correlation coefficient: 97.8%, coefficient of variation: 7.14%).

#### CONCLUSION

MR feature tracking can reliably measure AAA wall circumferential strain and is associated with recent growth rate independent of aneurysm diameter.

#### CLINICAL RELEVANCE/APPLICATION

MR strain of AAA may reflect the underlying dynamic degenerative remodeling of elastin fibers and shifting of the mechanical load to the much stiffer collagen, offering improved AAA risk stratification.

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## Abstract Archives of the RSNA, 2023

S4-SSVA01-4

### Predictors of Late Adverse Events in Patients with Surgically Managed Type I Aortic Dissection

Sunday, Nov. 26 1:00PM - 2:00PM Room: N226

Hyejin Park (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate and find predictors of adverse events in patients with AD type I using early postoperative CT after ascending aorta replacement.

#### **METHODS AND MATERIALS**

From January 2011 to December 2017, 103 consecutive patients ( $55.43 \pm 13.94$  years, men 49.5%) who underwent ascending aorta replacement due to AD type I and have available early postoperative CT within 3 months were included. Primary outcome was AD-related adverse events that defined as AD-related death and 2<sup>nd</sup> aorta operation due to AD associated aortic aneurysm or impending rupture. Secondary outcome was annual growth rate of the aorta. Postoperative CT exams were evaluated to determine the location and size of primary intimal tear, multi-level maximum diameter of the aorta, and false lumen status. Univariate and multivariable cox regression analyses were performed to find predictors that associated with AD-related adverse events.

#### **RESULTS**

Of all, 24 (23.3%) patients presented AD-related adverse events. Marfan syndrome, initial maximum diameter at multi-level of the aorta, and primary intimal tear size ( $=10$  mm) were independently associated with adverse events in univariate cox regression analysis. In multivariable cox regression analysis, Marfan syndrome (HR [hazard ratio], 15.33; 95% confidence interval [CI], 5.37-43.74;  $P < 0.001$ ), maximal aorta diameter  $\geq 40$  mm (HR, 4.90; 95% CI, 1.93-12.40;  $P < 0.001$ ), and multiple intimal tears  $\geq 3$  (HR, 7.12; 95% CI, 2.68-18.92;  $P < 0.001$ ) were significant factors associated with AD-related adverse events.

#### **CONCLUSION**

Maximal aortic diameter  $\geq 40$  mm and multiple intimal tears on early postoperative CT will help to identify patients with high risk of adverse events in whom more aggressive management would be necessary.

#### **CLINICAL RELEVANCE/APPLICATION**

Early postoperative CT findings can identify patients with high risk of adverse events, and careful follow-up with preventive intervention can be considered in those with high risk findings.

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## Abstract Archives of the RSNA, 2023

S4-SSVA01-5

### Recurrent Aortic Dissection: Imaging and Clinical Outcomes

Sunday, Nov. 26 1:00PM - 2:00PM Room: N226

Apichaya Sriprachyakul, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To describe the frequency, risk factors, radiologic findings and clinical outcome of recurrent aortic dissection (AD) compared with initial aortic dissection.

#### METHODS AND MATERIALS

The initial CT angiograms and all follow-up imaging studies of 445 consecutive patients with acute aortic syndrome (AAS) were retrospectively reviewed by 2 cardiovascular radiologists, and patients with acute aortic dissection were identified. Follow-up CT angiograms were assessed to determine recurrent AD. The demographics and risk factors were collected. CT scans at initial and recurrent ADs were evaluated for involved aortic segment (same, different, or overlapping segments), involved lumen (true, false or both lumens), and aneurysm formation. Associations between radiologic findings and mortality were evaluated using chi-squared or Fisher exact tests. Mortality rate was calculated. Prognostic factors were analyzed by log-rank test and Cox proportional hazards modelling.

#### RESULTS

We identified 276 initial ADs (196 men, mean age 60 years, range 23-95 years) and 24 recurrent ADs (20 men, mean age 55 years, range 23-81 years). Patients with recurrent AD were younger than patients experiencing a first AD ( $52 \pm 15$  versus  $60 \pm 15$  years;  $P=0.008$ ). The Marfan syndrome was significantly more common in recurrent AD (21% versus 7%;  $P=0.004$ ). The recurrent AD involved the same (previously dissected) or a different (previously non-dissected) aortic segments in 43% and 39%, respectively. If a recurrent AD affected the same segment ( $n=10$ ), the new dissection delaminated the already thinned, previously dissected outer wall of the false lumen in 6, and dissected the former true-lumen wall in 4. The involved aortic segment, involved lumen, and aneurysm formation in recurrent AD were not associated with mortality ( $P=0.679$ , 0.470, and 0.539 respectively). Patients with recurrent AD had a higher mortality rate at 1 year than in patients with initial AD (25.2% and 13.6%). Recurrent AD (HR =1.87; 95% CI 0.79-4.46;  $P=0.155$ ) was positively associated with 1-year mortality but was not a statically significant predictor.

#### CONCLUSION

Among patients with aortic dissection, 8 % present with recurrent AD. Recurrent AD is strongly associated with Marfan syndrome and younger age. Although a recurrent AD in the same segment can further delaminate an already thinned aortic wall, radiologic features were not significantly associated with mortality in this study. Recurrent AD was not significantly associated with early mortality.

#### CLINICAL RELEVANCE/APPLICATION

Recurrent AD is considered a rare but grave late complication of AD, particularly if it affects a previously dissected aortic segment; early mortality is similar, however, most patients survive into their next chronic phase of the disease.

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## Abstract Archives of the RSNA, 2023

S4-SSVA01-6

### **Clinical Evaluation of Non-contrast-Enhanced QISS Magnetic Resonance Angiography as Follow-up Examination Modality for the Evaluation of Aneurysms and Their Endoleaks After Abdominal Endovascular Aneurysm Repair**

Sunday, Nov. 26 1:00PM - 2:00PM Room: N226

Karim Mostafa, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Clinical evaluation of non-contrast-enhanced QISS magnetic resonance angiography in its ability to diagnose and monitor endoleaks and aneurysm diameters after abdominal endovascular aneurysm repair (EVAR) in direct comparison to contrast-enhanced computed tomography angiography (CE-CTA).

#### **METHODS AND MATERIALS**

Our study included 20 patients (17 male, median age 79.8 years) who underwent radial QISS-MRA and CE-CTA after non-fenestrated infrarenal EVAR at their first follow-up examination. Two radiologists evaluated datasets from both techniques for each patient concerning presence of endoleaks, types of endoleaks, aneurysm diameters and image quality.

#### **RESULTS**

Compared to CE-CTA, all endoleaks after abdominal EVAR were detected and classified correctly on QISS-MRA. The interobserver agreement between CE-CTA and QISS-MRA was almost perfect, except for type 2 endoleaks, where agreement was substantial. Intermodal aneurysm diameter measurements correlate "very strongly" for both observers. All results were statistically significant. Hyperdense imaging artefacts in CE-CTA cause aneurysm diameter measurements to be inaccurate by up to 1 cm. These artifacts were not present in QISS-MRA. Also, QISS-MRA seems to be more sensitive in detecting type II endoleaks. Some type II endoleaks could only be detected in QISS-MRA but not in CE-CTA, which was most likely due to low-flow endoleak-characteristics.

#### **CONCLUSION**

QISS-MRA is a contrast agent free technique for diagnosing and monitoring all types of endoleaks and aneurysms in patients after abdominal EVAR. It provides information about specific clinical questions concerning aneurysm size as well as presence and types of endoleaks without exposure to radiation and contrast agents.

#### **CLINICAL RELEVANCE/APPLICATION**

After implantation of an aortic prosthesis, patients will undergo a contrast-enhanced CT examination to then be stratified to risk groups. For low- and intermediate risk patients, aneurysm monitoring is recommended with ultrasound. In cases where ultrasound is not feasible due to its known limitations, CT diagnostics will be necessary with the side effect of radiation and contrast media exposure. In this scenario, QISS magnetic resonance angiography constitutes a radiation- and contrast free imaging modality that can answer specific clinical questions concerning aneurysm diameter and presence of endoleaks. In all patients after EVAR, a follow-up CT examination is recommended five years after prosthesis implantation. Here, QISS magnetic resonance angiography can be implemented as well, as it can provide necessary information about the aneurysm and its endoleaks with the advantage of avoidance radiation and contrast media exposure.

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## Abstract Archives of the RSNA, 2023

S4-STCE1

### Science Session (Generative AI)

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 1

#### Sub-Events

### S4-STCE1-1 A Variety Driven Generative Model for Binary Classifications in Radiological Imaging

Dong Ni, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Despite the potential benefits of using data augmentation for alleviating data insufficiency, traditional augmentation methods make decision boundary ambiguous. On the other hand, the quality of generated images remains uncertain, particularly in small-scale datasets. We developed a novel generative model effectively controlling the changes of generated images in cross-domain and inner-domain. If further validated, this generative model could have great clinical utility in limited annotated radiological datasets.

#### METHODS AND MATERIALS

A generative model enabling parameterized data projection is developed to online augment the training data. We use vertical and horizontal projection to generate cross-domain and inner-domain images respectively. The target images' projection distances are measured so that the parameterized generators learn to control the degree of variation while translating the source images in the forward pass. An auxiliary pre-trained classifier using hinge loss constructs a hyperplane to guide the projections. The source images' projection distance is also considered as the specified controllable parameter in the backward reconstruction pass. We mix two public ultrasound datasets for benign and malignant breast lesion classification and use a public CT dataset for non-COVID-19 and COVID-19 classification. The data split for breast ultrasound is set as 598(train), 106 (validation) and 106 (test), and for covid-19 detection is as 425(train), 118 (validation) and 203 (test). All training data is pre-augmented by horizontal flip.

#### RESULTS

The proposed generative model improved the generalization ability of the downstream classifiers. For the breast lesion classification, the AUC score increased by 0.026(AlexNet), 0.035(VGG13), 0.028(VGG16), 0.040(GoogleNet), 0.017(ResNet18), 0.009(ResNet34), 0.045(DenseNet121), 0.052(MobileNet V3), 0.023(Convnext) and decreased by -0.04(EfficientNet B5). For the covid-19 detection, the AUC score increased by 0.038 (AlexNet), 0.027(VGG16), 0.028(GoogleNet), 0.088(ResNet18), 0.094(ResNet34), 0.039(DenseNet121), 0.012(MobileNet V3), 0.006(EfficientNet B5), 0.019(Convnext) and decreased by -0.003(VGG13).

#### CONCLUSION

We showcase the effectiveness of parameterized data projection embedded in generators for generating images to improve the various downstream binary classifiers. We observe that enabling the control of the variety of generated data has more impact than blindly increasing the number of training data.

#### CLINICAL RELEVANCE/APPLICATION

The proposed generative model has the potential to alleviate training data insufficiency in clinical application. This is especially true in the medical field because of the data privacy issue and labeling cost.

### S4-STCE1-2 GPT language models for automated synoptic reporting and determination of resectability in pancreatic cancer

Rajesh Bhayana, MD, FRCPC (*Presenter*) Nothing to Disclose

#### PURPOSE

Structured radiology reports for pancreatic ductal adenocarcinoma (PDAC) staging are superior to free-text reports for surgical planning, but radiologist adoption is variable. The purpose of this study is to assess the accuracy of foundational GPT

language models in extracting key information from PDAC staging free-text reports to create synoptic reports, and to explore their ability to apply National Comprehensive Cancer Network (NCCN) criteria to determine tumor resectability.

## **METHODS AND MATERIALS**

In this IRB-approved retrospective study in progress, 100 consecutive initial PDAC staging CT free-text reports of patients referred to a quaternary care pancreatic cancer centre in 2018 were included. With few-shot prompting, GPT language models (GPT-3.5-turbo, GPT-4) were given free-text reports to create synoptic reports with 14 key parameters, including: tumor location, size, duct dilatation, status of major vessels, arterial variant anatomy, lymph nodes and metastases. Using the synoptic report, separately tuned models were prompted with a few-shot approach to classify the tumor as resectable, borderline resectable, locally advanced (unresectable), or metastatic (unresectable) using NCCN criteria. Synoptic reports were assessed for accuracy in data extraction overall and for each of the 14 parameters, along with classification of resectability.

## **RESULTS**

100 free-text PDAC staging CT reports were included. GPT-3.5 was 96.5% accurate in extracting key parameters into synoptic reports (1351 of 1400). It demonstrated near perfect or perfect accuracy in extracting tumor location (98%), size (98%), pancreatic duct dilatation (99%), biliary dilatation (97%), lymph nodes (99%), and metastases (98%); along with celiac artery (98%), common hepatic artery (100%), and aortic (100%) status. GPT-3.5 was less accurate at extracting superior mesenteric artery (92%) and venous (92%) status. GPT-3.5 correctly classified tumor resectability in 71% of cases (71 of 100). GPT-4 results and assessment of surgeon report preference are pending.

## **CONCLUSION**

With few-shot prompting, foundational GPT language models demonstrate impressive accuracy in extracting key parameters from free-text pancreatic cancer staging reports into synoptic reports. On the more advanced task of resectability determination, GPT-3.5 was less accurate.

## **CLINICAL RELEVANCE/APPLICATION**

Accurate automated synoptic reports derived from free-text pancreatic cancer staging reports would improve surgical planning by improving accessibility of key information. They could also save radiologists time and benefit researchers. More advanced and task-specific fine-tuned models may further improve classification of resectability, which could aid clinical decision making.

## **S4-STCE1-3 RoentGen: Vision-Language Model for text-guided Chest X-Ray Generation**

Christian A. Bluethgen, MD, MSc (*Presenter*) Nothing to Disclose

## **PURPOSE**

1) To generate synthetic chest x-rays (CXR) based on radiological text reports by adapting a generative latent denoising diffusion probabilistic model and a transformer-based text encoder to the radiology domain. 2) To establish an evaluation framework for text-conditioned synthesis of CXR. 3) To evaluate the added value of synthetic CXR for training deep learning (DL) models for radiological downstream tasks.

## **METHODS AND MATERIALS**

A large public dataset of 337k real CXR and corresponding radiology text reports (MIMIC-CXR) was used to fine-tune a denoising diffusion probabilistic model (Stable Diffusion, SD). The model's U-Net component and the model's transformer-based text-encoder (CLIP/ViT-L14) were fine-tuned alone or jointly. The evaluation framework consisted of multiple steps: 1) human evaluation by two board-certified radiologists for image quality and text-image alignment; 2) quantitative image assessment in the form of Frechet inception distance (FID) and MS-SSIM as measures of fidelity and generative diversity, respectively; 3) multi-label classification performance of classifiers trained on real CXR. Finally, synthetic CXR were used to train multilabel classification models.

## **RESULTS**

As confirmed by radiologists and quantitative metrics, the adapted model can synthesize high-quality artificial CXR whose appearance follows radiological text prompts (e.g., "large left-sided pleural effusion"). Quantitatively, synthetic CXR improved over a previous baseline in a few-shot setting in terms of fidelity (FID of 3.6 vs. 19.5 baseline), diversity (MS-SSIM of  $0.14 \pm 0.06$  vs.  $0.28 \pm 0.07$  baseline), classification performance (avg. AUC 0.81 vs. 0.61 baseline). Using synthetic CXR to train classification models slightly decreased in-distribution performance compared to training on real CXR (up to -3%) but improved performance in two out-of-distribution datasets (Chexpert, VinDr-CXR) by up to 5%.

## **CONCLUSION**

Domain adaptation of a large-scale pretrained text-to-image generative models for the creation of synthetic CXR is possible. The resulting CXR convey radiological concepts with high fidelity as established by the proposed evaluation framework, and may improve generalization performance of deep learning models.

## **CLINICAL RELEVANCE/APPLICATION**

Text-conditioned synthesis of CXR allows the creation of tailored training data, which could help in the context of data sharing (to mitigate privacy concerns) and could help to mitigate class imbalances (e.g., when training models for diseases with low prevalences or in the context of heavily biased data). An immediate clinical application is the education of medical students and residents, as synthetic CXR capture radiological concepts with high fidelity.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S4-STCE1-1

### A Variety Driven Generative Model for Binary Classifications in Radiological Imaging

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 1

Dong Ni, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Despite the potential benefits of using data augmentation for alleviating data insufficiency, traditional augmentation methods make decision boundary ambiguous. On the other hand, the quality of generated images remains uncertain, particularly in small-scale datasets. We developed a novel generative model effectively controlling the changes of generated images in cross-domain and inner-domain. If further validated, this generative model could have great clinical utility in limited annotated radiological datasets.

#### METHODS AND MATERIALS

A generative model enabling parameterized data projection is developed to online augment the training data. We use vertical and horizontal projection to generate cross-domain and inner-domain images respectively. The target images' projection distances are measured so that the parameterized generators learn to control the degree of variation while translating the source images in the forward pass. An auxiliary pre-trained classifier using hinge loss constructs a hyperplane to guide the projections. The source images' projection distance is also considered as the specified controllable parameter in the backward reconstruction pass. We mix two public ultrasound datasets for benign and malignant breast lesion classification and use a public CT dataset for non-COVID-19 and COVID-19 classification. The data split for breast ultrasound is set as 598(train), 106 (validation) and 106 (test), and for covid-19 detection is as 425(train), 118 (validation) and 203 (test). All training data is pre-augmented by horizontal flip.

#### RESULTS

The proposed generative model improved the generalization ability of the downstream classifiers. For the breast lesion classification, the AUC score increased by 0.026(AlexNet), 0.035(VGG13), 0.028(VGG16), 0.040(GoogleNet), 0.017(ResNet18), 0.009(ResNet34), 0.045(DenseNet121), 0.052(MobileNet V3), 0.023(Convnext) and decreased by -0.04(EfficientNet B5). For the covid-19 detection, the AUC score increased by 0.038 (AlexNet), 0.027(VGG16), 0.028(GoogleNet), 0.088(ResNet18), 0.094(ResNet34), 0.039(DenseNet121), 0.012(MobileNet V3), 0.006(EfficientNet B5), 0.019(Convnext) and decreased by -0.003(VGG13).

#### CONCLUSION

We showcase the effectiveness of parameterized data projection embedded in generators for generating images to improve the various downstream binary classifiers. We observe that enabling the control of the variety of generated data has more impact than blindly increasing the number of training data.

#### CLINICAL RELEVANCE/APPLICATION

The proposed generative model has the potential to alleviate training data insufficiency in clinical application. This is especially true in the medical field because of the data privacy issue and labeling cost.

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## Abstract Archives of the RSNA, 2023

S4-STCE1-2

### **GPT language models for automated synoptic reporting and determination of resectability in pancreatic cancer**

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 1

Rajesh Bhayana, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Structured radiology reports for pancreatic ductal adenocarcinoma (PDAC) staging are superior to free-text reports for surgical planning, but radiologist adoption is variable. The purpose of this study is to assess the accuracy of foundational GPT language models in extracting key information from PDAC staging free-text reports to create synoptic reports, and to explore their ability to apply National Comprehensive Cancer Network (NCCN) criteria to determine tumor resectability.

#### **METHODS AND MATERIALS**

In this IRB-approved retrospective study in progress, 100 consecutive initial PDAC staging CT free-text reports of patients referred to a quaternary care pancreatic cancer centre in 2018 were included. With few-shot prompting, GPT language models (GPT-3.5-turbo, GPT-4) were given free-text reports to create synoptic reports with 14 key parameters, including: tumor location, size, duct dilatation, status of major vessels, arterial variant anatomy, lymph nodes and metastases. Using the synoptic report, separately tuned models were prompted with a few-shot approach to classify the tumor as resectable, borderline resectable, locally advanced (unresectable), or metastatic (unresectable) using NCCN criteria. Synoptic reports were assessed for accuracy in data extraction overall and for each of the 14 parameters, along with classification of resectability.

#### **RESULTS**

100 free-text PDAC staging CT reports were included. GPT-3.5 was 96.5% accurate in extracting key parameters into synoptic reports (1351 of 1400). It demonstrated near perfect or perfect accuracy in extracting tumor location (98%), size (98%), pancreatic duct dilatation (99%), biliary dilatation (97%), lymph nodes (99%), and metastases (98%); along with celiac artery (98%), common hepatic artery (100%), and aortic (100%) status. GPT-3.5 was less accurate at extracting superior mesenteric artery (92%) and venous (92%) status. GPT-3.5 correctly classified tumor resectability in 71% of cases (71 of 100). GPT-4 results and assessment of surgeon report preference are pending.

#### **CONCLUSION**

With few-shot prompting, foundational GPT language models demonstrate impressive accuracy in extracting key parameters from free-text pancreatic cancer staging reports into synoptic reports. On the more advanced task of resectability determination, GPT-3.5 was less accurate.

#### **CLINICAL RELEVANCE/APPLICATION**

Accurate automated synoptic reports derived from free-text pancreatic cancer staging reports would improve surgical planning by improving accessibility of key information. They could also save radiologists time and benefit researchers. More advanced and task-specific fine-tuned models may further improve classification of resectability, which could aid clinical decision making.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-STCE1-3

### RoentGen: Vision-Language Model for text-guided Chest X-Ray Generation

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 1

Christian A. Bluethgen, MD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

1) To generate synthetic chest x-rays (CXR) based on radiological text reports by adapting a generative latent denoising diffusion probabilistic model and a transformer-based text encoder to the radiology domain. 2) To establish an evaluation framework for text-conditioned synthesis of CXR. 3) To evaluate the added value of synthetic CXR for training deep learning (DL) models for radiological downstream tasks.

#### METHODS AND MATERIALS

A large public dataset of 337k real CXR and corresponding radiology text reports (MIMIC-CXR) was used to fine-tune a denoising diffusion probabilistic model (Stable Diffusion, SD). The model's U-Net component and the model's transformer-based text-encoder (CLIP/ViT-L14) were fine-tuned alone or jointly. The evaluation framework consisted of multiple steps: 1) human evaluation by two board-certified radiologists for image quality and text-image alignment; 2) quantitative image assessment in the form of Frechet inception distance (FID) and MS-SSIM as measures of fidelity and generative diversity, respectively; 3) multi-label classification performance of classifiers trained on real CXR. Finally, synthetic CXR were used to train multilabel classification models.

#### RESULTS

As confirmed by radiologists and quantitative metrics, the adapted model can synthesize high-quality artificial CXR whose appearance follows radiological text prompts (e.g., "large left-sided pleural effusion"). Quantitatively, synthetic CXR improved over a previous baseline in a few-shot setting in terms of fidelity (FID of 3.6 vs. 19.5 baseline), diversity (MS-SSIM of  $0.14 \pm 0.06$  vs.  $0.28 \pm 0.07$  baseline), classification performance (avg. AUC 0.81 vs. 0.61 baseline). Using synthetic CXR to train classification models slightly decreased in-distribution performance compared to training on real CXR (up to -3%) but improved performance in two out-of-distribution datasets (Chexpert, VinDr-CXR) by up to 5%.

#### CONCLUSION

Domain adaptation of a large-scale pretrained text-to-image generative models for the creation of synthetic CXR is possible. The resulting CXR convey radiological concepts with high fidelity as established by the proposed evaluation framework, and may improve generalization performance of deep learning models.

#### CLINICAL RELEVANCE/APPLICATION

Text-conditioned synthesis of CXR allows the creation of tailored training data, which could help in the context of data sharing (to mitigate privacy concerns) and could help to mitigate class imbalances (e.g., when training models for diseases with low prevalences or in the context of heavily biased data). An immediate clinical application is the education of medical students and residents, as synthetic CXR capture radiological concepts with high fidelity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-STCE2

### Science Session (Theranostics)

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 2

#### Sub-Events

#### **S4-STCE2-1 Impact of pre- and post-contrast-enhanced MR-based attenuation correction on tracer quantification in malignant lesions in 68Ga-DOTATOC PET/MRI**

Aleksandar Milosevic, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Peptide Receptor Radionuclide Therapy (PRRT) is an established treatment concept in patients with neuroendocrine tumors (NET). Therefore, PETCT and PET/MRI imaging with 68Ga-DOTATOC is an important tool for initial receptor status assessment and treatment monitoring. As MR-based attenuation correction (MRAC) can be influenced by gadolinium-based contrast agents (CA), the purpose of the present study was to quantify the effects of CA administration on MRAC in the evaluation of target lesions in 68Ga-DOTATOC PET/MRI.

#### **METHODS AND MATERIALS**

Twenty-four NET patients with tumor lesions underwent whole-body 68Ga DOTATOC PET/MRI for staging purposes. According to a consensus reading, 72 target lesions (primaries and metastases) were selected for measurement of standardized uptake values (SUVmax, SUVpeak, SUVmean). High-resolution CAIPI-accelerated Dixon 3D VIBE sequences with bone atlas and truncation correction using HUGE method (B0 homogenization with gradient enhancement) were acquired before and after CA administration. PET data were subsequently reconstructed using both resulting  $\mu$ maps (MRACnative and MRACpostCA). Each target lesion was measured in both versions of MRAC-PET utilizing a volume of interest (VOI). Measured values were compared using the Pearson Correlation Coefficient. In addition, a Bland-Altman-analysis was performed to determine the limits of agreement (LOA).

#### **RESULTS**

A strong correlation was achieved for the SUV values before and after contrast medium administration (SUVmax. 0.99; SUVpeak. 0.997; SUVmean. 0.993;  $p < 0,001$ ). While Bland-Altman-analysis showed acceptable LOAs for SUVpeak (1.7 and -2.1), and SUVmean (1.8 and -2.2), wide LOAs for SUVmax (4.5 and -4.7) could be observed.

#### **CONCLUSION**

Certain deviations between the measured values in pre- and post-contrast attenuation-corrected corrected PET-images may occur due to the application of a gadolinium-based CAs.

#### **CLINICAL RELEVANCE/APPLICATION**

As the administration of CA can influence MRAC, special attention should be paid to the timepoint of CA administration in patients requiring 68Ga DOTATOC PET/MRI for treatment monitoring of PRRT.

#### **S4-STCE2-2 Assessment of Myocardial Viability in the Subacute Phase of Myocardial Infarction: A Comparative Study of Native T1, T2 Mapping, and Strain Analysis with Late Gadolinium Enhancement**

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to evaluate the potential of myocardial strain, T1, and T2 mapping as non-contrast-based methods for assessing myocardial damage extent and distinguishing viable from non-viable myocardium in the subacute phase of myocardial infarction.

## **METHODS AND MATERIALS**

Forty-three patients (mean age  $56.05 \pm 10$  years, 86% male) and eight sex and age-matched healthy volunteers underwent 1.5 T CMR with a viability protocol. Global myocardial strain parameters, including global longitudinal strain (GLS), global radial strain (GRS), and global circumferential strain (GCS), were measured and compared between the patient and control groups. Additionally, global T1 and T2 values were compared between the two groups. The segmental strain values and T1/T2 mapping were assessed in viable and non-viable myocardium, with late gadolinium enhancement (LGE) serving as the gold standard for viability assessment.

## **RESULTS**

GCS demonstrated the highest diagnostic accuracy (AUC 0.827,  $p < 0.001$ , 95%CI 0.792-0.861) in differentiating viable from non-viable myocardium among segmental parameters. A GCS cut-off of -8.809 enabled the differentiation of viable and non-viable segments with 81% sensitivity and 71% specificity.

## **CONCLUSION**

This findings suggest that strain, T1, and T2 mapping can be an effective non-contrast-based methods for assessing myocardial viability, with significant differences observed in parametric values between viable and non-viable segments. Moreover, the significant correlations between global values and enhanced/grey zone size support their potential use for viability assessment without the need for gadolinium contrast agents.

## **CLINICAL RELEVANCE/APPLICATION**

Determining viable from non viable myocardium is important in clinical decision making, if we can assess it through non invasive imaging it can help in patient management and treatment planning.

## **S4-STCE2-3 Machine Learning-based Prediction of Ventricular Function, Myocardial T2 star, and Liver Parameters in Thalassemia Patients using MRI Images**

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

In this study we introduce a method that could predict iron cardiomyopathy in thalassemia major patients. This situation is preventable, but delayed diagnosis may lead to grim prognosis. We want to predict left ventricular function, myocardial and liver T2 star in thalassemia major patients using machine learning methods based on MRI images. This can enhance our capability in diagnosis, treatment and preventing iron overload cardiomyopathy. This research has implications for early intervention and better management of thalassemia-associated cardiac complications.

## **METHODS AND MATERIALS**

We studied 300 thalassemia major patients who underwent cardiac MR imaging to assess cardiac status. The inclusion criteria were; patients with a left ventricular ejection fraction (LVEF) greater than 55%, cardiac iron deposition (T2 star) less than 20 ms, and liver deposition (T2 star) less than 11.4 ms based on CMR. valvular heart problems, congenital heart diseases, infectious diseases, hypertension, liver failure, diabetes, kidney diseases, and those using medications affecting myocardial function were excluded. after 18-month, CMR was repeated, and individuals with LVEF<55%, heart T2 star<20 ms, and liver T2 star<11.4 ms were selected for comparative analysis. three feature selection methods (LASSO, MRMR, and NCA) and also seven different classifiers were used for predictive modeling.

## **RESULTS**

495 radiomics features were extracted separately for end systole and end diastole from the images. Additionally, a set of features for the liver, as well as a combined set of features for end systole, diastole, and liver, along with clinical features such as age and gender, were utilized for feature selection and modeling. Among these, features based on GLCM (Gray level co matrix), as haaralick and tamura features, showed significant difference among groups who had decline in cardiac function and those who had not.

## **CONCLUSION**

This study showcases the capabilities of machine learning methods in risk stratifying of iron overload in thalassemia major patients by MRI images.

## **CLINICAL RELEVANCE/APPLICATION**

By predicting those patients who are at greater risk of developing iron overload cardiomyopathy, more aggressive treatment can delay cardiomyopathy and improve patient survival.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-STCE2-1

### Impact of pre- and post-contrast-enhanced MR-based attenuation correction on tracer quantification in malignant lesions in 68Ga-DOTATOC PET/MRI

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 2

Aleksandar Milosevic, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Peptide Receptor Radionuclide Therapy (PRRT) is an established treatment concept in patients with neuroendocrine tumors (NET). Therefore, PETCT and PET/MRI imaging with 68Ga-DOTATOC is an important tool for initial receptor status assessment and treatment monitoring. As MR-based attenuation correction (MRAC) can be influenced by gadolinium-based contrast agents (CA), the purpose of the present study was to quantify the effects of CA administration on MRAC in the evaluation of target lesions in 68Ga-DOTATOC PET/MRI.

#### METHODS AND MATERIALS

Twenty-four NET patients with tumor lesions underwent whole-body 68Ga DOTATOC PET/MRI for staging purposes. According to a consensus reading, 72 target lesions (primaries and metastases) were selected for measurement of standardized uptake values (SUVmax, SUVpeak, SUVmean). High-resolution CAIPI-accelerated Dixon 3D VIBE sequences with bone atlas and truncation correction using HUGE method (B0 homogenization with gradient enhancement) were acquired before and after CA administration. PET data were subsequently reconstructed using both resulting  $\mu$ maps (MRACnative and MRACpostCA). Each target lesion was measured in both versions of MRAC-PET utilizing a volume of interest (VOI). Measured values were compared using the Pearson Correlation Coefficient. In addition, a Bland-Altman-analysis was performed to determine the limits of agreement (LOA).

#### RESULTS

A strong correlation was achieved for the SUV values before and after contrast medium administration (SUVmax. 0.99; SUVpeak. 0.997; SUVmean. 0.993;  $p < 0,001$ ). While Bland-Altman-analysis showed acceptable LOAs for SUVpeak (1.7 and -2.1), and SUVmean (1.8 and -2.2), wide LOAs for SUVmax (4.5 and -4.7) could be observed.

#### CONCLUSION

Certain deviations between the measured values in pre- and post-contrast attenuation-corrected corrected PET-images may occur due to the application of a gadolinium-based CAs.

#### CLINICAL RELEVANCE/APPLICATION

As the administration of CA can influence MRAC, special attention should be paid to the timepoint of CA administration in patients requiring 68Ga DOTATOC PET/MRI for treatment monitoring of PRRT.

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## Abstract Archives of the RSNA, 2023

S4-STCE2-2

### Assessment of Myocardial Viability in the Subacute Phase of Myocardial Infarction: A Comparative Study of Native T1, T2 Mapping, and Strain Analysis with Late Gadolinium Enhancement

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 2

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to evaluate the potential of myocardial strain, T1, and T2 mapping as non-contrast-based methods for assessing myocardial damage extent and distinguishing viable from non-viable myocardium in the subacute phase of myocardial infarction.

#### METHODS AND MATERIALS

Forty-three patients (mean age  $56.05 \pm 10$  years, 86% male) and eight sex and age-matched healthy volunteers underwent 1.5 T CMR with a viability protocol. Global myocardial strain parameters, including global longitudinal strain (GLS), global radial strain (GRS), and global circumferential strain (GCS), were measured and compared between the patient and control groups. Additionally, global T1 and T2 values were compared between the two groups. The segmental strain values and T1/T2 mapping were assessed in viable and non-viable myocardium, with late gadolinium enhancement (LGE) serving as the gold standard for viability assessment.

#### RESULTS

GCS demonstrated the highest diagnostic accuracy (AUC 0.827,  $p < 0.001$ , 95%CI 0.792-0.861) in differentiating viable from non-viable myocardium among segmental parameters. A GCS cut-off of  $-8.809$  enabled the differentiation of viable and non-viable segments with 81% sensitivity and 71% specificity.

#### CONCLUSION

These findings suggest that strain, T1, and T2 mapping can be an effective non-contrast-based method for assessing myocardial viability, with significant differences observed in parametric values between viable and non-viable segments. Moreover, the significant correlations between global values and enhanced/grey zone size support their potential use for viability assessment without the need for gadolinium contrast agents.

#### CLINICAL RELEVANCE/APPLICATION

Determining viable from non-viable myocardium is important in clinical decision making, if we can assess it through non-invasive imaging it can help in patient management and treatment planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S4-STCE2-3

### Machine Learning-based Prediction of Ventricular Function, Myocardial T2 star, and Liver Parameters in Thalassemia Patients using MRI Images

Sunday, Nov. 26 1:00PM - 1:30PM Room: Learning Center Theater 2

Ali Mohammadzadeh Koupareh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In this study we introduce a method that could predict iron cardiomyopathy in thalassemia major patients. This situation is preventable, but delayed diagnosis may lead to grim prognosis. We want to predict left ventricular function, myocardial and liver T2 star in thalassemia major patients using machine learning methods based on MRI images. This can enhance our capability in diagnosis, treatment and preventing iron overload cardiomyopathy. This research has implications for early intervention and better management of thalassemia-associated cardiac complications.

#### METHODS AND MATERIALS

We studied 300 thalassemia major patients who underwent cardiac MR imaging to assess cardiac status. The inclusion criteria were; patients with a left ventricular ejection fraction (LVEF) greater than 55%, cardiac iron deposition (T2 star) less than 20 ms, and liver deposition (T2 star) less than 11.4 ms based on CMR. valvular heart problems, congenital heart diseases, infectious diseases, hypertension, liver failure, diabetes, kidney diseases, and those using medications affecting myocardial function were excluded. after 18-month, CMR was repeated, and individuals with LVEF<55%, heart T2 star<20 ms, and liver T2 star<11.4 ms were selected for comparative analysis. three feature selection methods (LASSO, MRMR, and NCA) and also seven different classifiers were used for predictive modeling.

#### RESULTS

495 radiomics features were extracted separately for end systole and end diastole from the images. Additionally, a set of features for the liver, as well as a combined set of features for end systole, diastole, and liver, along with clinical features such as age and gender, were utilized for feature selection and modeling. Among these, features based on GLCM (Gray level co matrix), as haaralick and tamura features, showed significant difference among groups who had decline in cardiac function and those who had not.

#### CONCLUSION

This study showcases the capabilities of machine learning methods in risk stratifying of iron overload in thalassemia major patients by MRI images.

#### CLINICAL RELEVANCE/APPLICATION

By predicting those patients who are at greater risk of developing iron overload cardiomyopathy, more aggressive treatment can delay cardiomyopathy and improve patient survival.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-SSBR02

### Breast Imaging (CEM: Advanced Applications)

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450B

Debra L. Monticciolo, MD (*Moderator*) Nothing to Disclose  
Gary J. Whitman, MD (*Moderator*) Consultant, Siemens AG; Editor, Wolters Kluwer nv  
Janice S. Sung, MD (*Moderator*) Research Grant, General Electric Company

#### Sub-Events

### S5-SSBR02-Role of Contrast-Enhanced Mammography (CEM) In the Assessment of the Outcome of Cryoablation Following One Year of Treatment<sup>1</sup>

Federica Di Naro, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the efficacy of ultrasound-guided cryoablation (UGC) of low-risk early-stage breast cancer, combining CEM and re-evaluation with biopsy.

#### METHODS AND MATERIALS

UGC was performed at our center on 28 biopsy-proven malignant lesions of 28 patients (mean age 73.4 years old) held inoperable by a multidisciplinary group, under hormone therapy. All the lesions were ultrasound-visible invasive ductal carcinoma (<30 mm), low to intermediate grade, HR-positive, HER2-negative. Each patient underwent Contrast Enhanced Mammography (CEM) staging to confirm the unifocality. Patients were subdivided according to molecular subtype, Ki67% and 1 cm dimensional cut-off. The outcome of UGC was analyzed assessing the size reduction rate (RR) with US, at 1, 3 and 6 months and with CEM and biopsy at 12 months. Samples were collected in the outer and core zones of the site. Our gold standard was the histology result. Fisher test and chi-square test were applied.

#### RESULTS

28 lesions had a mean RR of 20.1%, 66.4% and 94% at 1, 3 and 6 months respectively. Hyperechoic procedural scarrings were visible without any US recognizable trace of the index lesion in 13/28 after 3 months, and in 25/28 after 6 months. 14 were Luminal-A (Lum-A) and 14 Luminal B Her-2 negative (Lum-B): after 1 month, mean (RR) was similar for both subtypes (21.6% Lum-A, 19.8% Lum-B), after 3 months RR was higher for Lum-A (70.2%) versus 60.7% of Lum-B and after 6 months it was 96.8% for Lum-A and 93.4% for Lum-B. 24/28 were BC>1 cm and 4/28 we BC<1 cm: after 1 month RR was 19.7% for BC>1 cm and 23% for BC<1 cm, after 3 months RR was higher for BC<1 cm (84.4%) versus BC>1 cm (63.4%); after 6 months it was 100% for BC<1 cm and 93% for BC>1 cm. Furthermore, after 1 month RR for BC with Ki67<20% was 24.6% and 18.8% for BC with Ki67>20%. After 3 months it was 62.8% for BC with Ki67>20% and 65.3% for Ki67<20%. At 6 months, RR was 96.5% for BC with Ki67>20% and 93.4% for Ki67<20%. Any statistical significant difference emerged. At 12 months, all 28 patients underwent CEM. In 26 cases, no enhancement was detectable, in 2/28 enhancement was found (mainly as mass). In these cases, biopsy confirmed residual traces of B5 lesions only in the core zone of the scarring site, corresponding perfectly to CEM results. In all the negative CEM cases, biopsy reported only benign lesions (flogosis).

#### CONCLUSION

CEM findings perfectly matched the histology results, indeed enhancing masses were detected only where histology reported traces of B5 lesions. UGC is a safe, feasible and effective and CEM is a necessary useful and reliable exam in the follow up.

#### CLINICAL RELEVANCE/APPLICATION

Combining CEM and re-evaluation with biopsy, in selected histology of breast cancer, proved the efficacy of the UGC and the reliability of CEM as an essential useful annual follow-up exam

### S5-SSBR02-Factors Influencing False Positive Recall Rates on Contrast-Enhanced Mammography (CEM)<sup>2</sup>

Wendie A. Berg, MD, PhD (*Presenter*) Institutional Research Grant, Koios Medical, Inc

## PURPOSE

Breast density increases recalls on mammography as does background parenchymal enhancement (BPE) on MRI. We sought to evaluate impact of breast density, BPE, menopausal status, prior radiation therapy (XRT), and use of tamoxifen or aromatase inhibitors, on false-positive recall (FPR) rates on contrast-enhanced mammography (CEM).

## METHODS AND MATERIALS

From two ongoing IRB-approved studies of screening CEM, we evaluated false-positive recall rates by breast for prevalence screening CEM for exams completed through 12/31/2022. We prospectively recorded menopausal status [more than 1 year since last menstrual period (LMP) or bilateral oophorectomy; or date of LMP]; prior XRT; current endocrine therapy; visual BI-RADS density; and BPE (minimal, mild, moderate, marked). We considered each of two prospective specialist radiologist interpretations. We examined FPR rates as a function of each of these factors in bivariate analysis and then in a logistic regression model, and we report odds ratios [OR, (95%CI)] for FPR.

## RESULTS

Women ranged in age from 31 to 85 years and, overall, there were 7070 interpretations of 3535 breasts, including 555/7070 (7.9%) false-positives. Of the 7070 breast interpretations, 55 (0.8%) were in fatty breasts; 2630 (37.2%) scattered fibroglandular tissue; 4172 (59.0%) heterogeneously dense; and 213 (3.0%) extremely dense. Binarized as dense or not dense, in bivariate analysis the OR for FPR was 1.56 (1.29,1.89) for women with dense compared to non-dense breasts. Of the 7070 breast interpretations, BPE was minimal in 3804 (53.8%), mild in 2416 (34.2%), moderate in 731 (10.3%), and marked in 119 (1.7%); 1116 (15.8%) were in premenopausal women and 5954 (84.2%) postmenopausal; 1010 (14.3%) were in women taking endocrine therapy and 2166 (30.6%) were in breasts with prior XRT. Spearman's correlation of BPE with density was 0.36. With minimal BPE as referent, for mild BPE, OR was 1.74 (1.41,2.13); for moderate BPE, OR was 2.48 (1.85,3.33); for marked BPE, OR was 2.16 (1.18,3.75); and density was not independently significant, with OR 1.17 (0.95,1.44). Premenopausal status increased risk of FPR with OR 1.30 (1.03,1.65) and endocrine therapy tended to reduce FPR, OR 0.77 (0.58,1.02). Prior XRT did not affect FPR [OR1.14 (0.92,1.39)].

## CONCLUSION

The lowest FPR rates were seen in postmenopausal women with minimal BPE at 5.1% (180/3564) and highest at 16.7% (62/371) in premenopausal women with moderate-marked BPE.

## CLINICAL RELEVANCE/APPLICATION

Understanding the greater potential for false-positive recalls in premenopausal women with elevated BPE may help reduce such recalls and increase the net benefit of screening CEM.

## S5-SSBR02-Diagnostic Performance of Contrast-Enhanced Mammography for Varying Levels of Background Parenchymal Enhancement

Sarah Eskreis-Winkler, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Contrast-enhanced mammography (CEM) is increasingly used for breast cancer screening in the intermediate risk population but its diagnostic performance for varying levels of background parenchymal enhancement (BPE) has not yet been characterized. Herein, we compare CEM performance across the four BPE assessment categories.

## METHODS AND MATERIALS

In this IRB-approved HIPAA-compliant study, screening CEMs performed at our institution from 2013-2022 were retrospectively reviewed. Exams were excluded if they lacked standardized BPE assessments or lacked 12 month follow up. CEM was performed with dual-energy mammography, with imaging initiated 2-2.5 min after contrast injection. Standard performance metrics, including cancer detection rate (CDR), interval cancer rate (IC) and positive predictive value of biopsy (PPV3) were calculated for all patients, and for each BPE category. Metrics for high BPE (marked or moderate) were compared to low BPE (mild or minimal). For all comparisons, a two-tailed two-proportion Z-test was calculated.

## RESULTS

A total of 2938 screening CEDMs were included in the analysis. There were 1,005 (34%) minimal BPE, 1285 (44%) mild BPE, 491 (17%) moderate BPE, and 61 (2%) marked BPE exams. CDR was not statistically significantly different between high and low BPE (7.1 per 1000 v. 3.5 per 1000;  $p = 0.24$ ). PPV3 (33.3% v. 21.2%;  $p = 0.4$ ) and IC (5.3 per 1,000 v. 2.2 per 1,000;  $p=0.4$ ) were also not significantly different. However, both CDR and PPV showed an increasing trend from minimal to mild to moderate BPE. The pattern dropped off for marked BPE, possibly due to the small number of cases ( $n=61$ ).

## CONCLUSION

There is no statistically significant difference in the performance of CEM with increasing BPE. In fact, a trend of increasing CDR and PPV were observed from minimal to moderate BPE, possibly related to an intrinsic increase in risk, and further evaluation is warranted with a larger dataset.

## CLINICAL RELEVANCE/APPLICATION

CEM is increasingly used as a breast cancer screening tool in intermediate risk women, but its performance across BPE subtypes has not yet been evaluated. Despite concerns that high levels of BPE may mask cancer, this evaluation finds no statistically significant differences in performance across BPE categories, although further evaluation is warranted with a larger dataset.

### S5-SSBR02-Quantitative Analysis of Background Parenchymal Enhancement in Contrast Enhanced Mammography

Chang Liu, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast Enhanced Mammography (CEM) has shown clinical benefits, in a similar role as breast DCE-MRI. DCE-MRI background parenchymal enhancement (BPE), known as the contrast enhancement of fibroglandular tissue, is an important measure to characterize breast tumor. Recently, ACR released the BI-RADS criteria for qualitatively assessing BPE in CEM, but quantitative analytics of BPE in CEM is unexplored. We aim to establish an automated pipeline for quantifying CEM BPE and assess its characteristics on cancer and benign patients.

#### METHODS AND MATERIALS

Under an IRB-approved protocol, 292 consenting patients with 332 BI-RADS 4A/4B/4C or 5 breast lesions underwent pre-biopsy CEM (Biopsy outcome: 78 cancer and 254 benign), generating dual low (LE), high energy, and digital energy subtraction (DES) images. An experienced radiologists produced qualitative BPE using the BI-RADS descriptors (i.e., minimal, mild, moderate, marked). Following a similar concept to breast DCE-MRI, we developed an automatic pipeline to calculate three quantitative BPE measures: |BPE| (absolute area of enhanced pixels in fibroglandular tissue); BPE\_b% (|BPE| over the entire breast region), and BPE\_f% (|BPE| over the fibroglandular tissue region). We computed BPE measures with respect to a range of thresholds for two types of cutoffs: (A) the absolute pixel intensity (range: 2000- 2160) of DES image or (B) the intensity ratio (0%-200%) of DES over LE image. A pixel with an equal or greater value than a threshold is considered enhanced. We conducted t-test to compare BPE between patients with biopsy-proven cancer or benign lesions. We built a logistic regression model using quantitative vs. qualitative BPE and 5-fold cross-validation to compare AUCs of classifying cancer vs. benign cases.

#### RESULTS

A range of cutoff thresholds had a significant difference ( $p < 0.05$ ) between cancer and benign cases. The differences were significant for |BPE| and | BPE\_b% when the threshold fell into the intensity range of 2000-2064. A similar trend was seen when the ratio threshold was in 0%-80%. BPE\_f% showed distinguishing ability only in the range of 2080-2012. BPE under the two different cutoffs showed overall similar patterns. The AUC of radiologist's qualitative BPE is 0.59 (std=0.09) while it is 0.63 (std=0.11;  $p=0.39$ ) for the quantitative BPE.

#### CONCLUSION

We build an automated pipeline to quantify BPE in CEM. Similar to breast DCE-MRI, there is a range of thresholds where the derived BPE measures show significant differences between cancer and benign cases.

## CLINICAL RELEVANCE/APPLICATION

Characterizing BPE in CEM is important in evaluating CEM with respect to breast DCE-MRI. Automated quantification of BPE provides reproducible measures to increase clinical utilities of CEM.

### S5-SSBR02-Background Parenchymal Enhancement in CEM and MRI: Is There Always a High Agreement

Francesca Ferrara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Background parenchymal enhancement (BPE) refers to the physiological contrast enhancement of breast fibroglandular tissue on magnetic resonance imaging (MRI). BPE is increasingly recognized as a potential imaging biomarker. It remains unclear, whether insights on BPE in MRI can be translated to contrast-enhanced mammography (CEM), a novel technology based on the same physiological principles. The aim of this study was to determine the agreement between BPE on CEM and MRI and to investigate potential confounders.

#### METHODS AND MATERIALS

Eligible for this retrospective, IRB-approved, single-center study were women recalled from screening or with inconclusive findings on conventional imaging who were imaged by both CEM and MRI between 2018 and 2022 at our institution. Both MRI and CEM protocols followed international guidelines and recommendations. Exclusion criteria were more than one month between the two examinations and incomplete examinations. Two blinded breast fellows assessed breast density and BPE levels on CEM and MRI, according to BI-RADS. BPE on MRI was also graded in the late post-contrast acquisition. Data on

menopausal status and technical parameters (breast thickness, compression force) were retrieved. Univariate and multivariate tests were used to investigate the BPE agreement between CEM and MRI and the influence of confounders including menopausal status, mammographic density, and breast compression force on CEM.

## **RESULTS**

A total of 343 patients (mean age 55.6; SD 11.1; range 30-87) were consecutively enrolled in this study. In both modalities, post-menopausal patients showed significantly lower BPE levels ( $p < 0.001$ ). Agreement on BPE levels between CEM and MRI in the early phase was fair in both readers ( $R1 ? 0.342$ ,  $R2 ? 0.383$ ). Agreement between CEM and MRI in the late phase was moderate for R1 and fair for R2 ( $R1 ? 0.432$ ,  $R2 ? 0.368$ ). There was a significant correlation between BPE and density in CEM ( $R1 ? 0.399$ ,  $R2 ? 0.441$ ;  $p < 0.001$ ). A negative correlation was found between BPE on CEM and compression force in each projection ( $r = -0.100$ ,  $p = 0.001$ ). Inter-reader agreement for grading BPE on CEM and MRI in both phases was substantial (CEM  $? 0.678$ , BPE MRI early  $? 0.690$ , BPE MRI late  $? 0.692$ ).

## **CONCLUSION**

The agreement of BPE assessment between MRI and CEM was fair to moderate and reproducibility among readers in both modalities was high. While these results indicate that CEM and MRI measure a comparable physiological phenomenon, compression force, and mammographic breast density had an impact on BPE in CEM.

## **CLINICAL RELEVANCE/APPLICATION**

Mechanisms behind BPE on CEM are still under-investigated and might differ from those affecting MRI. Technical factors and breast density could play a major role in determining BPE levels on CEM.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSBR02-1

### Role of Contrast-Enhanced Mammography (CEM) In the Assessment of the Outcome of Cryoablation Following One Year of Treatment

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450B

Federica Di Naro, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the efficacy of ultrasound-guided cryoablation (UGC) of low-risk early-stage breast cancer, combining CEM and re-evaluation with biopsy.

#### METHODS AND MATERIALS

UGC was performed at our center on 28 biopsy-proven malignant lesions of 28 patients (mean age 73.4 years old) held inoperable by a multidisciplinary group, under hormone therapy. All the lesions were ultrasound-visible invasive ductal carcinoma (<30 mm), low to intermediate grade, HR-positive, HER2-negative. Each patient underwent Contrast Enhanced Mammography (CEM) staging to confirm the unifocality. Patients were subdivided according to molecular subtype, Ki67% and 1 cm dimensional cut-off. The outcome of UGC was analyzed assessing the size reduction rate (RR) with US, at 1, 3 and 6 months and with CEM and biopsy at 12 months. Samples were collected in the outer and core zones of the site. Our gold standard was the histology result. Fisher test and chi-square test were applied.

#### RESULTS

28 lesions had a mean RR of 20.1%, 66.4% and 94% at 1, 3 and 6 months respectively. Hyperechoic procedural scarrings were visible without any US recognizable trace of the index lesion in 13/28 after 3 months, and in 25/28 after 6 months. 14 were Luminal-A (Lum-A) and 14 Luminal B Her-2 negative (Lum-B): after 1 month, mean (RR) was similar for both subtypes (21.6% Lum-A, 19.8% Lum-B), after 3 months RR was higher for Lum-A (70.2%) versus 60.7% of Lum-B and after 6 months it was 96.8% for Lum-A and 93.4% for Lum-B. 24/28 were BC>1 cm and 4/28 we BC<1 cm: after 1 month RR was 19.7% for BC>1 cm and 23% for BC<1 cm, after 3 months RR was higher for BC<1 cm (84.4%) versus BC>1 cm (63.4%); after 6 months it was 100% for BC<1 cm and 93% for BC>1 cm. Furthermore, after 1 month RR for BC with Ki67<20% was 24.6% and 18.8% for BC with Ki67>20%. After 3 months it was 62.8% for BC with Ki67>20% and 65.3% for Ki67<20%. At 6 months, RR was 96.5% for BC with Ki67>20% and 93.4% for Ki67<20%. Any statistical significant difference emerged. At 12 months, all 28 patients underwent CEM. In 26 cases, no enhancement was detectable, in 2/28 enhancement was found (mainly as mass). In these cases, biopsy confirmed residual traces of B5 lesions only in the core zone of the scarring site, corresponding perfectly to CEM results. In all the negative CEM cases, biopsy reported only benign lesions (flogosis).

#### CONCLUSION

CEM findings perfectly matched the histology results, indeed enhancing masses were detected only where histology reported traces of B5 lesions. UGC is a safe, feasible and effective and CEM is a necessary useful and reliable exam in the follow up.

#### CLINICAL RELEVANCE/APPLICATION

Combining CEM and re-evaluation with biopsy, in selected histology of breast cancer, proved the efficacy of the UGC and the reliability of CEM as an essential useful annual follow-up exam

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## Abstract Archives of the RSNA, 2023

S5-SSBR02-2

### Factors Influencing False Positive Recall Rates on Contrast-Enhanced Mammography (CEM)

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450B

Wendie A. Berg, MD, PhD (*Presenter*) Institutional Research Grant, Koios Medical, Inc

#### PURPOSE

Breast density increases recalls on mammography as does background parenchymal enhancement (BPE) on MRI. We sought to evaluate impact of breast density, BPE, menopausal status, prior radiation therapy (XRT), and use of tamoxifen or aromatase inhibitors, on false-positive recall (FPR) rates on contrast-enhanced mammography (CEM).

#### METHODS AND MATERIALS

From two ongoing IRB-approved studies of screening CEM, we evaluated false-positive recall rates by breast for prevalence screening CEM for exams completed through 12/31/2022. We prospectively recorded menopausal status [more than 1 year since last menstrual period (LMP) or bilateral oophorectomy; or date of LMP]; prior XRT; current endocrine therapy; visual BI-RADS density; and BPE (minimal, mild, moderate, marked). We considered each of two prospective specialist radiologist interpretations. We examined FPR rates as a function of each of these factors in bivariate analysis and then in a logistic regression model, and we report odds ratios [OR, (95%CI)] for FPR.

#### RESULTS

Women ranged in age from 31 to 85 years and, overall, there were 7070 interpretations of 3535 breasts, including 555/7070 (7.9%) false-positives. Of the 7070 breast interpretations, 55 (0.8%) were in fatty breasts; 2630 (37.2%) scattered fibroglandular tissue; 4172 (59.0%) heterogeneously dense; and 213 (3.0%) extremely dense. Binarized as dense or not dense, in bivariate analysis the OR for FPR was 1.56 (1.29,1.89) for women with dense compared to non-dense breasts. Of the 7070 breast interpretations, BPE was minimal in 3804 (53.8%), mild in 2416 (34.2%), moderate in 731 (10.3%), and marked in 119 (1.7%); 1116 (15.8%) were in premenopausal women and 5954 (84.2%) postmenopausal; 1010 (14.3%) were in women taking endocrine therapy and 2166 (30.6%) were in breasts with prior XRT. Spearman's correlation of BPE with density was 0.36. With minimal BPE as referent, for mild BPE, OR was 1.74 (1.41,2.13); for moderate BPE, OR was 2.48 (1.85,3.33); for marked BPE, OR was 2.16 (1.18,3.75); and density was not independently significant, with OR 1.17 (0.95,1.44). Premenopausal status increased risk of FPR with OR 1.30 (1.03,1.65) and endocrine therapy tended to reduce FPR, OR 0.77 (0.58,1.02). Prior XRT did not affect FPR [OR1.14 (0.92,1.39)].

#### CONCLUSION

The lowest FPR rates were seen in postmenopausal women with minimal BPE at 5.1% (180/3564) and highest at 16.7% (62/371) in premenopausal women with moderate-marked BPE.

#### CLINICAL RELEVANCE/APPLICATION

Understanding the greater potential for false-positive recalls in premenopausal women with elevated BPE may help reduce such recalls and increase the net benefit of screening CEM.

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## Abstract Archives of the RSNA, 2023

S5-SSBR02-3

### Diagnostic Performance of Contrast-Enhanced Mammography for Varying Levels of Background Parenchymal Enhancement

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450B

Sarah Eskreis-Winkler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast-enhanced mammography (CEM) is increasingly used for breast cancer screening in the intermediate risk population but its diagnostic performance for varying levels of background parenchymal enhancement (BPE) has not yet been characterized. Herein, we compare CEM performance across the four BPE assessment categories.

#### METHODS AND MATERIALS

In this IRB-approved HIPAA-compliant study, screening CEMs performed at our institution from 2013-2022 were retrospectively reviewed. Exams were excluded if they lacked standardized BPE assessments or lacked 12 month follow up. CEM was performed with dual-energy mammography, with imaging initiated 2-2.5 min after contrast injection. Standard performance metrics, including cancer detection rate (CDR), interval cancer rate (IC) and positive predictive value of biopsy (PPV3) were calculated for all patients, and for each BPE category. Metrics for high BPE (marked or moderate) were compared to low BPE (mild or minimal). For all comparisons, a two-tailed two-proportion Z-test was calculated.

#### RESULTS

A total of 2938 screening CEDMs were included in the analysis. There were 1,005 (34%) minimal BPE, 1285 (44%) mild BPE, 491 (17%) moderate BPE, and 61 (2%) marked BPE exams. CDR was not statistically significantly different between high and low BPE (7.1 per 1000 v. 3.5 per 1000;  $p = 0.24$ ). PPV3 (33.3% v. 21.2%;  $p = 0.4$ ) and IC (5.3 per 1,000 v. 2.2 per 1,000;  $p=0.4$ ) were also not significantly different. However, both CDR and PPV showed an increasing trend from minimal to mild to moderate BPE. The pattern dropped off for marked BPE, possibly due to the small number of cases ( $n=61$ ).

#### CONCLUSION

There is no statistically significant difference in the performance of CEM with increasing BPE. In fact, a trend of increasing CDR and PPV were observed from minimal to moderate BPE, possibly related to an intrinsic increase in risk, and further evaluation is warranted with a larger dataset.

#### CLINICAL RELEVANCE/APPLICATION

CEM is increasingly used as a breast cancer screening tool in intermediate risk women, but its performance across BPE subtypes has not yet been evaluated. Despite concerns that high levels of BPE may mask cancer, this evaluation finds no statistically significant differences in performance across BPE categories, although further evaluation is warranted with a larger dataset.

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## Abstract Archives of the RSNA, 2023

S5-SSBR02-4

### Quantitative Analysis of Background Parenchymal Enhancement in Contrast Enhanced Mammography

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450B

Chang Liu, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast Enhanced Mammography (CEM) has shown clinical benefits, in a similar role as breast DCE-MRI. DCE-MRI background parenchymal enhancement (BPE), known as the contrast enhancement of fibroglandular tissue, is an important measure to characterize breast tumor. Recently, ACR released the BI-RADS criteria for qualitatively assessing BPE in CEM, but quantitative analytics of BPE in CEM is unexplored. We aim to establish an automated pipeline for quantifying CEM BPE and assess its characteristics on cancer and benign patients.

#### METHODS AND MATERIALS

Under an IRB-approved protocol, 292 consenting patients with 332 BI-RADS 4A/4B/4C or 5 breast lesions underwent pre-biopsy CEM (Biopsy outcome: 78 cancer and 254 benign), generating dual low (LE), high energy, and digital energy subtraction (DES) images. An experienced radiologist produced qualitative BPE using the BI-RADS descriptors (i.e., minimal, mild, moderate, marked). Following a similar concept to breast DCE-MRI, we developed an automatic pipeline to calculate three quantitative BPE measures: |BPE| (absolute area of enhanced pixels in fibroglandular tissue); BPE\_b% (|BPE| over the entire breast region), and BPE\_f% (|BPE| over the fibroglandular tissue region). We computed BPE measures with respect to a range of thresholds for two types of cutoffs: (A) the absolute pixel intensity (range: 2000- 2160) of DES image or (B) the intensity ratio (0%-200%) of DES over LE image. A pixel with an equal or greater value than a threshold is considered enhanced. We conducted t-test to compare BPE between patients with biopsy-proven cancer or benign lesions. We built a logistic regression model using quantitative vs. qualitative BPE and 5-fold cross-validation to compare AUCs of classifying cancer vs. benign cases.

#### RESULTS

A range of cutoff thresholds had a significant difference ( $p < 0.05$ ) between cancer and benign cases. The differences were significant for |BPE| and |BPE\_b% when the threshold fell into the intensity range of 2000-2064. A similar trend was seen when the ratio threshold was in 0%-80%. BPE\_f% showed distinguishing ability only in the range of 2080-2012. BPE under the two different cutoffs showed overall similar patterns. The AUC of radiologist's qualitative BPE is 0.59 (std=0.09) while it is 0.63 (std=0.11;  $p=0.39$ ) for the quantitative BPE.

#### CONCLUSION

We build an automated pipeline to quantify BPE in CEM. Similar to breast DCE-MRI, there is a range of thresholds where the derived BPE measures show significant differences between cancer and benign cases.

#### CLINICAL RELEVANCE/APPLICATION

Characterizing BPE in CEM is important in evaluating CEM with respect to breast DCE-MRI. Automated quantification of BPE provides reproducible measures to increase clinical utilities of CEM.

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## Abstract Archives of the RSNA, 2023

S5-SSBR02-6

### Background Parenchymal Enhancement in CEM and MRI: Is There Always a High Agreement

Sunday, Nov. 26 2:30PM - 3:30PM Room: E450B

Francesca Ferrara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Background parenchymal enhancement (BPE) refers to the physiological contrast enhancement of breast fibroglandular tissue on magnetic resonance imaging (MRI). BPE is increasingly recognized as a potential imaging biomarker. It remains unclear, whether insights on BPE in MRI can be translated to contrast-enhanced mammography (CEM), a novel technology based on the same physiological principles. The aim of this study was to determine the agreement between BPE on CEM and MRI and to investigate potential confounders.

#### METHODS AND MATERIALS

Eligible for this retrospective, IRB-approved, single-center study were women recalled from screening or with inconclusive findings on conventional imaging who were imaged by both CEM and MRI between 2018 and 2022 at our institution. Both MRI and CEM protocols followed international guidelines and recommendations. Exclusion criteria were more than one month between the two examinations and incomplete examinations. Two blinded breast fellows assessed breast density and BPE levels on CEM and MRI, according to BI-RADS. BPE on MRI was also graded in the late post-contrast acquisition. Data on menopausal status and technical parameters (breast thickness, compression force) were retrieved. Univariate and multivariate tests were used to investigate the BPE agreement between CEM and MRI and the influence of confounders including menopausal status, mammographic density, and breast compression force on CEM.

#### RESULTS

A total of 343 patients (mean age 55.6; SD 11.1; range 30-87) were consecutively enrolled in this study. In both modalities, post-menopausal patients showed significantly lower BPE levels ( $p < 0.001$ ). Agreement on BPE levels between CEM and MRI in the early phase was fair in both readers (R1 ? 0.342, R2 ? 0.383). Agreement between CEM and MRI in the late phase was moderate for R1 and fair for R2 (R1 ? 0.432, R2 ? 0.368). There was a significant correlation between BPE and density in CEM (R1 ? 0.399, R2 ? 0.441;  $p < 0.001$ ). A negative correlation was found between BPE on CEM and compression force in each projection (? -0.100,  $p = 0.001$ ). Inter-reader agreement for grading BPE on CEM and MRI in both phases was substantial (CEM ? 0.678, BPE MRI early ? 0.690, BPE MRI late ? 0.692).

#### CONCLUSION

The agreement of BPE assessment between MRI and CEM was fair to moderate and reproducibility among readers in both modalities was high. While these results indicate that CEM and MRI measure a comparable physiological phenomenon, compression force, and mammographic breast density had an impact on BPE in CEM.

#### CLINICAL RELEVANCE/APPLICATION

Mechanisms behind BPE on CEM are still under-investigated and might differ from those affecting MRI. Technical factors and breast density could play a major role in determining BPE levels on CEM.

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## Abstract Archives of the RSNA, 2023

S5-SSCA02

### Cardiac Imaging (Advanced CMR Techniques)

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451A

Karen G. Ordovas, MD, MS (*Moderator*) Nothing to Disclose  
Michael Markl, PhD (*Moderator*) Research support, Siemens AG Research Grant, Circle Cardiovascular Imaging Inc

#### Sub-Events

### S5-SSCA02-Compressed SENSE Accelerated Single-breath-hold 3D Isotropic Late Gadolinium Enhancement: Clinical Evaluation<sup>2</sup>

Lenhard Pennig, MD (*Presenter*) Speakers Bureau, Koninklijke Philips NV; Institutional Grant, Koninklijke Philips NV

#### PURPOSE

The purpose of this study was to investigate the clinical application of Compressed SENSE accelerated single-breath-hold late gadolinium enhancement (LGE) with 3D isotropic resolution (3D isotropic LGE) compared to conventional LGE imaging acquired in multiple breath-holds.

#### METHODS AND MATERIALS

This was a retrospective, single-center study including 105 examinations of 101 patients ( $48.2 \pm 16.8$  years, 47 females) referred for evaluation of ischemic or non-ischemic cardiomyopathies who received conventional breath-hold and 3D isotropic LGE ( $0.96 \times 0.96 \times 1.1$  mm<sup>3</sup> reconstructed voxel size, Compressed SENSE factor 6.5) sequences at 1.5T in clinical routine. Independently, two radiologists each evaluated 3,570 segments of the left ventricle (LV) for the presence of hyperenhanced lesions (including localization and transmural extent) and their scar edge sharpness (SES) based on a 5-point scale (1 poor - 5 excellent). Confidence of LGE assessment, image quality (IQ), and artifacts were rated using 5-point scales (1 poor - 5 excellent/none). Effects of LV ejection fraction (LVEF), heart rate, body mass index (BMI), and gender as possible confounders on IQ, artifacts, and confidence of LGE assessment were evaluated employing ordinal logistic regression analysis.

#### RESULTS

Using 3D isotropic LGE (average breath hold duration:  $16.0 \pm 3.0$  seconds), readers detected more hyperenhanced lesions ( $n=246$ , 13.8% of analyzed segments) compared to standard breath-hold LGE ( $n=216$ , 12.1% of analyzed segments;  $P < .0001$ ), pronounced at subendocardial, midmyocardial, and subepicardial localizations and for 1-50% of transmural extent. SES was rated superior in 3D isotropic LGE ( $4.1 \pm 0.8$  vs.  $3.3 \pm 0.8$ ;  $P < .001$ ). While 3D isotropic LGE yielded more artifacts ( $3.8 \pm 1.0$  vs.  $4.0 \pm 3.8$ ,  $P = .002$ ), IQ ( $4.1 \pm 1.0$  vs.  $4.2 \pm 0.9$ ;  $P = .122$ ) and confidence of LGE assessment ( $4.3 \pm 0.9$  vs.  $4.3 \pm 0.8$ ;  $P = .374$ ) were comparable between both techniques. Female gender negatively influenced artifacts in 3D isotropic LGE ( $P = .0028$ ) while increased heart rate led to decreased IQ in standard breath-hold LGE ( $P = .0029$ ). LVEF and BMI did not yield a significant influence.

#### CONCLUSION

In clinical routine, Compressed SENSE accelerated single-breath-hold 3D isotropic LGE yields image quality and confidence of LGE assessment comparable to standard breath-hold LGE while providing improved delineation of smaller LGE lesions with superior SES.

#### CLINICAL RELEVANCE/APPLICATION

Given the acquisition of 3D isotropic datasets in one breath hold with subsequent reformation in any arbitrary orientation, Compressed SENSE accelerated single-breath-hold 3D isotropic LGE can drastically reduce the acquisition time of LGE imaging.

### S5-SSCA02-Applying of 7 T Cardiac Magnetic Resonance Imaging to Investigate the Effect of Sodium Selenite on Right Ventricular Structure and Function Secondary to Pulmonary Arterial Hypertension<sup>3</sup>

MD (*Presenter*) Nothing to Disclose

## PURPOSE

Selenium is a trace element with antioxidant stress and anti-inflammatory pro-apoptotic properties. After the onset of pulmonary arterial hypertension (PAH), right ventricular (RV) status are the most crucial factors affecting the patient's prognosis. However, the specific effects of Sodium selenite (SS) on structure and function of the right ventricle secondary to PAH and the related mechanisms are yet to be proven. In this study, we aimed to investigate the effects of SS on RV structure and function subsequent to PAH by cardiac magnetic resonance (CMR) and to elucidate its properties mentioned above.

## METHODS AND MATERIALS

Sixty-two male SD rats were housed for 7 months at the Qinghai-Tibet Plateau with hypobaric hypoxic environment and divided into four groups: CON, MCT, MCT+SE and MCT+SI. The model of MCT/Hypoxia PAH was established by intraperitoneal injection 60 mg/kg of monocrotaline (MCT). One week later, 0.7 mg/kg of SS and 5 mg/kg of sildenafil were given to the MCT+SE group and MCT+SI, respectively. Then, all groups of rats underwent CMR imaging, including FLASH-cine and T2 mapping sequences, to evaluate RV function, strain and edema. Eventually, the sample of blood, heart and lung were obtained for relevant tests.

## RESULTS

Compared with the MCT group, SS intervention significantly elevated RV ejection fraction ( $51.98 \pm 7.88$  vs  $61.30 \pm 6.09$ ), global longitudinal ( $-12.90 \pm 3.53$  vs  $-18.05 \pm 3.43$ ) and circumferential ( $-20.46 \pm 2.47$  vs  $-22.67 \pm 1.32$ ) strain. However, there was no significant difference in T2 relaxation time between groups. Additionally, the blood biochemical results showed that superoxide dismutase ( $216.50 \pm 19.15$  vs  $292.60 \pm 44.38$ ) and glutathione peroxidase ( $9974.00 \pm 900.80$  vs  $17843.00 \pm 3585.00$ ) were significantly higher, while malondialdehyde ( $9.01 \pm 5.59$  vs  $5.53 \pm 1.15$ ), creatine kinase-MB ( $353.00 \pm 61.11$  vs  $210.80 \pm 59.57$ ) and lactic dehydrogenase ( $747.30 \pm 278.80$  vs  $357.90 \pm 135.70$ ) were significantly lower. These findings may be related to upregulate the expression of NRF2 and HO-1, as verified by PCR, immunohistochemical and WB assay. Cardiac-related staining demonstrated that SS treatment impeded the pathological inflammation and promoted RV apoptosis.

## CONCLUSION

Our study shows that SE treatment was found to significantly increase RVEF, GLS, and GCS by CMR imaging. In this regard, we have explored the corresponding mechanisms with the help of some assays.

## CLINICAL RELEVANCE/APPLICATION

Our work is expected to lay a foundation for the clinical evaluation and management of right ventricular dysfunction secondary to PAH.

## S5-SSCA02-Non-Inferiority of Low-Field Cine Cardiovascular Magnetic Resonance Imaging Parameters using a Novel Commercially Available 0.55 T Scanner: A Pilot Study Including Healthy Volunteers and Patients

Martin Segeroth (*Presenter*) Nothing to Disclose

## PURPOSE

To assess time-resolved (cine) cardiovascular magnetic resonance (CMR) imaging at 0.55T by comparing volume and function parameters as well as measures of subjective and objective image quality to a standard 1.5T scanner and thereby testing for non-inferiority.

## METHODS AND MATERIALS

11 healthy participants and 20 patients underwent same-day cine imaging on a 0.55T scanner (Siemens Free.Max) using an ECG-gated prototype cine sequence and on a standard 1.5T scanner (Siemens Avanto fit) system using a product sequence. Based on the results of a blinded, crossover reading study of the healthy participants regarding left- and right ventricular (LV/RV) volume and function parameters including two expert readers (R1/R2) we calculated the needed sample size of the patient cohort regarding non-inferiority with a power of 80% and 10% deviation for LV parameters (15% for RV parameters). Regarding the patient cohort, written reports from clinical routine of cine images acquired on a 1.5T scanner, assessed in a joined fashion by experts from cardiology/radiology, were compared with a blinded reading of two separate experts in cardiac imaging (R1/R2) of the same-patient, same-day 0.55T dataset. Bonferroni-correction was performed, yielding a significance level of 0.00113. Participant and patients evaluated comfort between the two scanners using a Likert-Score of 1 to 5.

## RESULTS

The image quality at both 0.55T and 1.5T was diagnostic for all datasets. Regarding the healthy participants, a high intrareader correlation (R1: 0.86; R2: 0.94) was observed. The average percentual deviation of 0.55T LV parameters from 1.5T was -2% (CI -7% - 3%), for RV -1% (CI -9% - 6%) for both readers. Regarding the patient cohort, a very strong

correlation was observed between 0.55T and 1.5T (R1:  $r = 0.97$ ; R2:  $r = 0.92$ ). LV parameters demonstrated an average percentual deviation of 0.55T from 1.5T of -1% (CI -5% - 3%), respectively RV -1% (CI -6% - 4%). All parameters except end-systolic volume of the LV and RV and SV of the LV demonstrated significantly non-inferiority. In a direct comparison, the participants and patients preferred the 0.55T scanner set-up (mean Likert-Score: 4.2 and 4.4).

#### **CONCLUSION**

Cardiovascular cine imaging at 0.55T yields no general inferior results for quantitative volume and function parameters compared to established imaging at 1.5T. Comfort was reported to be higher at the 0.55T system with the larger bore.

#### **CLINICAL RELEVANCE/APPLICATION**

Due to the larger bore, the lower total costs of ownership and the capability to deal with blackouts of the 0.55T, cine CMR imaging may expand to a larger patient population both in developed and emerging countries.

### **S5-SSCA02-Assessment of Left Ventricular Strain in Children: Comparison Between Free-Breathing 5 Compressed Sensing and Conventional Cine Cardiovascular Magnetic Resonance**

Ke Xu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cardiac magnetic resonance (CMR) feature-tracking (FT) (CMR-FT) has emerged as an established tool for quantitative analysis of myocardial strain which is typically performed on segmented balanced steady-state free precession (bSSFP) with breath holds (BHs). Recently, the compressed sensing (CS) technique has been applied to cine CMR, which has drastically reduced its acquisition time. However, it is unclear whether FT-strain measurements can be reliably derived from free breathing (FB) CS cine imaging, allowing for evaluation of pediatric population with impaired BH capacity. Thus, the aim of this study was to determine the feasibility, reproducibility and agreement of FB CS cine with conventional BH cine CMR for LV strain parameters measurement in children.

#### **METHODS AND MATERIALS**

Forty-one participants (28 patients: mean age  $12.3 \pm 2.4$  years; 13 volunteers:  $11.8 \pm 1.5$  years) were prospective enrolled and underwent both retrospective conventional cine CMR and adaptive CS cine CMR at 3 T. LV short-axis cine images covering the entire LV and vertical 2-chamber long axis and horizontal 4-chamber cine series were obtained and used for FT strain analysis. LV myocardial deformation parameters, including global longitudinal strain (GLS) and strain rate (GLSR), global circumferential strain (GCS) and strain rate (GCSR), as well as global radial strain (GRS) and strain rate (GRSR) were calculated from both cine CMR sequences. Interobserver and intra-observer variabilities of the LV strain values for the two cines method were determined using intraclass correlation coefficient (ICC).

#### **RESULTS**

The total examination time was  $122.4 \pm 7.6$  s for standard cine CMR and  $15.6 \pm 2.2$  s for CS cine CMR ( $p < 0.0001$ ). There was a small but significant ( $p < 0.05$ ) underestimation of GCS (2.2%) and GLS (3.3%) using the CS technique. Nevertheless, the limits of agreement between CS and conventional cine for all strains were narrow. We also observed a small but significant underestimation of GRSR (0.5 s<sup>-1</sup>). However, no significant differences were found in GCSR and GLSR between conventional and CS cine CMR. No difference in inter-observer or intra-observer variability were observed between the BH conventional cine and FB CS cine derived strain and strain rate metrics

#### **CONCLUSION**

FB CS cine CMR showed good agreement and reproducibility for the quantitative assessment of global strain and strain rate assessment by CMR-FT in children compared with conventional BH cine CMR.

#### **CLINICAL RELEVANCE/APPLICATION**

Free-breathing CS cine may have potential as a valid and reliable method for quantification of LV strain parameters with significantly shorter scan times in pediatric population with impaired BH capacity.

### **S5-SSCA02-Left Ventricular Flow Analysis: Changes in Flow Components and Kinetic Energy Profiles in 6 Heart Failure Patients with 4D Flow**

Hau Wai Wong, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to assess correlation between LV functions and flow components volume and kinetic energy using 4D Flow in asymptomatic controls and heart failure patients.

#### **METHODS AND MATERIALS**

32 heart-failure with preserved ejection fraction (HFpEF) patients, 7 heart failure with mid-range ejection fraction (HFmrEF) patients, 11 heart failure with reduced ejection fraction (HFrEF) patients, and 54 controls were included. Their cardiac MRI

images from Oct 2020 to Apr 2023 were retrospectively analysed with Circle Cardiovascular Imaging. Left intraventricular flow is divided into 4 components: direct flow (DF), delayed ejection (DE), retained inflow (RI) and residual volume(ReV) with 4D flow. Volume and kinetic energy (KE) of each component are expressed in its relative proportion and correlated with left ventricular ejection fraction (LVEF) and left ventricular end-diastolic volume index (LV-EDVi).

## **RESULTS**

Direct flow (DF) and residual volume (ReV) components correlate with LVEF and LV-EDVi. When LVEF increases, volume proportion (%) of DF increases ( $p < .001$ ) but that of ReV decreases ( $p < .001$ ). When LV-EDVi increases, volume proportion of DF decreases ( $p < .001$ ) but that of ReV increases ( $p < .001$ ). For KE, when LVEF increases, proportion of KE contributed by DF at peak-systolic and peak-diastolic phases of total KE increases ( $p < .001$ ), while that of ReV decreases ( $p < .001$ ). When LV-EDVi increases, proportion of KE contributed by DF decreases ( $p < .001$ ), while that by ReV increases ( $p < .001$ ). Comparing component's volume in controls and heart failure groups, controls have the highest DF portion, followed by HFpEF, HFmrEF and HFrEF (controls  $35.0 \pm 9.44$  vs. HFpEF  $23.6 \pm 10.6$  vs. HFmrEF  $15.8 \pm 8.06$  vs. HFrEF  $6.73 \pm 4.03$ ,  $p < .001$ ). Conversely, controls have the lowest ReV portion, followed by HFpEF, HFmrEF, and HFrEF (controls  $26.1 \pm 9.39$  vs. HFpEF  $33.2 \pm 13.7$  vs. HFmrEF  $38.4 \pm 12.6$  vs. HFrEF  $51.9 \pm 11.0$ ,  $p < .001$ ). Volume portions of DE and RI are similar. Comparing KE profiles, controls show the highest KE contribution (%) from DF and lowest from ReV, followed by HFpEF, HFmrEF and HFrEF patients (DF KE at peak-systole: controls  $65.0 \pm 10.2$  vs. HFpEF  $47.5 \pm 17.6$  vs. HFmrEF  $33.7 \pm 17.3$  vs. HFrEF  $15.7 \pm 13.1$ ) (ReV KE at peak-systole: controls  $3.46 \pm 1.77$  vs. HFpEF  $7.51 \pm 10.7$  vs. HFmrEF  $15.4 \pm 6.82$  vs. HFrEF  $25.9 \pm 18.6$ ).

## **CONCLUSION**

DF's volume and KE portion increases with LVEF but decreases with LV-EDVi. ReV's volume and KE portion decreases with LVEF but increases with LV-EDVi. CMR 4D flow derived LV DF and ReV parameters allows evaluation of HF patient's severity and delineates them from asymptomatic control.

## **CLINICAL RELEVANCE/APPLICATION**

4D Flow visualizes intraventricular flow and provides novel biomarkers in clinical assessment and management in heart failure patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSCA02-2

### Compressed SENSE Accelerated Single-breath-hold 3D Isotropic Late Gadolinium Enhancement: Clinical Evaluation

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451A

Lenhard Pennig, MD (*Presenter*) Speakers Bureau, Koninklijke Philips NV; Institutional Grant, Koninklijke Philips NV

#### PURPOSE

The purpose of this study was to investigate the clinical application of Compressed SENSE accelerated single-breath-hold late gadolinium enhancement (LGE) with 3D isotropic resolution (3D isotropic LGE) compared to conventional LGE imaging acquired in multiple breath-holds.

#### METHODS AND MATERIALS

This was a retrospective, single-center study including 105 examinations of 101 patients ( $48.2 \pm 16.8$  years, 47 females) referred for evaluation of ischemic or non-ischemic cardiomyopathies who received conventional breath-hold and 3D isotropic LGE ( $0.96 \times 0.96 \times 1.1$  mm<sup>3</sup> reconstructed voxel size, Compressed SENSE factor 6.5) sequences at 1.5T in clinical routine. Independently, two radiologists each evaluated 3,570 segments of the left ventricle (LV) for the presence of hyperenhanced lesions (including localization and transmural extent) and their scar edge sharpness (SES) based on a 5-point scale (1 poor - 5 excellent). Confidence of LGE assessment, image quality (IQ), and artifacts were rated using 5-point scales (1 poor - 5 excellent/none). Effects of LV ejection fraction (LVEF), heart rate, body mass index (BMI), and gender as possible confounders on IQ, artifacts, and confidence of LGE assessment were evaluated employing ordinal logistic regression analysis.

#### RESULTS

Using 3D isotropic LGE (average breath hold duration:  $16.0 \pm 3.0$  seconds), readers detected more hyperenhanced lesions ( $n=246$ , 13.8% of analyzed segments) compared to standard breath-hold LGE ( $n=216$ , 12.1% of analyzed segments;  $P < .0001$ ), pronounced at subendocardial, midmyocardial, and subepicardial localizations and for 1-50% of transmural extent. SES was rated superior in 3D isotropic LGE ( $4.1 \pm 0.8$  vs.  $3.3 \pm 0.8$ ;  $P < .001$ ). While 3D isotropic LGE yielded more artifacts ( $3.8 \pm 1.0$  vs.  $4.0 \pm 3.8$ ,  $P = .002$ ), IQ ( $4.1 \pm 1.0$  vs.  $4.2 \pm 0.9$ ;  $P = .122$ ) and confidence of LGE assessment ( $4.3 \pm 0.9$  vs.  $4.3 \pm 0.8$ ;  $P = .374$ ) were comparable between both techniques. Female gender negatively influenced artifacts in 3D isotropic LGE ( $P = .0028$ ) while increased heart rate led to decreased IQ in standard breath-hold LGE ( $P = .0029$ ). LVEF and BMI did not yield a significant influence.

#### CONCLUSION

In clinical routine, Compressed SENSE accelerated single-breath-hold 3D isotropic LGE yields image quality and confidence of LGE assessment comparable to standard breath-hold LGE while providing improved delineation of smaller LGE lesions with superior SES.

#### CLINICAL RELEVANCE/APPLICATION

Given the acquisition of 3D isotropic datasets in one breath hold with subsequent reformation in any arbitrary orientation, Compressed SENSE accelerated single-breath-hold 3D isotropic LGE can drastically reduce the acquisition time of LGE imaging.

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## Abstract Archives of the RSNA, 2023

S5-SSCA02-3

### Applying of 7 T Cardiac Magnetic Resonance Imaging to Investigate the Effect of Sodium Selenite on Right Ventricular Structure and Function Secondary to Pulmonary Arterial Hypertension

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451A

Hongke Yin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Selenium is a trace element with antioxidant stress and anti-inflammatory pro-apoptotic properties. After the onset of pulmonary arterial hypertension (PAH), right ventricular (RV) status are the most crucial factors affecting the patient's prognosis. However, the specific effects of Sodium selenite (SS) on structure and function of the right ventricle secondary to PAH and the related mechanisms are yet to be proven. In this study, we aimed to investigate the effects of SS on RV structure and function subsequent to PAH by cardiac magnetic resonance (CMR) and to elucidate its properties mentioned above.

#### METHODS AND MATERIALS

Sixty-two male SD rats were housed for 7 months at the Qinghai-Tibet Plateau with hypobaric hypoxic environment and divided into four groups: CON, MCT, MCT+SE and MCT+SI. The model of MCT/Hypoxia PAH was established by intraperitoneal injection 60 mg/kg of monocrotaline (MCT). One week later, 0.7 mg/kg of SS and 5 mg/kg of sildenafil were given to the MCT+SE group and MCT+SI, respectively. Then, all groups of rats underwent CMR imaging, including FLASH-cine and T2 mapping sequences, to evaluate RV function, strain and edema. Eventually, the sample of blood, heart and lung were obtained for relevant tests.

#### RESULTS

Compared with the MCT group, SS intervention significantly elevated RV ejection fraction ( $51.98 \pm 7.88$  vs  $61.30 \pm 6.09$ ), global longitudinal ( $-12.90 \pm 3.53$  vs  $-18.05 \pm 3.43$ ) and circumferential ( $-20.46 \pm 2.47$  vs  $-22.67 \pm 1.32$ ) strain. However, there was no significant difference in T2 relaxation time between groups. Additionally, the blood biochemical results showed that superoxide dismutase ( $216.50 \pm 19.15$  vs  $292.60 \pm 44.38$ ) and glutathione peroxidase ( $9974.00 \pm 900.80$  vs  $17843.00 \pm 3585.00$ ) were significantly higher, while malondialdehyde ( $9.01 \pm 5.59$  vs  $5.53 \pm 1.15$ ), creatine kinase-MB ( $353.00 \pm 61.11$  vs  $210.80 \pm 59.57$ ) and lactic dehydrogenase ( $747.30 \pm 278.80$  vs  $357.90 \pm 135.70$ ) were significantly lower. These findings may be related to upregulate the expression of NRF2 and HO-1, as verified by PCR, immunohistochemical and WB assay. Cardiac-related staining demonstrated that SS treatment impeded the pathological inflammation and promoted RV apoptosis.

#### CONCLUSION

Our study shows that SE treatment was found to significantly increase RVEF, GLS, and GCS by CMR imaging. In this regard, we have explored the corresponding mechanisms with the help of some assays.

#### CLINICAL RELEVANCE/APPLICATION

Our work is expected to lay a foundation for the clinical evaluation and management of right ventricular dysfunction secondary to PAH.

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## Abstract Archives of the RSNA, 2023

S5-SSCA02-4

### **Non-Inferiority of Low-Field Cine Cardiovascular Magnetic Resonance Imaging Parameters using a Novel Commercially Available 0.55 T Scanner: A Pilot Study Including Healthy Volunteers and Patients**

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451A

Martin Segeroth (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess time-resolved (cine) cardiovascular magnetic resonance (CMR) imaging at 0.55T by comparing volume and function parameters as well as measures of subjective and objective image quality to a standard 1.5T scanner and thereby testing for non-inferiority.

#### **METHODS AND MATERIALS**

11 healthy participants and 20 patients underwent same-day cine imaging on a 0.55T scanner (Siemens Free.Max) using an ECG-gated prototype cine sequence and on a standard 1.5T scanner (Siemens Avanto fit) system using a product sequence. Based on the results of a blinded, crossover reading study of the healthy participants regarding left- and right ventricular (LV/RV) volume and function parameters including two expert readers (R1/R2) we calculated the needed sample size of the patient cohort regarding non-inferiority with a power of 80% and 10% deviation for LV parameters (15% for RV parameters). Regarding the patient cohort, written reports from clinical routine of cine images acquired on a 1.5T scanner, assessed in a joined fashion by experts from cardiology/radiology, were compared with a blinded reading of two separate experts in cardiac imaging (R1/R2) of the same-patient, same-day 0.55T dataset. Bonferroni-correction was performed, yielding a significance level of 0.00113. Participant and patients evaluated comfort between the two scanners using a Likert-Score of 1 to 5.

#### **RESULTS**

The image quality at both 0.55T and 1.5T was diagnostic for all datasets. Regarding the healthy participants, a high intrareader correlation (R1: 0.86; R2: 0.94) was observed. The average percentual deviation of 0.55T LV parameters from 1.5T was -2% (CI -7% - 3%), for RV -1% (CI -9% - 6%) for both readers. Regarding the patient cohort, a very strong correlation was observed between 0.55T and 1.5T (R1:  $r = 0.97$ ; R2:  $r = 0.92$ ). LV parameters demonstrated an average percentual deviation of 0.55T from 1.5T of -1% (CI -5% - 3%), respectively RV -1% (CI -6% - 4%). All parameters except end-systolic volume of the LV and RV and SV of the LV demonstrated significantly non-inferiority. In a direct comparison, the participants and patients preferred the 0.55T scanner set-up (mean Likert-Score: 4.2 and 4.4).

#### **CONCLUSION**

Cardiovascular cine imaging at 0.55T yields no general inferior results for quantitative volume and function parameters compared to established imaging at 1.5T. Comfort was reported to be higher at the 0.55T system with the larger bore.

#### **CLINICAL RELEVANCE/APPLICATION**

Due to the larger bore, the lower total costs of ownership and the capability to deal with blackouts of the 0.55T, cine CMR imaging may expand to a larger patient population both in developed and emerging countries.

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## Abstract Archives of the RSNA, 2023

S5-SSCA02-5

### Assessment of Left Ventricular Strain in Children: Comparison Between Free-Breathing Compressed Sensing and Conventional Cine Cardiovascular Magnetic Resonance

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451A

Ke Xu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cardiac magnetic resonance (CMR) feature-tracking (FT) (CMR-FT) has emerged as an established tool for quantitative analysis of myocardial strain which is typically performed on segmented balanced steady-state free precession (bSSFP) with breath holds (BHs). Recently, the compressed sensing (CS) technique has been applied to cine CMR, which has drastically reduced its acquisition time. However, it is unclear whether FT-strain measurements can be reliably derived from free breathing (FB) CS cine imaging, allowing for evaluation of pediatric population with impaired BH capacity. Thus, the aim of this study was to determine the feasibility, reproducibility and agreement of FB CS cine with conventional BH cine CMR for LV strain parameters measurement in children.

#### METHODS AND MATERIALS

Forty-one participants (28 patients: mean age  $12.3 \pm 2.4$  years; 13 volunteers:  $11.8 \pm 1.5$  years) were prospectively enrolled and underwent both retrospective conventional cine CMR and adaptive CS cine CMR at 3 T. LV short-axis cine images covering the entire LV and vertical 2-chamber long axis and horizontal 4-chamber cine series were obtained and used for FT strain analysis. LV myocardial deformation parameters, including global longitudinal strain (GLS) and strain rate (GLSR), global circumferential strain (GCS) and strain rate (GCSR), as well as global radial strain (GRS) and strain rate (GRSR) were calculated from both cine CMR sequences. Interobserver and intra-observer variabilities of the LV strain values for the two cine methods were determined using intraclass correlation coefficient (ICC).

#### RESULTS

The total examination time was  $122.4 \pm 7.6$  s for standard cine CMR and  $15.6 \pm 2.2$  s for CS cine CMR ( $p < 0.0001$ ). There was a small but significant ( $p < 0.05$ ) underestimation of GCS (2.2%) and GLS (3.3%) using the CS technique. Nevertheless, the limits of agreement between CS and conventional cine for all strains were narrow. We also observed a small but significant underestimation of GRSR (0.5 s<sup>-1</sup>). However, no significant differences were found in GCSR and GLSR between conventional and CS cine CMR. No difference in inter-observer or intra-observer variability were observed between the BH conventional cine and FB CS cine derived strain and strain rate metrics.

#### CONCLUSION

FB CS cine CMR showed good agreement and reproducibility for the quantitative assessment of global strain and strain rate assessment by CMR-FT in children compared with conventional BH cine CMR.

#### CLINICAL RELEVANCE/APPLICATION

Free-breathing CS cine may have potential as a valid and reliable method for quantification of LV strain parameters with significantly shorter scan times in pediatric population with impaired BH capacity.

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## Abstract Archives of the RSNA, 2023

S5-SSCA02-6

### Left Ventricular Flow Analysis: Changes in Flow Components and Kinetic Energy Profiles in Heart Failure Patients with 4D Flow

Sunday, Nov. 26 2:30PM - 3:30PM Room: E451A

Hau Wai Wong, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to assess correlation between LV functions and flow components volume and kinetic energy using 4D Flow in asymptomatic controls and heart failure patients.

#### METHODS AND MATERIALS

32 heart-failure with preserved ejection fraction (HFpEF) patients, 7 heart failure with mid-range ejection fraction (HFmrEF) patients, 11 heart failure with reduced ejection fraction (HFrEF) patients, and 54 controls were included. Their cardiac MRI images from Oct 2020 to Apr 2023 were retrospectively analysed with Circle Cardiovascular Imaging. Left intraventricular flow is divided into 4 components: direct flow (DF), delayed ejection (DE), retained inflow (RI) and residual volume(ReV) with 4D flow. Volume and kinetic energy (KE) of each component are expressed in its relative proportion and correlated with left ventricular ejection fraction (LVEF) and left ventricular end-diastolic volume index (LV-EDVi).

#### RESULTS

Direct flow (DF) and residual volume (ReV) components correlate with LVEF and LV-EDVi. When LVEF increases, volume proportion (%) of DF increases ( $p < .001$ ) but that of ReV decreases ( $p < .001$ ). When LV-EDVi increases, volume proportion of DF decreases ( $p < .001$ ) but that of ReV increases ( $p < .001$ ). For KE, when LVEF increases, proportion of KE contributed by DF at peak-systolic and peak-diastolic phases of total KE increases ( $p < .001$ ), while that of ReV decreases ( $p < .001$ ). When LV-EDVi increases, proportion of KE contributed by DF decreases ( $p < .001$ ), while that by ReV increases ( $p < .001$ ). Comparing component's volume in controls and heart failure groups, controls have the highest DF portion, followed by HFpEF, HFmrEF and HFrEF (controls  $35.0 \pm 9.44$  vs. HFpEF  $23.6 \pm 10.6$  vs. HFmrEF  $15.8 \pm 8.06$  vs. HFrEF  $6.73 \pm 4.03$ ,  $p < .001$ ). Conversely, controls have the lowest ReV portion, followed by HFpEF, HFmrEF, and HFrEF (controls  $26.1 \pm 9.39$  vs. HFpEF  $33.2 \pm 13.7$  vs. HFmrEF  $38.4 \pm 12.6$  vs. HFrEF  $51.9 \pm 11.0$ ,  $p < .001$ ). Volume portions of DE and RI are similar. Comparing KE profiles, controls show the highest KE contribution (%) from DF and lowest from ReV, followed by HFpEF, HFmrEF and HFrEF patients (DF KE at peak-systole: controls  $65.0 \pm 10.2$  vs. HFpEF  $47.5 \pm 17.6$  vs. HFmrEF  $33.7 \pm 17.3$  vs. HFrEF  $15.7 \pm 13.1$ ) (ReV KE at peak-systole: controls  $3.46 \pm 1.77$  vs. HFpEF  $7.51 \pm 10.7$  vs. HFmrEF  $15.4 \pm 6.82$  vs. HFrEF  $25.9 \pm 18.6$ ).

#### CONCLUSION

DF's volume and KE portion increases with LVEF but decreases with LV-EDVi. ReV's volume and KE portion decreases with LVEF but increases with LV-EDVi. CMR 4D flow derived LV DF and ReV parameters allows evaluation of HF patient's severity and delineates them from asymptomatic control.

#### CLINICAL RELEVANCE/APPLICATION

4D Flow visualizes intraventricular flow and provides novel biomarkers in clinical assessment and management in heart failure patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGI03

### Gastrointestinal Imaging (Oncology)

Sunday, Nov. 26 2:30PM - 3:30PM Room: S404

Olga R. Brook, MD, MBA (*Moderator*) Nothing to Disclose

Lauren M. Burke, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### S5-SSGI03- Association between Body Composition and Survival in Patients with Gastroesophageal Adenocarcinoma: An Automated Deep Learning Approach<sup>1</sup>

Matthias Jung, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Body composition (BC) measures may play an important role for risk assessment and outcome prognostication in cancer patients. With advances in artificial intelligence, new possibilities to automatically quantify BC are available. We developed a deep learning (DL) model for fully automatic BC quantification on routine staging CTs and determined its prognostic role in a clinical cohort of patients with gastroesophageal adenocarcinoma (GEAC).

#### METHODS AND MATERIALS

We trained a DL model to quantify subcutaneous (SAT) and visceral adipose tissue (VAT), and skeletal muscle (SM) on manually annotated CTs at L3 level (n=100) and tested the model on an independent test set (n=40) using standard performance measures. Subsequently, the deep learning model estimated BC from a retrospective cohort of GEAC patients on baseline and 3-, 6-, and 12-month postoperative follow-up CTs (964 CT scans). The primary outcome was all-cause mortality. Multivariable Cox proportional hazards regression assessed the association between (I) body composition measures at baseline and mortality, and (II) the decrease in VAT and SAT (= 10%) and SM (= 20%) between baseline and postoperative follow ups and mortality.

#### RESULTS

Model performance was high in the independent test set: Dice coefficients were  $0.97 \pm 0.01$  for SAT,  $0.94 \pm 0.06$  for VAT, and  $0.97 \pm 0.02$  for SM. Among 356 patients with GEAC (age  $62.8 \pm 10.8$  years-old; 20.2% female), 172 (48.3%) deaths over a median follow-up of 28.3 months occurred. Baseline BC measures were associated with all-cause mortality after multivariable adjustment (age, sex, height, weight, neoadjuvant therapy. SAT: HR 1.33, 95% CI [1.03-1.73],  $p = 0.032$ ; VAT: HR: 1.24, 95% CI [1.01-1.54],  $p=0.049$ ; Muscle: HR: 0.37, 95% CI [0.15-0.92];  $p = 0.032$ ). Patients with a decrease in SAT and VAT >10% in the 6- to 12-month follow up had a significantly worse outcome than patients with stable adipose tissue measures (hazard ratios adjusted for age, sex, height, weight, neoadjuvant therapy, resection status, tumor grading. SAT: HR 1.82, 95% CI [1.13-2.92],  $p = 0.014$ ; VAT: HR 2.77, 95% CI [1.29-5.94],  $p = 0.009$ ). No association was detected for a decrease in SM measures.

#### CONCLUSION

DL can automatically quantify BC measures from routine staging CTs and provide prognostic information. Baseline BC and a decline in VAT and SAT in the 6- to 12-month follow up were associated with mortality in GEAC patients and may serve as an imaging biomarker to improve clinical decision making beyond traditional risk factors.

#### CLINICAL RELEVANCE/APPLICATION

DL-based opportunistic screening of BC can identify GEAC patients with worse outcome beyond traditional risk factors. Implementation of such methods may provide a fast and low-cost solution to inform risk assessment and improve patient management.

### S5-SSGI03- Trajectories of Body Composition in Hepatocellular Carcinoma Treated with Transarterial Chemoembolization plus Immunotherapy: A Longitudinal, Multicenter, Cohort Study<sup>2</sup>

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study aims to characterize longitudinal trajectories of body composition (BC) and evaluate its impact on clinical outcomes in hepatocellular carcinoma (HCC) patients treated with transarterial chemoembolization (TACE) plus immunotherapy.

## **METHODS AND MATERIALS**

Patients who underwent TACE plus immunotherapy with available abdominal computed tomography between April 2018 and May 2021 were included. The measurements of BC including skeletal muscle mass (SMM), subcutaneous adipose tissue (SAT), and visceral adipose tissue (VAT) were carried out with computed tomography at the L3 vertebra at baseline and follow-up imaging. Overall survival (OS) as primary study endpoint was analyzed by Kaplan-Meier and Cox regression. The overall trend of BC change and its impact on prognosis was identified by a joint model. A latent class trajectory model was applied to distinguish potential BC dynamic changing trajectories.

## **RESULTS**

A total of 392 consecutive HCC patients with 2054 time-point measurements were included. The median follow-up time point was 5 times (range: 3-17). The BC SMM, SAT, and VAT shows significant association with survival (for SMM, hazard ratio [HR]: 0.964, 95% confidence interval [CI]: 0.955-0.973,  $P < 0.001$ ; for SAT, HR: 0.982, 95%CI: 0.978-0.986,  $P < 0.001$ ; for VAT, HR: 0.992, 95%CI: 0.989-0.995,  $P < 0.001$ ), and all measurements exhibits an overall declining trend ( $P < 0.001$ ) along time. Thereafter, two distinct trajectories of SMM were identified, labeled as progressive decline (14.8%,  $n = 58$ ) and stable (85.2%,  $n = 334$ ). There was a significant difference in median overall survival between the two classes (17.0 months vs. 24.6 months;  $P < 0.001$ ). Treatment-emergent adverse events occurred in 10.7% and 31.0% of patients in stable and progressive decline groups ( $P < 0.001$ ), respectively.

## **CONCLUSION**

Longitudinal BC changes are significantly associated with survival for HCC treated with immunotherapy plus TACE. Progressive skeletal muscle decline occurs in a subset of patients, even those who have baseline high SMM, with poor prognosis and tolerance to treatment.

## **CLINICAL RELEVANCE/APPLICATION**

Longitudinal BC changes affect the prognosis of HCC patients. Our study first identified patients who are more likely to experience a progressive decline in skeletal muscle, and highlights the heterogeneity in these population.

## **S5-SSGI03- Spectral CT-based Iodine Quantification in Assessment of Response Following Locoregional Therapy in Liver Tumors**

Jinjin Cao, MD, MS (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate the role of spectral CT-based iodine quantification in the assessment of treatment response in liver tumors receiving locoregional therapy.

## **METHODS AND MATERIALS**

In this study, we included 45 patients (20 F;  $63.4 \pm 11.8$  years) who received locoregional therapy for primary and metastatic liver malignancies and underwent DECT scans before and after treatment. Treatment response determination was performed using tumor dimension (RECIST 1.1 and mRECIST), tumor attenuation, and iodine concentration. ? Attenuation value and ? Iodine concentration were obtained by subtracting baseline value from post-treatment value. Baseline and post treatment tumor parameters were compared using non-parametric Wilcoxon signed-rank test. Linear regression and Pearson correlation were used to correlate treatment response with survival metrics (survival time= deceased date- treatment finished date). A  $p$  value of  $< 0.05$  was considered statistically significant.

## **RESULTS**

A total of 45 target lesions were included for assessment (mean size:  $63.4 \pm 11.8$  mm before treatment) out of which  $n = 18$  patients with HCC, 19 with liver metastasis, 7 with cholangiocarcinoma, 1 with liver hemangiopericytoma. No significant difference was demonstrated before and after TACE or SIRT treatment while using RECIST 1.1 ( $p = 0.246$ ). There was significant difference before and after TACE/SIRT when using mRECIST, ? Attenuation value, and ? Iodine concentration ( $p = 0.003$ ,  $p < 0.001$ ,  $p < 0.001$  separately). Linear regression analysis was performed on the 27 deceased patients which indicated a significant positive correlation between survival time and ? Attenuation value ( $\beta = 0.382$ ,  $p = 0.025$ ). However, there was no statistically significant correlation between survival time and ? Iodine concentration, mRECIST, and RECIST 1.1 (Pearson correlation coefficients 0.102, 0.085, -0.005 separately) probably owing to the small sample size.

## **CONCLUSION**

Spectral CT-based iodine quantification enables assessment of response to locoregional therapy in hepatic malignancies.

## CLINICAL RELEVANCE/APPLICATION

Iodine quantification has the potential to be a surrogate imaging biomarker for assessment of response to locoregional therapies.

### **S5-SSGI03- What is the Optimal Strategy for Initial Staging of Esophageal Cancer: Comparison of Standard Staging Procedures (EUS, CT and FDG-PET/CT) and MRI**

Vincent Levy, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the diagnostic performance of MRI, CT, EUS and PET/CT and different combinations for the initial staging of esophageal cancer.

#### **METHODS AND MATERIALS**

In this prospective study we included 60 patients (M/F 50/10, mean age  $66 \pm 9$  yrs) with newly diagnosed esophageal cancer (34 adenocarcinomas, 25 squamous cell carcinomas and 2 neuroendocrine carcinomas). Each patient underwent a 3T MRI in addition to the standard staging procedures (EUS, contrast-enhanced CT and FDG-PET/CT) for initial tumor staging. Two independent readers (except for EUS) were asked to determine TNM-stage based on each procedure (T-stage using MRI, CT and EUS, N-stage using MRI, CT, PET/CT and EUS, M-stage using MRI, CT and PET/CT). Consensus was obtained in case of discordant cases using a third reader. The reference standard was the histopathology of the surgical specimen or TNM-staging established during the tumor board meeting considering all available imaging and endoscopic data. Interreader agreement was assessed. The diagnostic performance of each procedure was analyzed.

#### **RESULTS**

For T-stage, sensitivities and specificities for classifying non-advanced tumors (T1-T2) versus advanced tumors (T3-T4) were 98% and 80% for MRI, 92.5% and 100% for CT and 91.3% and 90% for EUS, respectively. Interreader agreement was strong for MRI and moderate for CT ( $\kappa=0.877$  and  $\kappa=0.788$ ). For N-stage, sensitivities and specificities for classifying N0 versus N+ were 87.5% and 69.2% for MRI, 94.4% and 55.6% for CT, 67.4% and 100% for PET/CT and 89.1% and 66.7% for EUS, respectively. Interreader agreement was moderate for MRI and PET/CT and strong for CT ( $\kappa=0.712$ ,  $\kappa=0.703$  and  $\kappa=0.901$ ). For M-stage, sensitivities and specificities for classifying M0 versus M+ were 100% and 100% for MRI and PET/CT and 40% and 100% for CT, respectively. Interreader agreement was moderate for PET/CT and strong to almost perfect for MRI and CT ( $\kappa=0.781$ ,  $\kappa=0.816$  and  $\kappa=1$ ). The combination of MRI+PET/CT showed optimal performance in differentiating T1-T2N0M0 from T3-T4N1-3M0.

#### **CONCLUSION**

MRI is highly accurate for initial TNM staging and allows optimal differentiation of early stage from advanced or metastatic esophageal cancer.

## CLINICAL RELEVANCE/APPLICATION

Non-invasive MRI allows an accurate staging of esophageal cancer as it reliably differentiates early-stage tumors from advanced tumors, and facilitates correct stage-dependent treatment decisions.

### **S5-SSGI03- Can Hepatobiliary Contrast Uptake Patterns on Gadoteric Acid-Enhanced MRI Predict Prognosis in Breast Cancer Liver Metastases?**

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to investigate whether the patterns of hepatobiliary phase (HBP) contrast uptake in liver metastases on gadoteric acid-enhanced magnetic resonance imaging (MRI) can predict overall survival (OS) in patients with breast cancer (BC).

#### **METHODS AND MATERIALS**

This retrospective study included 102 female patients (age range, 30-75 years) with BC and liver metastases who underwent gadoteric acid-enhanced MRI. The HBP signal characteristics were analyzed and liver metastases were classified as target-like or non-target-like groups. Kaplan-Meier analysis and Cox proportional hazards regression were used to evaluate prognostic factors for OS in BC and liver metastasis patients.

#### **RESULTS**

The target-like group (n=62), which included patients with target sign or reversed target sign, had a median OS of 26.5 months, while the non-target-like group (n=40), which included patients with inhomogeneous or homogeneous low signal, had a median OS of 38.2 months (P=0.009). The target-like group exhibited lower OS rates than the non-target-like group.

## **CONCLUSION**

The patterns of HBP contrast uptake in liver metastases on gadoxetic acid-enhanced MRI could be a useful imaging biomarker for predicting OS in patients with BC and liver metastases.

## **CLINICAL RELEVANCE/APPLICATION**

The identification of reliable biomarkers for predicting OS in BC patients with liver metastases is crucial for optimal clinical management. Based on the findings of this study, the patterns of HBP contrast uptake in liver metastases on gadoxetic acid-enhanced MRI could potentially serve as a non-invasive and useful imaging biomarker for predicting OS in female BC patients with liver metastases. This information could aid clinicians in making more informed treatment decisions and tailoring therapeutic strategies to individual patients.

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## Abstract Archives of the RSNA, 2023

S5-SSGI03-1

### Association between Body Composition and Survival in Patients with Gastroesophageal Adenocarcinoma: An Automated Deep Learning Approach

Sunday, Nov. 26 2:30PM - 3:30PM Room: S404

Matthias Jung, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Body composition (BC) measures may play an important role for risk assessment and outcome prognostication in cancer patients. With advances in artificial intelligence, new possibilities to automatically quantify BC are available. We developed a deep learning (DL) model for fully automatic BC quantification on routine staging CTs and determined its prognostic role in a clinical cohort of patients with gastroesophageal adenocarcinoma (GEAC).

#### METHODS AND MATERIALS

We trained a DL model to quantify subcutaneous (SAT) and visceral adipose tissue (VAT), and skeletal muscle (SM) on manually annotated CTs at L3 level (n=100) and tested the model on an independent test set (n=40) using standard performance measures. Subsequently, the deep learning model estimated BC from a retrospective cohort of GEAC patients on baseline and 3-, 6-, and 12-month postoperative follow-up CTs (964 CT scans). The primary outcome was all-cause mortality. Multivariable Cox proportional hazards regression assessed the association between (I) body composition measures at baseline and mortality, and (II) the decrease in VAT and SAT (= 10%) and SM (= 20%) between baseline and postoperative follow ups and mortality.

#### RESULTS

Model performance was high in the independent test set: Dice coefficients were  $0.97 \pm 0.01$  for SAT,  $0.94 \pm 0.06$  for VAT, and  $0.97 \pm 0.02$  for SM. Among 356 patients with GEAC (age  $62.8 \pm 10.8$  years-old; 20.2% female), 172 (48.3%) deaths over a median follow-up of 28.3 months occurred. Baseline BC measures were associated with all-cause mortality after multivariable adjustment (age, sex, height, weight, neoadjuvant therapy. SAT: HR 1.33, 95% CI [1.03-1.73],  $p = 0.032$ ; VAT: HR: 1.24, 95% CI [1.01-1.54],  $p=0.049$ ; Muscle: HR: 0.37, 95% CI [0.15-0.92];  $p = 0.032$ ). Patients with a decrease in SAT and VAT >10% in the 6- to 12-month follow up had a significantly worse outcome than patients with stable adipose tissue measures (hazard ratios adjusted for age, sex, height, weight, neoadjuvant therapy, resection status, tumor grading. SAT: HR 1.82, 95% CI [1.13-2.92],  $p = 0.014$ ; VAT: HR 2.77, 95% CI [1.29-5.94],  $p = 0.009$ ). No association was detected for a decrease in SM measures.

#### CONCLUSION

DL can automatically quantify BC measures from routine staging CTs and provide prognostic information. Baseline BC and a decline in VAT and SAT in the 6- to 12-month follow up were associated with mortality in GEAC patients and may serve as an imaging biomarker to improve clinical decision making beyond traditional risk factors.

#### CLINICAL RELEVANCE/APPLICATION

DL-based opportunistic screening of BC can identify GEAC patients with worse outcome beyond traditional risk factors. Implementation of such methods may provide a fast and low-cost solution to inform risk assessment and improve patient management.

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## Abstract Archives of the RSNA, 2023

S5-SSGI03-2

### Trajectories of Body Composition in Hepatocellular Carcinoma Treated with Transarterial Chemoembolization plus Immunotherapy: A Longitudinal, Multicenter, Cohort Study

Sunday, Nov. 26 2:30PM - 3:30PM Room: S404

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to characterize longitudinal trajectories of body composition (BC) and evaluate its impact on clinical outcomes in hepatocellular carcinoma (HCC) patients treated with transarterial chemoembolization (TACE) plus immunotherapy.

#### METHODS AND MATERIALS

Patients who underwent TACE plus immunotherapy with available abdominal computed tomography between April 2018 and May 2021 were included. The measurements of BC including skeletal muscle mass (SMM), subcutaneous adipose tissue (SAT), and visceral adipose tissue (VAT) were carried out with computed tomography at the L3 vertebra at baseline and follow-up imaging. Overall survival (OS) as primary study endpoint was analyzed by Kaplan-Meier and Cox regression. The overall trend of BC change and its impact on prognosis was identified by a joint model. A latent class trajectory model was applied to distinguish potential BC dynamic changing trajectories.

#### RESULTS

A total of 392 consecutive HCC patients with 2054 time-point measurements were included. The median follow-up time point was 5 times (range: 3-17). The BC SMM, SAT, and VAT shows significant association with survival (for SMM, hazard ratio [HR]: 0.964, 95% confidence interval [CI]: 0.955-0.973,  $P < 0.001$ ; for SAT, HR: 0.982, 95%CI: 0.978-0.986,  $P < 0.001$ ; for VAT, HR: 0.992, 95%CI: 0.989-0.995,  $P < 0.001$ ), and all measurements exhibits an overall declining trend ( $P < 0.001$ ) along time. Thereafter, two distinct trajectories of SMM were identified, labeled as progressive decline (14.8%,  $n = 58$ ) and stable (85.2%,  $n = 334$ ). There was a significant difference in median overall survival between the two classes (17.0 months vs. 24.6 months;  $P < 0.001$ ). Treatment-emergent adverse events occurred in 10.7% and 31.0% of patients in stable and progressive decline groups ( $P < 0.001$ ), respectively.

#### CONCLUSION

Longitudinal BC changes are significantly associated with survival for HCC treated with immunotherapy plus TACE. Progressive skeletal muscle decline occurs in a subset of patients, even those who have baseline high SMM, with poor prognosis and tolerance to treatment.

#### CLINICAL RELEVANCE/APPLICATION

Longitudinal BC changes affect the prognosis of HCC patients. Our study first identified patients who are more likely to experience a progressive decline in skeletal muscle, and highlights the heterogeneity in these population.

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## Abstract Archives of the RSNA, 2023

S5-SSGI03-3

### Spectral CT-based Iodine Quantification in Assessment of Response Following Locoregional Therapy in Liver Tumors

Sunday, Nov. 26 2:30PM - 3:30PM Room: S404

Jinjin Cao, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the role of spectral CT-based iodine quantification in the assessment of treatment response in liver tumors receiving locoregional therapy.

#### METHODS AND MATERIALS

In this study, we included 45 patients (20 F; 63.4±11.8 years) who received locoregional therapy for primary and metastatic liver malignancies and underwent DECT scans before and after treatment. Treatment response determination was performed using tumor dimension (RECIST 1.1 and mRECIST), tumor attenuation, and iodine concentration. ? Attenuation value and ? Iodine concentration were obtained by subtracting baseline value from post-treatment value. Baseline and post treatment tumor parameters were compared using non-parametric Wilcoxon signed-rank test. Linear regression and Pearson correlation were used to correlate treatment response with survival metrics (survival time= deceased date- treatment finished date). A p value of < 0.05 was considered statistically significant.

#### RESULTS

A total of 45 target lesions were included for assessment (mean size: 63.4 ± 11.8 mm before treatment) out of which n= 18 patients with HCC, 19 with liver metastasis, 7 with cholangiocarcinoma, 1 with liver hemangiopericytoma. No significant difference was demonstrated before and after TACE or SIRT treatment while using RECIST 1.1 (p=0.246). There was significant difference before and after TACE/SIRT when using mRECIST, ? Attenuation value, and ? Iodine concentration (p=0.003, p<0.001, p<0.001 separately). Linear regression analysis was performed on the 27 deceased patients which indicated a significant positive correlation between survival time and ? Attenuation value ( $\beta=0.382$ , p=0.025). However, there was no statistically significant correlation between survival time and ? Iodine concentration, mRECIST, and RECIST 1.1 (Pearson correlation coefficients 0.102, 0.085, -0.005 separately) probably owing to the small sample size.

#### CONCLUSION

Spectral CT-based iodine quantification enables assessment of response to locoregional therapy in hepatic malignancies.

#### CLINICAL RELEVANCE/APPLICATION

Iodine quantification has the potential to be a surrogate imaging biomarker for assessment of response to locoregional therapies.

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## Abstract Archives of the RSNA, 2023

S5-SSGI03-5

### What is the Optimal Strategy for Initial Staging of Esophageal Cancer: Comparison of Standard Staging Procedures (EUS, CT and FDG-PET/CT) and MRI

Sunday, Nov. 26 2:30PM - 3:30PM Room: S404

Vincent Levy, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic performance of MRI, CT, EUS and PET/CT and different combinations for the initial staging of esophageal cancer.

#### METHODS AND MATERIALS

In this prospective study we included 60 patients (M/F 50/10, mean age  $66 \pm 9$  yrs) with newly diagnosed esophageal cancer (34 adenocarcinomas, 25 squamous cell carcinomas and 2 neuroendocrine carcinomas). Each patient underwent a 3T MRI in addition to the standard staging procedures (EUS, contrast-enhanced CT and FDG-PET/CT) for initial tumor staging. Two independent readers (except for EUS) were asked to determine TNM-stage based on each procedure (T-stage using MRI, CT and EUS, N-stage using MRI, CT, PET/CT and EUS, M-stage using MRI, CT and PET/CT). Consensus was obtained in case of discordant cases using a third reader. The reference standard was the histopathology of the surgical specimen or TNM-staging established during the tumor board meeting considering all available imaging and endoscopic data. Interreader agreement was assessed. The diagnostic performance of each procedure was analyzed.

#### RESULTS

For T-stage, sensitivities and specificities for classifying non-advanced tumors (T1-T2) versus advanced tumors (T3-T4) were 98% and 80% for MRI, 92.5% and 100% for CT and 91.3% and 90% for EUS, respectively. Interreader agreement was strong for MRI and moderate for CT ( $\kappa=0.877$  and  $\kappa=0.788$ ). For N-stage, sensitivities and specificities for classifying N0 versus N+ were 87.5% and 69.2% for MRI, 94.4% and 55.6% for CT, 67.4% and 100% for PET/CT and 89.1% and 66.7% for EUS, respectively. Interreader agreement was moderate for MRI and PET/CT and strong for CT ( $\kappa=0.712$ ,  $\kappa=0.703$  and  $\kappa=0.901$ ). For M-stage, sensitivities and specificities for classifying M0 versus M+ were 100% and 100% for MRI and PET/CT and 40% and 100% for CT, respectively. Interreader agreement was moderate for PET/CT and strong to almost perfect for MRI and CT ( $\kappa=0.781$ ,  $\kappa=0.816$  and  $\kappa=1$ ). The combination of MRI+PET/CT showed optimal performance in differentiating T1-T2N0M0 from T3-T4N1-3M0.

#### CONCLUSION

MRI is highly accurate for initial TNM staging and allows optimal differentiation of early stage from advanced or metastatic esophageal cancer.

#### CLINICAL RELEVANCE/APPLICATION

Non-invasive MRI allows an accurate staging of esophageal cancer as it reliably differentiates early-stage tumors from advanced tumors, and facilitates correct stage-dependent treatment decisions.

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## Abstract Archives of the RSNA, 2023

S5-SSGI03-6

### Can Hepatobiliary Contrast Uptake Patterns on Gadoteric Acid-Enhanced MRI Predict Prognosis in Breast Cancer Liver Metastases?

Sunday, Nov. 26 2:30PM - 3:30PM Room: S404

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to investigate whether the patterns of hepatobiliary phase (HBP) contrast uptake in liver metastases on gadoteric acid-enhanced magnetic resonance imaging (MRI) can predict overall survival (OS) in patients with breast cancer (BC).

#### METHODS AND MATERIALS

This retrospective study included 102 female patients (age range, 30-75 years) with BC and liver metastases who underwent gadoteric acid-enhanced MRI. The HBP signal characteristics were analyzed and liver metastases were classified as target-like or non-target-like groups. Kaplan-Meier analysis and Cox proportional hazards regression were used to evaluate prognostic factors for OS in BC and liver metastasis patients.

#### RESULTS

The target-like group (n=62), which included patients with target sign or reversed target sign, had a median OS of 26.5 months, while the non-target-like group (n=40), which included patients with inhomogeneous or homogeneous low signal, had a median OS of 38.2 months (P=0.009). The target-like group exhibited lower OS rates than the non-target-like group.

#### CONCLUSION

The patterns of HBP contrast uptake in liver metastases on gadoteric acid-enhanced MRI could be a useful imaging biomarker for predicting OS in patients with BC and liver metastases.

#### CLINICAL RELEVANCE/APPLICATION

The identification of reliable biomarkers for predicting OS in BC patients with liver metastases is crucial for optimal clinical management. Based on the findings of this study, the patterns of HBP contrast uptake in liver metastases on gadoteric acid-enhanced MRI could potentially serve as a non-invasive and useful imaging biomarker for predicting OS in female BC patients with liver metastases. This information could aid clinicians in making more informed treatment decisions and tailoring therapeutic strategies to individual patients.

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## Abstract Archives of the RSNA, 2023

S5-SSGI04

### Gastrointestinal Imaging (Artificial Intelligence Clinical Techniques)

Sunday, Nov. 26 2:30PM - 3:30PM Room: S405

Hersh Chandarana, MD, MBA (*Moderator*) Institutional research agreement, Siemens AG; Equipment support, Siemens AG; Software support, Siemens AG

Bhavik N. Patel, MD, MBA (*Moderator*) Nothing to Disclose

#### Sub-Events

### **S5-SSGI04- Feasibility of Deep Learning-Accelerated Nonenhanced Abbreviated Liver MRI for Solid Focal Lesion Detection**

Yoonhee Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

For abbreviated liver MRI, deep learning reconstruction (DL) is expected to be highly advantageous by reducing scan time without compromising sensitivity for focal liver lesion (FLL) detection. This study evaluated the feasibility of nonenhanced abbreviated liver MRI by assessing image quality, per-lesion sensitivity for solid FLL, and scan time in sets of combinations of DL HASTE, free-breathing (FB) DL-DWI and breath-hold (BH) DL-DWI against conventional HASTE and FB-DWI (C-DWI).

#### METHODS AND MATERIALS

Consecutive 51 patients (30 males; mean age  $\pm$  SD, 60.6  $\pm$  13 years) with 40 FLLs who underwent routine liver MRI with additional DL HASTE, FB DL-DWI, and BH DL-DWI were included. Twenty-eight (54.9%) patients had chronic liver disease or liver cirrhosis. FLLs assessed were 12 (30%) HCCs, 16 (40%) metastases, and 12 (30%) hemangiomas. The DL scan parameters were matched to conventional sequences, except for the parallel imaging factor and number of averages in DWI. Two abdominal radiologists independently rated structural sharpness, artifacts, image noise, and overall image quality on a 5-point scale. Three sets of nonenhanced MRI sequences were reviewed for FLL detection: (1) HASTE/FB C-DWI, (2) DL-HASTE/FB DL-DWI, and (3) DL-HASTE/BH DL-DWI. Per-lesion sensitivity, lesion conspicuity, and margin sharpness were assessed and compared across image sets. Student's t-test and Mann-Whitney test with Bonferroni correction compared qualitative features.

#### RESULTS

The scan times for sets (1), (2), and (3) were 4 min 11 sec, 2 min 29 sec, and 1 min 37 sec, respectively. DL-HASTE and FB DL-DWI showed significantly better sharpness, fewer artifacts, less noise, and better overall image quality than their conventional counterparts ( $p$ s = 0.001). BH DL-DWI showed significantly less noise ( $p$  = 0.002) compared to FB C-DWI, while other qualitative scores were comparable. On FLL assessment, both DL sets showed a significantly sharper margin than set (1). The pooled per-lesion sensitivity for sets (1), (2), and (3) was 95.1%, 95.1%, and 85.1%, with no significant difference ( $p$  = 0.131). The overall sensitivities for detecting malignancies were 98.1%, 98.1%, and 93.7% in sets 1, 2, and 3, respectively. For detecting malignancies in patients at risk for HCC, the sensitivities were comparable across sets: (1) 96.8%, (2) 96.8%, and (3) 89.8% ( $p$  = 0.175).

#### CONCLUSION

DL-accelerated HASTE and FB DWI showed significantly better image quality and comparable sensitivity for solid FLL detection in 83% of the scan time compared to conventional sequences. BH DL-DWI markedly reduced scan time but showed lower sensitivity, which requires further refinement.

#### CLINICAL RELEVANCE/APPLICATION

DL-accelerated HASTE and FB DWI are feasible options for abbreviated nonenhanced liver MRI.

### **S5-SSGI04- Fully Automated Pancreatic Adenocarcinoma Localization: Validation of a Convolutional Neural Network (CNN) Model Using Standard-of-Care CTs**

Sovanlal Mukherjee, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To develop a CNN model for a fully-automated localization of PDA on standard-of-care CT exams.

## **METHODS AND MATERIALS**

Manual volumetric reference tumor segmentation was performed by radiologists on a highly curated CT dataset (portal phase; slice thickness=5-mm) from 1151 patients with treatment-naïve PDA [mean (range) tumor diameter: 4.34 (1.1-12.6)-cm]. Dataset was randomly divided into training/validation (n=921) and test subsets (n=230). A 3D CNN Detection model was trained using 5-fold cross-validation. Final model was obtained as an ensemble of the five models from the 5-fold training process. The model's output was a predicted bounding box that aimed to circumscribe the reference PDA segmentation. Model's performance was evaluated on the test subset using volumetric true positive fraction (TPF), which describes the proportion of the reference segmentation in the automated model-predicted bounding box. Model's generalizability was evaluated on The Cancer Imaging Archive (TCIA) (n=41) and Medical Segmentation Decathlon (MSD) (n=152) public datasets. Furthermore, model's performance in the test subset was sub-stratified for different image acquisition parameters (vendor, slice thickness) as well as tumoral features (location, density, and AJCC tumor-stage).

## **RESULTS**

On the test subset, the model had a TPF [mean (SD)] of 0.87(0.22). Model's performance was generalizable to MSD and TCIA datasets [TPF: 0.90(0.21), 0.89(0.24) respectively;  $p>0.05$ ]. There was no significant difference in the model's performance for different CT vendors and slice thicknesses ( $p>0.05$ ). Model's TPF was resilient to tumor density [hypodense: 0.88 (0.21) versus isodense: 0.81(0.27);  $p=0.06$ ] and tumor location [head: 0.87 (0.21), body: 0.91(0.13), tail: 0.83(0.31), extra-pancreatic extension: 0.96(0.05);  $p=0.22$ ]. Additionally, model's performance was comparable for tumor stages II-IV [TPF: 0.87(0.23)-0.90(0.17);  $p=0.36$ ] with lower performance for stage I [TPF: 0.59(0.42);  $p<0.05$ , n=5].

## **CONCLUSION**

A CNN model developed on a large CT dataset shows high accuracy and generalizability for a fully-automated PDA localization on standard-of-care CT exams.

## **CLINICAL RELEVANCE/APPLICATION**

Fully-automated PDA localization provides a critical tool for quantitative imaging biomarker-driven multi-omics models for PDA risk stratification, treatment response assessment, and prognostication.

## **S5-SSGI04- Comparison of Image Quality and Focal Lesions Between Free-Breathing deep Learning Diffusion-Weighted Imaging and Conventional Images in Liver MRI**

Jiyoung Yoon, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To compare image quality and diagnostic performance of focal liver lesions for malignancy between free-breathing diffusion weighted image using deep learning reconstruction (DWI-DL) and conventional DWI (c-DWI) in patients undergoing clinically indicated liver MRI.

## **METHODS AND MATERIALS**

A total of 199 consecutive patients who underwent 3 T liver MRI with DWI-DL and c-DWI were retrospectively included. DWI was performed with single-shot spin-echo echo-planar technique and fat-suppression in free breathing with matching parameters. Three radiologists evaluated two sequences for subjective image quality, independently. The apparent diffusion coefficient (ADC) was measured in 15 regions of the liver. A total of 64 patients with 160 focal liver lesions (FLLs) showing high signal intensity on DWI were analyzed by four radiologists regarding per-lesion diagnostic performance for malignancy.

## **RESULTS**

DWI-DL was 43.0% faster than c-DWI (119 vs. 209 sec). Compared with c-DWI, DWI-DL scored higher for all subjective image quality parameters (all,  $P < 0.001$ ). ADC values showed slightly more homogeneous on DWI-DL than those on c-DWI. And ADC values in the right lower section and the left upper, middle, and lower section revealed different between DWI-DL and c-DWI ( $P = 0.010$ ,  $<0.001$ ,  $<0.001$ , and  $0.003$ , respectively). Of 160 lesions, 116 malignancies (61 hepatocellular carcinoma, 3 cholangiocarcinoma, 52 metastasis) and 44 benignities were included. The diagnostic performance of DWI-DL showed comparable sensitivity (75.0-90.5% vs 75.9-82.8%), specificity (87.0-93.3% vs 82.6-97.7%), and accuracy (80.1-90.6% vs 80.5-84.4%), compared with c-DWI.

## **CONCLUSION**

Free-breathing DWI-DL is a clinically feasible technique achieving high image quality and diagnostic performance for malignancy with shorter acquisition time compared to c-DWI.

## CLINICAL RELEVANCE/APPLICATION

Free-breathing DWI using deep learning reduced scan time while improving image quality, compared with conventional DWI. The diagnostic performance of DWI-DL was comparable sensitivity (75.0-90.5% vs 75.9-82.8%), specificity (87.0-93.3% vs 82.6-97.7%), and accuracy (80.1-90.6% vs 80.5-84.4%), compared with c-DWI. Free-breathing DWI using deep learning may minimize motion-induced measurement error in ADC map while showing small differences of ADC values, compared with conventional DWI.

## S5-SSGI04- A Transformer-based deep Learning Model for Liver Stiffness Classification using Multiparametric Abdominal MRI in Children and Adults

Redha Ali, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

To develop a deep learning model that stratifies the degree of liver stiffening based on multiparametric MRI images from pediatric and adult patients with known or suspected chronic liver disease.

### METHODS AND MATERIALS

In this HIPAA-compliant, IRB-approved, multi-site retrospective study, patients with known or suspected chronic liver disease who underwent clinical abdominal MRI examinations with MR elastography (MRE) assessment of liver stiffness between 2011 and 2022 were identified from four institutions, including <BLINDED INSTITUTIONS>. Three conventional MRI sequences, including axial T1-weighted (T1w), T2-weighted (T2w), and diffusion-weighted (DWI) MR images were retrieved. Patients were categorized into two groups using multiple liver stiffness thresholds ( $=2.5$  kPa,  $=3$  kPa,  $=3.5$  kPa,  $=4$  kPa, and  $=5$  kPa) to formulate a series of binary classification tasks, reflecting various degrees of liver stiffening. Our multi-sequence DeepLiverNet 2.0 uses pre-trained Swin Transformer model to extract latent features for classification (Fig. 1A). We constructed three branches of multi-channel transfer learning feature extractors from 11 mid-liver slices of T1w, T2w, and DWI (highest b-value) images. We evaluated model performance using accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AuROC) in both internal multi-site 10-fold cross-validation (CV) and external validation experiments.

### RESULTS

A total of 3,365 patients (mean  $\pm$  SD age,  $49.9 \pm 16.6$  years; BMI  $28.8 \pm 6.5$  kg/m<sup>2</sup>; 1737 (51.6%) Females) were selected in two batches. Batch 1 (2,150 patients) was selected from 4 sites between 2011 and 2020 for internal CV, and later Batch 2 (1,215 patients) was selected from three sites <BLINDED INSTITUTIONS> between 2021 to 2022 for external temporal holdout validation. The model achieved mean [95% CI] AuROCs of 0.82 [0.80, 0.84], and 0.81 [0.78, 0.84] for internal and external validation, respectively, when using the  $= 3.0$  kPa threshold. Additional validation results are listed in Figs. 1B and 1C.

### CONCLUSION

The proposed DeepLiverNet 2.0 AI model demonstrated moderate diagnostic performance on a large, multi-site combined pediatric and adult dataset for categorically classifying the degree of liver stiffening using anatomic T1w, T2w, and DWI MRI data.

## CLINICAL RELEVANCE/APPLICATION

Our DeepLiverNet 2.0 AI model can categorically classify the severity of liver stiffening using multiparametric T1w, T2w, and DWI MRI data in children and adult. Model refinements and incorporation of clinical features may further improve performance and soon decrease the need for MRE elastography.

## S5-SSGI04- Effective Opportunistic Gastric Cancer Screening on Noncontrast CT Scans

6

Ling Zhang (*Presenter*) Nothing to Disclose

### PURPOSE

We devised an AI model for the detection of gastric cancer (GC) tumors using noncontrast CT scans, which shows potential to serve as an effective tool for opportunistic cancer screening.

### METHODS AND MATERIALS

We trained the AI model using 1,891 3D noncontrast CT volumes from a single hospital, comprising 687 patients with pathology-confirmed gastric cancer and 1,204 patients for normal control. The masks of tumors were annotated on the venous phase by an experienced radiologist specializing in gastric cancer with reference to clinical and endoscopy records as needed, and then registered to the noncontrast phase. Our model is a novel Mask Transformer-based framework that jointly segments the stomach and potential gastric cancer and outputs the probability of abnormality, using noncontrast CT only. The performance of the model was evaluated on a hold-out test set comprising 100 gastric cancer cases and 148 normal cases, as

well as an external test set of 903 normal cases. The performance of the model was also compared to a reader study of two experienced radiologists on the hold-out test set.

## **RESULTS**

The model's ROC curve in the task of gastric cancer detection (cancer vs. normal) on the held-out test set was above both two readers, with an area under the curve (AUC) of 0.939. Furthermore, the model's sensitivity (Sens 85.0%) and specificity (Spec 92.6%) exceeded the mean performance of the radiologists (Sens 73.5%, Spec 84.2%). The model outperformed the best-performing radiologist in detecting early-stage gastric cancer (T1 60.0% vs. 50.0%, T2 77.8% vs. 55.6%). The model achieved a specificity of 97.7% on the external test set with 903 normal cases. For relative performance comparison to established gastric cancer screening tests, i.e., blood test and endoscopy, we adjust the threshold of our model to achieve the same level of specificity and compare the sensitivity. The model achieved a comparable sensitivity (69.4% vs. 66.7%) at a specificity of 99.5% compared to the blood test, and obtained a higher sensitivity (85.0% vs. 69.0%) at a specificity of 96.0% compared to endoscopy.

## **CONCLUSION**

The proposed model detected gastric cancer tumors on noncontrast CT scans with a high degree of sensitivity and specificity, exceeding the performance of average radiologists by a large margin.

## **CLINICAL RELEVANCE/APPLICATION**

Our study aims to explore the viability of noncontrast CT plus AI as a novel, non-invasive opportunistic screening method for gastric cancer. Compared to traditional screening tools, such as blood tests and endoscopy, our findings suggest that noncontrast CT scans demonstrate favorable accuracy as a new clinical tool for the detection of gastric cancer. This approach may be particularly promising due to its simplicity, accessibility, and no additional costs.

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## Abstract Archives of the RSNA, 2023

S5-SSGI04-1

### Feasibility of Deep Learning-Accelerated Nonenhanced Abbreviated Liver MRI for Solid Focal Lesion Detection

Sunday, Nov. 26 2:30PM - 3:30PM Room: S405

Yoonhee Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

For abbreviated liver MRI, deep learning reconstruction (DL) is expected to be highly advantageous by reducing scan time without compromising sensitivity for focal liver lesion (FLL) detection. This study evaluated the feasibility of nonenhanced abbreviated liver MRI by assessing image quality, per-lesion sensitivity for solid FLL, and scan time in sets of combinations of DL HASTE, free-breathing (FB) DL-DWI and breath-hold (BH) DL-DWI against conventional HASTE and FB-DWI (C-DWI).

#### METHODS AND MATERIALS

Consecutive 51 patients (30 males; mean age  $\pm$  SD,  $60.6 \pm 13$  years) with 40 FLLs who underwent routine liver MRI with additional DL HASTE, FB DL-DWI, and BH DL-DWI were included. Twenty-eight (54.9%) patients had chronic liver disease or liver cirrhosis. FLLs assessed were 12 (30%) HCCs, 16 (40%) metastases, and 12 (30%) hemangiomas. The DL scan parameters were matched to conventional sequences, except for the parallel imaging factor and number of averages in DWI. Two abdominal radiologists independently rated structural sharpness, artifacts, image noise, and overall image quality on a 5-point scale. Three sets of nonenhanced MRI sequences were reviewed for FLL detection: (1) HASTE/FB C-DWI, (2) DL-HASTE/FB DL-DWI, and (3) DL-HASTE/BH DL-DWI. Per-lesion sensitivity, lesion conspicuity, and margin sharpness were assessed and compared across image sets. Student's t-test and Mann-Whitney test with Bonferroni correction compared qualitative features.

#### RESULTS

The scan times for sets (1), (2), and (3) were 4 min 11 sec, 2 min 29 sec, and 1 min 37 sec, respectively. DL-HASTE and FB DL-DWI showed significantly better sharpness, fewer artifacts, less noise, and better overall image quality than their conventional counterparts ( $p = 0.001$ ). BH DL-DWI showed significantly less noise ( $p = 0.002$ ) compared to FB C-DWI, while other qualitative scores were comparable. On FLL assessment, both DL sets showed a significantly sharper margin than set (1). The pooled per-lesion sensitivity for sets (1), (2), and (3) was 95.1%, 95.1%, and 85.1%, with no significant difference ( $p = 0.131$ ). The overall sensitivities for detecting malignancies were 98.1%, 98.1%, and 93.7% in sets 1, 2, and 3, respectively. For detecting malignancies in patients at risk for HCC, the sensitivities were comparable across sets: (1) 96.8%, (2) 96.8%, and (3) 89.8% ( $p = 0.175$ ).

#### CONCLUSION

DL-accelerated HASTE and FB DWI showed significantly better image quality and comparable sensitivity for solid FLL detection in 83% of the scan time compared to conventional sequences. BH DL-DWI markedly reduced scan time but showed lower sensitivity, which requires further refinement.

#### CLINICAL RELEVANCE/APPLICATION

DL-accelerated HASTE and FB DWI are feasible options for abbreviated nonenhanced liver MRI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-SSGI04-2

### Fully Automated Pancreatic Adenocarcinoma Localization: Validation of a Convolutional Neural Network (CNN) Model Using Standard-of-Care CTs

Sunday, Nov. 26 2:30PM - 3:30PM Room: S405

Sovanlal Mukherjee, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a CNN model for a fully-automated localization of PDA on standard-of-care CT exams.

#### METHODS AND MATERIALS

Manual volumetric reference tumor segmentation was performed by radiologists on a highly curated CT dataset (portal phase; slice thickness=5-mm) from 1151 patients with treatment-naïve PDA [mean (range) tumor diameter: 4.34 (1.1-12.6)-cm]. Dataset was randomly divided into training/validation (n=921) and test subsets (n=230). A 3D CNN Detection model was trained using 5-fold cross-validation. Final model was obtained as an ensemble of the five models from the 5-fold training process. The model's output was a predicted bounding box that aimed to circumscribe the reference PDA segmentation. Model's performance was evaluated on the test subset using volumetric true positive fraction (TPF), which describes the proportion of the reference segmentation in the automated model-predicted bounding box. Model's generalizability was evaluated on The Cancer Imaging Archive (TCIA) (n=41) and Medical Segmentation Decathlon (MSD) (n=152) public datasets. Furthermore, model's performance in the test subset was sub-stratified for different image acquisition parameters (vendor, slice thickness) as well as tumoral features (location, density, and AJCC tumor-stage).

#### RESULTS

On the test subset, the model had a TPF [mean (SD)] of 0.87(0.22). Model's performance was generalizable to MSD and TCIA datasets [TPF: 0.90(0.21), 0.89(0.24) respectively;  $p>0.05$ ]. There was no significant difference in the model's performance for different CT vendors and slice thicknesses ( $p>0.05$ ). Model's TPF was resilient to tumor density [hypodense: 0.88 (0.21) versus isodense: 0.81(0.27);  $p=0.06$ ] and tumor location [head: 0.87 (0.21), body: 0.91(0.13), tail: 0.83(0.31), extra-pancreatic extension: 0.96(0.05);  $p=0.22$ ]. Additionally, model's performance was comparable for tumor stages II-IV [TPF: 0.87(0.23)-0.90(0.17);  $p=0.36$ ] with lower performance for stage I [TPF: 0.59(0.42);  $p<0.05$ , n=5].

#### CONCLUSION

A CNN model developed on a large CT dataset shows high accuracy and generalizability for a fully-automated PDA localization on standard-of-care CT exams.

#### CLINICAL RELEVANCE/APPLICATION

Fully-automated PDA localization provides a critical tool for quantitative imaging biomarker-driven multi-omics models for PDA risk stratification, treatment response assessment, and prognostication.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGI04-3

### Comparison of Image Quality and Focal Lesions Between Free-Breathing deep Learning Diffusion-Weighted Imaging and Conventional Images in Liver MRI

Sunday, Nov. 26 2:30PM - 3:30PM Room: S405

Jiyoung Yoon, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare image quality and diagnostic performance of focal liver lesions for malignancy between free-breathing diffusion weighted image using deep learning reconstruction (DWI-DL) and conventional DWI (c-DWI) in patients undergoing clinically indicated liver MRI.

#### METHODS AND MATERIALS

A total of 199 consecutive patients who underwent 3 T liver MRI with DWI-DL and c-DWI were retrospectively included. DWI was performed with single-shot spin-echo echo-planar technique and fat-suppression in free breathing with matching parameters. Three radiologists evaluated two sequences for subjective image quality, independently. The apparent diffusion coefficient (ADC) was measured in 15 regions of the liver. A total of 64 patients with 160 focal liver lesions (FLLs) showing high signal intensity on DWI were analyzed by four radiologists regarding per-lesion diagnostic performance for malignancy.

#### RESULTS

DWI-DL was 43.0% faster than c-DWI (119 vs. 209 sec). Compared with c-DWI, DWI-DL scored higher for all subjective image quality parameters (all,  $P < 0.001$ ). ADC values showed slightly more homogeneous on DWI-DL than those on c-DWI. And ADC values in the right lower section and the left upper, middle, and lower section revealed different between DWI-DL and c-DWI ( $P = 0.010, < 0.001, < 0.001, \text{ and } 0.003$ , respectively). Of 160 lesions, 116 malignancies (61 hepatocellular carcinoma, 3 cholangiocarcinoma, 52 metastasis) and 44 benignities were included. The diagnostic performance of DWI-DL showed comparable sensitivity (75.0-90.5% vs 75.9-82.8%), specificity (87.0-93.3% vs 82.6-97.7%), and accuracy (80.1-90.6% vs 80.5-84.4%), compared with c-DWI.

#### CONCLUSION

Free-breathing DWI-DL is a clinically feasible technique achieving high image quality and diagnostic performance for malignancy with shorter acquisition time compared to c-DWI.

#### CLINICAL RELEVANCE/APPLICATION

Free-breathing DWI using deep learning reduced scan time while improving image quality, compared with conventional DWI. The diagnostic performance of DWI-DL was comparable sensitivity (75.0-90.5% vs 75.9-82.8%), specificity (87.0-93.3% vs 82.6-97.7%), and accuracy (80.1-90.6% vs 80.5-84.4%), compared with c-DWI. Free-breathing DWI using deep learning may minimize motion-induced measurement error in ADC map while showing small differences of ADC values, compared with conventional DWI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGI04-4

### A Transformer-based deep Learning Model for Liver Stiffness Classification using Multiparametric Abdominal MRI in Children and Adults

Sunday, Nov. 26 2:30PM - 3:30PM Room: S405

Redha Ali, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a deep learning model that stratifies the degree of liver stiffening based on multiparametric MRI images from pediatric and adult patients with known or suspected chronic liver disease.

#### METHODS AND MATERIALS

In this HIPAA-compliant, IRB-approved, multi-site retrospective study, patients with known or suspected chronic liver disease who underwent clinical abdominal MRI examinations with MR elastography (MRE) assessment of liver stiffness between 2011 and 2022 were identified from four institutions, including <BLINDED INSTITUTIONS>. Three conventional MRI sequences, including axial T1-weighted (T1w), T2-weighted (T2w), and diffusion-weighted (DWI) MR images were retrieved. Patients were categorized into two groups using multiple liver stiffness thresholds ( $=2.5$  kPa,  $=3$  kPa,  $=3.5$  kPa,  $=4$  kPa, and  $=5$  kPa) to formulate a series of binary classification tasks, reflecting various degrees of liver stiffening. Our multi-sequence DeepLiverNet 2.0 uses pre-trained Swin Transformer model to extract latent features for classification (Fig. 1A). We constructed three branches of multi-channel transfer learning feature extractors from 11 mid-liver slices of T1w, T2w, and DWI (highest b-value) images. We evaluated model performance using accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve (AuROC) in both internal multi-site 10-fold cross-validation (CV) and external validation experiments.

#### RESULTS

A total of 3,365 patients (mean  $\pm$  SD age,  $49.9 \pm 16.6$  years; BMI  $28.8 \pm 6.5$  kg/m<sup>2</sup>; 1737 (51.6%) Females) were selected in two batches. Batch 1 (2,150 patients) was selected from 4 sites between 2011 and 2020 for internal CV, and later Batch 2 (1,215 patients) was selected from three sites <BLINDED INSTITUTIONS> between 2021 to 2022 for external temporal holdout validation. The model achieved mean [95% CI] AuROCs of 0.82 [0.80, 0.84], and 0.81 [0.78, 0.84] for internal and external validation, respectively, when using the  $= 3.0$  kPa threshold. Additional validation results are listed in Figs. 1B and 1C.

#### CONCLUSION

The proposed DeepLiverNet 2.0 AI model demonstrated moderate diagnostic performance on a large, multi-site combined pediatric and adult dataset for categorically classifying the degree of liver stiffening using anatomic T1w, T2w, and DWI MRI data.

#### CLINICAL RELEVANCE/APPLICATION

Our DeepLiverNet 2.0 AI model can categorically classify the severity of liver stiffening using multiparametric T1w, T2w, and DWI MRI data in children and adult. Model refinements and incorporation of clinical features may further improve performance and soon decrease the need for MRE elastography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGI04-6

### Effective Opportunistic Gastric Cancer Screening on Noncontrast CT Scans

Sunday, Nov. 26 2:30PM - 3:30PM Room: S405

Ling Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

We devised an AI model for the detection of gastric cancer (GC) tumors using noncontrast CT scans, which shows potential to serve as an effective tool for opportunistic cancer screening.

#### METHODS AND MATERIALS

We trained the AI model using 1,891 3D noncontrast CT volumes from a single hospital, comprising 687 patients with pathology-confirmed gastric cancer and 1,204 patients for normal control. The masks of tumors were annotated on the venous phase by an experienced radiologist specializing in gastric cancer with reference to clinical and endoscopy records as needed, and then registered to the noncontrast phase. Our model is a novel Mask Transformer-based framework that jointly segments the stomach and potential gastric cancer and outputs the probability of abnormality, using noncontrast CT only. The performance of the model was evaluated on a hold-out test set comprising 100 gastric cancer cases and 148 normal cases, as well as an external test set of 903 normal cases. The performance of the model was also compared to a reader study of two experienced radiologists on the hold-out test set.

#### RESULTS

The model's ROC curve in the task of gastric cancer detection (cancer vs. normal) on the held-out test set was above both two readers, with an area under the curve (AUC) of 0.939. Furthermore, the model's sensitivity (Sens 85.0%) and specificity (Spec 92.6%) exceeded the mean performance of the radiologists (Sens 73.5%, Spec 84.2%). The model outperformed the best-performing radiologist in detecting early-stage gastric cancer (T1 60.0% vs. 50.0%, T2 77.8% vs. 55.6%). The model achieved a specificity of 97.7% on the external test set with 903 normal cases. For relative performance comparison to established gastric cancer screening tests, i.e., blood test and endoscopy, we adjust the threshold of our model to achieve the same level of specificity and compare the sensitivity. The model achieved a comparable sensitivity (69.4% vs. 66.7%) at a specificity of 99.5% compared to the blood test, and obtained a higher sensitivity (85.0% vs. 69.0%) at a specificity of 96.0% compared to endoscopy.

#### CONCLUSION

The proposed model detected gastric cancer tumors on noncontrast CT scans with a high degree of sensitivity and specificity, exceeding the performance of average radiologists by a large margin.

#### CLINICAL RELEVANCE/APPLICATION

Our study aims to explore the viability of noncontrast CT plus AI as a novel, non-invasive opportunistic screening method for gastric cancer. Compared to traditional screening tools, such as blood tests and endoscopy, our findings suggest that noncontrast CT scans demonstrate favorable accuracy as a new clinical tool for the detection of gastric cancer. This approach may be particularly promising due to its simplicity, accessibility, and no additional costs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGU02

### Genitourinary Imaging (Advances in Diagnosis and Staging of Renal Cell Carcinoma)

Sunday, Nov. 26 2:30PM - 3:30PM Room: N227B

Luciana Costa, PhD (*Moderator*) Nothing to Disclose  
Martin H. Goodenberger, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### S5-SSGU02-1 **CT-based Clear Cell Likelihood Scores for Small Renal Masses: External Validation of Three Contemporary Independent Systems and Their Comparative Performance**

Satheesh Krishna, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Small renal masses (SRMs) defined as being  $\leq 4$ cm are benign up to 20% of the time. In addition, different subtypes have different behaviour with clear cell RCC (ccRCC) having the highest risk of aggressiveness and risk of metastasis. Surgical resection may be considered for ccRCC, while biopsy or active surveillance may be appropriate strategies for non clear cell RCC. MRI based Clear Cell Likelihood scores have been established and validated. Multiple CT based clear cell likelihood scoring algorithms have been proposed (Al Nasibi et al - Multiparametric CT-score algorithm; Eldehimi et al - Modified CT score; Tubtawee et al - UCLA CT-score) but require validation.

#### METHODS AND MATERIALS

This IRB-approved retrospective, cross-sectional study included 194 consecutive solid SRMs (97 ccRCC (50%), 44 papillary RCC (23%), 27 chromophobe RCC (14%), 16 angiomyolipomas (8%), 9 oncocytomas (5%) and 1 collecting duct carcinoma) with a dedicated renal mass protocol CT and surgical histopathology reference standard. Cystic masses and those with macroscopic fat were excluded. Two readers assessed the individual variables which were part of the 3 scoring algorithms described above. The diagnostic accuracy was calculated for each scoring system.

#### RESULTS

Using a threshold of  $\geq 4$  for ccRCC, Al Nasibi et al - Multiparametric CT-score algorithm had a sensitivity of 63% and specificity of 90%. Using a similar threshold of  $\geq 4$  for ccRCC, Eldehimi et al Modified CT score had a sensitivity of 66% and specificity of 89%. When using a threshold of  $\geq 4$ , the Tubtawee et al - UCLA CT-score had a lower sensitivity but higher specificity of 15% and 97%; but when a threshold of  $\geq 3$  was used, sensitivity of 67%, specificity of 82% was identified (Table 1). While multiparametric CT-score algorithm and Modified CT score performed better than UCLA CT-score for a threshold of  $\geq 4$  ( $p < 0.001$ ), when the UCLA CT-score threshold of  $\geq 3$  was used, they were not statistically different ( $p = 0.34$ ).

#### CONCLUSION

Clear cell likelihood CT based scoring systems have a high specificity and moderate sensitivity. Multiparametric CT-score algorithm ( $\geq 4$ ), Modified CT score ( $\geq 4$ ) and UCLA CT-score ( $\geq 3$ ) have similar performance.

#### CLINICAL RELEVANCE/APPLICATION

There is potential for the use of CT based scoring systems as an alternative to MRI based ccLS in the triaging of SRMs. This can assist in the management of SRMs, particularly regarding active surveillance vs surgical resection.

#### S5-SSGU02-3 **Utility of Qualitative and Quantitative Imaging Features to Identify Perinephric Fat Invasion in Renal Cell Carcinoma**

Madhu Gowda, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the utility of quantifying kidney surface nodularity (SN) and perinephric fat attenuation in identifying perinephric fat invasion (PFI) and other high-grade features in RCC.

## METHODS AND MATERIALS

124 patients with RCC >7cm underwent pre-procedural CT imaging. A single rater used a repurposed surface nodularity tool to measure an average surface nodularity score by painting regions of interest along the lateral kidney surface with contralateral normal kidney as a control. A total distance of 50-80 cm along the tumor surface was measured. Attenuation of perinephric fat using five 100mm<sup>2</sup> regions of interest (ROIs) at representative levels along the tumor and five ROIs at similar levels on the non-tumor side was measured. A fellowship-trained abdominal radiologist provided subjective interpretation of PFI for comparison. Quantitative assessment was correlated with presence of perinephric fat invasion, nuclear grade, sarcomatoid features, metastasis and pathologic stage.

## RESULTS

A total of 124 tumors were assessed (82m/42F, mean age 60.5 yrs). Average tumor size was 10 cm, 102 clear cell, 65 high nuclear grade (grade 3-4), 40 with PFI, 9 sarcomatoid, 30 with necrosis, 32 with metastatic disease, 67 advanced stage (T3a or higher). Mean and median SN score in patients without PFI were 5.7±1.2, 5.5 compared to 6.4±1.2, 6.2 in those with PFI (p=0.01). SN demonstrated an AUC of 0.64 in identifying PFI and performed better than SN ratio. It also showed a weak association with presence of metastatic disease and higher pathologic stage (AUC 0.62, 0.62 respectively). Mean and median perinephric fat attenuation in patients without PFI was -72HU±22 and -76HU, compared to -65HU±12.9 and -63HU in patients with PFI (p=0.01). Fat attenuation and fat attenuation ratio showed similar performance in identifying PFI, with AUCs of 0.64 and 0.65 respectively; and also showed weak association with presence of metastatic disease and pathologic stage (AUC 0.65, 0.66 respectively). In multivariate analysis combining SN score and attenuation ratio, there is improvement in identification of PFI (AUC: 0.69). We found the performance of subjective assessment of PFI comparable to the objective measures, with slightly improved performance when all 3 (SN+fat attenuation+subjective assessment) are combined with an AUC of 0.74 in identifying PFI.

## CONCLUSION

SN and perinephric fat attenuation showed some association with presence of PFI, metastatic disease and advanced pathologic stage. When objective measures were combined with subjective assessment in a multivariate model, improved moderate association was seen.

## CLINICAL RELEVANCE/APPLICATION

Perinephric fat invasion (PFI) of renal cell carcinoma (RCC) is associated with a worse survival outcomes.

## S5-SSGU02-4 Contrast-enhanced CT Radiomic Analysis for the Preoperative Prediction of Pathological T3a Upstaging in Renal Cell Carcinoma

Enyu Yuan, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop and validate of contrast-enhanced CT-based radiomic model for predicting pathological T3a upstaging in patients with renal cell carcinoma.

## METHODS AND MATERIALS

A total of 743 patients with renal cell carcinoma in our hospital were retrospectively enrolled. The pathological T3a status of each patient was pathologically confirmed. Radiomic features of the lesion and the 5mm peritumoral area were extracted from the manually labeled portal venous phase CT images. The least absolute shrinkage and selection operator method was used for feature selection. Different predictive models based on selected radiomics features from the tumor, the peritumoral area, and their combination were constructed using logistic regression classifier. To minimize sampling bias, the Monte Carlo cross-validation were used to evaluate the models. The data were split into training and validation dataset in a 7:3 manner, and the splitting was repeated for 1000 times with different random state number. The model in each experiment was evaluated by using metrics of discrimination, calibration, and clinical utility, and the mean performance of 1000 experiments was reported. The frequencies of features being selected were also analyzed.

## RESULTS

For the tumor area, shape features were the most frequently selected features. For the peritumoral area, the gray level size zone matrix features were the most frequently selected features. In the training dataset, the combine model showed the best predictive capability with mean area under receiver operating characteristics curve (AUC) achieving 0.841, which was significantly higher than the tumor model (AUC, 0.839; p < 0.001) or the peritumoral model (AUC, 0.806; p < 0.001). Similar performance was observed in the validation dataset, and the mean AUCs of the tumor model, the peritumoral model and the combine model were 0.832, 0.796 and 0.834. The calibration curve showed good calibration of the tumor model and the combine model in both training and validation datasets. DCA demonstrated similarly good clinical usefulness in both training and validation datasets.

## CONCLUSION

The radiomic model that incorporated radiomics features from the tumor and peritumoral area showed favorable performance in predicting pathological T3a upstaging preoperatively in renal cell carcinoma patients, which could benefit clinical decision making.

## CLINICAL RELEVANCE/APPLICATION

The contrast-enhanced CT-based radiomic model showed good discrimination, calibration and clinical utility for preoperatively prediction of pathological T3a upstaging in renal cell carcinoma.

### S5-SSGU02-5 **Multiphase CT Radiomics Correlation with Clear Cell Renal Cell Carcinoma Tumor Immune Microenvironment: A Study on Tumor-Infiltrating Lymphocytes and Tumor-Associated Macrophages**

Alexander Shieh, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Clear cell renal cell carcinoma (ccRCC) is the most common type of kidney cancer. The tumor immune microenvironment (TIME) signatures of ccRCC have been studied as biomarkers for overall prognosis or response to future immunotherapy. However, TIME assessment is currently tissue-based, which can be expensive and time inefficient. In this study, we investigated radiomics correlation to histopathology-grounded TIME using standard multiphase CT. Two markers that correlated to poor clinical outcomes in ccRCC in prior studies: (1) elevated PD1+CD8+ to CD8+ ratio (2) elevated CD68+ to PanCK+ ratio were explored in depth. We demonstrated the feasibility of predicting these markers with an established CT radiomics panel and report the performance of both tasks.

## METHODS AND MATERIALS

Volumes of 78 primary ccRCC tumors from contrast-enhanced multiphase CT were manually segmented and analyzed using our radiomics pipeline validated on several RCC studies. The tumor specimens obtained via nephrectomy were stained with PanCK, CD8, PD1 and CD68 using the Opal multiplex immunohistochemistry (mIHC) kit. Areas of viable tumor epithelium were selected by expert pathologist for subsequent automated tissue and cell segmentation using the inForm software to delineate tumor and stroma as well as identifying specific cell phenotypes. Statistical machine learning methods including Random Forest, AdaBoost and Elastic Net were used to predict intratumoral PD1+CD8+ to CD8+ ratio and CD68+ to PanCK+ ratio. Sequential experiments with elevated ratio threshold defined at 0.2, 0.3 and 0.4 were performed.

## RESULTS

A total of 1,076 regions of interest were selected from the mIHC samples. After cell segmentation, 3,229,582 cells were identified. For radiomic correlation to PD1+CD8+ to CD8+ ratio, the AdaBoost model achieved the best AUROC of 0.77 (95% CI: [0.63, 0.91]) at threshold 0.3. The excretory phase discrete cosine transform features are most dominant in this experiment. As for CD68+ to PanCK+ ratio, the Random Forest model achieved the best AUROC of 0.73 (95% CI: [0.6, 0.87]) at threshold 0.4. The gray level size zone matrix features of the secretory phase had the highest importance in this model.

## CONCLUSION

We demonstrated the feasibility of using radiomics to correlate tumor-infiltrating lymphocyte (TIL) distribution (PD1+CD8+ to CD8+ ratio) and tumor-associated macrophage (TAM) quantification (CD68+ to PanCK+ ratio). Validation of the results with a larger sample size and external data is warranted.

## CLINICAL RELEVANCE/APPLICATION

We reported the first use of multiphase CT radiomics as a non-invasive method to assess TIL and TAM in ccRCC. These are TIME features that are associated with ccRCC prognosis and can possibly aid immunotherapy patient selection in the future.

### S5-SSGU02-6 **Identification of CT Imaging Features of High-grade Renal Cell Carcinoma using Precise Radiologic Pathologic Correlation**

Madhu Gowda, BS (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the CT imaging features of high nuclear grade in renal cell carcinoma (RCC) using precise radiologic-pathologic correlation in ex vivo specimens

## METHODS AND MATERIALS

20 patients with large (>7 cm) renal cell carcinoma were prospectively recruited for this HIPAA compliant, IRB approved study and written informed consent was obtained. Using preprocedure imaging, a formlabs kidney/ tumor mold was 3D printed prior to surgical resection. After kidney resection, it was placed in the mold for orientation and 3 tissue localization

clips were inserted into the tumor. The specimen was imaged with non-contrast CT then taken to surgical pathology. Three 1 cm pathology samples were taken around each tissue localization clip and a pathologic map was generated showing the nuclear grade for that site within the tumor. This was precisely correlated with unenhanced CT using the clips as landmarks, corresponding 2D ROIs were drawn, and radiomics features were extracted from each site. Nuclear grade 1-2 was categorized as low grade, 3-4 high. Ten machine learning algorithms were trained using radiomics data from CT images in order to identify high versus low grade tumors.

## **RESULTS**

20 tumors (14M/6F, ave age 63.1 yrs, 15 clear cell) were scanned with CT, 137 ROIs were evaluated (51 high grade, 86 low grade). The k-nearest neighbor algorithm demonstrated the best performance, with AUC 0.86, sensitivity 0.88, specificity 0.85 in identifying areas of high grade tumor. The next best performing algorithm was bagged decision tree (AUC 0.76, sens/spec 0.56/0.96). Logistic regression (LR) performed best in identification of areas of tumor necrosis, AUC 0.86, sensitivity/specificity 0.86/0.86 respectively.

## **CONCLUSION**

High grade areas of heterogeneous RCC may be identifiable with unenhanced CT radiomics features when precise radiologic-pathologic correlation is used.

## **CLINICAL RELEVANCE/APPLICATION**

Identification of high grade features in renal cell carcinoma impacts prognosis, outcomes and management.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-SSGU02-1

### CT-based Clear Cell Likelihood Scores for Small Renal Masses: External Validation of Three Contemporary Independent Systems and Their Comparative Performance

Sunday, Nov. 26 2:30PM - 3:30PM Room: N227B

Satheesh Krishna, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Small renal masses (SRMs) defined as being  $\leq 4$ cm are benign up to 20% of the time. In addition, different subtypes have different behaviour with clear cell RCC (ccRCC) having the highest risk of aggressiveness and risk of metastasis. Surgical resection may be considered for ccRCC, while biopsy or active surveillance may be appropriate strategies for non clear cell RCC. MRI based Clear Cell Likelihood scores have been established and validated. Multiple CT based clear cell likelihood scoring algorithms have been proposed (Al Nasibi et al - Multiparametric CT-score algorithm; Eldehimi et al - Modified CT score; Tubtawee et al - UCLA CT-score) but require validation.

#### METHODS AND MATERIALS

This IRB-approved retrospective, cross-sectional study included 194 consecutive solid SRMs (97 ccRCC (50%), 44 papillary RCC (23%), 27 chromophobe RCC (14%), 16 angiomyolipomas (8%), 9 oncocytomas (5%) and 1 collecting duct carcinoma) with a dedicated renal mass protocol CT and surgical histopathology reference standard. Cystic masses and those with macroscopic fat were excluded. Two readers assessed the individual variables which were part of the 3 scoring algorithms described above. The diagnostic accuracy was calculated for each scoring system.

#### RESULTS

Using a threshold of  $\geq 4$  for ccRCC, Al Nasibi et al - Multiparametric CT-score algorithm had a sensitivity of 63% and specificity of 90%. Using a similar threshold of  $\geq 4$  for ccRCC, Eldehimi et al Modified CT score had a sensitivity of 66% and specificity of 89%. When using a threshold of  $\geq 4$ , the Tubtawee et al - UCLA CT-score had a lower sensitivity but higher specificity of 15% and 97%; but when a threshold of  $\geq 3$  was used, sensitivity of 67%, specificity of 82% was identified (Table 1). While multiparametric CT-score algorithm and Modified CT score performed better than UCLA CT-score for a threshold of  $\geq 4$  ( $p < 0.001$ ), when the UCLA CT-score threshold of  $\geq 3$  was used, they were not statistically different ( $p = 0.34$ ).

#### CONCLUSION

Clear cell likelihood CT based scoring systems have a high specificity and moderate sensitivity. Multiparametric CT-score algorithm ( $\geq 4$ ), Modified CT score ( $\geq 4$ ) and UCLA CT-score ( $\geq 3$ ) have similar performance.

#### CLINICAL RELEVANCE/APPLICATION

There is potential for the use of CT based scoring systems as an alternative to MRI based cCLS in the triaging of SRMs. This can assist in the management of SRMs, particularly regarding active surveillance vs surgical resection.

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## Abstract Archives of the RSNA, 2023

S5-SSGU02-3

### Utility of Qualitative and Quantitative Imaging Features to Identify Perinephric Fat Invasion in Renal Cell Carcinoma

Sunday, Nov. 26 2:30PM - 3:30PM Room: N227B

Madhu Gowda, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the utility of quantifying kidney surface nodularity (SN) and perinephric fat attenuation in identifying perinephric fat invasion (PFI) and other high-grade features in RCC.

#### METHODS AND MATERIALS

124 patients with RCC >7cm underwent pre-procedural CT imaging. A single rater used a repurposed surface nodularity tool to measure an average surface nodularity score by painting regions of interest along the lateral kidney surface with contralateral normal kidney as a control. A total distance of 50-80 cm along the tumor surface was measured. Attenuation of perinephric fat using five 100mm<sup>2</sup> regions of interest (ROIs) at representative levels along the tumor and five ROIs at similar levels on the non-tumor side was measured. A fellowship-trained abdominal radiologist provided subjective interpretation of PFI for comparison. Quantitative assessment was correlated with presence of perinephric fat invasion, nuclear grade, sarcomatoid features, metastasis and pathologic stage.

#### RESULTS

A total of 124 tumors were assessed (82m/42F, mean age 60.5 yrs). Average tumor size was 10 cm, 102 clear cell, 65 high nuclear grade (grade 3-4), 40 with PFI, 9 sarcomatoid, 30 with necrosis, 32 with metastatic disease, 67 advanced stage (T3a or higher). Mean and median SN score in patients without PFI were 5.7±1.2, 5.5 compared to 6.4±1.2, 6.2 in those with PFI (p=0.01). SN demonstrated an AUC of 0.64 in identifying PFI and performed better than SN ratio. It also showed a weak association with presence of metastatic disease and higher pathologic stage (AUC 0.62, 0.62 respectively). Mean and median perinephric fat attenuation in patients without PFI was -72HU±22 and -76HU, compared to -65HU±12.9 and -63HU in patients with PFI (p=0.01). Fat attenuation and fat attenuation ratio showed similar performance in identifying PFI, with AUCs of 0.64 and 0.65 respectively; and also showed weak association with presence of metastatic disease and pathologic stage (AUC 0.65, 0.66 respectively). In multivariate analysis combining SN score and attenuation ratio, there is improvement in identification of PFI (AUC: 0.69). We found the performance of subjective assessment of PFI comparable to the objective measures, with slightly improved performance when all 3 (SN+fat attenuation+subjective assessment) are combined with an AUC of 0.74 in identifying PFI.

#### CONCLUSION

SN and perinephric fat attenuation showed some association with presence of PFI, metastatic disease and advanced pathologic stage. When objective measures were combined with subjective assessment in a multivariate model, improved moderate association was seen.

#### CLINICAL RELEVANCE/APPLICATION

Perinephric fat invasion (PFI) of renal cell carcinoma (RCC) is associated with a worse survival outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGU02-4

### Contrast-enhanced CT Radiomic Analysis for the Preoperative Prediction of Pathological T3a Upstaging in Renal Cell Carcinoma

Sunday, Nov. 26 2:30PM - 3:30PM Room: N227B

Enyu Yuan, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate of contrast-enhanced CT-based radiomic model for predicting pathological T3a upstaging in patients with renal cell carcinoma.

#### METHODS AND MATERIALS

A total of 743 patients with renal cell carcinoma in our hospital were retrospectively enrolled. The pathological T3a status of each patient was pathologically confirmed. Radiomic features of the lesion and the 5mm peritumoral area were extracted from the manually labeled portal venous phase CT images. The least absolute shrinkage and selection operator method was used for feature selection. Different predictive models based on selected radiomics features from the tumor, the peritumoral area, and their combination were constructed using logistic regression classifier. To minimize sampling bias, the Monte Carlo cross-validation were used to evaluate the models. The data were split into training and validation dataset in a 7:3 manner, and the splitting was repeated for 1000 times with different random state number. The model in each experiment was evaluated by using metrics of discrimination, calibration, and clinical utility, and the mean performance of 1000 experiments was reported. The frequencies of features being selected were also analyzed.

#### RESULTS

For the tumor area, shape features were the most frequently selected features. For the peritumoral area, the gray level size zone matrix features were the most frequently selected features. In the training dataset, the combine model showed the best predictive capability with mean area under receiver operating characteristics curve (AUC) achieving 0.841, which was significantly higher than the tumor model (AUC, 0.839;  $p < 0.001$ ) or the peritumoral model (AUC, 0.806;  $p < 0.001$ ). Similar performance was observed in the validation dataset, and the mean AUCs of the tumor model, the peritumoral model and the combine model were 0.832, 0.796 and 0.834. The calibration curve showed good calibration of the tumor model and the combine model in both training and validation datasets. DCA demonstrated similarly good clinical usefulness in both training and validation datasets.

#### CONCLUSION

The radiomic model that incorporated radiomics features from the tumor and peritumoral area showed favorable performance in predicting pathological T3a upstaging preoperatively in renal cell carcinoma patients, which could benefit clinical decision making.

#### CLINICAL RELEVANCE/APPLICATION

The contrast-enhanced CT-based radiomic model showed good discrimination, calibration and clinical utility for preoperatively prediction of pathological T3a upstaging in renal cell carcinoma.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGU02-5

### **Multiphase CT Radiomics Correlation with Clear Cell Renal Cell Carcinoma Tumor Immune Microenvironment: A Study on Tumor-Infiltrating Lymphocytes and Tumor-Associated Macrophages**

Sunday, Nov. 26 2:30PM - 3:30PM Room: N227B

Alexander Shieh, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Clear cell renal cell carcinoma (ccRCC) is the most common type of kidney cancer. The tumor immune microenvironment (TIME) signatures of ccRCC have been studied as biomarkers for overall prognosis or response to future immunotherapy. However, TIME assessment is currently tissue-based, which can be expensive and time inefficient. In this study, we investigated radiomics correlation to histopathology-grounded TIME using standard multiphase CT. Two markers that correlated to poor clinical outcomes in ccRCC in prior studies: (1) elevated PD1+CD8+ to CD8+ ratio (2) elevated CD68+ to PanCK+ ratio were explored in depth. We demonstrated the feasibility of predicting these markers with an established CT radiomics panel and report the performance of both tasks.

#### **METHODS AND MATERIALS**

Volumes of 78 primary ccRCC tumors from contrast-enhanced multiphase CT were manually segmented and analyzed using our radiomics pipeline validated on several RCC studies. The tumor specimens obtained via nephrectomy were stained with PanCK, CD8, PD1 and CD68 using the Opal multiplex immunohistochemistry (mIHC) kit. Areas of viable tumor epithelium were selected by expert pathologist for subsequent automated tissue and cell segmentation using the inForm software to delineate tumor and stroma as well as identifying specific cell phenotypes. Statistical machine learning methods including Random Forest, AdaBoost and Elastic Net were used to predict intratumoral PD1+CD8+ to CD8+ ratio and CD68+ to PanCK+ ratio. Sequential experiments with elevated ratio threshold defined at 0.2, 0.3 and 0.4 were performed.

#### **RESULTS**

A total of 1,076 regions of interest were selected from the mIHC samples. After cell segmentation, 3,229,582 cells were identified. For radiomic correlation to PD1+CD8+ to CD8+ ratio, the AdaBoost model achieved the best AUROC of 0.77 (95% CI: [0.63, 0.91]) at threshold 0.3. The excretory phase discrete cosine transform features are most dominant in this experiment. As for CD68+ to PanCK+ ratio, the Random Forest model achieved the best AUROC of 0.73 (95% CI: [0.6, 0.87]) at threshold 0.4. The gray level size zone matrix features of the secretory phase had the highest importance in this model.

#### **CONCLUSION**

We demonstrated the feasibility of using radiomics to correlate tumor-infiltrating lymphocyte (TIL) distribution (PD1+CD8+ to CD8+ ratio) and tumor-associated macrophage (TAM) quantification (CD60+ to PanCK+ ratio). Validation of the results with a larger sample size and external data is warranted.

#### **CLINICAL RELEVANCE/APPLICATION**

We reported the first use of multiphase CT radiomics as a non-invasive method to assess TIL and TAM in ccRCC. These are TIME features that are associated with ccRCC prognosis and can possibly aid immunotherapy patient selection in the future.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSGU02-6

### Identification of CT Imaging Features of High-grade Renal Cell Carcinoma using Precise Radiologic Pathologic Correlation

Sunday, Nov. 26 2:30PM - 3:30PM Room: N227B

Madhu Gowda, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the CT imaging features of high nuclear grade in renal cell carcinoma (RCC) using precise radiologic-pathologic correlation in ex vivo specimens

#### **METHODS AND MATERIALS**

20 patients with large (>7 cm) renal cell carcinoma were prospectively recruited for this HIPAA compliant, IRB approved study and written informed consent was obtained. Using preprocedure imaging, a formlabs kidney/ tumor mold was 3D printed prior to surgical resection. After kidney resection, it was placed in the mold for orientation and 3 tissue localization clips were inserted into the tumor. The specimen was imaged with non-contrast CT then taken to surgical pathology. Three 1 cm pathology samples were taken around each tissue localization clip and a pathologic map was generated showing the nuclear grade for that site within the tumor. This was precisely correlated with unenhanced CT using the clips as landmarks, corresponding 2D ROIs were drawn, and radiomics features were extracted from each site. Nuclear grade 1-2 was categorized as low grade, 3-4 high. Ten machine learning algorithms were trained using radiomics data from CT images in order to identify high versus low grade tumors.

#### **RESULTS**

20 tumors (14M/6F, ave age 63.1 yrs, 15 clear cell) were scanned with CT, 137 ROIs were evaluated (51 high grade, 86 low grade). The k-nearest neighbor algorithm demonstrated the best performance, with AUC 0.86, sensitivity 0.88, specificity 0.85 in identifying areas of high grade tumor. The next best performing algorithm was bagged decision tree (AUC 0.76, sens/spec 0.56/0.96). Logistic regression (LR) performed best in identification of areas of tumor necrosis, AUC 0.86, sensitivity/specificity 0.86/0.86 respectively.

#### **CONCLUSION**

High grade areas of heterogeneous RCC may be identifiable with unenhanced CT radiomics features when precise radiologic-pathologic correlation is used.

#### **CLINICAL RELEVANCE/APPLICATION**

Identification of high grade features in renal cell carcinoma impacts prognosis, outcomes and management.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-SSOB01

### OB/Gynecology (Obstetric Imaging)

Sunday, Nov. 26 2:30PM - 3:30PM Room: N229

Edward R. Oliver, MD, PhD (*Moderator*) Nothing to Disclose  
Emily Edwards, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### S5-SSOB01-2 **Placenta Accreta Spectrum Disorders: MRI-Based Scoring of Placental Invasion using Qualitative Imaging Parameters**

Benjamin D. Parnes, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the predictive performance of qualitative MRI features with and without clinical information for the diagnosis of placenta accreta spectrum (PAS) in pregnant women, and to develop a scoring system based on these features.

#### METHODS AND MATERIALS

131 pregnant women (mean age 36 years, age range 21-54; mean gestational age 28 weeks, (GA range 12-37 weeks) undergoing MRI for placental (n=122) or fetal/maternal indication (n=9, normal controls) were included in this 5 year retrospective study from (2016-2021). Demographic and clinical data were recorded. Three independent radiologists (Obs. 1, 1 year; Obs. 2, 3 years, Obs. 3, 19 years) analyzed the MRIs for the presence of MRI features: intraplacental T2-dark bands, uterine/placental bulge, loss of low T2 retroplacental line, myometrial thinning/disruption, bladder wall interruption, focal exophytic placental mass, abnormal vasculature of the placental bed, serosal vessel sign, bladder vessel sign, parametrial vessel sign, and placenta previa. Inter-reader disagreements for the 2 experienced radiologists were adjudicated by a consensus review by 2 separate radiologists (Obs. 4, 13 years; Obs. 5; 12 years), which was then used for initial analysis. The reference standard for PAS was established by pathology and/or inter-operative findings at delivery. Data were evaluated for PAS using univariable and multivariable logistic regression, which was used to create a scoring system. Area under the curve (AUC) and 95% confidence intervals (95%CI) were estimated. Inter-reader agreement for the qualitative MRI findings was assessed using Kappa statistics. Analyses were conducted using SPSS.

#### RESULTS

53 women had >1 prior C-section and 61 had >1 prior delivery. PAS was found in 54/113 at the reference standard. All 11 MRI features and prior delivery history were significant at univariable analysis (all p-values =0.05). Multivariable analysis found 3 MRI features yielded the strongest AUC for PAS: uterine/placental bulge (p=0.0016), focal exophytic placental mass (p=0.0084), and bladder vessel sign (p=0.0080). The AUC of the 3-predictor model was 0.83 (95%CI 0.76-0.90). Placenta previa showed high inter-reader agreement (kappa range 0.81-0.87), while the remaining MRI variables demonstrated moderate/low agreement (kappas <0.53).

#### CONCLUSION

A 3-predictor model based on MRI findings of uterine/placental bulge, exophytic placental mass and bladder vessel sign demonstrates an excellent AUC for predicting PAS.

#### CLINICAL RELEVANCE/APPLICATION

Placenta accreta spectrum (PAS) can cause severe maternal complications. MRI is used to guide management in challenging cases, although no validated MRI-based scoring system for prediction exists.

### S5-SSOB01-3 **Comparison of the Ultrasound Placenta Accreta Index in Severe Placenta Accreta Spectrum at Different Gestational Ages**

Quyen N. Do, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The placenta accreta index (PAI) is a standardized evaluation of ultrasound (US) parameters for the prediction of placenta accreta spectrum (PAS). The purpose of this study was to determine if the PAI value assigned in sonograms obtained between 17-27 weeks differ from PAI value of sonograms after 27 weeks within the same patient identified to have US and clinical risk factors for PAS.

## METHODS AND MATERIALS

This is a single-center retrospective study of pregnancies with concern for PAS between Sep 2019-Feb 2023 evaluated by serial US (17-27 weeks and after 27 weeks) with at least 5 weeks between sonograms. The Society of Maternal-Fetal Medicine recommends the use of a standardized approach for PAS US markers. At our center this is achieved by the application of the PAI. Medical records were reviewed for US-PAI parameters (Table 1) and surgical outcomes; patients were grouped according to outcome of cesarean hysterectomy, based on clinical FIGO classification of severe PAS at the time of cesarean delivery. Demographics were compared between groups (Wilcoxon and Fisher Exact test). Intraclass correlation coefficient (ICC) was used to assess the agreement between US-PAI before and after 27 weeks. Univariate logistic regression models and receiver operating areas under the curve (AUC) for the US-PAIs and number of prior cesarean deliveries were generated.

## RESULTS

Surgical outcomes were available on 44 pregnant patients with serial US-PAI; 24 (54.5%) required cesarean hysterectomy for PAS; 20 (45.5%) had a routine cesarean delivery. There were no differences in age, race, or gestational age at sonograms (Table 2). The number of prior cesarean deliveries was significantly associated with risk for cesarean hysterectomy ( $p=0.048$ ). US-PAIs obtained from 17-27 weeks sonograms and after 27 weeks sonograms had excellent agreement (ICC 0.88, 95% CI (0.79, 0.93), figure 1). AUC's of US-PAI were significantly predictive of the need for cesarean hysterectomy regardless of the gestational groups (Figure 2). When compared with number of prior cesarean deliveries alone, PAI was significantly more predictive of the need for cesarean hysterectomy (Prior cesarean deliveries' AUC of 0.67 versus 0.86 with  $p < 0.001$  for US-PAI before 27 weeks, and versus 0.91 with  $p < 0.001$  for US-PAI after 27 weeks).

## CONCLUSION

US-PAI AUCs obtained from sonograms between 17-27 weeks and after 27 weeks correlate to severe PAS requiring cesarean hysterectomy. There was no statistical difference between US-PAI obtained at earlier or later sonograms.

## CLINICAL RELEVANCE/APPLICATION

US-PAI is superior to prior cesarean number in predicting the need for cesarean hysterectomy for severe PAS, at both 17-27 weeks and after 27 weeks epochs, highlighting the consistency of this technique in prediction of PAS.

## S5-SSOB01-4 Comparison of Best Landmarks for Calculating Fetal Jaw Index by Ultrasound and MRI to Predict Postnatal Outcomes in Micrognathia

Bailey Lyttle, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Micrognathia is associated with significant perinatal mortality due to airway compromise at birth. Prenatal ultrasound is routinely used to diagnose micrognathia but is technically challenging and imperfect in its ability to predict postnatal outcomes. Fetal MRI has been utilized for measuring the jaw index (JI) using the posterior border of the masseter muscle, but its indistinct margins can lead to inaccuracy. The mandibular teeth buds are more clearly depicted by MRI. We hypothesize that the MRI JI measured using the posterior teeth buds, rather than the masseter muscles, more closely correlates with the ultrasound JI and postnatal outcomes.

## METHODS AND MATERIALS

We performed a retrospective review of pregnancies complicated by micrognathia who underwent fetal ultrasound and MRI between September 2013 and June 2022. MRI JI was calculated using both masseter muscles and posterior teeth buds as the posterior mandibular landmark. Each MRI measurement was performed independently by two radiologists. Pearson's correlations were used to assess inter-reader variability as well as correlation between MRI and ultrasound. Logistic regression was used to evaluate the predictability of postnatal outcomes including intubation or tracheostomy at delivery, need for jaw distraction, and postnatal mortality.

## RESULTS

Forty-three fetuses were included in the analysis. JI could not be obtained by ultrasound in 16 (37%) cases and by MRI in 3 (7.0%) cases. The correlation between MRI JI readers was stronger when using teeth buds ( $R=0.83$ ,  $p < 0.0001$ ) compared to masseter muscles ( $R=0.45$ ,  $p=0.003$ ). When comparing MRI JI to ultrasound JI, there was a stronger correlation when teeth buds were used ( $R=0.4$ ,  $p=0.03$ ) versus masseter muscles ( $R=0.32$ ,  $p=0.10$ ). MRI JI predicted need for jaw distraction when measured by tooth buds ( $p=0.01$ ) and masseter muscles ( $p=0.04$ ); but ultrasound did not. No measurement was predictive of other postnatal outcomes (Table).



## CONCLUSION

MRI JI correlated with ultrasound JI in fetuses with micrognathia. There was a stronger correlation and less inter-reader variability when using posterior teeth buds compared to masseter muscles on MRI. Ultrasound images were more frequently nondiagnostic for jaw measurements when compared to MRI and MRI JI was more predictive for need of postnatal jaw distraction, suggesting it is a useful tool for prenatal counseling and post-delivery planning.

## CLINICAL RELEVANCE/APPLICATION

Appropriate and accurate prenatal imaging is instrumental in adequately counseling families during the pregnancy and planning for potential interventions following delivery. Our findings highlight the utility of fetal MRI and its potential benefits for diagnosis and counseling.

## S5-SSOB01-6 Assessing the Corelation of Ultrasonography of Maternal Ophthalmic Artery Doppler as a Predictor of Pre-eclampsia

Khushboo Juneja, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to report the methodology for ophthalmic artery Doppler and summarize findings from the implementation of such assessment in the prediction of Preclampsia in later stage of pregnancy and correlate doppler indices value with maternal and fetal outcome.

## METHODS AND MATERIALS

Study was conducted on pregnant female between 14 to 22 weeks coming for routine antenatal scan at Radiology department. The study comprised 252 patients between time period of March 2021 to December 2022. Ophthalmic artery doppler were performed at 14 to 22 week and the same patients were followed up at 30 to 36 weeks. The data was analyzed using standard sensitivity and specificity formulas.

## RESULTS

In our study on comparing the foetal outcome with hypertensive status, most patients with low birth weight, IUFD and foetal distress were among preeclamptic patients, indicating a significant association between adverse fetal outcome and preeclampsia. On comparing the adverse maternal outcome with the hypertensive status, there was a significant ( $p < 0.001$ ) association between preeclampsia and adverse maternal complication. • Ophthalmic artery parameters such as PSV1, PSV2, PSV ratio, PI, RI, and uterine artery PI were used to predict preeclampsia. It was found there was a significant association observed among PSV2, PSV ratio, PI, and uterine artery PI, but there were no significant associations observed in measuring PSV1 and RI. Our study found that the PSV ratio is a better predictor of adverse maternal outcomes, and uterine artery PI is a better predictor of adverse foetal outcomes. On analysing the efficacy of the PSV ratio for predicting preeclampsia, the AUC was 0.845, which indicates a good predictor for PE, with 83.1% sensitivity and 42.9% specificity.

## CONCLUSION

Based on study, it was found there was a significant association observed among PSV2, PSV ratio, ophthalmic artery PI and uterine artery PI but there were no significant associations observed in measuring PSV1 and RI. Our study found that the PSV ratio is a better predictor of adverse maternal outcomes, and uterine artery PI is a better predictor of adverse foetal outcomes. On analysing the efficacy of the PSV ratio for predicting preeclampsia, the AUC was 0.845, which indicates a good predictor for PE, with 83.1% sensitivity and 42.9% specificity.

## CLINICAL RELEVANCE/APPLICATION

In the present study, there was an association between the abnormal ophthalmic artery indices and preeclampsia, among which the PSV ratio was an excellent predictor. The identification of the high-risk group be beneficial, so the clinician could provide timely interventions to prevent the development of PE and potentially reduce maternal and perinatal death and morbidity.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-SSOB01-2

### Placenta Accreta Spectrum Disorders: MRI-Based Scoring of Placental Invasion using Qualitative Imaging Parameters

Sunday, Nov. 26 2:30PM - 3:30PM Room: N229

Benjamin D. Parnes, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the predictive performance of qualitative MRI features with and without clinical information for the diagnosis of placenta accreta spectrum (PAS) in pregnant women, and to develop a scoring system based on these features.

#### METHODS AND MATERIALS

131 pregnant women (mean age 36 years, age range 21-54; mean gestational age 28 weeks, (GA range 12-37 weeks) undergoing MRI for placental (n=122) or fetal/maternal indication (n=9, normal controls) were included in this 5 year retrospective study from (2016-2021). Demographic and clinical data were recorded. Three independent radiologists (Obs. 1, 1 year; Obs. 2, 3 years, Obs. 3, 19 years) analyzed the MRIs for the presence of MRI features: intraplacental T2-dark bands, uterine/placental bulge, loss of low T2 retroplacental line, myometrial thinning/disruption, bladder wall interruption, focal exophytic placental mass, abnormal vasculature of the placental bed, serosal vessel sign, bladder vessel sign, parametrial vessel sign, and placenta previa. Inter-reader disagreements for the 2 experienced radiologists were adjudicated by a consensus review by 2 separate radiologists (Obs. 4, 13 years; Obs. 5; 12 years), which was then used for initial analysis. The reference standard for PAS was established by pathology and/or inter-operative findings at delivery. Data were evaluated for PAS using univariable and multivariable logistic regression, which was used to create a scoring system. Area under the curve (AUC) and 95% confidence intervals (95%CI) were estimated. Inter-reader agreement for the qualitative MRI findings was assessed using Kappa statistics. Analyses were conducted using SPSS.

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## Abstract Archives of the RSNA, 2023

S5-SSOB01-3

### Comparison of the Ultrasound Placenta Accreta Index in Severe Placenta Accreta Spectrum at Different Gestational Ages

Sunday, Nov. 26 2:30PM - 3:30PM Room: N229

Quyên N. Do, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The placenta accreta index (PAI) is a standardized evaluation of ultrasound (US) parameters for the prediction of placenta accreta spectrum (PAS). The purpose of this study was to determine if the PAI value assigned in sonograms obtained between 17-27 weeks differ from PAI value of sonograms after 27 weeks within the same patient identified to have US and clinical risk factors for PAS.

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## Abstract Archives of the RSNA, 2023

S5-SSOB01-4

### Comparison of Best Landmarks for Calculating Fetal Jaw Index by Ultrasound and MRI to Predict Postnatal Outcomes in Micrognathia

Sunday, Nov. 26 2:30PM - 3:30PM Room: N229

Bailey Lyttle, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Micrognathia is associated with significant perinatal mortality due to airway compromise at birth. Prenatal ultrasound is routinely used to diagnose micrognathia but is technically challenging and imperfect in its ability to predict postnatal outcomes. Fetal MRI has been utilized for measuring the jaw index (JI) using the posterior border of the masseter muscle, but its indistinct margins can lead to inaccuracy. The mandibular teeth buds are more clearly depicted by MRI. We hypothesize that the MRI JI measured using the posterior teeth buds, rather than the masseter muscles, more closely correlates with the ultrasound JI and postnatal outcomes.

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#### CLINICAL RELEVANCE/APPLICATION

Appropriate and accurate prenatal imaging is instrumental in adequately counseling families during the pregnancy and planning for potential interventions following delivery. Our findings highlight the utility of fetal MRI and its potential benefits for diagnosis and counseling.

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## Abstract Archives of the RSNA, 2023

S5-SSOB01-6

### Assesing the Corelation of Ultrasonography of Maternal Ophthalmic Artery Doppler as a Predictor of Pre-eclampsia

Sunday, Nov. 26 2:30PM - 3:30PM Room: N229

Khushboo Juneja, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to report the methodology for ophthalmic artery Doppler and summarize findings from the implementation of such assessment in the prediction of Preclampsia in later stage of pregnancy and correlate doppler indices value with maternal and fetal outcome.

#### METHODS AND MATERIALS

Study was conducted on pregnant female between 14 to 22 weeks coming for routine antenatal scan at Radiology department. The study comprised 252 patients between time period of March 2021 to December 2022. Ophthalmic artery doppler were performed at 14 to 22 week and the same patients were followed up at 30 to 36 weeks. The data was analyzed using standard sensitivity and specificity formulas.

#### RESULTS

In our study on comparing the foetal outcome with hypertensive status, most patients with low birth weight, IUFD and foetal distress were among preeclamptic patients, indicating a significant association between adverse fetal outcome and preeclampsia. On comparing the adverse maternal outcome with the hypertensive status, there was a significant ( $p < 0.001$ ) association between preeclampsia and adverse maternal complication. • Ophthalmic artery parameters such as PSV1, PSV2, PSV ratio, PI, RI, and uterine artery PI were used to predict preeclampsia. It was found there was a significant association observed among PSV2, PSV ratio, PI, and uterine artery PI, but there were no significant associations observed in measuring PSV1 and RI. Our study found that the PSV ratio is a better predictor of adverse maternal outcomes, and uterine artery PI is a better predictor of adverse foetal outcomes. On analysing the efficacy of the PSV ratio for predicting preeclampsia, the AUC was 0.845, which indicates a good predictor for PE, with 83.1% sensitivity and 42.9% specificity.

#### CONCLUSION

Based on study, it was found there was a significant association observed among PSV2, PSV ratio, ophthalmic artery PI and uterine artery PI but there were no significant associations observed in measuring PSV1 and RI. Our study found that the PSV ratio is a better predictor of adverse maternal outcomes, and uterine artery PI is a better predictor of adverse foetal outcomes. On analysing the efficacy of the PSV ratio for predicting preeclampsia, the AUC was 0.845, which indicates a good predictor for PE, with 83.1% sensitivity and 42.9% specificity.

#### CLINICAL RELEVANCE/APPLICATION

In the present study, there was an association between the abnormal ophthalmic artery indices and preeclampsia, among which the PSV ratio was an excellent predictor. The identification of the high-risk group be beneficial, so the clinician could provide timely interventions to prevent the development of PE and potentially reduce maternal and perinatal death and morbidity.

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## Abstract Archives of the RSNA, 2023

S5-STCE1

### Science Session (Sustainability in Imaging)

Sunday, Nov. 26 2:30PM - 3:00PM Room: Learning Center Theater 1

#### Sub-Events

#### S5-STCE1-1 Energy Stewardship in MRI

Anurag Dalai, BSc, MD (*Presenter*) Nothing to Disclose

##### PURPOSE

MRI scanning is energy intensive. We aimed to understand our department's MRI energy consumption and evaluate potential methods of improving energy efficiency during clinical operation.

##### METHODS AND MATERIALS

Operational approval was obtained from our hospital, including Departments of Medical Imaging and Facilities Management. Both MRI scanners (1.5T and 3T) were equipped with energy data loggers for 1 week in August 2021. Energy use was calculated (per time unit) for inactive downtime (department closed), active downtime (between cases) and individual cases (including subspecialty) using PACS time stamps. Cases scanned were also coded by subspecialty (musculoskeletal, neuroradiology including spine, body imaging and cardiac imaging). Carbon emissions were calculated using local emission conversion factor of 0.51 CO<sub>2</sub>/kWh. Kilowatt-hour cost was calculated by the price of electricity during the recorded billing cycle (0.1104 \$/kWh) at our institution.

##### RESULTS

The total week's MRI energy consumption was 7,612.1 kWh. The cost of electricity was \$840.40 CAD and the estimated emissions were 3,882.3 kg CO<sub>2</sub>. Collectively, the average energy use per MRI case was 19.8 kWh/case. The 3T and 1.5T scanners actively scanned for 51 and 47 hours respectively, but the 3T scanner used 70.4 % of total energy consumption. Subspecialty exam energy use across musculoskeletal, neuroradiology including spine, body and cardiac cases were similar. Energy use per minute was higher in active downtime (in-between cases) than inactive downtime (overnight) and highest while actively scanning. Average emissions per minute active scanning was 0.16 kg CO<sub>2</sub>/min and 0.43 kg CO<sub>2</sub>/min for the 1.5T and 3T scanners respectively.

##### CONCLUSION

Our weekly MRI emissions were 3,882.3 kg CO<sub>2</sub>, similar to an annual Canadian passenger vehicle emissions of 3,830 kg CO<sub>2</sub>. Since energy use was higher in active scanning, we implemented shorter protocols where possible such as FAST knee MRI protocols to improve clinical energy efficiency. Reduced case specific carbon emissions would require further work to confirm. This comes with the added benefits of shorter exams and therefore hopefully an improved patient experience.

##### CLINICAL RELEVANCE/APPLICATION

There is increasing awareness of the impact that radiology departments have on carbon emissions. Radiology departments present unique challenges when analyzing energy use while also present an opportunity to place radiologists amongst key stakeholders in healthcare's transition to energy sustainable model of care. This study may allow support for other radiology departments to improve MRI energy efficiency.

#### S5-STCE1-2 Unveiling a Paradigm in Sustainable Radiography: The World's Smallest and Lightest Carbon Nanotube-Based Pocket X-ray System for Soft X-ray Imaging and Irradiation, Featuring Low Energy Consumption and Powered by AAA Batteries

Amar P. Gupta, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop and characterize the carbon nanotube (CNTs)-based X-ray source that is smaller than the size of the human palm, powered by AAA battery, requiring half the energy to operate compared to filament-based X-ray source, and applicable for soft X-ray imaging, cell irradiation, and radiation survey meters calibration purposes. The study highlights its efficiency, portability, and potential contribution to sustainable and energy efficient X-ray source.

## METHODS AND MATERIALS

The diode ceramic X-ray tube was fabricated using vacuum brazing process, with CVD grown CNTs as the electron emitter (cathode) and Beryllium as the anode target. The X-ray tube dimensions were 10 mm in diameter, 14 mm in height, and 4.4 gm in weight. Subsequently, an X-ray system weighing 82.7 gm and measuring (75 X 33 X 28) mm was assembled. The system comprised X-ray tube, 3D printed envelope, two switches, two AAA batteries, and a compact, customized high-voltage pulsed power source capable of generating 16 kHz, 7 kV and 0.3 mA. The X-ray spectrum was obtained using an XR-100-CdTe X-ray detector. X-ray dosage measurement was done with a Fluke 451B Ion Chamber Survey meter positioned at 10 cm away from the X-ray window. Lastly, feasibility X-ray imaging tests were carried out using a highly sensitive mammo X-ray detector, evaluating various soft and hard objects.

## RESULTS

The current-voltage graph showed that at 4950 V, a tube current of 50 uA was obtained, resulting in a radiation dosage rate of 60 mGy/hr at 10 cm from the X-ray window. Interestingly, when the survey meter was placed adjacent to the X-ray window, the X-ray dose rate increased significantly to 950 mGy/hr. In the X-ray imaging tests using 7 kV and 1.8 mAs for 6 seconds, clear imaging of soft materials like leaves and banana chips was achieved, while harder materials like teeth or metal phantoms showed shadows like less distinct imaging results.

## CONCLUSION

CNT-based X-ray technology is paradigm shifting the medical X-ray field. Researches regarding the size reduction potential of CNT-based X-ray sources lacked substantiation. Our study, however, resulted in the creation of the world's foremost compact X-ray system, capable of soft X-ray imaging at 7 kV, yielding approximately 1 Gy/hr of radiation dose. This innovation positions it as a promising contender for Brachytherapy applications, operating proficiently with low-energy AAA batteries. Future endeavors will focus on enhancing X-ray energy and doses without substantial alterations to the system's dimensions.

## CLINICAL RELEVANCE/APPLICATION

This highly portable X-ray device is well-suited for on-site x-ray imaging of soft materials in every set up and convenient radiotherapy in skin cancer treatments at home for patients.

## S5-STCE1-3 Evaluating Maximum Echo Time Sufficient for Quantitative Susceptibility Mapping MRI in Brain

Salil Soman, MD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

The selection of an appropriate Time to Echo (TE) plays a crucial role in Quantitative Susceptibility Mapping (QSM) image generation and impacts scan time. Shortening scan times in medical imaging has the potential to make imaging more sustainable. Embracing energy-efficient and sustainable practices in healthcare contributes to both environmental conservation and improved patient care. In this study, we aimed to evaluate the application of statistical methods to identify the optimal TE sampling strategy for generating high-quality QSM images using the Multi-echo Complex Total Field Inversion (mcTFI) method that can balance shortening scan times with the necessary image quality for accurate diagnosis.

## METHODS AND MATERIALS

A cohort of 53 subjects (47 of them with known intracranial hemorrhage) who had undergone imaging an 11 echo multi-echo GRE imaging acquisition were included. For each subject, subsets of 3 or more echoes were selected from the original 11, and the corresponding mcTFI QSM image volume was created for each subset group. These subset-based mcTFI QSM images were then compared against the 11 echo mcTFI image using multiple 14 statistical metrics, including Mean Absolute Error (MAE), Root Mean Square Error (RMSE) Normalized Mutual Information (NMI) and etc.

## RESULTS

An inspection is conducted to explore the relationship between maximum echo time and statistical values. LMMD, GMMD, PMMD, DICE, NMI, and SSIM recommend the smallest maximum echo time due to unchanged imaging similarity compared to the largest. MAE shows periodic waves, with the 10th echo time having the maximum value. As the maximum TE value increases, imaging similarity generally decreases due to higher MAE or RMSE. RMSE reaches its minimum at the 10th echo time. LPIPS scores worsen when using all echo times but drop at the 10th or 9th echo time. C-FID trends reach a trough at the 10th echo time, possibly reducing further to 7-8th echo times. SAM values increase with larger maximum TE values, minimum at the 10th echo time. MS-SSIM score worsens at smaller maximum TE values, peaking at the 8th echo time. PSNR

has drops indicating worsened imaging similarity. ISSM generally increases with decreasing max TE values, peaking at the 10th echo time.

### **CONCLUSION**

The maximum echo time can be reduced to the 10th echo time to generate similar mCTFI QSM images from all 11 echoes. Six metrics suggest using the shortest echo time as the maximum instead of the largest, while the rest have their own thresholds. This makes it highly possible to reduce scan time using a shorter maximum echo time for desired QSM images.

### **CLINICAL RELEVANCE/APPLICATION**

Shortening imaging time for susceptibility neuroimaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-STCE1-1

### Energy Stewardship in MRI

Sunday, Nov. 26 2:30PM - 3:00PM Room: Learning Center Theater 1

Anurag Dalai, BSc, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

MRI scanning is energy intensive. We aimed to understand our department's MRI energy consumption and evaluate potential methods of improving energy efficiency during clinical operation.

#### METHODS AND MATERIALS

Operational approval was obtained from our hospital, including Departments of Medical Imaging and Facilities Management. Both MRI scanners (1.5T and 3T) were equipped with energy data loggers for 1 week in August 2021. Energy use was calculated (per time unit) for inactive downtime (department closed), active downtime (between cases) and individual cases (including subspecialty) using PACS time stamps. Cases scanned were also coded by subspecialty (musculoskeletal, neuroradiology including spine, body imaging and cardiac imaging). Carbon emissions were calculated using local emission conversion factor of 0.51 CO<sub>2</sub>/kWh. Kilowatt-hour cost was calculated by the price of electricity during the recorded billing cycle (0.1104 \$/kWh) at our institution.

#### RESULTS

The total week's MRI energy consumption was 7,612.1 kWh. The cost of electricity was \$840.40 CAD and the estimated emissions were 3,882.3 kg CO<sub>2</sub>. Collectively, the average energy use per MRI case was 19.8 kWh/case. The 3T and 1.5T scanners actively scanned for 51 and 47 hours respectively, but the 3T scanner used 70.4 % of total energy consumption. Subspecialty exam energy use across musculoskeletal, neuroradiology including spine, body and cardiac cases were similar. Energy use per minute was higher in active downtime (in-between cases) than inactive downtime (overnight) and highest while actively scanning. Average emissions per minute active scanning was 0.16 kg CO<sub>2</sub>/min and 0.43 kg CO<sub>2</sub>/min for the 1.5T and 3T scanners respectively.

#### CONCLUSION

Our weekly MRI emissions were 3,882.3 kg CO<sub>2</sub>, similar to an annual Canadian passenger vehicle emissions of 3,830 kg CO<sub>2</sub>. Since energy use was higher in active scanning, we implemented shorter protocols where possible such as FAST knee MRI protocols to improve clinical energy efficiency. Reduced case specific carbon emissions would require further work to confirm. This comes with the added benefits of shorter exams and therefore hopefully an improved patient experience.

#### CLINICAL RELEVANCE/APPLICATION

There is increasing awareness of the impact that radiology departments have on carbon emissions. Radiology departments present unique challenges when analyzing energy use while also present an opportunity to place radiologists amongst key stakeholders in healthcare's transition to energy sustainable model of care. This study may allow support for other radiology departments to improve MRI energy efficiency.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S5-STCE1-2

### **Unveiling a Paradigm in Sustainable Radiography: The World's Smallest and Lightest Carbon Nanotube-Based Pocket X-ray System for Soft X-ray Imaging and Irradiation, Featuring Low Energy Consumption and Powered by AAA Batteries**

Sunday, Nov. 26 2:30PM - 3:00PM Room: Learning Center Theater 1

Amar P. Gupta, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and characterize the carbon nanotube (CNTs)-based X-ray source that is smaller than the size of the human palm, powered by AAA battery, requiring half the energy to operate compared to filament-based X-ray source, and applicable for soft X-ray imaging, cell irradiation, and radiation survey meters calibration purposes. The study highlights its efficiency, portability, and potential contribution to sustainable and energy efficient X-ray source.

#### **METHODS AND MATERIALS**

The diode ceramic X-ray tube was fabricated using vacuum brazing process, with CVD grown CNTs as the electron emitter (cathode) and Beryllium as the anode target. The X-ray tube dimensions were 10 mm in diameter, 14 mm in height, and 4.4 gm in weight. Subsequently, an X-ray system weighing 82.7 gm and measuring (75 X 33 X 28) mm was assembled. The system comprised X-ray tube, 3D printed envelope, two switches, two AAA batteries, and a compact, customized high-voltage pulsed power source capable of generating 16 kHz, 7 kV and 0.3 mA. The X-ray spectrum was obtained using an XR-100-CdTe X-ray detector. X-ray dosage measurement was done with a Fluke 451B Ion Chamber Survey meter positioned at 10 cm away from the X-ray window. Lastly, feasibility X-ray imaging tests were carried out using a highly sensitive mammo X-ray detector, evaluating various soft and hard objects.

#### **RESULTS**

The current-voltage graph showed that at 4950 V, a tube current of 50 uA was obtained, resulting in a radiation dosage rate of 60 mGy/hr at 10 cm from the X-ray window. Interestingly, when the survey meter was placed adjacent to the X-ray window, the X-ray dose rate increased significantly to 950 mGy/hr. In the X-ray imaging tests using 7 kV and 1.8 mAs for 6 seconds, clear imaging of soft materials like leaves and banana chips was achieved, while harder materials like teeth or metal phantoms showed shadows like less distinct imaging results.

#### **CONCLUSION**

CNT-based X-ray technology is paradigm shifting the medical X-ray field. Researches regarding the size reduction potential of CNT-based X-ray sources lacked substantiation. Our study, however, resulted in the creation of the world's foremost compact X-ray system, capable of soft X-ray imaging at 7 kV, yielding approximately 1 Gy/hr of radiation dose. This innovation positions it as a promising contender for Brachytherapy applications, operating proficiently with low-energy AAA batteries. Future endeavors will focus on enhancing X-ray energy and doses without substantial alterations to the system's dimensions.

#### **CLINICAL RELEVANCE/APPLICATION**

This highly portable X-ray device is well-suited for on-site x-ray imaging of soft materials in every set up and convenient radiotherapy in skin cancer treatments at home for patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-STCE1-3

### Evaluating Maximum Echo Time Sufficient for Quantitative Susceptibility Mapping MRI in Brain

Sunday, Nov. 26 2:30PM - 3:00PM Room: Learning Center Theater 1

Salil Soman, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

The selection of an appropriate Time to Echo (TE) plays a crucial role in Quantitative Susceptibility Mapping (QSM) image generation and impacts scan time. Shortening scan times in medical imaging has the potential to make imaging more sustainable. Embracing energy-efficient and sustainable practices in healthcare contributes to both environmental conservation and improved patient care. In this study, we aimed to evaluate the application of statistical methods to identify the optimal TE sampling strategy for generating high-quality QSM images using the Multi-echo Complex Total Field Inversion (mcTFI) method that can balance shortening scan times with the necessary image quality for accurate diagnosis.

#### METHODS AND MATERIALS

A cohort of 53 subjects (47 of them with known intracranial hemorrhage) who had undergone imaging an 11 echo multi-echo GRE imaging acquisition were included. For each subject, subsets of 3 or more echoes were selected from the original 11, and the corresponding mcTFI QSM image volume was created for each subset group. These subset-based mcTFI QSM images were then compared against the 11 echo mcTFI image using multiple 14 statistical metrics, including Mean Absolute Error (MAE), Root Mean Square Error (RMSE) Normalized Mutual Information (NMI) and etc.

#### RESULTS

An inspection is conducted to explore the relationship between maximum echo time and statistical values. LMMD, GMMD, PMMD, DICE, NMI, and SSIM recommend the smallest maximum echo time due to unchanged imaging similarity compared to the largest. MAE shows periodic waves, with the 10th echo time having the maximum value. As the maximum TE value increases, imaging similarity generally decreases due to higher MAE or RMSE. RMSE reaches its minimum at the 10th echo time. LPIPS scores worsen when using all echo times but drop at the 10th or 9th echo time. C-FID trends reach a trough at the 10th echo time, possibly reducing further to 7-8th echo times. SAM values increase with larger maximum TE values, minimum at the 10th echo time. MS-SSIM score worsens at smaller maximum TE values, peaking at the 8th echo time. PSNR has drops indicating worsened imaging similarity. ISSM generally increases with decreasing max TE values, peaking at the 10th echo time.

#### CONCLUSION

The maximum echo time can be reduced to the 10th echo time to generate similar mcTFI QSM images from all 11 echoes. Six metrics suggest using the shortest echo time as the maximum instead of the largest, while the rest have their own thresholds. This makes it highly possible to reduce scan time using a shorter maximum echo time for desired QSM images.

#### CLINICAL RELEVANCE/APPLICATION

Shortening imaging time for susceptibility neuroimaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-STCE2

### Science Session (Generative AI)

Sunday, Nov. 26 2:30PM - 3:00PM Room: Learning Center Theater 2

#### Sub-Events

#### **S5-STCE2-1 Potential of Large Language Models for Chest X-ray Labeling from Their Radiology Reports**

Soyeon Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The extraction of clinical observations from chest X-rays (CXRs) reports has attracted significant interest as it enables large-scale training of medical imaging models. In this study, we developed an automatic labeling model using the Large Language Model (LLM) for 14 radiologic findings from CXR and aimed to whether utilizing LLM could achieve higher performance in this task.

#### **METHODS AND MATERIALS**

Among MIMIC-CXR dataset, we extracted 1,500 radiology reports with 1,000 reports for fine-tuning and 500 reports for internal test. For external test, another 500 CXR reports were randomly selected from the Open-I dataset. Reference standards for labels from CXR reports were made by a board-certified radiologist for the 14 radiologic findings following CheXpert labels: No Finding, mediastinal widening, cardiomegaly, lung lesion, lung opacity, edema, consolidation, pneumonia, atelectasis, pneumothorax, pleural effusion, pleural other, fracture, and support devices. The labels for each observation are either positive, negative, or uncertain. We generated a dataset for fine-tuning, which consisted of an instruction (prompt for the task), input (report), and output (14 labels) triplet, and developed out model using Meta's publicly-available LLM, LLaMA-13B. Following the Alpaca training methodology, we fine-tuned it using an instruction-tuning technique to enhance its task processing and understanding capabilities. To evaluate the model's performance, we computed Macro-F1 scores for each of the 14 radiologic findings and compared our model with two existing models: CheXpert and CheXbert, both of which were pretrained on a large-scale dataset with over 200,000 reports.

#### **RESULTS**

Our model showed Macro-F1 scores of 0.794 and 0.758 on internal and external tests respectively, surpassing CheXpert's scores of 0.685 and 0.671 and CheXbert's scores of 0.720 and 0.741. Compared to the existing two models, our model achieved higher F1 scores on 12 out of 14 observations in the internal test and 8 out of 14 observations in external test. Specifically, the largest improvements are observed for pneumothorax (0.271), lung lesion (0.172) in internal test, and No Finding (0.249) and pleural effusion (0.222) in external test compared to CheXbert.

#### **CONCLUSION**

Using LLM, we effectively extracted radiologic findings from CXR reports, achieving better performance with just 0.5% of the training data compared with previous models.

#### **CLINICAL RELEVANCE/APPLICATION**

The extracted observations from CXR reports can be used for large-scale training for medical AI model and standardization radiology reports for structured form.

#### **S5-STCE2-2 Comparison of diagnostic accuracy of commonly-encountered general surgery diagnoses using a novel radiology-pathology correlation tool.**

Michael C. Larson, MD, PhD (*Presenter*) Stockholder, D3Sciences; Stockholder, Emagine Solutions Technology

#### **PURPOSE**

Radiologists are often encountered with unclear indications when interpreting abdomen and/or pelvis scans. The goal of this was to evaluate radiology studies' diagnostic accuracy of commonly-encountered general surgery diagnoses regardless of clinical indication using a novel machine learning platform linking radiology to pathology reports.

## **METHODS AND MATERIALS**

PATHFINDER matches radiology and pathology reports with specific anatomic and pathologic annotations based on a medical lexicon (SNOMED CT from the UMLS 2022AA release), using large language and transformer models to train transformer-based text classifiers. PATHFINDER was used to evaluate the diagnostic accuracy, sensitivity and specificity of appendicitis and cholecystitis comparing various radiology modalities at different time points in any hospitalized or emergency department patient of a tertiary academic medical center over the past 3 years. The number of studies included in evaluation of appendicitis were 74 at week 1 up to 94 at week 3 for non-contrast CT evaluation of the abdomen and pelvis (CT A/P), 1007 to 1139 for contrast-enhanced CT A/P, and 603 to 626 for ultrasound of the pelvis. There were 86 to 121 nuclear scans, 867 to 1568 CT scans, 268 to 410 MRIs and 4312 to 5725 ultrasounds of the abdomen in evaluating cholecystitis across different follow-up time points after the radiology exam.

## **RESULTS**

Various diagnostic statistics at different follow-up time points can be seen in figure 1. Diagnostic accuracy for acute cholecystitis and appendicitis was above 0.83 for all modalities across all timepoints. Interestingly, accuracy of diagnosing acute appendicitis was not substantially different between contrast or non-contrast CT of the abdomen and pelvis. Sensitivity for cholecystitis for all modalities was lower than many published values (ranging from 0.38 to 0.74), while specificity was 0.89 or higher for all modalities. The timing of follow-up resulted in variable sensitivity values; for example, a 1 week follow-up time point after nuclear medicine evaluation for cholecystitis yielded only sensitivity of only 0.40, but this increased to 0.60 at 3 weeks.

## **CONCLUSION**

This shows the utility of a novel language-processing tool linking radiology reports to pathology in broadly evaluating diagnostic performance of various medical imaging modalities at different time points.

## **CLINICAL RELEVANCE/APPLICATION**

Diagnostic statistics should be interpreted with caution, as this novel rad-path tool highlights how such can vary depending on details such as the use of contrast or not and the timing of follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-STCE2-1

### Potential of Large Language Models for Chest X-ray Labeling from Their Radiology Reports

Sunday, Nov. 26 2:30PM - 3:00PM Room: Learning Center Theater 2

Soyeon Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

The extraction of clinical observations from chest X-rays (CXRs) reports has attracted significant interest as it enables large-scale training of medical imaging models. In this study, we developed an automatic labeling model using the Large Language Model (LLM) for 14 radiologic findings from CXR and aimed to whether utilizing LLM could achieve higher performance in this task.

#### METHODS AND MATERIALS

Among MIMIC-CXR dataset, we extracted 1,500 radiology reports with 1,000 reports for fine-tuning and 500 reports for internal test. For external test, another 500 CXR reports were randomly selected from the Open-I dataset. Reference standards for labels from CXR reports were made by a board-certified radiologist for the 14 radiologic findings following CheXpert labels: No Finding, mediastinal widening, cardiomegaly, lung lesion, lung opacity, edema, consolidation, pneumonia, atelectasis, pneumothorax, pleural effusion, pleural other, fracture, and support devices. The labels for each observation are either positive, negative, or uncertain. We generated a dataset for fine-tuning, which consisted of an instruction (prompt for the task), input (report), and output (14 labels) triplet, and developed out model using Meta's publicly-available LLM, LLaMA-13B. Following the Alpaca training methodology, we fine-tuned it using an instruction-tuning technique to enhance its task processing and understanding capabilities. To evaluate the model's performance, we computed Macro-F1 scores for each of the 14 radiologic findings and compared our model with two existing models: CheXpert and CheXbert, both of which were pretrained on a large-scale dataset with over 200,000 reports.

#### RESULTS

Our model showed Macro-F1 scores of 0.794 and 0.758 on internal and external tests respectively, surpassing CheXpert's scores of 0.685 and 0.671 and CheXbert's scores of 0.720 and 0.741. Compared to the existing two models, our model achieved higher F1 scores on 12 out of 14 observations in the internal test and 8 out of 14 observations in external test. Specifically, the largest improvements are observed for pneumothorax (0.271), lung lesion (0.172) in internal test, and No Finding (0.249) and pleural effusion (0.222) in external test compared to CheXbert.

#### CONCLUSION

Using LLM, we effectively extracted radiologic findings from CXR reports, achieving better performance with just 0.5% of the training data compared with previous models.

#### CLINICAL RELEVANCE/APPLICATION

The extracted observations from CXR reports can be used for large-scale training for medical AI model and standardization radiology reports for structured form.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S5-STCE2-2

### Comparison of diagnostic accuracy of commonly-encountered general surgery diagnoses using a novel radiology-pathology correlation tool.

Sunday, Nov. 26 2:30PM - 3:00PM Room: Learning Center Theater 2

Michael C. Larson, MD, PhD (*Presenter*) Stockholder, D3Sciences; Stockholder, Emagine Solutions Technology

#### PURPOSE

Radiologists are often encountered with unclear indications when interpreting abdomen and/or pelvis scans. The goal of this was to evaluate radiology studies' diagnostic accuracy of commonly-encountered general surgery diagnoses regardless of clinical indication using a novel machine learning platform linking radiology to pathology reports.

#### METHODS AND MATERIALS

PATHFINDER matches radiology and pathology reports with specific anatomic and pathologic annotations based on a medical lexicon (SNOMED CT from the UMLS 2022AA release), using large language and transformer models to train transformer-based text classifiers. PATHFINDER was used to evaluate the diagnostic accuracy, sensitivity and specificity of appendicitis and cholecystitis comparing various radiology modalities at different time points in any hospitalized or emergency department patient of a tertiary academic medical center over the past 3 years. The number of studies included in evaluation of appendicitis were 74 at week 1 up to 94 at week 3 for non-contrast CT evaluation of the abdomen and pelvis (CT A/P), 1007 to 1139 for contrast-enhanced CT A/P, and 603 to 626 for ultrasound of the pelvis. There were 86 to 121 nuclear scans, 867 to 1568 CT scans, 268 to 410 MRIs and 4312 to 5725 ultrasounds of the abdomen in evaluating cholecystitis across different follow-up time points after the radiology exam.

#### RESULTS

Various diagnostic statistics at different follow-up time points can be seen in figure 1. Diagnostic accuracy for acute cholecystitis and appendicitis was above 0.83 for all modalities across all timepoints. Interestingly, accuracy of diagnosing acute appendicitis was not substantially different between contrast or non-contrast CT of the abdomen and pelvis. Sensitivity for cholecystitis for all modalities was lower than many published values (ranging from 0.38 to 0.74), while specificity was 0.89 or higher for all modalities. The timing of follow-up resulted in variable sensitivity values; for example, a 1 week follow-up time point after nuclear medicine evaluation for cholecystitis yielded only sensitivity of only 0.40, but this increased to 0.60 at 3 weeks.

#### CONCLUSION

This shows the utility of a novel language-processing tool linking radiology reports to pathology in broadly evaluating diagnostic performance of various medical imaging modalities at different time points.

#### CLINICAL RELEVANCE/APPLICATION

Diagnostic statistics should be interpreted with caution, as this novel rad-path tool highlights how such can vary depending on details such as the use of contrast or not and the timing of follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSCH05

### Science Session with Keynote: Chest Imaging (Interstitial Lung Disease)

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S404

Shaunagh McDermott, MBBCh (*Moderator*) Nothing to Disclose  
Micheal McInnis, MD (*Moderator*) Speakers Bureau, Boehringer Ingelheim GmbH;Speakers Bureau, Bayer AG

#### Sub-Events

##### T1-SSCH05-Keynote Speaker

1

Micheal McInnis, MD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH;Speakers Bureau, Bayer AG

##### T1-SSCH05-Evaluating the Robustness of 2D and 3D Deep Learning-based Models for Idiopathic Pulmonary Fibrosis (IPF) Diagnosis within an Interstitial Lung Disease (ILD) Population Under Different CT Imaging Protocols

2

Wenxi Yu (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep learning-based systems have not yet been broadly implemented in clinical practice, in part due to unknown robustness across multiple imaging protocols. We aim to evaluate the robust AI model using various CT imaging protocols, to access the model performance in diagnosis.

#### METHODS AND MATERIALS

Three deep learning-based models, including one 2D and two 3D models, have been previously developed to classify interstitial lung disease (ILD) patients into idiopathic pulmonary fibrosis (IPF) or non-IPF based on chest CT scans. Three models were trained on CT image data from 389 IPF and 700 non-IPF ILD patients, retrospectively obtained from multi-center studies (model construction stage, these CT series are referred to as reference conditions). In one non-IPF ILD study, due to its specific study protocol, many patients had multiple CT image data sets that were acquired under both prone and supine positions and/or reconstructed under different imaging parameters from their clinical visit. To assess the robustness of the model, we used available CT data from this study (343 subjects) that had paired sets of CT images on the same patient between model construction stage and model evaluation stage (evaluation conditions). Generalized linear mixed effects model (GLMM) was utilized to identify the significant CT technical and clinical parameters that were associated with getting conflicting diagnostic results between reference and evaluation conditions. Selected parameters include effective tube current-time product (known as "effective mAs"), reconstruction kernels, slice thickness, patient orientation, manufacture model name, and clinical diagnosis.

#### RESULTS

For all three models, the overall specificity of the non-IPF ILD diagnosis model decreased when that model was applied to the evaluation conditions ( $P < 0.001$  for 2D and 3D-2 models, not for 3D-1 model). GLMM further suggests that for two out of three models, mean effective mAs across the scan is the key factor that leads to the decrease in model predictive performance ( $P < 0.001$ ); the difference of mean effective mAs between the reference and evaluation conditions, patient position, and slice thickness (3mm) are flagged as significant factors for one out of three models ( $p < 0.01$ ,  $p = 0.03$ , and  $p = 0.08$  at least in one model).

#### CONCLUSION

Preliminary findings demonstrated the lack of robustness of IPF diagnosis model when applying to CT series collected under different imaging protocols, which indicated that care should be taken when developing and deploying deep learning models into clinical practice.

## CLINICAL RELEVANCE/APPLICATION

Improving the explainability, assessing and enhancing the generalizability of DL models are indispensable steps towards building reliable AI models in clinical practice.

### T1-SSCH05-The Lung and Short of It: The Impact of Telomere Shortening on Progression of Interstitial Lung Disease

John A. Knopf (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to compare radiologic progression of interstitial lung disease (ILD) between patients with abnormal and normal telomere length.

#### METHODS AND MATERIALS

We conducted a retrospective analysis of medical records and imaging studies of patients who had undergone telomere length testing and at least 2 chest high-resolution computed tomography (HRCT) scans. The most common indications for telomere length measurement were personal or family history of ILD, pre-operative evaluation for lung transplant, and bone marrow failure. The patients were divided into two groups based on their telomere length: abnormal (less than the 10th percentile for age) and normal (above the 10th percentile for age).

#### RESULTS

Telomere length was abnormally decreased in 20 patients and normal in 50 patients. Fibrotic HRCT findings were identified in 70% of the abnormal group compared to 62% in the normal group. The rate of radiographic progression was significantly higher (70% vs. 42%) in the short telomere group. Multivariable logistic regression analysis showed that telomere length and fibrotic findings on HRCT were significantly associated with radiographic progression. The ORs were 0.32 (95% CI: 0.07 to 0.57) for telomere length at 1-10th percentile, 0.46 (95% CI: 0.02 to 0.51) for telomere length at =1st percentile, and 0.27 (0.03 to 0.52) for fibrotic HRCT findings.

#### CONCLUSION

Patients with abnormally short telomere length had a higher rate of ILD progression, particularly in patients with fibrotic HRCT findings at baseline and those with telomere length below the 1<sup>st</sup> percentile. These findings highlight the importance of identifying those with abnormal telomere length and monitoring them for radiographic abnormalities.

## CLINICAL RELEVANCE/APPLICATION

The findings of this study can potentially affect the management of ILD patients by identifying the subset who are at higher risk of radiographic deterioration. These high risk patients may benefit from close observation or early intervention.

### T1-SSCH05-Association Between Fat Depletion During the Disease Course and Prognosis of Idiopathic Pulmonary Fibrosis: CT-based Body Composition Analysis

Ji Young Lee, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the association between the changes in body composition derived from chest CT, using deep learning-based technique, during the first-year disease course and outcomes in patients with idiopathic pulmonary fibrosis (IPF).

#### METHODS AND MATERIALS

This retrospective study included consecutive patients diagnosed with IPF between January 2010 and December 2020 who had undergone chest CT and pulmonary function tests (PFTs) at diagnosis and a 1-year follow-up. Averaged fat area (cm<sup>2</sup>, sum of visceral and subcutaneous fat) and muscle area (cm<sup>2</sup>) at the T12-L1 level were calculated for baseline and first-year follow-up CT images using a commercially available deep learning-based body composition analysis software. The changes in averaged fat and muscle areas were dichotomized using the thresholds for the lowest quartiles, respectively. The composite outcome was the occurrence of lung transplantation or death. Multivariable Cox regression analyses and Kaplan-Meier plots with log-rank tests were performed to assess the prognostic implications of body composition changes during the disease courses.

#### RESULTS

A total of 307 IPF patients (mean age, 69.3±8.1; 238 men) were included. During the first year, averaged muscle and fat areas decreased by 1cm<sup>2</sup> and 15.4cm<sup>2</sup>, respectively. Body mass index (BMI) decreased by 0.4kg/m<sup>2</sup>. Regarding PFT, 93 (30.3%) and 59 (19.2%) patients had a decline of forced vital capacity of 5% and carbon monoxide diffusing capacity of 10%, respectively. During the median follow-up of 47 months, 146 patients had composite outcomes (47.6%; lung transplantation, n=15; death, n=139). After adjusting for baseline clinical variables, including age, sex, baseline PFT results, and IPF extent and pulmonary artery diameter on baseline CT, a significant decrease in the fat area during the first year



disease course was a poor prognostic factor (hazard ratio [HR], 1.617; 95% confidence interval [CI]: 1.1, 2.376, P=.014). In another model with variables including changes in BMI and PFT results, a significant decrease in the fat area was also a poor prognostic factor (HR, 1.495; 95% CI: 1.039, 2.151; P=.03), but BMI change was not (P=.905). Patients with a significant decrease in the fat area had more unfavorable outcomes than those without a significant decrease in the fat area (58.4% versus 43.9%, P=.007).

#### **CONCLUSION**

A significant decrease in body fat in the first-year disease course, derived from chest CT images by deep learning-based technique, was a poor prognostic factor in patients with IPF.

#### **CLINICAL RELEVANCE/APPLICATION**

During the disease courses, nutritional support based on the CT-derived body composition analysis can improve outcomes in patients with IPF.

### **T1-SSCH05-Automated and Semi-automated Quantitative CT Biomarkers for Predicting Transplant Free Survival in Idiopathic Pulmonary Fibrosis**

Steven A. Rothenberg, MD (*Presenter*) Founder, Empower Therapeutics Inc ;Member, Translation Holdings LLC;Consultant, Radiostics LLC

#### **PURPOSE**

To compare the accuracy of fully-automated and semi-automated quantitative CT (QCT) biomarkers for predicting transplant-free survival (TFS) in participants with idiopathic pulmonary fibrosis (IPF).

#### **METHODS AND MATERIALS**

For this retrospective multi-institutional study, high resolution chest CT (HRCT) images and survival outcomes were gathered from 63 centers and 546 participants with IPF who were prospectively enrolled in the Pulmonary Fibrosis Foundation patient registry. A fully automated artificial intelligence (AI) algorithm that was trained on external data was applied to the baseline axial HRCT images and used to quantify interstitial lung abnormalities including whole lung percentage and rind percentage (ILA-WL and ILA-R, respectively). The pulmonary surface irregularity (PSI) score was measured in a semi-automated manner using the same baseline axial HRCT images. The Gender-Age-Physiology (GAP) score, comprised of gender, age, pulmonary function test results, was also available at baseline. Each of the biomarkers were categorized into three groups. Cut points for the QCT biomarkers were derived from exploratory data analysis and Youden J statistics. Kaplan-meier plots with log rank test, cox hazards models, and concordance index were used to assess the accuracy of each biomarker for predicting TFS.

#### **RESULTS**

The cohort included 72% males and was 93% white. Mean age was 70 years. Mean BMI was 28. When comparing the highest to lowest stages for each biomarker, the risk of death was 5.7x for ILA-WL (HR:5.7, p<.001), 3.8x for ILA-R (HR:3.8, p<.001), 7.0x for the combination of ILA-WL/ILA-R (HR:7.0, p<.001), 3.4x for PSI score (HR:3.4, p<.001), 8.6x for the combination of ILA-WL/ILA-R/PSI score (HR:8.6, p<.001), 2.4x for GAP score (HR:2.4, p<.001), and 10.7x for the combination of ILA-WL/ILA-R/PSI score/GAP score (HR:10.7, p<.001). Concordance statistics for predicting TFS were 0.67 for ILA-WL, 0.65 for ILA-R, 0.65 for the combination of ILA-WL/ILA-R, 0.63 for PSI score, 0.67 for the combination of ILA-W/ILA-R/PSI score, 0.58 for GAP score, and 0.67 for the combination of ILA-W/ILA-R/PSI score/GAP score.

#### **CONCLUSION**

A fully-automated AI algorithm designed to quantify ILA findings on HRCT had higher accuracy for predicting TFS than the semi-automated PSI score and the GAP score in a multi-institutional cohort with IPF.

#### **CLINICAL RELEVANCE/APPLICATION**

IPF is the most common progressive and fatal fibrotic lung disease, and patients are universally evaluated by HRCT. A quantitative CT biomarker could be applied to existing HRCT images and would add no additional patient cost or radiation. In this study, we compare fully-automated and semi-automated quantitative CT biomarkers to the GAP score, a prognostic clinical marker.

### **T1-SSCH05-Utility of Automated CT Lung Texture Imaging Analysis for Surveillance in Lung Transplantation**

Grace K. Grafham, BSc, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

CT is indicated at chronic lung allograft dysfunction (CLAD) onset in lung transplant recipients. Recent evidence indicates that automated CT lung texture analysis and calculated pulmonary vessel volume (PVV) could accurately phenotype and prognosticate CLAD. However, there is limited data on CT imaging of the lung allograft at baseline despite the updated International Society of Heart and Lung Transplantation (ISHLT) CLAD consensus recommending that baseline CT be

performed at 6-months. The purpose of this study was to characterize the 6-month baseline CT in a cohort of lung transplant recipients and identify how lung texture and PVV change at CLAD onset.

## **METHODS AND MATERIALS**

This was a prospective double-lung transplant cohort (11/2017-11/2019) with CT at 6-month baseline. An automated CT analysis tool quantified normal, ground-glass opacity, reticulation, hyperlucent lung and pulmonary vessel volume (PVV) as a percent of CT total lung capacity. Values were correlated with pulmonary function at 6-months. In patients who developed CLAD (censor 04/2023), the CT closest to CLAD diagnosis was analyzed and compared to baseline. CLAD was phenotyped according to ISHLT consensus and grouped as bronchiolitis obliterans syndrome (BOS) or non-BOS.

## **RESULTS**

Of the 128 included patients, 44 developed CLAD (28 BOS, 7 restrictive allograft syndrome (RAS) or mixed, 9 unclassified or undefined). CT texture at baseline was predominately normal (median [IQR], 94.2% [85-97%]) with a PVV of 2.4% (2-3%). PVV outperformed lung texture in correlation with total lung capacity ( $r=-0.59$ ,  $p<0.01$ ) and forced expiratory volume in the first second ( $r=-0.55$ ,  $p<0.01$ ). CT variables were similar at 6-months between patients who develop CLAD and those who remained CLAD-free. From baseline to non-BOS CLAD onset, hyperlucent texture decreased (-1.3%,  $p=0.04$ ) and ground-glass (+4.2%,  $p=0.04$ ), reticulation (+2.8%,  $p<0.01$ ), and PVV increased (+1.8%,  $p=0.02$ ). Likewise, ground-glass (+4.9%,  $p=0.01$ ), reticulation (+2.7%,  $p<0.001$ ), and PVV (+2.2%,  $p=0.005$ ) were greater at onset of non-BOS versus BOS CLAD. PVV and lung texture were not different from baseline to BOS onset.

## **CONCLUSION**

PVV increased from baseline to CLAD onset for non-BOS phenotypes, in line with its previously described accuracy in phenotyping and strong association with poor prognosis. By identifying normal ranges at the 6-month baseline, we found that PVV in BOS was unchanged at CLAD onset consistent with its bronchocentric pathology and in contrast to the microvascular damage observed in non-BOS CLAD.

## **CLINICAL RELEVANCE/APPLICATION**

Increases in pulmonary vessel volume from the 6-month baseline CT were associated with chronic lung allograft dysfunction of a non-bronchiolitis obliterans syndrome phenotype.

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## Abstract Archives of the RSNA, 2023

T1-SSCH05-1

### Keynote Speaker

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S404

Micheal McInnis, MD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH;Speakers Bureau, Bayer AG

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSCH05-2

### Evaluating the Robustness of 2D and 3D Deep Learning-based Models for Idiopathic Pulmonary Fibrosis (IPF) Diagnosis within an Interstitial Lung Disease (ILD) Population Under Different CT Imaging Protocols

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S404

Wenxi Yu (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep learning-based systems have not yet been broadly implemented in clinical practice, in part due to unknown robustness across multiple imaging protocols. We aim to evaluate the robust AI model using various CT imaging protocols, to assess the model performance in diagnosis.

#### METHODS AND MATERIALS

Three deep learning-based models, including one 2D and two 3D models, have been previously developed to classify interstitial lung disease (ILD) patients into idiopathic pulmonary fibrosis (IPF) or non-IPF based on chest CT scans. Three models were trained on CT image data from 389 IPF and 700 non-IPF ILD patients, retrospectively obtained from multi-center studies (model construction stage, these CT series are referred to as reference conditions). In one non-IPF ILD study, due to its specific study protocol, many patients had multiple CT image data sets that were acquired under both prone and supine positions and/or reconstructed under different imaging parameters from their clinical visit. To assess the robustness of the model, we used available CT data from this study (343 subjects) that had paired sets of CT images on the same patient between model construction stage and model evaluation stage (evaluation conditions). Generalized linear mixed effects model (GLMM) was utilized to identify the significant CT technical and clinical parameters that were associated with getting conflicting diagnostic results between reference and evaluation conditions. Selected parameters include effective tube current-time product (known as "effective mAs"), reconstruction kernels, slice thickness, patient orientation, manufacture model name, and clinical diagnosis.

#### RESULTS

For all three models, the overall specificity of the non-IPF ILD diagnosis model decreased when that model was applied to the evaluation conditions ( $P < 0.001$  for 2D and 3D-2 models, not for 3D-1 model). GLMM further suggests that for two out of three models, mean effective mAs across the scan is the key factor that leads to the decrease in model predictive performance ( $P < 0.001$ ); the difference of mean effective mAs between the reference and evaluation conditions, patient position, and slice thickness (3mm) are flagged as significant factors for one out of three models ( $p < 0.01$ ,  $p = 0.03$ , and  $p = 0.08$  at least in one model).

#### CONCLUSION

Preliminary findings demonstrated the lack of robustness of IPF diagnosis model when applying to CT series collected under different imaging protocols, which indicated that care should be taken when developing and deploying deep learning models into clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

Improving the explainability, assessing and enhancing the generalizability of DL models are indispensable steps towards building reliable AI models in clinical practice.

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## Abstract Archives of the RSNA, 2023

T1-SSCH05-3

### **The Lung and Short of It: The Impact of Telomere Shortening on Progression of Interstitial Lung Disease**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S404

John A. Knopf (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to compare radiologic progression of interstitial lung disease (ILD) between patients with abnormal and normal telomere length.

#### **METHODS AND MATERIALS**

We conducted a retrospective analysis of medical records and imaging studies of patients who had undergone telomere length testing and at least 2 chest high-resolution computed tomography (HRCT) scans. The most common indications for telomere length measurement were personal or family history of ILD, pre-operative evaluation for lung transplant, and bone marrow failure. The patients were divided into two groups based on their telomere length: abnormal (less than the 10th percentile for age) and normal (above the 10th percentile for age).

#### **RESULTS**

Telomere length was abnormally decreased in 20 patients and normal in 50 patients. Fibrotic HRCT findings were identified in 70% of the abnormal group compared to 62% in the normal group. The rate of radiographic progression was significantly higher (70% vs. 42%) in the short telomere group. Multivariable logistic regression analysis showed that telomere length and fibrotic findings on HRCT were significantly associated with radiographic progression. The ORs were 0.32 (95% CI: 0.07 to 0.57) for telomere length at 1-10th percentile, 0.46 (95% CI: 0.02 to 0.51) for telomere length at =1st percentile, and 0.27 (0.03 to 0.52) for fibrotic HRCT findings.

#### **CONCLUSION**

Patients with abnormally short telomere length had a higher rate of ILD progression, particularly in patients with fibrotic HRCT findings at baseline and those with telomere length below the 1<sup>st</sup> percentile. These findings highlight the importance of identifying those with abnormal telomere length and monitoring them for radiographic abnormalities.

#### **CLINICAL RELEVANCE/APPLICATION**

The findings of this study can potentially affect the management of ILD patients by identifying the subset who are at higher risk of radiographic deterioration. These high risk patients may benefit from close observation or early intervention.

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## Abstract Archives of the RSNA, 2023

T1-SSCH05-4

### Association Between Fat Depletion During the Disease Course and Prognosis of Idiopathic Pulmonary Fibrosis: CT-based Body Composition Analysis

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S404

Ji Young Lee, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the association between the changes in body composition derived from chest CT, using deep learning-based technique, during the first-year disease course and outcomes in patients with idiopathic pulmonary fibrosis (IPF).

#### METHODS AND MATERIALS

This retrospective study included consecutive patients diagnosed with IPF between January 2010 and December 2020 who had undergone chest CT and pulmonary function tests (PFTs) at diagnosis and a 1-year follow-up. Averaged fat area (cm<sup>2</sup>, sum of visceral and subcutaneous fat) and muscle area (cm<sup>2</sup>) at the T12-L1 level were calculated for baseline and first-year follow-up CT images using a commercially available deep learning-based body composition analysis software. The changes in averaged fat and muscle areas were dichotomized using the thresholds for the lowest quartiles, respectively. The composite outcome was the occurrence of lung transplantation or death. Multivariable Cox regression analyses and Kaplan-Meier plots with log-rank tests were performed to assess the prognostic implications of body composition changes during the disease courses.

#### RESULTS

A total of 307 IPF patients (mean age, 69.3±8.1; 238 men) were included. During the first year, averaged muscle and fat areas decreased by 1cm<sup>2</sup> and 15.4cm<sup>2</sup>, respectively. Body mass index (BMI) decreased by 0.4kg/m<sup>2</sup>. Regarding PFT, 93 (30.3%) and 59 (19.2%) patients had a decline of forced vital capacity of 5% and carbon monoxide diffusing capacity of 10%, respectively. During the median follow-up of 47 months, 146 patients had composite outcomes (47.6%; lung transplantation, n=15; death, n=139). After adjusting for baseline clinical variables, including age, sex, baseline PFT results, and IPF extent and pulmonary artery diameter on baseline CT, a significant decrease in the fat area during the first year disease course was a poor prognostic factor (hazard ratio [HR], 1.617; 95% confidence interval [CI]: 1.1, 2.376, P=.014). In another model with variables including changes in BMI and PFT results, a significant decrease in the fat area was also a poor prognostic factor (HR, 1.495; 95% CI: 1.039, 2.151; P=.03), but BMI change was not (P=.905). Patients with a significant decrease in the fat area had more unfavorable outcomes than those without a significant decrease in the fat area (58.4% versus 43.9%, P=.007).

#### CONCLUSION

A significant decrease in body fat in the first-year disease course, derived from chest CT images by deep learning-based technique, was a poor prognostic factor in patients with IPF.

#### CLINICAL RELEVANCE/APPLICATION

During the disease courses, nutritional support based on the CT-derived body composition analysis can improve outcomes in patients with IPF.

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## Abstract Archives of the RSNA, 2023

T1-SSCH05-5

### Automated and Semi-automated Quantitative CT Biomarkers for Predicting Transplant Free Survival in Idiopathic Pulmonary Fibrosis

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S404

Steven A. Rothenberg, MD (*Presenter*) Founder, Empower Therapeutics Inc ;Member, Translation Holdings LLC;Consultant, Radiostics LLC

#### PURPOSE

To compare the accuracy of fully-automated and semi-automated quantitative CT (QCT) biomarkers for predicting transplant-free survival (TFS) in participants with idiopathic pulmonary fibrosis (IPF).

#### METHODS AND MATERIALS

For this retrospective multi-institutional study, high resolution chest CT (HRCT) images and survival outcomes were gathered from 63 centers and 546 participants with IPF who were prospectively enrolled in the Pulmonary Fibrosis Foundation patient registry. A fully automated artificial intelligence (AI) algorithm that was trained on external data was applied to the baseline axial HRCT images and used to quantify interstitial lung abnormalities including whole lung percentage and rind percentage (ILA-WL and ILA-R, respectively). The pulmonary surface irregularity (PSI) score was measured in a semi-automated manner using the same baseline axial HRCT images. The Gender-Age-Physiology (GAP) score, comprised of gender, age, pulmonary function test results, was also available at baseline. Each of the biomarkers were categorized into three groups. Cut points for the QCT biomarkers were derived from exploratory data analysis and Youden J statistics. Kaplan-meier plots with log rank test, cox hazards models, and concordance index were used to assess the accuracy of each biomarker for predicting TFS.

#### RESULTS

The cohort included 72% males and was 93% white. Mean age was 70 years. Mean BMI was 28. When comparing the highest to lowest stages for each biomarker, the risk of death was 5.7x for ILA-WL (HR:5.7,  $p<.001$ ), 3.8x for ILA-R (HR:3.8,  $p<.001$ ), 7.0x for the combination of ILA-WL/ILA-R (HR:7.0,  $p<.001$ ), 3.4x for PSI score (HR:3.4,  $p<.001$ ), 8.6x for the combination of ILA-WL/ILA-R/PSI score (HR:8.6,  $p<.001$ ), 2.4x for GAP score (HR:2.4,  $p<.001$ ), and 10.7x for the combination of ILA-WL/ILA-R/PSI score/GAP score (HR:10.7,  $p<.001$ ). Concordance statistics for predicting TFS were 0.67 for ILA-WL, 0.65 for ILA-R, 0.65 for the combination of ILA-WL/ILA-R, 0.63 for PSI score, 0.67 for the combination of ILA-W/ILA-R/PSI score, 0.58 for GAP score, and 0.67 for the combination of ILA-W/ILA-R/PSI score/GAP score.

#### CONCLUSION

A fully-automated AI algorithm designed to quantify ILA findings on HRCT had higher accuracy for predicting TFS than the semi-automated PSI score and the GAP score in a multi-institutional cohort with IPF.

#### CLINICAL RELEVANCE/APPLICATION

IPF is the most common progressive and fatal fibrotic lung disease, and patients are universally evaluated by HRCT. A quantitative CT biomarker could be applied to existing HRCT images and would add no additional patient cost or radiation. In this study, we compare fully-automated and semi-automated quantitative CT biomarkers to the GAP score, a prognostic clinical marker.

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## Abstract Archives of the RSNA, 2023

T1-SSCH05-6

### Utility of Automated CT Lung Texture Imaging Analysis for Surveillance in Lung Transplantation

Tuesday, Nov. 28 8:00AM - 9:00AM Room: S404

Grace K. Grafham, BSc, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

CT is indicated at chronic lung allograft dysfunction (CLAD) onset in lung transplant recipients. Recent evidence indicates that automated CT lung texture analysis and calculated pulmonary vessel volume (PVV) could accurately phenotype and prognosticate CLAD. However, there is limited data on CT imaging of the lung allograft at baseline despite the updated International Society of Heart and Lung Transplantation (ISHLT) CLAD consensus recommending that baseline CT be performed at 6-months. The purpose of this study was to characterize the 6-month baseline CT in a cohort of lung transplant recipients and identify how lung texture and PVV change at CLAD onset.

#### METHODS AND MATERIALS

This was a prospective double-lung transplant cohort (11/2017-11/2019) with CT at 6-month baseline. An automated CT analysis tool quantified normal, ground-glass opacity, reticulation, hyperlucent lung and pulmonary vessel volume (PVV) as a percent of CT total lung capacity. Values were correlated with pulmonary function at 6-months. In patients who developed CLAD (censor 04/2023), the CT closest to CLAD diagnosis was analyzed and compared to baseline. CLAD was phenotyped according to ISHLT consensus and grouped as bronchiolitis obliterans syndrome (BOS) or non-BOS.

#### RESULTS

Of the 128 included patients, 44 developed CLAD (28 BOS, 7 restrictive allograft syndrome (RAS) or mixed, 9 unclassified or undefined). CT texture at baseline was predominately normal (median [IQR], 94.2% [85-97%]) with a PVV of 2.4% (2-3%). PVV outperformed lung texture in correlation with total lung capacity ( $r=-0.59$ ,  $p<0.01$ ) and forced expiratory volume in the first second ( $r=-0.55$ ,  $p<0.01$ ). CT variables were similar at 6-months between patients who develop CLAD and those who remained CLAD-free. From baseline to non-BOS CLAD onset, hyperlucent texture decreased (-1.3%,  $p=0.04$ ) and ground-glass (+4.2%,  $p=0.04$ ), reticulation (+2.8%,  $p<0.01$ ), and PVV increased (+1.8%,  $p=0.02$ ). Likewise, ground-glass (+4.9%,  $p=0.01$ ), reticulation (+2.7%,  $p<0.001$ ), and PVV (+2.2%,  $p=0.005$ ) were greater at onset of non-BOS versus BOS CLAD. PVV and lung texture were not different from baseline to BOS onset.

#### CONCLUSION

PVV increased from baseline to CLAD onset for non-BOS phenotypes, in line with its previously described accuracy in phenotyping and strong association with poor prognosis. By identifying normal ranges at the 6-month baseline, we found that PVV in BOS was unchanged at CLAD onset consistent with its bronchocentric pathology and in contrast to the microvascular damage observed in non-BOS CLAD.

#### CLINICAL RELEVANCE/APPLICATION

Increases in pulmonary vessel volume from the 6-month baseline CT were associated with chronic lung allograft dysfunction of a non-bronchiolitis obliterans syndrome phenotype.

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## Abstract Archives of the RSNA, 2023

T1-SSGI08

### Gastrointestinal Imaging (Pancreas Focal Lesions)

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E352

Amir A. Borhani, MD (*Moderator*) Institutional research agreement, Siemens AG  
Jeong Hee Yoon, MD (*Moderator*) Speaker, Bayer AG; Grant, Koninklijke Philips NV

#### Sub-Events

### T1-SSGI08- The Association of Pancreatic Cystic Lesions on MRI with a Future Diagnosis of Pancreatic Carcinoma: Systematic Review<sup>1</sup>

Nika Elmi, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To conduct a systematic review and meta-analysis of proportions to determine the percentage of pancreatic cystic lesions (PCLs) on MRI that are associated with a future diagnosis of pancreatic carcinoma.

#### METHODS AND MATERIALS

MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials and Scopus were searched by an experienced hospital librarian up to April 1, 2022 (PROSPERO: CRD42022320502). All studies documenting PCLs and a future diagnosis of pancreatic carcinoma in adults were eligible. MRI was required to be >1.5 T with at least one T2-weighted sequence. Studies limited to PCLs that are not normally surveilled (e.g. serous cystadenomas), pancreatitis-related collections, patients with a history of pancreatic carcinoma, syndromes, and studies with <100 cases were excluded. Patients were confirmed positive for pancreatic carcinoma based on pathology-proof or a composite clinical reference standard. Patients were confirmed negative if there was no evidence of pancreatic carcinoma on histopathology, bloodwork or future imaging. Risk of bias was assessed using the QUADAS-2 tool. A meta-analysis of proportions was performed at the patient-level with 95% confidence intervals (95%CI) and meta-regression to explore the impact of risk of bias and the presence of Fukuoka criteria worrisome features or high-risk stigmata.  $P < 0.05$  = significance.

#### RESULTS

Ten studies with 3,560 patients were included. All studies included patients followed on imaging, and none consisted exclusively of patients who underwent surgical resection. Follow-up duration varied, with 9/10 studies having a median follow-up period =3 years, and the three largest studies having a median =4 years. 3.44% (95%CI 1.68%, 5.74%) of patients with a PCL on MRI developed pancreatic carcinoma on follow-up. Within-study heterogeneity  $I^2$  was high (88%) however between-study variance  $t^2$  was low (0.03). Study risk of bias had no impact ( $p=0.51$ ). The percentage of patients who developed pancreatic carcinoma did not differ in studies that included exclusively patients without worrisome features or high-risk stigmata ( $p=0.60$ ). Flow and timing was the main source of potential bias due to patients not undergoing a consistent follow-up protocol.

#### CONCLUSION

A low percentage of patients with PCLs on MRI develop pancreatic carcinoma at follow-up. Multiple societal guidelines recommending many years to lifelong surveillance of these patients may need to be revisited.

#### CLINICAL RELEVANCE/APPLICATION

The association of pancreatic cystic lesions on MRI with future pancreatic cancer is likely weaker than implied in older studies that were limited to patients imaged using less-sensitive techniques and who underwent surgical resection.

### T1-SSGI08- Inter-reader Agreement and Diagnostic Performance of Pancreatic Adenocarcinoma Resectability Assessment with Photon Counting CT Compared with Conventional Energy Integrating Detector CT<sup>2</sup>

Jesi Kim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Improved spatial resolution and iodine contrast to noise is achievable with photon counting CT (PCCT) compared with conventional energy-integrating CT (EIDCT). The purpose of this study is to determine the diagnostic performance and interreader agreement of pancreatic ductal adenocarcinoma (PDAC) resectability assessment with PCCT compared with EIDCT.

## METHODS AND MATERIALS

A HIPAA-compliant, IRB-approved retrospective database search identified all contrast-enhanced pancreatic protocol abdominal PCCT and EIDCT with PDAC between 4/11/2022 and 10/30/2022. Two abdominal radiologists assessed the degree of tumor involvement of the celiac artery, common hepatic artery, SMA, SMV, and main portal vein (MPV) [not involved, abuts (<180 degree), encases (>180 degree)] and classified tumor resectability (resectable, borderline resectable, locally advanced unresectable, unresectable metastatic). Reader confidence was assessed using a 5-point Likert scale. For immediately preoperative CT scans, diagnostic performance of PCCT and EIDCT for PDAC adenocarcinoma vascular involvement were determined using the operative note as the reference. CTDIVol was recorded. Fisher's exact and Mann-Whitney U tests were used for statistical comparisons. A  $p < .05$  indicated statistical significance.

## RESULTS

67 patients (36 men, mean[SD] age: 67[10]years) with PCCT and 66 patients (36 men, mean[SD] age: 64[9]years) with EIDCT were included. 38 (29%) patients had surgery immediately following the index CT scan. Interreader agreement (PCCT/EIDCT) was 83%/82%, ( $p = .96$ ) for celiac artery, 91%/88% ( $p = .76$ ) for common hepatic artery, 82%/87% ( $p = .60$ ) for SMA, 79%/73% ( $p = .53$ ) for SMV, 76%/81% ( $p = .62$ ) for MPV, and 66%/61% ( $p = .60$ ) for tumor classification. Overall interreader agreement between PCCT and EIDCT was similar (82.1% (312/380), 82.2% (304/370),  $p = .99$ , respectively). Diagnostic confidence (PCCT/EIDCT) was 4.64/4.62 ( $p = .42$ ) for reader 1 and 4.78/4.58 ( $p = .008$ ) for reader 2. There was significant improvement in diagnostic accuracy of MPV involvement for both readers (90% (18/20) for PCCT, 44% (8/18) EIDCT,  $p = .005$ ) and SMA involvement for reader 1 (100% (20/20) for PCCT, 78% (14/18) for EIDCT,  $p = .04$ ). Diagnostic performance for celiac artery, common hepatic artery, and SMV were similar ( $p > .05$ ). CTDIVol for PCCT and EIDCT were 17[7] and 30[27] mGy, respectively ( $p = .006$ ).

## CONCLUSION

In PDAC preoperative imaging, PCCT afforded significantly improved diagnostic accuracy of MPV and SMA involvement at lower patient radiation exposure. Radiologists also had greater diagnostic confidence with PCCT.

## CLINICAL RELEVANCE/APPLICATION

With its improved accuracy of vascular involvement assessment, PCCT could be preferentially utilized for surgical planning.

## T1-SSGI08- Correlation Between MRI-Based Radiomics and Tissue Metabolomics in Patients with Pancreatic Cancer: A Preliminary Study

Ying Zhao JR (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the associations between radiomics scores (radscores) based on magnetic resonance imaging (MRI) and tissue metabolomics biomarkers in pancreatic cancer (PC) patients and to determine the potential metabolic pathways.

## METHODS AND MATERIALS

We performed an untargeted metabolomics study based on the tissue samples of pancreatic cancer tissue (PCT) and their corresponding non-tumorous tissue adjacent to the tumors (NTT) from 18 PC patients between July 2018 and August 2021. The paired-samples t test, fold change (FC) analysis, and orthogonal partial least squares discrimination analysis (OPLS-DA) were used to select the differential metabolites between PCT and NTT groups. Radiomics features based on T2WI, DWI, ADC, and arterial phase (AP) images were extracted. The spearman's correlation test, univariate logistic analysis, and least absolute shrinkage and selection operator (LASSO) were used for radiomics feature selection, and radscores were also constructed with four MRI sequences respectively. The publicly available multiomics network algorithm xMWAS that automated existing network algorithms was applied to identify and graph clusters of correlated data between radscores and differential metabolites. We further conducted metabolic pathway enrichment analyses among the metabolites in each imaging-metabolite cluster to determine the potential metabolic pathways associated with PC patients in our cohort.

## RESULTS

In total, 126 differentially expressed metabolites were found in PC samples compared with controls, which were mainly related to ceramide, fatty acyl carnitine, glycerophosphocholine, glycerophosphoethanolamine, glycerophosphoglycerol, glycerophosphoinositol, glycosphingolipid, lysoglycerophosphocholine, lysoglycerophosphoethanolamine, sphingomyelin, and ubiquinone (Figure 1, Figure 2). The radscores of PCT group were significantly higher than NTT group. The integration of the radscores in PC patients with the 126 metabolic features generated two unique imaging-metabolite clusters (Figure 3).

Metabolic pathway analysis indicated dysregulated pathways in the glycerophospholipid metabolism was associated with PC (Figure 4).

#### **CONCLUSION**

Our study demonstrated that tissue metabolomics were associated with MRI-based radiomics in PC patients and preliminarily found the potential dysregulated metabolic pathway involving glycerophospholipid metabolism.

#### **CLINICAL RELEVANCE/APPLICATION**

These findings may provide potential metabolomics biomarkers associated with MRI-based radiomics for pancreatic cancer patients and potential targets for novel metabolic therapeutics.

### **T1-SGGI08- A Clinical-radiomics Nomogram Based on Dual-layer Spectral Detector CT to Predict Cancer Stage in Pancreatic Ductal Adenocarcinoma**

Linxia Wu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the performance of radiomics signatures based on polyenergetic images (PEI) and virtual monoenergetic images (VMI) obtained from dual-layer spectral detector CT (DLCT) and to build a clinical-radiomics nomogram based on DLCT for predicting cancer stage (early stage: stage I-II, advanced stage: stage III-IV) in pancreatic ductal adenocarcinoma (PDAC).

#### **METHODS AND MATERIALS**

From June 2020 to October 2022, 173 patients with pathologically confirmed PDAC who underwent contrast-enhanced DLCT were collected. Radiomics features were extracted from PEI and 40 keV VMI which were reconstructed at arterial phase as well as portal venous phase. Clinical information were collected and CT parameters were measured. PEI-based and 40keV VMI-based radiomics signatures were constructed respectively using the least absolute shrinkage and selection operator with tenfold cross-validation. Multivariate logistic regression analysis was performed to identify key clinical factors related to PDAC stage and develop a clinical-radiomics nomogram which integrated radiomics signature and relevant clinical factors. Receiver operating characteristics (ROC) curves, calibration curves and decision curves analysis (DCA) were utilized to assess the performance of the nomogram on discrimination, calibration and clinical utility, respectively.

#### **RESULTS**

Among 173 patients (mean age, 61 years  $\pm$  9 [SD]; 106 male), 49 were early PDAC and 124 were advanced PDAC. All patients were randomly divided into training (n=122) and test (n=51) cohorts at a 7:3 ratio. The PEI-based radiomics signature showed satisfactory diagnostic efficacy with the areas under ROC curves (AUCs) in the training and test cohorts of 0.92 and 0.92, respectively. The optimal radiomics signature based on 40keV VMI with the AUCs in the training and test cohorts of 0.96 and 0.94, respectively. The nomogram combined 40keV VMI-based radiomics signature with two clinical parameters (tumor diameter and normalized iodine density at portal venous phase) showed promising calibration and discrimination in the training and test cohorts (0.97 and 0.91, respectively). DCA exhibited the best clinical benefit of the clinical-radiomics nomogram.

#### **CONCLUSION**

The radiomics signature derived from 40keV VMI and the clinical-radiomics nomogram based on DLCT both showed outstanding performance for stratifying early from advanced stage in PDAC which helped clinical decision-making for PDAC patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Early diagnosis and suitable treatment are very critical and important for survival and prognosis of patients with PDAC. Clinical-radiomics nomogram based on DLCT is a reliable method for accurately differentiating stage for PDAC.

### **T1-SGGI08- Extracellular Volume Fraction Determined by Equilibrium Contrast-enhanced CT to Predict the Survival Outcomes in Patients with Resectable Pancreatic Ductal Adenocarcinoma**

Hongwei Liang SR, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate whether extracellular volume (ECV) fraction with equilibrium contrast-enhanced computed tomography (CT) can predict survival outcomes in patients with resectable pancreatic ductal adenocarcinoma (PDAC).

#### **METHODS AND MATERIALS**

Eighty-three PDAC patients who underwent radical resection and preoperative pancreatic CT from January 2014 to January 2019 were retrospectively included. ECV fraction was calculated using ROI measurement within the primary tumor and aorta on unenhanced and equilibrium-phase CT images, followed by the correction of hematocrit value. The CT variables (tumor margins, parenchymal atrophy, main pancreatic duct dilation, peripancreatic tumor infiltration, venous contact, adjacent

organ invasion) were assessed. Multivariable Cox proportional-hazards models were conducted to evaluate the effects of clinical factors, CT variables and ECV fraction on the recurrence-free survival (RFS) and overall survival (OS). Survival rates were derived by Kaplan-Meier method. We also evaluated the association between ECV fraction and recurrence pattern in PDAC.

## RESULTS

Median OS and RFS were 17.1 and 10.7 months, respectively. On multivariate analysis, tumor ECV fraction and adjacent organ invasion were found to be associated with RFS ( $P=0.017$ ;  $P=0.006$ ), and only tumor ECV fraction showed an independent prognostic factor for OS ( $P=0.022$ ). Increasing ECV fraction was associated with a positive effect on RFS (HR, 0.968; 95% CI: 0.942, 0.994), and OS (HR, 0.968; 95% CI: 0.942, 0.995). When stratified patients into low and high ECV groups, based on the median ECV fraction (35.4%, [IQR, 29.0-43.2%]). The median RFS and OS of patients with high ECV group were significantly longer than that of those with low ECV group (RFS, 14.7 months vs 8.3 months,  $P=0.047$ ; OS, 27.9 months vs 12.2 months,  $P=0.021$ ). In recurrence pattern analysis, the ECV fraction did not exhibit association between local recurrence and non-local recurrence groups ( $P=0.455$ ), while patients in low-ECV group were more inclined to experience distant recurrence ( $P=0.037$ ).

## CONCLUSION

ECV fraction determined by equilibrium contrast-enhanced CT was a useful imaging biomarker for predicting survival outcomes in resectable PDAC patients, which may facilitate further risk stratification and personalized care.

## CLINICAL RELEVANCE/APPLICATION

As equilibrium phase CT images can be easily integrated into routine examinations, the CT-derived ECV is expected to become a potential prognostic biomarker for risk stratification and treatment guidance in patients with PDAC.

## T1-SSGI08- Rim Enhancement and Peripancreatic Fat Stranding in Preoperative MDCT as Predictors for Occult Metastasis in PDAC Patients

Qing Xu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To identify the radiological features and clinical biomarkers that could predict the occult metastasis (OM) of pancreatic ductal adenocarcinoma (PDAC).

## METHODS AND MATERIALS

This retrospective study included PDAC patients who were radiologically diagnosed resectable (R) or borderline resectable (BR) and underwent surgical exploration from January 2018 to December 2021. Depending on whether distant metastasis was found during the exploration, patients were divided into OM and non-OM groups. Tumor imaging features were retrospectively evaluated, and clinical data were collected. Rim enhancement was defined as the ring-like enhancement around a relatively hypodense central area. Peripancreatic fat stranding was defined as the presence of haziness or strand structures derived from the tumor. Univariate and multivariable logistic regression analyses were performed to determine the radiological and clinical predictors for occult metastases. Model performance was determined by discrimination and calibration.

## RESULTS

A total of 502 patients were enrolled, among which 68 (13.5%) patients were found with distant metastases, with 45 liver-only, 19 peritoneal-only, four patients had both liver and peritoneal metastases. Rim enhancement and peripancreatic fat stranding were more frequent in the OM group than in the non-OM group. Tumor size ( $P=0.028$ ), tumor resectability ( $P=0.031$ ), rim enhancement ( $P<0.001$ ), peripancreatic fat stranding ( $P<0.001$ ) and level of CA125 ( $P=0.021$ ) were independent predictors of OM according to the multivariable analyses, and AUCs of predictors were 0.703, 0.594, 0.638, 0.655, 0.631, respectively. The combined model, with sensitivity of 83.82% and specificity of 68.89%, showed the highest AUC of 0.823 and was superior to the clinical model excluded two radiological features.

## CONCLUSION

Rim enhancement, peripancreatic fat stranding, tumor size, tumor resectability and level of CA125 are risk factors for OM of PDAC. The combined model of radiological and clinical features may help the preoperative prediction of OM in PDAC.

## CLINICAL RELEVANCE/APPLICATION

For PDAC patients, the only curative option is surgical resection, while some patients were detected with OM, defined as metastatic diseases invisible in preoperative imaging and encountered during the surgery. Our study introduced two newly discovered and simple radiological features of PDAC into model establishment, including rim enhancement and peripancreatic fat stranding. It is believed that the combination of radiological and clinical features might help identify patients with a higher risk of OM before surgery. Further examination will be recommended for these patients, to achieve accurate staging and assist in the final decision of curative operation.

## Abstract Archives of the RSNA, 2023

T1-SSGI08-1

### The Association of Pancreatic Cystic Lesions on MRI with a Future Diagnosis of Pancreatic Carcinoma: Systematic Review

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E352

Nika Elmi, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To conduct a systematic review and meta-analysis of proportions to determine the percentage of pancreatic cystic lesions (PCLs) on MRI that are associated with a future diagnosis of pancreatic carcinoma.

#### METHODS AND MATERIALS

MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials and Scopus were searched by an experienced hospital librarian up to April 1, 2022 (PROSPERO: CRD42022320502). All studies documenting PCLs and a future diagnosis of pancreatic carcinoma in adults were eligible. MRI was required to be >1.5 T with at least one T2-weighted sequence. Studies limited to PCLs that are not normally surveilled (e.g. serous cystadenomas), pancreatitis-related collections, patients with a history of pancreatic carcinoma, syndromes, and studies with <100 cases were excluded. Patients were confirmed positive for pancreatic carcinoma based on pathology-proof or a composite clinical reference standard. Patients were confirmed negative if there was no evidence of pancreatic carcinoma on histopathology, bloodwork or future imaging. Risk of bias was assessed using the QUADAS-2 tool. A meta-analysis of proportions was performed at the patient-level with 95% confidence intervals (95%CI) and meta-regression to explore the impact of risk of bias and the presence of Fukuoka criteria worrisome features or high-risk stigmata.  $P < 0.05$  = significance.

#### RESULTS

Ten studies with 3,560 patients were included. All studies included patients followed on imaging, and none consisted exclusively of patients who underwent surgical resection. Follow-up duration varied, with 9/10 studies having a median follow-up period =3 years, and the three largest studies having a median =4 years. 3.44% (95%CI 1.68%, 5.74%) of patients with a PCL on MRI developed pancreatic carcinoma on follow-up. Within-study heterogeneity  $I^2$  was high (88%) however between-study variance  $t^2$  was low (0.03). Study risk of bias had no impact ( $p=0.51$ ). The percentage of patients who developed pancreatic carcinoma did not differ in studies that included exclusively patients without worrisome features or high-risk stigmata ( $p=0.60$ ). Flow and timing was the main source of potential bias due to patients not undergoing a consistent follow-up protocol.

#### CONCLUSION

A low percentage of patients with PCLs on MRI develop pancreatic carcinoma at follow-up. Multiple societal guidelines recommending many years to lifelong surveillance of these patients may need to be revisited.

#### CLINICAL RELEVANCE/APPLICATION

The association of pancreatic cystic lesions on MRI with future pancreatic cancer is likely weaker than implied in older studies that were limited to patients imaged using less-sensitive techniques and who underwent surgical resection.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSGI08-2

### Inter-reader Agreement and Diagnostic Performance of Pancreatic Adenocarcinoma Resectability Assessment with Photon Counting CT Compared with Conventional Energy Integrating Detector CT

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E352

Jesi Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Improved spatial resolution and iodine contrast to noise is achievable with photon counting CT (PCCT) compared with conventional energy-integrating CT (EIDCT). The purpose of this study is to determine the diagnostic performance and interreader agreement of pancreatic ductal adenocarcinoma (PDAC) resectability assessment with PCCT compared with EIDCT.

#### METHODS AND MATERIALS

A HIPAA-compliant, IRB-approved retrospective database search identified all contrast-enhanced pancreatic protocol abdominal PCCT and EIDCT with PDAC between 4/11/2022 and 10/30/2022. Two abdominal radiologists assessed the degree of tumor involvement of the celiac artery, common hepatic artery, SMA, SMV, and main portal vein (MPV) [not involved, abuts (<180 degree), encases (>180 degree)] and classified tumor resectability (resectable, borderline resectable, locally advanced unresectable, unresectable metastatic). Reader confidence was assessed using a 5-point Likert scale. For immediately preoperative CT scans, diagnostic performance of PCCT and EIDCT for PDAC adenocarcinoma vascular involvement were determined using the operative note as the reference. CTDI<sub>vol</sub> was recorded. Fisher's exact and Mann-Whitney U tests were used for statistical comparisons. A  $p < .05$  indicated statistical significance.

#### RESULTS

67 patients (36 men, mean[SD] age: 67[10]years) with PCCT and 66 patients (36 men, mean[SD] age: 64[9]years) with EIDCT were included. 38 (29%) patients had surgery immediately following the index CT scan. Interreader agreement (PCCT/EIDCT) was 83%/82%, ( $p = .96$ ) for celiac artery, 91%/88% ( $p = .76$ ) for common hepatic artery, 82%/87% ( $p = .60$ ) for SMA, 79%/73% ( $p = .53$ ) for SMV, 76%/81% ( $p = .62$ ) for MPV, and 66%/61% ( $p = .60$ ) for tumor classification. Overall interreader agreement between PCCT and EIDCT was similar (82.1% (312/380), 82.2% (304/370),  $p = .99$ , respectively). Diagnostic confidence (PCCT/EIDCT) was 4.64/4.62 ( $p = .42$ ) for reader 1 and 4.78/4.58 ( $p = .008$ ) for reader 2. There was significant improvement in diagnostic accuracy of MPV involvement for both readers (90% (18/20) for PCCT, 44% (8/18) EIDCT,  $p = .005$ ) and SMA involvement for reader 1 (100% (20/20) for PCCT, 78% (14/18) for EIDCT,  $p = .04$ ). Diagnostic performance for celiac artery, common hepatic artery, and SMV were similar ( $p > .05$ ). CTDI<sub>vol</sub> for PCCT and EIDCT were 17[7] and 30[27] mGy, respectively ( $p = .006$ ).

#### CONCLUSION

In PDAC preoperative imaging, PCCT afforded significantly improved diagnostic accuracy of MPV and SMA involvement at lower patient radiation exposure. Radiologists also had greater diagnostic confidence with PCCT.

#### CLINICAL RELEVANCE/APPLICATION

With its improved accuracy of vascular involvement assessment, PCCT could be preferentially utilized for surgical planning.

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## Abstract Archives of the RSNA, 2023

T1-SSGI08-3

### Correlation Between MRI-Based Radiomics and Tissue Metabolomics in Patients with Pancreatic Cancer: A Preliminary Study

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E352

Ying Zhao JR (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the associations between radiomics scores (radscores) based on magnetic resonance imaging (MRI) and tissue metabolomics biomarkers in pancreatic cancer (PC) patients and to determine the potential metabolic pathways.

#### METHODS AND MATERIALS

We performed an untargeted metabolomics study based on the tissue samples of pancreatic cancer tissue (PCT) and their corresponding non-tumorous tissue adjacent to the tumors (NTT) from 18 PC patients between July 2018 and August 2021. The paired-samples t test, fold change (FC) analysis, and orthogonal partial least squares discrimination analysis (OPLS-DA) were used to select the differential metabolites between PCT and NTT groups. Radiomics features based on T2WI, DWI, ADC, and arterial phase (AP) images were extracted. The spearman's correlation test, univariate logistic analysis, and least absolute shrinkage and selection operator (LASSO) were used for radiomics feature selection, and radscores were also constructed with four MRI sequences respectively. The publicly available multiomics network algorithm xMWAS that automated existing network algorithms was applied to identify and graph clusters of correlated data between radscores and differential metabolites. We further conducted metabolic pathway enrichment analyses among the metabolites in each imaging-metabolite cluster to determine the potential metabolic pathways associated with PC patients in our cohort.

#### RESULTS

In total, 126 differentially expressed metabolites were found in PC samples compared with controls, which were mainly related to ceramide, fatty acyl carnitine, glycerophosphocholine, glycerophosphoethanolamine, glycerophosphoglycerol, glycerophosphoinositol, glycosphingolipid, lysoglycerophosphocholine, lysoglycerophosphoethanolamine, sphingomyelin, and ubiquinone (Figure 1, Figure 2). The radscores of PCT group were significantly higher than NTT group. The integration of the radscores in PC patients with the 126 metabolic features generated two unique imaging-metabolite clusters (Figure 3). Metabolic pathway analysis indicated dysregulated pathways in the glycerophospholipid metabolism was associated with PC (Figure 4).

#### CONCLUSION

Our study demonstrated that tissue metabolomics were associated with MRI-based radiomics in PC patients and preliminarily found the potential dysregulated metabolic pathway involving glycerophospholipid metabolism.

#### CLINICAL RELEVANCE/APPLICATION

These findings may provide potential metabolomics biomarkers associated with MRI-based radiomics for pancreatic cancer patients and potential targets for novel metabolic therapeutics.

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## Abstract Archives of the RSNA, 2023

T1-SSGI08-4

### **A Clinical-radiomics Nomogram Based on Dual-layer Spectral Detector CT to Predict Cancer Stage in Pancreatic Ductal Adenocarcinoma**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E352

Linxia Wu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the performance of radiomics signatures based on polyenergetic images (PEI) and virtual monoenergetic images (VMI) obtained from dual-layer spectral detector CT (DLCT) and to build a clinical-radiomics nomogram based on DLCT for predicting cancer stage (early stage: stage I-II, advanced stage: stage III-IV) in pancreatic ductal adenocarcinoma (PDAC).

#### **METHODS AND MATERIALS**

From June 2020 to October 2022, 173 patients with pathologically confirmed PDAC who underwent contrast-enhanced DLCT were collected. Radiomics features were extracted from PEI and 40 keV VMI which were reconstructed at arterial phase as well as portal venous phase. Clinical information were collected and CT parameters were measured. PEI-based and 40keV VMI-based radiomics signatures were constructed respectively using the least absolute shrinkage and selection operator with tenfold cross-validation. Multivariate logistic regression analysis was performed to identify key clinical factors related to PDAC stage and develop a clinical-radiomics nomogram which integrated radiomics signature and relevant clinical factors. Receiver operating characteristics (ROC) curves, calibration curves and decision curves analysis (DCA) were utilized to assess the performance of the nomogram on discrimination, calibration and clinical utility, respectively.

#### **RESULTS**

Among 173 patients (mean age, 61 years  $\pm$  9 [SD];106 male), 49 were early PDAC and 124 were advanced PDAC. All patients were randomly divided into training (n=122) and test (n=51) cohorts at a 7:3 ratio. The PEI-based radiomics signature showed satisfactory diagnostic efficacy with the areas under ROC curves (AUCs) in the training and test cohorts of 0.92 and 0.92, respectively. The optimal radiomics signature based on 40keV VMI with the AUCs in the training and test cohorts of 0.96 and 0.94, respectively. The nomogram combined 40keV VMI-based radiomics signature with two clinical parameters (tumor diameter and normalized iodine density at portal venous phase) showed promising calibration and discrimination in the training and test cohorts (0.97 and 0.91, respectively). DCA exhibited the best clinical benefit of the clinical-radiomics nomogram.

#### **CONCLUSION**

The radiomics signature derived from 40keV VMI and the clinical-radiomics nomogram based on DLCT both showed outstanding performance for stratifying early from advanced stage in PDAC which helped clinical decision-making for PDAC patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Early diagnosis and suitable treatment are very critical and important for survival and prognosis of patients with PDAC. Clinical-radiomics nomogram based on DLCT is a reliable method for accurately differentiating stage for PDAC.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-SSGI08-5

### Extracellular Volume Fraction Determined by Equilibrium Contrast-enhanced CT to Predict the Survival Outcomes in Patients with Resectable Pancreatic Ductal Adenocarcinoma

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E352

Hongwei Liang SR, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether extracellular volume (ECV) fraction with equilibrium contrast-enhanced computed tomography (CT) can predict survival outcomes in patients with resectable pancreatic ductal adenocarcinoma (PDAC).

#### METHODS AND MATERIALS

Eighty-three PDAC patients who underwent radical resection and preoperative pancreatic CT from January 2014 to January 2019 were retrospectively included. ECV fraction was calculated using ROI measurement within the primary tumor and aorta on unenhanced and equilibrium-phase CT images, followed by the correction of hematocrit value. The CT variables (tumor margins, parenchymal atrophy, main pancreatic duct dilation, peripancreatic tumor infiltration, venous contact, adjacent organ invasion) were assessed. Multivariable Cox proportional-hazards models were conducted to evaluate the effects of clinical factors, CT variables and ECV fraction on the recurrence-free survival (RFS) and overall survival (OS). Survival rates were derived by Kaplan-Meier method. We also evaluated the association between ECV fraction and recurrence pattern in PDAC.

#### RESULTS

Median OS and RFS were 17.1 and 10.7 months, respectively. On multivariate analysis, tumor ECV fraction and adjacent organ invasion were found to be associated with RFS ( $P=0.017$ ;  $P=0.006$ ), and only tumor ECV fraction showed an independent prognostic factor for OS ( $P=0.022$ ). Increasing ECV fraction was associated with a positive effect on RFS (HR, 0.968; 95% CI: 0.942, 0.994), and OS (HR, 0.968; 95% CI: 0.942, 0.995). When stratified patients into low and high ECV groups, based on the median ECV fraction (35.4%, [IQR, 29.0-43.2%]). The median RFS and OS of patients with high ECV group were significantly longer than that of those with low ECV group (RFS, 14.7 months vs 8.3 months,  $P=0.047$ ; OS, 27.9 months vs 12.2 months,  $P=0.021$ ). In recurrence pattern analysis, the ECV fraction did not exhibit association between local recurrence and non-local recurrence groups ( $P=0.455$ ), while patients in low-ECV group were more inclined to experience distant recurrence ( $P=0.037$ ).

#### CONCLUSION

ECV fraction determined by equilibrium contrast-enhanced CT was a useful imaging biomarker for predicting survival outcomes in resectable PDAC patients, which may facilitate further risk stratification and personalized care.

#### CLINICAL RELEVANCE/APPLICATION

As equilibrium phase CT images can be easily integrated into routine examinations, the CT-derived ECV is expected to become a potential prognostic biomarker for risk stratification and treatment guidance in patients with PDAC.

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## Abstract Archives of the RSNA, 2023

T1-SSGI08-6

### **Rim Enhancement and Peripancreatic Fat Stranding in Preoperative MDCT as Predictors for Occult Metastasis in PDAC Patients**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E352

Qing Xu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To identify the radiological features and clinical biomarkers that could predict the occult metastasis (OM) of pancreatic ductal adenocarcinoma (PDAC).

#### **METHODS AND MATERIALS**

This retrospective study included PDAC patients who were radiologically diagnosed resectable (R) or borderline resectable (BR) and underwent surgical exploration from January 2018 to December 2021. Depending on whether distant metastasis was found during the exploration, patients were divided into OM and non-OM groups. Tumor imaging features were retrospectively evaluated, and clinical data were collected. Rim enhancement was defined as the ring-like enhancement around a relatively hypodense central area. Peripancreatic fat stranding was defined as the presence of haziness or strand structures derived from the tumor. Univariate and multivariable logistic regression analyses were performed to determine the radiological and clinical predictors for occult metastases. Model performance was determined by discrimination and calibration.

#### **RESULTS**

A total of 502 patients were enrolled, among which 68 (13.5%) patients were found with distant metastases, with 45 liver-only, 19 peritoneal-only, four patients had both liver and peritoneal metastases. Rim enhancement and peripancreatic fat stranding were more frequent in the OM group than in the non-OM group. Tumor size ( $P=0.028$ ), tumor resectability ( $P=0.031$ ), rim enhancement ( $P<0.001$ ), peripancreatic fat stranding ( $P<0.001$ ) and level of CA125 ( $P=0.021$ ) were independent predictors of OM according to the multivariable analyses, and AUCs of predictors were 0.703, 0.594, 0.638, 0.655, 0.631, respectively. The combined model, with sensitivity of 83.82% and specificity of 68.89%, showed the highest AUC of 0.823 and was superior to the clinical model excluded two radiological features.

#### **CONCLUSION**

Rim enhancement, peripancreatic fat stranding, tumor size, tumor resectability and level of CA125 are risk factors for OM of PDAC. The combined model of radiological and clinical features may help the preoperative prediction of OM in PDAC.

#### **CLINICAL RELEVANCE/APPLICATION**

For PDAC patients, the only curative option is surgical resection, while some patients were detected with OM, defined as metastatic diseases invisible in preoperative imaging and encountered during the surgery. Our study introduced two newly discovered and simple radiological features of PDAC into model establishment, including rim enhancement and peripancreatic fat stranding. It is believed that the combination of radiological and clinical features might help identify patients with a higher risk of OM before surgery. Further examination will be recommended for these patients, to achieve accurate staging and assist in the final decision of curative operation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSGI09

### Gastrointestinal Imaging (Monitoring Response to Therapy)

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E351

Khaled M. Elsayes, MD, PhD (*Moderator*) Nothing to Disclose  
Nataly Horvat, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **T1-SSGI09- CT-Radiomics Derived Early Chemotherapy Response Prediction in Advanced Pancreatic Ductal Adenocarcinoma** 1

Felix N. Harder, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the value of radiomics-derived early chemotherapy response prediction in advanced pancreatic ductal adenocarcinoma (PDAC) based on features from the primary tumor site and hepatic metastases. Although the presence of liver metastases significantly impacts clinical outcome in PDAC the prognostic value of radiomics features derived from hepatic metastases has yet not been scrutinized. Moreover, current studies on radiomics in advanced PDAC lack prospectively collected datasets.

#### METHODS AND MATERIALS

164 patients with locally advanced and metastatic PDAC were retrospectively enrolled from a closely monitored large-scale prospective clinical study (COMPASS trial). Of these, 115 patients (70%) presented with liver metastases at first diagnosis. All patients underwent first-line chemotherapy treatment with modified FOLFIRINOX or gemcitabine/nab-paclitaxel. 3D radiomics features were obtained from the primary tumor site and the largest liver metastases at pre-therapeutic baseline CT. Radiomics-only and clinical-radiomics (+Moffitt signature) models were built to predict early progressive disease at first follow-up CT according to RECIST 1.1 in the overall cohort and liver metastases only cohort.

#### RESULTS

The clinical-radiomics model outperformed the radiomics-only model in the overall cohort for prediction of early progression at first follow-up CT (AUC: 0.788 vs. 0.731;  $p < 0.001$ ). In the liver metastases cohort, the clinical-radiomics model, combining features from the primary tumor site, largest liver metastasis (L1) and Moffitt-signature (AUC: 0.842) outperformed the radiomics-only models incorporating features from the primary site only (AUC = 0.721), L1 only (AUC = 0.702) and a combined primary and L1 model (AUC = 0.777) (all  $p < 0.001$ ). Based on the radiomics score, patients were stratified into high-risk and low-risk patients demonstrating significantly ( $p=0.011$ ) prolonged overall survival in low-risk patients in the full cohort.

#### CONCLUSION

Clinical-radiomics models enabled superior benefit to radiomics-only models for early response prediction in advanced PDAC. In patients with liver metastases, incorporating metastases-derived features provided additive value compared to primary tumor models alone. This finding in synopsis with the known clinical impact of hepatic metastases underlines the need to take metastasis-derived features into account when building prediction models in metastatic PDAC.

#### CLINICAL RELEVANCE/APPLICATION

Clinical-radiomics models may improve early chemotherapy response prediction in patients with advanced PDAC. Moreover, we propose that future studies take metastasis-derived features into account when building prediction models in metastatic PDAC.

### **T1-SSGI09- Monitor PDAC Tumor Response to Stroma-Targeting Therapy using CEST MRI** 2

Guanshu Liu, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

We sought to develop dextran-enhanced CEST MRI to accurately assess the therapeutic effects of stroma-targeting treatment in pancreatic ductal adenocarcinoma (PDAC). Thanks to their naturally carried, abundant exchangeable hydroxyl (OH) protons, dextrans have been explored as a new type of Chemical Exchange Saturation Transfer (CEST) contrast agent for a 'label-free' molecular imaging. The wide size range of dextrans makes them suitable for characterizing the tumor vascular permeability in the macro- to nano-size range, a feature especially useful for monoclonal antibodies and nanoparticulate therapeutics.

## METHODS AND MATERIALS

Animal model: The murine PDAC KPC cells were derived from Kras<sup>LSL.G12D/+</sup>; p53<sup>R172H/+</sup>; Pdx<sup>Cretg/+</sup> (or KPC) mice. To form syngeneic allograft PDAC tumors subcutaneously, 1 million cells (in 200  $\mu$ L) were subcutaneously injected into both flanks of C57BL/6J mice to form two tumors. PEGPH20 treatment. Randomly selected mice (n=4) will be treated with PEGylated human hyaluronidase (PEGPH20)<sup>2</sup> at 4.5 mg/kg, i.v. twice weekly for 3 weeks<sup>3</sup>. MRI: Mice were imaged using an 11.7 T Bruker Biospec scanner, with CEST MRI performed before and after the i.v. injection of 200  $\mu$ L dex10 (500 mg/kg b.w), using parameters: B<sub>1</sub>= 1.8  $\mu$ T, T<sub>sat</sub>= 3 s,  $\omega_1$  = -3 to +3 ppm, step= 0.2 ppm. MTR<sub>asym</sub>=(S<sub>- $\omega_1$</sub>  - S<sub>+ $\omega_1$</sub> )/S<sub>0</sub> was computed after the B<sub>0</sub> correction using the WASSR method.  $\Delta$ MTR<sub>asym</sub> (1 ppm) at each time point was calculated by MTR<sub>asym</sub> (t)- MTR<sub>asym</sub> (pre). Area-under-curve (AUC) was calculated by  $\Delta$ MTR<sub>asym</sub> between 0 and 22.5 min post-injection.

## RESULTS

The representative CEST maps and plots are shown in Figures 1a-c: without PEGPH20 treatment, KPC tumors had negligible Dex10 contrast enhancement, attributed to tumor desmoplasia, whereas PEGPH20 treatment led to substantial Dex10 contrast enhancement in the tumor. The quantitative analyses (Figures 1d-e) showed that the PEGPH20 treatment resulted in a 3-fold increased area under curve (AUC) within the first 22.5 min, and a 5-fold increased enhancing fraction (V<sub>f</sub>), the fraction of the tumor volume with non-zero enhancement voxels in the parametric maps.

## CONCLUSION

We have evaluated dextran-enhanced CEST MRI's ability to assess tumor responses to stroma-targeting therapy. Our data indicates that 10 kD dextran is suitable for monitoring the tumor responses to PEGPH20. Reference: 1. Dubick, M. A., et al., *J Trauma* 1994, 36 (3), 323-330. 2. Provenzano, P. P., et al., *Cancer cell* 2012, 21(3), 418-29. 3. Thompson, C. B., et al., *Mol Cancer Ther* 2010, 9 (11), 3052-3064.

## CLINICAL RELEVANCE/APPLICATION

Dextran-enhanced CEST MRI provides a safe while effective imaging approach to guide and monitor stroma-targeting therapies to achieve optimized outcomes in hypo-permeable PDAC.

## T1-SSGI09- Initial SHAPE Evaluation of Pancreatic Cancers Undergoing Chemotherapy with Sonoporation Treatment

Priscilla Machado, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Sonoporation is a novel method that can enhance therapeutic efficacy of co-administered chemotherapy by localized CEUS imaging, which temporarily changes tumor vascular microenvironment. An ongoing Phase II clinical trial aims to improve standard of care (SoC) chemotherapy treatment by adding sonoporation (i.e., augmenting treatment with CEUS and microbubbles). As part of this study, a noninvasive ultrasound technique, subharmonic-aided pressure estimation (SHAPE), was used to acquire intra-tumoral pressure measurements. The objective of this study was to use SHAPE during the chemotherapy with sonoporation treatment to evaluate changes in treatment response.

## METHODS AND MATERIALS

Subjects recently diagnosed with pancreatic cancer stages II, III or IV undergoing chemotherapy are eligible to be enrolled in this ongoing, IRB-approved study. Enrolled subjects underwent their SoC chemotherapy treatment (FOLFIRINOX or Gemcitabine/ Nab-Paclitaxel regimen) with 20 minutes of sonoporation treatment for each chemotherapy visit. A Logiq E10 scanner (GE Healthcare, Waukesha, WI) with C1-6 probe was used to image, target and induce sonoporation. This system also acquired SHAPE pressure measurements values (in dB) with mean difference between the values acquired with and without microbubbles used in the final analysis. Subjects were divided into responders and non-responders and their SHAPE values compared at three time points: first, third and last cycles of chemotherapy using t-tests.

## RESULTS

To date, 5 of the subjects enrolled in this ongoing study completed their first line chemotherapy treatment and had their SHAPE pressure data analyzed. The mean age of the subjects was 56 years (range: 43-67 years). Subjects were divided into responders (n = 1) and non-responders (n = 4) to the treatment regimen. First cycle values were  $-2.79 \pm 1.05$  dB for responders and  $-3.72 \pm 1.10$  dB for non-responders (p = 0.21). Third cycle values were  $3.25 \pm 4.08$  dB for responders and

-3.95 ± 1.02 dB for non-responders (p = 0.005). Last cycle values were -5.50 ± 1.37 dB for responders and -1.92 ± 1.03 dB for non-responders (p = 0.002).

#### **CONCLUSION**

This initial comparison of SHAPE intra-tumoral pressure measurements between responders and non-responders showed significant statistical differences for the third and for the last cycle (p < 0.006) suggesting SHAPE may be used to indicate chemotherapy response; albeit based on a small sample size.

#### **CLINICAL RELEVANCE/APPLICATION**

The use of non-invasive methods to determine intra-tumoral pressure measurements that evaluate chemotherapy response could help with patient care by providing a more precise indication of the tumor response to treatment.

#### **T1-SSGI09- Mucin Content in Rectal Adenocarcinoma: Quantity and Association with Clinical Outcomes after Total Neoadjuvant Therapy**

Sidra Javed-Tayyab, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Evaluate relationship between mucin pool and patient outcomes on baseline and restaging rectal magnetic resonance imaging (MRI) after total neoadjuvant therapy (TNT).

#### **METHODS AND MATERIALS**

This retrospective study analyzed the data of 199 patients (mean age, 58 years; range, 49-68; 81 women) diagnosed with rectal adenocarcinoma and treated with TNT between January 2018 and December 2018. The patients' baseline and restaging MRI scans, along with their treatment information, were carefully reviewed by two expert abdominal radiologists. The mucin content of the tumors was classified into five categories: no mucin, < 25%, 25-50%, 50-75%, or >75% mucin. Logistic regression was performed to compare patient outcomes for non-mucinous (< 50% mucin) versus mucinous (> 50% mucin) tumors, as well as for no mucin versus any mucin content tumors.

#### **RESULTS**

On baseline MRI, most had mid-rectal tumor (43%), majority were T3 (71%), positive nodes (79%), no extramural vascular invasion (EMVI) (82%), and positive circumferential resection margin (CRM) (55%). The majority had no mucin (85%), followed by 7% who had < 25% mucin; 2.5% who had 25-50% mucin, 2.5% who had 50-75% mucin, and 3% who had >75% mucin. In addition, 52% patients underwent total mesorectal excision and 14% had pathological complete response (pCR), whereas 41% underwent nonoperative management and 40% had sustained clinical complete response (scCR) after 3 years of follow up. Overall, no statistically significant associations were found for local recurrence/ regrowth, distant recurrence, or recurrence free survival. Mucin pool was not associated with complete response [49.1% vs 40%, p value= 0.35].

#### **CONCLUSION**

Although patients with mucinous rectal tumors have been shown to have worse prognoses in the literature, mucin content was not associated with patient outcomes in our patient population who underwent total neoadjuvant therapy. Therefore, mucin status may not be a good predictor of prognosis in this specific population. Further research is needed to explore significance of mucin content on MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

The prognostic implications of mucin content on MRI in rectal adenocarcinoma patients who are undergoing total neoadjuvant therapy is currently not established in the literature. Our study suggests that mucin content may not be predictive of worse outcomes when rectal adenocarcinoma patients are treated with the modern paradigm of total neoadjuvant therapy.

#### **T1-SSGI09- Noninvasive Prediction of Insufficient Biochemical Response after Ursodeoxycholic Acid Treatment in Patients with Primary Biliary Cholangitis based on Pretreatment Nonenhanced MRI**

Yun Zhang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the feasibility of pretreatment nonenhanced magnetic resonance imaging (MRI) in predicting insufficient biochemical response to ursodeoxycholic acid (UDCA) in patients with primary biliary cholangitis (PBC).

#### **METHODS AND MATERIALS**

From January 2009 to April 2022, consecutive PBC patients treated with UDCA who underwent non-enhanced MRI within 30 days before treatment were retrospectively enrolled. All MR images were independently evaluated by two blinded radiologists. Uni- and multivariable logistic regression analyses were performed to develop a predictive model for 12-month insufficient

biochemical response. Model performances were evaluated by computing the area under the receiver operating characteristic curve (AUC), sensitivity and specificity.

## **RESULTS**

A total of 74 patients ( $50.6 \pm 11.9$  years; 62 female) were included. Three pretreatment MRI features, including hepatomegaly (odds ratio [OR]: 4.580;  $p = 0.011$ ), periportal hyperintensity on T2-weighted imaging (T2WI) (OR: 4.795,  $p = 0.008$ ), and narrowing of the bile ducts (OR: 3.491;  $p = 0.027$ ) were associated with 12-month insufficient biochemical response at the multivariable analysis. A predictive model based on the above indicators showed an AUC of 0.781, sensitivity of 85.4%, and specificity of 61.5% for predicting insufficient biochemical response.

## **CONCLUSION**

A noninvasive model based on three pretreatment MRI features could accurately predict 12-month insufficient biochemical response to UDCA in patients with PBC. Early identification of PBC patients at increased risk for insufficient response can facilitate in time initiation of additional treatment.

## **CLINICAL RELEVANCE/APPLICATION**

There is an urgent need for identifying the characteristics or risk factors of PBC patients with insufficient response to UDCA, in order to achieve early screening of high-risk PBC patients prior to UDCA treatment and to assist in decision making. Our study developed a noninvasive model based on three pretreatment nonenhanced MRI features that can help in the early identification of high-risk PBC patients with an insufficient biochemical response to UDCA.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSGI09-1

### CT-Radiomics Derived Early Chemotherapy Response Prediction in Advanced Pancreatic Ductal Adenocarcinoma

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E351

Felix N. Harder, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the value of radiomics-derived early chemotherapy response prediction in advanced pancreatic ductal adenocarcinoma (PDAC) based on features from the primary tumor site and hepatic metastases. Although the presence of liver metastases significantly impacts clinical outcome in PDAC the prognostic value of radiomics features derived from hepatic metastases has yet not been scrutinized. Moreover, current studies on radiomics in advanced PDAC lack prospectively collected datasets.

#### METHODS AND MATERIALS

164 patients with locally advanced and metastatic PDAC were retrospectively enrolled from a closely monitored large-scale prospective clinical study (COMPASS trial). Of these, 115 patients (70%) presented with liver metastases at first diagnosis. All patients underwent first-line chemotherapy treatment with modified FOLFIRINOX or gemcitabine/nab-paclitaxel. 3D radiomics features were obtained from the primary tumor site and the largest liver metastases at pre-therapeutic baseline CT. Radiomics-only and clinical-radiomics (+Moffitt signature) models were built to predict early progressive disease at first follow-up CT according to RECIST 1.1 in the overall cohort and liver metastases only cohort.

#### RESULTS

The clinical-radiomics model outperformed the radiomics-only model in the overall cohort for prediction of early progression at first follow-up CT (AUC: 0.788 vs. 0.731;  $p < 0.001$ ). In the liver metastases cohort, the clinical-radiomics model, combining features from the primary tumor site, largest liver metastasis (L1) and Moffitt-signature (AUC: 0.842) outperformed the radiomics-only models incorporating features from the primary site only (AUC = 0.721), L1 only (AUC = 0.702) and a combined primary and L1 model (AUC = 0.777) (all  $p < 0.001$ ). Based on the radiomics score, patients were stratified into high-risk and low-risk patients demonstrating significantly ( $p=0.011$ ) prolonged overall survival in low-risk patients in the full cohort.

#### CONCLUSION

Clinical-radiomics models enabled superior benefit to radiomics-only models for early response prediction in advanced PDAC. In patients with liver metastases, incorporating metastases-derived features provided additive value compared to primary tumor models alone. This finding in synopsis with the known clinical impact of hepatic metastases underlines the need to take metastasis-derived features into account when building prediction models in metastatic PDAC.

#### CLINICAL RELEVANCE/APPLICATION

Clinical-radiomics models may improve early chemotherapy response prediction in patients with advanced PDAC. Moreover, we propose that future studies take metastasis-derived features into account when building prediction models in metastatic PDAC.

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## Abstract Archives of the RSNA, 2023

T1-SSGI09-2

### Monitor PDAC Tumor Response to Stroma-Targeting Therapy using CEST MRI

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E351

Guanshu Liu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We sought to develop dextran-enhanced CEST MRI to accurately assess the therapeutic effects of stroma-targeting treatment in pancreatic ductal adenocarcinoma (PDAC). Thanks to their naturally carried, abundant exchangeable hydroxyl (OH) protons, dextrans have been explored as a new type of Chemical Exchange Saturation Transfer (CEST) contrast agent for a 'label-free' molecular imaging. The wide size range of dextrans makes them suitable for characterizing the tumor vascular permeability in the macro- to nano-size range, a feature especially useful for monoclonal antibodies and nanoparticulate therapeutics.

#### METHODS AND MATERIALS

Animal model: The murine PDAC KPC cells were derived from *Kras<sup>LSL.G12D/+</sup>; p53<sup>R172H/+</sup>; Pdx<sup>Cretg/+</sup>* (or KPC) mice. To form syngeneic allograft PDAC tumors subcutaneously, 1 million cells (in 200  $\mu$ L) were subcutaneously injected into both flanks of C57BL/6J mice to form two tumors. PEGPH20 treatment. Randomly selected mice (n=4) will be treated with PEGylated human hyaluronidase (PEGPH20)<sub>2</sub> at 4.5 mg/kg, i.v. twice weekly for 3 weeks<sup>3</sup>. MRI: Mice were imaged using an 11.7 T Bruker Biospec scanner, with CEST MRI performed before and after the i.v. injection of 200  $\mu$ L dex10 (500 mg/kg b.w), using parameters:  $B_1 = 1.8 \mu$ T,  $T_{sat} = 3$  s,  $\omega = -3$  to  $+3$  ppm, step = 0.2 ppm.  $MTR_{asym} = (S_{-} - S_{+}) / S_0$  was computed after the B0 correction using the WASSR method.  $MTR_{asym}$  (1 ppm) at each time point was calculated by  $MTR_{asym}(t) - MTR_{asym}(pre)$ . Area-under-curve (AUC) was calculated by  $MTR_{asym}$  between 0 and 22.5 min post-injection.

#### RESULTS

The representative CEST maps and plots are shown in Figures 1a-c: without PEGPH20 treatment, KPC tumors had negligible Dex10 contrast enhancement, attributed to tumor desmoplasia, whereas PEGPH20 treatment led to substantial Dex10 contrast enhancement in the tumor. The quantitative analyses (Figures 1d-e) showed that the PEGPH20 treatment resulted in a 3-fold increased area under curve (AUC) within the first 22.5 min, and a 5-fold increased enhancing fraction ( $V_f$ ), the fraction of the tumor volume with non-zero enhancement voxels in the parametric maps.

#### CONCLUSION

We have evaluated dextran-enhanced CEST MRI's ability to assess tumor responses to stroma-targeting therapy. Our data indicates that 10 kD dextran is suitable for monitoring the tumor responses to PEGPH20. Reference: 1. Dubick, M. A., et al., *J Trauma* 1994, 36 (3), 323-330. 2. Provenzano, P. P., et al., *Cancer cell* 2012, 21(3), 418-29. 3. Thompson, C. B., et al., *Mol Cancer Ther* 2010, 9 (11), 3052-3064.

#### CLINICAL RELEVANCE/APPLICATION

Dextran-enhanced CEST MRI provides a safe while effective imaging approach to guide and monitor stroma-targeting therapies to achieve optimized outcomes in hypo-permeable PDAC.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-SSGI09-3

### Initial SHAPE Evaluation of Pancreatic Cancers Undergoing Chemotherapy with Sonoporation Treatment

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E351

Priscilla Machado, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Sonoporation is a novel method that can enhance therapeutic efficacy of co-administered chemotherapy by localized CEUS imaging, which temporarily changes tumor vascular microenvironment. An ongoing Phase II clinical trial aims to improve standard of care (SoC) chemotherapy treatment by adding sonoporation (i.e., augmenting treatment with CEUS and microbubbles). As part of this study, a noninvasive ultrasound technique, subharmonic-aided pressure estimation (SHAPE), was used to acquire intra-tumoral pressure measurements. The objective of this study was to use SHAPE during the chemotherapy with sonoporation treatment to evaluate changes in treatment response.

#### METHODS AND MATERIALS

Subjects recently diagnosed with pancreatic cancer stages II, III or IV undergoing chemotherapy are eligible to be enrolled in this ongoing, IRB-approved study. Enrolled subjects underwent their SoC chemotherapy treatment (FOLFIRINOX or Gemcitabine/ Nab-Paclitaxel regimen) with 20 minutes of sonoporation treatment for each chemotherapy visit. A Logiq E10 scanner (GE HealthCare, Waukesha, WI) with C1-6 probe was used to image, target and induce sonoporation. This system also acquired SHAPE pressure measurements values (in dB) with mean difference between the values acquired with and without microbubbles used in the final analysis. Subjects were divided into responders and non-responders and their SHAPE values compared at three time points: first, third and last cycles of chemotherapy using t-tests.

#### RESULTS

To date, 5 of the subjects enrolled in this ongoing study completed their first line chemotherapy treatment and had their SHAPE pressure data analyzed. The mean age of the subjects was 56 years (range: 43-67 years). Subjects were divided into responders ( $n = 1$ ) and non-responders ( $n = 4$ ) to the treatment regimen. First cycle values were  $-2.79 \pm 1.05$  dB for responders and  $-3.72 \pm 1.10$  dB for non-responders ( $p = 0.21$ ). Third cycle values were  $3.25 \pm 4.08$  dB for responders and  $-3.95 \pm 1.02$  dB for non-responders ( $p = 0.005$ ). Last cycle values were  $-5.50 \pm 1.37$  dB for responders and  $-1.92 \pm 1.03$  dB for non-responders ( $p = 0.002$ ).

#### CONCLUSION

This initial comparison of SHAPE intra-tumoral pressure measurements between responders and non-responders showed significant statistical differences for the third and for the last cycle ( $p < 0.006$ ) suggesting SHAPE may be used to indicate chemotherapy response; albeit based on a small sample size.

#### CLINICAL RELEVANCE/APPLICATION

The use of non-invasive methods to determine intra-tumoral pressure measurements that evaluate chemotherapy response could help with patient care by providing a more precise indication of the tumor response to treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSGI09-4

### **Mucin Content in Rectal Adenocarcinoma: Quantity and Association with Clinical Outcomes after Total Neoadjuvant Therapy**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E351

Sidra Javed-Tayyab, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Evaluate relationship between mucin pool and patient outcomes on baseline and restaging rectal magnetic resonance imaging (MRI) after total neoadjuvant therapy (TNT).

#### **METHODS AND MATERIALS**

This retrospective study analyzed the data of 199 patients (mean age, 58 years; range, 49-68; 81 women) diagnosed with rectal adenocarcinoma and treated with TNT between January 2018 and December 2018. The patients' baseline and restaging MRI scans, along with their treatment information, were carefully reviewed by two expert abdominal radiologists. The mucin content of the tumors was classified into five categories: no mucin, < 25%, 25-50%, 50-75%, or >75% mucin. Logistic regression was performed to compare patient outcomes for non-mucinous (< 50% mucin) versus mucinous (> 50% mucin) tumors, as well as for no mucin versus any mucin content tumors.

#### **RESULTS**

On baseline MRI, most had mid-rectal tumor (43%), majority were T3 (71%), positive nodes (79%), no extramural vascular invasion (EMVI) (82%), and positive circumferential resection margin (CRM) (55%). The majority had no mucin (85%), followed by 7% who had < 25% mucin; 2.5% who had 25-50% mucin, 2.5% who had 50-75% mucin, and 3% who had >75% mucin. In addition, 52% patients underwent total mesorectal excision and 14% had pathological complete response (pCR), whereas 41% underwent nonoperative management and 40% had sustained clinical complete response (scCR) after 3 years of follow up. Overall, no statistically significant associations were found for local recurrence/ regrowth, distant recurrence, or recurrence free survival. Mucin pool was not associated with complete response [49.1% vs 40%, p value= 0.35].

#### **CONCLUSION**

Although patients with mucinous rectal tumors have been shown to have worse prognoses in the literature, mucin content was not associated with patient outcomes in our patient population who underwent total neoadjuvant therapy. Therefore, mucin status may not be a good predictor of prognosis in this specific population. Further research is needed to explore significance of mucin content on MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

The prognostic implications of mucin content on MRI in rectal adenocarcinoma patients who are undergoing total neoadjuvant therapy is currently not established in the literature. Our study suggests that mucin content may not be predictive of worse outcomes when rectal adenocarcinoma patients are treated with the modern paradigm of total neoadjuvant therapy.

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## Abstract Archives of the RSNA, 2023

T1-SSGI09-6

### Noninvasive Prediction of Insufficient Biochemical Response after Ursodeoxycholic Acid Treatment in Patients with Primary Biliary Cholangitis based on Pretreatment Nonenhanced MRI

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E351

Yun Zhang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the feasibility of pretreatment nonenhanced magnetic resonance imaging (MRI) in predicting insufficient biochemical response to ursodeoxycholic acid (UDCA) in patients with primary biliary cholangitis (PBC).

#### METHODS AND MATERIALS

From January 2009 to April 2022, consecutive PBC patients treated with UDCA who underwent non-enhanced MRI within 30 days before treatment were retrospectively enrolled. All MR images were independently evaluated by two blinded radiologists. Uni- and multivariable logistic regression analyses were performed to develop a predictive model for 12-month insufficient biochemical response. Model performances were evaluated by computing the area under the receiver operating characteristic curve (AUC), sensitivity and specificity.

#### RESULTS

A total of 74 patients ( $50.6 \pm 11.9$  years; 62 female) were included. Three pretreatment MRI features, including hepatomegaly (odds ratio [OR]: 4.580;  $p = 0.011$ ), periportal hyperintensity on T2-weighted imaging (T2WI) (OR: 4.795,  $p = 0.008$ ), and narrowing of the bile ducts (OR: 3.491;  $p = 0.027$ ) were associated with 12-month insufficient biochemical response at the multivariable analysis. A predictive model based on the above indicators showed an AUC of 0.781, sensitivity of 85.4%, and specificity of 61.5% for predicting insufficient biochemical response.

#### CONCLUSION

A noninvasive model based on three pretreatment MRI features could accurately predict 12-month insufficient biochemical response to UDCA in patients with PBC. Early identification of PBC patients at increased risk for insufficient response can facilitate in time initiation of additional treatment.

#### CLINICAL RELEVANCE/APPLICATION

There is an urgent need for identifying the characteristics or risk factors of PBC patients with insufficient response to UDCA, in order to achieve early screening of high-risk PBC patients prior to UDCA treatment and to assist in decision making. Our study developed a noninvasive model based on three pretreatment nonenhanced MRI features that can help in the early identification of high-risk PBC patients with an insufficient biochemical response to UDCA.

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## Abstract Archives of the RSNA, 2023

T1-SSPD03

### Pediatric Imaging (Musculoskeletal and Quality Safety)

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353B

Victor M. Ho-Fung, MD (*Moderator*) Nothing to Disclose  
Maria A. Bedoya-Velez, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **T1-SSPD03-Normative Model of Cranial Bone Development Unveils Abnormal Local Bone Density in Pediatric CT Associated With Intra-Cranial Hypertension and Non-syndromic Sagittal Craniosynostosis**

Antonio Porras Perez, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

After surgical treatment of children with non-syndromic sagittal craniosynostosis (NSSC), signs of intra-cranial hypertension (ICH) may trigger reoperation to prevent neurological damage. However, noninvasive evaluation of pediatric ICH is subjective and based on variable clinical symptoms, since precise measurement of intracranial pressure requires invasive monitoring. Although local bone anomalies associated with ICH have been qualitatively described in CT images, the absence of curated datasets and quantitative normative references have prevented their systematic study to identify ICH. We used a normative cranial bone development model to explore local mineral density anomalies in both patients with ICH and with NSSC.

#### METHODS AND MATERIALS

We used deep-learning methods to automatically segment the calvarium from preoperative CT images of 55 patients with ICH (26 male, 29 female, age  $4.21 \pm 3.11$  years) and 122 patients with NSSC (92 male, 30 female, age  $4.20 \pm 3.96$  months). The etiology of ICH included hydrocephalus, idiopathic intracranial hypertension, arachnoid cysts, or intracranial neoplasms. Patients with any form of craniosynostosis were excluded from the ICH group. For each patient, we used our age- and sex-specific normative model built from CT images of 2,068 control subjects (age 0-10 years) to quantify local bone mineral density anomalies (in Hounsfield Units, HU) at every location on the calvarium.

#### RESULTS

Patients with ICH showed a global decrease in average calvarial bone mineral density ( $-40.44 \pm 77.18$  HU,  $p < 0.001$ ) compared to the normative reference, which was significant in all calvarial bones ( $p < 0.05$ ). Patients with NSSC showed a global decrease compared to normative in average calvarial bone mineral density ( $-7.96 \pm 20.01$  HU,  $p < 0.001$ ), which was greater in the parietal ( $-10.85 \pm 22.36$  HU,  $p < 0.001$ ) and occipital ( $-11.11 \pm 29.28$  HU,  $p < 0.001$ ) than in the frontal bones ( $-2.24 \pm 25.89$  HU,  $p = 0.01$ ). Patients with NSSC presented increased mineral density in the frontal ( $p < 0.001$ ) and occipital bones ( $p < 0.001$ ) compared to patients with ICH, but not in the parietal bones ( $p = 0.43$ ).

#### CONCLUSION

We present the first systematic quantitative study of local cranial bone density anomalies associated with ICH. Our results demonstrate significant bone density loss in patients with ICH, and similar local density patterns in the fused parietal bones of patients with NSSC that may be produced by the increased pressure from the constrained brain.

#### CLINICAL RELEVANCE/APPLICATION

Our new quantitative findings show the potential of quantitative CT to support the clinical evaluation of pediatric ICH to achieve earlier interventions and avoid invasive monitoring.

### **T1-SSPD03-Hip MRI-Based Synthetic CT Versus Conventional CT: A Morphometric and Clinical Comparison in Young Patients**

Jade Iwasaka-Neder, MD (*Presenter*) Nothing to Disclose

## PURPOSE

MRI-based synthetic CT (sCT) generates CT-like images from MRI data that can easily undergo 2D and 3D reformatting, a process that would otherwise require complex segmentation programs for MRI sequences. This study aims to evaluate the equivalence and reliability of sCT versus conventional CT (cCT) for assessing hip morphology and maturity in pediatric and young patients.

## METHODS AND MATERIALS

This IRB-approved prospective study included patients = 25 years old referred for both cCT and MRI of the hip and pelvis within a 6 month interval for hip pathology evaluation. Patients were scanned on a 3 Tesla MRI scanner according to standard department protocol, including a high-resolution dual-echo GRE sequence used to generate sCT images via a commercially available deep-learning enabled post-processing software. cCT scans were performed according to standard protocols on state-of-the-art multidetector scanners with submillimeter resolution. De-identified images were reviewed by two pediatric musculoskeletal radiologists who measured the following on each hip: lateral center edge angle, anterior center edge angle, acetabular version, acetabular index, acetabular quotient, Sharp angle, and joint space width. Reliability and agreement of measurements were assessed via intraclass correlations (ICCs), Bland-Altman plots, and two one-sided tests for equivalence. 3D surface distances between cCT and sCT were computed. The status of physeal maturity (open versus closed) at sCT and cCT was established by consensus review at 7 locations and sCT's accuracy to correctly determine physeal maturity calculated. Images were scored on a 5 point Likert scale for overall diagnostic quality, SNR, bony margins definition, corticomedullary differentiation and artifacts and compared to cCT via Wilcoxon signed rank test.

## RESULTS

The study cohort consisted of 50 hips from 25 patients ( $18 \pm 3.8$  years, range 9-25; male=6). The mean surface distance between cCT- and sCT-based bone models was  $0.23 \pm 0.18$  mm. cCT- and sCT-based measurements demonstrated good to excellent inter- and intra-observer correlation ( $0.77 < \text{ICC} < 0.98$ ). All measurements were statistically equivalent ( $p < 0.001$ ), with average intermodal differences within intra-observer limits of agreement. The accuracy to determine physeal patency by sCT was 96.3%. Overall diagnostic quality, SNR and artifacts were higher on sCT ( $p < 0.05$ ); clarity of bony margin and corticomedullary difference were not significantly different ( $p > 0.05$ ).

## CONCLUSION

sCT is equivalent to cCT for the assessment of hip morphology and maturity in young patients.

## CLINICAL RELEVANCE/APPLICATION

MRI-based synthetic CT offers an accurate radiation-free alternative for hip structural evaluation in young adult and pediatric patients.

## T1-SSPD03-Olecranon Bone Age Assessment in Puberty Using a Lateral Elbow Radiograph and a Deep-Learning Model

Gayoung Choi, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Accurate bone age evaluation is crucial for assessing skeletal maturation, especially during puberty. Hand bone age has limitations during this period, and elbow bone age evaluation can be a valuable alternative. This study aims to propose a more precise and feasible elbow bone age classification using characteristic morphological changes of the olecranon during puberty, and develop a deep-learning-based artificial intelligence (AI) model for olecranon bone age evaluation.

## METHODS AND MATERIALS

In this retrospective study, a total of 3508 lateral elbow radiographs were reviewed and classified based on the morphological changes of the olecranon ossification process. This novel classification of olecranon ossification process (novel olecranon method) was compared with previously established elbow bone age methods (Sauvegrain and Dimeglio) and hand and wrist bone age (Greulich Pyle and Korean standard bone age chart). Then, a deep-learning-based model for olecranon bone age classification was trained, validated, tested, and further improved through external validation.

## RESULTS

The novel olecranon method for puberty was established and the reference bone age was determined in correlation with Sauvegrain method. The interobserver agreement between two pediatric radiologists were 0.92 for the novel olecranon method, 0.90 for Dimeglio method, and 0.88 for Sauvegrain method. The novel olecranon method showed excellent reliability with both Sauvegrain and Dimeglio methods (ICC 0.97 and 0.98 in girls, 0.96 and 0.98 in boys each), and good reliability with hand and wrist bone age by both GP method (0.78 in girls, 0.84 in boys) and KS chart (0.87 in girls, 0.89 in boys). The deep-learning based model for olecranon bone age showed accuracy of 0.96 and specificity of 0.98 with Efficient-Det b4. In external validation, the accuracy was 0.86.

## CONCLUSION

The novel olecranon method for elbow bone age evaluation in puberty has several advantages, including the need for only a single lateral elbow radiograph, ease of use with greater detail compared to previous elbow bone age evaluation methods, almost perfect interobserver agreement, and excellent reliability with previous methods. Furthermore, the deep-learning-based AI model developed for the novel olecranon method exhibited high accuracy and specificity. The novel olecranon method and the developed AI model have the potential to enhance elbow bone age evaluation during puberty.

## CLINICAL RELEVANCE/APPLICATION

The novel olecranon method can be a simple and practical choice for bone age evaluation in puberty, a possible alternative for complicated Sauvegrain method and limited Dimeglio method. Deep-learning-based AI model for the novel olecranon method can further assist clinical practice.

## T1-SSPD03-Prospective Comparison of Low Dose Chest CT and Skeletal Survey for Detecting Fractures from Child Abuse

Kelly K. Horst, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The purpose of this study is to prospectively compare skeletal survey (SS) to ultra-low dose non-contrast (ULD CCT) chest CT performed for suspected child abuse.

### METHODS AND MATERIALS

Consecutive pediatric patients suspected to be victims of child abuse underwent non-contrast ultra-low dose chest CT (ULD CCT) and radiographic SS as both an initial and follow-up exam to identify imaging findings of abuse. Three CAQ-certified pediatric radiologists reviewed randomized, deidentified images. Rib fractures were categorized by rib number, laterality, and according to the location on the rib (costochondral junction, lateral, or posterior). If the majority of the pediatric radiologists rated a fracture as being definitely present across any imaging modality and time point at a specific location, a fracture was considered present. Fracture-level sensitivity was evaluated across modality and time points based on whether the majority of readers definitely identified fractures, and testing for differences in sensitivity was performed using generalized estimating equations. We report reader-averaged patient-level specificity across modalities and time points based on the lack of false positive detected fractures.

### RESULTS

Twenty-nine children [mean age 181 days, range: 22-453, 9 female] underwent concurrent skeletal survey and ULD CCT. Estimated radiation dose for ULD CCT [CTDIvol 0.13±0.05 mGy; DLP 0.22±0.08 mSv] was lower than for SS [0.43±0.16 mSv]. There were 52 definite rib fractures identified in 11 patients. Initial exam fracture-level sensitivity was 40% for ULD CCT vs 33% for SS (P=0.68), while follow-up exam sensitivity was 83% for ULD CCT vs. 29% for SS (P=0.001). Follow-up ULD CCT sensitivity was also significantly higher than baseline (P=0.049). Patient level specificity was comparable at both initial (ULD CCT=96%; SS=98%) and follow-up exams (ULD CCT=98%; SS=94%). SS had one false positive, where a lesion was characterized as an osteochondroma on CT and one false negative, where a fracture was identified on CT. One patient had a liver laceration on CT, despite no initial concern (i.e., no bruising) on physical examination.

## CONCLUSION

ULD CCT identified nearly twice as many fractures compared to SS when used as a screening tool in the work-up for abuse, identifies rib fractures in patients with negative skeletal survey, identifies soft tissue lesions that are occult on physical exam, and better characterizes bony lesions that mimic fractures on x-ray. CT identifies additional fractures at follow-up that are occult on initial SS and CT.

## CLINICAL RELEVANCE/APPLICATION

ULD CCT identified nearly twice as many fractures compared to SS when used as a screening tool in the work-up for child abuse, with comparable specificity at lower radiation doses.

## T1-SSPD03-A Preliminary Study of Evaluating the Active Lesions of Juvenile Localized Scleroderma With Superb Microvascular Imaging

Na Xu (*Presenter*) Nothing to Disclose

### PURPOSE

Scleroderma is a chronic connective tissue disease, including systemic scleroderma (SSc) and localized scleroderma (LS). Skin sclerosis is primary clinical symptom of LS, which primarily affects children and has a worse prognosis than adult patients. The aim of this study is to examine the correlation between the changes of microvessel of lesion skin tissue in juvenile localized scleroderma (JLS) and normal skin using ultrasound superb microvascular imaging (SMI) technique, and the evaluation value of ultrasound SMI technique on the activity of JLS lesion.

## **METHODS AND MATERIALS**

A prospective analysis was conducted on 11 children with JLS, diagnosed clinically and pathologically in the Department of Dermatology or Rheumatic Immunology Department of X Hospital from March 2021 to April 2023. The localized scleroderma assessment tool (LoSCAT), including modified local scleroderma skin severity index (MLoSSI) and localized scleroderma damage index (LoSDI), was used to evaluate the activity of lesions. Lesions received a score higher than 0 were deemed to be active. The lesion and its symmetrical normal skin were scanned using the SMI technique (Canon Aplio i800), and the vascular index (VI) was employed to objectively quantify the microvessel of them. The differences of VI between skin of active lesions and normal, inactive lesions and normal were compared.

## **RESULTS**

There were 12 active lesions and 12 inactive lesions in 11 children with JLS. The VI of skin of active lesions and normal were  $8.58 \pm 5.29\%$  and  $2.60 \pm 3.83\%$ , respectively. All active lesions' VI were higher than normal sides', and the difference was statistically significant ( $P < 0.05$ ). The VI of skin of inactive lesions and normal were  $0.21 \pm 0.69\%$  and  $0.06 \pm 0.18\%$ , respectively, and there was no significant difference between them ( $P > 0.05$ ).

## **CONCLUSION**

SMI technology could sensitively detect microvessel in the skin layer and indicate active lesions of children with JLS earlier than clinical evaluation. Moreover, ultrasound is practical and non-invasive, making it appropriate for tracking the development of JLS and determining the best course of action.

## **CLINICAL RELEVANCE/APPLICATION**

Skin sclerosis is primary clinical symptom of localized scleroderma (LS), which primarily affects children and has a worse prognosis than adult patients. This study examined the correlation between the changes of microvessel of lesion skin tissue in JLS and normal skin using ultrasound SMI technique. SMI technology could sensitively detect microvessel in the skin layer and indicate active lesions of children with JLS earlier than clinical evaluation. Ultrasound is practical and non-invasive, making it appropriate for tracking the development of lesions in children with JLS and determining the best course of action.

## **T1-SSPD03-The ACR Dose Index Registry for Digital Radiography: Developing Pediatric Registry Benchmarks**

Steven Don, MD (*Presenter*) Research Grant, Carestream Health, Inc.;

### **PURPOSE**

To develop pediatric dose-index benchmarks using data collected in the American College of Radiology (ACR) Dose Index Registry (DIR) for Digital Radiography (DR).

### **METHODS AND MATERIALS**

Dose-index values for exposure events from sites participating in the ACR DIR DR Working Group over a two-year period (2021 and 2022) were recorded. To be included, the data must have a local exam descriptor that is mapped to the ACR Common ID for that body part and the patient's age in years. The ACR TRIAD server automatically anonymized the data. The events were separated by age (<1, 1 to <5, 5 to <10, 10 to <15, 15 to 18, and adults >18 years old) and Common ID. For a Common ID to be included in the registry statistics there must be at least five facilities, each with =20 events per Common ID. The dose indices recorded are based on the IEC 62-494 standard and included the exposure index (EI), exposure index target (EIT), and deviation index (DI). Any EI <25 was excluded from the database. Kerma area-product (KAP) was also recorded. Each facility median values were tabulated and then the registry quartiles were compiled. The EIT mode was also reported.

### **RESULTS**

One children's hospital, five academic centers, and one community center submitted data. Some centers consisted of more than one facility. 219,039 pediatric exposure events were recorded over two years from 18 Common IDs for pediatrics, compared with 1,042,627 events from 41 Common IDs for adults. The pediatric Common IDs include chest, abdomen, clavicle, scoliosis, spine (cervical, thoracic, and lumbar), upper extremity (shoulder, elbow, radius/ulna, wrist, hand, and finger) and lower extremity (femur, knee, tibia/fibula, ankle, and foot). The EIT mode ranged from 160 (abdomen 1 to <5) to 400 (chest 2 age ranges). The most common EIT mode was 250, representing 78% of Common IDs. The adult EIT mode range was 242-800; the most common EIT mode was 250 (51%). As a general rule, central body work (chest, abdomen, and spine) had lower median EI values than extremity exams (elbow, hand, wrist, tibia/fibula and foot). Extremity exams (elbow, hand, wrist, tibia/fibula and foot) had a lower KAP than scoliosis, lumbar spine, and abdomen. Similar trends with adult examinations were noted for EI and KAP.

### **CONCLUSION**

Individual facilities can benchmark their results with this registry database. EI tended to be lower for central body work than for extremity exams while KAP was highest for scoliosis, lumbar spine and abdomen examinations. Pediatric exam registry

benchmarks were similar to the adult registry benchmarks. Increased participation will improve generalizability of future benchmarks.

**CLINICAL RELEVANCE/APPLICATION**

The ACR DIR for DR will enable participants to benchmark their dose indices' performance data against national values.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-SSPD03-1

### Normative Model of Cranial Bone Development Unveils Abnormal Local Bone Density in Pediatric CT Associated With Intra-Cranial Hypertension and Non-syndromic Sagittal Craniosynostosis

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353B

Antonio Porras Perez, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

After surgical treatment of children with non-syndromic sagittal craniosynostosis (NSSC), signs of intra-cranial hypertension (ICH) may trigger reoperation to prevent neurological damage. However, noninvasive evaluation of pediatric ICH is subjective and based on variable clinical symptoms, since precise measurement of intracranial pressure requires invasive monitoring. Although local bone anomalies associated with ICH have been qualitatively described in CT images, the absence of curated datasets and quantitative normative references have prevented their systematic study to identify ICH. We used a normative cranial bone development model to explore local mineral density anomalies in both patients with ICH and with NSSC.

#### METHODS AND MATERIALS

We used deep-learning methods to automatically segment the calvarium from preoperative CT images of 55 patients with ICH (26 male, 29 female, age  $4.21 \pm 3.11$  years) and 122 patients with NSSC (92 male, 30 female, age  $4.20 \pm 3.96$  months). The etiology of ICH included hydrocephalus, idiopathic intracranial hypertension, arachnoid cysts, or intracranial neoplasms. Patients with any form of craniosynostosis were excluded from the ICH group. For each patient, we used our age- and sex-specific normative model built from CT images of 2,068 control subjects (age 0-10 years) to quantify local bone mineral density anomalies (in Hounsfield Units, HU) at every location on the calvarium.

#### RESULTS

Patients with ICH showed a global decrease in average calvarial bone mineral density ( $-40.44 \pm 77.18$  HU,  $p < 0.001$ ) compared to the normative reference, which was significant in all calvarial bones ( $p < 0.05$ ). Patients with NSSC showed a global decrease compared to normative in average calvarial bone mineral density ( $-7.96 \pm 20.01$  HU,  $p < 0.001$ ), which was greater in the parietal ( $-10.85 \pm 22.36$  HU,  $p < 0.001$ ) and occipital ( $-11.11 \pm 29.28$  HU,  $p < 0.001$ ) than in the frontal bones ( $-2.24 \pm 25.89$  HU,  $p = 0.01$ ). Patients with NSSC presented increased mineral density in the frontal ( $p < 0.001$ ) and occipital bones ( $p < 0.001$ ) compared to patients with ICH, but not in the parietal bones ( $p = 0.43$ ).

#### CONCLUSION

We present the first systematic quantitative study of local cranial bone density anomalies associated with ICH. Our results demonstrate significant bone density loss in patients with ICH, and similar local density patterns in the fused parietal bones of patients with NSSC that may be produced by the increased pressure from the constrained brain.

#### CLINICAL RELEVANCE/APPLICATION

Our new quantitative findings show the potential of quantitative CT to support the clinical evaluation of pediatric ICH to achieve earlier interventions and avoid invasive monitoring.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPD03-2

### Hip MRI-Based Synthetic CT Versus Conventional CT: A Morphometric and Clinical Comparison in Young Patients

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353B

Jade Iwasaka-Neder, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

MRI-based synthetic CT (sCT) generates CT-like images from MRI data that can easily undergo 2D and 3D reformatting, a process that would otherwise require complex segmentation programs for MRI sequences. This study aims to evaluate the equivalence and reliability of sCT versus conventional CT (cCT) for assessing hip morphology and maturity in pediatric and young patients.

#### METHODS AND MATERIALS

This IRB-approved prospective study included patients = 25 years old referred for both cCT and MRI of the hip and pelvis within a 6 month interval for hip pathology evaluation. Patients were scanned on a 3 Tesla MRI scanner according to standard department protocol, including a high-resolution dual-echo GRE sequence used to generate sCT images via a commercially available deep-learning enabled post-processing software. cCT scans were performed according to standard protocols on state-of-the art multidetector scanners with submillimeter resolution. De-identified images were reviewed by two pediatric musculoskeletal radiologists who measured the following on each hip: lateral center edge angle, anterior center edge angle, acetabular version, acetabular index, acetabular quotient, Sharp angle, and joint space width. Reliability and agreement of measurements were assessed via intraclass correlations (ICCs), Bland-Altman plots, and two one-sided tests for equivalence. 3D surface distances between cCT and sCT were computed. The status of physeal maturity (open versus closed) at sCT and cCT was established by consensus review at 7 locations and sCT's accuracy to correctly determine physeal maturity calculated. Images were scored on a 5 point Likert scale for overall diagnostic quality, SNR, bony margins definition, corticomedullary differentiation and artifacts and compared to cCT via Wilcoxon signed rank test.

#### RESULTS

The study cohort consisted of 50 hips from 25 patients ( $18 \pm 3.8$  years, range 9-25; male=6). The mean surface distance between cCT- and sCT-based bone models was  $0.23 \pm 0.18$  mm. cCT- and sCT-based measurements demonstrated good to excellent inter- and intra-observer correlation ( $0.77 < ICC < 0.98$ ). All measurements were statistically equivalent ( $p < 0.001$ ), with average intermodal differences within intra-observer limits of agreement. The accuracy to determine physeal patency by sCT was 96.3%. Overall diagnostic quality, SNR and artifacts were higher on sCT ( $p < 0.05$ ); clarity of bony margin and corticomedullary difference were not significantly different ( $p > 0.05$ ).

#### CONCLUSION

sCT is equivalent to cCT for the assessment of hip morphology and maturity in young patients.

#### CLINICAL RELEVANCE/APPLICATION

MRI-based synthetic CT offers an accurate radiation-free alternative for hip structural evaluation in young adult and pediatric patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPD03-3

### **Olecranon Bone Age Assessment in Puberty Using a Lateral Elbow Radiograph and a Deep-Learning Model**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353B

Gayoung Choi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Accurate bone age evaluation is crucial for assessing skeletal maturation, especially during puberty. Hand bone age has limitations during this period, and elbow bone age evaluation can be a valuable alternative. This study aims to propose a more precise and feasible elbow bone age classification using characteristic morphological changes of the olecranon during puberty, and develop a deep-learning-based artificial intelligence (AI) model for olecranon bone age evaluation.

#### **METHODS AND MATERIALS**

In this retrospective study, a total of 3508 lateral elbow radiographs were reviewed and classified based on the morphological changes of the olecranon ossification process. This novel classification of olecranon ossification process (novel olecranon method) was compared with previously established elbow bone age methods (Sauvegrain and Dimeglio) and hand and wrist bone age (Greulich Pyle and Korean standard bone age chart). Then, a deep-learning-based model for olecranon bone age classification was trained, validated, tested, and further improved through external validation.

#### **RESULTS**

The novel olecranon method for puberty was established and the reference bone age was determined in correlation with Sauvegrain method. The interobserver agreement between two pediatric radiologists were 0.92 for the novel olecranon method, 0.90 for Dimeglio method, and 0.88 for Sauvegrain method. The novel olecranon method showed excellent reliability with both Sauvegrain and Dimeglio methods (ICC 0.97 and 0.98 in girls, 0.96 and 0.98 in boys each), and good reliability with hand and wrist bone age by both GP method (0.78 in girls, 0.84 in boys) and KS chart (0.87 in girls, 0.89 in boys). The deep-learning based model for olecranon bone age showed accuracy of 0.96 and specificity of 0.98 with Efficient-Det b4. In external validation, the accuracy was 0.86.

#### **CONCLUSION**

The novel olecranon method for elbow bone age evaluation in puberty has several advantages, including the need for only a single lateral elbow radiograph, ease of use with greater detail compared to previous elbow bone age evaluation methods, almost perfect interobserver agreement, and excellent reliability with previous methods. Furthermore, the deep-learning-based AI model developed for the novel olecranon method exhibited high accuracy and specificity. The novel olecranon method and the developed AI model have the potential to enhance elbow bone age evaluation during puberty.

#### **CLINICAL RELEVANCE/APPLICATION**

The novel olecranon method can be a simple and practical choice for bone age evaluation in puberty, a possible alternative for complicated Sauvegrain method and limited Dimeglio method. Deep-learning-based AI model for the novel olecranon method can further assist clinical practice.

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## Abstract Archives of the RSNA, 2023

T1-SSPD03-4

### Prospective Comparison of Low Dose Chest CT and Skeletal Survey for Detecting Fractures from Child Abuse

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353B

Kelly K. Horst, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to prospectively compare skeletal survey (SS) to ultra-low dose non-contrast (ULD CCT) chest CT performed for suspected child abuse.

#### METHODS AND MATERIALS

Consecutive pediatric patients suspected to be victims of child abuse underwent non-contrast ultra-low dose chest CT (ULD CCT) and radiographic SS as both an initial and follow-up exam to identify imaging findings of abuse. Three CAQ-certified pediatric radiologists reviewed randomized, deidentified images. Rib fractures were categorized by rib number, laterality, and according to the location on the rib (costochondral junction, lateral, or posterior). If the majority of the pediatric radiologists rated a fracture as being definitely present across any imaging modality and time point at a specific location, a fracture was considered present. Fracture-level sensitivity was evaluated across modality and time points based on whether the majority of readers definitely identified fractures, and testing for differences in sensitivity was performed using generalized estimating equations. We report reader-averaged patient-level specificity across modalities and time points based on the lack of false positive detected fractures.

#### RESULTS

Twenty-nine children [mean age 181 days, range: 22-453, 9 female] underwent concurrent skeletal survey and ULD CCT. Estimated radiation dose for ULD CCT [CTDIvol 0.13±0.05 mGy; DLP 0.22±0.08 mSv] was lower than for SS [0.43±0.16 mSv]. There were 52 definite rib fractures identified in 11 patients. Initial exam fracture-level sensitivity was 40% for ULD CCT vs 33% for SS (P=0.68), while follow-up exam sensitivity was 83% for ULD CCT vs. 29% for SS (P=0.001). Follow-up ULD CCT sensitivity was also significantly higher than baseline (P=0.049). Patient level specificity was comparable at both initial (ULD CCT=96%; SS=98%) and follow-up exams (ULD CCT=98%; SS=94%). SS had one false positive, where a lesion was characterized as an osteochondroma on CT and one false negative, where a fracture was identified on CT. One patient had a liver laceration on CT, despite no initial concern (i.e., no bruising) on physical examination.

#### CONCLUSION

ULD CCT identified nearly twice as many fractures compared to SS when used as a screening tool in the work-up for abuse, identifies rib fractures in patients with negative skeletal survey, identifies soft tissue lesions that are occult on physical exam, and better characterizes bony lesions that mimic fractures on x-ray. CT identifies additional fractures at follow-up that are occult on initial SS and CT.

#### CLINICAL RELEVANCE/APPLICATION

ULD CCT identified nearly twice as many fractures compared to SS when used as a screening tool in the work-up for child abuse, with comparable specificity at lower radiation doses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPD03-5

### **A Preliminary Study of Evaluating the Active Lesions of Juvenile Localized Scleroderma With Superb Microvascular Imaging**

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353B

Na Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Scleroderma is a chronic connective tissue disease, including systemic scleroderma (SSc) and localized scleroderma (LS). Skin sclerosis is primary clinical symptom of LS, which primarily affects children and has a worse prognosis than adult patients. The aim of this study is to examine the correlation between the changes of microvessel of lesion skin tissue in juvenile localized scleroderma (JLS) and normal skin using ultrasound superb microvascular imaging (SMI) technique, and the evaluation value of ultrasound SMI technique on the activity of JLS lesion.

#### **METHODS AND MATERIALS**

A prospective analysis was conducted on 11 children with JLS, diagnosed clinically and pathologically in the Department of Dermatology or Rheumatic Immunology Department of X Hospital from March 2021 to April 2023. The localized scleroderma assessment tool (LoSCAT), including modified local scleroderma skin severity index (MLoSSI) and localized scleroderma damage index (LoSDI), was used to evaluate the activity of lesions. Lesions received a score higher than 0 were deemed to be active. The lesion and its symmetrical normal skin were scanned using the SMI technique (Canon Aplio i800), and the vascular index (VI) was employed to objectively quantify the microvessel of them. The differences of VI between skin of active lesions and normal, inactive lesions and normal were compared.

#### **RESULTS**

There were 12 active lesions and 12 inactive lesions in 11 children with JLS. The VI of skin of active lesions and normal were  $8.58 \pm 5.29\%$  and  $2.60 \pm 3.83\%$ , respectively. All active lesions' VI were higher than normal sides', and the difference was statistically significant ( $P < 0.05$ ). The VI of skin of inactive lesions and normal were  $0.21 \pm 0.69\%$  and  $0.06 \pm 0.18\%$ , respectively, and there was no significant difference between them ( $P > 0.05$ ).

#### **CONCLUSION**

SMI technology could sensitively detect microvessel in the skin layer and indicate active lesions of children with JLS earlier than clinical evaluation. Moreover, ultrasound is practical and non-invasive, making it appropriate for tracking the development of JLS and determining the best course of action.

#### **CLINICAL RELEVANCE/APPLICATION**

Skin sclerosis is primary clinical symptom of localized scleroderma (LS), which primarily affects children and has a worse prognosis than adult patients. This study examined the correlation between the changes of microvessel of lesion skin tissue in JLS and normal skin using ultrasound SMI technique. SMI technology could sensitively detect microvessel in the skin layer and indicate active lesions of children with JLS earlier than clinical evaluation. Ultrasound is practical and non-invasive, making it appropriate for tracking the development of lesions in children with JLS and determining the best course of action.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPD03-6

### The ACR Dose Index Registry for Digital Radiography: Developing Pediatric Registry Benchmarks

Tuesday, Nov. 28 8:00AM - 9:00AM Room: E353B

Steven Don, MD (*Presenter*) Research Grant, Carestream Health, Inc.;

#### PURPOSE

To develop pediatric dose-index benchmarks using data collected in the American College of Radiology (ACR) Dose Index Registry (DIR) for Digital Radiography (DR).

#### METHODS AND MATERIALS

Dose-index values for exposure events from sites participating in the ACR DIR DR Working Group over a two-year period (2021 and 2022) were recorded. To be included, the data must have a local exam descriptor that is mapped to the ACR Common ID for that body part and the patient's age in years. The ACR TRIAD server automatically anonymized the data. The events were separated by age (<1, 1 to <5, 5 to <10, 10 to <15, 15 to 18, and adults >18 years old) and Common ID. For a Common ID to be included in the registry statistics there must be at least five facilities, each with =20 events per Common ID. The dose indices recorded are based on the IEC 62-494 standard and included the exposure index (EI), exposure index target (EIT), and deviation index (DI). Any EI <25 was excluded from the database. Kerma area-product (KAP) was also recorded. Each facility median values were tabulated and then the registry quartiles were compiled. The EIT mode was also reported.

#### RESULTS

One children's hospital, five academic centers, and one community center submitted data. Some centers consisted of more than one facility. 219,039 pediatric exposure events were recorded over two years from 18 Common IDs for pediatrics, compared with 1,042,627 events from 41 Common IDs for adults. The pediatric Common IDs include chest, abdomen, clavicle, scoliosis, spine (cervical, thoracic, and lumbar), upper extremity (shoulder, elbow, radius/ulna, wrist, hand, and finger) and lower extremity (femur, knee, tibia/fibula, ankle, and foot). The EIT mode ranged from 160 (abdomen 1 to <5) to 400 (chest 2 age ranges). The most common EIT mode was 250, representing 78% of Common IDs. The adult EIT mode range was 242-800; the most common EIT mode was 250 (51%). As a general rule, central body work (chest, abdomen, and spine) had lower median EI values than extremity exams (elbow, hand, wrist, tibia/fibula and foot). Extremity exams (elbow, hand, wrist, tibia/fibula and foot) had a lower KAP than scoliosis, lumbar spine, and abdomen. Similar trends with adult examinations were noted for EI and KAP.

#### CONCLUSION

Individual facilities can benchmark their results with this registry database. EI tended to be lower for central body work than for extremity exams while KAP was highest for scoliosis, lumbar spine and abdomen examinations. Pediatric exam registry benchmarks were similar to the adult registry benchmarks. Increased participation will improve generalizability of future benchmarks.

#### CLINICAL RELEVANCE/APPLICATION

The ACR DIR for DR will enable participants to benchmark their dose indices' performance data against national values.

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## Abstract Archives of the RSNA, 2023

T1-SSPH06

### Physics (MRI)

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N227B

Peter A. Hardy, PhD (*Moderator*) Nothing to Disclose

Daniel Kim, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **T1-SSPH06-Fast and Adaptive Parameter Mapping for Dynamic MRI using Active Learning and Autoregressive Flow**

Dongmyung Shin, PhD (*Presenter*) Researcher, RadiSen Co, Ltd

#### PURPOSE

A fast and adaptive parameter mapping using AI-guided dictionary learning is proposed for dynamic MRI. This method aims efficient computation to reduce computational cost and adapt to out-of-range parameters while maintaining accuracy (Fig. 1a b).

#### METHODS AND MATERIALS

Our method, which is referred to as Active dictionary learning, trains a neural network for parameter estimation via active dataset generation, reducing unnecessary simulation. The active learning approach begins with rough problem space learning, then adaptively generates additional data. An autoregressive flow model was used for exploring potential parameters. Our network was trained through iterative data recommendation and training. Initially, a small random dataset is used, followed by target signal inference. The inference was performed for a target signal, producing putative parameters as output. These outputs were applied to the simulator to generate signals which were utilized for the next network training. This process refines estimation results. Experiments demonstrated the quantification process with a FISP MRF sequence estimating  $M_0$ , T1, T2, B1, and  $\rho B_0$ . Target MR signals were simulated using tissue properties from in-vivo data, Gaussian-shaped B1, and horizontal-striped  $\rho B_0$ . Comparison included dictionary matching results and computational time. Experiment 1 validated the method in varying B1 and  $\rho B_0$  ranges. Experiment 2 evaluated a computationally expensive signal model with a 64-point slice profile. Experiment 3 showed adaptive estimation with out-of-range parameters.

#### RESULTS

In Experiment 1 (Fig. 1c), active dictionary learning estimated parameters using 60,000 simulations, with performance comparable to full dictionary matching, taking only 30 min for the entire process (Full dictionary matching: 6 hours generation and 36 hours matching). Experiment 2 (Fig. 1c) also demonstrate successful estimations, while taking only 3 hours despite the need for simulating the slice profile. In Experiment 3, our method demonstrated successful adaptation to the out-of-initial parameters range (Fig. 1d).

#### CONCLUSION

Our AI-guided Active dictionary learning for parameter quantification demonstrated efficient computation and adaptability to out-of-range parameters while maintaining accuracy. This approach significantly reduced the computational time compared to dictionary matching while achieving comparable or higher estimation accuracy.

#### CLINICAL RELEVANCE/APPLICATION

Our method may be valuable for dynamic imaging such as cardiac MRF, which changes the scan parameters for each subject, requiring dictionary generation for each case and, therefore, taking substantial computation and time when the conventional method is used.

### **T1-SSPH06-Development of Realistic Reference Phantoms for MR Sequence Design and AI Validation**

2

Paul Jahnke, MD (*Presenter*) Patent holder, DE202015104282U1; Patent holder, EP3135199A1; Patent holder, US9924919B2; Patent holder, US20180192986A1; Research funded, Berlin Institute of Health; Shareholder, PhantomX GmbH



## PURPOSE

To develop highly realistic phantoms reflecting human anatomy and pathology for objective assessment of MR imaging and AI performance.

## METHODS AND MATERIALS

We used inkjet printing with gadolinium-doped inks and hydrogel print substrates to create realistic phantoms for T1-weighted MR imaging. Our development encompassed agarose and polyacrylamide hydrogels, which we modified by coupling diethylenetriaminepentaacetic acid (DTPA) anchor molecules to bind printed gadolinium ions. We evaluated T1 mapping values and the modulation transfer function (MTF) in line pair phantoms to evaluate phantom stability over time. We produced anthropomorphic phantoms from scan data of patients with neck and liver masses and assessed the phantoms using similarity metrics and reader experiments.

## RESULTS

Inkjet printing of gadolinium-doped ink to DTPA-coupled hydrogel print substrates enabled production of highly realistic phantoms for T1-weighted MR imaging. Phantom stability was demonstrated by reproducible T1 mapping values and MTF results over a period of eighteen months. Highly accurate reproduction of anatomical and tumor detail was demonstrated by structural similarity index measure results =0.87 in neck and liver phantoms and confirmed by the results of the reader experiments.

## CONCLUSION

Gadolinium-doped inks and DTPA-coupled hydrogels enable inkjet printing of highly realistic MR phantoms. The method we present provides novel reference tools for the development, improvement and validation of sequence designs and artificial intelligence in MR imaging.

## CLINICAL RELEVANCE/APPLICATION

Patient scans are the only real-world data source, but have severe limitations in terms of accessibility and standardization for testing and validation purposes.

## T1-SSPH06-Retrospective Comparison of the Routine Brain MRI Protocol in Patients at 0.55T and 1.5/3T

Anna Lavrova, MD (*Presenter*) Research support, Siemens AG

## PURPOSE

To compare MRI images collected at 0.55T in patients as part of the clinical brain protocol with those collected at 1.5/3T, and to explore changes in radiologists' ratings of 0.55T images over time.

## METHODS AND MATERIALS

In this IRB-approved study, brain MRI images were collected on a 0.55T MRI system (MAGNETOM Free.Max, Siemens Healthineers, Erlangen, Germany) from 10/2021 to 04/2022 (30 patients) and from 09/2022 to 10/2022 (30 patients) using the same protocol and sequence settings. Images collected previously from the same patients at 1.5/3T were also identified; the average time between scans was 7.2 months. In total, 510 compatible image series were acquired using T1w SPACE ± CE, DWI/ADC, FLAIR, SWI, T1w TSE and T2w TSE sequences. All images were rated by two neuroradiologists for image quality (IQ) and anatomical features using a 3-point Likert scale (1: non-diagnostic, 2: acceptable, 3: good); the ability to answer the clinical question using only 0.55T images was also assessed. For each sequence, the mean ± SD of scores were calculated. Paired Wilcoxon test ( $p=0.05$ ) was used to compare the IQ between field strengths and between 0.55T ratings from both datasets. To determine inter-reader agreement the linear-weighted Cohen's Kappa coefficient was calculated.

## RESULTS

Brain image ratings at 0.55T show that it is possible to perform diagnostic quality exams on this MRI system, allowing radiologists to answer the clinical question. Overall, 98.8% of features in all sequences at 0.55T were rated as acceptable (=2). The one exception was T1w SPACE + CE in one patient, which Reader 1 identified as unacceptable (<2) due to motion artifacts. Upon comparison of 0.55T and 1.5/3T systems in the 1st dataset, all scores from Reader 1 for high-field (HF) images were significantly higher than those at 0.55T. For Reader 2, only HF DWI/ADC and SWI images were superior to those collected at 0.55T. Upon analyzing the 2nd dataset, a significant improvement in ratings for 0.55T images was seen in Reader 1 for FLAIR, T2w TSE, T1w SPACE + CE sequences; however, Reader 2 rated T1w SPACE significantly lower. The inter-rated agreement between two datasets improved from moderate ( $\kappa=0.439$ ) to substantial ( $\kappa=0.7537$ ).

## CONCLUSION

Diagnostic quality clinical brain images can be collected at 0.55T, despite lower ratings for sequences. Significant improvements in IQ scores for images collected at 0.55T were seen from one reader over time, indicating that experience reading 0.55T images may improve reader confidence.



## CLINICAL RELEVANCE/APPLICATION

Diagnostic quality brain images can be collected in patients at 0.55T, although some sequences had lower scores than at 1.5 or 3T. Ratings for 0.55T images improved over time, indicating that experience may increase reader confidence.

### **T1-SSPH06-Accuracy and Test-retest Repeatability of Stiffness Measurement with Magnetic Resonance Elastography: A Multicenter Phantom Study**

Efe Ozkaya, PhD, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Liver diseases due to various causes are a significant health concern. Liver biopsy is invasive, and there is a need for noninvasive methods, such as MRE, to stage liver fibrosis. The study aims to determine the accuracy and repeatability of MRE stiffness measurements in vitro in a multicenter study.

#### **METHODS AND MATERIALS**

Three cylindrical phantoms made of polyvinyl chloride gel with known stiffness (phantoms 1-3: low, medium and high stiffness) were circulated between 1 reference center and 4 testing centers and scanned on 10 MRE-equipped commercial systems (1.5T or 3T) from the 3 major vendors, using 2D gradient recalled echo (GRE) and/or 2D spin echo echoplanar imaging (SE-EPI) with similar acquisition parameters (Figure 1) and hardware. Mean phantom stiffness was measured by a single observer for each phantom/acquisition. Test-retest repeatability was measured during the same session at all centers. The reference standard measurements were obtained in the reference center. Accuracy error (based on the reference standard) and test-retest repeatability (based on Bland-Altman coefficient of repeatability) of stiffness measurement were calculated.

#### **RESULTS**

The reference stiffness measurements for phantoms 1-3 were (in kPa): 2.45, 4.41 and 7.52. The mean accuracy error [95% confidence intervals] for all 3 phantoms and both sequences combined was 10.2% [8.1%-12.3%]. Mean accuracy error was 8.3% [3.8%-12.9%] for the soft phantom, 8.8% [5.2%-12.4%] for the medium stiffness phantom and 13.2% [10.3%-16.1%] for the stiff phantom with both sequences combined (Figure 1). For 2D GRE and 2D SE-EPI sequences, mean accuracy error (all phantoms combined) was 8.5% [6.5%-10.6%] and 13.0% [8.5%-17.6%], respectively. The mean Bland-Altman coefficients of test-retest repeatability were 2.9% [1.9%-4.0%] for all phantoms and sequences combined. Test-retest repeatability for each individual phantom was 3.0% [0.3%-5.8%] for phantom 1, 1.9% [0.7%-3.0%] for phantom 2, and 3.7% [2.1%-5.5%] for phantom 3 with both sequences combined (Figure 1). Per sequence repeatability was 3.6% [1.5%-5.7%] for 2D SE-EPI and 2.5% [1.3%-3.6%] for 2D GRE (including all phantoms).

#### **CONCLUSION**

Our multicenter phantom study shows that MRE has excellent measurement accuracy and test-retest repeatability in vitro, when using the same protocol and hardware. These results may help design future multicenter MRE studies.

## CLINICAL RELEVANCE/APPLICATION

Liver stiffness measured with MRE can non-invasively stage liver fibrosis with high diagnostic performance, but there is limited knowledge on measurement accuracy, especially in the multicenter setting through an in vitro study.

### **T1-SSPH06-IAC Imaging at 7T using the Decoupled 8x2 Transceiver Head Coil**

Jullie W. Pan, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ultra-high field 7T MRI is known to be demanding for RF coil performance, as the shortened electromagnetic wavelength can generate artifacts with structural imaging using conventional coils. Furthermore, the increased susceptibility at 7T is excellent for T2\* studies but makes imaging through regions with brain/bone/ air interfaces difficult. In the basal aspects of the head, these problems are simultaneously present. We apply previously described methods with the 8x2 volume transceiver coil and a very high order shim insert at 7T to image the internal auditory canals IAC. This is compared with the Nova 8/32 volume coil in n=5 control subjects and assessed by two board certified clinical neuroradiologists.

#### **METHODS AND MATERIALS**

A Siemens 7T Terra operating with 8 channels in pTx mode was used with the Nova 8/32 volume head coil and decoupled 8x2 transceiver. The shim insert did not fit the Nova 8/32 head coil and was applied only with the transceiver. None of the acquisitions used dielectric pads, and n=5 (3F, 2M) control subjects were studied in random order with both coils. Table 1 shows the applied imaging parameters. First level SAR monitoring was used throughout. A 5 point scale in image quality was used for evaluation: IAC (left, right); trigeminal nerve (left, right), cerebellum, temporal lobes (combined L,R) and brainstem. The 5 level evaluation was: 1- Not visible, 2-Visible but with complete loss of detail, 3- visualization of some anatomical detail, 4- visualization of most anatomical detail, 5-perfect visualization of anatomical detail.

## RESULTS

Fig. 1 compares the achieved B1+ between the two coils. Over a group of n=3 subjects, the achieved mean B1+ of the Nova coil was 76% that of the transceiver with a 31.1% larger covariance. T2 SPC images from the two coils from two different subjects are shown in Fig. 2. Images are reformatted to show the IAC with a cross section showing the nerve roots of the facial and auditory nerves. Table 2 summarizes the radiological image quality evaluation between the various structures from the 0.63mm<sup>3</sup> T2 SPC; unpaired t-tests showed significantly better visibility for all structures with the transceiver with p values ranging from <0.001 to 0.05.

## CONCLUSION

At 7T, the skull base is difficult to image due to insufficient B1 and inhomogeneous B0. The decoupled 8x2 transceiver improved the B1 achieved in the inferior brain region without use of dielectric pads or adiabatic sequences and permitted improved visibility of the structures including the temporal lobe, cerebellum, IAC and trigeminal nerves.

## CLINICAL RELEVANCE/APPLICATION

We have presented methods that improve basilar brain imaging at 7T. Applications include high resolution 7T neuroimaging for lesions in the cerebellopontine angle, brainstem and vascular imaging.

## T1-SSPH06-Feasibility of Prostate MR Fingerprinting and ADC Mapping in the Quantitative Characterization of Malignant Transition Zone Lesions

Anna Lavrova, MD (*Presenter*) Research support, Siemens AG

## PURPOSE

To determine if MR Fingerprinting (MRF) combined with Apparent Diffusion Coefficient (ADC) mapping can be used to distinguish cancer from Normal Appearing Transition Zone (NATZ) and low from intermediate/high-grade TZ tumors, and to determine if MRF based TZ lesion characterization in a general screening population undergoing TRUS or modality agnostic targeted biopsy yields similar results to published literature for patients pre-selected for MR guided targeted biopsy.

## METHODS AND MATERIALS

In this IRB-approved, HIPAA-compliant, single institution study, prostate MRI studies from 34 patients (mean age 64, range 46-76 years) were acquired on 3T scanners between 12/2016 and 10/2020. All patients had biopsy-proven (from 17 systematic and 17 targeted biopsies - 9 fusion, 7 in-gantry and 1 cognitive) malignant TZ lesions corresponding to PIRADS v2 lesions identified on MRI. MRF (T1 and T2 maps) and ADC maps were analyzed retrospectively by a research fellow with 5 years of non-US radiology training. Regions of interest (ROIs) were drawn encompassing the entire TZ lesion as guided by the clinical radiology reports and on the contralateral NATZ on T1, T2 and ADC maps with 3D Slicer software. Paired t-test was used to assess for differences between tumors and NATZ, and between low-grade and clinically significant TZ tumors on MRF and ADC. Logistic regression was used to test the association of tumor grade (low vs high) with the measurements from T1, T2 and ADC maps ( $p=0.05$ ).

## RESULTS

Of 34 TZ tumors, 15 were low-grade (Gleason 6) and 19 clinically significant (Gleason score = 3+4=7). T1, T2 and ADC were lower in all tumors as compared to NATZ despite the marked heterogeneity of the TZ ( $p<0.0001$  for all,  $\Delta T1=289$  ms,  $\Delta T2=23$  ms,  $\Delta ADC=482 \times 10^{-6}$  mm<sup>2</sup>/s). There were no statistically significant differences between the T2 and ADC measurements of the various tumor grades ( $p>>0.05$ ). T1 measurements yielded a strong trend towards differentiating tumor grade ( $p=0.06$ ), though this did not reach statistical significance (mean  $\pm$  SD of T1 maps: 1526 msec  $\pm$  98 in low grade, and 1437 msec  $\pm$  125 in clinically significant tumors).

## CONCLUSION

MRF combined with ADC maps show significantly lower values in tumors compared to NATZ. Measurements of T1 values show a promising trend for differentiating low from intermediate/high grade tumor, which is similar to published literature. However, further work with more patients and carefully targeted biopsies or post-surgical radiological-pathological correlation is needed to see if there is a true difference in T1 in low and high grade TZ tumors.

## CLINICAL RELEVANCE/APPLICATION

MRF combined with ADC mapping are additional quantitative measures that can be used to distinguish tumor from and non-cancerous TZ tissue and predict the grade of TZ tumors.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPH06-1

### Fast and Adaptive Parameter Mapping for Dynamic MRI using Active Learning and Autoregressive Flow

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N227B

Dongmyung Shin, PhD (*Presenter*) Researcher, RadiSen Co, Ltd

#### PURPOSE

A fast and adaptive parameter mapping using AI-guided dictionary learning is proposed for dynamic MRI. This method aims efficient computation to reduce computational cost and adapt to out-of-range parameters while maintaining accuracy (Fig. 1a b).

#### METHODS AND MATERIALS

Our method, which is referred to as Active dictionary learning, trains a neural network for parameter estimation via active dataset generation, reducing unnecessary simulation. The active learning approach begins with rough problem space learning, then adaptively generates additional data. An autoregressive flow model was used for exploring potential parameters. Our network was trained through iterative data recommendation and training. Initially, a small random dataset is used, followed by target signal inference. The inference was performed for a target signal, producing putative parameters as output. These outputs were applied to the simulator to generate signals which were utilized for the next network training. This process refines estimation results. Experiments demonstrated the quantification process with a FISP MRF sequence estimating  $M_0$ , T1, T2, B1, and  $\rho B_0$ . Target MR signals were simulated using tissue properties from in-vivo data, Gaussian-shaped B1, and horizontal-striped  $\rho B_0$ . Comparison included dictionary matching results and computational time. Experiment 1 validated the method in varying B1 and  $\rho B_0$  ranges. Experiment 2 evaluated a computationally expensive signal model with a 64-point slice profile. Experiment 3 showed adaptive estimation with out-of-range parameters.

#### RESULTS

In Experiment 1 (Fig. 1c), active dictionary learning estimated parameters using 60,000 simulations, with performance comparable to full dictionary matching, taking only 30 min for the entire process (Full dictionary matching: 6 hours generation and 36 hours matching). Experiment 2 (Fig. 1c) also demonstrate successful estimations, while taking only 3 hours despite the need for simulating the slice profile. In Experiment 3, our method demonstrated successful adaptation to the out-of-initial parameters range (Fig. 1d).

#### CONCLUSION

Our AI-guided Active dictionary learning for parameter quantification demonstrated efficient computation and adaptability to out-of-range parameters while maintaining accuracy. This approach significantly reduced the computational time compared to dictionary matching while achieving comparable or higher estimation accuracy.

#### CLINICAL RELEVANCE/APPLICATION

Our method may be valuable for dynamic imaging such as cardiac MRF, which changes the scan parameters for each subject, requiring dictionary generation for each case and, therefore, taking substantial computation and time when the conventional method is used.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPH06-2

### Development of Realistic Reference Phantoms for MR Sequence Design and AI Validation

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N227B

Paul Jahnke, MD (*Presenter*) Patent holder, DE202015104282U1; Patent holder, EP3135199A1; Patent holder, US9924919B2; Patent holder, US20180192986A1; Research funded, Berlin Institute of Health; Shareholder, PhantomX GmbH

#### PURPOSE

To develop highly realistic phantoms reflecting human anatomy and pathology for objective assessment of MR imaging and AI performance.

#### METHODS AND MATERIALS

We used inkjet printing with gadolinium-doped inks and hydrogel print substrates to create realistic phantoms for T1-weighted MR imaging. Our development encompassed agarose and polyacrylamide hydrogels, which we modified by coupling diethylenetriaminepentaacetic acid (DTPA) anchor molecules to bind printed gadolinium ions. We evaluated T1 mapping values and the modulation transfer function (MTF) in line pair phantoms to evaluate phantom stability over time. We produced anthropomorphic phantoms from scan data of patients with neck and liver masses and assessed the phantoms using similarity metrics and reader experiments.

#### RESULTS

Inkjet printing of gadolinium-doped ink to DTPA-coupled hydrogel print substrates enabled production of highly realistic phantoms for T1-weighted MR imaging. Phantom stability was demonstrated by reproducible T1 mapping values and MTF results over a period of eighteen months. Highly accurate reproduction of anatomical and tumor detail was demonstrated by structural similarity index measure results  $\approx 0.87$  in neck and liver phantoms and confirmed by the results of the reader experiments.

#### CONCLUSION

Gadolinium-doped inks and DTPA-coupled hydrogels enable inkjet printing of highly realistic MR phantoms. The method we present provides novel reference tools for the development, improvement and validation of sequence designs and artificial intelligence in MR imaging.

#### CLINICAL RELEVANCE/APPLICATION

Patient scans are the only real-world data source, but have severe limitations in terms of accessibility and standardization for testing and validation purposes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPH06-3

### Retrospective Comparison of the Routine Brain MRI Protocol in Patients at 0.55T and 1.5/3T

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N227B

Anna Lavrova, MD (*Presenter*) Research support, Siemens AG

#### PURPOSE

To compare MRI images collected at 0.55T in patients as part of the clinical brain protocol with those collected at 1.5/3T, and to explore changes in radiologists' ratings of 0.55T images over time.

#### METHODS AND MATERIALS

In this IRB-approved study, brain MRI images were collected on a 0.55T MRI system (MAGNETOM Free.Max, Siemens Healthineers, Erlangen, Germany) from 10/2021 to 04/2022 (30 patients) and from 09/2022 to 10/2022 (30 patients) using the same protocol and sequence settings. Images collected previously from the same patients at 1.5/3T were also identified; the average time between scans was 7.2 months. In total, 510 compatible image series were acquired using T1w SPACE ± CE, DWI/ADC, FLAIR, SWI, T1w TSE and T2w TSE sequences. All images were rated by two neuroradiologists for image quality (IQ) and anatomical features using a 3-point Likert scale (1: non-diagnostic, 2: acceptable, 3: good); the ability to answer the clinical question using only 0.55T images was also assessed. For each sequence, the mean ± SD of scores were calculated. Paired Wilcoxon test ( $p=0.05$ ) was used to compare the IQ between field strengths and between 0.55T ratings from both datasets. To determine inter-reader agreement the linear-weighted Cohen's Kappa coefficient was calculated.

#### RESULTS

Brain image ratings at 0.55T show that it is possible to perform diagnostic quality exams on this MRI system, allowing radiologists to answer the clinical question. Overall, 98.8% of features in all sequences at 0.55T were rated as acceptable (=2). The one exception was T1w SPACE + CE in one patient, which Reader 1 identified as unacceptable (<2) due to motion artifacts. Upon comparison of 0.55T and 1.5/3T systems in the 1st dataset, all scores from Reader 1 for high-field (HF) images were significantly higher than those at 0.55T. For Reader 2, only HF DWI/ADC and SWI images were superior to those collected at 0.55T. Upon analyzing the 2nd dataset, a significant improvement in ratings for 0.55T images was seen in Reader 1 for FLAIR, T2w TSE, T1w SPACE + CE sequences; however, Reader 2 rated T1w SPACE significantly lower. The inter-rated agreement between two datasets improved from moderate ( $\kappa=0.439$ ) to substantial ( $\kappa=0.7537$ ).

#### CONCLUSION

Diagnostic quality clinical brain images can be collected at 0.55T, despite lower ratings for sequences. Significant improvements in IQ scores for images collected at 0.55T were seen from one reader over time, indicating that experience reading 0.55T images may improve reader confidence.

#### CLINICAL RELEVANCE/APPLICATION

Diagnostic quality brain images can be collected in patients at 0.55T, although some sequences had lower scores than at 1.5 or 3T. Ratings for 0.55T images improved over time, indicating that experience may increase reader confidence.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T1-SSPH06-4

### Accuracy and Test-retest Repeatability of Stiffness Measurement with Magnetic Resonance Elastography: A Multicenter Phantom Study

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N227B

Efe Ozkaya, PhD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Liver diseases due to various causes are a significant health concern. Liver biopsy is invasive, and there is a need for noninvasive methods, such as MRE, to stage liver fibrosis. The study aims to determine the accuracy and repeatability of MRE stiffness measurements in vitro in a multicenter study.

#### METHODS AND MATERIALS

Three cylindrical phantoms made of polyvinyl chloride gel with known stiffness (phantoms 1-3: low, medium and high stiffness) were circulated between 1 reference center and 4 testing centers and scanned on 10 MRE-equipped commercial systems (1.5T or 3T) from the 3 major vendors, using 2D gradient recalled echo (GRE) and/or 2D spin echo echoplanar imaging (SE-EPI) with similar acquisition parameters (Figure 1) and hardware. Mean phantom stiffness was measured by a single observer for each phantom/acquisition. Test-retest repeatability was measured during the same session at all centers. The reference standard measurements were obtained in the reference center. Accuracy error (based on the reference standard) and test-retest repeatability (based on Bland-Altman coefficient of repeatability) of stiffness measurement were calculated.

#### RESULTS

The reference stiffness measurements for phantoms 1-3 were (in kPa): 2.45, 4.41 and 7.52. The mean accuracy error [95% confidence intervals] for all 3 phantoms and both sequences combined was 10.2% [8.1%-12.3%]. Mean accuracy error was 8.3% [3.8%-12.9%] for the soft phantom, 8.8% [5.2%-12.4%] for the medium stiffness phantom and 13.2% [10.3%-16.1%] for the stiff phantom with both sequences combined (Figure 1). For 2D GRE and 2D SE-EPI sequences, mean accuracy error (all phantoms combined) was 8.5% [6.5%-10.6%] and 13.0% [8.5%-17.6%], respectively. The mean Bland-Altman coefficients of test-retest repeatability were 2.9% [1.9%-4.0%] for all phantoms and sequences combined. Test-retest repeatability for each individual phantom was 3.0% [0.3%-5.8%] for phantom 1, 1.9% [0.7%-3.0%] for phantom 2, and 3.7% [2.1%-5.5%] for phantom 3 with both sequences combined (Figure 1). Per sequence repeatability was 3.6% [1.5%-5.7%] for 2D SE-EPI and 2.5% [1.3%-3.6%] for 2D GRE (including all phantoms).

#### CONCLUSION

Our multicenter phantom study shows that MRE has excellent measurement accuracy and test-retest repeatability in vitro, when using the same protocol and hardware. These results may help design future multicenter MRE studies.

#### CLINICAL RELEVANCE/APPLICATION

Liver stiffness measured with MRE can non-invasively stage liver fibrosis with high diagnostic performance, but there is limited knowledge on measurement accuracy, especially in the multicenter setting through an in vitro study.

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## Abstract Archives of the RSNA, 2023

T1-SSPH06-5

### IAC Imaging at 7T using the Decoupled 8x2 Transceiver Head Coil

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N227B

Jullie W. Pan, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultra-high field 7T MRI is known to be demanding for RF coil performance, as the shortened electromagnetic wavelength can generate artifacts with structural imaging using conventional coils. Furthermore, the increased susceptibility at 7T is excellent for T2\* studies but makes imaging through regions with brain/bone/ air interfaces difficult. In the basal aspects of the head, these problems are simultaneously present. We apply previously described methods with the 8x2 volume transceiver coil and a very high order shim insert at 7T to image the internal auditory canals IAC. This is compared with the Nova 8/32 volume coil in n=5 control subjects and assessed by two board certified clinical neuroradiologists.

#### METHODS AND MATERIALS

A Siemens 7T Terra operating with 8 channels in pTx mode was used with the Nova 8/32 volume head coil and decoupled 8x2 transceiver. The shim insert did not fit the Nova 8/32 head coil and was applied only with the transceiver. None of the acquisitions used dielectric pads, and n=5 (3F, 2M) control subjects were studied in random order with both coils. Table 1 shows the applied imaging parameters. First level SAR monitoring was used throughout. A 5 point scale in image quality was used for evaluation: IAC (left, right); trigeminal nerve (left, right), cerebellum, temporal lobes (combined L,R) and brainstem. The 5 level evaluation was: 1- Not visible, 2-Visible but with complete loss of detail, 3- visualization of some anatomical detail, 4- visualization of most anatomical detail, 5-perfect visualization of anatomical detail.

#### RESULTS

Fig. 1 compares the achieved B1+ between the two coils. Over a group of n=3 subjects, the achieved mean B1+ of the Nova coil was 76% that of the transceiver with a 31.1% larger covariance. T2 SPC images from the two coils from two different subjects are shown in Fig. 2. Images are reformatted to show the IAC with a cross section showing the nerve roots of the facial and auditory nerves. Table 2 summarizes the radiological image quality evaluation between the various structures from the 0.63mm<sup>3</sup> T2 SPC; unpaired t-tests showed significantly better visibility for all structures with the transceiver with p values ranging from <0.001 to 0.05.

#### CONCLUSION

At 7T, the skull base is difficult to image due to insufficient B1 and inhomogeneous B0. The decoupled 8x2 transceiver improved the B1 achieved in the inferior brain region without use of dielectric pads or adiabatic sequences and permitted improved visibility of the structures including the temporal lobe, cerebellum, IAC and trigeminal nerves.

#### CLINICAL RELEVANCE/APPLICATION

We have presented methods that improve basilar brain imaging at 7T. Applications include high resolution 7T neuroimaging for lesions in the cerebellopontine angle, brainstem and vascular imaging.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T1-SSPH06-6

### Feasibility of Prostate MR Fingerprinting and ADC Mapping in the Quantitative Characterization of Malignant Transition Zone Lesions

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N227B

Anna Lavrova, MD (*Presenter*) Research support, Siemens AG

#### PURPOSE

To determine if MR Fingerprinting (MRF) combined with Apparent Diffusion Coefficient (ADC) mapping can be used to distinguish cancer from Normal Appearing Transition Zone (NATZ) and low from intermediate/high-grade TZ tumors, and to determine if MRF based TZ lesion characterization in a general screening population undergoing TRUS or modality agnostic targeted biopsy yields similar results to published literature for patients pre-selected for MR guided targeted biopsy.

#### METHODS AND MATERIALS

In this IRB-approved, HIPAA-compliant, single institution study, prostate MRI studies from 34 patients (mean age 64, range 46-76 years) were acquired on 3T scanners between 12/2016 and 10/2020. All patients had biopsy-proven (from 17 systematic and 17 targeted biopsies - 9 fusion, 7 in-gantry and 1 cognitive) malignant TZ lesions corresponding to PIRADS v2 lesions identified on MRI. MRF (T1 and T2 maps) and ADC maps were analyzed retrospectively by a research fellow with 5 years of non-US radiology training. Regions of interest (ROIs) were drawn encompassing the entire TZ lesion as guided by the clinical radiology reports and on the contralateral NATZ on T1, T2 and ADC maps with 3D Slicer software. Paired t-test was used to assess for differences between tumors and NATZ, and between low-grade and clinically significant TZ tumors on MRF and ADC. Logistic regression was used to test the association of tumor grade (low vs high) with the measurements from T1, T2 and ADC maps ( $p=0.05$ ).

#### RESULTS

Of 34 TZ tumors, 15 were low-grade (Gleason 6) and 19 clinically significant (Gleason score = 3+4=7). T1, T2 and ADC were lower in all tumors as compared to NATZ despite the marked heterogeneity of the TZ ( $p<0.0001$  for all,  $?T1=289$  ms,  $?T2=23$  ms,  $?ADC=482 \times 10^{-6}$  mm<sup>2</sup>/s). There were no statistically significant differences between the T2 and ADC measurements of the various tumor grades ( $p>>0.05$ ). T1 measurements yielded a strong trend towards differentiating tumor grade ( $p=0.06$ ), though this did not reach statistical significance (mean  $\pm$  SD of T1 maps: 1526 msec  $\pm$  98 in low grade, and 1437 msec  $\pm$  125 in clinically significant tumors).

#### CONCLUSION

MRF combined with ADC maps show significantly lower values in tumors compared to NATZ. Measurements of T1 values show a promising trend for differentiating low from intermediate/high grade tumor, which is similar to published literature. However, further work with more patients and carefully targeted biopsies or post-surgical radiological-pathological correlation is needed to see if there is a true difference in T1 in low and high grade TZ tumors.

#### CLINICAL RELEVANCE/APPLICATION

MRF combined with ADC mapping are additional quantitative measures that can be used to distinguish tumor from and non-cancerous TZ tissue and predict the grade of TZ tumors.

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## Abstract Archives of the RSNA, 2023

T1-SSPH07

### Physics (Photon Counting Detector CT II)

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N226

Marc Kachelriess, PhD (*Moderator*) Nothing to Disclose  
Shuai Leng, PhD (*Moderator*) License agreement, Siemens AG

#### Sub-Events

### T1-SSPH07-Simultaneous Photon Counting and Energy Integrating to Correct Pulse Pile-up Effects in Photon Counting Detectors 1

Kevin Treb, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

In photon counting detectors (PCDs), electric pulses from multiple x-ray photons can pile-up when their temporal separation is shorter than the detector deadtime, resulting in increased image noise for a given radiation dose, reduced quantitative accuracy of radiological path lengths, and worsened spectral resolution. The correction of pulse-pile-up-induced count loss is particularly difficult for paralyzable PCDs since a given value of recorded counts can correspond to two different true photon numbers. In comparison, energy integrating detectors (EIDs) integrate x-ray induced electric charge pulses rather than counting them, and do not suffer from pile-up losses. This work introduces an inexpensive and novel added readout circuit element to simultaneously collect integrated charge with photon counts to correct for pile-up-induced count losses.

#### METHODS AND MATERIALS

Prototype electronics with a digital counter and a charge integrator in parallel were connected to a CdTe-based PCD element so that the electric signal from the same x-ray interactions could be processed by both chains simultaneously. After recording PCD counts and the integrated charges for each imaging frame, a lookup table was generated to map raw counts in the total- and high-energy PCD bins and total charge to an estimate of pile-up-free counts in both energy bins. Proof-of-concept imaging experiments were also performed with a CdTe-based PCD array and a diagnostic x-ray tube with clinically relevant flux levels.

#### RESULTS

The proposed electronics successfully recorded photon counts and total charge simultaneously. With the proposed correction, PCD counts became linear with input flux for both energy bins, even under conditions where the PCD exhibits paralyzable behavior. Without the correction, log-normalized measurements of PMMA objects severely overestimated radiological path lengths for both energy bins; after correction, the measurements accurately represented the true path lengths. Image noise under severe pile-up conditions was reduced with the correction and remained unchanged under negligible pile-up. No impact on spatial resolution was observed after the correction in images of line-pair patterns.

#### CONCLUSION

Total charge can be collected simultaneously with photon counts using inexpensive electronics and used to correct for pulse pile-up in photon counting detectors. PCD counts in two energy bins were corrected in experimental studies, and image noise was reduced under severe pile-up conditions.

#### CLINICAL RELEVANCE/APPLICATION

Pulse pile-up may reduce dose efficiency, quantitative accuracy, and spectral resolution in PCD x-ray and CT. The proposed correction is inexpensive to implement and can correct the PCD counts data for all three of these effects.

### T1-SSPH07-Evaluation of a Prototype Photon-counting CT for Pulmonary Imaging using Patient-based Lung Phantoms 2

Kai Mei, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Characterization of a prototype photon-counting CT (PCCT) for pulmonary imaging using a realistic 3D-printed patient-based lung phantom.

## METHODS AND MATERIALS

In this study, a PixelPrint lung phantom containing four distinct lung nodules (two solid and two subsolid) was inserted into the outer ring of a multi-energy CT (MECT) phantom (Gammex, Sun Nuclear), to assess low-dose pulmonary imaging using both a conventional energy-integrating CT (EIDCT) and a prototype photon-counting CT (PCCT) system (Canon Medical Systems Corporation). Scans were performed at a tube voltage of 120 kVp with various exposure settings (200, 100, 50, 25, 20, and 17.5 mAs). All scans were reconstructed using a lung-specific reconstruction kernel. Seven circular regions of interest (ROIs) with a radius of 4 mm were placed in areas of different densities, including one ROI in the MECT phantom, and their locations were registered pairwise for each acquisition. Mean and standard deviation of HU values were measured in the ROIs, and noise levels were compared across all dose levels. Contrast-to-noise ratios (CNR) was evaluated from reconstructions obtained using the ROIs measured in EID and PCCT scans.

## RESULTS

The PixelPrint phantom yielded highly realistic and high-quality images in both EIDCT and PCCT scans. Lung nodules and other important CT image features were clearly visible at varying dose levels. In terms of accuracy, mean values in all regions showed minimal differences of less than 20 Hounsfield Units (HU) between EIDCT and PCCT scans. As expected, standard deviation in all regions increased with decreasing radiation exposure. Notably, PCCT images exhibited lower noise compared to EIDCT images, particularly at exposure levels below 50 mAs. In terms of CNR, PCCT outperformed EIDCT with a significant improvement of nearly 50% at all dose levels.

## CONCLUSION

PCCT consistently exhibited accurate Hounsfield Unit measurements, stability, and low noise levels across a broad range of dose values. Furthermore, the PCCT system demonstrated the capability to effectively visualize textures and small structures within the lung even at low dose levels.

## CLINICAL RELEVANCE/APPLICATION

As PCCT imaging becomes more prevalent in clinical routine, its low dose capabilities (particularly from the reduced influence of electronic noise) will enable further advancements in pulmonary imaging, including low-dose lung cancer screening.

## T1-SSPH07-Photon Counting Detector Cardiac CT: Impact of Patient Size, Scan Mode, Tube Potential (kV), and X-ray Tube Power

Michael R. Bruesewitz, RT (*Presenter*) Nothing to Disclose

## PURPOSE

Photon-counting-detector (PCD) CT has shown substantial benefits in cardiac imaging using an ultra-high-resolution (UHR) scan mode. However, image noise is a major limiting factor, especially for large patients, sharp reconstruction (recon) kernels, thin slices, and when at tube power limits (TPL) due to small UHR focal spot. This study aims to systematically optimize scan and recon parameters in coronary CT angiography (CTA) (scan mode, tube potential (kV), recon kernel, and slice thickness) as a function of patient size and TPL.

## METHODS AND MATERIALS

Anthropomorphic thorax phantoms and coronary artery stenosis rods (QRM GmbH) were used to emulate cardiac CT patients of multiple sizes (lateral width 30 to 50 cm). Phantoms were scanned on a clinical dual-source PCD-CT (NAEOTOM Alpha, Siemens) using both UHR (60 kW tube power) and standard resolution (SR) (120 kW tube power) cardiac imaging protocols. UHR scans used 120 x 0.2 mm collimation and tube potentials of 90 and 120 kV. SR scans used 144 x 0.4 mm collimation, tube potentials of 120 and 140 kV, and CARE-keV optimized for vascular (Vas) and non-contrast (NC) exams. Low-energy threshold (T3D) images were obtained using an iterative recon algorithm (QIR, strength=4), vascular kernels (Bv60 and Bv64), and slice thicknesses of [0.2 mm (UHR only) and 0.4 mm]. Qualitative and quantitative image quality (IQ) assessments performed included basic visual comparison, image contrast, noise, and iodine contrast-to-noise ratio (CNR).

## RESULTS

At 30 and 35 cm, the 90kV-UHR images at 0.2 mm and Bv64 kernel had the best IQ and highest CNR. At 40 cm, the 90kV-UHR mode reached TPL, increasing the noise and requiring images at 0.4 mm and Bv60. The 120kV-UHR scan had the best overall IQ, while 90kV-UHR had higher CNR. At 45 cm, 120kV-UHR reached TPLs but still provided reasonable image quality with the highest CNR (3.6). The 120kV-SR-Vas mode had similar dose as that of 120kV-UHR but worse image quality (CNR = 2.4). The 120kV-SR-NC had overall best IQ, however, dose was 1.7x greater than that of 120kV-UHR. At 50 cm, the 120kV-UHR was significantly past TPLs; 120kV-SR-NC had the best IQ and higher CNR (3.6), however, dose was 1.85x greater.

## CONCLUSION

Cardiac UHR PCD-CT provides high-quality images up to 40 cm width but encounters TPLs beyond 40 cm due to small focal spot. For large patients (e.g., 50 cm width), SR mode with larger focal spot and high tube power should be used. Scan mode, kV, recon kernel, and slice thickness need to be adapted to accommodate large patients, with radiation dose carefully considered.

## CLINICAL RELEVANCE/APPLICATION

A systematic approach to optimize coronary CTA imaging protocol in terms of scan and recon techniques based on patient size, scan mode, and TPL is critical to ensure optimal IQ and radiation dose.

### T1-SSPH07-Empirical Energy Weighting Optimization for Fast Grayscale Image Generation with Photon Counting CT

Yirong Yang, MEng (*Presenter*) Research support, General Electric Company

#### PURPOSE

To develop a novel algorithm to generate real-time, artifact-free, quantitative grayscale images from photon counting CT (PCCT) scans without additional noise, for fast CT image reconstruction.

#### METHODS AND MATERIALS

Photon counting CT leverages multiple energy bins to enable material decomposition (MD) and virtual monoenergetic images (VMI) for quantitative imaging. However, the MD process is computationally intensive, leading to longer reconstruction times and increased hardware cost. In practice, real-time, high-quality grayscale images are needed for the operator to verify image quality (IQ). We propose a method to combine the energy bins using energy weighting optimization based on a specified bias-variance trade-off (BVT), followed by a spectral correction (SC) to generate a VMI at a target energy (e.g., 60 keV). To obtain the optimal weights and SC parameters, we design an objective function that optimizes the BVT of the VMI projections. We utilize measurement-based MD calibration to map energy bin counts to known material thickness pairs, then calculate the corresponding variance and bias of the VMI projection estimation as well as the ground truth values. The algorithm is evaluated using an edge-on-irradiated silicon PCCT prototype with 8 energy bins and scans of a Gammex Multienergy phantom ("head" configuration) with 0, 2.5, 5, and 10 mg/ml iodine inserts. The results for optimal weights, as well as total counts (equal weighting of energy bins), are compared with reference MD-derived VMIs.

#### RESULTS

Grayscale images generated using optimal weights and total counts are reconstructed offline. The variance, absolute bias, and RMSE compared to the reference VMI for 4 ROIs are computed. With our optimal weighting method, we observe less than 5% noise increase, less than 4 HU absolute bias, and few beam hardening or ring artifacts, while total counts produce higher bias and more artifacts. The lower noise level of the total counts image is due to the induced bias, as the RMSE of our optimal weights image is lower or comparable to that of total counts.

## CONCLUSION

An IQ-based heuristic-driven weight optimization algorithm for near real-time, reduced artifact, accurate quantitative grayscale image generation is proposed. No additional calibration data are required to compute the weights. Subjective IQ exceeds that for conventional total counts. The algorithm is substantially faster than reconstruction via the MD-to-VMI process.

## CLINICAL RELEVANCE/APPLICATION

We present a novel algorithm for near real-time, high-quality, quantitative grayscale image generation from PCCT scans, which can be applied to photon counting image processing pipelines for fast CT image generation.

### T1-SSPH07-Plaque and Stent Appearance in a Novel Silicon-based Photon-counting CT Prototype: An ex Vivo Phantom Study

Emma Verelst, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare plaque and stent appearance between a prototype silicon-based photon-counting CT (Si-PCCT) and a conventional energy-integrating detector CT (EIDCT) system.

#### METHODS AND MATERIALS

A human-resected and stented (Atrium Advanta V12, Atrium Medical Corporation,  $d = 6$  mm) femoral artery was centrally embedded in a 2% agar-water cylindrical phantom ( $d = 20$  cm). Helical scans were acquired using a prototype Si-PCCT and a conventional EIDCT system (Revolution CT, GE Healthcare) at similar scan parameters (120 kV, 40 mm collimation, 0.9 pitch, 0.5 s rotation, 9 mGy CTDIvol). Images were reconstructed with a bone kernel and ASIRO, a 15 cm and 5 cm field-of-view

(FOV) and a slice thickness of 0.42 mm (Si-PCCT) and 0.63 mm (EIDCT). Quantitatively, plaque and stent appearance were evaluated by 1) a plaque-stent contrast ratio, i.e. a signal ratio relative to the plaque signal, 2) comparison of the true diameter and measured diameter obtained from a Hounsfield Unit (HU) profile through the stent wall, and 3) blooming as a ratio between inner and outer stent diameter. Qualitatively, two vascular radiologists in consensus evaluated plaque and stent appearance, plaque distinction and blooming using a 5-point Likert scale. Interreader agreement was assessed by using an intra-class correlation (ICC) coefficient. Quantitative and qualitative differences between Si-PCCT and EIDCT were tested by using a paired sample t-test and a Wilcoxon signed-rank test.

## RESULTS

Quantitatively, Si-PCCT images resulted in an increased plaque-stent contrast ratio (Si-PCCT:  $85.5\% \pm 37.4\%$ ; EIDCT:  $14\% \pm 11.5\%$ ,  $p = 0.005$ ), and reduced blooming artefacts (Si-PCCT:  $33\% \pm 2.5\%$ ; EIDCT:  $58.9\% \pm 4.5\%$ ,  $p < 0.001$ ). At a 5 cm FOV, Si-PCCT images resulted in improved diameter accuracy (Si-PCCT:  $6\text{ mm} \pm 0.2\text{ mm}$ ; EIDCT:  $6.3\text{ mm} \pm 0.1$ ;  $p = 0.017$ ). Qualitatively, Si-PCCT images were rated higher than EIDCT images based on: plaque appearance (Si-PCCT:  $4.3 \pm 0.5$ ; EIDCT:  $1.3 \pm 0.5$ ,  $p < 0.001$ ), stent appearance (Si-PCCT:  $4.3 \pm 0.5$ ; EIDCT:  $1.6 \pm 0.5$ ;  $p = 0.002$ ), plaque distinction (Si-PCCT:  $3.9 \pm 0.5$ ; EIDCT:  $1.7 \pm 0.7$ ;  $p = 0.002$ ), and blooming (Si-PCCT:  $3.8 \pm 0.4$ ; EIDCT:  $1.6 \pm 0.5$ ;  $p = 0.002$ ) with excellent interreader (ICC = 0.93) agreement.

## CONCLUSION

This study demonstrated an improved spatial resolution of a novel Si-PCCT prototype, leading to better plaque and stent appearance with respect to plaque-stent contrast, a more accurate stent diameter and reduced blooming, when compared to EIDCT.

## CLINICAL RELEVANCE/APPLICATION

Plaque and stent imaging remains challenging with EIDCT systems as these are prone to blooming and beam hardening artefacts. This study evaluated the ability of Si-PCCT to overcome those limitations by using an ex vivo vascular phantom.

## T1-SSPH07-Evaluation of Eigenbin Compression for Reducing Photon-counting CT Data Size

6

Taly Gilat Schmidt, PhD (*Presenter*) Research Grant, General Electric Company; Research collaboration, Varian Medical Systems, Inc

## PURPOSE

Photon-counting CT (PCCT) systems can acquire multiple spectral measurements at high spatial resolution, generating a large amount of data to transfer across the gantry slip ring. This experimental study on a silicon PCCT clinical prototype evaluates a data compression method based on principal component analysis (PCA).

## METHODS AND MATERIALS

The PCCT prototype acquires 8 energy bins; each projection measurement thus represents a point in an eight-dimensional (8-D) space. The proposed method performs PCA on a set of PCCT calibration measurements. PCA finds the orthogonal axes, or eigenvectors, that capture the maximum variance in the 8-D photon-count vector space. To reduce the dimensionality of the PCCT data, the data are linearly transformed into the N-D ( $N < 8$ ) space spanned by the N eigenvectors with highest eigenvalues (i.e., the vectors that account for most of the information in the data). Only N coefficients are then transferred per measurement, which we term eigenbin values. After transmission, the 8 energy-bin measurements are estimated as a linear combination of the N eigenvectors. We acquired PCCT data by scanning a 20 cm-diameter Gammex Multienergy phantom with different material inserts. The method is evaluated with the number of eigenbins varied between two and five. In each case, the eigenbins are used to estimate the 8-bin data, after which material decomposition is performed. The mean and standard deviation of values in the reconstructed basis and virtual monoenergetic images are compared for the original 8-bin data and the eigenbin data.

## RESULTS

Material decomposition basis images reconstructed from four eigenbins (50% data reduction) demonstrate accurate mean values with a 4-6% increase in noise standard deviation. Further reduction in dimensionality increases noise and error in the basis images. The 65 keV virtual monoenergetic image demonstrates less than 3% change in the mean values as well as noise standard deviation, when two or more eigenbins are used for compression.

## CONCLUSION

For the material decomposition basis images, the proposed eigenbin compression method reduces PCCT data volume by 50% while maintaining quantitative material decomposition accuracy and with a noise standard deviation penalty of approximately 5%. For VMI grayscale images, eigenbin compression provides 75% data reduction without affecting mean values or noise in this example.

## CLINICAL RELEVANCE/APPLICATION

The proposed eigenbin method demonstrates potential for reducing PCCT data volume, which may improve efficiency and reduce data transfer times for applications that require fast image generation. PCCT could thus benefit a wider range clinical

applications. Decreased hardware requirements can increase PCCT availability by reducing system cost.  
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## Abstract Archives of the RSNA, 2023

T1-SSPH07-1

### Simultaneous Photon Counting and Energy Integrating to Correct Pulse Pile-up Effects in Photon Counting Detectors

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N226

Kevin Treb, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

In photon counting detectors (PCDs), electric pulses from multiple x-ray photons can pile-up when their temporal separation is shorter than the detector deadtime, resulting in increased image noise for a given radiation dose, reduced quantitative accuracy of radiological path lengths, and worsened spectral resolution. The correction of pulse-pile-up-induced count loss is particularly difficult for paralyzable PCDs since a given value of recorded counts can correspond to two different true photon numbers. In comparison, energy integrating detectors (EIDs) integrate x-ray induced electric charge pulses rather than counting them, and do not suffer from pile-up losses. This work introduces an inexpensive and novel added readout circuit element to simultaneously collect integrated charge with photon counts to correct for pile-up-induced count losses.

#### METHODS AND MATERIALS

Prototype electronics with a digital counter and a charge integrator in parallel were connected to a CdTe-based PCD element so that the electric signal from the same x-ray interactions could be processed by both chains simultaneously. After recording PCD counts and the integrated charges for each imaging frame, a lookup table was generated to map raw counts in the total- and high-energy PCD bins and total charge to an estimate of pile-up-free counts in both energy bins. Proof-of-concept imaging experiments were also performed with a CdTe-based PCD array and a diagnostic x-ray tube with clinically relevant flux levels.

#### RESULTS

The proposed electronics successfully recorded photon counts and total charge simultaneously. With the proposed correction, PCD counts became linear with input flux for both energy bins, even under conditions where the PCD exhibits paralyzable behavior. Without the correction, log-normalized measurements of PMMA objects severely overestimated radiological path lengths for both energy bins; after correction, the measurements accurately represented the true path lengths. Image noise under severe pile-up conditions was reduced with the correction and remained unchanged under negligible pile-up. No impact on spatial resolution was observed after the correction in images of line-pair patterns.

#### CONCLUSION

Total charge can be collected simultaneously with photon counts using inexpensive electronics and used to correct for pulse pile-up in photon counting detectors. PCD counts in two energy bins were corrected in experimental studies, and image noise was reduced under severe pile-up conditions.

#### CLINICAL RELEVANCE/APPLICATION

Pulse pile-up may reduce dose efficiency, quantitative accuracy, and spectral resolution in PCD x-ray and CT. The proposed correction is inexpensive to implement and can correct the PCD counts data for all three of these effects.

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## Abstract Archives of the RSNA, 2023

T1-SSPH07-2

### Evaluation of a Prototype Photon-counting CT for Pulmonary Imaging using Patient-based Lung Phantoms

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N226

Kai Mei, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Characterization of a prototype photon-counting CT (PCCT) for pulmonary imaging using a realistic 3D-printed patient-based lung phantom.

#### METHODS AND MATERIALS

In this study, a PixelPrint lung phantom containing four distinct lung nodules (two solid and two subsolid) was inserted into the outer ring of a multi-energy CT (MECT) phantom (Gammex, Sun Nuclear), to assess low-dose pulmonary imaging using both a conventional energy-integrating CT (EIDCT) and a prototype photon-counting CT (PCCT) system (Canon Medical Systems Corporation). Scans were performed at a tube voltage of 120 kVp with various exposure settings (200, 100, 50, 25, 20, and 17.5 mAs). All scans were reconstructed using a lung-specific reconstruction kernel. Seven circular regions of interest (ROIs) with a radius of 4 mm were placed in areas of different densities, including one ROI in the MECT phantom, and their locations were registered pairwise for each acquisition. Mean and standard deviation of HU values were measured in the ROIs, and noise levels were compared across all dose levels. Contrast-to-noise ratios (CNR) was evaluated from reconstructions obtained using the ROIs measured in EID and PCCT scans.

#### RESULTS

The PixelPrint phantom yielded highly realistic and high-quality images in both EIDCT and PCCT scans. Lung nodules and other important CT image features were clearly visible at varying dose levels. In terms of accuracy, mean values in all regions showed minimal differences of less than 20 Hounsfield Units (HU) between EIDCT and PCCT scans. As expected, standard deviation in all regions increased with decreasing radiation exposure. Notably, PCCT images exhibited lower noise compared to EIDCT images, particularly at exposure levels below 50 mAs. In terms of CNR, PCCT outperformed EIDCT with a significant improvement of nearly 50% at all dose levels.

#### CONCLUSION

PCCT consistently exhibited accurate Hounsfield Unit measurements, stability, and low noise levels across a broad range of dose values. Furthermore, the PCCT system demonstrated the capability to effectively visualize textures and small structures within the lung even at low dose levels.

#### CLINICAL RELEVANCE/APPLICATION

As PCCT imaging becomes more prevalent in clinical routine, its low dose capabilities (particularly from the reduced influence of electronic noise) will enable further advancements in pulmonary imaging, including low-dose lung cancer screening.

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## Abstract Archives of the RSNA, 2023

T1-SSPH07-3

### Photon Counting Detector Cardiac CT: Impact of Patient Size, Scan Mode, Tube Potential (kV), and X-ray Tube Power

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N226

Michael R. Bruesewitz, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting-detector (PCD) CT has shown substantial benefits in cardiac imaging using an ultra-high-resolution (UHR) scan mode. However, image noise is a major limiting factor, especially for large patients, sharp reconstruction (recon) kernels, thin slices, and when at tube power limits (TPL) due to small UHR focal spot. This study aims to systematically optimize scan and recon parameters in coronary CT angiography (CTA) (scan mode, tube potential (kV), recon kernel, and slice thickness) as a function of patient size and TPL.

#### METHODS AND MATERIALS

Anthropomorphic thorax phantoms and coronary artery stenosis rods (QRM GmbH) were used to emulate cardiac CT patients of multiple sizes (lateral width 30 to 50 cm). Phantoms were scanned on a clinical dual-source PCD-CT (NAEOTOM Alpha, Siemens) using both UHR (60 kW tube power) and standard resolution (SR) (120 kW tube power) cardiac imaging protocols. UHR scans used 120 x 0.2 mm collimation and tube potentials of 90 and 120 kV. SR scans used 144 x 0.4 mm collimation, tube potentials of 120 and 140 kV, and CARE-keV optimized for vascular (Vas) and non-contrast (NC) exams. Low-energy threshold (T3D) images were obtained using an iterative recon algorithm (QIR, strength=4), vascular kernels (Bv60 and Bv64), and slice thicknesses of [0.2 mm (UHR only) and 0.4 mm]. Qualitative and quantitative image quality (IQ) assessments performed included basic visual comparison, image contrast, noise, and iodine contrast-to-noise ratio (CNR).

#### RESULTS

At 30 and 35 cm, the 90kV-UHR images at 0.2 mm and Bv64 kernel had the best IQ and highest CNR. At 40 cm, the 90kV-UHR mode reached TPL, increasing the noise and requiring images at 0.4 mm and Bv60. The 120kV-UHR scan had the best overall IQ, while 90kV-UHR had higher CNR. At 45 cm, 120kV-UHR reached TPLs but still provided reasonable image quality with the highest CNR (3.6). The 120kV-SR-Vas mode had similar dose as that of 120kV-UHR but worse image quality (CNR = 2.4). The 120kV-SR-NC had overall best IQ, however, dose was 1.7x greater than that of 120kV-UHR. At 50 cm, the 120kV-UHR was significantly past TPLs; 120kV-SR-NC had the best IQ and higher CNR (3.6), however, dose was 1.85x greater.

#### CONCLUSION

Cardiac UHR PCD-CT provides high-quality images up to 40 cm width but encounters TPLs beyond 40 cm due to small focal spot. For large patients (e.g., 50 cm width), SR mode with larger focal spot and high tube power should be used. Scan mode, kV, recon kernel, and slice thickness need to be adapted to accommodate large patients, with radiation dose carefully considered.

#### CLINICAL RELEVANCE/APPLICATION

A systematic approach to optimize coronary CTA imaging protocol in terms of scan and recon techniques based on patient size, scan mode, and TPL is critical to ensure optimal IQ and radiation dose.

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## Abstract Archives of the RSNA, 2023

T1-SSPH07-4

### Empirical Energy Weighting Optimization for Fast Grayscale Image Generation with Photon Counting CT

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N226

Yirong Yang, MEng (*Presenter*) Research support, General Electric Company

#### PURPOSE

To develop a novel algorithm to generate real-time, artifact-free, quantitative grayscale images from photon counting CT (PCCT) scans without additional noise, for fast CT image reconstruction.

#### METHODS AND MATERIALS

Photon counting CT leverages multiple energy bins to enable material decomposition (MD) and virtual monoenergetic images (VMI) for quantitative imaging. However, the MD process is computationally intensive, leading to longer reconstruction times and increased hardware cost. In practice, real-time, high-quality grayscale images are needed for the operator to verify image quality (IQ). We propose a method to combine the energy bins using energy weighting optimization based on a specified bias-variance trade-off (BVT), followed by a spectral correction (SC) to generate a VMI at a target energy (e.g., 60 keV). To obtain the optimal weights and SC parameters, we design an objective function that optimizes the BVT of the VMI projections. We utilize measurement-based MD calibration to map energy bin counts to known material thickness pairs, then calculate the corresponding variance and bias of the VMI projection estimation as well as the ground truth values. The algorithm is evaluated using an edge-on-irradiated silicon PCCT prototype with 8 energy bins and scans of a Gammex Multienergy phantom ("head" configuration) with 0, 2.5, 5, and 10 mg/ml iodine inserts. The results for optimal weights, as well as total counts (equal weighting of energy bins), are compared with reference MD-derived VMIs.

#### RESULTS

Grayscale images generated using optimal weights and total counts are reconstructed offline. The variance, absolute bias, and RMSE compared to the reference VMI for 4 ROIs are computed. With our optimal weighting method, we observe less than 5% noise increase, less than 4 HU absolute bias, and few beam hardening or ring artifacts, while total counts produce higher bias and more artifacts. The lower noise level of the total counts image is due to the induced bias, as the RMSE of our optimal weights image is lower or comparable to that of total counts.

#### CONCLUSION

An IQ-based heuristic-driven weight optimization algorithm for near real-time, reduced artifact, accurate quantitative grayscale image generation is proposed. No additional calibration data are required to compute the weights. Subjective IQ exceeds that for conventional total counts. The algorithm is substantially faster than reconstruction via the MD-to-VMI process.

#### CLINICAL RELEVANCE/APPLICATION

We present a novel algorithm for near real-time, high-quality, quantitative grayscale image generation from PCCT scans, which can be applied to photon counting image processing pipelines for fast CT image generation.

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## Abstract Archives of the RSNA, 2023

T1-SSPH07-5

### Plaque and Stent Appearance in a Novel Silicon-based Photon-counting CT Prototype: An ex Vivo Phantom Study

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N226

Emma Verelst, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare plaque and stent appearance between a prototype silicon-based photon-counting CT (Si-PCCT) and a conventional energy-integrating detector CT (EIDCT) system.

#### METHODS AND MATERIALS

A human-resected and stented (Atrium Advanta V12, Atrium Medical Corporation,  $d = 6$  mm) femoral artery was centrally embedded in a 2% agar-water cylindrical phantom ( $d = 20$  cm). Helical scans were acquired using a prototype Si-PCCT and a conventional EIDCT system (Revolution CT, GE Healthcare) at similar scan parameters (120 kV, 40 mm collimation, 0.9 pitch, 0.5 s rotation, 9 mGy CTDIvol). Images were reconstructed with a bone kernel and ASIRO, a 15 cm and 5 cm field-of-view (FOV) and a slice thickness of 0.42 mm (Si-PCCT) and 0.63 mm (EIDCT). Quantitatively, plaque and stent appearance were evaluated by 1) a plaque-stent contrast ratio, i.e. a signal ratio relative to the plaque signal, 2) comparison of the true diameter and measured diameter obtained from a Hounsfield Unit (HU) profile through the stent wall, and 3) blooming as a ratio between inner and outer stent diameter. Qualitatively, two vascular radiologists in consensus evaluated plaque and stent appearance, plaque distinction and blooming using a 5-point Likert scale. Interreader agreement was assessed by using an intra-class correlation (ICC) coefficient. Quantitative and qualitative differences between Si-PCCT and EIDCT were tested by using a paired sample t-test and a Wilcoxon signed-rank test.

#### RESULTS

Quantitatively, Si-PCCT images resulted in an increased plaque-stent contrast ratio (Si-PCCT:  $85.5\% \pm 37.4\%$ ; EIDCT:  $14\% \pm 11.5\%$ ,  $p = 0.005$ ), and reduced blooming artefacts (Si-PCCT:  $33\% \pm 2.5\%$ ; EIDCT:  $58.9\% \pm 4.5\%$ ,  $p < 0.001$ ). At a 5 cm FOV, Si-PCCT images resulted in improved diameter accuracy (Si-PCCT:  $6 \text{ mm} \pm 0.2 \text{ mm}$ ; EIDCT:  $6.3 \text{ mm} \pm 0.1$ ;  $p = 0.017$ ). Qualitatively, Si-PCCT images were rated higher than EIDCT images based on: plaque appearance (Si-PCCT:  $4.3 \pm 0.5$ ; EIDCT:  $1.3 \pm 0.5$ ,  $p < 0.001$ ), stent appearance (Si-PCCT:  $4.3 \pm 0.5$ ; EIDCT:  $1.6 \pm 0.5$ ;  $p = 0.002$ ), plaque distinction (Si-PCCT:  $3.9 \pm 0.5$ ; EIDCT:  $1.7 \pm 0.7$ ;  $p = 0.002$ ), and blooming (Si-PCCT:  $3.8 \pm 0.4$ ; EIDCT:  $1.6 \pm 0.5$ ;  $p = 0.002$ ) with excellent interreader (ICC = 0.93) agreement.

#### CONCLUSION

This study demonstrated an improved spatial resolution of a novel Si-PCCT prototype, leading to better plaque and stent appearance with respect to plaque-stent contrast, a more accurate stent diameter and reduced blooming, when compared to EIDCT.

#### CLINICAL RELEVANCE/APPLICATION

Plaque and stent imaging remains challenging with EIDCT systems as these are prone to blooming and beam hardening artefacts. This study evaluated the ability of Si-PCCT to overcome those limitations by using an ex vivo vascular phantom.

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## Abstract Archives of the RSNA, 2023

T1-SSPH07-6

### Evaluation of Eigenbin Compression for Reducing Photon-counting CT Data Size

Tuesday, Nov. 28 8:00AM - 9:00AM Room: N226

Taly Gilat Schmidt, PhD (*Presenter*) Research Grant, General Electric Company; Research collaboration, Varian Medical Systems, Inc

#### PURPOSE

Photon-counting CT (PCCT) systems can acquire multiple spectral measurements at high spatial resolution, generating a large amount of data to transfer across the gantry slip ring. This experimental study on a silicon PCCT clinical prototype evaluates a data compression method based on principal component analysis (PCA).

#### METHODS AND MATERIALS

The PCCT prototype acquires 8 energy bins; each projection measurement thus represents a point in an eight-dimensional (8-D) space. The proposed method performs PCA on a set of PCCT calibration measurements. PCA finds the orthogonal axes, or eigenvectors, that capture the maximum variance in the 8-D photon-count vector space. To reduce the dimensionality of the PCCT data, the data are linearly transformed into the N-D ( $N < 8$ ) space spanned by the N eigenvectors with highest eigenvalues (i.e., the vectors that account for most of the information in the data). Only N coefficients are then transferred per measurement, which we term eigenbin values. After transmission, the 8 energy-bin measurements are estimated as a linear combination of the N eigenvectors. We acquired PCCT data by scanning a 20 cm-diameter Gammex Multienergy phantom with different material inserts. The method is evaluated with the number of eigenbins varied between two and five. In each case, the eigenbins are used to estimate the 8-bin data, after which material decomposition is performed. The mean and standard deviation of values in the reconstructed basis and virtual monoenergetic images are compared for the original 8-bin data and the eigenbin data.

#### RESULTS

Material decomposition basis images reconstructed from four eigenbins (50% data reduction) demonstrate accurate mean values with a 4-6% increase in noise standard deviation. Further reduction in dimensionality increases noise and error in the basis images. The 65 keV virtual monoenergetic image demonstrates less than 3% change in the mean values as well as noise standard deviation, when two or more eigenbins are used for compression.

#### CONCLUSION

For the material decomposition basis images, the proposed eigenbin compression method reduces PCCT data volume by 50% while maintaining quantitative material decomposition accuracy and with a noise standard deviation penalty of approximately 5%. For VMI grayscale images, eigenbin compression provides 75% data reduction without affecting mean values or noise in this example.

#### CLINICAL RELEVANCE/APPLICATION

The proposed eigenbin method demonstrates potential for reducing PCCT data volume, which may improve efficiency and reduce data transfer times for applications that require fast image generation. PCCT could thus benefit a wider range clinical applications. Decreased hardware requirements can increase PCCT availability by reducing system cost.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPBR-1

### Federated Deep Learning Model Predicts Breast Cancer Risk from Mammography Images

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Daly B. Avendano, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To externally validate Mirai, a DL breast cancer risk model based on mammography studies, applied in the Hispanic population with two distinct mammography vendors, utilizing a federated learning approach.

#### METHODS AND MATERIALS

This study retrospectively reviewed a database of 58,321 consecutive screening mammograms obtained from 24,060 women who received care at the TecSalud health system between January 1, 2014, and December 31, 2021. The Mirai model was utilized without the need for data sharing, using a federated learning approach. Cancer outcomes were obtained through the institutional tumor registry or imaging follow-up. The primary objective of this study was to evaluate the performance of the Mirai model in predicting the risk of breast cancer at 1-5 years from the time of the mammogram. We assessed the C-index as a measure of predictive accuracy.

#### RESULTS

Among the 23,340 patients with breast cancer-negative mammograms, 23,170 had no evidence of cancer in the following 5 years, while 170 were diagnosed with cancer during this timeframe. Mirai's performance was evaluated using a concordance index, which was found to be 0.74 (95% CI 0.71 to 0.77).

#### CONCLUSION

Our evaluation of MIRAI risk predictions indicates that the model is well calibrated, with an accurate accumulation of risk and estimations of risk over time. Our findings demonstrate that MIRAI's predictions align well with the observed number of events among both the full patient cohort and the case-matched control group.

#### CLINICAL RELEVANCE/APPLICATION

Breast cancer risk assessment is the angular stone for personalized screening. Artificial intelligence models have demonstrated promising results. The use of fair algorithms is essential for accurately assessing the overall population and avoiding the underrepresentation of minority groups. To enhance the effectiveness of these algorithms and ultimately lead to better outcomes. By adopting these practices, we can establish more equitable and inclusive systems that benefit everyone.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPBR-2

### Comparison of Quantitative Volumetric and Subjective BI-RADS Density Classification in Women with Dense Breasts

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Stuart S. Kaplan, MD (*Presenter*) Advisory Panel, Hologic, Inc; Advisory Panel, Delphinus Medical Technologies, Inc

#### PURPOSE

Increased breast density is an independent risk factor for breast cancer. A radiation-free tool for breast density assessment would be advantageous, especially for younger women. The purpose of this study was to determine the level of agreement between automated breast density based on whole breast ultrasound tomography volumetric data and commercially available volumetric breast density from 3D mammography in dense breasts. We examined agreement of quantitatively derived BI-RADS density from these two modalities with subjective mammography density assessment by breast radiologists and technologists.

#### METHODS AND MATERIALS

448 women with heterogeneously or extremely dense breasts were enrolled in a prospective case collection registry between December 2016 and October 2019. Participants underwent their annual screening digital breast tomosynthesis (DBT) (Hologic) and same day SoftVue™ automated whole breast ultrasound tomography (SV). Technologists assessed breast density using the BI-RADS density composition scale. Radiologists interpreted the mammogram and SV simultaneously and included a final BI-RADS density assessment. Quantitative volumetric density data was gathered for each case from mammography with Volpara and from SV. The Volpara overall score was used. The SV density index, a number from 0 to 100 derived from the volume-averaged sound speed, was recorded for each breast and categorized as a through d. The densest rating from the two breasts was selected. Four- way and pairwise agreement was tested using Kendall's coefficient of concordance (W). Additional analysis was completed for the disagreement cohorts.

#### RESULTS

In women with dense breasts, there was statistically significant good agreement between SV, Volpara, the radiologists' and technologists' BI-RADS density assessments. When SV was analyzed with each of the 3 other methods, there was statistically significant agreement with slightly higher concordance values. The SV BI-RADS was at a lower density level than Volpara in 12.1% of cases and at a higher density level in 13.3%.

#### CONCLUSION

SV density index, algorithmically calculated from whole breast ultrasound transmission data, has good agreement with automated breast density assessments using 3D mammography. SV breast density index is comparable with both radiologist and technologist subjective BI-RADS assessments from mammography.

#### CLINICAL RELEVANCE/APPLICATION

SV's ultrasound breast density offers accuracy comparable with DBT-based tools or rating by radiologists and technologists. Clinical risk assessment using breast density may be applied, especially to women under age 40, without unnecessary radiation.

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## Abstract Archives of the RSNA, 2023

T2-SPBR-3

### Association of Breast Density Measured on Low-dose Chest Computed Tomography with Subsequent Breast Cancer Risk in Screened Population

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hyo-Jae Lee (*Presenter*) Nothing to Disclose

#### PURPOSE

Few studies identified the relationship between CT breast density and breast cancer risk, often with limited numbers of study cohorts and based on computer-aided quantitative methods which require laborious inputs by a trained user. This study aimed to determine the association between CT breast density grading by radiologists and breast cancer risk in a large screened population, furthermore the results were compared with mammographic density.

#### METHODS AND MATERIALS

In a retrospective cohort study using screened population in a tertiary hospital, women aged at least 40 years without a history of cancer who underwent both mammographic screening and low-dose chest CT in 2007-2016 were followed up through December 2022. Two board-certified radiologists with each special expertise in mammography and CT independently reviewed the breast density on mammography and CT images and classified each case into one of the four BI-RADS grades. The primary outcome focused on the occurrence of new cases of breast cancer, including both invasive breast cancer and ductal carcinoma in situ. The hazard ratio (HR) was calculated using Cox proportional hazard regression and adjusted for other covariates. To compare the relationship between breast densities on mammography and CT, the Spearman's correlation coefficient was adopted. Interreader agreements for the mammographic density and CT density grades were determined by using the Cohen weighted kappa statistic.

#### RESULTS

Among 1576 women (mean age, 65 years  $\pm$  9), the ascertainment of 17 incident breast cancers was obtained. CT density grade 4 showed a higher risk of breast cancer compared with those with grade 1 and 2 (HR, 10.502 [95% CI:1.227, 89.918],  $p = 0.032$  for reader 1; 6.368 [1.227, 33.049],  $p = 0.028$  for reader 2). There was a significant correlation on breast density between mammography and CT ( $r = 0.770$  and  $0.941$ , for reader 1 and 2, respectively) and the interreader agreement was good ( $\kappa = 0.613$  and  $0.701$ , for mammography and CT, respectively).

#### CONCLUSION

In this preliminary result, CT density provided future breast cancer risk information and correlated well with that from mammography.

#### CLINICAL RELEVANCE/APPLICATION

Low-dose chest CT scans for lung cancer screening can estimate breast density without sacrificing interreader agreement, and have an association with breast cancer risk, promising for future research on dedicated breast CT scans.

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## Abstract Archives of the RSNA, 2023

T2-SPBR-4

### Early Adulthood Adiposity, Attained Adiposity and Breast Parenchymal Complexity in Premenopausal Women

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Sneha Das Gupta, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Adiposity measures such as weight, body-mass index (BMI) and body fat% are associated with breast cancer risk. We assessed the relationship of breast parenchymal complexity with early adulthood adiposity, changes in adiposity over the life course, and attained adiposity among premenopausal women, while also accounting for breast density.

#### METHODS AND MATERIALS

We analyzed routine screening digital mammograms (Selenia Dimensions; Hologic) from 325 premenopausal women without breast cancer, recruited at the Joanne Knight Breast Health Center, Washington University in St. Louis, MO from December 2015 to October 2016. Trained research personnel assessed attained adiposity measures, while weight at ages 18 and 30 were self-reported. A wide array of radiomic features were automatically extracted from each mammogram using a validated computational imaging pipeline, standardized, and fused into a breast parenchymal complexity signature (BPCS). Volumetric percent density (VPD) was calculated using the Volpara software. Spearman correlations ( $r$ ) and multivariable linear regression models were used to evaluate the associations of adiposity measures with BPCS, adjusting for potential confounders (age, race, family history of breast cancer and parity) and VPD.

#### RESULTS

BPCS was moderately correlated ( $r = 0.61$ ) with VPD. Higher BPCS was significantly ( $p < 0.05$ ) associated with lower weight and BMI at age 18 and at age 30, independently of age, race, family history of breast cancer and parity; inverse associations with BPCS were also found for absolute and annual weight changes between age 18 and attained age as well as between age 30 and attained age ( $-0.60 < r < -0.15$ ; linear regression coefficients ( $b$ ) for adiposity measures ranging from  $-0.672$  to  $-0.008$ ). Attained weight, BMI and body fat were also significantly inversely associated with BPCS. When further adjusting for VPD, statistical significance was preserved, yet slightly attenuated, for most adiposity measures ( $-0.60 < r < -0.25$ ;  $-0.498 < b < -0.012$ ). Among all adiposity measures, strongest associations with BPCS were preserved for annual weight change from age 18 to attained age and annual weight change from age 30 to attained age.

#### CONCLUSION

Our preliminary data suggest that adiposity in early adulthood, as well as weight gain from early adulthood to attained age are inversely associated with breast parenchymal complexity among premenopausal women, and may have a lifelong impact on breast parenchymal tissue patterns, beyond breast density.

#### CLINICAL RELEVANCE/APPLICATION

Deeper understanding of the pathways through which early-adulthood adiposity modifies breast parenchymal tissue, and possibly breast cancer risk, can open new avenues for preventive interventions in premenopausal women.

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## Abstract Archives of the RSNA, 2023

T2-SPBR-5

### Predictive Performance of a Deep Learning Image-Based Five-Year Breast Cancer Risk Model Across Race/Ethnicity, Age, Breast Density and Family History of Breast Cancer

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hari Trivedi, MD (*Presenter*) Founder, Lightbox AI ; Consultant, Sirona Medical, Inc ; Consultant, Flatiron Health ; Consultant, PMX Inc ; Research support, Kheiron Medical Technologies ; Research support, Clairity, Inc ; Research support, Nightingale Open Science ;

#### PURPOSE

Traditional breast cancer risk models demonstrate modest predictive accuracy and are limited by worse performance in races/ethnicities outside of European Caucasian ancestry. We measured the performance of a deep learning (DL) image-based five-year breast cancer risk model across race/ethnicity, age, breast density, and family history of breast cancer.

#### METHODS AND MATERIALS

This retrospective study included 31,047 consecutive bilateral 2D full field digital screening mammograms from 11,536 patients from January 2011 through December 2016 from six screening facilities. These exams were not part of model training. Self-reported race and ethnicity were categorized as Black, Asian, Hispanic, White, or as all other races and ethnicities. To account for the large number of White, non-Hispanic patients, race and ethnicity were further classified as White/non-Hispanic (W/NH) or as patients of color and/or Hispanic ethnicity (POC/H). Age (<50 vs >50), breast density (dense vs not dense), and first-degree family history of breast cancer were extracted from electronic medical records. Cancer outcomes were obtained from local tumor registries and included DCIS and any invasive breast cancer. Model prediction was estimated across subgroups using areas under the receiver operating characteristic curve (AUCs).

#### RESULTS

We found point estimate AUCs consistently at or above 0.73 across all subgroups. AUC by subgroup: W/NH 0.75 [95% CI 0.73, 0.77] (n = 27,323), POC/H 0.75 [95% CI 0.68, 0.82] (n = 2,529); age < 50 0.73 [95% CI 0.70, 0.76] (n = 13,742), age >= 50 0.74 [95% CI 0.72, 0.77] (n = 16,110); dense 0.75 [95% CI 0.75, 0.76] (n = 17,146), not dense 0.79 [95% CI 0.78, 0.80] (n = 13,052); 1st degree relative with breast cancer 0.77 [95% CI 0.73, 0.80] (n=6,713), 1st degree relative without breast cancer 0.79 [95% CI 0.76, 0.83] (n=10,618), 1st degree relative with breast cancer (unknown) 0.76 [95% CI 0.74, 0.78] (n=13,172).

#### CONCLUSION

The DL model performed consistently at or above 0.73 AUC in all subgroups of race/ethnicity, age, breast density and first-degree family history of breast cancer. No differences in performance were identified in patients identifying as POC/H compared to those identifying as W/NH. Performance was significantly higher in not dense vs dense exams. No significant differences were found between other subgroups. This DL image-based model appears to reduce differences in performance associated with traditional risk models.

#### CLINICAL RELEVANCE/APPLICATION

A DL based breast cancer risk prediction model can perform consistently across key patient subgroups and appears to reduce limitations of traditional risk assessment, such as differences in performance across race/ethnic groups.

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## Abstract Archives of the RSNA, 2023

T2-SPBR-6

### Artificial Intelligence for Mammography to Predict Future Breast Cancer Risk : Incorporating Longitudinal Changes to Enhance a Feasibility

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Sanghyup S. Lee, MD (*Presenter*) Employee, Lunit Inc

#### PURPOSE

To investigate mammographic parenchymal patterns and longitudinal changes that are related to breast cancer beyond the mammographic breast density and develop an artificial intelligence (AI) model to predict future breast cancer risk.

#### METHODS AND MATERIALS

We developed a mammography-based deep learning algorithm for an AI predictive model to show the risk score for future breast cancer. risk model using a total of 16,113 full-field digital mammograms (Hologic, 72.3%; Siemens, 27.7%) from 9,113 women in the United States, who underwent at least mammogram and have information of pathology-confirmed breast cancer outcomes within 5 years. To discover the feasibility of incorporating prior images to train longitudinal changes of mammographic parenchymal patterns, the baseline model (AI-1) trained prior mammograms of non-cancer women and women with breast cancer, respectively, and the other model (AI-2) additionally trained with paired current and prior examinations per woman. Discriminatory performance was assessed using C-indices and receiver operating characteristic (ROC) curves for 1- to 3-year outcomes. Mammographic breast density was evaluated for each mammogram according to the BI-RADS composition category.

#### RESULTS

A total of 2,000 examinations, of which 500 cases were followed by a cancer diagnosis were evaluated with two AI predictive models. C-indices increased from 0.68 (95% CI: 0.65, 0.71) of AI-1 to 0.73 (95% CI: 0.70, 0.76) of AI-2 ( $P=0.004$ ). The AI-2 model demonstrated the risk of breast cancer with AUC of 0.75 (95% CI: 0.70, 0.79) at 1-year, 0.76 (95% CI: 0.68, 0.83) at 2-year, and 0.73 (95% CI: 0.68, 0.78) at 3-year. The performance was comparable in fatty (C-index, 0.74; 95% CI, 0.70, 0.78) and dense (0.71; 0.65, 0.76) breasts. 1076 of 2000 examinations showed no longitudinal changes of mammographic density, and the performance of AI-2 for this subgroup was similar (C-index, 0.72, 95% CI, 0.70, 0.76) to the overall performance.

#### CONCLUSION

This preliminary study demonstrated the feasibility of the AI predictive model to identify mammographic parenchymal features of future breast cancer. Incorporation of longitudinal changes might be feasible to enhance risk stratification of breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

The image-based risk model has a potential to be used to improve personalized screening of breast cancer.

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## Abstract Archives of the RSNA, 2023

T2-SPBR-7

### Performance of Traditional Breast Cancer Risk Models Compared to a Deep Learning Model Overall and by Race/Ethnicity

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hari Trivedi, MD (*Presenter*) Founder, Lightbox AI ; Consultant, Sirona Medical, Inc ; Consultant, Flatiron Health ; Consultant, PMX Inc ; Research support, Kheiron Medical Technologies ; Research support, Clairity, Inc ; Research support, Nightingale Open Science ;

#### PURPOSE

To compare the performance of traditional breast cancer risk models to a new deep learning (DL) image-based five-year breast cancer risk model overall and by race/ethnicity.

#### METHODS AND MATERIALS

This retrospective study included 10,101 consecutive bilateral 2D full field digital screening mammograms from 8,688 patients from February 2015 through December 2016 from a U.S.-based center that operates six screening facilities. Patient race/ethnicity and traditional risk model scores (Breast Cancer Risk Assessment Tool [BCRAT] and Tyrer-Cuzick v6 [TC6]) were extracted from electronic medical records. Patient self-reported race/ethnicity was used to create two groups: White, non-Hispanic (W/NH) and patients of color and/or Hispanic (POC/H). Cancer outcomes were obtained from local tumor registries. Cancer rates were defined as total cancers (DCIS and any invasive cancer) diagnosed within five years after the index mammogram/total exams. Model predictions were estimated using areas under the receiver operating characteristic curve (AUCs) and compared across risk models overall and by race/ethnicity using Chi-squared tests. NCCN thresholds were used to categorize predicted five-year risk scores as follows: average risk < 1.7%, intermediate risk > 1.7% and < 3.0%, and high risk > 3.0%.

#### RESULTS

DL model five-year predictions significantly outperformed BCRAT and TC6 five-year predictions. Overall AUC [95% confidence interval] and number of exams (n) by risk model: DL 0.75 [0.72, 0.77] (n = 10,101), BCRAT 0.62 [0.59, 0.65] (n = 10,101), and TC6 0.59 [0.56, 0.62] (n = 10,101). Observed five-year cancer rates by race/ethnicity: W/NH 4.4% and POC/H 4.2%. Predictions by BCRAT and TC6 models, but not DL model, exhibited statistically significant differences across race/ethnicity groups. Comparing risk group distributions for W/NH to POC/H generated chi-squared statistic and p-values of: BCRAT 162.36 (p<.00001), TC6 84.49 (p<.00001), DL 0.954 (p=.621). Compared to POC/H, W/NH patients were 3.8 times more likely to be labeled high risk by BCRAT and 2.3 times more likely by TC6. The DL model assessed a nearly identical percentage of W/NH and POC/H as high risk.

#### CONCLUSION

An image-based DL model outperformed traditional risk models in predicting five-year breast cancer risk. Traditional risk models exhibited meaningful differences in performance across race/ethnicity that was not observed in the DL model.

#### CLINICAL RELEVANCE/APPLICATION

A deep-learning based approach to breast cancer risk prediction outperforms traditional risk models and appears to remove differences in performance observed across racial/ethnic groups associated with traditional risk models

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## Abstract Archives of the RSNA, 2023

T2-SPBR-8

### Cryoablation, Ultraconservative Treatment for Low-risk Early Breast Cancer $\leq 2$ cm: Analysis of its Efficacy

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Maria Jose Roca Navarro, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate if in patients with Her2- luminal tumors  $\leq 2$ cm and ultrasound negative axilla, after cryoablation guided by ultrasound, there is absence of infiltrating carcinoma in the lumpectomy specimen. To demonstrate that the placement of pre-surgical seed at the moment prior to cryoablation does not interfere subsequently in the disappearance of tumor cells by freezing.

#### METHODS AND MATERIALS

Between April 2021 and March 2023 we performed preoperative cryoablation in 49 patients (aged 53-79 years) with 50 unifocal infiltrating ductal carcinomas (IDC) (between 4mm and 20mm). All IDCs were visible on ultrasound, were luminals low grade and ultrasound negative axilla. All patients were studied with mammography and tomosynthesis, staged and biopsied by ultrasound. MRI was performed to rule out extensive intraductal component in 16 of the 19 patients with associated intraductal carcinoma (DCIs) in the core needle biopsy (CNB). All of them underwent pre-surgical marking with ferromagnetic seed and cryoablation with 17G or 14G needle on the same procedure, taking advantage of the same anesthesia and cutaneous access. We used the ICEfx Galil Boston Scientific cryoablation system, applying the usual triple-phase protocol: freezing-passive thawing-freezing and duration of approximately 40 minutes. Subsequently we checked the correct placement of the seed with mammographic projection

#### RESULTS

Out of 50 low-risk unifocal IDC: -31 were pure IDC (without associated intraductal component in the diagnostic CNB): in none there was residual IDC in the lumpectomy specimen after performing pre-surgical cryoablation. -19 were IDC mixed (with associated DCIs in the diagnostic CNB): In 4 cases residual IDC was found in the surgical specimen, with some IDC focus remaining in the periphery of the post-cryoablation necrosis. In 8 patients, DCIs foci were detected far from the cryoablation area. All the specimens were considered by the pathologist to have tumor-free margins. There was no relevant complication.

#### CONCLUSION

Cryoablation is effective in 100% of cases for pure infiltrating tumors  $\leq 2$ cm. The presence of nests of DCIs away from the cryoablation area or millimeter foci of IDC at the margin of steatonecrosis in mixed IDC does not indicate failure of the technique, *as all surgical specimens were considered by the pathologist to have tumor-free margins*. Subsequent standard adjuvant treatment will equalize the risk of relapse to conventional lumpectomy, so it may be an alternative therapy in selected patients.

#### CLINICAL RELEVANCE/APPLICATION

In the near future, after evaluating studies with a larger number of cases and follow-up, in selected patients with luminal tumors = 2cm, cryoablation could be an alternative therapy thus avoiding surgery.

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## Abstract Archives of the RSNA, 2023

T2-SPBR-9

### Upgrade of MRI Detected Papillomas in Asymptomatic High Risk Patients, Patients with a History of Cancer, and Patients with Known Malignancy

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Kathryn W. Zamora, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose is to evaluate the upgrade of papilloma identified on MRI biopsy in patients with breast cancer and high-risk patients with or without a history of breast cancer.

#### METHODS AND MATERIALS

In this HIPAA-compliant IRB-approved retrospective study, all MRI-guided biopsies from 1/1/2011 to 1/31/2020 yielding papilloma were reviewed. Only patients with an imaging indication of high-risk screening, known breast malignancy, or history of breast malignancy were included. Other indications, including breast symptoms such as palpable masses or nipple discharge, were excluded. All included patients had a surgical excision with clear pathology or, at minimum, a 2-year follow-up MRI after biopsy. All cases without surgical excision or imaging follow-up were excluded. All MRI biopsy procedures were performed on a GE 1.5 T magnet using a Suros Atec 9-gauge vacuum-assisted biopsy device.

#### RESULTS

Of the initial 258 MRI-guided biopsies demonstrating papilloma, 45.3% (117/263) met inclusion criteria. Of the 141 patients excluded, 90 biopsies were excluded because of breast symptoms. Most examinations, 57% (67/117), were performed for high-risk screening, including a personal history of breast cancer. The other 43% (50/117) of examinations were performed for extent of disease. Of the 117 biopsies, 4.3% (5/117) were upgraded to malignancy. One biopsy (1/117, 0.9%) was upgraded to invasive malignancy and four (4/117, 3.4%) were upgraded to DCIS. Of the 117 biopsies, 31.6% (37/117) demonstrated atypia or additional high-risk pathology at time of percutaneous biopsy while 68.4% (80/117) demonstrated benign papilloma. The upgrade rate of benign papilloma at biopsy was 3.8% (3/80) with all cases non-invasive. The upgrade rate of papilloma with atypia or additional high-risk lesion at biopsy was 5.4% (2/37) with one non-invasive and one invasive malignancy. Age, race, ipsilateral malignancy, lesion type, or additional high-risk lesion at biopsy were not associated with upgrade rate.

#### CONCLUSION

Surgical excision of biopsy-proven papilloma identified by MRI biopsy in asymptomatic high-risk patients and patients with known malignancy may not be necessary.

#### CLINICAL RELEVANCE/APPLICATION

Excision is often recommended for papillomas in high-risk patients. In these patients with papillomas found on MRI, a low upgrade rate suggests surgical excision may not be necessary.

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## Abstract Archives of the RSNA, 2023

T2-SPCA-2

### Cardiac Magnetic Resonance Imaging Features of Myocardial Involvement in Psoriasis

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Lorenzo Dominici, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Psoriasis is a systemic chronic inflammatory condition, primarily affecting skin and joints, associated with increased risk of developing major cardiovascular events (MACEs). Inflammatory myocardial involvement in psoriasis (P-IMI) has been reported but not thoroughly investigated. The aim of our study was to describe the findings at cardiac magnetic resonance (CMR) imaging in a series of patients with psoriasis related myocarditis.

#### METHODS AND MATERIALS

One hundred consecutive patients (62M, mean age  $55 \pm 13.7$  years) with psoriasis were screened by 2D echocardiography for cardiac abnormalities. Among them, five male patients showed hypokinetic dilated cardiomyopathy (HDCM). All patients with HDCM underwent invasive coronary angiography (ICA), CMR and endomyocardial biopsies (EMB) with real time PCR for cardiotropic viruses and western blot analysis for myocardial expression of Toll-Like Receptor 4 (TLR-4) and Interleukin-17A (IL-17A). CMR exams were performed on a 1.5 T scanner. Protocol included cine-bSSFP, T2-weighted STIR, T2-prep sequences for T2 mapping, MOLLI sequences for T1 mapping, acquired before and after gadolinium administration and CE T1w IR for late gadolinium enhancement images.

#### RESULTS

All patients presented with heart failure with reduced ejection fraction (HFrEF, EF  $19 \pm 2.8\%$ ), NYHA Class III-IV and various ECG abnormalities. ICA showed normal coronary arteries in all patients. All five patients were diagnosed with acute/subacute myocarditis on CMR imaging according to the updated 2018 Lake Louise Criteria. Among them, two patients showed myocardial edema on T2WI, three patients had positive LGE, while all of them had increased T1 and T2 mapping relaxation times. EMB confirmed imaging findings as an active virus-negative lymphocytic myocarditis was revealed in all patients with positive anti-heart autoantibodies, overexpression of TLR-4 and enhancement of IL-17A at western blot analysis.

#### CONCLUSION

P-IMI is an underrecognized condition in patients with psoriasis, presenting with severe ventricular dysfunction at echocardiography, lymphocytic myocarditis at EMB and with variable myocardial signal abnormalities at CMR.

#### CLINICAL RELEVANCE/APPLICATION

Timely detection of P-IMI is crucial due to its prognostic and therapeutic implications. CMR may play a pivotal role, as a reliable and accurate non-invasive tool to identify myocardial inflammation and ventricular dysfunction.

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## Abstract Archives of the RSNA, 2023

T2-SPCA-3

### Left and Right Ventricle Feature Tracking CMR Strain in Patients with Thoracic Sarcoidosis

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Juan J. Urbina, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients with sarcoidosis may have clinically silent disease in 20-25%. Early detection of disease is essential for adequate therapy and prevent negative outcomes. This study aims to assess cardiac magnetic resonance (CMR) feature tracking (FT) strain for detection of subclinical cardiac dysfunction in patients with biopsy-proven extracardiac sarcoidosis.

#### METHODS AND MATERIALS

This retrospective study included patients who underwent chest CT and CMR examinations for biopsy-proven extracardiac sarcoidosis. For comparison age-matched controls with normal CMR were included. All CMR studies were performed with 1.5T or 3T scanners (Siemens). Chest CT examinations were conducted with 64-256 slice scanners (Siemens, General Electric). CMR used a standard protocol with b-SSFP cine sequences in long (2,3,4chamber) and short axis views for volumes/function analysis. Late gadolinium enhancement (LGE) sequences in the same orientation were performed >10 min after administration of Gadovist (0.1 mmol/Kg). CMR image analysis including strain (Global longitudinal, circumferential, or radial strain) was performed with dedicated software (CVI 42). Chest CT was analyzed by based on established criteria for the diagnosis of sarcoidosis.

#### RESULTS

The cohort included 49 patients (58.2±9.5y, 26m). Subgroups were defined by extracardiac sarcoidosis with/without lymph adenopathy and parenchymal disease (+chest) or cardiac involvement (+CMR). Group 1 13/49 (56.7±8.6y, 8m) with +chest/+CMR, group 2 33/49 (57.7±9.4y,16m) with +chest/-CMR and group 3 3/49 patients (70.3±9.0y, 2m) with -chest/-CMR for sarcoidosis. 10 studies (57.5±12.3y, 6m) served as controls. LVGLS was impaired in all three groups compared to controls. LVGLS was significantly different between Group 1 and controls (-13.0±5.1 vs. 17.9±1, p-value=0.0112) and Group 2 and controls (-13.8±3.3 vs. 17.9±1.7; p-value=0.0124). LVGRS LAX was significantly different between Group 1 and controls (20.6%±9.6 vs. 31%±3.6; p-value=0.0086) and Group 2 and controls (23%±7.2 vs. 31%±3.6p-value=0.022). Positive LGE was detected in 13 patients: subendocardial 3/13, midmyocardial 6/13, midmyocardial/subepicardial 1/13, subepicardial/transmural 1/13 and subendocardial/midmyocardial/subepicardial in 2/13.

#### CONCLUSION

In patients with biopsy-proven extracardiac sarcoidosis independent of cardiac involvement LV GLS and LV GRS are abnormal, even when LVEF is within normal range.

#### CLINICAL RELEVANCE/APPLICATION

Therefore, LV strain can be used to detect subclinical LV dysfunction in patients with extracardiac sarcoidosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPCA-4

### Primary Chylopericardium: A Study Based on CT Lymphangiography

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yimeng Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic value of CT lymphangiography (CTL) in primary chylopericardium.

#### **METHODS AND MATERIALS**

The clinical and imaging data of 39 patients with primary chylopericardium were retrospectively analyzed. All patients underwent CTL scan. CTL evaluated abnormal contrast distribution and reflux in the neck, chest, abdomen, pelvis and abnormalities in the pericardium, mediastinum, and lungs. The composition ratio of qualitative data was used for statistical description.

#### **RESULTS**

All 39 patients with CTL showed abnormal iodine oil deposition and reflux at different sites: (1) neck: 11 cases of the end of thoracic duct, 3 cases of the end of right lymphatic duct, 24 cases of cervical trunk reflux, 25 cases of subclavian trunk reflux; (2) chest: 23 cases of bronchial mediastinal trunk reflux, 22 cases of anterior mediastinum, 12 cases of main pulmonary artery window, 29 cases of peritracheal and bronchial, 30 cases of subcarina, 24 cases of posterior mediastinum, 7 cases of thoracic duct trunk reflux, 15 cases of pericardial reflux, 11 of which were transbronchial mediastinal trunk reflux, and 10 cases of abnormal distribution of intercostal, pleural, and Supra-diaphragm. (3) Abnormalities in the abdomen and pelvic region: 4 cases in the subdiaphragm, 18 cases of dilated and condensed iliac lymphatics on the contrast side, 21 cases of contralateral iliac reflux, 16 cases of abnormal distribution of contrast in the ipsilateral lumbar trunk, and 23 cases of contralateral lumbar trunk reflux. Extra-lymphatic manifestations of abnormalities: 39 cases showed fluid density in the pericardial cavity, 2 cases showed cloudy and swollen mediastinal soft tissues, 24 cases showed abnormalities in both lungs, 10 cases showed thickened lobular septa, 11 cases showed ground glass density, 10 cases showed thickened bronchovascular bundles, 5 cases showed thickened bronchial walls, 16 cases showed pleural effusion, and 11 cases showed pulmonary atelectasis or insufficiency. 16 patients were treated surgically and 7 cases were relieved after surgery.

#### **CONCLUSION**

CT lymphangiography can show the abnormalities of thoracic duct and accessory branches in primary chylopericardium, and abnormal lesions of mediastinum, pericardium and lungs in this disease, which can help to explore the pathogenesis, diagnosis and differential diagnosis of this disease.

#### **CLINICAL RELEVANCE/APPLICATION**

Exploring the CTL presentation features of primary chylopericardium will help the pathogenesis study, diagnosis and differential diagnosis of this disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPCA-6

### **Detection of Monosodium Urate Depositions & Atherosclerotic Plaques in the Cardiovascular System by Dual-energy Computed Tomography**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Haolin Ren (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study employed Dual-energy CT (DECT) material separation technology to quantitatively assess the urate accumulated in coronary plaques, and to compare this to the Coronary CTA (CCTA) Calcium score scan for distinguishing urate deposition from atherosclerosis. Additionally, this study aimed to explore the relationship between urate deposition and surrounding atherosclerotic plaques, and to confirm the contribution of urate deposition to the development of coronary atherosclerosis.

#### **METHODS AND MATERIALS**

We investigated the role of dual-energy computed tomography (DECT) in diagnosis of coronary atherosclerotic plaques and urate depositions in the patients with clinically suspected coronary artery disease. The patients were examined with DECT imaging system, and their clinical data were collected.

#### **RESULTS**

DECT showed among 872 patients, 441 patients had plaques in coronary arteries, the incidence of plaque was 50.6%. Among the patients with coronary plaques, there were 348 patients (78.9%) with simple atherosclerotic plaque (AP), 8 patients (1.8%) with simple urate depositions (UD), 85 patients (19.3%) with urate depositions and atherosclerotic plaques (UDAP). Compared with AP group, total plaque area and calcification score around the plaque in UDAP group were significantly increased, and urate deposition areas were correlated with surrounding atherosclerotic area ( $r=0.325$ ,  $p<0.001$ ). Compared with AP patients, cardiac ejection fraction in UDAP patients was slightly decreased ( $p<0.05$ ). There was no statistical difference in blood uric acid concentration and other clinical parameters between two groups.

#### **CONCLUSION**

Notably, patients with gout or a history of hyperuricemia were more likely to exhibit urate deposition in their atherosclerotic plaques. Furthermore, we observed a strong correlation between urate deposition and atherosclerotic plaques with larger volumes and higher calcification. Cardiac ejection fraction in UDAP patients was slightly decreased compared with AP patients.

#### **CLINICAL RELEVANCE/APPLICATION**

DECT may provide a relatively simple method for detection and identification of coronary urate deposition at risk for cardiovascular diseases.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPCA-7

### Periaortic Adipose Radiomics Texture Features Associated with Increased Coronary Calcium Score: First Results on a Photon-Counting CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Isabelle Ayx, MD (*Presenter*) Research Consultant, AstraZeneca PLC

#### PURPOSE

Cardiovascular diseases remain the world's primary cause of death. Identifying and treating patients at risk of cardiovascular events is as important as ever. Adipose tissue counts as a classic risk factor for cardiovascular diseases. It has been linked to systemic inflammation and is suspected to contribute to vascular calcification. To further investigate this issue, the use of texture analysis of adipose tissue using radiomics features could prove a feasible option.

#### METHODS AND MATERIALS

In this retrospective IRB-approved single-center study, 55 patients (mean age 55, 34 male, 21 female) were scanned on a first-generation photon-counting CT. On axial unenhanced images, periaortic adipose tissue surrounding the thoracic descending aorta was segmented manually. Patients were divided into three groups for feature extraction, depending on coronary artery calcification (Agatston Score 0, Agatston Score 1-99, Agatston Score =100). 106 features were extracted using pyradiomics. R statistics was used for statistical analysis, calculating mean and standard deviation with Pearson correlation coefficient for feature correlation. Feature selection was performed using Random Forest classification and visualized using Boxplots and heatmaps. Additionally, monovariate logistic regression predicting an Agatston Score > 0 was performed, selected features were tested for multicollinearity and a 10-fold cross-validation investigated the stability of the leading feature.

#### RESULTS

Two higher-order radiomics features, namely "glcm\_ClusterProminence" and "glcm\_ClusterTendency" were found to differentiate between patients without coronary artery calcification and those with coronary artery calcification with respective mean values (Agatston Score 0/1-99/=100) of 92.77/79.23/77.05 for "original\_glcm\_ClusterProminence" ( $p = 0.019$ ) and 5.72/5.33/5.24 for "original\_glcm\_ClusterTendency" ( $p = 0.078$ ). As the leading differentiating feature "glcm\_ClusterProminence" was identified after assessing multicollinearity.

#### CONCLUSION

Changes in periaortic adipose tissue texture seem to correlate with coronary artery calcium score, supporting a possible influence of inflammatory or fibrotic activity in perivascular adipose tissue. Radiomic texture features may potentially aid as corresponding biomarkers in the future.

#### CLINICAL RELEVANCE/APPLICATION

The possible correlation between PAAT texture and coronary artery sclerosis may allow the hypothesis of possible texture changes through inflammatory or fibrotic processes in perivascular adipose tissue influencing the process of arteriosclerosis. A radiomics signature could serve as an imaging biomarker for cardiovascular prevention in the future.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPCH-1

### Baseline Whole-lung CT Features Deriving from Deep Learning and Dadiomics: Prediction of Benign and Malignant Pulmonary Ground-glass Nodules

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Wenjun Huang (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate the model for predicting benign and malignant ground-glass nodules (GGN) based on the whole-lung baseline CT features deriving from deep learning and radiomics.

#### METHODS AND MATERIALS

This retrospective study included 385 GGN from 3 hospitals, confirmed by pathology. 239 GGN from Hospital 1 were used as the training and internal validation set. 115 and 31 GGN from Hospital 2 and Hospital 3 were used as the external test sets 1 and 2, respectively. Clinical and morphological features of GGN at baseline chest CT were evaluated, and the whole-lung radiomics features were extracted simultaneously. Besides, baseline whole-lung CT image features are further assisted and extracted using the convolutional neural network. Back propagation neural network was used to construct five prediction models based on different collocations of the features used for training. The area under the receiver operator characteristic curve (AUC) was used to compare the prediction performance among the five models. The Delong test was used to compare the differences in AUC between models pairwise.

#### RESULTS

The model integrated clinical-morphological features, whole-lung radiomic features, and whole-lung image features (CMRI) performed best among the five models, achieved the highest AUC in the internal validation set (Hospital 1), external test set 1 (Hospital 2), and external test set 2 (Hospital 3), which were 0.886 [95% confidence interval (CI): 0.841-0.921], 0.830 (95%CI: 0.749-0.893) and 0.879 (95%CI: 0.712-0.968), respectively. In all three sets, the differences in AUC between the CMRI model and other models were significant (all  $P < 0.05$ ).

#### CONCLUSION

The whole-lung baseline CT features were feasible to predict the benign and malignant GGN. The model combining clinical-morphological features, whole-lung radiomics, and whole-lung image features showed the best performance.

#### CLINICAL RELEVANCE/APPLICATION

The deep learning model based on whole-lung features can provide non-invasive and low-cost prediction and save the time of nodule segmentation.

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## Abstract Archives of the RSNA, 2023

T2-SPCH-2

### Deep Learning Models for Malignancy Estimation of Pulmonary Solid Nodules After Novel Classification

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Zichang Ma (*Presenter*) Nothing to Disclose

#### PURPOSE

Identifying the malignancy of pulmonary solid nodules larger than 8mm remains a challenging task. Our study is to make a novel classification of pulmonary solid nodules based on the adjacent relationship between the pulmonary pleura and nodules and use deep learning models to diagnose the pathology-confirmed nodules divided by this classification on CT scans of the chest.

#### METHODS AND MATERIALS

A total of 453 patients with pathology-confirmed solid nodules were enrolled from 2014 to 2022 and were randomly separated into training, validation, and test cohorts. Then we made a classification of solid nodules. Nodules that were adjacent to the pleura in the largest cross-sectional area were included in the pulmonary pleura solid nodules (PPSN) group. Nodules that were adjacent to only the lung tissues were included in the isolated solid nodules (ISN) group. Two groups were also divided into three cohorts. The Swin Transformer as a deep learning model, was used to identify the malignancy.

#### RESULTS

Before classification, the area under the receiver operating characteristic curve (AUC), specificity, and sensitivity in the validation and independent test cohorts were 0.892 [95% CI: 0.864, 0.920], 0.765, and 0.858; 0.878 [95% CI: 0.831, 0.924], 0.741, and 0.871. After classification, AUC, specificity, and sensitivity in validation and independent test cohorts in the ISN group were 0.921 [95% CI: 0.884, 0.958], 0.809, and 0.868; 0.905 [95% CI: 0.873, 0.938], 0.809, and 0.868. In the PPSN group, AUC, specificity, and sensitivity in the validation and test cohorts were 0.875 [95% CI: 0.776, 0.974], 0.632, 0.934; 0.806 [95% CI: 0.735, 0.876], 0.425, 0.871. The AUC of two divided groups in the independent test cohort was significantly different as determined by the DeLong test ( $p = 0.012$ ). The AUC in the ISN group is greater than that in the whole group.

#### CONCLUSION

When using deep learning models to predict pulmonary nodules, it is necessary to consider the surrounding tissues of the tumor, and detailed classification may help improve the prediction effect.

#### CLINICAL RELEVANCE/APPLICATION

After specific classification, the accuracy of using deep learning models to predict lung nodules surrounded by lung tissue would be improved.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPCH-3

### Prediction of Lung Malignancy Progression and Survival with Deep Learning Based on Pre-treatment FDG-PET/CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yongheng Luo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Artificial intelligence (AI) demonstrated potential for improved accuracy in the characterization of lung malignancies with fluorodeoxyglucose positron-emission tomography and computed tomography (FDG-PET/CT), but studies mostly relied on handcrafted features rather than deep learning, and focused on the prognostic utilities of CT and PET individually without investigating their additive value. The purpose of this study was to use deep learning with pre-treatment FDG-PET/CT to predict progression of lung malignancies and overall survival (OS).

#### METHODS AND MATERIALS

A retrospective review across three institutions identified patients with a pre-procedure FDG-PET/CT and an associated malignancy diagnosis. Lesions were manually and automatically segmented, and convolutional neural networks (CNNs) were trained using FDG-PET/CT inputs to predict malignancy progression. Performance was evaluated using area under the receiver operating characteristic curve (AUC), accuracy, sensitivity, and specificity. Image features were extracted from CNNs and by radiomics feature extraction, and random survival forests (RSF) were constructed to predict OS. Concordance index (C-index) and integrated brier score (IBS) were used to evaluate OS prediction.

#### RESULTS

1168 nodules (n=965 patients) were identified. 792 nodules had progression and 376 were progression-free. The most common malignancies were adenocarcinoma (n=740) and squamous cell carcinoma (n=179). For progression risk, the PET+CT ensemble model with manual segmentation (accuracy=0.790, AUC=0.876) performed similarly to the CT only (accuracy=0.723, AUC=0.888) and better compared to the PET only (accuracy=0.664, AUC=0.669) models. For OS prediction with deep learning features, the PET+CT+clinical RSF ensemble model (C-index=0.737) performed similarly to the CT only (C-index=0.730) and better than the PET only (C-index=0.595), and clinical only (C-index=0.595) models. RSF models constructed with radiomics features had comparable performance to those with CNN features.

#### CONCLUSION

CNNs trained using pre-treatment FDG-PET/CT and extracted performed well in predicting lung malignancy progression and OS. OS prediction performance with CNN features was comparable to a radiomics approach. The prognostic models could inform treatment options and improve patient care.

#### CLINICAL RELEVANCE/APPLICATION

Features extracted from the deep learning models predict overall survival well. After prospective validation, this model based on FDG-PET/CT could predict lung malignancy progression and overall survival with high accuracy, and therefore help inform treatment options and improve patient care.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPCH-4

### Effect of Emphysema on Lung Nodule Detection Performance of AI Software

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Nikolaos Sourlos (*Presenter*) Nothing to Disclose

#### PURPOSE

Emphysema influences the appearance of the lungs in chest CT scans. It is unclear how well artificial intelligence (AI) based software performs in emphysema presence. The goal of this study is to check if there is a difference in lung nodule detection performance between an AI software and the human reader when emphysema is present.

#### METHODS AND MATERIALS

We selected 121 participants with (n=39) and without (n=82) emphysema (mean age 61±8, 48% men) from the Imaging in Lifelines cohort. Detection of nodules sized 30-300mm<sup>3</sup> by a commercial AI software was compared to human reading, and findings only detected by the reader or AI (discrepancies) were reviewed by an expert panel of two radiologists (gold standard). Using the gold standard, the detection performance was compared between AI and human reader for emphysema and non-emphysema groups, based on sensitivity, F1 score, and FP/scan. McNemar's test was utilized to check if there are differences between findings detected by AI and human reader.

#### RESULTS

The human reader detected 206 nodular findings and AI 223. The expert panel reviewed 211 discrepancies. Of these, 30 were actual lung nodules, 68 non-nodules, and 113 lymph nodes. In the emphysema group, AI sensitivity was 0.95 [95%CI 0.83-0.99] vs 0.87 [95%CI 0.73-0.94] for the human reader, with 0.51 FP/scan for AI vs 0.15 FP/scan for the human reader (for nodules p=0.45, for FPs p=0.01). In the non-emphysema group, AI's sensitivity was 0.87 [95%CI 0.77-0.93] vs 0.80 [95%CI 0.69-0.88] for the human reader, with 0.23 FP/scan for AI vs 0.28 FP/scan for the human reader (for nodules p=0.40, for FPs p=0.64). AI performance based on the F1 score was slightly lower than that of the human reader in participants with emphysema (0.77 [95%CI 0.68-0.84] vs 0.86 [95%CI 0.77-0.92] respectively), whereas performance of AI was slightly better than the human reader in non-emphysema participants (F1 score 0.81 [95%CI 0.74-0.87] vs 0.75 [95%CI 0.68-0.81] respectively).

#### CONCLUSION

Overall, sensitivity of AI for lung nodules was higher than for the human reader but at the cost of higher false positive rate in emphysema presence. This resulted in slightly worse performance of AI (based on F1 score) in emphysema but slightly better than the human reader in non-emphysema.

#### CLINICAL RELEVANCE/APPLICATION

AI software can sensitively detect lung nodules in individuals with and without emphysema at least as well as the human reader, but with a higher number of FPs in emphysema cases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPCH-5

### CT-derived Radiomics Signatures as a Prognostic Factor in Osteosarcoma Patients with Pulmonary Metastasis Treated with Tyrosine Kinase Inhibitors

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Shan Shui Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

The tyrosine kinase inhibitors (TKIs) have become the main therapy in relapsed or advanced unresectable patients with osteosarcoma (OS). However, no accurate predictive biomarkers for response to TKIs have been found or reported. This study aims to explore the prognosis value of CT-based radiomics signatures and develop a multidimensional nomogram for predicting the progression-free (PFS) in OS patients with pulmonary metastasis treated with TKIs.

#### METHODS AND MATERIALS

A total of 90 OS patients with pulmonary metastasis were retrospectively enrolled in this study and were randomly divided into a training cohort (60) and a testing cohort (30). A total of 854 radiomics features were extracted from the segmentation of regions of interest based on baseline chest CT images. The intra-class correlation coefficient (ICC) was implemented to evaluate the feature reproducibility and stability. Only features with ICC greater than 0.8 were retained. The random survival forest (RSF) was performed to select features and generate radiomics signatures. Kaplan-Meier survival analysis with log-rank test was implemented for univariate selection. Two multivariate cox proportional hazards regression models were established with radiomics signatures and clinical factors (R-model and C-model) respectively. A multidimensional nomogram was then built based on all predictive parameters (RC-model). The discrimination abilities, goodness of fit and clinical benefits of models were validated and compared on both training and testing sets.

#### RESULTS

The R-model and radiomics signatures which was constructed with these 37 features showed good predictive ability and prognostic value in both training and testing cohorts (Training: C-index, 0.798, log-rank test,  $p < 0.0001$ ; Testing: C-index, 0.775, log-rank test,  $p = 0.04$ ). There are significant differences in C-index between the C-model from the R-model and RC-model in both training and testing cohorts (C-model: C-index, 0.567 and 0.556; RC-model: C-index, 0.798 and 0.773; all  $p < 0.05$ ). The calibration curves based on 12 and 24-month survival prediction showed better agreement between the predicted and actual probability of PFS in the R-model and RC-model than the C-model. The decision curve analysis curves showed that the R-model was similar to the RC-model, and gained much more net benefits than the C-model.

#### CONCLUSION

Radiomics signature derived by chest CT images is a potential predictor for the response to TKIs in OS patients with pulmonary metastasis.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics could be promising for identifying whether OS patients with relapsed or advanced unresectable disease have a good prognosis after treatment with TKIs and personalize risk stratification and treatment decisions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPCH-6

### Radiogenomics For EGFR Mutation Status Prediction in CT Images: Impact Of Model Design on Performance and Prospective Generalizability

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Jacob Gordon, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We hypothesized that design choices could affect predictive performance and generalizability of radiogenomic models. We investigated the impact of feature extraction and selection approaches on models developed to predict EGFR mutation status (EGFRm+/-) in NSCLC, assessing robustness on two different input CT image types.

#### METHODS AND MATERIALS

We analyzed CT images from CT and PET/CT studies of US patients with NSCLC from TCIA (25% EGFRm+). Two feature extraction techniques were compared: hand-crafted features from segmented lesions and deep features from a pre-trained ResNet applied to a bounding box around the largest tumor. Principal component analysis (PCA) or Least Absolute Shrinkage and Selection Operator (LASSO) was used to select 5 features prior to classification by a support vector machine, with model performances evaluated via 5-fold cross validation AUC. Splits were stratified by EGFRm and disease stage. Prospective generalizability was evaluated using a temporal split (80:20 based on shifted dates). AUCs were reported as median and interquartile range.

#### RESULTS

When predicting EGFR status from diagnostic CT images (n=171), hand-crafted features selected either with PCA or LASSO resulted in effective stratification: AUC of 0.80 (0.73 - 0.80) and 0.80 (0.69 - 0.82), respectively, and encouraging prospective generalizability (0.86 for PCA and 0.76 for LASSO). By contrast, deep features showed poor performance using either PCA (0.60 [0.60 - 0.67]) or LASSO (0.46 [0.44 - 0.66]) as well as poor prospective generalizability (0.68 and 0.38, respectively). When utilizing low-fidelity CT from PET/CT studies (n=134), hand-crafted features selected with PCA resulted in an AUC of 0.75 (0.73 - 0.77) vs. 0.66 (0.64 - 0.76) for LASSO. However, LASSO showed better prospective generalizability (0.79 vs 0.76). In this dataset, deep features combined with PCA showed improved predictive power compared with LASSO: AUCs of 0.72 (0.69 - 0.8) and 0.47 (0.46 - 0.67), respectively. With regard to prospective generalizability AUCs were 0.73 and 0.44 for PCA and LASSO, respectively.

#### CONCLUSION

Performance and prospective generalizability for predicting EGFR mutation status varied widely across design settings. Tumor-based hand-crafted features filtered by PCA performed better than deep feature-based approaches regardless of image type. The effectiveness of the hand-crafted feature models supports the potential of radiogenomics in early identification of patients likely to harbor EGFR mutations.

#### CLINICAL RELEVANCE/APPLICATION

Treatment planning in NSCLC depends on EGFRm. Radiogenomic models may help to rapidly identify patients who may harbor EGFRm. However, rigorous analysis of model design is key to successful model development.

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## Abstract Archives of the RSNA, 2023

T2-SPCH-7

### Impact of Body Composition on Lung Tumor Growth

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Jiantao Pu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung nodules, a sign of lung cancer, are common abnormal findings on low-dose computed tomography (LDCT). After a lung nodule is detected, the next step is to assess its likelihood of being cancerous, usually by monitoring its growth rate through follow-up CT scans. A nodule's growth rate can suggest its chance of being malignant and indicate the need for further tests such as biopsy or positron emission tomography (PET). This study aims to investigate the potential impact of body composition tissues as depicted on LDCT on tumor growth over time.

#### METHODS AND MATERIALS

We conducted a study involving 109 subjects (55 male and 54 female) who had undergone multiple LDCT lung cancer screenings and were found to have lung nodules on their baseline CT scans. The nodules identified on both baseline and follow-up scans were segmented, and their doubling time (DT) in days was calculated. These subjects were grouped based on a DT threshold of 365 days. We also segmented five different body composition tissues depicted on the baseline LDCT scans were segmented, including skeleton muscle (SM), subcutaneous adipose tissue (SAT), visceral adipose tissue (VAT), intramuscular adipose tissue (IMAT), and bone, and computed their volumes and densities in Hounsfield unit (HU). The backward stepwise multivariable logistic regression analysis was used to identify the body composition features associated with DT while adjusting for potential confounding factors, such as age, gender, pack/year, and presence of emphysema. The multicollinearity was checked by the variance inflation factor (VIF), where  $VIF > 3.0$  indicates high collinearity. The area under the receiver operating characteristics (ROC) curve (AUC) was used to evaluate the performance of the prediction models using a 5-fold cross-validation method.

#### RESULTS

The identified CT-derived body composition features significantly associated with DT include VAT volume ( $p=0.043$ ) and SAT volume ( $p<0.001$ ), while SM density is marginally significant ( $p=0.067$ ). Their combination achieved an AUC of 0.717 (95% CI: 0.619-0.814).

#### CONCLUSION

Body composition characteristics are significantly associated with the growth rate of a lung nodule over time and may be considered as novel image biomarkers to facilitate the assessment of indeterminate lung nodules detected in the screening setting.

#### CLINICAL RELEVANCE/APPLICATION

Approximately 50% of individuals who undergo LDCT lung cancer screening are found to have pulmonary nodules. Although the majority of lung nodules identified on CT scans (>95%) are not malignant, their presence can be worrisome for healthcare providers and anxiety-provoking for patients. Therefore, it is imperative to identify new biomarkers that can aid in the evaluation of indeterminate nodules.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPCH-8

### Preoperative CT-based Radiomics Model to Predict Tumor Status of Spread through Air Space in Non-small Cell Lung Cancer

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Kaihua Lou (*Presenter*) Nothing to Disclose

#### PURPOSE

This study is to establish radiomics model that can predict the spread through air space (STAS) of non-small cell lung cancer before surgery, and to explore whether the model efficiency can be improved by peritumoral information.

#### METHODS AND MATERIALS

A total of 373 patients were retrospectively collected from the two centers between January 2015 to June 2022. Patients in Center 1 were randomly divided into the training group and the internal test group in a 7:3 ratio, with Center 2 serving as the external test group. Classical tumor region of interest (ROI) and expanded tumor ROI were delineated for each lesion on Shenrui scientific research platform. Correlation analysis and logistic regression are used for feature screening, and support vector machine classifier is used for the establishment of prediction model, which is verified in both internal and external test groups. Receiver operating characteristic curve and area under the curve (AUC) are used to evaluate the effectiveness of the prediction model.

#### RESULTS

In this study, five models were established to predict the STAS status of patients with non-small cell lung cancer, including one clinical model, two radiomics models (classic tumor radiomics model and expanded tumor radiomics model) and two combined models (classic tumor combined model and expanded tumor combined model). In the external test group, the seven screened radiomics features show relatively good performance in predicting the STAS state alone, and most of the features had AUC values greater than 0.80. Among the prediction models, the clinical model shows relatively poor prediction efficiency, with AUC value of 0.63; The classic tumor combined model showed a relatively good prediction efficiency, with the AUC value of 0.84, which was higher than that of the single radiomics model (AUC was 0.82 and 0.71, respectively) and the expanded combined tumor model (AUC was 0.76).

#### CONCLUSION

The results of this study showed that the seven selected radiomics features showed good efficiency in the identification of STAS status alone. The classical tumor radiomics model and the classical tumor combined model can predict the STAS status of patients well, but the expanded tumor ROI does not significantly improve the efficacy of the model.

#### CLINICAL RELEVANCE/APPLICATION

STAS status affects the choice of surgical methods and prognosis of patients. The model established in this study can predict STAS status before surgery, which is conducive to guiding the selection of clinical surgical methods.

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## Abstract Archives of the RSNA, 2023

T2-SPER-1

### The Impact of Dermoid Size on the Chance of Torsion and the Diagnostic Performance of CT Observations in Emergency Department Patients

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Maitray D. Patel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Evaluate performance of CT observations for diagnosing twisted dermoids based on dermoid size..

#### METHODS AND MATERIALS

Text search of consecutive CT reports and pathology records between 1/1/2010 and 5/31/2022 identified ED patients with an ovarian dermoid, symptoms relevant to possible ovarian torsion, and absence of CT observations indicating alternative diagnosis. Operative and clinical notes established outcome...Three abdominal radiologists blinded to history, outcome, and cohort creation independently evaluated a maximum-size-matched review cohort containing all twisted dermoids with approximately twice as many non-twisted dermoids, scoring 6 adnexal torsion CT observations using a Likert scale:●●● tubal thickening●●● whirlpool sign●●● concentric or asymmetric wall thickening●●● adnexal deviation●●● uterine deviation●●● pelvic fat infiltration..Observation diagnostic metrics (sensitivity/specificity/accuracy/PPV/NPV) were based on presence of the observation indicated by at least two of the reviewers..

#### RESULTS

325 patients had 350 studies (19 patients with 2 studies, 3 patients with 3 studies, 10 patients with bilateral dermoids), showing 39 twisted dermoids and 321 non-twisted dermoids. The 10.8% overall torsion prevalence varied by dermoid size:●●● <40 mm = 0/180 (0%)●●● 40-69 mm = 6/96 (6.3%)●●● 70-99 mm = 16/43 (37.2%)●●● 100-159 mm = 15/30 (50.0%)●●● =160 mm = 2/11 (18.2%)..Tubal thickening and whirlpool sign had highest diagnostic performance in the review cohort (39 twisted averaging 97 mm and 70 non-twisted averaging 99 mm; 35.8% torsion prevalence).●●● For 84 dermoids =70 mm: the review cohort had all 51 of 51 non-twisted and 33 of 33 twisted dermoids of this size-----Tubal thickening: 84.8%/70.6%/76.2%/65.1%/87.8%-----Whirlpool sign: 63.6%/84.3%/76.2%/72.4%/78.2%●●● For 25 dermoids 40-69 mm: to achieve size match, the review cohort had 19 of the 90 non-twisted and 6 of the 6 twisted dermoids of this size-----Tubal thickening: 50.0%/89.5%/80.0%/60.0%/85.0%-----Whirlpool sign: 33.3%/94.7%/80.0%/66.7%/81.8%..Applying 40-69 mm diagnostic metrics to all 96 dermoids that size reduced tubal thickening PPV to 24.1% and reduced whirlpool sign PPV to 29.5%, reflecting more false positives due to low torsion prevalence..

#### CONCLUSION

10.8% of ovarian dermoids in ED patients with relevant symptoms and no other CT-identified cause for symptoms were twisted, involving no dermoids <40 mm, 6.3% of dermoids 40-69 mm, and 39.3% of dermoids ≥70 mm. Tubal thickening and whirlpool sign showed highest accuracy (80%), but with substantially lower PPV for dermoids <70 mm.

#### CLINICAL RELEVANCE/APPLICATION

Consider US confirmation of suspected dermoid torsion on CT when <70 mm due to low torsion prevalence.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPER-2

### Determination of the Most Suitable Monoenergetic Level of Virtual Monochromatic Images in Dual-source CT for the Diagnosis of Bowel Obstruction and Colitis

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Djamel Dabli (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the monoenergetic level with the best image quality for the diagnosis of colitis and bowel obstruction in an emergency context.

#### METHODS AND MATERIALS

The images of 64 patients who benefited from an enhanced abdominal-pelvis scan in dual-energy CT (DECT) mode for the diagnosis of colitis or bowel obstruction were retrospectively analyzed. Acquisitions were performed on a third-generation dual-source CT (DSCT) scanner at portal phase. Acquisitions were performed at 100/Sn150kVp. Mixed images (simulating images at 120kVp) were generated as well as virtual monochromatic images (VMI) at 40/50/60/70keV. An objective image quality assessment was performed by measuring contrast, noise and contrast-to-noise ratio (CNR). Subjective analysis was performed by anonymous scoring of the images by two radiologists evaluating the noise, smoothing, overall quality and diagnostic quality on a Likert scale. The results were compared between the different images using the Mann-Whitney U test for paired samples.

#### RESULTS

Of all the patients, 33 had intestinal obstruction, and 31 had colitis. The mean age was  $65\pm 20$  and  $49\pm 22$  years, respectively. The maximum CNR was measured in VMI at 60keV for both examination types, but the difference was significant only compared to 70keV for bowel obstruction and to 40keV, 70keV and mixed images for colitis. A good inter-observer agreement for all subjective criteria was found with a kappa index higher than 0.86. The VMI at 60keV presented higher scores for all criteria for bowel obstruction and colitis with no significant difference in smoothing score compared to mixed images ( $p=0.119$  and  $p=0.888$ , respectively).

#### CONCLUSION

VMI at 60keV could provide better image quality compared with other low monoenergetic levels and mixed images for the diagnosis of bowel obstruction and colitis.

#### CLINICAL RELEVANCE/APPLICATION

Improved diagnosis of colitis and digestive tract obstructions. Reduction of examination interpretation time in the emergency context by optimizing the DECT image workflow

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPGI-2

### Improving Preoperative Prediction of High-risk Esophageal Varices in Cirrhotic Patients: A Logistic Regression Model Based on Dual Energy CT Combined with Platelets

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Jiewen Chen (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the significance of preoperative prediction of high-risk esophageal varices (EV) in cirrhotic patients using ultrafast synchronized KV/mA switching dual energy CT (DECT), and to investigate the effectiveness of regression models that incorporate quantitative DECT parameters in conjunction with platelet for preoperative prediction.

#### METHODS AND MATERIALS

59 cirrhotic patients who underwent upper abdominal enhanced DECT scanning (Revolution Apex CT, GE) and gastroscopy were retrospectively enrolled. The risk of EV bleeding was divided into a low-risk group (LRV, n=38) and a high-risk group (HRV, n=21) based on gastroscopic findings. Basic clinical characteristics, hepatic transient elastography parameters derived by ultrasound (US), and DECT parameters in EV including portal phase esophageal venous iodine concentration (IC<sub>EV</sub>) was recorded for all patients. Non-parametric test was used to identify independent risk factors. Logistic regression models were constructed based on mixed models of DECT combined, and US combined with clinical factors, respectively. The receiver operating characteristic (ROC) curves, area under the ROC curve (AUC) and confusion matrix were calculated for assessing performance of two models.

#### RESULTS

A total of 59 patients were included, 38 with low-risk esophageal varices and 21 with high-risk esophageal varices. Non-parametric tests revealed significant differences between the high- and low-risk groups in terms of clinical characteristics including platelets (PLT), US factors including Liver stiffness, and DECT parameters including IC<sub>EV</sub>. The mixed model of US and PLT showed a 78% precision and sensitivity of 61.9%, specificity of 86.8%, positive prediction rate of 39% and negative prediction rate of 86.8%, and an AUC of 0.817. The mixed model of DECT and PLT demonstrated a precision of 83.1%, sensitivity of 76.2%, specificity of 86.8%, positive prediction rate of 48.5% and negative prediction rate of 86.8%, and an AUC of 0.916.

#### CONCLUSION

IC<sub>EV</sub> based on DECT combined with platelets can effectively exclude high-risk EV and has higher diagnostic efficacy than liver stiffness combined with platelets.

#### CLINICAL RELEVANCE/APPLICATION

According to Baveno VI guidelines, patients with cACLD at liver stiffness <20 Kpa and platelet count >150,000/ul may not require gastroscopy. The predictive model constructed for combined IC<sub>EV</sub> and PLT had better performance than the model combined liver stiffness and PLT, and was a potential model for non-invasive screening of high-risk EV in cirrhotic patients and avoiding gastroscopy.

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## Abstract Archives of the RSNA, 2023

T2-SPGI-3

### Feasibility Study of Quantitative Parameters of Single-source Dual Energy CT Spectrum Analysis Parameters to Predict Ki-67 Expression in Gastrointestinal Stromal Tumor

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hongyu Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility of preoperative prediction of Ki-6 expression in gastrointestinal stromal tumors(GIST)by multi-quantitative parameters of single-source dual-energy CT.

#### METHODS AND MATERIALS

The imaging data of 64 patients with GIST confirmed by single-source dual-energy CT three-phase energy spectrum enhanced scan and surgical pathology immunohistochemical index including Ki-67 were retrospectively analyzed. According to the Ki-67 expression index(>6 for high expression, <6 for low expression )the patients were divided into high expression group (n=28 )and low expression group(n=36 )The single energy CT value and iodine concentration IC value of the parenchymal area of the two groups were measured at 40-70 kV,and the normalized iodine concentration NIC)value and the slope of the energy spectrum curve were calculated.Univariate and multivariate Logistic regression analysis was performed on the two groups of patients to establish independent risk factors for predicting Ki-67 expression.

#### RESULTS

The CT values of 40-70 keV and NIC value in the arterial phase of the Ki-67 high expression group were higher than those in the low expression group, and the differences were statistically significant ( $P<0.05$ ), while the differences in the slope of the energy spectrum were not statistically significant ( $P>0.05$ ); The differences in the venous 40-70 keV CT values, slope of the energy spectrum and NIC values between the two groups were not statistically significant ( $P>0.05$ ). The CT values of 40~70 keV and slope of the energy spectrum value in the delayed phase of the Ki-67 high expression group were lower than those in the low expression group, and the differences were statistically significant ( $P<0.05$ ), while the differences in NIC values were not statistically significant ( $P>0.05$ ).Univariate and multivariate logistic regression showed that arterial phase,delayed phase 40KeV,70KeV CT values,and standardized iodine concentration values were independent risk factors for predicting Ki67 high expression.

#### CONCLUSION

Preoperative single-source dual-energy CT spectral parameters are helpful in predicting the expression of Ki-67 in gastrointestinal stromal tumors before surgery.

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## Abstract Archives of the RSNA, 2023

T2-SPGI-4

### Equilibrium Phase Imaging of the Abdomen on Photon-counting CT: Assessment of the Value of 50-keV vs 70-keV Imaging

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Toru Honda, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Equilibrium phase (EP) imaging of the abdominal CT has several diagnostic values but suffers from low contrast. The aim of this study was to perform the quantitative and qualitative assessments of virtual monochromatic images (VMIs) generated by photon counting CT (PCCT) during abdominal EP.

#### METHODS AND MATERIALS

This study included 20 patients who underwent abdominal dynamic contrast-enhanced CT using PCCT for the assessment of liver and pancreatic diseases including four patients with hepatocellular carcinoma and seven patients with pancreatic solid tumor. Portal venous phase (PVP) imaging was reconstructed to VMIs at 70 keV and EP imaging was reconstructed at 50 keV and 70 keV. One radiologist placed regions of interest on the three images and signal-to-noise ratio (SNR) were measured for the liver parenchyma, portal vein, hepatic vein, pancreas, and adrenal glands, as well as calculating the contrast-to-noise ratio (CNR) of the hepatic vessels and lesions. Two radiologists assessed the image quality using a 5-point scale regarding image noise, sharpness, organ and lesion conspicuity, and overall image quality. Friedman's test was used for the comparison among the three imaging.

#### RESULTS

The SNRs at 50 keV-EP imaging were significantly higher for the hepatic vessels ( $p < 0.05$ ), equivalent for the pancreas and adrenal glands, and significantly lower for the liver parenchyma compared with 70 keV-EP imaging ( $p < 0.05$ ). SNRs at the 50 keV- and 70keV-EP imaging were significantly lower than those at the 70 keV PVP imaging for all structures ( $p < 0.05$ ) except for the equivalent SNR for the portal vein at 50 keV-EP. CNRs of the hepatic vessels at 50 keV-EP were significantly higher than those at 70 keV-EP, but significantly lower than those at 70 keV-PVP ( $p < 0.05$ ). There were no significant differences among the three images in the CNR of the lesions. In the qualitative analyses, 70 keV-EP and -PVP imaging showed significantly better noise, sharpness, and overall image quality than 50 keV-EP imaging for both readers ( $p < 0.05$ ). The conspicuity of the hepatic vessels at 50 keV-EP were significantly higher than that at 70-keV EP for both readers ( $p < 0.05$ ), and equivalent to that at 70 keV-PVP for one reader. Conspicuity of the lesions and adrenal veins were significantly the highest at 50 keV-EP.

#### CONCLUSION

Although 50 keV-EP imaging had worse image quality, it provided the best conspicuity of hepatic or pancreatic lesions and adrenal veins compared with 70 keV-EP and 70 keV-PVP imaging.

#### CLINICAL RELEVANCE/APPLICATION

Virtual monoenergetic imaging at 50 keV during the equilibrium phase of abdominal CT may be helpful for the assessment of hepatocellular carcinoma, pancreatic cancer, and adrenal veins.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPGI-5

### The Extracellular Volume Fraction with Iodine (water) Image of Dual-energy Computed Tomography in Predicting P53 Expression of Rectal Cancer

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Chen Anliang (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the feasibility of extracellular volume (ECV) fraction determined with iodine(water) image of dual-energy computed tomography (DECT) for prediction of P53 expression of rectal cancer.

#### METHODS AND MATERIALS

A retrospective analysis was performed on 41 rectal cancer patients confirmed with P53 expression according to their postoperative pathology results who received abdominal enhanced DECT in our hospital. They were divided into group 1 (high-group; 21 patients; 14 male, 7 female, mean age: 67.95 years, range: 52-91 years) and group 2 (low-group; 20 patients, 15 male, 5 female, mean age: 64.60 years, range: 44-89 years) according to their P53 expression. Three ROIs were placed in the largest layer of rectal cancer in iodine(water) images created from equilibrium-phase contrast-enhanced DECT images. The iodine values of the left external iliac artery or femoral artery at the same layer with lesions were also measured. The ECV fraction were calculated and were analyzed with independent sample t-test. The ROC curve was generated using the ECV fraction, and the area under curve (AUC) was calculated to analyze the diagnostic performance of using the ECV fraction in predicting P53 expression of rectal cancer.

#### RESULTS

There was a statistically significant difference in the ECV fraction between high-group ( $45.83 \pm 9.76\%$ ) and low-group ( $55.81 \pm 12.83\%$ ) ( $p < 0.05$ ). The AUC, maximum Youden index and diagnostic threshold of using the ECV fraction for prediction of P53 expression of rectal cancer was 0.717, 0.407 and 56.73%, and the sensitivity and specificity were 55.0% and 85.7%, respectively.

#### CONCLUSION

ECV fraction determined with equilibrium contrast-enhanced iodine(water) image of DECT images was useful for predicting P53 expression of rectal cancer.

#### CLINICAL RELEVANCE/APPLICATION

ECV fraction created from gemstone spectral imaging (GSI) has a prospective clinical application in predicting the P53 expression of rectal cancer for the treatment decision-making.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPGI-6

### Assessment of the Liver Low-density Lesions with a Spectral CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Ying Xu (*Presenter*) Nothing to Disclose

#### PURPOSE

This study was aimed to compare and evaluate the image quality of intra-hepatic low-density lesions in spectrum computed tomography (CT) with different monochromatic energy images in the arterial phase, the portal vein phase, and the delayed phase, respectively, and to explore the exact monochromatic value of optimum image quality.

#### METHODS AND MATERIALS

Patients with intra-hepatic low-density lesions were prospectively enrolled in our institution. GE Revolution CT was used to perform enhanced upper abdominal scan. Adaptive statistical iterative reconstruction (ASIR-V) was set with 40%, 50%, 40%, and 30% for true non-enhanced abdominal scanning, enhanced abdominal scanning in the arterial phase, the portal vein phase, and the delayed phase, respectively. The arterial phase and the portal vein phase applied a spectral mode with fast switch 80/140 kV, and tube current was automatic (range from 100 to 600 mA). The average CT value and standard deviation (SD) of the lesions were measured and recorded at 50, 60, 70 and 80 keV in the arterial phase, the portal vein phase respectively, and the signal-to-noise ratio value was calculated and compared pair-to-pair. Paired-samples t-test was used to compare the mean value of SNR and SD in the arterial phase, the portal vein phase, and the delayed phase, respectively.  $P < 0.05$  was considered statistically significant.

#### RESULTS

A total of twenty patients were prospectively included finally (male: 5, female: 15; mean age: 65.4 years old), with a total of 35 lesions. For the arterial phase, the signal-to-noise ratio values of the lesion in the imaging with 80KeV was higher than those of 50, 60 and 70 keV ( $12.75 \pm 1.16$ ,  $0.49 \pm 1.18$ ,  $0.71 \pm 1.30$ ,  $0.94 \pm 1.41$ , respectively;  $P < 0.001$ ), and there was no statistically significant difference among the 50, 60, and 70 keV groups. For the portal vein phase, the signal-to-noise ratio values of 50, 60, 70, and 80 keV groups were  $1.32 \pm 1.08$ ,  $1.41 \pm 1.26$ ,  $1.49 \pm 1.44$ ,  $1.58 \pm 1.61$ , respectively; and there was no statistical difference among the different keV groups ( $P > 0.05$ ).

#### CONCLUSION

The image quality with 80keV of single-energy imaging of spectrum CT was significantly better than that of other monochromatic energy (50, 60, 70 keV) imaging in the arterial phase. But for the portal vein phase imaging, there was no statistical difference in the imaging quality of the liver lesions in scans with different keV. As a result, it is supposed to reduce the radiation dose of scans by decreasing the keV in the portal vein phase without compromising the image quality prospectively, but not in the arterial phase.

#### CLINICAL RELEVANCE/APPLICATION

It is supposed to reduce the radiation dose of scans by decreasing the keV in the portal vein phase without compromising the image quality prospectively, but not in the arterial phase.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPGI-7

### The Difference Between Virtual Non-enhanced Imaging and True Non-enhanced Imaging: A Comparison Study

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Ying Xu (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the difference in image quality and radiation dose between virtual non-enhanced (VNE) images and true non-enhanced (TNE) images in the arterial and the portal phase.

#### METHODS AND MATERIALS

Sixty-four patients were enrolled in this prospective study. GE Revolution CT was used for enhanced upper abdominal scanning. Adaptive statistical iterative reconstruction (ASIR-V) were set with 40%, 50%, 40%, and 30% for true non-enhanced abdominal scanning, enhanced abdominal scanning in arterial phase, portal vein phase, and delayed phase, respectively. The effective radiation dose (ED) and the size-specific dose estimation (SSDE) of virtual non-enhanced images and true non-enhanced images were calculated respectively. The mean CT values and standard deviation (SD) of liver parenchyma, spleen parenchyma and renal cortex in VNE images and TNE images were measured, and the signal-to-noise ratio (SNR) was calculated.

#### RESULTS

For radiation dose, the ED of VNE images gained from portal vein phase was the highest, followed by VNE from arterial phase reconstruction, and the lowest ED belonged to TNE images ( $4.59 \pm 1.98$ ,  $3.81 \pm 1.44$ ,  $3.67 \pm 1.71$ , respectively). The differences of ED between the latter two were significant compared with the portal phase. The significant difference was detected only between VNE images from the arterial (SSDEa) and the portal phase (SSDEp) ( $1.47 \pm 2.27$  vs  $10.50 \pm 2.03$ ,  $p=0.036$ ). For image quality: Liver There was no significant difference between the SNR of VNE images (SNRVNE) obtained from arterial phase and TNE (SNRTNE) ( $p=0.083$ ). The SNRVNE obtained from portal phase was better than that obtained from arterial phase and the SNRTNE. (SNRTNE vs portal SNRVNE:  $7.26 \pm 1.32$  vs  $12.85 \pm 2.21$ ,  $p < 0.001$ ; arterial SNRVNE vs portal SNRVNE:  $6.53 \pm 1.98$  vs  $12.85 \pm 2.21$ ,  $p < 0.001$ ). Spleen: The SNRVNE obtained from arterial phase and portal phase were better than that of SNRTNE and the difference was statistically significant (all  $p < 0.001$ ). Kidney The SNRVNE obtained from arterial phase and portal phase were better than that of SNRTNE and the difference was statistically significant (all  $p < 0.05$ ).

#### CONCLUSION

In terms of the radiation dose, the dose of VNE from portal vein was still the highest for ED, but its SSDE was the lowest instead. In terms of image quality, the VNE images of some organs at certain phases (such as hepatic portal phase, splenic artery phase and portal vein phase, renal artery phase and portal vein phase) were better than that of TNE images.

#### CLINICAL RELEVANCE/APPLICATION

Spectral CT was comparable to conventional CT in image quality, and even superior than it in the imaging of some organs, while radiation dose needed to be further verified.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPGU-1

### From Biopsy to Resection: Using CT to Predict Histologic Upgrading of Renal Masses

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Sandra Fiset, MD, BEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Despite the popularity of renal mass biopsy, discordance can occur between the biopsy nuclear grade and the surgical specimen grade. Nuclear grade affects recurrence and mortality rates, and any discordance can lead to suboptimal management. The rate of tumor growth has been used to predict upgrade despite limited literature evidence. This study aims to create a risk prediction model for upgrading of clear cell renal cell carcinoma (ccRCC) based on CT imaging features and compare its performance against tumor growth rate.

#### METHODS AND MATERIALS

This IRB-approved single-center retrospective case-control study included 114 patients (76 male, median age=62 years) who underwent renal mass biopsy followed by surgical resection. The upgrade group (n=57) was defined as low grade ccRCC (ISUP 1 or 2) on biopsy and high grade (ISUP 3 or 4) on subsequent nephrectomy, while the control group (n=57) had no upgrade. The average growth in largest dimension per month and tumor volume doubling time were calculated using available cross-sectional imaging prior to resection. Twenty-two imaging features were assigned utilizing pre-biopsy renal triphasic CT. Features that had inadequate differentiation following univariable logistic regression were excluded. Remaining features were included in a multivariable logistic regression model using a stepwise model selection. The predictive performance of the final risk prediction model was evaluated using repeated 10-fold cross-validation and compared with measures of tumor growth.

#### RESULTS

Arterial enhancement, delayed enhancement, relative arterial enhancement, relative delayed enhancement, arterial wash-in and imaging necrosis were significantly different between the groups ( $p<0.05$ ). Importantly, tumor growth rate and doubling time were not statistically different. Four features (1 qualitative, 3 quantitative) were included in the final risk prediction model: mass heterogeneity ("heterogeneous" or "homogeneous"; OR=0.53), arterial enhancement (OR=0.46), relative delayed enhancement (OR=0.64), and enhancement ratio (OR=4.01). Using this model, a nomogram was constructed to predict probability of upgrade. The final risk prediction model resulted in a mean AUC of 0.69 (SD=0.17). This model performed better than measures of tumor growth ( $p<0.001$ ).

#### CONCLUSION

A model using CT imaging features performed better than measures of tumor growth and can be used to stratify the risk of renal mass upgrade at the time of surgical resection.

#### CLINICAL RELEVANCE/APPLICATION

This model identifies patients appropriate for active surveillance (low likelihood of upgrade) or immediate surgery (high likelihood of upgrade), avoiding the need for follow up imaging to assess tumor growth rates.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPGU-2

### **Beyond the Knife: A Retrospective Study on Surveillance-Based Management of Bilateral Multifocal Renal Oncocytomas**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Bilateral multifocal renal oncocytomas account for approximately 4-6% of renal oncocytomas, and their optimal management strategy is still not well-defined due to a lack of consensus guidelines. This study aims to compare clinical, functional, and oncological outcomes of active surveillance (AS) versus surgical management in patients with bilateral multifocal renal oncocytomas, and to determine the appropriate management strategy for this group of patients.

#### **METHODS AND MATERIALS**

We conducted an IRB-approved retrospective cohort study on 62 patients with histopathologically confirmed bilateral multifocal renal oncocytomas. Patients with genetic alterations as seen in Birt-Hogg-Dubé syndrome or inadequate follow-up were excluded. The cohort was divided into three subgroups based on management received: active surveillance (AS) only, single unilateral surgery followed by AS, and multiple/bilateral surgeries. Clinical and imaging data were analyzed for longitudinal monitoring of tumor growth, new tumor/recurrence, and renal function changes. Statistical analysis was conducted to compare outcomes between the three management strategies.

#### **RESULTS**

The median age of the patients (n=62) was 64 years (IQR 57.5-69), and 49 (79%) were males. Patients were followed for an average of 5.5 years (2.8-7.2 years), and the median number of tumors per patient was 7, with no metastasis observed in any group. The overall median tumor growth rate was 0.3 cm/year (IQR 0.1-0.5), with no significant difference among the three management groups (p=0.73). The median age at death was 78.5 years (IQR 74.5-81.3, p=0.37), and no significant differences were found in serum creatinine levels between the three groups at the initial time point (p=0.67), final time point (p=0.5), or change in serum creatinine levels over the period of treatment (p=0.7).

#### **CONCLUSION**

Management strategies for bilateral multifocal renal oncocytomas are challenging, and clinicians face difficulties in choosing between surgical management and active surveillance. Findings of our study suggest that active surveillance is a safe and viable alternative to surgical management in patients with bilateral multifocal renal oncocytomas, with no detrimental impact on clinical, oncological, or functional outcomes as compared to surgical management.

#### **CLINICAL RELEVANCE/APPLICATION**

Active surveillance may be a safe alternative to surgical management of bilateral multifocal renal oncocytomas, especially for elderly patients or patients with comorbidities who are at a heightened risk of developing surgery-related adverse events.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPGU-3

### Predicting Growth Rate of Clear Cell Renal Cell Carcinoma: A Comprehensive Analysis using Machine-Learning

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Pouria Yazdian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Von Hippel-Lindau (VHL) syndrome is associated with multiple benign and malignant neoplasms, including renal cell carcinomas (RCC), resections of which overtime can lead to end-stage renal disease (ESRD). Active surveillance is recommended for small renal masses to avoid unnecessary surgeries while preserving renal function. However, there is currently no reliable method to predict the growth rate of renal lesions.

#### METHODS AND MATERIALS

A single-center retrospective study of 55 patients with VHL was conducted from 2015 to 2021. Prior to partial or radical nephrectomy, patients underwent two MRI scans, and tumors were pathologically confirmed. Two abdominal radiologists assessed lesions based on 12 unique anatomical and sequence-specific imaging parameters using preoperative MRI scans. Lesions were divided into slow-growing (SG) and rapid-growing (RG) groups based on a 0.5 cm/year growth rate threshold. A stacked ensemble technique was employed to combine XGBoost and Random Forest algorithms, creating models that associate radiomic signatures with tumor grades. Optimal algorithm parameters were determined using 5-fold cross-validation, and performance was assessed on 100 different random test and train set combinations (85% train, 15% test) to identify the best model. Results were reported using positive predictive value (PPV), sensitivity, F1 score, and area under the Receiver Operating Characteristic curve (AUC-ROC). by using inter class correlation between two readers, they had moderate agreement.

#### RESULTS

The stacked ensemble machine-learning model demonstrated promising performance in predicting the growth rate of clear cell renal cell carcinoma in VHL patients. The model demonstrated high accuracy (90%) and promising performance metrics, including a precision of 0.97 for SG tumors, recall of 0.98 for RG tumors, and an F1 score of 0.92 and 0.88 for SG and RG, respectively. The macro average for precision and recall was 0.89 and 0.92, respectively, with an overall F1 score of 0.90. The Matthews Correlation Coefficient (MCC) was 0.52, indicating a moderate correlation between the model's predictions and the true growth rates.

#### CONCLUSION

This study demonstrates the potential utility of using a stacked ensemble machine-learning model for predicting the growth rate of clear cell renal cell carcinomas in VHL patients. The model's high performance suggests it could be a valuable tool for guiding patient management and improving clinical decision-making in the active surveillance of small renal masses.

#### CLINICAL RELEVANCE/APPLICATION

This machine-learning model could help optimize patient care by reducing the need for unnecessary surgeries, preserving renal function, and enabling timely interventions for patients with renal neoplasms.

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## Abstract Archives of the RSNA, 2023

T2-SPHN-2

### Artificial Intelligence Model to Predict Bethesda Score in Thyroid Nodule CT Imaging

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Isabel Gomez Alonso, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this work is to predict the Bethesda score of thyroid nodules by performing radiomic analysis of these nodules on CT images.

#### METHODS AND MATERIALS

This retrospective cohort study was performed by selecting 57 adult patients with thyroid nodules who underwent a CT scan of the neck and a fine needle aspiration biopsy between 2013 and 2021. Segmentation of the thyroid nodules was performed by three PGY4 radiology residents using CT images. Subsequently, 3D Slicer was used to extract the radiomic data of every segmented section in each patient. Data were processed with Python, using logistic regression and Machine Learning algorithms to predict the different Bethesda scores (score II-V) based on the radiomic features obtained. Visual assessment of the nodules was also performed by the three PGY4 radiology residents. Results were processed using IBM SPSS Statistics software. The whole process was supervised by a 5 year experienced head and neck radiologist and a 30 year experienced neuroradiologist.

#### RESULTS

In differentiating Bethesda II and V nodules, both logistic regression and K means showed a low performance (45% precision, 33% sensitivity and 57% specificity for logistic regression and 51% precision for K means). Random Forest classifier displayed 69% precision, 100% sensitivity and 100% negative predictive value, being able to detect all Bethesda V nodules. Finally, Support Vector Machine classifier showed 77% precision (75% sensitivity, 77% specificity, 87% negative predictive value).

#### CONCLUSION

Texture analysis-based artificial intelligence algorithms have demonstrated a 77% precision in differentiating Bethesda II and V nodules on CT imaging.

#### CLINICAL RELEVANCE/APPLICATION

Thyroid nodule management is complex and often requires to perform invasive diagnostic procedures. Radiologists using artificial intelligence models may help predicting nodule malignancy and, consequently, reducing limitations of current diagnostic algorithms.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPHN-4

### **Pioneering a Multi-Modal Deep Learning Approach for Hypopharyngeal Cancer Segmentation: Comprehensive Evaluation and Performance Analysis using Diverse MRI Data Across Multiple Institutions**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

HE LIN KU, MA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Accurately annotating tumors is a time-consuming process, thus it is crucial to design an approach that can automate this process while maintaining accuracy. The study aims to develop and evaluate a multi-modality deep learning-based segmentation model for accurate and efficient delineation of hypopharyngeal cancer from T1-weighted image, contrast-enhanced T1-weighted image (T1c), and T2-weighted MRI scans. We utilized the nnU-Net architecture, ensembling techniques, and multi-institution datasets to improve the performance of our model.

#### **METHODS AND MATERIALS**

In this study, we used a dataset of 209 patients with hypopharyngeal cancer from National Taiwan University Hospital (NTUH) to train and ensemble three separate nnU-Net models on T1-weighted image, contrast-enhanced T1 (T1c), and T2-weighted MRI scans. To determine the best combination of models, we utilized nested five-fold cross-validation and ensembled the cross-validation results. The tumor annotations were performed by experienced oncologists on the patients treated between February 2011 and January 2015. We evaluated our model using various metrics on a testing dataset from Chang Gung Memorial Hospital (CGMH), which includes 91 patients treated between 2003 and 2013. The nnU-Net architecture was selected for this study due to its remarkable performance in various medical image segmentation challenges, which is expected to improve the segmentation results of hypopharyngeal cancer from multi-modality MRI scans. It consists of a 3D U-Net with an end-to-end pipeline that includes pre-processing, data augmentation, and post-processing.

#### **RESULTS**

The average tumor size in our training dataset from NTUH was 27.5 cm<sup>3</sup>. Our ensemble model achieved a mean Dice similarity coefficient (DSC) of 0.92 during training. On the independent testing dataset from CGMH our model achieved an overall DSC of 0.75 and a Hausdorff distance of 19 mm, demonstrating its robustness and generalizability.

#### **CONCLUSION**

The developed deep learning-based segmentation model can accurately and efficiently delineate hypopharyngeal cancer from multi-modalities and multi-institutional MRI scans, which has the potential to enhance clinical diagnosis and treatment planning for patients with hypopharyngeal cancer. The nnU-Net architecture and ensembling approach improve the segmentation performance and increase the robustness of the model, and have the potential to be applied to other cancer types and imaging modalities.

#### **CLINICAL RELEVANCE/APPLICATION**

Our metric analysis showed that the model has the potential to efficiently optimize hypopharyngeal cancer segmentation workflows and to be implemented in clinical decision support.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPHN-5

### AI for Automatic Localization and 3D Segmentation of Lymph Node Metastasis in Head and Neck Cancer

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Miriam Rinneburger, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Evaluation of an AI algorithm for localization and segmentation of lymph nodes (LNs) in contrast-enhanced computed tomography scans (CECTs) of the head and neck region on patients with head and neck cancer with confirmed LN metastasis.

#### METHODS AND MATERIALS

We searched our local database for patients sent from the otorhinolaryngological department from January 2000 to January 2021 for staging of a head and neck cancer who had at least one untreated LN metastasis confirmed through central necrosis, PET/CT-positivity, positive histology and/or progression/regression in a follow up scan. All 125 CECTs had a slice thickness of 1-2.5 mm, were conducted supine with venous contrast enhancement and reconstructed with a soft kernel. Patient age was 61,96 +/- 10,7 years, 25 patients were female and 100 male. On this cohort, we applied our existing 3D LN segmentation model. Independently, all LNs with a short axis diameter of  $\geq 5$  mm were manually segmented by an experienced radiologist and double-checked by a second radiologist as a reference. Additionally, LN metastases were labelled to evaluate the AI model's performance specifically on LN metastases.

#### RESULTS

In 125 CECT scans of the head and neck, the AI model marked 4271 LNs whilst 3656 LNs were segmented manually. Out of 544 LNs manually labelled as a clinical metastasis, the model detected 486. Overall, an average localization rate (LR) of 83.56% with 12.8 false positives (FPs) per CT scan was achieved. On average, only one of these FPs had an SAD of  $\leq 5$ mm. The model showed a statistically significant ( $p = 0.0029$ ) higher localization performance for metastatic LNs with an LR of 89.0% whilst for non-metastatic LNs, it reached an LR of 82.8%. The average global Dice accounts to 0.58 per CT scan. Segmentation accuracy was higher for non-metastatic LNs with a global Dice of 0.65 while it accounts to 0.42 for LN metastases. Sensitivity was higher in metastatic (0.69) than in non-metastatic LNs (0.58).

#### CONCLUSION

Our existing AI model for 3D segmentation of cervical LNs generalizes well to metastatic LNs. Overall, LR and segmentation sensitivity are higher in metastatic than in non-metastatic LNs whilst Dice is slightly worse. Clinical applicability of this model for metastatic LNs appears feasible.

#### CLINICAL RELEVANCE/APPLICATION

Automatic LN localization for N staging can speed up clinical practice. LN metastasis of head and neck cancer can differ from other malignancies in shape and texture. Thus, localization might need explicit training.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPIN-1

### TransUNet for Fully Automated Abdominal Multi-Organ Segmentation

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Khoschy Schawkat, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to validate the efficacy of CNN-Transformer hybrid architectures for multi-organ segmentation when applied to an independent, in-house dataset consisting of abdominal CT scans. The goal is to achieve a fully automated and highly accurate abdominal multi-organ segmentation computational framework that can be applied to the routine clinical workflow.

#### METHODS AND MATERIALS

The dataset consisted of 200 abdominal CT scans with 59 axial non-contrast and 131 contrast-enhanced abdominal (20 arterial phase, 90 portal venous phase, 19 late venous phase, and 12 elimination phase) clinical CT image series. Each CT volume consists of 44-392 slices of 512 x 512 pixels. The organ segmentations were performed manually and semiautomatically with manual verification on the liver, pancreas, left and right kidney, and spleen using free software for medical image processing (3D Slicer, version 4.11.0). We use the TransUNet architecture for our network, and train it using 5-fold cross validation with splits of 160/20 scans. TransUNet is trained on 4 organs of interest; liver, pancreas, kidneys and spleen. The 4 highest individual performing models are then ensembled. We report the average dice scores on a test set of 20 scans.

#### RESULTS

DICE scores for the labelmaps generated by the network, when compared against our ground truth images, for the liver, pancreas, kidneys, and spleen were 96.51, 83.02, 94.08, and 95.42, respectively. All organs of interest outperform the original scores reported in the authors' paper.

#### CONCLUSION

TransUNet, a U-Net structure in combination with transformers, achieves excellent performance in CT based multi-organ segmentation as shown in our independent in-house dataset.

#### CLINICAL RELEVANCE/APPLICATION

Large scale application of this fully-automated CT based multi-organ segmentation model allows for efficient assessment of volumetric and radiomics data.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPIN-2

### **Semi-Automated Longitudinal Performance Monitoring for Deployed Large Vessel Occlusion Detection Algorithm**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Chintan Shah, MD, MS (*Presenter*) Spouse, Employee, Merck & Co, Inc

#### **PURPOSE**

Real-world performance of artificial intelligence (AI) models can vary and degrade over time. However, local performance and monitoring are often overlooked and are resource-intensive. We built a semi-automated method in order to reduce the manual effort required for local performance monitoring of an AI algorithm, using intracranial large vessel occlusion (LVO) as a use case. We utilize a framework consisting of a combination of structured reporting (SR), language processing (LP), and manual review of reports to assess performance.

#### **METHODS AND MATERIALS**

Between January and May 2022, 1702 CTAs of the head and neck for stroke alert were processed with a commercial LVO detection algorithm (Viz LVO, Viz.ai). Scans were done at 17 different sites, including 12 hospitals, and 5 standalone ERs. Exams were interpreted by a neuroradiologist, asked to indicate concordance via an SR template. An analytical pipeline was developed for processing the reports utilizing KNIME analytics software (KNIME AG, Switzerland). Radiologist concordance was determined using SR when available. Language processing (LP) was then applied utilizing regular expression searches to identify positive or negative reports. LP results were reviewed to determine accuracy. Indeterminate reports were manually reviewed and categorized, as were those marked as discordant by either SR or LP. Summary performance statistics were calculated.

#### **RESULTS**

Radiologist compliance with the SR concordance statement was 57% (966/1702). Among the remainder, 74.3% (547/736) could be categorized as positive or negative reports utilizing LP, leaving 11% of original volume (189/1702) requiring manual review. Of exams marked as discordant in the SR template by the interpreting radiologist, 63% (42/67) were correctly categorized. The performance of LP in categorizing reports showed a sensitivity, specificity, negative- (NPV), and positive-predictive value (PPV) of 85, 95, 99, and 47%, respectively. After SR, LP and manual review, the sensitivity, specificity, NPV, and PPV of the commercial LVO detection algorithm were 77, 96, 98, and 59%, respectively.

#### **CONCLUSION**

SR alone was insufficient due to incomplete compliance and errors in categorization. The combined pipeline substantially reduced the workload of manual review better than structured reporting alone. The benefits persist after accounting for LP errors, which occurred more often with discordant than concordant results. We were able to corroborate local performance in this large multi-hospital dataset similar to that previously published.

#### **CLINICAL RELEVANCE/APPLICATION**

Incorrect AI inference can negatively impact patient care; local validation is necessary. A semi-automated pipeline can reduce the manual workload of this process.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPIN-3

### **MRI-based Radiomic Features Fail to Accurately Predict Primary Tumor Histology of Brain Metastases in External Validation: An Investigation of Class Imbalance and the Impact of Oversampling Techniques**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Quirin D. Strotzer, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Growing research demonstrates the ability to predict histology or genetic information of various malignancies using radiomic features extracted from imaging data. Our aim was to investigate MRI-based radiomics in predicting the primary tumor of brain metastases through internal and external validation, using oversampling techniques to address class imbalance.

#### **METHODS AND MATERIALS**

The local ethics committee approved this retrospective multicenter study. We included non-small and small cell lung cancer, melanoma, breast, and colorectal cancer (five-class classification). Internal train/validation/test data were acquired between 2003-2021 from 159 patients (422 metastases). External validation was performed with 67 patients (260 metastases) from the publicly available Stanford BrainMetShare dataset ([aimi.stanford.edu/brainmetshare](http://aimi.stanford.edu/brainmetshare)). Pre-processing included brain extraction, bias correction, co-registration, intensity normalization, and semi-manual binary tumor segmentation. 2889 radiomic and three location features were extracted from T1w, post-contrast T1w, FLAIR, and wavelet transforms for each sequence (eight decompositions). The internal dataset was split 80-20 into train/validation and test sets. Patients with multiple metastases were assigned to either the train/validation or test set to prevent data leakage. Various oversampling and machine learning techniques (five-fold cross-validation) were tested and evaluated on the test sets using accuracy, precision, recall, F1 score, AUC-ROC, and cross-entropy loss.

#### **RESULTS**

Baseline (no oversampling) internal test set performance was suboptimal with accuracy, F1 score, and AUC-ROC of 0.48, 0.27, and 0.66, respectively. Accuracy and F1 score were slightly improved after random oversampling of the training partition (0.49 and 0.39, respectively). The models were not able to generalize to the external test set. Incorrect data partitioning (oversampling before train/validation/test split) resulted in a massive overestimation of model performance.

#### **CONCLUSION**

Radiomics models' capability to predict histologic or genomic data from imaging should be critically assessed.

#### **CLINICAL RELEVANCE/APPLICATION**

Primary tumor histology of brain metastases is usually obtained by invasive biopsy, posing the risk of morbidity and mortality. AI methods could potentially noninvasively acquire this information.

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## Abstract Archives of the RSNA, 2023

T2-SPIN-4

### Unsupervised Learning of Chest Radiographs and Clinical Data Accurately Predicts Time to ICU Admission of COVID-19 Patients

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Justin Lu (*Presenter*) Nothing to Disclose

#### PURPOSE

To improve allocation of ICU resources to treat COVID patients, we developed an unsupervised learning pipeline that utilizes chest radiographs and clinical data to accurately predict time to ICU admission.

#### METHODS AND MATERIALS

This HIPAA-compliant study was performed with a waiver for informed consent following institutional review board approval. The training dataset consisted of 1834 COVID positive patients from March 9 and July 20, 2020 and the external testing dataset consisted of 475 COVID positive patients between March 1 and July 18, 2020. A vision transformer (ViT) autoencoder model was used to extract unsupervised imaging features from chest radiographs before undergoing dimensionality reduction using PCA to concentrate pertinent imaging characteristics. We then combined these imaging features with age, sex and common comorbidities prior to feeding into a partially unsupervised deep clustering survival machine (DCSM) for time to ICU prediction. DCSM characterizes each instance's survival information as a weighted combination of the learned expert distribution, which allows our model to better capture patient heterogeneity.

#### RESULTS

Of the 1834 patients (54.9 $\pm$ 19.8 years old, 51% Female), 493 were admitted to the ICU (27%) within 1.88  $\pm$  3 days. The DCSM model predicted time to ICU admission with a c-index of .731  $\pm$  .02 on the training dataset and .72  $\pm$  .01 on the external patient dataset.

#### CONCLUSION

We developed a pipeline with ViT autoencoder and DCSM models that incorporates radiography and clinical data to accurately predict time to ICU admission in COVID patients. This method can also be applied to other similar clinical problems.

#### CLINICAL RELEVANCE/APPLICATION

An unsupervised learning approach does not require manual annotation by a radiologist or healthcare worker and can be readily deployed in the clinical setting where it can be used to triage patients for ICU admission.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPIN-5

### Peritumoral and Intratumoral Texture Features Based on Multiparametric MRI and Multiple Machine Learning Methods to Preoperatively Evaluate the Pathological Outcomes of Pancreatic Cancer

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Xuhui Fan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiomics-based preoperative evaluation of lymph node metastasis (LNM) and histological grade (HG) might facilitate the decision-making for pancreatic cancer and further efforts are needed to develop effective models.

#### METHODS AND MATERIALS

The pancreatic cancer patients from the main center ( $n = 126$ ) were assigned to the training and validation sets at a 4:1 ratio. The patients from the other center ( $n = 40$ ) served as external test sets. The multiparametric MRI used in this study were: T2-weighted imaging, diffusion-weighted imaging, and dynamic contrast enhancement T1-weighted imaging. Peritumoral and intratumoral radiomics features were extracted which contained first-order, shape-based, and texture features. The following three-step method was applied to reduce the feature dimensionality: SelectKBest (a function from scikit-learn package), least absolute shrinkage and selection operator (LASSO), and recursive feature elimination based on random forest (RFE-RF). Six classifiers (random forest, logistic regression, support vector machine, K-nearest neighbor, decision tree, and XGBoost) were trained and selected based on their performance to construct the clinical, radiomics, and combination models.

#### RESULTS

12 significant features for LNM and 11 features for HG were obtained. Random forest and logistic regression performed better than the other classifiers in evaluating LNM and HG, respectively, according to the surgical pathological results. The best performance was obtained with the models that combined peritumoral and intratumoral features with area under curve (AUC) values of 0.944 and 0.892 in the validation and external test sets for HG and 0.924 and 0.875 for LNM.

#### CONCLUSION

Radiomics holds the potential to evaluate LNM and HG of pancreatic cancer. The combination of peritumoral and intratumoral features will make models more accurate.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics is a noninvasive diagnosis and prediction method with theoretically high accuracy. In this two-center study, radiomics models for predicting LNM and HD of pancreatic cancer are successfully developed, and they enable radiologists to preoperatively stratify the risk of pancreatic cancer and provide explicit guidance for surgical options.

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## Abstract Archives of the RSNA, 2023

T2-SPIN-6

### CFTR Modulator Therapy Influences Body Tissue Composition in Adults with Cystic Fibrosis: AI-based CT Analysis

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Marko Frings, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

A poor nutritional status is associated with worse pulmonary function and survival in patients with cystic fibrosis. CF transmembrane conductance regulator (CFTR) modulators can improve both pulmonary function and body weight, but more data is required to assess its effects on body composition.

#### METHODS AND MATERIALS

A pre-trained, deep-learning network was used to perform a fully automated body composition analysis (BCA) on chest CTs from adult patients with CF before (baseline) and after (longitudinal data) receiving triple-combination elexacaftor/tezacaftor/ivacaftor therapy. Muscle and adipose tissue were quantified and divided by bone volume to obtain body size-adjusted ratios. Results from BCA were correlated with lung function parameters and laboratory results.

#### RESULTS

At baseline, chest CT-based BCA was conducted in 85 patients, with 34 (40%) receiving either mono or dual-combination CFTR modulator therapy. Mono/ dual-combination CFTR modulator therapy was associated with higher adipose tissue ratios. Muscle ratio correlated with percent predicted FEV1 ( $r=0.465$ ,  $p<0.001$ ) and six-minute walk test ( $r=0.392$ ,  $p<0.001$ ). ETI therapy improved percent predicted FEV1 (+ 12 points,  $p<0.001$ ) in patients with CF at 3 months, independent of baseline BCA results. Follow-up chest CT scans were performed in 18 patients after starting elexacaftor/tezacaftor/ivacaftor therapy. Triple-combination therapy was associated with an increase of the total adipose tissue ratio (+27%,  $p=0.007$ ). However, muscle ratio remained stable ( $p=0.304$ ).

#### CONCLUSION

Fully automated CT-based BCA showed significant correlations with pulmonary function and six-minute walk test. Our findings suggest that CFTR modulator therapies primarily affect adipose tissue, not muscle tissue, in adults with CF. BCA may provide information on the individual nutritional status of patients with CF each time a CT scan is performed.

#### CLINICAL RELEVANCE/APPLICATION

Our work presents a state-of-the-art method to quantify all body tissues from routinely acquired chest CT scans, making body composition analysis useful for daily clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPIR-1

### **Preliminary Study on Changes in Biliary Microbiota Before and After Drainage of Malignant Biliary Obstruction**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Kai Yang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the changes in biliary microbiota before and after malignant biliary obstruction drainage, and to study the impact of biliary obstruction and drainage intervention on bile microbiota from the perspective of microbiota.

#### **METHODS AND MATERIALS**

42 patients with malignant biliary obstruction underwent percutaneous transhepatic catheter drainage (PTCD) in our department from January 2020 to December 2022. Under DSA guidance, a 22G drainage needle was inserted into the bile duct and confirmed by angiography to be located within the intrahepatic bile duct, after that 15-20ml of bile sample was extracted; Implantation of external or internal/external drainage tubes through guide wires; After 7 days, bile sample was extracted through a drainage tube; Two bile samples were sent for culture and next-generation sequencing. Collect and organize general patient information, including whether acute cholangitis has occurred and its severity, and whether antibiotics have been used for treatment.

#### **RESULTS**

Among the 42 patients, there were 20 cases of cholangiocarcinoma, 13 cases of pancreatic cancer, 3 cases of hepatocellular carcinoma, and 6 cases of hilar lymph node metastasis (gastrointestinal malignant tumor). The relative abundance of Burkholderia, Acinetobacter, Pseudomonas and Staphylococcus in the bile microbiota before drainage was high; After drainage, the abundance of Staphylococcus, Klebsiella, Enterobacteriaceae, Aeromonas, Paracoccus, Anaerococcus, Diplococcus, Campylobacter and Megabacterium in bile samples increased, and the diversity and evenness of other microbial species diversity in normal biliary tract decreased.

#### **CONCLUSION**

There is a stable microbiota in the normal biliary system, and the composition of the microbiota in malignant obstructive bile ducts is similar to that in non diseased bile ducts. After drainage, the abundance of Bacillus, Streptococcus, Staphylococcus and Klebsiella in bile increased, which inhibited the growth of other original bacteria in the bile duct ecology, leading to the reduction of species diversity and evenness of the microbial community. This imbalance of biliary microbiota can explain the clinical phenomenon that patients are more prone to biliary tract infections after biliary drainage.

#### **CLINICAL RELEVANCE/APPLICATION**

After biliary drainage, the microbial community in the bile duct undergoes dysbiosis, which may continue to occur with the invasion of more invasive dominant bacteria, leading to new biliary infections. Therefore, when patients continue to be infected, bile culture needs to be performed again and clinical medication needs to be adjusted.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPIR-2

### Characterization of Power and Microwave Ablation Volumes Following Arterial Embolization in an In Vivo Porcine Liver Model

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hiro D. Sparks, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Combination therapy using transarterial embolization and microwave ablation (MWA) is increasingly utilized to treat hepatocellular carcinomas larger than 3 cm in diameter. Predicting the size of a MWA zone after transarterial embolization is an important component of combination therapy treatment planning, specifically to minimize damage to critical structures while maintaining adequate tumor margins. Power-time settings found in manufacturer guidelines are not applicable in embolized liver lobes due to alterations in perfusion and related heat sink effects. This study aims to better characterize the relationship between ablation volume and power in an in vivo porcine liver model following embolization.

#### METHODS AND MATERIALS

With animal IRB approval, ten female Yorkshire swine, underwent either right (n= 5) or left (n= 5) hepatic artery embolization under fluoroscopic guidance. Subsequently, ultrasound guided MWA was performed in each liver segment (left lateral, left medial, right medial, right lateral) at either 30 Watts (W) (n=4 lobes), 60W (n=4), 65W (n=20), 90W (n=4), 120W (n=4), or 140W (n=4) continuously for 5 minutes (Certus 140 and PR-15, NeuWave Medical Inc, Madison, WI). Post-procedural volumetric segmentation was performed on standardized T1-weighted postcontrast images in arterial, venous, and delayed phases.

#### RESULTS

Paired Wilcoxon test demonstrated that ablation volumes in embolized lobes (16.9 +/- 8.9 cc) were significantly larger than non-embolized lobes (12.9 +/- 6.6 cc , P = 0.012, Figure 1). MWA power had a significant positive linear correlation with both embolized (Pearson R, P <0.01) and non-embolized lobes (P < 0.01, Figure 2). The slope of the linear model corresponded to a 0.21 cc/W and 0.12 cc/W increase in ablation volume per unit wattage in embolized and non-embolized lobes, respectively. Embolization had a larger effect on ablation volumes at higher Wattage with a projected convergence of trendlines at 26.7 W, suggesting minimal effect of embolization at lower powered ablation. Model-derived ablation volumes at varying power are displayed in Table 1.

#### CONCLUSION

Linear models demonstrate a near two-fold increase in ablation zone volume per additional Watt when applied to embolized lobes relative to non-embolized lobes. Volumetric differences between embolized and non-embolized lobes were greater at higher power MWA.

#### CLINICAL RELEVANCE/APPLICATION

In the setting of hepatic combination therapy, transarterial embolization decreased blood flow within the liver parenchyma and reduced heat dissipation during subsequent MWA. This work provides novel insight into of the interactions between power, embolization, and MWA volume, which are critically relevant to the safe planning of combination therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPIR-5

### Freiburg Index of Post-TIPS Survival (FIPS): Independent External Validation in a Cohort of Patients from a Low Socio-economic South Asian Country

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Zohaib M. Mallick, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

To externally validate the Freiburg Index of Post-TIPS Survival (FIPS) score in a new cohort of patients and assess its performance in predicting post-TIPS survival.

#### METHODS AND MATERIALS

Study design: This is a retrospective study of patients who underwent TIPS placement between January 1, 2006, and January 31, 2022, at a tertiary care center. Study population: The study population consisted of 44 patients. This study adheres to the TRIPOD checklist to ensure transparent reporting and facilitate the interpretation and reproducibility of our findings. Predictor: The FIPS score was calculated for each patient in the validation cohort using the original FIPS score equation. Outcome: The primary outcome was post-TIPS survival at 28 days, 3 months and 6 months. Statistical analysis: The discrimination and calibration of the FIPS score were assessed using the c-statistic and calibration plot, respectively. The performance of the FIPS score was compared to its original validation study, as well as to other post-TIPS survival prognostic models.

#### RESULTS

The FIPS score ranged from -4.2 to 2.44. The overall 6-month observed survival rate was 75.7%. Kaplan-Meier analysis showed that patients with a high-risk FIPS score ( $\geq 0.92$ ) demonstrated significantly reduced survival compared to those with a low-risk FIPS score ( $<0.92$ ;  $p=0.018$ ). The FIPS score demonstrated good discrimination in predicting post-TIPS survival in comparison to the MELD 3.0 score (c-statistic = 0.825 for FIPS vs 0.752 for MELD 3.0, 95%). The calibration plot showed good agreement between the observed and predicted 1-year survival rates. FIPS score showed better calibration compared to MELD 3.0 (Brier score 0.131 for FIPS vs 0.221 for MELD 3.0). The observed-to-predicted ratio (O:P) for FIPS was 1.354 and that for MELD 3.0 was 1.065. The performance of the FIPS score in the validation cohort was comparable to its original validation study.

#### CONCLUSION

Our study provides an independent external validation of the FIPS score in a new cohort of patients undergoing TIPS placement. The FIPS score showed good performance in predicting post-TIPS survival, suggesting that it can be a valuable tool in clinical practice for estimating post-TIPS survival. Further studies are needed to explore the applicability of the FIPS score in other patient populations and settings.

#### CLINICAL RELEVANCE/APPLICATION

Transjugular intrahepatic portosystemic shunt (TIPS) is a commonly performed procedure for patients with complications of portal hypertension. The Freiburg Index of Post-TIPS Survival (FIPS) score is a prediction model that was developed to estimate post-TIPS survival in patients with variceal bleeding and/or ascites. However, its performance has not yet been validated in South Asian populations.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPIR-6

### CT-based Deep Learning Model of Hepatic Venous Pressure Gradient for Predicting the Prognosis of Hepatocellular Carcinoma with Transarterial Chemoembolization (CHANCE-CHESS): A Multicenter Cohort Study

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yuqing Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of CT-based deep learning model of hepatic venous pressure gradient (HVPG) on prognosis of hepatocellular carcinoma (HCC) patients treated with transarterial chemoembolization (TACE) and systemic therapy.

#### METHODS AND MATERIALS

A total of 261 consecutive HCC patients treated with TACE and systemic therapy, and had a contrast-enhanced abdominal CT as part of their pre-surgical work-up, were retrospectively collected between January 2010 and December 2021. A CT-based HVPG Score, whose computed formula was:  $17.37 - 4.91 * \ln(\text{Liver/Spleen volume ratio}) + 3.8[\text{If presence of peri-hepatic ascites}]$ , was used to diagnose CSPH (HVPG=10mmHg) with a cut-off value 11.606. The 3D liver and spleen volume were automate calculated by a deep learning segmentation model, and the presence of peri-hepatic ascites was diagnosed by two independent investigators in portal-venous phase CT. Overall survival (OS) as study endpoint was analyzed by Kaplan-Meier and Cox regression.

#### RESULTS

Among 261 patients, 80(30.7%) were diagnosed with CSPH by CT-based HVPG Score. The median OS in CSPH group was significantly shorter than non-CSPH group (16.9 months vs. 20.7 months,  $P=0.022$ ). Multivariable analysis indicated that the presence of CSPH was a negative prognostic factor for OS (adjusted hazard ratio [HR], 1.423,  $P=0.045$ ).

#### CONCLUSION

The segmentation model shows good performance in liver and spleen segmentation in HCC patients, which may help non-invasive HVPG assessment and other CT imaging studies in HCC patients. CT-based HVPG Score was significantly associated with poor outcome and should be taken into consideration when managing HCC patients underwent TACE and systemic therapy.

#### CLINICAL RELEVANCE/APPLICATION

This real-world study builds a non-invasive CT-based approach for CSPH diagnosis using deep learning model, and also highlights importance of CSPH management on clinical decision-making and trial design in HCC patients treated with TACE and systemic therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPMK-1

### Adipose Distribution Patterns as Novel Prognostic Factors in Patients with HCC: A Systematic Review and Meta-analysis

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Shuo Shi (*Presenter*) Nothing to Disclose

#### PURPOSE

Obesity is the established risk factor for several cancers, with hepatocellular carcinoma (HCC) being strongly associated with it. However, obesity is a heterogeneous disease with high individual differences in the distribution of adipose tissue. Quantifying associations between adipose distribution patterns and the prognosis of HCC might provide vital support for the individualized management of patients. Therefore, we aim to find the optimal indicator of pretreatment adipose distribution patterns for predicting the prognosis of HCC patients through meta-analysis.

#### METHODS AND MATERIALS

A systematic retrieve was performed to identify studies investigating the association of adipose distribution patterns and the prognosis of HCC from the inception of PubMed, Embase, Cochrane Library, and Web of Science databases to April 27, 2022. Relevant survival data were extracted to conduct the meta-analysis.

#### RESULTS

30 studies were included in our studies. A total of 6,783 people were enrolled in the study, including 2,456 patients with HCV and 1,228 patients with HBV. The pooled results indicated that only pretreatment high visceral to subcutaneous adipose tissue area ratio (VSR) (univariate analysis of OS: HR=1.42, 95%CI=1.28-1.58, P<0.00001; multivariate analysis of OS: HR=1.45, 95%CI=1.27-1.65, P<0.00001; univariate analysis of RFS: HR=1.30, 95%CI=1.08-1.56, P=0.006; multivariate analysis of RFS: HR=1.36, 95%CI=1.10-1.67, P=0.004) was both related to worse OS and RFS. Meanwhile, no significant heterogeneities were found and pooled results were relatively robust.

#### CONCLUSION

Pretreatment VSR is the most valuable prognostic factor in adipose distribution patterns of HCC patients.

#### CLINICAL RELEVANCE/APPLICATION

This is the first meta-analysis to investigate how different adipose distribution patterns affect the prognosis of HCC patients. Our results demonstrate that pretreatment visceral to subcutaneous adipose tissue area ratio is the most valuable prognostic factor in adipose distribution patterns of HCC patients.

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## Abstract Archives of the RSNA, 2023

T2-SPMK-2

### Maintain Accuracy in Vertebral Density Measurement after Intravenous Injection using Material Decomposition Images in Dual-energy Spectral CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hui Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the ability of using the material decomposition (MD) images in dual-energy spectral CT in maintaining the vertebral bone mineral density (BMD) measurement accuracy in contrast-enhanced CT scans.

#### METHODS AND MATERIALS

Fifty-one abdominal patients (20 females, 31 males) who underwent dual-energy spectral CT imaging in the unenhanced and contrast-enhanced arterial phase (AP) and portal phase (PP) were included. The monochromatic images (40-140keV) and MD images using hydroxyapatite (HAP)-iodine as a base material pair were reconstructed. The HAP density was measured to represent BMD in the three imaging phases at the level of L1 with a region-of-interest (ROI) placed in a homogenous area of trabecular bone in the upper part of the vertebrae, excluding the cortex and focal inhomogeneous areas. The CT value in the same ROI was also measured using the 120kVp-like images to simulate measurement in conventional CT. Measurements in different imaging phases were statistically analyzed.

#### RESULTS

The CT value measurements for the L1 level vertebra in the unenhanced, AP and PP phases were  $154.17 \pm 52.47$  HU,  $175.44 \pm 58.40$  HU and  $181.10 \pm 52.84$  HU, respectively. There were differences between the unenhanced and AP and the unenhanced and PP phases with  $p < 0.05$  showing iodine contrast involvement and contamination in the measurement. On the other hand, the HAP density measurement (in mg/cm<sup>3</sup>) in these three phases were  $695.36 \pm 18.41$ ,  $695.34 \pm 23.35$ , and  $694.95 \pm 16.88$ , respectively with virtually no change ( $p > 0.05$ ). Post hoc analysis showed that no significant differences were present in HAP (Iodine) ( $p = 0.993$ ).

#### CONCLUSION

Our results showed that the conventional CT attenuation measurement in the vertebra after contrast injection may be skewed by the iodine involvement. The material density (HAP) measurement using the material decomposition in dual-energy spectral CT eliminated the iodine influence and provided quantitative and consistent measurement for BMD of the vertebra.

#### CLINICAL RELEVANCE/APPLICATION

The material density (HAP) measurement using the material decomposition in dual-energy spectral CT may be used to provide a quantitative and consistent vertebral bone mineral density measurement.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPMK-3

### Opportunistic Deep Learning 3D-CT for Osteoporosis: Optimizing Multimodal Strategies for DXA Estimation

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hanqing Yao (*Presenter*) Nothing to Disclose

#### PURPOSE

Osteoporosis is a disease marked by reduced trabecular bone mass and increased fracture risk. Dual X-ray Absorptiometry (DXA) is the clinical standard for assessing spine bone mineral density (BMD) and diagnosing osteoporosis, but remains underutilized. With ~25 million annual CTs of the chest and abdomen in the US, there exists a potential to screen for osteoporosis using CT without incurring extra cost, patient time, or radiation exposure. We hypothesized that we can (1) optimize the structure of 3D spine ROIs from abdominal CTs for DXA T-score estimation; (2) predict osteoporosis incidence by combining image measures, scanner parameters, and demographic information.

#### METHODS AND MATERIALS

Our study comprised 447 CT scans on 432 patients (332 women, mean age 65) who received a contrast-enhanced CT scan within 6 months of DXA screening (301/146 train/test scans). To optimize our 3D ROIs, we evaluated four methods for automatically segmenting and extracting 3D HU measures - (1) entire vertebra segmentations; (2) only vertebral bodies excluding spinous/transverse processes; (3) only vertebral bodies with HU constraints to exclude cortical bones; (4) 1 cm radius spherical ROIs placed at the centroids of the vertebral bodies. We augmented HU measures with tube voltage, contrast phase, slice thickness, sex, age and race in a linear regression model to predict DXA T-scores.

#### RESULTS

Entire vertebra segmentations exhibited the highest correlation across all vertebral levels (L1-L4), with Pearson correlation coefficients of 0.59, 0.57, 0.52, and 0.52, which were significantly higher than correlations of the other 3D ROI methods ( $P < < 0.001$ ). Including additional covariates improved the correlations at every level: 0.67, 0.68, 0.67, and 0.67 for L1-L4. Spine HU, tube voltage, and age-range buckets starting from 65 years old were significant predictors of T-scores ( $P < < 0.001$ ) for all levels. Using a -2.5 T-score osteoporosis threshold, we obtained area under the receiver operator characteristic curves (AUCs) of 0.69 (95% CI 0.59 - 0.79) for L1, 0.65 (95% CI 0.56 - 0.75) for L2, 0.66 (95% CI 0.57 - 0.75) for L3, and 0.63 (95% CI 0.54 - 0.72) for L4.

#### CONCLUSION

Optimizing the structure of 3D ROIs demonstrates the superiority of entire vertebra segmentations. Augmenting ROIs with scanner-based parameters can improve T-score estimates, highlighting the potential to correct for scanner-based variations. Our features significance analysis indicates that a combination of imaging, scanner-based, and demographic features are important for DXA estimation.

#### CLINICAL RELEVANCE/APPLICATION

This study shows the feasibility of opportunistic CT to approximate DXA T-scores by accounting for scanner-based variations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPMK-4

### Muscle Kinetics on Diffusion-weighted Imaging during Plantar Flexion for Age-related Muscle Quality in Healthy Calf Muscles

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Xinyue Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility of muscle kinetics on DWI during exercise for assessing age-related muscle quality in healthy skeletal muscles.

#### METHODS AND MATERIALS

This prospective study recruited 43 healthy participants (20-60 years) from November 2021 to December 2022. A plantar flexion-tailored DWI protocol was sequentially implemented with one rest phase, one exercise phase, and recovery 1, 2, and 3 phases. Each phase was corresponding to one DWI scanning. Absolute apparent diffusion coefficient (aADC,  $\times 10^{-3}$  mm<sup>2</sup>/sec) of triceps surae (TRIC) was measured in the ADC maps by two radiologists to acquire aADC in the rest phase (aADC<sub>rest</sub>), aADC in the exercise phase (aADC<sub>exer</sub>), and aADC in recovery phases (aADC<sub>reco1, 2, and 3</sub>). Based on aADC, muscle kinetics on DWI was developed by additionally collecting relative ADC (rADC,  $\times 10^{-3}$  mm<sup>2</sup>/sec) and recovery duration: rADC in the exercise phase (rADC<sub>exer</sub>) as aADC<sub>exer</sub> - aADC<sub>rest</sub>; rADC in the recovery phases (rADC<sub>reco1, 2, and 3</sub>) as aADC<sub>reco1, 2, and 3</sub> - aADC<sub>exer</sub>; recovery duration recorded as 1min, 2min, 3min, or >3min when first aADC<sub>reco</sub> showed no statistically significant difference from aADC<sub>rest</sub>. The independent or paired t-test was performed for comparing differences. The receiver operating characteristic curves were constructed for significant indices.

#### RESULTS

Two legs were imaged in all 43 participants (age range/mean, 23-58/41 $\pm$ 10 years; 22 male; 18 youth <40 years). Aged showed lower magnitudes of right-sided rADC<sub>exer</sub>, rADC<sub>reco1</sub>, rADC<sub>reco2</sub>, and rADC<sub>reco3</sub> than youth with P < .05; aged had longer recovery durations of >3min than 2min in youth for left leg. Right-sided rADC<sub>exer</sub> (0.76[0.60, 0.91]; P = .005) performed best for age-related muscle quality.

#### CONCLUSION

When implementing a plantar flexion-tailored DWI protocol, rADC<sub>exer</sub> performed best for age-related muscle quality in healthy TRIC.

#### CLINICAL RELEVANCE/APPLICATION

Muscle kinetics on diffusion-weighted imaging during plantar flexion were feasible for assessing age-related muscle quality in healthy calf muscles.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPMK-5

### Changes in Paraspinal Muscles Density in Young Patients with Chronic Non-specific Lower Back Pain Quantified by Using Dual-energy CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Jian Xiang (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to compare the muscle density of bilateral erector spinae muscles and multifidus muscles in chronic non-specific lower back pain patients with that of a normal control group.

#### METHODS AND MATERIALS

This study was conducted as a prospective study and two groups of people were studied: CNLBP group, included 56 patients (age:  $25.78 \pm 1.963$ , sex ratio: 21 Male/35 Female), control group, included 51 healthy volunteers (age:  $25.12 \pm 1.812$ , sex ratio: 19 Male/32 Female). All individuals received spectral CT imaging on lumbar. Virtual monochromatic images at 70 keV were generated. CT value which indicated density of multifidus (L2/3 to L5/S1 levels) and erector spinae (L1/2 to L4/5 levels) muscles was measured in Hounsfield units (HU) on the left and right sides, and the mean value of left and right was calculated. Density of multifidus and erector spinae muscle among CNLBP patients and healthy volunteers were compared by using independent samples t-test.

#### RESULTS

CNLBP group had lower muscle density at L4/5 level and L5/S1 level in multifidus muscle compared to control group (CNLBP vs. normal:  $42.891 \pm 6.232$  vs.  $47.381 \pm 5.965$  HU for L4/5,  $t = -3.8$ ,  $p < 0.001$ ;  $34.778 \pm 8.751$  vs.  $46.7265 \pm 6.264$  HU for L5/S1,  $t = -8.049$ ,  $p < 0.001$ ), however that for L2/3 (CNLBP vs. normal:  $48.616 \pm 4.439$  vs.  $49.908 \pm 6.614$  HU), L3/4 (CNLBP vs. normal:  $47.034 \pm 5.109$  vs.  $48.931 \pm 6.961$  HU) showed no statistical significance (both  $P > 0.05$ ). The difference in density of the erector spinae muscle at each level between the CNLBP group and normal control group was not statistically significant (CNLBP vs. normal:  $48.814 \pm 9.332$  vs.  $51.176 \pm 9.488$  HU for L1/2;  $48.779 \pm 3.481$  vs.  $49.086 \pm 4.373$  HU for L2/3;  $46.755 \pm 3.930$  vs.  $48.304 \pm 4.826$  HU for L3/4;  $43.421 \pm 7.018$  vs.  $45.352 \pm 6.209$  HU for L4/5; all  $P > 0.05$ ).

#### CONCLUSION

Patients with CNLBP have lower density in the multifidus muscle at the L<sub>4/5</sub> and L<sub>5/S1</sub> levels than healthy volunteers.

#### CLINICAL RELEVANCE/APPLICATION

The pathogenesis of CNLBP is unclear. Muscle density can be used to quantify the evaluation of fat and connective tissue infiltration. This study shows that the density of multifidus muscle at the L4/5 and L5/S1 levels is significantly lower in patients with CNLBP compared to healthy volunteers. Dual-energy CT measurement of muscle density can identify changes in the paravertebral muscles of patients with CNLBP, contributing the understanding of underlying mechanism, early diagnosis thus helping patients conducting interventions that can restore paravertebral muscle function and reduce recurrence of low back pain symptoms.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPMK-7

### **Non-expert usage of MRI-based Neuropathy Score Reporting and Data System (NS-RADS): Multi-Institutional Wider-usability Study of Peripheral Neuropathy Conditions**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Bayan Mogharrabi, MD, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of our study was to determine inter-reader reliability and diagnostic performance of classification and severity scales of NS-RADS among radiology readers of differing experience levels after limited teaching of the scoring system by expert radiologists at their centers. We hypothesized that participants across a broad range of experiences can exhibit good accuracy and inter-reader reliability using the scoring system.

#### **METHODS AND MATERIALS**

This is a multi-institutional, cross-sectional, retrospective study of MRI cases of nerves and proven peripheral neuropathy (PN) conditions. 31 radiology readers with varying degrees of training and experience levels were recruited from different institutions. Each reader attended and received a structured presentation that described the NS-RADS classification system containing imaging examples and illustrations, and a published article on this subject. After training, the readers were asked to perform NS-RADS scoring with designation of category, sub-category, and the most likely diagnosis. Inter-reader agreements were evaluated by Conger's kappa for all readers, trainees, and attendings. Diagnostic accuracy was calculated for each reader as the percent correct diagnosis. A linear mixed model was used to estimate and compare accuracy between the trainees and attendings.

#### **RESULTS**

Across all 31 total (trainee and attending) readers evaluating 150 different MRI cases, the agreement was good for NS-RADS category and fair for NS-RADS subcategory. Inter-reader agreements of trainees were comparable to the attendings. The estimated accuracy for attendings was 0.73 with 95% CI (0.62, 0.81) and for trainees was 0.69 (0.58, 0.78) without significant difference in average accuracies between the trainees and attendings ( $p = 0.5$ ).

#### **CONCLUSION**

Non-expert radiologists interpreted PN conditions with good accuracy and fair to good inter-reader reliability using the NS-RADS scoring system previously validated by expert radiologists.

#### **CLINICAL RELEVANCE/APPLICATION**

With limited training, the readers of differing experience and training levels can use NS-RADS scoring system in their practice to standardize MRI reporting and prudently aid in the management of PN patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPMK-8

### Feasibility Assessment of Deep-learning-based Automatic Segmentation of Intercostal Muscles on Computed Tomography Based on Bayesian U-Net

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yoko Murakami, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the feasibility of deep-learning-based automatic segmentation of intercostal muscles (IMs) using Bayesian U-net on CT images in 110 patients suspected of lung cancer.

#### METHODS AND MATERIALS

Using an original training dataset based on manual segmentation of IM in 10 arbitrarily selected cases, automatic segmentation with Bayesian U-Net was obtained in remaining 100 cases. Automatic segmentation was improved by updated training dataset created by manual modification in 10 cases selected in order of larger segmentation uncertainty among the remaining cases, in addition to the original one. For 95 cases, total IM volume (IMV) quantified with automatic segmentation based on final training dataset after similar process was repeated five times, were compared with quantitative pulmonary function and geographic data. For another 16 cases included as an external data set, predictive labels (PL) were generated using the identical final training dataset, and two ground truth (GT1 and GT2) was obtained with independent manual segmentation of right IM by two radiologists in median coronal cross-sections with a thickness of 10mm. Accuracy of IM segmentation by the Bayesian U-Net was assessed with Dice score (DS) as well as Bland-Altman plot analysis for regional IMV between the PL and each of GTs.

#### RESULTS

The mean values and limits of agreement for regional IMV between PL and GT1 and between PL and GT2 were -1.2 and 0.3 to -2.6, and -1.7 and 0.4 to -3.7 mm<sup>3</sup>, indicating excellent concordance and slight underestimation tendency for PL. The DSs between GT1 and GT2, between GT1 and PL, and between GT2 and PL were 0.78, 0.77, and 0.80, respectively. Total IMV was larger in males (378.7 ± 66.9 cm<sup>3</sup>) as compared with females (246.7 ± 41.2 cm<sup>3</sup>, and correlated positively with height (r=0.69), body weight (r=0.70), BMI (r=0.48), forced vital capacity (r=0.56), and forced expiratory volume in 1 second (r=0.47).

#### CONCLUSION

Automatic segmentation of IM based on Bayesian U-Net was feasible and quantified total IMV correlated with body habitus and pulmonary function test parameters.

#### CLINICAL RELEVANCE/APPLICATION

Automatic IM segmentation based on Bayesian U-Net can be applicable to evaluate the relation between IM impairment and respiratory functional disorder.

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## Abstract Archives of the RSNA, 2023

T2-SPMK-9

### Radiological Markers of Regenerative Maturity in Grade II Muscle Tears

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Natalia B. Pugliese SR (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish radiological signs of regenerative maturity or immaturity of muscle tears using ultrasound (US) and magnetic resonance imaging (MRI).

#### METHODS AND MATERIALS

Between August 2020 and April 2021, thirty six patients with grade 2 muscle tears diagnosed by ultrasound were included. Follow-up MRI and US was performed four weeks after diagnosis, and clinical follow-up four weeks later. According to the presence or absence of symptoms in these two instances, they were classified as immature or mature regeneration, respectively.

#### RESULTS

At follow-up imaging, there were no significant differences ( $p= 0.08$ ) regarding the characteristics of fibers between symptomatic and asymptomatic tears, with 12 (58%) of the asymptomatic tears showing effacement or retraction of the myotendinous junction. We found heterogeneous echogenicity in 13 (87%) symptomatic and 11 (52%) asymptomatic tears, and peripheral hypoechoogenicity in 1 (7%) symptomatic and 8 (38%) asymptomatic ( $p= 0.03$ ). A positive Doppler signal was identified in 3 (14%) asymptomatic and 15 (100%) symptomatic ( $p < 0.0001$ ) tears. By MRI, the symptomatic tears showed greater signs of edema ( $p = 0.002$ ), observing linear peripheral edema in 12 (57%) of the asymptomatic ones. The presence of positive Doppler was the variable statistically most related to the presence of symptoms, with an area under the ROC curve of 0.93 (95% CI 0.79-0.99).

#### CONCLUSION

Peripheral linear edema by MRI and US is a frequent finding in asymptomatic patients with regenerative maturity. The absence of a Doppler signal in the ultrasound controls one month after the muscle injury, was the best predictor of regenerative maturity.

#### CLINICAL RELEVANCE/APPLICATION

Diagnostic imaging studies provide information that influences the decision to return to play, being the absence of Doppler, a useful predictor of regenerative maturity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPMS-1

### Abbreviated Whole-Body MRI as a Novel Imaging Modality for Pediatric Lymphoma Follow-Up: A Multicenter Study

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This multicenter prospective study aimed to evaluate the diagnostic confidence and reproducibility of a novel abbreviated 30-minute whole-body MRI (WB-MRI) for response assessment in children and adolescent patients with lymphoma.

#### **METHODS AND MATERIALS**

The study included 103 pediatric patients aged 0 to 18 years with pathologically confirmed lymphoma, who underwent both PET/CT and abbreviated WB-MRI at baseline and during follow-up. Image quality of abbreviated WB-MRI was evaluated using a 5-point Likert scale, and interobserver agreement was assessed. Sensitivity, specificity, and accuracy of abbreviated WB-MRI for detecting residual or recurrent disease were calculated, with PET/CT used as the reference standard.

#### **RESULTS**

The image quality of abbreviated WB-MRI was rated good or excellent in 97% of cases, with high interobserver agreement. Abbreviated WB-MRI demonstrated a sensitivity of 90%, specificity of 96%, and accuracy of 94% for detecting residual or recurrent disease, with excellent agreement between abbreviated WB-MRI and PET/CT findings.

#### **CONCLUSION**

Abbreviated WB-MRI is a feasible and accurate imaging modality for follow-up of pediatric lymphoma patients undergoing various treatments, with high diagnostic performance and excellent image quality. The non-invasive nature and lack of radiation exposure make it a favorable option compared to PET/CT, especially for pediatric patients.

#### **CLINICAL RELEVANCE/APPLICATION**

The results of this study suggest that abbreviated WB-MRI is a clinically relevant and useful imaging modality for follow-up of pediatric patients with lymphoma, offering high diagnostic accuracy and image quality. Abbreviated WB-MRI has the advantage of being non-invasive and without radiation exposure, making it an attractive alternative to PET/CT for monitoring disease progression and response to treatment in pediatric patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNMMI-1

### Diagnosis of Primary Chyluria by $^{99}\text{Tc}^{\text{m}}$ -dextran Lymphography

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Qi Hao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic value of  $^{99}\text{Tc}^{\text{m}}$ -dextran (DX) lymphography in primary chyluria.

#### **METHODS AND MATERIALS**

Fifty patients with primary chyluria admitted and diagnosed in our hospital from January 2011 to 2020 were retrospectively collected, and all patients underwent  $^{99}\text{Tc}^{\text{m}}$ -DX lymphography with complete imaging data to observe the lymphatic reflux in bilateral lymphatic vessels of lower limbs, bilateral iliac lymphatics, bilateral lumbar trunks and thoracic duct, as well as the presence of abnormal radiological distribution in both kidney areas, abdominopelvic region and chest.

#### **RESULTS**

Among 50 patients with primary chyluria, early visualization was seen in the renal area in 20 cases (40%), including 11 cases (22.0%) unilaterally and 9 cases (18.0%) bilaterally; 13 cases (26.0%) had unilateral or bilateral slow lymphatic reflux in the lower extremities, 6 cases (12.0%) had abnormal increased radioactivity in the abdomen, 5 cases (10.0%) had abnormal increased radioactivity in the chest; In this study, the thoracic duct visualization was divided into three types: type I: 22 cases (44.0%) with obstruction at the end of the thoracic duct, which showed persistent widening of the venous angle visualization or abnormal drainage, type II: 14 cases (28.0%) with no visualization at the end of the thoracic duct, and type III: 14 cases (28.0%) with transient visualization at the end of the thoracic duct.

#### **CONCLUSION**

$^{99}\text{Tc}^{\text{m}}$ -DX is useful for observing abnormal renal reflux in patients with primary celiac disease, dynamically assessing systemic lymphatic reflux and thoracic duct reflux, and is a guide for the diagnosis of primary chyluria and for assisting in the search for its cause.

#### **CLINICAL RELEVANCE/APPLICATION**

It is a guide for the diagnosis of primary celiac disease and for assisting in the search for its cause.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNMMI-2

### PSMA PET Imaging Response Following a Single Dose 225Ac J591 Therapy in Metastatic Castration Resistant Prostate Cancer: A Lesion and Patient Based Analysis

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Judith Stangl-Kremser, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radionuclide therapy with 225Ac-labeled PSMA targeting agents have been studied in clinical trials and emerged as a promising treatment option in the management of men with mCRPC. We hypothesized that bone, nodal or visceral metastatic sites may differ in response to this treatment.

#### METHODS AND MATERIALS

28 men with mCRPC were treated with 225Ac-PSMA-J591 from 2017 to 2020 at our center on a prospective single ascending dose phase 1 trial (NCT03276572). Molecular imaging, assessing PSMA expression, was performed in most patients but was not used to select trial participants. We retrospectively analyzed 20 cases that had both a baseline 68Ga-PSMA-11 PET/CT (bPET) and a post-treatment (fPET). On the patient-level, biochemical response was defined as  $\geq 50\%$  PSA decline after treatment (PSA50 response), and the overall response was assessed on the fPET using PERCIST criteria and on conventional imaging in cases with measurable disease using RECIST guidelines. For the lesion-based analysis, the SUVpeak of the 3 most- and 3 least-avid lesions of the metastatic sites were measured. Pre- and post-treatment SUVpeak as well as percentage decline of SUVpeak were compared for every lesion. On the patient and lesion level, an objective imaging response was defined as complete or partial response. For the latter, the frequency of an objective imaging response was compared in bone, node, and visceral lesions.

#### RESULTS

Twenty patients were analyzed. Of those, 13 men (65%) had prior 223Ra (n=5), 177Lu-PSMA (n=10), two had both. The baseline PSA was 192.5 ng/mL (IQR: 69.1-887.3). 11 men had a PSA50 response and 7 an overall objective imaging response on the fPET. 8 cases had measurable disease; the majority had stable disease and one had progressive disease. Men with a biochemical response trended to have higher odds of having an imaging response. Overall, 204 lesions were measured on the bPET. The median SUVpeak was 4.1 (IQR 1.6-10.5). The decline of post-treatment SUVpeak was significant within all metastatic categories. The median decline in SUVpeak from bPET to fPET was -40% (IQR -71;-1) in bone lesions, -52% (IQR -81;-14) in visceral lesions, and -23% (IQR -53;-6) in nodal lesions. The objective imaging response rate was different in bone lesions (52%), visceral lesions (71%), and nodal lesions (39%) ( $p=0.0273$ ).

#### CONCLUSION

225Ac-PSMA-J591 effectively treats all metastatic categories. However, bone and visceral lesions may respond better than nodal lesions. Our findings need further validation but are informative for trial design and patient counselling.

#### CLINICAL RELEVANCE/APPLICATION

Metastatic patterns may influence treatment response to 225Ac-labeled PSMA targeting agents in men with mCRPC and should be considered in treatment planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNMMI-3

### High-risk Prostate Cancer Staging: Predictors of Extra-prostatic Spread in <sup>18</sup>F-PSMA-1007 PET-CT Scans

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Saptarshi Mukherjee, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

PSMA PET-CT has superior diagnostic accuracy over conventional imaging in staging patients with high-risk prostate cancer due to its ability to detect occult extra-prostatic disease. High-risk is defined as per the National Comprehensive Cancer Network: PSA = 20 ng/ml, Gleason score = 8, or a clinical stage of =T3. We sought to explore the predictors of bony and nodal spread in our patient cohort of high risk patients.

#### METHODS AND MATERIALS

A total of 411 18F-PSMA PET-CT studies were identified through local PACS database search which were done during the 18-month period between 01/01/2021 - 30/06/2022. A total of 192 consecutive patients who underwent a staging PSMA PET-CT scan for high risk disease over an 18 month period were retrospectively reviewed (duplicate records, re-staging studies and patients who had undergone prior treatment were excluded). Medical record search was also done to acquire data for parameters such as PSA, prostate volume (PSA density) Gleason score, MRI Staging and PI-RADS. The data was then categorized based on the PSMA PET-CT reports into extra prostatic disease and confined prostatic disease. Extra prostatic disease is defined for the purposed of this study, as any nodal involvement and/or bone metastases.

#### RESULTS

Of the 192 patients, 68 (35%) had evidence of malignant spread to nodes, bones or both (PMSA spread +ve). The remainder (124) showed no evidence of nodal or bony metastatic disease. There was significant difference in PSA levels ( $p < 0.01$ ; Mann-Whitney U test) between positive (46.3 ; n=68) and negative (26 ; n= 124). A significant proportion (47%) of node positive scans on PSMA were reported to have no nodal involvement on MRI. 50% of patients Gleason score = 8 showed extra-prostatic spread on PSMA PET-CT.

#### CONCLUSION

PSA level and Gleason score were accurate predictors of extra-prostatic disease in patients with high-risk prostatic carcinoma. DRE staging was less accurate. A significant proportion of node positive PSMA scans were deemed to have no nodal involvement on MRI scans.

#### CLINICAL RELEVANCE/APPLICATION

Within high-risk carcinoma of the prostate, Gleason score and PSA act as accurate predictors of extra-prostatic spread. The role of DRE staging alone as a parameter for high-risk classification needs to be explored further. Almost half of node positive disease on PSMA PET-CT were not picked up by MRI, reiterating the superiority of PET.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNPM-1

### Widening Disparities in Noninvasive Diagnostic Imaging Volume and wRVU Utilization for Medicare Across Hospital Referral Regions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate all US Medicare imaging claims for potential healthcare disparities in medical imaging utilization across 306 US hospital referral regions (HRRs).

#### METHODS AND MATERIALS

All diagnostic imaging claims submitted to Medicare from 2013 to 2019 were extracted from the Medicare POSPUF dataset, including year, CPT code, wRVUs, and zip code. Dartmouth imaging atlas was used to assign each claim to an HRR via zipcode and gather the number of Medicare enrollees in each HRR. HRRs were aggregated into percentiles based on exam and wRVU utilization rates (highest 10th percentile, 25th, 50th, 75th, and 90th). Compound annual growth rates (CAGR) were calculated.

#### RESULTS

Imaging exams totaled 156,739,445 in 2013 and 176,297,932 (+19,558,487, +12.5%) in 2019. In 2013, there were 52,179,386 total imaging wRVUs, and 63,276,990 (+21.3%) in 2019. The exam utilization rate per 1,000 Medicare enrollees across all HRRs was 3188/1,000 US Medicare enrollees in 2013 and 3077 in 2019 (median 1940, standard deviation 948; -135/1,000 since 2013, CAGR -0.6%). The 2019 exam utilization rate across HRRs ranged from 288 in Terre Haute, IN to 9517 in Rochester, MN (33 fold, 188.3% difference). The exam utilization rate CAGR from 2013 to 2019 by HRR utilization rate percentile was 90th percentile +0.1%, 75th +0.2%, 50th -1.6%, 25th -1.9%, and 10th -2.9%. The wRVU utilization rate per 1,000 Medicare enrollees across HRRs was 1739 in 2013 and 2106 in 2019 (median 1940, standard deviation 948; +367.6 since 2013, CAGR +2.5%). The 2019 wRVU utilization rate across HRRs ranged from 237 in Sun City, AZ to 7237 in Rochester, MN (31 fold, 187.3% difference). The wRVU utilization rate CAGR from 2013 to 2019 by HRR wRVU percentile was 90th percentile +3.2%, 75th +3.7%, 50th +1.6%, 25th +1.6%, and 10th -0.01%.

#### CONCLUSION

Imaging volume is decreasing and wRVUs are increasing in the US Medicare population, suggesting substitution of lower wRVU exams for those of higher wRVUs. Imaging utilization rates vary by more than 30 fold across HRRs, with the gap widening from 2013 to 2019 and HRRs with high percentile wRVUs per capita growing nearly 3.5% faster than others, annually. These findings could reflect variations in resources and/or allocation of some services across HRRs, and raise potential concern that imaging disparities across HRRs could be increasing, especially access to higher wRVU advanced imaging services.

#### CLINICAL RELEVANCE/APPLICATION

Variations in imaging across hospital referral regions are increasing, raising potential concern about healthcare access disparities for some imaging services, especially high wRVU services.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNPM-3

### Prevalence of Financial Hardship among Radiology Outpatients and Role of Price Transparency

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Desiree Caballero, MSc, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to assess the prevalence of medical financial hardship among patients receiving outpatient imaging at a tertiary center in Southern California and its correlation with price transparency

#### METHODS AND MATERIALS

Between November 2022 and March 2023 adult patients receiving outpatient advanced imaging (MRI, CT, PET/CT) at a tertiary academic center in Southern California were asked to complete a 15-minute survey screening for financial hardship. Multivariable logistic regression models were used to assess the association between financial hardship and price transparency.

#### RESULTS

430 patients were included (mean age:57.7 (SD15.6); 57.6% female; 45.9% Caucasian; 5% Black;19.2% Asian; 21.3% Hispanic). There were 14.2% Spanish speakers, and 4.4% Vietnamese. A total of 1.4% were uninsured, 11.7% and 37.3% had Medicaid and Medicare, respectively and 47.2% had commercial insurance. Mean score for financial worry measured by Comprehensive Score for financial Toxicity (COST score) was 24 (SD11) and 34% reported imaging was a financial hardship for them and their family. Material hardship (e.g., medical debt) was reported by 46% with less than 1% declaring bankruptcy. Cost related care nonadherence and imaging nonadherence were reported by 46% and 4.3%, respectively. Having interest in knowing imaging out-of-pocket cost (OOPC) prior to receipt of imaging was associated with lower likelihood of imaging hardship (OR 0.28;95% CI 0.15,0.52), material hardship (OR 0.47; 95% CI 25, 88), and cost-related care nonadherence (OR, 0.40; 95% CI 0.18, 0.90). There was no significant association between knowing imaging OOPC estimate prior to receipt of imaging and financial hardship.

#### CONCLUSION

Financial hardship is common in outpatient radiology encounters. While those interested in knowing their imaging OOPC are less likely to experience financial hardship, knowing the OOPC does not impact financial hardship.

#### CLINICAL RELEVANCE/APPLICATION

Given the high prevalence of financial hardship among radiology outpatients, interventions to mitigate financial hardship should be implemented at radiology practices. Price transparency alone may not decrease financial hardship.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-1

### Is MRI Sensitive Enough to Avoid Lumbar Puncture for the Diagnosis of Creutzfeldt-Jacob Disease?

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Shiva D. Yagobian, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the yield of lumbar puncture (LP) to diagnose clinically suspected Creutzfeldt-Jacob disease (CJD) in the absence of suggestive MRI findings.

#### METHODS AND MATERIALS

This single-center retrospective study included 103 patients clinically suspected of having CJD who underwent MRI and LP within 3 months of each other between December 2014 and January 2023. MRIs were re-interpreted for the study by a fellowship-trained CAQ-certified neuroradiologist blinded to LP results and eventual CJD diagnosis. MRIs were categorized as negative, intermediate, or positive for findings suggestive of CJD. The diagnosis from imaging was then compared to the CJD diagnosis determined clinically by a CSF prion panel. Positive and negative predictive values (PPV, NPV), sensitivity, specificity, and accuracy were calculated. A chi-squared test was performed to examine the relationship between MRI prediction and clinical diagnosis, with a threshold of  $p < 0.05$ .

#### RESULTS

Of the 103 patients suspected, 25 were eventually diagnosed with CJD (24%). Of the 103 MRIs, 18 MRIs were positive, 13 were intermediate, and 72 were negative. The PPV for positive MRIs was 83% and the NPV was 96% (95% CI = 88 to 99%). 54% of the intermediate MRIs corresponded to patients who were eventually diagnosed with CJD. Specificity of MRI was 88%, sensitivity was 88%, and accuracy was 88%. MRI categories and eventual diagnosis of CJD were statistically significantly correlated (Chi-square = 56.18,  $p < .00001$ ).

#### CONCLUSION

In patients without MRI findings of CJD, the diagnostic yield of lumbar puncture is 4%. In these patients, the expense of a prion panel and an invasive procedure with potential complications may not be appropriate. MRI is an excellent screening tool in cases of clinically suspected CJD.

#### CLINICAL RELEVANCE/APPLICATION

Patients without MRI findings of CJD are very unlikely to have confirmation of the disease on lumbar puncture. Screening with MRI may be used to avoid performing an invasive procedure in patients suspected of CJD.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPNR-10

### Not ADC but Advanced Diffusion MRI Parameters can Differentiate Brain Metastases from Glioblastomas

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Kiyohisa Kamimura, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our purpose was to determine whether advanced diffusion-weighted imaging (DWI) parameters, including time-dependent DWI parameters and microscopic fractional anisotropy ( $\mu$ FA) derived from double-diffusion-encoding (DDE) MRI, are useful for differentiating between glioblastomas and brain metastases.

#### METHODS AND MATERIALS

A retrospective study was conducted involving 102 consecutive patients with pathologically proven brain tumors (74 with glioblastoma and 28 with brain metastasis) using a 3T scanner and advanced DWI sequences. Time-dependent DWI was performed using a sequence with oscillating motion-probing gradients (effective diffusion time ( $\tau_{\text{eff}}$ ) = 7.1ms) and a pulsed gradient sequence ( $\tau_{\text{eff}}$  = 44.5ms). In addition to ADC maps at the two diffusion times (ADC7.1ms and ADC44.5ms), maps of the ADC change (cADC) and the relative ADC change (rcADC) between the two diffusion times (cADC = ADC7.1ms - ADC44.5ms), [rcADC = (ADC7.1ms - ADC44.5ms)/ADC44.5ms  $\times$  100 (%)] were generated. From the data acquired using a DDE MRI sequence, maps of  $\mu$ FA were generated. The average values of ADC44.5ms, ADC7.1ms, cADC, rcADC, and  $\mu$ FA within enhancing areas of each tumor were measured using a ROI analysis, and those indices were compared between glioblastomas and brain metastases. The diagnostic performances of the parameters were evaluated using ROC curve analysis, and their AUCs were compared using the DeLong's method.

#### RESULTS

There was no significant difference in ADC44.5ms nor ADC7.1ms between brain metastases and glioblastomas. The cADC ( $\times 10^{-3}$  mm<sup>2</sup>/s) and rcADC (%) of brain metastases were significantly higher than those of glioblastomas ( $0.25 \pm 0.12$  vs.  $0.14 \pm 0.03$ ;  $P < 0.0001$ ,  $23.6 \pm 9.4$  vs.  $14.5 \pm 5.7$ ;  $P < 0.0001$ ). The  $\mu$ FA of brain metastases were significantly higher than those of glioblastomas ( $0.472 \pm 0.148$  vs.  $0.371 \pm 0.134$ ;  $P = 0.0014$ ). The ROC curve analysis showed significance for cADC, rcADC, and  $\mu$ FA (AUC = 0.890, 0.834, and 0.705;  $P < 0.0001$ ,  $< 0.0001$ , 0.0014; respectively). The AUC for cADC, rcADC, and  $\mu$ FA were significantly greater than that for ADC44.5ms ( $P < 0.001$ , respectively).

#### CONCLUSION

The time-dependent DWI parameters and  $\mu$ FA provide valuable information to differentiate between glioblastomas and brain metastases, whereas conventional ADC does not. The cADC may be the most efficient DWI index for distinct differentiation of the two tumor types.

#### CLINICAL RELEVANCE/APPLICATION

Time-dependent DWI parameters and  $\mu$ FA may be helpful for differentiation between glioblastoma and brain metastasis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-11

### Clinical Feasibility of Multi-pool Model-based CEST Imaging in the Evaluation of Glioma Grading and Tumor Proliferation: Comparison with Apparent Diffusion Coefficient and Magnetization Transfer Ratio Asymmetry

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yasukage Takami (*Presenter*) Nothing to Disclose

#### PURPOSE

Although magnetization transfer ratio asymmetry (MTRasym) analysis is often used as a chemical exchange saturation transfer (CEST), it is semiquantitative and entails some pitfalls. Recently, we developed new parameters for CEST imaging by the multi-pool model (MPM). The purpose of this study was to evaluate the clinical significance of the new parameters on CEST imaging by assessing the glioma grading and tumor proliferation on CEST imaging by MPM compared to conventional apparent diffusion coefficient (ADC) and MTRasym.

#### METHODS AND MATERIALS

22 patients with gliomas underwent the preoperative MRI. MPM assumes the magnetization transfer (MT) between free water pool, APT pool, and binding water MT pool. "APT density" x "APT transfer rate" x ("Free water T1" or "T2") was visualized as APT\_T1 or APT\_T2, respectively. The maximum values of the parameters on CEST imaging and the minimum values of ADC were measured respectively by regions of interest analysis. Ki-67 index and the presence of isocitrate dehydrogenase 1 (IDH1) mutation were obtained from tumor specimens.

#### RESULTS

There were significant positive correlations between MTRasym and Ki-67 index ( $r = 0.78$ ,  $p < 0.01$ ), and APT\_T1 and Ki-67 index ( $r = 0.68$ ,  $p < 0.01$ ). There existed significant negative correlations between T2/T1 and Ki-67 index ( $r = -0.52$ ,  $p < 0.05$ ), and ADC and Ki-67 index ( $r = -0.76$ ,  $p < 0.01$ ). Significant differences in APT\_T1 were observed between grades II and III ( $p < 0.05$ ) and grades III and IV ( $p < 0.05$ ), as well as between grades II and IV ( $p < 0.001$ ). Significant differences in MTRasym, T2/T1, and ADC were observed between grades II and IV ( $p < 0.001$ ). MTRasym and APT\_T1 of IDH1 mutant glioma patients ( $n = 10$ ) were significantly lower than that of IDH1 wild-type patients ( $n = 12$ ) ( $p < 0.001$ ). ADC and T2/T1 of IDH1 mutant glioma patients ( $n = 10$ ) were significantly higher than that of IDH1 wild-type patients ( $n = 12$ ) ( $p < 0.05$ ). APT\_T1 of IDH1 mutant glioblastoma patients ( $n = 2$ ) were significantly lower than that of IDH1 wild-type patients ( $n = 11$ ) ( $p < 0.05$ ). With respect to other parameters, there were no significant differences between IDH1 mutant glioblastoma patients and IDH1 wild-type glioblastoma patients.

#### CONCLUSION

These preliminary results suggest that parameters on CEST imaging by MPM seem to correlate with the cell proliferation of gliomas as with MTRasym and ADC in patients with gliomas. APT\_T1 may be more useful than conventional parameters in evaluating the grade of glioma and the presence of IDH1 mutation in gliomas.

#### CLINICAL RELEVANCE/APPLICATION

Parameters on CEST imaging by MPM appear to correlate with glioma cell proliferation as well as MTRasym and ADC. In assessing the grade of glioma and the existence of IDH1 mutation in gliomas, APT\_T1 may be more helpful than conventional parameters.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-12

### Long-term Follow-up of Multinodular and Vacuolating Neuronal Tumors and Implications for Surveillance Imaging

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The majority of multinodular and vacuolating neuronal tumors (MVNTs) are diagnosed and followed up with imaging, without any change over time. However, there are no surveillance guidelines or quantitative volumetric assessments of these tumors. We evaluated MVNT volumes over long follow-up periods using segmentation tools with the aim of accurate quantitative assessment.

#### METHODS AND MATERIALS

All patients with "MVNT" or "multinodular and vacuolating neuronal tumor" in a brain MRI report in our system were reviewed. Patients with only one brain MRI or where MVNT was not clearly the most likely diagnosis were excluded. All MVNTs were manually segmented. For all follow-up exams, absolute and percent volume change from immediately prior and initial exams were calculated.

#### RESULTS

48 patients (32 women, median age 50.5 years at first scan) underwent 158 brain MRIs. Median duration between the first and last scan was 15.6 months (interquartile range [IQR] 5.7 months -29.6 months, maximum 6.4 years) and between consecutive scans was 6.7 months (IQR 3.3 months-12.4 months, maximum 4.9 years). Across all 48 individual patients, the median MVNT volume on the original scan was 0.40 cm<sup>3</sup> (IQR 0.16 to 0.77 cm<sup>3</sup>) while the median MVNT volume on the last scan was 0.34 cm<sup>3</sup> (IQR 0.14 to 0.75 cm<sup>3</sup>;  $p=0.94$ ). In comparison to the immediately prior scan, the median absolute change in volume across every follow-up scan was -0.02 cm<sup>3</sup> (IQR -0.06 to 0.02 cm<sup>3</sup>), while the median percent change in volume was -5.0% (IQR -13.7% to 7.9%). Pearson correlation coefficients between days since immediately prior scan versus absolute and percent volume change from immediately prior scan were  $r=0.05$  ( $p=0.60$ ) and  $r=0.07$  ( $p=0.45$ ) respectively. For the relationship between days since the first scan versus absolute and percent volume change from the first scan, values were  $r=-0.06$  ( $p=0.53$ ) and  $r=-0.04$  ( $p=0.67$ ) respectively (Figure 1).

#### CONCLUSION

MVNT segmentation across follow-up brain MRI exams did not demonstrate significant volume differences over the follow-up period, suggesting these tumors don't change or enlarge over time. Hence, frequent surveillance imaging of newly diagnosed MVNTs may not be necessary. In particular, no further contrast is needed after a stable follow-up contrast-enhanced exam.

#### CLINICAL RELEVANCE/APPLICATION

We provide the first set of quantitative volumetric measurements demonstrating multinodular and vacuolating neuronal tumors do not significantly change over time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-13

### Pretreatment ADC for Prediction of Relapsed and Refractory Primary Central Nervous System Lymphoma

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Ching-Chung Ko (*Presenter*) Nothing to Disclose

#### PURPOSE

A subset of primary central nervous system lymphoma (PCNSL) has been shown to undergo an early relapsed/refractory (R/R) period after first-line chemotherapy. This study investigated the pretreatment clinical and MRI features to predict R/R in PCNSL, emphasizing the apparent diffusion coefficient (ADC) values.

#### METHODS AND MATERIALS

This retrospective study investigated the pretreatment MRI features for predicting R/R in PCNSL. Only patients who had undergone complete preoperative and postoperative MRI follow-up studies were included. From January 2006 to December 2021, 52 patients from two medical institutions with a diagnosis of PCNSL were included (median follow-up time, 26.3 months). Among these, 24 (46.2%) had developed R/R (median time to relapse, 13 months). Cox proportional hazard regression analyses were performed to determine hazard ratios for all parameters.

#### RESULTS

Significant predictors of R/R in PCNSL were female sex, complete response to first-line chemotherapy, and ADC value/ratio ( $P < 0.05$ ). Cut-off points of ADC values and ADC ratios for prediction of R/R were  $0.68 \times 10^{-3} \text{ mm}^2/\text{s}$  and 0.97, with AUCs of 0.78 and 0.77, respectively ( $P < 0.05$ ). Multivariate Cox proportional hazards analysis showed that failure of CR to first-line chemotherapy and low ADC values ( $< 0.68 \times 10^{-3} \text{ mm}^2/\text{s}$ ) were significant risk factors for R/R, with hazard ratios of 5.22 and 14.45, respectively ( $P < 0.05$ ). Kaplan-Meier analysis showed that lower ADC values and ratios predicted significantly shorter progression-free survival ( $P < 0.05$ ).

#### CONCLUSION

Pretreatment ADC values and ratios for prediction of R/R offer valuable objective information for the treatment planning in PCNSL.

#### CLINICAL RELEVANCE/APPLICATION

Pretreatment ADC for prediction of relapsed and refractory PCNSL offers valuable information in the treatment planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-14

### Development of a Deep Learning Model Integrating Multisequence MRI to Assess EGFR Mutation Subtype in Brain Metastases

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Ye Li (*Presenter*) Nothing to Disclose

#### PURPOSE

There is a lack of studies evaluating epidermal growth factor receptor (EGFR) mutation status and subtype in non-small cell lung cancer (NSCLC) patients with brain metastasis (BM). The aim of this study was to establish a predictive model based on multisequence MRI using deep learning to identify wild-type (WT) EGFR, EGFR exon 19 deletion (19Del) and exon 21 point mutation (21L858R) simultaneously.

#### METHODS AND MATERIALS

A total of 399 patients with proven brain metastases (BM) of non-small cell lung cancer (NSCLC) were retrospectively enrolled and divided into training (n=306) and testing (n=99) cohort separately based on two timepoints. All patients underwent brain MRI (including T2WI, T2 fluid-attenuated inversion recovery (T2-FLAIR), diffusion weighted imaging (DWI) and contrast-enhanced T1-weighted imaging (T1-CE)) scans. Radiomics features were extracted from each lesion based on four MR sequences. Then a novel algorithm that combined radiomics approach with graph convolutional networks (GCN) architecture (Radio-GCN) was designed for the prediction of EGFR mutation status and subtype. The receiver operating characteristic (ROC) curve analysis was used to evaluate the predication capabilities of each model.

#### RESULTS

We extracted 1290 radiomics features of each MRI sequence. The Radio-GCN model showed an excellent discrimination power for identifying EGFR 19 Del, 21 L858R, and WT in lesion-wise with the AUCs of  $0.9955 \pm 0.0038$ ,  $0.971 \pm 0.013$  and  $1.0 \pm 0$  on independent testing cohort. It also yielded excellent AUCs of  $1.0 \pm 0$ ,  $0.9913 \pm 0.0086$  and  $1.0 \pm 0$  for predicting EGFR mutations respectively in patient-wise. The kappa coefficient reached 0.7352 and 0.8121 in two wises, respectively.

#### CONCLUSION

The study demonstrated that a Radio-GCN approach based on multisequence MRI can help to predict the EGFR mutation subtypes in NSCLC patients with BM, which is beneficial to guide individual treatment.

#### CLINICAL RELEVANCE/APPLICATION

The constructed Radio-GCN model can be potentially considered as new tools to predict the EGFR mutation status and subtype in NSCLC patients with BM.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-2

### Myocardial Involvement Characteristics by Cardiac MR Imaging in Neurological and Non-Neurological Wilson Disease Patients

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Xiaohu Li, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the characteristics of myocardial involvement in Wilson Disease (WD) patients by cardiac magnetic resonance (CMR).

#### METHODS AND MATERIALS

We prospectively included WD patients and age- and sex-matched healthy population. We applied CMR to analyze cardiac function, strain, T1 maps, T2 maps, extracellular volume fraction (ECV) maps and LGE images. Subgroup analyzes were performed for patients with WD with predominantly neurologic manifestations (WD-neuro+) or only hepatic manifestations (WD-neuro-).

#### RESULTS

41 WD patients (age  $27.9 \pm 8$  years) and 40 healthy controls (age  $25.4 \pm 2.9$  years) were included in this study. Compared to the controls, the T1, T2, and ECV values were significantly increased in the WD group (T1  $1085.1 \pm 39.1$  vs.  $1046.5 \pm 33.1$  ms, T2  $54.2 \pm 3.3$  ms vs.  $51.5 \pm 2.6$  ms, ECV  $31.8 \pm 3.6\%$  vs.  $24.3 \pm 3.7\%$ ) (all  $P < 0.001$ ). LGE analysis showed that LGE in WD patients was mainly found in the right ventricular insertion point and interventricular septum. In addition, the WD-neuro+ group showed more severe myocardial damage compared with WD-neuro- group. The Unified Wilson Disease Rating Scale score was significantly correlated with ECV (Pearson's  $r = 0.64$ ,  $P < 0.001$ ).

#### CONCLUSION

CMR could detect early myocardial involvement in WD patients without overt left ventricle dysfunction. Furthermore, characteristics of myocardial involvement were different between WD-neuro+ and WD-neuro-, and myocardial involvement might be more severe in WD-neuro+ patients.

#### CLINICAL RELEVANCE/APPLICATION

We found that CMR T1 mapping could detect early myocardial involvement in WD patients without overt left ventricle dysfunction. Furthermore, characteristics of myocardial involvement were different between WD-neuro+ and WD-neuro-, and myocardial involvement might be more severe in WD-neuro+ patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-3

### **Efficacy of 3T Segmented Acquisition Fast Spin-Echo Diffusion-Weighted Imaging for Differentiating Pituitary Abscess from Other Sellar Cystic Lesions**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

SOICHIRO ISHIUCHI, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Pituitary abscesses (PAs) are rare and often difficult to differentiate from other sellar cystic lesions (OSCLs). The split acquisition of fast spin-echo signals for diffusion-weighted imaging (SPLICE-DWI) sequence can reduce artifacts and distortion caused by susceptibility differences without sacrificing signal-to-noise ratio. We aimed to evaluate the efficacy of SPLICE-DWI for the differentiation between PA and OSCLs.

#### **METHODS AND MATERIALS**

Our study included 5 PAs and 27 OSCLs (11 Rathke's cleft cysts, 11 cystic pituitary adenomas, and 5 craniopharyngiomas) in 32 consecutive patients who underwent sagittal T1-, T2- and contrast-enhanced T1- weighted imaging (T1WI, T2WI, CET1WI) and SPLICE-DWI at 3T. Two radiologists qualitatively evaluated the signal intensity of cystic components on T1WI, T2WI, and SPLICE-DWI using a 5-point grading system (from 1 [very hypointensity] to 5 [very hyperintensity]). They also assessed the presence of ring enhancement, pituitary stalk enlargement and sphenoid sinusitis, and the percentage of cystic components on CET1WI. In addition, two radiologists measured apparent diffusion coefficient (ADC) values of cystic components, and the difference in the mean ADC values between PA and OSCL groups was assessed. Interobserver agreement was determined by calculating the  $\kappa$  coefficient. Statistical analyses, including receiver operating characteristic curve (ROC) analysis were performed.

#### **RESULTS**

Although the signal intensity of T1WI and T2WI, the presence of stalk enlargement, ring enhancement and sphenoid sinusitis, and the percentage of cystic components were not significantly different between PA and OSCL groups, the signal intensity of cystic components on SPLICE-DWI was significantly different ( $P = .04$ ). Interobserver agreement for SPLICE-DWI was good ( $\kappa = 0.77$ ). Mean ADC value was significantly lower for PA than OSCL ( $0.62 \pm 0.07$  vs.  $1.83 \pm 0.70 \times 10^{-3} \text{mm}^2/\text{s}$ ,  $P = .002$ ). The area under the ROC curve of the ADC value was 0.952.

#### **CONCLUSION**

Qualitative and quantitative assessment of SPLICE-DWI helps distinguish between PA and OSCLs.

#### **CLINICAL RELEVANCE/APPLICATION**

SPLICE-DWI is a useful non-invasive imaging tool for diagnosing pituitary abscesses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-4

### The Experience of a Tertiary Center in South Brazil with Opportunistic Central Nervous Diseases of Immunocompromised Patients

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Kelly R. Neves, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our aim is to present a wide spectrum of opportunistic diseases, including unusual pathologies, that can affect the central nervous system of immunocompromised patients in two tertiary centers at south Brazil.

#### METHODS AND MATERIALS

This is a cross-sectional retrospective study performed at two public tertiary centers in South Brazil. We selected a miscellanea of 10 illustrative cases of the various conditions that can affect the immunocompromised patients' central nervous system was selected.

#### RESULTS

Amongst 322 patients evaluated during the last 5 years, 10 illustrative cases were selecting to represent a gamut of opportunistic infectious diseases that affect the central nervous system of immunocompromised patients. We show the following diagnosed cases: toxoplasmosis, progressive multifocal leukoencephalopathy (PML mimicking MSA-C), cryptococcosis, tuberculosis, nocardiosis, and paracoccidioidomycosis infections, HIV-encephalitis, HIV vasculopathy, AIDS-related lymphoma (mimicking toxoplasmosis), and a rare case of eosinophilic meningitis caused by *Angiostrongylus catanensis* (in a slug consumer).

#### CONCLUSION

The Central Nervous System is frequently affected in immunocompromised patients, as many opportunistic diseases may involve the brain. The clinical manifestations are nonspecific and depend on the type and location of the lesions. As the diagnosis of these entities is frequently made with noninvasive methods, imaging studies, especially magnetic resonance imaging, are very useful tools for the diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

These pathological conditions can have similar clinical manifestations, so imaging plays a crucial role in the variable diagnostic conditions and the assessment of the extent of the disease, in order to decide the best therapeutic strategy to be followed.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPNR-5

### Usefulness of Amide Proton Transfer Imaging Combined With Pseudocontinuous Arterial Spin Labeling Imaging and Apparent Diffusion Coefficient Map in Differentiating Intracranial Malignant Tumors From Benign Tumors in Young Patients

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Fumine Tanaka, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to assess combined diagnostic value of amide proton transfer (APT), tumor blood flow (TBF) obtained by pseudocontinuous arterial spin labeling (pCASL), and apparent diffusion coefficient (ADC) for differentiating intracranial malignant tumors (MTs) from benign tumors (BTs) in young patients.

#### METHODS AND MATERIALS

A total of 20 patients with intracranial tumors aged 0-30 years old were enrolled. Fifteen patients were categorized into MTs by WHO 5th edition classification grade 3 or 4, or ICD behavior code /3, and five patients were categorized into BTs by WHO grade 1 or 2. All the patients were scanned with APT, pCASL, and diffusion-weighted image and evaluated by histogram analysis. Maximum (max), minimum (min), mean, 10th, 25th, 50th, 75th, and 90th percentiles, skewness, and kurtosis of APT, TBF, and ADC values were obtained by the region of interest method. The parameters were compared between the groups by Mann-Whitney U test. Diagnostic performance was evaluated by receiver operating characteristic analysis.

#### RESULTS

MTs included diffuse midline glioma H3K27-altered, grade 4 (2), Diffuse paediatric-type high-grade glioma H3-wildtype and IDH-wildtype, grade 4 (2), astroblastoma, MIN1-altered (1), germinoma (3), immature teratoma (2), astrocytoma, NOS, grade 3 (1), atypical teratoid/rhabdoid tumor, grade 4 (1), rhabdomyosarcoma, NOS (1), medulloblastoma, histologically defined, grade 4 (1), and mixed germ cell tumors (1). BTs included pilocytic astrocytoma, grade 1 (1), astrocytoma, IDH-mutant, grade 2 (1), angiocentric glioma, grade 1 (1), posterior fossa ependymoma, group A, grade 2 (1), and supratentorial ependymoma, NOS, grade 2 (1). Mean, 10th, 25th, and 50th percentiles of APT ( $p=0.025$ , respectively), and ADC min showed significant differences ( $p=0.042$ ), while no parameter of TBF showed significant difference between the groups. Median values of APT mean (%), TBF max (mL/100g/min), and ADC min ( $\times 10^{-3}$  mm<sup>2</sup>/sec) were 3.26, 23.73 and 1.14 for MTs, whereas 1.92, 20.83, and 1.03 for BTs. Mean, 10th, 25th, and 50th percentiles of APT, TBF max, and ADC min were the highest AUC values among all parameters of each sequence (0.840, 0.760, and 0.813, respectively) and AUC value for combination of those was 0.933.

#### CONCLUSION

Combination of APT, pCASL, and ADC may be useful in differentiating intracranial MTs from BTs in young patients.

#### CLINICAL RELEVANCE/APPLICATION

Combination of APT, pCASL, and ADC map may help differentiating malignant and benign intracranial tumors in young patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-7

### Whole-tumor Histogram Analysis of Postcontrast T1-weighted and Apparent Diffusion Coefficient in Predicting the Grade and Proliferative Activity of Adult Intracranial Ependymomas

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Liu Xianwang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of histogram analysis of postcontrast T1-weighted (T1C) and apparent diffusion coefficient (ADC) in predicting the grade and proliferative activity of adult intracranial ependymomas.

#### METHODS AND MATERIALS

Forty-seven patients with histologically proven adult intracranial ependymomas were retrospectively collected. The histogram parameters, including minimum, maximum, mean, and Perc.01, Perc.05, Perc.10, Perc.25, Perc.50, Perc.75, Perc.90, Perc.95, Perc.99, as well as standard deviation (SD), variance, coefficient of variation (CV), skewness, kurtosis, and entropy of T1C and ADC images were extracted from the whole tumor using FireVoxel software. Differences in histogram parameters between grade 2- and grade 3- adult intracranial ependymomas were compared. Receiver operating characteristic curves and logistic regression analyses were conducted to determine the differential diagnostic performance. Spearman's correlation analysis was used to evaluate the relationship between histogram parameters and the Ki-67 proliferation index.

#### RESULTS

Grade 3 intracranial ependymomas showed significantly higher Perc.95, Perc.99, SD, variance, CV, and entropy of T1C (all  $p < 0.05$ ), lower minimum, mean, Perc.01, Perc.05, Perc.10, Perc.25, Perc.50 of ADC, higher CV and entropy of ADC (all  $p < 0.05$ ), compared to grade 2 intracranial ependymomas. Entropy (T1C) and Perc.10 (ADC) have a higher diagnostic performance with AUCs of 0.805 and 0.827 among the histogram parameters of T1C and ADC, respectively. The diagnostic performance was further improved by combining the entropy (T1C) and Perc.10 (ADC), with an AUC of 0.857. Significant correlations were observed between significant histogram parameters of T1C and ADC and the Ki-67 proliferation index ( $p = 0.001-0.044$ ).

#### CONCLUSION

Whole-tumor histogram analysis of T1C and ADC may be a promising approach in predicting the grade and proliferative activity of adult intracranial ependymomas.

#### CLINICAL RELEVANCE/APPLICATION

Grading and proliferative activity significantly influence treatment decision-making in adult intracranial ependymomas. Whole-tumor histogram analysis of T1C and ADC are useful to preoperatively evaluate the grade and proliferative activity of adult intracranial ependymomas. The combination of entropy (T1C) and Perc.10 (ADC) achieved the best diagnostic performance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPNR-8

### Radiomics-based Prediction of TERT Promoter Mutation in Intracranial Meningiomas

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Burak H. Akkurt, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

In meningiomas, TERT promotor mutations are rare but qualify diagnosis of anaplasia, directly impacting adjuvant therapy. Effective screening for patients at risk for promotor mutations could enable more targeted molecular analyses and improve diagnosis and treatment.

#### METHODS AND MATERIALS

Semiautomatic segmentation of the meningiomas was performed on preoperative magnetic resonance imaging. Discriminatory power to predict TERT promotor mutations was analyzed in grade 2/3 meningiomas using a random forest algorithm with an increasing number of radiomic features. Two final models with 5 and 8 features were built with both fixed and differing radiomics features. Each model has been fully developed 100 times to eliminate random effects and avoid overfitting.

#### RESULTS

117 image sets including training (N=94) and test data (N=23) were analyzed. Established 5- and 8-feature models with both fixed and different radiomics features enabled prediction of TERT with similar but excellent performance. Of note, a significant increase in the average discriminatory power up to the fifth feature included was observed, while addition of further features up to N=8 features only slightly increased the performance. 5-feature (different/ fixed) model predicted TERT promotor mutation status with a mean AUC of 91.8%/94.3%, mean accuracy of 85.5%/88.9%, mean sensitivity of 88.6%/91.4%, mean specificity of 83.2%/87.0%, and a mean Cohen's Kappa of 71.0%/77.7%. 8-feature (different/ fixed) model predicted TERT promotor mutation status with a mean AUC of 92.7%/94.6%, mean accuracy of 87.3%/88.9%, mean sensitivity of 89.6%/90.6%, mean specificity of 85.5%/87.5%, and a mean Cohen's Kappa of 74.4%/77.6%.

#### CONCLUSION

Radiomics based machine learning enables prediction of TERT promotor mutation status in meningiomas with excellent discriminatory performance. Future analyses in larger cohorts should include grade 1 lesions as well as additional molecular alterations.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics might help in the non-invasive characterization of meningiomas, impacting diagnosis and therapy.

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## Abstract Archives of the RSNA, 2023

T2-SPNR-9

### Predicting Meningioma Recurrence/progression Based on MRI Radiomics

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Tao Han (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Preoperative prediction of meningioma recurrence/ progression should help in the selection of surgical options and provides a basis for guiding meningioma patients to achieve individualized treatment. However, only a few radiological features have been identified to aid in prediction. The aim of this study was to develop and validate an MRI-based nomogram to predict meningioma recurrence/progression.

#### **METHODS AND MATERIALS**

This retrospective study collected 88 patients with surgically pathologically confirmed meningiomas, including 28 patients with postoperative tumor recurrence and 60 patients with non-recurrence. All cases were randomly divided into training and validation sets according to 7:3, and 1874 features were extracted from each of preoperative T2WI and T1WI-enhanced images, respectively, and least absolute shrinkage and selection operator (LASSO) regularization was used to determine the best combination of clinical and MRI features to predict meningioma recurrence/progression, and subsequently machine learning algorithms were applied to construct a meningioma recurrence risk assessment prediction model, using receiver operating characteristic (ROC) curve analysis to determine predictive performance, and calibration curve and decision curve analysis to validate the consistency and clinical validity of the nomogram.

#### **RESULTS**

Finally, twelve radiomics features closely related to the risk of meningioma recurrence were screened to construct a nomogram of the RF model, and the results showed that the model had good predictive performance with AUCs of 0.950 and 0.852 in the training and validation sets, respectively.

#### **CONCLUSION**

The predictive model based on MRI radiomics features has good predictive performance in predicting meningioma recurrence/ progression and can be applied to clinical practice.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiomics models based on T2WI and T1C are helpful for predicting meningioma recurrence/progression.

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## Abstract Archives of the RSNA, 2023

T2-SPOB-1

### Could the 40keV Monochromatic Images in Dual-Energy Spectral CT Increase the Value and Consistency of Peritoneal Cancer Index in Advanced Epithelial Ovarian Cancer for Junior Radiologists

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Bao Li (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of using 40keV virtual monochromatic images (VMI) in dual-energy spectral CT (DEsCT) to increase peritoneal cancer index (PCI) value in advanced epithelial ovarian cancer (EOC) for junior radiologists and their consistency with senior radiologists.

#### METHODS AND MATERIALS

Retrospectively analyzed 32 advanced EOCs (27 serous, 2 mucinous and 3 clear cell carcinomas, and 28 in stage III and 4 in stage IV) who underwent primary cytoreduction (11 in satisfied and 21 in dissatisfied groups). VMI of venous phase at 40keV and 70keV (equivalent to 120kVp) were reconstructed from abdominal and pelvic DEsCT. A senior and junior radiologist evaluated VMIs double-blindly in the degree of ascites, abdominal and pelvic anatomical structures using Sugarbaker PCI standards and performed CT-PCI scoring for the entire and upper abdomen separately. SPSS 27.0 and Medcalc 20.1.0 were used for statistical analyses. Binary logistic regression was used to analyze parameters influencing the outcome prediction of unsatisfactory tumor reduction surgery.

#### RESULTS

The satisfied group had lower serum CA-125 level than the unsatisfied group (112 vs. 654 u/ml,  $U=58$ ,  $P=0.023$ ). And the upper abdominal (2 vs. 6,  $U=43$ ,  $P=0.003$ ) CT-PCI scores than dissatisfied group. There was no significant difference in age, FIGO stage, histological type, and ascites degree between these two groups. The 70 keV CT-PCI score was an independent factor in causing initial tumor reduction dissatisfaction in advanced EOCs ( $OR=1.785$ , 95%  $CI=1.024-3.111$ ,  $P=0.041$ ). The 70keV CT-PCI scores of senior and junior radiologists were all lower than that of the 40keV (senior: mean difference = -1.81,  $t=-6.06$ ,  $P<0.001$ ; junior: mean difference = -2.84,  $t=-6.99$ ,  $P<0.001$ ). The CT-PCI scores of the junior was lower than that of the senior when using 70keV VMI (mean difference = -1.13,  $t=-4.52$ ,  $P<0.001$ ), but no significant difference using the 40keV VMI (mean difference = -0.09,  $t=-1.36$ ,  $P=0.184$ ).

#### CONCLUSION

The use of 40keV VMI improves CT-PCI scores for both senior and junior radiologists and reduces their differences.

#### CLINICAL RELEVANCE/APPLICATION

The 40keV VMI in DEsCT increase the value and consistency of PCI in advanced EOC for junior radiologists, help clinical evaluation of tumor load in patients with advanced EOC, and guide the development of clinical treatment strategies.

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## Abstract Archives of the RSNA, 2023

T2-SPOB-2

### **OvCA Finder: An Interpretable Hybrid Model Integrating Multimodal Information for Ovarian Cancer Diagnosis**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Huiling Xiang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop an interpretable hybrid model (OvcaFinder) from multimodal information that allows preoperative identification of ovarian cancer.

#### **METHODS AND MATERIALS**

Consecutive patients with at least one pathology-confirmed adnexal lesion visible by transvaginal ultrasound were enrolled in this study. Ultrasound images of all lesions were independently assessed by five readers using the Ovarian-Adnexal Reporting and Data System (O-RADS). The following three models were built and internally validated using 724 cases from Hospital 1: a clinical model with variables including age, lesion diameter, and cancer antigen 125 concentration; an image-based DL predictive model; and our newly developed model, OvcaFinder, using multimodal information. The performance of the models was then externally validated using 387 cases from Hospital 2 and the diagnostic performances of the models were compared.

#### **RESULTS**

The readers achieved mean areas under the receiver operating characteristic curve (AUCs) of 0.927 and 0.904, using the O-RADS for the internal and external test datasets, respectively. OvcaFinder outperformed the clinical model (AUC, internal dataset: 0.978 vs. 0.936,  $p = .007$ ; external dataset: 0.947 vs. 0.842,  $p < .001$ ) and the image-based DL predictive model (AUC, internal dataset: 0.978 vs. 0.970,  $p = .152$ ; external dataset: 0.947 vs. 0.893,  $p < .001$ ). Readers assisted by OvcaFinder showed significant improvements in AUCs (internal dataset: 2.3-8.0%; external dataset: 1.9-5.3%) and a reduction in false positive rate (internal dataset: 13.3%,  $p = 0.029$ ; external dataset: 8.3%,  $p = 0.033$ ) than those without.

#### **CONCLUSION**

OvcaFinder, an interpretable hybrid model that integrates multimodal information, could be used by radiologists as a non-invasive tool for reliably diagnosing ovarian cancer, thus improving radiologists' diagnostic performance and helping to determine the appropriate treatment strategies.

#### **CLINICAL RELEVANCE/APPLICATION**

OvcaFinder, a novel hybrid model constructed from multimodal information can effectively distinguish between ovarian cancer and benign lesions and thus significantly improve the diagnostic performance of radiologists.

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## Abstract Archives of the RSNA, 2023

T2-SPOB-3

### Subendometrial Enhancement and Peritumoral Enhancement in the Uterus: Assessment of the Optimal Timing with High Spatial-temporal Resolution Multiphasic Contrast Enhanced-MRI

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Takahiro Tsuboyama, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The scanning protocol of dynamic contrast-enhanced MRI (DCE-MRI) for endometrial cancer has not been standardized due to the lack of evidence regarding the optimal timing for subendometrial enhancement (SEE) and peritumoral enhancement (PTE). The purpose of this study was to assess SEE and PTE with high spatial-temporal resolution multiphasic DCE-MRI using differential subsampling with cartesian ordering (DISCO).

#### METHODS AND MATERIALS

Fifty women (mean age, 56.8; range, 25-91 years) who underwent DCE-MRI for the assessment of suspected uterine diseases were included. Nineteen of them were proved to have endometrial cancer. DCE-MR included 11 early phases obtained with DISCO (voxel size, 0.6\*1.0\*4.0 mm) in which the first 10 phases were acquired from 20 to 50 s after contrast injection with temporal resolution of 3 s, followed by 11th phase with a full k-space data sampling at 60 s. One radiologist placed regions of interest on the uterine structures, and time-intensity curves were generated. Enhancement ratios (ERs) and contrast ratios (CRs) were calculated and compared using Wilcoxon test and Friedman test. Correlation between the start of uterine enhancement and the start of the plateau or peak of SEE was evaluated using a correlation coefficient.

#### RESULTS

SEE was detected in 48 of the 50 patients. It showed various degree of peak ER (range, 0.59-3.56). During the early phases, it reached a plateau in 25 patients and showed a progressive enhancement in the other 23 patients. The plateau started variably from 32 to 47 sec after contrast injection and had a moderate positive correlation with the contrast arrival time at the uterus ( $r = 0.52$ ,  $P < 0.01$ ). The mean ER of SEE on each phase was increased with time and was significantly the highest at 60 sec ( $P < 0.01$ ). CR between SEE and inner myometrium also increased with time and was the highest during 41 to 60 sec. PTE was detected in 15 patients with an endometrial cancer and displayed significantly higher peak ER and significantly earlier start of a plateau compared with SEE ( $P < 0.01$ ). The highest CR between PTE and SEE was observed during 32-44 s.

#### CONCLUSION

SEE may show optimal enhancement and contrast at 60 s after contrast injection and have different enhancement patterns from those of PTE. Given some varieties in the enhancement patterns of SEE and PTE among patients, DISCO may be useful to catch the optimal timing for the detection of SEE and PTE.

#### CLINICAL RELEVANCE/APPLICATION

Accurate assessment of SEE and PTE with high spatial-temporal resolution DCE-MRI using DISCO may increase the accuracies of preoperative staging of endometrial cancer.

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## Abstract Archives of the RSNA, 2023

T2-SPOB-4

### **Diagnostic Ability of Single-Shot Fast Spin-Echo T2-Weighted MRI with Deep Learning Reconstruction for the Assessment of Myometrial Invasion in Endometrial Cancer: A Comparison with Standard Sequences using PROPELLER and Fast Spin-Echo Imaging**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Takahiro Tsuboyama, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Single-shot fast spin-echo (SSFSE) T2-weighted MRI (T2WI) with deep learning reconstruction (DLR) is reported to achieve high image quality in an ultra-short acquisition time. The purpose of this study was to compare its diagnostic ability for the assessment of myometrial invasion in endometrial cancer with that of standard but time consuming T2WI using periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER) and fast spin-echo (FSE) imaging.

#### **METHODS AND MATERIALS**

Seventy-two consecutive patients who underwent preoperative dynamic contrast-enhanced (DCE) MRI for endometrial cancer were included. For the standard T2WI, para-axial FSE and parasagittal PROPELLER imaging were obtained. Para-axial and -sagittal SSFSE T2WI with DLR (SSFSE-DLR-T2WI) were also acquired. Two radiologists independently assessed the following four MRI sets; standard T2WI, standard T2WI+DCE, SSFSE-DLR-T2WI, and SSFSE-DLR-T2WI+DCE. Noise, artifacts, the visibility of the junctional zone and serosa of the uterus and that of the tumor were compared between standard T2WI and SSFSE-DLR-T2WI using the Wilcoxon signed-rank test. The diagnostic accuracies of the four MRI sets regarding superficial and deep myometrial invasion of the endometrial cancer were compared using the receiver operating characteristic analysis and the Cochran's Q test.

#### **RESULTS**

SSFSE-DLR-T2WI was significantly better than standard T2WI regarding noise, artifacts, and the visibility of the uterine structures and the tumor for both readers ( $p < 0.01$ ). As for the diagnosis of myometrial invasion, mean AUCs of standard T2WI, standard T2WI+DCE, SSFSE-DLR-T2WI, and SSFSE-DLR-T2WI+DCE by the two readers were 0.76, 0.83, 0.72, and 0.80, respectively for superficial myometrial invasion, and 0.87, 0.92, 0.82, and 0.91, respectively for deep myometrial invasion. There were no significant differences in AUCs, sensitivities, specificities, and accuracies between standard T2WI and SSFSE-DLR-T2WI and between standard T2WI+DCE and SSFSE-DLR-T2WI+DCE for both readers. Sensitivities for superficial myometrial invasion were significantly lower with standard T2WI than with standard T2WI+DCE and with SSFSE-DLR-T2WI+DCE for both readers ( $p < 0.05$ ).

#### **CONCLUSION**

For the assessment of myometrial invasion in endometrial cancer, SSFSE with DLR can provide better image quality and equivalent diagnostic accuracies compared with standard T2WI.

#### **CLINICAL RELEVANCE/APPLICATION**

Standard T2WI can be replaced by SSFSE with DLR for the assessment of myometrial invasion in endometrial cancer, which can reduce the examination time considerably.

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## Abstract Archives of the RSNA, 2023

T2-SPPD-1

### **Pediatric H3K27 Altered Diffuse Midline Gliomas: Imaging Features in 37 Children of One Institution**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Elzbieta Jurkiewicz, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Pediatric diffuse midline glioma PDMG arises from the thalami, hypothalamus, pineal gland, brainstem, cerebellum, and spinal cord. Regardless the location, the prognosis of PDMG is poor with a 2-year survival rate of <10%. According the 2021 WHO classification pediatric diffuse high grade gliomas are recognized as: diffuse midline glioma, H3K27 altered, diffuse hemispheric glioma, H G34-mutant, diffuse pediatric high-grade glioma, H3-wildtype/IDH-wildtype and infant-type hemispheric glioma. The overexpression of EZHIP, or an EGFR mutation are also observed in these tumors. The possibility of surgical resection is often limited, due to the involvement of critical brain structures. Radiation or chemotherapy is standard. We present MR examinations of 37 patients with diffuse midline glioma, H3 K27-altered, aged from 40 months to 17 years; median age 9.6 years.

#### **METHODS AND MATERIALS**

All patients were examined on 1.5 T scanner with protocol including T2/FLAIR images, DWI, SWI, and T1-weighted images without and with contrast injection. We characterized the structural MR imaging features of these tumors: presence of calcifications, hemorrhage, necrosis, and leptomeningeal spread. The presence and degree of contrast enhancement were also assessed. A biopsy was performed in all patients. Pathological/microscopic and molecular characterization was carried out in all children.

#### **RESULTS**

Tumors were located in pons in 28 patients, midbrain in 12, thalamus in 6, medulla oblongata in 6, and in spinal cord in one child. All tumors were hypointense on T1- and heterogeneously hyperintense on T2/FLAIR images. Contrast enhancement was seen in 16 patients (punctate or rim), restriction diffusion in 9. Exophytic component was noted in one child. Hydrocephalus was present in 5, necrosis in 9, and hemorrhagic component in 3 patients. Leptomeningeal spread at the time of diagnosis were diagnosed in one case. The mutations c.83A>T H3F3A were recognized in 35 children and mutations c.83A>T HIST1H3B (H3C2) in 2 patients.

#### **CONCLUSION**

We found that midline gliomas with histone H3 K27M mutation centered within the thalamus and brainstem were solid with infrequent exophytic component and hemorrhage.

#### **CLINICAL RELEVANCE/APPLICATION**

Molecular characterization of the PDMG may be relevant to individual patients for personalized molecular therapies based on genomic analysis of the tumours.

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## Abstract Archives of the RSNA, 2023

T2-SPPD-2

### [<sup>11</sup>C] Methionine PET in Diagnosing Pediatric Low-grade Gliomas

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yooyoung Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

Positron emission tomography (PET) imaging of the brain with amino acid tracers, such as [<sup>11</sup>C] Methionine (MET), is helpful in the evaluation of brain tumors. Although MET-PET has been extensively used in adults and some pediatric brain tumors, data on MET-PET imaging of pediatric low-grade gliomas (pLGG) are scarce. This study aimed to investigate the diagnostic performance of MET-PET in diagnosing pLGGs.

#### METHODS AND MATERIALS

Fifteen patients with newly diagnosed pLGG and twenty-six previously treated pLGG patients were evaluated with MET-PET and magnetic resonance imaging. Biopsy or tumor resection was performed in all patients within 6 months of the MET-PET. Qualitative and semi-quantitative analysis that included tumor to brain uptake ratios (TBR) were performed. TBR consisted of TBR<sub>max</sub>, TBR<sub>peak</sub>, and TBR<sub>mean</sub> analyses. TBR >1 was used to define a positive MET-PET test.

#### RESULTS

The sensitivity of MET-PET for diagnosing newly diagnosed pLGG was 87% for TBR<sub>max</sub> and TBR<sub>peak</sub>, 80% for TBR<sub>mean</sub>, and 94% for qualitative interpretation. The sensitivity of MET-PET for diagnosing previously treated pLGG was 100% for TBR<sub>max</sub> and TBR<sub>peak</sub>, 81% for TBR<sub>mean</sub>, and 96% for qualitative interpretation. The sensitivity for the combined cohort was 95% for both TBR<sub>max</sub> and TBR<sub>peak</sub>, 80% for TBR<sub>mean</sub>, and 95% for qualitative evaluation.

#### CONCLUSION

Both quantitative and qualitative MET-PET have high sensitivity in diagnosing pLGG, both newly diagnosed and previously treated.

#### CLINICAL RELEVANCE/APPLICATION

With its high sensitivity, MET-PET can be used to complement equivocal MRI.

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## Abstract Archives of the RSNA, 2023

T2-SPPH-1

### Quantification of Radial and Azimuthal Variation in Spatial Resolution due to Patient Positioning on Energy Integrating and Deep Silicon Photon Counting Detector CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Aria M. Salyapongse, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Mispositioning in CT degrades spatial resolution. Existing CT technologies address this degradation using scan modes that increase view angle sampling. In this work, we investigate spatial resolution loss away from isocenter for a prototype deep silicon photon-counting detector (PCD) CT scanner and compare with existing energy-integrating detector (EID) CT.

#### METHODS AND MATERIALS

We performed three sets of scans on a wire phantom at four radial positions in the bore (isocenter, 6.7 cm, 11.8 cm, and 17.1 cm off isocenter). The acquisition modes were: 120 kV EID CT, 120 kV high-definition (HD) EID CT, and 120 kV PCD CT. HD mode used double the projection view angles as the "regular" EID scan mode. Diameter of the wire was calculated by taking the full width of half max (FWHM) of a profile drawn over the radial and azimuthal directions of the wire. Change in apparent size of the wire was assessed by taking the ratio of the radial or azimuthal diameter at each position to the radial or azimuthal diameter at isocenter.

#### RESULTS

The deep silicon PCD CT had the smallest change in the ratio of the wire diameter for both radial (ratio of  $1.00 \pm 0.09$  versus  $1.15 \pm 0.01$  and  $1.21 \pm 0.04$ ,  $p < .001$ ) and azimuthal (ratio of  $0.99 \pm 0.09$  versus  $1.36 \pm 0.01$  and  $1.12 \pm 0.01$ ,  $p < .001$ ) directions versus EID and HD EID respectively. HD EID CT had a smaller change in the ratio of the wire diameter in the azimuthal direction compared with EID CT ( $p < .001$ ), and a larger change in the radial direction compared with EID CT ( $p < .001$ ).

#### CONCLUSION

Deep silicon PCD CT exhibits less change in spatial resolution in both the radial and azimuthal directions compared with both regular and HD modes on EID CT.

#### CLINICAL RELEVANCE/APPLICATION

Deep silicon PCD CT better preserved spatial resolution away from isocenter compared to EID CT which could translate into better bone and lung detail in regions located far away from isocenter.

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## Abstract Archives of the RSNA, 2023

T2-SPPH-10

### Accuracy of Volume and Linear Dimension Measurements of Hepatic Lesions with Dual Energy CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yifang Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

It has been proposed to use the volumes of hepatic lesions as a better metric than linear dimensions. However, as compared to linear dimensions, lesion volumes are more susceptible to segmentation error, hence the measurement accuracy remains unknown. We aimed to study the accuracy of both lesion volume and linear dimension measurements with dual energy CT using a simulated multi-phase liver phantom.

#### METHODS AND MATERIALS

The liver was simulated using material composition following ICRU 44. It was embedded in an abdomen phantom containing thoracic and lumbar spines. 34 lesions of iodine, iron, fat, and cyst were placed in the liver with known volumes (0.09 - 8.57 cc) and maximum linear dimensions (MLD) (10- 35 mm). The lesions are of various shapes (ellipsoidal and lobular), and contrast (-100 to 30 HU). The non-contrast, arterial, and venous phases were simulated by perfusing the parenchyma with different iodine concentrations (0, 0.68, and 1.89 mg/cc) in three consecutive slabs (40 - 50 mm thickness each). A GE Revolution CT was used at the dual-energy mode in three repeats with CTDIvol of 14 mGy (slice thickness 2.5 mm). 28 visually discernable lesions were contoured using GE AW-3.2 with auto segmentation and careful user correction for monochromatic reconstructed images of 50- 100 keV.

#### RESULTS

Compared with the known values, the overall volumes were overestimated across different energies by 9.4% +12.5%, whereas the overall MLDs were found underestimated by 4.7% +8.3%. The cyst and fat volumes were found most accurate with 3.1%+5.7% and 8.8%+8.1%, respectively, whilst the corresponding MLDs were with accuracies of 1.1%+1.8%, and 9.7%+9.5%. The iron and iodine volumes were measured higher than the ground truth by 12%+10% and 10%+14%, respectively, whilst the corresponding MLDs were found lower by 6.3%+6.7% and 3.2%+8.3%. The optimal energy for the volumes of the cyst, fat, iron, and iodine was found to be  $\leq 70$  keV, 55 keV, 65 keV, and 70 keV, respectively. For MLD measurements, the results were less dependent on energy with the overall accuracy of 4.7%+8.4%.

#### CONCLUSION

With the fast-kVp switch dual-energy CT, the liver lesion volumes were overestimated by 9.4%  $\pm$ 12.5%, and the optimal energies were identified with better accuracy. The MLD were underestimated with overall accuracy of 4.7%  $\pm$ 8.3% and the results were found less dependent on energy.

#### CLINICAL RELEVANCE/APPLICATION

Provide hepatic lesion volume and linear dimension accuracy in multiphase liver CT scans.

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## Abstract Archives of the RSNA, 2023

T2-SPPH-11

### Assessment of a Low-Dose Single-Scan Dynamic CT Myocardial Perfusion Technique using a Helical Scan Mode

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### PURPOSE

This study assessed the reproducibility and accuracy of a low-dose single-scan dynamic CT myocardial perfusion technique using a fast-pitch helical scan mode available on standard CT scanners.

#### METHODS AND MATERIALS

A total of 6 Yorkshire Swine ( $48.7 \pm 7.4$  Kg) were assessed under rest and stress conditions. Using a 320-slice CT scanner, 6 and 6 pairs of repeated CT perfusion measurements were obtained in helical and volume scan modes (100 kVp, 200 mA, and 2.5 s scan time), respectively. Myocardial perfusion measurements derived from a previously validated single-volume myocardial CT perfusion technique were used as a reference for accuracy assessment of measurements obtained from helical scans. Each helical pair was acquired following the acquisition of a volume pair, under the same perfusion conditions. Both contrast (0.5 mL/kg; 370 mgI/mL) and a diluted contrast/saline chaser (0.5 mL/kg; 30:70 contrast/saline) were injected peripherally at a rate of 5 mL/s. Following bolus tracking and triggering, a single scan was acquired at the peak of the aortic enhancement. Both the bolus tracking and the single scan data were used to derive perfusion in mL/min/g using a first-pass analysis model. The coronary perfusion territories of the left anterior descending (LAD), left circumflex (LCx) and right coronary artery (RCA) were automatically assigned for vessel-specific regional perfusion analysis. The reproducibility and accuracy of myocardial perfusion measurements in each coronary perfusion territory were assessed via regression analysis. The average CT dose index (CTDI) of perfusion measurements was recorded.

#### RESULTS

The first (PHel1) and second (PHel2) helical CT perfusion measurements were related by  $PHel2=0.89PHel1+0.13$  ( $r=0.91$ ; RMSE = 0.21 mL/min/g; RMSD = 0.20 mL/min/g) for the LAD, LCx, and RCA perfusion territories. The myocardial perfusion measurements obtained from helical and volume scans were also related by  $PHel=0.98PVol+0.02$  ( $r=0.99$ ; RMSE = 0.04 mL/min/g; RMSD = 0.05 mL/min/g) when assessed in the whole myocardium, and by  $PHel=0.95PVol+0.04$  in LAD, LCx, and RCA perfusion territories. The average CTDI of CT perfusion measurement was 30.1 mGy and 13.3 mGy for helical and volume acquisitions, respectively.

#### CONCLUSION

A standard CT scanner in a helical scan mode can provide reproducible and accurate myocardial perfusion measurement in mL/min/g using a low-dose single-scan dynamic CT myocardial perfusion technique, which enables the clinical applicability of the technique.

#### CLINICAL RELEVANCE/APPLICATION

Using a standard CT scanner in a helical mode, this technique will provide a noninvasive tool that allows comprehensive concurrent evaluation of coronary anatomy and physiology for routine assessment of coronary artery disease.

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## Abstract Archives of the RSNA, 2023

T2-SPPH-12

### Urinary Stone Differentiation using Material Decomposition Images in Dual Energy CT Urography

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yannan Cheng, BS,BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility of differentiating urinary stones using material decomposition (MD) images in dual energy CT urography (DECTU).

#### METHODS AND MATERIALS

108 consecutive patients (mean age:  $48.22 \pm 14.69$ y, male vs female: 75 vs 33) with suspected urinary stones and underwent triphasic DECTU were included. MD images with various basis material pairs at nephrographic (ENP) and excretory (EEP) phase were transferred to an AW4.7 for analysis. For stones larger than 3mm, regions of interest were defined as the largest circumference on the axial section of the images. MD densities of stones were measured using the GSI Viewer. Stones were divided into the pure calcium oxalate (pCaO: n=34), mixed calcium oxalate (mCaO: n=14) and mixed calcium phosphate (mCaP: n=70) according to the results of Fourier infrared spectrometer. One way ANOVA or Kruskal-Wallis H test was used to compare the MD density among the three stone groups with adjusted significance level. Thresholds for differentiating urinary stones were determined using receiver operating characteristics (ROC) analysis.

#### RESULTS

The MD densities of stones using different basis material pairs are listed in Tab.1. Significant differences on Calcium (Water) MD images at ENP were found between pCaO and mCaO; mCaO and mCaP. While COD (HAP) MD images at ENP provided higher ability to distinguish pCaO from mCaP. The ranges of AUC of using MD density on ENP images were 0.68-0.75 (Tab.2) and MD density on COD (HAP) based images at ENP provided higher ability to differentiate and display the three stones (Fig.1).

#### CONCLUSION

MD density on COD (HAP) based images at ENP provide relatively high accuracy in distinguishing calcium oxalate from calcium phosphate.

#### CLINICAL RELEVANCE/APPLICATION

Material decomposition images may play a role in identifying calcium oxalate stones and calcium phosphate, especially COD (HAP) MD images.

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## Abstract Archives of the RSNA, 2023

T2-SPPH-13

### Diagnostic Value of CT Lymphangiography in Patients with Primary Chyluria

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Qi Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the application value of CT lymphangiography in diagnosis in patients with primary chyluria.

#### METHODS AND MATERIALS

Clinical and CTL imaging data of 79 patients diagnosed with primary chyluria were collected retrospectively. For CTL, the indexes were: Distribution of abnormal lymphatic vessels in the kidney: unilateral or bilateral kidney, renal sinus, renal parenchymal, suprahilum area and subhilum area; Distribution of perirenal and retroperitoneal abnormal lymphatic vessels: retroperitoneal, lumbar trunk, renal perivascular area, fatty capsule, adrenal area, etc; Distribution of dilated lymphatic vessels and lymphatic reflux in chest, abdomen and pelvis. The clinical characteristics and CTL signs of patients with primary chyluria were statistically described by the composition ratio of classification variables.

#### RESULTS

CTL showed abnormal lipiodol deposition in kidney in 74 cases (93.7%), single kidney in 55 cases (69.6%), bilateral kidneys in 19 cases (24.1%), renal sinus in 74 cases (93.7%), renal parenchyma in 37 cases (46.8%); suprahilum area in 61 cases (77.2%), 52 cases (65.8%) were unilateral and 9 cases (11.4%) were bilateral; subhilum area in 61 cases (77.2%), 47 cases (59.5%) were unilateral and 14 cases (17.7%) were bilateral; retroperitoneal area in 78 cases (98.7%); lumbar trunk area in 76 cases (96.2%), 20 cases (25.3%) were unilateral and 56 cases (70.9%) were bilateral; perivascular area in 72 cases (91.1%), 45 cases (57.0%) were unilateral and 27 cases (34.2%) were bilateral; fatty capsule in 14 cases (17.7%), 13 cases (16.5%) were unilateral and 1 case (1.3%) were bilateral; adrenal area in 12 cases (15.2%); bladder in 31 cases (39.2%), perivesical area in 12 cases (15.2%), perivascular area of the iliac in 73 cases (92.4%), abdominal and pelvic wall in 14 cases (17.7%), perineal area in 12 cases (15.2%), perirectal area in 14 cases (17.7%), mesentery in 26 cases (32.9%), intestinal wall in 11 cases (13.9%), intestinal canal in 5 cases (6.3%), peripancreatic area in 15 cases (18.9%), perisplenic area in 2 cases (2.5%), perihepatic area in 7 cases (8.8%), hilum of the lung in 1 case (1.3%), mediastinum in 14 cases (17.7%), pericardium in 1 case (1.3%), extrapleural area in 25 cases (31.6%), chest wall in 2 cases (2.5%), skeleton in 2 cases (2.5%), end of thoracic duct in 70 cases (88.6%).

#### CONCLUSION

CTL can evaluate the distribution and range of intrarenal, perirenal and retroperitoneal dilated lymphatic vessels accurately, and evaluate the abnormal lymphatic vessels in the chest, abdomen and pelvis in patients with primary chyluria.

#### CLINICAL RELEVANCE/APPLICATION

CTL can provide image basis for the diagnosis, grading and treatment of primary chyluria.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPPH-2

### Application of Silver Nanotriangles as a Novel Contrast Agent in Tumor Computed Tomography Imaging

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Huiquan Yang, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to prepare chitosan-coated silver nanotriangles (AgNTs) and assess their computed tomography (CT) contrast property by in vitro and in vivo experiments.

#### **METHODS AND MATERIALS**

AgNTs with a range of sizes were synthesized by a seed-based growth method, and subsequently characterized by transmission electron microscopy (TEM), ultraviolet-visible absorption spectroscopy and dynamic light scattering. The X-ray attenuation capability of all prepared AgNTs was evaluated using micro CT. The CT contrast effect of AgNTs with the highest X-ray attenuation coefficient was investigated in MDA-MB-231 breast cancer cells and a mouse model of breast cancer.

#### **RESULTS**

The TEM results displayed that all synthesized AgNTs were triangular in shape and their mean edge lengths ranged from 60 to 149 nm. All AgNTs tested exhibited stronger X-ray attenuation capability than iohexol at the same mass concentration of the active elements, and the larger the AgNTs size, the higher the X-ray attenuation coefficient. AgNTs with the largest size were selected for further research, due to their strongest X-ray attenuation capability and best biocompatibility. The attenuation coefficient of breast cancer cells treated with AgNTs increased in a particle concentration-dependent manner. In vivo CT imaging showed that the contrast of the tumor injected with AgNTs was significantly enhanced.

#### **CONCLUSION**

Our findings suggested that AgNTs could serve as an excellent contrast agent for CT imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

The current study provided a new thought for the development of highly efficient tumor CT contrast agents.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPPH-3

### Improvement of Demonstrating Submillimeter Vessels by a Newly Developed Photon Counting Detector CT: Comparison with an Energy Integrating CT in a Vessel Phantom Model

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Shota Kondo (*Presenter*) Nothing to Disclose

#### PURPOSE

Demonstrating submillimeter vessels is not easy for the conventional energy integrating detector CT (EID-CT). PCD-CT offers several advantages over conventional EID-CT, including improvements in spatial resolution, image noise, and contrast resolution of materials including iodine as PCD-CT directly measure photon energy of each incident photon using a single semiconductor layer. The purpose of our study was to evaluate diagnostic capability of a newly developed PCD-CT on the visualization of submillimeter vessels compared with conventional EID-CT in a vessel phantom model.

#### METHODS AND MATERIALS

We used a prototype PCD-CT scanner developed by Canon Medical Systems for this phantom study. A phantom (outer diameter 200 mm) including simulated 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, and 10.0 mm vessels was scanned with a PCD- and EID-CT (Aquilion Precision, Canon Medical Systems). The simulated vessels were filled with diluted iodine contrast material (15mgI/ml). The scanning parameters for PCD-CT and EID-CT were matched: 120 kV, 9.5-9.7mGy CTDIvol. Both scans were reconstructed with hybrid-iterative reconstruction. PCD-CT scans were reconstructed using 1024- [ultra-high resolution (UHR) mode] while EID-CT scans were reconstructed using 512 matrix sizes. Modulation transfer function (MTF) was calculated using the simulated vessel with diameter of 10.0 mm. Profile curves were generated along a horizontal line crossing through the center of each simulated small vessel (diameter less than 3.0 mm) and the slope at the 50% point of each curve was calculated.

#### RESULTS

The margin of each simulated vessel was clearly demonstrate on PCD-CT- compared with EID-CT image. PCD-CT could barely demonstrate the simulated vessel with diameter of 0.5 mm but EID-CT could not .The MTF for PCD-CT showed higher response than for EID-CT in all frequency domains. The slope value for simulated small vessels was higher on PCD-CT than on EID-CT image especially for smaller vessels.

#### CONCLUSION

PCD-CT with UHR mode showed higher spatial resolution and better demonstration of submillimeter vessels than conventional EID-CT in a phantom model.

#### CLINICAL RELEVANCE/APPLICATION

PCD-CT with UHR mode may be able to demonstrate more detailed vascular anatomy such as the perforating branches of the brain than EID-CT; and PCD-CT has the potential to bring advances to medical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPPH-4

### Quantification of Lower Extremity Blood Flow using a Low-dose CT Perfusion Technique

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Alireza Shojazadeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the reproducibility and accuracy of lower extremity perfusion measurements with a low-dose first-pass analysis (FPA) dynamic CT perfusion technique.

#### METHODS AND MATERIALS

A total of sixteen Yorkshire Swine ( $46.3 \pm 7.2$ kg) were used in this study with twenty-two CT acquisitions for accuracy and thirty-three acquisition pairs for reproducibility assessments. In each animal, acquisition pairs were obtained at baseline blood flow and under various levels of femoral artery stenosis severity induced by a vascular occluder. Reference flow measurements were recorded for each acquisition using an ultrasound flow probe for comparison and accuracy assessment of the technique. Contrast agent (370 mg/mL iodine, 1 mL/kg) and saline chaser (0.5 mL/kg) were both injected peripherally at a rate of 5 mL/s. Bolus tracking was used, and a pre-contrast (120kVp; 50mA) and post-contrast (120kVp; 200mA) helical scan were acquired at the base and approximately the peak of the aortic enhancement (CT angiogram), respectively. The pre- and post-contrast helical scan data were then used as analytical inputs into a first-pass analysis model to derive perfusion in mL/min/g. The accuracy and reproducibility of lower extremity perfusion measurement were then assessed via linear regression, Bland-Altman analysis, and paired sample t-test (p-value). The average CT dose index (CTDI) for the perfusion measurements was recorded.

#### RESULTS

The first (P1) and second (P2) CT perfusion measurements were related by  $P2 = 0.97 P1 + 0.00$  ( $r = 0.97$ ,  $RMSE = 0.11$  mL/min/g and  $RMSD = 0.11$  mL/min/g,  $P$ -value = 0.56). The blood flow calculation derived from the CT perfusion technique (QCT) and the reference standard ultrasound blood flow measurement (QUS) were related by  $QCT = 0.93 QUS + 9.83$  ( $r = 0.96$ ,  $RMSE = 16.34$ ,  $RMSD = 32.20$ ,  $P$ -value = 0.09). The average CTDI of perfusion measurement using this technique was only 9.1 mGy.

#### CONCLUSION

This study shows that the low-dose quantitative CT perfusion technique can accurately measure lower extremity perfusion (mL/min/g) using only two helical scans. The CT angiogram and perfusion measurements can be used as a comprehensive technique for morphological and physiological assessment of limb ischemia.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative assessment of blood flow in peripheral extremities provides clinicians with a promising diagnostic tool for evaluating vascular diseases. Simultaneously acquiring CT angiography and providing accurate blood flow measurement can improve risk assessment and critical decision-making for patients across a wide spectrum of disease severity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPPH-5

### Noise Reduction at Coronary CT Angiography with Photon-counting Detector CT: A Structured Phantom Study

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Toru Higaki, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detector CT (PCD-CT) features a semiconductor detector that enables high-resolution imaging with a high-density detector element, and low-noise imaging based on electrical noise cancellation. We developed a photon-counting detector CT scanner whose detector is made of CdZnTe. Here we evaluate the noise characteristics of PCD-CT using a structured phantom that simulates coronary CT angiography (CCTA).

#### METHODS AND MATERIALS

Our CCTA structured phantom shown in Fig.1 uses a 3D printer (KEYENCE Agilista-3200). The vessels were filled with iodine contrast medium diluted to 20 mgI/ml. One simulated coronary artery harbored a 70% stenotic lesion, the other a stent graft (Medtronic, BeStent, 3.0 mm × 15 mm). We scanned the phantom on a PCD-CT scanner (Canon Medical Systems) in normal-resolution mode. The detector-element size was approximately the same as that of conventional EID-CT, the slice thickness was about 0.6 mm, the tube voltage was 120 kV, and the tube current was 250 mA. Comparisons were with a conventional energy-integrating detector CT (EID-CT, Aquilion ONE GENESIS, Canon Medical Systems). The structured phantom was scanned with a protocol that resulted in similar radiation exposure. All images were reconstructed with hybrid iterative reconstruction. To evaluate the image quality we measured the noise power spectrum (NPS) as a metric of the noise characteristics and the task-based modulation transfer function (MTF) as a metric of spatial resolution.

#### RESULTS

The radiation dose (CTDIvol) was approximately 9.5 mGy. The image noise of PCD-CT was lower than of EID-CT (SD: 8.9 v.s. 13.8 HU, Fig. 2 left). The spatial resolution of PCD-CT and EID-CT were comparable (Fig. 2 right). Comparison of the images in Figs. 3 and 4 confirmed the low image noise on PCD-CT scans.

#### CONCLUSION

Our PCD-CT suppressed the electrical noise and reduced the image noise on CCTA images.

#### CLINICAL RELEVANCE/APPLICATION

As the normal resolution mode of PCD-CT can reduce the image noise it may be useful for reducing the radiation dose of CCTA.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPPH-6

### **Radiation Dose and Image Quality at Coronary CT Angiography using a 256-detector Scanner at Different Heart Rates**

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yuta Hirose (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To retrospectively assess radiation dose and image quality (IQ) at coronary CT angiography (CCTA) with a 256-detector CT scanner in patients with different heart rates (HRs).

#### **METHODS AND MATERIALS**

From January 2022 through January 2023, consecutive 158 patients were included who underwent prospectively ECG-gated axial scanning of CCTA using the high-definition scan mode with the latest 256-detector CT scanner (Revolution CT Apex, GE). Each patient was classified into one of the following 3 groups based on mean HR and HR variability (HRV), defined as difference between maximum and minimum HRs, during the scanning: Group A, mean HR < 65 bpm and HRV < 20 bpm; Group B, mean HR = 65 bpm and HRV < 20 bpm; Group C, HRV = 20 bpm. Scan window was automatically selected based on mean HR and HRV just before the examination with dedicated software as follows: Group A, mid-diastole; Group B, end-systole to mid-diastole; Group C, entire cardiac cycle of a single heartbeat. Axial images of 0.625-mm slice were reconstructed with a deep-learning algorithm at optimal cardiac phase automatically selected with dedicated software. A motion correction algorithm was applied only when motion artifact remained significant. Standard deviation (SD) of CT value was measured in the ascending aorta as image noise. Two independent radiologists subjectively assessed IQ of the right coronary artery (RCA), left anterior descending artery (LAD), and left circumflex artery (LCX) regarding motion artifact using a 4-point scale (1, poor; 4, excellent; 2-4, acceptable). One-way ANOVA test was used to compare body mass index (BMI), SD, and dose-length product (DLP) and Kruskal-Wallis test was used to compare the IQ scores with Bonferroni correction among Groups A-C at the scanning. Weighted  $\kappa$  test was used to quantify inter-reader agreement.

#### **RESULTS**

Whereas BMI ( $P = 0.557$ ) and SD ( $P = 0.065$ ) were comparable among Groups A-C, DLP was significantly higher in Group C than in Groups A and B ( $P < 0.05$  for both) but comparable between Groups A and B at the scanning ( $P = 0.341$ ). The IQ score for RCA was significantly higher in Group A than in Group B ( $P < 0.001$ ) and for LAD and LCX, in Group A than in Groups B and C ( $P < 0.05$  for all); otherwise, comparable among Groups A-C ( $P > 0.05$  for all). IQ was acceptable in all vessels except one RCA in Group A and one RCA and one LCX in Group C. Inter-reader agreement was good ( $\kappa = 0.76$ ).

#### **CONCLUSION**

IQ regarding motion artifact was best in Group A but acceptable in all Groups whereas radiation dose was significantly increased in Group C at the CCTA.

#### **CLINICAL RELEVANCE/APPLICATION**

Whereas acceptable IQ regarding motion artifact can be preserved at CCTA with the latest 256-detector CT scanner, adequate use of beta blockers to lower HR and HRV can reduce radiation dose and improve IQ and diagnostic performance.

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## Abstract Archives of the RSNA, 2023

T2-SPPH-7

### Reproducibility of an Automated Lobar Lung Tissue Assignment Technique using Non-contrast CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### PURPOSE

Lobar segmentation is necessary for regional ventilation and perfusion analysis. This study evaluated the reproducibility of a vessel-specific minimum-cost path (MCP) technique used for lobar segmentation based on non-contrast CT.

#### METHODS AND MATERIALS

A total of 16 Yorkshire Swine ( $49.88 \pm 4.69$  kg) were used in this study with 46 independent CT acquisitions. A helical scan mode was used (100kV, 50 mA, 24 cm Z-coverage and 2.5s scan time). Following image acquisition, lung tissue segmentation and pulmonary arterial tree centerline extraction was performed. The pulmonary arterial tree was then divided into six lobar subtrees for lobar assignment. The MCP technique was used to assign lobar territories by assigning every voxel of the lung tissue to the nearest arterial tree segment. The reproducibility of the MCP technique was evaluated by quantitatively comparing the MCP-derived lobar territories between two CT acquisitions by tissue mass and volume, using linear regression, root mean square error (RMSE), root mean square deviation (RMSD) and paired sample t-test (p-value). An interobserver and intraobserver analysis of the lobar measurements were also performed.

#### RESULTS

The lobar mass measurements from the first (MLOBE1) and second (MLOBE2) CT acquisitions were correlated by  $MLOBE1 = 0.99MLOBE2 + 1.76$  ( $r = 0.99$ ) with a p-value of 0.120, RMSE = 7.99 g and RMSD = 7.91 g. The lobar volume measurements from the first (VLOBE1) and second (VLOBE2) CT acquisitions were correlated by  $VLOBE1 = 0.98VLOBE2 + 2.66$  ( $r = 0.99$ ) with a p-value of 0.160, RMSE = 15.26 mL and RMSD = 14.94 mL. The calculated whole lung mass measurements from the first (MLUNG1) and second (MLUNG2) CT acquisitions were correlated by  $MLUNG1 = 0.89 MLUNG2 + 76.32$  g ( $r = 0.96$ ) with a p-value of 0.306, RMSE = 29.13 g and RMSD = 26.10 g. The calculated whole lung volume measurements from the first (VLUNG1) and second (VLUNG2) CT acquisitions were correlated by  $VLUNG1 = 0.99 VLUNG2 - 3.27$  ( $r = 0.98$ ) with a p-value of 0.396, RMSE = 60.52 mL, RMSD = 59.49 mL.

#### CONCLUSION

The whole lung and lobar mass and volume measurements show excellent reproducibility using a vessel specific assignment technique. This technique can potentially be used for automated lung lobar segmentation, enabling regional ventilation and perfusion analysis for clinical applications.

#### CLINICAL RELEVANCE/APPLICATION

Assessment of lobar mass or volume in the lung lobes may allow for efficient treatment planning and region-specific treatment strategies for diseases such as pulmonary embolism and chronic thromboembolic pulmonary hypertension.

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## Abstract Archives of the RSNA, 2023

T2-SPPH-8

### Reproducibility of a Low-Dose Single-Volume Dynamic CT Myocardial Perfusion Technique

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Logan Hubbard, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The current methods for accurate diagnosis and assessment of the physiological effects of coronary artery disease (CAD) are limited. There have been previous reports of dynamic CT perfusion techniques capable of assessing CAD, but high radiation dose has hampered widespread clinical implementation of currently existing methods. This study assessed the reproducibility of myocardial perfusion measurements in mL/min/g using a low-dose single-volume dynamic CT myocardial perfusion technique.

#### METHODS AND MATERIALS

A total of 13 Yorkshire Swine ( $54.3 \pm 12.3$  kg) were used in this study. Thirty-four pairs of prospective CT measurements were made under rest and stress conditions. One or two acquisition pairs were acquired in each animal with a 10-minute delay between each acquisition. Contrast (0.5 mL/kg; 370 mgI/mL) and a diluted contrast/saline chaser (0.5 mL/kg; 30:70 contrast/saline) were injected peripherally at 5 mL/s, followed by bolus tracking, triggering, and acquisition of a single volume scan (100 kVp; 200 mA) using a 320-slice CT scanner. The delay time for acquisition of the single volume scan after triggering was determined using a previously validated contrast injection timing method. Following CT acquisition, both the bolus tracking and single volume scan data were used to derive perfusion in mL/min/g using a first-pass analysis model. After which, the coronary perfusion territories of the left anterior descending (LAD), left circumflex (LCx) and right coronary artery (RCA) were automatically assigned using a previously validated minimum-cost path technique. The reproducibility of CT myocardial perfusion measurement within the LAD, LCx, RCA, and the whole myocardium was assessed via regression analysis. The average CT dose index (CTDI) of perfusion measurement was also recorded.

#### RESULTS

The first ( $P_{myo1}$ ) and second ( $P_{myo2}$ ) single-volume CT perfusion measurements were related by  $P_{myo2} = 1.01P_{myo1} - 0.03$  ( $r = 0.99$ ; RMSE = 0.08 mL/min/g; RMSD = 0.07 mL/min/g) for the whole myocardium, and by  $P_{reg2} = 0.86P_{reg1} - 0.13$  ( $r = 0.91$ ; RMSE = 0.31 mL/min/g; RMSD = 0.29 mL/min/g) for the LAD, LCx, and RCA vessel-specific perfusion territories ( $P_{reg}$ ). The average CTDI of the single-volume CT perfusion measurement was 10.5 mGy.

#### CONCLUSION

The low-dose single-volume dynamic CT myocardial perfusion technique provides reproducible myocardial perfusion measurement in mL/min/g only requiring bolus tracking and a single whole-heart volume scan data.

#### CLINICAL RELEVANCE/APPLICATION

This technique is a noninvasive tool that reproducibly measures myocardial perfusion and provides coronary CT angiogram, which allows for simultaneous anatomic-physiologic assessment of myocardial ischemia.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPPH-9

### High Temporal Resolution and Low-dose Dynamic Imaging of Airway using Photon-counting-detector CT

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Dynamic CT imaging can provide valuable information for diagnosing airway abnormalities. Existing dynamic CT techniques for airway imaging are susceptible to cardiac and respiratory motion artifacts due to limited temporal resolution. In this work, we aim to implement and evaluate a low-dose dynamic scanning technique with a temporal resolution as fast as 66 milliseconds for airway imaging using a dual-source photon-counting-detector (PCD)-CT.

#### METHODS AND MATERIALS

An inflatable pig lung phantom (BioQuest, USA) that can mimic respiratory cycles through manual ventilation was used. Tubes with known diameters (2 and 3 mm) were attached to the lung as a measurement reference. The phantom was scanned on a whole-body PCD-CT scanner (Naeotom Alpha, Siemens) with two scanning modes, a dual-source prospectively-gated adaptive sequential mode with a slow (30 bpm) electrocardiogram (ECG) signal and a traditional dynamic cine mode, each at three dose levels (volume CT dose index (CTDI<sub>vol</sub>) = 0.8, 1.6, and 3.5 mGy). For the slow-ECG-gated mode, in order to utilize the rapid temporal resolution used for cardiac CT while providing multi-phase imaging and reconstruction of an entire breathing cycle, an ECG simulator was modified to generate a much slower signal simulating breathing cycles of 30 rpm. This slow ECG-gated mode has a temporal resolution of 66 ms, similar to cardiac CT. The techniques used for both dynamic CT scanning modes were adjusted to a low tube potential (90 kV) to achieve the lowest possible radiation dose. The rotation time was 0.25 seconds and field of view (FOV) 300 mm. Since the acquisition is performed with detector collimation of 144x0.4 mm minimum slice thickness for dynamic scan was 0.6 mm, while for adaptive sequential mode 0.4 mm. The diameters of the tubes were measured and compared with the truth to compare the impact of motion at the two scan modes.

#### RESULTS

Motion artifacts were significantly reduced on images acquired from the slow ECG-gated scans compared to the traditional cine-mode scans. On the slow ECG-gated dynamic images, the shape of the attached tubes was maintained, which provided a more accurate measurement of diameter than images from the cine-mode scans:  $3.10 \pm 0.02$  mm and  $1.9 \pm 0.02$  mm for ECG-gated scans, and  $3.9 \pm 0.6$  mm and  $2.6 \pm 0.5$  mm for cine-mode scans, for tubes of 3 and 2 mm, respectively.

#### CONCLUSION

Compared to conventional dynamic CT acquired in a cine mode, the proposed slow ECG-gated dynamic imaging technique on PCD-CT can achieve a better temporal resolution, which reduces motion artifacts and improves visualization and quantitation of airways.

#### CLINICAL RELEVANCE/APPLICATION

Implementation of a slow ECG-gated imaging method on the dual-source PCD-CT may provide dynamic images of airways with reduced motion artifacts.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPRO-1

### Preoperatively Identify Glypican-3 Positive HCC: Via Multi-phase CE-MRI Delta Radiomics

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Yifan Pan (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of multi-phase contrast enhanced magnetic resonance imaging (CE-MRI) based delta radiomics for identifying the glypican-3 (GPC3) positive hepatocellular carcinoma (HCC).

#### METHODS AND MATERIALS

One hundred and twenty-six patients with pathologically-confirmed HCC (GPC3 positive : GPC3 negative = 95 : 31; training cohort: n = 88; test cohort: n = 38) were retrospectively recruited. Basic information was obtained from our medical records. Preoperative Multi-phase CE-MRI images were reviewed by abdominal radiologists and semantic features were evaluated. The 3D volume of interest (VOI) of whole tumor was segmented on non-contrast T1 weighted imaging (T1-NC), arterial phase (AP), portal venous phase (PVP), delayed phase (DP), hepatobiliary phase (HBP). Radiomic features were extracted from each phase and 3 types delta features (standardized subtraction, direct subtraction, and relative subtraction) were calculated. Feature data were resampled using Synthetic Minority Over-sampling Technique (SMOTE) algorithm. A two-step feature selection strategy was applied. First, minimal-redundancy-maximal-relevance (mRMR) was used to select 20 features and then recursive feature elimination (RFE) was used for further selection. Radiomics models were built using logistic regression and support vector machine. By combining the best radiomics model and clinical risk factors, a nomogram was constructed and evaluated.

#### RESULTS

Univariate analysis showed that serum alpha-fetoprotein (AFP) levels > 400 ng/ml ( $p = 0.013$ ) was significantly related to GPC3 positive HCC. The optimal radiomic model composed of 8 delta radiomic features had an AUC of 0.805 in training cohort and 0.851 in test cohort. Additionally, the nomogram integrated the radiomics score and AFP achieved the best performance (training cohort: AUC = 0.844; test cohort: AUC = 0.862). Calibration curve showed good agreement between the nomogram predicted probabilities and actual outcomes of GPC3 expression in both training and test cohort. Decision curve analysis further demonstrate the clinical practicality of the nomogram.

#### CONCLUSION

Multi-phase CE-MRI based delta radiomics model can non-invasively predict GPC3 positive HCC and could be a useful method for individualized diagnosis and treatment.

#### CLINICAL RELEVANCE/APPLICATION

Multi-phase CE-MRI based delta radiomics model can non-invasively predict GPC3 positive HCC and could be a useful method for individualized diagnosis and treatment.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T2-SPVA-1

### Assessment of the Utility of CT Angiographic Reports for Evaluation of Deep Inferior Epigastric Artery in Preparation for Rectus Flap Surgery

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Collin Larkin, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Current radiology literature details the anatomy of the deep inferior epigastric artery (DIEP) and reporting requirements. However, the surgical requirements are specific, and our current literature is short of addressing those. We aim to compare imaging and surgical findings of DIEP perforators on CT angiographic (CTA) studies for improving radiology reports tailored to help in the surgical flap selection.

#### METHODS AND MATERIALS

Retrospective review of CTA from 1/2021 to 1/2023 for indication of DIEP evaluation for breast reconstruction planning. There were 95 studies, and 40 were included after excluding examinations with a large field of view, >3 mm slice thickness, and suboptimal image quality. The CTA was reviewed for anatomy of DIEP: origin, branching pattern, number of perforators, and their sizes. Two readers- one abdominal imaging fellow and a fellowship-trained radiologist reviewed the studies independently. The medical records were queried for factors that affect flap selection, including prior abdominal surgery, preoperative surgical choices, patient preference, clinical indication, operative findings, the reason for selecting or rejecting a flap, and post-operative complications. Descriptive statistics and kappa statistics were performed.

#### RESULTS

The patients ranged from 30-71 years of age. The readers reported 68-80% studies were of good quality. Inter-reader agreement for assessment of branching type and number of >1.5mm perforators on each side was moderate (Cohen's kappa value ranging 0.41-0.5). Though there were smaller number of patients with perforators that were >1.5 mm diameter and below the umbilicus that was crucial in surgical decision making, there were more perforators (up to 6) that were below the umbilicus but <1.5 mm size criteria. Sixteen patients had bilateral flap reconstruction, 9- unilateral flap of which 4 had combined rectus flap and latissimus TRAM flap surgeries. Nine patients had post-operative complications, which were ischemia and necrosis due to thrombosis of perforator or intimal tearing of the perforator during surgery.

#### CONCLUSION

CTA is a viable modality for presurgical planning in anticipation of breast reconstruction and has acceptable inter-reader agreement and correlation with surgical findings. It is essential to revise our radiology reports to include DIEP perforators up to 4 perforators that are >1.5 mm thickness at the subfascial plane and below the umbilicus to help the surgeons in decision-making.

#### CLINICAL RELEVANCE/APPLICATION

Awareness of anatomy and reporting of the crucial details about the number and course of DIEP perforators can help in surgical planning and avoid accidental vessel tears or injury during surgery, leading to necrosis and failure of flap reconstruction.

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## Abstract Archives of the RSNA, 2023

T2-SPVA-3

### MRI Relaxation Properties of Ferumoxytol: A Comparison of Brand Name vs Generic

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Rianne A. Van der Heijden, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the MRI relaxation properties of brand name ferumoxytol (Feraheme®, AMAG Pharmaceuticals) with generic ferumoxytol (Sandoz).

#### METHODS AND MATERIALS

A phantom experiment was performed using both brand name and generic ferumoxytol agents. Each agent was diluted in saline and also adult bovine whole blood at 5 concentrations ranging from 0.3-2.1mM within 30 ml vials, for a total of 20 vials. Prior to imaging, vials were placed in an MR compatible water bath at 37°C and imaged at both a 1.5T and 3.0T on clinical MRI systems (1.5T Artist, 3.0T Premier, GE Healthcare, Waukesha, WI) using a phase array torso coil (AIR coil). The protocol consisted of coronal acquisitions using 2D fast spin echo (FSE) inversion recovery with multiple inversion times to measure R1, 2D FSE sequence with multiple echoes to measure R2, and 3D multi-echo spoiled gradient echo chemical shift-encoded method (IDEAL-IQ) to measure R2\*. Relaxation rate constants, R1, R2, R2\* were measured in a manually drawn region of interest centrally located in each vial in three slices using Matlab. Differences in relaxivity between the agents were tested with chi-square with 2 or 3 degrees of freedom depending on the fitted model.

#### RESULTS

The dependences of R1, R2 and R2\* on ferumoxytol concentrations were linear in saline and non-linear in blood. R1 values (represented by the slope of the equation and SE (s-1mM-1)) of saline for AMAG and Sandoz, respectively at 1.5 T ( $16.3 \pm 2.2$ ;  $14.3 \pm 1.3$ ;  $p=.22$ ) and 3.0 T ( $9.5 \pm 0.04$ ;  $8.8 \pm 0.01$ ;  $p<.001$ ). R2 values of saline for AMAG and Sandoz respectively at 1.5 T ( $59.4 \pm 0.35$ ;  $60.0 \pm 4.9$ ;  $p=.82$ ) and 3.0 T ( $61.3 \pm 3.9$ ;  $57.8 \pm 1.8$ ;  $p=.13$ ). R2\* values of saline for AMAG and Sandoz respectively at 1.5 T ( $59.4 \pm 2.1$ ;  $72.0 \pm 3.3$ ;  $p<.001$ ) and 3.0 T ( $64.2 \pm 3.3$ ;  $65.3 \pm 4.5$ ;  $p=.92$ ). R1 relaxivity of blood followed a quadratic relationship for AMAG and Sandoz respectively at 1.5 T ( $6.7x^2+1.23x+7.4$ ;  $8.3x^2-1.9x+7.6$ ;  $p=.22$ ) and 3.0 T ( $1.4x^2+6.6x+0.8$ ;  $1.6x^2+5.4x+0.7$ ;  $p<.001$ ), where x=concentration. R2 relaxivity of blood for AMAG and Sandoz respectively at 1.5 T ( $20.1x^2+45.7x+12$ ;  $20.7x^2+35.5x+13.3$ ;  $p=.07$ ) and 3.0 T ( $15.9x^2+41.6x+15.2$ ;  $30.2x^2+6.8x+22.7$ ;  $p=.44$ ). R2\* relaxivity of blood for AMAG and Sandoz respectively at 1.5 T ( $60.0x^2-3.31x+108.5$ ;  $41.7x^2+30.0x+80$ ;  $p<.001$ ) and 3.0 T ( $43.9x^2+24.2x+57$ ;  $38.5x^2+26.2x+56$ ;  $p<.001$ ).

#### CONCLUSION

There were no statistically significant differences between the AMAG and Sandoz agents for most relaxivity values and those with differences were small and of doubtful clinical relevance.

#### CLINICAL RELEVANCE/APPLICATION

Ferumoxytol is increasingly being used for MR angiography and in patients with contraindications to gadolinium. The use of generic agents may reduce cost without any clinically relevant differences in the relaxation properties.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-STCE1

### Science Session (Generative AI)

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center Theater 1

#### Sub-Events

### T2-STCE1-1 Leveraging GPT-4 for Imaging Protocol Selection from Clinical Indications in Accordance with ACR Appropriateness Criteria

Ramin Farzaneh (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the application of GPT-4, a state-of-the-art large language model (LLM) developed by OpenAI, for determining appropriate imaging protocols from a spectrum of clinical indications. This investigation seeks to establish the model's efficacy in aligning these selections with the American College of Radiology (ACR) Appropriateness Criteria (AC).

#### METHODS AND MATERIALS

An initial pool of anonymized patient cases (n=707) from the Open-i dataset was randomly selected. Cases with incidental findings (n=131) were excluded, along with those having extended histories (>30 words, n=32) or no provided histories (n=23) to reflect typical clinical indications on request forms, yielding a sample size of n=521. Only sex, age and history were processed through GPT-4, which was instructed to suggest imaging protocols according to the ACR AC. The selections were then compared with this established set of guidelines, and 23 further cases were excluded due to ambiguity in validating the model's suggestion. The measure of success was the model's accuracy in selecting the adequate imaging protocols. Answers with an Appropriateness Rating (AR) < 4, disagreed upon by the ACR AC expert panel, unlisted in the ACR AC, contraindicated based on the provided history, or correct but suboptimal according to ACR AC literature were considered incorrect.

#### RESULTS

In the evaluation of 498 patient cases, GPT-4 accurately selected the appropriate imaging protocol, as dictated by the ACR AC, in 471 instances, yielding a 94.6% accuracy rate (95% CI: 92.2%-96.4%). Errors encountered (n=27) were categorized and attributed to GPT-4 either choosing the wrong modality (n=5), choosing the correct modality but incorrect protocol (n=9), suggesting imaging when not indicated (n=1) or not suggesting imaging when indicated (n=12). Additionally, errors were further stratified by imaging modality to provide insights into the performance of GPT-4 in relation to specific modalities: MRI (n=6), CT (n=4), x-ray (n=3) and ultrasound (n=1).

#### CONCLUSION

GPT-4 showed a high accuracy in selecting imaging protocols per ACR AC in the following study, suggesting its potential utility in streamlining radiological workflows and reducing human errors if used in conjunction with clinicians' opinions.

#### CLINICAL RELEVANCE/APPLICATION

The adoption of LLMs in discerning imaging protocols paves the way for a shift in radiology practice, potentially reducing errors, ensuring consistency, and ultimately improving patient outcomes.

### T2-STCE1-2 Evaluation of Effect of Knowledge Base on ChatGPT's Performance on the RANZCR Clinical Radiology Phase 2 Style Written Exam

Sijing Feng, MBChB, BMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

RANZCR Phase 2 clinical radiology examinations represent a major barrier to training progression for radiology trainees in Australia and New Zealand. ChatGPT is an emerging technology which has been shown to have the potential to help with medical education. Currently, there are 2 models, GPT3.5 and GPT4, the latter of which has been previously shown to perform better in reasoning tasks. Previous studies have shown GPT4 performed well on North American radiology board

exams, however, whether GPT4's performance can be improved given an exam-targeted knowledge base remains unknown. This study aims to determine the performance of GPT4 on RANZCR-style multiple-choice questions (MCQ) and to explore any improvement in the performance following the provision of an exam-targeted knowledge base (KB).

## **METHODS AND MATERIALS**

MCQ (50 pathology, 50 radiodiagnosis) were constructed by 4 RANZCR radiology fellows. The questions were reviewed and further subdivided into high (HO) and low-order (LO) questions according to Bloom's taxonomy. These questions were then tested on GPT4 with and without (baseline) the provision of an exam-targeted KB. KB was created from RANZCR fellow study notes and verified for quality assurance by RANZCR radiology attendings. Question-specific KB was introduced onto web-based GPT interface with the MCQ using a standardized prompt. Statistical significance was determined by Chi-square analysis with significant level set at 0.05.

## **RESULTS**

GPT4 scored 86% (43/50) on pathology MCQ at baseline and 100% (50/50) with KB ( $p < 0.01$ ). Further stratifying pathology MCQ, on LO pathology MCQ, GPT4 scored 80% at baseline and 100% with KB ( $p < 0.05$ ). On HO pathology MCQ, GPT4 scored 95% at baseline and 100% with KB ( $p = 0.31$ ). GPT4 scored 64% (32/50) on radiodiagnosis MCQ at baseline and 86% (43/50) with KB ( $p < 0.01$ ). On LO radiodiagnosis MCQ, GPT4 scored 61% at baseline and 83% with KB ( $p = 0.10$ ). On HO radiodiagnosis MCQ, GPT4 scored 67% at baseline and 89% with KB ( $p < 0.05$ ).

## **CONCLUSION**

GPT4 performed significantly better on both RANZCR-style pathology and radiodiagnosis MCQ with an exam-targeted KB compared to baseline. Most of the score increase resulted from improvement in the performance on LO pathology MCQ and HO radiodiagnosis MCQ.

## **CLINICAL RELEVANCE/APPLICATION**

High-quality performance from GPT4 with KB on RANZCR board-style MCQ paves the way for potential incorporation of GPT4 into radiology education across all levels of medical training.

## **T2-STCE1-3 Generative AI Synthesizes High-Fidelity fMRI from MRI and EEG**

Cooper U. Gamble, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

Functional Magnetic Resonance Imaging (fMRI) is a powerful technique for time series analysis of neurological and psychiatric pathologies, but acquisition cost and time is often an inhibitor for its widespread use. Magnetic Resonance Imaging (MRI) and Electroencephalogram (EEG) are common imaging techniques for structural and electrical analysis, respectively. In addition, their comparative acquisition cost and time is markedly more practical than that of fMRI. In this study, we demonstrate that MRI and EEG can be combined in a multimodal generative AI approach to generate high-fidelity, low-cost fMRI volumes.

## **METHODS AND MATERIALS**

We used a publicly available dataset (Lioi, G., et al. 2019) containing structural MRIs with simultaneous 64-channel EEG and fMRI during right-hand motor imagery and neurofeedback. We skull-stripped and coregistered each scan with FMRIB's FSL tool and University College London's Statistical Parametric Mapping. We developed and trained a 3D diffusion model with an attention-based UNet generator on 7,901 samples, each of which aimed to predict one time step in the target fMRI scan. We prioritized the preservation of physiological data from MRI scans and injection of electrical data from EEGs by attempting to compress and reconstruct MRIs while feeding EEG data to our model at each encoding and decoding step. Our objective function was mean squared error (MSE), and we reported the structural similarity index measure (SSIM) of our model's predictions and the corresponding ground truths. Both of these metrics are recognized as indicators of performance in generative imaging tasks.

## **RESULTS**

After training for 200 epochs, our model achieved an MSE of 0.041 and an SSIM of 0.772.

## **CONCLUSION**

We developed and trained a generative AI model to produce high-fidelity fMRI samples from EEG and MRI. We present an approach to reduce the temporal and fiscal cost of acquisition for fMRI by combining two practical modalities. Our next steps include pruning our network architecture to improve generative metrics and validating our methods on downstream tasks to demonstrate generalizability.

## **CLINICAL RELEVANCE/APPLICATION**

fMRI is a costly imaging technique with a demanding acquisition but of high clinical value. We present a generative AI-based approach to obtain fMRI data from more practical modalities with high fidelity and downstream applicability.

## Abstract Archives of the RSNA, 2023

T2-STCE1-1

### Leveraging GPT-4 for Imaging Protocol Selection from Clinical Indications in Accordance with ACR Appropriateness Criteria

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center Theater 1

Ramin Farzaneh (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the application of GPT-4, a state-of-the-art large language model (LLM) developed by OpenAI, for determining appropriate imaging protocols from a spectrum of clinical indications. This investigation seeks to establish the model's efficacy in aligning these selections with the American College of Radiology (ACR) Appropriateness Criteria (AC).

#### METHODS AND MATERIALS

An initial pool of anonymized patient cases (n=707) from the Open-i dataset was randomly selected. Cases with incidental findings (n=131) were excluded, along with those having extended histories (>30 words, n=32) or no provided histories (n=23) to reflect typical clinical indications on request forms, yielding a sample size of n=521. Only sex, age and history were processed through GPT-4, which was instructed to suggest imaging protocols according to the ACR AC. The selections were then compared with this established set of guidelines, and 23 further cases were excluded due to ambiguity in validating the model's suggestion. The measure of success was the model's accuracy in selecting the adequate imaging protocols. Answers with an Appropriateness Rating (AR) < 4, disagreed upon by the ACR AC expert panel, unlisted in the ACR AC, contraindicated based on the provided history, or correct but suboptimal according to ACR AC literature were considered incorrect.

#### RESULTS

In the evaluation of 498 patient cases, GPT-4 accurately selected the appropriate imaging protocol, as dictated by the ACR AC, in 471 instances, yielding a 94.6% accuracy rate (95% CI: 92.2%-96.4%). Errors encountered (n=27) were categorized and attributed to GPT-4 either choosing the wrong modality (n=5), choosing the correct modality but incorrect protocol (n=9), suggesting imaging when not indicated (n=1) or not suggesting imaging when indicated (n=12). Additionally, errors were further stratified by imaging modality to provide insights into the performance of GPT-4 in relation to specific modalities: MRI (n=6), CT (n=4), x-ray (n=3) and ultrasound (n=1).

#### CONCLUSION

GPT-4 showed a high accuracy in selecting imaging protocols per ACR AC in the following study, suggesting its potential utility in streamlining radiological workflows and reducing human errors if used in conjunction with clinicians' opinions.

#### CLINICAL RELEVANCE/APPLICATION

The adoption of LLMs in discerning imaging protocols paves the way for a shift in radiology practice, potentially reducing errors, ensuring consistency, and ultimately improving patient outcomes.

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## Abstract Archives of the RSNA, 2023

T2-STCE1-2

### Evaluation of Effect of Knowledge Base on ChatGPT's Performance on the RANZCR Clinical Radiology Phase 2 Style Written Exam

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center Theater 1

Sijing Feng, MBChB, BMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

RANZCR Phase 2 clinical radiology examinations represent a major barrier to training progression for radiology trainees in Australia and New Zealand. ChatGPT is an emerging technology which has been shown to have the potential to help with medical education. Currently, there are 2 models, GPT3.5 and GPT4, the latter of which has been previously shown to perform better in reasoning tasks. Previous studies have shown GPT4 performed well on North American radiology board exams, however, whether GPT4's performance can be improved given an exam-targeted knowledge base remains unknown. This study aims to determine the performance of GPT4 on RANZCR-style multiple-choice questions (MCQ) and to explore any improvement in the performance following the provision of an exam-targeted knowledge base (KB).

#### METHODS AND MATERIALS

MCQ (50 pathology, 50 radiodiagnosis) were constructed by 4 RANZCR radiology fellows. The questions were reviewed and further subdivided into high (HO) and low-order (LO) questions according to Bloom's taxonomy. These questions were then tested on GPT4 with and without (baseline) the provision of an exam-targeted KB. KB was created from RANZCR fellow study notes and verified for quality assurance by RANZCR radiology attendings. Question-specific KB was introduced onto web-based GPT interface with the MCQ using a standardized prompt. Statistical significance was determined by Chi-square analysis with significant level set at 0.05.

#### RESULTS

GPT4 scored 86% (43/50) on pathology MCQ at baseline and 100% (50/50) with KB ( $p < 0.01$ ). Further stratifying pathology MCQ, on LO pathology MCQ, GPT4 scored 80% at baseline and 100% with KB ( $p < 0.05$ ). On HO pathology MCQ, GPT4 scored 95% at baseline and 100% with KB ( $p = 0.31$ ). GPT4 scored 64% (32/50) on radiodiagnosis MCQ at baseline and 86% (43/50) with KB ( $p < 0.01$ ). On LO radiodiagnosis MCQ, GPT4 scored 61% at baseline and 83% with KB ( $p = 0.10$ ). On HO radiodiagnosis MCQ, GPT4 scored 67% at baseline and 89% with KB ( $p < 0.05$ ).

#### CONCLUSION

GPT4 performed significantly better on both RANZCR-style pathology and radiodiagnosis MCQ with an exam-targeted KB compared to baseline. Most of the score increase resulted from improvement in the performance on LO pathology MCQ and HO radiodiagnosis MCQ.

#### CLINICAL RELEVANCE/APPLICATION

High-quality performance from GPT4 with KB on RANZCR board-style MCQ paves the way for potential incorporation of GPT4 into radiology education across all levels of medical training.

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## Abstract Archives of the RSNA, 2023

T2-STCE1-3

### Generative AI Synthesizes High-Fidelity fMRI from MRI and EEG

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center Theater 1

Cooper U. Gamble, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Functional Magnetic Resonance Imaging (fMRI) is a powerful technique for time series analysis of neurological and psychiatric pathologies, but acquisition cost and time is often an inhibitor for its widespread use. Magnetic Resonance Imaging (MRI) and Electroencephalogram (EEG) are common imaging techniques for structural and electrical analysis, respectively. In addition, their comparative acquisition cost and time is markedly more practical than that of fMRI. In this study, we demonstrate that MRI and EEG can be combined in a multimodal generative AI approach to generate high-fidelity, low-cost fMRI volumes.

#### METHODS AND MATERIALS

We used a publicly available dataset (Lioi, G., et al. 2019) containing structural MRIs with simultaneous 64-channel EEG and fMRI during right-hand motor imagery and neurofeedback. We skull-stripped and coregistered each scan with FMRIB's FSL tool and University College London's Statistical Parametric Mapping. We developed and trained a 3D diffusion model with an attention-based UNet generator on 7,901 samples, each of which aimed to predict one time step in the target fMRI scan. We prioritized the preservation of physiological data from MRI scans and injection of electrical data from EEGs by attempting to compress and reconstruct MRIs while feeding EEG data to our model at each encoding and decoding step. Our objective function was mean squared error (MSE), and we reported the structural similarity index measure (SSIM) of our model's predictions and the corresponding ground truths. Both of these metrics are recognized as indicators of performance in generative imaging tasks.

#### RESULTS

After training for 200 epochs, our model achieved an MSE of 0.041 and an SSIM of 0.772.

#### CONCLUSION

We developed and trained a generative AI model to produce high-fidelity fMRI samples from EEG and MRI. We present an approach to reduce the temporal and fiscal cost of acquisition for fMRI by combining two practical modalities. Our next steps include pruning our network architecture to improve generative metrics and validating our methods on downstream tasks to demonstrate generalizability.

#### CLINICAL RELEVANCE/APPLICATION

fMRI is a costly imaging technique with a demanding acquisition but of high clinical value. We present a generative AI-based approach to obtain fMRI data from more practical modalities with high fidelity and downstream applicability.

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## Abstract Archives of the RSNA, 2023

T2-STCE2

### Science Session (Theranostics)

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center Theater 2

#### Sub-Events

#### T2-STCE2-2 Optimizing Tumor Retention using In Situ Site-Specific Self-Assembly of Modified Probes

WENYU SONG, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In the field of nuclear medicine, small molecule drugs hold significant promise for tumor diagnosis. Despite their potential, the clinical utility of these drugs is hindered by their limited retention time at the tumor site, leading to rapid efflux and potential omission of crucial lesions. To address this challenge, we present a novel in situ self-assembly strategy aimed at prolonging the retention time of c(RGD)yk at the tumor site, enabling improved cancer detection and targeted intervention.

#### METHODS AND MATERIALS

The probe (named as  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk) was made of a glutathione (GSH)-reactive self-assembling polypeptide (PEP) as the skeleton, NOTA as metal chelating group and c(RGD)yk as targeting group. Its characterization was analyzed by high-performance liquid chromatography, high-resolution mass spectrometry and transmission electron microscopy.  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk PET imaging of U87-MG tumor model mice ( $n = 3$ ) at different time points (1, 4, 24, 48 and 72 h) post tail vein injection (p.i.) were obtained. Subsequently, the major organs and tumors were collected for biological distribution analysis. Histological examination with HE staining was conducted on the tissues. The t-test were used to compare the differences between groups.

#### RESULTS

$^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk was successfully synthesized and identified to be assembled in glutathione environment in vitro. The micellar structures were well observed under TEM. High and uniform tumor distribution were seen in  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk group at different time point. Additionally, the probe provided clearer tumor imaging, and longer tumor retention time. Ex vivo imaging corroborated these results. In vivo toxicity evaluation showed that  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk can not cause significant changes in liver and kidney function in healthy mice.

#### CONCLUSION

For long-term tumor accumulation, we have created a self-assembled c(RGD)yk-based probe using phenylalanine polypeptides as the primary chain. The insertion of disulfide bonds into phenylalanine polypeptides resulted in persistent self-assembly in a high GSH tumor environment, considerably prolonging the retention effect. Furthermore, *in vivo* PET imaging revealed a considerable concentration of  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk in U87-MG tumor. The features of long-term retention and production of nanomaterials are more conducive to therapeutic possibility.

#### CLINICAL RELEVANCE/APPLICATION

The enhanced retention of c(RGD)yk through in situ self-assembly enables combination therapies, fostering synergistic effects and better treatment outcomes. Furthermore, the versatile chemical synthesis of the phenylalanine self-assembly platform allows broad application across various agents and disorders.

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## Abstract Archives of the RSNA, 2023

T2-STCE2-2

### Optimizing Tumor Retention using In Situ Site-Specific Self-Assembly of Modified Probes

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center Theater 2

WENYU SONG, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In the field of nuclear medicine, small molecule drugs hold significant promise for tumor diagnosis. Despite their potential, the clinical utility of these drugs is hindered by their limited retention time at the tumor site, leading to rapid efflux and potential omission of crucial lesions. To address this challenge, we present a novel in situ self-assembly strategy aimed at prolonging the retention time of c(RGD)yk at the tumor site, enabling improved cancer detection and targeted intervention.

#### METHODS AND MATERIALS

The probe (named as  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk) was made of a glutathione (GSH)-reactive self-assembling polypeptide (PEP) as the skeleton, NOTA as metal chelating group and c(RGD)yk as targeting group. Its characterization was analyzed by high-performance liquid chromatography, high-resolution mass spectrometry and transmission electron microscopy.  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk PET imaging of U87-MG tumor model mice ( $n = 3$ ) at different time points (1, 4, 24, 48 and 72 h) post tail vein injection (p.i.) were obtained. Subsequently, the major organs and tumors were collected for biological distribution analysis. Histological examination with HE staining was conducted on the tissues. The t-test were used to compare the differences between groups.

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#### CONCLUSION

For long-term tumor accumulation, we have created a self-assembled c(RGD)yk-based probe using phenylalanine polypeptides as the primary chain. The insertion of disulfide bonds into phenylalanine polypeptides resulted in persistent self-assembly in a high GSH tumor environment, considerably prolonging the retention effect. Furthermore, *in vivo* PET imaging revealed a considerable concentration of  $^{64}\text{Cu}$ -NOTA-PEP-c(RGD)yk in U87-MG tumor. The features of long-term retention and production of nanomaterials are more conducive to therapeutic possibility.

#### CLINICAL RELEVANCE/APPLICATION

The enhanced retention of c(RGD)yk through in situ self-assembly enables combination therapies, fostering synergistic effects and better treatment outcomes. Furthermore, the versatile chemical synthesis of the phenylalanine self-assembly platform allows broad application across various agents and disorders.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSBR05

### Breast Imaging (Applications of AI in Screening)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406B

Linda Moy, MD (*Moderator*) Grant, Siemens AG Advisory Board, Lunit Inc Advisory Board, iCad, Inc  
Fredrik Strand, MD, PhD (*Moderator*) Speaker, Lunit Inc

#### Sub-Events

#### T3-SSBR05-Multimodal Artificial Intelligence (AI) System for Breast Cancer Screening

1

Laura Heacock, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the added value of screening breast ultrasound (US) to use of mammography/digital breast tomosynthesis (DBT) in a multimodal AI system for detecting breast cancer.

#### METHODS AND MATERIALS

This retrospective study was IRB-approved. Our multimodal AI system utilized full-field digital mammography (FFDM), DBT and breast US examinations performed 2010-2020 consisting of 1,964,416 exams in 324,978 patients. We used a patient-based training/validation/test split, of 60%/10%/30%. For testing, we used consecutive screening combined FFDM/DBT and US exams from patients excluded from training/validation sets (12,517 patients, 213/12,517 (1.70%) patients with pathology-proven cancer). AI scores were dichotomized into discrete recall/no recall based on clinical recall rates. Specificity was therefore standardized across categories. Diagnostic accuracy of the AI system was compared for FFDM/DBT only, US only and multimodal FFDM/DBT/US models. AUROC and sensitivity were compared between modalities and breast density.

#### RESULTS

On a test set of 12,517 patients (21,523 exams, mean age 58.8, standard deviation 10.7), the AI system achieved an AUROC of 0.907 for multimodal (DBT/FFDM/US) screening exams, detecting 74.2% (158/212) of breast cancers. Multimodal AI outperformed both the FFDM/DBT alone model (AUROC 0.849, sensitivity 62.4%) and the US alone model (AUROC 0.751, sensitivity 50.2%). For women with dense breasts, multimodal AUROC was 0.888, sensitivity 70.7%. For women with non-dense breasts, multimodal AUROC was 0.936, sensitivity 78.9%. Adding US to FFDM/DBT improved AI screening performance from sensitivity of 60.2% to 70.7% in dense breasts. Adding US to FFDM/DBT improved AI screening performance in non-dense breasts from sensitivity of 63.4% to 78.9%.

#### CONCLUSION

AI for DBT/FFDM has been shown to have high sensitivity and specificity for breast cancer detection. Adding US to multimodal trained AI increases accuracy and sensitivity in breast cancer screening in both dense and non-dense breasts.

#### CLINICAL RELEVANCE/APPLICATION

Supplemental screening ultrasound is recommended for women with intermediate to high lifetime risk of breast cancer and women with dense breasts. Multimodal AI trained on FFDM/DBT/US improves breast cancer screening performance in women screened with both mammography/US compared to FFDM/DBT-only AI systems.

#### T3-SSBR05-Artificial Intelligence Assessment of Breast Arterial Calcifications on Mammography in a Large Screening Population

2

Chirag R. Parghi, MD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

This study evaluates the accuracy and feasibility of using artificial intelligence (AI) for the detection and assessment of breast arterial calcifications (BAC) on mammography in a large screening population across 15 sites in a prospective study.

## METHODS AND MATERIALS

Sequentially accrued 2D mammograms from 15,785 asymptomatic screening women during a 1-month period (3/23/2023-4/19/23) across 15 screening sites were analyzed using a deep learning AI algorithm specifically designed for BAC detection. Age of the women ranged from 20 to 97, with a median of 56. The study assessed overall prevalence of BAC, as well as distribution of BAC across four age groups: < 50, 50-59, 60-69, and = 70. The AI model was trained using an internal Real World Dataset of 2D mammograms to detect BAC based on expert annotation and provides an assessment score of 0-5 for BAC according to the total area of BAC and its density. Prior to the study, the accuracy of the AI algorithm is validated on a validation dataset of 2D mammograms from 8,898 women. There is no overlap between the training, validation and 15,785 women prospective study datasets.

## RESULTS

The AI algorithm achieved an area under the ROC curve (AUC) of 0.938 (95% CI: 0.928 - 0.949) on the validation dataset, indicating high accuracy in BAC detection. In the prospective study with 15,785 women, the overall prevalence of BAC detected by the AI algorithm was 14.9% (95% CI: 14.5% - 15.3%), with a prevalence of 4.0% (95% CI: 3.6% - 4.4%) in women < 50, 8.8% (95% CI: 8.1% - 9.4%) in women 50-59, 19.8% (95% CI: 18.7% - 20.8%) in women 60-69, and 40.8% (95% CI: 39.3% - 42.3%) in women = 70 with a BAC score cutoff of 2 and above.

## CONCLUSION

AI based BAC detection on mammography in a large screening population across 15 sites is feasible and accurate. The AI algorithm demonstrated high accuracy in BAC detection, with a prevalence and distribution of BAC increasing with age as expected in a screening population. Our results suggest that AI can standardize BAC detection at scale, potentially improving efficiency and reducing inter-observer variability. The age-specific prevalence of BAC provided by our study can inform clinical decision-making and risk assessment with an expectation of patient volumes.

## CLINICAL RELEVANCE/APPLICATION

Breast arterial calcium is gaining popularity as a proxy for global atherosclerotic disease. Accurate quantitative models for automated BAC assessment from mammograms can offer an adjunct screening tool for heart disease.

## T3-SSBR05-The Multi-Center Multi-Vendor VAI-B Validation Platform for AI in Breast Imaging

3

Haiko Schurz, BSc, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Artificial Intelligence Computer-Aided Detection (AI CAD) has shown its potential to detect breast cancer in screening mammograms. In collaboration between Swedish research groups, hospitals, and regional cancer centers, the validation platform for AI in Breast imaging (VAI-B) aims to provide the necessary pre-deployment diagnostic validation and benchmarking of AI CAD systems.

## METHODS AND MATERIALS

For the pilot phase of VAI-B, screening information was collected from three regions in Sweden (2008-2021). Separate case-control (all cancer; 1:5 random sample of healthy) and cohort (all exams from 2017) datasets were created. A three-year follow-up period with biopsy-verification defined the reference standard of diagnosed or healthy. Images were uploaded from each hospital to a cloud platform and processed by three AI CAD systems (Therapixel, France; Vara, Germany; Lunit, South Korea). Accuracy and robustness metrics were assessed, and AI CAD systems were analyzed standalone and paired with a radiologist.

## RESULTS

38529 screening examinations from 34353 women of whom 5773 with breast cancer were included. Overall, all AI CAD systems had similar accuracy across the regions (Östergötland AUC: 0.832, 0.845, 0.846; Södermanland AUC: 0.829, 0.836, 0.822; Västmanland AUC: 0.835, 0.842, 0.827). All AI CAD systems outperformed single reader radiologists whose operating points were below the confidence intervals of the AI CAD receiver operating curves. Compared to the standard double reading radiologists, combining AI with one radiologist increased sensitivity 10%-30% with a loss of specificity 2%-7%. AI systems were robust to different mammography equipment manufacturers in terms of area under the curve (AUC), but the AI score distribution shifted for two of three AI CAD systems. The AI CAD systems were not robust to GE manufacturer model variants, showing differences both in AUC and the AI score distribution.

## CONCLUSION

We have demonstrated the feasibility of the VAI-B platform to validate and benchmark commercial AI CAD systems. Accuracy metrics showed that all three AI systems paired with one radiologist provide an improvement compared to two radiologists. Robustness metrics showed that two of three AI CAD systems require manufacturer-specific calibration to deliver the expected diagnostic performance. The expandable VAI-B platform can provide important feedback to AI CAD system vendors and can assist hospitals in benchmarking before procurement decisions are made.

## CLINICAL RELEVANCE/APPLICATION

VAI-B provides a technical platform and consistent methodologies to validate AI CAD for screening mammography. This could inform procurement decisions and improve patient safety for participating hospitals and AI CAD vendors.

### T3-SSBR05-Features of Invasive Breast Cancers Missed by Artificial Intelligence-based Computer-assisted Diagnosis on Mammograms 4

SANGUN KIM, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

There have been little studies on how Artificial intelligence-based computer-aided diagnosis (AI-CAD) missed invasive breast cancers on mammogram. The purpose of this study was to assess the false-negative result (FNR) of AI-CAD according to molecular subtypes, and to investigate the features of missed cancers.

#### METHODS AND MATERIALS

From 2014 to 2020, 1082 consecutive patients diagnosed with 1097 cancers were retrospectively included. Commercial AI-CAD was applied to digital mammograms and abnormality scores were acquired. FNR was defined by abnormality score less than 10. The FNR and abnormality scores were evaluated according to the molecular subtypes (Hormone receptor-positive [luminal] vs. human epidermal growth factor receptor-2 [HER-2] positive vs. triple negative [TN]). Missed cancers by AI-CAD were blindly reviewed by three radiologists. Features of missed cancers were analyzed.

#### RESULTS

Among 1097 invasive cancers, 155 (14.0%) were missed by AI-CAD and the FNR was higher in luminal than other subtypes (17.2% in luminal vs. 14.5% in TN vs. 9.0% in HER2-positive,  $P = 0.001$ ). AI-CAD assigned low abnormality scores in luminal subtype (mean abnormality scores = 68.9 in luminal vs. 73.8 in TN vs. 78.4 in HER-2 positive,  $P < 0.001$ ). Among the 155 cancers missed by AI-CAD, 95 (61.2%) were detected by two of three radiologists. Of 95 cancers, 57 (60.0%) were partially obscured by parenchymal densities, 12 (12.6%) were architectural distortions, 12 (12.6%) were located in retromammary or subcutaneous fat layer, 6 (6.3%) were located in subareolar area, 5 (5.2%) were located in far upper breast near axilla, and 3 (3.3%) were calcifications.

#### CONCLUSION

AI-CAD most frequently missed luminal cancers. For detecting invasive cancers missed by AI-CAD, considerable attention should be paid to dense breasts, architectural distortion or masses located outside the mammary zone of the breast.

## CLINICAL RELEVANCE/APPLICATION

Understanding the features of invasive breast cancers missed by AI-CAD on mammogram could help reduce the missed cancers.

### T3-SSBR05-Incorporating Prior Imaging in Artificial Intelligence (AI) for Breast Cancer Screening: Analysis of Cancer Type Detection 5

Laura Heacock, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Prior imaging is not always incorporated into AI breast cancer detection models for full-field digital mammography (FFDM) and/or digital breast tomosynthesis (DBT). The purpose of this study was to explore additive value of prior exams by years included and cancer types.

#### METHODS AND MATERIALS

In this IRB approved study, our AI system was trained and evaluated utilizing full-field digital mammography (FFDM) and digital breast tomosynthesis (DBT) examinations performed 2010-2020 consisting of 1,964,416 exams in 324,978 patients. We used a patient-based training/validation/test split of 60%, 10%, and 30%. Testing used consecutive screening FFDM or FFDM/DBT combination exams from patients excluded from training/validation with at least three years' prior exams available. Histopathology or imaging stability was the reference standard. Four AI models were tested: 1) current exam, no priors, 2) current exam + 1 year prior exams, 3) current exam + 2 years priors, 4) current exam + 3 years priors. Recall % was standardized across all model types by using the original radiologist BI-RADS score. Diagnostic accuracy of the AI system was compared for each iteration by calculating AUROC, sensitivity, specificity, PPV and NPV. Cancer types detected by each additional round of priors were compared.

#### RESULTS

In a test set of 29,845 patients (74,030 exams, mean age 59.1, standard deviation 11.09) 2.05% (612/29,845) had pathology-proven cancer. The AI system achieved AUROC for breast cancer detection as follows: no priors, 0.885, 1 year prior, 0.891, 2 years prior, 0.894, 3 years prior, 0.892. Sensitivity was 70.00% (428/612 cancers) for no priors, 71.40%

(437/612) for 1 year prior, 73.70% (451/612) for 2 years priors and 73.20% (448/612) for 3 years priors. Specificity was held constant at 88.10% for thresholds. AUROC improved from 0.864 to 0.873 in dense breasts with the addition of 2 years prior exams and sensitivity improved from 68.7% to 70.6% with an additional 8 cancers detected compared to no priors. AUROC improved from 0.901 to 0.910 in non-dense breasts, with an additional 15 cancers detected. Additional cancers detected with priors were predominantly low-to-intermediate grade invasive ductal carcinoma (56.3%, 18/32) and high-grade ductal carcinoma in situ (DCIS) (21.9%, 7/32). Impact on performance was non-monotonic.

## **CONCLUSION**

Adding prior exams to AI DBT/FFDM screening models improves sensitivity for breast cancer detection. Malignancies detected with the use of prior examinations included invasive cancer and high-grade DCIS.

## **CLINICAL RELEVANCE/APPLICATION**

Incorporating up to two years of prior exams into AI models can improve detection of both invasive cancers and DCIS. Including further prior exams may not improve and potentially degrades performance.

## **T3-SSBR05-Artificial Intelligence Model for Breast Lesion and Carcinoma in Situ Classification in Contrast Enhanced Mammography: A Multicenter Study**

Yi Dai, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

We aimed to establish an artificial intelligence (AI)-based method for preoperative differentiation of benign and malignant breast lesions and carcinoma in situ from contrast enhanced mammography (CEM) as well as to explore the biological mechanism.

## **METHODS AND MATERIALS**

This retrospective study includes 1430 eligible patients who underwent CEM examination from June 2017 to July 2022 and were divided into construction set (n=1101), internal test set (n=196), and external test set (n=133). The primary lesions of low-energy and recombined images on cranial-caudal view were delineated by radiologists. The AI model first adopted RefineNet as a backbone network. Then, an attention sub-network, named convolutional block attention module (CBAM), was built upon the backbone for adaptive feature refinement. Finally, an XGBoost classifier was used to integrate the refined deep learning features with clinical characteristics to perform the final classification of breast lesions. Furthermore, the AI model was developed again to achieve secondary diagnosis of carcinoma in situ and invasive carcinoma among malignant candidates. RNA-sequencing data from 12 patients were used to explore the underlying biological basis of the AI prediction. The model's performance was evaluated by the receiver operating characteristic (ROC) curve and was compared with other deep learning (DL) models, traditional radiomics models, and radiologists.

## **RESULTS**

The AI model combining refined deep learning features and clinical characteristics (age, lesion diameter) achieved an AUC of 0.932 in the external test set, better than the best performing DL model (RefineNet+CBAM AUC: 0.893) and the best performing radiomics model (logistic regression AUC: 0.674). Moreover, the AI model has also achieved satisfactory results in the differentiation of carcinoma in situ, with an AUC of 0.822 in internal test set. In addition, the AI model outperformed and improved radiologists' diagnostic performance. Further the biological basis exploration revealed that high-risk group was associated with the pathways such as ECM-receptor interaction, focal adhesion, and extracellular matrix organization.

## **CONCLUSION**

The AI model based on CEM and clinical characteristics had good predictive performance in the classification of benign and malignant breast lesions and carcinoma in situ.

## **CLINICAL RELEVANCE/APPLICATION**

The AI model provides an automatic and preoperative non-invasive way to differentiate benign and malignant breast lesions, and improves the sensitivity and specificity of CEM image identification.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSBR05-1

### Multimodal Artificial Intelligence (AI) System for Breast Cancer Screening

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406B

Laura Heacock, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the added value of screening breast ultrasound (US) to use of mammography/digital breast tomosynthesis (DBT) in a multimodal AI system for detecting breast cancer.

#### METHODS AND MATERIALS

This retrospective study was IRB-approved. Our multimodal AI system utilized full-field digital mammography (FFDM), DBT and breast US examinations performed 2010-2020 consisting of 1,964,416 exams in 324,978 patients. We used a patient-based training/validation/test split, of 60%/10%/30%. For testing, we used consecutive screening combined FFDM/DBT and US exams from patients excluded from training/validation sets (12,517 patients, 213/12,517 (1.70%) patients with pathology-proven cancer). AI scores were dichotomized into discrete recall/no recall based on clinical recall rates. Specificity was therefore standardized across categories. Diagnostic accuracy of the AI system was compared for FFDM/DBT only, US only and multimodal FFDM/DBT/US models. AUROC and sensitivity were compared between modalities and breast density.

#### RESULTS

On a test set of 12,517 patients (21,523 exams, mean age 58.8, standard deviation 10.7), the AI system achieved an AUROC of 0.907 for multimodal (DBT/FFDM/US) screening exams, detecting 74.2% (158/212) of breast cancers. Multimodal AI outperformed both the FFDM/DBT alone model (AUROC 0.849, sensitivity 62.4%) and the US alone model (AUROC 0.751, sensitivity 50.2%). For women with dense breasts, multimodal AUROC was 0.888, sensitivity 70.7%. For women with non-dense breasts, multimodal AUROC was 0.936, sensitivity 78.9%. Adding US to FFDM/DBT improved AI screening performance from sensitivity of 60.2% to 70.7% in dense breasts. Adding US to FFDM/DBT improved AI screening performance in non-dense breasts from sensitivity of 63.4% to 78.9%.

#### CONCLUSION

AI for DBT/FFDM has been shown to have high sensitivity and specificity for breast cancer detection. Adding US to multimodal trained AI increases accuracy and sensitivity in breast cancer screening in both dense and non-dense breasts.

#### CLINICAL RELEVANCE/APPLICATION

Supplemental screening ultrasound is recommended for women with intermediate to high lifetime risk of breast cancer and women with dense breasts. Multimodal AI trained on FFDM/DBT/US improves breast cancer screening performance in women screened with both mammography/US compared to FFDM/DBT-only AI systems.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSBR05-2

### Artificial Intelligence Assessment of Breast Arterial Calcifications on Mammography in a Large Screening Population

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406B

Chirag R. Parghi, MD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

This study evaluates the accuracy and feasibility of using artificial intelligence (AI) for the detection and assessment of breast arterial calcifications (BAC) on mammography in a large screening population across 15 sites in a prospective study.

#### METHODS AND MATERIALS

Sequentially accrued 2D mammograms from 15,785 asymptomatic screening women during a 1-month period (3/23/2023-4/19/23) across 15 screening sites were analyzed using a deep learning AI algorithm specifically designed for BAC detection. Age of the women ranged from 20 to 97, with a median of 56. The study assessed overall prevalence of BAC, as well as distribution of BAC across four age groups: < 50, 50-59, 60-69, and = 70. The AI model was trained using an internal Real World Dataset of 2D mammograms to detect BAC based on expert annotation and provides an assessment score of 0-5 for BAC according to the total area of BAC and its density. Prior to the study, the accuracy of the AI algorithm is validated on a validation dataset of 2D mammograms from 8,898 women. There is no overlap between the training, validation and 15,785 women prospective study datasets.

#### RESULTS

The AI algorithm achieved an area under the ROC curve (AUC) of 0.938 (95% CI: 0.928 - 0.949) on the validation dataset, indicating high accuracy in BAC detection. In the prospective study with 15,785 women, the overall prevalence of BAC detected by the AI algorithm was 14.9% (95% CI: 14.5% - 15.3%), with a prevalence of 4.0% (95% CI: 3.6% - 4.4%) in women < 50, 8.8% (95% CI: 8.1% - 9.4%) in women 50-59, 19.8% (95% CI: 18.7% - 20.8%) in women 60-69, and 40.8% (95% CI: 39.3% - 42.3%) in women = 70 with a BAC score cutoff of 2 and above.

#### CONCLUSION

AI based BAC detection on mammography in a large screening population across 15 sites is feasible and accurate. The AI algorithm demonstrated high accuracy in BAC detection, with a prevalence and distribution of BAC increasing with age as expected in a screening population. Our results suggest that AI can standardize BAC detection at scale, potentially improving efficiency and reducing inter-observer variability. The age-specific prevalence of BAC provided by our study can inform clinical decision-making and risk assessment with an expectation of patient volumes.

#### CLINICAL RELEVANCE/APPLICATION

Breast arterial calcium is gaining popularity as a proxy for global atherosclerotic disease. Accurate quantitative models for automated BAC assessment from mammograms can offer an adjunct screening tool for heart disease.

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## Abstract Archives of the RSNA, 2023

T3-SSBR05-3

### The Multi-Center Multi-Vendor VAI-B Validation Platform for AI in Breast Imaging

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406B

Haiko Schurz, BSc, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Artificial Intelligence Computer-Aided Detection (AI CAD) has shown its potential to detect breast cancer in screening mammograms. In collaboration between Swedish research groups, hospitals, and regional cancer centers, the validation platform for AI in Breast imaging (VAI-B) aims to provide the necessary pre-deployment diagnostic validation and benchmarking of AI CAD systems.

#### METHODS AND MATERIALS

For the pilot phase of VAI-B, screening information was collected from three regions in Sweden (2008-2021). Separate case-control (all cancer; 1:5 random sample of healthy) and cohort (all exams from 2017) datasets were created. A three-year follow-up period with biopsy-verification defined the reference standard of diagnosed or healthy. Images were uploaded from each hospital to a cloud platform and processed by three AI CAD systems (Therapixel, France; Vara, Germany; Lunit, South Korea). Accuracy and robustness metrics were assessed, and AI CAD systems were analyzed standalone and paired with a radiologist.

#### RESULTS

38529 screening examinations from 34353 women of whom 5773 with breast cancer were included. Overall, all AI CAD systems had similar accuracy across the regions (Östergötland AUC: 0.832, 0.845, 0.846; Södermanland AUC: 0.829, 0.836, 0.822; Västmanland AUC: 0.835, 0.842, 0.827). All AI CAD systems outperformed single reader radiologists whose operating points were below the confidence intervals of the AI CAD receiver operating curves. Compared to the standard double reading radiologists, combining AI with one radiologist increased sensitivity 10%-30% with a loss of specificity 2%-7%. AI systems were robust to different mammography equipment manufacturers in terms of area under the curve (AUC), but the AI score distribution shifted for two of three AI CAD systems. The AI CAD systems were not robust to GE manufacturer model variants, showing differences both in AUC and the AI score distribution.

#### CONCLUSION

We have demonstrated the feasibility of the VAI-B platform to validate and benchmark commercial AI CAD systems. Accuracy metrics showed that all three AI systems paired with one radiologist provide an improvement compared to two radiologists. Robustness metrics showed that two of three AI CAD systems require manufacturer-specific calibration to deliver the expected diagnostic performance. The expandable VAI-B platform can provide important feedback to AI CAD system vendors and can assist hospitals in benchmarking before procurement decisions are made.

#### CLINICAL RELEVANCE/APPLICATION

VAI-B provides a technical platform and consistent methodologies to validate AI CAD for screening mammography. This could inform procurement decisions and improve patient safety for participating hospitals and AI CAD vendors.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSBR05-4

### Features of Invasive Breast Cancers Missed by Artificial Intelligence-based Computer-assisted Diagnosis on Mammograms

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406B

SANGUN KIM, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

There have been little studies on how Artificial intelligence-based computer-aided diagnosis (AI-CAD) missed invasive breast cancers on mammogram. The purpose of this study was to assess the false-negative result (FNR) of AI-CAD according to molecular subtypes, and to investigate the features of missed cancers.

#### METHODS AND MATERIALS

From 2014 to 2020, 1082 consecutive patients diagnosed with 1097 cancers were retrospectively included. Commercial AI-CAD was applied to digital mammograms and abnormality scores were acquired. FNR was defined by abnormality score less than 10. The FNR and abnormality scores were evaluated according to the molecular subtypes (Hormone receptor-positive [luminal] vs. human epidermal growth factor receptor-2 [HER-2] positive vs. triple negative [TN]). Missed cancers by AI-CAD were blindly reviewed by three radiologists. Features of missed cancers were analyzed.

#### RESULTS

Among 1097 invasive cancers, 155 (14.0%) were missed by AI-CAD and the FNR was higher in luminal than other subtypes (17.2% in luminal vs. 14.5% in TN vs. 9.0% in HER2-positive,  $P = 0.001$ ). AI-CAD assigned low abnormality scores in luminal subtype (mean abnormality scores = 68.9 in luminal vs. 73.8 in TN vs. 78.4 in HER-2 positive,  $P < 0.001$ ). Among the 155 cancers missed by AI-CAD, 95 (61.2%) were detected by two of three radiologists. Of 95 cancers, 57 (60.0%) were partially obscured by parenchymal densities, 12 (12.6%) were architectural distortions, 12 (12.6%) were located in retromammary or subcutaneous fat layer, 6 (6.3%) were located in subareolar area, 5 (5.2%) were located in far upper breast near axilla, and 3 (3.3%) were calcifications.

#### CONCLUSION

AI-CAD most frequently missed luminal cancers. For detecting invasive cancers missed by AI-CAD, considerable attention should be paid to dense breasts, architectural distortion or masses located outside the mammary zone of the breast.

#### CLINICAL RELEVANCE/APPLICATION

Understanding the features of invasive breast cancers missed by AI-CAD on mammogram could help reduce the missed cancers.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSBR05-5

### **Incorporating Prior Imaging in Artificial Intelligence (AI) for Breast Cancer Screening: Analysis of Cancer Type Detection**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406B

Laura Heacock, MD, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Prior imaging is not always incorporated into AI breast cancer detection models for full-field digital mammography (FFDM) and/or digital breast tomosynthesis (DBT). The purpose of this study was to explore additive value of prior exams by years included and cancer types.

#### **METHODS AND MATERIALS**

In this IRB approved study, our AI system was trained and evaluated utilizing full-field digital mammography (FFDM) and digital breast tomosynthesis (DBT) examinations performed 2010-2020 consisting of 1,964,416 exams in 324,978 patients. We used a patient-based training/validation/test split of 60%, 10%, and 30%. Testing used consecutive screening FFDM or FFDM/DBT combination exams from patients excluded from training/validation with at least three years' prior exams available. Histopathology or imaging stability was the reference standard. Four AI models were tested: 1) current exam, no priors, 2) current exam + 1 year prior exams, 3) current exam + 2 years priors, 4) current exam + 3 years priors. Recall % was standardized across all model types by using the original radiologist BI-RADS score. Diagnostic accuracy of the AI system was compared for each iteration by calculating AUROC, sensitivity, specificity, PPV and NPV. Cancer types detected by each additional round of priors were compared.

#### **RESULTS**

In a test set of 29,845 patients (74,030 exams, mean age 59.1, standard deviation 11.09) 2.05% (612/29,845) had pathology-proven cancer. The AI system achieved AUROC for breast cancer detection as follows: no priors, 0.885, 1 year prior, 0.891, 2 years prior, 0.894, 3 years prior, 0.892. Sensitivity was 70.00% (428/612 cancers) for no priors, 71.40% (437/612) for 1 year prior, 73.70% (451/612) for 2 years priors and 73.20% (448/612) for 3 years priors. Specificity was held constant at 88.10% for thresholds. AUROC improved from 0.864 to 0.873 in dense breasts with the addition of 2 years prior exams and sensitivity improved from 68.7% to 70.6% with an additional 8 cancers detected compared to no priors. AUROC improved from 0.901 to 0.910 in non-dense breasts, with an additional 15 cancers detected. Additional cancers detected with priors were predominantly low-to-intermediate grade invasive ductal carcinoma (56.3%, 18/32) and high-grade ductal carcinoma in situ (DCIS) (21.9%, 7/32). Impact on performance was non-monotonic.

#### **CONCLUSION**

Adding prior exams to AI DBT/FFDM screening models improves sensitivity for breast cancer detection. Malignancies detected with the use of prior examinations included invasive cancer and high-grade DCIS.

#### **CLINICAL RELEVANCE/APPLICATION**

Incorporating up to two years of prior exams into AI models can improve detection of both invasive cancers and DCIS. Including further prior exams may not improve and potentially degrades performance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSBR05-6

### Artificial Intelligence Model for Breast Lesion and Carcinoma in Situ Classification in Contrast Enhanced Mammography: A Multicenter Study

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S406B

Yi Dai, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to establish an artificial intelligence (AI)-based method for preoperative differentiation of benign and malignant breast lesions and carcinoma in situ from contrast enhanced mammography (CEM) as well as to explore the biological mechanism.

#### METHODS AND MATERIALS

This retrospective study includes 1430 eligible patients who underwent CEM examination from June 2017 to July 2022 and were divided into construction set (n=1101), internal test set (n=196), and external test set (n=133). The primary lesions of low-energy and recombined images on cranial-caudal view were delineated by radiologists. The AI model first adopted RefineNet as a backbone network. Then, an attention sub-network, named convolutional block attention module (CBAM), was built upon the backbone for adaptive feature refinement. Finally, an XGBoost classifier was used to integrate the refined deep learning features with clinical characteristics to perform the final classification of breast lesions. Furthermore, the AI model was developed again to achieve secondary diagnosis of carcinoma in situ and invasive carcinoma among malignant candidates. RNA-sequencing data from 12 patients were used to explore the underlying biological basis of the AI prediction. The model's performance was evaluated by the receiver operating characteristic (ROC) curve and was compared with other deep learning (DL) models, traditional radiomics models, and radiologists.

#### RESULTS

The AI model combining refined deep learning features and clinical characteristics (age, lesion diameter) achieved an AUC of 0.932 in the external test set, better than the best performing DL model (RefineNet+CBAM AUC: 0.893) and the best performing radiomics model (logistic regression AUC: 0.674). Moreover, the AI model has also achieved satisfactory results in the differentiation of carcinoma in situ, with an AUC of 0.822 in internal test set. In addition, the AI model outperformed and improved radiologists' diagnostic performance. Further the biological basis exploration revealed that high-risk group was associated with the pathways such as ECM-receptor interaction, focal adhesion, and extracellular matrix organization.

#### CONCLUSION

The AI model based on CEM and clinical characteristics had good predictive performance in the classification of benign and malignant breast lesions and carcinoma in situ.

#### CLINICAL RELEVANCE/APPLICATION

The AI model provides an automatic and preoperative non-invasive way to differentiate benign and malignant breast lesions, and improves the sensitivity and specificity of CEM image identification.

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## Abstract Archives of the RSNA, 2023

T3-SSCA05

### Cardiac Imaging (Quality Improvement)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N227B

Carole J. Dennie, MD, FRCPC (*Moderator*) Research Consultant, AstraZeneca PLC  
Jadranka Stojanovska, MD, MS (*Moderator*) Nothing to Disclose

#### Sub-Events

### T3-SSCA05-Coronary Artery Calcium Volume Measurement: A Comparison between Photon-Counting CT<sup>2</sup> and Ultra-High-Resolution CT using a Cardiac CT Calibration Phantom

Fuminari Tatsugami, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting CT (PCCT) is a novel technology that combines the electrical signal of multiple X-ray photons into a single intensity value. It has a higher contrast-to-noise ratio for high atomic number materials such as iodine or calcium, improved spatial resolution, and reduction of blooming. On the other hand, ultra-high-resolution CT (U-HRCT; Aquilion Precision, Canon Medical Systems) has smaller detector elements and yields diagnostic images with high spatial resolution, making it useful for assessing coronary artery calcification (CAC) more precisely. The purpose of this study was to evaluate the performance of PCCT in detecting CAC at various radiation doses and compare it to U-HRCT, using a cardiac CT calibration phantom.

#### METHODS AND MATERIALS

We scanned a cardiac CT calibration phantom (QRM, Germany) containing nine cylindrical inserts varying in size (1-, 3-, and 5-mm) and density (hydroxyapatite at 200, 400, and 800 mg/cm<sup>3</sup>) using a PCCT scanner developed by Canon Medical Systems. Images were acquired at 120 kV with four levels of radiation dose (CTDIvol, 3.8, 5.7, 7.6, 9.5 mGy). The images were reconstructed with a slice thickness and reconstruction interval of 0.206 mm and a matrix size of 512 x 512. We also scanned the same phantom on a U-HRCT with identical radiation doses; images were reconstructed with a slice thickness and reconstruction interval of 0.25 mm and a matrix size of 512 x 512. All images were generated using a hybrid iterative reconstruction algorithm (AIDR 3D, Canon) at standard settings. For each examination, we calculated the contrast-to-noise ratios (CNR) and calcium volume for these calcifications and compared them between the two CT scanner. CNR were calculated as:  $CNR = (CT \text{ number of the CAC} - CT \text{ number of background}) / \text{image noise}$ .

#### RESULTS

The mean image noise in PCCT images was lower than in U-HRCT images at all levels of radiation dose (9.7, 8.5, 8.8, and 8.0 vs. 15.3, 14.0, 12.4, and 11.2, respectively). The CNR of CAC was much higher in PCCT than in U-HRCT images at all radiation exposures (Table 1). The calcium volume for PCCT was comparable to that for U-HRCT in the module of 800- and 400 mg/cm<sup>3</sup> (mean: 101.3 vs. 104.7 and 106.7 vs. 107.1, respectively) (true value of 120.1 mm<sup>3</sup>). In the module of 200 mg/cm<sup>3</sup>, the calcium volume for PCCT was higher than that for U-HRCT and more similar to the true value (mean: 105.1 vs. 97.6) (Table 2).

#### CONCLUSION

The use of PCCT has the potential to accurately depict coronary artery calcification compared to U-HRCT, even with low density.

#### CLINICAL RELEVANCE/APPLICATION

Based on the results of our phantom study, coronary artery calcification can be detected accurately even with low density using PCCT.

### T3-SSCA05-Development of T1 Mapping Standardization Using T1MES Phantom for Multi-Center and Multi-Vendor Studies<sup>3</sup>

JINHO PARK, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop a standardized z-score of T1 mapping that is independent of complex external factors among multi-center and multi-vendors using T1MES Phantom.

## METHODS AND MATERIALS

A total of 67 healthy volunteers (male: female = 33:34, aged 20s (n=16), 30s (n=17), 40s (n=14), 50s (n=11), 60s or older (n=9)) were recruited from four medical institutions (three of Siemens scanners and one of Philips scanner) and acquired T1 mapping. For the development the standardized T1 values across different centers, using T1 MES phantom as the reference value, myocardial T1 values of healthy volunteers in each scanner and institution was converted to standardized z-score. Finally, we compared the z-scores of all healthy volunteers of four center and two vendors.

## RESULTS

T1 value of females (1248.1±31.71 ms) showed a higher value than males (1219.45±34.09 ms), with a difference of 28.65 ms, and both genders had a standard deviation of ±31 ms. However, when standardized with z-scores, both males (-0.07±1.13) and females (0.54±0.91) showed values within the normal range. In terms of age-related T1 values, they were 1230.61±30.31ms for those in their 20s, 1230.9±33.45 ms for those in their 30s, 1221.15±42.17 ms for those in their 40s, 1229.27±44.18 ms for those in their 50s, and 1246.74±27.83 ms for those over 60 years old. These values were converted to z-scores, which were 0.45±0.83 for those in their 20s, 0.18±1.02 for those in their 30s, -0.37±1.30 for those in their 40s, -0.01±1.31 for those in their 50s, and 0.47±0.81 for those over 60 years old. All z-scores for healthy volunteers were within range of -3 to 2.01.

## CONCLUSION

Using the T1MES phantom, standardized z-score of T1 mapping across different centers and vendors can be developed.

## CLINICAL RELEVANCE/APPLICATION

Standardized z-score of T1 mapping using the T1MES phantom is expected to enable quantification of T1 values in cases where reference values are not available and may reduce the inter-center and inter-scanner variability.

## T3-SSCA05-Myocardial Strain Measurements Derived from MR Feature-tracking: Influence of Sex, Age, Field Strength and Vendors on Reference Values

Yining Wang, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to characterize the normal reference values for myocardial strain in all four cardiac chambers using cardiovascular magnetic resonance feature tracking(CMR-FT) and identify factors that contribute to variations in FT strains through a systematic review and meta-analysis of the CMR-FT literature.

## METHODS AND MATERIALS

We searched PubMed, Embase, and Scopus for myocardial strains of all four chambers measured by CMR-FT in healthy adults. The pooled means of all strain parameters were generated using a random-effects model. Subgroup analyses and meta-regressions were performed to identify the sources of variations.

## RESULTS

44 studies with a total of 3,359 healthy subjects were included in the meta-analysis. The pooled means of left ventricular global longitudinal strain(LV-GLS), LV global radial strain and LV global circumferential strain were -18.4%(95%CI:-19.2%, -17.6%), 43.7%(95%CI:40.0%, 47.4%), and -21.4%(95%CI:-22.3%, -20.6%), respectively. The pooled means of left atrial global longitudinal strain(LA-GLS, corresponding to total strain, passive strain and active strain) were 34.9% (95%CI:29.6%, 40.2%), 21.3%(95%CI:16.5%, 26.1%) and 14.3%(95%CI:11.8%, 16.8%), respectively. The pooled means of right ventricular global longitudinal strain(RV-GLS) and right atrial global longitudinal total strain were -24.0%(95%CI:-25.8%, -22.1%) and -36.2%(95%CI:-53.9%, -18.6%), respectively. Meta-regression identified field strength and FT vendor(both P<0.001) as significant confounders contributing to heterogeneity of LV-GLS. The variations of LA-GLS<sub>active</sub> were associated with regional distribution and FT vendor(both P<0.001). Differences in FT vendor were attributed to variations of LV-GCS and RV-GLS(both P<0.05).

## CONCLUSION

Our study demonstrated the normal reference values of CMR-FT strain parameters in all four cardiac chambers in healthy subjects. Differences in FT vendor contributed to the heterogeneity of LV-GLS, LV-GCS, LA-GLS<sub>active</sub> and RV-GLS, while sex, age and MR vendor had no effect on the normal values of CMR-FT strain measurements.

## **CLINICAL RELEVANCE/APPLICATION**

Myocardial strain derived from CMR-FT has become a viable surrogate marker for accurately assessing both ventricular and atrial myocardial deformation based on post-processing of conventional CMR cine without the need for dedicated acquisition. In this meta-analysis, the reference values of CMR-FT strain parameters of the all four cardiac chambers in healthy adults were demonstrated. The pooled means obtained under different conditions (MRI vendor, field strength, FT vendor, region, gender and age) were provided in the subgroup analysis and would serve as a reasonable guide for clinical workers and researchers.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSCA05-2

### Coronary Artery Calcium Volume Measurement: A Comparison between Photon-Counting CT and Ultra-High-Resolution CT using a Cardiac CT Calibration Phantom

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N227B

Fuminari Tatsugami, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting CT (PCCT) is a novel technology that combines the electrical signal of multiple X-ray photons into a single intensity value. It has a higher contrast-to-noise ratio for high atomic number materials such as iodine or calcium, improved spatial resolution, and reduction of blooming. On the other hand, ultra-high-resolution CT (U-HRCT; Aquilion Precision, Canon Medical Systems) has smaller detector elements and yields diagnostic images with high spatial resolution, making it useful for assessing coronary artery calcification (CAC) more precisely. The purpose of this study was to evaluate the performance of PCCT in detecting CAC at various radiation doses and compare it to U-HRCT, using a cardiac CT calibration phantom.

#### METHODS AND MATERIALS

We scanned a cardiac CT calibration phantom (QRM, Germany) containing nine cylindrical inserts varying in size (1-, 3-, and 5-mm) and density (hydroxyapatite at 200, 400, and 800 mg/cm<sup>3</sup>) using a PCCT scanner developed by Canon Medical Systems. Images were acquired at 120 kV with four levels of radiation dose (CTDIvol, 3.8, 5.7, 7.6, 9.5 mGy). The images were reconstructed with a slice thickness and reconstruction interval of 0.206 mm and a matrix size of 512 x 512. We also scanned the same phantom on a U-HRCT with identical radiation doses; images were reconstructed with a slice thickness and reconstruction interval of 0.25 mm and a matrix size of 512 x 512. All images were generated using a hybrid iterative reconstruction algorithm (AIDR 3D, Canon) at standard settings. For each examination, we calculated the contrast-to-noise ratios (CNR) and calcium volume for these calcifications and compared them between the two CT scanner. CNR were calculated as:  $CNR = (CT \text{ number of the CAC} - CT \text{ number of background}) / \text{image noise}$ .

#### RESULTS

The mean image noise in PCCT images was lower than in U-HRCT images at all levels of radiation dose (9.7, 8.5, 8.8, and 8.0 vs. 15.3, 14.0, 12.4, and 11.2, respectively). The CNR of CAC was much higher in PCCT than in U-HRCT images at all radiation exposures (Table 1). The calcium volume for PCCT was comparable to that for U-HRCT in the module of 800- and 400 mg/cm<sup>3</sup> (mean: 101.3 vs. 104.7 and 106.7 vs. 107.1, respectively) (true value of 120.1 mm<sup>3</sup>). In the module of 200 mg/cm<sup>3</sup>, the calcium volume for PCCT was higher than that for U-HRCT and more similar to the true value (mean: 105.1 vs. 97.6) (Table 2).

#### CONCLUSION

The use of PCCT has the potential to accurately depict coronary artery calcification compared to U-HRCT, even with low density.

#### CLINICAL RELEVANCE/APPLICATION

Based on the results of our phantom study, coronary artery calcification can be detected accurately even with low density using PCCT.

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## Abstract Archives of the RSNA, 2023

T3-SSCA05-3

### Development of T1 Mapping Standardization Using T1MES Phantom for Multi-Center and Multi-Vendor Studies

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N227B

JINHO PARK, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a standardized z-score of T1 mapping that is independent of complex external factors among multi-center and multi-vendors using T1MES Phantom.

#### METHODS AND MATERIALS

A total of 67 healthy volunteers (male: female = 33:34, aged 20s (n=16), 30s (n=17), 40s (n=14), 50s (n=11), 60s or older (n=9)) were recruited from four medical institutions (three of Siemens scanners and one of Philips scanner) and acquired T1 mapping. For the development the standardized T1 values across different centers, using T1 MES phantom as the reference value, myocardial T1 values of healthy volunteers in each scanner and institution was converted to standardized z-score. Finally, we compared the z-scores of all healthy volunteers of four center and two vendors.

#### RESULTS

T1 value of females ( $1248.1 \pm 31.71$  ms) showed a higher value than males ( $1219.45 \pm 34.09$  ms), with a difference of 28.65 ms, and both genders had a standard deviation of  $\pm 31$  ms. However, when standardized with z-scores, both males ( $-0.07 \pm 1.13$ ) and females ( $0.54 \pm 0.91$ ) showed values within the normal range. In terms of age-related T1 values, they were  $1230.61 \pm 30.31$  ms for those in their 20s,  $1230.9 \pm 33.45$  ms for those in their 30s,  $1221.15 \pm 42.17$  ms for those in their 40s,  $1229.27 \pm 44.18$  ms for those in their 50s, and  $1246.74 \pm 27.83$  ms for those over 60 years old. These values were converted to z-scores, which were  $0.45 \pm 0.83$  for those in their 20s,  $0.18 \pm 1.02$  for those in their 30s,  $-0.37 \pm 1.30$  for those in their 40s,  $-0.01 \pm 1.31$  for those in their 50s, and  $0.47 \pm 0.81$  for those over 60 years old. All z-scores for healthy volunteers were within range of -3 to 2.01.

#### CONCLUSION

Using the T1MES phantom, standardized z-score of T1 mapping across different centers and vendors can be developed.

#### CLINICAL RELEVANCE/APPLICATION

Standardized z-score of T1 mapping using the T1MES phantom is expected to enable quantification of T1 values in cases where reference values are not available and may reduce the inter-center and inter-scanner variability.

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## Abstract Archives of the RSNA, 2023

T3-SSCA05-5

### Myocardial Strain Measurements Derived from MR Feature-tracking: Influence of Sex, Age, Field Strength and Vendors on Reference Values

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N227B

Yining Wang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to characterize the normal reference values for myocardial strain in all four cardiac chambers using cardiovascular magnetic resonance feature tracking (CMR-FT) and identify factors that contribute to variations in FT strains through a systematic review and meta-analysis of the CMR-FT literature.

#### METHODS AND MATERIALS

We searched PubMed, Embase, and Scopus for myocardial strains of all four chambers measured by CMR-FT in healthy adults. The pooled means of all strain parameters were generated using a random-effects model. Subgroup analyses and meta-regressions were performed to identify the sources of variations.

#### RESULTS

44 studies with a total of 3,359 healthy subjects were included in the meta-analysis. The pooled means of left ventricular global longitudinal strain (LV-GLS), LV global radial strain and LV global circumferential strain were -18.4% (95%CI: -19.2%, -17.6%), 43.7% (95%CI: 40.0%, 47.4%), and -21.4% (95%CI: -22.3%, -20.6%), respectively. The pooled means of left atrial global longitudinal strain (LA-GLS, corresponding to total strain, passive strain and active strain) were 34.9% (95%CI: 29.6%, 40.2%), 21.3% (95%CI: 16.5%, 26.1%) and 14.3% (95%CI: 11.8%, 16.8%), respectively. The pooled means of right ventricular global longitudinal strain (RV-GLS) and right atrial global longitudinal total strain were -24.0% (95%CI: -25.8%, -22.1%) and -36.2% (95%CI: -53.9%, -18.6%), respectively. Meta-regression identified field strength and FT vendor (both  $P < 0.001$ ) as significant confounders contributing to heterogeneity of LV-GLS. The variations of LA-GLS<sub>active</sub> were associated with regional distribution and FT vendor (both  $P < 0.001$ ). Differences in FT vendor were attributed to variations of LV-GCS and RV-GLS (both  $P < 0.05$ ).

#### CONCLUSION

Our study demonstrated the normal reference values of CMR-FT strain parameters in all four cardiac chambers in healthy subjects. Differences in FT vendor contributed to the heterogeneity of LV-GLS, LV-GCS, LA-GLS<sub>active</sub> and RV-GLS, while sex, age and MR vendor had no effect on the normal values of CMR-FT strain measurements.

#### CLINICAL RELEVANCE/APPLICATION

Myocardial strain derived from CMR-FT has become a viable surrogate marker for accurately assessing both ventricular and atrial myocardial deformation based on post-processing of conventional CMR cine without the need for dedicated acquisition. In this meta-analysis, the reference values of CMR-FT strain parameters of the all four cardiac chambers in healthy adults were demonstrated. The pooled means obtained under different conditions (MRI vendor, field strength, FT vendor, region, gender and age) were provided in the subgroup analysis and would serve as a reasonable guide for clinical workers and researchers.

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## Abstract Archives of the RSNA, 2023

T3-SSER01

### Emergency Radiology (Artificial Intelligence)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451A

David Dreizin, MD (*Moderator*) Nothing to Disclose  
Melissa A. Davis, MD, MBA (*Moderator*) Nothing to Disclose

#### Sub-Events

### **T3-SSER01- AIRib Framework: Development of an End-to-End Pipeline for the Automated Detection, Characterization, Prognostication and Reporting of Traumatic Rib Fractures from CT Scans** 1

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Rib fracture is the most common form of blunt thoracic injury. Multiple rib fractures have associated complications and increased mortality but are often missed in high volume setups. RibScore is a validated radiographic score which helps prognosticating patients with rib fractures and guide operative management. Existing AI models to characterise rib fractures have not yet demonstrated utility in prognostication, and none include all parameters necessary for RibScore calculation.

#### METHODS AND MATERIALS

In our initial pilot study, we have generated an AIRib1 dataset with 1014 rib fractures from 101 CT scans acquired using 3 different scanners. All parameters required for calculating RibScore including location, displacement, presence of comminution, segmental or flail components were incorporated. We evaluated existing AI models and developed a novel machine learning (ML) model for segmentation and subsequent classification of rib fractures. We tested 5 models including a novel DiaUNet++ Model for segmentation and ResNet for classification. Fracture characteristics were used to generate a radiology report including an automatically calculated RibScore.

#### RESULTS

Our novel segmentation algorithm DiaUNet++ showed a sensitivity of 64.1% and Dice Score of 40.17% in this pilot study. ResNet achieved best AUC, Recall (sensitivity) and F1 score for fracture characterisation: 0.887, 0.813 and 0.793 respectively. In the final AIRib pipeline, DiaUNet++ and ResNet were selected, and final outputs were used for automatic report generation.

#### CONCLUSION

The AIRib Framework is one of the first attempts to develop a complete pipeline to automatically calculate a prognosticating score in traumatic rib fractures from CT scans. Our classification algorithm is one of the first ML algorithms incorporating all details needed for computation of RibScore and has unique advantages over the existing ML models which are not yet validated for prognostication purposes.

#### CLINICAL RELEVANCE/APPLICATION

The AIRib Framework has significant management implications for patients, especially for triaging and prognostication, with CT scans having higher RibScore being prioritised for viewing and reporting in the worklist. By incorporating fracture details in a preliminary report, it can assist the trauma radiologist in decreasing the rate of missed rib fractures and significantly reduce their reporting time.

### **T3-SSER01- Low-dose Whole Brain CT Perfusion-driven CT Angiography: Evaluation of Image Quality and Diagnostic Value Using Deep Learning Image Reconstruction Algorithm** 2

Yuhan Zhou, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study was to investigate the image quality and diagnostic accuracy of CT angiography (CTA) driven from low-dose CT perfusion (CTP) arterial peak phase with deep learning image reconstruction (DLIR) compared to adaptive statistical iterative reconstruction-Veo (ASIR-V) and filtered back projection (FBP) algorithm in patients with acute ischemic stroke (AIS) due to large vessel occlusion (LVO) using .

## METHODS AND MATERIALS

This prospective study collected 62 patients with AIS caused by LVO within 24 hours of symptom onset, where 32 patients received standard dose (SD, 80keV 150mAs) CTP examination, and 30 patients received low-dose (LD, 80keV 100mAs) CTP examination. The FBP, ASIR-V40% / 80% were applied in the SD group, and ASIR-V80% and DLIR (M, H) were used to reconstruct LD group. ROIs were drawn on the siphon portion of the internal carotid artery (ICA), middle cerebral artery M1 segment (MCA-M1), and temporal lobe in the healthy side of axial CTP arterial peak phase images for objective evaluation of CT value, image noise, SNR, and CNR. Subjective evaluation included edge sharpness of vascular lumen, display of small blood vessels, and overall image quality. Additionally, 6 point scale was used to evaluate collateral circulation in the six groups of CTA images.

## RESULTS

Among the six groups of CTA images from the two different radiation dose, there was no statistically significant difference in CT values for the ICA siphon, MCA-M1, and temporal lobe. The LD DLIR-H group showed lower image noise. CNR of LD DLIR-H group in the ICA and MCA-M1 were higher than SD FBP, ASIR-V40% groups, and LD DLIR-M group ( $P < 0.05$ ). In terms of small vessel display, overall image quality, and vessel edge clarity, the LD DLIR-H group was superior to the standard-dose FBP, ASIR-V40% groups, and LD DLIR-M group ( $P < 0.05$ ). The collateral circulation scores for each patient's reconstructed CTA images were consistent. The radiation dose in the LD group was significantly lower than that in the SD group ( $P < 0.05$ ).

## CONCLUSION

Compared with FBP and ASIR-V algorithms, the application of DLIR-H reconstruction for LD CTP arterial peak phase images enables accurate evaluation of the responsible vessel and collateral circulation scores in patients with AIS, significantly improving both objective and subjective image quality, without requiring additional radiation exposure or contrast agent use.

## CLINICAL RELEVANCE/APPLICATION

Reconstruction of LD CTP arterial peak phase images through DLIR may aid in the detection of small responsible vessels. Reconstruction of CTA images from CTP data provides a valuable LD scanning option for clinical evaluation without the need for additional scanning protocols and extra radiation exposure. It also shortens the examination time for patients with AIS.

## T3-SSER01- Radiologist Worklist Reprioritization Using Artificial Intelligence: Measuring Turnaround Time for Fracture Detection on MSK X-Rays Sourced from more than 200 Imaging Centers in the United States

Sean D. Raj, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Turnaround Time is a key metric for outpatient radiology centers, emergency departments and health systems in order to assess and optimize patient care. To evaluate the effect of artificial intelligence (AI)-based radiologist prioritization on report turnaround times for X-ray examinations positive for fractures in more than 200 outpatient nationwide imaging centers.

## METHODS AND MATERIALS

This retrospective multi-center study included patients who underwent X-ray exams before (between February 15th, 2022, and March 14th, 2022; pre-AI period) and after (between February 15th, 2023 and March 14th, 2023; post-AI period) implementation of an AI tool that prioritized X-ray examinations if detecting fractures. PACS data were used to determine turnaround times (time from examination completion to report availability). Times for reports positive for fracture, using final radiology reports as reference, were compared between periods.

## RESULTS

The study included 50682 examinations, including 23088 and 27594 examinations from pre-AI and post-AI period, respectively. Frequency of acute fracture, based on radiology reports, was 10.6% during pre-AI period and 11.5% during post-AI period. For fracture-positive examinations, post-AI period, compared to pre-AI period, showed significantly shorter mean report turnaround time [8.5 hours vs 47.5 hours; mean difference, 39 hours (95% CI, 0.5 - 125 hours)].

## CONCLUSION

AI-driven reprioritization yielded tremendous reductions in report turnaround time for fracture-positive X-ray examinations.

## CLINICAL RELEVANCE/APPLICATION

By assisting radiologists in providing rapid diagnoses, an AI tool could potentially enable earlier interventions for fractures, leading to better patient outcomes and more efficient use of healthcare resources.

### **T3-SSER01- Non-radiology Healthcare Professionals Significantly benefit from AI-Assistance in Emergency-Related Chest Radiography Analysis**

Jan P. Rudolph, MD (*Presenter*) Institutional Grant, Siemens AG; Institutional Grant, Mediare GmbH

#### **PURPOSE**

To quantify the added clinical value of a convolutional neural network based artificial intelligence (AI) system for interpreting chest radiographs (CXR) in an emergency unit (EU) setting.

#### **METHODS AND MATERIALS**

A total of 563 CXRs acquired in EU were twice retrospectively assessed by 3 board-certified radiologists (BCRs), 3 radiology residents (RRs), and 3 EU-experienced non-radiology residents (NRRs) in the form of a two-step reading process: (1) without AI-support (woAI), (2) with AI-support providing secondary captures (wAI). Evaluation of four suspected pathologies (pleural effusion, pneumothorax, consolidations suspicious for pneumonia, lung lesions) was reported on a 5-point Likert scale. BCRs' confidence scores were converted into 4 binary reference standards (RFSI-IV) of different sensitivities (RFSI = most specific, RFSIV = most sensitive). RRs' and NRRs' performances were statistically analyzed using receiver operating characteristics (ROCs), Youden statistics and ROC fitting.

#### **RESULTS**

Considering the most clinically relevant RFSIV, it was shown that the NRR consensus improved significantly wAI in all pathologies. E.g., for the time-critical pathology pneumothorax, the AUC (mean, 95% confidence interval) was woAI: 0.846 (0.785-0.907) and wAI: 0.974 (0.947-1.000), which represented a gain of 30% in sensitivity and 2% in accuracy. The greatest effect was seen in the detection of lung lesions, with NRR wAI improving sensitivity by 53% and accuracy by 7% (AUC woAI: 0.723 [0.661-0.785], wAI: 0.890 [0.848-0.931]). The RR consensus wAI showed smaller, mostly non-significant gains in performance, sensitivity and accuracy.

#### **CONCLUSION**

NRRs were able to significantly improve performance, sensitivity and accuracy in CXR diagnostics through AI support in the four pathologies tested.

## CLINICAL RELEVANCE/APPLICATION

In an emergency department setting without 24/7 radiology coverage or with long reporting times where NRR have to interpret images themselves, the presented AI solution features a very good clinical support tool similar to a second reader and allows for a more accurate primary diagnosis and thus earlier therapy initiation.

### **T3-SSER01- An Explainable Interactive AI/ML Method and Interface for Splenic AAST Grading: Evaluation as a Diagnostic Aid with Performance and User Acceptance Data**

Nathan Sarkar, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

There is an unmet need for explainable interactive AI within trauma imaging. Performance and user acceptance studies of prototype tools can avoid misspent effort and address needs of practicing radiologists. With ASER AI/ML Expert Panel end-users, we evaluate concurrent reader diagnostic performance and dimensions of user acceptance for a prototype splenic AAST grading XAI w mock-up GUI.

#### **METHODS AND MATERIALS**

Diag performance: two ASER panelists (1 8 yr trauma experience) graded 76 blunt splenic trauma CTs using the AAST OIS w/o and with AI assistance and 2-mo. washout. Primary outcome was AUC for predicting hemostatic intervention. Weighted K was used to assess agreement. Interpretation was compared. User acceptance: three versions of the AI with increasing explainability were presented: 1) a "recommender widget", with AAST grade as only output, 2) a "feature widget", providing AAST rec + AI-determined lac volume and vascular injury detections, and 3) a full GUI with scrollable CT visualization of segmented laceration, Vasc injury, and interactive/modifiable elements for AAST grading. 4 grade-normalized cases were presented to 4 ASER AI/ML expert panelists for each approach. Likert scales and free-text responses were recorded for dimensions of: diagnostic utility (DU), mental support (MS), effort workload and frustration (EWF), trust and reliability (TR), and likelihood of future use (LFU).

## RESULTS

Diag. performance: The XAI GUI decreased interpretation time in both readers ( $p < 0.0001$ ). Weighted K between raters increased from 0.53 to 0.70 with AI assistance. The junior reader AUC increased from 0.80 to 0.85, whereas AUC was nearly identical for the senior reader (0.88 and 0.87). Likert scores recorded during the human-computer interaction (HCI)/user acceptance study were more favorable for the XAI GUI than the widgets for MS ( $p < 0.0001-0.045$ ), EWF ( $p = 0.001-0.51$ ), TR ( $p < 0.0001$ ), and LFU ( $p < 0.0001-0.0016$ ), but not DU ( $p = 0.57-0.85$ ).

## CONCLUSION

The GUI nearly halved interpretation time and resulted in higher inter-rater agreement. AUC increased for the junior reader. Increasing explainability of the AI tool was associated with positive reactions among ASER AI/ML expert panelists regarding mental support, trust and reliability, and likelihood of future use. Based on these results, this tool is likely to improve performance in less experienced readers, improve objectivity, reduce turnaround time and decrease workload. Larger studies with a multi-reader-multi-case design will be needed to further assess diagnostic utility.

## CLINICAL RELEVANCE/APPLICATION

This pilot study examines the diagnostic performance and user acceptance of a splenic AAST grading XAI graphical user interface to determine optimal adoption in the clinical setting.

### T3-SSER01- Threshold Optimization in Chest Radiography Interpreting Artificial Intelligence Algorithms: 6 Balancing Sensitivity and Fraction of Called Images in Clinical Routine

Jan P. Rudolph, MD (*Presenter*) Institutional Grant, Siemens AG; Institutional Grant, Mediaire GmbH

## PURPOSE

Chest radiography (CXR) analyzing artificial intelligence (AI) algorithms are commonly validated by receiver operating characteristics (ROC). Limitations are underlying numerical AI scores pathology-enriched validation cohorts, both far away from clinical routine. We go beyond by applying sensitivity-optimized AI thresholds to clinical routine images, thereby relating algorithm sensitivities to the frequency of "AI-calls" in clinical routine.

## METHODS AND MATERIALS

563 standing CXRs (study group) were evaluated by six reference readers (three board-certified radiologists, three experienced radiology residents) for the presence of: suspected pneumonia, pleural effusion, pneumothorax, and pulmonary lesions. Algorithm ROCs were calculated individually for each reference reader. Based on given target sensitivities, the corresponding confidence score thresholds were derived from ROC curves and applied to a one-year (2018) clinical cohort from a large university hospital in Europe (15.786 standing CXRs). Maximum target sensitivities (MTS) were calculated, defined by the fact that a further increase disproportionately also increases the percentage of "AI-calls" (PC) in the clinical CXR cohorts (inpatients [IP] outpatients [OP] separately considered).

## RESULTS

Achievable MTSs were considerably lower / corresponding PCs considerably higher for the IP compared with the OP subgroup: pneumothorax MTS 93% / PC 4.4% (OP) vs MTS 84% / PC 8.4% (IP), pleural effusion MTS 89% / PC 6.6% (OP) vs MTS 81% / PC 42.1% (IP), consolidations MTS 90% / PC 12.9% (OP) vs MTS 78% / PC 38.9% (IP) and suspicious lesions MTS 92% / PC 15% (OP) vs MTS 59% / PC 14.2% (IP). The presented differentially optimized thresholds for varying clinical subgroups (here: IP vs OP) would not have been accessible by ROC analysis on enriched validation data alone.

## CONCLUSION

Customary ROC/Area under the curve (AUC)-based AI performance evaluation based on artificial study cohorts does not adequately reflect the clinical perception of algorithms. The sicker a patient (e. g. IP vs OP) and the more difficult pathologies to interpret / distinguish on CXR (e.g., consolidations), the greater the likelihood that "fixed" AI algorithms thresholds are going to "pathologize" large proportions of images - leading to unsatisfying AI perception and loss of trust among users.

## CLINICAL RELEVANCE/APPLICATION

Optimizing the AI threshold plays a crucial role in the daily clinical application of CXR AI solutions. Customer-individual AI threshold adjustment depending on individual preferences, different clinical scenarios and patient characteristics needs to be addressed.

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## Abstract Archives of the RSNA, 2023

T3-SSER01-1

### **AIRib Framework: Development of an End-to-End Pipeline for the Automated Detection, Characterization, Prognostication and Reporting of Traumatic Rib Fractures from CT Scans**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451A

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Rib fracture is the most common form of blunt thoracic injury. Multiple rib fractures have associated complications and increased mortality but are often missed in high volume setups. RibScore is a validated radiographic score which helps prognosticating patients with rib fractures and guide operative management. Existing AI models to characterise rib fractures have not yet demonstrated utility in prognostication, and none include all parameters necessary for RibScore calculation.

#### **METHODS AND MATERIALS**

In our initial pilot study, we have generated an AIRib1 dataset with 1014 rib fractures from 101 CT scans acquired using 3 different scanners. All parameters required for calculating RibScore including location, displacement, presence of comminution, segmental or flail components were incorporated. We evaluated existing AI models and developed a novel machine learning (ML) model for segmentation and subsequent classification of rib fractures. We tested 5 models including a novel DiaUNet++ Model for segmentation and ResNet for classification. Fracture characteristics were used to generate a radiology report including an automatically calculated RibScore.

#### **RESULTS**

Our novel segmentation algorithm DiaUNet++ showed a sensitivity of 64.1% and Dice Score of 40.17% in this pilot study. ResNet achieved best AUC, Recall (sensitivity) and F1 score for fracture characterisation: 0.887, 0.813 and 0.793 respectively. In the final AIRib pipeline, DiaUNet++ and ResNet were selected, and final outputs were used for automatic report generation.

#### **CONCLUSION**

The AIRib Framework is one of the first attempts to develop a complete pipeline to automatically calculate a prognosticating score in traumatic rib fractures from CT scans. Our classification algorithm is one of the first ML algorithms incorporating all details needed for computation of RibScore and has unique advantages over the existing ML models which are not yet validated for prognostication purposes.

#### **CLINICAL RELEVANCE/APPLICATION**

The AIRib Framework has significant management implications for patients, especially for triaging and prognostication, with CT scans having higher RibScore being prioritised for viewing and reporting in the worklist. By incorporating fracture details in a preliminary report, it can assist the trauma radiologist in decreasing the rate of missed rib fractures and significantly reduce their reporting time.

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## Abstract Archives of the RSNA, 2023

T3-SSER01-2

### Low-dose Whole Brain CT Perfusion-driven CT Angiography: Evaluation of Image Quality and Diagnostic Value Using Deep Learning Image Reconstruction Algorithm

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451A

Yuhan Zhou, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study was to investigate the image quality and diagnostic accuracy of CT angiography (CTA) driven from low-dose CT perfusion (CTP) arterial peak phase with deep learning image reconstruction (DLIR) compared to adaptive statistical iterative reconstruction-Veo (ASIR-V) and filtered back projection (FBP) algorithm in patients with acute ischemic stroke (AIS) due to large vessel occlusion (LVO) using .

#### METHODS AND MATERIALS

This prospective study collected 62 patients with AIS caused by LVO within 24 hours of symptom onset, where 32 patients received standard dose (SD, 80keV 150mAs) CTP examination, and 30 patients received low-dose (LD, 80keV 100mAs) CTP examination. The FBP, ASIR-V40% / 80% were applied in the SD group, and ASIR-V80% and DLIR (M, H) were used to reconstruct LD group. ROIs were drawn on the siphon portion of the internal carotid artery (ICA), middle cerebral artery M1 segment (MCA-M1), and temporal lobe in the healthy side of axial CTP arterial peak phase images for objective evaluation of CT value, image noise, SNR, and CNR. Subjective evaluation included edge sharpness of vascular lumen, display of small blood vessels, and overall image quality. Additionally, 6 point scale was used to evaluate collateral circulation in the six groups of CTA images.

#### RESULTS

Among the six groups of CTA images from the two different radiation dose, there was no statistically significant difference in CT values for the ICA siphon, MCA-M1, and temporal lobe. The LD DLIR-H group showed lower image noise. CNR of LD DLIR-H group in the ICA and MCA-M1 were higher than SD FBP, ASIR-V40% groups, and LD DLIR-M group ( $P < 0.05$ ). In terms of small vessel display, overall image quality, and vessel edge clarity, the LD DLIR-H group was superior to the standard-dose FBP, ASIR-V40% groups, and LD DLIR-M group ( $P < 0.05$ ). The collateral circulation scores for each patient's reconstructed CTA images were consistent. The radiation dose in the LD group was significantly lower than that in the SD group ( $P < 0.05$ ).

#### CONCLUSION

Compared with FBP and ASIR-V algorithms, the application of DLIR-H reconstruction for LD CTP arterial peak phase images enables accurate evaluation of the responsible vessel and collateral circulation scores in patients with AIS, significantly improving both objective and subjective image quality, without requiring additional radiation exposure or contrast agent use.

#### CLINICAL RELEVANCE/APPLICATION

Reconstruction of LD CTP arterial peak phase images through DLIR may aid in the detection of small responsible vessels. Reconstruction of CTA images from CTP data provides a valuable LD scanning option for clinical evaluation without the need for additional scanning protocols and extra radiation exposure. It also shortens the examination time for patients with AIS.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSER01-3

### **Radiologist Worklist Reprioritization Using Artificial Intelligence: Measuring Turnaround Time for Fracture Detection on MSK X-Rays Sourced from more than 200 Imaging Centers in the United States**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451A

Sean D. Raj, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Turnaround Time is a key metric for outpatient radiology centers, emergency departments and health systems in order to assess and optimize patient care. To evaluate the effect of artificial intelligence (AI)-based radiologist prioritization on report turnaround times for X-ray examinations positive for fractures in more than 200 outpatient nationwide imaging centers.

#### **METHODS AND MATERIALS**

This retrospective multi-center study included patients who underwent X-ray exams before (between February 15th, 2022, and March 14th, 2022; pre-AI period) and after (between February 15th, 2023 and March 14th, 2023; post-AI period) implementation of an AI tool that prioritized X-ray examinations if detecting fractures. PACS data were used to determine turnaround times (time from examination completion to report availability). Times for reports positive for fracture, using final radiology reports as reference, were compared between periods.

#### **RESULTS**

The study included 50682 examinations, including 23088 and 27594 examinations from pre-AI and post-AI period, respectively. Frequency of acute fracture, based on radiology reports, was 10.6% during pre-AI period and 11.5% during post-AI period. For fracture-positive examinations, post-AI period, compared to pre-AI period, showed significantly shorter mean report turnaround time [8.5 hours vs 47.5 hours; mean difference, 39 hours (95% CI, 0.5 - 125 hours)].

#### **CONCLUSION**

AI-driven reprioritization yielded tremendous reductions in report turnaround time for fracture-positive X-ray examinations.

#### **CLINICAL RELEVANCE/APPLICATION**

By assisting radiologists in providing rapid diagnoses, an AI tool could potentially enable earlier interventions for fractures, leading to better patient outcomes and more efficient use of healthcare resources.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSER01-4

### **Non-radiology Healthcare Professionals Significantly benefit from AI-Assistance in Emergency-Related Chest Radiography Analysis**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451A

Jan P. Rudolph, MD (*Presenter*) Institutional Grant, Siemens AG; Institutional Grant, Mediaire GmbH

#### **PURPOSE**

To quantify the added clinical value of a convolutional neural network based artificial intelligence (AI) system for interpreting chest radiographs (CXR) in an emergency unit (EU) setting.

#### **METHODS AND MATERIALS**

A total of 563 CXRs acquired in EU were twice retrospectively assessed by 3 board-certified radiologists (BCRs), 3 radiology residents (RRs), and 3 EU-experienced non-radiology residents (NRRs) in the form of a two-step reading process: (1) without AI-support (woAI), (2) with AI-support providing secondary captures (wAI). Evaluation of four suspected pathologies (pleural effusion, pneumothorax, consolidations suspicious for pneumonia, lung lesions) was reported on a 5-point Likert scale. BCRs' confidence scores were converted into 4 binary reference standards (RFSI-IV) of different sensitivities (RFSI = most specific, RFSIV = most sensitive). RRs' and NRRs' performances were statistically analyzed using receiver operating characteristics (ROCs), Youden statistics and ROC fitting.

#### **RESULTS**

Considering the most clinically relevant RFSIV, it was shown that the NRR consensus improved significantly wAI in all pathologies. E.g., for the time-critical pathology pneumothorax, the AUC (mean, 95% confidence interval) was woAI: 0.846 (0.785-0.907) and wAI: 0.974 (0.947-1.000), which represented a gain of 30% in sensitivity and 2% in accuracy. The greatest effect was seen in the detection of lung lesions, with NRR wAI improving sensitivity by 53% and accuracy by 7% (AUC woAI: 0.723 [0.661-0.785], wAI: 0.890 [0.848-0.931]). The RR consensus wAI showed smaller, mostly non-significant gains in performance, sensitivity and accuracy.

#### **CONCLUSION**

NRRs were able to significantly improve performance, sensitivity and accuracy in CXR diagnostics through AI support in the four pathologies tested.

#### **CLINICAL RELEVANCE/APPLICATION**

In an emergency department setting without 24/7 radiology coverage or with long reporting times where NNR have to interpret images themselves, the presented AI solution features a very good clinical support tool similar to a second reader and allows for a more accurate primary diagnosis and thus earlier therapy initiation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSER01-5

### An Explainable Interactive AI/ML Method and Interface for Splenic AAST Grading: Evaluation as a Diagnostic Aid with Performance and User Acceptance Data

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451A

Nathan Sarkar, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

There is an unmet need for explainable interactive AI within trauma imaging. Performance and user acceptance studies of prototype tools can avoid misspent effort and address needs of practicing radiologists. With ASER AI/ML Expert Panel end-users, we evaluate concurrent reader diagnostic performance and dimensions of user acceptance for a prototype splenic AAST grading XAI w mock-up GUI.

#### METHODS AND MATERIALS

Diag performance: two ASER panelists (1 8 yr trauma experience) graded 76 blunt splenic trauma CTs using the AAST OIS w/o and with AI assistance and 2-mo. washout. Primary outcome was AUC for predicting hemostatic intervention. Weighted K was used to assess agreement. Interpretation was compared. User acceptance: three versions of the AI with increasing explainability were presented: 1) a "recommender widget", with AAST grade as only output, 2) a "feature widget", providing AAST rec + AI-determined lac volume and vascular injury detections, and 3) a full GUI with scrollable CT visualization of segmented laceration, Vasc injury, and interactive/modifiable elements for AAST grading. 4 grade-normalized cases were presented to 4 ASER AI/ML expert panelists for each approach. Likert scales and free-text responses were recorded for dimensions of: diagnostic utility (DU), mental support (MS), effort workload and frustration (EWF), trust and reliability (TR), and likelihood of future use (LFU).

#### RESULTS

Diag. performance: The XAI GUI decreased interpretation time in both readers ( $p < 0.0001$ ). Weighted K between raters increased from 0.53 to 0.70 with AI assistance. The junior reader AUC increased from 0.80 to 0.85, whereas AUC was nearly identical for the senior reader (0.88 and 0.87). Likert scores recorded during the human-computer interaction (HCI)/user acceptance study were more favorable for the XAI GUI than the widgets for MS ( $p < 0.0001-0.045$ ), EWF ( $p = 0.001-0.51$ ), TR ( $p < 0.0001$ ), and LFU ( $p < 0.0001-0.0016$ ), but not DU ( $p = 0.57-0.85$ ).

#### CONCLUSION

The GUI nearly halved interpretation time and resulted in higher inter-rater agreement. AUC increased for the junior reader. Increasing explainability of the AI tool was associated with positive reactions among ASER AI/ML expert panelists regarding mental support, trust and reliability, and likelihood of future use. Based on these results, this tool is likely to improve performance in less experienced readers, improve objectivity, reduce turnaround time and decrease workload. Larger studies with a multi-reader-multi-case design will be needed to further assess diagnostic utility.

#### CLINICAL RELEVANCE/APPLICATION

This pilot study examines the diagnostic performance and user acceptance of a splenic AAST grading XAI graphical user interface to determine optimal adoption in the clinical setting.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSER01-6

### **Threshold Optimization in Chest Radiography Interpreting Artificial Intelligence Algorithms: Balancing Sensitivity and Fraction of Called Images in Clinical Routine**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E451A

Jan P. Rudolph, MD (*Presenter*) Institutional Grant, Siemens AG; Institutional Grant, Mediaire GmbH

#### **PURPOSE**

Chest radiography (CXR) analyzing artificial intelligence (AI) algorithms are commonly validated by receiver operating characteristics (ROC). Limitations are underlying numerical AI scores pathology-enriched validation cohorts, both far away from clinical routine. We go beyond by applying sensitivity-optimized AI thresholds to clinical routine images, thereby relating algorithm sensitivities to the frequency of "AI-calls" in clinical routine.

#### **METHODS AND MATERIALS**

563 standing CXRs (study group) were evaluated by six reference readers (three board-certified radiologists, three experienced radiology residents) for the presence of: suspected pneumonia, pleural effusion, pneumothorax, and pulmonary lesions. Algorithm ROCs were calculated individually for each reference reader. Based on given target sensitivities, the corresponding confidence score thresholds were derived from ROC curves and applied to a one-year (2018) clinical cohort from a large university hospital in Europe (15.786 standing CXRs). Maximum target sensitivities (MTS) were calculated, defined by the fact that a further increase disproportionately also increases the percentage of "AI-calls" (PC) in the clinical CXR cohorts (inpatients [IP] outpatients [OP] separately considered).

#### **RESULTS**

Achievable MTSs were considerably lower / corresponding PCs considerably higher for the IP compared with the OP subgroup: pneumothorax MTS 93% / PC 4.4% (OP) vs MTS 84% / PC 8.4% (IP), pleural effusion MTS 89% / PC 6.6% (OP) vs MTS 81% / PC 42.1% (IP), consolidations MTS 90% / PC 12.9% (OP) vs MTS 78% / PC 38.9% (IP) and suspicious lesions MTS 92% / PC 15% (OP) vs MTS 59% / PC 14.2% (IP). The presented differentially optimized thresholds for varying clinical subgroups (here: IP vs OP) would not have been accessible by ROC analysis on enriched validation data alone.

#### **CONCLUSION**

Customary ROC/Area under the curve (AUC)-based AI performance evaluation based on artificial study cohorts does not adequately reflect the clinical perception of algorithms. The sicker a patient (e. g. IP vs OP) and the more difficult pathologies to interpret / distinguish on CXR (e.g., consolidations), the greater the likelihood that "fixed" AI algorithms thresholds are going to "pathologize" large proportions of images - leading to unsatisfying AI perception and loss of trust among users.

#### **CLINICAL RELEVANCE/APPLICATION**

Optimizing the AI threshold plays a crucial role in the daily clinical application of CXR AI solutions. Customer-individual AI threshold adjustment depending on individual preferences, different clinical scenarios and patient characteristics needs to be addressed.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSHNO2

### Science Session with Keynote: Head and Neck Imaging (Temporal Bone and Skull Base Imaging)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N226

Shinji Naganawa, MD, PhD (*Moderator*) Nothing to Disclose  
Jacqueline D. Angel, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T3-SSHNO2-1 Identification of Endolymphatic Hydrops Semi-Automatically in the Inner Ear With 3D-Real IR MRI**

Wei Chen, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The diagnosis of endolymphatic hydrops (EH) had always been an important topic. In this study, we aimed to make the preliminary exploration of a new method to diagnose EH semi-automatically.

#### **METHODS AND MATERIALS**

MRIs of the inner ears were obtained in 112 patients. Multivariable logistic regression analysis was employed to find independent predictors for developing a clinical model. The least absolute shrinkage and selection operator (LASSO) regression was applied for radiomics signature selection and model building. A combined model was constructed employing both the clinical and radiomics signatures. The vestibule and cochlea were modeled separately. The efficiency of identifying EH in all models was compared.

#### **RESULTS**

As for the vestibule, the area under the curve (AUC) values in the training and test sets: clinical model (0.742/0.616); radiomics model (0.967/0.960); combined model (0.976/0.955). As for the cochlea, the AUC values in the training and test sets: clinical model (0.711/0.643); radiomics model (0.914/0.940); combined model (0.920/0.940). The AUC values of the junior radiologist in the training and test sets were 0.858 and 0.823, respectively.

#### **CONCLUSION**

We successfully explored a new method employing the radiomics signature for identifying EH of the inner ear semi-automatically. The radiomics and combined models excelled in identifying EH in the vestibule or cochlea, and they both outperformed the clinical model and junior radiologist.

#### **CLINICAL RELEVANCE/APPLICATION**

Hopefully, the radiomics model can reach the level of senior radiologists in the identification of EH and can be expected to be routinely applied in clinical practice to assist radiologists to realize automatic diagnosis of EH.

#### **T3-SSHNO2-2 Characterizing Static and Dynamic Intrinsic Brain Activity and its Relationship to Clinical Dysfunction in Unilateral Sudden Sensorineural Hearing Loss**

Wenliang Fan, MD, BMedSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study was to explore the association between clinical dysfunction in patients with unilateral sudden sensorineural hearing loss (SSHL) and both static and dynamic fractional amplitude of low-frequency fluctuations (fALFF) using rs-fMRI. Additionally, we aimed to assess the potential of these measures as biomarkers for SSHL clinical classification by support vector machine.

## METHODS AND MATERIALS

A total of 102 SSHL patients and 95 healthy controls (HC) resting state fMRI data were collected. The static fALFF and dynamic fALFF was computed using a sliding window approach with a window length of 50 TRs and a shift size of 5 TRs. The coefficient of variation was used to assess variability in dynamic fALFF. Gaussian random field correction method was employed to determine group differences between the SSHL and HC groups in both static and dynamic fALFF. Correlation analyses were conducted between regional mean static and dynamic fALFF values and clinical measurements. Statistical differences in static fALFF and dynamic fALFF between both groups were used as features to explore whether they could differentiate SSHL from HC through support vector machine method.

## RESULTS

Compared with HC, SSHL patients showed significantly decreased static fALFF in the left fusiform gyrus, left precentral gyrus, and right inferior frontal gyrus, and increased static fALFF in the left inferior frontal gyrus, left superior frontal gyrus, and right middle temporal gyrus. For dynamic fALFF, the SSHL patients exhibited significantly increased dynamic fALFF in the right superior frontal gyrus and right middle frontal gyrus compared with HC. Correlation analyses revealed a positive correlation between static fALFF in the left fusiform gyrus and hearing loss duration. The support vector machine analysis achieved an accuracy of 89.34%, sensitivity of 85.29%, and specificity of 93.68%.

## CONCLUSION

Our study revealed significant alterations in both the static and dynamic intrinsic brain activity in SSHL patients, involving not only the auditory network but also the sensorimotor, attention, and limbic networks. These findings suggest a potential role of intrinsic brain activity in the pathophysiology of SSHL and offer promising biomarkers for SSHL classification. Moreover, the combination of static and dynamic analyses provided complementary evidence for a better understanding of the neuropathology of SSHL and its functional impairments in emotion regulation, sensorimotor control, and attention.

## CLINICAL RELEVANCE/APPLICATION

The current study contributes to the understanding of the neuropathology of SSHL. The identified potential biomarkers have the potential to aid in clinical classification and assessment of SSHL.

### T3- SSHN02-4 Association Between Types of Skull Base Osteomyelitis, Source and Infection Spread in Patients with Histopathology/ Culture Proven SBO

David E. Timaran Montenegro, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Skull base osteomyelitis (SBO) is a challenging diagnosis with variety of non-specific clinical manifestations and imaging findings. The aim of this study was to determine the association between types of SBO with source and infection spread in patients with histopathology/ culture proven SBO.

## METHODS AND MATERIALS

Over a 5-year period, 55 patients with suspected SBO were reviewed. In total, 22 patients (40%) were excluded because histology resulted in neoplasia without associated infection (2[9%]), or negative imaging findings of SBO. Finally, 33 patients with positive cultures (16[48.4%]), or negative cultures with inflammation on histopathology (17[51.6%]) were included.

## RESULTS

Bacterial SBO was identified in 16 patients (48.4%) with *P. aeruginosa* and *S. aureus* detected in 9 cases (22%). Fungal SBO was identified in 3 patients (9%). Typical SBO (TSBO) was observed in 21 patients (63.64%). Central skull base SBO (atypical [ASBO]) was identified in 12 subjects (36.36%). Nasopharynx was the source of infection in 4 patients with ASBO (33%) ( $p=0.04$ ). Among them, 9 (75%) patients ( $p=0.01$ ) presented extension to the masticator space, 7 (58.33%) involvement of the temporomandibular joint ( $p=0.06$ ), and 9 (75%) involvement of the carotid space ( $p<0.01$ ), with thrombosis of the ICA in 6 patients (50%) ( $p<0.01$ ). On MRI, the clivus was compromised in 8 patients (66%) ( $p<0.01$ ), with bone marrow edema in 6 patients (50%) ( $p=0.01$ ), soft tissue edema in 8 patients (66%), and abnormal irregular enhancement along the central skull base in 10 patients (83.3%) ( $p=0.07$ ). On CT, bony erosions were identified in all patients with fungal infections (3) ( $p=0.05$ ), and in 9 patients with bacterial infections (56.2%) ( $p=0.07$ ).

## CONCLUSION

Central/ atypical SBO was identified in up to 36.36% of the patients. Among them, intra and extracranial infection spread was observed compromising the masticator space, temporomandibular joint and carotid space, with thrombosis of the ICA in up to 50% of the subjects. Along the central skull base, involvement of the clivus and adjacent soft tissue was frequently observed in up to 66% of the cases, with abnormal enhancement in up to 88% of the patients on MRI. Bony erosions were observed in 100% of the patients with fungal infections and 56.2% of the bacterial infections. Finally, nasopharynx was the main source of infection in 33% patients with ASBO.

## CLINICAL RELEVANCE/APPLICATION

Skull base osteomyelitis represents a diagnostic challenge due to insidious clinical presentation and non-specific imaging findings. This investigation evaluates imaging patterns among >30 cases of skull base osteomyelitis.

### T3-SSHN02-5 **Precise Visualization of Intracavernous Cranial Nerves in Patients with Diplopia Using High-Resolution Contrast-Enhanced 3D T1 Volumetric Interpolated Breath-Hold Examination MRI**

Eunhee Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the visualization score of normal and abnormal cranial nerve (CN) III, V1, V2, and VI of the cavernous sinus on 3D high-resolution T1 VIBE images in patients with diplopia.

#### METHODS AND MATERIALS

Among 117 consecutive 3T MRIs for diplopia for 1 year, 112 MRIs were analyzed retrospectively, excluding 5 MRIs of the same patient. Contrast-enhanced 3D T1 VIBE images with fat suppression are acquired in the coronal plane with a slice thickness of 1.5mm. Two radiologists independently evaluated the intracavernous CN III, V1, V2, and VI bilaterally on 3D T1 VIBE images. The intracavernous CN IV was too small to be included in this analysis. The visualization score was defined as the identifiable proportion of the total cavernous segment of each cranial nerve on coronal T1 VIBE images. If less than 50% of the length of the intracavernous CN was identified, it was classified as grade 1, 50% to less than 75% as grade 2, 75% to less than 100% as grade 3, and 100% as grade 4 (completely identified).

#### RESULTS

The intracavernous CN III, V1, V2, and VI were all normal in 84 of 112 patients (female=45, mean age 53 years, range of 18-83 years). Among 168 normal bilateral CN, all CN IIIs were completely identified (grade 4). For the CN V1, 145 (86%) were grade 4, 16 (10%) were grade 3, and 7 (4%) were grade 2. The CN V2 was identified as grade 4 in 153 (91%) and grade 3 in 4 (2%), but 9 (5%) were classified as grade 2 and 2 (1%) as grade 1 due to susceptibility artifact of the skull base. For the CN VI, 144 (86%) were identified as grade 4, 17 (10%) as grade 3, 6 (4%) as grade 2, and 1 (1%) as grade 1. Twenty-eight patients (female=17, mean age 60 years, range 19-79 years) showed neural enhancement in one or more of the intracavernous CNs. Abnormal neural enhancement due to cavernous sinus lesion was seen in CN III (n=20), CN V1 (n=8), CN V2 (n=5), and CN VI (n=11), respectively. Excluding CN III with abnormal neural enhancement (n=20), 35 (97%) of normal 36 CN III were classified as grade IV and 1 (3%) as grade I. Of the 48 normal CN V1s, 37 (77%) were grade 4, 10 (21%) were grade 3, and 1(2%) were grade 2. For CN V2 (n=51), 48 (94%) were grade 4, 2 (4%) were grade 2, and 1 (2%) grade 1. In CN VI (n=45), 33 (73%) were grade 4, 11 (24%) grade 3, and 1 (2%) grade 2.

#### CONCLUSION

In the majority of cases, normal or abnormal cavernous segments of CN III, CN V<sub>1</sub>, CN V<sub>2</sub>, and CN VI can be identified completely on 3D T1 VIBE images.

## CLINICAL RELEVANCE/APPLICATION

High-resolution contrast-enhanced coronal 3D T1 VIBE sequence with fat suppression is the most optimized sequence for evaluating the cavernous segment of the cranial nerves by uniformly and strongly enhancing the cavernous sinus. High-resolution 3D T1 VIBE MRI is a promising new neuro-ophthalmic imaging technique that provides precise visualization of cranial nerves in patients with diplopia.

### T3-SSHN02-6 **Keynote Speaker: MR Imaging for Endolymphatic Hydrops**

Shinji Naganawa, MD, PhD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T3-SSHN02-1

### Identification of Endolymphatic Hydrops Semi-Automatically in the Inner Ear With 3D-Real IR MRI

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N226

Wei Chen, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The diagnosis of endolymphatic hydrops (EH) had always been an important topic. In this study, we aimed to make the preliminary exploration of a new method to diagnose EH semi-automatically.

#### METHODS AND MATERIALS

MRIs of the inner ears were obtained in 112 patients. Multivariable logistic regression analysis was employed to find independent predictors for developing a clinical model. The least absolute shrinkage and selection operator (LASSO) regression was applied for radiomics signature selection and model building. A combined model was constructed employing both the clinical and radiomics signatures. The vestibule and cochlea were modeled separately. The efficiency of identifying EH in all models was compared.

#### RESULTS

As for the vestibule, the area under the curve (AUC) values in the training and test sets: clinical model (0.742/0.616); radiomics model (0.967/0.960); combined model (0.976/0.955). As for the cochlea, the AUC values in the training and test sets: clinical model (0.711/0.643); radiomics model (0.914/0.940); combined model (0.920/0.940). The AUC values of the junior radiologist in the training and test sets were 0.858 and 0.823, respectively.

#### CONCLUSION

We successfully explored a new method employing the radiomics signature for identifying EH of the inner ear semi-automatically. The radiomics and combined models excelled in identifying EH in the vestibule or cochlea, and they both outperformed the clinical model and junior radiologist.

#### CLINICAL RELEVANCE/APPLICATION

Hopefully, the radiomics model can reach the level of senior radiologists in the identification of EH and can be expected to be routinely applied in clinical practice to assist radiologists to realize automatic diagnosis of EH.

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## Abstract Archives of the RSNA, 2023

T3-SSHN02-2

### Characterizing Static and Dynamic Intrinsic Brain Activity and its Relationship to Clinical Dysfunction in Unilateral Sudden Sensorineural Hearing Loss

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N226

Wenliang Fan, MD, BMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to explore the association between clinical dysfunction in patients with unilateral sudden sensorineural hearing loss (SSHL) and both static and dynamic fractional amplitude of low-frequency fluctuations (fALFF) using rs-fMRI. Additionally, we aimed to assess the potential of these measures as biomarkers for SSHL clinical classification by support vector machine.

#### METHODS AND MATERIALS

A total of 102 SSHL patients and 95 healthy controls (HC) resting state fMRI data were collected. The static fALFF and dynamic fALFF was computed using a sliding window approach with a window length of 50 TRs and a shift size of 5 TRs. The coefficient of variation was used to assess variability in dynamic fALFF. Gaussian random field correction method was employed to determine group differences between the SSHL and HC groups in both static and dynamic fALFF. Correlation analyses were conducted between regional mean static and dynamic fALFF values and clinical measurements. Statistical differences in static fALFF and dynamic fALFF between both groups were used as features to explore whether they could differentiate SSHL from HC through support vector machine method.

#### RESULTS

Compared with HC, SSHL patients showed significantly decreased static fALFF in the left fusiform gyrus, left precentral gyrus, and right inferior frontal gyrus, and increased static fALFF in the left inferior frontal gyrus, left superior frontal gyrus, and right middle temporal gyrus. For dynamic fALFF, the SSHL patients exhibited significantly increased dynamic fALFF in the right superior frontal gyrus and right middle frontal gyrus compared with HC. Correlation analyses revealed a positive correlation between static fALFF in the left fusiform gyrus and hearing loss duration. The support vector machine analysis achieved an accuracy of 89.34%, sensitivity of 85.29%, and specificity of 93.68%.

#### CONCLUSION

Our study revealed significant alterations in both the static and dynamic intrinsic brain activity in SSHL patients, involving not only the auditory network but also the sensorimotor, attention, and limbic networks. These findings suggest a potential role of intrinsic brain activity in the pathophysiology of SSHL and offer promising biomarkers for SSHL classification. Moreover, the combination of static and dynamic analyses provided complementary evidence for a better understanding of the neuropathology of SSHL and its functional impairments in emotion regulation, sensorimotor control, and attention.

#### CLINICAL RELEVANCE/APPLICATION

The current study contributes to the understanding of the neuropathology of SSHL. The identified potential biomarkers have the potential to aid in clinical classification and assessment of SSHL.

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## Abstract Archives of the RSNA, 2023

T3-SSHN02-4

### Association Between Types of Skull Base Osteomyelitis, Source and Infection Spread in Patients with Histopathology/ Culture Proven SBO

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N226

David E. Timaran Montenegro, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Skull base osteomyelitis (SBO) is a challenging diagnosis with variety of non-specific clinical manifestations and imaging findings. The aim of this study was to determine the association between types of SBO with source and infection spread in patients with histopathology/ culture proven SBO.

#### METHODS AND MATERIALS

Over a 5-year period, 55 patients with suspected SBO were reviewed. In total, 22 patients (40%) were excluded because histology resulted in neoplasia without associated infection (2[9%]), or negative imaging findings of SBO. Finally, 33 patients with positive cultures (16[48.4%]), or negative cultures with inflammation on histopathology (17[51.6%]) were included.

#### RESULTS

Bacterial SBO was identified in 16 patients (48.4%) with *P. aeruginosa* and *S. aureus* detected in 9 cases (22%). Fungal SBO was identified in 3 patients (9%). Typical SBO (TSBO) was observed in 21 patients (63.64%). Central skull base SBO (atypical [ASBO]) was identified in 12 subjects (36.36%). Nasopharynx was the source of infection in 4 patients with ASBO (33%) ( $p=0.04$ ). Among them, 9 (75%) patients ( $p=0.01$ ) presented extension to the masticator space, 7 (58.33%) involvement of the temporomandibular joint ( $p=0.06$ ), and 9 (75%) involvement of the carotid space ( $p<0.01$ ), with thrombosis of the ICA in 6 patients (50%) ( $p<0.01$ ). On MRI, the clivus was compromised in 8 patients (66%) ( $p<0.01$ ), with bone marrow edema in 6 patients (50%) ( $p=0.01$ ), soft tissue edema in 8 patients (66%), and abnormal irregular enhancement along the central skull base in 10 patients (83.3%) ( $p=0.07$ ). On CT, bony erosions were identified in all patients with fungal infections (3) ( $p=0.05$ ), and in 9 patients with bacterial infections (56.2%) ( $p=0.07$ ).

#### CONCLUSION

Central/ atypical SBO was identified in up to 36.36% of the patients. Among them, intra and extracranial infection spread was observed compromising the masticator space, temporomandibular joint and carotid space, with thrombosis of the ICA in up to 50% of the subjects. Along the central skull base, involvement of the clivus and adjacent soft tissue was frequently observed in up to 66% of the cases, with abnormal enhancement in up to 88% of the patients on MRI. Bony erosions were observed in 100% of the patients with fungal infections and 56.2% of the bacterial infections. Finally, nasopharynx was the main source of infection in 33% patients with ASBO.

#### CLINICAL RELEVANCE/APPLICATION

Skull base osteomyelitis represents a diagnostic challenge due to insidious clinical presentation and non-specific imaging findings. This investigation evaluates imaging patterns among >30 cases of skull base osteomyelitis.

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## Abstract Archives of the RSNA, 2023

T3-SSHN02-5

### Precise Visualization of Intracavernous Cranial Nerves in Patients with Diplopia Using High-Resolution Contrast-Enhanced 3D T1 Volumetric Interpolated Breath-Hold Examination MRI

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N226

Eunhee Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the visualization score of normal and abnormal cranial nerve (CN) III, V1, V2, and VI of the cavernous sinus on 3D high-resolution T1 VIBE images in patients with diplopia.

#### METHODS AND MATERIALS

Among 117 consecutive 3T MRIs for diplopia for 1 year, 112 MRIs were analyzed retrospectively, excluding 5 MRIs of the same patient. Contrast-enhanced 3D T1 VIBE images with fat suppression are acquired in the coronal plane with a slice thickness of 1.5mm. Two radiologists independently evaluated the intracavernous CN III, V1, V2, and VI bilaterally on 3D T1 VIBE images. The intracavernous CN IV was too small to be included in this analysis. The visualization score was defined as the identifiable proportion of the total cavernous segment of each cranial nerve on coronal T1 VIBE images. If less than 50% of the length of the intracavernous CN was identified, it was classified as grade 1, 50% to less than 75% as grade 2, 75% to less than 100% as grade 3, and 100% as grade 4 (completely identified).

#### RESULTS

The intracavernous CN III, V1, V2, and VI were all normal in 84 of 112 patients (female=45, mean age 53 years, range of 18-83 years). Among 168 normal bilateral CN, all CN IIIs were completely identified (grade 4). For the CN V1, 145 (86%) were grade 4, 16 (10%) were grade 3, and 7 (4%) were grade 2. The CN V2 was identified as grade 4 in 153 (91%) and grade 3 in 4 (2%), but 9 (5%) were classified as grade 2 and 2 (1%) as grade 1 due to susceptibility artifact of the skull base. For the CN VI, 144 (86%) were identified as grade 4, 17 (10%) as grade 3, 6 (4%) as grade 2, and 1 (1%) as grade 1. Twenty-eight patients (female=17, mean age 60 years, range 19-79 years) showed neural enhancement in one or more of the intracavernous CNs. Abnormal neural enhancement due to cavernous sinus lesion was seen in CN III (n=20), CN V1 (n=8), CN V2 (n=5), and CN VI (n=11), respectively. Excluding CN III with abnormal neural enhancement (n=20), 35 (97%) of normal 36 CN III were classified as grade IV and 1 (3%) as grade I. Of the 48 normal CN V1s, 37 (77%) were grade 4, 10 (21%) were grade 3, and 1(2%) were grade 2. For CN V2 (n=51), 48 (94%) were grade 4, 2 (4%) were grade 2, and 1 (2%) grade 1. In CN VI (n=45), 33 (73%) were grade 4, 11 (24%) grade 3, and 1 (2%) grade 2.

#### CONCLUSION

In the majority of cases, normal or abnormal cavernous segments of CN III, CN V<sub>1</sub>, CN V<sub>2</sub>, and CN VI can be identified completely on 3D T1 VIBE images.

#### CLINICAL RELEVANCE/APPLICATION

High-resolution contrast-enhanced coronal 3D T1 VIBE sequence with fat suppression is the most optimized sequence for evaluating the cavernous segment of the cranial nerves by uniformly and strongly enhancing the cavernous sinus. High-resolution 3D T1 VIBE MRI is a promising new neuro-ophthalmic imaging technique that provides precise visualization of cranial nerves in patients with diplopia.

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## Abstract Archives of the RSNA, 2023

T3-SSH02-6

### **Keynote Speaker: MR Imaging for Endolymphatic Hydrops**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N226

Shinji Naganawa, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSIR02

### Science Session with Keynote: Interventional Radiology (Translational Research)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S501

Federico Colletini, MD (*Moderator*) Research Grant, PharmaCept Research Grant, Philips Research Grant, Siemens Healthineers Speakers Bureau, Bayer AG Speakers Bureau, PharmaCept Speakers Bureau, Angiodynamics  
Terence P. Gade, MD, PhD (*Moderator*) Scientific Advisory Board, TriSalus Life Sciences; Research Consultant, Instylla, Inc; Research Grant, Instylla, Inc

#### Sub-Events

#### **T3-SSIR02- Keynote Speaker: Advances in Treatment Planning and Guidance Tools for the Future IR Suite** 1

Punit Prakash, PhD (*Presenter*) Nothing to Disclose

#### **T3-SSIR02- Artificial Intelligence-Based CT Body Composition Improve Post-procedural Mortality Prediction in Patients Undergoing Transjugular Intrahepatic Portosystemic Shunt (TIPS)** 2

Tarig S. Elhakim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the role of CT body composition metrics derived from an artificial intelligence (AI) algorithm with mortality risk prediction post-TIPS and to assess its performance as a complement to MELD score.

#### **METHODS AND MATERIALS**

A retrospective study were 122 patients met the inclusion criteria: 1) Have a CT abdomen/pelvis with contrast performed 6 - 9 months prior to TIPS from year 2005 - 2017; 2) Undergone TIPS at our institution; and 3) have follow-up data available for 90 days post-TIPS. Clinical data was extracted, including MELD score. At L3 vertebral body level, a previously validated fully automated AI algorithm was used to extract CT body composition skeletal-based and fat-based metrics including; skeletal muscle area (SMA), skeletal muscle index (SMI), skeletal muscle density (SMD), subcutaneous fat area (SFA), visceral fat area (VFA), visceral-to-subcutaneous fat ratio (VSR), and visceral fat index (VFI). Independent t-tests, univariate and multivariate logistic regression models, and ROC curve analysis were used to assess the association of those metrics with 90-day mortality post-TIPS and its performance as a complement to MELD score.

#### **RESULTS**

From 122 patients, 83 (68%) were male and 39 (32%) female with a mean age of 58.2 years[11.8]. 29 (23.8%) died within 90 days post-TIPS and were found to have a significantly higher MELD Score ( $p < 0.01$ ) and lower SMA ( $p < 0.01$ ), SMI ( $p = 0.02$ ), SFA ( $p < 0.01$ ), SFI ( $p = 0.02$ ), VFA ( $p < 0.01$ ) and VFI ( $p = 0.01$ ). Univariate logistic regression model demonstrated that most CT body composition metrics were significant predictors of 90-day mortality, including SMA (OR=0.9,  $p < 0.01$ ), SMI (OR=0.9,  $p = 0.04$ ), SFA (OR=0.9,  $p < 0.01$ ), VFA (OR=0.9,  $p < 0.01$ ), and VFI (OR =0.9,  $p = 0.03$ ). When adjusting for MELD score, the multivariable logistic regression model showed that SMA (OR=0.9,  $p < 0.01$ ), SMI (OR=0.9,  $p = 0.03$ ), SFI (OR=0.9,  $p = 0.05$ ) and VFA (OR =0.9,  $p = 0.02$ ) remained significant predictors of 90-day mortality. ROC curve analysis for MELD score generated an AUC of 0.76 while the addition of SMA, SFA and VFA significantly improved the predictive power of MELD in predicting 90-day mortality after TIPS (AUC 0.84,  $p = 0.03$ ).

#### **CONCLUSION**

Our study demonstrates that CT body composition metrics can predict 90-day mortality post-TIPS, and incorporating these metrics enhances the predictive performance of MELD Score. Although generalizability is limited to our study population, this research indicates that AI-based CT body composition may serve as a valuable tool for assessing patient risk during TIPS evaluation.

## CLINICAL RELEVANCE/APPLICATION

AI-based CT body composition have a great potential in improving the current risk prediction models and identifying patients at risk of complications contributing to better clinical outcomes.

### T3-SSIR02- Correlation between Tumor Complexity Scoring Systems and Outcomes in Percutaneous Renal Cryoablation

Cristina Marrocchio, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the usefulness of currently available renal tumor complexity scores, i.e., PADUA, RENAL, and ABLATE, in predicting outcomes in patients who undergo percutaneous cryoablation (PCA).

#### METHODS AND MATERIALS

Patients who underwent PCA between 2012 and 2021 in our Institution for one or more clinically localized renal masses were included, regardless of histology. PCA was performed by two radiologists with 13 and 30 years of experience in interventional radiology, respectively. Pre-ablation CT was evaluated by 3 radiologists in consensus to determine PADUA, RENAL, and ABLATE scores for each lesion, which was classified as low-, moderate- or high-risk accordingly. The association between the scores and post-procedural complications was evaluated for all lesions. Correlation with oncologic outcomes, in terms of the rate of persistence or recurrence of treated tumors, was also assessed. Accuracy of scores was calculated using ROC analysis for complication rate and the cumulative incidence function for oncologic outcomes.

#### RESULTS

The cohort included 158 patients and 193 renal lesions (M:111; F:47, median age at PCA: 75y, range: 43-90) with a mean follow-up of  $27 \pm 24.9$  months. According to PADUA, 60 lesions were low-risk, 69 medium-risk, and 64 high-risk; according to RENAL, 75 were low-risk, 106 medium-risk, and 12 high-risk. Median ABLATE score was 6.5 (IQR: 4.5, 9). Complications were present in 58 lesions and none of the scores showed statistical correlation. AUC values were 0.54 (95%CI=0.45-0.62) for PADUA ( $p=0.4$ ), 0.46 (95%CI=0.37-0.55) for RENAL ( $p=0.4$ ), with no differences in subgroup analyses according to the risk category, and 0.55 (95%CI=0.46-0.63) for ABLATE ( $p=0.3$ ). Twenty-one patients had persistent or recurrent disease. No statistically significant difference was observed in the scores of each scoring system between lesions that persisted/recurred and lesions that did not recur.

#### CONCLUSION

None of the currently available scores are able to predict the risk of complications or persistence/recurrence of renal lesions after percutaneous cryoablation.

## CLINICAL RELEVANCE/APPLICATION

Since current renal scores are not able to predict outcomes, the development of a new score dedicated to ablation procedures and able to successfully predict patients' outcomes is needed.

### T3-SSIR02- What Treatment Factors are Associated with Oncological Efficacy after MRI-guided Focused Ultrasound (MRgFUS) Focal Therapy of Prostate Cancer

Pejman Ghanouni, MD, PhD (*Presenter*) Medical Advisory Board, InSightec Ltd;Scientific Advisory Board, SonALASense

#### PURPOSE

A phase 2b multicenter trial assessed efficacy and safety of MRI-guided Focused Ultrasound (MRgFUS) as an alternative to radical therapy for MRI-visible, intermediate-risk Gleason Grade Group (GGG) 2 or 3 prostate cancer. Of 89 men with 24-month biopsy, 78 had no evidence of GGG =2 prostate cancer in the treated area [1]. Erectile function and urinary continence outcomes compared favorably to radical therapy [1]. This study presents a retrospective analysis to determine if patient selection or treatment factors are associated with oncologic efficacy of MRgFUS ablation.

#### METHODS AND MATERIALS

Oncologic efficacy was defined by the absence of clinically significant (GGG =2) cancer in the treatment zone on 24-month biopsy. Baseline patient, screening characteristics and treatment parameters, such as the ratio of ablated, or non-perfused volume (NPV), to MRI-visible lesion volume, and the ratio of NPV to total prostate volume (Figure 1), were analyzed to determine an association with oncologic efficacy. Impact of ablation on urinary and erectile functional outcomes was also assessed.

#### RESULTS

Comparing men with and without GGG =2 at 24-month biopsy revealed no difference in baseline characteristics such as patient age, PSA, prostate volume, or total and positive biopsies (Table 1). Overall, the mean lesion volume was 0.82 mL, and the mean non-perfused volume around the MRI-visible lesion was 27 mL. The volume of ablated prostate tissue

encompassing the MRI-visible lesion volume (NPV/lesion volume) was twice as large in men without significant cancer on 24-month biopsy of the treated area compared to men with significant cancer. ( $p=0.018$ , Table 1). Figure 2 shows that oncologic efficacy increases as the ratio of NPV/lesion volume increases; however, NPV as a fraction of total prostate volume was not associated with oncologic efficacy (Table 1). Among men with new erectile dysfunction or severe urinary symptoms, there was no difference in NPV/lesion volume ratio ( $p=0.3$ ,  $p=0.8$ , respectively).

#### **CONCLUSION**

Insufficient ablation margin around the MRI-visible lesion was associated with the presence of clinically significant cancer at 24-month biopsy after focal MR guided focused ultrasound ablation. Adequate ablation volume is determined by extent of coverage around the MRI-visible lesion volume, not by the fraction of the prostate volume ablated. Importantly, ablating a larger volume of tissue around the MRI-visible lesion did not increase the risk of erectile or urinary dysfunction at 24 months.

#### **CLINICAL RELEVANCE/APPLICATION**

Focal therapy of prostate cancer must overcome MRI underestimation of tumor extent. A larger volume of ablated tissue relative to targeted tumor volume is associated with better oncologic outcome at 2 years post-ablation.

### **T3-SSIR02- Percutaneous Cryoablation of Clinical Stage I/II Breast Cancer in Patients with Omission of Surgical Axillary Staging**

Jose Maria Oliver-Goldaracena (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To review the efficacy of percutaneous treatment of infiltrating breast cancer (BC) by ultrasound-guided cryoablation in patients with clinical stage I/II without indication for surgical axillary staging

#### **METHODS AND MATERIALS**

Patients with clinical stage I/II BC without indication for surgical axillary staging (SLNB or TAD) who were treated by ultrasound-guided cryoablation were collected from our files. Patients who had a minimum follow-up of 12 months were selected. The cryoablation devices used were the ICEfx Galil argon gas system (Boston Scientific, USA) and the ProSense liquid nitrogen system (IceCure Medical Ltd, Caesarea, Israel). The "triple phase" protocol was applied: freezing, thaw and freezing. The duration of each phase was 10 minutes. The ultrasound follow up were: the first between 1-2 months (to assess residual lesions due to incomplete treatment) and subsequently every six months (to assess recurrences). Residual lesions and recurrences were confirmed with CNB and in all cases treatment with new (salvage) cryoablation was considered. The efficacy of the procedure was assessed on local control in the breast.

#### **RESULTS**

Between March 2019 and April 2023, 105 patients with 117 BC in clinical stage I/II with omission of surgical axillary staging were treated with ultrasound-guided cryoablation. The inclusion criteria of the retrospective study were met by 54 patients (58-96 years, mean 83, SD  $\pm 7,64$ ) with 61 BC (between 5-60mm, mean 17, SD  $\pm 13,75$ ) who were followed during a mean period of 22 months (between 12-49 months). There were four patients with incomplete treatment and eight patients relapsed (between 9-27 months, mean 17). All were treated with salvage cryoablation. Local control at 12 months was 90.5% (probability 0.905 standard error 0.045) and in 94% of patients (51/54) the BC was locally controlled. Six patients died, three due to progression of the BC and three due to other causes. All procedures were well tolerated and there were no serious complications.

#### **CONCLUSION**

Ultrasound-guided cryoablation is an effective percutaneous treatment for the local control of BC in patients with clinical stage I/II with omission of surgical axillary staging.

#### **CLINICAL RELEVANCE/APPLICATION**

Cryoablation is effective in the local control of breast carcinoma in patients with stage I/II without indication for surgical axillary staging and opens the possibility of percutaneous management of breast cancer in this group of patients, changing the paradigm of surgery as treatment of choice.

### **T3-SSIR02- Keynote Speaker**

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Gustavo V. Andrade, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T3-SSIR02-1

**Keynote Speaker: Advances in Treatment Planning and Guidance Tools for the Future IR Suite**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S501

Punit Prakash, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSIR02-2

### Artificial Intelligence-Based CT Body Composition Improve Post-procedural Mortality Prediction in Patients Undergoing Transjugular Intrahepatic Portosystemic Shunt (TIPS)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S501

Tarig S. Elhakim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the role of CT body composition metrics derived from an artificial intelligence (AI) algorithm with mortality risk prediction post-TIPS and to assess its performance as a complement to MELD score.

#### METHODS AND MATERIALS

A retrospective study were 122 patients met the inclusion criteria: 1) Have a CT abdomen/pelvis with contrast performed 6 - 9 months prior to TIPS from year 2005 - 2017; 2) Undergone TIPS at our institution; and 3) have follow-up data available for 90 days post-TIPS. Clinical data was extracted, including MELD score. At L3 vertebral body level, a previously validated fully automated AI algorithm was used to extract CT body composition skeletal-based and fat-based metrics including; skeletal muscle area (SMA), skeletal muscle index (SMI), skeletal muscle density (SMD), subcutaneous fat area (SFA), visceral fat area (VFA), visceral-to-subcutaneous fat ratio (VSR), and visceral fat index (VFI). Independent t-tests, univariate and multivariate logistic regression models, and ROC curve analysis were used to assess the association of those metrics with 90-day mortality post-TIPS and its performance as a complement to MELD score.

#### RESULTS

From 122 patients, 83 (68%) were male and 39 (32%) female with a mean age of 58.2 years[11.8]. 29 (23.8%) died within 90 days post-TIPS and were found to have a significantly higher MELD Score ( $p < 0.01$ ) and lower SMA ( $p < 0.01$ ), SMI ( $p = 0.02$ ), SFA ( $p < 0.01$ ), SFI ( $p = 0.02$ ), VFA ( $p < 0.01$ ) and VFI ( $p = 0.01$ ). Univariate logistic regression model demonstrated that most CT body composition metrics were significant predictors of 90-day mortality, including SMA (OR=0.9,  $p < 0.01$ ), SMI (OR=0.9,  $p = 0.04$ ), SFA (OR=0.9,  $p < 0.01$ ), VFA (OR=0.9,  $p < 0.01$ ), and VFI (OR =0.9,  $p = 0.03$ ). When adjusting for MELD score, the multivariable logistic regression model showed that SMA (OR=0.9,  $p < 0.01$ ), SMI (OR=0.9,  $p = 0.03$ ), SFI (OR=0.9,  $p = 0.05$ ) and VFA (OR =0.9,  $p = 0.02$ ) remained significant predictors of 90-day mortality. ROC curve analysis for MELD score generated an AUC of 0.76 while the addition of SMA, SFA and VFA significantly improved the predictive power of MELD in predicting 90-day mortality after TIPS (AUC 0.84,  $p = 0.03$ ).

#### CONCLUSION

Our study demonstrates that CT body composition metrics can predict 90-day mortality post-TIPS, and incorporating these metrics enhances the predictive performance of MELD Score. Although generalizability is limited to our study population, this research indicates that AI-based CT body composition may serve as a valuable tool for assessing patient risk during TIPS evaluation.

#### CLINICAL RELEVANCE/APPLICATION

AI-based CT body composition have a great potential in improving the current risk prediction models and identifying patients at risk of complications contributing to better clinical outcomes.

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## Abstract Archives of the RSNA, 2023

T3-SSIR02-3

### Correlation between Tumor Complexity Scoring Systems and Outcomes in Percutaneous Renal Cryoablation

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S501

Cristina Marrocchio, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the usefulness of currently available renal tumor complexity scores, i.e., PADUA, RENAL, and ABLATE, in predicting outcomes in patients who undergo percutaneous cryoablation (PCA).

#### METHODS AND MATERIALS

Patients who underwent PCA between 2012 and 2021 in our Institution for one or more clinically localized renal masses were included, regardless of histology. PCA was performed by two radiologists with 13 and 30 years of experience in interventional radiology, respectively. Pre-ablation CT was evaluated by 3 radiologists in consensus to determine PADUA, RENAL, and ABLATE scores for each lesion, which was classified as low-, moderate- or high-risk accordingly. The association between the scores and post-procedural complications was evaluated for all lesions. Correlation with oncologic outcomes, in terms of the rate of persistence or recurrence of treated tumors, was also assessed. Accuracy of scores was calculated using ROC analysis for complication rate and the cumulative incidence function for oncologic outcomes.

#### RESULTS

The cohort included 158 patients and 193 renal lesions (M:111; F:47, median age at PCA: 75y, range: 43-90) with a mean follow-up of  $27 \pm 24.9$  months. According to PADUA, 60 lesions were low-risk, 69 medium-risk, and 64 high-risk; according to RENAL, 75 were low-risk, 106 medium-risk, and 12 high-risk. Median ABLATE score was 6.5 (IQR: 4.5, 9). Complications were present in 58 lesions and none of the scores showed statistical correlation. AUC values were 0.54 (95%CI=0.45-0.62) for PADUA ( $p=0.4$ ), 0.46 (95%CI=0.37-0.55) for RENAL ( $p=0.4$ ), with no differences in subgroup analyses according to the risk category, and 0.55 (95%CI=0.46-0.63) for ABLATE ( $p=0.3$ ). Twenty-one patients had persistent or recurrent disease. No statistically significant difference was observed in the scores of each scoring system between lesions that persisted/recurred and lesions that did not recur.

#### CONCLUSION

None of the currently available scores are able to predict the risk of complications or persistence/recurrence of renal lesions after percutaneous cryoablation.

#### CLINICAL RELEVANCE/APPLICATION

Since current renal scores are not able to predict outcomes, the development of a new score dedicated to ablation procedures and able to successfully predict patients' outcomes is needed.

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## Abstract Archives of the RSNA, 2023

T3-SSIR02-4

### What Treatment Factors are Associated with Oncological Efficacy after MRI-guided Focused Ultrasound (MRgFUS) Focal Therapy of Prostate Cancer

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S501

Pejman Ghanouni, MD, PhD (*Presenter*) Medical Advisory Board, InSightec Ltd; Scientific Advisory Board, SonALASense

#### PURPOSE

A phase 2b multicenter trial assessed efficacy and safety of MRI-guided Focused Ultrasound (MRgFUS) as an alternative to radical therapy for MRI-visible, intermediate-risk Gleason Grade Group (GGG) 2 or 3 prostate cancer. Of 89 men with 24-month biopsy, 78 had no evidence of GGG =2 prostate cancer in the treated area [1]. Erectile function and urinary continence outcomes compared favorably to radical therapy [1]. This study presents a retrospective analysis to determine if patient selection or treatment factors are associated with oncologic efficacy of MRgFUS ablation.

#### METHODS AND MATERIALS

Oncologic efficacy was defined by the absence of clinically significant (GGG =2) cancer in the treatment zone on 24-month biopsy. Baseline patient, screening characteristics and treatment parameters, such as the ratio of ablated, or non-perfused volume (NPV), to MRI-visible lesion volume, and the ratio of NPV to total prostate volume (Figure 1), were analyzed to determine an association with oncologic efficacy. Impact of ablation on urinary and erectile functional outcomes was also assessed.

#### RESULTS

Comparing men with and without GGG =2 at 24-month biopsy revealed no difference in baseline characteristics such as patient age, PSA, prostate volume, or total and positive biopsies (Table 1). Overall, the mean lesion volume was 0.82 mL, and the mean non-perfused volume around the MRI-visible lesion was 27 mL. The volume of ablated prostate tissue encompassing the MRI-visible lesion volume (NPV/lesion volume) was twice as large in men without significant cancer on 24-month biopsy of the treated area compared to men with significant cancer. ( $p=0.018$ , Table 1). Figure 2 shows that oncologic efficacy increases as the ratio of NPV/lesion volume increases; however, NPV as a fraction of total prostate volume was not associated with oncologic efficacy (Table 1). Among men with new erectile dysfunction or severe urinary symptoms, there was no difference in NPV/lesion volume ratio ( $p=0.3$ ,  $p=0.8$ , respectively).

#### CONCLUSION

Insufficient ablation margin around the MRI-visible lesion was associated with the presence of clinically significant cancer at 24-month biopsy after focal MR guided focused ultrasound ablation. Adequate ablation volume is determined by extent of coverage around the MRI-visible lesion volume, not by the fraction of the prostate volume ablated. Importantly, ablating a larger volume of tissue around the MRI-visible lesion did not increase the risk of erectile or urinary dysfunction at 24 months.

#### CLINICAL RELEVANCE/APPLICATION

Focal therapy of prostate cancer must overcome MRI underestimation of tumor extent. A larger volume of ablated tissue relative to targeted tumor volume is associated with better oncologic outcome at 2 years post-ablation.

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## Abstract Archives of the RSNA, 2023

T3-SSIR02-5

### **Percutaneous Cryoablation of Clinical Stage I/II Breast Cancer in Patients with Omission of Surgical Axillary Staging**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S501

Jose Maria Oliver-Goldaracena (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To review the efficacy of percutaneous treatment of infiltrating breast cancer (BC) by ultrasound-guided cryoablation in patients with clinical stage I/II without indication for surgical axillary staging

#### **METHODS AND MATERIALS**

Patients with clinical stage I/II BC without indication for surgical axillary staging (SLNB or TAD) who were treated by ultrasound-guided cryoablation were collected from our files. Patients who had a minimum follow-up of 12 months were selected. The cryoablation devices used were the ICEfx Galil argon gas system (Boston Scientific, USA) and the ProSense liquid nitrogen system (IceCure Medical Ltd, Caesarea, Israel). The "triple phase" protocol was applied: freezing, thaw and freezing. The duration of each phase was 10 minutes. The ultrasound follow up were: the first between 1-2 months (to assess residual lesions due to incomplete treatment) and subsequently every six months (to assess recurrences). Residual lesions and recurrences were confirmed with CNB and in all cases treatment with new (salvage) cryoablation was considered. The efficacy of the procedure was assessed on local control in the breast.

#### **RESULTS**

Between March 2019 and April 2023, 105 patients with 117 BC in clinical stage I/II with omission of surgical axillary staging were treated with ultrasound-guided cryoablation. The inclusion criteria of the retrospective study were met by 54 patients (58-96 years, mean 83, SD  $\pm$  7,64) with 61 BC (between 5-60mm, mean 17, SD  $\pm$ 13,75) who were followed during a mean period of 22 months (between 12-49 months). There were four patients with incomplete treatment and eight patients relapsed (between 9-27 months, mean 17). All were treated with salvage cryoablation. Local control at 12 months was 90.5% (probability 0.905 standard error 0.045) and in 94% of patients (51/54) the BC was locally controlled. Six patients died, three due to progression of the BC and three due to other causes. All procedures were well tolerated and there were no serious complications.

#### **CONCLUSION**

Ultrasound-guided cryoablation is an effective percutaneous treatment for the local control of BC in patients with clinical stage I/II with omission of surgical axillary staging.

#### **CLINICAL RELEVANCE/APPLICATION**

Cryoablation is effective in the local control of breast carcinoma in patients with stage I/II without indication for surgical axillary staging and opens the possibility of percutaneous management of breast cancer in this group of patients, changing the paradigm of surgery as treatment of choice.

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## Abstract Archives of the RSNA, 2023

T3-SSIR02-6

### Keynote Speaker

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S501

Gustavo V. Andrade, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

T3-SSMK05

### Musculoskeletal Imaging (Spine)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E352

Gunnar K. Astrom, PhD (*Moderator*) Royalties, AprioMed AB  
Joshua M. Polster, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### T3-SSMK05-1 **AI-based Quantifications of Lumbar Spinal Canal Stenosis on MRI**

Sanja Bogdanovic, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To clinically validate a fully automated deep convolutional neural network (DCNN) for MRI-based quantifications of the lumbar spinal canal.

#### METHODS AND MATERIALS

This retrospective study included the lumbar spine MRI of 50 consecutive clinical patients (age  $57.9 \pm 17$  years, 21 females, 29 males). All MRI were performed on 1.5 (31 examinations) and 3 Tesla scanners (19 examinations) with heterogeneous imaging protocols. The DCNN performed segmentations of the thecal sac at the level of the intervertebral discs on axial T2-weighted sequences. Based on these segmentations, the anteroposterior (AP) and mediolateral (ML) distance and the area of the thecal sac were measured in a fully automated manner. Two fellowship-trained musculoskeletal radiologists performed the same measurements independently. One radiologist performed additional thecal sac segmentations. Statistics included one-sample t-tests, the intraclass correlation coefficient (ICC), Bland-Altman-Plots, and Dice-coefficients. Measurements of the radiologists were averaged for statistics due to high inter-reader agreement (ICC > 0.9 for all measurements). A p-value of = 0.5 was considered statistically significant.

#### RESULTS

The average measurements of the DCNN and the radiologists were  $192.1 \pm 76.0$  mm<sup>2</sup> vs.  $175.7 \pm 73.5$  mm<sup>2</sup> ( $p < 0.01$ ) for the area,  $12.8 \pm 3.3$  mm vs.  $12.2 \pm 3.3$  mm ( $p < 0.01$ ) for AP-distance, and  $19.6 \pm 4.2$  mm vs.  $19.7 \pm 4.2$  mm ( $p = 0.23$ ) for ML-distance, respectively. Significant differences in the measurements also existed in-between both radiologists for the area ( $p < 0.01$ ) and the ML distance ( $p < 0.01$ ) but not for the AP distance ( $p = 0.51$ ). The agreement between the DCNN and the radiologists showed an ICC of 0.97 for the area, 0.96 for the ap-distance, and 0.91 for the ML distance, while the inter-reader agreements between the radiologists were similar with 0.98, 0.96, and 0.90, respectively. Bland-Altman analysis between DCNN and radiologists showed a mean difference with limits of agreement of  $-16.4$  mm<sup>2</sup>  $\pm$   $18.6$  mm<sup>2</sup> for the area,  $0.6$  mm  $\pm$   $0.7$  mm for the AP-distance, and  $0.2$  mm  $\pm$   $3.5$  mm for the ML-distance. Comparisons of the thecal sac segmentations between the DCNN and the radiologist showed a mean Dice-coefficient of 0.925 (95% CI: 0.916 to 0.935).

#### CONCLUSION

A fully automated DCNN achieves high agreements with experienced radiologists for segmentations and quantifications of the lumbar spinal canal. Small differences in the absolute measurements may be within clinically acceptable limits.

#### CLINICAL RELEVANCE/APPLICATION

Artificial intelligence support with human-level performance may aid radiologists in mastering the steadily increasing workload in clinical practice, particularly in the often time-consuming assessments of frequently performed lumbar spine MRI.

#### T3-SSMK05-2 **Magnetic Resonance Imaging Analysis of Redundant Nerve Roots of the Cauda Equina in Lumbar Central Canal Stenosis: Correlation with Clinical Significance**

Seyoung Ko, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate magnetic resonance imaging (MRI) findings associated with redundant nerve roots of the cauda equina (RNRCEs) in patients with lumbar spinal canal stenosis and whether the presence or type of RNRCEs affects the degree of symptoms or prognosis according to treatment methods.

## METHODS AND MATERIALS

Between January 2017 and December 2018, radiological records were searched, and 224 patients (139 females, 85 males, mean age: 69.19 years [40-91 years]) demonstrating moderate-to-severe stenosis of the spinal canal on MRI were included. On lumbar spine MRI, we investigated the number of spinal canal stenoses, disc herniation shape, the presence of ligamentum flavum thickening, facet joint degeneration, and prominent epidural fat at the stenosis level. We also evaluated the presence, level, type (normal, stretched, mild and moderate tortuosity, serpentine), length of RNRCEs, and presence of nerve root swelling. Clinically, the degree of symptoms and symptom changes after treatment were investigated. We used multinomial logistic regression for statistical analysis.

## RESULTS

RNRCEs were present in 142 (63.4%) and 170 patients (75.9%). Most RNRCEs were observed above the site of spinal canal stenosis (58.9%). The most common type of RNRCE was tortuous (mild: 21.4%; moderate: 34.4%). Of the 142 patients with modified RNRCEs, 89 (63%) showed nerve root redundancy over the length of two or more vertebral bodies. The swelling of nerve roots was observed in 73 patients (32.6%). RNRCE was associated with the number of stenoses and symptom duration ( $p < 0.05$ ). The presence, level, type, and length of RNRCE and nerve root swelling significantly affected the severity of symptoms ( $p < 0.05$ ). The treatment type influenced the changes in symptoms ( $p < 0.05$ ).

## CONCLUSION

The assessment of RNRCEs on spinal MRI is clinically important because the presence, level, type, and length of RNRCE may be associated with the degree of symptoms. In patients with RNRCEs, surgery might be helpful for improving symptoms.

## CLINICAL RELEVANCE/APPLICATION

RNRCEs characterized by the tortuosity of elongated and enlarged nerve roots in the subarachnoid space of the lumbar spine. We investigated whether the presence or type of RNRCE affects the degree of symptoms or prognosis according to the treatment methods.

## T3-SSMK05-3 Total Versus Localized Spine Magnetic Resonance Imaging (MRI) Utilization Traced Over a Decade in a Cohort of Emergency Department Patients

Katelyn E. Rudisill, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Spine magnetic resonance imaging (MRI) is increasingly considered for emergency department (ED) patients. These can be localized to defined regions of the spine (typically higher resolution and shorter studies) or be of the total spine (typically lower resolution and longer studies). The current study aimed to assess trends in localized versus total spine MRIs for patients in the ED over a decade.

## METHODS AND MATERIALS

The 2010 to 2021 M151Ortho PearlDiver dataset was used to identify patients who presented to the emergency department (ED) who received a spine MRI. Such MRIs were categorized as localized MRI (cervical, thoracic, lumbar, cervical and thoracic, or thoracic and lumbar) or total spine. Patient characteristics were then defined, including age, sex, Elixhauser Comorbidity Index (ECI), insurance, geographic region, and diagnosis (trauma/infection/neoplasm or degenerative/other). These characteristics were compared with univariate and multivariate analyses.

## RESULTS

Of 275,999 patients in the ED who received a spinal MRI, localized MRI was performed for 93.2%, and total spine MRI was performed for 6.8%. Over the years of the study, total spine MRIs increased from 4.85% of MRIs completed in 2010 to 12.38% in 2021 (significant increase with  $p < 0.0001$ , Figure 1). Independent predictive factors for receiving a total spine MRI for patients in the ED included younger age (odds ratio [OR] 1.47 per decade decrease), male sex (OR 1.21), higher ECI (OR 1.38), region of the country (relative to South, West OR 1.32), insurance (relative to Commercial, Medicare OR 1.10 and Medicaid OR 1.23) and diagnosis (relative to Degenerative/Other, Trauma/Infection/Neoplasm OR 1.30) with  $p < 0.0001$  for each.

## CONCLUSION

Of those patients getting spine MRIs, total spine MRIs constitute an increasing percentage of the studies over the years. The current study found an increase in total spine MRI use over a decade for patients presenting to the ED, revealing evolving imaging ordering processes that may not reflect best clinical practice. Several predictive factors for patients receiving a total

spine MRI versus a localized spine MRI were identified, suggesting certain patients may be viewed to be more clinically favorable for total spine imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

Indications for ordering a total spine MRI versus a localized spine MRI should be clearly defined to facilitate appropriate imaging and reduce healthcare expenditures where possible.

### **T3-SSMK05-4 Deep Learning to Predict Morbidity and Mortality from Spine Dual-energy Absorptiometry (DXA) Images**

Alex Cheng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Chronological age does not reflect the rate of “biological aging”. Image-based estimates of age may more accurately assess underlying aging processes and improve risk assessment. Spinal dual-energy absorptiometry (DXA) is routinely used for osteoporosis screening; however, these images may contain additional information beyond bone mineral density to measure biologic aging. The aim of this study was to test whether deep learning can estimate biological age from DXA and whether this measure was associated with cardiovascular disease and all-cause mortality.

#### **METHODS AND MATERIALS**

A convolutional neural network was developed to produce “Spinal-Age” using lateral and lumbar spine DXA from 44,638 UK Biobank participants, an observational study of volunteers in the UK. The primary outcome was a composite of incident myocardial infarction, stroke, and all-cause mortality over median 2.68 years of follow-up. The model was validated in 8,951 UK Biobank participants not used for model development. Cox proportional hazards regression and Kaplan-Meier curves assessed model performance adjusted for sex, smoking status, BMI, bone mineral density (BMD), Townsend deprivation index, and Charlson Comorbidity Index. Comorbidities were assessed using international classification of disease (ICD 10) codes.

#### **RESULTS**

The testing set contained 8,951 individuals, mean age 65.1±7.8 years with 48.1% men. The primary outcome was seen in 2.8% of participants. Spinal-Age was strongly associated with chronologic age ( $r = 0.66$ ); to avoid collinearity, results are presented stratified by age. For participants over 65 years, a 1-year increase in spinal age was associated with the composite outcome (unadjusted HR 1.07 (1.04,1.10),  $p < 0.001$ ; adjusted HR 1.05 (1.01,1.09),  $p=0.008$ ). Similar results were seen in participants under 65 (unadjusted HR 1.14 (1.07,1.21),  $p < 0.001$ ; adjusted HR 1.08 (1.01,1.16),  $p=0.03$ ). In adjusted phenome-wide association analyses, higher spinal age was associated with prevalent and incident hypertension, diabetes, ischemic heart disease and atherosclerosis (all corrected  $p < 0.05$ ).

#### **CONCLUSION**

A deep learning-based estimate of biologic age from spinal DXA was associated with all-cause mortality and cardiovascular events, beyond prevalent risk factors and spinal BMD.

#### **CLINICAL RELEVANCE/APPLICATION**

Spinal DXA are a common test, routinely administered for osteoporosis screening. The Spinal-Age score may enable opportunistic screening for other age-related diseases.

### **T3-SSMK05-5 Illuminating Metastases: Advancing Vertebral Bone Lesion Detection in using Temporal Subtraction CT**

Martin Segeroth (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To improve the detection of bone metastases, this study implemented a user friendly temporal subtraction method and assessed its effectiveness in detecting vertebral bone metastases in the lumbar spine. The goal was to improve radiologist detection rates and efficiency for bone lesions in serial follow-up CT scans.

#### **METHODS AND MATERIALS**

Automated segmentation algorithms were used to produce temporal subtraction (TS) images, which were evaluated on 40 paired CT examinations of patients with vertebral metastases and 34 paired controls. Definitive diagnosis of bone metastases was determined on the basis of a following MRI evaluated by an experienced board certified MSK radiologist. Temporal increases and decreases of the HU values were visualized on three plane reconstructions with adjustable colour scale. The presence and progression of vertebral metastases were evaluated independently by comparing serial CT examinations both with and without additional TS map. The readings were carried out by a board-certified radiologist and a radiology resident (3 years of experience) with an interval of at least 14 days. Lesion-based sensitivity was calculated. Reading time was recorded and compared. Significance of these values was tested with the Ranksum test.

## **RESULTS**

The study showed that the lesion-based sensitivity for detecting vertebral metastases increased with an additional TS image with an increase of 18 % for the radiology resident (0.542; 0.639) and 0.5 % increase for the board-certified radiologist (0.569; 0.572). Detection sensitivity for stationary or progressive changes increased by 16 % for the radiology resident with additional TS maps (0.661; 0.768), but decreased by 1 % for the board-certified radiologist (0.696; 0.689). The average reading time was reduced with additional CT-TS images, although not significantly (87 s vs. 81 s,  $P = .422$ ).

## **CONCLUSION**

Temporal subtraction enables an improvement in the diagnosis of vertebral metastases, especially for inexperienced radiologists.

## **CLINICAL RELEVANCE/APPLICATION**

Improved detection of bone metastases can facilitate early diagnosis, leading to better patient outcomes.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSMK05-1

### AI-based Quantifications of Lumbar Spinal Canal Stenosis on MRI

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E352

Sanja Bogdanovic, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To clinically validate a fully automated deep convolutional neural network (DCNN) for MRI-based quantifications of the lumbar spinal canal.

#### METHODS AND MATERIALS

This retrospective study included the lumbar spine MRI of 50 consecutive clinical patients (age  $57.9 \pm 17$  years, 21 females, 29 males). All MRI were performed on 1.5 (31 examinations) and 3 Tesla scanners (19 examinations) with heterogeneous imaging protocols. The DCNN performed segmentations of the thecal sac at the level of the intervertebral discs on axial T2-weighted sequences. Based on these segmentations, the anteroposterior (AP) and mediolateral (ML) distance and the area of the thecal sac were measured in a fully automated manner. Two fellowship-trained musculoskeletal radiologists performed the same measurements independently. One radiologist performed additional thecal sac segmentations. Statistics included one-sample t-tests, the intraclass correlation coefficient (ICC), Bland-Altman-Plots, and Dice-coefficients. Measurements of the radiologists were averaged for statistics due to high inter-reader agreement (ICC > 0.9 for all measurements). A p-value of = 0.5 was considered statistically significant.

#### RESULTS

The average measurements of the DCNN and the radiologists were  $192.1 \pm 76.0$  mm<sup>2</sup> vs.  $175.7 \pm 73.5$  mm<sup>2</sup> ( $p < 0.01$ ) for the area,  $12.8 \pm 3.3$  mm vs.  $12.2 \pm 3.3$  mm ( $p < 0.01$ ) for AP-distance, and  $19.6 \pm 4.2$  mm vs.  $19.7 \pm 4.2$  mm ( $p = 0.23$ ) for ML-distance, respectively. Significant differences in the measurements also existed in-between both radiologists for the area ( $p < 0.01$ ) and the ML distance ( $p < 0.01$ ) but not for the AP distance ( $p = 0.51$ ). The agreement between the DCNN and the radiologists showed an ICC of 0.97 for the area, 0.96 for the ap-distance, and 0.91 for the ML distance, while the inter-reader agreements between the radiologists were similar with 0.98, 0.96, and 0.90, respectively. Bland-Altman analysis between DCNN and radiologists showed a mean difference with limits of agreement of  $-16.4$  mm<sup>2</sup>  $\pm$   $18.6$  mm<sup>2</sup> for the area,  $0.6$  mm  $\pm$   $0.7$  mm for the AP-distance, and  $0.2$  mm  $\pm$   $3.5$  mm for the ML-distance. Comparisons of the thecal sac segmentations between the DCNN and the radiologist showed a mean Dice-coefficient of 0.925 (95% CI: 0.916 to 0.935).

#### CONCLUSION

A fully automated DCNN achieves high agreements with experienced radiologists for segmentations and quantifications of the lumbar spinal canal. Small differences in the absolute measurements may be within clinically acceptable limits.

#### CLINICAL RELEVANCE/APPLICATION

Artificial intelligence support with human-level performance may aid radiologists in mastering the steadily increasing workload in clinical practice, particularly in the often time-consuming assessments of frequently performed lumbar spine MRI.

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## Abstract Archives of the RSNA, 2023

T3-SSMK05-2

### Magnetic Resonance Imaging Analysis of Redundant Nerve Roots of the Cauda Equina in Lumbar Central Canal Stenosis: Correlation with Clinical Significance

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E352

Seyoung Ko, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate magnetic resonance imaging (MRI) findings associated with redundant nerve roots of the cauda equina (RNRCEs) in patients with lumbar spinal canal stenosis and whether the presence or type of RNRCEs affects the degree of symptoms or prognosis according to treatment methods.

#### METHODS AND MATERIALS

Between January 2017 and December 2018, radiological records were searched, and 224 patients (139 females, 85 males, mean age: 69.19 years [40-91 years]) demonstrating moderate-to-severe stenosis of the spinal canal on MRI were included. On lumbar spine MRI, we investigated the number of spinal canal stenoses, disc herniation shape, the presence of ligamentum flavum thickening, facet joint degeneration, and prominent epidural fat at the stenosis level. We also evaluated the presence, level, type (normal, stretched, mild and moderate tortuosity, serpentine), length of RNRCEs, and presence of nerve root swelling. Clinically, the degree of symptoms and symptom changes after treatment were investigated. We used multinomial logistic regression for statistical analysis.

#### RESULTS

RNRCEs were present in 142 (63.4%) and 170 patients (75.9%). Most RNRCEs were observed above the site of spinal canal stenosis (58.9%). The most common type of RNRCE was tortuous (mild: 21.4%; moderate: 34.4%). Of the 142 patients with modified RNRCEs, 89 (63%) showed nerve root redundancy over the length of two or more vertebral bodies. The swelling of nerve roots was observed in 73 patients (32.6%). RNRCE was associated with the number of stenoses and symptom duration ( $p < 0.05$ ). The presence, level, type, and length of RNRCE and nerve root swelling significantly affected the severity of symptoms ( $p < 0.05$ ). The treatment type influenced the changes in symptoms ( $p < 0.05$ ).

#### CONCLUSION

The assessment of RNRCEs on spinal MRI is clinically important because the presence, level, type, and length of RNRCE may be associated with the degree of symptoms. In patients with RNRCEs, surgery might be helpful for improving symptoms.

#### CLINICAL RELEVANCE/APPLICATION

RNRCEs characterized by the tortuosity of elongated and enlarged nerve roots in the subarachnoid space of the lumbar spine. We investigated whether the presence or type of RNRCE affects the degree of symptoms or prognosis according to the treatment methods.

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## Abstract Archives of the RSNA, 2023

T3-SSMK05-3

### Total Versus Localized Spine Magnetic Resonance Imaging (MRI) Utilization Traced Over a Decade in a Cohort of Emergency Department Patients

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E352

Katelyn E. Rudisill, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Spine magnetic resonance imaging (MRI) is increasingly considered for emergency department (ED) patients. These can be localized to defined regions of the spine (typically higher resolution and shorter studies) or be of the total spine (typically lower resolution and longer studies). The current study aimed to assess trends in localized versus total spine MRIs for patients in the ED over a decade.

#### METHODS AND MATERIALS

The 2010 to 2021 M151Ortho PearlDiver dataset was used to identify patients who presented to the emergency department (ED) who received a spine MRI. Such MRIs were categorized as localized MRI (cervical, thoracic, lumbar, cervical and thoracic, or thoracic and lumbar) or total spine. Patient characteristics were then defined, including age, sex, Elixhauser Comorbidity Index (ECI), insurance, geographic region, and diagnosis (trauma/infection/neoplasm or degenerative/other). These characteristics were compared with univariate and multivariate analyses.

#### RESULTS

Of 275,999 patients in the ED who received a spinal MRI, localized MRI was performed for 93.2%, and total spine MRI was performed for 6.8%. Over the years of the study, total spine MRIs increased from 4.85% of MRIs completed in 2010 to 12.38% in 2021 (significant increase with  $p < 0.0001$ , Figure 1). Independent predictive factors for receiving a total spine MRI for patients in the ED included younger age (odds ratio [OR] 1.47 per decade decrease), male sex (OR 1.21), higher ECI (OR 1.38), region of the country (relative to South, West OR 1.32), insurance (relative to Commercial, Medicare OR 1.10 and Medicaid OR 1.23) and diagnosis (relative to Degenerative/Other, Trauma/Infection/Neoplasm OR 1.30) with  $p < 0.0001$  for each.

#### CONCLUSION

Of those patients getting spine MRIs, total spine MRIs constitute an increasing percentage of the studies over the years. The current study found an increase in total spine MRI use over a decade for patients presenting to the ED, revealing evolving imaging ordering processes that may not reflect best clinical practice. Several predictive factors for patients receiving a total spine MRI versus a localized spine MRI were identified, suggesting certain patients may be viewed to be more clinically favorable for total spine imaging.

#### CLINICAL RELEVANCE/APPLICATION

Indications for ordering a total spine MRI versus a localized spine MRI should be clearly defined to facilitate appropriate imaging and reduce healthcare expenditures where possible.

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## Abstract Archives of the RSNA, 2023

T3-SSMK05-4

### Deep Learning to Predict Morbidity and Mortality from Spine Dual-energy Absorptiometry (DXA) Images

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E352

Alex Cheng (*Presenter*) Nothing to Disclose

#### PURPOSE

Chronological age does not reflect the rate of “biological aging”. Image-based estimates of age may more accurately assess underlying aging processes and improve risk assessment. Spinal dual-energy absorptiometry (DXA) is routinely used for osteoporosis screening; however, these images may contain additional information beyond bone mineral density to measure biologic aging. The aim of this study was to test whether deep learning can estimate biological age from DXA and whether this measure was associated with cardiovascular disease and all-cause mortality.

#### METHODS AND MATERIALS

A convolutional neural network was developed to produce “Spinal-Age” using lateral and lumbar spine DXA from 44,638 UK Biobank participants, an observational study of volunteers in the UK. The primary outcome was a composite of incident myocardial infarction, stroke, and all-cause mortality over median 2.68 years of follow-up. The model was validated in 8,951 UK Biobank participants not used for model development. Cox proportional hazards regression and Kaplan-Meier curves assessed model performance adjusted for sex, smoking status, BMI, bone mineral density (BMD), Townsend deprivation index, and Charlson Comorbidity Index. Comorbidities were assessed using international classification of disease (ICD 10) codes.

#### RESULTS

The testing set contained 8,951 individuals, mean age  $65.1 \pm 7.8$  years with 48.1% men. The primary outcome was seen in 2.8% of participants. Spinal-Age was strongly associated with chronologic age ( $r = 0.66$ ); to avoid collinearity, results are presented stratified by age. For participants over 65 years, a 1-year increase in spinal age was associated with the composite outcome (unadjusted HR 1.07 (1.04,1.10),  $p < 0.001$ ; adjusted HR 1.05 (1.01,1.09),  $p=0.008$ ). Similar results were seen in participants under 65 (unadjusted HR 1.14 (1.07,1.21),  $p < 0.001$ ; adjusted HR 1.08 (1.01,1.16),  $p=0.03$ ). In adjusted phenome-wide association analyses, higher spinal age was associated with prevalent and incident hypertension, diabetes, ischemic heart disease and atherosclerosis (all corrected  $p < 0.05$ ).

#### CONCLUSION

A deep learning-based estimate of biologic age from spinal DXA was associated with all-cause mortality and cardiovascular events, beyond prevalent risk factors and spinal BMD.

#### CLINICAL RELEVANCE/APPLICATION

Spinal DXA are a common test, routinely administered for osteoporosis screening. The Spinal-Age score may enable opportunistic screening for other age-related diseases.

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## Abstract Archives of the RSNA, 2023

T3-SSMK05-5

### **Illuminating Metastases: Advancing Vertebral Bone Lesion Detection in using Temporal Subtraction CT**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E352

Martin Segeroth (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To improve the detection of bone metastases, this study implemented a user friendly temporal subtraction method and assessed its effectiveness in detecting vertebral bone metastases in the lumbar spine. The goal was to improve radiologist detection rates and efficiency for bone lesions in serial follow-up CT scans.

#### **METHODS AND MATERIALS**

Automated segmentation algorithms were used to produce temporal subtraction (TS) images, which were evaluated on 40 paired CT examinations of patients with vertebral metastases and 34 paired controls. Definitive diagnosis of bone metastases was determined on the basis of a following MRI evaluated by an experienced board certified MSK radiologist. Temporal increases and decreases of the HU values were visualized on three plane reconstructions with adjustable colour scale. The presence and progression of vertebral metastases were evaluated independently by comparing serial CT examinations both with and without additional TS map. The readings were carried out by a board-certified radiologist and a radiology resident (3 years of experience) with an interval of at least 14 days. Lesion-based sensitivity was calculated. Reading time was recorded and compared. Significance of these values was tested with the Ranksum test.

#### **RESULTS**

The study showed that the lesion-based sensitivity for detecting vertebral metastases increased with an additional TS image with an increase of 18 % for the radiology resident (0.542; 0.639) and 0.5 % increase for the board-certified radiologist (0.569; 0.572). Detection sensitivity for stationary or progressive changes increased by 16 % for the radiology resident with additional TS maps (0.661; 0.768), but decreased by 1 % for the board-certified radiologist (0.696; 0.689). The average reading time was reduced with additional CT-TS images, although not significantly (87 s vs. 81 s,  $P = .422$ ).

#### **CONCLUSION**

Temporal subtraction enables an improvement in the diagnosis of vertebral metastases, especially for inexperienced radiologists.

#### **CLINICAL RELEVANCE/APPLICATION**

Improved detection of bone metastases can facilitate early diagnosis, leading to better patient outcomes.

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## Abstract Archives of the RSNA, 2023

T3-SSMK06

### Musculoskeletal Imaging (Infection, Trauma and Fractures)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E351

Jorge A. Vidal, MD (*Moderator*) Nothing to Disclose  
Jade A. Anderson, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### T3-SSMK06-1 **Fast Imaging for Osteomyelitis using an Isotropic 3D T1-weighted Sequence**

Patrick Debs, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic performance of a 3D T1-weighted sequence with isotropic voxel size to that of a 2D T1-weighted conventional sequence for the detection of osteomyelitis (OM) of the foot.

#### METHODS AND MATERIALS

In this retrospective, HIPAA compliant study of 130 people who underwent 3T MRI of the foot for suspected OM including both 3DT1 (CAIPIRINHA SPACE TSE) and three-plane 2DT1 (TSE) sequences, two readers evaluated imaging in two sessions (3DT1 with fluid-sensitive sequences, 2DT1 with fluid-sensitive sequences). Readers recorded the presence/absence of a hypointense signal, its dimension and its margins (poorly-defined, mixed definition, well-defined) on T1-weighted sequences. Readers also recorded the presence/absence of periostitis, cortex or joint extension, neurovascular involvement, adjacent skin ulcerations or sinus tracts, and T2 hyperintensity in marrow and adjacent soft tissues before giving an overall diagnosis of OM as positive, negative or inconclusive with each session. Acquisition times for 3DT1 and 2DT1 were recorded. Imaging results were compared to the gold standard (bone biopsy or treatment-proof). Wilcoxon-Signed rank test, paired student's t-test, and McNemar's test were used for analysis.

#### RESULTS

There were 76/130 (58.5 %) cases of clinically-proven OM in the phalanges (60/130, 46.2%), the metatarsals (47/130, 36.2%) and the calcaneus (29/130, 22.3%). Differences existed in the presence of T1 hypointensity (70/130 (3D) vs 42/130 (2D)), dimension of T1 abnormality (1.9 cm (3D) vs 1.6 cm (2D)), and skin ulceration (101/130 (3D) vs 83/130 (2D)) ( $P=0.006$ , 0.017, and 0.000 respectively). There were no differences between 3D and 2D sequences for margin, periostitis, cortex/joint extension, neurovascular involvement, sinus tracts, and T2 hyperintense signal in marrow/soft tissues ( $P>0.05$ ). The imaging diagnosis reported by readers did not differ between sessions ( $P=0.572$ ), and the sensitivity of 3DT1 was equivalent to 2DT1 (90%). The acquisition time for three-plane 2DT1 imaging was substantially longer than for a 3DT sequence (571.5 sec vs 235 sec respectively).

#### CONCLUSION

An accelerated 3D CAIPIRINHA SPACE T1 sequence provides a fast technique with comparable diagnostic performance to 2DT1 MRI when evaluating suspected OM of the foot.

#### CLINICAL RELEVANCE/APPLICATION

For OM of the foot, isotropic volume acquisitions and multiplanar reformation capabilities of 3DT1 imaging obviate the need for 2DT1 acquisitions in multiple planes.

#### T3-SSMK06-2 **Diffusion Weighted MR Imaging Added to Conventional MRI Exhibits Superior Accuracy in Foot and Ankle Osteomyelitis than Conventional MRI Alone with Surgical Histopathology as the Reference Standard: A Prospective Study**

Shamrez Haider, BS (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this prospective study was to evaluate if the inclusion of diffusion-weighted-imaging (DWI) in foot and ankle MRI protocol improves accuracy of determination of osteomyelitis (OM) with histopathology as the reference standard.

## METHODS AND MATERIALS

An Institutional Review Board approved American Diabetic association sponsored prospective study of patients with suspected OM of the foot and ankle. After informed consent, all patients underwent pre-operative multiparametric MRI and surgical biopsy of the region of interest (ROI). Two musculoskeletal fellowship trained radiologists determined OM in two separate settings with and without DWI, blinded to the final results. Presence of OM and mean ADC (apparent diffusion coefficient) of affected bone and adjacent normal bone were obtained using free hand ROI. Sensitivities and specificities of conventional MRI (cMRI) and DWI+MRI (dMRI) were calculated. Significance was set at  $p < 0.05$ .

## RESULTS

47 recruited patients with mean BMI of  $29.8 (\pm 3.7)$ - 33 males (70%) and 14 females (30%) with histopathology (HPE) and dMRI available were included, including 6/47 (13%) with Charcot arthropathy and 46/47 (98%) with diabetes mellitus. 26/47 (55%) were HPE positive OM while 21/47 (45%) were negative. Conventional MRI showed sensitivity, specificity, positive predictive, and negative predictive values of 80.8%, 47.6%, 65.6% and 66.7%. for detection of OM, respectively. Corresponding results for dMRI were higher at 84.62%, 85.71%, 88% and 81.82%, respectively ( $psen=0.317$ ,  $pspe=0.005$ ). The mean ADC values of HPE positive OM ( $1.381 \pm 0.511$ ) were significantly higher than HPE negative patients ( $0.976 \pm 0.552$ ) ( $p = 0.013$ ). There was no difference in mean ADC of normal adjacent bone for both HPE positive OM ( $0.371 \pm 0.151$ ) and HPE negative patients ( $0.470 \pm 0.295$ ) ( $p=0.175$ ). For both HPE positive OM and negative OM, there were significantly greater mean ADCs than the adjacent normal bones ( $0.731 \pm 0.151$ ) ( $p < 0.001$ ) and ( $0.470 \pm 0.295$ ) ( $p=0.001$ ), respectively. Inter-reader reliability was determined with intraclass coefficient (ICC) on cMRI of 0.68 (0.54, 0.82) for OM presence. ICC on dMRI was 0.74 (0.62, 0.86) for OM presence.

## CONCLUSION

The results of this prospective evaluation confirm that DWI adds incremental value over conventional MRI for the diagnosis of OM in increasing its diagnostic accuracy.

## CLINICAL RELEVANCE/APPLICATION

Prompt non-invasive and accurate diagnostic evaluation of suspected OM is critical for successful management of foot and ankle OM. DWI can be added to infection MRI protocols to aid in the diagnosis of OM.

## T3-SSMK06-3 Fluoroscopic-guided Aspiration of the Acutely Dislocated Total Hip Arthroplasty: A Feasible, High Yield and Safe Procedure

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To determine the feasibility, yield and safety of fluoroscopy-guided aspiration of the acutely dislocated total hip arthroplasty (THA).

## METHODS AND MATERIALS

IRB approved, retrospective review of fluoroscopic-guided aspirations of acutely dislocated THA between 2005 - 2022 at an adult academic hospital was performed. Data from electronic medical records and fluoroscopy images/reports included patient demographics, dislocation direction, whether spontaneous aspirate or saline rinse was obtained, fluoroscopy time and complications (bleeding or neuropraxia). Positive yield was defined as successful spontaneous aspirate or saline rinse adequate for microbiology analysis. Subanalysis by needle target site (femoral neck or acetabular cup) was performed for spontaneous aspiration rate, aspirate volume and fluoroscopy time. Differences between groups were analyzed with unpaired, 2-tailed t-test and between proportions with Fisher's exact test, with significance set at  $p < 0.05$ .

## RESULTS

20 hips (12 left, 8 right) in 19 patients (12F,7M) with mean age (SD, range) of 73 years (16, 37-94) underwent fluoroscopic-guided aspiration of a THA acutely dislocated in either the posterior (11/20), lateral (8/20) or anterior (1/20) directions. Aspirations targeted the femoral neck in 55% (11/20) or acetabular cup in 45% (9/20) of cases. Positive yield was obtained in 95% (19/20) of procedures, with spontaneous aspirate in 75% (15/20) and saline rinse in 20% (4/20) of cases; in 5% (1/20) neither aspirate nor saline rinse was obtained. For spontaneous aspirate, the mean volume (SD, range) was 8.3mL (6.9, 0.2-25), and when subdivided by needle target, significantly higher for the acetabular cup 11.2mL (6.9, 5-25) vs. the femoral neck 4.0mL (4.4, 0.2-12) [ $p=0.026$ ]. The rate of spontaneous aspiration based on needle target was significantly higher for the acetabular cup 100% (9/9) vs. the femoral neck 55% (6/11) [ $p=0.038$ ]. The mean fluoroscopy time (SD, range) for all cases was 43s (25, 19-102), and when subdivided by needle target site was significantly shorter for the acetabular cup 32s (16, 19-75) vs. the femoral neck 56s (28, 28-102) [ $p=0.034$ ]. No immediate complications of bleeding or neuropraxia occurred in any of the 20 aspirations.



## CONCLUSION

Fluoroscopic-guided aspiration of the acutely dislocated THA is a feasible, high yielding and safe procedure. Targeting the acetabular cup results in higher rate of spontaneous aspiration, larger aspiration volume and lower fluoroscopy time compared to the femoral neck.

## CLINICAL RELEVANCE/APPLICATION

Although the acutely dislocated THA results in distortion of landmarks and displacement of anatomic structures, radiologists can safely aspirate the prosthetic joint under fluoroscopic guidance with high yield.

### T3-SSMK06-4 **Dual-Energy CT-derived Bone Mineral Density Assessment Predicts the Risk to Sustain Osteoporotic Fractures**

Scherwin Mahmoudi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the association and predictive value of dual-energy CT (DECT)-derived bone mineral density (BMD) assessment with the occurrence of acute insufficiency fractures of the spine and follow-up fractures in a 2-year period.

#### METHODS AND MATERIALS

L1 of 160 patients (77 men, 83 women; mean age, 64.1 years, range, 19-94 years) who underwent dual-source DECT between 01/2016 and 12/2020 was retrospectively analyzed. For phantomless BMD assessment, a dedicated DECT postprocessing software based on material decomposition was manually applied. All depicted vertebrae were examined for signs of recent insufficiency fractures, and electronic health records were examined to obtain the incidence of osteoporotic fractures for a follow-up of 2 years after DECT. Receiver-operating characteristic (ROC) analysis was used to calculate AUC values, and logistic regression models were used to determine the associations of BMD, sex, and age with the occurrence of insufficiency fractures and follow-up fractures.

#### RESULTS

A DECT-derived BMD threshold of 120.40 mg/cm<sup>3</sup> yielded an AUC of 0.82 ( $p < .0001$ ) to identify patients with one or more insufficiency fractures of the spine, and a DECT-derived BMD cut-off of 93.70 mg/cm<sup>3</sup> yielded an AUC of 0.9373 (CI, 0.867-0.977,  $p < .001$ ) for the prediction of follow-up fractures within 2 years after DECT. A lower DECT-derived BMD was associated with an increased risk to sustain insufficiency fractures (Odds ratio of 0.93, 95% CI, 0.91-0.96,  $p < .001$ ) and follow-up fractures (Odds ratio of 0.8710, 95% CI, 0.091-0.9375,  $p < .001$ ), demonstrating a protective effect of increased DECT-derived BMD.

## CONCLUSION

Conclusion: Dual-energy CT-derived bone mineral density assessment from routine examinations can be used to stratify the risk of sustaining osteoporosis-associated fractures following acute trauma and during a follow-up period of 2 years.

## CLINICAL RELEVANCE/APPLICATION

We demonstrate the potential of dual-energy CT to extract bone mineral density measurements from routine examinations. This information can be used to stratify the risk of patients to sustain fractures and to start patients at risk on osteoporosis treatment without the requirement to perform additional examinations.

### T3-SSMK06-5 **Automated Detection of Multiple Fractures from X-Rays Using Multitask Deep Neural Network**

Huib Ruitenbeek, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

X-ray imaging is the primary diagnostic imaging technique utilized during the evaluation of suspected fractures in patients that visit emergency departments (EDs). However, missing fractures on radiographs may occur due to factors like imaging interpretation under stressful conditions in the EDs, the experience level of the readers and patient age. This might result in delayed treatment and poor prognosis. Computer-assisted detection (CAD) systems based on deep learning can help identify fractures from X-rays, which can serve as a reliable second opinion for clinicians. Furthermore, there is limited evidence that CAD can accurately diagnose fractures in actual clinical situations.

#### METHODS AND MATERIALS

From January 2019 to November 2022, 5489 X-ray scans, comprising of 1877 scans with fractures and 3612 scans without fractures, along with their respective clinical radiology reports, were included. The fractures detected were of different types, including Femur, Clavicle, Ankle, Wrist, and Hip. The X-ray scans were collected consecutively, and other abnormalities like osteosarcoma, osteochondroma, arthritis, and calcification were also identified in the radiology reports. A multitask deep neural network (MDNN) trained on 450,000 and tested on 150,000 X-rays was utilized to detect X-rays with and without



fractures. The standard performance evaluation metrics in terms of Area Under the Curve (AUC), True positive rate (TPR), False Positive Rate (FPR), and Average Precision (AP) were used to assess the performance of the MDNN.

## RESULTS

The MDNN achieved an overall AUC of 0.95 (C.I. 0.939 - 0.954), a TPR, TNR, and AP of 0.94 and 0.91 and 0.92, respectively. The AUC for detecting fractures in the femur, clavicle, ankle, wrist, and hip was 0.96 (C.I. 0.950 - 0.987), 0.94 (C.I. 0.927 - 0.961), 0.93 (C.I. 0.912 - 0.944), 0.93 (C.I. 0.907 - 0.945), and 0.95 (C.I. 0.924 - 0.968) respectively. The highest achieved TPR, TNR, and AP was 0.954 for the hip, 0.912 for the femur, and 0.971 for the clavicle. The MDNN attained a minimum of 0.926 >AUC, 0.882 >TPR, 0.847 >TNR, and 0.826 > AP for all body parts.

## CONCLUSION

The validation of the CAD is demonstrated in consecutive data with the presence of other comorbidities. The MDNN performed remarkably in detecting fractures in different body parts. The results obtained this dataset demonstrate the generalizability of CAD in real-world clinical settings.

## CLINICAL RELEVANCE/APPLICATION

The study showed that using CAD as an assistance tool can benefit high-workload healthcare facilities, especially in busy ERs, where patients might have different orthopedic conditions. The lack of trained radiologists in ER and the increasing number of fractures require reliable and accurate CAD for automated detection and reduce missed fractures.

## T3-SSMK06-6 Ultra High-resolution Photon-counting CT in Cadaveric Fracture Models: Spatial Frequency is Not Everything

Theresa Sophie Patzer, MD (*Presenter*) Nothing to Disclose

## PURPOSE

While studies confirm the advantages of photon-counting detector (PCD) CT over energy-integrating detector (EID) CT for the depiction of bone microarchitecture, the effect of convolutional kernel selection on the assessability of the appendicular skeleton in ultrahigh-resolution (UHR) mode has not been thoroughly evaluated thus far. Aiming to fill this research gap, the present study employed various cadaveric fracture models to investigate the impact of convolution kernel sharpness in potential trauma settings.

## METHODS AND MATERIALS

In total, sixteen cadaveric extremities (eight fractured) were examined with a standardized 120 kVp scan protocol (CTDIvol 10 mGy). In two cadaveric specimens, a board-certified trauma surgeon induced fractures of the distal radial bone, metacarpal bone, distal tibia, distal fibula, and metatarsal bone. Images were reconstructed with the sharpest non-UHR kernel (Br76) and all available UHR kernels (Br80 to Br96). Seven radiologists evaluated image quality and fracture assessability. Interrater agreement was assessed with the intraclass correlation coefficient. For quantitative comparisons, signal-to-noise-ratios (SNR) were calculated based on CT number measurements in standard ROIs.

## RESULTS

Subjective image quality was best for Br84 (median 1, interquartile range 1-3;  $p=0.003$ ). Regarding fracture assessability, no significant difference was ascertained between Br76, Br80 and Br84 ( $p>0.999$ ), with inferior ratings for all sharper kernels ( $p<0.001$ ). Interrater agreement for image quality (0.795, 0.732-0.848;  $p<0.001$ ) and fracture assessability (0.880; 0.842-0.911;  $p<0.001$ ) was good. SNR was highest for Br76 (3.4, 3.0-3.9) with no significant difference to Br80 and Br84 ( $p>0.999$ ). Br76 and Br80 produced higher SNR than all kernels sharper than Br84 ( $p=0.026$ ).

## CONCLUSION

PCD-CT reconstructions with a moderate UHR kernel offer superior image quality for visualizing the appendicular skeleton. Fracture assessability benefits from sharp non-UHR and moderate UHR kernels, while ultra-sharp reconstructions incur augmented image noise.

## CLINICAL RELEVANCE/APPLICATION

The tradeoff between noise and sharpness in PCD-CT appears to be optimal for moderate UHR kernels, allowing for detailed delineation of fine bone microarchitecture. Proper kernel selection aids depiction of the appendicular skeleton in trauma setting.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSMK06-1

### Fast Imaging for Osteomyelitis using an Isotropic 3D T1-weighted Sequence

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E351

Patrick Debs, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic performance of a 3D T1-weighted sequence with isotropic voxel size to that of a 2D T1-weighted conventional sequence for the detection of osteomyelitis (OM) of the foot.

#### METHODS AND MATERIALS

In this retrospective, HIPAA compliant study of 130 people who underwent 3T MRI of the foot for suspected OM including both 3DT1 (CAIPIRINHA SPACE TSE) and three-plane 2DT1 (TSE) sequences, two readers evaluated imaging in two sessions (3DT1 with fluid-sensitive sequences, 2DT1 with fluid-sensitive sequences). Readers recorded the presence/absence of a hypointense signal, its dimension and its margins (poorly-defined, mixed definition, well-defined) on T1-weighted sequences. Readers also recorded the presence/absence of periostitis, cortex or joint extension, neurovascular involvement, adjacent skin ulcerations or sinus tracts, and T2 hyperintensity in marrow and adjacent soft tissues before giving an overall diagnosis of OM as positive, negative or inconclusive with each session. Acquisition times for 3DT1 and 2DT1 were recorded. Imaging results were compared to the gold standard (bone biopsy or treatment-proof). Wilcoxon-Signed rank test, paired student's t-test, and McNemar's test were used for analysis.

#### RESULTS

There were 76/130 (58.5 %) cases of clinically-proven OM in the phalanges (60/130, 46.2%), the metatarsals (47/130, 36.2%) and the calcaneus (29/130, 22.3%). Differences existed in the presence of T1 hypointensity (70/130 (3D) vs 42/130 (2D)), dimension of T1 abnormality (1.9 cm (3D) vs 1.6 cm (2D)), and skin ulceration (101/130 (3D) vs 83/130 (2D)) ( $P=0.006$ ,  $0.017$ , and  $0.000$  respectively). There were no differences between 3D and 2D sequences for margin, periostitis, cortex/joint extension, neurovascular involvement, sinus tracts, and T2 hyperintense signal in marrow/soft tissues ( $P>0.05$ ). The imaging diagnosis reported by readers did not differ between sessions ( $P=0.572$ ), and the sensitivity of 3DT1 was equivalent to 2DT1 (90%). The acquisition time for three-plane 2DT1 imaging was substantially longer than for a 3DT sequence (571.5 sec vs 235 sec respectively).

#### CONCLUSION

An accelerated 3D CAIPIRINHA SPACE T1 sequence provides a fast technique with comparable diagnostic performance to 2DT1 MRI when evaluating suspected OM of the foot.

#### CLINICAL RELEVANCE/APPLICATION

For OM of the foot, isotropic volume acquisitions and multiplanar reformation capabilities of 3DT1 imaging obviate the need for 2DT1 acquisitions in multiple planes.

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## Abstract Archives of the RSNA, 2023

T3-SSMK06-2

### Diffusion Weighted MR Imaging Added to Conventional MRI Exhibits Superior Accuracy in Foot and Ankle Osteomyelitis than Conventional MRI Alone with Surgical Histopathology as the Reference Standard: A Prospective Study

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E351

Shamrez Haider, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this prospective study was to evaluate if the inclusion of diffusion-weighted-imaging (DWI) in foot and ankle MRI protocol improves accuracy of determination of osteomyelitis (OM) with histopathology as the reference standard.

#### METHODS AND MATERIALS

An Institutional Review Board approved American Diabetic association sponsored prospective study of patients with suspected OM of the foot and ankle. After informed consent, all patients underwent pre-operative multiparametric MRI and surgical biopsy of the region of interest (ROI). Two musculoskeletal fellowship trained radiologists determined OM in two separate settings with and without DWI, blinded to the final results. Presence of OM and mean ADC (apparent diffusion coefficient) of affected bone and adjacent normal bone were obtained using free hand ROI. Sensitivities and specificities of conventional MRI (cMRI) and DWI+MRI (dMRI) were calculated. Significance was set at  $p < 0.05$ .

#### RESULTS

47 recruited patients with mean BMI of  $29.8 (\pm 3.7)$ - 33 males (70%) and 14 females (30%) with histopathology (HPE) and dMRI available were included, including 6/47 (13%) with Charcot arthropathy and 46/47 (98%) with diabetes mellitus. 26/47 (55%) were HPE positive OM while 21/47 (45%) were negative. Conventional MRI showed sensitivity, specificity, positive predictive, and negative predictive values of 80.8%, 47.6%, 65.6% and 66.7%. for detection of OM, respectively. Corresponding results for dMRI were higher at 84.62%, 85.71%, 88% and 81.82%, respectively ( $psen=0.317$ ,  $pspe=0.005$ ). The mean ADC values of HPE positive OM ( $1.381 \pm 0.511$ ) were significantly higher than HPE negative patients ( $0.976 \pm 0.552$ ) ( $p = 0.013$ ). There was no difference in mean ADC of normal adjacent bone for both HPE positive OM ( $0.371 \pm 0.151$ ) and HPE negative patients ( $0.470 \pm 0.295$ ) ( $p=0.175$ ). For both HPE positive OM and negative OM, there were significantly greater mean ADCs than the adjacent normal bones ( $0.731 \pm 0.151$ ) ( $p < 0.001$ ) and ( $0.470 \pm 0.295$ ) ( $p=0.001$ ), respectively. Inter-reader reliability was determined with intraclass coefficient (ICC) on cMRI of 0.68 (0.54, 0.82) for OM presence. ICC on dMRI was 0.74 (0.62, 0.86) for OM presence.

#### CONCLUSION

The results of this prospective evaluation confirm that DWI adds incremental value over conventional MRI for the diagnosis of OM in increasing its diagnostic accuracy.

#### CLINICAL RELEVANCE/APPLICATION

Prompt non-invasive and accurate diagnostic evaluation of suspected OM is critical for successful management of foot and ankle OM. DWI can be added to infection MRI protocols to aid in the diagnosis of OM.

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## Abstract Archives of the RSNA, 2023

T3-SSMK06-3

### Fluoroscopic-guided Aspiration of the Acutely Dislocated Total Hip Arthroplasty: A Feasible, High Yield and Safe Procedure

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E351

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the feasibility, yield and safety of fluoroscopy-guided aspiration of the acutely dislocated total hip arthroplasty (THA).

#### METHODS AND MATERIALS

IRB approved, retrospective review of fluoroscopic-guided aspirations of acutely dislocated THA between 2005 - 2022 at an adult academic hospital was performed. Data from electronic medical records and fluoroscopy images/reports included patient demographics, dislocation direction, whether spontaneous aspirate or saline rinse was obtained, fluoroscopy time and complications (bleeding or neuropraxia). Positive yield was defined as successful spontaneous aspirate or saline rinse adequate for microbiology analysis. Subanalysis by needle target site (femoral neck or acetabular cup) was performed for spontaneous aspiration rate, aspirate volume and fluoroscopy time. Differences between groups were analyzed with unpaired, 2-tailed t-test and between proportions with Fisher's exact test, with significance set at  $p < 0.05$ .

#### RESULTS

20 hips (12 left, 8 right) in 19 patients (12F, 7M) with mean age (SD, range) of 73 years (16, 37-94) underwent fluoroscopic-guided aspiration of a THA acutely dislocated in either the posterior (11/20), lateral (8/20) or anterior (1/20) directions. Aspirations targeted the femoral neck in 55% (11/20) or acetabular cup in 45% (9/20) of cases. Positive yield was obtained in 95% (19/20) of procedures, with spontaneous aspirate in 75% (15/20) and saline rinse in 20% (4/20) of cases; in 5% (1/20) neither aspirate nor saline rinse was obtained. For spontaneous aspirate, the mean volume (SD, range) was 8.3mL (6.9, 0.2-25), and when subdivided by needle target, significantly higher for the acetabular cup 11.2mL (6.9, 5-25) vs. the femoral neck 4.0mL (4.4, 0.2-12) [ $p = 0.026$ ]. The rate of spontaneous aspiration based on needle target was significantly higher for the acetabular cup 100% (9/9) vs. the femoral neck 55% (6/11) [ $p = 0.038$ ]. The mean fluoroscopy time (SD, range) for all cases was 43s (25, 19-102), and when subdivided by needle target site was significantly shorter for the acetabular cup 32s (16, 19-75) vs. the femoral neck 56s (28, 28-102) [ $p = 0.034$ ]. No immediate complications of bleeding or neuropraxia occurred in any of the 20 aspirations.

#### CONCLUSION

Fluoroscopic-guided aspiration of the acutely dislocated THA is a feasible, high yielding and safe procedure. Targeting the acetabular cup results in higher rate of spontaneous aspiration, larger aspiration volume and lower fluoroscopy time compared to the femoral neck.

#### CLINICAL RELEVANCE/APPLICATION

Although the acutely dislocated THA results in distortion of landmarks and displacement of anatomic structures, radiologists can safely aspirate the prosthetic joint under fluoroscopic guidance with high yield.

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## Abstract Archives of the RSNA, 2023

T3-SSMK06-4

### Dual-Energy CT-derived Bone Mineral Density Assessment Predicts the Risk to Sustain Osteoporotic Fractures

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E351

Scherwin Mahmoudi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the association and predictive value of dual-energy CT (DECT)-derived bone mineral density (BMD) assessment with the occurrence of acute insufficiency fractures of the spine and follow-up fractures in a 2-year period.

#### METHODS AND MATERIALS

L1 of 160 patients (77 men, 83 women; mean age, 64.1 years, range, 19-94 years) who underwent dual-source DECT between 01/2016 and 12/2020 was retrospectively analyzed. For phantomless BMD assessment, a dedicated DECT postprocessing software based on material decomposition was manually applied. All depicted vertebrae were examined for signs of recent insufficiency fractures, and electronic health records were examined to obtain the incidence of osteoporotic fractures for a follow-up of 2 years after DECT. Receiver-operating characteristic (ROC) analysis was used to calculate AUC values, and logistic regression models were used to determine the associations of BMD, sex, and age with the occurrence of insufficiency fractures and follow-up fractures.

#### RESULTS

A DECT-derived BMD threshold of 120.40 mg/cm<sup>3</sup> yielded an AUC of 0.82 ( $p < .0001$ ) to identify patients with one or more insufficiency fractures of the spine, and a DECT-derived BMD cut-off of 93.70 mg/cm<sup>3</sup> yielded an AUC of 0.9373 (CI, 0.867-0.977,  $p < .001$ ) for the prediction of follow-up fractures within 2 years after DECT. A lower DECT-derived BMD was associated with an increased risk to sustain insufficiency fractures (Odds ratio of 0.93, 95% CI, 0.91-0.96,  $p < .001$ ) and follow-up fractures (Odds ratio of 0.8710, 95% CI, 0.091-0.9375,  $p < .001$ ), demonstrating a protective effect of increased DECT-derived BMD.

#### CONCLUSION

Conclusion: Dual-energy CT-derived bone mineral density assessment from routine examinations can be used to stratify the risk of sustaining osteoporosis-associated fractures following acute trauma and during a follow-up period of 2 years.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrate the potential of dual-energy CT to extract bone mineral density measurements from routine examinations. This information can be used to stratify the risk of patients to sustain fractures and to start patients at risk on osteoporosis treatment without the requirement to perform additional examinations.

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## Abstract Archives of the RSNA, 2023

T3-SSMK06-5

### Automated Detection of Multiple Fractures from X-Rays Using Multitask Deep Neural Network

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E351

Huib Ruitenbeek, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

X-ray imaging is the primary diagnostic imaging technique utilized during the evaluation of suspected fractures in patients that visit emergency departments (EDs). However, missing fractures on radiographs may occur due to factors like imaging interpretation under stressful conditions in the EDs, the experience level of the readers and patient age. This might result in delayed treatment and poor prognosis. Computer-assisted detection (CAD) systems based on deep learning can help identify fractures from X-rays, which can serve as a reliable second opinion for clinicians. Furthermore, there is limited evidence that CAD can accurately diagnose fractures in actual clinical situations.

#### METHODS AND MATERIALS

From January 2019 to November 2022, 5489 X-ray scans, comprising of 1877 scans with fractures and 3612 scans without fractures, along with their respective clinical radiology reports, were included. The fractures detected were of different types, including Femur, Clavicle, Ankle, Wrist, and Hip. The X-ray scans were collected consecutively, and other abnormalities like osteosarcoma, osteochondroma, arthritis, and calcification were also identified in the radiology reports. A multitask deep neural network (MDNN) trained on 450,000 and tested on 150,000 X-rays was utilized to detect X-rays with and without fractures. The standard performance evaluation metrics in terms of Area Under the Curve (AUC), True positive rate (TPR), False Positive Rate (FPR), and Average Precision (AP) were used to assess the performance of the MDNN.

#### RESULTS

The MDNN achieved an overall AUC of 0.95 (C.I. 0.939 - 0.954), a TPR, TNR, and AP of 0.94 and 0.91 and 0.92, respectively. The AUC for detecting fractures in the femur, clavicle, ankle, wrist, and hip was 0.96 (C.I. 0.950 - 0.987), 0.94 (C.I. 0.927 - 0.961), 0.93 (C.I. 0.912 - 0.944), 0.93 (C.I. 0.907 - 0.945), and 0.95 (C.I. 0.924 - 0.968) respectively. The highest achieved TPR, TNR, and AP was 0.954 for the hip, 0.912 for the femur, and 0.971 for the clavicle. The MDNN attained a minimum of 0.926 >AUC, 0.882 >TPR, 0.847 >TNR, and 0.826 > AP for all body parts.

#### CONCLUSION

The validation of the CAD is demonstrated in consecutive data with the presence of other comorbidities. The MDNN performed remarkably in detecting fractures in different body parts. The results obtained this dataset demonstrate the generalizability of CAD in real-world clinical settings.

#### CLINICAL RELEVANCE/APPLICATION

The study showed that using CAD as an assistance tool can benefit high-workload healthcare facilities, especially in busy ERs, where patients might have different orthopedic conditions. The lack of trained radiologists in ER and the increasing number of fractures require reliable and accurate CAD for automated detection and reduce missed fractures.

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## Abstract Archives of the RSNA, 2023

T3-SSMK06-6

### Ultra High-resolution Photon-counting CT in Cadaveric Fracture Models: Spatial Frequency is Not Everything

Tuesday, Nov. 28 9:30AM - 10:30AM Room: E351

Theresa Sophie Patzer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

While studies confirm the advantages of photon-counting detector (PCD) CT over energy-integrating detector (EID) CT for the depiction of bone microarchitecture, the effect of convolutional kernel selection on the assessability of the appendicular skeleton in ultrahigh-resolution (UHR) mode has not been thoroughly evaluated thus far. Aiming to fill this research gap, the present study employed various cadaveric fracture models to investigate the impact of convolution kernel sharpness in potential trauma settings.

#### METHODS AND MATERIALS

In total, sixteen cadaveric extremities (eight fractured) were examined with a standardized 120 kVp scan protocol (CTDIvol 10 mGy). In two cadaveric specimens, a board-certified trauma surgeon induced fractures of the distal radial bone, metacarpal bone, distal tibia, distal fibula, and metatarsal bone. Images were reconstructed with the sharpest non-UHR kernel (Br76) and all available UHR kernels (Br80 to Br96). Seven radiologists evaluated image quality and fracture assessability. Interrater agreement was assessed with the intraclass correlation coefficient. For quantitative comparisons, signal-to-noise-ratios (SNR) were calculated based on CT number measurements in standard ROIs.

#### RESULTS

Subjective image quality was best for Br84 (median 1, interquartile range 1-3;  $p=0.003$ ). Regarding fracture assessability, no significant difference was ascertained between Br76, Br80 and Br84 ( $p>0.999$ ), with inferior ratings for all sharper kernels ( $p<0.001$ ). Interrater agreement for image quality (0.795, 0.732-0.848;  $p<0.001$ ) and fracture assessability (0.880; 0.842-0.911;  $p<0.001$ ) was good. SNR was highest for Br76 (3.4, 3.0-3.9) with no significant difference to Br80 and Br84 ( $p>0.999$ ). Br76 and Br80 produced higher SNR than all kernels sharper than Br84 ( $p=0.026$ ).

#### CONCLUSION

PCD-CT reconstructions with a moderate UHR kernel offer superior image quality for visualizing the appendicular skeleton. Fracture assessability benefits from sharp non-UHR and moderate UHR kernels, while ultra-sharp reconstructions incur augmented image noise.

#### CLINICAL RELEVANCE/APPLICATION

The tradeoff between noise and sharpness in PCD-CT appears to be optimal for moderate UHR kernels, allowing for detailed delineation of fine bone microarchitecture. Proper kernel selection aids depiction of the appendicular skeleton in trauma setting.

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## Abstract Archives of the RSNA, 2023

T3-SSMS02

### Multisystem (Advancements in Novel Techniques and Applications in Differentiation of Various Types of Cancer and Metastatic vs Benign Conditions)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N228

Peiman Habibollahi, MD (*Moderator*) Nothing to Disclose

Amir Pourmorteza, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T3-SSMS02-2 Impact of Pre-Infusion Tumor Growth Rate on Incidence and Severity of CRS and ICANS in Lymphoma under CAR T-Cell Therapy**

Wolfgang G. Kunz, MD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

Chimeric antigen receptor T-cell therapy (CART) has emerged as an effective tool in treatment of relapsed or refractory (r/r) lymphoma and leukemia. On the opposite CART is associated with side effects like the cytokine release syndrome (CRS) the immune effector cell-associated neurotoxicity syndrome (ICANS). We aimed to study the value of the pre-infusion tumor growth rate (TGRpre-BL) as dynamica parameter and biomarker for incidence and severity of CRS and ICANS.

#### METHODS AND MATERIALS

Consecutive patients with available pre-baseline (pre-BL) and baseline (BL) CT or PET/CT scan before CART were included. TGR was determined as both absolute and percentage change of Lugano criteria-based tumor burden between pre-BL and BL in relation to days between imaging exams. CRS and ICANS were graded according to ASTCT consensus criteria. All patients were prospectively monitored closely for CRS and ICANS. Clinical metadata was collected with institutional review board approval and incorporated a waiver of informed consent. The international prognostic index (IPI) was calculated and LDH was determined both before apheresis and before lymphodepletion.

#### RESULTS

62 out of 80 patients met the inclusion criteria (median age: 62 years, 40% female). The median TGRpre-BL [abs] was 7.5 mm<sup>2</sup>/d (interquartile range: -14.6 mm<sup>2</sup>/d to 48.7 mm<sup>2</sup>/d) and median TGRpre-BL [%] was 30.9%/d (interquartile range: -36.3%/d to 207.8%/d). CRS grade was 0 in 8 patients (13%), 1 in 30 patients (13%), 2 in 18 patients (29%), and 3 in 6 patients (10%). ICANS grade was 0 in 40 patients (65%), 1 in 10 patients (16%), 2 in 6 patients (10%), 3 in 3 patients (5%), and 4 in 3 patients (5%). Both TGRpre-BL [abs] and TGRpre-BL [%] displayed no correlation with the grade of CRS (r[abs]=0.14 and r[%]=0.13) and ICANS (r[abs]=-0.06 and r[%]=-0.07). There was a weak positive correlation between grade of CRS and grade of ICANS (r=0.35; p=0.005) whereas there was no correlation of CRS or ICANS to any other of the examined parameters.

#### CONCLUSION

In the context of CART, differences in pre-infusion tumor kinetics showed only minor differences in predicting the frequency and severity of CRS and no significant differences in predicting ICANS. In addition, no benefit was observed compared with the use of baseline tumor burden alone.

#### CLINICAL RELEVANCE/APPLICATION

In this patient population of r/r lymphomas, pre-BL TGR showed no added value as a potential biomarker for outpatient therapy and early prediction of CRS and ICANS.

#### **T3-SSMS02-3 Validation of Node Reporting and Data System 1.0 (Node-RADS) on Abdominal Lymphadenopathy Dataset**

Francesca Rigioli, MD (*Presenter*) Nothing to Disclose



## PURPOSE

. To validate Node-RADS system using the largest reported cohort of abdominal lymph nodes with pathologic diagnosis, by evaluating the malignancy rate within the Node-RADS categories.

## METHODS AND MATERIALS

. Consecutive patients who underwent CT-guided biopsy of abdominal lymph nodes between 7/1/2016 and 9/30/2021 in a single tertiary institution were included in this IRB-approved, HIPAA-compliant study. A body radiology fellow, blinded to pathology results and patients' outcomes, reviewed pre-procedure contrast-enhanced CT and MRI studies performed within 30 days before the biopsy. Size and configuration of lymph nodes were evaluated to produce Node-RADS level of suspicion for malignancy involvement: "1—very low"; "2—low"; "3—equivocal"; "4—high"; "5—very high". Node-RADS scores were compared to the biopsy or surgical pathology results. When the pathology result was inconclusive, subsequent imaging or clinical follow-up was used as the reference standard. Inter-reader agreement was assessed with linear weighted Cohen kappa test based on a subset of 55 cases reviewed by an additional body fellow, blinded to previous scores and outcomes.

## RESULTS

373 consecutive CT-guided abdominal lymph node biopsies were included (median age 67 years, IQR 58-75 years), 224/373 (60%) men, with 233/373 (62%) retroperitoneal, 95/373 (25%) pelvic and 45/373 (12%) mesenteric lymph nodes. 17/373 (5%) lymph nodes were classified as Node-RADS 2, 43/373 (11%) Node-RADS 3, 66/373 (18%) Node-RADS 4 and 247/373 (66%) Node-RADS 5. Reference standard for outcome was pathology in 352/373 (94%) patients, imaging follow-up in 17/373 (5%) and clinical follow-up in 4/373 (1%) patients. Malignancy rates were 6/17 (35%, 95% Confidence Interval: 14-62%) of Node-RADS 2, 26/43 (60%, 95%CI: 44-75%) of Node-RADS 3, 52/66 (79%, 95%CI: 67-88%) of Node-RADS 4 and 226/247 (91%, 95%CI: 87-95%) of Node-RADS 5. Inter-reader agreement was moderate, with kappa=0.58.

## CONCLUSION

Node Reporting and Data System 1.0 (Node-RADS) categories were validated on the largest cohort of abdominal lymph nodes with pathologic diagnosis. Outcomes corresponded to increasing risk of malignancy with the increase in the Node-RADS score.

## CLINICAL RELEVANCE/APPLICATION

Node Reporting and Data System 1.0 (Node-RADS) categories can be used in providing a numeric risk score for malignancy involvement in abdominal lymphadenopathy..

## T3-SSMS02-4 Noninvasive Diagnostic Models Based on CT Scans for Differentiating Solitary Pulmonary Metastasis in Colorectal Cancer Patients by Artificial Intelligence: A Multicenter Study

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Indeterminate solitary pulmonary nodules are often encountered on CT scans, and diagnosis of solitary pulmonary metastasis (PM) is important for patients with colorectal cancer (CRC). We aim to build and validate proper noninvasive artificial intelligence diagnostic models based on routine chest CT for solitary PM in CRC patients.

## METHODS AND MATERIALS

All patients (n=212) with pretreated solitary CRC PM on chest CT were reviewed in the local database in A Cancer Hospital between 2012 and 2022, and randomly divided into the training or internal validation groups on 7: 3. A total of 185 patients with pretreated T1 stage primary lung cancer and 256 patients with benign solitary pulmonary nodules were randomly selected. Artificial intelligence models based on machine learning (Decision Tree, Extra Trees, Light GBM, Radom Forest, Support Vector Machine, XGBoost) and deep learning were built to classify the solitary pulmonary nodules as PM, benign lesion or primary lung cancer. External validation group included 44 CRC patients with solitary PM from two independent hospitals.

## RESULTS

For classification between PM and benign solitary pulmonary nodule, the machine learning model based on support vector machine showed the best diagnostic ability, with a 0.995 area under the curve (AUC) in the internal validation, a 0.977 AUC in external validation. The deep learning model showed a 0.966 AUC in the internal validation, and 0.893 AUC in external validation. For classification between PM and lung cancer, the best machine learning model based on support vector machine showed a 0.991 AUC in internal validation and the deep learning model showed a 0.949 AUC.

## CONCLUSION

Non-contrast CT based radiomic analyses can be useful for noninvasively differentiating solitary PM and benign pulmonary nodule or primary T1 stage lung cancer which can aid clinical decision in CRC patients with indeterminate solitary pulmonary nodules detected by CT.

## CLINICAL RELEVANCE/APPLICATION

This study provided alternative noninvasive diagnostic tools for determining the optimal management of indeterminate solitary lung nodules detected by chest CT scans in CRC patients.

### T3-SSMS02-5 **Differentiating Subcentimeter Lung Metastases in Colorectal Cancer by Integration of Radiomics and Deep Learning**

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to develop and validate discriminative radiomics and deep learning approaches for differentiating subcentimeter lung metastases (LMs) in colorectal cancer (CRC) patients.

#### METHODS AND MATERIALS

Models were developed in a primary cohort included 1194 consecutive CRC patients with subcentimeter LMs on CT. Patients were randomly assigned (7:3) to the training or internal validation cohorts (IVC). Machine learning (ML), deep learning (DL), and the integration of radiomics and DL features were applied to classify the subcentimeter lung nodules as LM or benign lesions. Two external validation cohorts (EVC) consisted of 101 (EVC1) and 40 (EVC2) patients. Stepwise validations on the subgroups according to the nodule's largest diameter were conducted.

#### RESULTS

CRC patients included 845 men and 490 women (average age  $58.53 \pm 10.74$  years). Support vector machine showed a 0.981 (95% CI:0.971-0.991) AUC in IVC, a 0.961(95% CI:0.948-0.971) and 0.996 (95% CI:0.992-0.998) AUC in EVC1 and EVC2. The DL model showed a 0.953 (95% CI:0.937-0.967) AUC in the IVC and a 0.906 (95% CI:0.874-0.926) and 0.951(95% CI:0.938-0.965) AUC in EVC1 and EVC2. The best integration model showed a 0.973 (95% CI:0.957-0.983) AUC in the IVC and a 0.943 (95% CI:0.920-0.960) and 0.974 (95% CI:0.966-0.985) AUC in EVC1 and EVC2. Stepwise validation demonstrated that the integration model was the most stable, and was the best for LM =5 mm.

#### CONCLUSION

This study provided an automatic and noninvasive diagnostic solution with improved diagnostic accuracy for determining subcentimeter LM in CRC. Specially, novel integration model was the best with LM  $\leq 5$  mm.

## CLINICAL RELEVANCE/APPLICATION

This study provided an automatic and noninvasive solution for determining subcentimeter LMs in the individual management of CRC with improved diagnostic accuracy comparing with radiologists.

### T3-SSMS02-6 **Deep Learning for Identifying the Genetic Clusters of Pheochromocytoma and Paraganglioma Using CT Scans**

Pritam Mukherjee, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Pheochromocytomas and paragangliomas (intra- and extra-adrenal tumors, respectively; PPGLs) are rare neuroendocrine tumors arising from chromaffin cells whose pathogenesis and progression are greatly regulated by their genetics. PPGLs have a high probability (over 35%) of harboring germline pathogenic variants and can metastasize in up to 50% of patients. The genetic spectrum of PPGLs can be broadly categorized into four groups: cluster 1A (SDHx), cluster 1B (VHL/EPAS1), cluster 2 [kinase signaling (KS)], and sporadic (patients lacking a family history of PPGLs and being negative for germline/somatic pathogenic variants). Identifying PPGL's genetic cluster is essential as clinical management and outcomes vary based on genetic cluster. But genetic testing for PPGLs is currently expensive and time-consuming. Whole-body CT scans are acquired at the beginning of patient management for PPGL staging and determining the next therapeutic steps. Thus, we aim to demonstrate a deep learning-based scheme that uses contrast-enhanced CT (CE-CT) scans to identify PPGLs' genetic clusters.

#### METHODS AND MATERIALS

We curated a dataset (would be made publicly available) of 1010 PPGLs (584 SDHx, 107 VHL/EPAS1, 133 KS, and 186 sporadic) extracted from the CE-CT scans of 285 patients [136 male (47.7%), median (range) age, 41 (5-75) years]. To address the multiple challenges of class imbalance, intra-class variance, inter-class similarity, and large tumor size variation, we developed a two-branch vision transformer (PPGL-Transformer) to identify each tumor's genetic cluster. The standard of reference for each tumor included its genetic cluster from genetic testing, and its anatomical location (head and neck, chest, adrenal, and abdominopelvic excluding adrenal). A supervised contrastive learning strategy was used to train the PPGL-Transformer by optimizing contrastive and classification losses for the genetic cluster and anatomic location of PPGLs.

## **RESULTS**

Our PPGL-Transformer achieved balanced accuracy (BA) of  $62.8 \pm 6.3\%$  and F1-score of  $46.5 \pm 8.1\%$  on five-fold cross-validation and outperformed competing methods [support vector machine and random forest with radiomics features, convolutional neural networks, and vision transformer] by 3-10% on BA and 3-14% on F1-score. Sporadic and SDHx groups achieved higher performance on BA ( $68.3 \pm 0.1\%$ ) and F1-score ( $74.8 \pm 0.1\%$ ), respectively.

## **CONCLUSION**

Our method and the dataset may lead to a faster and more widely available genetic characterization of PPGLs.

## **CLINICAL RELEVANCE/APPLICATION**

We demonstrate that deep learning provides very reliable information about PPGLs' genetic clusters offering timely personalized management including early and proper diagnostic decision-making approach and follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSMS02-2

### Impact of Pre-Infusion Tumor Growth Rate on Incidence and Severity of CRS and ICANS in Lymphoma under CAR T-Cell Therapy

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N228

Wolfgang G. Kunz, MD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

Chimeric antigen receptor T-cell therapy (CART) has emerged as an effective tool in treatment of relapsed or refractory (r/r) lymphoma and leukemia. On the opposite CART is associated with side effects like the cytokine release syndrome (CRS) the immune effector cell-associated neurotoxicity syndrome (ICANS). We aimed to study the value of the pre-infusion tumor growth rate (TGRpre-BL) as dynamica parameter and biomarker for incidence and severity of CRS and ICANS.

#### METHODS AND MATERIALS

Consecutive patients with available pre-baseline (pre-BL) and baseline (BL) CT or PET/CT scan before CART were included. TGR was determined as both absolute and percentage change of Lugano criteria-based tumor burden between pre-BL and BL in relation to days between imaging exams. CRS and ICANS were graded according to ASTCT consensus criteria. All patients were prospectively monitored closely for CRS and ICANS. Clinical metadata was collected with institutional review board approval and incorporated a waiver of informed consent. The international prognostic index (IPI) was calculated and LDH was determined both before apheresis and before lymphodepletion.

#### RESULTS

62 out of 80 patients met the inclusion criteria (median age: 62 years, 40% female). The median TGRpre-BL [abs] was 7.5 mm<sup>2</sup>/d (interquartile range: -14.6 mm<sup>2</sup>/d to 48.7 mm<sup>2</sup>/d) and median TGRpre-BL [%] was 30.9%/d (interquartile range: -36.3%/d to 207.8%/d). CRS grade was 0 in 8 patients (13%), 1 in 30 patients (13%), 2 in 18 patients (29%), and 3 in 6 patients (10%). ICANS grade was 0 in 40 patients (65%), 1 in 10 patients (16%), 2 in 6 patients (10%), 3 in 3 patients (5%), and 4 in 3 patients (5%). Both TGRpre-BL [abs] and TGRpre-BL [%] displayed no correlation with the grade of CRS ( $r[\text{abs}] = 0.14$  and  $r[\%] = 0.13$ ) and ICANS ( $r[\text{abs}] = -0.06$  and  $r[\%] = -0.07$ ). There was a weak positive correlation between grade of CRS and grade of ICANS ( $r = 0.35$ ;  $p = 0.005$ ) whereas there was no correlation of CRS or ICANS to any other of the examined parameters.

#### CONCLUSION

In the context of CART, differences in pre-infusion tumor kinetics showed only minor differences in predicting the frequency and severity of CRS and no significant differences in predicting ICANS. In addition, no benefit was observed compared with the use of baseline tumor burden alone.

#### CLINICAL RELEVANCE/APPLICATION

In this patient population of r/r lymphomas, pre-BL TGR showed no added value as a potential biomarker for outpatient therapy and early prediction of CRS and ICANS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSMS02-3

### Validation of Node Reporting and Data System 1.0 (Node-RADS) on Abdominal Lymphadenopathy Dataset

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N228

Francesca Rigioli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

. To validate Node-RADS system using the largest reported cohort of abdominal lymph nodes with pathologic diagnosis, by evaluating the malignancy rate within the Node-RADS categories.

#### METHODS AND MATERIALS

. Consecutive patients who underwent CT-guided biopsy of abdominal lymph nodes between 7/1/2016 and 9/30/2021 in a single tertiary institution were included in this IRB-approved, HIPAA-compliant study. A body radiology fellow, blinded to pathology results and patients' outcomes, reviewed pre-procedure contrast-enhanced CT and MRI studies performed within 30 days before the biopsy. Size and configuration of lymph nodes were evaluated to produce Node-RADS level of suspicion for malignancy involvement: "1—very low"; "2—low"; "3—equivocal"; "4—high"; "5—very high". Node-RADS scores were compared to the biopsy or surgical pathology results. When the pathology result was inconclusive, subsequent imaging or clinical follow-up was used as the reference standard. Inter-reader agreement was assessed with linear weighted Cohen kappa test based on a subset of 55 cases reviewed by an additional body fellow, blinded to previous scores and outcomes.

#### RESULTS

373 consecutive CT-guided abdominal lymph node biopsies were included (median age 67 years, IQR 58-75 years), 224/373 (60%) men, with 233/373 (62%) retroperitoneal, 95/373 (25%) pelvic and 45/373 (12%) mesenteric lymph nodes. 17/373 (5%) lymph nodes were classified as Node-RADS 2, 43/373 (11%) Node-RADS 3, 66/373 (18%) Node-RADS 4 and 247/373 (66%) Node-RADS 5. Reference standard for outcome was pathology in 352/373 (94%) patients, imaging follow-up in 17/373 (5%) and clinical follow-up in 4/373 (1%) patients. Malignancy rates were 6/17 (35%, 95% Confidence Interval: 14-62%) of Node-RADS 2, 26/43 (60%, 95%CI: 44-75%) of Node-RADS 3, 52/66 (79%, 95%CI: 67-88%) of Node-RADS 4 and 226/247 (91%, 95%CI: 87-95%) of Node-RADS 5. Inter-reader agreement was moderate, with kappa=0.58.

#### CONCLUSION

Node Reporting and Data System 1.0 (Node-RADS) categories were validated on the largest cohort of abdominal lymph nodes with pathologic diagnosis. Outcomes corresponded to increasing risk of malignancy with the increase in the Node-RADS score.

#### CLINICAL RELEVANCE/APPLICATION

Node Reporting and Data System 1.0 (Node-RADS) categories can be used in providing a numeric risk score for malignancy involvement in abdominal lymphadenopathy..

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSMS02-4

### **Noninvasive Diagnostic Models Based on CT Scans for Differentiating Solitary Pulmonary Metastasis in Colorectal Cancer Patients by Artificial Intelligence: A Multicenter Study**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N228

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Indeterminate solitary pulmonary nodules are often encountered on CT scans, and diagnosis of solitary pulmonary metastasis (PM) is important for patients with colorectal cancer (CRC). We aim to build and validate proper noninvasive artificial intelligence diagnostic models based on routine chest CT for solitary PM in CRC patients.

#### **METHODS AND MATERIALS**

All patients (n=212) with pretreated solitary CRC PM on chest CT were reviewed in the local database in A Cancer Hospital between 2012 and 2022, and randomly divided into the training or internal validation groups on 7: 3. A total of 185 patients with pretreated T1 stage primary lung cancer and 256 patients with benign solitary pulmonary nodules were randomly selected. Artificial intelligence models based on machine learning (Decision Tree, Extra Trees, Light GBM, Radom Forest, Support Vector Machine, XGBoost) and deep learning were built to classify the solitary pulmonary nodules as PM, benign lesion or primary lung cancer. External validation group included 44 CRC patients with solitary PM from two independent hospitals.

#### **RESULTS**

For classification between PM and benign solitary pulmonary nodule, the machine learning model based on support vector machine showed the best diagnostic ability, with a 0.995 area under the curve (AUC) in the internal validation, a 0.977 AUC in external validation. The deep learning model showed a 0.966 AUC in the internal validation, and 0.893 AUC in external validation. For classification between PM and lung cancer, the best machine learning model based on support vector machine showed a 0.991 AUC in internal validation and the deep learning model showed a 0.949 AUC.

#### **CONCLUSION**

Non-contrast CT based radiomic analyses can be useful for noninvasively differentiating solitary PM and benign pulmonary nodule or primary T1 stage lung cancer which can aid clinical decision in CRC patients with indeterminate solitary pulmonary nodules detected by CT.

#### **CLINICAL RELEVANCE/APPLICATION**

This study provided alternative noninvasive diagnostic tools for determining the optimal management of indeterminate solitary lung nodules detected by chest CT scans in CRC patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSMS02-5

### Differentiating Subcentimeter Lung Metastases in Colorectal Cancer by Integration of Radiomics and Deep Learning

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N228

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to develop and validate discriminative radiomics and deep learning approaches for differentiating subcentimeter lung metastases (LMs) in colorectal cancer (CRC) patients.

#### METHODS AND MATERIALS

Models were developed in a primary cohort included 1194 consecutive CRC patients with subcentimeter LMs on CT. Patients were randomly assigned (7:3) to the training or internal validation cohorts (IVC). Machine learning (ML), deep learning (DL), and the integration of radiomics and DL features were applied to classify the subcentimeter lung nodules as LM or benign lesions. Two external validation cohorts (EVC) consisted of 101 (EVC1) and 40 (EVC2) patients. Stepwise validations on the subgroups according to the nodule's largest diameter were conducted.

#### RESULTS

CRC patients included 845 men and 490 women (average age  $58.53 \pm 10.74$  years). Support vector machine showed a 0.981 (95% CI:0.971-0.991) AUC in IVC, a 0.961(95% CI:0.948-0.971) and 0.996 (95% CI:0.992-0.998) AUC in EVC1 and EVC2. The DL model showed a 0.953 (95% CI:0.937-0.967) AUC in the IVC and a 0.906 (95% CI:0.874-0.926) and 0.951(95% CI:0.938-0.965) AUC in EVC1 and EVC2. The best integration model showed a 0.973 (95% CI:0.957-0.983) AUC in the IVC and a 0.943 (95% CI:0.920-0.960) and 0.974 (95% CI:0.966-0.985) AUC in EVC1 and EVC2. Stepwise validation demonstrated that the integration model was the most stable, and was the best for LM  $\leq 5$  mm.

#### CONCLUSION

This study provided an automatic and noninvasive diagnostic solution with improved diagnostic accuracy for determining subcentimeter LM in CRC. Specially, novel integration model was the best with LM  $\leq 5$  mm.

#### CLINICAL RELEVANCE/APPLICATION

This study provided an automatic and noninvasive solution for determining subcentimeter LMs in the individual management of CRC with improved diagnostic accuracy comparing with radiologists.

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## Abstract Archives of the RSNA, 2023

T3-SSMS02-6

### Deep Learning for Identifying the Genetic Clusters of Pheochromocytoma and Paraganglioma Using CT Scans

Tuesday, Nov. 28 9:30AM - 10:30AM Room: N228

Pritam Mukherjee, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Pheochromocytomas and paragangliomas (intra- and extra-adrenal tumors, respectively; PPGLs) are rare neuroendocrine tumors arising from chromaffin cells whose pathogenesis and progression are greatly regulated by their genetics. PPGLs have a high probability (over 35%) of harboring germline pathogenic variants and can metastasize in up to 50% of patients. The genetic spectrum of PPGLs can be broadly categorized into four groups: cluster 1A (SDHx), cluster 1B (VHL/EPAS1), cluster 2 [kinase signaling (KS)], and sporadic (patients lacking a family history of PPGLs and being negative for germline/somatic pathogenic variants). Identifying PPGL's genetic cluster is essential as clinical management and outcomes vary based on genetic cluster. But genetic testing for PPGLs is currently expensive and time-consuming. Whole-body CT scans are acquired at the beginning of patient management for PPGL staging and determining the next therapeutic steps. Thus, we aim to demonstrate a deep learning-based scheme that uses contrast-enhanced CT (CE-CT) scans to identify PPGLs' genetic clusters.

#### METHODS AND MATERIALS

We curated a dataset (would be made publicly available) of 1010 PPGLs (584 SDHx, 107 VHL/EPAS1, 133 KS, and 186 sporadic) extracted from the CE-CT scans of 285 patients [136 male (47.7%), median (range) age, 41 (5-75) years]. To address the multiple challenges of class imbalance, intra-class variance, inter-class similarity, and large tumor size variation, we developed a two-branch vision transformer (PPGL-Transformer) to identify each tumor's genetic cluster. The standard of reference for each tumor included its genetic cluster from genetic testing, and its anatomical location (head and neck, chest, adrenal, and abdominopelvic excluding adrenal). A supervised contrastive learning strategy was used to train the PPGL-Transformer by optimizing contrastive and classification losses for the genetic cluster and anatomic location of PPGLs.

#### RESULTS

Our PPGL-Transformer achieved balanced accuracy (BA) of  $62.8 \pm 6.3\%$  and F1-score of  $46.5 \pm 8.1\%$  on five-fold cross-validation and outperformed competing methods [support vector machine and random forest with radiomics features, convolutional neural networks, and vision transformer] by 3-10% on BA and 3-14% on F1-score. Sporadic and SDHx groups achieved higher performance on BA ( $68.3 \pm 0.1\%$ ) and F1-score ( $74.8 \pm 0.1\%$ ), respectively.

#### CONCLUSION

Our method and the dataset may lead to a faster and more widely available genetic characterization of PPGLs.

#### CLINICAL RELEVANCE/APPLICATION

We demonstrate that deep learning provides very reliable information about PPGLs' genetic clusters offering timely personalized management including early and proper diagnostic decision-making approach and follow-up.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSNR07

### Science Session with Keynote: Neuroradiology (Brain: Stroke (Risk Factors and Prevention))

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S405

Jae W. Song, MD, MS (*Moderator*) Nothing to Disclose  
Vivek Yedavalli, MD, MS (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T3-SSNR07-1 Optimizing Hemorrhagic Transformation Risk Prediction in Acute Ischemic Stroke Patients after Endovascular Interventions: Novel Insights from Venous Collateral Circulation Analysis Using 4D CTA**

Ruoyao Cao, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to evaluate the predictive value of venous collateral circulation assessment in acute ischemic stroke (AIS) patients undergoing endovascular treatments (EVTs) for hemorrhagic transformation (HT) risk.

#### METHODS AND MATERIALS

A retrospective analysis of 102 AIS patients receiving EVT was conducted. Clinical and radiological data were collected. A novel cortical venous collateral score based on 4D CTA (4D-VCS) was used to assess venous collateral status, arterial collateral circulation score based on 4D CTA (4D-ACS) was used to assess arterial collateral status. The least absolute shrinkage and selection operator algorithm was performed to select significant variables, followed by logistic regression analysis to investigate their association with HT. The predictive performance of these parameters and combined models was assessed using receiver operating characteristic (ROC) analysis and DeLong's test.

#### RESULTS

HT occurred in 39.2% (40/102) of patients. Higher clot burden score (CBS) (OR: 0.89, 95% CI: 0.71-0.95,  $p=0.010$ ), good arterial collateral circulation (OR: 0.53, 95% CI: 0.45-0.80,  $p=0.005$ ) and good venous collateral circulation (OR: 0.83, 95% CI: 0.70-0.93,  $p=0.016$ ) were significantly associated with a reduced risk of HT. Among the single predictors, the AUC values for CBS, 4D-ACS, and 4D-VCS were 0.730, 0.772, and 0.795, respectively. For Model 1 (4D-VCS+CBS), the AUC was 0.820, showing a statistically significant improvement over CBS alone ( $p=0.0133$ ). Model 2 (4D-VCS+4D-ACS) produced an AUC of 0.829, which was significantly higher than that of 4D-ACS alone ( $p=0.0271$ ). Model ALL (4D-VCS+4D-ACS+CBS) achieved the highest AUC of 0.851, indicating the strongest diagnostic efficiency among all models.

#### CONCLUSION

Venous collateral circulation assessment using 4D-VCS can improve HT risk prediction in AIS patients after EVT. Combining 4D-VCS with other predictors improves diagnostic performance, highlighting the potential of venous collateral circulation in HT risk prediction.

#### CLINICAL RELEVANCE/APPLICATION

Our study is the first to introduce a novel scoring system called 4D-VCS to examine the added value of venous collateral circulation in improving the prediction of HT risk in AIS patients following EVT. We found that good venous collateral circulation are associated with a decreased risk of HT after EVT. The integration of 4D-VCS with other predictors, such as CBS and arterial collateral scores, significantly enhances diagnostic performance in assessing HT risk. These findings suggest that venous collateral circulation holds significant potential in HT risk prediction in AIS patients undergoing EVT, and future large-scale prospective studies are warranted to validate our findings.

#### **T3-SSNR07-2 Keynote Speaker**

Arindam R. Chatterjee, MD (*Presenter*) Nothing to Disclose

### **T3-SSNR07-3 Carotid Artery Geometry - Potential Predictor for Intracranial Atherosclerosis in Patient Under 60 Years Old With No Risk Factors**

Yi-Tong Liu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the association between carotid artery geometry and middle cerebral artery (MCA) atherosclerosis in patients under 60 years old with no traditional cardiocerebrovascular risk factors, using head-neck combined high-resolution magnetic resonance imaging (HRMRI) and to look for the potential predictors for intracranial atherosclerosis.

#### **METHODS AND MATERIALS**

Analyzed 150 artery units of ipsilateral anterior circulation from patients under 60 years old with no traditional cardiocerebrovascular risk factors. Artery units were categorized into MCA atherosclerosis (+) group and MCA atherosclerosis (-) group, according to whether MCA atherosclerotic plaque was observed in HRMRI. Comparisons of carotid bifurcation angle, carotid arteries lumen area ratio and configuration of extracranial and intracranial internal carotid artery (ICA) between two groups were performed. Logistic regression was utilized to evaluate the independent association between carotid artery geometry and MCA atherosclerosis, with predictive value of carotid artery geometry assessed.

#### **RESULTS**

Compared with MCA atherosclerosis (-) group (n=113), MCA atherosclerosis (+) group (n=37) had a larger carotid bifurcation angle (p=0.026). The outflow/inflow lumen area ratio was larger, the extracranial ICA was less smooth, more tortuous and kinked, and the intracranial ICA had less obtuse-angle, more right-angle and acute-angle shapes in MCA atherosclerosis (+) group, but these differences were not statistically significant. After adjusting for confounding factors by logistic multivariate regression, the carotid bifurcation angle was independently associated with MCA atherosclerosis (OR=1.232, every 10° increase, 95%CI 1.007-1.507, p=0.042). By backward stepwise logistic regression, the carotid bifurcation angle performed well in predicting MCA atherosclerosis (OR=1.276, every 10° increase, 95%CI 1.050-1.550, p=0.014). The area under the ROC was 0.622 (0.515-0.730), the cutoff value was 37.0°, with sensitivity of 57.5%, and specificity of 64.9%.

#### **CONCLUSION**

For patients under 60 years old with no traditional cardiocerebrovascular risk factors, the carotid bifurcation angle is independently associated with MCA atherosclerosis.

#### **CLINICAL RELEVANCE/APPLICATION**

Carotid artery geometry could be a potential imaging marker for intracranial atherosclerosis.

### **T3-SSNR07-4 Metabolic Analysis within an Atherosclerotic Plaque Using Chemical Exchange Saturation Transfer Imaging**

Yuki Kanazawa, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the characteristics of atherosclerotic plaques for carotid artery stenosis, we demonstrated biological metabolic activity using a multi-pool model of chemical exchange saturation transfer imaging (CEST) -MRI.

#### **METHODS AND MATERIALS**

Our prospective study was approved by the institutional review board, and all imaging datasets of the 41 patients with carotid stenosis were acquired after informed consent was obtained. All patients had carotid endarterectomy (CEA) and accepted the pathological diagnosis. On a 3 Tesla MR scanner, CEST-MRI was performed with a single-shot fast spin-echo sequence of Field-of-view Optimized and Constrained Undistorted Single-shot (FOCUS) and phase cycle radio frequency preparation at 1.0  $\mu$ T. T1-weighted (T1w) and T2-weighted (T2w) images using three-dimensional fast Spin-Echo with Motion-Sensitized Driven Equilibrium (3D-FSE-MSDE) were acquired. Regions of interest analysis were manually outlined on MR images for areas of the atherosclerotic plaques and sternocleidomastoid muscle. Four parameter images, e.g., bulk water, magnetization transfer (MT), amide proton transfer (APT), and nuclear Overhauser effect (NOE), were calculated from the CEST-MRI dataset. T1w- and T2w- signal-ratios were defined as each plaque signal intensity normalized with muscle. Regression analysis was performed, and the relationship between CEST parameters and each signal-ratio was carried out. Comparisons of each CEST parameter were made. Furthermore, CEST imaging and pathological findings were compared.

#### **RESULTS**

These pathological findings revealed atherogenesis formations for all plaques, in which hemorrhage and/or thrombus were almost observed. There were weak positive correlations between T1w-signal-ratio and estimation parameters; bulk water (R = 0.42), APT (R = 0.35), and NOE (R = 0.34). In contrast, there was no correlation between T2w-signal-ratio and each

estimation parameter. The mean parameter for MT was higher than for bulk water, APT, and NOE ( $P < .001$  for all). There were no significant differences between mean APT and NOE.

#### **CONCLUSION**

We found that both APT and NOE signals make an impact on the evaluation of atherosclerotic plaques using CEST imaging. Multi-pool CEST imaging makes it possible to assess characteristics, including tissue components and biological metabolic activity within an atherosclerotic plaque.

#### **CLINICAL RELEVANCE/APPLICATION**

Our result indicates that CEST plaque imaging should be evaluated by distinguishing APT and NOE rather than the generally used MT-ratio asymmetry analysis.

### **T3-SSNR07-5 Sex Difference in Intracranial Plaque Burden in Patients with Type 2 Diabetes Mellitus with Acute Ischemic Cerebrovascular Disease**

Xuejiao Yan, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Studies have shown that there were sex differences in the prevalence of type 2 diabetes and its associated macrovascular diseases outcomes, including atherosclerosis and ischemic cerebrovascular disease. The aims of this study were to investigate whether sex differences in type 2 diabetes patients with acute cerebral ischemia affect intracranial atherosclerotic plaque burden, and further to analyze whether the effects of diabetes treatment on intracranial plaque burden is sex-specific.

#### **METHODS AND MATERIALS**

From August 2017 to February 2023, the single-center medical imaging center high-resolution vessel wall imaging (HR-VWI) database based on ischemic stroke imaging packages was continuously reviewed. Patients with type 2 diabetes who had acute cerebral infarction or TIA due to intracranial atherosclerotic stenosis were included. The proximal and distal plaques of the middle cerebral artery M1-3, anterior cerebral artery A1-2, and posterior cerebral artery P1-2 were counted as plaque burden. Patients with a history of diabetes mellitus and on hypoglycemic drug use were defined as being treated. Poisson log-linear regression models or negative binomial regression models were used to determine the possible relationship between sex and intracranial atherosclerotic plaque burden and the interaction between treatment and sex.

#### **RESULTS**

Seventy-three patients (including 49 men) were finally included. The levels of Apo A1 ( $P=0.004$ ), homocysteine ( $P=0.016$ ), uric acid ( $P=0.030$ ) and smoking rate ( $P<0.001$ ) in males were higher than those in females. After adjustment, the intracranial total and proximal plaque burden in males were 1.422 (95%CI:1.088-1.858,  $P=0.010$ ) and 1.590 (95%CI: 1.106-2.285,  $P=0.012$ ) times higher than that in females, respectively. After treatment, the proximal plaque burden was significantly reduced in female patients, with a male/female relative risk of 3.389 (95%CI: 1.881-5.753). Without treatment, there was no difference in relative risk between men and women (1.073 (95%CI: 0.697-1.653)). In the interaction analysis of sex and treatment, the two hazard ratios were statistically significant at 1.983 (95% CI: 1.007-3.906,  $P=0.048$ ).

#### **CONCLUSION**

The total and proximal burden of intracranial atherosclerotic plaque in male patients with type 2 diabetes with acute cerebrovascular disease were significantly higher than those in female patients. In addition, treatment had a sex-specific effect on intracranial proximal plaque burden. Compared with men, the proximal intracranial plaque burden was significantly reduced in women receiving diabetes treatment, suggesting that hypoglycemic therapy has a protective effect on the proximal intracranial plaque burden in women.

#### **CLINICAL RELEVANCE/APPLICATION**

NONE

### **T3-SSNR07-6 Could the New pRELAX Traction Maneuver be the Long-awaited Solution for the Treatment of Posthemorrhagic Cerebral Vasospasm**

Ali Khanafer (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cerebral vasospasm (CVS) is a frequent complication of subarachnoid hemorrhage (SAH). Medicinal and endovascular means play a supportive role in the prevention of subsequent brain infarction. Recently, studies have shown a beneficial effect of CVS treatment with self-expanding retrievable stents. We report our experience with stent angioplasty and the new pRELAX traction maneuver in the treatment of CVS.

## **METHODS AND MATERIALS**

We treated 21 patients suffering from posthemorrhagic CVS with either stent retrievers or the dedicated vasospasm device pRELAX (WallabyPhenox, Bochum, Germany). In Group 1, we deployed for 5 minutes a conventional stent retriever or a pRELAX into a narrow brain artery and retrieved it into the microcatheter. In group 2, we deployed the pRELAX into a narrow artery and pulled it back unfolded into the internal carotid artery (ICA), using a technique similar to mechanical thrombectomy. Immediate angiographic results, periprocedural complications, and angiographic follow-up data were recorded.

## **RESULTS**

15 patients and 21 treated vessels were included in Group 1 (5 middle cerebral artery (MCA), 8 anterior cerebral artery, 1 basilar artery, 1 posterior cerebral artery). All treatments were technically successful without periprocedural complications. Four vessels showed no angiographic improvement and required further treatment, and 14 vessels showed short-term CVS recurrence, requiring re-treatment. 13 vessels (8 MCA; 5 intradural ICA) in 6 patients (Group 2) were treated using the pRELAX Traction Maneuver. All maneuvers were technically successful without complications and all patient showed significant angiographic improvement. None of the treated vessels showed recurrent CVS requiring further endovascular treatment. No new ischemia was found in the treated territories and no vascular injury was seen on follow-up angiographies.

## **CONCLUSION**

Stent retriever angioplasty for CVS is a safe treatment modality with sobering short-term outcomes. The pRELAX traction manoeuvre showed promising results and may be the long-awaited solution for the treatment of CVS. The pRELAX traction maneuver might also be applied as a preventive measure early after the hemorrhage and prior to the development of CVS.

## **CLINICAL RELEVANCE/APPLICATION**

CVS is by far the most frequent reason for poor outcome after SAH. Medicinal and interventional treatment failed so far to prevent catastrophic outcomes. The pRELAX traction maneuver is a safe, easy to use and lasting method to treat CVS.  
Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSNR07-1

### Optimizing Hemorrhagic Transformation Risk Prediction in Acute Ischemic Stroke Patients after Endovascular Interventions: Novel Insights from Venous Collateral Circulation Analysis Using 4D CTA

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S405

Ruoyao Cao, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to evaluate the predictive value of venous collateral circulation assessment in acute ischemic stroke (AIS) patients undergoing endovascular treatments (EVTs) for hemorrhagic transformation (HT) risk.

#### METHODS AND MATERIALS

A retrospective analysis of 102 AIS patients receiving EVT was conducted. Clinical and radiological data were collected. A novel cortical venous collateral score based on 4D CTA (4D-VCS) was used to assess venous collateral status, arterial collateral circulation score based on 4D CTA (4D-ACS) was used to assess arterial collateral status. The least absolute shrinkage and selection operator algorithm was performed to select significant variables, followed by logistic regression analysis to investigate their association with HT. The predictive performance of these parameters and combined models was assessed using receiver operating characteristic (ROC) analysis and DeLong's test.

#### RESULTS

HT occurred in 39.2% (40/102) of patients. Higher clot burden score (CBS) (OR: 0.89, 95% CI: 0.71-0.95,  $p=0.010$ ), good arterial collateral circulation (OR: 0.53, 95% CI: 0.45-0.80,  $p=0.005$ ) and good venous collateral circulation (OR: 0.83, 95% CI: 0.70-0.93,  $p=0.016$ ) were significantly associated with a reduced risk of HT. Among the single predictors, the AUC values for CBS, 4D-ACS, and 4D-VCS were 0.730, 0.772, and 0.795, respectively. For Model 1 (4D-VCS+CBS), the AUC was 0.820, showing a statistically significant improvement over CBS alone ( $p=0.0133$ ). Model 2 (4D-VCS+4D-ACS) produced an AUC of 0.829, which was significantly higher than that of 4D-ACS alone ( $p=0.0271$ ). Model ALL (4D-VCS+4D-ACS+CBS) achieved the highest AUC of 0.851, indicating the strongest diagnostic efficiency among all models.

#### CONCLUSION

Venous collateral circulation assessment using 4D-VCS can improve HT risk prediction in AIS patients after EVT. Combining 4D-VCS with other predictors improves diagnostic performance, highlighting the potential of venous collateral circulation in HT risk prediction.

#### CLINICAL RELEVANCE/APPLICATION

Our study is the first to introduce a novel scoring system called 4D-VCS to examine the added value of venous collateral circulation in improving the prediction of HT risk in AIS patients following EVT. We found that good venous collateral circulation are associated with a decreased risk of HT after EVT. The integration of 4D-VCS with other predictors, such as CBS and arterial collateral scores, significantly enhances diagnostic performance in assessing HT risk. These findings suggest that venous collateral circulation holds significant potential in HT risk prediction in AIS patients undergoing EVT, and future large-scale prospective studies are warranted to validate our findings.

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## Abstract Archives of the RSNA, 2023

T3-SSNR07-2

### Keynote Speaker

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S405

Arindam R. Chatterjee, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSNR07-3

### Carotid Artery Geometry - Potential Predictor for Intracranial Atherosclerosis in Patient Under 60 Years Old With No Risk Factors

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S405

Yi-Tong Liu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the association between carotid artery geometry and middle cerebral artery (MCA) atherosclerosis in patients under 60 years old with no traditional cardiocerebrovascular risk factors, using head-neck combined high-resolution magnetic resonance imaging (HRMRI) and to look for the potential predictors for intracranial atherosclerosis.

#### METHODS AND MATERIALS

Analyzed 150 artery units of ipsilateral anterior circulation from patients under 60 years old with no traditional cardiocerebrovascular risk factors. Artery units were categorized into MCA atherosclerosis (+) group and MCA atherosclerosis (-) group, according to whether MCA atherosclerotic plaque was observed in HRMRI. Comparisons of carotid bifurcation angle, carotid arteries lumen area ratio and configuration of extracranial and intracranial internal carotid artery (ICA) between two groups were performed. Logistic regression was utilized to evaluate the independent association between carotid artery geometry and MCA atherosclerosis, with predictive value of carotid artery geometry assessed.

#### RESULTS

Compared with MCA atherosclerosis (-) group (n=113), MCA atherosclerosis (+) group (n=37) had a larger carotid bifurcation angle ( $p=0.026$ ). The outflow/inflow lumen area ratio was larger, the extracranial ICA was less smooth, more tortuous and kinked, and the intracranial ICA had less obtuse-angle, more right-angle and acute-angle shapes in MCA atherosclerosis (+) group, but these differences were not statistically significant. After adjusting for confounding factors by logistic multivariate regression, the carotid bifurcation angle was independently associated with MCA atherosclerosis (OR=1.232, every  $10^\circ$  increase, 95%CI 1.007-1.507,  $p=0.042$ ). By backward stepwise logistic regression, the carotid bifurcation angle performed well in predicting MCA atherosclerosis (OR=1.276, every  $10^\circ$  increase, 95%CI 1.050-1.550,  $p=0.014$ ). The area under the ROC was 0.622 (0.515-0.730), the cutoff value was  $37.0^\circ$ , with sensitivity of 57.5%, and specificity of 64.9%.

#### CONCLUSION

For patients under 60 years old with no traditional cardiocerebrovascular risk factors, the carotid bifurcation angle is independently associated with MCA atherosclerosis.

#### CLINICAL RELEVANCE/APPLICATION

Carotid artery geometry could be a potential imaging marker for intracranial atherosclerosis.

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## Abstract Archives of the RSNA, 2023

T3-SSNR07-4

### Metabolic Analysis within an Atherosclerotic Plaque Using Chemical Exchange Saturation Transfer Imaging

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S405

Yuki Kanazawa, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the characteristics of atherosclerotic plaques for carotid artery stenosis, we demonstrated biological metabolic activity using a multi-pool model of chemical exchange saturation transfer imaging (CEST) -MRI.

#### METHODS AND MATERIALS

Our prospective study was approved by the institutional review board, and all imaging datasets of the 41 patients with carotid stenosis were acquired after informed consent was obtained. All patients had carotid endarterectomy (CEA) and accepted the pathological diagnosis. On a 3 Tesla MR scanner, CEST-MRI was performed with a single-shot fast spin-echo sequence of Field-of-view Optimized and Constrained Undistorted Single-shot (FOCUS) and phase cycle radio frequency preparation at 1.0  $\mu$ T. T1-weighted (T1w) and T2-weighted (T2w) images using three-dimensional fast Spin-Echo with Motion-Sensitized Driven Equilibrium (3D-FSE-MSDE) were acquired. Regions of interest analysis were manually outlined on MR images for areas of the atherosclerotic plaques and sternocleidomastoid muscle. Four parameter images, e.g., bulk water, magnetization transfer (MT), amide proton transfer (APT), and nuclear Overhauser effect (NOE), were calculated from the CEST-MRI dataset. T1w- and T2w- signal-ratios were defined as each plaque signal intensity normalized with muscle. Regression analysis was performed, and the relationship between CEST parameters and each signal-ratio was carried out. Comparisons of each CEST parameter were made. Furthermore, CEST imaging and pathological findings were compared.

#### RESULTS

These pathological findings revealed atherogenesis formations for all plaques, in which hemorrhage and/or thrombus were almost observed. There were weak positive correlations between T1w-signal-ratio and estimation parameters; bulk water ( $R = 0.42$ ), APT ( $R = 0.35$ ), and NOE ( $R = 0.34$ ). In contrast, there was no correlation between T2w-signal-ratio and each estimation parameter. The mean parameter for MT was higher than for bulk water, APT, and NOE ( $P < .001$  for all). There were no significant differences between mean APT and NOE.

#### CONCLUSION

We found that both APT and NOE signals make an impact on the evaluation of atherosclerotic plaques using CEST imaging. Multi-pool CEST imaging makes it possible to assess characteristics, including tissue components and biological metabolic activity within an atherosclerotic plaque.

#### CLINICAL RELEVANCE/APPLICATION

Our result indicates that CEST plaque imaging should be evaluated by distinguishing APT and NOE rather than the generally used MT-ratio asymmetry analysis.

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## Abstract Archives of the RSNA, 2023

T3-SSNR07-5

### Sex Difference in Intracranial Plaque Burden in Patients with Type 2 Diabetes Mellitus with Acute Ischemic Cerebrovascular Disease

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S405

Xuejiao Yan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Studies have shown that there were sex differences in the prevalence of type 2 diabetes and its associated macrovascular diseases outcomes, including atherosclerosis and ischemic cerebrovascular disease. The aims of this study were to investigate whether sex differences in type 2 diabetes patients with acute cerebral ischemia affect intracranial atherosclerotic plaque burden, and further to analyze whether the effects of diabetes treatment on intracranial plaque burden is sex-specific.

#### METHODS AND MATERIALS

From August 2017 to February 2023, the single-center medical imaging center high-resolution vessel wall imaging (HR-VWI) database based on ischemic stroke imaging packages was continuously reviewed. Patients with type 2 diabetes who had acute cerebral infarction or TIA due to intracranial atherosclerotic stenosis were included. The proximal and distal plaques of the middle cerebral artery M1-3, anterior cerebral artery A1-2, and posterior cerebral artery P1-2 were counted as plaque burden. Patients with a history of diabetes mellitus and on hypoglycemic drug use were defined as being treated. Poisson log-linear regression models or negative binomial regression models were used to determine the possible relationship between sex and intracranial atherosclerotic plaque burden and the interaction between treatment and sex.

#### RESULTS

Seventy-three patients (including 49 men) were finally included. The levels of Apo A1 ( $P=0.004$ ), homocysteine ( $P=0.016$ ), uric acid ( $P=0.030$ ) and smoking rate ( $P<0.001$ ) in males were higher than those in females. After adjustment, the intracranial total and proximal plaque burden in males were 1.422 (95%CI:1.088-1.858,  $P=0.010$ ) and 1.590 (95%CI: 1.106-2.285,  $P=0.012$ ) times higher than that in females, respectively. After treatment, the proximal plaque burden was significantly reduced in female patients, with a male/female relative risk of 3.389 (95%CI: 1.881-5.753). Without treatment, there was no difference in relative risk between men and women (1.073 (95%CI: 0.697-1.653)). In the interaction analysis of sex and treatment, the two hazard ratios were statistically significant at 1.983 (95% CI: 1.007-3.906,  $P=0.048$ ).

#### CONCLUSION

The total and proximal burden of intracranial atherosclerotic plaque in male patients with type 2 diabetes with acute cerebrovascular disease were significantly higher than those in female patients. In addition, treatment had a sex-specific effect on intracranial proximal plaque burden. Compared with men, the proximal intracranial plaque burden was significantly reduced in women receiving diabetes treatment, suggesting that hypoglycemic therapy has a protective effect on the proximal intracranial plaque burden in women.

#### CLINICAL RELEVANCE/APPLICATION

NONE

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## Abstract Archives of the RSNA, 2023

T3-SSNR07-6

### Could the New pRELAX Traction Maneuver be the Long-awaited Solution for the Treatment of Posthemorrhagic Cerebral Vasospasm

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S405

Ali Khanafer (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral vasospasm (CVS) is a frequent complication of subarachnoid hemorrhage (SAH). Medicinal and endovascular means play a supportive role in the prevention of subsequent brain infarction. Recently, studies have shown a beneficial effect of CVS treatment with self-expanding retrievable stents. We report our experience with stent angioplasty and the new pRELAX traction maneuver in the treatment of CVS.

#### METHODS AND MATERIALS

We treated 21 patients suffering from posthemorrhagic CVS with either stent retrievers or the dedicated vasospasm device pRELAX (WallabyPhenox, Bochum, Germany). In Group 1, we deployed for 5 minutes a conventional stent retriever or a pRELAX into a narrow brain artery and retrieved it into the microcatheter. In group 2, we deployed the pRELAX into a narrow artery and pulled it back unfolded into the internal carotid artery (ICA), using a technique similar to mechanical thrombectomy. Immediate angiographic results, periprocedural complications, and angiographic follow-up data were recorded.

#### RESULTS

15 patients and 21 treated vessels were included in Group 1 (5 middle cerebral artery (MCA), 8 anterior cerebral artery, 1 basilar artery, 1 posterior cerebral artery). All treatments were technically successful without periprocedural complications. Four vessels showed no angiographic improvement and required further treatment, and 14 vessels showed short-term CVS recurrence, requiring re-treatment. 13 vessels (8 MCA; 5 intradural ICA) in 6 patients (Group 2) were treated using the pRELAX Traction Maneuver. All maneuvers were technically successful without complications and all patient showed significant angiographic improvement. None of the treated vessels showed recurrent CVS requiring further endovascular treatment. No new ischemia was found in the treated territories and no vascular injury was seen on follow-up angiographies.

#### CONCLUSION

Stent retriever angioplasty for CVS is a safe treatment modality with sobering short-term outcomes. The pRELAX traction maneuver showed promising results and may be the long-awaited solution for the treatment of CVS. The pRELAX traction maneuver might also be applied as a preventive measure early after the hemorrhage and prior to the development of CVS.

#### CLINICAL RELEVANCE/APPLICATION

CVS is by far the most frequent reason for poor outcome after SAH. Medicinal and interventional treatment failed so far to prevent catastrophic outcomes. The pRELAX traction maneuver is a safe, easy to use and lasting method to treat CVS.

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## Abstract Archives of the RSNA, 2023

T3-SSNR08

### Neuroradiology (Brain: Vascular (Excluding Acute Stroke)/Stroke (Diagnosis and Treatment))

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S402

Justin E. Costello, DO (*Moderator*) Nothing to Disclose  
Abdelkader Mahammedi, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T3-SSNR08-1 Optimal Photon Counting CT Parameters for Evaluation of Previously Treated Intracranial Aneurysms**

David Urick (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Photon Counting CT (PCCT) offers several significant benefits compared to energy-integrating detector (EID) CT systems: higher spatial resolution, increased contrast-to-noise ratio, and reduced image artifacts. PCCT has potential for improving clinical evaluation of treated intracranial aneurysms, which are poorly evaluated by traditional EID CT due to metal artifact, image noise, and limited resolution. However, optimal PCCT acquisition and reconstruction parameters for evaluating treated intracranial aneurysms are still uncertain.

#### **METHODS AND MATERIALS**

A patient realistic phantom simulating a coiled intracranial aneurysm was used for initial parameterization. Representative sample scans were acquired at 140 kVp in single-energy mode with a Siemens NAEOTOM Alpha system and a Siemens SOMATOM Flash system. Virtual monoenergetic reconstructions (VMR) were compared to select the best reconstruction kernel, metal reduction algorithm, and keV level. These preliminary results guided the analysis of PCCT scans from patients with previously treated intracranial aneurysms. Resulting images were assessed qualitatively by fellowship trained neuroradiologists and a quantitative assessment of the contrast-to-noise ratio (CNR) was performed to identify the ideal parameters for imaging this patient population.

#### **RESULTS**

A 55 keV VMR was found to offer the best view of the phantom model after using vendor-specific metal artifact reduction (IMAR). The same reconstruction parameters were found to offer the highest image quality for patients with treated aneurysms, representing a significant improvement over images obtained with energy integrating CT. Specifically, optimally reconstructed PCCT images offered decreased metal artifact and improved contrast to noise for the intracranial vasculature.

#### **CONCLUSION**

VMRs at 55 keV and IMAR provide the optimal image quality for assessing treated intracranial aneurysms using photon counting CT. These images outperform both EID CT as well as other photon counting reconstructions on a qualitative and quantitative basis.

#### **CLINICAL RELEVANCE/APPLICATION**

Optimally reconstructed PCCT offers superior image quality for evaluation of treated intracranial aneurysms and may ultimately provide a non-invasive alternative to catheter angiography for post-treatment aneurysm follow up.

#### **T3-SSNR08-2 Drug-Eluting Stents for the Treatment of Drug-Refractory Intracranial Stenoses**

Philipp Von Gottberg, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Intracranial atherosclerotic disease (IAD) causing intracranial arterial stenosis (ICS) is a main risk factor for stroke and death. Conservative treatment is considered first line therapy for symptomatic ICS. However, this is based on evidence from randomized controlled multicenter trials dating back more than 10 years that showed a higher rate recurrent stroke (RS) for

the endovascular procedures compared to conservative treatment. A main reason for RS after ICS is seen in neointimal hyperplasia causing restenosis. In the non-neurovascular setting, drug-eluting endovascular devices are frequently used to challenge neointimal hyperplasia. However, drug-eluting devices are still only used to a limited extent in neurointerventional procedures. We therefore analyzed the effect of drug-eluting stents (DES) in the endovascular treatment of drug-refractory ICS.

## **METHODS AND MATERIALS**

We analyzed the outcome of all patients who received de novo endovascular treatment of ICS caused by IAD with DES at our institution between 2013 and 2021. Patients had to be clinically or radiologically demonstrably symptomatic under best medical treatment prior to the endovascular procedure. Scheduled follow-up physical and neurological examinations as well as digital subtraction angiography 3 and 6 months after treatment were analyzed for new ischemia/RS, changes in mRS score and restenosis.

## **RESULTS**

102 patients were included in the analysis. All patients were treated by two experienced neurointerventionalists using the same procedure with the same model of DES. 52 patients received treatment of the anterior circulation, 50 patients received treatment of the posterior circulation. Periprocedural complications occurred in 4.9% (transient ischemic attack in 1 patient/0.98%, stroke in 4 patients/3.92%), among these, one patient died in the in-hospital phase due to intracranial hemorrhage (0.98%). Within 6 months of follow-up, 3.9% of all patients developed recurrent stenosis; one patient (0.98%) had a decrease in mRS of one point, two patients (1.96%) experienced a decrease of 3 points due to recurrent stroke (RS rate of 2.94%).

## **CONCLUSION**

DES for the treatment of drug-refractory ICS arising from IAD are, in our experience, a viable and safe treatment option compared to treatment with bare-metal stents. The risk of peri- and post-procedural stroke and death as well as restenosis is lower in our data than the rates reported in the multicenter, randomized controlled SAMMPRIS- and VISSIT-trials. We therefore advocate a re-evaluation of the role of endovascular treatment of ICS with particular reference to drug-eluting devices.

## **CLINICAL RELEVANCE/APPLICATION**

Our data present a new way to address common problems in endovascular treatment of intracranial stenosis.

## **T3-SSNR08-3 Pseudo-DSA Images from Photon Counting CT Based Computational Fluid Dynamics Simulations**

David Urick (*Presenter*) Nothing to Disclose

## **PURPOSE**

Digital subtraction angiography (DSA) is the current gold standard for imaging cerebral aneurysms. Recently, there has been increasing effort to replicate the sensitivity and specificity offered by DSA using non-invasive imaging methods. Advances in CT including photon-counting CT (PCCT) systems offer increased image contrast and spatial resolution. However, CT is still unable to offer time resolved vascular imaging as achieved with DSA. Computational fluid dynamics (CFD) offers highly accurate simulations of blood flow and has previously been used to replicate DSA studies in large arteries such as the abdominal aorta. Here we demonstrate the combination of high resolution PCCT angiography and CFD to create non-invasive time-resolved DSA-like images in a patient with a cerebrovascular large vessel occlusion.

## **METHODS AND MATERIALS**

This was a retrospective proof-of-concept study evaluating routine clinical PCCT acquired for suspected intracranial large vessel occlusion. CTA of the head and neck was obtained using the Siemens NAEOTOM Alpha system at 140 kVp, 136 mAs, IQ level 25, and a spiral pitch factor of 0.8. Images were reconstructed with an Hv36f kernel at QIR level 3. CTDIvol was 32.2 mGy, DLP was 639 mGy\*cm and SSDE was 31.9 mGy. A previously described deep-learning bone-removal method was used for initial image segmentation. Vascular tree segmentation was performed using a semi-autonomous threshold based method to create a 3D mesh of the intracranial arteries. CFD simulations were performed using HARVEY. Results were processed using in-house code to produce time resolved images mimicking traditional DSA.

## **RESULTS**

CTA images demonstrated non-opacification of the right intracranial internal carotid artery from the cervical carotid bifurcation to the supraclinoid segment. CFD simulations demonstrated the expected pattern of compensatory blood flow through the circle of Willis, with retrograde flow supplied by the remaining internal carotid artery through the right posterior communicating artery and antegrade flow through the left. This flow pattern was easily visualized on DSA-like images generated from the CFD simulations.

## **CONCLUSION**

High resolution vascular imaging combined with CFD enables non-invasive assessment of cerebrovascular blood flow.

## CLINICAL RELEVANCE/APPLICATION

This study demonstrates the combination of PCCT, deep-learning, and CFD to simulate time-resolved DSA-like images of the cerebral vasculature, which may ultimately allow non-invasive evaluation of the cerebral vasculature dynamics.

### **T3-SSNR08-4 Cerebral Amyloid Angiopathy (CAA) is Associated with Higher Regional Transverse Relaxation Rate ( $R_2$ ) in Gray Matter: An Ex-vivo MRI and Neuropathology Study**

Md Tahmid Yasar, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral amyloid angiopathy (CAA) is characterized by accumulation of amyloid- $\beta$  (A $\beta$ ) protein in small vessels of the cortex and leptomeninges. CAA is common in older adults and is linked to intracerebral hemorrhage and cognitive decline. In this study, the association of CAA with the transverse relaxation rate  $R_2$  of MRI was investigated in gray matter regions from a large cohort of community-based older adults.

#### METHODS AND MATERIALS

Cerebral hemispheres from 802 older adults participating in four cohort studies of aging, the Rush Memory and Aging Project, the Minority Aging Research Study, the Religious Orders Study, and the Clinical Core of the Rush Alzheimer's Disease Research Center were included in this work. All hemispheres were imaged ex-vivo using 3T MRI scanners.  $R_2$  maps were generated from multi-echo spin-echo images. Gray matter was segmented into 34 cortical and 8 subcortical regions. Median  $R_2$  values were obtained from each region. Following ex-vivo MRI, all hemispheres underwent detailed neuropathologic assessment. Evaluated neuropathologies included: CAA, A $\beta$  plaques, neurofibrillary tangles, gross infarcts, microinfarcts, TDP-43 pathology, hippocampal sclerosis, Lewy bodies, atherosclerosis, and arteriolosclerosis. Multiple linear regression was conducted in each segmented gray matter region independently to test the association of the corresponding median  $R_2$  value with the global CAA score, controlling for all other neuropathologies, age at death, sex, education, postmortem interval to fixation and to imaging, and scanners. False discovery rate (FDR) was used to correct for multiple comparisons. Statistical significance was set at  $p < 0.05$ .

#### RESULTS

A significant positive association of median  $R_2$  with CAA pathology was found in several cortical regions of the temporal and frontal lobes as well as in subcortical structures. No gray matter region showed lower median  $R_2$  for higher CAA score. Furthermore, we observed similar findings when also controlling for normalized regional volume and for clinical variables such as history of hypertension, diabetes, smoking, blood pressure levels, and the presence of the APOE e4 allele in the regression model.

#### CONCLUSION

This investigation showed that CAA is independently associated with elongated  $R_2$  in cortical regions of the temporal and frontal lobes as well as in subcortical structures in a large number of community-based older adults. This relation was independent of other neuropathologies, demographics and imaging covariates

## CLINICAL RELEVANCE/APPLICATION

Our work in older adults shows the association of CAA with gray matter regional MRI- $R_2$  in cortical regions and subcortical structures. The findings can be used to generate features for classifiers that can detect the CAA pathology.

### **T3-SSNR08-5 Estimating Differences in Adverse Stroke Thrombectomy Outcomes Between Radiology and Neurology: An Instrumental Variables Analysis**

Soryan Kumar, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study estimates differences in readmission, mortality, length of stay, and post-acute care discharge for Medicare patients undergoing stroke thrombectomy performed by either Radiology-based specialties (RAD) or Neurology-based specialties (NEURO).

#### METHODS AND MATERIALS

Our primary data source was the 100% MEDPAR files from 2016 to 2019 which includes all Traditional Medicare (TM) and most Medicare Advantage (MA) hospitalizations. Our study sample included all Medicare beneficiaries who received stroke thrombectomies, classified using ICD-10-PCS and DRG codes used in prior studies. Our primary exposure was if the patient received care from a hospital that was RAD-dominant or NEURO-dominant based on whether the majority of thrombectomies at that institution were performed by RAD or NEURO physicians. We used a quasi-experimental instrumental variables (IV) design based on the distance between each patient and the nearest RAD or NEURO-dominant institution. We adjusted our models for patient age, race, sex, social deprivation, MA status, dual eligibility, disability, end-stage renal disease, ER use,

and institutional volume of stroke procedures. Additionally, we conduct subanalyses using patient MA enrollment and county-level fixed effects.

## RESULTS

Our sample included 34,074 stroke patients who underwent stroke thrombectomy at 621 institutions nationally (RAD = 354, NEURO = 267). In our IV analysis, patients admitted to RAD-dominant institutions had a significantly larger home discharge (1.9%,  $p = 0.034$ ), lower 30D readmission (-3.4%,  $p = 0.009$ ), lower 60D readmission (-3.6%,  $p = 0.008$ ), lower 90D readmission (-3.7%,  $p = 0.006$ ), and lower 90D mortality (-2.5%,  $p = 0.044$ ) relative to NEURO-dominant facilities. Upon further stratification by MA vs. TM, MA patients admitted to RAD-dominant institutions had a significantly lower 30D readmission (-4.5%,  $p = 0.028$ ), lower 60D readmission (-4.7%,  $p = 0.025$ ), and lower 90D readmission (-5.3%,  $p = 0.013$ ) than MA patients admitted to NEURO-dominant institutions. After adding county-level fixed effects, all above findings are nullified.

## CONCLUSION

In this quasi-experimental study comparing RAD and NEURO dominant facilities, we find that RAD facilities were associated with modest reductions in readmission and mortality, especially among MA advantage patients. These effects likely vary by geographic location, which may indicate null stroke thrombectomy outcome differences between RAD and NEURO facilities.

## CLINICAL RELEVANCE/APPLICATION

As stroke remains a leading cause of death, determining factors to reduce adverse outcomes have become increasingly relevant. Effective outcome comparison can inform educational training and health policy regarding stroke treatment.

## T3-SSNR08-6 The Value of Clinical 5.0 T Ultrahigh-Field MRI Magnetic Sensitivity-Weighted Imaging to Assess Cerebral Veins and Deep Medullary Veins

Liu Chang (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the value of 5.0 T ultra-high field MR magnetic susceptibility weighted imaging (SWI) technique to evaluate cerebral veins and deep medullary veins in a healthy population.

## METHODS AND MATERIALS

Fifty healthy adults recruited from March to May 2023 were collected and divided into 3.0 T and 5.0 T MR group using a completely randomized design, with 25 subjects in each group. All subjects underwent magnetic SWI, and image quality was assessed using subjective Likert 5-point scale scores and SNR and CNR, and the quality of the deep medullary vein display [the great cerebral vein (VofG), the internal cerebral vein (ICV), the anterior septal vein (ASV), and the inflow into the anterior septal vein (ASV)] was assessed using a 3-point scale method. DV of ASV, DV of TCV, DV of TLV] were evaluated using a 3-point scale. t-test and Mann Whitney U test were used to compare quantitative indicators between the 2 groups.

## RESULTS

Among the 50 subjects, 27 were male and 23 were female, aged 21-73 ( $43 \pm 11$ ) years. SNR and CNR values of images in the 5.0 T MR group were higher than those in the 3.0 T MR group, with statistically significant differences ( $t=23.62$  and  $21.45$ , respectively,  $P < 0.001$ ), but the differences in subjective scores of image quality between the 5.0 T MR and 3.0 T MR groups were not statistically significant [5.0 (5.0, 5.0), 5.0 (4.0, 5.0) points, respectively,  $Z=-1.46$ ,  $P=0.113$ ]. On the assessment of the deep medullary cerebral veins, SWI in the 3.0 T MR group and 5.0 T MR group showed better in both VofG and ICV, with no statistically significant difference in scores ( $P > 0.05$ ), while in the display of ASV both 5.0 T MR group images were significantly better than 3.0 T MR group images ( $P < 0.05$ ). In the evaluation of DV of ASV, DV of TCV, and DV of TLV, it was found that the 5.0 T MR group showed significantly better display of deep medullary veins than the 3.0 T MR group images in all cases ( $P < 0.001$ ).

## CONCLUSION

The 5.0 T ultra-high field intensity MR SWI technique scan shows excellent cerebral veins and deep medullary veins, which provides the possibility of constructing a medullary venous network for the diagnosis and differential diagnosis of cerebral venous diseases.

## CLINICAL RELEVANCE/APPLICATION

5.0T ultra-high field SWI has unique advantages for displaying DMVs, and the supratentorial cerebral deep medullary veins are characteristically distributed along the peri-lateral ventricles. Understanding and mastering the anatomical characteristics of the deep medullary veins can not only improve the diagnosis of clinicians, but also contribute to the in-depth study of the pathophysiological mechanisms of related neurological diseases and help in disease prognosis, early prevention and intervention.

## Abstract Archives of the RSNA, 2023

T3-SSNR08-1

### Optimal Photon Counting CT Parameters for Evaluation of Previously Treated Intracranial Aneurysms

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S402

David Urick (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon Counting CT (PCCT) offers several significant benefits compared to energy-integrating detector (EID) CT systems: higher spatial resolution, increased contrast-to-noise ratio, and reduced image artifacts. PCCT has potential for improving clinical evaluation of treated intracranial aneurysms, which are poorly evaluated by traditional EID CT due to metal artifact, image noise, and limited resolution. However, optimal PCCT acquisition and reconstruction parameters for evaluating treated intracranial aneurysms are still uncertain.

#### METHODS AND MATERIALS

A patient realistic phantom simulating a coiled intracranial aneurysm was used for initial parameterization. Representative sample scans were acquired at 140 kVp in single-energy mode with a Siemens NAEOTOM Alpha system and a Siemens SOMATOM Flash system. Virtual monoenergetic reconstructions (VMR) were compared to select the best reconstruction kernel, metal reduction algorithm, and keV level. These preliminary results guided the analysis of PCCT scans from patients with previously treated intracranial aneurysms. Resulting images were assessed qualitatively by fellowship trained neuroradiologists and a quantitative assessment of the contrast-to-noise ratio (CNR) was performed to identify the ideal parameters for imaging this patient population.

#### RESULTS

A 55 keV VMR was found to offer the best view of the phantom model after using vendor-specific metal artifact reduction (IMAR). The same reconstruction parameters were found to offer the highest image quality for patients with treated aneurysms, representing a significant improvement over images obtained with energy integrating CT. Specifically, optimally reconstructed PCCT images offered decreased metal artifact and improved contrast to noise for the intracranial vasculature.

#### CONCLUSION

VMRs at 55 keV and IMAR provide the optimal image quality for assessing treated intracranial aneurysms using photon counting CT. These images outperform both EID CT as well as other photon counting reconstructions on a qualitative and quantitative basis.

#### CLINICAL RELEVANCE/APPLICATION

Optimally reconstructed PCCT offers superior image quality for evaluation of treated intracranial aneurysms and may ultimately provide a non-invasive alternative to catheter angiography for post-treatment aneurysm follow up.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSNR08-2

### Drug-Eluting Stents for the Treatment of Drug-Refractory Intracranial Stenoses

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S402

Philipp Von Gottberg, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Intracranial atherosclerotic disease (IAD) causing intracranial arterial stenosis (ICS) is a main risk factor for stroke and death. Conservative treatment is considered first line therapy for symptomatic ICS. However, this is based on evidence from randomized controlled multicenter trials dating back more than 10 years that showed a higher rate recurrent stroke (RS) for the endovascular procedures compared to conservative treatment. A main reason for RS after ICS is seen in neointimal hyperplasia causing restenosis. In the non-neurovascular setting, drug-eluting endovascular devices are frequently used to challenge neointimal hyperplasia. However, drug-eluting devices are still only used to a limited extent in neurointerventional procedures. We therefore analyzed the effect of drug-eluting stents (DES) in the endovascular treatment of drug-refractory ICS.

#### METHODS AND MATERIALS

We analyzed the outcome of all patients who received de novo endovascular treatment of ICS caused by IAD with DES at our institution between 2013 and 2021. Patients had to be clinically or radiologically demonstrably symptomatic under best medical treatment prior to the endovascular procedure. Scheduled follow-up physical and neurological examinations as well as digital subtraction angiography 3 and 6 months after treatment were analyzed for new ischemia/RS, changes in mRS score and restenosis.

#### RESULTS

102 patients were included in the analysis. All patients were treated by two experienced neurointerventionalists using the same procedure with the same model of DES. 52 patients received treatment of the anterior circulation, 50 patients received treatment of the posterior circulation. Periprocedural complications occurred in 4.9% (transient ischemic attack in 1 patient/0.98%, stroke in 4 patients/3.92%), among these, one patient died in the in-hospital phase due to intracranial hemorrhage (0.98%). Within 6 months of follow-up, 3.9% of all patients developed recurrent stenosis; one patient (0.98%) had a decrease in mRS of one point, two patients (1.96%) experienced a decrease of 3 points due to recurrent stroke (RS rate of 2.94%).

#### CONCLUSION

DES for the treatment of drug-refractory ICS arising from IAD are, in our experience, a viable and safe treatment option compared to treatment with bare-metal stents. The risk of peri- and post-procedural stroke and death as well as restenosis is lower in our data than the rates reported in the multicenter, randomized controlled SAMMPRIS- and VISSIT-trials. We therefore advocate a re-evaluation of the role of endovascular treatment of ICS with particular reference to drug-eluting devices.

#### CLINICAL RELEVANCE/APPLICATION

Our data present a new way to address common problems in endovascular treatment of intracranial stenosis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSNR08-3

### Pseudo-DSA Images from Photon Counting CT Based Computational Fluid Dynamics Simulations

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S402

David Urick (*Presenter*) Nothing to Disclose

#### PURPOSE

Digital subtraction angiography (DSA) is the current gold standard for imaging cerebral aneurysms. Recently, there has been increasing effort to replicate the sensitivity and specificity offered by DSA using non-invasive imaging methods. Advances in CT including photon-counting CT (PCCT) systems offer increased image contrast and spatial resolution. However, CT is still unable to offer time resolved vascular imaging as achieved with DSA. Computational fluid dynamics (CFD) offers highly accurate simulations of blood flow and has previously been used to replicate DSA studies in large arteries such as the abdominal aorta. Here we demonstrate the combination of high resolution PCCT angiography and CFD to create non-invasive time-resolved DSA-like images in a patient with a cerebrovascular large vessel occlusion.

#### METHODS AND MATERIALS

This was a retrospective proof-of-concept study evaluating routine clinical PCCT acquired for suspected intracranial large vessel occlusion. CTA of the head and neck was obtained using the Siemens NAEOTOM Alpha system at 140 kVp, 136 mAs, IQ level 25, and a spiral pitch factor of 0.8. Images were reconstructed with an Hv36f kernel at QIR level 3. CTDIvol was 32.2 mGy, DLP was 639 mGy\*cm and SSDE was 31.9 mGy. A previously described deep-learning bone-removal method was used for initial image segmentation. Vascular tree segmentation was performed using a semi-autonomous threshold based method to create a 3D mesh of the intracranial arteries. CFD simulations were performed using HARVEY. Results were processed using in-house code to produce time resolved images mimicking traditional DSA.

#### RESULTS

CTA images demonstrated non-opacification of the right intracranial internal carotid artery from the cervical carotid bifurcation to the supraclinoid segment. CFD simulations demonstrated the expected pattern of compensatory blood flow through the circle of Willis, with retrograde flow supplied by the remaining internal carotid artery through the right posterior communicating artery and antegrade flow through the left. This flow pattern was easily visualized on DSA-like images generated from the CFD simulations.

#### CONCLUSION

High resolution vascular imaging combined with CFD enables non-invasive assessment of cerebrovascular blood flow.

#### CLINICAL RELEVANCE/APPLICATION

This study demonstrates the combination of PCCT, deep-learning, and CFD to simulate time-resolved DSA-like images of the cerebral vasculature, which may ultimately allow non-invasive evaluation of the cerebral vasculature dynamics.

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## Abstract Archives of the RSNA, 2023

T3-SSNR08-4

### **Cerebral Amyloid Angiopathy (CAA) is Associated with Higher Regional Transverse Relaxation Rate ( $R_2$ ) in Gray Matter: An Ex-vivo MRI and Neuropathology Study**

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S402

Md Tahmid Yasar, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cerebral amyloid angiopathy (CAA) is characterized by accumulation of amyloid- $\beta$  (A $\beta$ ) protein in small vessels of the cortex and leptomeninges. CAA is common in older adults and is linked to intracerebral hemorrhage and cognitive decline. In this study, the association of CAA with the transverse relaxation rate  $R_2$  of MRI was investigated in gray matter regions from a large cohort of community-based older adults.

#### **METHODS AND MATERIALS**

Cerebral hemispheres from 802 older adults participating in four cohort studies of aging, the Rush Memory and Aging Project, the Minority Aging Research Study, the Religious Orders Study, and the Clinical Core of the Rush Alzheimer's Disease Research Center were included in this work. All hemispheres were imaged ex-vivo using 3T MRI scanners.  $R_2$  maps were generated from multi-echo spin-echo images. Gray matter was segmented into 34 cortical and 8 subcortical regions. Median  $R_2$  values were obtained from each region. Following ex-vivo MRI, all hemispheres underwent detailed neuropathologic assessment. Evaluated neuropathologies included: CAA, A $\beta$  plaques, neurofibrillary tangles, gross infarcts, microinfarcts, TDP-43 pathology, hippocampal sclerosis, Lewy bodies, atherosclerosis, and arteriolosclerosis. Multiple linear regression was conducted in each segmented gray matter region independently to test the association of the corresponding median  $R_2$  value with the global CAA score, controlling for all other neuropathologies, age at death, sex, education, postmortem interval to fixation and to imaging, and scanners. False discovery rate (FDR) was used to correct for multiple comparisons. Statistical significance was set at  $p < 0.05$ .

#### **RESULTS**

A significant positive association of median  $R_2$  with CAA pathology was found in several cortical regions of the temporal and frontal lobes as well as in subcortical structures. No gray matter region showed lower median  $R_2$  for higher CAA score. Furthermore, we observed similar findings when also controlling for normalized regional volume and for clinical variables such as history of hypertension, diabetes, smoking, blood pressure levels, and the presence of the APOE e4 allele in the regression model.

#### **CONCLUSION**

This investigation showed that CAA is independently associated with elongated  $R_2$  in cortical regions of the temporal and frontal lobes as well as in subcortical structures in a large number of community-based older adults. This relation was independent of other neuropathologies, demographics and imaging covariates

#### **CLINICAL RELEVANCE/APPLICATION**

Our work in older adults shows the association of CAA with gray matter regional MRI- $R_2$  in cortical regions and subcortical structures. The findings can be used to generate features for classifiers that can detect the CAA pathology.

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## Abstract Archives of the RSNA, 2023

T3-SSNR08-5

### Estimating Differences in Adverse Stroke Thrombectomy Outcomes Between Radiology and Neurology: An Instrumental Variables Analysis

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S402

Soryan Kumar, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study estimates differences in readmission, mortality, length of stay, and post-acute care discharge for Medicare patients undergoing stroke thrombectomy performed by either Radiology-based specialties (RAD) or Neurology-based specialties (NEURO).

#### METHODS AND MATERIALS

Our primary data source was the 100% MEDPAR files from 2016 to 2019 which includes all Traditional Medicare (TM) and most Medicare Advantage (MA) hospitalizations. Our study sample included all Medicare beneficiaries who received stroke thrombectomies, classified using ICD-10-PCS and DRG codes used in prior studies. Our primary exposure was if the patient received care from a hospital that was RAD-dominant or NEURO-dominant based on whether the majority of thrombectomies at that institution were performed by RAD or NEURO physicians. We used a quasi-experimental instrumental variables (IV) design based on the distance between each patient and the nearest RAD or NEURO-dominant institution. We adjusted our models for patient age, race, sex, social deprivation, MA status, dual eligibility, disability, end-stage renal disease, ER use, and institutional volume of stroke procedures. Additionally, we conduct subanalyses using patient MA enrollment and county-level fixed effects.

#### RESULTS

Our sample included 34,074 stroke patients who underwent stroke thrombectomy at 621 institutions nationally (RAD = 354, NEURO = 267). In our IV analysis, patients admitted to RAD-dominant institutions had a significantly larger home discharge (1.9%,  $p = 0.034$ ), lower 30D readmission (-3.4%,  $p = 0.009$ ), lower 60D readmission (-3.6%,  $p = 0.008$ ), lower 90D readmission (-3.7%,  $p = 0.006$ ), and lower 90D mortality (-2.5%,  $p = 0.044$ ) relative to NEURO-dominant facilities. Upon further stratification by MA vs. TM, MA patients admitted to RAD-dominant institutions had a significantly lower 30D readmission (-4.5%,  $p = 0.028$ ), lower 60D readmission (-4.7%,  $p = 0.025$ ), and lower 90D readmission (-5.3%,  $p = 0.013$ ) than MA patients admitted to NEURO-dominant institutions. After adding county-level fixed effects, all above findings are nullified.

#### CONCLUSION

In this quasi-experimental study comparing RAD and NEURO dominant facilities, we find that RAD facilities were associated with modest reductions in readmission and mortality, especially among MA advantage patients. These effects likely vary by geographic location, which may indicate null stroke thrombectomy outcome differences between RAD and NEURO facilities.

#### CLINICAL RELEVANCE/APPLICATION

As stroke remains a leading cause of death, determining factors to reduce adverse outcomes have become increasingly relevant. Effective outcome comparison can inform educational training and health policy regarding stroke treatment.

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## Abstract Archives of the RSNA, 2023

T3-SSNR08-6

### The Value of Clinical 5.0 T Ultrahigh-Field MRI Magnetic Sensitivity-Weighted Imaging to Assess Cerebral Veins and Deep Medullary Veins

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S402

Liu Chang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of 5.0 T ultra-high field MR magnetic susceptibility weighted imaging (SWI) technique to evaluate cerebral veins and deep medullary veins in a healthy population.

#### METHODS AND MATERIALS

Fifty healthy adults recruited from March to May 2023 were collected and divided into 3.0 T and 5.0 T MR group using a completely randomized design, with 25 subjects in each group. All subjects underwent magnetic SWI, and image quality was assessed using subjective Likert 5-point scale scores and SNR and CNR, and the quality of the deep medullary vein display [the great cerebral vein (VofG), the internal cerebral vein (ICV), the anterior septal vein (ASV), and the inflow into the anterior septal vein (ASV)] was assessed using a 3-point scale method. DV of ASV, DV of TCV, DV of TLV] were evaluated using a 3-point scale. t-test and Mann Whitney U test were used to compare quantitative indicators between the 2 groups.

#### RESULTS

Among the 50 subjects, 27 were male and 23 were female, aged 21-73 ( $43\pm 11$ ) years. SNR and CNR values of images in the 5.0 T MR group were higher than those in the 3.0 T MR group, with statistically significant differences ( $t=23.62$  and  $21.45$ , respectively,  $P<0.001$ ), but the differences in subjective scores of image quality between the 5.0 T MR and 3.0 T MR groups were not statistically significant [5.0 (5.0, 5.0), 5.0 (4.0, 5.0) points, respectively,  $Z=-1.46$ ,  $P=0.113$ ]. On the assessment of the deep medullary cerebral veins, SWI in the 3.0 T MR group and 5.0 T MR group showed better in both VofG and ICV, with no statistically significant difference in scores ( $P>0.05$ ), while in the display of ASV both 5.0 T MR group images were significantly better than 3.0 T MR group images ( $P<0.05$ ). In the evaluation of DV of ASV, DV of TCV, and DV of TLV, it was found that the 5.0 T MR group showed significantly better display of deep medullary veins than the 3.0 T MR group images in all cases ( $P<0.001$ ).

#### CONCLUSION

The 5.0 T ultra-high field intensity MR SWI technique scan shows excellent cerebral veins and deep medullary veins, which provides the possibility of constructing a medullary venous network for the diagnosis and differential diagnosis of cerebral venous diseases.

#### CLINICAL RELEVANCE/APPLICATION

5.0T ultra-high field SWI has unique advantages for displaying DMVs, and the supratentorial cerebral deep medullary veins are characteristically distributed along the peri-lateral ventricles. Understanding and mastering the anatomical characteristics of the deep medullary veins can not only improve the diagnosis of clinicians, but also contribute to the in-depth study of the pathophysiological mechanisms of related neurological diseases and help in disease prognosis, early prevention and intervention.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSOB02

### OB/Gynecology (Pelvic Imaging)

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S502

Stephanie Nougaret, MD, PhD (*Moderator*) Nothing to Disclose  
Angela Tong, MD (*Moderator*) Equipment support, Siemens AG

#### Sub-Events

### **T3-SSOB02-2 Exploring the Recently Proposed Non contrast MRI Score for Characterization of Ovarian-Adnexal Masses vis a vis ORADS MRI Score**

Shabnam B. Grover, MD, DMRD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ovarian tumors are amongst the leading cause of mortality in the female population. ACR ORADS MRI is a recently proposed algorithm for characterization of ovarian adnexal masses which entails a mp-MRI protocol including evaluation of dynamic contrast kinetics within the tumor. However, concerns for contrast agent contraindications in patients with renal dysfunction and economy of equipment time have generated proposals for abbreviated protocols amongst stake holders. We explored the recently proposed "non contrast MRI score" for characterization of ovarian-adnexal masses versus ORADS MRI score, against histopathology as reference standard.

#### METHODS AND MATERIALS

This was a prospective IRB approved study of 50 patients with ovarian adnexal masses who underwent standard mp-MRI, as per ACR ORADS MRI protocol for tumor characterization and the final histopathology result was available. Three dedicated body Imaging experts (one faculty, plus two Fellows) retrospectively categorized the available studies using "non contrast MRI score" proposed 2021, by Sahin Addley et al, to explore its diagnostic accuracy and compared it with ACR-ORADS MRI score and with gold standard histopathology in the available data set.

#### RESULTS

The histopathology diagnosis was 20 benign and 30 malignant tumors. The sensitivity, specificity, PPV and NPV was found to be 96.77%, 73.68%, 85.71% and 93.33%, for "non-contrast MRI score", versus 93.55 %, 78.95 %, 87.88 % and 88.24%, for ORADS MRI score. For "non-contrast MRI score", the diagnostic accuracy was 70%, while that for ORADS MRI score was 88%. Fischer's exact test ( $p < 0.001$ ) was highly significant for either scoring system. Kappa value of 0.958 implied excellent agreement between scoring systems.

#### CONCLUSION

The abbreviated protocol without DCE MRI has an acceptable accuracy and good agreement with ORADS MRI score and should be explored further, especially in the context of contrast contraindications, patient cooperation and the financial advantages of an abbreviated protocol.

#### CLINICAL RELEVANCE/APPLICATION

The "Non-Contrast MRI score" technique for ovarian adnexal tumors is relevant in patients for whom contrast injection is contraindicated in view of renal derangement or other constraints. Further, in view of saving patient and equipment time and contrast agent expenditure, it will be of immense utility in low resource settings which are rife with restrictions of both, infrastructure and trained Radiologists.

### **T3-SSOB02-3 Outcomes and Reinterventions Following Uterine Artery Embolization for the Treatment of Uterine Leiomyomas**

Alexis M. Medema, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

Uterine leiomyomas, commonly known as uterine fibroids, are benign tumors that arise from smooth muscle and can significantly impact patients' quality of life due to abnormal bleeding or bulk symptoms. Over the past two decades, uterine artery embolization (UAE) has risen as a minimally invasive alternative treatment to hysterectomy or myomectomy for the management of symptomatic leiomyomas. While prior work has established the safety of this procedure, there are few reports quantifying subsequent treatment and complications. The purpose of this study is to assess the frequency and type of secondary interventions implemented after UAE, as well as to determine the rate of primary ovarian insufficiency following treatment.

## METHODS AND MATERIALS

This was a retrospective study consisting of 199 patients who presented with symptomatic leiomyoma(s) confirmed by MRI. The cohort underwent embolization between January 2013 and December 2018 at a single academic institution. Data were collected from the electronic medical record and included demographics, symptomology, imaging, procedural details, and follow-up care. This information was subsequently analyzed to quantify the frequencies of various outcomes at 4-10 years following embolization.

## RESULTS

All patients underwent technically successful UAE. At the time of chart review, follow-up data was available for 188/199 (94.5%) patients. Of these, 145 (77.1%) reported significant symptomatic improvement. Seven (3.7%) reported amenorrhea, and 34 (18.1%) required secondary treatment, with 17/188 (9.0%) receiving medical reintervention and 17/188 (9.0%) undergoing surgical reintervention. The most common secondary medical management was any method of hormone therapy (15/188, 8.0%) and the most common subsequent gynecologic procedure was hysterectomy (13/188, 6.9%).

## CONCLUSION

Given its minimally invasive nature, rapid recovery time, and uterine-sparing capability, UAE should be considered a frontline therapy for symptomatic leiomyomas. This study revealed a low rate of ovarian dysfunction and a low rate of secondary reintervention after UAE. Following embolization, only 9% of patients required additional medical management, and only 9% required a second procedural intervention.

## CLINICAL RELEVANCE/APPLICATION

When undergoing UAE evaluation, patients can be counseled that there is low risk for needing further surgical intervention or experiencing ovarian dysfunction following the procedure.

## T3-SSOB02-4 How to Protocol an MRI to Explore Deep Pelvic Endometriosis

Isabelle Thomassin-Naggara, MD (*Presenter*) Researcher, General Electric Company; Research funded, General Electric Company; Researcher, Canon Medical Systems Corporation; Research funded, Canon Medical Systems Corporation; Research funded, Hologic, Inc; Research funded, Siemens AG; Research funded, Guerbet SA

## PURPOSE

To evaluate the diagnostic value of vaginal, rectal opacification, bowel enema preparation, gadolinium injection in MR protocol for detection of deep pelvic endometriosis (DE) pelvic lesion.

## METHODS AND MATERIALS

ENDOVALIRM database was retrospectively analyzed and 571 women with mean age 33 years old (range = 17-49) with subsequent pelvic surgery for endometriosis in 7 French centers between 2019/01/01 and 2020/12/31 were included. All women underwent a pelvic MRI with various type of MR protocol and preparation, including rectal and/or vaginal opacification, bowel enema preparation and gadolinium injection. Two radiologists independently quoted each MRI and made a detailed evaluation for DE pelvic location based on the dPEi classification. Were tested the impact of vaginal opacification, rectal opacification, bowel preparation, type of MR unit strength (1.5T or 3T) and additional sequences thin slices T2 sequence or 3DT2 sequence on reader performance for the diagnosis of each DE location.

## RESULTS

MR correctly predicted surgical locations of DE on bladder (OR = 332,8 [95%CI 104.48-1302.24]) ( $p < .05$ ), rectosigmoid (OR=27 [95%CI 16.97-43.87]) ( $p < .05$ ), torus/USL (OR = 25,3 [95%CI 13.07-48.88]) ( $p < .05$ ), and posterior vaginal pouch (OR= 13,4 [ 95%CI 8.04-23,06]) ( $p < .005$ ). Interobserver agreement was good for bladder DE (? =0.838[95% CI, 0.74-0.92])substantial for vaginal (? =0.70[95% CI, 0.63-0.77]) and rectosigmoid DE (? = 0.749[95% CI, 0.69-0.80]), moderate for lateral compartment DE (? = 0,57 [95% CI, 0.50-0.65]) and poor/fair for torus/USL DE (? = 0.40[95% CI, 0.29-0.51]). Interobserver agreement was substantial between the two readers for the 3 categories of the dPEI score (mild, moderate, and severe) (? = 0.70 [95% CI, 0.64-0.75]).MR with bowel enema preparation correctly diagnosed 94.9% (295/311) torus/USL DE location while MR without bowel preparation correctly diagnosed 85% (221/260) torus/USL (location  $p < 0,0001$ ). MR with bowel preparation was more accurate than MR without bowel preparation for diagnosis of rectosigmoid

nodule, respectively 85,9% (267/311) versus 77,7% (202/260) ( $p=0,01$ ). MR without vaginal opacification was more accurate than MR with vaginal opacification for the diagnosis of torus/USL DE location (94,1% (301/320) versus 85,7% (215/251)) ( $p<0,0001$ ) without any difference for the diagnosis of vaginal nodule ( $p=0,83$ ).

#### **CONCLUSION**

Bowel preparation prior to MR examination should be preferred to rectal or vaginal opacification for the diagnosis of DE.

#### **CLINICAL RELEVANCE/APPLICATION**

To improve the MRI protocol for endometriosis.

### **T3-SSOB02-5 Validation of MRI O-RADS for the Triage of Ovarian Masses in a Tertiary Oncology Center**

Andrew Nanapragasam, FRCPC, FRCR (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to evaluate the efficacy of MRI O-RADS for triage of patients to surgical gynaecologist or oncologist according to high or low risk of malignancy (invasive cancer/Low-malignant potential epithelial tumors (LMP)) in a large cohort of pathology-confirmed adnexal masses.

#### **METHODS AND MATERIALS**

We conducted a retrospective MRI review of consecutive patients who underwent surgical resection between January 2008 and December 2018. Two radiologists with different experience independently evaluated MRIs and classified each ovarian mass according to MRI O-RADS. In patients who underwent ultrasound prior to MRI, MRI O-RADS accuracy values were compared with accuracy values of US O-RADS reviewed by the more experienced radiologist. Sensitivity, specificity, positive and negative predictive values (PPV and NPV) were calculated using an US and MRI O-RADS score = 4 as the threshold for malignancy. Chi-square and Kappa testing were used.

#### **RESULTS**

317 adnexal masses in 298 patients (aged 18-92) were assessed, 197 were benign, 20 LMP, 100 malignant. O-RADS categories 2 ( $n=98$ ), 3 ( $n=98$ ), 4 ( $n=73$ ), 5 ( $n=48$ ) for Reviewer#1 (more experienced) had LMP/malignant rates of 2%, 11%, 86%, and 92% respectively. MRI O-RADS = 4 had a sensitivity, specificity, NPV, PPV, and accuracy values of 89% (CI: 82-94), 93% (CI: 88-96), 93% (CI: 89-96), 88% (CI: 81-93), and 92% (CI: 88-94) for the Reviewer#1 and 95% (CI: 89-98), 77% (CI:70-82), 96% (CI:92-98), 71% (CI:63-78), and 83% (CI:79-87) for the Reviewer#2. While the more experienced reader had higher specificity, PPV, and accuracy ( $p<0.05$ ), inter-observer agreement was substantial (Kappa = 0.71) between the two reviewers. MRI assessment significantly improved ( $p < 0.05$ ) triage of patients in the subset of patients with prior US ( $n=96$ ) that had a sensitivity, specificity, NPV, PPV, and accuracy of 89% (CI:52-99), 68% (CI:58-78), 98% (CI:92-99), 22% (CI:10-38), and 70% (CI:61-79), respectively.

#### **CONCLUSION**

MRI O-RADS demonstrated high performance for triaging adnexal masses in a tertiary referral centre, with the more experienced reader demonstrating higher specificity, PPV, and accuracy values but substantial inter-observer agreement. MRI specificity, PPV values were significantly better than US in a subset who underwent both examinations.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI O-RADS enhances adnexal mass assessment by improving patient triage to surgical gynaecologist versus oncologist.

### **T3-SSOB02-6 Intravasation Complicating Hysterosalpingo-foam Sonography (HyFoSy) Using Foam**

Jemma Ford, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We aimed to assess the intravasation rate of HyFoSy using ExEm® Foam and association with endometrial thickness, ExEm® Foam volume, uterine length, adenomyosis severity, uterine morphology or pain score.

#### **METHODS AND MATERIALS**

An ethics-approved retrospective study on all HyFoSy examinations between 23 January 2018 and 27 October 2021 on sub-fertile patients, trying to conceive. Initial transvaginal sonography confirmed anatomy, uterine morphology, adenomyosis severity and endometrial thickness. Subspecialist radiologists performed HyFoSy with sonographer assistance. Intravasation was identified in real time but also checked for afterwards. Patients were asked to rate instillation pain/discomfort from one to ten immediately afterward

## RESULTS

Four hundred and thirty-six ( $n = 436$ ) patients met inclusion criteria. Thirty (6.9%) experienced intravasation. Endometrial thickness and pain score were associated with intravasation. For every millimetre increase in endometrial thickness, the odds of intravasation decreased by 26% ( $P = 0.010$ ). For every point increase on the pain scale, the odds of intravasation increased by 22% ( $P = 0.032$ ). There was no evidence of an association between instilled ExEm® Foam volume or the other previously published parameters with intravasation.

## CONCLUSION

A 6.9% rate of intravasation was observed. Both endometrial thickness and pain score were significantly associated with intravasation. There was no evidence of an association between ExEm® Foam volume and intravasation.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-SSOB02-2

### Exploring the Recently Proposed Non contrast MRI Score for Characterization of Ovarian-Adnexal Masses vis a vis ORADS MRI Score

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S502

Shabnam B. Grover, MD, DMRD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ovarian tumors are amongst the leading cause of mortality in the female population. ACR ORADS MRI is a recently proposed algorithm for characterization of ovarian adnexal masses which entails a mp-MRI protocol including evaluation of dynamic contrast kinetics within the tumor. However, concerns for contrast agent contraindications in patients with renal dysfunction and economy of equipment time have generated proposals for abbreviated protocols amongst stake holders. We explored the recently proposed "non contrast MRI score" for characterization of ovarian-adnexal masses versus ORADS MRI score, against histopathology as reference standard.

#### METHODS AND MATERIALS

This was a prospective IRB approved study of 50 patients with ovarian adnexal masses who underwent standard mp-MRI, as per ACR ORADS MRI protocol for tumor characterization and the final histopathology result was available. Three dedicated body Imaging experts (one faculty, plus two Fellows) retrospectively categorized the available studies using "non contrast MRI score" proposed 2021, by Sahin Addley et al, to explore its diagnostic accuracy and compared it with ACR-ORADS MRI score and with gold standard histopathology in the available data set.

#### RESULTS

The histopathology diagnosis was 20 benign and 30 malignant tumors. The sensitivity, specificity, PPV and NPV was found to be 96.77%, 73.68%, 85.71% and 93.33%, for "non-contrast MRI score", versus 93.55 %, 78.95 %, 87.88 % and 88.24%, for ORADS MRI score. For "non-contrast MRI score", the diagnostic accuracy was 70%, while that for ORADS MRI score was 88%. Fischer's exact test ( $p$  less than 0.001) was highly significant for either scoring system. Kappa value of 0.958 implied excellent agreement between scoring systems.

#### CONCLUSION

The abbreviated protocol without DCE MRI has an acceptable accuracy and good agreement with ORADS MRI score and should be explored further, especially in the context of contrast contraindications, patient cooperation and the financial advantages of an abbreviated protocol.

#### CLINICAL RELEVANCE/APPLICATION

The "Non-Contrast MRI score" technique for ovarian adnexal tumors is relevant in patients for whom contrast injection is contraindicated in view of renal derangement or other constraints. Further, in view of saving patient and equipment time and contrast agent expenditure, it will be of immense utility in low resource settings which are rife with restrictions of both, infrastructure and trained Radiologists.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSOB02-3

### Outcomes and Reinterventions Following Uterine Artery Embolization for the Treatment of Uterine Leiomyomas

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S502

Alexis M. Medema, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Uterine leiomyomas, commonly known as uterine fibroids, are benign tumors that arise from smooth muscle and can significantly impact patients' quality of life due to abnormal bleeding or bulk symptoms. Over the past two decades, uterine artery embolization (UAE) has risen as a minimally invasive alternative treatment to hysterectomy or myomectomy for the management of symptomatic leiomyomas. While prior work has established the safety of this procedure, there are few reports quantifying subsequent treatment and complications. The purpose of this study is to assess the frequency and type of secondary interventions implemented after UAE, as well as to determine the rate of primary ovarian insufficiency following treatment.

#### METHODS AND MATERIALS

This was a retrospective study consisting of 199 patients who presented with symptomatic leiomyoma(s) confirmed by MRI. The cohort underwent embolization between January 2013 and December 2018 at a single academic institution. Data were collected from the electronic medical record and included demographics, symptomology, imaging, procedural details, and follow-up care. This information was subsequently analyzed to quantify the frequencies of various outcomes at 4-10 years following embolization.

#### RESULTS

All patients underwent technically successful UAE. At the time of chart review, follow-up data was available for 188/199 (94.5%) patients. Of these, 145 (77.1%) reported significant symptomatic improvement. Seven (3.7%) reported amenorrhea, and 34 (18.1%) required secondary treatment, with 17/188 (9.0%) receiving medical reintervention and 17/188 (9.0%) undergoing surgical reintervention. The most common secondary medical management was any method of hormone therapy (15/188, 8.0%) and the most common subsequent gynecologic procedure was hysterectomy (13/188, 6.9%).

#### CONCLUSION

Given its minimally invasive nature, rapid recovery time, and uterine-sparing capability, UAE should be considered a frontline therapy for symptomatic leiomyomas. This study revealed a low rate of ovarian dysfunction and a low rate of secondary reintervention after UAE. Following embolization, only 9% of patients required additional medical management, and only 9% required a second procedural intervention.

#### CLINICAL RELEVANCE/APPLICATION

When undergoing UAE evaluation, patients can be counseled that there is low risk for needing further surgical intervention or experiencing ovarian dysfunction following the procedure.

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## Abstract Archives of the RSNA, 2023

T3-SSOB02-4

### How to Protocol an MRI to Explore Deep Pelvic Endometriosis

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S502

Isabelle Thomassin-Naggara, MD (*Presenter*) Researcher, General Electric Company; Research funded, General Electric Company; Researcher, Canon Medical Systems Corporation; Research funded, Canon Medical Systems Corporation; Research funded, Hologic, Inc; Research funded, Siemens AG; Research funded, Guerbet SA

#### PURPOSE

To evaluate the diagnostic value of vaginal, rectal opacification, bowel enema preparation, gadolinium injection in MR protocol for detection of deep pelvic endometriosis (DE) pelvic lesion.

#### METHODS AND MATERIALS

ENDOVALIRM database was retrospectively analyzed and 571 women with mean age 33 years old (range = 17-49) with subsequent pelvic surgery for endometriosis in 7 French centers between 2019/01/01 and 2020/12/31 were included. All women underwent a pelvic MRI with various type of MR protocol and preparation, including rectal and/or vaginal opacification, bowel enema preparation and gadolinium injection. Two radiologists independently quoted each MRI and made a detailed evaluation for DE pelvic location based on the dPEi classification. Were tested the impact of vaginal opacification, rectal opacification, bowel preparation, type of MR unit strength (1.5T or 3T) and additional sequences thin slices T2 sequence or 3DT2 sequence on reader performance for the diagnosis of each DE location.

#### RESULTS

MR correctly predicted surgical locations of DE on bladder (OR = 332,8 [95%CI 104.48-1302.24]) ( $p < .05$ ), rectosigmoid (OR=27 [95%CI 16.97-43.87]) ( $p < .05$ ), torus/USL (OR = 25,3 [95%CI 13.07-48.88]) ( $p < .05$ ), and posterior vaginal pouch (OR= 13,4 [ 95%CI 8.04-23,06]) ( $p < .005$ ). Interobserver agreement was good for bladder DE (? =0.838[95% CI, 0.74-0.92])substantial for vaginal (? =0.70[95% CI, 0.63-0.77]) and rectosigmoid DE (? = 0.749[95% CI, 0.69-0.80]), moderate for lateral compartment DE (? = 0,57 [95% CI, 0.50-0.65]) and poor/fair for torus/USL DE (? = 0.40[95% CI, 0.29-0.51]). Interobserver agreement was substantial between the two readers for the 3 categories of the dPEI score (mild, moderate, and severe) (? = 0.70 [95% CI, 0.64-0.75]).MR with bowel enema preparation correctly diagnosed 94.9% (295/311) torus/USL DE location while MR without bowel preparation correctly diagnosed 85% (221/260) torus/USL (location  $p < 0,0001$ ). MR with bowel preparation was more accurate than MR without bowel preparation for diagnosis of rectosigmoid nodule , respectively 85,9% (267/311) versus 77,7% (202/260) ( $p=0,01$ ). MR without vaginal opacification was more accurate than MR with vaginal opacification for the diagnosis of torus/USL DE location(94,1% (301/320) versus 85,7% (215/251)) ( $p < 0,0001$ ) without any difference for the diagnosis of vaginal nodule ( $p=0,83$ ).

#### CONCLUSION

Bowel preparation prior to MR examination should be preferred to rectal or vaginal opacification for the diagnosis of DE.

#### CLINICAL RELEVANCE/APPLICATION

To improve the MRI protocol for endometriosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-SSOB02-5

### Validation of MRI O-RADS for the Triage of Ovarian Masses in a Tertiary Oncology Center

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S502

Andrew Nanapragasam, FRCPC, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the efficacy of MRI O-RADS for triage of patients to surgical gynaecologist or oncologist according to high or low risk of malignancy (invasive cancer/Low-malignant potential epithelial tumors (LMP)) in a large cohort of pathology-confirmed adnexal masses.

#### METHODS AND MATERIALS

We conducted a retrospective MRI review of consecutive patients who underwent surgical resection between January 2008 and December 2018. Two radiologists with different experience independently evaluated MRIs and classified each ovarian mass according to MRI O-RADS. In patients who underwent ultrasound prior to MRI, MRI O-RADS accuracy values were compared with accuracy values of US O-RADS reviewed by the more experienced radiologist. Sensitivity, specificity, positive and negative predictive values (PPV and NPV) were calculated using an US and MRI O-RADS score = 4 as the threshold for malignancy. Chi-square and Kappa testing were used.

#### RESULTS

317 adnexal masses in 298 patients (aged 18-92) were assessed, 197 were benign, 20 LMP, 100 malignant. O-RADS categories 2 (n=98), 3 (n=98), 4 (n=73), 5 (n=48) for Reviewer#1 (more experienced) had LMP/malignant rates of 2%, 11%, 86%, and 92% respectively. MRI O-RADS = 4 had a sensitivity, specificity, NPV, PPV, and accuracy values of 89% (CI: 82-94), 93% (CI: 88-96), 93% (CI: 89-96), 88% (CI: 81-93), and 92% (CI: 88-94) for the Reviewer#1 and 95% (CI: 89-98), 77% (CI:70-82), 96% (CI:92-98), 71% (CI:63-78), and 83% (CI:79-87) for the Reviewer#2. While the more experienced reader had higher specificity, PPV, and accuracy ( $p < 0.05$ ), inter-observer agreement was substantial (Kappa = 0.71) between the two reviewers. MRI assessment significantly improved ( $p < 0.05$ ) triage of patients in the subset of patients with prior US (n=96) that had a sensitivity, specificity, NPV, PPV, and accuracy of 89% (CI:52-99), 68% (CI:58-78), 98% (CI:92-99), 22% (CI:10-38), and 70% (CI:61-79), respectively.

#### CONCLUSION

MRI O-RADS demonstrated high performance for triaging adnexal masses in a tertiary referral centre, with the more experienced reader demonstrating higher specificity, PPV, and accuracy values but substantial inter-observer agreement. MRI specificity, PPV values were significantly better than US in a subset who underwent both examinations.

#### CLINICAL RELEVANCE/APPLICATION

MRI O-RADS enhances adnexal mass assessment by improving patient triage to surgical gynaecologist versus oncologist.

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## Abstract Archives of the RSNA, 2023

T3-SSOB02-6

### Intravasation Complicating Hysterosalpingo-foam Sonography (HyFoSy) Using Foam

Tuesday, Nov. 28 9:30AM - 10:30AM Room: S502

Jemma Ford, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to assess the intravasation rate of HyFoSy using ExEm® Foam and association with endometrial thickness, ExEm® Foam volume, uterine length, adenomyosis severity, uterine morphology or pain score.

#### METHODS AND MATERIALS

An ethics-approved retrospective study on all HyFoSy examinations between 23 January 2018 and 27 October 2021 on sub-fertile patients, trying to conceive. Initial transvaginal sonography confirmed anatomy, uterine morphology, adenomyosis severity and endometrial thickness. Subspecialist radiologists performed HyFoSy with sonographer assistance. Intravasation was identified in real time but also checked for afterwards. Patients were asked to rate instillation pain/discomfort from one to ten immediately afterward

#### RESULTS

Four hundred and thirty-six ( $n = 436$ ) patients met inclusion criteria. Thirty (6.9%) experienced intravasation. Endometrial thickness and pain score were associated with intravasation. For every millimetre increase in endometrial thickness, the odds of intravasation decreased by 26% ( $P = 0.010$ ). For every point increase on the pain scale, the odds of intravasation increased by 22% ( $P = 0.032$ ). There was no evidence of an association between instilled ExEm® Foam volume or the other previously published parameters with intravasation.

#### CONCLUSION

A 6.9% rate of intravasation was observed. Both endometrial thickness and pain score were significantly associated with intravasation. There was no evidence of an association between ExEm® Foam volume and intravasation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-STCE1

### Science Session (Sustainability in Imaging)

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 1

#### Sub-Events

#### T3-STCE1-1 Addressing Healthcare's Carbon Footprint: Imaging Practices and Environmental Impact

Mackenzie Szczepanski, BS (*Presenter*) Nothing to Disclose

##### PURPOSE

This poster aims to: 1) Analyze the environmental impact of radiologic studies. 2) Compare carbon footprints among different radiologic studies. 3) Examine the influence of imaging guidelines on appropriate imaging use.

##### METHODS AND MATERIALS

This section outlines the methods used to gather peer-reviewed articles from PubMed, Google Scholar, and NIH for research on the environmental impact of radiology and healthcare, including topics like carbon emissions of imaging, carbon footprint of healthcare, medical waste, and medical imaging guidelines. The search strategy used specific key terms, and articles were included if peer-reviewed, published in English, and focused on relevant environmental aspects. The search covered articles up to the latest available date, and data collection methods varied for each database. Articles were screened based on titles and abstracts for relevance and met inclusion criteria upon full-text review.

##### RESULTS

Healthcare is a significant contributor to annual carbon emissions, with imaging studies playing a substantial role. MRI leads with 17 kg of CO<sub>2</sub> emissions per scan, followed by CT scans with 9 kg of CO<sub>2</sub>. Over the last decade, medical imaging overuse has risen by ~3% annually, exacerbating the environmental impact. Nurse practitioners and physician assistants tend to order 0.3% more unnecessary imaging per patient encounter, underscoring the need for increased awareness and education on appropriate imaging practices. Implementing imaging guidelines has proven effective in reducing unnecessary orders by 3-25%.

##### CONCLUSION

Technological advancements have contributed to alarming rises in carbon emissions over the years, often without direct consequences. Radiology can play a crucial role in curbing these emissions through mindful and ethical ordering of imaging. The ACR appropriateness criteria can bring attention to emission concerns within the medical community. Educating healthcare professionals on correct imaging protocols reduces unnecessary requests and fosters sustainable healthcare practices.

##### CLINICAL RELEVANCE/APPLICATION

Amidst the ongoing global climate crisis, every industry must explore and promote innovative approaches to reduce their carbon footprint. The ACR appropriateness criteria presents a promising avenue for the field of Radiology to mitigate its carbon emissions. A study evaluating imaging decline following the "Choosing Wisely campaign" highlights the potential for medical providers to utilize criteria to minimize low-value imaging orders. This approach aims to re-educate MDs, DOs, PAs, and NPs on scan appropriateness, including financial and environmental impact, without eliminating essential scans.

#### T3-STCE1-2 Environmental Sustainability of Syringeless Multi-Dose Contrast Injectors in Radiological Procedures

Seyedeh Niloufar Rafiei Alavi, MD (*Presenter*) Nothing to Disclose

##### PURPOSE

Contrast agents used in radiological procedures have a negative impact on greenhouse emissions and generates considerable waste, including harmful water iodinated contrast microcontaminants. One potential solution to mitigate these environmental

effects is adopting multi-dose injector devices. Our study aims to evaluate the environmental advantages of multi dose injector devices by comparing it to common single dose contrast injectors.

## **METHODS AND MATERIALS**

All contrast enhanced CT scans performed in level 1 trauma center of our academic medical center From January 2022 to January 2023 were identified our database. Consumed contrast material volumes and scan dates were collected. For single-dose injections, the standard equipment includes a contrast vial, a 50 mL saline bag, two syringes, and accompanying tubing. As for multi-dose injector, it uses two 500 mL contrast vials, a 1000 mL saline bag which can be used up to 8 hours, pump tubing (up to 24hrs), and single use patient tubing. Based on this, we estimated the total wasted contrast, mean contrast use and waste per patient, and the average number of syringes and spikes per patient for the multi-dose injector device. Additionally, we documented the average weight of disposable plastic materials based on the manufacturer's catalog, enabling us to approximate the yearly plastic waste in kilograms. Taking into account that 1 kg of plastic production emits 6 kg of CO<sub>2</sub> emissions, we further calculated the yearly CO<sub>2</sub> emissions for both types of injector devices.

## **RESULTS**

The multidose injector significantly reduced contrast use (107.33 vs. 113.41 mL), contrast waste (4.38 vs. 10.46 mL), the mean number of syringes/spikes (2 vs 0.05), and saline waste (50 vs 8.2) per patient. The total estimated amount of plastic waste was significantly lower in the multi-dose injector (679.59 vs. 876.92 kg), resulting in significantly lower CO<sub>2</sub> gas emissions (4077.54 vs. 5261.52 kg).

## **CONCLUSION**

The multi-dose injector offers substantial reductions in material waste, including contrast, syringes, and spikes. These improvements patient workflow and reduce costs and contribute to a notable reduction in greenhouse gas emissions associated with radiological procedures. Further, it decreases the disposal of harmful iodinated contrast residues, mitigating their potential environmental impact.

## **CLINICAL RELEVANCE/APPLICATION**

Adopting syringeless multi-dose contrast injectors represents a promising and practicable step toward sustainable radiological practices. This approach aligns with environmental conservation efforts, positively impacting patient care and the overall well-being of our planet.

## **T3-STCE1-3 A Global Assessment of Energy Consumption in Radiology and Radiation Oncology: An Environmental Impact Study**

Shakthi K. Ramasamy, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The objective of this study is to quantify the global energy consumption of radiology and radiation oncology machinery, thus casting light on the environmental impact of these essential healthcare devices.

## **METHODS AND MATERIALS**

Data were consolidated from a broad range of sources, such as the WHO Global Health Observatory, OECD, and regional health databases, to estimate the global distribution and types of radiology and radiation oncology machines. The countries included in the study are Belgium, Luxembourg, Costa Rica, Denmark, Bulgaria, Netherlands, Korea, Israel, Estonia, Czech Republic, Croatia, Romania, Spain, Finland, Chile, Poland, Hungary, Latvia, United States, Canada, United Kingdom, Australia, Lithuania, Slovak Republic, Portugal, Iceland, Italy, France, Switzerland, Slovenia, Greece, Austria, Norway, and Germany. The estimation takes into account the number of Computed Tomography (CT) scanners, Magnetic Resonance Imaging (MRI) units, mammography machines, and radiotherapy equipment in ambulatory care providers and hospitals, per 1,000,000 inhabitants. Furthermore, the estimation includes the number of MRI and CT exams conducted in ambulatory care providers and hospitals, per 1,000 inhabitants. Energy consumption metrics for each type of scanner and radiotherapy device were acquired from manufacturers and scientific literature, and estimated usage hours were derived from healthcare utilization data.

## **RESULTS**

The study suggests an approximate presence of 2 million radiology and radiation oncology machines globally, collectively consuming an estimated 10 billion kilowatt-hours per year. CT scanners emerged as the dominant contributors, accounting for nearly 50% of the total energy consumption.

## **CONCLUSION**

The research emphasizes the significant and often disregarded energy consumption of radiology and radiation oncology machines. With the ongoing rise in demand for radiology and radiation oncology services worldwide, it becomes imperative to undertake efforts to curb this environmental impact. This could involve increasing the energy efficiency of machines and looking into alternative energy sources.

## **CLINICAL RELEVANCE/APPLICATION**

The insights gained from this research carry significant implications for sustainable healthcare. A thorough understanding of the environmental footprint of radiology and radiation oncology can assist clinicians, hospital administrators, and policymakers in making environmentally sensitive decisions. This could involve the procurement of energy-efficient machines, refining usage schedules, or endorsing renewable energy sources.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-STCE1-1

### Addressing Healthcare's Carbon Footprint: Imaging Practices and Environmental Impact

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 1

Mackenzie Szczepanski, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

This poster aims to: 1) Analyze the environmental impact of radiologic studies. 2) Compare carbon footprints among different radiologic studies. 3) Examine the influence of imaging guidelines on appropriate imaging use.

#### METHODS AND MATERIALS

This section outlines the methods used to gather peer-reviewed articles from PubMed, Google Scholar, and NIH for research on the environmental impact of radiology and healthcare, including topics like carbon emissions of imaging, carbon footprint of healthcare, medical waste, and medical imaging guidelines. The search strategy used specific key terms, and articles were included if peer-reviewed, published in English, and focused on relevant environmental aspects. The search covered articles up to the latest available date, and data collection methods varied for each database. Articles were screened based on titles and abstracts for relevance and met inclusion criteria upon full-text review.

#### RESULTS

Healthcare is a significant contributor to annual carbon emissions, with imaging studies playing a substantial role. MRI leads with 17 kg of CO<sub>2</sub> emissions per scan, followed by CT scans with 9 kg of CO<sub>2</sub>. Over the last decade, medical imaging overuse has risen by ~3% annually, exacerbating the environmental impact. Nurse practitioners and physician assistants tend to order 0.3% more unnecessary imaging per patient encounter, underscoring the need for increased awareness and education on appropriate imaging practices. Implementing imaging guidelines has proven effective in reducing unnecessary orders by 3-25%.

#### CONCLUSION

Technological advancements have contributed to alarming rises in carbon emissions over the years, often without direct consequences. Radiology can play a crucial role in curbing these emissions through mindful and ethical ordering of imaging. The ACR appropriateness criteria can bring attention to emission concerns within the medical community. Educating healthcare professionals on correct imaging protocols reduces unnecessary requests and fosters sustainable healthcare practices.

#### CLINICAL RELEVANCE/APPLICATION

Amidst the ongoing global climate crisis, every industry must explore and promote innovative approaches to reduce their carbon footprint. The ACR appropriateness criteria presents a promising avenue for the field of Radiology to mitigate its carbon emissions. A study evaluating imaging decline following the "Choosing Wisely campaign" highlights the potential for medical providers to utilize criteria to minimize low-value imaging orders. This approach aims to re-educate MDs, DOs, PAs, and NPs on scan appropriateness, including financial and environmental impact, without eliminating essential scans.

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## Abstract Archives of the RSNA, 2023

T3-STCE1-2

### Environmental Sustainability of Syringeless Multi-Dose Contrast Injectors in Radiological Procedures

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 1

Seyedeh Niloufar Rafiei Alavi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast agents used in radiological procedures have a negative impact on greenhouse emissions and generates considerable waste, including harmful water iodinated contrast microcontaminants. One potential solution to mitigate these environmental effects is adopting multi-dose injector devices. Our study aims to evaluate the environmental advantages of multi dose injector devices by comparing it to common single dose contrast injectors.

#### METHODS AND MATERIALS

All contrast enhanced CT scans performed in level 1 trauma center of our academic medical center From January 2022 to January 2023 were identified our database. Consumed contrast material volumes and scan dates were collected. For single-dose injections, the standard equipment includes a contrast vial, a 50 mL saline bag, two syringes, and accompanying tubing. As for multi-dose injector, it uses two 500 mL contrast vials, a 1000 mL saline bag which can be used up to 8 hours, pump tubing (up to 24hrs), and single use patient tubing. Based on this, we estimated the total wasted contrast, mean contrast use and waste per patient, and the average number of syringes and spikes per patient for the multi-dose injector device. Additionally, we documented the average weight of disposable plastic materials based on the manufacturer's catalog, enabling us to approximate the yearly plastic waste in kilograms. Taking into account that 1 kg of plastic production emits 6 kg of CO<sub>2</sub> emissions, we further calculated the yearly CO<sub>2</sub> emissions for both types of injector devices.

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The multidose injector significantly reduced contrast use (107.33 vs. 113.41 mL), contrast waste (4.38 vs. 10.46 mL), the mean number of syringes/spikes (2 vs 0.05), and saline waste (50 vs 8.2) per patient. The total estimated amount of plastic waste was significantly lower in the multi-dose injector (679.59 vs. 876.92 kg), resulting in significantly lower CO<sub>2</sub> gas emissions (4077.54 vs. 5261.52 kg).

#### CONCLUSION

The multi-dose injector offers substantial reductions in material waste, including contrast, syringes, and spikes. These improvements patient workflow and reduce costs and contribute to a notable reduction in greenhouse gas emissions associated with radiological procedures. Further, it decreases the disposal of harmful iodinated contrast residues, mitigating their potential environmental impact.

#### CLINICAL RELEVANCE/APPLICATION

Adopting syringeless multi-dose contrast injectors represents a promising and practicable step toward sustainable radiological practices. This approach aligns with environmental conservation efforts, positively impacting patient care and the overall well-being of our planet.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-STCE1-3

### **A Global Assessment of Energy Consumption in Radiology and Radiation Oncology: An Environmental Impact Study**

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 1

Shakthi K. Ramasamy, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The objective of this study is to quantify the global energy consumption of radiology and radiation oncology machinery, thus casting light on the environmental impact of these essential healthcare devices.

#### **METHODS AND MATERIALS**

Data were consolidated from a broad range of sources, such as the WHO Global Health Observatory, OECD, and regional health databases, to estimate the global distribution and types of radiology and radiation oncology machines. The countries included in the study are Belgium, Luxembourg, Costa Rica, Denmark, Bulgaria, Netherlands, Korea, Israel, Estonia, Czech Republic, Croatia, Romania, Spain, Finland, Chile, Poland, Hungary, Latvia, United States, Canada, United Kingdom, Australia, Lithuania, Slovak Republic, Portugal, Iceland, Italy, France, Switzerland, Slovenia, Greece, Austria, Norway, and Germany. The estimation takes into account the number of Computed Tomography (CT) scanners, Magnetic Resonance Imaging (MRI) units, mammography machines, and radiotherapy equipment in ambulatory care providers and hospitals, per 1,000,000 inhabitants. Furthermore, the estimation includes the number of MRI and CT exams conducted in ambulatory care providers and hospitals, per 1,000 inhabitants. Energy consumption metrics for each type of scanner and radiotherapy device were acquired from manufacturers and scientific literature, and estimated usage hours were derived from healthcare utilization data.

#### **RESULTS**

The study suggests an approximate presence of 2 million radiology and radiation oncology machines globally, collectively consuming an estimated 10 billion kilowatt-hours per year. CT scanners emerged as the dominant contributors, accounting for nearly 50% of the total energy consumption.

#### **CONCLUSION**

The research emphasizes the significant and often disregarded energy consumption of radiology and radiation oncology machines. With the ongoing rise in demand for radiology and radiation oncology services worldwide, it becomes imperative to undertake efforts to curb this environmental impact. This could involve increasing the energy efficiency of machines and looking into alternative energy sources.

#### **CLINICAL RELEVANCE/APPLICATION**

The insights gained from this research carry significant implications for sustainable healthcare. A thorough understanding of the environmental footprint of radiology and radiation oncology can assist clinicians, hospital administrators, and policymakers in making environmentally sensitive decisions. This could involve the procurement of energy-efficient machines, refining usage schedules, or endorsing renewable energy sources.

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## Abstract Archives of the RSNA, 2023

T3-STCE2

### Science Session (Imaging of Immunotherapy)

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 2

#### Sub-Events

#### **T3-STCE2-1 <sup>18</sup>F-BMS-986192 Molecular Imaging of programmed cell death ligand 1 expression in the liver and spleen in patients with breast cancer receiving combined immuno-chemotherapy**

Ashwin Singh S. Parihar, MBBS, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Spleen and liver are intricately involved in the anti-tumor immune response, however, there are limited data on the modulation of programmed cell death ligand-1 (PD-L1) expression in these tissues during therapy. Specifically, whether immune-checkpoint inhibitor therapy induces *in vivo* alterations in PD-L1 expression by normal liver and spleen is unknown. <sup>18</sup>F-BMS-986192 is an adnectin-based human PD-L1 PET tracer, developed to assess whole-body PD-L1 expression. Standardized uptake values (SUVs) on PD-L1 PET have a strong correlation with PD-L1 levels on immunohistochemistry. We therefore analyzed a subset of prospectively enrolled patients with advanced breast cancer undergoing immuno-chemotherapy to assess for therapy-related changes in SUVs in the liver and spleen

#### **METHODS AND MATERIALS**

This is a secondary analysis of a subset of patients enrolled at our site in a prospective phase-1 trial studying combined nivolumab, ipilimumab, and nab-paclitaxel in ER-positive, HER2-negative, advanced breast cancer (NCT04132817). Patients underwent PD-L1 PET/CT before and after the initiation of therapy. A 3 cm diameter spherical volume of interest (VOI) in the right hemi-liver, and 2 cm diameter spherical VOIs in the spleen and the descending thoracic aorta (i.e., blood pool) were used to calculate the maximum SUV (SUV<sub>max</sub>). A paired samples t-test was used to assess for differences in mean SUV<sub>max</sub> on the PD-L1 PET/CT performed at baseline and after treatment initiation. A  $p < 0.05$  was considered significant.

#### **RESULTS**

Seven women were prospectively enrolled in the trial from 2020 -2021 and underwent a baseline PD-L1 PET/CT. A follow-up PET/CT was performed in five patients (mean age,  $50.4 \pm 15.7$  years) at  $29 \pm 5.3$  days from the baseline study. No significant difference was noted in the mean blood pool SUV<sub>max</sub> (baseline:  $2.7 \pm 0.6$ ; follow-up:  $2.7 \pm 0.3$ ;  $p = 1.0$ ). However, there was a significant increase in SUV<sub>max</sub> of the liver (baseline:  $8.7 \pm 1.4$ ; follow-up:  $10.9 \pm 2.1$ ;  $p = 0.04$ ) and spleen (baseline:  $25.2 \pm 4.4$ ; follow-up:  $30.7 \pm 3.4$ ;  $p = 0.03$ ) between scans. The SUV<sub>max</sub> of the liver showed a mean increase of 27% (maximum: 55.4%) while that of the spleen increased by 24% (maximum: 45.2%) on follow-up.

#### **CONCLUSION**

A significant increase in the SUV<sub>max</sub> presumed to reflect *in vivo* PD-L1 expression was noted in the liver and spleen following immuno-chemotherapy without any change in blood pool activity.

#### **CLINICAL RELEVANCE/APPLICATION**

Although based on a small cohort, the results suggest potential early up-regulation of PD-L1 in the liver and spleen, following immune-checkpoint inhibition. This may have implications for delivery of checkpoint inhibitors to tumors, tumor response to treatment, and for the pathogenesis of immune-related adverse events.

#### **T3-STCE2-2 Assessment and prognostication of immunotherapy related adverse cardiovascular events with cardiac MRI**

Anjuna Reghunath, MD, FRCR (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the utility of cardiac MRI (CMR) in evaluating immune related adverse events (IRAE) in patients presenting with raised or rising or fluctuating Troponin T and/ or pro BNP levels while undergoing immunotherapy

## METHODS AND MATERIALS

A retrospective cross-sectional study of 66 patients (mean age 67.5) on immunotherapy who were requested cardiac MRI from 2022 to 2023 were included in the study. Indication for scan was suspected myocarditis in 57 and left ventricle (LV) dysfunction in 9 patients, based on biomarkers and symptoms. Of these, 11 participants could not tolerate the scan or expired before the scan and hence were excluded (final N=55; suspected myocarditis (N=46) and suspected LV dysfunction (N=9)). Scans were performed on 1.5T (n= 34) and 3T (n=21) Siemens machine. Native T1 and T2 map values were calculated by drawing ROI of 10mm<sup>2</sup> in the 16 AHA segments in mid wall region; the highest value in any segment was considered for analysis. Maps were not done for 2 patients on 3T scanner due to severe artefacts. LV ejection fraction (EF) was calculated based on volumetry analysis. T2FS or STIR and late gadolinium enhanced (LGE) sequences were used to assess myo/pericardial edema and enhancement respectively. The presence of myocardial edema with or without enhancement was considered positive for acute myocarditis.

## RESULTS

Mean T1 value for suspected myocarditis (N=30 in 1.5T, N=14 in 3T) was 1109ms (scanner normal range 947-1055ms) and median 1095ms (IQR 109) on 1.5T while mean T1 value was 1271ms (scanner normal range 1136- 1263ms) and median 1282ms (IQR 109) on 3T scanner. Mean T2 value for suspected myocarditis (N=30 patients in 1.5T, N=14 patients in 3T) was 55ms (scanner normal range 43-52ms) and median 53.5ms (IQR 13) on 1.5T while mean T2 value was 39.7ms (scanner normal range 35-54ms) and median 39ms (IQR 4) on 3T scanner. Mean EF was 61% (median 62%; IQR 14). Edema sensitive sequences were positive in 26 patients (47%). Positive LGE was seen in 22 subjects (40%) with the most common pattern being subepicardial. Based on MRI, 25 patients were diagnosed with myocarditis, 4 with pericarditis and 7 with myopericarditis while the remaining 19 patients had no imaging evidence of inflammation. Of the 36 patients who were diagnosed with myo/ peri/ myopericarditis on MRI, the condition was fatal for 23 (64%).

## CONCLUSION

Myocarditis is the commonest cardiovascular IRAE with grave prognosis. Elevated T1/ T2 values are indicative of myocardial edema and hence early predictors of inflammation.

## CLINICAL RELEVANCE/APPLICATION

CMR is a useful tool to diagnose IRAE but may be limited by patient-related factors and arrhythmias leading to image degradation artifacts. T1/ T2 maps improve specificity of CMR in equivocal cases.

## T3-STCE2-3 Genomic-Based Personalized Therapies and Precision Imaging in Cholangiocarcinoma Patients: A Study at Two German Comprehensive Cancer Centers

Christian P. Reinert, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Cisplatin/Gemcitabine is recommended as the initial treatment for inoperable cholangiocarcinoma or post-surgery recurrence, following guidelines. In the absence of established second-line options, evidence-based treatment decisions can be made by molecular tumor boards. This study focuses on implementing a molecular tumor board at two comprehensive cancer centers in Germany to assess its adoption and impact.

## METHODS AND MATERIALS

Patients with cholangiocarcinoma were enrolled from May 2019 to September 2021 and referred to the molecular tumor boards at University Hospitals of Tübingen and Ulm. Data on treatment recommendations, regimens, and survival outcomes were collected from a prospective register. Staging and follow-up exams used contrast-enhanced CT, and some patients received additional 18F-FDG-PET/CT scans at the physician's discretion. Treatment response was evaluated using RECIST 1.1 criteria.

## RESULTS

Among the 583 patients referred to the molecular tumor boards, 35 individuals (18 females) with a median age of 60.2 years (range: 22 to 80 years) underwent cholangiocarcinoma treatment. One hospital had a median of 2 prior treatment lines (range: 1-4), while the other had a median of 1 (range: 0-2). Of these patients, 26 had received prior Cisplatin/Gemcitabine. Treatment recommendations based on molecular tumor profiles were provided to 28 out of 35 patients, with 14 receiving the recommended treatment. Each patient had 1 to 3 identified treatment options. Imaging follow-up data were available for 27 patients: 22 underwent CT, 5 had 18F-FDG-PET/CT, and 1 had MRI. According to RECIST 1.1 criteria, two patients achieved an objective response (one with partial response and Pemigatinib treatment, the other with tumor vaccination), fourteen had stable disease, and eleven showed disease progression at the first follow-up. Median progression-free survival was 20 weeks, with 16 weeks for non-compliant patients and 25 weeks for compliant patients (although not statistically significant).

## **CONCLUSION**

Personalized cancer treatments showed a promising trend towards longer progression-free survival, despite infrequent objective responses. Whole-body imaging plays a crucial role in monitoring treatment effectiveness and response evaluation in personalized cancer care.

## **CLINICAL RELEVANCE/APPLICATION**

The study underscores the importance of molecular tumor boards in guiding evidence-based treatment choices. While objective responses were rare with personalized treatments, the potential for improved progression-free survival is highlighted. Whole-body imaging's role in monitoring personalized cancer treatment effectiveness and response evaluation is emphasized for clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T3-STCE2-1

### **<sup>18</sup>F-BMS-986192 Molecular Imaging of programmed cell death ligand 1 expression in the liver and spleen in patients with breast cancer receiving combined immuno-chemotherapy**

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 2

Ashwin Singh S. Parihar, MBBS, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Spleen and liver are intricately involved in the anti-tumor immune response, however, there are limited data on the modulation of programmed cell death ligand-1 (PD-L1) expression in these tissues during therapy. Specifically, whether immune-checkpoint inhibitor therapy induces *in vivo* alterations in PD-L1 expression by normal liver and spleen is unknown. <sup>18</sup>F-BMS-986192 is an adnectin-based human PD-L1 PET tracer, developed to assess whole-body PD-L1 expression. Standardized uptake values (SUVs) on PD-L1 PET have a strong correlation with PD-L1 levels on immunohistochemistry. We therefore analyzed a subset of prospectively enrolled patients with advanced breast cancer undergoing immuno-chemotherapy to assess for therapy-related changes in SUVs in the liver and spleen

#### **METHODS AND MATERIALS**

This is a secondary analysis of a subset of patients enrolled at our site in a prospective phase-1 trial studying combined nivolumab, ipilimumab, and nab-paclitaxel in ER-positive, HER2-negative, advanced breast cancer (NCT04132817). Patients underwent PD-L1 PET/CT before and after the initiation of therapy. A 3 cm diameter spherical volume of interest (VOI) in the right hemi-liver, and 2 cm diameter spherical VOIs in the spleen and the descending thoracic aorta (i.e., blood pool) were used to calculate the maximum SUV (SUV<sub>max</sub>). A paired samples t-test was used to assess for differences in mean SUV<sub>max</sub> on the PD-L1 PET/CT performed at baseline and after treatment initiation. A  $p < 0.05$  was considered significant.

#### **RESULTS**

Seven women were prospectively enrolled in the trial from 2020 -2021 and underwent a baseline PD-L1 PET/CT. A follow-up PET/CT was performed in five patients (mean age, 50.4±15.7 years) at 29±5.3 days from the baseline study. No significant difference was noted in the mean blood pool SUV<sub>max</sub> (baseline: 2.7±0.6; follow-up: 2.7±0.3;  $p = 1.0$ ). However, there was a significant increase in SUV<sub>max</sub> of the liver (baseline: 8.7±1.4; follow-up: 10.9±2.1;  $p = 0.04$ ) and spleen (baseline: 25.2±4.4; follow-up: 30.7±3.4;  $p = 0.03$ ) between scans. The SUV<sub>max</sub> of the liver showed a mean increase of 27% (maximum: 55.4%) while that of the spleen increased by 24% (maximum: 45.2%) on follow-up.

#### **CONCLUSION**

A significant increase in the SUV<sub>max</sub> presumed to reflect *in vivo* PD-L1 expression was noted in the liver and spleen following immuno-chemotherapy without any change in blood pool activity.

#### **CLINICAL RELEVANCE/APPLICATION**

Although based on a small cohort, the results suggest potential early up-regulation of PD-L1 in the liver and spleen, following immune-checkpoint inhibition. This may have implications for delivery of checkpoint inhibitors to tumors, tumor response to treatment, and for the pathogenesis of immune-related adverse events.

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## Abstract Archives of the RSNA, 2023

T3-STCE2-2

### Assessment and prognostication of immunotherapy related adverse cardiovascular events with cardiac MRI

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 2

Anjuna Reghunath, MD, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the utility of cardiac MRI (CMR) in evaluating immune related adverse events (IRAE) in patients presenting with raised or rising or fluctuating Troponin T and/ or pro BNP levels while undergoing immunotherapy

#### METHODS AND MATERIALS

A retrospective cross-sectional study of 66 patients (mean age 67.5) on immunotherapy who were requested cardiac MRI from 2022 to 2023 were included in the study. Indication for scan was suspected myocarditis in 57 and left ventricle (LV) dysfunction in 9 patients, based on biomarkers and symptoms. Of these, 11 participants could not tolerate the scan or expired before the scan and hence were excluded (final N=55; suspected myocarditis (N=46) and suspected LV dysfunction (N=9)). Scans were performed on 1.5T (n= 34) and 3T (n=21) Siemens machine. Native T1 and T2 map values were calculated by drawing ROI of 10mm<sup>2</sup> in the 16 AHA segments in mid wall region; the highest value in any segment was considered for analysis. Maps were not done for 2 patients on 3T scanner due to severe artefacts. LV ejection fraction (EF) was calculated based on volumetry analysis. T2FS or STIR and late gadolinium enhanced (LGE) sequences were used to assess myo/pericardial edema and enhancement respectively. The presence of myocardial edema with or without enhancement was considered positive for acute myocarditis.

#### RESULTS

Mean T1 value for suspected myocarditis (N=30 in 1.5T, N=14 in 3T) was 1109ms (scanner normal range 947-1055ms) and median 1095ms (IQR 109) on 1.5T while mean T1 value was 1271ms (scanner normal range 1136- 1263ms) and median 1282ms (IQR 109) on 3T scanner. Mean T2 value for suspected myocarditis (N=30 patients in 1.5T, N=14 patients in 3T) was 55ms (scanner normal range 43-52ms) and median 53.5ms (IQR 13) on 1.5T while mean T2 value was 39.7ms (scanner normal range 35-54ms) and median 39ms (IQR 4) on 3T scanner. Mean EF was 61% (median 62%; IQR 14). Edema sensitive sequences were positive in 26 patients (47%). Positive LGE was seen in 22 subjects (40%) with the most common pattern being subepicardial. Based on MRI, 25 patients were diagnosed with myocarditis, 4 with pericarditis and 7 with myopericarditis while the remaining 19 patients had no imaging evidence of inflammation. Of the 36 patients who were diagnosed with myo/ peri/ myopericarditis on MRI, the condition was fatal for 23 (64%).

#### CONCLUSION

Myocarditis is the commonest cardiovascular IRAE with grave prognosis. Elevated T1/ T2 values are indicative of myocardial edema and hence early predictors of inflammation.

#### CLINICAL RELEVANCE/APPLICATION

CMR is a useful tool to diagnose IRAE but may be limited by patient-related factors and arrhythmias leading to image degradation artifacts. T1/ T2 maps improve specificity of CMR in equivocal cases.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T3-STCE2-3

### Genomic-Based Personalized Therapies and Precision Imaging in Cholangiocarcinoma Patients: A Study at Two German Comprehensive Cancer Centers

Tuesday, Nov. 28 10:00AM - 10:30AM Room: Learning Center Theater 2

Christian P. Reinert, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cisplatin/Gemcitabine is recommended as the initial treatment for inoperable cholangiocarcinoma or post-surgery recurrence, following guidelines. In the absence of established second-line options, evidence-based treatment decisions can be made by molecular tumor boards. This study focuses on implementing a molecular tumor board at two comprehensive cancer centers in Germany to assess its adoption and impact.

#### METHODS AND MATERIALS

Patients with cholangiocarcinoma were enrolled from May 2019 to September 2021 and referred to the molecular tumor boards at University Hospitals of Tübingen and Ulm. Data on treatment recommendations, regimens, and survival outcomes were collected from a prospective register. Staging and follow-up exams used contrast-enhanced CT, and some patients received additional 18F-FDG-PET/CT scans at the physician's discretion. Treatment response was evaluated using RECIST 1.1 criteria.

#### RESULTS

Among the 583 patients referred to the molecular tumor boards, 35 individuals (18 females) with a median age of 60.2 years (range: 22 to 80 years) underwent cholangiocarcinoma treatment. One hospital had a median of 2 prior treatment lines (range: 1-4), while the other had a median of 1 (range: 0-2). Of these patients, 26 had received prior Cisplatin/Gemcitabine. Treatment recommendations based on molecular tumor profiles were provided to 28 out of 35 patients, with 14 receiving the recommended treatment. Each patient had 1 to 3 identified treatment options. Imaging follow-up data were available for 27 patients: 22 underwent CT, 5 had 18F-FDG-PET/CT, and 1 had MRI. According to RECIST 1.1 criteria, two patients achieved an objective response (one with partial response and Pemigatinib treatment, the other with tumor vaccination), fourteen had stable disease, and eleven showed disease progression at the first follow-up. Median progression-free survival was 20 weeks, with 16 weeks for non-compliant patients and 25 weeks for compliant patients (although not statistically significant).

#### CONCLUSION

Personalized cancer treatments showed a promising trend towards longer progression-free survival, despite infrequent objective responses. Whole-body imaging plays a crucial role in monitoring treatment effectiveness and response evaluation in personalized cancer care.

#### CLINICAL RELEVANCE/APPLICATION

The study underscores the importance of molecular tumor boards in guiding evidence-based treatment choices. While objective responses were rare with personalized treatments, the potential for improved progression-free survival is highlighted. Whole-body imaging's role in monitoring personalized cancer treatment effectiveness and response evaluation is emphasized for clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPBR-1

### Screening after Breast Conserving Surgery with Acellular Dermal Matrix Reconstruction: Mammography, Ultrasonography and MRI

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Dawon Jung, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

& 9;To investigate the findings of postoperative images of patients who underwent breast reconstruction with acellular dermal matrix (ADM) and assess which imaging modality is more feasible to detect local tumor recurrence: mammography(MG), ultrasound(US), or MRI.

#### **METHODS AND MATERIALS**

& 9;This retrospective study included consecutive women who were first diagnosed with breast cancer and underwent breast-conserving surgery between Jan 2015 and Aug 2021 and immediate reconstruction with MegaDerm®, followed by at least one MG, US, and MRI. Postoperative images were analyzed by breast radiologists and classified as positive for BI-RADS categories 0, 4, and 5 and negative for BI-RADS categories 1,2, and 3. The reference standard was defined with 1-year follow-up Imaging findings and pathologic reports. Diagnostic performances of each imaging modality was evaluated. Imaging features of ipsilateral recurrent breast cancers were reviewed.

#### **RESULTS**

& 9;207 women (mean age 46 years) were enrolled with a total 725 MG, 1097 US and 621 MRI. During the follow-up, the mean numbers of MG, US, and MRI scans of 3.5, 5.3, and 3.0 respectively, and a mean follow-up interval of 35.5 months (range 13-71 months). Among 207 women, total recurrence occurred in 15 (7.2%) patients and 11 (5.3%) patients recurred on the same breast. Sensitivity was 80 % for MG and 100% for both US and MRI. Specificity was 99% for MG, 99.4% for US and 96.9% for MRI. Diagnostic accuracy was 98.6% for MG, 99.4% for US and 96.9% for MRI. All 11 ipsilateral recurrence were suspicious on both US and MRI, while 3 cases (27.3%) were considered as benign on MG. All ipsilateral recurrences showed masses/nom-mass lesions with hypervascularity and enhancement, near the ADM.

#### **CONCLUSION**

Screenings with MG, US and MRI are useful imaging tool, after breast conserving surgery with ADM reconstruction. Especially, US and MRI are helpful modalities for the ipsilateral recurrence.

#### **CLINICAL RELEVANCE/APPLICATION**

& 9;After breast conserving surgery with ADM reconstruction, screening with MG, US and MRI might be hindered by ADMs. However, all screening modalities are useful, especially US and MRI. The most common findings of ipsilateral recurrence was mass/nom-mass lesion with hypervascularity and enhancement, near the ADM.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPBR-2

### The Observation of VM1 Gadolinium Tumor Markers Placed in Fibroadenomas Over Time

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Lindsey K. Greenlund, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Fibroadenomas are one of the most common breast masses, affecting nearly 10% of women. These benign tumors most often appear in the 3rd and 4th decades of life, but can arise at any age. Fibroadenomas can be recognized on imaging by their characteristic smooth, solid, ovoid appearance, being narrower in the A/P diameter, and with discrete internal echoes. Gadolinium (Gd) tumor markers are the only markers visible on all imaging modalities. These markers also have the benefit of remaining stable during radiation treatment. Often, they are surgically resected, however, if they are placed in benign tumors, they may remain in the patient (pt) indefinitely. In this study, we followed scans of pts with Gd tumor markers placed in biopsy-proven fibroadenomas. It was hypothesized that over time, the marker would remain the same intensity, would not migrate, and that the tumor bed would be unchanged.

#### METHODS AND MATERIALS

Charts of pts who had VM1 Gd tumor markers placed between 2016 and 2020 for breast masses were reviewed. Initial scans were assessed, and those with masses characteristic of fibroadenomas were separated. Pts with biopsy-proven fibroadenomas were included. Subsequent imaging studies were reviewed, and the implanted tumor marker, as well as the tumor bed, were assessed for changes over time.

#### RESULTS

Thirty-six pts who had VM1 tumor markers placed for discrete breast masses were identified and seven had biopsy-proven fibroadenomas diagnosed during the study period. Three pts had scans suitable for analysis, two had subsequent surgical resections, and two pts were lost to follow-up. One pts had imaging for six-months following VM1 marker placement, one pt had imaging for two years, and one pt had imaging for seven subsequent years. In these three pts, the VM1 tumor marker did not change in position, brightness, or intensity, nor did the fibroadenoma change in size or internal characteristics.

#### CONCLUSION

In this study, we assessed the stability of VM1 Gd tumor markers placed in fibroadenomas. Although only a small group of pts were assessed, our study demonstrated that VM1 Gd tumor markers remain stable over time with regard to position and appearance. Additionally, the fibroadenomas in which the markers were placed did not change over time. Further studies should seek to include more pts over longer follow-up periods.

#### CLINICAL RELEVANCE/APPLICATION

This study shows unresected VM1 Gd tumor markers remain stable in appearance and in place for up to seven years in subsequent imaging. The VM1 Gd marker is available as the first new FDA approved soft tissue marker in nearly 10 years and is visible on all imaging modalities (MRI, ultrasound, tomo, X-Ray). This information will aid radiologists in localizing breast masses over time and assessing them for future change.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPBR-3

### The Value of Imaging Combined with Clinicopathological Features in the Diagnosis of High-risk Breast Lesions

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Jiayin Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

Comparing the diagnostic and predictive value of imaging features of different modes for breast high-risk lesions (HRLs) to improve image recognition and assist in clinical decisions.

#### METHODS AND MATERIALS

We retrospectively reviewed 230 HRLs detected by mammography, ultrasound, and MRI before biopsy at the XXX Hospital from January 2017 to March 2018. The clinical features, imaging data according to the Breast Imaging Reporting and Data System (BI-RADS) lexicon, and tumor upgrade rates were received. Based on the different risks of upgrade reported, the lesions were classified into high-risk I (HR-I, with atypical hyperplasia (AH)) and high-risk II (HR-II, without AH). We analyzed the association between clinicopathological and imaging factors and upgrade. We used the receiver operating characteristic (ROC) curve to compare the efficacy of three imaging modes for predicting upgrade.

#### RESULTS

We included 230 HRLs in 230 women in the study, and the overall upgrade rate was 20.4% (47/230). The upgrade rate was higher in HR-I compared to HR-II (38.5% vs. 4.1%,  $P < 0.01$ ). In patients with AH, estrogen receptor-positive (ER+) patients accounted for 81.0% (64/79). For all HRLs and HR-I, in clinical characteristics, age, maximum size of lesion, and menopausal status were significantly associated with upgrade ( $P < 0.05$ ). In imaging factors, MRI background parenchymal enhancement (BPE), signs of MRI and ultrasound were significantly correlated with upgrade ( $P < 0.05$ ). Patients with negative MRI or ultrasound manifestations had lower upgrade rates ( $P < 0.01$ ). For HR-II, only BPE showed a significant difference between groups ( $P = 0.001$ ). Multifactorial analysis of all HRLs showed that age and BPE were independent predictors of upgrade ( $P < 0.01$ ). AUCs for predicting upgrade in mammography, ultrasound, and MRI were 0.606, 0.590, and 0.913, respectively, indicating that MRI diagnosis was significantly better than mammography and ultrasound ( $P < 0.001$ ).

#### CONCLUSION

HRLs with AH had a higher rate of upgrade and increased ER expression. Among three imaging modes, MRI was more effective than ultrasound and mammography in diagnosing the upgrade of HRLs. Older age and moderate to marked BPE can indicate malignant upgrade. MRI can provide a certain value for the diagnosis and follow-up of HRLs.

#### CLINICAL RELEVANCE/APPLICATION

We explored the relationship between the imaging signs of different modes and the upgrade of HRLs, helping to suggest the correlation between HRLs and the risk of breast cancer, and providing references for clinical decision-making in the follow-up treatment of HRLs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPBR-4

### Outcomes of Pre-operative MRI versus Ultrasound in Axillary Nodal Staging: Association with Clinicopathological Breast Cancer Features

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Firouzeh K. Arjmandi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic accuracy of MRI versus ultrasound (US) in breast cancer axillary nodal evaluation in the same patient cohort.

#### METHODS AND MATERIALS

All breast cancer (BCA) patients that underwent dynamic contrast-enhanced breast MRI (N=529) for baseline staging between 2.2013-3.2016 at 2 hospitals (university and safety net) were reviewed. Race, clinicopathological features, size, and radiologist axillary assessment on imaging prior to biopsy [suspicious=Rad(+), benign=Rad(-)] were collected. Radiologist imaging assessment (regardless of biopsy result) was compared to surgical pathology [(SLNB or axillary node dissection (ALND), pN)]. We collected the sequence of US and MRI evaluation of axilla in diagnostic order to identify initial detection of a suspicious lymph node (LN) in 319/529 patients. Chi-square test was used to compare hormone status, multifocality, axillary imaging modality [MRI first vs US first] and Mann-Whitney-U to compare age, tumor size, and Ki67% between defined groups.

#### RESULTS

Mean age was 51.3 (SD±23.6) years and tumor size was 37.4 mm (SD± 23.6). Patients received US first (includes US+MRI and US+MRI+US groups) in 80.6% and MRI first [(includes MRI alone (MRI) and MRI followed by US (MRI+US))] in 19.4%. Axillae were Rad(+) in 52.4% and Rad(-) in 48.0%. FN values were calculated in Rad(-). Negative predictive value (NPV) for patients that underwent MRI first vs. US first was 85.1% vs. 70.1% (p<0.05). Hispanics and Blacks were more likely to have FN on MRI (22.2% and 18.2%) compared to non-Hispanic Whites (p=0.8) and on US, Hispanics were more likely than non-Hispanic Whites (37.5% vs. 27.7%, p=0.2). On both MRI and US, FNs were higher in younger age, higher clinical T stage (cT) and lower Ki67. FNs were lowest in triple negative (TNBC) and highest in HER2+ (p=0.2, p=0.4, respectively). Unifocal tumors had significantly lower FNs compared to multifocal/centric (21.2% vs. 44.7%, p=0.009) in the US first group but not in MRI first (14.7% vs. 15.4%, p=1). Overall sensitivity and specificity in MRI first was 93.4% and 72.7% (p<0.001) and in US first was 72.3% and 74.2% (p=0.8), respectively.

#### CONCLUSION

MRI performs better than US for LN metastasis with better NPV and higher sensitivity. For both MRI and US, FNs are highest in Hispanics (followed by Blacks on MRI), increase in younger age and higher cT, and are lowest in TNBC and highest in HER2+ subtypes.

#### CLINICAL RELEVANCE/APPLICATION

MRI performs better than US in LN metastasis, and NPV is affected by clinicopathological factors in both. MRI should be considered especially in higher cT stage.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPBR-6

### **Lymph Node Status in Breast Cancer Patients: Can Tumor Features Predict it More Accurately than Direct Axillary Imaging Evaluation**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Panagiotis Kapetas, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the diagnostic performance of tumoral imaging and clinical characteristics with the direct evaluation of the axillary lymph nodes (LNs) for the prediction of the LN status in breast cancer (BC) patients.

#### **METHODS AND MATERIALS**

This retrospective, IRB-approved study included 513 patients with histologically confirmed invasive BC and a histological confirmation of their LN status (either pre-therapeutic, for patients undergoing neoadjuvant treatment, or at the time of surgery for all others). By search of the local PACS, the diagnostic examinations (mammography-MG, ultrasound-US and magnetic resonance imaging-MRI) of the patients were identified. Further clinical information (age, tumor proliferation index Ki-67 and hormone- and HER2-receptor status) were recorded as well. 4 readers (2 breast fellows and 2 experienced radiology residents who had completed both stages of their breast imaging rotation), blinded to the LN status of the patient, independently evaluated the images, assessing both the tumor according to BI-RADS descriptors and the depicted LNs, using standardized criteria. Logistic regression was used to identify independent predictors of metastatic LNs, both among the tumor and the LN descriptors and create respective models, based on the different imaging modalities and their combinations. The diagnostic performance of the models was evaluated using ROC curve analysis. Histopathology served as the standard of reference.

#### **RESULTS**

114 patients (22.2%) had metastatic LNs. None of the clinical or tumoral MRI-based features reached predictive statistical significance. From the tumor-based models, the one combining MG and US features performed significantly better than the others, however at an AUC of 0.593. All models based on LN features (cortical thickening in US and MRI, short axis >1cm in MG) performed significantly better than the ones based on tumoral ones, with AUCs ranging between 0.648 and 0.719. There was no significant difference between the individual LN-based models, which were able to correctly predict 75.1-78.5% of all cases.

#### **CONCLUSION**

Tumor characteristics in BC patients are less predictive of the LN status as compared to the imaging evaluation of the axillary LNs per se.

#### **CLINICAL RELEVANCE/APPLICATION**

Direct imaging assessment of axillary lymph nodes in breast cancer patients remains more accurate than the prediction of their status based on imaging and clinical tumor features.

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## Abstract Archives of the RSNA, 2023

T5A-SPBR-7

### Mammographic Changes within Two Years Following Novel Breast Intraoperative Radiation Therapy

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Kassandra Tulenko, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Intraoperative radiation therapy (IORT) is accelerated partial breast irradiation (APBI) that involves a single dose of RT at the time of breast conserving surgery (BCS). Precision Breast intraoperative radiation therapy (PB-IORT) is a novel form of IORT that combines CT-on-rails imaging to guide high dose rate (HDR) balloon brachytherapy to deliver 12.5 Gy of radiation to the lumpectomy bed at the time of BCS. The goal of the present study is to describe the short-term mammographic appearance of participants treated with PB-IORT.

#### METHODS AND MATERIALS

All patients were part of a multi-institutional clinical trial with an inclusion criteria of age  $\geq$ 45 years, N0, and invasive or in situ tumors  $<$  3 cm. Participants received annual diagnostic mammograms post PB-IORT and additional imaging was performed if warranted clinically. All participants with 2 years of follow-up were included in this study. Mammograms were reviewed and categorized by breast density and radiographic changes, including scar formation, trabecular thickening, fat necrosis, seroma, skin thickening, skin retraction, calcifications, asymmetry, or mass. Presence of suspicious findings (BI-RADS 4 or 5) and biopsy results were also recorded.

#### RESULTS

The cohort included 567 mammograms in 291 participants. The median timing of mammograms included in the study was 23 months post IORT (6 to 30 months). Median age was 64 years (46 to 83 years) and mean tumor size was 9.76mm  $\pm$  6.56mm. Scar and trabecular thickening were the most frequent imaging findings, occurring in 286 (98.3%) and 230 (79.0%) participants respectively. Fat necrosis occurred in 187 (64.3%), seroma in 80 (27.5%), skin thickening in 115 (39.5%), skin retraction in 140 (48.1%), calcifications in 78 (26.8%), asymmetry in 3 (1.0%), and mass in 6 (2.1%) of participants. Thirteen biopsies were performed in 12 participants: 8 were benign, 2 were atypical and 3 were malignant. When stratified by breast density, there were no statistically significant differences of mammographic findings or biopsy frequency between the dense and non-dense groups.

#### CONCLUSION

Participants who underwent PB-IORT developed mammographic findings of scar, trabecular thickening, seroma, fat necrosis, skin thickening and skin retraction. Breast density does not have a significant impact on post PB-IORT imaging findings or biopsy rate. This study is unique as it compares post treatment mammographic findings with respect to breast density. Knowledge of the spectrum of radiographic changes after IORT can facilitate image interpretation and guide management.

#### CLINICAL RELEVANCE/APPLICATION

Knowledge of the spectrum of imaging findings, biopsy rate, and impact of breast density after IORT can facilitate image interpretation and guide management.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPBR-8

### **Nomogram Based on US and Clinicopathologic Characteristics: Axillary Nodal Evaluation Following Neoadjuvant Chemotherapy in Patients with Node-Positive Breast Cancer**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Xiao-Qing Pei, PhD, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To avoid surgical over-treatment of the axilla in breast cancer patients with lymph node (LN) conversion following neoadjuvant chemotherapy (NAC), this study is designed to develop a convenient modality to predict the axillary response to NAC.

#### **METHODS AND MATERIALS**

In this a multi-center study, breast cancer patients with biopsy-proven positive node receiving NAC followed by axillary lymph node dissection (ALND) were identified. A total of 1019 patients were randomly assigned to the training and validation groups at a ratio of 7:3. Clinicopathologic and ultrasound (US) characteristics of both primary tumors and LNs were used to develop corresponding prediction models, and a nomogram integrating clinicopathologic and US predictors was generated to predict the axillary response to NAC.

#### **RESULTS**

Axillary pathological complete response (pCR) was achieved for 47.79% in patients with initially node-positive breast cancer. The expression of estrogen receptor, human epidermal growth factor receptor -2, Ki-67 score, and clinical nodal stage were independent predictors for the nodal response to NAC. Location and radiological response of primary tumors, cortical thickness and shape of LNs on US were also significantly associated with nodal pCR. In the validation cohort, the discrimination of US model (AUC, 0.76; sensitivity, 68.67%; specificity, 75.00%) was superior to clinicopathologic model (AUC, 0.68; sensitivity, 74.67%; specificity, 53.85%). AUCs of the nomogram based on clinicopathologic and US characteristics was 0.85, with a sensitivity of 83.33% and specificity of 73.72%.

#### **CONCLUSION**

US characteristics of primary tumors and axillary LNs were independently associated with axillary status after NAC for breast cancer with initially positive-node. The nomogram constructed with readily available clinicopathologic features and US characteristics improved the predictive capability.

#### **CLINICAL RELEVANCE/APPLICATION**

Even if patients with excellent response to chemotherapy may be potential candidates for omission of ALND, it is difficult to determine status of axillary LNs following NAC. Nomogram incorporating routine clinicopathologic and US characteristics of breast tumors and axillary LNs can predict nodal pCR after NAC and may be a feasible modality to aid in surgical decisions-making for axilla.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5A-SPBR-9

### The Value of IVIM-DWI and DCE-MRI in Predicting Molecular Subtypes of Breast Cancer

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Tingting Lin (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the value of IVIM-DWI and DCE-MRI in predicting the molecular subtypes of breast cancer.

#### METHODS AND MATERIALS

187 patients with suspected breast cancer admitted to our hospital from March, 2019 to December, 2021 were enrolled in this study. Pathological examination was performed after MRI to observe the expression of ER, PR, HER-2 and Ki-67. The quantitative parameters of IVIM-DWI (ADC<sub>standard</sub>, ADC<sub>slow</sub>, ADC<sub>fast</sub>, f) and DCE-MRI (K<sub>trans</sub>, K<sub>ep</sub>, V<sub>e</sub>) were measured. SPSS software was used to analyze the relationship between all parameters and the expression of ER, PR, HER-2 and Ki-67 as well as the correlation between all parameters and the prognostic factors of breast cancer. The differences in parameters of IVIM-DWI and DCE-MRI of different molecular subtypes were compared. Receiver operating characteristic curve (ROC) was plotted for parameters with statistical significance and the area under curve (AUC) was calculated.

#### RESULTS

180 cases of breast cancer were included. Containing 15 cases of LuminalA, 45 cases of LuminalB (HER-2-), 68 cases of LuminalB (HER-2+), 30 cases of HER-2 over expression, and 22 cases of triple negative. DCE:K<sub>ep</sub> and K<sub>trans</sub> showed statistically significant differences between HER-2 positive and negative groups and Ki-67 high and low expression groups, but no statistically significant differences between ER and PR positive and negative groups, while V<sub>e</sub> was significantly different between ER, PR, HER-2 positive and negative groups, but was not different between Ki-67 high and low expression groups. K<sub>ep</sub> still had predictive value for HER-2 status and V<sub>e</sub> still had statistical significance for PR status prediction in Logistic multivariate regression analysis. The prediction threshold of K<sub>ep</sub> ( $p < 0.001$ , AUC=0.878) and V<sub>e</sub> ( $p < 0.001$ , AUC=0.84) was 0.602 (specificity=87.5%, sensitivity=72.7%) and 0.547 (specificity=96.1%, sensitivity=58.6%), respectively. IVIM: ADC<sub>standard</sub> and ADC<sub>slow</sub> showed statistical significance between positive and negative groups of ER, PR and HER-2, but no statistical significance between high and low expression groups of Ki-67 ( $p > 0.05$ ). K<sub>ep</sub>, K<sub>trans</sub>, V<sub>e</sub>, ADC<sub>standard</sub> and ADC<sub>slow</sub> showed statistically significant differences among different molecular subtypes of breast cancer.

#### CONCLUSION

K<sub>ep</sub>, K<sub>trans</sub>, V<sub>e</sub>, ADC<sub>standard</sub> and ADC<sub>slow</sub> have certain predictive value for different molecular subtypes, and can provide an important reference for clinical development of personalized treatment.

#### CLINICAL RELEVANCE/APPLICATION

Provide a non-invasive prediction method for the preoperative diagnosis of molecular subtypes of breast cancer, which lays a foundation for the accurate diagnosis of breast cancer and the formulation of personalized treatment programs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPCA-1

### Association of Liver Multiparameter Quantitative Metrics Determined by Dual Layer Spectral Detector CT with Coronary Plaque Scores: A Preliminary Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Wang Min (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore potential impacts of the extent and severity of coronary artery plaques on the liver quantitative metrics measured by dual-layer spectral detector CT (SDCT).

#### METHODS AND MATERIALS

Patients who underwent an unenhanced SDCT scan of the upper abdomen and coronary computed tomography angiography (CCTA) were enrolled. The segmental stenosis score (SSS) and segmental involvement score (SIS) were used to evaluate the extent and severity of plaques and then grouped by SIS and SSS, The CT attenuation of liver assessed by polychromatic images and spectral metrics of the liver were assessed by virtual mono-energetic images at 40keV and 70keV, the slope of spectral attenuation curve and effective atomic number (written as CT40keV, CT70keV,  $\mu$ HU and Zeff, respectively). Logistic regression model was used to evaluate association of liver quantitative metrics with SIS and SSS.

#### RESULTS

644 patients were enrolled, including low SIS (<5) group (n=451), high SIS (=5) group (n=193), low SSS (<5) group (n=461) and high SSS (=5) group (n=183)). Except for the CT70poly value (p=0.115) in SSS group, other liver spectral steatosis metrics were significantly different between SIS and SSS groups (All p<0.05). Compared with other collinearity spectral metrics, Zeff was more closely correlated with the SIS and SSS. Zeff was divided into four groups according to the interquartile interval. Compared with the patients in the lowest quartile of Zeff, the adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for SIS were 2.401 (1.284-4.493), 3.215(1.661-6.224), and 4.126 (2.152-7.911) for those in the second, the third, and the fourth quartile of Zeff, whereas the corresponding ORs (95% CI) for SSS were 2.098 (1.130-3.894), 3.078(1.602-5.916), and 3.582 (1.876-6.840) for the upper three quartiles of Zeff, especially among these who were < 60 years old, male and VAT/SAT < 1.18.

#### CONCLUSION

The quantitative parameter Zeff from SDCT, was an independent factor of the extent and severity of coronary artery plaques. Liver fat quantification may be useful for evaluating risk and prognosis of coronary artery disease.

#### CLINICAL RELEVANCE/APPLICATION

Liver multi-parameter metrics measured by SDCT may help to achieve the screening and primary prevention of high-risk population of coronary artery disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPCA-2

### Feasibility of Fast Manual Left Atrial Long-axis Strain Using Cardiac Computed Tomography in Patients with Paroxysmal Atrial Fibrillation

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Takaaki Hosokawa (*Presenter*) Nothing to Disclose

#### PURPOSE

Left atrial (LA) function is important for the prognosis of patients with atrial fibrillation (AF). LA strain (LAS) is a sensitive parameter that reflects the complex LA function. Recently, it can be evaluated using cardiac computed tomography (CT). However, LAS analysis requires a dedicated software and experience owing to complex LA anatomy (pulmonary veins and appendages). Semi-automatic fast long-axis strain is a novel simplified method for LAS analysis that improves reproducibility and reduces analysis time; however, it requires a dedicated software, limiting its availability. We hypothesized that LAS could be evaluated manually without using a dedicated software with fast long-axis strain. We aimed to assess the feasibility of fast manual LA long-axis strain (FM-LALS) in patients with paroxysmal AF (PAF).

#### METHODS AND MATERIALS

In this study, 40 patients with PAF who underwent cardiac CT and echocardiography were retrospectively enrolled. CT data of the entire cardiac cycle was reconstructed every 5% of RR intervals (RR; 0-95%). LA reservoir and pump strain were evaluated by conventional semi-automatic LAS (cLAS) and FM-LALS. FM-LALS was derived by measuring the distance between the left atrioventricular junction and LA posterior wall in three phases (end-diastole, end-systole, and mid-diastole). Moreover, LAS was assessed using speckle tracking echocardiography (STE). We assessed the correlations between cLAS, FM-LALS, and STE. Inter-observer reproducibility was evaluated in 15 randomly selected patients by two radiologists.

#### RESULTS

FM-LALS showed an extremely strong correlation with cLAS ( $r = 0.93-0.94$ ,  $p < 0.001$ ). FM-LALS and cLAS showed moderate to strong correlations with STE ( $r = 0.67-0.77$ ,  $p < 0.001$ ). FM-LALS and cLAS showed good to excellent reproducibility (intraclass correlation coefficient 0.85-0.91). FM-LALS significantly reduced the analysis time compared to cLAS (median 92 vs 146 s,  $p < 0.001$ ), while cLAS consumed an additional 4 min for pre-processing.

#### CONCLUSION

FM-LALS enables rapid and highly reproducible LAS analysis without using a dedicated software and is useful as a highly available LAS analysis method in patients with PAF.

#### CLINICAL RELEVANCE/APPLICATION

FM-LALS can be assessed rapidly and easily without using a dedicated software, providing high clinical availability.

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## Abstract Archives of the RSNA, 2023

T5A-SPCA-3

### Dual Energy Computed Tomography to Evaluate Coronary Pericoronary Adipose Tissue Attenuation in Acute Aortic Dissection Patients

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yongbo Tu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Pericoronary adipose tissue (PCAT) attenuation is an indicator of active inflammation of perivascular adipose tissue and is supposed to increase in acute aortic dissection (AAD) patients. We aimed to investigate the PCAT attenuation values in acute aortic dissection patients with or without atherosclerosis of the coronary arteries.

#### METHODS AND MATERIALS

Consecutive patients with chest pain were prospectively enrolled and underwent coronary computed tomography angiography (CCTA) and/or aorta computed tomography angiography. The patients were divided into two groups, AAD and non-AAD, according to the results of CTA. The PCAT attenuation values of three major epicardial coronary vessels were measured. The PCAT attenuation values were compared between the AAD and non-AAD subjects according to the atherosclerosis of the coronary arteries. Similarly, the PCAT attenuation values of the AAD patients were compared between the preoperative and postoperative steady states.

#### RESULTS

A total of 136 patients (42 female, 94 male; mean age,  $63 \pm 11.9$  years) were divided into two groups according to the presence of aortic dissection on CTA. PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were significantly higher in AAD subjects than in non-AAD subjects, regardless of the presence of atherosclerosis of the coronary arteries ( $-85.1 \pm 9.3$  HU vs.  $-92.9 \pm 10.0$  HU;  $-83.2 \pm 7.4$  HU vs.  $-89.9 \pm 9.1$  HU;  $-77.5 \pm 8.4$  HU vs.  $-85.6 \pm 7.9$  HU,  $p < 0.05$  all). The preoperative PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were higher in the AAD patients than in postoperative steady-state subjects ( $-82.9 \pm 8.7$  HU vs.  $-97.6 \pm 8.8$  HU;  $-79.8 \pm 7.6$  HU vs.  $-92.8 \pm 6.8$  HU;  $-74.6 \pm 7.1$  HU vs.  $-87.7 \pm 6.9$  HU,  $p < 0.05$  all). According to multivariable logistic regression analysis, PCAT<sub>RCA</sub> and PCAT<sub>LAD</sub> were the parameters showing consistent difference between the AAD and non-AAD patients (OR=0.010; 95%CI:0.001 to 0.189;  $p=0.002$ , OR=0.115; 95%CI:0.023 to 0.563;  $p=0.008$ , OR=0.156; 95%CI:0.032 to 0.770;  $p=0.023$  and OR=0.014; 95%CI:0.001 to 0.177;  $p=0.001$ , OR=0.041; 95%CI:0.008 to 0.210;  $p<0.001$ ).

#### CONCLUSION

PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were significantly higher in AAD patients than in non-AAD patients regardless of atherosclerosis of the coronary artery. Similarly, in AAD patients with atherosclerosis of the coronary artery, PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were significantly higher preoperatively than postoperatively.

#### CLINICAL RELEVANCE/APPLICATION

It provides more clinical evidence for the relationship between macrovascular adipose tissue and extracardiac adipose tissue, and can provide more information for drug treatment for the mutual disease.

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## Abstract Archives of the RSNA, 2023

T5A-SPCA-4

### iPSC-based Engineered Heart Tissue for Myocardial Repair - An In-vivo Pilot Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Christopher Yi-Han Hasenauer (*Presenter*) Nothing to Disclose

#### PURPOSE

Chronic heart failure as a result of myocardial infarction remains a major burden on the healthcare systems of the industrialized countries and the respective average life expectancy of their citizens. This calls for therapies targeting the regeneration of the underlying loss of cardiomyocytes. The aim of the project was a proof of concept for the remuscularization of the myocardium by the use of engineered heart tissue based on induced pluripotent stem cells (iPSC) in a macaque model (non-human primate).

#### METHODS AND MATERIALS

Engineered heart tissue was implanted as functional tissue patches to 14 macaques in two cohorts. An epicardial midventricular position of the left ventricle was chosen for implantation. The heart function was quantified using 3T MRI. After two baseline measurements the first cohort received a single dose (40x20x1 mm cell cluster consisting of 40 million myocytes) and a monthly follow-up for three months. The second cohort received a five-fold dose (48x48x2.5 mm, 200 million cells) and an additional fourth follow-up measurement after six months. The evaluation was carried out by two different examiners. The animal experiments were carried out as part of an approved study.

#### RESULTS

After three months the systolic and diastolic wall thickness of the left ventricle of all animals increased ( $7\pm 1$  mm to  $9\pm 2$  mm  $p=0.001$ ). At the end of the follow-up the left ventricular mass increased ( $12\pm 2$  g to  $13\pm 3$  g,  $p=0.11$ ). The left ventricular ejection fraction increased ( $59\pm 3\%$  to  $60\pm 5\%$   $p=0.001$ ) without a significant change in the cardiac output. The right ventricular ejection fraction and wall thickness did not change significantly. The longitudinal strain the 4-chamber view and vertical longitudinal axis did not show any significant changes during the observation period.

#### CONCLUSION

The implantation of artificial heart tissue from iPSC resulted in a sustained increase in left ventricular mass and wall thickness in healthy animals without any adverse effects.

#### CLINICAL RELEVANCE/APPLICATION

iPSC-based functional myocardial patches are a promising therapy of infarct-related chronic heart failure. This proof-of-concept study in a non-human primate shows feasibility and safety of this innovative approach. It is the first step towards its application in patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPCA-6

### Fat Fraction Analysis as a Novel Method for the Assessment of Pericoronary Adipose Tissue Inflammation

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Caterina B. Monti, MD, PhD (*Presenter*) Travel support, Bracco Group

#### PURPOSE

The aim of our study was to assess pericoronary adipose tissue via the analysis of its fat fraction (FF), comparing it to conventional biomarkers such as pericoronary fat attenuation index (FAI) and the degree of coronary stenosis.

#### METHODS AND MATERIALS

We retrospectively included all consecutive patients who underwent a dual-energy, unenhanced computed tomography (CT) scan for calcium scoring at our institution. For each patient, we processed the FF maps through a dedicated software, and segmented regions of interest around each coronary artery, namely the left anterior descending artery (LAD), circumflex artery (LCX) and right coronary artery (RCA) to obtain FF and FAI. We retrieved data concerning coronary stenosis from CT reports.

#### RESULTS

Overall, 99 patients were included, 32 (32%) of whom females, with a median age of 66 years (interquartile range, IQR, 58-74 years). For each coronary artery, pericoronary FF displayed moderate, negative correlations with FAI (LAD:  $r=-0.617$ ,  $p<0.001$ ; LCX:  $r=-0.493$ ,  $p<0.001$ ; RCA:  $r=-0.506$ ,  $p<0.001$ ). Pericoronary FF displayed a weak negative correlation with coronary stenosis at the LAD ( $r=-0.220$ ,  $p=0.035$ ), whereas at the LCX and RCA no significant correlations were observed ( $p=0.572$ ).

#### CONCLUSION

Our proof-of-concept analysis indicates that epicardial adipose tissue FF, which can be easily computed on dual-energy, unenhanced CT scans, could represent an additional biomarker of cardiovascular risk and coronary inflammation.

#### CLINICAL RELEVANCE/APPLICATION

Evaluating pericoronary fat fraction at dual energy CT could provide data concerning the status of coronary arteries even from unenhanced cardiac CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPCH-2

### Clinical Values of Deep Learning-based Lung Nodule Detection System for Metastasis Evaluation in Patients with Colorectal Cancer: In-depth Analyses of Effects on Thoracic Radiologists

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Chul Hwan Park, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to evaluate the clinical values of a deep learning-based computer-aided diagnosis (DL-CAD) system with in-depth analyses of radiologists' performance and reading time in pulmonary metastasis evaluation on chest computed tomography (CT).

#### METHODS AND MATERIALS

The multi-reader study with a randomized cross-over design was performed during two reading sessions. For the six experienced thoracic radiologists, 64 chest CT scans from patients with colorectal cancer, including 77 pulmonary nodules, were prepared based on a pilot study's sample size calculation. Each reader evaluated nodule presence, size, and location with or without a commercially available DL-CAD system with a 4-week washout period. The reading platform automatically measured the reading time. Per-nodule sensitivity, false-positive per scan, and readers' reading time with or without the DL-CAD system were compared using logistic regression, Poisson regression, and linear mixed model, respectively. Inter-reader agreements for nodule detection and size measurement were analyzed with Fleiss kappa ( $k$ ) and concordance correlation coefficient (CCC).

#### RESULTS

Using the DL-CAD system, the pooled sensitivity of six readers for lung nodules significantly improved (from 0.703 [95% CI, 0.651-0.756] to 0.842 [95% CI, 0.782-0.902],  $p < 0.001$ ), reading time significantly reduced (from 212.8 s [95% CI, 198.9-226.7] to 165 s [95% CI, 151.1-178.8],  $p < 0.001$ ), and inter-reader agreements for nodule detection ( $k$ , 0.682-0.884,  $p < 0.001$ ) and size measurement (CCC, 0.385-0.543,  $p < 0.001$ ) enhanced. The improved sensitivity was significant for nodules located in the intraparenchymal (from 0.597 [95% CI, 0.359-0.836] to 0.986 [95% CI, 0.959-1.013],  $p = 0.002$ ) and perivascular (from 0.553 [95% CI, 0.383-0.723] to 0.649 [95% CI, 0.472-0.826],  $p = 0.006$ ) areas and those  $< 6$ mm in axial diameter (from 0.669 [95% CI, 0.611-0.728] to 0.823 [95% CI, 0.750-0.895],  $p < 0.001$ ). However, there was no significant change in the pooled false-positive per case without versus with the DL-CAD system (0.094 [95% CI, 0.052-0.168] vs. 0.094 [95% CI, 0.054-0.163],  $p > 0.999$ ).

#### CONCLUSION

With the DL-CAD system, the readers showed significantly improved performance for pulmonary nodule detection and reduced CT reading time without a false-positive increase in pulmonary metastasis evaluation on chest CT.

#### CLINICAL RELEVANCE/APPLICATION

The DL-CAD system show good enough performance to be clinically utilized as an assistant in the setting of pulmonary metastasis screening.

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## Abstract Archives of the RSNA, 2023

T5A-SPCH-5

### **Conjugate Gradient (CG) Reconstruction vs. Grid Reconstruction: Capabilities for Acquisition Time Reduction, Image Quality and Nodule Detection on Pulmonary Thin-Section MR Imaging with Ultra-Short TE at *In Vitro* and *In Vivo* Studies**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

#### **PURPOSE**

Pulmonary thin-section MR imaging with UTE (UTE-MRI) has been reported its' clinical potential as substitution for thin-section CT for lung nodule detection or characterization in the last several years. However, one of its' drawbacks are relatively longer acquisition time because of high numbers of 3D radial sampling and grid reconstruction method. In this situation, we develop and clinically set conjugate gradient (CG) reconstruction for UTE-MRI to overcome this drawback. The purpose of this study was to directly compare utility for acquisition time reduction with keeping image quality and nodule detection capability among UTE-MRI obtained with different sampling spoke numbers and reconstructed with CG and grid reconstructions at in vitro and in vivo studies.

#### **METHODS AND MATERIALS**

At in vitro study, commercially available MR phantom for evaluation of image distortion was scanned by UTE-MRI sequence with original ( $n=1$ ), 1/2, 1/4 and 1/6 sampling spoke numbers at five times, and each UTE-MRI data was reconstructed with CG and grid reconstructions. Moreover, at in vivo study, 40 patients suspected with lung nodule underwent thin-section CT and UTE-MRI by same sequence with original, 1/2, 1/4 and 1/6 sampling spoke numbers. Then, all UTE-MRI data were also reconstructed with CG and grid reconstructions. Standard protocol in this study was UTE-MRI obtained with original sampling spoke number and reconstructed with grid reconstruction. To determine the influence of sampling spoke number reduction and reconstruction method difference at in vitro study, full width at half maximum (FWHM) of each phantom was measured. At in vivo study, lung signal-to-noise ratio (SNR), overall image quality, artifact and probability for nodule presence were assessed by ROI measurement or 5-point scales. FWHM and SNR were compared between each UTE-MRI and standard protocols by Student's t-test. All qualitative indexes were compared by Wilcoxon's signed rank test between each UTE-MRI and standard protocols.

#### **RESULTS**

FWHM and SNR of standard protocol had significant differences with those of all UTE-MRI protocols except UTE-MRIs obtained with original and 1/2 sampling numbers and reconstructed with CG reconstruction ( $p<0.05$ ). Each qualitative index of standard protocol had significant differences with those of all UTE-MRI protocols except UTE-MRIs obtained with original and 1/2 sampling numbers and reconstructed with CG reconstruction ( $p<0.05$ ).

#### **CONCLUSION**

CG reconstruction is useful for reducing acquisition time without any influence on image quality and nodule detection on UTE-MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

CG reconstruction is useful for reducing acquisition time without any influence on image quality and nodule detection on UTE-MRI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5A-SPCH-6

### Low-Field (0.55T) Fourier-Decomposition Magnetic Resonance Imaging for Ventilation and Perfusion Defect Evaluation of Pulmonary Diseases

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Dante Capaldi, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Low field (0.55T) MRI has recently shown great potential for lung imaging, with reduced susceptibility artifacts and superior image quality for anatomical assessment as compared to higher field MRI. Fourier decomposition MRI (FDMRI) offers a non contrast enhanced, free breathing method to generate both pulmonary ventilation and perfusion maps over a short tidal breathing duration. Our objective was to evaluate for both pulmonary ventilation and perfusion in volunteers and lung disease patients using low field FDMRI. As patients with lung pathology are more frequently known to have ventilation or perfusion defects, we hypothesize that FDMRI ventilation and perfusion defects would be visible and elevated in these patients as compared to our volunteers.

#### METHODS AND MATERIALS

We prospectively enrolled 17 patients with heterogeneous lung disease diagnoses (57±17yrs, interstitial lung disease=4, sarcoidosis=1, bronchiectasis=1, non small cell lung cancer=4, chronic thromboembolic pulmonary hypertension=2, emphysema=1, benign nodules=4) and four volunteers (48±17yrs) who provided written informed consent. Multi slice coronal plane (anterior, center, posterior) free breathing 1H MRI were acquired over a period of 90s per plane using an optimized balanced steady state free precession sequence on a 0.55T scanner (MAGNETOM Free.Max, Siemens Healthineers, Erlangen, Germany). FDMRI analysis was performed using an inhouse software (MATLAB) and the ventilation (VDP) and perfusion defect percent (QDP) were generated using a hierarchical k means clustering approach to extract the ventilation and perfusion defect volumes and a seeded region growing algorithm to segment the thoracic cavity volume. Quantitative comparisons between volunteers and patients with lung disease were performed using unpaired t tests.

#### RESULTS

Low field FDMRI ventilation and perfusion maps showed visible ventilation heterogeneity (i.e. V/Q mismatch) in the lung disease patients, such as visible ventilation defects in fibrotic sarcoidosis patients and perfusion defects in a patient with pulmonary hypertension, as compared to the volunteers. Quantitatively as compared to the volunteers, both VDP (volunteer=1.9±0.6%, disease=5.1±3.8%; p=0.03) and QDP (volunteer=2.5±0.3%, disease=7.8±4.4%; p=0.03) were significantly elevated in lung disease patients.

#### CONCLUSION

In patients with lung disease, low field FDMRI ventilation and perfusion defects were qualitatively visible and quantitatively elevated, as compared to volunteers.

#### CLINICAL RELEVANCE/APPLICATION

Low field (0.55T) free breathing MR ventilation/perfusion (MRVQ) holds promise to functionally evaluate pulmonary diseases without needing intravenous/inhaled contrast agents or ionizing radiation.

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## Abstract Archives of the RSNA, 2023

T5A-SPCH-7

### Free Breathing 19F MRI Detects Lobar Differences in Ventilation Kinetics

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Courtney Wing, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study was conducted to interpret lobar ventilation kinetics in both healthy supine subjects using a free-breathing 19F MRI ventilation technique.

#### METHODS AND MATERIALS

5 healthy volunteers completed a single MR session on a Siemens 3T Prisma. 1H ultrashort-echo time (UTE) MRI sequences were used for registration and masking, and ventilation images with 19-Fluorine (19F) MRI were obtained while the subjects breathed a normoxic mixture of 79% perfluoropropane and 21% oxygen (O<sub>2</sub>). 0.4 second spiral 19F MR imaging was performed during a free breathing recovery breath. The 19F spiral data were denoised using a low-rank matrix recovery approach. Lobar ventilation mapping was created via manual segmentation tools available using 3D Slicer software on the UTE images. Time constants for wash-in and wash-out kinetics ( $t_1(s)$ ,  $t_2(s)$ , respectively) taken from right upper lobe (RUL), right middle lobe (RML), right lower lobe (RLL), left upper lobe (LUL), and left lower lobe (LLL) were used to measure physiologic lobar differences in ventilation kinetics among healthy supine patients.

#### RESULTS

19F gas wash-in and wash-out rate constants ( $t_1(s)$ ,  $t_2(s)$ ) were used to measure efficiency of gas exchange in the inspiratory and expiratory phases. On average, bilateral lower lobes demonstrated the most rapid wash-in and wash-out rates in supine subjects (average  $t_1(s)$  RLL = 69.42, RML = 73.3, RUL = 83.5, LUL = 68.0, LLL = 58.1, average  $t_2(s)$  LUL = 27.5, LLL = 22.8).

#### CONCLUSION

This follows known physiologic principles in standing patients, in which maximum perfusion in the lower lung zones allows for the largest potential for gas exchange. In order to maintain the most efficient rates of gas exchange in bilateral lower lobes, "standing" pulmonary perfusion ratios must be maintained. This may be explained by supine pulmonary blood flow regulatory mechanisms that are not yet studied. Ventilation mapping with free-breathing 19F MRI is sufficiently sensitive to detect known lobar differences in ventilation kinetics among healthy supine subjects.

#### CLINICAL RELEVANCE/APPLICATION

Free breathing 19F MRI has already been proven valuable in monitoring treatment outcomes in CF as well as progression of disease. Here, we offer its utility in studying regional ventilation kinetics in supine subjects, which is not possible with current standard ventilation-space MRI techniques. 19F also lacks dependence on hyperpolarization protocols needed for current functional MRI (Helium-3 (<sup>3</sup>He), Xenon-129 (<sup>129</sup>Xe)), so it can be offered at institutions that may lack the resources for hyperpolarization protocols.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPCH-8

### Assessment of Lung Density in Preterm Infants Using Three-dimensional Ultrashort Echo-time MRI

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yujie Chen, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Postnatal Lung development is important in infants, especially in preterm children, while relevant imaging data is scarce. Recent studies have shown that normalized lung signal intensity using UTE-MRI could be correlated to lung density comparable to CT, so we aim to explore the quantitative ability of UTE-MRI for assessing lung tissue density and analyze the differences in lung signal intensity among premature infants.

#### METHODS AND MATERIALS

A prospective recruitment from March 2021 to October 2022 was conducted at the West China Second University Hospital of Sichuan University for infants aged 0-2 years. A total of 101 subjects were enrolled and divided into three groups based on gestational age (GA): extremely-to-very preterm group (GA<28 weeks, n=33), mid-to-late preterm group (GA>28 weeks and <37 weeks, n=34), and full-term group (GA=37 weeks, n=34). All subjects underwent pulmonary MRI using a 3.0-Tesla pediatric-specific MRI scanner (UIH uMR Alpha), including UTE sequence scanning. The lung-to-muscle ratio (LMR) was used to normalize lung signal intensity and quantify lung tissue density, and investigate the anterior-to-posterior(A-P) gradient of lung tissue and the inter-group differences among premature infants.

#### RESULTS

LMR-A and LMR-P based on UTE-MRI were found to be linearly correlated ( $R^2=0.582$ ,  $P<0.001$ ), indicating a A-P gradient in lung density. There is a gradually decreased tendency of the mean LMR in full-term, mid-to-late preterm, and extremely-to-very preterm infants, the whole lung LMR averages were 45.1, 48.7 and 50.8, respectively, with a statistically-significant difference between extremely-to-very preterm and full-term group ( $P=0.045$ ), and a nearly statistically-significant difference between extremely-to-very preterm and mid-to-late preterm group ( $P=0.083$ ), but the difference between mid-to-late preterm and full-term group was not statistically significant ( $P=0.290$ ).

#### CONCLUSION

UTE-MRI shows the quantitative ability for assessing lung tissue density, and extremely-to-very preterm infants had lower lung tissue density compared to term infants.

#### CLINICAL RELEVANCE/APPLICATION

Our study reflects that, the extremely-to-very preterm infants with GA<32 weeks, especially those with bronchopulmonary dysplasia (BPD), may have persistent structural abnormalities, such as alveolar simplification and impaired vascular growth, thereby lead to hyperinflation or cysts manifested as reduced signal intensity on UTE-MRI. Our results provides structural evidence for that, extremely-to-very preterm infants may have persistently reduced lung function compared to full-term infants, and have higher risk to get early-onset chronic obstructive pulmonary disease (COPD), as previous studies suggested.

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## Abstract Archives of the RSNA, 2023

T5A-SPER-1

### Optic Nerve Sheath Diameter Measurement for Predicting Raised Intracranial Pressure in Pediatric Patients: A Meta Analysis

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Seong Jong Yun, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This meta-analysis was aim to evaluate the diagnostic performance of optic nerve sheath diameter (ONSD) for diagnosis of raised intracranial pressure (ICP) in pediatric patients.

#### METHODS AND MATERIALS

A database search of PubMed and EMBASE was performed to identify relevant studies. Bivariate modelling and hierarchical summary receiver operating characteristics (HSROC) modelling were performed to evaluate diagnostic performance. A pooled diagnostic odds ratio (DOR) with a 95% confidence interval (CI) not including 1 was considered informative. Subgroup analysis was performed according to the modality (ocular ultrasound vs. brain computed tomography [CT]/magnetic resonance imaging [MRI]). We performed meta-regression analyses for heterogeneity exploration.

#### RESULTS

Eleven studies including 546 patients were included. According to pooled DORs, ONSD was informative for evaluation of the raised ICP (DOR, 47; 95% CI, 11-206). ONSD showed a pooled sensitivity of 0.88 (95% CI, 0.79-0.94), a pooled specificity of 0.86 (95% CI, 0.70-0.95), and an area under the HSROC curve of 0.93 (95% CI, 0.91-0.95) for diagnosis of raised ICP. According to the subgroup analysis, ocular ultrasound (sensitivity, 0.91 [95% CI, 0.81-0.96]; specificity, 0.86 [95% CI, 0.65-0.96]) showed higher sensitivity and comparable specificity than ONSD measured on brain CT/MRI (sensitivity, 0.75 [95% CI, 0.51-0.99]; specificity, 0.91 [95% CI, 0.74-1.00]). On meta-regression analysis, study design, number of patients, and reference standard were sources of heterogeneity.

#### CONCLUSION

ONSD may be a useful method for predicting raised ICP in pediatric patients.

#### CLINICAL RELEVANCE/APPLICATION

We recommend that measurement of ONSD be performed using ocular ultrasound for more accurate diagnosis of raised ICP in pediatric patients.

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## Abstract Archives of the RSNA, 2023

T5A-SPER-2

### Is it Necessary to Perform Triple Rule-out Computed Tomography Angiography that Includes Abdominal Aorta in Patients with Chest Pain: A Study with More than 1000 Patients

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Tingting Qu (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate whether it is necessary to perform the triple rule-out (TRO) computed tomography angiography (CTA) that includes abdominal aorta in patients with chest pain.

#### METHODS AND MATERIALS

A total of 1482 patients with nontraumatic chest pain (chief complaints: chest pain, difficulty in breathing, or hemoptysis) were included in this retrospective study. Four hundred and fourteen patients underwent the conventional TRO-CTA scans, and 1068 patients underwent TRO-CTA that included the abdominal aorta (TRO-CTAwAA) under the request of clinicians. All scanning parameters were the same only the scanning range for the third phase in TRO-CTA was different: conventional TRO-CTA covered only the thoracic aorta, while TRO-CTAwAA extended to the entire aorta. Patient etiology was investigated and the detection rates of major vessel abnormalities (aortic dissection, aneurysm, penetrating ulcer, vascular occlusion, and thrombosis) between the two groups and within the TRO-CTAwAA group (thoracic aorta vs. entire aorta) were compared using chi square tests and paired chi square tests. The radiation dose (CTDIvol and DLP) between the two groups was compared using analysis of variance (ANOVA).

#### RESULTS

The TRO-CTAwAA had significantly higher detection rate of major artery abnormalities than the TRO-CTA group (38.8% Vs. 8.5%,  $P < 0.001$ ). Within the TRO-CTAwAA group, only 28.4% abnormalities happened in thoracic aorta, which means the vessel abnormalities of 111 patients (27%) in this group would be missed with the conventional scan range. The TRO-CTAwAA group had slightly higher CTDIvol ( $5.64 \pm 1.44$  mGy) and DLP ( $473.64 \pm 146.50$  mGy\*cm) values for the complete examination than the TROCTA group ( $5.25 \pm 1.38$  mGy and  $453.03 \pm 139.22$  mGy\*cm, respectively). However, the differences were not statistically significant (all  $P > 0.05$ ).

#### CONCLUSION

TRO-CTA with scan range including the abdominal aorta significantly improves the detection rate for major vessel abnormalities in patients with chest pain with minor radiation dose increase.

#### CLINICAL RELEVANCE/APPLICATION

For chest pain patients, the scan range of triple rule-out CTA should be extended to include abdominal aorta since about quarter of the major vessel abnormalities happen beyond the thoracic aorta.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-1

### Correlation between Triglyceride/high-density Lipoprotein Cholesterol Ratio and Spectral Parameters Measured on a Fast kVp Switching Dual-energy CT

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Anjie Xie (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the correlation between triglyceride/high-density lipoprotein cholesterol (TG/HDL-C) ratio and spectral parameters measured on a fast kVp switching dual-energy CT

#### METHODS AND MATERIALS

This study included 50 patients with non-alcoholic fatty liver disease (NAFLD) and 46 healthy individuals, all received TG and HDL-C examination and TG/HDL-C was calculated. According to TG/HDL-C, the individuals were divided into two groups: low-ratio group (TG/HDL-C  $\leq$  1.5, n=56), and high-ratio group (TG/HDL-C  $>$  1.5, n=40). Abdominal spectral imaging was performed on all individuals. Virtual monochromatic images at 50keV, 70keV, 90keV, and 100keV were reconstructed, the CT value of liver at 50-100 keV (HU<sub>50-100 keV</sub>) and that of spleen at 70keV were measured and the CT value of liver/ CT value of spleen ratio (HUL/S) was calculated. Mann Whitney U or two-sample t test was used to compare the differences between two groups, Spearman or Pearson correlation analysis was used to analyze the correlation between TG/HDL-C ratio and CT quantitative parameters, and ROC curve was used to analyze the performances of those parameters in predicting TG/HDL-C ratio.

#### RESULTS

Correlation analysis showed that TG/HDL ratio was negatively correlated with HU<sub>50keV</sub>, HU<sub>70keV</sub>, HU<sub>90keV</sub>, HU<sub>100keV</sub>, HUL/S, and the correlation coefficients were -0.4171 (-0.5740 to -0.2307,  $p < 0.0001$ ), -0.6129 (-0.7272 to -0.4655,  $p < 0.0001$ ), -0.6878 (-0.7830 to -0.5612,  $p < 0.0001$ ), -0.7006 (-0.7923 to -0.5778,  $p < 0.0001$ ), -0.7513 (-0.8291 to -0.6450,  $p < 0.0001$ ). HU<sub>50keV</sub>, HU<sub>70keV</sub>, HU<sub>90keV</sub>, HU<sub>100keV</sub>, and HUL/S in high-ratio group were lower than those in low-ratio group ( $p < 0.05$ ). When using HU<sub>50keV</sub> (threshold 68.625), HU<sub>70keV</sub> (57.71), HU<sub>90keV</sub> (58.785), HU<sub>100keV</sub> (55.89) and HUL/S (threshold 1.105) to predict TG/HDL-C ratio, the sensitivities were 0.804, 0.821, 0.625, 0.732 and 0.804, the specificities were 0.69, 0.714, 0.952, 0.8821 and 0.833, and AUC were 0.723, 0.803, 0.832, 0.835 and 0.837, respectively.

#### CONCLUSION

Conclusion The quantitative spectral parameters (HU<sub>50keV</sub>, HU<sub>70keV</sub>, HU<sub>90keV</sub>, HU<sub>100keV</sub>, HUL/S) were all correlated with TG/HDL-C ratio and had high performance to predict TG/HDL-C in NAFLD patients.

#### CLINICAL RELEVANCE/APPLICATION

Spectral imaging can help predict cardiovascular events in NAFLD patients, which is valuable for therapy and prognosis.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-2

### Opportunistic Screening for Bone Mineral Density Changes using Virtual Non-calcium of Spectral CTE in Patients with Inflammatory Bowel Disease

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Shaotong Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

Objective The purpose of this study was to explore the feasibility of opportunistic screening for bone mineral density (BMD) changes in patients with inflammatory bowel disease using virtual non-calcium of spectral computer tomography enterography (CTE)

#### METHODS AND MATERIALS

Materials and Methods Twenty patients (10 males, 10 females, average age  $38.2 \pm 11.5$ ) confirmed with inflammatory bowel disease (IBD) were prospectively enrolled. And 19 patients with non-inflammatory bowel disease (10 males, 9 females, mean age  $37.8 \pm 10.1$ ) were enrolled as control group. Patients were excluded if they had the following conditions: (a) no informed consent; (b) fracture in spine; (c) primary or metastatic bone tumors in the spine; (d) incomplete CT images; (f) Severe degenerative changes. Dual energy CTE was performed at 100/Sn150kVp using a 3rd generation dual-source CT scanner (SOMATOM Force, Siemens Healthcare). Dual energy images were reconstructed with a) virtual non-contrast images (VNC), b) virtual non-calcium images (VNCa). The CT value for contrast media (CM), the contrast agent density (CaD) which correspond to the CT value of calcium density, CT value of 50% mixed- energy imaging (CTmix) and fat fraction (FF) for 1st lumbar were measured, respectively.

#### RESULTS

Results FF and CaD of IBD group were significantly higher than those of control group ( $p < 0.05$ ). But CM and CTmix were similar between two groups ( $p > 0.05$ ). The results were shown in Table 1.

#### CONCLUSION

FF and CaD measurements on VNCa images in spectral CT could provide feasibility of BMD quantification in patients with IBD by spectral CTE.

#### CLINICAL RELEVANCE/APPLICATION

Clinical application Spectral CTE prescribed for IBD evaluation could also provide opportunistic screening for BMD changes, extending the clinical application of Spectral CT without additional radiation to patients.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-3

### Feasibility of Diagnosing Non-alcoholic Fatty Liver Disease using Spectral Imaging and Multi-material Decomposition Technique on Dual-energy CT

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Anjie Xie (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility to diagnose non-alcoholic fatty liver disease (NAFLD) using multi-material decomposition (MMD) measured liver fat fraction (FF) and spectral parameters.

#### METHODS AND MATERIALS

Fifty patients with clinically diagnosed NAFLD (reference of ultrasound examination or liver biopsy results) and 46 without NAFLD volunteers (N-NAFLD) were included in this study. Abdominal spectral imaging was performed on all individuals. Then visceral fat content (FV) and visceral fat content percentage (FCV) were measured by an auto measurement software. The FF in the left lobe of liver (FFL), right anterior lobe of liver (FFRA), and right posterior lobe of liver (FFRP) were measured using MMD. Virtual monochromatic images at 50keV, 70keV, 90keV, and 100keV were reconstructed, the CT value of liver at 50-100 keV (HU50-100 keV) and that of spleen at 70keV were measured. CT value of liver/ CT value of spleen ratio (HUL/S) and slope of spectral curve  $\gamma$ HU which was defined as  $(HU_{100keV} - HU_{40keV}) / (100 - 40)$  were calculated. Differences between groups were compared using Mann Whitney U. Receiver operating characteristic curves were used to analyze the performances of those parameters in the diagnosis of NAFLD, sensitivity, specificity and area under the curve (AUC) were calculated.

#### RESULTS

Comparing to N-NAFLD group, NAFLD group had higher FFL, FFRA, FFRP, FV, FCV ( $p < 0.05$ ), and lower HU50keV, HU70keV, HU90keV, HU100keV, HUL/S ( $p < 0.05$ ).  $\gamma$ HU was not statistically different between two groups. When using FFL (threshold of 0.981%), FFRP (1.065%), FFRA (4.2635%), and FV (68.8%), FVC (13013mm<sup>2</sup>), HU50keV (67.29 HU), HU70keV (58.05 HU), HU90keV (54.8 HU), HU100keV (55.678 HU), and HUL/S (1.1) to diagnose NAFLD, the sensitivities were 0.96, 0.96, 0.96, 0.52, 0.92, 0.978, 1, 1, 0.935 and 0.978, the specificities were 0.957, 0.935, 1, 0.891, 0.674, 0.72, 0.8, 0.84, 0.94 and 0.88, the AUC were 0.991, 0.989, 0.999, 0.743, 0.873, 0.84, 0.934, 0.978, 0.984 and 0.968, respectively. Therein, FFL, FFRA, FFRP had highest diagnostic performances.

#### CONCLUSION

CT spectral scanning could provide additional quantitative parameters for diagnosis of NAFLD, and FF measured by MMD had highest performance.

#### CLINICAL RELEVANCE/APPLICATION

MMD technique in spectral imaging mode has great potential in rapid and non-invasive diagnosis of NAFLD.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-4

### Photon Counting CT of the Abdomen and Pelvis: A Clinical Comparison of Image Quality to Dual Energy CT Across Different Virtual Monoenergetic Images

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Winston Joe, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon counting detector computed tomography (PCCT) represents the latest step forward in CT technology with early experience demonstrating improvements in spatial resolution, artifact reduction, material decomposition, and dose reduction, yet there are few studies documenting how these advancements translate to improved clinical utility, especially when compared to prior state of the art dual energy integrating detector CT (DECT). The purpose of this work is to evaluate the spectral capabilities of PCCT by comparing image quality of PCCT to that of DECT across a range of virtual monoenergetic images (VMI).

#### METHODS AND MATERIALS

In this institutional review board-approved retrospective study, we identified patients who underwent both routine contrast enhanced CT of the abdomen and pelvis on a clinical PCCT scanner (NAEOTOM Alpha, Siemens Healthineers) and a clinical DECT (SOMATOM FORCE, Siemens Healthineers) since December 2021 ( $n = 12$ ). Individual subjects received the same iodine contrast dose for both examinations. PCCT was performed at a tube voltage of 120 kVp, and DECT performed with a tube voltage pair of 100/150 kVp. Subsequently, VMIs from both scans were reconstructed at 40, 50, 60, 70, 100, and 150 keV. For both PCCT and DECT examinations, contrast-to-noise ratios (CNR) were calculated relative to the psoas musculature for select organs and vessels (aorta, liver, spleen, renal cortex, and pancreas). Quantitative signal-to-noise ratios (SNR) were calculated. PCCT versus DECT were evaluated with respect to CNR and SNR at each virtual monoenergetic image reconstruction. Average radiation doses were compared between PCCT and DECT.

#### RESULTS

PCCT has superior CNR of the aorta at 40 keV and SNR at 40 keV and 50 keV and superior CNR and SNR for renal cortex at 40 keV. There was no significant difference in CNR of the liver or pancreas for all evaluated VMIs, while DECT showed slightly improved CNR in the spleen at 100 keV and 150 keV. PCCT achieved a statistically significant 16% radiation dose reduction compared to DECT.

#### CONCLUSION

At lower keV virtual monoenergetic images, PCCT offers improved CNR and SNR with respect to the aorta and renal cortex. Comparable contrast and signal to noise characteristics were observed for the liver, spleen, and pancreas at lower keV reconstructions. Importantly, these findings were achieved at a statistically significant 16% radiation dose reduction compared to DECT.

#### CLINICAL RELEVANCE/APPLICATION

At low keV monoenergetic image reconstructions, PCCT enables quantitatively comparable to improved image quality compared to DECT while allowing for a statically significant reduction in radiation dose.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-5

### Longitudinal Intra Individual Consistency of Virtual Unenhanced Images Derived from Spectral Detector CT

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Nils Grosse Hokamp, MD, PhD (*Presenter*) Research Grant, Koninklijke Philips NV; Speakers Bureau, Koninklijke Philips NV; Consultant, Bristol-Myers Squibb Company

#### PURPOSE

Virtual non-contrast images (VNC) images obtained from different dual energy approaches are frequently suggested to serve as problem-solvers in case of missing true unenhanced acquisitions and even as replacement of the latter. While ex vivo consistency have been reported as accurate in literature, data on longitudinal, intra-individual consistency is lacking, yet another helpful measurement of their clinical utility. The objective of this study is the evaluation of longitudinal, intraindividual consistency of virtual unenhanced images (VNC) reconstructed from spectral detector CT (SDCT) in large patient cohort.

#### METHODS AND MATERIALS

Baseline and follow-up examinations of 166 patients with malignant melanoma were retrospectively included, resulting in a total of 323 scans. All patients underwent clinically indicated SDCT examinations of the chest and abdomen. In all patients, contrast administration, image acquisition and reconstruction were performed using a standardized protocol. Using additional cross-sectional follow-up imaging (=3 months), macroscopic tumor burden was excluded. A total of 35 ROI in parenchymatous organs, vessels and connective tissue were placed in contrast-enhanced scans (to allow for exclusion of unrepresentative tissues such as fasciae or vessels). To allow for identical ROI placement, baseline and follow-up images were displayed side-by-side using a dedicated software for oncologic image analysis (MintLesion Research, MintMedical, Heidelberg). The software then automatically copied and pasted all ROI on VNC images and collected attenuation and its standard deviation in VNC images for all ROI. Data was statistically assessed using a normalized deviation parameter:  $NDP = \frac{|(TP1;TP2)|}{\text{mean}(TP1;TP2)}$ .

#### RESULTS

As suggested earlier, a difference = 1 standard deviation was considered indicative of excellent reproducibility and found in 85% of cases. Good reproducibility (indicated by  $NDP = 2$  standard deviations) was found for 91% of all ROI. While good reproducibility was found for arterial vessels and all parenchymatous organs of the upper abdomen as well as connective tissues; differences in pelvic organs and venous vessels showed greater variation.

#### CONCLUSION

SDCT-derived VNC reconstructions demonstrate little intraindividual, longitudinal variations and good reproducibility. These findings substantiate the validity of VNC calculations and further underline the clinical applicability of VNC reconstructions.

#### CLINICAL RELEVANCE/APPLICATION

VNC are more commonly used as a replacement for a true unenhanced acquisition, our data provides further substantiation that this is a valid approach.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-6

### Four-Dimensional Esophageal Computed Tomography Imaging: Assessment of Treatment Effect for Esophago-gastric Junction Outflow Disorders after Per-oral Endoscopic Myotomy

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Hikaru Nishiyama (*Presenter*) Nothing to Disclose

#### PURPOSE

Per-oral endoscopic myotomy (POEM) is a novel minimally invasive treatment method for Disorders of EGJ outflow (disorders of EGJO). However, there is no consensus on the method for evaluating the therapeutic effect of esophageal achalasia treatment other than the subjective clinical symptom score called the "Eckardt score". This study aimed to examine the clinical feasibility of four-dimensional esophageal computed tomography imaging (4D-ECT) for assessing treatment effect for esophageal achalasia after POEM.

#### METHODS AND MATERIALS

This prospective study included 24 patients with esophageal achalasia or EGJO obstruction who underwent 4D-ECT using 320-detector-row CT scanner before and after POEM. The patients were seated on the chair in a semi-reclining position at a 45-60 degree angle. Dynamic volume CT scan was performed during swallow of 5% diluted contrast medium (Ioversol, 320mgI/mL). Scanning was performed in sequence over a 10 s duration for swallow, and scan range was from thoracic esophagus to gastric cardia including lower esophageal sphincter (LES). CT images were reconstructed in 102 phases at an interval of 0.1 s. The maximum esophageal length and area at LES level. The volume integral with time (VIT) of contrast medium during scanning was calculated to evaluate esophageal clearance. Additionally, the Eckardt score was recorded to assess treatment effect of POEM. These results were compared between pre- and post-POEM using Wilcoxon signed-rank test.

#### RESULTS

For all patients, POEM were successful without major complications, and the median Eckardt score was significantly improved after POEM (7.0 [5.0-8.8] vs. 0.5 [0-1.0],  $p < 0.0001$ ). The median of maximum esophageal length at LES level was significantly longer (2.1 [0.7-4.9] vs 7.7 [5.6-9.4] mm,  $p = 0.0001$ ), and the median of maximum esophageal area at LES level was significantly larger after POEM (2.0 [0.2-10.8] vs 23.0 [12.4-47.0] mm<sup>2</sup>,  $p = 0.0001$ ). The VIT was significantly smaller after POEM (602.1 [216.4-717.3] vs 92.9 [50.3-333.1] ml/s,  $p < 0.0001$ ).

#### CONCLUSION

4D-ECT allowed for the quantitative assessment of improving both impaired relaxation of LES and esophageal clearance after POEM.

#### CLINICAL RELEVANCE/APPLICATION

4D-ECT is a novel imaging technique for the assessment of esophageal dynamics, and provides quantitative parameters for evaluating esophageal morphology, motility, and clearance. 4D-ECT enables quantitative and objective assessment of treatment effect for EGJO disorders after POEM.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-7

### Quantitative Spectral Computed Tomography Parameters as Pre-operative Prediction Factors for Ki-67 Expression in Hepatocellular Carcinoma

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Caiyun Li, BMedSc, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the performance of spectral parameters measured by a dual-energy CT for predicting the Ki-67 expression in hepatocellular carcinoma (HCC).

#### METHODS AND MATERIALS

This study retrospectively analyzed 91 patients with HCC who underwent both Ki-67 immunohistochemistry and two-phase contrast-enhanced spectral CT imaging. These patients were divided into two groups according to the positive rate of Ki-67 (Ki-67%): high expression (Ki-67% > 20%, n = 51) and low expression (Ki-67% = 20%, n = 40). CT values on 100 and 140 keV monochromatic energy images (HU100-140keV), normalized effective atomic number (Neff-Z), water density (Dwater) and fat density (Dfat) were measured and calculated. Receiver Operating Characteristics (ROC) curves were utilized for evaluating the predicting performance, area under curve (AUC), sensitivity and specificity were calculated, and multi-variable logistic regression analysis were conducted.

#### RESULTS

In prediction of Ki-67 expression, the AUCs of Neff-Z, Dfat, HU100-140keV and Dwater were 0.650, 0.677, 0.692-0.750, 0.777, with thresholds of 0.68, 995.28, 64.42-48.79 and 1035.17 respectively. The corresponding sensitivities were 0.647, 0.804, 0.529-0.824 and 0.961, respectively. The specificities were 0.600, 0.525, 0.825-0.625 and 0.475, respectively. Dwater was an independent predicting factor for high Ki-67 expression (OR=1.286, P<0.001), and had the highest prediction efficiency with area under the curve (AUC) of 0.777. The multi-variable analysis combining spectral CT parameters and morphological characteristics improved the prediction efficiency (AUC=0.814).

#### CONCLUSION

Spectral CT provides a non-invasive method to evaluate the proliferation status of HCC cells, and the efficiency would be improved by combining spectral CT parameters and morphologic features.

#### CLINICAL RELEVANCE/APPLICATION

Ki-67 was a significant marker for HCC prognosis and clinical decision, however current method to evaluate Ki-67 always needs surgery, which is detrimental for assessing patients who lost surgery chance. Contrast-enhanced spectral imaging on dual-energy CT provides various parameters to predict cell proliferation in HCC with good performance, shedding lights in clinical diagnosis and therapeutic strategy decision.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI-8

### Imaging, Pathological and Molecular Characteristics of Programmed Cell Death Ligand 1 Positive Hepatocellular Carcinoma

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Azusa Kitao, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Immunotherapy has been rapidly developed and is being applied for increasing number of hepatocellular carcinoma (HCC) patients. The purpose of this study is to clarify the imaging, pathological and molecular characteristics of hepatocellular carcinoma showing programmed cell death ligand 1 (PD-L1) expression, for the prediction of immunotherapy reactivity.

#### METHODS AND MATERIALS

We enrolled surgically resected 353 HCCs from April 2008 to July 2018 at our institution and classified into PD-L1 positive HCCs and PD-L1 negative HCCs by immunohistochemistry. We compared the qualitative and quantitative findings on dynamic CT and gadoteric acid-enhanced MRI, pathology and immunohistological expression of P53, beta-catenin, glutamine synthetase and organic anion transporting polypeptide 1B3 (OATP1B3). Mann-Whitney test, chi-square test, multivariable analysis and Pearson's correlation analysis were used for statistical analyses.

#### RESULTS

PD-L1 positive HCC (n=82) frequently showed arterial phase rim enhancement or heterogenous hypo-hyperenhancement compared to PD-L1 negative HCC (n=271) (52.4% vs 29.0%,  $P < 0.001$ , odds ratio=5.00, 95% CI 2.34-10.68). Apparent diffusion coefficient (ADC) in PD-L1 positive HCC was lower than in PD-L1 negative HCC ( $1.13 \times 10^{-3}$  mm<sup>2</sup>/s vs  $1.30 \times 10^{-3}$  mm<sup>2</sup>/s,  $P = 0.01$ , odds ratio=0.45 [cutoff value  $1.18 \times 10^{-3}$  mm<sup>2</sup>/s], 95% CI 0.24-0.82). Patients with PD-L1 positive HCC showed higher serum AFP level than those without PD-L1 positive HCC (median 20 ng/ml vs 10 ng/ml,  $P < 0.001$ ). Poorly differentiated HCC was frequent in PD-L1 positive HCC (37.8% vs 19.9%,  $P < 0.001$ ). PD-L1 expression grade showed a significant positive correlation with P53 expression grade ( $P < 0.0001$ ,  $R = 0.36$ ), however, no correlation with the other molecules.

#### CONCLUSION

Imaging characteristics of PD-L1 positive HCC are arterial phase rim enhancement or heterogenous enhancement and lower ADC value. PD-L1 positive HCC showed higher serum AFP level, higher percentage of poorly differentiated HCC and a positive correlation with p53 expression, indicating aggressive biological natures.

#### CLINICAL RELEVANCE/APPLICATION

Imaging characteristics of PD-L1 positive HCC with more aggressive natures, namely arterial phase rim enhancement or heterogenous enhancement in dynamic CT and low ADC value will be useful to predict immunotherapy response in personalized medicine.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPGU-1

### **An MRI-based Grading System for Preoperative Risk Estimation of Positive Surgical Margin after Radical Prostatectomy**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Lili Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to construct a simplified grading system based on MRI features to predict positive surgical margin (PSM) after radical prostatectomy (RP) and then validate it internally.

#### **METHODS AND MATERIALS**

Patients who had undergone prostate MRI followed by RP at our institution between January 2017 and January 2021 were retrospectively enrolled as the derivation group, and those between February 2021 and November 2022 were enrolled as the validation group. One radiologist evaluated tumor-related MRI features, including the capsule contact length (CCL) of lesions, capsular irregularity or bulge, neurovascular bundle asymmetry, obliteration of rectoprostatic angle, frank extraprostatic extension (EPE), and apex abutting. Binary logistic regression and decision tree analysis were used to select risk features for PSM among the significant variables from univariate analysis. The area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of different systems were calculated and then compared. The interreader agreement of the scoring systems was evaluated using the kappa statistic.

#### **RESULTS**

A total of 42 (29.8%) and 32 (36.4%) patients had PSM in the derivation and validation cohorts, respectively. The first grading system was proposed (mrPSM1) using two imaging features, namely, CCL = 20 mm and apex abutting. After combining the radiologist's perspective, the grading system was updated by adding frank EPE (mrPSM2) as follows: Grade 1, CCL < 20 mm without apex abutting; Grade 2, CCL = 20 mm or apex abutting; Grade 3, CCL = 20 mm and apex abutting, or frank EPE. In the derivation group, the AUC was 0.705 for mrPSM1 and 0.713 for mrPSM2. In the validation group, our grading systems showed slightly higher AUC than Park et al.'s model (0.672-0.686 vs. 0.646,  $p > 0.05$ ) and significantly higher specificity (0.732-0.750 vs. 0.411,  $p < 0.001$ ). The kappa value was 0.764 for mrPSM1 and 0.776 for mrPSM2. Decision curve analysis showed a higher net benefit for mrPSM2.

#### **CONCLUSION**

The proposed grading systems based on MRI have feasibility in predicting PSM and are easily interpretable.

#### **CLINICAL RELEVANCE/APPLICATION**

Our proposed MRI-based grading systems for PSM might benefit the management of prostate cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPGU-3

### Performance of an Ultra-fast Deep-learning Accelerated MRI Screening Protocol for Prostate Cancer Compared to a Standard Multiparametric Protocol

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Benedict Oerther, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish and evaluate an ultra-fast MRI screening protocol for prostate cancer in biopsy-naïve men regarding PI-RADSv2.1 classification in comparison to the standard multiparametric protocol.

#### METHODS AND MATERIALS

This prospective monoinstitutional study included consecutive patients with suspected prostate cancer without prior biopsy. A PI-RADSv2.1 conform mpMRI protocol was acquired in a 3 T MRI scanner (triplanar T2 TSE, axial T1 DIXON native and contrast-enhanced, DWI, DCE; scan time: 23min, 43sec). Additionally, two deep-learning accelerated sequences (axial T2-weighted TSE and diffusion-weighted „ZOOMit“) were acquired (scan time: 3min 28sec). Two experienced readers independently evaluated the images for image quality (Likert-scale; 1=non-diagnostic, 5=excellent) and the presence of prostate cancer according to PI-RADSv2.1 criteria. In a first reading session, only the screening protocol (axial T2-weighted and ZOOMit imaging was available). Subsequently, the full conventional mpMRI protocol was assessed (blinded to the results of the first session) and served as a reference standard. Intrareader-agreement was assessed using weighted kappa statistics.

#### RESULTS

The final cohort after exclusions consisted of 77 patients. Diagnostic performance of the screening protocol was excellent with a sensitivity and specificity of 87.5%/100% and 100%/100% (cut-off = PI-RADS 4) for reader 1 and reader 2, respectively. Mean image quality was 4.4 (R1) and 3.9 (R2) for the standard protocol vs. 4.6 and 4.7 for the accelerated T2- and diffusion-weighted images ( $p < 0.05$ ). Intrareader-agreement was substantial ( $k=0.72$ ) for reader 1 and excellent ( $k=0.98$ ) for reader 2.

#### CONCLUSION

An abbreviated screening protocol for prostate cancer in biopsy-naïve men proved similar diagnostic performance and better imaging quality compared to the conventional extensive mpMRI protocol, requiring just 15% of scan time.

#### CLINICAL RELEVANCE/APPLICATION

Ultra-fast deep-learning accelerated MRI protocols can render prostate cancer screening more time efficient.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPHN-1

### CT Diagnosis of Cricoarytenoid Joint Dislocation

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Xueming Zeng (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of CT in diagnosis of cricoarytenoid joint dislocation, and evaluate the diagnostic points of different types of dislocation.

#### METHODS AND MATERIALS

41 patients who had been diagnosed with cricoarytenoid joint dislocation retrospectively reviewed, all patients were treated by reduction forceps, and the voice returned to normal or significantly improved. Including respiratory phase and phonation phase CT images. ?Observe the exposure of arytenoid articular surface of cricoid cartilage on VR images: complete exposure means total dislocation, incomplete exposure means subluxation; posterior part exposure means anterior dislocation, anterior part exposure means posterior dislocation; lateral part exposure means medial dislocation, medial part exposure means external dislocation (respiratory phase). ?Observe laryngoscopic video of each case, judge the direction of dislocation (anterior and posterior) according to morphology of vocal folds; compare the results with CT judgment. ?The characteristics of MPR CT images in each case were analyzed based on VR images.

#### RESULTS

? On VR images, there were 38 cases of cricoarytenoid subluxation (92.7%, 38/41), 3 cases of complete dislocation (7.3%, 3/41); 32 cases (78.0%, 32/41) of left dislocation, 9 cases (22.0%, 9/41) of right dislocation; Posterior dislocation in 37 cases (90.2%, 37/41), anterior dislocation in 4 cases (9.8%, 4/41); There were 32 cases of medial dislocation (78.0%, 32/41), 2 cases of external dislocation (4.9%, 2/41), 7 cases without obvious internal/external dislocation (17.1%, 7/41). 3 cases of complete dislocation were left posterior and internal dislocation. ?On laryngoscopy, there were 24 cases of posterior dislocation (58.5%, 24/41), 12 cases of anterior dislocation (29.3%, 12/41), 5 cases were difficult to assess (12.2%, 5/41). Laryngoscopy diagnosis were consistent with CT in 20 cases (55.6%, 20/36), inconsistent in 16 cases (44.4%, 16/36). ?On MPR CT images, dislocated arytenoid cartilage ridged on the top of cricoid cartilage plate in all 3 cases of complete dislocation. The manifestations of 38 cases of cricoarytenoid joint subluxation on MPR CT images are shown in Table 1. ( Fig.1~6)

#### CONCLUSION

VR images can display dislocation of cricoarytenoid joint visually and accurately. MPR images can compensate for the poor evaluation of VR in younger patients.

#### CLINICAL RELEVANCE/APPLICATION

This study is based on the diagnostic method of limb joint dislocation and has high diagnostic accuracy. Reduction forceps adopts different techniques for total dislocation and subluxation, only CT can distinguish them currently.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5A-SPHN-2

### Identification of Methicillin-resistant Staphylococcus Aureus (MRSA) via Head and Neck Imaging

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Alice Yun, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

It is currently unclear how methicillin-resistant Staphylococcus aureus (MRSA) infection presents in medical imaging uniquely from other types of acute infection. The characteristics of MRSA neck infections in radiological exams have not yet been established. This study aimed to compare the presentation of MRSA positive patients to that of patients with other types of acute neck infection in radiological exams.

#### METHODS AND MATERIALS

A retrospective review of children and young adults aged 0 to 24 years who underwent medical imaging for suspected acute infection at our pediatric hospital between January 2013 and September 2022 was conducted. A blinded radiologist reviewed initial and follow-up head and neck CT and MR imaging of patients with and without MRSA infection. Noted features included nodal necrosis, pattern of fat stranding, discrete abscess, and retropharyngeal edema. MRSA diagnosis was determined using microbiology lab results.

#### RESULTS

A total of 18 patients were reviewed, with a mean age of  $6.4 \pm 7.7$  years old (range 0-24) at time of diagnosis. 7 patients were female and 12 patients were male. 8 patients were positive for MRSA (MRSA-P), and 10 patients were MRSA negative but had acute neck infection (MRSA-N). Statistical analysis was conducted using SPSS 28.0.1.0 (142). No significant difference was found in age or sex between MRSA-P and MRSA-N groups. More MRSA-P patients (5/8, 62.5%) had nodal necrosis compared to the MRSA-N group (2/10, 20.0%), a borderline significant difference in proportions of 0.425,  $p = 0.145$ . All but one MRSA-P patients (7/8, 87.5%) had a diffuse pattern of fat stranding compared to the MRSA-N group (6/10, 60.0%), but we failed to find a significant difference in proportions ( $p > 0.10$ ). A higher number of MRSA-P patients (7/8, 87.5%) had discrete abscess compared to MRSA-N patients (5/10, 50.0%), with the 0.375 difference in proportions being borderline significant,  $p = 0.152$ . More MRSA-P patients (4/8, 50.0%) had retropharyngeal edema compared to the MRSA-N patients (1/10, 10.0%), with a borderline significant difference in proportions of 0.400,  $p = 0.118$ .

#### CONCLUSION

MRSA neck infections show a higher proportion of observed nodal necrosis, diffuse pattern of fat stranding, discrete abscess, and retropharyngeal edema than acute neck infections unrelated to MRSA. However, these differences are not necessarily significant and further investigation with a larger patient sample size is needed to validate the significance of our findings and establish their potential use in clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

The differences in presentation between neck infections due to MRSA vs. other pathogens in head and neck MR and CT exams will allow for enhanced ability to identify MRSA from other types of neck infection.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPHN-3

### **MRI in the Evaluation of Facial Dermal Fillers**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Marco Di Girolamo, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To ascertain with MRI the presence of filler injected in facial soft tissue and to evaluate contrast-enhancement in filler-related complications.

#### **METHODS AND MATERIALS**

45 pts after filler augmentation underwent MRI. 19 pts (10 after temporary and 9 after permanent filler) had no problem while 26 pts had filler-related problems. TSE-T1-weighted, TSE-T2-weighted, fat-saturated TSE-T2-weighted and TIRM scans on axial and coronal plane were performed. In filler-related complications, fat-suppressed TSE-T1-weighted scans were performed after i.v. administration of Gadolinium-DOTA. Skin biopsy was performed in patients with soft tissue enhancement and in 5 pts without any enhancement who haven't any clinical improvement after antibiotic therapy. Fisher's exact test was used for statistical analysis. In complicated cases, cervical lymph node enlargement was evaluated (longitudinal axis > 10mm).

#### **RESULTS**

MRI always identified and quantified the filler in soft tissue. Temporary dermal fillers appeared as spots hypointense on T1-weighted and hyperintense on T2-weighted images. Permanent fillers appeared as hypointense spots on T1-weighted images while the signal intensity on T2-weighted images varied. In patients with complications, on T2-weighted images they appeared hyperintense in 20 pts and hypointense in 16 pts. When a positive subcutaneous contrast-enhancement was detected (9 pts), skin biopsy always found an inflammatory granulomatous reaction which wasn't found in 5 pts without contrast-enhancement. Fisher's exact test found a significant correlation ( $P < 0,001$ ) between subcutaneous contrast-enhancement and granulomatous reaction. Cervical lymph nodes enlargement was found in 16 complicated patients and their levels determined (IA, IB, IIA, IIB).

#### **CONCLUSION**

MRI is a useful and non-invasive tool for visualization of facial dermal filler and i.v. Gadolinium administration is advised in complicated cases.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI criteria to evaluate patients after facial dermal filler implants in normal and pathological cases and to diagnose a possible granulomatous reaction using i.v. administration of paramagnetic contrast media.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPHN-4

### Feasibility of Paranasal Sinus MR Imaging at 0.5T: Comparison with CT and 1.5T MR

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Arjun Narula, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

CT is imaging modality of choice for medical and surgical management of the paranasal sinus (PNS) such as for inflammation, ESS and DNS. It is however associated with radiation exposure especially to eyes and in young individuals. Usage of CT also limits the repeat imaging follow-up of the PNS patients. It has been shown that MRI can be used in place of CT and can give additional information about various soft tissues in sinus. However due to the sensitivity of MRI to metal such as that present in dental crowns can limit the use of MRI. 0.5T is impacted much less by the metal and can be used to replace CT for sinus evaluation.

#### METHODS AND MATERIALS

Over the period of 3 weeks, all patients who visited the diagnostic centre for PNS CT was given an option to participate in IRB approved MRI study. Further patients undergoing MRI exam and have sinus related issues were given option to participate in the study. These patients were scanned with thin section CT and high-resolution thin slice MRI scan (Cor T2w, Cor T2 STIR, Ax T2, Cor T1w) at both 1.5T commercial MRI scanner and 0.5T MRI scanner. 2 expert radiologists reviewed the CT, and MR images from 1.5T and 0.5T independently and reported their findings. These findings were then compared to access if any clinical finding is missing in any of CT, 1.5T and 0.5T MRI reports.

#### RESULTS

3 patients were scanned at CT and both the MRI scanners and additional 5 patients were scanned at both the MRI scanners. Scans were successfully completed. No clinical finding was missed at either of the CT, 1.5T and 0.5T MRI reports of the two radiologists. MRI was preferred by the two-radiologist due to additional soft tissue information in MRI. One patient has large dental cap which was causing susceptibility artifact in 1.5T MRI over the maxillary sinus but reduced extent of artifact was observed for 0.5T MRI with clear diagnosis over the maxillary sinus area.

#### CONCLUSION

Compared to CT 1.5T and 0.5T MRI showed similar clinical diagnosis for medical and surgical management of the sinus patients. Unlike 1.5T MRI 0.5T is minimally affected by the metal and can be used in imaging with metal embeddings like dental fillings and crown. Therefore 0.5T can potentially replace CT for imaging management of sinus diseases and clinically superior for soft tissue tumors and fungal soft tissue involvement.

#### CLINICAL RELEVANCE/APPLICATION

CT imaging for PNS leads to unwanted exposure to eyes and in young patients where DNS surgery is typically performed. The usage of 0.5T MRI will enable sinus imaging even in the presence of metal such as dental crowns and braces. AI augmented 0.5T MRI could be more accessible to cities and patients where MRI was previously not accessible.

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## Abstract Archives of the RSNA, 2023

T5A-SPHN-5

### Feasibility, Diagnostic Efficacy, and Safety of Core Needle Biopsy as a First-Line Biopsy Method for Cervical Lymph Nodes

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Chan Yeop Jeong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The role of ultrasound-guided core needle biopsy (CNB) as a first-line method for cervical lymph nodes (LNs) has not yet been established. This retrospective study aimed to determine the feasibility, diagnostic efficacy, and safety of ultrasound-guided CNB as a first-line biopsy method for cervical LNs in patients with cervical nodal disease of non-thyroid origin.

#### METHODS AND MATERIALS

From March 2017 to October 2022, CNB was routinely applied as a first-line biopsy method by an experienced radiologist to 1331 cervical LNs in 995 consecutive patients with cervical nodal disease of non-thyroidal origin. CNB was performed by using 18-gauge, single- or double action spring-activated needles and the number of CNB sampling was 2-4 times in most cases. The hydrodissection technique was selectively used for high risk LNs located adjacent to large vessels and critical neck nerves. The results of CNB were categorized into four categories of inadequate, benign, indeterminate, and malignant. The feasibility of CNB was evaluated by the technical success rate. The diagnostic efficacy was evaluated by the inadequacy rate and diagnostic accuracy (sensitivity, specificity, and accuracy) for malignant LNs. The diagnostic accuracy was estimated by two criteria for test positivity (criterion 1, malignant; criterion 2, malignant or indeterminate) in 1097 LNs with final diagnoses (634 benign and 463 malignant LNs). The safety of the CNB procedure was evaluated by the major and minor complication rates.

#### RESULTS

The technical success rate was 99.4 % (987/995 patients) and CNB procedure technically failed in six patients with small LNs adjacent to the lung apex and two patients with poor cooperation. The CNB results were inadequate in 15 (1.1%), benign in 659 (49.5 %), indeterminate in 53 (4.0 %), and malignant in 604 (45.4 %) of 1331 LNs. The sensitivity, specificity, and accuracy of CNB for malignant LNs were 95.3%, 100%, and 97.3% with criterion 1 and those were 99.5%, 97.4%, and 98.8 % with criterion 2. The sensitivity and specificity of CNB for diagnosis of lymphoma were 73.2% and 100% with criterion 1 and those were 98.2%, 97.4% with criterion 2. There were no major complication such as large symptomatic hemorrhage requiring admission or needle tract seeding. Minor complication (asymptomatic small hematoma) was found only in 8 (0.8%) patients.

#### CONCLUSION

CNB was technically feasible, effective, and safe as a first-line biopsy method for cervical LNs in patients with cervical nodal disease of non-thyroid origin with high diagnostic accuracy for malignant nodal disease.

#### CLINICAL RELEVANCE/APPLICATION

CNB can be used as an effective first-line diagnostic method for LNs in patients with cervical nodal disease of non-thyroid origin.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPHN-6

### Stellate Ganglion Block with CT Guidance for Post-COVID Parosmia

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Adam C. Zoga, MD, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

Long term anosmia and parosmia are known late sequelae of COVID-19. While promising treatments for anosmia have evolved, parosmia is often refractory to pharmaceutical and topical therapies, leading to mood disorders, weight loss, and decreased quality of life. We worked with ENT colleagues to assess the potential benefits of CT-guided stellate ganglion block (SGB) in patients with long term post-COVID parosmia.

#### METHODS AND MATERIALS

Subjects were referred from an ENT olfactory subspecialist after at least 6 months of post-COVID parosmia, refractory to pharmaceutical/topical therapies. Situs was selected based upon hand dominance. CT guidance was used to position a 25-gauge spinal needle anterior to the lateral margin of the longus coli muscle at the level of T1 and positioning was confirmed with iodinated contrast. 1cc Lidocaine was injected and any Horner's syndrome was documented. In this location, 40mg of Depo Medrol and 2cc of were injected at the stellate ganglion. Change in symptoms was monitored through scheduled survey responses.

#### RESULTS

54 subjects presented for SGT (74% female, mean age 46 and range 14-71). Follow-up was obtained for 65% (37/54) of patients among whom 59% (22/37) reported improved symptoms at 1 week post injection. 82% (18/22) experienced progressive improvement with significant increase in mean reported improvement by 1 month post procedure ( $p=0.02$ , Figure 1). At 3 months, responders to SGB reported a mean of 49% improvement in symptoms (range 10-100%). 26 subjects returned for a contralateral injection with at least a 6 week interval. Of these, 100% (8/8) who reported no improvement after the 1st injection had no improvement after the 2nd injection. 86% (12/14) of subjects who reported some improvement after the 1st injection reported additional improvement after subsequent contralateral injection. For all injections, a Horner's syndrome was confirmed by exam in 95% (76/80), and all signs of Horner's syndrome resolved within 30 minutes of the injection. No complications or adverse events were reported.

#### CONCLUSION

Percutaneous SGB shows promise for patients with long term post-COVID parosmia, and CT provides ideal efficiency and guidance. For patients with improvement post SGB, and 2nd contralateral treatment may provide additional benefit.

#### CLINICAL RELEVANCE/APPLICATION

CT-guided stellate ganglion block is a new, minimally invasive and potentially impactful image guided therapy for patients with longstanding post-COVID parosmia.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPHN-7

### Preoperative Prediction of Pathologic Response to Neoadjuvant Immunotherapy in Resectable Locally Advanced Head and Neck Squamous Cell Carcinoma Using Multiparametric MRI

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yaqin Zhang, MD,PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to evaluate the value of quantitative changes in MRI imaging after neoadjuvant immunotherapy in predicting pathologic response in resectable locally advanced head and neck squamous cell carcinoma (HNSCC) patients.

#### METHODS AND MATERIALS

Fifteen patients with resectable locally advanced HNSCC who were enrolled in the prospective phase Ib clinical trial were included in the current retrospective analysis. In this current analysis, patients have undergone contrast-enhanced MRI and diffusion-weighted MRI scanning before neoadjuvant immunotherapy and radical resection of the tumor respectively. Response to neoadjuvant immunotherapy was based on histopathological evaluation of the resected specimen. The volume of the primary tumor and the value of the apparent diffusion coefficient (ADC) were measured. The difference between the two groups of treatment response (good response and poor response) was assessed using Fisher's exact test and the Mann-Whitney U test. The ability of the relative changes of the ADC value and tumor volume to discriminate between different pathologic response groups was quantified using the area under the receiver operating characteristic curve.

#### RESULTS

Good response was found in 33.3% of all patients. Relative changes in primary tumor volume ( $V_{\text{primary}}$   $p=0.001$ ) and in DW-MRI parameters ( $ADC_{\text{primary}}$   $p=0.03$ ) after neoadjuvant immunotherapy were significantly different between the groups of good response and poor response. When the relative changes in tumor volume were used for predicting treatment response, the area under the receiver operating characteristics curve (AUC) was 0.98 with a sensitivity of 100% and a specificity of 90%. Change in ADC value achieved an AUC of 0.89 with a sensitivity of 100% and a specificity of 71% for the prediction of treatment response.

#### CONCLUSION

Changes in tumor volume and ADC value after neoadjuvant immunotherapy can help identify patients with good response to neoadjuvant immunotherapy in HNSCC.

#### CLINICAL RELEVANCE/APPLICATION

Accurate preoperative prediction of pathologic response to Neoadjuvant immunotherapy in patients with HNSCC could guide clinical selection and the patients could also be spared from ineffective and unnecessary toxicity. Although the use of MRI to evaluate the progression of immunotherapy has been explored in other types of tumors, information on HNSCC is limited. As far as we are aware, there are no published studies that use the gold standard of surgical histopathology to assess the response of neoadjuvant immunotherapy for HNSCC on imaging. The results of this study showed that the changes of tumor volume and ADC value can effectively evaluate the immunotherapy response of HNSCC in clinical work.

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## Abstract Archives of the RSNA, 2023

T5A-SPIN-1

### Transitioning to Fully-Supervised Pre-Training with Large-Scale Radiology ImageNet for Improved AI Transferability in Three-Dimensional Medical Segmentation

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Fully-supervised pre-training has experienced long-standing success in the realm of computer vision, largely attributable to the extensive annotated ImageNet dataset. This research examined the transferability of medical AI fully supervised pre-trained on a similarly sized Radiology ImageNet.

#### METHODS AND MATERIALS

We first constructed a large-scale dataset by assembling 3,410 publicly available abdominal CT scans with partially annotated 25 organs and 6 tumors. We then completed the missing annotations using an efficient human-in-the-loop approach, resulting in Radiology ImageNet. This dataset enabled us to pre-train an AI model using full supervision. Segmentation, partitioning an image into multiple segments, can be viewed as a per-voxel classification. Therefore, the per-voxel annotations in our Radiology ImageNet (2,109 million annotated voxels) provided an order of magnitude larger than the per-image annotations in ImageNet (14 million images). AI transferability was evaluated on three medical segmentation tasks, i.e., 19 cardiovascular structures, 22 muscles, and 18 organs, using two external datasets, i.e., TotalSegmentator and JHH, comprising 6,062 CT scans. Dice Similarity Coefficient (DSC) was used as the evaluation metric. For a comprehensive comparison, we benchmarked fully-supervised pre-training against three dominant AI models pre-trained on 5,050, 5,022, and 888 unlabeled CT scans, respectively.

#### RESULTS

Fully-supervised pre-training demonstrated improved transfer learning performance compared to self-supervised counterparts, with increases from 86.5% to 90.9%, 89.9% to 94.4%, and 85.8% to 90.4% for the segmentation of cardiovascular structures, muscles, and organs in CT scans, respectively, using the TotalSegmentator dataset. As the annotated CT scans became more limited, fully-supervised pre-training achieved substantially better performance than self-supervised pre-training, with improvements of 17.5%, 12.1%, and 16.6% for 5-shot, 10-shot, and 20-shot transfer learning in the JHH dataset.

#### CONCLUSION

We created Radiology ImageNet and demonstrated its importance in the field of medical image analysis. Pre-training medical AI on this dataset led to an improved transferability for segmenting various anatomical structures in the human body. Our investigation suggested that fully-supervised pre-training mitigated the marked difference between self-supervised and segmentation tasks. This highlighted the potential of fully supervised pre-training to advance precision medicine.

#### CLINICAL RELEVANCE/APPLICATION

Medical AI, pre-trained on our Radiology ImageNet, excelled in the segmentation of anatomical structures, executing its vast potential in robotic surgery and treatment planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPIN-2

### Nomogram based on CT-derived extracellular volume to predict pathological grading of hepatocellular carcinoma: a multicenter study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Jie Li (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the potential of CT-derived extracellular volume (ECV) to predict the pathological grading of hepatocellular carcinoma (HCC), and to develop two nomograms that combine clinical factors to predict high-grade HCC preoperatively.

#### METHODS AND MATERIALS

A total of 230 patients diagnosed with HCC were collected from Hospital X and Hospital Y. Due to the presence of multiple lesions in some patients' livers, a total of 238 lesions were included in the study. Due to the imbalance in data, we have used oversampling techniques (SMOTE) to balance it. After balancing, patients from Hospital X were included in the training and internal validation sets at a ratio of 7:3, while patients from Hospital Y were used as an independent external validation set. Absolute enhancement values of the liver tumor and the abdominal artery were calculated using non-contrast enhanced and delayed phase images. The ECV was calculated using the following formula:  $ECV (\%) = \frac{HU_{tumor}}{HU_{aorta}} [100 - Hct(\%)]$ . Two machine learning algorithms (logistic regression and random forest) were selected for modeling the nomogram.

#### RESULTS

According to the logistic regression algorithm, CT-derived ECV is an independent predictive factor for distinguishing high and low-grade HCC, with statistically significant differences ( $p < 0.001$ ). In the training, internal, and external validation cohorts, the AUCs of CT-ECV for evaluating the pathological grading of high-grade HCC were 0.895, 0.832, and 0.740, respectively. The logistic regression-nomogram model had AUCs of 0.899, 0.853, and 0.750 in the training, internal, and external validation cohorts, respectively. The random forest-nomogram model had AUCs of 0.905, 0.847, and 0.812 in the training, internal, and external validation cohorts, respectively. Both models had satisfactory goodness of fit in the training and validation cohorts, and good clinical net benefit.

#### CONCLUSION

CT-derived ECV may represent a new quantitative CT marker for the identification of HCC pathological grading, providing incremental diagnostic value. The nomogram presents the predicted results in a visual and easy-to-understand manner, which helps physicians and patients better understand the disease progression and prognosis.

#### CLINICAL RELEVANCE/APPLICATION

ECV is an indicator that reflects the changes in the microenvironment of liver tumors, which can calculate the percentage of extracellular space in the total volume of liver tumor tissue through contrast agent kinetic characteristics. The level of ECV is closely related to the malignancy and prognosis of liver tumors, and therefore has important significance in the diagnosis and treatment of liver tumors.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5A-SPIN-3

### Deep Learning for Automated Measurement of Patellofemoral Anatomic Landmarks

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Alexander Zhou, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To train a deep learning model to identify patellofemoral anatomic landmarks and enable the automated measurement of anatomical parameters.

#### METHODS AND MATERIALS

This is an IRB-approved retrospective study with CT knee imaging from 483 patients acquired from April 2017-May 2022. Patients were selected from two cohorts: a pathological cohort of patients scheduled for knee arthroplasty (KA), and one of patients with healthy knee anatomy. 14,652 CT images were annotated with the location of 7 patellofemoral landmarks by trainees and approved by a senior musculoskeletal radiologist. A two-stage deep learning model was trained to predict landmark coordinates. A modified ResNet50 architecture was used, with an additional supervision mechanism. Models were initialized with self-supervised learning pre-trained weights on the RadImageNet radiological imaging database.

#### RESULTS

Spatial accuracy is critical for model performance, as all patellofemoral measurements are calculated based on the predicted landmark coordinates. The mean absolute error between predicted and ground truth landmarks was 3.70 pixels in the healthy cohort and 5.33 pixels in the KA cohort at a 512x512 resolution. Various patellofemoral parameters were calculated, including transepicondylar axis (TEA) length, TEA-posterior femur axis angle, sulcus medial asymmetry ratio, and sulcus angle. There was no statistically significant difference ( $p>0.05$ ) between the predicted and ground truth measurements for all four parameters in both cohorts, except for the sulcus angle in the healthy cohort.

#### CONCLUSION

We have developed a deep learning model that accurately identifies key anatomic landmarks of the patellofemoral compartment with 3-5 pixel accuracy on a 512x512 image and produces measurements with no statistically significant difference from human-derived measurements on healthy and pathological knees. This work represents the first deep learning regression model for automated patellofemoral annotation trained on both physiologic and pathologic CT imaging at this scale. This novel model has the potential to enhance our ability to analyze anatomy of the patellofemoral compartment at scale.

#### CLINICAL RELEVANCE/APPLICATION

KA procedures are among the most common surgeries, but morbidity has been associated with patellofemoral compartment-related complications in up to 20% of cases. Understanding this anatomy is crucial for restoring anatomic knee morphology and function, but patellofemoral anatomy has not been well-characterized. Developing a tool that enables the automated annotation of key landmarks would enable the measurement of anatomical parameters at scale in a precise, reproducible, and time-sensitive fashion free of inter- and intra-rater variability.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPIN-4

### Development of a Small-data Deep-learning Model Based on an MTANN for Soft Tissue Sarcoma Diagnosis in MRI

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yuqiao Yang, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Deep learning requires a large number of training cases (i.e., 10k to 100k), which makes the development of AI for rare cancer less feasible. Our purpose was to develop a "small-data" deep-learning model based on a massive-training artificial neural network (MTANN) to accurately discriminate between benign and malignant soft-tissue tumors in MRI.

#### METHODS AND MATERIALS

We collected T2-weighted MRI of 146 patients with 96 benign and 50 malignant soft-tissue tumors in this study, where tumors were segmented by a radiologist and reviewed by an orthopedic surgeon. The proposed scheme used a patch-wise neural network called an MTANN which was trained in a patch-to-pixel manner. Desired teaching images were generated with a Gaussian-blurred manual tumor segmentation mask for malignancy and a completely dark image for benignancy. During the training phase, the input was a 3D image patch extracted from input MR images. The neural network predicted a probability of malignancy for the input patch. The cross-entropy was used as the loss function to train the model. Once the MTANN model was trained, the entire image was computed as the likelihood map of malignancy by shifting the patch-wise window over the input image in a convolutional manner. Finally, a fully-connected classification layer with the image features extracted from the likelihood maps in a feature-scoring layer was used to classify the known tumor.

#### RESULTS

Our small-data MTANN model was able to be trained with only 77 benign and 40 malignant soft-tissue tumors. Our experiment showed that our MTANN model outperformed several state-of-the-art radiomics and other deep learning models in discriminating between benign and malignant tumors and achieved an area under the curve (AUC) of 0.78 which was higher than that (0.73) of the best-performing state-of-the-art model with a p-value <0.05.

#### CONCLUSION

Our small-data patch-wise deep-learning model based on an MTANN showed higher performance in discriminating between benign tumors and malignant soft-tissue tumors, which are rare cancer, in MRI, compared with several state-of-the-art radiomics and deep-learning models.

#### CLINICAL RELEVANCE/APPLICATION

Our small-data MTANN deep-learning model makes the development of deep learning for rare cancer possible. It can potentially prevent non-expert radiologists from diagnosing rare cancer inaccurately.

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## Abstract Archives of the RSNA, 2023

T5A-SPIN-5

### Deep Learning-enabled CT Number Neutralization in Heterogeneous Tube Voltage CT Imaging: A Pilot Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Dongok Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

Depending on types of examinations and image applications, CT images are frequently taken with various tube voltages which results in differing Hounsfield units for the same tissue. This causes difficulties in quantification of imaging biomarkers in various applications. We postulated that application of deep learning might enable neutralization of CT numbers in heterogeneous tube voltage CT imaging. This study presents a pilot experimental result.

#### METHODS AND MATERIALS

We used datasets of abdomen which were acquired from Siemens Somatom Force Dual Energy CT where A tube has 80 kV and B tube has 150 kV tube voltage. Among the total of 211 cases, 200 were used for training/validating and 11 were used for testing. A generative deep learning model architecture was employed consisting of a generator and a discriminator. The generator was designed to have five residual blocks and a skip connection which connects the first block with the last block. It takes in 80 kV CT images and outputs 150 kV CT images. Since true 150 kV CT images are available, the discriminator is given both images, generated-150 kV CT images made by the generator and real-150 kV CT images and trained to discern between the two. The loss is fed back into the generator to produce more accurate 150 kV CT images. The average Hounsfield unit for 80 kV, generated-150 kV and real-150 kV are compared using t-test on homogeneous regions of organs, such as liver, aorta and thoracic spine in order to observe statistical difference between them. Also scatter plot was used to compare between generated-150 kV and real-150 kV with linear equation and R-squared calculated.

#### RESULTS

The average Hounsfield unit for 80 kV, generated-150 kV and real-150 kV were 80.4, 61.6 and 63.0 for liver, 513.4, 181.1 and 180.0 for aorta, and 226.6, 111.6 and 111.5 for thoracic bone, respectively. For all tissues, p-value between 80 kV and real-150 kV was less than 0.001, indicating both are significantly different and p-value between generated-150 kV and real-150 kV ranged from 0.14 to 0.77, indicating both are not significantly different. The scatter plot results in a linear equation  $y = 1.01 * x - 2.28$  and  $R^2 = 0.9911$ .

#### CONCLUSION

From given 80 kV CT images, the network was able to produce generated-150 kV CT images statistically indistinguishable to that of real-150 kV CT images. Our study demonstrated the application of deep learning enabled neutralization of CT numbers from CT images taken with different tube voltage settings.

#### CLINICAL RELEVANCE/APPLICATION

The work has shown the ability to convert 80 kV CT images to 150 kV CT images. In the future, it could be possible to convert any CT images taken with a different kV to single standard kV CT images, and thus neutralize CT numbers in heterogeneous tube voltage CT imaging.

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## Abstract Archives of the RSNA, 2023

T5A-SPIN-6

### Improved Prognostic Prediction of Pancreatic Cancer Using Multi-Phase CT by Integrating Neural Distance and Texture-Aware Transformer

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Hexin Dong (*Presenter*) Nothing to Disclose

#### PURPOSE

Pancreatic ductal adenocarcinoma (PDAC) is a highly lethal cancer in which the tumor-vascular involvement greatly affects the resectability and, thus, overall survival of patients. We propose a novel learnable neural distance that describes the precise relationship between the tumor and vessels. Combined with dynamic tumor-related texture features in multi-phase contrast-enhanced CT (CECT), We aim to develop a new deep learning-based CT imaging-derived biomarker for predicting PDAC survival.

#### METHODS AND MATERIALS

We conducted a multicenter study with 1,070 patients to validate our method, using one center (892 patients) for training and the other three centers (178 patients) for independent testing. The CECT protocol included non-contrast, pancreatic, and portal venous phases. We constructed a prognostic biomarker - NDTAT-PDAC - which captures both tumor enhancement patterns and tumor-vascular involvement for OS prediction. The marker was tested in both nested 5-fold cross-validation and external validation cohorts to evaluate its performance, robustness, and clinical usefulness.

#### RESULTS

The continuous NDTAT-PDAC score performed a c-index of 0.656 (95% CI 0.639-0.673) and a AUC of 0.695 (95% CI 0.672-0.718) in the nested 5-fold cross-validation cohort, and a c-index of 0.710 and a AUC of 0.792 in the external validation cohort. We used univariate and multivariate Cox proportional-hazards models to evaluate our signature and other clinicopathologic factors in the independent test set. The proposed risk stratification was a significant prognostic factor, along with other factors like pathological TNM stages. After selecting significant variables ( $p < 0.05$ ) in univariate analysis, our proposed staging remained strong in multivariable analysis (HR=1.847,  $p=0.027$ ) after adjusting for important prognostic markers like pT (HR=2.438,  $p < 0.0001$ ) and resection margins (HR=1.681,  $p=0.091$ ). Notably, our proposed marker remained the strongest among all pre-operative markers, such as tumor size and CA 19-9.

#### CONCLUSION

We developed a new deep learning-based CT imaging-derived biomarker for predicting PDAC survival. The new biomarker was the strongest predictor of overall survival among preoperative factors and it has the potential to be combined with established clinical factors to select patients at higher risk who might benefit from neoadjuvant therapy.

#### CLINICAL RELEVANCE/APPLICATION

Our novel tool sets a new standard in this area, and can benefit clinicians by selecting patients who might benefit from neoadjuvant chemotherapy with aggressive tumor types. Our represents a significant advancement in the development of prognostic models and may lead to improved clinical decision-making, ultimately resulting in better patient outcomes.

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## Abstract Archives of the RSNA, 2023

T5A-SPIR-1

### **A Multi-institutional One-year Prospective Follow-up of Fluoroscopic, Cholangioscopy-assisted Large Bore Gallstone Extraction for Inoperable Calculous Cholecystitis**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Venkatesh Balaji, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study is to assess for recurrent cholelithiasis on one-year imaging post percutaneous large bore (24-30 French) gallstone extraction for a subset of patients who are poor surgical candidates for cholecystectomy.

#### **METHODS AND MATERIALS**

This is a multi-institutional Institutional Review Board approved prospective observational review of patients at two large academic centers who present with acute calculous cholecystitis and were deemed high-risk surgical candidates. Review parameters include procedural technical and clinical data, clinical presentation, average hospital length of stay, and post-intervention symptom reduction. Technical success was defined as the removal of all stones during the procedure. Clinical success was defined as stone-free on 12-month follow-up imaging.

#### **RESULTS**

Fifteen patients (mean age 77.9yr, range 52-94yr; 8 male and 7 female) underwent large bore sheath (24-30Fr) cholangioscopy assisted gallstone extraction. The size of the gallstones ranged from 0.5-4.0cm. All patients had prior transhepatic or transperitoneal cholecystostomy access for 3-6 weeks prior to gallstone extraction. All patients' indwelling accesses were upsized to 24Fr or 30Fr sheaths using the NephroMax balloon sheath system (Boston Scientific, Marlborough, MA). There was 86.7% technical success rate with no major procedure-related complications. 86.7% were symptom and pain-free immediately post-procedure. There were no major complications. Median hospital stay was 1-day post-procedure. Of the fifteen patients, twelve patients had 12-month follow-up US or CT. 75% did not have recurrent cholelithiasis on imaging.

#### **CONCLUSION**

Majority of patients were stone-free and asymptomatic on one-year follow-up imaging after percutaneous fluoroscopic-guided large bore (24 -30 French) gallstone extraction.

#### **CLINICAL RELEVANCE/APPLICATION**

High risk patients diagnosed with calculous cholecystitis who are poor candidates for cholecystectomy may benefit from a cholangioscopy-assisted large bore gallstone extraction for symptom reduction. This proved to be a safe and effective procedure with no major complications and a median hospital stay of 1 day. The majority of cases achieved technical and clinical success with no recurrent cholelithiasis.

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## Abstract Archives of the RSNA, 2023

T5A-SP1R-2

### Combined Multiple Regional Anesthesia for Microwave Ablation of Liver Tumors Initial Experience

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Man Lu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility and safety of combined multiple regional anesthesia (CMRA) in reducing pain and intravenous analgesic requirements during and following the ultrasound guided microwave ablation (US-guided-MWA) of liver tumors.

#### METHODS AND MATERIALS

A total of 75 patients with 99 liver tumors who received US-guided-MWA of liver tumors were recruited. They were randomly divided into three groups: A, B, C. Before ablation, patients in group A received hepatic hilar block (HHB), Transversus abdominis plane block (TAPB) and local anesthesia (LA). Patients in group B received HHB+LA. Patients in group C received TAPB+LA. Numerical Rating Scale (NRS) scores, morphine intake, complications and the factors influent perioperative pain were evaluated.

#### RESULTS

All the patients were successfully received the US-guided-MWA. The maximum NRS score for pain during ablation of the three groups were  $2.36 \pm 1.19$ ,  $3.28 \pm 1.59$  and  $4.24 \pm 1.42$  respectively ( $P < 0.01$ ), while the number of patients used morphine were 4/25, 8/25, 13/25 respectively ( $P < 0.01$ ). NRS scores of the three groups at 4, 8, 12, 24 and 36 hours after operation all showed a trend of rising first and then decreasing, and the order at each time point was:  $A < C < B$ . The patients with larger tumor, more tumors, longer procedure and ablation time experienced more pain ( $P < 0.05$ ). There were no major complications occurred among the three groups.

#### CONCLUSION

For patients not suitable for or unwilling to undergo general anesthesia, combined multiple anesthesia is an effective and safe way to control pain during and after microwave ablation of liver tumors. Factors influencing pain during microwave ablation include tumor size, number of tumors, procedure time, ablation time and shortest distance from lesional edge to live capsule.

#### CLINICAL RELEVANCE/APPLICATION

Percutaneous thermal ablation is now a frontline treatment option for liver tumors. During the procedure, general anesthesia and conscious sedation are often used for pain control. But some patients can't use general anesthesia. Regional anesthesia is a crucial component of anesthesia. Especially in the last 2 or 3 decades, the practice of regional anesthesia regimens has changed considerably and it is extensively be applied to provide peri-procedural pain control. Our study presents a feasibility and safety study of combined multiple regional anesthesia (CMRA) in an effort to reduce pain and intravenous analgesic requirements during and following the ultrasound guided microwave ablation (US-guided-MWA) of liver tumors. For patients not suitable for or unwilling to undergo general anesthesia, CMRA is an effective and safe way to control pain during and after US-guided-MWA of liver tumors.

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## Abstract Archives of the RSNA, 2023

T5A-SP1R-3

### Radiofrequency Ablation Followed by Cavity Creation and Cement Augmentation with Steerable Devices in the Management of Painful Spinal Metastases

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Claudio Pusceddu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In the treatment of spinal metastases, cement distribution following radiofrequency ablation can be unpredictable due to several tumor factors. Achieving satisfactory filling of the vertebrae requires advanced devices to prevent cement leakage. This study aimed to assess the safety and efficacy of using steerable technologies with an articulating radiofrequency ablation (RFA) probe and targeted cavity creation before vertebral augmentation to manage painful spinal metastases.

#### METHODS AND MATERIALS

Sixteen patients (mean age, 67 years) underwent RFA with vertebral augmentation after the creation of a targeted balloon cavity for metastatic spinal disease. The patients were followed up for six months, and pain and functional mobility were assessed pre-treatment and post-treatment using the Visual Analogue Score (VAS) and Functional Mobility Scale (FMS). Data on complications, predictability of cement distribution, anatomical restoration, and local recurrence were collected. Technical success was defined as successful intraoperative ablation and predictable cement distribution after cavity creation without major complications.

#### RESULTS

Sixteen patients with 21 lesions in the thoracolumbar spine were treated. All treatments were technically successful and were followed by targeted cavity creation and vertebral augmentation. A significant reduction in median VAS score was observed one week after RFA treatment ( $p < 0.001$ ). Of the seven patients who reported limited painful ambulation before treatment, six reported normal ambulation one month after treatment, while the remaining patient reported no improvement. Patients who reported wheelchair use before treatment improved to normal ambulation (four/eight) or limited painful ambulation (four/eight). The improvement in mobility before and after treatment was statistically significant ( $p = 0.002$ ). Technical success was achieved in all the combined procedures.

#### CONCLUSION

The combination of RFA and vertebral augmentation with a steerable platform that allows the creation of a targeted cavity before cement injection is a safe and effective procedure for managing painful spinal metastases. The procedure resulted in improved quality of life as assessed by the VAS and FMS.

#### CLINICAL RELEVANCE/APPLICATION

New technique combined with steerable devices to cement and treat complex vertebral metastases with radiofrequency ablation

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## Abstract Archives of the RSNA, 2023

T5A-SP1R-4

### Minimally Invasive Treatment of Vertebral Metastases with Combined CT-Guided Percutaneous Microwave Ablation, Pedicle Screw Fixation, and Vertebroplasty

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Salvatore Marsico (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this retrospective study was to assess the safety and effectiveness of the combined approach of percutaneous microwave ablation (MWA) guided by CT and pedicle screw fixation followed by vertebroplasty (MASFVA) for the treatment and stabilization of painful vertebral metastases involving vertebral pedicles.

#### METHODS AND MATERIALS

We retrospectively evaluated the records of 11 patients with 16 vertebral metastatic lesions who underwent MASFVA between January 2015 and January 2018. The technical success, complication rate, and pain relief using the visual analogue scale (VAS) and Oswestry Disability Index (ODI) were analyzed along with local tumor control.

#### RESULTS

Technical success was achieved in all cases without any significant complications. The VAS and ODI scores improved significantly after the procedure (VAS from  $6.8 \pm 0.7$  to  $0.6 \pm 0.6$  and ODI from  $3.1 \pm 0.7$  to  $1.2 \pm 0.4$ ). All patients could walk independently without neurological complications one week after the procedure. During the 12-month follow-up, no new bone fractures or local disease recurrence occurred.

#### CONCLUSION

The combination of MWA, percutaneous pedicle screw fixation, and vertebroplasty is a safe and effective treatment for painful vertebral metastases with vertebral pedicle involvement, providing both pain relief and local tumor control.

#### CLINICAL RELEVANCE/APPLICATION

First description of combined treatment of vertebroplasty, microwave ablation and pedicle fixation in complex vertebral metastases with pedicle extension.

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## Abstract Archives of the RSNA, 2023

T5A-SPIR-5

### Evaluation of Ice-ball Size and Temperature Change During Cryoablation in a Lard Phantom

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Nai-Wen Chang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cryoablation is a minimally invasive technique to treat various kinds of soft tissue tumors. It may be applied in tissues with various water and fat composition. Whether the fat concentration of the ablation target or environment will influence the ice-ball size and temperature change has not yet been explored. In this in-vitro study, we aim to evaluate how different concentrations of lard affect temperature change and ice ball size during cryoablation.

#### METHODS AND MATERIALS

We constructed a phantom with 6 glass bottles, including one bottle of 0.9% normal saline (NS) as control, and the others contains 100ml of agar phantoms with lard and NS mixed in five different fractions (0%, 10%, 40%, 70% and 100% of lard). A total of 6 Endocare V-Probes (Cryocare cryoablation system, Varian Medical system, Palo Alto, California, US), with 2.5cm cool-tip, were placed into each bottle aiming at the center. The freezing started simultaneously in 6 bottles with a starting temperature at 20°C. The temperature readings of the probes were documented every 10 seconds during the 9-minute freezing. Axial CT scans of the bottles were done before and 3, 6, 9 minutes after initiation of freezing, and the largest diameter of the ice-ball in each bottle was measured with the longitudinal view (coronal view) in the 1mm reconstructed image.

#### RESULTS

The probe temperature of the NS and 0% lard agar phantom (which contains 0.9% NS agar) have a similar freezing rate, reaching -80°C at about 320 seconds of freezing, and stabilized until 540 second. The rest of the agar phantoms that contain lard showed an increased freezing rate with increased concentration of lard, and all stabilized at around -150°C after 490 seconds of freezing until 540 second. The ice ball diameter was largest in the 0% and 10% lard agar phantom, both reaching 3.4 cm at 9 minutes of freezing. We observed a marked decrease in diameter of the ice ball with increased concentration of lard, with only 0.9cm at 9 minutes in the 100% lard agar.

#### CONCLUSION

Different concentrations of lard may affect the temporal temperature change and ice ball size during cryotherapy.

#### CLINICAL RELEVANCE/APPLICATION

This ex-vivo study demonstrated that the fat composition may influence the temperature change and ice-ball size during cryoablation and should be taken into consideration when treatment planning.

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## Abstract Archives of the RSNA, 2023

T5A-SP1R-6

### Oligoprogression in Neuroendocrine Liver Metastases - CT-guided HDR-brachytherapy to Delay Systemic Therapy Escalation

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Uli Fehrenbach, MD (*Presenter*) Grant, Siemens AG; Grant, Bayer AG; Grant, Ipsen SA; Grant, Asahi Intecc Co, Ltd; Grant, ESGAR; Grant, General Electric Company

#### PURPOSE

Heterogeneous growth behavior of hepatic metastases are not uncommon in gastroenteropancreatic neuroendocrine tumors (GEP-NETs). Rapid progression of one or two metastases make therapy escalation necessary despite the otherwise stable disease. If these progressive metastases could be controlled by local therapy, the patients could be managed further with their current strategy. The present study aims on determining the period by which CT-guided high-dose-rate brachytherapy (CT-HDR-BT) of rapidly growing liver metastases can delay the indication of systemic therapy escalation.

#### METHODS AND MATERIALS

In this retrospective, monocentric observational study a total of 23 patients from our ENETS center of excellence were retrospectively included. A total of 37 CT-HDR-BT sessions were performed in these patients. In addition to the parameters described in previous studies (local tumor control (LTC), progression-free survival (PFS), overall survival (OS)), this study evaluated the delay of a systemic therapy escalation.

#### RESULTS

Median follow up was 46 months. 82% OS was shown after 102 months. Mean LTC was 64 months (95%-CI: 55-74; median was not reached), median PFS (not RECIST based) was 6 months (95%-CI: 2-10) and mean OS was 75 months (95%-CI, 55-96; median not reached). No further escalation of therapy (Watch and wait- and/or SSA-therapy) after CT-HDR-BT was necessary in 6/23 cases (26%). A median delay of 19 months (median; 95%-CI, 9-29 months) to the escalation of systemic therapy could be achieved.

#### CONCLUSION

In oligotopic progression of liver metastases and otherwise stable disseminated GEP-NET, CT-HDR-BT as a safe one-time procedure can delay the onset of systemic therapy escalation. This offers a significant interval without drug related side effects and costs and saves the patients systemic treatment options for a later date.

#### CLINICAL RELEVANCE/APPLICATION

Our study reveals that CT-HDR-BT can significantly postpone the need for systemic therapy escalation in patients with oligotopic progression of neuroendocrine liver metastases. This approach offers patients a valuable interval without the burden of drug-related side effects and associated costs, while also preserving other therapeutic options for future disease progression. As systemic therapy options for this condition are limited, CT-HDR-BT may prove to be a safe and effective alternative in select cases.

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## Abstract Archives of the RSNA, 2023

T5A-SPMK-2

### Neurovascular Crossovers between Leash of Henry and Deep Branch of Radial Nerve: Implications for Diagnostic Imaging and Neurointervention

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Aurea V. Mohana-Borges, MD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify the crossing patterns of the LoH and DBRN, specifically the ascending branch of the radial recurrent artery (RRAab) and the transverse muscular vessels to the mobile wad by high-resolution ultrasound (HRUS), using B-mode and Doppler.

#### METHODS AND MATERIALS

In this cross-sectional study, HRUS was performed in the short axis of the DBRN in asymptomatic participants, bilaterally and in two different forearm positions (pronation and supination), enrolled over a 6 month period. Inclusion criteria included asymptomatic volunteers of both genders over 15 years of age. Exclusion criteria were as follows: a) previous interventional procedure or surgery in the radial tunnel and elbow, and b) incidental masses compressing the nerve. HRUS was performed with an 18-5 MHz linear transducer (Philips, Affiniti 50) by a single musculoskeletal radiologist with more than 20 years of experience. B-mode and Doppler cine clips taken in the short axis of the nerve were acquired and saved for offline analysis. Images were evaluated in consensus by two radiologists. The crossings were evaluated in the nerve segment between the origin from the radial nerve to the superior arcade of the supinator muscle. They were classified as occurring above or below the DBRN. The pattern was characterized as unrelated when no observed vessel was seen crossing the nerve. Welch's test was used as appropriate.

#### RESULTS

The study population consisted of 102 nerves from 55 asymptomatic participants (median age, 37.0 years; interquartile range [IQR], 23.5 - 51.0 years; age range, 16-63 years; 29 [52.7%] women), with 48 participants with bilateral evaluation. Eight DBRN relationships were excluded from the analysis because of Doppler unavailability (N= 6 limbs, 3 right sides) and the undetectability of the muscular branch on B-mode (N= 2 limbs bilaterally). Age was not significantly different between women (median 37 years, IQR, 24.0 - 50.0 years) and men (median 36.5 years, IQR, 22.8 - 52.8 years) with  $p = 0.74$ . The neurovascular crossings were as follows: a) RRAab above DBRN = 15 (14.7%) and muscular branch above= 12 (11.7%), below= 0 (0%), and unrelated= 3 (2.9%), and b) RRAab below DBRN = 87 (85.3%) and muscular branch above= 53 (52.0%), below= 28 (27.4%), and unrelated= 6 (5.9%).

#### CONCLUSION

There is a predominant pattern of neurovascular crossings, with the RRAab mainly crossing below the DBRN from an inferomedial position and the transverse vessels of LoH crossing above the nerve, proximal to the arcade of Frohse.

#### CLINICAL RELEVANCE/APPLICATION

Anatomic variations in the relationship of the neurovascular crossover of the Leash of Henry (LoH) and the deep branch of the radial nerve (DBRN) are relevant for diagnostic imaging and interventional procedures, but poorly described in the literature.

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## Abstract Archives of the RSNA, 2023

T5A-SPMK-3

### Undifferentiated and Preclinical Rheumatoid Arthritis and Longitudinal Thigh Muscle Loss: Deep-Learning Derived Data from Osteoarthritis Initiative

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Kamyar Moradi (*Presenter*) Nothing to Disclose

#### PURPOSE

Undifferentiated Arthritis (UA) and Preclinical Rheumatoid Arthritis (Pre-RA) are considered as early-stage inflammatory arthropathy before clinical RA occurrence. Pre-RA is retrospectively defined as the early stage prior to development of clinical RA. UA is defined as a type of arthritis when criteria for RA or other connective tissue diseases are not met. UA/Pre-RA could potentially cause generalized muscle degeneration by provoking systemic inflammation and autoimmunity akin to established RA that is clearly associated with Rheumatoid Cachexia. Aim of this study was to investigate the association of UA/Pre-RA with longitudinal changes in muscle quality.

#### METHODS AND MATERIALS

All the 4,796 participants of the Osteoarthritis Initiative (OAI) were initially included as established RA were excluded from this cohort. OAI participants were categorized to UA, Pre-RA (not exclusionary to the OAI), and control groups in baseline (Fig. 1). Longitudinal 4-year changes of thigh muscles quality in Pre-RA and UA groups were compared with their propensity score (PS)-matched control groups. PS matching was conducted to minimize the potential effect of confounding variables. For measurement of thigh muscle quality, we used our previously validated deep learning model to segment and quantify all available MRIs of thigh muscles at baseline, year 2-4 of the cohort. Outcome measures were MRI biomarkers of thigh muscle mass [i.e., cross-sectional area (CSA)] and composition [i.e., intramuscular adipose tissue (intra-MAT) and contractile percentage (non-fat muscle CSA/total muscle CSA)] in the thigh muscle groups (Fig. 2).

#### RESULTS

After PS-matching of the groups for confounding variables (Table 1), regression models of comparison of MRI biomarkers of total thigh muscles between Pre-RA and control group over a 4-year period showed that presence of Pre-RA is associated with decreased CSA (MD, 95% CI: -220.12 mm<sup>2</sup>, -310.58 - -129.66) but a similar change in intra-MAT (MD, 95% CI: 11.57 mm<sup>2</sup>, -167.16 - 190.30) and contractile percentage (MD, 95% CI: -0.50 %, -1.98 - 0.97) (Table 2). On the other hand, comparison of MRI-derived biomarkers between UA and matched control group showed that neither of changes in CSA, intra-MAT, and contractile percentage are significantly different between the groups (Table 2).

#### CONCLUSION

Presence of Pre-RA is associated with a longitudinal decrease in CSA but not increase in Intra- or Inter-MAT akin to rheumatoid cachexia seen in established RA patients. Causal effect of Pre-RA on muscle quality requires further attention.

#### CLINICAL RELEVANCE/APPLICATION

Results of this study could promote the role of secondary preventive treatment (e.g., low dose DMARD) to mitigate accelerated muscle degeneration among Pre-RA subjects.

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## Abstract Archives of the RSNA, 2023

T5A-SPMK-4

### Improving Sonographic Visualization of the Ulnar Nerve and Morphology

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Shabber H. Syed, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cubital Tunnel Syndrome (CuTS) is defined as ulnar nerve compression in the cubital tunnel of the elbow, the second most common upper extremity peripheral nerve entrapment. CuTS often remains undiagnosed until patients present with progressive motor deficits, usually indicating severe nerve injury. Quantitative diagnostic criteria for ultrasound have been developed for other nerve entrapment syndromes, including carpal tunnel syndrome, however greater variability of diagnostic criteria is in use for the diagnosis of CuTS. New transducer technology may enable better imaging of the ulnar nerve and development of new diagnostic criteria for CuTS. Our study aimed to objectively evaluate this newer transducer technology compared to conventional transducers in the evaluation of the ulnar nerve and to assess a reproducible ratio for more reliable nerve measurement.

#### METHODS AND MATERIALS

Seven fresh frozen cadaveric specimens were examined using both 18 MHz and 24 MHz transducers (GE Healthcare, Milwaukee, WI). The number of ulnar nerve fascicles was measured in each specimen just proximal to the cubital tunnel with both transducers. Two examiners assessed the number of nerve fascicles with consensus agreement reached on the final count. The cross-sectional area of the ulnar nerve was measured proximally at both the cubital tunnel and distally at the anatomical location where the ulnar artery and nerve meet in the distal forearm.

#### RESULTS

The 24 MHz probe visualized more fascicles of the ulnar nerve (mean 8.7, std dev 2.3) compared to the 18 MHz transducer (mean 4.4, std dev 2.7,  $p < 0.005$ ). The mean of the proximal ulnar nerve cross-sectional area (CSA) measured 7.08 mm<sup>2</sup> (std dev 2.40). The mean distal ulnar nerve CSA was 5.08 mm<sup>2</sup> (std dev 1.21,  $p = 1.21$ ). The cross-sectional area of the proximal ulnar nerve was not found to be statistically different compared to the distal CSA of the ulnar nerve, 7.1 mm<sup>2</sup> (std dev 2.4) vs. 5.1 mm<sup>2</sup> (std dev 1.2),  $p = 0.112$ .

#### CONCLUSION

A higher frequency 24 MHz transducer can visualize more fascicles of the ulnar nerve at the cubital tunnel compared to a conventional 18 MHz transducer. Utilizing this 24 MHz transducer, there was no statistical difference in the measurement of the cross-sectional area of the ulnar nerve proximal and distal to the cubital tunnel in our cadaver specimens. Further investigation of ulnar nerve morphology and of the ratio of nerve measurement of symptomatic cubital tunnel syndrome patients and normal controls with new higher frequency transducers may enable the development of better diagnostic criteria for CuTS.

#### CLINICAL RELEVANCE/APPLICATION

Nerve fascicle count and size in addition to the use of nerve ratios for size assessment may help to more accurately differentiate demyelinating neuropathies from nerve entrapment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPMK-5

### Improved Visualization of the Brachial Plexus MR Neurography with Deep Learning Reconstruction in Conventional and Accelerated Sequences: Study of Healthy Volunteers

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

ILKWON KO (*Presenter*) Nothing to Disclose

#### PURPOSE

To prospectively compare the effectiveness of deep learning reconstruction(DLR) for brachial plexus MR imaging with that of a conventional and accelerated MR imaging protocol in healthy volunteers.

#### METHODS AND MATERIALS

This prospective study included 14 healthy volunteers (7 men, 7 women; mean age,  $24.3 \pm 3.5$  [SD] years) who underwent 3-T brachial plexus contrast enhanced STIR sequence . Examinations included conventional sequence with parallel factor(PF) 3 (scan time, 7 minutes 5 seconds) and accelerated sequences with PF 5 (4 minutes 39 seconds), Standard(PF3) and accelerated sequences(PF 5) were acquired with and without DLR.Two musculoskeletal radiologists qualitatively evaluated examinations for brachial plexus visualization (1-3, none to full), and motion artifact , visualization of the supraspinatus and axillary nerve (1-4, none to complete), which was scored individually at three separate regions along the brachial plexus: supraclavicular (extraforaminal roots, trunks, and proximal divisions), retroclavicular (distal divisions), and infraclavicular (cords). Interobserver agreement between two readers for the image quality were assessed using weighted kappa statistics. Comparisons of quantitative scores were performed with use of student T-test.  $P < .05$  was deemed statistically significant.

#### RESULTS

A total of 28 brachial plexus images were included in 14 subjects. Standard(PF3) and accelerated sequences(PF 5) with DLR enabled significantly improved visualization of the brachial plexus ( $P < .001$ ) and motion artifact ( $P < .05$ ) in the all three regions for two readers except for PF3 at the supraclavicular area( $p=0.09$ ) and retroclavicular area( $p=0.06$ ) in reader 1.For visualization of the axillary nerve, only PF5 with DLR images significantly improved image quality( $p=0.007-0.037$ ). However, there was no improvement in image quality with DLR for visualization of suprascapular nerve in PF3 and PF5( $p=0.07-0.71$ ) except for PF3 at the retroclavicular area in reader 2( $p=0.0014$ ). Agreement between image two readers ranged from a kappa of 0.5-0.83 in brachial plexus visualization 0.5-0.77 in motion artifact , 0.59-0.91 in suprascapular nerve and 0.58-0.85 in axillary nerve.

#### CONCLUSION

Accelerated sequences with DLR effectively reduce scan time and artifacts , providing similar subjective image quality to conventional sequences for brachial plexus MR imaging.

#### CLINICAL RELEVANCE/APPLICATION

Accelerated sequences with DLR may provide an alternative to standard sequences for clinical brachial plexus MRI

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## Abstract Archives of the RSNA, 2023

T5A-SPMK-6

### The Diagnostic Value of Multimodal Imaging for Primary Lower Limb Lymphedema

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

MENGKE LIU (*Presenter*) Nothing to Disclose

#### PURPOSE

To retrospectively analyze the imaging characteristics of primary lower limb lymphedema on CT and MRI multi-modal sequences, compare the diagnostic value of multi-modal imaging examinations for lower limb lymphedema, and identify the optimal techniques or methods for displaying lymphedema.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on patients with primary lower extremity lymphedema (LEL) admitted to our lymphatic surgery department from January to December 2019. All patients underwent both CT and MRI examinations of the lower extremities. The MRI multi-modal sequences included Short Time Inversion Recovery (STIR) and mDIXON sequences. Image analysis and scoring were independently performed by two radiologists, including assessment of skin thickening, fat separation, fascial effusion (effusion above and below the fascia). Skin thickening was defined as dermal thickness  $>2\text{mm}$ ; fat separation was defined as abnormal signal and density shadows distributed in a mesh-like or honeycomb-like pattern around the fat lobules; fascial effusion was defined as abnormal signal or density shadows in a strip or crescent shape on the fascial surface or below the fascia. The frequency of appearance of CT and MR manifestations in the affected limb was recorded. The sensitivity of lesions displayed by CT and MR sequence were evaluated as clear, general, or unidentifiable, and the best imaging method for displaying edema was selected. The frequency differences of multi-modal imaging manifestations of lower extremity lymphedema were compared using chi-square test or Fisher's exact test.

#### RESULTS

A total of 36 patients were included in the study. There was no statistically significant difference in the detection rate of skin thickening among other imaging methods ( $P>0.05$ ). The detection rate of fascial superficial lymphatic fluid by mDIXON-FAT was significantly lower than that by other imaging methods ( $P<0.05$ ), and there was no statistically significant difference in the detection rate of fascial superficial lymphatic fluid among other imaging methods ( $P>0.05$ ). STIR had higher sensitivity than CT and mDIXON sequences for detecting fat septa, subfascial/epifascial effusion, and dilated tubular shadows

#### CONCLUSION

Multi-modal imaging has high diagnostic value for primary lower extremity lymphedema. The STIR sequence is more sensitive than other CT and MRI sequences for detecting primary lower extremity lymphedema, and can be used as the preferred imaging sequence for the diagnosis and evaluation of lymphedema

#### CLINICAL RELEVANCE/APPLICATION

Multi-modality imaging can accurately diagnose primary lower extremity lymphedema, with STIR sequence having the highest sensitivity for detecting edema

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## Abstract Archives of the RSNA, 2023

T5A-SPMK-7

### Optimization of keV for Radiomics Extracted from Spectral Virtual Monochromatic Images to Predict Osteoporosis

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Jinling Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the effect of radiomics obtained from different virtual monochromatic images (VMIs) by dual-energy computed tomography (CT) on the prediction of osteoporosis.

#### METHODS AND MATERIALS

A retrospective study of 62 participants who underwent both single source dual-energy CT and quantitative computed tomography (QCT) lumbar-spine examination were enrolled. With QCT as the reference standard, the patients were divided into two groups according to the guidelines introduced by the International Society for Clinical Densitometry (ISCD) and American College of Radiology (ACR), osteoporosis (n=16) of the spine was defined as a BMD value <80 mg/cm<sup>3</sup>, and non-osteoporosis (n=46 [osteopenia and normal]) was defined as a BMD value ≥80 mg/cm<sup>3</sup>. Radiomics scores (RSs) for osteoporosis prediction were constructed from 11 sets of VMIs (40-140 keV, 10 keV interval). Receiver operating characteristic (ROC) curves were drawn and the area under the curves (AUCs) was calculated to evaluate the discriminatory power of RS for each VMI.

#### RESULTS

The AUC values for osteoporosis prediction with RS of 40-140 keV VMIs were 0.995, 0.996, 1.000, 1.000, 1.000, 1.000, 0.793, 0.787, 0.807, 0.821, 0.846. The accuracies of RS of VMIs were 0.952, 0.968, 0.984, 1.000, 1.000, 1.000, 0.705, 0.721, 0.746, 0.742, 0.770. The sensitivities of RS of VMIs were 0.882, 0.938, 0.941, 1.000, 1.000, 1.000, 0.400, 0.375, 0.444, 0.444, 0.545. The specificities of RS of VMIs were 0.978, 0.978, 1.000, 1.000, 1.000, 1.000, 0.765, 0.774, 0.796, 0.792, 0.820. The negative prediction values of RS of VMIs were 0.957, 0.978, 0.979, 1.000, 1.000, 1.000, 0.867, 0.891, 0.896, 0.894, 0.891. And the positive prediction values of RS of VMIs were 0.938, 0.938, 1.000, 1.000, 1.000, 1.000, 0.250, 0.200, 0.267, 0.267, 0.400.

#### CONCLUSION

The RS obtained from multiple VMIs in dual-energy CT had a good ability to predict osteoporosis. And the RS of 40-90 keV VMIs showed higher performance than the RS of 100-140 keV VMIs.

#### CLINICAL RELEVANCE/APPLICATION

The prevalence of osteoporosis in the population is increasing year by year. One of the reference standards for the diagnosis of osteoporosis today is the volumetric BMD measured by QCT, but the QCT post-processing process is very complex and requires additional phantom calibration, etc. Spectral CT imaging provides VMIs to improve the image quality thereby radiomics efficacy, however the optimized keV for radiomics extraction was still obscure. Our proposed RS models obtained from 40-90 keV VMIs can serve as useful tools for osteoporosis prediction and have the potential to be applied in clinical treatment planning in the future.

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## Abstract Archives of the RSNA, 2023

T5A-SPMK-8

### Quantitative Analysis of Bone Mineral Density in Patients with Chronic Kidney Disease by Revolution CT Substance Separation Technique

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Na Gao (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients with chronic kidney disease are prone to fracture and other serious complications. Early and accurate measurement of Bone mineral density (BMD), an important index of bone mass in human body, is of great clinical significance for predicting the risk of fracture in patients with CKD. X-ray attenuation images of Revolution CT scanned by high and low voltages can be expressed as density maps of two substances, thus realizing substance separation of single voxel. Therefore, this study explored the value of Revolution CT in the diagnosis of BMD in patients with CKD.

#### METHODS AND MATERIALS

Total abdominal energy spectrum plain scan data of 48 patients with CKD were collected. According to the principle of three quantiles, the patients were divided into three groups: Group A (= 48 years old), Group B (49-61 years old) and Group C (= 62 years old). GSI scanning mode combined with 40% ASiR-V, at automatically modulated tube current (Smart mAs), noise index was 9. Using GSI Viewer software, the images of HAP (FAT)-based material pairs were reconstructed from 0.625mm thick images, and the Region of interest (ROI) was placed in the middle layer of L3 vertebral body (ROI was about 100mm<sup>2</sup>), and the HAP concentration was recorded. One-way analysis of variance was used to compare the concentration of HAP in vertebral body of L3 in different age groups of patients with CKD. Pearson correlation analysis was used to analyze the concentration of HAP in vertebral body of L3 in three age groups. The difference was statistically significant with  $P < 0.05$ .

#### RESULTS

The concentrations of HAP in vertebrae of L3 were  $(185.12 \pm 11.83) \text{mg/cm}^3$ ,  $(138.55 \pm 12.58) \text{mg/cm}^3$ ,  $(96.38 \pm 10.16) \text{mg/cm}^3$  in each age group of patients with CKD, and there was statistical differences between three groups ( $P < 0.05$ ). There was a negative correlation between the age of the three groups and the concentrations of HAP ( $r = -0.309, -0.211, -0.028$ ,  $P < 0.05$ ).

#### CONCLUSION

The HAP concentration measured by energy spectrum CT in L3 vertebral cancellous of patients with CKD is related to age, and the HAP concentration in vertebral body of CKD patients gradually decreases with age after 48 years old.

#### CLINICAL RELEVANCE/APPLICATION

Revolution CT based material imaging technology provides a new idea for BMD measurement. HAP (FAT) as a base material pair can reflect the change of BMD with age. For patients with CKD, Revolution CT can find the changes of bone mass as early as possible, and provide basis for making personalized diagnosis and treatment plans.

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## Abstract Archives of the RSNA, 2023

T5A-SPMS-1

### **A Cross-sectional Study to Quantify Cardiac, Hepatic and Pancreatic Iron Overload on MR Imaging in Beta Thalassemia Major Patients**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Reissa Maria Ribeiro, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Regular blood transfusions are the mainstay in beta thalassemia major; however, it may cause cardiac and hepatic hemosiderosis - the most common cause of death in these patients. Chelation requires constant adjustments to avoid either iron or chelator toxicity. In recent years, various MRI methods have been validated for quantifying iron overload.

#### **METHODS AND MATERIALS**

31 beta-thalassemia major patients (22 males and 9 females) (age range 8-18 years) receiving regular blood transfusions and chelation therapy were enrolled. Patients were scanned on 3-Tesla MRI and mFFE T2\* and R2\* weighted sequences were acquired with parameters mentioned in Figure 1. LIC and MIC values were calculated using the formulae:  $0.032 \times R2^* - 0.14$  and  $(0.0254 \times R2^*) + 0.202$  respectively. They were then graded as follows: For LIC Normal < 2 Light 2-7, Moderate 7-15, Severe >15. For MIC Normal <1.16, Light 1.16-1.65, Moderate 1.65-2.71, Severe >2.71. For pancreas Normal <30, Mild 30-100, Moderate 100-400, Severe >400.

#### **RESULTS**

This is an interim analysis of an ongoing study. Liver R2\* had a very weak but insignificant positive correlation with SF levels ( $r = 0.167$ ,  $p = 0.397$ ). Cardiac R2\* had a moderate but significant positive correlation with SF levels ( $r = 0.535$ ,  $p = 0.003$ ). Pancreatic T2\* had a weak but insignificant positive correlation with SF levels ( $r = 0.281$ ,  $p = 0.165$ ). LIC had a very weak but insignificant positive correlation with SF levels ( $r = 0.146$ ,  $p = 0.459$ ). MIC had a moderate but significant positive correlation with SF levels ( $r = 0.427$ ,  $p = 0.024$ ). Liver T2\* had a weak but insignificant positive correlation with serum total bilirubin levels ( $r = 0.258$ ,  $p = 0.223$ ). LIC had a very weak but insignificant positive correlation with SGPT ( $r = 0.170$ ,  $p = 0.439$ ). LIC had a weak but insignificant positive correlation with SGOT ( $r = 0.270$ ,  $p = 0.212$ ). No statistically significant difference in mean SF, LIC and MIC values between 2-weekly, 3-weekly and 4-weekly transfusion regimens.

#### **CONCLUSION**

LIC had a very weak positive correlation with serum ferritin. Whereas, MIC had a moderate and significant positive correlation with serum ferritin. Pancreatic T2\* and R2\* values had a weak positive correlation with serum ferritin. LIC showed a weak and insignificant positive correlation with liver function tests (LFTs). No statistically significant difference was seen in the mean serum ferritin, LIC and MIC values between 2-weekly, 3-weekly and 4-weekly transfusion regimens. However, a larger sample size is required to determine true statistical significance and we plan to achieve the same in the near future.

#### **CLINICAL RELEVANCE/APPLICATION**

At present, our study shows that T2\*/R2\* MRI prove to be a valuable non-invasive method for evaluating iron overload, especially when compared to a liver biopsy.

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## Abstract Archives of the RSNA, 2023

T5A-SPNMMI-1

### Differential FDG Uptake in the Brain at Early and Delayed Imaging Assessed by Dual Time-point Total-body PET

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Shashi B. Singh, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of the study was to examine the changes in the global FDG uptake in the brain from early to delayed scans in dual time-point imaging (DTPI) before and after treatment in patients with lymphoma, using total-body PET/CT. We also assessed uptake in the brain before and after 2 cycles of chemotherapy.

#### METHODS AND MATERIALS

FDG-PET/CT data from 20 patients referred for initial staging of non-Hodgkin's lymphoma at UC Davis- age 12 to 74.9 years (mean =  $44.12 \pm 19.70$  years; males = 9; females = 11) were analyzed. It included 40 scans conducted 60 and 120 minutes following intravenous injection of 8 mCi of FDG. Interim scans after 2 cycles of chemotherapy (6/20 patients) were assessed at both 60 and 120 minutes after injection of 8 mCi of FDG. The FDG-PET/CT scans were analyzed using OsiriX MD software v. 12.5.2 (Pixmeo SARL, Bernex, Sweden). A region of interest was manually placed on fused PET/CT images for global assessment of FDG uptake in the entire brain, including the supratentorial region, cerebellum, midbrain, and medulla but excluding spinal cord. Metabolic activity was assessed by calculating global SUVmean across all slices. Finally, global SUVmean scores were compared at 60 and 120 minutes of scan in both baseline and post-treatment scans.

#### RESULTS

For the baseline scans, an overall increase in FDG uptake in the brain was observed from 60 minutes to 120 minutes. The average SUVmean at 60 minutes was  $7.48 \pm 2.10$  (range: 3.81 to 11.99) whereas at 120 minutes was  $8.51 \pm 2.32$  (range: 4.36 to 12.88) at baseline. The difference in the average SUVmean at 120 minutes and 60 minutes was found to be  $1.03 \pm 0.66$  (range: 0.45 to 3.17) ( $p < .00001$ ) and the average 60-120 min percent change was  $14.32 \% \pm 10.25 \%$  (range: 7.28 % to 53.21 %). Similarly, for post-treatment scans, an overall increase in FDG uptake in the brain was observed from 60 minutes to 120 minutes. The average SUVmean at 60 minutes was  $6.97 \pm 2.45$  (range: 3.71 to 10.43) whereas at 120 minutes was  $7.56 \pm 2.47$  (range: 4.40 to 11.18). The difference between the average SUVmean at 120 minutes and 60 minutes was found to be  $0.59 \pm 0.30$  (range: 0.006 to 0.84) ( $p = 0.00518$ ) and the average 60-120 min percent change was  $9.64 \% \pm 6.21 \%$  (range: 0.08 % to 18.76 %).

#### CONCLUSION

FDG uptake in the brain increases from 60 minutes to 120 minutes during DTPI of the brain with total body FDG PET/CT. Therefore, early imaging of the patients with suspected brain tumors may help to identify the lesions more clearly than delayed imaging due to relatively lower background uptake. In addition, this study demonstrated an initial possible decrease in brain uptake after 2 cycles of chemotherapy.

#### CLINICAL RELEVANCE/APPLICATION

It may be possible to distinguish the lesions more clearly with early imaging than with delayed imaging in patients with suspected brain tumors.

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## Abstract Archives of the RSNA, 2023

T5A-SPNMMI-2

### Comparison of Diagnostic Image Quality and Radiation Dose of Directly Contrast-enhanced CT for FDG-PET Image Attenuation and Co-registration to Sequential Non-enhanced PET/CT Followed a Dedicated Diagnostic CT

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Thomas F. Hany, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare diagnostic image quality and extent of attenuation correction artifacts due to iodinated contrast in PET images and total radiation dose of the CT-component of sequential partial body (head to thigh) non-enhanced CT F-18 Fluorodeoxy (FDG) - PET/CT followed by a dedicated diagnostic contrast-enhanced CT (thorax/abdomen/neck) (cePET/CT) protocol to directly intravenous contrast-enhanced FDG-PET/CT protocol (head to thigh) (dicePET/CT) in the same oncological patient population.

#### METHODS AND MATERIALS

An inter-group comparison of 48 patients (m=20, f=28, initial mean age 65.8 y;33-81 y) undergoing cePET/CT and dicePET/CT in clinical oncological routine on the same PET/CT scanner (Siemens mCT128) within an average of 529 d (76 - 949d) were compared. PET-image quality were objectively (standard uptake value SUVc cerebellum, SUVbp blood pool, SUVlu lung and SUVli liver) and subjectively evaluated for the presence of attenuation artifacts. Average effective CT radiation dose (aeCTRD) of the CT component for both groups were determined.

#### RESULTS

Average dose for scePET/CT and dcePET/CT was 3.48 and 3.50 MBq/kg, respectively. Significant attenuation artifacts in PET image quality was seen in both groups only by mis-match in the brain and liver (n=2) not in the vasculature. No significant differences were found in the SUV values for the scePET/CT and dcePET/CT - SUVc 12.3 vs. 12.3 (p=0.93), SUVbp 3.0 vs. 3.2 (p=0.07), SUVlu 0.80 vs. 0.85 (p= 0.13), SUVli 3.9 vs. 4.1 (p= 0.08). aeCTRD for scePET/CT and dcePET/CT was 15.03 mSv vs. 7.08 mSv, respectively (Difference 52.3%).

#### CONCLUSION

If a ceCT in the FDG-PET/CT protocol ist needed, a direct contrast enhanced CT protocol is favorable due to significant radiation dose reduction without constraints in PET image quality and quantitative analysis since a non-enhanced CT head-to-thigh for attenuation correction can be omitted and attenuation artifacts due to intravenous enhancement is negligible.

#### CLINICAL RELEVANCE/APPLICATION

If a ceCT in the FDG-PET/CT protocol ist needed, a direct contrast enhanced CT protocol is favorable due to significant radiation dose reduction.

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## Abstract Archives of the RSNA, 2023

T5A-SPNMMI-3

### Evaluating the Ability of ChatGPT to Create a Differential Diagnosis from Transcribed Radiological Findings in Nuclear Medicine

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Gillean A. Cortes, DO (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in creating a differential diagnosis from transcribed radiological findings of specific nuclear medicine cases.

#### METHODS AND MATERIALS

A sample of 50 cases specific to nuclear medicine imaging was selected from a radiology textbook, from which the answers were used as the gold standard. The history and case images were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, the top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were entered into the ChatGPT3.5 and ChatGPT4 algorithms. The output diagnoses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracies were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

#### RESULTS

The top 1 accuracy and top 3 accuracy for ChatGPT3.5 versus ChatGPT4 were 60.0% compared to 70.0% ( $p = 0.15$ ) and 12.0% compared to 10.0% ( $p = 0.37$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 58.1% compared to 58.7% ( $p = 0.48$ ). ChatGPT3.5 and ChatGPT4 hallucinated 41.5% versus 8.3% ( $p = 0.00006$ ) of the references provided and generated 6 total false statements versus 4 total false statements, respectively.

#### CONCLUSION

While ChatGPT has shown some potential in generating accurate diagnoses, this technology requires further development before it can be implemented into clinical and educational practice. It is important to acknowledge that the most recent version of ChatGPT has made slight improvements in the accuracy of its diagnoses as well as reducing the hallucination effect.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models have the potential to impact clinical and educational medicine. Knowledge of the accuracy and possible errors of these algorithms can provide a better understanding of the limitations of these tools.

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## Abstract Archives of the RSNA, 2023

T5A-SPNPM-1

### The Association Between Food Security and Mammography Screening: Cross-Sectional Survey Results from the National Health Interview Survey

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Jade A. Anderson, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In one prior randomized control trial, providing food vouchers and a food pantry to food insecure individuals was associated with a 94.6% cancer treatment completion percentage. There is limited data about food insecurity within the cancer screening setting. To inform the potential need for food insecurity interventions, our study evaluated the association between food security and mammographic screening among eligible participants.

#### METHODS AND MATERIALS

Female survey respondents aged 40-74 in the 2019 National Health Interview Survey (NHIS) without history of breast cancer were included. Food insecurity was assessed using the Six-Item Food Security Scale developed by the National Center for Health Statistics. Scores from the six questions were aggregated to assign food security status. Individuals with low or very low food security were defined as food insecure. Proportion of patients who reported mammographic screening within the last year was estimated, stratified by food security status. Multiple variable logistic regression analyses were conducted to evaluate the association between food security and mammography screening, adjusted for potential confounders. All analyses were performed accounting for complex survey design features.

#### RESULTS

9,139 weighted survey respondents met inclusion criteria. Due to lack of money for food, 11.8% of participants indicated that the food they bought wouldn't last, 10.9% couldn't afford to eat balanced meals, and 10.1% worried that food would run out. 90.1% were classified as having high or marginal food security of whom 56.6% reported mammography screening. 6.1% were classified with low food security of whom 42.1% reported screening. 3.8% were classified with very low food security of whom 43.1% reported screening. In our unadjusted analyses, participants with low food security (OR 0.56, 95%CI 0.44 to 0.70,  $p < 0.001$ ) and very low food security (OR 0.58, 95%CI 0.44 to 0.77,  $p < 0.001$ ) were less likely to report mammography screening within the last year. In our adjusted analyses, participants with very low food security (OR 0.54, 95%CI 0.33 to 0.88,  $p = 0.013$ ) were less likely to report mammography screening within the last year.

#### CONCLUSION

In a nationally representative cross-sectional survey, 9.9% of eligible participants experienced food insecurity. In our unadjusted and adjusted analyses, food insecurity was associated with significantly reduced mammography screening percentages.

#### CLINICAL RELEVANCE/APPLICATION

Radiology practices should consider screening patients for food insecurity and other social determinants of health using validated instruments. Evidence-based food insecurity interventions should be made available to participants experiencing food insecurity.

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## Abstract Archives of the RSNA, 2023

T5A-SPNPM-2

### Can ChatGPT help promote health literacy?: Generating, summarizing and simplifying patient-facing information about breast cancer prevention and screening

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Hana L. Haver, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Disparities in health literacy are known to impact patient decision-making, particularly in the context of breast cancer prevention and screening. We evaluated the use of the large language model ChatGPT as a tool to generate and simplify responses to common questions about breast cancer.

#### METHODS AND MATERIALS

ChatGPT was asked to simplify responses to 25 fundamental questions about breast cancer prevention and screening to a 6th grade reading level from a prior study by Haver et al. (*Radiology* 2023). The simplified responses were evaluated for clinical appropriateness by a fellowship-trained breast radiologist. Language complexity was assessed on the Flesch Reading Ease scale and readability was assessed on 5 scales: Flesch-Kincaid Grade Level, Gunning-Fog Index, Coleman-Liau Index, Automated Readability Index, and the Simple Measure of Gobbledygook. Paired t-tests of mean language complexity and mean readability scores for the original and simplified for each question were analyzed. Based on NIH guidelines, we considered language complexity score of <60 and readability score > 8th grade reading level to be too difficult for the average adult patient.

#### RESULTS

For ChatGPT's original responses, the average language complexity was 45 and the average readability of 13.2 grade level which was considered too difficult for the average adult patient. The responses that had been simplified by ChatGPT to a "6th grade" reading level had improved readability metrics with an average language complexity of 59 (higher is better) and 11th grade readability level ( $p < 0.005$  across all scales compared to original responses) [Figure 1]; these were still considered too difficult for the average adult patient, however. The simplified responses were appropriate 88% of the time upon review by a board-certified breast imaging radiologist, which is the same as that of the original responses by ChatGPT, as reported previously by Haver et al. (*Radiology* 2023).

#### CONCLUSION

ChatGPT provides health information about breast cancer screening that is accurate and appropriate 88% of the time, albeit at high reading levels inappropriate for the average adult patient. When provided with an appropriate prompt, ChatGPT can simplify its responses' readability by >2 grade levels while retaining the appropriateness of its responses. With improved prompt engineering, these readability levels will likely be able to be further improved, which our group is actively working on next.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT's answers to questions about breast cancer are difficult to read. This model can be prompted to simplify this information, though it underestimates the readability level of the output.

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## Abstract Archives of the RSNA, 2023

T5A-SPNPM-3

### Ecodesign and Operational Strategies to Reduce MRI Energy Consumption: Cost Savings and Reduced Carbon Footprint

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Sean A. Woolen, MD, MS (*Presenter*) Research Grant, Siemens AG; Investigator, Siemens AG

#### PURPOSE

To determine the energy, cost, and carbon savings that could be achieved through different MRI scanner power management strategies.

#### METHODS AND MATERIALS

Four outpatient MRI scanners from three vendors were individually equipped with power meters (1-Hz sampling rate). Power measurement logs were extracted over 39 days. Data were segmented into off, idle, prepared-to-scan, scan, or Eco-Power (one vendor's power-saving mode) modes for each scanner. Energy, cost (assuming a mean cost of \$0.14 per kWh), and carbon savings were calculated for the lowest scanner activity modes.

#### RESULTS

Projected annual energy-consumption per scanner ranged from 82.7-171.1 MWh, with 72-91% defined as non-productive. Power draws for each mode were measured as  $6.4 \pm 0.1$  kW (Eco-Power),  $7.3 \pm 0.6$  kW to  $9.7 \pm 0.2$  kW (off),  $9.5 \pm 0.9$  to  $14.5 \pm 0.5$  kW (idle),  $17.3 \pm 0.5$  to  $25.6 \pm 0.6$  kW (prepared-to-scan), and  $28.6 \pm 8.6$  to  $48.3 \pm 11.8$  kW (scan). Switching MRIs from idle to off mode for 12 overnight hours reduced power-consumption by 25-33%, translating to a potential annual savings of 12.3-21.0 MWh, \$1,717-\$2,943 USD, and 8.7-14.9 mt CO<sub>2</sub>eq. The Eco-Power mode further reduced consumption by 28% compared to off mode, potentially saving an additional 11.0 MWh, \$1,533 USD, and 7.8 mt CO<sub>2</sub>eq per year for 12 hours overnight. Turning off a fleet of 30 MRIs for 12 hours overnight offers a potential savings of 367.9-630.7 MWh, \$51,509-\$88,301 USD, and 260.9-447.2 mt CO<sub>2</sub>eq. Overnight implementation of Eco-Power mode on all outpatient MRI in the U.S. could save U.S. healthcare 73,354.1 MWh, \$10.3 million USD, and 52,008 mt CO<sub>2</sub>eq.

#### CONCLUSION

Powering down MRIs when not needed can make radiology departments more energy efficient and gain substantial sustainability and cost benefits.

#### CLINICAL RELEVANCE/APPLICATION

Our data details how an ecodesign approach by scanner vendors and strategic changes to routine MRI operations by healthcare systems can be effectively used to reduce cost and impact environmental sustainability. These results should help radiologists, healthcare administrators, and corporate partners understand the benefits of energy-efficient MRI operations.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-1

### Multisequence MRI-Based Radiomics Signature as Potential Biomarkers for Predicting KRAS Mutations in Brain Metastases

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Xinna Lv (*Presenter*) Nothing to Disclose

#### PURPOSE

Kirsten rat sarcoma virus (KRAS) has evolved from a genotype with predictive value to a therapeutic target recently with the observation of novel agents. The aim of this study was to establish non-invasive radiomics models based on MRI to discriminate Kirsten rat sarcoma virus (KRAS) from epidermal growth factor receptor (EGFR) or anaplastic lymphoma kinase (ALK) mutations in lung cancer patients with brain metastases (BM), then further explore the optimal sequence for prediction.

#### METHODS AND MATERIALS

This retrospective study involved 317 patients with proven BM of lung cancer (218 patients in the training cohort and 99 patients in the testing cohort) who had confirmed of KRAS, EGFR or ALK mutations. Radiomics features were separately extracted from T2WI, T2 fluid-attenuated inversion recovery (T2-FLAIR), diffusion weighted imaging (DWI) and contrast-enhanced T1-weighted imaging (T1-CE) sequences. Synthetic minority oversampling technique was used in the training cohort to separately balance KRAS to EGFR or ALK mutations in consideration of the unbalanced nature of the training dataset. The maximal information coefficient and recursive feature elimination method were used to select informative features based on these four regular sequences respectively. Then we separately construct four radiomics models for differentiating KRAS from EGFR or ALK mutations using random forest classifier. ROC curves were used to validate the capability of the models in the training and testing cohorts.

#### RESULTS

The four radiomics models for discriminating KRAS from EGFR mutations all worked well, especially DWI and T2WI model with AUCs of 0.942 and 0.949, 0.942 and 0.954 in the training and testing cohorts. The T1-CE and T2-FLAIR models yielded AUCs of 0.918 and 0.954, 0.956 and 0.838 in the two cohorts. When KRAS compared to ALK mutations, the AUCs were 0.947 and 0.850, 0.917 and 0.824, 0.896 and 0.795, 0.892 and 0.790 in DWI, T2-FLAIR, T2WI and T1-CE sequences in training and testing cohorts respectively. The DWI and T2-FLAIR models showed excellent performance in distinguishing KRAS from ALK mutation.

#### CONCLUSION

The radiomics classifiers integrating MRI may have potential to discriminate KRAS from EGFR (DWI and T2WI model) or ALK mutations (DWI and T2-FLAIR model) that could guide targeted therapy.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics classifiers integrating multisequence MRI may have potential to identify KRAS mutations, which are helpful to guide clinical therapeutic strategies and facilitate the discovery of new approaches capable of achieving this long-sought goal of cure in populations of patients with KRAS-mutant lung cancer.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-10

### Prediction of IDH and EGFR Mutation Status in Diffuse Glioma Patients Using Dynamic Susceptibility Contrast Imaging-derived Oxygenation and Microvascular Transit Time Heterogeneity Biomarkers

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yunhwa Roh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To obtain tumor microvascular and oxygenation information and evaluate their potential for noninvasive assessment of IDH and EGFR mutation status in diffuse glioma patients using perfusion MRI.

#### METHODS AND MATERIALS

This retrospective single-institution study included patients with adult diffuse glioma who had undergone preoperative dynamic susceptibility contrast (DSC) perfusion MRI. Contrast-enhancing lesion (CEL) and non-enhancing lesion (NEL) were segmented using deep learning segmentation. Imaging parameters of cerebral blood volume (CBV), cerebral blood flow (CBF), capillary transit time heterogeneity (CTH), oxygen extraction fraction (OEF), and cerebral metabolic rate of oxygen (CMRO<sub>2</sub>) were obtained using the capillary function-based perfusion model (Cercare Medical Neurosuite) for CEL and NEL, respectively. The diagnostic abilities of the imaging biomarkers for predicting IDH and EGFR mutation status were independently assessed. Predictors were selected using logistic regression analysis, and performance was measured with the area under the receiver operating characteristics curve (AUC) analysis.

#### RESULTS

A total of 110 patients were included (mean age, 58.8 years; range, 25-82; 49 women), with 25 cases of IDH mutation. Of the 85 patients with IDH wild-type glioblastoma, 34 patients showed EGFR mutation. Lower rCBV (Odds ratio [OR] 0.69; 95% confidence interval [CI]: 0.55-0.82,  $P < .001$ ) and lower rCMRO<sub>2</sub> (OR 0.7; 95% CI: 0.54-0.85,  $P = .002$ ) measured in CEL were predictive for the presence of IDH mutation. The combination of rCBV and rCMRO<sub>2</sub> showed an AUC of 0.85 in predicting IDH mutation status. In IDH-wild type gliomas, higher rCMRO<sub>2</sub> (OR 1.15; 95% CI: 1.02-1.31,  $P = .029$ ) in CEL and higher rCBF (OR 1.38; 95% CI: 1.06-1.87,  $P = .023$ ) in NEL was predictive of EGFR mutation. The combination of the parameters showed an AUC of 0.66 in predicting EGFR mutation status.

#### CONCLUSION

Perfusion MRI utilizing the cerebral metabolic rate of oxygen, vascular density, and flow parameters provided the diagnostic value of predicting IDH and EGFR mutation status in glioma patients. Lower rCMRO<sub>2</sub> is indicative for IDH mutation, while higher rCMRO<sub>2</sub> is indicative for EGFR mutation.

#### CLINICAL RELEVANCE/APPLICATION

The molecular status of IDH and the EGFR mutation have prognostic significance in glioma. Our study on perfusion MRI used a capillary function-based model and calculated the cerebral metabolic rate of oxygen (CMRO<sub>2</sub>) along with vascular density and flow parameters. The tumor oxygenation parameters enabled noninvasive diagnosis of IDH and EGFR mutation status, which may support the clinical standard of care in glioma patients.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-11

### Role of DOTATATE PET/MRI in Evaluating WHO grade 3 Meningiomas: Potential for Differentiating Secondary Progressive and De novo Tumors

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Joon Tae Kim, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

MRI has significant limitations in meningioma evaluation, especially in intermediate- and high-risk tumors. [68-Ga]-DOTATATE PET has demonstrated high utility in meningioma evaluation and treatment planning. While rare, and thus understudied, WHO grade 3 meningiomas (WHO3-M) are particularly aggressive with higher propensity for recurrence, metastases, and worse clinical outcomes compared to lower grade meningiomas. There thus exists a marked unmet need for improved targeted imaging strategies in the management of WHO3-M. Here, we evaluate the clinical, pathology, imaging characteristics and outcomes of patients with WHO3-M in our larger prospective cohort of patients with meningiomas undergoing DOTATATE PET/MRI and explore differences in PET findings between patients with de novo versus secondary progressive WHO3-M, as the latter are known to have worse prognosis.

#### METHODS AND MATERIALS

Inclusion criteria were patients with WHO3-M who underwent DOTATATE PET/MRI. Clinical chart review was performed to document clinical course, surgical and radiation (RT) therapy, WHO grade, and molecular pathology. Progression free survival (PFS) was determined by applying RANO criteria to follow-up MRI. Mann-Whitney Tests were used to determine statistical significance.

#### RESULTS

15 patients were included, 8 with secondary progressive and 7 with de novo WHO3-M. Secondary progressive cohort had significantly higher per-patient number of surgeries (4.0 vs 1.6;  $p = 0.012$ ) and a trend for higher number of RT courses (2.5 vs 1.6;  $p = 0.23$ ), higher cumulative RT dose (106 vs 68.3;  $p = 0.31$ ), and decreased PFS (20.9 vs 37.7 months;  $p = 0.17$ ). Secondary progressive tumors had distinct molecular pathology profiles with higher number of mutations (3.6 vs 1.3;  $p = 0.037$ ). DOTATATE PET demonstrated significantly higher SUV in secondary progressive tumors (17.1 vs 12.4;  $p = 0.0052$ ).

#### CONCLUSION

This is the first study evaluating clinical characteristics and the utility of DOTATATE PET/MRI in WHO3-M and comparing secondary progressive and de novo cohorts. In addition to distinct molecular profiles, we report significantly increased SUV in secondary progressive WHO3-M compared to de novo WHO3-M. This work further supports DOTATATE PET/MRI as a useful management strategy in WHO3-M and raises the possibility of differentiating secondary progressive and de novo WHO3-M with PET/MRI in the clinical context. This work raises important questions regarding meningioma biology such as the potential role of SSTR2 signaling in WHO3-M.

#### CLINICAL RELEVANCE/APPLICATION

DOTATATE PET/MRI may be of particular clinical benefit in WHO3 meningiomas, improving diagnosis and treatment planning as well as identifying the secondary progressive subtype which conveys worse clinical outcomes.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-12

### **Radiomics Nomogram Based on Multiparametric MRI Features for Preoperative Prediction of MGMT Promoter Methylation Status in Glioblastomas**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Jun Lu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Preoperative identification of O6-methylguanine-DNA methyltransferase (MGMT) promoter methylation status is of great clinical significance in selecting potential patients who might benefit from therapy. This study aimed to establish and validate a radiomics nomogram using the radiomics features and clinical characteristics for preoperative prediction MGMT promoter methylation status in glioblastomas.

#### **METHODS AND MATERIALS**

216 patients in local institution and 68 patients from The Cancer Genome Atlas (TCGA) were enrolled. 851 radiomics features were extracted from the apparent diffusion coefficient (ADC) and isotropic volumetric contrast-enhanced T1 (ISO-CE-T1) weighted images, respectively. The features were selected using Mann-Whitney U-test, followed by refining using least absolute shrinkage and selection operator (LASSO) regression combining 10-fold cross-validation. Three radiomics signatures were built based on ADC, ISO-CE and joint radiomics features. The optimal radiomics signature with age and sex were processed by multivariate logistic regression analysis to construct a prediction model, which was developed in the training dataset and tested in the test and independent external validation dataset from TCGA. A radiomics nomogram was plotted to represent the prediction model. The performance of the radiomics nomogram was evaluated using discrimination, calibration, and decision curves.

#### **RESULTS**

Three radiomics signatures comprising of five, five and six robust features were built. The joint signature showed the highest area under the curve (AUC) of 0.811/0.790 in the test and validation dataset. The accuracy, sensitivity, specificity and AUC were 84.62%, 82.76%, 86.11%, 0.903(0.804-0.963) and 80.88%, 81.25%, 80.56%, 0.845(0.737-0.922) in the test and external validation dataset, respectively. The radiomics nomogram with clinical data outperformed the radiomics signature alone. The Hosmer-Lemeshow test concluded that the radiomics nomogram showed goodness of fit (all  $p > 0.05$ ). Decision curve analysis demonstrated the clinical value of the radiomics nomogram.

#### **CONCLUSION**

The radiomics nomogram based on multiparametric MRI features is a promising approach for preoperatively predicting the MGMT promoter methylation status in glioblastomas noninvasively. The combination of radiomics features from different sequences and the addition of clinical characteristics to the nomogram showed incremental predictive value.

#### **CLINICAL RELEVANCE/APPLICATION**

This study aimed to find imaging biomarkers for noninvasively predicting the MGMT promoter methylation status for a tailored treatment plan and prognosis assessment in GBM patients from the initial stage of the tumor diagnosis.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-13

### Diagnostic Performance of T1 $\rho$ Imaging and Diffusion-weighted Imaging (DWI) in Glioma IDH Mutation Status Prediction: A Pilot Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Guanxun Cheng, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to evaluate the diagnostic performance of T1 relaxation time in a rotating frame (T1 $\rho$ ) and apparent diffusion coefficient (ADC) in glioma IDH mutation status prediction

#### METHODS AND MATERIALS

15 glioma patients (10 IDH-wild-type gliomas, 5 IDH-mutant-type gliomas) were prospectively imaged with multiparametric MRI on 3-T, including T1 $\rho$  imaging and DWI before surgery. In addition, since T1 $\rho$  relaxation time (T1 $\rho$ ) depends not only on the structure characteristics, but also on spin lock frequency (FSL), we have set up three different spin lock frequencies (FSL = 100Hz, 200Hz, 500Hz) to compare whether there are differences between them. For ADC and T1 $\rho$  measurement, place the target ROIs, avoid tumor necrosis, cysts, and hemorrhagic areas by the help of conventional MR sequences and SWI images. Statistical significance was tested by using the Mann-Whitney U test. Receiver operating characteristic curve (ROC) analysis was performed to evaluate the diagnostic performance.

#### RESULTS

Table 1 summarizes the characteristics of the evaluated tumor patients. A total of 15 glioma patients (five male and ten female) were included in this study, containing five IDH-m patients (4 with diffuse astrocytomas, WHO grade II; 1 with anaplastic astrocytoma, WHO grade III) and ten IDH-w patients (WHO grade II/III/IV, 1/2/6; 1 can't be graded due to imperfect molecular pathological detection). Differences in mean ADC values and T1 $\rho$  relaxation time (T1 $\rho$ ) between IDH-m and IDH-w groups are shown in Table 2 and depicted in Figure 1 and 2. Mean ADC values of the tumor parenchymal area of IDH-w gliomas were significantly lower than that of IDH-m gliomas ( $0.852 \times 10^{-3} \text{mm}^2/\text{s}$  vs  $1.324 \times 10^{-3} \text{mm}^2/\text{s}$ , respectively;  $p=0.019$ ). Whether FSL (spin lock frequency) is equal to 100, 200 or 500 Hz, the T1 $\rho$  values of the tumor parenchyma of IDH-w gliomas were significantly lower than that of IDH-m gliomas (87.50/86.72/84.21ms vs 112.92/120.67/122.17ms, respectively;  $p<0.05$ ). The AUC value of the ADC (0.880) revealed lower diagnostic performance compared with the T1 $\rho$  relaxation time. The AUC value (0.960) of the T1 $\rho$  (FSL=100Hz) was the same as that of T1 $\rho$  (FSL=500Hz). Logistic regression analysis showed that the combination of the ADC and T1 $\rho$  (FSL=500Hz) did not improve the diagnostic performance.

#### CONCLUSION

This pilot study demonstrates that the T1 $\rho$  values may be a feasible noninvasive imaging parameter for predicting the glioma IDH mutation status. Different spin-lock frequencies have similar diagnostic performance to IDH mutation status.

#### CLINICAL RELEVANCE/APPLICATION

All patients included in the study were in accordance with the ethical standards of the institutional and/or national research committee.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-14

### A Deep Learning Framework Enables Non-invasive Detection of Tumor Mutational Burden in Brain Metastases

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Syed Rakin Ahmed (*Presenter*) Nothing to Disclose

#### PURPOSE

Brain metastases (BM) are the most common central nervous system malignancy and are an emerging unmet need in modern oncology. While precision medicine for BM has demonstrated impressive responses, many patients are not able to benefit from this treatment paradigm given the morbidity associated with tissue sampling. Tumor mutational burden (TMB), defined as the number of non-synonymous somatic mutations per megabase (Mb), is a predictive biomarker for efficacy of immune checkpoint inhibition (ICI) for BM. Here, we present a non-invasive technique, using deep neural networks (DNN), to quantitate TMB within BM to inform rational use of ICI.

#### METHODS AND MATERIALS

We conducted our experiments on 297 multiparametric MRI (mpMRI) scans of BM patients of diverse histologies from MGH/DFCI, split into 75% train : 15% validation : 15% test. Consistent with prior literature, we binarized the TMB by defining values greater than 12 per Mb as "high", and the converse as "low". We limited our initial analysis to FLAIR, T1 pre- and T1 post-contrast MRI sequences. We employed a multi-step preprocessing pipeline involving skull stripping, isotropic resampling, registration, N4 bias correction and intensity normalization. We additionally investigated several unique input strategies to our DNN that incorporated combinations of MRI sequences and slice orientations, using the corresponding maximum intensity projection (MIP) image stack. We conducted our experiments both with and without five-fold cross validation, utilizing several classification architectures, and cross entropy loss with weighted sampling.

#### RESULTS

Using a resnet18 architecture, our best performing model achieved an area under the receiver operating characteristics curve (AUROC) of 0.88 on the held-aside test set and comprised the axial FLAIR MIP image as input. Across all types of inputs and architectures investigated, our AUROCs ranged from 0.72 - 0.88. These results were consistent across each fold for the five-fold cross validation experiments.

#### CONCLUSION

To fully translate clinically actionable genomic alterations within BM into clinical medicine, non-invasive biomarkers are desperately needed. To this end, we demonstrate that a DNN displays strong performance in quantifying TMB within BM. We are optimizing performance of this model with an expanded mpMRI dataset, as well as performing additional studies to noninvasively identify oncogenic drivers in BM (e.g. CDK, PI3K pathway alterations), which can help guide choice of targeted therapy.

#### CLINICAL RELEVANCE/APPLICATION

We developed a deep learning model, using mpMRI, that achieves strong performance in quantifying TMB status within BM, which can augment clinical decision making through facilitating rational use of ICI in patients.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-2

### Usefulness of Pituitary High-resolution 3D MRI using Deep-learning-based Reconstruction for Pre- and postoperative Evaluations in Patients with Pituitary Adenoma/pituitary Neuroendocrine Tumor

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yuka Ishimoto (*Presenter*) Nothing to Disclose

#### PURPOSE

In the management of pituitary adenomas, an MRI sequence with high sensitivity for detecting small lesions and high precision for delineating the normal pituitary glands is desirable. The recently developed deep-learning-based reconstruction (DLR) improves the image quality of thin-slice MRI. The previous investigators applied DLR to a 2D spin-echo sequence and showed that for the postoperative evaluation of pituitary adenoma, 1-mm-slice-thickness 2D CE-T1WI with DLR (1-mm 2D T1WI with DLR) showed greater diagnostic performance than conventional 2D CE-T1WI with 3-mm slice thickness. However, there were no study which applied DLR to a 3D fast spin-echo sequence. Therefore, for contrast-enhanced (CE) MRI, we assessed the diagnostic value of T1-weighted 3D fast spin-echo sequence (CUBE) with DLR for evaluating pituitary adenoma.

#### METHODS AND MATERIALS

We assessed 24 patients with pituitary or residual adenoma who underwent 3D CUBE with and without DLR (imaging time: 5 min, 7 sec), 1-mm-slice-thickness 2D spin-echo T1WI (1-mm 2D T1WI) with DLR, and 3D spoiled gradient echo sequence (SPGR) as CE-T1WI. For these MRI sequences, the depiction of the pituitary adenoma and parasellar region(cavernous sinus) was scored by two neuroradiologists, and the contrast-to-noise ratio (CNR) between the pituitary adenoma and the brain parenchyma was calculated.

#### RESULTS

Scores for the depictions of pituitary or residual adenoma were significantly higher with 3D CUBE with DLR than with 3D CUBE without DLR, 1-mm 2D T1WI with DLR, and 3D SPGR ( $P < .001$ ). In one patient, 3D CUBE with DLR identified a microadenoma that was not observed on other sequences (1-mm 2D T1WI with DLR and 3D SPGR) (Figure). The score for the depiction of the boundary between the adenoma and the cavernous sinus was higher with 3D CUBE with DLR than with 1-mm 2D T1WI with DLR and 3D SPGR. For the evaluation of adenomas, 3D CUBE with DLR provided better interobserver agreement than 1-mm 2D T1WI with DLR (0.75 vs. 0.41). For the CNR, the 3D CUBE with DLR was significantly higher than that with 3D SPGR, but there were no significant differences between the 3D CUBE with DLR and the 1-mm 2D T1WI with DLR.

#### CONCLUSION

For 3D evaluation of the pituitary and parasellar regions, DLR may be a useful method to shorten the acquisition time while maintaining sufficient image quality. Compared to 1-mm 2D T1WI with DLR, 3D CUBE with DLR provided better image quality for depicting pituitary adenoma, with better interobserver agreement.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning-based reconstruction technique can allow 3D fast spin-echo T1WI with high spatial resolution, which is superior to 1-mm-slice-thickness 2D T1WI for the pre- and postoperative evaluation of pituitary adenomas.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-3

### **Meningiomas: Correlation between Tumors' Cellularity and Recurrence**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Luiz F. Borella (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Meningiomas are the most frequent tumors of the central nervous system. According to the World Health Organization, they can be categorized into 3 categories. There are benign tumors or grade I lesions. Secondly, grade II or atypical meningiomas (intermediate). Lastly, grade III meningiomas (malignant). In recent years, tools to predict patient's outcome have been proposed. In this study, we evaluate the meningioma's densities on CT and their mean values in ADC and correlate these variables with tumor recurrence. The main hypothesis was the greater the cellularity of the tumor (reflected by higher CT density and lower ADC mean value), more frequent tumors' recurrence.

#### **METHODS AND MATERIALS**

We listed 32 patients of our institution with histological diagnosis of meningioma that were submitted to CT and MRI evaluation before and after surgical exploration, between 2012 and 2020. To predict tumors' cellularity, we measure their CT density and ADC mean value using the largest ROI possible to englobe the lesion.

#### **RESULTS**

To find statistical correlation between tumors' cellularity and recurrence, we discriminated CT densities (in HU) and ADC mean values (in  $10^{-3} \text{ mm}^2/\text{s}$ ) and the patient's outcome in "recurrence" and "non-recurrence". We applied two different analyses: Pearson's correlation test found that there is correlation between CT density and tumor recurrence, classified as moderated and directly proportional. Also, there is correlation between ADC mean value and tumor recurrence, classified as moderated and inversely proportional ( $r = + 0.49$ ,  $p < 0.05$ ). Logistic regression also demonstrates correlation between CT density and tumor recurrence, and between ADC mean value and tumor recurrence ( $p = 0.01$ ;). This test demonstrated ROC curve 84.4% (sensitivity = 80%, specificity = 83.3%).

#### **CONCLUSION**

Our analysis showed moderated correlation between tumor's presumed cellularity (reflected by higher CT density and lower ADC mean value) and meningiomas' recurrence.

#### **CLINICAL RELEVANCE/APPLICATION**

Measuring CT densities and ADC mean values, especially before surgical exploration, can be used as tools to predict meningiomas' recurrence. Tumors with higher cellularity can be submitted to follow-up exams more often than the others.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-4

### Diffusion Kurtosis Imaging in Detecting Changes in the White Matter of the Brain Non-visible on Conventional MRI in Patients with Brain Gliomas

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Aram Tonoyan, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ki-67/MIB-1 labeling index (LI) characterizes cellular proliferation and is used in glioma grading and predicting glioma prognosis (Louis et al., 2021; Louis et al., 2007). Some researchers consider diffuse gliomas as a systemic disease of the brain rather than a local tumor. Application of antibodies specific to the R132H protein, which is present in cells of gliomas with IDH-1 mutation and absent in normal neuroglial cells, showed the presence of tumor cells in brain regions significantly distant from the glioma, including the opposite brain hemisphere (Agarwal et al., 2011; Sahm et al., 2012). The aim of this study was to assess the ability of diffusion kurtosis imaging (DKI) to find a correlation between Ki-67/MIB-1 LI of gliomas and diffusion kurtosis parameters in the normal-appearing on conventional MRI white matter of the opposite hemisphere of the brain.

#### METHODS AND MATERIALS

84 patients with newly diagnosed brain gliomas underwent 3T MRI before treatment. In all cases, the diagnosis was confirmed by biopsy or surgical resection. 49 patients had high-grade gliomas (HGG), and 35 patients had low-grade gliomas (LGG). The age of patients with HGG was  $43.8 \pm 14.7$ , and with LGG was  $37.7 \pm 9.6$ . DKI was performed using b values of 0, 1000, and 2500 s/mm<sup>2</sup> and 60 gradient directions. The following parameters were obtained using DKI: mean kurtosis (MK), axial kurtosis (AK), radial kurtosis (RK), kurtosis anisotropy (KA), mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD), fractional anisotropy (FA), relative anisotropy (RA). The Spearman correlation coefficient was calculated between Ki-67/MIB-1 LI of gliomas and diffusion kurtosis parameters in the normal-appearing on conventional MRI white matter of the opposite hemisphere of the brain ( $p < 0.05$  significance level). Conventional MRI included T1, T1+Gd, T2, T2-FLAIR weighted images.

#### RESULTS

Statistically significant correlation of glioma Ki-67/MIB-1 LI was found with (r = -0,28, ? = 0,01), RD (r = 0,3, ? = 0,02), FA (r = -0,27, ? = 0,003) and RA (r = -0,27, ? = 0,004) in the white matter of the opposite hemisphere of the brain. A decrease of RK ( $p < 0.05$ ) and an increase of RD ( $p < 0.05$ ) in the white matter of the opposite hemisphere of the brain with higher Ki-67/MIB-1 LI of gliomas can be due to the decreased axonal density. A decrease of both FA ( $p < 0.05$ ) and RA ( $p < 0.05$ ) with higher Ki-67/MIB-1 LI of gliomas can reflect higher cellularity and decreased axonal density in the contralateral white matter.

#### CONCLUSION

DKI demonstrated a potential to detect changes in the white matter of the brain non-visible on conventional MRI in patients with gliomas.

#### CLINICAL RELEVANCE/APPLICATION

Understanding the changes occurring in brain areas distant from the tumor is crucial for treatment and patient care.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-5

### **Covariance Structural Abnormalities: The Key Networks of Heterogeneous Mild Traumatic Brain Injury - A Result from Longitudinal Study with EZ-MAP for Detection of Regional FA Abnormalities**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yanan Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the covariance structural abnormalities of heterogeneous mild traumatic brain injury (mTBI) at subacute phase and 1-3 months, 6-12 months post-injury.

#### **METHODS AND MATERIALS**

: Diffusion tensor imaging tractography of whole brain and conventional MR were performed in 72 mTBI patients of subacute phase, 27 mTBI patients of 3 months and 21 mTBI patients of 6-12 months post injury. 46 age- and gender-equivalent healthy controls were also involved, 10 healthy controls and 11 healthy controls were scanned respectively 1 month, 6-12 months later. Voxelwise assessment methods of Enhanced Z-score Microstructural Assessment of Pathology (EZ-MAP) were used to detect regional FA abnormalities in each patient's fractional anisotropy (FA) maps. All subjects were administered the following neuropsychological tests: the Mini-Mental state examination (MMSE), Hamilton Depression (HAMD), Fatigue Severity Scale (FSS), Clinical Dementia Rating (CDR), Postconcussive Symptoms Scale (PSS), the Trail Making Test A, the Trail Making Test B, State Trait Anxiety Inventory (STAI-Y). Pearson's correlation coefficients between the FA values of covariance location with clinical measurements at all 3 time points post injury were calculated.

#### **RESULTS**

Respectively, 29.17% of subacute phase, 37.03% of 3 months post injury, 38.09% of 6-12 months post injury mTBI patients had abnormal brain MRI. During the period of post injury from subacute phase to 6-12 months, general pattern of reduced FA and /raised MD were present in various white matter tracts such as Body of corpus callosum, Splenium of corpus callosum, Fornix, Cerebral peduncle L, Anterior limb of internal capsule L, Posterior limb of internal capsule L, Anterior corona radiata L, Superior corona radiata L, Anterior limb of internal capsule R, Anterior corona radiata R, and Superior corona radiata R. In subacute phase, raised FA in Posterior limb of internal capsule L, Cerebral peduncle L, Anterior corona radiata R and Superior corona radiata R were in correlation with better clinical performance in MMSE, Traveling-A, and CDR.

#### **CONCLUSION**

Covariance structural abnormalities were the key networks of heterogeneous mild traumatic brain injury, serving as indicator and predictor of mTBI.

#### **CLINICAL RELEVANCE/APPLICATION**

To assess covariance structural abnormalities provided a new method to serve as indicator and predictor of heterogeneous mTBI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPNR-6

### Abnormal Functional Connectivity in Mild Traumatic Brain Injury at Subacute Phase and 1-3 Months Post-injury by Independent Component Analysis

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yanan Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To examine the resting state networks of homogeneous mTBI patients and investigate the dynamic changes of brain networks at both subacute phase and 1-3 months post-injury

#### **METHODS AND MATERIALS**

: A total of 60 first-episode mTBI patients at subacute phase (within 21 days post-injury) were recruited from the Local Emergency Department, and 35 mTBI patients who conducted the follow-up 1-3 month post-injury were enrolled. 43 healthy volunteers who matched with age, sex, and educational level were recruited as normal controls. Neuropsychological tests and self-reported symptoms were assessed within 24 hours after MR scan for all the participants. Independent component analysis (ICA) was carried out by using Multivariate Exploratory Linear Optimized Decomposition into Independent Components (MELODIC) implemented in FSL. A dual regression approach was used to perform voxel-wise comparisons of functional connectivity between groups. the Pearson's correlation coefficients between the averaged Z score in regions and clinical measurements both at subacute and 1-3month post injury subgroup were calculated.

#### **RESULTS**

Decreased functional connectivity within the default mode network (DMN) and increased network strengthen in the frontoparietal network (FPN) in mTBI patients at subacute phase were found, and the abnormality of the DMN function was specifically predicated by with the individual cognitive impairments. After 1-3months post-injury, increased connectivity in the DMN and decreased connectivity in the dorsal attention network (DAN) emerged. Reduced functional connectivity in the anterior cingulate cortex was correlated with aggravated syndrome of fatigue.

#### **CONCLUSION**

Alterations of connectivity in multiple intrinsic networks exist early after and during recovery of injury, which may underlie the mechanisms of the reduced and improved performance in neurocognitive testing.

#### **CLINICAL RELEVANCE/APPLICATION**

Whole brain functional connectivity, especially DMN, can serve as indicator and predictor to monitor disease progression or recovery of mTBI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPNR-7

### Local and Global Functional Connectome Disruption in Patients with Gliomas

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Giulia Sprugnoli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the disruption of functional connectome patterns in patients with brain tumors, based on resting-state functional magnetic resonance imaging (rs-fMRI) data in patients with gliomas.

#### METHODS AND MATERIALS

Fifty-four patients with newly diagnosed or recurrent gliomas were included ( $M = 34$ , Mean Age = 50.8 yr). Manual segmentation of solid lesions was performed on T1w and T2w MRI scans following RANO criteria. Rs-fMRI was acquired before surgery on a 3T scanner. Whole-brain network measures of centrality, modularity, integration and segregation were computed for a set of Regions of Interest (ROIs) including the Harvard Oxford (HO) anatomical atlas and tumor-related ROIs (i.e., edema, solid tumor, necrotic core). A  $p < 0.05$ , two-sided, FDR corrected threshold was used for statistical analysis; analysis was performed on connectivity matrices representing multiple sparsity levels ranging from 50% to 100%.

#### RESULTS

In newly diagnosed patients ( $n = 18$ ), we found a decrease of Integration (Degree, Global Efficiency) and Centrality (Betweenness centrality), and an increase of Segregation (Clustering Coefficient) in the tumor ROIs respect to healthy brain regions. Such an integration/segregation imbalance pattern seems to follow a gradient moving from the edema to the solid tumor and the necrotic core (i.e., less altered in the edema, more altered in the necrotic core). In the entire "Network" composed by all the brain regions of the HO atlas plus all the tumor ROIs, its indexes fit between those of the healthy grey matter (frontal poles, blue bars) and the tumor ROIs, confirming the relevance of the alteration induced by the tumor across the whole brain functioning system. In patients at recurrence ( $n = 36$ ), the same pattern was found, though with a less clear separation between tissue classes within the tumor. This might be due to an altered environment caused by functional plastic rearrangement and the neurocognitive effects of multiple interventions (i.e., surgery, chemotherapy, radiation damage).

#### CONCLUSION

We found significant alteration of functional connectome measures in brain regions affected by the tumor (i.e., tumor mass, necrotic core and edema), with a decrease of network integration and an increase of network segregation measures. Notably, a linear change in integration/segregation ratio was observed from the necrotic core to the edema, possibly reflecting tumor progression and therefore possibly capturing neuronal damage.

#### CLINICAL RELEVANCE/APPLICATION

Connectome-level markers of glioma functional behavior could deepen our understanding of glioma pathophysiology, provide insight on neurocognitive sequelae, as well as be investigated as a potential marker of tumor progression.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPNR-8

### Value of Contrast-Enhanced T1 WI Histogram Analysis in the Differential Diagnosis of Prolactin and Non-Prolactin Pituitary Macroadenomas

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Wei Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

Based on the World Health Organization's classification for pituitary neuroendocrine tumors in 2022, this study aims to investigate the value of contrast-enhanced T1 weighted imaging (CE-T1WI) histogram analysis in distinguishing prolactin pituitary macroadenomas and non-prolactin pituitary macroadenomas.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on data from 10 patients with prolactin pituitary macroadenomas and 13 patients with non-prolactin pituitary macroadenomas who were diagnosed by histopathology. All procedures of this study were approved by the Ethics Committee of our hospital. Written informed consent was obtained from all patients. The 3D Slicer software was used to draw the region of interest (ROI) of the tumor at the best plane, followed by gray-level histogram analysis to extract seven histogram parameters including Perc.10%, Perc.90%, kurtosis, mean, median, maximum and minimum values. Independent sample T-tests or Mann-Whitney U-tests were used to compare metric data between the two groups. Receiver operating characteristic (ROC) curves were plotted, and the area under the curve (AUC) was calculated to evaluate the diagnostic performance of the relevant parameters in distinguishing prolactin pituitary macroadenomas from non-prolactin pituitary macroadenomas.

#### RESULTS

In CE-T1WI histogram parameters, Perc.10%, mean, minimum value, and total parameters showed significant differences between the two groups of tumors with P values of 0.014, 0.0347, 0.0057, and <0.001, respectively. Table 1 presented the mean values and standard deviations of each parameter in the two groups. The area under the ROC curve, sensitivity, and specificity for each parameter were 0.808 (0.700, 0.923), 0.769 (0.700, 0.923), and 0.892 (0.800, 0.846), respectively, indicating good diagnostic accuracy. The AUC for the total parameter model was 0.954 (0.800, 1.000), significantly higher than that of individual parameters, suggesting that the combination of multiple parameters can improve the diagnostic accuracy.

#### CONCLUSION

CE-T1WI histogram analysis has certain value in the differential diagnosis of prolactin pituitary macroadenomas and non-prolactin pituitary macroadenomas, and can be used as an auxiliary method for distinguishing pituitary nerve prolactinomas.

#### CLINICAL RELEVANCE/APPLICATION

Since prolactin pituitary macroadenomas can be treated with medication only, while non-prolactin pituitary macroadenomas require surgery, which can be invasive, accurately differentiating between the two can help avoid unnecessary surgical trauma.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR-9

### Effective Atomic Number as a Novel Quantitative CT Imaging Marker for Differentiating Glioblastomas, Brain Metastases and Primary Central Nervous System Lymphomas

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Tsubasa Nakano (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine whether dual-energy CT parameters including effective atomic number ( $Z_{\text{eff}}$ ) and electron density (ED) could be quantitative imaging markers for differentiating glioblastomas (GBMs), brain metastases and primary central nervous system lymphomas (PCNSLs).

#### METHODS AND MATERIALS

This study included 102 consecutive patients with pathologically proven GBMs ( $n = 56$ ), metastases ( $n = 23$ ) and PCNSLs ( $n = 23$ ). For all patients, preoperative non-contrast dual-energy CT examination was performed using a spectral detector CT scanner. Images of conventional CT (CTconv), ED,  $Z_{\text{eff}}$  were obtained. These CT images and MR images (T2WI, FLAIR, ADC map and post-contrast T1WI) were co-registered using SPM12. For each lesion, semiautomatic tumor segmentation was performed to delineate contrast enhanced area of tumors using ITK-SNAP, and VOIs were placed on each image. The mean CTconv, ED,  $Z_{\text{eff}}$  and ADC values were compared between 3 groups using Mann-Whitney U test. ROC curve analysis was performed to assess the diagnostic abilities of each parameter and their combinations.

#### RESULTS

$Z_{\text{eff}}$  showed significant difference across all three groups, whereas ED showed no significant between-group differences. CTconv and ADC showed significant differences between GBMs and PCNSLs and between metastases and PCNSLs, but not between GBMs and metastases. Between GBMs and metastases, only  $Z_{\text{eff}}$  showed significant difference ( $P = 0.02$ ), and the area under the ROC curve (AUC) for their differentiation was 0.667. In discriminating between metastases and PCNSLs,  $Z_{\text{eff}}$  showed the best diagnostic performance (AUC = 0.827), followed by ADC (0.761) and CTconv (0.701). The AUC further improved up to 0.921 when  $Z_{\text{eff}}$  was combined with ADC. Between GBMs and PCNSLs, the AUCs were 0.744, 0.681 and 0.798 for CTconv,  $Z_{\text{eff}}$  and ADC, respectively. Although  $Z_{\text{eff}}$  had lower diagnostic performance compared to CTconv and ADC, AUC improved up to 0.829 with the combination of CTconv,  $Z_{\text{eff}}$  and ADC.

#### CONCLUSION

Our preliminary results suggested that  $Z_{\text{eff}}$  can be a novel quantitative CT imaging marker that captures inherent characteristics of the tumors which are not reflected in conventional images, and it may be useful for differentiating GBMs, brain metastases and PCNSLs.

#### CLINICAL RELEVANCE/APPLICATION

The effective atomic number can be a novel quantitative CT imaging marker for differentiating GBMs, brain metastases and PCNSLs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPOB-1

### Does Abdominal Fat Distribution Impact Endometrial Cancer Prognosis

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Kristine E. Fasmer, PhD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantify abdominal fat distribution from clinically acquired computed tomography (CT) scans at primary diagnosis and at follow-up in a large endometrial cancer (EC) cohort, and to explore its relation to disease progression and prognosis.

#### METHODS AND MATERIALS

From CT images of 293 EC patients at primary diagnosis ( $n_{\text{primary}}$ ), total- (TAV), subcutaneous- (SAV), visceral abdominal fat volume (VAV), and visceral-to-total abdominal fat ratio (VAV/TAV) were derived using iNTuition (TeraRecon Inc., USA). The obesity markers were assessed in relation to body mass index (BMI) using Spearman's rank order correlation ( $r = \rho$ ), and to tumor histology from surgical specimen (endometrioid EC (EEC) grade 1-3, non-endometrioid EC (NEEC)) using Mann-Whitney U test. Time-dependent receiver operating characteristic curves, and Cox hazards ratios (HRs) were used to assess the obesity markers in relation to progression-free survival (PFS). Delta ( $d$ ) fat changes from primary diagnosis to follow-up 13 (2-41) [median (range)] months after diagnosis, were derived for 152/263 patients ( $n_{\text{follow-up}}$ ) with follow-up CT.  $d$ TAV,  $d$ VAV,  $d$ SAV, and  $d$ (VAV/TAV) were compared for patients with progression versus patients with no signs of progression, using Mann-Whitney U-test.

#### RESULTS

At primary diagnosis ( $n_{\text{primary}}=293$  patients), TAV, VAV, and SAV were all highly correlated to BMI ( $r = 0.78$ ), while VAV/TAV ratio was not ( $r = -0.12$ ). Patients with high-risk histology (EEC grade 3/NEEC) had significantly lower TAV, SAV, and BMI ( $p=0.03$ ), while higher VAV/TAV ratio ( $p=0.001$ ) than patients with low-risk histology (EEC grade 1-2). High VAV/TAV ratio ( $=36\%$ ) predicted poor PFS both in univariable analysis ( $HR=2.4$ ,  $p=0.04$ ), and when stratified for surgicopathologic International Federation of Gynecology and Obstetrics (FIGO) stage I-IV ( $HR=2.8$ ,  $p=0.02$ ). At follow-up ( $n_{\text{follow-up}}=152$  patients), median TAV, VAV, and SAV were significantly lower than at primary diagnosis ( $p<0.001$  for all), while no significant difference was observed for VAV/TAV ratio ( $p=0.31$ ). Patients experiencing progression had a larger reduction in visceral fat compartments ( $d$ VAV= $-19\%$ ,  $d$ VAV/TAV= $-2\%$ ), than patients with no signs of progression ( $d$ VAV= $-11\%$ ,  $d$ VAV/TAV= $0\%$ ,  $p=0.04$  for both).

#### CONCLUSION

High VAV/TAV ratio, measured at primary diagnosis, is associated with high-risk histology and reduced survival in EC. Patients experiencing disease progression have a more pronounced reduction in visceral fat volume than patients with no signs of progression at follow-up.

#### CLINICAL RELEVANCE/APPLICATION

Abdominal fat distribution markers from preoperative abdominal CT predict endometrial cancer prognosis, and higher visceral fat loss during/following therapy is associated with disease progression.

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## Abstract Archives of the RSNA, 2023

T5A-SPOB-2

### Early Treatment Response is Captured by Whole-tumor MRI Radiomics in Patient-derived Organoid Endometrial Cancer Models

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Kristine E. Fasmer, PhD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiomics can capture microscale information in medical images beyond what is visible to the naked human eye. Using a clinically relevant mouse model for endometrial cancer, the purpose of this study was to develop and validate a radiomic signature (RS) predicting response to standard chemotherapy.

#### METHODS AND MATERIALS

Mice orthotopically implanted with a patient-derived grade 3 endometrioid endometrial cancer organoid model (O-PDX) were allocated to chemotherapy (combined paclitaxel/carboplatin, n=11) or saline/control (n=13). During tumor progression, the mice underwent weekly T2-weighted (T2w) MRI. Segmentation of primary tumor volume (vMRI) allowed radiomic feature extraction from whole-volume tumor masks. A radiomic prediction model employing least absolute shrinkage and selection operator (LASSO) statistics for predicting treatment group (chemotherapy vs. control) was derived using endpoint images in the orthotopic O-PDX, and subsequently applied on the earlier study timepoints (RS\_O at baseline, and week 1-3). For external validation, the radiomic prediction model was further tested in a separate T2w-MRI dataset on segmented whole-volume subcutaneous tumors (RS\_S) from the same O-PDX model, imaged at three timepoints (baseline, day 3 and day 10/endpoint) after start of chemotherapy (combined paclitaxel/carboplatin) (n=8 tumors) or saline/control (n=8 tumors).

#### RESULTS

The RS\_O yielded rapidly increasing area under the receiver operating characteristic curves (AUCs) for predicting treatment groups, from baseline until endpoint; AUC=0.38 (baseline); 0.80 (week 1), 0.85 (week 2); 0.96 (week 3) and 1.0 (endpoint). In comparison, vMRI yielded AUCs of 0.37 (baseline); 0.69 (week 1); 0.83 (week 2); 0.92 (week 3) and 0.97 (endpoint). When tested in the external validation dataset, RS\_S yielded high accuracy for prediction of treatment group at day 10/endpoint (AUC=0.85), and tended to yield higher AUC than vMRI (AUC=0.78, p=0.18). Neither RS\_S nor vMRI predicted treatment groups at day 3 in the external validation set (AUC=0.56 for both).

#### CONCLUSION

We have developed and validated a radiomic signature that was able to capture treatment response prior to a decrease in tumor volume. This study supports the promising role of preclinical imaging with radiomic tumor profiling to detect early treatment response in cancer models.

#### CLINICAL RELEVANCE/APPLICATION

Radiomic MRI signatures capture treatment response prior to visible decrease in tumor volume in a preclinical endometrial cancer model and represent a promising approach for capturing early treatment response.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5A-SPOB-3

### Magnetic Resonance Imaging of Primary Ovarian Carcinosarcoma: Is the "Mille-feuille Sign" Useful in Diagnosis

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Yuriko Watanabe, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Primary ovarian carcinosarcoma (POC) is a rare and aggressive variant of ovarian cancer with a poorer prognosis than that of high-grade serous ovarian cancer. Thus, preoperative imaging diagnosis is crucial; however, few reports on MRI of POC exist. Kurokawa et al. proposed a new morphologic classification of ovarian tumors on imaging and reported that the mille-feuille sign, with a layered structure in the cystic tumor, indicates ovarian metastasis from colorectal carcinoma with high specificity and is useful in the differential diagnosis of primary ovarian carcinoma (Eur J Radiol. 2020; 124: 108823). In this presentation, we analyzed the MRI findings of 12 cases of POC and investigated the imaging features, including a new morphologic classification.

#### METHODS AND MATERIALS

MRI scans of 12 POC patients were obtained. The following features were evaluated: (1) tumor size; (2) ADC values of the solid component; (3) intratumoral hemorrhage; (4) signal intensities compared to the skeletal muscle and heterogeneity of the solid component on T2WI; (5) heterogeneity of enhancement of the solid component on Gd-enhanced T1WI; and (6) tumor morphology on T2WI and Gd-enhanced T1WI, according the following four categories: "mille-feuille sign," "solid and cystic," "multicystic without nodules," and "multicystic with nodules." Among (3)-(6), three radiologists who were blinded to prior clinical information were evaluated. In case of disagreement among the readers, the diagnosis was determined through a majority decision. Interobserver agreement for subjective image quality was calculated using the Fleiss' kappa statistic.

#### RESULTS

(1) tumor size: mean,  $133.7 \pm 127.5$  mm, (2) ADC values: mean,  $0.80 \pm 0.26 \times 10^{-3}$  mm<sup>2</sup>/s, (3) intratumoral hemorrhage: 11/12 (?=0.54), (4) heterogeneously high intensity: 12/12 (?=1), (5) heterogeneous enhancement: 12/12 (?=1), (6) tumor morphology on T2WI: solid and cystic (n=10) and mille-feuille sign (n=2) (?=0.56), tumor morphology on Gd-enhanced T1WI: solid and cystic (n=7) and mille-feuille sign (n=5) (?=0.89).

#### CONCLUSION

POC shows relatively large ovarian tumors with hemorrhage, heterogeneous solid components, and low ADC values. Gd-enhanced T1WI showed solid and cystic or mille-feuille signs with excellent interobserver agreement. We considered the mille-feuille sign as a suspicious finding for POC in addition to ovarian metastasis from colorectal carcinoma.

#### CLINICAL RELEVANCE/APPLICATION

Primary ovarian carcinosarcomas (POCs) are aggressive and have a poor prognosis; therefore, preoperative imaging diagnosis is crucial. The "mille-feuille sign" on Gd-enhanced T1WI can be useful to suspect POC preoperatively.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPOB-4

### Habitat-based Radiomics Enhances the Ability to Predict Lymphovascular Interstitial Infiltration in Cervical Cancer: A Multicenter Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Jingshan Gong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

As lymph-vascular space invasion (LVSI) was closely related to lymph node metastasis and prognosis, the preoperative assessment of LVSI in cervical cancer is crucial for patients. As such, we investigated the potential of habitat analysis as a novel tumor biomarker in predicting LVSI in cervical cancer.

#### METHODS AND MATERIALS

This retrospective study of 300 patients with cervical cancer who had received surgical treatment at two institutions, with data from institution 1 as the training ( $n = 198$ ) cohort and institution 2 as the validation ( $n = 102$ ) cohort. Based on the voxel and entropy values of CE-T1WI images clustered by K-means method, the VOI was divided sub-regions and the radiomics features were extracted from the sub-regions respectively. Pearson correlation coefficient and LASSO regression methods were used for feature selection. Pearson correlation coefficient and LASSO regression methods were used for feature selection. The SVM machine learning model was used to construct prediction models for each sub-region radiomics features and the model effects were evaluated by an external test cohort.

#### RESULTS

The voxels and entropy values of CE-T1WI images are clustered into 3 sub-regions. In the training cohort, AUCs of the SVM models based on the radiomics features derived from all tumor, Habitat1, Habitat2 and Habitat3 were 0.805 (95% CI: 0.745 - 0.864), 0.873 (95% CI: 0.824 - 0.922), 0.869 (95% CI: 0.821 - 0.917) and 0.870 (95% CI: 0.821 - 0.920), respectively. Comparing with all tumor, the predictive performances of Habitat1-3 were higher with statistical significant. The Habitat3 model archived the highest AUC in the external test cohort (0.780 [95% CI: 0.692 - 0.869]). The difference was not statistical significant ( $p=0.073$ ). The accuracy, sensitivity, specificity, positive predictive value and negative predictive value for LVSI were 0.745, 0.741, 0.75, 0.769 and 0.720, respectively.

#### CONCLUSION

A tumor sub-regional habitat-based radiomics model could obtain higher predictive performance for LVSI in cervical cancer the radiomics derived from all tumor, which might be a potential noninvasive approach to facilitate treatment decision-making in clinical settings

#### CLINICAL RELEVANCE/APPLICATION

Pretreatment acknowledge of LVSI status in patients with cervical cancer can facilitate personalized therapeutic strategy. The current work provided a noninvasive approach for assessing LVSI without radiation, which is very important for the women of childbearing age, who have the intention for fertility preservation.

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## Abstract Archives of the RSNA, 2023

T5A-SPPD-2

### Abnormal Brain Functional Connectivity in Children with Spastic Cerebral Palsy: A Resting-state Functional Magnetic Resonance Imaging Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Ying Peng (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral palsy (CP) is the most common dyskinesia syndrome in children, and spastic cerebral palsy (SCP) is the most common clinical type. Existing neuroimaging studies have found that there are extensive structural and functional changes in children with SCP. However, few studies focus on the intrinsic functional features of network organization throughout the brain. Therefore, the purpose of this study was to use degree centrality (DC) analysis at the voxel level to characterize the potential pattern of intrinsic connectivity disorders in the whole brain functional network in children with SCP.

#### METHODS AND MATERIALS

34 children with SCP and 17 demographically matched healthy controls (HCs) participated in the study. All subjects were evaluated for gross motor function and hand function, and underwent resting state functional magnetic resonance imaging. DC is a graph theory-based measure that represents the total number of functional connections between a voxel and other voxels. We used DC analysis and seed-based functional connectivity (FC) analysis to identify abnormal FC.

#### RESULTS

The DC values of the left supplementary motor area (SMA), bilateral medial cingulate gyrus (MCC) and left precuneus were significantly lower than the HCs group. Further seed-based FC analysis showed that, compared with the HCs group, when seed was located on the left SMA, the SCP group showed decreases connections with the left anterior cingulate gyrus, parahippocampal gyrus, ventrolateral prefrontal cortex and right anterior cingulate gyrus, thalamus, amygdala, and putamen. When seed was located in the left precuneus, the SCP group showed decreases connections with the left thalamus, right hippocampus, precuneus, lingual gyrus, and putamen. When seed was located in the left MCC, the association with the left insula, precuneus, medial prefrontal cortex, right putamen and thalamus was reduced in the SCP group. When seed was located in the right MCC, the association between the left cuneus and the right lingual gyrus, precuneus and thalamus was reduced in the SCP group. Correlation analysis showed that the FC between the left SMA and the right putamen was negatively correlated with the hand function evaluation grade.

#### CONCLUSION

The brain functional network in children with SCP had extensive internal connectivity disorders, including the damage of the default brain network, the central executive network and the salient network in addition to the sensorimotor network.

#### CLINICAL RELEVANCE/APPLICATION

The changes of brain functional network provide a basis for understanding the pathophysiological mechanism of SCP motor and cognitive impairment, and may provide a new therapeutic target for the treatment of children with SCP.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-1

### Assessing Coronary Artery Calcium Scoring in Lung Cancer Screening: A Dynamic Cardiac Phantom Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Chao Guo, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Calcification of coronary arteries is strongly associated with cardiovascular diseases. Low dose lung cancer screening (LCS) is gaining popularity in practice. For asymptomatic patients, the feasibility of using LCS scans for coronary artery calcium scoring (CACs) has not been explored apart from incidental findings. We aimed to quantify the calcium score using LCS scans in comparison with the ground truth obtained by ECG gated CACs.

#### METHODS AND MATERIALS

The CIRS Dynamic Cardiac Phantom was utilized with 12 calcification inserts of various density (50, 100, 250 and 400 mg/cc) and diameters (1.2, 3 and 5 mm). Scans were performed with simulated ECG with the heart rate from 50 to 100 beats per minute, using the non-gated LCS (CTDIvol = 0.17 mGy) and gated CACs (CTDIvol = 1.74 mGy) protocols. The gated CACs scans served as the ground truth. A FOV of 200 mm was used throughout this study. Additionally, 4 seconds breath motion was added during the LCS scan for comparison purposes. Siemens SyngoVia was used to score the calcifications by individual readers.

#### RESULTS

The visibility of calcium inserts from LCS scans were affected by cardiac motion, which caused blurring and distortion, particularly for small-diameter inserts. As compared with the ground truth, Agatston scores were found lower by 39.5% to 56.7% depending on the heart rate. Within the non-gated scans, the added breathing motion generated additional score difference up to 17.6%. It was found that the calcification detectability is sensitive to the insert density. Calcifications of density higher than 250 mg/cc were detectable. However, inserts with densities 100 mg/cc or lower were not detectable at any heart rate.

#### CONCLUSION

As compared to the ground truth, CAC score using non gated LCS scans is underestimated by 39.5% to 56.7%. It was found that calcium density exceeds 250 mg/cc was detectable. However, calcifications with a density lower than 100 mg/cc cannot be scored with CACs and LCS protocols, regardless of heart rate. Although heart rate may affect the calcium scoring, major calcifications can still be accurately assessed with a significant reduction in patient dose.

#### CLINICAL RELEVANCE/APPLICATION

Using coronary artery calcium scoring as a screening tool has the potential to detect major coronary artery events. Incorporating it into lung cancer screening exams could provide an opportunity for further simultaneous diagnosis.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-10

### CNN-Based Metal Artifact Reduction Method with Mask for Planning CT in Radiation Treatment

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Won Jin Lee, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

For radiation treatment of cancer, CT scans are essential. Metal artifacts are generated during CT scans by metal objects inserted into the body for various reasons, which make accurate dose calculation for radiation therapy impossible. Recently, many metal artifacts reduction methods applying deep learning have been proposed. However, compared to other human body parts, metal artifacts are not effectively removed by the existing methods in the head neck area, which has a relatively complex structure and has strong artifacts due to the insertion of dental filling and implant. In this study, we proposed a CNN-based deep learning model using a pre-trained mask extraction model that reduces strong metal artifacts in the head neck area.

#### METHODS AND MATERIALS

The training process was divided into two steps. In first step, a model to extract masks including bone and metal was trained using supervised contrastive learning(SCL) with 30 patients. The tissue pixel distribution includes more of patient's identity and effects of metal artifacts than the bone pixel distribution. Therefore, a bone mask was obtained by separating the tissue distribution from the bone distribution through SCL. In second step, a model for reducing metal artifacts was trained with 85 patients. Metal and bone have a wide pixel range, while tissues concentrate in narrow range of values, resulting in a more than ten-fold difference in the MSE for each area. Therefore, Instead of calculating the loss for the entire image including bones, metal, and tissues, a masked MSE was applied using the bone mask extracted in the first step. As a result, a weighted masked MSE was applied to remove metal artifacts from both tissue and bone.

#### RESULTS

In the evaluation metrics for the synthetic dataset, our proposed model showed average scores of MSE, SSIM, PSNR, and PCC of 0.000106, 0.9986, 42.4130, and 0.9944. Overall evaluation values ??showed improved results than baseline and others. In the qualitative results, the proposed model showed higher performance compared to a commercial software and other models in real-world data.

#### CONCLUSION

In this study, we proposed a CNN-based metal artifacts reduction model with weighted masked MSE. Our proposed model demonstrated the best performance on both generated and real-world data, effectively removing strong artifacts near metal as well as stripe-shaped artifacts located far from metal.

#### CLINICAL RELEVANCE/APPLICATION

Our proposed model effectively resolves severe artifacts in complex structures such as head neck regions. Therefore, the proposed model is expected to be applied to CT metal artifact reduction in radiation treatment planning process, especially dose calculation for patients with metal implants inserted in the head neck where strong artifacts appear.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-SPPH-11

### Reconstruction of Fast Acquisition MRI with Under-sampled K-space Data by Using Massive-Training Artificial Neural Networks (MTANNs)

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Kenji Suzuki, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Accelerated MRI acquisitions by taking fewer samples in the K-space involves a trade-off between image quality degradation and acquisition time. We aimed to reduce artifacts in MR images reconstructed from under-sampled k-space data in fast-acquisition MRI by using our MTANN deep learning.

#### METHODS AND MATERIALS

We developed a scheme consisting of several iterable cross-domain massive-training artificial neural network (MTANN) modules, namely, an MTANN in the image space (iMTANN) with multiple kernels and multiple frequency-specific MTANNs in the K-space (kMTANNs) to improve the image quality in both spaces in fast acquisition MRI with under-sampled k-space data. A public dataset used in this study contains 20 full k-space volumes of 795 images. Simulated accelerated under-sampled (1/8) MR images were created with a universal sampling pattern. Our MTANN model was trained with the simulated under-sampled MR data as input and the corresponding fully-sampled MR data as “teaching” images.

#### RESULTS

To evaluate the image quality quantitatively, we used the structural similarity index (SSIM) and mean squared error (MSE) between the predicted MR and fully-sampled MR images. Compared with the state-of-the-art XPDNet, the SSIM and MSE for our scheme were improved from 0.885 and 31.95 to 0.900 and 23.97, respectively. The differences were statistically significant ( $P < 0.05$  in paired t-tests). In the comparison experiment, our hybrid MTANN preserved the anatomical structure of the knee better than XPDNet. XPDNet changed the appearance of the original anatomical structures, causing significant errors in the reconstruction of MR images, whereas our hybrid MTANN removed the artifacts substantially while preserving those important anatomical structures from the under-sampled MR images.

#### CONCLUSION

Our hybrid MTANN improved the image quality by reducing truncation artifacts substantially in 8-times faster acquisition MRI, while anatomic structures were preserved well.

#### CLINICAL RELEVANCE/APPLICATION

Our scheme was able to shorten the acquisition time of MRI by a factor of 8, while preserving important anatomical structures, which improves the throughput of MR exams.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-12

### Feature Map Visualization for Explaining Black-Box Deep Learning Model in Liver Tumor Segmentation

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Ze Jin, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

A chief limitation of current artificial-intelligence (AI)-aided diagnosis is the lack of transparency in a black-box deep learning model in the AI system, it would lose radiologists' trust in AI decisions. To address this issue, we developed an explainable AI (XAI) method to visualize the functions of groups of hidden units in a massive-training artificial neural network (MTANN) model for liver tumor segmentation in CT.

#### METHODS AND MATERIALS

The dataset used in this study came from the public LiTS database which contained dynamic contrast-enhanced CT scans. Seven and 24 cases were selected for training and testing, respectively. To segment liver tumors, a patch-based MTANN model was trained with input liver CT images and corresponding "gold-standard" manual liver segmentation by radiologists as "teaching" images. Our proposed sensitivity-based structure optimization algorithm was applied to the trained model to obtain a compact yet comparable model from a larger one by removing "redundant" hidden units of the model. After the optimization, we grouped the hidden units into several groups of similar functions by using an unsupervised hierarchical clustering algorithm. In this way, the functions of the model were characterized by visualizing the feature maps of each group. Light, gray, and dark pixels in the feature maps indicated enhancement, doing nothing, and suppression, respectively.

#### RESULTS

We used a Dice score to compare the performance of the models. The initial MTANN model with 80 hidden units (Dice = 0.714) was optimized with our algorithm and resulted in a compact model with 9 hidden units (Dice=0.701). These 9 hidden units were clustered into three groups by using the clustering algorithm according to a distance function among the weighted feature maps of the hidden units. Their functions were revealed and explainable by visualizing the feature maps as follows: (a) enhancing the liver area, (b) suppressing non-tumor areas, and (c) suppressing the liver's boundary and reducing the false positive pixels inside the liver. In addition, our experimental analysis by tumor sizes did not change the functions of three groups, demonstrating the robustness of our method. The modified model using only groups A and B achieved a higher performance in tumor segmentation, as they showed improved agreement with the tumor region boundary.

#### CONCLUSION

This study demonstrated how our optimization and clustering algorithm could be used to understand and explain the functions of the MTANN model in liver tumor segmentation. It provided a valuable tool to analyze the behavior of black-box models better.

#### CLINICAL RELEVANCE/APPLICATION

Our XAI method aiming to improve the transparency of an MTANN deep learning model would help radiologists gain their trust in AI's decisions.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-13

### Weakly Supervised Deep Learning Model for Automatically Delineating the Skeleton and Soft Tissue Organs from Whole-Body Diffusion Weighted Imaging (WBDWI)

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Antonio Candito, PhD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

WBDWI is a non-invasive, radiation-free, and quantitative technique for staging and therapy response assessment in patients with malignant bone lesions and metastatic visceral disease. The technique offers excellent contrast between disease and tissue background and allows measuring the Total Diffusion Volume (TDV in millilitres) and the Apparent Diffusion Coefficient (ADC), a surrogate imaging biomarker of tumour cellularity. However, clinicians still need to perform tedious and time-consuming delineations to obtain these biomarkers. Therefore, the development of automated segmentation tools is desirable. As an initial step, we have developed a supervised deep learning model from "weak annotations" for automatically delineating the skeleton and soft tissue from WBDWI data.

#### METHODS AND MATERIALS

A 3D patch-based U-Net model was developed for delineating ten body regions from WBDWI: six skeleton regions (long bones, pelvis, lumbar/thoracic/cervical spine, ribcage) and bladder, kidneys, liver and spleen. WBDWI multi-centre datasets were used to train and validate the U-Net model: a dataset of 189 patients with Advanced Prostate Cancer (APC with baseline and follow-up scans) and 35 patients with Multiple Myeloma (MM with only baseline scan). The network employed a 2-channel input (i) the ADC map and (ii)  $b=0$  s/mm<sup>2</sup> image, derived from the mono-exponential fitting of the diffusion data. Annotations were automatically defined through a set of uncertainty maps (non-binary segmentations) derived from a computationally expensive atlas-based segmentation algorithm.

#### RESULTS

The trained U-Net model was able to generate the body region segmentation maps within 20 seconds on CPU (2.4 GHz Quad-Core). On average, the dice score for skeleton regions on 15 test datasets was 0.62, with precision and recall of 0.67 and 0.72, respectively. Average dice score for soft tissue organs was 0.75, with precision and recall of 0.73 and 0.78, respectively.

#### CONCLUSION

Our deep learning model could facilitate the development of signal-based automated tool for delineation and quantification of malignant bone lesions and metastatic visceral disease in patients with APC and MM.

#### CLINICAL RELEVANCE/APPLICATION

Our model could assist clinicians in detecting and quantifying disease from WBDWI in patients with MM, APC, advanced breast and melanoma cancer, and, for screening subjects with high-cancer risk.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-2

### Optimizing Image Quality in Breast Screening: A Medical Physics 3.0 Approach

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Niall Phelan, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

In order to maximize sensitivity and specificity in population based breast screening, image quality should be optimized but equally must be consistent for all women screened. Imaging optimization projects have largely been underpinned by equipment performance metrics, established by technical image quality and dose indicators from physics quality control (QC) tests. However, the correlation between phantom image quality and impact on the clinical outcome is poorly understood and tenuous in many cases. We have applied the principles of Medical Physics 3.0 to combine medical physics QC data with screening outcome data to drive optimization and consistency of technical quality in a national breast screening programme.

#### METHODS AND MATERIALS

The screening programme data management system enables collection and analysis of performance data including cancer detection rate (CDR) by individual mammography system for quality audit and reporting. However the requirement to accumulate sufficient data means these reviews can only be done retrospectively. We have used CDR analysis of more than 2 million screening examinations as a proxy indicator for comparison of equipment performance, correlated with routine medical physics image quality tests to monitor and audit quality and consistency.

#### RESULTS

Following a large scale imaging equipment replacement with two new mammography system types, we observed that while the performance of both systems was consistent with previous system types and exceeded programme standards for cancer detection, significant differences were observed between them. This result offered an opportunity to review and standardize technical performance to achieve consistency across the programme. Experimental imaging and simulation studies were carried out to determine improved automatic exposure control (AEC) system set-up which was then implemented across the programme by the vendor. Operational radiation dose increased but remained lower than European (EUREF) guidelines. Subsequent retrospective analysis demonstrated convergence of technical image quality and CDR for the two systems.

#### CONCLUSION

Differences in mammography equipment technical performance were identified through medical physics QC monitoring and correlated with screening outcome data, providing an opportunity for successful optimization and quality improvement.

#### CLINICAL RELEVANCE/APPLICATION

Using Medical Physics 3.0 principles to incorporate the use of aggregated screening data and clinical outcome measures in support of medical physics quality assurance processes has demonstrated potential to deliver optimization of quality for individual women and for the screened population.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-3

### Diagnostic Value of Direct Lymphangiography in Primary Chyluria: A Retrospective Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Qi Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the diagnostic value of direct lymphangiography (DLG) in primary chyluria.

#### METHODS AND MATERIALS

Thirty-seven patients diagnosed as primary chyluria were recruited in this retrospective study. All patients were examined by DLG. The DLG examination was performed using the American GE Innova 2000-IQ DSA machine. According to the patient's clinical condition, one side of the foot was selected for lipiodol injection, and if the patient had combined lower limb lymphedema, the healthy side of the foot was selected. The patient was placed in a supine position, and a mixture of methylene blue and 2% lidocaine (1:1) was injected intradermally and subcutaneously between the roots of the 1st to 3rd toes on one side of the foot about 1-2 ml. A blue-stained shallow lymphatic was found under the skin, and the lymphatic was entered by puncture with a lymphography needle, and a total of about 7-15 ml of lipiodol was injected at a flow rate of 6-8 ml/h. The lipiodol development and regurgitation were observed dynamically under DSA until the lipiodol entering at the end of the thoracic duct was revealed, and the observation time ranged from 1.5 to 4.0h. For DLG, the indexes were: Distribution, reflux and dilatation of abnormal lymphatic vessels in the urinary system, chest and abdomen. The DLG signs of primary chyluria patients were statistically described by composition ratio of classification variables.

#### RESULTS

DLG showed ipsilateral iliac lymphatic tortuosity and dilatation in 30 cases (81.1%); contralateral iliac lymphatic reflux in 17 cases (45.9%); ipsilateral lumbar trunk tortuosity and dilatation and reflux in 19 cases (51.4%); contralateral lumbar trunk reflux in 21 cases (56.8%); ipsilateral pelvic sinus reflux in 17 cases (45.9%); contralateral pelvic sinus reflux in 21 cases (56.8%); thoracic duct reflux obstruction in 37 cases (100.0%); 7 cases (18.9%) of bronchial mediastinal trunk reflux, including 1 case (2.7%) of hilar reflux and 3 cases (8.1%) of intercostal reflux (Figure 11%); 4 cases (10.8%) of perineal reflux; 1 case (2.7%) of abdominal reflux; 21 cases (56.8%) of cervical trunk and subclavian trunk reflux.

#### CONCLUSION

DLG is able to visualize lymphatic reflux and abnormal reflux dynamically, evaluate lymphatic vessel morphology accurately, and achieve a diagnostic rate of 81.8% for primary chyluria.

#### CLINICAL RELEVANCE/APPLICATION

DLG can provide an important imaging basis for the diagnosis and preoperative evaluation of primary chyluria.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-4

### Retrospective Analysis of Doses Delivered during Embolization Procedures over the Last 10 Years

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Joel Greffier, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to retrospectively analyze dosimetric indicators recorded since 2012 for thoracic, abdominal or pelvic embolizations to evaluate the contribution of new tools and technologies in dose reduction.

#### **METHODS AND MATERIALS**

Dosimetric indicators (dose area product (DAP) and air kerma (AK)) from 1449 embolizations were retrospectively reviewed from August 2012 to March 2022. A total of 1089 embolizations were performed in an older fixed C-Arm system (A1), 222 in a newer fixed C-Arm system (A2) and 138 in a 4DCT system (A3). The embolization procedures were gathered to compare A1, A2 and A3.

#### **RESULTS**

DAP were significantly lower with A2 compared to A1 for all procedures (median -50% +/- 5%,  $p < 0.05$ ), except for uterine elective embolizations and gonadal vein embolization. The DAP values were significantly lower with A3 than with A1 ( $p < 0.001$ ). CT scan was used for guidance in 90% of embolization procedures.

#### **CONCLUSION**

This monocentric retrospective analysis of the doses delivered during thoracic, abdominal and pelvic embolization procedures over a 10-year period showed the contribution of the new IR tools in dose reduction and patient management. The last C-arm technology reduced the image noise and improved image quality, allowing a 50% reduction of the air kerma and showing a significant dose reduction. The implementation of a CT scan inside the IR room allowed a more precise 3D guidance without increasing the dose delivered to the patients.

#### **CLINICAL RELEVANCE/APPLICATION**

The last C-arm technology reduced the image noise and improved image quality, allowing a 50% reduction of the air kerma and showing a significant dose reduction. The implementation of a CT scan inside the IR room allowed a more precise 3D guidance without increasing the dose delivered to the patients.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-5

### Relationship between Presurgical DTI Motor Tract Maps and Intraoperative Evoked Potentials

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Juan Jose Sanchez Fernandez, DPhil, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To study the accuracy of DTI in the presurgical identification of the motor tract and its correlation with evoked potentials obtained during brain tumor surgery.

#### METHODS AND MATERIALS

54 pyramidal tractographies based on DTI images were performed before and after surgery in patients with glioma tumours histologically confirmed (17 diffuse anaplastic gliomas, 8 oligoastrocytomas and 29 multiform glioblastoma) which were immediately adjacent or in direct contact to the pyramidal tract. During surgery, central sulcus was identified and confirmed by evoked potentials. For evoked potential a direct phase technique for cortical stimulation with high frequency (250Hz) monopolar electrodes was used. For cortical stimulation an 8 contacts electrode was used whereas a current waveform with eight electromyograms was used for evoked potentials continuous monitoring. When resection approaches the pyramidal tract, subcortical stimulators were used and the electromyographic response was observed after subcortical stimulation. The minimum distance ratio between the resection cavity and subcortical stimulation intensity, in relation to the pyramidal tract, was studied using regression and ANOVA correlation analysis. The p-value was considered as  $p < 0.05$

#### RESULTS

The distance between the resection cavity and the motor tract in tractographic sequences postoperatively were 2.5 to 23.7 mm. The results were correlated with data obtained from cortical evoked potentials monitored during surgery. There was a significant linear correlation of 1.08 by applying a regression test between distance and stimulus intensity ( $R^2 = 0.8202$ ,  $P < 0.001$ ).

#### CONCLUSION

Correlation was demonstrated between the electrophysiological and DTI in the analysis of the pyramidal tract by imaging based on the use of direct subcortical stimulation. The DTI should be systematically included in the standard imaging protocol for the study of brain tumours both for etiologic diagnosis to treatment planning in order to preserve the maximum motor tract as possible.

#### CLINICAL RELEVANCE/APPLICATION

The identification by DTI of the corticospinal tract prior to brain glioma surgery allows the neurosurgeon an accurate planning of the maximum tumour removal with motor tract preservation. Monitorization with intraoperative evoked potentials showed correlation with presurgical tractography MR studies.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-6

### **CRLM-GAN: The Optimization Effect on Automatic Segmentation of T2-weighted Images for Colorectal Liver Metastases Combining with Transfer Learning and Generative Adversarial Network under Small-scale Sample**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Shaojun Xia (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Colorectal cancer liver metastase (CRLM) is a ubiquitous digestive tract tumor, it is estimated that more than 50% colorectal cancer patients will eventually develop liver metastases during the course of illness. As for the diagnosis of CRLM, T2WI can serve as an important supplementary modality beyond the conventional examination of contrast-enhanced CT or DWI MRI. In this study, we proposed a modified hybrid auto-segmentation model based on transfer learning (TL) and generative adversarial network (GAN), i.e. CRLM-GAN, to explore the optimization effect under small-scale sample, thus expanding the application potential of T2WI images in intelligent diagnosis for CRLM.

#### **METHODS AND MATERIALS**

A retrospective cohort was enrolled involving 70 patients with pathologically confirmed CRLM. All the images were acquired by the axial fast recovery, fast spin-echo and T2WI sequence, sourced from a 1.5-T MRI scanner using an 8-channel phased array body coil. In the fore-end of the network, UNet++ was employed as the generator to initially segment probabilistic maps. Then the generated probabilistic maps and real labels were multiplied with the original images respectively, resulting in the predicted tumor and the real tumor images. Both of them were input into the discriminator-a pre-trained ResNet-50 to extract and fuse the deep convolutional features. Ultimately, a comprehensive loss function was computed by combining the binary cross-entropy, Dice, and the multiscale loss. Moreover, Tversky Loss was incorporated into the training to optimize the final results.

#### **RESULTS**

20% of the patients were used for the independent testing, and the model performance was assessed by five typical metrics, with Dice, Jaccard, Recall, Precision, F1-score of 0.7163, 0.5580, 0.5898, 0.9118, 0.7040. Our method achieved an average improvement of 6.23%, 4.32%, and 4.32% for the Dice, Jaccard, and F1-score compared with UNet. In contrast to UNet++, the three indicators increased by 2.29%, 1.91%, and 1.86%, respectively. When taking into account the addition of the Tversky loss, the Dice and Jaccard still improved by 0.16% and 0.20%, separately.

#### **CONCLUSION**

This study designed a novel segmentation network based on TL and GAN. The results demonstrated that it can significantly enhance the accuracy under small-scale sample. Future work will focus on the generalization of the model in multi-center and medium-sized samples, so as to further expand the application scope.

#### **CLINICAL RELEVANCE/APPLICATION**

The work provides a relatively reliable auto-segmentation tool for radiologists in the case of small samples. Besides, it also extends the application value of T2WI images in intelligent diagnosis on CRLM, compared to the auto-segmentation of routine image modalities such as CT or DWI.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-7

### Two-stage Few-shot Segmentation Framework on Lung Nodule CT Images

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Mengxiao Geng (*Presenter*) Nothing to Disclose

#### PURPOSE

Although deep learning has demonstrated remarkable results for lung nodules, it is limited by the need for extensive manual labeling and high computational costs. Similarly, traditional active contour-based methods require manual adjustment and can be sensitive to the selection of initial contours. As such, there is a need for novel segmentation frameworks that address these challenges.

#### METHODS AND MATERIALS

Our proposed few-shot segmentation framework (FSSF) combines deep learning with an optimized active contour model to segment lung nodules. First, deep learning is used to obtain prior position information based on a small amount of data. This prior information is then input as the initial contour into the optimized active contour model (OACM), which significantly enhances the segmentation accuracy of the deep network for lung nodules in small sample situations. Specifically, the active contour model includes heat kernel convolution to reduce computational complexity, while adaptive weighted functions and high-order total variation maintain segmentation accuracy. To solve the model efficiently, we used the alternating direction method of multipliers to split it into subproblems. In the experiment, the clinical CT dataset was acquired from Guangdong Provincial People's Hospital using a Siemens CT scanner (SENSATION 16 SLICE). The dataset included 199 subjects (102 males and 97 females, aged  $58.9 \pm 11.89$  years [range of 32-89]) who were collected from January to December 2020. To evaluate the proposed few-shot segmentation method, lung CT images from 10 patients were used for presegmentation model training, with 20 slices selected as test images.

#### RESULTS

Our proposed method was compared against state-of-the-art methods such as U-Net, WBHV, WBHV+, ICTM, and ICTM+ in terms of their segmentation effectiveness. The results demonstrate that our proposed method showed significant improvement compared to other methods, with Dice improving by 6.9%, JS improving by 9.9%, and ? improving by 7.0%. Compared to the state-of-the-art methods, our method still achieves much better performance.

#### CONCLUSION

Compared to other segmentation methods, our proposed method demonstrates superior performance in both visual and quantitative evaluations.

#### CLINICAL RELEVANCE/APPLICATION

CT image segmentation of pulmonary nodules is a useful technique for early detection, quantitative evaluation, and monitoring of lung cancer and other diseases. This technique separates nodules from surrounding tissue and calculates morphological features, providing support for clinical medicine.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-8

### Improving Image Quality in Low-dose Abdominal and Pelvic CT Angiography Using Deep Learning Image Reconstruction: Comparison with Filtered Back-projection and Iterative Reconstruction

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Tingting Qu (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate image quality among the traditional FBP, adaptive statistical iterative reconstruction (ASIR-V) and deep learning image reconstruction (DLIR, TrueFidelity) algorithms in low-dose abdominal and pelvic CT angiography (CTA).

#### METHODS AND MATERIALS

Forty-six abdominal and pelvic CTA patients were included. All patients underwent low-dose CTA with 80kVp and smart tube current modulation (100-720mA). Images were reconstructed using FBP, ASIR-V with strength of 50% (AV-50) and 100% (AV-100), TrueFidelity with medium (TF-M) and high (TF-H) strength. The CT value and standard deviation (SD) value of abdominal aorta, psoas major muscle and subcutaneous fat were measured, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. The CT value skewness in psoas major muscle with uniform density was also measured to reflect the image texture change. A 5-point scoring method was used to evaluate the granularity, fuzziness and beam hardening artifacts of all images. The above indexes of the five image groups were compared.

#### RESULTS

The volume CT dose index was low at  $1.09 \pm 0.37$  mGy. CT values were all similar among the five groups ( $P > 0.05$ ). But, SD values were different among groups with FBP being the largest and AV-100 the smallest which resulted in different SNR and CNR values opposite of the SD values. AV-100 and TF-H also had the best score in granularity while FBP had the worst. However, AV-100 had significantly higher skewness and fuzziness than other four groups ( $P < 0.001$ ), with FBP and DL-M had the smallest and TF-H marginally higher. The TF-H group had the best beam hardening artifact score while FBP and AV-50 group had the worst ( $P < 0.001$ ).

#### CONCLUSION

Compared with FBP and ASIR-V, TrueFidelity reconstruction algorithm better balances image noise, smoothness, image texture, and artifacts in low-dose abdominal and pelvic CTA, with TF-H provides the best overall image quality.

#### CLINICAL RELEVANCE/APPLICATION

TrueFidelity with high (TF-H) strength reconstruction algorithm provides the best image quality in low-dose abdominal and pelvic CTA.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH-9

### Metal Artifact Reduction for Head and Neck CBCT with Attentional Dual Encoder Fusion UNet

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Jungmok Lee (*Presenter*) Nothing to Disclose

#### PURPOSE

Since the insertion of metallic implants in surgical method has been grown, there also have been severe metal artifact in CT and CBCT. So the metal artifact reduction methods became on the rise. In addition, the application of convolutional neural network based structure in metal artifact reduction has shown a great performance, still it lacks of extracting features which both efficiently removes artifact and restores the tissue structure. In this study, we propose the dual encoder fusion UNet structure for effective cone-beam CT metal artifact reduction, which can extract both the artifact removal feature and tissue structure feature through dual encoder network.

#### METHODS AND MATERIALS

Our model architecture is based on UNet architecture with two encoders. The first encoder mostly focuses on removing metal artifact rather than restoring the tissue structure, and the second encoder focuses on restoring the tissue structure instead of removing metal artifacts. Two bottleneck features are fused through attentional fusion, which consist of spatial and global attention. Similar to bottleneck feature fusion, the encoder features for skip connection is fused using attentional fusion. Our model was trained in generated synthetic dataset for 100 epochs with mean squared error and auxiliary loss. Auxiliary loss was calculated by direct mean squared error between the encoder feature and target. And our model was evaluated on mean squared error(MSE), peak signal-to-ratio(PSNR), pearson correlation coefficient(PCC), and structural similarity(SSIM). The quantitative analysis has also done in real patients.

#### RESULTS

Compared to single encoder architectures with similar parameter numbers, our model has shown the noticeable performance in both synthetic data real patients without ground truth. The evaluation metric(MSE, PSNR, PCC, SSIM) in synthetic data is 0.000086, 41.859071, 0.993072, 0.993681. Our model has removed the metal artifact effectively, and shown the best structure restoration in real patients while other models has made the greyish artifacts for the restoration.

#### CONCLUSION

In this study, we proposed the dual encoder UNet architecture for effective metal artifact reduction, and it has shown that model can focus on both effective artifacts reduction and tissue structure restoration. We also showed that attention-fused features helps in performance of artifact removal and tissue restoration.

#### CLINICAL RELEVANCE/APPLICATION

We expect that our proposed model can be successfully applied to the metal artifact reduction especially in CBCT for radiation treatment, since there is no artifact reduction software for CBCT at this moment.

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## Abstract Archives of the RSNA, 2023

T5A-SPRO-1

### The Application Value of Energy Spectrum CT Iodine-water Scatter Plot in Predicting Surgical Margins of Pancreaticoduodenectomy

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Ruibo Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To predict the surgical margins of pancreaticoduodenectomy by analyzing the energy spectrum CT iodine-water scatter plot of patients with duodenal malignant tumors and adjacent normal tissues, and to guide the optimal selection of clinical surgical targets.

#### METHODS AND MATERIALS

28 patients with duodenal malignant tumor were selected as research objects, and the patients were retrospectively collected with surgical pathological confirmation and complete energy spectrum CT scan data before surgery, and multi-point delineation and analysis of iodine-water scatter plots were performed in the solid part of duodenal malignant tumor and the area of interest of surgical margin. Statistical analysis of iodine-water scatter plot and postoperative pathology diagnosis rate.

#### RESULTS

There was a clear demarcation between the solid part of the lesion and the iodine-water scatter plot of the surgical margin, and the diagnosis rate with the postoperative pathology was 100%, with a statistically significant difference ( $p < 0.05$ ).

#### CONCLUSION

The negative/positive surgical margins of pancreaticoduodenectomy can be distinguished by using energy spectrum CT iodine-water scatter plot to maximize the preservation of normal tissues around the margins.

#### CLINICAL RELEVANCE/APPLICATION

The application value of energy spectrum CT iodine-water scatter plot in predicting surgical margins of pancreaticoduodenectomy

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## Abstract Archives of the RSNA, 2023

T5A-SPVA-1

### Magnetic resonance Lymphangiography - An Initial Clinical Experience

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Robert M. Siepmann, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Lymphedema is defined by chronic accumulation of fluid in soft tissue. Due to an increasing number of lymphonectomies associated with breast or pelvic surgery in the past years, secondary lymphedema has become more prevalent. Many patients fail conservative treatment and need surgery, e.g. lymphaticovenous anastomosis (LVA). For surgical treatment planning, visualization of lymphatic vessels is crucial. Established lymphography procedures like lymphoscintigraphy and indocyanine lymphography suffer from poor spatial resolution or in case of conventional lymphangiography require surgical isolation. Magnetic resonance lymphangiography (MRL) is an emerging imaging technique, allowing non-invasive visualization of lymphatic vessels. We report on our initial experience with MRL in patients with suspected lymphedema including patients after microsurgical therapy.

#### METHODS AND MATERIALS

11 consecutive patients (11 female; mean age 46 years) undergoing MRL between 05-2022 and 04-2023 were included. In 10/11 (91%) patients with suspected lymphedema final work-up confirmed the diagnosis. 9/10 had secondary lymphedema (7 after lymphonectomy, 1 after liposuction; 1 postpartum) and 1/10 patients had idiopathic lymphedema. The remaining patient suffered from chronic venous obstruction. 10/11 (91%) showed edema in the lower extremities, 1/11 (9%) in the upper extremities. 3 patients underwent LVA-surgery prior to MRL resulting in a total of 10 anastomoses. MRL was performed on a 1.5 T system. For evaluation of the extent of edema a T2w TSE DIXON was obtained. To visualize the lymphatic system a T1w GRE with fatsat was obtained after interstitial transpedal injection of a gadolinium-based contrast agent (Gadobutrol). Analysis included location and extent of edema, technical success rate and qualitative assessment of the MRL images.

#### RESULTS

In all patients MRL was technically successful without complications and allowed direct visualization of the lymphatic vessels. 8/10 LVAs were identified on MRL. In one patient, lymphatic inflow to iatrogenic lymphoceles after liposuction was directly visualized by MRL. Based on MRL 9/10 patients were correctly diagnosed with lymphedema. MRL correctly identified the one patient with chronic venous obstruction. MRL led to either performed or scheduled LVA surgery in 6/10 cases. Three patients continued to be treated conservatively.

#### CONCLUSION

MRL appears to be a safe and precise for diagnosis of lymphedema and allows reliable visualization of the lymphatic vessels including LVAs.

#### CLINICAL RELEVANCE/APPLICATION

MRL seems to be a promising addition to established lymphography procedures, particularly for treatment planning in patients scheduled for LVA or for postoperative follow-up after LVA.

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## Abstract Archives of the RSNA, 2023

T5A-SPVA-3

### Single-phase Steady-state Ferumoxytol-enhanced MR Angiography of Neck, Chest, Abdomen, and Pelvis: A Feasibility Study

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Soheil Kooraki, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Comprehensive vascular imaging is often required as part of the pre-multi visceral transplant workup. This study aimed to assess the feasibility of single-phase steady-state Ferumoxytol-enhanced (Fe-MRA) for vascular mapping of neck, chest, abdomen and pelvic arteries and veins.

#### METHODS AND MATERIALS

In this IRB-approved, HIPAA-compliant, single-center study, eleven patients (5 females, median age of 24 years, ranging from 5-93) underwent a single-phase Fe-MRA of neck, chest, abdomen, and pelvis as part of the pre-multi visceral transplant assessment. The Fe-MRA was achieved by slow intravenous infusion of 4 mg/kg ferumoxytol and using a 1.5 or 3 Tesla MR scanner. The time from localizer image acquisition to completion of the angiographic acquisition was measured. Two radiologists independently scored images for overall quality, motion artifact, diagnostic confidence for assessment of arterial and venous segments, using a 5-point Likert scale (5: excellent, 4: good, 3: diagnostic, 2: limited, 1: non-diagnostic). Inter-observer agreement was assessed using Intraclass Correlation Coefficient.

#### RESULTS

The scans were technically successful, with an average scan time of 11 minutes (ranged 5-25 minutes) and without any major adverse effects. The overall image quality was excellent in 7, good in 3 and diagnostic in one patient(s), and there were no non-evaluable vascular segments in any of the scans. A total of 545 named vascular segments were scored, of which the image quality for diagnostic confidence was good to excellent in 91.7% (500/545). There were not any motion artifacts to impede the diagnostic assessment (all scores = 3). There was excellent inter-reader agreement for scoring diagnostic confidence in each vascular segment (all  $\kappa > 0.9$ ).

#### CONCLUSION

This study demonstrated the feasibility, high image quality and diagnostic confidence of Fe-MRA for comprehensive vascular mapping in pre-multi visceral transplant workup. The scan can be completed in as little as 5 minutes.

#### CLINICAL RELEVANCE/APPLICATION

Non-nephrotoxic Fe-MRA is a quick and feasible method for comprehensive vascular mapping in patients who are undergoing multi-visceral transplant, with the advantage of obtaining both arteriogram and venogram in a single-phase image.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPBR-1

### Artificial Intelligence DWI without Segmentation Has Comparable Diagnostic Performance with Standard Breast MRI in the Differentiation of Malignant and Benign Breast Tumors

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Mami Iima, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our aim was to develop a machine-learning model that can differentiate benign and malignant breast tumors using diffusion-weighted MRI.

#### METHODS AND MATERIALS

This prospective study included 530 breast lesions. 334 breast lesions with confirmed histology or no enlargement on follow-up were analyzed. The data was divided into dataset for train and 10-fold cross-validation (139 malignant 67 benign) and test dataset (85 malignant, 43 benign) with no overlap of patients. 3T breast MRI DWI was acquired with 5 b values up to 1500 s/mm<sup>2</sup> in addition to DCE-MRI. Only the lesion slice was selected without lesion segmentation. To develop a deep-learning model that can differentiate between benign and malignant tumors, we compared various combinations of basic data augmentations: A: random elastic deformation, B: random affine transformation/random noise, and C: mix-up. The small 2D CNN model was also compared to 3D CNN and ResNet18. The diagnostic performance of the deep learning model obtained from DW images and standard breast DCE MRI based on BI-RADS was evaluated using ROC analysis.

#### RESULTS

The augmentations improved accuracy in all experiments (AUC:0.86-0.90 VS. 0.86 in validation dataset, and AUC:0.85-0.88 VS. 0.87 in test dataset) except augmentation C (AUC:0.86 and 0.83). The result using 2D CNN resulted in a better AUC than 3D CNN (AUC:0.88-0.90 VS. 0.72-0.75). All results of 10-fold cross validations showed small 2D CNN with data augmentation A and B to be the best model (AUC: 0.90), and it was also the best against test dataset (AUC:0.88) that was comparable to standard breast MRI (0.89 and 0.87). Specificity tended to be higher in the deep learning model with 2D CNN from DW images than in standard breast MRI (85% VS. 81% in validation dataset, and 81% VS. 74% in test dataset), with higher sensitivity in standard breast MRI (80% VS. 98% in validation dataset, and 86% VS. 99% in test dataset).

#### CONCLUSION

While some studies evaluated the diagnostic performance of breast MRI using deep learning, so far as we know, no study has yet evaluated using only breast DWI with a deep learning model. AI can achieve good performance comparable to standard breast MRI for differentiating between malignant and benign breast tumors. DWI-AI provided better specificity than standard breast DCE-MRI, while the sensitivity was slightly inferior. Those results underline the great potential of supplementing the diagnostic performance of standard breast MRI with variable specificity, without additional reading time by breast radiologists, and beneficial in patients who are allergic to contrast agents.

#### CLINICAL RELEVANCE/APPLICATION

A machine-learning model with diffusion-weighted MRI has the potential to improve specificity in distinguishing between benign and malignant breast tumors.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPBR-3

### Breast Lesion Morphology Assessment with High and Standard b Values in Diffusion-weighted Breast MRI at 3.0 Tesla

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Sara A. Christner, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This investigation compared diffusion weighted imaging (DWI) with b values of 800 and 1600 s/mm<sup>2</sup> to dynamic contrast-enhanced imaging (DCE) for lesion morphology assessment in high-resolution breast MRI at 3.0 Tesla - an area that has been occupied traditionally by DCE.

#### METHODS AND MATERIALS

Multiparametric breast MRI was performed in 91 patients with 93 histopathologically proven lesions (31 benign, 62 malignant). Two radiologists evaluated three datasets per patient independently and assessed lesion visibility and BIRADS morphology criteria. Bland-Altman analyses were conducted for lesion size comparisons. In addition, diagnostic accuracy was calculated for each reader and dataset.

#### RESULTS

The visibility of carcinomas was considered better compared to benign findings in both DWIb800 and DWIb1600 ( $p < 0.001$ ) with no b value-dependent difference. Similarly, mass lesions were easier assessable compared to non-mass lesions, irrespective of the DWI images' b value ( $p < 0.001$ ). Intra-reader reliability for the analysis of morphologic BIRADS criteria among DCE and DWI datasets was at least moderate ( $\kappa = 0.557$ ), while at least substantial inter-reader agreement was ascertained over all assessed categories ( $\kappa = 0.776$ ). In pairwise Bland-Altman analyses, the measurement bias between DCE and DWIb800 was 0.7 mm, whereas the difference between DCE and DWIb1600 was 2.8 mm. DWIb1600 images allowed for higher specificity than DCE ( $p = 0.007/0.062$ ).

#### CONCLUSION

DWI can be employed for reliable morphologic lesion characterization in high-resolution breast MRI. The use of high b values increases diagnostic specificity, while lesion size assessment is more precise with standard 800 s/mm<sup>2</sup> images.

#### CLINICAL RELEVANCE/APPLICATION

Given ongoing concerns regarding the safety of Gd-based contrast media and continuing efforts on abbreviated breast MRI protocols, morphology assessment using DWI shows promising results in the differentiation of malignant from benign breast lesions.

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## Abstract Archives of the RSNA, 2023

T5B-SPBR-4

### Association of Preoperative MRI with Breast Cancer Treatment and Survival: A Single Institution Observational Study

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the association between preoperative breast MRI with surgery type, contralateral cancer, recurrence-free (RFS) and overall survival (OS) in women with early stage breast cancer.

#### METHODS AND MATERIALS

In this single institution, retrospective study, we identified women with Stage I-III breast cancer diagnosed between 03/01/2014-03/31/2021 with available follow-up. Patient and tumor characteristics were recorded. Two cohorts were created based on the use of preoperative MRI (PMRI) versus not (NoMRI) with Wilcoxon signed-rank and  $\chi^2$  tests utilized for cross-group comparisons. Kaplan-Meier method and log-rank tests were used to compare RFS and OS in women with and without MRI. Multivariable Cox proportional hazards model analysis was performed to evaluate RFS and OS by preoperative MRI status while controlling for other variables that could adversely impact outcomes.

#### RESULTS

593 eligible patients were included [322 (54.3%) with PMRI, 271 (45.7%) noMRI]. Mean patient age was younger ( $53.8 \pm 11.8$  vs  $59.3 \pm 12.6$  years,  $p < 0.001$ ) and dense breasts more common (51.4% vs 22.0%,  $p < 0.001$ ) in PMRI group. Seventeen bilateral cancers (2.9%) were in PMRI (14/17, 82.4% only detected on MRI) vs 10 (1.7%) in no-MRI ( $p = 0.34$ ). No significant difference between clinical Tstage rates (cT0-2 88.8% ; 91.9% ,  $p = 0.22$ ) or invasive molecular subtype (luminal A, 22.7% vs 28.5%; luminal B, 56.3% vs 46.6%; HER2, 5.4% vs 4.1%; triple negative, 15.5% vs 20.7%,  $p = 0.13$ ) in MRI vs no-MRI groups, respectively. PMRI group had higher rates of cN+ (27.3% vs 18.1%,  $p < 0.01$ ), and neoadjuvant therapy (41.3% vs 18.8%,  $p < 0.001$ ). Total mastectomy (57.8% vs 51.3% ,  $p = 0.12$ ), margin positivity (6.2% vs 7.4%,  $p = 0.57$ ), recurrence (10.2% vs 7.0%,  $p = 0.17$ ) and death rates (8.1% vs 7.7%,  $p = 0.88$ ) were similar in PMRI vs noMRI, respectively. At median follow-up of 69 months (IQR, 61-75), time to recurrence was [24 (IQR, 18-48) vs 23 (IQR, 9-30) months,  $p = 0.05$ ]. Mastectomy rates remained comparable after adjusting for age and breast density ( $p = 0.28$ ). Contralateral cancers were identified sooner and more frequently in the no-MRI group [4 (2.1%) vs 2 (0.9%) cancers,  $21 \pm 20$  vs  $48 \pm 13$  months].

#### CONCLUSION

In this single-institution retrospective study, the use of preoperative MRI is not associated with improved surgical margin, RFS or OS. At surveillance contralateral cancers are identified earlier and more frequently in the noMRI group.

#### CLINICAL RELEVANCE/APPLICATION

Detecting clinically and mammographically occult contralateral breast cancers on preoperative MRI may help decrease contralateral cancer events at early surveillance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPBR-7

### Do Breast Oedema and Shrinkage Pattern during NAC Provide Additional Value for Predicting Treatment Response in Locally Advanced Luminal Breast Cancer?

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Shiyun Sun (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the predictive value of oedema and shrinkage patterns for the neoadjuvant chemotherapy (NAC) response in luminal breast cancer and whether they have added value when combined with traditional MRI features such as tumour size and apparent diffusion coefficient.

#### METHODS AND MATERIALS

Patients with luminal breast cancer were consecutively enrolled in this retrospective study to assess the relationship between MRI features and treatment response (including pCR and Miller-Payne [M-P] grade). Patients were classified into the development cohort and validation cohort. The traditional MRI features, breast oedema and shrinkage pattern were assessed before and early NAC (within 2 cycles of NAC). Oedema was divided into four categories (grade 1: no oedema, grade 2: peritumoral oedema, grade 3: prepectoral or subcutaneous oedema, grade 4: diffuse oedema), and regression was refined into two categories (concentric shrinkage and eccentric shrinkage). Univariate and multivariable analyses were used to identify independent imaging markers for pCR and MP grade. Prediction models were developed and evaluated for discrimination, calibration, and clinical applicability.

#### RESULTS

In total, 267 eligible patients were consecutively enrolled and divided into the development cohort (n=187) and validation cohort (n=81). Early diffuse oedema was a shared unfavourable biomarker in the prediction of both M-P grade and pCR (OR = 0.36 and 0.27). Peritumoral oedemas before and early NAC were another predictors of non-pCR (OR = 0.69 and 0.23), while unchanged or increased oedema grade during NAC (OR = 0.25 and 0.20) were another predictors of ineffective treatment, respectively. The addition of oedema improved the predictive value of tumour size for M-P grade (AUC from 0.64 to 0.71) and pCR (AUC from 0.67 to 0.74). The shrinkage pattern showed potential predictive value for M-P grade (P = 0.049) and pCR (P = 0.041) in the univariate analysis but was not an independent indicator. Prediction models showed comparable performance for predicting M-P grade and pCR in both the development (AUC = 0.82 and 0.81) and validation cohorts (AUC = 0.79 and 0.78).

#### CONCLUSION

Breast oedema is a valuable predictor of treatment response in luminal breast cancer in that it improves the performance of tumour size. The predictive value of the shrinkage pattern remains to be further studied.

#### CLINICAL RELEVANCE/APPLICATION

The goal of this work is to develop an MRI-based model for a more accurate prediction of response to NAC in patients with luminal breast cancer. The model utilizes conventional MRI features instead of radiomics and novelty is introduced to the model by describing four types of edema that have long been shown to be predictive and prognostic that are readily available in clinics.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPBR-8

### Diagnosis of Breast Lesions on MRI using BI-RADS and Kaiser Scores in Mass and Non-Mass Enhancement: Benefit of KS and KS+ for Readers with Different Experience Levels

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jiejie Zhou, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Kaiser score (KS) is a machine learning-derived clinical decision rule based on MRI BI-RADS descriptors, which provides the structure of an intuitive flowchart to guide the reader through a stepwise lesion assessment. The main considered features are root sign, DCE pattern, internal enhancement, and peritumoral edema. This study is aiming to: (1) compare the diagnostic performance of three readers with different experiences for breast cancer using BI-RADS and KS systems; (2) evaluate the benefit of the modified KS+ when diffusion was considered; and (3) separately assess the diagnostic performance in mass and NME lesions.

#### METHODS AND MATERIALS

A total of 630 patients including 393 malignant and 237 benign pathological confirmed lesions were analyzed. Based on the morphology, the cases were separated into 458 masses and 172 NMEs. Three radiologists with different levels of experience in breast MRI (3, 6, and 13 years) reviewed the cases to make a diagnosis using BI-RADS descriptors and KS. Of the 630 cases, 596 cases (434 mass and 162 NME) had DWI, and the apparent diffusion coefficient (ADC) was measured to modify KS to KS+. For lesions with  $ADC = 1.4 \times 10^{-3} \text{ mm}^2/\text{s}$ , the KS was reduced by 4. The diagnostic AUC of KS and KS+ made by three readers in mass and NME were compared to evaluate the benefit of KS+.

#### RESULTS

The diagnostic performance increased with years of experience among three readers. When using BI-RADS, AUC was 0.878, 0.915, and 0.941 for mass, and 0.771, 0.838, 0.902 for NME for Reader-1, 2, and 3, respectively (Table 1). When using KS compared to BI-RADS, the AUC was improved for the less experienced Readers. For Reader-1, AUC was increased from 0.878 to 0.916 for mass ( $p=0.005$ ), and from 0.771 to 0.822 for NME ( $p=0.124$ ). For Reader-2, AUC was about the same for mass (0.915 to 0.921) and increased from 0.838 to 0.883 for NME ( $p=0.114$ ). For the most experienced Reader-3, the results made by BI-RADS and KS were about the same. When ADC was considered to change to KS+, the AUC was significantly improved for all three readers for the mass lesions, but AUC was about the same for NME.

#### CONCLUSION

The benefit of KS was more remarkable for mass than for NME, especially for the less experienced reader. The root sign and internal enhancement were not well defined for NME, and since many NMEs would show the plateau DCE pattern, this feature was not helpful either. When considering ADC to modify KS to KS+, again, the benefit was mostly seen for mass, possibly due to the use of the cut-off threshold of  $1.4 \times 10^{-3} \text{ mm}^2/\text{s}$  developed from mass lesions.

#### CLINICAL RELEVANCE/APPLICATION

Kaiser Score provides an intuitive method for lesion interpretation, which is mostly helpful for mass lesions read by less experienced readers. KS+ is mainly applicable to mass lesions. For NME, the KS criteria need to be improved.

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## Abstract Archives of the RSNA, 2023

T5B-SPBR-9

### A Pilot Study on the Correlation between the Parameters of Oscillating Gradient Spin Echo based Diffusion Weighted MRI and Pathological Lymphatic Vessel Invasion in Breast Cancer

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Lanqing Yang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the value of oscillating gradient spin echo (OGSE) based diffusion weighted MRI in predicting the lymphatic vessel invasion (LVI) status in patients with breast cancer.

#### METHODS AND MATERIALS

22 biopsy proved breast cancer patients were prospectively enrolled in this study. They all received preoperative clinical routine breast MRI, including T2 weighted imaging (T2WI), T1 weighted imaging (T1WI), diffusion weighted imaging (DWI), and contrast dynamic enhancement (DCE); and OGSE DWI sequences, including pulsed gradient spin echo (PGSE), OGSE(N=1), and OGSE (N=2). Patients were grouped into LVI negative (n=16) and positive (n=6) groups, with reference to pathological reports of surgical specimens. ROIs delineation was independently performed by two radiologists on three largest slices of tumor on b=1000 s/mm<sup>2</sup> images. Then, four quantitative parameters of Vin (intracellular volume fraction), Dex (mean extracellular diffusivity), D (mean cell size) and cellularity were derived from MATLAB software. Interobserver agreement assessment, independent t test, Mann-Whitney U test, ROC analysis, and spearman correlation analysis were used for statistical analyses.

#### RESULTS

The overall interobserver agreement was excellent for two radiologists of Dex value (intraclass correlation coefficient, ICC=0.865). Patients with LVI positive status had significantly lower Dex value compared with LVI negative group (1.686±0.170 vs. 2.107±0.183×10<sup>-3</sup>mm<sup>2</sup>/s, P=0.007). ROC results showed that Dex presented a high AUCs of 0.958 in predicting LVI status. In addition, there was also significant strong negative correlation between LVI status and the value of Dex, with a spearman rank correlation coefficient of 0.710 (P=0.014). Other parameters including Vin, D, and cellularity showed no significant difference between two groups.

#### CONCLUSION

Dex (mean extracellular diffusivity) value calculated from OGSE DWI sequences could help to predict the LVI status of breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

lymphatic vessel invasion (LVI) is a high-risk factor for blood metastasis of breast cancer, which suggests that breast cancer patients have a higher risk of recurrence and metastasis, and a poor prognosis. Preoperative evaluation of LVI status with MRI could help risk stratification, thus may guide the clinical management of patients with breast cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCA-1

### Vascular Enhancement and Radiation Dose on 256-slice CT Angiography with Reduced Iodinated Contrast Volume for Pre-operative TAVI: Comparison of 64-slice CT Angiography with Standard Iodinated Contrast Volume

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Takayuki Yoshiura, BA, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Multi-slice CT is now the standard noninvasive imaging method for preoperative evaluation of transcatheter aortic valve implantation (TAVI). The purpose of this study is to evaluate the vascular attenuation and radiation dose on 256-slice CT with reduced iodinated contrast volume for pre-operative TAVI as compared to 64-slice CT with standard iodinated contrast volume.

#### METHODS AND MATERIALS

The study included 52 patients who underwent pre-TAVI CT scan with the 64-slice CT (Lightspeed VCT; GE Healthcare, Milwaukee, Wisconsin) and 47 patients who underwent pre-TAVI CT scan with the 256-slice CT (Revolution Apex; GE Healthcare, Milwaukee, Wisconsin). A contrast dose was injected at 450 mgI/kg over 22 seconds on 64-slice CT and 300 mgI/kg over 20 seconds on 256-slice CT, respectively. Measurements were performed on the CT enhancement of the ascending aorta (AAO), abdominal aorta (Abd AO), both subclavian arteries (SCA), and both femoral arteries (FA) as well as for the image noise of muscle tissue; then the contrast-to-noise ratio (CNR) and signal-to-noise ratio (SNR) were calculated. The volume CT dose index (CTDIvol) and dose length product (DLP) were recorded for both CT scans.

#### RESULTS

Despite the reduced iodinated contrast volume on 256-slice CT, the vascular enhancement of both SCA were significantly higher than those for 64-slice CT ( $p < 0.01$ ), with no significant differences in the other access routes in both CT scans. The CNR for AAO, Abd AO and both SCA was significantly higher the 256-slice CT, with no significant differences in the other access routes ( $p > 0.01$ ). The SNR was significantly higher the 256-slice CT for Abd AO and both SCA, with no other significant differences. The radiation dose for 64-slice and 256-slice CT scans were 82.4 mGy and 68.3 mGy for CTDIvol, and 2342.9 mGy-cm and 2066.7 mGy-cm for DLP, respectively. The radiation dose with 256-slice CT was obtained lower values.

#### CONCLUSION

The 256-slice CT with reduce iodinated contrast volume for pre-operative TAVI resulted in reduction of radiation dose and maintained or improved the vascular enhancement of the aortic annulus and access route vessels, compared to 64-slice CT, despite using approximately 52% less iodinated contrast volume.

#### CLINICAL RELEVANCE/APPLICATION

256-slice CT with reduced iodinated contrast volume for pre-operative TAVI maintains image quality and reduced radiation dose.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCA-2

### Estimation of High Coronary Artery Calcium (CAC) Score from Aortic Arch Calcification: An Efficient Tool for Selection of Non-optimal Candidates for Coronary CTA?

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Pietro Giacomo Lacaita, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Overutilization of healthcare resources is causing a high economic burden. Patients with high-CAC scores >1000 AU are not optimal candidates for coronary CTA and can be more efficiently examined with other modalities (myocardial perfusion testing or a direct-to-ICA strategy). Therefore the objective of our study was to evaluate whether a 4-scale aortic arch calcification severity score predicts high-CAC scores (>1000AU and >800AU).

#### METHODS AND MATERIALS

162 patients referred to coronary/aortic CT Angiography and non-enhanced CAC score were enrolled (age 76.3 years, 45% females). Patients with prior PTCI/STENT and CABG were excluded. The severity of aortic arch calcification was scored on a 4-point scale as 0=absent, 1=minimal (<25% of circumference) 2=mild (25-50%), 3=moderate (50-75%) and 4=severe (100% of circumference) on thoracic CT (coronal MPR reformations).

#### RESULTS

In 130 patients, the absence of aortic arch calcification was highly accurate to rule out CAC>1000AU (sens. 100%). No or minimal (grade 1) calcification had a high NPV of 95.6% , and no, minimal and mild (grade 1+2) a NPV of 86.96% to rule out CAC>1000AU. There was a moderate correlation between grading of aortic arch calcification severity and CAC ( $r=0.663$ ,  $p<0.001$ ) by CT. In patients with severe aortic arch calcium (grade 4), the prevalence of CAC >1000 was with 32/45 (71.1%) significantly higher as compared to other groups with 13/45 (28.8%)( $p<0.001$ ). The AUC for the 4-scale aortic arch calcium severity score to predict CAC >1000 was  $c=0.84$  ( $p<0.001$ ; 95%CI:0.771-0.91) and similar for prediction of CAC>800 AU with  $c=0.813$  ( $p<0.001$ ;95% CI:0.686-0.865). AUC for prediction of CAC >1000 was slightly lower with  $c=0.792$  for moderate-to-severe (grade 3+4) and  $c=0.775$  for severe (grade 4) aortic arch calcification ( $p<0.001$  for both).

#### CONCLUSION

Patients with moderate-to-severe aortic arch calcium have a high probability of CAC >1000 AU, but not those with no, minimal and mild calcifications. The absence of aortic arch calcium rules out CAC>1000 AU.

#### CLINICAL RELEVANCE/APPLICATION

Estimation of aortic arch calcium severity is a valuable tool for a quick decision-making on the optimal non-invasive testing strategy (coronary CTA vs myocardial perfusion testing or a direct-to-ICA approach) for coronary artery disease in clinical routine.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCA-3

### Using 7.0T Cardiac MR to Explore Cangai Volatile Oil Treat Different Degrees of Myocardial Hypertrophy in Rats Exposed to Chronic Hypobaric Hypoxia at Plateau

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Boshen Liang (*Presenter*) Nothing to Disclose

#### PURPOSE

This study was intended to investigate whether cardiovascular magnetic resonance (CMR) imaging could reveal the protective effect of Cangai volatile oil (CAVO) on the heart of rats with chronic hypobaric hypoxia at plateau. On this basis, further explore the therapeutic effect of CAVO on isoproterenol induced myocardial hypertrophy in rats.

#### METHODS AND MATERIALS

Seventy rats were randomized into the Control group (CON), plateau group (P group), P+ CAVOh (plateau + CAVOh), P+ CAVOI(plateau + CAVOI), P+MH (plateau+ myocardial hypertrophy,PM), P+MH+CAVOh(PM+ CAVOh), P+MH+CAVOI (PM+CAVOI). Except the Control group (altitude: 500 m), rats in other groups were transported to Yushu (altitude: 4,250m) for two months, where the group of PM,PM+CAVOh,PM+CAVOI were underwent intraperitoneal injection of ISO (3 mg/kg for 14 days) and P, P+CAVOh,P+CAVOI group were underwent intraperitoneal injection of saline in the same time. Left ventricular function, global strain of the rats can be measured by 7.0T high-field CMR and analyzed using the cine tissue tracking. Biochemical tests, histopathology and electronic microscopy were used to evaluate the protective effect of CAVO on the heart tissue of cardiac damage rats exposed to a high-altitude environment.

#### RESULTS

The left ventricular ejection fraction (LVEF) and global strains were improved in all group after treat by CAVO compared with the Hypobaric Hypoxia group ( $p < 0.05$ ). Furthermore, the oxidative stress injuries were after CAVO treatment, evidenced by the increases of SOD, GSH-Px, while the decreases of MDA and LDH contents (all  $p < 0.05$ ). The results of western blot indicated that CAVO treatment dramatically restrained Keap-1, COL-1,  $\alpha$ -SMA protein expressions in cardiac tissues of mice, NRF2, HO-1 protein expression increased.

#### CONCLUSION

CAVO can reduce cardiac damage caused by hypobaric hypoxia and ventricular hypertrophy induced by Isoprenaline (ISO) at plateau through oxidative stress-related indicators, this effect can be measured by 7.0T high-field CMR.

#### CLINICAL RELEVANCE/APPLICATION

This experiment provides a new treatment approach for different degrees of ventricular hypertrophy in plateau for clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCA-4

### Feasibility Analysis of Non-ECG-triggered Chest LDCT using a kV-independent Reconstruction Algorithm for Predicting Cardiovascular Disease Risk in Patients Receiving Maintenance Hemodialysis

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Ao Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to explore the feasibility and accuracy of non-electrocardiogram (ECG)-triggered chest low-dose computed tomography (LDCT) with a kV-independent reconstruction algorithm in assessing the degree of coronary artery calcification (CAC) and the risk of cardiovascular diseases in patients receiving maintenance hemodialysis (MHD).

#### METHODS AND MATERIALS

181 patients receiving MHD who needed chest CT and coronary artery calcium score (CACS) scans underwent non-ECG-triggered, automated tube voltage selection, high-pitch chest LDCT scan using a kV-independent reconstruction algorithm (research scan) and ECG-triggered standard CACS scan (standard scan) sequentially. The image quality, radiation doses, CACS and cardiac risk classifications of the two scans were compared.

#### RESULTS

Among the 181 patients, 89, 83, and 9 underwent scanning at 100, 110, and 120 kV, respectively. Excluding those scanned at 120 kV, 172 patients were enrolled. The Visual Scores (VSs) of the research scan showed high interobserver agreement (ICC = 0.944; 95% CI: 0.925-0.958). A significant difference was observed between the non-ECG-triggered VS and the standard CACS Agatston score (AS) on cardiac risk classification ( $\chi^2 = 34.333$ ,  $P < 0.001$ ; weighted kappa value = 0.813; 95% CI: 0.756-0.869). The accuracy of cardiac risk classification of non-ECG-triggered VS was 77.91% (134/172), considering the cardiac risk classification of standard CACS AS as the gold standard. Although the ASs obtained from the research scan were lower than those obtained from the standard scan ( $739.90 \pm 1098.38$  vs  $801.56 \pm 1129.60$ ;  $P < 0.001$ ), the agreement and correlation of them were excellent, and ICCs and Pearson's correlation coefficients were both  $>0.96$ . No significant difference was observed in cardiac risk classifications between the two scans ( $\chi^2 = 3.933$ ,  $P = 0.269$ ), and the agreement was excellent (weighted kappa value = 0.936; 95% CI: 0.903-0.970). The accuracy of cardiac risk classification based on non-ECG-triggered AS was 92.44% (159/172). The effective radiation doses (ED) of the standard scan and the research scan were  $1.34 \pm 0.74$  mSv and  $1.04 \pm 0.35$  mSv. With the equivalent image quality, the average ED and CTDIvol of the research scan were reduced by 21.77% and 59.93%, respectively.

#### CONCLUSION

A CT protocol using the non-ECG-triggered, automated tube voltage selection, high-pitch chest LDCT protocol with a kV-independent reconstruction algorithm can accurately demonstrate the degree of CAC, maintain the overall cardiac risk classification and significantly reduce the radiation exposure of patients.

#### CLINICAL RELEVANCE/APPLICATION

This protocol can implement one-stop scanning of the chest and CACS and significantly reduce the radiation dose.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCA-6

### **Novel Technique of Multi-slice Acquisition of Simultaneous Myocardial T2-weighted Imaging (T2WI) and Multi-echo T2 Mapping using Deep Resolve Reconstruction (MS-T2WI/Map)**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yui Tanaka, RT (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Myocardial T2-weighted image (T2WI) and T2 mapping, which are used to assess the edema and inflammation, require the long acquisition time, and mapping is acquired only single slice per single breath hold. Deep Resolve (DR) technique, which is novel reconstruction with denoising and increased sharpness based on deep learning architecture, permit the shortening scan time with maintaining image quality. The aim was to evaluate the feasibility of multi-slice acquisition of simultaneous T2WI and T2 mapping using DR technique (MS-T2WI/Map) for myocardial T2 characterization.

#### **METHODS AND MATERIALS**

We obtained the MS-T2WI/Map and conventional single-slice T2 map and T2WI in 10 volunteers and 14 patients with cardiomyopathy at short-axial slice, and volunteers underwent in repeated three times. MS-T2WI/Map consists of triple-contrast spin-echo (TE=13, 56 and 107 msec) with black-blood and fat suppression, and can acquire simultaneously 3 slices in a single breath-hold. The obtained images were reconstructed using DR method. T2 map was obtained using 3 TE images. Further, images with TE=56 msec yield T2WI. In T2WI, image quality using the 4-point scale and contrast ratio (CR) between myocardium and muscle were evaluated. In T2 map, we measured the T2 values at septal wall and obtained coefficient of variation (CV) in three times. In patients, the detection of focal abnormality in T2WI and T2 value (defined as >2SD of normal) were also evaluated.

#### **RESULTS**

The mean acquisition time of MS-T2WI/Map was 26 sec, which was 75% shorter than the conventional scans. There were no significant differences in image quality of T2WI between both scans. CR in MS-T2WI/Map showed good correlation with that in reference (volunteers: $r=0.68$ , patients: $r=0.86$ ). T2 values obtained from MS-T2WI/Map underestimated compared with conventional T2 map, but there were good correlation and agreement between two methods (volunteers: $r=0.94$ , patients: $r=0.65$ ). Further, CV in MS-T2WI/Map showed comparable reproducibility with conventional map. Abnormal myocardial changes were identified in all participants with MS-T2WI/Map in similar to conventional T2-based imaging.

#### **CONCLUSION**

MS-T2WI/Map with DR is a promising tool for shortening acquisition time with equivalent image quality and T2 measurement to conventional sequences, enabling the multi-slice simultaneous myocardial T2 characterization in single-breath-hold.

#### **CLINICAL RELEVANCE/APPLICATION**

MS-T2WI/Map permits the simultaneous myocardial T2WI and T2 map with equivalent image quality and quantification to conventional methods, enabling multi-slice assessment of focal disease. Our proposed method is useful and practical approach for the reduction of acquisition time and the integrated assessment of both T2WI and T2 map.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCA-7

### Improving In-stent Stenosis Visibility for Prototype Photon Counting Detector CT with High-resolution Plaque Kernel

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yoshinori Funama, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon counting detector CT (PCD-CT) with dedicated high-resolution (HR) plaque kernel is newly introduced for improving in-stent stenosis visibility in coronary CT angiography. PCD-CT with HR-plaque kernel enable improved visualization and accurate assessment of coronary plaques. The present study aimed to investigate the performance of PCD-CT with HR-plaque kernel as compared with conventional energy-integrating detector CT (EID-CT) in terms of lumen size and in-stent stenosis visibility.

#### METHODS AND MATERIALS

A vessel tube with non-calcified plaque in a 3.0-mm stent was scanned by using EID-CT (FUJIFILM Healthcare Corporation, Tokyo, Japan) and prototype PCD-CT (Ultra-High Resolution mode, FUJIFILM Healthcare Corporation) with HR-plaque kernel at 3 stent directions (0, 45, and 90 degrees). The tube voltage and tube current-time product were set at 120 kVp and 300 mAs. A rectangular region of interest was set across both sides of the stent struts with a 50% stenotic portion on multiplanar reformation (MPR) images. The profile curves were obtained from two types of PCD- and EID-CT images. The lumen size was calculated from the distance between the inner strut positions. The 50% stenotic portion was also measured using the profile curve.

#### RESULTS

The lumen sizes for PCD-CT and EID-CT images were 2.13 and 1.80 mm at 0 degree, 2.20 and 1.17 mm at 45 degrees, 2.27 mm and 1.67 mm at 90 degrees. The lumen sizes for PCD were wider than those for EID-CT regardless of the stent directions. The measurements of in-stent stenosis were 67.6% - 72.7% at 0 - 90 degrees in PCD-CT. For EID-CT, the measurements of in-stent stenosis were 90.7% - 90.0% at 0 - 90 degrees. The stenotic portion for PCD-CT images enabled more accurate measurements than that for EID-CT. PCD-CT images and MPR images showed fewer blooming artifacts and better plaque conspicuity and iodine enhancement than EID-CT images.

#### CONCLUSION

PCD-CT images with HR-plaque kernel showed improved lumen size and accurate measurements of in-stent stenotic portion as compared with conventional EID-CT images regardless of the stent directions.

#### CLINICAL RELEVANCE/APPLICATION

The PCD-CT with HR-plaque kernel provide better visibility of the coronary plaque and iodine enhancement and accurate assessment of the stenotic portion on coronary CT angiography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCH-1

### A Study Design for Quantitative Characterization of Pulmonary Gas Exchange in Long COVID Using Hyperpolarized $^{129}\text{Xe}$ MRI

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Aiah Alatoum, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

The use of hyperpolarized Xenon (HP-Xe) was approved by the FDA (Xenoview<sup>TM</sup>) for MRI-based evaluation of lung function in adults and pediatric patients over 12 years. Quantitative characterization of ventilation and gas exchange metrics is critical in ensuring the accuracy and reliability of HP-Xe MRI as a diagnostic tool. This study provides a framework for quantitative validation using dual-energy computed tomography (DECT).

#### METHODS AND MATERIALS

15 participants with a history of COVID-19 (diagnosed 17+/-5 months prior) of varying severity, were recruited. HP-Xe imaging of regional ventilation and gas exchange and contrast-enhanced perfusion imaging was performed on a 3T scanner. Gas exchange HP-Xe using a 1-point Dixon technique was used to estimate Xenon transfer into the pulmonary tissues and plasma (Membrane), as well as the red blood cells (RBC). The ratio of these signals, (RBC: Membrane), was used as the surrogate marker for gas exchange. The participants also underwent ventilation/perfusion (V/Q) imaging on DECT using non-contrast Total Lung Capacity (TLC) to virtual non-contrast Functional Residual Capacity (FRC) warping for V and DECT perfused blood volume (PBV as a surrogate for Q) at FRC. The heterogeneity of gas exchange was characterized using the 2nd moments of the normalized V and PBV distributions vs. V/Q ratio in the log scale (lnSDV and lnSDQ) in a 50-compartment model, similar to classical techniques for VQ matching. These metrics rely on absolute quantification of true ventilation and perfusion and have been adapted to the normalized CT-derived datasets.

#### RESULTS

Our study confirmed, as shown in previous literature, the correlation between RBC: Membrane from HP Xenon MRI and DLCO ( $R_2 = 0.74$ ,  $p=0.0005$ ) in our 15 participants. The baseline data from the 7 participants in the preliminary analysis showed that the RBC: Membrane ratio from HP-Xe MRI was significantly correlated to the CT-derived lnSDQ ( $R_2 = 0.58$ ,  $p=0.047$ ), indicating agreement between modalities in assessing heterogeneity of gas exchange.

#### CONCLUSION

Preliminary data supports quantitative comparisons between hyperpolarized Xe MRI and CT-derived assessments of gas exchange. Cross-sectional analyses using disease severity at diagnosis, longitudinal follow-up, and comprehensive assessment of spatially-matched ventilation and perfusion distributions are in process for direct regional comparisons between modalities.

#### CLINICAL RELEVANCE/APPLICATION

Hyperpolarized Xe imaging provides a non-ionizing alternative to DECT, allowing for regular follow-up in patients with persistent symptoms beyond their initial diagnosis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5B-SPCH-2

### Quantitative Chest of Marijuana Use

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Ozgu Alkali, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recreational and medical marijuana use has increased in recent years, in part due to legalization driven by arguments that marijuana is relatively safe and with numerous health benefits. We aimed to investigate marijuana's effect on the lungs through quantitative analysis as well as image review.

#### METHODS AND MATERIALS

By searching the electronic medical record, we identified patients who were marijuana users who never smoked; current smokers; and non-marijuana never smokers, who underwent chest CT in our healthcare system in 2019. We generated a random sample of 100 marijuana users as well as 100 each age- and sex- matched controls from the current smoker and never smoker groups. Quantitative CT lung density analysis was performed to measure total lung volume (TLV) and percent high attenuation area (HAA, -600 to -250 HU). We defined >3% HAA as abnormal. A thoracic radiologist reviewed chest CTs in a blinded fashion for presence of emphysema.

#### RESULTS

TLV was higher in smokers than marijuana users and non-smokers ( $p < .01$  for both). By visual analysis, 62% of smokers had emphysema versus 4% of marijuana users ( $p < .001$ ). Marijuana users were more likely to have increased HAA (18%) compared to smokers (7%) or non-smokers (9%),  $p = 0.04$ . In a multivariable analysis, larger pulmonary artery (PA) size (OR 1.1 per mm,  $p = 0.01$ ) and marijuana use (OR 3.5 versus smoking,  $p = 0.02$ ) were associated with increased HAA.

#### CONCLUSION

While emphysema and hyperinflation were common in smokers, they were rare in marijuana users. However, marijuana users had more high-attenuation, which also correlated with enlarged pulmonary arteries, suggesting a vasoactive effect of marijuana on the pulmonary arterial system.

#### CLINICAL RELEVANCE/APPLICATION

While it does not appear to cause emphysema, marijuana use does affect the lungs, potentially through the pulmonary arterial system, and may not be as safe as initially assumed.

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## Abstract Archives of the RSNA, 2023

T5B-SPCH-3

### High Spatial Resolution Data Improves Diagnostic Performance of Machine-Learning Radiomics Model: Prediction for Invasive Adenocarcinoma of the Lung

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Masahiro Yanagawa, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

First, to construct two machine-learning radiomics models to predict invasive adenocarcinoma (IVA) using training data from normal-spatial resolution (NR) and high spatial resolution (HR), respectively. Second, in another test cohort, to validate diagnostic performance of two models (model-NR and -HR) while comparing results by two independent radiologists with and without model-HR.

#### METHODS AND MATERIALS

Enrolled were 447 patients with 465 nodules (n=97, non-IVA; and n=368, IVA) who underwent 160-row high-spatial-resolution CT (Aquilion Precision, Canon Medical Systems). All CT images were reconstructed using iterative reconstruction method with NR data (512×512 matrix size, 0.5-mm slice thickness) and HR data (2048×2048 matrix size, 0.25-mm slice thickness), respectively. 465 nodules were divided into the training set (n=61, non-IVA; n=165, IVA) and the test set (n=36, non-IVA; n=203, IVA). Two models were developed by selecting 15 significant factors from 172 radiomics features in the training set, using correlation analysis and variance inflation factor, and establishing a random forest. In the test set, the area under the receiver operator characteristic curves (AUC) were statistically analyzed using DeLong's test to compare between model-NR and -HR. To compare accuracy (acc), sensitivity (sen), and specificity (spc) of two radiologists (R1, R2) with and without model-HR using McNemar test. P values<0.05 were considered significant.

#### RESULTS

In the training set, AUC of the model-HR (0.839) was significantly higher than model-NR (0.723) (p<0.05). In the test set, AUC of the model-HR (0.863) was also significantly higher than model-NR (0.718) (p<0.05). Without the model-HR, acc, sen, and spc of the radiologists were as follows: R1, 77.0%, 79.3%, and 63.9%; and R2, 83.7%, 85.7%, and 72.2%, respectively. With the model-HR, acc, sen, and spc of the radiologists were as follows: R1, 86.6%, 93.1%, and 52.8%; and R2, 83.7%, 86.7%, and 66.7%, respectively. Acc and sen of R1 was significantly higher with than without the model-HR (p<0.0001). Acc and sen of R2 was equal or higher with than without the model-HR, but not significant (p>0.50). Spc of R1 and R2 tended to decrease with AI, but not significant (p>0.21).

#### CONCLUSION

High spatial resolution significantly improved diagnostic performance of IVA by the machine-learning radiomics model. When used by radiologists, the present model tended to increase the accuracy and sensitivity of IVA diagnosis at the expense of specificity.

#### CLINICAL RELEVANCE/APPLICATION

Machine-learning radiomics model trained by high spatial resolution data can greatly enhance diagnostic performance of invasive adenocarcinoma, providing support to radiologist, especially in improving accuracy and sensitivity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCH-4

### Radiological-Histological Correlation on Ultra-High-Resolution CT Using Cadaveric Human Lungs: Nodule and Airway Analysis

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the performance of ultra-high-resolution CT (UHR-CT) to evaluate nodules and airways (bronchioles and bronchi) compared with conventional CT (C-CT) using cadaveric human lungs.

#### METHODS AND MATERIALS

Image data of 20 cadaveric lungs were acquired by C-CT and UHR-CT at radiation dose with a noise level equivalent to the diagnostic reference level image (CTDIvol: 9.1mGy). C-CT images were reconstructed with 512 matrix, 0.5 mm thickness, and hybrid iterative reconstruction (hIR). UHR-CT images were reconstructed with three settings; UHR-512: same as C-CT; UHR-DLR: 1024 matrix, 0.25 mm thickness, and DLR; UHR-2048: 2048 matrix, 0.25 mm thickness, and hIR. Two specimens per lung were obtained and examined using hematoxylin and eosin stains. The CT images were evaluated for nodules and airways on a 5-point scale comparing with histology (1=Not identifiable, 2=Barely identifiable, 3=Identifiable, but difficult to assess detail, 4=Partially consistent with histology, 5=Nearly consistent with histology). For identifiable nodules, error rates were calculated as the absolute difference between diameters on CT and true diameters on histology divided by the true diameters. Objective noise was evaluated by measuring standard deviation. The Wilcoxon signed-rank test with Bonferroni correction was used for statistical analyses.

#### RESULTS

In total, 70 nodules (median 1195  $\mu$ m, range 235 - 8803  $\mu$ m) and 91 airways (median 855  $\mu$ m, range 204 - 3324  $\mu$ m) in 40 specimens were evaluated. In terms of nodules, UHR-2048, UHR-DLR, UHR-512, and C-CT scored significantly higher in that order (C-CT, 2.6 $\pm$ 1.1; UHR-512, 2.9 $\pm$ 1.2; UHR-DLR, 3.4 $\pm$ 1.4; UHR-2048, 3.6 $\pm$ 1.5; all  $p$ <0.002). The error rate on UHR-CTs tended to be lower than that of C-CT, but there was no significant difference (C-CT, 0.17 $\pm$ 0.13; UHR-512, 0.13 $\pm$ 0.16; UHR-DLR, 0.12 $\pm$ 0.13; UHR-2048, 0.12 $\pm$ 0.10; all  $p$ >0.05). In terms of airways, UHR-DLR and UHR-2048 scored significantly higher than C-CT and UHR-512 (C-CT, 1.9 $\pm$ 1.5; UHR-512, 2.1 $\pm$ 1.5; UHR-DLR, 2.9 $\pm$ 1.7; UHR-2048, 2.7 $\pm$ 1.7). UHR-DLR tended to score higher than UHR-2048, but there was no significant difference ( $p$ =0.022>0.0083 [Bonferroni correction]). Objective noise was significantly larger for UHR-2048, UHR-512, UHR-DLR, and C-CT in that order (C-CT, 21 $\pm$ 4HU; UHR-512, 41 $\pm$ 5HU; UHR-DLR, 33 $\pm$ 6HU; UHR-2048, 50 $\pm$ 4HU; all  $p$ <0.001).

#### CONCLUSION

UHR-CT images with high resolution reconstruction setting outperformed C-CT in the assessment of nodules and airways. Hybrid IR with 2048 matrix showed a better score than DLR with 1024 matrix for nodule assessment.

#### CLINICAL RELEVANCE/APPLICATION

UHR-CT is suitable for the assessment of nodules and airways in detail. Hybrid IR with 2048 matrix may be the most advantageous for the assessment of the fine morphology of nodules.

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## Abstract Archives of the RSNA, 2023

T5B-SPCH-6

### Motion Artifact Correction using a New Deep Learning Reconstruction (MC-DLR) in the Chest Computed Tomography

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yoichiro Ota, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

A new motion correction method, motion correction - deep learning reconstruction (MC-DLR), has been developed using a deep learning framework to estimate patient motion in chest computed tomography (CT). This study aimed to assess the effect of MC-DLR in emergencies.

#### METHODS AND MATERIALS

This single-institution retrospective study was approved by our institutional review board. The requirement for written informed patient consent was waived. The subjects included 20 emergency cases (15 of whom were male patients, with a median age of 78) during July and August 2022. All CT scans were obtained using a 320-row CT scanner (Aquilion One Genesis, Canon Medical Systems, Otawara, Tochigi, Japan) at 120 kVp using automatic exposure control. Two types of images were reconstructed, with and without MC-DLR, both with a  $512 \times 512$  matrix size and 0.5-mm slice thickness. A technologist developed a multi-planer image obtained at the sino-tubular junction of the ascending aorta in each CT image (Fig.1). Six radiologists and six technologists measured the maximum aortic diameter and its perpendicular diameter on each image, in a randomized and independent manner, without any prior information. Additionally, they scored the motion artifact of the aorta using a four-step scale (0 = none, 1 = slight, 2 = mild, 3 = severe). Three certified chest radiologists compared all CT images with and without MC-DLR sets side by side and graded the motion artifact in the ascending aorta, coronary arteries, the left lower lobe of the lung, and other areas of the lung using a four-step scale. The total artifact score was determined as the sum of these individual scores. We compared these aortic diameters and scores using a paired t-test.

#### RESULTS

The mean artifact score in the MPR image evaluation decreased significantly from  $1.64 \pm 0.96$  in the image without MC-DLR to  $1.32 \pm 1.03$  in the image with MC-DLR ( $p < 0.001$ ). The mean aortic diameter did not differ significantly between the two image sets, measuring  $33.0 \pm 3.3$  mm without MC-DLR and  $33.0 \pm 3.5$  mm with MC-DLR. However, the mean perpendicular diameter increased significantly, measuring  $30.7 \pm 3.3$  mm without MC-DLR and  $31.4 \pm 3.5$  mm with MC-DLR ( $p < 0.001$ ). When CT images were evaluated by certified radiologists, the total motion artifact score decreased significantly from  $6.8 \pm 2.8$  in the images without MC-DLR to  $4.6 \pm 2.9$  in those with MC-DLR ( $p < 0.001$ ).

#### CONCLUSION

MC-DLR, a new motion correction method, decreases motion artifacts in chest CT images.

#### CLINICAL RELEVANCE/APPLICATION

Obtaining high-quality CT images is often challenging in emergency cases. MC-DLR effectively reduces motion artifacts in post-processed images, improving the image quality.

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## Abstract Archives of the RSNA, 2023

T5B-SPCH-8

### Assessment of Lung Perfusion using Dynamic Digital Radiography and Comparison with Nuclear Medicine Lung Scintigraphy

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Naga Sai Rasagna Mareddy, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Assessment of lung perfusion is an important element in the preoperative evaluation of patients being considered for lung transplant or resection. Dynamic digital radiography (DDR) is a newer radiographic technique acquiring rapid sequential diagnostic radiographs of the chest throughout multiple respiratory cycles. The regional lung perfusion can be estimated using DDR by assessing pixel signal changes throughout the cardiac cycle. This study will compare the results of the differential lung perfusion estimated using DDR with the same results obtained from Nuclear Medicine (NM) lung scintigraphy, a conventional imaging modality.

#### METHODS AND MATERIALS

A retrospective review of patients evaluated with both nuclear medicine lung scintigraphy and DDR was performed. The DDR examinations were performed between January 14, 2022 and April 25, 2023. Each patient had a lung scintigraphy perfusion study within 6 months of the DDR examination. The percent differential of perfusion between the lungs was calculated using both modalities and the results were analyzed for statistical correlation.

#### RESULTS

Results for 53 patients were reviewed (mean age - 56 years, 21 females). The mean absolute percent differential in perfusion between the right and left lungs was ( $14.6 \pm 24.9\%$ ) using DDR and ( $16.4 \pm 25.7\%$ ) using lung scintigraphy. There was only one patient in which there was a discrepancy between the two modalities in determining which lung was better perfused. The perfusion results obtained using the two modalities were strongly correlated ( $r = 0.923$ ,  $p < .001$ , 95% CI [0.870,0.955]).

#### CONCLUSION

Differential lung perfusion estimated by DDR is strongly correlated with the same result obtained using lung scintigraphy. The speed and cost effectiveness of DDR make it an attractive option for clinicians, potentially reducing wait times and healthcare cost for patients.

#### CLINICAL RELEVANCE/APPLICATION

Dynamic digital radiography (DDR) is a novel functional imaging modality for assessment of lung perfusion, with strong correlation to nuclear medicine lung scintigraphy making it a faster and more cost-effective option for preoperative evaluation of lung transplant/resection candidates.

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## Abstract Archives of the RSNA, 2023

T5B-SPER-2

### Prediction Of Enhancement Peaking Time Of Pulmonary Artery Computed Tomography Angiography: Based On Physiological Data And Random Forest Model

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Tuo He (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a random forest model for preoperative prediction of contrast peaking time in pulmonary computed tomography angiography using patient physiological data.

#### METHODS AND MATERIALS

A total of 511 patients with 53 sets of physiological data (including baseline, clinical, hemodynamic, radiographic structural) and pulmonary artery contrast peaking time were enrolled. Peaking times were extracted from time-density curves obtained from previous low-dose contrast tests performed with pulmonary CTA. The region of interest was placed in the pulmonary artery trunk. The prediction model was developed in a primary cohort that consisted of 409 patients. Least absolute shrinkage and selection operator (LASSO) regression model was used for data feature selection, and signature building. Random forest method was used to develop the predicting model. An independent validation cohort contained 102 consecutive patients, 10-fold cross-validation was used to validate the peaking time prediction model. The predictive efficacy of the model was assessed using the area under the receiver operating characteristic (ROC) curve (AUC), sensitivity, and specificity in primary and validation cohort. All examinations were performed on a 256-row Revolution CT. Statistical analysis was conducted with R software. The reported statistical significance levels were all two-sided, with statistical significance set at 0.05.

#### RESULTS

16 selected feature variables including COPD history, cardiac function classification (NYHA), hypothyroidism, hypertension classification and risk stratification, coronary heart disease history, valvular disease history, Injection site, Sex, Age, Contrast agent does, Superior vena cava size (long diameter and short diameter), Pulmonary artery width, Pulse rate and Diastolic pressure were significantly associated with peaking time. The AUC, sensitivity and specificity of the peaking time prediction based on the proposed model was 0.795, 0.047, 0.997 in the primary cohort, and 0.738, 0.056, 0.796 in the validation cohort.

#### CONCLUSION

A random forest model that incorporates various physiological data may be used to preoperatively predict contrast peaking time to optima contrast use in pulmonary CTA.

#### CLINICAL RELEVANCE/APPLICATION

The empirical time method, small-dose contrast agent test method, and the dynamic tracking threshold trigger method are commonly used in the current peak time calculation for contrast-enhanced examinations. However, these methods have the disadvantages of insufficient accuracy, increased contrast injection and increased radiation dose to the patient, respectively. In contrast, the prediction of peak time by random forest models can perfectly solve these drawbacks mentioned above.

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## Abstract Archives of the RSNA, 2023

T5B-SPGI-1

### High Resolution CT Imaging with a 1024 Matrix: Impact of Matrix Size, Slice Thickness, Reconstruction Algorithm, and Reslicing on Radiomic Feature Quantification in Hepatocellular Carcinoma

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Masatoshi Hori, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### PURPOSE

Following the emergence of ultra-high-resolution (UHR) CT or photon-counting CT systems, 1024-matrix abdominal imaging has become clinically relevant. These depictions offer superior spatial resolution compared to conventional images. However, the impact of matrix size, slice thickness, reconstruction algorithm, and reslicing on radiomic evaluations remains poorly understood. The aim was to elucidate the consequences of these parameters on CT radiomic feature quantification in hepatocellular carcinoma (HCC).

#### METHODS AND MATERIALS

This retrospective analysis involved 29 subjects (16 males, 13 females; median age, 73 years) diagnosed with HCC, who underwent contrast-enhanced CT during late arterial and portal venous phases employing super-high-resolution mode with a UHR CT scanner (Aquilion Precision; Canon). Lesions exhibited a median diameter of 32.6 mm (range, 11.1-113.6mm). UHR CT images with a 1024-matrix were reconstructed utilizing filtered back projection and hybrid iterative reconstruction. Slice thicknesses comprised 0.5, 1.0, and 5.0 mm. CT images with a 512-matrix were also reconstructed with the normal-resolution simulation algorithm. A representative tumor was three-dimensionally segmented per patient. Subsequently, 120 radiomic features, with and without reslice at 1-mm voxel, were calculated in three dimensions for each image set. Features were categorized as first-order (n=19), shape (n=26), and texture (n=75). A linear mixed-effects model evaluated the impact of imaging parameters on features, deeming P-value < 0.05 divided by 120 for Bonferroni correction significant.

#### RESULTS

Within both arterial and portal venous phases, among 120 features, slice thickness significantly impacted 30 (25.0%) and 28 (23.3%) features, respectively. The 1024-matrix affected 19 (15.8%) and 18 (15.0%) features, whereas reslicing influenced 14 (11.7%) and 16 (13.3%) features, respectively. Conversely, the reconstruction algorithm exerted minimal effect on 2 (1.7%) and 0 (0.0%) features.

#### CONCLUSION

Slice thickness emerged as the most influential factor affecting the measurement values of features. Subsequently, when employing UHR images (1024 matrix) compared to conventional-resolution images (512 matrix), significant differences were observed in 15-16% of feature measurements in both arterial and portal venous phases. The effects of reslicing were discernible in approximately 10% of features, while the impact of the reconstruction algorithm was minimal.

#### CLINICAL RELEVANCE/APPLICATION

Radiomic features procured from UHR CT employing a 1024 matrix diverge from those garnered through conventional CT. Slice thickness prevails as the primary determinant, with the 1024-matrix as the subsequent influencer.

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## Abstract Archives of the RSNA, 2023

T5B-SPGI-2

### Predictive Value of LI-RADS v2018 Combined ADC for Hepatocellular Carcinoma and Other Primary Hepatic Malignancies in the LI-RADS M Classification

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jiangyang Pan (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the predictive value of LI-RADS v2018 MR imaging features, ADC values to identify hepatocellular carcinoma (HCC) and other hepatic primary malignancy (OM) in the LI-RADS M (LR-M) classification.

#### METHODS AND MATERIALS

MR imaging of 142 patients with primary liver cancer were classified as LR-M by two radiologists, 62 in the HCC group and 80 in the OM group. Comparing ADC and general clinical data including age, gender, location, AFP, CA19-9, length diameter of patients between the two groups, as well as LI-RADS MR imaging features: nonperipheral "washout", enhancing "capsule", nodule-in-nodule, mosaic architecture, blood products in mass, fat in mass, rim APHE, peripheral "washout", delayed central enhancement, targetoid restriction, bile duct dilatation. ADC were converted to dichotomous variables by ROC curves, and the independent predictors of HCC and OM in LR-M were screened by single-factor and multi-factor regression analysis, and the predictive value of each independent predictor and predictive model was analysed by ROC curves.

#### RESULTS

Elevated AFP (42/62, 67.7%), enhancing "capsule" (41/62, 66.1%) and blood products in mass (13/62, 21%) were seen in a higher rate in the HCC group, with  $ADC = 1.083 \times 10^{-3} \text{ mm}^2/\text{s}$ . The OM group showed elevated CA19-9 (42/80, 52.5%), a higher rate of delayed central enhancement (51/80, 63.8%), targetoid restriction (41/80, 51.3%) and bile duct dilatation (41/80, 51.3%), and  $ADC > 1.083 \times 10^{-3} \text{ mm}^2/\text{s}$ . The differences in these parameters were statistically significant ( $P < 0.05$ ). Multi-factor regression analysis showed that AFP, enhancing "capsule", ADC classification, and bile duct dilatation were independent predictors of the HCC and OM groups, and ROC curves showed the highest AUC of 0.950 for the prediction model, with a sensitivity of 85.5% and a specificity of 91.2%.

#### CONCLUSION

The ADC classification is an independent predictor for differentiating HCC and OM in the LR-M classification. Combined with elevated AFP, enhanced capsule, and bile duct dilatation, ADC classification can effectively improve the ability to distinguish HCC from OM.

#### CLINICAL RELEVANCE/APPLICATION

LI-RADS v2018 combined with ADC values can effectively predict hepatocellular carcinoma (HCC) and other hepatic primary malignancy (OM) in the LR-M classification.

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## Abstract Archives of the RSNA, 2023

T5B-SPGI-3

### Association of CEUS and CT/MRI LI-RADS Major Feature with Hepatocellular Carcinoma: Comparison of Cirrhosis and Hepatitis B Risk Factors using Individual Participant Data Meta-analysis

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Robert G. Adamo (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the association of LI-RADS major features with HCC and positive predictive value (PPV) for HCC of LI-RADS categories in patients with cirrhosis, HBV-related cirrhosis, and non-cirrhotic chronic-HBV using Individual Participant Data(IPD) meta-analysis.

#### METHODS AND MATERIALS

IPD was extracted from studies evaluating CT, MRI and contrast-enhanced ultrasound(CEUS) for diagnosis of HCC using LI-RADS(v2014-2022) (protocol link). Mixed models were applied. Odds ratios(ORs) for each major feature and PPV for each LI-RADS category were determined using multivariable logistic regression in three subgroups: Group-A(cirrhosis), Group-B(HBV-related cirrhosis), and Group-C(HBV without cirrhosis). Risk of bias was assessed using QUADAS-2.

#### RESULTS

29 studies(3453 patients) were included: Group-A(3453/4448 patients/observations), Group-B(1106/1232), and Group-C(721/781). CT/MRI major features[threshold growth not assessed, low data] were all associated with HCC: Group-A OR ranges 1.84-5.25; Group-B OR ranges 2.36-8.18; Group-C OR ranges 2.63-5.92. CEUS features associated with HCC: Group-A OR ranges 2.78-6.90, Group-B OR 9.88, and Group-C insufficient data(n=44). In CT/MRI and CEUS, the PPVs were comparable for LI-RADS categories 4(LR-4) and 5(LR-5) between Group-A, Group-B, and Group-C. Twenty-two studies (79%) had high risk of bias in at least one QUADAS-2 domain.

#### CONCLUSION

CT/MRI, LI-RADS major features (other than TG) were independently associated with HCC in patients with non-HBV cirrhosis, HBV-cirrhosis, and non-cirrhotic HBV, suggesting that LI-RADS major features are applicable in patients with HBV, regardless of cirrhosis status. CEUS, there were insufficient data to evaluate differences among groups. CT/MRI and CEUS, PPV was comparable between groups for LR-4 and LR-5.

#### CLINICAL RELEVANCE/APPLICATION

The CT/MRI LI-RADS major features show similar independent associations with HCC, and the positive predictive value (PPV) for LR-4 and LR-5 in CT/MRI and CEUS is comparable between cirrhosis (Group A), HBV-related cirrhosis (Group B), and non-cirrhotic HBV (Group C) patients. Therefore, this study supports the current LI-RADS v2018 approach, which does not adjust major imaging features based on different patient populations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPGI-4

### **Nontarget Y90 Transarterial Radioembolization (TARE): Can It Affect Post-Treatment HCC Localization and LIRADS-Treatment Response Algorithm (LR-TRA)?**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Charis Wang, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In a prior study, we assessed the accuracy of the LIRADS-TRA in categorizing post-therapy response of HCC treated with TARE with yttrium-90, using liver explant pathology as the reference standard. However, Y90 TARE can cause variable non-target/background liver radiation features, confounding congruent LR-TRA assessment between readers. This study aimed to assess multireader variability of post-treatment lesion localization and the confounding effect of non-target radiation on the LR-TRA.

#### **METHODS AND MATERIALS**

96 patients who had liver explant pathology after Y90 treatment for HCC between Oct 2015 and Oct 2021 were identified using data science tools. Patients with less than 90 days between Y90 treatment and pre-transplant MRI or CT were excluded due to immediate post-treatment enhancement confounding LR-TRA assessment. From the remaining 69 patients, there were 64 MRIs and 5 CTs completed before liver transplant, with 9 excluded for technical issues. Using post-contrast sequences, three readers independently reviewed each patient's exams and indicated the location of the pre-treatment lesion on the post-treatment image with an arrow. Arrow locations were compared and marked as congruent or noncongruent. Fisher's exact test was used to analyze interreader congruency of post-treatment lesion localization LR-TRA assessments of treatment response, and the respective correlations with the presence of non-target post-radiation changes.

#### **RESULTS**

Lesion localization data was obtained for 60 exams. Among the 34 patients without nontarget changes, 32 (94.1%) demonstrated lesion localization congruency; while among the 26 patients without nontarget changes, only 13 (50%) were congruent ( $p < 0.001$ ). For LIRADS TRA classification, 76.5% (26/34) were congruent on exams without nontarget changes, while 42.3% (11/26) were noncongruent. ( $p = 0.05$ ). LR-TRA classification noncongruency was highest for the equivocal vs nonviable subcohort (30.8%; 8/26).

#### **CONCLUSION**

Although non-target/background liver post-treatment (Y90) radiation changes can be variable, its presence can significantly impact interreader congruency for lesion localization and LIRADS-TRA classification.

#### **CLINICAL RELEVANCE/APPLICATION**

The effect of non-target radiation changes on accurate lesion localization and LR-TRA classification should be taken into account when assessing therapeutic response of HCC treated with TARE with Y90.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPGI-5

### **LI-RADS Treatment Response Algorithm v2023 versus v2018: Assessing Diagnostic Performance and Inter-reader Agreement in Patients with Hepatocellular Carcinoma Treated with Stereotactic Body Radiotherapy**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Joshua Breeden, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the accuracy and inter-reader agreement of the updated LI-RADS Treatment Response Algorithm (LR TRA) v2023 for assessing tumor viability of hepatocellular carcinoma (HCC) treated with stereotactic body radiotherapy (SBRT) using explant as the gold standard.

#### **METHODS AND MATERIALS**

This retrospective IRB approved study included patients who underwent SBRT for treatment of HCC between 2008 and 2021 with subsequent liver transplantation. Five readers independently reviewed all treated lesions according to LR TRA v2023, LR TRA v2018 and mRECIST. Observations were characterized as Viable, Non-viable, Nonprogressing (using v2023), or Equivocal (using v2018) based on LR TRA and complete response, partial response, stable disease, or progressive disease based on mRECIST. Predictive values for Viable and Nonviable categories were compared to pathology results using 100% as complete pathologic necrosis and less than 100% as incomplete pathologic necrosis. Performance metrics for assessing Viability and Nonviability of treated observation were calculated for each reader and reader agreement was determined for v2023 and v2018.

#### **RESULTS**

44 lesions in 27 patients (median age: 63 [59-65 years]; 25 males) were included. Overall reader agreement for final category was 33%, 31%, and 30% for v2023, v2018 and mRECIST, respectively. Reader agreement amongst faculty and trainees for v2023, v2018 and mRECIST was 33%, 29%, and 31% and 42%, 33%, and 41%, respectively. There was increased reader agreement amongst faculty assigning Viable category from v2018 to v2023 (v2018: 25%; v2023: 35%) compared to Non-viable and Equivocal/Nonprogressing category (Nonviable v2018 to v2023: 37% to 37% and Equivocal v2018 to Nonprogressing v2023: 22% to 28%, respectively). Sensitivity and negative predictive value for predicting complete necrosis was 69% and 71% (v2023) and 63% and 70% (v2018), respectively, when Nonprogressing/Equivocal category were treated as Viable, accounting for subject clustering. Sensitivity and positive predictive value for predicting incomplete necrosis was 96% and 62% (v2023) versus 94% and 62% (v2018), respectively, when the Nonprogressing/Equivocal category was treated as Nonviable.

#### **CONCLUSION**

LR TRA v2023 demonstrates improvement in reader agreement using newly defined terminology for persistently enhancing SBRT-treated HCC. LR TRA v2023 demonstrates similar diagnostic performance compared to v2018 for predicting incomplete and complete necrosis.

#### **CLINICAL RELEVANCE/APPLICATION**

SBRT-treated HCC undergo slow necrosis and show persistent post-treatment APHE which should not be retreated. LR-TR Nonprogressing is a new category aiming to improve reporting consistency to reduce unnecessary early retreatment.

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## Abstract Archives of the RSNA, 2023

T5B-SPGI-6

### Intelligent Radiomics for Individualized Evaluation of Target in Patients with Advanced Hepatocellular Carcinoma

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Mingguang Yang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the use of intelligent imaging methods to develop intelligent imaging markers based on CT images and construct a visualization Nomogram to individually predict the efficacy of ronvatinib in patients with advanced hepatocellular carcinoma.

#### METHODS AND MATERIALS

This study retrospectively analyzed 168 patients with hepatocellular carcinoma treated with ranvastinib and divided them into two independent study cohorts. First, image features were extracted from baseline CT images of 79 patients in cohort 1 using image omics analysis. A nested 10-fold cross-validation and Cox proportional hazard regression model were used to construct intelligent image omics markers combined with LASSO algorithm to predict treatment failure time TTF and overall survival OS in advanced HCC patients receiving targeted therapy. The efficacy of intelligent imaging markers was verified in a cohort of 89 patients.

#### RESULTS

The nested 10-fold cross-verified training was repeated for 100 rounds, and the average consistency index C-index was 0.682 (t test  $P < 0.001$ ). Ultimately, intelligent imaging markers consisting of eight image features were significantly associated with TTF and OS ( $P < 0.001$ ), and were able to classify advanced HCC patients receiving targeted therapy into low-risk and high-risk groups, with 1-year treatment failure rates of 53.2% and 6.8%, respectively. The 2-year survival rates were 62.3% and 15.6%, respectively. Multivariate analysis showed that smart imaging markers were independent prognostic factors for TTF (HR: 4.840, 95%CI: 2.554-7.468,  $P < 0.001$ ) and OS (HR: 4.325, 95%CI: 2.034-11.225,  $P < 0.001$ ). A Nomogram integrated with intelligent imaging markers and clinicopathological parameters further improves the prediction performance.

#### CONCLUSION

Intelligent imaging markers based on CT images can effectively predict treatment failure time and overall survival in advanced HCC patients receiving targeted therapy with ranvatinib. A Nomogram model was synthesized by fitting intelligent imaging markers and clinicopathological parameters to guide individualized targeted therapy for patients with advanced HCC.

#### CLINICAL RELEVANCE/APPLICATION

In this study, intelligent imaging markers based on CT images combined with artificial intelligence technology can be used to guide individualized targeted therapy for patients with advanced HCC.

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## Abstract Archives of the RSNA, 2023

T5B-SPGI-8

### Machine Learning for Malignant versus Benign Focal Liver Lesions on US and CEUS: A Systematic Review and Meta-Analysis

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Carlos Alberto Campello Jorge, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To perform a meta-analysis of the diagnostic performance of learning (ML) algorithms (conventional and deep-learning algorithms) for the classification of malignant versus benign focal liver lesions (FLLs) on US and CEUS.

#### METHODS AND MATERIALS

Available databases were searched for relevant published studies through September 2022. Studies met eligibility criteria if they evaluate the diagnostic performance of ML for the classification of malignant and benign focal liver lesions on US and CEUS. The pooled per-lesion sensitivities and specificities for each modality with 95% confidence intervals were calculated.

#### RESULTS

A total of 8 studies on US, 11 on CEUS, and 1 study evaluating both methods met the inclusion criteria with a total of 34,245 FLLs evaluated. The pooled sensitivity and specificity of ML for the malignancy classification of FLLs were 81.7% (95% CI, 77.2-85.4%) and 84.8% (95% CI, 76.0-90.8%) for US, compared to 87.1% (95% CI, 81.8-91.0%) and 87.0% (95% CI, 83.1-90.1%) for CEUS. In the subgroup analysis of studies that evaluated deep learning algorithms, the sensitivity and specificity of CEUS (n=4) increased to 92.4% (95% CI, 88.5-95.0%) and 88.2% (95% CI, 81.1-92.9%). Studies assessing multiple malignant and benign etiologies for FLLs had no lower diagnostic performance than those comparing only one etiology in each group for both methods.

#### CONCLUSION

The diagnostic performance of ML algorithms for the malignant classification of FLLs was high for both US and CEUS with overall similar sensitivity and specificity. The similar performance of US may be related to the higher prevalence of DL models in that group.

#### CLINICAL RELEVANCE/APPLICATION

Machine learning algorithms applied for the classification of focal liver lesions demonstrated high accuracy for both CEUS and US.

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## Abstract Archives of the RSNA, 2023

T5B-SPGU-1

### Global Variation in Magnetic Resonance Imaging of the Prostate using PI-QUAL: A Multicentre Study

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Francesco Giganti, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

High variability in prostate MRI quality reduces the accuracy of this technique in the detection of prostate cancer. The Prostate Imaging Quality (PI-QUAL) score is the first standardised scoring system that evaluates image quality using five points, where a score of 5 means the scan is of optimal diagnostic quality and a score of 1 means that all sequences are below the minimum standard for diagnostic quality. We aimed to assess prostate MRI quality following the application of PI-QUAL in the scans from different centres across the world undergoing quality control as part of an ongoing trial. We determined whether appropriate modifications to MRI protocols could optimise their diagnostic quality.

#### METHODS AND MATERIALS

For each scanner, centres submitted 5 consecutive MRI scans and the MRI protocols (Phase 1). Submitted data were evaluated in consensus by two expert genitourinary radiologists using PI-QUAL. Feedback was provided for scanners not reaching PI-QUAL 5, and centres were invited to resubmit a new study using the modified protocol (Phase 2).

#### RESULTS

In Phase 1, 41 centres from 18 countries submitted a total of 355 MRI images from 71 scanners, with 9 (13%), 39 (55%) and 23 (32%) scanners scoring a PI-QUAL score of 3, 4 and 5, respectively. Of the 48/71 (68%) scanners which received feedback to improve, the dynamic contrast enhanced sequences were those with the highest variability (44/48, 92%), followed by diffusion-weighted imaging (20/48, 42%) and T2-weighted imaging (19/48, 40%). 36 centres from 17 countries resubmitted revised studies, resulting in a total of 62/64 (97%) scanners completing Phase 2, scoring PI-QUAL 5.

#### CONCLUSION

We observed significant variation in prostate MRI quality, particularly with dynamic contrast enhanced sequences. Basic evaluation and modifications to MRI protocols using PI-QUAL can lead to substantial improvements in the global quality of prostate MRI.

#### CLINICAL RELEVANCE/APPLICATION

There is significant global variation in prostate MR image quality, particularly in the dynamic contrast enhanced sequences. However, quality can be optimised with basic modifications to MRI protocols. Basic changes using the PI-QUAL score (that includes adherence to technical recommendations outlined in the PI-RADS guidelines) markedly improved the quality of scanners, with 97% and 3% of scans obtaining a PI-QUAL score of 5 and 4, respectively.

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## Abstract Archives of the RSNA, 2023

T5B-SPGU-2

### More with Less: A Quality Improvement Initiative to Evolve Multiparametric MR Prostate Imaging beyond the Endorectal Coil

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Scott H. Robertson, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To establish a consistent, efficient, and patient-friendly 3 Tesla MRI protocol for performing high-quality prostate MRI without an endorectal coil (ERC).

#### METHODS AND MATERIALS

As part of the ACR Prostate MR Image Quality Improvement Collaborative, this single-center quality improvement (QI) project audited image quality across three project phases: pre-improvement, improvement, and post-improvement. Approximately 30 exams were audited each week (1114 exams total). All prostate exams were obtained on a 3T Siemens Magnetom Skyra (Syngo MR E11, Siemens Healthineers, Erlangen, Germany) with multiplanar T2-weighted imaging, DWI and ADC maps, and DCE imaging series following PI-RADS v2/2.1 guidelines. During the pre-improvement phase, our QI team regularly observed the imaging department using Gemba Walks, mapped out the imaging process, performed current state analysis, investigated root causes, and identified key drivers. Four months of pre-improvement exams were audited to quantify baseline performance and establish our SMART goal: achieving PI-QUAL = 4 for 85% of non-ERC MRI exams by the end of the 9-month Collaborative. In the improvement phase, interventions were implemented in rapid Plan-Do-Survey-Act cycles. A prostate phantom was developed for intervention testing to minimize the effects of patient variability. Progress was tracked on a run chart plotting the percentage of cases achieving PI-QUAL = 4. During the post-improvement phase, we tracked image quality to see how well the results were sustained. Educational materials for training technologists were developed by comparing image quality between ERC and non-ERC exams.

#### RESULTS

Pre-improvement, 64.8% (318/491) of baseline exams achieved PI-QUAL = 4. Performance improved to 79.4% (181/228) after introducing a 200-lb. weight-limit for ERC usage and switching to R/L phase encoding. This increased further to 89.1% (212/238) after enabling the abdomen shimming mode and expanding the shim box to encompass the full pelvis. Following the Collaborative, these improvements have been sustained for three months with 93.9% (245/261) of exams achieving PI-QUAL = 4.

#### CONCLUSION

Following the structured and data-driven QI process laid out by the ACR Learning Network, we can now routinely obtain high-quality prostate MRI without an ERC, and in some cases, forgoing the ERC even offers advantages.

#### CLINICAL RELEVANCE/APPLICATION

While providing prostate MRI exams without an ERC offers clear advantages for patients, staff, and clinical workflow, it's crucial to ensure sufficient image quality for accurate diagnosis. Therefore, transitioning away from ERC usage in prostate MRI requires a thoughtful and evidence-based improvement process.

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## Abstract Archives of the RSNA, 2023

T5B-SPGU-3

### Association of Quantitative Multiparametric MRI Parameters and Aggressive Prostate Cancer Morphologies

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the relationship between 3 Tesla quantitative multiparametric magnetic resonance imaging (qmpMRI) and pathologic features of aggressive prostate cancer (PCa) including cribriform morphology and intraductal carcinoma (IDC).

#### METHODS AND MATERIALS

This IRB-approved, HIPAA compliant study involved patients with PCa who underwent robotic radical prostatectomy between 2019 and 2022 and pre-operative mpMRI. Both mpMRI and whole mount histopathology (WMHP) were re-reviewed during a multidisciplinary meeting to assess imaging and pathology lesion matching and the presence of cribriform and IDC. All UCLA and PIRADSV2.1=3 lesions on mpMRI were contoured and the following quantitative parameters were extracted: mean apparent diffusion coefficient (ADC,  $\times 10^{-6} \text{mm}^2/\text{s}$ ) and perfusion parameters including  $K_{\text{trans}}$  ( $\text{min}^{-1}$ ),  $K_{\text{ep}}$  ( $\text{min}^{-1}$ ),  $i\text{AUC}$  ( $\text{mMsec}$ ). The cohort was divided into three subcohorts with increasing aggressiveness: (1) cribriform-/IDC-, (2) cribriform+/IDC-, and (3) cribriform+/IDC+. The cohort was also divided a binary manner into cribriform-/IDC- (subcohort 1) and cribriform+/IDC $\pm$  (subcohort 2 and 3). We used one-way ANOVA to assess group differences, Jonckheere test to evaluate trends, and a classification and regression tree (CART) model to estimate the discrimination ability by using all qmpMRI parameters.

#### RESULTS

The study cohort comprised of 130 patients (mean age and PSA:  $62.6 \pm 7.2$  years and  $9.3 \pm 6.2$  ng/mL) with 141 PCa lesions on mpMRI with 41/141, 49/141, and 51/141 in subcohorts 1, 2, and 3, respectively. The mean ADC and  $i\text{AUC}$  were  $892 \pm 202$  and  $5.4 \pm 2.5$ ,  $826 \pm 209$  and  $6.7 \pm 3.0$ ,  $763 \pm 163$  and  $6.9 \pm 3.5$  in subcohorts 1, 2, and 3, respectively (mean ADC,  $p=0.007$ ;  $i\text{AUC}$ ,  $p=0.037$ ). The mean ADC,  $K_{\text{ep}}$ , and  $i\text{AUC}$  of cribriform+/IDC $\pm$  (subcohort 2 and 3) were  $794 \pm 188$ ,  $1.9 \pm 1.3$ , and  $6.8 \pm 3.2$  which were significantly different compared to cribriform-/IDC- (subcohort 1) with  $p=0.007$  (mean ADC),  $p=0.019$  ( $K_{\text{ep}}$ ),  $p=0.011$  ( $i\text{AUC}$ ). As aggressive PCa hosts increased cellularity and increased vascularity leading to low diffusion and high perfusion parameters, the Jonckheere test confirmed that mean ADC ( $p=0.004$ ) was negatively correlated, and  $K_{\text{ep}}$  ( $p=0.048$ ) and  $i\text{AUC}$  ( $p=0.037$ ) were positively correlated with increasing PCa aggressiveness. Using mean ADC and  $i\text{AUC}$  cutoffs of 893 and 5.7, the CART model correctly allocated 62%, 60%, and 45% of PCa lesions to subgroups 1, 2, and 3.

#### CONCLUSION

3T qmpMRI diffusion and perfusion parameters were significantly correlated with increasingly aggressive PCa histological findings including presence of cribriform and IDC.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative mpMRI parameters show significant association with aggressive prostate cancer morphologies aiding to the diagnostic performance of mpMRI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5B-SPHN-1

### Diagnosing Cervical Lymph Node Metastasis in Oral Squamous Cell Carcinoma based on Third-generation Dual-source, Dual-energy Computed Tomography

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yongheng Luo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the potential of dual-energy computed tomography (DECT) parameters in identifying metastatic cervical lymph nodes in oral squamous cell carcinoma (OSCC) patients and to explore the relationships between DECT and pathological features.

#### METHODS AND MATERIALS

Clinical and DECT data were collected from patients who underwent radical resection of OSCC and cervical lymph node dissection between November 2019 and June 2021. Microvascular density was assessed using the Weidner counting method. The electron density (ED) and effective atomic number ( $Z_{\text{eff}}$ ) in non-contrast phase and iodine concentration (IC), normalized IC, slope of the energy spectrum curve ( $\Delta\text{HU}$ ), and dual-energy index (DEI) in parenchymal phase were compared between metastatic and non-metastatic lymph nodes. Student's t-test, Pearson's rank correlation and receiver operating characteristic curves were performed.

#### RESULTS

The inclusion criteria were met in 399 lymph nodes from 103 patients. Metastatic nodes ( $n=158$ ) displayed significantly decreased ED, IC, normalized IC,  $\Delta\text{HU}$ , and DEI values compared with non-metastatic ( $n=241$ ) nodes (all  $p < 0.01$ ). Strong correlations were found between IC ( $r = 0.776$ ), normalized IC ( $r = 0.779$ ),  $\Delta\text{HU}$  ( $r = 0.738$ ), DEI ( $r = 0.734$ ), and microvascular density. Area under the curve (AUC) for normalized IC performed the highest (0.875) in diagnosing metastatic nodes. When combined with the width of nodes, AUC increased to 0.918.

#### CONCLUSION

DECT parameters IC, normalized IC,  $\lambda_{\text{HU}}$ , and DEI reflect pathologic changes in lymph nodes to a certain extent, and aid for detection of metastatic cervical lymph nodes from OSCC.

#### CLINICAL RELEVANCE/APPLICATION

1. Electron density, iodine concentration, normalized iodine concentration,  $\Delta\text{HU}$ , and dual-energy index values showed significant differences between metastatic and non-metastatic nodes. 2. Strong correlations were found between iodine concentration, normalized iodine concentration, slope of the spectral Hounsfield unit curve, dual-energy index, and microvascular density. 3. DECT qualitative parameters reflect the pathologic changes in lymph nodes to a certain extent, and aid for the detection of metastatic cervical lymph nodes in patients with OSCC and aid clinical decision-making.

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## Abstract Archives of the RSNA, 2023

T5B-SPHN-2

### To Evaluate the Role of the 18 F FDG PET/CT in the Evaluation of the Post Head and Neck Surgery Prognosis and Survival

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Sikandar M. Shaikh, DMRD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of the study was to evaluate the various clinical and preoperative PET/CT findings in evaluation of the overall survival (OS) and for the evaluation of the distant metastasis for the diagnosis of the disease free survival (DMFS) in the cohort of head and neck squamous cell carcinoma patients who were treated with surgery. This study also correlates the prognostic model of OS and DMFS, by which there can be validation of the prognostic model with an independent cohort.

#### METHODS AND MATERIALS

This was the retrospective study comprising of the 382 patients who had diagnosed head and neck squamous cell carcinoma, and this was further divided into training (n = 318) and validation (n = 64) cohorts . This was based on the various parameters like various PET/CT parameters which were analysed: clinical parameters, SUVmax, SUVmean, metabolic tumor volume (MTV), total lesion glycolysis, and distance parameters for the primary tumor and lymph nodes and these were defined by 2 segmentation methods (relative SUVmax threshold and absolute SUV threshold). The Cox analyses was also performed for OS and DMFS in the training cohort. The concordance index (c-index) was used to identify highly prognostic parameters in this study . All these prognostic parameters were externally tested in the validation cohort and were validated

#### RESULTS

In multivariable analysis, the various important parameters for OS were T stage and nodal MTV, with a c-index of 0.64 (P < 0.001). For the DMFS, the various parameters were T stage, nodal MTV, and maximal tumor-node distance, with a c-index of 0.76 (P < 0.001). There were many combinations of parameters and all this were validated externally with c-indices of 0.63 (P < 0.001) and 0.71 (P < 0.001) for OS and DMFS, respectively

#### CONCLUSION

The nodal MTV and the maximal tumor-node distance was significantly correlated with the risk of DMFS. And this parameter was associated with significant increase in the higher risk of death. These all prognostic factors will be used as tailor-made concept for the individualized treatment

#### CLINICAL RELEVANCE/APPLICATION

PET-CT is the important modality for the evaluation of the post operative status of the head and neck cancers

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPHN-3

### Multi-parametric MRI-based Radiomics Approach with Deep Transfer Learning for Preoperative Prediction of Ki-67 Status in Sinonasal Squamous Cell Carcinoma

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Naier Lin, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Preoperative prediction of Ki-67 status in sinonasal squamous cell carcinoma (SNSCC) is critical for individualized treatment. Based on comparison of different machine learning (ML) models, we developed the model that integrates traditional hand-crafted (HC) features and deep transfer learning (DTL) features from multi-parametric MRI to predict Ki67 status in SNSCC.

#### METHODS AND MATERIALS

231 SNSCC patients were retrospectively reviewed [training cohort (n= 185), test cohort (n = 46)]. Clinical data and conventional MRI characteristics were analyzed to choose the independent predictor. HC and DTL radiomics features were extracted from fat-saturated T2-weighted imaging, contrast-enhanced-T1WI and apparent diffusion coefficient map. In this study, ResNet50 was chosen as the pretrained CNN model and it was trained on the ILSVRC-2012 dataset. Then, HC and DTL features were fused to formulate the deep learning-based radiomics (DLR) features. After features selection and radiomics signature (RS) building, we compared the predictive ability of RS-HC, RS-DTL and RS-DLR.

#### RESULTS

No independent predictors were found based on clinical and conventional MRI characteristics. After features selection, 42 HC and 10 DTL radiomics features were retained. The ML algorithm of Support Vector Machine (SVM), LightGBM and ExtraTrees (ET) were the best classifier for RS-HC, RS-DTL and RS-DLR, respectively. In the training cohort, the predictive ability of RS-DLR was higher than those of RS-DTL and RS-HC. In the test set, the area under curve (AUC) of RS-DLR was also the highest (AUC = 0.817, 95% CI: 0.697 - 0.937), better than those of RS-DTL (AUC = 0.650, 95% CI:0.487 - 0.812) and RS-HC (AUC = 0.803, 95% CI: 0.679 - 0.927).

#### CONCLUSION

Based on ET algorithm classifier, the integrated RS-DLR, which combine the HC and DTL features from multiple MR sequences, yielded more biological information about tumor and showed great potential in improving the prediction of Ki67 status in SNSCC.

#### CLINICAL RELEVANCE/APPLICATION

As a noninvasive and convenient method, the integrated RS-DLR represented an opportunity to advance precise prediction for the proliferation status in SNSCC preoperatively and benefit individualized treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPHN-4

### The Value of Synthetic MRI in Differentiating Metastatic and Non-metastatic Lymph Nodes in Nasopharyngeal Carcinoma, Compared with Size Criteria

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Fan Yang (*Presenter*) Nothing to Disclose

#### PURPOSE

The accurate diagnosis of metastatic lymph nodes (LNs) affects the target delineation and dose distribution of radiotherapy in nasopharyngeal carcinoma (NPC). The purpose was to explore the potential value of synthetic MRI (SyMRI) combined with histogram analysis in diagnosing LN metastasis (LNM) and how it compares to size criteria.

#### METHODS AND MATERIALS

Fifty-three consecutive patients with pathologically proven NPC were enrolled in this prospective study, and 377 cervical LNs with a maximum short axis diameter (MSAD) = 4 mm were evaluated. All patients underwent standard treatment and the median follow-up time after treatment was 36.13 (17.62, 42.19) months. Two senior radiologists (with 21 and 18 years of tumor-imaging experience) independently evaluated and labelled LNs, and any disagreement was resolved by discussion. A cervical LN was considered to be metastatic if it resolved after the patients completed treatment or showed stable size after treatment but progressed during the follow-up MRI. A cervical LN was considered to be non-metastatic if it showed stability in size after the completion of treatment and the patient remained disease-free during the follow-up MRI (Fig.1). Therefore, 297 and 80 LNs were diagnosed with metastatic and non-metastatic. Histogram features were extracted from the T1, T2, and proton density (PD) maps and MSAD was recorded. According to the Size criteria for cervical LNs, MASD of LNs = 5 mm in the retropharyngeal region, = 11 mm in level II and = 10 mm in other levels of neck were considered metastatic, otherwise, LNs were divided into the non-metastatic group. The dataset was assigned in a 7:3 ratio to either training group or validation group. Multivariate logistic regression analysis and ROC analysis were used to explore the performance in the diagnosis of cervical LNs and level II LNs. Then the DeLong test was used, and nomogram and calibration curves were constructed.

#### RESULTS

T1\_10th Percentile, T1\_Variance, PD\_10th Percentile, and PD\_Minimum were used to construct SyMRI model (AUC: 0.895 and 0.903 in the train and validation group), which is higher than Size criteria model (AUC: 0.824 and 0.797), with both  $P = 0.023$ . Moreover, SyMRI + Size criteria model showed the highest performance (AUC: 0.941 and 0.938) compared with SyMRI model only (both  $P = 0.043$ ) and Size criteria model only (both  $P = 0.007$ ).

#### CONCLUSION

SyMRI derived histogram parameters could effectively differentiate metastatic from non-metastatic whether in cervical LNs or level II LNs. Moreover, the combination of SyMRI and Size criteria could significantly improve diagnostic performance.

#### CLINICAL RELEVANCE/APPLICATION

The model built by SyMRI makes it possible to effectively evaluate individual LN within the MRI scan.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPHN-5

### Uniting Dual-Modal MRI/Chemiluminescence Nanotheranostics: Spatially and Sensitive Self-Reporting Photodynamic Therapy in Oral Cancer

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Ying-Sheng Cheng (*Presenter*) Nothing to Disclose

#### PURPOSE

In order to achieve precise and efficient diagnosis and treatment of tumors, the integrated nanosystem has been recognized by many interdisciplinary fields and has broad development prospects. However, there are still many challenges in real-time monitoring of targeted delivery and efficacy control of nanomedicines. Firstly, the unpredictable *in vivo* behaviors of nanotheranostics, that is, real-time tracking where, when, and how nanodrugs delivered. Next, limited by the uncontrollability of the therapeutic dose, how to monitor the treatment behavior and control the curative effect is the main bottlenecks. Therefore, inspired by the Boolean logic idea, designing sequence-activated nanotheranostics strategy is expected to become a breakthrough to solve the above difficulties and realize high-performance diagnosis and treatment applications.

#### METHODS AND MATERIALS

A sequence-responsive MRI/chemiluminescence (CL) dual-mode strategy was constructed through uniform spatio-temporal resolution. The nanotheranostics system Pa-MnCH-A@P was prepared by combining the Mn<sup>2+</sup> chelated photosensitizer (Pa) and the CL molecule (CH-A) through FNP technology. Then we explored the structural characterization, spectral properties, MR properties and CL properties of the nanomaterials. The human oral squamous cell carcinoma cell CAL27 was selected as cell model of the tumor to further explore the PDT properties and CL imaging to further explore the photodynamic properties and chemiluminescence imaging properties in cells, as well as the dual-modality imaging were performed in tumor model of oral cancer in mice.

#### RESULTS

We innovatively combined MR and CL imaging through FNP (flash nanoprecipitation) technology to quantitatively monitor *in vivo* distribution and PDT performance, overcoming the dilemma between spatial resolution and sensitivity.

#### CONCLUSION

Based on near-infrared fluorescence imaging, chemiluminescence imaging, magnetic resonance imaging and photodynamic therapy, this research combined diagnosis and treatment to construct nanotheranostics system. We successfully designed nanoprobess Pa-Mn&CH-A@P to real-time tracking unpredictable biological distribution and behavior *in vivo* and PDT feedback, which expanded the application of sequence-activated nanotheranostics system.

#### CLINICAL RELEVANCE/APPLICATION

Integration of diagnosis and treatment of oral cancer.

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## Abstract Archives of the RSNA, 2023

T5B-SPHN-6

### **The Impact of the COVID-19 Pandemic on Nasopharyngeal Carcinoma Extent at FDG PET/MR Staging: The NPCOVIPET Study**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yuanfan Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the impact of coronavirus disease 2019 (COVID-19) pandemic on disease extent in nasopharyngeal carcinoma (NPC) patients using 18 fluorodeoxyglucose (FDG) positron emission tomography (PET)/magnetic resonance imaging (MRI) staging as surrogate measure.

#### **METHODS AND MATERIALS**

Retrospective observational study including biopsy-proven, newly diagnosed NPC patients using whole-body FDG PET/MR staging in two selected intervals: May 1, 2017 to January 31, 2020 (Group A), and February 1, 2020 to June 30, 2021 (Group B). Data regarding primary tumour, regional lymph nodal (N) status and number of involved regional lymph nodal stations, and presence and number of distant metastases (M) were collected.

#### **RESULTS**

Three hundred ninety patients were included (201 in Group A vs 189 in Group B, respectively). The median intervals to PET/MR from the initial symptom in group A and group B were 2.5 (0.1-60.4) and 3.4 (0.2-56.3) months, respectively ( $p>0.05$ ). The median intervals to treatment from the initial symptom in group A and group B were 2.8 (0.2-60.5) and 3.6 (0.3-56.3) months, respectively ( $p>0.05$ ). No significant difference was observed in terms of T classification, N classification, overall stage, N stations and M stations between the two groups ( $p>0.05$ ). For the the involved neck node levels, more patients had developed level Vc metastasis in the group B ( $p=0.044$ ).

#### **CONCLUSION**

For NPC, staging by PET/MR and therapy were not significantly delayed after quarantine restrictions initiated. Although the overall stage was not affected, more NPC patients had developed level Vc metastasis in the era of COVID-19.

#### **CLINICAL RELEVANCE/APPLICATION**

None

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## Abstract Archives of the RSNA, 2023

T5B-SPHN-7

### Use of 18F-FDG PET/MR as an Initial Staging Procedure for Nasopharyngeal Carcinoma

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yuanfan Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to determine the clinical value and cost-effectiveness of PET/MR as an initial staging procedure for nasopharyngeal carcinoma (NPC) compared with the conventional work-up (CWU).

#### **METHODS AND MATERIALS**

From May 2018 to March 2021, 1020 consecutive patients with biopsy-proven, newly diagnosed NPC in our center were enrolled in this study. Among them, 343 patients underwent PET/MR before treatment and the remaining 677 patients only underwent CWU. For PET/MR and CWU, charges were used as issued in 2021 by the Medical Insurance Administration Bureau of Zhejiang, China. Incremental costeffectiveness ratio (ICER) measured cost of using PET/MR per percent of patients who avoided a false-positive (FP).

#### **RESULTS**

For the whole group, the de novo metastatic disease rate was 5.2% (53/1020). A total of 187 patients with FP results were observed. More patients with FP results were observed in the CWU group (25.6% vs. 4.1%,  $p < 0.001$ ). The mean interval from pathological diagnosis to initiation of treatment was 13.1 days in the CWU group versus 7.9 days in the PET/MR group ( $p < 0.001$ ). Mean cost per patient was \$417 for CWU and \$1585 for PET/MR. The ICER was \$54 for each percent of patients who avoided a FP.

#### **CONCLUSION**

Compared with CWU, PET/MR reduced FP risk and decreased workup of incidental findings, allowing for earlier treatment start. PET/MR may be cost-effective in initial staging procedure for NPC.

#### **CLINICAL RELEVANCE/APPLICATION**

None

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## Abstract Archives of the RSNA, 2023

T5B-SPIN-1

### **Knee Osteoarthritis Deep Learning Models Demonstrate Greater Biases Based on Sex Than Race**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Deep learning (DL) models for chest x-ray (CXR) diagnosis have demonstrated biases against historically disadvantaged groups across sex, and race, raising concerns about the equitable use of these tools. It is unclear, however, if similar biases exist for DL models in other body parts like the knee. The purpose of our study was to evaluate for sex and race-based bias in a DL model for knee osteoarthritis (OA) severity grading.

#### **METHODS AND MATERIALS**

We used the Osteoarthritis Initiative (OAI) dataset of weight-bearing AP knee radiographs for DL model development and testing. We first trained a YOLO-v5 object detection model to localize the right and left knees using 4,490 bilateral knee radiographs with bounding box annotations split at the patient-level into 70%/10%/20% splits for training/validation/test sets. We then used this localization model to crop knee joints from 19,777 knee radiographs used to train and test the knee OA severity grading (groundtruth Kellgren-Lawrence grades [KLG] provided by OAI); there were 42% males and 81% white patients. These images were split based on race and sex at the patient level, using 20% for testing and the rest for five-fold cross-validation (Figure 1A). The model's performance was evaluated on the test set with AUROC subgroup analysis based on sex and race (white vs. not white).

#### **RESULTS**

The knee joint localization model achieved a mean average precision (mAP) of 0.97. The OA grading model had an average AUROC of 0.91 on the five validation folds and an AUROC of 0.90 on the entire test set. Subgroup analysis showed biases favoring males for all KLG groups, except for KLG 3, which favored females; for example, for KLG 1 grading, AUROC for males was 0.8 compared to 0.76 for females (Figure 1B). Race-based bias was less pronounced, with no difference in AUROC between white and non-white patients for KLG 0 and 2, and differences of 0.02 for KLG 1, 3, and 4 (Figure 1C).

#### **CONCLUSION**

Our DL OA severity grading model performed at a state-of-the-art level, but demonstrated sex-based biases favoring males in 4/5 KLG categories, echoing previous findings for DL models for CXR diagnosis. The model demonstrated less pronounced race-based biases, however, indicating that demographic-based biases in DL models may vary between specific diagnostic use cases and body parts. We recommend further study to elucidate the mechanisms behind these demographic biases in DL models in radiology.

#### **CLINICAL RELEVANCE/APPLICATION**

We show that deep learning models can diagnose knee osteoarthritis with high accuracy, but can also exhibit biases based on sex and, to a lesser extent, race. Evaluation of demographic bias is critical to ensure the equitable use of these exciting technologies that hold much promise to transform medical imaging.

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## Abstract Archives of the RSNA, 2023

T5B-SPIN-2

### **"Radiobiometry": Deep-learning-based re-identification of Patients from De-identified Medical Images**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Alistair Yap, BEng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

When two radiographs are presented for follow-up evaluation, a radiologist must ensure they are from the same patient, which is not a trivial task. In some cases, patients may be misregistered, potentially leading to a medical error. Thus, the purpose of the study was to develop and assess a deep-learning "radiobiometry" method to determine whether two radiographs are from the same or different patients.

#### **METHODS AND MATERIALS**

Convolutional Neural Networks (CNN) were trained with contrastive learning to distinguish radiographs of different patients. Using the MIMIC-CXR dataset, CNNs for frontal chest radiographs and multi-view chest radiographs (frontal and lateral) were trained. Additionally, CNNs were trained on radiographs from the Osteoarthritis Initiative (OAI) for 4 other anatomic regions: pelvis, bilateral knees, bilateral hands, and right hand.

#### **RESULTS**

After preprocessing, 247,522 frontal chest radiographs from 64,564 patients of the predefined MIMIC-CXR training set were used to train the frontal chest-radiograph CNN. This model was tested on 3,630 images from 292 patients of the internal test set, as well as the test set of the ChestX-ray8 dataset consisting of 25,596 images from 2,797 patients. A further 120,973 lateral chest radiographs from MIMIC-CXR were used in combination with the frontal radiographs above to train the multi-view chest-radiograph CNN. This was similarly evaluated on the internal test set with an additional 1,501 lateral images. For CNNs trained on OAI data, 4-fold cross-validation was performed on 26,524, 11,357, 6,165, and 1,799 radiographs of bilateral knees, pelvis, bilateral hands, and right hand, from 4,796, 4,763, 3,504, and 1,000 patients, respectively. In all-pairs-similarity evaluation, all models achieved a test AUROC and rank-1 accuracy in excess of 0.99. Despite a minor drop in performance, the multi-view chest-radiograph CNN maintained an AUROC and rank-1 accuracy of over 0.99 when matching radiographs of differing laterality.

#### **CONCLUSION**

While falling short of mature biometric modalities with enormous and specialized datasets, initial results using modestly sized medical imaging datasets demonstrate the potential for radiographs as a novel biometric modality for identification and authentication systems. While radiobiometry can be useful for verifying patients in radiology clinical practice, it may also raise concerns for the re-identification of public anonymized medical imaging data.

#### **CLINICAL RELEVANCE/APPLICATION**

"Radiobiometry" systems for identifying patients from radiographs can help to reduce bookkeeping errors in clinical follow-up evaluation, protecting against misdiagnoses while consolidating mislabeled imaging records.

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## Abstract Archives of the RSNA, 2023

T5B-SPIN-3

### Efficient Deformable Registration with Local Self-similarity for Multi-Phase Abdominal CT Images

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Tony C. W. MOK, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We developed a fast deformable multi-phase abdominal CT registration algorithm, which addresses the non-linear misalignment of the intra-patient multi-phase abdominal CT images in real time.

#### METHODS AND MATERIALS

Our model is a learning-based method. The training data includes 1,503 cases of three-phase (non-contrast, arterial, and venous) CT volumes from one hospital, including 399 with pancreatic ductal adenocarcinoma (PDAC), 751 with non-PDAC, and 353 normal. We trained the model in a semi-supervised manner. To address the large non-linear misalignment and inhomogeneous image intensity across multi-phase CT, we developed a novel multi-level convolutional neural network to learn to maximize the local self-similarity of the images. To further improve the registration accuracy, we leverage anatomical delineations segmented by a robust multi-organ segmentation model to co-supervise the registration model. The model was independently evaluated on a combined internal test set of 25 cases (5 PDAC, 15 non-PDAC, and 5 normal).

#### RESULTS

The registration accuracy, robustness and smoothness of the deformation field are quantified with the Dice coefficient (DSC) of six anatomical delineations (Left and right kidneys, spleen, liver, stomach, and pancreas), the 30% lowest DSC (DSC30), and the standard deviation of the Jacobian determinant (SDLogJ), respectively. In arterial to non-contrast phase registration, our method's registration accuracy (DSC 93.6%) and robustness (DSC30 91.5%) are higher than the mean performance (DSC 92.7% and DSC30 88.8%) of the best-performing conventional multi-modal registration tool (DEEDs). Similar trends are observed in the venous to non-contrast phase registration. Our method outperforms the conventional image registration by a significant margin of 1.2% and 1.4% in DSC and DSC30, respectively, while maintaining a comparable smoothness in the solution (SDLogJ 0.152 vs 0.154). Our method circumvents the costly iterative optimization in the conventional method, which requires a mean running time of 119.5 seconds, and achieves real-time registration (0.33 sec per registration) for multi-phase CT images.

#### CONCLUSION

Our method can efficiently register multi-phase abdominal CT images, outperforming the registration performance of the conventional method by a significant margin.

#### CLINICAL RELEVANCE/APPLICATION

Our time-efficient registration method can be used in image fusion of multi-phase abdominal images, facilitating daily work of radiologists in imaging reading across multiple phases, and aggregating diverse image features for learning-based diagnostic systems. Our work suggests good feasibility in high-throughput environments that need to process dozens to thousands of multi-phase CT scans.

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## Abstract Archives of the RSNA, 2023

T5B-SPIN-4

### Identifying Metastatic Lymph Node Stations using a Local-Global Deep Hybrid Network with Prior-guided Supervision in Esophageal Cancer Patients

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Dazhou Guo (*Presenter*) Nothing to Disclose

#### PURPOSE

The diagnosis of lymph node (LN) metastasis in computed tomography (CT) is an essential yet challenging task in esophageal cancer staging and treatment planning. Although criteria (e.g., RECIST, morphological/texture features) are proposed to predict LN metastasis, the diagnostic accuracy remains low with sensitivity <50% and specificity <75%, as reported in previous studies. Deep learning (DL) has the potential to address this issue by learning from large-scale labeled data. However, due to the practical surgery procedure in LN dissection, it is difficult to pair the metastasis of individual LN reported in the pathology report to the LN instance found in the CT image. Hence, in this study, we first use pathology reports to determine the lymph node station (LNS) metastasis, then develop a multiple instance deep learning (MIDL) model to predict LNS metastasis.

#### METHODS AND MATERIALS

We collected data from 1,205 esophageal cancer patients who underwent preoperative contrast-enhanced CT scans. Using a recently developed automatic mediastinal LNS segmentation model, we segmented LNS 1 to 8 based on the IASLC protocol. For each LNS, we cropped the local CT region of interest (ROI) to generate station-wise CT patches, labeling the LNS as metastatic if at least one metastatic LN was indicated in the pathology report. We trained a 3D CNN-Transformer hybrid network using these CT patches. To incorporate LN position priors, we segmented LN instances (with a short axis =5mm) and added them as auxiliary input to the MIDL model. We also proposed a lymph node prior attention loss to supervise the transformer's attention map using LN instance masks. We conducted a five-fold cross-validation to evaluate the MIDL model's performance, reporting sensitivity, specificity, and AUC as classification metrics.

#### RESULTS

The proposed MIDL model exhibited an overall AUC of 0.8574, significantly outperforming the second best comparing method (MobileNetV2) by 4.78% (0.8574 vs. 0.8096). The specificity was assessed at a threshold yielding a recall of 0.8, at which point the MIDL model achieved a specificity of 0.7735 (MobileNetV2: 0.6553). Additionally, the sensitivity was evaluated at a threshold leading to a specificity of 0.8, where the MIDL model obtained a sensitivity of 0.7719 (MobileNetV2: 0.6309).

#### CONCLUSION

The proposed MIDL model can substantially improve the LNS metastasis prediction and has the potential to play an essential role in cancer staging, treatment planning, and prognostic analysis.

#### CLINICAL RELEVANCE/APPLICATION

The proposed algorithm can identify the metastasis lymph node stations in CT scan with high accuracy. The model may be applied in the clinical workflow to assist the diagnosis and treatment for esophageal cancer patients.

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## Abstract Archives of the RSNA, 2023

T5B-SPIN-5

### Fully Automated CT-Based Body Composition Tools Identify Increased Risk Factors for Adverse Health Outcomes in Socioeconomically Disadvantaged Individuals

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Matthew H. Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Socioeconomic disadvantage is associated with adverse health outcomes. The purpose of this study is to evaluate the relationship between socioeconomic disadvantage and CT-based body composition (BC) measures derived from a panel of fully automated artificial intelligence (AI) tools to identify individuals at increased risk for death and major adverse cardiovascular events (MACE).

#### METHODS AND MATERIALS

A fully automated panel of AI body composition tools quantifying abdominal aortic calcium (AoCa, Agatston score), abdominal fat (visceral adipose tissue area [VAT], visceral-to-subcutaneous fat ratio [VSR]), and muscle attenuation (muscle HU; mean at L3 level) was applied to non-contrast CT examinations in asymptomatic adults undergoing screening CT colonography (CTC). Patients were partitioned into 5 socioeconomic groups based on the national area deprivation index (ADI). One-way analysis of variance was used to compare means across groups. Odds ratios (ORs) were generated from high specificity (90% specificity) BC thresholds with more disadvantaged groups being compared to the least disadvantaged group (ADI<20) for each body composition measure.

#### RESULTS

7785 asymptomatic adults (mean age, 57 years; 4361:3424 F:M) underwent screening CTC from April 2004-December 2016. Median ADI was 31 (IQR 22-43). Significant correlation was observed for all measures (all  $p < 0.001$ ). More socioeconomically disadvantaged groups had significantly higher AoCa, higher VAT, higher VSR, and lower muscle attenuation. Compared with the least disadvantaged group, mean differences for the most disadvantaged group (ADI>80) were: AoCa=567, VAT=27 cm<sup>2</sup>, VSR=0.1, and muscle HU=-6 HU (all  $p < 0.05$ ). Compared with the least disadvantaged group, the most disadvantaged group had significantly higher odds of having high-risk body composition measures: AoCa OR=3.8, VAT OR=2.5, VSR OR=2.0, and muscle HU OR=3.1 (all  $p < 0.001$ ).

#### CONCLUSION

Fully automated CT-based AI body composition tools show that socioeconomic disadvantage is associated with high-risk BC measures and can be used to identify individuals at increased risk for death and MACE.

#### CLINICAL RELEVANCE/APPLICATION

Fully automated AI body composition tools are promising for opportunistic screening to identify markers of increased risk of death and MACE associated with socioeconomic disadvantage using data that typically go unused in clinical practice offering added value without additional patient time or dose.

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## Abstract Archives of the RSNA, 2023

T5B-SPIN-6

### Deep learning-based Model for Prediction of Hepatocellular Carcinoma Recurrence in Pre-operative Computed Tomography after Curative Surgery

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Wan Hang K. Chiu, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

Curative surgery is the treatment of choice for early-stage hepatocellular carcinoma (HCC) yet recurrence occurs in over 70% of cases. Recurrence, particularly within the first 5 years, is associated with poor prognosis and currently, few clinical risk scores can accurately predict recurrence. While histological microvascular invasion (MVI) predicts recurrence, it can only be confidently ascertained from surgical specimens thus unable to provide pre-treatment prognostication. Here, we developed a deep learning-based model for the prediction of HCC recurrence.

#### METHODS AND MATERIALS

Chinese patients with resected histology-confirmed HCC were recruited from 5 centers in Hong Kong. They were randomly divided in an 8:2 ratio to training and internal validation. A residual-network deep learning-based model to predict HCC recurrence was developed through the training-validation-testing approach utilizing pre-operative CT and clinical data (age, sex, comorbidities, and baseline blood tests). The model was externally tested using an independent cohort from Taiwan. Area-under-curve (AUC), positive and negative predictive values (PPV/ NPV) were calculated and survival analyses were also performed and compared with tumour MVI status.

#### RESULTS

This interim analysis included 1,254 patients (82.9% male, age 62.2 +/- 10.8 years, median follow-up 7.8 [5.8-10.0] years), with 368 (29.3%) and 710 (56.6%) developing recurrence within 1 and 5 years respectively. Of those, 551 (43.9%), 140 (11.2%), and 563 (44.9%) patients were included in the training, internal validation, and external testing cohorts. The model was trained for 42 epochs and the model achieved AUCs of 0.855 (95% CI 0.682-0.907; PPV 75.4%; NPV 84.3%) and 0.803 (95% CI 0.631-0.859; PPV 89.7%; NPV 55.1%) for predicting HCC recurrence at 1 and 5 years. In the external testing cohort, the deep learning-based model achieved AUCs of 0.775 (95% CI 0.536-0.840; PPV 49.7%; NPV 85.2%) and 0.733 (95% CI 0.539-0.766; PPV 87.0%; NPV 45.8%) for HCC recurrence at 1 and 5 years, significantly higher than MVI (AUCs 0.617 [0.496-0.725]; PPV 32.9%; NPV 88.5% and 0.560 [0.418-0.688]; PPV 67.9% NPV 46.4%) respectively. Furthermore, the deep learning-based model had superior discriminative ability on 1 and 5-year recurrence risk compared with MVI (49.7% vs 32.9% and 87.0% vs 67.9% respectively, both  $p < 0.05$ ).

#### CONCLUSION

Our deep learning-based model can accurately predict HCC recurrence after curative surgery in early-stage HCC outperforming MVI in risk stratification.

#### CLINICAL RELEVANCE/APPLICATION

Deep Learning can combine radiological images and clinical data and develop models that have the potential to become novel tools for pre-treatment prognostication for short- and intermediate-term outcomes in HCC.

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## Abstract Archives of the RSNA, 2023

T5B-SPIR-1

### Timing Matters: Which CT Phase for Colorectal Liver Metastasis Segmentation is Better for Ablative Margin Quantification in Predicting Local Outcomes?

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the use of three-dimensional minimal ablative margin (MAM) quantified by tumor segmentation using hepatic arterial (HAP) versus portal venous (PVP) phases CT for predicting residual tumor and local tumor progression (LTP) following colorectal liver metastasis (CLM) thermal ablation.

#### METHODS AND MATERIALS

This two-institution retrospective study included patients undergoing microwave and radiofrequency ablation between 2010 and 2021 with intraprocedural pre-ablation HAP and PVP and post-ablation PVP CT. Patients with follow-up less than one year without residual tumor or LTP were excluded. Tumors were segmented on pre-ablation HAP and PVP CT and ablation zones were segmented on post-ablation PVP CT. MAMs were quantified by a biomechanical deformable image registration method. Prognostic value of MAM in predicting residual tumor and one-year LTP was investigated using area under the receiver operating characteristic curve (AUC) and the association with LTP was tested using Fine-Gray subdistribution hazard regression model.

#### RESULTS

A total of 80 patients (mean age, 60 years  $\pm$  12 [SD]) with 151 CLMs were included. During a median follow-up of 27.3 months, 5 residual tumors were noted, and the LTP rate was 15.7% (23/146). The median tumor volume was 1.6 mL and 1.2 mL segmented on HAP and PVP CT, respectively ( $P=0.006$ ), with corresponding median MAM of 2.2 mm and 4.0 mm, respectively ( $P=0.007$ ). The AUC in predicting residual tumor and one-year LTP by HAP and PVP were 0.75 (95% confidence interval [CI]: 0.67, 0.84) and 0.81 (95% CI: 0.74, 0.89), respectively ( $P=0.006$ ). MAM of 0 mm on PVP CT was an independent predictor of LTP with a subdistribution hazard ratio of 7.7 (95%CI: 3.0, 19.6;  $P<0.001$ ), compared to 4.7 (95%CI: 1.8,12.0,  $P=0.001$ ) on HAP CT.

#### CONCLUSION

Ablative margin quantification using intraprocedural portal venous phase CT for colorectal liver metastasis segmentation significantly outperformed arterial phase CT in predicting ablation outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Ablative margins should be quantified on intraprocedural portal venous phase CT instead of arterial phase CT, as the latter may overestimate tumor size.

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## Abstract Archives of the RSNA, 2023

T5B-SPIR-2

### **Microwave Ablation in Hepatocellular Carcinoma: Dynamics of Extracellular Vesicles and Immunological Response**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Thomas J. Vogl, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To characterize extracellular vesicles by liquid biopsy in preinterventional patients with primary and secondary hepatic malignancies treated with microwave ablation (MWA).

#### **METHODS AND MATERIALS**

Blood samples of 38 HCC patients and 15 patients with hepatic metastases were collected immediately pre and postinterventional. Subsequently, the characterization of 37 surface epitopes of EVs by magnetic bead-based particle sorting and fluorescence-associated cell scanning (FACS) was conducted.

#### **RESULTS**

The HCC-group before intervention revealed an activation of T-cell-associated EV protein expressions with significantly increased CD40, CD86 and CD8, ( $p=0.022$ ;  $p=0.003$  and  $p=0.024$ , respectively) vs. the non-HCC group. Additionally, the pre- and post-interventional HCC group showed an increment of the B-cell associated marker CD20 vs. the non-HCC group,  $p=0.005$  and  $p=0.014$ , respectively. The tumor cell associated surface epitopes, CD44, CD133 and CD24 were significantly higher expressed in the pre-interventional HCC vs. non-HCC group ( $p=0.029$ ,  $p=0.009$ ,  $p=0.004$ ). Regarding the clinical parameters, the HCC group showed a significantly higher expression of CD9 in patients with recurrent HCC, nonalcoholic steatohepatitis (NASH)-related HCC and cirrhotic HCC. Furthermore, the subgroup analysis of HCC patients showed a significantly lower expression of CD44 in NASH-related HCC and cirrhotic HCC. Pre-interventional cytokine levels of TH1 and Treg cells (IL2 and IL17) correlated strongly with elevated CD44 levels in HCC patients. Additionally, pre-interventional IL6 levels correlated strongly with a high expression of CD19 and CD86. Regarding the post-interventional changes increased CD19, CD20 and CD44 levels correlated strongly with an elevated CD4/CD8 ratio and negatively correlated with CD4/CD8 ratio changes.

#### **CONCLUSION**

EV surface expressions correlated with cytokine levels in pre-interventional HCC patients showed a CD4+ TH1 response, associated with CD44 expression.

#### **CLINICAL RELEVANCE/APPLICATION**

EV surface expressions can be used as a prognostic parameter in MWA of HCC.

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## Abstract Archives of the RSNA, 2023

T5B-SPIR-3

### **Microwave Ablation versus Laser-induced Thermotherapy in the Treatment of Hepatocellular Carcinoma: Evaluation of Therapy Response and Survival Rates**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Thomas J. Vogl, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To retrospectively compare CT-guided microwave ablation (MWA) with MR-guided laser-induced thermal ablation (LITT) of hepatocellular carcinoma (HCC) regarding therapy response and overall survival (OS)

#### **METHODS AND MATERIALS**

In total, 303 patients (64f, 239m) were treated with 521 sessions of thermal ablation: 250 patients (52f, 198m; mean: 66±10 years) with 445 CT-guided MWAs and 53 patients (12f, 41m; mean: 67.5±8 years) with 76 MR-guided LITTs. Diameter of HCC lesions, technical success, complete ablation, local tumor progression and OS rates were evaluated in all cases.

#### **RESULTS**

Mean tumor diameter was 2.16 cm in the MWA group vs. 2.4 cm in the LITT group. Technical success was achieved in all ablations in both groups. Complete ablation was achieved in 97.7% of the tumors in the MWA group and in 98.7% in the LITT group. In the MWA group 6% of the patients and in the LITT group 3.8% developed local tumor progression. The 1-, 3-, and 5-year OS rates starting at the date of ablation were 86.6%, 53.4% and 40.4% in the MWA group and 85%, 37.7% and 17% in the LITT group, respectively. (p-value:0.001). No peri-procedural deaths were reported in both groups.

#### **CONCLUSION**

Image-guided thermal ablation like LITT and MWA are both effective and safe for the local treatment of HCC. Patients in the MWA group had an overall longer survival time, but with higher rate of local tumor progression than the patients in the LITT-group.

#### **CLINICAL RELEVANCE/APPLICATION**

Both MWA and LITT provide long OS with low complication rates in patients with HCC

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## Abstract Archives of the RSNA, 2023

T5B-SPIR-4

### **Transarterial Chemoembolisation (TACE) for Unresectable or Recurrent Hepatic Cholangiocarcinoma: Added Value of Local Thermal Ablation**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Thomas J. Vogl, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To retrospectively evaluate the local tumor control and survival rates after targeted local therapy using transarterial chemoembolisation (TACE) with or without local thermal ablation in patients with unresectable or recurrent hepatic cholangiocarcinoma (CCA).

#### **METHODS AND MATERIALS**

From January 2007 to December 2017, 152 patients (69 males and 83 females; mean: 58.7 years) with cholangiocarcinoma (CCA) were retrospectively evaluated. The study included patients with both unresectable (80.2%) and recurrent lesions (19.8%). Patients were treated with at least three therapeutic cycles of TACE (3-26 cycles). 32 patients received combined TACE and local thermal ablation. Local tumor response was assessed by contrast-enhanced magnetic resonance imaging (CE-MRI) based on the modified RECIST criteria (mRECIST) and the survival evaluated using the Kaplan-Meier method.

#### **RESULTS**

The mean survival for all patients was 28.7 months (CI:21.8-35.7). Patients who received additional ablation sessions showed significantly longer survival compared to those who received only TACE (median 28 and 18 months respectively;  $P < 0.007$ ). The tumor response after three cycles of TACE was either stable (35.5%), partial response (41.4%) progressive (23%) or complete response (0%) and the response at the last follow up was 25.7%, 15.2%, 59.2% and 3.5 % respectively. The following significant prognostic factors were found: nodal and/or systemic metastases, pre-therapeutic tumor load, initial local tumor response and associated application of local thermal ablation.

#### **CONCLUSION**

Targeted therapy of unresectable or recurrent CCA using TACE with an added value of thermal ablation treatment may provide a therapeutic option for local tumor control and may improve patient's survival.

#### **CLINICAL RELEVANCE/APPLICATION**

TACE is a relevant targeted therapy tool in the regional treatment of CCA.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPIR-5

### **KRAS Gene Mutation Influence after Ablation of Colorectal Cancer Lung Metastases: Prediction of Local Recurrence and Chemotherapy-free Survival Time**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Marcelo Liberato Coelho Mendes De Carvalho, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The primary objectives of the study were to evaluate if KRAS gene mutation predicts local recurrence in patients undergoing ablation of colorectal cancer lung metastases and to evaluate the chemotherapy-free interval of these patients. The secondary objective was to assess overall survival rate of these patients.

#### **METHODS AND MATERIALS**

This is a retrospective observational study of the medical records of patients who underwent lung ablation of colorectal cancer metastases, performed at a quaternary hospital. Radiofrequency (RFA) and microwave (MWA) ablations were used. Intraoperative planning and overlaps were defined by the assistant team of interventional radiologists, based on the size and location of the metastases. A review of pre-, intra-, and post-procedure images was performed by one of the authors. The data were then charted in Microsoft® Excel® and exported for statistical analysis to IBM® SPSS® Statistics version 20. Statistical significance was evaluated using Fisher's exact test.

#### **RESULTS**

Data were obtained from the medical records of 59 patients who underwent ablation of lung metastases from colorectal cancer. The gender distribution was homogeneous (30 men and 29 women), and mean age was 60.8 years. In 31 cases the initial location of the cancer was in the rectum, in 17 in the sigmoid, and in 11 in the colon and cecum. Before ablation, 50 patients had had a chemotherapy cycle, and 11 had had a surgical resection. RFA was performed in 58 patients, and MWA in 1. There were no complications in 55 patients, and 4 had pneumothorax. The number of nodules ablated varied, as follows: 1 nodule in 40 patients, 2 in 10 patients, 3 in 4 patients and 4 in 5 patients. There was recurrence in 27 patients: 2 local and 25 distant. There was no statistically significant association between KRAS gene mutation and local ( $p$  0.407), distant ( $p$  0.710) or global ( $p$  0.999) recurrence. There was no statistically significant association between local recurrence ( $p$  0.999) and proximity to the bronchi or vessels. The chemotherapy-free interval was 19.3 months (95% CI: 14.8-23.8), and overall survival (OS) at 67 months of follow-up was 49.3% (1-year OS: 93%; 3-year OS: 80%).

#### **CONCLUSION**

Ablation of lung metastases is an effective and safe method. Mutation of the KRAS gene did not show to be a predictive factor in the rate of recurrence of lung metastases from colorectal cancer. Ablation allows an overall survival similar to surgical treatment. The longer chemotherapy-free interval provides better quality of life for patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Mutation of the KRAS gene determines a higher rate of local recurrence after liver ablations, but there was no description in the literature about its influence in pulmonary ablative treatments.

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## Abstract Archives of the RSNA, 2023

T5B-SPIR-6

### Percutaneous Cryoablation of Progressing Extra-abdominal Desmoid Tumors (DT)

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Andrea Vanzulli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the efficacy of percutaneous cryoablation of extra-abdominal desmoid tumors (DT) progressing after first-line treatments, including active surveillance, non-steroidal anti-inflammatory drugs and chemotherapy.

#### METHODS AND MATERIALS

We retrospectively evaluated baseline and post-treatment MRI and/or CT imaging of 19 patients with progressing extra-abdominal DT (average diameter 80,2 mm; range 40-125 mm) treated with percutaneous cryoablation at our Institution between May 2021 and November 2022, with a median imaging follow-up time of 149 days. Response to treatment was evaluated both with standard and modified (m) RECIST1.1 criteria, as tumor shrinkage alone does not take into account tissue viability/necrosis and therefore incompletely describes responses to local treatments. Tumor locations included the cervical district (3), the thoracic (3) and abdominal wall (11), the lumbo-sacral (1) and gluteal region (1).

#### RESULTS

Both standard and modified RECIST1.1 criteria classified all 19 patients as non-progressive. According to standard RECIST 1.1, 16 patients showed stable disease (SD) and 3 patients displayed a partial response (PR). According to modified RECIST criteria, 9 patients presented with SD, 4 patients with PR and one patient with a complete response (CR), with 2 RECIST-SD patients being reallocated to PR and CR categories, respectively. Five patients didn't have adequate pre-treatment imaging and couldn't therefore be categorized with mRECIST. No major periprocedural complications were registered, with 84% of patients reporting significant improvement of symptoms and quality of life.

#### CONCLUSION

Desmoid tumors are rare (5-6 cases/million/year), locally aggressive fibroblastic proliferations characterized by infiltrative growth and a tendency to local recurrence. Although unable to metastasize, DT can cause significant morbidity through invasion of surrounding structures, causing chronic pain, functional impairment, and deformities. Due to high rates of recurrence after surgery and frequent spontaneous regression or stabilization, active surveillance generally represents the first-line treatment. Available therapeutic strategies achieve poor response rates, with many patients suffering from disease progression. In such context, cryoablation is emerging as a feasible and effective treatment to reduce tumor burden of extra-abdominal DT progressing after multiple lines of treatment. Furthermore, we report that mRECIST outperform standard RECIST1.1 criteria to evaluate DT response to cryoablation.

#### CLINICAL RELEVANCE/APPLICATION

To the best of our knowledge, this study represents one of the biggest casuistries of progressing extra-abdominal DT treated with percutaneous cryoablation.

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## Abstract Archives of the RSNA, 2023

T5B-SPIR-7

### Response Post Local Tumor Ablation in HCC is Dependent Upon Interferon-gamma Linked Pathways with Associated C-X-C Chemokine Ligand Family Proteins

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Maurice M. Heimer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To uncover post-therapeutic systemic pathways and their potential as biomarkers in HCC patients treated by CT-guided local tumor ablation.

#### METHODS AND MATERIALS

Twenty-four consecutive HCC patients treated with CT-guided high-dose rate brachytherapy (HDR-BT) (1x15 Gy) were included in this prospective IRB-approved study. Ninety-two proteins were quantified in blood samples acquired at baseline and 48hr post-HDR-BT and analyzed with a multimarker tool (Olink proteomics Target 96 immuno-oncology panel with Proximity Extension Assay technology). Ratios post-therapy in comparison to baseline (reported as fold change; FC) were calculated to detect a threshold of 30 % elevation or decrease. Patients were classified as responders (R, n=12) in absence of local progression within 6m and no systemic progression within 2yr observed on follow-up MRI or CT imaging. Non-responders (NR, n=12) had recurrence within 6m and/or tumor progression with more than 3 nodules or individual lesion diameter more than 3 cm or extrahepatic disease within 2yr. Statistical analyses was performed comparing the two groups using paired and unpaired t-tests.

#### RESULTS

For all patients regardless of outcome, the most prominent pathway change was a decrease in interferon-gamma (IFN- $\gamma$ , FC 0.48,  $p=0.001$ ) and 2 downstream members of the CXC family (CXCL9 FC 0.73,  $p=0.001$  and CXCL10 FC 0.65,  $p=0.001$ ). Moreover, non-responders showed increased values in pro-neutrophil and angiogenic CXCL5 in comparison to a decrease for responders (NR FC 1.51, R FC 0.78,  $p=0.043$ ) and increased values in pro-tumorigenic CXCL12 in comparison to responders (NR FC 1.06, R FC 0.89,  $p=0.042$ ). Accompanying CXCL5, granzyme-B, an additional neutrophil marker was significantly decreased in responders (FC 0.57,  $p=0.003$ ), but unchanged in non-responders (FC 1.01,  $p=0.942$ ). No significant differences were seen between responders and non-responders for other IFN- $\gamma$  pathway-associated proteins including CXCL1, CXCL9, CXCL10, CXCL11 and CXCL13.

#### CONCLUSION

HDR-BT induces decreases of circulating IFN- $\gamma$  and associated pathway chemokines potentially contributing to inhibition of immune cell infiltration, alteration of neutrophil activation, and angiogenesis post-therapy. Chemokine ligands CXCL5 and CXCL12 may enable differentiation between responders and non-responders post-therapy and potentially serve as biomarkers for response prediction.

#### CLINICAL RELEVANCE/APPLICATION

Elucidating the molecular pathways associated with interventional oncologic therapies can potentially generate biomarkers predicting outcome and offer rational targets for combination adjuvant therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPMK-1

### High-Resolution Bone Image from Shoulder MRI using Deep Neural Network on 3-D Accelerated Dixon GRE (CAIPIRINHA Dixon)

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jooyeon Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To test the feasibility of generating high-resolution bone image resembling CT from shoulder 3-D CAIPIRINHA Dixon MRI data using deep neural network.

#### METHODS AND MATERIALS

In this IRB-approved retrospective study, patients with 3.0T MRI for shoulder pain were enrolled. Those without CT or 3D VIBE CAIPI-DIXON were excluded. The 3D VIBE CAIPI-DIXON protocol was ; TR/TE 12.7 /2.5,+3.6ms; FA 10°; FOV 159 x 159 mm; spatial resolution 0.4x0.4 mm<sup>3</sup>; acquisition time 3.02 min (Magnetom Vida, Siemens Healthineers, Germany). The dicom files were reconstructed using a commercially available DNN-based denoising and resolution enhancement algorithm (SwiftMR, AIRS Medical, Korea). The in-phase and opposed phase CAIPI-Dixon original PACS image ("CAIPI-i-ori", "CAIPI-o-ori"), and the corresponding CAIPI-Dixon after DNN processing images ("CAIPI-i-dn", "CAIPI-o-dn") were viewed after gray-scale inversion, and quantitatively and qualitatively evaluated by two radiologists. The images were first orthogonally rotated to measure the diameters of the glenoid. Studies were scored from 1 to 5 for the clarity of the cortical outline and trabecular bone of the humeral head and glenoid, any pseudolesion, visibility of fractures. The humeral head, glenoid neck, deltoid, and infraspinatus muscles were marked with regions of interest. ROIs were drawn on vacant quadrants for noise. CT was used to compare the glenoid dimension measurements, ROI values, SNR, and CNR. For statistical analysis, Kruskal-Wallis and Spearman tests were used ( $p < 0.05$ ).

#### RESULTS

Final group included 10 patients (4 females, mean age 60.6 years). The glenoid diameters measured from CAIPI-i-dn, o-dn, CAIPI i-ori, o-ori, and CT did not differ significantly ( $p > 0.05$ ). CAIPI-i-dn, o-dn, and CAIPI-o-ori had higher humerus cortical scores than CAIPI-i-ori ( $4.94 \pm 0.236$ ,  $3.611 \pm 0.195$ ,  $4.39 \pm 0.916$ , vs  $3.00 \pm 0.29$ ). CAIPI-i-o-dn showed higher glenoid cortical scores than CAIPI-i-o-ori ( $4.17 \pm 1.043$  than  $3.56 \pm 1.247$ ,  $p < 0.05$ ). SNR of humerus and glenoid significantly improved with CAIPI-dn compared to CAIPI-ori (4 from 1.07,  $p < 0.05$ ). CT density negatively correlated with CAIPI-o-dn ROI in the humerus and glenoid (correlation coefficient -53.3, and -60.3,  $p < 0.05$ ). ICC value of the semiquantitative scores of CAIPI-i- o-dn (eg. cortical and trabecular outline) was 79.5 among the two readers. ICC value of quantitative scores (eg. ROI) was 96.4 ( $p < 0.05$ ).

#### CONCLUSION

Combining 3D VIBE CAIPI-DIXON MRI and the DNN algorithm enabled high resolution cortical and trabecular bone imaging.

#### CLINICAL RELEVANCE/APPLICATION

High resolution CT-like bone images could be generated from 3D MRI with DNN processing. Cortical and trabecular information can be obtained. Quantification may be comparable to that of CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPMK-2

### Multivariable Logistic Regression Analysis of Risk Factors for Pericollapse Stage of Osteonecrosis of the Femoral Head: Collapse-related Changes with CT and MRI

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Ji Young Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to determine the diagnostic values of collapse-related changes to distinguish between Association Research Circulation Osseous (ARCO) stage 2 and 3A (named as pericollapse stage) in patients with osteonecrosis of the femoral head (ONFH).

#### METHODS AND MATERIALS

A retrospective analysis was conducted in 124 hips with ONFH of either ARCO stage 2 ( $n = 49$ ; 23 females; mean age, 50.7 years) or 3A ( $n = 75$ ; 20 females; mean age, 53.2 years), in patients who underwent CT and MRI from May 2017 to August 2022 in our hospital. We assessed four types of collapse-related changes; on CT- 1) bone resorption area, 2) cystic change, and on MRI- 3) bone marrow edema, 4) joint effusion. We compared these collapse-related changes between stage 2 and 3A, analyzed the diagnostic performance of each variable for detecting stage 3A, and finally performed multivariate analysis to find the best predictor variable for stage 3A. ARCO stage 3A referred to the pericollapse stage as a period from the occurrence of subchondral fracture to early collapse ( $=2\text{mm}$ ).

#### RESULTS

All four types of collapse-related changes were significantly more common in stage 3A than in stage 2 (bone resorption area [72.0% vs. 4.1%]; cystic change [52.0% vs. 0.0%]; bone marrow edema [93.5% vs. 43.6%]; joint effusion [76.0% vs. 24.5%],  $p < 0.001$  in all). The sensitivity, specificity, and diagnostic accuracy for stage 3A were 72.0%, 96.0%, and 81.0% for bone resorption area; 52.0%, 100%, and 71.0% for cystic change; 93.0%, 56.0%, and 76.0% for bone marrow edema; and 76.0%, 76.0%, and 76.0% for joint effusion. In the multivariate analysis, bone resorption area (OR=32.952,  $p=0.002$ ), cystic change (OR=26.281,  $p=0.008$ ), and joint effusion (OR=9.603,  $p=0.004$ ) were independent predictors of stage 3A. Combination model of bone resorption area and cystic change showed the best area under the curve (AUC, 0.900) for stage 3A.

#### CONCLUSION

Collapse-related changes were significantly more frequent in stage 3A than in stage 2. Bone resorption area and cystic change were highly specific findings favoring stage 3A, while bone marrow edema and joint effusion were highly sensitive findings for stage 3A. Among them, bone resorption area was the best single predictor for stage 3A by multivariate logistic regression analysis. Combination of bone resorption area and cystic change was the best model in diagnosis of stage 3A with AUC of 0.900.

#### CLINICAL RELEVANCE/APPLICATION

The accurate diagnosis of ARCO stage 3A is essential for future treatment plan in ONFH. It is often difficult to clearly distinguish this pericollapse stage by subchondral fracture alone. Imaging findings of collapse-related changes on CT and MRI can help to detect stage 3A as pericollapse period.

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## Abstract Archives of the RSNA, 2023

T5B-SPMK-3

### Application of Deep Learning Reconstruction Algorithm (AiCE) in Low-dose CT Scanning of Sacroiliac Joints

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Likun Cao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the effect of deep learning reconstruction(DLR) in improving the image quality and reducing radiation dosage of low-dose sacroiliac joint CT scans by comparing with hybrid iterative reconstruction(HIR).

#### METHODS AND MATERIALS

A total of 76 patients who underwent sacroiliac joint CT scans in our hospital from May 2021 to March 2022 were prospectively included. All patients gave written informed consent for the acquisition of low-dose CT(LDCT) after a clinically indicated standard-dose CT(SDCT). The SDCT series were reconstructed with HIR and the LDCT were reconstructed with DLR and HIR. The effective dose(ED) and size-specific dose estimate(SSDE) were calculated. All images were evaluated objectively, including the background noise(BN) of images, signal to noise ratio(SNR) and contrast to noise ratio(CNR) of the first sacral vertebra and iliac bone. Subjective 5-point Likert scale was used to score the reconstructed images of the three groups, and bilateral sacroiliac joints were graded according to the New York classification standard. All patients were divided into 3 groups(normal weight, overweight and obese groups) according to the BMI. The differences of objective and subjective evaluation were compared among the 3 kinds of reconstructed images.

#### RESULTS

The ED and SSDE of LDCT were significantly lower than those of SDCT ( $p < 0.001$ ) and the reduction rates of ED and SSDE increased with the increase of the BMI. The BN, SNR, CNR and subjective scores showed significant differences ( $p < 0.001$ ) among SD-HIR, LD-HIR and LD-DLR images. The BN values were lower, and SNR and CNR values were higher on LD-DLR than those of SD-HIR and LD-HIR images ( $p < 0.05$ ). The subjective scores of LD-DLR images were significantly higher than those of LD-HIR images ( $p < 0.001$ ), and had no significant differences compared with SD-HIR ( $p = 0.808$ ). In addition, the diagnostic consistency of SD-HIR and LD-DLR images for sacroiliac arthritis grading was superior with Kappa value = 0.888 ( $p < 0.001$ ).

#### CONCLUSION

The use of DLR can reduce the radiation dose and improve the image quality of sacroiliac joint CT, with comparable efficacy of diagnosis to HIR. Thus, DLR algorithm is helpful to improve the safety of CT scanning of sacroiliac joint.

#### CLINICAL RELEVANCE/APPLICATION

The DLR algorithm, Deep Learning Reconstruction algorithm(AiCE), can help improve image quality and detect sacroiliac joint diseases with extremely low radiation dose for pelvis area of patients.

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## Abstract Archives of the RSNA, 2023

T5B-SPMK-4

### Anatomic Variants of the Acetabular Labrum of the Hip

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Brandon Knight, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The acetabular labrum is a ring of fibrocartilaginous tissue continuous with the distal edge of the acetabulum and completed inferiorly in its arc by the transverse acetabular ligament. Tears of the acetabular labrum can occur due to various factors and are diagnosed by clinical signs and imaging. Because of their similar appearance on imaging to non-pathologic labral variants, such as labral sulci, proper differentiation of labral tears from non-pathologic anatomic variants is essential for correct diagnosis and prevention of unnecessary treatment. However, few studies have collected observational data on labral sulci. This study aimed to observe the prevalence and locations of non-pathologic anatomic variants of the acetabular labrum, including sublabral sulci and transverse sulci. Teaching points will also be highlighted in the identification of sulci.

#### METHODS AND MATERIALS

Hip MR imaging from 109 patients who presented to our hospital system for hip arthroscopy was retrospectively analyzed. Surgical findings were used to determine the presence of labral tears, while MR imaging was available and reviewed for all cases to determine the presence of labral sulci, which was then confirmed by surgical findings of labral sulci or by a lack of abnormal surgical findings at that location (with imaging findings being analyzed alongside surgical findings when available). Prevalence, location, and other attributes were observed of these anatomic variants, as well as of labral tears and paralabral cysts.

#### RESULTS

After retrospective analysis, 130 acetabular labral tears out of 135 total cases were found in surgery, with 19% of those cases associated with paralabral cysts. A total of 43% of the patient population was observed to have at least one sublabral sulcus. The majority of sulci were found in the posteroinferior quadrant. Among all patients a total of 64 sublabral sulci were found, with some patients presenting with multiple sulci unilaterally or bilaterally. In 44% of cases, 49% of patients displaying at least one transverse sulcus were found on imaging.

#### CONCLUSION

Normal anatomic variants occur commonly in the hip joint, including sublabral sulci and transverse sulci, and may be mistaken on imaging for acetabular labrum tears. Understanding their prevalence improves the proper differentiation of these anatomic variants from labral tears, increasing the specificity of acetabular labral tear diagnosis and thus decreasing false positive rates and improving patient outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Acetabular labral tears account for a large proportion of groin/hip pain patients and may be mistaken for sulci on imaging. Properly differentiating labral sulci and labral tears on imaging increases the specificity of labral tear diagnosis.

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## Abstract Archives of the RSNA, 2023

T5B-SPMK-5

### Additional Pain Generators on Lumbosacral Plexus Magnetic Resonance Neurography

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Hanna Tomsan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Pain in sciatic nerve distribution is a common cause of disability worldwide with a reported prevalence of 43%. Identifying the cause of sciatica-type symptoms is clinically problematic, particularly when the symptoms are non-discogenic in origin. Magnetic resonance imaging (MRI) of the lumbosacral plexus has become a study of choice for sciatica, providing excellent anatomic detail and allowing comprehensive assessment of peripheral nerves, however, it demonstrates positive nerve findings in only 36-45% of patients according to literature. Our aim was to evaluate the prevalence of additional pain generators in patients undergoing lumbosacral plexus MRI, that commonly contribute to sciatica symptoms.

#### METHODS AND MATERIALS

A retrospective review of 125 lumbosacral plexus MRI examinations performed from September 2015 through September 2022 on a 3T scanner was undertaken. The studies were independently reviewed in a blinded fashion by 3 radiologists. The findings were graded on a 0-3 scale depending on the presence or absence of particular non-neurologic pain confounders and the diagnostic quality of the study. Fleiss' Kappa (FK) was used to evaluate the interreader agreement.

#### RESULTS

The presence of additional pain generators was demonstrated in 91% of examinations. Common etiologies observed included labral tears (62.4%, FK 0.7), hamstring tendinopathy/tears (57.6%, FK 0.72), gluteus tendinopathy/tears (56%, FK 0.63), greater trochanteric bursitis (40%, FK 0.65), ischiofemoral impingement (20.8 %, FK 0.75), sciatic nerve compression or variant anatomy (11.2%, FK 0.77), paralabral cysts (8%, FK 0.8), and moderate/severe hip osteoarthritis (8%, FK 0.72). Other incidental findings observed included disc herniation with nerve root compression (4%), sacral insufficiency fractures (1.6%), femoral head avascular necrosis (0.8%), and calcific tendinosis (0.8%). Of note, lumbosacral nerve abnormalities were only detected in 48% of the study group.

#### CONCLUSION

Lumbosacral plexus MRI examinations permit accurate detection and localization of additional pain generators in patients with non-discogenic sciatica. Our study demonstrated substantial interreader agreement regarding the presence or absence of sciatica/buttock pain confounders and a high level of confidence in their detection by radiologists.

#### CLINICAL RELEVANCE/APPLICATION

Extra-neural causes of sciatica can be consistently identified on lumbosacral plexus MR neurography studies, both on conventional T1/T2-weighted and lumbosacral plexus-specific series. This becomes particularly important when no nerve pathology is detected, as it can serve as a cost-effective initial imaging strategy.

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## Abstract Archives of the RSNA, 2023

T5B-SPMK-6

### Deep Learning-based Fully Automated Fat Quantification of the Supraspinatus Muscle on MRI

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Woonyoung Baek, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purposes were to (1) measure the total volume and fat-fraction (FF, %) of the supraspinatus muscle (SSm) with deep learning (DL)-based fully automated fat quantification algorithm from a 6-point Dixon sequence according to retraction grade and tear severity; and (2) determine the whether the standard assessment for muscle fatty infiltration at a single image slice is representative.

#### METHODS AND MATERIALS

Between December 2020 and November 2022, 107 patients were retrospectively enrolled in this study with extended oblique sagittal T1-weighted images and FF map generated from 6 point Dixon sequence including total SSm. A DL-based fully automated muscle segmentation using a FF map was developed by modifying our institute's previously developed muscle segmentation method. The total volume and fat content of SSm were obtained from this algorithm. The FF at a single image slice was measured by manually drawing an ROI at a Y view or Fossa view (2~3 slices medial to Y view). Then, the FF of SSm at a single slice image (FFy or FFfo) and total MR slices (FFt) were compared. The influence of retraction grade and tear severity was evaluated.

#### RESULTS

Total supraspinatus volume and fat fraction were easily measured with a DL-based fully automated segmentation algorithm using a FF map. A comparison of FFy, FFfo and FFt was done by using the Wilcoxon signed rank test ( $P < 0.001$ ). There was significant difference if FFy was included, and no significant difference between FFfo and FFt. Dividing the patients by retraction grade and fat degeneration grade, there was significant difference in grade 0 of retraction ( $P < 0.001$ ) and grade 1 of fat degeneration ( $P < 0.001$ ). Dividing by tear severity, there was significant difference in patients with no tear ( $P < 0.001$ ) and partial tear ( $P = 0.014$ ). Regarding the FFt as the gold standard, we verified the value of Y view and the proposed method (fossa view). Both methods showed high correlation with FFt (Y-view correlation coefficient = 0.894 ( $P < 0.001$ ) and fossa view correlation coefficient = 0.874 ( $P < 0.001$ )). But the precision is slightly decreased at proposed method, referring to Bland-Altman plot.

#### CONCLUSION

Regardless of retraction grade and fat degeneration, the FF evaluated through the proposed method provides a better representation of the total FF of the entire SSm than the conventional method with high accuracy. However, the precision was slightly lower than Y view.

#### CLINICAL RELEVANCE/APPLICATION

DL based automatic quantification could allow accurate and rapid fat quantification of total SSm. If we should choose to pick one MR slice instead of measuring the fat fraction of the entire SSm, fossa view could be a better representation than conventional view. It could be a more accurate preoperative factor to predict surgical outcome.

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## Abstract Archives of the RSNA, 2023

T5B-SPMK-7

### CT with Tin-filtration for Bone Imaging: Dose Optimization using an Ex-vivo Pig Model

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Renxin Chu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

CT via tin-filtration (CTTF) is an effective strategy in reducing radiation dose without sacrificing image quality. A parametric study via an ex-vivo pig model may be the most clinically relevant approach to better understand the trade-off between image quality and radiation dose. As skeletal assessment is a common clinical application for CT, we began by optimizing CTTF for bone imaging. As such, the objective of this study was to utilize an ex-vivo pig model to characterize the image quality of CTTF as a function of radiation dose for bone imaging.

#### METHODS AND MATERIALS

We imaged a pig shoulder (1.7 kg) using Siemens SOMATOM Force dual-source CT scanner at different volume CT dose index (CTDI<sub>vol</sub>). The following parameters were used for image acquisition: tube voltage of 100kV with the tin filter (100Sn), rotation time of 250 ms, and ultra-high pitch of 2.45, and slice thickness of 3 mm. We conducted a parametric study by adjusting the mAs settings to achieve 5 different levels of CTDI<sub>vol</sub>. Specifically, we used the following five mAs settings: 242, 182, 122, 60, and 30. Reconstruction kernel Br69, ADMIRE strength of 3 were used for bone image reconstruction. We used the 3D slicer software to generate the 3D volume renderings. For the CTTF images acquired at each CTDI<sub>vol</sub>, we calculated the contrast-to-noise ratio (CNR) of the bone-to-muscle; and judged the CTTF image quality based on the following three subjective criteria: (1) clarity of the depicted anatomy (i.e., foreground bone versus background soft tissue); (2) image noise; and (3) contours of the 3D surface renderings.

#### RESULTS

The CNRs of bone-to-muscle were 6.9, 6.2, 4.8, 3.4, and 2.9 at CTDI<sub>vol</sub> dose levels of 0.8 mGy, 0.6 mGy, 0.4 mGy, 0.2 mGy, and 0.1 mGy, respectively. However, despite this decreasing CNR, we found that the CTTF images at radiation doses as low as 0.2 mGy were deemed of comparable subjective quality to the CTTF images at the maximum dose of 0.8 mGy.

#### CONCLUSION

Based on our parametric study, we conclude that there was no substantial deterioration in subjective image quality of CT<sub>TF</sub> when the radiation dose was reduced down to CTDI<sub>vol</sub> = 0.2 mGy. We postulated that the inherent high contrast between the foreground bone and the background soft tissue combined with a strong non-linear dose reduction by ADMRE was able to overcome the decreasing CNR to maintain diagnostic image quality at ultra-low radiation dose during CT<sub>TF</sub> bone imaging.

#### CLINICAL RELEVANCE/APPLICATION

The results of our study are the initial steps in optimizing CT with tin-filtration for bone imaging.

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## Abstract Archives of the RSNA, 2023

T5B-SPMK-8

### Clinical and MRI-based Radiomics Models for Predicting Hidden Blood Loss during Surgery for Spinal Metastasis

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Weili Zhao (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the role of clinical and MRI-based radiomics models for predicting the risk of hidden blood loss (HBL) in patients undergoing spinal metastasis surgery.

#### METHODS AND MATERIALS

Consecutive patients who underwent surgery for spinal metastasis between January 2018 and December 2021 at our institution were retrospectively analyzed. Baseline demographic, clinical, and surgical data were collected. HBL was calculated using the Gross formula. Potential clinical risk factors were accessed using univariate and multivariate logistic regression analyses. Radiomics features were extracted from sagittal T1-weighted and fat-suppressed T2-weighted imaging sequences, and manual delineation was performed by two radiologists. The datasets were Z-score normalized, and features with intraclass correlation coefficient values  $\leq 0.80$  were excluded. The least absolute shrinkage and selection operator method was employed for optimal feature selection. Clinical, radiomics, and combined clinical-radiomics models were established. Clinical utility of the best prediction model was evaluated using calibration and decision curves.

#### RESULTS

A total of 202 patients were included, 149 and 53 of whom were classified as low and high HBL. Extraspinal metastases, New York Heart Association grade, operation site, and operation time were identified as independent predictors of high HBL ( $P < 0.05$ ). The best predictive efficacy was shown in the combined clinical and T2WI-based radiomics model (AUC value of 0.893 and 0.816, and ACC of 80.2% and 77.3% respectively in the training and validation cohort). Additionally, the proposed clinical-radiomics nomogram demonstrated good clinical utility.

#### CONCLUSION

Our combined clinical-radiomics model may serve as a promising prediction tool for the risk of HBL in patients undergoing spinal metastasis surgery, and guide perioperative planning to improve surgical outcomes.

#### CLINICAL RELEVANCE/APPLICATION

- Our study aimed to develop and evaluate the predictive efficacy of clinical and MRI-based radiomics models for high HBL during spinal metastasis surgery.
- The combined clinical and T2WI-based radiomics model achieved the best predictive performance in both the training and testing cohorts.
- Our proposed clinical-radiomics nomogram demonstrated promising clinical utility in guiding the indications of preventative and treatment interventions in such patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPMK-9

### Musculoskeletal Diffusion Tensor Imaging in Adolescent Elite Rowers and Association of Imaging Findings with Rowing Technique

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jonas Alexander Leppig, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Muscular overuse injuries are a common health issue in elite athletes. Changes in the muscular microenvironment can be depicted by Diffusion Tensor Imaging (DTI). We hypothesize that the biomechanics of different rowing techniques plays a role in tissue injury and tested our hypothesis by examining the lumbar spine muscles of adolescent rowers using DTI.

#### METHODS AND MATERIALS

Sixteen male elite rowers underwent 3 Tesla multiparametric MRI of the lumbar spine 6 hours after cessation of training. Axial diffusivity (AD), radial diffusivity (RD), apparent diffusion coefficient (ADC), and fractional anisotropy (FA) were calculated for the erector spinae (ES) and multifidus (MF) muscles. These DTI parameters were correlated with demographic data, training data, and low back pain (LBP) questionnaire scores.

#### RESULTS

ADC values in ES and MF were significantly higher ( $p = 0.039$ ) and FA values significantly lower ( $p < 0.001$ ) in sweep rowers compared to scull rowers. Training-related LBP episodes in the last 12 months were reported by 88.9% of participants. There was no significant association between DTI parameters and training volume or LBP questionnaire scores.

#### CONCLUSION

Our DTI results show that lumbar spine muscle diffusivity is higher in sweep rowers than in scull rowers. Altered muscle diffusivity is suggestive of microscopic tissue disruption and might be attributable to biomechanical differences between rowing techniques.

#### CLINICAL RELEVANCE/APPLICATION

The differences identified with DTI are not detectable with conventional MRI techniques. Therefore, DTI might have a role in the early noninvasive detection of overuse injuries in athletes before symptoms develop.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPMS-1

### Virtual Non-calcium Imaging for Qualitative and Quantitative Assessment of Bone Marrow Involvement in Multiple Myeloma: Our Experience with Dual-energy Computed Tomography

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Alessandro Onori, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to compare the diagnostic performance of virtual non-calcium imaging (VNCA) and Conventional Computed Tomography imaging (CCT) in the evaluation of bone marrow (BM) involvement in patients affected by multiple myeloma and to investigate the impact of VNCA values on patients' prognoses.

#### METHODS AND MATERIALS

In this mono-centred retrospective study, consecutive patients with MM who underwent Dual Energy Computed Tomography (DECT) in the last 12 months were enrolled. Two readers randomly and independently reviewed two datasets of images per patient (VNCA and monochromatic 120kVp-like) for the presence of BM involvement. The number and dimension of BM lesions were compared on a per segment analysis. CT numbers of BM lesions and unaffected bone were measured on VNCA images. Results were stratified according to the disease status (stable or progression).

#### RESULTS

Significantly more lesions (n=748) were identified on VNCA images compared to CCT (n=502) ( $p < 0,0001$ ). No significant differences were observed for lesions' dimensions ( $18,72 \pm 9,68$  mm,  $p = 0,6352$ ). VNCA CT numbers showed a significant difference between lesions in patients with stable disease and lesions in patients with progressive disease ( $-143,67 \pm 202,63$  HU vs  $4,54 \pm 51,95$  HU;  $p = 0,0087$ ). There was almost perfect agreement for both number and dimension of the lesions among readers (ICC = 0.93 [95% CI 0.84-0.71] and ICC = 0.89 [95% CI 0.75-0.96], respectively).

#### CONCLUSION

VNCA is superior to CCT in identifying BM involvement in MM and ROI-based analysis of the lesions could also be an interesting tool for its prognostic implications.

#### CLINICAL RELEVANCE/APPLICATION

VNCA imaging may be a promising technique to easily assess with good confidence the presence of bone lesions in patients with MM. Quantitative analysis and its prognostic implications may be useful for risk stratification and for personalized therapeutical planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPNMMI-1

### **Semi-quantification Approach of Amyloid PET: A Study of Familial Alzheimer's Disease Associated with Heterozygous NPC1 Mutation**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Anna Lisa Martini (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Many studies try to develop model to compare and integrate visual reading of amyloid PET with independent semi-quantification methods. Here we describe new semi-quantification approach of amyloid PET in a family with apparently autosomal dominant Alzheimer's disease (AD) harbouring a novel NPC1 mutation in heterozygous state.

#### **METHODS AND MATERIALS**

All 5 living siblings were evaluated. We performed clinical assessment, neuropsychological tests, genetic analysis, assessment of cerebrospinal fluid markers. Patients n. 1, 2, 4 and 5 underwent early and late amyloid PET that should be read using qualitative analysis but also investigated by innovative visual and automatic semi-quantification analyses using: Standardized Uptake Values Ratio, the ratio of counts in one or more regions of interest to a reference region; Evaluation of Brain Amyloidosis, evaluates the geometric distribution of contrast without fixed, reference or segmentation ROIs and measures the geometric properties of the iso-intensity surfaces, the changes are related to the amyloid burden; Time-delayed ratio, a level of contrast between early and late scans; uptake and baseline ROIs are extrapolated from the early scan and track high-flow districts.

#### **RESULTS**

In 4 of them, a diagnosis of AD was defined according to biomarkers (A+, T+, N+) and serum oxysterol analysis. Early PET images of patients n.1 and 2 showed rather severe hypoperfusion in bilateral temporal, posterior parietal, posterior cingulate and precuneus cortices. In these patients, late amyloid PET images detected high rate of amyloid burden in bilateral frontal, temporal, posterior parietal, precuneus and posterior cingulate areas and final likelihood for positive scan. In patient n.4, early PET scan showed a mild hypoperfusion in left temporal, left posterior parietal and right precuneus cortices. In this patient, late amyloid PET images showed a moderate amyloid accumulation in left temporal, left posterior parietal and left frontal cortices with a positive scan. Finally, slight amyloid accumulation in frontal cortex consistent with negative scan without clear perfusion pattern of AD was found in patient n.5.

#### **CONCLUSION**

The present results demonstrated that early and late acquisitions images supported use of amyloid PET to study cerebral perfusion and amyloid deposition. Finally, the new semi-quantitative approach of amyloid PET provides data on the regional amyloid deposition allowing a better longitudinal evaluation of patients that could benefit from already available drugs against NPC.

#### **CLINICAL RELEVANCE/APPLICATION**

This study supports use of early amyloid PET acquisitions and of this novel semi-quantitative approach on regional amyloid deposition to improved longitudinal assessment of patients.

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## Abstract Archives of the RSNA, 2023

T5B-SPNMMI-2

### **In Vivo Assessment of Regional Tau Deposition, Gray Matter Volume and Cognition in Alzheimer Disease: A Head-to-head <sup>18</sup>F-flortaucipir PET/MR study**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Xinru Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Despite the associations of A $\beta$  deposition with connectivity alterations, atrophy, and cognition, the exact role of tau and regional atrophy on cognition in Alzheimer's disease remains unclear. This study aimed to investigate the relationship between regional tau pathology, gray matter volume in vivo and their effects on cognitive function improving effective clinical trials and future therapeutic strategies for AD.

#### **METHODS AND MATERIALS**

Thirty-four patients with amyloid-positive mild cognitive impairment or dementia and 23 healthy controls underwent standardized clinical and neuropsychological assessments followed by <sup>18</sup>F-flortaucipir positron emission tomography imaging and 3D T1-weighted magnetic resonance imaging. The regional tau standardized uptake value ratio and gray matter volumes (GMV) were measured. Group differences in the two imaging modalities were compared. Partial correlations and mediation analysis were then performed in brain regions showing an association between cognition and both <sup>18</sup>F-flortaucipir uptake and gray matter volume.

#### **RESULTS**

The <sup>18</sup>F-flortaucipir retention was observed in the entorhinal cortex, hippocampus, parietal lobe, temporal lobe, precuneus and posterior cingulate. The regional tau deposition was associated with GMV in medial temporal and lateral temporal regions (range standardized  $\beta$ s of residual=-0.45--0.77,  $p < 0.05$ ) in MCI/AD patients. Both increased <sup>18</sup>F-flortaucipir SUVR and decreased GMV in the medial temporal lobes and medial parietal lobes were related to cognitive impairment. The GMV of the entorhinal cortex and medial parietal lobes mediated the effect of local region <sup>18</sup>F-flortaucipir SUVR on cognitive impairment (mediation effect=0.54,0.93; explained variance=32.86%, 37.94%, respectively). The GMV of the medial parietal lobes and medial temporal lobes mediated the effect of distant region <sup>18</sup>F-flortaucipir SUVR on cognitive impairment (mediation effect=0.75-0.85; explained variance=57.01%-58.14%).

#### **CONCLUSION**

Tau pathology was associated with local and distant areas of brain atrophy in the brains of MCI and AD patients. The mediation analysis enabled data fusion across multiple imaging modalities (PET and MRI), local and distant atrophy played a mediating role between tau binding and cognitive impairment in these patients.

#### **CLINICAL RELEVANCE/APPLICATION**

tau PET/MR can be a potentially useful imaging biomarker for predicting the risk of developing clinical AD based on more than one pathology and determining when is the optimal time for anti-tau target treatment.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5B-SPNMMI-3

### Validation of SSTR2 Expression and Assessing Correlation of Variable F<sup>18</sup>-FDG PET/CT Parameters in EBV Associated Nasopharyngeal Cancer

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Thangalakshmi Sivathapandi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Epstein-Barr virus (EBV), a known nasopharyngeal carcinoma (NPC) driver, promotes somatostatin receptor 2 (SSTR2) expression via NFκB, detectable by immunohistochemistry. To assess the correlation of EBV associated NPC and SSTR2 expression and evaluate the association between F18-FDG PET CT parameters and EBV associated NPC

#### METHODS AND MATERIALS

In this retrospective study done between 2017-2022, SSTR2 immunohistochemistry on our cohort of EBV NPC (n=15), HPV-positive sinonasal SCC (n=7, HPVSCC), and virus-negative sinonasal SCC (n=8, VNSCC), reviewed by two board-certified pathologists. The F18-FDG PET/CT was reviewed by two board-certified nuclear medicine physicians. Histopathology was scored as positive or negative in a binary system. H-score was calculated using the intensity and extent of tumor staining. The association between various parameters of F18-FDG PET/CT (primary tumor and nodes) and SSTR2 expressing EBV positive nasopharyngeal carcinoma were analyzed

#### RESULTS

Using a positive/negative system, 93.3% EBVNPC (n=14/15), 14% HPVSCC (n=1/7), and 25% VNSCC (n=2/8) demonstrated multifocal to diffuse strong SSTR2 expression. The sensitivity, specificity, negative predictive value, and positive predictive values for SSTR2 IHC were 93.3%, 80%, 92.3%, and 82.4%, respectively. The median H-score for EBVNPC was 180 (range 12-295; mean 179), whereas the median H-scores for HPVSCC and VNSCC were 0 (range 0-56; mean 8) and 0 (range 0-125; mean 31), respectively (p<0.001). No significant association was found between SUV max, metabolic tumor volume (MTV) and total lesion glycolysis (TLG) between EBV associated and other types of HNSCC (p value>0.005). The SUV max range for primary tumor was found to be 6.67-29.95 and SUV max range for metastatic nodes was 4.11-25.53. Among the 15 EBVNPC patients 53% of patients had overlap of primary tumor uptake with physiologic FDG brain activity

#### CONCLUSION

EBV associated NPC showed stronger expression of SSTR2 comparing to HNSCC in other subsites. No significant difference in F18-FDG PET/CT parameters between EBV positive NPC and other types of HNSCC. Future directions would include assessing the role of Cu<sup>64</sup>-DOTATATE PET/MRI in evaluation of EBV positive NPC and its impact on radiation therapy planning.

#### CLINICAL RELEVANCE/APPLICATION

The strong correlation between EBV positive NPC and SSTR2 expression infers that Ga68/Cu64- DOTATATE PET imaging could be a valuable tool in accurate staging, therapy planning and surveillance of these patients. Peptide receptor radionuclide therapy (PRRT) using therapeutic nuclide-labeled DOTA-peptide may be a potential therapeutic tool in these patients with metastases

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## Abstract Archives of the RSNA, 2023

T5B-SPNPM-1

### **Radiologist's Impact on the Frequency of Pediatric Head CT for Trauma: A Machine Learning Model Analysis using a Nationwide Claims Database**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Kanako K. Kumamaru, MD, PhD (*Presenter*) Research Grant, General Electric Company

#### **PURPOSE**

The purpose of this study is to develop a machine-learning model that can predict factors that independently affect the frequency of pediatric head CT for trauma (pHCTT). The study also aims to evaluate the impact of the number of radiologists per population (radiologist density) on the frequency of pHCTT.

#### **METHODS AND MATERIALS**

The study used data on the number of outpatient pHCTT performed in 254 medical areas in Japan for the fiscal year 2020, extracted from the national open database of health insurance claims. Over a hundred regional variables, such as population, number of hospitals, and number of pediatricians, were used to train 34 algorithms to predict the number of pHCTT per 10,000 child population, without including radiologist density measure. The best-performing machine-learning algorithm, based on poisson deviance ranking, was then identified. We compared the radiologist density between medical areas that exceeded the predicted pHCTT frequency and those that fell below the prediction, as an indicator of radiologist's impact on pHCTT frequency.

#### **RESULTS**

A total of 18,313 outpatient pHCTT were performed in 2020 in Japan, with a large variability in the number of pHCTT per 10,000 child population across medical areas (range: 0-114, median: 2.94). The random forest regressor model showed the highest prediction power with a poisson deviance of 11.61 on cross-validation, identifying total population density, the proportion of elderly people, the total number of stroke care units, growing care units, and CT examinations per population as strong predictors. The number of doctors working in clinics per population also had a significant influence on the prediction. The radiologist density was significantly lower in the medical areas where pHCTTs were performed more frequently than predicted, compared to the medical areas where pHCTTs were performed below the prediction (radiology density, median (IQR): 27.5 (19.5, 49.5) vs. 48 (22, 76),  $p=0.037$ ).

#### **CONCLUSION**

The number of pHCTT per child population varied significantly across different medical areas. In medical areas where pHCTTs were performed more frequently than predicted by the machine-learning algorithm, the radiology density was lower, which may suggest the impact of radiologists on appropriate pediatric imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

Increasing the number and involvement of radiologists may reduce the variability in the frequency of pediatric head CT for trauma and promote appropriate utilization.

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## Abstract Archives of the RSNA, 2023

T5B-SPNPM-2

### Computed Tomography-based Sarcopenia: Diagnostic Cutoff Values in Patients with Chronic Liver Disease and Mortality: A systematic Review and Meta-analysis

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Joao Rafael T. Vicentini, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Sarcopenia is a known complication of patients with Chronic Liver Disease (CLD). The assessment of psoas muscle mass by Computed Tomography (CT) can be done using the Psoas Muscle Index (PMI). This method is easy to perform using regular CT scans and not easily altered by ascites. We aimed to investigate the influence of sarcopenia diagnosed by CT using the PMI method as a predictor of mortality in patients with CLD after liver transplantation.

#### METHODS AND MATERIALS

The protocol was registered with the international prospective register of systematic reviews (PROSPERO CRD42022370684). We systematically searched PubMed, Scopus, and Cochrane Central Register of Controlled Trials from inception to November 2022 with the following search terms: (sarcopenia OR muscle mass OR psoas muscle) AND (chronic liver disease OR CLD OR cirrhosis OR liver transplantation OR liver transplant) AND (Computed Tomography OR CT OR psoas muscle). Cochran's Q test and I2 statistics were used to assess for heterogeneity; P values inferior to 0.10 and I2 > 25% were considered significant for heterogeneity. We used a fixed-effect model for outcomes with low heterogeneity (I2 < 25%). We calculated standard effect estimates and random effects (odds ratio) for meta-analysis with binary outcome data. Clustering was performed by the Mantel-Haenszel method.

#### RESULTS

The initial search yielded 1,414 results. After removal of duplicate records and ineligible studies, 163 remained and were fully reviewed based on inclusion criteria. Of these, a total of 11 studies were included in qualitative synthesis and 4 studies were included in quantitative analysis (meta-analysis) comprising 382 patients. Patients diagnosed by CT scan using the PMI method with muscle mass loss after liver transplantation had a 4.1 times higher risk of death than non-sarcopenic patients (Random effects model OR 4.1386; 95% CI 2.4215- 7.0730; P < 0.0001). Heterogeneity among studies was assessed by visual inspection of the graphs, the I2 statistic, Cochran's Q test, and Tau2. Interpretatively, a scale with an I2 value close to 0% indicates no heterogeneity. The other criteria also did not reject the hypothesis of homogeneity among the articles.

#### CONCLUSION

Patients with sarcopenia diagnosed by CT using the PMI method had a fourfold increase in mortality risk after liver transplantation.

#### CLINICAL RELEVANCE/APPLICATION

The findings reinforce the need to identify sarcopenic patients preoperatively to optimize liver transplantation outcomes. Opportunistic diagnosis by CT using Psoas Muscle Index (PMI) can be helpful in this setting.

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## Abstract Archives of the RSNA, 2023

T5B-SPNPM-3

### Autonomous AI-based CXR Interpretation for Predicting Congestive Heart Failure: A Multicenter Study

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Favorable treatment outcomes of a progressive disease like heart failure (HF) depend on early detection. We conducted a multicenter study to assess if an autonomous AI model can help identify chest radiography (CXR) signs of HF in patients without a previous cardiovascular history or diagnosis.

#### METHODS AND MATERIALS

Our retrospective, standalone study included 1455 patients (age range 69 +- 13 years; M:F 670:785) with an AP/PA CXR. A total of 751 patients had the CXR taken within one year before their HF diagnosis. The rest (n= 704) of the CXR were selected from patients without any NT-proBNP exam, echocardiography or HF diagnosis after the radiological examination date. All patients belong to 17 sites including two quaternary care hospitals and 15 community hospitals and outpatient clinics. 1455 deidentified CXRs were processed with the AI algorithm for HF (qXR-HF, Qure.AI) to obtain information on enlarged cardiac silhouette, pleural effusion, and an HF-index. CXRs were stratified based on their lead time from HF diagnosis (<3 months, 3-6 months, 7-9 months, 9-12 months). Data were analyzed using R version 3.6.2 to derive accuracy, sensitivity, specificity, and area under the curve (AUC) for the receiver operating characteristics (ROC).

#### RESULTS

Among the 1455 patients, 751 patients had HF while the remaining 704 patients did not have HF. We report 0.80 ROC AUC (95% CI 0.78-0.82), 0.70 accuracy, 0.57 sensitivity, and 0.83 specificity for the overall AI performance for predicting HF. AI AUCs (< 3 months: 0.83; 4-6 months: 0.81, 7-9 months: 0.79, 10-12 months: 0.79), specificity (constant: 0.83) and accuracy (0.77-0.78) remained stable, but sensitivity declined with increasing lead time from HF diagnosis (< 3 months: 0.6; 10-12 months: 0.5). The performance of CXR-AI derived HF index was significantly higher compared to enlarged cardiac silhouette (0.75) and pleural effusion (0.74,  $p < 0.01$ ).

#### CONCLUSION

Our autonomous AI model can help identify signs of HF up to 12 months prior to the clinical diagnosis of HF with a high and consistent AUC and accuracy, regardless of patient gender, age group (>45 years), and imaging site.

#### CLINICAL RELEVANCE/APPLICATION

Detection of HF signs with an autonomous CXR-based AI algorithm can help in early diagnosis and treatment of unsuspected HF.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-1

### Systematic Review of the Determination of EGFR Status in Glioblastomas by Feature Characterization on MR

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Joseph Duero (*Presenter*) Nothing to Disclose

#### PURPOSE

Glioblastoma (GBMs) is the most common and deadly type of adult brain tumor. The clinical treatment for GBMs varies depending on genetic profile. There has been a push to identify imaging markers of genes implicated in GBMs. Epidermal growth factor receptor (EGFR) represents one such gene. Multiple studies have described relative cerebral blood volume (rCBV) as a potential marker for EGFR status, but a systematic review of those studies has not been performed. The objective of this review is to objectively summarize the current literature on the potential for rCBV to serve as a marker for EGFR status in patients with diagnosed GBM.

#### METHODS AND MATERIALS

A systematic review was conducted following PRISMA guidelines with a strategy to identify articles pertaining to radiologic markers of GBM. Examples of pertinent MeSH terms to be used are as follows: "glioma", "glioblastoma", "EGFR", "epidermal growth factor receptor", and "magnetic resonance imaging." Studies were included or excluded based on pre-established criteria. A primary review will be conducted by two separate independent researchers blinded to each other's results to determine which papers meet inclusion/exclusion criteria. Discrepancy between reviewers will be resolved via consensus. The bias of studies will be assessed via QUADAS2 bias assessment tool.

#### RESULTS

A preliminary review was conducted to collect papers from Pubmed and Scopus databases. This search resulted in 14 papers eligible for primary review, including 1864 of tumors, with (818) EGFR amplified and (1046) EGFR wild type tumors. Chi square analysis will be done to compare cerebral blood volumes and/or tumor location. Odds ratios and forest plots will be generated for inter group comparisons.

#### CONCLUSION

Based on preliminary review, a direct correlation is expected to be observed between eGFR amplification and increased rCBV. Significant differences in location, diffusion coefficient, transfer coefficient, and relative plasma volume may also be shown.

#### CLINICAL RELEVANCE/APPLICATION

Identifying rCBV as a radiologic marker of EGFR status in GBM patients will allow for non-invasive and faster identification of the best treatment plan.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-10

### BT-RADS Posttreatment Brain Tumor Response: An Interobserver Agreement Analysis

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Fabiano Reis (*Presenter*) Nothing to Disclose

#### PURPOSE

In recent years, synoptic reporting has been shown to improve the consistency, reproducibility, quality, readability, and clarity of radiological reports; which is supported by the success of previous models such as BI-RADS. In light of these favorable results, Weinberg et al proposed a brain tumor reporting data system (BT-RADS) to assess the treatment response of brain tumors. In this study, we evaluate the consistency of the BT-RADS model by measuring the agreement of the reports between two radiologists.

#### METHODS AND MATERIALS

We compiled a list of brain MRI studies from patients with brain tumors, along with relevant medical records, and provided it to two radiologists for categorization. The first one had one year of experience as a radiologist, while the second one, a university professor specialized in neuroradiology, had over thirteen years of experience. For each study, the radiologists gave a report based on the BT-RADS model unbeknownst to the score given by their peers in the same studies.

#### RESULTS

Both radiologists reviewed 85 exams, of which 23 were BT-RADS 0 by default. The BT-RADS 0 score is meant for studies that will serve as a baseline for future studies; this includes the first study after surgery or before chemoradiotherapy. Sixty-two studies remained for analysis. We applied Cohen's Fleiss' kappa to measure inter-rater reliability between the two radiologists. The Cohen's kappa value was equal to 0.94, with a confidence interval of 95% and an alpha value of  $p=0.05$ . The lower bound was 0.88, while the upper bound was 0.99. We also calculated Fleiss' kappa for each category, and each showed a high agreement rate, except for category 3c.

#### CONCLUSION

Our analyses showed a strong inter-rater reliability agreement despite the difference in experience between the two observers.

#### CLINICAL RELEVANCE/APPLICATION

The BT-RADS demonstrated a high inter-observer agreement rate, despite the experience gap between the two radiologists. This finding is promising for the validation of BT-RADS for future broad use. The BT-RADS model is still in development, so some changes in its protocol are still expected to happen.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-11

### Leveraging CT Imaging and Machine Learning: Enhancing Prognostic Accuracy for Functional Outcomes in Anterior Circulation Large Vessel Occlusion Stroke Patients

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to predict the functional outcome of acute ischemic stroke patients with anterior circulation large vessel occlusions (LVOs) using only imaging parameters in machine learning (ML) models, regardless of how they were treated or the severity of the stroke at admission, and to investigate the precision of imaging parameter utilization in ML models.

#### METHODS AND MATERIALS

Patients with acute ischemic stroke (AIS) due to anterior circulation LVO, as confirmed by computed tomography angiography (CTA) and CT perfusion (CTP) scans, were screened in this retrospective study. Demographic and clinical data, such as sex, age, race, admission NIHSS score, modified Rankin Score (mRS) at 90 days, and treatment information, were extracted. Radiological variables were collected by a neuroradiologist, who recorded the spatial location, and assessed the baseline ASPECTS, occluded vessel, occluded segment, occlusion laterality, and presence of hyperdense MCA. Additional data, such as rCBF, Tmax, CBV, mismatch volume, mismatch ratio, hypoperfusion index, DSA collateral score, clot burden score, single-phase CTA collateral score, and multiphase CTA collateral score, were extracted. These data were used as input, and the outcome was mRS at 90 days, which was dichotomized as mRS 0-2 (good outcome) and mRS 3-6. To address missing data, imputation techniques were employed for both infinite values and missing values using k-nearest neighbor imputation. The sample was divided into training (60%), validation (20%), and test (20%) sets. CatBoost, XGBoost, and Random Forest ML algorithms were employed. The SHAP method was employed to determine the relative importance of predictor elements.

#### RESULTS

180 patients were included. 88 patients had an mRS between 3-6 and 92 had an mRS between 0-2. The best algorithm was XGBoost, with an area under the receiver operating characteristic curve of 0.907 (95% CI: 0.686 - 0.979) and an area under the precision recall curve of 0.827 (95% CI: 0.703 - 0.951). The top three most significant features were multiphase CTA collateral score, CBV < 42%, and mismatch volume.

#### CONCLUSION

Our model was highly accurate using only imaging parameters, indicating that imaging parameters may be as accurate as conventional predictors. The multiphase CTA collateral score was the most predictive variable, highlighting the importance of collaterals and demonstrating that incorporating them into ML models could lead to accurate prediction.

#### CLINICAL RELEVANCE/APPLICATION

This study emphasizes the importance of imaging parameters, particularly collateral circulation markers, in predicting functional outcomes for AIS patients, regardless of stroke severity at admission or treatment method that physicians can tailor to improve patient prognosis.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-12

### Decoding the Enigma of Distal Medium Vessel Occlusions: Harnessing Machine Learning for Prognostic Predictions in Acute Ischemic Stroke Patients

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We hypothesized that machine learning (ML) algorithms using CT perfusion (CTP) and clinical variables as input parameters can successfully predict the outcome in distal medium vessel occlusion (DMVO) acute ischemic stroke (AIS) patients regardless of the preferred treatment method, given CTP's expected impact on stroke diagnosis and management.

#### METHODS AND MATERIALS

DMVO-AIS patients with available CTP scans were screened in this retrospective cohort study. Demographic, clinical, and radiologic data were collected, including blood samples and radiologic variables such as occlusion location, ASPECTS, rCBF, Tmax, CBV, mismatch volume, hypoperfusion index, and diffusion-weighted imaging (DWI) volume on follow up MRI within seven days of symptom onset. These data were used as input, and the outcome was National Institutes of Health Stroke Scale (NIHSS) shift score (admission NIHSS score - discharge NIHSS score). Patients with an NIHSS shift score above the median score and patients with an NIHSS shift score below the median score were assigned to the favorable outcome group and the unfavorable outcome group, respectively. Since admission and discharge NIHSS scores are directly related with our outcome, NIHSS shift, they were not included in the predictor variables. Data preprocessing involved imputation of missing values, scaling of continuous variables, normalization, and encoding of categorical variables. Recursive feature elimination (RFE) was used for feature selection. Five supervised machine learning algorithms were employed. SHAP were used to examine the relative weights of predictor variables.

#### RESULTS

There were 35 patients who had a favorable outcome and 34 patients who had an unfavorable outcome. RFE produced ten features, the top three most important of which were mismatch volume, Tmax > 6s, and DWI volume. XGBoost showed the best performance in predicting unfavorable outcome with an area under the curve of receiver operating characteristic curve of 0.865 and an area under the precision-recall curve of 0.811.

#### CONCLUSION

In patients with DMVO-AIS, our ML model trained on baseline quantitative CTP parameters and laboratory data was able to predict the short-term outcome, NIHSS shift score. The most important variable was the mismatch volume in the best-performing model. Notably, neither the admission NIHSS score nor the patient's age were used in our model to predict the prognosis of AIS patients, despite the fact that these factors are normally very important predictors of prognosis.

#### CLINICAL RELEVANCE/APPLICATION

We were able to accurately predict the prognosis of DMVO-AIS patients using CT perfusion parameters, demonstrating the importance of imaging. These preliminary findings may aid clinicians in predicting patient prognoses.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5B-SPNR-13

### Effect of Statins on Different Intracranial Plaques & Its Influencing Factors: A High-Resolution Magnetic Resonance Vessel Wall Imaging Study

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jiayuan Hu (*Presenter*) Nothing to Disclose

#### PURPOSE

High-resolution magnetic resonance vessel wall imaging (HRMR-VWI) is a non-invasive examination that can evaluate intracranial atherosclerotic plaque stability. This study applied HRMR-VWI to evaluate the effect of statins on vulnerable and stable intracranial plaques and explore the influencing factors of statin therapy.

#### METHODS AND MATERIALS

Between July 2017 and August 2021, patients with intracranial atherosclerosis treated with statins underwent HRMR-VWI. The plaque characteristics were measured using PACS system and Vessel Explorer software, including plaque length, thickness, burden, luminal stenosis, plaque enhancement, and plaque location. According to the baseline plaque enhancement, each plaque was classified into a vulnerable plaque group or stable plaque group. The plaque characteristics before and after treatment were compared by using the signed-rank test and paired-samples t-test. The plaque characteristics after treatment between the two groups were compared by using Wilcoxon rank sum test. According to the tri-sectional quantiles of plaque enhancement rate change, each plaque was classified into a good or poor effect group. The baseline plaque characteristics between the two groups were compared by using the independent-samples t-test or Wilcoxon rank sum test. Multiple linear regression was used to investigate the relationship between baseline plaque characteristics and the effect of statin therapy.

#### RESULTS

This study included 53 patients with a total of 107 plaques, including 61 stable plaques and 46 vulnerable plaques. In the vulnerable plaque group, plaque enhancement ( $P < 0.001$ ), plaque burden ( $P < 0.023$ ), and luminal stenosis ( $P < 0.027$ ) in the follow-up period were significantly reduced compared to baseline. The extent of reduction in plaque enhancement was significantly higher in the vulnerable plaque group than that in the stable plaque group ( $P < 0.025$ ). Compared with the poor effect group, the baseline plaque burden was greater ( $P < 0.025$ ) and luminal stenosis was higher ( $P < 0.024$ ) in the good effect group. Multiple linear regression showed that plaques located in anterior circulation ( $B = 0.16$ ,  $P = 0.014$ ) and those with obvious enhancement at baseline ( $\%$ ,  $B = -0.218$ ,  $P = 0.007$ ) were positively correlated with a decreased rate of plaque enhancement after statin treatment.

#### CONCLUSION

This study confirmed by HRMR-VWI that statins have certain effects on vulnerable plaques, and their efficacy is better than that on stable plaques. The treatment benefit may be greater for plaques located in the anterior circulation and have a higher baseline enhancement degree.

#### CLINICAL RELEVANCE/APPLICATION

This result may provide a theoretical basis for individualized treatment for patients with intracranial artery stenosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPNR-14

### Automated Machine Learning Based on Clinical Factors and Multimodal Radiomics of Diffusion Kurtosis Imaging and Conventional Magnetic Resonance Imaging Predicts the Functional Outcome of Acute Ischemic Stroke

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yiran Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to investigate the predictive value of the radiomics from diffusion kurtosis imaging (DKI) for the functional outcome of acute ischemic stroke (AIS) patients and develop a prediction model based on radiomics and clinical factors using automated machine learning to accurately predict the functional outcome.

#### METHODS AND MATERIALS

The clinical and imaging data of 203 patients with AIS were retrospectively collected and randomly divided into the training cohort ( $n = 163$ ) and testing cohort ( $n = 40$ ). Based on the modified Rankin Scale (mRS) at three months after hospital discharge, the functional outcome was dichotomized into good ( $mRS = 2$ ) and poor ( $mRS > 2$ ). Radiomics features were extracted from DKI parametric maps, T2 fluid-attenuated inversion recovery (FLAIR), diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps and categorized into four feature sets (set 1: DWI and ADC maps; set 2: T2 FLAIR, DWI and ADC maps; set 3: DKI parametric maps including mean diffusivity, mean kurtosis and fractional anisotropy maps; set 4: all of the above features). The tree-based pipeline optimization tool (TPOT) was applied to establish the prediction models based on the simple feature sets and the combination of the radiomics score and clinical factors, respectively. For each feature set, TPOT was repeated 10 times to obtain a best model. Then the best models were validated on the testing cohort. The area under the curve (AUC), average precision, accuracy, sensitivity and specificity were used to evaluate the performance of the models.

#### RESULTS

Four radiomics models and four radiomics-clinical models were developed by TPOT. The models combining radiomics score from DKI parametric maps and clinical factors achieved the best performance in the testing cohort (AUC = 0.923, average precision = 0.896, accuracy = 0.775, sensitivity = 0.800, specificity = 0.760). The 5 most important factors were radiomics score, baseline National Institute of Health stroke scale score, age, infarct volume and baseline mRS. In addition, the AUC of DKI-based radiomics model was higher than the models based on conventional magnetic resonance imaging.

#### CONCLUSION

The DKI-based radiomics could further improve the performance for predicting the AIS outcome compared with conventional magnetic resonance imaging. The models developed by TPOT based on radiomics score from DKI parametric maps and clinical factors could predict the functional outcome of AIS patients with a high discriminatory accuracy.

#### CLINICAL RELEVANCE/APPLICATION

The model developed by TPOT could assist clinicians to accurately predict the outcome of AIS patients and formulate individual treatment plans at the early stage of onset, which may improve the prognosis of AIS patients.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-2

### Double Expressor Lymphoma Subtype in Primary Central Nervous System Lymphoma: Its MR Imaging Features and Clinical Relevance

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Goh Sasaki, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Unlike most B-cell lymphomas, double-expressor lymphomas (DELs) can lead to increased risk of relapse and worse prognosis. To date, there are no studies evaluating MRI findings in primary central nervous system lymphoma (PCNSL) patients with DEL (PCNSL-DEL). We aimed to determine whether PCNSL-DEL has MR imaging and clinical features compared to non-DEL.

#### METHODS AND MATERIALS

This retrospective study included 36 patients with PCNSL, 16 of whom were pathologically confirmed with DEL and 20 with non-DEL. All patients underwent preoperative 3-T MRI including diffusion-weighted imaging (DWI) and dynamic susceptibility contrast (DSC) perfusion studies. Cerebral blood volume (CBV), leakage-corrected CBV (cCBV) and K2 were calculated by using a block-circulant deconvolution method. The regions of interest (ROIs) were placed at enhancing lesions with high DWI intensity, while control ROIs were set at the contralateral portions. Mean apparent diffusion coefficient (ADC), CBV, cCBV ratios and K2 value were compared between DEL and non-DEL groups using the Mann-Whitney U test. The Kaplan-Meier method was used to estimate progression-free survival (PFS) differences.

#### RESULTS

Compared with non-DEL group, DEL group had significantly lower mean CBV ratio ( $0.23 \pm 0.55$  vs.  $0.25 \pm 0.27$ ,  $p = 0.016$ ) and cCBV ratio ( $1.48 \pm 0.98$  vs  $2.08 \pm 0.80$ ,  $p = 0.028$ ). There was no significant difference in ADC ratio ( $1.07 \pm 0.23$  vs  $0.97 \pm 0.22$ ,  $p = 0.14$ ) and K2 ( $481 \pm 287$  vs  $421 \pm 276$ ,  $p = 0.336$ ) between the two types of PCNSL. PFS was shorter for DEL than non-DEL, but there was no significant difference.

#### CONCLUSION

In PCNSL, DEL has lower CBV and cCBV and tends to have shorter PFS than non-DEL.

#### CLINICAL RELEVANCE/APPLICATION

DSC perfusion imaging is a promising tool for identifying DEL, a subtype of PCNSL.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPNR-3

### MRI Histogram Analysis of TERT Mutation Status in Patients with IDH-wildtype Glioblastoma

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Bin Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

TERT mutation is an important predictor of poor prognosis in IDH wild-type glioblastoma patients. To investigate the value of MRI histogram analysis in predicting TERT mutation status of IDH wild-type glioblastoma.

#### METHODS AND MATERIALS

**POPULATION and SEQUENCE:** T1WI contrast-enhanced (T1C) and T2WI images of 182 patients with IDH-wildtype glioblastoma confirmed by surgery and molecular pathology were retrospectively collected. **IMAGE ANALYSIS:** Two radiologists imported images in the Dicom format into Firevoxel (current version: 416C, NYU School of Medicine, NY, <https://wp.nyu.edu/firevoxel/downloads/>) to independently analyze the entire lesion. Subsequently, the largest lesion slice was selected. Based on the T1WI and T2WI images, two radiologists manually traced the ROIs in all 182 GBM margin along the axial T1C without the surrounding brain tissue, and oedema. The software automatically generated a grayscale histogram of the ROI. Histogram analysis was performed using the largest slices to obtain the following histogram parameters: maximum, minimum, mean, standard deviation (SD), variance, coefficient of variation (CV), skewness, kurtosis, entropy, and 1st-99th percentiles. The necrotic/necrotic ratio of the maximum tumor layer was calculated by delineating the necrotic/necrotic area. **STATISTICAL TESTS:** Pearson's and Spearman's - rho correlation analysis was used to analyze the correlation. Receiver operating characteristic (ROC) analysis was used to evaluate the utility of the T1C histogram parameter in the TERT mutation state. All statistical analyses were performed using SPSS (IBM SPSS Statistics version 25.0; Chicago, IL, USA) software.

#### RESULTS

In the T1C histogram features, the maximum value, standard deviation, variance, 99th percentile and coefficient of variation (CV) were positively correlated with TERT mutation status ( $P < 0.05$ ). ROC curve analysis showed that when  $CV=0.319$ , the AUC value was the highest (0.775; 95% confidence interval (CI) :0.702-0.848), and the sensitivity and specificity were 0.803 and 0.729, respectively. In addition, CV was positively correlated with the ratio of maximum level necrosis to cystic degeneration.

#### CONCLUSION

Preoperative T1C histogram analysis has predictive value for TERT mutation status in IDH wild-type GBM patients.

#### CLINICAL RELEVANCE/APPLICATION

CV in the T1C histogram can objectively and comprehensively reflect the intrinsic heterogeneity of the tumor, and can predict the TERT mutation status of IDH wild-type glioblastoma before surgery. We performed interpretative analysis of the histogram characteristic parameters and concluded that CV was positively correlated with the ratio of necrosis to cystic degeneration at the maximum tumor level.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-4

### **Impaired Peritumoral Cerebrovascular Reactivity Measured with Arterial Spin Labeling in Gliomas. Emerging Techniques in the Pre-surgical Workup of Brain Tumors**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Marta Calvo-Imirizaldu, MD (*Presenter*) Research Grant, Siemens AG

#### **PURPOSE**

The purpose of our study was to evaluate the feasibility of cerebrovascular reactivity (CVR) mapping with arterial spin labeling (ASL) technique using a breath-holding task, and its potential to depict infiltrative tumor beyond the limits of contrast enhancement and non-enhancing components.

#### **METHODS AND MATERIALS**

16 newly diagnosed patients with grade 4 brain gliomas (WHO 2021, biopsy confirmed) who underwent presurgical brain MRI were prospectively recruited. A non-invasive PCASL sequence with apnea challenge consisting of 10 cycles of 21s of apnea/breath-hold task and 42s of normal breathing was added to the clinical protocol, for CVR mapping. All studies were performed in a 3T Siemens Skyra MRI scanner with 32-channel head coil. Informed written consent was obtained. Automatic segmentation masks of gray matter (GM), white matter (WM), were obtained in SPM, with a threshold of 0.9. Contrast enhanced tumor (CE) and non-contrast enhanced tumor (nCE) masks were manually drawn by an experienced neuroradiologist on each patient T1 weighted image. Several expanding volume-of-interest (VOI) rings of 6 mm width were evaluated in the peritumoral area to assess the infiltrative lesion. Cerebral blood flow (CBF) and CVR of the affected side, contralateral hemisphere, tumor lesion (merging CE and nCE components when applicable) and in the perilesional expanding VOIs were recorded. CVR was evaluated as percentage signal change (PSC) in CBF. Data were analysed for normality using Shapiro-Wilk test. Differences in CBF were assessed in the tumor lesion versus the homologous contralateral region, with paired T-test. Differences in CVR were assessed for the tumor and perilesional VOIs with paired T-test, corrected for multiples comparisons using false discovery rate test.

#### **RESULTS**

A total of 16 patients were included (11 men, mean age  $56.19 \pm 10.73$  years). Mean CBF in the tumor was  $57.62 \pm 38.12$  ml/100g/min, significantly higher compared to the contralateral side ( $p = 0.021$ ). CVR in the tumor was decreased compared to the contralateral homologous region (ipsilateral PSC =  $22.03 \pm 14.25$  vs contralateral PSC =  $31.94 \pm 11.04$  PSC;  $p = 0.028$ ). Perilesional CVR was also impaired in the periphery of the tumor, reaching a plateau in the last two VOIs (18 to 24 mm from the tumor). Significant differences in CVR between the contralateral and ipsilateral VOIs were found ( $p$ -values, VOI 6mm = 0.009, VOI 12mm = 0.028, VOI 18mm = 0.029, VOI 24mm = 0.045).

#### **CONCLUSION**

CVR mapping is feasible with ASL and can provide information about the perilesional environment of the tumor that may help to detect infiltrative disease.

#### **CLINICAL RELEVANCE/APPLICATION**

Trying to precisely delineate the infiltrative glioma region for an accurate complete resection is a challenge in glioma imaging.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-5

### The Cavernous Sinuses Lesions - A South Brazilian Experience

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Kelly R. Neves, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to present our experience at South Brazil of the various and unusual pathologies that can affect the cavernous sinuses. They have great clinical importance, and this review and iconographic essay help us to keep these conditions in mind at the moment we face them in our daily practice.

#### METHODS AND MATERIALS

This is a cross-sectional retrospective study performed at two large institutions in South Brazil. We did a research from April 2013 to April 2023, then selected a miscellanea of 16 very illustrative and representative cases of the variable conditions that can affect the cavernous sinuses.

#### RESULTS

Our research showed as results inflammatory/infectious, neoplastic, vascular, and cryptogenic pathologies, as we illustrate: fusiform aneurysm, carotid cavernous fistula, septic thrombosis, hemangioma, dermoid cyst,, adenoid cystic carcinoma, hypertrophic pachymeningitis, macroadenoma, lymphoma, meningioma, plexiform neurofibroma, mucormycosis, oculomotor mononeuropathy, and Tolosa-Hunt.

#### CONCLUSION

The cavernous sinuses are interconnected venous plexuses situated in the floor of the middle cranial fossa on either side of the sella turcica and sphenoid sinus. They can communicate with the orbit, pterygopalatine fossa, infratemporal fossa, nasopharynx and posterior cranial fossa through various foramina, fissures and channels at the base of the skull. In addition, it contains important vascular and nerve structures, including the internal carotid arteries, the oculomotor and abducens cranial nerves, and the ophthalmic and maxillary branches of the trigeminal nerve. These pathological conditions can have similar clinical manifestations, so imaging plays a crucial role in the diagnosis, assessment of the extent of the disease, biopsy planning, when necessary, and aid in the decision of the best therapeutic strategy to be followed, including radiotherapy, microsurgery or clinical treatment.

#### CLINICAL RELEVANCE/APPLICATION

Because of all these reasons, the diagnosis may be very challenging and knowing these possibilities in advance must make us aware to keep them in mind for prompt suspicion.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-6

### Clinical Significance of Apparent Diffusion Coefficient in Differential Diagnosis of Primary Central Nervous System Lymphoma and Meningioma

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Fengyu Z. Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

To analyze the clinical significance of apparent diffusion coefficient in differential diagnosis of primary central nervous system lymphoma and meningioma.

#### METHODS AND MATERIALS

Thirty-five patients with primary central nervous system lymphoma and 35 patients with meningioma confirmed by surgery and pathology were selected as Group A and Group B respectively. The average ADC value, the minimum ADC value, the maximum ADC value and the contralateral normal white matter, the average (contralateral) ADC value were obtained, logistic regression analysis and ROC curve were used to analyze the diagnostic efficacy of each index.

#### RESULTS

The mean ADC value, minimum ADC value, maximum ADC value and contralateral ADC value in group A were statistically different ( $P < 0.05$ ); the minimum ADC value and contralateral ADC value in group B were not statistically different ( $P > 0.05$ ), while the rest of items were statistically different ( $P < 0.05$ ); the mean ADC value, minimum ADC value and maximum ADC value in group A were lower than those in group B ( $P < 0.05$ ). The logistic regression analysis showed that the maximum ADC value was an independent risk factor, while the mean ADC value and the minimum ADC value were protective factors ( $P < 0.05$  and  $P < 0.01$ , respectively). The AUC of the combined indices was 0.926, with an accuracy of 93.5%, sensitivity of 90.3%, and specificity of 94.7% ( $P = 0.000$ ).

#### CONCLUSION

Different ADC values in tumor parenchyma provide the molecular imaging basis for noninvasive differential diagnosis of primary central nervous system lymphoma and meningioma, and the combined diagnosis of the three parameters can effectively improve the diagnostic efficiency by using logistic regression model.

#### CLINICAL RELEVANCE/APPLICATION

Accurate differential diagnosis of primary central nervous system lymphoma and meningioma is essential for early intervention and survival. Conventional MRI findings of some primary central nervous system lymphoma often overlap with meningiomas and are difficult to differentiate. Diffusion-weighted imaging (DWI) can reflect the characteristics of the lesions from the molecular diffusion level before the morphology. The apparent diffusion coefficient (ADC) of DWI can quantitatively reflect the density and malignant degree of the tumor cells. This study was to investigate the value of ADC in the differential diagnosis of primary central nervous system lymphoma and meningioma, and to provide valuable reference for the early diagnosis and early intervention of the two diseases.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-7

### Comparison between Postcontrast T1-weighted Thin-slice 2D Spin Echo and 3D SPACE Sequences in the Detection of Brain Metastases at 1.5T and 3T

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Aaron Rulseh, MD,PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The accurate detection of metastatic brain lesions (MBL) before radiotherapy is critical. Although spin echo (SE) are superior to gradient echo sequences in detecting small MBL, thin-slice whole-brain coverage is time consuming. The sampling perfection with application optimized contrasts using different flip angle evolution (SPACE) sequence shares many advantages with SE, but with faster acquisition and greater resolution while achieving whole-brain coverage.

#### METHODS AND MATERIALS

Fifty-six patients with MBL were included and underwent a standard protocol (1.5T n=37, 3T n=19), including postcontrast T1-weighted SE and SPACE (postcontrast order: SE first n=26, SPACE first n=30). Rating was performed by 3 raters in 2 sessions >6 weeks apart; images were de-identified and order randomized, only SE or SPACE per-subject per-session. The true number of MBL was determined using all available imaging including follow up. Intraclass correlations were determined; consistency for intra-rater (SE vs. SPACE) and agreement for inter-rater (same sequence). A paired t-test was used to evaluate postcontrast sequence order.

#### RESULTS

A total of 135 MBL were identified (mean/subject 2.41, SD 6.4). Relatively fewer lesions were identified on the first postcontrast sequence (SE/SPACE), however the difference was not significant ( $p=0.08$ ). Intra-rater consistency (SE vs. SPACE) was excellent (ICC: R1, 0.984; R2, 0.971; R3, 0.946), as was inter-rater agreement, with ICC values of 0.984 and 0.969 for SE and SPACE sequences, respectively. Finally, agreement between individual sequences and the true number of lesions was excellent (SE ICC: R1, 0.981; R2, 0.973; R3, 0.977; SPACE ICC: R1, 0.984; R2, 0.971; R3, 0.965).

#### CONCLUSION

The emergence of fast computer-assisted treatment planning of targeted radiosurgery techniques in the management of MBL requires precise, fast and reliable MRI workup. The reliable detection of MBL with MRI depends on a number of factors, particularly pulse sequence and contrast agent type, dose and application delay. Although SE sequences are superior to gradient echo sequences in the detection of small brain metastases, they have relatively long acquisition times and are prone to artifacts. To our knowledge this is the first comparison between thin-slice T1-weighted SE and SPACE sequences in the detection of brain metastases at 1.5 Tesla and 3 Tesla. Our results show that T1-weighted SPACE is not inferior to standard thin slice SE sequences in the detection of brain metastases.

#### CLINICAL RELEVANCE/APPLICATION

The T1-weighted SPACE sequence has several advantages over other sequences commonly used in the detection of metastatic brain lesions while maintaining excellent consistency with ratings on standard thin-slice spin echo images.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-8

### Predicting IDH-Mutation in Low Grade Glioma using Different MRI Sequences

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Gala Nacul Mora, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Low grade gliomas are classified by analyzing molecular characteristics such as IDH mutation status. In this retrospective study we applied radiomics to different MRI sequences to determine which one is the most suitable.

#### **METHODS AND MATERIALS**

In our retrospective study, we used MR images of 106 patients with histologically confirmed glioma. All MR images were acquired with four MRI sequences each: T1 without and with administration of a contrast agent (T1 native and T1 CE), T2 and Flair. We performed image segmentation of the tumours semi-automatically using the open-source software platform 3D Slicer and extracted a total of 107 radiomic features from each of the images. We subsequently tested different conventional machine learning algorithms and a neural network to predict the IDH mutation status and to find the most suitable MR sequence for this task.

#### **RESULTS**

In our analyses, the T1 CE sequence was found to be the most suitable for predicting IDH mutation status. Using independent test data and a 9-feature model constructed with Lasso (Least Absolute Shrinkage and Selection Operator) regression, we achieved an AUC of 0.849, an accuracy of 0.801, a sensitivity of 0.849, and a specificity of 0.704. The second-best results were achieved with the Flair sequence, and the T2 sequence proved to be the most unsuitable.

#### **CONCLUSION**

Although radiomics applied to different MRI sequences is suitable to predict the IDH mutation in low grade gliomas, the most accurate results were achieved analyzing T1 CE sequences.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI based radiomics helps predicting molecular status of low grade gliomas.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR-9

### Tumor Characteristics, Brain Functional Activity and Connectivity of Tinnitus in Patients with Vestibular Schwannoma: A Pilot Study

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jiayu Huang (*Presenter*) Nothing to Disclose

#### PURPOSE

Tinnitus in patients with vestibular schwannoma (VS) can negatively affect their mental health, focus, sleep quality, and social life. However, the mechanism of tinnitus is still unclear. Therefore, this study aims to explore the correlation between preoperative clinical characteristics of VS, postoperative changes in brain function, and tinnitus in patients with VS.

#### METHODS AND MATERIALS

We collected data from 80 VS patients before surgery and from 28 VS patients before and after surgery, and recruited 28 healthy controls. We used paired t-tests to identify brain regions where patients had significant changes in amplitude of low frequency fluctuations (ALFF) and regional homogeneity (ReHo) after surgery. Tinnitus severity was evaluated using the Tinnitus Handicap Inventory (THI) and Visual Analog Scale (VAS). And Pearson correlation were applied to assess the relationship between the changes in ALFF and ReHo and the changes in THI and VAS scores postoperatively. Finally, we also conducted seed- and ROI-based functional connectivity (FC) analyses.

#### RESULTS

Prior to surgery, VS patients with tinnitus had smaller tumors ( $t = 3.293$ ,  $p < 0.001$ ), more solid tumor ( $p = 0.033$ ), and less extrusion into the cerebellum brain stem ( $p = 0.001$ ) than those without tinnitus. After surgery, 28 VS patients showed a significant reduction in ALFF in the left cerebellum crus 2 (ROI 1) and a significant reduction in ReHo in the left cerebellum crus 1 (ROI 2) and the right precuneus (ROI 3). Conversely, ReHo was significantly increased in the right precentral gyrus (ROI 4) (cluster-level p value family-wise error [pFWE]  $< 0.05$ ). Additionally, the changes in ALFF values were negatively correlated with changes in the VAS score on the left side ( $r = -0.32$ ,  $p < 0.05$ ). Moreover, the FC strengths of patients between ROI 2 and the left and right posterior cingulate gyrus respectively were significantly decreased after the surgery (FDR correction,  $p < 0.05$ ).

#### CONCLUSION

Preoperative tinnitus in patients with VS may be influenced by tumor size, tumor nature, and degree of extrusion into the cerebellum brain stem. Additionally, the functional activities of the default mode network, the somatomotor network, and the cerebellum are altered postoperatively. Notably, the changes in ALFF in the left cerebellum are correlated with tinnitus severity.

#### CLINICAL RELEVANCE/APPLICATION

Clinical characteristics and brain regions related or unrelated to hearing can influence tinnitus symptom in VS patients, which may be potential therapeutic targets for tinnitus in VS patients.

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## Abstract Archives of the RSNA, 2023

T5B-SPOB-1

### **Uterine Sarcoma or Degenerating Fibroid? Validating the New Consensus MRI Algorithm for Evaluating Atypical Uterine Masses**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Aja Green Walker, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our study is to evaluate the validity of a recently published consensus MRI diagnostic algorithm (PMID: 36194109) for differentiating benign degenerating leiomyomas and malignant uterine sarcomas.

#### **METHODS AND MATERIALS**

Atypical uterine masses on pelvic MRI were identified through the Radiology information system and report search engine using "atypical leiomyoma", "atypical fibroid", and "sarcoma", and the electronic medical record was reviewed for pathologic proof. Two radiologists blinded to clinical, surgical, and pathologic reports retrospectively and independently reviewed 40 pelvic MRI examinations dated 1/2007-9/2022 to determine if the masses by imaging were benign or malignant, using the 2022 consensus atypical uterine mass flow chart. Imaging features assessed included: peritoneal metastases, abnormal lymph nodes, intermediate/high signal intensity (SI) at T2-weighted imaging, high DWI SI (equal or higher SI than endometrium or lymph nodes on high b value imaging), and ADC value =  $0.905 \times 10^{-3}$  mm.

#### **RESULTS**

Of the 40 atypical uterine mass cases, 24 masses were benign (22 leiomyomas, 1 adenomyoma, and 1 borderline ovarian tumor) and 16 masses were malignant (6 leiomyosarcomas, 6 carcinosarcomas, 3 endometrial sarcomas, and 1 low grade uterine sarcoma). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) to determine if masses were benign or malignant were 75%, 95.8%, 92.3%, and 85% for reader 1, and 81.2%, 91.7%, 86.7%, and 88% for reader 2 respectively. Interreader agreement was strong, kappa: 0.89. Endometrial sarcomas had higher T2 signal and higher ADC values than leiomyosarcomas.

#### **CONCLUSION**

The new consensus pelvic MRI algorithm for evaluating atypical uterine masses has good specificity, sensitivity, PPV, and NPV for determining malignancy, particularly for uterine sarcomas that are predominantly myometrial origin (leiomyosarcoma), with  $ADC \leq 0.905 \times 10^{-3}$ mm. However, if ADC is near but not below  $0.905 \times 10^{-3}$ mm, the mass may be malignant, especially if using b value lower than 1000. If the atypical uterine mass is predominantly endometrial, morphology should guide suspicion.

#### **CLINICAL RELEVANCE/APPLICATION**

The 2022 consensus algorithm to distinguish benign from malignant atypical uterine masses has important clinical implications, as surgical and medical management for degenerating fibroids is very different from uterine sarcomas.

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## Abstract Archives of the RSNA, 2023

T5B-SPOB-3

### **Cer-ConvN3Unet: An End-to-end Multimodal Pipeline for Auto-detection and Auto-segmentation of Cervical Cancer based on ConvNeXt and Double U-Net**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Shaojun Xia (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cervical cancer is a common gynecological pelvic tumor with an incidence rate of 3.1% and mortality rate of 3.4%, ranking eighth and ninth among all cancers worldwide. The routine MRI examination typically includes multi-planar T2WI, DWI and CE-T1WI. Hence, it is of paramount importance to extract the multimodal information for subsequent volume calculation, radiomics analysis, radiotherapy dose optimization, surgical preparation, and etc. In this study, we proposed an innovative two-phase pipeline for auto-detection and auto-segmentation on multimodal cervical cancer MRI images, which integrated the advantages of ConvNeXt and Double U-Net, thereby providing an end-to-end multimodal outlining tool for gynecologists.

#### **METHODS AND MATERIALS**

Totally 100 patients underwent pelvic MRI examinations consisting of T2WI, DWI and CE-T1WI. Patients with no contraindications received an intramuscular injection of 10mg raceanisodamine hydrochloride before image acquisition to reduce bowel motion artifacts. 2533 DWI slices, 2448 T2 slices, and 7176 CE-T1 slices were obtained by extracting 3D MRI images layer-by-layer from axial plane. In the auto-detection phase, a six-classifier was designed based on ConvNeXt blocks for the multimodal recognition. In the second stage, the whole identified tumor slices were separately input into auto-segmentation module developed by 3-channel Double U-Nets. The accuracy, precision, recall, Kappa and F1-score were used to evaluate the classification performance, while DSC and Jaccard were applied to quantitative analysis the segmentation performance.

#### **RESULTS**

20 patients were excluded from the modeling process for independent testing. The initial auto-detection module achieved the average results of 92.37%, 83.60%, 77.65%, 75.70%, 0.8045 for accuracy, precision, recall, Kappa and F1-score. And no error occurred in the distinguishment between the three modalities. Entering into segmentation stage, the mean values of DSC and Jaccard on DWI, T2, CE-T1 were (83.25%, 71.49%), (78.62%, 65.17%), (73.62%, 58.81%), respectively.

#### **CONCLUSION**

Strict independent experiments demonstrated that the end-to-end multimodal pipeline was capable of getting high recognition and segmentation accuracy with less manual intervention. In the future, the clinical utility will be further optimized in large-sample and multi-center prospective cohorts and generalized to more MRI modalities.

#### **CLINICAL RELEVANCE/APPLICATION**

The pipeline has high potential to be an alternative tool for gynecologists in routine MRI image reading and processing of cervical cancer. Meanwhile, it can also serve as the basis for a series of scientific research works related to tumor lesions, liberating from labor-intensive manual delineation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPOB-4

### **Intratumoral and Peritumoral MRI Radiomics Nomogram for Predicting Parametrial Invasion in Patients with Early-stage Cervical Adenocarcinoma and Adenosquamous Carcinoma**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Le Fu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop a comprehensive model based on MRI intra- and peritumoral radiomics signatures and independent risk factors for predicting parametrial invasion (PMI) in patients with early-stage cervical adenocarcinoma (AC) and adenosquamous carcinoma (ASC).

#### **METHODS AND MATERIALS**

In total, 747 patients with IB to IIB cervical AC and ASC who underwent radical trachelectomy/hysterectomy were retrospectively reviewed and divided into the primary, internal validation cohort, and external validation cohorts. The original (Ori) and original-wavelet (Ori-Wav) feature-based radiomics signatures from the primary tumor (RST) and 3 mm- and 5 mm-peritumoral regions (RS3 and RS5) were respectively built to investigate their diagnostic values in predicting PMI. The feature selection includes the following steps: 1) feature reproducibility assessment; 2) Pearson correlation test; 3) maximum relevance and minimum redundancy (mRMR); 4) the least absolute shrinkage and selection operator (LASSO). Finally, a nomogram was constructed by integrating optimal intra- and peritumoral signatures and independent risk factors.

#### **RESULTS**

FIGO stage, disruption of the cervical stromal ring (DCSRMR), parametrial invasion on MRI (PMSMR), and serum CA-125 were found to be independent risk factors. The combined nomogram constructed by integrating independent risk factors, Ori-Wav features-based RST, and RS5 yielded AUCs of 0.874 (0.810-0.922), 0.885 (0.834-0.924) and 0.966 (0.887-0.995) for assessing PMI in the primary, internal and external validation cohorts, respectively. Furthermore, the combined nomogram was significantly superior to radiomics signatures and clinical models for assessing PMI in the three cohorts.

#### **CONCLUSION**

This study demonstrated that the combined nomogram can preoperatively, accurately, and noninvasively identify PMI in patients with early-stage cervical AC and ASC

#### **CLINICAL RELEVANCE/APPLICATION**

As important parts of cervical cancers, AC and ASC have an increasing incidence and mortality, especially in young women. The preoperative and accurate identification of PMI can facilitate precise treatment decisions of chemoradiotherapy or radical hysterectomy in patients with early-stage cervical AC and ASC. The combined nomogram integrating independent risk factors, Ori-Wav features based RST, and RS5 can preoperatively, accurately, and noninvasively identify PMI in patients with early-stage cervical AC and ASC.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPPD-1

### **Radiation Dose Reduction of Newborns without Anti-scatter Grids in X-ray Fluoroscopic Imaging Systems with Flat Panel Detectors: A Newborn Whole Body Phantom Study of Dosimetry and Visual Assessment**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Noriyuki Sakai, MSc, RT (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Anti-scatter grids (ASG) effectively improve image contrast by absorbing scattered X-ray caused by a thick adult body. We hypothesized that removal of ASG would reduce radiation dose of a thin newborn body without loss of diagnostic value in X-ray fluoroscopic examinations. Our purpose was to compare radiation dose and visibility of image findings of a peripherally inserted central catheter (PI catheter), a nasogastric tube (NG tube) and contrast agent using a newborn whole body phantom between with and without ASG in X-ray fluoroscopic imaging systems with flat panel detectors.

#### **METHODS AND MATERIALS**

This study consisted of dosimetry and visual assessment. A newborn whole body phantom was used. In the dosimetry, continuous fluoroscopy for 300 seconds and twenty consecutive radiographs were performed with and without ASG. The entrance surface dose (ESD) of each dosimetry was measured by dosimeters placed on the chest and abdomen of the phantom, respectively. In visual assessment, the PI catheter and NG tube with and without inserting guidewire were placed on the phantom, respectively. Cylinders filled in contrast agent diluted by water (1/2, 1/4, 1/6, 1/8 and 1/10 dilutions) were inserted into the rectum of the phantom. Images of the PI catheter, NG tube and contrast agent were obtained by performing fluoroscopy and radiography with and without ASG, respectively. The obtained images were visually scored on a four-point scale by two observers (a board-certified diagnostic radiologist and a radiological technologist). We used the Wilcoxon signed-rank test to identify any significant differences between with and without ASG in the mean ESD and the mean visual scores. A P-value less than 0.05 was considered significant. Inter- and intra-observer agreement were calculated by weighted kappa statistics.

#### **RESULTS**

There were significant differences in the mean ESD between with and without ASG in both the fluoroscopy (chest, 1.7 vs. 1.1 mGy; abdomen, 2.0 vs. 1.3 mGy) and the radiography (chest, 3.5 vs. 2.0 mGy; abdomen, 4.1 vs. 2.4 mGy), respectively ( $P < .05$ ). There was no significant difference in the visual scores between with and without ASG in all comparisons of two observers ( $P > .05$ ). Inter- and intra-observer agreement were almost perfect in all comparisons (range, 0.87-1.00).

#### **CONCLUSION**

Removal of ASG significantly reduced radiation dose of a newborn phantom with acceptable image quality in X-ray fluoroscopic imaging systems with flat panel detectors.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiation dose reduction of newborn infants could be achievable in X-ray fluoroscopic examinations without loss of diagnostic value by removal of ASG.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPPD-2

### **Cranial Suture Ultrasound: Its Value in the Diagnosis and Radiation-reduction Potential of Suspected Craniosynostosis**

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Sara C. Albort Verges, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Given the growing concern about the use of ionizing radiation in the pediatric population, in the last years, ultrasound (US) has emerged as an alternative modality in the assessment of cranial sutures. This study aims to determine the accuracy of cranial ultrasound in the diagnosis of craniosynostosis in patients with clinical suspicion, its advantages and limitations, based on the hypothesis that it is a useful technique for this purpose and that it can potentially reduce the performance of tests using ionizing radiation.

#### **METHODS AND MATERIALS**

A retrospective study was performed reviewing the US findings and clinical records of the patients who underwent a cranial suture US in our institution between 2021-2022 for clinical suspicion of craniosynostosis. The main variables analyzed were: age, gender, suspected diagnosis and US findings. The results were classified as positive, negative or inconclusive for early suture closure. Subsequently, it was analyzed in which cases US findings and clinical follow-up were sufficient, or which required further confirmatory studies.

#### **RESULTS**

326 infants (214 male and 112 female), 4 of them with relevant pathologic history. Ages between 1 - 13 months. 283 patients had a negative US result for early suture closure (87%), 13 positive (4%) and 30 inconclusive (9%). Of the 283 negatives, 22 underwent subsequent studies, of which only 2 were positive (not considered false negatives, since in one case the CT scan was performed 9 months after the US, and the other case was positive for early closure of the right sphenofrontal suture, not explored with US). Of the 13 positives, 11 underwent complementary studies for confirmation, of which 7 were positive (4 false positives). Of the 30 inconclusive, 28 underwent complementary studies, of which only 2 were positive. Of the sample of 326 children, only 61 patients (19%) required complementary X-ray and CT scans, so we can deduce that the use of ionizing radiation was avoided in 265 patients (81%).

#### **CONCLUSION**

Cranial suture US is a valid and accurate technique in the diagnosis of suspected craniosynostosis. This method has numerous advantages, such as the short examination time, the possibility to perform a targeted scan of the "suspicious suture", as well as the non-use of ionizing radiation and sedation. The main documented limitations included, its operator-dependent nature, the patient's lack of collaboration, hair growth or structural features of the skull.

#### **CLINICAL RELEVANCE/APPLICATION**

We can conclude that the cranial suture US it is a useful, valid and accurate technique in the diagnosis of craniosynostosis, which avoided the use of ionizing radiation techniques in 81% of patients of our sample, a fact of special relevance given that we are dealing with a pediatric population.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPPH-1

### Simultaneous Denoising and Super Resolution in Clinical CT Images using Deep learning with Simulated Training Data

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Bruno De Man, PhD, MSc (*Presenter*) Employee, General Electric Company

#### PURPOSE

Improved CT image resolution and noise characteristics can improve visualization of small anatomical structures, including small lung nodules and coronary artery calcifications. This work reports a deep learning (DL)-based simultaneous denoising and super-resolution approach and its initial evaluation on clinical images.

#### METHODS AND MATERIALS

A challenge for DL-based denoising and super-resolution applied to clinical images is the lack of easy ways to generate high quality training data. We propose a method to build super-resolution digital phantoms based on sharpened and denoised clinical patient images, and then simulate the CT imaging chain and generate the relatively low-resolution training inputs. We also shrink the image voxel size of the phantom to introduce miniature anatomical structures beyond the intrinsic resolution of the clinical image. Here, we report initial evaluation of the method as applied to clinical data. Thirteen patient cardiac images were acquired using clinical settings. Ten cases were used for training a deep convolutional neural network (CNN), one for validation, and two for evaluation. During inference, the network was applied to patient CT images reconstructed with filtered back-projection (FBP) images for a 20 cm field of view.

#### RESULTS

The CNN network was tested on two datasets. The first contains the held-out testing cases where low-resolution data were simulated from the high-resolution phantoms. The second is composed of the real CT images acquired using clinical settings. In both cases, the enhanced images produced by the CNN network are visually sharper and contain less noise than their corresponding input images. Compared to the real CT input image, the network output improves the full width at half maximum by  $\sim 20\%$  along a small blood vessel. The contrast-to-noise ratio between ascending aorta and the surrounding tissue is increased by  $\sim 32\%$  (from 52.2 dB to 69.1 dB).

#### CONCLUSION

Simultaneous CT image denoising and resolution enhancement was achieved by using a DL method on clinical cardiac data. To overcome the difficulty in acquiring high quality data as training labels, we trained the model on simulation data and adapted the model to images reconstructed using standard clinical settings. This technique greatly facilitates the creation of high-resolution, low noise CT images in clinical applications.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning-based denoising and super-resolution approach may provide improved image quality and clinical diagnosis confidence for CT imaging.

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## Abstract Archives of the RSNA, 2023

T5B-SPPH-11

### Quantitative Evaluation of the Accuracy of MR Thermometry in the Presence of RNS Using a 3D Printed Realistic Head Phantom

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Chen Lin, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The Responsive Neurostimulator (RNS), a device for seizure treatment, is implanted on the skull. It can cause severe artifacts in brain MRI, including MR thermometry, which is used for monitoring tissue temperature change during intervention procedures such as laser interstitial thermal therapy (LITT). The purpose of this study is to evaluate the impact of temperature mapping in the brain due to RNS.

#### METHODS AND MATERIALS

To simulate MR-guided LITT of brain lesions in the presence of RNS, a realistic head phantom was 3D printed based on head CT images. Two indentations for mounting RNS were created at clinically appropriate locations. The inside of head phantom was filled with polyacrylic acid (PAA) gel per ASTM F2182 standards to mimic brain tissue. Black ink was when preparing the gel to increase the absorption of laser light. MR-guided LITT was performed on the phantom using a Philips 1.5T MR scanner with the Visualase™ MRI-guided laser ablation system and a laser probe with a 15mm diffuser. In each LITT session, the laser was turned on for 2 minutes at 50% of the maximum power of 10 watts. Four NetOptix fiber optic temperature sensors (FOTS) were placed 10mm away and shielded from direct laser exposure. Temperature maps (TMAP) were acquired with a 4ch flex coil and a 3D GRE sequence with receiver bandwidth of 100Hz/pixel. Five LITT sessions were performed with cooling periods in between. In sessions 1 and 5, no RNS was present in order to evaluate the accuracy and reproducibility of MR thermometry. In sessions 2 and 3, the RNS was implanted on the ipsilateral side of the ablation zone with different distances from the region of temperature mapping. In session 4, the RNS was moved to the contralateral side.

#### RESULTS

The temperature changes at the tips of the four FOTS measured by both FOTS and MR thermometry, were plotted and compared. Both FOTS and TMAP were reproducible in sessions 1 through 5. The differences in the measured temperature change in MR thermometry without and with RNS appeared to be within the variation of MR thermometry itself. Good correlations of TMAP results without and with RNS at ipsilateral side close to ablation zone and the TMAP results between the first and last sessions both without RNS were observed. There was a large systematic difference between FOTS and TMAP for each session. The sources of such a difference require further investigation as subsequent testing and calibration of FOTS found them to be accurate.

#### CONCLUSION

Despite the systematic difference between FOTS and TMAP, MR thermometry results are consistent without and with RNS at clinically acceptable locations.

#### CLINICAL RELEVANCE/APPLICATION

MR thermometry at 1.5T is relatively robust with regard to the potential artifact and impact from RNS.

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## Abstract Archives of the RSNA, 2023

T5B-SPPH-13

### Longitudinal Relaxivity Estimation of Gadolinium-Based Contrast Agents at 64 mT

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Sudarshan S. Ragnathan, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Point of care (POC) MRI scanners have been shown to improve accessibility to imaging for patients in different clinical environments, particularly in the neurocritical care units<sup>1</sup>. The use of contrast agents is prevalent at conventional field strengths (e.g., 1.5 and 3 T) for enhancing visualization and characterization of pathologies. However, the use of contrast agents at ultra-low-field (ULF) has not been characterized to the same extent as at conventional field strengths. Gadopiclenol is a high relaxivity gadolinium-based contrast agent (GBCA) that has demonstrated similar pathology enhancement compared to other commercially available GBCAs at half the dose<sup>2</sup>. The aim of this study is to estimate the longitudinal relaxivity of gadopiclenol at 64mT.

#### METHODS AND MATERIALS

The study was performed using a 64 mT portable MR system (Swoop®, Hyperfine, Inc., Guilford, CT) fitted with a standard head coil and two phantoms, each comprised of different concentrations of gadolinium-based contrast agents (GBCAs) namely gadobutrol (Gadavist, Bayer HealthCare Pharmaceuticals, Whippany, NJ), and gadopiclenol (Elucirem, Guerbet LLC, Princeton, NJ). Data were obtained using an inversion recovery fast spin-echo (FSE) sequence with TR = 4 s, TE = 5.9 ms, voxel size = 1.56 mm x 1.56 mm x 5.0 mm, and inversion times (TI) in 12 intervals ranging from 100 ms to 800 ms. Longitudinal relaxation rates (R1) were calculated using a three-parameter nonlinear curve fitting algorithm (MATLAB, Natick, MA) of the median signal magnitude as a function of TI. Longitudinal relaxivity (r1) was obtained as the rate of change of R1 with respect to GBCA concentration. The median signal magnitude values were used for quantitative analysis to mitigate the influence of outliers.

#### RESULTS

The average longitudinal relaxivities of gadopiclenol and gadobutrol were 32.6 mM<sup>-1</sup>.s<sup>-1</sup> and 8.7 mM<sup>-1</sup>.s<sup>-1</sup>, respectively. These values of r1 for gadopiclenol were observed to be higher at 64 mT than those reported at 0.47 T and 1.5 T<sup>2</sup>.

#### CONCLUSION

The relaxivity of gadopiclenol was observed to be greater than 3 times that of gadobutrol. These values indicate that optimizing sequence parameters would enable a significant improvement in contrast to noise (CNR) ratio when using gadopiclenol, with the potential to enhance visualization of pathologies, such as metastatic tumors and multiple sclerosis, using POC MRI.

#### CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced POC MRI critically ill patients for whom conventional imaging would not be possible.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPPH-2

### Quantifying Accuracy in Deformable Image Registration: An Informed Selection of CT Image Pairs with Applications in Longitudinal Imaging

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Amanda J. Gong, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Image registration to align images for comparison reads has broad applications in assessment for interval change, including cancer screening and treatment response assessment. The accuracy of this registration has a meaningful impact on the validity of downstream image processing and automated tasks such as new lesion detection and lesion monitoring. We compare 3 metrics of deformable registration accuracy to inform the selection of a CT image pair (simulated baseline/follow-up) and evaluate CNN performance in new liver lesion detection in simulated longitudinal CT.

#### METHODS AND MATERIALS

We used two public CT datasets: 1) diseased liver (DL) a subset of DeepLesion [1] 2) healthy liver (HL) from potential liver donors [2]. We registered each DL scan with each HL scan using sequential translation, affine, and B-spline transformations, creating image pairs that simulate a new liver lesion from healthy baseline. We utilized 3 metrics to define 3 subsets of the registered image-pairs; each metric informed the selection of one simulated baseline from a pool of candidate healthy scans. Our metrics: 1) Dice Similarity Coefficient (DSC) on liver segmentations 2) the product of DSC and mutual information in liver only (DSC-MI-liver), and 3) the product of DSC and mutual information in full CT (DSC-MI-full). We trained 3 models (ResNet50 architecture), one on each data subset, and compared performance on an image classification task that relies on quality registration: automated new lesion detection in paired image-patches. 5-fold cross validation and one-way ANOVA compared AUC. Ref: 1. doi: 10.1117/1.JMI.5.3.036501; 2. Med Image Anal 69 (2021) 101950

#### RESULTS

Of 10,594 CT studies (4,427 patients) in DeepLesion, we registered 1595 DL scans (819 patients with liver lesions < 3cm longest diameter) with each of 20 registered HL scans (20 patients), creating 31,804 registered image pairs. Each metric selects a data subset of 1595 HL/DL image pairs, simulating baseline/follow-up. The model using the DSC metric outperformed the DSC-MI-liver and DSC-MI-full models, with AUC 0.928, 0.916, and 0.901, respectively ( $p=0.0379$ ).

#### CONCLUSION

When comparing similarity metrics for quantifying image registration accuracy, DSC outperformed DSC-MI-liver and DSC-MI-full in the selection of simulated baseline/follow-up CT images for new liver lesion detection.

#### CLINICAL RELEVANCE/APPLICATION

In longitudinal imaging, image registration supports the assessment for interval change, including treatment response assessment. The quantification of registration accuracy can inform the selection of a comparison study.

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## Abstract Archives of the RSNA, 2023

T5B-SPPH-3

### Evaluation of Deep Learning Denoising Algorithms for Digital Mammography by Assessing Objective Task-based Performance using Computer Simulations

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Stephen J. Glick, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recent research suggests that degradation of image quality with reduced radiation exposure in full-field digital mammography (FFDM) can be mitigated by post-processing mammograms with denoising algorithms based on convolutional neural networks. In this work we use an *in silico* study to assess a deep learning denoising method and evaluate microcalcification detection accuracy when denoising is applied to scans of reduced dose.

#### METHODS AND MATERIALS

A previously published deep learning denoiser was trained and tested using an anthropomorphic breast phantom and simulated Monte Carlo mammography images containing small (100-240 micron) microcalcifications within a cluster containing 5-10 microcalcifications. Two different algorithms were tested, one with training on a dataset composed of 100% signal absent (SA) images (i.e, no MCC cluster), and one with training on a dataset composed of 50% signal absent (SA) and 50% signal present (SP). Human reader studies were conducted to assess and compare image quality in a set of binary signal detection 4-AFC experiments, with 4-AFC proportion of correct (PC) responses being the performance metric.

#### RESULTS

Microcalcification detection accuracy was decreased significantly when reducing the phantom dose from a full-dose level to a half-dose level. Deep learning denoising visually reduces the noise in the half-dose images, with a similar appearance to the full-dose images. For the algorithm trained on 100% SA images, no improvement in task-based performance (i.e., PC) was observed between half-dose images and denoised half-dose images. However, a statistically-significant improvement in PC was observed when using the algorithm trained on 50% SA and 50% SP. (see Figure below)

#### CONCLUSION

Deep-learning denoising algorithms applied to FFDM produced visually appealing images and improved global similarity metrics of MSE and SSIM. However, task-based assessment of microcalcification detection shows that deep-learning denoising applied to half-dose FFDM images resulted in decreased performance compared to that with full-dose FFDM images. In addition, our findings conjecture that deep learning denoising algorithms may benefit from enriching training datasets with signal-present regions of interest, at least in cases involving the detection of microcalcification clusters with smaller size microcalcifications.

#### CLINICAL RELEVANCE/APPLICATION

A study of Deep Learning denoising shows; 1) global metrics such as MSE and SSIM might not correlate with task-based performance; and 2) the importance of adequately including images with features of diagnostic interest when training the network.

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## Abstract Archives of the RSNA, 2023

T5B-SPPH-4

### Fast and Robust Ring Artifact Correction in Photon-counting CT using a Conditional Score-based Diffusion Model with Hijacked Reverse Diffusion

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Dennis Hein (*Presenter*) Research Collaborator, General Electric Company

#### PURPOSE

Diffusion models have emerged as the current state-of-the-art, outperforming even generative adversarial networks (GANs), for a wide range of image generation tasks and show great potential for denoising and artifact correction in medical imaging. However, long inference times have so far been a limiting factor. We propose an accelerated conditional score-based diffusion model and evaluate its performance for the task of image-domain ring artifact correction in photon-counting CT.

#### METHODS AND MATERIALS

Diffusion models exhibit an inherent tradeoff between speed and image quality negotiated by the number of steps, or noise scales, in the diffusion process. We suggest mitigating this tradeoff by "hijacking" the reverse diffusion at some step  $n$ . For a total number of steps  $N$ , we inject the condition image diffused  $N-n$  steps into step  $n$  of the reverse diffusion. We demonstrate the clinical utility of diffusion models and our suggested hijacking approach for the task of ring artifact correction in photon-counting CT. A conditional score-based diffusion model (cSBDM) is trained on 2576  $512 \times 512$  slices from 6 neuro patients scanned by CT systems from various vendors. Artificial ring artifacts are injected directly in the image domain to generate paired data. The NCSN++ network was trained to estimate the time-dependent conditional score function on extracted  $256 \times 256$  patches, with a batch size of 32, and  $N=2000$ , on one A6000 GPU for 150000 iterations. The predictor-corrector scheme was used for sampling. The network is evaluated on  $1024 \times 1024$  images of skull, water, and Lungman phantoms scanned by a prototype photon-counting system from GE HealthCare with the default ring correction disabled.

#### RESULTS

Our results indicate strong performance across the phantoms considered. On a A6000 GPU with batch size 1, cSBDM\_2000 (full diffusion) takes about 11 minutes and cSBDM\_5 (hijacked at step 1995) takes about 1.6 seconds. In other words, our suggested method achieves 400 times faster sampling. This gain in evaluation speed appears to come with a negligible drop in performance and image quality.

#### CONCLUSION

This work has suggested a ring artifact correction technique in photon-counting CT using a conditional score-based diffusion model. By hijacking the reverse diffusion, we achieve 400 times faster sampling than a vanilla cSBDM, with negligible drop in performance, pushing the required time on a medium range GPU from 11 minutes to 1.6 seconds per slice and thereby making the approach clinically viable. The method is robust to previously unseen anatomy.

#### CLINICAL RELEVANCE/APPLICATION

With photon-counting CT scanners now clinically available, the proposed method improves workflow by correcting for ring artifacts without the need for time-consuming detector calibration.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPPH-5

### Deep Learning Image Reconstruction Algorithm to Improve the Quality of Vascular Imaging during the Peak Phase of Brain CT Perfusion

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Fang Wang, PhD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the degree of deep learning image reconstruction (DLIR) algorithm to improve the peak arterial quality of CT perfusion (CTP) images in acute stroke cases.

#### METHODS AND MATERIALS

Clinically suspected acute stroke patients were selected for one-stop CTP imaging and randomly divided into two groups. The scanning tube voltage was 80 kV, and the current of low and high dose tube was set to 50 and 150 mA, respectively. Low dose scan data image reconstruction used DLIR 3 different intensities (low, medium and high), and only FBP was used for high dose scan data images reconstruction. Objective evaluation and subjective evaluation (point system) Image quality: The objective evaluation mainly measures the normal measurement of arterial peak period, the CT value and noise of the middle cerebral artery, calculates the signal-to-noise ratio (SNR) and the contrast noise ratio (CNR); the subjective evaluation uses arterial reinforcement, small artery detail display, image noise and venous pollution, each with 0-2 points: 0, poor; 1, medium; 2 points, good. Radiation dose was compared by t-test and image objective score by one-way ANOVA (ANOVA). The subjective scores of image quality were compared using the Cruskal-Wallis test.  $P < 0.05$  were considered to be statistically significant.

#### RESULTS

The mean effective radiation dose between the high dose and low dose scanning regimen was 3.25 and 1.08 mSv, respectively, significant ( $t = -1303.629$ ,  $P < 0.001$ ). The image obtained at low dose gradually decreased with the increase of DLIR intensity, and the image SNR and CNR were gradually increased ( $F = 5.397, 3.450, 2.934$ ,  $P < 0.05$ ). The noise of high-intensity DLIR images and high-dose FBP images was ( $33.9 \pm 2.7$ ), ( $40.5 \pm 11.3$ ), SNR ( $14.3 \pm 6.8, 12.2 \pm 1.9$ ), and CNR ( $13.1 \pm 6.5$  and  $10.6 \pm 1.8$ ), respectively. The differences were statistically significant (t-values were -1.961, -0.989, -1.288, and P-values  $< 0.05$ ). The subjective scores of high intensity DLIR images and high dose FBP images were ( $6.17 \pm 0.4$ ) and ( $4.31 \pm 0.5$ ), respectively, which were statistically significant ( $Z = -4629$ ,  $P < 0.001$ ).

#### CONCLUSION

The application of high-intensity DLIR algorithm is beneficial to achieve low-dose brain CTP, which can significantly improve the image quality and improve the peak period vascular assessment.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning algorithm improves the quality of vascular imaging in the peak period of low-dose cerebral perfusion artery, and provides clinical basis for the realization of one-stop cerebrovascular and cerebral perfusion imaging.

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## Abstract Archives of the RSNA, 2023

T5B-SPPH-6

### Class-wise Combination of Data Augmentation Can Enhance Learning on Class Imbalanced Dataset

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Helen Hong, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Data augmentation (DA) plays an essential role in enhancing learning efficiency and avoiding overfitting in medical image analysis, particularly faced with limited training data or class imbalance. However, recent studies indicate that the effect of DA can differ among classes. We investigated the individual class effects of MixUp and AugMix DAs on focal liver lesions (FLLs) classification in CT images, and proposed a class-wise combination of these DAs with different ratios for each class to address class imbalance.

#### METHODS AND MATERIALS

Our dataset included CT scans from 502 colorectal cancer patients with 1290 FLL images with 676 cysts, 130 hemangiomas, and 484 metastases. We proposed a class-wise combination of MixUp and AugMix DAs by applying them at different rates for each class. For the major classes, cyst and metastasis, MixUp and AugMix are applied at an equal ratio of 50% each, while for the minor class, hemangioma, the rate is adjusted to 75% MixUp and 25% AugMix. We trained a VGG-16 network on these augmented training images to classify FLLs. To evaluate the effectiveness of our method in class imbalance learning, we assessed the accuracy, F1 score, sensitivity, and specificity and analyzed the t-SNE feature distribution of the classification results.

#### RESULTS

Our performance evaluation and feature distribution analysis showed that MixUp improved the sensitivity of the major classes by augmenting the data in the boundary area between classes, while AugMix enhanced the sensitivity of the minor class by augmenting the data within the class itself. By applying these two DAs in different ratios for each class, our method improved the F1 score and the sensitivity for cyst and hemangioma compared to using MixUp and AugMix alone.

#### CONCLUSION

We observed that MixUp and AugMix had different effects on each class within the class imbalanced dataset for FLL classification in CT images. By applying these two DAs at different ratios for each class, our method enhanced the learning efficiency for both major and minor classes in class imbalance learning. (This work was supported by the National Research Foundation of Korea Grant funded by the Korea government (No. RS-2023-00207947))

#### CLINICAL RELEVANCE/APPLICATION

Our proposed method can be applied to various medical image analysis tasks to enhance learning efficiency by utilizing multiple DA methods.

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## Abstract Archives of the RSNA, 2023

T5B-SPPH-8

### Evaluation of Extracellular Volume Changes using Conductivity Tensor Imaging

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jin Woong Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Changes in extracellular volume (ECV) could be an effective biomarker of a disease state, such as fibrosis, edema, and cell swelling. Conductivity tensor imaging (CTI) using MRI has been developed to improve the limitations of existing MR-based conductivity imaging. Without injecting currents into the imaging object, CTI utilizes information on intracellular and extracellular compartments to produce both low-frequency and high-frequency conductivity images. The ECV fraction is one of the parameters that needs to be measured in CTI. In addition, it would have clinical utility if it can be measured reliably. The purpose of this study was to experimentally verify CTI parameters, with a specific focus on ECV fraction, by using a phantom with position-dependent ECV fractions.

#### METHODS AND MATERIALS

Giant vesicle suspension (GVS) was prepared using the reverse phase method. An acrylic phantom was used for the CTI imaging experiment. The changes in ECV were controlled by the GVS chambers with four different densities: electrolyte only and low (GVS #1), middle (GVS #2), and high (GVS #3) densities of GVS. The CTI experiment was performed using a 9.4T MR scanner with a single-channel body coil. A multi-echo spin-echo MR pulse sequence was applied to the phantom to acquire B1 phase maps to reconstruct high-frequency conductivity (sH) images. The single-shot spin-echo echo-planar imaging sequence was used for multi-b-value diffusion-weighted imaging

#### RESULTS

Figure 1 shows the CTI parameters obtained from the imaging experiment of the GVS phantom. MR image shows the morphology of the phantom. The signal intensity was found to be highest in the chamber with electrolyte only, but there was no clear difference in signal intensity between the chambers with different GVS densities. The sH image did not show a clear difference in terms of contrast between the four different densities of GVS. However, a, dew, and sL all showed clear differences in contrast depending on the densities of GVS. Specifically, the contrast of these parameters was decreased as the density of GVS increased. Meanwhile, the contrast of diw was slightly increased with increasing of GVS density. There was no contrast in the chamber of electrolyte only due to the absence of GVS.

#### CONCLUSION

The ECV fraction is a key parameter for measuring CTI because the electrolytes inside and outside of the giant vesicle have similar ionic concentrations. As the vesicle density increased, the ECV decreased, resulting in decreased low-frequency conductivity.

#### CLINICAL RELEVANCE/APPLICATION

Changes in the extracellular space can be indicators of disease progression, such as fibrosis, edema, and cell swelling. CTI can provide information about changes in the extracellular space, such as the ECV fraction.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5B-SPVA-1

### Comparison of 4D Flow MRI-derived Aortic Flow Profiles in Patients with Abdominal Aortic Aneurysms below and above Intervention Threshold

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Inka Ristow, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare 4D flow MRI-derived aortic flow profiles in patients with abdominal aortic aneurysms (AAA) below and above intervention threshold.

#### METHODS AND MATERIALS

We prospectively performed 4D flow MRI of the abdominal aorta at 3T in 22 male AAA patients (72±9 years). Maximum aneurysm diameters were assessed using non-contrast 3D MR angiography. Based on the threshold for intervention, patients were divided into two groups: patients under surveillance with aortic diameters <5.5 cm (n=11) and ii) patients with diameters =5.5 cm with indication for therapeutic intervention (n=11). 4D flow MRI-derived flow rates and velocities were determined at the level of the maximum aneurysm diameter. Presence or absence of vortical flow in the infrarenal aorta was evaluated using a 3-point scale (0: no vortex, 1: local vortex, 2: global vortex). Data were statistically compared using unpaired Mann-Whitney U tests.

#### RESULTS

Mean AAA diameters of patients above intervention threshold were significantly higher as compared to patients under surveillance (4.3±0.7 cm vs. 5.8±0.5, p<0.001). Peak flow rate was significantly higher in patients above intervention threshold when compared to patients under surveillance (165±40ml vs. 108±37, p<0.05). Forward and backward stroke volume of patients above intervention threshold were also significantly higher as compared to patients under surveillance (50±18 ml vs. 30±16 ml and -16±8 vs. -10±0.9 ml, both p<0.008). Pathological vortical flow patterns were present in all (11/11) patients (100%) above surgical threshold as compared to 6/11 patients (55%) under surveillance, resulting in average vortical flow ratings of 1.5±0.5 vs. 0.9±1.0.

#### CONCLUSION

Quantitative and qualitative 4D flow MRI-derived blood flow profiles are significantly altered in AAA patients above intervention threshold when compared to AAA patients under surveillance.

#### CLINICAL RELEVANCE/APPLICATION

Our 4D flow MRI study revealed in about half of the patients under surveillance pathological flow profiles, warranting to investigate if these pathological flow profiles may serve an imaging biomarker to predict future aortic dilation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPVA-2

### Micro-vascularity of the Feet and Toes using Non-contrast MR Perfusion

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Mitsue Miyazaki, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop novel non-contrast 3D MR perfusion techniques for assessing micro-vascularity of the feet and toes in human subjects.

#### METHODS AND MATERIALS

All experiments were performed on a clinical 3T scanner using non-contrast MR perfusion using arterial spin labeling (ASL). Seven healthy subjects (30 to 72 years old, 5 males and 2 females) were enrolled and bilateral feet were imaged with tag-on and tag-off alternating inversion recovery spin labeling for determining perfusion in micro-vascularity. We compared an ASL technique with 1-tag pulse against 4-tag pulses. For perfusion, we determined signal increase ratio (SIR) at varying inversion times (TI) from 0.5 to 2 sec. SIR versus TI data were fit to determine perfusion metrics of peak height (PH), time to peak (TTP), mean transit time (MTT), apparent blood volume (aBV) and apparent blood flow (aBF) in the distal foot and individual toes. Using analysis of variance (ANOVA), effects of tag pulse and ROI on the mean perfusion metrics were assessed.

#### RESULTS

Using MR perfusion techniques, SIR versus TI data showed well-defined leading and trailing edges, with a peak near TI of 0.75 to 1.0 sec and subsiding quickly to near zero by TI of 2 sec, particularly when 4-tag pulses were used. In our normal subjects imaged with 1-tag pulse, the overall (of all ROIs and subjects) mean  $\pm$  standard deviation values of PH, TTP, MTT, aBV, and aBF were  $6.5\pm 4.5\%$ ,  $0.65\pm 0.26$  sec,  $0.60\pm 0.23$  sec,  $8.4\pm 4.6\%$ ·sec, and  $15.0\pm 9.0\%$ , respectively. When imaged with 4-tag pulse sequence, we found a significantly greater values in PH ( $13.4\pm 7.3\%$ ,  $p<0.00001$ ), TTP ( $0.60\pm 0.25$  sec,  $p=0.005$ ), aBV ( $13.7\pm 6.3\%$ ·sec,  $p<0.00001$ ), and aBF ( $25.4\pm 16.1\%$ ,  $p=0.008$ ).

#### CONCLUSION

Feasibility of MR perfusion imaging of the distal foot was studied, and advantages of the 4-tag pulse technique were studied, showing greater SIR and perfusion metrics compared to 1-tag pulse technique. This will likely benefit those with low perfusion due to aging or diseases such as PAD and diabetic foot.

#### CLINICAL RELEVANCE/APPLICATION

Our study demonstrated the feasibility of a novel application of a 3D ASL technique for the feet and toes, with a greater possibility of evaluation of diabetic foot.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5-STCE1

### Science Session (Theranostics)

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center Theater 1

#### Sub-Events

### **T5-STCE1-2 <sup>177</sup>Lu PSMA in Metastatic Castration Resistant Prostate Cancer Treatment: Brazilian Multicentric Study Preliminary Analysis**

Elba C. Etchebehere, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Assess biochemical response and safety of Brazilian patients with metastatic resistant prostate cancer submitted to <sup>177</sup>Lu-PSMA therapy.

#### **METHODS AND MATERIALS**

Data for this retrospective multicentric study was collected from Brazilian centers that performed <sup>177</sup>Lu-PSMA IT in at least two patients with diagnosis of metastatic castration resistant prostate cancer. Data with skewed distribution were reported as median and interquartile range (IQR). Clinical profiles of patients were reported as proportions or frequencies. Primary outcome was assessed by the proportion of patients that reached = 50% PSA decline, compared with baseline (pre-treatment values).

#### **RESULTS**

Patients from 8 centers from 6 Brazilian federative units (SP, PE, CE, RJ, SC and DF) were included, totaling 78 patients. Median age was 74 years old (IQR 67 - 83 years old). <sup>177</sup>Lu-PSMA was the seventh (median) line of therapy (IQR 5-8). A total of 268 cycles were performed with a median of 4 cycles (IQR 2-4). Of 58 patients with data available for the assessment of biochemical response, 55% presented PSA decline and 31% presented PSA decline = 50% from baseline. Of patients with available data for safety assessment 87% do not presented adverse events or presented grades 1 or 2; only 13% presented grade 3 hematologic adverse events and none presented grade 4.

#### **CONCLUSION**

Radioisotope therapy with <sup>177</sup>Lu-PSMA was demonstrated to be effective in the Brazilian population since 31% of patients have achieved at least 50% of PSA levels reduction from baseline, despite being in median the 7<sup>th</sup> line of therapy. Our results are slightly inferior to the results reported in randomized prospective studies (VISION and TheraP). However some differences should be noticed: Late <sup>177</sup>Lu-PSMA (7<sup>th</sup> line) vs earlier <sup>177</sup>Lu-PSMA in the disease course; PSMA I&T vs PSMA-617. Despite being in median the 7<sup>th</sup> line, radioisotope therapy with <sup>177</sup>Lu-PSMA was demonstrated to be safe in the majority (87%) of Brazilian men.

#### **CLINICAL RELEVANCE/APPLICATION**

Despite being in median the 7<sup>th</sup> therapeutic line in the Brazilian population <sup>177</sup>Lu-PSMA was effective since 55% of patients presented PSA reduction and 31% reached the primary endpoint of at least 50% reduction in PSA levels. <sup>177</sup>Lu-PSMA also demonstrated to be safe in the Brazilian population.

### **T5-STCE1-3 ASSESSMENT OF METABOLIC TUMOR BURDEN IN PRIMARY STAGING OF RECTAL CANCERS USING FDG PET/CT**

Elba C. Etchebehere, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the prognostic role of FDG PET/CT metabolic tumor burden in the primary staging of rectal cancer.

## **METHODS AND MATERIALS**

A retrospective analysis was conducted on 82 consecutive histology-proven rectal cancer patients, including 29 females (37%), with a mean age of 60.8 years. These patients underwent staging FDG PET/CT, and various metabolic tumor burden parameters (hSUVmax, tuMTV, wbMTV, tuTLG, wbTLG) were calculated. The study assessed the correlation between metabolic tumor burden parameters and overall survival (OS), progression-free survival (PFS), as well as histopathology, clinical staging, performance status, bone-mineral indexes, hematology, and therapy management strategies.

## **RESULTS**

The study revealed that metabolic tumor burden, along with the presence of sarcopenia and absence of surgery, were significantly and independently associated with overall survival. Notably, a wbTLG cutoff value of 354 effectively discriminated survivors from non-survivors ( $p = 0.0007$ ) with 83% specificity. Furthermore, higher whole-body tumor burden (wbTLG:  $p = 0.0090$ ) and low body mass index ( $p = 0.0231$ ) were significantly linked to an increased risk of disease progression.

## **CONCLUSION**

This research suggests that whole-body tumor burden assessed through staging FDG PET/CT can serve as an independent imaging biomarker for prognostication in rectal cancer patients.

## **CLINICAL RELEVANCE/APPLICATION**

The prognostic value of FDG PET/CT metabolic tumor burden has been established in various solid tumors, but its significance in the staging of rectal cancer remains underexplored.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5-STCE1-2

### 177 Lu PSMA in Metastatic Castration Resistant Prostate Cancer Treatment: Brazilian Multicentric Study Preliminary Analysis

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center Theater 1

Elba C. Etchebehere, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assess biochemical response and safety of Brazilian patients with metastatic resistant prostate cancer submitted to 177Lu-PSMA therapy.

#### METHODS AND MATERIALS

Data for this retrospective multicentric study was collected from Brazilian centers that performed 177Lu-PSMA IT in at least two patients with diagnosis of metastatic castration resistant prostate cancer. Data with skewed distribution were reported as median and interquartile range (IQR). Clinical profiles of patients were reported as proportions or frequencies. Primary outcome was assessed by the proportion of patients that reached = 50% PSA decline, compared with baseline (pre-treatment values).

#### RESULTS

Patients from 8 centers from 6 Brazilian federative units (SP, PE, CE, RJ, SC and DF) were included, totaling 78 patients. Median age was 74 years old (IQR 67 - 83 years old). 177Lu-PSMA was the seventh (median) line of therapy (IQR 5-8). A total of 268 cycles were performed with a median of 4 cycles (IQR 2-4). Of 58 patients with data available for the assessment of biochemical response, 55% presented PSA decline and 31% presented PSA decline = 50% from baseline. Of patients with available data for safety assessment 87% do not presented adverse events or presented grades 1 or 2; only 13% presented grade 3 hematologic adverse events and none presented grade 4.

#### CONCLUSION

Radioisotope therapy with <sup>177</sup>Lu-PSMA was demonstrated to be effective in the Brazilian population since 31% of patients have achieved at least 50% of PSA levels reduction from baseline, despite being in median the 7<sup>th</sup> line of therapy. Our results are slightly inferior to the results reported in randomized prospective studies (VISION and TheraP). However some differences should be noticed: Late <sup>177</sup>Lu-PSMA (7<sup>th</sup> line) vs earlier <sup>177</sup>Lu-PSMA in the disease course; PSMA I&T vs PSMA-617. Despite being in median the 7<sup>th</sup> line, radioisotope therapy with <sup>177</sup>Lu-PSMA was demonstrated to be safe in the majority (87%) of Brazilian men.

#### CLINICAL RELEVANCE/APPLICATION

Despite being in median the 7<sup>th</sup> therapeutic line in the Brazilian population 177 Lu-PSMA was effective since 55% of patients presented PSA reduction and 31% reached the primary endpoint of at least 50% reduction in PSA levels. 177 Lu-PSMA also demonstrated to be safe in the Brazilian population.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5-STCE1-3

### ASSESSMENT OF METABOLIC TUMOR BURDEN IN PRIMARY STAGING OF RECTAL CANCERS USING FDG PET/CT

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center Theater 1

Elba C. Etchebehere, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the prognostic role of FDG PET/CT metabolic tumor burden in the primary staging of rectal cancer.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on 82 consecutive histology-proven rectal cancer patients, including 29 females (37%), with a mean age of 60.8 years. These patients underwent staging FDG PET/CT, and various metabolic tumor burden parameters (hSUVmax, tuMTV, wbMTV, tuTLG, wbTLG) were calculated. The study assessed the correlation between metabolic tumor burden parameters and overall survival (OS), progression-free survival (PFS), as well as histopathology, clinical staging, performance status, bone-mineral indexes, hematology, and therapy management strategies.

#### RESULTS

The study revealed that metabolic tumor burden, along with the presence of sarcopenia and absence of surgery, were significantly and independently associated with overall survival. Notably, a wbTLG cutoff value of 354 effectively discriminated survivors from non-survivors ( $p = 0.0007$ ) with 83% specificity. Furthermore, higher whole-body tumor burden (wbTLG:  $p = 0.0090$ ) and low body mass index ( $p = 0.0231$ ) were significantly linked to an increased risk of disease progression.

#### CONCLUSION

This research suggests that whole-body tumor burden assessed through staging FDG PET/CT can serve as an independent imaging biomarker for prognostication in rectal cancer patients.

#### CLINICAL RELEVANCE/APPLICATION

The prognostic value of FDG PET/CT metabolic tumor burden has been established in various solid tumors, but its significance in the staging of rectal cancer remains underexplored.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5-STCE2

### Science Session (Generative AI)

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center Theater 2

#### Sub-Events

### **T5-STCE2-1 Multimodal Medical Image Classification: A Comparative Study of Vision Transformers and Convolutional Neural Networks**

Salil Patel, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Vision transformers (ViTs) are an emerging architecture for medical image analysis. Compared to convolutional neural networks (CNNs), the current dominant approach, ViTs can handle images of arbitrary size and orientation alongside leveraging long-range dependencies. This study developed and compared ViT against CNNs for multi-modal classification across MRI brain scans, ultrasound breast scans, and CT kidney imaging.

#### **METHODS AND MATERIALS**

For each modality, custom ViT and CNN architectures were implemented using TensorFlow/Keras. Open-access datasets were leveraged, comprising 15,485 MRI scans, 780 ultrasound images, and 12,446 CT slices. The ViT comprised a custom ViT-B16 backbone (21M parameters) and dense output layer. The CNN consisted of four Convolutional Blocks and three Linear Blocks. Images were resized to 128x128 pixels, and one-hot encoded into 4 severity categories. Data was split into train, validation, test sets (60/10/30). K-fold cross-validation ( $k=10$ ) was utilised. Performance metrics included accuracy, precision, recall, F1-score, and ROC AUC, averaged over folds.

#### **RESULTS**

Results were averaged over 10-fold cross-validation for robust evaluation. On Alzheimer's disease classification from MRI scans, the ViT achieved 98.88% accuracy, exceeding the 95.44% accuracy of the CNN. For classification of breast lesions from ultrasound images, the ViT attained 85.26% accuracy, surpassing the CNN's accuracy of 77%. For categorization of kidney conditions from CT scans, the ViT achieved 98.75% accuracy, significantly higher than the CNN's 89% accuracy. Across all three imaging modalities, the ViT consistently demonstrated higher precision, recall, F1-scores, and ROC AUC compared to the CNN models.

#### **CONCLUSION**

This study demonstrated ViTs can exceed CNN performance for medical image classification tasks across imaging modalities. The ViTs leveraged long-range dependencies in images alongside handling varying sizes/orientations.

#### **CLINICAL RELEVANCE/APPLICATION**

This study suggests ViTs may offer advantages over established CNNs in multimodal medical image classification.

### **T5-STCE2-3 Simplifying Radiology reports into layman language with Large Language Models: a pilot study of effect on patient satisfaction**

#### **PURPOSE**

To use Large Language Models (LLM) to provide simplified radiology reports along with vernacular translations to oncology patients and assess its impact on patient satisfaction and understanding.

#### **METHODS AND MATERIALS**

A prospective study was conducted after obtaining ethical approval. The initial phase consisted of prompt engineering, where we fed the impression section of 25 radiology reports from our tertiary-care oncology centre to Chat-GPT4 . We asked it to simplify the report into layman language and translate into <blinded language> and identified specific prompts that resulted in most acceptable outputs. In the next phase, we provided such simplified reports to 100 patients (or their first degree

relatives) who underwent computed tomography at our centre and performed a questionnaire-based survey. All participants were first given the conventional radiology reports, and asked a few questions about their understanding of the disease. Subsequently they were provided the simplified, translated version and then asked a few more questions regarding their perceived utility, and impact on their radiology experience. The participant responses were analysed using descriptive statistics.

## **RESULTS**

Of 100 reports included in the study, 78 were received by a close relative, and 22 by the patient themselves. Nine of the recipients held a post-graduate degree, 34 did not receive formal education and others had education level in between the above. Prior to receiving the report, 9 participants did not know anything about their underlying disease; 27 participants knew their diagnosis of cancer, but not the site of cancer; 55 participants knew only site of cancer; 5 participants knew the site and stage of cancer, while 4 close-relatives said they did not know anything about the patient's medical history. After receiving the traditional report in English, 2 patients could read and understand their report. 98 patients reported that they could not read the report (72 percent), or could read but had no understanding of the report (28 percent). 9 patients needed assistance with reading even the simplified impression. 96 percent of the patients reported that the simplified translated version helped them understand their disease better, 2 suggested that the simplified version added to their anxiety, and 2 said they preferred hearing the report from their clinician.

## **CONCLUSION**

Simplified radiology reports generated using LLMs can positively impact the patient's understanding of their disease status and improve their overall radiology experience.

## **CLINICAL RELEVANCE/APPLICATION**

Easily understandable radiology reports for the patients can help them to actively participate in clinical decision making and nurture a mutualistic doctor-patient relationship.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T5-STCE2-1

### Multimodal Medical Image Classification: A Comparative Study of Vision Transformers and Convolutional Neural Networks

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center Theater 2

Salil Patel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Vision transformers (ViTs) are an emerging architecture for medical image analysis. Compared to convolutional neural networks (CNNs), the current dominant approach, ViTs can handle images of arbitrary size and orientation alongside leveraging long-range dependencies. This study developed and compared ViT against CNNs for multi-modal classification across MRI brain scans, ultrasound breast scans, and CT kidney imaging.

#### METHODS AND MATERIALS

For each modality, custom ViT and CNN architectures were implemented using TensorFlow/Keras. Open-access datasets were leveraged, comprising 15,485 MRI scans, 780 ultrasound images, and 12,446 CT slices. The ViT comprised a custom ViT-B16 backbone (21M parameters) and dense output layer. The CNN consisted of four Convolutional Blocks and three Linear Blocks. Images were resized to 128x128 pixels, and one-hot encoded into 4 severity categories. Data was split into train, validation, test sets (60/10/30). K-fold cross-validation (k=10) was utilised. Performance metrics included accuracy, precision, recall, F1-score, and ROC AUC, averaged over folds.

#### RESULTS

Results were averaged over 10-fold cross-validation for robust evaluation. On Alzheimer's disease classification from MRI scans, the ViT achieved 98.88% accuracy, exceeding the 95.44% accuracy of the CNN. For classification of breast lesions from ultrasound images, the ViT attained 85.26% accuracy, surpassing the CNN's accuracy of 77%. For categorization of kidney conditions from CT scans, the ViT achieved 98.75% accuracy, significantly higher than the CNN's 89% accuracy. Across all three imaging modalities, the ViT consistently demonstrated higher precision, recall, F1-scores, and ROC AUC compared to the CNN models.

#### CONCLUSION

This study demonstrated ViTs can exceed CNN performance for medical image classification tasks across imaging modalities. The ViTs leveraged long-range dependencies in images alongside handling varying sizes/orientations.

#### CLINICAL RELEVANCE/APPLICATION

This study suggests ViTs may offer advantages over established CNNs in multimodal medical image classification.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5-STCE2-3

### **Simplifying Radiology reports into layman language with Large Language Models: a pilot study of effect on patient satisfaction**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center Theater 2

#### **PURPOSE**

To use Large Language Models (LLM) to provide simplified radiology reports along with vernacular translations to oncology patients and assess its impact on patient satisfaction and understanding.

#### **METHODS AND MATERIALS**

A prospective study was conducted after obtaining ethical approval. The initial phase consisted of prompt engineering, where we fed the impression section of 25 radiology reports from our tertiary-care oncology centre to Chat-GPT4 . We asked it to simplify the report into layman language and translate into <blinded language> and identified specific prompts that resulted in most acceptable outputs. In the next phase, we provided such simplified reports to 100 patients (or their first degree relatives) who underwent computed tomography at our centre and performed a questionnaire-based survey. All participants were first given the conventional radiology reports, and asked a few questions about their understanding of the disease. Subsequently they were provided the simplified, translated version and then asked a few more questions regarding their perceived utility, and impact on their radiology experience. The participant responses were analysed using descriptive statistics.

#### **RESULTS**

Of 100 reports included in the study, 78 were received by a close relative, and 22 by the patient themselves. Nine of the recipients held a post-graduate degree, 34 did not receive formal education and others had education level in between the above. Prior to receiving the report, 9 participants did not know anything about their underlying disease; 27 participants knew their diagnosis of cancer, but not the site of cancer; 55 participants knew only site of cancer; 5 participants knew the site and stage of cancer, while 4 close-relatives said they did not know anything about the patient's medical history. After receiving the traditional report in English, 2 patients could read and understand their report. 98 patients reported that they could not read the report (72 percent), or could read but had no understanding of the report (28 percent). 9 patients needed assistance with reading even the simplified impression. 96 percent of the patients reported that the simplified translated version helped them understand their disease better, 2 suggested that the simplified version added to their anxiety, and 2 said they preferred hearing the report from their clinician.

#### **CONCLUSION**

Simplified radiology reports generated using LLMs can positively impact the patient's understanding of their disease status and improve their overall radiology experience.

#### **CLINICAL RELEVANCE/APPLICATION**

Easily understandable radiology reports for the patients can help them to actively participate in clinical decision making and nurture a mutualistic doctor-patient relationship.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSCH06

### Chest Imaging (Infection and Parenchymal Lung Disease)

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E350

Jens Bremerich, MD (*Moderator*) Nothing to Disclose

Brent P. Little, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### T6-SSCH06-Utility of Machine Learning and Radiomics Based on Cavity for Predicting Therapeutic Response of Multidrug-Resistant Tuberculosis<sup>1</sup>

Ye Li (*Presenter*) Nothing to Disclose

#### PURPOSE

The sputum culture status at the sixth month is essential for predicting therapeutic response to the longer multidrug-resistant tuberculosis (MDR-TB) regimens. Regulating therapeutic strategy and formulating individualized treatment is closely associated with the sputum status at this time-point. The aim of this study was to construct a predictive model using radiomics based on cavity to predict the sputum status at the sixth month for MDR-TB patients treated with longer regimens.

#### METHODS AND MATERIALS

The retrospective study recruited 315 MDR-TB patients treated with longer regimens from two centers (250 patients from center 1, 65 patients from center 2) which were divided into sputum positive and negative conversion groups according to sputum results. Radiomics features were extracted based on cavity. The synthetic minority oversampling technique was firstly used to balance the amounts of two groups. Then maximal information coefficient, recursive feature elimination and random forest classifier were applied to select the informative features and establish a predictive model. Basic clinical characteristics and primary CT signs which were analyzed independently with significant differences were integrated to build a clinical model. Finally, a combined model was generated from the radiomics and clinical models. Receiver operator characteristic (ROC) curves, F1-score and decision curve analysis (DCA) were used to assess the predictive performance of models.

#### RESULTS

According to an overview of baseline patient characteristics and primary CT signs, age, previous TB treatment duration, tree-in-bud (TIB) sign, consolidation and emphysema were selected to establish the clinical model. Twenty-eight radiomics features were selected to build the radiomics model for predicting sputum status. The radiomics model for status of sputum culture achieve an encouraging performance with the area under the ROC curves (AUCs) of 0.892 and 0.839 in training and testing cohort, respectively as shown in Fig.5 which was similar to the performance of combined model (0.913 and 0.815). The clinical model yielded AUCs of 0.688 and 0.525 in two cohorts. The DCA curves showed radiomics and combined model would offer net benefits over the "treat-all" or "treat-none" scheme within a certain range of thresholds.

#### CONCLUSION

The radiomics and combined model have excellently predictive potential, especially the radiomics features based on cavity have great value in predicting the sputum culture status at the sixth month for patients receiving longer MDR-TB regimens.

#### CLINICAL RELEVANCE/APPLICATION

The radiomics model has potential to predict the sputum culture status for MDR-TB patients receiving longer regimens that could guide follow-up treatment effectively.

### T6-SSCH06-Deep-learning Derived Measurements of Pectoralis Muscle Composition and Incident Pneumonia Hospitalizations: The MESArthritis Sub-Ancillary Study<sup>2</sup>

Hamza Ibad, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

Pneumonia resulting in hospitalization has many risk factors, including chronic obstructive pulmonary disease (COPD). Advanced skeletal muscle loss due to aging (i.e., sarcopenia) or chronic illnesses (i.e., cachexia) has also been associated with pneumonia and its complications. Deep-learning algorithms allow robust, fast, and reliable muscle composition measurements using any conventional chest CT examination. This may provide clinically feasible imaging markers for the detection and monitoring of early skeletal muscle loss as a possible predictor for pneumonia hospitalizations. To develop a fully automated deep-learning algorithm to extract pectoralis muscle composition measures from conventional chest CT and investigate longitudinal associations between these measures and incident pneumonia according to the presence of COPD.

## METHODS AND MATERIALS

This analysis from the Multi-Ethnic Study of Atherosclerosis included participants with available Chest CT between 2010-2012. We developed and validated a fully automated deep-learning (DL) algorithm for pectoralis two-dimensional segmentation. Furthermore, associations between pectoralis muscle composition measures and risk of incident pneumonia hospitalizations were evaluated using Cox Proportional Hazards Models adjusted for age, sex, physical activity, race, smoking history, hypertension, diabetes, and cholesterol levels. Stratification analyses were conducted based on COPD status.

## RESULTS

This study included 3031 CT examinations for deep learning algorithm development and 2595 participants for longitudinal analyses. Dice scores between DL derived measurements and 600 manual measurements were 0.90 [0.90-0.91] and 0.90 [0.89-0.90] for the training and testing sets, respectively. In the overall study population, pectoralis muscle composition measurements did not predict incident pneumonia. However, among participants with COPD (N = 507), DL-derived CT measures such as extramyocellular fat index (1.89, 95%CI: 1.16, 3.06, p-value: 0.02) predicted incident pneumonia.

## CONCLUSION

Pectoralis muscle composition measurements can be reliably obtained from conventional chest CT using DL algorithms. These measurements predicted incident pneumonia hospitalization among participants with known COPD but not in the overall population.

## CLINICAL RELEVANCE/APPLICATION

Deep-learning algorithms may opportunistically measure pectoralis muscle composition to predict downstream adverse health outcomes

## T6-SSCH06-Is Smoking Marijuana Safe? The Effects of Smoking Cannabis on the Chest

3

Jessie Kang, MD, FRCPC (*Presenter*) Nothing to Disclose

## PURPOSE

To prospectively investigate the effects of marijuana (MJ) smoking on the lungs and chest wall (gynecomastia), by examining the CT chest images in regular marijuana smokers.

## METHODS AND MATERIALS

This was a multi centered, prospective study involving 3 different hospitals. Inclusion criteria for the study included patients who regularly smoke MJ (at least 2 year history, 4x a month) and who have had a CT chest. Exclusion criteria included patients who use MJ as edibles or oral drops. Outcomes for the study included: Emphysema, Mucous plugging, Bronchial wall thickening, Gynecomastia. We had 4 cohorts: non smokers, cigarette smokers, MJ smokers, MJ and cigarette smokers. We used Fisher's exact test and logistic regression using a generalized linear model and tukey's contrasts.

## RESULTS

The proportion of patients with paraseptal emphysema is higher in the MJ Smoker and Smoker Only groups. The association of a MJ only smoker with paraseptal emphysema is 5-7x higher than non-smokers. Association of a MJ Smoker with bronchial wall thickening is 4 times more than non-smokers. No association between gynecomastia and MJ smoking group.

## CONCLUSION

The association of MJ only smokers with paraseptal emphysema is higher than with nonsmokers. The mean number of MJ smoking years was less than compared to cigarette smokers, however, they may have an increased effect on the lungs as the marijuana smoked is often unfiltered. Proportion of patients with centrilobular and paraseptal emphysema is higher in MJ/cigarette smoking and cigarette smoking groups. The association between MJ and smoking with bronchial wall thickening is significant, but interestingly, association with MJ only and smoking only with bronchial wall thickening was not, suggesting that the combination of cigarette smoking and MJ smoking may have a synergistic role on the lung/airways. Interestingly, there was no association between gynecomastia and MJ use.

## CLINICAL RELEVANCE/APPLICATION

Marijuana is the most widely used illicit psychoactive substance in the world, and use has increased in Canada since legalization of non-medical marijuana in 2018. Currently, not much research exists in the effects of marijuana smoking on the lungs. There is a common public misconception that marijuana smoking is not as "harmful" as cigarette smoking. More research needs to be done in this area so the public can make an informed decision on their recreational usage of marijuana. With our study, we show that there are physical effects of marijuana smoking on the lungs, and that cigarette smoking and marijuana smoking may have a combined damaging effect on the lungs.

## T6-SSCH06-Radiologic Pattern of Fibrosis in Combined Pulmonary Fibrosis with Emphysema: Impact on Disease Trajectories and Prognostic Outcomes

Minseon Kim (*Presenter*) Nothing to Disclose

### PURPOSE

This study aimed to evaluate disease trajectories of combined pulmonary fibrosis with emphysema (CPFE) and whether the radiologic pattern of fibrosis is associated with distinct outcomes.

### METHODS AND MATERIALS

This retrospective cohort study included patients with CPFE (emphysema of any subtype involving at least 10% in total lung volume and fibrosis on CT) with available follow-up data. Radiologic pattern of fibrosis was classified based on presence of UIP/probable UIP pattern (radiologic UIP) or others including nonspecific interstitial pneumonia (NSIP) and smoking-related interstitial fibrosis (SRIF) or desquamative interstitial pneumonia (DIP). Deep learning-based quantification was performed to evaluate extent of emphysema and fibrosis. Longitudinal follow-up outcomes were evaluated.

### RESULTS

Total 111 patients with CPFE were included (mean age,  $66.3 \pm 7.8$ ; 109 male) and categorized as 32 UIP (29%), 20 NSIP (18%), 50 SRIF (45%) and 9 DIP (8%). Median follow-up duration was 5.4 years (range, 1.0-13.1). A progressive fibrosing (PF) phenotype defined at one year was identified in 10% (6/53) of patients with SRIF/DIP which was significantly lower than those with UIP (56% [18/32],  $P < .001$ ). There was no significant difference in lung cancer development and median time to progression of emphysema ( $P > .05$ ). Median time to fibrotic progression showed significantly slower progression rate in SRIF (3.0 years), followed by NSIP (2.1 years) and UIP (1.2 years;  $P < .001$ ). Among the 44 patients with current smokers at diagnosis, smoking cessation during the follow-up period did not significantly impact the disease trajectories regarding fibrotic progression (log-rank test,  $P = .84$ ). For time to progression, only radiological pattern was a significant predictor (adjusted HR: 0.26 [ $P < .001$ ] for SRIF/DIP; and 0.51 [ $P = .03$ ] for NSIP compared with UIP) adjusted by age, pack-year, smoking status, extent of emphysema and fibrosis on CT. For lung transplant-free survival, age, lung cancer development and extent of fibrosis on baseline were significant risk factors but radiologic patterns were not.

### CONCLUSION

In patient with CPFE, radiologic pattern of fibrosis was associated with rate of fibrotic progression and PF phenotype was identified in 10% in patients with SRIF/DIP. The quantified baseline fibrosis extent along with lung cancer development were significant prognostic factor for lung-transplant free survival outcome.

## CLINICAL RELEVANCE/APPLICATION

Identifying and reporting the radiologic pattern of fibrosis in patients with CPFE could aid in predicting radiologic disease progression, with quantified baseline fibrosis extent as significant predictor for mortality. These could potentially inform how to monitor disease progression in CPFE.

## T6-SSCH06-Quantitative CT Evaluation of Lung Vessels in Systemic Sclerosis-related Pulmonary Hypertension

Cristina Marrocchio, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Pulmonary hypertension (PH) is a relatively frequent complication of systemic sclerosis (SSc) with a complex etiopathogenesis and significant prognostic implications. Recent studies have utilized automated software to perform quantitative analyses on lung vessels and reported initial evidence in SSc, correlating quantitative vessel parameters with ILD features. However, no study has investigated the potential role of quantitative CT in patients with SSc and PH. This study aims to use quantitative CT to characterize the vascular alterations in patients with SSc and to identify specific disease phenotypes in patients with SSc-related PH.

### METHODS AND MATERIALS

This is a multicenter retrospective study including patients with a diagnosis of SSc who had a chest CT suitable for quantitative analysis from 2007 to 2022. SSc patients were stratified into having or not having PH based on

echocardiography/right heart catheterization. A matched control population with no underlying connective tissue disease and a CT showing no significant abnormalities was identified. Radiological images were analyzed using a commercially available quantification software (Aview, Coreline Soft, Seoul, Republic of Korea). Three radiologists reviewed the images in consensus to manually correct the segmentation and assess for any associated relevant abnormalities. Groups were compared using Mann-Whitney test.

## **RESULTS**

The final population will include a minimum of 50 patients with SSc and PH, and 50 patients with SSc and no PH. Preliminary results included 26 patients who met the study criteria (F:22, M:4, mean age:  $62.6 \pm 9.7$  years). Eighteen patients had SSc, of whom 9 had ILD and 10 had PH; 8 were normal controls, not significantly different in demographics. Patients with SSc had a mean number of lung vessels of  $1313.7 \pm 600.8$ , significantly lower than normal controls ( $2060.3 \pm 604.5$ ,  $p=0.009$ ). The SSc group had also significantly lower number of vessels  $<5 \text{ mm}^2$  ( $p=0.005$ ), lower aggregate volume of vessels  $<5 \text{ mm}^2$  normalized to total blood volume (BV5/TBV) ( $p=0.04$ ), and an increased mean vessel diameter ( $2.1 \pm 0.3 \text{ mm}$  vs  $1.7 \pm 0.2 \text{ mm}$ ,  $p=0.0003$ ). When comparing SSc patients having and not having PH, the total surface area of lung vessels was significantly lower in patients with SSc and PH ( $p=0.02$ ).

## **CONCLUSION**

Our preliminary results show that patient with SSc, and specifically those with PH, have lung vessels changes that can be detected at quantitative analysis.

## **CLINICAL RELEVANCE/APPLICATION**

This study will assess the vascular changes in patients with SSc and PH, potentially leading to a better understanding of the pathophysiology of the disease and providing important additional information on its severity and prognosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSCH06-1

### Utility of Machine Learning and Radiomics Based on Cavity for Predicting Therapeutic Response of Multidrug-Resistant Tuberculosis

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E350

Ye Li (*Presenter*) Nothing to Disclose

#### PURPOSE

The sputum culture status at the sixth month is essential for predicting therapeutic response to the longer multidrug-resistant tuberculosis (MDR-TB) regimens. Regulating therapeutic strategy and formulating individualized treatment is closely associated with the sputum status at this time-point. The aim of this study was to construct a predictive model using radiomics based on cavity to predict the sputum status at the sixth month for MDR-TB patients treated with longer regimens.

#### METHODS AND MATERIALS

The retrospective study recruited 315 MDR-TB patients treated with longer regimens from two centers (250 patients from center 1, 65 patients from center 2) which were divided into sputum positive and negative conversion groups according to sputum results. Radiomics features were extracted based on cavity. The synthetic minority oversampling technique was firstly used to balance the amounts of two groups. Then maximal information coefficient, recursive feature elimination and random forest classifier were applied to select the informative features and establish a predictive model. Basic clinical characteristics and primary CT signs which were analyzed independently with significant differences were integrated to build a clinical model. Finally, a combined model was generated from the radiomics and clinical models. Receiver operator characteristic (ROC) curves, F1-score and decision curve analysis (DCA) were used to assess the predictive performance of models.

#### RESULTS

According to an overview of baseline patient characteristics and primary CT signs, age, previous TB treatment duration, tree-in-bud (TIB) sign, consolidation and emphysema were selected to establish the clinical model. Twenty-eight radiomics features were selected to build the radiomics model for predicting sputum status. The radiomics model for status of sputum culture achieve an encouraging performance with the area under the ROC curves (AUCs) of 0.892 and 0.839 in training and testing cohort, respectively as shown in Fig.5 which was similar to the performance of combined model (0.913 and 0.815). The clinical model yielded AUCs of 0.688 and 0.525 in two cohorts. The DCA curves showed radiomics and combined model would offer net benefits over the "treat-all" or "treat-none" scheme within a certain range of thresholds.

#### CONCLUSION

The radiomics and combined model have excellently predictive potential, especially the radiomics features based on cavity have great value in predicting the sputum culture status at the sixth month for patients receiving longer MDR-TB regimens.

#### CLINICAL RELEVANCE/APPLICATION

The radiomics model has potential to predict the sputum culture status for MDR-TB patients receiving longer regimens that could guide follow-up treatment effectively.

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## Abstract Archives of the RSNA, 2023

T6-SSCH06-2

### Deep-learning Derived Measurements of Pectoralis Muscle Composition and Incident Pneumonia Hospitalizations: The MESArthritis Sub-Ancillary Study

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E350

Hamza Ibad, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Pneumonia resulting in hospitalization has many risk factors, including chronic obstructive pulmonary disease (COPD). Advanced skeletal muscle loss due to aging (i.e., sarcopenia) or chronic illnesses (i.e., cachexia) has also been associated with pneumonia and its complications. Deep-learning algorithms allow robust, fast, and reliable muscle composition measurements using any conventional chest CT examination. This may provide clinically feasible imaging markers for the detection and monitoring of early skeletal muscle loss as a possible predictor for pneumonia hospitalizations. To develop a fully automated deep-learning algorithm to extract pectoralis muscle composition measures from conventional chest CT and investigate longitudinal associations between these measures and incident pneumonia according to the presence of COPD.

#### METHODS AND MATERIALS

This analysis from the Multi-Ethnic Study of Atherosclerosis included participants with available Chest CT between 2010-2012. We developed and validated a fully automated deep-learning (DL) algorithm for pectoralis two-dimensional segmentation. Furthermore, associations between pectoralis muscle composition measures and risk of incident pneumonia hospitalizations were evaluated using Cox Proportional Hazards Models adjusted for age, sex, physical activity, race, smoking history, hypertension, diabetes, and cholesterol levels. Stratification analyses were conducted based on COPD status.

#### RESULTS

This study included 3031 CT examinations for deep learning algorithm development and 2595 participants for longitudinal analyses. Dice scores between DL derived measurements and 600 manual measurements were 0.90 [0.90-0.91] and 0.90 [0.89-0.90] for the training and testing sets, respectively. In the overall study population, pectoralis muscle composition measurements did not predict incident pneumonia. However, among participants with COPD (N = 507), DL-derived CT measures such as extramyocellular fat index (1.89, 95%CI: 1.16, 3.06, p-value: 0.02) predicted incident pneumonia.

#### CONCLUSION

Pectoralis muscle composition measurements can be reliably obtained from conventional chest CT using DL algorithms. These measurements predicted incident pneumonia hospitalization among participants with known COPD but not in the overall population.

#### CLINICAL RELEVANCE/APPLICATION

Deep-learning algorithms may opportunistically measure pectoralis muscle composition to predict downstream adverse health outcomes

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## Abstract Archives of the RSNA, 2023

T6-SSCH06-3

### Is Smoking Marijuana Safe? The Effects of Smoking Cannabis on the Chest

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E350

Jessie Kang, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To prospectively investigate the effects of marijuana (MJ) smoking on the lungs and chest wall (gynecomastia), by examining the CT chest images in regular marijuana smokers.

#### **METHODS AND MATERIALS**

This was a multi centered, prospective study involving 3 different hospitals. Inclusion criteria for the study included patients who regularly smoke MJ (at least 2 year history, 4x a month) and who have had a CT chest. Exclusion criteria included patients who use MJ as edibles or oral drops. Outcomes for the study included: Emphysema, Mucous plugging, Bronchial wall thickening, Gynecomastia. We had 4 cohorts: non smokers, cigarette smokers, MJ smokers, MJ and cigarette smokers. We used Fisher's exact test and logistic regression using a generalized linear model and tukey's contrasts.

#### **RESULTS**

The proportion of patients with paraseptal emphysema is higher in the MJ Smoker and Smoker Only groups. The association of a MJ only smoker with paraseptal emphysema is 5-7x higher than non-smokers. Association of a MJ Smoker with bronchial wall thickening is 4 times more than non-smokers. No association between gynecomastia and MJ smoking group.

#### **CONCLUSION**

The association of MJ only smokers with paraseptal emphysema is higher than with nonsmokers. The mean number of MJ smoking years was less than compared to cigarette smokers, however, they may have an increased effect on the lungs as the marijuana smoked is often unfiltered. Proportion of patients with centrilobular and paraseptal emphysema is higher in MJ/cigarette smoking and cigarette smoking groups. The association between MJ and smoking with bronchial wall thickening is significant, but interestingly, association with MJ only and smoking only with bronchial wall thickening was not, suggesting that the combination of cigarette smoking and MJ smoking may have a synergistic role on the lung/airways. Interestingly, there was no association between gynecomastia and MJ use.

#### **CLINICAL RELEVANCE/APPLICATION**

Marijuana is the most widely used illicit psychoactive substance in the world, and use has increased in Canada since legalization of non-medical marijuana in 2018. Currently, not much research exists in the effects of marijuana smoking on the lungs. There is a common public misconception that marijuana smoking is not as "harmful" as cigarette smoking. More research needs to be done in this area so the public can make an informed decision on their recreational usage of marijuana. With our study, we show that there are physical effects of marijuana smoking on the lungs, and that cigarette smoking and marijuana smoking may have a combined damaging effect on the lungs.

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## Abstract Archives of the RSNA, 2023

T6-SSCH06-4

### **Radiologic Pattern of Fibrosis in Combined Pulmonary Fibrosis with Emphysema: Impact on Disease Trajectories and Prognostic Outcomes**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E350

Minseon Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to evaluate disease trajectories of combined pulmonary fibrosis with emphysema (CPFE) and whether the radiologic pattern of fibrosis is associated with distinct outcomes.

#### **METHODS AND MATERIALS**

This retrospective cohort study included patients with CPFE (emphysema of any subtype involving at least 10% in total lung volume and fibrosis on CT) with available follow-up data. Radiologic pattern of fibrosis was classified based on presence of UIP/probable UIP pattern (radiologic UIP) or others including nonspecific interstitial pneumonia (NSIP) and smoking-related interstitial fibrosis (SRIF) or desquamative interstitial pneumonia (DIP). Deep learning-based quantification was performed to evaluate extent of emphysema and fibrosis. Longitudinal follow-up outcomes were evaluated.

#### **RESULTS**

Total 111 patients with CPFE were included (mean age,  $66.3 \pm 7.8$ ; 109 male) and categorized as 32 UIP (29%), 20 NSIP (18%), 50 SRIF (45%) and 9 DIP (8%). Median follow-up duration was 5.4 years (range, 1.0-13.1). A progressive fibrosing (PF) phenotype defined at one year was identified in 10% (6/53) of patients with SRIF/DIP which was significantly lower than those with UIP (56% [18/32],  $P < .001$ ). There was no significant difference in lung cancer development and median time to progression of emphysema ( $P > .05$ ). Median time to fibrotic progression showed significantly slower progression rate in SRIF (3.0 years), followed by NSIP (2.1 years) and UIP (1.2 years;  $P < .001$ ). Among the 44 patients with current smokers at diagnosis, smoking cessation during the follow-up period did not significantly impact the disease trajectories regarding fibrotic progression (log-rank test,  $P = .84$ ). For time to progression, only radiological pattern was a significant predictor (adjusted HR: 0.26 [ $P < .001$ ] for SRIF/DIP; and 0.51 [ $P = .03$ ] for NSIP compared with UIP) adjusted by age, pack-year, smoking status, extent of emphysema and fibrosis on CT. For lung transplant-free survival, age, lung cancer development and extent of fibrosis on baseline were significant risk factors but radiologic patterns were not.

#### **CONCLUSION**

In patient with CPFE, radiologic pattern of fibrosis was associated with rate of fibrotic progression and PF phenotype was identified in 10% in patients with SRIF/DIP. The quantified baseline fibrosis extent along with lung cancer development were significant prognostic factor for lung-transplant free survival outcome.

#### **CLINICAL RELEVANCE/APPLICATION**

Identifying and reporting the radiologic pattern of fibrosis in patients with CPFE could aid in predicting radiologic disease progression, with quantified baseline fibrosis extent as significant predictor for mortality. These could potentially inform how to monitor disease progression in CPFE.

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## Abstract Archives of the RSNA, 2023

T6-SSCH06-6

### Quantitative CT Evaluation of Lung Vessels in Systemic Sclerosis-related Pulmonary Hypertension

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E350

Cristina Marrocchio, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Pulmonary hypertension (PH) is a relatively frequent complication of systemic sclerosis (SSc) with a complex etiopathogenesis and significant prognostic implications. Recent studies have utilized automated software to perform quantitative analyses on lung vessels and reported initial evidence in SSc, correlating quantitative vessel parameters with ILD features. However, no study has investigated the potential role of quantitative CT in patients with SSc and PH. This study aims to use quantitative CT to characterize the vascular alterations in patients with SSc and to identify specific disease phenotypes in patients with SSc-related PH.

#### METHODS AND MATERIALS

This is a multicenter retrospective study including patients with a diagnosis of SSc who had a chest CT suitable for quantitative analysis from 2007 to 2022. SSc patients were stratified into having or not having PH based on echocardiography/right heart catheterization. A matched control population with no underlying connective tissue disease and a CT showing no significant abnormalities was identified. Radiological images were analyzed using a commercially available quantification software (Aview, Coreline Soft, Seoul, Republic of Korea). Three radiologists reviewed the images in consensus to manually correct the segmentation and assess for any associated relevant abnormalities. Groups were compared using Mann-Whitney test.

#### RESULTS

The final population will include a minimum of 50 patients with SSc and PH, and 50 patients with SSc and no PH. Preliminary results included 26 patients who met the study criteria (F:22, M:4, mean age:  $62.6 \pm 9.7$  years). Eighteen patients had SSc, of whom 9 had ILD and 10 had PH; 8 were normal controls, not significantly different in demographics. Patients with SSc had a mean number of lung vessels of  $1313.7 \pm 600.8$ , significantly lower than normal controls ( $2060.3 \pm 604.5$ ,  $p=0.009$ ). The SSc group had also significantly lower number of vessels  $<5$  mm<sup>2</sup> ( $p=0.005$ ), lower aggregate volume of vessels  $<5$ mm<sup>2</sup> normalized to total blood volume (BV5/TBV) ( $p=0.04$ ), and an increased mean vessel diameter ( $2.1 \pm 0.3$  mm vs  $1.7 \pm 0.2$  mm,  $p=0.0003$ ). When comparing SSc patients having and not having PH, the total surface area of lung vessels was significantly lower in patients with SSc and PH ( $p=0.02$ ).

#### CONCLUSION

Our preliminary results show that patient with SSc, and specifically those with PH, have lung vessels changes that can be detected at quantitative analysis.

#### CLINICAL RELEVANCE/APPLICATION

This study will assess the vascular changes in patients with SSc and PH, potentially leading to a better understanding of the pathophysiology of the disease and providing important additional information on its severity and prognosis.

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## Abstract Archives of the RSNA, 2023

T6-SSGU04

### Genitourinary Imaging (Imaging of Benign Genitourinary Pathologies)

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N227B

Elaine M. Caoili, MD, MS (*Moderator*) Steering Committee, ProKidney, LLC  
Wendy Tu, MD, FRCPC (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T6-SSGU04-2 Evaluation of Male Voiding Function using Upright CT in the Standing Posture: A Pilot Study**

Masahiro Jinzaki, MD, PhD (*Presenter*) Support, Canon Medical Systems Corporation; Support, General Electric Company

#### **PURPOSE**

This study aims to utilize the upright 4D CT imaging technique during urination to elucidate the mechanism of normal urination in asymptomatic male volunteers, comparing it with the urination mechanism in patients with benign prostate hypertrophy (BPH). Background: The traditional evaluation of lower urinary tract dysfunction (LUTD) as BPH relies on voiding-cystourethrography and urodynamic studies. However, these methods are invasive, requiring transurethral or rectal catheter insertion, and cannot produce three or four-dimensional evaluations of the soft tissues such as the bladder, prostate, and pelvic floor muscles.

#### **METHODS AND MATERIALS**

Four asymptomatic male volunteers and eight dysuria cases underwent upright 4D CT scans during urination. The first five scans were taken every 2 seconds, followed by scans every 5 seconds. Scans were performed 40 minutes post intravenous contrast medium administration without transurethral catheter insertion. The radiation dosage ranged from 2.5 to 8 mSv depending on patient size. Urinary output was measured simultaneously by uroflowmetry during the CT scan. We analyzed the correlation between urinary output and changes in bladder volume before and after urination on CT. We evaluated the urination mechanism was visually inspected in both asymptomatic volunteers and BPH patients.

#### **RESULTS**

The correlation coefficient between urinary output as measured by uroflowmetry and as calculated by CT was  $r = 0.99$  ( $p < 0.01$ ). In asymptomatic males, urination started with coccyx displacement, leading to the bladder neck opening. Urination ceased not by closing the bladder neck but by closing the entire prostatic urethra once the bladder was emptied. However, in BPH cases, the urethra closed partially or entirely, even with residual urine in the bladder. A review of patients with no postoperative symptom improvement revealed no partial urethral stricture during urination and weak bladder contractility, suggesting drug therapy could be a more suitable treatment option.

#### **CONCLUSION**

The 4D CT imaging technique in a standing position has the potential to illuminate the standard urination mechanism in males. Identifying variations from this norm in dysuria patients can guide toward more appropriate treatment strategies for such conditions.

#### **CLINICAL RELEVANCE/APPLICATION**

Upright 4D CT imaging could improve LUTD diagnostics, offering a non-invasive method to understand urination mechanisms and guide appropriate treatment for conditions like BPH.

#### **T6-SSGU04-3 Novel Non-invasive and Quantitative Assessment of Renal Function of the Transplanted Kidney using Doppler Ultrasound with the Vascular Index of Superb Microvascular Imaging**

Eunji Lee, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the reproducibility and value of the vascular index of superb microvascular imaging (SMI) in Doppler ultrasound (US) for the assessment of renal function in the transplanted kidney

## METHODS AND MATERIALS

From January 2022 to February 2023, 63 renal transplant patients who underwent US including grayscale and Doppler study with SMI were included in this retrospective study. Two radiologists independently measured the vascular index of transplanted kidneys using three methods (VIbox, VIF1, VIF2). The vascular index measured by the three methods was compared among CKD groups according to eGFR (G1, eGFR>60mL/min; G2, 60-45; G3, eGFR<45) and KDIGO CKD risk groups based on eGFR and albuminuria (low, moderate, and high). The correlation between the vascular index and renal function, reflected either by serum creatinine or eGFR, was evaluated. Inter-observer agreement was analyzed for the vascular index of the SMI. Univariate and multivariate linear regression analysis was used to determine factors predictive of eGFR.

## RESULTS

There was a statistically significant difference in the vascular index of the transplanted kidney according to CKD groups based on eGFR (all  $p < 0.001$ ) and KDIGO CKD risk groups based on eGFR and albuminuria (VIbox,  $p = 0.039$ ; VIF1,  $p = 0.011$ ; VIF2,  $p < 0.001$ ). Among the three methods measuring the vascular index of the transplanted kidney, VIF1 and VIF2 showed a moderately high correlation with eGFR ( $r = 0.626$ ,  $p < 0.000$ ,  $r = 0.657$ ,  $p < 0.000$ , respectively) and serum creatinine ( $r = -0.634$ ,  $p = 0.000$ ,  $r = -0.656$ ,  $p = 0.000$ , respectively). VIbox showed a moderate correlation with eGFR ( $r = 0.430$ ,  $p = 0.000$ ) or serum creatinine ( $r = -0.428$ ,  $p = 0.000$ ). The inter-observer agreement of the three methods of VI measurement was excellent (interclass correlation coefficient: VIbox, 0.953; VIF1, 0.988; VIF2, 0.932, respectively). Multivariate linear regression analysis showed ACR (urine albumin-creatinine ratio) (adjusted odds ratio[aOR] = -0.006, 95% confidence interval[CI] = -0.010, -0.002,  $p = 0.030$ ), and VIF2 (aOR = 1.114, 95% CI = 0.466, 1.235,  $p < 0.000$ ) were independently associated with eGFR.

## CONCLUSION

The vascular index, measured by drawing a ROI along the border of the transplanted kidney in SMI (VI<sub>F1</sub> and VI<sub>F2</sub>), is highly reproducible and correlates well with eGFR. VI<sub>F2</sub> and ACR are independent predictors of eGFR.

## CLINICAL RELEVANCE/APPLICATION

The vascular index of SMI in Doppler US provides a non-invasive, quantitative, and reproducible assessment of renal function in the transplanted kidney.

## T6-SSGU04-5 Sub-millisievert Abdominal Photon-counting CT for the Diagnosis of Urinary Calculi

Henner Huflage, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Constituting the primary means of detecting urolithiasis, unenhanced abdominal CT represents one of the most common radiologic examinations in emergency departments worldwide. This study was designed to compare dose-optimized energy-integrating detector CT (EID-CT) with an experimental photon-counting CT (PCD-CT) scan protocol employing tin prefiltration at 100 kVp in a large patient population with suspected urinary calculi.

## METHODS AND MATERIALS

A total of 507 patients (190 women, 37.5%) were enrolled during a 14-month period, of which the PCD-CT group included 229 subjects (45.2%). BMI distribution between cohorts differed slightly, leaning toward EID-CT ( $26.6 \pm 5.5$  vs.  $27.7 \pm 5.7$  kg/m<sup>2</sup>; +3.9%;  $P = .030$ ). Conversely, no significant difference was ascertained for age ( $P = .952$ ) and sex ( $P = .411$ ) among cohorts. Signal and noise measurements were performed within three anatomic levels (kidney, psoas muscle, internal obturator muscle). Additionally, presence and number of urinary calculi was assessed individually by three radiologists for both kidneys and the respective urinary tracts.

## RESULTS

Median CTDI<sub>vol</sub> amounted to 1.17 mGy (0.97-1.49 mGy) with PCD-CT and 1.99 mGy (1.49-2.58 mGy) with EID-CT. Corresponding effective dose was reported at 0.79 mSv (0.63-0.99 mSv) and 1.39 mSv (1.01-1.87 mSv). Despite the higher radiation exposure, SNR at the kidney, psoas, and obturator level was 29.8%, 23.4%, and 16.8% lower in EID-CT ( $P < .001$ ). Nephrolithiasis was detected in 129/127/129 individuals within the PCD-CT sample (reader 1/2/3) and in 94/94/94 patients of the EID-CT cohort. Likewise, 113/114/114 and 152/153/152 cases of ureterolithiasis were described in the respective groups. Notwithstanding study cohort and calculi localization, interrater agreement was almost perfect (Krippendorff's  $\alpha = 0.991$ ). Across all observers, reader confidence was excellent with no difference between PCD-CT and EID-CT groups ( $P = .572$ ).

## CONCLUSION

Sub-millisievert abdominal PCD-CT for the diagnosis of urinary calculi is feasible without compromising image quality or diagnostic performance.

## CLINICAL RELEVANCE/APPLICATION

In comparison with already dose-optimized EID-CT, the radiation exposure in unenhanced abdominal PCD-CT can be reduced by an additional 43.6%.

## T6-SSGU04-6 Comparison of Photon-counting and Energy-integrating Detector CT Systems for the Characterization of Cystic Renal Lesions on Virtual Noncontrast Imaging

Ludovica Lofino, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to compare the absolute CT attenuation errors of cystic renal lesions and abdominal organs on virtual noncontrast images (VNC) between photon-counting (PCCT) and energy-integrating (EID) detector CT systems.

## METHODS AND MATERIALS

In this HIPAA compliant, IRB-approved retrospective study, multiphase CT scans from one commercially available PCCT (NAEOTOM Alpha, Siemens Healthineers) and two EID dual-source dual-energy CT systems (SOMATOM Definition Flash and SOMATOM Force, Siemens Healthineers) were retrieved. A total of 56 BMI-matched patients (26 women, 30 men; mean age  $58.5 \pm 15.3$  years; range 19-81 years, mean BMI  $29.0 \pm 6.8$  kg/m<sup>2</sup>, range 13-47 kg/m<sup>2</sup>) were included: 16 for PCCT and 20 each per EID systems. Attenuation measurements of abdominal organs (liver, pancreas, spleen, kidney, and aorta) were recorded on VNC and True Noncontrast (TNC) datasets. Furthermore, attenuation measurements of 16 cystic renal lesions (eight for PCCT and eight for EID) were compared on VNC and TNC datasets. Absolute CT attenuation errors  $|HUVNC - HUTNC|$  were calculated and compared between PCCT and EID systems for the entire population and a subset of 20 obese patients (BMI:  $>30$  kg/m<sup>2</sup>), using paired t-tests. Absolute CT attenuation errors were also compared for all cystic renal lesions and for renal lesions  $<1$  cm, separately.

## RESULTS

PCCT yielded significantly lower absolute CT attenuation errors than EID using VNC in comparison with TNC images for the liver ( $4.3 \pm 5.4$  vs  $8.8 \pm 10.4$ ), spleen ( $2.6 \pm 6.2$  vs  $8.0 \pm 10.3$ ) and pancreas ( $4.4 \pm 1.8$  vs  $7.7 \pm 9.7$ ) for all patients ( $P < 0.01$ ) and for spleen and pancreas in the obese patient cohort ( $P < 0.05$ ). Furthermore, PCCT yielded significantly lower absolute CT attenuation errors compared to EID for all cystic renal lesions ( $2.0 \pm 1.3$  vs.  $12.0 \pm 8.9$ ;  $P < 0.01$ ) and for renal lesions  $<1$  cm ( $1.4 \pm 0.9$  vs.  $19.1 \pm 6.8$ ;  $P < 0.01$ ).

## CONCLUSION

PCCT yields significantly lower absolute CT attenuation errors for abdominal organs and cystic renal lesions in VNC images, compared to two dual-source dual-energy EID systems. Our results were corroborated in a subset of obese patients and small ( $<1$  cm) renal lesions.

## CLINICAL RELEVANCE/APPLICATION

Reliable CT attenuation values of virtual non-contrast imaging are necessary to replace true non-contrast acquisitions. This can be achieved with photon-counting CT with important implications in radiation dose reduction.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSGU04-2

### Evaluation of Male Voiding Function using Upright CT in the Standing Posture: A Pilot Study

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N227B

Masahiro Jinzaki, MD, PhD (*Presenter*) Support, Canon Medical Systems Corporation; Support, General Electric Company

#### PURPOSE

This study aims to utilize the upright 4D CT imaging technique during urination to elucidate the mechanism of normal urination in asymptomatic male volunteers, comparing it with the urination mechanism in patients with benign prostate hypertrophy (BPH). Background: The traditional evaluation of lower urinary tract dysfunction (LUTD) as BPH relies on voiding-cystourethrography and urodynamic studies. However, these methods are invasive, requiring transurethral or rectal catheter insertion, and cannot produce three or four-dimensional evaluations of the soft tissues such as the bladder, prostate, and pelvic floor muscles.

#### METHODS AND MATERIALS

Four asymptomatic male volunteers and eight dysuria cases underwent upright 4D CT scans during urination. The first five scans were taken every 2 seconds, followed by scans every 5 seconds. Scans were performed 40 minutes post intravenous contrast medium administration without transurethral catheter insertion. The radiation dosage ranged from 2.5 to 8 mSv depending on patient size. Urinary output was measured simultaneously by uroflowmetry during the CT scan. We analyzed the correlation between urinary output and changes in bladder volume before and after urination on CT. We evaluated the urination mechanism was visually inspected in both asymptomatic volunteers and BPH patients.

#### RESULTS

The correlation coefficient between urinary output as measured by uroflowmetry and as calculated by CT was  $r = 0.99$  ( $p < 0.01$ ). In asymptomatic males, urination started with coccyx displacement, leading to the bladder neck opening. Urination ceased not by closing the bladder neck but by closing the entire prostatic urethra once the bladder was emptied. However, in BPH cases, the urethra closed partially or entirely, even with residual urine in the bladder. A review of patients with no postoperative symptom improvement revealed no partial urethral stricture during urination and weak bladder contractility, suggesting drug therapy could be a more suitable treatment option.

#### CONCLUSION

The 4D CT imaging technique in a standing position has the potential to illuminate the standard urination mechanism in males. Identifying variations from this norm in dysuria patients can guide toward more appropriate treatment strategies for such conditions.

#### CLINICAL RELEVANCE/APPLICATION

Upright 4D CT imaging could improve LUTD diagnostics, offering a non-invasive method to understand urination mechanisms and guide appropriate treatment for conditions like BPH.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSGU04-3

### **Novel Non-invasive and Quantitative Assessment of Renal Function of the Transplanted Kidney using Doppler Ultrasound with the Vascular Index of Superb Microvascular Imaging**

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N227B

Eunji Lee, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the reproducibility and value of the vascular index of superb microvascular imaging (SMI) in Doppler ultrasound (US) for the assessment of renal function in the transplanted kidney

#### **METHODS AND MATERIALS**

From January 2022 to February 2023, 63 renal transplant patients who underwent US including grayscale and Doppler study with SMI were included in this retrospective study. Two radiologists independently measured the vascular index of transplanted kidneys using three methods (VIbox, VIF1, VIF2). The vascular index measured by the three methods was compared among CKD groups according to eGFR (G1, eGFR>60mL/min; G2, 60-45; G3, eGFR<45) and KDIGO CKD risk groups based on eGFR and albuminuria (low, moderate, and high). The correlation between the vascular index and renal function, reflected either by serum creatinine or eGFR, was evaluated. Inter-observer agreement was analyzed for the vascular index of the SMI. Univariate and multivariate linear regression analysis was used to determine factors predictive of eGFR.

#### **RESULTS**

There was a statistically significant difference in the vascular index of the transplanted kidney according to CKD groups based on eGFR (all  $p < 0.001$ ) and KDIGO CKD risk groups based on eGFR and albuminuria (VIbox,  $p = 0.039$ ; VIF1,  $p = 0.011$ ; VIF2,  $p < 0.001$ ). Among the three methods measuring the vascular index of the transplanted kidney, VIF1 and VIF2 showed a moderately high correlation with eGFR ( $r = 0.626$ ,  $p < 0.000$ ,  $r = 0.657$ ,  $p < 0.000$ , respectively) and serum creatinine ( $r = -0.634$ ,  $p = 0.000$ ,  $r = -0.656$ ,  $p = 0.000$ , respectively). VIbox showed a moderate correlation with eGFR ( $r = 0.430$ ,  $p = 0.000$ ) or serum creatinine ( $r = -0.428$ ,  $p = 0.000$ ). The inter-observer agreement of the three methods of VI measurement was excellent (interclass correlation coefficient: VIbox, 0.953; VIF1, 0.988; VIF2, 0.932, respectively). Multivariate linear regression analysis showed ACR (urine albumin-creatinine ratio) (adjusted odds ratio[aOR] = -0.006, 95% confidence interval[CI] = -0.010, -0.002,  $p = 0.030$ ), and VIF2 (aOR = 1.114, 95% CI = 0.466, 1.235,  $p < 0.000$ ) were independently associated with eGFR.

#### **CONCLUSION**

The vascular index, measured by drawing a ROI along the border of the transplanted kidney in SMI (VI<sub>F1</sub> and VI<sub>F2</sub>), is highly reproducible and correlates well with eGFR. VI<sub>F2</sub> and ACR are independent predictors of eGFR.

#### **CLINICAL RELEVANCE/APPLICATION**

The vascular index of SMI in Doppler US provides a non-invasive, quantitative, and reproducible assessment of renal function in the transplanted kidney.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-SSGU04-5

### Sub-millisievert Abdominal Photon-counting CT for the Diagnosis of Urinary Calculi

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N227B

Henner Huflage, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Constituting the primary means of detecting urolithiasis, unenhanced abdominal CT represents one of the most common radiologic examinations in emergency departments worldwide. This study was designed to compare dose-optimized energy-integrating detector CT (EID-CT) with an experimental photon-counting CT (PCD-CT) scan protocol employing tin prefiltration at 100 kVp in a large patient population with suspected urinary calculi.

#### METHODS AND MATERIALS

A total of 507 patients (190 women, 37.5%) were enrolled during a 14-month period, of which the PCD-CT group included 229 subjects (45.2%). BMI distribution between cohorts differed slightly, leaning toward EID-CT ( $26.6 \pm 5.5$  vs.  $27.7 \pm 5.7$  kg/m<sup>2</sup>; +3.9%;  $P=.030$ ). Conversely, no significant difference was ascertained for age ( $P=.952$ ) and sex ( $P=.411$ ) among cohorts. Signal and noise measurements were performed within three anatomic levels (kidney, psoas muscle, internal obturator muscle). Additionally, presence and number of urinary calculi was assessed individually by three radiologists for both kidneys and the respective urinary tracts.

#### RESULTS

Median CTD<sub>Ivol</sub> amounted to 1.17 mGy (0.97-1.49 mGy) with PCD-CT and 1.99 mGy (1.49-2.58 mGy) with EID-CT. Corresponding effective dose was reported at 0.79 mSv (0.63-0.99 mSv) and 1.39 mSv (1.01-1.87 mSv). Despite the higher radiation exposure, SNR at the kidney, psoas, and obturator level was 29.8%, 23.4%, and 16.8% lower in EID-CT ( $P<.001$ ). Nephrolithiasis was detected in 129/127/129 individuals within the PCD-CT sample (reader 1/2/3) and in 94/94/94 patients of the EID-CT cohort. Likewise, 113/114/114 and 152/153/152 cases of ureterolithiasis were described in the respective groups. Notwithstanding study cohort and calculi localization, interrater agreement was almost perfect (Krippendorff's  $\alpha = 0.991$ ). Across all observers, reader confidence was excellent with no difference between PCD-CT and EID-CT groups ( $P=.572$ ).

#### CONCLUSION

Sub-millisievert abdominal PCD-CT for the diagnosis of urinary calculi is feasible without compromising image quality or diagnostic performance.

#### CLINICAL RELEVANCE/APPLICATION

In comparison with already dose-optimized EID-CT, the radiation exposure in unenhanced abdominal PCD-CT can be reduced by an additional 43.6%.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSGU04-6

### Comparison of Photon-counting and Energy-integrating Detector CT Systems for the Characterization of Cystic Renal Lesions on Virtual Noncontrast Imaging

Tuesday, Nov. 28 1:30PM - 2:30PM Room: N227B

Ludovica Lofino, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to compare the absolute CT attenuation errors of cystic renal lesions and abdominal organs on virtual noncontrast images (VNC) between photon-counting (PCCT) and energy-integrating (EID) detector CT systems.

#### METHODS AND MATERIALS

In this HIPAA compliant, IRB-approved retrospective study, multiphase CT scans from one commercially available PCCT (NAEOTOM Alpha, Siemens Healthineers) and two EID dual-source dual-energy CT systems (SOMATOM Definition Flash and SOMATOM Force, Siemens Healthineers) were retrieved. A total of 56 BMI-matched patients (26 women, 30 men; mean age  $58.5 \pm 15.3$  years; range 19-81 years, mean BMI  $29.0 \pm 6.8$  kg/m<sup>2</sup>, range 13-47 kg/m<sup>2</sup>) were included: 16 for PCCT and 20 each per EID systems. Attenuation measurements of abdominal organs (liver, pancreas, spleen, kidney, and aorta) were recorded on VNC and True Noncontrast (TNC) datasets. Furthermore, attenuation measurements of 16 cystic renal lesions (eight for PCCT and eight for EID) were compared on VNC and TNC datasets. Absolute CT attenuation errors  $|HUVNC-HUTNC|$  were calculated and compared between PCCT and EID systems for the entire population and a subset of 20 obese patients (BMI:  $>30$  kg/m<sup>2</sup>), using paired t-tests. Absolute CT attenuation errors were also compared for all cystic renal lesions and for renal lesions  $<1$  cm, separately.

#### RESULTS

PCCT yielded significantly lower absolute CT attenuation errors than EID using VNC in comparison with TNC images for the liver ( $4.3 \pm 5.4$  vs  $8.8 \pm 10.4$ ), spleen ( $2.6 \pm 6.2$  vs  $8.0 \pm 10.3$ ) and pancreas ( $4.4 \pm 1.8$  vs  $7.7 \pm 9.7$ ) for all patients ( $P<0.01$ ) and for spleen and pancreas in the obese patient cohort ( $P<0.05$ ). Furthermore, PCCT yielded significantly lower absolute CT attenuation errors compared to EID for all cystic renal lesions ( $2.0 \pm 1.3$  vs.  $12.0 \pm 8.9$ ;  $P<0.01$ ) and for renal lesions  $<1$  cm ( $1.4 \pm 0.9$  vs.  $19.1 \pm 6.8$ ;  $P<0.01$ ).

#### CONCLUSION

PCCT yields significantly lower absolute CT attenuation errors for abdominal organs and cystic renal lesions in VNC images, compared to two dual-source dual-energy EID systems. Our results were corroborated in a subset of obese patients and small ( $<1$  cm) renal lesions.

#### CLINICAL RELEVANCE/APPLICATION

Reliable CT attenuation values of virtual non-contrast imaging are necessary to replace true non-contrast acquisitions. This can be achieved with photon-counting CT with important implications in radiation dose reduction.

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## Abstract Archives of the RSNA, 2023

T6-SSPH08

### Physics (Artificial Intelligence in Medical Imaging)

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E351

Ran Zhang, PhD (*Moderator*) Nothing to Disclose  
Andrew Missert, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T6-SSPH08-Evaluation of AI Bias Mitigation Algorithms by Systematically Promoting Sources of Bias 1**

Ravi K. Samala, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To facilitate evaluation of bias mitigation methods, we create a systematic approach to amplify bias in artificial intelligence (AI) models by promoting spurious correlations between sensitive attributes and AI output tasks.

#### **METHODS AND MATERIALS**

The MIDRC/Open-A1 chest x-ray dataset was split by patient into training (2,632), tuning (1,584) and test (1,048) sets, each stratified by sex, race and COVID status. We promoted spurious correlations between sex subgroups and COVID status by modifying the latent space. To achieve this, a two-stage transfer learning pipeline was developed. In stage 1, the model was trained to classify patient sex. In stage 2, the model was fine-tuned to classify COVID status. The two-stage transfer learning approach encourages the use of the features used to classify patient sex in stage 1 for the classification of COVID status in stage 2. By freezing layers between stages 1 and 2, we can reduce the opportunities for the model to learn new features, thereby further encouraging the creation of spurious correlations between sex and COVID status. We also altered the direction of bias in stage 2 by flipping which class is 0 or 1 in stage 1. A baseline model was developed by skipping stage 1. ResNet18 architecture was implemented, and the same training/tuning set was used throughout model development. A post-processing bias mitigation algorithm that aims to ensure equalized odds between subgroups while maintaining calibration was implemented and evaluated on these models. The demographic parity difference (?DP), positive average equality gap (pAEG), and subgroup area under the ROC curve (AUC) were calculated on the test set to measure the bias at both baseline and after bias amplification with/without mitigation. Higher ?DP and pAEG values indicate larger bias between subgroups.

#### **RESULTS**

The approach of freezing the first layer resulted in increased ?DP of  $0.02 \pm 0.001$  and pAEG of  $0.06 \pm 0.007$  compared to  $0.01 \pm 0.002$  and  $0.02 \pm 0.006$  for baseline respectively. Freezing more layers increased the bias level, ?DP and pAEG increased to  $0.04 \pm 0.002$  and  $0.11 \pm 0.008$ , respectively. By flipping classes, both measurements showed similar trend but towards another sex subgroup. After mitigation, pAEG significantly dropped to between  $0.01 \pm 0.005$  and  $0.03 \pm 0.008$  for bias amplified models with ?DP slightly decreased and no significant change in subgroup AUC.

#### **CONCLUSION**

We developed a novel approach to systematically amplify bias in AI models to facilitate a comprehensive evaluation of bias mitigation methods.

#### **CLINICAL RELEVANCE/APPLICATION**

Bias in medical devices has the potential to create healthcare disparities. Our work provides a novel approach to assess emerging bias mitigation methods, which can be an effective strategy to prevent these disparities.

#### **T6-SSPH08-Attention and Spatial Transformer-based Cardiac Motion Artifact Correction for Stenosis 2 Assessment in Energy-integrating-detector and Photon-counting-detector CT**

Hao Gong, PHD (*Presenter*) Nothing to Disclose

## PURPOSE

Coronary CT angiography (CCTA) is commonly used in stenosis assessment. Yet, its utility is limited by detrimental cardiac motion artifacts in patients with high / irregular heartbeat rates, despite the advancements in dual source CT (DSCT) and motion correction methods in single source CT. We aim to improve the visualization and accuracy of stenosis assessment via reducing cardiac motion artifacts with a deep learning method based on attention and spatial transformer sub-networks (ATOM)

## METHODS AND MATERIALS

ATOM used cross-phase temporospatial information to semi-implicitly model motion vector fields and detect dynamic structures, and used custom attention and transformer sub-networks to adaptively correct motion artifacts. It was trained with retrospectively collected ECG-gated patient CCTA images (n=30; heart rate >60bpm) from an energy integrating detector (EID) DSCT (SOMATOM Flash, Siemens; max temporal resolution (TR) 75ms). Training used the paired patches of coronary arteries reconstructed at four phases (65%, 70%, 75%, 80%R-R) and two TRs (140ms and 75ms). In the pilot study, ATOM was quantitatively validated using plaque-mimicking rods (artificial heart rate 60bpm) scanned on EID-DSCT. Two motion artifact metrics (entropy and transformed positivity) and the percent stenosis were compared in rod images before and after motion correction. ATOM was qualitatively assessed using patient cases (n=6, all heart rate >60bpm) collected from a clinical photon-counting-detector (PCD) DSCT (NAEOTOM Alpha, Siemens; max TR 66ms). The visualization of vessels and plaques before and after correction was compared

## RESULTS

In phantom data, ATOM reduced motion artifacts, improved rod/plaque visualization and stenosis quantification across testing phases unseen in training, e.g., metrics before vs after correction at 140ms 45%R-R and 75ms 50%R-R: Median entropy 0.54 vs 0.49, and 0.90 vs 0.56 (Sign-rank test  $p < 0.05$ ); Median transformed positivity 23.4 vs 20.7, and 43.1 vs 25.7 (Sign-rank test  $p < 0.05$ ); for the 50% stenosis (ground truth), the measured percent blockage 89% vs 55%, and 76% vs 55%. In PCD-DSCT patient images before correction, the delineation of coronaries was degraded, and the distorted plaque falsely represented much larger or smaller blockage to the lumen. ATOM can suppress motion-induced distortion while improving the depiction of lumen and plaques, which can facilitate accurate stenosis quantification

## CONCLUSION

ATOM reduced motion artifacts and improved diagnostic image quality for stenosis assessment in CCTA

## CLINICAL RELEVANCE/APPLICATION

ATOM could improve temporal resolution and reduce motion artifacts in EID- and PCD-DSCT, which is potential to improve stenosis assessment in CCTA and downstream patient management

## T6-SSPH08-Federated Learning for Classification of COVID-19 Severity based on Chest X-rays

3

Matthew Beaubien, BEng (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the effectiveness of federated learning on classifying COVID chest x-rays into severe or non-severe.

## METHODS AND MATERIALS

We used two multi-institutional datasets, MIDRC and BrixIA, and employed collaborative federated learning (FL) techniques for training deep learning models for COVID severity classification. BrixIA contained 3,755 images and was split by case into 3,285 images for training and 470 images for validation. MIDRC contained 650 images and was split by case into 582 images for training and 68 images for validation. We investigated two FL methods. Cyclic sequential learning is a form of FL where a model is first trained to a satisfactory accuracy level at the first site, and then the model is sent to a second site for training until it is satisfactorily accurate. This process is continued until the model has been passed around to every site. In ensemble learning, each site concurrently trains the model for some predetermined number of epochs with the same hyperparameters (batch size, learning rate, etc.). After all sites have completed training their models with local data, all models are sent to an aggregator that will combine the weights across models. Both methods may also be continued for multiple cycles. We used the ImageNet-pre-trained Inception V1 network for all models. We compared the performance of the models trained using ensemble learning to both a baseline model trained on the combined data from all sites and a model trained using cyclic sequential learning. We also experimented with dividing the BrixIA set into smaller partitions to simulate more training sites with roughly balanced training data sizes.

## RESULTS

Our baseline model achieved validation AUC of 0.75 on BrixIA and 0.85 on MIDRC. Ensemble learning on MIDRC and the entire BrixIA training set resulted in a very unstable model. Partitioning BrixIA improved the training convergence. Models trained using FL techniques eventually achieved AUCs of 0.9 on MIDRC and 0.78 on BrixIA. When comparing models trained on both the MIDRC set and BrixIA partitions with models trained only on BrixIA partitions, the models trained on both the MIDRC set and BrixIA partitions achieved better validation AUCs than the models trained on only BrixIA partitions.

## CONCLUSION

Ensemble learning outperformed sequential learning. FL on multiple sites with balanced dataset size substantially improved both performance and stability.

## CLINICAL RELEVANCE/APPLICATION

Our study shows the effectiveness of federated learning in assessing COVID chest x-rays, which may be useful for treatment decision support.

## T6-SSPH08-Multi-modality Nasopharyngeal Carcinoma Segmentation in CT and MRI Using Context-aware Modality Selection

Dazhou Guo (*Presenter*) Nothing to Disclose

### PURPOSE

Gross tumor volume (GTV) segmentation is an essential step in nasopharyngeal carcinoma (NPC) radiotherapy treatment planning. In clinical practice, radiation oncologists often manually delineate the GTV in radiotherapy CT (RTCT) with the help of diagnostic MRI. However, this manual delineation process is time consuming and the cross modality registration between MRI and RTCT in current treatment planning software is error-prone. We aim to develop an accurate NPC GTV segmentation model by exploiting both RTCT and MRI imaging under the imperfect cross modality registration constraints.

### METHODS AND MATERIALS

We collected 124 NPC patients with diagnostic MRI and RTCT scans who underwent chemoradiotherapy or radiotherapy treatment. For MRI, we use T1-weighted and T2-weighted MRI phases. Ground truth GTV are manually delineated by an experienced radiology oncologist (25 year in head neck imaging) on RTCT with reference to the corresponding diagnostic MRI and the clinical information. A context-aware multi-modality selection framework is proposed for accurate NPC GTV segmentation under imperfect RTCT and MRI registration. Given RTCT and auto-registered MRI with possible registration errors, a single-modality deep network (nnUNet) using only RTCT and another multi-modality probabilistic deep network using RTCT and MRI both generate tumor predictions as candidates. Given these candidates, another module learns to discern the subtle variations between the candidates and select the one with the minimal estimated error as the final prediction. For evaluation, we randomly split patients into 60%, 10%, 30% for training, validation, and testing.

### RESULTS

The proposed method achieves a Dice score (DSC) of 79.6%, outperforms the nnUNet-based single modality (RTCT) model and multi-modality (RTCT MRI) model by 3.0% and 2.1% in DSC respectively. It also outperforms a state-of-the-art multi-modality model (mix of early and late fusion) by 1.6% in DSC. The distance metrics are also markedly decreased. Compared to the single-modality model, HD95 error is reduced by 12%, and ASD is reduced by 17%. Compared to the multi-modality model (RTCT with MRI), HD95 and ASD error are reduced by 11% and 10%, respectively.

## CONCLUSION

We propose a context-aware multi-modality selection framework for NPC GTV segmentation. It facilitates accurate GTV segmentation under the challenging and imperfect cross-modality registration results. The proposed method achieves better performance compared to baseline and state-of-the-art methods.

## CLINICAL RELEVANCE/APPLICATION

The proposed method has the potential to improve computer-assisted NPC GTV segmentation accuracy and consistency, and significantly reduce the workload of radiation oncologists in radiotherapy practice.

## T6-SSPH08-Development of Novel Models for Liver Segment 2+3 Hypertrophy Prediction by Integrating Dose-Volume and Texture-Based Radiomics Features

Aashish C. Gupta, MS (*Presenter*) Nothing to Disclose

### PURPOSE

Dose-volume histogram (DVH) and radiomics features are underutilized in understanding liver segment volumetric response after radiotherapy (RT) in liver cancer treatment. This work aims to determine the utility of DVH and radiomic features to predict segment 2+3 hypertrophy. First, we aim to develop prediction models for segment 2+3 hypertrophy and quantify the predictive power of individual segmental features derived from DVH and texture features. Second, we aim to quantify the individual and combined impact of radiomics and DVH features on prediction accuracy.

### METHODS AND MATERIALS

RT planning CT and the 3-month-followup CTs of 141 patients treated for primary/metastatic liver cancer were studied. Liver segments 1, 2, 3, 4, 5-8 were contoured on CTs using an in-house segmentation model. Sixty-one dosimetric/clinical features and 110 Gray-Level Co-Occurrence Matrix radiomics features were collected from each segment and tumor. Dataset was

divided into a train (Tr) and a complete withheld test set (Ts) of 112 and 29 patients, respectively. A Chi-squared/Fisher-Exact test and logistic regression were performed on Tr to determine significant predictors. Random forest models were used to train binary response model of segment 2+3 with 10-fold cross validation within groups that included DVH features only (GDVH), radiomics features only (GRadiomics), and both radiomics and DVH features (GDVH+Radiomics). Within each group, model complexity was increased by subsequently adding features from different segments and tumors. We compared models using balanced accuracy, AUROC, and AUPRC, and assessed statistical differences using the DeLong test.

## RESULTS

Within GRadiomics, the best model was trained with features from segment 2+3, 4, and tumor (Balanced Accuracy: 0.70, AUROC: 0.82 and AUPRC: 0.84). Within GDVH, there were two best models with same results (Balanced Accuracy: 0.71, AUROC: 0.74, and AUPRC: 0.65) and were trained with features from segment 2+3, 5-8 and tumor. Within GDVH+Radiomics, the best model was trained with features from segment 2+3, 4 and tumor (Balanced Accuracy: 0.73, AUROC: 0.82 and AUPRC: 0.82) which was also the best model across all three groups. DeLong test showed model including features from all segments and tumor from GDVH+Radiomics were significantly different than model with all features from GDVH ( $p < 0.05$ ).

## CONCLUSION

Radiomics and DVH features of segment 2+3, 4, and tumor are strong predictors of segment 2+3 response. Addition of radiomics features to DVH improves the prediction accuracy of the model.

## CLINICAL RELEVANCE/APPLICATION

Prediction models for liver hypertrophy will result in a decision support system for clinicians and help optimize radiotherapy plans for the liver, promoting overall patient survival.

## T6-SSPH08-Methods for Improved Understanding of Evolving AI Model Learning and Knowledge Retention Across Sequential Modification Steps

Alexis Burgon, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Evolving AI models benefit when training data are added over time but have a tradeoff between the abilities to learn new information and retain previous learning. We present a novel approach to evaluate AI across sequential modification steps.

## METHODS AND MATERIALS

AI models were trained to classify COVID status on chest X-rays from OpenA1 (A1) and OpenR1 (R1) MIDRC repositories. Initial models (step 0) were developed using A1 and the portion of R1 was increased in each subsequent step (steps 1-4). We simulated two scenarios: I) training on both A1 and added R1 throughout, and II) initial training using A1 and subsequent training only on the added R1. Our proposed evaluation methods are three measurements (M#) based on the performance metric AUC, area under the ROC curve. M1: Improvement in AUC from the previous step measured on the current test set, showing the effect of added training data irrespective of change to the test set. M2: Average AUC on current and previous test sets, providing insight into knowledge retention from previous steps. M3: Average AUC of previous model on current and previous test sets, showing when the new data are sufficiently different from previous data to challenge the model. We compare our evaluation approach to traditional performance assessment on fixed and updating test sets.

## RESULTS

For scenario I across all steps: The AUC on the fixed and updating test sets changed by  $-0.019 \pm 0.005$  and  $0.006 \pm 0.005$ , respectively. M1 decreased from  $0.02 \pm 0.007$  to  $0.00 \pm 0.004$ , showing a diminishing effect of each training step. M2 increased from  $0.78 \pm 0.010$  to  $0.80 \pm 0.010$ , showing that the performance increase did not cost performance on previous data. M3 increased from  $0.78 \pm 0.007$  to  $0.80 \pm 0.008$ , showing that the data became less challenging as the model trained for more steps. For scenario II: From step 0 to 1 the AUC of  $0.78 \pm 0.011$  decreased to  $0.71 \pm 0.017$  and  $0.58 \pm 0.058$  on the fixed and updating test sets, respectively. AUC declined to  $0.67 \pm 0.013$  on the fixed set and increased to  $0.61 \pm 0.021$  on the updating set. M1 was  $-0.02 \pm 0.039$  at step 1, increased to  $0.02 \pm 0.024$  at step 2, before decreasing to  $0.01 \pm 0.016$ . M2 was  $\sim 0.64$  for all steps indicating that the improved performance on R1 after step 1 did not cost performance on A1. M3 dropped from  $0.69 \pm 0.028$  to  $0.58 \pm 0.043$  at step 1 then increased to  $0.60 \pm 0.027$ , showing the model adjusted to the challenge of switching from A1 to R1.

## CONCLUSION

Our evaluation methods provide insights into evolving AI's learning and retention abilities over sequential modifications.

## CLINICAL RELEVANCE/APPLICATION

Evolving AI allows for the continual improvement but presents new challenges to ensuring safety. Our proposed evaluation methods provide insight into changes beyond traditional performance assessment.

## Abstract Archives of the RSNA, 2023

T6-SSPH08-1

### Evaluation of AI Bias Mitigation Algorithms by Systematically Promoting Sources of Bias

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E351

Ravi K. Samala, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To facilitate evaluation of bias mitigation methods, we create a systematic approach to amplify bias in artificial intelligence (AI) models by promoting spurious correlations between sensitive attributes and AI output tasks.

#### METHODS AND MATERIALS

The MIDRC/Open-A1 chest x-ray dataset was split by patient into training (2,632), tuning (1,584) and test (1,048) sets, each stratified by sex, race and COVID status. We promoted spurious correlations between sex subgroups and COVID status by modifying the latent space. To achieve this, a two-stage transfer learning pipeline was developed. In stage 1, the model was trained to classify patient sex. In stage 2, the model was fine-tuned to classify COVID status. The two-stage transfer learning approach encourages the use of the features used to classify patient sex in stage 1 for the classification of COVID status in stage 2. By freezing layers between stages 1 and 2, we can reduce the opportunities for the model to learn new features, thereby further encouraging the creation of spurious correlations between sex and COVID status. We also altered the direction of bias in stage 2 by flipping which class is 0 or 1 in stage 1. A baseline model was developed by skipping stage 1. ResNet18 architecture was implemented, and the same training/tuning set was used throughout model development. A post-processing bias mitigation algorithm that aims to ensure equalized odds between subgroups while maintaining calibration was implemented and evaluated on these models. The demographic parity difference ( $\Delta DP$ ), positive average equality gap (pAEG), and subgroup area under the ROC curve (AUC) were calculated on the test set to measure the bias at both baseline and after bias amplification with/without mitigation. Higher  $\Delta DP$  and pAEG values indicate larger bias between subgroups.

#### RESULTS

The approach of freezing the first layer resulted in increased  $\Delta DP$  of  $0.02 \pm 0.001$  and pAEG of  $0.06 \pm 0.007$  compared to  $0.01 \pm 0.002$  and  $0.02 \pm 0.006$  for baseline respectively. Freezing more layers increased the bias level,  $\Delta DP$  and pAEG increased to  $0.04 \pm 0.002$  and  $0.11 \pm 0.008$ , respectively. By flipping classes, both measurements showed similar trend but towards another sex subgroup. After mitigation, pAEG significantly dropped to between  $0.01 \pm 0.005$  and  $0.03 \pm 0.008$  for bias amplified models with  $\Delta DP$  slightly decreased and no significant change in subgroup AUC.

#### CONCLUSION

We developed a novel approach to systematically amplify bias in AI models to facilitate a comprehensive evaluation of bias mitigation methods.

#### CLINICAL RELEVANCE/APPLICATION

Bias in medical devices has the potential to create healthcare disparities. Our work provides a novel approach to assess emerging bias mitigation methods, which can be an effective strategy to prevent these disparities.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-SSPH08-2

### Attention and Spatial Transformer-based Cardiac Motion Artifact Correction for Stenosis Assessment in Energy-integrating-detector and Photon-counting-detector CT

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E351

Hao Gong, PHD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary CT angiography (CCTA) is commonly used in stenosis assessment. Yet, its utility is limited by detrimental cardiac motion artifacts in patients with high / irregular heartbeat rates, despite the advancements in dual source CT (DSCT) and motion correction methods in single source CT. We aim to improve the visualization and accuracy of stenosis assessment via reducing cardiac motion artifacts with a deep learning method based on attention and spatial transformer sub-networks (ATOM)

#### METHODS AND MATERIALS

ATOM used cross-phase temporospatial information to semi-implicitly model motion vector fields and detect dynamic structures, and used custom attention and transformer sub-networks to adaptively correct motion artifacts. It was trained with retrospectively collected ECG-gated patient CCTA images (n=30; heart rate >60bpm) from an energy integrating detector (EID) DSCT (SOMATOM Flash, Siemens; max temporal resolution (TR) 75ms). Training used the paired patches of coronary arteries reconstructed at four phases (65%, 70%, 75%, 80%R-R) and two TRs (140ms and 75ms). In the pilot study, ATOM was quantitatively validated using plaque-mimicking rods (artificial heart rate 60bpm) scanned on EID-DSCT. Two motion artifact metrics (entropy and transformed positivity) and the percent stenosis were compared in rod images before and after motion correction. ATOM was qualitatively assessed using patient cases (n=6, all heart rate >60bpm) collected from a clinical photon-counting-detector (PCD) DSCT (NAEOTOM Alpha, Siemens; max TR 66ms). The visualization of vessels and plaques before and after correction was compared

#### RESULTS

In phantom data, ATOM reduced motion artifacts, improved rod/plaque visualization and stenosis quantification across testing phases unseen in training, e.g., metrics before vs after correction at 140ms 45%R-R and 75ms 50%R-R: Median entropy 0.54 vs 0.49, and 0.90 vs 0.56 (Sign-rank test  $p < 0.05$ ); Median transformed positivity 23.4 vs 20.7, and 43.1 vs 25.7 (Sign-rank test  $p < 0.05$ ); for the 50% stenosis (ground truth), the measured percent blockage 89% vs 55%, and 76% vs 55%. In PCD-DSCT patient images before correction, the delineation of coronaries was degraded, and the distorted plaque falsely represented much larger or smaller blockage to the lumen. ATOM can suppress motion-induced distortion while improving the depiction of lumen and plaques, which can facilitate accurate stenosis quantification

#### CONCLUSION

ATOM reduced motion artifacts and improved diagnostic image quality for stenosis assessment in CCTA

#### CLINICAL RELEVANCE/APPLICATION

ATOM could improve temporal resolution and reduce motion artifacts in EID- and PCD-DSCT, which is potential to improve stenosis assessment in CCTA and downstream patient management

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T6-SSPH08-3

### Federated Learning for Classification of COVID-19 Severity based on Chest X-rays

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E351

Matthew Beaubien, BEng (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the effectiveness of federated learning on classifying COVID chest x-rays into severe or non-severe.

#### METHODS AND MATERIALS

We used two multi-institutional datasets, MIDRC and BrixIA, and employed collaborative federated learning (FL) techniques for training deep learning models for COVID severity classification. BrixIA contained 3,755 images and was split by case into 3,285 images for training and 470 images for validation. MIDRC contained 650 images and was split by case into 582 images for training and 68 images for validation. We investigated two FL methods. Cyclic sequential learning is a form of FL where a model is first trained to a satisfactory accuracy level at the first site, and then the model is sent to a second site for training until it is satisfactorily accurate. This process is continued until the model has been passed around to every site. In ensemble learning, each site concurrently trains the model for some predetermined number of epochs with the same hyperparameters (batch size, learning rate, etc.). After all sites have completed training their models with local data, all models are sent to an aggregator that will combine the weights across models. Both methods may also be continued for multiple cycles. We used the ImageNet-pre-trained Inception V1 network for all models. We compared the performance of the models trained using ensemble learning to both a baseline model trained on the combined data from all sites and a model trained using cyclic sequential learning. We also experimented with dividing the BrixIA set into smaller partitions to simulate more training sites with roughly balanced training data sizes.

#### RESULTS

Our baseline model achieved validation AUC of 0.75 on BrixIA and 0.85 on MIDRC. Ensemble learning on MIDRC and the entire BrixIA training set resulted in a very unstable model. Partitioning BrixIA improved the training convergence. Models trained using FL techniques eventually achieved AUCs of 0.9 on MIDRC and 0.78 on BrixIA. When comparing models trained on both the MIDRC set and BrixIA partitions with models trained only on BrixIA partitions, the models trained on both the MIDRC set and BrixIA partitions achieved better validation AUCs than the models trained on only BrixIA partitions.

#### CONCLUSION

Ensemble learning outperformed sequential learning. FL on multiple sites with balanced dataset size substantially improved both performance and stability.

#### CLINICAL RELEVANCE/APPLICATION

Our study shows the effectiveness of federated learning in assessing COVID chest x-rays, which may be useful for treatment decision support.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSPH08-4

### Multi-modality Nasopharyngeal Carcinoma Segmentation in CT and MRI Using Context-aware Modality Selection

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E351

Dazhou Guo (*Presenter*) Nothing to Disclose

#### PURPOSE

Gross tumor volume (GTV) segmentation is an essential step in nasopharyngeal carcinoma (NPC) radiotherapy treatment planning. In clinical practice, radiation oncologists often manually delineate the GTV in radiotherapy CT (RTCT) with the help of diagnostic MRI. However, this manual delineation process is time consuming and the cross modality registration between MRI and RTCT in current treatment planning software is error-prone. We aim to develop an accurate NPC GTV segmentation model by exploiting both RTCT and MRI imaging under the imperfect cross modality registration constraints.

#### METHODS AND MATERIALS

We collected 124 NPC patients with diagnostic MRI and RTCT scans who underwent chemoradiotherapy or radiotherapy treatment. For MRI, we use T1-weighted and T2-weighted MRI phases. Ground truth GTV are manually delineated by an experienced radiology oncologist (25 year in head neck imaging) on RTCT with reference to the corresponding diagnostic MRI and the clinical information. A context-aware multi-modality selection framework is proposed for accurate NPC GTV segmentation under imperfect RTCT and MRI registration. Given RTCT and auto-registered MRI with possible registration errors, a single-modality deep network (nnUNet) using only RTCT and another multi-modality probabilistic deep network using RTCT and MRI both generate tumor predictions as candidates. Given these candidates, another module learns to discern the subtle variations between the candidates and select the one with the minimal estimated error as the final prediction. For evaluation, we randomly split patients into 60%, 10%, 30% for training, validation, and testing.

#### RESULTS

The proposed method achieves a Dice score (DSC) of 79.6%, outperforms the nnUNet-based single modality (RTCT) model and multi-modality (RTCT MRI) model by 3.0% and 2.1% in DSC respectively. It also outperforms a state-of-the-art multi-modality model (mix of early and late fusion) by 1.6% in DSC. The distance metrics are also markedly decreased. Compared to the single-modality model, HD95 error is reduced by 12%, and ASD is reduced by 17%. Compared to the multi-modality model (RTCT with MRI), HD95 and ASD error are reduced by 11% and 10%, respectively.

#### CONCLUSION

We propose a context-aware multi-modality selection framework for NPC GTV segmentation. It facilitates accurate GTV segmentation under the challenging and imperfect cross-modality registration results. The proposed method achieves better performance compared to baseline and state-of-the-art methods.

#### CLINICAL RELEVANCE/APPLICATION

The proposed method has the potential to improve computer-assisted NPC GTV segmentation accuracy and consistency, and significantly reduce the workload of radiation oncologists in radiotherapy practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSPH08-5

### Development of Novel Models for Liver Segment 2+3 Hypertrophy Prediction by Integrating Dose-Volume and Texture-Based Radiomics Features

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E351

Aashish C. Gupta, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Dose-volume histogram (DVH) and radiomics features are underutilized in understanding liver segment volumetric response after radiotherapy (RT) in liver cancer treatment. This work aims to determine the utility of DVH and radiomic features to predict segment 2+3 hypertrophy. First, we aim to develop prediction models for segment 2+3 hypertrophy and quantify the predictive power of individual segmental features derived from DVH and texture features. Second, we aim to quantify the individual and combined impact of radiomics and DVH features on prediction accuracy.

#### METHODS AND MATERIALS

RT planning CT and the 3-month-followup CTs of 141 patients treated for primary/metastatic liver cancer were studied. Liver segments 1, 2, 3, 4, 5-8 were contoured on CTs using an in-house segmentation model. Sixty-one dosimetric/clinical features and 110 Gray-Level Co-Occurrence Matrix radiomics features were collected from each segment and tumor. Dataset was divided into a train (Tr) and a complete withheld test set (Ts) of 112 and 29 patients, respectively. A Chi-squared/Fisher-Exact test and logistic regression were performed on Tr to determine significant predictors. Random forest models were used to train binary response model of segment 2+3 with 10-fold cross validation within groups that included DVH features only (GDVH), radiomics features only (GRadiomics), and both radiomics and DVH features (GDVH+Radiomics). Within each group, model complexity was increased by subsequently adding features from different segments and tumors. We compared models using balanced accuracy, AUROC, and AUPRC, and assessed statistical differences using the DeLong test.

#### RESULTS

Within GRadiomics, the best model was trained with features from segment 2+3, 4, and tumor (Balanced Accuracy: 0.70, AUROC: 0.82 and AUPRC: 0.84). Within GDVH, there were two best models with same results (Balanced Accuracy: 0.71, AUROC: 0.74, and AUPRC: 0.65) and were trained with features from segment 2+3, 5-8 and tumor. Within GDVH+Radiomics, the best model was trained with features from segment 2+3, 4 and tumor (Balanced Accuracy: 0.73, AUROC: 0.82 and AUPRC: 0.82) which was also the best model across all three groups. DeLong test showed model including features from all segments and tumor from GDVH+Radiomics were significantly different than model with all features from GDVH ( $p < 0.05$ ).

#### CONCLUSION

Radiomics and DVH features of segment 2+3, 4, and tumor are strong predictors of segment 2+3 response. Addition of radiomics features to DVH improves the prediction accuracy of the model.

#### CLINICAL RELEVANCE/APPLICATION

Prediction models for liver hypertrophy will result in a decision support system for clinicians and help optimize radiotherapy plans for the liver, promoting overall patient survival.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-SSPH08-6

### Methods for Improved Understanding of Evolving AI Model Learning and Knowledge Retention Across Sequential Modification Steps

Tuesday, Nov. 28 1:30PM - 2:30PM Room: E351

Alexis Burgon, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Evolving AI models benefit when training data are added over time but have a tradeoff between the abilities to learn new information and retain previous learning. We present a novel approach to evaluate AI across sequential modification steps.

#### METHODS AND MATERIALS

AI models were trained to classify COVID status on chest X-rays from OpenA1 (A1) and OpenR1 (R1) MIDRC repositories. Initial models (step 0) were developed using A1 and the portion of R1 was increased in each subsequent step (steps 1-4). We simulated two scenarios: I) training on both A1 and added R1 throughout, and II) initial training using A1 and subsequent training only on the added R1. Our proposed evaluation methods are three measurements (M#) based on the performance metric AUC, area under the ROC curve. M1: Improvement in AUC from the previous step measured on the current test set, showing the effect of added training data irrespective of change to the test set. M2: Average AUC on current and previous test sets, providing insight into knowledge retention from previous steps. M3: Average AUC of previous model on current and previous test sets, showing when the new data are sufficiently different from previous data to challenge the model. We compare our evaluation approach to traditional performance assessment on fixed and updating test sets.

#### RESULTS

For scenario I across all steps: The AUC on the fixed and updating test sets changed by  $-0.019 \pm 0.005$  and  $0.006 \pm 0.005$ , respectively. M1 decreased from  $0.02 \pm 0.007$  to  $0.00 \pm 0.004$ , showing a diminishing effect of each training step. M2 increased from  $0.78 \pm 0.010$  to  $0.80 \pm 0.010$ , showing that the performance increase did not cost performance on previous data. M3 increased from  $0.78 \pm 0.007$  to  $0.80 \pm 0.008$ , showing that the data became less challenging as the model trained for more steps. For scenario II: From step 0 to 1 the AUC of  $0.78 \pm 0.011$  decreased to  $0.71 \pm 0.017$  and  $0.58 \pm 0.058$  on the fixed and updating test sets, respectively. AUC declined to  $0.67 \pm 0.013$  on the fixed set and increased to  $0.61 \pm 0.021$  on the updating set. M1 was  $-0.02 \pm 0.039$  at step 1, increased to  $0.02 \pm 0.024$  at step 2, before decreasing to  $0.01 \pm 0.016$ . M2 was  $\sim 0.64$  for all steps indicating that the improved performance on R1 after step 1 did not cost performance on A1. M3 dropped from  $0.69 \pm 0.028$  to  $0.58 \pm 0.043$  at step 1 then increased to  $0.60 \pm 0.027$ , showing the model adjusted to the challenge of switching from A1 to R1.

#### CONCLUSION

Our evaluation methods provide insights into evolving AI's learning and retention abilities over sequential modifications.

#### CLINICAL RELEVANCE/APPLICATION

Evolving AI allows for the continual improvement but presents new challenges to ensuring safety. Our proposed evaluation methods provide insight into changes beyond traditional performance assessment.

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## Abstract Archives of the RSNA, 2023

T6-STCE1

### Science Session (Generative AI)

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 1

#### Sub-Events

#### **T6-STCE1-1 Ensuring Generative AI Safety for Radiology Report Rewriting by Contrastive Pretraining**

Chun-Nan Hsu, PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

A promising application of generative AI in radiology is to rewrite radiology reports to improve their readability for patients. However, the risk of content distortion by rewriting must be minimized. Reinforcement learning with human feedback and rule-based reward models were approaches to ensure safety for large language models (LLM) such as GPT-4. We previously developed a contrastive learning approach and would like to empirically compare its performance with four other LLMs for the report rewriting task.

##### **METHODS AND MATERIALS**

5180 sentences from the radiology report corpus from VA covering all modalities were randomly sampled for this research, manually annotated by 1) abnormality: if a sentence reports an abnormal finding (2358/5180); 2) ambiguity: if a sentence contains jargon, contradiction, or grammar errors (1461/5180), and split randomly by 7:1:2 for train/val/test. Approach: a contrastive loss was applied to the pretraining of a seq2seq model BART to push learned sentence embeddings closer if they express similar findings and pull away otherwise. To determine whether two sentences express similar findings, we leveraged the sentence embeddings from RadBERT, a radiology-specialized language model. The BART model was then trained to generate a rewriting that disambiguates an input sentence not far away in the embedding space. Four LLMs, including GPT3 (davinci-003), ChatGPT (GPT3.5-turbo), LLaMa (vissuna-7B) and BioMedLM were considered. Among them, 2nd and 3rd were fine-tuned by reinforcement learning with human feedback and/or a rule-based reward model for general safety. We prompted these LLMs by either zero-shot or few-shot (2 to 4) to perform the report sentence rewriting task. Performance was measured by 1) Disambiguation: accuracy decrements of a classifier of sentence ambiguity applied to the rewriting compared to the original sentences. 2) Content distortion: accuracy decrements of a classifier to see if a sentence stating any abnormality findings. The idea is that if rewriting is more difficult for the classifier than the input (and scores higher), the rewriting may flip a normal finding to abnormal often and distort the contents more. The idea for 1) is similar but a higher score is better (i.e., rewriting is less ambiguous).

##### **RESULTS**

Our model suppressed content distortion by an order of magnitude lower than LLMs, while achieving a disambiguation score close to LLaMa and better than BioMedLM.

##### **CONCLUSION**

We showed that contrastive pretraining can effectively enhance safety for report rewriting without costly human feedback or rule crafting.

##### **CLINICAL RELEVANCE/APPLICATION**

Trustworthy report rewriting provides effective communication with patients that may improve outcomes while incurring no new workload for radiologists.

#### **T6-STCE1-2 From Abstract to Impact: Using LLM to Classify and Rank the Clinical Significance of Artificial Intelligence (AI)-related RSNA Abstracts**

Shmyle Ghuman, BS, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Can an LLM parse the overwhelming number of presentations and scientific content? Using LLM (ChatGPT4) to process large textual data, we classified RSNA abstracts as related/unrelated to AI and ranked their clinical impact based on a point-based strength score for their methodology.

## METHODS AND MATERIALS

Our study included 4,274 RSNA scientific abstracts from 2018-2022. Abstract text data were structured with ChatGPT4 (openAI) into section headings and categorized by topics using abstracts' unique identifiers and title content. A random sample of 1207 abstracts that included abstracts from each year and category were split into training (606 abstracts) and validation sets (n=601). ChatGPT Code Interpreter was used to train a model to categorize abstracts as related/unrelated to AI based on the training set. ChatGPT Code Interpreter then analyzed these abstracts via a heuristical rules-based approach with keyword matching and iterative prompting to correct its logic for identifying AI related abstracts and assigning a point-based strength score for their methodology (1 point each for multi-center data; > 1000 subjects or imaging studies; external validation data; multi-reader study). The model was then applied on the validation dataset and the remaining 3,067 abstracts to identify AI abstracts and their strengths. Two study co-investigators assessed the model performance on the validation dataset. Descriptive statistics were obtained.

## RESULTS

The model's performance on the validation set was robust, with an AUC-ROC of 0.97, PPV of 0.96, NPV of 0.89, an accuracy of 0.91. Applying the model to the remaining 3,067 abstracts in the data set revealed 734 abstracts that were related to AI, with 345 abstracts scoring a one, 56 abstracts scoring a two, and 2 abstracts scoring a three with none of the abstracts scoring a four.

## CONCLUSION

A robust LLM-based models can help identify the best AI-related abstracts at the RSNA. Identifying such strong scientific content can help audience target attendance and automate the review process while making it objective and free of human biases.

## CLINICAL RELEVANCE/APPLICATION

LLM-based models can help users identify relevant and strong AI-related scientific abstracts. Such models can be evolved to parse through peer-reviewed scientific literature and potentially aid in the review process as well.

## T6-STCE1-3 WESTERN-RLP: Augmenting Image-Caption Radiology Datasets using Image Embeddings Search of Large-Scale Natural Image Databases for Generative LLM VQA

Kartik Gupta, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

Recent breakthroughs in multimodal Large Language Models (LLM's) potentiate advanced Visual Question Answering (VQA) models in clinical radiology, requiring however, numerous high-quality text captioned images to train. Open-source datasets such as Radiology Objects in COntext (ROCO), are modest in size (N=65,419), dwarfed by much larger natural image datasets derived from large Internet web crawls, such as LAION-5B (N=5.85 Billion). We investigate the potential dataset augmentation yield of searching large natural image databases for radiology relevant images, utilizing vector embedding image similarity searches.

## METHODS AND MATERIALS

65,419 images from the ROCO dataset were input to a pre-computed KNN ViT/L-14 embeddings search of LAION-5B. From every ROCO image, the Top 100, 1000, and 10000 result depth vector searches from LAION-5B were processed and deduplicated (i.e. D100, D1000, D10000). To pre-categorize the image sets, an image classifier (MobileNet-v2) was trained on 3500 "Relevant", 3426 "Conditional Relevant (Usable With Post-Processing)", and 2748 "Non-Relevant" images sampled from ROCO Non-Relevant LAION-5B images. The augmented image sets were randomly sampled (5 samples; 250 images), to perform manual category validation and confirm automated estimates.

## RESULTS

Augmented similar image searches resulted in 133,960, 515,220, and 1,180,148 unique images for D100, D1000, and D10000 searches respectively. The MobileNet-v2 image classifier in a held-out ROCO/LAION-5B test group had a 93% accuracy and 79% F1 score. Automated estimated absolute and percent yields over ROCO inputs for combined Relevant and Conditionally Relevant classes for the D100, D1000, and D10000 searches were 57,954 (+89%), 122,276 (+187%), and 185,021 (+283%) images respectively. This was concordant with scaled yields derived from manual sub-sampling validation which estimates a combined Relevant and Conditional Relevant count of 55,727-71,802 (+85-110%), 86,557- 142,200 (+132-217%), and 103,853-207,706 (+159-318%) additional images respectively. Sources of non-relevant contamination images included: anatomic illustration, medical artistic renderings, surgical images, veterinary radiographs, and electronic microscopy images.

## **CONCLUSION**

We demonstrate a novel form of image dataset augmentation, by using vector embedding searches of natural image datasets, with potential ties to generative AI. Our estimates show up to a 1.5-3 times augmentation on the ROCO dataset. This method is potentially generalizable to any pre-existing set of radiology images.

## **CLINICAL RELEVANCE/APPLICATION**

This study demonstrates the feasibility of using vector embedding searches on natural image datasets to augment existing medical image datasets.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-STCE1-1

### Ensuring Generative AI Safety for Radiology Report Rewriting by Contrastive Pretraining

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 1

Chun-Nan Hsu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

A promising application of generative AI in radiology is to rewrite radiology reports to improve their readability for patients. However, the risk of content distortion by rewriting must be minimized. Reinforcement learning with human feedback and rule-based reward models were approaches to ensure safety for large language models (LLM) such as GPT-4. We previously developed a contrastive learning approach and would like to empirically compare its performance with four other LLMs for the report rewriting task.

#### METHODS AND MATERIALS

5180 sentences from the radiology report corpus from VA covering all modalities were randomly sampled for this research, manually annotated by 1) abnormality: if a sentence reports an abnormal finding (2358/5180); 2) ambiguity: if a sentence contains jargon, contradiction, or grammar errors (1461/5180), and split randomly by 7:1:2 for train/val/test. Approach: a contrastive loss was applied to the pretraining of a seq2seq model BART to push learned sentence embeddings closer if they express similar findings and pull away otherwise. To determine whether two sentences express similar findings, we leveraged the sentence embeddings from RadBERT, a radiology-specialized language model. The BART model was then trained to generate a rewriting that disambiguates an input sentence not far away in the embedding space. Four LLMs, including GPT3 (davinci-003), ChatGPT (GPT3.5-turbo), LLaMa (vscuna-7B) and BioMedLM were considered. Among them, 2nd and 3rd were fine-tuned by reinforcement learning with human feedback and/or a rule-based reward model for general safety. We prompted these LLMs by either zero-shot or few-shot (2 to 4) to perform the report sentence rewriting task. Performance was measured by 1) Disambiguation: accuracy decrements of a classifier of sentence ambiguity applied to the rewriting compared to the original sentences. 2) Content distortion: accuracy decrements of a classifier to see if a sentence stating any abnormality findings. The idea is that if rewriting is more difficult for the classifier than the input (and scores higher), the rewriting may flip a normal finding to abnormal often and distort the contents more. The idea for 1) is similar but a higher score is better (i.e., rewriting is less ambiguous).

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#### CONCLUSION

We showed that contrastive pretraining can effectively enhance safety for report rewriting without costly human feedback or rule crafting.

#### CLINICAL RELEVANCE/APPLICATION

Trustworthy report rewriting provides effective communication with patients that may improve outcomes while incurring no new workload for radiologists.

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## Abstract Archives of the RSNA, 2023

T6-STCE1-2

### From Abstract to Impact: Using LLM to Classify and Rank the Clinical Significance of Artificial Intelligence (AI)-related RSNA Abstracts

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 1

Shmyle Ghumman, BS, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Can an LLM parse the overwhelming number of presentations and scientific content? Using LLM (ChatGPT4) to process large textual data, we classified RSNA abstracts as related/unrelated to AI and ranked their clinical impact based on a point-based strength score for their methodology.

#### METHODS AND MATERIALS

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#### RESULTS

The model's performance on the validation set was robust, with an AUC-ROC of 0.97, PPV of 0.96, NPV of 0.89, an accuracy of 0.91. Applying the model to the remaining 3,067 abstracts in the data set revealed 734 abstracts that were related to AI, with 345 abstracts scoring a one, 56 abstracts scoring a two, and 2 abstracts scoring a three with none of the abstracts scoring a four.

#### CONCLUSION

A robust LLM-based models can help identify the best AI-related abstracts at the RSNA. Identifying such strong scientific content can help audience target attendance and automate the review process while making it objective and free of human biases.

#### CLINICAL RELEVANCE/APPLICATION

LLM-based models can help users identify relevant and strong AI-related scientific abstracts. Such models can be evolved to parse through peer-reviewed scientific literature and potentially aid in the review process as well.

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## Abstract Archives of the RSNA, 2023

T6-STCE1-3

### **WESTERN-RLP: Augmenting Image-Caption Radiology Datasets using Image Embeddings Search of Large-Scale Natural Image Databases for Generative LLM VQA**

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 1

Kartik Gupta, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recent breakthroughs in multimodal Large Language Models (LLM's) potentiate advanced Visual Question Answering (VQA) models in clinical radiology, requiring however, numerous high-quality text captioned images to train. Open-source datasets such as Radiology Objects in COntext (ROCO), are modest in size (N=65,419), dwarfed by much larger natural image datasets derived from large Internet web crawls, such as LAION-5B (N=5.85 Billion). We investigate the potential dataset augmentation yield of searching large natural image databases for radiology relevant images, utilizing vector embedding image similarity searches.

#### **METHODS AND MATERIALS**

65,419 images from the ROCO dataset were input to a pre-computed KNN ViT/L-14 embeddings search of LAION-5B. From every ROCO image, the Top 100, 1000, and 10000 result depth vector searches from LAION-5B were processed and deduplicated (i.e. D100, D1000, D10000). To pre-categorize the image sets, an image classifier (MobileNet-v2) was trained on 3500 "Relevant", 3426 "Conditional Relevant (Usable With Post-Processing)", and 2748 "Non-Relevant" images sampled from ROCO Non-Relevant LAION-5B images. The augmented image sets were randomly sampled (5 samples; 250 images), to perform manual category validation and confirm automated estimates.

#### **RESULTS**

Augmented similar image searches resulted in 133,960, 515,220, and 1,180,148 unique images for D100, D1000, and D10000 searches respectively. The MobileNet-v2 image classifier in a held-out ROCO/LAION-5B test group had a 93% accuracy and 79% F1 score. Automated estimated absolute and percent yields over ROCO inputs for combined Relevant and Conditionally Relevant classes for the D100, D1000, and D10000 searches were 57,954 (+89%), 122,276 (+187%), and 185,021 (+283%) images respectively. This was concordant with scaled yields derived from manual sub-sampling validation which estimates a combined Relevant and Conditional Relevant count of 55,727-71,802 (+85-110%), 86,557- 142,200 (+132-217%), and 103,853-207,706 (+159-318%) additional images respectively. Sources of non-relevant contamination images included: anatomic illustration, medical artistic renderings, surgical images, veterinary radiographs, and electronic microscopy images.

#### **CONCLUSION**

We demonstrate a novel form of image dataset augmentation, by using vector embedding searches of natural image datasets, with potential ties to generative AI. Our estimates show up to a 1.5-3 times augmentation on the ROCO dataset. This method is potentially generalizable to any pre-existing set of radiology images.

#### **CLINICAL RELEVANCE/APPLICATION**

This study demonstrates the feasibility of using vector embedding searches on natural image datasets to augment existing medical image datasets.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T6-STCE2

### Science Session (Theranostics)

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 2

#### Sub-Events

### **T6-STCE2-1 Uterine Artery Embolization for Adenomyosis. A Review of Imaging, Techniques, Complications and Outcomes**

Victor Tran (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This review provides a comprehensive summary of the literature regarding the use of uterine artery embolization (UAE) in the treatment of pure adenomyosis and documents indications, imaging, results and complications for symptomatic patients who have failed conservative treatment and wish to avoid hysterectomy.

#### **METHODS AND MATERIALS**

A comprehensive search was performed in the bibliographic databases to identify all relevant studies. Search terms included controlled MeSH terms as well as free text terms. In total 25 papers described the use of UAE for the treatment of adenomyosis or combined groups with adenomyosis and leiomyoma. Publications with data on pure adenomyosis were considered for outcome and adverse event analysis using the Society of Interventional Radiology (SIR) complications classification system. Data regarding imaging, embolization techniques, fertility, and pain management were also collected and analyzed.

#### **RESULTS**

A cumulative total of 1,081 patients with a mean follow-up time of 27.3 (3-58.8) months were included in the analysis. Overall improvement was stated as an outcome measure in 220 patients, from 299 (73.58%) seeing an overall improvement. Dysmenorrhea improvement was documented with 487 of 682 (71.41%) women seeing improvement. Abnormal uterine bleeding or menorrhagia was documented to have improved in 532 women, from 712 (74.72%). Improvement of bulk symptoms was observed in 30 out of 44 (68.18%) women. In 464 patients where additional interventions were recorded, 3 (0.65%) required repeat UAE and 26 (5.6%) underwent hysterectomy. The median time to hysterectomy was 17.5 months following UAE.

#### **CONCLUSION**

This comprehensive literature review has demonstrated a 73.58% improvement in patients' overall symptoms with a 71.41% and 74.72% improvement of symptoms of dysmenorrhea and abnormal uterine bleeding/menorrhagia, respectively. The overall major complication rate of UAE (SIR category C-F) was found to be 3.6%, primarily permanent amenorrhea with a minor complication rate (SIR category A-B) of 6.08%.

#### **CLINICAL RELEVANCE/APPLICATION**

Pure adenomyosis has historically been treated with conservative pharmacological treatments. When such treatments have failed, hysterectomy has served as a definitive treatment for patients with symptomatic adenomyosis. However, the use of UAE to treat symptomatic adenomyosis has gained attraction in recent years as a less invasive and uterine sparing procedure, which may prove to be a suitable alternative for patients wishing to avoid hysterectomy. With the low rate of major complications in accordance with the Society of Interventional Radiology (SIR) classification and good success rates, UAE should be proposed as an alternative for patients who have failed medical therapy.

### **T6-STCE2-2 Multitask deep learning for prediction of microvascular invasion and recurrence-free survival in hepatocellular carcinoma based on MRI images: a multicenter retrospective study**

Fang Wang (*Presenter*) Nothing to Disclose

## PURPOSE

Accurate preoperative MVI identification in HCC is crucial for personalized treatment and better prognosis. Our aims was to develop predictive models for MVI and prognosis in HCC.

## METHODS AND MATERIALS

A retrospective cohort of 725 patients from seven institutions was utilized to develop a multitask deep learning model for simultaneous MVI and recurrence-free survival (RFS) prediction based on preoperative MRI images. The training cohort (n = 234) and internal validation cohort (n = 58) were from our hospital. The remaining three external test cohorts (n = 212, 111, 110) were recruited from six other Chinese institutions. We assessed the prognostic accuracy of the model and its association with postoperative adjuvant transcatheter arterial chemoembolization (PA-TACE). Additionally, we evaluated the impact of model on radiologists' ability to predict MVI.

## RESULTS

The deep learning model consistently exhibited high accuracy in predicting MVI in the training cohort (AUC: 0.918; 95% CI: 0.878 - 0.948), internal test cohort (0.800; 0.664 - 0.917), external test cohort 1 (0.837; 0.778 - 0.893), external test cohort 2 (0.815; 0.716 - 0.902), and external test cohort 3 (0.800; 0.667 - 0.916) (Fig. 1A-C). When integrated with the artificial intelligence (AI) model, the sensitivity and inter-rater agreement of radiologists for predicting MVI significantly improved. The model effectively predicted RFS in the training cohort (C-index: 0.763; 95% CI: 0.719 - 0.806), internal test cohort (0.716; 0.618 - 0.814), external test cohort 1 (0.628; 0.566 - 0.690), external test cohort 2 (0.675; 0.599 - 0.750), and external test cohort 3 (0.728; 0.634 - 0.822) (Fig. 1D). Multivariable analysis revealed that the model independently predicted MVI and RFS, irrespective of clinical characteristics ( $p < 0.001$  for all). Notably, PA-TACE showed improved RFS only in patients with a predicted high risk of MVI and low survival score (HR: 0.587 [95% CI: 0.426 - 0.809];  $p < 0.001$ ) (Fig. 1E).

## CONCLUSION

Our deep learning model allows accurate MVI and survival prediction in HCC patients. Prospective studies are warranted to assess the clinical utility of this model in guiding personalized treatment in conjunction with clinical criteria.

## CLINICAL RELEVANCE/APPLICATION

The deep learning model's clinical relevance lies in accurate MVI and RFS prediction from MRI, guiding personalized treatment and identifying high-risk patients. Integrating the model enhances prediction accuracy and reduces inter-observer variability. It empowers personalized precision medicine, optimizing patient care, and potentially revolutionizing HCC management.

## T6-STCE2-3 CMR and Endomyocardial Biopsy in Acute Myocarditis: Unveiling False-Negative Results and the Role of the 2018 Lake Louise Criteria

Yining Wang, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The diagnostic performance of cardiovascular magnetic resonance (CMR) compared with endomyocardial biopsy (EMB) in patients with suspected acute myocarditis (AMC) has not been extensively evaluated, and characteristics of patients with false-negative EMB results are not well understood. This study aimed to evaluate the diagnostic performance of CMR compared with EMB in patients with suspected AMC and identify the characteristics of patients with false-negative EMB results.

## METHODS AND MATERIALS

A total of 311 patients with clinically suspected AMC underwent CMR with 3.0T. First, the diagnostic performance of CMR and EMB was compared, using 2013-ESC statement for clinically suspected myocarditis as diagnostic reference. In the second part, patients were considered to have definite myocarditis when both the ESC statement and the 2018 Lake Louise criteria (LLC) fulfill the diagnostic criteria, and negative EMB findings in these patients were considered as false-negative.

## RESULTS

The 2018 LLC yielded a sensitivity of 96.3% and a specificity of 84.6%, while the sensitivity of EMB was 62.8% and the specificity was 85.7%. Based on pre-specified classification criteria, 27 patients (29.0%) were classified in the false-negative group, 53 (57.0%) in the true-positive group, and 11 (11.8%) in the true-negative group. In the false-negative group, up to 55.6% of patients showed atypical ring-like late gadolinium enhancement (LGE), 29.6% showed inferolateral segment LGE (typical form), while 11.1% and 3.7% of patients showed septal and inferior wall enhancement, respectively.

## CONCLUSION

Patients with false-negative EMB results prone to have infarct-like symptoms, and with CMR features including preserved left ventricular ejection fraction, atypical ring-like LGE patterns and elevated T1 or T2 relaxation times.

## **CLINICAL RELEVANCE/APPLICATION**

For the first time, we focused on the patients with false-negative EMB results and their CMR characteristics. We found that approximately one-third of patients undergoing EMB may have received false-negative results for a variety of reasons, even though they met both the 2018 LLC and the 2013 ESC criteria. Patients in the false-negative group had increased T1 or T2 mapping values and atypical ring-like LGE, and were more commonly found in the infarct-like group, with better NYHC functional class and relatively young age. Our findings may help to establish a better diagnostic strategy for myocarditis and minimizes the negative impact of false-negative EMB.

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## Abstract Archives of the RSNA, 2023

T6-STCE2-1

### **Uterine Artery Embolization for Adenomyosis. A Review of Imaging, Techniques, Complications and Outcomes**

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 2

Victor Tran (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This review provides a comprehensive summary of the literature regarding the use of uterine artery embolization (UAE) in the treatment of pure adenomyosis and documents indications, imaging, results and complications for symptomatic patients who have failed conservative treatment and wish to avoid hysterectomy.

#### **METHODS AND MATERIALS**

A comprehensive search was performed in the bibliographic databases to identify all relevant studies. Search terms included controlled MeSH terms as well as free text terms. In total 25 papers described the use of UAE for the treatment of adenomyosis or combined groups with adenomyosis and leiomyoma. Publications with data on pure adenomyosis were considered for outcome and adverse event analysis using the Society of Interventional Radiology (SIR) complications classification system. Data regarding imaging, embolization techniques, fertility, and pain management were also collected and analyzed.

#### **RESULTS**

A cumulative total of 1,081 patients with a mean follow-up time of 27.3 (3-58.8) months were included in the analysis. Overall improvement was stated as an outcome measure in 220 patients, from 299 (73.58%) seeing an overall improvement. Dysmenorrhea improvement was documented with 487 of 682 (71.41%) women seeing improvement. Abnormal uterine bleeding or menorrhagia was documented to have improved in 532 women, from 712 (74.72%). Improvement of bulk symptoms was observed in 30 out of 44 (68.18%) women. In 464 patients where additional interventions were recorded, 3 (0.65%) required repeat UAE and 26 (5.6%) underwent hysterectomy. The median time to hysterectomy was 17.5 months following UAE.

#### **CONCLUSION**

This comprehensive literature review has demonstrated a 73.58% improvement in patients' overall symptoms with a 71.41% and 74.72% improvement of symptoms of dysmenorrhea and abnormal uterine bleeding/menorrhagia, respectively. The overall major complication rate of UAE (SIR category C-F) was found to be 3.6%, primarily permanent amenorrhea with a minor complication rate (SIR category A-B) of 6.08% .

#### **CLINICAL RELEVANCE/APPLICATION**

Pure adenomyosis has historically been treated with conservative pharmacological treatments. When such treatments have failed, hysterectomy has served as a definitive treatment for patients with symptomatic adenomyosis. However, the use of UAE to treat symptomatic adenomyosis has gained attraction in recent years as a less invasive and uterine sparing procedure, which may prove to be a suitable alternative for patients wishing to avoid hysterectomy. With the low rate of major complications in accordance with the Society of Interventional Radiology (SIR) classification and good success rates, UAE should be proposed as an alternative for patients who have failed medical therapy.

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## Abstract Archives of the RSNA, 2023

T6-STCE2-2

### Multitask deep learning for prediction of microvascular invasion and recurrence-free survival in hepatocellular carcinoma based on MRI images: a multicenter retrospective study

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 2

Fang Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate preoperative MVI identification in HCC is crucial for personalized treatment and better prognosis. Our aim was to develop predictive models for MVI and prognosis in HCC.

#### METHODS AND MATERIALS

A retrospective cohort of 725 patients from seven institutions was utilized to develop a multitask deep learning model for simultaneous MVI and recurrence-free survival (RFS) prediction based on preoperative MRI images. The training cohort ( $n = 234$ ) and internal validation cohort ( $n = 58$ ) were from our hospital. The remaining three external test cohorts ( $n = 212, 111, 110$ ) were recruited from six other Chinese institutions. We assessed the prognostic accuracy of the model and its association with postoperative adjuvant transcatheter arterial chemoembolization (PA-TACE). Additionally, we evaluated the impact of the model on radiologists' ability to predict MVI.

#### RESULTS

The deep learning model consistently exhibited high accuracy in predicting MVI in the training cohort (AUC: 0.918; 95% CI: 0.878 - 0.948), internal test cohort (0.800; 0.664 - 0.917), external test cohort 1 (0.837; 0.778 - 0.893), external test cohort 2 (0.815; 0.716 - 0.902), and external test cohort 3 (0.800; 0.667 - 0.916) (Fig. 1A-C). When integrated with the artificial intelligence (AI) model, the sensitivity and inter-rater agreement of radiologists for predicting MVI significantly improved. The model effectively predicted RFS in the training cohort (C-index: 0.763; 95% CI: 0.719 - 0.806), internal test cohort (0.716; 0.618 - 0.814), external test cohort 1 (0.628; 0.566 - 0.690), external test cohort 2 (0.675; 0.599 - 0.750), and external test cohort 3 (0.728; 0.634 - 0.822) (Fig. 1D). Multivariable analysis revealed that the model independently predicted MVI and RFS, irrespective of clinical characteristics ( $p < 0.001$  for all). Notably, PA-TACE showed improved RFS only in patients with a predicted high risk of MVI and low survival score (HR: 0.587 [95% CI: 0.426 - 0.809];  $p < 0.001$ ) (Fig. 1E).

#### CONCLUSION

Our deep learning model allows accurate MVI and survival prediction in HCC patients. Prospective studies are warranted to assess the clinical utility of this model in guiding personalized treatment in conjunction with clinical criteria.

#### CLINICAL RELEVANCE/APPLICATION

The deep learning model's clinical relevance lies in accurate MVI and RFS prediction from MRI, guiding personalized treatment and identifying high-risk patients. Integrating the model enhances prediction accuracy and reduces inter-observer variability. It empowers personalized precision medicine, optimizing patient care, and potentially revolutionizing HCC management.

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## Abstract Archives of the RSNA, 2023

T6-STCE2-3

### **CMR and Endomyocardial Biopsy in Acute Myocarditis: Unveiling False-Negative Results and the Role of the 2018 Lake Louise Criteria**

Tuesday, Nov. 28 1:30PM - 2:00PM Room: Learning Center Theater 2

Yining Wang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The diagnostic performance of cardiovascular magnetic resonance (CMR) compared with endomyocardial biopsy (EMB) in patients with suspected acute myocarditis (AMC) has not been extensively evaluated, and characteristics of patients with false-negative EMB results are not well understood. This study aimed to evaluate the diagnostic performance of CMR compared with EMB in patients with suspected AMC and identify the characteristics of patients with false-negative EMB results.

#### **METHODS AND MATERIALS**

A total of 311 patients with clinically suspected AMC underwent CMR with 3.0T. First, the diagnostic performance of CMR and EMB was compared, using 2013-ESC statement for clinically suspected myocarditis as diagnostic reference. In the second part, patients were considered to have definite myocarditis when both the ESC statement and the 2018 Lake Louise criteria (LLC) fulfill the diagnostic criteria, and negative EMB findings in these patients were considered as false-negative.

#### **RESULTS**

The 2018 LLC yielded a sensitivity of 96.3% and a specificity of 84.6%, while the sensitivity of EMB was 62.8% and the specificity was 85.7%. Based on pre-specified classification criteria, 27 patients (29.0%) were classified in the false-negative group, 53 (57.0%) in the true-positive group, and 11 (11.8%) in the true-negative group. In the false-negative group, up to 55.6% of patients showed atypical ring-like late gadolinium enhancement (LGE), 29.6% showed inferolateral segment LGE (typical form), while 11.1% and 3.7% of patients showed septal and inferior wall enhancement, respectively.

#### **CONCLUSION**

Patients with false-negative EMB results prone to have infarct-like symptoms, and with CMR features including preserved left ventricular ejection fraction, atypical ring-like LGE patterns and elevated T1 or T2 relaxation times.

#### **CLINICAL RELEVANCE/APPLICATION**

For the first time, we focused on the patients with false-negative EMB results and their CMR characteristics. We found that approximately one-third of patients undergoing EMB may have received false-negative results for a variety of reasons, even though they met both the 2018 LLC and the 2013 ESC criteria. Patients in the false-negative group had increased T1 or T2 mapping values and atypical ring-like LGE, and were more commonly found in the infarct-like group, with better NYHC functional class and relatively young age. Our findings may help to establish a better diagnostic strategy for myocarditis and minimizes the negative impact of false-negative EMB.

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## Abstract Archives of the RSNA, 2023

T7-SSBR06

### Breast Imaging (Pathologic Outcomes)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404

Stamatia V. Destounis, MD (*Moderator*) Medical Advisory Board, iCad, Inc  
Lars J. Grimm, MD (*Moderator*) Advisor, Hologic, Inc; Consultant, Hologic, Inc; Editorial Advisory Board, WebMD Health Corp (WebMD, Inc)  
Simone Schiaffino, MD (*Moderator*) Speakers Bureau, General Electric Company

#### Sub-Events

### T7-SSBR06-Long Term Outcomes Following Management of Indeterminate Breast Lesions With Vacuum 1 Excision

Nerys Forester, MBBCh, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Management of indeterminate breast (B3) lesions has evolved with current UK management comprising vacuum assisted excision (VAE) and mammography follow-up. Limited data for lesions managed this way is published. This prospective study addresses the incidence, nature and timing of malignancies arising after B3 diagnosis to assess the effectiveness of VAE management pathways and risk of subsequent malignancy following B3 lesion diagnosis

#### METHODS AND MATERIALS

Prospective review following B3 lesion diagnosis (with no previous or concurrent malignancy) between 01/12-12/16 for subsequent breast cancer, compared to control group of screen-detected benign lesions identified from the NHS BSP in 2012. Follow up was until December 2021.

#### RESULTS

514 B3 lesions identified (RS/CSL (22.2%), AIDEP (21.4%), papillomas (21.8%), LN (18.3%), FEA (8.4%), misc (5.3%)). 391 patients underwent VAE; 36 (9.2%) upgraded to B5. 18 patients upgraded to B5 following diagnostic excision (overall upgrade 10.5%). Remaining 460 patients had surveillance mammography, yearly or 3 yearly. Mean of 3.4 follow-up mammograms (range 0-8). 44 had no further follow up (age/personal choice). 14 deaths (1 breast cancer). 33 women (7.2%) subsequently developed breast cancer (24 invasive, 9 in situ), with 23 identified on mammography. One developed a lymphoma detected on mammography. Median time-to-diagnosis was 4 years (range 1-11 years). 10 cancers were at the site of the initial B3 lesion. No significant difference between cancer development in B3 subgroups was observed. 147 women had benign lesions identified at screening during 2012 (B2/C2 pathology). 8 (5.5%) subsequently developed cancer. No significant difference between rate of subsequent cancer between B3 lesions or controls at 5 years identified.

#### CONCLUSION

7.2% of women with prior B3 lesions subsequently develop breast cancer, but this was not significantly higher than that in screened controls. Cancer occurred at original B3 site in less than one third and did not represent under management of the original B3 lesion, proving that percutaneous, non operative management of B3 lesions is safe and effective. Subsequent cancers were mammographically detected in two thirds of cases, but mammography had a high recall rate and false positive rate in this population. As such, enhanced surveillance strategies may not offer additional cancer detection over usual screening and result in over diagnosis and increased patient anxiety.

#### CLINICAL RELEVANCE/APPLICATION

Follow up of a large group of indeterminate breast lesions managed by vacuum excision pathways shows this to be safe and effective with low onward risk of subsequent cancer

### T7-SSBR06-Breast Biopsy Malignancy Rates by the Method of Detection 2

Alan Zhu, BS (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the rates of malignancy for findings undergoing image-guided breast biopsy by reported method of detection (MOD).

## METHODS AND MATERIALS

This retrospective, observational study was conducted across a multispecialty healthcare enterprise that provides care at 18 imaging sites across 4 US states. Radiologists performing image-guided breast biopsies utilized standardized templates to categorize the MOD, defined as the first imaging test or clinical event that detected the finding being biopsied. All image-guided breast biopsies since the implementation of the MOD-inclusive standardized template from October 31, 2017 to October 4, 2022 were extracted. Biopsies that did not use the template, lacked a pathology addendum, or had nondiagnostic pathology results were excluded. The rates of malignant, elevated risk, and benign pathology results were calculated for each MOD. Significance between categorical variables was assessed using the 2-tailed chi-square test.

## RESULTS

25887 biopsies were extracted. 863 (3.3%) lacked an associated pathology addendum, 139 (0.5%) did not use the standardized template, and 59 (0.2%) had nondiagnostic pathology results, and were excluded. 24826 biopsies were included in this analysis. 10 different MODs were reported across 24323 (98.0%) biopsies. There was a significantly higher rate of malignancy in the symptomatic MODs (45.4%, n=2377) compared to imaging MODs (28.5%, n=21761,  $p < 0.001$ ). The highest rates of malignancy were seen in PET (59.0%, n=173), incidental imaging (50.0%, n=122), other (49.2%, n=182), clinical exam (47.7%, n=384), and self exam (44.9%, n=1993). The lowest rates of malignancy were seen in MRI (20.1%, n=3693), MBI (20.3%, n=350), US (23.6%, n=2906), and mammography (31.1%, n=14273).

## CONCLUSION

This is the largest study to date comparing the pathology results of different MODs. The rate of malignancy varied greatly by the MOD. Notably, lower rates of malignancy were observed with findings detected on common breast imaging modalities, while higher rates of malignancy were observed with other imaging modalities and symptomatic detection. To further investigate the malignant biopsies identified in this study, future research can compare breast cancer types between MODs.

## CLINICAL RELEVANCE/APPLICATION

Radiologist awareness of the malignancy rates by MOD, in conjunction with imaging findings, can support informed discussions and management plans in patients potentially undergoing breast biopsy.

## T7-SSBR06-Update on Management of Patients Diagnosed with Lobular Carcinoma in Situ at Needle Core Biopsy in an Outpatient Breast Imaging Center: A 20 Year Review

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

## PURPOSE

To show the importance of surgical excision when there is a diagnosis of lobular carcinoma in situ (LCIS) on needle core biopsy.

## METHODS AND MATERIALS

A retrospective evaluation of all cases of LCIS diagnosed on needle core biopsy at an outpatient community-based breast imaging center was conducted. Data review from 2000 - 2022 was performed. There was a total of 114 patients with 120 diagnoses of LCIS on needle core biopsy and comprised the study cohort. Data recorded included patient demographics, patient presentation, breast density, personal and family history of breast cancer, lesion characteristics, biopsy method, pathology lab, and correlation of core results with open surgical biopsy or follow-up imaging.

## RESULTS

A total of 114 patients with 120 diagnoses of LCIS comprised the study cohort. The patients ranged in age from 36-93 years (average, 57.9 years). The lesions consisted of 70 microcalcifications, 11 masses with calcium, 11 masses, 2 asymmetries, 14 architectural distortion, and 12 MRI abnormalities. Mammography demonstrated the finding in 85% and 15% were not visualized. Sonography demonstrated the lesion in 32.5% and 67.5% were sonographically occult. Four abnormalities were detected on MRI. Needle core biopsy was performed in all cases: 89 stereotactic biopsies, 24 ultrasound-guided biopsies, and 7 MRI-guided biopsies. 113 of 120 proceeded to open surgical biopsy; revealing 36 (32%) cancers - 14 (39%) were invasive and 22 (61%) in situ; of the remaining cases 68 were atypical/high risk (60%); 48 LCIS, 15 ALH, and 5 ADH; and 9 (8%) were benign.

## CONCLUSION

The diagnosis of LCIS at needle core biopsy does warrant recommendation for open surgical biopsy, as 92% were malignant or atypical/high risk at excision; 32% were carcinoma of which a substantial number were invasive.

## CLINICAL RELEVANCE/APPLICATION

Recommendation for surgical excision of LCIS remains a debated topic. Our 20-year review demonstrates that there is a 32% upgrade at excision, which does warrant the recommendation for excision.

### **T7-SSBR06-Upgrade Rates of Atypical Ductal Hyperplasia on Image Guided Breast Biopsies: 10-Year Experience Using Multidisciplinary Consensus Guidelines**

Lonie R. Salkowski, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The upgrade rate (UGR) of biopsy proven atypical ductal hyperplasia (ADH) varies from 10%-40%, suggesting that not all lesions need excision. In 2015, our institution developed Multidisciplinary Consensus Guidelines (MCGs) for the management of ADH on core biopsy. These MCGs were updated in 2019 to codify evidence-based variables that categorize ADH as "lower risk" of upgrade enabling a surgical shared decision-making discussion offering imaging as an alternative to surgical excision. The purpose of this study was to evaluate ADH lesion level UGRs over a ten-year period.

#### **METHODS AND MATERIALS**

A retrospective review included ADH (stereotactic, ultrasound, MRI biopsies) from 1/1/2012 to 12/31/2022, from our practice. ADH with concurrent ipsilateral cancer, deemed discordant at rad-path correlation conference, without a surgical consultation, or without 12-month follow-up were excluded. We divided the study period into 3 phases: Pre guideline change (PG) (1/1/2012-10/28/2015), early post-guideline change (EG) (10/29/2015-10/6/2019), and late post-guideline change (LG) (10/7/2019-12/31/2022). All PG patients were recommended surgical excision (PG) or imaging follow-up (diagnostic imaging at 6, 12, and 24 mos) if surgery was deferred (EG/LG). We compared biopsy characteristics including surgical excision and UGR over different MCG phases using T-tests and chi-squared analyses.

#### **RESULTS**

Our study identified 594 cases of ADH, 337 were excluded based on pre-specified exclusion criteria. Overall, 257 ADH lesions (in 251 patients) were included: 93 PG, 104 EG, and 60 LG. In PG 88 lesions underwent surgical excision, and 5 underwent imaging follow up, with UGRs of 11.8% and 0% respectively. In EG 91 lesions underwent surgical excision, and 13 underwent imaging follow up with UGRs of 15.4% and 7.7% respectively. In LG 38 lesions underwent surgical excision, and 22 underwent imaging follow up with UGRs of 10.0% and 4.5% respectively. Patient age, lesion type, and biopsy type were comparable over the 10-year period. Comparing average lesion size, lesions that upgraded tended to be larger (13.2 vs 10.0 mm;  $p = 0.054$ ). There was no significant difference in UGRs across the different timepoints ( $p = 0.574$ ).

#### **CONCLUSION**

Our study results challenge historical approaches of universal ADH excision and demonstrate a successful and safe transition to less invasive approaches in lower risk ADH lesions using evidence-based variables implemented via an MCG.

## CLINICAL RELEVANCE/APPLICATION

MCGs developed with radiology, surgery, and pathology input can help risk-stratify ADH lesions for non-invasive management in select cases with no increase in UGRs.

### **T7-SSBR06-Outcomes of Radiologists Categorizing Breast Cancer Method of Detection across a Multisite Healthcare Enterprise Over 5 Years**

Alan Zhu, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the feasibility and accuracy of radiologists categorizing the method of detection (MOD) when performing image-guided breast biopsies.

#### **METHODS AND MATERIALS**

This retrospective, observational study was conducted across a multispecialty healthcare enterprise that provides care at 18 imaging sites across 4 US states. Radiologists performing image-guided breast biopsies utilized standardized templates to categorize the MOD, defined as the first imaging test or clinical event that detected the finding being biopsied. Training to categorize MOD was limited to a field description and staff announcement. All image-guided breast biopsies since the implementation of the MOD-inclusive standardized template from October 31, 2017 to October 4, 2022 were extracted. Biopsies reported without the standardized template and those without a pathology addendum were excluded. A random sample of biopsy reports was manually reviewed to evaluate the accuracy of MOD categorization, with correctness defined as congruence between the original and reviewer MOD categories.

## RESULTS

25887 biopsies were extracted. 803 (3.10%) without an associated pathology addendum and 139 (0.54%) without the standardized template were excluded. The remaining 24945 biopsies were analyzed. MOD was reported in 24437 (98.0%) biopsies at a rate over 93% in every consecutive month-long block over nearly 5 years. MOD was consistently reported across all 18 sites, with site-specific reporting rates ranging from 95.1% to 100%. There were 10 reported MOD categories, including mammogram 14342 (57.5%), MRI 3706 (14.9%), US 2922 (11.7%), self exam 2003 (8.0%), clinical exam 384 (1.5%), MBI 350 (1.4%), contrast mammogram 248 (1.0%), other 187 (0.7%), PET imaging 173 (0.7%), and incidental imaging 122 (0.5%). Radiologist-assigned MOD categories agreed with author assignments in 87% of manually reviewed biopsies (n=100, 95% CI: [80.4%, 93.6%]).

## CONCLUSION

This is the largest study to date investigating the MOD of breast biopsy findings. Creation of an MOD-inclusive standardized template in conjunction with minimal user training enabled radiologists to categorize MOD consistently and accurately over nearly 5 years. Further research is needed to optimize training, workflows, and systems to ensure efficient and accurate MOD reporting.

## CLINICAL RELEVANCE/APPLICATION

Radiologists collecting MOD data may improve our understanding of how imaging services impact patient outcomes, such as the relative contributions of screening and treatment in reducing breast cancer mortality.

## T7-SSBR06-Significance of T2 Signal Intensity in HER2+ Cancers and Histopathologic Outcomes

6

Jirarat Jirarayapong, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To determine the association of intratumoral and peritumoral T2 signal intensity (T2 SI) of HER2+ cancers at initial staging breast MRI with pathologic outcomes.

## METHODS AND MATERIALS

An IRB-approved retrospective review from January 2015 to July 2022 identified 224 contrast-enhanced breast MRI studies with 225 HER2+ cancers prior to neoadjuvant chemotherapy. 6 cancers with mucinous features, 1 poorly differentiated carcinoma in an intramammary lymph node, 1 chest wall recurrence, 3 cancers with uncertain biopsy date, and 2 cancers with poor fat suppression on T2-weighted images (T2WI) were excluded. Morphology and multiplicity of the cancers were collected. Two radiologists blinded to pathology reviewed T2 SI on fat-suppressed T2WI. High T2 SI surrounding biopsy sites, hematoma, and subcutaneous edema were considered post-biopsy changes. Chi square test and logistic regression were performed to test associations of T2 SI with histologic outcomes.

## RESULTS

Of 212 HER2+ cancers, 138 (65.1%) were hormone receptor positive (HER2+/HR+) and 74 (34.9%) were HER2+ only (HER2+/HR-). Cancers had high T2 SI intratumorally in 96/212 (45.3%), peritumorally in 81/212 (38.2%), or both in 36/212 (17.0%) cancers. High peritumoral T2 SI was associated with histologic grade 3 than iso-low T2 SI (72.8% vs 58.5%,  $p = 0.03$ ). No significant difference in histologic grade, HR status, presence of DCIS, lymphovascular invasion (LVI), and axillary node metastasis was found between groups of high vs iso-low T2 SI at intratumoral regions. In cancers with peritumoral high T2 SI, nonmass enhancement (NME) was associated with DCIS (82.0% vs 48.4%,  $p = 0.001$ ) and LVI (34.0% vs 12.9%,  $p = 0.04$ ) than mass only. In cancers with intratumoral high T2 SI, multicentric and multifocal distributions were associated with LVI (33.3% vs 13.7%,  $p = 0.02$ ) and axillary node metastasis (71.1% vs 35.3%,  $p < 0.001$ ) than unifocal distribution. HER2+/HR- cancers were more often histologic grade 3 than HER2+/HR+ cancers (74.3% vs 58.4%,  $p = 0.02$ ); however, there was no significant difference of MRI morphology, multiplicity, and T2 SI.

## CONCLUSION

High intratumoral T2 SI combined with multicentric and multifocal distribution were associated with LVI and lymph node metastasis. High peritumoral T2 SI was associated with histologic grade 3, and when combined with presence of NME, associated with DCIS and LVI. Both intra- and peritumoral T2 SI, morphology, and multiplicity were not different between HER2+/HR+ and HER2+/HR- cancers.

## CLINICAL RELEVANCE/APPLICATION

High T2 SI at intratumoral or peritumoral regions combined with presence of NME and tumor multiplicity may represent aggressiveness of HER2+ cancers regardless of hormone receptor status.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSBR06-1

### Long Term Outcomes Following Management of Indeterminate Breast Lesions With Vacuum Excision

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404

Nerys Forester, MBBCh, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Management of indeterminate breast (B3) lesions has evolved with current UK management comprising vacuum assisted excision (VAE) and mammography follow-up. Limited data for lesions managed this way is published. This prospective study addresses the incidence, nature and timing of malignancies arising after B3 diagnosis to assess the effectiveness of VAE management pathways and risk of subsequent malignancy following B3 lesion diagnosis

#### METHODS AND MATERIALS

Prospective review following B3 lesion diagnosis (with no previous or concurrent malignancy) between 01/12-12/16 for subsequent breast cancer, compared to control group of screen-detected benign lesions identified from the NHS BSP in 2012. Follow up was until December 2021.

#### RESULTS

514 B3 lesions identified (RS/CSL (22.2%), AIDEP (21.4%), papillomas (21.8%), LN (18.3%), FEA (8.4%), misc (5.3%)). 391 patients underwent VAE; 36 (9.2%) upgraded to B5. 18 patients upgraded to B5 following diagnostic excision (overall upgrade 10.5%). Remaining 460 patients had surveillance mammography, yearly or 3 yearly. Mean of 3.4 follow-up mammograms (range 0-8). 44 had no further follow up (age/personal choice). 14 deaths (1 breast cancer). 33 women (7.2%) subsequently developed breast cancer (24 invasive, 9 in situ), with 23 identified on mammography. One developed a lymphoma detected on mammography. Median time-to-diagnosis was 4 years (range 1-11 years). 10 cancers were at the site of the initial B3 lesion. No significant difference between cancer development in B3 subgroups was observed. 147 women had benign lesions identified at screening during 2012 (B2/C2 pathology). 8 (5.5%) subsequently developed cancer. No significant difference between rate of subsequent cancer between B3 lesions or controls at 5 years identified.

#### CONCLUSION

7.2% of women with prior B3 lesions subsequently develop breast cancer, but this was not significantly higher than that in screened controls. Cancer occurred at original B3 site in less than one third and did not represent under management of the original B3 lesion, proving that percutaneous, non operative management of B3 lesions is safe and effective. Subsequent cancers were mammographically detected in two thirds of cases, but mammography had a high recall rate and false positive rate in this population. As such, enhanced surveillance strategies may not offer additional cancer detection over usual screening and result in over diagnosis and increased patient anxiety.

#### CLINICAL RELEVANCE/APPLICATION

Follow up of a large group of indeterminate breast lesions managed by vacuum excision pathways shows this to be safe and effective with low onward risk of subsequent cancer

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSBR06-2

### Breast Biopsy Malignancy Rates by the Method of Detection

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404

Alan Zhu, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the rates of malignancy for findings undergoing image-guided breast biopsy by reported method of detection (MOD).

#### METHODS AND MATERIALS

This retrospective, observational study was conducted across a multispecialty healthcare enterprise that provides care at 18 imaging sites across 4 US states. Radiologists performing image-guided breast biopsies utilized standardized templates to categorize the MOD, defined as the first imaging test or clinical event that detected the finding being biopsied. All image-guided breast biopsies since the implementation of the MOD-inclusive standardized template from October 31, 2017 to October 4, 2022 were extracted. Biopsies that did not use the template, lacked a pathology addendum, or had nondiagnostic pathology results were excluded. The rates of malignant, elevated risk, and benign pathology results were calculated for each MOD. Significance between categorical variables was assessed using the 2-tailed chi-square test.

#### RESULTS

25887 biopsies were extracted. 863 (3.3%) lacked an associated pathology addendum, 139 (0.5%) did not use the standardized template, and 59 (0.2%) had nondiagnostic pathology results, and were excluded. 24826 biopsies were included in this analysis. 10 different MODs were reported across 24323 (98.0%) biopsies. There was a significantly higher rate of malignancy in the symptomatic MODs (45.4%, n=2377) compared to imaging MODs (28.5%, n=21761,  $p < 0.001$ ). The highest rates of malignancy were seen in PET (59.0%, n=173), incidental imaging (50.0%, n=122), other (49.2%, n=182), clinical exam (47.7%, n=384), and self exam (44.9%, n=1993). The lowest rates of malignancy were seen in MRI (20.1%, n=3693), MBI (20.3%, n=350), US (23.6%, n=2906), and mammography (31.1%, n=14273).

#### CONCLUSION

This is the largest study to date comparing the pathology results of different MODs. The rate of malignancy varied greatly by the MOD. Notably, lower rates of malignancy were observed with findings detected on common breast imaging modalities, while higher rates of malignancy were observed with other imaging modalities and symptomatic detection. To further investigate the malignant biopsies identified in this study, future research can compare breast cancer types between MODs.

#### CLINICAL RELEVANCE/APPLICATION

Radiologist awareness of the malignancy rates by MOD, in conjunction with imaging findings, can support informed discussions and management plans in patients potentially undergoing breast biopsy.

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## Abstract Archives of the RSNA, 2023

T7-SSBR06-3

### Update on Management of Patients Diagnosed with Lobular Carcinoma in Situ at Needle Core Biopsy in an Outpatient Breast Imaging Center: A 20 Year Review

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

#### PURPOSE

To show the importance of surgical excision when there is a diagnosis of lobular carcinoma in situ (LCIS) on needle core biopsy.

#### METHODS AND MATERIALS

A retrospective evaluation of all cases of LCIS diagnosed on needle core biopsy at an outpatient community-based breast imaging center was conducted. Data review from 2000 - 2022 was performed. There was a total of 114 patients with 120 diagnoses of LCIS on needle core biopsy and comprised the study cohort. Data recorded included patient demographics, patient presentation, breast density, personal and family history of breast cancer, lesion characteristics, biopsy method, pathology lab, and correlation of core results with open surgical biopsy or follow-up imaging.

#### RESULTS

A total of 114 patients with 120 diagnoses of LCIS comprised the study cohort. The patients ranged in age from 36-93 years (average, 57.9 years). The lesions consisted of 70 microcalcifications, 11 masses with calcium, 11 masses, 2 asymmetries, 14 architectural distortion, and 12 MRI abnormalities. Mammography demonstrated the finding in 85% and 15% were not visualized. Sonography demonstrated the lesion in 32.5% and 67.5% were sonographically occult. Four abnormalities were detected on MRI. Needle core biopsy was performed in all cases: 89 stereotactic biopsies, 24 ultrasound-guided biopsies, and 7 MRI-guided biopsies. 113 of 120 proceeded to open surgical biopsy; revealing 36 (32%) cancers - 14 (39%) were invasive and 22 (61%) in situ; of the remaining cases 68 were atypical/high risk (60%); 48 LCIS, 15 ALH, and 5 ADH; and 9 (8%) were benign.

#### CONCLUSION

The diagnosis of LCIS at needle core biopsy does warrant recommendation for open surgical biopsy, as 92% were malignant or atypical/high risk at excision; 32% were carcinoma of which a substantial number were invasive.

#### CLINICAL RELEVANCE/APPLICATION

Recommendation for surgical excision of LCIS remains a debated topic. Our 20-year review demonstrates that there is a 32% upgrade at excision, which does warrant the recommendation for excision.

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## Abstract Archives of the RSNA, 2023

T7-SSBR06-4

### Upgrade Rates of Atypical Ductal Hyperplasia on Image Guided Breast Biopsies: 10-Year Experience Using Multidisciplinary Consensus Guidelines

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404

Lonie R. Salkowski, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The upgrade rate (UGR) of biopsy proven atypical ductal hyperplasia (ADH) varies from 10%-40%, suggesting that not all lesions need excision. In 2015, our institution developed Multidisciplinary Consensus Guidelines (MCGs) for the management of ADH on core biopsy. These MCGs were updated in 2019 to codify evidence-based variables that categorize ADH as "lower risk" of upgrade enabling a surgical shared decision-making discussion offering imaging as an alternative to surgical excision. The purpose of this study was to evaluate ADH lesion level UGRs over a ten-year period.

#### METHODS AND MATERIALS

A retrospective review included ADH (stereotactic, ultrasound, MRI biopsies) from 1/1/2012 to 12/31/2022, from our practice. ADH with concurrent ipsilateral cancer, deemed discordant at rad-path correlation conference, without a surgical consultation, or without 12-month follow-up were excluded. We divided the study period into 3 phases: Pre guideline change (PG) (1/1/2012-10/28/2015), early post-guideline change (EG) (10/29/2015-10/6/2019), and late post-guideline change (LG) (10/7/2019-12/31/2022). All PG patients were recommended surgical excision (PG) or imaging follow-up (diagnostic imaging at 6, 12, and 24 mos) if surgery was deferred (EG/LG). We compared biopsy characteristics including surgical excision and UGR over different MCG phases using T-tests and chi-squared analyses.

#### RESULTS

Our study identified 594 cases of ADH, 337 were excluded based on pre-specified exclusion criteria. Overall, 257 ADH lesions (in 251 patients) were included: 93 PG, 104 EG, and 60 LG. In PG 88 lesions underwent surgical excision, and 5 underwent imaging follow up, with UGRs of 11.8% and 0% respectively. In EG 91 lesions underwent surgical excision, and 13 underwent imaging follow up with UGRs of 15.4% and 7.7% respectively. In LG 38 lesions underwent surgical excision, and 22 underwent imaging follow up with UGRs of 10.0% and 4.5% respectively. Patient age, lesion type, and biopsy type were comparable over the 10-year period. Comparing average lesion size, lesions that upgraded tended to be larger (13.2 vs 10.0 mm;  $p = 0.054$ ). There was no significant difference in UGRs across the different timepoints ( $p = 0.574$ ).

#### CONCLUSION

Our study results challenge historical approaches of universal ADH excision and demonstrate a successful and safe transition to less invasive approaches in lower risk ADH lesions using evidence-based variables implemented via an MCG.

#### CLINICAL RELEVANCE/APPLICATION

MCGs developed with radiology, surgery, and pathology input can help risk-stratify ADH lesions for non-invasive management in select cases with no increase in UGRs.

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## Abstract Archives of the RSNA, 2023

T7-SSBR06-5

### Outcomes of Radiologists Categorizing Breast Cancer Method of Detection across a Multisite Healthcare Enterprise Over 5 Years

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404

Alan Zhu, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility and accuracy of radiologists categorizing the method of detection (MOD) when performing image-guided breast biopsies.

#### METHODS AND MATERIALS

This retrospective, observational study was conducted across a multispecialty healthcare enterprise that provides care at 18 imaging sites across 4 US states. Radiologists performing image-guided breast biopsies utilized standardized templates to categorize the MOD, defined as the first imaging test or clinical event that detected the finding being biopsied. Training to categorize MOD was limited to a field description and staff announcement. All image-guided breast biopsies since the implementation of the MOD-inclusive standardized template from October 31, 2017 to October 4, 2022 were extracted. Biopsies reported without the standardized template and those without a pathology addendum were excluded. A random sample of biopsy reports was manually reviewed to evaluate the accuracy of MOD categorization, with correctness defined as congruence between the original and reviewer MOD categories.

#### RESULTS

25887 biopsies were extracted. 803 (3.10%) without an associated pathology addendum and 139 (0.54%) without the standardized template were excluded. The remaining 24945 biopsies were analyzed. MOD was reported in 24437 (98.0%) biopsies at a rate over 93% in every consecutive month-long block over nearly 5 years. MOD was consistently reported across all 18 sites, with site-specific reporting rates ranging from 95.1% to 100%. There were 10 reported MOD categories, including mammogram 14342 (57.5%), MRI 3706 (14.9%), US 2922 (11.7%), self exam 2003 (8.0%), clinical exam 384 (1.5%), MBI 350 (1.4%), contrast mammogram 248 (1.0%), other 187 (0.7%), PET imaging 173 (0.7%), and incidental imaging 122 (0.5%). Radiologist-assigned MOD categories agreed with author assignments in 87% of manually reviewed biopsies (n=100, 95% CI: [80.4%, 93.6%]).

#### CONCLUSION

This is the largest study to date investigating the MOD of breast biopsy findings. Creation of an MOD-inclusive standardized template in conjunction with minimal user training enabled radiologists to categorize MOD consistently and accurately over nearly 5 years. Further research is needed to optimize training, workflows, and systems to ensure efficient and accurate MOD reporting.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists collecting MOD data may improve our understanding of how imaging services impact patient outcomes, such as the relative contributions of screening and treatment in reducing breast cancer mortality.

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## Abstract Archives of the RSNA, 2023

T7-SSBR06-6

### Significance of T2 Signal Intensity in HER2+ Cancers and Histopathologic Outcomes

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S404

Jirarat Jirarayapong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the association of intratumoral and peritumoral T2 signal intensity (T2 SI) of HER2+ cancers at initial staging breast MRI with pathologic outcomes.

#### METHODS AND MATERIALS

An IRB-approved retrospective review from January 2015 to July 2022 identified 224 contrast-enhanced breast MRI studies with 225 HER2+ cancers prior to neoadjuvant chemotherapy. 6 cancers with mucinous features, 1 poorly differentiated carcinoma in an intramammary lymph node, 1 chest wall recurrence, 3 cancers with uncertain biopsy date, and 2 cancers with poor fat suppression on T2-weighted images (T2WI) were excluded. Morphology and multiplicity of the cancers were collected. Two radiologists blinded to pathology reviewed T2 SI on fat-suppressed T2WI. High T2 SI surrounding biopsy sites, hematoma, and subcutaneous edema were considered post-biopsy changes. Chi square test and logistic regression were performed to test associations of T2 SI with histologic outcomes.

#### RESULTS

Of 212 HER2+ cancers, 138 (65.1%) were hormone receptor positive (HER2+/HR+) and 74 (34.9%) were HER2+ only (HER2+/HR-). Cancers had high T2 SI intratumorally in 96/212 (45.3%), peritumorally in 81/212 (38.2%), or both in 36/212 (17.0%) cancers. High peritumoral T2 SI was associated with histologic grade 3 than iso-low T2 SI (72.8% vs 58.5%,  $p = 0.03$ ). No significant difference in histologic grade, HR status, presence of DCIS, lymphovascular invasion (LVI), and axillary node metastasis was found between groups of high vs iso-low T2 SI at intratumoral regions. In cancers with peritumoral high T2 SI, nonmass enhancement (NME) was associated with DCIS (82.0% vs 48.4%,  $p = 0.001$ ) and LVI (34.0% vs 12.9%,  $p = 0.04$ ) than mass only. In cancers with intratumoral high T2 SI, multicentric and multifocal distributions were associated with LVI (33.3% vs 13.7%,  $p = 0.02$ ) and axillary node metastasis (71.1% vs 35.3%,  $p < 0.001$ ) than unifocal distribution. HER2+/HR- cancers were more often histologic grade 3 than HER2+/HR+ cancers (74.3% vs 58.4%,  $p = 0.02$ ); however, there was no significant difference of MRI morphology, multiplicity, and T2 SI.

#### CONCLUSION

High intratumoral T2 SI combined with multicentric and multifocal distribution were associated with LVI and lymph node metastasis. High peritumoral T2 SI was associated with histologic grade 3, and when combined with presence of NME, associated with DCIS and LVI. Both intra- and peritumoral T2 SI, morphology, and multiplicity were not different between HER2+/HR+ and HER2+/HR- cancers.

#### CLINICAL RELEVANCE/APPLICATION

High T2 SI at intratumoral or peritumoral regions combined with presence of NME and tumor multiplicity may represent aggressiveness of HER2+ cancers regardless of hormone receptor status.

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## Abstract Archives of the RSNA, 2023

T7-SSBR07

### Breast Imaging (Breast MRI: Screening and Diagnostic Applications)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S401

Ritse M. Mann, MD, PhD (*Moderator*) Researcher, Siemens AG; Consultant, Siemens AG; Researcher, Bayer AG; Consultant, Bayer AG; Researcher, Medtronic plc; Consultant, Medtronic plc; Researcher, Becton, Dickinson and Company; Consultant, Becton, Dickinson and Company; Researcher, ScreenPoint Medical BV  
Lilian Wang, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### T7-SSBR07-Preoperative Breast MRI in HER2-Positive, ER-Negative Breast Cancer: Surgical Outcomes 1 Using Propensity Score Matching

Yoon Ji Hwang (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the association between preoperative MRI and surgical outcomes in HER2-positive, ER-negative breast cancer by using propensity score (PS) analysis.

#### METHODS AND MATERIALS

Women with HER2-positive, ER-negative breast cancer between 2007 and 2014 who had or had not undergone preoperative MRI were retrospectively identified. Inverse probability weighting (IPW) and PS matching were used to adjust 16 variables and to create a balance between MRI and no-MRI group. Surgical outcomes were compared between two groups and clinicopathologic variables were evaluated to determine who benefited from MRI.

#### RESULTS

A total of 965 women (mean age  $\pm$  standard deviation, 52 years  $\pm$  10) were evaluated. Among 423 women who underwent preoperative MRI, 23 (5%) showed size discrepancy and 48 (11%) depicted additional suspicious lesions with 17 lesions (35%) being malignant. In the MRI group, a change in surgical management occurred in 50 of the 423 patients (12%) and the change was appropriate in 32 patients (64%). In both IPW analysis and PS matching, the MRI group showed lower odds of overall mastectomy rate (OR, 0.62; 95% CI: 0.46, 0.83; P = .001, OR, 0.72; 95% CI: 0.52, 0.98; P = .034) compared to no-MRI group. Positive resection margin and reoperation rate did not show significant difference between MRI and no-MRI. Initial mastectomy rate did not show consistent results in IPW and PS matching. Asymptomatic patients were found to benefit more from MRI than symptomatic patients (11.7% vs. 4.6%, P = .006).

#### CONCLUSION

Preoperative MRI was associated with lower likelihood of overall mastectomy rate in HER2-positive, ER-negative breast cancer patients.

#### CLINICAL RELEVANCE/APPLICATION

Preoperative MRI is useful for planning surgical management with lower likelihood of overall mastectomy rate in patients with HER2-positive, ER-negative breast cancer.

### T7-SSBR07-Advanced Second Breast Cancer in Women with or without Postoperative Surveillance 2 Breast MRI: A Propensity Score-Matched Analysis

Jiyoung Yoon, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Postoperative surveillance breast MRI has been increasingly used as a surveillance tool in women with a personal history of breast cancer (PHBC). Although previous studies have consistently reported higher cancer detection rates than with mammography or US, direct measures like survival rates require long-term follow-up. Comparison of advanced second breast

cancers, rather than overall second breast cancers, could provide valuable information regarding the clinical benefit of postoperative surveillance MRI. However, a direct comparison between patients would likely be biased because of the different characteristics of patients who were referred for surveillance breast MRI. Therefore, we assessed the association between postoperative surveillance breast MRI and subsequent advanced second breast cancer in patients with a PHBC by using propensity score (PS) analysis.

## **METHODS AND MATERIALS**

In this single-center retrospective study, women with a PHBC who underwent breast cancer surgery between January 2009 and December 2014 were identified. Second breast cancer was defined as ipsilateral breast tumor recurrence or contralateral breast cancer diagnosed at least 1 year after surgery. Patients with distant metastasis at initial diagnosis, previous breast cancer, bilateral breast cancer, or a follow-up period of less than 1 year were excluded. Advanced second breast cancer was defined as 1) second breast cancer =T2 or lymph node (LN)-positive or 2) second breast cancer =T2 or LN-positive or HER2-positive/triple negative cancer >1cm. PS matching was used to adjust for 14 variables. After matching, the rates of advanced second breast cancer were compared using the McNemar test.

## **RESULTS**

The matched sample consisted of 1439 women who received postoperative surveillance breast MRI and 1439 women who had not. The median follow-up was 108.8 months (range, 18.2-167.3 months) and 110.2 months (range, 12.1-168.4 months) for women with and without surveillance MRI, respectively. The incidence of advanced second breast cancer was significantly higher in the group that did not receive postoperative surveillance breast MRI when advanced second breast cancer was defined as 1) second breast cancer =T2 or LN-positive (15 [1.0%] vs. 4 [0.3%],  $p = .012$ ), or 2) second breast cancer =T2 or LN-positive or HER2-positive/triple negative breast cancer >1cm (26 [1.8%] vs. 7 [0.5%],  $p < .001$ ).

## **CONCLUSION**

Surveillance breast MRI was associated with a reduced incidence of advanced second breast cancer in women with a PHBC.

## **CLINICAL RELEVANCE/APPLICATION**

Surveillance breast MRI is associated with a reduced incidence of advanced second breast cancer in women with a PHBC and may contribute to decreased breast cancer mortality.

## **T7-SSBR07-Surveillance Outcome in Women with a Personal History of Breast Cancer for First 5 Years**

3

Myoung Kyoung Kim (*Presenter*) Nothing to Disclose

## **PURPOSE**

There is a lack of consensus regarding the effect of the combination of imaging modalities and screening intervals in women with a personal history of breast cancer. To compare performance of surveillance mammography, ultrasound, and MRI for the initial 5 years postoperatively in patients with breast cancer and determine the characteristics of second breast cancers according to different combinations of imaging modalities and screening intervals.

## **METHODS AND MATERIALS**

In this retrospective observational study, 5832 consecutive women with stage 0-III breast cancer who underwent breast cancer surgery between January 2011 and December 2014 were included. We calculated performance outcomes for each modality and compared cancer characteristics according to the combination of imaging modalities and screening intervals.

## **RESULTS**

We enrolled a total of 5832 participants (median age, 49 years; age range, 20-90 years). We reviewed 23616 mammography, 36354 ultrasound, and 1858 MRI. The cancer detection rate of MRI was significantly higher than mammography and US (9.7 [95% CI: 5.2, 14.1] vs. 3.1 [95% CI: 2.4, 3.8] and 3.5 [95% CI: 2.9, 4.1]). MRI showed a higher abnormal interpretation rate than mammography and ultrasound (8.4% [95% CI: 7.0- 9.7] vs. 4.4% [95% CI: 4.2-4.79] and 6.7% [95% CI: 6.5-7.0]) and lower specificity than mammography and ultrasound (92.6% [95% CI: 91.4-93.8] vs. 96.5% [95% CI: 96.3-96.7] and 94.1% [95% CI: 93.9-94.4]). Histologic type and HER2 positivity affected the modality of detection of second breast cancer. The tumor size of second breast cancers detected at 6 month interval was smaller than those of second breast cancers detected at 1 year interval; however, it was not significant.

## **CONCLUSION**

The performance of surveillance MRI was better than mammography and ultrasound. The characteristics of second breast cancer differed based on the imaging modality but not the screening interval.

## **CLINICAL RELEVANCE/APPLICATION**

In this study of women with stage 0-III breast cancer, MRI detected more cancer and abnormal interpretations than mammography or ultrasound during the initial 5 years; however, its specificity was lower. Mammography was more likely to detect ductal carcinoma in situ and HER2-positive tumors, while ultrasound detected invasive carcinoma and HER2-negative

tumors ( $P = .02$  and  $.01$ , respectively). Second breast cancer detected at 6 months and 1 year had similar tumor size and nodal status.

## **T7-SSBR07-Screening Without Mammography Using Abbreviated Breast-MRI Alone**

4

Stephanie Morscheid, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Breast MRI is recommended for supplemental screening for women with dense breasts. However, in women undergoing screening MRI, the additional cancer detection rate attributable to mammography has been shown to be limited. Based on recently published cost-effectiveness analyses, using MRI alone for screening would represent the most cost effective screening method. However, there is so far no evidence available on the outcome of women undergoing MRI as stand-alone screening test, i.e. without mammogram. The purpose of this study was therefore to report first results on the outcome of women undergoing breast MRI as sole screening method (without mammography).

### **METHODS AND MATERIALS**

Ongoing study on so far 844 women aged 40-85 years (median 57 years) without personal history of breast cancer who underwent abbreviated MRI alone for screening (without mammography). Breast MRI was performed on a 1.5T system with multichannel coil, according to a standardized protocol. Validation of MRI diagnoses was achieved by either follow-up for at least 2 years (715/844) or biopsy (129/844).

### **RESULTS**

Women underwent a total 2,732 MRI studies (mean 3.2 studies/participant), covering a mean of 4 years of follow-up per woman, for a total 3,538 women years. MRI was positive (BIRADS4-5) in 129/2,732 examinations (4.7%). Breast cancer was confirmed in 48, yielding a PPV3 (of biopsy) of 37.2%. Overall cancer detection rate was 13.6 per 1000 women years. A total of 23 cancers were found at the first (prevalence) screening round for a cancer-detection-rate of 27.3 per 1000; another 25 cancers were detected in the 1,888 subsequent screening MRIs covering 3509 women years, for an incidence cancer detection rate of 7.1 per 1000 women years. Median age of women diagnosed with cancer was 58 (range 48-77 years). Cancers were DCIS (Tis) in 11/48; invasive in 37. Of the invasive cancers, cancers were staged pT1a in 6/37; pT1b in 21/37, pT1c in 9/37, and pT2 in 1/37, and as N0 in 34/37 (92%); N1 and N1mi in the remaining cases; all were staged M0. Two additional clinically occult invasive cancers were detected by additional self-initiated ultrasound screening in 2 women at 8 and 23 months after the respective screening MRI, for an interval-cancer-rate of 0.57 per 1000 women years. Of the 44/48 patients with MRI-detected cancer underwent bilateral pre-operative 3D mammography. The MRI-known cancer was occult on mammography in 29/44 (66%).

### **CONCLUSION**

Abbreviated breast MRI alone appears sufficient for breast cancer screening. It ensures early detection of breast cancer with low interval cancer rates compared with mammographic screening.

### **CLINICAL RELEVANCE/APPLICATION**

Abbreviated breast MRI alone ensures early detection of breast cancer with low interval cancer rates compared to mammographic screening.

## **T7-SSBR07-Background Parenchymal Enhancement (BPE) on Breast Magnetic Resonance Imaging as a Biomarker of Breast Cancer Risk Among BRCA1/2 Carriers**

5

Anne Marie McCarthy, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

BRCA1/2 carriers are recommended to undergo breast MRI screening annually. Fibroglandular tissue (FGT) can enhance with MRI contrast agent termed background parenchymal enhancement (BPE). BPE has been shown to be more strongly associated with breast cancer risk than breast density in patients undergoing breast MRI. The purpose of the study was to evaluate the association of BPE with breast cancer risk among BRCA1/2 mutation carriers undergoing MRI screening.

### **METHODS AND MATERIALS**

We identified 412 BRCA1/2 carriers from the University of Pennsylvania with no prior history of breast or ovarian cancer at the time of breast MRI. Of these, 43 were diagnosed with breast cancer =6 months after MRI. BPE was quantified using a fully automated, validated method developed at our institution. Briefly, breast segmentation was via the T1-weighted nonfat-saturated image; N4ITK was used for bias-field correction and fibroglandular tissue (FGT) was segmented using a soft-margin support vector machine classifier. The T1-weighted nonfat-saturated image and the derived FGT mask were registered to the precontrast image, from which the first post contrast image and FGT mask were used to compute the relative enhancement. Median BPE enhancement was calculated as the median enhancement of all voxels within the FGT mask and the BPE enhancement ratio as the proportion of voxels enhancing at  $\geq 20\%$  of voxels within the FGT mask. We performed Cox proportional hazards regression to estimate the hazard ratios (HR) for breast cancer for each BPE metric, with first MRI as the

time origin and censoring upon bilateral mastectomy, ovarian cancer diagnosis, death, or loss to follow-up and adjustment for age at MRI, oophorectomy status at MRI, BRCA1 vs. BRCA2 mutation and volumetric breast density (VBD).

## **RESULTS**

The mean age at MRI was 38.9 [IQR 32.3-49.2] for cases and 36.4 [IQR 29.5-45.8] for non-cases. There were no significant differences in median BPE (11.28 [IQR 7.23, 20.23] vs. 12.14 [IQR 7.06, 17.72],  $p=0.960$ ) or BPE ratio (34.3 [IQR 21.3, 51.0] vs. 34.89 [IQR 22.49, 48.12],  $p=0.820$ ) between cases and non-cases. In regression analyses adjusted for age, oophorectomy, VBD and mutation, higher BPE ratio was significantly associated with increased breast cancer risk (HR=1.15 per 10 unit increase in BPE ratio, 95% CI 1.02 - 1.28,  $p=0.044$ ). VBD was not significantly associated with breast cancer after adjusting for BPE.

## **CONCLUSION**

Our results suggest that BPE ratio  $\geq 20\%$  is significantly associated with future breast cancer diagnosis among *BRCA1/2* carriers undergoing breast MRI screening.

## **CLINICAL RELEVANCE/APPLICATION**

Incorporation of quantitative measurement of BPE from MRI may improve breast cancer risk assessment among *BRCA1/2* carriers.

## **T7-SSBR07-Keynote Speaker: Can We Create Breast MRI Capacity for the Expanding Screening 6 Indications?**

Ritse M. Mann, MD, PhD (*Presenter*) Researcher, Siemens AG; Consultant, Siemens AG; Researcher, Bayer AG; Consultant, Bayer AG; Researcher, Medtronic plc; Consultant, Medtronic plc; Researcher, Becton, Dickinson and Company; Consultant, Becton, Dickinson and Company; Researcher, ScreenPoint Medical BV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSBR07-1

### Preoperative Breast MRI in HER2-Positive, ER-Negative Breast Cancer: Surgical Outcomes Using Propensity Score Matching

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S401

Yoon Ji Hwang (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the association between preoperative MRI and surgical outcomes in HER2-positive, ER-negative breast cancer by using propensity score (PS) analysis.

#### METHODS AND MATERIALS

Women with HER2-positive, ER-negative breast cancer between 2007 and 2014 who had or had not undergone preoperative MRI were retrospectively identified. Inverse probability weighting (IPW) and PS matching were used to adjust 16 variables and to create a balance between MRI and no-MRI group. Surgical outcomes were compared between two groups and clinicopathologic variables were evaluated to determine who benefited from MRI.

#### RESULTS

A total of 965 women (mean age  $\pm$  standard deviation, 52 years  $\pm$  10) were evaluated. Among 423 women who underwent preoperative MRI, 23 (5%) showed size discrepancy and 48 (11%) depicted additional suspicious lesions with 17 lesions (35%) being malignant. In the MRI group, a change in surgical management occurred in 50 of the 423 patients (12%) and the change was appropriate in 32 patients (64%). In both IPW analysis and PS matching, the MRI group showed lower odds of overall mastectomy rate (OR, 0.62; 95% CI: 0.46, 0.83;  $P = .001$ , OR, 0.72; 95% CI: 0.52, 0.98;  $P = .034$ ) compared to no-MRI group. Positive resection margin and reoperation rate did not show significant difference between MRI and no-MRI. Initial mastectomy rate did not show consistent results in IPW and PS matching. Asymptomatic patients were found to benefit more from MRI than symptomatic patients (11.7% vs. 4.6%,  $P = .006$ ).

#### CONCLUSION

Preoperative MRI was associated with lower likelihood of overall mastectomy rate in HER2-positive, ER-negative breast cancer patients.

#### CLINICAL RELEVANCE/APPLICATION

Preoperative MRI is useful for planning surgical management with lower likelihood of overall mastectomy rate in patients with HER2-positive, ER-negative breast cancer.

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## Abstract Archives of the RSNA, 2023

T7-SSBR07-2

### Advanced Second Breast Cancer in Women with or without Postoperative Surveillance Breast MRI: A Propensity Score-Matched Analysis

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S401

Jiyoung Yoon, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Postoperative surveillance breast MRI has been increasingly used as a surveillance tool in women with a personal history of breast cancer (PHBC). Although previous studies have consistently reported higher cancer detection rates than with mammography or US, direct measures like survival rates require long-term follow-up. Comparison of advanced second breast cancers, rather than overall second breast cancers, could provide valuable information regarding the clinical benefit of postoperative surveillance MRI. However, a direct comparison between patients would likely be biased because of the different characteristics of patients who were referred for surveillance breast MRI. Therefore, we assessed the association between postoperative surveillance breast MRI and subsequent advanced second breast cancer in patients with a PHBC by using propensity score (PS) analysis.

#### METHODS AND MATERIALS

In this single-center retrospective study, women with a PHBC who underwent breast cancer surgery between January 2009 and December 2014 were identified. Second breast cancer was defined as ipsilateral breast tumor recurrence or contralateral breast cancer diagnosed at least 1 year after surgery. Patients with distant metastasis at initial diagnosis, previous breast cancer, bilateral breast cancer, or a follow-up period of less than 1 year were excluded. Advanced second breast cancer was defined as 1) second breast cancer =T2 or lymph node (LN)-positive or 2) second breast cancer =T2 or LN-positive or HER2-positive/triple negative cancer >1cm. PS matching was used to adjust for 14 variables. After matching, the rates of advanced second breast cancer were compared using the McNemar test.

#### RESULTS

The matched sample consisted of 1439 women who received postoperative surveillance breast MRI and 1439 women who had not. The median follow-up was 108.8 months (range, 18.2-167.3 months) and 110.2 months (range, 12.1-168.4 months) for women with and without surveillance MRI, respectively. The incidence of advanced second breast cancer was significantly higher in the group that did not receive postoperative surveillance breast MRI when advanced second breast cancer was defined as 1) second breast cancer =T2 or LN-positive (15 [1.0%] vs. 4 [0.3%],  $p = .012$ ), or 2) second breast cancer =T2 or LN-positive or HER2-positive/triple negative breast cancer >1cm (26 [1.8%] vs. 7 [0.5%],  $p < .001$ ).

#### CONCLUSION

Surveillance breast MRI was associated with a reduced incidence of advanced second breast cancer in women with a PHBC.

#### CLINICAL RELEVANCE/APPLICATION

Surveillance breast MRI is associated with a reduced incidence of advanced second breast cancer in women with a PHBC and may contribute to decreased breast cancer mortality.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-SSBR07-3

### Surveillance Outcome in Women with a Personal History of Breast Cancer for First 5 Years

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S401

Myoung Kyoung Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

There is a lack of consensus regarding the effect of the combination of imaging modalities and screening intervals in women with a personal history of breast cancer. To compare performance of surveillance mammography, ultrasound, and MRI for the initial 5 years postoperatively in patients with breast cancer and determine the characteristics of second breast cancers according to different combinations of imaging modalities and screening intervals.

#### METHODS AND MATERIALS

In this retrospective observational study, 5832 consecutive women with stage 0-III breast cancer who underwent breast cancer surgery between January 2011 and December 2014 were included. We calculated performance outcomes for each modality and compared cancer characteristics according to the combination of imaging modalities and screening intervals.

#### RESULTS

We enrolled a total of 5832 participants (median age, 49 years; age range, 20-90 years). We reviewed 23616 mammography, 36354 ultrasound, and 1858 MRI. The cancer detection rate of MRI was significantly higher than mammography and US (9.7 [95% CI: 5.2, 14.1] vs. 3.1 [95% CI: 2.4, 3.8] and 3.5 [95% CI: 2.9, 4.1]). MRI showed a higher abnormal interpretation rate than mammography and ultrasound (8.4% [95% CI: 7.0- 9.7] vs. 4.4% [95% CI: 4.2-4.79] and 6.7% [95% CI: 6.5-7.0]) and lower specificity than mammography and ultrasound (92.6% [95% CI: 91.4-93.8] vs. 96.5% [95% CI: 96.3-96.7] and 94.1% [95% CI: 93.9-94.4]). Histologic type and HER2 positivity affected the modality of detection of second breast cancer. The tumor size of second breast cancers detected at 6 month interval was smaller than those of second breast cancers detected at 1 year interval; however, it was not significant.

#### CONCLUSION

The performance of surveillance MRI was better than mammography and ultrasound. The characteristics of second breast cancer differed based on the imaging modality but not the screening interval.

#### CLINICAL RELEVANCE/APPLICATION

In this study of women with stage 0-III breast cancer, MRI detected more cancer and abnormal interpretations than mammography or ultrasound during the initial 5 years; however, its specificity was lower. Mammography was more likely to detect ductal carcinoma in situ and HER2-positive tumors, while ultrasound detected invasive carcinoma and HER2-negative tumors ( $P = .02$  and  $.01$ , respectively). Second breast cancer detected at 6 months and 1 year had similar tumor size and nodal status.

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## Abstract Archives of the RSNA, 2023

T7-SSBR07-4

### Screening Without Mammography Using Abbreviated Breast-MRI Alone

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S401

Stephanie Morscheid, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Breast MRI is recommended for supplemental screening for women with dense breasts. However, in women undergoing screening MRI, the additional cancer detection rate attributable to mammography has been shown to be limited. Based on recently published cost-effectiveness analyses, using MRI alone for screening would represent the most cost effective screening method. However, there is so far no evidence available on the outcome of women undergoing MRI as stand-alone screening test, i.e. without mammogram. The purpose of this study was therefore to report first results on the outcome of women undergoing breast MRI as sole screening method (without mammography).

#### METHODS AND MATERIALS

Ongoing study on so far 844 women aged 40-85 years (median 57 years) without personal history of breast cancer who underwent abbreviated MRI alone for screening (without mammography). Breast MRI was performed on a 1.5T system with multichannel coil, according to a standardized protocol. Validation of MRI diagnoses was achieved by either follow-up for at least 2 years (715/844) or biopsy (129/844).

#### RESULTS

Women underwent a total 2,732 MRI studies (mean 3.2 studies/participant), covering a mean of 4 years of follow-up per woman, for a total 3,538 women years. MRI was positive (BIRADS4-5) in 129/2,732 examinations (4.7%). Breast cancer was confirmed in 48, yielding a PPV3 (of biopsy) of 37.2%. Overall cancer detection rate was 13.6 per 1000 women years. A total of 23 cancers were found at the first (prevalence) screening round for a cancer-detection-rate of 27.3 per 1000; another 25 cancers were detected in the 1,888 subsequent screening MRIs covering 3509 women years, for an incidence cancer detection rate of 7.1 per 1000 women years. Median age of women diagnosed with cancer was 58 (range 48-77 years). Cancers were DCIS (Tis) in 11/48; invasive in 37. Of the invasive cancers, cancers were staged pT1a in 6/37; pT1b in 21/37, pT1c in 9/37, and pT2 in 1/37, and as N0 in 34/37 (92%); N1 and N1mi in the remaining cases; all were staged M0. Two additional clinically occult invasive cancers were detected by additional self-initiated ultrasound screening in 2 women at 8 and 23 months after the respective screening MRI, for an interval-cancer-rate of 0.57 per 1000 women years. Of the 44/48 patients with MRI-detected cancer underwent bilateral pre-operative 3D mammography. The MRI-known cancer was occult on mammography in 29/44 (66%).

#### CONCLUSION

Abbreviated breast MRI alone appears sufficient for breast cancer screening. It ensures early detection of breast cancer with low interval cancer rates compared with mammographic screening.

#### CLINICAL RELEVANCE/APPLICATION

Abbreviated breast MRI alone ensures early detection of breast cancer with low interval cancer rates compared to mammographic screening.

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## Abstract Archives of the RSNA, 2023

T7-SSBR07-5

### Background Parenchymal Enhancement (BPE) on Breast Magnetic Resonance Imaging as a Biomarker of Breast Cancer Risk Among BRCA1/2 Carriers

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S401

Anne Marie McCarthy, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

BRCA1/2 carriers are recommended to undergo breast MRI screening annually. Fibroglandular tissue (FGT) can enhance with MRI contrast agent termed background parenchymal enhancement (BPE). BPE has been shown to be more strongly associated with breast cancer risk than breast density in patients undergoing breast MRI. The purpose of the study was to evaluate the association of BPE with breast cancer risk among BRCA1/2 mutation carriers undergoing MRI screening.

#### METHODS AND MATERIALS

We identified 412 BRCA1/2 carriers from the University of Pennsylvania with no prior history of breast or ovarian cancer at the time of breast MRI. Of these, 43 were diagnosed with breast cancer =6 months after MRI. BPE was quantified using a fully automated, validated method developed at our institution. Briefly, breast segmentation was via the T1-weighted nonfat-saturated image; N4ITK was used for bias-field correction and fibroglandular tissue (FGT) was segmented using a soft-margin support vector machine classifier. The T1-weighted nonfat-saturated image and the derived FGT mask were registered to the precontrast image, from which the first post contrast image and FGT mask were used to compute the relative enhancement. Median BPE enhancement was calculated as the median enhancement of all voxels within the FGT mask and the BPE enhancement ratio as the proportion of voxels enhancing at =20% of voxels within the FGT mask. We performed Cox proportional hazards regression to estimate the hazard ratios (HR) for breast cancer for each BPE metric, with first MRI as the time origin and censoring upon bilateral mastectomy, ovarian cancer diagnosis, death, or loss to follow-up and adjustment for age at MRI, oophorectomy status at MRI, BRCA1 vs. BRCA2 mutation and volumetric breast density (VBD).

#### RESULTS

The mean age at MRI was 38.9 [IQR 32.3-49.2] for cases and 36.4 [IQR 29.5-45.8] for non-cases. There were no significant differences in median BPE (11.28 [IQR 7.23, 20.23] vs. 12.14 [IQR 7.06, 17.72],  $p=0.960$ ) or BPE ratio (34.3 [IQR 21.3, 51.0] vs. 34.89 [IQR 22.49, 48.12],  $p=0.820$ ) between cases and non-cases. In regression analyses adjusted for age, oophorectomy, VBD and mutation, higher BPE ratio was significantly associated with increased breast cancer risk (HR=1.15 per 10 unit increase in BPE ratio, 95% CI 1.02 - 1.28,  $p=0.044$ ). VBD was not significantly associated with breast cancer after adjusting for BPE.

#### CONCLUSION

Our results suggest that BPE ratio  $\geq 20\%$  is significantly associated with future breast cancer diagnosis among BRCA1/2 carriers undergoing breast MRI screening.

#### CLINICAL RELEVANCE/APPLICATION

Incorporation of quantitative measurement of BPE from MRI may improve breast cancer risk assessment among BRCA1/2 carriers.

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## Abstract Archives of the RSNA, 2023

T7-SSBR07-6

### **Keynote Speaker: Can We Create Breast MRI Capacity for the Expanding Screening Indications?**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S401

Ritse M. Mann, MD, PhD (*Presenter*) Researcher, Siemens AG; Consultant, Siemens AG; Researcher, Bayer AG; Consultant, Bayer AG; Researcher, Medtronic plc; Consultant, Medtronic plc; Researcher, Becton, Dickinson and Company; Consultant, Becton, Dickinson and Company; Researcher, ScreenPoint Medical BV

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## Abstract Archives of the RSNA, 2023

T7-SSCA06

### Cardiac Imaging (Risk Stratification and Outcomes)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353B

Suhny Abbara, MD (*Moderator*) Royalties, RELX  
Ming-Yen Ng, BMBS, FRCR (*Moderator*) Education Grant, General Electric Company; Education Grant, Bayer AG; Education Grant, Circle Cardiovascular Imaging Inc; Education Grant, TeraRecon, Inc; Education Grant, Arterys Inc; Speakers Bureau, Boehringer Ingelheim GmbH

#### Sub-Events

### **T7-SSCA06-Cardiovascular Disease Risk Prediction Beyond Coronary Artery Calcium using Deep Learning** **1 Applied to Chest Computed Tomography**

Vineet K. Raghun, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Current guidelines to determine who should take a statin to prevent a first atherosclerotic cardiovascular disease (ASCVD) event hinge on accurate risk estimation. While coronary artery calcium score (CAC) measured on cardiac computed tomography (CT) can refine risk, the utility of commonly performed chest CT beyond CAC for ASCVD risk prediction is not understood. We test whether deep learning can estimate ASCVD risk from chest computed tomography images beyond clinical risk factors and CAC.

#### METHODS AND MATERIALS

We developed a deep learning model (CT-CV-Risk) using 51,182 chest CTs from 12,433 smokers in the National Lung Screening Trial. The CT-CV-Risk model was trained to predict the probability of cardiovascular mortality over 12 years of follow-up. Independent testing was performed in a held-out set of 7,405 individuals with no history of type 2 diabetes, myocardial infarction, or stroke (i.e., eligible for primary prevention) for the prediction of 12-year cardiovascular mortality. Results are provided in the testing dataset only. CT-CV-Risk was compared to a baseline regression model using demographics, smoking, BMI, comorbidities, and imaging findings (e.g., lung nodules, emphysema, CAC) from the CT.

#### RESULTS

In the independent testing dataset of 7,405 persons (mean age 61.0±4.9 years; 65.9% male), 3.1% of individuals died of cardiovascular disease. Adding the CT-CV-Risk score to the baseline regression model significantly improved discrimination for cardiovascular mortality (combined AUC 0.72 [0.68,0.75] vs. baseline AUC 0.69 [0.66,0.73],  $p < 0.001$ ). Similar results were seen for secondary outcomes of fatal myocardial infarction and stroke. In a subset of 4,384 participants with CAC, CT-CV-Risk risk predicted cardiovascular mortality beyond CAC and baseline risk factors (CT-CV-Risk + baseline + CAC AUC 0.74 [0.69,0.78] vs. baseline + CAC AUC 0.71 [0.66,0.75];  $p = 0.002$ ).

#### CONCLUSION

Based on a single CT image, CT-CVD-Risk predicted 10-year cardiovascular mortality beyond prevalent risk factors, CAC, and imaging findings.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning can estimate cardiovascular risk from a chest CT image. This may enable opportunistic risk assessment to guide decisions for primary prevention of cardiovascular disease.

### **T7-SSCA06-Radiomics Analysis of Peri-coronary Adipose Tissue from Baseline CCTA Enables Prediction** **2 of Coronary Plaque Progression**

Rui Chen, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Plaque progression is an intermediate step between subclinical atherosclerosis and coronary events. Coronary computed tomography angiography (CCTA)-derived quantitative plaque features and peri-coronary adipose tissue (PCAT) have been confirmed as predictors for plaque progression. However, the relationship between plaque progression and PCAT radiomics has not been comprehensively evaluated. We analyzed radiomics features derived from PCAT on baseline CCTA to predict coronary plaque progression and evaluate their incremental value over quantitative plaque characteristics.

## METHODS AND MATERIALS

Between January 2009 and December 2020, 500 patients underwent serial CCTA =2 years apart were retrospectively analyzed and randomly stratified into a training and a testing dataset with a ratio of 7:3. Quantitative plaque characteristics and radiomics features of PCAT were extracted from baseline CCTA. Plaque progression was confirmed when the annual change of plaque burden (?PB/y, %/y) exceeded the median value of the study cohort. The benefit of combining PCAT radiomics to quantitative plaque characteristics was explored by comparing area (AUC) under the receiver operating characteristics curves (ROC). Considering various definitions of plaque progression, we also conducted a sensitivity analysis using ?PAV/y of 1.0% as the progression threshold.

## RESULTS

The baseline results of the training set showed that the values of noncalcified plaque volume (NCPV), fibrous plaque volume (FPV), lesion length (LL), fat attenuation index (FAI) were larger in the plaque progression group than in the non-progression group (all  $p < 0.05$ ). In multivariable logistic analysis, NCPV and FAI were independent predictors of coronary plaque progression. PCAT radiomics exhibited significantly superior prediction over quantitative plaque characteristics both in the training (AUC 0.814 vs. 0.615,  $p < 0.001$ ) and testing (0.736 vs. 0.594,  $p = 0.007$ ) datasets. Sensitivity analysis yielded similar comparison among these three predictive models.

## CONCLUSION

PCAT radiomics derived from baseline CCTA dominated in the combined model and achieved significantly better prediction of plaque progression than quantitative plaque characteristics.

## CLINICAL RELEVANCE/APPLICATION

The diagnostic performance of PCAT radiomics was superior to that of quantitative plaque characteristics for identification of plaque progression. Adding PCAT radiomics to quantitative plaque characteristics was comparable to PCAT radiomics alone in diagnostic ability for identifying plaque progression.

## T7-SSCA06- Fractal Analysis to Predict Outcomes in Patients with Dilated Cardiomyopathy: Trabecular Complexity as New Marker

Xiaorui Xiang, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Trabecular complexity is a unique biometric marker like fingerprint, but its prognostic impact in patients with dilated cardiomyopathy (DCM) remains unclear. This study aimed to explore the prognostic value of trabecular complexity by using fractal analysis in patients with DCM.

## METHODS AND MATERIALS

A total of 276 consecutive patients with DCM from January 2011 to December 2012 were enrolled in this study. Comprehensive clinical evaluation and cardiovascular magnetic resonance (CMR) imaging investigation were obtained. Trabecular complexity was quantified with fractal analysis of cine images to estimate the global, basal, and apical fractal dimensions (FD). All patients were followed up for major adverse cardiac events (MACE) of all-cause mortality, aborted sudden cardiac death, and heart transplantation. Univariable and multivariable Cox regression analyses were applied to identify the predictors. Patients' survival was illustrated by Kaplan-Meier curves and differences were evaluated by log-rank test. The reproducibility of FD assessment was evaluated by intraclass correlation coefficients.

## RESULTS

Over a 5.37-year median follow-up, 103 (37.32%) patients experienced MACE. All left ventricular FD parameters were higher in patients with events than those without events (all  $P < 0.05$ ). Max Basal FD emerged as the strongest MACE prognosticator among FD parameters (area under the curve [AUC], 0.84 [95% CI, 0.78-0.88]), and the optimal cutoff value was 1.27. Furthermore, Cox proportional hazards analysis revealed that Max Basal FD was independently associated with MACE (hazard ratio [HR]: 1.07 per %,  $p = 0.002$ ) after adjustment for clinical and imaging risk factors including NT-proBNP, left ventricular ejection fraction (LVEF), and late gadolinium enhancement (LGE) presence. By Kaplan-Meier analysis, the risk of MACE increased significantly with increased Global FD, Mean Basal FD, and Max Basal FD (all log-rank  $p < 0.001$ ).

## CONCLUSION

Left ventricular max basal FD was an independent predictor of adverse outcomes, and fractal analysis may contribute to improving the risk stratification for patients with DCM.

## CLINICAL RELEVANCE/APPLICATION

(1) This is the & 7;rst study to apply fractal analysis to predict outcomes in DCM, demonstrating that increased left ventricular fractal dimensions are associated with adverse cardiac events.(2) Fractal analysis provides an automatable quantitative measure of trabecular complexity in CMR images with clinical benefits.(3) Myocardial trabecular complexity as a new marker has the potential to improve DCM risk stratification algorithms.

## T7-SSCA06-MRI-Derived Extracellular Volume as a Biomarker of Cancer Therapy Cardiotoxicity: Systematic Review and Meta-Analysis

Caterina B. Monti, MD, PhD (*Presenter*) Travel support, Bracco Group

### PURPOSE

MRI-derived extracellular volume (ECV) allows characterization of myocardial changes before the onset of overt pathology, which may be caused by cancer therapy cardiotoxicity. Our purpose was to review studies exploring the role of MRI-derived ECV as an early cardiotoxicity biomarker.

### METHODS AND MATERIALS

In April 2022, we performed a systematic search on EMBASE and PubMed for articles on MRI-derived ECV as a biomarker of cancer therapy cardiotoxicity. Two blinded researchers performed screening of the retrieved articles, including those reporting ECV values at least 3 months from cardiotoxic treatment. Data extraction was performed for each article, including clinical and technical data, and ECV values. Pooled ECV was calculated using the random effects model and compared among different treatment regimens and among those who did or did not experience overt cardiac dysfunction. Meta-regression analyses were conducted to appraise which clinical or technical variables yielded a significant impact on ECV.

### RESULTS

Overall, 19 studies were included. Study populations ranged from 9 to 236 patients, for a total of 1123 individuals, with an average age ranging from 12.5 to 74 years. Most studies included patients with breast and esophageal cancer, treated with anthracyclines and chest radiotherapy. Pooled ECV was 28.44% (95% confidence interval, CI, 26.85-30.03%) among subjects who had undergone cardiotoxic cancer therapy, versus 25.23% (95%CI 23.31-27.14%) among those who had not ( $p=.003$ ).

## CONCLUSION

A higher ECV in patients who underwent cardiotoxic treatment could imply subclinical changes in the myocardium, present even before overt cardiac pathology is detectable.

## CLINICAL RELEVANCE/APPLICATION

MRI-derived ECV could act as an early biomarker of cardiotoxicity in patients undergoing cancer therapy, to identify those at higher risk of cardiac dysfunction and plan effective preventive measures.

## T7-SSCA06-Association between Cardiac Size, Function, and Complications in Vascular Ehlers-Danlos Syndrome

Aly Fawzy, BSc (*Presenter*) Nothing to Disclose

### PURPOSE

Vascular Ehlers-Danlos syndrome (vEDS) is a rare and severe heritable aortic disease caused by pathogenic variants in COL3A1 gene. vEDS is characterized by spontaneous arterial dissection and hollow organ rupture. The purpose is to evaluate cardiac size, function and explore correlations with complications in vEDS.

### METHODS AND MATERIALS

In this retrospective cohort study, genetically confirmed vEDS patients who underwent cardiac MRI were evaluated and compared with healthy controls. Cardiac MRI analysis included ventricular volumetry, evaluation of thoracoabdominal aorta and major arteries. vEDS-associated complications including dissection, aneurysm and organ rupture were collected.

### RESULTS

26 vEDS patients and 45 controls similar in age and sex were analyzed ( $39\pm 16$  years vs.  $40\pm 14$  years,  $p=0.61$ , 50% vs. 58% female,  $p=0.53$ ). While left and right ventricular (LV, RV) volumes were similar, vEDS patients had lower LV and RV ejection fractions (EF) compared to controls ( $58\pm 6\%$  vs.  $61\pm 4\%$ ,  $p=0.01$ ;  $54\pm 5\%$  vs.  $57\pm 4\%$ ,  $p=0.01$ ). Significant differences persisted after excluding potential confounders for systolic dysfunction including coronary dissection ( $n=3$ ), type A

aortic dissection (n=2) and severe valve regurgitation (n=2). Median clinical follow-up was 2(1-4) years. 22 dissections occurred in 13 patients: 2 type A and 20 other arterial dissections [coronary, common carotid, splenic, and iliac arteries were the most common (15% each)]. 26 aneurysms were observed in 8 patients, common iliac artery aneurysms were the most common (31%). Indexed LV end-diastolic volume (EDVi) correlated significantly with the presence of any aneurysm ( $r=0.52$ ,  $p=0.04$ ). RVEDVi, indexed LV and RV stroke volumes and left atrial (LA) area also correlated with the presence of any aneurysm ( $r=0.53$ ,  $p=0.03$ ;  $r=0.56$ ,  $p=0.02$ ;  $r=0.58$ ,  $p=0.02$ ;  $r=0.76$ ,  $p=0.002$ ) and number of aneurysms ( $r=0.56$ ,  $p=0.03$ ;  $r=0.53$ ,  $p=0.03$ ;  $r=0.63$ ,  $p=0.009$ ;  $r=0.79$ ,  $p<0.001$ ). LA area correlated with the number of dissections ( $r=0.55$ ,  $p=0.04$ ). Spontaneous pneumothorax was the most frequent non-vascular complication (18 events in 5 patients), exclusively among those with LVEF below the mean ( $p=0.04$ ).

#### **CONCLUSION**

Biventricular EFs are slightly reduced in vEDS. Larger LV, RV, LA volumes and lower LVEF are associated with higher frequency of complications. While the impact of COL3A1 mutations on the myocardium is yet to be investigated, our data raises the possibility of a genotype-related subtle cardiomyopathy in vEDS. Large longitudinal studies are necessary to confirm and determine the prognostic significance of these findings.

#### **CLINICAL RELEVANCE/APPLICATION**

Cardiac MRI derived ventricular volumetry may have prognostic importance in vEDS and identify those at a higher risk for complications.

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## Abstract Archives of the RSNA, 2023

T7-SSCA06-1

### Cardiovascular Disease Risk Prediction Beyond Coronary Artery Calcium using Deep Learning Applied to Chest Computed Tomography

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353B

Vineet K. Raghu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Current guidelines to determine who should take a statin to prevent a first atherosclerotic cardiovascular disease (ASCVD) event hinge on accurate risk estimation. While coronary artery calcium score (CAC) measured on cardiac computed tomography (CT) can refine risk, the utility of commonly performed chest CT beyond CAC for ASCVD risk prediction is not understood. We test whether deep learning can estimate ASCVD risk from chest computed tomography images beyond clinical risk factors and CAC.

#### METHODS AND MATERIALS

We developed a deep learning model (CT-CV-Risk) using 51,182 chest CTs from 12,433 smokers in the National Lung Screening Trial. The CT-CV-Risk model was trained to predict the probability of cardiovascular mortality over 12 years of follow-up. Independent testing was performed in a held-out set of 7,405 individuals with no history of type 2 diabetes, myocardial infarction, or stroke (i.e., eligible for primary prevention) for the prediction of 12-year cardiovascular mortality. Results are provided in the testing dataset only. CT-CV-Risk was compared to a baseline regression model using demographics, smoking, BMI, comorbidities, and imaging findings (e.g., lung nodules, emphysema, CAC) from the CT.

#### RESULTS

In the independent testing dataset of 7,405 persons (mean age  $61.0 \pm 4.9$  years; 65.9% male), 3.1% of individuals died of cardiovascular disease. Adding the CT-CV-Risk score to the baseline regression model significantly improved discrimination for cardiovascular mortality (combined AUC 0.72 [0.68,0.75] vs. baseline AUC 0.69 [0.66,0.73],  $p < 0.001$ ). Similar results were seen for secondary outcomes of fatal myocardial infarction and stroke. In a subset of 4,384 participants with CAC, CT-CV-Risk risk predicted cardiovascular mortality beyond CAC and baseline risk factors (CT-CV-Risk + baseline + CAC AUC 0.74 [0.69,0.78] vs. baseline + CAC AUC 0.71 [0.66,0.75];  $p = 0.002$ ).

#### CONCLUSION

Based on a single CT image, CT-CVD-Risk predicted 10-year cardiovascular mortality beyond prevalent risk factors, CAC, and imaging findings.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning can estimate cardiovascular risk from a chest CT image. This may enable opportunistic risk assessment to guide decisions for primary prevention of cardiovascular disease.

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## Abstract Archives of the RSNA, 2023

T7-SSCA06-2

### Radiomics Analysis of Peri-coronary Adipose Tissue from Baseline CCTA Enables Prediction of Coronary Plaque Progression

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353B

Rui Chen, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Plaque progression is an intermediate step between subclinical atherosclerosis and coronary events. Coronary computed tomography angiography (CCTA)-derived quantitative plaque features and peri-coronary adipose tissue (PCAT) have been confirmed as predictors for plaque progression. However, the relationship between plaque progression and PCAT radiomics has not been comprehensively evaluated. We analyzed radiomics features derived from PCAT on baseline CCTA to predict coronary plaque progression and evaluate their incremental value over quantitative plaque characteristics.

#### METHODS AND MATERIALS

Between January 2009 and December 2020, 500 patients underwent serial CCTA =2 years apart were retrospectively analyzed and randomly stratified into a training and a testing dataset with a ratio of 7:3. Quantitative plaque characteristics and radiomics features of PCAT were extracted from baseline CCTA. Plaque progression was confirmed when the annual change of plaque burden ( $\Delta$ PB/y, %/y) exceeded the median value of the study cohort. The benefit of combining PCAT radiomics to quantitative plaque characteristics was explored by comparing area (AUC) under the receiver operating characteristics curves (ROC). Considering various definitions of plaque progression, we also conducted a sensitivity analysis using  $\Delta$ PAV/y of 1.0% as the progression threshold.

#### RESULTS

The baseline results of the training set showed that the values of noncalcified plaque volume (NCPV), fibrous plaque volume (FPV), lesion length (LL), fat attenuation index (FAI) were larger in the plaque progression group than in the non-progression group (all  $p < 0.05$ ). In multivariable logistic analysis, NCPV and FAI were independent predictors of coronary plaque progression. PCAT radiomics exhibited significantly superior prediction over quantitative plaque characteristics both in the training (AUC 0.814 vs. 0.615,  $p < 0.001$ ) and testing (0.736 vs. 0.594,  $p = 0.007$ ) datasets. Sensitivity analysis yielded similar comparison among these three predictive models.

#### CONCLUSION

PCAT radiomics derived from baseline CCTA dominated in the combined model and achieved significantly better prediction of plaque progression than quantitative plaque characteristics.

#### CLINICAL RELEVANCE/APPLICATION

The diagnostic performance of PCAT radiomics was superior to that of quantitative plaque characteristics for identification of plaque progression. Adding PCAT radiomics to quantitative plaque characteristics was comparable to PCAT radiomics alone in diagnostic ability for identifying plaque progression.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSCA06-3

### Fractal Analysis to Predict Outcomes in Patients with Dilated Cardiomyopathy: Trabecular Complexity as New Marker

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353B

Xiaorui Xiang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Trabecular complexity is a unique biometric marker like fingerprint, but its prognostic impact in patients with dilated cardiomyopathy (DCM) remains unclear. This study aimed to explore the prognostic value of trabecular complexity by using fractal analysis in patients with DCM.

#### METHODS AND MATERIALS

A total of 276 consecutive patients with DCM from January 2011 to December 2012 were enrolled in this study. Comprehensive clinical evaluation and cardiovascular magnetic resonance (CMR) imaging investigation were obtained. Trabecular complexity was quantified with fractal analysis of cine images to estimate the global, basal, and apical fractal dimensions (FD). All patients were followed up for major adverse cardiac events (MACE) of all-cause mortality, aborted sudden cardiac death, and heart transplantation. Univariable and multivariable Cox regression analyses were applied to identify the predictors. Patients' survival was illustrated by Kaplan-Meier curves and differences were evaluated by log-rank test. The reproducibility of FD assessment was evaluated by intraclass correlation coefficients.

#### RESULTS

Over a 5.37-year median follow-up, 103 (37.32%) patients experienced MACE. All left ventricular FD parameters were higher in patients with events than those without events (all  $P < 0.05$ ). Max Basal FD emerged as the strongest MACE prognosticator among FD parameters (area under the curve [AUC], 0.84 [95% CI, 0.78-0.88]), and the optimal cutoff value was 1.27. Furthermore, Cox proportional hazards analysis revealed that Max Basal FD was independently associated with MACE (hazard ratio [HR]: 1.07 per %,  $p = 0.002$ ) after adjustment for clinical and imaging risk factors including NT-proBNP, left ventricular ejection fraction (LVEF), and late gadolinium enhancement (LGE) presence. By Kaplan-Meier analysis, the risk of MACE increased significantly with increased Global FD, Mean Basal FD, and Max Basal FD (all log-rank  $p < 0.001$ ).

#### CONCLUSION

Left ventricular max basal FD was an independent predictor of adverse outcomes, and fractal analysis may contribute to improving the risk stratification for patients with DCM.

#### CLINICAL RELEVANCE/APPLICATION

(1) This is the first study to apply fractal analysis to predict outcomes in DCM, demonstrating that increased left ventricular fractal dimensions are associated with adverse cardiac events. (2) Fractal analysis provides an automatable quantitative measure of trabecular complexity in CMR images with clinical benefits. (3) Myocardial trabecular complexity as a new marker has the potential to improve DCM risk stratification algorithms.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSCA06-4

### **MRI-Derived Extracellular Volume as a Biomarker of Cancer Therapy Cardiotoxicity: Systematic Review and Meta-Analysis**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353B

Caterina B. Monti, MD, PhD (*Presenter*) Travel support, Bracco Group

#### **PURPOSE**

MRI-derived extracellular volume (ECV) allows characterization of myocardial changes before the onset of overt pathology, which may be caused by cancer therapy cardiotoxicity. Our purpose was to review studies exploring the role of MRI-derived ECV as an early cardiotoxicity biomarker.

#### **METHODS AND MATERIALS**

In April 2022, we performed a systematic search on EMBASE and PubMed for articles on MRI-derived ECV as a biomarker of cancer therapy cardiotoxicity. Two blinded researchers performed screening of the retrieved articles, including those reporting ECV values at least 3 months from cardiotoxic treatment. Data extraction was performed for each article, including clinical and technical data, and ECV values. Pooled ECV was calculated using the random effects model and compared among different treatment regimens and among those who did or did not experience overt cardiac dysfunction. Meta-regression analyses were conducted to appraise which clinical or technical variables yielded a significant impact on ECV.

#### **RESULTS**

Overall, 19 studies were included. Study populations ranged from 9 to 236 patients, for a total of 1123 individuals, with an average age ranging from 12.5 to 74 years. Most studies included patients with breast and esophageal cancer, treated with anthracyclines and chest radiotherapy. Pooled ECV was 28.44% (95% confidence interval, CI, 26.85-30.03%) among subjects who had undergone cardiotoxic cancer therapy, versus 25.23% (95%CI 23.31-27.14%) among those who had not ( $p=.003$ ).

#### **CONCLUSION**

A higher ECV in patients who underwent cardiotoxic treatment could imply subclinical changes in the myocardium, present even before overt cardiac pathology is detectable.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI-derived ECV could act as an early biomarker of cardiotoxicity in patients undergoing cancer therapy, to identify those at higher risk of cardiac dysfunction and plan effective preventive measures.

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## Abstract Archives of the RSNA, 2023

T7-SSCA06-5

### Association between Cardiac Size, Function, and Complications in Vascular Ehlers-Danlos Syndrome

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E353B

Aly Fawzy, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Vascular Ehlers-Danlos syndrome (vEDS) is a rare and severe heritable aortic disease caused by pathogenic variants in COL3A1 gene. vEDS is characterized by spontaneous arterial dissection and hollow organ rupture. The purpose is to evaluate cardiac size, function and explore correlations with complications in vEDS.

#### METHODS AND MATERIALS

In this retrospective cohort study, genetically confirmed vEDS patients who underwent cardiac MRI were evaluated and compared with healthy controls. Cardiac MRI analysis included ventricular volumetry, evaluation of thoracoabdominal aorta and major arteries. vEDS-associated complications including dissection, aneurysm and organ rupture were collected.

#### RESULTS

26 vEDS patients and 45 controls similar in age and sex were analyzed (39±16 years vs. 40±14 years,  $p=0.61$ , 50% vs. 58% female,  $p=0.53$ ). While left and right ventricular (LV, RV) volumes were similar, vEDS patients had lower LV and RV ejection fractions (EF) compared to controls (58±6% vs. 61±4%,  $p=0.01$ ; 54±5% vs. 57±4%,  $p=0.01$ ). Significant differences persisted after excluding potential confounders for systolic dysfunction including coronary dissection ( $n=3$ ), type A aortic dissection ( $n=2$ ) and severe valve regurgitation ( $n=2$ ). Median clinical follow-up was 2(1-4) years. 22 dissections occurred in 13 patients: 2 type A and 20 other arterial dissections [coronary, common carotid, splenic, and iliac arteries were the most common (15% each)]. 26 aneurysms were observed in 8 patients, common iliac artery aneurysms were the most common (31%). Indexed LV end-diastolic volume (EDVi) correlated significantly with the presence of any aneurysm ( $r=0.52$ ,  $p=0.04$ ). RVEDVi, indexed LV and RV stroke volumes and left atrial (LA) area also correlated with the presence of any aneurysm ( $r=0.53$ ,  $p=0.03$ ;  $r=0.56$ ,  $p=0.02$ ;  $r=0.58$ ,  $p=0.02$ ;  $r=0.76$ ,  $p=0.002$ ) and number of aneurysms ( $r=0.56$ ,  $p=0.03$ ;  $r=0.53$ ,  $p=0.03$ ;  $r=0.63$ ,  $p=0.009$ ;  $r=0.79$ ,  $p<0.001$ ). LA area correlated with the number of dissections ( $r=0.55$ ,  $p=0.04$ ). Spontaneous pneumothorax was the most frequent non-vascular complication (18 events in 5 patients), exclusively among those with LVEF below the mean ( $p=0.04$ ).

#### CONCLUSION

Biventricular EFs are slightly reduced in vEDS. Larger LV, RV, LA volumes and lower LVEF are associated with higher frequency of complications. While the impact of COL3A1 mutations on the myocardium is yet to be investigated, our data raises the possibility of a genotype-related subtle cardiomyopathy in vEDS. Large longitudinal studies are necessary to confirm and determine the prognostic significance of these findings.

#### CLINICAL RELEVANCE/APPLICATION

Cardiac MRI derived ventricular volumetry may have prognostic importance in vEDS and identify those at a higher risk for complications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSGI10

### Gastrointestinal Imaging (Dual/Multienergy CT Diagnosis)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E352

Avinash R. Kambadakone, MD, FRCR (*Moderator*) Advisory Board, Bayer AG Research Grant, General Electric Company Research Grant, Koninklijke Philips NV Research Grant, PanCAN Research Grant, Bayer

Bari Dane, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### T7-SSGI10- Value of Dual-Energy Computed Tomography in the Diagnosis of Bowel Ischemia in Patients with Mechanical Small Bowel Obstruction

Alain Luciani, MD, PhD (*Presenter*) Research Consultant, Bracco Group; Research Grant, Bracco Group; Research Consultant, General Electric Company; Research Consultant, Siemens AG

#### PURPOSE

To investigate the diagnostic value of rapid kV-switching single-source dual-energy CT (DECT) for the detection of bowel ischemia (BI) in patients with mechanical small bowel obstruction (SBO), compared to 77-keV virtual monochromatic images (VMI) (equivalent to 120-kV polychromatic images).

#### METHODS AND MATERIALS

This retrospective bicentric study included 112 consecutive patients with confirmed mechanical SBO who underwent DECT including true unenhanced (TUE) and portal-venous VMI covering the abdomen and pelvis between November 2019 and September 2022. Clinical and surgical outcomes with histological findings were recorded as the reference standard. TUE images and 77-keV VMI (dataset 1), and TUE images, virtual unenhanced images, iodine images and 50-keV VMI (dataset 2) were reviewed without knowledge of clinical information. Presence of bowel ischemia was visually assessed based on the following items: increased unenhanced bowel-wall attenuation, reduced bowel-wall enhancement, diffuse mesenteric congestion, closed-loop mechanism. In addition, both wall bowel attenuation and iodine uptake were measured in involved bowel loops using maximal transmural region-of-interests on 50-keV and 77-keV VMI and on iodine images. Contingency tables were used to evaluate visual analysis and quantitative bowel wall measurements were compared using Mann-Whitney U-test. Association between iodine uptake and BI was analysed using logistic regression and ROC curve.

#### RESULTS

Forty-one (37%) patients with SBO underwent surgery within two days of the DECT. Twenty-four (21%) patients had pathologically proven BI including 11 (10%) patients with transmural complete necrosis. Performances for BI detection were not significantly different between datasets 1 and 2 (sensitivity [Se]: 83% and 96% respectively,  $p=0.35$ ; specificity [Sp]: 98% and 97% respectively,  $p=1$ ). Median bowel-wall iodine uptake (1.4 [1.1-2.0] mg/mL vs 2.4 [2.0-2.9] mg/mL;  $p<0.001$ ) and 50-keV VMI attenuation (132 [111-160] vs. 174 [144-206] HU;  $p<0.001$ ) in involved bowel loops were significantly lower in patients with BI than in those without BI; there was no significant difference when using 77-keV VMI (75 vs 87 HU,  $p=0.11$ ). Iodine uptake was able to identify BI (AUC 0.81) with 84% Sp, 73% Se, 53% positive predictive value (PPV) and 93% negative predictive value (NPV) using a threshold of 1.85 mg/mL, and bowel necrosis (AUC 0.86) with 83% Sp, 82% Se, 35% PPV and 99% NPV using a threshold of 1.82 mg/mL.

#### CONCLUSION

Bowel-wall iodine uptake and attenuation on low-keV VMI may help improve the detection of bowel ischemia in patients with mechanical SBO.

#### CLINICAL RELEVANCE/APPLICATION

DECT may help identify bowel ischemia and optimize the therapeutic management of patients with mechanical SBO.

### T7-SSGI10- Spectral CT Based Nomogram for Pretreatment Prediction of Pathologic Response to Neoadjuvant Chemotherapy in Locally Advanced Gastric Cancer: A Prospective Study

(Presenter) Nothing to Disclose

## PURPOSE

To investigate the potential of spectral CT for early prediction of treatment response to neoadjuvant chemotherapy (NAC) in locally advanced gastric cancer (LAGC)

## METHODS AND MATERIALS

This study prospectively recruited 222 patients (177 males, 45 females, 59.6 ±9.5 years) who received NAC and radical gastrectomy. Triple enhanced spectral CT scans were performed within one week before NAC. According to tumor regression grading (TRG) reports, patients were labeled as responders (TRG=0+1) and non-responders (TRG=2+3), and split into a training (154) and validation (68) dataset in chronological order and in a 7:3 ratio. We collected and compared clinicopathological data, follow-up information, iodine concentration (IC), and normalized IC values (nICs) at arterial/venous/delayed phases (AP/VP/DP) between responders and non-responders. Independent risk factors of response were screened by multivariable logistic regression and used to establish a nomogram. The capability of the nomogram was determined by receiver operating characteristic (ROC) curves. Its clinical use was evaluated by decision curve analysis. The correlations of TRG and the nomogram with patients' survival were estimated by log-rank survival analysis

## RESULTS

Borrmann classification, ICDP, and nICDP were independent predictors of TRG and used to construct the nomogram. The nomogram yielded higher area under the curves (AUCs) of 0.797 (0.692-0.879) and 0.741(0.661-0.811) in primary and validation dataset than any other parameters ( $P<0.05$ ). The nomogram was associated with disease-free survival in the validation dataset (Hazard ratio (HR): 5.190 [1.175-12.926],  $P=0.024$ )

## CONCLUSION

The spectral CT based nomogram demonstrated higher efficacy than a single parameter for the prediction of pathologic response after NAC in LAGC

## CLINICAL RELEVANCE/APPLICATION

GC response to NAC varies remarkably. Early prediction of response is important for therapeutic strategy and prognosis evaluation. Spectral CT provides morphologic features and quantitative parameters in a one-stop scan, which may assist clinicians in determining the appropriate management for LAGC population

## T7-SSGI10- Pancreatic Iodine Uptake Evaluation And Related Influences In Multiphase Spectral CT

6

Yu Shi, MD (Presenter) Nothing to Disclose

## PURPOSE

This study aims to explore the impact of patients' different physiological states and unhealthy lifestyle habits on iodine uptake of the pancreas in multiphase spectral CT scan, and normalizing methods.

## METHODS AND MATERIALS

This dual-institution retrospective study included patients (without pancreatic disease) who were scheduled to undergo multiphase abdominal spectral CT scans. The arterial phase (AP), pancreatic phase (PP) and equilibrium phase (EP) of spectral CT were defined as 25s-45s, 55s-75s, and 150s-180s after the injection of contrast agent, respectively. Levels of abdominal obesity were determined by the measurement of the visceral fat area (VFA) using axial unenhanced CT images. Normalized iodine concentration (NIC) (ratio of iodine density of pancreas to that of abdominal aorta) was used to avoid bias between institutions. Multiple linear regression analyses were performed to determine independent factors that influenced iodine uptake.

## RESULTS

A total of 565 participants (institution A: 469, mean age 57 years ±14 [standard deviation] with 220 men; institution B: 96, mean age 55 years ± 11 with 64 men) were evaluated. The mean iodine density (ID) values of institution A and B had significant differences (AP: 2.05 mg/mL vs. 2.65 mg/mL; PP: 1.63 mg/mL vs. 2.30 mg/mL; EP: 1.19 mg/mL vs. 1.76 mg/mL. All  $P < 0.001$ ), while after normalization, there were no significant differences (AP: 0.22 vs. 0.23,  $P = 0.391$ ; PP: 0.42 vs. 0.43,  $P = 0.165$ ; EP: 0.49 vs. 0.48,  $P = 0.605$ ). In multiple linear regression, at AP, gender (ID:  $\beta=-0.464$ , NIC:  $\beta=-0.258$ ; both  $P < 0.001$ ), VFA (ID:  $\beta=-0.155$ , NIC:  $\beta=-0.178$ ; both  $P < 0.001$ ), smoking (ID:  $\beta=-0.308$ , NIC:  $\beta=-0.292$ ; both  $P < 0.001$ ), and alcohol abuse (ID:  $\beta=-0.142$ ,  $P = 0.049$ ; NIC:  $\beta=-0.171$ ,  $P = 0.023$ ) were independent factors for iodine uptake. At PP, only VFA (ID:  $\beta=-0.207$ ,  $P < 0.001$ ; NIC:  $\beta=-0.179$ ,  $P = 0.048$ ) and smoking (ID:  $\beta=-0.273$ ,  $P = 0.041$ ; NIC:  $\beta=-0.198$ ,  $P < 0.001$ ) were independent factors. At EP, VFA (ID:  $\beta=-0.166$ ,  $P = 0.042$ ; NIC:  $\beta=-0.370$ ,  $P < 0.001$ ) and smoking (ID:  $\beta=-0.142$ ,  $P = 0.036$ ; NIC:  $\beta=-0.246$ ,  $P = 0.015$ ) were independent factors.

## **CONCLUSION**

Abdominal obesity, gender, smoking, and alcohol abuse are independent factors affecting iodine uptake in pancreatic multiphase spectral CT. NIC values between two institutions showed no significant differences.

## **CLINICAL RELEVANCE/APPLICATION**

This study provides new indicators and risk factors for early screening of pancreatic diseases and new reference data for other pancreatic spectral CT studies. The utility of NIC can ensure consistency in pancreatic iodine uptake across institutions.  
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## Abstract Archives of the RSNA, 2023

T7-SSGI10-1

### Value of Dual-Energy Computed Tomography in the Diagnosis of Bowel Ischemia in Patients with Mechanical Small Bowel Obstruction

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E352

Alain Luciani, MD, PhD (*Presenter*) Research Consultant, Bracco Group; Research Grant, Bracco Group; Research Consultant, General Electric Company; Research Consultant, Siemens AG

#### PURPOSE

To investigate the diagnostic value of rapid kV-switching single-source dual-energy CT (DECT) for the detection of bowel ischemia (BI) in patients with mechanical small bowel obstruction (SBO), compared to 77-keV virtual monochromatic images (VMI) (equivalent to 120-kV polychromatic images).

#### METHODS AND MATERIALS

This retrospective bicentric study included 112 consecutive patients with confirmed mechanical SBO who underwent DECT including true unenhanced (TUE) and portal-venous VMI covering the abdomen and pelvis between November 2019 and September 2022. Clinical and surgical outcomes with histological findings were recorded as the reference standard. TUE images and 77-keV VMI (dataset 1), and TUE images, virtual unenhanced images, iodine images and 50-keV VMI (dataset 2) were reviewed without knowledge of clinical information. Presence of bowel ischemia was visually assessed based on the following items: increased unenhanced bowel-wall attenuation, reduced bowel-wall enhancement, diffuse mesenteric congestion, closed-loop mechanism. In addition, both wall bowel attenuation and iodine uptake were measured in involved bowel loops using maximal transmural region-of-interests on 50-keV and 77-keV VMI and on iodine images. Contingency tables were used to evaluate visual analysis and quantitative bowel wall measurements were compared using Mann-Whitney U-test. Association between iodine uptake and BI was analysed using logistic regression and ROC curve.

#### RESULTS

Forty-one (37%) patients with SBO underwent surgery within two days of the DECT. Twenty-four (21%) patients had pathologically proven BI including 11 (10%) patients with transmural complete necrosis. Performances for BI detection were not significantly different between datasets 1 and 2 (sensitivity [Se]: 83% and 96% respectively,  $p=0.35$ ; specificity [Sp]: 98% and 97% respectively,  $p=1$ ). Median bowel-wall iodine uptake (1.4 [1.1-2.0] mg/mL vs 2.4 [2.0-2.9] mg/mL;  $p<0.001$ ) and 50-keV VMI attenuation (132 [111-160] vs. 174 [144-206] HU;  $p<0.001$ ) in involved bowel loops were significantly lower in patients with BI than in those without BI; there was no significant difference when using 77-keV VMI (75 vs 87 HU,  $p=0.11$ ). Iodine uptake was able to identify BI (AUC 0.81) with 84% Sp, 73% Se, 53% positive predictive value (PPV) and 93% negative predictive value (NPV) using a threshold of 1.85 mg/mL, and bowel necrosis (AUC 0.86) with 83% Sp, 82% Se, 35% PPV and 99% NPV using a threshold of 1.82 mg/mL.

#### CONCLUSION

Bowel-wall iodine uptake and attenuation on low-keV VMI may help improve the detection of bowel ischemia in patients with mechanical SBO.

#### CLINICAL RELEVANCE/APPLICATION

DECT may help identify bowel ischemia and optimize the therapeutic management of patients with mechanical SBO.

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## Abstract Archives of the RSNA, 2023

T7-SSGI10-4

### Spectral CT Based Nomogram for Pretreatment Prediction of Pathologic Response to Neoadjuvant Chemotherapy in Locally Advanced Gastric Cancer: A Prospective Study

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E352

Jing Li, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the potential of spectral CT for early prediction of treatment response to neoadjuvant chemotherapy (NAC) in locally advanced gastric cancer (LAGC)

#### METHODS AND MATERIALS

This study prospectively recruited 222 patients (177 males, 45 females,  $59.6 \pm 9.5$  years) who received NAC and radical gastrectomy. Triple enhanced spectral CT scans were performed within one week before NAC. According to tumor regression grading (TRG) reports, patients were labeled as responders (TRG=0+1) and non-responders (TRG=2+3), and split into a training (154) and validation (68) dataset in chronological order and in a 7:3 ratio. We collected and compared clinicopathological data, follow-up information, iodine concentration (IC), and normalized IC values (nICs) at arterial/venous/delayed phases (AP/VP/DP) between responders and non-responders. Independent risk factors of response were screened by multivariable logistic regression and used to establish a nomogram. The capability of the nomogram was determined by receiver operating characteristic (ROC) curves. Its clinical use was evaluated by decision curve analysis. The correlations of TRG and the nomogram with patients' survival were estimated by log-rank survival analysis

#### RESULTS

Borrmann classification, ICDP, and nICDP were independent predictors of TRG and used to construct the nomogram. The nomogram yielded higher area under the curves (AUCs) of 0.797 (0.692-0.879) and 0.741(0.661-0.811) in primary and validation dataset than any other parameters ( $P < 0.05$ ). The nomogram was associated with disease-free survival in the validation dataset (Hazard ratio (HR): 5.190 [1.175-12.926],  $P = 0.024$ )

#### CONCLUSION

The spectral CT based nomogram demonstrated higher efficacy than a single parameter for the prediction of pathologic response after NAC in LAGC

#### CLINICAL RELEVANCE/APPLICATION

GC response to NAC varies remarkably. Early prediction of response is important for therapeutic strategy and prognosis evaluation. Spectral CT provides morphologic features and quantitative parameters in a one-stop scan, which may assist clinicians in determining the appropriate management for LAGC population

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## Abstract Archives of the RSNA, 2023

T7-SSGI10-6

### Pancreatic Iodine Uptake Evaluation And Related Influences In Multiphase Spectral CT

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E352

Yu Shi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to explore the impact of patients' different physiological states and unhealthy lifestyle habits on iodine uptake of the pancreas in multiphase spectral CT scan, and normalizing methods.

#### METHODS AND MATERIALS

This dual-institution retrospective study included patients (without pancreatic disease) who were scheduled to undergo multiphase abdominal spectral CT scans. The arterial phase (AP), pancreatic phase (PP) and equilibrium phase (EP) of spectral CT were defined as 25s-45s, 55s-75s, and 150s-180s after the injection of contrast agent, respectively. Levels of abdominal obesity were determined by the measurement of the visceral fat area (VFA) using axial unenhanced CT images. Normalized iodine concentration (NIC) (ratio of iodine density of pancreas to that of abdominal aorta) was used to avoid bias between institutions. Multiple linear regression analyses were performed to determine independent factors that influenced iodine uptake.

#### RESULTS

A total of 565 participants (institution A: 469, mean age 57 years  $\pm$ 14 [standard deviation] with 220 men; institution B: 96, mean age 55 years  $\pm$  11 with 64 men) were evaluated. The mean iodine density (ID) values of institution A and B had significant differences (AP: 2.05 mg/mL vs. 2.65 mg/mL; PP: 1.63 mg/mL vs. 2.30 mg/mL; EP: 1.19 mg/mL vs. 1.76 mg/mL. All  $P < 0.001$ ), while after normalization, there were no significant differences (AP: 0.22 vs. 0.23,  $P = 0.391$ ; PP: 0.42 vs. 0.43,  $P = 0.165$ ; EP: 0.49 vs. 0.48,  $P = 0.605$ ). In multiple linear regression, at AP, gender (ID:  $\beta = -0.464$ , NIC:  $\beta = -0.258$ ; both  $P < 0.001$ ), VFA (ID:  $\beta = -0.155$ , NIC:  $\beta = -0.178$ ; both  $P < 0.001$ ), smoking (ID:  $\beta = -0.308$ , NIC:  $\beta = -0.292$ ; both  $P < 0.001$ ), and alcohol abuse (ID:  $\beta = -0.142$ ,  $P = 0.049$ ; NIC:  $\beta = -0.171$ ,  $P = 0.023$ ) were independent factors for iodine uptake. At PP, only VFA (ID:  $\beta = -0.207$ ,  $P < 0.001$ ; NIC:  $\beta = -0.179$ ,  $P = 0.048$ ) and smoking (ID:  $\beta = -0.273$ ,  $P = 0.041$ ; NIC:  $\beta = -0.198$ ,  $P < 0.001$ ) were independent factors. At EP, VFA (ID:  $\beta = -0.166$ ,  $P = 0.042$ ; NIC:  $\beta = -0.370$ ,  $P < 0.001$ ) and smoking (ID:  $\beta = -0.142$ ,  $P = 0.036$ ; NIC:  $\beta = -0.246$ ,  $P = 0.015$ ) were independent factors.

#### CONCLUSION

Abdominal obesity, gender, smoking, and alcohol abuse are independent factors affecting iodine uptake in pancreatic multiphase spectral CT. NIC values between two institutions showed no significant differences.

#### CLINICAL RELEVANCE/APPLICATION

This study provides new indicators and risk factors for early screening of pancreatic diseases and new reference data for other pancreatic spectral CT studies. The utility of NIC can ensure consistency in pancreatic iodine uptake across institutions.

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## Abstract Archives of the RSNA, 2023

T7-SSGI11

### Gastrointestinal Imaging (Artificial Intelligence Clinical Implementation)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E351

Silvia D. Chang, MD, FRCPC (*Moderator*) Nothing to Disclose  
Marc D. Kohli, MD (*Moderator*) Founder, Alara Imaging; Stockholder, Alara Imaging

#### Sub-Events

### T7-SSGI11- Testing the Ability of ChatGPT to Generate Differential Diagnoses from Transcribed Radiological Findings in Abdominal Radiology<sup>1</sup>

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of specific abdominal radiology cases.

#### METHODS AND MATERIALS

A sample of 70 cases specific to gastrointestinal and genitourinary imaging were evaluated. Cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

#### RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 35.7% compared to 51.4% ( $p=0.031$ ) and 7.1% compared to 10.0% ( $p=0.27$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 42.4% compared to 44.7% ( $p=0.39$ ). ChatGPT3.5 and ChatGPT4 hallucinated 38.2% versus 18.8% ( $p=0.0012$ ) of the references provided and generated 23 total false statements versus 4 total false statements, respectively.

#### CONCLUSION

The two generations of ChatGPT were able to generate a differential diagnosis for prompts containing descriptive radiological findings. The contents of these responses matched the expert literature from which the cases originated a minority of the time, though a statistically significant improvement was made in the top 1 diagnosis accuracy from 3.5 to the 4th generation algorithm. The well-known hallucination effect was encountered more commonly in citations produced than in statements made by the algorithm, both of which improved with the newest generation.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) have a large potential to impact clinical and educational medicine. Knowledge of the accuracy and erroneous possibilities of these algorithms will provide a better understanding of the limitations of these new tools.

### T7-SSGI11- Analysis of Pre-diagnostic CT Images with Artificial Intelligence Facilitates Early Detection of Pancreatic Cancer<sup>3</sup>

Po-Ting Chen, MD (*Presenter*) Nothing to Disclose

## PURPOSE

CT is the major detection tool for pancreatic cancer (PC). An end-to-end computer-aided detection (CAD) tool for PC on contrast-enhanced CT images has been developed to supplement radiologist interpretation. This study aims to investigate whether analysis of pre-diagnostic CT images with the CAD tool could facilitate early detection of PC.

## METHODS AND MATERIALS

An end-to-end CAD tool was developed using contrast-enhanced CT images from National Taiwan University Hospital (NTUH) comprising 745 patients with histologically/cytologically-confirmed PC and 2371 controls. The CAD tool was constructed with a deep learning segmentation model and an ensemble classification model based on radiomic analysis and deep learning. The patients with PC between January 2006 and July 2018 were reviewed retrospectively to retrieve pre-diagnostic CT images, and two board-certified experienced abdominal radiologists reviewed the images to determine the tumor location. The diagnosis of PC was verified with cancer registry, and images of patients with indwelling biliary stents, prior pancreatic resection, and prior chemotherapy or immunotherapy for PC were excluded. The pre-diagnostic CT studies were analyzed by the CAD tool and compared with the original formal radiologist reports.

## RESULTS

A total of 71 PC patients with pre-diagnostic CT images were included in this study. The median time between pre-diagnostic CT images and diagnosis was 207 days (interquartile range [IQR] 70 to 892 days). According to the consensus of the two reviewing radiologists, pre-diagnostic CT images of 41 patients had PCs, whereas those of the remaining 30 patients had unremarkable pancreas. Among the 30 cases with unremarkable pancreas, the pre-diagnostic CT studies were performed within one year before cancer diagnosis in three patients and thus were considered as harboring PC. The CAD tool achieved 75.0% (33/44) overall sensitivity, with 78.0% (32/41) sensitivity in 41 pre-diagnostic CT images with visible tumors and 33.3% (1/3) sensitivity in those obtained within one year preceding diagnosis but without visible tumor. Eighteen of the 41 pre-diagnostic CT images with visible tumors were missed in the original radiologist report, with 13 of them being detected by the CAD tool. The sensitivity of the CAD tool for PC decreased with increasing interval between the pre-diagnostic CT studies and cancer diagnosis (<3 months before diagnosis, 80.0%; >3 to = 6 months, 75.0%; >6 to = 12 months, 57.1%; more than 1 year, 80.0%).

## CONCLUSION

The deep learning and radiomics-based CAD tool could supplement radiologists in detecting PC on pre-diagnostic CT images.

## CLINICAL RELEVANCE/APPLICATION

The CAD tool holds potential for supplementing radiologists for detection of PCs in clinical practice.

## T7-SSGI11- A Predictive Model for Pancreatic Cystic Lesions Progression Based on Clinical and Radiological Features

Wenyi Deng (*Presenter*) Nothing to Disclose

## PURPOSE

The guidelines of American Gastroenterological Association point out that one of the key components of clinical management of pancreatic cystic lesions (PCLs) is to accurately predict lesions that will develop malignancy in the future. Therefore, we proposed a PCLs progression prediction model based on clinical and radiological features.

## METHODS AND MATERIALS

Baseline enhanced CTs of 181 PCLs were retrospectively analysed, from July 2014 to December 2022. The inclusion criteria were as follows: a) without jaundice, main pancreatic duct (MPD) = 10mm, mural nodule, cysts = 4cm, positive cytology and other symptoms that require surgery at baseline CTs. b) without solid lesions of pancreas, active cancer or family history of pancreatic cancer. According to whether lesions showed high-risk surgical features within 3 years after baseline CTs, they were divided into progression group and control group. Dataset was randomly divided into training (40 progressions and 87 controls) and independent testing (21 progressions and 33 controls) cohorts. Two radiologists recorded 10 clinical features and 13 radiological features independently, with any inconsistencies resolved through discussion. After applying the F-test based feature selection, 7 machine learning models were constructed by 10-fold cross-validation procedure, including Support Vector Machine (SVM), Logistic Regression, Linear Discriminant Analysis, Gaussian NB, K Nearest Neighbors, Bernoulli NB and Decision Tress, to identify the optimal predictive model for distinguishing between progression and non-progression lesions.

## RESULTS

The average time between baseline CTs and progression was 545±314 days in the testing cohort. Total 3 clinical features (pancreatitis history, gender and serum carcinoembryonic antigen level) and 6 radiological features (cyst size, thick cystic wall, thick septation, diameter of MPD, dilation of MPD = 5mm and calcification) were selected. SVM had the highest area under the receiver operating characteristic curve (AUC) of 0.920 in the cross-validation cohort, so was chosen as the best model. The AUC, accuracy, sensitivity and specificity of SVM in the training cohort were 0.944, 0.898, 0.850 and 0.920

respectively, and these in the testing cohort were 0.857, 0.741, 0.667 and 0.788 respectively. The inter-reader radiologist agreement of all 13 radiological features ranged from 0.462 to 0.985, indicating moderate to excellent consistent.

## **CONCLUSION**

The clinical and radiological based SVM model can help predict PCLs progression within 3 years at a substantial lead time prior to image diagnosis.

## **CLINICAL RELEVANCE/APPLICATION**

The SVM model we built can help early detection of malignant and assist clinical management of PCLs more efficiently.

## **T7-SSGI11- Radiomics Analysis from Magnetic Resonance Imaging in Predicting the Grade of Nonfunctioning Pancreatic Neuroendocrine Tumors: A Multicenter Study**

Haibin Zhu, MD, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To explore the potential of radiomic features to predict histologic grade in Nonfunctioning pancreatic neuroendocrine tumors (NF-PNETs) patients using non-contrast sequence based on MRI from a multi-center study.

## **METHODS AND MATERIALS**

228 patients with NF-PNETs that underwent MRI at 5 centers in China were retrospectively analyzed. Data from center 1 (n=115) were used as training cohort and data from center 2-5 (n=113) constituted testing cohort. Baseline clinical information and radiological characteristics were reviewed to identify significant predictors. Radiomics features were extracted from T2-weighted images (T2WI) and apparent diffusion coefficient (ADC). The least absolute shrinkage and selection operator was applied to select the most important features and to develop radiomics signatures. The area under receiver operating characteristic curve (AUC) were performed to assess the performance of models.

## **RESULTS**

Radiological characteristics, including tumor boundary, enhancement homogeneity and vascular invasion, were used to construct the radiological model to stratify NF-PNET patients into grade 1 and 2/3 groups, which yielded AUC of 0.884 and 0.684 in the training and testing groups. A radiomics model including 4 features from T2WI and ADC were constructed to stratify NF-PNET patients into grade 1 and 2/3 groups, with an AUC of 0.941 and 0.871 in the training and testing cohorts. In addition, the fusion model combining the radiomic signature and radiological characteristics showed good performance in the training set (AUC=0.956) and in the testing set (AUC=0.864), respectively.

## **CONCLUSION**

The developed model that integrates radiomics features with radiological characteristics could be used as a non-invasive, dependable, and accurate tool for preoperatively prediction of grade in NF-PNETs.

## **CLINICAL RELEVANCE/APPLICATION**

The diagnostic performance of the radiomic model and fusion model was better than model based on clinical information and radiological features in the training and testing cohort in predicting grade 1 and 2/3 of NF-PNETs. In addition, the radiomics features were selected from non-contrast T2WI and DWI sequence, which means that the administration of contrast agent was not needed in grading the NF-PNETs.

## **T7-SSGI11- Shortening Acquisition Time for Pelvic MRI by using a Deep Learning Reconstruction for Diffusion-weighted Imaging at 1.5 Tesla**

Judith Herrmann, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study was to determine the impact on acquisition time reduction and image quality of a Deep Learning (DL) reconstruction for accelerated diffusion-weighted imaging (DWI) of the pelvis at 1.5 T in comparison to standard DWI.

## **METHODS AND MATERIALS**

A total of 55 patients (mean age, 61 ± 13 years; range, 27 - 89; 20 men, 35 women) were consecutively included in this retrospective, monocentric between February and November 2022. Inclusion criteria were (a) standard DWI (DWIS) in clinically indicated standard MRI at 1.5 T, and (b) DL-reconstruction of the DWI (DWIDL). All patients were examined using the institution's standard MRI protocol according to their diagnosis including DWI with two different b-values (0 s/mm<sup>2</sup> and 800 s/mm<sup>2</sup>) and calculation of apparent diffusion coefficient (ADC) maps. Image quality was assessed using signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) from region-of-interest analysis and qualitatively assessed by four radiologists using a visual Likert scale ranging from 1 - 5 with 5 being the best using the following criteria: overall image quality, noise level, extent of artifacts, sharpness, and diagnostic confidence.

## RESULTS

The overall image quality was evaluated to be significantly superior in DWIDL as compared to DWIS for  $b=0$  s/mm<sup>2</sup>,  $b=800$  s/mm<sup>2</sup>, and ADC maps by all readers ( $p<0.05$ ). The extent of noise was evaluated to be significantly less in DWIDL as compared to DWIS for  $b=0$  s/mm<sup>2</sup>,  $b=800$  s/mm<sup>2</sup>, and ADC maps by all readers ( $p<0.001$ ). No significant differences were found regarding artifacts, lesion detectability, sharpness of organs, and diagnostic confidence ( $p>0.05$ ). TA for DWIS was 2:06 min and simulated TA for DWIDL was 1:12 min.

## CONCLUSION

Deep learning image reconstruction shortens the acquisition time for diffusion-weighted MRI of the pelvis at 1.5T of more than 40% (TA for DWI<sub>S</sub> was 2:06 min and simulated TA for DWI<sub>DL</sub> was 1:12 min) without compromising the image quality.

## CLINICAL RELEVANCE/APPLICATION

This immense reduction in scan time of more than 40% not only significantly increases patient throughput, but also improves patient comfort for the individual patient, helping to face the challenges of today's healthcare environment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSGI11-1

### Testing the Ability of ChatGPT to Generate Differential Diagnoses from Transcribed Radiological Findings in Abdominal Radiology

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E351

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of specific abdominal radiology cases.

#### METHODS AND MATERIALS

A sample of 70 cases specific to gastrointestinal and genitourinary imaging were evaluated. Cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

#### RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 35.7% compared to 51.4% ( $p=0.031$ ) and 7.1% compared to 10.0% ( $p=0.27$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 42.4% compared to 44.7% ( $p=0.39$ ). ChatGPT3.5 and ChatGPT4 hallucinated 38.2% versus 18.8% ( $p=0.0012$ ) of the references provided and generated 23 total false statements versus 4 total false statements, respectively.

#### CONCLUSION

The two generations of ChatGPT were able to generate a differential diagnosis for prompts containing descriptive radiological findings. The contents of these responses matched the expert literature from which the cases originated a minority of the time, though a statistically significant improvement was made in the top 1 diagnosis accuracy from 3.5 to the 4th generation algorithm. The well-known hallucination effect was encountered more commonly in citations produced than in statements made by the algorithm, both of which improved with the newest generation.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) have a large potential to impact clinical and educational medicine. Knowledge of the accuracy and erroneous possibilities of these algorithms will provide a better understanding of the limitations of these new tools.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-SSGI11-3

### Analysis of Pre-diagnostic CT Images with Artificial Intelligence Facilitates Early Detection of Pancreatic Cancer

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E351

Po-Ting Chen, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

CT is the major detection tool for pancreatic cancer (PC). An end-to-end computer-aided detection (CAD) tool for PC on contrast-enhanced CT images has been developed to supplement radiologist interpretation. This study aims to investigate whether analysis of pre-diagnostic CT images with the CAD tool could facilitate early detection of PC.

#### METHODS AND MATERIALS

An end-to-end CAD tool was developed using contrast-enhanced CT images from National Taiwan University Hospital (NTUH) comprising 745 patients with histologically/cytologically-confirmed PC and 2371 controls. The CAD tool was constructed with a deep learning segmentation model and an ensemble classification model based on radiomic analysis and deep learning. The patients with PC between January 2006 and July 2018 were reviewed retrospectively to retrieve pre-diagnostic CT images, and two board-certified experienced abdominal radiologists reviewed the images to determine the tumor location. The diagnosis of PC was verified with cancer registry, and images of patients with indwelling biliary stents, prior pancreatic resection, and prior chemotherapy or immunotherapy for PC were excluded. The pre-diagnostic CT studies were analyzed by the CAD tool and compared with the original formal radiologist reports.

#### RESULTS

A total of 71 PC patients with pre-diagnostic CT images were included in this study. The median time between pre-diagnostic CT images and diagnosis was 207 days (interquartile range [IQR] 70 to 892 days). According to the consensus of the two reviewing radiologists, pre-diagnostic CT images of 41 patients had PCs, whereas those of the remaining 30 patients had unremarkable pancreas. Among the 30 cases with unremarkable pancreas, the pre-diagnostic CT studies were performed within one year before cancer diagnosis in three patients and thus were considered as harboring PC. The CAD tool achieved 75.0% (33/44) overall sensitivity, with 78.0% (32/41) sensitivity in 41 pre-diagnostic CT images with visible tumors and 33.3% (1/3) sensitivity in those obtained within one year preceding diagnosis but without visible tumor. Eighteen of the 41 pre-diagnostic CT images with visible tumors were missed in the original radiologist report, with 13 of them being detected by the CAD tool. The sensitivity of the CAD tool for PC decreased with increasing interval between the pre-diagnostic CT studies and cancer diagnosis (<3 months before diagnosis, 80.0%; >3 to = 6 months, 75.0%; >6 to = 12 months, 57.1%; more than 1 year, 80.0%).

#### CONCLUSION

The deep learning and radiomics-based CAD tool could supplement radiologists in detecting PC on pre-diagnostic CT images.

#### CLINICAL RELEVANCE/APPLICATION

The CAD tool holds potential for supplementing radiologists for detection of PCs in clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSGI11-4

### **A Predictive Model for Pancreatic Cystic Lesions Progression Based on Clinical and Radiological Features**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E351

Wenyi Deng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The guidelines of American Gastroenterological Association point out that one of the key components of clinical management of pancreatic cystic lesions (PCLs) is to accurately predict lesions that will develop malignancy in the future. Therefore, we proposed a PCLs progression prediction model based on clinical and radiological features.

#### **METHODS AND MATERIALS**

Baseline enhanced CTs of 181 PCLs were retrospectively analysed, from July 2014 to December 2022. The inclusion criteria were as follows: a) without jaundice, main pancreatic duct (MPD) = 10mm, mural nodule, cysts = 4cm, positive cytology and other symptoms that require surgery at baseline CTs. b) without solid lesions of pancreas, active cancer or family history of pancreatic cancer. According to whether lesions showed high-risk surgical features within 3 years after baseline CTs, they were divided into progression group and control group. Dataset was randomly divided into training (40 progressions and 87 controls) and independent testing (21 progressions and 33 controls) cohorts. Two radiologists recorded 10 clinical features and 13 radiological features independently, with any inconsistencies resolved through discussion. After applying the F-test based feature selection, 7 machine learning models were constructed by 10-fold cross-validation procedure, including Support Vector Machine (SVM), Logistic Regression, Linear Discriminant Analysis, Gaussian NB, K Nearest Neighbors, Bernoulli NB and Decision Tress, to identify the optimal predictive model for distinguishing between progression and non-progression lesions.

#### **RESULTS**

The average time between baseline CTs and progression was  $545 \pm 314$  days in the testing cohort. Total 3 clinical features (pancreatitis history, gender and serum carcinoembryonic antigen level) and 6 radiological features (cyst size, thick cystic wall, thick septation, diameter of MPD, dilation of MPD = 5mm and calcification) were selected. SVM had the highest area under the receiver operating characteristic curve (AUC) of 0.920 in the cross-validation cohort, so was chosen as the best model. The AUC, accuracy, sensitivity and specificity of SVM in the training cohort were 0.944, 0.898, 0.850 and 0.920 respectively, and these in the testing cohort were 0.857, 0.741, 0.667 and 0.788 respectively. The inter-reader radiologist agreement of all 13 radiological features ranged from 0.462 to 0.985, indicating moderate to excellent consistent.

#### **CONCLUSION**

The clinical and radiological based SVM model can help predict PCLs progression within 3 years at a substantial lead time prior to image diagnosis.

#### **CLINICAL RELEVANCE/APPLICATION**

The SVM model we built can help early detection of malignant and assist clinical management of PCLs more efficiently.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSGI11-5

### **Radiomics Analysis from Magnetic Resonance Imaging in Predicting the Grade of Nonfunctioning Pancreatic Neuroendocrine Tumors: A Multicenter Study**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E351

Haibin Zhu, MD, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the potential of radiomic features to predict histologic grade in Nonfunctioning pancreatic neuroendocrine tumors (NF-PNETs) patients using non-contrast sequence based on MRI from a multi-center study.

#### **METHODS AND MATERIALS**

228 patients with NF-PNETs that underwent MRI at 5 centers in China were retrospectively analyzed. Data from center 1 (n=115) were used as training cohort and data from center 2-5 (n=113) constituted testing cohort. Baseline clinical information and radiological characteristics were reviewed to identify significant predictors. Radiomics features were extracted from T2-weighted images (T2WI) and apparent diffusion coefficient (ADC). The least absolute shrinkage and selection operator was applied to select the most important features and to develop radiomics signatures. The area under receiver operating characteristic curve (AUC) were performed to assess the performance of models.

#### **RESULTS**

Radiological characteristics, including tumor boundary, enhancement homogeneity and vascular invasion, were used to construct the radiological model to stratify NF-PNET patients into grade 1 and 2/3 groups, which yielded AUC of 0.884 and 0.684 in the training and testing groups. A radiomics model including 4 features from T2WI and ADC were constructed to stratify NF-PNET patients into grade 1 and 2/3 groups, with an AUC of 0.941 and 0.871 in the training and testing cohorts. In addition, the fusion model combining the radiomic signature and radiological characteristics showed good performance in the training set (AUC=0.956) and in the testing set (AUC=0.864), respectively.

#### **CONCLUSION**

The developed model that integrates radiomics features with radiological characteristics could be used as a non-invasive, dependable, and accurate tool for preoperatively prediction of grade in NF-PNETs.

#### **CLINICAL RELEVANCE/APPLICATION**

The diagnostic performance of the radiomic model and fusion model was better than model based on clinical information and radiological features in the training and testing cohort in predicting grade 1 and 2/3 of NF-PNETs. In addition, the radiomics features were selected from non-contrast T2WI and DWI sequence, which means that the administration of contrast agent was not needed in grading the NF-PNETs.

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## Abstract Archives of the RSNA, 2023

T7-SSGI11-6

### Shortening Acquisition Time for Pelvic MRI by using a Deep Learning Reconstruction for Diffusion-weighted Imaging at 1.5 Tesla

Tuesday, Nov. 28 3:00PM - 4:00PM Room: E351

Judith Herrmann, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to determine the impact on acquisition time reduction and image quality of a Deep Learning (DL) reconstruction for accelerated diffusion-weighted imaging (DWI) of the pelvis at 1.5 T in comparison to standard DWI.

#### METHODS AND MATERIALS

A total of 55 patients (mean age,  $61 \pm 13$  years; range, 27 - 89; 20 men, 35 women) were consecutively included in this retrospective, monocentric between February and November 2022. Inclusion criteria were (a) standard DWI (DWIS) in clinically indicated standard MRI at 1.5 T, and (b) DL-reconstruction of the DWI (DWIDL). All patients were examined using the institution's standard MRI protocol according to their diagnosis including DWI with two different b-values ( $0 \text{ s/mm}^2$  and  $800 \text{ s/mm}^2$ ) and calculation of apparent diffusion coefficient (ADC) maps. Image quality was assessed using signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) from region-of-interest analysis and qualitatively assessed by four radiologists using a visual Likert scale ranging from 1 - 5 with 5 being the best using the following criteria: overall image quality, noise level, extent of artifacts, sharpness, and diagnostic confidence.

#### RESULTS

The overall image quality was evaluated to be significantly superior in DWIDL as compared to DWIS for  $b=0 \text{ s/mm}^2$ ,  $b=800 \text{ s/mm}^2$ , and ADC maps by all readers ( $p < 0.05$ ). The extent of noise was evaluated to be significantly less in DWIDL as compared to DWIS for  $b=0 \text{ s/mm}^2$ ,  $b=800 \text{ s/mm}^2$ , and ADC maps by all readers ( $p < 0.001$ ). No significant differences were found regarding artifacts, lesion detectability, sharpness of organs, and diagnostic confidence ( $p > 0.05$ ). TA for DWIS was 2:06 min and simulated TA for DWIDL was 1:12 min.

#### CONCLUSION

Deep learning image reconstruction shortens the acquisition time for diffusion-weighted MRI of the pelvis at 1.5T of more than 40% (TA for  $DWI_S$  was 2:06 min and simulated TA for  $DWI_{DL}$  was 1:12 min) without compromising the image quality.

#### CLINICAL RELEVANCE/APPLICATION

This immense reduction in scan time of more than 40% not only significantly increases patient throughput, but also improves patient comfort for the individual patient, helping to face the challenges of today's healthcare environment.

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## Abstract Archives of the RSNA, 2023

T7-SSIN03

### Imaging Informatics (Images are Data: Recent Advances in Radiomics)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N227B

Paulo E. Kuriki, MD (*Moderator*) Nothing to Disclose  
Matthew P. Thorpe, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

### **T7-SSIN03- Predicting Overall Survival of Patients with Melanoma and NSCLC Treated with Immunotherapy using AI Combining Total Tumor Volume and Tumor Heterogeneity on CT-Scans.**

Felix Wirth, MEng, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a prognostic imaging signature based on tumor heterogeneity and tumor volume extracted from baseline thorax-abdomen-pelvis CT-scans in patients with melanoma and non-small cell lung cancer (NSCLC) treated with immunotherapy.

#### METHODS AND MATERIALS

This retrospective study included 607 patients treated from 2014 to 2019. Treatment baseline CT-scans were collected. All visible lesions were 2D-outlined on the largest diameter axial slice by two senior radiologists with double reading. The total tumor volume (TTV) was computed by adding estimated lesion volumes. Patients were randomly split into train, test and validation sets with a 56-14-30 ratio stratified by cancer type. Texture features were extracted using either radiomics or a neural network trained via self-supervised learning. Heterogeneity indexes were developed on the train set only, and hyperparameters were tuned on the test set. Two heterogeneity signatures were obtained using PCA followed by random survival forests fit to predict overall survival (OS): radiomics heterogeneity risk (RadH) and AI risk (AiH). These were combined with TTV using a Cox model to establish two imaging scores (TTV-RadH, TTV-AiH). Cut-offs were determined using maximally selected rank statistics on the train set. Two populations (low risk - high risk) were evaluated using Kaplan-Meier and Log-Rank tests. Correlations were studied using the Pearson correlation coefficient.

#### RESULTS

In total, 19877 lesions were annotated. The train, test and validation sets contained 339, 85 and 183 patients. Preliminary results were computed on the train and test sets. 1120 radiomics texture features were extracted per tumor. The neural network yielded 512 features per tumor. The cut-off for TTV was 102 cm<sup>3</sup>. On the test set, TTV-RadH low and high risk groups had median OS of 3.09 and 16.29 months, while TTV-AiH had median OS of 3.09 and 19.04 months. All Log-Rank tests were statistically significant ( $p < 0.001$ ). The correlation was strong between TTV and RadH ( $r = 0.67$ ), moderate between AiH and RadH ( $r = 0.40$ ), and weak between TTV and AiH ( $r = 0.27$ ).

#### CONCLUSION

This study aimed to develop new prognostic imaging signatures based on baseline CT-scans. These combine both total tumor volume and heterogeneity indexes, extracted using radiomics or a novel method based on self-supervised learning. These methods were able to predict survival of cancer patients treated with immunotherapy in both train and test sets. RadH was more correlated than AiH with volume.

#### CLINICAL RELEVANCE/APPLICATION

Using total tumor volume and AI tumor heterogeneity from CT scans, it may be possible to predict the prognosis of oncology patients, identify those who could benefit from immunotherapy, and provide valuable guidance for treatment.

### **T7-SSIN03- Radiomics-Based Machine Learning Models in Bladder Cancer: Predicting p53 Mutation**

Okan Ince, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to develop and assess the performance of machine learning models for predicting tumor protein p53 mutation status in bladder cancers using CT-based radiomics, with the potential to enhance personalized treatment strategies.

## METHODS AND MATERIALS

Computed tomography urography (CTU) images of patients with and without p53 mutation were obtained from a public database. Tumors were semi-automatically segmented from CTU images. Following image preprocessing, a comprehensive set of radiomic features were extracted from original, Laplacian of Gaussian, and wavelet-filtered images. The feature selection process was conducted in three steps to optimize model performance. First, student's t-test was performed to each feature, second, features with high collinearity based on Pearson's correlation coefficient were eliminated. Last, a wrapper-based sequential feature selection algorithm was implemented. Multi-Layer Perceptron (MLP) and Support Vector Machine (SVM) classifiers were developed. Performance metrics were calculated using ten-fold cross-validation technique.

## RESULTS

67 patients were included in the study (32 with p53 mutation and 35 without). Both SVM and MLP models demonstrated 95% of accuracy in classifying patients based on p53 mutation status. For SVM, sensitivity, specificity, area under curve (AUC), precision, recall, and F1 scores were 91%, 91%, 90%, 91%, 91%, and 91%, respectively. And for MLP the scores were 96%, 86%, 85%, 86%, 97%, and 91%, respectively.

## CONCLUSION

The machine learning models utilizing radiomics features derived from CT images exhibit great potential for accurately predicting p53 mutation status in bladder cancer. These models may contribute to improved patient stratification and personalized treatment planning.

## CLINICAL RELEVANCE/APPLICATION

Accurate prediction of p53 mutation status may facilitate personalized bladder cancer treatment, potentially improving patient outcomes and resource utilization.

## T7-SSIN03- Risk of Bias in Chest X-Ray Radiomics Models: Looking Beyond Neural Networks

4

Hadiseh Kavandi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Deep learning (DL) neural networks have shown a risk of bias by being able to predict demographics like self-reported race on chest x-rays (CXR). We evaluated if CXR radiomics models have similar ability to predict demographics and, therefore, similar risk of demographic bias.

## METHODS AND MATERIALS

Our datasets comprised 25,565 and 29,453 randomly-chosen frontal CXRs from the NIH CXR14 and CheXpert datasets, respectively, which were divided into 80/15/5% training/validation/test splits. Each CXR was preprocessed by segmenting the heart, right and left lungs, and spine using a previously-validated U-Net model. For each anatomical segmentation, 116 radiomics features were extracted, including first-order statistics and shape-based features. A multilayer perceptron model was trained and tested using radiomics features from a) all 4 anatomical segmentations and b) each individual anatomical segmentation to predict patient age, sex, and self-reported race. Model performance was evaluated using AUROC for sex and race, and Pearson correlation coefficient (PCC) for age.

## RESULTS

The models combining radiomics features from all 4 anatomical segmentations had the highest performance for all demographic categories and test sets, with AUROCs of 0.94-0.95 for sex, 0.73-0.79 for race, and 0.76-0.78 PCC for age. For single-anatomical region radiomics models, right and left lung models had the best performance for sex prediction (AUROCs 0.85-0.91), left lung for race prediction (AUROCs 0.69-0.71), and left lung and heart for age (PCC 0.65).

## CONCLUSION

Similar to DL neural networks, radiomics CXR models demonstrate similar encoding of demographic characteristics of age, sex, and race, which raises concerns about risks of bias in these models. Further study is needed to understand the mechanisms of demographic prediction in radiomics models and their impact on subsequent biases in disease prediction in order to facilitate the safe and equitable development of these potentially game-changing technologies.

## CLINICAL RELEVANCE/APPLICATION

Radiomic features encode demographic characteristics that may contribute to bias in diagnostic classifications, confirming that these concerns about bias extend beyond deep learning neural networks.

### **T7-SSIN03- Ensemble Machine Learning Model Incorporating Radiomics and Body Composition for Predicting Intraoperative HDI in PPGL**

Xiaoping Yi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Intraoperative hemodynamic instability (HDI) can lead to cardiovascular and cerebrovascular complications during surgery for pheochromocytoma and paraganglioma (PPGL). Assessing the risk of intraoperative HDI in patients with PPGL could help to improve surgical outcome.

#### **METHODS AND MATERIALS**

A total of 199 consecutive patients with PPGL confirmed by surgical pathology were retrospectively included in this study. This cohort was separated into two groups according to intraoperative systolic blood pressure, the HDI group (n = 101) and the hemodynamic stability group (HDS group, n = 98). It was also divided into two sub cohorts for predictive modeling: the training cohort (n = 140) and the validation cohort (n = 59). Prediction models were developed with both ensemble machine learning methods (EL model) and multivariate logistic regression (LR model) using body composition parameters at the L3 cross-sectional level on CT, tumor radiomic, and clinical data. The efficiency of the models for predicting the risk of HDI was evaluated with discrimination, calibration and decision curves.

#### **RESULTS**

The EL model showed good discrimination between the HDI and HDS groups, with an area under the curve of (AUC) of 96.2 % (95 %CI: 93.5%-99.0%) in the training cohort, and an AUC of 93.7 % (95 %CI: 88.0%-99.4 %) in the validation cohort. And the AUC values from the EL model were significantly higher than the LR model. Favorable calibration performance and clinical applicability of the EL model were observed using calibration and decision curve analysis.

#### **CONCLUSION**

The EL model combining preoperative CT-based body composition, tumor radiomics and clinical data could potentially help predict individual intraoperative HDI in patients with PPGL.

#### **CLINICAL RELEVANCE/APPLICATION**

We developed an effective ensemble machine learning model incorporating preoperative radiomic features and body composition features based on clinically acquired CT images for predicting intraoperative HDI for patients with PPGL. In addition, our study showed that a machine learning model performed better than the multivariate logistic regression. Future prospective multicenter studies with a larger sample size will be needed to validate our study result and to optimize the prediction models for clinical practice.

### **T7-SSIN03- Open-Radiomics: A Research Protocol to Make Radiomics-based Machine Learning Pipelines Reproducible**

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

As an important branch of AI pipelines in medical imaging, Radiomics faces two major challenges namely reproducibility and accessibility. In this work, we introduce Open-Radiomics, a set of radiomics datasets along with a comprehensive radiomics pipeline to investigate the effects of radiomics feature extraction settings such as binWidth and image normalization on the reproducibility of the radiomics performance.

#### **METHODS AND MATERIALS**

We used the BraTS 2020 open-source Magnetic Resonance Imaging (MRI) dataset for brain tumor, which includes T1-weighted (T1), gadolinium-based contrast agent (GBCA) enhanced T1-weighted (T1CE), T2-weighted (T2), and T2 Fluid-Attenuated Inversion Recovery (FLAIR) sequences. The cohort includes 369 adult patients with brain tumors (76 low-grade glioma (LGG), and 293 high-grade glioma (HGG)). Using PyRadiomics library for LGG vs. HGG classification, we created 288 radiomics datasets; a combinations of 4 sequences, 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), 6 image normalization methods (NoNormalization, MinMax, ZScore, Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient), and 4 tumor subregions (Whole tumor, Necrotic (NCR) and the non-enhancing (NET) tumor core, peritumoral edematous/invaded tissue (ED), and active tumor (AT)). The radiomics datasets can be accessed at [www.openradiomics.org](http://www.openradiomics.org). We used Random Forest (RF) classifiers, and for each radiomics dataset, we repeated the train-validation-test (60/20/20) experiment with different data splits and model random states 100 times (28,800 test results) and calculated the Area Under Receiver Operating Characteristic Curve (AUC).

## **RESULTS**

BinWidth 15, no normalization, AT subregion, and T1CE resulted in the highest number of failures for PyRadiomics to extract the features. Unlike binWidth and image normalization, tumor subregion and imaging sequence significantly affected performance of the models. T1CE and the union of NCR and NET subregions resulted in the highest AUCs (average test AUC 0.951, 95% confidence interval of (0.949, 0.952)). Although few settings and data splits (28 out of 28800) yielded test AUC of 1, they were not reproducible.

## **CONCLUSION**

Our experiments demonstrate the sources of variability in radiomics pipelines (e.g., tumor subregion) can have a significant impact on the results, which may lead to superficial perfect performances that are irreproducible. A comprehensive set of experiments is required for a robust radiomics pipeline evaluation.

## **CLINICAL RELEVANCE/APPLICATION**

Radiomics is an established branch of quantitative research in radiology, and the proposed Open-Radiomics enhances the consistency and reproducibility of research projects in this field.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-SSIN03-2

### **Predicting Overall Survival of Patients with Melanoma and NSCLC Treated with Immunotherapy using AI Combining Total Tumor Volume and Tumor Heterogeneity on CT-Scans.**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N227B

Felix Wirth, MEng, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop a prognostic imaging signature based on tumor heterogeneity and tumor volume extracted from baseline thorax-abdomen-pelvis CT-scans in patients with melanoma and non-small cell lung cancer (NSCLC) treated with immunotherapy.

#### **METHODS AND MATERIALS**

This retrospective study included 607 patients treated from 2014 to 2019. Treatment baseline CT-scans were collected. All visible lesions were 2D-outlined on the largest diameter axial slice by two senior radiologists with double reading. The total tumor volume (TTV) was computed by adding estimated lesion volumes. Patients were randomly split into train, test and validation sets with a 56-14-30 ratio stratified by cancer type. Texture features were extracted using either radiomics or a neural network trained via self-supervised learning. Heterogeneity indexes were developed on the train set only, and hyperparameters were tuned on the test set. Two heterogeneity signatures were obtained using PCA followed by random survival forests fit to predict overall survival (OS): radiomics heterogeneity risk (RadH) and AI risk (AiH). These were combined with TTV using a Cox model to establish two imaging scores (TTV-RadH, TTV-AiH). Cut-offs were determined using maximally selected rank statistics on the train set. Two populations (low risk - high risk) were evaluated using Kaplan-Meier and Log-Rank tests. Correlations were studied using the Pearson correlation coefficient.

#### **RESULTS**

In total, 19877 lesions were annotated. The train, test and validation sets contained 339, 85 and 183 patients. Preliminary results were computed on the train and test sets. 1120 radiomics texture features were extracted per tumor. The neural network yielded 512 features per tumor. The cut-off for TTV was 102 cm<sup>3</sup>. On the test set, TTV-RadH low and high risk groups had median OS of 3.09 and 16.29 months, while TTV-AiH had median OS of 3.09 and 19.04 months. All Log-Rank tests were statistically significant ( $p < 0.001$ ). The correlation was strong between TTV and RadH ( $r = 0.67$ ), moderate between AiH and RadH ( $r = 0.40$ ), and weak between TTV and AiH ( $r = 0.27$ ).

#### **CONCLUSION**

This study aimed to develop new prognostic imaging signatures based on baseline CT-scans. These combine both total tumor volume and heterogeneity indexes, extracted using radiomics or a novel method based on self-supervised learning. These methods were able to predict survival of cancer patients treated with immunotherapy in both train and test sets. RadH was more correlated than AiH with volume.

#### **CLINICAL RELEVANCE/APPLICATION**

Using total tumor volume and AI tumor heterogeneity from CT scans, it may be possible to predict the prognosis of oncology patients, identify those who could benefit from immunotherapy, and provide valuable guidance for treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSIN03-3

### Radiomics-Based Machine Learning Models in Bladder Cancer: Predicting p53 Mutation

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N227B

Okan Ince, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to develop and assess the performance of machine learning models for predicting tumor protein p53 mutation status in bladder cancers using CT-based radiomics, with the potential to enhance personalized treatment strategies.

#### METHODS AND MATERIALS

Computed tomography urography (CTU) images of patients with and without p53 mutation were obtained from a public database. Tumors were semi-automatically segmented from CTU images. Following image preprocessing, a comprehensive set of radiomic features were extracted from original, Laplacian of Gaussian, and wavelet-filtered images. The feature selection process was conducted in three steps to optimize model performance. First, student's t-test was performed to each feature, second, features with high collinearity based on Pearson's correlation coefficient were eliminated. Last, a wrapper-based sequential feature selection algorithm was implemented. Multi-Layer Perceptron (MLP) and Support Vector Machine (SVM) classifiers were developed. Performance metrics were calculated using ten-fold cross-validation technique.

#### RESULTS

67 patients were included in the study (32 with p53 mutation and 35 without). Both SVM and MLP models demonstrated 95% of accuracy in classifying patients based on p53 mutation status. For SVM, sensitivity, specificity, area under curve (AUC), precision, recall, and F1 scores were 91%, 91%, 90%, 91%, 91%, and 91%, respectively. And for MLP the scores were 96%, 86%, 85%, 86%, 97%, and 91%, respectively.

#### CONCLUSION

The machine learning models utilizing radiomics features derived from CT images exhibit great potential for accurately predicting p53 mutation status in bladder cancer. These models may contribute to improved patient stratification and personalized treatment planning.

#### CLINICAL RELEVANCE/APPLICATION

Accurate prediction of p53 mutation status may facilitate personalized bladder cancer treatment, potentially improving patient outcomes and resource utilization.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSIN03-4

### **Risk of Bias in Chest X-Ray Radiomics Models: Looking Beyond Neural Networks**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N227B

Hadiseh Kavandi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Deep learning (DL) neural networks have shown a risk of bias by being able to predict demographics like self-reported race on chest x-rays (CXR). We evaluated if CXR radiomics models have similar ability to predict demographics and, therefore, similar risk of demographic bias.

#### **METHODS AND MATERIALS**

Our datasets comprised 25,565 and 29,453 randomly-chosen frontal CXRs from the NIH CXR14 and CheXpert datasets, respectively, which were divided into 80/15/5% training/validation/test splits. Each CXR was preprocessed by segmenting the heart, right and left lungs, and spine using a previously-validated U-Net model. For each anatomical segmentation, 116 radiomics features were extracted, including first-order statistics and shape-based features. A multilayer perceptron model was trained and tested using radiomics features from a) all 4 anatomical segmentations and b) each individual anatomical segmentation to predict patient age, sex, and self-reported race. Model performance was evaluated using AUROC for sex and race, and Pearson correlation coefficient (PCC) for age.

#### **RESULTS**

The models combining radiomics features from all 4 anatomical segmentations had the highest performance for all demographic categories and test sets, with AUROCs of 0.94-0.95 for sex, 0.73-0.79 for race, and 0.76-0.78 PCC for age. For single-anatomical region radiomics models, right and left lung models had the best performance for sex prediction (AUROCs 0.85-0.91), left lung for race prediction (AUROCs 0.69-0.71), and left lung and heart for age (PCC 0.65).

#### **CONCLUSION**

Similar to DL neural networks, radiomics CXR models demonstrate similar encoding of demographic characteristics of age, sex, and race, which raises concerns about risks of bias in these models. Further study is needed to understand the mechanisms of demographic prediction in radiomics models and their impact on subsequent biases in disease prediction in order to facilitate the safe and equitable development of these potentially game-changing technologies.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiomic features encode demographic characteristics that may contribute to bias in diagnostic classifications, confirming that these concerns about bias extend beyond deep learning neural networks.

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## Abstract Archives of the RSNA, 2023

T7-SSIN03-5

### Ensemble Machine Learning Model Incorporating Radiomics and Body Composition for Predicting Intraoperative HDI in PPGL

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N227B

Xiaoping Yi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Intraoperative hemodynamic instability (HDI) can lead to cardiovascular and cerebrovascular complications during surgery for pheochromocytoma and paraganglioma (PPGL). Assessing the risk of intraoperative HDI in patients with PPGL could help to improve surgical outcome.

#### METHODS AND MATERIALS

A total of 199 consecutive patients with PPGL confirmed by surgical pathology were retrospectively included in this study. This cohort was separated into two groups according to intraoperative systolic blood pressure, the HDI group (n = 101) and the hemodynamic stability group (HDS group, n = 98). It was also divided into two sub cohorts for predictive modeling: the training cohort (n = 140) and the validation cohort (n = 59). Prediction models were developed with both ensemble machine learning methods (EL model) and multivariate logistic regression (LR model) using body composition parameters at the L3 cross-sectional level on CT, tumor radiomic, and clinical data. The efficiency of the models for predicting the risk of HDI was evaluated with discrimination, calibration and decision curves.

#### RESULTS

The EL model showed good discrimination between the HDI and HDS groups, with an area under the curve of (AUC) of 96.2 % (95 %CI: 93.5%-99.0%) in the training cohort, and an AUC of 93.7 % (95 %CI: 88.0%-99.4 %) in the validation cohort. And the AUC values from the EL model were significantly higher than the LR model. Favorable calibration performance and clinical applicability of the EL model were observed using calibration and decision curve analysis.

#### CONCLUSION

The EL model combining preoperative CT-based body composition, tumor radiomics and clinical data could potentially help predict individual intraoperative HDI in patients with PPGL.

#### CLINICAL RELEVANCE/APPLICATION

We developed an effective ensemble machine learning model incorporating preoperative radiomic features and body composition features based on clinically acquired CT images for predicting intraoperative HDI for patients with PPGL. In addition, our study showed that a machine learning model performed better than the multivariate logistic regression. Future prospective multicenter studies with a larger sample size will be needed to validate our study result and to optimize the prediction models for clinical practice.

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## Abstract Archives of the RSNA, 2023

T7-SSIN03-6

### Open-Radiomics: A Research Protocol to Make Radiomics-based Machine Learning Pipelines Reproducible

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N227B

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

As an important branch of AI pipelines in medical imaging, Radiomics faces two major challenges namely reproducibility and accessibility. In this work, we introduce Open-Radiomics, a set of radiomics datasets along with a comprehensive radiomics pipeline to investigate the effects of radiomics feature extraction settings such as binWidth and image normalization on the reproducibility of the radiomics performance.

#### METHODS AND MATERIALS

We used the BraTS 2020 open-source Magnetic Resonance Imaging (MRI) dataset for brain tumor, which includes T1-weighted (T1), gadolinium-based contrast agent (GBCA) enhanced T1-weighted (T1CE), T2-weighted (T2), and T2 Fluid-Attenuated Inversion Recovery (FLAIR) sequences. The cohort includes 369 adult patients with brain tumors (76 low-grade glioma (LGG), and 293 high-grade glioma (HGG)). Using PyRadiomics library for LGG vs. HGG classification, we created 288 radiomics datasets; a combinations of 4 sequences, 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), 6 image normalization methods (NoNormalization, MinMax, ZScore, Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient), and 4 tumor subregions (Whole tumor, Necrotic (NCR) and the non-enhancing (NET) tumor core, peritumoral edematous/invaded tissue (ED), and active tumor (AT)). The radiomics datasets can be accessed at [www.openradiomics.org](http://www.openradiomics.org). We used Random Forest (RF) classifiers, and for each radiomics dataset, we repeated the train-validation-test (60/20/20) experiment with different data splits and model random states 100 times (28,800 test results) and calculated the Area Under Receiver Operating Characteristic Curve (AUC).

#### RESULTS

BinWidth 15, no normalization, AT subregion, and T1CE resulted in the highest number of failures for PyRadiomics to extract the features. Unlike binWidth and image normalization, tumor subregion and imaging sequence significantly affected performance of the models. T1CE and the union of NCR and NET subregions resulted in the highest AUCs (average test AUC 0.951, 95% confidence interval of (0.949, 0.952)). Although few settings and data splits (28 out of 28800) yielded test AUC of 1, they were not reproducible.

#### CONCLUSION

Our experiments demonstrate the sources of variability in radiomics pipelines (e.g., tumor subregion) can have a significant impact on the results, which may lead to superficial perfect performances that are irreproducible. A comprehensive set of experiments is required for a robust radiomics pipeline evaluation.

#### CLINICAL RELEVANCE/APPLICATION

Radiomics is an established branch of quantitative research in radiology, and the proposed Open-Radiomics enhances the consistency and reproducibility of research projects in this field.

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## Abstract Archives of the RSNA, 2023

T7-SSIN04

### Imaging Informatics (Informatics and AI Tools to Optimize Radiology Workflows)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

Morgan P. McBee, MD (*Moderator*) Nothing to Disclose  
Maggie Chung, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### T7-SSIN04- Optimized Hanging Protocols and DICOM Metadata Harmonization Using Pixel-Based Deep- 1 Learning Models

Thomas C. Arnold, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Hanging protocols enhance radiology workflows by providing standardized image displays, thereby improving interpretation efficiency. However, hanging protocols are brittle rules-based systems that have difficulty with unreliable DICOM metadata and repeated scans, leading to display errors that reduce workflow efficiency. To improve optimal image selection, we augment hanging protocols with three pixel-based, deep learning (DL) algorithms that classify MRI sequence type, image quality, and anatomical coverage.

#### METHODS AND MATERIALS

We analyzed 90 brain MRI cases (752 total images) that were acquired from multiple imaging centers. All images were classified according to sequence type by a medical imaging expert (PG, PhD: 16 years of experience). We applied three DL based algorithms to classify each image's sequence type, image quality, and anatomical coverage (Fig. 1A). We then compared two hanging protocols that selected 6 images for display, one following a simple rules-based algorithm and the other which was augmented with the DL algorithm outputs. For repeat scans, the DL-augmented protocol only retained the image with the highest quality score. Images with poor quality or anatomical coverage were also removed. Ranked similarity measures (i.e. Kendall's Tau for all images, rank-biased overlap (RBO) for top 6 only) were used to assess the impact of DL models on hanging protocol display image selection.

#### RESULTS

Out of 752 images, 31 (4.1%) were repeat scans (i.e. exact same sequence), 146 (19.4%) were duplicate scans (i.e. same sequence type and orientation), 105 (14.1%) had poor image quality, and 95 (12.6%) had poor anatomical coverage. Sequence classifier accuracy was 90.4% across all classes and 95.9% when considering T1 and T1c as the same class (Fig. 1B). After removal of repeat, low quality, and poor anatomical coverage scans, the final set contained 466 (62.0%) images. Similarity between hanging protocol image selection was compared using Kendall's Tau ( $0.69 \pm 0.29$ , Fig. 1C) and RBO ( $0.83 \pm 0.25$ , Fig. 1D). When ranking only the top 6 images for display, the hanging protocols differed in at least one image ranking for 65/90 (72.2%) cases. Figure 1E illustrates examples from repeated sequences where the DL-augmented hanging protocol would select the higher quality image.

#### CONCLUSION

Hanging protocols which operate using solely DICOM metadata frequently select nonoptimal images for display. DL algorithms can be used to clean metadata, screen out low quality images, and select the best available image when repeat scans are performed.

#### CLINICAL RELEVANCE/APPLICATION

Image-based DL algorithms can be used to improve the reliability of hanging protocols, thus preventing poor quality images from being displayed and improving radiologists' workflow.

## **T7-SSIN04- NLP for Classification of Digital Radiology Consultations Based on a Novel Taxonomy**

2

Tyler J. Geshay, BA, MD (*Presenter*) Stockholder, AbbVie Inc; Stockholder, Bausch Health Companies Inc.; Stockholder, Bristol-Myers Squibb Company; Stockholder, Gilead Sciences, Inc; Stockholder, Johnson & Johnson; Stockholder, Eli Lilly and Company; Stockholder, 3M Company; Stockholder, Pfizer Inc; Stockholder, The Procter & Gamble Company; Stockholder, Takeda Pharmaceutical Company Limited

### **PURPOSE**

Providing consultations is a key role of the radiologist, however consults are often informal and untracked. We created an electronic solution for ordering providers and technologists to submit consults resulting in a digital record of consults. This enables analysis and classification of consults. To this end we have created a taxonomy of radiology consultations and leveraged natural language processing (NLP) methods to automatically classify consults into taxonomy categories. Our hypothesis is that digitizing consultations allows for classification of consults to create a multilevel taxonomy which can then be automated using NLP for the purpose of optimizing consult routing and workflow.

### **METHODS AND MATERIALS**

The first 1079 digital consults were classified by a resident and reviewed by an attending. Digital consults are composed of the sender's name, question, and urgency. Consults were categorized based on the optimal endpoint, function requested from the endpoint (function), and consult type. For NLP analysis, we generated a term-frequency inverse document frequency feature vector for each consult. Extreme Gradient Boosting (XGBoost) models were developed using 5-fold cross validation to predict consult type and function categories with at least 10% representation in the data and the ROC AUC was calculated.

### **RESULTS**

Of 1079 consults, 1057 were analyzed, with the remaining excluded due to duplications, tests, and system misuse. Of these, 98% (1038/1051) were directed to the radiologist, while 2% (19/1057) would have been better directed to technologists and the film library. Consults requiring radiologist expertise included 45% (469/1051). Consults related to radiologist workflow (e.g. stat reads) occurred in 27% (288/1057). Consults from technologists requesting support (e.g. protocoling) resulted in 24% (252/1057). Using NLP automatic classification, "support", "expertise", and "radiologist workflow" function categories had a ROC AUC of 0.94, 0.90, and 0.58 respectively. Protocoling, review, and read expedite consult types had a ROC AUC of 0.98, 0.54, and 0.30 respectively.

### **CONCLUSION**

We have successfully created a multilevel taxonomy to classify digital radiology reading room consultations and trained NLP to perform the classification. In our sample, 45% of consultations requested radiologist expertise and 24% were from radiology technologists requesting support, NLP achieved a reasonable accuracy in classifying these functions.

### **CLINICAL RELEVANCE/APPLICATION**

By classifying consults at the point of submission, we can devise solutions to minimize radiologist disruption. For example, 27% of consults were workflow-related questions that can be automatically addressed through intelligent integrations.

## **T7-SSIN04- Impact on Radiologist Workflow Due to a Computer-Aided Triage and Notification (CADt) Device: A Case Study**

3

Jonathan K. Fergus, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To investigate the impact on radiologist workflow at a tertiary academic medical center due to a Computer-Aided Triage and Notification (CADt) device that prioritizes STAT Chest Computed Tomography (CT) and Chest CT Angiography (CTA) cases suspected with Pulmonary Embolism (PE).

### **METHODS AND MATERIALS**

Timestamp data and radiologist reports of Chest CT and CTA studies were retrospectively extracted from PACS and radiology report database (mPower, Nuance) between 2019 and 2022. Data was divided into two categories: before and after the CADt implementation. To study the wait-time-savings of the CADt device, the turnaround time for each study, as defined by the time between when the image enters PACS and when the first review was completed by a radiologist, was recorded. The pre-CADt and post-CADt turnaround time distributions were compared. Overall correlation coefficient between radiologists' diagnosis decisions and the CADt artificial intelligence (AI) predictions was calculated using post-CADt data; this was stratified by resident and staff to assess the potential differences in skill level. For each radiologist, the effective reading time is estimated using the inter-open time between two consecutive study-close timestamps from all cases reviewed by the radiologist. The aggregated effective reading times for positive and negative PE cases before and after CADt implementation were compared.



## RESULTS

Over 9,800 chest CT and CTA PE studies were collected, 40% of which were prior to the use of CADt. Over 70 radiologists were involved in those cases. The average pre-CADt and post-CADt turnaround times for positive PE studies are 50.4 min [95% range: 2.33, 230] and 43.9 min [2.0, 175] respectively. With post-CADt data, the case-level correlation coefficient between radiologists and CADt is 0.75. The radiologist-level correlation coefficients are 0.79 [0.51, 1.00] and 0.73 [0.39, 0.92] for residents and staff respectively. The average reading times for studies diagnosed with PE are 20.5 min [7.63, 69.6] pre-CADt and 17.1 min [5.05, 49.7] post-CADt. For negative PE cases, the effective reading times are 15.3 min [6.06, 44.3] and 14.3 min [7.09, 43.6] before and after the CADt device was adopted.

## CONCLUSION

Adoption of a CADt device at a tertiary academic medical center resulted in a slight decrease in turnaround time. Both resident and staff radiologists tend to agree with the CADt predictions, and the effective reading times do not seem to be significantly impacted by the use of CADt.

## CLINICAL RELEVANCE/APPLICATION

Radiological CADt devices use AI to process patient images and prioritize suspected findings. Our work investigated the real-world time-saving benefits a CADt may bring to a clinic and its potential impacts on radiologist's performance.

### **T7-SSIN04- Development and Evaluation of an Automated Protocol Recommendation System for Chest CT using Natural Language Processing with Clever Terminology Word Replacement**

Patrik Rogalla, MD, MBA (*Presenter*) Institutional Research Grant, Canon Medical Systems Corporation; Institutional Research Grant, KA Imaging

## PURPOSE

To evaluate the accuracy and clinical performance of a Natural Language Processing model with Machine Learning (NLP-ML) for automatic protocolling of chest CT imaging requests.

## METHODS AND MATERIALS

210,000 consecutive historical imaging requests for chest CT between 2018 and 2022 were extracted from a RIS database containing 16 associated patient information values, including the clinical history, requested imaging study, referring MD, and the free-text comment field. Protocols with <100 occurrences were removed, leaving 18 protocols. The fields containing free text (indication, comment) were merged into a single free-text field. The free-text was pre-processed (punctuation removed, stopwords removed, low-frequency words removed, highly co-occurring pairs of words were hyphenated, CLEVER terminology word replacements) and then used to create a bag-of-words model. The bag-of-words features were then used to train a multinomial logistic regression classifier with the 18 protocols as the class labels. Four readers (radiologists) protocollered 300 historical imaging requests (not used for training) based on all clinically available information. After their selection was made, the PRS selection and the clinically executed protocol (CP) were unblinded, and the readers were asked to rate the agreement (1=severe error, 2=moderate error, 3=disagreement but acceptable, 4=agreement) and given a chance to modify their selection. All 5 human responses (CP and 4 readers) were used to establish the best possible ground truth against which the PRS was compared. The accuracy of the PRS was also calculated against individual readers. The readers' protocolling reliability was measured using Fleiss' Kappa.

## RESULTS

For establishing the ground truth, 4 readers only agreed on 203/300 protocols, 3 readers agreed on 82/300 cases, and on 15 cases, the historical protocol (CP) was needed to break the tie. Severe PRS errors were found by the 4 readers in 3, 2, 3, and 2 cases, respectively. The accuracy of the PRS against the 4 individual readers and the ground truth for ratings (4)/(4 and 3 combined) was 71%/99%, 85%/97%, 86%/99%, 88%/99%, and 85%/98%, respectively. Only one reader changed their mind in 3 cases after unblinding the PRS result (1%). The Fleiss' Kappa for all readers and all protocols was 0.805.

## CONCLUSION

An automated protocolling recommendation system for chest CT achieves high clinical accuracy and may help reduce current variability in human protocolling. Ongoing training will be required to reduce the error rate of the PRS further.

## CLINICAL RELEVANCE/APPLICATION

An NLP-based automated protocolling system has the potential to improve quality and eliminate the time-consuming, repetitive task of protocolling incoming chest CT requests.

### **T7-SSIN04- Development of Clinical PACS Deployment Pipeline for Bi-parametric MRI (bpMRI) AI Algorithms in Prostate Imaging**

Jesse Tetreault, MS, BS (*Presenter*) Employee, NVIDIA Corporation



## PURPOSE

The purpose of this study was to integrate an AI-based prostate lesion segmentation and classification algorithm within a clinical PACS environment to enable point-of-care assessment under a prospective clinical trial scenario.

## METHODS AND MATERIALS

A dedicated deployment server was installed within the firewall of our institution's Radiology department: Intel® Xeon CPU E5-2667v3 3.2GHz (32 cores), x84-64bit Linux/GNU, and two T4 NVIDIA GPUs. A previously validated AI model for detection and segmentation of intra-prostatic lesions on bpMRI using axial T2W and diffusion-weighted (ADC, high b-value) was converted for deployment within NVIDIA Clara Deploy SDK. Components included a DICOM Service Class Provider (SCP) that receives DICOM images pushed from PACS (Philips/Carestream Vue PACS, v12.2) under Application Entity (AE) Titles specifically associated to each inference pipeline, which triggers separate operators for series selection, organ segmentation, lesion segmentation, and lesion PIRADSV2classification. The resulting output files of the pipeline included both organ and lesion segmentation masks, a DICOM-wrapped PDF report with computed lesion information, and STL files embedded in DICOM private tags for 3D visualization. All patients prospectively enrolling to clinical trial from Aug 31- Oct 1, 2022 and undergoing routine mpMRI for clinical assessment or suspicion of localized prostate cancer were prospectively evaluated by AI algorithm within PACS system and independently read by an expert radiologist.

## RESULTS

During the study interval, 72 patients were prospectively consented and enrolled to protocol enabling clinical AI deployment. Diagnostic axial T2W, ADC, and high b-value (1500 or 2000) series were selected in PACS and pushed by a radiologist to deployment server, and results were received back to PACS, viewable to the user as "For Research Purposes Only". 2/72 studies failed to complete pipeline due to incompatible DICOM series selection (incorrect DWI). In 70 successfully deployments, average time for pipeline completion was <2min. Compared to expert radiologist, detection sensitivity was 54.9% (45/82) for any radiologist-identified lesion and 75.6% (31/41) for PIRADSV2.1 >3. Penalty was 1 (range 1-3) false positive per study.

## CONCLUSION

In a prospective clinical trial, real-time deployment of an AI-based prostate segmentation model was achieved within the clinical radiology environment, utilizing a publicly-available platform on a dedicated inference server.

## CLINICAL RELEVANCE/APPLICATION

High quality segmentation results, comparable to off-line results, were obtained within the PACS environment within two minutes of activation, delivering point-of-care AI solutions.

## T7-SSIN04- Postproduction Monitoring Infrastructure for Radiology AI: A Use Case

6

Panagiotis Korfiatis, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

As AI applications become available in radiology, there is a need for automated, timely and efficient post-production monitoring to ensure patient safety and the ability to flag and address concerns or failures quickly. However, AI tools differ from traditional imaging applications, and they can face challenges such as drift and bias, and adoption issues among radiologists. It is important to establish post-production monitoring techniques that capture the value of AI in workflows, ensure the safety of patients and assure the AI tool is functioning as intended. Tools that enable the documentation of incident tracking and resolution must be available. Such information may also be required from regulatory bodies like the FDA.

## METHODS AND MATERIALS

Monitoring complex workflows requires the integration of multiple systems and data sources. In this study, we designed a database that is updated daily to capture performance related information from algorithm execution, DICOM metadata-related information, image routing, and user (i.e. Radiologists) interactions with the algorithm output (e.g. accept/reject). This database is enriched with demographic and clinical data associated with the patient to enable a complete view for monitoring bias, drift, and overall performance. To be able to interpret the information collected, custom dashboards and notifications based on predefined rules are needed.

## RESULTS

We deployed an analytic that automates the fusion of PET and CT images and used this infrastructure for post-production monitoring. Our dashboard allowed us to monitor the model's performance in terms of accepts and rejects and analyze this performance based on parameters that may affect it as well as processing times. The post-production 0.8% algorithm failure rate was lower than the predetermined 1.5% clinical failure rate requirement. Additionally, we provided FTE savings estimation as part of this dashboard (6.42 +- 1.23 hours/week). However, our infrastructure and clinical data sources did not allow for real-time monitoring. and multiple dashboards may be needed depending on audience.

## **CONCLUSION**

This study shows the importance of establishing post-production monitoring techniques to ensure the safety of patients and evaluate the value added in real life workflows. By using a database to capture information and tools to interpret it, we can create dashboards and notifications, record incident tracking, and estimate FTE savings in an automated way. Further infrastructure work is needed to add real-time monitoring and customize the dashboard for different audiences.

## **CLINICAL RELEVANCE/APPLICATION**

Efficient infrastructure and postproduction monitoring processes are needed to capture the impact of the AI algorithm in real life workflows

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSIN04-1

### Optimized Hanging Protocols and DICOM Metadata Harmonization Using Pixel-Based Deep-Learning Models

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

Thomas C. Arnold, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Hanging protocols enhance radiology workflows by providing standardized image displays, thereby improving interpretation efficiency. However, hanging protocols are brittle rules-based systems that have difficulty with unreliable DICOM metadata and repeated scans, leading to display errors that reduce workflow efficiency. To improve optimal image selection, we augment hanging protocols with three pixel-based, deep learning (DL) algorithms that classify MRI sequence type, image quality, and anatomical coverage.

#### METHODS AND MATERIALS

We analyzed 90 brain MRI cases (752 total images) that were acquired from multiple imaging centers. All images were classified according to sequence type by a medical imaging expert (PG, PhD: 16 years of experience). We applied three DL based algorithms to classify each image's sequence type, image quality, and anatomical coverage (Fig. 1A). We then compared two hanging protocols that selected 6 images for display, one following a simple rules-based algorithm and the other which was augmented with the DL algorithm outputs. For repeat scans, the DL-augmented protocol only retained the image with the highest quality score. Images with poor quality or anatomical coverage were also removed. Ranked similarity measures (i.e. Kendall's Tau for all images, rank-biased overlap (RBO) for top 6 only) were used to assess the impact of DL models on hanging protocol display image selection.

#### RESULTS

Out of 752 images, 31 (4.1%) were repeat scans (i.e. exact same sequence), 146 (19.4%) were duplicate scans (i.e. same sequence type and orientation), 105 (14.1%) had poor image quality, and 95 (12.6%) had poor anatomical coverage. Sequence classifier accuracy was 90.4% across all classes and 95.9% when considering T1 and T1c as the same class (Fig. 1B). After removal of repeat, low quality, and poor anatomical coverage scans, the final set contained 466 (62.0%) images. Similarity between hanging protocol image selection was compared using Kendall's Tau ( $0.69 \pm 0.29$ , Fig. 1C) and RBO ( $0.83 \pm 0.25$ , Fig. 1D). When ranking only the top 6 images for display, the hanging protocols differed in at least one image ranking for 65/90 (72.2%) cases. Figure 1E illustrates examples from repeated sequences where the DL-augmented hanging protocol would select the higher quality image.

#### CONCLUSION

Hanging protocols which operate using solely DICOM metadata frequently select nonoptimal images for display. DL algorithms can be used to clean metadata, screen out low quality images, and select the best available image when repeat scans are performed.

#### CLINICAL RELEVANCE/APPLICATION

Image-based DL algorithms can be used to improve the reliability of hanging protocols, thus preventing poor quality images from being displayed and improving radiologists' workflow.

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## Abstract Archives of the RSNA, 2023

T7-SSIN04-2

### NLP for Classification of Digital Radiology Consultations Based on a Novel Taxonomy

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

Tyler J. Geshay, BA, MD (*Presenter*) Stockholder, AbbVie Inc; Stockholder, Bausch Health Companies Inc.; Stockholder, Bristol-Myers Squibb Company; Stockholder, Gilead Sciences, Inc; Stockholder, Johnson & Johnson; Stockholder, Eli Lilly and Company; Stockholder, 3M Company; Stockholder, Pfizer Inc; Stockholder, The Procter & Gamble Company; Stockholder, Takeda Pharmaceutical Company Limited

#### PURPOSE

Providing consultations is a key role of the radiologist, however consults are often informal and untracked. We created an electronic solution for ordering providers and technologists to submit consults resulting in a digital record of consults. This enables analysis and classification of consults. To this end we have created a taxonomy of radiology consultations and leveraged natural language processing (NLP) methods to automatically classify consults into taxonomy categories. Our hypothesis is that digitizing consultations allows for classification of consults to create a multilevel taxonomy which can then be automated using NLP for the purpose of optimizing consult routing and workflow.

#### METHODS AND MATERIALS

The first 1079 digital consults were classified by a resident and reviewed by an attending. Digital consults are composed of the sender's name, question, and urgency. Consults were categorized based on the optimal endpoint, function requested from the endpoint (function), and consult type. For NLP analysis, we generated a term-frequency inverse document frequency feature vector for each consult. Extreme Gradient Boosting (XGBoost) models were developed using 5-fold cross validation to predict consult type and function categories with at least 10% representation in the data and the ROC AUC was calculated.

#### RESULTS

Of 1079 consults, 1057 were analyzed, with the remaining excluded due to duplications, tests, and system misuse. Of these, 98% (1038/1051) were directed to the radiologist, while 2% (19/1057) would have been better directed to technologists and the film library. Consults requiring radiologist expertise included 45% (469/1051). Consults related to radiologist workflow (e.g. stat reads) occurred in 27% (288/1057). Consults from technologists requesting support (e.g. protocoling) resulted in 24% (252/1057). Using NLP automatic classification, "support", "expertise", and "radiologist workflow" function categories had a ROC AUC of 0.94, 0.90, and 0.58 respectively. Protocoling, review, and read expedite consult types had a ROC AUC of 0.98, 0.54, and 0.30 respectively.

#### CONCLUSION

We have successfully created a multilevel taxonomy to classify digital radiology reading room consultations and trained NLP to perform the classification. In our sample, 45% of consultations requested radiologist expertise and 24% were from radiology technologists requesting support, NLP achieved a reasonable accuracy in classifying these functions.

#### CLINICAL RELEVANCE/APPLICATION

By classifying consults at the point of submission, we can devise solutions to minimize radiologist disruption. For example, 27% of consults were workflow-related questions that can be automatically addressed through intelligent integrations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSIN04-3

### Impact on Radiologist Workflow Due to a Computer-Aided Triage and Notification (CADt) Device: A Case Study

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

Jonathan K. Fergus, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the impact on radiologist workflow at a tertiary academic medical center due to a Computer-Aided Triage and Notification (CADt) device that prioritizes STAT Chest Computed Tomography (CT) and Chest CT Angiography (CTA) cases suspected with Pulmonary Embolism (PE).

#### METHODS AND MATERIALS

Timestamp data and radiologist reports of Chest CT and CTA studies were retrospectively extracted from PACS and radiology report database (mPower, Nuance) between 2019 and 2022. Data was divided into two categories: before and after the CADt implementation. To study the wait-time-savings of the CADt device, the turnaround time for each study, as defined by the time between when the image enters PACS and when the first review was completed by a radiologist, was recorded. The pre-CADt and post-CADt turnaround time distributions were compared. Overall correlation coefficient between radiologists' diagnosis decisions and the CADt artificial intelligence (AI) predictions was calculated using post-CADt data; this was stratified by resident and staff to assess the potential differences in skill level. For each radiologist, the effective reading time is estimated using the inter-open time between two consecutive study-close timestamps from all cases reviewed by the radiologist. The aggregated effective reading times for positive and negative PE cases before and after CADt implementation were compared.

#### RESULTS

Over 9,800 chest CT and CTA PE studies were collected, 40% of which were prior to the use of CADt. Over 70 radiologists were involved in those cases. The average pre-CADt and post-CADt turnaround times for positive PE studies are 50.4 min [95% range: 2.33, 230] and 43.9 min [2.0, 175] respectively. With post-CADt data, the case-level correlation coefficient between radiologists and CADt is 0.75. The radiologist-level correlation coefficients are 0.79 [0.51, 1.00] and 0.73 [0.39, 0.92] for residents and staff respectively. The average reading times for studies diagnosed with PE are 20.5 min [7.63, 69.6] pre-CADt and 17.1 min [5.05, 49.7] post-CADt. For negative PE cases, the effective reading times are 15.3 min [6.06, 44.3] and 14.3 min [7.09, 43.6] before and after the CADt device was adopted.

#### CONCLUSION

Adoption of a CADt device at a tertiary academic medical center resulted in a slight decrease in turnaround time. Both resident and staff radiologists tend to agree with the CADt predictions, and the effective reading times do not seem to be significantly impacted by the use of CADt.

#### CLINICAL RELEVANCE/APPLICATION

Radiological CADt devices use AI to process patient images and prioritize suspected findings. Our work investigated the real-world time-saving benefits a CADt may bring to a clinic and its potential impacts on radiologist's performance.

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## Abstract Archives of the RSNA, 2023

T7-SSIN04-4

### Development and Evaluation of an Automated Protocol Recommendation System for Chest CT using Natural Language Processing with Clever Terminology Word Replacement

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

Patrik Rogalla, MD, MBA (*Presenter*) Institutional Research Grant, Canon Medical Systems Corporation; Institutional Research Grant, KA Imaging

#### PURPOSE

To evaluate the accuracy and clinical performance of a Natural Language Processing model with Machine Learning (NLP-ML) for automatic protocolling of chest CT imaging requests.

#### METHODS AND MATERIALS

210,000 consecutive historical imaging requests for chest CT between 2018 and 2022 were extracted from a RIS database containing 16 associated patient information values, including the clinical history, requested imaging study, referring MD, and the free-text comment field. Protocols with <100 occurrences were removed, leaving 18 protocols. The fields containing free text (indication, comment) were merged into a single free-text field. The free-text was pre-processed (punctuation removed, stopwords removed, low-frequency words removed, highly co-occurring pairs of words were hyphenated, CLEVER terminology word replacements) and then used to create a bag-of-words model. The bag-of-words features were then used to train a multinomial logistic regression classifier with the 18 protocols as the class labels. Four readers (radiologists) protocollated 300 historical imaging requests (not used for training) based on all clinically available information. After their selection was made, the PRS selection and the clinically executed protocol (CP) were unblinded, and the readers were asked to rate the agreement (1=severe error, 2=moderate error, 3=disagreement but acceptable, 4=agreement) and given a chance to modify their selection. All 5 human responses (CP and 4 readers) were used to establish the best possible ground truth against which the PRS was compared. The accuracy of the PRS was also calculated against individual readers. The readers' protocolling reliability was measured using Fleiss' Kappa.

#### RESULTS

For establishing the ground truth, 4 readers only agreed on 203/300 protocols, 3 readers agreed on 82/300 cases, and on 15 cases, the historical protocol (CP) was needed to break the tie. Severe PRS errors were found by the 4 readers in 3, 2, 3, and 2 cases, respectively. The accuracy of the PRS against the 4 individual readers and the ground truth for ratings (4)/(4 and 3 combined) was 71%/99%, 85%/97%, 86%/99%, 88%/99%, and 85%/98%, respectively. Only one reader changed their mind in 3 cases after unblinding the PRS result (1%). The Fleiss' Kappa for all readers and all protocols was 0.805.

#### CONCLUSION

An automated protocolling recommendation system for chest CT achieves high clinical accuracy and may help reduce current variability in human protocolling. Ongoing training will be required to reduce the error rate of the PRS further.

#### CLINICAL RELEVANCE/APPLICATION

An NLP-based automated protocolling system has the potential to improve quality and eliminate the time-consuming, repetitive task of protocolling incoming chest CT requests.

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## Abstract Archives of the RSNA, 2023

T7-SSIN04-5

### Development of Clinical PACS Deployment Pipeline for Bi-parametric MRI (bpMRI) AI Algorithms in Prostate Imaging

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

Jesse Tetreault, MS, BS (*Presenter*) Employee, NVIDIA Corporation

#### PURPOSE

The purpose of this study was to integrate an AI-based prostate lesion segmentation and classification algorithm within a clinical PACS environment to enable point-of-care assessment under a prospective clinical trial scenario.

#### METHODS AND MATERIALS

A dedicated deployment server was installed within the firewall of our institution's Radiology department: Intel® Xeon CPU E5-2667v3 3.2GHz (32 cores), x84-64bit Linux/GNU, and two T4 NVIDIA GPUs. A previously validated AI model for detection and segmentation of intra-prostatic lesions on bpMRI using axial T2W and diffusion-weighted (ADC, high b-value) was converted for deployment within NVIDIA Clara Deploy SDK. Components included a DICOM Service Class Provider (SCP) that receives DICOM images pushed from PACS (Philips/Carestream Vue PACS, v12.2) under Application Entity (AE) Titles specifically associated to each inference pipeline, which triggers separate operators for series selection, organ segmentation, lesion segmentation, and lesion PIRADSV2classification. The resulting output files of the pipeline included both organ and lesion segmentation masks, a DICOM-wrapped PDF report with computed lesion information, and STL files embedded in DICOM private tags for 3D visualization. All patients prospectively enrolling to clinical trial from Aug 31- Oct 1, 2022 and undergoing routine mpMRI for clinical assessment or suspicion of localized prostate cancer were prospectively evaluated by AI algorithm within PACS system and independently read by an expert radiologist.

#### RESULTS

During the study interval, 72 patients were prospectively consented and enrolled to protocol enabling clinical AI deployment. Diagnostic axial T2W, ADC, and high b-value (1500 or 2000) series were selected in PACS and pushed by a radiologist to deployment server, and results were received back to PACS, viewable to the user as "For Research Purposes Only". 2/72 studies failed to complete pipeline due to incompatible DICOM series selection (incorrect DWI). In 70 successfully deployments, average time for pipeline completion was <2min. Compared to expert radiologist, detection sensitivity was 54.9% (45/82) for any radiologist-identified lesion and 75.6% (31/41) for PIRADSV2.1 >3. Penalty was 1 (range 1-3) false positive per study.

#### CONCLUSION

In a prospective clinical trial, real-time deployment of an AI-based prostate segmentation model was achieved within the clinical radiology environment, utilizing a publicly-available platform on a dedicated inference server.

#### CLINICAL RELEVANCE/APPLICATION

High quality segmentation results, comparable to off-line results, were obtained within the PACS environment within two minutes of activation, delivering point-of-care AI solutions.

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## Abstract Archives of the RSNA, 2023

T7-SSIN04-6

### Postproduction Monitoring Infrastructure for Radiology AI: A Use Case

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N228

Panagiotis Korfiatis, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

As AI applications become available in radiology, there is a need for automated, timely and efficient post-production monitoring to ensure patient safety and the ability to flag and address concerns or failures quickly. However, AI tools differ from traditional imaging applications, and they can face challenges such as drift and bias, and adoption issues among radiologists. It is important to establish post-production monitoring techniques that capture the value of AI in workflows, ensure the safety of patients and assure the AI tool is functioning as intended. Tools that enable the documentation of incident tracking and resolution must be available. Such information may also be required from regulatory bodies like the FDA.

#### METHODS AND MATERIALS

Monitoring complex workflows requires the integration of multiple systems and data sources. In this study, we designed a database that is updated daily to capture performance related information from algorithm execution, DICOM metadata-related information, image routing, and user (i.e. Radiologists) interactions with the algorithm output (e.g. accept/reject). This database is enriched with demographic and clinical data associated with the patient to enable a complete view for monitoring bias, drift, and overall performance. To be able to interpret the information collected, custom dashboards and notifications based on predefined rules are needed.

#### RESULTS

We deployed an analytic that automates the fusion of PET and CT images and used this infrastructure for post-production monitoring. Our dashboard allowed us to monitor the model's performance in terms of accepts and rejects and analyze this performance based on parameters that may affect it as well as processing times. The post-production 0.8% algorithm failure rate was lower than the predetermined 1.5% clinical failure rate requirement. Additionally, we provided FTE savings estimation as part of this dashboard (6.42 +/- 1.23 hours/week). However, our infrastructure and clinical data sources did not allow for real-time monitoring. and multiple dashboards may be needed depending on audience.

#### CONCLUSION

This study shows the importance of establishing post-production monitoring techniques to ensure the safety of patients and evaluate the value added in real life workflows. By using a database to capture information and tools to interpret it, we can create dashboards and notifications, record incident tracking, and estimate FTE savings in an automated way. Further infrastructure work is needed to add real-time monitoring and customize the dashboard for different audiences.

#### CLINICAL RELEVANCE/APPLICATION

Efficient infrastructure and postproduction monitoring processes are needed to capture the impact of the AI algorithm in real life workflows

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## Abstract Archives of the RSNA, 2023

T7-SSMK07

### Musculoskeletal Imaging (Ankle and Foot)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406B

Richard E. Walker, MD, FRCPC (*Moderator*) Nothing to Disclose  
Avneesh Chhabra, MD, MBA (*Moderator*) Consultant, ICON plc; Consultant, Treace Medical Concepts, Inc; Author with royalties, Wolters Kluwer nv; Author with royalties, Jaypee Brothers Medical Publishers Ltd; Speaker, Siemens AG; Medical Advisor, ImageBiopsy Lab; Research Grant, ImageBiopsy Lab

#### Sub-Events

#### **T7-SSMK07-1 Correlation of Neuromuscular Lesions on Ankle MRI to Patient Outcome Measurements in Diabetes Mellitus**

Brian Lue, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To identify and characterize trends and correlations of neuromuscular MRI findings on Ankle MRIs with patient outcomes in diabetic patients receiving ankle MRI studies and their nondiabetic counterparts.

#### **METHODS AND MATERIALS**

102 patients who received 110 ankle MRI studies at a single county hospital from November 1, 2019, to July 11, 2021, who met inclusion criteria were identified. Patients were divided into 2 cohorts: diabetic (n = 63) and non-diabetic (n = 39). Demographics and clinical data, including HgbA1c level, neuropathy diagnosis, presence of infection, number of hospital admissions related to the foot and ankle since MRI study, length of stay during admission for MRI, bone resection (amputation) since receiving MRI, number of repeat infections after MRI, and death, were collected. Abductor Hallucis (AH) ADC mean and minimum (min) values, Posterior Tibialis Nerve (PTN) ADC mean and minimum values, presence of AH muscle edema, distribution of the edema as patchy or diffuse, amount of muscle fatty infiltration, and standardized measurements of the cross-sectional area of the posterior, medial, and lateral tibial nerves were recorded blinded to clinical history (Figure). Spearman's rank correlation analyses were performed in R.

#### **RESULTS**

Presence of muscle edema, increasing muscle fatty infiltration, presence of increased T2 nerve signal and increased measured cross-sectional area of the PTN, as well as increased AH and PTN ADC (mean) values were significantly correlated (all  $p < 0.05$ , see Table) with increased number of hospital admissions, longer length of stays, and receiving bone resection (amputation) on follow-ups. Presence of muscle edema, increased muscle fatty infiltration, and increased AH ADC (mean and minimum) values were additionally significantly correlated (all  $p < 0.05$ , see Table) with death.

#### **CONCLUSION**

Neuromuscular alterations related to diabetes mellitus significantly correlated with worse clinical patient outcome measures.

#### **CLINICAL RELEVANCE/APPLICATION**

While reporting ankle MRI studies, neuromuscular signal and size alterations should be reported as they are worse prognostic factors in patients with diabetes mellitus.

#### **T7-SSMK07-3 Development of Screening AI in Ankle Stress Radiography to Reduce Workload**

Jiho Park, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ankle stress radiography is a diagnostic procedure for ligament instability. We trained an artificial intelligence (AI) model to screen negative ankle stress radiography and evaluate the agreement and workload change with and without AI.

## METHODS AND MATERIALS

Anterior draw test (ADT) and varus stress radiographs (VAR) of bilateral ankles were retrieved from one institution (2010-2022). Patients with fractures, metal devices, and severe ankylosis were excluded. A total of 2476 ADT and 2476 VAR images from 1238 patients (median age 49) were collected. Each image was labeled negative or positive for instability without AI assistance by reader 1 (expert radiologist), reader 2 (less experienced radiologist), and reader 3 (The actual radiology report by multiple readers). Readers 1 and 2 used measurements for labeling (positive when, anterior talar translation: >10mm, tibiotalar tilt angle: >9 degrees). To train a model with a high negative predictive value (NPV), the ground truth label was determined to be positive if either readers 1 or 2 assigned it as positive, or negative if both readers 1 and 2 assigned it as negative. After augmentation, 4142 ADT and 3848 VAR images were used to train 2 VGG16 models with 50 epochs. Weights from an epoch with the highest NPV were selected from the validation and tested on 247 ADT and 247 VAR images. To simulate an AI screening scenario, "AI-assisted readers 1, 2, 3" were defined as follows: For AI-negative predicted images, label as negative. For AI-positive predicted cases, use labels from readers 1, 2, 3. Cohen's kappa was computed for inter- and intra-readers between all readers and AI-assisted readers. Workload reduction percent was calculated as the number of AI-predicted negative images divided by the total number of images.

## RESULTS

The test set NPVs of the AI model alone were 0.9 and 0.98 for ADT and VAR. The intra-reader agreements between with and without AI assistance (Readers 1, 2, 3 vs. AI-assisted readers 1, 2, 3) were moderate in ADT and near perfect in VAR for all three readers. These intra-reader agreements were equivalent to or higher than the inter-reader agreements without AI in ADT and VAR for all three readers, except for reader 1 in ADT. AI assistance also improved the inter-reader agreements, especially between reader 3 and the other two readers. The workload was reduced by 79.4% in ADT and 75.3% in VAR (382 out of 494 were automatically reported as negative in AI-assisted scenario).

## CONCLUSION

The workload was reduced by 75% using AI screening, with comparable agreements between human-only and AI-assisted human labels, and reduction in inter-reader agreements.

## CLINICAL RELEVANCE/APPLICATION

AI screening can reduce workload and improve inter-reader agreements of radiologists in ankle stress radiography.

## T7-SSMK07-4 Dual-Energy CT-based Collagen Mapping for the Assessment of the Distal Tibiofibular Syndesmosis in Patients with Acute Trauma

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

## PURPOSE

To evaluate the diagnostic accuracy of third-generation dual-source dual-energy CT (DECT) color-coded collagen reconstructions for the assessment of the integrity of the distal tibiofibular syndesmosis (DTFS).

## METHODS AND MATERIALS

Patients were included in this retrospective study if they underwent third-generation dual-source DECT followed by 3T-MRI or ankle joint surgery within 14 days between January 2016 and December 2021. Three radiologists blinded to all patient data independently evaluated grayscale images and, after 8 weeks, grayscale and collagen mapping images for the presence of injury to the DTFS. MRI and surgery provided the reference standard.

## RESULTS

49 patients (median age, 49 years; 32 male) were evaluated. Application of collagen mapping significantly increased sensitivity (25/30 [83%] vs. 20/30 [67%]), specificity (110/118 [93%] vs. 70/118 [60%]), PPV (25/33 [76%] vs. 20/67 [30%]), NPV (110/115 [96%] vs. 70/80 [88%]) and accuracy (134/147 [91%] vs. 90/147 [61%]) for the detection of injury to the DTFS (all parameters,  $p < .001$ ). Collagen mapping achieved higher diagnostic confidence, image quality, and noise scores compared to grayscale CT (all parameters,  $p < .001$ ).

## CONCLUSION

Collagen mapping yields substantially higher diagnostic accuracy and confidence for assessing the integrity of the distal tibiofibular syndesmosis compared to grayscale CT in patients with acute trauma.

## CLINICAL RELEVANCE/APPLICATION

By visualization of the distal tibiofibular syndesmosis from routine CT examinations, radiologists can assess the extent of ligamentous injury in patients with ankle trauma without supplementary MRI. This additional information can help to guide treatment decisions towards or away from surgery in an acute setting without the requirement for additional imaging.

## T7-SSMK07-5 Correlations between Elastic Modulus and Ultrashort Echo Time (UTE) Adiabatic T1p Relaxation Time (UTE-Adiab-T1p) in Achilles Tendons and Enteses

Jerban, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the correlations of ultrashort echo time (UTE) T1 relaxation time (UTE-T1) and adiabatic T1 $\rho$  relaxation time (UTE-Adiab-T1 $\rho$ ) with the indentation-based mechanical properties of Achilles tendons and entheses.

## METHODS AND MATERIALS

28 tendon-enthesis sections (4-6-mm thick sagittal cuts) from 11 donors (52 $\pm$ 18 yo) were imaged with UTE-T1 and UTE-Adiab-T1 $\rho$  sequences on a 3T clinical scanner (MR750, GE) in a knee coil. To measure UTE-T1, an actual flip angle imaging-variable flip angle (AFI-VFA) sequence (AFI: TE=0.032ms, TRs=20,100ms, FA=45 $^\circ$ ; VFA: TE=0.032ms, TR=20ms, FAs=5, 10, 20, 30 $^\circ$ ) (1) was performed. To measure UTE-Adiab-T1 $\rho$ , five 3D-UTE-Cones sequences with adiabatic T1 $\rho$  preparation were performed with the following parameters: TR=500 ms; FA=10 $^\circ$ , spin-locking time=0, 12, 24, 36, and 48ms (2). Field of view, matrix dimension, pixel size, slice thickness, and scan time were 11cm, 340 $\times$ 340, 0.8 $\times$ 0.8mm<sup>2</sup>, and 55 mins, respectively. The elastic modulus, E, of the specimens, was measured using a commercial indentation testing system (MACH-1, Biomomentum). Specimens were tested along 7-10 rows of points (distal to proximal, Fig1.A, B) depending on the size of the specimens. Points in each row were labeled as the enthesis, transition, or tensile tendon zones, based on the distance from the bone edge and the length of each row. Maximum load (Pmax) was used to calculate the Hayes elastic modulus (3). T1 and T1 $\rho$  were calculated in 3 $\times$ 3-pixel regions, centered at the indentation points. Single-component exponential fitting models were used to measure T1 and T1 $\rho$  relaxation times. Spearman's rank correlations were calculated between the mean MRI and mechanical properties.

## RESULTS

The mean and standard deviation of T1, T1 $\rho$ , Pmax, and E are presented in Fig1.C within the enthesis, transition, and tensile tendon zones, and where averaged for all points in each specimen. Elastic modulus showed a significant inverse correlation with T1 $\rho$  values (Fig.1 D-G) within the enthesis (R=-0.46), transition (R=-0.54), and tensile tendon (R=-0.61) zones, and where averaged for all points in each specimen (R=-0.49). UTE-MRI and E were significantly lower in the tensile tendon compared with the enthesis regions (11, 13, and 43% lower for T1 $\rho$ , T1, and E, respectively).

## CONCLUSION

UTE-Adiab-T1 $\rho$  showed significant correlations with the elastic modulus of Achilles tendons and entheses. This study highlights the potential of the UTE-Adiab-T1 $\rho$  technique for tendons and entheses evaluation.

## CLINICAL RELEVANCE/APPLICATION

An MRI-based technique capable of quantitative evaluation of tendons and entheses related to their mechanical properties can help in early diagnosis of tendinopathy and assessment of the efficacy of clinical studies on treatments for tendinopathy.

## T7- SSMK07-6 Identification of Transient Bone Marrow Edema of the Ankle and Foot: Diagnostic Accuracy of Dual-energy CT in Comparison to MRI

Giovanni Foti, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the diagnostic accuracy of dual-energy Computed Tomography (DECT) in identifying transient bone marrow edema (BME) of the ankle and foot in comparison to magnetic resonance imaging (MRI).

## METHODS AND MATERIALS

This prospective institutional review board-approved study included 120 consecutive patients (59 males and 61 females; mean age of 59.6, range 27-79 years) studied between January 2021 and December 2022. All patients underwent DECT (80 kV and tin filter 150 kV) and MRI within 7 days. DECT data were postprocessed on a dedicated offline workstation by using a three-material decomposition algorithm for generating VNCA images of the ankle. Four radiologists (21, 16, 13 and 5 years of experience, respectively), blinded to MRI, evaluated the presence of BME on DECT images. MRI images served as standard of reference (consensus reading of two additional experienced MSK radiologists). Diagnostic accuracy values of DECT images (qualitative assessment) were calculated on a per-patient basis using a multi-reader multi-case analysis. DECT numbers (quantitative assessment) were assessed and analyzed by using receiver operator curves (ROC) and relative area under the curve (AUC). Inter-observer agreement was calculated with Cohen k-index. Continuous and categorical variables were evaluated by using t test and  $\chi^2$  or Fisher exact test, as appropriate. A value of p<0.05 was considered statistically significant.

## RESULTS

MRI revealed the presence of bone marrow edema in 87/120 patients (72.5%). Sensitivity, specificity and overall accuracy of DECT were 91.9% (80/87), 90.9% (30/33) and 91.6% (110/120), and 94.3% (82/87), 87.9% (29/33) and 92.5% (111/120), as concerns the qualitative and the quantitative analysis, respectively. DECT numbers were significantly different between positive (mean - 12.2  $\pm$  26.7 HU) and negative cases (mean -54.2  $\pm$  31.9 HU) with a p value <0.001. The ROC

curve analysis revealed an AUC of 0.946 (95% confidence interval: 0.846-0.980). The inter-observer agreement was near perfect ( $k=0.82$ ).

#### **CONCLUSION**

DECT can accurately identify transient BME of the ankle and foot, with respect to MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

DECT represents a fast and reliable imaging tool for demonstration of transient bone marrow edema of the ankle and foot in non-traumatic patients with contraindications for MRI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSMK07-1

### Correlation of Neuromuscular Lesions on Ankle MRI to Patient Outcome Measurements in Diabetes Mellitus

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406B

Brian Lue, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify and characterize trends and correlations of neuromuscular MRI findings on Ankle MRIs with patient outcomes in diabetic patients receiving ankle MRI studies and their nondiabetic counterparts.

#### METHODS AND MATERIALS

102 patients who received 110 ankle MRI studies at a single county hospital from November 1, 2019, to July 11, 2021, who met inclusion criteria were identified. Patients were divided into 2 cohorts: diabetic ( $n = 63$ ) and non-diabetic ( $n = 39$ ). Demographics and clinical data, including HgbA1c level, neuropathy diagnosis, presence of infection, number of hospital admissions related to the foot and ankle since MRI study, length of stay during admission for MRI, bone resection (amputation) since receiving MRI, number of repeat infections after MRI, and death, were collected. Abductor Hallucis (AH) ADC mean and minimum (min) values, Posterior Tibialis Nerve (PTN) ADC mean and minimum values, presence of AH muscle edema, distribution of the edema as patchy or diffuse, amount of muscle fatty infiltration, and standardized measurements of the cross-sectional area of the posterior, medial, and lateral tibial nerves were recorded blinded to clinical history (Figure). Spearman's rank correlation analyses were performed in R.

#### RESULTS

Presence of muscle edema, increasing muscle fatty infiltration, presence of increased T2 nerve signal and increased measured cross-sectional area of the PTN, as well as increased AH and PTN ADC (mean) values were significantly correlated (all  $p < 0.05$ , see Table) with increased number of hospital admissions, longer length of stays, and receiving bone resection (amputation) on follow-ups. Presence of muscle edema, increased muscle fatty infiltration, and increased AH ADC (mean and minimum) values were additionally significantly correlated (all  $p < 0.05$ , see Table) with death.

#### CONCLUSION

Neuromuscular alterations related to diabetes mellitus significantly correlated with worse clinical patient outcome measures.

#### CLINICAL RELEVANCE/APPLICATION

While reporting ankle MRI studies, neuromuscular signal and size alterations should be reported as they are worse prognostic factors in patients with diabetes mellitus.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSMK07-3

### Development of Screening AI in Ankle Stress Radiography to Reduce Workload

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406B

Jiho Park, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ankle stress radiography is a diagnostic procedure for ligament instability. We trained an artificial intelligence (AI) model to screen negative ankle stress radiography and evaluate the agreement and workload change with and without AI.

#### METHODS AND MATERIALS

Anterior draw test (ADT) and varus stress radiographs (VAR) of bilateral ankles were retrieved from one institution (2010-2022). Patients with fractures, metal devices, and severe ankylosis were excluded. A total of 2476 ADT and 2476 VAR images from 1238 patients (median age 49) were collected. Each image was labeled negative or positive for instability without AI assistance by reader 1 (expert radiologist), reader 2 (less experienced radiologist), and reader 3 (The actual radiology report by multiple readers). Readers 1 and 2 used measurements for labeling (positive when, anterior talar translation: >10mm, tibiotalar tilt angle: >9 degrees). To train a model with a high negative predictive value (NPV), the ground truth label was determined to be positive if either readers 1 or 2 assigned it as positive, or negative if both readers 1 and 2 assigned it as negative. After augmentation, 4142 ADT and 3848 VAR images were used to train 2 VGG16 models with 50 epochs. Weights from an epoch with the highest NPV were selected from the validation and tested on 247 ADT and 247 VAR images. To simulate an AI screening scenario, "AI-assisted readers 1, 2, 3" were defined as follows: For AI-negative predicted images, label as negative. For AI-positive predicted cases, use labels from readers 1, 2, 3. Cohen's kappa was computed for inter- and intra-readers between all readers and AI-assisted readers. Workload reduction percent was calculated as the number of AI-predicted negative images divided by the total number of images.

#### RESULTS

The test set NPVs of the AI model alone were 0.9 and 0.98 for ADT and VAR. The intra-reader agreements between with and without AI assistance (Readers 1, 2, 3 vs. AI-assisted readers 1, 2, 3) were moderate in ADT and near perfect in VAR for all three readers. These intra-reader agreements were equivalent to or higher than the inter-reader agreements without AI in ADT and VAR for all three readers, except for reader 1 in ADT. AI assistance also improved the inter-reader agreements, especially between reader 3 and the other two readers. The workload was reduced by 79.4% in ADT and 75.3% in VAR (382 out of 494 were automatically reported as negative in AI-assisted scenario).

#### CONCLUSION

The workload was reduced by 75% using AI screening, with comparable agreements between human-only and AI-assisted human labels, and reduction in inter-reader agreements.

#### CLINICAL RELEVANCE/APPLICATION

AI screening can reduce workload and improve inter-reader agreements of radiologists in ankle stress radiography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSMK07-4

### Dual-Energy CT-based Collagen Mapping for the Assessment of the Distal Tibiofibular Syndesmosis in Patients with Acute Trauma

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406B

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

#### PURPOSE

To evaluate the diagnostic accuracy of third-generation dual-source dual-energy CT (DECT) color-coded collagen reconstructions for the assessment of the integrity of the distal tibiofibular syndesmosis (DTFS).

#### METHODS AND MATERIALS

Patients were included in this retrospective study if they underwent third-generation dual-source DECT followed by 3T-MRI or ankle joint surgery within 14 days between January 2016 and December 2021. Three radiologists blinded to all patient data independently evaluated grayscale images and, after 8 weeks, grayscale and collagen mapping images for the presence of injury to the DTFS. MRI and surgery provided the reference standard.

#### RESULTS

49 patients (median age, 49 years; 32 male) were evaluated. Application of collagen mapping significantly increased sensitivity (25/30 [83%] vs. 20/30 [67%]), specificity (110/118 [93%] vs. 70/118 [60%]), PPV (25/33 [76%] vs. 20/67 [30%]), NPV (110/115 [96%] vs. 70/80 [88%]) and accuracy (134/147 [91%] vs. 90/147 [61%]) for the detection of injury to the DTFS (all parameters,  $p < .001$ ). Collagen mapping achieved higher diagnostic confidence, image quality, and noise scores compared to grayscale CT (all parameters,  $p < .001$ ).

#### CONCLUSION

Collagen mapping yields substantially higher diagnostic accuracy and confidence for assessing the integrity of the distal tibiofibular syndesmosis compared to grayscale CT in patients with acute trauma.

#### CLINICAL RELEVANCE/APPLICATION

By visualization of the distal tibiofibular syndesmosis from routine CT examinations, radiologists can assess the extent of ligamentous injury in patients with ankle trauma without supplementary MRI. This additional information can help to guide treatment decisions towards or away from surgery in an acute setting without the requirement for additional imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSMK07-5

### Correlations between Elastic Modulus and Ultrashort Echo Time (UTE) Adiabatic T1 $\rho$ Relaxation Time (UTE-Adiab-T1 $\rho$ ) in Achilles Tendons and Entheses

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406B

Saeed Jerban, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the correlations of ultrashort echo time (UTE) T1 relaxation time (UTE-T1) and adiabatic T1 $\rho$  relaxation time (UTE-Adiab-T1 $\rho$ ) with the indentation-based mechanical properties of Achilles tendons and entheses.

#### METHODS AND MATERIALS

28 tendon-enthesis sections (4-6-mm thick sagittal cuts) from 11 donors (52 $\pm$ 18 yo) were imaged with UTE-T1 and UTE-Adiab-T1 $\rho$  sequences on a 3T clinical scanner (MR750, GE) in a knee coil. To measure UTE-T1, an actual flip angle imaging-variable flip angle (AFI-VFA) sequence (AFI: TE=0.032ms, TRs=20,100ms, FA=45 $^\circ$ ; VFA: TE=0.032ms, TR=20ms, FAs=5, 10, 20, 30 $^\circ$ ) (1) was performed. To measure UTE-Adiab-T1 $\rho$ , five 3D-UTE-Cones sequences with adiabatic T1 $\rho$  preparation were performed with the following parameters: TR=500 ms; FA=10 $^\circ$ , spin-locking time=0, 12, 24, 36, and 48ms (2). Field of view, matrix dimension, pixel size, slice thickness, and scan time were 11cm, 340 $\times$ 340, 0.8 $\times$ 0.8mm<sup>2</sup>, and 55 mins, respectively. The elastic modulus, E, of the specimens, was measured using a commercial indentation testing system (MACH-1, Biomomentum). Specimens were tested along 7-10 rows of points (distal to proximal, Fig1.A, B) depending on the size of the specimens. Points in each row were labeled as the enthesis, transition, or tensile tendon zones, based on the distance from the bone edge and the length of each row. Maximum load (Pmax) was used to calculate the Hayes elastic modulus (3). T1 and T1 $\rho$  were calculated in 3 $\times$ 3-pixel regions, centered at the indentation points. Single-component exponential fitting models were used to measure T1 and T1 $\rho$  relaxation times. Spearman's rank correlations were calculated between the mean MRI and mechanical properties.

#### RESULTS

The mean and standard deviation of T1, T1 $\rho$ , Pmax, and E are presented in Fig1.C within the enthesis, transition, and tensile tendon zones, and where averaged for all points in each specimen. Elastic modulus showed a significant inverse correlation with T1 $\rho$  values (Fig.1 D-G) within the enthesis (R=-0.46), transition (R=-0.54), and tensile tendon (R=-0.61) zones, and where averaged for all points in each specimen (R=-0.49). UTE-MRI and E were significantly lower in the tensile tendon compared with the enthesis regions (11, 13, and 43% lower for T1 $\rho$ , T1, and E, respectively).

#### CONCLUSION

UTE-Adiab-T1 $\rho$  showed significant correlations with the elastic modulus of Achilles tendons and entheses. This study highlights the potential of the UTE-Adiab-T1 $\rho$  technique for tendons and entheses evaluation.

#### CLINICAL RELEVANCE/APPLICATION

An MRI-based technique capable of quantitative evaluation of tendons and entheses related to their mechanical properties can help in early diagnosis of tendinopathy and assessment of the efficacy of clinical studies on treatments for tendinopathy.

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## Abstract Archives of the RSNA, 2023

T7-SSMK07-6

### Identification of Transient Bone Marrow Edema of the Ankle and Foot: Diagnostic Accuracy of Dual-energy CT in Comparison to MRI

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S406B

Giovanni Foti, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic accuracy of dual-energy Computed Tomography (DECT) in identifying transient bone marrow edema (BME) of the ankle and foot in comparison to magnetic resonance imaging (MRI).

#### METHODS AND MATERIALS

This prospective institutional review board-approved study included 120 consecutive patients (59 males and 61 females; mean age of 59.6, range 27-79 years) studied between January 2021 and December 2022. All patients underwent DECT (80 kV and tin filter 150 kV) and MRI within 7 days. DECT data were postprocessed on a dedicated offline workstation by using a three-material decomposition algorithm for generating VNCA images of the ankle. Four radiologists (21, 16, 13 and 5 years of experience, respectively), blinded to MRI, evaluated the presence of BME on DECT images. MRI images served as standard of reference (consensus reading of two additional experienced MSK radiologists). Diagnostic accuracy values of DECT images (qualitative assessment) were calculated on a per-patient basis using a multi-reader multi-case analysis. DECT numbers (quantitative assessment) were assessed and analyzed by using receiver operator curves (ROC) and relative area under the curve (AUC). Inter-observer agreement was calculated with Cohen k-index. Continuous and categorical variables were evaluated by using t test and  $\chi^2$  or Fisher exact test, as appropriate. A value of  $p < 0.05$  was considered statistically significant.

#### RESULTS

MRI revealed the presence of bone marrow edema in 87/120 patients (72.5%). Sensitivity, specificity and overall accuracy of DECT were 91.9% (80/87), 90.9% (30/33) and 91.6% (110/120), and 94.3% (82/87), 87.9% (29/33) and 92.5% (111/120), as concerns the qualitative and the quantitative analysis, respectively. DECT numbers were significantly different between positive (mean  $-12.2 \pm 26.7$  HU) and negative cases (mean  $-54.2 \pm 31.9$  HU) with a p value  $< 0.001$ . The ROC curve analysis revealed an AUC of 0.946 (95% confidence interval: 0.846-0.980). The inter-observer agreement was near perfect ( $k=0.82$ ).

#### CONCLUSION

DECT can accurately identify transient BME of the ankle and foot, with respect to MRI.

#### CLINICAL RELEVANCE/APPLICATION

DECT represents a fast and reliable imaging tool for demonstration of transient bone marrow edema of the ankle and foot in non-traumatic patients with contraindications for MRI.

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## Abstract Archives of the RSNA, 2023

T7-SSNPM02

### Noninterpretive Skills (Beyond Imaging) (Workforce Challenges in Radiology)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S501

Jay R. Parikh, MD, FRCPC (*Moderator*) Nothing to Disclose  
Matthew D. Bucknor, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

##### T7-SSNPM02-1 **Pink on Pink Aggression**

Ami Gokli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Female-to-female, or “pink on pink” aggression in the workplace has been studied in nursing and non-healthcare settings but has received less attention among physicians. This phenomenon describes behavior by a woman with higher power status, usually a more senior figure, that is intended to degrade, ridicule, or undermine the work of a woman with a lesser power status, and may impede the career goals of junior female radiologists. Senior women may or may not be aware of their role in perpetuating this behavior.

#### METHODS AND MATERIALS

An adapted version of a validated survey was developed and distributed electronically in October 2022 to all (1694) SPR members on the listserv including all genders. The 17-question survey included both multiple choice and free-text fields. Members were given two weeks to respond to the survey with two reminders electronically delivered prior to survey closing. Three questions addressed demographics, eleven questions addressed personal experience with POPA and three questions addressed potential causes and handling of POPA. Descriptive statistics are for analysis. Non-parametric statistics will be used to compare group responses.

#### RESULTS

Of 1694 SPR members surveyed, 199 responses were received (12% response rate) with 73% female, 27% male and 0.5% nonbinary. Respondents ranged from in-training to 21+ years in practice and ages 25-66+. Of all respondents, 47% (n=93) have personally been the recipient of POPA, and 68% (n=135) have witnessed it. Even more surprising, 36% (n=71) of respondents admit to exerting this behavior on other women. Most respondents agree that POPA is a phenomenon limited to a few people rather than being widespread or caused by many, however 39% (n=76) rank POPA as a middle or top cause of stress/tension related to their jobs, and 46% (n=88) noted that it had changed or affected their career path. 76 respondents included descriptions of POPA experiences and 109 had suggestions for solving problems related to POPA.

#### CONCLUSION

Female-to-female aggression is experienced by > 33% of female radiologists during their medical career and may negatively impact the careers of junior female radiologists. Characterizing the extent of this experience in our field will raise awareness and may help prevent or mitigate it.

#### CLINICAL RELEVANCE/APPLICATION

Characterizing the extent of this experience in our field will raise awareness and may help prevent or mitigate it. We would like to spread the word outside of pediatric radiology as well as discuss reasons for why this is happening and steps that can be taken in the future.

##### T7-SSNPM02-2 **Trends in wRVU Productivity for Diagnostic Radiology**

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Evaluate trends in the productivity of radiologists serving the US Medicare population overall, and by geographic region and state.

## METHODS AND MATERIALS

Fee-for-service imaging claims billed to Medicare by diagnostic radiologists from 2013 through 2019 were extracted from the CMS Physician and Other Supplier Public Use File. Imaging services per diagnostic radiologist and wRVUs per diagnostic radiologist were analyzed nationally, as well as by geographic region and state.

## RESULTS

Total imaging services performed in the Medicare population were stable from 90,061,276 in 2013 to 90,726,993 in 2019 (+665,717; + 0.7%). Number of radiologists slightly increased from 28,372 in 2013 to 29,947 in 2019 (+1,575; +5.5%). Total wRVUs produced markedly increased from 52,179,380 in 2013 to 63,276,980 in 2019 (+11,097,600; +21.3%). Average wRVU per exam increased from 0.58 in 2013 to 0.70 in 2019 (+0.12; +20.7%). Imaging services per diagnostic radiologist decreased from 3173.3 in 2013 to 3029.6 in 2019 (-144.7, -4.6%). wRVUs per diagnostic radiologist increased from 1839.1 in 2013 to 2113.0 (+273.9, +14.9%) in 2020. Similar increases were seen across most US regions, and wide variations were noted across US states.

## CONCLUSION

Growth in imaging wRVUs is significantly outpacing growth of radiologists and number of imaging services in the US Medicare population. A shift toward higher RVU examinations and significant geographic based variations in per radiologist productivity raise potential quality and workforce challenges, and concern for over- and underutilization.

## CLINICAL RELEVANCE/APPLICATION

Total imaging services are constant and the exchange of lower RVU services, such as radiography, for those of higher RVU, is resulting in increases in radiologist workload.

## T7-SSNPM02-3 Burnout of Radiologists in the United States: Current Status & Trends Over the Past Decade

Pedram Keshavarz, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to review studies that reported the burnout of practicing and training radiologists in the United States based on the Maslach Burnout Inventory-Human Services Survey (MBI-HSS).

## METHODS AND MATERIALS

A systematic search of PubMed, Web of Science, Scopus, Embase, and Google Scholar was performed based on PRISMA guidelines (February 18th, 2023). Random-effects proportion meta-analysis was conducted. The sensitivity analysis and meta-regression were used to explore the influence of categorical variables on heterogeneity. Cochrane's Q test and the I2 statistic were utilized to determine heterogeneity.

## RESULTS

Nine studies (15,135 participants), including 13,257 (87.6%) practicing radiologists with subspecialty training such as pediatric (1,453, 9.6%), musculoskeletal (1,248, 8.2%), cardiothoracic (874, 5.8%), breast (2,280, 15.1%), and interventional radiology (7,402, 48.9%), as well as residents/trainees (1,878, 12.4%), were included. The highest and lowest response rate was observed in musculoskeletal 40% (95% confidence interval [CI]:37-43%) and interventional radiologists 5% (95%CI:4-5%), respectively. Trainees including residents, had the highest rate of lack of personal accomplishment (PA) 58% (95%CI:51-65%). The lowest lack of PA with the highest emotional exhaustion (EE) was reported in breast imaging radiologists 9% (95%CI:6-12%) and 69% (95%CI:64-74%), respectively. The pooled proportion rate for depersonalization was high in the cardiothoracic 79% (95%CI:74-83%) followed by breast imaging 63% (95%CI:58-68%), and pediatric radiologists 61% (95%CI:56-66%), respectively. Having a partner, child, and debt level < \$200,000 was significantly positively associated with lower EE and higher PA, especially among R3 diagnostic or interventional radiology residents.

## CONCLUSION

Major problems such as emotional exhaustion and depersonalization are widespread among radiologists and trainees. Moreover, we observed that residents/trainees are a moderate burnout risk group with the highest rate of low personal accomplishment compared to other sub-cohorts.

## CLINICAL RELEVANCE/APPLICATION

The high rates of depersonalization and emotional exhaustion are warning signs for professional drop-out and/or retirement. Future cross-sectional studies are required that may impact the progression of burnout syndrome among radiologists. We recommend investigating interventions aimed at preventing and/or decreasing these common factors of burnout.

## **T7- Radiology Visa Policies Towards International Trainees**

**SSNPM02-4**

Neda Khalili, MD, MPH (*Presenter*) Nothing to Disclose

### **PURPOSE**

We sought to assess the visa policies of American radiology departments towards international trainees.

### **METHODS AND MATERIALS**

A survey of all radiology chairs of departments listed in the National Residency Match Program 2022 directory was created in Qualtrics and sent via an individual and anonymous link by email. The survey consisted of 14 questions regarding departmental and institutional policies regarding visas. Email reminders over a 6-week period were sent to improve survey completion. In this survey, residents, clinical fellows, and postdoctoral fellows were defined as trainees. The NRMP website was assessed to evaluate the results of the 2021-2022 radiology residency match.

### **RESULTS**

The survey response rate was 65% (115/177 chairs). Of the 103 chairs who knew their policies, 12 (11.7%) said they frequently and 24 (23.3%) said they sometimes offer H1B visas to trainees. Also, 67 (65.0%) said they rarely or never offer H1B visas to international trainees. Regarding J1 visas, 67/102 (65.7%) frequently or sometimes offer international trainees this visa, whereas 35/102 (34.3%) programs rarely or never offer J1 visas to trainees. Most programs (67.4%, 64/95) said that they currently have less than 5 trainees in their department that are on a visa and 10/95 (10.5%) programs have more than 12 trainees on visas. Of the 979 diagnostic radiology residency spots filled in 2021, 84 (8.6%) were filled by non-US international medical graduates (IMGs). The match success rate for non-US IMGs was 35.9% (84/234) in that same year. In 2022, 59 (5.9%) of the 996 matched residents were non-US IMGs. The match success rate for non-US IMGs was 41.5% (66/159) in 2022.

### **CONCLUSION**

While most programs (65.7%) offer J1 visas to international radiology trainees, 34.3% are reluctant to offer J1 visas to potential candidates despite the fact that they represent 5.9-8.6% of matched applicants in 2021-2022. H1B visas are only offered frequently or sometimes by 35% of departments. As more non-US IMGs apply for radiology residencies, the visas offered may be a determinant of programs' attractiveness.

### **CLINICAL RELEVANCE/APPLICATION**

The shortage of physician workforce in the US, exacerbated by the COVID-19 pandemic, is a workforce issue that needs to be addressed. Overcoming the bureaucratic difficulties, time and monetary expense, and lack of expertise in processing visa applications may allow departments to be able to recruit qualified IMGs.

## **T7- Demographics, Performance, and Visa Challenges Related to International Medical Graduates in Radiology Residencies: A Survey Study of Program Directors**

**SSNPM02-5**

Parisa Khoshpouri, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

The number of international medical graduates (IMG) in radiology residencies has varied year to year even as the number of candidates continues to grow. It is unclear from which countries the IMGs are arriving and what visas are being used to accommodate them.

### **METHODS AND MATERIALS**

We sent a survey to 195 program directors (PD) in diagnostic radiology (DR) inquiring about the number and nationality of IMG residents in their program, their attitudes about IMG candidates, the performance of their IMG trainees, and the visas that are offered.

### **RESULTS**

We received responses from 121 of 195 (62.1%) diagnostic radiology programs (121/149 = 81.2% of actionable emails). 80/121 (66.1%) had at least one IMG in their DR residency program and the countries of origin included India (36), Iran (30), Saudi Arabia (24), Egypt (16), Canada (14) Brazil (14) and Pakistan (9), as the most common. While most programs (76/104, 73.1%) offered J1 visas, 23/99 (23.2%) provided H-1B visas to trainees. IMG DR residents overall performed as well as American graduates, with an equal number of PDs saying IMGs performed better and worse than American graduates. PDs' issues with IMGs centered on visas: 1) expense, 2) lack of familiarity, 3) ECFMG regulations, and 4) time commitment in submitting paperwork.

## CONCLUSION

Most radiology IMG residents originate from India and Middle Eastern countries. Once enrolled, IMG residents perform similarly to US graduates. However, adding IMG candidates to the training program requires overcoming bureaucratic and monetary hurdles around visas.

## CLINICAL RELEVANCE/APPLICATION

Efficient visa processes are essential to addressing the visa-related barriers faced by international medical graduates seeking to join radiology residency programs, thereby enabling them to contribute to the healthcare workforce in the United States.

### T7- **Impact of Current Radiology Visa Policies on Recruitment of Faculty** SSNPM02-6

Nastaran Khalili, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

To determine the impact of visa policies of American Radiology Departments in the recruitment and retention of international faculty candidates.

## METHODS AND MATERIALS

We used Qualtrics to create a 14-question online survey regarding the visa policy of diagnostic radiology departments in the United States. The survey was sent to all chairpersons of departments that are listed in the National Residency Match Program 2022 directory. Email reminders were sent over a six-week period to maximize response rate.

## RESULTS

The response rate of our survey was 67% (115/171). Most respondents (72.3%, 73/101) stated that their visa policies were institutional rather than being individually set by departments (14.35%, 15/101). Another 10% indicated that their visa policy was determined by other entities such as state or government organizations. Overall, 40.0% (34/85 Chairs responding) of programs declared that their visa policy had resulted in the loss of existing faculty and/or difficulties in recruiting new faculty. However, 49.4% of programs (42/85) cited problems other than visas as the reason for not being able to hire international applicants; some Chairs cited obtaining medical state licensure as a more significant hurdle in hiring foreign faculty compared to visa policies. The organization that sets visa policy (departmental vs non-departmental) did not significantly differ based on whether the program was university-based or non-university-based (community, hybrid, private, etc.) ( $p=0.22$ ). Also, there was no meaningful difference between university versus non-university-based programs in terms of failing to retain international applicants ( $p=0.48$ ).

## CONCLUSION

The visa policies of Radiology departments have led to the loss of current or potential faculty in 40% of departments. However, Department Chairs may not be able to revise their policies because institutional statutes control the agenda in 72.3% of cases. This may constrain the ability to fill vacant faculty positions with international candidates.

## CLINICAL RELEVANCE/APPLICATION

Increasing diversity and inclusion in Radiology departments requires a multifaceted approach that includes revising visa policies, actively recruiting and retaining diverse faculty candidates, and fostering a culture of inclusion. By implementing these strategies, Radiology departments can promote a more diverse and inclusive academic community that is better equipped to meet the healthcare needs of an increasingly diverse patient population.

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## Abstract Archives of the RSNA, 2023

T7-SSNPM02-1

### Pink on Pink Aggression

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S501

Ami Gokli, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Female-to-female, or “pink on pink” aggression in the workplace has been studied in nursing and non-healthcare settings but has received less attention among physicians. This phenomenon describes behavior by a woman with higher power status, usually a more senior figure, that is intended to degrade, ridicule, or undermine the work of a woman with a lesser power status, and may impede the career goals of junior female radiologists. Senior women may or may not be aware of their role in perpetuating this behavior.

#### METHODS AND MATERIALS

An adapted version of a validated survey was developed and distributed electronically in October 2022 to all (1694) SPR members on the listserve including all genders. The 17-question survey included both multiple choice and free-text fields. Members were given two weeks to respond to the survey with two reminders electronically delivered prior to survey closing. Three questions addressed demographics, eleven questions addressed personal experience with POPA and three questions addressed potential causes and handling of POPA. Descriptive statistics are for analysis. Non-parametric statistics will be used to compare group responses.

#### RESULTS

Of 1694 SPR members surveyed, 199 responses were received (12% response rate) with 73% female, 27% male and 0.5% nonbinary. Respondents ranged from in-training to 21+ years in practice and ages 25-66+. Of all respondents, 47% (n=93) have personally been the recipient of POPA, and 68% (n=135) have witnessed it. Even more surprising, 36% (n=71) of respondents admit to exerting this behavior on other women. Most respondents agree that POPA is a phenomenon limited to a few people rather than being widespread or caused by many, however 39% (n=76) rank POPA as a middle or top cause of stress/tension related to their jobs, and 46% (n=88) noted that it had changed or affected their career path. 76 respondents included descriptions of POPA experiences and 109 had suggestions for solving problems related to POPA.

#### CONCLUSION

Female-to-female aggression is experienced by > 33% of female radiologists during their medical career and may negatively impact the careers of junior female radiologists. Characterizing the extent of this experience in our field will raise awareness and may help prevent or mitigate it.

#### CLINICAL RELEVANCE/APPLICATION

Characterizing the extent of this experience in our field will raise awareness and may help prevent or mitigate it. We would like to spread the word outside of pediatric radiology as well as discuss reasons for why this is happening and steps that can be taken in the future.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSNPM02-2

### Trends in wRVU Productivity for Diagnostic Radiology

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S501

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Evaluate trends in the productivity of radiologists serving the US Medicare population overall, and by geographic region and state.

#### METHODS AND MATERIALS

Fee-for-service imaging claims billed to Medicare by diagnostic radiologists from 2013 through 2019 were extracted from the CMS Physician and Other Supplier Public Use File. Imaging services per diagnostic radiologist and wRVUs per diagnostic radiologist were analyzed nationally, as well as by geographic region and state.

#### RESULTS

Total imaging services performed in the Medicare population were stable from 90,061,276 in 2013 to 90,726,993 in 2019 (+665,717; + 0.7%). Number of radiologists slightly increased from 28,372 in 2013 to 29,947 in 2019 (+1,575; +5.5%). Total wRVUs produced markedly increased from 52,179,380 in 2013 to 63,276,980 in 2019 (+11,097,600; +21.3%). Average wRVU per exam increased from 0.58 in 2013 to 0.70 in 2019 (+0.12; +20.7%). Imaging services per diagnostic radiologist decreased from 3173.3 in 2013 to 3029.6 in 2019 (-144.7, -4.6%). wRVUs per diagnostic radiologist increased from 1839.1 in 2013 to 2113.0 (+273.9, +14.9%) in 2020. Similar increases were seen across most US regions, and wide variations were noted across US states.

#### CONCLUSION

Growth in imaging wRVUs is significantly outpacing growth of radiologists and number of imaging services in the US Medicare population. A shift toward higher RVU examinations and significant geographic based variations in per radiologist productivity raise potential quality and workforce challenges, and concern for over- and underutilization.

#### CLINICAL RELEVANCE/APPLICATION

Total imaging services are constant and the exchange of lower RVU services, such as radiography, for those of higher RVU, is resulting in increases in radiologist workload.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSNPM02-3

### **Burnout of Radiologists in the United States: Current Status & Trends Over the Past Decade**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S501

Pedram Keshavarz, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to review studies that reported the burnout of practicing and training radiologists in the United States based on the Maslach Burnout Inventory-Human Services Survey (MBI-HSS).

#### **METHODS AND MATERIALS**

A systematic search of PubMed, Web of Science, Scopus, Embase, and Google Scholar was performed based on PRISMA guidelines (February 18th, 2023). Random-effects proportion meta-analysis was conducted. The sensitivity analysis and meta-regression were used to explore the influence of categorical variables on heterogeneity. Cochrane's Q test and the I<sup>2</sup> statistic were utilized to determine heterogeneity.

#### **RESULTS**

Nine studies (15,135 participants), including 13,257 (87.6%) practicing radiologists with subspecialty training such as pediatric (1,453, 9.6%), musculoskeletal (1,248, 8.2%), cardiothoracic (874, 5.8%), breast (2,280, 15.1%), and interventional radiology (7,402, 48.9%), as well as residents/trainees (1,878, 12.4%), were included. The highest and lowest response rate was observed in musculoskeletal 40% (95% confidence interval [CI]:37-43%) and interventional radiologists 5% (95%CI:4-5%), respectively. Trainees including residents, had the highest rate of lack of personal accomplishment (PA) 58% (95%CI:51-65%). The lowest lack of PA with the highest emotional exhaustion (EE) was reported in breast imaging radiologists 9% (95%CI:6-12%) and 69% (95%CI:64-74%), respectively. The pooled proportion rate for depersonalization was high in the cardiothoracic 79% (95%CI:74-83%) followed by breast imaging 63% (95%CI:58-68%), and pediatric radiologists 61% (95%CI:56-66%), respectively. Having a partner, child, and debt level < \$200,000 was significantly positively associated with lower EE and higher PA, especially among R3 diagnostic or interventional radiology residents.

#### **CONCLUSION**

Major problems such as emotional exhaustion and depersonalization are widespread among radiologists and trainees. Moreover, we observed that residents/trainees are a moderate burnout risk group with the highest rate of low personal accomplishment compared to other sub-cohorts.

#### **CLINICAL RELEVANCE/APPLICATION**

The high rates of depersonalization and emotional exhaustion are warning signs for professional drop-out and/or retirement. Future cross-sectional studies are required that may impact the progression of burnout syndrome among radiologists. We recommend investigating interventions aimed at preventing and/or decreasing these common factors of burnout.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-SSNPM02-4

### Radiology Visa Policies Towards International Trainees

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S501

Neda Khalili, MD, MPH (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We sought to assess the visa policies of American radiology departments towards international trainees.

#### **METHODS AND MATERIALS**

A survey of all radiology chairs of departments listed in the National Residency Match Program 2022 directory was created in Qualtrics and sent via an individual and anonymous link by email. The survey consisted of 14 questions regarding departmental and institutional policies regarding visas. Email reminders over a 6-week period were sent to improve survey completion. In this survey, residents, clinical fellows, and postdoctoral fellows were defined as trainees. The NRMP website was assessed to evaluate the results of the 2021-2022 radiology residency match.

#### **RESULTS**

The survey response rate was 65% (115/177 chairs). Of the 103 chairs who knew their policies, 12 (11.7%) said they frequently and 24 (23.3%) said they sometimes offer H1B visas to trainees. Also, 67 (65.0%) said they rarely or never offer H1B visas to international trainees. Regarding J1 visas, 67/102 (65.7%) frequently or sometimes offer international trainees this visa, whereas 35/102 (34.3%) programs rarely or never offer J1 visas to trainees. Most programs (67.4%, 64/95) said that they currently have less than 5 trainees in their department that are on a visa and 10/95 (10.5%) programs have more than 12 trainees on visas. Of the 979 diagnostic radiology residency spots filled in 2021, 84 (8.6%) were filled by non-US international medical graduates (IMGs). The match success rate for non-US IMGs was 35.9% (84/234) in that same year. In 2022, 59 (5.9%) of the 996 matched residents were non-US IMGs. The match success rate for non-US IMGs was 41.5% (66/159) in 2022.

#### **CONCLUSION**

While most programs (65.7%) offer J1 visas to international radiology trainees, 34.3% are reluctant to offer J1 visas to potential candidates despite the fact that they represent 5.9-8.6% of matched applicants in 2021-2022. H1B visas are only offered frequently or sometimes by 35% of departments. As more non-US IMGs apply for radiology residencies, the visas offered may be a determinant of programs' attractiveness.

#### **CLINICAL RELEVANCE/APPLICATION**

The shortage of physician workforce in the US, exacerbated by the COVID-19 pandemic, is a workforce issue that needs to be addressed. Overcoming the bureaucratic difficulties, time and monetary expense, and lack of expertise in processing visa applications may allow departments to be able to recruit qualified IMGs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSNPM02-5

### Demographics, Performance, and Visa Challenges Related to International Medical Graduates in Radiology Residencies: A Survey Study of Program Directors

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S501

Parisa Khoshpouri, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The number of international medical graduates (IMG) in radiology residencies has varied year to year even as the number of candidates continues to grow. It is unclear from which countries the IMGs are arriving and what visas are being used to accommodate them.

#### METHODS AND MATERIALS

We sent a survey to 195 program directors (PD) in diagnostic radiology (DR) inquiring about the number and nationality of IMG residents in their program, their attitudes about IMG candidates, the performance of their IMG trainees, and the visas that are offered.

#### RESULTS

We received responses from 121 of 195 (62.1%) diagnostic radiology programs (121/149 = 81.2% of actionable emails). 80/121 (66.1%) had at least one IMG in their DR residency program and the countries of origin included India (36), Iran (30), Saudi Arabia (24), Egypt (16), Canada (14) Brazil (14) and Pakistan (9), as the most common. While most programs (76/104, 73.1%) offered J1 visas, 23/99 (23.2%) provided H-1B visas to trainees. IMG DR residents overall performed as well as American graduates, with an equal number of PDs saying IMGs performed better and worse than American graduates. PDs' issues with IMGs centered on visas: 1) expense, 2) lack of familiarity, 3) ECFMG regulations, and 4) time commitment in submitting paperwork.

#### CONCLUSION

Most radiology IMG residents originate from India and Middle Eastern countries. Once enrolled, IMG residents perform similarly to US graduates. However, adding IMG candidates to the training program requires overcoming bureaucratic and monetary hurdles around visas.

#### CLINICAL RELEVANCE/APPLICATION

Efficient visa processes are essential to addressing the visa-related barriers faced by international medical graduates seeking to join radiology residency programs, thereby enabling them to contribute to the healthcare workforce in the United States.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSNPM02-6

### Impact of Current Radiology Visa Policies on Recruitment of Faculty

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S501

Nastaran Khalili, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the impact of visa policies of American Radiology Departments in the recruitment and retention of international faculty candidates.

#### METHODS AND MATERIALS

We used Qualtrics to create a 14-question online survey regarding the visa policy of diagnostic radiology departments in the United States. The survey was sent to all chairpersons of departments that are listed in the National Residency Match Program 2022 directory. Email reminders were sent over a six-week period to maximize response rate.

#### RESULTS

The response rate of our survey was 67% (115/171). Most respondents (72.3%, 73/101) stated that their visa policies were institutional rather than being individually set by departments (14.35%, 15/101). Another 10% indicated that their visa policy was determined by other entities such as state or government organizations. Overall, 40.0% (34/85 Chairs responding) of programs declared that their visa policy had resulted in the loss of existing faculty and/or difficulties in recruiting new faculty. However, 49.4% of programs (42/85) cited problems other than visas as the reason for not being able to hire international applicants; some Chairs cited obtaining medical state licensure as a more significant hurdle in hiring foreign faculty compared to visa policies. The organization that sets visa policy (departmental vs non-departmental) did not significantly differ based on whether the program was university-based or non-university-based (community, hybrid, private, etc.) ( $p=0.22$ ). Also, there was no meaningful difference between university versus non-university-based programs in terms of failing to retain international applicants ( $p=0.48$ ).

#### CONCLUSION

The visa policies of Radiology departments have led to the loss of current or potential faculty in 40% of departments. However, Department Chairs may not be able to revise their policies because institutional statutes control the agenda in 72.3% of cases. This may constrain the ability to fill vacant faculty positions with international candidates.

#### CLINICAL RELEVANCE/APPLICATION

Increasing diversity and inclusion in Radiology departments requires a multifaceted approach that includes revising visa policies, actively recruiting and retaining diverse faculty candidates, and fostering a culture of inclusion. By implementing these strategies, Radiology departments can promote a more diverse and inclusive academic community that is better equipped to meet the healthcare needs of an increasingly diverse patient population.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSPH09

### Science Session with Keynote: Physics (Dual-energy/Multi-energy CT)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N229

Lifeng Yu, PhD (*Moderator*) Nothing to Disclose  
Web W. Stayman, PhD (*Moderator*) Research Grant, Fischer Medical; Research Grant, General Electric Company; Research Grant, Canon Medical Systems Corporation; Research collaboration, Koninklijke Philips NV; Research collaboration, Siemens AG; Researcher, Varex Imaging Corporation

#### Sub-Events

### T7-SSPH09-Optimal Spectral Performance for Pediatric Imaging on Photon Counting CT: A Comparative Analysis of Different kVs<sup>1</sup>

Wei Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the spectral performance of kV options for pediatric body imaging on photon counting CT (PCCT), in terms of accuracy of quantification in iodine map (IM) and CT number in virtual monoenergetic images (VMIs).

#### METHODS AND MATERIALS

4 phantoms of variable sizes were included to represent abdomen of newborn, 5-year-old, 10-year-old, and adult size pediatric patients, respectively. 1 solid water and 4 solid iodine inserts (Gammex) were attached to or inserted into phantoms, with known concentration (2, 5, 10 and 15 mgI/cc) and reference CT number at variable keV levels. Each phantom setting was scanned on a PCCT system (Siemens Alpha) with 4 kV options (70, 90, 120 and 140kV) based on clinical pediatric abdominal protocol (dual source 3.0 pitch). For each phantom setting, radiation dose (CTDIvol) was determined by clinical settings and matched for all kV acquisitions of each size. 60% clinical dose level images were also acquired. Reconstruction was matched among all kVs using Qr40 and QIR level 3. Low- and high-energy images were reconstructed from each scan and used to generate IM using an image-based 2-material decomposition method. VMIs between 40 to 80keV with 10keV interval were generated. Root mean square error (RMSE) of iodine quantification from IM was compared among kVs, across phantom sizes. Percent error (PE) of iodine CT number accuracy in VMIs was compared among kVs, across phantom sizes.

#### RESULTS

Across all pediatric sizes, RMSE and PE are higher from low kV acquisitions (70, 90 kV) than high kV (120, 140 kV) on PCCT. For newborn size at full dose, RMSE is 1.80, 1.51, 1.28, 1.31 mgI/cc and average PE is 4.39%, 6.02%, 2.18%, 2.19%, when kV increases from 70 to 140 kV. For 5-year-old size at full dose, RMSE is 1.94, 1.67, 1.32, 1.38 mgI/cc and average PE is 4.72%, 6.19%, 2.99%, 1.74%, when kV increases from 70 to 140 kV. For 10-year-old size at full dose, RMSE is 1.86, 1.68, 1.40, 1.42 mgI/cc and average PE is 4.93%, 6.10%, 5.02%, 3.94%, when kV increases from 70 to 140 kV. For adult size at full dose, RMSE is 1.62, 2.34, 1.94, 1.77 mgI/cc and average PE is 21.76%, 4.50%, 3.61%, 2.45% when kV increases from 70 to 140 kV. At 60% dose level, the RMSE and PE are worse than full dose while comparisons across kVs are similar to full dose.

#### CONCLUSION

We showed 120 and 140kV outperformed 70 or 90kV across all pediatric body sizes in terms of spectral performance, indicating high kV is the optimal choice for pediatric PCCT spectral imaging.

#### CLINICAL RELEVANCE/APPLICATION

Selecting optimal kV for pediatric PCCT imaging is a crucial yet unresolved issue. Our study has showed, for the 1st time, that 120 and 140 kV on PCCT offer better spectral performance than commonly used lower kV, regardless of pediatric size. This finding provides valuable clinical guidance for pediatric PCCT imaging.

Timothy N. Winfree, BS, MS (*Presenter*) Nothing to Disclose

## **T7-SSPH09-Photon-counting-detector (PCD) CT versus Energy-integrating-detector (EID) CT for Coronary Artery Calcium Quantitation**

### **PURPOSE**

Photon-counting-detector (PCD) CT offers improved spatial and contrast resolution, which may improve quantitative measurements. This work aims to prospectively determine in human subjects the impact of dual-source PCD-CT on the quantitation of coronary artery calcification (CAC) compared to dual-source energy-integrating-detector (EID) CT in both 1- and 3-mm images.

### **METHODS AND MATERIALS**

In October 2022, this prospective study enrolled patients receiving a clinical EID-CT CAC exam to undergo a research PCD-CT CAC exam. Axial images were reconstructed with a 512x512 matrix, 200-mm field-of-view, 3-mm section thickness/1.5-mm interval using a quantitative kernel (Qr36). Sharper kernels (Qr56/QIR strength 4 for PCD and Qr49/ADMIRE strength 5 for EID) were used to reconstruct images with 1-mm section thickness at 0.5-mm intervals. Images were reviewed for motion artifacts, and CAC volume and Agatston scores were calculated using a commercial tool. Pooled analysis was performed for all calcifications with non-zero values, and volume and Agatston score were compared between EID-CT and PCD-CT. A Wilcoxon signed-rank test was performed with <0.05 considered statistically significant.

### **RESULTS**

A total of 22 subjects were enrolled between October 11, 2022 and October 31, 2022 (median age 58 years, range 50-75 years; 13 male). The mean and standard deviation of patient weight was  $82.2 \pm 14.7$  kg (range 64 to 116 kg). For the EID scans, 8/22 (36%) were scanned using the SOMATOM Definition Flash scanner (pitch 3.4); the remainder were scanned on the SOMATOM Force scanner (pitch 3.2). The applied radiation dose (volume CT Dose Index) for the PCD-CT scan was  $2.1 \pm 0.6$  mGy. For the EID-CT scan, the volume CT Dose Index was  $2.4 \pm 0.7$  mGy. These were statistically different ( $p < 0.001$ ). One subject had severe motion artifact at PCD-CT and was excluded from the analysis. Another subject had a stent in the LAD and that vessel was excluded from the analysis. A total of 41 calcifications were detected at 3 mm and 45 calcifications at 1 mm. EID-CT CAC volume and Agatston score were significantly lower than for PCD-CT ( $P < 0.001$ ). The mean (standard deviation) increase for PCD-CT was 8.2 (17.2) mm<sup>3</sup> for volume and 8.2 (25.6) for score at 3-mm thickness.

### **CONCLUSION**

Relative to energy-integrating-detector CT, photon-counting-detector CT demonstrated a small but significant increase in coronary artery calcium volume and Agatston score

### **CLINICAL RELEVANCE/APPLICATION**

CAC scoring, using both volume and Agatston scores, is similar when performed using PCD CT at either 1- or 3-mm image thickness relative to when performed using EID CT, indicating that robust measurements can be made on either platform.

## **T7-SSPH09-Automated Differentiation of Iodine and Blood in Stroke Patients using DECT**

3

Colin Schaeffer, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Patients presenting with stroke-like symptoms often receive a CT scan with iodinated contrast. If it is then determined that the patient is having an ischemic stroke, the patient is treated with blood thinners; however, blood thinners put the patient at further risk of hemorrhagic transformation. Therefore, it is hospital protocol to rescan the patient using dual-energy CT (DECT) within 24 hours to monitor for bleeds. The problem with rescanning in such a short period of time is that it is possible for residual iodine contrast to still be present in the brain. Discriminating between hemorrhages and residual contrast is a difficult task for radiologists. What we propose in this study is a form of computer aided diagnosis system that uses a three step A.I. pipeline to identify images with lesions, segment the lesion, and then classify it as either residual contrast or an intracranial hemorrhage. Prior work has shown the results of the first two steps in the pipeline. This project presents the final step in the pipeline: Lesion classification.

### **METHODS AND MATERIALS**

Under IRB approval, we retrospectively obtained DECT exams from 81 patients who contained a hyperdensity of either iodine or blood from which we extracted ROI measurements of the following DECT image maps: 1) iodine maps, 2) virtual non-contrast images, 3) 120-kV equivalent images, 4) effective atomic number maps, 5) electron density maps, 6) 80-kVp images, 7) 135-kVp images, and 8) best CNR monoenergetic images. Using radiology reports from an associated MRI, we classified our dataset as 52 patients containing a lesion of blood and 29 patients containing a lesion of iodine. We then trained a support vector machine model using a five-fold nested cross validation technique to optimize model hyperparameters. Final models were then evaluated on a reserved test set.

## RESULTS

For lesion classification using a single map, the best performance was obtained by the electron density map which gave an accuracy of 88.7%. This was closely followed by the iodine map which gave an accuracy of 88.1%. Lesion classification was optimized when using the effective atomic number in conjunction with the best CNR image which gave a lesion classification accuracy of 99.1%.

## CONCLUSION

We have developed a machine learning model to classify hyperdensities in post-intervention stroke imaging using DECT measurements.

## CLINICAL RELEVANCE/APPLICATION

An A.I. pipeline such as the one proposed in this study addresses the clinical problem of residual contrast in follow-up stroke imaging. Residual iodine contrast can hinder diagnosis. While reader studies using DECT iodine maps have been published addressing this problem, no quantitative model to differentiate blood from iodine has been published.

## T7-SSPH09-Improving Iodine Quantification Performance on a Clinical Photon-Counting CT with Emulated Dual-kV-Four-Energy Configuration

Yue Zhang, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the Iodine quantification performance on a clinical dual-source photon-counting CT (PCCT) with an emulated dual-kV-four-energy configuration, compared to the standard single-kV-dual-energy PCCT and an energy-integrating dual-source dual-energy CT (DS-DECT).

## METHODS AND MATERIALS

Six solid iodine rods of 0.2 to 10 mg/mL concentrations were inserted into three multi-energy CT phantoms (Sun Nuclear). Each phantom was scanned on a PCCT (NAEOTOM Alpha, Siemens) using the standard and the proposed configurations. The standard PCCT scans were performed at 70, 90, 120, 140, and Sn140 kV, each kV with 2 energy bins. Since the two X-ray tubes currently cannot be configured to operate at different kV levels, the proposed PCCT configuration was emulated by sequentially scanning the same phantom at a low kV (70 or 90 kV) and a high kV (120, 140, or Sn140 kV; Sn: 0.6mm tin filter), resulting in six kV pairs, each pair with 4 energy bins in total. The same phantoms were also scanned on a DS-DECT (SOMATOM Force, Siemens) with 70/Sn150, 80/Sn150, 90/Sn150, and 100/Sn150 kV. The total radiation dose was matched among all scans. All images were reconstructed using a filtered back-projection algorithm with a quantitative kernel (Qr40). An image-based two-material decomposition was performed to generate iodine and water maps using two or four energy bins/beams from PCCT and DS-DECT. On each iodine map, mean mass concentration ( $\pm$  standard deviation) was measured using a circular region-of-interest ( $\sim 2.2$  cm<sup>2</sup>) drawn on each iodine rod and the root-mean-square-error (RMSE) was calculated to quantify the iodine signals and compared across all data acquisition configurations and phantom sizes.

## RESULTS

No obvious artifacts were observed on any of the reconstructed images from either of the systems, even those acquired at low kV settings. All measured mass concentrations were linearly correlated with the nominal values ( $R^2 > 0.99$ ). DS-DECT with wider spectral separation provided lower RMSE values, with 70/Sn150 kV being the optimal acquisition setting for all phantom sizes (RMSE: 0.63, 1.00, and 1.19 mg/mL). The PCCT standard configuration had the best iodine quantification performance at 140 kV (RMSE: 1.47, 1.93, and 2.19 mg/mL). However, with the proposed PCCT configuration, the RMSE values were reduced to 0.70, 0.86, and 0.94 mg/mL at the optimal kV pair of 70/Sn140 kV.

## CONCLUSION

The proposed PCCT configuration could significantly improve iodine quantification performance and provide comparable or even better performance than DS-DECT.

## CLINICAL RELEVANCE/APPLICATION

By enabling the dual-kV-four-energy configuration, the clinical dual-source PCCT has the potential to significantly improve the iodine quantification performance in all contrast-enhanced CT.

## T7-SSPH09-Keynote Speaker

6

Ke Li, PhD (*Presenter*) Research Consultant, Pulmera Inc.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSPH09-1

### Optimal Spectral Performance for Pediatric Imaging on Photon Counting CT: A Comparative Analysis of Different kVs

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N229

Wei Zhou, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the spectral performance of kV options for pediatric body imaging on photon counting CT (PCCT), in terms of accuracy of quantification in iodine map (IM) and CT number in virtual monoenergetic images (VMIs).

#### METHODS AND MATERIALS

4 phantoms of variable sizes were included to represent abdomen of newborn, 5-year-old, 10-year-old, and adult size pediatric patients, respectively. 1 solid water and 4 solid iodine inserts (Gammex) were attached to or inserted into phantoms, with known concentration (2, 5, 10 and 15 mgI/cc) and reference CT number at variable keV levels. Each phantom setting was scanned on a PCCT system (Siemens Alpha) with 4 kV options (70, 90, 120 and 140kV) based on clinical pediatric abdominal protocol (dual source 3.0 pitch). For each phantom setting, radiation dose (CTDIvol) was determined by clinical settings and matched for all kV acquisitions of each size. 60% clinical dose level images were also acquired. Reconstruction was matched among all kVs using Qr40 and QIR level 3. Low- and high-energy images were reconstructed from each scan and used to generate IM using an image-based 2-material decomposition method. VMIs between 40 to 80keV with 10keV interval were generated. Root mean square error (RMSE) of iodine quantification from IM was compared among kVs, across phantom sizes. Percent error (PE) of iodine CT number accuracy in VMIs was compared among kVs, across phantom sizes.

#### RESULTS

Across all pediatric sizes, RMSE and PE are higher from low kV acquisitions (70, 90 kV) than high kV (120, 140 kV) on PCCT. For newborn size at full dose, RMSE is 1.80, 1.51, 1.28, 1.31 mgI/cc and average PE is 4.39%, 6.02%, 2.18%, 2.19%, when kV increases from 70 to 140 kV. For 5-year-old size at full dose, RMSE is 1.94, 1.67, 1.32, 1.38 mgI/cc and average PE is 4.72%, 6.19%, 2.99%, 1.74%, when kV increases from 70 to 140 kV. For 10-year-old size at full dose, RMSE is 1.86, 1.68, 1.40, 1.42 mgI/cc and average PE is 4.93%, 6.10%, 5.02%, 3.94%, when kV increases from 70 to 140 kV. For adult size at full dose, RMSE is 1.62, 2.34, 1.94, 1.77 mgI/cc and average PE is 21.76%, 4.50%, 3.61%, 2.45% when kV increases from 70 to 140 kV. At 60% dose level, the RMSE and PE are worse than full dose while comparisons across kVs are similar to full dose.

#### CONCLUSION

We showed 120 and 140kV outperformed 70 or 90kV across all pediatric body sizes in terms of spectral performance, indicating high kV is the optimal choice for pediatric PCCT spectral imaging.

#### CLINICAL RELEVANCE/APPLICATION

Selecting optimal kV for pediatric PCCT imaging is a crucial yet unresolved issue. Our study has showed, for the 1st time, that 120 and 140 kV on PCCT offer better spectral performance than commonly used lower kV, regardless of pediatric size. This finding provides valuable clinical guidance for pediatric PCCT imaging.

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## Abstract Archives of the RSNA, 2023

T7-SSPH09-2

### Photon-counting-detector (PCD) CT versus Energy-integrating-detector (EID) CT for Coronary Artery Calcium Quantitation

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N229

Timothy N. Winfree, BS, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting-detector (PCD) CT offers improved spatial and contrast resolution, which may improve quantitative measurements. This work aims to prospectively determine in human subjects the impact of dual-source PCD-CT on the quantitation of coronary artery calcification (CAC) compared to dual-source energy-integrating-detector (EID) CT in both 1- and 3-mm images.

#### METHODS AND MATERIALS

In October 2022, this prospective study enrolled patients receiving a clinical EID-CT CAC exam to undergo a research PCD-CT CAC exam. Axial images were reconstructed with a 512x512 matrix, 200-mm field-of-view, 3-mm section thickness/1.5-mm interval using a quantitative kernel (Qr36). Sharper kernels (Qr56/QIR strength 4 for PCD and Qr49/ADMIRE strength 5 for EID) were used to reconstruct images with 1-mm section thickness at 0.5-mm intervals. Images were reviewed for motion artifacts, and CAC volume and Agatston scores were calculated using a commercial tool. Pooled analysis was performed for all calcifications with non-zero values, and volume and Agatston score were compared between EID-CT and PCD-CT. A Wilcoxon signed-rank test was performed with <0.05 considered statistically significant.

#### RESULTS

A total of 22 subjects were enrolled between October 11, 2022 and October 31, 2022 (median age 58 years, range 50-75 years; 13 male). The mean and standard deviation of patient weight was  $82.2 \pm 14.7$  kg (range 64 to 116 kg). For the EID scans, 8/22 (36%) were scanned using the SOMATOM Definition Flash scanner (pitch 3.4); the remainder were scanned on the SOMATOM Force scanner (pitch 3.2). The applied radiation dose (volume CT Dose Index) for the PCD-CT scan was  $2.1 \pm 0.6$  mGy. For the EID-CT scan, the volume CT Dose Index was  $2.4 \pm 0.7$  mGy. These were statistically different ( $p < 0.001$ ). One subject had severe motion artifact at PCD-CT and was excluded from the analysis. Another subject had a stent in the LAD and that vessel was excluded from the analysis. A total of 41 calcifications were detected at 3 mm and 45 calcifications at 1 mm. EID-CT CAC volume and Agatston score were significantly lower than for PCD-CT ( $P < 0.001$ ). The mean (standard deviation) increase for PCD-CT was 8.2 (17.2) mm<sup>3</sup> for volume and 8.2 (25.6) for score at 3-mm thickness.

#### CONCLUSION

Relative to energy-integrating-detector CT, photon-counting-detector CT demonstrated a small but significant increase in coronary artery calcium volume and Agatston score

#### CLINICAL RELEVANCE/APPLICATION

CAC scoring, using both volume and Agatston scores, is similar when performed using PCD CT at either 1- or 3-mm image thickness relative to when performed using EID CT, indicating that robust measurements can be made on either platform.

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## Abstract Archives of the RSNA, 2023

T7-SSPH09-3

### Automated Differentiation of Iodine and Blood in Stroke Patients using DECT

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N229

Colin Schaeffer, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients presenting with stroke-like symptoms often receive a CT scan with iodinated contrast. If it is then determined that the patient is having an ischemic stroke, the patient is treated with blood thinners; however, blood thinners put the patient at further risk of hemorrhagic transformation. Therefore, it is hospital protocol to rescan the patient using dual-energy CT (DECT) within 24 hours to monitor for bleeds. The problem with rescanning in such a short period of time is that it is possible for residual iodine contrast to still be present in the brain. Discriminating between hemorrhages and residual contrast is a difficult task for radiologists. What we propose in this study is a form of computer aided diagnosis system that uses a three step A.I. pipeline to identify images with lesions, segment the lesion, and then classify it as either residual contrast or an intracranial hemorrhage. Prior work has shown the results of the first two steps in the pipeline. This project presents the final step in the pipeline: Lesion classification.

#### METHODS AND MATERIALS

Under IRB approval, we retrospectively obtained DECT exams from 81 patients who contained a hyperdensity of either iodine or blood from which we extracted ROI measurements of the following DECT image maps: 1) iodine maps, 2) virtual non-contrast images, 3) 120-kV equivalent images, 4) effective atomic number maps, 5) electron density maps, 6) 80-kVp images, 7) 135-kVp images, and 8) best CNR monoenergetic images. Using radiology reports from an associated MRI, we classified our dataset as 52 patients containing a lesion of blood and 29 patients containing a lesion of iodine. We then trained a support vector machine model using a five-fold nested cross validation technique to optimize model hyperparameters. Final models were then evaluated on a reserved test set.

#### RESULTS

For lesion classification using a single map, the best performance was obtained by the electron density map which gave an accuracy of 88.7%. This was closely followed by the iodine map which gave an accuracy of 88.1%. Lesion classification was optimized when using the effective atomic number in conjunction with the best CNR image which gave a lesion classification accuracy of 99.1%.

#### CONCLUSION

We have developed a machine learning model to classify hyperdensities in post-intervention stroke imaging using DECT measurements.

#### CLINICAL RELEVANCE/APPLICATION

An A.I. pipeline such as the one proposed in this study addresses the clinical problem of residual contrast in follow-up stroke imaging. Residual iodine contrast can hinder diagnosis. While reader studies using DECT iodine maps have been published addressing this problem, no quantitative model to differentiate blood from iodine has been published.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSPH09-5

### Improving Iodine Quantification Performance on a Clinical Photon-Counting CT with Emulated Dual-kV-Four-Energy Configuration

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N229

Yue Zhang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the Iodine quantification performance on a clinical dual-source photon-counting CT (PCCT) with an emulated dual-kV-four-energy configuration, compared to the standard single-kV-dual-energy PCCT and an energy-integrating dual-source dual-energy CT (DS-DECT).

#### METHODS AND MATERIALS

Six solid iodine rods of 0.2 to 10 mg/mL concentrations were inserted into three multi-energy CT phantoms (Sun Nuclear). Each phantom was scanned on a PCCT (NAEOTOM Alpha, Siemens) using the standard and the proposed configurations. The standard PCCT scans were performed at 70, 90, 120, 140, and Sn140 kV, each kV with 2 energy bins. Since the two X-ray tubes currently cannot be configured to operate at different kV levels, the proposed PCCT configuration was emulated by sequentially scanning the same phantom at a low kV (70 or 90 kV) and a high kV (120, 140, or Sn140 kV; Sn: 0.6mm tin filter), resulting in six kV pairs, each pair with 4 energy bins in total. The same phantoms were also scanned on a DS-DECT (SOMATOM Force, Siemens) with 70/Sn150, 80/Sn150, 90/Sn150, and 100/Sn150 kV. The total radiation dose was matched among all scans. All images were reconstructed using a filtered back-projection algorithm with a quantitative kernel (Qr40). An image-based two-material decomposition was performed to generate iodine and water maps using two or four energy bins/beams from PCCT and DS-DECT. On each iodine map, mean mass concentration ( $\pm$  standard deviation) was measured using a circular region-of-interest ( $\sim 2.2$  cm<sup>2</sup>) drawn on each iodine rod and the root-mean-square-error (RMSE) was calculated to quantify the iodine signals and compared across all data acquisition configurations and phantom sizes.

#### RESULTS

No obvious artifacts were observed on any of the reconstructed images from either of the systems, even those acquired at low kV settings. All measured mass concentrations were linearly correlated with the nominal values ( $R^2 > 0.99$ ). DS-DECT with wider spectral separation provided lower RMSE values, with 70/Sn150 kV being the optimal acquisition setting for all phantom sizes (RMSE: 0.63, 1.00, and 1.19 mg/mL). The PCCT standard configuration had the best iodine quantification performance at 140 kV (RMSE: 1.47, 1.93, and 2.19 mg/mL). However, with the proposed PCCT configuration, the RMSE values were reduced to 0.70, 0.86, and 0.94 mg/mL at the optimal kV pair of 70/Sn140 kV.

#### CONCLUSION

The proposed PCCT configuration could significantly improve iodine quantification performance and provide comparable or even better performance than DS-DECT.

#### CLINICAL RELEVANCE/APPLICATION

By enabling the dual-kV-four-energy configuration, the clinical dual-source PCCT has the potential to significantly improve the iodine quantification performance in all contrast-enhanced CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSPH09-6

### Keynote Speaker

Tuesday, Nov. 28 3:00PM - 4:00PM Room: N229

Ke Li, PhD (*Presenter*) Research Consultant, Pulmera Inc.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSRO03

### Science Session with Keynote: Radiation Oncology (CNS)

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402

Anupama Chundury, MD (*Moderator*) Nothing to Disclose  
Kelli B. Pointer, MD, PhD (*Moderator*) Nothing to Disclose  
Timothy L. Sita, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T7-SSRO03-1 A Lightweight 3D Segmentation Tool for Radiation Treatment Planning for Glioblastoma**

Karthik K. Ramesh, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Standard treatment of glioblastoma (GBM) involves surgical resection of visible tumor in CE-T1w (contrast-enhanced T1-weighted) MRI followed by radiation therapy (RT) that targets a high-dose to residual enhancing tumor in CE-T1w and a lower dose to lesions in T2w/FLAIR (Fluid-Attenuated Inversion Recovery) MRI. Despite this regimen, patients have a median survival of 15-16 months. While there have been several efforts to segment brain lesion such as through the BraTS Challenge, those efforts used brain MRIs before surgical resection. There have been minimal efforts to develop segmentation algorithms to assist RT planning post-surgery where there is usually a cavity with blood product and altered morphology. Due to the unique visual morphology of post-surgical lesions, we sought to develop a lightweight deep learning algorithm that could assist radiation oncologists in generating RT volumes.

#### **METHODS AND MATERIALS**

RT planning MRIs from 225 newly-diagnosed GBM patients over the past 10 years were used to train our segmentation model. For each patient, T2w/FLAIR and CE-T1w MRIs were collected as well as their corresponding RT contours. Specifically, gross tumor volumes generated from FLAIR (GTV1) and CE-T1w MRI (GTV2) were collected. FLAIR MRIs were registered and interpolated to their CE-T1w counterparts. All imaging were skull-stripped and resampled to a [256,256,160] volume before zero-mean, unit-variance normalization. For each GTV1 and GTV2 segmentation, CE-T1w and FLAIR image volumes were fed as a 2-channel input into a 3D-Unet model with a depth of 3 for training. After a five-fold cross validation procedure for hyperparameter tuning, the 225-patient dataset was split into a training set of 202 patients and a validation set of 23 patients. An independent test dataset containing 30 patients from three sites was used to evaluate the Dice coefficient for segmentation performance.

#### **RESULTS**

The model had mean Dice scores of  $0.72 \pm 0.17$  for GTV1 and  $0.73 \pm 0.17$  for GTV2 in the test dataset. Of the 30 patients in the test dataset, a Dice score greater than 0.7 was achieved for 19 GTV1s and 18 GTV2s.

#### **CONCLUSION**

We have successfully developed a lightweight, 3D deep learning model that generates RT contours for post-surgical brain MRIs. Efforts are underway to improve this performance in difficult cases where resection cavities are close to the skull by leveraging Swin Transformers and other attention-based techniques. Long term plans involve integrating this model in clinical workflows to save clinicians time in manual contouring.

#### **CLINICAL RELEVANCE/APPLICATION**

In this study, we developed a deep learning model to segment brain tumor lesions in two standard MRI sequences for the unique purpose of radiation treatment planning of glioblastoma from multiple sites.

#### **T7-SSRO03-2 Machine Learning Supported MRI Radiomics to Predict the Volumetric Response of Pituitary Adenomas after Gamma Knife Radiosurgery**

Herwin Speckter (*Presenter*) Nothing to Disclose

## PURPOSE

In previous studies, we analyzed the potential of both Diffusion Tensor Imaging and the value of machine learning radiomics in predicting volumetric changes induced by Gamma Knife Stereotactic Radiosurgery (GKRS) for meningiomas. In this study, we analyzed the value of radiomics together with feature selection based on machine learning in the prediction of volumetric changes after GKRS in pituitary adenomas.

## METHODS AND MATERIALS

The retrospective prediction model of pituitary adenoma responsiveness to GKRS included T1-weighted, non-contrast enhanced MRI scans obtained from 80 patients before GKRS. Tumor volumes were measured before GKRS and after a mean follow-up period of 40 [6 - 106] months. Only one tumor progressed slightly after SRS, a medium volume reduction of 47% [-90.2%, 1.9%] after SRS was observed, corresponding to a volumetric decrease of 1.67% per month [-9.84%, 0.14%] on average. Normalized volumetric changes were corrected for the interval of the follow-up time. Imaging data obtained before GKRS was analyzed, and adenoma morphology was quantified by calculating 2190 shape, first-order, and second-order radiomic features. Analysis was performed on original unfiltered 3D MR images and after their transformation by a total of nine filters.

## RESULTS

The LASSO machine learning selected the following radiomic features, of which increasing values are associated with less favorable volumetric outcome: LBP 3D-k-first order median (association with the volumetric response by linear regression:  $R^2=0.13$ ;  $P=0.003$ ). A higher value of this feature indicates that the median pixel gray-level intensity in images transformed by local binary pattern is higher. Exponential GLCM LMC1 ( $R^2=0.08$ ;  $P=0.003$ ). A higher value indicates that there are more compact regions that have a smaller surface area relative to their volume in exponentially transformed images. Square root GLCM joint energy ( $R^2=0.08$ ;  $P=0.002$ ). A higher value indicates more texture and variation in gray-level values within the lesion in square-root transformed images.

## CONCLUSION

This is the first report of a strong association between the MRI radiomic features and the volumetric response of pituitary adenoma to radiosurgery.

## CLINICAL RELEVANCE/APPLICATION

The clinical importance of the early and reliable prediction of pituitary adenoma responsiveness to GKRS is based on its potential to provide decision support in personalized pituitary adenoma therapy.

## T7-SSR003-3 A Comparison of Brain Metastasis Detection using Contrast-Enhanced 3D-T1W-TSE at 1.5T and 3T MRI: An Inter-Observer Analysis

Oi Lei Wong, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Brain metastases (BM) are a common complication of cancer, and their accurate detection is critical for appropriate patient management. Although contrast-enhanced 3D-T1W-TSE has shown superior performance over 3D-GRE in BM detection at 3T, there is a lack of information on its performance at 1.5T. Therefore, this study aims to compare the inter-observer agreement in the detectability of BM using contrast-enhanced 3D-T1W-TSE at 1.5T and 3T.

## METHODS AND MATERIALS

The study retrospectively enrolled 23 patients with BM who underwent a 3T diagnostic scan using the dedicated volumetric head array coil, followed by a 1.5T planning scan using surface array coils within 14 days, using the same contrast agent and registration protocol, and with no intervention between the two scans. Two radiologists independently detected BMs on 1.5T (isotropic 1.0mm voxel) and 3T (isotropic 0.9mm voxel) 3D-T1W-TSE MRI datasets, with an interval of more than 30 days. Small BMs that were found only at 1.5T MRI scans were excluded due to the potential of being new BMs. The size of the BMs was calculated by measuring the longest diameter. The BMs were divided into two groups based on size ( $\geq 5$ mm and  $< 5$ mm). Percent agreement was calculated to measure the intra- and inter-observer agreement in BM detection. A chi-square test was used to compare the intra- and inter-observer agreement.

## RESULTS

Radiologist A detected a total of 83 and 84 BMs in 3T and 1.5T MRI scans, respectively, while radiologist B detected 97 and 105 BMs, respectively, with no statistically significant difference in the inter-observer agreement (79% for both 3T and 1.5T,  $P>0.05$ ). Five BMs were found only in 3T MRI, where the largest size was 5.6mm, and four others were smaller than 5mm. For BMs with a size  $\geq 5$ mm, the inter-observer agreement significantly increased to 93% and 96% for both scans ( $P<0.05$ ). However, the inter-observer agreement when the BMs were smaller than 5mm was significantly lower (around 55%) for both scans ( $P<0.05$ ). The overall intra-observer agreement between the two radiologists' readings was approximately 84%. Similarly, the intra-observer agreement was significantly higher ( $\sim 94\%$ ) when the BMs were  $\geq 5$ mm and lower ( $\sim 70\%$ ) when the BMs were  $< 5$ mm.

## CONCLUSION

The study demonstrated comparable performance in detecting BMs using 3D-T1W-TSE at 1.5T and 3T MRI, with no significant difference in inter-observer agreement. Caution should be taken when interpreting BMs smaller than 5mm by both modalities.

## CLINICAL RELEVANCE/APPLICATION

The findings of this study suggest that contrast-enhanced 3D-T1W-TSE MRI can be a reliable method for detecting brain metastases (BM) at both 1.5T and 3T. This also suggests that 1.5T MRI may be a viable alternative to 3T MRI, when 3T MRI is not available or feasible.

### T7-SSR003-4 **Imaging Biomarkers for Predicting Overall Survival of Newly Diagnosed Glioblastoma Treated With Belinostat and Standard of Care**

Karthik K. Ramesh, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Despite aggressive treatment, glioblastoma (GBM) has poor prognosis, with a median survival of 15 - 16 months. Standard of care involves surgical resection followed by high-dose radiation therapy (RT) to enhancing lesion in T1-weighted contrast-enhanced MRI (CE-T1w) and chemotherapy. Spectroscopic MRI (sMRI) measures endogenous metabolite levels and can better characterize the extent of tumor infiltration. Regions with elevated Choline (Cho) and decreased N-acetylaspartate (NAA) harbor proliferating tumor cells that are often undetected in CE-T1w. In a multisite pilot study (NCT02137759), newly-diagnosed GBM patients were treated with Belinostat, a histone deacetylase inhibitor capable of crossing the blood-brain-barrier and a radio-sensitizer, concurrently with standard-of-care RT. The patients had a previously reported median overall survival (OS) of 18.5 months. We sought to investigate whether there is a relationship between undertreated tumor detected by sMRI and OS.

## METHODS AND MATERIALS

For the 12-patient cohort treated with Belinostat, pre-RT CE-T1w lesions excluding resection cavity were contoured. Then, sMRI lesion volumes were determined where the ratio of Cho/NAA was greater than twice normal for each patient (Cho/NAA = 2x). The difference was taken between lesion volumes from Cho/NAA = 2x and CE-T1w. The cohort was then split into two subgroups using the median difference as cutoff (16.1 cc) with group 1 having much larger undertreated sMRI tumor. We used the Kaplan-Meier estimator to calculate median OS for each subgroup. Log-rank testing was performed to assess survival differences between subgroups. Finally, r-squared correlation coefficient was calculated between lesion volumes from CE-T1w and Cho/NAA = 2x.

## RESULTS

Each subgroup had two patients with MGMT hypermethylation status. The average CE-T1w tumor volume for group 1 was  $12.1 \pm 4.5$ cc and  $10.1 \pm 4.6$ cc for group 2. While the CE-T1w tumor volumes were similar, the average Cho/NAA =2x for group 1 was  $49.9 \pm 5.8$ cc and  $17.7 \pm 3.4$  cc for group 2. The lack of a relationship between CE-T1w and Cho/NAA volumes was further reflected by the r-squared of 0.05 between lesion volumes. The median OS for group 1 and group 2 was 14.4 and 34.3 months respectively, with the difference approaching statistical significance ( $p=0.07$ ).

## CONCLUSION

We find that patients treated with standard-of-care therapy plus Belinostat, that also had lower volumes of undertreated tumor detected by sMRI, had better survival outcomes highlighting the potential of integrating sMRI with Belinostat.

## CLINICAL RELEVANCE/APPLICATION

In this retrospective analysis of GBM patients treated with Belinostat, we aim to determine if there is a relationship between undertreated lesion detected by sMRI and survival.

### T7-SSR003-5 **Keynote Speaker**

Tarita O. Thomas, MD, PhD (*Presenter*) Nothing to Disclose

### T7-SSR003-6 **Automated Analysis Pipeline Using Longitudinal Spectroscopic MRI Data to Assess Therapy Response in GBM Patients**

Anuradha Trivedi, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Accurate tumor delineation is crucial for glioblastoma (GBM) treatment but may be challenging using standard of care MRIs due to the infiltrative nature of GBM. T1-weighted contrast-enhanced (T1w-CE) and T2-weighted fluid-attenuated inversion recovery (FLAIR) MRIs may not sufficiently characterize the full tumor extent, resulting in suboptimal radiation treatment (RT) targeting and undertreatment. Whole-brain spectroscopic MRI (sMRI) maps tumor using metabolite levels such as

choline (Cho) and N-acetylaspartate (NAA) and can quantify early treatment-induced molecular changes that other modalities cannot measure. We have developed an analysis tool to determine volumetric sMRI changes between any two study dates.

## **METHODS AND MATERIALS**

As proof-of-principle, we used data from a study (NCT03137888) where GBM patients received an escalated dose of RT guided by the Cho/NAA twice normal (Cho/NAA = 2x) volume from sMRI scans acquired for treatment planning (pre-RT). A second sMRI scan was acquired after completing two weeks of RT (mid-RT). sMRI volumes from both scan dates were co-registered using SimpleITK (Python) or Velocity (Varian Medical Systems) and approved by a board-certified medical physicist. Next, we calculated several spatial overlap statistics between sMRI volumes for each patient (n=29). Finally, we generated 2D and 3D visualizations of the contours using the Visual Toolkit (VTK) library in Python. The contours were then visually inspected in 3D through rotations, zooming in and out, and various opacities to view the overlaps.

## **RESULTS**

Between the pre- and mid-RT Cho/NAA = 2x volumes, the median total overlap was 0.785 (range: 0 - 0.964), median Jaccard index was 0.224 (0 - 0.723), median Dice coefficient was 0.365 (0 - 0.839) and median Hausdorff distance was 21.2 mm (8.54 - 92.2 mm) for patients on the study. Lower overlap values indicated the region of metabolic abnormality changed substantially within the first two weeks of RT. Without considering spatial change, 13 patients experienced an increase in the volume of metabolic abnormality after two weeks of RT (median increase of 75%). The remaining 16 patients experienced a decrease in volume of metabolic abnormality (median decrease of 23%).

## **CONCLUSION**

Our automated analysis technique identified changes in the volume of metabolic abnormality during early stages of RT in our dose escalation trial data, suggesting the potential of adaptive RT planning based on mid-RT scans. This pipeline can be applied to a variety of modalities apart from sMRI, including DWI, PWI, PET, and CT.

## **CLINICAL RELEVANCE/APPLICATION**

Identifying spatial and volumetric changes in metabolically abnormal brain tissue identified by spectroscopic MRI can be used to longitudinally assess radiation therapy response.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSR003-1

### A Lightweight 3D Segmentation Tool for Radiation Treatment Planning for Glioblastoma

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402

Karthik K. Ramesh, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Standard treatment of glioblastoma (GBM) involves surgical resection of visible tumor in CE-T1w (contrast-enhanced T1-weighted) MRI followed by radiation therapy (RT) that targets a high-dose to residual enhancing tumor in CE-T1w and a lower dose to lesions in T2w/FLAIR (Fluid-Attenuated Inversion Recovery) MRI. Despite this regimen, patients have a median survival of 15-16 months. While there have been several efforts to segment brain lesion such as through the BraTS Challenge, those efforts used brain MRIs before surgical resection. There have been minimal efforts to develop segmentation algorithms to assist RT planning post-surgery where there is usually a cavity with blood product and altered morphology. Due to the unique visual morphology of post-surgical lesions, we sought to develop a lightweight deep learning algorithm that could assist radiation oncologists in generating RT volumes.

#### METHODS AND MATERIALS

RT planning MRIs from 225 newly-diagnosed GBM patients over the past 10 years were used to train our segmentation model. For each patient, T2w/FLAIR and CE-T1w MRIs were collected as well as their corresponding RT contours. Specifically, gross tumor volumes generated from FLAIR (GTV1) and CE-T1w MRI (GTV2) were collected. FLAIR MRIs were registered and interpolated to their CE-T1w counterparts. All imaging were skull-stripped and resampled to a [256,256,160] volume before zero-mean, unit-variance normalization. For each GTV1 and GTV2 segmentation, CE-T1w and FLAIR image volumes were fed as a 2-channel input into a 3D-Unet model with a depth of 3 for training. After a five-fold cross validation procedure for hyperparameter tuning, the 225-patient dataset was split into a training set of 202 patients and a validation set of 23 patients. An independent test dataset containing 30 patients from three sites was used to evaluate the Dice coefficient for segmentation performance.

#### RESULTS

The model had mean Dice scores of  $0.72 \pm 0.17$  for GTV1 and  $0.73 \pm 0.17$  for GTV2 in the test dataset. Of the 30 patients in the test dataset, a Dice score greater than 0.7 was achieved for 19 GTV1s and 18 GTV2s.

#### CONCLUSION

We have successfully developed a lightweight, 3D deep learning model that generates RT contours for post-surgical brain MRIs. Efforts are underway to improve this performance in difficult cases where resection cavities are close to the skull by leveraging Swin Transformers and other attention-based techniques. Long term plans involve integrating this model in clinical workflows to save clinicians time in manual contouring.

#### CLINICAL RELEVANCE/APPLICATION

In this study, we developed a deep learning model to segment brain tumor lesions in two standard MRI sequences for the unique purpose of radiation treatment planning of glioblastoma from multiple sites.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T7-SSR003-2

### Machine Learning Supported MRI Radiomics to Predict the Volumetric Response of Pituitary Adenomas after Gamma Knife Radiosurgery

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402

Herwin Speckter (*Presenter*) Nothing to Disclose

#### PURPOSE

In previous studies, we analyzed the potential of both Diffusion Tensor Imaging and the value of machine learning radiomics in predicting volumetric changes induced by Gamma Knife Stereotactic Radiosurgery (GKRS) for meningiomas. In this study, we analyzed the value of radiomics together with feature selection based on machine learning in the prediction of volumetric changes after GKRS in pituitary adenomas.

#### METHODS AND MATERIALS

The retrospective prediction model of pituitary adenoma responsiveness to GKRS included T1-weighted, non-contrast enhanced MRI scans obtained from 80 patients before GKRS. Tumor volumes were measured before GKRS and after a mean follow-up period of 40 [6 - 106] months. Only one tumor progressed slightly after SRS, a medium volume reduction of 47% [-90.2%, 1.9%] after SRS was observed, corresponding to a volumetric decrease of 1.67% per month [-9.84%, 0.14%] on average. Normalized volumetric changes were corrected for the interval of the follow-up time. Imaging data obtained before GKRS was analyzed, and adenoma morphology was quantified by calculating 2190 shape, first-order, and second-order radiomic features. Analysis was performed on original unfiltered 3D MR images and after their transformation by a total of nine filters.

#### RESULTS

The LASSO machine learning selected the following radiomic features, of which increasing values are associated with less favorable volumetric outcome: LBP 3D-k-first order median (association with the volumetric response by linear regression:  $R^2=0.13$ ;  $P=0.003$ ). A higher value of this feature indicates that the median pixel gray-level intensity in images transformed by local binary pattern is higher. Exponential GLCM LMC1 ( $R^2=0.08$ ;  $P=0.003$ ). A higher value indicates that there are more compact regions that have a smaller surface area relative to their volume in exponentially transformed images. Square root GLCM joint energy ( $R^2=0.08$ ;  $P=0.002$ ). A higher value indicates more texture and variation in gray-level values within the lesion in square-root transformed images.

#### CONCLUSION

This is the first report of a strong association between the MRI radiomic features and the volumetric response of pituitary adenoma to radiosurgery.

#### CLINICAL RELEVANCE/APPLICATION

The clinical importance of the early and reliable prediction of pituitary adenoma responsiveness to GKRS is based on its potential to provide decision support in personalized pituitary adenoma therapy.

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## Abstract Archives of the RSNA, 2023

T7-SSRO03-3

### **A Comparison of Brain Metastasis Detection using Contrast-Enhanced 3D-T1W-TSE at 1.5T and 3T MRI: An Inter-Observer Analysis**

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402

Oi Lei Wong, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Brain metastases (BM) are a common complication of cancer, and their accurate detection is critical for appropriate patient management. Although contrast-enhanced 3D-T1W-TSE has shown superior performance over 3D-GRE in BM detection at 3T, there is a lack of information on its performance at 1.5T. Therefore, this study aims to compare the inter-observer agreement in the detectability of BM using contrast-enhanced 3D-T1W-TSE at 1.5T and 3T.

#### **METHODS AND MATERIALS**

The study retrospectively enrolled 23 patients with BM who underwent a 3T diagnostic scan using the dedicated volumetric head array coil, followed by a 1.5T planning scan using surface array coils within 14 days, using the same contrast agent and registration protocol, and with no intervention between the two scans. Two radiologists independently detected BMs on 1.5T (isotropic 1.0mm voxel) and 3T (isotropic 0.9mm voxel) 3D-T1W-TSE MRI datasets, with an interval of more than 30 days. Small BMs that were found only at 1.5T MRI scans were excluded due to the potential of being new BMs. The size of the BMs was calculated by measuring the longest diameter. The BMs were divided into two groups based on size ( $\geq 5\text{mm}$  and  $< 5\text{mm}$ ). Percent agreement was calculated to measure the intra- and inter-observer agreement in BM detection. A chi-square test was used to compare the intra- and inter-observer agreement.

#### **RESULTS**

Radiologist A detected a total of 83 and 84 BMs in 3T and 1.5T MRI scans, respectively, while radiologist B detected 97 and 105 BMs, respectively, with no statistically significant difference in the inter-observer agreement (79% for both 3T and 1.5T,  $P > 0.05$ ). Five BMs were found only in 3T MRI, where the largest size was 5.6mm, and four others were smaller than 5mm. For BMs with a size  $\geq 5\text{mm}$ , the inter-observer agreement significantly increased to 93% and 96% for both scans ( $P < 0.05$ ). However, the inter-observer agreement when the BMs were smaller than 5mm was significantly lower (around 55%) for both scans ( $P < 0.05$ ). The overall intra-observer agreement between the two radiologists' readings was approximately 84%. Similarly, the intra-observer agreement was significantly higher ( $\sim 94\%$ ) when the BMs were  $\geq 5\text{mm}$  and lower ( $\sim 70\%$ ) when the BMs were  $< 5\text{mm}$ .

#### **CONCLUSION**

The study demonstrated comparable performance in detecting BMs using 3D-T1W-TSE at 1.5T and 3T MRI, with no significant difference in inter-observer agreement. Caution should be taken when interpreting BMs smaller than 5mm by both modalities.

#### **CLINICAL RELEVANCE/APPLICATION**

The findings of this study suggest that contrast-enhanced 3D-T1W-TSE MRI can be a reliable method for detecting brain metastases (BM) at both 1.5T and 3T. This also suggests that 1.5T MRI may be a viable alternative to 3T MRI, when 3T MRI is not available or feasible.

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## Abstract Archives of the RSNA, 2023

T7-SSRO03-4

### Imaging Biomarkers for Predicting Overall Survival of Newly Diagnosed Glioblastoma Treated With Belinostat and Standard of Care

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402

Karthik K. Ramesh, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Despite aggressive treatment, glioblastoma (GBM) has poor prognosis, with a median survival of 15 - 16 months. Standard of care involves surgical resection followed by high-dose radiation therapy (RT) to enhancing lesion in T1-weighted contrast-enhanced MRI (CE-T1w) and chemotherapy. Spectroscopic MRI (sMRI) measures endogenous metabolite levels and can better characterize the extent of tumor infiltration. Regions with elevated Choline (Cho) and decreased N-acetylaspartate (NAA) harbor proliferating tumor cells that are often undetected in CE-T1w. In a multisite pilot study (NCT02137759), newly-diagnosed GBM patients were treated with Belinostat, a histone deacetylase inhibitor capable of crossing the blood-brain-barrier and a radio-sensitizer, concurrently with standard-of-care RT. The patients had a previously reported median overall survival (OS) of 18.5 months. We sought to investigate whether there is a relationship between undertreated tumor detected by sMRI and OS.

#### METHODS AND MATERIALS

For the 12-patient cohort treated with Belinostat, pre-RT CE-T1w lesions excluding resection cavity were contoured. Then, sMRI lesion volumes were determined where the ratio of Cho/NAA was greater than twice normal for each patient (Cho/NAA = 2x). The difference was taken between lesion volumes from Cho/NAA = 2x and CE-T1w. The cohort was then split into two subgroups using the median difference as cutoff (16.1 cc) with group 1 having much larger undertreated sMRI tumor. We used the Kaplan-Meier estimator to calculate median OS for each subgroup. Log-rank testing was performed to assess survival differences between subgroups. Finally, r-squared correlation coefficient was calculated between lesion volumes from CE-T1w and Cho/NAA = 2x.

#### RESULTS

Each subgroup had two patients with MGMT hypermethylation status. The average CE-T1w tumor volume for group 1 was  $12.1 \pm 4.5$ cc and  $10.1 \pm 4.6$ cc for group 2. While the CE-T1w tumor volumes were similar, the average Cho/NAA = 2x for group 1 was  $49.9 \pm 5.8$ cc and  $17.7 \pm 3.4$  cc for group 2. The lack of a relationship between CE-T1w and Cho/NAA volumes was further reflected by the r-squared of 0.05 between lesion volumes. The median OS for group 1 and group 2 was 14.4 and 34.3 months respectively, with the difference approaching statistical significance ( $p=0.07$ ).

#### CONCLUSION

We find that patients treated with standard-of-care therapy plus Belinostat, that also had lower volumes of undertreated tumor detected by sMRI, had better survival outcomes highlighting the potential of integrating sMRI with Belinostat.

#### CLINICAL RELEVANCE/APPLICATION

In this retrospective analysis of GBM patients treated with Belinostat, we aim to determine if there is a relationship between undertreated lesion detected by sMRI and survival.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSR003-5

### Keynote Speaker

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402

Tarita O. Thomas, MD, PhD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-SSR003-6

### Automated Analysis Pipeline Using Longitudinal Spectroscopic MRI Data to Assess Therapy Response in GBM Patients

Tuesday, Nov. 28 3:00PM - 4:00PM Room: S402

Anuradha Trivedi, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate tumor delineation is crucial for glioblastoma (GBM) treatment but may be challenging using standard of care MRIs due to the infiltrative nature of GBM. T1-weighted contrast-enhanced (T1w-CE) and T2-weighted fluid-attenuated inversion recovery (FLAIR) MRIs may not sufficiently characterize the full tumor extent, resulting in suboptimal radiation treatment (RT) targeting and undertreatment. Whole-brain spectroscopic MRI (sMRI) maps tumor using metabolite levels such as choline (Cho) and N-acetylaspartate (NAA) and can quantify early treatment-induced molecular changes that other modalities cannot measure. We have developed an analysis tool to determine volumetric sMRI changes between any two study dates.

#### METHODS AND MATERIALS

As proof-of-principle, we used data from a study (NCT03137888) where GBM patients received an escalated dose of RT guided by the Cho/NAA twice normal (Cho/NAA = 2x) volume from sMRI scans acquired for treatment planning (pre-RT). A second sMRI scan was acquired after completing two weeks of RT (mid-RT). sMRI volumes from both scan dates were co-registered using SimpleITK (Python) or Velocity (Varian Medical Systems) and approved by a board-certified medical physicist. Next, we calculated several spatial overlap statistics between sMRI volumes for each patient (n=29). Finally, we generated 2D and 3D visualizations of the contours using the Visual Toolkit (VTK) library in Python. The contours were then visually inspected in 3D through rotations, zooming in and out, and various opacities to view the overlaps.

#### RESULTS

Between the pre- and mid-RT Cho/NAA = 2x volumes, the median total overlap was 0.785 (range: 0 - 0.964), median Jaccard index was 0.224 (0 - 0.723), median Dice coefficient was 0.365 (0 - 0.839) and median Hausdorff distance was 21.2 mm (8.54 - 92.2 mm) for patients on the study. Lower overlap values indicated the region of metabolic abnormality changed substantially within the first two weeks of RT. Without considering spatial change, 13 patients experienced an increase in the volume of metabolic abnormality after two weeks of RT (median increase of 75%). The remaining 16 patients experienced a decrease in volume of metabolic abnormality (median decrease of 23%).

#### CONCLUSION

Our automated analysis technique identified changes in the volume of metabolic abnormality during early stages of RT in our dose escalation trial data, suggesting the potential of adaptive RT planning based on mid-RT scans. This pipeline can be applied to a variety of modalities apart from sMRI, including DWI, PWI, PET, and CT.

#### CLINICAL RELEVANCE/APPLICATION

Identifying spatial and volumetric changes in metabolically abnormal brain tissue identified by spectroscopic MRI can be used to longitudinally assess radiation therapy response.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-STCE1

### Science Session (Theranostics)

Tuesday, Nov. 28 2:30PM - 3:00PM Room: Learning Center Theater 1

#### Sub-Events

#### **T7-STCE1-1 Targeted theranostic nanomedicine, using targeted CT-imageable particles that release the bispecific antibody IMC-KRASG12D with the KRASG12D neoantigen, directed by two radiation sessions.**

Satoshi G. Harada, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of the present study was to evaluate targeted theranostic nanomedicine for the CD3+ bispecific antibody associated with the KRASG12D neoantigen by two radiation sessions. Rag2-/- C57BL/6 mice with KP9093 sarcoma in the left foot pad with lung metastases were enrolled. CT-imageable hyaluronate-alginate nanocapsules (HA-NCs, F564 nm) or liposome-protamine-hyaluronate nanoparticles (LPH-NPs, F43 nm), which release their contents upon radiation exposure, were evaluated.

#### **METHODS AND MATERIALS**

In session 1, KRASG12D and IFN- $\gamma$  LPH-NPs were prepared with the self-assembly method and encapsulated into  $\gamma$ 4 $\beta$ 1-antibody-labeled HA-NCs with P-selectin, using electrospray and Fe-polymerization. At 9 h after the intravenous injection of  $1 \times 10^{10}$  HA-NCs, 10 or 20 Gy  $^{60}\text{Co}$   $\gamma$ -ray was administered to the primary tumor and metastasis lesion. In session 2, JD1a96b35  $\times$  anti-CD3 ScFv-bispecific antibody (IMC-KRASG12D), which have high affinities to KRASG12D and CD3+T-cell, were encapsulated into P-selectin-antibody-labeled HA-NCs. These HA-NCs were injected intravenously 24 h after the first irradiation. Subsequently, 24 h after the injection, session 2 was carried out in the same way as session 1.

#### **RESULTS**

In session 1, anti- $\gamma$ 4 $\beta$ 1-antibody HA-NCs were accumulated to  $\gamma$ 4 $\beta$ 1 in the endothelium of the primary tumor and metastasis lesion, which could be imaged by CT. After session 1, HA-NCs discharged and continuously released IFN- $\gamma$  and KRASG12D LPH-NPs. The released IFN- $\gamma$  induced HLA-A\*11, and released KRASG12D was captured to HLA-A\*11, which formed an HLA-A\* 11-KRASG12D complex. HA-NCs also released P-selectins to tumor vessels. In session 2, P-selectin antibody-labeled HA-NCs were accumulated to P-selectin. HA-NCs continuously released IMC-KRASG12D and formed an immunological synapse consisting of the HLA-A\* 11-KRASG12D, IMC-KRASG12D, and CD3 on T-cells. CD3+ T-cells released perforin/granzymes, resulting in cytolysis of the primary tumor and metastasis, synergistically with radiation. These phenomena in sessions 1 and 2 resulted in EF 1.7 in primary tumor and 79% reduction in metastasis.

#### **CONCLUSION**

This targeted theranostic nanomedicine improved the diagnostic ability and therapeutic effect.

#### **CLINICAL RELEVANCE/APPLICATION**

The targeted theranostic nanomedicine in IMC-KRASG12D can improve the diagnostic ability and therapeutic effect in radioimmunotherapy.

#### **T7-STCE1-2 Assessment of Oxygen Saturation in Breast Tumors Using Photoacoustic Imaging: Correlation with Benign and Malignant Disease**

Zhibin Huang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To measure the oxygenation status of tissue in and on both sides of the tumor in BC participants using a multimodal Photoacoustic/ultrasound (PA/US) imaging system and to determine the correlation between So<sub>2</sub> measured by PA imaging

and benign or malignant disease.

## **METHODS AND MATERIALS**

Multimodal PA/US imaging and gray-scale US (GSUS) of breast tumor were performed in consecutive BC participants treated in the US Outpatient Clinic between 2022 and 2023. Dual-wavelength PA imaging was used to measure the So<sub>2</sub> value inside the tumor and on both sides of the tissue, and to distinguish benign from malignant tumors based on the So<sub>2</sub> value. The ability of So<sub>2</sub> to distinguish benign from malignant breast tumors was evaluated by the receiver operating characteristic curve (ROC) and the De-Long test.

## **RESULTS**

A total of 120 BC participants (median age, 42.5 years) were included in the study. The malignant tumors exhibited lower So<sub>2</sub> levels compared to benign tumors (malignant: 71.30%; benign: 83.81%;  $p < .01$ ). Moreover, PA /US imaging demonstrates superior diagnostic results compared to GSUS, with an area under the curve (AUC) of 0.89 versus 0.70, sensitivity of 89.58% versus 85.42%, and specificity of 86.11% versus 55.56% at the So<sub>2</sub> cut-off value of 78.85 ( $p < .001$ ). The false positive rate in GSUS reduced by 30.75%, and the false negative rate diminished by 4.16% with PA /US diagnosis. Finally, SO<sub>2</sub> was on both sides of malignant tumor tissues below the sides of benign tumors.

## **CONCLUSION**

PA imaging allows for the assessment of So<sub>2</sub> within the tumors of BC patients, thereby facilitating a superior distinction between benign and malignant tumors.

## **CLINICAL RELEVANCE/APPLICATION**

Photoacoustic imaging technology can provide additional information about tumors, assist gray-scale ultrasound to diagnose breast tumors more accurately, distinguish between benign and malignant, and reduce false positives and false negatives in the diagnosis of breast tumors by gray-scale ultrasound. Using photoacoustic imaging to assess the oxygenation status of tumors, more precise diagnosis of breast cancer is possible.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-STCE1-1

### Targeted theranostic nanomedicine, using targeted CT-imageable particles that release the bispecific antibody IMC-KRASG12D with the KRASG12D neoantigen, directed by two radiation sessions.

Tuesday, Nov. 28 2:30PM - 3:00PM Room: Learning Center Theater 1

Satoshi G. Harada, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of the present study was to evaluate targeted theranostic nanomedicine for the CD3+ bispecific antibody associated with the KRASG12D neoantigen by two radiation sessions. Rag2<sup>-/-</sup> C57BL/6 mice with KP9093 sarcoma in the left foot pad with lung metastases were enrolled. CT-imageable hyaluronate-alginate nanocapsules (HA-NCs, F564 nm) or liposome-protamine-hyaluronate nanoparticles (LPH-NPs, F43 nm), which release their contents upon radiation exposure, were evaluated.

#### METHODS AND MATERIALS

In session 1, KRASG12D and IFN- $\gamma$  LPH-NPs were prepared with the self-assembly method and encapsulated into  $\alpha$ 4 $\beta$ 1-antibody-labeled HA-NCs with P-selectin, using electrospray and Fe-polymerization. At 9 h after the intravenous injection of  $1 \times 10^{10}$  HA-NCs, 10 or 20 Gy <sup>60</sup>Co  $\gamma$ -ray was administered to the primary tumor and metastasis lesion. In session 2, JD1a96b35  $\times$  anti-CD3 ScFv-bispecific antibody (IMC-KRASG12D), which have high affinities to KRASG12D and CD3+T-cell, were encapsulated into P-selectin-antibody-labeled HA-NCs. These HA-NCs were injected intravenously 24 h after the first irradiation. Subsequently, 24 h after the injection, session 2 was carried out in the same way as session 1.

#### RESULTS

In session 1, anti- $\alpha$ 4 $\beta$ 1-antibody HA-NCs were accumulated to  $\alpha$ 4 $\beta$ 1 in the endothelium of the primary tumor and metastasis lesion, which could be imaged by CT. After session 1, HA-NCs discharged and continuously released IFN- $\gamma$  and KRASG12D LPH-NPs. The released IFN- $\gamma$  induced HLA-A\*11, and released KRASG12D was captured to HLA-A\*11, which formed an HLA-A\* 11-KRASG12D complex. HA-NCs also released P-selectins to tumor vessels. In session 2, P-selectin antibody-labeled HA-NCs were accumulated to P-selectin. HA-NCs continuously released IMC-KRASG12D and formed an immunological synapse consisting of the HLA-A\* 11-KRASG12D, IMC-KRASG12D, and CD3 on T-cells. CD3+ T-cells released perforin/granzymes, resulting in cytolysis of the primary tumor and metastasis, synergistically with radiation. These phenomena in sessions 1 and 2 resulted in EF 1.7 in primary tumor and 79% reduction in metastasis.

#### CONCLUSION

This targeted theranostic nanomedicine improved the diagnostic ability and therapeutic effect.

#### CLINICAL RELEVANCE/APPLICATION

The targeted theranostic nanomedicine in IMC-KRASG12D can improve the diagnostic ability and therapeutic effect in radioimmunotherapy.

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## Abstract Archives of the RSNA, 2023

T7-STCE1-2

### Assessment of Oxygen Saturation in Breast Tumors Using Photoacoustic Imaging: Correlation with Benign and Malignant Disease

Tuesday, Nov. 28 2:30PM - 3:00PM Room: Learning Center Theater 1

Zhibin Huang (*Presenter*) Nothing to Disclose

#### PURPOSE

To measure the oxygenation status of tissue in and on both sides of the tumor in BC participants using a multimodal Photoacoustic/ultrasound (PA/US) imaging system and to determine the correlation between So<sub>2</sub> measured by PA imaging and benign or malignant disease.

#### METHODS AND MATERIALS

Multimodal PA/US imaging and gray-scale US (GSUS) of breast tumor were performed in consecutive BC participants treated in the US Outpatient Clinic between 2022 and 2023. Dual-wavelength PA imaging was used to measure the So<sub>2</sub> value inside the tumor and on both sides of the tissue, and to distinguish benign from malignant tumors based on the So<sub>2</sub> value. The ability of So<sub>2</sub> to distinguish benign from malignant breast tumors was evaluated by the receiver operating characteristic curve (ROC) and the De-Long test.

#### RESULTS

A total of 120 BC participants (median age, 42.5 years) were included in the study. The malignant tumors exhibited lower So<sub>2</sub> levels compared to benign tumors (malignant: 71.30%; benign: 83.81%;  $p < .01$ ). Moreover, PA /US imaging demonstrates superior diagnostic results compared to GSUS, with an area under the curve (AUC) of 0.89 versus 0.70, sensitivity of 89.58% versus 85.42%, and specificity of 86.11% versus 55.56% at the So<sub>2</sub> cut-off value of 78.85 ( $p < .001$ ). The false positive rate in GSUS reduced by 30.75%, and the false negative rate diminished by 4.16% with PA /US diagnosis. Finally, SO<sub>2</sub> was on both sides of malignant tumor tissues below the sides of benign tumors.

#### CONCLUSION

PA imaging allows for the assessment of So<sub>2</sub> within the tumors of BC patients, thereby facilitating a superior distinction between benign and malignant tumors.

#### CLINICAL RELEVANCE/APPLICATION

Photoacoustic imaging technology can provide additional information about tumors, assist gray-scale ultrasound to diagnose breast tumors more accurately, distinguish between benign and malignant, and reduce false positives and false negatives in the diagnosis of breast tumors by gray-scale ultrasound. Using photoacoustic imaging to assess the oxygenation status of tumors, more precise diagnosis of breast cancer is possible.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-STCE2

### Science Session (Sustainability in Imaging)

Tuesday, Nov. 28 2:30PM - 3:00PM Room: Learning Center Theater 2

#### Sub-Events

### T7-STCE2-1 Field Strength-Dependent Differences in Energy Consumption of MRI Pulse Sequences - Comparison Between 0.55T, 1.5T and 3T

Jan Vosshenrich, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the extent of field strength-dependent differences in energy consumption of MRI pulse sequences between 0.55T, 1.5T and 3T.

#### METHODS AND MATERIALS

Our tertiary care radiology department operates six MRI scanners, including one 0.55T system (MAGNETOM Free.Max; gradient system: 26 mT/m [amplitude]; 45 T/m/s [slew rate]), two 1.5T systems (MAGNETOM Avanto FIT; 45 mT/m, 200 T/m/s) and three 3T systems (MAGNETOM Skyra; 45mT/m, 200 T/m/s, MAGENTOM Skyra FIT; 45mT/m, 200 T/m/s, and MAGNETOM Prisma; 80 mT/m, 200 T/m/s) from the same vendor. MRI units were equipped power measurement sensors (2-Hz sampling rate). Power consumption data with reconstructed 1-second data intervals was extracted from the central building information system and matched with scanner log files and anonymized examination metadata from the radiology information system using timestamps. Data was reviewed for MRI examinations performed at all three field strengths with identical imaging protocols. Mean energy consumption of 20 individual pulse sequences from six distinct imaging protocols was calculated in kilowatt-hours (kWh) and compared between MRI units.

#### RESULTS

Mean energy consumption per pulse sequence increased with field strength and gradient power both overall ( $1.4 \pm 0.8$  kWh [0.55T] vs.  $1.7 \pm 0.8$  kWh [1.5T; +21% vs. 0.55T] vs.  $2.4 \pm 1.0$  kWh [3T; +41% vs. 1.5T; +71% vs. 0.55T]), and for distinct sequences, e.g. the sagittal T1-weighted sequence in lumbar spine MRI ( $0.8 \pm 0.1$  kWh [0.55T] vs.  $1.1 \pm 0.2$  kWh [1.5T; +38% vs. 0.55T] vs.  $1.9 \pm 0.1$  kWh [3T; +73% vs. 1.5T; +138% vs. 0.55T]). Highest mean energy consumption was observed for the axial DWI in prostate MRI ( $3.8 \pm 0.2$  kWh [0.55T] vs.  $4.2 \pm 0.3$  kWh [1.5T; +11% vs. 0.55T] vs.  $4.7 \pm 0.2$  kWh [3T; +12% vs. 1.5T; +24% vs. 0.55T]), lowest for axial T1 Dixon sequences acquired in a single breath hold in abdominal MRI exams ( $0.1 \pm 0.0$  kWh [0.55T] vs.  $0.1 \pm 0.0$  kWh [1.5T] vs.  $0.2 \pm 0.0$  kWh [3T; +100% vs. 0.55T and 1.5T]). On an examination level, total energy consumption per imaging protocol similarly increased with field strength and gradient power, despite often longer measurement times at 0.55T, e.g. for an ankle MRI ( $6.5$  kWh [0.55T] vs.  $10.0$  kWh [1.5T; +54% vs. 0.55T] vs.  $20.2$  kWh [3T; +102% vs. 1.5T; +211% vs. 0.55T]) or a lumbar spine MRI ( $5.5$  kWh [0.55T] vs.  $6.4$  kWh [1.5T; +16% vs. 0.55T] vs.  $11.3$  kWh [3T; +77% vs. 1.5T; +105% vs. 0.55T]).

#### CONCLUSION

MRI energy consumption of pulse sequences and imaging protocols increases substantially with increasing field strength and gradient power of the MRI scanner system used for image acquisition.

#### CLINICAL RELEVANCE/APPLICATION

Acquiring MRI examinations at a lower field strength when reasonable from a diagnostic performance perspective may reduce energy consumption and improve the sustainability of imaging.

### T7-STCE2-2 The Energy Consumption of Angiography in Interventional Radiology - Operational Strategies to Reduce Carbon Footprint and Costs

Jan Vosshenrich, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the energy consumption, cost and carbon footprint of angiography units and determine savings through changes in power management strategies.

## METHODS AND MATERIALS

Our interventional radiology division operates two angiography and one fluoroscopy unit. In total, around 2'500 procedures are performed annually. Devices were equipped with kilowatt-hour energy measurement sensors (0.5-second sampling rate [2 Hz]). Energy measurements and procedural information from the radiology information system were analyzed over a 4-week period (09/01/2022 - 09/28/2022) and segmented into system states: (1) off, (2) idle, (3) procedure (patient in room). Furthermore, individual procedural dose information was retrieved to calculate actual fluoro times. Energy consumption and carbon emissions overall, per imaging system and for the different system states were calculated. Annual energy consumption, electricity cost, carbon emissions and cost saving opportunities by shutting down systems during off-hours were estimated based on the available data.

## RESULTS

Power draws for each mode were measured as  $0.5\pm 0.1$  kW to  $1.0\pm 0.1$  kW (system off),  $2.1\pm 0.1$  kW to  $7.7\pm 0.3$  kW (idle), and  $3.3\pm 0.2$  kW to  $8.8\pm 2.0$  kW (procedure). Projected annual energy consumption per unit ranged between 19.9 and 68.2 MW-hours, respectively. When switching the units from idle to off mode during off-hours (as it is now current practice at our institution), energy consumption could be decreased between 45.7% and 65.5% to 10.9 to 25.5 MW-hours, respectively. 78.4% to 90.4% of the measurement time period represented nonproductive energy consumption of the imaging units (idle and system off mode), with overall procedure times (patient in room) representing only 64:26 hours to 101:05 hours per unit over the 4-week measurement period (672:00 hours). Furthermore, actual image acquisition time (fluoro time) only added up to 9.6% and 21.6% of the total procedure time for angiography, and 0.8% for fluoroscopy. Projected annual savings by switching off angiography and fluoroscopy units during off-hours added up to 89.3 MW-hours in energy consumption, \$22'325 USD in cost (electricity price: \$0.25 USD per kWh) and 11.4 metric tons of carbon dioxide equivalent (MTCO<sub>2</sub>eq).

## CONCLUSION

Powering down angiography units during off-hours and longer periods of idle time has substantial sustainability and cost benefits, and make radiology departments more energy efficient without affecting patient care.

## CLINICAL RELEVANCE/APPLICATION

Knowledge on energy consumption and subsequent implementation of power-saving measures, such as switching angiography and fluoroscopy units off when not in use can help radiology departments to substantially reduce energy, expenses, and carbon emissions.

## T7-STCE2-3 Revolutionizing 3T Animal Imaging: Metamaterials' Advantages in Enhancing Contrast and Low-Carbon Endeavors

Shiman Wu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Metamaterials have specific electromagnetic properties due to their element arrangement, enhancing MRI receiving field, improving SNR, image quality, and scan time. This reduces the need for repeat scans and energy-intensive processes. They also increase the efficiency of the body coil by reducing its power, minimizing electric power waste. Owing to their nonlinearity, the metamaterials are compatible with all commonly used sequences without requiring parameter adjustments, preserving intrinsic contrast T1 and T2 values of tested tissue. This study aims to investigate their application in enhancing 3T animal imaging contrast and resolution compared to traditional commercial animal coils.

## METHODS AND MATERIALS

The study was conducted on a 3T MRI system (Prisma, Siemens, Germany). One healthy SD rat and one healthy C57 mouse were scanned using metamaterials (TsingMeta, Beijing, China) along with a 64-channel head coil (Siemens), with a commercial animal-specific coil as control. Both coil configurations acquired T2 weighted imaging (T2WI) by T2 Fast Spin Echo (FSE) and T1WI by T1 StarVibe sequences. Imaging parameters (FOV, matrix size, slice thickness, TE, TR) were same for comparability. Experienced radiologists assessed image quality and anatomical visualization for each coil. Quantitative comparisons were made by signal-to-noise ratio (SNR).  $SNR (ROI \text{ thalamus}) = \text{Signal} (ROI \text{ thalamus}) / SD (ROI \text{ air})$ .

## RESULTS

Compared to traditional commercial rat coils, the metamaterials coil configurations exhibited a significant improvement in resolution, achieving  $0.16*0.16*1$  mm on T2WI and  $0.13*0.13*1$  mm on T1WI for both mouse and rat imaging, outperforming traditional animal coils. SNR was significantly enhanced for both mice (2.2-fold for T2WI, 7.1-fold for T1WI) and rats (1.2-fold for T2WI, 3.3-fold for T1WI). The higher resolution facilitated clearer delineation of the anatomy, such as the olfactory bulb, cortex, medulla and pons. T2WI scan times: mice (2min12s), rats (3min47s). T1WI scan times: mice (3min1s), rats (4min1s).

## **CONCLUSION**

Metamaterials coils exceed traditional coils in resolution and contrast, with clinical significance due to their adaptability and ability to achieve high-resolution imaging in low-field MRI systems. Increased coil efficiency directly leads to lower electricity consumption.

## **CLINICAL RELEVANCE/APPLICATION**

Metamaterials provide wireless connections and are compatible with MRI machines, enabling high-resolution imaging and shorter scan times. Using them optimizes medical imaging efficiency, reduces energy usage, and advances low-carbon initiatives, minimizing healthcare's environmental impact.

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## Abstract Archives of the RSNA, 2023

T7-STCE2-1

### Field Strength-Dependent Differences in Energy Consumption of MRI Pulse Sequences - Comparison Between 0.55T, 1.5T and 3T

Tuesday, Nov. 28 2:30PM - 3:00PM Room: Learning Center Theater 2

Jan Vosshenrich, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the extent of field strength-dependent differences in energy consumption of MRI pulse sequences between 0.55T, 1.5T and 3T.

#### METHODS AND MATERIALS

Our tertiary care radiology department operates six MRI scanners, including one 0.55T system (MAGNETOM Free.Max; gradient system: 26 mT/m [amplitude]; 45 T/m/s [slew rate]), two 1.5T systems (MAGNETOM Avanto FIT; 45 mT/m, 200 T/m/s) and three 3T systems (MAGNETOM Skyra; 45mT/m, 200 T/m/s, MAGENTOM Skyra FIT; 45mT/m, 200 T/m/s, and MAGNETOM Prisma; 80 mT/m, 200 T/m/s) from the same vendor. MRI units were equipped power measurement sensors (2-Hz sampling rate). Power consumption data with reconstructed 1-second data intervals was extracted from the central building information system and matched with scanner log files and anonymized examination metadata from the radiology information system using timestamps. Data was reviewed for MRI examinations performed at all three field strengths with identical imaging protocols. Mean energy consumption of 20 individual pulse sequences from six distinct imaging protocols was calculated in kilowatt-hours (kWh) and compared between MRI units.

#### RESULTS

Mean energy consumption per pulse sequence increased with field strength and gradient power both overall ( $1.4 \pm 0.8$  kWh [0.55T] vs.  $1.7 \pm 0.8$  kWh [1.5T; +21% vs. 0.55T] vs.  $2.4 \pm 1.0$  kWh [3T; +41% vs. 1.5T; +71% vs. 0.55T]), and for distinct sequences, e.g. the sagittal T1-weighted sequence in lumbar spine MRI ( $0.8 \pm 0.1$  kWh [0.55T] vs.  $1.1 \pm 0.2$  kWh [1.5T; +38% vs. 0.55T] vs.  $1.9 \pm 0.1$  kWh [3T; +73% vs. 1.5T; +138% vs. 0.55T]). Highest mean energy consumption was observed for the axial DWI in prostate MRI ( $3.8 \pm 0.2$  kWh [0.55T] vs.  $4.2 \pm 0.3$  kWh [1.5T; +11% vs. 0.55T] vs.  $4.7 \pm 0.2$  kWh [3T; +12% vs. 1.5T; +24% vs. 0.55T]), lowest for axial T1 Dixon sequences acquired in a single breath hold in abdominal MRI exams ( $0.1 \pm 0.0$  kWh [0.55T] vs.  $0.1 \pm 0.0$  kWh [1.5T] vs.  $0.2 \pm 0.0$  kWh [3T; +100% vs. 0.55T and 1.5T]). On an examination level, total energy consumption per imaging protocol similarly increased with field strength and gradient power, despite often longer measurement times at 0.55T, e.g. for an ankle MRI ( $6.5$  kWh [0.55T] vs.  $10.0$  kWh [1.5T; +54% vs. 0.55T] vs.  $20.2$  kWh [3T; +102% vs. 1.5T; +211% vs. 0.55T]) or a lumbar spine MRI ( $5.5$  kWh [0.55T] vs.  $6.4$  kWh [1.5T; +16% vs. 0.55T] vs.  $11.3$  kWh [3T; +77% vs. 1.5T; +105% vs. 0.55T]).

#### CONCLUSION

MRI energy consumption of pulse sequences and imaging protocols increases substantially with increasing field strength and gradient power of the MRI scanner system used for image acquisition.

#### CLINICAL RELEVANCE/APPLICATION

Acquiring MRI examinations at a lower field strength when reasonable from a diagnostic performance perspective may reduce energy consumption and improve the sustainability of imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-STCE2-2

### The Energy Consumption of Angiography in Interventional Radiology - Operational Strategies to Reduce Carbon Footprint and Costs

Tuesday, Nov. 28 2:30PM - 3:00PM Room: Learning Center Theater 2

Jan Vosshenrich, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the energy consumption, cost and carbon footprint of angiography units and determine savings through changes in power management strategies.

#### METHODS AND MATERIALS

Our interventional radiology division operates two angiography and one fluoroscopy unit. In total, around 2'500 procedures are performed annually. Devices were equipped with kilowatt-hour energy measurement sensors (0.5-second sampling rate [2 Hz]). Energy measurements and procedural information from the radiology information system were analyzed over a 4-week period (09/01/2022 - 09/28/2022) and segmented into system states: (1) off, (2) idle, (3) procedure (patient in room). Furthermore, individual procedural dose information was retrieved to calculate actual fluoro times. Energy consumption and carbon emissions overall, per imaging system and for the different system states were calculated. Annual energy consumption, electricity cost, carbon emissions and cost saving opportunities by shutting down systems during off-hours were estimated based on the available data.

#### RESULTS

Power draws for each mode were measured as  $0.5 \pm 0.1$  kW to  $1.0 \pm 0.1$  kW (system off),  $2.1 \pm 0.1$  kW to  $7.7 \pm 0.3$  kW (idle), and  $3.3 \pm 0.2$  kW to  $8.8 \pm 2.0$  kW (procedure). Projected annual energy consumption per unit ranged between 19.9 and 68.2 MW-hours, respectively. When switching the units from idle to off mode during off-hours (as it is now current practice at our institution), energy consumption could be decreased between 45.7% and 65.5% to 10.9 to 25.5 MW-hours, respectively. 78.4% to 90.4% of the measurement time period represented nonproductive energy consumption of the imaging units (idle and system off mode), with overall procedure times (patient in room) representing only 64:26 hours to 101:05 hours per unit over the 4-week measurement period (672:00 hours). Furthermore, actual image acquisition time (fluoro time) only added up to 9.6% and 21.6% of the total procedure time for angiography, and 0.8% for fluoroscopy. Projected annual savings by switching off angiography and fluoroscopy units during off-hours added up to 89.3 MW-hours in energy consumption, \$22'325 USD in cost (electricity price: \$0.25 USD per kWh) and 11.4 metric tons of carbon dioxide equivalent (MTCO<sub>2</sub>eq).

#### CONCLUSION

Powering down angiography units during off-hours and longer periods of idle time has substantial sustainability and cost benefits, and make radiology departments more energy efficient without affecting patient care.

#### CLINICAL RELEVANCE/APPLICATION

Knowledge on energy consumption and subsequent implementation of power-saving measures, such as switching angiography and fluoroscopy units off when not in use can help radiology departments to substantially reduce energy, expenses, and carbon emissions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T7-STCE2-3

### Revolutionizing 3T Animal Imaging: Metamaterials' Advantages in Enhancing Contrast and Low-Carbon Endeavors

Tuesday, Nov. 28 2:30PM - 3:00PM Room: Learning Center Theater 2

Shiman Wu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Metamaterials have specific electromagnetic properties due to their element arrangement, enhancing MRI receiving field, improving SNR, image quality, and scan time. This reduces the need for repeat scans and energy-intensive processes. They also increase the efficiency of the body coil by reducing its power, minimizing electric power waste. Owing to their nonlinearity, the metamaterials are compatible with all commonly used sequences without requiring parameter adjustments, preserving intrinsic contrast T1 and T2 values of tested tissue. This study aims to investigate their application in enhancing 3T animal imaging contrast and resolution compared to traditional commercial animal coils.

#### METHODS AND MATERIALS

The study was conducted on a 3T MRI system (Prisma, Siemens, Germany). One healthy SD rat and one healthy C57 mouse were scanned using metamaterials (TsingMeta, Beijing, China) along with a 64-channel head coil (Siemens), with a commercial animal-specific coil as control. Both coil configurations acquired T2 weighted imaging (T2WI) by T2 Fast Spin Echo (FSE) and T1WI by T1 StarVibe sequences. Imaging parameters (FOV, matrix size, slice thickness, TE, TR) were same for comparability. Experienced radiologists assessed image quality and anatomical visualization for each coil. Quantitative comparisons were made by signal-to-noise ratio (SNR).  $SNR (ROI\ thalamus) = Signal (ROI\ thalamus) / SD (ROI\ air)$ .

#### RESULTS

Compared to traditional commercial rat coils, the metamaterials coil configurations exhibited a significant improvement in resolution, achieving  $0.16 \times 0.16 \times 1$  mm on T2WI and  $0.13 \times 0.13 \times 1$  mm on T1WI for both mouse and rat imaging, outperforming traditional animal coils. SNR was significantly enhanced for both mice (2.2-fold for T2WI, 7.1-fold for T1WI) and rats (1.2-fold for T2WI, 3.3-fold for T1WI). The higher resolution facilitated clearer delineation of the anatomy, such as the olfactory bulb, cortex, medulla and pons. T2WI scan times: mice (2min12s), rats (3min47s). T1WI scan times: mice (3min1s), rats (4min1s).

#### CONCLUSION

Metamaterials coils exceed traditional coils in resolution and contrast, with clinical significance due to their adaptability and ability to achieve high-resolution imaging in low-field MRI systems. Increased coil efficiency directly leads to lower electricity consumption.

#### CLINICAL RELEVANCE/APPLICATION

Metamaterials provide wireless connections and are compatible with MRI machines, enabling high-resolution imaging and shorter scan times. Using them optimizes medical imaging efficiency, reduces energy usage, and advances low-carbon initiatives, minimizing healthcare's environmental impact.

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## Abstract Archives of the RSNA, 2023

T8-SSNMMI04

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Cardiovascular and Pulmonary)

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353C

Andrei Iagaru, MD (*Moderator*) Research Grant, General Electric Company; Research Grant, Lantheus Holdings; Research Grant, Novartis AG

Ryan J. Avery, MD (*Moderator*) Research Consultant, Konica Minolta, Inc

#### Sub-Events

#### T8-SSNMMI04-1 **Keynote Speaker**

1 Andrei Iagaru, MD (*Presenter*) Research Grant, General Electric Company; Research Grant, Lantheus Holdings; Research Grant, Novartis AG

#### T8-SSNMMI04-2 **Diagnostic Performance of Ultra-Early Phase <sup>99m</sup>Tc-PYP Scintigraphy for Detecting ATTR Cardiac Amyloidosis**

Shinichiro Kida (*Presenter*) Nothing to Disclose

#### PURPOSE

<sup>99m</sup>Tc-PYP scintigraphy is a noninvasive imaging modality used to diagnose transthyretin cardiac amyloidosis (ATTR-CA). The heart-to-contralateral (H/CL) ratio is an essential imaging biomarker for semi-quantitative interpretation of <sup>99m</sup>Tc-PYP uptake in myocardium. However, measuring the H/CL ratio requires planar imaging at 1 hour and/or 3 hours post-injection, which is time-consuming and can cause physical exhaustion and discomfort for elderly patients. In this study, we investigated the diagnostic performance of the ultra-early phase H/CL ratio measurement for ATTR-CA.

#### METHODS AND MATERIALS

We retrospectively evaluated 8 patients who underwent <sup>99m</sup>Tc-PYP scintigraphy and endomyocardial biopsy. Four patients were biopsy-proven diagnosis of ATTR-CA, while the other 4 patients were initially suspected of ATTR-CA but were ultimately diagnosed with hypertensive cardiomyopathy (non-CA). Each patient underwent to dynamic scintigraphic scanning starting at intravenous injection of approximately 740MBq of <sup>99m</sup>Tc-PYP. Three-minute planar images were reconstructed from the dynamic data every minute from 3 to 20 minutes and then every 5-minutes from 25 to 60 minutes after injection. The H/CL ratio was assessed on each planar image.

#### RESULTS

Myocardial uptake of <sup>99m</sup>Tc-PYP was visually observed on the planar images obtained 5 minutes after injection. The H/CL ratio on the planar images acquired at 5 minutes post-injection showed a significant difference between ATTR-CA and non-CA patients (1.88 vs. 1.46, respectively,  $p=0.032$ ). The H/CL ratios in all planar images reconstructed using dynamic data acquired from 5 minutes after injection onwards were significantly higher in ATTR-CA patients than in non-CA patients ( $p<0.05$ ). According to the ROC analysis for detecting ATTR-CA, the area under the curve was 0.9375 at 5 minutes and 1.0 for time points later than 6 minutes after injection. The optimal cut off value was determined to be 1.6 at 5 minutes with 100% sensitivity and 75% specificity.

#### CONCLUSION

The ultra-early phase <sup>99m</sup>Tc-PYP scintigraphy can help to distinguish ATTR-CA from non-CA as early as 5 minutes post-injection. This imaging technique is less time-consuming and less burdensome, making it particularly suitable for elderly patients.

#### CLINICAL RELEVANCE/APPLICATION



Ultra-early phase 99mTc-PYP scintigraphy can detect ATTR-CA with 100% sensitivity at 5 minutes after tracer injection. It is less time-consuming and more beneficial particularly for elderly patients than the conventional protocol.

### **T8-SSNMMI04-3 18F-FDG PET Predicts Patient Survival in Patients with Systemic Sclerosis Associated Interstitial Lung Disease (SSc-ILD)**

David M. Lilburn, PhD, FRCR (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the potential of 18F-FDG-PET/ CT to predict mortality in patients with systemic sclerosis associated interstitial lung disease (SSc-ILD).

#### **METHODS AND MATERIALS**

45 patients with SSc-ILD (12-male, 33-female, mean-age 58.9±9.9yrs) were prospectively recruited for 18F-FDG-PET/CT. All patients underwent full clinical assessment including multidisciplinary team review, HRCT evaluation and standard pulmonary function tests (PFTs). Follow up was defined from the date of scan to death (all cause) or until August 2021 (8 years). The overall maximum pulmonary uptake of 18F-FDG (SUV<sub>max</sub>), the minimum pulmonary uptake or background-lung-activity (SUV<sub>min</sub>) and target-to-background (SUV<sub>max</sub>/SUV<sub>min</sub>) ratio (TBR) were quantified using routine region-of-interest analysis. Kaplan-Meier analysis was used to identify associations with mortality. Associations between PET metrics and PFTs were also performed. Finally, we compared associations between PET metrics and the established ILD-GAP scoring system (gender (G), age (A), and 2 lung physiology (P) measurements [FVC and TLCO]) to predict mortality. Stepwise forward Wald-Cox analysis assessed the independence of the significant PET measurement(s) from the ILD-GAP index. Synergies between pulmonary 18F-FDG-PET measurements and ILD-GAP index for risk stratification in SSc-ILD patients were investigated.

#### **RESULTS**

During a mean follow-up of 53.8 months there were 15 deaths. The mean SUV<sub>max</sub>±SD was 3.2±1.1 and TBR was 6.8±2.6. Mortality was associated with high pulmonary SUV<sub>max</sub> (p=0.027), high SUV<sub>min</sub> (p=0.002), high TBR (p=0.016) and low forced vital capacity (FVC, p=0.021), low lung carbon monoxide diffusion coefficient (KCO, p=0.021) and low transfer factor (TLCO, p=0.012), high ILD-GAP score (p=0.010) and high ILD-GAP index (p=0.005). Moderate correlation between SUV<sub>max</sub> and FVC was demonstrated (rs=0.341, p=0.022). Cox-regression analysis revealed that pulmonary SUV<sub>min</sub> was independent of ILD-GAP classification (p=0.024). Combining 18F-FDG PET with ILD-GAP data (modified ILD-GAP score) refined the ability to predict mortality (p<0.001).

#### **CONCLUSION**

High pulmonary uptake of 18F-FDG (SUV<sub>max</sub> and TBR) is able to predict increased risk of mortality in patients with SSc-ILD. High background uptake in normal appearing lung (SUV<sub>min</sub>) may have an additional independent prognostic benefit in addition to the ILD-GAP index. 18F-FDG PET may be a much clinically needed sensitive biomarker to help risk stratify patients with SSc-ILD.

#### **CLINICAL RELEVANCE/APPLICATION**

We present original data showing that high pulmonary 18F-FDG uptake is associated with poor survival in SSc-ILD patients in a condition where early, sensitive prognostic biomarkers are currently lacking.

### **T8-SSNMMI04-4 18F-FDG Uptake Patterns in PET/CT Caused by Inflammation and/or Infection after Thoracic Vascular Graft Surgery**

Lars Husmann, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of the study was to identify 18F-fluorodeoxyglucose (FDG) uptake patterns in positron emission tomography/computed tomography (PET/CT) caused by infection, inflammation, and/or operation material/technique in patients after aortic dissection and thoracic aortic graft surgery.

#### **METHODS AND MATERIALS**

Consecutive patients after aortic dissection and thoracic aortic graft surgery (n=610) were screened for postoperative PET/CT examinations. Of 65 patients, five had no written consent; hence, 60 patients with 187 PET/CT were retrospectively included. We quantified FDG uptake in all grafts by using maximum standardized uptake values (SUV<sub>max</sub>) and SUV<sub>max</sub> in relation to liver background (SUV<sub>ratio</sub>), and determined whether the uptake was focal, diffuse and/or associated with the graft anastomosis. Mixed linear regression models with random slope and intercept were applied for the analysis of associations with SUV<sub>ratio</sub> and generalized estimating equations (binomial family and logit link) to analyze the associations with uptake at the graft anastomosis.

## RESULTS

Focal FDG uptake in PET/CT after thoracic aortic graft surgery was frequent (54/60, 90%), generally high (mean SUVmax 6.9, mean SUVratio 2.0), higher in infected than in non-infected grafts (mean SUVratio 2.09; 95% confidence interval (CI) 1.94-2.25 versus 1.63; 1.41-1.85,  $P < 0.001$ ), and potentially very slowly decreasing over time (SUVratio per year since operation  $-0.04$ ; 95% CI  $-0.11$  to  $0.03$ ,  $P = 0.25$ ), without a difference in slope between infected versus non-infected grafts ( $P = 0.62$ ). There was no evidence of an interaction between the slope and intercept of SUVratio and the use of surgical adhesives (BioGlue®) (intercept  $P = 0.46$ , slope  $P = 0.71$ ), and no evidence of an association with graft material (gelatin  $P = 0.97$ , collagen  $P = 0.98$ ). Focal FDG uptake associated with the location of anastomosis was found in 45% (27/60) of patients, more frequently in non-infected than in infected grafts (65% versus 16%, odds ratio (OR) 9.56; 95% CI 3.13-29.2,  $P < 0.001$ ). With BioGlue®, FDG uptake showed a weak trend towards less frequently being associated with the location of anastomosis (OR 0.39; 95% CI 0.11-1.40,  $P = 0.15$ ).

## CONCLUSION

FDG uptake in PET/CT after thoracic aortic graft surgery is higher in infected than in non-infected grafts. Notably, uptake in non-infected grafts is also frequent, not associated with the type of graft material, but uptake patterns may be affected by the use of tissue surgical adhesives.

## CLINICAL RELEVANCE/APPLICATION

Expanding knowledge on FDG uptake patterns in PET/CT after graft surgery due to inflammation and/or infection may have a direct effect on patients leading to more certain diagnoses and reducing unnecessary treatment.

## T8-SSNMMI04-5 Comparison of Measurement and Prognostic Power of SUV between High Definition and Standard PET Imaging in Non-Small Cell Lung Cancer Patients

Yonglin Pu, MD, PhD (*Presenter*) Stockholder, Myovant Sciences Ltd; Stockholder, Lantheus Holdings

## PURPOSE

To compare the measurement and prognostic power of maximal standardized uptake value of whole-body tumor (SUVmaxWB) measured on high definition (HD) PET imaging (Siemens TrueX incorporating point spread function modeling with smaller voxels) versus standard definition (SD) PET imaging (OSEM) on pretreatment PET/CT images for prognostication in non-small cell lung cancer (NSCLC) patients.

## METHODS AND MATERIALS

A total of 243 consecutive patients with pathology-proven NSCLC who underwent pretreatment PET/CT examination between 4/12/2018 and 1/31/2021 were included in the study. Studies were performed on a Siemens Biograph mCT. For SD PET, reconstructions were performed with OSEM3D + TOF, 2 iterations, 21 subsets, 4.5 mm Gaussian filter, and 2.89 mm x 2.89 mm x 3.00 mm voxels. For HD, reconstructions were performed with PSF + TOF (TrueX), 3 iterations, 21 subsets, 2 mm Gaussian filter, and 1.85 mm x 1.85 mm x 2.03 mm voxels. Each tumor was contoured, and SUVmax and tumor to background ratio (TBR = tumor SUVmax divided by SUVmean of background) of that tumoral lesion was determined. The background SUVmean of normal lung, right atrial blood pool, normal liver and lumbar vertebral body was measured for the calculation of TBR of primary lung tumor, mediastinal nodal metastases, soft tissue and bone metastases, respectively. SUVmaxWB is defined as the maximum of SUVmax of all detected tumors. Overall survival was assessed using Cox regression.

## RESULTS

The study included 243 patients with a mean age of 67.6 years, of whom 59% were female. Over a median follow-up period of 29.5 months among survivors, there were 83 deaths. The SUVmaxWB was significantly higher on HD PET than on SD PET (mean = 19.9 and 13.1, respectively;  $p < 0.001$ ), and the TBR of SUVmax of 639 tumoral lesions in 82 patients was significantly higher on HD PET (median = 7.4 vs 4.0,  $p < 0.0001$ ). Univariate Cox regression analysis revealed that SUVmaxWB on both HD PET and SD PET were significantly associated with overall survival, with hazard ratios of 1.03 (1.02-1.04,  $p < 0.001$ ) and 1.05 (1.03 - 1.06,  $p < 0.001$ ), respectively. After adjusting for clinical TNM stage in a multivariate Cox regression analysis, SUVmaxWB on SD PET was found to be significantly associated with survival (hazard ratio = 1.02, 95% CI 1.0-1.04,  $p = 0.04$ ). However, there was no significant association found between SUVmaxWB on HD PET and survival after adjusting for clinical TNM stage ( $p = 0.16$ ).

## CONCLUSION

In NSCLC patients, HD PET provides statistically significant higher SUVmaxWB and TBR; but less prognostic value compared to SD PET imaging.

## CLINICAL RELEVANCE/APPLICATION

HD PET imaging may improve lesion detection due to its higher TBR, but its SUVmaxWB is not as prognostic in NSCLC patients as compared to that on SD PET, when controlling for TNM stage.

Ryan J. Avery, MD (*Presenter*) Research Consultant, Konica Minolta, Inc



## Abstract Archives of the RSNA, 2023

T8-SSNMMI04-1

### Keynote Speaker

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353C

Andrei Iagaru, MD (*Presenter*) Research Grant, General Electric Company; Research Grant, Lantheus Holdings; Research Grant, Novartis AG

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## Abstract Archives of the RSNA, 2023

T8-SSNMMI04-2

### Diagnostic Performance of Ultra-Early Phase $^{99m}\text{Tc}$ -PYP Scintigraphy for Detecting ATTR Cardiac Amyloidosis

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353C

Shinichiro Kida (*Presenter*) Nothing to Disclose

#### PURPOSE

$^{99m}\text{Tc}$ -PYP scintigraphy is a noninvasive imaging modality used to diagnose transthyretin cardiac amyloidosis (ATTR-CA). The heart-to-contralateral (H/CL) ratio is an essential imaging biomarker for semi-quantitative interpretation of  $^{99m}\text{Tc}$ -PYP uptake in myocardium. However, measuring the H/CL ratio requires planar imaging at 1 hour and/or 3 hours post-injection, which is time-consuming and can cause physical exhaustion and discomfort for elderly patients. In this study, we investigated the diagnostic performance of the ultra-early phase H/CL ratio measurement for ATTR-CA.

#### METHODS AND MATERIALS

We retrospectively evaluated 8 patients who underwent  $^{99m}\text{Tc}$ -PYP scintigraphy and endomyocardial biopsy. Four patients were biopsy-proven diagnosis of ATTR-CA, while the other 4 patients were initially suspected of ATTR-CA but were ultimately diagnosed with hypertensive cardiomyopathy (non-CA). Each patient underwent to dynamic scintigraphic scanning starting at intravenous injection of approximately 740MBq of  $^{99m}\text{Tc}$ -PYP. Three-minute planar images were reconstructed from the dynamic data every minute from 3 to 20 minutes and then every 5-minutes from 25 to 60 minutes after injection. The H/CL ratio was assessed on each planar image.

#### RESULTS

Myocardial uptake of  $^{99m}\text{Tc}$ -PYP was visually observed on the planar images obtained 5 minutes after injection. The H/CL ratio on the planar images acquired at 5 minutes post-injection showed a significant difference between ATTR-CA and non-CA patients (1.88 vs. 1.46, respectively,  $p=0.032$ ). The H/CL ratios in all planar images reconstructed using dynamic data acquired from 5 minutes after injection onwards were significantly higher in ATTR-CA patients than in non-CA patients ( $p<0.05$ ). According to the ROC analysis for detecting ATTR-CA, the area under the curve was 0.9375 at 5 minutes and 1.0 for time points later than 6 minutes after injection. The optimal cut off value was determined to be 1.6 at 5 minutes with 100% sensitivity and 75% specificity.

#### CONCLUSION

The ultra-early phase  $^{99m}\text{Tc}$ -PYP scintigraphy can help to distinguish ATTR-CA from non-CA as early as 5 minutes post-injection. This imaging technique is less time-consuming and less burdensome, making it particularly suitable for elderly patients.

#### CLINICAL RELEVANCE/APPLICATION

Ultra-early phase  $^{99m}\text{Tc}$ -PYP scintigraphy can detect ATTR-CA with 100% sensitivity at 5 minutes after tracer injection. It is less time-consuming and more beneficial particularly for elderly patients than the conventional protocol.

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## Abstract Archives of the RSNA, 2023

T8-SSNMMI04-3

### **<sup>18</sup>F-FDG PET Predicts Patient Survival in Patients with Systemic Sclerosis Associated Interstitial Lung Disease (SSc-ILD)**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353C

David M. Lilburn, PhD, FRCR (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the potential of <sup>18</sup>F-FDG-PET/ CT to predict mortality in patients with systemic sclerosis associated interstitial lung disease (SSc-ILD).

#### **METHODS AND MATERIALS**

45 patients with SSc-ILD (12-male, 33-female, mean-age 58.9±9.9yrs) were prospectively recruited for <sup>18</sup>F-FDG-PET/CT. All patients underwent full clinical assessment including multidisciplinary team review, HRCT evaluation and standard pulmonary function tests (PFTs). Follow up was defined from the date of scan to death (all cause) or until August 2021 (8 years). The overall maximum pulmonary uptake of <sup>18</sup>F-FDG (SUV<sub>max</sub>), the minimum pulmonary uptake or background-lung-activity (SUV<sub>min</sub>) and target-to-background (SUV<sub>max</sub>/SUV<sub>min</sub>) ratio (TBR) were quantified using routine region-of-interest analysis. Kaplan-Meier analysis was used to identify associations with mortality. Associations between PET metrics and PFTs were also performed. Finally, we compared associations between PET metrics and the established ILD-GAP scoring system (gender (G), age (A), and 2 lung physiology (P) measurements [FVC and TLCO]) to predict mortality. Stepwise forward Wald-Cox analysis assessed the independence of the significant PET measurement(s) from the ILD-GAP index. Synergies between pulmonary <sup>18</sup>F-FDG-PET measurements and ILD-GAP index for risk stratification in SSc-ILD patients were investigated.

#### **RESULTS**

During a mean follow-up of 53.8 months there were 15 deaths. The mean SUV<sub>max</sub>±SD was 3.2±1.1 and TBR was 6.8±2.6. Mortality was associated with high pulmonary SUV<sub>max</sub> (p=0.027), high SUV<sub>min</sub> (p=0.002), high TBR (p=0.016) and low forced vital capacity (FVC, p=0.021), low lung carbon monoxide diffusion coefficient (KCO, p=0.021) and low transfer factor (TLCO, p=0.012), high ILD-GAP score (p=0.010) and high ILD-GAP index (p=0.005). Moderate correlation between SUV<sub>max</sub> and FVC was demonstrated (rs=0.341, p=0.022). Cox-regression analysis revealed that pulmonary SUV<sub>min</sub> was independent of ILD-GAP classification (p=0.024). Combining <sup>18</sup>F-FDG PET with ILD-GAP data (modified ILD-GAP score) refined the ability to predict mortality (p<0.001).

#### **CONCLUSION**

High pulmonary uptake of <sup>18</sup>F-FDG (SUV<sub>max</sub> and TBR) is able to predict increased risk of mortality in patients with SSc-ILD. High background uptake in normal appearing lung (SUV<sub>min</sub>) may have an additional independent prognostic benefit in addition to the ILD-GAP index. <sup>18</sup>F-FDG PET may be a much clinically needed sensitive biomarker to help risk stratify patients with SSc-ILD.

#### **CLINICAL RELEVANCE/APPLICATION**

We present original data showing that high pulmonary <sup>18</sup>F-FDG uptake is associated with poor survival in SSc-ILD patients in a condition where early, sensitive prognostic biomarkers are currently lacking.

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## Abstract Archives of the RSNA, 2023

T8-SSNMMI04-4

### FDG Uptake Patterns in PET/CT Caused by Inflammation and/or Infection after Thoracic Vascular Graft Surgery

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353C

Lars Husmann, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of the study was to identify 18F-fluorodeoxyglucose (FDG) uptake patterns in positron emission tomography/computed tomography (PET/CT) caused by infection, inflammation, and/or operation material/technique in patients after aortic dissection and thoracic aortic graft surgery.

#### METHODS AND MATERIALS

Consecutive patients after aortic dissection and thoracic aortic graft surgery (n=610) were screened for postoperative PET/CT examinations. Of 65 patients, five had no written consent; hence, 60 patients with 187 PET/CT were retrospectively included. We quantified FDG uptake in all grafts by using maximum standardized uptake values (SUVmax) and SUVmax in relation to liver background (SUVratio), and determined whether the uptake was focal, diffuse and/or associated with the graft anastomosis. Mixed linear regression models with random slope and intercept were applied for the analysis of associations with SUVratio and generalized estimating equations (binomial family and logit link) to analyze the associations with uptake at the graft anastomosis.

#### RESULTS

Focal FDG uptake in PET/CT after thoracic aortic graft surgery was frequent (54/60, 90%), generally high (mean SUVmax 6.9, mean SUVratio 2.0), higher in infected than in non-infected grafts (mean SUVratio 2.09; 95% confidence interval (CI) 1.94-2.25 versus 1.63; 1.41-1.85,  $P < 0.001$ ), and potentially very slowly decreasing over time (SUVratio per year since operation -0.04; 95% CI -0.11 to 0.03,  $P = 0.25$ ), without a difference in slope between infected versus non-infected grafts ( $P = 0.62$ ). There was no evidence of an interaction between the slope and intercept of SUVratio and the use of surgical adhesives (BioGlue®) (intercept  $P = 0.46$ , slope  $P = 0.71$ ), and no evidence of an association with graft material (gelatin  $P = 0.97$ , collagen  $P = 0.98$ ). Focal FDG uptake associated with the location of anastomosis was found in 45% (27/60) of patients, more frequently in non-infected than in infected grafts (65% versus 16%, odds ratio (OR) 9.56; 95% CI 3.13-29.2,  $P < 0.001$ ). With BioGlue®, FDG uptake showed a weak trend towards less frequently being associated with the location of anastomosis (OR 0.39; 95% CI 0.11-1.40,  $P = 0.15$ ).

#### CONCLUSION

FDG uptake in PET/CT after thoracic aortic graft surgery is higher in infected than in non-infected grafts. Notably, uptake in non-infected grafts is also frequent, not associated with the type of graft material, but uptake patterns may be affected by the use of tissue surgical adhesives.

#### CLINICAL RELEVANCE/APPLICATION

Expanding knowledge on FDG uptake patterns in PET/CT after graft surgery due to inflammation and/or infection may have a direct effect on patients leading to more certain diagnoses and reducing unnecessary treatment.

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## Abstract Archives of the RSNA, 2023

T8-SSNMMI04-5

### Comparison of Measurement and Prognostic Power of SUV between High Definition and Standard PET Imaging in Non-Small Cell Lung Cancer Patients

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353C

Yonglin Pu, MD, PhD (*Presenter*) Stockholder, Myovant Sciences Ltd; Stockholder, Lantheus Holdings

#### PURPOSE

To compare the measurement and prognostic power of maximal standardized uptake value of whole-body tumor (SUV<sub>maxWB</sub>) measured on high definition (HD) PET imaging (Siemens TrueX incorporating point spread function modeling with smaller voxels) versus standard definition (SD) PET imaging (OSEM) on pretreatment PET/CT images for prognostication in non-small cell lung cancer (NSCLC) patients.

#### METHODS AND MATERIALS

A total of 243 consecutive patients with pathology-proven NSCLC who underwent pretreatment PET/CT examination between 4/12/2018 and 1/31/2021 were included in the study. Studies were performed on a Siemens Biograph mCT. For SD PET, reconstructions were performed with OSEM3D + TOF, 2 iterations, 21 subsets, 4.5 mm Gaussian filter, and 2.89 mm x 2.89 mm x 3.00 mm voxels. For HD, reconstructions were performed with PSF + TOF (TrueX), 3 iterations, 21 subsets, 2 mm Gaussian filter, and 1.85 mm x 1.85 mm x 2.03 mm voxels. Each tumor was contoured, and SUV<sub>max</sub> and tumor to background ratio (TBR = tumor SUV<sub>max</sub> divided by SUV<sub>mean</sub> of background) of that tumoral lesion was determined. The background SUV<sub>mean</sub> of normal lung, right atrial blood pool, normal liver and lumbar vertebral body was measured for the calculation of TBR of primary lung tumor, mediastinal nodal metastases, soft tissue and bone metastases, respectively. SUV<sub>maxWB</sub> is defined as the maximum of SUV<sub>max</sub> of all detected tumors. Overall survival was assessed using Cox regression.

#### RESULTS

The study included 243 patients with a mean age of 67.6 years, of whom 59% were female. Over a median follow-up period of 29.5 months among survivors, there were 83 deaths. The SUV<sub>maxWB</sub> was significantly higher on HD PET than on SD PET (mean = 19.9 and 13.1, respectively;  $p < 0.001$ ), and the TBR of SUV<sub>max</sub> of 639 tumoral lesions in 82 patients was significantly higher on HD PET (median = 7.4 vs 4.0,  $p < 0.0001$ ). Univariate Cox regression analysis revealed that SUV<sub>maxWB</sub> on both HD PET and SD PET were significantly associated with overall survival, with hazard ratios of 1.03 (1.02-1.04,  $p < 0.001$ ) and 1.05 (1.03 - 1.06,  $p < 0.001$ ), respectively. After adjusting for clinical TNM stage in a multivariate Cox regression analysis, SUV<sub>maxWB</sub> on SD PET was found to be significantly associated with survival (hazard ratio = 1.02, 95% CI 1.0-1.04,  $p = 0.04$ ). However, there was no significant association found between SUV<sub>maxWB</sub> on HD PET and survival after adjusting for clinical TNM stage ( $p = 0.16$ ).

#### CONCLUSION

In NSCLC patients, HD PET provides statistically significant higher SUV<sub>maxWB</sub> and TBR; but less prognostic value compared to SD PET imaging.

#### CLINICAL RELEVANCE/APPLICATION

HD PET imaging may improve lesion detection due to its higher TBR, but its SUV<sub>maxWB</sub> is not as prognostic in NSCLC patients as compared to that on SD PET, when controlling for TNM stage.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-SSNMMI04-6

### Keynote Speaker

Tuesday, Nov. 28 4:30PM - 5:30PM Room: E353C

Ryan J. Avery, MD (*Presenter*) Research Consultant, Konica Minolta, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-SSNR09

### Neuroradiology (Spine)

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N227B

Gayle R. Salama, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **T8-SSNR09-1 Bolus-Tracking Dynamic CT Myelography for Detection of CSF-Venous Fistulas: High Diagnostic Yield Stratified by Brain MRI Findings**

Donna Parizadeh, MD, MPH (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Optimizing imaging techniques to better detect cerebrospinal fluid-venous fistulas (CVF) is critical for guiding treatment of patients with spontaneous intracranial hypotension (SIH). We sought to evaluate the diagnostic yield of real-time bolus tracking during contrast injection to standardize the timing of image acquisitions post-contrast injection for dynamic CT myelography (BT-dCTM). Specifically, we aimed to evaluate the yield stratified by the patients' MRI brain findings.

#### **METHODS AND MATERIALS**

A retrospective review of consecutive suspected SIH patients evaluated with BT-dCTM was performed, excluding patients with extradural fluid collection on spine MRI. Bern SIH score was calculated based on brain MRI to predict the probability of identifying a spinal CSF leak source and categorized as low (score 0-2), intermediate (score 3-4), and high (score 5-9). Bilateral BT-dCTM was performed for each patient on two separate days with the patient in lateral decubitus Trendelenburg position using angled foam wedges. Axial CT bolus tracking was performed at a single level in the upper thoracic spine with 5 second acquisition intervals during manual intrathecal contrast injection; at least 3 CT acquisitions of the complete spine were obtained after contrast was visualized on bolus monitoring. Diagnostic yield of BT-dCTM for CVF detection was evaluated stratified by Bern SIH categories and receiver operating characteristic (ROC) analysis was used to assess Bern SIH score's performance in predicting CVF detection.

#### **RESULTS**

Of the 49 patients included, BT-dCTM was performed successfully in all and identified a CVF in 24 (49%). CVFs were located at T6-T11 (n=22), T4 (n=1), and L1 (n=1) and were more common on the right (n=17/24, 71%). CVF was identified in 100% (22/22) of patients with high Bern SIH score, 20% (2/10) of patients with intermediate score, and none of the 26 patients with low score. On ROC analysis, the area under the curve was 0.99 and the maximum value of Youden index was at a Bern SIH score of 5. Using a score of 5 or higher (high Bern SIH score), sensitivity and specificity were 92% and 100%, respectively.

#### **CONCLUSION**

BT-dCTM is feasible and allows for standardized timing of imaging acquisition after intrathecal contrast injection. The technique has a high diagnostic yield for CVF identification and localization. Bern SIH score is strongly associated with probability of identifying CVF on BT-dCTM and may be used as an effective tool to identify patients who will most likely benefit from BT-dCTM.

#### **CLINICAL RELEVANCE/APPLICATION**

BT-dCTM has a high diagnostic yield for detection of CVF especially in patients with a high Bern SIH score. Bern SIH score can be used as an effective triage tool to select patients for evaluation by BT-dCTM.

#### **T8-SSNR09-2 Benefit of Photon Counting Detector CT Myelography for Detecting CSF Venous Fistulas**

Ajay A. Madhavan, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Photon-counting detector (PCD) CT provides high spatial/temporal resolution and spectral capabilities. It may improve detection of subtle CSF-venous fistulas (CVFs), a common cause of spontaneous intracranial hypotension (SIH). We hypothesized that PCD CT myelography (CTM) may detect CVFs missed on digital subtraction myelography (DSM), the current gold standard at many institutions.

## METHODS AND MATERIALS

We included patients meeting ICHD-3 criteria for SIH who underwent PCD CTM from 2/2023 to 4/2023, excluding any without prior DSM and any with extradural fluid on spine MRI. PCD CTM was performed in the decubitus positions (right, then left) using a PCD CT (NAEOTOM Alpha, Siemens). After intrathecal injection of 3-5mL Omnipaque 300, 3-6 scans of the spine were performed, with the final two in ultra-high resolution (UHR mode). Images were reconstructed at 40 keV and using a low energy threshold (T3D). Slice thickness was 0.4mm or 0.2mm (UHR). Two neuroradiologists reviewed images for the presence of a CVF based on consensus. Reviewers noted whether the CVF was most apparent on 40 keV images versus 0.2mm T3D reconstructions, and whether temporal variation over multiple scans was necessary to make the diagnosis.

## RESULTS

34 patients underwent PCD CTM. 11 were excluded due to lack of DSM. No patients had extradural fluid on spine MRI. All patients had negative DSMs (23/23). 19/23 (83%) patients had a definitive CVF on PCD CTM. CVFs were best seen at 40 keV at 0.4mm (15/19) or T3D at 0.2mm (4/19). In 8 cases, temporal variation of the CVF on successive scans was necessary to make the diagnosis.

## CONCLUSION

PCD CTM detects CVFs in some SIH patients with negative DSM. Use of 40 keV reconstructions, high spatial resolution, and high temporal resolution likely account for this.

## CLINICAL RELEVANCE/APPLICATION

Decubitus PCD CTM should be considered for evaluation of CVFs in SIH patients.

## T8-SSNR09-3 Detecting and Localizing Cervical Spine Fracture Using an End-to-End 3D Deep Learning Pipeline

Mana Moassefi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Commercially available computer-aided diagnosis tools are being utilized to triage studies and prioritize patients with suspected cervical spine fractures. However, their effectiveness is limited in patients with coexisting degenerative diseases and osteoporosis, with reported sensitivity ranging from 54% to 76%. This study aims to develop a deep learning algorithm capable of reliably detecting and localizing cervical spine fractures in CT scans.

## METHODS AND MATERIALS

Data from the RSNA Cervical Spine Fracture Challenge (n=2019) was used to train and validate the algorithm. This data was collected from twelve different institutions, allowing for the development of a more generalizable model. Taking inspiration from the holistic approach used by radiologists, an end-to-end 3D method was employed to avoid mistaking artifacts that mimic fractures in 2D slices, such as nutrition canals. A weakly supervised approach was initially used to localize the C1-C7 vertebrae by applying a trained model to the data and manually correcting masks for 400 studies. This was followed by training a segmentation model to fine-tune the segmentation masks. The segmented vertebrae were then cropped from the image and straightened along the z-axis to account for possible neck flexion. Each 3D vertebrae volume was resized to 256x256x64 and used to train a 3D EfficientNetB4 to classify images as either with or without a fracture (Figure 1). The performance of the segmentation model is reported on an internal test set with human-annotated ground truth. We used 5-fold cross-validation to develop a more robust classifier and reported the ensemble results.

## RESULTS

The segmentation model achieved a Dice Similarity Coefficient of 0.93. The vertebrae-level fracture detection model had an area under the receiver operating curve (AUROC) of 0.92. When combined in an ensemble on a patient level, the model achieved an AUROC of 0.93 with a sensitivity of 89% and specificity of 87%.

## CONCLUSION

This work presents a 3D deep learning model for detecting and localizing cervical spine fractures in CT scans from multiple institutions. The high sensitivity of the model makes it suitable for screening purposes. Additionally, the per-vertebrae nature of the workflow enables precise localization of fractures, which can help expedite evaluation by expert radiologists to verify or reject the model's predictions.

## CLINICAL RELEVANCE/APPLICATION

Over 1.5 million spine fractures occur annually in the United States alone, resulting in over 17,000 spinal cord injuries. The cervical spine is the most common site of spine fracture, and computer tomography (CT) is the preferred modality for detecting these fractures. Prompt automated fracture detection could help prevent irreversible neurological deficits.

### **T8-SSNR09-4 Diagnostic Performance of Computed Tomography-Digital Subtraction Angiography and Conventional Magnetic Resonance Imaging for Evaluating the Vascularity of Osseous Spinal Tumors**

Ting-Wei Liao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Patients with hypervascular spinal tumors may have severe blood loss during tumor resection, which increases the risks of perioperative morbidity and mortality. However, the preoperative evaluation of tumor vascularity may be challenging; moreover, the reliability of the data obtained in conventional preoperative noninvasive imaging is debatable. In this study, we compared conventional magnetic resonance imaging (MRI) and subtraction computed tomography angiography (CTA) in terms of their performance in vascularity evaluation. The catheter digital subtraction angiography (DSA) technique was used as a reference standard.

#### **METHODS AND MATERIALS**

This study included 123 consecutive patients with spinal tumor who underwent subtraction CTA, catheter DSA, and subsequent surgery between October 2015 and October 2021. Data regarding qualitative and semiquantitative subtraction CTA parameters and conventional MRI signs were collected for comparison with tumor vascularity graded through catheter DSA. The diagnostic performance of qualitative CTA, quantitative CTA, and conventional MRI in assessing spinal tumor vascularity was analyzed.

#### **RESULTS**

Qualitative subtraction CTA was the best noninvasive imaging modality in terms of diagnostic performance (area under the receiver operating characteristic curve [AUROC], 0.95). Quantitative CTA was relatively inferior (AUROC, 0.87). MRI results had low reliability (AUROC, 0.51 to 0.59). Intratumoral hemorrhage and prominent foraminal venous plexus were found to be the specific signs for hypervascularity (specificity 93.2%).

#### **CONCLUSION**

Subtraction CTA has a diagnostic value in the evaluation of spinal tumor vascularity. Although conventional MRI may not be a reliable approach, certain MRI signs may have high specificity, which may be crucial for assessing spinal tumor vascularity.

## CLINICAL RELEVANCE/APPLICATION

In clinical practice, hypervascular spinal metastasis is difficult to assess on routine spinal MRI, and vascularity is often evaluated by the result of CT or catheter angiography. However, this seemingly important topic has been surprisingly of few evidence in previous literatures. Therefore, in this manuscript, we retrospectively analyze and describe the diagnostic performance of noninvasive imaging including computed tomography-digital subtraction angiography and conventional Magnetic Resonance Imaging to evaluate the vascularity of osseous spinal tumors in the cohort of our institute. We believe that this manuscript is important because the diagnostic value of noninvasive imaging can play crucial role in preoperative assessment of spinal tumor vascularity, thereby improving patients outcome.

### **T8-SSNR09-5 Comparison of Image Quality and Diagnostic Efficacy of Routine Clinical Lumbar Spine Imaging at 0.55T and 1.5/3T**

Anna Lavrova, MD (*Presenter*) Research support, Siemens AG

#### **PURPOSE**

To compare image quality and assess inter-reader variability of routine lumbar spine sequences used in clinical protocols at 0.55T with those collected at standard field strengths (1.5/3T).

#### **METHODS AND MATERIALS**

In this IRB-approved study, 35 patients (16F, mean age  $59.5 \pm 15.2$  y., range 23-89) with lumbar spine MRIs acquired on both a MAGNETOM Siemens Free.Max 0.55T MRI system (low field, LF) from 11/2021 to 11/2022 and at conventional field strengths 1.5/3T (high field, HF) were retrospectively reviewed. In total, 665 image series across the 70 studies were assessed (mean time interval between scans 10.6 m.). Sequences included: T2w TSE, T1w TSE  $\pm$  CE, T2w fs TSE, STIR, T1w TSE fs + CE. Two neuroradiology fellows blinded to the field strength rated all sequences for overall imaging quality (OIQ), artifacts, and accurate visualization of intervertebral disc signal (IDS), neural foramina (NF), spinal cord signal (SCS), and bone marrow signal (BMS, sagittal only) and conus / cauda equina nerve roots (CNS-CENR, axial only) using a 4-point Likert scale (1 = non-diagnostic to 4 = excellent). For the 0.55T scans, they selected the most appropriate diagnosis(es) from the

following pick-list: osteomyelitis/discitis, osseous metastatic disease, acute or subacute compression fracture, degenerative disc disease with / without critical/severe spinal canal stenosis, post-operative changes with / without complicating feature. The mean  $\pm$  SD of the aggregate scores all sequences and OIQ for each sequence and reader at HF and LF were calculated. Paired t-tests ( $p=0.05$ ) were used to compare ratings between field strengths. To determine inter-reader agreement on OIQ at LF, the single score intraclass correlation test (ICC; 95% CI) was performed using all scored features for all images. Inter-reader agreement on diagnosis at LF was calculated using linear-weighted Cohen's Kappa coefficient.

## RESULTS

Diagnostic image quality (=2) was demonstrated at LF when taking all sequences in aggregate. For Reader 1, scores for OIQ, IDS, SCS, BMS, and CNS-CENR at HF scanners were significantly higher than those from 0.55T. For Reader 2, only NF and CNS-CENR features were superior at HF. In OIQ ratings, only T2w TSE images received lower scores from Reader 1. ICC on OIQ at LF was 0.235 (poor), however, the inter-reader agreement on diagnosis was determined to be substantial ( $\kappa=0.786$ ).

## CONCLUSION

Routine clinical lumbar spine imaging at 0.55T produces diagnostic quality images and high inter-reader agreement in diagnosis of routine spinal pathology, although T2w TSE imaging may benefit from further optimization.

## CLINICAL RELEVANCE/APPLICATION

Spine imaging at 0.55T MRI yields acceptable image quality with a high inter-reader agreement for routine spinal pathologies.

## T8-SSNR09-6 Clinical CT-Based Finite Element Simulation of Bone Damage Accumulation Strongly Predicts Osteolytic and Osteosclerotic Human Vertebrae Strength and Stiffness

Ron N. Alkalay, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To use a novel computational framework for modeling the effect of metastatic bone lesions on spatial damage accumulation patterns within osteolytic and osteosclerotic vertebrae to predict human pathologic vertebrae's strength and stiffness from CT imaging.

## METHODS AND MATERIALS

11 thoracic and lumbar vertebrae from donors with cancer (prostate, breast, lung and kidney), radiographically showing osteolytic and osteosclerotic bone metastases, were CT imaged (0.31m3 voxel size,  $\mu$ CT100, Scanco, Switzerland) and mechanically tested to failure in axial compression. A novel finite element computational framework was used for each vertebra tested to establish a nonlinear finite element (hFE) model incorporating heterogeneous spatial bone properties from the CT data. The mechanical tests were simulated to evaluate the metastasis's effect on the evolution of spatial damage within the vertebral bodies and the damage models used to compute vertebral strength and stiffness.

## RESULTS

Regression analysis found that the damage-based model strongly predicted the measured vertebral strength ( $R^2=0.95$ ,  $p<0.0001$ ) and stiffness ( $R^2=0.78$ ,  $p=0.0003$ ), independent of lesion type, Fig 1. Simulated strength and stiffness were significantly higher ( $p=0.0204$  and  $p=0.0405$ , respectively) for sclerotic than the lytic vertebrae. In lytic vertebrae, bone damage was predicted to progress in a spatially diffused manner through the body under increased loading. In osteosclerotic vertebrae, damage accumulation was confined to regions of low bone volume to tissue volume, Fig 2.B. Vertebral failure was predicted when the cancellous bone damage evolved to the vertebral cortexes.

## CONCLUSION

Using a newly developed computational damage-based model, we demonstrate that metastasis type differentially affects the evolution of spatial damage and that this damage pattern strongly predicts vertebral strength and stiffness across lesion types. Our model offers a pathway for developing image-based diagnostics to predict the risk and location of impending failure within the vertebral body.

## CLINICAL RELEVANCE/APPLICATION

Spine metastases produce severe pain and vertebral fracture risk. Predicting bone expected fracture location and spinal instability can guide therapy to reduce the risk of severe complications and neural compression.

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## Abstract Archives of the RSNA, 2023

T8-SSNR09-1

### **Bolus-Tracking Dynamic CT Myelography for Detection of CSF-Venous Fistulas: High Diagnostic Yield Stratified by Brain MRI Findings**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N227B

Donna Parizadeh, MD, MPH (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Optimizing imaging techniques to better detect cerebrospinal fluid-venous fistulas (CVF) is critical for guiding treatment of patients with spontaneous intracranial hypotension (SIH). We sought to evaluate the diagnostic yield of real-time bolus tracking during contrast injection to standardize the timing of image acquisitions post-contrast injection for dynamic CT myelography (BT-dCTM). Specifically, we aimed to evaluate the yield stratified by the patients' MRI brain findings.

#### **METHODS AND MATERIALS**

A retrospective review of consecutive suspected SIH patients evaluated with BT-dCTM was performed, excluding patients with extradural fluid collection on spine MRI. Bern SIH score was calculated based on brain MRI to predict the probability of identifying a spinal CSF leak source and categorized as low (score 0-2), intermediate (score 3-4), and high (score 5-9). Bilateral BT-dCTM was performed for each patient on two separate days with the patient in lateral decubitus Trendelenburg position using angled foam wedges. Axial CT bolus tracking was performed at a single level in the upper thoracic spine with 5 second acquisition intervals during manual intrathecal contrast injection; at least 3 CT acquisitions of the complete spine were obtained after contrast was visualized on bolus monitoring. Diagnostic yield of BT-dCTM for CVF detection was evaluated stratified by Bern SIH categories and receiver operating characteristic (ROC) analysis was used to assess Bern SIH score's performance in predicting CVF detection.

#### **RESULTS**

Of the 49 patients included, BT-dCTM was performed successfully in all and identified a CVF in 24 (49%). CVFs were located at T6-T11 (n=22), T4 (n=1), and L1 (n=1) and were more common on the right (n=17/24, 71%). CVF was identified in 100% (22/22) of patients with high Bern SIH score, 20% (2/10) of patients with intermediate score, and none of the 26 patients with low score. On ROC analysis, the area under the curve was 0.99 and the maximum value of Youden index was at a Bern SIH score of 5. Using a score of 5 or higher (high Bern SIH score), sensitivity and specificity were 92% and 100%, respectively.

#### **CONCLUSION**

BT-dCTM is feasible and allows for standardized timing of imaging acquisition after intrathecal contrast injection. The technique has a high diagnostic yield for CVF identification and localization. Bern SIH score is strongly associated with probability of identifying CVF on BT-dCTM and may be used as an effective tool to identify patients who will most likely benefit from BT-dCTM.

#### **CLINICAL RELEVANCE/APPLICATION**

BT-dCTM has a high diagnostic yield for detection of CVF especially in patients with a high Bern SIH score. Bern SIH score can be used as an effective triage tool to select patients for evaluation by BT-dCTM.

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## Abstract Archives of the RSNA, 2023

T8-SSNR09-2

### Benefit of Photon Counting Detector CT Myelography for Detecting CSF Venous Fistulas

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N227B

Ajay A. Madhavan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detector (PCD) CT provides high spatial/temporal resolution and spectral capabilities. It may improve detection of subtle CSF-venous fistulas (CVFs), a common cause of spontaneous intracranial hypotension (SIH). We hypothesized that PCD CT myelography (CTM) may detect CVFs missed on digital subtraction myelography (DSM), the current gold standard at many institutions.

#### METHODS AND MATERIALS

We included patients meeting ICHD-3 criteria for SIH who underwent PCD CTM from 2/2023 to 4/2023, excluding any without prior DSM and any with extradural fluid on spine MRI. PCD CTM was performed in the decubitus positions (right, then left) using a PCD CT (NAEOTOM Alpha, Siemens). After intrathecal injection of 3-5mL Omnipaque 300, 3-6 scans of the spine were performed, with the final two in ultra-high resolution (UHR mode). Images were reconstructed at 40 keV and using a low energy threshold (T3D). Slice thickness was 0.4mm or 0.2mm (UHR). Two neuroradiologists reviewed images for the presence of a CVF based on consensus. Reviewers noted whether the CVF was most apparent on 40 keV images versus 0.2mm T3D reconstructions, and whether temporal variation over multiple scans was necessary to make the diagnosis.

#### RESULTS

34 patients underwent PCD CTM. 11 were excluded due to lack of DSM. No patients had extradural fluid on spine MRI. All patients had negative DSMs (23/23). 19/23 (83%) patients had a definitive CVF on PCD CTM. CVFs were best seen at 40 keV at 0.4mm (15/19) or T3D at 0.2mm (4/19). In 8 cases, temporal variation of the CVF on successive scans was necessary to make the diagnosis.

#### CONCLUSION

PCD CTM detects CVFs in some SIH patients with negative DSM. Use of 40 keV reconstructions, high spatial resolution, and high temporal resolution likely account for this.

#### CLINICAL RELEVANCE/APPLICATION

Decubitus PCD CTM should be considered for evaluation of CVFs in SIH patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T8-SSNR09-3

### Detecting and Localizing Cervical Spine Fracture Using an End-to-End 3D Deep Learning Pipeline

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N227B

Mana Moassefi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Commercially available computer-aided diagnosis tools are being utilized to triage studies and prioritize patients with suspected cervical spine fractures. However, their effectiveness is limited in patients with coexisting degenerative diseases and osteoporosis, with reported sensitivity ranging from 54% to 76%. This study aims to develop a deep learning algorithm capable of reliably detecting and localizing cervical spine fractures in CT scans.

#### METHODS AND MATERIALS

Data from the RSNA Cervical Spine Fracture Challenge (n=2019) was used to train and validate the algorithm. This data was collected from twelve different institutions, allowing for the development of a more generalizable model. Taking inspiration from the holistic approach used by radiologists, an end-to-end 3D method was employed to avoid mistaking artifacts that mimic fractures in 2D slices, such as nutrition canals. A weakly supervised approach was initially used to localize the C1-C7 vertebrae by applying a trained model to the data and manually correcting masks for 400 studies. This was followed by training a segmentation model to fine-tune the segmentation masks. The segmented vertebrae were then cropped from the image and straightened along the z-axis to account for possible neck flexion. Each 3D vertebrae volume was resized to 256x256x64 and used to train a 3D EfficientNetB4 to classify images as either with or without a fracture (Figure 1). The performance of the segmentation model is reported on an internal test set with human-annotated ground truth. We used 5-fold cross-validation to develop a more robust classifier and reported the ensemble results.

#### RESULTS

The segmentation model achieved a Dice Similarity Coefficient of 0.93. The vertebrae-level fracture detection model had an area under the receiver operating curve (AUROC) of 0.92. When combined in an ensemble on a patient level, the model achieved an AUROC of 0.93 with a sensitivity of 89% and specificity of 87%.

#### CONCLUSION

This work presents a 3D deep learning model for detecting and localizing cervical spine fractures in CT scans from multiple institutions. The high sensitivity of the model makes it suitable for screening purposes. Additionally, the per-vertebrae nature of the workflow enables precise localization of fractures, which can help expedite evaluation by expert radiologists to verify or reject the model's predictions.

#### CLINICAL RELEVANCE/APPLICATION

Over 1.5 million spine fractures occur annually in the United States alone, resulting in over 17,000 spinal cord injuries. The cervical spine is the most common site of spine fracture, and computer tomography (CT) is the preferred modality for detecting these fractures. Prompt automated fracture detection could help prevent irreversible neurological deficits.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

T8-SSNR09-4

### **Diagnostic Performance of Computed Tomography-Digital Subtraction Angiography and Conventional Magnetic Resonance Imaging for Evaluating the Vascularity of Osseous Spinal Tumors**

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N227B

Ting-Wei Liao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Patients with hypervascular spinal tumors may have severe blood loss during tumor resection, which increases the risks of perioperative morbidity and mortality. However, the preoperative evaluation of tumor vascularity may be challenging; moreover, the reliability of the data obtained in conventional preoperative noninvasive imaging is debatable. In this study, we compared conventional magnetic resonance imaging (MRI) and subtraction computed tomography angiography (CTA) in terms of their performance in vascularity evaluation. The catheter digital subtraction angiography (DSA) technique was used as a reference standard.

#### **METHODS AND MATERIALS**

This study included 123 consecutive patients with spinal tumor who underwent subtraction CTA, catheter DSA, and subsequent surgery between October 2015 and October 2021. Data regarding qualitative and semiquantitative subtraction CTA parameters and conventional MRI signs were collected for comparison with tumor vascularity graded through catheter DSA. The diagnostic performance of qualitative CTA, quantitative CTA, and conventional MRI in assessing spinal tumor vascularity was analyzed.

#### **RESULTS**

Qualitative subtraction CTA was the best noninvasive imaging modality in terms of diagnostic performance (area under the receiver operating characteristic curve [AUROC], 0.95). Quantitative CTA was relatively inferior (AUROC, 0.87). MRI results had low reliability (AUROC, 0.51 to 0.59). Intratumoral hemorrhage and prominent foraminal venous plexus were found to be the specific signs for hypervascularity (specificity 93.2%).

#### **CONCLUSION**

Subtraction CTA has a diagnostic value in the evaluation of spinal tumor vascularity. Although conventional MRI may not be a reliable approach, certain MRI signs may have high specificity, which may be crucial for assessing spinal tumor vascularity.

#### **CLINICAL RELEVANCE/APPLICATION**

In clinical practice, hypervascular spinal metastasis is difficult to assess on routine spinal MRI, and vascularity is often evaluated by the result of CT or catheter angiography. However, this seemingly important topic has been surprisingly of few evidence in previous literatures. Therefore, in this manuscript, we retrospectively analyze and describe the diagnostic performance of noninvasive imaging including computed tomography-digital subtraction angiography and conventional Magnetic Resonance Imaging to evaluate the vascularity of osseous spinal tumors in the cohort of our institute. We believe that this manuscript is important because the diagnostic value of noninvasive imaging can play crucial role in preoperative assessment of spinal tumor vascularity, thereby improving patients outcome.

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## Abstract Archives of the RSNA, 2023

T8-SSNR09-5

### Comparison of Image Quality and Diagnostic Efficacy of Routine Clinical Lumbar Spine Imaging at 0.55T and 1.5/3T

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N227B

Anna Lavrova, MD (*Presenter*) Research support, Siemens AG

#### PURPOSE

To compare image quality and assess inter-reader variability of routine lumbar spine sequences used in clinical protocols at 0.55T with those collected at standard field strengths (1.5/3T).

#### METHODS AND MATERIALS

In this IRB-approved study, 35 patients (16F, mean age  $59.5 \pm 15.2$  y., range 23-89) with lumbar spine MRIs acquired on both a MAGNETOM Siemens Free.Max 0.55T MRI system (low field, LF) from 11/2021 to 11/2022 and at conventional field strengths 1.5/3T (high field, HF) were retrospectively reviewed. In total, 665 image series across the 70 studies were assessed (mean time interval between scans 10.6 m.). Sequences included: T2w TSE, T1w TSE  $\pm$  CE, T2w fs TSE, STIR, T1w TSE fs + CE. Two neuroradiology fellows blinded to the field strength rated all sequences for overall imaging quality (OIQ), artifacts, and accurate visualization of intervertebral disc signal (IDS), neural foramina (NF), spinal cord signal (SCS), and bone marrow signal (BMS, sagittal only) and conus / cauda equina nerve roots (CNS-CENR, axial only) using a 4-point Likert scale (1 = non-diagnostic to 4 = excellent). For the 0.55T scans, they selected the most appropriate diagnosis(es) from the following pick-list: osteomyelitis/discitis, osseous metastatic disease, acute or subacute compression fracture, degenerative disc disease with / without critical/severe spinal canal stenosis, post-operative changes with / without complicating feature. The mean  $\pm$  SD of the aggregate scores all sequences and OIQ for each sequence and reader at HF and LF were calculated. Paired t-tests ( $p=0.05$ ) were used to compare ratings between field strengths. To determine inter-reader agreement on OIQ at LF, the single score intraclass correlation test (ICC; 95% CI) was performed using all scored features for all images. Inter-reader agreement on diagnosis at LF was calculated using linear-weighted Cohen's Kappa coefficient.

#### RESULTS

Diagnostic image quality ( $=2$ ) was demonstrated at LF when taking all sequences in aggregate. For Reader 1, scores for OIQ, IDS, SCS, BMS, and CNS-CENR at HF scanners were significantly higher than those from 0.55T. For Reader 2, only NF and CNS-CENR features were superior at HF. In OIQ ratings, only T2w TSE images received lower scores from Reader 1. ICC on OIQ at LF was 0.235 (poor), however, the inter-reader agreement on diagnosis was determined to be substantial ( $\kappa=0.786$ ).

#### CONCLUSION

Routine clinical lumbar spine imaging at 0.55T produces diagnostic quality images and high inter-reader agreement in diagnosis of routine spinal pathology, although T2w TSE imaging may benefit from further optimization.

#### CLINICAL RELEVANCE/APPLICATION

Spine imaging at 0.55T MRI yields acceptable image quality with a high inter-reader agreement for routine spinal pathologies.

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## Abstract Archives of the RSNA, 2023

T8-SSNR09-6

### Clinical CT-Based Finite Element Simulation of Bone Damage Accumulation Strongly Predicts Osteolytic and Osteosclerotic Human Vertebrae Strength and Stiffness

Tuesday, Nov. 28 4:30PM - 5:30PM Room: N227B

Ron N. Alkalay, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To use a novel computational framework for modeling the effect of metastatic bone lesions on spatial damage accumulation patterns within osteolytic and osteosclerotic vertebrae to predict human pathologic vertebrae's strength and stiffness from CT imaging.

#### METHODS AND MATERIALS

11 thoracic and lumbar vertebrae from donors with cancer (prostate, breast, lung and kidney), radiographically showing osteolytic and osteosclerotic bone metastases, were CT imaged (0.31mm<sup>3</sup> voxel size,  $\mu$ CT100, Scanco, Switzerland) and mechanically tested to failure in axial compression. A novel finite element computational framework was used for each vertebra tested to establish a nonlinear finite element (hFE) model incorporating heterogeneous spatial bone properties from the CT data. The mechanical tests were simulated to evaluate the metastasis's effect on the evolution of spatial damage within the vertebral bodies and the damage models used to compute vertebral strength and stiffness.

#### RESULTS

Regression analysis found that the damage-based model strongly predicted the measured vertebral strength ( $R^2=0.95$ ,  $p<0.0001$ ) and stiffness ( $R^2=0.78$ ,  $p=0.0003$ ), independent of lesion type, Fig 1. Simulated strength and stiffness were significantly higher ( $p=0.0204$  and  $p=0.0405$ , respectively) for sclerotic than the lytic vertebrae. In lytic vertebrae, bone damage was predicted to progress in a spatially diffused manner through the body under increased loading. In osteosclerotic vertebrae, damage accumulation was confined to regions of low bone volume to tissue volume, Fig 2.B. Vertebral failure was predicted when the cancellous bone damage evolved to the vertebral cortexes.

#### CONCLUSION

Using a newly developed computational damage-based model, we demonstrate that metastasis type differentially affects the evolution of spatial damage and that this damage pattern strongly predicts vertebral strength and stiffness across lesion types. Our model offers a pathway for developing image-based diagnostics to predict the risk and location of impending failure within the vertebral body.

#### CLINICAL RELEVANCE/APPLICATION

Spine metastases produce severe pain and vertebral fracture risk. Predicting bone expected fracture location and spinal instability can guide therapy to reduce the risk of severe complications and neural compression.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSMS03

### Multisystem (Multimodality Evaluation of Various Tumor Treatment Response)

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406B

Elliot K. Fishman, MD (*Moderator*) Co-founder, HipGraphics, Inc Stockholder, HipGraphics, Inc Institutional Grant support, Siemens AG Institutional Grant support, General Electric Company Consultant, Exact Sciences Corporation Consultant, Imaging Endpoints II LLC  
Carolyn L. Wang, MD (*Moderator*) Research Grant, General Electric Company

#### Sub-Events

#### W1-SSMS03-1 **Dual Energy CT Iodine Concentration as a Predictor for Response to Immunotherapy Checkpoint Inhibitors**

Natalie Wiley (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the predictive value of tumor iodine concentration obtained using Dual Energy CT (DECT) on a per lesion response in patients treated with immunotherapy checkpoint inhibitors (ICI).

#### METHODS AND MATERIALS

In this IRB-approved single-center, HIPAA-compliant study, metastatic melanoma, renal cell carcinoma (RCC) and Merkel cell carcinoma (MCC) patients starting first line treatment with ICI underwent contrast-enhanced DECT exams at baseline (BL), at first follow-up after ICI (FU1), and a final follow-up scan (FFU) defined as the scan either at progression event or nearest to 12-months following BL. DECT-based whole-volume tumor iodine concentration normalized to the aorta (IC) and size measurements were obtained for target lesions. Lesion status was categorized as responders (complete response [CR], partial response [PR]) and non-responders (stable disease [SD], progressive disease [PD]) based on RECIST 1.1. We used GEE-based logistic regression to assess the relationship between the lesion response at FFU (binary outcome) and BL-to-FU1 change in IC (predictor), while controlling for the effects of lesion response at FU1 (binary covariate). The proportion of variance in the lesion response at FFU explained by the predictors was assessed with adjusted R<sup>2</sup>. Performance of IC in diagnosing pseudoprogression was summarized with sensitivity and specificity.

#### RESULTS

Study population included 45 patients (11 female; mean age 62 years): 16 melanoma, 28 RCC and 1 MCC with 159 target lesions. The distribution of target lesions at FU1 was 14 PD, 76 SD, 60 PR, 9 CR and at FFU was 22 PD, 36 SD, 63 PR, 38 CR. Increase in IC between BL and FU1 was associated with lesion non-response at FFU (OR 2.8 per 1-SD increase;  $P < .001$ ), explaining 6.2% of variance in lesion status at FFU, beyond the 30% of variance from the lesion status at FU1 ( $P < .001$ ). 35/90 non-responding lesions at FU1 changed to response by FFU. Of those 35 responding lesions at FFU, 27 decreased in IC from BL to FU1 (sensitivity 77%). Specificity was 37/55 (67%).

#### CONCLUSION

In study patients, change in iodine concentration from baseline to first follow-up was a significant predictor of lesion status at final follow-up beyond lesion status at first follow-up per RECIST 1.1. Iodine concentration may be helpful in identifying pseudoprogression in patients on immune checkpoint inhibitors.

#### CLINICAL RELEVANCE/APPLICATION

Iodine concentration as an indicator of treatment response adds predictive value beyond size change and may be helpful in identifying pseudoprogression in patients on immune checkpoint inhibitors.

#### W1-SSMS03-2 **Correlating the Utility of MR Diffusion Weighted Imaging with Liver Imaging Reporting and Data System (LI-RADS) Treatment Response (LR-TR) Categories to Determine Tumor Response to Y-90 Radio-embolization for Hepatocellular Carcinoma**

Sidney Mirgati, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Radioactive Yttrium-90 (Y90) is a treatment option for hepatocellular carcinoma (HCC). The treatment response is qualitatively evaluated via contrast-enhanced CT/MR imaging but cannot be quantified. Diffusion weighted imaging (DWI) with ADC maps provides an absolute quantitative assessment of molecular motion, making it ideal to determine response to Y90 treatment. This study aims to quantify and determine the serial post-treatment ADC changes in HCC from Y90 treatments and correlate them with Liver Imaging Reporting and Data System (LI-RADS) Treatment Response (LR-TR) categories.

## **METHODS AND MATERIALS**

IRB approved retrospective review of patients (n=19) with single focal HCC tumors with single Y90 treatment (high dose of >190Gy) at our institution was performed that included patients with MRI-ADCs measured at pre and within 1 year post-treatment scans. Patients with multiple Y90 treatments, liver transplant, TACE were excluded. ADC maps were calculated from DWI images acquired using b-values: 50, 400 and 800 s/mm<sup>2</sup> on 1.5 T Siemens and GE MRI scanners. ROIs were drawn to measure ADC on pre and post Y90 treated tumor and normal liver parenchyma at specific time intervals. The ratios of ADC values of treated tumors to normal were computed for changes in the ADCTumor to ADCNormal ratio. The LI-RADS LR-TR categories (Nonviable (NV), Equivocal (EQ), and Viable (V)) was recorded for each lesion by sub-specialty trained radiologists, and correlated with the ADC ratios.

## **RESULTS**

The study showed that the mean ADCTumor to ADCNormal ratio increased from pre-MR to 1-2 months post MR and 3-4 months post treatment MR (statistically significant;  $p = 0.05$ ), and then decreased over the remaining months. The post-treatment ratio gradually increasing from post-treatment 1 month and peaking at 3-4 months possibly reflects the time the treatment response was apparent while the immediate post-treatment inflammatory findings resolved. The decrease in ADC ratios after 4 months post treatment is likely related to the decrease in size of the treated tumor and ensuing fibrosis at the treated lesion site. For the LR-TR categories, 38% of lesions were reported as NV, 55% EQ, and 7% viable. The correlation between ADC values and the LR-TR categories showed the mean ADC ratio was  $2.02 \pm 1.06$  for NV tumors and  $1.833 \pm 0.67$  for EQ tumors. This suggests higher quantitative ADC values in tumors categorized as NV than EQ.

## **CONCLUSION**

Quantitative ADC values and ratios can be used as an ancillary marker for Y90 treatment response in conjunction with other findings.

## **CLINICAL RELEVANCE/APPLICATION**

Quantitative ADC ratios with the reported LR-TR values can help establish and quantify the tumor treatment response to Y90 of HCCs, rather than just the ADC values, post contrast T1-images or the LR-TR values.

## **W1-SSMS03-3 Baseline Imaging Parameters Predicting Overall and Progression-Free Survival for Patients with Pulmonary Metastases from Soft Tissue Sarcoma**

Konstantin Klambauer, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Soft tissue sarcoma is a rare group of tumors arising from mesenchymal cells. A frequent site of metastases for aggressive sarcoma is the lung. However, data on imaging predictors of survival is still scarce. The aim of this study was to evaluate imaging parameters in relation to overall survival (OS) and progression-free survival (PFS) in patients with pulmonary metastases from soft tissue sarcoma.

## **METHODS AND MATERIALS**

Consecutive patients with soft tissue sarcoma who were treated at our facility from 2016 to 2021 were screened. We excluded patients without lung metastases, with non-measurable lung metastases, after lung surgery, with missing clinical information or with missing baseline CT-scans. Up to five target lesions of the lung were segmented using mintLesion (Mint Medical, Heidelberg, Germany) at baseline CT-imaging prior to systemic therapy. The sum of target volume (STLV), the sum of target long axis (STLA) and the long axis of largest target lesion (LATL) were used to represent tumor burden. The total number of lesions was assessed. The resulting tumor burden was split by terciles into equally sized groups (T1: <33%; T2: 33-66%; T3: >66%). Dichotomized subgroups of patients with different total number of target lesions were defined. All terciles and subgroups were tested for OS and PFS.

## **RESULTS**

Sixty-eight patients were included. The median age was 55 years (50% male) the median OS was 25.2 months and the median PFS was 6.4 months. No significant difference in OS or PFS in patients with different STLV, STLA and LATL was observed (Figure 1, A-F). There was a significant difference in the OS depending on the number of target lesions (median

survival for patients with =5 vs. <5 target lesions: 21.9 vs. 35.5 months;  $p=0.036$ ), whereas PFS showed no significant difference (5.5 vs. 6.9 months;  $p=0.206$ ) (Figure 2, A-B).

## CONCLUSION

In this study on patients with lung metastases from soft tissue sarcoma, the data indicates that the number of target lesions outperforms the total tumor burden with regard to OS prediction at baseline. We found no imaging parameters that were associated with PFS.

## CLINICAL RELEVANCE/APPLICATION

Soft tissue sarcoma is rare and prognostic information is scarce. As patients routinely undergo cancer staging by CT, identifying prognostic parameters from imaging data may support therapy guidance.

## W1-SSMS03-4 Target Lesion-Based CT Texture Analysis for Predicting Tumor Response in Patients with Metastatic Renal Cell Carcinoma Undergoing PD-1 Inhibitor Therapy

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to investigate the predictive efficacy of target lesion-based texture analysis on baseline contrast-enhanced CT scans for tumor response in patients with metastatic renal clear cell carcinoma undergoing PD-1 inhibitor therapy.

## METHODS AND MATERIALS

A total of 42 patients with metastatic clear cell renal cell carcinoma who received PD-1 inhibitors after standard treatment failure between June 2015 and April 2022 were enrolled in this study. Contrast-enhanced CT scans were performed at baseline before treatment and follow-up every 8 to 10 weeks. Tumor response was assessed according to iRECIST, and all target lesions were classified as response/non-response, complete response/non-complete response groups according to tumor response evaluation. CT texture features were compared between each group. Univariate and multivariate logistic regression analysis was used to screen independent predictors of tumor response. The receiver operating characteristic curve (ROC) and the area under the curve (AUC) were used to evaluate the predictive efficacy of independent predictors and the model.

## RESULTS

Significant differences in texture features were observed between the iCRL group and non-iCRL group, with odds ratio (OR) values of 0.071 (95% CI: 0.021-0.235), 3.532 (95% CI: 1.591-7.841), and 0.342 (95% CI: 0.152-0.768), respectively. The follow-up texture models predicting iCR achieved an AUC of 0.928 (95% CI: 0.8645-0.9915), 0.7984 (95% CI: 0.6291-0.9676), and 0.757 (95% CI: 0.5967-0.9177) by ROC analysis. Significant differences in texture features were observed between the response group and the non-response group, with AUC values of 0.645 (95% CI: 0.5091-0.7817) and 0.703 (95% CI: 0.5731-0.8341), respectively.

## CONCLUSION

This study developed and validated a CT texture-based model for predicting tumor response in patients treated with PD-1 inhibitors. Texture features demonstrated significant differences between the response/non-response and complete response/non-complete response lesions. This model provides a non-invasive tool to predict treatment response, guide clinical decision-making, and improve patient outcomes.

## CLINICAL RELEVANCE/APPLICATION

The findings of this study have important clinical implications for the management of patients with metastatic renal clear cell carcinoma undergoing PD-1 inhibitor therapy. The target lesion-based texture analysis using contrast-enhanced CT scans presented in this study can potentially serve as a valuable, non-invasive tool for predicting treatment response. This information can guide clinicians in identifying patients who are likely to benefit from PD-1 inhibitor therapy or who may require alternative treatment strategies.

## W1-SSMS03-5 Comparison of RECIST 1.1, mRECIST and PERCIST for Assessment of Peptide Receptor Radionuclide Therapy (PRRT) Treatment Response in Metastatic Neuroendocrine Tumor

Jack Zhao, BA (*Presenter*) Nothing to Disclose

## PURPOSE

To compare RECIST 1.1, modified RECIST (mRECIST) and PERCIST for assessment of Peptide Receptor Radionuclide Therapy (PRRT) treatment response in metastatic neuroendocrine tumors.

## METHODS AND MATERIALS

In this IRB-approved, HIPAA compliant retrospective study, patients treated with PRRT between July, 2019 and Dec, 2022 were identified. Inclusion criteria were presence of at least one pre-and one post-treatment imaging (CT, MRI, Ga 68 or Cu64



DOTATATE PET/CT) within one year of the start and end of PRRT respectively. The imaging was reviewed independently by two radiologists using RECIST 1.1, modified RECIST (mRECIST) and PERCIST criteria. Subsequently, discrepancies in response assessment were resolved through consensus. The response on the first post treatment scan and presence of disease progression during follow-up were recorded along with the date of best response and disease progression. Demographic information, histopathologic data, type of treatment before PRRT and date of last follow-up or death were obtained from the electronic medical records. Statistical analysis was performed to determine inter-reader agreement and agreement between the various response criteria using kappa statistics.

## RESULTS

Demographic and histopathologic data are presented in Table 1. Best response by RECIST 1.1 was recorded in 26 patients (PR-7, SD- 13, PD- 6), by mRECIST in 22 patients (PR-7, SD- 10, PD- 5), by PERCIST in 14 patients (PR-4, SD- 3, PD- 7) (Fig 1). Inter-reader agreement was highest for PERCIST (weighted kappa 0.921, standard error 0.078 95% CI 0.769 to 1.000) followed by RECIST 1.1 (weighted kappa 0.897, standard error 0.071 95% CI 0.758 to 1.000) and mRECIST (weighted kappa 0.883, standard error 0.079 95% CI 0.727 to 1.000). There was very good agreement between RECIST 1.1 and mRECIST (weighted kappa 1.0) and good between mRECIST and PERCIST (weighted kappa 0.714, standard error 0.147 95% CI 0.427 to 1.000) but only moderate between RECIST 1.1 and PERCIST (weighted kappa 0.593, standard error 0.149 95% CI 0.301 to 0.885). Sub-group analysis showed PERCIST detected more number of non-responders than RECIST 1.1 or mRECIST although detection of responders was similar by all three criteria.

## CONCLUSION

PERCIST had the best inter-reader agreement and detected more number of non-responders to PRRT than RECIST 1.1 or mRECIST. PERCIST and mRECIST had good agreement.

## CLINICAL RELEVANCE/APPLICATION

PERCIST performs better than RECIST 1.1 or mRECIST in assessing response of neuroendocrine tumors to PRRT.

## W1- SSMS03-6 Correlating Total Tumor Volume on CT-Scan and Liquid Biopsy ctDNA in 1017 Patients With Metastatic Cancer: A Novel Study

Lama DAWI, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The objective is to correlate quantitative imaging features computed from thorax-abdomen-pelvis (TAP) CT-scans to ctDNA tumor fraction (TF) and blood Tumor Mutational Burden (bTMB) from liquid biopsy in 1017 patients with a variety of metastatic cancers.

## METHODS AND MATERIALS

This retrospective multi-center study included 1017 patients with metastatic cancer and a variety of systemic treatments. Liquid biopsy results and contemporaneous TAP CT-scans were collected from 2021 to 2023. TF and bTMB values were computed using FoundationOne Liquid CDX Roche methodology, defining high tumor fraction as a TF over 10%. Two expert radiologists manually outlined all cancerous lesions in the largest diameter axial slice. Total tumor volume (TTV) was computed by adding lesion volumes. Patients were assigned to train and external validation sets, the latter consisting of imaging data from a single specific center. Continuous values distributions by category were tested using the Mann-Whitney U-test, and a threshold was set with ROC curve analysis using Youden's Index. High and low groups were defined using this cutoff, and a  $\chi^2$  test of independence was used to examine the correlation. Sensitivity and specificity were reported with imaging features taken as the gold standard. Subanalysis were run on patients with liver metastasis.

## RESULTS

Overall, 55294 lesions were annotated, most commonly located in the lung (n=20074), liver (n=11297) and lymph nodes (n=10222). The train and validation sets included 599 and 418 patients, respectively. Preliminary analyses were performed on the train set. Patients with low TF had significantly less TTV than those with high TF (p<0.0001). ROC analysis using TTV as the continuous value yields an AUC of 0.63. The selected threshold for TTV was 106 cm<sup>3</sup>. Correlation was significant between TTV and TF categories ( $\chi^2$  test: p<0.001). The sensitivity and specificity were 76% and 42%. In a subanalysis of patients with liver lesions (n=253) the volume threshold was 108 cm<sup>3</sup> with an AUC of 0.66. Correlation was significant between TTV and TF categories ( $\chi^2$  test: p<0.001). The sensitivity and specificity were 82% and 42%.

## CONCLUSION

The analysis on the train set showed significant correlation between total tumor volume and ctDNA tumor fraction. Sensitivity was higher for patients with liver lesions, suggesting that some organs shed circulating tumor DNA more than others. The study of tumor heterogeneity on imaging and its correlation to blood tumor mutational burden is in progress.

## CLINICAL RELEVANCE/APPLICATION

Liquid biopsy is a new emerging technology capable of diagnosing cancer, where CT-imaging is the gold standard. Tailored to the patient's cancer phenotype, it may be a strong complementary tool for diagnosis and follow-up.





## Abstract Archives of the RSNA, 2023

W1-SSMS03-1

### Dual Energy CT Iodine Concentration as a Predictor for Response to Immunotherapy Checkpoint Inhibitors

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406B

Natalie Wiley (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the predictive value of tumor iodine concentration obtained using Dual Energy CT (DECT) on a per lesion response in patients treated with immunotherapy checkpoint inhibitors (ICI).

#### METHODS AND MATERIALS

In this IRB-approved single-center, HIPAA-compliant study, metastatic melanoma, renal cell carcinoma (RCC) and Merkel cell carcinoma (MCC) patients starting first line treatment with ICI underwent contrast-enhanced DECT exams at baseline (BL), at first follow-up after ICI (FU1), and a final follow-up scan (FFU) defined as the scan either at progression event or nearest to 12-months following BL. DECT-based whole-volume tumor iodine concentration normalized to the aorta (IC) and size measurements were obtained for target lesions. Lesion status was categorized as responders (complete response [CR], partial response [PR]) and non-responders (stable disease [SD], progressive disease [PD]) based on RECIST 1.1. We used GEE-based logistic regression to assess the relationship between the lesion response at FFU (binary outcome) and BL-to-FU1 change in IC (predictor), while controlling for the effects of lesion response at FU1 (binary covariate). The proportion of variance in the lesion response at FFU explained by the predictors was assessed with adjusted R<sup>2</sup>. Performance of IC in diagnosing pseudoprogression was summarized with sensitivity and specificity.

#### RESULTS

Study population included 45 patients (11 female; mean age 62 years): 16 melanoma, 28 RCC and 1 MCC with 159 target lesions. The distribution of target lesions at FU1 was 14 PD, 76 SD, 60 PR, 9 CR and at FFU was 22 PD, 36 SD, 63 PR, 38 CR. Increase in IC between BL and FU1 was associated with lesion non-response at FFU (OR 2.8 per 1-SD increase;  $P < .001$ ), explaining 6.2% of variance in lesion status at FFU, beyond the 30% of variance from the lesion status at FU1 ( $P < .001$ ). 35/90 non-responding lesions at FU1 changed to response by FFU. Of those 35 responding lesions at FFU, 27 decreased in IC from BL to FU1 (sensitivity 77%). Specificity was 37/55 (67%).

#### CONCLUSION

In study patients, change in iodine concentration from baseline to first follow-up was a significant predictor of lesion status at final follow-up beyond lesion status at first follow-up per RECIST 1.1. Iodine concentration may be helpful in identifying pseudoprogression in patients on immune checkpoint inhibitors.

#### CLINICAL RELEVANCE/APPLICATION

Iodine concentration as an indicator of treatment response adds predictive value beyond size change and may be helpful in identifying pseudoprogression in patients on immune checkpoint inhibitors.

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## Abstract Archives of the RSNA, 2023

W1-SSMS03-2

### Correlating the Utility of MR Diffusion Weighted Imaging with Liver Imaging Reporting and Data System (LI-RADS) Treatment Response (LR-TR) Categories to Determine Tumor Response to Y-90 Radio-embolization for Hepatocellular Carcinoma

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406B

Sidney Mirgati, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radioactive Yttrium-90 (Y90) is a treatment option for hepatocellular carcinoma (HCC). The treatment response is qualitatively evaluated via contrast-enhanced CT/MR imaging but cannot be quantified. Diffusion weighted imaging (DWI) with ADC maps provides an absolute quantitative assessment of molecular motion, making it ideal to determine response to Y90 treatment. This study aims to quantify and determine the serial post-treatment ADC changes in HCC from Y90 treatments and correlate them with Liver Imaging Reporting and Data System (LI-RADS) Treatment Response (LR-TR) categories.

#### METHODS AND MATERIALS

IRB approved retrospective review of patients (n=19) with single focal HCC tumors with single Y90 treatment (high dose of >190Gy) at our institution was performed that included patients with MRI-ADCs measured at pre and within 1 year post-treatment scans. Patients with multiple Y90 treatments, liver transplant, TACE were excluded. ADC maps were calculated from DWI images acquired using b-values: 50, 400 and 800 s/mm<sup>2</sup> on 1.5 T Siemens and GE MRI scanners. ROIs were drawn to measure ADC on pre and postY90 treated tumor and normal liver parenchyma at specific time intervals. The ratios of ADC values of treated tumors to normal were computed for changes in the ADCTumor to ADCNormal ratio. The LI-RADS LR-TR categories (Nonviable (NV), Equivocal (EQ), and Viable (V)) was recorded for each lesion by sub-specialty trained radiologists, and correlated with the ADC ratios.

#### RESULTS

The study showed that the mean ADCTumor to ADCNormal ratio increased from pre-MR to 1-2 months post MR and 3-4 months post treatment MR (statistically significant;  $p = 0.05$ ), and then decreased over the remaining months. The post-treatment ratio gradually increasing from post-treatment 1 month and peaking at 3-4 months possibly reflects the time the treatment response was apparent while the immediate post-treatment inflammatory findings resolved. The decrease in ADC ratios after 4 months post treatment is likely related to the decrease in size of the treated tumor and ensuing fibrosis at the treated lesion site. For the LR-TR categories, 38% of lesions were reported as NV, 55% EQ, and 7% viable. The correlation between ADC values and the LR-TR categories showed the mean ADC ratio was  $2.02 \pm 1.06$  for NV tumors and  $1.833 \pm 0.67$  for EQ tumors. This suggests higher quantitative ADC values in tumors categorized as NV than EQ.

#### CONCLUSION

Quantitative ADC values and ratios can be used as an ancillary marker for Y90 treatment response in conjunction with other findings.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative ADC ratios with the reported LR-TR values can help establish and quantify the tumor treatment response to Y90 of HCCs, rather than just the ADC values, post contrast T1-images or the LR-TR values.

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## Abstract Archives of the RSNA, 2023

W1-SSMS03-3

### Baseline Imaging Parameters Predicting Overall and Progression-Free Survival for Patients with Pulmonary Metastases from Soft Tissue Sarcoma

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406B

Konstantin Klambauer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Soft tissue sarcoma is a rare group of tumors arising from mesenchymal cells. A frequent site of metastases for aggressive sarcoma is the lung. However, data on imaging predictors of survival is still scarce. The aim of this study was to evaluate imaging parameters in relation to overall survival (OS) and progression-free survival (PFS) in patients with pulmonary metastases from soft tissue sarcoma.

#### METHODS AND MATERIALS

Consecutive patients with soft tissue sarcoma who were treated at our facility from 2016 to 2021 were screened. We excluded patients without lung metastases, with non-measurable lung metastases, after lung surgery, with missing clinical information or with missing baseline CT-scans. Up to five target lesions of the lung were segmented using mintLesion (Mint Medical, Heidelberg, Germany) at baseline CT-imaging prior to systemic therapy. The sum of target volume (STLV), the sum of target long axis (STLA) and the long axis of largest target lesion (LATL) were used to represent tumor burden. The total number of lesions was assessed. The resulting tumor burden was split by terciles into equally sized groups (T1: <33%; T2: 33-66%; T3: >66%). Dichotomized subgroups of patients with different total number of target lesions were defined. All terciles and subgroups were tested for OS and PFS.

#### RESULTS

Sixty-eight patients were included. The median age was 55 years (50% male) the median OS was 25.2 months and the median PFS was 6.4 months. No significant difference in OS or PFS in patients with different STLV, STLA and LATL was observed (Figure 1, A-F). There was a significant difference in the OS depending on the number of target lesions (median survival for patients with =5 vs. <5 target lesions: 21.9 vs. 35.5 months;  $p=0.036$ ), whereas PFS showed no significant difference (5.5 vs. 6.9 months;  $p=0.206$ ) (Figure 2, A-B).

#### CONCLUSION

In this study on patients with lung metastases from soft tissue sarcoma, the data indicates that the number of target lesions outperforms the total tumor burden with regard to OS prediction at baseline. We found no imaging parameters that were associated with PFS.

#### CLINICAL RELEVANCE/APPLICATION

Soft tissue sarcoma is rare and prognostic information is scarce. As patients routinely undergo cancer staging by CT, identifying prognostic parameters from imaging data may support therapy guidance.

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## Abstract Archives of the RSNA, 2023

W1-SSMS03-4

### Target Lesion-Based CT Texture Analysis for Predicting Tumor Response in Patients with Metastatic Renal Cell Carcinoma Undergoing PD-1 Inhibitor Therapy

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406B

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to investigate the predictive efficacy of target lesion-based texture analysis on baseline contrast-enhanced CT scans for tumor response in patients with metastatic renal clear cell carcinoma undergoing PD-1 inhibitor therapy.

#### METHODS AND MATERIALS

A total of 42 patients with metastatic clear cell renal cell carcinoma who received PD-1 inhibitors after standard treatment failure between June 2015 and April 2022 were enrolled in this study. Contrast-enhanced CT scans were performed at baseline before treatment and follow-up every 8 to 10 weeks. Tumor response was assessed according to iRECIST, and all target lesions were classified as response/non-response, complete response/non-complete response groups according to tumor response evaluation. CT texture features were compared between each group. Univariate and multivariate logistic regression analysis was used to screen independent predictors of tumor response. The receiver operating characteristic curve (ROC) and the area under the curve (AUC) were used to evaluate the predictive efficacy of independent predictors and the model.

#### RESULTS

Significant differences in texture features were observed between the iCRL group and non-iCRL group, with odds ratio (OR) values of 0.071 (95% CI: 0.021-0.235), 3.532 (95% CI: 1.591-7.841), and 0.342 (95% CI: 0.152-0.768), respectively. The follow-up texture models predicting iCR achieved an AUC of 0.928 (95% CI: 0.8645-0.9915), 0.7984 (95% CI: 0.6291-0.9676), and 0.757 (95% CI: 0.5967-0.9177) by ROC analysis. Significant differences in texture features were observed between the response group and the non-response group, with AUC values of 0.645 (95% CI: 0.5091-0.7817) and 0.703 (95% CI: 0.5731-0.8341), respectively.

#### CONCLUSION

This study developed and validated a CT texture-based model for predicting tumor response in patients treated with PD-1 inhibitors. Texture features demonstrated significant differences between the response/non-response and complete response/non-complete response lesions. This model provides a non-invasive tool to predict treatment response, guide clinical decision-making, and improve patient outcomes.

#### CLINICAL RELEVANCE/APPLICATION

The findings of this study have important clinical implications for the management of patients with metastatic renal clear cell carcinoma undergoing PD-1 inhibitor therapy. The target lesion-based texture analysis using contrast-enhanced CT scans presented in this study can potentially serve as a valuable, non-invasive tool for predicting treatment response. This information can guide clinicians in identifying patients who are likely to benefit from PD-1 inhibitor therapy or who may require alternative treatment strategies.

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## Abstract Archives of the RSNA, 2023

W1-SSMS03-5

### Comparison of RECIST 1.1, mRECIST and PERCIST for Assessment of Peptide Receptor Radionuclide Therapy (PRRT) Treatment Response in Metastatic Neuroendocrine Tumor

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406B

Jack Zhao, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare RECIST 1.1, modified RECIST (mRECIST) and PERCIST for assessment of Peptide Receptor Radionuclide Therapy (PRRT) treatment response in metastatic neuroendocrine tumors.

#### METHODS AND MATERIALS

In this IRB-approved, HIPAA compliant retrospective study, patients treated with PRRT between July, 2019 and Dec, 2022 were identified. Inclusion criteria were presence of at least one pre-and one post-treatment imaging (CT, MRI, Ga 68 or Cu64 DOTATATE PET/CT) within one year of the start and end of PRRT respectively. The imaging was reviewed independently by two radiologists using RECIST 1.1, modified RECIST (mRECIST) and PERCIST criteria. Subsequently, discrepancies in response assessment were resolved through consensus. The response on the first post treatment scan and presence of disease progression during follow-up were recorded along with the date of best response and disease progression. Demographic information, histopathologic data, type of treatment before PRRT and date of last follow-up or death were obtained from the electronic medical records. Statistical analysis was performed to determine inter-reader agreement and agreement between the various response criteria using kappa statistics.

#### RESULTS

Demographic and histopathologic data are presented in Table 1. Best response by RECIST 1.1 was recorded in 26 patients (PR-7, SD- 13, PD- 6), by mRECIST in 22 patients (PR-7, SD- 10, PD- 5), by PERCIST in 14 patients (PR-4, SD- 3, PD- 7) (Fig 1). Inter-reader agreement was highest for PERCIST (weighted kappa 0.921, standard error 0.078 95% CI 0.769 to 1.000) followed by RECIST 1.1 (weighted kappa 0.897, standard error 0.071 95% CI 0.758 to 1.000) and mRECIST (weighted kappa 0.883, standard error 0.079 95% CI 0.727 to 1.000). There was very good agreement between RECIST 1.1 and mRECIST (weighted kappa 1.0) and good between mRECIST and PERCIST (weighted kappa 0.714, standard error 0.147 95% CI 0.427 to 1.000) but only moderate between RECIST 1.1 and PERCIST (weighted kappa 0.593, standard error 0.149 95% CI 0.301 to 0.885). Sub-group analysis showed PERCIST detected more number of non-responders than RECIST 1.1 or mRECIST although detection of responders was similar by all three criteria.

#### CONCLUSION

PERCIST had the best inter-reader agreement and detected more number of non-responders to PRRT than RECIST 1.1 or mRECIST. PERCIST and mRECIST had good agreement.

#### CLINICAL RELEVANCE/APPLICATION

PERCIST performs better than RECIST 1.1 or mRECIST in assessing response of neuroendocrine tumors to PRRT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSMS03-6

### Correlating Total Tumor Volume on CT-Scan and Liquid Biopsy CTDNA in 1017 Patients With Metastatic Cancer: A Novel Study

Wednesday, Nov. 29 8:00AM - 9:00AM Room: S406B

Lama DAWI, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The objective is to correlate quantitative imaging features computed from thorax-abdomen-pelvis (TAP) CT-scans to ctDNA tumor fraction (TF) and blood Tumor Mutational Burden (bTMB) from liquid biopsy in 1017 patients with a variety of metastatic cancers.

#### METHODS AND MATERIALS

This retrospective multi-center study included 1017 patients with metastatic cancer and a variety of systemic treatments. Liquid biopsy results and contemporaneous TAP CT-scans were collected from 2021 to 2023. TF and bTMB values were computed using FoundationOne Liquid CDX Roche methodology, defining high tumor fraction as a TF over 10%. Two expert radiologists manually outlined all cancerous lesions in the largest diameter axial slice. Total tumor volume (TTV) was computed by adding lesion volumes. Patients were assigned to train and external validation sets, the latter consisting of imaging data from a single specific center. Continuous values distributions by category were tested using the Mann-Whitney U-test, and a threshold was set with ROC curve analysis using Youden's Index. High and low groups were defined using this cutoff, and a  $\chi^2$  test of independence was used to examine the correlation. Sensitivity and specificity were reported with imaging features taken as the gold standard. Subanalysis were run on patients with liver metastasis.

#### RESULTS

Overall, 55294 lesions were annotated, most commonly located in the lung ( $n=20074$ ), liver ( $n=11297$ ) and lymph nodes ( $n=10222$ ). The train and validation sets included 599 and 418 patients, respectively. Preliminary analyses were performed on the train set. Patients with low TF had significantly less TTV than those with high TF ( $p<0.0001$ ). ROC analysis using TTV as the continuous value yields an AUC of 0.63. The selected threshold for TTV was 106 cm<sup>3</sup>. Correlation was significant between TTV and TF categories ( $\chi^2$  test:  $p<0.001$ ). The sensitivity and specificity were 76% and 42%. In a subanalysis of patients with liver lesions ( $n=253$ ) the volume threshold was 108 cm<sup>3</sup> with an AUC of 0.66. Correlation was significant between TTV and TF categories ( $\chi^2$  test:  $p<0.001$ ). The sensitivity and specificity were 82% and 42%.

#### CONCLUSION

The analysis on the train set showed significant correlation between total tumor volume and ctDNA tumor fraction. Sensitivity was higher for patients with liver lesions, suggesting that some organs shed circulating tumor DNA more than others. The study of tumor heterogeneity on imaging and its correlation to blood tumor mutational burden is in progress.

#### CLINICAL RELEVANCE/APPLICATION

Liquid biopsy is a new emerging technology capable of diagnosing cancer, where CT-imaging is the gold standard. Tailored to the patient's cancer phenotype, it may be a strong complementary tool for diagnosis and follow-up.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNMMI05

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Neuroradiology and Head/Neck)

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E350

Satoshi Minoshima, MD, PhD (*Moderator*) Consultant, Hamamatsu Photonics KK; Grant, Hamamatsu Photonics KK; Grant, Nihon Medi-Physics Co, Ltd; Grant, FUJIFILM Holdings Corporation  
Katherine A. Zukotynski, MD, PhD (*Moderator*) Research Consultant, Konica Minolta, Inc; Research Consultant, General Electric Company; Speakers Bureau, Jubilant DraxImage Inc

#### Sub-Events

#### W1-SSNMMI05- **Incidental Detection of Oropharyngeal Malignancy on PET: Diagnostic Yield of Asymmetric Radiotracer Uptake**

1

Brian J. Burkett, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

The incidental detection of asymmetric oropharyngeal radiotracer uptake on PET can result in uncertainty regarding appropriate steps in further evaluation. Frequently, patients are referred to otolaryngology for direct visualization of the oropharynx; however, risk stratification based on the PET may help guide further management. We aim to characterize the yield of incidental asymmetric uptake for diagnosing a new oropharyngeal (OPX) malignancy and to define thresholds of  $^{18}\text{F}$ -FDG uptake, optimized for the diagnosis of OPX malignancy.

#### METHODS AND MATERIALS

PET reports from January 2001-December 2018 were searched for terms related to asymmetric oropharyngeal uptake. Patients with a known oropharyngeal malignancy were excluded. Clinical records including pathology reports were reviewed. A radiologist blinded to the diagnosis of OPX malignancy measured standard uptake values (SUV) in the OPX site of concern (SUV<sub>maxIL</sub>) and contralateral site (SUV<sub>maxCL</sub>). For  $^{18}\text{F}$ -FDG PET, SUV measurements and ratios were compared using a student's t-test ( $p < 0.05$  considered significant). Clinical features associated with malignancy were evaluated with logistic regression. Receiver operating characteristic (ROC) curves were generated to determine cutpoints of SUV measurements to optimize the sensitivity and specificity for OPX cancer.

#### RESULTS

Patients with asymmetric uptake in the oropharynx ( $n=1422$ ) were identified, with 337 meeting inclusion criteria. Biopsy proven OPX malignancy was found in 21 patients (6.2%), including squamous cell carcinoma ( $n=12$ ), lymphoma ( $n=8$ ), and sarcoma ( $n=1$ ). Older age and male gender were associated with malignancy. Compared to benign cases, malignant lesions had significantly higher SUV<sub>maxIL</sub> (8.7 vs 5.3,  $p < 0.01$ ) and SUV<sub>max</sub> ratio (3.0 vs 1.6,  $p < 0.01$ ). Patients with a CT abnormality were over 5-fold more likely to have an OPX malignancy (OR 5.3, 95% CI 1.7 to 14.8,  $p=0.002$ ). Of the SUV-derived measurements, SUV<sub>max</sub> ratio had the highest area under the ROC curve of 86.2%, with an optimal cutpoint of 1.98, resulting in a sensitivity of 72.2% and specificity of 91.1% (Figure).

#### CONCLUSION

In patients with incidental OPX uptake on PET, a new OPX malignancy was found in a small but non-negligible percentage of patients. The presence of a correlative CT abnormality, the level of uptake measured by SUV<sub>maxIL</sub>, and especially SUV<sub>max</sub> ratio may help to risk stratify patients in determining the need to pursue more invasive examination and tissue sampling.

#### CLINICAL RELEVANCE/APPLICATION

Asymmetric oropharyngeal uptake on PET results diagnosis in a new cancer diagnosis in a small percentage of patients. SUV<sub>max</sub> ratio and presence of an associated CT abnormality may help risk stratify patients.

#### W1-SSNMMI05- **Simultaneous Hybrid $^{18}\text{F}$ -FDG PET/MRI-Based Multiparameter from Intratumor and Peritumoral Brain Regions for Grading of Glioma**



**PURPOSE**

Survival of patients with glioma varies greatly depending on tumor grade. Although challenging, accurate grade of glioma is critical for clinical decision-making in order to maximize prognosis and patient-tailored precision medicine. We aimed to investigate the <sup>18</sup>F-fluorodeoxyglucose (<sup>18</sup>F-FDG) PET/MR-derived multiple parameters from the tumor's solid part and peritumoral brain zone (PBZ) to differentiate high-grade (HGG) from lower-grade (LGG) gliomas.

**METHODS AND MATERIALS**

Preoperative <sup>18</sup>F-FDG PET/MRI data of 76 patients with pathologically confirmed glioma were retrospectively analyzed. The differences of imaging characteristics including the maximum standardized uptake value (SUVmax), relative cerebral blood flow (rCBF) and minimum apparent diffusion coefficient (ADCmin) in both the solid part and PBZ were compared. Receiver operating characteristic (ROC) curve was used to assess the tumor-grading performance. A nomogram was constructed to predict the probability of HGG.

**RESULTS**

The HGG displayed higher SUVmax and rCBF but lower ADCmin in the solid part and 5mm-adjacent PBZ, with lower ADCmin in the 10mm PBZ and higher rCBF in the 15mm and 20mm PBZ. The SUVmax in the solid part solely performed best [area under the curve (AUC) = 0.865] in glioma-grading. The combination of SUVmax in the solid and adjacent 20mm performed better (AUC = 0.881). Combined three indicators in the solid part and adjacent 20mm performed best (AUC = 0.928). The nomogram consisting of SUVmax, rCBF and ADCmin in both the solid part and 20mm PBZ predicted HGG with a C-index of 0.906.

**CONCLUSION**

Multiparametric <sup>18</sup>F-FDG PET/MRI quantitative analysis of the solid part and PBZ is superior to single parameter in differentiation of HGG and LGG, which should be considered in the clinical practice.

**CLINICAL RELEVANCE/APPLICATION**

The Combination of SUVmax, rCBF and ADCmin based on hybrid PET/MRI in the peritumoral regions, as well as the solid portion, provide valuable, enhanced diagnostic efficacy relative to single parameter alone. The predictive accuracy of these parameters aids our understanding of the cellular and metabolic features of the PBZ not only in HGG but also in LGG, which is crucial for identifying new therapeutic targets. Moreover, implementation of multiparametric <sup>18</sup>F-FDG PET/MRI may optimize the workflow efficiency for differentiating HGG from LGG.

**W1- SSNMMI05- FDG PET Investigation of Histopathologically-Confirmed Alzheimer's Disease, Frontotemporal Dementia, and Newly Recognized Fused In Sarcoma Proteinopathy**

Donna J. Cross, PhD (*Presenter*) Scientific Advisory Board, Ceremark Pharma

**PURPOSE**

To characterize the <sup>18</sup>F-fluorodeoxyglucose positron emission tomography (FDG PET) findings in histopathologically-confirmed Alzheimer's disease (AD), frontotemporal dementia (FTD), and fused in sarcoma (FUS) a newly recognized proteinopathy causing progressive dementia, for which specific imaging biomarkers are not yet available.

**METHODS AND MATERIALS**

FDG PET images from, 28 AD (70.1±9.1yrs), 10 FTD (67±6.7), and 3 FUS (51.6±17.0 yrs) were compared to 51 age-similar normal subjects. Patient autopsies assessed the presence of amyloid, tau, alpha-synuclein, ubiquitin and fused in sarcoma protein with immunohistochemistry. All images were anatomically standardized, and pixel values normalized to the pons, followed by 3D-SSP cortical activity extraction. Individual Z score maps of patients in comparison to the normal subjects as well as disease group comparison maps were generated. Regional metabolic activities were assessed for predefined regions.

**RESULTS**

There were general reductions in FDG uptake in cortical gray matter in AD and FTD (-16% and -15%, respectively, p<0.005). When comparing AD and FTD, FDG uptake in parietal association cortex, temporal association cortex, posterior cingulate cortex, and precuneus was more significantly decreased in AD as compared to FTD (-24%, -20%, -23%, -22% vs -15%, -15%, -16%, -14%, respectively). In contrast, FDG uptake in frontal association cortex, medial frontal cortex, and caudate head was more significantly reduced in FTD as compared to AD (-20%, -17%, -22% vs -17%, -13%, -15%, respectively). The FUS subjects, who were much younger on average, showed patterns of decreased FDG uptake similar to those of FTD, with prominent reductions in the anterior temporal lobe, orbitofrontal cortex, and caudate head (-33% as compared to -22% in FTD). FDG uptake in anterior cingulate cortex was equally reduced in FTD and FUS (-20% and -22%, respectively).



## CONCLUSION

In this series of histopathologically proven AD, FTD, and FUS, FDG PET demonstrated distinct patterns of AD vs FTD as expected. In addition, this is the first FDG-PET assessment of FUS patients, a newly recognized form of neurodegenerative proteinopathy, which demonstrated decreased FDG pattern similar to those seen in FTD but with some distinct features involving the anterior temporal lobe, orbitofrontal cortex, and caudate head. Further investigations are warranted for characterization of imaging findings of dementing proteinopathies.

## CLINICAL RELEVANCE/APPLICATION

In the absence of protein-specific radiotracers to stratify neurodegenerative dementias, FDG has value to aid in a differential diagnosis, when the characteristic hypometabolic patterns are identified.

### W1-SSNMMI05-4 **Keynote Speaker**

Katherine A. Zukotynski, MD, PhD (*Presenter*) Research Consultant, Konica Minolta, Inc; Research Consultant, General Electric Company; Speakers Bureau, Jubilant DraxImage Inc

### W1-SSNMMI05-5 **Keynote Speaker: Molecular Brain Imaging - Current and Future Status**

Satoshi Minoshima, MD, PhD (*Presenter*) Consultant, Hamamatsu Photonics KK; Grant, Hamamatsu Photonics KK; Grant, Nihon Medi-Physics Co, Ltd; Grant, FUJIFILM Holdings Corporation

### W1-SSNMMI05-6 **Brain Network Biomarkers with Dual-phase PET [<sup>18</sup>F]PI-2620 for the A/T/N Classification of Alzheimer's Disease**

Ana M. Franceschi, MD, PhD (*Presenter*) Consultant, Biogen Idec Inc

## PURPOSE

In this study, we sought to identify spatial covariance patterns of [18F]-PI-2620 PET in amyloid-positive Alzheimer's disease (AD) and normal controls (NC) using a data-driven scaled subprofile model (SSM)/principal-component analysis (PCA). We also tested SSM/PCA pattern expression for its ability to predict amyloid status and evaluate the potential of PI-2620 as a single biomarker for the A/T/N classification of neurodegenerative disease.

## METHODS AND MATERIALS

25 subjects (15 male, 10 female, mean age: 64.5 ± 10.1, range 51-89) were included; 15 patients with amyloid-positive AD (A+/T+/N+) and 10 controls (A-/T-/N-). All subjects underwent [18F]-PI-2620 PET (early-phase: 0-5min post-injection [pi] for brain perfusion; late-phase: 45-75min pi for tau pathology) and late-phase [18F]-florbetaben (FBB) 90-110 min pi for amyloid, alongside T1-MPRAGE MRI. Standard uptake value ratios (SUVR) in reference to cerebellum and MRI maps of grey matter (GM) were compared between the two groups by brain mapping analysis using SSM/PCA toolbox and SPM12.

## RESULTS

We identified four distinct AD-related patterns (ADRP) of covariance for brain perfusion, tau, amyloid and atrophy. Subject expression scores of these four ADPRs discriminated AD from NC (AUC = 0.99, 0.93, 1.00 and 0.80). Both ADRP-tau5 and ADRP-tau45 scores accurately predicted amyloid status (96 %). Moreover, subject scores of ADRP-Tau5, ADRP-Tau45 and ADRP-FBB correlated strongly among themselves ( $r = 0.69$ ,  $P < 0.0001$ ) and individually with clinical measures of disease (Mini-Mental State Examination:  $r = -0.57$ ,  $p < 0.05$ ; Clinical Dementia Rating:  $r = 0.49$ ,  $P < 0.05$ ; Alzheimer's Disease Assessment Scale-Cognitive Subscale:  $r = 0.69$ ,  $P < 0.0001$ ) in the combined sample. Subject scores of ADRP-Tau45 were also elevated in FBB scans (AUC = 0.973) and correlated with those of the 3 ADPRs ( $r = 0.76$ ,  $P < 0.0001$ ) and clinical measures ( $r = 0.42$ ,  $P < 0.05$ ), indicating overlap and differences in tau and amyloid deposition in AD. Of note, subject scores of ADRP-GM correlated weakly ( $r = 0.45$ ,  $P < 0.05$ ) with those of the 3 PET-based ADPRs without clinical correlation, suggesting only minimal influence of brain atrophy on PET findings.

## CONCLUSION

Preliminary analysis of AD-neurodegeneration and controls demonstrates the potential of PI-2620 to serve as a single biomarker ("one-stop-shop" approach) for the A/T/N classification of patients with cognitive impairment. Future work will validate this biomarker in patients with amyloid-negative neurodegeneration (A-/T+/N+).

## CLINICAL RELEVANCE/APPLICATION

This single biomarker approach may make PI-2620 PET more useful in dementia classification, patient selection, and monitoring of target engagement in disease-modifying treatment trials.

## Abstract Archives of the RSNA, 2023

W1-SSNMMI05-1

### Incidental Detection of Oropharyngeal Malignancy on PET: Diagnostic Yield of Asymmetric Radiotracer Uptake

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E350

Brian J. Burkett, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

The incidental detection of asymmetric oropharyngeal radiotracer uptake on PET can result in uncertainty regarding appropriate steps in further evaluation. Frequently, patients are referred to otolaryngology for direct visualization of the oropharynx; however, risk stratification based on the PET may help guide further management. We aim to characterize the yield of incidental asymmetric uptake for diagnosing a new oropharyngeal (OPX) malignancy and to define thresholds of 18F-FDG uptake, optimized for the diagnosis of OPX malignancy.

#### METHODS AND MATERIALS

PET reports from January 2001-December 2018 were searched for terms related to asymmetric oropharyngeal uptake. Patients with a known oropharyngeal malignancy were excluded. Clinical records including pathology reports were reviewed. A radiologist blinded to the diagnosis of OPX malignancy measured standard uptake values (SUV) in the OPX site of concern (SUV<sub>maxIL</sub>) and contralateral site (SUV<sub>maxCL</sub>). For 18F-FDG PET, SUV measurements and ratios were compared using a student's t-test ( $p < 0.05$  considered significant). Clinical features associated with malignancy were evaluated with logistic regression. Receiver operating characteristic (ROC) curves were generated to determine cutpoints of SUV measurements to optimize the sensitivity and specificity for OPX cancer.

#### RESULTS

Patients with asymmetric uptake in the oropharynx ( $n=1422$ ) were identified, with 337 meeting inclusion criteria. Biopsy proven OPX malignancy was found in 21 patients (6.2%), including squamous cell carcinoma ( $n=12$ ), lymphoma ( $n=8$ ), and sarcoma ( $n=1$ ). Older age and male gender were associated with malignancy. Compared to benign cases, malignant lesions had significantly higher SUV<sub>maxIL</sub> (8.7 vs 5.3,  $p < 0.01$ ) and SUV<sub>max</sub> ratio (3.0 vs 1.6,  $p < 0.01$ ). Patients with a CT abnormality were over 5-fold more likely to have an OPX malignancy (OR 5.3, 95% CI 1.7 to 14.8,  $p=0.002$ ). Of the SUV-derived measurements, SUV<sub>max</sub> ratio had the highest area under the ROC curve of 86.2%, with an optimal cutpoint of 1.98, resulting in a sensitivity of 72.2% and specificity of 91.1% (Figure).

#### CONCLUSION

In patients with incidental OPX uptake on PET, a new OPX malignancy was found in a small but non-negligible percentage of patients. The presence of a correlative CT abnormality, the level of uptake measured by SUV<sub>maxIL</sub>, and especially SUV<sub>max</sub> ratio may help to risk stratify patients in determining the need to pursue more invasive examination and tissue sampling.

#### CLINICAL RELEVANCE/APPLICATION

Asymmetric oropharyngeal uptake on PET results diagnosis in a new cancer diagnosis in a small percentage of patients. SUV<sub>max</sub> ratio and presence of an associated CT abnormality may help risk stratify patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNMMI05-2

### Simultaneous Hybrid $^{18}\text{F}$ -FDG PET/MRI-Based Multiparameter from Intratumor and Peritumoral Brain Regions for Grading of Glioma

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E350

Ping Liu, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Survival of patients with glioma varies greatly depending on tumor grade. Although challenging, accurate grade of glioma is critical for clinical decision-making in order to maximize prognosis and patient-tailored precision medicine. We aimed to investigate the  $^{18}\text{F}$ -fluorodeoxyglucose ( $^{18}\text{F}$ -FDG) PET/MR-derived multiple parameters from the tumor's solid part and peritumoral brain zone (PBZ) to differentiate high-grade (HGG) from lower-grade (LGG) gliomas.

#### METHODS AND MATERIALS

Preoperative  $^{18}\text{F}$ -FDG PET/MRI data of 76 patients with pathologically confirmed glioma were retrospectively analyzed. The differences of imaging characteristics including the maximum standardized uptake value (SUVmax), relative cerebral blood flow (rCBF) and minimum apparent diffusion coefficient (ADCmin) in both the solid part and PBZ were compared. Receiver operating characteristic (ROC) curve was used to assess the tumor-grading performance. A nomogram was constructed to predict the probability of HGG.

#### RESULTS

The HGG displayed higher SUVmax and rCBF but lower ADCmin in the solid part and 5mm-adjacent PBZ, with lower ADCmin in the 10mm PBZ and higher rCBF in the 15mm and 20mm PBZ. The SUVmax in the solid part solely performed best [area under the curve (AUC) = 0.865] in glioma-grading. The combination of SUVmax in the solid and adjacent 20mm performed better (AUC = 0.881). Combined three indicators in the solid part and adjacent 20mm performed best (AUC = 0.928). The nomogram consisting of SUVmax, rCBF and ADCmin in both the solid part and 20mm PBZ predicted HGG with a C-index of 0.906.

#### CONCLUSION

Multiparametric  $^{18}\text{F}$ -FDG PET/MRI quantitative analysis of the solid part and PBZ is superior to single parameter in differentiation of HGG and LGG, which should be considered in the clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

The Combination of SUVmax, rCBF and ADCmin based on hybrid PET/MRI in the peritumoral regions, as well as the solid portion, provide valuable, enhanced diagnostic efficacy relative to single parameter alone. The predictive accuracy of these parameters aids our understanding of the cellular and metabolic features of the PBZ not only in HGG but also in LGG, which is crucial for identifying new therapeutic targets. Moreover, implementation of multiparametric  $^{18}\text{F}$ -FDG PET/MRI may optimize the workflow efficiency for differentiating HGG from LGG.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNMMI05-3

### **FDG PET Investigation of Histopathologically-Confirmed Alzheimer's Disease, Frontotemporal Dementia, and Newly Recognized Fused In Sarcoma Proteinopathy**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E350

Donna J. Cross, PhD (*Presenter*) Scientific Advisory Board, Ceremark Pharma

#### **PURPOSE**

To characterize the 18F-fluorodeoxyglucose positron emission tomography (FDG PET) findings in histopathologically-confirmed Alzheimer's disease (AD), frontotemporal dementia (FTD), and fused in sarcoma (FUS) a newly recognized proteinopathy causing progressive dementia, for which specific imaging biomarkers are not yet available.

#### **METHODS AND MATERIALS**

FDG PET images from, 28 AD (70.1±9.1yrs), 10 FTD (67±6.7), and 3 FUS (51.6±17.0 yrs) were compared to 51 age-similar normal subjects. Patient autopsies assessed the presence of amyloid, tau, alpha-synuclein, ubiquitin and fused in sarcoma protein with immunohistochemistry. All images were anatomically standardized, and pixel values normalized to the pons, followed by 3D-SSP cortical activity extraction. Individual Z score maps of patients in comparison to the normal subjects as well as disease group comparison maps were generated. Regional metabolic activities were assessed for predefined regions.

#### **RESULTS**

There were general reductions in FDG uptake in cortical gray matter in AD and FTD (-16% and -15%, respectively,  $p < 0.005$ ). When comparing AD and FTD, FDG uptake in parietal association cortex, temporal association cortex, posterior cingulate cortex, and precuneus was more significantly decreased in AD as compared to FTD (-24%, -20%, -23%, -22% vs -15%, -15%, -16%, -14%, respectively). In contrast, FDG uptake in frontal association cortex, medial frontal cortex, and caudate head was more significantly reduced in FTD as compared to AD (-20%, -17%, -22% vs -17%, -13%, -15%, respectively). The FUS subjects, who were much younger on average, showed patterns of decreased FDG uptake similar to those of FTD, with prominent reductions in the anterior temporal lobe, orbitofrontal cortex, and caudate head (-33% as compared to -22% in FTD). FDG uptake in anterior cingulate cortex was equally reduced in FTD and FUS (-20% and -22%, respectively).

#### **CONCLUSION**

In this series of histopathologically proven AD, FTD, and FUS, FDG PET demonstrated distinct patterns of AD vs FTD as expected. In addition, this is the first FDG-PET assessment of FUS patients, a newly recognized form of neurodegenerative proteinopathy, which demonstrated decreased FDG pattern similar to those seen in FTD but with some distinct features involving the anterior temporal lobe, orbitofrontal cortex, and caudate head. Further investigations are warranted for characterization of imaging findings of dementing proteinopathies.

#### **CLINICAL RELEVANCE/APPLICATION**

In the absence of protein-specific radiotracers to stratify neurodegenerative dementias, FDG has value to aid in a differential diagnosis, when the characteristic hypometabolic patterns are identified.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNMMI05-4

### Keynote Speaker

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E350

Katherine A. Zukotynski, MD, PhD (*Presenter*) Research Consultant, Konica Minolta, Inc; Research Consultant, General Electric Company; Speakers Bureau, Jubilant DraxImage Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNMMI05-5

### **Keynote Speaker: Molecular Brain Imaging - Current and Future Status**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E350

Satoshi Minoshima, MD, PhD (*Presenter*) Consultant, Hamamatsu Photonics KK;Grant, Hamamatsu Photonics KK;Grant, Nihon Medi-Physics Co, Ltd;Grant, FUJIFILM Holdings Corporation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNMMI05-6

### Brain Network Biomarkers with Dual-phase PET [<sup>18</sup>F]PI-2620 for the A/T/N Classification of Alzheimer's Disease

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E350

Ana M. Franceschi, MD, PhD (*Presenter*) Consultant, Biogen Idec Inc

#### PURPOSE

In this study, we sought to identify spatial covariance patterns of [<sup>18</sup>F]-PI-2620 PET in amyloid-positive Alzheimer's disease (AD) and normal controls (NC) using a data-driven scaled subprofile model (SSM)/principal-component analysis (PCA). We also tested SSM/PCA pattern expression for its ability to predict amyloid status and evaluate the potential of PI-2620 as a single biomarker for the A/T/N classification of neurodegenerative disease.

#### METHODS AND MATERIALS

25 subjects (15 male, 10 female, mean age:  $64.5 \pm 10.1$ , range 51-89) were included; 15 patients with amyloid-positive AD (A+/T+/N+) and 10 controls (A-/T-/N-). All subjects underwent [<sup>18</sup>F]-PI-2620 PET (early-phase: 0-5min post-injection [pi] for brain perfusion; late-phase: 45-75min pi for tau pathology) and late-phase [<sup>18</sup>F]-florbetaben (FBB) 90-110 min pi for amyloid, alongside T1-MPRAGE MRI. Standard uptake value ratios (SUVR) in reference to cerebellum and MRI maps of grey matter (GM) were compared between the two groups by brain mapping analysis using SSM/PCA toolbox and SPM12.

#### RESULTS

We identified four distinct AD-related patterns (ADRP) of covariance for brain perfusion, tau, amyloid and atrophy. Subject expression scores of these four ADPRs discriminated AD from NC (AUC = 0.99, 0.93, 1.00 and 0.80). Both ADRP-tau5 and ADRP-tau45 scores accurately predicted amyloid status (96 %). Moreover, subject scores of ADRP-Tau5, ADRP-Tau45 and ADRP-FBB correlated strongly among themselves ( $r = 0.69$ ,  $P < 0.0001$ ) and individually with clinical measures of disease (Mini-Mental State Examination:  $r = -0.57$ ,  $p < 0.05$ ; Clinical Dementia Rating:  $r = 0.49$ ,  $P < 0.05$ ; Alzheimer's Disease Assessment Scale-Cognitive Subscale:  $r = 0.69$ ,  $P < 0.0001$ ) in the combined sample. Subject scores of ADRP-Tau45 were also elevated in FBB scans (AUC = 0.973) and correlated with those of the 3 ADPRs ( $r = 0.76$ ,  $P < 0.0001$ ) and clinical measures ( $r = 0.42$ ,  $P < 0.05$ ), indicating overlap and differences in tau and amyloid deposition in AD. Of note, subject scores of ADRP-GM correlated weakly ( $r = 0.45$ ,  $P < 0.05$ ) with those of the 3 PET-based ADPRs without clinical correlation, suggesting only minimal influence of brain atrophy on PET findings.

#### CONCLUSION

Preliminary analysis of AD-neurodegeneration and controls demonstrates the potential of PI-2620 to serve as a single biomarker ("one-stop-shop" approach) for the A/T/N classification of patients with cognitive impairment. Future work will validate this biomarker in patients with amyloid-negative neurodegeneration (A-/T+/N+).

#### CLINICAL RELEVANCE/APPLICATION

This single biomarker approach may make PI-2620 PET more useful in dementia classification, patient selection, and monitoring of target engagement in disease-modifying treatment trials.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNPM03

### Noninterpretive Skills (Beyond Imaging) (Health Equity and Access to Care in Radiology)

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E351

Melissa A. Davis, MD, MBA (*Moderator*) Nothing to Disclose  
Andrew B. Ross, MD, MPH (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W1-SSNPM03-1 **Assessment of Geographic Trends in Patient Travel to Interventional Radiology Services in a Resource-Limited Setting**

Jared M. Alswang (*Presenter*) Nothing to Disclose

#### PURPOSE

Interventional radiology (IR) services in sub-Saharan Africa (SSA) are extremely limited - centralized to a few large metropolitan areas with substantial territorial gaps in which IR is unavailable to over a billion people. Therefore, this study aims to evaluate the patient geographic makeup of Tanzania's first IR service and provide preliminary data on the geographic range and resulting gaps in coverage in effort to help optimize future IR growth strategies in Tanzania and the region at large.

#### METHODS AND MATERIALS

From October 2018 to August 2022, travel time (1,339 patients) and home region (1,184 patients) were prospectively recorded from 1,434 patients undergoing IR procedures at Tanzania's largest referral center. Distances traveled by road were calculated from the administrative capital of each region using a web mapping platform (google.com/maps). The hospital's home region was subdivided amongst its five administrative districts and were instead utilized for distance calculation for residents of this region. The impact of various factors, including procedure type, gender, and age on distance and time traveled were assessed using chi-square and Kruskal-Wallis statistical tests.

#### RESULTS

Patients from all 31 regions in Tanzania underwent IR procedures with 60.1% coming from within the hospital's home region. 25.0% of patients traveled for over six hours for their procedure. The mean, median, and maximum calculated distance traveled by patients were 241.6 km (SD=356.5 km), 45.0 km (Q1=5.0 km; Q3=456.0 km), and 1,387 km, respectively. There was no statistically significant difference in age ( $p=0.13$ ;  $H=7.21$ ) and gender ( $p=0.62$ ;  $\chi^2=2.63$ ) relative to distance traveled. Patients traveled furthest on average for genitourinary procedures (293.4 km) and biliary procedures (292.4 km) and least for angioplasty and stenting (123.9 km) and central venous access (153.1 km) ( $p<0.001$ ;  $H=30.89$ ). Patients from the hospital's home region were up to 296.4 times more likely to have undergone an IR procedure in Tanzania compared to distant regions - six of which with less than 2 IR procedures performed per 1,000,000 population.

#### CONCLUSION

By analyzing empirical patient data, this study provides a real-world characterization of the catchment area of Tanzania's first IR service. As demonstrated, a single IR service in SSA can have a large impact in a geographically vast area. However, there remains a need to further decentralize services to increase population access and reduce patient travel times.

#### CLINICAL RELEVANCE/APPLICATION

Given human and physical capital constraints in resource-limited settings, empirical patient data is needed to accurately characterize the geographic profile of IR services, optimize coverage, and guide future specialty growth.

#### W1-SSNPM03-2 **Prevalence of Financial Hardship and Other Health-Related Social Risks Among Radiology Outpatients With Cancelled or No-Show Appointments**

Andrew Cuyegkeng, BS (*Presenter*) Nothing to Disclose



## PURPOSE

Patients who cancel or are no-shows to their outpatient radiology appointments have been shown to have worse health outcomes, possibly due to delay in diagnosis and treatment. We assessed the prevalence of financial hardship and other health-related social risks (HRSR) among radiology outpatients with cancelled or no-show appointments.

## METHODS AND MATERIALS

Between 11/2022 and 04/2023, patients who cancelled or did not show up to their outpatient CT, MRI, mammography, or PET/CT imaging test at a tertiary academic healthcare center were invited to complete a 10-minute survey. The survey assessed reasons for cancellation, risk of financial hardship, and other HRSRs. Descriptive statistics were used to analyze data.

## RESULTS

165 patients were included (mean age: 55; 73% female; 54% white, 18% Asian, 16% Hispanic). 57.4% had commercial insurance, 33.9% had Medicare or government insurance, 6.8% had Medicaid, and 1.8% were uninsured. Of the appointments that were missed, 36% were for MRI, 36% for mammography, and 20% for CT. A total of 30.1% reported that their scheduled imaging appointment was a financial hardship for them and their family, and for 6.1% of patients, not being able to afford the cost was the reason for cancellation/no show. Those who knew an estimate of their imaging out of pocket cost were more likely to have cancellation/no shows due to cost ( $p = 0.009$ ). 47.4% reported experiencing at least one HRSR (26.7% food insecurity, 13.5% housing instability, 12.9% transportation problem, 9.9% utility concerns). Only 10.4% were previously screened for HRSRs and 8.6% received prior financial assistance.

## CONCLUSION

Financial hardship and HRSRs are common among radiology outpatients who cancel or do not show up to their appointment and may contribute to reasons for cancellations or no shows.

## CLINICAL RELEVANCE/APPLICATION

It is crucial to identify and intervene on patients at risk for financial hardship and HRSRs as a modifiable barrier to receipt of radiology services.

## W1-SSNPM03-3 Patient Engagement with Radiology Report Content: A Retrospective Analysis of 60,572 Radiology Report Views

Ryan G. Short, MD (*Presenter*) Co-founder, Scanslated, Inc; Officer, Scanslated, Inc

## PURPOSE

Many patients have immediate access to their radiology reports via online portals. There is limited data exploring patient experience and interaction with radiology reports in real-world clinical settings. Using modern web technologies, however, patient interaction with radiology reports can be recorded and analyzed. This study aims to evaluate patient engagement with radiology report content to inform further evolution of radiology reports for a patient audience.

## METHODS AND MATERIALS

Webpage-style interactive radiology reports with patient-centered content were made available to patients via an online portal. Simple language explanations of terms and phrases in the reports were accessible to patients via a clickable hyperlink. For each viewed radiology report over a one-year study period, we assessed patient engagement with the interactive report by recording the specific terms and phrases clicked by patients, the number of clicks of each term, as well as a count of the total number of available term and phrase explanations in the annotated report. The terms were categorized according to the hierarchical RadLex Tree Browser.

## RESULTS

In 60,572 unique viewed reports, there were 380,798 term clicks out of 4,264,663 available annotated terms (overall click rate 8.9%). 878 terms were annotated = 1000 times in the corpus of reports. The click rate for these high-frequency terms ranged from 0.1% to 63.2%. The average term click rate for RadLex categories varied from 16.7% for the 'clinical findings' category to 7.9% for the 'property' category.

## CONCLUSION

Our results provide further evidence that patients want to understand their radiology reports. Click rate data suggests that patients are more interested in terms categorized as clinical findings (e.g., hemangioma, cyst, pneumothorax) and imaging observations (e.g., lesion, nodule, mass) than terms categorized as anatomical entities (e.g., heart, spine, hip) or properties (e.g., iterative reconstruction, alignment, intravenous contrast). This suggests that patients are more interested in the specific findings of their radiology report, such as the presence of a tumor or a fracture than in the general anatomical location of the finding or the technical details of the imaging study. While the rationale underlying the observed variation in click rate between terms is unknown, we hypothesize that terms with higher click rates are less familiar to patients and perceived to be more relevant to individual health than terms with low click rates.

## CLINICAL RELEVANCE/APPLICATION

Modern web technologies can provide insight into the patient experience of viewing radiology reports online and could inform further evolution of radiology reports for a patient audience.

### W1-SSNPM03-4 **Community-Based Qualitative Study to Inform a Health Equity Curriculum for Radiologists: Project HEALTH [Health Equity Assessment, Learning & Training Hub]**

Esteban Barreto (*Presenter*) Nothing to Disclose

#### PURPOSE

To employ community-based focus group discussions to explore high-priority topics related to health equity, social determinants of health and patient barriers to radiology care, to inform the development of a health equity curriculum for radiology professionals.

#### METHODS AND MATERIALS

A multi-institutional qualitative study was performed that leveraged community-based focus group discussions. Key community partners were recruited from 2 large academic medical centers, 5 community organizations, 3 medical schools, and 3 radiology trainee programs. A focus group guide was developed using an adapted version of the evidence-based participant and relationship-centered research engagement model to discuss health equity topics (e.g. "what have you heard about health equity?"; "what do you wish healthcare providers in radiology knew about health equity?"). Focus groups were conducted in-person and virtually, recorded, and transcribed from December 2022 to April 2023. Double coding of verbatim transcripts was performed by two graduate students, with a senior analyst reviewing for emerging common themes during content analysis.

#### RESULTS

Focus group participants included medical students (n = 19), radiology residents (n = 6), and community members (n = 14) across 4 groups. Three major themes arose throughout the focus group sessions: experiencing health inequities, including health equity in medical education, and leading with empathy in radiology care. Experiencing Health Inequities: While most participants reported experiencing health inequities first-hand, others observed inequities through their patients' or family members' experience. Including Health Equity in Medical Education: Medical students and radiology residents indicated that there is a disconnect between theory and practice. Similarly, community members discussed the need to train future health professionals to care for diverse patients. Leading with Empathy in Radiology Care: Many community members emphasized the need for patients to be heard and seen when being cared for based on their lived experiences. Radiology residents and medical students also emphasized the importance of considering the social determinants of their patients' health to provide equitable care.

#### CONCLUSION

The design of a community-informed health equity medical curriculum should incorporate lived experiences with health inequities, practical applications for health equity in medical education, and leading with empathy in radiology care.

## CLINICAL RELEVANCE/APPLICATION

Multi-institutional collaborations with patients and other key interest groups can foster the development of a practical and relevant radiology health equity curriculum that is generalizable to radiology professionals.

### W1-SSNPM03-5 **The Feasibility of Screening for Health-related Social Risks at Outpatient Radiology Encounters**

Riya Bansal (*Presenter*) Nothing to Disclose

#### PURPOSE

Health-related Social Risks (HRSR) are linked to worse health outcomes. We assessed the HRSRs prevalence and feasibility of screening during outpatient radiology encounters.

#### METHODS AND MATERIALS

Between 11/2022 and 03/2023, we asked adult English-, Spanish- and Vietnamese-speaking patients receiving any of CT, MRI, or PET/CT as an outpatient at a tertiary academic healthcare to complete a 15 minute survey querying about HRSRs and feasibility of screening at Radiology encounters. Descriptive and multivariable regression statistics were used.

#### RESULTS

430 patients were included (mean age: 57.1 (SD: 15.6); 67% female; 54.9% White, 1.2% Black, 19.2% Asian, 21.3% Hispanics). Majority were English-speaking; 14.2% and 4.4% were Spanish- and Vietnamese-speaking. 52.8% had public insurance; 47.2% had commercial insurance. 54% reported having at least one HRSR (15.7% housing insecurity, 28.3% food insecurity, 11.2% transportation issue, and 6.9% utilities issue). 15.1% reported previously being screened for HRSRs at

other health encounters and 11.4% received prior financial assistance. Majority (79.7%) believed it was appropriate to be screened for HRSRs at a radiology encounter, while 18.4% felt uncomfortable answering questions about HRSRs. In multivariable regression analyses those married (OR 22.9; 95% CI: 2.5, 209) or having Medicare compared to commercial insurance (OR, 21.3; 95% CI: 2.4, 188) were more likely to report it was appropriate to be screened for HRSR during radiology encounter, while those with receipt of prior HRSR screening were less likely to believe it was appropriate (OR, 0.1; 95% CI, 0.0, 0.6). Those screened positive for at least one HRSR were more likely to be uncomfortable with being asked about HRSRs during radiology encounter (OR, 6.7; 95% CI: 1.3, 33.6).

## **CONCLUSION**

More than half of the radiology outpatients experience HRSRs. While majority are comfortable being screened for HRSRs at radiology encounter, those who screen positive for HRSRs felt more uncomfortable discussing them.

## **CLINICAL RELEVANCE/APPLICATION**

Initiative to increasing patients' comfort level to discuss HRSRs allows identification of those at risk and early intervention.

## **W1- SSNPM03-6 Assessing Role of Patient Social Factors on Radiology Cancellations and No-Shows**

Arham N. Aijaz, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

No-shows or cancellations for imaging appointments can lead to delayed care, and worsened health outcomes. We aimed to assess sociodemographic factors associated with patient-initiated cancellations and no-shows in outpatient radiology clinics of an urban academic health center.

## **METHODS AND MATERIALS**

Clinical data warehouse was inquired for a list of adult patients with cancellation or no-shows to outpatient imaging appointments at an urban academic health center between January 1st, 2022, and January 31st, 2023. Logistic regression models were used to assess sociodemographic factors associated with patient-initiated (e.g., transportation, financial, personal, etc.) vs. provider-initiated cancellations and no-shows vs. cancellations.

## **RESULTS**

19,262 patients were included (67.1% female, mean age:  $60.8 \pm 15.5$  years; 63.9% white; 20.0% Asian; 22.0% Hispanics). 64.6%, 27.3%, and 8.1% of patients had patient-initiated, provider-initiated cancellation and no-shows, respectively. Women (OR, 1.28), English speakers (OR, 1.20), those undergoing MRI (OR, 1.25) or mammography (OR, 1.86) (compared to CT) were more likely to have patient-initiated cancellations, while Asian (compared to White) (OR, 0.87) and those undergoing PET-CT (compared to CT) (OR, 0.34) were less likely to have patient-initiated cancellations. Black (compared to White) (OR, 1.41), Hispanics (OR, 1.39), those single (OR, 1.34) or divorced/separated (OR, 1.35) compared to married, having Medicare (OR, 1.21), Medicaid (OR, 1.33) or being uninsured (OR, 2.38) (compared to commercial insurance) were more likely to have no-shows. Older patients (OR, 0.98) and English speakers compared to non-English (OR, 0.71) were less likely to have no-shows.

## **CONCLUSION**

Patient-initiated cancellation and no-shows are more common in certain sociodemographic subgroups resulting in health disparity in patient outcomes.

## **CLINICAL RELEVANCE/APPLICATION**

This research sheds light on the disparities seen in patient-initiated imaging cancellations and no-shows between different sociodemographic subgroups. By doing so, it remains clinically relevant as it seeks to improve the care of patients by ensuring that all groups of patients receive their timely and necessary diagnostic imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNPM03-1

### Assessment of Geographic Trends in Patient Travel to Interventional Radiology Services in a Resource-Limited Setting

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E351

Jared M. Alswang (*Presenter*) Nothing to Disclose

#### PURPOSE

Interventional radiology (IR) services in sub-Saharan Africa (SSA) are extremely limited - centralized to a few large metropolitan areas with substantial territorial gaps in which IR is unavailable to over a billion people. Therefore, this study aims to evaluate the patient geographic makeup of Tanzania's first IR service and provide preliminary data on the geographic range and resulting gaps in coverage in effort to help optimize future IR growth strategies in Tanzania and the region at large.

#### METHODS AND MATERIALS

From October 2018 to August 2022, travel time (1,339 patients) and home region (1,184 patients) were prospectively recorded from 1,434 patients undergoing IR procedures at Tanzania's largest referral center. Distances traveled by road were calculated from the administrative capital of each region using a web mapping platform (google.com/maps). The hospital's home region was subdivided amongst its five administrative districts and were instead utilized for distance calculation for residents of this region. The impact of various factors, including procedure type, gender, and age on distance and time traveled were assessed using chi-square and Kruskal-Wallis statistical tests.

#### RESULTS

Patients from all 31 regions in Tanzania underwent IR procedures with 60.1% coming from within the hospital's home region. 25.0% of patients traveled for over six hours for their procedure. The mean, median, and maximum calculated distance traveled by patients were 241.6 km (SD=356.5 km), 45.0 km (Q1=5.0 km; Q3=456.0 km), and 1,387 km, respectively. There was no statistically significant difference in age ( $p=0.13$ ;  $H=7.21$ ) and gender ( $p=0.62$ ;  $\chi^2=2.63$ ) relative to distance traveled. Patients traveled furthest on average for genitourinary procedures (293.4 km) and biliary procedures (292.4 km) and least for angioplasty and stenting (123.9 km) and central venous access (153.1 km) ( $p<0.001$ ;  $H=30.89$ ). Patients from the hospital's home region were up to 296.4 times more likely to have undergone an IR procedure in Tanzania compared to distant regions - six of which with less than 2 IR procedures performed per 1,000,000 population.

#### CONCLUSION

By analyzing empirical patient data, this study provides a real-world characterization of the catchment area of Tanzania's first IR service. As demonstrated, a single IR service in SSA can have a large impact in a geographically vast area. However, there remains a need to further decentralize services to increase population access and reduce patient travel times.

#### CLINICAL RELEVANCE/APPLICATION

Given human and physical capital constraints in resource-limited settings, empirical patient data is needed to accurately characterize the geographic profile of IR services, optimize coverage, and guide future specialty growth.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNPM03-2

### Prevalence of Financial Hardship and Other Health-Related Social Risks Among Radiology Outpatients With Cancelled or No-Show Appointments

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E351

Andrew Cuyegkeng, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients who cancel or are no-shows to their outpatient radiology appointments have been shown to have worse health outcomes, possibly due to delay in diagnosis and treatment. We assessed the prevalence of financial hardship and other health-related social risks (HRSR) among radiology outpatients with cancelled or no-show appointments.

#### METHODS AND MATERIALS

Between 11/2022 and 04/2023, patients who cancelled or did not show up to their outpatient CT, MRI, mammography, or PET/CT imaging test at a tertiary academic healthcare center were invited to complete a 10-minute survey. The survey assessed reasons for cancellation, risk of financial hardship, and other HRSRs. Descriptive statistics were used to analyze data.

#### RESULTS

165 patients were included (mean age: 55; 73% female; 54% white, 18% Asian, 16% Hispanic). 57.4% had commercial insurance, 33.9% had Medicare or government insurance, 6.8% had Medicaid, and 1.8% were uninsured. Of the appointments that were missed, 36% were for MRI, 36% for mammography, and 20% for CT. A total of 30.1% reported that their scheduled imaging appointment was a financial hardship for them and their family, and for 6.1% of patients, not being able to afford the cost was the reason for cancellation/no show. Those who knew an estimate of their imaging out of pocket cost were more likely to have cancellation/no shows due to cost ( $p = 0.009$ ). 47.4% reported experiencing at least one HRSR (26.7% food insecurity, 13.5% housing instability, 12.9% transportation problem, 9.9% utility concerns). Only 10.4% were previously screened for HRSRs and 8.6% received prior financial assistance.

#### CONCLUSION

Financial hardship and HRSRs are common among radiology outpatients who cancel or do not show up to their appointment and may contribute to reasons for cancellations or no shows.

#### CLINICAL RELEVANCE/APPLICATION

It is crucial to identify and intervene on patients at risk for financial hardship and HRSRs as a modifiable barrier to receipt of radiology services.

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## Abstract Archives of the RSNA, 2023

W1-SSNPM03-3

### Patient Engagement with Radiology Report Content: A Retrospective Analysis of 60,572 Radiology Report Views

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E351

Ryan G. Short, MD (*Presenter*) Co-founder, Scanslated, Inc; Officer, Scanslated, Inc

#### PURPOSE

Many patients have immediate access to their radiology reports via online portals. There is limited data exploring patient experience and interaction with radiology reports in real-world clinical settings. Using modern web technologies, however, patient interaction with radiology reports can be recorded and analyzed. This study aims to evaluate patient engagement with radiology report content to inform further evolution of radiology reports for a patient audience.

#### METHODS AND MATERIALS

Webpage-style interactive radiology reports with patient-centered content were made available to patients via an online portal. Simple language explanations of terms and phrases in the reports were accessible to patients via a clickable hyperlink. For each viewed radiology report over a one-year study period, we assessed patient engagement with the interactive report by recording the specific terms and phrases clicked by patients, the number of clicks of each term, as well as a count of the total number of available term and phrase explanations in the annotated report. The terms were categorized according to the hierarchical RadLex Tree Browser.

#### RESULTS

In 60,572 unique viewed reports, there were 380,798 term clicks out of 4,264,663 available annotated terms (overall click rate 8.9%). 878 terms were annotated = 1000 times in the corpus of reports. The click rate for these high-frequency terms ranged from 0.1% to 63.2%. The average term click rate for RadLex categories varied from 16.7% for the 'clinical findings' category to 7.9% for the 'property' category.

#### CONCLUSION

Our results provide further evidence that patients want to understand their radiology reports. Click rate data suggests that patients are more interested in terms categorized as clinical findings (e.g., hemangioma, cyst, pneumothorax) and imaging observations (e.g., lesion, nodule, mass) than terms categorized as anatomical entities (e.g., heart, spine, hip) or properties (e.g., iterative reconstruction, alignment, intravenous contrast). This suggests that patients are more interested in the specific findings of their radiology report, such as the presence of a tumor or a fracture than in the general anatomical location of the finding or the technical details of the imaging study. While the rationale underlying the observed variation in click rate between terms is unknown, we hypothesize that terms with higher click rates are less familiar to patients and perceived to be more relevant to individual health than terms with low click rates.

#### CLINICAL RELEVANCE/APPLICATION

Modern web technologies can provide insight into the patient experience of viewing radiology reports online and could inform further evolution of radiology reports for a patient audience.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSNPM03-4

### **Community-Based Qualitative Study to Inform a Health Equity Curriculum for Radiologists: Project HEALTH [Health Equity Assessment, Learning & Training Hub]**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E351

Esteban Barreto (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To employ community-based focus group discussions to explore high-priority topics related to health equity, social determinants of health and patient barriers to radiology care, to inform the development of a health equity curriculum for radiology professionals.

#### **METHODS AND MATERIALS**

A multi-institutional qualitative study was performed that leveraged community-based focus group discussions. Key community partners were recruited from 2 large academic medical centers, 5 community organizations, 3 medical schools, and 3 radiology trainee programs. A focus group guide was developed using an adapted version of the evidence-based participant and relationship-centered research engagement model to discuss health equity topics (e.g. "what have you heard about health equity?"; "what do you wish healthcare providers in radiology knew about health equity?"). Focus groups were conducted in-person and virtually, recorded, and transcribed from December 2022 to April 2023. Double coding of verbatim transcripts was performed by two graduate students, with a senior analyst reviewing for emerging common themes during content analysis.

#### **RESULTS**

Focus group participants included medical students (n = 19), radiology residents (n = 6), and community members (n = 14) across 4 groups. Three major themes arose throughout the focus group sessions: experiencing health inequities, including health equity in medical education, and leading with empathy in radiology care. Experiencing Health Inequities: While most participants reported experiencing health inequities first-hand, others observed inequities through their patients' or family members' experience. Including Health Equity in Medical Education: Medical students and radiology residents indicated that there is a disconnect between theory and practice. Similarly, community members discussed the need to train future health professionals to care for diverse patients. Leading with Empathy in Radiology Care: Many community members emphasized the need for patients to be heard and seen when being cared for based on their lived experiences. Radiology residents and medical students also emphasized the importance of considering the social determinants of their patients' health to provide equitable care.

#### **CONCLUSION**

The design of a community-informed health equity medical curriculum should incorporate lived experiences with health inequities, practical applications for health equity in medical education, and leading with empathy in radiology care.

#### **CLINICAL RELEVANCE/APPLICATION**

Multi-institutional collaborations with patients and other key interest groups can foster the development of a practical and relevant radiology health equity curriculum that is generalizable to radiology professionals.

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## Abstract Archives of the RSNA, 2023

W1-SSNPM03-5

### The Feasibility of Screening for Health-related Social Risks at Outpatient Radiology Encounters

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E351

Riya Bansal (*Presenter*) Nothing to Disclose

#### PURPOSE

Health-related Social Risks (HRSR) are linked to worse health outcomes. We assessed the HRSRs prevalence and feasibility of screening during outpatient radiology encounters.

#### METHODS AND MATERIALS

Between 11/2022 and 03/2023, we asked adult English-, Spanish- and Vietnamese-speaking patients receiving any of CT, MRI, or PET/CT as an outpatient at a tertiary academic healthcare to complete a 15 minute survey querying about HRSRs and feasibility of screening at Radiology encounters. Descriptive and multivariable regression statistics were used.

#### RESULTS

430 patients were included (mean age: 57.1 (SD: 15.6); 67% female; 54.9% White, 1.2% Black, 19.2% Asian, 21.3% Hispanics). Majority were English-speaking; 14.2% and 4.4% were Spanish- and Vietnamese-speaking. 52.8% had public insurance; 47.2% had commercial insurance. 54% reported having at least one HRSR (15.7% housing insecurity, 28.3% food insecurity, 11.2% transportation issue, and 6.9% utilities issue). 15.1% reported previously being screened for HRSRs at other health encounters and 11.4% received prior financial assistance. Majority (79.7%) believed it was appropriate to be screened for HRSRs at a radiology encounter, while 18.4% felt uncomfortable answering questions about HRSRs. In multivariable regression analyses those married (OR 22.9; 95% CI: 2.5, 209) or having Medicare compared to commercial insurance (OR, 21.3; 95% CI: 2.4, 188) were more likely to report it was appropriate to be screened for HRSR during radiology encounter, while those with receipt of prior HRSR screening were less likely to believe it was appropriate (OR, 0.1; 95% CI, 0.0, 0.6). Those screened positive for at least one HRSR were more likely to be uncomfortable with being asked about HRSRs during radiology encounter (OR, 6.7; 95% CI: 1.3, 33.6).

#### CONCLUSION

More than half of the radiology outpatients experience HRSRs. While majority are comfortable being screened for HRSRs at radiology encounter, those who screen positive for HRSRs felt more uncomfortable discussing them.

#### CLINICAL RELEVANCE/APPLICATION

Initiative to increasing patients' comfort level to discuss HRSRs allows identification of those at risk and early intervention.

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## Abstract Archives of the RSNA, 2023

W1-SSNPM03-6

### Assessing Role of Patient Social Factors on Radiology Cancellations and No-Shows

Wednesday, Nov. 29 8:00AM - 9:00AM Room: E351

Arham N. Aijaz, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

No-shows or cancellations for imaging appointments can lead to delayed care, and worsened health outcomes. We aimed to assess sociodemographic factors associated with patient-initiated cancellations and no-shows in outpatient radiology clinics of an urban academic health center.

#### METHODS AND MATERIALS

Clinical data warehouse was inquired for a list of adult patients with cancellation or no-shows to outpatient imaging appointments at an urban academic health center between January 1st, 2022, and January 31st, 2023. Logistic regression models were used to assess sociodemographic factors associated with patient-initiated (e.g., transportation, financial, personal, etc.) vs. provider-initiated cancellations and no-shows vs. cancellations.

#### RESULTS

19,262 patients were included (67.1% female, mean age:  $60.8 \pm 15.5$  years; 63.9% white; 20.0% Asian; 22.0% Hispanics). 64.6%, 27.3%, and 8.1% of patients had patient-initiated, provider-initiated cancellation and no-shows, respectively. Women (OR, 1.28), English speakers (OR, 1.20), those undergoing MRI (OR, 1.25) or mammography (OR, 1.86) (compared to CT) were more likely to have patient-initiated cancellations, while Asian (compared to White) (OR, 0.87) and those undergoing PET-CT (compared to CT) (OR, 0.34) were less likely to have patient-initiated cancellations. Black (compared to White) (OR, 1.41), Hispanics (OR, 1.39), those single (OR, 1.34) or divorced/separated (OR, 1.35) compared to married, having Medicare (OR, 1.21), Medicaid (OR, 1.33) or being uninsured (OR, 2.38) (compared to commercial insurance) were more likely to have no-shows. Older patients (OR, 0.98) and English speakers compared to non-English (OR, 0.71) were less likely to have no-shows.

#### CONCLUSION

Patient-initiated cancellation and no-shows are more common in certain sociodemographic subgroups resulting in health disparity in patient outcomes.

#### CLINICAL RELEVANCE/APPLICATION

This research sheds light on the disparities seen in patient-initiated imaging cancellations and no-shows between different sociodemographic subgroups. By doing so, it remains clinically relevant as it seeks to improve the care of patients by ensuring that all groups of patients receive their timely and necessary diagnostic imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSVA03

### Vascular Imaging (Peripheral Vascular Imaging)

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N226

Dominik Fleischmann, MD (*Moderator*) Research Grant, Siemens AG; Stockholder, iSchemaView, Inc; Stockholder, Segmed, Inc  
Tugce Agirlar Trabzonlu, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W1-SSVA03-1 **Using Artificial Intelligence in the Classification of Peripheral Artery Disease Lesion Composition from Ultra-High Resolution Magnetic Resonance Histology**

Judit Csore, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to semi-automatically differentiate soft vs hard PAD lesion components and crossability using multi-contrast 9.4T MRI images, custom-made AI algorithm and histological samples.

#### METHODS AND MATERIALS

9.4T ultra-high resolution MRI scan was performed on 6 PAD lesions harvested from amputated legs with 3 contrasts: T1, T2 and Ultrashort Echo Time (UTE). 3D imaging volumes were spatially registered (3DSlicer), and pseudo-color red-green-blue (RGB) composites (red: T1; green T2; blue: UTE) were generated. For image recognition, a custom-made 2D variational autoencoder (VAE) was designed. Images were classified into PAD tissue classes, assigning a numerical tissue score (TS) to each class: lumen is patent (TS=0), occluded with soft tissue (TS=1), occluded with soft and hard tissue (TS= 3), occluded with hard tissue (TS= 5). Average TS for each tissue segment was recorded. Crossability (crossable/non-crossable; non-crossable if =50% of the lumen was occluded with hard tissue) was evaluated by 2 readers visually on preselected MRI slices compared to histologic samples, using the latter as the standard of reference. Percent agreement was calculated for inter-rater reliability.

#### RESULTS

4014 multiplanar reconstructed images were obtained. Multi-contrast MRI registration succeeded for all lesion sections. Pseudo-colors were as follows; smooth muscle cells: pink/red, fatty lesions: green, collagen: dark blue, calcification: black. VAE classification separated axial sections successfully into tissue classes. Average TS ranged from 1.0 to 4.81 and corresponded well to the composition of tissues inspected visually. 20 slices showed appropriate alignment, for the evaluation of crossability, 11 were excluded due to lack of sufficient histological sample and inadequate MRI image quality, inter-rater reliability for crossability was 100% on the remaining 9 slices (7 crossable, 2 non-crossable).

#### CONCLUSION

Custom-made AI algorithm was successful in identifying tissue properties from high-resolution, multi-contrast MRI-histology of PAD lesions. AI-aided analysis may help rapid, accurate evaluation of lesion crossability in planning endovascular procedures and rationally guide device selection to improve the outcome of lower extremity PVI.

#### CLINICAL RELEVANCE/APPLICATION

PVI has been the standard of care for PAD, but this has been called into question in recent years. UTE was demonstrated to discriminate between different soft and hard tissue types, particularly for PAD lesions. Using these novel MRI techniques and AI-aided analysis may facilitate the evaluation of lesion morphology in planning endovascular procedures and rationally guide device selection to improve the outcomes of lower extremity PVI.

#### W1-SSVA03-2 **The Utilization of Double Contrast-Enhancement Ce-Boost for the Lower Extremity Vessel on CT Angiography**

Chuluunbaatar Otgonbaatar, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this study was to compare the vascular contrast attenuation in lower-extremity CT angiography using double contrast-enhancement boost technique

## METHODS AND MATERIALS

This retrospective study enrolled 45 patients who underwent lower-extremity CT angiography. The contrast-enhancement (CE) boost image was generated using contrast-enhanced CT and non-contrast-enhanced CT images (Fig. 1). The CT attenuation number, image noise, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and image sharpness with full width at half width maximum (FWHM) was evaluated in the lower extremity vessels including infrarenal abdominal aorta, common iliac artery, external iliac artery, superficial femoral artery, popliteal artery, anterior tibial artery, dorsal pedis artery, and plantar artery. Subjective image quality was evaluated with a four-point scale using overall image quality, contrast enhancement, image sharpness, and vessel delineation.

## RESULTS

Image noise was significantly ( $p < 0.001$ ) lower in double CE-boost ( $6.50 \pm 2.26$  HU) than conventional ( $11.89 \pm 1.66$  HU) and CE-boost images ( $7.45 \pm 1.83$  HU). The CT attenuation in HU was significantly ( $p < 0.001$ ) increased in all different locations of lower extremity with double CE-boost images ( $834.49 \pm 140.73$ ) than conventional ( $399.63 \pm 62.01$ ) and CE-boost images ( $572.66 \pm 93.61$ ). The SNR and CNR of the double CE-boost image was significantly ( $p < 0.001$ ) improved compared than conventional and CE-boost image (Fig. 2). FMWH of popliteal artery ( $p = 0.828$ ), anterior tibial artery ( $p = 0.671$ ), and dorsal pedis artery ( $p = 0.281$ ) showed equivalent between conventional, CE-boost, and double CE-boost images (Fig. 2). The subjective image analysis showed higher scores with double CE-boost compared with other images (Fig. 3).

## CONCLUSION

Implementation of double CE-boost technique improves the image quality by lower image noise, higher CT attenuation, SNR, CNR, and sharpness compared with CE-boost and conventional image.

## CLINICAL RELEVANCE/APPLICATION

CE-boost technique and double CE-boost technique improve the vascular contrast attenuation, SNR, CNR, subjective analysis and reduces the image noise in the lower extremity vessels especially below the knee arteries without increasing the injection rate and concentration of contrast media.

## W1-SSVA03-4 Influence of Reconstruction Kernels in Photon-Counting CT Angiographies of the Leg: Standardized Assessment Using a Continuous Extracorporeal Perfusion Model

Philipp Gruschwitz, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study evaluated the influence of different vascular reconstruction kernels on the image quality of CT angiographies of the lower extremity runoff using a 1st-generation photon-counting-detector CT (PCD-CT) in comparison to dose-matched examinations on a 3rd-generation energy-integrating detector (EID-CT).

## METHODS AND MATERIALS

Inducing continuous extracorporeal perfusion in a human cadaveric model, we performed CT angiographies of eight upper leg arterial runoffs with radiation dose-equivalent 120 kVp acquisition protocols (CTDI<sub>vol</sub> 5 mGy). Reconstructions were executed with different vascular kernels, matching the individual modulation transfer functions between scanners. Signal-to-noise-ratios (SNR) and contrast-to-noise-ratios (CNR) were computed to assess objective image quality. Furthermore, six radiologists evaluated image quality subjectively using a browser-based forced-choice pairwise comparison tool. Interrater agreement was established by calculating Kendall's concordance coefficient (W).

## RESULTS

The intraluminal attenuation of PCD-CT images was significantly higher than of EID-CT ( $414.7 \pm 27.3$  HU vs.  $329.3 \pm 24.5$  HU;  $p < 0.001$ ). Using comparable kernels, image noise with PCD-CT ( $7.8 \pm 2.5$  to  $22.0 \pm 4.8$  HU) was significantly lower than with EID-CT ( $10.0 \pm 3.6$  to  $30.5 \pm 6.7$  HU;  $p < 0.044$ ). Correspondingly, SNR and CNR were approximately 2-fold higher for PCD-CT (SNR<sub>fat</sub>  $22.7 \pm 3.0$  to  $52.3 \pm 4.6$  / CNR<sub>fat</sub> ( $21.5 \pm 3.0$  to  $51.3 \pm 4.6$  vs. SNR<sub>fat</sub>:  $12.4 \pm 1.9$  to  $37.4 \pm 3.3$  / CNR<sub>fat</sub>:  $10.5 \pm 1.7$  to  $36.3 \pm 3.3$ ;  $p < 0.001$ ). Increasing the spatial frequency for PCD-CT reconstructions by one level resulted in similar metrics compared to EID-CT (CNR<sub>fat</sub>; EID-CT - Bv49:  $21.7 \pm 3.7$  versus PCD-CT - Bv60:  $21.4 \pm 3.5$ ). Overall image quality of PCD-CTA achieved ratings superior to EID-CTA irrespective of the used reconstruction kernels (best: PCD-CT - Bv60; worst: EID-CT - Bv40;  $p < 0.001$ ). Interrater agreement was good ( $W = 0.78$ ).

## CONCLUSION

Concluding, PCD-CT offers superior intraluminal attenuation, SNR, and CNR compared to EID-CT in angiographies of the upper leg arterial runoff. In combination with improved subjective image quality, PCD-CT facilitates the use of sharper convolution kernels and ultimately bears the potential of improved vascular structure assessability.

## CLINICAL RELEVANCE/APPLICATION

Improved image quality supports in evaluating further treatment options and thus potential indications for surgical or interventional therapy and therefore omitting of unnecessary invasive treatments.

### W1-SSVA03-5 **Evaluation of Lesion Crossability in Peripheral Artery Disease Using High-Resolution 7 Tesla Magnetic Resonance Histology**

Judit Csore, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our purpose with this study was to determine whether using magnetic resonance (MRI) histology can identify impenetrable plaques in a high-fidelity human cadaveric leg model from peripheral artery disease (PAD) patients that will be most reflective of the patient population at high risk of endovascular failure.

#### METHODS AND MATERIALS

8 vessels were characterized in detail from 6 amputated legs of PAD patients. Ultrashort echo time (UTE) sequence was performed on a 7T MRI at 200 micron isotropic resolution to characterize hard (calcium and dense collagen) vs. soft (fat, smooth muscle, soft matrix, thrombus) lesion components. Lesions were characterized as non-crossable if  $\geq 50\%$  of the lumen was occluded with hard tissue. Lesion length (short (<6cm), intermediate (6-10 cm), long (>10 cm), as well as distribution (concentric, eccentric, central) and level of calcification (none; mild (<25% circumference); moderate (25%-50% circumference); or severe (>50% circumference)) was also recorded. Following the MRI, percutaneous vascular intervention (PVI) was performed using 0.014" wire. DSA images were recorded to mark the location of the lesion and evaluate patency. Crossing mode of the target lesion was also documented. Lesions were harvested for histopathologic analysis. Preprocedural duplex ultrasound (DUS) images were retrospectively evaluated for comparison.

#### RESULTS

Of 8 lesions, 6 (75%) were scored as "crossable" and 2 (25%) as "non-crossable" based on the MRI image characteristics. 1 lesion (12.5%) was scored as having mild, and 7 (87.5%) lesions with severe calcification. 7T MRI scores identified crossable and non-crossable lesions with 100% accuracy. Both lesions described as non-crossable on MRI were immediate technical failures/complications: in 1 case, the physician could cross subintimally but could not re-enter the true lumen, in the other case the vessel was perforated. Of note, in 1 patient, DUS showed a long, calcified total occlusion, but lesion was scored as "crossable" on MRI and proved to be easily crossable intraprocedurally.

#### CONCLUSION

7T MRI identifies crossable and non-crossable lesions with 100% accuracy in this limited sample set. Future work using MRI histology on a greater patient population may help determine which peripheral arterial lesions are more difficult to cross with a guidewire, hence, it can aid endovascular treatment planning.

## CLINICAL RELEVANCE/APPLICATION

Not all PAD lesions are amenable to PVI, but predicting this using conventional imaging modalities is currently impossible. Novel high-resolution MRI-histology methods may help to identify impenetrable PAD lesions and guide optimal procedure planning and device selection.

### W1-SSVA03-6 **Peripheral Artery Disease Imaging Using 7 Tesla Magnetic Resonance Histology, Intravascular Ultrasound and Digital Subtraction Angiography - Future Directions in Endovascular Treatment Planning**

Judit Csore, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to determine whether 7 Tesla magnetic resonance (MRI) histology and intravascular ultrasound (IVUS) can provide more accurate vessel diameters than conventional digital subtraction angiography (DSA) and help evaluate calcified plaque burden in below-the-knee arteries in a high-fidelity human cadaveric leg model from peripheral artery disease (PAD) patients.

#### METHODS AND MATERIALS

16 lesions were evaluated in detail from 7 amputated legs of PAD patients. 200 microns isotropic Ultrashort Echo Time (UTE) sequence was performed on the amputated legs using a 7T MRI. Following MRI, DSA and IVUS were performed. Reference vessel diameter, minimal diameter at the site of stenosis and degree of stenosis were evaluated for each lesion on 7T MRI, DSA and IVUS images. Difference in lumen dimensions between the three imaging methods was calculated. Circumferential distribution of calcification was recorded on MRI and IVUS using 4 groups (1=0-90°, 2=90-180°, 3=180-270°, 4=270-360°). Reliability of each method was measured by using intraclass correlation coefficient (ICC).

## RESULTS

A significant difference has been shown in the evaluation of stenosis diameters, both for IVUS vs MRI and DSA vs IVUS comparison; IVUS gave higher stenosis diameters (2.25 (0.63) mm) compared to each method (MRI: 1.70 (0.93) mm; DSA, 1.65 (0.45) mm), the difference was more noticeable as to DSA (MRI: -0.60 (0.43) mm; DSA: -0.65 (0.80); all  $p < 0.001$ ). In stenosis degree measurement, significant difference was found between IVUS and DSA (27.89 (15.65) % vs 43.82 (20.38) %; difference -6.19 (9.04) %,  $p < 0.001$ ), DSA indicating higher level of stenosis than IVUS. ICC in stenosis diameter assessment for MRI vs IVUS was almost excellent, 0.891 ( $p < 0.001$ ; CI 95%, 0.689-962). In the evaluation of the degree of stenosis, IVUS vs DSA comparison showed good reliability (0.798,  $p = 0.001$ ; 95% CI, 0.423-0.930), suggesting that although there may be a difference in diameter assessment, both techniques are consistent and reliable for evaluating the degree of stenosis. In the assessment of calcified plaque distribution, MRI (4[3.75-4]) and IVUS (4[2.75-4]) showed excellent agreement (ICC: 0.956,  $p < 0.001$ ).

## CONCLUSION

High-resolution 7T MRI and IVUS have been shown to be at least as good as the "gold standard" and may provide surgeons with an array of tools to assist in imaging.

## CLINICAL RELEVANCE/APPLICATION

DSA is a traditional gold standard for PAD imaging, however, it has several limitations resulting in a tendency for arteriography to underestimate vessel diameters. Novel MRI-histology methods and IVUS has the capacity to optimally define vessel dimensions, atherosclerotic plaque morphology with high precision, being able to potentially guide treatment modality (i.e. sizing stents, and balloons).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W1-SSVA03-1

### Using Artificial Intelligence in the Classification of Peripheral Artery Disease Lesion Composition from Ultra-High Resolution Magnetic Resonance Histology

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N226

Judit Csore, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to semi-automatically differentiate soft vs hard PAD lesion components and crossability using multi-contrast 9.4T MRI images, custom-made AI algorithm and histological samples.

#### METHODS AND MATERIALS

9.4T ultra-high resolution MRI scan was performed on 6 PAD lesions harvested from amputated legs with 3 contrasts: T1, T2 and Ultrashort Echo Time (UTE). 3D imaging volumes were spatially registered (3DSlicer), and pseudo-color red-green-blue (RGB) composites (red: T1; green T2; blue: UTE) were generated. For image recognition, a custom-made 2D variational autoencoder (VAE) was designed. Images were classified into PAD tissue classes, assigning a numerical tissue score (TS) to each class: lumen is patent (TS=0), occluded with soft tissue (TS=1), occluded with soft and hard tissue (TS= 3), occluded with hard tissue (TS= 5). Average TS for each tissue segment was recorded. Crossability (crossable/non-crossable; non-crossable if =50% of the lumen was occluded with hard tissue) was evaluated by 2 readers visually on preselected MRI slices compared to histologic samples, using the latter as the standard of reference. Percent agreement was calculated for inter-rater reliability.

#### RESULTS

4014 multiplanar reconstructed images were obtained. Multi-contrast MRI registration succeeded for all lesion sections. Pseudo-colors were as follows; smooth muscle cells: pink/red, fatty lesions: green, collagen: dark blue, calcification: black. VAE classification separated axial sections successfully into tissue classes. Average TS ranged from 1.0 to 4.81 and corresponded well to the composition of tissues inspected visually. 20 slices showed appropriate alignment, for the evaluation of crossability, 11 were excluded due to lack of sufficient histological sample and inadequate MRI image quality, inter-rater reliability for crossability was 100% on the remaining 9 slices (7 crossable, 2 non-crossable).

#### CONCLUSION

Custom-made AI algorithm was successful in identifying tissue properties from high-resolution, multi-contrast MRI-histology of PAD lesions. AI-aided analysis may help rapid, accurate evaluation of lesion crossability in planning endovascular procedures and rationally guide device selection to improve the outcome of lower extremity PVI.

#### CLINICAL RELEVANCE/APPLICATION

PVI has been the standard of care for PAD, but this has been called into question in recent years. UTE was demonstrated to discriminate between different soft and hard tissue types, particularly for PAD lesions. Using these novel MRI techniques and AI-aided analysis may facilitate the evaluation of lesion morphology in planning endovascular procedures and rationally guide device selection to improve the outcomes of lower extremity PVIs.

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## Abstract Archives of the RSNA, 2023

W1-SSVA03-2

### The Utilization of Double Contrast-Enhancement Ce-Boost for the Lower Extremity Vessel on CT Angiography

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N226

Chuluunbaatar Otgonbaatar, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to compare the vascular contrast attenuation in lower-extremity CT angiography using double contrast-enhancement boost technique

#### METHODS AND MATERIALS

This retrospective study enrolled 45 patients who underwent lower-extremity CT angiography. The contrast-enhancement (CE) boost image was generated using contrast-enhanced CT and non-contrast-enhanced CT images (Fig. 1). The CT attenuation number, image noise, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and image sharpness with full width at half width maximum (FWMH) was evaluated in the lower extremity vessels including infrarenal abdominal aorta, common iliac artery, external iliac artery, superficial femoral artery, popliteal artery, anterior tibial artery, dorsal pedis artery, and plantar artery. Subjective image quality was evaluated with a four-point scale using overall image quality, contrast enhancement, image sharpness, and vessel delineation.

#### RESULTS

Image noise was significantly ( $p < 0.001$ ) lower in double CE-boost ( $6.50 \pm 2.26$  HU) than conventional ( $11.89 \pm 1.66$  HU) and CE-boost images ( $7.45 \pm 1.83$  HU). The CT attenuation in HU was significantly ( $p < 0.001$ ) increased in all different locations of lower extremity with double CE-boost images ( $834.49 \pm 140.73$ ) than conventional ( $399.63 \pm 62.01$ ) and CE-boost images ( $572.66 \pm 93.61$ ). The SNR and CNR of the double CE-boost image was significantly ( $p < 0.001$ ) improved compared than conventional and CE-boost image (Fig. 2). FWHM of popliteal artery ( $p = 0.828$ ), anterior tibial artery ( $p = 0.671$ ), and dorsal pedis artery ( $p = 0.281$ ) showed equivalent between conventional, CE-boost, and double CE-boost images (Fig. 2). The subjective image analysis showed higher scores with double CE-boost compared with other images (Fig. 3).

#### CONCLUSION

Implementation of double CE-boost technique improves the image quality by lower image noise, higher CT attenuation, SNR, CNR, and sharpness compared with CE-boost and conventional image.

#### CLINICAL RELEVANCE/APPLICATION

CE-boost technique and double CE-boost technique improve the vascular contrast attenuation, SNR, CNR, subjective analysis and reduces the image noise in the lower extremity vessels especially below the knee arteries without increasing the injection rate and concentration of contrast media.

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## Abstract Archives of the RSNA, 2023

W1-SSVA03-4

### **Influence of Reconstruction Kernels in Photon-Counting CT Angiographies of the Leg: Standardized Assessment Using a Continuous Extracorporeal Perfusion Model**

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N226

Philipp Gruschwitz, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study evaluated the influence of different vascular reconstruction kernels on the image quality of CT angiographies of the lower extremity runoff using a 1st-generation photon-counting-detector CT (PCD-CT) in comparison to dose-matched examinations on a 3rd-generation energy-integrating detector (EID-CT).

#### **METHODS AND MATERIALS**

Inducing continuous extracorporeal perfusion in a human cadaveric model, we performed CT angiographies of eight upper leg arterial runoffs with radiation dose-equivalent 120 kVp acquisition protocols (CTDIvol 5 mGy). Reconstructions were executed with different vascular kernels, matching the individual modulation transfer functions between scanners. Signal-to-noise-ratios (SNR) and contrast-to-noise-ratios (CNR) were computed to assess objective image quality. Furthermore, six radiologists evaluated image quality subjectively using a browser-based forced-choice pairwise comparison tool. Interrater agreement was established by calculating Kendall's concordance coefficient (W).

#### **RESULTS**

The intraluminal attenuation of PCD-CT images was significantly higher than of EID-CT ( $414.7 \pm 27.3$  HU vs.  $329.3 \pm 24.5$  HU;  $p < 0.001$ ). Using comparable kernels, image noise with PCD-CT ( $7.8 \pm 2.5$  to  $22.0 \pm 4.8$  HU) was significantly lower than with EID-CT ( $10.0 \pm 3.6$  to  $30.5 \pm 6.7$  HU;  $p < 0.044$ ). Correspondingly, SNR and CNR were approximately 2-fold higher for PCD-CT (SNRfat  $22.7 \pm 3.0$  to  $52.3 \pm 4.6$  / CNRfat ( $21.5 \pm 3.0$  to  $51.3 \pm 4.6$  vs. SNRfat:  $12.4 \pm 1.9$  to  $37.4 \pm 3.3$  / CNRfat:  $10.5 \pm 1.7$  to  $36.3 \pm 3.3$ ;  $p < 0.001$ ). Increasing the spatial frequency for PCD-CT reconstructions by one level resulted in similar metrics compared to EID-CT (CNRfat; EID-CT - Bv49:  $21.7 \pm 3.7$  versus PCD-CT - Bv60:  $21.4 \pm 3.5$ ). Overall image quality of PCD-CTA achieved ratings superior to EID-CTA irrespective of the used reconstruction kernels (best: PCD-CT - Bv60; worst: EID-CT - Bv40;  $p < 0.001$ ). Interrater agreement was good ( $W = 0.78$ ).

#### **CONCLUSION**

Concluding, PCD-CT offers superior intraluminal attenuation, SNR, and CNR compared to EID-CT in angiographies of the upper leg arterial runoff. In combination with improved subjective image quality, PCD-CT facilitates the use of sharper convolution kernels and ultimately bears the potential of improved vascular structure assessability.

#### **CLINICAL RELEVANCE/APPLICATION**

Improved image quality supports in evaluating further treatment options and thus potential indications for surgical or interventional therapy and therefore omitting of unnecessary invasive treatments.

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## Abstract Archives of the RSNA, 2023

W1-SSVA03-5

### Evaluation of Lesion Crossability in Peripheral Artery Disease Using High-Resolution 7 Tesla Magnetic Resonance Histology

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N226

Judit Csore, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our purpose with this study was to determine whether using magnetic resonance (MRI) histology can identify impenetrable plaques in a high-fidelity human cadaveric leg model from peripheral artery disease (PAD) patients that will be most reflective of the patient population at high risk of endovascular failure.

#### METHODS AND MATERIALS

8 vessels were characterized in detail from 6 amputated legs of PAD patients. Ultrashort echo time (UTE) sequence was performed on a 7T MRI at 200 micron isotropic resolution to characterize hard (calcium and dense collagen) vs. soft (fat, smooth muscle, soft matrix, thrombus) lesion components. Lesions were characterized as non-crossable if  $\geq 50\%$  of the lumen was occluded with hard tissue. Lesion length (short (<6cm), intermediate (6-10 cm), long (>10 cm), as well as distribution (concentric, eccentric, central) and level of calcification (none; mild (<25% circumference); moderate (25%-50% circumference); or severe (>50% circumference)) was also recorded. Following the MRI, percutaneous vascular intervention (PVI) was performed using 0.014" wire. DSA images were recorded to mark the location of the lesion and evaluate patency. Crossing mode of the target lesion was also documented. Lesions were harvested for histopathologic analysis. Preprocedural duplex ultrasound (DUS) images were retrospectively evaluated for comparison.

#### RESULTS

Of 8 lesions, 6 (75%) were scored as "crossable" and 2 (25%) as "non-crossable" based on the MRI image characteristics. 1 lesion (12.5%) was scored as having mild, and 7 (87.5%) lesions with severe calcification. 7T MRI scores identified crossable and non-crossable lesions with 100% accuracy. Both lesions described as non-crossable on MRI were immediate technical failures/complications: in 1 case, the physician could cross subintimally but could not re-enter the true lumen, in the other case the vessel was perforated. Of note, in 1 patient, DUS showed a long, calcified total occlusion, but lesion was scored as "crossable" on MRI and proved to be easily crossable intraprocedurally.

#### CONCLUSION

7T MRI identifies crossable and non-crossable lesions with 100% accuracy in this limited sample set. Future work using MRI histology on a greater patient population may help determine which peripheral arterial lesions are more difficult to cross with a guidewire, hence, it can aid endovascular treatment planning.

#### CLINICAL RELEVANCE/APPLICATION

Not all PAD lesions are amenable to PVI, but predicting this using conventional imaging modalities is currently impossible. Novel high-resolution MRI-histology methods may help to identify impenetrable PAD lesions and guide optimal procedure planning and device selection.

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## Abstract Archives of the RSNA, 2023

W1-SSVA03-6

### Peripheral Artery Disease Imaging Using 7 Tesla Magnetic Resonance Histology, Intravascular Ultrasound and Digital Subtraction Angiography - Future Directions in Endovascular Treatment Planning

Wednesday, Nov. 29 8:00AM - 9:00AM Room: N226

Judit Csore, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to determine whether 7 Tesla magnetic resonance (MRI) histology and intravascular ultrasound (IVUS) can provide more accurate vessel diameters than conventional digital subtraction angiography (DSA) and help evaluate calcified plaque burden in below-the-knee arteries in a high-fidelity human cadaveric leg model from peripheral artery disease (PAD) patients.

#### METHODS AND MATERIALS

16 lesions were evaluated in detail from 7 amputated legs of PAD patients. 200 microns isotropic Ultrashort Echo Time (UTE) sequence was performed on the amputated legs using a 7T MRI. Following MRI, DSA and IVUS were performed. Reference vessel diameter, minimal diameter at the site of stenosis and degree of stenosis were evaluated for each lesion on 7T MRI, DSA and IVUS images. Difference in lumen dimensions between the three imaging methods was calculated. Circumferential distribution of calcification was recorded on MRI and IVUS using 4 groups (1=0-90°, 2=90-180°, 3=180-270°, 4=270-360°). Reliability of each method was measured by using intraclass correlation coefficient (ICC).

#### RESULTS

A significant difference has been shown in the evaluation of stenosis diameters, both for IVUS vs MRI and DSA vs IVUS comparison; IVUS gave higher stenosis diameters (2.25 (0.63) mm) compared to each method (MRI: 1.70 (0.93) mm; DSA, 1.65 (0.45) mm), the difference was more noticeable as to DSA (MRI: -0.60 (0.43) mm; DSA: -0.65 (0.80); all  $p < 0.001$ ). In stenosis degree measurement, significant difference was found between IVUS and DSA (27.89 (15.65) % vs 43.82 (20.38) %; difference -6.19 (9.04) %,  $p < 0.001$ ), DSA indicating higher level of stenosis than IVUS. ICC in stenosis diameter assessment for MRI vs IVUS was almost excellent, 0.891 ( $p < 0.001$ ; CI 95%, 0.689-962). In the evaluation of the degree of stenosis, IVUS vs DSA comparison showed good reliability (0.798,  $p = 0.001$ ; 95% CI, 0.423-0.930), suggesting that although there may be a difference in diameter assessment, both techniques are consistent and reliable for evaluating the degree of stenosis. In the assessment of calcified plaque distribution, MRI (4[3.75-4]) and IVUS (4[2.75-4]) showed excellent agreement (ICC: 0.956,  $p < 0.001$ ).

#### CONCLUSION

High-resolution 7T MRI and IVUS have been shown to be at least as good as the "gold standard" and may provide surgeons with an array of tools to assist in imaging.

#### CLINICAL RELEVANCE/APPLICATION

DSA is a traditional gold standard for PAD imaging, however, it has several limitations resulting in a tendency for arteriography to underestimate vessel diameters. Novel MRI-histology methods and IVUS has the capacity to optimally define vessel dimensions, atherosclerotic plaque morphology with high precision, being able to potentially guide treatment modality (i.e. sizing stents, and balloons).

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## Abstract Archives of the RSNA, 2023

W2-SPBR-2

### Preoperative Diagnosis of Multifocal, Multicentric and Contralateral Breast Cancer: Additional Benefit of Diffusion-Weighted Magnetic Resonance Imaging

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

HAJUNG KIM (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance of dynamic contrast enhanced (DCE) MRI and diffusion weighted (DW) MRI, named multi-parametric MRI, for the diagnosis of multifocal, multicentric and contralateral breast cancer in patients with newly diagnosed breast cancer.

#### METHODS AND MATERIALS

Between June 2019 to June 2021, our database search identified consecutive women who were diagnosed with invasive breast cancer, underwent MRI, and had at least one DCE MRI detected additional lesion. Two experienced breast radiologists retrospectively measured apparent diffusion coefficient (ADC) values. A BI-RADS category = 4 was considered positive result. The reference standard was histopathology or 1-year follow-up. The ADC cut-off for differentiation between benign and malignant lesions was calculated and performance measures of DCE MRI alone and multi-parametric MRI were compared. In addition, we validated ADC value of  $1.3 \times 10^{-3}$  mm<sup>2</sup>/s, recommended by the European Society of Breast Radiology (EUSOBI) guideline.

#### RESULTS

Among finally included 219 patients (mean age, 50.9 years) with 298 lesions, 169 (57%) were benign (mean size, 1.4cm) and 129 (43%) were malignant (mean size, 1.7cm). There were 45 masses (27%) and 124 nonmass (73%) among benign lesions and 33 (26%) masses and 76 (74%) nonmass among malignant lesions. The median ADC of benign lesion was  $1.23 \times 10^{-3}$  mm<sup>2</sup>/s and median ADC of malignant lesion was  $0.88 \times 10^{-3}$  mm<sup>2</sup>/s ( $P < .001$ ). The best ADC cut-off to differentiate benign from malignant lesions determined using ROC-curve was  $1.0 \times 10^{-3}$  mm<sup>2</sup>/s, which yielded sensitivity of 74.4% and specificity of 76.9%. The area under the ROC curve was 0.80 (95% CI: 0.75-0.86). With DCE MRI alone, sensitivity was 98.5% (127 of 129, 95% CI: 96.3, 100.0), specificity was 29.6% (50 of 169, 95% CI: 22.7, 36.5) and accuracy was 59.4% (177 of 298, 95% CI: 53.8, 64.9). In comparison, multi-parametric MRI showed decreased sensitivity of 75.2% (97 of 129, 95% CI: 67.7, 82.6;  $P = .01$ ), but improved specificity of 76.3% (129 of 169, 95% CI: 69.9, 82.7;  $P < .001$ ) and accuracy of 75.8% (226 of 298, 95% CI: 70.9, 80.7;  $P < .001$ ). With ADC value of  $1.3 \times 10^{-3}$  mm<sup>2</sup>/s, sensitivity of 96.2% (124 of 129; 95% CI: 92.8, 99.4), specificity of 38.5% (65 of 169, 95% CI: 31.1, 45.8) and accuracy of 63.4% (189 of 298, 95% CI: 57.9, 68.9) were observed.

#### CONCLUSION

Multi-parametric MRI can increase the specificity and maximize accuracy of DCE MRI detected additional lesions in patients with newly diagnosed breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

In patients with newly diagnosed breast cancer, multi-parametric MRI with implementation of DW MRI can help increase specificity and accuracy of DCE MRI detected additional lesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPBR-6

### MR Imaging Features Associated with High and Low Expression of Tumor-Infiltrating Lymphocytes: Stratified Analysis According to Molecular Subtypes

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Jiejie Zhou, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

It is known that the expression of tumor-infiltrating lymphocytes (TILs) is different in different molecular subtypes of breast cancer (BC); and thus, the studies analyzing the mixed subtypes would be heavily dependent on the composition of subtypes, and the obtained results are not generalizable. To investigate the association of MRI features with TILs and subtypes, three analyses were performed: (1) Comparison of the rate of high vs. low TILs in 3 subtypes: Hormonal-Receptor positive, HER2 negative (HR+/HER2-), HER2 positive (HER2+), and Triple negative (TN); (2) Comparison of the MR imaging features among 3 subtypes; (3) In each subtype, the comparison of imaging features between high vs. low TILs cases.

#### METHODS AND MATERIALS

A total of 457 patients with pathologically diagnosed BC were included in this study. Breast MRI with 3.0 T scanner was performed, including T2, DWI, and DCE-MRI. The expression of TILs was evaluated on HE-stained slides according to the recommendations by an International TILs Working Group 2014. The percentage of TILs in the stroma adjacent to the tumor cells was assessed, stratified as low (< 10%) and high (= 10%). MRI features, including morphology as mass or non-mass enhancement (NME), shape, margin, internal enhancement, peritumoral edema, and the DCE kinetic pattern were assessed and compared between groups.

#### RESULTS

Of the 241 HR+/HER2- cases, 82% had low TILs, and only 18% had high TILs. There were 134 HER2+ cases, 63% low TILs and 37% high TILs. Of the 82 TN, 56% had low TILs and 44% had high TILs. The composition of high TILs was significantly increased from HR+ to HER2+ to TN ( $p < 0.001$ ). For MRI features among the 3 subtypes (Table 1), the size was smaller for HR+/HER2- ( $p < 0.001$ ); HER2+ was more likely to present as NME ( $p = 0.031$ ); homogeneous enhancement was more seen in HR+ ( $p < 0.001$ ); and the peritumoral edema was present in 45% HR+, 71% HER2+, and 80% TN ( $p < 0.001$ ). The MRI features between low and high TILs in each subtype are listed in Table 2. In HR+/HER2-, the peritumoral edema was more likely to be present in high TILs (70%) than in low TILs (40%,  $p < 0.001$ ). In TN, high TILs were more like to present a regular shape (33%) than low TILs (13%,  $p = 0.029$ ); and more like to present the circumscribed margin (19%) than low TILs (2%,  $p = 0.009$ ).

#### CONCLUSION

HER2+ and TN cancers have significantly higher TILs compared to HR+ cancers. In HR+, high TILs cases were more likely to present peritumoral edema. In TN, high TILs cases were more likely to present regular shapes and circumscribed margins.

#### CLINICAL RELEVANCE/APPLICATION

TILs expression increases from HR+ to HER2+ to TN. MRI features in different molecular subtypes show substantial variations. When building MR radiomics models to predict TILs, different models should be built for different subtypes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPBR-7

### Interpretation of Unenhanced Breast MRI with Diffusion-Weighted Imaging for Breast Cancer Detection: Effect of Training on the Performance and Agreement of Radiologists

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate whether training improves the performance and agreement of radiologists interpreting unenhanced breast magnetic resonance imaging (MRI) with diffusion-weighted imaging (DWI).

#### METHODS AND MATERIALS

A reader study of 96 breasts (35 screening-detected cancer cases and 61 benign or negative cancer cases) of 48 asymptomatic women was performed. High-resolution DWI (in-plane resolution  $<1.3 \times 1.3$  mm) was performed using a 3.0-T system and b values of 0, 800, and 1200 sec/mm<sup>2</sup>. Sixteen breast radiologists independently reviewed DWI, apparent diffusion coefficient maps, and T1-weighted MRI and recorded the Breast Imaging Reporting and Data System (BI-RADS) assessment category for each breast. After a 2-hour training session and 5-month washout period, they re-evaluated the BI-RADS assessment categories. A BI-RADS category of 4 or more was considered a positive reading. The diagnostic performance of each reader for each breast during the first review and that during the second review were compared. Inter-reader agreement regarding the final assessment was evaluated using a multi-rater  $\kappa$  analysis.

#### RESULTS

Before training, the mean sensitivity, specificity, and accuracy of 16 readers who performed unenhanced MRI assessments were 70.7% (95% confidence interval [CI]: 59.4-79.9), 90.8% (95% CI: 85.1-94.2), and 83.5% (95% CI: 78.6-87.4), respectively. After training, significant improvements in specificity (95.2%; 95% CI: 90.8-97.5;  $P = 0.001$ ) and accuracy (85.9%; 95% CI: 80.9-89.8;  $P < 0.001$ ) were observed, but no difference in sensitivity (69.8%; 95% CI: 58.1-79.4;  $P = 0.58$ ) was observed. Regarding inter-reader agreement, the  $\kappa$  values were 0.57 (95% CI: 0.52-0.63) before training and 0.68 (95% CI: 0.62-0.74) after training, with a difference of 0.10 (95% CI: 0.02-0.18), which was statistically significant ( $P = 0.01$ ).

#### CONCLUSION

Minimal training improved the performance and agreement of interpretations by radiologists using unenhanced MRI with DWI.

#### CLINICAL RELEVANCE/APPLICATION

To use DWI as an effective screening tool, besides the need for standardization of DWI acquisition, training for standardized interpretation is required.

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## Abstract Archives of the RSNA, 2023

W2-SPBR-8

### Standardizing Qualitative and Quantitative Breast Parenchymal Enhancement Assessment in Breast MRI

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Gustav Mueller-Franzes, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Despite being a crucial research focus in the field of breast cancer studies, Background Parenchymal Enhancement (BPE) lacks standardized qualitative and quantitative assessments, which poses an obstacle in its evaluation as a breast cancer risk marker. The purpose of this study was to examine the relationship between and to compare qualitative and quantitative assessments of BPE.

#### METHODS AND MATERIALS

In this retrospective study of 5773 breast MRI examinations from 3207 women acquired between January 2010 and December 2019, the BPE was rated as part of the clinical routine as minimal, mild, moderate, and strong following the ACR BI-RADS guidelines. For the quantitative assessment of BPE, the fibroglandular tissue (FGT) was segmented in the pre- and post-contrast T1-weighted sequences. Four quantitative BPE calculation methods were identified as most commonly used by previous studies and were applied to the given dataset. Correlation and agreement between qualitative and quantitative assessments were calculated using the Spearman correlation ( $r$ ) coefficient.

#### RESULTS

The mean age of the patients was 60 years  $\pm$  10 [SD] and the average volumetric fraction of FGT to the full breast was 17%  $\pm$  12 [SD]. Radiologists rated the BPE in 3787 (66%) of the examinations as minimal, 1380 (24%) as mild, 543 (9%) as moderate, and 63 (1%) as marked. Among the four quantitative BPE definitions tested, the definition that measured the relative difference in the signal intensity before and after contrast agent injection had the highest correlation to human rating with  $r=0.56$ . The lowest correlation ( $r=0.50$ ) to expert radiologists was found for the BPE definition that measured the ratio of the enhancing FGT volume to the entire breast volume.

#### CONCLUSION

The agreement between qualitative and quantitative BPE assessments was found to be, at most, fair. Further studies are needed to investigate the consequences of differences between qualitative and quantitative assessment as well as the differences among quantitative definitions on the prognostic value as a diagnostic marker for breast cancer and treatment response.

#### CLINICAL RELEVANCE/APPLICATION

Given the at most fair agreement between qualitative and four quantitative assessments of BPE demonstrated in our study, and the known relation between BPE and breast cancer risk, it is essential to further research the relation between breast cancer risk and quantitative BPE measurements.

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## Abstract Archives of the RSNA, 2023

W2-SPBR-9

### Optimising Axillary Management following Neoadjuvant Chemotherapy in Patients with Breast Cancer

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Anum Pervez, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### PURPOSE

Optimal management of the axilla in breast cancer following neoadjuvant chemotherapy (NAC) remains uncertain. Current practice at our institution is dictated by the initial nodal burden. For N1 disease (=3 nodes), a sentinel lymph node biopsy (SLNB) is performed and in N2 disease (=4 nodes) patients proceed to an immediate axillary nodal clearance (ANC). However, this pathway fails to take into account response to NAC. If there is node normalization on the post-treatment MRI, an ANC is arguably overtreatment. Whereas, an SLNB becomes undertreatment in cases of limited MRI response as patients undergo a second stage completion ANC. In this study, we examine the predictive role of the post-treatment MRI. We also investigate the importance of HER-2 status and how, in combination with the post-treatment MRI, it can offer a more tailored approach.

#### METHODS AND MATERIALS

A retrospective analysis was performed on NAC patients between 2017-2022. Ultrasound guided-core biopsy confirmed axillary nodal involvement, along with the tumor HER-2 status. The baseline MRI was reviewed with registration of number of abnormal nodes, followed by the post-treatment MRI and surgical histopathology.

#### RESULTS

148 patients identified with node positive axillary disease prior to NAC, of which 54 were HER-2 positive. 103 (70%) had node normalization on imaging. The post-treatment MRI demonstrated 86% specificity and 42% sensitivity. MRI also showed 82% positive predictive value (PPV) but 50% negative predictive value (NPV) for residual axillary disease. Of the HER-2 positive patients, 44 (81%) had node normalization on imaging with 28/44 (63%) complete pathological response at surgery. In particular, in N2 disease and node normalization (n=12), 67% were HER-2 positive. Hence HER-2 positive patients are more likely to respond to NAC, irrespective of initial nodal burden. In our study, 22 patients with N1 disease could have undergone an immediate ANC rather than a two-stage completion ANC. Whereas 12 patients with N2 disease could have avoided an ANC all together.

#### CONCLUSION

We have established high specificity and PPV of the post-treatment MRI. Thus, a core biopsy should be offered for initial N1 status and residual axillary disease, with a positive result leading to an immediate ANC rather than the traditional SLNB. In addition to this, consideration should be given to de-escalating axillary treatment with an SLNB rather than an immediate ANC in the subset of patients with N2 disease, imaging node normalization and a HER-2 positive status.

#### CLINICAL RELEVANCE/APPLICATION

Persistent MRI nodal disease should be a reason to offer a core biopsy, followed by an immediate ANC if positive. Whereas, immediate ANC may be avoided in N2 disease with MRI node normalization and HER-2 positive status.

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## Abstract Archives of the RSNA, 2023

W2-SPCA-1

### Diagnostic Performance of 4D-CT Myocardial Maximum Principal Strain to Detect Reduced Myocardial Viability

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Shigeo Okuda, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

A new technique enables to demonstrate myocardial maximum principal strain (MPS) on 4D-CT. The purpose of this study is to evaluate the diagnostic performance of MPS to detect reduced myocardial viability defined by late gadolinium enhancement (LGE) in patients with known coronary artery disease.

#### METHODS AND MATERIALS

A total of 82 patients (63 men,  $66.3 \pm 9.6$  years old) with a history of myocardial infarction were prospectively enrolled in this study at five university hospitals. ECG-synchronized 4D-CT studies were performed with wide-detector scanners (Aquilion ONE, Canon, Japan). Full-cardiac cycle CT data was reconstructed into 20 phases at 5% intervals. The MPS was demonstrated on the color chart of AHA-17 segments excluding the apex (#17) on a workstation (Ziostation 2, Ziosoft, Tokyo, Japan). The LGE was also obtained in cardiac MRI which was performed during the period before or after 3 months of the 4D-CT. On LGE of MRI, the reduced myocardial viability was defined as the segments with a >50% extent of LGE in the myocardial wall. The MPS color charts were independently interpreted by two other readers with more than 10 years-experience of cardiac imaging for detecting segments which had >50% LGE extent on MRI. The readers were provided three sets of MPS chart and MRI LGE for directly comparing between them before blind reading as a training. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated for detecting segments demonstrating LGE extent with >50% LGE on the 79 patients. The quantitative MPS values were statistically compared between two groups with or without >50% LGE using Mann-Whitney U test.

#### RESULTS

A total of 1264 segments were analyzed, including 316 (25 %) segments with >50% LGE extent. The sensitivity, specificity, accuracy, PPV and NPV averaged between two observers to diagnose segments with >50% of LGE were calculated as follows: 81.0% (256/316), 48.2% (492/948), 35.9% (256/712), 89.1% (492/552), and 59.1% (748/1264), respectively. The agreement of reduced MPS between two readers was 83.9% and kappa coefficient of 0.556 on the presence of >50% LGE extent of myocardial wall. The mean MPS value in segments with preserved viability was significantly higher than one with reduced viability ( $40.0 \pm 15.7$  vs.  $32.0 \pm 13.6$ ,  $p < 0.0001$ ).

#### CONCLUSION

Because of its excellent NPV, the myocardial MPS analysis can be used for detecting viable myocardium with a good agreement between two readers.

#### CLINICAL RELEVANCE/APPLICATION

4D-CT myocardial maximum strain analysis can be a new option to evaluate and quantify myocardial viability particularly in patients with contraindication for cardiac MRI.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-SPCA-2

### Exploring the Impact of Flip Angle and Contrast Agent on Single Breath-hold Cardiac Magnetic Resonance Compressed Sensing Cine for Biventricular Strain Analysis

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Fuyan Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

Compressed sensing (CS) cine has been shown to provide comparable images to conventional balanced steady-state free precession (bSSFP) cine. As an important tool for strain analysis, cardiovascular magnetic resonance (CMR) cine-based tissue tracking could reliably detect the displacement of myocardial segments. However, the effects of CS technique on feature tracking (FT) need to be carefully studied. In this study, we aimed to investigate the impact of gadolinium contrast agent and flip angle on biventricular strain analysis of single breath-hold CS cine in patients with different kinds of cardiac dysfunction.

#### METHODS AND MATERIALS

102 participants with 12 different cardiovascular etiologies (75 men, with a mean age of  $46.5 \pm 17.1$  (SD) years) were enrolled in this study. Each patient underwent four consecutive cine sequences with same slice localization, including the reference multi-breath-hold bSSFP (bSSFPref) cine, the single breath-hold CS cine with the same flip angle as bSSFPref before (CS45) and after (eCS45) contrast enhancement, and the CS cine (eCS70) with 70-degree flip angle after contrast agent injection.

#### RESULTS

Global strain parameters of both ventricles, including global radial strain (GRS), global circumferential strain (GCS), and global longitudinal strain (GLS), obtained from CS cine were found to be significantly lower than those obtained from bSSFPref (all  $p < 0.001$ ). However, the GRS and GCS values of the left ventricle derived from both CS45 and eCS70 cine sequences showed no difference. Similarly, the GRS, GCS, and GLS values of the right ventricle obtained from eCS45 and eCS70 cine sequences showed no significant difference as well. Evaluation of CS45 and eCS45 cine sequences demonstrated that the use of contrast agents can result in a reduction in GRS and GCS values of both ventricles (all  $p < 0.001$ ), but did not have any effect on the GLS values.

#### CONCLUSION

Despite the use of contrast agents and increased flip angle, CS cine consistently produced lower values for GRS, GCS, and GLS of both ventricles compared to conventional bSSFP cine. However, the impact of contrast agents on left ventricular GRS and GCS can be compensated by increasing the flip angle of CS cine. In contrast, increasing the flip angle of CS cine did not affect the GRS, GSC, and GLS values of the right ventricle. Furthermore, the administration of contrast agents resulted in a reduction of biventricular GRS and GCS values derived from CS cine.

#### CLINICAL RELEVANCE/APPLICATION

Feature tracking based on routine CMR cine could reliably detect the displacement of myocardial segments, however, the effect of drastically increased using compressed sensing cine on strain analysis need to be carefully studied.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPCA-3

### Single Breath-hold Assessment of Cardiac Function and Strain using a 3-dimensional Cine Enhanced SENSE by Static Outer-volume Subtraction Acquisition

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Pu Qian (*Presenter*) Nothing to Disclose

#### PURPOSE

To validate the clinical feasibility of a novel 3-dimensional (3D) ultrafast cardiac magnetic resonance (CMR) protocol for the assessment of ventricular function and strain in a single breath-hold.

#### METHODS AND MATERIALS

A total of 26 patients were enrolled prospectively, and all patients underwent CMR using both the standard breath-hold 2D cine balanced steady-state free precession acquisition (2D cine bSSFP) and single-breath-hold 3D cine Enhanced sensitivity encoding (SENSE) by Static Outer-volume Subtraction acquisition (3D cine ESSOS). Images of 3D cine were reconstructed and the left ventricular ejection fraction (LVEF), right ventricular ejection fraction (RVEF), global circumferential strain (GCS), global radial strain (GRS) and global longitudinal strain (GLS) of 3D and 2D cine were assessed by post-processing software. The difference and agreement of the two sequences were assessed.

#### RESULTS

Two patients could not hold their breath well and the image quality could not satisfy the quantitative analysis. The 3D cine images of the remaining 24 patients were of good quality and allowed quantification. Mean acquisition time was  $23 \pm 1$ s versus  $273 \pm 20$ s for 3D and 2D cine imaging, respectively. LVEF by 3D and 2D cine were 58.27 (95% confidence interval [CI], 50.85 to 61.89) and 59.03 (95% CI, 51.15 to 61.67), respectively, with excellent agreement (intraclass correlation coefficient [ICC]: 0.99, 95% CI, 0.98 to 0.99) and insignificant bias. RVEF by 3D and 2D cine were 52.20 (95% CI, 44.17 to 53.76) and 51.65 (95% CI, 44.93 to 53.72), respectively, with excellent agreement (ICC: 0.83, 95% CI, 0.65 to 0.92) and insignificant bias. GCS by 3D and 2D cine were -15.95 (95% CI, -17.58 to -13.18) and -18.20 (95% CI, -19.60 to -15.30), respectively, with acceptable agreement (ICC: 0.77, 95% CI, 0.54 to 0.89) and insignificant bias. GRS by 3D and 2D cine were 28.20 (95% CI, 21.08 to 31.05) and 31.15 (95% CI, 23.05 to 33.95), respectively, with excellent agreement (ICC: 0.83, 95% CI, 0.64 to 0.92) and insignificant bias. GLS by 3D and 2D cine were -10.4 (95% CI, -13.45 to -6.75) and -16.10 (95% CI, -17.93 to -11.78), respectively, with acceptable agreement (ICC: 0.76, 95% CI, 0.53 to 0.89) and insignificant bias. Although the differences in cardiac function and strain between 2D and 3D cine were statistically significant, their differences were within the clinically acceptable range.

#### CONCLUSION

We demonstrate that the image quality of 3D cine is slightly lower than 2D cine, but it can realize the rapid acquisition of cine images and good consistency. 3D cine ensures rapid assessment of cardiac function and strain.

#### CLINICAL RELEVANCE/APPLICATION

ESSOS sequence can be used as an examination method for heart disease screening and for patients who cannot tolerate a long examination.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPCA-4

### Coronary Stent Evaluation by CCTA using Super-Resolution Deep Learning Reconstruction: Compared with Invasive Coronary Angiography

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Cheng Xu (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of a novel super-resolution deep-learning reconstruction (SR-DLR) algorithm on the visible and diagnostic performance of coronary CT angiography (CCTA) in stents evaluation.

#### METHODS AND MATERIALS

This retrospective study included 20 patients with 28 coronary stents who underwent CCTA on a 320-row scanner. Raw data were reconstructed with hybrid iterative reconstruction (HIR, AIDR 3D, FC04), DLR (AiCE), and SR-DLR (PIQE). The maximum visible in-stent lumen diameter were measured. CT attenuation profiles across the stents were generated, then the width of the edge rise distance (ERD) and the edge rise slope (ERS) were measured. The diagnostic confidence was evaluated using a 4-point scale (1=poor, 4=excellent). The patency of stent were evaluated and in-stent restenosis was defined as = 50% stenosis. Invasive coronary angiography served as reference standard.

#### RESULTS

SR-DLR images showed the largest in-stent lumen diameters among all reconstruction approaches (all  $P < 0.05$ ). There was no significant difference in the ERD between different reconstruction approaches ( $P = 0.10$ ), but the ERS on SR-DLR images ( $416.05 \pm 135.45$  HU/mm) was greater than that on HIR images ( $170.27 \pm 90.24$  HU/mm;  $P < 0.05$ ) or DLR images ( $195.06 \pm 96.35$  HU/mm;  $P < 0.05$ ). The diagnostic confidence was comparable for SR-DLR and DLR ( $3.70 \pm 0.79$  vs.  $3.60 \pm 0.56$ ,  $P = 0.40$ ), but higher than HIR ( $3.30 \pm 0.65$ , all  $P < 0.05$ ). SR-DLR images provided optimal diagnostic performance in the evaluation of in-stent patency, the diagnostic accuracy were 86.7%, 83.3% and 76.7% for SR-DLR, DLR and HIR images, respectively (all  $p < 0.05$ ).

#### CONCLUSION

Compared with HIR and DLR algorithm, SR-DLR improves the visible and diagnostic performance of CCTA in stents evaluation.

#### CLINICAL RELEVANCE/APPLICATION

SR-DLR algorithm improves the diagnostic accuracy and confidence of coronary stent evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPCA-5

### Optimizing Residual-Dense Blocks for Myocardial Delayed Enhancement CT Denoising for Future Edge-Based AI

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Takuma Kobayashi, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

In myocardial delayed enhancement (MDE) CT, post hoc denoising methods using residual-dense networks (RDN)s have been reported to improve diagnostic performance. RDNs maintain hierarchical information and deepen the network using residual-dense blocks (RDBs). Optimization of the number of RDBs for each target task is crucial. This study aimed to determine the effect of the number of RDBs on MDE CT denoising. As the number of blocks was reduced, we evaluated denoising precision, inference time, and image similarity to the reference 20-block (RDB20) image.

#### METHODS AND MATERIALS

We retrospectively reviewed 100 consecutive cases who underwent MDE CT. RDNs were trained on a denoising task using pre- and post-additive averaged images as teacher data. We prepared models with 1, 3, 5, 10, and 20 blocks, using RDB20 as a reference. For the hold-out test group (other 40 patients), we performed inference on five models to create denoised images and recorded processing times. We measured CT values and standard deviations (SD) of the blood pool and myocardium, determined image noise and contrast noise ratios for the blood pool and myocardium, and assessed image similarity using structural similarity (SSIM), peak signal to noise ratio (PSNR), learned perceptual image patch similarity (LPIPS), and visual information fidelity (VIF) compared to the reference RDB20 image. We used the Wilcoxon signed-rank sum test with Holm's multiple testing correction for comparisons.

#### RESULTS

The RDN achieved 30% image noise from only one block, gradually increasing with increasing blocks ( $p < .001$  for all), especially in the low-frequency range. Processing time per patient was 24.6s in RDB20, and significantly decreased to 12.6s (51%) in RDN10, 6.6s (27%) in RDB5, 4.2s (17%) in RDB3, and 1.8s (7%) in RDB1, respectively. Increased RDBs achieved significantly high similarity with reference ( $p < .001$  for all); RDB10 showed an SSIM of 0.99996, PSNR of 77.9, LPIPS of 0.0006, and VIF of 0.83, indicating high similarity to RDB20 with half computation costs.

#### CONCLUSION

Increasing RDBs significantly improved denoising effects and similarity to the reference image. However, computational costs also increased.

#### CLINICAL RELEVANCE/APPLICATION

Our findings on optimizing the trade-off between denoising effects and computational costs in RDNs can guide the development of edge-based AI denoising applications in clinical settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPCA-7

### Super-resolution Deep-learning Reconstruction: Image Quality and Myocardial Homogeneity in Coronary Computed Tomography Angiography

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Sung Min Ko, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The present study aimed to investigate whether super-resolution deep learning reconstruction (SR-DLR) has advantages in the overall image quality including signal-to-noise ratio (SNR), contrast to noise ratio (CNR) and sharpness as well as intensity homogeneity on coronary CTA with 4 different approaches; filtered-back projection (FBP), hybrid iterative reconstruction (IR), DLR and SR-DLR.

#### METHODS AND MATERIALS

Sixty-three patients (mean age, 61±11 years; range, 18-81 years; 40 men) who had undergone coronary CT angiography between June-October 2022 were retrospectively included. Image reconstruction was performed using FBP, hybrid IR, DLR, and SR-DLR. Image noise, SNR, and CNR were quantified in both proximal and distal segments of the major coronary arteries. The left ventricle myocardium contrast homogeneity was analyzed. Two independent reviewers scored the overall image quality, image noise, image sharpness, and myocardial homogeneity.

#### RESULTS

Image noise in HU was significantly lower ( $p < 0.001$ ) for the SR-DLR ( $11.2 \pm 2.0$ ) compared to those associated with other image reconstruction methods including FBP ( $30.5 \pm 10.5$ ), hybrid IR ( $20.0 \pm 5.4$ ), and DLR ( $14.2 \pm 2.5$ ). SR-DLR significantly improved SNR and CNR in both the proximal and distal segments of the major coronary arteries (Fig.1). No significant difference ( $p = 0.345$ ) was observed in the myocardial CT attenuation with SR-DLR. Conversely, FBP and hybrid IR (both,  $p < 0.001$ ) resulted in inhomogeneous myocardial CT attenuation (Fig.2). Two reviewers graded subjective image analyses with SR-DLR images higher than other image reconstruction techniques (Fig. 3-4).

#### CONCLUSION

SR-DLR improved image quality, demonstrated clearer delineation of distal segments of coronary arteries, and was seemingly accurate for quantifying CT attenuation in the myocardium.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study demonstrate that SR-DLR achieves higher image quality, better visualization of small distal segments of coronary arteries, and minimum inhomogeneous myocardium attenuation on coronary CT angiography than those associated with FBP, hybrid IR, and DLR.

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## Abstract Archives of the RSNA, 2023

W2-SPCH-2

### Comparison of CT and Wide-angle Stationary Digital Chest Tomosynthesis in the Detection of Pulmonary Nodules

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Alan H. Zhao, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung cancer remains the number one cause of cancer death. Screening remains underutilized despite the clear evidence of benefit. A need exists for a safe, mobile, low radiation dose, intra-procedural method to localize biopsy instruments within target nodules. This retrospective cross sectional reader feasibility study evaluates the ability of clinicians to identify pulmonary nodules using a wide angle carbon nanotube x-ray enabled stationary digital chest tomosynthesis system.

#### METHODS AND MATERIALS

A "LUNGMAN" phantom with pulmonary nodules was scanned with both CT and the tomosynthesis system. Nodules of varied size (3, 5, 8, 10, 12 mm) and radiodensity (HU-800, -600, +130) were placed randomly into different lobes of the phantom. For each test case, 3 nodules (one of each density) were randomly placed into the phantom. A total of 8 nodule test cases were recorded. CT scanning was performed under the ACR recommended lung cancer screening protocol. Chest tomosynthesis imaging was performed with a custom built "wide-angle" CNT system consisting of a meter long x-ray source with 60 independent activated x-ray sources opposite a digital detector, representing a 40 degree angular span. Imaging was performed at 120kV and total mAs of 2.358. Tomosynthesis images were reconstructed into the coronal plane with 3 mm slice thickness and presented to readers on PACS compliant monitors. Two board certified radiologists participated as readers. Each scan (CT or tomosynthesis) was independently reviewed, and the positions of lung nodules were documented by each reader.

#### RESULTS

The specificity of both the CT and tomosynthesis in detecting any sized pulmonary nodules was 1. For actionable pulmonary nodules, or those 8 mm or greater in size, both the CT and tomosynthesis had a specificity of 1. The sensitivity of CT and tomosynthesis in detecting any sized pulmonary nodules is 0.929 and 0.708, respectively. The sensitivity of CT and tomosynthesis in detecting actionable pulmonary nodules is 0.958 and 0.850, respectively. The sensitivity of tomosynthesis increases with dense pulmonary nodules, with actionable pulmonary nodules of HU+130 being detected with a sensitivity of 1.

#### CONCLUSION

Wide-angle tomosynthesis was found to consistently identify dense nodules of at least 8 mm in size. Further studies are needed to evaluate the sensitivity and specificity of the system to actionable lung nodules. With system and carbon nanotube array optimization, we hypothesize the detection rate for nodules will improve. Additional study is needed to evaluate its use in target and tool co-localization and target biopsy.

#### CLINICAL RELEVANCE/APPLICATION

The development of an effective, low-radiation and mobile method for pulmonary nodules could improve screening of lung cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPCH-3

### Value of Deep Learning Reconstruction Algorithm Combined with Low Tube Voltage in Routine Lung CT Scanning

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Ren-feng LV (*Presenter*) Nothing to Disclose

#### PURPOSE

To study the effect of deep learning reconstruction (DLIR) algorithm combined with low tube voltage (100 KVp) on lung CT scan image quality and radiation dose.

#### METHODS AND MATERIALS

50 patients with routine lung CT scans were selected and were divided into 120 KVp group and 100 KVp group according to the difference of tube voltage, 25 patients in each group. Among them, Group A: Tube voltage 120 KVp, adaptive statistical iterative reconstruction (ASiR-V, 30%) algorithm, reconstruction mode (lung). The raw data of 100KVp group were reconstructed according to different reconstruction algorithm and reconstruction mode, Group B: Deep learning reconstruction (DLIR-H) algorithm, standard reconstruction mode (Std). Group C: Deep learning reconstruction (DLIR-H) algorithm, standard reconstruction mode (Std) + image enhancement filter (LU). All scans using a tube current of 100 ma, other parameter settings are the same. The thickness of 1.25mm was reconstructed image. The CT values, noise (SD), CTDI, within the subcutaneous fat and lung tissue on both sides of the same location were recorded, signal noise ratio (SNR) and radiation dose (ED) were calculated, two chest doctors evaluated the image quality subjectively and made statistical analysis of the data between the three groups.

#### RESULTS

There was no statistical difference in the CT values measured in all three groups of lung images ( $P > 0.05$ ); The SD, SNR and image quality evaluation were statistically different between the three image groups ( $P < 0.05$ ), the noise of the images of B and C groups is significantly lower than that of group A, group C images provide better sharpness and clearly shows the structure and branches of lung markings; The radiation dose of the 100 KVp group was significantly lower than the 120 KVp group ( $P < 0.05$ ).

#### CONCLUSION

Using tube voltage 100 KVp combined with DLIR algorithm significantly reduces the radiation dose. Compared with ASiR algorithm, using DLIR algorithm combined with image enhanced filter (LU) reconstruction mode can significantly lower the image noise, and improved the display ability of lung tissue and lung markings.

#### CLINICAL RELEVANCE/APPLICATION

Routine low-dose lung CT examination used low tube current combined with iterative algorithm, the noise suppression and radiation dose reduction are not obvious, DLIR algorithm combined with low tube voltage imaging can significantly reduce the radiation dose, the DLIR algorithm standard reconstruction mode combined with image enhancement filtering (LU) can provide a good contrast image of the lung tissue. Due to the significant noise suppression of the DLIR algorithm, the application of routine lung CT physical examination and lung nodule screening using a tube voltage of 80 KVp or even lower becomes possible.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPCH-4

### **CT Pulmonary Angiograms (CTPA) in Pregnant Patients: Multicenter Study on Imaging Findings, Management, and Follow-up of Patients beyond an Optimal and Suboptimal CTPA**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Shadi Ebrahimian, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Risk of pulmonary embolism (PE) is increased in pregnancy. However, CTPA usage is limited given the risks of radiation exposure to the mother and fetus. The aim of this study was to assess the frequency of suboptimal CTPAs in pregnant population, the factors related to sub-optimality, and factors contributing to patients' outcome.

#### **METHODS AND MATERIALS**

Our IRB approved, retrospective study included 440 consecutive CTPA examinations of pregnant patients scanned between 2015-2021 at one of the five participating quaternary and community hospitals. For the control group, we included 474 consecutive, female patients who underwent CTPA. All CTPA exams were reviewed for diagnostic evaluability (optimal or suboptimal) as well as the presence of PE. In addition, we recorded patients' age, gestational age at the time of CTPA, weight, imaging data (Doppler US, chest radiograph, and ventilation perfusion scan), and information on patient and pregnancy outcomes following CTPA.

#### **RESULTS**

PE positive CTPA rates in pregnant (3.4%) and non-pregnant (9.7%) patients were significantly different ( $p=0.004$ ). The frequency of suboptimal CTPA (11.2%, 49/440) in pregnant and non-pregnant patients (11.2% vs 8.2%;  $p=0.657$ ) was not significantly different. Pregnant patients with suboptimal CTPA had higher weight (92 kg vs 77 kg), and advanced gestational age ( $\geq 20$  weeks vs  $< 20$  weeks) in comparison with optimal CTPA. Additional imaging including CXR (46.9%), Doppler (46.9%), repeat CTPA (10.2%), and V:Q (2.0%) were performed in less than 50% of patients with suboptimal CTPA. Although patients with suboptimal CTPA had a higher rate of hospitalization than those with optimal CTPA (40.8% vs 29.9%), it was not significantly different. Non-PE findings such as pneumonia, edema, and pleural effusions, were more frequent findings in CTPAs. CTDIvol and DLP were significantly higher in suboptimal CTPA (CTDI: 9 vs 8, DLP: 271, 238,  $p<0.001$ ).

#### **CONCLUSION**

The low rate of PE-positive CTPA in pregnant patients comparing to non-pregnant patients as well as additional testing performed following suboptimal CTPA suggest over-utilization of CTPA in pregnant population. Pregnancy does not attribute to higher suboptimality rate in CTPAs. However, suboptimal CTPA is more expected in patients with higher body weight and age of pregnancy. Although not statistically significant, the higher rate of hospitalizations among patients with suboptimal CTPA suggests presence of a more severe underlying disease. Suboptimal CTPA exposes extra radiation dose to patients comparing to optimal CTPA.

#### **CLINICAL RELEVANCE/APPLICATION**

Over-utilization of CTPA in pregnant populations leads to unnecessary exposure of radiation and contrast to mother and fetus.

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## Abstract Archives of the RSNA, 2023

W2-SPCH-5

### Performance Evaluation of a 3D Camera System for Automated Patient Positioning in Routine Chest and Abdominal CT

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Tim Busselot (*Presenter*) Nothing to Disclose

#### PURPOSE

Patient out-of-center positioning in computed tomography (CT) scanning is a common issue, possibly resulting in inferior image quality and/or increased patient dose due to suboptimal tube current modulation. Automated patient positioning, using a three-dimensional (3D) camera promises more accurate and robust positioning. This study aimed to compare manual versus 3D camera based patient positioning in the clinical workflow.

#### METHODS AND MATERIALS

A total of 6618 routine thoracic and abdominal scans of adult patients were included in the study. The scans were performed on 2 CT scanners, one of which was equipped with a 3D camera system (Naeotom Alpha CT by Siemens Healthineers), which automatically positions the patient; the 3D camera was used in the 1597 scans. The patient positioning after each scan, as well as the corresponding patient effective diameter (ED), were calculated by DOSE (Qaelum), the dose monitoring system used in the hospital. An extensive study was performed by evaluating the positioning of each scan taking into account the scan region, the patient size (in terms of ED) and the gender. A vertical bidirectional offset from the CT isocenter smaller than 10 mm (threshold) was defined as 'accurate positioning', since no significant impact on image quality and patient dose was found in literature. Before using the positioning calculations of DOSE, a validation was executed.

#### RESULTS

Mean manual patient positioning was 16.55 mm 95% CI [16.05, 17.06], while positioning with the 3D camera resulted in a significantly different ( $p < 0.0001$ ) mean positioning of -3.33 mm, 95% CI [-4.27, -2.39]. Positioning distribution indicated a more centralized positioning with the 3D camera (53%) compared to manual positioning (31%). Sub-analysis regarding the scan region resulted in significant differences ( $p = 0.001$ ) between manual and automatic positioning in both thorax and abdomen exams. Patient size comparisons showed that small patients (ED=28cm) were on average worse positioned compared to medium (28cm<ED<31cm) and large (ED=31cm) patients, in both manual and automatic positioning. Still, automatic positioning was significantly ( $p = 0.001$ ) more accurate. Gender wise comparison provided evidence of the superiority of the automatic positioning in all patients, independent on the gender.

#### CONCLUSION

Automated patient positioning using a 3D camera resulted in a significantly more accurate positioning of the patient in the CT scanner, compared to manual positioning. Sub-analyses regarding scan region, patient size and gender showed an overall improvement, indicating the camera based positioning is robust.

#### CLINICAL RELEVANCE/APPLICATION

Automated 3D camera positioning was shown to provide more accurate and robust positioning in routine CT practice.

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## Abstract Archives of the RSNA, 2023

W2-SPCH-6

### The Effect of Pitch and Rotation Time on the Quantitative Analysis of Lung Nodules by Artificial Intelligence in Low-dose Lung CT Screen

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Xuan Su (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the influence of the choice of pitch and rotation time on the quantitative analysis of lung nodules by artificial intelligence in low-dose lung CT screening.

#### METHODS AND MATERIALS

A thorax anthropomorphic phantom (Lungman, Kyoto Kagaku Inc.) was scanned by with a 256-row CT (Revolution CT, GE Healthcare) , which contained 9 simulated nodules (CT value, 100 HU, -630HU and -800HU; diameter: 8mm, 10mm, 12mm). Six groups of images were obtained with same tube voltage and current (120kV, 45mA) but different combination of pitch and rotation time (Group 0: 0.984, 0.28s; Group 1: 0.992, 0.35s; Group 2: 0.992, 0.28s; Group 3: 1.375, 0.5s; Group 4: 1.531, 0.5s ; Group 5: 0.984, 0.35s). The images with different group were analyzed by an artificial intelligence software (Intelligent 4D Imaging System for Chest 5.5, YITU Healthcare). The CT value, SD of pulmonary nodules and air in front of sternum at the same slice were measured. CT dose index (CTDI), the product of dose length (DLP) of each scan were recorded. Signal-to-noise ratio ( $SNR = \frac{CT_{\text{nodule}}}{SD_{\text{nodule}}}$ ) and contrast signal to noise ratio ( $CNR = \frac{CT_{\text{nodule}} - CT_{\text{air}}}{SD_{\text{air}}}$ ) were calculated. All statistical analyses were performed using SPSS statistical software (version 22.0).

#### RESULTS

Changing pitch and rotation time at low dose has no effect on the size of lung nodules measured by AI (mean diameter,  $P > 0.05$ ; diameter difference percentage,  $P > 0.05$ ); changing the scan pitch and rotation speed does not affect the CT of lung nodules Measurement of values (average CT value,  $P > 0.05$ ; percentage difference in CT value,  $P > 0.05$ ). The changes of scanning pitch and rotation speed have no effect on the image quality ( $SNR$ ,  $P > 0.05$ ;  $CNR$ ,  $P > 0.05$ ). The CT effective dose is different under different conditions (CTDL,  $P < 0.05$ , DLP,  $P < 0.05$ ), the DLP value is the lowest when the scanning pitch is 0.984 and the rotation speed is 0.28s (DLP = 27.79 (mGy \* cm)).

#### CONCLUSION

In low-dose lung screening, changes in scan pitch and rotational speed will not affect image quality. Choosing a distance of 0.984 and a rotational speed of 0.28s can provide lung screening with lower radiation dose.

#### CLINICAL RELEVANCE/APPLICATION

In clinical workflow, it is of great significance to minimize radiation dose while keep image quality constantly.

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## Abstract Archives of the RSNA, 2023

W2-SPCH-8

### Value of Deep Learning Reconstruction of Chest Low-dose CT for Image Quality Improvement and Lung Parenchyma Assessment on Lung Window

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Jinhua Wang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the performance of low-dose computed tomography (LDCT) with deep learning reconstruction (DLR) for the improvement of image quality and assessment of lung parenchyma.

#### METHODS AND MATERIALS

Sixty patients underwent chest regular-dose CT (RDCT) followed by LDCT during same patient encounter. RDCT images were reconstructed with hybrid iterative reconstruction (HIR) and LDCT images were reconstructed with HIR and DLR, both using lung algorithm. Radiation exposure was recorded. Image noise, signal-to-noise ratio, and subjective image quality of normal and abnormal CT features were evaluated and compared using the Kruskal-Wallis test with Bonferroni correction.

#### RESULTS

The effective radiation dose of LDCT was significantly lower than that of RDCT ( $0.29 \pm 0.03$  vs  $2.05 \pm 0.65$  mSv,  $p < 0.001$ ). The mean image noise  $\pm$  standard deviation was  $33.9 \pm 4.7$ ,  $39.6 \pm 4.3$  and  $31.1 \pm 3.2$  HU in RDCT, LDCT HIR-Strong and LDCT DLR-Strong, respectively ( $p < 0.001$ ). The overall image quality of LDCT DLR-Strong was significantly better than that of LDCT HIR-Strong ( $p < 0.001$ ) and comparable to that of RDCT ( $p > 0.05$ ). LDCT DLR-Strong was comparable to RDCT in evaluating solid nodules, increased attenuation, linear opacity, and airway lesions (all  $p > 0.05$ ). The visualization of subsolid nodules and decreased attenuation was better with DLR than with HIR in LDCT but inferior to RDCT (all  $p < 0.05$ ).

#### CONCLUSION

LDCT-DLR can effectively reduce image noise and improve image quality. LDCT-DLR provides good performance for evaluating pulmonary lesions, except for subsolid nodules and decreased lung attenuation, compared to RDCT-HIR.

#### CLINICAL RELEVANCE/APPLICATION

DLR enables LDCT maintaining image quality even with very low radiation doses.

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## Abstract Archives of the RSNA, 2023

W2-SPER-1

### Imaging Findings of Elder Abuse on the Trauma Service: A retrospective Case-control Study of Two Institutions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Omar Yaghi, BS, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Elder abuse is common and consequential for its victims, with impact ranging from reduced quality of life to physical injury and death. Screening is a recognized strategy for detection, but less effective in elders with diminished ability to communicate or psychosocial reasons to fear disclosure. This study aimed to identify imaging findings of elder abuse.

#### **METHODS AND MATERIALS**

Preliminary data from this retrospective case control study identified 17 patients above 60 years of age with keywords "assault" and "abuse" from two institutional trauma registries from 2015-2022, as well as 17 age and gender matched controls. Demographic information, clinical information, and imaging findings were reviewed.

#### **RESULTS**

Majority of the abuse victims were women (71%) and White (88%), with mean age of 74 years (range 61-91 years). Known risk factors for elder abuse were common. The alleged abuser was most frequently the patient's child, followed by partner. Blunt trauma was more common (14/17). Rib fractures (7/17), head (8/17) and facial (5/17) injuries were the most frequent imaging findings. Central injuries (to neck, torso) were more common in elder abuse victims compared to control trauma patients, while the latter more frequently had extremity injuries. Abuse victims with extremity injuries demonstrated tendency towards distal injury particularly of the upper extremity (forearm, hand), while control patients tended towards proximal injury (humerus, femur).

#### **CONCLUSION**

This study demonstrated that radiologists can be helpful in assessment of elder abuse, identified injuries to the head/face, central body, and distal upper extremity as warning signs of elder abuse, and highlighted the importance of further research to identify imaging patterns of abuse in this vulnerable population.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiologists can help in recognition of elder abuse by identifying injuries occult to physical examination in victims who are unable or unwilling to disclose abuse.

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## Abstract Archives of the RSNA, 2023

W2-SPGI-1

### A Pilot Study on the Classification of Focal Liver Lesions using Normalized Viscoelastic Parameters with Intrinsic MR Elastography

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Amirhosein Baradaran Najar, MSc, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Evaluate the accuracy of nonlinear inversion-intrinsic magnetic resonance elastography (NLI-iMRE), which uses natural pressure pulse and cardiac induced motion, for determining the viscoelastic properties of liver lesions and distinguishing between benign and malignant tumors.

#### METHODS AND MATERIALS

This prospective, cross-sectional study was approved by an institutional review board and patient consent was obtained. Adult patients undergoing 3T clinical MRI for characterization of liver lesions were included. A 4D-phase contrast quantitative sequence with retrospective cardiac gating was acquired to encode motion. Using the 3D displacement field at eight cardiac cycle phases, viscoelastic parameters  $G'$  (storage modulus),  $G''$  (loss modulus), and  $|G^*|$  (magnitude of the complex shear modulus) were computed within the imaging volume using the subzone-based NLI-iMRE reconstruction method. To ensure comparability between subjects, viscoelastic properties were calculated for the liver and spleen, and liver properties were normalized by the mean spleen property values. The composite reference standard included lesion classification by clinical MRI or histopathology. Unpaired t-tests and receiver operating characteristic (ROC) curves were used to compare benign and malignant lesions.

#### RESULTS

34 patients with 34 lesions were included. Normalized  $G'$  values showed significant differences between hemangiomas and LR-4 ( $p < 0.01$ ), LR-5 ( $p = 0.02$ ), and metastasis ( $p < 0.01$ ) and between focal nodular hyperplasias (FNH) and LR-4 ( $p < 0.01$ ), LR-5 ( $p = 0.03$ ), and metastasis ( $p < 0.01$ ). The  $|G^*|$  values showed significant differences between FNH and LR-4 ( $p < 0.0001$ ), LR-5 ( $p = 0.03$ ), and metastases ( $p = 0.04$ ). ROC curves were used to differentiate benign and malignant lesions, with the area under the curves for  $G'$ ,  $G''$ , and  $|G^*|$  being 0.90, 0.61, and 0.71, respectively.

#### CONCLUSION

This study shows that cardiac activated iMRE which has the advantage of not requiring external mechanical stimulation, is a promising method for differentiating benign and malignant liver lesions using normalized  $G'$  and  $|G^*|$ , with results consistent with prior findings from extrinsic MRE studies, while the normalized  $G''$  did not show a meaningful trend for different lesion types.

#### CLINICAL RELEVANCE/APPLICATION

This study found that NLI-iMRE accurately distinguishes between benign and malignant liver lesions using viscoelastic properties, with normalized  $G'$  and  $|G^*|$  values showing significant differences between lesion types. This non-invasive method, based on standard clinical imaging sequences, has the potential for clinical use without the need for external actuation.

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## Abstract Archives of the RSNA, 2023

W2-SPGI-2

### Multimodal Imaging Evaluation of Hepatic Alveolar Echinococcosis in Children

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Hai Hua Bao (*Presenter*) Nothing to Disclose

#### PURPOSE

Hepatic alveolar echinococcosis (HAE) has an aggressiveness similar to that of malignant tumors. Children have a rich blood supply to the liver, and the lesions grow rapidly after infection, which makes the disease serious and difficult to treat. The purpose of this study is to investigate the growth characteristics of HAE in children through various imaging techniques.

#### METHODS AND MATERIALS

Fifty pediatric patients (age range 1-14 years, mean age  $11.24 \pm 2.82$  years) diagnosed with HAE at the Affiliated Hospital of Qinghai University from 2014 to 2020 were included for imaging (low-dose abdominal CT plain + enhancement, abdominal T1WI, T2WI, MR enhancement, DWI) and clinical examination, we obtained morphological features of the lesions based on images, imaging staging and PNM staging, intrahepatic vascular and bile duct invasion, marginal zone continuity and ADC values, and assessed the liver function and systemic nutritional status of the children based on clinical test results such as glutamate transaminase (ALT) and hemoglobin (Hb), and comprehensively evaluated the growth characteristics of HAE lesions in children.

#### RESULTS

All children underwent CT plain scan(1), of which 41 had CT-enhanced scans(2), and a total of 27 had MR scans(3-8). Both the right and left lobes of the liver were invaded in 48% of the cases, the left lobe only in 14%, and the right lobe only in 38%. 96% of cases had calcification formation; 52% of cases had vascular and bile duct involvement (Table 1); P1 stage lesions accounted for the most PNM staging and parenchymal type accounted for the most imaging staging; P1 stage lesions had higher marginal zone activity than P2+P3 stage (There was no statistically significant difference in ADC values between P2 and P3 phases, so the joint comparison with P1 phase; P4 phase had a small sample size, so no statistics were done). Large lesions, parenchymal lesions, and P2 stage lesions have a greater impact on liver function in pediatric patients; parenchymal lesions have a greater impact on the nutritional status of the children.

#### CONCLUSION

CT images can clearly show the calcification within the lesion, MR images can clearly show the invasion of hepatic vessels and bile ducts by the lesion, DWI and ADC values can determine the activity of the marginal zone of the lesion, and the characteristics of HAE lesions can be effectively evaluated by using multimodal imaging techniques.

#### CLINICAL RELEVANCE/APPLICATION

HAE infection is asymptomatic in the early stage, and most of them are in the advanced stage when there are obvious symptoms, and children are poorly tolerated and difficult to treat surgically, early diagnosis and knowledge of its growth characteristics are crucial for clinicians to choose the appropriate treatment plan and thus reduce the mortality rate.

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## Abstract Archives of the RSNA, 2023

W2-SPGI-3

### Amide Proton Transfer-Weighted MRI in Preoperative Assessment of Microvascular Invasion of Hepatocellular Carcinoma

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Xianfu Luo (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to explore the potential of APTw imaging in predicting microvascular invasion (MVI) of hepatocellular carcinoma.

#### METHODS AND MATERIALS

32 patients with surgical pathologic confirmed hepatocellular carcinoma were studied. All patients underwent liver MR scanning on a 3.0-tesla scanner. Images at 52 frequencies were acquired for APTw, including 49 frequencies ranging from -600 to 600 Hz with an increment of 25 Hz. The applied saturation B1 power was  $2\mu\text{T}$  and the saturation duration was 2000ms. Three identical ROIs were placed in the solid component of tumor for each patient on unsaturated M0 images and were copied on MTRasym mapping. Large cystic cavities, large areas of necrosis were excluded from ROI selections. Averaged MTRasym values were used for further analysis. The inter-class correlation coefficient (ICC) was used to evaluate the inter-observer agreement of measuring APTw value between two radiologists. The comparisons between APTw value for MVI- and MVI+ groups were analyzed using the independent t test. Receiver operating characteristic (ROC) curves were generated for each APTw parameter value to assess the areas under the curve (AUC).

#### RESULTS

MVI was pathologically confirmed from tumor resection including 13 cases with MVI (MVI+) and 15 without MVI (MVI-). The ICC of two observers' measurements of APTw was 0.912. The APTw value of MVI+ group was significantly higher than that of MVI- group [  $(1.33\pm 0.76)\%$  vs  $(0.32\pm 1.06)\%$ ;  $P=0.008$ ]. The cut-off APTw value for differentiating MVI+ and MVI- groups was 0.30% (sensitivity, 60%; specificity, 100%; AUC, 0.782, 95%CI: 0.609, 0.955)

#### CONCLUSION

APTw imaging showed promising ability in differentiating MVI+ and MVI- hepatocellular carcinoma.

#### CLINICAL RELEVANCE/APPLICATION

APTw could serve as a robust technique to predicting MVI of hepatocellular carcinoma without the use of contrast agents and providing additional auxiliary value for the selection of clinical treatment methods of hepatocellular carcinoma patients.

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## Abstract Archives of the RSNA, 2023

W2-SPGI-4

### Free Breathing Acquisition using Radial Sampling and Compressed Sensing Improves Success Rate and Image Quality of Gadoteric Acid Enhancing Liver MRI in Elderly Patients

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Masaya Kutsuna (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare successful rate of examination and clinical image quality of liver dynamic MR images using gadoteric acid in elderly patients between free breathing acquisition using radial sampling and compressed sensing and conventional breath-hold acquisition.

#### METHODS AND MATERIALS

This retrospective single-center study included 100 patients older than 60 years who underwent liver MR examination using gadoteric acid using free breathing acquisition (FB group,  $n = 50$ ) or conventional breath-hold acquisition (BH group,  $n = 50$ ). All included examinations were performed on a 3.0-T MR scanner (Ingenia Elition, Philips). The representative parameters of FB group were as follows: pseudo-golden angle free breathing sequence using compressed sensing with soft-gating (SmartSpeed 4D-FreeBreathing); temporal resolution, 10 sec/phase; C-SENSE factor, 4. The parameters for BH group were as follows: spoiled gradient echo with compressed sensing (eTHRIVE); scan time, 14.9 sec; C-SENSE factor, 6. As qualitative analysis, all images of arterial (AP), portal venous (PVP), and transitional phase (TP) were evaluated by 2 independent radiologists using a 5-point scale (1 - 5, 5 is excellent quality) in terms of motion artifact, streak artifact, sharpness of liver edge, and overall quality. The cases with an overall quality score of 3 or above were regarded as diagnosable and successful examinations. As qualitative analysis, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were evaluated by board-certified another radiologist placing region-of-interest to each 5 segments of liver. P value less than 0.05 was regarded as statistically significant.

#### RESULTS

The success rate was 100% (50/50) for the three phases in FB group, while in BH group, 82% (41/50,  $p = 0.005$ ) for AP, 98% (49/50,  $p = 1.0$ ) for PVP, and 100% (50/50,  $p = 1.0$ ) for TP (Figure A). In the qualitative analysis, BH group showed better score in motion artifact and sharpness of liver edge in the three phases ( $p < 0.005$ , Figure B). There was no significant difference of overall quality in AP ( $p = 0.09$ ). The SNR and CNR of BH group showed higher in PVP and TP. In the AP, the SNR and CNR of FB group tended to be higher but not significant ( $p = 0.19-0.76$ ). Two representative cases were shown in Figure C.

#### CONCLUSION

Free breathing acquisition using radial sampling and compressed sensing improved success rate and clinical image quality of gadoteric acid enhancing liver MRI in elderly patients compared with conventional breath-hold acquisition.

#### CLINICAL RELEVANCE/APPLICATION

Free breathing acquisition improves quality of liver MR examination using gadoteric acid in elderly patients and has potential to improve diagnostic performance of hypervascular hepatic lesions.

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## Abstract Archives of the RSNA, 2023

W2-SPGI-6

### Diagnostic Accuracy of Liver MR Elastography for Assessment of Liver Fibrosis in Children with AIH and Post LTx

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Paulina Chodnicka (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic accuracy of MRE in liver fibrosis staging using liver biopsy as the reference standard in pediatric patients with AIH and post LTx.

#### METHODS AND MATERIALS

Overall, 48 patients with AIH and 25 patients post-LTx were included in the study. The median age of patients with AIH was 14.54 (range 2,82-17.98), the group included 22 boys and 26 girls. The median age of patients post-LTx was 14.16 (range 7.89-17.94), the group included 11 boys and 14 girls. All patients underwent MR elastography and liver biopsy. The liver stiffness value on MRE was independently measured by two radiologists. The weighted arithmetic mean was calculated from elastograms obtained at 4 levels of the liver in the axial plane. Biopsy samples were separately evaluated by two pathologists to stage liver fibrosis according to the Ischak fibrosis scale. Statistical analysis was performed, ROC curves were plotted with the optimal cut-off values and corresponding AUCs were calculated to evaluate sensitivity and specificity, inter-rater agreement was determined.

#### RESULTS

In patients with AIH MRE detected fibrosis stage 4 or higher with a sensitivity of 100% and specificity of 70,6% for cut-off value  $>2,92$ , AUC 0,88,  $p<0.05$ , and fibrosis stage 5 or higher with a sensitivity of 83% and specificity 89% for cut-off value  $>3,65$ , AUC 0,90,  $p<0.05$ . In patients post-LTx MRE detected fibrosis stage 4 or higher with a sensitivity of 100% and specificity of 90,5% for cut-off value  $>3,06$ , AUC 0,95,  $p<0.05$  and fibrosis stage 5 or higher with sensitivity 100% and specificity 83% for cut-off value  $>3,06$ , AUC 0,91,  $p<0.05$ . The weighted Kappa value calculated for inter-observer agreement between radiologists was 0,90.

#### CONCLUSION

MRE is a non-invasive technique that has high sensitivity and specificity in detecting advanced stages of liver fibrosis with a very good intraobserver strength of agreement.

#### CLINICAL RELEVANCE/APPLICATION

It may be possible to reduce the number of liver biopsies in patients with elevated liver stiffness identified with MRE.

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## Abstract Archives of the RSNA, 2023

W2-SPGI-7

### The Role of Four-dimensional Flow MR Imaging as an Add-on Tool to Endoscopy for Predicting Actual Bleeding in Cirrhotic Patients with Esophageal Varices

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Eunju Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether four-dimensional (4D) flow MRI with quantitative hemodynamic parameters could be used as an add-on tool to endoscopy for predicting actual bleeding in cirrhotic patients with esophageal varices.

#### METHODS AND MATERIALS

All the cirrhotic patients who were attributable to hepatitis B and/or C virus underwent 4D flow MRI using a 3-T scanner (Skyra; Siemens Healthcare, Erlangen, Germany). The velocity-encoding sensitivity for x, y, and z flow-encoding directions was set to 30 cm/s, 20 cm/s, and 20 cm/s, respectively. A total of 109 cirrhotic patients with endoscopically confirmed esophageal varices were divided into groups A (negative red color (RC) sign with no variceal bleeding, n = 60, 35 - 81 years), group B (negative RC sign with variceal bleeding, n = 13, 41 - 80 years), group C (positive RC sign with no variceal bleeding, n = 10, 49 - 81 years), and group D (positive RC sign with variceal bleeding, n = 26, 48 - 81 years). The presence of variceal bleeding was defined as the occurrence of active bleeding within one year after initial diagnosis of esophageal varices based on the endoscopic and clinical findings. The quantitative parameter of 4D flow MRI included the net flow rate (mL/s), mean flow rate (mL/s), peak flow rate (mL/s), and net forward volume (mL) in each vessels. The 4D flow MR parameters were compared among the groups using Mann-Whitney U test, and the receiver operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance.

#### RESULTS

The values of all 4D flow MR parameters in the PV of patients with a positive RC sign were significantly lower than those of patients with a negative RC sign ( $P < 0.05$ ). The patients with variceal bleeding in group B and D showed lower values in all MR parameters in the PV than those of patients with no variceal bleeding in group A and C, respectively ( $P < 0.05$ ). However, there were no significant differences among the groups regarding the MR parameters in the SV and SMV. In the ROC analysis for evaluating the diagnostic performance of actual variceal bleeding in order to distinguish patients with variceal bleeding from patients with non-variceal bleeding, the area under the curve (AUC) values were 0.762 and 0.770 ~ 0.787 in endoscopy alone and MR alone, respectively. However, in the combination of endoscopy and 4D flow MRI, the AUC value increased significantly to 0.844 ~ 0.864 ( $P < 0.05$ ).

#### CONCLUSION

The 4D flow MRI can be useful as an additional tool to endoscopy in predicting actual bleeding in cirrhotic patients with esophageal varices.

#### CLINICAL RELEVANCE/APPLICATION

4D flow MRI could significantly contribute to improving the diagnostic accuracy of endoscopy in predicting actual bleeding in cirrhotic patients with esophageal varices.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPGI-8

### Intensive Respiratory Instruction Reduces Transient Motion Artifact in Liver Dynamic MR Examination using Gadoxetic Acid

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Satoshi Funayama, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To validate the efficacy of intensive respiratory instruction during liver MR examination using gadoxetic acid, especially whether it reduces transient severe motion artifact (TSMA).

#### METHODS AND MATERIALS

This retrospective study reviewed 493 patients who underwent liver dynamic MR examination using gadoxetic acid before and after intensive respiratory instruction (IRI) was started on May 2022. To determine population size, power analysis was performed based on the reported frequency of TSMA (7.2%) and breath-hold failure in case of extracellular contrast agent (2.2%) (power = 0.7, significant level = 0.05). All examinations were performed on a 3.0-T MR scanner (SIGNA Premier, GE Healthcare). The dual arterial phase was acquired using spoiled gradient echo sequence (LAVA-FLEX) with compressed sensing (HyperSense) with scan time of 11 sec/phase. The detail of the IRI procedure was as follows. First, patients were instructed to start deep breathing before starting of acquisition for pre or contrast agent injection and continue it until breath-hold command. Technologists started the injection after confirming 4 or 5 times of patients' deep breathing through the abdominal bellows signal curve. The breath-hold command was started when contrast agent reached abdominal aorta on FluoroTrigger real time imaging and the patient was in expiratory phase. In the conventional procedure, only auto breath-hold command was played on the scanner. To evaluate respiratory motion, abdominal bellows curve was classified into 6 classes (type 1 - type 6, Figure A) on pre, arterial (AP), and portal venous phase (PVP). A board-certified radiologist evaluated motion artifact using 5-point scale (1 - 5; 5, the best) on pre, first arterial (AP1), second arterial (AP2), and PVP. The motion artifact score of 3 or less was regarded as TSMA.

#### RESULTS

Finally, 450 patients were included (225 for conventional group [Conv group]; 225 for IRI group). The successful breath-hold was more frequent in IRI group in AP ( $p < 0.001$ ) and PVP ( $p < 0.001$ ) (Figure A). The frequency of TSMA was 6.7% (Conv group) and 1.3% (IRI group,  $p = 0.007$ ) for AP1; 7.1% (Conv group) and 1.8% (IRI group,  $p = 0.01$ ) for AP2. The motion artifact score was significantly higher (better image quality) in IRI group on AP1 ( $p < 0.001$ ) and AP2 ( $p < 0.001$ ). The score was not significantly different on pre ( $p = 1.0$ ) and PVP ( $p = 0.341$ ) (Figure B).

#### CONCLUSION

Intensive respiratory instruction improved success rate of breath-hold and significantly reduced transient severe motion artifact.

#### CLINICAL RELEVANCE/APPLICATION

Intensive respiratory instruction improves quality of arterial phase in liver dynamic MR examination using gadoxetic acid and has potential to improve diagnostic performance of hypervascular hepatic lesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPGU-1

### Impact of Image Quality on Detection of Extraprostatic Extension on MRI: Evaluation with a Deep Learning-based AI Algorithm

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Yue Lin, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess impact of image quality on extraprostatic extension (EPE) detection on MRI using a deep learning-based AI algorithm.

#### METHODS AND MATERIALS

This retrospective study included consecutive patients who were imaged with mpMRI and subsequently underwent radical prostatectomy (RP) from January 2007 to August 2022. One genitourinary radiologist prospectively evaluated each case using a previously published and validated grading system to assess the presence of EPE on mpMRI. EPE grade of 0 = no suspicion of EPE, 1 = long curvilinear contact or capsular irregularity/bulge, 2 = both long curvilinear contact and capsular irregularity/bulge, 3 = frank EPE. An EPE grading score =1 was considered as positive EPE call on mpMRI. Histopathologic EPE evaluation was performed at RP according to the International Society of Urological Pathology (ISUP) consensus statement. For each patient, T2WI and ADC maps were individually classified as non-diagnostic vs. diagnostic by an in-house AI algorithm. Fisher's exact tests were performed to compare EPE detection metrics (i.e., specificity) between non-diagnostic and diagnostic images.

#### RESULTS

A total of 812 patients (median age 62 [interquartile range 57-67] years; median prostate specific antigen level 6.7 [4.6-10.3] ng/mL) were evaluated. The median time from mpMRI to RP was 3 (1-5) months. At radical prostatectomy, 23% (188/812) of patients had EPE at pathology and 41% (133/324) of positive EPE calls on mpMRI were found to have EPE. For T2WI quality analysis, 35% (284/812) of sequences were classified as non-diagnostic and 65% (528/812) were categorized as diagnostic by the AI algorithm. For ADC maps, 32% (260/812) were classified as non-diagnostic and 68% (552/812) as diagnostic. Compared to non-diagnostic T2WI, diagnostic scans were associated with lower MRI/pathology mismatch for prediction of EPE (34% [97/284] vs. 28% [149/528],  $P=0.093$ ) and lower false positive rate (28% [80/284] vs. 21% [111/528],  $P=0.024$ ). Diagnostic T2WI also had significantly higher specificity for detection of EPE at mpMRI than non-diagnostic images (73% [294/405] vs. 63% [139/219],  $P=0.023$ ). No significant difference in EPE evaluation were observed between diagnostic and non-diagnostic ADC maps.

#### CONCLUSION

Our study successfully employed a deep learning-based AI algorithm to classify image quality of prostate MRI and demonstrated that preoperative T2WI quality is crucial for accurate EPE evaluation. Better quality T2WI was associated with higher specificity and fewer false positive calls for prediction of EPE at final pathology.

#### CLINICAL RELEVANCE/APPLICATION

Preoperative T2WI quality is critical for ruling out EPE at pathology using MRI, and AI can be used to objectively assess the quality of prostate MRI scans.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPGU-2

### Histopathological Validation of Prostate Cancer Characterization with Magnetic Resonance Fingerprinting and Apparent Diffusion Coefficient Mapping

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Barbara D. Wichtmann, MD, MSc (*Presenter*) Speaker, Koninklijke Philips NV

#### PURPOSE

To evaluate the utility of magnetic resonance fingerprinting (MRF) and apparent diffusion coefficient (ADC) mapping for characterizing prostate lesions with histopathological validation.

#### METHODS AND MATERIALS

This institutional review board-approved retrospective study included prospectively collected data of 91 biopsy-naive men with elevated PSA-levels suspected of having prostate cancer (PCa; 65.7 +/- 7.8 years). All patients underwent a multiparametric MRI examination at a 3T Philips Ingenia scanner (Philips Healthcare, Best, the Netherlands) and were classified by trained radiologists following the PI-RADS 2.1 scoring system. T1 and T2 mapping was performed using 2D fast imaging with steady-state precession-based MRF with spiral readout. ADC maps were calculated based on b-values = 100, 400, 800 s/mm<sup>2</sup>. Zonal segmentation of the prostate was performed using a convolutional neural network with subsequent revision by a trained radiologist. Lesions were manually segmented and correlated with histopathology after targeted biopsy/prostatectomy. Systematic differences of T1-/T2-relaxation times and ADC values between different histopathological ISUP scores were assessed using one-way analysis of variance with Tukey type post hoc comparisons to adjust for multiple testing.

#### RESULTS

32 patients were classified as PI-RADS 2, 21 as PI-RADS 3, 21 as PI-RADS 4 and 17 as PI-RADS 5. In total 89 lesions were segmented, 72 in the peripheral zone (PZ), 17 in the central gland. In 3 patients clinically insignificant PCa was found in histology that had previously not been described on imaging. 4 patients did not undergo biopsy/surgery. Mean ADC values decreased significantly with increasing ISUP scores (e.g. mean ADC in PZ  $1.5 \times 10^{-3}$  mm<sup>2</sup>/s vs. mean ADC in ISUP 3 lesion  $1.0 \times 10^{-3}$  mm<sup>2</sup>/s;  $p < 0.0001$ ). Mean T1-/T2-relaxation times decreased significantly particularly with higher ISUP scores, i.e.  $\geq 3$  (e.g. mean T1-/T2-relaxation time in PZ 1759.1/50.5 ms vs. mean T1-/T2-relaxation time in ISUP 3 lesion 1541.5/30.9 ms;  $p < 0.0001$  /  $p = 0.0012$ ).

#### CONCLUSION

ADC and MRF based relaxometry allow quantitative characterization of prostate lesions that correlate with histopathology. MRF based relaxation times might aid in the diagnosis of clinically significant PCa. Further validation studies are needed.

#### CLINICAL RELEVANCE/APPLICATION

There is growing interest in the clinical application of quantitative imaging techniques for more objective assessment of prostate lesions. MRF is a fast and efficient method that promises to differentiate low- and intermediate/high-grade PCa in the future. In particular, with regard to the application of artificial intelligence and deep learning this could be an interesting approach in addition to traditional ADC assessment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPHN-1

### Evaluating the Application of Multiplexed Sensitivity Encoding (MUSE) Diffusion Weighted Imaging (DWI) in Nasopharyngeal Tumors: Comparison with Single-shot DWI with and without Deep Learning Reconstruction

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the image quality of multiplexed sensitivity encoding (MUSE) diffusion weighted imaging (DWI) for the evaluation of nasopharyngeal tumors comparing with single-shot DWI with and without deep learning reconstruction (ssDWI-DL and ssDWI).

#### METHODS AND MATERIALS

This study retrospectively evaluated patients with nasopharyngeal tumors who underwent MRI from July 2022 to February 2023. All patients underwent ssDWI, ssDWI-DL, MUSE, and fat-suppressed T2-weighted imaging. Two radiologists evaluated the image quality on a 5-point scale (1= no-diagnostic quality, 2=substantial deficits in image quality, 3=moderate, 4=good, and 5=excellent) in terms of the distortion of the original tumor, lymph node morphology, and overall image quality. Apparent diffusion coefficient (ADC) values were calculated in the original tumor and the lymph node. The image quality scores and ADC values were compared among ssDWI, ssDWI-DL, and MUSE using the Wilcoxon signed rank test and paired t-test, respectively. Bonferroni correction was used for the multiple comparisons.

#### RESULTS

A total of 23 patients (age  $70 \pm 17$  years; 5 women) were included in this study. In terms of the original tumor, MUSE showed a significantly higher score than ssDWI and ssDWI-DL (ssDWI,  $2.89 \pm 0.88$ ; ssDWI-DL,  $2.85 \pm 0.90$ ; and MUSE,  $3.78 \pm 0.75$ ). MUSE, ssDWI-DL, and ssDWI showed significantly higher scores in that order for the lymph node and overall image quality (lymph node; ssDWI,  $2.14 \pm 0.54$ ; ssDWI-DL,  $3.06 \pm 1.12$ ; MUSE,  $3.36 \pm 0.78$ ; overall image quality; ssDWI,  $1.80 \pm 0.29$ ; ssDWI-DL,  $2.74 \pm 0.64$ ; MUSE,  $3.26 \pm 0.56$ ). There was no significant difference among ssDWI, ssDWI-DL, and MUSE (ssDWI,  $1.03 \pm 0.35$ ; ssDWI-DL,  $1.00 \pm 0.31$ ; MUSE,  $0.98 \pm 0.30$ ).

#### CONCLUSION

MUSE was advantageous in evaluation of nasopharyngeal tumors by decreasing the image distortion compared with ssDWI and ssDWI-DL.

#### CLINICAL RELEVANCE/APPLICATION

MUSE may be useful for imaging of nasopharyngeal tumors or lesions that are in contact with air and where distortion affects image quality.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPHN-3

### Application of Dual-energy CT Spectral Quantification in Diagnosing of Cervical Lymph Node Metastasis in Papillary Thyroid Carcinoma

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Qiyang Tang (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the value of spectral quantitative measurements on dual-energy CT (DECT) for preoperative diagnosis of metastasis to the cervical lymph nodes (LNs) in patients with papillary thyroid carcinoma (PTC).

#### METHODS AND MATERIALS

Twenty-two consecutive patients with thyroid nodules who underwent spectral imaging on dual-energy CT before surgery were collected. Virtual monochromatic images at energy of 70 keV, water-calcium and fat-hydroxyapatite (HAP) decomposition images were reconstructed. For each lymph node, DECT-derived water and fat concentration were measured. Student's t test was used for continuous variables. Receiver operating characteristic (ROC) analysis was performed to evaluate the diagnostic efficacy of the continuous variables. The area under the curve (AUC), optimal cut-off value and the corresponding sensitivity and specificity were calculated.

#### RESULTS

A total of 18 LNs (8 metastatic, 10 non-metastatic) from 15 patients (9 patients with PTC, 6 patients with benign thyroid nodules) were detected by spectral CT imaging with the reference of postoperative pathologic examination. Assessment of quantitative measurements revealed significant differences between metastatic and non-metastatic LNs in water concentration ( $1032.91 \pm 10.65$  mg/cm<sup>3</sup> vs  $1042.11 \pm 6.20$  mg/cm<sup>3</sup>;  $t=2.296$ ,  $P=0.036$ ) and fat concentration ( $986.85 \pm 8.02$  mg/cm<sup>3</sup> vs  $997.12 \pm 7.94$  mg/cm<sup>3</sup>;  $t=2.714$ ,  $P=0.015$ ), respectively. The AUCs of water and fat concentration for diagnosing lymph node metastasis were 0.750 and 0.838, respectively. The optimal cut-off values of water and fat concentration were 1031.48 mg/cm<sup>3</sup> (sensitivity, 62.5%; specificity, 100.0%) and 990.67 mg/cm<sup>3</sup> (sensitivity, 75.0%; specificity, 90.0%).

#### CONCLUSION

Quantitative assessment with dual-energy spectral CT showed promising value for preoperative diagnosis of metastatic cervical lymph nodes in patients with PTC.

#### CLINICAL RELEVANCE/APPLICATION

Preoperative assessment of LN metastasis in PTC by CT spectral imaging is of great clinical value to locate metastatic LNs accurately and reduce unnecessary lateral neck dissections.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPHN-4

### Amide Proton Transfer Imaging of Differentiation in Malignant and Benign Parotid Tumors

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Yihua Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the usefulness of amide proton transfer weighted imaging (APT<sub>w</sub>) in the differentiation of parotid gland tumors

#### METHODS AND MATERIALS

Patients with parotid gland tumors who underwent APT<sub>w</sub> were retrospectively enrolled and divided into groups according to pathology. Two radiologists evaluated the APT<sub>w</sub> image quality independently with quality score=2 were enrolled. The maximum and average value of APT (APT<sub>max</sub> and APT<sub>mean</sub>) were measured (Figure 2). The APT<sub>max</sub> and APT<sub>mean</sub> were compared in differentiating between malignant and benign tumors (BTs), and in characterizing pleomorphic adenomas (PAs), Warthin tumors (WTs) and malignant tumors (MTs). Independent sample t test, Kruskal-Wallis H test and Receiver-operating-characteristic (ROC) analysis were used for statistical analysis.

#### RESULTS

Seventy three patients were included for image quality evaluation (Figure 1). 32/73 parotid tumors and 29/73 were considering for score 4 and 3 respectively. After excluding lesions with quality score<2, the APT<sub>mean</sub> and APT<sub>max</sub> of MTs were  $(4.15 \pm 1.33)\%$  and  $(7.43 \pm 1.61)\%$ , higher than BTs  $(2.74 \pm 1.04)\%$  and  $(5.25 \pm 1.54)\%$  respectively ( $p<0.05$ ). The area under the corresponding curve (AUC) of APT<sub>mean</sub>, and APT<sub>max</sub> was 0.819 and 0.821 respectively. MTs indicated significantly higher APT<sub>mean</sub> and APT<sub>max</sub> than PAs ( $p<0.05$ ) and WTs ( $p<0.05$ ). (Table 3-6)

#### CONCLUSION

Both APT<sub>max</sub> and APT<sub>mean</sub> can differentiate BTs and MTs, However, the images of parotid glands still needs to be improved to reduce artifacts. Most APT<sub>w</sub> images in parotid tumors had acceptable image quality to APT<sub>w</sub> value evaluation.

#### CLINICAL RELEVANCE/APPLICATION

APT imaging is an usefulness method that can be performed without contrast enhancement for the differentiation of parotid tumors.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-SPHN-5

### Differentiation of Common Benign Parotid Gland Tumors by T2WI-Based Texture Analysis and Susceptibility-Weighted Imaging

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Yihua Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the role of T2WI-based texture analysis and its combination with susceptibility-weighted Imaging (SWI) in characterizing pleomorphic adenoma (PA) and Warthin's tumor (WT).

#### METHODS AND MATERIALS

Thirty-seven patients (21 PA and 16 WT) who underwent T2WI and SWI at 3.0T (Ingenia CX, Philips Healthcare, the Netherlands) were retrospectively enrolled (Table 1). Two radiologists assessed MRI sequences retrospectively. Fat-suppressed T2-weighted image was used for texture analysis (TA) on the software 3D-Slicer and Intratumoral susceptibility signal intensities (ITSS) were measured in minimum intensity projection (SWI-MinP) according to the previous study. The ROI for TA was drawn to cover the lesion as completely as possible on each slice excluding necrotic and blood vessels (Figure 1). Histogram parameters including mean, median, entropy, skewness, kurtosis, maximum, minimum and 10th, 90th percentiles were calculated. The interobserver reliability was assessed via intraclass correlation coefficient (ICC) (good agreement if ICC > 0.75). The mean values from the two observers were used for the subsequent analysis. The independent sample t-test or Mann-Whitney U test was used to compare the differences in histogram parameters and ITSS between PA and WT. The diagnostic value was determined on receiver operating characteristic (ROC) analysis. Logistic regression was used to calculate the AUC of TA parameters combined with ITSS.

#### RESULTS

Interobserver reliability between the two observers was good (Table 2~3). WT showed significantly lower values on mean, entropy and significantly higher values on skewness and kurtosis than PA ( $p < 0.05$ ). The differences in ITSS grades were statistically significant between PA and WT ( $p < 0.05$ ) (Table 2~3). The area under the corresponding curve (AUC) of mean, entropy, skewness, kurtosis and ITSS were 0.779, 0.726, 0.754, 0.687 and 0.718 respectively. The combined AUC of entropy and ITSS could improve diagnostic performance which was statistically different from ITSS ( $p = 0.04$ ) (Table 4~5, Figure 2).

#### CONCLUSION

Mean, entropy, skewness, kurtosis and ITSS allowed the identification of PA and WT. The combination of four significant histogram parameters and ITSS may suggest the improvement in diagnostic performance.

#### CLINICAL RELEVANCE/APPLICATION

PA and WT are the most common benign tumors in the parotid gland. PA can recur and had a tendency to be malignant. WT rarely has malignant transformation and only needs to be treated tumor resection.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPHN-6

### MR Imaging with 15-channel Dental Coil Compared with Standard 20-channel Coil in Patients with Head and Neck Tumors and Suspected Bone Invasion

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Simon S. Martin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic accuracy of a high-resolution 15-channel dental coil with that of a standard 20-channel head and neck coil in MRI diagnosis of head and neck tumors with suspected bone invasion.

#### METHODS AND MATERIALS

A total of 37 patients (20 men and 17 women; mean age,  $65.8 \pm 15.0$  years; range: 28-95 years) with head and neck tumors and clinical suspicion of bone invasion underwent staging MRI with both coils in the same examination before surgery. Two specialized radiologists with 4 and 10 years of experience retrospectively evaluated both image datasets for bone infiltration. Additionally, subjective image quality, metal artefacts, and delineation of the tumors were rated on a 5-point-rating-scale. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of tumor lesions were calculated to quantitatively measure image quality. Sensitivity and specificity of the different coils in detecting bone invasion were evaluated by comparing the imaging results with postoperative histopathologic findings. Interobserver agreement was calculated using the Cohens Kappa.

#### RESULTS

SNR and CNR values of tumor lesions were significantly higher with the 15-channel dental coil compared to the standard 20-channel head and neck coil (SNR averaged 12.1 versus 9.9, CNR 3.6 versus 1.5). The 15-channel dental coil was found to be more sensitive than standard head and neck coils (100% vs. 72%) and was more specific (98% vs. 88%) in detecting tumor bone invasion. Of 21 histopathologically confirmed tumors with bone invasion, 16 were detected using the standard 20-channel head and neck coil and 21 were detected using the 15-channel dental coil. The 15-channel dental coil was superior in terms of image quality, metal artifacts, lesion delineation, and assessment of jaw infiltration. A high degree of interinvestigator agreement was noted for overall image quality ( $\kappa=0.93$ ), artifact reduction ( $\kappa=0.82$ ), lesion delineation ( $\kappa=0.80$ ), and assessment of jaw infiltration ( $\kappa=0.89$ ).

#### CONCLUSION

MR imaging with 15-channel dental coils has significantly better image quality and accuracy in detecting head and neck cancer compared with 20-channel head and neck coils.

#### CLINICAL RELEVANCE/APPLICATION

The use of a 15-channel dental coil improves diagnostic accuracy in the detection and characterization of head and neck cancer especially with bone infiltration and contributes to more accurate cancer treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPHN-7

### The Imaging Quality Assessment of Synthetic MRI in Nasopharyngeal Carcinoma: A Preliminary Study

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Fan Yang (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the imaging quality between the conventional and synthetic T1WI and T2WI.

#### METHODS AND MATERIALS

Fifty-nine patients with nasopharyngoscope-confirmed nasopharyngeal carcinoma (NPC) were prospectively included between August 2018 and May 2019. The image quality was evaluated by two radiologists (1 and 2, with 21 and 2 years of tumor-imaging experience, respectively). The patient order was randomized, as was the review order of the conventional or synthetic T1WI and T2WI images. The image quality was assessed based on following 4 factors on a 5-point Likert scale. (1) Sharpness of the lesion edge (1 = not sharp; 2 = a little sharp; 3 = moderately sharp; 4 = well sharp; 5 = very sharp); (2) Lesion conspicuity (1 = difficult to find; 2 = minimally perceivable; 3 = recognizable; 4 = easy to detect, good contrast of lesion; 5 = excellent contrast of lesion); (3) Motion artifacts (1 = severe, difficult to diagnose; 2 = a little severe, accessible to diagnose; 3 = moderate; 4 = mild; 5 = absence of artifacts); (4) Overall image quality (the three factors above added together, 1 = unacceptable; 2 = poor; 3 = moderate; 4 = good; 5 = excellent). As for overall image quality, ratings of = 3 were considered acceptable overall. The Wilcoxon signed-rank test was adopted to compare the image quality scores between conventional and synthetic T1WI and T2WI. The inter-class agreement of image scores between two radiologists was evaluated by Kappa value (0.21-0.30, fair; 0.41-0.60, moderate; 0.61-0.80, good; 0.81-1.00, excellent).

#### RESULTS

The interobserver agreements of image quality scores for conventional and synthetic T1WI and T2WI were good or excellent (Kappa values = 0.637-0.919). There were no statistically significant differences between conventional and synthetic T2WI in sharpness of the lesion edge, lesion conspicuity, motion artifacts, and overall image quality ( $P = 0.074-0.835$ , Table). However, conventional T1WI showed higher image quality than synthetic T1WI (all  $P = 0.007$ , Table). As for diagnostic qualify scoring, all synthetic T1WI and T2WI images had scores = 3, which showed acceptable image quality in clinical practice.

#### CONCLUSION

Synthetic T1WI and T2WI may be acceptable for clinical use in nasopharynx, and with its ability to generate other contrast images (including PDWI, FLAIR and so on) and three quantitative maps (T1, T2 and PD maps) in a single scan, SyMRI has good prospects for clinical application.

#### CLINICAL RELEVANCE/APPLICATION

The application of SyMRI in clinical could shorten the scan time while maintain acceptable image quality, which can reduce workload and increase productivity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPIN-1

### Reproducibility of Automated Segmentation of Abdominal Anatomical Structures on CT using the Total Segmentator

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Lorraine Abel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the reproducibility of segmentation results of TotalSegmentator, an artificial intelligence based segmentation algorithm, on various anatomical structures across multiphasic computer tomography (CT) exams.

#### METHODS AND MATERIALS

We retrospectively collected 1483 multiphasic abdominal CT exams acquired at the University Hospital in Basel between 01.01.2012 and 31.12.2022, each consisting of non-contrast (NC), arterial (ART), and portal venous (PV) phase, totaling 4449 image series. Using the AI-based segmentation model TotalSegmentator (<https://github.com/wasserth/TotalSegmentator>), the volume of 34 abdominal organs and additional structures (including bone, muscles) were obtained on all 4449 series. Similarity of the segmentation across all contrast phases was evaluated for each exam with two metrics: the spatial overlap in terms of Dice Similarity Coefficient (DSC) and the difference of segmented volumes. Volume differences below 5% were considered reproducible, as they are not typically clinically relevant and lie close to human inter-rater variability. Thus, non-inferiority and non-superiority testing was performed using a 5% margin.

#### RESULTS

Overall, the automated segmentation demonstrated high reproducibility in terms of mean DSC regarding comparison of PV versus ART 0.887 (95% CI: 0.882, 0.891), ART versus NC 0.867 (95% CI: 0.861, 0.872) and PV versus NC 0.853 (95% CI: 0.848-0.859) for all structures. The liver showed the lowest variability among abdominal organs, with a DSC of 0.920 (95% CI: 0.917, 0.923). Reproducibility was particularly high for bones and muscles with a mean DSC of 0.922 (95% CI: 0.919, 0.926) and 0.939 (95% CI: 0.936, 0.942) respectively. Lower DSC scores were observed mainly in cases with anatomically relevant pathologies (e.g. organ bleeding) which blur the organ boundaries, and in smaller structures. The volume of 31 of the 34 structures varied less than 5% ( $p < 0.05$ ) between contrast phases: a volume difference greater than 5% was observed exclusively for the adrenal glands and the gallbladder when comparing NC to PV.

#### CONCLUSION

The automated segmentations produced by TotalSegmentator demonstrated high reproducibility for most of the evaluated abdominal structures when comparing different contrast phases in multiphasic abdominal CTs. Small and variable structures demonstrated lower reproducibility. Also, relevant pathologies blurring the organ boundaries hampered the segmentation performance.

#### CLINICAL RELEVANCE/APPLICATION

A clinically reliable automated segmentation tool (TotalSegmentator) segmenting multiple organs and structures while being aware of its disadvantages may further support radiological research and ultimately enhance the clinical impact of radiology.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPIN-2

### Deep Learning Assisted Curation of the CANDID-III Dataset with Free-text Reports

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Sijing Feng, MBChB, BMedSc (*Presenter*) Nothing to Disclose

#### PURPOSE

This project aims to curate the CANDID-III dataset, which consists of adult chest radiographs with comprehensive labels derived from both manual and AI-assisted annotation.

#### METHODS AND MATERIALS

The CANDID-II dataset is an in-development chest radiograph dataset containing 33,486 anonymized free-text radiological reports. CANDID-III inherited the same 45 radiological labels from the CANDID-II dataset, which were mapped to UMLS ontology for standardization, forming the manually labelled portion of the CANDID-III dataset. An ensemble transformer-based label extraction model, combining three individual natural-language processing (NLP) algorithms, was trained and validated on the CANDID-II dataset in an 80:20 proportion. Each algorithm was individually trained on every radiological label, and the highest accuracy algorithm was chosen on a per-label basis for inclusion into the final ensemble model. The model was then used to automatically label the remaining CANDID-III dataset. An evaluation set of 552 reports, with balanced sampling across radiological findings from the AI-labeled portion of the CANDID-III dataset, was assessed by selected annotation team members, including a final-year radiology trainee and a fourth-year postgraduate medical doctor. Label-specific 'mention' F1 scores were calculated for the final ensemble model, with 'not mentioned' as negative and 'indeterminate, absent, present' as combined positive classifications.

#### RESULTS

The completed CANDID-III dataset contains 322,473 images and 220,977 anonymized free-text radiological reports from 94,210 unique patients (1:1.04 M:F ratio). AI-assisted annotation was performed on 88% of the CANDID-III dataset. For the AI-assisted annotation portion of the CANDID-III dataset, the labelling model has a macro-F1 score of 0.88 and micro-F1 score of 0.94 across all findings. Seven labels are shared with CheXpert, with F1 scores ranging from 0.93 to 1.0. F1 scores for 30 CANDID-III labels are above 0.90, while 8 labels range between 0.80 and 0.90.

#### CONCLUSION

The CANDID-III dataset provides a large, comprehensively labeled, and high-quality adult chest radiograph dataset with anonymized free text reports. The dataset adds numerous new clinically significant radiological annotations that are labelled to a high accuracy. It contributes to the repertoire of publicly available chest radiograph datasets for AI development. Instructions to access the dataset can be accessed at DOI: [10.17608/k6.auckland.22726004](https://doi.org/10.17608/k6.auckland.22726004).

#### CLINICAL RELEVANCE/APPLICATION

The CANDID-III dataset can be used to train and test AI algorithms for a variety of applications including triaging, lung cancer screening, image generation, and automated preliminary detection of radiographic abnormalities.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPIN-3

### Estimating the Impact of Chest Radiograph Triage using AI: A Real-life Multicenter Diagnostic Cohort Study

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Louis L. Plesner, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiology worklist prioritization with AI can potentially reduce the turnaround time for remarkable cases. This study externally tested a chest radiograph (CXR) artificial intelligence (AI) tool for relocating remarkable CXRs to the top of the worklist and compared this model to the current standard, where CXRs are sorted due to a priority level set by the ordering physician.

#### METHODS AND MATERIALS

In this retrospective external validation study, we included consecutive CXRs from the radiology departments of four hospitals in Denmark. The reference standard was based on two thoracic radiologists independently labelling all CXRs into remarkable or unremarkable CXRs. In case of disagreement, a third thoracic radiologist independently adjudicated the results. A commercially available CE-marked and partly FDA-cleared AI model was post-processed to output a probability score for CXR remarkableness. Binary clinical priority levels (urgent/routine) were extracted from the local RIS and compared to the AI tool priority (remarkable/unremarkable) output using McNemar tests, i.e., 'urgent' was juxtaposed to 'remarkable' and 'routine' to 'unremarkable'.

#### RESULTS

The analysis was performed on 1990 consecutive CXRs after exclusion of 77 primarily due to insufficient lung visualization and 7 due to processing error by the AI. Of these; 1276 (64%) were remarkable and 717 (36%) unremarkable according to the reference. The AI model achieved an AUC of 0.926 [95% CI: 0.915-0.937]. At a pre-specified 90% sensitivity threshold the model predicted 1148 (57.7%) as remarkable with a sensitivity of 90% [88.2-91.5%], a negative predictive value (NPV) of 81.0% [77.8-83.9%], positive predictive value (PPV) of 87.2% [85.3-88.9%] and specificity of 76.5% [73.2-79.5%]. This binary clinical priority level had 1422 (71.5%) classified as 'urgent' giving a sensitivity of 78.5% [76.2-80.7%], NPV of 51.8% [47.6-55.9%], PPV of 70.5% [68.0-72.8%] and specificity at 41.2% [37.5-44.9%] ( $p < 0.001$  for all comparisons).

#### CONCLUSION

An AI model achieved an excellent discrimination between unremarkable and remarkable CXRs in a consecutive multicenter cohort. The AI model was superior to the clinical priority levels for identifying remarkable and unremarkable CXRs.

#### CLINICAL RELEVANCE/APPLICATION

This AI tool, specifically post-processed to output a probability score for remarkableness, can be used to prioritize CXR worklists, which can confer a significant benefit in terms of worklist prioritizing compared to the traditional clinical priority levels used today.

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## Abstract Archives of the RSNA, 2023

W2-SPIN-5

### Automatic Detection of Endotracheal Tube Positioning on Chest Radiograph

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Nicholas J. Primiano, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Endotracheal tubes (ETTs) are poorly positioned in up to 25% of out of operating room intubations [1]. Misplacement of ETTs can lead to pneumothoraces and inadequate ventilation. Rapid identification of ETT positioning is essential to minimize adverse outcomes. Current deep learning (DL) methods involve classification of correct vs incorrect ETT placement or crude bounding box localization. These methods lack the ability to accurately identify both the carina and ETT tip [2]. The purpose of this study is to evaluate a DL model that automatically measures the distance between the tip of the ETT and the carina.

#### METHODS AND MATERIALS

In this retrospective study, a region proposal keypoint convolutional neural network (R-CNN) was trained on a subset of the publicly available CLiP dataset consisting of 1320 frontal CXRs. The CLiP dataset contains 30083 radiographs from the NIH Clinical Center. The model identifies two keypoints corresponding to the tip of the ETT and the carina on each radiograph. Various augmentation techniques (brightness, contrast, noise, rotation) were applied to the training set. Predictive performance on a held-out test set with 5-fold cross-validation was evaluated by comparing the distance between ground truth and predicted keypoints.

#### RESULTS

The model correctly identifies  $98.9 \pm 0.20\%$  (mean  $\pm$  SD) of these keypoints on a held-out test set consisting of 109 images. A correctly identified keypoint is defined as a prediction that falls within one centimeter of the corresponding ground truth keypoint. The average error in distance for each individual keypoint detection was  $0.72 \pm 0.24$  cm. This is comparable to inter-radiologist error, which has been reported as 0.7 cm [3]. The mean absolute error in ETT to carina measurement was  $0.35 \pm 0.12$  cm. For classification of correct vs incorrect placement, the model achieved an accuracy of  $93.1 \pm 0.9\%$  (precision  $95.4 \pm 2.7\%$ ; recall  $95.5 \pm 2.4\%$ ; NPV  $86.1 \pm 8.2\%$ ; specificity  $86.9 \pm 6.6\%$ ; F1  $95.4 \pm 0.6\%$ ).

#### CONCLUSION

A deep learning model can correctly identify the tip of an ETT and the carina on CXR. It can accurately measure the distance between carina and ETT, thereby detecting misplaced ETTs at the time of image acquisition.

#### CLINICAL RELEVANCE/APPLICATION

This method has the potential to expedite the detection of misplaced ETTs, thereby facilitating prompt interventions and improving patient outcomes. Furthermore, our findings surpass those of prior classification-only strategies, as our approach offers an estimate of the distance required to either advance or withdraw the ETT. Lastly, this versatile technique can be adapted for use in a wide range of measurement tasks on 2D imaging.[1] [doi.org/10.1038/s41597-021-01066-8](https://doi.org/10.1038/s41597-021-01066-8)[2] [doi.org/10.1016/j.acra.2022.04.022](https://doi.org/10.1016/j.acra.2022.04.022) [3] [doi.org/10.1007/s10278-021-00495-6](https://doi.org/10.1007/s10278-021-00495-6)

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## Abstract Archives of the RSNA, 2023

W2-SPIN-6

### Opportunistic Breast Cancer Screening using Non-contrast CT Imaging

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Wei Fang (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a non-contrast CT based opportunistic breast cancer screening approach as an alternative to mammography for detecting breast cancer using artificial intelligence.

#### METHODS AND MATERIALS

Our proposed model is a two-stage approach. In the first stage, we locate and crop out the two breasts using a breast segmentation model, which is trained using nnUNet. In the second stage, a customized multi-task U-net is employed to process the single cropped breast, producing simultaneous segmentation and classification results. The segmentation results include the breast and tumor masks, while the classification result outputs the approximate probability of breast cancer. The training dataset for the second stage includes 411 cancerous breasts and 411 healthy breasts as normal control, with confirmation through pathology reports. The external test dataset includes 386 cancerous cases from another institution and 905 normal cases from three other institutions (473/230/202). Additionally, the breast tumor masks were annotated on corresponding contrast-enhanced CT images by experienced radiation oncologists and then transferred to non-contrast CT.

#### RESULTS

The proposed model achieved a performance comparable to the recently reported mammography-based AI breast cancer screening system. For the 5-fold cross-validation on the internal dataset, the model achieved an AUC of 0.970 (95% confidence interval (CI) 0.958-0.982), sensitivity of 0.824 (95% CI 0.783-0.866), and specificity of 0.982 (95% CI 0.966-0.994), which were superior to the mammography-based AI system. In addition, the proposed model demonstrated advantages in generalization ability on the external test dataset, with an AUC of 0.939 (95% CI 0.922-0.955), sensitivity of 0.762 (95% CI 0.717-0.805) and specificity of 0.961 (95% CI 0.949-0.974) compared to mammography-based AI system.

#### CONCLUSION

The proposed non-contrast CT based opportunistic breast cancer screening approach using a two-stage model achieves a performance comparable to the recently reported mammography-based AI screening system, providing a promising way for opportunistic breast cancer screening.

#### CLINICAL RELEVANCE/APPLICATION

The proposed approach of using non-contrast CT for breast cancer screening has the potential to overcome the limitations of mammography-based screening in developing countries where medical resources are limited. This could improve early detection and ultimately contribute to prolonged survival rates for breast cancer patients. Further studies are needed to confirm the effectiveness of this approach and to optimize its implementation in clinical settings.

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## Abstract Archives of the RSNA, 2023

W2-SPIR-1

### Gastrointestinal Tract Perforation after Radiofrequency Ablation for Hepatic Tumor: Incidence and Risk Factors

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Kyowon Gu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the incidence of gastrointestinal (GI) tract perforation after radiofrequency ablation (RFA) for hepatic tumor and to assess its risk factors.

#### METHODS AND MATERIALS

The study included a retrospective cohort ( $n = 4,799$ ) of patients with malignant tumors underwent RFAs ( $n = 7,206$ ) between November 2008 and May 2020. Among them, 69 cases with thermal injury of GI tract were identified through a search of electronic medical records system. These patients were divided into presence of perforation ( $n = 8$ ) or not ( $n = 61$ ) based on the imaging review of following computed tomographic (CT) findings: (a) gastrointestinal wall defect and (b) pneumoperitoneum. Risk factors for GI tract perforation based on clinical, technical, and follow-up CT were identified with multivariate logistic regression analysis.

#### RESULTS

The incidence of thermal injury of GI tract and its perforation during observation period was 0.9% (69 of 7206) and 0.1% (8 of 7206), respectively. All perforation cases were not identified on CT immediately after RFA. The median time to its development was 7 days (range, 1-31 days). The type of adjacent GI tract and presence of diabetes mellitus were significantly different between the two groups ( $p < 0.05$ ). Among the various risk factors, the type of adjacent GI tract (small bowel) was only significant factor for GI tract perforation after ablation (Odds ratio, 22.69; 95% confidence interval, 2.60-198.34;  $p = 0.005$  [reference standard, stomach]).

#### CONCLUSION

GI tract perforation after RFA for hepatic tumor was rare, but it occurred late. Thus, the careful follow-up is needed when we treat the index tumor adjacent small bowels.

#### CLINICAL RELEVANCE/APPLICATION

GI tract perforation is a rare complication of liver RFA but can be missed on immediate post-ablation CT. Careful follow-up is recommended especially when the tumor is near small bowel and for DM patients.

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## Abstract Archives of the RSNA, 2023

W2-SPIR-2

### **CT-guided Percutaneous Radiofrequency Ablation Therapy for Liver Malignancies Adjacent to the Heart: A Safety and Efficacy Analysis in 42 cases**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Hong-Tao Hu, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the safety and effectiveness of CT-guided percutaneous radiofrequency ablation (RFA) in the treatment of hepatic malignancies adjacent to the heart.

#### **METHODS AND MATERIALS**

From January 2019 to December 2020, 412 patients who underwent RFA for hepatic malignancies were retrospectively analyzed, of which 42 patients had lesions less than 5 mm from the border of the heart. During the follow-up period, the complete ablation rate within 1 month and 24 months and the treatment-related complications within 30 days were recorded, and the complete ablation rate of adjacent cardiac lesions and non-adjacent cardiac lesions was calculated. Univariate and multivariate Logistic regression analyzes were used to analyze the relevant prognostic factors affecting complete ablation.

#### **RESULTS**

A total of 42 patients had 61 lesions. The average tumor size of 42 adjacent cardiac lesions was  $3.01 \pm 1.04$ cm, and the total diameter of intrahepatic lesions was 3.60 (2.98, 4.73)cm. During the 1-month follow-up, the complete ablation rates of lesions adjacent to the heart and non-adjacent to the heart were 85.7% (36/42) and 89.5% (17/19). The follow-up time ranged from 12 to 26 months, and 2 patients were lost to follow-up. The complete ablation rate of adjacent cardiac lesions was 82.5% (33/40), and the complete ablation rate of non-adjacent cardiac lesions was 88.2% (15/17). Univariate and multivariate Logistic regression analysis showed that liver metastases and not receiving preoperative TACE were independent risk factors affecting the rate of complete ablation ( $P < 0.05$ ). No serious complications related to RFA occurred during the treatment, and the overall safety was controllable.

#### **CONCLUSION**

CT-guided radiofrequency ablation of tumors adjacent to the heart is safe and effective.

#### **CLINICAL RELEVANCE/APPLICATION**

It provides a new safe and effective method for liver tumors near the heart

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## Abstract Archives of the RSNA, 2023

W2-SP1R-3

### Artificial Intelligence for Rapid Prediction of Tumor Coverage after RF Ablation of Hepatocellular Carcinoma

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Nicole Varble, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the technical success of radiofrequency ablation (RFA) in patients with hepatocellular carcinoma (HCC), we developed an artificial intelligence (AI) model to promptly estimate the percent tumor coverage without the need for segmentation or registration tools.

#### METHODS AND MATERIALS

From 550 patients in the OPTIMA trial (patients with solitary HCC lesions between 3-7cm, randomized to RFA or RFA+LTLD), 185 patients were selected with well-defined pre-RFA tumor and devascularized (ablation) zones on enhanced CT, 1-month post-RFA. The isocenter of the tumor and of the ablation zones were identified and 2D axial images were extracted from CT and cropped with the region of interest (tumor/ablation) at the center. Images were augmented (Gaussian-noise and rotation applied), with a total of 1,456 image pairs available for training and testing. Feature extraction was performed on the image pairs using a Siamese network with CNN VGG16 and ImageNet weights, and predictive modeling was achieved using a 30-tree random forest classification algorithm. The percent of the tumor covered (ground-truth) was determined by semi-automatic 3D tumor and ablation zone image segmentation and elastic registration (3DSlicer). Cases were split into 4 classes: =50%, 50-70%, 70-90%, or =90% tumor coverage, depicting incomplete, partially incomplete, acceptable, or complete ablation given the technical difficulty of the ablation and potentially desired immune response. Training was done on 80% of cases (n=1,168 image pairs), and 20% of cases were set aside for testing (n=288 image pairs). The model was validated on 16 interventional radiology cases from a separate institution, with the key difference that confirmation images were taken immediately post-ablation in the external validation set.

#### RESULTS

Overall model accuracy was 90% (AUC = 0.98, true positive rate = 0.87, and true negative rate = 0.96) reliably predicting the class of percent tumor coverage. Visual review of the test cases suggests that those with poor tumor coverage might be subject to an atypically rapid ablation zone shrinkage 1-month post-RFA whereas validation cases showed a more coherent percent tumor coverage immediately post-RFA, consistent with the AI model design.

#### CONCLUSION

An AI model that uses 2D images at the center of the tumor and 1-month post ablation can accurately estimate ablation tumor coverage for immediate estimation of technical RFA success.

#### CLINICAL RELEVANCE/APPLICATION

Clinical tools for ablation confirmation need to be efficient to hope for adoption and treatment optimization. AI models can achieve ablation confirmation without applying resource-intensive segmentation and registration models.

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## Abstract Archives of the RSNA, 2023

W2-SPIR-4

### **Percutaneous Image-guided Liver Tumor Ablations: Analysis of the Registry of the German Society for Interventional Radiology and Minimally Invasive Therapy (DeGIR) 2018-2021**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Sebastian Zensen, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Percutaneous image-guided tumor ablations are an essential tool in the treatment of liver malignancies. The aim of this evaluation was to analyze the use, technical success and complications of those interventions based on data from the prospectively managed multinational registry of the German Society for Interventional Radiology and Minimally Invasive Therapy (DeGIR, Deutsche Gesellschaft für Interventionelle Radiologie und minimal-invasive Therapie).

#### **METHODS AND MATERIALS**

A total of 5792 percutaneous liver ablation procedures from 133 centers in Germany and Austria were examined. Median age was 67 years (IQR 58-75 years), 31.4% (1821/5792) of patients were female. For image guidance, CT was used in 91.4% (5293/5792), MRI in 2.4% (137/5792), ultrasound in 3.8% (222/5792), and combined imaging in 2.4% (140/5792). Ablation of the tumor with a safety margin was considered technical success.

#### **RESULTS**

Microwave ablation (MWA) was used in 64.3% (3725/5792), and radiofrequency ablation (RFA) in 33.5% (1940/5792). A total of 3999 cases reported tumor etiology, in which 61.4% (2456/3999) were performed for liver metastases and 36.2% (1446/3999) for hepatocellular carcinoma (HCC). The median lesion diameter was 19 mm (IQR 12-27 mm). 90.6% (5247/5792) ablations were technically successful. The rate of technically successful ablations was significantly higher in MWA (93.4%, 3481/3725) than in RFA (84.8%, 1645/1940,  $p < 0.0001$ ). The total complication rate was 2.9% (170/5792). Compared to RFA, which had a complication rate of 1.0% (19/1940), MWA had a considerably higher complication rate of 3.9% (147/3725,  $p < 0.0001$ ). In 37.2% (2156/5792) of ablations additive needle track ablation was performed. Ablations with needle track ablation did not have a significantly higher rate of major complications (23.2%, (22/95) vs. 26.7% (20/75),  $p = 0.60$ )).

#### **CONCLUSION**

MWA is the most frequent ablation method ahead of RFA. Percutaneous image-guided liver tumor ablations have a high technical success rate, which is higher for MWA than RFA. Though generally low, the rate of complications is higher with MWA than RFA.

#### **CLINICAL RELEVANCE/APPLICATION**

For the treatment of liver malignancies, percutaneous image-guided liver ablations such as microwave ablation and radiofrequency ablation are efficient treatment options with low complication rates.

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## Abstract Archives of the RSNA, 2023

W2-SPIR-5

### Estimation of Recurrence and Survival in Breast Cancer Cryoablation: A Retrospective Multisite Analysis of Patients Excluded from Prospective Cryoablation Clinical Trials

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Grayson L. Baird, PhD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Estimation of recurrence and survival in breast cancer cryoablation patients excluded from clinical trials.

#### METHODS AND MATERIALS

Cryoablation is a well-tolerated minimally-invasive alternative to surgical excision for treating breast cancer. In keeping with clinical trial inclusion criteria, the optimal candidate would have a unifocal invasive ductal carcinoma without significant intraductal component, less than 1.5 cm in size, Nottingham grade 1-2 of 3, ER/PR+ and HER2-, at least 0.5-1 cm from the overlying skin and 0.3 cm from the underlying muscle. Requiring only local anesthesia, cryoablation may be particularly useful in patients with medical comorbidities placing them at higher risk for surgery with general anesthesia. Patients included in this study were excluded from cryoablation clinical trials. A retrospective review of ipsilateral breast tumor recurrence (IBTR) encompassing true recurrence (TR) and new primary (NP) events was done for n=123 patients treated outside of clinical trials across 7 institutions over 5.4 years; all patients were women and median age was 72 (range 37-99). To control for death before recurrence, a Competing Risk Analysis (CRA) model was used; Kaplan Meier (KM) estimation was used.

#### RESULTS

All procedures were technically successful. There were a total of 6 (4.9%) minor procedure complications rated 1 on CTCAE scale. In all, there were 8 TRs, 6 NPs, and 10 deaths before TR or NP, and 11 deaths total—only 1 death was cancer related. Using CRA, the cumulative incidence of TR was 4.1% at 1 year, 8.2% at year 2, and 11.8% at year 3. The cumulative incidence of NP was 2.7% at year 1 and 7% at year 2. Together, the cumulative incidence of IBTR was 6.7% at year 1, 13.1% at year 2, and 17.9% at year 3. Finally, the cumulative incidence of death was 2.9% at year 1, 5.9% at year 2, 14.6% at year 3 and 21.7% at year 4.

#### CONCLUSION

Breast cancer cryoablation is a safe and feasible alternative to surgical excision for select patients, including older patients, patients excluded from trials and patients who are considered high-risk for general anesthesia and surgery.

#### CLINICAL RELEVANCE/APPLICATION

Cryoablation is an alternative to surgical excision for patients with breast cancer, even when considered suboptimal for cryoablation in select cases, and this may be particularly true for patients with medical comorbidities placing them at higher risk for surgery with general anesthesia.

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## Abstract Archives of the RSNA, 2023

W2-SP1R-6

### Retrospective Analysis of MRI-guided Transurethral Ultrasound Ablation (TULSA) in Prostate Cancer Lesions at the Extreme Apex

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Joseph J. Busch, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Maintenance of urinary continence when treating prostate cancer (PCa) at the extreme apex is a challenge for surgery, radiation, and focal therapy. Regulatory studies of TULSA spared 3mm at the apex, and the performance of dual ultrasound frequency MRI-controlled ablation in short target radii near the external sphincter is not yet known. This single-center retrospective analysis reports functional, imaging, and cancer surveillance outcomes in TULSA patients with extreme apical lesions.

#### METHODS AND MATERIALS

Men with apical PCa lesions abutting or involving the external sphincter were identified among 138 men with =6 months follow-up after lesion-targeted or whole-gland TULSA. The target volume was defined based on disease factors and patient preference, using intraoperative DWI, ADC, and T2w images. A 10mm margin was targeted around the visible lesion when feasible. At the sphincter, a 5mm margin was targeted, including =50% of the external sphincter. Patients were followed with daily communication for 2 weeks, PSA every 3 months, and MRI, IPSS, IIEF at 6-9 months. Post-TULSA mpMRI was assessed for local recurrence using PI-RR.

#### RESULTS

42 patients with treatment of apical lesions (37 primary PCa, 5 salvage) were identified, with median age of 63 (IQR 59-68) years, and follow-up availability of 9 (6-16) months. The proportion of men with primary GG 1-5 PCa were: 7%, 54%, 20%, 12%, and 7%, all having an MRI visible lesion. Median target volume was 29cc (IQR 22-34, range 10-70), with 99% (IQR 98-99%) of the target volume achieving a lethal thermal dose =240CEM43. PSA decreased from median 6.7 (IQR 4.7-9.7) to 0.9 (0.3-2.0) ng/mL. 93% of patients with follow-up mpMRI (n=28) had no evidence of residual disease; PI-RR scores 1-5 were: 8, 18, 0, 2, 0. Both men with PI-RR=4 underwent a repeat TULSA; 6 months after repeat ablation both had PI-RR=2 with PSA of 0.2 and 1.0 ng/mL. All patients are pad-free; two experienced urine leakage resolved by 3 months. 82% maintained baseline erection firmness sufficient for penetration (IIEF Q2=2). IPSS symptom scores were stable. 10 patients experienced Grade 1-2 adverse events (LUTS, mild hematuria, bladder spasms, and hydrocele) resolving within 4 weeks with oral medication. Two patients had Grade 3 events requiring endoscopic intervention (1 retention, 1 retention and bladder neck contracture). No grade =4 events and no rectal injuries occurred.

#### CONCLUSION

This retrospective analysis demonstrates promising safety and efficacy of TULSA in patients with extreme apical lesions, preserving urinary continence despite ablation near the external sphincter.

#### CLINICAL RELEVANCE/APPLICATION

TULSA is a promising prostate cancer treatment with minimal impact on urinary continence for thermal ablation of extreme apical lesions.

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## Abstract Archives of the RSNA, 2023

W2-SPMK-1

### Clinically Relevant Incidental Findings Detected on MRI Lumbar Spine Examinations: Our Experience in 1450 Studies

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Dinesh S. Baviskar, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of our study was to evaluate the types of incidental findings encountered during evaluation of MRI lumbar spine examinations and to ascertain their clinical relevance in view of the presenting symptoms.

#### METHODS AND MATERIALS

A total of 1450 patients (male-to-female ratio, 626:824; age range, 12-97 years) with history of low back pain / suspected herniated intervertebral disk, who underwent MRI of the lumbar spine between 1st June 2022 - 31st December 2022 were evaluated by trained Radiologists. The examinations were evaluated for the presence of any incidental findings. We defined incidental finding as any abnormal finding detected outside the Lumbar spine, bony canal, its contents and the paraspinal soft tissues. Incidence of the incidental imaging findings were calculated. For analysis, the relationship of incidental findings with clinical data of patient was used.

#### RESULTS

Overall, 128 patients (8.8%) had clinically relevant incidental findings. Uterine fibroids were the commonest (3.2% of total examinations) incidental findings seen in the females, whereas heterogeneous signal in the prostatic parenchyma was the commonest (3.8% of total examinations) findings in the male patients. Other findings encountered were - Pelvic Kidney, Adenomyosis of uterine myometrium, Pelvic congestion, Ovarian cyst, Dermoid cyst, Uterine polyp, Renal mass lesion, lymphadenopathy, etc.

#### CONCLUSION

Clinically relevant incidental findings detected on MRI examination of the lumbar spine were common and associated with symptoms confused with lumbar spine / backache causes. Most of the findings were benign, but we encountered one renal lesion which was later proven to be Renal cell carcinoma. An awareness of the prevalence of the clinically relevant incidental findings detected at MRI of the lumbar spine exams are helpful for diagnosing lesions which might be the primary cause of the presenting symptoms.

#### CLINICAL RELEVANCE/APPLICATION

Awareness about incidental findings on radiology examinations is very vital, particularly in cases where the symptoms might be overlapping and the primary cause might be the incidental finding detected on imaging. The clinical significance of these incidental finding has to be ascertained to avoid delay in initiating prompt and appropriate treatment to aid patient care.

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## Abstract Archives of the RSNA, 2023

W2-SPMK-2

### The Diagnostic Value of Electron Density Map from Dual-layer Detector Spectral CT in Acute and Chronic Osteoporotic Vertebral Fractures

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Dongfeng Xu (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic efficacy of electron density map (EDM) obtained from dual-layer detector spectral CT in acute and chronic osteoporotic vertebral fractures (OVFs).

#### METHODS AND MATERIALS

Retrospective study was performed on 48 patients with 53 acute and 57 chronic OVFs that were confirmed by MR. All the patients underwent DLCT plain scanning, and quantitative parameters such as electron density(ED), effective atomic number(z<sub>eff</sub>) and the attenuation of conventional 120 kVp polyenergetic image(PI) and 40, 70 and 100 keV virtual monoenergetic images(VMI) were measured. CT signs are evaluated by the radiologist, including endplate interruption sign, bone cortical folds, increased vertebral density, intravertebral gas shadow, anteroposterior diameter of vertebral body increased and vertebral compression degree. The quantitative parameters and CT signals between acute and chronic OVFs were compared using independent- samples t test or Chi-Square test. Logistic regression analysis was used to identify the independent risk factors and built predictive model. ROC curve was used to analyze the efficacy in the differential diagnosis of acute and chronic OVFs.

#### RESULTS

There were significant differences between acute and chronic OVFs in endplate interruption sign, bone cortical folds, increased vertebral density, intravertebral gas shadow and vertebral compression degree (all  $P < 0.05$ ). There were significant differences between acute and chronic OVFs in PI, 40, 70 and 100keV VMI attenuation value, z<sub>eff</sub> and ED (all  $P < 0.05$ ). Attenuation values of PI (OR=0.876,  $P=0.023$ ), ED (OR=10.446,  $P=0.024$ ), bone cortical folds (OR=0.023,  $P=0.012$ ), increased vertebral density (OR=0.020,  $P=0.012$ ) were independent risk factors for acute OVFs. The combined model obtained the highest AUC (0.977) by combining attenuation values of PI, ED, bone cortical folds and increased vertebral density, with a sensitivity of 98.1%, and a specificity of 94.7%.

#### CONCLUSION

In the differential diagnosis of acute and chronic OVFs, the diagnostic efficacy of EDM is higher than the CT values in PI and VMI; The efficacy is further enhanced when EDM is combined with CT values in PI, bone cortical fold, vertebral density increasing.

#### CLINICAL RELEVANCE/APPLICATION

EDM can help clinicians make treatment decisions and improve patient prognosis by differentiating between acute and chronic OVFs.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-SPMK-3

### Paraspinal Muscle Activation Quantified by Intravoxel Incoherent Motion Imaging (IVIM): Influence of Exercise Intensity on Muscle Perfusion in Adolescent Athletes

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Adrian A. Marth, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Intravoxel incoherent motion (IVIM) imaging provides information on the perfusion of the muscular microstructure. This study aims to reveal relationships between IVIM signal changes and different levels of exercise intensity in adolescent athletes.

#### METHODS AND MATERIALS

Twenty male athletes with a mean age of 15.7 years (SD 1.2) underwent magnetic resonance imaging (MRI) of the lumbar spine muscles at rest and after ergometer training at low intensity (50 Watt, n = 6), moderate intensity (100 Watt, n = 8) or high intensity (150 Watt, n = 6). IVIM images were analyzed to calculate the diffusion coefficient (D), pseudo-diffusion coefficient (D\*) and perfusion fraction (f). Analysis of covariance was used to compare mean values at rest and different exercise intensity levels.

#### RESULTS

After exercise, IVIM parameters increased with exercise intensity and were significantly elevated compared with baseline (all  $p < 0.05$ ). The increase in f and D differed significantly between low and moderate intensity ( $p = 0.02$  and  $p = 0.007$ ), but not between moderate and high intensity ( $p = 0.58$  and  $p = 0.22$ ), while the increase in D\* showed significant differences between each intensity level ( $p = 0.008$  and  $p = 0.003$ ).

#### CONCLUSION

IVIM parameters detected changes in muscular perfusion after activation. Our findings demonstrate a relationship between microvascular blood flow, blood volume and exercise intensity.

#### CLINICAL RELEVANCE/APPLICATION

While these results need to be further validated, they suggest that IVIM parameters can further our understanding of physiological muscle response after activation. Moreover, IVIM may have a role in identifying individuals susceptible to impaired muscle perfusion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPMK-4

### **In Vivo Comparative Study of Fast kVp Switching Dual-energy Computed Tomography Based Two-material Decomposition Technique and Quantitative Computed Tomography in the Measurement of Lumbar Bone Mineral Density**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Xuee Zhu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the feasibility of the fast kVp switching dual-energy computed tomography (DECT) based hydroxyapatite (HAP) - water decomposition technique in measuring human lumbar bone mineral density (BMD), and to investigate its accuracy in comparison with quantitative computed tomography (QCT).

#### **METHODS AND MATERIALS**

This study was approved by our institutional review board and the requirement to obtain informed consent was waived. A total of 118 consecutive patients who simultaneously underwent both DECT and QCT of the spine were retrospectively enrolled in our study. The patients were 19-88 years old, 56 males and 62 females. The density of HAP (water) was measured along with BMD in the trabecular bone of lumbar level 2-4 by DECT and QCT, respectively. The regions of interest (ROI) were drawn by a radiologist who had 5 years of experience in general radiology. A musculoskeletal radiologist with more than 10 years of experience checked every case that the general radiologist measured. Pearson correlation analysis and paired sample t test were conducted to assess the correlation and difference between DECT- and QCT-derived BMD, respectively. Bland-Altman analysis would be done to evaluate the agreement between two measurements if paired sample t test shows no significant difference between them.

#### **RESULTS**

Strong linear correlation was observed between DECT- and QCT-derived BMD ( $r = 0.962$ ,  $p < 0.01$ ). DECT-derived BMD (L2,  $110.76 \pm 35.83 \text{ mg/cm}^3$ ; L3,  $103.05 \pm 36.19 \text{ mg/cm}^3$ ; L4,  $105.53 \pm 34.57 \text{ mg/cm}^3$ ; L2-4,  $106.56 \pm 35.57 \text{ mg/cm}^3$ ) was slightly lower than QCT-derived result (L2,  $124.04 \pm 49.96 \text{ mg/cm}^3$ ; L3,  $115.08 \pm 49.74 \text{ mg/cm}^3$ ; L4,  $117.21 \pm 48.79 \text{ mg/cm}^3$ ; L2-4,  $118.92 \pm 49.50 \text{ mg/cm}^3$ ) and the difference was statistically significant ( $p < 0.01$ ).

#### **CONCLUSION**

Fast kVp switching DECT based HAP-water decomposition technique enables in vivo BMD quantification of human lumbar vertebrae, and its measurement is slightly lower than QCT.

#### **CLINICAL RELEVANCE/APPLICATION**

Osteoporosis is the most common chronic metabolic bone disease, which is associated with low bone mineral density (BMD). As BMD is an important life-long monitoring index for osteoporosis and fractures, especially for the women and older people. Therefore, it is important to obtain accurate BMD measurement. Besides dual-energy X-ray absorptiometry (DXA) and quantitative computed tomography (QCT), dual-energy computed tomography (DECT) is considered to be another potential technique to assess BMD. It is needed to evaluate the diagnostic performance of the new method.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPMK-5

### **Fast kVp-switching Dual-energy Computed Tomography Water-(hydroxyapatite) Display of Vertebral Fractures: Impact on Diagnostic Accuracy of Radiologists with Varying Levels of Experience in Correlation to Magnetic Resonance Imaging**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Xuee Zhu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate whether a fast kVp-switching dual-energy computed tomographic (DECT) water-hydroxyapatite (HAP) decomposition technique can improve the detection rate of acute vertebral compression fractures in patients with that at magnetic resonance imaging (MRI) depending on the level of experience of the reading radiologist.

#### **METHODS AND MATERIALS**

Fifty consecutive patients who underwent both DECT and MRI of the spine within 3 days after trauma were retrospectively enrolled in our study. Four independent radiologists with varying levels of experience blindly evaluated gray-scale CT scans for the presence of fractures and their suspected age. Then, water-(HAP)images were assessed by the same readers to detect bone marrow edema. Findings were compared with those from fat-suppressed T2-weighted MR images (the standard of reference). Sensitivity, specificity, accuracy, positive predictive value and negative predictive value analyses for diagnostic performance and matched pair analyses were performed on vertebral fractures and patient levels.

#### **RESULTS**

In total, fifty-four fractures were classified as fresh and 38 as old at MR imaging. The diagnostic performance of all readers in the detection of fresh fractures improved with the addition of water-(HAP)reconstructions compared with that with conventional CT alone. The diagnostic accuracy of the least experienced reader with CT alone, 76%; accuracy with water-(HAP)images, 87%. The most experienced reader improved his accuracy with water-(HAP) images from 84% to 93% , coming closer to that with MR imaging. The number of vertebrae rated as unclear decreased by 70%-92% or from 12-23 to 1-7 in absolute numbers across readers. The number of patients potentially referred to MR imaging decreased by 71%-91% (from 11-14 to 1-4 patients). Considering the real decision-making gain with the water-HAP decomposition technique on a patient level, 10 to 11 MR examinations could have been avoided.

#### **CONCLUSION**

Fast kVp-switching DECT based water-HAP decomposition technique can improve the ability of the radiologists with variable levels of experience to detect acute vertebral compression fractures.

#### **CLINICAL RELEVANCE/APPLICATION**

Single-energy CT of the spine is the standard examination for fast exclusion or closer assessment of suspected vertebral fractures. However, it is sometimes difficult to distinguish between acute and chronic fractures, where further MRI is usually recommended for the differential diagnosis. Compared with single-energy CT, DECT based water-hydroxyapatite decomposition technique can help the radiologists to improve the detection rate of acute vertebral compression fractures, so as to reduce the number of patients requiring further MR scanning.

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## Abstract Archives of the RSNA, 2023

W2-SPMK-6

### Comparative Analysis of Cancellous Bone Mineral Density between Vertebral Body and Pedicle Screw Trajectory using Quantitative Computed Tomography

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Xuee Zhu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate quantitative computed tomography (QCT) for analysis of cancellous bone mineral density (BMD) of vertebral body and pedicle screw trajectory and to investigate whether there's any difference between them.

#### METHODS AND MATERIALS

This study was approved by our institutional review board and the requirement to obtain informed consent was waived. A total of 99 consecutive participants (20~80 years old, 48 males and 51 females) who underwent lumbar QCT examinations were retrospectively analyzed. Each pedicle screw trajectory was further divided into intrapedicular segment (R1) and intracorporal segment (R2). BMD of R1, R2, and the vertebral body (R3) were all measured in the trabecular bone of lumbar level 2,3 and 4 by a commercial QCT BMD analysis system. One-way ANOVA analysis was conducted to assess the differences of BMD among R1, R2, and R3. The paired t test was performed to evaluate the difference of BMD between R3 and the global pedicle screw trajectory.  $P < 0.01$  was considered statistically significant for all used tests.

#### RESULTS

Mean pedicle screw trajectory BMD (R1,  $173.66 \pm 71.84$  mg/cm<sup>3</sup>; R2,  $113.81 \pm 48.83$  mg/cm<sup>3</sup>; global,  $143.73 \pm 55.49$  mg/cm<sup>3</sup>;) showed significant difference between R1-R2 ( $P < 0.01$ ) and there was no significant difference at both sides (left,  $143.14 \pm 70.06$  mg/cm<sup>3</sup>; right,  $144.33 \pm 66.56$  mg/cm<sup>3</sup>;  $P > 0.01$ ) or different lumbar levels (L2,  $141.25 \pm 50.32$  mg/cm<sup>3</sup>; L3,  $138.31 \pm 56.85$  mg/cm<sup>3</sup>; L4,  $151.64 \pm 58.62$  mg/cm<sup>3</sup>;  $P > 0.01$ ). Average BMD of R3 was not significantly different between lumbar level 2, 3 and 4 (L2,  $124.28 \pm 47.04$  mg/cm<sup>3</sup>; L3,  $115.36 \pm 46.34$  mg/cm<sup>3</sup>; L4,  $117.19 \pm 48.33$  mg/cm<sup>3</sup>;  $P > 0.01$ ). Mean R1-R3 was significantly different (R3,  $118.94 \pm 47.24$  mg/cm<sup>3</sup>;  $P < 0.01$ ) while comparison of R2-R3 did not reach significance ( $P > 0.01$ ). The global pedicle screw trajectory BMD was higher than R3 and the difference was statistically significant ( $p < 0.01$ ).

#### CONCLUSION

QCT allows for BMD assessment both of the vertebral body and pedicles. BMD of the global pedicle screw trajectory is significantly higher than that of the same segmental vertebral body.

#### CLINICAL RELEVANCE/APPLICATION

Pedicle screw fixation is the standard technique for spine stabilization with a potential complication of screw loosening. The screw fixation strength is clearly related to the bone mineral density (BMD) of vertebrae. Currently in clinical only BMD of the vertebral body was estimated, which may not represent the situation in the screw trajectory. Our study shows there's a significant difference of BMD between them. It indicates that measuring BMD of the screw trajectory using quantitative computed tomography (QCT) is needed to predict screw loosening.

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## Abstract Archives of the RSNA, 2023

W2-SPMK-7

### The Value of Magnetic Resonance Image Compilation (MAGIC) Sequence in the Diagnosis of Sacroiliac Joint Bone Marrow Edema and Activity in Early Axial Spondyloarthritis

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Zhaorong Tian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The study explored the feasibility of using Magnetic resonance image compilation (MAGIC) parameters to quantitatively evaluate changes of sacroiliac joint in axial spondyloarthritis (SpA), in order to provide a quantitative index for the evaluation of sacroiliac joint inflammatory activity in SpA. and to evaluate the correlations of MAGIC parameters with BASDAI and SPARCC scores.

#### METHODS AND MATERIALS

A total of 68 SpA patients with sacroiliitis and 35 healthy controls were enrolled. All patients were scanned using a SIGNATM Architect 3.0T MRI scanner by T1WI, FS-T2WI and MAGIC sequence of the sacroiliac joints. According to whether subchondral bone marrow edema was present in the FS-T2WI sequence, the 68 patients were divided into an active group (40 cases) and an inactive group (28 cases). The T1, T2 and PD values of the subchondral bone marrow were measured in the active group, the inactive group, and the healthy control group using the MAGIC sequence. The T1, T2 and PD values of the active, inactive, and healthy groups were compared using one-way analysis of variance (ANOVA). Receiver operating characteristic (ROC) curves were used to analyze the diagnostic efficacy of T1, T2 and PD values for sacroiliitis. The correlations of the T1, T2 and PD values with the BASDAI and SPARCC scores were analyzed using Spearman's rho.

#### RESULTS

T2 and PD values of active groups ( $119.00 \pm 9.56$ ms,  $86.03 \pm 14.79$ pu) were both higher than inactive groups ( $96.61 \pm 8.86$ ms,  $68.12 \pm 7.77$ pu), higher than those in the healthy control group ( $78.94 \pm 6.20$ ms,  $53.71 \pm 6.69$ pu), ( $T=15.332, T=15.972, all p < 0.001$ ); The T1 values ( $531.04 \pm 60.28$ ms) in the active group were lower than those in the inactive group ( $691.50 \pm 72.44$ ms), lower than those in the healthy control group ( $933.23 \pm 100.98$ ms), ( $T=-11.517, p < 0.001$ ). The areas under the ROC curves (AUCs) of T1, T2 and PD values between the active and inactive groups were  $0.976$  (95%CI,  $0.949-0.991$ ),  $0.988$  (95%CI,  $0.970-0.997$ ),  $0.887$  (95%CI,  $0.842-0.923$ ), respectively. The T1, T2 and PD values of the SpA patients were positively correlated with BASDAI scores, and the correlation coefficients (r) were  $-0.771, 0.914$  and  $0.846$  (all  $p < 0.001$ ), respectively. And positively correlated with SPARCC scores, and the correlation coefficients (r) were  $-0.924, 0.915$  and  $0.938$  (all  $p < 0.001$ ), respectively.

#### CONCLUSION

MAGIC imaging can help in quantitatively assessing the activity of sacroiliitis in SpA patients. In particular, T1 and T2 values of high value in distinguishing active sacroiliac arthritis.

#### CLINICAL RELEVANCE/APPLICATION

MAGIC parameters can be used to quantitatively assess the activity of SpA, and provided imaging bases for the clinical diagnosis of sacroiliitis.

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## Abstract Archives of the RSNA, 2023

W2-SPMK-8

### Performance of SPECT MRI for Assessing Spinal Pain Generator Compared to MRI and SPECT CT Alone

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Arman Parsai, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Back pain is a common disease and affect a large portion of the musculoskeletal patient population. The imaging modalities used to assess the cause of the pain is usually MRI of the spine. More recently the use of SPECT CT has been shown to be useful in assessing the pain generators (3). Unfortunately despite these imaging modalities a large proportion of patient remain symptomatic and do not respond to standard care including physiotherapy and pain management with targeted nerve root injections. The cause of the back pain which can be related to nerve root compression is readily assessed on MRI. However, axial vertebral spondylosis and facet joint disease can be better assessed using SPECT CT. The SPECT CT assesses the osteoblastic activity of the bone and has been shown to demonstrate areas of increased bone remodelling related to stress and degenerative changes. The SPECT component of the study is registered with a low dose CT scan for attenuation correction and localisation. The aim of our study is to assess the utility of retrospective fusion of SPECT and MRI compared to SPECT CT and MRI alone in patients with chronic back pain refractory to initial medical management.

#### METHODS AND MATERIALS

Between January 2014 and December 2022, 552 patients with chronic back pain initially assessed with spine MRI and SPECT CT were retrospectively reviewed. The initial diagnosis, patients history and management were reviewed. Out of the 552 patients, 138 (25%) were selected for their lack of response to initial management (targeted injection and/or physiotherapy) after 12 months with ongoing back pain. The baseline MRI and SPECT were retrospectively fused using a semi-automated software (Hermes Software®) and images were reviewed by two experienced readers blinded to the initial diagnosis. Potential pain generators were recorded and readers confidence graded using Likert score (graded 1 to 5). Results were compared to MRI and SPECT CT alone.

#### RESULTS

In our preliminary analysis to date, SPECT MRI detected new sites of pain generators in 105 out of 138 patients (76%) compared to MRI or SPECT CT alone. The readers assessed that in 16 patients (15.3%) this would have potentially altered management. Readers confidence was higher for SPECT MRI compared to MRI and SPECT CT alone.

#### CONCLUSION

Retrospective fusion of SPECT with MRI improves detection of pain generators in the spine and readers confidence.

#### CLINICAL RELEVANCE/APPLICATION

The new sites of pain generator assessed on SPECT MRI would potentially impact patient's management. Further studies would be needed to assess if the potential new sites would be the cause of the absence of response to treatment.

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## Abstract Archives of the RSNA, 2023

W2-SPMS-1

### Prospective Evaluation of 3T Whole Body MRI and <sup>18</sup>F-FDG PET/CT in the Assessment of Multiple Myeloma

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Alice Rossi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the clinical relevance and diagnostic performance of Whole body-MRI (WB-MRI) and fluorine 18 (<sup>18</sup>F) fluorodeoxyglucose (FDG) PET/CT for the detection of bone marrow infiltration (BMI) in myeloma patients.

#### METHODS AND MATERIALS

Between January 2021 and March 2023, we enrolled myeloma patients in a prospective trial who underwent a 3 Tesla WB-MRI (conducted in accordance with the Myeloma Response Assessment and Diagnosis System, MY-RADS) and PET/CT to assess BMI, para and extramedullary disease, as well as clinico-laboratoristic data collection, all within a month. Two specialized haematologists agreed on management strategies based on International Myeloma Working Group (IMWG) standards after evaluating all the data. This was used to assess the diagnostic performance of WB-MRI and PET/CT.

#### RESULTS

The study included 135 patients (78 Male; mean age, 63 years  $\pm$  12 [SD]) divided into 3 clinical groups: 35 with a newly diagnosed High Risk Smoldering Multiple Myeloma (HR-SMM- group 1); 37 had a newly diagnosed Multiple Myeloma (MM- group 2); 38 were in follow-up after autologous stem cell transplantation and 25 were affected by relapsed/refractory MM with clinical or laboratorist data suspicious for relapse or progression (group 3). HR-SMM analysis showed discordance between the two imaging modalities in 23/35 (66%). 10 diffuse patterns of BMI without any overt focal lesions in WB-MRI (4 correlate with a nonspecific diffusion pattern in PET/CT) and 1 WB-MRI with an equivocal focal lesion emphasized the HR-SMM diagnosis. WB-MRI identified focal bone lesions in 4 patients, 3 of which were confirmed by PET/CT, and resulted in the diagnosis of MM and a change in treatment approach (11%). Analysis of the 100 patients in groups 2 and 3 revealed that WB-MRI and PET/CT were consistent in 79% of the instances and inconsistent in 21% of the cases. In 16/21 (76%, 12 cases of micronodular or diffuse pattern) of these, there was agreement with WB-MRI, whereas in 5/21 (24%) of cases, PET/CT accurately identified 3 positive and 2 negative cases. Overall sensibility and specificity of WB-MRI in the detection of MM was of 94% and 98%, whilst for PET/CT was 81% and 94%. WB-MRI led to an overall changing in therapeutic path in 49/135 cases (36%), PET/CT in 42/135 (31%), WB-MRI plus PET/CT in 53/135 (39%).

#### CONCLUSION

Our data highlight the pivotal role of functional imaging in the evaluation of BMI in myeloma patients with a superior sensibility of WB-MRI. The two techniques may play a complimentary role in cases of suspected relapsed or progressing MM.

#### CLINICAL RELEVANCE/APPLICATION

Our prospective trial supports the utmost role of WB-MRI and FGD PET/CT in the assessment of patients affected by high risk smoldering multiple myeloma and multiple myeloma at both diagnosis and relapse.

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## Abstract Archives of the RSNA, 2023

W2-SPNMMI-1

### The Impact of Preoperative [<sup>18</sup>F]FET-PET in Former Low Grade Glioma: Reclassification According to WHO CNS 2021

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Wolfgang Roll (*Presenter*) Nothing to Disclose

#### PURPOSE

Amino acid PET with [<sup>18</sup>F]-fluoroethylthymine (FET) is frequently used in the initial assessment of high grade glioma and suspected tumor recurrence. In low-grade gliomas, [<sup>18</sup>F]FET-PET can identify metabolically active tumor components and thus determine the surgical strategy. This study sheds light on the prognostic value of [<sup>18</sup>F]FET-PET for therapy-naive patients with low-grade gliomas.

#### METHODS AND MATERIALS

Retrospectively, all therapy-naive patients from 01/2012-03/2022 with [<sup>18</sup>F]FET-PET before microsurgical resection, diagnosed as former low-grade gliomas (WHO grade II according to WHO classification at the date of diagnosis) were included in the analysis. Diagnosis was updated following WHO CNS 2021. The [<sup>18</sup>F]FET-PET/CT or PET/MRI were quantitatively evaluated. In cases in which dynamic imaging was available, late uptake kinetics were graded as increasing vs. indifferent/decreasing. The primary oncologic outcome measure was progression-free survival (PFS).

#### RESULTS

Out of 103 patients, 26 patients were diagnosed with an oligodendroglioma and 57 patients with a WHO grade 2 astrocytoma IDH-mutated. 20 patients initially diagnosed as IDH-wildtype low grade tumors, were reclassified as IDH-wild-type glioblastoma following the new WHO 2021 classification. TBRmax values are significantly higher in oligodendrogliomas compared to IDH-mutated astrocytoma ( $p < 0.001$ ). Quantitative uptake parameters cannot predict the IDH status in this cohort. Increasing late kinetics is associated with a significantly longer PFS compared to indifferent/decreasing kinetics ( $p = 0.015$ ) in the entire cohort. In the subgroup of IDH-mutated astrocytomas without adjuvant treatment, patients with a TBRmax  $> 1.9$  showed significantly longer PFS compared to patients with lower TBRmax ( $p < 0.01$ ).

#### CONCLUSION

Preoperative [<sup>18</sup>F]FET-PET aids in tumor characterization in low-grade gliomas and can provide prognostic metrics.

#### CLINICAL RELEVANCE/APPLICATION

Prospective studies need to demonstrate whether [<sup>18</sup>F]FET-PET can be used as a decision support for or against adjuvant therapy after microsurgical resection.

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## Abstract Archives of the RSNA, 2023

W2-SPNMMI-2

### Association of ctDNA Levels and PET Radiomics Features in Patients with HPV-positive Head and Neck Squamous Cell Carcinoma

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Mitsuaki Tatsumi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Circulating tumor DNA (ctDNA), which is circulating in the blood after being shed from cancer cells in the body, has recently gained attention as an excellent tumor marker. The purpose of this study was to evaluate if ctDNA levels associated with PET radiomics features in patients (pts) with human papillomavirus (HPV)-positive head and neck squamous cell carcinoma (HNSCC).

#### METHODS AND MATERIALS

This study included 50 pts with oropharyngeal SCC (OPSCC) and 5 with SCC of unknown primary (SCCUP) before treatment. All of them had blood sampling to test ctDNA levels and FDG PET-CT examinations. ct-HPV type16 DNA (ctHPV16DNA) was analyzed as ctDNA using the droplet digital PCR system. Radiomics features in PET-CT included SUVmax, metabolic tumor volume (MTV), and texture features of the primary tumor (PT) and the largest metastatic lymph node (LN), and MTV of whole-body lesions (wbMTV) in each pt. Fifty-six TFs were evaluated in this study, and entropy, homogeneity, low- and high-gray-level zone emphasis (LGZE, HGZE), and short- and long- run emphasis (SRE, LRE) were included as recommended by Orhac, et al (JNM 2014). ctHPV16DNA levels were compared to TFs of PTs and other PET parameters in OPSCC pts (Group A) or TFs of the largest lesions (PTs or LNs) and other PET parameters in OPSCC and SCCUP pts (Group B). Spearman rank correlation test and multiple regression analysis were used to confirm the associations between ctHPV16DNA levels and PET parameters.

#### RESULTS

ctHPV16DNA levels correlated with wbMTV ( $r=0.52$  and  $0.53$ , respectively,  $p < 0.0005$  for both), but not with SUV or MTV in Group A and B. In Group A, ctHPV16DNA levels exhibited a weak negative correlation with LGZE ( $r = -0.35$ ,  $p < 0.05$ ) among 56 TFs evaluated. In Group B, the largest lesions consisted of 40 PTs and 15 LNs (10 from OPSCC). ctHPV16DNA levels exhibited a weak negative correlation with LGZE ( $r = -0.36$ ,  $p < 0.01$ ) or contrast ( $r = -0.29$ ,  $p < 0.05$ ). Multiple regression analysis revealed that wbMTV ( $p < 0.0001$ ) and HGZE ( $p < 0.005$ ) were the significant factors for ctHPV16DNA levels in Group B. The parameter ctHPV16DNA/wbMTV to reduce the effect of tumor volume had a weak negative correlation with LGZE ( $r = -0.29$ ,  $p < 0.05$ ) in Group B. These results were not obtained in Group A.

#### CONCLUSION

This study demonstrated that ctHPV16DNA levels correlated with the whole-body tumor burden visualized on FDG PET-CT in pts with HPV-positive HNSCC. ctHPV16DNA levels exhibited a weak correlation with the tumor heterogeneity, especially in the large OPSCC or LN lesions. This study provides new insights into the quantitative connection between gene expression and imaging biomarkers.

#### CLINICAL RELEVANCE/APPLICATION

ctHPV16DNA levels were demonstrated to correlate with the whole-body tumor burden and tumor heterogeneity in HPV-positive HNSCC.

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## Abstract Archives of the RSNA, 2023

W2-SPNPM-1

### **An Accelerating Emergency: Trends in Nationwide Emergency Department Imaging Volume from 2008 to 2020**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Husayn F. Ramji, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The emergency department (ED) is an essential provider of urgent and emergent care worldwide. As the demand and use of the ED has increased, so has the volume of patients seeking care and receiving diagnostic imaging. This study aims to benchmark multi-year multi-modality trends in imaging utilization in progressively overcrowded EDs, in order to inform future imaging guidelines, awareness, and stewardship efforts.

#### **METHODS AND MATERIALS**

This IRB exempt retrospective study utilized imaging data from the National Hospital Ambulatory Medical Care Survey (NHAMCS) for years 2008-2020. Data for X-ray, CT, Ultrasound, MRI, and the summation of all modalities in an "Any" category, as well as their year-by-year utilization rates, underwent normality testing followed by least squares regression analysis. Data was weighted, and analysis was performed using JMP Pro (SAS Institute Inc, Clara, NC) and SPSS (SPSS Inc, Chicago, IL).

#### **RESULTS**

From 2008-2020, there were statistically significant increases in the number (in thousands) of X-ray, CT, MRI, Ultrasound, and summation of Any imaging taking place in the ED. However, there were only statistically significant increases in utilization rates for CT (14.60% to 21.61%, +48.0%,  $p < 0.001$ ), MRI (0.58% to 1.04%, +79.3%,  $p < 0.001$ ), Ultrasound (3.1% to 5.7%, +83.8%,  $p < 0.001$ ), and Any (46.61% to 53.39%, +14.6%,  $p < 0.001$ ). The rate of utilization of X-ray did increase but was not found to be significant (35.52% to 37.57%, +5.7%,  $p > 0.05$ ).

#### **CONCLUSION**

Multiple modalities have seen significant increases in utilization in the ED from 2008-2020. Possible factors contributing to these increases includes increased access to technology, duplicate scans, challenges in health information exchange, communication or information gaps, or even ordering physician preference. Future studies utilizing NHAMCS data could consider stratifying the data by geographic region, patient variables such as insurance status, and comparing modality utilization by indication.

#### **CLINICAL RELEVANCE/APPLICATION**

Identifying trends in imaging utilization in nationwide cohorts can help inform future imaging stewardship guidelines and awareness campaigns. Further study should elucidate the underlying contributing factors to increase imaging in EDs nationwide.

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## Abstract Archives of the RSNA, 2023

W2-SPNPM-2

### An Examination of NIH Funded Radiology Research between Clinical Radiologists and Non-Clinicians

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Kyle Tegtmeier, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Research in radiology is conducted by both clinical radiologists and non-clinical researchers. Little is currently known about the balance of research grant funding between clinician and non-clinician researchers, and the scale of grants awarded to clinician-scientists. This project seeks to characterize differences in funding and funding trends between clinician and non-clinician scientists in radiology.

#### METHODS AND MATERIALS

Data on National Institutes of Health (NIH) grants awarded for all radiology projects were obtained from the NIH Reporter from 2012 through early 2023. A list of all practicing clinical radiologists was obtained from the National Plan and Provider Enumeration System (NPPES) from the Centers for Medicare and Medicaid Services. Using NPPES data, all available NIH grants were categorized based on whether the principal investigator was a practicing/billing radiologist.

#### RESULTS

A total of \$5.01 Billion of NIH grant funding was awarded for radiology research between 2012 and early 2023 across a total of 11,056 projects, awarded to a total of 1762 unique principal investigators. Among those principal investigators, 264 (14.98%) were practicing radiologists. A total of \$700 million in financing was provided to 1613 projects led by practicing radiologists, accounting for 13.97% of all funds awarded for radiology research by the NIH. Clinician and non-clinician researchers received a median of four grants, with a mean of 6.2 and 6.3 grants and mean grant funding of \$2.6 million and \$2.9 million, respectively. While increased grant funding was seen across all radiology projects, the greatest growth was seen among clinician-researchers, with the number of grants and total funding increasing from \$40.7 million across 102 grants in 2012 to \$93.9 million across 224 grants in 2022. Among clinician researchers, 192 (72.7%) identify as male, and the remaining 72 (27.3%) identify as female. Primary specialties of clinician researchers within radiology are as follows: 138 (52.3%) within diagnostic radiology, 12 (4.5%) within interventional radiology, and 114 (43.2%) within radiation oncology.

#### CONCLUSION

As imaging volumes continue to rise, with greater pressure placed on meeting the increased imaging volume demands, clinician scientists continue to offer great value and contribute significantly to the scientific advance of radiology. Despite comprising a relatively small percentage of grants and funding amongst the overall radiology specialty, clinical radiologists are seeing stronger increases in grant funding in recent years.

#### CLINICAL RELEVANCE/APPLICATION

The proportion of NIH grant funding to clinical radiologists relative to the whole specialty, as well as funding levels and trends over time are currently not well known.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNPM-3

### Accuracy of Disclosed Financial Relationships by Physicians publishing in Radiology Journal in 2021

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Dheeman Futela, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Transparency of physician-industry relationships is required by law. The United States Congress passed the Physician Payments Sunshine Act in 2010, which requires drug, device, and medical supply manufacturers to report payments over a certain amount (\$12.69 for 2023) made to healthcare providers. The physicians are expected to disclose payments received from the medical industry when publishing. This study aims to assess the accuracy and completeness of self-disclosures by authors in the journal Radiology.

#### METHODS AND MATERIALS

Manuscripts published in Radiology journal between January 1 and May 31, 2021 were retrospectively reviewed, and self-reported author disclosures were cross-referenced with the Open Payments database between 2019-2021.

#### RESULTS

A total of 68 articles having 513 authorships by US physicians were published in Radiology journal during the inclusion period, out of which 199 (39 %) received payments from the industry. There were 2918 payments totaling \$32,826,946.99 made to these 199 authorships. The median total amount received per authorship was \$10,598.7 (IQR = \$748.70 - \$120,386.01). Out of the 199 authorships receiving payments, 128 (64 %) did not disclose OPD-recorded relationships. 51 (26 %) authorships disclosed some of the OPD-recorded payments and 20 (10 %) disclosed all payments. The total undisclosed payments amounted to \$15,452,628.72 in research, \$4,579,475 in ownership and \$3,102,833.69 in general payments with a median undisclosed amount per authorship being \$2,726.

#### CONCLUSION

Our study shows that over a recent six-month period, 64 % of US physician authors with manuscripts published in Radiology did not disclose any industry relationship and another 26% disclosed only some of their payments. There is a significant discrepancy between physician authors' financial relationships with industry and their self-reported disclosures of the same.

#### CLINICAL RELEVANCE/APPLICATION

Publishing physicians are expected to disclose financial relationships with the medical industry. Our study uncovers a significant lack of transparency, both in terms of the number of authors who did not disclose and the total undisclosed amount, from physician authors of Radiology in 2021.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-1

### Impact of IA on Care Metrics for Stroke Patients during the COVID19 Pandemic: A Retrospective Analysis

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Pablo A. Diluca, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The COVID-19 pandemic has presented unprecedented challenges to the healthcare system, including the management of time-dependent pathologies such as stroke. We aimed to evaluate the impact of implementing the AI software, RAPID.AI, for image analysis in patients with stroke due to large cerebral vessel occlusion (LVO) during the pandemic.

#### METHODS AND MATERIALS

We created two groups of patients with LVO who received intravenous reperfusion therapy plus endovascular (TEV) or direct TEV. Group 1 included patients admitted between January 2019 and June 2020, and Group 2 included patients admitted from July 2020 to December 2021 and studied with RAPID.AI. We analyzed demographic data, risk factors, temporal metrics, National Institute of Health Stroke Scale (NIHSS) score at admission, modified functional Rankin Scale (mRS) score at 90 days, and compared data according to arrival time.

#### RESULTS

Group 1 comprised 153 patients, and Group 2 comprised 133 patients. No significant differences were identified regarding age, gender, admission NIHSS, or risk factors. However, the median door-to-image time was significantly shorter in Group 2 (19 minutes vs. 25 minutes,  $p < 0.0001$ ), and the door-recanalization time was also shorter in Group 2 (73 minutes vs. 85 minutes,  $p = 0.042$ ). Between 8:00 a.m and 8:00 p.m patients admitted in Group 2 had a shorter imaging time despite including a chest CT. Patients admitted to Group 2 between 8:01 p.m. and 7:59 a.m. had longer onset-admission times, higher NIHSS scores, and lower proportions of mRS = 2 at 90 days. As a limitation to the study, the measures implemented to shorten the door-image time were not analyzed.

#### CONCLUSION

Our study demonstrates that the measures implemented during the pandemic together with the use of AI for image analysis in stroke patients during the COVID-19 pandemic resulted in improved door-to-image and door-to-recanalization metrics. Additionally, the use of AI compensated for delays in patient arrival, providing specific information for decision-making. These findings highlight the potential utility of AI in improving stroke care and outcomes during times of crisis.

#### CLINICAL RELEVANCE/APPLICATION

AI software can improve care metrics for stroke patients with large cerebral vessel occlusion, enhancing decision making.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-10

### **Radiomics Features on Computed Tomography Combined with Clinical and Radiological Factors Predicting Hemorrhage Expansion**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Huiming Lee (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop an optimal model based on either intra- and peri-hematoma radiomics features as well as clinical data to predict hematoma expansion (HE) and compare their prediction performance.

#### **METHODS AND MATERIALS**

Clinical and radiological data of 406 ICH patients were collected retrospectively, who underwent initial NCCT within 6 hours of ictus and follow-up CT within 48 hours after initial NCCT. The data were randomized into a training set and a testing set at a ratio of 7:3. Radiomics features were extracted from the intra- and perihematoma regions. Univariate and multivariable logistic regression analyses were implemented to screen clinical and radiological factors. Then radiomics (single or combined) models, a radiomics-radiologic model, and an integrated model were constructed in the training cohort using FAE. The receiver operating characteristic curve and Delong test evaluated the predictive performance of radiomics features from different regions.

#### **RESULTS**

The predictive performance of intra- and perihematoma features was comparable in the training area under the receiver operating characteristic curve (AUC) 0.613 versus 0.645, which had no statistical difference. By incorporating intra- and perihematoma features, the model achieved an AUC of 0.620 in the test cohort. Regression analysis identified 4 risk factors, including 2 radiographic features and 3 clinical features. The radiological-radiomics (RR) model using radiographic features combined with the radiomics features achieved an area under the curve (AUC) of 0.744 in the test set. After incorporating the 2 clinical predictors and RR, the AUC of the radiologic-radiomics-clinical (RR-CL) model for discriminating early HE was 0.768. The RR-CL I model's prediction performance was better than the RR model, while the predictive nomogram combining the radiomics features with clinical-radiological characteristics performed best. Delong test proved that the performance of radiomics-based features was boosted by incorporating radiological factors, with the volume of hematoma and blend sign ( $p < 0.05$ ). While, the clinical factors, with time from onset to scan, NEUT and PT being the most important contributors, made the RR-CL equivalent to RR model in diagnostic efficiency.

#### **CONCLUSION**

NCCT models based on multivariable, clinical, and radiological features could improve the discrimination of early HE. The combined model was the best-recommended model to identify ICH patients at risk of early HE. And NEUT in the model may indicate early inflammatory reaction within perihematoma.

#### **CLINICAL RELEVANCE/APPLICATION**

The combined model was the best-recommended model to identify ICH patients at risk of early HE.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-11

### Comparison of Ultra-High-Resolution and Normal-Resolution CT-Angiography for Intracranial Aneurysm Detection in Patients with Subarachnoid Hemorrhage

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Marius Frenzel (*Presenter*) Nothing to Disclose

#### PURPOSE

Ruptured intracranial aneurysms (IAs) are the leading cause for atraumatic subarachnoid hemorrhage. In case of aneurysm rupture, patients may face life-threatening complications and require aneurysm occlusion. Detection of the aneurysm in CT imaging is therefore essential for patient outcome. This study provides an evaluation of the diagnostic accuracy of Ultra-High-Resolution CT-Angiography (UHR-CTA) and Normal-Resolution CT-Angiography (NR-CTA) concerning IA detection and characterization.

#### METHODS AND MATERIALS

Consecutive patients with atraumatic subarachnoid hemorrhage who received Digital Subtraction Angiography (DSA) and either UHR-CTA or NR-CTA were retrospectively included. Three readers evaluated CT-Angiography datasets regarding image quality, diagnostic confidence and presence of IAs. Sensitivity and specificity were calculated on patient-level and segment-level with DSA-imaging serving as reference standard. Additionally, the CTA patient radiation exposure (effective dose) was assessed and compared.

#### RESULTS

108 patients were identified (mean age=57.8±14.1years, 65 women). UHR-CTA revealed significantly higher image quality and diagnostic confidence ( $p<0.001$ ) for all readers and significantly lower effective dose ( $p<0.001$ ). Readers correctly classified =55/56 patients on UHR-CTA and =44/52 patients on NR-CTA. We noted significantly higher patient-level sensitivity for UHR-CTA compared to NR-CTA for all three readers (Reader 1: 41/41[100%] vs. 28/34[82%], Reader 2: 41/41[100%] vs. 30/34[88%], Reader 3: 41/41[100%] vs. 30/34[88%],  $p=0.04$ ). Segment-level analysis also revealed significantly higher sensitivity for UHR-CTA compared to NR-CTA for all three readers (Reader 1: 47/49[96%] vs. 34/45[76%], Reader 2: 47/49[96%] vs. 37/45[82%], Reader 3: 48/49[98%] vs. 37/45[82%],  $p=0.04$ ). Specificity was comparable for both techniques.

#### CONCLUSION

We found Ultra-High-Resolution CT-Angiography to provide higher sensitivity than Normal-Resolution CT-Angiography for the detection of intracranial aneurysms in patients with aneurysmal subarachnoid hemorrhage while improving image quality and reducing patient radiation exposure.

#### CLINICAL RELEVANCE/APPLICATION

In addition to achieving the universally sought-after reduction of radiation dose, the increased detection of intracranial aneurysms in UHR-CT imaging may facilitate therapeutic decisions and hence improve patient outcome.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-12

### Delay Filling of Intracranial Blood Flow Distal to Thrombus Predict Clinical Outcome after Endovascular Thrombectomy

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Song Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

Delay filling of intracranial blood flow evaluated by multiphase CT angiography (mCTA) can provide complementary information of hemodynamics. To investigate the relationship between phase of delay filling (PDF) and thrombolysis before EVT, and whether phases of delay filling (PDF) can help to predict clinical outcomes of patients with endovascular thrombectomy (EVT).

#### METHODS AND MATERIALS

In this retrospective study, patients with AIS treated with EVT were enrolled. All the patients underwent mCTA on admission. Based on the PDF, patients were classified into red PDF group (PDF with red on ColorViz of mCTA) and non-red PDF group (PDF with green or blue on ColorViz of mCTA). PDF of mCTA was acquired on the FastStroke research prototype. Chi-square test and Mann-Whitney test was applied to compare the difference between two groups. P value <0.05 was considered significant for all tests.

#### RESULTS

A total of 99 patients underwent EVT were included. In red PDF group, the percentage of thrombolysis before EVT was higher than non-red PDF group (8/28[28.57%] vs 2/60[3.33%], P = 0.005). Mismatch volume and Tmax > 10 seconds volume of red PDF group were lower than non-red PDF group (Mismatch volume: 129.00 [59.00-180.00] ml vs 152.80 [112.90-214.43] ml; Z = -2.209, P = 0.027; Tmax > 10 seconds volume: 41.00 [0.00-76.00] ml vs 59.00 [24.00-98.30] ml; Z = -2.285, P = 0.022). Clinical outcomes of red PDF group were more favourable than non-red PDF group (Score 6: 1 [2.94%] versus 5 [8.77%]; Score 5: 4 [11.76%] versus 5 [8.77%]; Score 4: 5 [14.72%] versus 5 [8.77%]; Score 3: 1 [2.94%] versus 18 [31.58%]; Score 2: 11 [32.65%] versus 10 [17.55%]; Score 1: 9 [26.47%] versus 13 [22.81%]; Score 0: 3 [8.82%] versus 1 [1.75%]; P = 0.041).

#### CONCLUSION

PDF was associated with thrombolysis before EVT, mismatch volume and Tmax > 10 seconds volume. More favourable outcomes was found in patients with red PDF than patients non-red PDF.

#### CLINICAL RELEVANCE/APPLICATION

Phase of delay filling depicts the compensatory capacity of intracranial blood flow, and it may be associated with thrombolysis before EVT. Moreover, later delay filling of blood flow may indicate the poor outcome of patients.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-SPNR-13

### 3.0T Three-dimensional High Resolution Vessel Wall MRI for Displaying Lenticulostriate Artery Changes of Cerebral Small Vessel Disease

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Yukun Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To observe the value of 3.0T three -dimensional high resolution vessel wall MRI (3D HR-VMI) for displaying lenticulostriate artery (LSA) changes of cerebral small vessel disease (CSVD), and to explore the feasibility of taking LSA changes as imaging markers of CSVD.

#### METHODS AND MATERIALS

Fifty-eight CSVD patients (CSVD group, 26 males and 32 females with an average age of  $63.0 \pm 7.2$  years) and 35 cases of other diseases with CSVD total burden scores of 0 (control group, 15 males and 20 females with an average age of  $62.6 \pm 7.2$  years) were enrolled. The imaging characteristics, including the number, length, and tortuosity of LSA were observed on 3D HR-VMI reconstruction images (Fig.1). The general information and imaging characteristics were compared between 2 groups and logistic regression analysis was performed, the independent risk factors for the occurrence of CSVD and CSVD total burden scores were evaluated (Fig.2).

#### RESULTS

There were significant differences in the incidence of hypertension and the numbers of LSA between groups (both  $P < 0.05$ ). CSVD total burden scores were negatively correlated with the number of LSA in CSVD patients ( $r = -0.48$ ,  $P < 0.001$ ). Hypertension and decreased number of LSA were independent risk factors for the occurrence of CSVD (Fig. 3), while aging, alcohol consumption and a decrease in the number of LSA were independent risk factors for the increase of CSVD total burden scores (Fig. 4).

#### CONCLUSION

3.0T 3D HR-VMI could clearly display LSA changes of CSVD. Decreased number of LSA was an independent risk factor for the occurrence of CSVD and increased CSVD total burden scores, which could be taken as an imaging marker of CSVD.

#### CLINICAL RELEVANCE/APPLICATION

Early detection and characterize LSA in the brain may provide valuable information on risk stratification and therapeutic interventions for patients with cerebral small vessel disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-14

### **Predictive Value of Intracranial Atherosclerosis Coexisted with Atherosclerotic Plaques in Different Carotid Segments for Subsequent Vascular Event: A Magnetic Resonance Imaging Study**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Richen Zhao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to examine the association between coexisting intracranial and extracranial carotid artery atherosclerotic plaque characteristics among different carotid segments, as detected using MR vessel wall imaging, and subsequent vascular events.

#### **METHODS AND MATERIALS**

Patients who recent cerebrovascular symptoms in anterior circulation and at least one carotid plaque were consecutively enrolled. All patients underwent multi-contrast MR vessel wall imaging for extracranial carotid arteries and 3D time-of-flight MR angiography for intracranial arteries at baseline. After baseline examination, all patients were followed-up for at least 1 year to record the vascular events. The coexisting cerebrovascular atherosclerosis was defined as the presence of atherosclerosis in both intracranial artery in anterior circulation and extracranial artery. Univariate and multivariate Cox regressions were used to calculate the hazard ratio (HR) and corresponding 95% confidence interval (CI) of co-existing plaques in predicting subsequent vascular events.

#### **RESULTS**

In total, 122 patients (mean age:  $62.2 \pm 11.9$  years; 89 males) were recruited. During the median follow-up time of 12.0 months, 36 (29.5%) patients experienced vascular events. Coexisting intracranial artery stenosis and atherosclerotic plaques in carotid bulb segment of carotid artery (HR, 2.51; 95% CI, 1.14-5.54;  $P = 0.023$ ) was significantly associated with subsequent vascular events, respectively. After adjusting for baseline confounding factors, this association remained statistically significant (HR = 3.08, 95% CI 1.18-8.07,  $P = 0.022$ , respectively). No significant association was found between intracranial stenosis coexistent with atherosclerotic plaque in other segments of carotid artery and vascular events (all  $P > 0.05$ ).

#### **CONCLUSION**

Coexisting intracranial artery stenosis and atherosclerotic plaque in the segment of carotid bulb was independently associated with subsequent vascular event.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings indicate that coexisting intracranial artery stenosis and atherosclerotic plaque in the segment of carotid bulb was independently associated with subsequent vascular event, indicating that coexisting intracranial stenosis and atherosclerotic plaque in carotid bulb may have a higher predictive value for vascular events than coexisting plaques in other carotid artery segments. Our findings indicate that it is valuable to assess the segmental distribution of coexisting intracranial and extracranial atherosclerosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-2

### Low Proportion of Calcification in Large Volume Plaque as a Marker of Carotid Plaque Vulnerability in Embolic Stroke of Undetermined Source

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Yu Sakai, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Current focus has centered on non-calcified inflammatory plaque components [intraplaque hemorrhage (IPH) and lipid rich necrotic core (LRNC)] in nonstenotic carotid plaque in patients with embolic stroke of undetermined source (ESUS). Although calcified inflammatory plaque components, such as spotty calcifications, are associated in acute coronary syndromes, its role in ESUS-carotid plaque is unclear. We investigated the relationship of spotty calcifications and low calcific plaque burden in nonstenotic carotid plaque ipsilateral to stroke side in patients with ESUS.

#### METHODS AND MATERIALS

Calcific carotid plaques were identified on neck CTAs from a retrospective dataset comprised of patients with unilateral anterior circulation ESUS. Blinded to stroke side, each carotid plaque calcification was manually scored (e.g., arc), annotated using 3D-Slicer, and segmented using a semi-automated plaque composition software (Elucid Bioimaging). Plaques were scored for presence of a spotty calcification (calcification <3mm in length and <90° arc of the lumen). IPH and LRNC volumes are summed as plaque inflammation (Inflmvol). Plaque burden (PB) is the sum of all plaque components (IPH, LRNC, calcification, matrix). Subgroup analysis of plaques with high plaque burden (HPB) was performed and defined as all cases above the median PB (median=858mm<sup>3</sup>). Plaques were defined as low relative calcific PB (Low%Calc) if the calcific plaque volume comprised =2% of total PB (1st quartile). Mann-Whitney U and Chi-squared tests were performed to test plaque features ipsilateral versus contralateral to stroke side.

#### RESULTS

86 patients met criteria (mean age= 66.8; N=41 women). No statistically significant differences were observed between carotid plaques ipsilateral versus contralateral to stroke side for presence of spotty calcifications (p=0.42), Inflmvol (p=0.70), or Low%Calc plaque (p=0.26). Among plaques with HPB (N=66), there was no significant difference between ipsilateral versus contralateral plaques with spotty calcifications (p=0.76) or Inflmvol (p=0.57). Plaques identified as Low%Calc ipsilateral to stroke side were significantly more frequent than on the contralateral side [10/11 (91%), p = 0.02].

#### CONCLUSION

Plaques with low relative calcific plaque burden may be a stronger vulnerable carotid plaque feature in patients with ESUS rather than the presence of spotty carotid plaque calcifications.

#### CLINICAL RELEVANCE/APPLICATION

Volumetric based categories of plaque classifications should be considered when determining potential imaging biomarkers of nonstenotic culprit carotid plaque to capture the multidimensional and complex patterns of vulnerable plaque in patients with ESUS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-3

### Deep Learning-enabled Identification of Large Vessel Occlusion on Four-dimensional Computed Tomography Angiography(4D-CTA)

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Yuling Peng, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the role of deep learning in aiding the detection of large vessel occlusion (LVO) on four-dimensional computed tomography angiography (4D-CTA).

#### METHODS AND MATERIALS

This retrospective study involved 104 LVO patients and 105 non-LVO patients in the construction of the deep learning models. Another 30 LVO patients and 31 non-LVO patients formed the time-independent validation set. Four phases (arterial phase P1, arterial-venous phase P2, venous phase P3 and late venous phase P4) extracted from 4D-CTA were combined using two different input methods, namely combined input and superimposed input. Totally 26 deep learning models were constructed using a modified HRNet network. Assessment metrics included the areas under the curve (AUC), accuracy, sensitivity, specificity and F1 score. Kappa analysis was performed to assess inter-rater agreement between the best model and radiologists of different seniority.

#### RESULTS

The P1+P2 model (combined input) had the best diagnostic performance. In the internal validation set, the AUC was 0.975 (95%CI: 0.878-0.999), accuracy was 0.911, sensitivity was 0.889, specificity was 0.944, and the F1 score was 0.909. In the time-independent validation set, the model demonstrated consistently high performance with an AUC of 0.942 (95%CI: 0.851-0.986), accuracy of 0.902, sensitivity of 0.867, specificity of 0.935, and an F1 score of 0.901. The best model showed strong consistency with the diagnostic efficacy of three radiologists of different seniority ( $k=0.84, 0.80, 0.70$  for 8, 5, and 1 year of diagnostic experience, respectively).

#### CONCLUSION

The proposed deep learning algorithm derived from 4D CTA can be very highly effective in detecting LVO, alerting radiologists to speed up the diagnosis. In particular, the combination of the arterial and arterial-venous phases can improve detection efficacy.

#### CLINICAL RELEVANCE/APPLICATION

We introduced a high-performance deep learning algorithm for detecting large vessel occlusions in 4D-CTA, showing that the combination of multiple phases improved the detection of LVO and the combination of the arterial-venous phase with the arterial phase yielded the best deep learning model performance. The diagnostic efficacy of the best deep learning model was in good agreement between radiologists of different years of experience and was slightly better than that of less experienced trainee radiologist. Our results showed that deep learning can be very effective in facilitating accelerated screening and diagnosis of LVO in urgent clinical settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-4

### Investigation of Radiologic Characteristics between Branch Atheromatous Disease and Cerebral Small Vessel Disease: A High-resolution Magnetic Resonance Vessel Wall Imaging Study

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Peipei Chang (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare lenticulostriate arteries (LSAs) morphology and other imaging features of branch atheromatous disease (BAD) and cerebral small vessel disease (CSVD) and to investigate whether the imaging features can distinguish the different etiological mechanisms of cerebral infarction in basal ganglia.

#### METHODS AND MATERIALS

Fifty patients with suspected acute cerebral infarction in the LSA territory were prospectively enrolled. All subjects underwent multimodal magnetic resonance imaging (MRI) examination and were divided into BAD and CSVD groups, depending on whether there was plaque in the middle cerebral artery by high-resolution vascular wall MRI (3D HR VMI). The morphological characteristics of visible LSAs (the number of stems and branches, length, distance, and tortuosity) were quantitatively analyzed by two radiologists. Typical image features indexes of CSVD including white matter hyperintensities (WMHs), lacunes, enlarged perivascular spaces (EPVS), microscopic bleedings (CMBs) were assessed. Global cerebral blood flow (CBF) values obtained by arterial spin labeling (ASL) were used to analyze the whole brain differences of perfusion between two groups. To assess the imaging parameters between groups, independent-samples t test, nonparametric tests and Chi-square test were used. Binary logistic regression was used to explore the influencing factors of BAD and CSVD.

#### RESULTS

There were significant differences in the sex, MRs (Modified Rankin Scale) and NIHSS (National Institutes of Health Stroke Scale) scores between the two groups, showing more significant neurological impairment in BAD group. The LSA branches of BAD were significantly reduced compared with the contralateral side, while with no significant difference to those observed in the CSVD group. CSVD was more likely to have EPVS. The length and distance of LSAs were influencing factors of BAD and CSVD.

#### CONCLUSION

There are fewer LSA branches in BAD, and the length and distance of LSA are the influencing factors of BAD and CSVD.

#### CLINICAL RELEVANCE/APPLICATION

The morphological characteristics of LSAs and image features indexes of CSVD might provide method to distinguish the different underlying mechanisms of cerebral infarction in basal ganglia.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-5

### Clinical Evaluation of Deep-learning Model for Classifying Stroke Patients of Emergent Large Vessel Occlusion on Non-contrast CT

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Dohyun Kim, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this clinical study is to evaluate the clinical applicability of a deep learning (DL) model that classifies patients with emergent large vessel occlusion (ELVO) through analysis of non-contrast CT (NCCT) images only. In clinical practice, if patients of suspected ELVO can be quickly screened through analysis of only NCCT images that can be scanned without contrast media, it has the advantage of improving the prognosis by reducing the time required for treatment of ELVO patients. Therefore, clinical effectiveness was evaluated by comparing the accuracy to classify ELVO patients through reading NCCT images with or without referring to the result of DL-based software by clinician.

#### METHODS AND MATERIALS

The NCCT of 744 patients (ELVO positive: 519 cases) were used for learning the DL model. The primary endpoint of clinical test was the statistical difference of the sensitivity and specificity of ELVO patient classification according to whether or not the DL model results were referenced. 477 patients (ELVO positive: 112 cases) were registered in the clinical evaluation, and a reference standard was created based on the final diagnosis results. A wash-out period of 2 weeks was set between the two readings depending on whether or not the DL model was referenced, and both results of reading were derived by the consensus of five stroke experts. The sensitivity and specificity were calculated by comparing the both readings of consensus to the reference standard. Finally, through McNemar's test, statistical differences were evaluated according to whether or not the results of the DL model were referenced.

#### RESULTS

In the classification result of ELVO patient, the sensitivity of experts' consensus was 75.89% when reading by only NCCT and 91.96% when the result of DL model was referred. In addition, the specificity of the experts' consensus was 83.01% when read only by NCCT and 92.6% when referring to the DL model results. As the result of the McNemar's test to compare the primary endpoint, it was confirmed that both sensitivity ( $p=0.0009$ ) and specificity ( $p<0.0001$ ) were significantly improved when the results of the DL model were referred to. Therefore, the primary endpoint of the clinical test was successfully accomplished.

#### CONCLUSION

It was confirmed that the accuracy was significantly higher when referring to the results of the DL-based software in NCCT-based ELVO patient classification. Therefore, it is highly recommended to use for assisting clinicians in clinical environment.

#### CLINICAL RELEVANCE/APPLICATION

This deep-learning model has been integrated into the commercial Heuron ELVO software. It will be a useful tool for clinicians to make fast decision, especially, it will be valuable in remote regions where clinical expert may be limited.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-6

### Single-phase plus Dynamic CTA Accurately Identifies Favorable Outcomes in Patients with Acute Ischemic Stroke

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Hui Li (*Presenter*) Nothing to Disclose

#### PURPOSE

Sufficient collateral blood supply is crucial for favorable outcomes in patients with acute ischemic stroke (AIS) after endovascular treatment. In clinical practice, imaging of collaterals is often performed with single-phase computed tomography angiography (CTA) that is unable to precisely time the acquisition time-points, leading to the mislabeled collateral status. Dynamic CTA (dCTA) derived from CT perfusion source images is a novel method that contains more time points than single-phase CTA, and allows complete tracking of the transit of contrast bolus. We hypothesized that single-phase plus dCTA would predict clinical outcomes better than single-phase CTA.

#### METHODS AND MATERIALS

Patients with AIS due to proximal middle cerebral artery occlusion or internal carotid artery occlusion after endovascular treatment were included. Patients underwent non-contrast CT, whole-brain CT perfusion, and single-phase CTA. dCTA were computed from CT perfusion source images with KWIA denoising, vessel filtering and MIP along 3 views. The pial collateral status was scored using Alberta Stroke Program Early CT Score on collaterals with single-phase CTA, dCTA, and single-phase plus dCTA. Good clinical outcomes included 90-day modified Rankin Scale (mRS) score of 0-2. Association between the pial collateral status and functional outcomes was assessed using multivariable binary logistic regression. Then, hypoperfusion intensity ratio (HIR) were computed on CT perfusion and combined with pial collateral status to assess the total collateral status. 3 groups were defined: good collaterals (good pial collaterals and HIR), poor collaterals (poor pial collaterals and HIR) and mixed collaterals (remainder of patients). The predictive ability of total collateral status on functional outcomes were analyzed by receiver operating characteristic curve.

#### RESULTS

One hundred and forty-four patients with a mean age of 68.5 years were included. Pial collateral status as assessed with single-phase plus dCTA was more strongly associated with functional outcomes (OR=3.14 [95% CI 1.65-5.96];  $p < 0.001$ ) than with dCTA (OR=2.34 [95% CI 1.29-4.27];  $p = 0.005$ ) or with single-phase CTA (OR=1.90 [95% CI 1.21-2.98];  $p = 0.005$ ). Furthermore, good total collateral status could predict good functional outcomes (Area Under Curve (AUC)=0.67 for single-phase CTA and HIR, AUC=0.69 for dCTA and HIR, AUC=0.70 for single-phase plus dCTA and HIR).

#### CONCLUSION

dCTA provides a more detailed assessment of collaterals than single-phase CTA. Collateral status is a strong predictor of clinical outcomes in patients treated by endovascular treatment.

#### CLINICAL RELEVANCE/APPLICATION

dCTA derived from CT perfusion source images may be used to select AIS patients for endovascular treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-7

### Disparities in Access to Endovascular Thrombectomy for Patients with Large Vessel Occlusion

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Mihir Khunte (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the racial, socioeconomic, and geographic disparities that exist in both access to high volume endovascular care centers (ECCs) and receiving thrombectomy once admitted to an ECC in patients with large vessel occlusion (LVO).

#### METHODS AND MATERIALS

A retrospective study was performed for the years 2016 - 2019 of the National Inpatient Sample for all adult inpatient admissions with LVO. International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis, and procedural coding system (PCS) were used to identify patients with LVO. Patient characteristics such as gender, age, race, and income quartile and hospital characteristics such as region, rural/urban status, and size were recorded. Hospitals that performed  $\geq 10$  EVT procedures in one year were classified as high-volume endovascular capable centers (ECCs).

#### RESULTS

There were 727,010 patients with LVO during the 2016-2019 period. A total of 428,745 (59.0%) patients were admitted to a high volume ECC. Black patients were admitted to high volume ECCs at higher rates than white patients (61.0% vs 58.3%) but after adjusting for other factors using a multivariable logistic regression model, we found that when comparing Black to White patients, the OR of admission to a high volume ECC was 0.94 (95% CI 0.88 - 1.02). Among patients admitted to a high volume ECC, black patients were less likely to receive thrombectomy than white patients (17.6% vs 19.2%). This trend remained true after adjusting for other variables including the occlusion site. Comparing high volume ECC patients with private insurance to those with Medicare, the OR of receiving EVT was 1.13 (95% CI 1.06-1.20).

#### CONCLUSION

Our study shows that disparities existed both in accessing an ECC after LVO and receiving thrombectomy after admission to an ECC. While Black patients with LVO were more likely to be admitted to a high volume ECC than white patients, they were less likely to receive EVT once admitted. Age, sex, income, region of the U.S., and insurance status also played a role in determining whether a patient received thrombectomy after admission to a high volume ECC.

#### CLINICAL RELEVANCE/APPLICATION

EVT is an important treatment strategy for selected patients with LVO but significant barriers exist in accessing appropriate treatment.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-SPNR-8

### Trends in Use of Endovascular Thrombectomy in Anterior Circulation Large-vessel-occlusion by Age

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Mihir Khunte (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess trends in US nationwide use of endovascular thrombectomy (EVT) in patients with large vessel occlusion (LVO) in different age groups.

#### METHODS AND MATERIALS

The National Inpatient Sample database was queried to identify adult patients (18 years or older) with a primary diagnosis code for cerebral infarction due to unilateral internal carotid artery (ICA) or middle cerebral artery (MCA) thrombosis or embolism. The International Classification of Diseases, Tenth Revision, Clinical Modification [ICD-10-CM] diagnosis and procedural coding system (PCS) was used to identify patients with LVO and the interventions performed from 2016-2020. Patients with additional coding for occlusions in the vertebral, basilar, cerebellar, posterior cerebral, and anterior cerebral arteries were excluded. For each age category, trends in EVT utilization were evaluated and compared using Pearson's chi-square test.

#### RESULTS

Among 316,290 patients with ICA/MCA occlusion from 2016-2020, 68,780 (21.7%) received EVT and 71,260 (22.5%) received tPA. The proportion of anterior circulation LVO patients receiving EVT increased from 15.7% in 2016 to 27.6% in 2020. The rate of EVT increased most in patients aged 75 to 84 years (14.6% in 2016 to 27.4% in 2020) and 85 years and older (12.6% in 2016 to 26.3% in 2020). The proportion increased by 10.3 percentage points in patients younger than 55 years (19.0% in 2016 to 29.3% in 2020), 10.1 percentage points in patients aged 55 to 64 (17.2% in 2016 to 27.3% in 2020), 11.3 percentage points in patients aged 65 to 74 (16.7% in 2016 to 28.0% in 2020). In contrast to in 2016, in 2020, the rate of EVT was not statistically significantly different between age groups ( $P = 0.328$ ).

#### CONCLUSION

Our study results show a significant increase in use of EVT in patients with anterior circulation LVO across all age groups, with approximately 27.6% of patients receiving EVT in 2020.

#### CLINICAL RELEVANCE/APPLICATION

From 2016-2020, there has been a significant increase in the use of EVT in older patients above 75 years of age with the rate of EVT use nearing that in younger patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPNR-9

### Trends in the Use of Intravenous Thrombolysis and Endovascular Thrombectomy in Patients with Large Vessel Occlusion Stroke from 2016-2020 and the Impact of COVID-19 Pandemic

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Mihir Khunte (*Presenter*) Nothing to Disclose

#### PURPOSE

To study the use of intravenous thrombolysis (IVT) and endovascular thrombectomy (EVT) nationally in the United States in patients with large-vessel-occlusion (LVO) in 2020, compared it to the previous 4 years, and evaluated their use specifically in COVID-positive patients.

#### METHODS AND MATERIALS

The National Inpatient Sample database was queried to identify adult patients (18 years or older) with a primary diagnosis code for cerebral infarction due to unilateral internal carotid artery (ICA) or middle cerebral artery (MCA) thrombosis or embolism. The International Classification of Diseases, Tenth Revision, Clinical Modification [ICD-10-CM] diagnosis and procedural coding system (PCS) was used to identify patients with LVO and the interventions performed from 2016-2020. Patients with additional coding for occlusions in the vertebral, basilar, cerebellar, posterior cerebral, and anterior cerebral arteries were excluded. In the 2020 data, patients with a concomitant diagnosis of coronavirus disease 2019 (COVID-19) were identified. Rates of EVT and IVT were assessed by COVID-19 status.

#### RESULTS

A total of 316,290 patients were hospitalized for acute ischemic stroke with an ICA/MCA occlusion from 2016-2020. Of these patients, 21.7% (N = 68,780) received thrombectomy and 22.5% (N = 71,260) received IVT. From 2019 to 2020, the fraction of patients receiving thrombectomy increased 2.1 percentage points from 25.5% in 2019 to 27.6% in 2020 ( $p = 0.020$ , Figure 1). Meanwhile, rates of thrombolysis remained relatively constant, (22.4% in 2016 vs 21.7% in 2020,  $p = 0.128$ , Figure 1). Among the 63,785 patients presenting with ICA/MCA occlusion in 2020, 1,170 (1.8%) had a co-diagnosis of COVID-19. The rate of EVT among COVID-19 and non-COVID-19 stroke patients with LVO in 2020 was 29.1% and 27.6% respectively ( $p = 0.605$ ). In addition, the proportion of patients receiving IVT was 21.8% and 21.7% for COVID-19 and non-COVID-19 stroke patients respectively ( $p=0.962$ ).

#### CONCLUSION

The proportion of patients with an MCA/ICA LVO receiving IVT and EVT did not decline in 2020 compared to the previous four years. Specifically, COVID- positive patients received recanalization therapies in similar proportion to COVID-negative patients for the whole year.

#### CLINICAL RELEVANCE/APPLICATION

COVID-positive patients with acute ischemic stroke received recanalization therapies in similar proportion to COVID-negative patients in 2020.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPD-1

### Does Follow-up MRI after Esophageal Button Battery Ingestion Cause Thermal Injury: An In-vitro Study

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Norihiro Shinkawa, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The button battery (BB) is a dangerous pediatric foreign body, and an ingested esophageal BB should be removed immediately. However, severe complications such as tracheoesophageal or aortoesophageal fistula may develop after endoscopic BB removal and patients require follow-up with magnetic resonance imaging (MRI). Since the injured area after BB removal can contain metallic debris such as iron, radiologists should be aware of the risk of thermal injury from the metallic debris during MRI examinations. This in vitro study investigated temperature and histological changes before and after MRI examination of tissues injured by BB.

#### METHODS AND MATERIALS

Two each of the following three types of chicken pectoralis minor muscle were prepared: untreated control; MRI-scanned BB injury; and non-MRI-scanned BB injury. The negative pole surface of an unused 3-V BB was brought into contact with the muscle tissue and left for 10 h to generate a BB injury. Computed tomography (CT) and histological Perls' Prussian blue staining were performed to confirm the presence of metallic debris in the injured area after BB removal. Temperatures were measured before and after MRI of BB-injured muscle specimens after BB removal and in untreated control specimens using a needle-type digital thermometer. Temperatures were measured at five sites for each specimen. MRI was performed according to the non-enhanced mediastinal sequence at our hospital, assuming tracheoesophageal and aortoesophageal fistula. Hematoxylin-eosin and Perls' Prussian blue staining were used to compare MRI-scanned and non-MRI-scanned BB injuries histologically. These steps were performed at room temperature (20-22°C).

#### RESULTS

BB injury showed high attenuation (mean: 242 Hounsfield units) on CT suggestive of the presence of metallic debris. Histologically, BB injury showed positive staining for Perls' Prussian blue, representing evidence of Fe<sup>3+</sup>. Both BB-injured specimens with or without MRI scans showed coagulation necrosis. Temperature before MRI was 21.7 ± 0.1°C for both BB-injured and control specimens. Temperature after MRI was 22.2 ± 0.2°C for both BB-injured and control specimens. No difference in histopathological findings was seen between specimens with or without MRI scans.

#### CONCLUSION

No temperature increase or histopathological findings suggestive of thermal injury due to metallic debris during MRI of BB injury were evident. However, radiologists should be aware of the potential for thermal injury from MRI as long as foreign metal is present in the body.

#### CLINICAL RELEVANCE/APPLICATION

Follow-up of esophageal BB injury by endoscopy or esophagography is invasive, and safer noninvasive MRI is needed.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPH-10

### A Practical Approach to Sustainable Radiology

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Hans-Martin Klein, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To examine the effect of regenerative energy and energy efficient imaging technology on the energy balance in MRI.

#### **METHODS AND MATERIALS**

We built an energy saving bungalow with a 29.8 kWp rooftop solar array and a 10 kWh Li-Ion Battery. MR imaging was carried out using a 0.35T permanent magnet system with water-cooled gradients, installed in 2019 (Siemens Magnetom CI, Siemens Healthineers/Germany) and a 0.4 T permanent magnet system with air-cooling (Aperto Lucent Plus, Fujifilm healthcare/Japan) installed in 2022. Energy consumption was measured using the power management system of the solar array.

#### **RESULTS**

The 0.35T MRI consumed 9.5 kW/h during scan procedures (including cooling). Annual consumption of the imaging system was 16.100 kWh in 2020. Energy consumption including all practice components in 2020 was 38.810 kWh. Energy production of the solar array was 30.846 kWh in 2020. Net energy consumption for the whole project was therefore 8.397 kWh in 2020. The state of the art 0.4T MRI consumes 5 kW/h. In February 2023, the imaging system consumed 1.495,36 kWh. Compared with February 2020 (1.951,21 kWh), this is a reduction by 5.618 kWh or 23,4%. If all other parameters are kept constant, we expect a total practice net energy consumption of 2.780 kWh in 2023.

#### **CONCLUSION**

Using state of the art imaging technique and rooftop solar energy production, an energy neutral MRI site is possible.

#### **CLINICAL RELEVANCE/APPLICATION**

Optimizing the energy balance is a challenge. Radiology, as an energy intense discipline, can contribute considerably to sustainable medical care. For developing countries, energy neutral operation can help to provide medical care independent from (unstable) power grids.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPH-11

### Quantitative Knee Evaluation using Deep-Learning in a Low-Field 0.55T MRI: In Vivo Study of Healthy Controls

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Rupsa Bhattacharjee, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the performance of standard in-practice DL (bone, and cartilage segmentation) algorithms to generate bone shape and cartilage thickness maps in addition to compartment-wise cartilage thickness values in healthy controls at 0.55T

#### METHODS AND MATERIALS

Unilateral knees of four healthy controls (Age:  $28 \pm 3.8$  years, BMI:  $24.08 \pm 2.88$ , 2 females) were included in this IRB approved study. The subjects underwent MRI scanning on a 0.55T (MAGNETOM Free.Max, Siemens Healthineers, Erlangen, Germany), with knee wrapped in a Contour-S coil. Sagittal 3D PD fat-saturated SPACE images were acquired with FOV  $160 \times 160$  mm<sup>2</sup>, resolution  $0.6 \times 0.6 \times 0.6$  mm<sup>3</sup>, and 224 slices (TR/TE = 800/36 ms). The images underwent a modified 2D-CNN architecture<sup>1</sup> and a 3D V-Net architecture<sup>2</sup> respectively to segment the bones (femur, tibia, patella) and cartilages (femoral, tibial, patellar). Both the DL architectures were previously trained and validated on similar image contrasts at 3.0T and were inferred on the 0.55T images. Mean cartilage thickness values for three cartilages were automatically computed using a Euclidean distance transform<sup>3</sup>. The overall segmentation quality was assessed using a 5-point Likert scale by a musculoskeletal radiologist with over three years of experience.

#### RESULTS

Without any sort of pre-trainings, as an initial inference run, both the segmentation models were able to segment the three major bones and cartilage masks with moderate to substantial ability, demonstrated in figure 1. The cartilage thickness values estimated for femoral, tibial, and patellar cartilages were  $1.40 \pm 0.84$ ,  $1.54 \pm 0.62$ , and  $2.18 \pm 0.62$  mm respectively. The cartilage segmentation algorithm outperformed the bone segmentation module, in the femoral and tibial regions, in terms of precision in detecting smaller cartilage regions with confusing boundaries. However, both the segmentation modules, especially the cartilage one, suffered in the detection of the patellar region, due to non-sufficient training in low-SNR images. Nevertheless, it demonstrates a decent baseline of quantitative capabilities with possibilities for improvement using further training with 0.55T images, along with comparative assessment with paired 3T segmented data.

#### CONCLUSION

Initial results demonstrate a moderate-to-substantial technical feasibility of translating existing quantitative deep-learning-based image segmentation techniques from 3T to 0.55T for knee MRI, especially in terms of measuring cartilage thickness.

#### CLINICAL RELEVANCE/APPLICATION

The 0.55T low-field-value-MRI, can be technically useful for evaluating knee cartilage thickness and bone features aided by established DL algorithms, with potential for further improvement in biomarker quantification performance.

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## Abstract Archives of the RSNA, 2023

W2-SPPH-12

### Feasibility of ZTE-based Silent and Motion-robust Techniques for Neuroimaging

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

James Holmes, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Conventional MRI generates high levels of acoustic noise from the rapidly changing imaging gradients. This loud acoustic noise presents challenges for sensitive populations such as pediatrics and patients with hyperacusis including inner ear disorders, autism, and depression. Acquisition strategies including radial zero-echo time (ZTE) have been shown to reduce acoustic noise. Radial sampling methods can provide motion robustness or even allow correction, making the radial ZTE approach appealing. We present progress in developing multi-contrast ZTE imaging protocols with motion correction.

#### METHODS AND MATERIALS

T1w and T2w 3D radial ZTE acquisitions with intermittent magnetization preparation pulses were acquired on a 3T clinical MRI (Premier, GE Healthcare) in two normal healthy volunteers under written consent and IRB approval. Each acquisition was performed twice, and volunteers were instructed to remain still for the first acquisition and to periodically move during the second. A modified HEALPix radial view order provided coverage of angles within each segmented readout. Motion was estimated from the k-space data using a deep learning approach and corrected during image reconstruction. Conventional Cartesian imaging was performed using 3D gradient echo T1w MPRAGE and 3D T2w FSE CUBE. Acoustic noise measurements of the maximum sound pressure level (SPL) were performed at the head coil in the MRI bore during volunteer scans.

#### RESULTS

T2w and T1w ZTE images provided qualitatively similar image contrast to the Cartesian acquisitions. As expected, conventional Cartesian images were heavily impacted by subject motion however the ZTE combined with motion correction allowed for recovery of image quality with only modest loss compared to images when no motion was present. This included visualization of the middle cerebral arteries in T2w as well as sulci and ventricles on T1w. ZTE T2w and T1w (peak average SPL 71dBc and 69dBc respectively) were considerably quieter than the conventional Cartesian T2w and T1w (peak average SPL 89dBc and 87dBc respectively).

#### CONCLUSION

We present progress to date on developing a ZTE-based silent and motion-robust neuroimaging protocol. ZTE with intermittent magnetization preparation and the HEALPix radial view order and motion correction provided motion robust standard T1w and T2w contrasts. The modified ZTE approach allowed SPL levels well below conventional Cartesian protocols while allowing motion correction. Future work will include studies in pediatrics and autism.

#### CLINICAL RELEVANCE/APPLICATION

Sensitive patient populations struggle with MRI due to loud acoustic noise and inability to hold still. This work proposes a ZTE MRI acquisition and deep learning reconstruction to overcome these challenges.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPH-13

### Comparison of Deep Learning-Based Accelerated Diffusion Weighted Imaging with Conventional Diffusion Weighted Imaging in Female Pelvic Imaging

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Lillian Chiu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare deep learning based accelerated diffusion weighted images (DL-DWI) and conventional DWI (c-DWI) of the female pelvis using qualitative and quantitative metrics.

#### METHODS AND MATERIALS

Consecutive patients who had MRI of female pelvis from 12/16/2023-2/3/2023 were included if they had axial c-DWI and a prototype DL-DWI (Siemens, Erlangen, Germany, Bae et al, Eur J Radiolo. 2022) acquired on 3T MRI. Exclusion criteria: prior hysterectomy/oophorectomy. c-DWI used b50, 400, 1000 s/mm<sup>2</sup> and DL-DWI used b50, 800, 1000 s/mm<sup>2</sup>. Axial T2, c-DWI or DL-DWI, and associated ADC maps of each were blinded, randomized and evaluated by 3 fellowship trained radiologists (17, 3, and 1 y exp) using a 5pt Likert scale (1 non diagnostic to 5 excellent quality) for strength of fat suppression, sharpness of uterine margin, conspicuity of ovary, conspicuity of endometrium, quality with respect to susceptibility artifact or other artifacts, and conspicuity of fibroids on b1000 DWI and ADC. The ADC value from a 1 cm diameter ROI of the myometrium and fibroid if present were also collected by a trainee and confirmed by a fellowship trained radiologist. Wilcoxon signed rank test was used to compare Likert scores. Paired T test and Bland Altman plot were used to compare ADC values.

#### RESULTS

108 pts met criteria. Mean acquisition times: c-DWI: 2.44±0.45 min, DL-DWI: 1.03±0.16 min. Significantly different image quality scores: Strength of fat suppression (R1 c-DWI 4.96, DL-DWI 4.89, p=0.03, R3 c-DWI 4.33, DL-DWI 4.04, p<.001), Sharpness of uterine margin (R1 c-DWI 4.22, DL-DWI 4.28, p=0.04, R2 c-DWI 3.58, DL-DWI 3.74, p=0.02, R3 c-DWI 4.30, DL-DWI 4.56, p=0.01), Conspicuity of ovary (R1 c-DWI 4.26, DL-DWI 4.44, p=0.01, R3 c-DWI 4.31, DL-DWI 4.71, p<.001), Conspicuity of endometrium (R2 c-DWI 3.26, DL-DWI 3.10, p=0.05), Susceptibility artifact (5 excellent quality) (R1 c-DWI 3.80, DL-DWI 4.00, p=0.03, R2 c-DWI 3.60, DL-DWI 4.07, p<.001), Other artifact (5 excellent quality) (R3 c-DWI 4.34, DL-DWI 4.15, p=0.03), Conspicuity of fibroid on DWI (R3 c-DWI 3.93, DL-DWI 4.52, p<.001), Conspicuity of fibroid on ADC (R3 c-DWI 4.11, DL-DWI 4.65, p<.001). Mean ADC value of myometrium was c-DWI 1250±220 mm<sup>2</sup>/s, DL-DWI 1620±270 mm<sup>2</sup>/s, p<.001. Mean ADC value of fibroids (59/108) was c-DWI 890±210 mm<sup>2</sup>/s, DL-DWI 1170±220 mm<sup>2</sup>/s, p<.001.

#### CONCLUSION

Image quality scores were similar between c-DWI and DL-DWI. All readers scored DL-DWI significantly higher than c-DWI for sharpness of uterine margin. ADC values were significantly higher on DL-DWI than c-DWI which may be due to smoothing process in DL reconstruction vs slightly different b values obtained.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning accelerated DWI showed excellent and comparative image quality despite 2 fold reduction in acquisition time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPH-2

### Meningioma Grade Discrimination using a Novel Ultrafast T2 Mapping Technique

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Zongye Li (*Presenter*) Nothing to Disclose

#### PURPOSE

Meningioma grade plays a significant role in treatment planning and prognosis prediction. Despite the numerous prior studies, preoperative diagnosis of meningioma grade remains challenging. Many studies demonstrated the unique value of T2 mapping MRI for characterizing disease pathology, yet often limited by the long scan time. In this study, we employed a deep learning-based single-shot ultrafast T2 mapping technique, which can acquire whole-brain T2 maps within 32 s, and conventional apparent diffusion coefficient (ADC) maps for the WHO grade discrimination of meningiomas.

#### METHODS AND MATERIALS

Sixty-nine patients were enrolled, among which 59 were diagnosed with low-grade meningiomas (LGM, grade 1,  $57.34 \pm 9.40$  years) and ten with high-grade meningiomas (HGM, grade 2 and 3,  $58.18 \pm 9.36$  years). All the MRI examinations were performed on a 3.0 T scanner (MAGNETOM Prisma, Siemens Healthcare, Erlangen, Germany) with a 64-channel head coil. Axial T2 mapping, T2-dark-fluid imaging, diffusion-weighted imaging, and contrast-enhanced T1-weighted imaging were performed for all patients. With 3D Slicer (version 4.10.2, [www.slicer.org](http://www.slicer.org)), regions of interest were manually delineated on each slice of T2 maps by the consensus of two blind neuroradiologists. Necrosis, large vessels, and calcification were excluded. From each ROI, we calculated the following histogram parameters using FeAture Explorer (FAE; <https://github.com/salan668/FAE>): mean, median, maximum, minimum, ten percentiles (P10), 90 percentiles (P90), interquartile range (IQR), range, entropy, skewness, kurtosis, uniformity, and variance. Parameters were compared using the independent t-test or Mann-Whitney U test. Multivariate logistic regression and receiver operating characteristic (ROC) analysis were performed to evaluate their diagnostic efficiency. The significance level of p value is 0.05.

#### RESULTS

Compared to HGM, there were significantly higher T2 ( $p = 0.021$ ) and ADC ( $p = 0.012-0.002$ ) histogram parameters in LGM. ADC P10 had the highest area under the ROC curve (AUC = 0.811) among all the ADC parameters and T2 kurtosis showed an AUC of 0.564. Notably, the combination of T2 and ADC exhibited the best diagnostic performance (AUC = 0.868).

#### CONCLUSION

It has been demonstrated that T2 and ADC histogram parameters could be used to distinguish LGM from HGM, which is consistent with previous studies. Furthermore, the multivariate logistic regression model combining T2 and ADC was suggested to have the best diagnostic efficiency.

#### CLINICAL RELEVANCE/APPLICATION

Meningioma grade is an essential factor that affects the treatment planning and recurrence rate. The combination of T2 and ADC values could provide significant value for the non-invasive prediction of meningioma grade.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W2-SPPH-3

### Deep Learning-Based Spatial Resolution Improving Algorithm (Precise IQ Engine: PIQE) for MRI: Capability for Scan Time Reduction and Image Quality Improvement as Compared with Deep Learning Reconstruction (DLR) with and without New Fine Reconstruction Algorithm

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

#### PURPOSE

Deep learning reconstruction (DLR) with and without fine reconstruction algorithm (i.e. fine recon) has been clinically set for denoising MR images with and without increasing spatial resolution. In this time, deep learning-based spatial resolution improving algorithm with denoising (Precise IQ Engine: PIQE) is developed for MRI. The purpose of this study was to directly compare utilities of PIQE for scan time reduction and image quality improvement of MRI as compared with DLR with and without fine recon.

#### METHODS AND MATERIALS

Sixty-eight consecutive patients suspected with 28 brain tumors, 14 musculoskeletal diseases, 14 uterine or ovarian tumors and 12 prostatic cancers were prospectively scanned with conventional MR protocols and new MR protocols, which were obtained same sequences with reducing matrix sizes ranged from 50% to 70%. Then, each conventional MR data was reconstructed with DLR with and without fine recon, and all new protocol data were reconstructed with PIQE as well as DLR with and without fine recon (total five data sets). To compare scan time reduction and quantitative spatial resolution improvement among all protocols, mean examination time including reconstruction time and edge slope width (ESW) between two different structures were compared among five protocols by Tukey's HSD test. To evaluate qualitative spatial resolution improvement, overall image quality and diagnostic confidence level were assessed by 5-point scales and compared among all protocols by Wilcoxon's signed rank test.

#### RESULTS

Mean examination times of new MR protocols were significantly shorter than that of conventional protocols ( $p < 0.05$ ), although mean examination time had no significant differences among all new protocols. Mean ESW of new protocol with PIQE ( $1.1 \pm 0.3 \text{ mm}$ ) was significantly smaller than that of all protocols except conventional protocol with DLR and fine recon ( $1.4 \pm 0.4 \text{ mm} = \text{other ESWs} = 1.8 \pm 0.4 \text{ mm}$ ,  $p < 0.05$ ). Overall image quality and diagnostic confidence level of new protocol with PIQE were significantly higher than those of others except conventional protocol with DLR and fine recon (overall image quality:  $p < 0.0001$ , diagnostic confidence level:  $p < 0.0001$ ). Artifact of new protocol with PIQE was significantly smaller than those of others without conventional protocol with DLR and fine recon ( $p < 0.0001$ ).

#### CONCLUSION

PIQE has superior potential to DLR with and without fine reconstruction for reducing temporal resolution and improving spatial resolution, although fine reconstruction can only improve image quality of DLR at conventional protocol.

#### CLINICAL RELEVANCE/APPLICATION

PIQE has superior potential to DLR with and without fine reconstruction with reducing temporal resolution and improving spatial resolution.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPH-4

### Early Detection of Myocardial Involvement by Noncontrast T1 $\rho$ Mapping of Cardiac Magnetic Resonance in Type 2 Diabetes Mellitus

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Xiaohu Li, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility of T1 $\rho$  in detecting myocardial fibrosis in type 2 diabetes mellitus (T2DM) patients by comparing with native T1 and Extracellular volume (ECV) fraction.

#### METHODS AND MATERIALS

35 T2DM patients free of cardiovascular symptoms and preserved ventricular systolic function and 30 healthy controls were prospectively enrolled for T1 mapping, T2 mapping T1 $\rho$  mapping, and late gadolinium enhancement (LGE) examination. ECV mps were calculated using pre- and post-contrast T1 maps. Global native T1, T1 $\rho$ , ECV and 2D global longitudinal strain (GLS) values were generated in respective maps. Receiver operating curves were used to show the diagnostic performance of ECV, T1 $\rho$ , GLS and native T1 in distinguishing T2DM patients and controls. The Student's t-test, Pearson's chi-squared test, Pearson correlation coefficient (r) and Delong test were used in this study.  $P < 0.05$  indicates statistical significance.

#### RESULTS

The global ECV and T1 $\rho$  of T2DM group (ECV =  $32.1 \pm 3.2\%$ , T1 $\rho$  =  $53.1 \pm 2.0$  msec) were significantly higher than those of controls (ECV =  $26.2 \pm 1.6\%$ , T1 $\rho$  =  $51.6 \pm 3.8$  msec) (all  $P < 0.001$ ), whether there was no significant difference in native T1 between T2DM and controls ( $P = 0.264$ ). The GLS decreased significantly in T2DM patients ( $-16.5 \pm 2.4\%$  vs.  $-18.3 \pm 2.6\%$ ,  $P = 0.015$ ). The T1 $\rho$  and native T1 were associated with ECV (Pearson's  $r = 0.50$  and  $0.25$ , respectively, both  $P < 0.001$ ), the native T1, T1 $\rho$ , and ECV were associated with hemoglobin A1c (Pearson's  $r = 0.41$ ,  $0.52$ , and  $0.61$ , respectively, all  $P < 0.05$ ), the ECV were associated with diabetes duration (Pearson's  $r = 0.41$ ,  $P = 0.016$ ). The AUC of ECV, T1 $\rho$ , GLS, and native T1 were  $0.869$ ,  $0.810$ ,  $0.659$ , and  $0.524$ , respectively.

#### CONCLUSION

In T2DM patients, T1 $\rho$  may be a new noncontrast cardiac magnetic resonance technique for identifying myocardial diffuse fibrosis, and T1 $\rho$  may be more sensitive than native T1 in the detection of myocardial diffuse fibrosis.

#### CLINICAL RELEVANCE/APPLICATION

It has shown that T1 $\rho$  mapping allow early detection of myocardial diffuse fibrosis in diabetic monkeys. However, T1 $\rho$  has not been reported in patients with type 2 diabetes mellitus (T2DM). In this project, the purpose of this study is to evaluate the feasibility of T1 $\rho$  in detecting myocardial diffuse fibrosis in T2DM in a comparison with myocardial native T1 and ECV.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPH-5

### Changes in Brain Susceptibility in Wilson's Disease Patients: A Quantitative Susceptibility Mapping Study

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Xiaohu Li, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To reveal changes in the susceptibility of the caudate nucleus (CN), putamen (Put), and globus pallidus (GP) in patients with neurological and hepatic Wilson's disease (WD) by quantitative susceptibility mapping (QSM).

#### **METHODS AND MATERIALS**

We retrospectively analyzed brain MRI images of 33 patients diagnosed with Wilson's disease (WD) and 20 age-matched controls. All subjects underwent brain T1-weighted, T2-weighted, and QSM images using a 1.5T MRI scanner. The QSM maps were calculated using STISuite toolbox. The quantitative susceptibility of the CN, Put, and GP was analyzed using region-of-interest analysis on QSM maps. The differences among the neurological WD patients, hepatic patients, and controls were compared.

#### **RESULTS**

Susceptibility values were significantly higher in all examined structures (CN, Put, GP) in patients with neurological WD compared to controls (all  $P < 0.05$ ) and hepatic WD patients (all  $P < 0.05$ ). No statistically significant differences were found in susceptibility values between patients with hepatic WD and controls (all  $P > 0.05$ ).

#### **CONCLUSION**

The QSM technique is a valuable tool for detecting changes in susceptibility in the brain of WD patients, indicating abnormal metal deposition. Notably, our findings suggest that neurological WD patients exhibit more severe susceptibility changes than hepatic WD patients. Therefore, QSM can be utilized as a complementary method to detect brain injury in WD patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Quantitative magnetic susceptibility imaging (QSM) is an advanced MRI technique for magnetic susceptibility evaluation, providing accurate quantitative measurements of the spatial distribution of magnetic susceptibility

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPPH-6

### Vendor-independent MRI Pulse Sequence Development to Increase Comparability in Cross-vendor Imaging Studies

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Simon Konstandin, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic Resonance Imaging is a complex and versatile imaging method, given by the ability to visualize various contrasts and physiological processes. MRI research is commonly achieved by implementing new pulse sequences in vendor-specific development environments. During the last years, vendor-independent MRI frameworks gained attention. Previously, we introduced a vendor-independent MRI pulse sequence development framework that provides a product-like experience on-site, called gammaSTAR [Cordes C et al. Magn Reson Med 2020;83(4):1277-90.]. Until today, none of these frameworks was able to run the same MRI sequence on the MRI hardware of the three largest MRI vendors: Siemens, GE and Philips. In this abstract, for the first time, we show cross-vendor use of gammaSTAR MRI sequences on all three platforms.

#### METHODS AND MATERIALS

A modular web frontend (free version here: [gamma-star.mevis.fraunhofer.de](http://gamma-star.mevis.fraunhofer.de)) is used to implement MRI sequences and export them into a generalized sequence format. This does not consist of fixed hardware instructions, but holds the fundamental calculation logic of the implemented MRI sequence, allowing for product-like interaction with the MRI sequence and protocol. gammaSTAR driver software is implemented using the vendors development environments to interpret the gammaSTAR sequences and translate events into the vendor-specific hardware commands.

#### RESULTS

MRI experiments show the feasibility of running MRI sequences developed in the vendor-independent gammaSTAR framework on Siemens, GE and Philips MRI scanners. Image quality is similar to corresponding product MRI sequences and the framework allows for the same protocol interaction and positioning. Low cross-vendor comparability of conventional MRI arises from underlying implementation differences. The use of the same MRI sequence for execution on different MRI hardware allows, for the first time, a comparison of the exact same MRI sequence in a multi-vendor scenario.

#### CONCLUSION

MRI sequences developed in gammaSTAR were for the first time executed on hardware platforms of all three major MRI vendors. This will eventually open up science and improve the significance of multi-vendor clinical trials by harmonizing imaging technology.

#### CLINICAL RELEVANCE/APPLICATION

The current state of vendor-centric MRI pulse sequence development limits reuse of MRI applications for different MRI models, software versions. The execution of generalized MRI sequences on MRI hardware of the three largest MRI vendors presents a chance for higher comparability in multi-vendor clinical trials, between follow-ups acquired in different clinics and re-use of MRI sequences for opening up science and accelerating the way of innovation into clinical practice.

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## Abstract Archives of the RSNA, 2023

W2-SPPH-8

### Egress Pathways of Intrinsic CSF Outflow Altered by Physical Exercise in Healthy Humans

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Mitsue Miyazaki, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate egress pathways of intrinsic CSF outflow and their quantitative metrics using a spin-labeling MRI technique on healthy adults with active and sedentary lifestyles. We also examined changes in the CSF outflow metrics in sedentary adults after they increased their physical activity levels for three weeks.

#### METHODS AND MATERIALS

Eighteen healthy adults with informed consent were enrolled in this study using a clinical 3-Tesla MRI scanner. We classified participants into two groups based on reported time spent sitting per day (active group < 7 hours or an average of  $5.3 \pm 0.7$  and sedentary group = 7 hours or an average of  $10.4 \pm 1.7$ ). To reveal the effect of exercise, the sedentary individuals were asked to increase their activity to at least about 3.5 hours per week for 3 weeks. To elucidate intrinsic CSF outflow pathways and quantitative metrics, we studied a signal increase ratio (SIR) of time-resolved images at various inversion times (TI). Our hypothesis is that intrinsic CSF egress pathways of 1) dura mater to superior sagittal sinus (SSS), via parasagittal dura (PSD), and 2) the lower PSD pathway from the perivascular space of subcortical or bridging veins. We also measured quantitative outflow metrics at 5 segmented region-of-interests (ROIs); upper PSD, middle PSD, lower PSD, SSS, and entire SSS.

#### RESULTS

The active lifestyle group shows greater intrinsic CSF outflow metrics in peak height (PH), relative CSF volume (rCFV), and relative CSF flow (rCFF) ( $p < 0.05$ ) in all above ROIs than the sedentary lifestyle group. However, the sedentary group shows increased outflow metrics after 3 weeks of increased physical activity. This improvement was notable at the PSD, where outflow metrics were highest among the active group and after exercise in sedentary group. These quantitative CSF results indicate a new pathway of CSF outflow from the lower PSD to the SSS that is most evident in physically active individuals.

#### CONCLUSION

The results show that physical exercise alters CSF outflow metrics to a greater degree in the lower PSD pathway, which may be responsible for the perivascular space of cortical veins or subpial space.

#### CLINICAL RELEVANCE/APPLICATION

Our findings in healthy adults with active and sedentary lifestyles reveal differences in quantitative CSF outflow metrics related to activity levels. These quantitative outflow findings at the lower PSD add credence to the hypothesis of a distinct, recruitable second pathway of CSF egress from the subpial space to the SSS, with potential implications for future use as a biomarker for cognitive decline and/or therapeutic targeting in aging and neurodegeneration.

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## Abstract Archives of the RSNA, 2023

W2-SPPH-9

### A Robust Spectroscopic Imaging Sequence for 7T Brain Glioma Evaluation

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Jullie W. Pan, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To implement a robust fast targeted spectroscopic imaging sequence at 7T for brain tumors. While 3T single voxel spectroscopy is an excellent acquisition, with limited scan time, small voxel targets, and the need to place single voxels by the technologist can be difficult. These problems can be better managed with higher SNR at 7T; however, 7T can be difficult for spectroscopy with limited RF and susceptibility. We implement the decoupled transceiver coil and a high degree shim insert with an efficient spatial encoding strategy to assess its performance in glioma patients.

#### METHODS AND MATERIALS

With IRB oversight, tumor patients were recruited from Tumor Board review (10 patients recruited; 9 completed). An 8 channel pTx Siemens 7T Terra, decoupled transceiver and very high order shim (VHOS) insert was used. After whole brain MP2RAGE imaging and RF shimming, the target regions were identified. For optimal shimming, single slices were studied, shimmed using a high accuracy field map with the VHOS insert. A moderate echo TE=40ms spectroscopic imaging sequence encoded with a noncartesian rosette trajectory was used (32x32 resolution, 4.5min single slice). First level SAR monitoring was used. Automated LCModel curve fit was used to determine metabolite ratios. Values of maximum Ch/NAA value in the region of the lesion were used to identify 3 groups of abnormality:  $\geq 1.7$ ,  $\geq 0.9$  to  $< 1.7$  or  $< 0.9$ . All studies were blinded to clinical and imaging data to independently compare clinical to spectroscopic imaging group.

#### RESULTS

Fig. 1 shows data from a patient with two regions of interest. Based on literature and the patient data, the ratios for Ch/NAA and Ch/Cr were used for initial classification (control value for parenchymal Ch/NAA  $0.56 \pm 0.17$ , Ch/Cr  $1.03 \pm 0.15$ ). The spectroscopic group based on the maximum Ch/NAA in the region of tumor was compared with their clinical group, either active tumor, treatment effect or no change, Table 1. N=5 patients with Ch/NAA  $\geq 1.7$  were classified with active tumor; 1 patient classified as normal had low Ch/NAA  $< 0.9$ . The remaining 3 patients ( $0.9 \leq \text{Ch/NAA} < 1.7$ ) were clinically described as treatment effect (1), progression (1) or no change (1); the last "no change" patient was identified 6mos later to have progression.

#### CONCLUSION

At 7T with the decoupled transceiver and high degree shim insert, the spectroscopic imaging was able to identify patients with active tumor. An intermediate threshold for Ch/NAA of 0.9 to 1.7 identified those with treatment effect or very early recurrence. With additional data, better classification may be possible.

#### CLINICAL RELEVANCE/APPLICATION

We have implemented 7T methods that can acquire robust spectroscopic images in glioma patients which can contribute to a better or earlier understanding of the tumor state.

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## Abstract Archives of the RSNA, 2023

W2-SPRO-1

### Deep Learning Prediction of Post-Radiation Magnetic Resonance Images to Inform Stereotactic Radiotherapy of Breast Cancer Metastases to the Brain

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Natarajan Raghunand, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Changes on standard multiparametric MRI (mpMRI), including T1-weighted unenhanced (T1w) and contrast-enhanced (T1wCE), T2-weighted (T2w), Fluid-Attenuated Inversion Recovery (FLAIR), and Apparent Diffusion Coefficient of water (ADC) images are mechanistically relatable to voxel-level tumor response to Radiation Therapy (RT). While Stereotactic Radiosurgery (SRS) provides high local control rates for the management of Breast Cancer Metastases to the Brain (BCMB), tools to enable voxel-level optimization of RT dose plans for local tumor control with minimal toxicity to normal tissues do not exist. We have trained deep learning “forward models” to predict post-SRS T1w, T1wCE, T2w, FLAIR and ADC maps from the corresponding 5 pre-SRS mpMRIs and the delivered RT dose map. We also trained an “inverse model” to predict the delivered RT dose map from 5 pre-SRS and 5 post-SRS mpMRI images. The overarching goal is to enable the radiation oncologist to compute the RT dose map to achieve prescribed post-SRS values of ADC, T1wCE, T1w, T2w and FLAIR within the GTV, simulate mpMRI outcomes and iteratively optimize RT plans for local control of BCMB.

#### METHODS AND MATERIALS

Planning CT images and associated RT dose maps, and T1w, T1wCE, T2w, FLAIR images and ADC maps acquired pre-SRS, post-SRS, and at tumor recurrence were curated from 27 BCMB patients (18 Training, 9 Test) with confirmed controlled and locally recurrent metastases. Patients were treated with SRS dose of 1-40 Gy between 2013-2019. After co-registration to the planning CT, all mpMRIs were intensity-calibrated, variance-normalized and scaled. A pix2pix framework used to predict post-SRS MRIs from pre-SRS MRIs and the RT dose map (5 forward models). Another pix2pix model was trained to predict the RT dose map from pre-SRS and post-SRS MRIs (inverse model).

#### RESULTS

On testing, forward model accuracy for predicting the direction of post-SRS intensity change within the Gross Tumor Volume (GTV) was highest for T1wCE (83%), followed by T1w (77%), FLAIR (75%), T2w (68%), and ADC (46%). In agreement with expectations, higher RT doses within the GTV are predicted by the inverse model to achieve greater suppression of intensity on T1wCE and/or higher ADC within the GTV post-SRS.

#### CONCLUSION

We have demonstrated the feasibility of predicting post-RT mpMRI images from pre-RT mpMRIs and the delivered RT dose map. For a given set of pre-RT mpMRIs, we have also demonstrated the feasibility of predicting the RT dose map that would be required to achieve prescribed post-RT intensities within the GTV.

#### CLINICAL RELEVANCE/APPLICATION

We present a new paradigm in RT planning, viz., voxel-level optimization of SRS dose to achieve prescribed post-SRS mpMRI characteristics of treated tumors using the presented forward and inverse models.

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## Abstract Archives of the RSNA, 2023

W2-SPVA-1

### Tele-robotic Ultrasound Usability Testing on a Phantom

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Leah Groves, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Annually, 16 million North American patients struggle to access diagnostic ultrasound (US) services due to sonographer shortages. Rural and remote patients are required to travel excessive distances to access diagnostic US services, which can be time-consuming and expensive resulting in patients failing to attend their appointments. The aim of this study is to validate a proof-of-concept tele-robotic US system which serves to make diagnostic healthcare more accessible.

#### METHODS AND MATERIALS

The equipment used in the study included the Kinova Gen 3 robot, Clarius L7 US probe, the Inverse3 (input device), and an advanced deep-vein thrombosis (DVT) phantom. First, seven sonographers performed freehand DVT scans on the phantom. After successful training, each sonographer performed a teleoperated DVT scan, where they controlled the robot using the input device. The required US images, clot diameter, and scan duration were recorded for the freehand and teleoperated scans. The users then completed a survey, where various parameters were ranked on a scale of 1-5, with 5 being optimal. Next, each user performed three teleoperated scans with three random and counter-balanced latencies (0, 300, 600 ms). They started at a standardized position, located the clot, and measured its diameter. The duration of each test was recorded.

#### RESULTS

The clot diameters collected using freehand and teleoperated US were  $1.1 \pm 0.2$  cm and  $1.0 \pm 0.3$  cm, respectively. The time associated with performing the freehand and teleoperated DVT scans were  $8.7 \pm 3.8$  min and  $8.0 \pm 2.0$  min, respectively. The usability survey yielded the following average rankings for input device features: naturalism and usable workspace, 3.4; ergonomics, 3.9; ease of use, 4.3. The rankings for the robotic system features were: smoothness, 3.1; naturalism, 3.4; range of motion, 3.6; and control accuracy, control ease, and synchronicity, 3.7. The clot diameter collected with teleoperated US were  $1.2 \pm 0.24$  cm,  $1.1 \pm 0.32$  cm, and  $1.1 \pm 0.24$  cm for 0, 300, and 600 ms latencies, respectively. The duration of the tests subject to 0, 300, 600 ms latencies were  $1.3 \pm 0.69$  min,  $1.4 \pm 0.69$  min, and  $1.9 \pm 0.68$  min, respectively.

#### CONCLUSION

This study provides a proof-of-concept for the use of teleoperated diagnostic US as sonographers were able to measure the clot diameter within 0.1 cm of their freehand equivalent without increasing the time required for the scan. Latencies up to 600 ms did not affect the accuracy of the resultant clot diameter or scan time.

#### CLINICAL RELEVANCE/APPLICATION

The results of this proof of concept study encourages the continued pursuit of teleoperated US research as there is a strong potential it could result in more patients obtaining diagnostic US, improved outcomes from earlier diagnosis, and safer pregnancies.

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## Abstract Archives of the RSNA, 2023

W2-SPVA-2

### **Diagnostic Accuracy of Photon-Counting CT Angiography in Lower Extremity Peripheral Artery Disease: A Head-to-Head Comparison with Invasive Angiography**

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Niklas Verloh, MD (*Presenter*) Speaker, Bayer AG; Research Funded, Bayer AG

#### **PURPOSE**

CT Angiography (CTA) has gained increasing importance in assessing the presence and severity of peripheral artery disease (PAD). However, the diagnostic performance of the lower leg vasculature remains challenging due to small vessel diameters and impaired image quality caused by the blooming of calcified plaques. Recently introduced photon-counting detector CT (PCD-CT) technology may overcome these limitations. Therefore, we aimed to investigate and compare the diagnostic accuracy of PCD-CT for PAD of the lower leg with invasive digital subtraction angiography (DSA) as the reference standard.

#### **METHODS AND MATERIALS**

Consecutive patients with suspected PAD of the lower leg, who underwent CT and DSA within 48 hours, were prospectively included. Five series were reconstructed using dedicated vascular kernels (Bv40, Bv44, Bv48, Bv56, and Bv60). DSA of the lower extremities was acquired in two orthogonal orientations as the gold standard. To assess and compare the diagnostic performance of the different PCD-CT reconstructions, two interventional radiologists assessed all PCD-CT and DSA data independently in random order. They were blinded to the type of reconstruction. First, overall image quality was rated on a 5-Point Likert scale (5=excellent). Secondly, the presence and diagnostic confidence (5-Point Likert scale; 5=excellent) of potentially hemodynamic-relevant stenosis (=50%) was assessed.

#### **RESULTS**

Among twenty-three patients included in the final analysis (70±11 years, 39% female), six hemodynamic-relevant stenoses were detected on DSA. The highest overall image quality was found for the Bv56 and the Bv60 kernel (4 [4-4]; 4 [3-5];  $p=0.001$ ), followed by softer kernels. Also, the Bv56 kernel yielded the highest sensitivity (83.33%) and specificity (94.12%) for the detection of potentially relevant stenosis with the highest diagnostic confidence (4 [3-5];  $p=0.001$ ) and inter-reader agreement ( $k=0.7$ ), similarly followed by Bv60 and softer kernels.

#### **CONCLUSION**

PCD-CT CTA with a sharp vascular kernel (Bv56) allows for detecting relevant stenosis in the lower leg vasculature with high diagnostic accuracy and confidence. These results can potentially strengthen the role of CTA in the workup of patients with known or suspected PAD and reduce the number of invasive diagnostic DSA.

#### **CLINICAL RELEVANCE/APPLICATION**

CTA is important in the workup of PAD but remains challenging due to small vessel caliber and potential blooming artifacts. PCD-CT CTA with a sharp vascular kernel may improve image quality and, thus, patient management. Using PCD-CT may ultimately reduce the need for invasive diagnostic procedures.

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## Abstract Archives of the RSNA, 2023

W2-STCE1

### Science Session (Generative AI)

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center Theater 1

#### Sub-Events

#### **W2-STCE1- Advanced Oncologist Assistance: Generating Alarms for new Oncologic Issues based on Radiologic Reports of Serial CT Scans with GPT-4** 1

Na Yeon Han (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Abdominal CT play crucial roles for assessment of treatment response for cancer patients. However, radiologic reports often lack standardization, encompassing a plethora of information beyond cancer-related findings. Moreover, the multitude of test results conducted in cancer patients can be overwhelming, leading oncologists occasionally missing critical findings. This study aims to investigation on the feasibility of generative AI to generating the alarm for clinically significant oncologic Issues in serial CT reports.

#### **METHODS AND MATERIALS**

We studied 101 patients with various primary tumors, obtaining two consecutive radiologic reports per patient. We designed 4 multiple-choice questions to assess oncologic issues in the reports. Questions were designed to contain progressively added specific conditions, such as radiologic report's chronological sequence, precise criteria for oncologic issues, and the patient's treatment status. GPT-4 (July 20 Version) was asked to choose the correct answer based on radiologic reports among the four alternatives for each question. Consensus ground truth was established by two blinded radiologists. Since GPT-4 does not always output the same answer, each question was repeated three times, and the most frequently occurring value was recorded. GPT-4 responses were compared to ground truth, and the model's performance was compared using McNemar-Test. P-values < 0.05 were considered statistically significant.

#### **RESULTS**

Among 101 patients, 31 had no new oncologic issues, 18 improved, 18 remained stable, and 34 worsened. GPT-4 showed accuracy rate of 0.92 (93/101) for Question (Q)1; 0.97 (98/101) for Q2; 0.99 (100/101) for Q3 and 0.99 (100/101) for Q4. Accuracy rate was significantly higher for Q2 (p-value of 0.041) and for Q3 and Q4 (p-value of 0.023) than for Q1. Upon reviewing the radiologic report of one patient who had incorrect output for Q3 and Q4, we identified an error in the consensus review. This error arose from the fact that the lesion, which had already been mentioned in report 1, was reported as a "newly developed lesion" in report 2, resulting in an erroneous entry of the ground truth.

#### **CONCLUSION**

In this study, utilizing GPT-4 to generate alarms for new oncologic issues in radiologic reports of Serial CT Scans demonstrated high performance, particularly when specific questions were asked. These results indicate the potential for various future studies using generative AI to enhance interpretation accuracy and prevent important information omission in patient care.

#### **CLINICAL RELEVANCE/APPLICATION**

Using GPT-4 to provide accurate alarms for new oncologic issues based on radiologic reports can help reduce oncologists' data review time and prevent patient information omissions.

#### **W2-STCE1- Generative Language Model for Risk-Specific Metabolic Health Report Generation from Deep Learning-Based Opportunistic Assessment of Lung Cancer Screening CT** 2

Florian A. Huber, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The majority of CT examinations cover large body volumes that allow for the assessment of imaging biomarkers to predict bone health and cardiometabolic risk. Novel deep learning-based automated post-processing and analysis techniques allow opportunistic screening using routine clinical CTs. We aimed to prove the feasibility of generating personalized metabolic reports using a novel proprietary generative AI tool (GPT-4, OpenAI) in combination with a custom deep learning-based post-processing algorithm for opportunistic assessment of CT examinations in a diverse US metropolitan population.

## METHODS AND MATERIALS

Demographic and CT data of 5442 patients who underwent low-dose CT of the lungs for lung cancer screening were included. All imaging was acquired in accordance with institutional protocol standards (peak tube voltage: 120 kVp, tube current modulation: = 80 mAs, pitch: 1.25 to 1.5, rotation time: = 500 milliseconds). A validated deep learning-based assessment tool was used for automated evaluation of bone mineral density (BMD), liver steatosis, aortic calcification, and muscle mass and quality. We performed interrogative strings with a generative tool based on GPT-4 that was aware of clinical and academic knowledge published until 2021. Subsequently, the language model was asked to provide personalized patient-readable health reports for a combination of 5 different clinical findings (aortic calcification, sarcopenia, myosteatosis, BMD, liver steatosis). Results were tested for all present scenarios of possible disease combinations and assessed for readability, appropriateness, and impact on patient management using a 4-point Likert scale (absent, poor, satisfactory, excellent for each parameter separately in each of the 5 clinical findings, see Figure 1). Descriptive statistics were applied to evaluate results from the generated personalized health reports.

## RESULTS

We identified 70 clinical scenarios among our cohort. The generative AI model was able to provide individual reports for each scenario (n=70, 100%). Average ratings were considered excellent, with total scores as follows (median, range; maximum score in each category: 15): 14[13-15] for readability, 13[12-15] for appropriateness, 13[11-14] for clinical impact.

## CONCLUSION

Generative models are capable of translating medical information into patient-centered health reports at excellent overall quality.

## CLINICAL RELEVANCE/APPLICATION

The application of opportunistic CT assessment algorithms can be linked with novel generative language tools to improve patient interaction and understandability of clinical findings unrelated to primary clinical requests.

## W2-STCE1- Utilizing Large Language Models for Neuro-Oncologic Prediction: A Multi-Center Study on 3 Magnetic Resonance Imaging Reports

Maliha R. Imami, MEng (*Presenter*) Nothing to Disclose

## PURPOSE

Central nervous system tumors are a leading cause of cancer-related mortality worldwide. Longitudinal neuroimaging data with magnetic resonance (MR) imaging is essential for evaluating radiographic response and prognosis. We aimed to develop large language models (LLMs) using MR imaging reports for the automated curation of neuro-oncologic outcomes across a diverse array of brain tumor types to enhance prognostication accuracy.

## METHODS AND MATERIALS

We retrieved MR reports and clinical data from patients with intracranial brain tumors from two large academic centers in the United States. 9,055 free-text radiology reports from a cohort of 1,580 brain tumor patients were manually annotated for: (1) cancer presence or absence and (2) tumor stability (stable versus progressive disease). Three LLMs (ClinicalBERT, BlueBERT, and ELECTRA) and four baseline NLP models (CNN, RNN, GRU, LSTM) were developed. Models were trained and validated with data from Institution-1 and externally tested on Institution-2 reports. Performance was compared via weighted-F1 and accuracy; model decision interpretability tools were generated. Multivariate cox proportional hazards regressions were used to correlate model output with survival.

## RESULTS

For cancer presence task, the training dataset from Institution-1 had 4,621 reports (70.4% "cancer present") and 3,954 external test reports (55.4% "cancer present") from Institution-2. The tumor stability task had 5,017 training reports (74.2% "stable/improving") and 4,038 testing reports (81.1% "stable/improving"). The three LLMs demonstrated superiority over baseline models and ELECTRA exhibited the best performance among the LLMs for both tasks. For cancer presence, ELECTRA achieved a weighted F1-score of 0.822, accuracy of 0.822, sensitivity of 0.804, and specificity of 0.836. Weighted F1-score, accuracy, sensitivity, and specificity were 0.933, 0.934, 0.807, and 0.963 for tumor stability, respectively. Hazard ratios revealed higher mortality risk for patients with reports classified as cancer present (3x) and progressive disease (2x). Sample interpretability outputs are provided.

## **CONCLUSION**

Our ELECTRA transformer was able to extract salient neuro-oncologic outcomes from unstructured radiology reports and risk stratify patients in a sample-efficient and explainable manner. These results illustrate utility of LLMs for effective prediction of clinically salient neuro-oncologic outcomes.

## **CLINICAL RELEVANCE/APPLICATION**

Automated, explainable LLM frameworks can provide clinicians involved in neuro-oncologic care with rapid and reliable interpretation of imaging findings to streamline workflows, risk stratify patients and facilitate longitudinal monitoring.

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## Abstract Archives of the RSNA, 2023

W2-STCE1-1

### Advanced Oncologist Assistance: Generating Alarms for new Oncologic Issues based on Radiologic Reports of Serial CT Scans with GPT-4

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center Theater 1

Na Yeon Han (*Presenter*) Nothing to Disclose

#### PURPOSE

Abdominal CT play crucial roles for assessment of treatment response for cancer patients. However, radiologic reports often lack standardization, encompassing a plethora of information beyond cancer-related findings. Moreover, the multitude of test results conducted in cancer patients can be overwhelming, leading oncologists occasionally missing critical findings. This study aims to investigation on the feasibility of generative AI to generating the alarm for clinically significant oncologic Issues in serial CT reports.

#### METHODS AND MATERIALS

We studied 101 patients with various primary tumors, obtaining two consecutive radiologic reports per patient. We designed 4 multiple-choice questions to assess oncologic issues in the reports. Questions were designed to contain progressively added specific conditions, such as radiologic report's chronological sequence, precise criteria for oncologic issues, and the patient's treatment status. GPT-4 (July 20 Version) was asked to choose the correct answer based on radiologic reports among the four alternatives for each question. Consensus ground truth was established by two blinded radiologists. Since GPT-4 does not always output the same answer, each question was repeated three times, and the most frequently occurring value was recorded. GPT-4 responses were compared to ground truth, and the model's performance was compared using McNemar-Test. P-values < 0.05 were considered statistically significant.

#### RESULTS

Among 101 patients, 31 had no new oncologic issues, 18 improved, 18 remained stable, and 34 worsened. GPT-4 showed accuracy rate of 0.92 (93/101) for Question (Q)1; 0.97 (98/101) for Q2; 0.99 (100/101) for Q3 and 0.99 (100/101) for Q4. Accuracy rate was significantly higher for Q2 (p-value of 0.041) and for Q3 and Q4 (p-value of 0.023) than for Q1. Upon reviewing the radiologic report of one patient who had incorrect output for Q3 and Q4, we identified an error in the consensus review. This error arose from the fact that the lesion, which had already been mentioned in report 1, was reported as a "newly developed lesion" in report 2, resulting in an erroneous entry of the ground truth.

#### CONCLUSION

In this study, utilizing GPT-4 to generate alarms for new oncologic issues in radiologic reports of Serial CT Scans demonstrated high performance, particularly when specific questions were asked. These results indicate the potential for various future studies using generative AI to enhance interpretation accuracy and prevent important information omission in patient care.

#### CLINICAL RELEVANCE/APPLICATION

Using GPT-4 to provide accurate alarms for new oncologic issues based on radiologic reports can help reduce oncologists' data review time and prevent patient information omissions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-STCE1-2

### Generative Language Model for Risk-Specific Metabolic Health Report Generation from Deep Learning-Based Opportunistic Assessment of Lung Cancer Screening CT

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center Theater 1

Florian A. Huber, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The majority of CT examinations cover large body volumes that allow for the assessment of imaging biomarkers to predict bone health and cardiometabolic risk. Novel deep learning-based automated post-processing and analysis techniques allow opportunistic screening using routine clinical CTs. We aimed to prove the feasibility of generating personalized metabolic reports using a novel proprietary generative AI tool (GPT-4, OpenAI) in combination with a custom deep learning-based post-processing algorithm for opportunistic assessment of CT examinations in a diverse US metropolitan population.

#### METHODS AND MATERIALS

Demographic and CT data of 5442 patients who underwent low-dose CT of the lungs for lung cancer screening were included. All imaging was acquired in accordance with institutional protocol standards (peak tube voltage: 120 kVp, tube current modulation: = 80 mAs, pitch: 1.25 to 1.5, rotation time: = 500 milliseconds). A validated deep learning-based assessment tool was used for automated evaluation of bone mineral density (BMD), liver steatosis, aortic calcification, and muscle mass and quality. We performed interrogative strings with a generative tool based on GPT-4 that was aware of clinical and academic knowledge published until 2021. Subsequently, the language model was asked to provide personalized patient-readable health reports for a combination of 5 different clinical findings (aortic calcification, sarcopenia, myosteotosis, BMD, liver steatosis). Results were tested for all present scenarios of possible disease combinations and assessed for readability, appropriateness, and impact on patient management using a 4-point Likert scale (absent, poor, satisfactory, excellent for each parameter separately in each of the 5 clinical findings, see Figure 1). Descriptive statistics were applied to evaluate results from the generated personalized health reports.

#### RESULTS

We identified 70 clinical scenarios among our cohort. The generative AI model was able to provide individual reports for each scenario (n=70, 100%). Average ratings were considered excellent, with total scores as follows (median, range; maximum score in each category: 15): 14[13-15] for readability, 13[12-15] for appropriateness, 13[11-14] for clinical impact.

#### CONCLUSION

Generative models are capable of translating medical information into patient-centered health reports at excellent overall quality.

#### CLINICAL RELEVANCE/APPLICATION

The application of opportunistic CT assessment algorithms can be linked with novel generative language tools to improve patient interaction and understandability of clinical findings unrelated to primary clinical requests.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-STCE1-3

### Utilizing Large Language Models for Neuro-Oncologic Prediction: A Multi-Center Study on Magnetic Resonance Imaging Reports

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center Theater 1

Maliha R. Imami, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Central nervous system tumors are a leading cause of cancer-related mortality worldwide. Longitudinal neuroimaging data with magnetic resonance (MR) imaging is essential for evaluating radiographic response and prognosis. We aimed to develop large language models (LLMs) using MR imaging reports for the automated curation of neuro-oncologic outcomes across a diverse array of brain tumor types to enhance prognostication accuracy.

#### METHODS AND MATERIALS

We retrieved MR reports and clinical data from patients with intracranial brain tumors from two large academic centers in the United States. 9,055 free-text radiology reports from a cohort of 1,580 brain tumor patients were manually annotated for: (1) cancer presence or absence and (2) tumor stability (stable versus progressive disease). Three LLMs (ClinicalBERT, BlueBERT, and ELECTRA) and four baseline NLP models (CNN, RNN, GRU, LSTM) were developed. Models were trained and validated with data from Institution-1 and externally tested on Institution-2 reports. Performance was compared via weighted-F1 and accuracy; model decision interpretability tools were generated. Multivariate cox proportional hazards regressions were used to correlate model output with survival.

#### RESULTS

For cancer presence task, the training dataset from Institution-1 had 4,621 reports (70.4% "cancer present") and 3,954 external test reports (55.4% "cancer present") from Institution-2. The tumor stability task had 5,017 training reports (74.2% "stable/improving") and 4,038 testing reports (81.1% "stable/improving"). The three LLMs demonstrated superiority over baseline models and ELECTRA exhibited the best performance among the LLMs for both tasks. For cancer presence, ELECTRA achieved a weighted F1-score of 0.822, accuracy of 0.822, sensitivity of 0.804, and specificity of 0.836. Weighted F1-score, accuracy, sensitivity, and specificity were 0.933, 0.934, 0.807, and 0.963 for tumor stability, respectively. Hazard ratios revealed higher mortality risk for patients with reports classified as cancer present (3x) and progressive disease (2x). Sample interpretability outputs are provided.

#### CONCLUSION

Our ELECTRA transformer was able to extract salient neuro-oncologic outcomes from unstructured radiology reports and risk stratify patients in a sample-efficient and explainable manner. These results illustrate utility of LLMs for effective prediction of clinically salient neuro-oncologic outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Automated, explainable LLM frameworks can provide clinicians involved in neuro-oncologic care with rapid and reliable interpretation of imaging findings to streamline workflows, risk stratify patients and facilitate longitudinal monitoring.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSBR08

### Science Session with Keynote: Breast Imaging (New Applications in Contrast Imaging)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406A

John M. Lewin, MD (*Moderator*) Officer, Novian Health Inc  
Jessica W. Leung, MD (*Moderator*) Scientific Advisory Board, Subtle Medical, Inc; Speaker, General Electric Company; Speaker, Hologic, Inc; Scientific Advisory Board, Seno Medical Instruments, Inc  
Rebecca Rakow-Penner, MD, PhD (*Moderator*) Research Grant, General Electric Company; Consultant, Human Longevity Inc; Stockholder, CureMetrix, Inc; Stock options, CorTechs Labs, Inc

#### Sub-Events

#### **W3-SSBR08-1 Contrast-Enhanced Mammography-Guided Biopsy for MRI-Detected Lesions: Feasibility and Factors Predicting Success**

Yuying Cao, BSC (*Presenter*) Nothing to Disclose

#### PURPOSE

This study assessed the utility of stereotactic contrast-enhanced mammography (CEM)-guided biopsy for MRI-detected lesions. Biopsy success rate was evaluated as well as factors that may predict success. Patient satisfaction and radiologist confidence level were also assessed.

#### METHODS AND MATERIALS

94 women (mean age 54.9 + 11.3 years) were enrolled in this prospective IRB-approved study, with 114 MRI-suspicious lesions BI-RADS 4A or greater for which CEM biopsy was attempted. Biopsy success was defined by enhancing lesion retrieval, biopsy clip position on post-procedure mammogram, and radiology-pathology correlation. Surveys were given to patients and clinicians. Success rate was evaluated with the Wilson score interval. Lesion characteristics {size, type [mass, focus, or non-mass enhancement (NME); distribution; internal enhancement pattern], patient breast density, MRI kinetics, MRI background parenchymal enhancement (BPE)} from successful and failed biopsies were compared using Wilcoxon rank-sum test (breast density, MRI BPE), two-sample t-test (lesion size), and Fisher's exact test (all others).

#### RESULTS

Of 114 MRI-detected breast lesions, 15 proved malignant. 69/114 (61%, 95% CI 51-69) successfully underwent CEM-guided biopsy, including 12 malignant lesions. Of the 45 failures, 41 (91.1%) were due to lack of enhancement on CEM, with no CEM biopsy attempted; 35/45 (77.8%) were then biopsied using MR guidance and 3 proved malignant. Successful CEM biopsy was more likely for larger lesions (mean = 21.5 + 25.3 mm vs 10.0 + 9.3 mm,  $P=0.004$ ). NME lesion type was associated with success ( $P=0.01$ ), comprising 46/69 (66.7%) successful biopsies and 19/45 (42.2%) failures. NMEs were further compared between successful and failed groups, and no association was found for distribution ( $P=0.2$ ); internal enhancement pattern (homogeneous vs heterogeneous vs clumped vs clustered ring) was of borderline significance ( $P=0.05$ ). No association was found between success and MRI kinetics ( $P=0.5$ ). No differences were found between successful and failed biopsies for breast density ( $P=0.3$ ) or BPE ( $P=0.6$ ). Patient satisfaction was rated 4.8/5 + 0.7. For enhancing lesions, radiologist confidence in biopsy success was rated 4.4/5 + 0.8.

#### CONCLUSION

CEM-guided biopsy for MRI-detected lesions had a 61% success rate. Larger lesion size and NME lesion type were associated with success. Patients were overall satisfied with the procedure, and radiologists were overall confident in success.

#### CLINICAL RELEVANCE/APPLICATION

Evaluation of success rate of CEM-guided biopsy for MRI-detected lesions along with factors associated with success may inform guidelines regarding CEM biopsy use, and elucidate which MRI lesions should undergo attempted CEM biopsy.

#### **W3-SSBR08-2 Deep Learning Based Contrast Dose Reduction in Breast MRI Using Synthetic Low-dose Images**



Venkata, MSc (*Presenter*) Employee, Subtle Medical, Inc; Stockholder, Subtle Medical, Inc

## PURPOSE

Gadolinium-based contrast agent (GBCA)-enhanced breast MRI is widely used for breast cancer screening and evaluating treatment response. Due to various safety concerns of GBCAs, including long-term tissue deposition, there is a need for dose reduction. In this work, we investigate the feasibility of a deep learning (DL) method for contrast dose reduction in dynamic contrast-enhanced (DCE) breast MRI, using synthesized low-dose images.

## METHODS AND MATERIALS

Previously, a DL model was trained to synthesize full-dose CE brain MRI images from real pre-contrast and 10% low-dose images. This DL dose reduction model was repurposed to synthesize post-contrast breast MRI images (Synth-Gad) from real pre-contrast images and synthetic low-dose (Synth-Low) images (Fig 1A). The synthetic low-dose breast images were generated from pre- (Pre-Gad) post-contrast (Real-Gad) images, using a vision transformer that was trained with brain MRI data (Fig 1B) to perform arbitrary low-dose simulation. DCE breast MRI data from 60 patients (30 internal, 30 Duke Breast MRI public dataset) were used for evaluation. The CE images were normalized and co-registered to Pre-Gad, and the first time point post injection was used as Real-Gad. In order to simplify the intensity normalization process, axial images were manually cropped to remove signals posterior to the pectoral muscles. Left right sides were separated and processed individually by the DL model. Similarity metrics (PSNR SSIM) were calculated between Real-Gad and Synth-Gad images. Enhancement kinetic curves (time post injection vs signal intensity - SI) were drawn with Pre-Gad, Real-Gad and the other CE time points along with the average SI of Synth-Low and Synth-Gad images.

## RESULTS

The mean PSNR SSIM between Real- Synth-Gad was ( $31.55 \pm 3.26$  dB  $0.85 \pm 0.07$ ). Qualitative examples shown in (Fig 1C) demonstrate that enhancement patterns in Synth-Gad images are similar to those present in Real-Gad images. The corresponding enhancement kinetic curves show that the SI of Real Synth-Gad images are similar and the SI of Synth-Low is lower indicating the reduced contrast dose.

## CONCLUSION

Quantitative and qualitative assessment has shown that DL based contrast dose reduction is feasible in breast MRI. Though shown using synthetic low-dose images, the DL model can be extended to real low-dose images thus significantly reducing the amount of contrast dose used in breast MRI procedures.

## CLINICAL RELEVANCE/APPLICATION

Enhancement patterns of DL-synthesized DCE images are similar to standard dose images and can be used for contrast dose reduction in breast MRI exams, reducing both patient and environmental exposure to GBCAs.

### W3-SSBR08-3 **Keynote Speaker: Why are We Still Giving Gadolinium on a Breast MR? Do We Have To?**

Rebecca Rakow-Penner, MD, PhD (*Presenter*) Research Grant, General Electric Company; Consultant, Human Longevity Inc; Stockholder, CureMetrix, Inc; Stock options, CorTechs Labs, Inc

### W3-SSBR08-4 **Contrast-Enhanced Breast Imaging: A Head-To-Head Comparison of CEM and MRI Regarding Lesion Conspicuity**

Ambra Santonocito, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Contrast-enhanced Magnetic Resonance Imaging (MRI) is considered the most sensitive method for detection of breast cancer. Contrast-enhanced mammography (CEM) relies on a similar principle, highlighting tissue vasculature which is pathologically altered by malignant transformation. Our study aims to compare lesion conspicuity in CEM against MRI in patients with suspicious breast lesions.

## METHODS AND MATERIALS

Two blinded readers retrospectively evaluated a sample of 463 suspicious findings in a population of 441 consecutive patients (mean age 68 +- 5.5) who underwent CEM and CE-MRI from October 2018 to September 2022, with an average time interval between CEM and MRI of 10 days. Each reader rated the qualitative lesion conspicuity on each image using a visual grading scale from 1 to 5, with 5 representing perfect conspicuity. Interoperator agreement was evaluated. Data were compared using Visual Grading Characteristics (VGC) analysis providing the area under the curve (AUC). A sub-analysis was also performed for malignant and benign lesions.

## RESULTS

Visual grading characteristics of lesion conspicuity scores found a statistically significant AUC of 0.692 (95%-CI 0.658-0.726,  $p < 0.001$ ) in favor of MRI. On MRI, 15.6% (R1) and 16.8% (R2) of the lesions showed no enhancement, while 26.6% (R1)

and 27.4% (R2) showed perfect conspicuity. On CEM, 41.9% (R1) and 47.5% (R2) of the lesions showed no enhancement, while 13.2% (R1) and 12.7% (R2) showed perfect conspicuity. Sub-analysis results also showed a statistically significant AUC of 0.688 (0.630-0.746 95%CI,  $p < 0.001$ ) for malignant lesions, as well as for benign lesions with an AUC of 0.763 (0.713-0.813 95%CI,  $p < 0.001$ ). Regarding the visibility of malignant lesions on MRI only 0.6% (R1) and 1.9% (R2) showed no enhancement; while 54.4% (R1) and 55% (R2) presented with perfect conspicuity. On CEM, 13.1% (R1) and 16.2% (R2) of the malignant lesions showed no enhancement, while 30% (R1) and 30.6% (R2) were assigned the maximum conspicuity category. For benign lesions, the highest category of lesion conspicuity was observed in 19.2% (R1) and 19.8% (R2) on MRI and in 7.3% (R1) and 5.6% (R2) on CEM. Benign lesions that demonstrated no enhancement on MRI were observed in 10.2% (R1) and 13% (R2) compared to 46.6% (R1) and 52.5% (R2) on CEM.

## CONCLUSION

Our results showed better visibility of lesions on MRI both for benign and malignant lesions compared to CEM. A significantly higher rate of low or not enhancing lesions has to be expected using CEM.

## CLINICAL RELEVANCE/APPLICATION

Although CEM offers similar diagnostic results on lesion enhancement compared to MRI, its sensitivity to detect enhancements is lower. The application of CEM in clinical practice needs specific training and a multimodal approach.

## W3-SSBR08-5 The Radiogenomic Model Based on Subregions of DCE-MRI Can Simultaneously Predict the Pathological Complete Response and Prognosis of Patients with Triple-Negative Breast Cancer

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

### PURPOSE

TNBC is highly heterogeneous, different patients respond differently to neoadjuvant chemotherapy. We aim to use subregions to characterize spatial heterogeneity of tumors, develop radiogenomic models to accurately predict pathological complete response (pCR), and explore their potential value in predicting prognosis.

### METHODS AND MATERIALS

We collected baseline dynamic contrast material-enhanced magnetic resonance imaging (DCE-MRI), clinicopathological, and genomic data of patients with triple-negative breast cancer (TNBC) who received neoadjuvant chemotherapy from August 2011 to March 2022. The tumor was divided into multiple phenotypically consistent subregions based on four kinetic parameters at DCE-MRI. Radiomics features were extracted from subregions and peritumoral regions, and time domain features were extracted from tumor body. Logistic regression was used to construct three radiomics-only models and two models integrating clinicopathological and genomic features. Prognostic implications of the models were assessed by measuring disease-free survival (DFS) using KM survival curve and multivariable Cox regression.

### RESULTS

Finally, 315 patients had both radiomics and clinicopathological features were included in the study, of which 98 patients also had genomic features. The radiomics Model (Model 3) fused subregional, peritumoral and time domain features could well predict pCR with an AUC of 0.79. The predictive ability of the pathology-radiomics model (PRM) incorporating clinicopathological features was improved (AUC=0.88). The genomics-pathology-radiomics model (GPRM) constructed by further incorporating genomic features achieved the highest predictive ability (AUC=0.93). Model 3, PRM and GPRM had the ability to layer DFS ( $P = 0.034, 0.001$  and  $0.019$ , respectively).

## CONCLUSION

The subregional MRI-based radiomics-only and radiogenomic models provide markers of treatment and prognosis in TNBC. The radiogenomic model that integrate radiomics, clinicopathology, and genomic features is superior to other models.

## CLINICAL RELEVANCE/APPLICATION

The models can simultaneously predict efficacy and prognosis of TNBC, help to identify patients who may not achieve pCR, help clinicians make appropriate treatment and surgical decisions, and ultimately improve patients' prognosis.

## W3-SSBR08-6 Quantitative Parameters from Dual-Layer Spectral Detector CT for Differentiating Benign and Malignant Breast Lesions and Predicting Breast Cancer Biomarker Expression

Han Xia (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the performance of quantitative parameters derived from dual-layer spectral detector CT (DLCT) for differentiating between benign and malignant breast lesions and predicting the level of immunohistochemical biomarker expression in breast cancer.

## **METHODS AND MATERIALS**

This study prospectively enrolled consecutive patients suspected of breast cancer who underwent preoperative dual-phase contrast-enhanced DLCT. Lesions were classified as benign or malignant, and the malignant lesions were further classified based on expression levels of immunohistochemical biomarkers. Mean and maximum value of CT attenuation of conventional CT-images and virtual non-contrast enhanced imaging (VNC), effective atomic number (Zeff) in arterial and venous phases were measured, the ratios of the values in breast lesions to the values in normal breast tissue and muscle were all calculated. The areas under the operating characteristic curve (AUC) were used to evaluate the performance. The correlations between DLCT parameters and immunohistochemical biomarkers of cancer were analyzed.

## **RESULTS**

127 patients with 144 breast lesions were finally included, of which 110 were malignant lesions. The univariable analysis showed significant differences in the ratios of mean IC and mean Zeff between breast cancer to normal breast tissues in venous phase (VR\_B\_NICMean and VR\_B\_NZefMean) and maximum CT attenuation at VNC (VNCmax) between malignant and benign lesions ( $p < 0.05$ ). ER-positive group and PR-positive group both showed lower VNCmax than ER-negative group and PR-negative group ( $p < 0.05$ , AUC of 0.63 and 0.649), VNCmax was negatively correlated with the value of ER and PR expression ( $r = -0.157 \sim -0.307$ ). There is no significant difference between HER2-positive and HER2-negative groups. For ki-67, the ratios of maximum Zeff and CT attenuation in venous phase between breast cancer to normal breast tissues demonstrated significant difference ( $P < 0.05$ ). Both of them were negatively correlated with the value of ki67 ( $r = -0.078 \sim -0.144$ ). In the multivariable analysis, the combination of VR\_B\_NICMean, VR\_B\_NZefMean and VNCmax can distinguish benign and malignant breast lesions, which had an AUC of 0.753, a sensitivity of 74.5%, a specificity of 67.6% and an accuracy of 72.9%.

## **CONCLUSION**

Quantitative parameters from DLCT is a feasible way of differentiating benign and malignant breast lesions and identifying the expression of immunohistochemical biomarkers of breast cancer.

## **CLINICAL RELEVANCE/APPLICATION**

It is essential to differentiate benign and malignant breast lesions and the expression of immunochemical biomarkers of breast cancer for breast management. DLCT can help in the assessment of appropriate therapy and prognosis prior to primary tumor biopsy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSBR08-1

### Contrast-Enhanced Mammography-Guided Biopsy for MRI-Detected Lesions: Feasibility and Factors Predicting Success

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406A

Yuying Cao, BSC (*Presenter*) Nothing to Disclose

#### PURPOSE

This study assessed the utility of stereotactic contrast-enhanced mammography (CEM)-guided biopsy for MRI-detected lesions. Biopsy success rate was evaluated as well as factors that may predict success. Patient satisfaction and radiologist confidence level were also assessed.

#### METHODS AND MATERIALS

94 women (mean age 54.9 + 11.3 years) were enrolled in this prospective IRB-approved study, with 114 MRI-suspicious lesions BI-RADS 4A or greater for which CEM biopsy was attempted. Biopsy success was defined by enhancing lesion retrieval, biopsy clip position on post-procedure mammogram, and radiology-pathology correlation. Surveys were given to patients and clinicians. Success rate was evaluated with the Wilson score interval. Lesion characteristics {size, type [mass, focus, or non-mass enhancement (NME); distribution; internal enhancement pattern], patient breast density, MRI kinetics, MRI background parenchymal enhancement (BPE)} from successful and failed biopsies were compared using Wilcoxon rank-sum test (breast density, MRI BPE), two-sample t-test (lesion size), and Fisher's exact test (all others).

#### RESULTS

Of 114 MRI-detected breast lesions, 15 proved malignant. 69/114 (61%, 95% CI 51-69) successfully underwent CEM-guided biopsy, including 12 malignant lesions. Of the 45 failures, 41 (91.1%) were due to lack of enhancement on CEM, with no CEM biopsy attempted; 35/45 (77.8%) were then biopsied using MR guidance and 3 proved malignant. Successful CEM biopsy was more likely for larger lesions (mean = 21.5 + 25.3 mm vs 10.0 + 9.3 mm,  $P=0.004$ ). NME lesion type was associated with success ( $P=0.01$ ), comprising 46/69 (66.7%) successful biopsies and 19/45 (42.2%) failures. NMEs were further compared between successful and failed groups, and no association was found for distribution ( $P=0.2$ ); internal enhancement pattern (homogeneous vs heterogeneous vs clumped vs clustered ring) was of borderline significance ( $P=0.05$ ). No association was found between success and MRI kinetics ( $P=0.5$ ). No differences were found between successful and failed biopsies for breast density ( $P=0.3$ ) or BPE ( $P=0.6$ ). Patient satisfaction was rated 4.8/5 + 0.7. For enhancing lesions, radiologist confidence in biopsy success was rated 4.4/5 + 0.8.

#### CONCLUSION

CEM-guided biopsy for MRI-detected lesions had a 61% success rate. Larger lesion size and NME lesion type were associated with success. Patients were overall satisfied with the procedure, and radiologists were overall confident in success.

#### CLINICAL RELEVANCE/APPLICATION

Evaluation of success rate of CEM-guided biopsy for MRI-detected lesions along with factors associated with success may inform guidelines regarding CEM biopsy use, and elucidate which MRI lesions should undergo attempted CEM biopsy.

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## Abstract Archives of the RSNA, 2023

W3-SSBR08-2

### Deep Learning Based Contrast Dose Reduction in Breast MRI Using Synthetic Low-dose Images

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406A

Srivathsa P. Venkata, MSc (*Presenter*) Employee, Subtle Medical, Inc; Stockholder, Subtle Medical, Inc

#### PURPOSE

Gadolinium-based contrast agent (GBCA)-enhanced breast MRI is widely used for breast cancer screening and evaluating treatment response. Due to various safety concerns of GBCAs, including long-term tissue deposition, there is a need for dose reduction. In this work, we investigate the feasibility of a deep learning (DL) method for contrast dose reduction in dynamic contrast-enhanced (DCE) breast MRI, using synthesized low-dose images.

#### METHODS AND MATERIALS

Previously, a DL model was trained to synthesize full-dose CE brain MRI images from real pre-contrast and 10% low-dose images. This DL dose reduction model was repurposed to synthesize post-contrast breast MRI images (Synth-Gad) from real pre-contrast images and synthetic low-dose (Synth-Low) images (Fig 1A). The synthetic low-dose breast images were generated from pre- (Pre-Gad) post-contrast (Real-Gad) images, using a vision transformer that was trained with brain MRI data (Fig 1B) to perform arbitrary low-dose simulation. DCE breast MRI data from 60 patients (30 internal, 30 Duke Breast MRI public dataset) were used for evaluation. The CE images were normalized and co-registered to Pre-Gad, and the first time point post injection was used as Real-Gad. In order to simplify the intensity normalization process, axial images were manually cropped to remove signals posterior to the pectoral muscles. Left right sides were separated and processed individually by the DL model. Similarity metrics (PSNR SSIM) were calculated between Real-Gad and Synth-Gad images. Enhancement kinetic curves (time post injection vs signal intensity - SI) were drawn with Pre-Gad, Real-Gad and the other CE time points along with the average SI of Synth-Low and Synth-Gad images.

#### RESULTS

The mean PSNR SSIM between Real- Synth-Gad was ( $31.55 \pm 3.26$  dB  $0.85 \pm 0.07$ ). Qualitative examples shown in (Fig 1C) demonstrate that enhancement patterns in Synth-Gad images are similar to those present in Real-Gad images. The corresponding enhancement kinetic curves show that the SI of Real Synth-Gad images are similar and the SI of Synth-Low is lower indicating the reduced contrast dose.

#### CONCLUSION

Quantitative and qualitative assessment has shown that DL based contrast dose reduction is feasible in breast MRI. Though shown using synthetic low-dose images, the DL model can be extended to real low-dose images thus significantly reducing the amount of contrast dose used in breast MRI procedures.

#### CLINICAL RELEVANCE/APPLICATION

Enhancement patterns of DL-synthesized DCE images are similar to standard dose images and can be used for contrast dose reduction in breast MRI exams, reducing both patient and environmental exposure to GBCAs.

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## Abstract Archives of the RSNA, 2023

W3-SSBR08-3

### **Keynote Speaker: Why are We Still Giving Gadolinium on a Breast MR? Do We Have To?**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406A

Rebecca Rakow-Penner, MD, PhD (*Presenter*) Research Grant, General Electric Company; Consultant, Human Longevity Inc; Stockholder, CureMetrix, Inc; Stock options, CorTechs Labs, Inc

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSBR08-4

### Contrast-Enhanced Breast Imaging: A Head-To-Head Comparison of CEM and MRI Regarding Lesion Conspicuity

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406A

Ambra Santonocito, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Contrast-enhanced Magnetic Resonance Imaging (MRI) is considered the most sensitive method for detection of breast cancer. Contrast-enhanced mammography (CEM) relies on a similar principle, highlighting tissue vasculature which is pathologically altered by malignant transformation. Our study aims to compare lesion conspicuity in CEM against MRI in patients with suspicious breast lesions.

#### METHODS AND MATERIALS

Two blinded readers retrospectively evaluated a sample of 463 suspicious findings in a population of 441 consecutive patients (mean age 68 +- 5.5) who underwent CEM and CE-MRI from October 2018 to September 2022, with an average time interval between CEM and MRI of 10 days. Each reader rated the qualitative lesion conspicuity on each image using a visual grading scale from 1 to 5, with 5 representing perfect conspicuity. Interoperator agreement was evaluated. Data were compared using Visual Grading Characteristics (VGC) analysis providing the area under the curve (AUC). A sub-analysis was also performed for malignant and benign lesions.

#### RESULTS

Visual grading characteristics of lesion conspicuity scores found a statistically significant AUC of 0.692 (95%-CI 0.658-0.726,  $p < 0.001$ ) in favor of MRI. On MRI, 15.6% (R1) and 16.8% (R2) of the lesions showed no enhancement, while 26.6% (R1) and 27.4% (R2) showed perfect conspicuity. On CEM, 41.9% (R1) and 47.5% (R2) of the lesions showed no enhancement, while 13.2% (R1) and 12.7% (R2) showed perfect conspicuity. Sub-analysis results also showed a statistically significant AUC of 0.688 (0.630-0.746 95%CI,  $p < 0.001$ ) for malignant lesions, as well as for benign lesions with an AUC of 0.763 (0.713-0.813 95%CI,  $p < 0.001$ ). Regarding the visibility of malignant lesions on MRI only 0.6% (R1) and 1.9% (R2) showed no enhancement; while 54.4% (R1) and 55% (R2) presented with perfect conspicuity. On CEM, 13.1% (R1) and 16.2% (R2) of the malignant lesions showed no enhancement, while 30% (R1) and 30.6% (R2) were assigned the maximum conspicuity category. For benign lesions, the highest category of lesion conspicuity was observed in 19.2% (R1) and 19.8% (R2) on MRI and in 7.3% (R1) and 5.6% (R2) on CEM. Benign lesions that demonstrated no enhancement on MRI were observed in 10.2% (R1) and 13% (R2) compared to 46.6% (R1) and 52.5% (R2) on CEM.

#### CONCLUSION

Our results showed better visibility of lesions on MRI both for benign and malignant lesions compared to CEM. A significantly higher rate of low or not enhancing lesions has to be expected using CEM.

#### CLINICAL RELEVANCE/APPLICATION

Although CEM offers similar diagnostic results on lesion enhancement compared to MRI, its sensitivity to detect enhancements is lower. The application of CEM in clinical practice needs specific training and a multimodal approach.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSBR08-5

### The Radiogenomic Model Based on Subregions of DCE-MRI Can Simultaneously Predict the Pathological Complete Response and Prognosis of Patients with Triple-Negative Breast Cancer

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406A

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

TNBC is highly heterogeneous, different patients respond differently to neoadjuvant chemotherapy. We aim to use subregions to characterize spatial heterogeneity of tumors, develop radiogenomic models to accurately predict pathological complete response (pCR), and explore their potential value in predicting prognosis.

#### METHODS AND MATERIALS

We collected baseline dynamic contrast material-enhanced magnetic resonance imaging (DCE-MRI), clinicopathological, and genomic data of patients with triple-negative breast cancer (TNBC) who received neoadjuvant chemotherapy from August 2011 to March 2022. The tumor was divided into multiple phenotypically consistent subregions based on four kinetic parameters at DCE-MRI. Radiomics features were extracted from subregions and peritumoral regions, and time domain features were extracted from tumor body. Logistic regression was used to construct three radiomics-only models and two models integrating clinicopathological and genomic features. Prognostic implications of the models were assessed by measuring disease-free survival (DFS) using KM survival curve and multivariable Cox regression.

#### RESULTS

Finally, 315 patients had both radiomics and clinicopathological features were included in the study, of which 98 patients also had genomic features. The radiomics Model (Model 3) fused subregional, peritumoral and time domain features could well predict pCR with an AUC of 0.79. The predictive ability of the pathology-radiomics model (PRM) incorporating clinicopathological features was improved (AUC=0.88). The genomics-pathology-radiomics model (GPRM) constructed by further incorporating genomic features achieved the highest predictive ability (AUC=0.93). Model 3, PRM and GPRM had the ability to layer DFS ( $P = 0.034, 0.001$  and  $0.019$ , respectively).

#### CONCLUSION

The subregional MRI-based radiomics-only and radiogenomic models provide markers of treatment and prognosis in TNBC. The radiogenomic model that integrate radiomics, clinicopathology, and genomic features is superior to other models.

#### CLINICAL RELEVANCE/APPLICATION

The models can simultaneously predict efficacy and prognosis of TNBC, help to identify patients who may not achieve pCR, help clinicians make appropriate treatment and surgical decisions, and ultimately improve patients' prognosis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSBR08-6

### Quantitative Parameters from Dual-Layer Spectral Detector CT for Differentiating Benign and Malignant Breast Lesions and Predicting Breast Cancer Biomarker Expression

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S406A

Han Xia (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the performance of quantitative parameters derived from dual-layer spectral detector CT (DLCT) for differentiating between benign and malignant breast lesions and predicting the level of immunohistochemical biomarker expression in breast cancer.

#### METHODS AND MATERIALS

This study prospectively enrolled consecutive patients suspected of breast cancer who underwent preoperative dual-phase contrast-enhanced DLCT. Lesions were classified as benign or malignant, and the malignant lesions were further classified based on expression levels of immunohistochemical biomarkers. Mean and maximum value of CT attenuation of conventional CT-images and virtual non-contrast enhanced imaging (VNC), effective atomic number (Zeff) in arterial and venous phases were measured, the ratios of the values in breast lesions to the values in normal breast tissue and muscle were all calculated. The areas under the operating characteristic curve (AUC) were used to evaluate the performance. The correlations between DLCT parameters and immunohistochemical biomarkers of cancer were analyzed.

#### RESULTS

127 patients with 144 breast lesions were finally included, of which 110 were malignant lesions. The univariable analysis showed significant differences in the ratios of mean IC and mean Zeff between breast cancer to normal breast tissues in venous phase (VR\_B\_NICMean and VR\_B\_NZefMean) and maximum CT attenuation at VNC (VNCmax) between malignant and benign lesions ( $p < 0.05$ ). ER-positive group and PR-positive group both showed lower VNCmax than ER-negative group and PR-negative group ( $p < 0.05$ , AUC of 0.63 and 0.649), VNCmax was negatively correlated with the value of ER and PR expression ( $r = -0.157 \sim -0.307$ ). There is no significant difference between HER2-positive and HER2-negative groups. For ki-67, the ratios of maximum Zeff and CT attenuation in venous phase between breast cancer to normal breast tissues demonstrated significant difference ( $P < 0.05$ ). Both of them were negatively correlated with the value of ki67 ( $r = -0.078 \sim -0.144$ ). In the multivariable analysis, the combination of VR\_B\_NICMean, VR\_B\_NZefMean and VNCmax can distinguish benign and malignant breast lesions, which had an AUC of 0.753, a sensitivity of 74.5%, a specificity of 67.6% and an accuracy of 72.9%.

#### CONCLUSION

Quantitative parameters from DLCT is a feasible way of differentiating benign and malignant breast lesions and identifying the expression of immunohistochemical biomarkers of breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

It is essential to differentiate benign and malignant breast lesions and the expression of immunochemical biomarkers of breast cancer for breast management. DLCT can help in the assessment of appropriate therapy and prognosis prior to primary tumor biopsy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSCA07

### Science Session with Keynote: Cardiac Imaging (Cardiac CT Technical Innovations)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E352

Eric E. Williamson, MD (*Moderator*) Nothing to Disclose  
Diana Litmanovich, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

##### W3-SSCA07-1 **Keynote Speaker**

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

##### W3-SSCA07-2 **Head-to-Head Comparison of On-Site Computed Tomography-Derived Fractional Flow Reserve using Different Algorithms: Preliminary Results**

Jing Luo (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic results of on-site computed tomography-derived fractional flow reserve (CT-FFR) using different algorithms.

#### METHODS AND MATERIALS

This retrospective study included 124 consecutive patients with CAG-confirmed severe stenosis (stenosis =70%) in at least one vessel. The same set of coronary CT angiography raw images of the patients were simultaneously sent to a 3D computational flow dynamics (CFD)-based CT-FFR(M-software) and a reduced-order CFD-based CT-FFR(K-software) on-site servers for analysis and comparison. CT-FFR measurements included lesion-specific CT-FFR (measurement location was at 2 cm distal to the stenosis), vessel-specific CT-FFR (measurement location was at the distal-most vessel with diameter of 2 mm) and ?CT-FFR (difference between proximal and distal CT-FFR of the lesion).

#### RESULTS

More coronary arteries processing failed in 3D-CFD model than in reduced-order CFD model (18 vs. 6,  $P=0.012$ ). The most of lesion-specific CT-FFR, vessel-specific CT-FFR and ?CT-FFR values of LAD, LCX and RCA based on reduced-order CFD model were higher than those based on 3D-CFD model (all  $p < 0.05$ ). On Spearman correlation analysis, the degree of stenosis and plaque characteristics identified by two software were significantly correlated (all  $p < 0.001$ ). CT-FFR values based on 3D-CFD model showed a tendency to correlate more closely with the plaque characteristics than reduced-order CFD model. The lesion-specific CT-FFR values based on 3D-CFD model were significantly correlated with calcification score (all  $p < 0.001$ ), but vessel-specific CT-FFR values did not correlate with calcification score. On Bland-Altman analysis, the mean difference (95% limits of agreement) of lesion-specific CT-FFR between two software in LAD, LCX and RCA is 0.02(-0.03-0.08), 0.09(0.01-0.18), 0.14(0.07-0.21), respectively. The mean difference (95% limits of agreement) of vessel-specific CT-FFR between two software in LAD, LCX and RCA is 0.07(0.01-0.12), 0.00(-0.04-0.05), 0.11(0.05-0.17), respectively.

#### CONCLUSION

The results of CT-FFR measured by different algorithms were significantly different, and CT-FFR based on reduced-order CFD model showed a tendency to higher values than 3D-CFD model.

#### CLINICAL RELEVANCE/APPLICATION

This study found that the use of different algorithms can affect the results of CT-FFR, suggesting that the influence of algorithms should be considered when using CT-FFR software. Further prospective studies with catheter-based FFR comparisons are needed in future.

##### W3-SSCA07-3 **Feasibility of Coronary CT Angiography-based Fractional Flow Reserve Using a Clinical Photon-Counting Detector CT System**

Zsarnoczay, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Coronary CT angiography (CCTA)-based fractional flow reserve (CT-FFR) allows the noninvasive determination of the functional severity of anatomic lesions in patients with coronary artery disease. The aim of this study was to intra-individually compare CT-FFR between photon-counting detector (PCD) and conventional energy-integrating detector (EID) CT systems.

## METHODS AND MATERIALS

In this single-center prospective study, adults who underwent CCTA on an EID-CT system were recruited for research PCD-CT scans between July 2021 to March 2022. EID-CT images were reconstructed with Bv36 kernel, iterative reconstruction strength level 3, and at 0.5 mm slice thickness. PCD-CT images were post-processed with settings matched to EID-CT as close as possible using a Bv36 kernel, quantum iterative reconstruction level 3, at a virtual monoenergetic level 55 keV and 0.6 mm slice thickness. CT-FFR was obtained semi-automatically using a prototype on-site machine learning algorithm by two readers. The lowest CT-FFR value was used for the per-patient analysis and a CT-FFR =0.75 was considered hemodynamically significant. Correlation and reliability between CT-FFREID-CT and CT-FFRPCD-CT were assessed with Spearman ( $r$ ) and intraclass correlation coefficients (ICC).

## RESULTS

A total of 23 patients (63 years  $\pm$  10; 7 women) were included. The median time between EID-CT and PCD-CT was 6 days (IQR, 3 - 11 days). Comparison of CT-FFREID-CT vs. CT-FFRPCD-CT showed no significant difference and strong agreement in the per-vessel analysis (CT-FFREID-CT: 0.87 [0.71-0.94] vs. CT-FFRPCD-CT: 0.87 [0.76-0.93],  $p$  = 0.119, mean bias 0.02, limits of agreement (LoA) -0.15/0.19,  $r$  = 0.85, ICC = 0.93) and in the per-patient analysis (CT-FFREID-CT: 0.80 [0.61-0.85] vs. CT-FFRPCD-CT: 0.76 [0.65-0.85],  $p$  = 0.520, mean bias 0.02, LoA -0.15/0.20,  $r$  = 0.89, ICC = 0.93). CT-FFR =0.75 was observed in 10 patients with EID-CT and 9 patients with PCD-CT.

## CONCLUSION

PCD-CT-based CT-FFR evaluation is feasible and correlates well with EID-CT-based CT-FFR.

## CLINICAL RELEVANCE/APPLICATION

CCTA-based CT-FFR using PCD-CT is a feasible option, yielding results comparable to those of EID-CT when applying similar reconstruction techniques.

## W3-SSCA07-4 Coronary Artery Calcium Scoring on Photon-Counting Detector CT: Towards a New Standard 2.0

Nicola Fink, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Coronary artery calcium (CAC) scoring using the Agatston score is a well-established method for calcium quantification and cardiovascular risk assessment. However, this method is known to have suboptimal rescan reproducibility. For energy-integrating detector (EID)-CT, a new, multivendor validated protocol has already been proposed. The present study aimed to investigate the score variability of photon-counting detector (PCD)-CT-based CAC scoring and to propose a new protocol with less radiation dose and improved score reproducibility. The performance of this new proposed PCD-CT protocol was compared to the previously proposed multivendor EID-CT protocol.

## METHODS AND MATERIALS

An anthropomorphic phantom simulating three chest diameters and containing nine calcifications was scanned on a clinical PCD-CT. Scans were performed using routine protocols as well as different tube voltages (90 and 120 kVp), tube currents (four radiation dose levels from 100 to 25%), slice thicknesses (3 and 1 mm) and quantum iterative reconstructions (QIR, strength 1-4). To evaluate interscan variability, each phantom was scanned five times per protocol with slight movements between the scans. The standard PCD-CT protocol was defined as using 120kVp, 100% dose and 3mm slice thickness. Agatston scores, the number of detected calcifications and image noise were assessed. All results using the proposed PCD-CT protocol were compared to corresponding values from the standard PCD-CT and the previously proposed EID-CT protocols.

## RESULTS

Compared to the standard PCD-CT protocol, score variability decreased by 20.2% when using a thin-sliced protocol at 120kVp with 25% dose reduction, and even by 37.2% when additionally using QIR2. Comparing this new PCD-CT protocol with the proposed EID-CT protocol, showed 66.1% lower score variability. The proposed PCD-CT protocol also met the recommended noise target and did not exceed the upper threshold for increased possibility of false-positives. While  $6.0 \pm 0.0$  and  $7.0 \pm 0.4$  calcifications were detected using the PCD-CT standard and the proposed EID-CT protocol, respectively,  $7.1 \pm 0.7$  calcifications were detected when using the proposed PCD-CT protocol at QIR2. Agatston scores from the proposed PCD-CT protocol were comparable to those using the standard PCD-CT and the proposed EID-CT protocol for every phantom size ( $p > 0.05$ ).

## CONCLUSION

Score variability and calcification detectability in PCD-CT-based CAC scoring can be improved using a thin-slice, 25%-reduced dose protocol at 120kVp.

## CLINICAL RELEVANCE/APPLICATION

This proposed PCD-CT protocol has the potential to allow reproducible CAC quantification in clinical practice at lower radiation dose and seems to perform better than the proposed, multivendor EID-CT protocol.

## W3-SSCA07-5 Parametric Image Generation from the Static Computed Tomography Perfusion with Convolutional Neural Network

Jun Dong (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the accessibility of a dynamic parametric image, the myocardial blood flow (MBF), with the static myocardial computed tomography perfusion (CTP) image so as to circumvent the conventional dynamic input function in order to substantially decrease the requisite radiation exposure.

## METHODS AND MATERIALS

This retrospective study was approved by the hospital's Ethics Committee. 183 subjects with intermediate-to-high pretest probabilities of obstructive coronary artery disease (CAD) were enrolled. All subjects were screened with the dynamic myocardial CTP examination and the MBF was derived correspondingly. A convolutional neural network (CNN) was applied to convert the input simulated static CTP into MBF. Pretraining was applied to boost the model performance. For the evaluation of output MBF, different criteria like the structural similarity index measure (SSIM), peak signal-to-noise ratio (PSNR) and root mean square error (RMSE) were utilized to estimate the image quality, clinical functional assessments were also applied to the output MBF to distinguish the ischemia myocardium segments. The consistency and correlation between the output and the real MBF were also analyzed.

## RESULTS

The output MBF was highly close to the referenced MBF. The overall average SSIM, between the synthetic MBF and the target reached 0.91. According to a receiver operating curve (ROC) analysis of ischemic segments, the synthetic MBF had an area under the curve (AUC) of 0.938, showing excellent functionality. Overall, the testing results illustrated adequate consistency and correlation.

## CONCLUSION

The quality of the output parametric image is acceptable and the clinical functionality of the output MBF is satisfactory. However, since the static CTP used in this study is obtained via simulation, validation of the dose reduction reliability and the actual clinical applications still need further investigation.

## CLINICAL RELEVANCE/APPLICATION

The output parametric image is satisfactory in clinical functionality therefore it has the potential of reducing the radiation dose.

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## Abstract Archives of the RSNA, 2023

W3-SSCA07-1

### Keynote Speaker

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E352

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSCA07-2

### Head-to-Head Comparison of On-Site Computed Tomography-Derived Fractional Flow Reserve using Different Algorithms: Preliminary Results

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E352

Jing Luo (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic results of on-site computed tomography-derived fractional flow reserve (CT-FFR) using different algorithms.

#### METHODS AND MATERIALS

This retrospective study included 124 consecutive patients with CAG-confirmed severe stenosis (stenosis =70%) in at least one vessel. The same set of coronary CT angiography raw images of the patients were simultaneously sent to a 3D computational flow dynamics (CFD)-based CT-FFR(M-software) and a reduced-order CFD-based CT-FFR(K-software) on-site servers for analysis and comparison. CT-FFR measurements included lesion-specific CT-FFR (measurement location was at 2 cm distal to the stenosis), vessel-specific CT-FFR (measurement location was at the distal-most vessel with diameter of 2 mm) and  $\Delta$ CT-FFR (difference between proximal and distal CT-FFR of the lesion).

#### RESULTS

More coronary arteries processing failed in 3D-CFD model than in reduced-order CFD model (18 vs. 6,  $P=0.012$ ). The most of lesion-specific CT-FFR, vessel-specific CT-FFR and  $\Delta$ CT-FFR values of LAD, LCX and RCA based on reduced-order CFD model were higher than those based on 3D-CFD model (all  $p < 0.05$ ). On Spearman correlation analysis, the degree of stenosis and plaque characteristics identified by two software were significantly correlated (all  $p < 0.001$ ). CT-FFR values based on 3D-CFD model showed a tendency to correlate more closely with the plaque characteristics than reduced-order CFD model. The lesion-specific CT-FFR values based on 3D-CFD model were significantly correlated with calcification score (all  $p < 0.001$ ), but vessel-specific CT-FFR values did not correlate with calcification score. On Bland-Altman analysis, the mean difference (95% limits of agreement) of lesion-specific CT-FFR between two software in LAD, LCX and RCA is 0.02(-0.03-0.08), 0.09(0.01-0.18), 0.14(0.07-0.21), respectively. The mean difference (95% limits of agreement) of vessel-specific CT-FFR between two software in LAD, LCX and RCA is 0.07(0.01-0.12), 0.00(-0.04-0.05), 0.11(0.05-0.17), respectively.

#### CONCLUSION

The results of CT-FFR measured by different algorithms were significantly different, and CT-FFR based on reduced-order CFD model showed a tendency to higher values than 3D-CFD model.

#### CLINICAL RELEVANCE/APPLICATION

This study found that the use of different algorithms can affect the results of CT-FFR, suggesting that the influence of algorithms should be considered when using CT-FFR software. Further prospective studies with catheter-based FFR comparisons are needed in future.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSCA07-3

### Feasibility of Coronary CT Angiography-based Fractional Flow Reserve Using a Clinical Photon-Counting Detector CT System

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E352

Emese Zsarnoczay, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary CT angiography (CCTA)-based fractional flow reserve (CT-FFR) allows the noninvasive determination of the functional severity of anatomic lesions in patients with coronary artery disease. The aim of this study was to intra-individually compare CT-FFR between photon-counting detector (PCD) and conventional energy-integrating detector (EID) CT systems.

#### METHODS AND MATERIALS

In this single-center prospective study, adults who underwent CCTA on an EID-CT system were recruited for research PCD-CT scans between July 2021 to March 2022. EID-CT images were reconstructed with Bv36 kernel, iterative reconstruction strength level 3, and at 0.5 mm slice thickness. PCD-CT images were post-processed with settings matched to EID-CT as close as possible using a Bv36 kernel, quantum iterative reconstruction level 3, at a virtual monoenergetic level 55 keV and 0.6 mm slice thickness. CT-FFR was obtained semi-automatically using a prototype on-site machine learning algorithm by two readers. The lowest CT-FFR value was used for the per-patient analysis and a CT-FFR =0.75 was considered hemodynamically significant. Correlation and reliability between CT-FFREID-CT and CT-FFRPCD-CT were assessed with Spearman ( $r$ ) and intraclass correlation coefficients (ICC).

#### RESULTS

A total of 23 patients (63 years  $\pm$  10; 7 women) were included. The median time between EID-CT and PCD-CT was 6 days (IQR, 3 - 11 days). Comparison of CT-FFREID-CT vs. CT-FFRPCD-CT showed no significant difference and strong agreement in the per-vessel analysis (CT-FFREID-CT: 0.87 [0.71-0.94] vs. CT-FFRPCD-CT: 0.87 [0.76-0.93],  $p = 0.119$ , mean bias 0.02, limits of agreement (LoA) -0.15/0.19,  $r = 0.85$ , ICC = 0.93) and in the per-patient analysis (CT-FFREID-CT: 0.80 [0.61-0.85] vs. CT-FFRPCD-CT: 0.76 [0.65-0.85],  $p = 0.520$ , mean bias 0.02, LoA -0.15/0.20,  $r = 0.89$ , ICC = 0.93). CT-FFR =0.75 was observed in 10 patients with EID-CT and 9 patients with PCD-CT.

#### CONCLUSION

PCD-CT-based CT-FFR evaluation is feasible and correlates well with EID-CT-based CT-FFR.

#### CLINICAL RELEVANCE/APPLICATION

CCTA-based CT-FFR using PCD-CT is a feasible option, yielding results comparable to those of EID-CT when applying similar reconstruction techniques.

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## Abstract Archives of the RSNA, 2023

W3-SSCA07-4

### Coronary Artery Calcium Scoring on Photon-Counting Detector CT: Towards a New Standard 2.0

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E352

Nicola Fink, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary artery calcium (CAC) scoring using the Agatston score is a well-established method for calcium quantification and cardiovascular risk assessment. However, this method is known to have suboptimal rescan reproducibility. For energy-integrating detector (EID)-CT, a new, multivendor validated protocol has already been proposed. The present study aimed to investigate the score variability of photon-counting detector (PCD)-CT-based CAC scoring and to propose a new protocol with less radiation dose and improved score reproducibility. The performance of this new proposed PCD-CT protocol was compared to the previously proposed multivendor EID-CT protocol.

#### METHODS AND MATERIALS

An anthropomorphic phantom simulating three chest diameters and containing nine calcifications was scanned on a clinical PCD-CT. Scans were performed using routine protocols as well as different tube voltages (90 and 120 kVp), tube currents (four radiation dose levels from 100 to 25%), slice thicknesses (3 and 1 mm) and quantum iterative reconstructions (QIR, strength 1-4). To evaluate interscan variability, each phantom was scanned five times per protocol with slight movements between the scans. The standard PCD-CT protocol was defined as using 120kVp, 100% dose and 3mm slice thickness. Agatston scores, the number of detected calcifications and image noise were assessed. All results using the proposed PCD-CT protocol were compared to corresponding values from the standard PCD-CT and the previously proposed EID-CT protocols.

#### RESULTS

Compared to the standard PCD-CT protocol, score variability decreased by 20.2% when using a thin-sliced protocol at 120kVp with 25% dose reduction, and even by 37.2% when additionally using QIR2. Comparing this new PCD-CT protocol with the proposed EID-CT protocol, showed 66.1% lower score variability. The proposed PCD-CT protocol also met the recommended noise target and did not exceed the upper threshold for increased possibility of false-positives. While  $6.0 \pm 0.0$  and  $7.0 \pm 0.4$  calcifications were detected using the PCD-CT standard and the proposed EID-CT protocol, respectively,  $7.1 \pm 0.7$  calcifications were detected when using the proposed PCD-CT protocol at QIR2. Agatston scores from the proposed PCD-CT protocol were comparable to those using the standard PCD-CT and the proposed EID-CT protocol for every phantom size ( $p > 0.05$ ).

#### CONCLUSION

Score variability and calcification detectability in PCD-CT-based CAC scoring can be improved using a thin-slice, 25%-reduced dose protocol at 120kVp.

#### CLINICAL RELEVANCE/APPLICATION

This proposed PCD-CT protocol has the potential to allow reproducible CAC quantification in clinical practice at lower radiation dose and seems to perform better than the proposed, multivendor EID-CT protocol.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSCA07-5

### Parametric Image Generation from the Static Computed Tomography Perfusion with Convolutional Neural Network

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E352

Jun Dong (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the accessibility of a dynamic parametric image, the myocardial blood flow (MBF), with the static myocardial computed tomography perfusion (CTP) image so as to circumvent the conventional dynamic input function in order to substantially decrease the requisite radiation exposure.

#### METHODS AND MATERIALS

This retrospective study was approved by the hospital's Ethics Committee. 183 subjects with intermediate-to-high pretest probabilities of obstructive coronary artery disease (CAD) were enrolled. All subjects were screened with the dynamic myocardial CTP examination and the MBF was derived correspondingly. A convolutional neural network (CNN) was applied to convert the input simulated static CTP into MBF. Pretraining was applied to boost the model performance. For the evaluation of output MBF, different criteria like the structural similarity index measure (SSIM), peak signal-to-noise ratio (PSNR) and root mean square error (RMSE) were utilised to estimate the image quality, clinical functional assessments were also applied to the output MBF to distinguish the ischemia myocardium segments. The consistency and correlation between the output and the real MBF were also analyzed.

#### RESULTS

The output MBF was highly close to the referenced MBF. The overall average SSIM, between the synthetic MBF and the target reached 0.91. According to a receiver operating curve (ROC) analysis of ischemic segments, the synthetic MBF had an area under the curve (AUC) of 0.938, showing excellent functionality. Overall, the testing results illustrated adequate consistency and correlation.

#### CONCLUSION

The quality of the output parametric image is acceptable and the clinical functionality of the output MBF is satisfactory. However, since the static CTP used in this study is obtained via simulation, validation of the dose reduction reliability and the actual clinical applications still need further investigation.

#### CLINICAL RELEVANCE/APPLICATION

The output parametric image is satisfactory in clinical functionality therefore it has the potential of reducing the radiation dose.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSCH07

### Chest Imaging (Lung Quantitative Evaluation)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S404

Jonathan G. Goldin, MD, PhD (*Moderator*) Founder, MedQIA Imaging Core Laboratory  
Jonathan H. Chung, MD (*Moderator*) Speaker, Veracyte, Inc; Consultant, Veracyte, Inc; Consultant, Boehringer Ingelheim GmbH; Speaker, Boehringer Ingelheim GmbH; Consultant, F. Hoffmann-La Roche Ltd; Speaker, F. Hoffmann-La Roche Ltd

#### Sub-Events

#### **W3-SSCH07-1 Artificial Intelligence-based Automated Matching of Pulmonary Nodules on Follow-up Chest CT**

Matthias P. Fabritius, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The follow-up of pulmonary nodules, including matching and measuring identical pulmonary nodules on serial computed tomography (CT) scans can be tedious and time-consuming. This study aimed to assess the performance of an artificial intelligence (AI)-based system for automated matching of nodules in serial CT scans of the chest.

#### METHODS AND MATERIALS

In this study, 100 patients (62 [57-69] years; 46% female) with pulmonary nodules and at least two successive chest CT scans (total CT scans included: n=253) were included. Regardless of whether the included patients received two or three CT scans, each follow-up was evaluated separately, resulting in 153 follow-up examinations. All data sets were analyzed using a cloud-based AI-based algorithm prototype for automated nodule matching. The matching rate and the root causes for incorrect matching (false-positive detection; missed matching; incorrect assignment) were evaluated in the ten largest lesions (5-30mm) registered on baseline CT. In addition, the dependence of the matching rate on nodule number and localization (parenchymal; peripheral; juxtavascular; juxtaphrenic) was analyzed.

#### RESULTS

By focusing on the ten largest lesions registered in baseline CT, 1,141 lesions were identified, of which 964 (84.5%) were correctly detected and matched. When considering only nodules registered in both scans, correct matching rate was 97.8%. The median per case matching rate was 90.0% (80.0-100.0%). While the correct matching rate was similar in follow-ups with less than 20 and 20-50 nodules (100.0% [80.0-100.0%] vs. 90.0% [80.0-100.0%]; p=0.37), it was significantly lower in follow-ups with more than 50 nodules (80.0% [65.0-90.0%]; p<0.05) with an overrepresentation of missed nodule matching. Furthermore, the matching rate was significantly higher in parenchymal, peripheral, and juxtavascular than in juxtaphrenic nodules (91.8% vs. 84.4% vs. 82.4% vs. 71.1%; p<0.001). Missed matching was overrepresented in juxtavascular and incorrect assignment of two non-identical nodules in juxtaphrenic nodules.

#### CONCLUSION

The correct automated matching rate of metastatic pulmonary nodules in follow-up examinations was high but depends on localization and number of nodules.

#### CLINICAL RELEVANCE/APPLICATION

The algorithm enables precise nodule matching, thus provides a good basis for standardized assessment. Knowing strengths and weaknesses depending on nodule number and localization allows an accurate interpretation of AI results.

#### **W3-SSCH07-4 Clinical and Radiologic Predictors of Unresectability in Malignant Pleural Mesothelioma**

Maria Mayoral Penalva, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The current clinical staging of malignant pleural mesothelioma (MPM) is often discordant with the pathologic staging, particularly the T-component. The International Association for the Study of Lung Cancer (IASLC) Mesothelioma Staging Project developed a simple methodology to take reproducible measurements of pleural thickness (PT) and provide precise prognosis. Surgical procedures are complex and potentially morbid. Accurate evaluation of preoperative imaging with the inclusion of PT measurements may provide valuable information when assessing the surgical risk. We aimed to determine the utility of clinical and radiologic features to predict unresectability in MPM.

## METHODS AND MATERIALS

Twenty-two descriptive radiologic features were retrospectively evaluated on preoperative CT and/or PET/CT scans for patients who were thought to be resectable and taken to the operation room for attempted resection. The maximum and sum PT measurements at three levels of the thorax (upper-, middle- and lower-levels) were obtained according to the IASLC methodology. Clinical and radiologic features, including clinical stage, were compared between resectable and unresectable tumors by univariate analysis and logistic regression models.

## RESULTS

Of 133 patients, 69 (52%) had resectable and 64 (48%) unresectable MPM. Differences among groups regarding asbestos exposure ( $p=0.005$ ), neoadjuvant treatment ( $p=0.001$ ), clinical T-stage ( $p<0.0001$ ), all PT measurements ( $p<0.05$ ), PT pattern ( $p<0.0001$ ) and degree ( $p=0.033$ ), extrapleural space obliteration ( $p<0.0001$ ), extension to subphrenic space ( $p<0.0004$ ), and a combination of variables that represented extensive diaphragmatic contact or chest wall involvement ( $p=0.002$ ) and/or mediastinal invasion ( $p<0.0001$ ) were found to be statistically significant. In the multivariate analysis, the model that included neoadjuvant chemotherapy, degree of pleural thickening (encasement vs discontinuous), upper-level maximum PT, extrapleural fat obliteration and a combination of variables that represented mediastinal infiltration obtained the highest diagnostic performance (AUC 0.876). The feature that added the most value to this model was extrapleural space obliteration (OR 5.33; 95% CI, 1.97 - 14.45;  $p=0.001$ ). Another model that integrated clinical and radiologic variables through clinical T-stage assessment also obtained a very strong diagnostic performance (AUC 0.879).

## CONCLUSION

Selected clinical and radiologic features appear to be strong predictors of unresectability in MPM.

## CLINICAL RELEVANCE/APPLICATION

A more accurate prediction of unresectability in the preoperative assessment of patients with MPM may avoid unnecessary surgery and prompt initiation of nonsurgical treatments.

## W3-SSCH07-6 Time to Lung Cancer Surgery and Factors Associated with Delayed Surgery in a Lung Cancer Screening Program

Raquelle H. El Alam, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Patient pathways from suspicious imaging until surgical treatment for lung cancer vary and in some instances cause considerable delay. The aim of this study was to identify factors associated with this delay.

## METHODS AND MATERIALS

: In this study, we evaluated patients in the Lung Cancer Screening (LCS) program across a large tertiary healthcare network from 5/2015 through 10/2021 who underwent surgical resection for a malignant lung nodule. The analysis was performed on patients with Lung-RADS 4B/4X which should be considered for biopsy or surgery rather than follow-up imaging. We evaluated the relationship between lung cancer surgical delay and several factors including Lung-RADS category (4B versus 4X), site of surgery (2 academic sites and 1 community site), smoking status (current versus former smoker), median income by zip code, initial biopsy finding (benign/nondiagnostic versus malignant), patient's language (English versus non-English speaking), patient's race (White versus non-White), and patient's age. A cut-off of more than 60 days between screening CT and surgery was considered as delay.

## RESULTS

During the study period, a total of 21366 LCS CTs were performed in 9050 patients, and 267 pathologically-proven lung cancers were identified. Of these, 227 went to surgical treatment, and 150 of these patients were Lung-RADS 4B/4X, with 59 Lung-RADS 4B and 91 Lung-RADS 4X. Time from LCS CT to surgery ranged from 8 to 585 days with a median of 52 days, and interquartile range of 36-75 days. 60 of 150 experienced delay to surgery of > 60 days. A statistically significant difference between surgical delay and 2 academic sites was observed ( $p=.045$ ) with 14 (29 %) out of 48 experiencing delays in academic site 1 versus 42 (48 %) out of 88 in academic site 2; delays occurred in 4 (29 %) out of 14 in community site. In addition, patients from zip codes with higher median income were less likely to experience delays, with odds ratio for delay 0.88 per \$10,000 ( $p=.02$ ). There was no statistically significant difference in delays by smoking status (current smoker versus former smoker,  $p=.09$ ), Lung-RADS category ( Lung-RADS-4B versus Lung-RADS 4X,  $p=.38$ ), biopsy result (initially

benign or nondiagnostic biopsy versus cancer,  $p=.5$ ), language (English versus non-English speaking,  $p=.15$ ), race (white versus non-white,  $p=.31$ ), and age ( $p=.27$ ).

#### **CONCLUSION**

Patients in a lung cancer screening frequently experience long intervals between a suspicious finding and surgery. Delays were associated with site of care and median income by zip code.

#### **CLINICAL RELEVANCE/APPLICATION**

Surgical delays for lung cancer may exacerbate disparities in care, particularly among patients from low-income areas.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSCH07-1

### Artificial Intelligence-based Automated Matching of Pulmonary Nodules on Follow-up Chest CT

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S404

Matthias P. Fabritius, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The follow-up of pulmonary nodules, including matching and measuring identical pulmonary nodules on serial computed tomography (CT) scans can be tedious and time-consuming. This study aimed to assess the performance of an artificial intelligence (AI)-based system for automated matching of nodules in serial CT scans of the chest.

#### METHODS AND MATERIALS

In this study, 100 patients (62 [57-69] years; 46% female) with pulmonary nodules and at least two successive chest CT scans (total CT scans included: n=253) were included. Regardless of whether the included patients received two or three CT scans, each follow-up was evaluated separately, resulting in 153 follow-up examinations. All data sets were analyzed using a cloud-based AI-based algorithm prototype for automated nodule matching. The matching rate and the root causes for incorrect matching (false-positive detection; missed matching; incorrect assignment) were evaluated in the ten largest lesions (5-30mm) registered on baseline CT. In addition, the dependence of the matching rate on nodule number and localization (parenchymal; peripheral; juxtavascular; juxtaphrenic) was analyzed.

#### RESULTS

By focusing on the ten largest lesions registered in baseline CT, 1,141 lesions were identified, of which 964 (84.5%) were correctly detected and matched. When considering only nodules registered in both scans, correct matching rate was 97.8%. The median per case matching rate was 90.0% (80.0-100.0%). While the correct matching rate was similar in follow-ups with less than 20 and 20-50 nodules (100.0% [80.0-100.0%] vs. 90.0% [80.0-100.0%]; p=0.37), it was significantly lower in follow-ups with more than 50 nodules (80.0% [65.0-90.0%]; p<0.05) with an overrepresentation of missed nodule matching. Furthermore, the matching rate was significantly higher in parenchymal, peripheral, and juxtavascular than in juxtaphrenic nodules (91.8% vs. 84.4% vs. 82.4% vs. 71.1%; p<0.001). Missed matching was overrepresented in juxtavascular and incorrect assignment of two non-identical nodules in juxtaphrenic nodules.

#### CONCLUSION

The correct automated matching rate of metastatic pulmonary nodules in follow-up examinations was high but depends on localization and number of nodules.

#### CLINICAL RELEVANCE/APPLICATION

The algorithm enables precise nodule matching, thus provides a good basis for standardized assessment. Knowing strengths and weaknesses depending on nodule number and localization allows an accurate interpretation of AI results.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSCH07-4

### Clinical and Radiologic Predictors of Unresectability in Malignant Pleural Mesothelioma

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S404

Maria Mayoral Penalva, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The current clinical staging of malignant pleural mesothelioma (MPM) is often discordant with the pathologic staging, particularly the T-component. The International Association for the Study of Lung Cancer (IASLC) Mesothelioma Staging Project developed a simple methodology to take reproducible measurements of pleural thickness (PT) and provide precise prognosis. Surgical procedures are complex and potentially morbid. Accurate evaluation of preoperative imaging with the inclusion of PT measurements may provide valuable information when assessing the surgical risk. We aimed to determine the utility of clinical and radiologic features to predict unresectability in MPM.

#### METHODS AND MATERIALS

Twenty-two descriptive radiologic features were retrospectively evaluated on preoperative CT and/or PET/CT scans for patients who were thought to be resectable and taken to the operation room for attempted resection. The maximum and sum PT measurements at three levels of the thorax (upper-, middle- and lower-levels) were obtained according to the IASLC methodology. Clinical and radiologic features, including clinical stage, were compared between resectable and unresectable tumors by univariate analysis and logistic regression models.

#### RESULTS

Of 133 patients, 69 (52%) had resectable and 64 (48%) unresectable MPM. Differences among groups regarding asbestos exposure ( $p=0.005$ ), neoadjuvant treatment ( $p=0.001$ ), clinical T-stage ( $p<0.0001$ ), all PT measurements ( $p<0.05$ ), PT pattern ( $p<0.0001$ ) and degree ( $p=0.033$ ), extrapleural space obliteration ( $p<0.0001$ ), extension to subphrenic space ( $p<0.0004$ ), and a combination of variables that represented extensive diaphragmatic contact or chest wall involvement ( $p=0.002$ ) and/or mediastinal invasion ( $p<0.0001$ ) were found to be statistically significant. In the multivariate analysis, the model that included neoadjuvant chemotherapy, degree of pleural thickening (encasement vs discontinuous), upper-level maximum PT, extrapleural fat obliteration and a combination of variables that represented mediastinal infiltration obtained the highest diagnostic performance (AUC 0.876). The feature that added the most value to this model was extrapleural space obliteration (OR 5.33; 95% CI, 1.97 - 14.45;  $p=0.001$ ). Another model that integrated clinical and radiologic variables through clinical T-stage assessment also obtained a very strong diagnostic performance (AUC 0.879).

#### CONCLUSION

Selected clinical and radiologic features appear to be strong predictors of unresectability in MPM.

#### CLINICAL RELEVANCE/APPLICATION

A more accurate prediction of unresectability in the preoperative assessment of patients with MPM may avoid unnecessary surgery and prompt initiation of nonsurgical treatments.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSCH07-6

### Time to Lung Cancer Surgery and Factors Associated with Delayed Surgery in a Lung Cancer Screening Program

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S404

Raquelle H. El Alam, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patient pathways from suspicious imaging until surgical treatment for lung cancer vary and in some instances cause considerable delay. The aim of this study was to identify factors associated with this delay.

#### METHODS AND MATERIALS

: In this study, we evaluated patients in the Lung Cancer Screening (LCS) program across a large tertiary healthcare network from 5/2015 through 10/2021 who underwent surgical resection for a malignant lung nodule. The analysis was performed on patients with Lung-RADS 4B/4X which should be considered for biopsy or surgery rather than follow-up imaging. We evaluated the relationship between lung cancer surgical delay and several factors including Lung-Rads category (4B versus 4X), site of surgery (2 academic sites and 1 community site), smoking status (current versus former smoker), median income by zip code, initial biopsy finding (benign/nondiagnostic versus malignant), patient's language (English versus non-English speaking), patient's race (White versus non-White), and patient's age. A cut-off of more than 60 days between screening CT and surgery was considered as delay.

#### RESULTS

During the study period, a total of 21366 LCS CTs were performed in 9050 patients, and 267 pathologically-proven lung cancers were identified. Of these, 227 went to surgical treatment, and 150 of these patients were Lung-RADS 4B/4X, with 59 Lung-RADS 4B and 91 Lung-RADS 4X. Time from LCS CT to surgery ranged from 8 to 585 days with a median of 52 days, and interquartile range of 36-75 days. 60 of 150 experienced delay to surgery of > 60 days. A statistically significant difference between surgical delay and 2 academic sites was observed ( $p=.045$ ) with 14 (29 %) out of 48 experiencing delays in academic site 1 versus 42 (48 %) out of 88 in academic site 2; delays occurred in 4 (29 %) out of 14 in community site. In addition, patients from zip codes with higher median income were less likely to experience delays, with odds ratio for delay 0.88 per \$10,000 ( $p=.02$ ). There was no statistically significant difference in delays by smoking status (current smoker versus former smoker,  $p=.09$ ), Lung-RADS category ( Lung-RADS-4B versus Lung-RADS 4X,  $p=.38$ ), biopsy result (initially benign or nondiagnostic biopsy versus cancer,  $p=.5$ ), language (English versus non-English speaking,  $p=.15$ ), race (white versus non-white,  $p=.31$  ), and age ( $p= .27$ ).

#### CONCLUSION

Patients in a lung cancer screening frequently experience long intervals between a suspicious finding and surgery. Delays were associated with site of care and median income by zip code.

#### CLINICAL RELEVANCE/APPLICATION

Surgical delays for lung cancer may exacerbate disparities in care, particularly among patients from low-income areas.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSER02

### Emergency Radiology (State of the Art Imaging)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451B

Aaron D. Sodickson, MD, PhD (*Moderator*) Institutional research agreement, Siemens AG ;Speaker, Siemens AG;Consultant, Canon Medical Systems Corporation

Scott D. Steenburg, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

### W3-SSER02-1 Multi-Parameter Spectral CT Enhanced Imaging for Differential Diagnosis of Portal Vein Thrombosis and Malignant Thrombosis

Zhihao Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

This study is to investigate the differential diagnostic performance of spectral-based image-enhanced imaging for portal vein thrombosis (PVT) and malignant thrombus (MT), with the aim of enhancing the clinical efficiency of differential diagnosis between the PVT and MT.

#### METHODS AND MATERIALS

This retrospective study included 100 patients with portal vein thrombosis who underwent spectral CT imaging from February 2023 to April 2023. According to clinical data and pathological diagnosis, 52cases of portal vein thrombosis and 48 cases of malignant thrombosis were enrolled. Using post-processing software, conventional CT images (CI), iodine density maps (ID), effective atomic number maps (Z-eff), and spectral curves were reconstructed from the spectral data. Regions of interest (ROIs) were drawn at the site of occlusion, and CT values (CIHU), iodine density values (ID), effective atomic numbers (Z-eff), and spectral curve slopes were measured (?HU). Independent sample t-tests were used to analyze the differences between parameters. A single-factor logistic regression was used to evaluate the predictive probability of spectral multi-parameters for portal vein thrombosis and tumor thrombus, and a spectral multi-parameter combined model was established. Receiver operating characteristic (ROC) curves were plotted, and the area under the curve (AUC) and cutoff value were calculated to compare the diagnostic efficacy of various spectral parameters in differentiating portal vein thrombosis and tumor thrombus.

#### RESULTS

Compared to CT values (AUC 0.92, cutoff value 142.5, sensitivity 86%, specificity 93%), ID values (AUC 0.965, cutoff value 3.24, sensitivity 92%, specificity 96.5%), Z-eff values (AUC 0.952, cutoff 12.05 , sensitivity 90%, specificity 96.2%), and ? HU values (AUC 0.962, sensitivity 96%, specificity 95%), the multi-parameter spectral combined model (AUC 0.97, sensitivity 94%, specificity 97%) exhibits the highest discriminatory power in distinguishing between portal vein thrombosis and malignant thrombosis.

#### CONCLUSION

The multi-parameter spectral combined model exhibits superior differential diagnostic capabilities compared to traditional CT values and various spectral parameters for distinguishing between portal vein thrombosis and cancer thrombus.

#### CLINICAL RELEVANCE/APPLICATION

Spectral multi-parameter CT can help clinicians accurately determine the nature, lesion homogeneity, location, size, and adjacent relationship of portal vein thrombi. This provides more accurate imaging evidence for the early diagnosis, treatment strategy, and prognosis prediction of tumor patients.

### W3-SSER02-2 High-Pitch Head CT in Uncooperative Emergency Department Patients With Acute Head and Neck Trauma: Evaluation of Image Quality and Detection of Acute Intracranial Pathologies

Daniel Heinrich Leitner, BSc (*Presenter*) Nothing to Disclose



## PURPOSE

To evaluate image quality and diagnostic accuracy of acute intracranial pathologies of an unenhanced high-pitch head CT protocol used in uncooperative Emergency Department (ED) patients after acute trauma in comparison to standard CT protocols.

## METHODS AND MATERIALS

This retrospective study was IRB approved with a waiver for informed consent. We compared a novel high-pitch (1.55) head CT protocol (CTDIVOL 34.4 mGy) on a dual-source CT platform used in uncooperative ED patients and 1:1 age-matched ED patients who underwent standard-pitch (0.55) head CT protocol (CTDIVOL 39.5 mGy) after acute trauma and scanned between 01/2023 and 03/2023. Gray matter (GM) signal-to-noise ratio (SNR), white matter (WM) SNR, GM-WM contrast-to-noise ratio (CNR), and posterior fossa artifact index (PFAI) were compared. Two radiologists performed qualitative image evaluation of intracranial and bone structures, artifacts, and diagnostic evaluation for acute intracranial pathologies and fractures.

## RESULTS

Results: In total, 41 patients [male, n=27 (65.9%), 68±20 years] were scanned using high-pitch CT protocol. Only one scan had poor image quality due to motion (2.4%). Quantitative image evaluation did not show significant differences between high-pitch and standard protocols: GM SNR, mean±SD, 18.5±3.5 vs. 17.2±2.9, WM SNR, 15.5±2.5 vs. 14.7±2.2, GM-WM CNR 2.3±0.6 vs 2.2±0.5, PFAI, 3.5±0.3, all p=0.41. Grey-white differentiation [median (IQR); 5(4, 5) vs. 5 (4, 5)], delineation of cerebrospinal fluid spaces (5 vs. 5), mastoid cells (5 vs. 5) and bone structures (5 vs. 5) were rated very good for both protocols w/o significant differences (all p=0.05). Artifacts in the supratentorial region were low in both protocols (p=0.09), while beam-hardening artifacts in the infratentorial region were slightly worse in high-pitch scans [2 (1,3) vs. 1 (1,2), p=0.001]. Diagnostic confidence to evaluate for intracranial hemorrhage, brain herniation and fracture was very good for both protocols w/o significant differences. Interrater agreement for the detection of intracranial hemorrhages (n=18), herniation (n=9) and fractures (n=6) was excellent for both protocols (? ,1.0).

## CONCLUSION

High-pitch head CT protocol provides similar image quality to standard head CT protocol and is a safe and robust alternative in uncooperative ED patients to evaluate for acute intracranial pathologies after trauma.

## CLINICAL RELEVANCE/APPLICATION

ED patients after acute head trauma are frequently uncooperative and difficult to evaluate. High-pitch head CT is a robust protocol that allows scans in less than 1 second and provides excellent image quality to evaluate for acute intracranial pathologies and fractures.

## W3-SSER02-3 Serum Creatinine Testing in the Emergency Department Prior to Contrast-Enhanced CT Exam Does Not Typically Change Patient Management

Jennifer S. McDonald, PhD (*Presenter*) Research Grant, General Electric Company;Scientific Advisor, General Electric Company;Consultant, General Electric Company

## PURPOSE

Standard practices and guidelines recommend or require that a recent serum creatinine (SCr) result (typically within 7-30 days) must be available in the medical record or a SCr test must be ordered before a patient receives intravenous ICM. However this practice adds cost and time, potentially delaying imaging, diagnosis and patient management, particularly in patients who present to emergency departments (ED). The purpose of this retrospective study was to examine SCr testing performed in the emergency department of a large quaternary center prior to performing a contrast-enhanced CT exam and determine how frequently this testing changed patient management.

## METHODS AND MATERIALS

This retrospective study consisted of all adult and pediatric patients that presented to our ED from 1/1/2017 to 1/1/2020 and had a contrast-enhanced CT exam ordered during the ED visit. At our institution, patients with a pre-CT eGFR<30 ml/min may not receive contrast at the discretion of the ordering provider and radiologist. All patient, laboratory, and radiology data was retrieved by automated search and chart review. Pre-CT eGFR was calculated for each patient from the serum creatinine (SCr) result using the MDRD equation.

## RESULTS

A total of 19,127 ED visits with CECT were included in the study. Most visits had a SCr result available before the CECT was ordered (n=17,370, 91%). Median turnaround time between SCr order and result was 34 minutes (IQR 26-46 minutes). In almost all ED visits where SCr testing was performed and results were available pre-CECT, the patient's eGFR result was > 30 ml/min (n=17,139, 99%), with only a small number of patients with eGFR <30 ml/min (n=231, 1.3%). A CECT exam was still performed in 179 of the eGFR <30 ml/min patients (62%). In 46 patients (20% of eGFR<30 ml/min patients, 0.24% of

cohort) the CECT was canceled out of concern for CIN. In those 46 canceled cases, four of the patients underwent a CECT in the 60 days following the ED visit.

#### **CONCLUSION**

Serum creatinine testing in the ED did not affect the decision to perform a CECT exam in the vast majority of cases.

#### **CLINICAL RELEVANCE/APPLICATION**

Most patients with eGFR<30 ml/min who presented to the ED received a CECT. Creatinine testing prior to iodinated contrast material exposure may not be necessary in patients presenting to the emergency department, as the benefit of administering contrast in acute situations likely outweighs the risk of contrast-induced acute kidney injury.

### **W3-SSER02-4 Relationship Between Injury Severity and Trauma Whole-Body CT Report Turnaround Times**

Nathan Sarkar, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Background/Purpose: Trauma is a leading cause of death in the United States. Whole-Body CT is frequently used to screen trauma patients for major injuries and hemorrhage, as well as for surgical planning. However, delayed Report Turn-Around-Time (RTAT) remains a bottleneck in the flow of patient management in trauma, especially severely injured patients.

#### **METHODS AND MATERIALS**

Methods: This dataset consisted of 11,251 patients who underwent admission trauma whole body CT from two trauma centers within a single hospital system; a level I tertiary care trauma center (n=9043) and a regional urban level II trauma center (n=2208). Patients were selected between July 2016 and September 2022. Patients were discretized by age index ( $\geq 55$  or  $< 55$  years), polytrauma (ISS =16), whether they required any transfusion, or massive transfusion (MT) defined as  $\geq 10$  units of Packed Red Blood Cells (PRBCs) within 24 hours, and by shock index (HR/SBP)  $>$  or  $= 1$ , where a value  $> 1$  indicates hemodynamic shock. Bivariate comparisons of medians were performed with the Mann-Whitney U test. Tests of proportions were performed using the Chi square test. In all cases, p-value  $< 0.05$  was considered statistically significant.

#### **RESULTS**

Results: Overall median RTAT was 24 minutes (IQR: 4-48). RTAT was significantly longer in those in hemodynamic shock (37 minutes vs 22 minutes,  $p < 0.0001$ ), those with polytrauma (ISS=16 vs ISS<16) (34 minutes vs 21 minutes,  $p < 0.0001$ ), those who received massive transfusion versus those who did not (47.5 minutes vs 24 minutes,  $p < 0.0001$ ), those who ultimately expired (41 minutes vs 23 minutes,  $p < 0.0001$ ), the older cohort (age $> 55$ ) (28 minutes vs 22 minutes,  $p < 0.0001$ ), and those with penetrating vs blunt injuries (27 minutes vs 23 minutes,  $p = 0.001$ ).

#### **CONCLUSION**

Conclusion: Multiple markers of traumatic injury severity were associated with longer RTATs, despite evidence showing that more severely injured patients require faster diagnosis and treatment. The field of trauma radiology must search for ways to improve the RTAT in patients who are severely injured with time-sensitive injuries.

#### **CLINICAL RELEVANCE/APPLICATION**

Existing evidence shows that more severely injured trauma patients require faster diagnosis and treatment. However, we found that multiple markers of traumatic injury severity were associated with longer report turn-around times.

### **W3-SSER02-5 Occult Fractures in the Tibial Plateau: 3D Augmented X-Ray Pilot Study**

Luis Fandino, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The tibial plateau (TP) is a common site of missed fractures on conventional radiographs (CR). 3D augmented X-ray is a new cone beam-based tomography imaging concept that provides CRs along with digital tomography images that can be reformatted in axial, coronal, and sagittal planes with 0.5mm slice thickness. The purpose of this study is to evaluate the value of 3D Augmented X-ray in the detection of fractures of the tibial plateau.

#### **METHODS AND MATERIALS**

Over the course of 4 months, 23 patients referred from the Emergency Department with a high clinical suspicion for knee fracture were evaluated with a 3D Augmented X-ray exam (Multitom RAX, Siemens Healthineers, Germany). Three radiologists with 12-, 4- and 1-year experience sequentially reviewed CR and 3D images in a blinded fashion and recorded their confidence level for the absence/presence of a TP fracture on a 5-point ordinal scale (definitely absent, likely absent, neutral, likely present, definitely present). The ground-truth for presence of fracture was established by either subsequent magnetic resonance imaging (MRI) or consensus of three musculoskeletal radiology specialists. The confidence levels were entered into software for receiver-operating characteristic (ROC) analysis. Reader-average area-under-curve (AUC) values were obtained from this analysis and compared for CR versus 3D.

## RESULTS

5 TP fractures were identified by reference standard (21.7% of exams, 95% CI: 7.5-43.7%). The reviewer with 12 years of experience identified two of these fractures on CR, while all 5 were identified using the 3D images, with no false positives in either case. The fractures identified only on 3D were all located in the lateral tibial plateau, winter sports injuries, relatively small, and were managed without surgery. Image quality was generally adequate. Reader averaged AUC values for TP fractures were  $0.800 \pm .087$  for CR and  $0.957 \pm 0.433$  for 3D. Accounting for correlations from a paired study design, the 90% confidence interval for the difference ("3D minus CR") in reader-averaged AUC is [0.0220,0.2918]. The difference is statistically significant with 90% confidence (p-value: 0.056).

## CONCLUSION

This pilot study suggests 3D Augmented X-rays detect more fractures than conventional radiography (>90% confidence, p-value: 0.056).

## CLINICAL RELEVANCE/APPLICATION

3D Augmented X-ray technology using cone-beam digital tomography generated images can detect subtle tibial plateau fractures that may be missed on conventional radiography.

## W3-SSER02-6 **Change in Emergency Department Length of Stay Following Routine Adoption of Dual-Energy Computed Tomography (DECT) to Differentiate Intracranial Hemorrhage from Calcification**

Ngoc-Anh Tran, MD (*Presenter*) Nothing to Disclose

## PURPOSE

DECT is an advanced technique shown to improve accuracy in distinguishing intracranial hemorrhage (ICH) from calcification which can be challenging on conventional CT. The purpose of this study is to quantify emergency department (ED) length of stay (LOS) before after implementing automated DECT processing in the evaluation of indeterminate intracranial hyperdensities, with the hypothesis that DECT decreases repeat imaging ED LOS.

## METHODS AND MATERIALS

Retrospective chart review at a level 1 trauma center ED 1-year before (7/2016-6/2017) after (7/2018-6/2019) implementing DECT head protocol with automated post-processing of calcium map virtual non-calcium images. Included were patients scanned for headache, trauma or fall, who were discharged home from the ED; excluded were those admitted, taken to the operating room, or left against medical advice (pre-DECT n=908, post-DECT n=1170). Intracranial hyperdensities were identified by report or imaging review, excluding those determined to represent calcification by classic location, morphology, or Hounsfield units>100, leaving only indeterminate hyperdensities (pre-DECT n=17, post-DECT n=18). Primary outcome measure was ED LOS. Secondary measures were number of CT scans with follow-up imaging. Student t-test Mann-Whitney test were used for continuous data; Chi2 for dichotomous/categorical variables.

## RESULTS

There were no difference in patient demographics (age, sex, and CT head indication) between the pre post-DECT cohorts. There was a significant difference in ED LOS in the final cohorts: mean pre-DECT LOS=421 minutes (mins), post-DECT LOS=272 mins, mean LOS reduction=149 mins. Change in baseline LOS increased from 20 mins (p=0.002) to 149 mins after the exclusion criteria (p=0.003). Increased ED LOS correlated with increased frequency of neurosurgical consultation repeat CT head for indeterminate hyperdensities. There were no other major changes in the ED workflow or care algorithm to explain these differences.

## CONCLUSION

Automatic DECT postprocessing improves characterization of ICH & calcium, decreasing ED LOS for a select group of patients by reducing unnecessary neurosurgical consultation & repeat imaging. These changes may improve ED workflow, efficiency, cost, as well as patient care & outcomes.

## CLINICAL RELEVANCE/APPLICATION

Increased advanced diagnostic imaging is a major contributor to increased ED LOS, which is linked to increased healthcare costs, poorer quality of care/patient outcomes, increased mortality, and is an important quality metric which many hospitals aim to safely minimize. The potential downstream outcomes of improved differentiation of ICH calcium using DECT include decreased repeat imaging, hospital-to-hospital transfers, ED LOS.

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## Abstract Archives of the RSNA, 2023

W3-SSER02-1

### Multi-Parameter Spectral CT Enhanced Imaging for Differential Diagnosis of Portal Vein Thrombosis and Malignant Thrombosis

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451B

Zhihao Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

This study is to investigate the differential diagnostic performance of spectral-based image-enhanced imaging for portal vein thrombosis (PVT) and malignant thrombus (MT), with the aim of enhancing the clinical efficiency of differential diagnosis between the PVT and MT.

#### METHODS AND MATERIALS

This retrospective study included 100 patients with portal vein thrombosis who underwent spectral CT imaging from February 2023 to April 2023. According to clinical data and pathological diagnosis, 52 cases of portal vein thrombosis and 48 cases of malignant thrombosis were enrolled. Using post-processing software, conventional CT images (CI), iodine density maps (ID), effective atomic number maps (Z-eff), and spectral curves were reconstructed from the spectral data. Regions of interest (ROIs) were drawn at the site of occlusion, and CT values (CIHU), iodine density values (ID), effective atomic numbers (Z-eff), and spectral curve slopes were measured (?HU). Independent sample t-tests were used to analyze the differences between parameters. A single-factor logistic regression was used to evaluate the predictive probability of spectral multi-parameters for portal vein thrombosis and tumor thrombus, and a spectral multi-parameter combined model was established. Receiver operating characteristic (ROC) curves were plotted, and the area under the curve (AUC) and cutoff value were calculated to compare the diagnostic efficacy of various spectral parameters in differentiating portal vein thrombosis and tumor thrombus.

#### RESULTS

Compared to CT values (AUC 0.92, cutoff value 142.5, sensitivity 86%, specificity 93%), ID values (AUC 0.965, cutoff value 3.24, sensitivity 92%, specificity 96.5%), Z-eff values (AUC 0.952, cutoff 12.05, sensitivity 90%, specificity 96.2%), and ? HU values (AUC 0.962, sensitivity 96%, specificity 95%), the multi-parameter spectral combined model (AUC 0.97, sensitivity 94%, specificity 97%) exhibits the highest discriminatory power in distinguishing between portal vein thrombosis and malignant thrombosis.

#### CONCLUSION

The multi-parameter spectral combined model exhibits superior differential diagnostic capabilities compared to traditional CT values and various spectral parameters for distinguishing between portal vein thrombosis and cancer thrombus.

#### CLINICAL RELEVANCE/APPLICATION

Spectral multi-parameter CT can help clinicians accurately determine the nature, lesion homogeneity, location, size, and adjacent relationship of portal vein thrombi. This provides more accurate imaging evidence for the early diagnosis, treatment strategy, and prognosis prediction of tumor patients.

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## Abstract Archives of the RSNA, 2023

W3-SSER02-2

### High-Pitch Head CT in Uncooperative Emergency Department Patients With Acute Head and Neck Trauma: Evaluation of Image Quality and Detection of Acute Intracranial Pathologies

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451B

Daniel Heinrich Leitner, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate image quality and diagnostic accuracy of acute intracranial pathologies of an unenhanced high-pitch head CT protocol used in uncooperative Emergency Department (ED) patients after acute trauma in comparison to standard CT protocols.

#### METHODS AND MATERIALS

This retrospective study was IRB approved with a waiver for informed consent. We compared a novel high-pitch (1.55) head CT protocol (CTDIVOL 34.4 mGy) on a dual-source CT platform used in uncooperative ED patients and 1:1 age-matched ED patients who underwent standard-pitch (0.55) head CT protocol (CTDIVOL 39.5 mGy) after acute trauma and scanned between 01/2023 and 03/2023. Gray matter (GM) signal-to-noise ratio (SNR), white matter (WM) SNR, GM-WM contrast-to-noise ratio (CNR), and posterior fossa artifact index (PFAI) were compared. Two radiologists performed qualitative image evaluation of intracranial and bone structures, artifacts, and diagnostic evaluation for acute intracranial pathologies and fractures.

#### RESULTS

Results: In total, 41 patients [male, n=27 (65.9%), 68±20 years] were scanned using high-pitch CT protocol. Only one scan had poor image quality due to motion (2.4%). Quantitative image evaluation did not show significant differences between high-pitch and standard protocols: GM SNR, mean±SD, 18.5±3.5 vs. 17.2±2.9, WM SNR, 15.5±2.5 vs. 14.7±2.2, GM-WM CNR 2.3±0.6 vs 2.2±0.5, PFAI, 3.5±0.3, all p=0.41. Grey-white differentiation [median (IQR); 5(4, 5) vs. 5 (4, 5)], delineation of cerebrospinal fluid spaces (5 vs. 5), mastoid cells (5 vs. 5) and bone structures (5 vs. 5) were rated very good for both protocols w/o significant differences (all p=0.05). Artifacts in the supratentorial region were low in both protocols (p=0.09), while beam-hardening artifacts in the infratentorial region were slightly worse in high-pitch scans [2 (1,3) vs. 1 (1,2), p=0.001]. Diagnostic confidence to evaluate for intracranial hemorrhage, brain herniation and fracture was very good for both protocols w/o significant differences. Interrater agreement for the detection of intracranial hemorrhages (n=18), herniation (n=9) and fractures (n=6) was excellent for both protocols (? ,1.0).

#### CONCLUSION

High-pitch head CT protocol provides similar image quality to standard head CT protocol and is a safe and robust alternative in uncooperative ED patients to evaluate for acute intracranial pathologies after trauma.

#### CLINICAL RELEVANCE/APPLICATION

ED patients after acute head trauma are frequently uncooperative and difficult to evaluate. High-pitch head CT is a robust protocol that allows scans in less than 1 second and provides excellent image quality to evaluate for acute intracranial pathologies and fractures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSER02-3

### **Serum Creatinine Testing in the Emergency Department Prior to Contrast-Enhanced CT Exam Does Not Typically Change Patient Management**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451B

Jennifer S. McDonald, PhD (*Presenter*) Research Grant, General Electric Company; Scientific Advisor, General Electric Company; Consultant, General Electric Company

#### **PURPOSE**

Standard practices and guidelines recommend or require that a recent serum creatinine (SCr) result (typically within 7-30 days) must be available in the medical record or a SCr test must be ordered before a patient receives intravenous ICM. However this practice adds cost and time, potentially delaying imaging, diagnosis and patient management, particularly in patients who present to emergency departments (ED). The purpose of this retrospective study was to examine SCr testing performed in the emergency department of a large quaternary center prior to performing a contrast-enhanced CT exam and determine how frequently this testing changed patient management.

#### **METHODS AND MATERIALS**

This retrospective study consisted of all adult and pediatric patients that presented to our ED from 1/1/2017 to 1/1/2020 and had a contrast-enhanced CT exam ordered during the ED visit. At our institution, patients with a pre-CT eGFR <30 ml/min may not receive contrast at the discretion of the ordering provider and radiologist. All patient, laboratory, and radiology data was retrieved by automated search and chart review. Pre-CT eGFR was calculated for each patient from the serum creatinine (SCr) result using the MDRD equation.

#### **RESULTS**

A total of 19,127 ED visits with CECT were included in the study. Most visits had a SCr result available before the CECT was ordered (n=17,370, 91%). Median turnaround time between SCr order and result was 34 minutes (IQR 26-46 minutes). In almost all ED visits where SCr testing was performed and results were available pre-CECT, the patient's eGFR result was > 30 ml/min (n=17,139, 99%), with only a small number of patients with eGFR <30 ml/min (n=231, 1.3%). A CECT exam was still performed in 179 of the eGFR <30 ml/min patients (62%). In 46 patients (20% of eGFR <30 ml/min patients, 0.24% of cohort) the CECT was cancelled out of concern for CIN. In those 46 canceled cases, four of the patients underwent a CECT in the 60 days following the ED visit.

#### **CONCLUSION**

Serum creatinine testing in the ED did not affect the decision to perform a CECT exam in the vast majority of cases.

#### **CLINICAL RELEVANCE/APPLICATION**

Most patients with eGFR <30 ml/min who presented to the ED received a CECT. Creatinine testing prior to iodinated contrast material exposure may not be necessary in patients presenting to the emergency department, as the benefit of administering contrast in acute situations likely outweighs the risk of contrast-induced acute kidney injury.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSER02-4

### Relationship Between Injury Severity and Trauma Whole-Body CT Report Turnaround Times

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451B

Nathan Sarkar, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Background/Purpose: Trauma is a leading cause of death in the United States. Whole-Body CT is frequently used to screen trauma patients for major injuries and hemorrhage, as well as for surgical planning. However, delayed Report Turn-Around-Time (RTAT) remains a bottleneck in the flow of patient management in trauma, especially severely injured patients.

#### METHODS AND MATERIALS

Methods: This dataset consisted of 11,251 patients who underwent admission trauma whole body CT from two trauma centers within a single hospital system; a level I tertiary care trauma center (n=9043) and a regional urban level II trauma center (n=2208). Patients were selected between July 2016 and September 2022. Patients were discretized by age index ( $\geq 55$  or  $< 55$  years), polytrauma (ISS =16), whether they required any transfusion, or massive transfusion (MT) defined as  $\geq 10$  units of Packed Red Blood Cells (PRBCs) within 24 hours, and by shock index (HR/SBP)  $>$  or  $= 1$ , where a value  $> 1$  indicates hemodynamic shock. Bivariate comparisons of medians were performed with the Mann-Whitney U test. Tests of proportions were performed using the Chi square test. In all cases, p-value  $< 0.05$  was considered statistically significant.

#### RESULTS

Results: Overall median RTAT was 24 minutes (IQR: 4-48). RTAT was significantly longer in those in hemodynamic shock (37 minutes vs 22 minutes,  $p < 0.0001$ ), those with polytrauma (ISS=16 vs ISS<16) (34 minutes vs 21 minutes,  $p < 0.0001$ ), those who received massive transfusion versus those who did not (47.5 minutes vs 24 minutes,  $p < 0.0001$ ), those who ultimately expired (41 minutes vs 23 minutes,  $p < 0.0001$ ), the older cohort (age $> 55$ ) (28 minutes vs 22 minutes,  $p < 0.0001$ ), and those with penetrating vs blunt injuries (27 minutes vs 23 minutes,  $p = 0.001$ ).

#### CONCLUSION

Conclusion: Multiple markers of traumatic injury severity were associated with longer RTATs, despite evidence showing that more severely injured patients require faster diagnosis and treatment. The field of trauma radiology must search for ways to improve the RTAT in patients who are severely injured with time-sensitive injuries.

#### CLINICAL RELEVANCE/APPLICATION

Existing evidence shows that more severely injured trauma patients require faster diagnosis and treatment. However, we found that multiple markers of traumatic injury severity were associated with longer report turn-around times.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSER02-5

### Occult Fractures in the Tibial Plateau: 3D Augmented X-Ray Pilot Study

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451B

Luis Fandino, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The tibial plateau (TP) is a common site of missed fractures on conventional radiographs (CR). 3D augmented X-ray is a new cone beam-based tomography imaging concept that provides CRs along with digital tomography images that can be reformatted in axial, coronal, and sagittal planes with 0.5mm slice thickness. The purpose of this study is to evaluate the value of 3D Augmented X-ray in the detection of fractures of the tibial plateau.

#### METHODS AND MATERIALS

Over the course of 4 months, 23 patients referred from the Emergency Department with a high clinical suspicion for knee fracture were evaluated with a 3D Augmented X-ray exam (Multitom RAX, Siemens Healthineers, Germany). Three radiologists with 12-, 4- and 1-year experience sequentially reviewed CR and 3D images in a blinded fashion and recorded their confidence level for the absence/presence of a TP fracture on a 5-point ordinal scale (definitely absent, likely absent, neutral, likely present, definitely present). The ground-truth for presence of fracture was established by either subsequent magnetic resonance imaging (MRI) or consensus of three musculoskeletal radiology specialists. The confidence levels were entered into software for receiver-operating characteristic (ROC) analysis. Reader-average area-under-curve (AUC) values were obtained from this analysis and compared for CR versus 3D.

#### RESULTS

5 TP fractures were identified by reference standard (21.7% of exams, 95% CI: 7.5-43.7%). The reviewer with 12 years of experience identified two of these fractures on CR, while all 5 were identified using the 3D images, with no false positives in either case. The fractures identified only on 3D were all located in the lateral tibial plateau, winter sports injuries, relatively small, and were managed without surgery. Image quality was generally adequate. Reader averaged AUC values for TP fractures were  $0.800 \pm .087$  for CR and  $0.957 \pm 0.433$  for 3D. Accounting for correlations from a paired study design, the 90% confidence interval for the difference ("3D minus CR") in reader-averaged AUC is [0.0220,0.2918]. The difference is statistically significant with 90% confidence (p-value: 0.056).

#### CONCLUSION

This pilot study suggests 3D Augmented X-rays detect more fractures than conventional radiography (>90% confidence, p-value: 0.056).

#### CLINICAL RELEVANCE/APPLICATION

3D Augmented X-ray technology using cone-beam digital tomography generated images can detect subtle tibial plateau fractures that may be missed on conventional radiography.

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## Abstract Archives of the RSNA, 2023

W3-SSER02-6

### Change in Emergency Department Length of Stay Following Routine Adoption of Dual-Energy Computed Tomography (DECT) to Differentiate Intracranial Hemorrhage from Calcification

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E451B

Ngoc-Anh Tran, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

DECT is an advanced technique shown to improve accuracy in distinguishing intracranial hemorrhage (ICH) from calcification which can be challenging on conventional CT. The purpose of this study is to quantify emergency department (ED) length of stay (LOS) before after implementing automated DECT processing in the evaluation of indeterminate intracranial hyperdensities, with the hypothesis that DECT decreases repeat imaging ED LOS.

#### METHODS AND MATERIALS

Retrospective chart review at a level 1 trauma center ED 1-year before (7/2016-6/2017) after (7/2018-6/2019) implementing DECT head protocol with automated post-processing of calcium map virtual non-calcium images. Included were patients scanned for headache, trauma or fall, who were discharged home from the ED; excluded were those admitted, taken to the operating room, or left against medical advice (pre-DECT n=908, post-DECT n=1170). Intracranial hyperdensities were identified by report or imaging review, excluding those determined to represent calcification by classic location, morphology, or Hounsfield units>100, leaving only indeterminate hyperdensities (pre-DECT n=17, post-DECT n=18). Primary outcome measure was ED LOS. Secondary measures were number of CT scans with follow-up imaging. Student t-test Mann-Whitney test were used for continuous data; Chi2 for dichotomous/categorical variables.

#### RESULTS

There were no difference in patient demographics (age, sex, and CT head indication) between the pre post-DECT cohorts. There was a significant difference in ED LOS in the final cohorts: mean pre-DECT LOS=421 minutes (mins), post-DECT LOS=272 mins, mean LOS reduction=149 mins. Change in baseline LOS increased from 20 mins (p=0.002) to 149 mins after the exclusion criteria (p=0.003). Increased ED LOS correlated with increased frequency of neurosurgical consultation repeat CT head for indeterminate hyperdensities. There were no other major changes in the ED workflow or care algorithm to explain these differences.

#### CONCLUSION

Automatic DECT postprocessing improves characterization of ICH & calcium, decreasing ED LOS for a select group of patients by reducing unnecessary neurosurgical consultation & repeat imaging. These changes may improve ED workflow, efficiency, cost, as well as patient care & outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Increased advanced diagnostic imaging is a major contributor to increased ED LOS, which is linked to increased healthcare costs, poorer quality of care/patient outcomes, increased mortality, and is an important quality metric which many hospitals aim to safely minimize. The potential downstream outcomes of improved differentiation of ICH calcium using DECT include decreased repeat imaging, hospital-to-hospital transfers, ED LOS.

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## Abstract Archives of the RSNA, 2023

W3-SSGI12

### Gastrointestinal Imaging (Biliary)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N228

Dong Ho Lee, MD (*Moderator*) Nothing to Disclose  
Motoyo Yano, MD, PhD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W3-SSGI12-1 The Nine Important Imaging Signs of Intraductal Papillary Neoplasm of the Bile Duct (IPNB): A Reappraisal of 342 Cases been Resected**

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

intraductal papillary neoplasm of the bile duct (IPNB)--- are rare that have special clinical, imaging features, and pathological results. IPNB has recently been further classified into "so-called IPNBs" (Type-1) and "narrow-sense papillary cholangiocarcinomas" (Type-2), but their differential diagnosis is challenging. Our study aimed to reevaluate these two types CT and MR Images to find some valuable signs. The purpose of understanding these signs is to improve the accuracy of preoperative diagnosis.

#### METHODS AND MATERIALS

342 patients (from our hospital, 2013-2023) who underwent papillary bile-duct tumor resection were included. We used nine CT/MRI features (I, thread sign; II, papilla sign; III, biliary dilatation; IV, hepatic lobe atrophy; V, cyst; VI, combined calculus; VII, common bile duct stenosis; VIII, combined IPMN, and IX, clonorchiosis history) to score these tumors. Meanwhile, we used five pathological features (location, mucin secretion, histological type, low/intermediate-dysplasia component, and proportion of the invasive component), CA-199, CEA and immunohistochemical results also included in the score. Tumor scoring 10-16 were classified as Type-1, 0-5 as Type-2, and 6-9 as Type- Unclassifiable. In addition, we compared the nine scores of the images with the pathology scores of 342 tumors.

#### RESULTS

The 342 papillary bile-duct tumor patients were divided into three groups, consisting of 30 Type-1, 61 Type-2, and 251 type- Unclassifiable, which means uncertain gray-zone tumors occupying the largest proportion of IPNB. The invasive component has a correlation with imaging features.

#### CONCLUSION

The imaging scoring system worked well for IPNB to reflect a continuous spectrum of pathological features.

#### CLINICAL RELEVANCE/APPLICATION

Through retrospective analysis of 342 large IPNB samples, we can establish an imaging scoring system for accurate preoperative evaluation of tumors in the bile ducts.

#### **W3-SSGI12-2 Disease Severity Prognostication in Primary Sclerosing Cholangitis Patients using Gadoteric Acid-Enhanced MRI: A Validation of the Anali Score and Comparison with the Potential Functional Stricture**

Sami Ba-Ssalamah (*Presenter*) Nothing to Disclose

#### PURPOSE

To validate the Anali scores with and without gadolinium (ANALIGd and ANALInoGd) and to compare their prognostic ability with the recently-proposed potential functional stricture (PFS), based on the hepatobiliary phase (HBP) of gadoteric acid-enhanced MRI (GA-MRI) in PSC patients.

## METHODS AND MATERIALS

Three readers scored the Anali scores components, including intrahepatic bile duct change severity, hepatic dysmorphism, liver parenchymal heterogeneity, and portal hypertension on GA-MRI, including T2-MRCP, to generate ANALIGd and ANALInoGd. They also evaluated 20-minute HBP images for PFS, i.e., absent contrast excretion in first order bile ducts (i.e., LHD/RHD/CHD/CBD) or none at all vs normal biliary excretion, i.e., no functional stricture (NFS). Inter- and intrareader agreement were assessed and Kaplan-Meier curves generated for survival analysis. Uni- and multivariate Cox regression analyses were performed to evaluate association between ANALInoGd, ANALIGd, and PFS with clinical scores, labs and outcomes.

## RESULTS

For 129 patients, mean age 41.4 years, ICC agreement was almost perfect (0.95) for PFS, and substantial (0.74), for ANALInoGd. ANALIGd, agreement was better on HBP than arterial-phase, (0.66 vs 0.81). Univariate Cox regression showed that the hazard ratio (HR) of decompensated cirrhosis, orthotopic liver transplantation (OLT) or death was 7.3 for PFS ( $p < 0.001$ ) vs (6.1,  $p < 0.001$ ) for ANALInoGd vs (7.9,  $p < 0.004$ ) for the HBP and (4.5,  $p < 0.125$ ) for the arterial-phase of the ANALIGd. Multivariate analyses for PFS, Anali scores and clinical scores identified the PFS and ANALIGd HBP as independent risk factors with HRs (3.7,  $p < 0.028$  and 3.2,  $p = 0.021$ , respectively).

## CONCLUSION

GA-MRI-derived parameters, including the Anali scores and PFS can noninvasively predict clinical outcomes in PSC patients. The HBP scores, including PFS and ANALIGd appear more robust.

## CLINICAL RELEVANCE/APPLICATION

Prognostic model using three-dimensional MRCP and gadoxetic acid enhanced MRI can be used to determine PSC severity non-invasively.

### W3-SSGI12-3 **Bile Duct DWI Abnormalities: Potential Biomarker Predicting Ischemic Cholangiopathy in ABO-incompatible Liver Transplant Recipients**

Kyowon Gu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Ischemic cholangiopathy (IC) remains a significant complication in ABO incompatible liver transplantation (ABOi-LT) patients despite the introduction of Rituximab and plasmapheresis, impacting graft survival and patient outcomes. This study aimed to evaluate the potential of postoperative diffusion-weighted imaging (DWI) in predicting IC development in ABOi-LT patients.

## METHODS AND MATERIALS

A total of 56 ABOi-LT patients underwent postoperative magnetic resonance cholangiography (MRCP) including DWI, during the postoperative hospitalization period. Two independent readers assessed periportal diffusion restriction, periportal edema, wall thickening, associated signal alteration of liver parenchyma, bile duct dilatation, and stricture site on MRCP. Inter-reader agreement was determined using Cohen's kappa method for DWI abnormality which was categorized as normal, equivocal or abnormal. Endoscopic retrograde cholangiopancreatography (ERCP) was conducted for patients with abnormal liver function tests during follow-up. IC was considered present if multifocal or diffuse stricture, excluding anastomosis sites, was observed. Progression of IC was also assessed and categorized as biliary dilatation, abscess formation, or hepatic necrosis causing graft failure.

## RESULTS

The median follow-up period was 346.5 days, with a median interval of 17.5 days (range, 7-37) between ABOi-LT and MRCP. Substantial inter-reader agreement was observed in assessing DWI abnormality (Kappa = 0.710). In one case, DWI was not suitable for evaluation due to artifact caused by portal vein stent. The median interval between LT and ERCP demonstrating IC was 109 days (range, 21-510). Patients with periportal DWI abnormality on postoperative MRCP ( $n=18$ ) exhibited a significant difference in the ratio of developing IC during follow-up ( $p=0.029$ ). Among 15 patients with biliary stricture on ERCP, 5 showed progressive stricture or complications. Periportal DWI abnormality was significantly associated with a higher likelihood of progressive biliary stricture ( $p=0.007$ ).

## CONCLUSION

Postoperative DWI abnormalities demonstrate potential as a non-invasive imaging modality for predicting IC development and progression following ABOi-LT. Early identification of at-risk patients may facilitate timely interventions, potentially improving graft survival and patient outcomes.

## CLINICAL RELEVANCE/APPLICATION

Postoperative diffusion-weighted imaging abnormalities of the bile duct can be used as a biomarker predicting ischemic cholangiopathy after ABO-incompatible liver transplantation.

### **W3-SSGI12-5 Differentiating between Benign and Malignant Ampullary Strictures: A Prediction Model using Contrast Enhanced MR Imaging and Clinical Findings**

Jonghun Woo, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To construct a predictive nomogram for differentiating malignant from benign ampullary strictures using contrast-enhanced magnetic resonance imaging (MRI) findings combined with clinical findings.

#### **METHODS AND MATERIALS**

In this retrospective study, 76 patients with ampullary stricture (51 benign and 25 malignant) who underwent contrast-enhanced MRI were included. Various imaging findings of the ampulla, bile duct, main pancreatic duct, and periampullary area were evaluated and clinical findings including the presence of jaundice, carbohydrate antigen 19-9 level, and history of cholecystectomy were collected. Among them, statistically significant findings were identified using univariable and multivariable logistic regression analyses. A nomogram was constructed to differentiate benign and malignant ampullary strictures and was internally validated.

#### **RESULTS**

Multivariable analysis revealed that jaundice (odds ratio [OR]: 12.41,  $p = 0.019$ ), presence of ampullary mass (OR: 8.42,  $p = 0.047$ ), bulging ampulla (OR: 8.32,  $p = 0.033$ ), and diffusion restriction of the ampulla (OR: 42.76,  $p = 0.004$ ) were significant factors for predicting the presence of malignant ampullary stricture and were used to construct a nomogram. Among them, diffusion restriction of the ampulla showed the highest OR and predictor point on the nomogram. The calibration plots showed excellent agreement between the predicted probabilities and the actual rates of malignant ampullary strictures, on internal validation.

#### **CONCLUSION**

Combination of clinical and imaging findings could aid in predicting malignant ampullary strictures using significant findings of jaundice, presence of ampullary mass, bulging ampulla, and diffusion restriction of the ampulla. A predictive nomogram based on contrast-enhanced MR imaging findings combined with clinical findings can be useful for differentiating between benign and malignant ampullary strictures.

#### **CLINICAL RELEVANCE/APPLICATION**

The nomogram constructed using contrast-enhanced MRI and clinical findings could aid in predicting malignant ampullary strictures.

### **W3-SSGI12-6 Improvement of Diagnosis of Adjacent Organ Invasion of Extrahepatic Bile Duct Cancer by Adding Arterial and Delayed Phases**

Eisuke Mukaida, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our study was to clarify the role of dynamic computed tomography (CT) in the diagnosis of extrahepatic bile duct (EHD) cancer involving adjacent organs.

#### **METHODS AND MATERIALS**

This retrospective study included patients who were pathologically diagnosed with EHD cancer between January 2011 and December 2021 and had undergone dynamic contrast-enhanced CT before previous biliary intervention, surgery, or chemotherapy. For each patient, the mean CT values of the abdominal aorta, portal vein (PV), hepatic parenchyma, pancreatic parenchyma, and EHD cancer were measured during each phase. In patients who had undergone surgery, two radiologists independently reviewed the CT images in the portal, dual (adding arterial phase), and triple phases (adding delayed phase). Two radiologists assessed the biliary segment-wise longitudinal tumor extent, arterial and PV invasion, organ invasion, and regional lymph node metastasis on a five-point scale for each phase. The performances of the portal, dual, and triple phase images were compared using the sensitivity, specificity, and AUC of each reader's results for pathological diagnosis.

#### **RESULTS**

In total, 120 patients (mean age,  $71.7 \pm 8.8$ ; 84 males) were evaluated for CT values. Contrast peaks of EHD cancer, hepatic parenchyma, and PV were observed in the portal phase. Among them, 80 patients were evaluated on a five-point scale. The AUC of pancreatic, duodenal, and arterial invasion increased with the addition of the phase at each observer (observer 1, 0.79 to 0.93,  $p < 0.01$ , 0.71 to 0.86,  $p = 0.04$ , 0.74 to 0.99,  $p = 0.02$ , respectively; observer 2, 0.88 to 0.96,  $p = 0.01$ , 0.73 to 0.94,  $p < 0.01$ , 0.80 to 0.99,  $p = 0.04$ , respectively). Statistically, the AUC for biliary segment-wise longitudinal tumor extent, hepatic, and PV invasion did not change with the addition phase.

## **CONCLUSION**

Addition of the arterial and delayed phases increased the AUC of pancreatic, duodenal, and arterial invasion.

## **CLINICAL RELEVANCE/APPLICATION**

Histological evaluation of patients with EHD cancer often reveals invasion of adjacent organs, which may lead to curative resection failure or early postoperative recurrence. Because the adjacent organs of EHD cancer vary according to the site of origin, the diagnostic performance of adjacent organ invasion may be influenced by contrast effects specific to that organ; however, no reports have been retrieved on this effect. Our results provide an important preoperative imaging strategy to achieve R0 resection of EHD cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGI12-1

### **The Nine Important Imaging Signs of Intraductal Papillary Neoplasm of the Bile Duct (IPNB): A Reappraisal of 342 Cases been Resected**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N228

Xinyi Gao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

intraductal papillary neoplasm of the bile duct (IPNB)--- are rare that have special clinical, imaging features, and pathological results. IPNB has recently been further classified into "so-called IPNBs" (Type-1) and "narrow-sense papillary cholangiocarcinomas" (Type-2), but their differential diagnosis is challenging. Our study aimed to reevaluate these two types CT and MR Images to find some valuable signs. The purpose of understanding these signs is to improve the accuracy of preoperative diagnosis.

#### **METHODS AND MATERIALS**

342 patients (from our hospital, 2013-2023) who underwent papillary bile-duct tumor resection were included. We used nine CT/MRI features (I, thread sign; II, papilla sign; III, biliary dilatation; IV, hepatic lobe atrophy; V, cyst; VI, combined calculus; VII, common bile duct stenosis; VIII, combined IPMN, and IX, clonorchiosis history) to score these tumors. Meanwhile, we used five pathological features (location, mucin secretion, histological type, low/intermediate-dysplasia component, and proportion of the invasive component), CA-199, CEA and immunohistochemical results also included in the score. Tumor scoring 10-16 were classified as Type-1, 0-5 as Type-2, and 6-9 as Type- Unclassifiable. In addition, we compared the nine score features of the images with the pathology scores of 342 tumors.

#### **RESULTS**

The 342 papillary bile-duct tumor patients were divided into three groups, consisting of 30 Type-1, 61 Type-2, and 251 type- Unclassifiable, which means uncertain gray-zone tumors occupying the largest proportion of IPNB. The invasive component has a correlation with imaging features.

#### **CONCLUSION**

The imaging scoring system worked well for IPNB to reflect a continuous spectrum of pathological features.

#### **CLINICAL RELEVANCE/APPLICATION**

Through retrospective analysis of 342 large IPNB samples, we can establish an imaging scoring system for accurate preoperative evaluation of tumors in the bile ducts.

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## Abstract Archives of the RSNA, 2023

W3-SSGI12-2

### **Disease Severity Prognostication in Primary Sclerosing Cholangitis Patients using Gadoteric Acid-Enhanced MRI: A Validation of the Anali Score and Comparison with the Potential Functional Stricture**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N228

Sami Ba-Ssalamah (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To validate the Anali scores with and without gadolinium (ANALIGd and ANALInoGd) and to compare their prognostic ability with the recently-proposed potential functional stricture (PFS), based on the hepatobiliary phase (HBP) of gadoteric acid-enhanced MRI (GA-MRI) in PSC patients.

#### **METHODS AND MATERIALS**

Three readers scored the Anali scores components, including intrahepatic bile duct change severity, hepatic dysmorphism, liver parenchymal heterogeneity, and portal hypertension on GA-MRI, including T2-MRCP, to generate ANALIGd and ANALInoGd. They also evaluated 20-minute HBP images for PFS, i.e., absent contrast excretion in first order bile ducts (i.e., LHD/RHD/CHD/CBD) or none at all vs normal biliary excretion, i.e., no functional stricture (NFS). Inter- and intrareader agreement were assessed and Kaplan-Meier curves generated for survival analysis. Uni- and multivariate Cox regression analyses were performed to evaluate association between ANALInoGd, ANALIGd, and PFS with clinical scores, labs and outcomes.

#### **RESULTS**

For 129 patients, mean age 41.4 years, ICC agreement was almost perfect (0.95) for PFS, and substantial (0.74), for ANALInoGd. ANALIGd, agreement was better on HBP than arterial-phase, (0.66 vs 0.81). Univariate Cox regression showed that the hazard ratio (HR) of decompensated cirrhosis, orthotopic liver transplantation (OLT) or death was 7.3 for PFS ( $p < 0.001$ ) vs (6.1,  $p < 0.001$ ) for ANALInoGd vs (7.9,  $p < 0.004$ ) for the HBP and (4.5,  $p < 0.125$ ) for the arterial-phase of the ANALIGd. Multivariate analyses for PFS, Anali scores and clinical scores identified the PFS and ANALIGd HBP as independent risk factors with HRs (3.7,  $p < 0.028$  and 3.2,  $p = 0.021$ , respectively).

#### **CONCLUSION**

GA-MRI-derived parameters, including the Anali scores and PFS can noninvasively predict clinical outcomes in PSC patients. The HBP scores, including PFS and ANALIGd appear more robust.

#### **CLINICAL RELEVANCE/APPLICATION**

Prognostic model using three-dimensional MRCP and gadoteric acid enhanced MRI can be used to determine PSC severity non-invasively.

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## Abstract Archives of the RSNA, 2023

W3-SSGI12-3

### **Bile Duct DWI Abnormalities: Potential Biomarker Predicting Ischemic Cholangiopathy in ABO-incompatible Liver Transplant Recipients**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N228

Kyowon Gu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ischemic cholangiopathy (IC) remains a significant complication in ABO incompatible liver transplantation (ABOi-LT) patients despite the introduction of Rituximab and plasmapheresis, impacting graft survival and patient outcomes. This study aimed to evaluate the potential of postoperative diffusion-weighted imaging (DWI) in predicting IC development in ABOi-LT patients.

#### **METHODS AND MATERIALS**

A total of 56 ABOi-LT patients underwent postoperative magnetic resonance cholangiography (MRCP) including DWI, during the postoperative hospitalization period. Two independent readers assessed periportal diffusion restriction, periportal edema, wall thickening, associated signal alteration of liver parenchyma, bile duct dilatation, and stricture site on MRCP. Inter-reader agreement was determined using Cohen's kappa method for DWI abnormality which was categorized as normal, equivocal or abnormal. Endoscopic retrograde cholangiopancreatography (ERCP) was conducted for patients with abnormal liver function tests during follow-up. IC was considered present if multifocal or diffuse stricture, excluding anastomosis sites, was observed. Progression of IC was also assessed and categorized as biliary dilatation, abscess formation, or hepatic necrosis causing graft failure.

#### **RESULTS**

The median follow-up period was 346.5 days, with a median interval of 17.5 days (range, 7-37) between ABOi-LT and MRCP. Substantial inter-reader agreement was observed in assessing DWI abnormality (Kappa = 0.710). In one case, DWI was not suitable for evaluation due to artifact caused by portal vein stent. The median interval between LT and ERCP demonstrating IC was 109 days (range, 21-510). Patients with periportal DWI abnormality on postoperative MRCP (n=18) exhibited a significant difference in the ratio of developing IC during follow-up (p=0.029). Among 15 patients with biliary stricture on ERCP, 5 showed progressive stricture or complications. Periportal DWI abnormality was significantly associated with a higher likelihood of progressive biliary stricture (p=0.007).

#### **CONCLUSION**

Postoperative DWI abnormalities demonstrate potential as a non-invasive imaging modality for predicting IC development and progression following ABOi-LT. Early identification of at-risk patients may facilitate timely interventions, potentially improving graft survival and patient outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

Postoperative diffusion-weighted imaging abnormalities of the bile duct can be used as a biomarker predicting ischemic cholangiopathy after ABO-incompatible liver transplantation.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSGI12-5

### Differentiating between Benign and Malignant Ampullary Strictures: A Prediction Model using Contrast Enhanced MR Imaging and Clinical Findings

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N228

Jonghun Woo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To construct a predictive nomogram for differentiating malignant from benign ampullary strictures using contrast-enhanced magnetic resonance imaging (MRI) findings combined with clinical findings.

#### METHODS AND MATERIALS

In this retrospective study, 76 patients with ampullary stricture (51 benign and 25 malignant) who underwent contrast-enhanced MRI were included. Various imaging findings of the ampulla, bile duct, main pancreatic duct, and periampullary area were evaluated and clinical findings including the presence of jaundice, carbohydrate antigen 19-9 level, and history of cholecystectomy were collected. Among them, statistically significant findings were identified using univariable and multivariable logistic regression analyses. A nomogram was constructed to differentiate benign and malignant ampullary strictures and was internally validated.

#### RESULTS

Multivariable analysis revealed that jaundice (odds ratio [OR]: 12.41,  $p = 0.019$ ), presence of ampullary mass (OR: 8.42,  $p = 0.047$ ), bulging ampulla (OR: 8.32,  $p = 0.033$ ), and diffusion restriction of the ampulla (OR: 42.76,  $p = 0.004$ ) were significant factors for predicting the presence of malignant ampullary stricture and were used to construct a nomogram. Among them, diffusion restriction of the ampulla showed the highest OR and predictor point on the nomogram. The calibration plots showed excellent agreement between the predicted probabilities and the actual rates of malignant ampullary strictures, on internal validation.

#### CONCLUSION

Combination of clinical and imaging findings could aid in predicting malignant ampullary strictures using significant findings of jaundice, presence of ampullary mass, bulging ampulla, and diffusion restriction of the ampulla. A predictive nomogram based on contrast-enhanced MR imaging findings combined with clinical findings can be useful for differentiating between benign and malignant ampullary strictures.

#### CLINICAL RELEVANCE/APPLICATION

The nomogram constructed using contrast-enhanced MRI and clinical findings could aid in predicting malignant ampullary strictures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGI12-6

### Improvement of Diagnosis of Adjacent Organ Invasion of Extrahepatic Bile Duct Cancer by Adding Arterial and Delayed Phases

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N228

Eisuke Mukaida, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of our study was to clarify the role of dynamic computed tomography (CT) in the diagnosis of extrahepatic bile duct (EHD) cancer involving adjacent organs.

#### METHODS AND MATERIALS

This retrospective study included patients who were pathologically diagnosed with EHD cancer between January 2011 and December 2021 and had undergone dynamic contrast-enhanced CT before previous biliary intervention, surgery, or chemotherapy. For each patient, the mean CT values of the abdominal aorta, portal vein (PV), hepatic parenchyma, pancreatic parenchyma, and EHD cancer were measured during each phase. In patients who had undergone surgery, two radiologists independently reviewed the CT images in the portal, dual (adding arterial phase), and triple phases (adding delayed phase). Two radiologists assessed the biliary segment-wise longitudinal tumor extent, arterial and PV invasion, organ invasion, and regional lymph node metastasis on a five-point scale for each phase. The performances of the portal, dual, and triple phase images were compared using the sensitivity, specificity, and AUC of each reader's results for pathological diagnosis.

#### RESULTS

In total, 120 patients (mean age, 71.7±8.8; 84 males) were evaluated for CT values. Contrast peaks of EHD cancer, hepatic parenchyma, and PV were observed in the portal phase. Among them, 80 patients were evaluated on a five-point scale. The AUC of pancreatic, duodenal, and arterial invasion increased with the addition of the phase at each observer (observer 1, 0.79 to 0.93,  $p<0.01$ , 0.71 to 0.86,  $p=0.04$ , 0.74 to 0.99,  $p=0.02$ , respectively; observer 2, 0.88 to 0.96,  $p=0.01$ , 0.73 to 0.94,  $p<0.01$ , 0.80 to 0.99  $p=0.04$ , respectively). Statistically, the AUC for biliary segment-wise longitudinal tumor extent, hepatic, and PV invasion did not change with the addition phase.

#### CONCLUSION

Addition of the arterial and delayed phases increased the AUC of pancreatic, duodenal, and arterial invasion.

#### CLINICAL RELEVANCE/APPLICATION

Histological evaluation of patients with EHD cancer often reveals invasion of adjacent organs, which may lead to curative resection failure or early postoperative recurrence. Because the adjacent organs of EHD cancer vary according to the site of origin, the diagnostic performance of adjacent organ invasion may be influenced by contrast effects specific to that organ; however, no reports have been retrieved on this effect. Our results provide an important preoperative imaging strategy to achieve R0 resection of EHD cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGI13

### Gastrointestinal Imaging (Esophagus/Stomach)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N227B

Meghan G. Lubner, MD (*Moderator*) Spouse, Consultant, Elephas Bio  
Matthew A. Morgan, MD (*Moderator*) Advisory Board, sanofi-aventis Group

#### Sub-Events

#### W3-SSGI13-1 **Quantitative DCE-MRI Parameters Combined with Apparent Diffusion Coefficient for Evaluation of T Stage in Resectable Gastric Adenocarcinoma**

Yan Liangliang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the feasibility of dynamic contrast-enhanced magnetic resonance imaging quantitative DCE parameters combined with apparent diffusion coefficient (ADC) values for predicting T stage of gastric adenocarcinoma.

#### METHODS AND MATERIALS

95 patients with gastric adenocarcinoma who underwent DCE-MRI and DWI from April 2018 to January 2020 were retrospectively enrolled. The Kruskal Wallis test was used to compare differences in quantitative DCE parameters or ADC values between different T stages of gastric cancer (GC). Multivariate logistic regression was used to identify independent predictors of GC of T1 + 2, T3 + 4a stages or T1 + 2 + 3, T4a stages. ROC curves were used to determine the optimal parameters and diagnostic efficacy for predicting GC of T1 + 2, T3 + 4a stages or T1 + 2 + 3, T4a stages.

#### RESULTS

Quantitative DCE parameters Ktrans, Kep, and ADC values were useful in identifying different T stages of GC ( $p < 0.001$ ,  $0.002$ ,  $0.008$ , respectively). Ktrans, Kep, and ADC were independent risk factors for predicting GC of T1 + 2, T3 + 4a stages. The area under the curve, sensitivities, specificities of Ktrans, Kep, ADC, Ktrans + Kep + ADC were 0.769, 0.751, 0.731, 0.893; 80.0%, 70.0%, 80.0%, 74.7%; 70.7%, 74.7%, 65.3%, 90.0%, respectively. Meanwhile, Ktrans and ADC were independent risk factors for predicting GC of T1 + 2 + 3, T4a stages. The area under the curve, sensitivities, specificities of Ktrans, ADC, Ktrans + ADC were 0.709, 0.643, 0.782; 57.7%, 65.4%, 57.7%; 81.2%, 58.0%, 89.9%, respectively.

#### CONCLUSION

Quantitative DCE parameters combined with ADC values can be used to identify T stage of gastric adenocarcinoma.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative DCE parameters combined with ADC values can be used to identify T stage of gastric adenocarcinoma, which provides a theoretical basis for evaluating the malignancy of gastric adenocarcinoma and the selection of treatment options.

#### W3-SSGI13-3 **Prediction of Epithelial-to-mesenchymal Transition Molecular Subtype using CT Radiomics in Gastric Cancer**

Chaeyoung Lim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Epithelial-to-mesenchymal transition (EMT) subtype gastric cancer (GC) is known to demonstrate extremely poor prognosis. The purpose of the research is to develop and evaluate a prediction model for identifying Epithelial-to-mesenchymal transition (EMT) subtype gastric cancer (GC) using computed tomography (CT) radiomics and clinicopathologic factors.

## METHODS AND MATERIALS

This retrospective study included 418 patients with GC who underwent primary resection and molecular subgroup analysis between October 1995 and May 2008. Using preoperative CT images, we extracted 1,223 CT radiomics features from the volume of interest on portal venous phase images. Radiomics features for the prediction model were selected based on a filter method with correlation matrix and variance inflation factor (VIF), and an embedded method with least absolute shrinkage and selection operator (LASSO). To develop the radiomics-based prediction model, patient data were randomly divided into development (70%) and validation (30%) datasets. We used logistic regression (LR) and random forest (RF) algorithms with 5 repeated 5-fold cross-validation for model development. The area under the curve (AUC) was calculated to evaluate their performances. Clinicopathologic factors were added to evaluate the increase in predictive performance.

## RESULTS

70 patients had EMT subtype GC and 348 patients with non-EMT subtype based on transcriptome analysis. There were 276 men (66.0%) with median age 59 (range: 24-86). The AUCs of the CT radiomics-based prediction models were 0.824 and 0.736 for development and testing, respectively, using LR, and 1.000 and 0.692 for development and testing, respectively, using RF. After adding clinicopathologic factors of age, tumor size, signet ring cell type, and Lauren classification, the AUCs of the models using LR were 0.849 and 0.840 for development and testing, respectively, and the AUCs of the models using RF were 1.000 and 0.827 for development and testing, respectively.

## CONCLUSION

Our study demonstrated that a prediction model using CT radiomics for the EMT subtype of GC showed good performance, and the addition of clinicopathologic factors improved its predictive performance.

## CLINICAL RELEVANCE/APPLICATION

CT radiomics and clinicopathologic factors can predict EMT subtype GC with good performance.

### **W3-SSGI13-4 Contrast-enhanced Computed Tomography-based Radiomics to Predict Resectability in Patients with Gastric Cancer Invading the Pancreas Treated with Neoadjuvant Chemotherapy**

Xiaoyi Chen, BS (*Presenter*) Nothing to Disclose

## PURPOSE

The pancreas is the most vulnerable to invasion by gastric cancer, and combined resection is extremely difficult and traumatic. However, the assessment of resectability during the available examinations is limited. The purpose of this study is to construct a radiomics model for predicting the resectability for the patients receiving neoadjuvant chemotherapy with gastric cancer invading the pancreas.

## METHODS AND MATERIALS

843 gastric cancer patients suspected of having the pancreas invaded from two centers between January 2018 and January 2023 were collected. All patients received neoadjuvant chemotherapy with capecitabine and oxaliplatin (XELOX), and were evaluated by the MDT team to recommend surgery based on the latest preoperative contrast-enhanced computed tomography (CE-CT). Patients were divided into radical resection (R0) and non-radical resection (NO-R0) group based on their medical and pathological records, with 602 (Center 1) and 241 (Center 2) patients in the training and validation groups, respectively. The radiomic features were extracted after segment the whole tumor and pancreatic regions in all the slices with the latest preoperative tri-phase CE-CT. Clinical model, tri-phase radiomics signatures and combined nomogram were constructed. Two methods were employed to achieve dimensionality reduction: (I) the Least Absolute Shrinkage and Selection Operator (LASSO); and (II) the Minimum Redundancy Maximum Relevance (mRMR) algorithms. We utilized Logistic regression, Support Vector Machine (SVM), Decision Tree and Adaptive Boosting tree (AdaBoost) algorithms as the machine learning classifiers. The performance of the models was evaluated by ROC, Decision Curve Analysis (DCA) and calibration curve.

## RESULTS

615 and 228 patients with R0 and NO-R0 were included. In the validation group, the AUC of the clinical model was 0.712 (95% CI: 0.654-0.770). The tri-phase radiomics features combined with the SVM algorithm was the best radiomics signature with an AUC of 0.806 (95% CI: 0.748-0.864). The nomogram was the best predictive model with an AUC of 0.862 (95% CI: 0.804-0.919). In the training and validation groups, the calibration and DCA curves of the nomogram showed satisfactory result.

## CONCLUSION

The nomogram has good accuracy and stability in distinguishing whether patients with gastric cancer invading the pancreas can undergo R0 after neoadjuvant chemotherapy.

## CLINICAL RELEVANCE/APPLICATION

Current guidance on resectability mainly relies on the surgeon's techniques and preoperative examinations. The radiomics model can provide a reference for the success rate and best timing of surgery.

### W3-SSGI13-6 **Diagnostic Value of MR on Metastatic Lymph Node after Neoadjuvant Therapy in Esophageal Squamous Cell Carcinoma: A Prospectively Comparative Study on Node-to-Node Basis**

Shuo Yan (*Presenter*) Nothing to Disclose

#### PURPOSE

To analyze the multiple features of lymph node on pre-treatment and preoperative esophageal MR and to establish a diagnostic model on node-to-node basis that could accurately diagnose the metastatic lymph nodes after NAC or NAC+ICI therapy.

#### METHODS AND MATERIALS

The medical records and pretreatment and preoperative esophageal MR images of 112 patients who underwent NAC or NAC+ICI combined radical esophagectomy between December 2020 and October 2022 were prospectively collected. Based on the node-to-node basis, comparison of MR, surgical findings and pathological findings of lymph nodes were conducted. The diagnostic efficacy of esophageal MR on metastatic lymph nodes was evaluated with pathology as the gold standard. The ROC curve was used to analyze the diagnostic accuracy of MR features, and the markers independently correlated to the risk of lymph node metastasis were analyzed by Logistic regression, and a multiparameter diagnostic model was established based on the results of Logistic regression. The pathological findings that could affect the diagnostic performance of MR multiparameter model were explored.

#### RESULTS

In the study of diagnostic performance of MR for metastatic lymph nodes after NAC or NAC+ICI treatment according to MR-surgery-pathology comparison on node-to-node basis, multivariate Logistic regression analysis showed that lymph node location based on the station of the Japanese Society for Esophageal Diseases (JSED), preoperative ring-like enhancement, degree of preoperative delayed enhancement, and increased DWI signal intensity after treatment were independent predictors for metastatic lymph nodes ( $p < 0.05$ ). The multiparameter combined model constructed with the above MR features showed good diagnostic performance, with an AUC of 0.82 (95% CI: 0.78-0.86), a sensitivity of 85.9% and a specificity of 64.9%. The diagnostic sensitivity of the MR model for metastatic lymph nodes elevated with the increase of size of lymph nodes, and the sensitivity were all over 75.0%. For patients with tumors of high or low risk of metastasis, the diagnostic accuracies of MR were all over 70.0%.

#### CONCLUSION

The combined diagnostic model based on multiparameter of pre-treatment and preoperative MR features could accurately identify metastatic lymph nodes of esophageal squamous cell carcinoma after NAC or NAC+ICI therapy.

## CLINICAL RELEVANCE/APPLICATION

A combination of MR features of lymph nodes could provide valuable information for the preoperative diagnosis of metastasis and N stage on node-to-node basis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGI13-1

### Quantitative DCE-MRI Parameters Combined with Apparent Diffusion Coefficient for Evaluation of T Stage in Resectable Gastric Adenocarcinoma

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N227B

Yan Liangliang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the feasibility of dynamic contrast-enhanced magnetic resonance imaging quantitative DCE parameters combined with apparent diffusion coefficient (ADC) values for predicting T stage of gastric adenocarcinoma.

#### METHODS AND MATERIALS

95 patients with gastric adenocarcinoma who underwent DCE-MRI and DWI from April 2018 to January 2020 were retrospectively enrolled. The Kruskal Wallis test was used to compare differences in quantitative DCE parameters or ADC values between different T stages of gastric cancer (GC). Multivariate logistic regression was used to identify independent predictors of GC of T1 + 2, T3 + 4a stages or T1 + 2 + 3, T4a stages. ROC curves were used to determine the optimal parameters and diagnostic efficacy for predicting GC of T1 + 2, T3 + 4a stages or T1 + 2 + 3, T4a stages.

#### RESULTS

Quantitative DCE parameters  $K_{trans}$ ,  $K_{ep}$ , and ADC values were useful in identifying different T stages of GC ( $p < 0.001$ ,  $0.002$ ,  $0.008$ , respectively).  $K_{trans}$ ,  $K_{ep}$ , and ADC were independent risk factors for predicting GC of T1 + 2, T3 + 4a stages. The area under the curve, sensitivities, specificities of  $K_{trans}$ ,  $K_{ep}$ , ADC,  $K_{trans} + K_{ep} + ADC$  were 0.769, 0.751, 0.731, 0.893; 80.0%, 70.0%, 80.0%, 74.7%; 70.7%, 74.7%, 65.3%, 90.0%, respectively. Meanwhile,  $K_{trans}$  and ADC were independent risk factors for predicting GC of T1 + 2 + 3, T4a stages. The area under the curve, sensitivities, specificities of  $K_{trans}$ , ADC,  $K_{trans} + ADC$  were 0.709, 0.643, 0.782; 57.7%, 65.4%, 57.7%; 81.2%, 58.0%, 89.9%, respectively.

#### CONCLUSION

Quantitative DCE parameters combined with ADC values can be used to identify T stage of gastric adenocarcinoma.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative DCE parameters combined with ADC values can be used to identify T stage of gastric adenocarcinoma, which provides a theoretical basis for evaluating the malignancy of gastric adenocarcinoma and the selection of treatment options.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGI13-3

### Prediction of Epithelial-to-mesenchymal Transition Molecular Subtype using CT Radiomics in Gastric Cancer

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N227B

Chaeyoung Lim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Epithelial-to-mesenchymal transition (EMT) subtype gastric cancer (GC) is known to demonstrate extremely poor prognosis. The purpose of the research is to develop and evaluate a prediction model for identifying Epithelial-to-mesenchymal transition (EMT) subtype gastric cancer (GC) using computed tomography (CT) radiomics and clinicopathologic factors.

#### METHODS AND MATERIALS

This retrospective study included 418 patients with GC who underwent primary resection and molecular subgroup analysis between October 1995 and May 2008. Using preoperative CT images, we extracted 1,223 CT radiomics features from the volume of interest on portal venous phase images. Radiomics features for the prediction model were selected based on a filter method with correlation matrix and variance inflation factor (VIF), and an embedded method with least absolute shrinkage and selection operator (LASSO). To develop the radiomics-based prediction model, patient data were randomly divided into development (70%) and validation (30%) datasets. We used logistic regression (LR) and random forest (RF) algorithms with 5 repeated 5-fold cross-validation for model development. The area under the curve (AUC) was calculated to evaluate their performances. Clinicopathologic factors were added to evaluate the increase in predictive performance.

#### RESULTS

70 patients had EMT subtype GC and 348 patients with non-EMT subtype based on transcriptome analysis. There were 276 men (66.0%) with median age 59 (range: 24-86). The AUCs of the CT radiomics-based prediction models were 0.824 and 0.736 for development and testing, respectively, using LR, and 1.000 and 0.692 for development and testing, respectively, using RF. After adding clinicopathologic factors of age, tumor size, signet ring cell type, and Lauren classification, the AUCs of the models using LR were 0.849 and 0.840 for development and testing, respectively, and the AUCs of the models using RF were 1.000 and 0.827 for development and testing, respectively.

#### CONCLUSION

Our study demonstrated that a prediction model using CT radiomics for the EMT subtype of GC showed good performance, and the addition of clinicopathologic factors improved its predictive performance.

#### CLINICAL RELEVANCE/APPLICATION

CT radiomics and clinicopathologic factors can predict EMT subtype GC with good performance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGI13-4

### Contrast-enhanced Computed Tomography-based Radiomics to Predict Resectability in Patients with Gastric Cancer Invading the Pancreas Treated with Neoadjuvant Chemotherapy

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N227B

Xiaoyi Chen, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

The pancreas is the most vulnerable to invasion by gastric cancer, and combined resection is extremely difficult and traumatic. However, the assessment of resectability during the available examinations is limited. The purpose of this study is to construct a radiomics model for predicting the resectability for the patients receiving neoadjuvant chemotherapy with gastric cancer invading the pancreas.

#### METHODS AND MATERIALS

843 gastric cancer patients suspected of having the pancreas invaded from two centers between January 2018 and January 2023 were collected. All patients received neoadjuvant chemotherapy with capecitabine and oxaliplatin (XELOX), and were evaluated by the MDT team to recommend surgery based on the latest preoperative contrast-enhanced computed tomography(CE-CT). Patients were divided into radical resection(R0) and non-radical resection (NO-R0) group based on their medical and pathological records, with 602 (Center 1) and 241 (Center 2) patients in the training and validation groups, respectively. The radiomic features were extracted after segment the whole tumor and pancreatic regions in all the slices with the latest preoperative tri-phase CE-CT. Clinical model, tri-phase radiomics signatures and combined nomogram were constructed. Two methods were employed to achieve dimensionality reduction: (I) the Least Absolute Shrinkage and Selection Operator (LASSO); and (II) the Minimum Redundancy Maximum Relevance (mRMR) algorithms. We utilized Logistic regression, Support Vector Machine (SVM), Decision Tree and Adaptive Boosting tree (AdaBoost) algorithms as the machine learning classifiers. The performance of the models was evaluated by ROC, Decision Curve Analysis (DCA) and calibration curve.

#### RESULTS

615 and 228 patients with R0 and NO-R0 were included. In the validation group, the AUC of the clinical model was 0.712 (95% CI: 0.654-0.770). The tri-phase radiomics features combined with the SVM algorithm was the best radiomics signature with an AUC of 0.806 (95% CI: 0.748-0.864). The nomogram was the best predictive model with an AUC of 0.862 (95% CI: 0.804-0.919). In the training and validation groups, the calibration and DCA curves of the nomogram showed satisfactory result.

#### CONCLUSION

The nomogram has good accuracy and stability in distinguishing whether patients with gastric cancer invading the pancreas can undergo R0 after neoadjuvant chemotherapy.

#### CLINICAL RELEVANCE/APPLICATION

Current guidance on resectability mainly relies on the surgeon's techniques and preoperative examinations. The radiomics model can provide a reference for the success rate and best timing of surgery.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSGI13-6

### **Diagnostic Value of MR on Metastatic Lymph Node after Neoadjuvant Therapy in Esophageal Squamous Cell Carcinoma: A Prospectively Comparative Study on Node-to-Node Basis**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N227B

Shuo Yan (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To analyze the multiple features of lymph node on pre-treatment and preoperative esophageal MR and to establish a diagnostic model on node-to-node basis that could accurately diagnose the metastatic lymph nodes after NAC or NAC+ICI therapy.

#### **METHODS AND MATERIALS**

The medical records and pretreatment and preoperative esophageal MR images of 112 patients who underwent NAC or NAC+ICI combined radical esophagectomy between December 2020 and October 2022 were prospectively collected. Based on the node-to-node basis, comparison of MR, surgical findings and pathological findings of lymph nodes were conducted. The diagnostic efficacy of esophageal MR on metastatic lymph nodes was evaluated with pathology as the gold standard. The ROC curve was used to analyze the diagnostic accuracy of MR features, and the markers independently correlated to the risk of lymph node metastasis were analyzed by Logistic regression, and a multiparameter diagnostic model was established based on the results of Logistic regression. The pathological findings that could affect the diagnostic performance of MR multiparameter model were explored.

#### **RESULTS**

In the study of diagnostic performance of MR for metastatic lymph nodes after NAC or NAC+ICI treatment according to MR-surgery-pathology comparison on node-to-node basis, multivariate Logistic regression analysis showed that lymph node location based on the station of the Japanese Society for Esophageal Diseases (JSED), preoperative ring-like enhancement, degree of preoperative delayed enhancement, and increased DWI signal intensity after treatment were independent predictors for metastatic lymph nodes ( $p < 0.05$ ). The multiparameter combined model constructed with the above MR features showed good diagnostic performance, with an AUC of 0.82 (95% CI: 0.78-0.86), a sensitivity of 85.9% and a specificity of 64.9%. The diagnostic sensitivity of the MR model for metastatic lymph nodes elevated with the increase of size of lymph nodes, and the sensitivity were all over 75.0%. For patients with tumors of high or low risk of metastasis, the diagnostic accuracies of MR were all over 70.0%.

#### **CONCLUSION**

The combined diagnostic model based on multiparameter of pre-treatment and preoperative MR features could accurately identify metastatic lymph nodes of esophageal squamous cell carcinoma after NAC or NAC+ICI therapy.

#### **CLINICAL RELEVANCE/APPLICATION**

A combination of MR features of lymph nodes could provide valuable information for the preoperative diagnosis of metastasis and N stage on node-to-node basis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGI14

### Gastrointestinal Imaging (MRI Advanced Applications)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N226

Jin-Young Choi, MD (*Moderator*) Nothing to Disclose  
Zhen J. Wang, MD (*Moderator*) Stockholder, Nextrest, Inc

#### Sub-Events

#### **W3-SSGI14-1 Intravoxel Incoherent Motion Diffusion-Weighted Imaging (IVIM-DWI) of Pancreas for Non-invasive Assessment of $\beta$ -cell Dysfunction in Patients with Hyperglycemia**

Ping Liu, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Approximately 50% of the  $\beta$ -cell function is impaired for most patients with type 2 diabetes mellitus (T2DM) at the time of diagnosis, and probably commences years before diagnosis. Early detection of damaged  $\beta$ -cell function may help provide timely protection and stop the final progression of patients with hyperglycemia to T2DM. Animal tests considered that the impaired  $\beta$ -cell function may be associated with the damaged pancreatic microstructure. The pancreatic microstructural changes may serve as the biomarker for  $\beta$ -cell dysfunction. Thus, we evaluate the microstructural changes of the pancreas in patients with hyperglycemia employing intravoxel incoherent motion diffusion-weighted imaging (IVIM-DWI) and explore the correlation between the imaging marker and the damage of  $\beta$ -cell function.

#### METHODS AND MATERIALS

60 hyperglycemic patients and 22 healthy controls were included. IVIM-DWI and the blood examination were performed, and calculated the  $\beta$ -cell function indexes. We divided patients into three grades according to diagnostic criteria, prediabetes (n= 10), T2DM diagnosed by isolated 2-h glucose increasing (n= 10), T2DM diagnosed by fasting and 2-h glucose increasing simultaneously (n= 40), and compared them with healthy controls. We observed the relationship between the imaging parameters with the  $\beta$ -cell function indexes and the diagnostic performance of the parameters for the grades of hyperglycemia.

#### RESULTS

The imaging parameters of ADC, Dt, and Dp gradually decreased among the groups, and the significant difference existed of them: ADC (p< 0.0001), Dt (p< 0.0001), Dp (p= 0.013). The optimal diagnostic performance of the parameters for differentiating the grades of hyperglycemia was Dt. There were some correlations between imaging metrics with  $\beta$ -cell function indexes (p< 0.05).

#### CONCLUSION

IVIM-DWI of pancreases is a reliable and non-invasive tool with great potential in detecting the early damaged  $\beta$ -cell function when the DM is still in the insidious stage, and help to avoid the development of hyperglycemia to DM.

#### CLINICAL RELEVANCE/APPLICATION

IVIM-DWI measurements can effectively detect the microstructure and microcirculation changes of the pancreas, which also can effectively distinguish T2DM from hyperglycemia. It may be a promising, noninvasive method for identifying the damaged  $\beta$ -cell function especially for patients with early-stage hyperglycemia but without obvious clinical manifestation or history of DM. And this could facilitate to timely prevent and effectively manage the T2DM.

#### **W3-SSGI14-2 Prediction of Microvascular Invasion and Vessels Encapsulated Tumor Clusters in Hepatocellular Carcinoma by Multi-frequency Magnetic Resonance Elastography: A Preliminary Study**

Lin Hui Zhong, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the feasibility of multi-frequency magnetic resonance elastography (mf-MRE) for predicting microvascular invasion (MVI+) and further forecasting MVI+ combined vessels encapsulated tumor clusters (VETC+) (MVI+ VETC+) in hepatocellular carcinoma (HCC) patients.

## METHODS AND MATERIALS

The study protocol was approved by the local Research Ethics Committee. Informed consent was obtained from all subjects. A total of 328 patients with clinical proposed HCC were prospectively recruited and undergone conventional MRI and mf-MRE (the parameter presented in table 1) on 3.0T MRI, which were divided into two-class (Task 1: MVI+ vs MVI-; Task 2: MVI+ VETC+ vs no MVI+ VETC+) with the pathological findings (Fig 1). Patients' clinical data were collected, conventional MRI imaging features were evaluated, and  $c$  (m/s) and  $f$  (rad) were measured with mf-MRE in the tumor and background liver parenchyma. For above data, clinical model, radiomics model, mf-MRE model and all were developed to predict the task 1 and task 2 (Table 2,3). Predictive efficacy was evaluated using the area under the ROC curve (AUC). The clinical utility of the models was evaluated by decision curve analysis (DCA), and its calibration was evaluated (Fig 2,3).

## RESULTS

A total of 124 patients (MVI+ (n=49) vs MVI- (n=75); MVI+ VETC+ (n=29) vs no-MVI+ VETC+ (n=95) with postoperative pathologically confirmed HCC were included. For task1: Multifactorial logistic regression results showed that intratumoral artery, smoothness of tumor margin and tumor stiffness  $c$  were independent risk factors for MVI+ ( $P < 0.05$ ). The AUC values for Models A-B were 0.850 (0.788-0.911), 0.742 (0.655-0.829). Model C had the highest specificity (0.89), AUC value 0.911 (0.864-0.959), sensitivity and accuracy (0.86 and 0.82, respectively). For task2: Multifactorial logistic regression results showed that AFP, DCP and intratumoral artery were independent risk factors for MVI+ VETC+ ( $P < 0.05$ ). The AUC values for Models A-C were 0.773 (0.689-0.858), 0.709 (0.623-0.794) and 0.718 (0.612-0.824). Model D had the highest AUC value 0.854 (0.788-0.921) and sensitivity (0.97).

## CONCLUSION

The multi-frequency MRE mechanical parameters can predict MVI, MVI+ & VETC+ status preoperatively. Clinical, radiomics and mf-MRE combined model can enhance the prediction of MVI, MVI+ & VETC+ efficacy and had the most AUC.

## CLINICAL RELEVANCE/APPLICATION

The incorporation of multi-frequency MRE into routine sequences of liver MRI examinations is expected to be used to accurately predict MVI, VETC+/MVI+ status preoperatively, which can assist clinicians in determining treatment plans and provide more accurate protocols for risk stratification of patients with hepatocellular carcinoma after resection.

## W3-SSGI14-3 Amide Proton Transfer MRI for Treatment Response of Locally Advanced Rectal Cancer Following Neoadjuvant Chemotherapy and Radiation Therapy

Lan Zhang, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Precise evaluation of treatment response is the premise of the selection of the following treatment strategies for patients with locally advanced rectal cancer (LARC) after neoadjuvant chemotherapy and radiation therapy (NCRT). Unfortunately a recent meta-analysis concluded that the overall accuracy of MRI including T2-weighted images (T2WI) and diffusion-weighted images (DWI) was only 52%. For better evaluating treatment response of LARC after NCRT, a more accurate imaging biomarker is desirable. Amide proton transfer-weighted (APT<sub>w</sub>) imaging is a molecular MRI technique that generates image contrast based predominantly on the amide protons in mobile cellular proteins and peptides that are endogenous in tissue. We thus conducted the present study to determine whether APT<sub>w</sub> imaging is precise in evaluating treatment response of LARC after NCRT by comparing to T2WI and DWI.

## METHODS AND MATERIALS

Patients with histological diagnostic rectal cancer and clinical T3-4 or N+ were prospectively recruited into this institutional review board-approved study. All participants were scanned at 3.0T (Ingenia CX, Philips Healthcare, Best, the Netherlands) using standard rectal protocols (T1WI, T2WI, DWI, contrast-enhanced) and APT<sub>w</sub>-imaging at baseline and after NCRT, imaging parameters listed in Table 1. Total mesorectal excision was performed and pathological tumor regression stage (TRG) was evaluated. Two readers manually drew regions of interest (ROIs) on the APT maps by using a free and open software (3D slicer 5.0.3, NA-MIC, NAC, BIRN, NCIGT and the Slicer Community) and histogram analysis performed. Independent sample t test or Mann-Whitney U test, receiver operating characteristic (ROC) analysis with the area under the curve (AUC) were performed.

## RESULTS

Eight patients with tumors TRG0 and 26 patients with tumors TRG123, were included. The mean APT were significantly lower in TRG0 group than TRG123 ( $P = 0.043$ ). The AUC of the APT mean and T2WIDWI in predicting TRG0 tumors were 0.73 and 0.66. When specificity was maximized (both the APT and the T2WIDWI were required to have positive findings), the AUC of

the combined MRI diagnosis for TRG0 was 0.70. When sensitivity was maximized (either the APT or the T2WIDWI showed positive findings), the AUC for combined MRI was 0.77.

#### **CONCLUSION**

APTw imaging is precise in evaluating treatment response of LARC after NCRT, meanwhile combining APTw imaging and T2WIDWI is more potential.

#### **CLINICAL RELEVANCE/APPLICATION**

As a useful biomarker for evaluating treatment response of LARC after NCRT, APTw imaging may have great potential applications for the selection of treatment strategies.

### **W3-SSGI14-5 Deep Learning-based Super-resolution Algorithm Tailored to Partial Fourier Acquisitions for the Multi-arterial Phase Images: Improvement of the Image Quality to Assess the Small Hypervascular Hepatic Tumor on Gadoteric Acid-enhanced Liver MRI**

Sumin Yun, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the impact of a deep learning-based super-resolution algorithm tailored to partial Fourier acquisitions for the multi arterial phase (AP) images in patients with small hypervascular hepatic tumor on gadoteric acid enhanced liver MRI.

#### **METHODS AND MATERIALS**

We retrospectively enrolled 55 patients (33 men, 22 women; mean age: 64.90 years) with clinically or pathologically confirmed hepatic hypervascular tumors between December 2022 and February 2023 with the following inclusion criteria: patients with hypervascular hepatic tumor (lesser than 3 cm) who performed multi AP gadoteric acid enhanced MRI. For the multi AP images, two radiologists analyzed and compared the image qualities between two image sets: standard T1 weighted VIBE image (VIBESD) and T1 weighted VIBE image reconstructed with deep learning-based super-resolution algorithm tailored to partial Fourier acquisitions (VIBEDL). Quantitative image analysis including signal to noise ratio (SNR), contrast to noise ratio (CNR) and noise was performed. We also performed qualitative assessment with Likert scale including motion artifact (MA), liver edge (LE), hepatic vessel clarity (HVC) and image quality (IQ). The average of the two reader's results was used for further analysis. The paired t-test was used for quantitative analysis, and the Wilcoxon rank sum test was used for qualitative analysis.

#### **RESULTS**

Finally, 55 patients were enrolled (33 patients, HCC; 4 patients, cholangiocarcinoma; 6 patients, metastases; 1 patient, hepatic adenoma; 3 patients, focal nodular hyperplasia; 8 patients, hemangioma). The SNR, CNR and noise were significantly improved in VIBEDL compared to VIBESD (SNR on AP1, 741.62 vs. 494.06; SNR on AP2, 839.51 vs. 506.92; CNR on AP1, 277.35 vs. 177.43; CNR on AP2, 320.39 vs. 180.51; noise on AP1, 0.53 vs. 0.82; noise on AP2, 0.51 vs. 0.87, all p-values < 0.05). The LE, HVC, and IQ were significantly improved in VIBEDL compared to VIBESD (LE on 1 st AP, 1.22 vs. 1.61; LE on 2 nd AP, 1.21 vs. 1.65; HVC on 1 st AP, 1.24 vs. 1.39; HVC on 2 nd AP, 1.20 vs. 1.53; IQ on 1 st AP, 1.17 vs. 1.45; IQ on 2 nd AP, 1.17 vs. 1.47, all p-values < 0.05). The MA was not statistically improved in VIBEDL compared to VIBESD (MA on 1 st AP, 1.12 vs. 1.15; MA on 2 nd AP, 1.16 vs. 1.18, p=0.18 and 0.16, respectively).

#### **CONCLUSION**

For gadoteric acid-enhanced liver MRI, VIBEDL can improve the quality of multi AP images in patients with small hypervascular hepatic tumor.

#### **CLINICAL RELEVANCE/APPLICATION**

The gadoteric acid enhanced MRI is an excellent tool but weak arterial enhancement is one of the weakness. VIBEDL was able to improve image quality. Especially, VIBEDL can overcome the weak arterial enhancement resulting in the increased CNR.

### **W3-SSGI14-6 Dilution and Slow Injection with Care Bolus Technique can Reduce Artifacts and Optimise Timing of Arterial-phase Gadoteric Acid-enhanced MRI: A Large-cohort Study**

Antonia Kristic, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the effect of dilution and slow injection of gadoteric acid (GA) using automated fluoroscopic triggering on liver MRI arterial-phase (AP) acquisition timing, artifact frequency, and lesion visibility.

#### **METHODS AND MATERIALS**

Saline-diluted 1:1 of 10 ml fixed-dose gadoteric acid was injected at 1 mL/s (total volume 20 ml) into 1985 consecutive patients for 3T liver MRI. Initially, one abdominal radiologist with 5 years of experience who did not participate in the analysis

assessed all MR exams, comparing them to previous and follow up images, as well as the radiology report on record. . This served as the standard of reference for lesion detection and characterization. Then, 3 readers independently evaluated the AP images for artifact type [truncation (TA), transient severe motion (TSM) or mixed], for artifact severity, acquisition timing and, if present, focal liver lesion visibility. AP artifact-severity impact on diagnostic performance was rated on a 5-point scale, AP acquisition timing on a 4-point scale, and AP visibility of = 5 mm hypervascular lesions on a 4-point scale. One reader assessed the presence of ascites, pleural effusions and cirrhosis

## **RESULTS**

A total of 1793 exams, (male =891 (49.7%), female =902 (50.3%)), with a mean age of 56.3 y, were included. Diagnostic-quality arterial-phase images included 1163 (67.8%) without artifacts, 415 (24.2%) with minimal, and 171 (9.8%) with moderate artifacts. Only 44 patients (2.5%) had non-diagnostic exams, 39 (2.2%) with severe AP artifacts and 5 (0.3%) with uninterpretable images. The inter-rater agreement between the three readers was substantial (Kappa =0.670,  $p<0.001$ ). AP acquisition timing was optimal in 1567 (91.3%) exams. In 366 (21.3%) exams there was ascites, in 319 (18.6%) pleural effusions and in 352 (20.5%) liver cirrhosis. Artifact occurrence was significantly higher with ascites ( $p=0.002$ ), pleural effusions ( $p<0.001$ ), and advanced age ( $p=0.006$ ).

## **CONCLUSION**

Combined dilution and slow injection of gadoxetic acid with MR-fluoroscopic triggering results in well-timed arterial-phase images and few severe- or non-diagnostic arterial-phase artifacts, 2.5%.

## **CLINICAL RELEVANCE/APPLICATION**

A fixed dose of 10 ml gadoxetic acid with 1:1 saline dilution injected at 1ml/s produces high-quality images with negligible AP artifacts.

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## Abstract Archives of the RSNA, 2023

W3-SSGI14-1

### **Intravoxel Incoherent Motion Diffusion-Weighted Imaging (IVIM-DWI) of Pancreas for Non-invasive Assessment of $\beta$ -cell Dysfunction in Patients with Hyperglycemia**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N226

Ping Liu, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Approximately 50% of the  $\beta$ -cell function is impaired for most patients with type 2 diabetes mellitus (T2DM) at the time of diagnosis, and probably commences years before diagnosis. Early detection of damaged  $\beta$ -cell function may help provide timely protection and stop the final progression of patients with hyperglycemia to T2DM. Animal tests considered that the impaired  $\beta$ -cell function may be associated with the damaged pancreatic microstructure. The pancreatic microstructural changes may serve as the biomarker for  $\beta$ -cell dysfunction. Thus, we evaluate the microstructural changes of the pancreas in patients with hyperglycemia employing intravoxel incoherent motion diffusion-weighted imaging (IVIM-DWI) and explore the correlation between the imaging marker and the damage of  $\beta$ -cell function.

#### **METHODS AND MATERIALS**

60 hyperglycemic patients and 22 healthy controls were included. IVIM-DWI and the blood examination were performed, and calculated the  $\beta$ -cell function indexes. We divided patients into three grades according to diagnostic criteria, prediabetes (n= 10), T2DM diagnosed by isolated 2-h glucose increasing (n= 10), T2DM diagnosed by fasting and 2-h glucose increasing simultaneously (n= 40), and compared them with healthy controls. We observed the relationship between the imaging parameters with the  $\beta$ -cell function indexes and the diagnostic performance of the parameters for the grades of hyperglycemia.

#### **RESULTS**

The imaging parameters of ADC, Dt, and Dp gradually decreased among the groups, and the significant difference existed of them: ADC ( $p < 0.0001$ ), Dt ( $p < 0.0001$ ), Dp ( $p = 0.013$ ). The optimal diagnostic performance of the parameters for differentiating the grades of hyperglycemia was Dt. There were some correlations between imaging metrics with  $\beta$ -cell function indexes ( $p < 0.05$ ).

#### **CONCLUSION**

IVIM-DWI of pancreases is a reliable and non-invasive tool with great potential in detecting the early damaged  $\beta$ -cell function when the DM is still in the insidious stage, and help to avoid the development of hyperglycemia to DM.

#### **CLINICAL RELEVANCE/APPLICATION**

IVIM-DWI measurements can effectively detect the microstructure and microcirculation changes of the pancreas, which also can effectively distinguish T2DM from hyperglycemia. It may be a promising, noninvasive method for identifying the damaged  $\beta$ -cell function especially for patients with early-stage hyperglycemia but without obvious clinical manifestation or history of DM. And this could facilitate to timely prevent and effectively manage the T2DM.

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## Abstract Archives of the RSNA, 2023

W3-SSGI14-2

### Prediction of Microvascular Invasion and Vessels Encapsulated Tumor Clusters in Hepatocellular Carcinoma by Multi-frequency Magnetic Resonance Elastography: A Preliminary Study

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N226

Lin Hui Zhong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the feasibility of multi-frequency magnetic resonance elastography (mf-MRE) for predicting microvascular invasion (MVI+) and further forecasting MVI+ combined vessels encapsulated tumor clusters (VETC+) (MVI+ VETC+) in hepatocellular carcinoma (HCC) patients.

#### METHODS AND MATERIALS

The study protocol was approved by the local Research Ethics Committee. Informed consent was obtained from all subjects. A total of 328 patients with clinical proposed HCC were prospectively recruited and undergone conventional MRI and mf-MRE (the parameter presented in table 1) on 3.0T MRI, which were divided into two-class (Task 1: MVI+ vs MVI-; Task 2: MVI+ VETC+ vs no MVI+ VETC+) with the pathological findings (Fig 1). Patients' clinical data were collected, conventional MRI imaging features were evaluated, and  $c$  (m/s) and  $f$  (rad) were measured with mf-MRE in the tumor and background liver parenchyma. For above data, clinical model, radiomics model, mf-MRE model and all were developed to predict the task 1 and task 2 (Table 2,3). Predictive efficacy was evaluated using the area under the ROC curve (AUC). The clinical utility of the models was evaluated by decision curve analysis (DCA), and its calibration was evaluated (Fig 2,3).

#### RESULTS

A total of 124 patients (MVI+ (n=49) vs MVI- (n=75); MVI+ VETC+ (n=29) vs no-MVI+ VETC+ (n=95) with postoperative pathologically confirmed HCC were included. For task1: Multifactorial logistic regression results showed that intratumoral artery, smoothness of tumor margin and tumor stiffness  $c$  were independent risk factors for MVI+ ( $P < 0.05$ ). The AUC values for Models A-B were 0.850 (0.788-0.911), 0.742 (0.655-0.829). Model C had the highest specificity (0.89), AUC value 0.911 (0.864-0.959), sensitivity and accuracy (0.86 and 0.82, respectively). For task2: Multifactorial logistic regression results showed that AFP, DCP and intratumoral artery were independent risk factors for MVI+ VETC+ ( $P < 0.05$ ). The AUC values for Models A-C were 0.773 (0.689-0.858), 0.709 (0.623-0.794) and 0.718 (0.612-0.824). Model D had the highest AUC value 0.854 (0.788-0.921) and sensitivity (0.97).

#### CONCLUSION

The multi-frequency MRE mechanical parameters can predict MVI, MVI+ & VETC+ status preoperatively. Clinical, radiomics and mf-MRE combined model can enhance the prediction of MVI, MVI+ & VETC+ efficacy and had the most AUC.

#### CLINICAL RELEVANCE/APPLICATION

The incorporation of multi-frequency MRE into routine sequences of liver MRI examinations is expected to be used to accurately predict MVI, VETC+/MVI+ status preoperatively, which can assist clinicians in determining treatment plans and provide more accurate protocols for risk stratification of patients with hepatocellular carcinoma after resection.

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## Abstract Archives of the RSNA, 2023

W3-SSGI14-3

### Amide Proton Transfer MRI for Treatment Response of Locally Advanced Rectal Cancer Following Neoadjuvant Chemotherapy and Radiation Therapy

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N226

Lan Zhang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Precise evaluation of treatment response is the premise of the selection of the following treatment strategies for patients with locally advanced rectal cancer (LARC) after neoadjuvant chemotherapy and radiation therapy (NCRT). Unfortunately a recent meta-analysis concluded that the overall accuracy of MRI including T2-weighted images(T2WI) and diffusion-weighted images(DWI) was only 52%. For better evaluating treatment response of LARC after NCRT, a more accurate imaging biomarker is desirable. Amide proton transfer-weighted (APT<sub>w</sub>) imaging is a molecular MRI technique that generates image contrast based predominantly on the amide protons in mobile cellular proteins and peptides that are endogenous in tissue. We thus conducted the present study to determine whether APT<sub>w</sub> imaging is precise in evaluating treatment response of LARC after NCRT by comparing to T2WI and DWI.

#### METHODS AND MATERIALS

Patients with histological diagnostic rectal cancer and clinical T3-4 or N+ were prospectively recruited into this institutional review board-approved study. All participants were scanned at 3.0T (Ingenia CX, Philips Healthcare, Best, the Netherlands) using standard rectal protocols (T1WI, T2WI, DWI, contrast-enhanced) and APT<sub>w</sub>-imaging at baseline and after NCRT, imaging parameters listed in Table 1. Total mesorectal excision was performed and pathological tumor regression stage(TRG) was evaluated. Two readers manually drew regions of interest (ROIs) on the APT maps by using a free and open software (3D slicer 5.0.3, NA-MIC, NAC, BIRN, NCIGT and the Slicer Community) and histogram analysis performed. Independent sample t test or Mann-Whitney U test, receiver operating characteristic (ROC) analysis with the area under the curve (AUC) were performed.

#### RESULTS

Eight patients with tumors TRG0 and 26 patients with tumors TRG123, were included. The mean APT were significantly lower in TRG0 group than TRG123(P ,0.043). The AUC of the APT mean and T2WIDWI in predicting TRG0 tumors were 0.73 and 0.66. When specificity was maximized (both the APT and the T2WIDWI were required to have positive findings), the AUC of the combined MRI diagnosis for TRG0 was 0.70. When sensitivity was maximized (either the APT or the T2WIDWI showed positive findings), the AUC for combined MRI was 0.77.

#### CONCLUSION

APT<sub>w</sub> imaging is precise in evaluating treatment response of LARC after NCRT, meanwhile combining APT<sub>w</sub> imaging and T2WIDWI is more potential.

#### CLINICAL RELEVANCE/APPLICATION

As a useful biomarker for evaluating treatment response of LARC after NCRT, APT<sub>w</sub> imaging may have great potential applications for the selection of treatment strategies.

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## Abstract Archives of the RSNA, 2023

W3-SSGI14-5

### Deep Learning-based Super-resolution Algorithm Tailored to Partial Fourier Acquisitions for the Multi-arterial Phase Images: Improvement of the Image Quality to Assess the Small Hypervascular Hepatic Tumor on Gadoteric Acid-enhanced Liver MRI

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N226

Sumin Yun, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the impact of a deep learning-based super-resolution algorithm tailored to partial Fourier acquisitions for the multi arterial phase (AP) images in patients with small hypervascular hepatic tumor on gadoteric acid enhanced liver MRI.

#### METHODS AND MATERIALS

We retrospectively enrolled 55 patients (33 men, 22 women; mean age: 64.90 years) with clinically or pathologically confirmed hepatic hypervascular tumors between December 2022 and February 2023 with the following inclusion criteria: patients with hypervascular hepatic tumor (lesser than 3 cm) who performed multi AP gadoteric acid enhanced MRI. For the multi AP images, two radiologists analyzed and compared the image qualities between two image sets: standard T1 weighted VIBE image (VIBESD) and T1 weighted VIBE image reconstructed with deep learning-based super-resolution algorithm tailored to partial Fourier acquisitions (VIBEDL). Quantitative image analysis including signal to noise ratio (SNR), contrast to noise ratio (CNR) and noise was performed. We also performed qualitative assessment with Likert scale including motion artifact (MA), liver edge (LE), hepatic vessel clarity (HVC) and image quality (IQ). The average of the two reader's results was used for further analysis. The paired t-test was used for quantitative analysis, and the Wilcoxon rank sum test was used for qualitative analysis.

#### RESULTS

Finally, 55 patients were enrolled (33 patients, HCC; 4 patients, cholangiocarcinoma; 6 patients, metastases; 1 patient, hepatic adenoma; 3 patients, focal nodular hyperplasia; 8 patients, hemangioma). The SNR, CNR and noise were significantly improved in VIBEDL compared to VIBESD (SNR on AP1, 741.62 vs. 494.06; SNR on AP2, 839.51 vs. 506.92; CNR on AP1, 277.35 vs. 177.43; CNR on AP2, 320.39 vs. 180.51; noise on AP1, 0.53 vs. 0.82; noise on AP2, 0.51 vs. 0.87, all p-values < 0.05). The LE, HVC, and IQ were significantly improved in VIBEDL compared to VIBESD (LE on 1 st AP, 1.22 vs. 1.61; LE on 2 nd AP, 1.21 vs. 1.65; HVC on 1 st AP, 1.24 vs. 1.39; HVC on 2 nd AP, 1.20 vs. 1.53; IQ on 1 st AP, 1.17 vs. 1.45; IQ on 2 nd AP, 1.17 vs. 1.47, all p-values < 0.05). The MA was not statistically improved in VIBEDL compared to VIBESD (MA on 1 st AP, 1.12 vs. 1.15; MA on 2 nd AP, 1.16 vs. 1.18, p=0.18 and 0.16, respectively).

#### CONCLUSION

For gadoteric acid-enhanced liver MRI, VIBEDL can improve the quality of multi AP images in patients with small hypervascular hepatic tumor.

#### CLINICAL RELEVANCE/APPLICATION

The gadoteric acid enhanced MRI is an excellent tool but weak arterial enhancement is one of the weakness. VIBEDL was able to improve image quality. Especially, VIBEDL can overcome the weak arterial enhancement resulting in the increased CNR.

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## Abstract Archives of the RSNA, 2023

W3-SSGI14-6

### **Dilution and Slow Injection with Care Bolus Technique can Reduce Artifacts and Optimise Timing of Arterial-phase Gadoteric Acid-enhanced MRI: A Large-cohort Study**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: N226

Antonia Kristic, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the effect of dilution and slow injection of gadoteric acid (GA) using automated fluoroscopic triggering on liver MRI arterial-phase (AP) acquisition timing, artifact frequency, and lesion visibility.

#### **METHODS AND MATERIALS**

Saline-diluted 1:1 of 10 ml fixed-dose gadoteric acid was injected at 1 mL/s (total volume 20 ml) into 1985 consecutive patients for 3T liver MRI. Initially, one abdominal radiologist with 5 years of experience who did not participate in the analysis assessed all MR exams, comparing them to previous and follow up images, as well as the radiology report on record. This served as the standard of reference for lesion detection and characterization. Then, 3 readers independently evaluated the AP images for artifact type [truncation (TA), transient severe motion (TSM) or mixed], for artifact severity, acquisition timing and, if present, focal liver lesion visibility. AP artifact-severity impact on diagnostic performance was rated on a 5-point scale, AP acquisition timing on a 4-point scale, and AP visibility of = 5 mm hypervascular lesions on a 4-point scale. One reader assessed the presence of ascites, pleural effusions and cirrhosis

#### **RESULTS**

A total of 1793 exams, (male =891 (49.7%), female =902 (50.3%), with a mean age of 56.3 y, were included. Diagnostic-quality arterial-phase images included 1163 (67.8%) without artifacts, 415 (24.2%) with minimal, and 171 (9.8%) with moderate artifacts. Only 44 patients (2.5%) had non-diagnostic exams, 39 (2.2%) with severe AP artifacts and 5 (0.3%) with uninterpretable images. The inter-rater agreement between the three readers was substantial (Kappa =0.670,  $p < 0.001$ ). AP acquisition timing was optimal in 1567 (91.3%) exams. In 366 (21.3%) exams there was ascites, in 319 (18.6%) pleural effusions and in 352 (20.5%) liver cirrhosis. Artifact occurrence was significantly higher with ascites ( $p = 0.002$ ), pleural effusions ( $p < 0.001$ ), and advanced age ( $p = 0.006$ ).

#### **CONCLUSION**

Combined dilution and slow injection of gadoteric acid with MR-fluoroscopic triggering results in well-timed arterial-phase images and few severe- or non-diagnostic arterial-phase artifacts, 2.5%.

#### **CLINICAL RELEVANCE/APPLICATION**

A fixed dose of 10 ml gadoteric acid with 1:1 saline dilution injected at 1ml/s produces high-quality images with negligible AP artifacts.

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## Abstract Archives of the RSNA, 2023

W3-SSGU05

### Genitourinary Imaging (Evolving Clinical Applications of Prostate MRI)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E350

Sadhna Verma, MD (*Moderator*) Nothing to Disclose  
Sandeep S. Arora, MBBS (*Moderator*) Research support, Profound Medical Inc

#### Sub-Events

#### **W3-SSGU05-1 MRI for the Detection of Aggressive Prostate Cancer in Patients on Active Surveillance using the Precise Criteria: A Multicentre Study**

Francesco Giganti, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The PRECISE recommendations provide a 1-to-5 scale to evaluate the radiological change on serial MRI in patients on active surveillance for prostate cancer: PRECISE 1-2 denotes radiological regression, PRECISE 3 indicates stability and PRECISE 4-5 implies progression. We present the data for the validation of the PRECISE scoring system as a tool to predict disease progression in a multi-centre international setting.

#### METHODS AND MATERIALS

We collected data from 22 centres across the world and applied two entry criteria: i) at least two scans (baseline and follow-up); ii) at least two biopsies (baseline and follow-up, the latter after the second MR). Local radiologists reported according to the PRECISE recommendations. Histological progression was defined as any increase in Gleason score from baseline biopsy (that could include only Gleason 3+3 or also low-risk Gleason 3+4 disease as per local institutional protocols). Progression-free survival (PFS) was estimated using Kaplan-Meier curves. Multivariable Cox hazards model tested the predictive role of PRECISE.

#### RESULTS

A total of 1,556 patients were included in this analysis, 1389 (89%) of which had Gleason 3+3 and 167 (11%) had Gleason 3+4 disease at baseline. Median follow-up was 48 months (IQR 26-75 months), and 513 (33%) patients experienced histological progression. For PRECISE 1-2 (n=158), PFS was 88% at two years and 77% at five years from first follow-up MRI, while for PRECISE 4-5 (n=413), PFS was 52% and 35%, respectively. In those patients with PRECISE 3 [stability] and visible lesions (n=597), 2- and 5-year PFS was 76% and 50%, while for PRECISE 3 [stability] and non-visible (NV) lesions (n=388), PFS was similar to PRECISE 1-2 (two- and five-year PFS: 91% and 80%; Log Rank  $p < 0.001$ ). At multivariable analysis, PRECISE 4-5 remained an independent predictor of histological progression (hazard ratio 2.63, 95% CI 1.82-3.79;  $p < 0.0001$ ).

#### CONCLUSION

Our work has validated a new MRI-based scoring system to assess disease progression during AS internationally and will contribute to the creation of a risk model that incorporates both clinical and radiological data to fully benefit from prostate MRI and targeted biopsies. This will help identify the number of patients on AS with more aggressive disease and a higher likelihood of developing advanced prostate cancer in a timely manner.

#### CLINICAL RELEVANCE/APPLICATION

PRECISE can contribute to the creation of a risk model that incorporates both clinical and radiological data.

#### **W3-SSGU05-2 MRI-guided Active Surveillance without Re-biopsies in Patients with ISUP Grade Group 1 and 2 Prostate Cancer -The PROMM-AS Study**

Birte Valentin, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the ability of mpMRI to reduce guideline-mandated biopsy and to predict ISUP grade group upgrading in patients with ISUP1 and ISUP2 PC. Using this MR-guided pathway, AS disqualification rate thought to be reduced to 15%.

## METHODS AND MATERIALS

In this prospective single-center cohort study patients with ISUP GG 1 and 2 PC after MRI/TRUS fusion-guided biopsy were included and the 2-year outcome of an mpMRI-guided AS protocol (PROMM-AS) were analyzed. All men underwent mpMRI 12 months after inclusion. In case of stable mpMRI according to PRECISE criteria, re-biopsy was deferred and follow-up mpMRI after 24 months performed. In case of mpMRI progression or at the end of study, follow-up MRI/TRUS fusion-guided biopsy was indicated. Sensitivity, specificity, positive (PPV) and negative predictive values (NPV) for ISUP GG upgrading on MRI were calculated and regression analyses were performed.

## RESULTS

In total, 101 patients (60 with ISUP1 and 41 with ISUP2) were analyzed. Histopathological progression occurred in total in 29 patients. Thus, the aim of reducing AS disqualification to 15% could not be reached. In the ISUP1 subgroup, 18 patients had progression, whereas 11 patients progressed in ISUP2 subgroup. Sensitivity, specificity, PPV and NPV for PRECISE was 94%, 64%, 81% and 88% in the ISUP1 and 92%, 50%, 92% and 50% in ISUP2 subgroup, respectively. On regression analysis, initial PSA ( $p < 0.001$ ), and higher PRECISE scores (4-5) ( $p = 0.005$ ) were significant predictors of histological progression in ISUP1 and higher PRECISE score ( $p = 0.009$ ), initial PI-RADS ( $p = 0.009$ ), previous negative biopsy ( $p = 0.02$ ) and percentage of Gleason pattern 4 ( $p = 0.04$ ) in ISUP2 PC.

## CONCLUSION

MRI-guided monitoring of patients on AS including PRECISE criteria avoids unnecessary follow-up biopsies in 88% of patients with ISUP1 and predicts grade group upgrading over a follow-up period of 2 years in both ISUP1 and ISUP2.

## CLINICAL RELEVANCE/APPLICATION

Avoidance of unnecessary follow-up biopsies as well as prediction of grade group upgrade in patients undergoing AS by MRI-guided monitoring.

## W3-SSGU05-3 Magnetic Resonance Imaging-Led Active Surveillance for Prostate Cancer: Outcomes From a Large Cohort Study

Cameron Englman, BSc, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Active surveillance (AS) is a management option for low- and favourable intermediate-risk prostate cancer (PCa) that includes prostate-specific antigen (PSA) monitoring, MRI, and follow-up biopsies. We report on the clinical, histological, and radiological outcomes from our MRI-led AS cohort.

## METHODS AND MATERIALS

A total of 1,019 patients were enrolled in our AS programme between June 1997 and September 2022. Inclusion criteria include low-risk Gleason score (GS) 3+3 or favourable intermediate-risk GS 3+4 PCa at entry, PSA  $< 20$ ng/ml, and at least two MR scans (baseline and follow-up). Primary outcomes were: i) event-free survival (EFS) defined as a transition to treatment or watchful waiting, histological upgrade to GS 4+3 or higher, or death; ii) treatment-free survival (TFS). Secondary outcomes included the rates of all-cause mortality, PCa-related mortality, transition to treatment, radiological progression, and histological upgrade. We used Kaplan-Meier curves, log-rank tests, t-tests, and one-way analysis of variance.

## RESULTS

The cohort consisted of 6,179 total person-years of follow-up (median = 68 months). Overall EFS and TFS were significantly lower for patients with GS 3+4 and MR-visible (V) disease at baseline (log-rank test:  $p < 0.001$ ). The five-year rates were similar for patients with GS 3+3, V and GS 3+4, non-visible (NV) disease at baseline. The rate of all-cause mortality was low (4.7 deaths/1,000 person-years) with no deaths related to PCa, and the overall survival rate was high (97.2%). In total, 287 patients (28%) were treated (46.4 patients/1000 person-years) with radical treatment ( $n = 143$ ), focal therapy ( $n = 130$ ), hormone deprivation ( $n = 17$ ), or watchful waiting ( $n = 18$ ). There was a significant difference in the percentage of patients experiencing radiological progression in those with a visible lesion and higher GS at baseline (GS 3+3, NV = 98/358 [27.4%]; GS 3+3, V = 123/344 [35.7%]; GS 3+4, NV = 37/137 [27.2%]; GS 3+4, V = 72/180 [40%];  $p = 0.003$ ) and histological upgrade (GS 3+3, NV = 8/358 [2.2%]; GS 3+3, V = 13/344 [3.8%]; GS 3+4, NV = 7/137 [5.1%]; GS 3+4, V = 13/180 [7.2%];  $p = 0.042$ ).

## CONCLUSION

The rates of survival and initiation-of-treatment in our MR-led AS cohort were comparable to published data from mandated protocol based-biopsy during AS, suggesting that such an approach (stable MRI and PSA kinetics) can safely defer or omit follow-up biopsy.

## CLINICAL RELEVANCE/APPLICATION

This is the largest single-centre cohort study of patients undergoing MRI-led AS to date. The rates for survival and treatment were comparable to AS regimes that utilise protocol-mandated follow-up biopsies. Patients on AS can be safely monitored with MRI and the decision to biopsy can be based according to MRI findings and PSA (including PSA density) kinetics.

### **W3-SSGU05-4 Magnetic Resonance Imaging PI-RADS Score as an Independent Predictor of Active Surveillance Prostate Cancer Outcome: Data from the Large Cohort Michigan Urological Surgery Improvement Collaborative (MUSIC)**

Kiran R. Nandalur, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The active surveillance decision-making process for prostate cancer typically involves PSA and Gleason score, with MRI utilization becoming increasingly common. The purpose of our study was to evaluate the association of baseline MRI findings with surveillance outcomes of 1) treatment-free survival and 2) high-grade prostate cancer-free survival.

#### **METHODS AND MATERIALS**

We identified men in the Michigan Urological Surgery Improvement Collaborative database (46 hospital based/academic/private practice urology groups) with National Comprehensive Cancer Network (NCCN) very low/low (low) risk and favorable intermediate risk prostate cancer who underwent MRI within 3 months of initial biopsy and enrolled in active surveillance (AS) from June 2016 to June 2020. The primary objective was to determine the association of MRI PI-RADS score (positive result defined as =4 lesion) with treatment-free survival, defined as definitive treatment. Secondary outcome was reclassification to high-grade prostate cancer (=grade group 3) on surveillance biopsy. Multivariable Cox proportional hazards regression models were constructed and adjusted for pathologic, clinical, and demographic factors. Subset analysis was performed for biopsy-based genomic score, if available.

#### **RESULTS**

Total of 2374 men were included with median age 64.4 years (interquartile range (IQ) 59.0-70.0) with median follow-up 31.6 months (IQ: 19.0-43.0). Approximately 81.5% and 68.0% of patients remained on AS at 3 and 5 yr, respectively. For the entire cohort, PI-RADS=4 lesion was associated with an increased risk of definitive therapy (hazard ratio (HR) 2.21 (95% confidence interval (CI): 1.80-2.71,  $p < 0.0001$ ) and biopsy reclassification (HR 1.98 (95% CI: 1.37-2.85,  $p = 0.0003$ ) on multivariable analysis. For low-risk prostate cancer patients ( $n = 1840$ ), PI-RADS=4 lesion was associated with an increased risk of definitive therapy (HR 2.25 (95% CI: 1.76-2.89,  $p < 0.0001$ ) and biopsy reclassification (HR 2.29 (95% CI: 1.44-3.64,  $p = 0.0005$ ). For favorable intermediate risk prostate cancer patients ( $n = 534$ ), PI-RADS=4 lesion was associated with an increased risk of definitive therapy (HR 2.04 (95% CI: 1.43-2.91,  $p < 0.0001$ ) but not biopsy reclassification ( $p = 0.09$ ). Genomic score showed no significant association with definitive therapy or biopsy reclassification.

#### **CONCLUSION**

In this large, multicenter cohort study, upfront MRI PI-RADS score was a significant independent predictor of definitive treatment and biopsy reclassification in men undergoing active surveillance for prostate cancer.

## CLINICAL RELEVANCE/APPLICATION

Baseline MRI PI-RADS score may help tailor the intensity of surveillance testing for men on active surveillance for prostate cancer.

### **W3-SSGU05-5 A Novel Integration of Multiparametric MRI-based Deep Learning Classifier and Clinical Parameters to Improve Long-term Prediction of Postoperative Biochemical Recurrence-Free Survival of Prostate Cancer**

Min Je Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Biochemical recurrence (BCR) following radical prostatectomy (RP) remains the first sign of aggressive disease, hence, a better assessment of the likelihood of long-term post-RP BCR-free survival is crucial. We aimed to evaluate the potential of a combined clinical-deep learning (DL) model for predicting postoperative BCR-free survival in men with prostate cancer (PCa).

#### **METHODS AND MATERIALS**

Between 2008 and 2009, 437 patients with PCa from a single institution who underwent 3 Tesla multiparametric MRI (mpMRI) followed by RP were included in this retrospective study. Radiomics features were extracted from T2 weighted imaging, apparent diffusion coef& 7;cient maps, and dynamic contrast-enhanced imaging that manually delineated the index tumors on mpMRI. Radiomic signatures (RM-Multi) were built using radiomics features on the training set, and the integrated models (CRM-Multi) were built by adding the clinical characteristics with a stratified five-fold cross-validation. The Cox proportional-hazards model used deep features of mpMRI derived from a newly curated deep neural network (an

EfficientNetB0 network pretrained with large-scale natural images) for long-term BCR-free survival prediction following RP. A DL model (DLM-deep feature) and a clinical-DL combined model (CDLM-deep feature) were constructed. We compared the prognostic performance and clinical benefit of various models for BCR-free survival following RP.

## RESULTS

With a median follow-up of 61 months, 110 of 437 (25.2%) patients experienced BCR. The DLM-deep features yielded a higher hazard ratio (HR) (4.37, 95% confidence interval (CI) 0.00-8.83,  $P=0.0219$ ), concordance index (C-index) (0.74, 95% CI 0.59-0.88), and integrated time-dependent area under the curve (iAUC) 0.77 than RM-Multi (HR 2.73, 95% CI 0.39-5.06,  $P=0.68$ ; C-index 0.66, 95% CI 0.57-0.76, and iAUC 0.68). Most importantly, the combined model incorporating DL-based deep features and clinical risk factors (CDLM-Deep feature) achieved the best performance with an HR (7.72, 95% CI 1.24-14.19,  $P=0.0008$ ), C-index (0.89, 95% CI 0.65-0.88), and iAUC 0.93, while the radiomics model incorporating clinical variables (CRM-Multi) demonstrated only moderate predictive power (HR 5.59, 95% CI 3.38-7.79,  $P=0.0007$ ; C-index 0.83, 95% CI 0.72-0.93, iAUC 0.87).

## CONCLUSION

We demonstrated the high performance of integrating deep features from original mpMRI using a radiomic DL approach with the clinicopathological risk factors to predict the long-term BCR-free survival following RP in patients with PCa.

## CLINICAL RELEVANCE/APPLICATION

Our novel DL risk model could facilitate prognostication based on routine prostate mpMRI, facilitating patient stratification following RP and individualized postoperative management.

### W3-SSGU05-6 Can a Biparametric MRI-based AI Model Assist in Detecting Locally Recurrent Prostate Cancer in Post-radiotherapy Patients?

Enis C. Yilmaz, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the performance of a biparametric MRI (bpMRI)-based artificial intelligence (AI) model in detecting local recurrence in patients who received radiotherapy for prostate cancer (PCa).

## METHODS AND MATERIALS

This retrospective study included patients under investigation for PCa recurrence after definitive radiotherapy who were scanned at mpMRI and underwent MRI/US fusion-guided and/or systematic biopsy. An expert genitourinary radiologist prospectively read each case prior to the biopsy sessions utilizing all multiparametric MRI sequences including dynamic contrast enhanced MRI. All scans were evaluated by an automated prostate lesion detection model which was developed on a multi-institutional dataset of 1240 treatment-naïve patients on bpMRI. The AI model's recurrent cancer detection rate was compared to the radiologist read using the Wald test with biopsy outcomes serving as ground truth. Subgroup analyses were conducted based on radiotherapy technique (external beam radiation treatment [EBRT] or brachytherapy) and prostate volume quartiles to investigate the impact of these factors on AI model performance.

## RESULTS

Sixty-two patients (median age, 70; interquartile range [IQR], 65-75 years) with a median prostate volume of 27.55 mL (IQR, 21-34 mL) were included. A total of 56 cancer foci were identified in 46 patients in histopathological assessment. The AI model identified 40 cancer foci in 35 patients and achieved a sensitivity of 76.1% (35/46) and 71.4% (40/56) on patient- and lesion-level, respectively. The radiologist PCa detection performance was higher than the AI model on both patient-level (91.3% versus 76.1%,  $P=0.02$ ) and lesion-level (87.5% versus 71.4%,  $P=0.01$ ). The mean number of false positive calls of the AI model and the radiologist were 0.35 (range: 0-2) and 0.34 (range: 0-2), respectively. The AI performed better in the post-EBRT subgroup as compared to the post-brachytherapy subgroup on both patient-level (EBRT: 81.5% [22/27] vs. brachytherapy: 68.4% [13/19]) and lesion-level (EBRT: 79.4% [27/34] vs. brachytherapy: 59.1% [13/22]). The sensitivity of the AI was numerically best in the quartile of largest prostate volumes (>34 mL) with a patient- and lesion-level sensitivity of 100% ( $n=11/11$ ) and 94.1% ( $n=16/17$ ), respectively.

## CONCLUSION

A bpMRI-based AI model can be used to detect the majority of histopathologically verified recurrent PCa lesions after radiotherapy. AI performance was better among patients with larger glands and those who received EBRT.

## CLINICAL RELEVANCE/APPLICATION

An automated prostate lesion detection tool was able to identify most of the locally recurrent PCa in post-radiotherapy patients without utilizing dynamic contrast enhanced MRI.



## Abstract Archives of the RSNA, 2023

W3-SSGU05-1

### **MRI for the Detection of Aggressive Prostate Cancer in Patients on Active Surveillance using the Precise Criteria: A Multicentre Study**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E350

Francesco Giganti, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The PRECISE recommendations provide a 1-to-5 scale to evaluate the radiological change on serial MRI in patients on active surveillance for prostate cancer: PRECISE 1-2 denotes radiological regression, PRECISE 3 indicates stability and PRECISE 4-5 implies progression. We present the data for the validation of the PRECISE scoring system as a tool to predict disease progression in a multi-centre international setting.

#### **METHODS AND MATERIALS**

We collected data from 22 centres across the world and applied two entry criteria: i) at least two scans (baseline and follow-up); ii) at least two biopsies (baseline and follow-up, the latter after the second MR). Local radiologists reported according to the PRECISE recommendations. Histological progression was defined as any increase in Gleason score from baseline biopsy (that could include only Gleason 3+3 or also low-risk Gleason 3+4 disease as per local institutional protocols). Progression-free survival (PFS) was estimated using Kaplan-Meier curves. Multivariable Cox hazards model tested the predictive role of PRECISE.

#### **RESULTS**

A total of 1,556 patients were included in this analysis, 1389 (89%) of which had Gleason 3+3 and 167 (11%) had Gleason 3+4 disease at baseline. Median follow-up was 48 months (IQR 26-75 months), and 513 (33%) patients experienced histological progression. For PRECISE 1-2 (n=158), PFS was 88% at two years and 77% at five years from first follow-up MRI, while for PRECISE 4-5 (n=413), PFS was 52% and 35%, respectively. In those patients with PRECISE 3 [stability] and visible lesions (n=597), 2- and 5-year PFS was 76% and 50%, while for PRECISE 3 [stability] and non-visible (NV) lesions (n=388), PFS was similar to PRECISE 1-2 (two- and five-year PFS: 91% and 80%; Log Rank  $p < 0.001$ ). At multivariable analysis, PRECISE 4-5 remained an independent predictor of histological progression (hazard ratio 2.63, 95% CI 1.82-3.79;  $p < 0.0001$ ).

#### **CONCLUSION**

Our work has validated a new MRI-based scoring system to assess disease progression during AS internationally and will contribute to the creation of a risk model that incorporates both clinical and radiological data to fully benefit from prostate MRI and targeted biopsies. This will help identify the number of patients on AS with more aggressive disease and a higher likelihood of developing advanced prostate cancer in a timely manner.

#### **CLINICAL RELEVANCE/APPLICATION**

PRECISE can contribute to the creation of a risk model that incorporates both clinical and radiological data.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGU05-2

### **MRI-guided Active Surveillance without Re-biopsies in Patients with ISUP Grade Group 1 and 2 Prostate Cancer -The PROMM-AS Study**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E350

Birte Valentin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the ability of mpMRI to reduce guideline-mandated biopsy and to predict ISUP grade group upgrading in patients with ISUP1 and ISUP2 PC. Using this MR-guided pathway, AS disqualification rate thought to be reduced to 15%.

#### **METHODS AND MATERIALS**

In this prospective single-center cohort study patients with ISUP GG 1 and 2 PC after MRI/TRUS fusion-guided biopsy were included and the 2-year outcome of an mpMRI-guided AS protocol (PROMM-AS) were analyzed. All men underwent mpMRI 12 months after inclusion. In case of stable mpMRI according to PRECISE criteria, re-biopsy was deferred and follow-up mpMRI after 24 months performed. In case of mpMRI progression or at the end of study, follow-up MRI/TRUS fusion-guided biopsy was indicated. Sensitivity, specificity, positive (PPV) and negative predictive values (NPV) for ISUP GG upgrading on MRI were calculated and regression analyses were performed.

#### **RESULTS**

In total, 101 patients (60 with ISUP1 and 41 with ISUP2) were analyzed. Histopathological progression occurred in total in 29 patients. Thus, the aim of reducing AS disqualification to 15% could not be reached. In the ISUP1 subgroup, 18 patients had progression, whereas 11 patients progressed in ISUP2 subgroup. Sensitivity, specificity, PPV and NPV for PRECISE was 94%, 64%, 81% and 88% in the ISUP1 and 92%, 50%, 92% and 50% in ISUP2 subgroup, respectively. On regression analysis, initial PSA ( $p < 0.001$ ), and higher PRECISE scores (4-5) ( $p = 0.005$ ) were significant predictors of histological progression in ISUP1 and higher PRECISE score ( $p = 0.009$ ), initial PI-RADS ( $p = 0.009$ ), previous negative biopsy ( $p = 0.02$ ) and percentage of Gleason pattern 4 ( $p = 0.04$ ) in ISUP2 PC.

#### **CONCLUSION**

MRI-guided monitoring of patients on AS including PRECISE criteria avoids unnecessary follow-up biopsies in 88% of patients with ISUP1 and predicts grade group upgrading over a follow-up period of 2 years in both ISUP1 and ISUP2.

#### **CLINICAL RELEVANCE/APPLICATION**

Avoidance of unnecessary follow-up biopsies as well as prediction of grade group upgrade in patients undergoing AS by MRI-guided monitoring.

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## Abstract Archives of the RSNA, 2023

W3-SSGU05-3

### Magnetic Resonance Imaging-Led Active Surveillance for Prostate Cancer: Outcomes From a Large Cohort Study

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E350

Cameron Englman, BSc, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Active surveillance (AS) is a management option for low- and favourable intermediate-risk prostate cancer (PCa) that includes prostate-specific antigen (PSA) monitoring, MRI, and follow-up biopsies. We report on the clinical, histological, and radiological outcomes from our MRI-led AS cohort.

#### METHODS AND MATERIALS

A total of 1,019 patients were enrolled in our AS programme between June 1997 and September 2022. Inclusion criteria include low-risk Gleason score (GS) 3+3 or favourable intermediate-risk GS 3+4 PCa at entry, PSA <20ng/ml, and at least two MR scans (baseline and follow-up). Primary outcomes were: i) event-free survival (EFS) defined as a transition to treatment or watchful waiting, histological upgrade to GS 4+3 or higher, or death; ii) treatment-free survival (TFS). Secondary outcomes included the rates of all-cause mortality, PCa-related mortality, transition to treatment, radiological progression, and histological upgrade. We used Kaplan-Meier curves, log-rank tests, t-tests, and one-way analysis of variance.

#### RESULTS

The cohort consisted of 6,179 total person-years of follow-up (median = 68 months). Overall EFS and TFS were significantly lower for patients with GS 3+4 and MR-visible (V) disease at baseline (log-rank test:  $p < 0.001$ ). The five-year rates were similar for patients with GS 3+3, V and GS 3+4, non-visible (NV) disease at baseline. The rate of all-cause mortality was low (4.7 deaths/1,000 person-years) with no deaths related to PCa, and the overall survival rate was high (97.2%). In total, 287 patients (28%) were treated (46.4 patients/1000 person-years) with radical treatment ( $n=143$ ), focal therapy ( $n=130$ ), hormone deprivation ( $n=17$ ), or watchful waiting ( $n=18$ ). There was a significant difference in the percentage of patients experiencing radiological progression in those with a visible lesion and higher GS at baseline (GS 3+3, NV = 98/358 [27.4%]; GS 3+3, V = 123/344 [35.7%]; GS 3+4, NV = 37/137 [27.2%]; GS 3+4, V = 72/180 [40%];  $p=0.003$ ) and histological upgrade (GS 3+3, NV = 8/358 [2.2%]; GS 3+3, V = 13/344 [3.8%]; GS 3+4, NV = 7/137 [5.1%]; GS 3+4, V = 13/180 [7.2%];  $p=0.042$ ).

#### CONCLUSION

The rates of survival and initiation-of-treatment in our MR-led AS cohort were comparable to published data from mandated protocol based-biopsy during AS, suggesting that such an approach (stable MRI and PSA kinetics) can safely defer or omit follow-up biopsy.

#### CLINICAL RELEVANCE/APPLICATION

This is the largest single-centre cohort study of patients undergoing MRI-led AS to date. The rates for survival and treatment were comparable to AS regimes that utilise protocol-mandated follow-up biopsies. Patients on AS can be safely monitored with MRI and the decision to biopsy can be based according to MRI findings and PSA (including PSA density) kinetics.

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## Abstract Archives of the RSNA, 2023

W3-SSGU05-4

### **Magnetic Resonance Imaging PI-RADS Score as an Independent Predictor of Active Surveillance Prostate Cancer Outcome: Data from the Large Cohort Michigan Urological Surgery Improvement Collaborative (MUSIC)**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E350

Kiran R. Nandalur, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The active surveillance decision-making process for prostate cancer typically involves PSA and Gleason score, with MRI utilization becoming increasingly common. The purpose of our study was to evaluate the association of baseline MRI findings with surveillance outcomes of 1) treatment-free survival and 2) high-grade prostate cancer-free survival.

#### **METHODS AND MATERIALS**

We identified men in the Michigan Urological Surgery Improvement Collaborative database (46 hospital based/academic/private practice urology groups) with National Comprehensive Cancer Network (NCCN) very low/low (low risk and favorable intermediate risk prostate cancer who underwent MRI within 3 months of initial biopsy and enrolled in active surveillance (AS) from June 2016 to June 2020. The primary objective was to determine the association of MRI PI-RADS score (positive result defined as =4 lesion) with treatment-free survival, defined as definitive treatment. Secondary outcome was reclassification to high-grade prostate cancer (=grade group 3) on surveillance biopsy. Multivariable Cox proportional hazards regression models were constructed and adjusted for pathologic, clinical, and demographic factors. Subset analysis was performed for biopsy-based genomic score, if available.

#### **RESULTS**

Total of 2374 men were included with median age 64.4 years (interquartile range (IQ) 59.0-70.0) with median follow-up 31.6 months (IQ: 19.0-43.0). Approximately 81.5% and 68.0% of patients remained on AS at 3 and 5 yr, respectively. For the entire cohort, PI-RADS=4 lesion was associated with an increased risk of definitive therapy (hazard ratio (HR) 2.21 (95% confidence interval (CI): 1.80-2.71,  $p<0.0001$ ) and biopsy reclassification (HR 1.98 (95% CI: 1.37-2.85,  $p=0.0003$ ) on multivariable analysis. For low-risk prostate cancer patients ( $n=1840$ ), PI-RADS=4 lesion was associated with an increased risk of definitive therapy (HR 2.25 (95% CI: 1.76-2.89,  $p<0.0001$ ) and biopsy reclassification (HR 2.29 (95%CI: 1.44-3.64,  $p=0.0005$ ). For favorable intermediate risk prostate cancer patients ( $n=534$ ), PI-RADS=4 lesion was associated with an increased risk of definitive therapy (HR 2.04 (95% CI: 1.43-2.91,  $p<0.0001$ ) but not biopsy reclassification ( $p=0.09$ ). Genomic score showed no significant association with definitive therapy or biopsy reclassification.

#### **CONCLUSION**

In this large, multicenter cohort study, upfront MRI PI-RADS score was a significant independent predictor of definitive treatment and biopsy reclassification in men undergoing active surveillance for prostate cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

Baseline MRI PI-RADS score may help tailor the intensity of surveillance testing for men on active surveillance for prostate cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSGU05-5

### **A Novel Integration of Multiparametric MRI-based Deep Learning Classifier and Clinical Parameters to Improve Long-term Prediction of Postoperative Biochemical Recurrence-Free Survival of Prostate Cancer**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E350

Min Je Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Biochemical recurrence (BCR) following radical prostatectomy (RP) remains the first sign of aggressive disease, hence, a better assessment of the likelihood of long-term post-RP BCR-free survival is crucial. We aimed to evaluate the potential of a combined clinical-deep learning (DL) model for predicting postoperative BCR-free survival in men with prostate cancer (PCa).

#### **METHODS AND MATERIALS**

Between 2008 and 2009, 437 patients with PCa from a single institution who underwent 3 Tesla multiparametric MRI (mpMRI) followed by RP were included in this retrospective study. Radiomics features were extracted from T2 weighted imaging, apparent diffusion coefficient maps, and dynamic contrast-enhanced imaging that manually delineated the index tumors on mpMRI. Radiomic signatures (RM-Multi) were built using radiomics features on the training set, and the integrated models (CRM-Multi) were built by adding the clinical characteristics with a stratified five-fold cross-validation. The Cox proportional-hazards model used deep features of mpMRI derived from a newly curated deep neural network (an EfficientNetB0 network pretrained with large-scale natural images) for long-term BCR-free survival prediction following RP. A DL model (DLM-deep feature) and a clinical-DL combined model (CDLM-deep feature) were constructed. We compared the prognostic performance and clinical benefit of various models for BCR-free survival following RP.

#### **RESULTS**

With a median follow-up of 61 months, 110 of 437 (25.2%) patients experienced BCR. The DLM-deep features yielded a higher hazard ratio (HR) (4.37, 95% confidence interval (CI) 0.00-8.83,  $P=0.0219$ ), concordance index (C-index) (0.74, 95% CI 0.59-0.88), and integrated time-dependent area under the curve (iAUC) 0.77 than RM-Multi (HR 2.73, 95% CI 0.39-5.06,  $P=0.68$ ; C-index 0.66, 95% CI 0.57-0.76, and iAUC 0.68). Most importantly, the combined model incorporating DL-based deep features and clinical risk factors (CDLM-Deep feature) achieved the best performance with an HR (7.72, 95% CI 1.24-14.19,  $P=0.0008$ ), C-index (0.89, 95% CI 0.65-0.88), and iAUC 0.93, while the radiomics model incorporating clinical variables (CRM-Multi) demonstrated only moderate predictive power (HR 5.59, 95% CI 3.38-7.79,  $P=0.0007$ ; C-index 0.83, 95% CI 0.72-0.93, iAUC 0.87).

#### **CONCLUSION**

We demonstrated the high performance of integrating deep features from original mpMRI using a radiomic DL approach with the clinicopathological risk factors to predict the long-term BCR-free survival following RP in patients with PCa.

#### **CLINICAL RELEVANCE/APPLICATION**

Our novel DL risk model could facilitate prognostication based on routine prostate mpMRI, facilitating patient stratification following RP and individualized postoperative management.

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## Abstract Archives of the RSNA, 2023

W3-SSGU05-6

### Can a Biparametric MRI-based AI Model Assist in Detecting Locally Recurrent Prostate Cancer in Post-radiotherapy Patients?

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E350

Enis C. Yilmaz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the performance of a biparametric MRI (bpMRI)-based artificial intelligence (AI) model in detecting local recurrence in patients who received radiotherapy for prostate cancer (PCa).

#### METHODS AND MATERIALS

This retrospective study included patients under investigation for PCa recurrence after definitive radiotherapy who were scanned at mpMRI and underwent MRI/US fusion-guided and/or systematic biopsy. An expert genitourinary radiologist prospectively read each case prior to the biopsy sessions utilizing all multiparametric MRI sequences including dynamic contrast enhanced MRI. All scans were evaluated by an automated prostate lesion detection model which was developed on a multi-institutional dataset of 1240 treatment-naïve patients on bpMRI. The AI model's recurrent cancer detection rate was compared to the radiologist read using the Wald test with biopsy outcomes serving as ground truth. Subgroup analyses were conducted based on radiotherapy technique (external beam radiation treatment [EBRT] or brachytherapy) and prostate volume quartiles to investigate the impact of these factors on AI model performance.

#### RESULTS

Sixty-two patients (median age, 70; interquartile range [IQR], 65-75 years) with a median prostate volume of 27.55 mL (IQR, 21-34 mL) were included. A total of 56 cancer foci were identified in 46 patients in histopathological assessment. The AI model identified 40 cancer foci in 35 patients and achieved a sensitivity of 76.1% (35/46) and 71.4% (40/56) on patient- and lesion-level, respectively. The radiologist PCa detection performance was higher than the AI model on both patient-level (91.3% versus 76.1%,  $P=0.02$ ) and lesion-level (87.5% versus 71.4%,  $P=0.01$ ). The mean number of false positive calls of the AI model and the radiologist were 0.35 (range: 0-2) and 0.34 (range: 0-2), respectively. The AI performed better in the post-EBRT subgroup as compared to the post-brachytherapy subgroup on both patient-level (EBRT: 81.5% [22/27] vs. brachytherapy: 68.4% [13/19]) and lesion-level (EBRT: 79.4% [27/34] vs. brachytherapy: 59.1% [13/22]). The sensitivity of the AI was numerically best in the quartile of largest prostate volumes (>34 mL) with a patient- and lesion-level sensitivity of 100% ( $n=11/11$ ) and 94.1% ( $n=16/17$ ), respectively.

#### CONCLUSION

A bpMRI-based AI model can be used to detect the majority of histopathologically verified recurrent PCa lesions after radiotherapy. AI performance was better among patients with larger glands and those who received EBRT.

#### CLINICAL RELEVANCE/APPLICATION

An automated prostate lesion detection tool was able to identify most of the locally recurrent PCa in post-radiotherapy patients without utilizing dynamic contrast enhanced MRI.

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## Abstract Archives of the RSNA, 2023

W3-SSIN05

### Science Session with Keynote: Imaging Informatics (Current State of Large Language Models (LLM) in Radiology: Chat-GPT, NLP and More)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S402

John W. Garrett, PhD (*Moderator*) Nothing to Disclose

Tara A. Retson, MD, PhD (*Moderator*) Research Consultant, CureMetrix, Inc Stock options, CureMetrix, Inc

#### Sub-Events

#### W3-SSIN05-1 Prompting for Generalizable Clinical Concept Extraction from Radiology Reports

Kawshik Kannan, MS, BEng (*Presenter*) Employee, Covera Health

#### PURPOSE

Radiology reports describe various anatomical structures, creating a need to extract only the sentences pertaining to a particular structure to identify the corresponding pathology. This paper introduces STITCH (Structured Information Tagger for Clinical Health-records), a prompt based model that can detect sentence relevance for new, unseen anatomical structures and concepts in a zero-shot manner.

#### METHODS AND MATERIALS

STITCH is a BERT based model that uses adapters for parameter-efficient learning. Given a sentence and an anatomical structure, it determines if the sentence describes the anatomical structure. For this study, we used 8503 studies manually annotated for the presence of pathologies in 25 structures (17 in knee, 8 in shoulder), with a total of 55k sentence-structure pairs for training, 12k for validation and 15k for testing. Moreover, when a concept cannot be succinctly stated with a prompt, the model can learn soft prompts from the continuous vocabulary space to appropriately describe the concept.

#### RESULTS

The model that was trained on knee structures generalizes to unseen shoulder structures, achieving a sensitivity, specificity of 0.83, 0.80 whereas a n-way classifier model trained on shoulder data achieves a sensitivity, specificity of 0.82, 0.89 . However, the model trained on both knee and shoulder structures reaches a sensitivity, specificity of 0.95, 0.85, showcasing the benefits of training with more anatomical structures and sentences. Furthermore, as an unseen task, STITCH was used to detect post-operative changes in reports using soft prompts. This model was trained on knee post-op sentences and achieves 0.81, 0.998 for unseen shoulder post-op sentences whereas a standard binary classifier achieves scores of 0.62, 0.993, sensitivity, specificity respectively. With the advent of large language models changing the direction of the field, STITCH is attractive in part due to its lightweight architecture and task-specific representations which are easier to evaluate.

#### CONCLUSION

The prompt based task formulation used for STITCH alongside a large number of anatomical structures allows the model to generalize to predicting sentence relevance for unseen concepts.

#### CLINICAL RELEVANCE/APPLICATION

Automatic detection of structures in reports can help comprehend large datasets and ease downstream tasks such as pathology extraction, cohort building, outcome tracking and quality assessment.

#### W3-SSIN05-2 Automated Categorization of Pathology in Radiology Report Impressions by GPT-4; A Tool to Enable Precision Education

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The ACGME has adopted a learner centered competency based education model that requires residents to master specific knowledge skills and achieve key milestones. A significant component of resident education is based on daily readouts with

attendings. It is easy to track the volume and type of examinations interpreted but difficult to measure the breadth of pathology seen and the accuracy of resident interpretations. An automated method that categorizes the pathology listed in the impression of the resident's preliminary report as well as in the final report would provide objective metrics of both. The goal of this study is to assess the accuracy of GPT-4 in categorizing the pathology that is described in the impression of radiology reports.

## **METHODS AND MATERIALS**

A list of 204 pathologies based on our residency's musculoskeletal curriculum and the ABR Core Exam Blueprints was created. Impressions were extracted from 190 de-identified musculoskeletal (MSK) reports (105 Xray, 44 CT, and 41 MR). To identify and extract the pathologies from the impressions in a machine-readable form, we constructed an input prompt for GPT-4 that asked it to list any of the listed pathologies that were mentioned as definite or possible findings as a CSV file. To reduce uncertainty in the output, we used python and GPT-4 webservices, to process each report 5 times and generated a list of pathologies that were mentioned as definite or possible in at least 3 of the 5 answers. An experienced MSK radiologist reviewed the output and identified missing or incorrectly listed pathologies.

## **RESULTS**

All outputs only included pathologies from the input list. GPT identified 306 of the 311 definite findings and 84 of the 90 possible findings correctly. It identified 25 false positive definite findings and 22 false positive possible findings. Given 38760 binary tests (190 reports x 204 pathologies) the recall, specificity, and precision for the definite findings are 98.4%, 99.9% and 92.4%. and for the possible findings 93.3%, 99.9%, and 79.2%.

## **CONCLUSION**

With a well-engineered prompt, GPT4 is able to automatically and accurately identify pathologies in radiology impressions and output them in a machine-readable form with excellent accuracy. It is likely that that its performance can be further improved by fine-tuning the prompt and the description of the pathologies in the pick list. The method is easy to implement and may be generalizable to other areas.

## **CLINICAL RELEVANCE/APPLICATION**

Automated categorization of pathology contained in radiology reports can be an important tool to enable precision radiology resident education.

### **W3-SSIN05-3 Keynote Speaker**

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc; Shareholder, MD.ai, Inc

### **W3-SSIN05-4 Large Language Models for Zero-shot Application of a Clinical Reporting System (CAD-RADS) to Unstructured Reports**

Veit Sandfort, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Large language models (LLMs) are rapidly increasing in performance and are now capable of performing tasks guided only by natural language instructions, without domain-specific training data (zero-shot). This enables the automatic processing of unstructured radiology reports with minimal development effort. We sought to determine the performance of LLMs in deriving the appropriate CAD-RADS category from unstructured coronary CTA reports.

## **METHODS AND MATERIALS**

Fully anonymized CCTA reports (n=500) from four hospitals across three US regions (East, Midwest, and Southwest) were obtained from Segmed Inc. CAD-RADS categories were determined by three cardiovascular experts, and any mention of CAD-RADS in the reports was manually removed to avoid bias. We used three LLMs for the analysis: gpt-3.5-turbo (ChatGPT, OpenAI) and two LLMs derived from publicly available MetaAI models (LLaMA): Stanford ALPACA 7B and 13B. The prompt used for all LLMs included: the CCTA report, CAD-RADS definitions, and instructions to provide a CAD-RADS category as output. Of note, no prompt optimization was performed. LLMs' performance to achieve accurate CAD-RADS scores was evaluated with Cohen's kappa using expert-derived scores as the reference standard.

## **RESULTS**

CAD-RADS categories were removed from 152 (30.4%) CCTA reports. ChatGPT showed good agreement with expert-derived scores with a Cohen's kappa of 0.67 (CI 0.62 - 0.72), and a significantly higher performance compared to Alpaca 7B and 13B (see figure). Alpaca 13B showed significantly higher performance compared to Alpaca 7B, with Cohen's kappa 0.44 (CI 0.40 - 0.49) vs. 0.23 (CI 0.19 - 0.28), respectively.

## **CONCLUSION**

OpenAI's ChatGPT showed good performance in assigning CAD-RADS categories to unstructured coronary CTA reports while both locally run ALPACA models showed lower performance compared to ChatGPT, with the 13B model performing better than

the 7B model.

### **CLINICAL RELEVANCE/APPLICATION**

LLM-assisted CAD-RADS categorization without the need for extensive development or generation of training data enables rapid deployment in the setting of quality improvement, administrative analyses, billing, research, and report quality control and can accelerate the development of clinical NLP models. We also suspect this method could be useful for other reporting and data systems (RADS).

### **W3-SSIN05-5 A Comparative Analysis of Modern Clinical NLP Tools From Amazon, Google, Azure, and John Snow Labs on Pediatric Radiology Reports**

Shruti Hegde, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To quantify the differences in the performance of commercial clinical natural language processing (NLP) tools on pediatric radiology reports.

#### **METHODS AND MATERIALS**

Four commercial NLP systems for clinical electronic health record data, Amazon Comprehend Medical (AWS), Google Healthcare Natural Language API (GC), Azure Text analytics for Health (AZ), and John Snow Lab's spark NLP models for radiology reports (SP), were evaluated on 88,766 pediatric (Mean age:  $8 \pm 7.5$  years, Male/Female ratio: 1.2) radiology reports for chest radiography examinations. Clinical NLP systems performed four major tasks: named entity recognition, entity linking, relationship detection, and assertion detection. Uncertainty associated with entities extracted by each NLP task is reported as a probabilistic score (0 - 1). Anonymized reports were submitted as REST API queries for AWS, GC, and AZ; for SP, an academic license was used, and inference was performed locally on the radiology specific model. Outputs in JSON format were harmonized, and initial analysis focused on medical conditions, findings, diagnosis, symptoms, and diseases. Lemmatization and stemming were performed on extracted medical entities to standardize them between the four services and compared. The range of uncertainty scores reported by each system for pneumonia and atelectasis were quantified. Cosine similarity measures between each NLP service on all extracted medical entities are also calculated and reported.

#### **RESULTS**

Total (unique) medical entities detected by AWS, AZ, GC, and SP were 867,477 (25,670), 455,297 (11,574), 1,175,674 (29,566), and 972,151 (38,115), respectively. After stemming, 4,577 common entities remained. Mean (min-max) uncertainty scores for pneumonia extraction: AWS 0.986 (0.501-0.999), AZ 0.999 (0.599-0.999), GC 0.982 (0.550-1.0), SP 0.87 (0.325-0.987). For atelectasis, the scores were: AWS 0.874 (0.302-0.997), AZ 0.998 (0.513-0.999), GC 0.831(0.550-1.0), SP 0.917 (0.427-0.990). For cosine similarity, GC and SP was highest (0.83), AZ and SP were lowest (0.46).

#### **CONCLUSION**

Major differences in the extracted medical entities and the associated uncertainty scores for named entity recognition on pediatric CXR radiology reports were observed between 4 commercial clinical NLP services even after standardization of the outputs. Further analysis with manual oversight is required to understand the discrepancies between each system.

### **CLINICAL RELEVANCE/APPLICATION**

As clinical NLP services are becoming mainstream and are playing an increasing role in both Radiology research and quality assurance/ improvement, it is important to understand the uncertainties associated with each service before they can be used for downstream tasks.

### **W3-SSIN05-6 Comparative Performance of Artificial Intelligence Large Language Models on Diagnostic Radiology In-Training Exam**

Christopher Kaufmann, MD, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

There is limited and often unclear information on the accuracy and sources of publicly available AI tools such as ChatGPT, Bard, BingChat specifically related to radiology domains. While these tools are powerful search and assistive reference aids, in order for a radiologist to decide how, if at all, to utilize these assistive AI technologies, the output accuracy, relevance, and reliability needs to be better understood. This study attempts to compare the latest publicly accessible AI large language models (LLMs) across multiple subspecialty areas of radiology.

#### **METHODS AND MATERIALS**

The American College of Radiology Diagnostic In-Training Exam (ACR DXIT) practice test question set from July 2022 were filtered to exclude image-based questions (n=64 image dependent, n=42 image independent questions). The image independent questions were distributed across various radiology disciplines including breast, cardiothoracic, GI/GU, musculoskeletal, neuroradiology, nuclear, pediatrics, ultrasound, interventional and radiology physics. Three publicly available



AI LLMs platforms (OpenAI ChatGPT 3.5 4.0, Google BARD, and Windows BingChat) were used to evaluate for correct answer responses to the input test questions. The questions were entered into the AI interface in their original text format without prompting or modification guidance, except for one instance which flagged a question answer word for "inappropriate content".

## **RESULTS**

ChatGPT 4.0 answered 90.5% correctly (n=38 of 42) and ChatGPT 3.5 answered 79% of questions correctly (33 of 42). While overall improvement was noted using GPT4, 2 previously correct responses using GPT3.5 were outputted incorrectly using GPT4. Google Bard answered 71% correctly in which all 3 draft responses were correct (n=30 of 42). There were partially correct responses (lack of concordance across 3 output drafts) in 14% of Bard outputs (n=6 of 42). BingChat performed the lowest with 60% correct (n=25 of 42).

## **CONCLUSION**

Performance of the latest ChatGPT4-0 on the image-independent ACR DXIT practice set questions was above 90% correct. The results demonstrate the powerful efficiency and improving accuracy of evolving publicly available AI tools when applied to the radiology specific domain. As LLMs evolve into more discipline specific AI support tools, determining the trustworthiness and up-to-date accuracy of these AI technologies will remain key criteria for their ultimate clinical adoption and use in practice.

## **CLINICAL RELEVANCE/APPLICATION**

With the rapid, almost daily evolution of readily available AI technologies such as ChatGPT, Bard, or BingChat, determining their radiology-domain specific performance and output reliability is important for potential use in radiology practice.

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## Abstract Archives of the RSNA, 2023

W3-SSIN05-1

### Prompting for Generalizable Clinical Concept Extraction from Radiology Reports

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S402

Kawshik Kannan, MS, BEng (*Presenter*) Employee, Covera Health

#### PURPOSE

Radiology reports describe various anatomical structures, creating a need to extract only the sentences pertaining to a particular structure to identify the corresponding pathology. This paper introduces STITCH (STRUCTURED Information Tagger for Clinical Health-records), a prompt based model that can detect sentence relevance for new, unseen anatomical structures and concepts in a zero-shot manner.

#### METHODS AND MATERIALS

STITCH is a BERT based model that uses adapters for parameter-efficient learning. Given a sentence and an anatomical structure, it determines if the sentence describes the anatomical structure. For this study, we used 8503 studies manually annotated for the presence of pathologies in 25 structures (17 in knee, 8 in shoulder), with a total of 55k sentence-structure pairs for training, 12k for validation and 15k for testing. Moreover, when a concept cannot be succinctly stated with a prompt, the model can learn soft prompts from the continuous vocabulary space to appropriately describe the concept.

#### RESULTS

The model that was trained on knee structures generalizes to unseen shoulder structures, achieving a sensitivity, specificity of 0.83, 0.80 whereas a n-way classifier model trained on shoulder data achieves a sensitivity, specificity of 0.82, 0.89 . However, the model trained on both knee and shoulder structures reaches a sensitivity, specificity of 0.95, 0.85, showcasing the benefits of training with more anatomical structures and sentences. Furthermore, as an unseen task, STITCH was used to detect post-operative changes in reports using soft prompts. This model was trained on knee post-op sentences and achieves 0.81, 0.998 for unseen shoulder post-op sentences whereas a standard binary classifier achieves scores of 0.62, 0.993, sensitivity, specificity respectively. With the advent of large language models changing the direction of the field, STITCH is attractive in part to its lightweight architecture and task-specific representations which are easier to evaluate.

#### CONCLUSION

The prompt based task formulation used for STITCH alongside a large number of anatomical structures allows the model to generalize to predicting sentence relevance for unseen concepts.

#### CLINICAL RELEVANCE/APPLICATION

Automatic detection of structures in reports can help comprehend large datasets and ease downstream tasks such as pathology extraction, cohort building, outcome tracking and quality assessment.

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## Abstract Archives of the RSNA, 2023

W3-SSIN05-2

### Automated Categorization of Pathology in Radiology Report Impressions by GPT-4; A Tool to Enable Precision Education

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S402

Michael P. Recht, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The ACGME has adopted a learner centered competency based education model that requires residents to master specific knowledge skills and achieve key milestones. A significant component of resident education is based on daily readouts with attendings. It is easy to track the volume and type of examinations interpreted but difficult to measure the breadth of pathology seen and the accuracy of resident interpretations. An automated method that categorizes the pathology listed in the impression of the resident's preliminary report as well as in the final report would provide objective metrics of both. The goal of this study is to assess the accuracy of GPT-4 in categorizing the pathology that is described in the impression of radiology reports.

#### METHODS AND MATERIALS

A list of 204 pathologies based on our residency's musculoskeletal curriculum and the ABR Core Exam Blueprints was created. Impressions were extracted from 190 de-identified musculoskeletal (MSK) reports (105 Xray, 44 CT, and 41 MR). To identify and extract the pathologies from the impressions in a machine-readable form, we constructed an input prompt for GPT-4 that asked it to list any of the listed pathologies that were mentioned as definite or possible findings as a CSV file. To reduce uncertainty in the output, we used python and GPT-4 webservices, to process each report 5 times and generated a list of pathologies that were mentioned as definite or possible in at least 3 of the 5 answers. An experienced MSK radiologist reviewed the output and identified missing or incorrectly listed pathologies.

#### RESULTS

All outputs only included pathologies from the input list. GPT identified 306 of the 311 definite findings and 84 of the 90 possible findings correctly. It identified 25 false positive definite findings and 22 false positive possible findings. Given 38760 binary tests (190 reports x 204 pathologies) the recall, specificity, and precision for the definite findings are 98.4%, 99.9% and 92.4%. and for the possible findings 93.3%, 99.9%, and 79.2%.

#### CONCLUSION

With a well-engineered prompt, GPT4 is able to automatically and accurately identify pathologies in radiology impressions and output them in a machine-readable form with excellent accuracy. It is likely that that its performance can be further improved by fine-tuning the prompt and the description of the pathologies in the pick list. The method is easy to implement and may be generalizable to other areas.

#### CLINICAL RELEVANCE/APPLICATION

Automated categorization of pathology contained in radiology reports can be an important tool to enable precision radiology resident education.

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## Abstract Archives of the RSNA, 2023

W3-SSIN05-3

### Keynote Speaker

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S402

George L. Shih, MD, MS (*Presenter*) Consultant, MD.ai, Inc;Shareholder, MD.ai, Inc

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## Abstract Archives of the RSNA, 2023

W3-SSIN05-4

### Large Language Models for Zero-shot Application of a Clinical Reporting System (CAD-RADS) to Unstructured Reports

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S402

Veit Sandfort, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Large language models (LLMs) are rapidly increasing in performance and are now capable of performing tasks guided only by natural language instructions, without domain-specific training data (zero-shot). This enables the automatic processing of unstructured radiology reports with minimal development effort. We sought to determine the performance of LLMs in deriving the appropriate CAD-RADS category from unstructured coronary CTA reports.

#### METHODS AND MATERIALS

Fully anonymized CCTA reports (n=500) from four hospitals across three US regions (East, Midwest, and Southwest) were obtained from Segmed Inc. CAD-RADS categories were determined by three cardiovascular experts, and any mention of CAD-RADS in the reports was manually removed to avoid bias. We used three LLMs for the analysis: gpt-3.5-turbo (ChatGPT, OpenAI) and two LLMs derived from publicly available MetaAI models (LLaMA): Stanford ALPACA 7B and 13B. The prompt used for all LLMs included: the CCTA report, CAD-RADS definitions, and instructions to provide a CAD-RADS category as output. Of note, no prompt optimization was performed. LLMs' performance to achieve accurate CAD-RADS scores was evaluated with Cohen's kappa using expert-derived scores as the reference standard.

#### RESULTS

CAD-RADS categories were removed from 152 (30.4%) CCTA reports. ChatGPT showed good agreement with expert-derived scores with a Cohen's kappa of 0.67 (CI 0.62 - 0.72), and a significantly higher performance compared to Alpaca 7B and 13B (see figure). Alpaca 13B showed significantly higher performance compared to Alpaca 7B, with Cohen's kappa 0.44 (CI 0.40 - 0.49) vs. 0.23 (CI 0.19 - 0.28), respectively.

#### CONCLUSION

OpenAI's ChatGPT showed good performance in assigning CAD-RADS categories to unstructured coronary CTA reports while both locally run ALPACA models showed lower performance compared to ChatGPT, with the 13B model performing better than the 7B model.

#### CLINICAL RELEVANCE/APPLICATION

LLM-assisted CAD-RADS categorization without the need for extensive development or generation of training data enables rapid deployment in the setting of quality improvement, administrative analyses, billing, research, and report quality control and can accelerate the development of clinical NLP models. We also suspect this method could be useful for other reporting and data systems (RADS).

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## Abstract Archives of the RSNA, 2023

W3-SSIN05-5

### A Comparative Analysis of Modern Clinical NLP Tools From Amazon, Google, Azure, and John Snow Labs on Pediatric Radiology Reports

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S402

Shruti Hegde, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantify the differences in the performance of commercial clinical natural language processing (NLP) tools on pediatric radiology reports.

#### METHODS AND MATERIALS

Four commercial NLP systems for clinical electronic health record data, Amazon Comprehend Medical (AWS), Google Healthcare Natural Language API (GC), Azure Text analytics for Health (AZ), and John Snow Lab's spark NLP models for radiology reports (SP), were evaluated on 88,766 pediatric (Mean age:  $8 \pm 7.5$  years, Male/Female ratio: 1.2) radiology reports for chest radiography examinations. Clinical NLP systems performed four major tasks: named entity recognition, entity linking, relationship detection, and assertion detection. Uncertainty associated with entities extracted by each NLP task is reported as a probabilistic score (0 - 1). Anonymized reports were submitted as REST API queries for AWS, GC, and AZ; for SP, an academic license was used, and inference was performed locally on the radiology specific model. Outputs in JSON format were harmonized, and initial analysis focused on medical conditions, findings, diagnosis, symptoms, and diseases. Lemmatization and stemming were performed on extracted medical entities to standardize them between the four services and compared. The range of uncertainty scores reported by each system for pneumonia and atelectasis were quantified. Cosine similarity measures between each NLP service on all extracted medical entities are also calculated and reported.

#### RESULTS

Total (unique) medical entities detected by AWS, AZ, GC, and SP were 867,477 (25,670), 455,297 (11,574), 1,175,674 (29,566), and 972,151 (38,115), respectively. After stemming, 4,577 common entities remained. Mean (min-max) uncertainty scores for pneumonia extraction: AWS 0.986 (0.501-0.999), AZ 0.999 (0.599-0.999), GC 0.982 (0.550-1.0), SP 0.87 (0.325-0.987). For atelectasis, the scores were: AWS 0.874 (0.302-0.997), AZ 0.998 (0.513-0.999), GC 0.831(0.550-1.0), SP 0.917 (0.427-0.990). For cosine similarity, GC and SP was highest (0.83), AZ and SP were lowest (0.46).

#### CONCLUSION

Major differences in the extracted medical entities and the associated uncertainty scores for named entity recognition on pediatric CXR radiology reports were observed between 4 commercial clinical NLP services even after standardization of the outputs. Further analysis with manual oversight is required to understand the discrepancies between each system.

#### CLINICAL RELEVANCE/APPLICATION

As clinical NLP services are becoming mainstream and are playing an increasing role in both Radiology research and quality assurance/ improvement, it is important to understand the uncertainties associated with each service before they can be used for downstream tasks.

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## Abstract Archives of the RSNA, 2023

W3-SSIN05-6

### Comparative Performance of Artificial Intelligence Large Language Models on Diagnostic Radiology In-Training Exam

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S402

Christopher Kaufmann, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

There is limited and often unclear information on the accuracy and sources of publicly available AI tools such as ChatGPT, Bard, BingChat specifically related to radiology domains. While these tools are powerful search and assistive reference aids, in order for a radiologist to decide how, if at all, to utilize these assistive AI technologies, the output accuracy, relevance, and reliability needs to be better understood. This study attempts to compare the latest publicly accessible AI large language models (LLMs) across multiple subspecialty areas of radiology.

#### METHODS AND MATERIALS

The American College of Radiology Diagnostic In-Training Exam (ACR DXIT) practice test question set from July 2022 were filtered to exclude image-based questions (n=64 image dependent, n=42 image independent questions). The image independent questions were distributed across various radiology disciplines including breast, cardiothoracic, GI/GU, musculoskeletal, neuroradiology, nuclear, pediatrics, ultrasound, interventional and radiology physics. Three publicly available AI LLMs platforms (OpenAI ChatGPT 3.5 4.0, Google BARD, and Windows BingChat) were used to evaluate for correct answer responses to the input test questions. The questions were entered into the AI interface in their original text format without prompting or modification guidance, except for one instance which flagged a question answer word for "inappropriate content".

#### RESULTS

ChatGPT 4.0 answered 90.5% correctly (n=38 of 42) and ChatGPT 3.5 answered 79% of questions correctly (33 of 42). While overall improvement was noted using GPT4, 2 previously correct responses using GPT3.5 were outputted incorrectly using GPT4. Google Bard answered 71% correctly in which all 3 draft responses were correct (n=30 of 42). There were partially correct responses (lack of concordance across 3 output drafts) in 14% of Bard outputs (n=6 of 42). BingChat performed the lowest with 60% correct (n=25 of 42).

#### CONCLUSION

Performance of the latest ChatGPT4-0 on the image-independent ACR DXIT practice set questions was above 90% correct. The results demonstrate the powerful efficiency and improving accuracy of evolving publicly available AI tools when applied to the radiology specific domain. As LLMs evolve into more discipline specific AI support tools, determining the trustworthiness and up-to-date accuracy of these AI technologies will remain key criteria for their ultimate clinical adoption and use in practice.

#### CLINICAL RELEVANCE/APPLICATION

With the rapid, almost daily evolution of readily available AI technologies such as ChatGPT, Bard, or BingChat, determining their radiology-domain specific performance and output reliability is important for potential use in radiology practice.

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## Abstract Archives of the RSNA, 2023

W3-SSIN06

### Imaging Informatics (Bias, Anonymization and Cybersecurity)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S401

Martha G. Menchaca, MD, PhD (*Moderator*) Nothing to Disclose  
Joseph H. Yacoub, MD (*Moderator*) Stockholder, NVIDIA Corporation

#### Sub-Events

#### **W3-SSIN06-1 Identification and Mitigation of Bias in Multi-Modal Pulmonary Embolism Data to Improve Survival Analysis Prediction**

Shreyas Kulkarni, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Bias in healthcare unfairly impacts lower socioeconomic populations and can be baked into predictive modeling datasets. This is a problem in multimodal datasets where different biases can pool together. Our purpose is to develop a model that debiases multimodal Pulmonary Embolism (PE) datasets and to improve survival prediction (SP) over the current clinical standard of Pulmonary Embolism Severity Index (PESI).

#### **METHODS AND MATERIALS**

918 PE patients with 3978 CTPA images and 918 clinical reports were collected from 3 institutions including race, ethnicity, gender, survival time-to-event labels, and the 11 PESI variables. We built feature extraction networks using GatorTron to extract text features from clinical notes and PEnet to extract imaging features. We then developed 3 SP modules, each based on a single mode of data: PESI variables, clinical text features, and imaging features. For a multimodal prediction, the different outputs from the 3 SPs were integrated into a CoxPH. Each SP module contained a baseline and a debiased version. Debiasing used disentanglement learning to measure and mitigate bias. We then ran experiments to compare PESI predictions against our debiased multimodal SP model, evaluating within and debiasing 1 population bias factor: race (White or not White), Ethnicity (Latino or not Latino), or Gender (Male or Female). C-index was used to measure accuracy of survival predictions, with higher c-indexes meaning more accurate predictions.

#### **RESULTS**

Compared to PESI, our debiased multimodal SP had higher c-indexes and lower biases across all three potential population biases of race, ethnicity, and gender. Additionally, while PESI c-indexes showed great variations within population bias groups, our debiased SP achieved more consistent predictions within the groups. The Latino PESI c-index was 0.481 which was significantly lower than the non-Latino PESI c-index of 0.687, indicating PESI's poor prognostic value for Latino populations. After ethnicity debiasing, the debiased SP Latino c-index was 0.731 and 0.723 for non-Latino populations. A similar result occurred with gender disentanglement with a female PESI c-index of 0.529 and male PESI c-index of 0.739. Our gender debiased SP had a female c-index of 0.763 and a male c-index of 0.785.

#### **CONCLUSION**

Our results demonstrate that disentangling population bias in multimodal datasets is possible and improves SP. The debiased multimodal SP was also more accurate and equitable for populations relative to the standard of PESI.

#### **CLINICAL RELEVANCE/APPLICATION**

Our work demonstrates a method to minimize population biases in multimodal datasets while producing a debiasing SP model that is more equitable and accurate than the current clinical standard of PESI. We offer an improvement in equity.

#### **W3-SSIN06-2 Total Data in Radiology Exams Increase More than Appreciated by the Increase in Number of Exams**

Tomas Bjerner, MD, PhD (*Presenter*) Medical Advisory Board, Carestream Health, Inc

## PURPOSE

Scanners for radiological examinations can examine an increasing number of patients per time unit and generate increasing amounts of data per scanned patient. Most radiology departments follow their production in number of examinations and reports of increasing workload for radiologists are available in the literature. The increase in workload for radiologists can be assumed to, at least in part, depend on the number of studies read and the complexity of the studies. The complexity of studies might be related to the amount of data within them and in some countries, there are systems addressing the complexity of exams using relative value units (RVU). The aim of the present study is to estimate the development of the workload for radiologists over time including both number of examinations and complexity (approximated by the amount of stored data).

## METHODS AND MATERIALS

The total number of stored data, images, series and studies in the PACS database (Philips VuePACS 12.2.8, Best, the Netherlands) in a regional health care organization including a tertiary imaging center in Sweden for the years 2009-2022 were calculated. Data for CT and MR were used and only production from within the healthcare organization was included (imported studies from other hospitals were omitted). From these numbers the average size of a study could be calculated as well as the change of these parameters over time.

## RESULTS

Over the period 2009-2022 the number of CT studies increased by 87.2% equal to 4.9% per year. Over the same period, stored data for these studies increased more than 6 times (525%) or 15.1% per year. The number of images increased by 459% or 14.2% per year. This resulted in the average CT study increasing from 229 to 765MB (234%) during this time span. Over the same period the number of MR studies increased 101% equal to 5.5% per year. Over the same period, stored data for these studies increased more than 5 times (412%) or 13.4% per year. The number of images increased by 364% or 12.5% per year. This resulted in the average MR study increasing from 84.7 to 216MB (155%) during this time span.

## CONCLUSION

Over the period 2009-2022, the data in studies for radiologists to analyze increased 5-6 times while the number of studies only doubled. This was mainly due to the increased number of images in studies. This resulted in an increase in the workload for reading radiologists that is higher than when only the number of studies is considered.

## CLINICAL RELEVANCE/APPLICATION

Over the period 2009-2022, total data in exams for radiologists to analyze increased 5-6 times while the corresponding number of studies only doubled. This ratio is important when planning the workload in a radiology department.

## W3-SSIN06-3 The Comprehensive Open Federated Ecosystem (COFE): Enabling Impactful Healthcare Studies

Sarthak Pati, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

Robustness generalizability of artificial intelligent (AI) models is dependent on using ample diverse data. Data ownership legal hurdles hinder access to such data in the current paradigm of multi-site collaborations. To address these, we introduce the community-driven Comprehensive Open Federated Ecosystem (COFE), which intends to make distributed healthcare AI more accessible by leveraging zero/low code principles. COFE models get to learn across data silos using federated learning (FL) we assess their performance on diverse out-of-distribution datasets using federated evaluation (FE). As initial use-cases, COFE enabled the Federated Tumor Segmentation (FeTS) Initiative, which focused on the boundary detection of histologically-distinct brain tumor sub-compartments in MRI scans, the FeTS Challenge, the first FL-focused community benchmark.

## METHODS AND MATERIALS

We designed COFE to be agnostic to data type (imaging, EHR, genomics) the model to train. COFE offered an end-to-end solution to the FeTS initiative through 4 distinct modes of operation: data preprocessing, automatic tumor sub-compartment delineation by label fusion of pre-trained AI models, manual refinement of these delineations FL using the Linux Foundation's OpenFL. Additionally, building upon the collaborative network of the FeTS initiative we used MedPerf to conduct the FeTS Challenge, which followed a clinical trial design to evaluate AI methods on real-world conditions.

## RESULTS

In the FeTS Initiative, we observe an average improvement of 25% in the accuracy of the model on each collaborator's validation data when compared to a model trained on publicly available data. Notably, the difficult regions of the tumor showed the most improvement, with the most prominent being the region for surgical intervention, the tumor core, which improved by 33%. In the FeTS Challenge, inference-time data augmentation combined with post-processing yielded optimal results.



## CONCLUSION

Our findings on FeTS support that COFE enables training of a consensus AI model that has gained knowledge from data of geographically distinct collaborators, while the data of each collaborator are always retained within their institution, overcoming legal & ownership hurdles. At the same time, it can perform evaluations of pretrained models across completely out-of-distribution datasets to quantify the robustness & generalizability of the model.

## CLINICAL RELEVANCE/APPLICATION

Federated Learning allows training of AI models using diverse datasets without sharing the data, while Federated Evaluation allows AI models to be trained on true out-of-sample data. Combined, this would result in more robust models without raising ethical dilemmas.

### W3-SSIN06-4 **Anonymizing Radiographs and Making Them "AI Ready" Using a Deep Learning Algorithm**

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiographs play a crucial role in medical care by providing valuable information about a patient's anatomy and potential pathologies. Most radiographs contain radio-opaque markers that display information such as the side, positioning, radiographer initials, and often patient identifier. In this study, we develop a deep learning (DL) model that detects and selectively removes these markers from images to enable de-identified data sharing and improve the suitability of images for training robust deep learning models.

#### METHODS AND MATERIALS

To create our ground-truth dataset, we annotated 2000 pelvic radiographs collected between 2000 and 2021. Each marker area was annotated with a bounding box. The data was then split at the patient level into 60%/20%/20% for training, validation, and testing, respectively. Images were resampled to 512x512 pixels, and a YOLOv5-x model was trained to localize markers. Mean average precision at a 50% threshold (mAP-50) was reported as a measure of model performance on the test set. While removing identification markers is important, laterality markers contain valuable information that helps guide the pre-processing pipeline of deep learning models. We developed an image processing algorithm that examines each marker area and sends it to an OCR algorithm for characterization. In our case, laterality markers were retained if "R" and "L" characters were detected in the image (Figure 1). To externally validate the model, we applied it to chest radiographs from the validation set of the CheXpert dataset to assess its performance on data from different body parts and organizations.

#### RESULTS

The model reached a mAP-50 of 0.99 and 0.98 on the validation and internal test sets, respectively. It had a de-identification accuracy of 100% (400/400) on the test set, with a false-positive rate of 1% (8/632). The retention accuracy was 93% (359/386). On the external set of chest radiographs, the model successfully removed markers from 96% of radiographs (221/231). After fine-tuning on 20 CheXpert radiographs, the model was able to remove markers from 99.6% (230/231) of chest radiographs.

## CONCLUSION

We present a pipeline for de-identifying radiographs by selectively removing patient identifiers. This model can be easily refined to effectively detect radiographic markers on a wide variety of x-rays, demonstrating its generalizability.

## CLINICAL RELEVANCE/APPLICATION

Radiographic markers hinder data sharing and the development of public, multi-centric datasets and can introduce spectrum bias, which can lead to overfitting when training DL models. A robust de-identification algorithm capable of removing these markers could facilitate inter-institutional data sharing and more robust DL model training.

### W3-SSIN06-5 **Evaluating Radiologist Recall from Memory: A Data Protection Study on X-ray Image Re-identification**

Vanessa Wyrwoll, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To date there are no reliable measures for radiologist's re-identification rate in the literature. This study quantifies the rate at which experienced radiologists can re-identify chest radiographs from memory, and thus, the risk of an "accidental" reidentification when working with de-identified radiographic data sets.

#### METHODS AND MATERIALS

We conducted an online survey with 22 radiologists from the RACOON network, consisting of 38 university clinics. Readers had 3.9+-1.82 years of clinical experience on average. All participants created structured reports for chest radiographs of five different patients sequentially (phase 1). Each radiograph was assigned a pseudonym displayed alongside the image. 24

hours after completion of this task, participants were presented with ten different, randomly selected chest radiographs (phase 2). For half of the participants, these included a follow up study of one patient of phase 1. For each image, participants were asked to match a specific patient from phase 1 to the radiographs of phase 2.

## RESULTS

From 210 answers, 163 were correct with 0 true positives and 10 false positives. Readers took 8.9+-12.5 seconds to respond in phase 2, which had no correlation to accuracy (mean accuracy 77.6%). False positive rate (FPR) is greater than 0.141 ( $p=0.049$ ). The true positive rate (TPR) is less than to be expected by random input with weak evidence ( $p=0.144$ ). This illustrates that the probability of correctly identifying a patient in a set of pictures was less and the number of mistakenly recognized images has been greater than expected at random. Also, according to this study, the probability of a patient being incorrectly identified as the target patient ranges from 13% to 24.5% (95% CI).

## CONCLUSION

Readers falsely assumed patient reidentification in 17.6% of cases. Even for a moderately-sized pool of patients from which images might have been sampled, the reader cannot rule out misidentifications at a high level of confidence. For example, if candidate images have been sampled from a population the size of 80 million, the likelihood of a claimed match being correct would be 0.0000067%.

## CLINICAL RELEVANCE/APPLICATION

Provided that images with rare and distinctive anatomical features have been excluded, recollection from memory is not a relevant data privacy risk when dealing with large public data sets of radiographs that have been de-identified by DICOM header anonymization, even under the pessimistic assumption that the correct patient is part of the data set. If the population from which patients may have been sampled is sufficiently large, the large number of incorrectly identified patients renders the likelihood of a presumed identification being correct minute.

## W3-SSIN06-6 Safe Medical AI in Diagnostic Informatics: Defending Adversarial Attacks

Degan Hao, MS (*Presenter*) Intern, F. Hoffmann-La Roche Ltd

## PURPOSE

Deep learning-based computer aided diagnosis are being actively developed and evaluated for clinical translation and deployment, especially in the frontier of mammographic breast cancer diagnosis. Deep learning diagnosis models however are shown vulnerable to adversarial attacks - where adversarial data, i.e., data corrupted intentionally by small perturbations, can fool a deep learning model to produce misdiagnosis. This creates a threat to safely deploy deep learning models in clinical imaging informatics workflow. The purpose of this study is to develop and evaluate a novel technical framework to defend adversarial attacks in the context of a deep learning-based breast cancer diagnosis model.

## METHODS AND MATERIALS

In this IRB-approved study, we identified a dataset of 4,346 mammograms from a cohort of 1,284 women who underwent full-field digital mammography for breast cancer screening. We first built a diagnosis model using a VGG-16 network to classify breast cancer (366 biopsy-proven malignancy) vs. normal (918 negative cases). We evaluated two types of adversarial attacks: (1) white-box attack (attackers know about AI model parameters) where adversarial data were generated by the projected gradient descent method to insert adversarial noises to mammogram images, and (2) black-box attacks (attackers have no access to AI model parameters) where adversarial data were generated by intentionally inserting or removing tumorous tissue in mammograms. To defend the attacks, we designed a novel defense framework using the adversarial training strategy (i.e., enhanced model training using adversarial data), where we developed a regularization algorithm to facilitate learning adversarially robust features for classification and a label independent data augmentation to resolve the common issue of data leakage introduced by black-box data synthesis. We used five-fold cross validation to compare the AUC values of the proposed adversarial training vs. regular training without our method.

## RESULTS

The breast cancer diagnosis model has an AUC of 0.668 with regular training. Under white-box attack, the model's performance degrades to an AUC of 0.415, but our proposed framework brings the AUC to 0.673. Likewise, black-box attack downgrades the model to an AUC of 0.461 but our framework brings the AUC to 0.637.

## CONCLUSION

The proposed defending framework can make the breast cancer diagnosis model resilient to both white-box and black-box adversarial attacks.

## CLINICAL RELEVANCE/APPLICATION

In active efforts of deploying medical AI into clinical informatics workflow, our proposed method can effectively defend potential adversarial attacks, ensuring safe and secure use of AI for patient care.

## Abstract Archives of the RSNA, 2023

W3-SSIN06-1

### Identification and Mitigation of Bias in Multi-Modal Pulmonary Embolism Data to Improve Survival Analysis Prediction

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S401

Shreyas Kulkarni, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Bias in healthcare unfairly impacts lower socioeconomic populations and can be baked into predictive modeling datasets. This is a problem in multimodal datasets where different biases can pool together. Our purpose is to develop a model that debiases multimodal Pulmonary Embolism (PE) datasets and to improve survival prediction (SP) over the current clinical standard of Pulmonary Embolism Severity Index (PESI).

#### METHODS AND MATERIALS

918 PE patients with 3978 CTPA images and 918 clinical reports were collected from 3 institutions including race, ethnicity, gender, survival time-to-event labels, and the 11 PESI variables. We built feature extraction networks using GatorTron to extract text features from clinical notes and PENet to extract imaging features. We then developed 3 SP modules, each based on a single mode of data: PESI variables, clinical text features, and imaging features. For a multimodal prediction, the different outputs from the 3 SPs were integrated into a CoxPH. Each SP module contained a baseline and a debiased version. Debiasing used disentanglement learning to measure and mitigate bias. We then ran experiments to compare PESI predictions against our debiased multimodal SP model, evaluating within and debiasing 1 population bias factor: race (White or not White), Ethnicity (Latino or not Latino), or Gender (Male or Female). C-index was used to measure accuracy of survival predictions, with higher c-indexes meaning more accurate predictions.

#### RESULTS

Compared to PESI, our debiased multimodal SP had higher c-indexes and lower biases across all three potential population biases of race, ethnicity, and gender. Additionally, while PESI c-indexes showed great variations within population bias groups, our debiased SP achieved more consistent predictions within the groups. The Latino PESI c-index was 0.481 which was significantly lower than the non-Latino PESI c-index of 0.687, indicating PESI's poor prognostic value for Latino populations. After ethnicity debiasing, the debiased SP Latino c-index was 0.731 and 0.723 for non-Latino populations. A similar result occurred with gender disentanglement with a female PESI c-index of 0.529 and male PESI c-index of 0.739. Our gender debiased SP had a female c-index of 0.763 and a male c-index of 0.785.

#### CONCLUSION

Our results demonstrate that disentangling population bias in multimodal datasets is possible and improves SP. The debiased multimodal SP was also more accurate and equitable for populations relative to the standard of PESI.

#### CLINICAL RELEVANCE/APPLICATION

Our work demonstrates a method to minimize population biases in multimodal datasets while producing a debiasing SP model that is more equitable and accurate than the current clinical standard of PESI. We offer an improvement in equity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSIN06-2

### Total Data in Radiology Exams Increase More than Appreciated by the Increase in Number of Exams

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S401

Tomas Bjerner, MD, PhD (*Presenter*) Medical Advisory Board, Carestream Health, Inc

#### PURPOSE

Scanners for radiological examinations can examine an increasing number of patients per time unit and generate increasing amounts of data per scanned patient. Most radiology departments follow their production in number of examinations and reports of increasing workload for radiologists are available in the literature. The increase in workload for radiologists can be assumed to, at least in part, depend on the number of studies read and the complexity of the studies. The complexity of studies might be related to the amount of data within them and in some countries, there are systems addressing the complexity of exams using relative value units (RVU). The aim of the present study is to estimate the development of the workload for radiologists over time including both number of examinations and complexity (approximated by the amount of stored data).

#### METHODS AND MATERIALS

The total number of stored data, images, series and studies in the PACS database (Philips VuePACS 12.2.8, Best, the Netherlands) in a regional health care organization including a tertiary imaging center in Sweden for the years 2009-2022 were calculated. Data for CT and MR were used and only production from within the healthcare organization was included (imported studies from other hospitals were omitted). From these numbers the average size of a study could be calculated as well as the change of these parameters over time.

#### RESULTS

Over the period 2009-2022 the number of CT studies increased by 87.2% equal to 4.9% per year. Over the same period, stored data for these studies increased more than 6 times (525%) or 15.1% per year. The number of images increased by 459% or 14.2% per year. This resulted in the average CT study increasing from 229 to 765MB (234%) during this time span. Over the same period the number of MR studies increased 101% equal to 5.5% per year. Over the same period, stored data for these studies increased more than 5 times (412%) or 13.4% per year. The number of images increased by 364% or 12.5% per year. This resulted in the average MR study increasing from 84.7 to 216MB (155%) during this time span.

#### CONCLUSION

Over the period 2009-2022, the data in studies for radiologists to analyze increased 5-6 times while the number of studies only doubled. This was mainly due to the increased number of images in studies. This resulted in an increase in the workload for reading radiologists that is higher than when only the number of studies is considered.

#### CLINICAL RELEVANCE/APPLICATION

Over the period 2009-2022, total data in exams for radiologists to analyze increased 5-6 times while the corresponding number of studies only doubled. This ratio is important when planning the workload in a radiology department.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSIN06-3

### The Comprehensive Open Federated Ecosystem (COFE): Enabling Impactful Healthcare Studies

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S401

Sarthak Pati, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Robustness generalizability of artificial intelligent (AI) models is dependent on using ample diverse data. Data ownership legal hurdles hinder access to such data in the current paradigm of multi-site collaborations. To address these, we introduce the community-driven Comprehensive Open Federated Ecosystem (COFE), which intends to make distributed healthcare AI more accessible by leveraging zero/low code principles. COFE models get to learn across data silos using federated learning (FL) we assess their performance on diverse out-of-distribution datasets using federated evaluation (FE). As initial use-cases, COFE enabled the Federated Tumor Segmentation (FeTS) Initiative, which focused on the boundary detection of histologically-distinct brain tumor sub-compartments in MRI scans, the FeTS Challenge, the first FL-focused community benchmark.

#### METHODS AND MATERIALS

We designed COFE to be agnostic to data type (imaging, EHR, genomics) the model to train. COFE offered an end-to-end solution to the FeTS initiative through 4 distinct modes of operation: data preprocessing, automatic tumor sub-compartment delineation by label fusion of pre-trained AI models, manual refinement of these delineations FL using the Linux Foundation's OpenFL. Additionally, building upon the collaborative network of the FeTS initiative we used MedPerf to conduct the FeTS Challenge, which followed a clinical trial design to evaluate AI methods on real-world conditions.

#### RESULTS

In the FeTS Initiative, we observe an average improvement of 25% in the accuracy of the model on each collaborator's validation data when compared to a model trained on publicly available data. Notably, the difficult regions of the tumor showed the most improvement, with the most prominent being the region for surgical intervention, the tumor core, which improved by 33%. In the FeTS Challenge, inference-time data augmentation combined with post-processing yielded optimal results.

#### CONCLUSION

Our findings on FeTS support that COFE enables training of a consensus AI model that has gained knowledge from data of geographically distinct collaborators, while the data of each collaborator are always retained within their institution, overcoming legal & ownership hurdles. At the same time, it can perform evaluations of pretrained models across completely out-of-distribution datasets to quantify the robustness & generalizability of the model.

#### CLINICAL RELEVANCE/APPLICATION

Federated Learning allows training of AI models using diverse datasets without sharing the data, while Federated Evaluation allows AI models to be trained on true out-of-sample data. Combined, this would result in more robust models without raising ethical dilemmas.

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## Abstract Archives of the RSNA, 2023

W3-SSIN06-4

### Anonymizing Radiographs and Making Them "AI Ready" Using a Deep Learning Algorithm

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S401

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiographs play a crucial role in medical care by providing valuable information about a patient's anatomy and potential pathologies. Most radiographs contain radio-opaque markers that display information such as the side, positioning, radiographer initials, and often patient identifier. In this study, we develop a deep learning (DL) model that detects and selectively removes these markers from images to enable de-identified data sharing and improve the suitability of images for training robust deep learning models.

#### METHODS AND MATERIALS

To create our ground-truth dataset, we annotated 2000 pelvic radiographs collected between 2000 and 2021. Each marker area was annotated with a bounding box. The data was then split at the patient level into 60%/20%/20% for training, validation, and testing, respectively. Images were resampled to 512x512 pixels, and a YOLOv5-x model was trained to localize markers. Mean average precision at a 50% threshold (mAP-50) was reported as a measure of model performance on the test set. While removing identification markers is important, laterality markers contain valuable information that helps guide the pre-processing pipeline of deep learning models. We developed an image processing algorithm that examines each marker area and sends it to an OCR algorithm for characterization. In our case, laterality markers were retained if "R" and "L" characters were detected in the image (Figure 1). To externally validate the model, we applied it to chest radiographs from the validation set of the CheXpert dataset to assess its performance on data from different body parts and organizations.

#### RESULTS

The model reached a mAP-50 of 0.99 and 0.98 on the validation and internal test sets, respectively. It had a de-identification accuracy of 100% (400/400) on the test set, with a false-positive rate of 1% (8/632). The retention accuracy was 93% (359/386). On the external set of chest radiographs, the model successfully removed markers from 96% of radiographs (221/231). After fine-tuning on 20 CheXpert radiographs, the model was able to remove markers from 99.6% (230/231) of chest radiographs.

#### CONCLUSION

We present a pipeline for de-identifying radiographs by selectively removing patient identifiers. This model can be easily refined to effectively detect radiographic markers on a wide variety of x-rays, demonstrating its generalizability.

#### CLINICAL RELEVANCE/APPLICATION

Radiographic markers hinder data sharing and the development of public, multi-centric datasets and can introduce spectrum bias, which can lead to overfitting when training DL models. A robust de-identification algorithm capable of removing these markers could facilitate inter-institutional data sharing and more robust DL model training.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSIN06-5

### Evaluating Radiologist Recall from Memory: A Data Protection Study on X-ray Image Re-identification

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S401

Vanessa Wyrwoll, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To date there are no reliable measures for radiologist's re-identification rate in the literature. This study quantifies the rate at which experienced radiologists can re-identify chest radiographs from memory, and thus, the risk of an "accidental" reidentification when working with de-identified radiographic data sets.

#### METHODS AND MATERIALS

We conducted an online survey with 22 radiologists from the RACOON network, consisting of 38 university clinics. Readers had 3.9+-1.82 years of clinical experience on average. All participants created structured reports for chest radiographs of five different patients sequentially (phase 1). Each radiograph was assigned a pseudonym displayed alongside the image. 24 hours after completion of this task, participants were presented with ten different, randomly selected chest radiographs (phase 2). For half of the participants, these included a follow up study of one patient of phase 1. For each image, participants were asked to match a specific patient from phase 1 to the radiographs of phase 2.

#### RESULTS

From 210 answers, 163 were correct with 0 true positives and 10 false positives. Readers took 8.9+-12.5 seconds to respond in phase 2, which had no correlation to accuracy (mean accuracy 77.6%). False positive rate (FPR) is greater than 0.141 ( $p=0.049$ ). The true positive rate (TPR) is less than to be expected by random input with weak evidence ( $p=0.144$ ). This illustrates that the probability of correctly identifying a patient in a set of pictures was less and the number of mistakenly recognized images has been greater than expected at random. Also, according to this study, the probability of a patient being incorrectly identified as the target patient ranges from 13% to 24.5% (95% CI).

#### CONCLUSION

Readers falsely assumed patient reidentification in 17.6% of cases. Even for a moderately-sized pool of patients from which images might have been sampled, the reader cannot rule out misidentifications at a high level of confidence. For example, if candidate images have been sampled from a population the size of 80 million, the likelihood of a claimed match being correct would be 0.0000067%.

#### CLINICAL RELEVANCE/APPLICATION

Provided that images with rare and distinctive anatomical features have been excluded, recollection from memory is not a relevant data privacy risk when dealing with large public data sets of radiographs that have been de-identified by DICOM header anonymization, even under the pessimistic assumption that the correct patient is part of the data set. If the population from which patients may have been sampled is sufficiently large, the large number of incorrectly identified patients renders the likelihood of a presumed identification being correct minute.

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## Abstract Archives of the RSNA, 2023

W3-SSIN06-6

### Safe Medical AI in Diagnostic Informatics: Defending Adversarial Attacks

Wednesday, Nov. 29 9:30AM - 10:30AM Room: S401

Degan Hao, MS (*Presenter*) Intern, F. Hoffmann-La Roche Ltd

#### PURPOSE

Deep learning-based computer aided diagnosis are being actively developed and evaluated for clinical translation and deployment, especially in the frontier of mammographic breast cancer diagnosis. Deep learning diagnosis models however are shown vulnerable to adversarial attacks - where adversarial data, i.e., data corrupted intentionally by small perturbations, can fool a deep learning model to produce misdiagnosis. This creates a threat to safely deploy deep learning models in clinical imaging informatics workflow. The purpose of this study is to develop and evaluate a novel technical framework to defend adversarial attacks in the context of a deep learning-based breast cancer diagnosis model.

#### METHODS AND MATERIALS

In this IRB-approved study, we identified a dataset of 4,346 mammograms from a cohort of 1,284 women who underwent full-field digital mammography for breast cancer screening. We first built a diagnosis model using a VGG-16 network to classify breast cancer (366 biopsy-proven malignancy) vs. normal (918 negative cases). We evaluated two types of adversarial attacks: (1) white-box attack (attackers know about AI model parameters) where adversarial data were generated by the projected gradient descent method to insert adversarial noises to mammogram images, and (2) black-box attacks (attackers have no access to AI model parameters) where adversarial data were generated by intentionally inserting or removing tumorous tissue in mammograms. To defend the attacks, we designed a novel defense framework using the adversarial training strategy (i.e., enhanced model training using adversarial data), where we developed a regularization algorithm to facilitate learning adversarially robust features for classification and a label independent data augmentation to resolve the common issue of data leakage introduced by black-box data synthesis. We used five-fold cross validation to compare the AUC values of the proposed adversarial training vs. regular training without our method.

#### RESULTS

The breast cancer diagnosis model has an AUC of 0.668 with regular training. Under white-box attack, the model's performance degrades to an AUC of 0.415, but our proposed framework brings the AUC to 0.673. Likewise, black-box attack downgrades the model to an AUC of 0.461 but our framework brings the AUC to 0.637.

#### CONCLUSION

The proposed defending framework can make the breast cancer diagnosis model resilient to both white-box and black-box adversarial attacks.

#### CLINICAL RELEVANCE/APPLICATION

In active efforts of deploying medical AI into clinical informatics workflow, our proposed method can effectively defend potential adversarial attacks, ensuring safe and secure use of AI for patient care.

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## Abstract Archives of the RSNA, 2023

W3-SSMK08

### Musculoskeletal Imaging (Clinical and Applied Artificial Intelligence, Outcomes and Comparative Effectiveness)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450A

Kenneth A. Buckwalter, MD, MBA (*Moderator*) Nothing to Disclose

Elisabeth R. Garwood, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W3-SSMK08-1 Association Between Abdominal CT Measurements of Body Composition and Waitlist Mortality in Kidney Transplant Candidates

Omid Shafaat, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Body mass index (BMI) is often used to determine kidney transplant (KT) candidacy. However, this measure of body composition has several limitations including the inability to accurately capture dry weight in KT candidates undergoing dialysis. Objective CT-based measures of body composition may improve pre- KT risk stratification and capture physiologic aging more accurately. We quantified the association between three CT-based body composition measurements (sarcopenia, myosteatosis, and sarcopenic obesity) and waitlist mortality in KT candidates.

#### METHODS AND MATERIALS

We leveraged a prospective cohort of 828 KT candidates from 2010-2022 with clinically obtained CT scans that included the third lumbar vertebral level using adjusted competing risk regression. Body composition measurements, including skeletal muscle index (SMI) and skeletal muscle radiation attenuation (SM-RA) were obtained using OsiriX software by drawing a closed polygon and using the region of interest tool. Sarcopenia was defined as an SMI < 50 cm<sup>2</sup> /m<sup>2</sup> for males and an SMI < 39 cm<sup>2</sup> /m<sup>2</sup> for females. Myosteatosis was defined as an SM-RA < 41 mean HU for recipients with a BMI < 25 kg/m<sup>2</sup> and an SM-RA < 33 mean HU for recipients with a BMI = 25 kg/m<sup>2</sup>. Sarcopenic obesity was defined as a BMI = 30 kg/m<sup>2</sup> for sarcopenic recipients. Differences in characteristics were tested using Fisher's exact tests for categorical, ANOVA tests for normally distributed continuous, and Kruskal-Wallis tests for non-normally distributed continuous variables.

#### RESULTS

Among 828 KT candidates, 570 (68.8%) had myosteatosis, 352 (42.5%) had sarcopenia, and 94 (11.4%) had sarcopenic obesity. Sarcopenia (aSHR=1.04, 95%CI:0.74-1.47) and sarcopenic obesity (aSHR=1.28, 95%CI:0.83-2.04) were not associated with mortality. Patients with myosteatosis were at a 1.62-fold elevated risks of mortality (95%CI:1.07-2.45). When stratified by age, sarcopenic obesity (aSHR=2.21, 95%CI:1.28-3.83), and myosteatosis (aSHR=1.95, 95%CI:1.18-3.21) were associated with an elevated risk among candidates <65 years but not among those =65 years. Sarcopenic obesity was also associated with waitlist mortality among frail candidates (aHR=2.54, 95%CI:1.28-5.05).

#### CONCLUSION

Myosteatosis was associated with elevated risks of waitlist mortality in KT candidates. Furthermore, sarcopenic obesity was associated with elevated risks of waitlist mortality among younger KT candidates and among those who are frail.

#### CLINICAL RELEVANCE/APPLICATION

Clinicians should implement CT- based body composition measurements as a tool to improve risk prediction. Identifying high risk patients allows for ample time to implement early interventions such as prehabilitation.

#### W3-SSMK08-2 Bone Marrow Biopsies: Is CT, Fluoroscopy, or No Imaging Guidance the Most Cost-Effective Strategy

Madalena Da Silva Cardoso, MS, BA (*Presenter*) Nothing to Disclose

## PURPOSE

To determine the most cost-effective strategy for bone marrow biopsies.

## METHODS AND MATERIALS

A decision analytic model from the health care system perspective was used to evaluate the cost-effectiveness of three bone marrow biopsy techniques, no-imaging, CT guided, and fluoroscopy guided, for patients with high clinical concern for multiple myeloma. The time horizon used was 1 month to focus on the costs and impact on quality of life that this biopsy workflow has on this patient population. Model input data on utilities, costs, and probabilities were obtained from comprehensive literature review and expert opinion. Costs were estimated in 2023 U.S. dollars. Primary effectiveness outcome was quality adjusted life days (QALD).

## RESULTS

CT guided biopsy was the most cost-effective strategy as it was the most effective, 15.75 QALDs, had the highest net monetary benefit (NMB), \$4,095, and an incremental cost-effectiveness ratio (ICER) of \$169, below the willingness to pay threshold. Fluoroscopy guided biopsy was excluded by extended dominance as it had a higher ICER, \$294, than a strategy (CT) that produced more effectiveness (15.62 vs 15.75 QALDs). No imaging had the lowest effectiveness, 15.26 QALDs, and 2nd highest NMB, \$4,089. The model was sensitive to the probability of getting a diagnostic biopsy result for each of the three strategies. Probabilistic sensitivity analysis found CT guided biopsy to be the most cost-effective in 100% of simulations over a wide range of willingness to pay thresholds.

## CONCLUSION

CT guided biopsy appears to be the most cost-effective strategy for bone marrow biopsy in patients suspected of multiple myeloma.

## CLINICAL RELEVANCE/APPLICATION

While CT guidance appears to be the most cost-effectiveness biopsy strategy, consideration of resource availability and the impact that these biopsies have on overall CT scanner workflow and capacity should be considered when deciding on the best way to perform these biopsies.

## W3-SSMK08-3 Radiomics Analysis Based on CT for the Diagnosis of Ewing Sarcoma and Osteosarcoma

Ying Liu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to develop and validate radiomics models on the basis of computed tomography (CT) and clinical features for the diagnosis of Ewing sarcoma (ES) and Osteosarcoma(OS).

## METHODS AND MATERIALS

A total of 294 ES and OS patients from June 2009 to August 2022 were retrospectively involved in this study, and the patients enrolled before September 2019 were randomly divided into a train cohort (n=195) and a test cohort (n=49) according to a ratio of 8:2. Fifty patients (25 cases of OS, 25 cases of ES) in our hospital from September 2019 to August 2022 were defined as independent internal validation cohort. We manually segmented the tumor lesions along the tumor margins on CT-enhanced (CTE) images. The intralesional region and the intra-and perilesional regions of 3mm were defined as region of interest (ROIs) for the radiomics features analysis. The most valuable radiomics features for differential diagnosis of ES were selected using analysis of variance (ANOVA) and the least absolute shrinkage and selection operator (LASSO), and then the radiomics models (CTE and CTE+3mm models) and clinical-radiomics models (CTE\_clinical and CTE+3mm\_clinical models) were established. The performance of different models were evaluated by the area under the operating characteristic curve (AUC), accuracy (ACC), sensitivity, and specificity. The comparisons between AUCs of the radiomics models were conducted by using DeLong test.

## RESULTS

The AUC values of CTE and CTE+3mm models obtained by applying the Gaussian process (GP) classifier were higher than other models, and the AUC values were 0.907/0.903/0.912 and 0.896/0.898/0.891 in the train cohort, test cohort and internal validation cohort, respectively (The AUC values of CTE model using logistic regression [LR] classifier: 0.905, 0.877 and 0.899; the AUC values of CTE+3mm model using LR classifier: 0.876, 0.873 and 0.883). There was no statistically significant difference between the diagnostic effectiveness of the two models in the train cohort, test cohort and internal validation cohort ( $P>0.05$ ). There was no statistically significant difference between the AUC values of the clinical-radiomics models and radiomics models in the test cohort and internal validation cohort ( $P>0.05$ ).

## CONCLUSION

The radiomics models based on CT-enhanced images can be used for the differential diagnosis of ES and OS, and the diagnostic efficiency of the CTE+3mm model covering intra-tumoral and peritumoral features has not improved compared with the CTE model.

## CLINICAL RELEVANCE/APPLICATION

In summary, the CT based radiomics model could be an accurate auxiliary diagnostic tool for the differentiation of ES and OS, which may relatively improve the diagnostic efficiency of clinicians.

### W3-SSMK08-5 **Analysis of Shoulder Kinematics and Determination of Scapulohumeral Rhythm Using a Machine Learning Algorithm and Dynamic Digital Radiography Images**

John M. Sabol, PhD (*Presenter*) Employee, Konica Minolta, Inc

#### PURPOSE

Dynamic digital radiography (DDR) is a novel imaging technique that utilizes a pulsed x-ray source and rapid read-out detector to acquire radiographs at 6 or 15 Hz. DDR has been applied to several thoracic and musculoskeletal imaging applications. Although dynamic visualization of anatomy is useful to detect numerous pathologies, quantitative assessment of joint motion may improve sensitivity and specificity of DDR in diagnosis and evaluation of therapy response. Manual measurement suffers from inter- and intra-reader variability and is impractical given the large number of images. This studies purpose is to evaluate the performance of an Artificial Intelligence/Machine Learning (ML) algorithm to quantify scapulohumeral rhythm (SHR) and demonstrate proof of concept use the tool to differentiate multiple shoulder pathologies.

#### METHODS AND MATERIALS

A prototype ML algorithm using an HRNet classification architecture, an efficient approach for pose estimation, was trained on 447 images from 267 cases to recognize the humerus and scapula positions, calculate the scapulo-thoracic and gleno-humeral angles, and thus determine the SHR across the complete range of abduction. The performance of this algorithm was evaluated by comparison with manual human reader measurements on a unique dataset (not used for training or testing) of 73 shoulder exams (23 normal controls, 41 rotator cuff tears, 9 adhesive capsulitis, as determined by clinical exam and MRI). Two trained physician readers measured the SHR at 30-60, 60-90 and 30-90 degrees of glenohumeral motion. The AI and human measurements were compared using intra class correlations (ICC).

#### RESULTS

A total of 219 paired measurements were made by both the ML algorithm and manual physician methods. For SHR the inter-reader reliability was excellent between the two manual measurements (ICC 0.87 (95% CI 0.75-0.93)). Moderate reliability was observed between the manual and ML measurements of SHR. The SHR evaluated across the range of motion was shown to be an effective means of differentiating the pathologic shoulders from each other and the normal controls.

#### CONCLUSION

The prototype ML algorithm shows promise as a practical and efficient means to determine SHR and has potential to diagnose shoulder conditions by automated analysis of scapular and humeral kinematics. Further training using more specific anatomic landmarks and a larger dataset is required to improve the agreement with manual measurements of SHR.

## CLINICAL RELEVANCE/APPLICATION

Dynamic digital radiography enables dynamic assessment of shoulder kinematics and visualization of pathologic motion. ML quantitative assessment can automatically determine the SHR and has potential for efficient characterization of normal and pathologic motion.

### W3-SSMK08-6 **Identifying Patients at Risk for Bone Non-Union: Evaluation of Dual-Energy CT-derived Metrics in Distal Radius Fractures**

Leon D. Gruenewald, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Distal radius fractures (DRF) are among the most diagnosed fractures in emergency departments, and bone non-union is a significant complication that can lead to persistent pain and functional limitations. Despite the clinical implications, there is currently no established approach to identify patients at risk for bone non-union. The purpose of this study was to evaluate various metrics derived from routine CT scans of the distal radius to identify patients at risk of bone non-union.

#### METHODS AND MATERIALS

The distal radius of patients who underwent dual-energy CT (DECT) between 01/2016 and 08/2021 was retrospectively analysed. Cortical HU, trabecular HU, cortical thickness, and DECT-based bone mineral density (BMD) were obtained from all examinations. Patient files and follow-up images of patients were examined for the occurrence of bone non-union. Receiver-operating characteristic (ROC) analysis identified AUC values for BMD, HU values and cortical thickness, and logistic regression models were used to evaluate their associations with the occurrence of bone non-union.

## **RESULTS**

263 patients (median age, 52 years; interquartile range 36 - 64; 132 women; 192 fractures) were included in this study. ROC curve analysis demonstrated a significantly higher AUC value for DECT-derived BMD compared to cortical HU, trabecular HU and cortical thickness (0.83 vs. 0.63, 0.60 and 0.56, respectively;  $P < .01$ ). Logistic regression models confirmed a significant association of lower DECT-derived BMD with the occurrence of bone non-union (Odds Ratio, 0.93;  $P < .001$ ), but not of cortical HU, trabecular HU or cortical thickness ( $P > .05$  for all values, respectively).

## **CONCLUSION**

CT examinations of the distal radius obtained in clinical routine may serve as a useful tool in identifying patients at risk of developing bone non-union. In this context, dual-energy CT-derived bone mineral density is a better predictor of bone non-union compared to cortical HU, trabecular HU, and cortical thickness.

## **CLINICAL RELEVANCE/APPLICATION**

By using one or multiple of the suggested CT-metrics, ideally DECT-based BMD, radiologists could predict the likelihood of bone non-union in patients with distal radius fractures. This can help in determining the optimal treatment strategy and follow-up plan for patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSMK08-1

### Association Between Abdominal CT Measurements of Body Composition and Waitlist Mortality in Kidney Transplant Candidates

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450A

Omid Shafaat, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Body mass index (BMI) is often used to determine kidney transplant (KT) candidacy. However, this measure of body composition has several limitations including the inability to accurately capture dry weight in KT candidates undergoing dialysis. Objective CT-based measures of body composition may improve pre- KT risk stratification and capture physiologic aging more accurately. We quantified the association between three CT-based body composition measurements (sarcopenia, myosteotosis, and sarcopenic obesity) and waitlist mortality in KT candidates.

#### METHODS AND MATERIALS

We leveraged a prospective cohort of 828 KT candidates from 2010-2022 with clinically obtained CT scans that included the third lumbar vertebral level using adjusted competing risk regression. Body composition measurements, including skeletal muscle index (SMI) and skeletal muscle radiation attenuation (SM-RA) were obtained using OsiriX software by drawing a closed polygon and using the region of interest tool. Sarcopenia was defined as an SMI < 50 cm<sup>2</sup> /m<sup>2</sup> for males and an SMI < 39 cm<sup>2</sup> /m<sup>2</sup> for females. Myosteotosis was defined as an SM-RA < 41 mean HU for recipients with a BMI < 25 kg/m<sup>2</sup> and an SM-RA < 33 mean HU for recipients with a BMI = 25 kg/m<sup>2</sup>. Sarcopenic obesity was defined as a BMI = 30 kg/m<sup>2</sup> for sarcopenic recipients. Differences in characteristics were tested using Fisher's exact tests for categorical, ANOVA tests for normally distributed continuous, and Kruskal-Wallis tests for non-normally distributed continuous variables.

#### RESULTS

Among 828 KT candidates, 570 (68.8%) had myosteotosis, 352 (42.5%) had sarcopenia, and 94 (11.4%) had sarcopenic obesity. Sarcopenia (aSHR=1.04, 95%CI:0.74-1.47) and sarcopenic obesity (aSHR=1.28, 95%CI:0.83-2.04) were not associated with mortality. Patients with myosteotosis were at a 1.62-fold elevated risks of mortality (95%CI:1.07-2.45). When stratified by age, sarcopenic obesity (aSHR=2.21, 95%CI:1.28-3.83), and myosteotosis (aSHR=1.95, 95%CI:1.18-3.21) were associated with an elevated risk among candidates <65 years but not among those =65 years. Sarcopenic obesity was also associated with waitlist mortality among frail candidates (aHR=2.54, 95%CI:1.28-5.05).

#### CONCLUSION

Myosteotosis was associated with elevated risks of waitlist mortality in KT candidates. Furthermore, sarcopenic obesity was associated with elevated risks of waitlist mortality among younger KT candidates and among those who are frail.

#### CLINICAL RELEVANCE/APPLICATION

Clinicians should implement CT- based body composition measurements as a tool to improve risk prediction. Identifying high risk patients allows for ample time to implement early interventions such as prehabilitation.

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## Abstract Archives of the RSNA, 2023

W3-SSMK08-2

### **Bone Marrow Biopsies: Is CT, Fluoroscopy, or No Imaging Guidance the Most Cost-Effective Strategy**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450A

Madalena Da Silva Cardoso, MS, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the most cost-effective strategy for bone marrow biopsies.

#### **METHODS AND MATERIALS**

A decision analytic model from the health care system perspective was used to evaluate the cost-effectiveness of three bone marrow biopsy techniques, no-imaging, CT guided, and fluoroscopy guided, for patients with high clinical concern for multiple myeloma. The time horizon used was 1 month to focus on the costs and impact on quality of life that this biopsy workflow has on this patient population. Model input data on utilities, costs, and probabilities were obtained from comprehensive literature review and expert opinion. Costs were estimated in 2023 U.S. dollars. Primary effectiveness outcome was quality adjusted life days (QALD).

#### **RESULTS**

CT guided biopsy was the most cost-effective strategy as it was the most effective, 15.75 QALDs, had the highest net monetary benefit (NMB), \$4,095, and an incremental cost-effectiveness ratio (ICER) of \$169, below the willingness to pay threshold. Fluoroscopy guided biopsy was excluded by extended dominance as it had a higher ICER, \$294, than a strategy (CT) that produced more effectiveness (15.62 vs 15.75 QALDs). No imaging had the lowest effectiveness, 15.26 QALDs, and 2nd highest NMB, \$4,089. The model was sensitive to the probability of getting a diagnostic biopsy result for each of the three strategies. Probabilistic sensitivity analysis found CT guided biopsy to be the most cost-effective in 100% of simulations over a wide range of willingness to pay thresholds.

#### **CONCLUSION**

CT guided biopsy appears to be the most cost-effective strategy for bone marrow biopsy in patients suspected of multiple myeloma.

#### **CLINICAL RELEVANCE/APPLICATION**

While CT guidance appears to be the most cost-effectiveness biopsy strategy, consideration of resource availability and the impact that these biopsies have on overall CT scanner workflow and capacity should be considered when deciding on the best way to perform these biopsies.

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## Abstract Archives of the RSNA, 2023

W3-SSMK08-3

### Radiomics Analysis Based on CT for the Diagnosis of Ewing Sarcoma and Osteosarcoma

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450A

Ying Liu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to develop and validate radiomics models on the basis of computed tomography (CT) and clinical features for the diagnosis of Ewing sarcoma (ES) and Osteosarcoma(OS).

#### METHODS AND MATERIALS

A total of 294 ES and OS patients from June 2009 to August 2022 were retrospectively involved in this study, and the patients enrolled before September 2019 were randomly divided into a train cohort (n=195) and a test cohort (n=49) according to a ratio of 8:2. Fifty patients (25 cases of OS, 25 cases of ES) in our hospital from September 2019 to August 2022 were defined as independent internal validation cohort. We manually segmented the tumor lesions along the tumor margins on CT-enhanced (CTE) images. The intralesional region and the intra-and perilesional regions of 3mm were defined as region of interest (ROIs) for the radiomics features analysis. The most valuable radiomics features for differential diagnosis of ES were selected using analysis of variance (ANOVA) and the least absolute shrinkage and selection operator (LASSO), and then the radiomics models (CTE and CTE+3mm models) and clinical-radiomics models (CTE\_clinical and CTE+3mm\_clinical models) were established. The performance of different models were evaluated by the area under the operating characteristic curve (AUC), accuracy (ACC), sensitivity, and specificity. The comparisons between AUCs of the radiomics models were conducted by using DeLong test.

#### RESULTS

The AUC values of CTE and CTE+3mm models obtained by applying the Gaussian process (GP) classifier were higher than other models, and the AUC values were 0.907/0.903/0.912 and 0.896/0.898/0.891 in the train cohort, test cohort and internal validation cohort, respectively (The AUC values of CTE model using logistic regression [LR] classifier: 0.905, 0.877 and 0.899; the AUC values of CTE+3mm model using LR classifier: 0.876, 0.873 and 0.883). There was no statistically significant difference between the diagnostic effectiveness of the two models in the train cohort, test cohort and internal validation cohort ( $P>0.05$ ). There was no statistically significant difference between the AUC values of the clinical-radiomics models and radiomics models in the test cohort and internal validation cohort ( $P>0.05$ ).

#### CONCLUSION

The radiomics models based on CT-enhanced images can be used for the differential diagnosis of ES and OS, and the diagnostic efficiency of the CTE+<sub>3mm</sub> model covering intra-tumoral and peritumoral features has not improved compared with the CTE model.

#### CLINICAL RELEVANCE/APPLICATION

In summary, the CT based radiomics model could be an accurate auxiliary diagnostic tool for the differentiation of ES and OS, which may relatively improve the diagnostic efficiency of clinicians.

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## Abstract Archives of the RSNA, 2023

W3-SSMK08-5

### Analysis of Shoulder Kinematics and Determination of Scapulothoracic Rhythm Using a Machine Learning Algorithm and Dynamic Digital Radiography Images

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450A

John M. Sabol, PhD (*Presenter*) Employee, Konica Minolta, Inc

#### PURPOSE

Dynamic digital radiography (DDR) is a novel imaging technique that utilizes a pulsed x-ray source and rapid read-out detector to acquire radiographs at 6 or 15 Hz. DDR has been applied to several thoracic and musculoskeletal imaging applications. Although dynamic visualization of anatomy is useful to detect numerous pathologies, quantitative assessment of joint motion may improve sensitivity and specificity of DDR in diagnosis and evaluation of therapy response. Manual measurement suffers from inter- and intra-reader variability and is impractical given the large number of images. This study's purpose is to evaluate the performance of an Artificial Intelligence/Machine Learning (ML) algorithm to quantify scapulothoracic rhythm (SHR) and demonstrate proof of concept use of the tool to differentiate multiple shoulder pathologies.

#### METHODS AND MATERIALS

A prototype ML algorithm using an HRNet classification architecture, an efficient approach for pose estimation, was trained on 447 images from 267 cases to recognize the humerus and scapula positions, calculate the scapulothoracic and glenohumeral angles, and thus determine the SHR across the complete range of abduction. The performance of this algorithm was evaluated by comparison with manual human reader measurements on a unique dataset (not used for training or testing) of 73 shoulder exams (23 normal controls, 41 rotator cuff tears, 9 adhesive capsulitis, as determined by clinical exam and MRI). Two trained physician readers measured the SHR at 30-60, 60-90 and 30-90 degrees of glenohumeral motion. The AI and human measurements were compared using intra class correlations (ICC).

#### RESULTS

A total of 219 paired measurements were made by both the ML algorithm and manual physician methods. For SHR the inter-reader reliability was excellent between the two manual measurements (ICC 0.87 (95% CI 0.75-0.93)). Moderate reliability was observed between the manual and ML measurements of SHR. The SHR evaluated across the range of motion was shown to be an effective means of differentiating the pathologic shoulders from each other and the normal controls.

#### CONCLUSION

The prototype ML algorithm shows promise as a practical and efficient means to determine SHR and has potential to diagnose shoulder conditions by automated analysis of scapular and humeral kinematics. Further training using more specific anatomic landmarks and a larger dataset is required to improve the agreement with manual measurements of SHR.

#### CLINICAL RELEVANCE/APPLICATION

Dynamic digital radiography enables dynamic assessment of shoulder kinematics and visualization of pathologic motion. ML quantitative assessment can automatically determine the SHR and has potential for efficient characterization of normal and pathologic motion.

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## Abstract Archives of the RSNA, 2023

W3-SSMK08-6

### Identifying Patients at Risk for Bone Non-Union: Evaluation of Dual-Energy CT-derived Metrics in Distal Radius Fractures

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E450A

Leon D. Gruenewald, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Distal radius fractures (DRF) are among the most diagnosed fractures in emergency departments, and bone non-union is a significant complication that can lead to persistent pain and functional limitations. Despite the clinical implications, there is currently no established approach to identify patients at risk for bone non-union. The purpose of this study was to evaluate various metrics derived from routine CT scans of the distal radius to identify patients at risk of bone non-union.

#### METHODS AND MATERIALS

The distal radius of patients who underwent dual-energy CT (DECT) between 01/2016 and 08/2021 was retrospectively analysed. Cortical HU, trabecular HU, cortical thickness, and DECT-based bone mineral density (BMD) were obtained from all examinations. Patient files and follow-up images of patients were examined for the occurrence of bone non-union. Receiver-operating characteristic (ROC) analysis identified AUC values for BMD, HU values and cortical thickness, and logistic regression models were used to evaluate their associations with the occurrence of bone non-union.

#### RESULTS

263 patients (median age, 52 years; interquartile range 36 - 64; 132 women; 192 fractures) were included in this study. ROC curve analysis demonstrated a significantly higher AUC value for DECT-derived BMD compared to cortical HU, trabecular HU and cortical thickness (0.83 vs. 0.63, 0.60 and 0.56, respectively;  $P < .01$ ). Logistic regression models confirmed a significant association of lower DECT-derived BMD with the occurrence of bone non-union (Odds Ratio, 0.93;  $P < .001$ ), but not of cortical HU, trabecular HU or cortical thickness ( $P > .05$  for all values, respectively).

#### CONCLUSION

CT examinations of the distal radius obtained in clinical routine may serve as a useful tool in identifying patients at risk of developing bone non-union. In this context, dual-energy CT-derived bone mineral density is a better predictor of bone non-union compared to cortical HU, trabecular HU, and cortical thickness.

#### CLINICAL RELEVANCE/APPLICATION

By using one or multiple of the suggested CT-metrics, ideally DECT-based BMD, radiologists could predict the likelihood of bone non-union in patients with distal radius fractures. This can help in determining the optimal treatment strategy and follow-up plan for patients.

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## Abstract Archives of the RSNA, 2023

W3-SSNR10

### Neuroradiology (Techniques and Methods: AI for Image Acquisition)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353C

Sumit N. Niogi, MD, PhD (*Moderator*) Nothing to Disclose  
Charles H. Li, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W3-SSNR10-1 Prospective Validation of Accelerated Brain MRI Using Deep Learning-Based Reconstruction: Simultaneous Application to Spin-Echo and Gradient-Echo Sequence**

Kyu Sung Choi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the effectiveness of brain MRI with deep learning-based fast reconstructed MRI (DL-FR) by comparing qualitative and quantitative image quality of conventional MRI for both spin-echo and gradient-echo sequences.

#### METHODS AND MATERIALS

In this multi-reader, multi-sequence, and multi-vendor prospective study, both synthetic and conventional MRI pairs with T1-weighted, T2-weighted, T2-FLAIR, and 3D T1-weighted images from 100 subjects (29 males; 57.3±16.0 years; 34 subjects with GE, 35 with Philips, and 31 with Siemens), were examined by 4 blinded neuroradiologists. The images were randomized, and evaluated for overall image quality, delineation of structures, and artifacts using 5-point Likert scale, in the two separate sessions. Intraclass correlation coefficient was calculated for Inter-reader agreement. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) was obtained for both 3D T1w and T2 FLAIR. For quantitative analysis, volumetric analysis of brain parcellation and white matter T2 hyperintensity (WMH) was performed using LesionQuant (LQ) and NeuroQuant (NQ), respectively.

#### RESULTS

DL-FR showed median 41% (24-51%) reduced acquisition time with improvements in overall image quality (mean±SD, 3.79±0.72 vs. 3.40±0.63,  $p<0.001$ ); and enhanced structure delineation (3.59±0.81 vs. 3.45±0.77,  $p<0.001$ ), while lesion conspicuity (3.34±1.05 vs. 3.26±1.08,  $p=0.32$ ), Fazekas scale (2.24±1.40 vs 2.18±1.40,  $p=0.37$ ), enlarged perivascular space grading (1.93±1.21 vs 1.90±1.20,  $p=0.65$ ), and image artifacts (3.78±0.73 vs. 3.79±0.69,  $p=0.47$ ) was comparable. Inter-reader agreement was moderate to substantial ( $\kappa=0.74$  for structure and lesion delineation;  $\kappa=0.52$  for artifact; and  $\kappa=0.55$  for overall quality), indicating reliable qualitative assessments. SNR and CNR was increased compared to conventional MRI (82.0±23.1 vs 31.4±10.8,  $p=0.02$ ; and 12.4±4.1 vs 4.4±11.2,  $p=0.02$ ). In the volumetric analysis, no significant differences were observed in 1253 out of 1276 (98.2%) regional volumes ( $r=0.92\pm0.10$ , range 0.38-1.00), with the exception of the deep gray matter including thalamus. Additionally, 5 out of 6 (83.3%) lesion categories showed no significant differences, except for juxtacortical lesion counts ( $r=0.64\pm0.29$ , range 0.12-0.92).

#### CONCLUSION

Deep learning-based fast reconstruction significantly improves the efficiency and quality of brain MRI in both spin-echo and gradient-echo sequences without compromising lesion detection and quantitative volumetric analysis.

#### CLINICAL RELEVANCE/APPLICATION

Enhanced image quality and reduced acquisition time provided by deep learning-based fast reconstruction may facilitate better diagnostics at lower healthcare costs.

#### **W3-SSNR10-2 DICOM-based Deep Learning Generated Synthetic STIR Spine Images are Interchangeable with and Offer Better Quality than Conventional STIR MR Scans**

Lawrence Neil N. Tanenbaum, MD, FACR (*Presenter*) Speaker, General Electric Company; Speaker, Siemens AG; Speaker, Guerbet SA; Speaker, Koninklijke Philips NV; Consultant, icoMetrix NV; Consultant, Subtle Medical, Inc; Consultant,

## PURPOSE

Purpose Deep learning (DL) image reconstruction allows faster MR acquisitions while matching or exceeding standard of care (SOC) and can create synthetic images from existing data sets. This multicenter, multi-reader spine study evaluated the performance of synthetically created STIR (Syn-STIR) compared to acquired STIR (Acq-STIR).

## METHODS AND MATERIALS

Material Methods From a multicenter, multi-scanner database of 328 clinical cases, a non-reader neuroradiologist randomly selected 110 spine MRI studies in 93 patients (sagittal T1, T2, STIR) and classified into five categories of disease and normal. A DICOM-based DL application generated a Syn-STIR series from the Sag T1 and T2. Five radiologists (3 neuro, 1 MSK, 1 generalist) rated STIR quality and classified disease pathology (study 1, n=80). They then assessed the presence or absence of findings typically evaluated with STIR in patients with trauma (study 2, n=30). The readers evaluated studies with either Acq-STIR or Syn-STIR in a blinded and randomized fashion with a 1-month washout period. Interchangeability of Acq-STIR and Syn-STIR was assessed using a non-inferiority threshold of 10%.

## RESULTS

Results For classification, there was a decrease in inter-reader agreement expected by randomly introducing Syn-STIR of 3.23%. For trauma, there was an overall increase in inter-reader agreement by +1.9%. The lower bound of confidence for both exceeded the non-inferiority threshold, indicating interchangeability of Syn-STIR with Acq-STIR. Both Wilcoxon signed-rank and t-test showed higher IQ scores for Syn-STIR over Acq-STIR ( $P < 0.0001$ ).

## CONCLUSION

Conclusion Syn-STIR spine MR images were diagnostically interchangeable with Acq-STIR, while providing significantly higher image quality, suggesting routine clinical practice potential.

## CLINICAL RELEVANCE/APPLICATION

Clinical relevance DL generated synthetic STIR spine MR images were interchangeable with a conventionally acquired STIR, while providing significantly higher image quality, suggesting the potential to replace them in clinical practice, the reducing overall scan times and enhancing the patient experience.

## W3-SSNR10-3 Deep-Learning Based Contrast Boosting Improves Lesion Visualization and Image Quality: A Multi-Reader Study on Diagnostically Interchangeability with Standard Contrast Enhanced MRI of Brain Tumors

Srivathsa P. Venkata, MSc (*Presenter*) Employee, Subtle Medical, Inc; Stockholder, Subtle Medical, Inc

## PURPOSE

Higher Gadolinium contrast doses in brain tumor imaging can increase lesion sensitivity, but larger doses elevate safety concerns. Here, we evaluate the clinical performance of a deep learning (DL) based method for boosting contrast, without increasing dose, relative to standard-dose images in a multireader study.

## METHODS AND MATERIALS

We analyzed data from 40 patients ( $63 \pm 14$  years, 20 female) undergoing brain MRI with contrast. Contrast boosted (CB) images were generated using pre-contrast standard post-contrast (SC) 3D T1w images as input (Fig 1A). Three readers (board-certified radiologists with 9, 15, 18 years of experience) were presented 100 cases in a blinded randomized fashion. Each case contained a pre-contrast T1w image and either a SC (N=40) or CB image (N=40). 20 cases were repeated. Readers made a diagnostic classification (Dx) (6 classes: glioma, meningioma, lymphoma, metastasis, other tumor, or none) and rated post-contrast images for lesion enhancement, border delineation, internal morphology, vessel conspicuity, and overall image quality (IQ) using a 5-point Likert scale. Inter- intra-reader variability (RV) was assessed using Cohen's Kappa intraclass correlation coefficients. Wilcoxon signed rank tests were conducted on qualitative measures to compare SC and CB images. We assessed whether images were diagnostically interchangeable (DI) by the decrease in inter-RV when comparing SC vs CB to SC alone (10% limit for non-inferiority testing). Quantitative metrics (lesion-to-brain ratio - LBR and contrast enhancement % - CEP) were computed on SC CB with respect to the pre-contrast.

## RESULTS

CB images were rated higher than SC for lesion enhancement, delineation, morphology and IQ (Fig 1B, all  $p < 0.005$ ). Vessel conspicuity was rated as being unlikely to affect Dx in a lower % of CB images (82% vs 93%). Fig 1C visualizes some examples. Inter-RV for Dx was similar for paired SC CB (0.523 vs 0.475), or when comparing SC to CB images (0.496). Intra-RV increased for CB over SC (0.969 vs 0.844). The decrease in inter-RV when interchanging SC with CB was 5.2% (CI: [-5.7%, 9.6%]; 1000 bootstrapped samples) and SC CB were considered DI (non-inferiority test,  $p = 0.02$ , Fig 1D). LBR CEP for CB ( $5.22 \pm 1.43$  89.95%) were significantly better ( $p < 0.0001$ ) than those of SC ( $3.78 \pm 0.90$  185.10%).

## CONCLUSION

This study establishes that CB images have superior qualitative perception for lesion features and IQ, and are DI with SC images for tumor categorization. Future studies will evaluate CB performance on more contrast sensitive tasks.

## CLINICAL RELEVANCE/APPLICATION

DL-synthesized contrast boosted images offer better visualization of pathology and have interchangeable diagnostic performance with standard contrast images for tumor categorization.

### W3-SSNR10-4 **A Generative Adversarial Network Approach for Low-Field to High-Field Image Translation**

Alfredo Lucas, BS, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Portable low-field strength (64mT) MRI scanners promise to increase access to neuroimaging for clinical and research purposes but produce images of lower quality and resolution compared to high field strength scanners. In this study, we developed and evaluated a deep learning method to generate high-field quality brain images from low-field inputs using a paired dataset of multiple sclerosis (MS) patients scanned at 64mT and 3T.

## METHODS AND MATERIALS

A total of 65 MS patients were scanned on portable 64mT (Hyperfine) and standard 3T scanners (Siemens) at Penn or NIH with T1, T2 and FLAIR acquisitions at both field strengths. Using 32/65 patients, we trained a generative adversarial network (GAN) architecture for low to high field image super resolution and translation that consisted of two main parts. The first half consists of 3 pix2pix layers in parallel, each trained on a different orthogonal imaging plane with T1, T2, and FLAIR images as input channels. The second half consists of a 3D patch-based U-Net that combines the parallel outputs from the first half into a cohesive volume. We used the 33 remaining subjects as out-of-sample test subjects.

## RESULTS

All presented results reflect out-of-sample test subjects. Reconstructed high-field output images demonstrated visually superior quality than low-field input images. Quantitatively, reconstructed outputs had significantly higher structural similarity (SSIM) to paired high-field images than input low-field images across T1 (pFDR=0.006), FLAIR (pFDR=0.03), and T2 (pFDR=0.024) contrasts. Measuring thalamic volumes, a clinically relevant MS biomarker, using a state-of-the-art segmentation pipeline (SynthSeg), our reconstructed outputs outperformed another published super resolution algorithm (SynthSR) in producing results approximating 3T and correcting undersegmentation seen at 64mT. Total MS lesion volume based on automated segmentation (MiMOSA) in our reconstructed outputs was better correlated (Spearman's Rho = 0.65) with high-field volumes, than original low-field volumes (Spearman's Rho = 0.55). MS lesions also appeared more conspicuous in our reconstructed outputs than original input images.

## CONCLUSION

Our generative adversarial network approach for low-field to high-field super resolution generates synthetic high-field images that have comparable visual and quantitative quality, regional volumetry, and lesion burden, as their paired high-field counterparts.

## CLINICAL RELEVANCE/APPLICATION

Enhancing portable low-field MRI image quality can boost clinician confidence, leading to wider adoption of these affordable, accessible technologies, benefiting patients who may not have had access to MR imaging before.

### W3-SSNR10-5 **Development of Paired-CycleGAN-based Deep Learning Algorithm for MRI Harmonization: Validation in Follow-up MRI Evaluation in Post-treatment Glioma Patients**

Roh-Eul Yoo, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop a paired CycleGAN-based deep learning algorithm for MRI harmonization and to validate its utility on follow-up MRI evaluation in post-treatment glioma patients

## METHODS AND MATERIALS

This retrospective study included 184 datasets from 64 post-treatment glioma patients from January 2006 to September 2020, who showed no significant change in MRI readings during 3 follow-up (FU) examinations with the second MRI taken at a different MRI vendor. The data were randomly split into the training and validation sets in a 8:2 ratio. Paired-CycleGAN was trained to generate harmonized second FU MRI images with the similar image impression as the baseline MRI images. Unlike traditional CycleGAN, we modulated the model to learn head-to-head images containing slices at the same position in a different domain. We trained the proposed model with two training metrics, structural similarity index measure (SSIM) and learned perceptual image patch similarity (LPIPS). The mean and standard deviation of intensity values, contrast-to-noise

ratios (CNR) of gray matter (GM) and white matter (WM), and 3D SSIM score were used to assess the harmonized images in the validation set. A five-point diagnostic confidence scale and the presence of change in lesion characteristics (border, size, contrast, internal morphology) were evaluated by a blinded reader.

## RESULTS

As the training progressed, LPIPS score typically decreased, while SSIM score increased. The changes in 3D SSIM score between the baseline and harmonized FU images were higher than those between the baseline and original FU images (0.87 vs. 0.82,  $P < .001$  [Siemens to Philips]; 0.89 vs. 0.83 [Philips to Siemens],  $P < .001$ ). Differences compared to baseline in the mean and standard deviation of intensity values and CNR of GM and WM were lower in the harmonized FU images than in original FU images (All  $P < .001$ ). In the reader evaluation study, more cases were read to be not changed on harmonized FU images and the diagnostic confidence was significantly higher with harmonized FU images than with original FU images ( $4.8 \pm 0.4$  vs.  $4.4 \pm 0.6$ ,  $P < .001$ ).

## CONCLUSION

A paired CycleGAN-based deep learning algorithm showed good performance in MRI harmonization and resulted in increased diagnostic confidence in follow-up MRI evaluation in post-treatment glioma patients.

## CLINICAL RELEVANCE/APPLICATION

Glioma patients often undergo follow-up MRI examinations after standard treatment in different scanners due to limited MR resources; our paired-CycleGAN-based MRI harmonization technique may increase the diagnostic confidence in follow-up MRI evaluation in post-treatment glioma patients in such clinical setting.

## W3-SSNR10-6 The Relaxation Normalized Proton Transfer Rate MRAPTR in the Evaluation of pH Changes of the Acute Cerebral Infarction

Jianzhong Yin, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Amide proton transfer (APT) imaging is sensitive to intracellular pH and has shown great potential for the evaluation of cerebral strokes. The relaxation normalized proton transfer rate MRAPTR has shown improved quantification of pH contrast. This study aimed to explore the different abilities between the relaxation normalized proton transfer rate MRAPTR and the routine MTR<sub>asym</sub> metrics for evaluating acute strokes.

## METHODS AND MATERIALS

6 normal subjects and 106 patients with ischemic stroke were enrolled. All patients underwent an MRI examination including T1WI, T2WI, DWI, and APTw imaging. The magnetization transfer ratio asymmetry (MTR<sub>asym</sub>) and magnetization transfer and relaxation normalized proton transfer rate (MRAPTR) were analyzed. The interobserver and repeatability of the APT(w) signal were assessed by ICCs. The Mann-Whitney U tests were used to compare the difference between infarction lesions and contralateral normal regions of different APTw metrics. The receiver operating characteristic curve (ROC) analysis was used to evaluate the diagnostic efficiency of MTR<sub>asym</sub> and MRAPTR for infarction. The reverse rate of MTR<sub>asym</sub> and MRAPTR was also compared by the ANOVA test.

## RESULTS

The ICCs of MRAPTR were similar to those of MTR<sub>asym</sub> for the interobserver agreement and intersite reliability analysis. But MRAPTR value was closer to the baseline than MTR<sub>asym</sub>, and the data distribution was more centralized. The APTw metric maps showed a decreased MTR<sub>asym</sub> and MRAPTR, which implied an acidosis and decreased proton exchange in the infarction lesions. The MTR<sub>asym</sub> and MRAPTR at the infarction lesions showed obviously differences toward contralateral normal regions ( $P = 0.001$  and  $< 0.001$ , respectively). But APTw metrics at the infarction lesions were elevated in some cases, which implied a reversal of the APT results. MRAPTR showed a significantly decreased reverse rate of the infarction lesions compared to the MTR<sub>asym</sub> (24.5% and 2.8%, respectively). MRAPTR had better efficiency than MTR<sub>asym</sub> in reflecting acute ischemic lesions.

## CONCLUSION

APTw metrics exhibited similar repeatability in this study, but MRAPTR was more stable than MTR<sub>asym</sub>. Both APTw metrics could reflect ischemic lesions and MRAPTR had better efficiency than MTR<sub>asym</sub>.

## CLINICAL RELEVANCE/APPLICATION

These results demonstrated that pH-weighted imaging could reveal acidosis in patients with acute ischemic stroke.

## Abstract Archives of the RSNA, 2023

W3-SSNR10-1

### Prospective Validation of Accelerated Brain MRI Using Deep Learning-Based Reconstruction: Simultaneous Application to Spin-Echo and Gradient-Echo Sequence

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353C

Kyu Sung Choi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the effectiveness of brain MRI with deep learning-based fast reconstructed MRI (DL-FR) by comparing qualitative and quantitative image quality of conventional MRI for both spin-echo and gradient-echo sequences.

#### METHODS AND MATERIALS

In this multi-reader, multi-sequence, and multi-vendor prospective study, both synthetic and conventional MRI pairs with T1-weighted, T2-weighted, T2-FLAIR, and 3D T1-weighted images from 100 subjects (29 males; 57.3±16.0 years; 34 subjects with GE, 35 with Philips, and 31 with Siemens), were examined by 4 blinded neuroradiologists. The images were randomized, and evaluated for overall image quality, delineation of structures, and artifacts using 5-point Likert scale, in the two separate sessions. Intraclass correlation coefficient was calculated for Inter-reader agreement. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) was obtained for both 3D T1w and T2 FLAIR. For quantitative analysis, volumetric analysis of brain parcellation and white matter T2 hyperintensity (WMH) was performed using LesionQuant (LQ) and NeuroQuant (NQ), respectively.

#### RESULTS

DL-FR showed median 41% (24-51%) reduced acquisition time with improvements in overall image quality (mean±SD, 3.79±0.72 vs. 3.40±0.63,  $p<0.001$ ); and enhanced structure delineation (3.59±0.81 vs. 3.45±0.77,  $p<0.001$ ), while lesion conspicuity (3.34±1.05 vs. 3.26±1.08,  $p=0.32$ ), Fazekas scale (2.24±1.40 vs 2.18±1.40,  $p=0.37$ ), enlarged perivascular space grading (1.93±1.21 vs 1.90±1.20,  $p=0.65$ ), and image artifacts (3.78±0.73 vs. 3.79±0.69,  $p=0.47$ ) was comparable. Inter-reader agreement was moderate to substantial ( $\kappa=0.74$  for structure and lesion delineation;  $\kappa=0.52$  for artifact; and  $\kappa=0.55$  for overall quality), indicating reliable qualitative assessments. SNR and CNR was increased compared to conventional MRI (82.0±23.1 vs 31.4±10.8,  $p=0.02$ ; and 12.4±4.1 vs 4.4±11.2,  $p=0.02$ ). In the volumetric analysis, no significant differences were observed in 1253 out of 1276 (98.2%) regional volumes ( $r=0.92\pm0.10$ , range 0.38-1.00), with the exception of the deep gray matter including thalamus. Additionally, 5 out of 6 (83.3%) lesion categories showed no significant differences, except for juxtacortical lesion counts ( $r=0.64\pm0.29$ , range 0.12-0.92).

#### CONCLUSION

Deep learning-based fast reconstruction significantly improves the efficiency and quality of brain MRI in both spin-echo and gradient-echo sequences without compromising lesion detection and quantitative volumetric analysis.

#### CLINICAL RELEVANCE/APPLICATION

Enhanced image quality and reduced acquisition time provided by deep learning-based fast reconstruction may facilitate better diagnostics at lower healthcare costs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-SSNR10-2

### **DICOM-based Deep Learning Generated Synthetic STIR Spine Images are Interchangeable with and Offer Better Quality than Conventional STIR MR Scans**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353C

Lawrence Neil N. Tanenbaum, MD, FACR (*Presenter*) Speaker, General Electric Company; Speaker, Siemens AG; Speaker, Guerbet SA; Speaker, Koninklijke Philips NV; Consultant, icoMetrix NV; Consultant, Subtle Medical, Inc; Consultant, Columbo; Consultant, iMedis; Consultant, Agamon; Consultant, FUJIFILM Holdings Corporation

#### **PURPOSE**

Purpose Deep learning (DL) image reconstruction allows faster MR acquisitions while matching or exceeding standard of care (SOC) and can create synthetic images from existing data sets. This multicenter, multi-reader spine study evaluated the performance of synthetically created STIR (Syn-STIR) compared to acquired STIR (Acq-STIR).

#### **METHODS AND MATERIALS**

Material Methods From a multicenter, multi-scanner database of 328 clinical cases, a non-reader neuroradiologist randomly selected 110 spine MRI studies in 93 patients (sagittal T1, T2, STIR) and classified into five categories of disease and normal. A DICOM-based DL application generated a Syn-STIR series from the Sag T1 and T2. Five radiologists (3 neuro, 1 MSK, 1 generalist) rated STIR quality and classified disease pathology (study 1, n=80). They then assessed the presence or absence of findings typically evaluated with STIR in patients with trauma (study 2, n=30). The readers evaluated studies with either Acq-STIR or Syn-STIR in a blinded and randomized fashion with a 1-month washout period. Interchangeability of Acq-STIR and Syn-STIR was assessed using a non-inferiority threshold of 10%.

#### **RESULTS**

Results For classification, there was a decrease in inter-reader agreement expected by randomly introducing Syn-STIR of 3.23%. For trauma, there was an overall increase in inter-reader agreement by +1.9%. The lower bound of confidence for both exceeded the non-inferiority threshold, indicating interchangeability of Syn-STIR with Acq-STIR. Both Wilcoxon signed-rank and t-test showed higher IQ scores for Syn-STIR over Acq-STIR ( $P < 0.0001$ ).

#### **CONCLUSION**

Conclusion Syn-STIR spine MR images were diagnostically interchangeable with Acq-STIR, while providing significantly higher image quality, suggesting routine clinical practice potential.

#### **CLINICAL RELEVANCE/APPLICATION**

Clinical relevance DL generated synthetic STIR spine MR images were interchangeable with a conventionally acquired STIR, while providing significantly higher image quality, suggesting the potential to replace them in clinical practice, the reducing overall scan times and enhancing the patient experience.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSNR10-3

### Deep-Learning Based Contrast Boosting Improves Lesion Visualization and Image Quality: A Multi-Reader Study on Diagnostically Interchangeability with Standard Contrast Enhanced MRI of Brain Tumors

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353C

Srivathsa P. Venkata, MSc (*Presenter*) Employee, Subtle Medical, Inc; Stockholder, Subtle Medical, Inc

#### PURPOSE

Higher Gadolinium contrast doses in brain tumor imaging can increase lesion sensitivity, but larger doses elevate safety concerns. Here, we evaluate the clinical performance of a deep learning (DL) based method for boosting contrast, without increasing dose, relative to standard-dose images in a multireader study.

#### METHODS AND MATERIALS

We analyzed data from 40 patients ( $63 \pm 14$  years, 20 female) undergoing brain MRI with contrast. Contrast boosted (CB) images were generated using pre-contrast standard post-contrast (SC) 3D T1w images as input (Fig 1A). Three readers (board-certified radiologists with 9, 15, 18 years of experience) were presented 100 cases in a blinded randomized fashion. Each case contained a pre-contrast T1w image and either a SC (N=40) or CB image (N=40). 20 cases were repeated. Readers made a diagnostic classification (Dx) (6 classes: glioma, meningioma, lymphoma, metastasis, other tumor, or none) and rated post-contrast images for lesion enhancement, border delineation, internal morphology, vessel conspicuity, and overall image quality (IQ) using a 5-point Likert scale. Inter- intra-reader variability (RV) was assessed using Cohen's Kappa intraclass correlation coefficients. Wilcoxon signed rank tests were conducted on qualitative measures to compare SC and CB images. We assessed whether images were diagnostically interchangeable (DI) by the decrease in inter-RV when comparing SC vs CB to SC alone (10% limit for non-inferiority testing). Quantitative metrics (lesion-to-brain ratio - LBR and contrast enhancement % - CEP) were computed on SC CB with respect to the pre-contrast.

#### RESULTS

CB images were rated higher than SC for lesion enhancement, delineation, morphology and IQ (Fig 1B, all  $p < 0.005$ ). Vessel conspicuity was rated as being unlikely to affect Dx in a lower % of CB images (82% vs 93%). Fig 1C visualizes some examples. Inter-RV for Dx was similar for paired SC CB (0.523 vs 0.475), or when comparing SC to CB images (0.496). Intra-RV increased for CB over SC (0.969 vs 0.844). The decrease in inter-RV when interchanging SC with CB was 5.2% (CI: [-5.7%, 9.6%]; 1000 bootstrapped samples) and SC CB were considered DI (non-inferiority test,  $p = 0.02$ , Fig 1D). LBR CEP for CB ( $5.22 \pm 1.43$  89.95%) were significantly better ( $p < 0.0001$ ) than those of SC ( $3.78 \pm 0.90$  185.10%).

#### CONCLUSION

This study establishes that CB images have superior qualitative perception for lesion features and IQ, and are DI with SC images for tumor categorization. Future studies will evaluate CB performance on more contrast sensitive tasks.

#### CLINICAL RELEVANCE/APPLICATION

DL-synthesized contrast boosted images offer better visualization of pathology and have interchangeable diagnostic performance with standard contrast images for tumor categorization.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSNR10-4

### A Generative Adversarial Network Approach for Low-Field to High-Field Image Translation

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353C

Alfredo Lucas, BS, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Portable low-field strength (64mT) MRI scanners promise to increase access to neuroimaging for clinical and research purposes but produce images of lower quality and resolution compared to high field strength scanners. In this study, we developed and evaluated a deep learning method to generate high-field quality brain images from low-field inputs using a paired dataset of multiple sclerosis (MS) patients scanned at 64mT and 3T.

#### METHODS AND MATERIALS

A total of 65 MS patients were scanned on portable 64mT (Hyperfine) and standard 3T scanners (Siemens) at Penn or NIH with T1, T2 and FLAIR acquisitions at both field strengths. Using 32/65 patients, we trained a generative adversarial network (GAN) architecture for low to high field image super resolution and translation that consisted of two main parts. The first half consists of 3 pix2pix layers in parallel, each trained on a different orthogonal imaging plane with T1, T2, and FLAIR images as input channels. The second half consists of a 3D patch-based U-Net that combines the parallel outputs from the first half into a cohesive volume. We used the 33 remaining subjects as out-of-sample test subjects.

#### RESULTS

All presented results reflect out-of-sample test subjects. Reconstructed high-field output images demonstrated visually superior quality than low-field input images. Quantitatively, reconstructed outputs had significantly higher structural similarity (SSIM) to paired high-field images than input low-field images across T1 (pFDR=0.006), FLAIR (pFDR=0.03), and T2 (pFDR=0.024) contrasts. Measuring thalamic volumes, a clinically relevant MS biomarker, using a state-of-the-art segmentation pipeline (SynthSeg), our reconstructed outputs outperformed another published super resolution algorithm (SynthSR) in producing results approximating 3T and correcting undersegmentation seen at 64mT. Total MS lesion volume based on automated segmentation (MiMOSA) in our reconstructed outputs was better correlated (Spearman's Rho = 0.65) with high-field volumes, than original low-field volumes (Spearman's Rho = 0.55). MS lesions also appeared more conspicuous in our reconstructed outputs than original input images.

#### CONCLUSION

Our generative adversarial network approach for low-field to high-field super resolution generates synthetic high-field images that have comparable visual and quantitative quality, regional volumetry, and lesion burden, as their paired high-field counterparts.

#### CLINICAL RELEVANCE/APPLICATION

Enhancing portable low-field MRI image quality can boost clinician confidence, leading to wider adoption of these affordable, accessible technologies, benefiting patients who may not have had access to MR imaging before.

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## Abstract Archives of the RSNA, 2023

W3-SSNR10-5

### Development of Paired-CycleGAN-based Deep Learning Algorithm for MRI Harmonization: Validation in Follow-up MRI Evaluation in Post-treatment Glioma Patients

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353C

Roh-Eul Yoo, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a paired CycleGAN-based deep learning algorithm for MRI harmonization and to validate its utility on follow-up MRI evaluation in post-treatment glioma patients

#### METHODS AND MATERIALS

This retrospective study included 184 datasets from 64 post-treatment glioma patients from January 2006 to September 2020, who showed no significant change in MRI readings during 3 follow-up (FU) examinations with the second MRI taken at a different MRI vendor. The data were randomly split into the training and validation sets in a 8:2 ratio. Paired-CycleGAN was trained to generate harmonized second FU MRI images with the similar image impression as the baseline MRI images. Unlike traditional CycleGAN, we modulated the model to learn head-to-head images containing slices at the same position in a different domain. We trained the proposed model with two training metrics, structural similarity index measure (SSIM) and learned perceptual image patch similarity (LPIPS). The mean and standard deviation of intensity values, contrast-to-noise ratios (CNR) of gray matter (GM) and white matter (WM), and 3D SSIM score were used to assess the harmonized images in the validation set. A five-point diagnostic confidence scale and the presence of change in lesion characteristics (border, size, contrast, internal morphology) were evaluated by a blinded reader.

#### RESULTS

As the training progressed, LPIPS score typically decreased, while SSIM score increased. The changes in 3D SSIM score between the baseline and harmonized FU images were higher than those between the baseline and original FU images (0.87 vs. 0.82,  $P < .001$  [Siemens to Philips]; 0.89 vs. 0.83 [Philips to Siemens],  $P < .001$ ). Differences compared to baseline in the mean and standard deviation of intensity values and CNR of GM and WM were lower in the harmonized FU images than in original FU images (All  $P < .001$ ). In the reader evaluation study, more cases were read to be not changed on harmonized FU images and the diagnostic confidence was significantly higher with harmonized FU images than with original FU images ( $4.8 \pm 0.4$  vs.  $4.4 \pm 0.6$ ,  $P < .001$ ).

#### CONCLUSION

A paired CycleGAN-based deep learning algorithm showed good performance in MRI harmonization and resulted in increased diagnostic confidence in follow-up MRI evaluation in post-treatment glioma patients.

#### CLINICAL RELEVANCE/APPLICATION

Glioma patients often undergo follow-up MRI examinations after standard treatment in different scanners due to limited MR resources; our paired-CycleGAN-based MRI harmonization technique may increase the diagnostic confidence in follow-up MRI evaluation in post-treatment glioma patients in such clinical setting.

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## Abstract Archives of the RSNA, 2023

W3-SSNR10-6

### The Relaxation Normalized Proton Transfer Rate MRAPTR in the Evaluation of pH Changes of the Acute Cerebral Infarction

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353C

Jianzhong Yin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Amide proton transfer (APT) imaging is sensitive to intracellular pH and has shown great potential for the evaluation of cerebral strokes. The relaxation normalized proton transfer rate MRAPTR has shown improved quantification of pH contrast. This study aimed to explore the different abilities between the relaxation normalized proton transfer rate MRAPTR and the routine MRT<sub>asym</sub> metrics for evaluating acute strokes.

#### METHODS AND MATERIALS

6 normal subjects and 106 patients with ischemic stroke were enrolled. All patients underwent an MRI examination including T1WI, T2WI, DWI, and APTw imaging. The magnetization transfer ratio asymmetry (MTR<sub>asym</sub>) and magnetization transfer and relaxation normalized proton transfer rate (MRAPTR) were analyzed. The interobserver and repeatability of the APT(w) signal were assessed by ICCs. The Mann-Whitney U tests were used to compare the difference between infarction lesions and contralateral normal regions of different APTw metrics. The receiver operating characteristic curve (ROC) analysis was used to evaluate the diagnostic efficiency of MTR<sub>asym</sub> and MRAPTR for infarction. The reverse rate of MTR<sub>asym</sub> and MRAPTR was also compared by the ANOVA test.

#### RESULTS

The ICCs of MRAPTR were similar to those of MTR<sub>asym</sub> for the interobserver agreement and intersite reliability analysis. But MRAPTR value was closer to the baseline than MTR<sub>asym</sub>, and the data distribution was more centralized. The APTw metric maps showed a decreased MTR<sub>asym</sub> and MRAPTR, which implied an acidosis and decreased proton exchange in the infarction lesions. The MTR<sub>asym</sub> and MRAPTR at the infarction lesions showed obviously differences toward contralateral normal regions ( $P = 0.001$  and  $< 0.001$ , respectively). But APTw metrics at the infarction lesions were elevated in some cases, which implied a reversal of the APT results. MRAPTR showed a significantly decreased reverse rate of the infarction lesions compared to the MTR<sub>asym</sub> (24.5% and 2.8%, respectively). MRAPTR had better efficiency than MTR<sub>asym</sub> in reflecting acute ischemic lesions.

#### CONCLUSION

APTw metrics exhibited similar repeatability in this study, but MRAPTR was more stable than MTR<sub>asym</sub>. Both APTw metrics could reflect ischemic lesions and MRAPTR had better efficiency than MTR<sub>asym</sub>.

#### CLINICAL RELEVANCE/APPLICATION

These results demonstrated that pH-weighted imaging could reveal acidosis in patients with acute ischemic stroke.

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## Abstract Archives of the RSNA, 2023

W3-SSNR11

### Neuroradiology (Techniques and Methods: AI for Image Analysis)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353B

Michael Iv, MD (*Moderator*) Consultant, Octave Bioscience; Consultant, Hanalytics Pte Ltd; Consultant, NordicImagingLab AS  
Nathan M. Cross, MD, MS (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W3-SSNR11-1 A Weakly Supervised Method for Brain Tumor Segmentation in MR Images

Jay Yoo, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Segmentation of regions of interest (ROIs) for identifying abnormalities is a leading problem in medical imaging. Machine Learning (ML) generally requires manually annotated ground-truth segmentations, demanding extensive time and resources from radiologists. We present a novel weakly supervised (WS) approach that utilizes image-level labels such as the presence of tumor, which are much simpler to acquire, to automatically segment ROIs in Magnetic Resonance Imaging (MRI) scans without requiring ground truth annotations for training.

#### METHODS AND MATERIALS

This REB-approved retrospective study included two MRI datasets: 1) in-house dataset of pediatric low-grade neuroepithelial tumors (PLGNT) (N=340), 2) public Multimodal Brain Tumor Segmentation Challenge 2020 (BraTS) dataset (N=369). Seeds indicating regions likely and unlikely to contain tumors were inferred from a model trained to detect the presence of tumors. A generative adversarial network was trained to convert cancerous 2D scans to healthy variants. The seeds and L1 maps, which are the absolute difference between images and their non-cancerous variants, were used to train a segmentation model without utilizing ground truth manual segmentations. To evaluate the efficacy of our method for downstream clinical tasks, for each patient MRI volume, we extracted Radiomic features from the 5 largest WS slice segmentations among the volume's top 25% WS slice segmentations. The top WS slice segmentations were estimated using the L1 maps. Random forest models were trained on the Radiomic features to predict the genetic markers (BRAF fusion vs BRAF V600E mutation) and pathology (low-grade glioma vs high-grade glioma) of tumors for the PLGNT and BraTS datasets, respectively.

#### RESULTS

Tumor classification using Radiomic features extracted from our WS segmentations achieved a mean test Area Under the Receiver Operating Characteristic Curve (AUC) of  $0.822 \pm 3.20e-2$  on the PLGNT dataset and a mean test AUC of  $0.933 \pm 9.17e-3$  on the BraTS dataset. For comparison, using the 5 largest manual segmentations from each patient volume achieved mean test AUCs of  $0.830 \pm 2.04e-2$  on the PLGNT dataset and  $0.958 \pm 1.27e-2$  on the BraTS dataset.

#### CONCLUSION

The proposed WS method generates segmentations that are nearly as effective as manually annotated segmentations on downstream tumor classification tasks without the need for manually acquired ground truth annotations for training. Removing the need for radiologists to manually segment brain tumors can expedite diagnosis and treatment.

#### CLINICAL RELEVANCE/APPLICATION

The proposed approach allows for MR images to be reliably segmented without the need for manual annotations, relieving radiologists of the need to manually segment any images for training ML models.

#### W3-SSNR11-2 AI System for Precise ASD Assessment Using sMRI

Mostafa Abdelrahim, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

Autism Spectrum Disorder (ASD) affects communication, social interaction, and behavior as a neurological disorder. Due to the diverse symptoms and severity levels experienced by individuals, it is considered a spectrum disorder. This study aims to use morphological markers extracted from Structure Magnetic Resonance (sMRI) scans and their correlation with Social Responsiveness Scale (SRS) behavioral scores to classify patients as ASD or TD

## METHODS AND MATERIALS

The proposed framework for Machine Learning (ML) consists of two major steps. Firstly, morphological markers are extracted from various brain areas that correlate with the severity level of the Social Responsiveness Scale (SRS) behavioral analysis reports. Secondly, the extracted markers from different brain areas generate different ML models that are stacked to train Support Vector Machine (SVM) based classifiers to diagnose subjects as autistic or control and determine the severity level in case of an autistic diagnosis. The ML-Based diagnostic system is tested on the Autism Brain Imaging Data Exchange-II (ABIDE-II) dataset (521 autistic and 593 control subjects) provided by the Autism Brain Imaging Data Exchange. It's worth noting that this system is the first ML-Based system that can determine the severity of autism

## RESULTS

The proposed ML-Based system using SVM achieved an overall accuracy of 94% with a sensitivity of 98.18% and specificity of 95.56% on the ABIDE-II database on average using 5-fold cross-validation with statistical significance  $p < 0.001$

## CONCLUSION

In conclusion, this study demonstrates that autism can be diagnosed and its severity determined using morphological markers extracted from sMRI scans, based on the correlation with SRS behavioral analysis reports. It's worth noting that our approach is not limited to SRS reports and can also be used with other behavioral reports, such as the Autism Diagnostic Observation Schedule (ADOS) reports. Furthermore, the proposed system is not limited to ASD, and it can be utilized for the diagnosis of any brain disorder

## CLINICAL RELEVANCE/APPLICATION

Early and accurate diagnosis of ASD is crucial for improving the quality of life for individuals with the disorder. Additionally, precise determination of autism severity and its position on the autism spectrum can aid in better management of the disorder and reduce treatment costs

## W3-SSNR11-3 Bidirectional Connectivity Alterations in Schizophrenia: A Multivariate, Machine-Learning Approach

Minchul Kim, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

It is well known that altered functional connectivity is the core pathophysiology of schizophrenia. However, there is debate on the direction of connectivity alterations, i.e., increasing or decreasing. In this study, we aimed to determine the direction of the connectivity alteration associated with schizophrenia using a multivariate, data-driven approach.

## METHODS AND MATERIALS

Resting-state functional magnetic resonance imaging data were acquired from 109 individuals with schizophrenia and 120 controls across two openly available datasets. A whole-brain resting-state functional connectivity (rsFC) matrix was computed for each individual. A modified connectome-based predictive model (CPM) with a support vector machine (SVM) was used to classify patients and controls. We conducted a series of multivariate classification analyses using three different feature sets, increased, decreased, and both increased and decreased rsFC.

## RESULTS

For both datasets, combining information from both increased and decreased rsFC matrices substantially improved prediction accuracy (Dataset 1: accuracy = 70.2%, permutation  $p = 0.001$ ; Dataset 2: accuracy = 64.4%, permutation  $p = 0.003$ ). When tested across datasets, prediction models using decreased and both increased and decreased rsFC performed above chance. The identified predictive features of decreased rsFC were similarly distributed between the two datasets.

## CONCLUSION

These findings suggest that bidirectional alterations in rsFC are distributed in the brains of individuals with schizophrenia, with the pattern of decreased connectivity being more similar across different populations.

## CLINICAL RELEVANCE/APPLICATION

Our data-driven and machine learning approach suggests a somewhat universal pattern of decreases in rsFC in schizophrenia, while increased rsFCs exist but are more heterogeneous, findings which may deepen the understanding of the

pathophysiology of schizophrenia. Additionally, our results suggest a promising direction for future research on the detection of individual patients with schizophrenia.

### **W3-SSNR11-4 Urgent vs Non-urgent Triage of CTB Based on a Comprehensive AI Model: Validation on a Ground-Truthed, Real-World Dataset**

Richard G. Abramson, MD, MS (*Presenter*) Consultant, ICON plc;

#### **PURPOSE**

Artificial intelligence (AI) shows promise in reducing radiological reporting costs by identifying studies with potential time-critical pathology for urgent reporting overnight. This retrospective study assessed the performance of a comprehensive AI model which detects 130 findings on brain CT (CTB) in differentiating cases that were urgent.

#### **METHODS AND MATERIALS**

Predictions of the Annalise Enterprise CTB AI model were post-processed into a single output score aiming to maximise identification of urgent cases. 51 of the 130 CTB findings, including infarcts, venous thrombosis, fractures, intracranial haemorrhage and mass effect, were considered as urgent based on the need for immediate triage to prevent significant patient morbidity/mortality. Consultant radiologists blinded to the model outputs ground-truthed a test dataset of 2807 CTB cases, comprising 1193 urgent and 1614 non-urgent studies which were mutually exclusive from model training data at the patient level. Performance on bootstrapped samples of the test data for 2000 cases with 12.5% prevalence of urgent findings (approximating real world emergency departments) was reported at thresholds determined from model training data aiming to predict 25%, 40%, and 50% of cases as non-urgent.

#### **RESULTS**

The post-processed output achieved an AUC of 0.92 on the overall dataset (42% urgent cases). On sampled datasets of 2000 cases with 12.5% prevalence of urgent findings, at the target 25% non-urgent threshold, the model achieved a sensitivity of 0.99 (0.98-1.00), specificity of 0.18 (0.16-0.19), a negative predictive value (NPV) of 1.00 (0.99-1.00), with 15% (14%-17%) of cases predicted negative, with 1 (0-4) false negatives. At the target 40% non-urgent threshold, sensitivity was 0.98 (0.96-1.00), specificity was 0.31 (0.29-0.33), NPV was 0.99 (0.98-1.00) with 27% (25%-29%) cases predicted negative and 5 (1-10) false negatives. At the 50% target non-urgent threshold, sensitivity was 0.97 (0.95-0.99), specificity was 0.40 (0.37-0.42), NPV was 0.99 (0.98-1.00) with 35% (37%-42%) cases predicted negative and 7 (2-13) false negatives. False negatives tended to be subtle cerebral infarcts.

#### **CONCLUSION**

Processing the CTB AI model outputs into a single score to distinguish urgent from non-urgent cases was shown to have effective performance. This internal validation produced metrics suggesting viability in settings such as the emergency department, the clinical efficacy and financial benefit of which could be evaluated in future prospective studies.

#### **CLINICAL RELEVANCE/APPLICATION**

Many health jurisdictions routinely send non-contrast CT brain scans for overnight reporting. Confidently identifying non-urgent scans allows for cost savings by delaying reporting until the next day.

### **W3-SSNR11-5 Hierarchical Feature Learning and Identification of Alzheimer's Disease with Resting-state fMRI: A Multiscale Research**

Zhiyuan Ding (*Presenter*) Nothing to Disclose

#### **PURPOSE**

A hierarchical framework was applied, including contrastive learning and graph neural network, for analyzing Alzheimer's Disease (AD) from the healthy on multi-scale levels (voxel, brain area and sample level) with resting-state fMRI automatically.

#### **METHODS AND MATERIALS**

149 AD cases and 102 healthy controls (HCs) were investigated (table 1). For all cases, The resting-state fMRI (rs-fMRI) and high-resolution 3D T1WI images were acquired on a SIEMENS Trio 3T scanner. The rs-fMRI data contains 240 time points (TR=2000ms), and each time point is composed of 64×64×41 voxels. The single voxel size is 3.4×3.4×3mm<sup>3</sup>. The rs-fMRI data is processed using DPARSF. Brain ROIs of AD dataset are processed based on automated anatomical labeling (AAL) template (90 ROIs) respectively. BOLD signals with variance less than 0.1 are removed by filtering and standardized normalized. The framework we applied involves two stages to extract voxel, brain area (ROI) and sample level features step by step (Figure 1). Firstly, on the voxel level, a network is employed to perform voxel-level clustering and feature extraction in a contrastive learning manner using BOLD signals as input (Figure 2). Secondly, on the ROI level, graph neural network is constructed by taking weighted averaged ROI features as node features to extract disease-specific sample-level features in a contrastive manner. Finally, we use the sample-level features as the input for the population-based graph neural network (GNN) classifier in reference (Figure 3).

## RESULTS

The sample features extracted from rs-fMRI features in AD vs HC have the following effects on the identification: 0.768 in accuracy, 0.770 in AUC, 0.764 in TPR, 0.776 in 1-FPR. It can be inferred that the extracted sample-level features starting from voxel level have effective identification performance.

## CONCLUSION

1. The voxel-ROI-sample hierarchical framework for analyzing the functional brain network generates disease-sensitive sample-level features that reflect the differences between groups. 2. Our results demonstrate that the applied framework achieves high accuracy in AD diagnosis.

## CLINICAL RELEVANCE/APPLICATION

Using a multi-scale framework starting from the voxel level is an effective computer-aided method to assist clinicians in identifying AD from healthy individuals. Our findings demonstrate the effectiveness of starting at the voxel level and then extracting sample level features for identifying AD diseases. This approach offers a new perspective for the study of AD.

## W3-SSNR11-6 Comparative Effectiveness of Two Comprehensive Artificial Intelligence (AI) Solutions for Large Vessel Occlusion (LVO) Detection and Perfusion Deficits in Acute Ischemic Stroke (AIS)

Ashlesha S. Udare, MBBS, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the diagnostic performance of two FDA-approved comprehensive AI solutions in LVO detection using identical CTA datasets in a series of consecutive code-stroke patients. To determine whether the automated CTP estimation of ischemic core and penumbra volumes are significantly different and their comparison to the final infarct volume (FIV) on the 48-hour DWI MRI.

## METHODS AND MATERIALS

IRB approval with waiver of consent was obtained for retrospective collection of consecutive head and neck CTA and CTP performed for acute code strokes between April 2020-Sept 2021. Inclusion criteria: Adequate quality CTA/CTP imaging DICOM dataset complete processing by both AI software solutions. Exclusion criteria: Technically inadequate images or errors in processing by either AI solutions. Isolated posterior circulation, ACA, M3/M4 LVOs. Ground truth for LVO detection was the final report by the neuroradiologist. Reader 2, blinded to prior reads, re-evaluated CTAs to detect and classify LVOs: ICA, M1 and M2 to evaluate segment-wise performance. AI1 was used in the real-world setting, and the same dataset was run through the AI2 platform. The sensitivity, specificity, PPV, NPV, and accuracy for LVO detection of the 2 AI solutions were compared to the ground truth. McNemar test to evaluate if they were significantly different. Paired t-test was used to identify differences in automated CTP volumes. Bland-Altman analysis was used to determine if there was significant difference between the automated CTP volumes and FIV.

## RESULTS

Of 633 code stroke studies, 529 CTA 192 CTP studies were deemed adequate quality. 69 (13%) patients had LVO 460 (87%) had no LVO per ground truth. For all types of LVO detection, there was no significant difference between the sensitivity of AI1 (0.77) AI2 (0.75). However, there was significant difference in the specificity PPV of the two AI solutions. Sensitivities for isolated M2 segment LVO detection were much lower. Mismatch volumes between the two AI solutions were significantly different, particularly at larger mismatch range. In the non-reperfusion group there was significant difference between  $T_{max} > 6$  and FIV with AI1 overestimating the volumes in most instances.

## CONCLUSION

Performance of both AI solutions for M2 occlusions was low with significant difference in their specificities. Divergent performance for  $T_{max} > 6$  volumes could impact treatment decisions.

## CLINICAL RELEVANCE/APPLICATION

Both AI solutions should be used as a support tool for triage and not for final diagnosis. High specificity of AI2 reduces the number of unnecessary notifications and mobile alerts to the on-call stroke team. Automated CTP cut-offs used in AIS endovascular trials are not uniformly applicable across the spectrum of FDA approved AI solutions.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W3-SSNR11-1

### A Weakly Supervised Method for Brain Tumor Segmentation in MR Images

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353B

Jay Yoo, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Segmentation of regions of interest (ROIs) for identifying abnormalities is a leading problem in medical imaging. Machine Learning (ML) generally requires manually annotated ground-truth segmentations, demanding extensive time and resources from radiologists. We present a novel weakly supervised (WS) approach that utilizes image-level labels such as the presence of tumor, which are much simpler to acquire, to automatically segment ROIs in Magnetic Resonance Imaging (MRI) scans without requiring ground truth annotations for training.

#### METHODS AND MATERIALS

This REB-approved retrospective study included two MRI datasets: 1) in-house dataset of pediatric low-grade neuroepithelial tumors (PLGNT) (N=340), 2) public Multimodal Brain Tumor Segmentation Challenge 2020 (BraTS) dataset (N=369). Seeds indicating regions likely and unlikely to contain tumors were inferred from a model trained to detect the presence of tumors. A generative adversarial network was trained to convert cancerous 2D scans to healthy variants. The seeds and L1 maps, which are the absolute difference between images and their non-cancerous variants, were used to train a segmentation model without utilizing ground truth manual segmentations. To evaluate the efficacy of our method for downstream clinical tasks, for each patient MRI volume, we extracted Radiomic features from the 5 largest WS slice segmentations among the volume's top 25% WS slice segmentations. The top WS slice segmentations were estimated using the L1 maps. Random forest models were trained on the Radiomic features to predict the genetic markers (BRAF fusion vs BRAF V600E mutation) and pathology (low-grade glioma vs high-grade glioma) of tumors for the PLGNT and BraTS datasets, respectively.

#### RESULTS

Tumor classification using Radiomic features extracted from our WS segmentations achieved a mean test Area Under the Receiver Operating Characteristic Curve (AUC) of  $0.822 \pm 3.20e-2$  on the PLGNT dataset and a mean test AUC of  $0.933 \pm 9.17e-3$  on the BraTS dataset. For comparison, using the 5 largest manual segmentations from each patient volume achieved mean test AUCs of  $0.830 \pm 2.04e-2$  on the PLGNT dataset and  $0.958 \pm 1.27e-2$  on the BraTS dataset.

#### CONCLUSION

The proposed WS method generates segmentations that are nearly as effective as manually annotated segmentations on downstream tumor classification tasks without the need for manually acquired ground truth annotations for training. Removing the need for radiologists to manually segment brain tumors can expedite diagnosis and treatment.

#### CLINICAL RELEVANCE/APPLICATION

The proposed approach allows for MR images to be reliably segmented without the need for manual annotations, relieving radiologists of the need to manually segment any images for training ML models.

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## Abstract Archives of the RSNA, 2023

W3-SSNR11-2

### AI System for Precise ASD Assessment Using sMRI

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353B

Mostafa Abdelrahim, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Autism Spectrum Disorder (ASD) affects communication, social interaction, and behavior as a neurological disorder. Due to the diverse symptoms and severity levels experienced by individuals, it is considered a spectrum disorder. This study aims to use morphological markers extracted from Structure Magnetic Resonance (sMRI) scans and their correlation with Social Responsiveness Scale (SRS) behavioral scores to classify patients as ASD or TD

#### METHODS AND MATERIALS

The proposed framework for Machine Learning (ML) consists of two major steps. Firstly, morphological markers are extracted from various brain areas that correlate with the severity level of the Social Responsiveness Scale (SRS) behavioral analysis reports. Secondly, the extracted markers from different brain areas generate different ML models that are stacked to train Support Vector Machine (SVM) based classifiers to diagnose subjects as autistic or control and determine the severity level in case of an autistic diagnosis. The ML-Based diagnostic system is tested on the Autism Brain Imaging Data Exchange-II (ABIDE-II) dataset (521 autistic and 593 control subjects) provided by the Autism Brain Imaging Data Exchange. It's worth noting that this system is the first ML-Based system that can determine the severity of autism

#### RESULTS

The proposed ML-Based system using SVM achieved an overall accuracy of 94% with a sensitivity of 98.18% and specificity of 95.56% on the ABIDE-II database on average using 5-fold cross-validation with statistical significance  $p < 0.001$

#### CONCLUSION

In conclusion, this study demonstrates that autism can be diagnosed and its severity determined using morphological markers extracted from sMRI scans, based on the correlation with SRS behavioral analysis reports. It's worth noting that our approach is not limited to SRS reports and can also be used with other behavioral reports, such as the Autism Diagnostic Observation Schedule (ADOS) reports. Furthermore, the proposed system is not limited to ASD, and it can be utilized for the diagnosis of any brain disorder

#### CLINICAL RELEVANCE/APPLICATION

Early and accurate diagnosis of ASD is crucial for improving the quality of life for individuals with the disorder. Additionally, precise determination of autism severity and its position on the autism spectrum can aid in better management of the disorder and reduce treatment costs

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## Abstract Archives of the RSNA, 2023

W3-SSNR11-3

### **Bidirectional Connectivity Alterations in Schizophrenia: A Multivariate, Machine-Learning Approach**

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353B

Minchul Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

It is well known that altered functional connectivity is the core pathophysiology of schizophrenia. However, there is debate on the direction of connectivity alterations, i.e., increasing or decreasing. In this study, we aimed to determine the direction of the connectivity alteration associated with schizophrenia using a multivariate, data-driven approach.

#### **METHODS AND MATERIALS**

Resting-state functional magnetic resonance imaging data were acquired from 109 individuals with schizophrenia and 120 controls across two openly available datasets. A whole-brain resting-state functional connectivity (rsFC) matrix was computed for each individual. A modified connectome-based predictive model (CPM) with a support vector machine (SVM) was used to classify patients and controls. We conducted a series of multivariate classification analyses using three different feature sets, increased, decreased, and both increased and decreased rsFC.

#### **RESULTS**

For both datasets, combining information from both increased and decreased rsFC matrices substantially improved prediction accuracy (Dataset 1: accuracy = 70.2%, permutation  $p = 0.001$ ; Dataset 2: accuracy = 64.4%, permutation  $p = 0.003$ ). When tested across datasets, prediction models using decreased and both increased and decreased rsFC performed above chance. The identified predictive features of decreased rsFC were similarly distributed between the two datasets.

#### **CONCLUSION**

These findings suggest that bidirectional alterations in rsFC are distributed in the brains of individuals with schizophrenia, with the pattern of decreased connectivity being more similar across different populations.

#### **CLINICAL RELEVANCE/APPLICATION**

Our data-driven and machine learning approach suggests a somewhat universal pattern of decreases in rsFC in schizophrenia, while increased rsFCs exist but are more heterogeneous, findings which may deepen the understanding of the pathophysiology of schizophrenia. Additionally, our results suggest a promising direction for future research on the detection of individual patients with schizophrenia.

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## Abstract Archives of the RSNA, 2023

W3-SSNR11-4

### Urgent vs Non-urgent Triage of CTB Based on a Comprehensive AI Model: Validation on a Ground-Truthed, Real-World Dataset

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353B

Richard G. Abramson, MD, MS (*Presenter*) Consultant, ICON plc;

#### PURPOSE

Artificial intelligence (AI) shows promise in reducing radiological reporting costs by identifying studies with potential time-critical pathology for urgent reporting overnight. This retrospective study assessed the performance of a comprehensive AI model which detects 130 findings on brain CT (CTB) in differentiating cases that were urgent.

#### METHODS AND MATERIALS

Predictions of the Annalise Enterprise CTB AI model were post-processed into a single output score aiming to maximise identification of urgent cases. 51 of the 130 CTB findings, including infarcts, venous thrombosis, fractures, intracranial haemorrhage and mass effect, were considered as urgent based on the need for immediate triage to prevent significant patient morbidity/mortality. Consultant radiologists blinded to the model outputs ground-truthed a test dataset of 2807 CTB cases, comprising 1193 urgent and 1614 non-urgent studies which were mutually exclusive from model training data at the patient level. Performance on bootstrapped samples of the test data for 2000 cases with 12.5% prevalence of urgent findings (approximating real world emergency departments) was reported at thresholds determined from model training data aiming to predict 25%, 40%, and 50% of cases as non-urgent.

#### RESULTS

The post-processed output achieved an AUC of 0.92 on the overall dataset (42% urgent cases). On sampled datasets of 2000 cases with 12.5% prevalence of urgent findings, at the target 25% non-urgent threshold, the model achieved a sensitivity of 0.99 (0.98-1.00), specificity of 0.18 (0.16-0.19), a negative predictive value (NPV) of 1.00 (0.99-1.00), with 15% (14%-17%) of cases predicted negative, with 1 (0-4) false negatives. At the target 40% non-urgent threshold, sensitivity was 0.98 (0.96-1.00), specificity was 0.31 (0.29-0.33), NPV was 0.99 (0.98-1.00) with 27% (25%-29%) cases predicted negative and 5 (1-10) false negatives. At the 50% target non-urgent threshold, sensitivity was 0.97 (0.95-0.99), specificity was 0.40 (0.37-0.42), NPV was 0.99 (0.98-1.00) with 35% (37%-42%) cases predicted negative and 7 (2-13) false negatives. False negatives tended to be subtle cerebral infarcts.

#### CONCLUSION

Processing the CTB AI model outputs into a single score to distinguish urgent from non-urgent cases was shown to have effective performance. This internal validation produced metrics suggesting viability in settings such as the emergency department, the clinical efficacy and financial benefit of which could be evaluated in future prospective studies.

#### CLINICAL RELEVANCE/APPLICATION

Many health jurisdictions routinely send non-contrast CT brain scans for overnight reporting. Confidently identifying non-urgent scans allows for cost savings by delaying reporting until the next day.

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## Abstract Archives of the RSNA, 2023

W3-SSNR11-5

### Hierarchical Feature Learning and Identification of Alzheimer's Disease with Resting-state fMRI: A Multiscale Research

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353B

Zhiyuan Ding (*Presenter*) Nothing to Disclose

#### PURPOSE

A hierarchical framework was applied, including contrastive learning and graph neural network, for analyzing Alzheimer's Disease (AD) from the healthy on multi-scale levels (voxel, brain area and sample level) with resting-state fMRI automatically.

#### METHODS AND MATERIALS

149 AD cases and 102 healthy controls (HCs) were investigated (table 1). For all cases, The resting-state fMRI (rs-fMRI) and high-resolution 3D T1WI images were acquired on a SIEMENS Trio 3T scanner. The rs-fMRI data contains 240 time points (TR=2000ms), and each time point is composed of  $64 \times 64 \times 41$  voxels. The single voxel size is  $3.4 \times 3.4 \times 3$ mm<sup>3</sup>. The rs-fMRI data is processed using DPARSF. Brain ROIs of AD dataset are processed based on automated anatomical labeling (AAL) template (90 ROIs) respectively. BOLD signals with variance less than 0.1 are removed by filtering and standardized normalized. The framework we applied involves two stages to extract voxel, brain area (ROI) and sample level features step by step (Figure 1). Firstly, on the voxel level, a network is employed to perform voxel-level clustering and feature extraction in a contrastive learning manner using BOLD signals as input (Figure 2). Secondly, on the ROI level, graph neural network is constructed by taking weighted averaged ROI features as node features to extract disease-specific sample-level features in a contrastive manner. Finally, we use the sample-level features as the input for the population-based graph neural network (GNN) classifier in reference (Figure 3) .

#### RESULTS

The sample features extracted from rs-fMRI features in AD vs HC have the following effects on the identification: 0.768 in accuracy, 0.770 in AUC, 0.764 in TPR, 0.776 in 1-FPR. It can be inferred that the extracted sample-level features starting from voxel level have effective identification performance.

#### CONCLUSION

1. The voxel-ROI-sample hierarchical framework for analyzing the functional brain network generates disease-sensitive sample-level features that reflect the differences between groups. 2. Our results demonstrate that the applied framework achieves high accuracy in AD diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

Using a multi-scale framework starting from the voxel level is an effective computer-aided method to assist clinicians in identifying AD from healthy individuals. Our findings demonstrate the effectiveness of starting at the voxel level and then extracting sample level features for identifying AD diseases. This approach offers a new perspective for the study of AD.

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## Abstract Archives of the RSNA, 2023

W3-SSNR11-6

### Comparative Effectiveness of Two Comprehensive Artificial Intelligence (AI) Solutions for Large Vessel Occlusion (LVO) Detection and Perfusion Deficits in Acute Ischemic Stroke (AIS)

Wednesday, Nov. 29 9:30AM - 10:30AM Room: E353B

Ashlesha S. Udare, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic performance of two FDA-approved comprehensive AI solutions in LVO detection using identical CTA datasets in a series of consecutive code-stroke patients. To determine whether the automated CTP estimation of ischemic core and penumbra volumes are significantly different and their comparison to the final infarct volume (FIV) on the 48hour DWI MRI.

#### METHODS AND MATERIALS

IRB approval with waiver of consent was obtained for retrospective collection of consecutive head and neck CTA and CTP performed for acute code strokes between April 2020-Sept 2021. Inclusion criteria: Adequate quality CTA/CTP imaging DICOM dataset complete processing by both AI software solutions. Exclusion criteria: Technically inadequate images or errors in processing by either AI solutions. Isolated posterior circulation, ACA, M3/M4 LVOs. Ground truth for LVO detection was the final report by the neuroradiologist. Reader 2, blinded to prior reads, re-evaluated CTAs to detect and classify LVOs: ICA, M1 and M2 to evaluate segment-wise performance. AI1 was used in the real-world setting, and the same dataset was run through the AI2 platform. The sensitivity, specificity, PPV, NPV, and accuracy for LVO detection of the 2AI solutions were compared to the ground truth. McNemar test to evaluate if they were significantly different. Paired t-test was used to identify differences in automated CTP volumes. Bland-Altman analysis was used to determine if there was significant difference between the automated CTP volumes and FIV.

#### RESULTS

Of 633 code stroke studies, 529 CTA 192 CTP studies were deemed adequate quality. 69(13%) patients had LVO 460(87%) had no LVO per ground truth. For all types of LVO detection, there was no significant difference between the sensitivity of AI1(0.77) AI2(0.75). However, there was significant difference in the specificity PPV of the two AI solutions. Sensitivities for isolated M2 segment LVO detection were much lower. Mismatch volumes between the two AI solutions were significantly different, particularly at larger mismatch range. In the non-reperfusion group there was significant difference between  $T_{max}>6$  and FIV with AI1 overestimating the volumes in most instances.

#### CONCLUSION

Performance of both AI solutions for M2 occlusions was low with significant difference in their specificities. Divergent performance for  $T_{max}>6$  volumes could impact treatment decisions.

#### CLINICAL RELEVANCE/APPLICATION

Both AI solutions should be used as a support tool for triage and not for final diagnosis. High specificity of AI2 reduces the number of unnecessary notifications and mobile alerts to the on-call stroke team. Automated CTP cut-offs used in AIS endovascular trials are not uniformly applicable across the spectrum of FDA approved AI solutions.

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## Abstract Archives of the RSNA, 2023

W3-STCE1

### Science Session (Sustainability in Imaging)

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 1

#### Sub-Events

#### **W3-STCE1- Safety of gadopixelenol for magnetic resonance imaging (MRI): a pooled analysis of eight studies**

Eric Lancelot, PharmD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Gadopixelenol (Elucirem™, Guerbet) is a new high relaxivity macrocyclic gadolinium-based contrast agent (GBCA) registered in US and currently under review by EU regulatory authorities. The aim of this analysis was to evaluate the global safety of gadopixelenol based on pooled data from all completed clinical studies.

#### **METHODS AND MATERIALS**

Data were obtained from eight phase I to III clinical studies. Overall, 1047 patients or healthy volunteers received gadopixelenol (0.025 to 0.3 mmol/kg), including 80 patients aged 2-17 years (0.05 mmol/kg). In cross-over studies, 791 patients also received another GBCA (gadobenate dimeglumine or gadobutrol), administered at 0.1 mmol/kg. Safety data included post-injection adverse events (AEs), laboratory measures, vital signs, and electrocardiograms (ECG).

#### **RESULTS**

Most subjects (67.6%) received gadopixelenol at 0.05 mmol/kg. AEs considered related to gadopixelenol by the investigators were reported for 8.5% of the subjects. Similar rates of AEs were reported with the other GBCAs in comparative studies. The most common AEs related to gadopixelenol were injection site pain (1.9%), headache (1.3%), nausea (0.7%) and injection site coldness (0.6%). Most AEs were of mild (83.3%) or moderate (12.8%) intensity. Three severe AEs were related to gadopixelenol: injection site pain (2 patients) and upper abdominal pain (1 patient). One serious AE was assessed as related to gadopixelenol (blood creatinine increase of mild intensity). All resolved. Among the pediatric patients, 2 (2.5%) experienced AEs related to gadopixelenol: a mild QT interval prolongation and a moderate maculopapular rash. A good safety profile was also observed in other sensitive populations, such as elderly patients, and patients with renal impairment. No safety concerns were raised from vital signs, laboratory parameters, and ECG data. The thorough QT study confirmed the cardiac safety of gadopixelenol.

#### **CONCLUSION**

Gadopixelenol showed a good safety profile consistent with other GBCAs when used for MRI of the central nervous system and other body regions in adults and pediatric patients aged 2-17 years.

#### **CLINICAL RELEVANCE/APPLICATION**

Gadopixelenol, used at half the standard dose of other GBCAs thereby reducing the total cumulative dose of gadolinium by 50%, could be of particular importance in patients requiring repeated MRIs. Further, a reduced dose reduces the carbon footprint.

#### **W3-STCE1- Energy Consumption, Cost and Carbon Footprint of Point-of-Care Medical 3D Printing**

Alina Carolin Seifert, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the energy consumption, cost and carbon footprint of point-of-care medical 3D printing in a university hospital setting.

## METHODS AND MATERIALS

Our radiology and craniomaxillofacial departments jointly operate an interdisciplinary 3D print lab with multiple facilities, performing 3D printing in both research and clinical settings and including any of the existing standard types of 3D printing technologies. Out of the 1700 annually produced anatomic models, a substantial portion is created in our point-of-care facility adjacent to the radiology department, where 13 3D printers, 3 post-processing stations, 2 PC workstations and 1 air cleaner are operated. Devices were equipped with kilowatt-hour energy measurement sensors (1-second sampling rate [1 Hz]). Measurements and log files from 03/23/2023 - 04/21/2023 were analyzed and segmented into system modes (off, idle, active). Energy consumption and carbon emissions overall, per 3D printer and for individual 3D print jobs were calculated. Annual energy consumption, electricity cost, carbon emissions and cost saving opportunities were estimated based on the available data.

## RESULTS

Total energy consumption of all point-of-care devices over 30 days was 363 kWh. The projected annual electricity demand of the 3D print lab thus adds up to 4'356 kWh, with resulting costs of \$3'746 (local electricity price: \$0.86/kWh) and carbon emissions of 558 kgCO<sub>2</sub>eq (national specific carbon intensity: 0.128 kgCO<sub>2</sub>eq/kWh). 9 out of the 13 tracked 3D printers were never switched off during the study period, with 56-67% of their energy consumption being attributed to nonproductive idle time (range: 13.3±0.1 - 80.7±2.0 Watt/hour). Switching the printers off could result in annual energy savings of 40 - 571 kWh per printer (cost savings: \$34 - 491, carbon savings: 5 - 73 kgCO<sub>2</sub>eq). Depending on the printer, energy consumption during print jobs ranged between 45±5 - 203±40 Watt/hour, thus 2.5-3 times higher compared with idle mode. Linear regression analysis of individual prints confirmed near perfect positive linear correlation between print duration and energy consumption for all printers ( $r= 0.994 - 0.999$ ), thus allowing to accurately predict energy consumption, electricity cost and carbon emissions per future print job / anatomic model.

## CONCLUSION

Energy consumption and carbon footprint of point-of-care medical 3D printing are low compared to imaging equipment used for raw data acquisition (e.g. CT). Nevertheless, substantial saving potential is present during nonproductive idle mode, which can increase energy efficiency.

## CLINICAL RELEVANCE/APPLICATION

Knowledge on cost and carbon-saving potentials can help 3D print labs to decrease their carbon footprint and operational cost simultaneously.

## W3-STCE1- As Low as Reasonably Achievable: Reducing plastic waste and optimizing cost efficiency in musculoskeletal interventional procedures.

Angela Atinga, MBBChir, FRCPC (*Presenter*) Nothing to Disclose

## PURPOSE

Assess potential cost savings and waste diversion by employing the ALARA principle (As Low as Reasonably Achievable) in relation to materials utilized in performing common musculoskeletal interventional procedures by comparing a) our institution's preset procedure tray and b) the hypothetical usage of essential, individualized items (ALARA materials) over a calendar year.

## METHODS AND MATERIALS

Retrospective study. Local PACS search was performed, between January 1, 2022 and December 31, 2022, with the following search terms: injection and/or aspiration. Results were confined to fluoroscopic and ultrasound guided procedures performed by musculoskeletal radiologists at our institution. The contents, mass, and cost of a) a preset procedure tray and b) ALARA materials were obtained. The following metrics were calculated: cost savings, number of items per category diverted from landfill, and mass of waste diverted from landfill (per procedure and per year).

## RESULTS

893 musculoskeletal imaging procedures were performed at our institution in 2022 (358 fluoro guided injections, 47 fluoro guided aspirations, 280 US guided aspirations, and 208 US guided aspirations). ALARA items consist of: 3 cc syringe, 5 cc syringe, 1 drape, 1 bandage, 1 piece of gauze, 22 g needle, 25 gauge needle. Total mass of these items is 49.1 g. Total cost of the ALARA items is \$9.28. Pre-set tray includes the aforementioned items, in addition to: 20 cc syringe, 1 scalpel, 20 g needle, 2 plastic vials, 1 plastic 6 inch ruler, 1 plastic tray, 2 towels, 2 stick sponges, 1 plastic wrap, 6 glass slides, 3 pieces of gauze, and 1 plastic bag. These latter items are not used and are considered waste. Total mass of the unused items is 200.5 g. Total cost of the tray is \$15.17. Cost savings is \$5.89, or 38.2%, per procedure. Total cost savings is \$5259.77 per year. A total of 893 syringes, scalpels, needles, plastic rulers, trays, wraps, bags; 1786 plastic vials, towels, stick sponges; 2679 pieces of gauze; and 5358 glass slides would be diverted from landfill. Mass of waste diverted from landfill is 201 g per procedure, or 179.4 kg per year. The mass equivalent is that of two average American males. The % reduction in waste (by mass) is 83.2%.

## **CONCLUSION**

Sole usage of ALARA materials in common MSK interventional procedures would yield a cost savings of 38.2% and waste reduction of 83.2% (per procedure and year) at our institution.

## **CLINICAL RELEVANCE/APPLICATION**

ALARA materials for image guided procedures yields significant cost savings and waste reduction -- much of which is plastic. Implementation of such a paradigm would represent an important step towards sustainability in radiology and the health care sector as a whole.

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## Abstract Archives of the RSNA, 2023

W3-STCE1-1

### Safety of gadopichlenol for magnetic resonance imaging (MRI): a pooled analysis of eight studies

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 1

Eric Lancelot, PharmD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Gadopichlenol (Elucirem™, Guerbet) is a new high relaxivity macrocyclic gadolinium-based contrast agent (GBCA) registered in US and currently under review by EU regulatory authorities. The aim of this analysis was to evaluate the global safety of gadopichlenol based on pooled data from all completed clinical studies.

#### METHODS AND MATERIALS

Data were obtained from eight phase I to III clinical studies. Overall, 1047 patients or healthy volunteers received gadopichlenol (0.025 to 0.3 mmol/kg), including 80 patients aged 2-17 years (0.05 mmol/kg). In cross-over studies, 791 patients also received another GBCA (gadobenate dimeglumine or gadobutrol), administered at 0.1 mmol/kg. Safety data included post-injection adverse events (AEs), laboratory measures, vital signs, and electrocardiograms (ECG).

#### RESULTS

Most subjects (67.6%) received gadopichlenol at 0.05 mmol/kg. AEs considered related to gadopichlenol by the investigators were reported for 8.5% of the subjects. Similar rates of AEs were reported with the other GBCAs in comparative studies. The most common AEs related to gadopichlenol were injection site pain (1.9%), headache (1.3%), nausea (0.7%) and injection site coldness (0.6%). Most AEs were of mild (83.3%) or moderate (12.8%) intensity. Three severe AEs were related to gadopichlenol: injection site pain (2 patients) and upper abdominal pain (1 patient). One serious AE was assessed as related to gadopichlenol (blood creatinine increase of mild intensity). All resolved. Among the pediatric patients, 2 (2.5%) experienced AEs related to gadopichlenol: a mild QT interval prolongation and a moderate maculopapular rash. A good safety profile was also observed in other sensitive populations, such as elderly patients, and patients with renal impairment. No safety concerns were raised from vital signs, laboratory parameters, and ECG data. The thorough QT study confirmed the cardiac safety of gadopichlenol.

#### CONCLUSION

Gadopichlenol showed a good safety profile consistent with other GBCAs when used for MRI of the central nervous system and other body regions in adults and pediatric patients aged 2-17 years.

#### CLINICAL RELEVANCE/APPLICATION

Gadopichlenol, used at half the standard dose of other GBCAs thereby reducing the total cumulative dose of gadolinium by 50%, could be of particular importance in patients requiring repeated MRIs. Further, a reduced dose reduces the carbon footprint.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-STCE1-2

### Energy Consumption, Cost and Carbon Footprint of Point-of-Care Medical 3D Printing

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 1

Alina Carolin Seifert, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the energy consumption, cost and carbon footprint of point-of-care medical 3D printing in a university hospital setting.

#### METHODS AND MATERIALS

Our radiology and craniomaxillofacial departments jointly operate an interdisciplinary 3D print lab with multiple facilities, performing 3D printing in both research and clinical settings and including any of the existing standard types of 3D printing technologies. Out of the 1700 annually produced anatomic models, a substantial portion is created in our point-of-care facility adjacent to the radiology department, where 13 3D printers, 3 post-processing stations, 2 PC workstations and 1 air cleaner are operated. Devices were equipped with kilowatt-hour energy measurement sensors (1-second sampling rate [1 Hz]). Measurements and log files from 03/23/2023 - 04/21/2023 were analyzed and segmented into system modes (off, idle, active). Energy consumption and carbon emissions overall, per 3D printer and for individual 3D print jobs were calculated. Annual energy consumption, electricity cost, carbon emissions and cost saving opportunities were estimated based on the available data.

#### RESULTS

Total energy consumption of all point-of-care devices over 30 days was 363 kWh. The projected annual electricity demand of the 3D print lab thus adds up to 4'356 kWh, with resulting costs of \$3'746 (local electricity price: \$0.86/kWh) and carbon emissions of 558 kgCO<sub>2</sub>eq (national specific carbon intensity: 0.128 kgCO<sub>2</sub>eq/kWh). 9 out of the 13 tracked 3D printers were never switched off during the study period, with 56-67% of their energy consumption being attributed to nonproductive idle time (range: 13.3±0.1 - 80.7±2.0 Watt/hour). Switching the printers off could result in annual energy savings of 40 - 571 kWh per printer (cost savings: \$34 - 491, carbon savings: 5 - 73 kgCO<sub>2</sub>eq). Depending on the printer, energy consumption during print jobs ranged between 45±5 - 203±40 Watt/hour, thus 2.5-3 times higher compared with idle mode. Linear regression analysis of individual prints confirmed near perfect positive linear correlation between print duration and energy consumption for all printers ( $r = 0.994 - 0.999$ ), thus allowing to accurately predict energy consumption, electricity cost and carbon emissions per future print job / anatomic model.

#### CONCLUSION

Energy consumption and carbon footprint of point-of-care medical 3D printing are low compared to imaging equipment used for raw data acquisition (e.g. CT). Nevertheless, substantial saving potential is present during nonproductive idle mode, which can increase energy efficiency.

#### CLINICAL RELEVANCE/APPLICATION

Knowledge on cost and carbon-saving potentials can help 3D print labs to decrease their carbon footprint and operational cost simultaneously.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-STCE1-3

### **As Low as Reasonably Achievable: Reducing plastic waste and optimizing cost efficiency in musculoskeletal interventional procedures.**

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 1

Angela Atinga, MBBChir, FRCPC (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Assess potential cost savings and waste diversion by employing the ALARA principle (As Low as Reasonably Achievable) in relation to materials utilized in performing common musculoskeletal interventional procedures by comparing a) our institution's preset procedure tray and b) the hypothetical usage of essential, individualized items (ALARA materials) over a calendar year.

#### **METHODS AND MATERIALS**

Retrospective study. Local PACS search was performed, between January 1, 2022 and December 31, 2022, with the following search terms: injection and/or aspiration. Results were confined to fluoroscopic and ultrasound guided procedures performed by musculoskeletal radiologists at our institution. The contents, mass, and cost of a) a preset procedure tray and b) ALARA materials were obtained. The following metrics were calculated: cost savings, number of items per category diverted from landfill, and mass of waste diverted from landfill (per procedure and per year).

#### **RESULTS**

893 musculoskeletal imaging procedures were performed at our institution in 2022 (358 fluoro guided injections, 47 fluoro guided aspirations, 280 US guided aspirations, and 208 US guided aspirations). ALARA items consist of: 3 cc syringe, 5 cc syringe, 1 drape, 1 bandage, 1 piece of gauze, 22 g needle, 25 gauge needle. Total mass of these items is 49.1 g. Total cost of the ALARA items is \$9.28. Pre-set tray includes the aforementioned items, in addition to: 20 cc syringe, 1 scalpel, 20 g needle, 2 plastic vials, 1 plastic 6 inch ruler, 1 plastic tray, 2 towels, 2 stick sponges, 1 plastic wrap, 6 glass slides, 3 pieces of gauze, and 1 plastic bag. These latter items are not used and are considered waste. Total mass of the unused items is 200.5 g. Total cost of the tray is \$15.17. Cost savings is \$5.89, or 38.2%, per procedure. Total cost savings is \$5259.77 per year. A total of 893 syringes, scalpels, needles, plastic rulers, trays, wraps, bags; 1786 plastic vials, towels, stick sponges; 2679 pieces of gauze; and 5358 glass slides would be diverted from landfill. Mass of waste diverted from landfill is 201 g per procedure, or 179.4 kg per year. The mass equivalent is that of two average American males. The % reduction in waste (by mass) is 83.2%.

#### **CONCLUSION**

Sole usage of ALARA materials in common MSK interventional procedures would yield a cost savings of 38.2% and waste reduction of 83.2% (per procedure and year) at our institution.

#### **CLINICAL RELEVANCE/APPLICATION**

ALARA materials for image guided procedures yields significant cost savings and waste reduction -- much of which is plastic. Implementation of such a paradigm would represent an important step towards sustainability in radiology and the health care sector as a whole.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W3-STCE2

### Science Session (Imaging of Immunotherapy)

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 2

#### Sub-Events

#### **W3-STCE2- Morphologic Variations Quantified Over Time for Unresectable Primary Liver Tumors after Checkpoint Inhibition as an Alternate to Standard Response Criteria** 1

Laetitia Saccenti, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In the setting of immunotherapies, conventional response criteria (ie RECIST 1.1, or mRECIST, iRECIST) may not be perfectly reflective of molecular responses in liver cancer. The aim of this study was to assess the feasibility of quantification of morphologic changes in tumors during immunotherapy, as a reflection of response or survival, as an alternative to conventional imaging criteria

#### **METHODS AND MATERIALS**

Retrospective single-center analysis was performed in patients with unresectable hepatocellular carcinoma (HCC) or cholangiocarcinoma, previously enrolled in clinical trials combined immunotherapy (tremelimumab +/- durvalumab) and locoregional treatment (ablation or transarterial chemoembolization). Conventional response (RECIST 1.1) was assessed at 6-month follow-up. The biggest target lesion was manually segmented on the axial slice with maximum diameter on contrast enhanced CT (ImageJ). Solidity (area/convex hull area) and circularity ( $4\pi \times \text{area} / \text{perimeter}^2$ ) of tumors were calculated at baseline and at 6-months follow up. Patients (target tumors) were stratified by survival at 9 months. Non-paired t-tests were done using R (v.4.3.1)

#### **RESULTS**

From the 68 patients enrolled in clinical trials, 26 did not have target lesions separate from volumes treated by locoregional therapies, 16 had less than 6 months overall survival (OS) and 2 had no follow-up CT available. 25 evaluable patients (4 with cholangiocarcinoma and 21 with HCC) were included. 14/25 had extra hepatic disease. Median OS was 360 days (IQR 286-586). 50 tumors were manually segmented (25 at baseline, and 25 at 6-months). Target tumors included liver tumors (64%), lymphadenopathy (24%), adrenal metastasis (4%) and bone metastasis (4%). At 6-month follow up, according to RECIST 1.1, 13/25 (52%) patients had progressive disease, 11/25 (44%) has a stable disease and 1/25 (4%) patient had a partial response. Poor outcome tumors at 9 months (5/25) had higher solidity and higher circularity at 6-month follow-up than good outcome tumors (20/25), (respectively  $0.936 \pm 0.042$  versus  $0.973 \pm 0.007$ ,  $p=0.002$ , and  $0.765 \pm 0.095$  versus  $0.845 \pm 0.044$ ,  $p=0.005$ ). At baseline, their solidity and circularity were similar (respectively  $0.951 \pm 0.030$  versus  $0.951 \pm 0.032$ ,  $p=0.358$ , and  $0.778 \pm 0.103$  versus  $0.805 \pm 0.105$ ,  $p=0.494$ )

#### **CONCLUSION**

Tumor morphology can evolve during treatment and disease progression and may correlate with outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

Quantitative morphologic variations such as circularity and solidity merit further consideration as factors in response criteria, and may be associated with survival in this limited feasibility assessment. Larger datasets, automatic segmentation, 3D analysis, radiomic or deep learning tools may facilitate further study.

#### **W3-STCE2- Improving Clear Cell Renal Cell Carcinoma PD-L1 Expression Prediction from CT Radiomics with Green Learning** 2

Alexander Shieh, MD (*Presenter*) Nothing to Disclose

## PURPOSE

PD-L1 is one of the most widely used immunotherapy targets for treating clear cell renal cell carcinoma (ccRCC). Previous studies showed feasibility of predicting PD-L1 from ccRCC radiomics but the performance was not great. This study aimed to improve the prediction of PD-L1 using features extracted from ccRCC tumors coupled with the Green Learning (GL) approach. GL is a suite of lightweight methods that may add advantage to prediction performance compared with conventional machine learning (ML).

## METHODS AND MATERIALS

The PD-L1 levels of 52 ccRCC patients were determined using quantitative multiplex immunofluorescence (mIF) from tissue samples. The mIF method is automated and considers the entire tumor opposed to the conventional immunohistochemistry (IHC) method that required manual counting on small areas. Two methods in the GL suite were used: the Discriminant Feature Test (DFT) for feature dimension reduction and Least-square Normal Transform (LNT) for new feature generation. DFT was used to select a subset of 1708 radiomic features extracted from multiphase CT volumes of ccRCC. LNT then adds an adaptive feature. Both DFT and LNT are entirely data-driven. Together the selected and newly generated features became the input to an XGBoost classifier to predict PD-L1 level. Five-fold cross-validation was used to develop the models.

## RESULTS

The GL pipeline achieved AUROC of 0.76 (95% CI: [0.62, 0.89]) for PD-L1 > 1%, 0.85 (95% CI: [0.70, 1.00]) for PD-L1 > 5% and 0.88 (95% CI: [0.80, 0.96]) for PD-L1 > 10%. Conventional ML without GL only had AUROC 0.61 for PD-L1 > 1%, 0.75 for PD-L1 > 5% and 0.85 for PD-L1 > 10%. The GL approach provides performance benefits across all experiments. Feature importance analysis showed the new feature generated by LNT ranked 7th, 14th, 4th in the three experiments.

## CONCLUSION

Radiomics analysis enhanced by the GL pipeline can predict PD-L1 levels in ccRCC with better performance. The DFT method is effective in feature selection and the LNT method generates feature with high importance.

## CLINICAL RELEVANCE/APPLICATION

Predicting PD-L1 levels in ccRCC patients may help patient selection and prognosis prediction for immunotherapy. Identifying patients who benefit the most from immunotherapy is crucial, yet conventional tissue-based analysis is resource-intensive. Radiomics analysis provides a non-invasive modality that is readily available in clinical scans. GL is a set of novel methods that are lightweight and achieved good empirical performance with imaging data. Unlike deep learning methods, GL methods do not need large scale optimization and are data-efficient. We demonstrated the effectiveness of GL used in improving radiomics analysis for immunotherapy patient selection.

## W3-STCE2- Development and clinical validation of an AI-based assistive software tool for automated detection and quantification of amyloid-related imaging abnormalities

Dirk Smeets, PhD (*Presenter*) Employee, icoMetrix NV

## PURPOSE

Amyloid-related imaging abnormalities (ARIA) are brain magnetic resonance imaging (MRI) findings associated with the use of amyloid beta-directed monoclonal antibody therapies in Alzheimer's disease (AD). ARIA monitoring is important to inform treatment dosing decisions and might be improved through assistive software. As such, we developed an artificial intelligence (AI)-based software for assisting radiological interpretation of brain MRI scans in patients monitored for ARIA, and assessed its clinical performance.

## METHODS AND MATERIALS

We conducted a multireader multicase study to compare the diagnostic performance of radiologists assessing ARIA on MRI scans from patients treated with aducanumab, both unassisted and assisted by the AI-based software. The study encompassed 199 cases from the EMERGE, ENGAGE and PRIME clinical trials and 16 U.S. board certified radiologists with a range of experience. Radiologists reported the presence and severity of ARIA-E and ARIA-H, either assisted or unassisted by the software. Of all cases, 44 did not contain ARIA findings, 84 had both ARIA-E and ARIA-H and the remaining cases had either ARIA-E (n = 39) or ARIA-H (n = 36) only, according to consensus of 3 experts. The co-primary study endpoints were the difference between assisted and unassisted detection accuracy of ARIA-E and ARIA-H separately, assessed with the area under the receiver operating characteristics curve (AUC), where the reader assessments for ARIA severity were compared against a consensus of 3 experts.

## RESULTS

Radiologists assisted by the AI-based software were significantly better in detecting ARIA. Assisted reading performance was superior (vs unassisted) for both ARIA detection co-primary endpoints, with an AUC difference of 0.051 (95% CI: 0.020, 0.083) for ARIA-E (p=0.001) and 0.044 (95% CI: 0.017, 0.070) for ARIA-H (p=0.001). The average assisted AUC was 0.873 (95% CI: 0.835, 0.911) for ARIA-E detection, and 0.825 (95% CI: 0.781, 0.869) for ARIA-H detection. Sensitivity increased

significantly from 70.9% (unassisted) to 86.5% (assisted) for ARIA-E detection, and from 68.7% to 79.0% for ARIA-H detection, while specificity remained above 80% for the detection of both ARIA types.

#### **CONCLUSION**

Radiological reading performance is significantly improved when using the developed AI-based software. Hence, the software can be a clinically impactful tool to improve safety monitoring and management of AD patients treated with amyloid beta-directed monoclonal antibody therapies.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiological assessment of ARIA can be significantly improved using AI-based software and may contribute to improved safety monitoring of patients treated with amyloid beta-directed monoclonal antibody therapies.

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## Abstract Archives of the RSNA, 2023

W3-STCE2-1

### Morphologic Variations Quantified Over Time for Unresectable Primary Liver Tumors after Checkpoint Inhibition as an Alternate to Standard Response Criteria

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 2

Laetitia Saccenti, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In the setting of immunotherapies, conventional response criteria (ie RECIST 1.1, or mRECIST, iRECIST) may not be perfectly reflective of molecular responses in liver cancer. The aim of this study was to assess the feasibility of quantification of morphologic changes in tumors during immunotherapy, as a reflection of response or survival, as an alternative to conventional imaging criteria

#### METHODS AND MATERIALS

Retrospective single-center analysis was performed in patients with unresectable hepatocellular carcinoma (HCC) or cholangiocarcinoma, previously enrolled in clinical trials combined immunotherapy (tremelimumab +/- durvalumab) and locoregional treatment (ablation or transarterial chemoembolization). Conventional response (RECIST 1.1) was assessed at 6-month follow-up. The biggest target lesion was manually segmented on the axial slice with maximum diameter on contrast enhanced CT (ImageJ). Solidity (area/convex hull area) and circularity ( $4\pi \times \text{area} / \text{perimeter}^2$ ) of tumors were calculated at baseline and at 6-months follow up. Patients (target tumors) were stratified by survival at 9 months. Non-paired t-tests were done using R (v.4.3.1)

#### RESULTS

From the 68 patients enrolled in clinical trials, 26 did not have target lesions separate from volumes treated by locoregional therapies, 16 had less than 6 months overall survival (OS) and 2 had no follow-up CT available. 25 evaluable patients (4 with cholangiocarcinoma and 21 with HCC) were included. 14/25 had extra hepatic disease. Median OS was 360 days (IQR 286-586). 50 tumors were manually segmented (25 at baseline, and 25 at 6-months). Target tumors included liver tumors (64%), lymphadenopathy (24%), adrenal metastasis (4%) and bone metastasis (4%). At 6-month follow up, according to RECIST 1.1, 13/25 (52%) patients had progressive disease, 11/25 (44%) has a stable disease and 1/25 (4%) patient had a partial response. Poor outcome tumors at 9 months (5/25) had higher solidity and higher circularity at 6-month follow-up than good outcome tumors (20/25), (respectively  $0.936 \pm 0.042$  versus  $0.973 \pm 0.007$ ,  $p=0.002$ , and  $0.765 \pm 0.095$  versus  $0.845 \pm 0.044$ ,  $p=0.005$ ). At baseline, their solidity and circularity were similar (respectively  $0.951 \pm 0.030$  versus  $0.951 \pm 0.032$ ,  $p=0.358$ , and  $0.778 \pm 0.103$  versus  $0.805 \pm 0.105$ ,  $p=0.494$ )

#### CONCLUSION

Tumor morphology can evolve during treatment and disease progression and may correlate with outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Quantitative morphologic variations such as circularity and solidity merit further consideration as factors in response criteria, and may be associated with survival in this limited feasibility assessment. Larger datasets, automatic segmentation, 3D analysis, radiomic or deep learning tools may facilitate further study.

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## Abstract Archives of the RSNA, 2023

W3-STCE2-2

### Improving Clear Cell Renal Cell Carcinoma PD-L1 Expression Prediction from CT Radiomics with Green Learning

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 2

Alexander Shieh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

PD-L1 is one of the most widely used immunotherapy targets for treating clear cell renal cell carcinoma (ccRCC). Previous studies showed feasibility of predicting PD-L1 from ccRCC radiomics but the performance was not great. This study aimed to improve the prediction of PD-L1 using features extracted from ccRCC tumors coupled with the Green Learning (GL) approach. GL is a suite of lightweight methods that may add advantage to prediction performance compared with conventional machine learning (ML).

#### METHODS AND MATERIALS

The PD-L1 levels of 52 ccRCC patients were determined using quantitative multiplex immunofluorescence (mIF) from tissue samples. The mIF method is automated and considers the entire tumor opposed to the conventional immunohistochemistry (IHC) method that required manual counting on small areas. Two methods in the GL suite were used: the Discriminant Feature Test (DFT) for feature dimension reduction and Least-square Normal Transform (LNT) for new feature generation. DFT was used to select a subset of 1708 radiomic features extracted from multiphase CT volumes of ccRCC. LNT then adds an adaptive feature. Both DFT and LNT are entirely data-driven. Together the selected and newly generated features became the input to an XGBoost classifier to predict PD-L1 level. Five-fold cross-validation was used to develop the models.

#### RESULTS

The GL pipeline achieved AUROC of 0.76 (95% CI: [0.62, 0.89]) for PD-L1 > 1%, 0.85 (95% CI: [0.70, 1.00]) for PD-L1 > 5% and 0.88 (95% CI: [0.80, 0.96]) for PD-L1 > 10%. Conventional ML without GL only had AUROC 0.61 for PD-L1 > 1%, 0.75 for PD-L1 > 5% and 0.85 for PD-L1 > 10%. The GL approach provides performance benefits across all experiments. Feature importance analysis showed the new feature generated by LNT ranked 7th, 14th, 4th in the three experiments.

#### CONCLUSION

Radiomics analysis enhanced by the GL pipeline can predict PD-L1 levels in ccRCC with better performance. The DFT method is effective in feature selection and the LNT method generates feature with high importance.

#### CLINICAL RELEVANCE/APPLICATION

Predicting PD-L1 levels in ccRCC patients may help patient selection and prognosis prediction for immunotherapy. Identifying patients who benefit the most from immunotherapy is crucial, yet conventional tissue-based analysis is resource-intensive. Radiomics analysis provides a non-invasive modality that is readily available in clinical scans. GL is a set of novel methods that are lightweight and achieved good empirical performance with imaging data. Unlike deep learning methods, GL methods do not need large scale optimization and are data-efficient. We demonstrated the effectiveness of GL used in improving radiomics analysis for immunotherapy patient selection.

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## Abstract Archives of the RSNA, 2023

W3-STCE2-3

### Development and clinical validation of an AI-based assistive software tool for automated detection and quantification of amyloid-related imaging abnormalities

Wednesday, Nov. 29 10:00AM - 10:30AM Room: Learning Center Theater 2

Dirk Smeets, PhD (*Presenter*) Employee, icoMetrix NV

#### PURPOSE

Amyloid-related imaging abnormalities (ARIA) are brain magnetic resonance imaging (MRI) findings associated with the use of amyloid beta-directed monoclonal antibody therapies in Alzheimer's disease (AD). ARIA monitoring is important to inform treatment dosing decisions and might be improved through assistive software. As such, we developed an artificial intelligence (AI)-based software for assisting radiological interpretation of brain MRI scans in patients monitored for ARIA, and assessed its clinical performance.

#### METHODS AND MATERIALS

We conducted a multireader multicase study to compare the diagnostic performance of radiologists assessing ARIA on MRI scans from patients treated with aducanumab, both unassisted and assisted by the AI-based software. The study encompassed 199 cases from the EMERGE, ENGAGE and PRIME clinical trials and 16 U.S. board certified radiologists with a range of experience. Radiologists reported the presence and severity of ARIA-E and ARIA-H, either assisted or unassisted by the software. Of all cases, 44 did not contain ARIA findings, 84 had both ARIA-E and ARIA-H and the remaining cases had either ARIA-E (n = 39) or ARIA-H (n = 36) only, according to consensus of 3 experts. The co-primary study endpoints were the difference between assisted and unassisted detection accuracy of ARIA-E and ARIA-H separately, assessed with the area under the receiver operating characteristics curve (AUC), where the reader assessments for ARIA severity were compared against a consensus of 3 experts.

#### RESULTS

Radiologists assisted by the AI-based software were significantly better in detecting ARIA. Assisted reading performance was superior (vs unassisted) for both ARIA detection co-primary endpoints, with an AUC difference of 0.051 (95% CI: 0.020, 0.083) for ARIA-E (p=0.001) and 0.044 (95% CI: 0.017, 0.070) for ARIA-H (p=0.001). The average assisted AUC was 0.873 (95% CI: 0.835, 0.911) for ARIA-E detection, and 0.825 (95% CI: 0.781, 0.869) for ARIA-H detection. Sensitivity increased significantly from 70.9% (unassisted) to 86.5% (assisted) for ARIA-E detection, and from 68.7% to 79.0% for ARIA-H detection, while specificity remained above 80% for the detection of both ARIA types.

#### CONCLUSION

Radiological reading performance is significantly improved when using the developed AI-based software. Hence, the software can be a clinically impactful tool to improve safety monitoring and management of AD patients treated with amyloid beta-directed monoclonal antibody therapies.

#### CLINICAL RELEVANCE/APPLICATION

Radiological assessment of ARIA can be significantly improved using AI-based software and may contribute to improved safety monitoring of patients treated with amyloid beta-directed monoclonal antibody therapies.

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## Abstract Archives of the RSNA, 2023

W5A-SPBR-1

### Correlation between Sarcopenia Evaluated with CT and Toxicity in Patients Affected by Breast Cancer during Adjuvant Chemotherapy

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Marco Di Girolamo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Recent evidences suggest that in severe depletion of skeletal muscle, known as sarcopenia, the anti-cancer therapy is associated with poor prognosis and toxicity. Sarcopenia, often unrecognized, affects patients with low, normal or high body mass index (BMI). Aim of this study was to evaluate the association between lumbar skeleton muscle status (LSMI) evaluated with CT scans and toxicity in breast cancer patients receiving standard adjuvant chemotherapy

#### METHODS AND MATERIALS

22 breast cancer women (mean age:55) receiving epirubicin-based chemotherapy were enrolled in a prospective study. Skeletal muscle cross-sectional area at the third lumbar vertebra was measured by CT scans and sarcopenia was defined using the cut off point for LSMI of  $<38.5 \text{ cm}^2/\text{m}^2$ . BMI and BSA were measured at every cycle of chemotherapy. CT scan was performed before the first and fourth cycle of chemotherapy. Toxicity was assessed after every cycle of treatment and it was graded according to the National Cancer Institute Common Toxicity Criteria. Serum samples were evaluated at every cycle to determine drug concentrations.

#### RESULTS

Before the first cycle of chemotherapy, 86.36% of patients were classified as sarcopenic. The sarcopenia mean value was  $32.22 \text{ cm}^2/\text{m}^2$  (SD: 5.78), and no differences by age and BMI were found. The BMI mean value was 23.97 (SD: 4.32). After the fourth cycle of chemotherapy the BMI mean value was 24.19 (SD: 4.74; range) and the sarcopenia mean value was  $32.18$  (SD: 5.68). 18% of patients reported severe toxicities (grade 3 or 4). Sarcopenia mean values were found significantly different ( $p$ -value 0.048) in patients with severe toxicity compared with patients with absent/mild toxicities (mean value: 27.17, SD, 3.27 versus 33.30, SD, 5.55, respectively). Changes in LSMI were associated with significant changes in toxicities ( $p$ -value 0.004). In 18% of patients with a severe toxicity, a decrease in LSMI values after the 4th cycle of chemotherapy was always detected.

#### CONCLUSION

Preliminary analysis of available data showed an association between sarcopenia and toxicities, suggesting also that sarcopenia could be considered an early condition in breast cancer.

#### CLINICAL RELEVANCE/APPLICATION

If the association between changes in sarcopenia and toxicities will be confirmed in larger population, the measure of LSMI with CT scan could be used to personalized the dose of chemotherapy

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## Abstract Archives of the RSNA, 2023

W5A-SPBR-2

### Complex Interplay of MRI and Clinicopathology Variables in pCR Prediction across Breast Cancer Subtypes

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Sarah Eskreis-Winkler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Breast cancers exhibit different rates of pathologic complete response (pCR) according to tumor receptor status: HR+/HER2-, HER2+, and triple negative (TNBC). Deep learning (DL) models using MR have been developed for pCR prediction, but the comparative performance of pCR prediction for different subtypes has not yet been investigated. Herein, we build pCR prediction models for each subtype, compare performance across subtypes, and explore relationships to clinicopathology (CP) models.

#### METHODS AND MATERIALS

This IRB-approved HIPAA-compliant study included 719 breast MRs performed between 2014-2018 on breast cancer patients prior to neoadjuvant chemotherapy. Tumor subtype, pCR status, and CP variables were collected, including age, race, cancer history, clinical stage, nuclear grade, histological grade, and histology. A ResNet50-based architecture was built to predict pCR for each subtype using MR. Data was randomly split 80/10/10 into training, tuning and testing. Pre-contrast, post-contrast, subtraction, and T2 images were co-registered; tumor ROIs were automatically segmented and passed through the model. Final hyperparameters: 25 epochs; learning rate  $2e-4$ , batch size 64. A penalized logistic regression model was built to predict pCR using CP variables alone. Patients were randomly assigned to training and testing with an 80/20 split. ROC curves were generated and AUCs were calculated for each subtype, for the MR and CP models. DeLong's test assessed statistical significance of differences in model performance.

#### RESULTS

Breast MRs included 210 HR+/HER2- (5050 axial slices), 349 HER2+ (8325 axial slices) and 160 TNBC (4521 axial slices) cases. Test set AUCs for the MR models were 0.62 for HR+/HER2-, 0.48 for HER2+, and 0.78 for TNBC. The best AUC (i.e. TNBC) was statistically significantly higher than to the worst AUC (i.e. HER2+) ( $p < 0.001$ ). For the CP model, test set AUCs were 0.80 for HR+/HER2-, 0.68 for HER2+, and 0.55 for TNBC.

#### CONCLUSION

DL-based MR model performance for pCR prediction varies by subtype with the TNBC (AUC = 0.78) significantly outperforming HER2+. In contrast, the CP model exhibited poor performance for TNBC (AUC = 0.55). This suggests synergistic potential for pCR prediction using medical images and CP. We are actively working to develop a composite model that integrates multimodality inputs to optimize pCR prediction across all patients and all tumor subtypes.

#### CLINICAL RELEVANCE/APPLICATION

DL-based MR models for pCR prediction perform better on some tumor subtypes than others, providing complimentary information to clinicopathology variables. This suggests synergistic potential for pCR prediction using a multimodality approach, enabling optimization of treatment planning for all breast cancer patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPBR-3

### What is the Optimal Post Contrast Timing of Breast MRI to Evaluate Residual Tumor during the Course of Neoadjuvant Chemotherapy

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Phuong T. Duong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients undergoing neoadjuvant chemotherapy (NAC) are often monitored using dynamic contrast enhanced (DCE)-MRI, a sensitive tool for residual tumor assessment. NAC can have antiangiogenic effects that can impact accurate assessment of residual tumors. Purpose of this study is to evaluate the optimal post contrast timing to evaluate residual tumor during the course of NAC.

#### METHODS AND MATERIALS

An IRB approved study was performed. Publicly available 351 MRI exams from 117 breast cancer patients undergoing NAC in the ACRIN 6698 multi-institution trial were used for this study. The average age of patients was 49 y.o. (+/-11). Of 117 patients, 36 patients (30.8%) achieved pathologic complete response (pCR) and 81 patients (69.2%) did not (non-pCR). Of 117 patients, 36 patients (30.7%) had triple negative tumors (ER-,PR-,HER2-), 30 patients (25.6%) had HER2+ tumors and 51 patients (43.6%) had ER+/HER2- tumors. The MRI exams included those from pretreatment [T0], early NAC treatment [T1], and mid-NAC treatment [T2]. For each tumor, we calculated the time to peak (TTP) to achieve maximal tumor enhancement and evaluated changes in TTP over the course of NAC treatment. TTP was calculated by segmenting the tumor and calculating the phase with maximum signal intensity measured within the tumor. TTP subanalysis was performed comparing patients with tumors that achieved pCR vs non-pCR and between subtypes of breast cancer. Statistical significance was determined with  $p < 0.05$  from a 2-tailed paired t-test.

#### RESULTS

The TTP increased significantly over the course of NAC treatment. The TTP at T1 was 265 sec (+/-151), at T2 was 314 s (+/- 314) and at T3 was 385 s (+/- 183). The average TTP increase of 159 s (+/- 146) from T0 to T2 was statistically significant ( $p < 0.05$ ). Tumors of patients that achieved pCR had significantly greater change in TTP from T0 to T1 compared to non-pCR [183 s (+/-147) vs. 15 s (+/- 103),  $p < 0.05$ ]. Patients with triple negative and HER2+ tumors had greater change in TTP from T0 to T1 compared to ER+/HER2- tumors [90 s (+/-212) and 63 s (+/- 209) vs. 5 s (+/- 229)] but was not statistically significant.

#### CONCLUSION

The optimal post contrast timing of breast MRI increases with NAC likely due to antiangiogenic treatment effects. DCE-MRI protocol should include delayed post dynamic sequences inclusive of 314 s to 385 s to enable maximal tumor enhancement to best evaluate residual tumor during NAC, particularly in triple negative and HER2+ tumors. A significant increase in TTP from T0 to T1 could be a possible novel biomarker of pCR but needs further studies.

#### CLINICAL RELEVANCE/APPLICATION

In the setting of NAC, the most optimal timing of breast MRI is likely on the delayed post contrast images and should be part of the evaluation to most accurately assess residual breast tumor.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPBR-4

### Correlation of MRI and Pathological Responses after Neoadjuvant Chemotherapy with Disease-Free Survival in Breast Cancer Patients: Subtype Analysis

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Ricardo Fernandes Da Cunha, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To correlate response evaluation after neoadjuvant chemotherapy (NAC), assessed by magnetic resonance imaging (MRI) and pathology, with disease-free survival (DFS) in breast cancer patients, according to the subtype.

#### METHODS AND MATERIALS

This single-center, IRB-approved, retrospective cohort study included consecutive breast cancer patients who underwent NAC and preoperative breast MRI. Pathologic response was assessed through the residual cancer burden (RCB) system, and absence of invasive carcinoma in the breast and axilla was defined as complete pathological response (pCR or RCB-0). Radiological complete response (rCR) was defined as the absence of abnormal enhancement in the tumor site on MRI. Kaplan-Meier estimator was used to estimate the disease-free survival. Cox regression analysis was used to estimate hazard ratio (HR) values.

#### RESULTS

750 patients were included with mean age of 47 years (range: 26-90 years). The most common immunophenotype was Luminal (n=362; 48.3%), followed by triple-negative (n=198; 26.4%) and Her-2 overexpressed (n=190; 25.3%). Most patients (n=474; 63.2%) had clinical stage III at diagnosis. Overall, 34.5% of the patients had rCR, while 30.3% had pCR. During a mean follow-up of 72 months, patients who had both rCR and pCR had a better DFS curve, while patients with non-rCR and non-pCR had worse DFS curve, and those who had rCR or pCR presented an intermediate curve (LogRank p=0.001). The statistically significant difference on DFS curves persisted for triple-negative (LogRank p<0.001) and Her-2 overexpressed subtypes (LogRank p = 0.014), but not for luminal tumors (LogRank p=0.495). Cox regression showed a higher risk of recurrence in patients with non-rCR and non-pCR (HR: 8.686; p=0.003), those who had non-pCR and rCR (HR: 7.658; p=0.008), and those who had pCR and non-rCR (HR: 3.644; p=0.109), when compared to patients with rCR and pCR.

#### CONCLUSION

The association of MRI and pathological responses after NAC might better stratify the risk of recurrence and prognosis in breast cancer patients, particularly for the triple-negative subtype.

#### CLINICAL RELEVANCE/APPLICATION

Association of response evaluation after neoadjuvant chemotherapy by pathology and MRI allows better stratification of prognosis than both criteria used alone.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPBR-5

### Features of MRI Screen-Detected Breast Cancers

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Naveen Ghuman, BS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Breast cancer is a leading cause of death in women in the United States. Supplemental screening with breast MRI in addition to mammography is recommended annually for patients who have greater than 20% lifetime risk for breast cancer. While there is robust data regarding features of screen-detected breast cancer using mammography, there is limited data regarding MRI screen-detected cancers. This study aims to identify features of breast cancers initially detected by MRI.

#### METHODS AND MATERIALS

In this institutional review board-approved retrospective study, breast MRIs performed between August 1, 2016 and July 30, 2022 identified 51 screen-detected breast cancers in 48 patients. Clinical and imaging features of all eligible cancers were recorded, as well as frequency of cancer type and clinical stage.

#### RESULTS

During the study period, 51 MRI-screen detected cancers were identified in 48 patients. Most cancers (33/51, 64.8%) were invasive and most (45/51, 88.2%) were stage 0 or I at diagnosis. At the end of the study period, 1/48 (2.1%) had metastasis (in a patient with recurrent angiosarcoma), 1/48 (2.1%) had died from other causes, and 46/47 (97.9%) had no evidence of disease following treatment. Final pathology showed that 26/51 (51.0%) of MRI screen-detected cancers were invasive ductal carcinoma, 6/51 (11.8%) invasive lobular carcinoma, 1/51 (2.0%) angiosarcoma and 18/51 (35.3%) DCIS. MRI-screen detected cancers most commonly presented as a mass (26/51, 51%) or non-mass enhancement (NME) (25/51, 47.1%), with only 1/51 (2%) presenting as a focus. Internal T2 signal was hypointense to fibroglandular tissue in 4/51 (7.8%), isointense in 29/51 (56.9%) and hyperintense in 18/51 (35.3%). Of those cancers that presented as a mass, the majority 15/27 (55.6%) had an irregular shape, 13/27 (48.1%) had irregular margins, and 15/27 (55.6%) had homogeneous internal enhancement. Of those that presented as NME, the majority 13/24 (54.2%) were linear NME and had homogeneous internal enhancement 15/24 (62.5%). Many of the cancers were in patients who had prior MRI exams (37/51, 72.5%).

#### CONCLUSION

MRI screen-detected cancers were most often invasive, rather than in situ, cancers. Cancers detected by MRI screening had an excellent prognosis in our study population, supporting the clinical utility of breast MRI in the early diagnosis of breast cancer. Common MRI presentations included an irregular mass and linear non-mass enhancement.

#### CLINICAL RELEVANCE/APPLICATION

Screening MRI often detected small, invasive breast cancers, underscoring its clinical importance in women at high risk for breast cancer. Understanding the most common imaging presentations of MRI-screen-detected cancers may guide interpretation and diagnostic performance of the exam.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPBR-6

### Does the Addition of MRI Help in Cancer Detection in Women with Low Breast Tissue Density in a Population-based High-risk Breast Screening Program

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

David G. Martin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The High-Risk Ontario Breast Screening Program (HROBSP) screens women ages 30-69 who are confirmed to be at high risk of developing breast cancer (gene mutation carriers or lifetime risk =25%) with annual mammography and breast MRI. Mammographic breast tissue density (BTD) is an independent risk factor for breast cancer, and the sensitivity of mammography is diminished in women with dense versus fatty breasts. We aimed to compare cancer detection rate (CDR) according to BTD and determine if breast MRI in HROBSP patients with fatty BTD is necessary given the improved sensitivity of mammography.

#### **METHODS AND MATERIALS**

IRB approved retrospective review of all HROBSP breast MRIs performed at our institution from 04/04/2016 to 06/05/2022 was conducted. For each study, BI-RADS® BTD was recorded, and charts were reviewed to identify patients with breast cancers diagnosed during the screening period. Imaging was reviewed to determine if the cancer was seen on mammography, MRI or both.

#### **RESULTS**

6468 MRIs were reviewed (2082 patients) over 6-year study period. 66 cancers were detected in all (cancer detection rate (CDR)=10.2/1000); 5(7.6%) detected in category A, 20(30.3%) in B, 34(51.5%) in C and 7(10.6%) in D. 468(7.2%) MRIs were performed in 12.5%(260/2082) women with category A, who had 4 cancers (80%) detected on MRI alone and 1 cancer on both mammography and MRI. There was no difference in CDR by BTD (CDR for category A=10.7/1000, B=8.6/1000, C=11.8/1000, and D=9.1/1000, p=0.7).

#### **CONCLUSION**

Adjunctive screening with breast MRI in HROBSP patients is necessary for women with category A density breasts, despite the increased sensitivity of mammography in this patient population.

#### **CLINICAL RELEVANCE/APPLICATION**

The HROBSP program with yearly mammography and breast MRI aids in early detection of breast cancer in all women, regardless of breast density.

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## Abstract Archives of the RSNA, 2023

W5A-SPBR-7

### Outcomes of Supplemental Breast MRI in a High Risk Screening Program

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

#### PURPOSE

The Tyrer-Cuzick (TC) model has increasingly been used to identify high-risk women in breast imaging centers. The accuracy of the model has been studied in several patient cohorts, but, outcomes of using the TC model to make supplemental breast MRI recommendations are less reported. We studied the incidence of breast cancer and tumor characteristics at a community-based breast imaging center to better understand the outcomes of the risk assessment program.

#### METHODS AND MATERIALS

A retrospective analysis of patients participating in the risk assessment program starting in December 2016 was performed. Patients with a TC lifetime risk score >20% were offered supplemental MRI screening and are defined as high-risk (HR) in this study. Data were collected from the electronic health record, including Breast MRI data and cancer outcomes, and was matched to the risk assessment and imaging studies data. We limited our cohort to those with at least 5 years of follow-up. Patients with history of breast cancer prior to the first risk assessment, patients who were under 40 or over 79 years old, and patients without a valid TC score were excluded.

#### RESULTS

There were 54,706 patients who met study inclusion criteria with median age of 57, at median follow-up time of 5.2 years during which 2,259 cancers arose. The HR group was comprised of 8,737 (15.5%) patients (median age 52); LR group had a median age of 58 ( $P < 0.001$ ). Of HR patients, there were 2,108 (24.1%) who had breast MRI with a high-risk exam indication (median age 51). Odds ratio (OR) for breast cancer for the total HR group compared to the LR group was 1.50 (95% CI: 1.36 to 1.67,  $P < 0.0001$ ). OR for the HR group who were getting MRI compared to the LR group was 1.47 (95% CI: 1.21 to 1.78,  $P < 0.0001$ ). OR for the HR group who were not getting MRI compared to the LR group was 1.51 (95% CI: 1.35 to 1.70,  $P < 0.0001$ ). When considering tumor size of T2 or greater as large, the OR for a larger tumor when comparing the HR group to the LR was 0.57 (95% CI: 0.39 to 0.84,  $P = 0.0038$ ). For the HR group with MRI the OR was 0.39 (95% CI: 0.17 to 0.91,  $P = 0.029$ ) and the OR for HR group without MRI was 0.63 (95% CI: 0.42 to 0.96,  $P = 0.030$ ). Though not statistically significant, 12.9% of cancers in the LR group were node positive, compared to 6.4% in the HR group with MRI ( $P = 0.0698$ ).

#### CONCLUSION

Supplemental MRI screening in high-risk women can lead to earlier detection of breast cancer, finding tumors at lower stage that may lower the burden of disease. Further investigation in how to improve the uptake of high-risk interventions such as breast MRI screening will be beneficial.

#### CLINICAL RELEVANCE/APPLICATION

This study reports the impact of offering supplemental breast MRI as part of a large breast screening program. This high-risk cohort had an increased cancer rate and smaller tumors.

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## Abstract Archives of the RSNA, 2023

W5A-SPBR-8

### Application Value of Imaging Manifestations Combined with Tumor-Related Diffusion-Weighted Imaging Models in Predicting Molecular Subtype of Breast Invasive Ductal Carcinoma

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Cece Dong (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate and compare the value of MR imaging manifestations and 6 tumor-related DWI models in predicting the molecular subtypes of breast invasive ductal carcinoma (IDC).

#### METHODS AND MATERIALS

This study included 100 patients with breast IDC confirmed by pathological examination in our hospital. All the patients underwent routine MRI and multiple-b-value DWI examinations on a 3T scanner (MAGNETOM Vida, Siemens, Erlangen, Germany). The scanning parameters are shown in Table 1. The patients were divided into three groups, including luminal (n=72), HER-2 overexpressing (n=13), and triple-negative (n=15) subtypes. The value in predicting the molecular subtype of IDC was evaluated in terms of imaging manifestations and quantitative parameters of DWI models. All the 14 quantitative parameters (CTRW\_a, CTRW\_β, CTRW\_D, FROC\_β, FROC\_D, FROC\_μ, DKI\_D, DKI\_K, IVIM\_D, IVIM\_D\*, IVIM\_f, Mono\_ADC, SEM\_a, and SEM\_DDC) of the 6 DWI models were calculated by an in-house developed software called BoDiLab based on Python 3.7. All ROI measurements were done on the ITK-SNAP. Univariate and multivariate regression analysis were performed to screen independent predictive factors for different molecular subtypes, and a combined model was established, which was then visualized with a nomogram. ROC curves were used to assess the diagnostic performance of each parameters or model in discriminating molecular subtypes. All the analysis was performed using the software SPSS 26.0 and R language.

#### RESULTS

Margin burr and rim enhancement were independent imaging manifestation-related predictors of triple-negative breast cancer (TNBC) ( $P < 0.05$ ), which showed high diagnostic performance when combined with CTRW\_a and DKI\_K (AUC/sensitivity/specificity value of 0.870/80.0%/88.2%) (Figure 1). Luminal IDC was more likely to appear with margin burrs ( $P < 0.05$ ), and the diagnostic performance was higher when combined with CTRW\_a, DKI\_K, and IVIM\_f. HER-2-overexpressing IDC was commonly accompanied by peritumoral edema ( $P < 0.05$ ), and IVIM\_f showed high diagnostic value for this subtype (Table 2, 3). Nomogram for predicting the TNBC and luminal subtype were shown in figure 2.

#### CONCLUSION

The combined diagnostic model based on imaging manifestations and multiple DWI quantitative parameters has high diagnostic value in predicting the molecular subtype of breast IDC, and the parameters may be used as non-invasive biomarkers in future clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

This study explored the value of MRI manifestations combined with different DWI quantitative parameters in predicting the molecular subtypes for breast IDC, which may have guiding significance for the formulation of individualized treatment strategies in clinical practice.

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## Abstract Archives of the RSNA, 2023

W5A-SPCA-1

### Diagnostic Accuracy of Spectral CT Aortograms for the Detection of Acute Myocardial Infarction

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Dene Ellis, BMBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Acute myocardial infarction (MI) presentation is often atypical and unclear, justifying further investigations for other causes of chest pain. Thus, in modern practice CT aortograms (CTAs) are essential to exclude acute aortic syndrome (AAS). Despite being a non-dedicated study for the assessment of coronary heart disease (CHD), new spectral CT technologies may enable interrogation of coronary abnormalities or discernible myocardial perfusion defects. The aim of this study is to assess the diagnostic performance of gated-spectral CTAs in diagnosing acute MI. This will help to determine the prevalence of acutely presenting CT-imaging features by measuring myocardial Hounsfield Unit (HU) values indicative of evolving regional ischaemia.

#### METHODS AND MATERIALS

Retrospective consecutive cohort analysis was conducted to include acute chest pain patients that underwent urgent gated-spectral CTAs as a triple rule-out test for AAS at a large tertiary centre, over 12 months (Jan-Dec 2022). CTAs performed for reasons other than acute pain (e.g. trauma) were excluded. Data sources included patients' electronic records and the institution's PACS, to collate patients' demographics, clinical information, imaging findings, outcomes of further investigations and definitive management. This enabled correlation with troponin levels, ECG, and echocardiographic observations. On CTAs, LV myocardial hypo-enhancement HU was measured after visual assessment by two cardiac-trained radiologists to localise culprit diseased coronary arteries.

#### RESULTS

In a total of 309 CTAs, n=30 (9.7%) studies showed regional myocardial hypo-enhancement, confirmed later as acute MI. Of those, n=18/30 (60%); underwent urgent invasive angiography, where n=13 received percutaneous interventions and n=7 required urgent coronary artery bypass graft (CABG) surgery. Two patients died shortly after CTA acquisition, one of which had a post-mortem examination confirming a large territory MI. CTA yields an 90.9% sensitivity, 99.3% specificity and 98.4% accuracy in identifying acute MI (prevalence-adjusted). Ischaemic myocardial regional hypo-enhancement was (HU=50, SD=17.7) significantly lower ( $p<0.001$ ) than healthy myocardium (HU=126, SD=19.4).

#### CONCLUSION

At our institution, gated-spectral CTA has been utilised to investigate equivocal acute chest pain presentations in the emergency setting. The benefits of its excellent diagnostic accuracy can be achieved by educating reporting radiologists and cardiologists.

#### CLINICAL RELEVANCE/APPLICATION

Gated-spectral CTA can preclude the need for post-mortem examination, but it is most beneficial in reducing time-to-intervention by avoiding unnecessary further tests, especially in equivocal NSTEMI cases.

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## Abstract Archives of the RSNA, 2023

W5A-SPCA-2

### Measurement Accuracy of Aortic Valve Annulus with and without Whole-heart Motion Correction Algorithm in Multi-slice CT for Pre-operative TAVI: Compared to 3D Transesophageal Echocardiography

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Takayuki Yoshiura, BA, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate measurements of the aortic valve annulus with multi-slice CT (MSCT) are required for the success of pre-operative transcatheter aortic valve implantation (TAVI) procedure. The whole-heart motion correction (MC) algorithm is useful for reducing aortic annulus motion artifacts and is expected to measurement accuracy. The purpose of this study is to investigate the measurement accuracy of the aortic valve annulus with and without MC algorithm in MSCT compared to three-dimensional transesophageal echocardiography (3D TEE).

#### METHODS AND MATERIALS

We retrospectively analyzed 15 patients who underwent TAVI. The three mutually perpendicular planes so that the cross-sectional plane just passed through the plane of the lowest point of the aortic valve leaflet attachment, and the resulting section was the aortic annulus plane. The axial plane was reconstructed for the minimum aortic annulus diameter, and the valsalva and aortic annulus diameter were measured using 256-slice CT (Revolution Apex; GE Healthcare, Milwaukee, Wisconsin). We created an annulus plane on 3D TEE (EPIQ CVx; Koninklijke Philips Ultrasound, USA) using the same method as CT, and measured the minimum diameter of the valsalva and aortic annulus in the sagittal plane. All CT images were using the with and without MC algorithms and compared to 3D TEE measurements.

#### RESULTS

The measured mean diameter of valsalva for axial plane was 30.00 mm and 28.61 mm for with and without MC algorithms. The measured mean diameter of valsalva for the sagittal plane was 30.22 mm for 3D TEE, showing a significant difference between without MC algorithm and 3D TEE ( $p < 0.01$ ), but not between with MC algorithm and 3D TEE ( $p > 0.05$ ). The measured mean diameter of aortic annulus for the axial plane was 20.20 mm and 19.53 mm for with and without MC algorithms. The measured diameter of aortic annulus for the sagittal plane 20.50 mm for 3D TEE, showing a significant difference between without MC algorithm and 3D TEE ( $p < 0.01$ ), but not between with MC algorithm and 3D TEE ( $p > 0.05$ ).

#### CONCLUSION

MC algorithm in MSCT enabled the accurate measurements of aortic valve annulus for pre-operative TAVI.

#### CLINICAL RELEVANCE/APPLICATION

The application of MC algorithm in MSCT is useful for the accurate measurements of aortic valve annulus for pre-operative TAVI.

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## Abstract Archives of the RSNA, 2023

W5A-SPCA-3

### Association between Coronary Sinus Flow Estimated by Dynamic Coronary CT Angiography and $^{13}\text{N}$ -ammonia PET-derived Myocardial Flow Reserve

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Michinobu Nagao, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary sinus (CS) flow is regulated by global myocardial blood flow (MBF) and directly affects myocardial flow reserve (MFR) reduction. We devised a new method for CS flow quantification using 320-row dynamic coronary CT angiography (CCTA) and investigated the relationship between CS flow determined via CCTA and MBF or MFR values obtained via  $^{13}\text{N}$ -ammonia positron emission tomography ( $^{13}\text{N}$ -PET).

#### METHODS AND MATERIALS

Forty patients with moderate to severe coronary artery stenosis on dynamic CCTA who subsequently underwent adenosine-stress  $^{13}\text{N}$ -PET were enrolled in this study. Time-attenuation curves of the CS and the ascending aorta were extracted from dynamic CCTA data. The upslope of the CS was defined as the initial slope of the CS attenuation increase divided by that of the ascending aorta. CS start time (s) was defined as the timepoint between the peak aortic attenuation and the initial increase in CS attenuation. Global MBF was calculated from dynamic  $^{13}\text{N}$ -PET data. Global MFR was defined as the ratio of adenosine-stress MBF to the rest MBF.

#### RESULTS

The CS upslope was moderately positively correlated with rest MBF (Pearson correlation coefficient  $r$ , 0.443;  $p$  = 0.004), and CS start time was moderately negatively correlated with MFR ( $r$ , -0.540;  $p$  < 0.001). The diagnostic performance predicting MFR < 2.0 according to the following criteria: CS starting time > -0.36 seconds was 86% sensitivity, 76% specificity, and an area under the curve of 0.83.

#### CONCLUSION

Dynamic CCTA-estimated CS flow measurements were significantly correlated with  $^{13}\text{N}$ -PET-derived MBF and MFR values. A delayed CS start time can be used to predict a significant decrease in MFR in coronary artery disease.

#### CLINICAL RELEVANCE/APPLICATION

This method may help estimate MFR even in facilities that do not have a PET scanner.

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## Abstract Archives of the RSNA, 2023

W5A-SPCA-4

### Impact of Super-Resolution Deep Learning Reconstruction Technique on Dynamic Myocardial Computed Tomography Perfusion Imaging

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Tomoro Morikawa, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Super-resolution deep-learning reconstruction (SR-DLR) is a novel computed tomography (CT) image reconstruction technique using a deep convolutional neural network that allows for improvement of spatial resolution on CT images as with ultra-high-resolution CT. This study aims to evaluate the impact of SR-DLR on the image quality and hemodynamic parameter of dynamic myocardial computed tomography perfusion (CTP) by comparing with hybrid iterative reconstruction (HIR) and DLR.

#### METHODS AND MATERIALS

This retrospective study included 26 patients who underwent dynamic myocardial CTP with pharmacological stress using 320-detector-row CT scanner for assessing coronary artery disease. The CTP images were reconstructed with HIR, DLR, and SR-DLR. For qualitative image quality assessment, overall visual score was evaluated on 4-point scale (1=poor, 4=excellent). For quantitative image quality assessment, CT attenuation and standard deviation in the myocardium (septum and lateral wall) and blood pool were recorded to calculate the image noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR). Additionally, the CT attenuation profile across the myocardium and blood pool was generated to measure the edge rise slope (ERS) and edge rise distance (ERD). For hemodynamic parameter assessment, overall CT-derived myocardial blood flow (CT-MBF) was quantified. These results were compared among three different CTP images reconstructed by HIR, DLR, and SR-DLR.

#### RESULTS

The mean visual image quality score on SR-DLR was better than on HIR and DLR (3.6 vs 2.2 and 2.8;  $p < 0.01$ ). The median image noise on SR-DLR was significantly lower than on HIR and DLR (15.6 vs 23.1 and 17.8;  $p < 0.01$ ). The mean SNR and CNR on SR-DLR were significantly higher than on HIR and DLR (SNR: 9.7 vs 7.3 and 7.9,  $p < 0.01$ ; CNR: 28.5 vs 20.1 and 23.4,  $p < 0.01$ ). The median ERD on SR-DLR was significantly shorter than on HIR and DLR (2.3 vs 3.0 and 2.6;  $p < 0.01$ ), and the mean ERS on SR-DLR was significantly steeper than on HIR and DLR (168.4 vs 126.1 and 151.2;  $p < 0.01$ ). There was no significant difference in mean CT-MBF among the three different CTP images reconstructed by HIR, DLR, and SR-DLR (2.37, 2.38 vs 2.39 mL/g/min).

#### CONCLUSION

SR-DLR was superior to HIR and DLR with respect to the image noise and the sharpness of myocardial margins without altering CT-MBF quantification in dynamic myocardial CTP imaging.

#### CLINICAL RELEVANCE/APPLICATION

SR-DLR allows for improving the image noise and sharpness more effectively than conventional reconstruction techniques in dynamic myocardial CTP imaging without requiring hardware changes. SR-DLR has a potential to improve the detectability of myocardial perfusion abnormality by taking advantage of the high spatial resolution and noise reduction capability.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPCA-5

### Deep-Learning Image Reconstruction Algorithm: Impact on Plaque Analysis in Coronary Computed Tomography Angiography

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Domenico De Santis, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Plaque composition in Coronary Computed Tomography Angiography (CCTA) relies on plaque density measurements and subsequent partition in different components: lipid, fibro-fatty, and calcified. Newly developed deep-learning image reconstruction algorithms (DLIR) hold promises to replace iterative reconstructions in CCTA, granting high image quality, low dose, and no detrimental effect on image texture; however, different strength levels may have an impact in plaque features extraction. The aim of this study was to assess the influence of DLIR at different strength levels on coronary plaque analysis.

#### METHODS AND MATERIALS

Forty consecutive patients (mean age  $61.9 \pm 15.4$  y) who underwent clinically indicated retrospectively ECG-gated CCTA were included in the study. CT scans were performed on a 128-row CT scanner (Revolution EVO, GE Healthcare) with the following parameters: tube voltage, 100 kV; tube current: 200 mA; detector collimation: .625 mm, rotation time: .6 s, automatically adjusted spiral pitch from .16 to .30, and matrix:  $512 \times 512$  pixels. A fixed amount (60 mL) of iodinated contrast medium (Iomeprol 400) was intravenously administered at a flow-rate of 5 mL/s. Raw data were reconstructed using ASiR-V 50% and DLIR at three strength levels (DLIR\_L, DLIR\_M, and DLIR\_H). Plaque analysis was performed using a dedicated software (SurePlaque, Canon Medical Systems, Japan): plaque burden, plaque volume, mean density, and plaque composition were assessed on a per-vessel analysis. Statistical analysis was performed by means of Kruskal-Wallis H Test, followed by Dunn's test for pairwise comparisons.

#### RESULTS

Fifty-seven plaques were analyzed for each reconstruction, for a total of 228 plaques. Total plaque burden was 61.1%, plaque volume was 132 mm<sup>3</sup>, and mean density was 179 HU. DLIR at different strength levels did not show statistically significant differences in the three parameters (all  $P = .906$ ). In terms of plaque composition, no differences have been found for fibro-fatty and calcified components ( $P = .503$  and  $= .821$ , respectively). The mean density of lipid plaques was statistically different among the four algorithms ( $P = .013$ ), in particular pairwise comparison showed difference between DLIR\_L and DLIR\_H ( $P = .009$ ).

#### CONCLUSION

DLIR has no impact on overall plaque analysis compared to routinely applied ASiR-V; DLIR\_L might return lower density values for lipid plaque component.

#### CLINICAL RELEVANCE/APPLICATION

DLIR grants reliable coronary plaque analysis; therefore, it can be safely implemented in CCTA examinations. DLIR\_L impact on lipid component should not hinder plaque analysis, since lower lipid density values broaden the density differences with fibro-fatty plaque component.

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## Abstract Archives of the RSNA, 2023

W5A-SPCA-6

### Evaluation of Dual-Source Photon-Counting CT Virtual Monoenergetic Imaging of Coronary Arteries in TAVI Patients

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Daniel Overhoff, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Transcatheter aortic valve implantation (TAVI) is a widely utilized valve replacement procedure. The coronary arteries must be assessed before each procedure, which is usually done using invasive catheter angiography. The photon counting detector-CT (PCD-CT) yields the possibility to evaluate the specifications of the valve and the coronary arteries with a one-stop-shop approach. The aim of this study was to evaluate the impact of low energy virtual monoenergetic images (VMI+) objective image parameters (vessel enhancement, noise (standard deviation of vessel attenuation), signal to noise ratio (SNR), contrast to noise ratio (CNR)) of the coronary arteries in pre-TAVI CT examinations.

#### METHODS AND MATERIALS

We retrospectively analyzed 125 pre-TAVI CT datasets from a first generation Dual-Source PCD-CT (Naeotom alpha, Siemens Healthineers, Forchheim Germany). The coronary arteries were analyzed in virtual monoenergetic images ranging from 40 to 100 keV in 15 keV steps. Maximum vessel density Hounsfield Units (HU) were measured for Left main (LM), Right coronary artery (RCA), Left circumflex (LCX) and Left anterior descending (LAD) at the proximal vessel segment. Signal-to-noise ratio and contrast-to-noise ratio were calculated.

#### RESULTS

A total of 125 patients (73 male/52 female) were included in the final assessment. Maximum intraluminal enhancement of coronary arteries was measured for 40keV ( $1123\pm 312$ HU) with decreasing density values with increasing keV values (100keV  $220\pm 55$ HU). SNR showed a significant reciprocal values with highest SNR at 100keV compared to 40keV ( $14.55\pm 9.47$  vs  $10.68\pm 6.68$   $p<0.001$ ). The CNR, in turn, demonstrated significantly improved values at lower keV levels. (40keV vs 100keV/  $26.37\pm 10.15$  vs  $8.50\pm 3.50$   $p<0.001$ ). There were no significant gender differences in the above changes.

#### CONCLUSION

PCD-CT virtual monoenergetic images offer the possibility to improve the image quality for the assessment of the coronary arteries in pre-TAVI-CT. The highest vascular contrast and CNR are achieved at 40keV. SNR is highest at 100keV and decreases at lower keV levels.

#### CLINICAL RELEVANCE/APPLICATION

PCD-CT virtual monoenergetic images yield the possibility of potential reduction of contrast media and an optimization of image quality with reduction of radiation dose for the analysis of coronary arteries in TAVI patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPCH-1

### Impact of Different AI User Interfaces on Lung Nodule and Mass Detection on Chest Radiographs

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Jennifer S. Tang, MBBS, FRANZCR (*Presenter*) Founder, STAT Innovations Pty Ltd

#### PURPOSE

To explore the impact of different user interfaces (UIs) for artificial intelligence (AI) outputs on radiologist performance and user preference in detecting lung nodules and masses on chest radiographs.

#### METHODS AND MATERIALS

A retrospective paired-reader study with a 4 week washout period was used to evaluate three different AI UIs compared with no AI output. Ten radiologists (8 radiology attendings and 2 trainees) evaluated 140 chest radiographs (81 with histologically confirmed nodules and 59 confirmed as normal by CT), with either no AI or one of three UI outputs: 1) text only, 2) combined AI confidence score and text, or 3) combined text, AI confidence score and image overlay. Areas under the receiver operating characteristic curve (AUCs) were calculated to compare radiologist diagnostic performance with each UI with performance without AI. Radiologists reported their user interface preference.

#### RESULTS

AUC improved when radiologists used the text-only output compared with no AI (0.87 vs 0.82,  $p$ -value<0.001). There was no difference in performance for the combined text and AI confidence score output compared with no AI (0.77 vs 0.82,  $p$ -value=0.46) and for the combined text, AI confidence score and image overlay output compared with no AI (0.80 vs 0.82,  $p$ -value=0.66). Eight of the 10 radiologists (80%) preferred the combined text, AI confidence score and image overlay output over the other two interfaces.

#### CONCLUSION

Text only UI output significantly improved radiologist performance compared with no AI in the detection of lung nodules and masses on chest radiographs, but user preference did not correspond with user performance.

#### CLINICAL RELEVANCE/APPLICATION

Understanding the impacts of how different user interfaces may alter reader performance is a crucial aspect of AI implementation in radiology.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5A-SPCH-2

### Physics-based Data Augmentation to Improve Chest X-ray Abnormality Classification

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Heejun Shin, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Many AI methods to detect chest X-ray (CXR) abnormalities have demonstrated promising results by adopting image pre-processing techniques (e.g., histogram equalization (HE), contrast limited adaptive histogram equalization (CLAHE), and unsharp masking (UM)). However, those methods showed limited diagnostic performance when applied to CXRs with different image characteristics from various X-ray scanners. Here, we propose an X-ray physics-based data augmentation (i.e., XPA) that perturbs CXRs during AI training to overcome this problem.

#### METHODS AND MATERIALS

Unlike conventional image pre-processing methods (e.g., HE, CLAHE, and UM) that normalize CXRs before AI training and testing, XPA randomly perturbs image characteristics on training CXRs by applying a series of image processing methods (e.g., gamma correction for contrast perturbation) to mimic hardware-related changes (e.g., voltage, current, etc.) during AI training. Seven datasets from different X-ray machines (digital radiography (DR) or computed radiography (CR)) and institutions were collected. One dataset was from a Vietnam hospital and annotated by a radiologist as normal or abnormal (e.g., opacity, etc.) for AI (7,202 CXRs for training; 1,278 CXRs for testing (VHDR1)). Four datasets were from Indonesian hospitals, including a dataset acquired from a portable X-ray machine (IHCR1,Portable:204; IHCR2 :227; IHCR3:356; IHDR2:1,909 CXRs) and annotated for AI testing. Two datasets (i.e., Shenzhen (SZDR3) and Montgomery (MGCR4)) were from public domains as testing data. We trained four AI models (EfficientNet-B6) using HE, CLAHE, UM, and proposed XPA to classify CXRs as normal or abnormal and compared their diagnostic performance. To check the capability of each method to cover CXRs from different machines, only the CXRs acquired using the DR system in the Vietnam hospital were utilized for training.

#### RESULTS

For VHDR1 (internal test dataset), the diagnostic performance of all AI models was not statistically significant (i.e.,  $p$ -value $>0.05$ ). However, in most of the test datasets, the AI model with XPA outperformed the others, including the datasets acquired from the different CR detectors (IHCR2, IHCR3, and MGCR4), portable X-ray machine (IHCR1,Portable; AUC: 0.950 for XPA; 0.924 for HE; 0.920 for CLAHE; 0.891 for UM;  $p$ -value $<0.05$ ), and DR detectors (IHDR2 and SZDR3).

#### CONCLUSION

The diagnostic performance of the AI model was improved with XPA for the CXR datasets from different X-ray machines (i.e., DR, CR, and portable machines) compared to those of the other AI models with conventional image pre-processing methods.

#### CLINICAL RELEVANCE/APPLICATION

The proposed AI showed potential clinical usage when the CXRs were acquired using various X-ray scanners.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPCH-3

### Investigating the Feasibility of Using AI to Detect Unreported Chronic Disease Findings on Chest X-Ray in a Retrospective Aged Patient Dataset

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Jonathan S. Luchs, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study evaluates the feasibility of using an artificial intelligence (AI) model to retrospectively identify 27 chronic disease findings in an aged patient chest X-ray (CXR) dataset. The aim of this study was to investigate the ability of the AI model to identify findings not previously reported in the radiologists' report. This aims to validate the usefulness of AI as a quality improvement device to improve the characterization of patient cardiovascular disease risk.

#### METHODS AND MATERIALS

The study dataset consisted of 1,261 CXRs from patients  $\geq 65$  years, collected from outpatient clinics. CXR images were retrospectively processed by the AI for the presence of predefined chronic disease findings. As a comparison, the radiologist report was manually reviewed for the presence/absence of these findings, with findings considered absent if they were not mentioned in the report. In cases where there was a discrepancy between the model and report, a radiologist adjudicator evaluated the CXR scan to determine ground truth (GT), i.e. if the finding was overcalled or under called by the AI model/radiologist.

#### RESULTS

Reported prevalence of findings varied between the AI model and report. The AI model reported 505, 731, 650 and 783 instances of cardiomegaly, unfolded aorta (UA), aortic arch calcification (AAC) and spine arthritis (SA), compared to 194, 12, 622 and 562 in the report, respectively. There were 133, 48 and 29 instances of lower, upper, and diffuse interstitial thickening reported by the AI model, compared to 554, 553 and 557 in the report, respectively. Across all findings, Cohen's Kappa agreement was 0.17, indicating slight agreement. Comparison with the GT showed that cardiomegaly, UA, AAC and SA were underreported in the report compared to the AI model (report sensitivity (sens): 0.32, 0.02, 0.54, 0.44, vs. AI model sens: 0.83, 0.86, 0.75, 0.75, respectively). This resulted in 68%, 98%, 46%, and 56% of these findings being missed by the report, while 17%, 14%, 25%, and 25% were missed by the AI model. Conversely, diffuse, lower and upper interstitial thickening were over reported compared to the AI model, as shown by reduced specificity of the report (report; 0.58, 0.58, 0.58 vs. AI; 0.99, 0.92, 0.96, respectively).

#### CONCLUSION

AI models in medical imaging have typically focused on radiological finding detection to provide diagnostic assistance to radiologists. Here we present evidence that a quality improvement AI device can enhance patient care and management through the detection of under and over reporting of chronic disease findings.

#### CLINICAL RELEVANCE/APPLICATION

Chronic diseases are often incidentally detected on CXR but not reported due to their low-risk nature. However, these findings can be significant predictors of patient health risk.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPCH-4

### **Multiclass Labelling of Foreign Hardware on Chest Radiographs using a Convolutional Neural Network**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Leon Chalil, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the accuracy of transfer learning with a pre-trained convolutional neural network (CNN) in detecting multiple classes of medical devices and other foreign bodies on chest radiographs.

#### **METHODS AND MATERIALS**

A total of 2000 de-identified, publicly available chest radiographs were binary labelled for the presence of 18 different types of foreign bodies by two radiology fellows. The images were split into training and validation data sets (80:20 ratio). A pre-trained ResNet50 convolutional neural network model based on weights obtained from ImageNet was loaded from the TensorFlow environment. The top layer was removed and replaced with a single densely connected layer. The ResNet50 pretrained model expects a 224 x 224 x 3 channel input. The x-ray images were down sampled to 224 x 224 using simple averaging.

#### **RESULTS**

After several epochs the neural network could correctly classify the presence or absence of different medical devices or foreign objects with an accuracy of 78-99% on the validation data set, and 10/17 classes were detected with >90% accuracy. This model did show high average specificity (98% [93-100%]) but variable sensitivity (57% [11-100%]) across classes, likely attributable to the small size of the dataset and high similarity in form and position of several devices.

#### **CONCLUSION**

Transfer learning using a pre-trained neural network permits high accuracy classification of foreign bodies and medical devices on chest radiographs without the need for hyperparameter tuning. Larger datasets and improved annotation will be required to further improve the performance of future models.

#### **CLINICAL RELEVANCE/APPLICATION**

These findings represents an important step towards more accurate and rapid confirmation of device presence in comparatively undifferentiated CXRs.

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## Abstract Archives of the RSNA, 2023

W5A-SPCH-5

### Radiomics Analysis for Predicting Progression of Part-Solid Nodules on CT

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Shiny Weng, BA, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiomics, with its diverse set of features, has the potential to reveal novel avenues for identifying malignant nodules and detecting subtle patterns not visible to the naked eye. In clinical practice, identifying progressive nodules is crucial for detecting malignancies. Hence, this study aims to explore the statistical significance of radiomic and clinical features in predicting overall growth in part-solid nodules (PSNs).

#### METHODS AND MATERIALS

In this retrospective study, institutional chest CT scans between 2015 and 2019 were collected. Corresponding radiology reports were used to extract ground truth labels for nodules' growth status (i.e., increase vs. unchanged), as well as other related information such as nodule size, location, slice, component sizes, and compared studies. An automated NLP pipeline was used for the extraction, and manual review was used to ensure the dataset's accuracy. Additionally, associated CT scans were run through a commercial nodule characterization algorithm. The parameters generated from this algorithm, such as nodule size and location, were then compared and matched with the extracted features from the original radiology reports.

#### RESULTS

The final dataset consists of 1276 PSNs, and ground truth labels are available for 1009 PSNs (830 unchanged, 166 growing, 13 decreasing). From this dataset and using radiomic (from pyRadiomics) and clinical features (e.g., patient age, gender), we developed various ML models for predicting growth in PSNs, of which Random Forests achieved the highest AUC of 0.78 on the validation set. Moreover, in the statistical analyses of the association of radiomic and clinical features with nodule progression, 88 radiomic features were statistically significant ( $p < 0.05$ ) based on a Mann-Whitney U Test. Such radiomic features include Surface Volume Ratio, Zone Variance, and Small Dependence High Gray Level Emphasis, all of which had high feature importance for identifying progressive nodules in the Random Forests model. Among clinical features, Patient Age exhibited high feature importance. 75 features were used for the Random Forests model, which were selected using random forest importance, recursive feature elimination, and univariate selection.

#### CONCLUSION

We developed a model to identify nodule progression from a predictive set of radiomic and clinical features, achieving an AUC of 0.78 on the validation set. Additionally, we have assembled a labeled dataset of 1009 PSNs, which includes various attributes such as nodule size, type, and location.

#### CLINICAL RELEVANCE/APPLICATION

By employing radiomics, statistical analysis, and machine learning, we may produce accurate early characterization of growing adenocarcinoma spectrum nodules and optimize management and outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPCH-6

### Artificial Intelligence System for Identification of Overlooked Lung Metastasis in Abdominal CTs of Patients with Malignancy

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Hye Soo Cho (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate whether an artificial intelligence (AI) system can identify metastatic nodules in basal lungs covered by abdominal CTs initially overlooked by radiologists.

#### METHODS AND MATERIALS

We retrospectively abdominal CT images with the following inclusion criteria: a) CTs obtained from patients with any solid organ malignancy between March 1st and 31st, 2019 in a single institution; b) abdominal CT interpreted as negative for metastasis in covered basal lungs. Patients who underwent chest CT on the same day with abdominal CT, and patients lost to follow-up within 3 years without clinical diagnosis of lung metastasis. The reference standards for the diagnosis of lung metastasis were confirmed by the review of medical records and subsequent CT images. An AI system that can automatically detect lung nodules in CT images was retrospectively applied. The AI results were reviewed by a radiologist to confirm the lesion is a true lung nodule with the possibility of metastasis. The detection yield (the proportion of true-positive results among entire patients), sensitivity, and positive predictive value (PPV) of the AI system and the radiologist who reviewed AI results were evaluated, for the identification of patients with basal lung metastasis overlooked during the initial interpretation.

#### RESULTS

A total of 878 patients (66% men; mean age 65 years) were included. The most common primary malignancy was hepatocellular carcinoma (411, 47%), followed by stomach (169, 19%) and colorectal cancer (11%). Lung metastases were diagnosed in 69 patients (7.8%) within 3 years from the abdominal CT. Among them, 12 patients (1.4%) had overlooked metastasis in the basal lungs covered by the abdominal CT. The AI system identified 319 lesions in 176 patients (positive rate, 20%). Among the 319 AI results, 261 (81.8%) were true lung nodules by the radiologists' review, and 25 (7.8%) were metastatic nodules overlooked during the initial interpretation. The detection yield, sensitivity, and PPV of the AI system to identify patients with overlooked basal lung metastasis were 1.4% (12/878), 100% (12/12), and 6.8% (12/176), respectively. Meanwhile, the radiologist's review of AI results resulted in the detection yield, sensitivity, and PPV of 1.4% (12/878), 100% (12/12), and 14% (12/86), respectively.

#### CONCLUSION

In patients with solid organ malignancies, an AI system exhibited excellent sensitivity for the identification of metastases in basal lungs covered by abdominal CTs that radiologists initially overlooked.

#### CLINICAL RELEVANCE/APPLICATION

An AI system may help radiologists not overlook small lung basal lung metastasis in abdominal CTs by providing feedback to the radiologists in case of suspicions, which could be an efficient method to reduce interpretation errors.

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## Abstract Archives of the RSNA, 2023

W5A-SPCH-7

### **Surveillance Breeds Conformity! Multicenter, Post-market Surveillance of a Multi-finding AI Algorithm for the Interpretation of Chest Radiographs**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Giridhar Dasegowda, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Post-market surveillance of AI algorithms can help assess real world performance and impact of AI algorithms. We performed a multicenter, post-market surveillance (PMS) of a multi-finding AI algorithm for the interpretation of chest radiographs (CXR).

#### **METHODS AND MATERIALS**

Our retrospective, multicenter study included 2066 consecutive CXRs obtained from 7 practices across 7 geographically diverse states in India. CXRs belonged to 1167 men and 899 women with a mean age of  $46 \pm 17$  years. All centers had Qure.AI CXR algorithm implemented in routine clinical interpretation of CXRs. For a fraction of CXRs, AI outputs were either unavailable due to technical difficulties or not used due to low confidence interval for the findings. All consecutive CXRs from the centers were de-identified and uploaded on the annotation platform. An experienced thoracic radiologist blinded to the AI output evaluated the CXRs to establish the ground truth. We compared the performance of AI-aided and unaided clinical interpretation of CXRs. Sensitivity, specificity, ROC AUC with 95% confidence interval were used to evaluate the performance.

#### **RESULTS**

The AI output had a better standalone performance compared to radiology reports (AUC of 0.72 - 0.90, sensitivity 44%-83% and specificity 81%-100%). The overall reporting performance for cardiomegaly, nodule, opacities, blunted costophrenic angle, cavity and to differentiate normal from abnormal CXRs compared to the ground truth had an AUC of 0.62 - 0.75, 28%-88% sensitivities and 56%-100% specificities. The performance of radiologists improved significantly with AI-aided reporting over those CXRs reported without AI outputs at the time of reporting with an effective increase in 6%-19% in AUC ( $p < 0.01$ ).

#### **CONCLUSION**

Our PMS study demonstrates an overall improvement in the radiologists' performance with AI-aided interpretation of CXRs.

#### **CLINICAL RELEVANCE/APPLICATION**

In the real-world application, the assessed AI algorithm improves the interpretation of for CXRs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPCH-8

### The Path to Successful AI Adoption in Radiology: Investigating Hurdles in The Computer-Assisted Diagnosis Implementation within Hospital Settings

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

James H. Scrivner JR, MBA, ARRT (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate that AI implementation in hospital radiological practice requires careful business assessment and planning: from the end-user experiences to training and workflow adjustments.

#### METHODS AND MATERIALS

Radiologists who agreed to participate in quantitative and qualitative surveys were prospectively recruited from December 2022 to April 2023. To identify the challenges in AI adoption, this study measured the CAD technology acceptance and diffusion using an extended diffusion framework, namely the Extended Technology Acceptance Model (ETAM) based on 1) Unified Theory of Acceptance and Use of Technology (UTAUT) and 2) Diffusion of Technology (DOI). This integrated model evaluated the interaction of CAD and radiologists by incorporating the latent structures of trust, accuracy, efficiency, adoption, and diffusion from a behavioral, psychological, and social perspective. Following the ACR Data Science Institute Artificial Intelligence survey (2020), this study also collected information on AI usage, demographics, and AI performance evaluation.

#### RESULTS

A total of 10 radiologists participated in qualitative interviews and 68 radiologists participated in quantitative surveys (~5% response rate). The overall perception of clinical AI usage is higher than national usage (39% versus 26%). The findings highlighted several challenges facing the adoption of AI in radiology. While most participants expressed trust in AI innovation, they demonstrated major hurdles in AI adoption, including interpretation time and time management issues. The major concerns are in the poor integration and usability caused by the lack of radiologists' involvement in user testing. As a result, many participants used AI only as a second reader or triage tool.

#### CONCLUSION

While the potential benefits of AI in healthcare are widely acknowledged, it is important to recognize that the adoption of AI technology is not guaranteed simply by implementing AI tools. Successful AI adoption requires careful consideration of factors such as user training, workflow integration, and the development of appropriate governance and validation frameworks.

#### CLINICAL RELEVANCE/APPLICATION

As the use of AI solutions for improving diagnostic accuracy gains significant attention, the need for an operational framework that would involve radiologists as end-users becomes increasingly apparent. Such a framework would guide the deployment, interoperability, and validation of AI in clinical practice, ultimately contributing to the development of safe and effective AI-based diagnostic tools. This study documents operational issues and proposes initial guidelines for clinical implementations.

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## Abstract Archives of the RSNA, 2023

W5A-SPER-1

### Identifying and Communicating Urgent Findings in Emergency Radiology: A Scoping Review

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Lucas Corallo, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine existing published standards for the identification and communication of critical actionable imaging findings in emergency radiology. To identify the associated facilitators and barriers to the communication and management of critical imaging findings.

#### METHODS AND MATERIALS

A scoping review of published literature was performed through 2 databases (PubMed, Embase) with search terms pertaining to critical findings in emergency radiology. Articles and guidelines published in all languages from January 2010 to September 2022 were considered. Screening of database hits using pre-established inclusion criteria was performed by 3 analysts with reconciliation of discordance by consensus. A gray literature search for societal guidelines and high-impact policies was added to the database search. Data extraction included the following: year, country, resource type, scope/purpose, participants, context, standards to identifying/communicating critical findings, facilitators/barriers, method type, recommendations, applicability, and disclosures.

#### RESULTS

60 records were included in the final analysis, including 12 societal/commission guidelines. Among the included guidelines, no standardized lists of critical findings were identified, however, recommendations to create a local policy for critical findings were made in 5/12 guidelines. Reference to critical findings policies from the Joint Commission (16/60 articles), and ACR (30/60 articles) were most frequent. Standards used by centres for critical findings often applied a formal list of findings or classifications based on acuity. Among standards based on acuity (n=12), a 3-tier classification system was most common. Standards for communication included direct closed-loop communication for high acuity findings, with more flexible communication channels for less acute findings. Interventions for critical findings management most frequently fell into 4 categories: electronic (n=7), hybrid electronic/admin (n=5), feedback/education (n=5), and administrative (n=2).

#### CONCLUSION

There are variable standards, policies, and interventions for the management of critical findings in emergency radiology. ACR and Joint Commission standards were most frequently applied. Interventions applied EMR-based strategies, call-centres, and traditional phone/fax. Further research should seek to evaluate consistency and efficiency of closed-loop communication protocols, provider satisfaction, and patient outcomes.

#### CLINICAL RELEVANCE/APPLICATION

Summarizes the policies around critical results reporting in emergency radiology. Provides a guide for consensus building, innovation and rapid adoption towards greater patient safety, and provider satisfaction.

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## Abstract Archives of the RSNA, 2023

W5A-SPGI-1

### **Sensitivity of MRI to Detect Microscopic Fat in Adrenal Adenomas: Comparison of 2D Dual Gradient-echo and 3D DIXON Techniques**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Abdullah Khan, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the sensitivity of 2D dual gradient-echo and 3D DIXON chemical shift MRI (CSI) for detecting microscopic fat in adrenal adenomas.

#### **METHODS AND MATERIALS**

We performed a retrospective study of 35 patients (15 male, 20 female, mean age 61.8 years) with adrenal nodules who underwent both 2D dual gradient-echo and 3D DIXON T1-weighted CSI on a 1.5T scanner. The signal intensity (SI) of the nodules was obtained using a single ROI in the center of the nodule (comprising at least 2/3rds the nodule diameter) and the signal intensity index (SII) was calculated [ $100 \times (\text{SI in phase} - \text{SI out of phase}) / \text{SI in phase}$ ]. Reference standard for the diagnosis of 29 adenomas was made by no change in nodule size or growth  $< 3\text{mm/year}$  in long axis for at least 1 year on follow up imaging ( $n=19$ ), unenhanced CT attenuation of  $< 10$  HU ( $n=8$ ), or pathology ( $n=2$ ). The mean time to imaging follow up was 4.5 years (range 1.1-10.5 years). The diagnosis of metastasis was made by pathology ( $n=1$ ) and nodule growth  $> 3\text{mm/year}$  in a patient with known cancer ( $n=1$ ). There was one pheochromocytoma diagnosed by pathology. Three nodules had no adequate reference standard. Sensitivity for the diagnosis of adrenal adenoma was determined using a SII of  $> 16.5\%$ .

#### **RESULTS**

There were 35 nodules (mean size 22 mm, range 11-55 mm). The SII was higher on 2D CSI compared to 3D DIXON in 80% (28/35) of nodules by a mean of 14.4%. Of the 29 adenomas, the SII was higher on 2D CSI compared to 3D DIXON in 90% (26/29) of nodules. Among adenomas, the mean SII was 48% on 2D CSI and 33% on 3D DIXON ( $p=.02$ ). Sensitivity for the diagnosis of adenoma was 89.7% (26/29; 95% CI 72.7-97.8%) for 2D and 75.9% (22/29; 95% CI 56.5-89.7%) for 3D DIXON. None of the 3 non-adenomas had SII  $> 16.5\%$  on either technique.

#### **CONCLUSION**

2D dual gradient-echo CSI has a higher sensitivity for detection of microscopic fat in adrenal nodules and the diagnosis of adrenal adenoma than the 3D DIXON technique. The sensitivity of 2D dual gradient-echo CSI for adrenal adenoma is approximately 90%.

#### **CLINICAL RELEVANCE/APPLICATION**

Adrenal MRI protocols should include 2D dual gradient-echo CSI and not rely solely on 3D DIXON techniques for the diagnosis of adrenal adenomas.

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## Abstract Archives of the RSNA, 2023

W5A-SPGI-4

### Deep Learning Reconstruction Improves Image Quality of Acquired and Computed Diffusion-weighted MR Imaging of the Liver

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Hiromitsu Onishi, MD, PhD (*Presenter*) Research Grant, General Electric Company; Speakers Bureau, General Electric Company

#### PURPOSE

Image noise is the main problem in diffusion-weighted (DW) MR imaging. Deep learning reconstruction (DLR) can improve the image quality of MR imaging. The aim of this study was to determine whether DLR can improve the image quality of acquired and computed DW images of the liver.

#### METHODS AND MATERIALS

This retrospective study included 44 consecutive patients with suspected focal liver lesions who underwent liver MR examinations with a 3.0-T system. DW images of the whole liver were acquired at b-values of 0 and 1000 s/mm<sup>2</sup> during breath-hold (TR/TE = 4500/76 msec, 5 mm thickness, and 96×96 matrix). Computed high b-value DW images (b = 1500 s/mm<sup>2</sup>) were synthesized from the acquired DW images. One radiologist measured the signal-to-noise ratio (SNR) of the liver parenchyma and the contrast-to-noise ratio (CNR) between malignant tumors and parenchyma on acquired and computed DW images with and without DLR. Another radiologist assessed image quality using a five-point visual scoring system (1 [unacceptable] to 5 [excellent]). Results were compared using paired t-test for quantitative assessment and Wilcoxon signed rank test for visual assessment of image quality.

#### RESULTS

Both acquired and computed DW images with DLR had significantly higher SNRs and CNRs than DW images without DLR; mean SNR was 13.6 versus 9.4 for acquired images ( $P < .001$ ) and 8.1 versus 5.9 for computed images ( $P < .001$ ), and mean CNR was 56.6 versus 37.2 ( $P < .001$ ) and 33.7 versus 23.6 ( $P < .001$ ), respectively. Qualitative analyses showed that DLR significantly improved image noise and image sharpness ( $P < .001$  for each), but did not change motion artifacts and signal loss just below the heart. DW imaging with DLR also demonstrated superior overall image quality compared to DW imaging without DLR; median score was 4 versus 2 for acquired images ( $P < .001$ ), 3 versus 2 for computed images ( $P < .001$ ).

#### CONCLUSION

DLR efficiently reduced image noise and significantly improved the image quality of both acquired and computed DW MR images of the liver.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning reconstruction improves the image quality of liver diffusion-weighted images with a short acquisition time and can greatly contribute to the efficiency of liver MR examinations.

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## Abstract Archives of the RSNA, 2023

W5A-SPGI-5

### **Radiologic Response and Association with Prognosis in Patients Treated with Transarterial Radioembolization or Stereotactic Body Radiation Therapy for HCC**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Sangyun Lee, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Transarterial radioembolization (TARE) and stereotactic body radiation therapy (SBRT) are locoregional therapies for potentially resectable and unresectable HCC. A limited number of studies have evaluated radiologic treatment response and association with prognosis in radiation-based therapy-treated HCC. We evaluated the radiologic appearance of post-TARE and SBRT-treated images of HCCs to assess treatment response and identify its association with prognosis.

#### **METHODS AND MATERIALS**

We retrospectively identified 104 patients (77 males; mean age  $\pm$  SD, 65.9  $\pm$  12.6 years) treated with SBRT (68 patients, 83.4%) and TARE (36 patients, 34.6%) from 2015 to 2022. Pre- and post-treatment contrast-enhanced CT or MRI scans performed 3 months after treatment were evaluated for treatment response according to the following rules: no intralesional APHE as nonviable; stability or decrease in size and/or degree of intralesional APHE as non-progressing; new or increased size of intralesional APHE as viable disease. Pre- and post-treatment AFP levels, tumor and APHE component size, portal vein tumor thrombus, etiology of liver disease, overall survival (OS) and progression-free survival (PFS) were recorded. Cox proportional hazards model and Kaplan-Meier curves with log-rank test were used for statistical analysis.

#### **RESULTS**

The mean size of HCC was 4.9 cm, and 25 patients (24%) had portal vein tumor thrombus. The mean AFP level was 2314.3 ng/mL. Median follow-up was 20.6 months (range, 3-142), with 29 (27.9%) deaths and 69 (66.3%) disease progressions. Sixty-three (60.6%) patients achieved non-viable disease at least once during follow-up. At the first 3-month follow-up, 40 (38.5%), 43 (41.3%), and 21 (20.2%) patients had nonviable, non-progressing, and viable disease, respectively. In univariate analysis, radiologic response at 3 months and nonviable disease ever during follow-up were significantly associated with OS, but only radiologic response at 3 months was the independent factor in multivariate analysis ( $p = 0.009$ ). For PFS, viable disease at the first 3-month follow-up, nonviable disease ever during follow-up, tumor size, male sex, and initial AFP level were the independent predictors in multivariate analysis ( $p = 0.034$ ). The type of radiotherapy did not affect OS or PFS. The 2-year cumulative OS for non-viable, non-progressing, and viable disease was 96.6%, 72.6%, and 67.9%, respectively.

#### **CONCLUSION**

Response to radiotherapy at 3 months and during follow-up assessed by changes in radiologic APHE significantly correlated with OS and PFS.

#### **CLINICAL RELEVANCE/APPLICATION**

Persistent APHE 3 months after radiotherapy for HCC may indicate a poor prognosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPGI-6

### Comparing Early Treatment Response as Assessed by RECIST 1.1, mRECIST, and Choi Criteria in HCC Treated with Atezolizumab plus Bevacizumab

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Seung Hoon Choi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Atezolizumab plus bevacizumab (Ate/Beva) is endorsed as first-line systemic therapy for unresectable HCC ineligible for transplantation or locoregional therapy. Given the anti-angiogenic effect of the regimen, RECIST version 1.1 may underestimate the treatment response, potentially leading to unnecessary early discontinuation of the therapy. We aimed to compare RECIST 1.1, modified RECIST (mRECIST), and Choi criteria in assessing early treatment response in Ate/Beva-treated HCCs and their correlations with overall survival (OS) and progression-free survival (PFS).

#### METHODS AND MATERIALS

From May 2022 to December 2022, 42 patients (36 men; mean  $\pm$  SD age, 61.9  $\pm$  12.9 years) who received Ate/Beva for unresectable HCC without prior systemic therapy were retrospectively included. Pre-treatment and the first post-treatment contrast-enhanced CT or MRI scans, performed after completion of at least three cycles of Ate/Beva, were reviewed by two abdominal radiologists to assess treatment response according to RECIST 1.1, mRECIST, and Choi criteria. OS and PFS were recorded. Kaplan-Meier curves with log-rank test and Cohen's kappa were used for the statistical analysis.

#### RESULTS

The median time from the start of Ate/Beva to the first response assessment was 99 days (range, 51-182 days). Responders (patients with a complete or partial response) were 10 (23.8%), 13 (31.0%), and 18 (42.9%) when evaluated by RECIST 1.1, mRECIST, and Choi criteria, respectively. One (2.4%) and two (4.8%) patients classified as having progressive disease (PD) by RECIST 1.1 were re-assessed as stable disease and partial response by mRECIST and Choi criteria, respectively. The inter-reader agreement  $\kappa$  for RECIST 1.1, mRECIST, and Choi criteria was 0.85, 0.75, and 0.85, respectively. Responders identified by RECIST 1.1 did not show a significant correlation with OS ( $p = 0.082$ ), while those identified by mRECIST and Choi were correlated with prolonged OS ( $p$ s = 0.049). Responders identified by all three criteria showed a significant correlation with PFS ( $p$ s = 0.029). Cumulative 1-year PFS rates for responders were 72%, 76.4%, and 78.4% for RECIST 1.1, mRECIST, and Choi, respectively, and 74.4%, 72.4%, and 66.7% for non-responders.

#### CONCLUSION

In Ate/Beva-treated HCC, only a small number of PDs identified by RECIST 1.1 were re-classified as non-PD by mRECIST and Choi, indicating similar performance in the assessment of treatment failure. mRECIST and Choi criteria identified more early responders to treatment than RECIST 1.1 and significantly correlated with prolonged OS and PFS.

#### CLINICAL RELEVANCE/APPLICATION

mRECIST and Choi criteria may be more accurate than RECIST 1.1 in identifying early responders to Ate/Beva and may better assess prognosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPGI-7

### Value of Liver Volumetry for the Evaluation of Treatment Response to Hepatic Artery Infusion Chemotherapy Compared with RECIST 1.1 Criteria in Uveal Melanoma Patients with Liver Metastases

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Sebastian Zensen, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

In uveal melanoma patients with liver metastases, short-term evaluation of treatment response to hepatic artery infusion chemotherapy (HAIC) using the Response Evaluation Criteria in Solid Tumors (RECIST) 1.1 criteria is often challenging due to the diffuse metastatic spread to the liver. Because of the diffuse organ involvement, liver enlargement can frequently be observed and easily assessed by liver volumetry. Therefore, this study aims to compare RECIST 1.1 and LV for the evaluation of HAIC treatment response.

#### METHODS AND MATERIALS

Treatment response was evaluated in 143 patients by RECIST 1.1 and liver volumetry on CT imaging performed before and after first HAIC. The mean age was  $65.1 \pm 10.9$  years, 54% were female. To establish an appropriate threshold to differentiate between stable disease (SD) and progressive disease (PD) in liver volumetry, various increases in liver volume were assessed. Overall survival (OS) was calculated from first HAIC to patient death using Kaplan-Meier test. Multivariate analysis was performed for RECIST 1.1 and liver volumetry.

#### RESULTS

The median OS (mOS) was 13.5 months (95% CI 11.2-15.8 months). In liver volumetry, a threshold of 10% increase in liver volume was suited to identify patients with significantly reduced OS (SD: 103/143 patients, mOS 15.9 months; PD: 40/143 patients, 6.6 months;  $p < 0.001$ ). Compared to RECIST 1.1, liver volumetry is the only significant prognostic factor that can identify a decreased OS.

#### CONCLUSION

In uveal melanoma patients with liver metastases, a threshold of 10% increase in liver volume is suitable to identify patients with a significantly shortened life expectancy by liver volumetry.

#### CLINICAL RELEVANCE/APPLICATION

Liver volumetry is an appropriate method for evaluating treatment response in uveal melanoma patients with liver metastases and offers advantages over RECIST 1.1 criteria.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPGI-8

### **DW-MRI of the Abdomen for the Preoperative Detection of Liver Metastasis from Pancreatic Cancer to Prevent Futile Surgeries: A Meta-analysis**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Stephan Altmayer, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recent studies have shown the superior diagnostic performance of diffusion-weighted magnetic resonance imaging (DW-MRI) for detecting liver metastasis. Despite the advantage of DW-MRI, the most recent 2022 National Comprehensive Cancer Network guidelines do not routinely recommend performing MRI on all patients who may have resectable disease. Our purpose was to perform a systematic review and meta-analysis to evaluate if diffusion-weighted magnetic resonance imaging (DW-MRI) adds value compared to contrast-enhanced computed tomography (CECT) alone in the preoperative evaluation of pancreatic cancer.

#### **METHODS AND MATERIALS**

MEDLINE, EMBASE, and Cochrane databases were searched for relevant published studies through October 2022. Studies met eligibility criteria if they evaluated the per-patient diagnostic performance of DW-MRI in preoperative patients with pancreatic cancer compared to CECT. Our primary outcome was to determine the proportion of futile surgeries potentially prevented using DW-MRI, defined as those in which CECT was negative and DW-MRI was positive for liver metastasis. The secondary outcome was to determine the proportion of cases in which DW-MRI changes management, a composite outcome that includes false positive liver metastasis on CECT, indeterminate lesions on CECT, and the primary outcome. Per-patient sensitivity and specificity of DW-MRI were also calculated using a random-effects model.

#### **RESULTS**

9 studies met the inclusion criteria with a total of 1121 patients, 172 of which had liver metastasis (15.3%). The average size of the hepatic lesions was smaller than 10 mm in all 6 studies that reported this data. The mean time between CT and MRI was reported for 7 out of 9 studies and was often fewer than 28 days. The proportion of futile surgeries potentially reduced by DW-MRI was 6.0% (95% CI, 3.0-11.6%), yielding a number necessary to treat of 16.6. The proportion of cases that DW-MRI changed management was 18.1% (95% CI, 9.9- 30.7), corresponding to an NNT of 5.5. The heterogeneity was high for both primary (of I<sup>2</sup> = 86%) and secondary (I<sup>2</sup> = 94%) outcomes. The per-patient sensitivity and specificity of DW-MRI was 92.4% (95% CI, 87.4-95.6%) and 97.3% (95% CI, 96.0- 98.1) with no heterogeneity.

#### **CONCLUSION**

The potential NNT of DW-MRI to prevent potential futile surgeries in patients with pancreatic cancer and occult liver metastasis on CECT was 16.6.

#### **CLINICAL RELEVANCE/APPLICATION**

A significant number of subcentimeter liver metastases are not identified in the preoperative staging of pancreatic cancer with CECT. DW-MRI may add value in the evaluation of this patients with a potential NNT to prevent one futile pancreatic resection of CECT of 16.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPGU-1

### Quantitative PSMA PET and Multiparametric MRI features may help Predict Aggressive Prostate Cancer on Whole-Mount Histopathology

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Ida Sonni, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Two aggressive histopathological subtypes of prostate cancer (PC) include intraductal carcinoma (IDC) and the large cribriform growth pattern. The goal of this analysis was to assess which quantitative features of preoperative 68Ga-PSMA-11 PET/CT (PSMA PET) and multiparametric magnetic resonance imaging (mpMRI) correlate and predict cribriform/IDC patterns on post robotic prostatectomy (RALP) whole mount histopathology (WMHP).

#### METHODS AND MATERIALS

With IRB approval and HIPAA compliance, we derived a study cohort of PC patients who underwent PSMA PET <3 months prior to RALP and WMHP with description of the presence/absence of cribriform/IDC pattern between 05/2019 and 08/2022. A nuclear medicine physician contoured all PC lesions on PSMA PET, after matching them with a GU pathologist on WMHP. PSMA PET metrics (SUVmax, SUVmean, tumor volume, total lesion activity - TLA) were extracted. A sub-analysis was conducted on patients with available quantitative measures on pre-surgical mpMRI. All PIRADS=3 lesions on mpMRI were contoured and quantitative parameters were extracted: mean apparent diffusion coefficient (ADC,  $\times 10^{-6} \text{mm}^2/\text{s}$ ),  $K_{\text{trans}}$  (min-1),  $K_{\text{ep}}$ (min-1), iAUC (mMsec). All matching lesions were categorized as sub-cohort 1 (SC 1) cribriform+/IDC-, (SC 2) cribriform+/IDC+, and (SC 3) cribriform-/IDC-. One way-ANOVA assessed significant differences among the imaging parameters in the three sub-cohorts. The area under the curve (AUC) from ROC analysis was used to assess the ability of imaging metrics to predict the presence of aggressive PC features on WMHP.

#### RESULTS

The PSMA PET analysis comprised 77 patients (82 lesions) with mean PSA at time of RALP of 9.07 ng/ml  $\pm$  5.8. On WMHP, SC 1, 2 and 3 comprised 21/83, 41/83, and 20/83 lesions with significant differences in SUVmean and TLA among these sub-cohorts ( $p=0.003$  and  $0.039$ ). On AUC analysis, SUVmean predicted the aggressive PC features on WMHP with 67% accuracy. The PSMA PET/mpMRI cohort comprised 52 patients (53 lesions) with mean PSA at time of RALP of 9.67 ng/ml  $\pm$  6.76. On WMHP, SC 1, 2 and 3 comprised 17/53, 25/53, and 10/53 lesions with significant differences in SUVmean on PSMA PET and ADC on mpMRI among the three sub-cohorts ( $p=0.031$  and  $0.018$ ). On AUC analysis, SUVmean and ADC predicted aggressive PC on WMHP with 65% and 63% accuracy, respectively

#### CONCLUSION

Significantly elevated SUVmean on PSMA PET and lower ADC on mpMRI predicted the presence of aggressive PC features (cribriform pattern and IDC) on WMHP with moderate AUC on ROC analysis.

#### CLINICAL RELEVANCE/APPLICATION

The ability to predict the presence of pathology features of aggressive PC is critical in case WMHP is not available. Presurgical PSMA PET and mpMRI quantitative parameters can help identify these features with moderate accuracy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPGU-2

### Diagnostic Value of Very Early Diffusion Weighted Changes at MRI after Single-Dose Ablative Radiation Therapy (SDART) for Organ-confined Prostate Cancer

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Cammillo R. Talei Franzesi (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate diagnostic value of diffusion-weighted (DWI) MRI early changes, 1 hour after treatment, in patients with organ confined unfavorable prostate cancer (PCa) treated with Single-Dose Ablative Radiation Therapy (SDART), in comparison with biochemical markers (PSA and testosterone).

#### METHODS AND MATERIALS

Twenty four patients treated with a single fraction of 24 Gy to the whole prostate with urethra sparing in association with androgen deprivation therapy (ADT) were prospectively enrolled. MRI was performed before SDART (time 0), one-hour post-SDART (time 1), and 3-month after treatment (time 2). All patients were examined on a 3.0-T MRI scanner (Ingenia; Philips Healthcare) with a phased-array external coil, with bowel preparations and 20mg of butyl-scopolamine (Buscopan) intravenously administered; the bladder was filled with 120cc of saline solution, to simulate the same conditions during irradiation. MRI was performed with axial T1-weighted TSE sequences and high resolution multi-planar T2-weighted TSE sequences. Diffusion weighted imaging (DWI) was acquired with six b-values (0,50,100,150,800,1600mm<sup>2</sup>/s) and Apparent Diffusion Coefficient (ADC) (0,800) maps were calculated. Finally, axial contrast-enhanced dynamic imaging was obtained during intravenous injection of gadobutrol (0.1 mmol/kg, flow rate of 2.5 ml/s). ADC values were calculated at time 0,1, and 2 by placing region-of-interests (ROI) on ADC maps and the results were compared with PSA and testosterone blood levels at time 0 and 2.

#### RESULTS

Median patient's age was 78 years (range 61-84). Median prostate volume was 36.2 cc (range 10-60). An increase of ADC value of tumor lesion of 27% (range 7%-69%) and 54% (range 20%-83%) was registered at time 1 and time 2 respectively, compared to the baseline. Median prostate volume was found unchanged at time 1, while decreased by about 25% (range 9%-59%) at time 2. At 3-months follow-up, all patients were found bNED with PSA and testosterone levels of <0.01 ng/ml and <0.20 ng/ml, respectively, and 9 of them obtained a complete response.

#### CONCLUSION

Our findings demonstrated high diagnostic value of DWI imaging with good correlation between very early changes (one-hour after treatment) in ADC values after SDART and later tumor response (biochemical and imaging) in patients with unfavorable PCa.

#### CLINICAL RELEVANCE/APPLICATION

DWI with ADC values could be used as an early biomarker of treatment outcome in patients treated with SDART of the whole prostate with urethra sparing.

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## Abstract Archives of the RSNA, 2023

W5A-SPHN-1

### Operating Characteristics of ATA 2015 Thyroid Nodule Risk Malignancy in Colombian Population

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Nicole Erazo Morera, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Determine the operating characteristics of the ATA 2015 ultrasound risk classification of thyroid nodules in Colombian population, to see if it can be standardized and applied as it is in American population.

#### METHODS AND MATERIALS

We conducted a retrospective quantitative diagnosing test study, where the operating characteristics for the ATA 2015 risk stratification scale was determined. The study was carried out between Sept 2020- Sept 2021. Population: Patients with thyroid nodules with thyroid US in the imaging department of the HUSI (a fourth level institution in Bogotá, Colombia) with an indication for biopsy or surgical removal of the nodule according to ATA 2015. Data collection was carried out by two radiologists from the Radiology Department of the HUSI, one of them with 6 yrs of experience and one of them in training with 3 yrs of experience. Patients with very low and low suspicion nodules according to the 2015 ATA classification were defined as negative whereas intermediate and high suspicion of malignancy were defined as positive. These results were compared with a mixed gold standard, where true negatives are Bethesda II or surgical specimen with benign pathological report, and true positives are Bethesda V/VI or surgical piece positive for malignancy.

#### RESULTS

For a "high" risk in the ATA classification, the Likelihood Ratio values for both cases yield results close to 4, being slightly higher when risk III of the BETHESDA classification is excluded. For the "intermediate" classification, the two combinations have a Likelihood Ratio close to 1, indicating an indeterminate result for those that cannot be classified as malignant and benign. For the "low" and "very low" classification, the LR is below 1, when risk III of the BETHESDA classification is excluded and taken into account.

#### CONCLUSION

The present study demonstrates that the ATA 2015 sonographic risk stratification scale can be used and implemented in the Colombian population in a similar way to the American population. It is especially applicable if the thyroid nodule evaluated by ultrasonography presents characteristics of "low" or "high" risk of malignancy with a confidence of 95% for an established risk of 5-10% or 70-90% respectively. The category with the lowest sensitivity and specificity is the "intermediate" which is not statistically significant in any of the analyses.

#### CLINICAL RELEVANCE/APPLICATION

Validation, of an already used risk stratification scale, in the Colombian population, understanding in which cases there must be a careful appliance (specifically intermediate risk nodule) in this population base.

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## Abstract Archives of the RSNA, 2023

W5A-SPHN-2

### Utility of Radiomics Features in Predicting Human Papillomavirus Status in Head and Neck Squamous Cell Carcinoma: A Systemic Review and Meta-analysis

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Golnoosh Ansari, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Human papilloma virus (HPV) is one of the main risk factors and a potential prognostic indicator for head and neck squamous cell carcinoma (HNSCC). We sought to analyze the value of radiomics features in the determination of HPV status in HNSCC as an alternative to immunohistochemical typing.

#### METHODS AND MATERIALS

A systemic search was conducted on PubMed, Scopus and other major web-based repositories using the search terms HPV, Radiomics, HNSCC, head and neck, papilloma and oropharyngeal SCC. Diagnostic accuracy measures, and the confusion matrix of each study were extracted and the data were utilized to perform meta-analysis based on the random effects model. Fagan's nomogram was used to determine clinical utility. Deek's funnel plot was used to determine publication bias.

#### RESULTS

Twenty six articles were included in the systemic review and 14 were used for the meta-analysis. The median radiomics quality score was 9 out of 36, showing an overall poor quality in the currently available literature. There was no significant publication bias among the publications included in the meta-analysis. The overall sensitivity of the included studies equaled 0.772 (0.73, 0.809) and the overall specificity equaled 0.763 (0.714, 0.806). The I<sup>2</sup> statistic showed that heterogeneities for sensitivity and specificity were medium (I<sup>2</sup> = 56.91%, and 55.44%, respectively). Only one percent of the heterogeneity witnessed was due to threshold effect.. Diagnostic odds ratio equaled (DOR) 10.932 (7.847, 15.23). Using a radiomics model generated on cross-sectional imaging would increase the post-test probability to 82% from 58% with a positive likelihood ratio of 3 when the pretest was positive. When the pretest was negative the post-test probability decreased to 29% with a negative likelihood ratio of 0.3.

#### CONCLUSION

Radiomics features showed moderate success in the determination of HPV status in HNSCCC and could be employed when conventional para-clinical laboratory methods are not available. More studies, especially those trained and tested on multiple independent datasets, are needed to determine the clinical utility of radiomics trained machine learning models in this regard.

#### CLINICAL RELEVANCE/APPLICATION

As currently there are no FDA-approved diagnostic modalities for the determination of HPV status in HNSCC, radiomics features may be able to act as a means of "virtual biopsy" and alleviate the need for IHC staining.

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## Abstract Archives of the RSNA, 2023

W5A-SPHN-5

### The Value of Texture Features based on Dynamic Contrast-enhanced Magnetic Resonance Imaging in Predicting the Efficacy of Radiotherapy and Chemotherapy in Nasopharyngeal Carcinoma

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Nan Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

the purpose of this study was to explore the value of texture features based on DCE-MRI in predicting the efficacy of radiotherapy and chemotherapy in primary NPC.

#### METHODS AND MATERIALS

1. SubjectsForty-nine patients with NPC who underwent nasopharyngeal/cervical DCE-MRI examination and confirmed by pathology were analyzed retrospectively. According to the follow-up of MR and/or pathology after 6 months of treatment, the efficacy of radiotherapy and chemotherapy of NPC was divided into two groups: poor prognosis group (residue or recurrence) (n=22) and good prognosis group (no residue and recurrence) (n=27).2.Image analysis A 3.0T MR (Signa HDxt, GE Medical Systems, Milwaukee, WI, USA) scanner was used with an 8-channel phased array coil in the head and neck.The permeability parameters of the DCE-MRI images: Ktrans, Kep, and Ve functional maps were imported into 3D Slicer software. Two imaging diagnostic physicians manually sketched the ROI. (Fig. 1, 2). Record the texture feature parameters of each functional map respectively.

#### RESULTS

1.DCE- measured by two observers. The texture feature parameters of the MRI function map are consistent (ICC values are all>0.75) (Table 1)2. the MinimumKtrans signal intensity and JointAverageKep of the good prognosis group were higher than those of the poor prognosis group, while the values of AutocorrelationKtrans, JointAverageKtrans, SumAverageKtrans, AutocorrelationKep, and SumAverageKep were lower than those of the poor prognosis group, and the difference was statistically significant (Table 2). However, there is no difference in the texture parameters of the Ve signal intensity map.3. ROC analysis of Ktrans and Kep signal intensity map texture parameters to identify NPC efficacy (Table 3). The area under the curve predicted by the threshold of Autocorrelation, JointAverage, and SumAverage of Kep signal strength was the largest, which was 0.684, the sensitivity was 81.48%, and the specificity was 59.09% (figure 3).

#### CONCLUSION

The texture feature based on DCE-MRI has potential value in predicting the efficacy of radiotherapy and chemotherapy in nasopharyngeal carcinoma before treatment.

#### CLINICAL RELEVANCE/APPLICATION

nasopharyngeal carcinoma is a tumor with significant geographical distribution and is a common malignant tumor of the head and neck in southern China. Radiotherapy and chemotherapy are considered the first choice of treatment, but there are still patients with poor prognoses (residue or recurrence) due to treatment failure. Early prediction of the efficacy of radiotherapy and chemotherapy can optimize the treatment plan of NPC patients and improve the survival cycle, which has significant clinical significance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPHN-6

### Multi-parameter Quantitative Magnetic Resonance in Early Assessment of Radiation Induced Parotid Damage in Nasopharyngeal Carcinoma Patients after Intensity Modulated Radiotherapy

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Zhifeng Xu (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to investigate the value of Intravoxel Incoherent Motion Imaging (IVIM) and 3D Pulsed Continuous Arterial Spin Labeling (ASL) in assessing dynamic changes of parotid gland (PG) in nasopharyngeal carcinoma (NPC) patients after radiotherapy (RT).

#### METHODS AND MATERIALS

A total of 18 patients with NPC underwent Intensity-Modulated Radiotherapy (IMRT) were enrolled. All patients underwent conventional MRI, and IVIM and ASL imaging for bilateral PGs within 2 weeks before RT (pre-RT), 1 week and 3 months after RT (post-RT). Pure diffusion coefficient (D), pseudo-diffusion coefficient (D\*), perfusion fraction (F) and blood flow (BF) were analyzed.

#### RESULTS

From pre-RT to 1W post-RT, D and CBF values both increased significantly [change rate, 39.28% (38.23%) and 60.84% (54.88%)], and continued to increase significantly from 1W post-RT to 3M post-RT [change rate, 55.44% (40.56%) and 120.39% (128.74%)]. From pre-RT to 1W post-RT, F value increased significantly [change rate, 28.13% (44.66%)], and then decreased significantly from 1W post-RT to 3M post-RT, whereas no significant differences was found between pre-RT to 3M post-RT. From pre-RT to 1w post-RT and 1M post-RT, D\* value decreased significantly [change rate, -41.86% (51.71%) and -29.11% (42.67%)]. No significant difference was found between different post-RT time intervals. There was a significant positive correlation between percentage change in  $\Delta$ CBF1W and radiation dose ( $R=0.548$ ,  $p=0.001$ ).

#### CONCLUSION

Both IVIM-DWI and ASL can help to detect/predict radiation-induced parotid damage in early stage after RT. They may contribute to clarify the correlations between damage of PGs and patient-/treatment-related variables by assessing individual microcapillary perfusion and tissue diffusivity.

#### CLINICAL RELEVANCE/APPLICATION

To reveal the mechanism of parotid radiation injury, realize early non-invasive diagnosis, and allow patients to obtain timely treatment to improve the quality of life of patients

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## Abstract Archives of the RSNA, 2023

W5A-SPHN-7

### Prognostic Significance of MRI-Defined Sarcopenia in Patients with Nasopharyngeal Carcinoma: A Propensity Score Matched Analysis of Real-World Data

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Shuyi Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

Image-defined sarcopenia is linked to increased mortality among patients with cancer. Nevertheless, its effect on patients with nasopharyngeal carcinoma (NPC) is incompletely established. This study's aim was to investigate the prognostic significance of MRI-defined sarcopenia at the level of the third cervical vertebra (C3) on the survival of patients undergoing concurrent chemoradiotherapy (CCRT) ± inducing chemotherapy (IC) for NPC treatment

#### METHODS AND MATERIALS

1,307 patients from two tertiary centers who had stage II-IVa NPC diagnosis between July 1, 2010, and September 30, 2019, were included in this retrospective study. Sarcopenia was defined using skeletal muscle index (SMI) determined through baseline MRI at the C3 level. The association of sarcopenia with overall survival (OS) and progression-free survival (PFS) was assessed by computing the Hazard ratios (HRs). Using 1:1 propensity score matching (PSM) analysis, Cox regression models were adjusted for age, body mass index (BMI), sex, and treatment. The PSM analysis revealed 331 pairs. We also conducted a stratification analysis using BMI and treatment strategies.

#### RESULTS

The patients' median (range) age was 48 (18-80) years, with 821 patients (62.8%) presenting with sarcopenia. Before and after PSM, sarcopenia was an independent risk factor for both OS and PFS (all  $P < 0.05$ ). However, BMI was not substantially linked to tumor progression and overall mortality (all  $P > 0.05$ ). Sarcopenic patients showed lower rates of OS (HR = 2.00, 95% CI: 1.54-2.60,  $P < 0.001$ ) and PFS (HR = 1.67, 95% CI: 1.35-2.07,  $P < 0.001$ ) in contrast with nonsarcopenic patients. Similar findings were obtained after PSM. According to stratification analysis, being overweight was linked to a protective effect in nonsarcopenic patients only. In addition, sarcopenic patients showed similar OS and PFS regardless of the treatment modality.

#### CONCLUSION

Sarcopenia is underrecognized in NPC patients. Measurement of sarcopenia using routine MRI scans in NPC patients provided significant prognostic information, outperforming BMI. Patients with sarcopenia failed to benefit from an additional IC regimen.

#### CLINICAL RELEVANCE/APPLICATION

Sarcopenia could be used as a marker for predicting NPC patients' prognoses before treatment utilizing MRI images.

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## Abstract Archives of the RSNA, 2023

W5A-SPIN-1

### Automated Quantification of Uncertainty for Emphysema Evaluation from CT Images using Hybrid Bayesian Deep Learning

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Antonio Porras Perez, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Emphysema quantification from computed tomography (CT) images is important to evaluate chronic obstructive pulmonary disease (COPD). Although volume-adjusted lung density (ALD) can be used for prognosis, it has shown sensitivity to variations between scanners and there are no metrics of its reliability. We present a hybrid Bayesian deep learning model to predict lung density from CT images that can quantify both the aleatoric and the epistemic uncertainty, which are associated with the imaging protocol and the prediction, respectively. These measures of reliability can be used during clinical evaluation.

#### METHODS AND MATERIALS

Inspiratory lung CTs from 1,936 COPDGene participants (age  $59.36 \pm 9.00$  years; 1,038 female) were used. The data were randomly split into training (80%), validation (10%) and test images (10%). We trained a model to predict lung density at the 15th percentile of the CT histogram (Perc15) and quantify ALD. Our model consisted of convolutional blocks that quantify CT image features followed by fully connected layers. The final layer was Bayesian and weights were trained as probabilistic distributions instead of point estimates. ALD was calculated as the product of predicted Perc15 and the ratio of observed versus expected lung volume. Aleatoric and epistemic uncertainty were estimated over 50 stochastic forward passes in the test set. Deep learning ALD (DL-ALD) was compared to conventional ALD, and Cox proportional hazards models were used to determine the association between uncertainty and mortality.

#### RESULTS

The average root mean squared error for DL-ALD was 4.70 (95% CI: 4.68, 4.73). The mean aleatoric uncertainty was 23.77 (95% CI: 13.04, 34.51). The mean epistemic uncertainty was 1.22 (95% CI: 0.73, 1.71). DL-ALD was significantly associated with mortality ( $p < 0.001$ ) when adjusting for age, body mass index, smoking status, gender, and race. Adjusting for DL-ALD and demographics, epistemic uncertainty had a significant positive association with mortality ( $p = 0.013$ ) but aleatoric uncertainty did not ( $p = 0.134$ ).

#### CONCLUSION

DL-ALD performs as well as conventional ALD in predicting survival but it provides measures of uncertainty. This represents a substantial improvement over conventional methods that cannot estimate uncertainty. Aleatoric uncertainty associated with imaging protocol was higher than uncertainty from the model. Additionally, higher model uncertainty was associated with increased mortality risk, suggesting a need for reliability metrics to improve survival prediction through ALD.

#### CLINICAL RELEVANCE/APPLICATION

Uncertainty estimation when evaluating emphysema through hybrid Bayesian deep learning improves reliability of lung density measures over conventional image intensity-based analysis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPIN-2

### Deep Learning Model for Acute Respiratory Distress Syndrome (ARDS) Detection in the Pediatric Intensive Care Unit (PICU) Setting

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Vahid Khalkhali, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Acute respiratory distress syndrome (ARDS) is a significant cause of morbidity and mortality in the pediatric intensive care unit (PICU). ARDS diagnosis involves chest x-ray criteria combined with clinical and laboratory parameters. Machine learning models have demonstrated utility in the detection of ARDS on chest radiographs.

#### METHODS AND MATERIALS

In this retrospective, IRB-approved study, we identified 368 children admitted to the PICU with a diagnosis of ARDS, at a large pediatric academic center from 2014 to 2019. A single randomly selected radiograph from all patients admitted to the PICU without a diagnosis of ARDS during 2018 was used to establish the control cohort, (n=1127). The train:validation:test ratio was 60/20/20. Using transfer learning, we utilized a pretrained convolutional neural network (CNN) structure to determine the diagnosis of ARDS (PyTorch, version 1.2). The criterion was to minimize weighted cross-entropy loss. Area under the receiver operating characteristics (AUROC) was the main performance metric. Two pediatric radiologists independently assigned labels of ARDS to the training-set, and interrater reliability was calculated. Correlations between radiologists and the models were calculated using Pearson correlation and Cohen's Kappa. All statistical analysis used Type-I error of 5% and power of 80%.

#### RESULTS

The interrater reliability between the radiologists was 94.5% (Cohen's Kappa of 85.8%) for the training cohort. The ARDS diagnostic performance of two radiologists yielded an AUROC (balanced accuracy) of 72.5%, while the DenseNet161 model achieved 86.0% (AUROC of 92.5%) and ensemble of models reach to 83.7% (AUROC of 93.5%). Radiologist diagnoses were only 81% correlated (Cohen's Kappa 51.6%) with the DenseNet161 model and 83% (Cohen's Kappa 60.5%) with ensemble of models. While Pearson correlation between two radiologists were high (> 90%) on the test set, the difference between the detection of different models were statistically significant ( $p < 0.01$ ).

#### CONCLUSION

Using transfer learning, we trained a CNN to reliably detect ARDS in the PICU and compared its performance with the diagnostic rates of two experienced radiologists. Machine learning can automatically detect ARDS on chest radiographs, with a performance which parallels those of radiologists.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning detection of ARDS could improve the triage of patients in the intensive care unit before the availability of dedicated pediatric radiologist reads.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPIN-3

### Predicting the Occurrence of Immune Checkpoint Inhibitor-related Pneumonitis on Non-small Cell Lung Cancer Patients via Deep Learning

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Immune-checkpoint inhibition (ICI) has conveyed a paradigm shift in advanced lung cancer treatment in recent years. However, ICI therapy related pneumonitis, which is an immune related adverse event (irAE), can limit delivery of treatment to some patients. With overall incidence of nearly 6%, it is considered one of the more common irAEs resulting in a significant burden of morbidity and mortality in the lung cancer population. Predicting ICI-pneumonitis is crucial for identifying at-risk patients and adjusting their treatment to prevent the occurrence of ICI-pneumonitis. We in this study try to predict ICI-pneumonitis based on patients' imaging and clinical data.

#### METHODS AND MATERIALS

We collected data from 1,254 lung cancer patients who received immunotherapy between 2015 and 2021. In the dataset, 53 patients developed ICI-pneumonitis and were included in this study. Another 41 patients who received immunotherapy without developing ICI-pneumonitis were randomly selected and used as a control group. We proposed a deep learning framework to predict ICI-pneumonitis based on deep learning features and radiomics features. A vision transformer was first pre-trained on over 25,000 CT scans from the NLST dataset and then used to extract deep learning features. Radiomics features were extracted using the Python pyradiomics package after lung segmentation. After feature selection, 17 deep features and 20 radiomic features were used for prediction. A network with three fully connected layers was trained for ICI-pneumonitis prediction using five-fold cross-validation.

#### RESULTS

Using only deep learning features, we achieved an AUC of 0.934 (95%CI: [0.883, 0.986]). Similarly, with only radiomics features, the prediction AUC was 0.928 (95%CI: [0.873, 0.982]). When combining deep features with radiomics features, the prediction accuracy further improved to an AUC of 0.958 (95%CI: [0.917, 0.999]).

#### CONCLUSION

Our proposed method can predict the occurrence of ICI-pneumonitis with high accuracy, indicating the potential for using deep learning to predict ICI-pneumonitis in advanced lung cancer patients receiving immunotherapy. This approach could be valuable for treatment planning in the future.

#### CLINICAL RELEVANCE/APPLICATION

Prediction of ICI pneumonitis will have an important positive impact as early detection and timely recognition are critical to initiate prompt treatment and prevent further morbidity and mortality for these oncology patients.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5A-SPIN-4

### **SAMConvex: Fast Discrete Optimization for Deformable CT Registration using Multi-scale Self-supervised Anatomical Embedding and Correlation Volume**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Zi Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Deformable image registration is a fundamental medical image analysis task. Estimating displacement vector field via a cost volume computed in the feature space suffers excessive computation burdens. Moreover, existing feature descriptors only extract local features incapable of representing the global semantic information that is important for handling large transformations. To address these issues, we propose SAMConvex, a fast coarse-to-fine discrete optimization method for CT image registration. It includes a decoupled convex optimization procedure to obtain deformation fields based on a self-supervised anatomical embedding (SAM) feature extractor that captures both local and global information.

#### **METHODS AND MATERIALS**

Our proposed model, named SAMConvex, consists of two major components: (1) A discriminative feature extractor based on a SAM that encodes global and local embeddings for each voxel. The global embeddings memorize the 3D contextual information of body parts on a coarse resolution level, while the local embeddings differentiate adjacent structures with similar appearances. (2) A lightweight correlation pyramid that constructs multi-scale 6D cost volume by taking the inner product of SAM embeddings. With coarse-to-fine strategy, we estimate a sequence of deformation fields. The final field is computed via the composition of all the deformation fields. We conduct the registration in 3 levels of resolutions. The registration performance is extensively evaluated in two inter-patient registration datasets, i.e., Abdomen CT (20 patients for train and 10 for test), and HeadNeck CT (62/10 patients for train/test) and intra-patient Lung CT (35 patients, each with inspiratory and expiratory breath-hold CT pairs). The average Dice score computed for the labeled organs is used to evaluate the accuracy.

#### **RESULTS**

SAMConvex outperforms state-of-the-art registration methods, such as LapIRN, and Deeds, over all three datasets with an average 2.4% Dice score improvement as compared to the second-best performing method (Deeds). E.g., SAMConvex is consistently better than the second-best (Deeds) and third-best (LapIRN) registration methods on most examined abdominal organs, in 11 out of 13 organs. Moreover, as an optimization-based method, SAMConvex only takes  $\sim 2s$  for one paired scans, as compared to  $\sim 100s$  required by Deeds.

#### **CONCLUSION**

The proposed deep registration model (SAMConvex) demonstrates state-of-the-art accuracy, good generalization, and high computation efficiency over previous leading models.

#### **CLINICAL RELEVANCE/APPLICATION**

The proposed algorithm can accurately register the CT scans. The method can be applied in various downstream tasks such as longitudinal lesion quantification and image-guided radiotherapy.

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## Abstract Archives of the RSNA, 2023

W5A-SPIN-5

### Effective Opportunistic Screening for Colorectal Cancer using Abdominal or Chest Noncontrast CTs

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Mingyan Qiu, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We designed an AI model for detecting colorectal cancer (CRC) using noncontrast chest or abdominal CT scans, which offers the advantage of opportunistic screening a broad asymptomatic population.

#### METHODS AND MATERIALS

The training data consisted of 1,561 3D noncontrast abdominal CTs from a single hospital, including 566 cases with pathology-confirmed CRC and 995 cases without CRC. The initial CRC masks in the training set were manually annotated on the venous phase CT by an experienced radiologist (10-yr), referring to reports as needed. We then employed a robust image registration method to register the annotated mask from venous to noncontrast CT for model training. Our AI model is a UNet for segmentation of CRC and colorectum, which is further enhanced by a classification branch and is trained end-to-end to classify the patient as CRC or normal. To improve the differentiation of CRC tumor from colorectal content and normal tissues, we designed a content augmentation method and a contrastive loss. The model performance was evaluated on an internal hold-out test cohort comprising 147 patients with CRC and 153 normal cases, and external test cohorts comprising 181 abdominal CTs with CRC, one chest CT with CRC, and 2,477 normal chest CTs from three centers. One radiologist specialized in CRC imaging (20-yr) is invited for the reader study on the hold-out test cohort.

#### RESULTS

On the internal test cohort, the model had an area under the curve of 0.978, sensitivity of 91.2%, and specificity of 97.4%; while the radiologist's sensitivity was 79.6% and specificity was 97.4%. Moreover, the model outperformed the radiologist in detecting early-stage CRC (T1 33.3% vs. 16.7%, T2 75.0% vs. 50.0%). On the external test cohorts, the model's sensitivity was 80.7% and 100% for abdominal CTs and chest CT, respectively; and the specificity was 99.6% for normal chest CT. Additionally, a preliminary comparison shows that our approach has comparable performance and may even outperform the established CRC screening tests in both sensitivity and specificity, such as CT colonography (Sens 90%, Spec 86%) and FIT (Sens 74%, Spec 95%).

#### CONCLUSION

The proposed model could detect colorectal cancer tumors on chest and abdominal noncontrast CT scans with a high sensitivity and specificity, exceeding the sensitivity of an experienced radiologist specialized in CRC imaging.

#### CLINICAL RELEVANCE/APPLICATION

Our study aims to investigate a novel, non-invasive, opportunistic screening solution for colorectal cancer using noncontrast CT and AI. The multi-center experimental results show that our solution achieves both high sensitivity and specificity, indicating that opportunistic population-based CRC screening in asymptomatic adults could potentially be performed in abdominal and chest CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPIN-6

### Deep Learning Analysis of Chest Radiographs to Predict Coronary Artery Calcium and Triage Patients Deferrable from CT

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Yisak Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a deep learning (DL) model to predict the coronary artery calcium (CAC) using chest radiographs (CRs), validate its performance in patients from different institution and investigate the clinical utility of the model as a triage tool for deferring additional computational tomography (CT) scan.

#### METHODS AND MATERIALS

We retrospectively searched adult patients who had undergone both a calcium score CT and posteroanterior chest radiography within a 3-month period from three different institutions; a total of 4,858 radiographs (age  $60.6 \pm 12.2$ ; women 2,458) from institution A, 4,109 radiographs (age  $61.0 \pm 12.3$ ; women 1,823) from institution B, and 979 radiographs (age  $57.0 \pm 11.3$ ; women 334) from institution C. Patients from institution A and B were used as a developmental cohort, and institution C as an external test cohort. The total Agaston scores calculated from CT were divided into 5 grades: 0, 1-100, 11-100, 100-400, and over 400, and considered ground truth labels. Images were cropped to fit the lung and heart area and normalized using energy bands and a region of interest obtained by heart segmentation. total of six different image sets were generated; original, lung area and heart area for non-normalized and energy bands normalized. Separate DL models based on DenseNet-161 were individually trained for each of six image sets and the final performance was calculated using ensemble theses six models. Conditional Ordinal Regression for Neural Networks (CORN) method was used for 5 ordinal CAC grade classification.

#### RESULTS

Binary classification between under and over 100 CAC scores attained AUCs of 0.81, 0.79, 0.83, 0.77 on validation dataset, internal test A, internal test B and external test respectively. All test datasets showed more than 99% sensitivity at a threshold of sensitivity rate 99% attained from validation, and showed specificity of 27%, 28%, 18% and 26% for validation dataset, internal test A, internal test B and external test respectively. Using a threshold of sensitivity rate 99% attained from validation dataset, the DL model correctly identified 23.7% (66 of 278) and 14% (101 of 722) of patients in the internal test set A and B as CAC score under 100 so that additional CT scan may be deferred. Among them, true individuals showing CAC score under 100 (NPV) were 100% (66 of 66) and 98% (99 of 101) in the internal test set A and B respectively. On the external test set, DL model was able to defer 21.5% of all patients (212 of 977), and the NPV was 99.1% (210 of 212).

#### CONCLUSION

DL model could predict the CAC from CRs and could be used for helping clinical decision-makings such as taking additional CT.

#### CLINICAL RELEVANCE/APPLICATION

The proposed model may assist in deferring additional CT scans using CRs by triaging patients with a under 100 CAC score.

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## Abstract Archives of the RSNA, 2023

W5A-SPIR-1

### Uncovering Hidden Lesions - Incidental Ring Hyperenhancing Liver Micronodules in Computed Tomography during Hepatic Arteriography Guidance in Percutaneous Thermal Ablation of Colorectal Liver Metastasis

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To describe and evaluate the nature of incidental ring hyperenhancing liver micronodules (RHLMs) detected on computed tomography during hepatic arteriography (CTHA) in patients with colorectal liver metastases (CLM) undergoing percutaneous ablation.

#### METHODS AND MATERIALS

Twenty-two CLM patients who underwent 24 CTHA-guided percutaneous thermal ablation sessions (AS) for 41 CLMs were included. CTHA images were obtained before and after ablation for tumor targeting and ablation margins assessment. Two radiologists independently reviewed pre-ablation images, and the interobserver agreement was assessed using Cohen's kappa. Incidental RHLMs were defined as small nodules with continuous ring enhancement visible in late arterial phase on three planes, with an average Hounsfield Unit at least twice that of adjacent liver parenchyma, not detected on baseline imaging. The nature of incidental RHLMs was determined by histological confirmation and/or follow-up image assessment. A biomechanical deformable image registration (DIR) method was used to map incidental RHLMs and newly detected CLMs on follow-up CT imaging. RHLMs were considered as CLMs if their segmentations overlapped.

#### RESULTS

The median time from baseline contrast-enhanced cross-sectional and/or functional imaging to AS was 29.4 days ( $\pm$  19.1 days). 25 incidental RHLMs with a mean largest diameter of 0.8 cm (range 0.3-1.7) were identified in 41.7% (10 of 24) of the AS. The agreement between two observers on identifying incidental RHLMs was almost perfect ( $\kappa = 0.907$ ). 4 incidental RHLMs were ablated during the AS given their similarity to targeted CLMs. Of the remaining 21 incidental RHLMs, 71.4% (15 of 21) disclosed to be CLMs, with 20% (3 of 15) confirmed by histology and 80% (12 of 15) by follow-up imaging using a DIR method at a mean time of 52 days ( $\pm$  27.8 days) post-ablation. The nature of the last 28.6% (6 of 21) incidental RHLMs was unknown, but no intrahepatic progression was observed on follow-up after chemotherapy.

#### CONCLUSION

Incidental RHLMs can be an early indicator of small CLMs, as confirmed by histology and DIR-based imaging analysis. Further investigation is needed to evaluate their relevance, as CLM resection is the only potentially curative treatment for liver-limited disease.

#### CLINICAL RELEVANCE/APPLICATION

The presence of incidental ring hyperenhancing liver micronodules on computed tomography during hepatic arteriography can indicate early-stage colorectal liver metastasis, which could impact the treatment approach.

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## Abstract Archives of the RSNA, 2023

W5A-SPIR-2

### Added Value of Kupffer-phase Imaging of Sonazoid-enhanced Ultrasound in Liver Ablation

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Dae Woong Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the usefulness of Kupffer-phase imaging (KPI) in Sonazoid-enhanced ultrasound (SZUS) for local ablation of liver tumors and to identify factors related to tumor conspicuity on the KPI of SZUS.

#### METHODS AND MATERIALS

A total of 73 patients with 112 liver tumors (95 HCCs and 17 non-HCCs), who underwent gadoxetic acid-enhanced MRI (Gd-EOB-MRI), B-mode planning US (BPUS), and SZUS-assisted radiofrequency ablation (RFA) from January 2020 to February 2023, were included. RFA was performed by an experienced radiologist using SZUS/MR image fusion, 30 to 50 minutes after intravenous injection of Sonazoid. The characteristics of both patients and liver tumors were evaluated. Tumor conspicuity was assessed sequentially using a 4-point scoring scale on hepatobiliary phase (HBP) of Gd-EOB-MRI, BPUS, and KPI of SZUS at 1-week intervals by the consensus of two experienced abdominal radiologists. The tumor echogenicity on BPUS were classified into hypoechoic and non-hypoechoic groups. Conspicuity scores of 1 and 2 were classified as the poor conspicuity group, while scores of 3 and 4 were classified as the good conspicuity group. We also investigated factors related to tumor conspicuity on the KPI of SZUS, as well as the technical success rate of RFA.

#### RESULTS

The mean size of tumors was  $13.1 \pm 5.9$  mm. There was no significant difference in size or location between HCCs and non-HCCs. The tumor conspicuity score on KPI of SZUS ( $2.88 \pm 0.85$ ) was higher than that of BPUS ( $1.85 \pm 0.74$ ). The correlation between tumor conspicuity on KPI of SZUS and HBP of Gd-EOB-MRI was higher than that of BPUS and KPI of SZUS (HCCs [ $rs=0.38$ ,  $p<0.001$ ], non-HCCs [ $rs=0.76$ ,  $p<0.001$ ], and total [ $rs=0.44$ ,  $p<0.001$ ] versus HCCs [ $rs=0.33$ ,  $p<0.001$ ], non-HCCs [ $rs=0.31$ ,  $p=0.224$ ], and total [ $rs=0.34$ ,  $p<0.001$ ]). The factors related to tumor conspicuity on KPI of SZUS were hypoechoic on BPUS and good conspicuity on HBP of Gd-EOB-MRI ( $p=0.034$  and  $p=0.01$ , respectively). The technical success rate of RFA using KPI was 97.3%.

#### CONCLUSION

KPI of SZUS could be a valuable tool for successful liver ablation in cases where the tumor is not clearly visible on BPUS but is well-defined on the HBP of Gd-EOB-MRI.

#### CLINICAL RELEVANCE/APPLICATION

When liver tumors are not clearly visible on ultrasound, performing liver ablation can be challenging. Although SZUS has the potential to improve tumor conspicuity, it is not widely used in liver ablation due to various limitations including its high cost, unpredictable effect on improving tumor visibility, short duration of the vascular phase, and long waiting time for KPI. However, using KPI of SZUS for liver ablation can significantly reduce procedure time and improve the technical success rate, especially when liver tumors are clearly visible on HBP of Gd-EOB-MRI.

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## Abstract Archives of the RSNA, 2023

W5A-SPIR-3

### Post Embolization Syndrome Following Histotripsy: An Indicator of Immune Activation

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Nathan E. Loudon, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Post-embolization syndrome (PES) is a reported phenomenon that can occur following transarterial chemoembolization (TACE) or radioembolization (TARE). It is thought to occur as a result of immune and inflammatory response to cell death during tumor necrosis. The most commonly described symptoms are pain, fever, and leukocytosis. The purpose of this study was to determine whether these symptoms would be seen following histotripsy at higher or lower frequency compared to TACE or TARE.

#### METHODS AND MATERIALS

This was a single center IRB approved retrospective cohort study which compared post-embolization syndrome symptoms of fever, right upper quadrant abdominal pain, and leukocytosis among patients who underwent ablation of liver tumors using histotripsy (n=10), TARE (n=32), or TACE (n=34). Our analysis considered size of largest lesion, tumor type, LR category, and BCLC staging.

#### RESULTS

When adjusted for the size of the lesion and tumor type (HCC vs non-HCC), the odds of experiencing fever were 7.17 times higher in patients who underwent histotripsy compared to TACE (95% CI = 1.16 - 52.33, p=.039), and 50 times higher compared to TARE (95% CI = 5.74 - 1589.36, p=.003). The odds of experiencing abdominal pain were 14.70 times higher in the histotripsy group compared to TACE (95% CI = 2.09 - 302.12, p=.02) and 50 times higher compared to TARE (95% CI = 7.02 - 1307.34, p=.001). The histotripsy group had a smaller change in WBC from pre to post treatment compared to TACE (2.49, 95% CI = 0.34 - 4.64, p=0.024), and no statistically significant difference in WBC change compared to TARE.

#### CONCLUSION

As histotripsy becomes a more widely available treatment offered to patients it is important to understand the range of expected clinical symptoms which can occur following ablation. This study suggests that patients who undergo histotripsy are more likely to experience fever and abdominal pain following ablation compared to TACE and TARE.

#### CLINICAL RELEVANCE/APPLICATION

Histotripsy is a novel ablation modality and as such its expected post-treatment symptoms are still being elucidated. Pre-clinical data have shown that histotripsy is highly immunogenic on both a local and systemic level. PES is thought to be a result of inflammatory and immune response to tumor ablation. Studying the incidence of PES in this population could provide valuable insights into the clinical manifestations of immune activity following ablation.

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## Abstract Archives of the RSNA, 2023

W5A-SPIR-4

### Prediction of Initial Lung Microwave Ablation Zone Through Tumor and Ablation Characteristics

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the effect of tumor and ablation characteristics on dimensions and size of lung microwave ablation zone and establish a prediction model.

#### METHODS AND MATERIALS

This IRB-approved, HIPAA compliant study cohort involved patients who underwent CT-guided lung microwave ablation for their malignancy between 2012 to 2023. All patient demographics, treatment history, tumor characteristics, ablation duration, and maximum temperature (Tmax) reached were recorded. The peripheral location was defined as the area within 2cm from the edge of the visceral pleura. Ablation images without specific intraprocedural labels indicating post-initial ablation or cases without complete ablation details were excluded. The initial ablation zone was represented by the elliptical ground-glass opacity surrounding the target site and its dimensions were measured. Dataset was divided into 70% training and 30% test set and univariate and multivariate linear regression models were used to build a prediction model for the major axis, minor axis, and area of the ablation zone.

#### RESULTS

This study cohort was composed of 89 lesions that underwent microwave ablations. Of these ablations, 25 were with history of prior lung radiation therapy (Hrad) (28%) and 7 with history of prior lung surgery (Hsurg) (8%), and 45 lesions were located at the peripheral region. The median duration of the initial ablation was 1.5 minutes ranging from 0.5 to 10 minutes, the power used was 65W for all ablations, and mean of Tmax was  $100 \pm 17^\circ\text{C}$ . The measured mean major, minor axes, and area were  $3.1 \pm 0.8\text{cm}$ ,  $1.8 \pm 0.5\text{cm}$ , and  $4.7 \pm 2.5\text{cm}^2$ . A parsimonious prediction model was built keeping only the predictors with  $p < 0.15$ . For the major axis, duration ( $p < 0.001$ ), Tmax ( $p = 0.002$ ), Hsurg ( $p < 0.001$ ), and Hrad ( $p = 0.102$ ) were predictors. For minor axis, duration ( $p < 0.001$ ), Tmax ( $p < 0.001$ ), Hsurg ( $p = 0.001$ ), and peripheral location ( $p = 0.099$ ) were predictors. For the area, duration ( $p < 0.001$ ), Tmax ( $p < 0.001$ ), and Hsurg ( $p < 0.001$ ) were predictors. The fitted model equation for major axis was:  $3.176 + 0.597 * \log(\text{duration}) - 0.003 * (\text{Tmax}) - 0.302 * (\text{Hrad}) + 1.146 * (\text{Hsurg})$  with test root mean square error (RMSE)=0.55,  $R^2=0.29$ . The equation for minor axis was:  $1.575 + 0.332 * \log(\text{duration}) + 0.001 * (\text{Tmax}) + 0.022 * (\text{Hsurg}) + 0.106 * (\text{peripheral})$  with test RMSE=0.53,  $R^2=0.33$ . The equation for area was:  $5.772 + 2.431 * \log(\text{duration}) - 0.021 * (\text{Tmax}) + 1.658 * (\text{Hsurg})$  with test RMSE=2.11,  $R^2=0.40$ .

#### CONCLUSION

Lung tumor and ablation characteristics are shown to be significant predictors of microwave ablation dimensions and size which can be used to establish a prediction model.

#### CLINICAL RELEVANCE/APPLICATION

Estimate of lung microwave ablation dimensions and size can aid in effective treatment of lung tumors.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPIR-5

### **Efficacy and Safety of Tract Cautery for Lung Microwave Ablation**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the efficacy and safety of tract cautery for lung microwave ablation through comparison of post-procedure complication rate.

#### **METHODS AND MATERIALS**

This IRB-approved, HIPAA compliant study involved patients who underwent lung microwave ablation for their malignancy between 2012 to 2021. All patient demographics, treatment history, tumor characteristics, ablation details were collected. The study cohort was divided into whether tract cautery was conducted during probe removal. Immediate, persistent, and enlarging pneumothorax (PTX) were each defined as the observation of PTX on CT or chest radiograph during the termination of procedure, detection of non-expanding PTX, and expanding PTX for 3-5 hours post-procedure. Other complications including pleural effusion, delayed complication (more than one week), and post-procedural interventions needed for management of complications were recorded. A subgroup analyses of patients with no history of radiation therapy were also included. Univariate and multivariate logistic regression models were used to compare differences in complication rates.

#### **RESULTS**

This study cohort was composed of 171 lung microwave ablation sessions of 62 patients (mean age  $59 \pm 12$ ). 58/171 were with history of radiation therapy of the lung (33.9%) and 33/171 were with history of lung surgery (19.3%). 80 ablations exhibited immediate PTX, 45 persistent PTX, 19 enlarging PTX, 26 pleural effusion, 8 delayed complications, and 14 required interventions. Tract cautery was conducted in 126/171 ablations. Patients who did not receive tract cautery had 10 times the odds of exhibiting delayed complications than patients who did receive tract cautery ( $p=0.003$ ). Ablations with tumor size less than 1cm and history of emphysema had 5.9 times ( $p=0.035$ ) and 5.7 times ( $p=0.032$ ) the odds of requiring interventions. Increasing the total ablation time by 1 minute was associated with a 24% reduction in odds of delayed complications. Furthermore, a subgroup of ablations composed of patients without history of lung radiation therapy included 81 ablations with and 32 without tract cautery. This subgroup showed ablations conducted without tract cautery had 3.0 times the odds of exhibiting enlarging PTX ( $p=0.026$ ) and 5.3 times the odds of requiring interventions ( $p=0.026$ ) compared to ablations conducted with tract cautery.

#### **CONCLUSION**

Utilizing tract cauterization in lung microwave ablation shows significant reduced incidence of post-ablation delayed complications and enlarging PTX and interventions in patient without history of lung radiation therapy.

#### **CLINICAL RELEVANCE/APPLICATION**

Tract cautery proves to be a useful method in reducing complications and interventions required for management of complications.

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## Abstract Archives of the RSNA, 2023

W5A-SPIR-6

### Pre-ablation Biopsy and the Effect of Histopathologic Grade on Thermal Ablation Outcomes for Hepatocellular Carcinoma

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Abinaya Ramakrishnan (*Presenter*) Nothing to Disclose

#### PURPOSE

Thermal ablation has been increasingly used as a minimally invasive treatment for hepatocellular carcinoma (HCC), with clinical outcomes comparable to surgical resection. While prior studies have analyzed the influence of size, location, and morphology on ablation outcomes, few have examined the role of histopathologic grade. This is partly because standard of care in LI-RADS 5 HCCs does not require biopsy. In this study, we determined the relationship between histopathological grade of the tumor on the clinical outcome after thermal ablation using time to local tumor progression-free survival (LTPFS) and overall survival (OS).

#### METHODS AND MATERIALS

Between February 2015 to November 2022, 186 patients with nodular LI-RADS 5 HCCs that underwent ablation (MWA=165, RFA=21 with biopsies within prior 3 months) were included in this single-center, retrospective cohort study. All tumors were histologically classified using WHO criteria as Poor (n=25), Moderately (n=119), or Well (n=42) differentiated. Patients underwent continuous follow-up imaging to determine local tumor progression free survival (LTPFS). After retrospective review of medical records and follow-up MRI examinations, the rates of LTPFS and OS hazard ratios from Kaplan-Meier method were calculated and compared among the groups.

#### RESULTS

Pre-ablation histopathologic grade was identified as a significant predictor for post-thermal ablation outcomes. Poorly-differentiated HCCs had significantly shorter LTPFS compared to well-differentiated HCCs (hazard ratio [0.21, 0.07-0.6],  $p=0.008$ ). Poorly-differentiated HCCs also had shorter LTPFS compared to moderately-differentiated HCCs (hazard ratio [0.68, 0.33-1.39],  $p=0.28$ ), although this difference was not significant. In terms of OS, poorly-differentiated HCCs had significantly shorter OS compared to well-differentiated HCCs [0.20, 0.07-0.59,  $p=0.0035$ ],  $p=0.0082$ ) and moderately-differentiated HCCs [hazard ratio [0.61, 0.3-1.25],  $p=0.0035$ ).

#### CONCLUSION

Poorly-differentiated HCCs was an important prognostic biomarker correlating with shorter LTPFS as well as OS after thermal ablation of HCC. While not currently considered standard of care, HCC biopsy prior to ablation can help tailor more aggressive patient-specific treatment planning and surveillance protocol.

#### CLINICAL RELEVANCE/APPLICATION

Pre-ablation biopsies in HCC patients can play a critical role in the management of patients post-ablation. Poorly differentiated tumors may benefit from more aggressive treatment and surveillance given shorter LTPFS and OS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPMK-1

### Radiomics Analysis based on Dual-energy CT Hydroxyapatite (HAP)-fat Decomposition Technique for Osteoporosis Prediction

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Jinling Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a radiomics model based on the hydroxyapatite (HAP)-fat material decomposition (MD) images of dual-energy CT for osteoporosis prediction.

#### METHODS AND MATERIALS

83 patients who underwent dual-energy CT included L1-L5 and quantitative computed tomography (QCT) were collected. With QCT as the reference standard, the patients were divided into two groups according to the guidelines introduced by the International Society for Clinical Densitometry (ISCD) and American College of Radiology (ACR), osteoporosis of the spine was defined as a BMD value  $<80$  mg/cm<sup>3</sup>, and non-osteoporosis (osteopenia and normal) was defined as a BMD value  $\geq 80$  mg/cm<sup>3</sup>. Radiomic features were selected from HAP-fat MD images of dual-energy CT. A radiomics model was constructed from linear combinations of the selected features weighted by their coefficients. The ROC curve was performed to evaluate the performance of the radiomics model.

#### RESULTS

The radiomics model, which comprised 8 selected radiomics features (shape\_Maximum2DDiameterColumn, shape\_Maximum2DDiameterSlice, shape\_Sphericity, firstorder\_10Percentile, firstorder\_90Percentile, firstorder\_Skewness, gldm\_LargeDependenceHighGrayLevelEmphasis, gldm\_LargeDependenceLowGrayLevelEmphasis) based on HAP-fat MD images of dual-energy CT, showed excellent differential ability with AUC of 0.999 (95%CI, 0.987-1.000), sensitivity of 0.983, specificity of 1.000, negative prediction value of 0.960, positive prediction value of 1.000 in the cohort. The discrimination performance of the radiomics model to identify osteoporosis from non-osteoporosis (osteopenia and normal) showed high accuracy of 98.8% in the cohort.

#### CONCLUSION

The radiomics model comprised 8 selected radiomics features had excellent ability to predict osteoporosis based on dual-energy CT HAP-fat MD images.

#### CLINICAL RELEVANCE/APPLICATION

The prevalence of osteoporosis in the population is increasing year by year. One of the reference standards for the diagnosis of osteoporosis today is the volumetric BMD measured by QCT, but the QCT post-processing process is very complex and requires additional phantom calibration, etc. Our proposed radiomics model based on HAP-fat material decomposition images can serve as a useful tool for osteoporosis prediction and has the potential to be applied in clinical treatment planning in the future.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPMK-3

### Clinical Impact of the Results of Spine Biopsy in Patients with Suspected Discitis-Osteomyelitis

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Joey Mustafa (*Presenter*) Nothing to Disclose

#### PURPOSE

Vertebral osteomyelitis is a serious and potentially life-threatening condition that is challenging to diagnose and treat. Image-guided biopsy is often performed to identify the causative microorganism. Previous studies have primarily focused on the yield of the cultures from these biopsies, but the impact of these results on clinical management has not been thoroughly studied. The objective of this study is to evaluate the impact of image-guided biopsy on the clinical management of vertebral osteomyelitis.

#### METHODS AND MATERIALS

This retrospective study was conducted using patient data from a single academic institution in the USA, and included patients who underwent CT-guided biopsy for suspected vertebral osteomyelitis between January 2013 and April 2022. The study aimed to calculate the positivity rate of the biopsy sampling and assess how the biopsy results impacted the clinical management of patients with vertebral osteomyelitis. Specifically, the study examined whether clinicians changed the management of vertebral osteomyelitis through narrowing or broadening of antibiotic regimens based on the biopsy results.

#### RESULTS

The study included 92 patients who underwent CT-guided bone biopsy for suspected vertebral osteomyelitis. Cultures from biopsy sampling were positive in 35% of patients. In 18% of all cases, the antibiotic regimen was changed based on the biopsy results and the specific organism identified. In contrast, the biopsy results had no significant impact on the subsequent antibiotic protocol in 82% of cases ( $\chi^2=40.96$ ;  $P<0.0001$ ), either because the cultures were negative, the organism could have been predicted without biopsy, or other clinical factors.

#### CONCLUSION

The study highlights the challenges in diagnosing and treating vertebral osteomyelitis, as well as the limitations of image-guided biopsy in impacting the clinical management of this condition. The biopsy results did not lead to a change in the antibiotic regimen for the vast majority of cases. The risks and benefits of biopsy should be carefully considered in light of this knowledge.

#### CLINICAL RELEVANCE/APPLICATION

Spine biopsies can be challenging procedures and the yield of such procedures may be low. This is the only study we are aware of that examines the clinical impact of biopsies performed for suspected discitis-osteomyelitis and the results show that biopsy/culture results do not change clinical management in the majority of patients.

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## Abstract Archives of the RSNA, 2023

W5A-SPMK-4

### Prediction of High-Risk Cytogenetic Status in Multiple Myeloma using Dual-energy Spectral Computed Tomography

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Siya Shi (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the predictive value of quantitative parameters derived from dual-energy spectral computed tomography (DESCT) for a high-risk cytogenetic (HRC) status in multiple myeloma (MM) patients.

#### METHODS AND MATERIALS

This study involved 24 MM patients with 102 lesions who had undergone spinal DESCT. Among them, 5 patients with 18 lesions were diagnosed with HRC status, including the presence of at least one of the following cytogenetic abnormalities (CAs): del(17p), t (4;14), t (14;16), t (14;20), gain (1p), or p53 mutation. The quantitative parameters of DESCT parameters were generated by the regions of interest defined on lesions. Univariate logistic regression was performed to determine the relevant variables with HRC status. The least absolute shrinkage and selection operator (LASSO) was used to build a model for predicting the HRC status. Waterfall plot was used to visualize the performance of the model. Receiver operating characteristic (ROC) analysis was performed to determine potential utility of the model and the sensitivity and specificity determined by the Youden Index were also calculated.

#### RESULTS

Statistical differences were observed according to univariate logistic regression including Mono 40- Kev, Ca (Fat), Ca (Water), Fat (Ca), Fat (HAP), HAP (Fat), HAP (Water), Water (Ca), Water (HAP) and Effective atomic number (Eff-Z) (all  $P < 0.05$ ). Fat (HAP) and Water (Ca) were selected according to LASSO to build a prediction model for HRC status. Waterfall plot demonstrated the favorable predictive performance of the model. ROC analysis indicated the area under the curve was 0.799 (95% confidence interval: 0.656-0.942) with sensitivity of 0.722, specificity of 0.857 and Youden index of 0.579.

#### CONCLUSION

Analysis of DESCT offers potential as a quantitative method to predict the HRC status in MM.

#### CLINICAL RELEVANCE/APPLICATION

The DESCT quantitative parameters could be used to predict HRC in MM patients and to facilitate treatment selection and prognosis prediction.

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## Abstract Archives of the RSNA, 2023

W5A-SPMK-5

### Opportunistic Screening for Acute Vertebral Fractures on Routine Abdominal or Chest CT using an Automated Deep Learning Model

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Jonghun Woo, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop an opportunistic screening model based on deep learning algorithm to detect recent vertebral compression fractures in abdominal or chest CT

#### METHODS AND MATERIALS

This retrospective single center design study collected 1309 coronal reformatted images from abdomen, pelvis or chest CT, performed within the preceding two months in patients recently diagnosed with a vertebral compression fracture or normal spine on spinal MRI. They consists of 504 recent fracture labeled images (119 patients, mean age  $61.6 \pm 19.2$ [SD], M: F=64:55) and 805 normal unlabeled images (115 patients, mean age  $56.2 \pm 15.0$ [SD], M: F=68:47) from September 2018 to April 2022. One radiologic resident and one board certified musculoskeletal radiologist participated in image selection and manual labeling the fractured segment on each CT images. Image selection in recent fracture group was made on the condition that two out of three radiologic findings suggestive of a recent fracture such as cortical step-off, impaction of trabeculae, or visual fracture line were included and three images per each fractured vertebral segment were obtained. For the CT image of the normal patient group, 7 images were obtained at the same interval between the most anterior vertebral body and the posterior vertebral body in the coronal scan. The labeled 480 images and unlabeled 700 images was split randomly into training set, validation set, and internal test set in a ratio of 75%:10%:15%, respectively. Remained labeled 24 images and unlabeled 105 images was included for secondary internal validation set. The primary outcome was test accuracy, precession, and F1 score. Neuro-T (version 2.3.3; Neurocle Inc), a commercially available software was used in establishing algorithm

#### RESULTS

For training, validation and internal test set, the algorithm achieved 99.86 % test accuracy, 91.22 % precision, and 89.18 % F1 score, respectively for detection of recent vertebral compression fracture. Then in secondary internal validation set, our system achieved 99.90% test accuracy, 74.93 % precision and 78.30 % F1 score, respectively.

#### CONCLUSION

Automated deep learning model showed high accuracy in test set and also in internal validation set. If this algorithm is applied opportunistically to daily abdomen or chest CT evaluation, it will be helpful for early detection of vertebral compression fracture.

#### CLINICAL RELEVANCE/APPLICATION

Automated deep learning model showed high accuracy in test set and also in internal validation set. If this algorithm is applied opportunistically to daily abdomen or chest CT evaluation, it will be helpful for early detection of vertebral compression fracture.

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## Abstract Archives of the RSNA, 2023

W5A-SPMK-6

### Detection of Bone Marrow Edema in Vertebral Compression Fractures using Deep Learning Segmentation Quantitative Material Density Imaging in Fast kVp-switched Dual Energy CT

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Reisuke Nishihara (*Presenter*) Nothing to Disclose

#### PURPOSE

Water (hydroxyapatite, [HAP]) material density images derived from dual energy CT (DECT) are used to detect bone marrow edema (BME) in vertebral compression fractures (VCF). However, task-irrelevant anatomy is also enhanced in water (HAP) images, and this can affect BME detection accuracy. This study investigates the diagnostic performance of BME in VCF using water (HAP) density images with deep learning (DL) bone segmentation.

#### METHODS AND MATERIALS

172 vertebral bodies, from the images of 20 patients who underwent both DECT and MRI between Dec 2021 and Feb 2023 for suspected VCF, were included in this study. Vertebral bodies with heights of less than 4 mm, and those imaged after percutaneous vertebroplasty, were excluded. DECT was performed using a 256-row fast kVp switching dual energy CT (Revolution CT, GE HealthCare). Virtual monochromatic images (VMI, 70 keV with 0.625 mm-slices) were reconstructed and processed using dedicated software (Spectral Bone Marrow [SBM], GE HealthCare). SBM generates a bone mask using a DL-based DECT bone segmentation algorithm. This mask defines bone regions upon which water (HAP) material density images are overlaid on the base VMI. The window width and level of the color overlay images are set to optimize visualization of bone marrow. This fully automatic procedure yields 2.5 mm-slice axial, sagittal and coronal water (HAP) density-VMI fused images. Presence of BME was assessed by MRI. Two radiologists, blinded to the MRI results, evaluated each vertebral body for the presence of BME on the water (HAP) density-VMI fused image using a binary classification. Sensitivity, specificity, positive predicted value (PPV) and negative predicted value (NPV) were assessed using MRI as reference standard. Regions of interest (ROI) were placed on each vertebral body. Cut-off values of water (HAP) density were calculated using ROC analysis.

#### RESULTS

The DECT-based algorithm detected BME with 100% sensitivity, 98% specificity, 96% PPV and 100% NPV. A cutoff value of 996.6 mg/cm<sup>3</sup> provided 96 % sensitivity and 99% specificity.

#### CONCLUSION

The DECT BME detection algorithm demonstrates excellent performance in VCF, as evidenced by quantitative analysis as well as concordance with radiologist impressions.

#### CLINICAL RELEVANCE/APPLICATION

Currently, BME diagnosis in VCF is mainly performed using MRI. This work demonstrates that, thanks to advances in deep learning-based segmentation, quantitative projection-based material decomposition direct from projection views, and VMI-water (HAP) image fusion, DECT may provide a viable alternative. DECT may improve patient throughput vs MRI owing to shorter scan time and increase availability because of lower cost per scan.

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## Abstract Archives of the RSNA, 2023

W5A-SPMK-7

### The Value of Trabecular Bone Score in the Reclassification of Bone Quality in Chinese Postmenopausal Women

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Fang Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the clinical value of trabecular bone score (TBS) in the reclassification of bone quality in Chinese postmenopausal women.

#### METHODS AND MATERIALS

The retrospective study included Chinese postmenopausal women who had dual X-ray absorptiometry (DXA) examination between September 2022 and April 2023. DXA images were analyzed to measure bone mineral density (BMD) at lumbar spine (LS), left hip (LH), and femoral neck (FN). was calculated by the TBS iNsite software (version 3.0.0.15). The degradation of bone microstructure was determined following the cutoff values: TBS = 1.310 (normal); 1.230 = TBS = 1.310 (partially degraded); and TBS < 1.230 (degraded). The DXA parameters and clinical characteristics were compared among different BMD categories (normal, osteopenia, osteoporosis) by using rank sum test. Factors related to TBS were determined by Spearman correlation analysis.  $P < 0.05$  was considered statistically significant.

#### RESULTS

A total of 300 subjects were included in this study, with 100 subjects per bone mass category. There was no significant difference in the age between any two of the groups ( $P > 0.05$ ). The TBS was significantly lower in osteoporosis ( $1.212 \pm 0.075$ ,  $P < 0.001$ ) and osteopenia groups ( $1.291 \pm 0.085$ ,  $P < 0.001$ ) than in normal BMD group ( $1.345 \pm 0.097$ ). Significant differences for BMI, weight and DXA parameters were also observed between any two of the groups. For normal BMD group, 3% of subjects still showed degraded microstructure. The number was obviously increased in both osteopenia (7.67%) and osteoporosis (19.66%) groups. For partially degraded microstructure, 8%, 11.33% and 11.34% of subjects were observed in normal BMD, osteopenia and osteoporosis groups, respectively. Spearman correlation analysis showed that the factors related to low TBS were age, weight, BMI, BMD and T-score.

#### CONCLUSION

TBS and BMD were significantly lower in the osteoporosis group than in osteopenia and normal BMD groups. Low TBS was associated with age, weight, BMI, and BMD at lumbar spine, left hip and femur neck. It was notable that a proportion of Chinese postmenopausal women with osteopenia and normal BMD still suffered from degraded microstructure according to their TBS.

#### CLINICAL RELEVANCE/APPLICATION

BMD and TBS are essentially two different and independent indices to describe bone quantity and quality, respectively. Patients with osteopenia may also have degraded bone, which is at higher risk of fracture but not easily detected in clinical. However, in combination of BMD, TBS is able to uncover the presence of these patients. Therefore, TBS is also of great value for the clinical management of Chinese patients with osteoporosis and those at risk of fracture, as well as for treatment decisions and recommendations.

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## Abstract Archives of the RSNA, 2023

W5A-SPMK-8

### TBS Helps Identify Degraded Bone Microstructure in Chinese PHPT Patients

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Wang Ling, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the value of trabecular bone score (TBS) in evaluating the bone microstructure in Chinese primary hyperparathyroidism (PHPT).

#### METHODS AND MATERIALS

We performed a retrospective study of Chinese PHPT patients who were diagnosed between August 2022 to April 2023. The patients all underwent dual-energy X-ray absorptiometry (DXA) examination. Patients without DXA or TBS examination, and suffering from disease that might affect bone metabolism were excluded. Normal control and case groups were matched for age and sex. TBS for each subject was evaluated based on their lumbar spine DXA image by the TBS iNsight software (version 3.0.0.15). The integrity of bone microarchitecture was evaluated based on different TBS cutoff values: TBS = 1.310 (normal microstructure), 1.230 = TBS = 1.310 (partially degraded microarchitecture), and TBS < 1.230 (degraded microarchitecture). The difference of DXA parameters, including TBS and BMD, and clinical information between the groups were analyzed by T-test and Rank sum test.  $P < 0.05$  was considered as significant.

#### RESULTS

A total of 18 Chinese PHPT patients (female: male = 7: 2) and 35 age- and sex-matched controls were included in the study. The bone mass index (BMI) of the included patients was at 15-35kg/m<sup>2</sup>. There were 21 and 14 subjects with normal BMD and bone mass loss in the control group, respectively. Clinical characteristics, including height, weight and BMI, were not significantly different between the groups. A significant difference was observed for lumbar spine BMD ( $P = 0.000$ ) and TBS ( $P = 0.026$ ), as well as left hip (LH) and femoral neck (FN) BMD ( $P = 0.000$  for both) between the control and case groups. In particular, in terms of the mean value, TBS of PHPT groups indicated degraded microstructure, while no degradation was observed in the control group. BMD and TBS were significantly correlated in both groups (PHPT:  $r = 0.891$ ,  $p = 0.000$ ; control group:  $r = 0.569$ ,  $p = 0.000$ ).

#### CONCLUSION

Lumbar spine BMD and TBS was significantly lower in Chinese PHPT patients than control group. In addition, there was a significant correlation between TBS and BMD in PHPT and the control group. In the basis of BMD, TBS could be used to better evaluate the microstructure of Chinese PHPT patients and therefore their fracture risk.

#### CLINICAL RELEVANCE/APPLICATION

BMD does not reflect bone microstructure and hence bone strength. Trabecular bone score (TBS) is a textural index that evaluates pixel gray-level variations in the lumbar spine DXA image, providing an indirect index of trabecular microarchitecture. TBS could be a useful tool to evaluate the bone microstructure of Chinese PHPT patients, providing a better evaluation of their fracture risk.

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## Abstract Archives of the RSNA, 2023

W5A-SPMS-1

### Correlation between Volumetric CT Tumor Burden and Circulating Tumor DNA as Response Parameters in Patients with Advanced Metastatic Melanoma Undergoing Immunotherapy

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Anna Streckenbach, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Circulating tumor DNA (ctDNA) is a promising tool for treatment monitoring of patients with advanced melanoma, as it may serve as a measure of tumour burden. There is a need to understand the correlation between visual tumour burden assessed by imaging and ctDNA levels. Thus, the purpose of our study was to compare ctDNA values with volumetric tumor burden assessed by computed tomography as indicators for therapy response in melanoma patients undergoing immunotherapy.

#### METHODS AND MATERIALS

In this retrospective, institutional review board approved study, a total of 35 patients (19 male, 16 female, age 63 +/- 17) with histologically confirmed metastatic melanoma (AJCC v8 stages III/IV) underwent systemic immunotherapy. All patients received a baseline and at least 2 subsequent staging CT examination after initiation of therapy. This resulted in a total of 107 CT examinations, including a body CT scan (neck, chest and abdomen) as well as cranial CT or MRI. The volumetric tumor burden was measured separately in different anatomical regions (bones, lung, liver, lymph node, cutaneous and brain metastases) using a dedicated commercially available software tool. The total tumor burden as well as subgroup analysis of different metastatic sites were correlated with the plasma ctDNA levels at each follow-up time point. The detection of somatic mutations in plasma DNA included hotspot analyses in 5 different genes: BRAF, EGFR, KRAS, NRAS, PIC3CA.

#### RESULTS

Lymph node metastases were the most common metastatic site (53.6%), followed by lung metastases (30.7%) and subcutaneous metastases (26.9%) and brain metastases (26.9%). The mean ctDNA level was 0.99 %/mL and the mean volumetric total tumor burden was 118 mL. There was a statistically significant difference for relative changes in total tumor burden and ctDNA levels between non-responders (progressive disease [PD]) and responders (partial response [PR] and complete response [CR]). A strong and statistically significant correlation was observed between relative changes of ctDNA levels and total tumor burden ( $r= 0.87$ ;  $p<0.05$ ). Of note, subgroup correlation of the two most frequent sites of metastasis (lymph node, lung) between tumor burden and ctDNA levels was moderate ( $r= 0.6$ ;  $p<0.05$ ).

#### CONCLUSION

Changes in both total tumor burden and ctDNA can be used for precise response assessment in advanced melanoma patients undergoing immunotherapy. Given the strong correlation between the two markers, inherent challenges of immunotherapy response assessment such as pseudo-progression could be identified and differentiated earlier.

#### CLINICAL RELEVANCE/APPLICATION

Combining imaging with other biomarkers is vital to address inherent challenges of immunotherapy response assessment such as pseudo-progression.

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## Abstract Archives of the RSNA, 2023

W5A-SPNMMI-1

### Immuno-PET Imaging of B7-H4 Immune Checkpoint in Prostate Cancer

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Manoj Kumar, MS, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

B7-H4 is an immune checkpoint sibling of PD-L1 that suppresses T-cells' tumor-killing functions. In addition to cancer cells, B7-H4 is also expressed by tumor-associated macrophages (M $\phi$ ), comprising 30-50% of tumor stromal cell populations. This study aimed to design and develop a novel B7-H4 immunoPET probe and perform the first proof-of-concept B7-H4 immunoPET imaging.

#### METHODS AND MATERIALS

Anti-B7-H4 mAb was functionally characterized and tested using ELISA assay. The antibody was conjugated with chelator NODAGA-NHS and labeled with radioisotope copper-64 ( $^{64}\text{Cu}$ ). Tumor xenografts were generated in C57BL/6J mice by subcutaneously injecting TRAMP-C2 prostate cancer cells on the right flank. 5 mice/group were intraperitoneally injected with either PBS, B7-H4 mAb (10mg/kg) to block B7-H4, or chlodronate liposome (15mg/kg) to cause M $\phi$  depletion. MicroPET imaging was performed post-tail vein injection of 100 $\mu\text{Ci}$   $^{64}\text{Cu}$ -B7-H4-mAb. Radiotracer uptake was measured as the maximum percentage injected dose per gram body weight (max %ID/g). Statistical significance was determined using two-way ANOVA with Tukey correction for multiple testing.

#### RESULTS

Immunoconjugation yielded a chelator-to-antibody ratio of 1.8-2.2 and 94-98% radiochemical purity of radiotracer  $^{64}\text{Cu}$ -B7-H4-mAb with an average specific activity of 2645.45 mCi/ $\mu\text{mol}$ . The immunoreactivity of  $^{64}\text{Cu}$ -B7-H4-mAb was similar to that of naked B7-H4 mAb, with unaffected potency in targeting B7-H4 protein moiety. PET imaging demonstrated tumor uptake of radiotracer as  $13.12 \pm 4.867$ ,  $36.38 \pm 5.71$ , and  $42.16 \pm 11.95$  %ID/g at 4-, 24-, and 48 hours, respectively. By comparison, the radiotracer uptake in B7-H4 blocked tumors was  $10.56 \pm 2.26$ ,  $25.92 \pm 6.28$ , and  $27.20 \pm 11.01$  %ID/g at 4-, 24, and 48 hours, respectively. Blocking B7-H4 in vivo significantly reduced radiotracer uptake at the 48-hour time point ( $p=0.0088$ ). Depletion of M $\phi$  also demonstrated a non-significant tendency of reduced tumor uptake radiotracer ( $8.34 \pm 4.37$ ,  $26.04 \pm 4.08$ ,  $35.42 \pm 10.22$  at 4-, 24-, and 48 hours, respectively). Immunohistochemical staining of B7-H4 demonstrated significantly stronger protein levels in untreated tumors compared to B7-H4 blocked or M $\phi$  depleted group.

#### CONCLUSION

The new  $^{64}\text{Cu}$ -B7-H4-mAb radiotracer showed preferential tumor accumulation. In vivo B7-H4 blocking and M $\phi$  depletion reduced the tumor accumulation of the new radiotracer; however, a statistically significant difference was only observed between the control and the blocked group at 48 hours.

#### CLINICAL RELEVANCE/APPLICATION

The new B7-H4 immunoPET probe is a clinically translatable imaging biomarker that could inform clinical trial design immediately. B7-H4 PET imaging could guide clinical decision-making to improve therapeutic benefits.

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## Abstract Archives of the RSNA, 2023

W5A-SPNMMI-2

### Prostate-specific Membrane Antigen (PSMA) as a Novel Theranostic Target in Glioblastoma Multiforme (GBM): Feasibility Study in a Preclinical Xenograft Model

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Steven Pan, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Glioblastoma (GBM) is the most common and aggressive primary malignant brain tumor. Accurate differentiation of viable tumor versus treatment-related change and delivery of targeted therapies is critical to improving clinical outcomes. Prostate specific membrane antigen (PSMA) has recently entered clinical practice as a theranostic (ie diagnostic PET and radionuclide) target in malignancies such as prostate cancer, and PSMA expression in GBM has recently been shown. The purpose of our study was to confirm PSMA expression in GBM with immunohistochemistry (IHC), and to evaluate PSMA as a radionuclide target in a mouse model of GBM.

#### METHODS AND MATERIALS

IRB and IACUC approval was obtained for the human tissue and in vivo mouse model components of the study. IHC was performed in tissue specimen from six GBM patients to validate PSMA expression. Subcutaneous xenografting of a mosaic tumor model consisting of a PSMA+ endothelial cell line and a GBM stem cell line was performed in 5 mice. Three mice were treated with 1 mCi of [Lu177]-PSMA, and tumor localization of radionuclide was validated using post-treatment single-photon computerized tomography (SPECT) imaging. Treatment response was assessed with longitudinal monitoring of tumor size using calipers to measure length (L) and width (W), and estimating ellipsoid volume (V) through the modeling formula,  $V = 0.5 \times L \times W^2$

#### RESULTS

In 5/5 (100%) patient tumor specimen, IHC demonstrated PSMA expression in both tumor stroma as well as tumor vasculature, noting inter-patient heterogeneity. Post-therapy [Lu177]-PSMA SPECT demonstrated specific localization of radionuclide in the subcutaneous tumor xenograft in 3/3 (100%) mice, validating in vivo expression of PSMA in our mosaic model as well as delivery of radionuclide to the tumor site. Treated tumors demonstrated reduction in tumor volume and slowed growth compared to the untreated control group, although no animal demonstrated complete tumor killing.

#### CONCLUSION

We validated previous pilot studies showing PSMA expression in human GBM specimen. We further demonstrate feasibility of PSMA-targeted radionuclide therapy in our in vivo mouse xenograft model, with evidence of partial response. Our findings support further evaluation of PSMA as an emerging theranostic target in GBM, both as a standalone approach and in combination with other therapeutic strategies. Future directions include correlative studies between PSMA expression and clinical outcomes to further elucidate its potential for personalized therapies and a predictor for clinical outcomes.

#### CLINICAL RELEVANCE/APPLICATION

This study combines human GBM tissue and mouse model investigations to validate PSMA as an emerging theranostic target in GBM and has the potential to improve clinical outcomes.

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## Abstract Archives of the RSNA, 2023

W5A-SPNPM-1

### **Burnout Among Radiology Physicians: A Systematic Review and Call to Action**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Nader Ashraf, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Burnout is on the rise among physicians, including radiologists, with prevalence rates exceeding 50%. Burnout in healthcare can result in medical errors, malpractice suits, low patient satisfaction, and poor care delivery. Hence, we aimed to systematically review studies reporting the prevalence of burnout in physicians in the radiology department and to provide an overview of the factors associated with burnout among radiologists.

#### **METHODS AND MATERIALS**

Searches were run from inception until November 13th, 2022, in multiple databases. This systematic review included studies that addressed the prevalence of burnout in radiologists of any sample size, using a valid method of assessment, reporting estimates of overall burnout syndrome or its subdimensions, and were cross-sectional, observational, or prospective survey peer-reviewed studies, without restrictions on publication time or language, following the PICOS framework. Data were extracted into a standardized Excel® sheet and descriptive statistics were generated by the same program.

#### **RESULTS**

Twenty-two cross-sectional studies involving 4230 radiology physicians in 7 countries published between 1996 and 2022 reporting on burnout were included. Fifteen studies (68.2%, n = 3181) were conducted in the United States. The studies had a range of participants from 26 to 460, with a median of 156 and an interquartile range of 89-265. Only 81.8% of the studies identified the gender of their sample, with 57.7% males and 42.3% females. The overall burnout prevalence estimates were reported by 13 studies (59.1%) and varied from 33% to 88%. High burnout prevalence estimates were reported by only 5 studies (22.7%) and ranged from 5% to 62%. Still, the prevalence estimates from these studies cannot be combined nor compared due to the variability in burnout assessment techniques, definitions, and outcomes, as well as statistical heterogeneity.

#### **CONCLUSION**

We identified 22 studies with a high degree of heterogeneity reporting prevalence estimates on burnout among radiologists. Burnout in radiology is increasing globally, with prevalence estimates reaching 88% and 62% for overall and high burnout, respectively, and a myriad of factors identified to be contributing to the increased prevalence. This data should be used as a starting point for discussion to evaluate and resolve these difficulties in the global radiology work environment.

#### **CLINICAL RELEVANCE/APPLICATION**

With the modest number of studies included and the significant methodological discrepancies, there is a need for further high-quality and methodologically robust studies conducted with standardization of burnout definition and assessment techniques.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPNPM-2

### Exploring the Potential of Microsoft Bing Chatbot for Answering Patient Questions Regarding Radiologic Examinations and Procedures

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Ian J. Kuckelman, BS, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the accuracy and completeness of AI chatbot responses to questions commonly asked by patients regarding radiologic examinations and procedures.

#### METHODS AND MATERIALS

We developed ten conversational-style questions for three common radiologic examinations and procedures (CT abdomen, MRI spine, and bone biopsy) and asked them to the Microsoft Bing Chatbot in two trials across three different settings, "More Creative", "More Balanced", and "More Precise". Two reviewers, one an attending radiologist with eight years of experience and the other a fourth-year medical student, independently compared the responses provided by the Chatbot to a gold-standard resource—radiologyinfo.org—and rated them for accuracy and completeness on a scale of 1-3, (1-incorrect/incomplete, potentially harmful; 2-mostly correct/complete, unlikely to cause confusion or harm; and 3-entirely correct/complete). Descriptive statistics were calculated. Differences in accuracy and completeness ratings were compared by chatbot setting and exam type with a Kruskal-Wallis test. Inter-rater reliability was assessed using Cohen's kappa statistic.

#### RESULTS

Of the 180 total responses collected, 166 (92%) were rated as "entirely correct" and 14 (8%) as "mostly correct". For completeness, 119 responses (66%) were rated "complete" and 61 (34%) "mostly complete." Both reviewers rated all responses as either "entirely correct/complete" or "mostly correct/complete", with no responses rated as "inaccurate" or "incomplete" by either reviewer. Neither completeness nor accuracy differed significantly by chatbot setting or exam type. Inter-rater agreement was moderate with a Kappa of 0.66.

#### CONCLUSION

Our study shows that the Microsoft Bing Chatbot has potential as a tool for patient education regarding radiologic examinations and procedures. Directing patients to this online resource represents a potentially cost-effective way for health systems and providers to provide patients with important information regarding how to prepare for a procedure, as well as reduce patient anxiety and improve overall experience. Limitations include potential variability of responses based on question phrasing and the omission of important information not explicitly requested.

#### CLINICAL RELEVANCE/APPLICATION

AI-powered chatbots show potential as a tool for patient education associated with radiologic examinations and procedures.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPNPM-3

### Can ChatGPT Answer Questions about Lung Cancer and Screening

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Hana L. Haver, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The recent surge of worldwide interest in dialogue-based artificial intelligence (AI) large language models (LLM) such as ChatGPT is prompting evaluation of information available on such platforms. Early studies have found that ChatGPT provides generally appropriate clinical recommendations in areas ranging from cardiovascular disease, antibiotic selection for infectious diseases and breast cancer. Lung cancer remains a leading cause of death in the United States, so we sought to evaluate how ChatGPT would respond to fundamental questions about lung cancer prevention, screening and the Lung CT screening Reporting and Data System (Lung-RADS).

#### METHODS AND MATERIALS

In February 2023, we submitted 25 questions to ChatGPT and asked it to generate three answers, as inconsistencies among answers are reported. Three fellowship-trained cardiothoracic radiologists graded each set of responses based on clinical judgment as 1) "appropriate," 2) "inappropriate", or 3) "inconsistent" if the responses contained inappropriate or varied information, respectively. Final appropriateness for each set was determined by the majority of reviewer responses, which were summarized using descriptive statistics.

#### RESULTS

ChatGPT-generated responses were determined to be appropriate for 76% (19/25) questions in both contexts by three fellowship-trained cardiothoracic radiologists. Four of 25 (16%) generated responses were characterized as inappropriate and 2/25 (8%) as inconsistent in both hypothetical contexts (Table 1). Inappropriate and inconsistent responses were related to lung cancer screening indication and frequency as well as those related to the Lung-RADS lexicon.

#### CONCLUSION

ChatGPT demonstrates the potential to automate provision of healthcare information related to lung cancer prevention and screening. ChatGPT performed more poorly on topics about lung cancer compared to previous reports on clinically appropriate information to questions about cardiovascular disease and breast cancer. This difference could be due to lack of information about lung cancer versus cardiovascular disease in the model's training dataset. Radiologist oversight remains critical, given the inappropriate and inconsistent radiology-specific information. Future study of applications for LLMs to improve healthcare education and counseling is encouraged.

#### CLINICAL RELEVANCE/APPLICATION

ChatGPT generates largely appropriate answers to questions about lung cancer prevention and screening, though gaps remain in specific radiology topics and physician oversight remains imperative.

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## Abstract Archives of the RSNA, 2023

W5A-SPNR-1

### Assessment for Carotid Atherosclerotic Plaque using Vessel Wall Magnetic Resonance Imaging: A Multi-reader ROC Study to Determine Optimal Sequence for Detecting Vessel Wall Calcification

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Hideki Ishimaru, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to compare conventional vessel wall MR imaging techniques and quantitative susceptibility mapping to determine the optimal sequence for detecting carotid artery calcification.

#### METHODS AND MATERIALS

Twenty-two patients who underwent carotid vessel wall MR imaging and neck CT were enrolled. Four slices of 6-mm sections from the bilateral internal carotid bifurcation were subdivided into 4 segments according to clock position (0-3, 3-6, 6-9, and 9-12) and assessed for calcification. Two blinded radiologists independently reviewed a total of 704 segments and scored the likelihood of calcification using a 5-point scale on T1-, T2-, PD-weighted imaging, the first echo-time images of FLASH, and quantitative susceptibility mapping. Quantitative susceptibility mapping was calculated using phase images of FLASH. The observer performance for detecting calcification was evaluated by a multireader, multiple-case receiver operating characteristic study. Weighted  $\kappa$  statistics were calculated to assess interobserver agreement with respect to calcification scoring.

#### RESULTS

Quantitative susceptibility mapping had a mean area under the receiver operating characteristic curve of 0.85, which was significantly higher than that of any other sequence ( $p < 0.01$ ) and showed substantial interreader agreement ( $\kappa = 0.68$ ). When a segment with a score of 3-5 was defined as positive and a segment with a score of 1-2 was defined as negative, the sensitivity and specificity of QSM were 0.75 and 0.87, respectively.

#### CONCLUSION

Quantitative susceptibility mapping was the most reliable MR sequence for the detection of plaque calcification.

#### CLINICAL RELEVANCE/APPLICATION

A low signal on quantitative susceptibility mapping is a reliable marker of carotid plaque calcification.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPNR-11

### Contribution of Cerebral Microbleeds and Sleep Quality to Persistent Post-concussive Working-Memory Decline Through Glymphatic Clearance Dysfunction

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Yung-Chieh Chen, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral microbleeds (CMBs) and sleep disorders are linked to persistent cognitive decline after a concussion (mild traumatic brain injury, mTBI). However, the pathomechanism is not fully understood. We hypothesized that the inefficient glymphatic clearance function may contribute to prolonged working-memory dysfunction, which may be partially attributed to both poor sleep and concussion-related CMBs.

#### METHODS AND MATERIALS

We conducted a 1-year prospective magnetic resonance imaging (MRI) and neuropsychological study on patients with concussion (N=61) and demographically matched controls (N=61). Susceptibility-weighted MRI was used to detect CMBs. The diffusion tensor imaging analysis along the perivascular space (DTI-ALPS) index was used to evaluate glymphatic function. The Pittsburgh sleep quality index (PSQI) and digit span (DS) scores were employed to assess participants' sleep quality and working memory, respectively. The baseline DTI-ALPS index, PSQI scores, and the demographic data were used to train the machine learning-based model to predict the 1-year DS score.

#### RESULTS

Patients with CMBs demonstrated a lower DTI-ALPS index compared with patients without CMBs and controls. Additionally, patients demonstrated poorer sleep quality than controls. The 1-year DS score was significantly correlated with both glymphatic diffusivity (DTI-ALPS;  $r=0.592$ ,  $p<0.001$ ) and sleep quality (PSQI;  $r=-0.551$ ,  $p<0.001$ ) assessed at baseline. Potential baseline biomarkers, such as the number of CMBs, DTI-ALPS index, and PSQI score, the confounding factors, including age, sex, education level, and duration from injury to MRI, were employed as the potential feature factors to predict long-term working memory function (1-year DS score). We then developed several machine learning-based models using the key features selected by the Lasso method to predict the DS score at the 1-year follow-up. Among the models, the Gaussian Process Regression method yielded the best predictions of the 1-year DS score, with an  $R^2$  value of 0.78 and a root-mean-squared error of 2.8827.

#### CONCLUSION

CMB and poor sleep quality are contributing factors for glymphatic dysfunction, as measured using the DTI-ALPS index, and related to persistent postconcussive working-memory impairment. Our systematic analyses not only further our understanding of glymphatic dysfunction after concussion but also provide a framework for precise and personalized predictions of protracted cognitive decline.

#### CLINICAL RELEVANCE/APPLICATION

The study highlights the importance of monitoring sleep quality and glymphatic function in patients with concussion, and suggests a potential therapeutic target for preventing persistent cognitive dysfunction after concussion.

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## Abstract Archives of the RSNA, 2023

W5A-SPNR-12

### Magnetic Resonance Imaging in Traumatic Brain Injury Patients and Associations with In-hospital Outcomes: Analysis of a National Representative Sample

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Nnamdi J. Omenuko, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic Resonance Imaging (MRI) has gained increasing attention due to its superior ability to visualize brain tissue injury. Several studies have demonstrated the superior diagnostic accuracy of MRI compared to computed tomography (CT) which is the most used imaging modality in the acute setting. The presence of intracranial hemorrhage has been associated with poor outcomes in traumatic brain injury patients. Therefore, the appropriate use of imaging modalities is crucial in predicting outcomes and providing optimal care. We aim to study the use of MRI in Traumatic Brain Injury (TBI) patients and their associations with in-hospital outcomes.

#### METHODS AND MATERIALS

The National Inpatient Sample (NIS) was queried for MRI use, discharge disposition, length of hospital stays, intracranial hemorrhage, and in-hospital mortality among those with TBI in 2015. The effect of MRI use on these endpoints was evaluated using bivariate and multivariate regression analysis independently, controlling for significant baseline differences in demographics, comorbidities, and hospital status.

#### RESULTS

A total of 45293 patients admitted with a diagnosis of TBI were included in this study. 25.7 %, 35.6%, 24.0%, and 14.6% of the patients were in age groups 20-40, 40-65, 65-80, and >80, respectively. 55% of the patients were female. 58% were Whites, while Hispanic, Black, and other races accounted for 17%, 14%, and 9%, respectively. In the unadjusted analysis, inpatient CT brain was associated with lower rates of mortality (unadjusted OR 0.657, 95% CI 0.163-2.651) compared to those who did not have a CT scan. Inpatient CT use was also associated with lower odds of short hospital stays (unadjusted OR 0.810, 95% CI 0.729-0.900) compared to those who did not. After adjusting for confounders, MRI and CT use was not significantly associated with in-hospital mortality, discharge disposition, length of stay, or inpatient complications.

#### CONCLUSION

We present that there seems to be no difference in inpatient outcomes and complications when MRI is used in the evaluation of traumatic brain injuries. Clinical decision-making regarding the use of MRI versus CT scan in TBI patients should be based on the severity of the injury and clinical presentation. Further research is needed to explore the long-term outcomes.

#### CLINICAL RELEVANCE/APPLICATION

The clinical relevance of comparing MRI use versus CT scan in TBI patients lies in the potential to improve in-hospital outcomes. The appropriate imaging modality can provide accurate and timely diagnosis, which can lead to better treatment decisions and improved patient outcomes. Understanding the associations between these imaging modalities and in-hospital outcomes can aid in clinical decision-making and lead to better patient care.

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## Abstract Archives of the RSNA, 2023

W5A-SPNR-13

### Quantitative Analysis of Calcification in Cerebral Microvasculature by Micro-computed Tomography (microCT)

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Janet Back, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Vascular calcification (VC) is a predictor of both cardiovascular and cerebrovascular events. While it is known that coronary VC results in impaired vasomotor response and reduced myocardial perfusion, less is known about the prevalence and impact of VC in brain microcirculation. We examined the distribution of intracranial calcification in a cohort of human cadavers using micro-computed tomography (microCT). We aimed to exhibit the feasibility of quantifying calcification volume (CV) in cadaveric brain vasculature using microCT and apply this method to compare CV across brain regions in which VC has been incidentally noted in case studies.

#### METHODS AND MATERIALS

In a cohort of elderly human donor cadavers with and without dementia documented at time of death, brain tissue was sampled bilaterally from basal ganglia (BG), substantia nigra (SN), subventricular zone (SVZ), hippocampus (Hc), and posterior cingulate cortex (PCC). Samples were scanned by microCT at 10  $\mu$ m resolution. 3D-reconstructed images were segmented into standardized regions of interest (ROI) and thresholded at the level of calcium detection (130 Hounsfield units). CV was defined as voxel quantity  $\geq$ 130 HU within each ROI; CVs exceeding .01% per ROI were considered "positive". Findings were confirmed by histologic evaluation using Alizarin red calcium-binding stain.

#### RESULTS

All subjects exhibited parenchymal and/or vascular calcification in at least one region. Calcification volume exceeding .01% per ROI for the no dementia cohort (n=6) was 83% globus pallidus (GP), 66% SN, 17% SVZ, 17% Hc, and 33% PCC compared to the dementia cohort (n=6) which was 100% GP, 33% SN, 50% SVZ, 100% Hc, and 100% PCC. Prevalence of Hc and PCC was significantly greater in subjects with documented dementia compared to age-matched subjects (n=12,  $p < 0.01$ ).

#### CONCLUSION

Our findings demonstrate the utility of microCT for quantifying CV in human brain tissue. All subjects exhibited calcification in at least one brain region, indicating that intracranial calcification is more prevalent than published estimates (~30% in general population). Consistent with the literature, VC was most prevalent in the GP. Subjects with dementia exhibited significantly higher Hc and PCC CVs than age-matched subjects without dementia. This finding supports recently published evidence of increased Hc and BG calcification in human cadaveric brains with Alzheimer's disease relative to age-matched controls. Expansion of our study cohort remains ongoing in order to further investigate this relationship.

#### CLINICAL RELEVANCE/APPLICATION

Analyzing the patterns of VC in cerebral vasculature using microCT can aid in the development of therapeutics against cerebrovascular and neurodegenerative diseases.

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## Abstract Archives of the RSNA, 2023

W5A-SPNR-4

### Predictors of Positive Remodeling in Patients with Acute Ischemia Stroke

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Li-Ping Ma, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to compare the differences in the culprit plaques characteristics between positive remodeling (PR) and non-positive remodeling (NPR) patterns in patients with acute ischemia stroke (AIS), and to evaluate potential relative risk factors for PR of intracranial atherosclerosis (ICAS).

#### METHODS AND MATERIALS

Patients with AIS recruited and underwent the HR-VWI scan within 2 weeks after onset. Plaque morphological parameters, as well as clinical variables of both PR and NPR groups were compared using non-parametric tests. A binary logistic regression model was used to analyze the parameters promoting the development of PR, and further determine the independent predictors of PR. The sensitivity and specificity of the model were tested by receiver operating characteristic curve.

#### RESULTS

In all, 84 eligible patients (mean age  $58.07 \pm 1.35$  years, 66 (78.6%) were male) were assigned to the PR (n=28, 33.3%) or NPR (n=56, 66.4%) group according to remodeling ratio (RR). Compared with the NPR group, the PR group had a greater plaque area ( $P < 0.001$ ), greater wall area (WA) ( $P < 0.001$ ), longer plaque length ( $P = 0.018$ ), larger RR ( $P < 0.001$ ), higher blood glucose ( $P = 0.01$ ) and a greater number of HBP ( $P = 0.16$ ). Binary Logistic regression analysis showed that plaque area was independently associated with PR (OR 3.71, 95% CI, 1.49-9.24).

#### CONCLUSION

HR-VWI can identify positive remodeling in ICAS with large plaque area, suggesting a high burden of intracranial vascular lesions and promoting PR.

#### CLINICAL RELEVANCE/APPLICATION

To evaluate the effect of plaque morphological properties and clinical parameters on cerebrovascular remodeling patterns to improve the classification of cardiovascular risk.

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## Abstract Archives of the RSNA, 2023

W5A-SPNR-5

### Early Brain Amyloid Accumulation on PET in Military Instructors Exposed to Sub-concussive Blast Injuries

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Carlos Leiva-Salinas, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Traumatic brain injury (TBI) is the leading cause of disability in young adults. Recurrent TBI is associated with a wide range of neurologic sequelae, but the contributing factors behind the development of such chronic encephalopathy are poorly understood. Purpose: To quantify early amyloid beta (A $\beta$ ) deposition in the brain of otherwise healthy adult men exposed to repeated subconcussive blast injury using amyloid PET.

#### METHODS AND MATERIALS

In this prospective study from January 2020 to December 2021, military instructors routinely exposed to repeat blast events were evaluated at two different time points: baseline, prior to blast exposure from breacher or grenade, and approximately 5 months after baseline, after blast exposure. Age-matched healthy controls not exposed to blasts and without a history of prior brain injury were evaluated at similar two time points. Neurocognitive evaluation was performed with standard neuropsychological testing for both groups. Analysis of PET data consisted of SUV measurements in six relevant brain regions, and whole brain voxel-based statistical approach.

#### RESULTS

All participants were men (9 controls, 9 blast-exposed). The median age of the controls was 33 years.; IQR: [32, 36]. That of the blast-exposed group was 33; IQR: [30, 34] ( $p=0.824$ ). In the latter, four brain regions showed significantly increased amyloid deposition after blast exposure: infero-medial frontal lobe, precuneus, anterior cingulum and superior parietal lobule ( $P$  values=0.004, 0.02, 0.002, and 0.003 respectively). No amyloid deposition was observed in the controls. Discriminant analysis based on regional changes of amyloid accumulation correctly classified all 9 healthy controls as a healthy controls (100%) and 7 of the 9 blast-exposed (78%) as a blast-exposed. Based on the above voxel-based analysis, whole brain parametric maps of early abnormal early amyloid uptake were obtained. Conclusion: Early brain amyloid accumulation was identified and quantified on PET in otherwise healthy adult men exposed to repetitive subconcussive traumatic events.

#### CONCLUSION

Early brain amyloid accumulation was identified and quantified on PET in otherwise healthy adult men exposed to repetitive subconcussive traumatic events.

#### CLINICAL RELEVANCE/APPLICATION

Our results might have direct clinical implications; if the individuals that are at risk of developing amyloid-related neurotoxicity can be identified, therapies to clear A $\beta$  in the brain might reduce or slow the development of long-term secondary traumatic encephalopathy.

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## Abstract Archives of the RSNA, 2023

W5A-SPNR-7

### Optimizing Traumatic Brain Injury Prognosis Prediction: Leveraging Machine Learning with CT Imaging and GFAP/UCH-L1 Blood Biomarkers

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to develop an interpretable machine learning (ML)-based predictive model that combines clinical variables, blood biomarkers, and imaging biomarkers to improve the prognostic prediction, triage management, and treatment strategy in traumatic brain injury (TBI) patients.

#### METHODS AND MATERIALS

In this retrospective cohort study, 662 patients transported to the emergency department with a trauma alert and suspected TBI were screened. Data extraction from electronic medical records included demographic and clinical information. Blood samples were collected and analyzed for GFAP and UCH-L1 using a sandwich enzyme-linked immunosorbent assay. Non-contrast head CT scans were assessed by neuroradiologists for TBI common data elements (CDEs). The collected data was used as input for the ML models. Three outcomes were designed to predict: discharged or admitted for further management (prediction 1), in hospital mortality (prediction 2), and course of hospital stay (prediction 3). Machine learning models, including XGBoost, Random Forest, decision tree, support vector machines, and logistic regression, were trained using the training sets to compare their performances. Cross-validation and hyperparameter tuning were employed. SHapley Additive exPlanations (SHAP) values were used to evaluate the relative significance of predictor factors.

#### RESULTS

A total of 440 patients were finally included. Random Forest models achieved the best performance. For prediction 1 (discharged or admitted for further management), the test set accuracy was 0.95, and the Kappa value was 0.88. For prediction 2 (deceased or not deceased), the accuracy was 0.98, with a Kappa value of 0.49. In prediction 3 (admission only, prolonged stay, or neurosurgery performed), the Random Forest model achieved an accuracy of 0.82 and a Kappa value of 0.72 during the testing phase. SHAP analyses showed that the three most important features for prediction 1 were other major extracranial injury, hemorrhage, UCH - L1. The top three features for prediction 2 were Glasgow Coma Scale, age, GFAP. GFAP, subdural hemorrhage volume, and pneumocephalus were the five most significant features for prediction 3.

#### CONCLUSION

Our study demonstrates the potential of ML models in predicting the hospital course and mortality of TBI patients using non-contrast CT CDEs and blood biomarkers GFAP and UCH - L1. Blood biomarkers like GFAP and UCH - L1 were among the significant variables for prediction, demonstrating the originality of our study.

#### CLINICAL RELEVANCE/APPLICATION

These models may help physicians tailor individualized care plans and provide more accurate prognostic information for patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPNR-8

### Asymmetric Cerebral Perfusion Abnormalities are Hallmark in Chronic Traumatic Brain Injury Imaging

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Farzaneh Rahmani, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Advanced MRI methods identify biomarkers of grey or white matter damage including perfusion defects, diffusion abnormalities or atrophy. These biomarkers might improve sensitivity for detection of chronic traumatic brain injury (TBI), even when acute evidence of the insult are subtle or absent on conventional imaging sequences.

#### METHODS AND MATERIALS

Sixty-seven participants (29 men and 38 women, age:  $47.1 \pm 13.5$ ) with a history of traumatic brain injury were enrolled from individuals referred to the Neuroevolution LLC. under IRB exemption #Pro00071328. Participants were required to be at least 18 years old and have a T1-weighted brain MRI acquired within 3 months of the date of injury. Additionally, 60 participants (26 men and 34 women, age:  $47.8 \pm 13.1$ ) had arterial spin labeling (ASL) perfusion and 55 had diffusion MRI (dMRI) scans available. Volumetric assessments were done using the Neuroreader program which is FDA-cleared, yielding absolute, normalized and standardized volumes for 83 cortical and subcortical brain structures. The Neuro Reader index (NR-index) was defined as the regional z-score divided by the size of the normative database, while the left-right asymmetry scores were calculated as described in prior work. ASL-MRICloud was used to extract relative regional cerebral blood flow (rCBF) and their respective z-score maps. Abnormal white matter (WM) fractional anisotropy (FA) was identified through comparison of automated ROI defined regions to age and sex-matched references.

#### RESULTS

Regions with highest prevalence of abnormal NR-index included the bilateral cerebellar grey matters, lateral ventricles, pallidi and the right temporal lobe. Significant left-right asymmetry was seen in the frontal lobes in 31%, in parietal lobes in 25%, in occipital lobes, and in temporal lobes in 31% of the participants, while the pallidi were most likely to demonstrate left-right asymmetry among subcortical regions. Similarly, Figure 1 demonstrate a significant left-right asymmetry in the average perfusion z-score map of all participants, with a distinct right frontal: left parietal, coup-contrecoup pattern. WM FA was found to be abnormally low ( $< -2$  z-score) in 7.3% and 9.1% of participants in the right and left internal capsules. Rate of FA abnormality was even lower in the splenium (3.6%) and genu (1.8%) of IC, right and left parietal WM (0% AND 3.6), and right and left frontal WM (1.8% and 0%).

#### CONCLUSION

Asymmetric abnormalities in brain perfusion are common in chronic post TBI setting and their prevalence exceeds those of volumetric or diffusion abnormalities.

#### CLINICAL RELEVANCE/APPLICATION

This work establishes the added importance of advanced neuroimaging techniques, namely perfusion imaging, in identifying evidence of chronic TBI.

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## Abstract Archives of the RSNA, 2023

W5A-SPNR-9

### Differences in Corpus Callosum White Matter Integrity in mTBI Patients with and without PTSD Comorbidity

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Priya Santhanam, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to compare corpus callosum diffusion tensor imaging (DTI) findings in mild traumatic brain injury (mTBI) patients who presented either with or without post-traumatic stress disorder (PTSD) symptomology.

#### METHODS AND MATERIALS

DTI and clinical data were obtained from retrospective chart review of 451 civilian patients (mean age 43 years, range 13-82) with clinically diagnosed mTBI. Patients were identified as having PTSD if presenting with signs and symptoms consistent with the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-V) diagnostic criteria. The corpus callosum and its subregions (anterior/inferior, anterior, mid-body, posterior, posterior-inferior) were defined by hand tracing in Olea Sphere (v3.0 SP12). Fractional anisotropy (FA) values were compared between patients with mTBI only and those with mTBI+PTSD by Mann-Whitney U test.

#### RESULTS

FA was lower in patients with mTBI+PTSD as compared to those with mTBI only in the corpus callosum overall and within all subregions. Statistical comparisons between groups found FA was significantly lower in the whole corpus callosum ( $p < 0.001$ ) as well as in the anterior/inferior ( $p = 0.003$ ), anterior ( $p < 0.001$ ), mid-body ( $p = 0.006$ ), posterior ( $p = 0.007$ ), and posterior/inferior ( $p = 0.017$ ) subregions individually.

#### CONCLUSION

Patients with mTBI and comorbid PTSD had reduced white matter integrity across the corpus callosum. While the contribution of PTSD to brain injured patients is not well-understood, some prior research indicates a possible influence of PTSD in military TBI populations. Further examination is needed to determine any mechanism for concomitant trauma and PTSD in civilian patients.

#### CLINICAL RELEVANCE/APPLICATION

White matter integrity in the corpus callosum of trauma patients may be further compromised for those with mTBI and PTSD comorbidity.

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## Abstract Archives of the RSNA, 2023

W5A-SPOB-1

### **Black Hole Pattern on Diffusion Weighted Images (DWI) May Help Predict Placental Invasiveness in Women at High Risk for Placenta Accreta Spectrum (PAS) Disorders**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Charis Bourgioti, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To quantify placental inhomogeneity using 'black hole' pattern on diffusion weighted imaging (DWI) in women at high risk for placenta accreta spectrum (PAS) disorders; to investigate its predictive ability for presence and degree of placental invasiveness.

#### **METHODS AND MATERIALS**

Between 3/2018 and 9/2022, 59 pregnant women underwent dedicated prenatal MRI for placental evaluation with a 3.0T unit. All women underwent C-section within 6 weeks from MRI. DWI data were prospectively compiled for review by two experienced genitourinary radiologists and manual placental segmentation for each participant was performed. Black hole, a pattern previously observed by the readers only on high b value DWI, was defined by consensus as a discrete intraplacental areas of signal loss on high b value (1500) images. A semi-automated algorithm using 28.70 as a threshold pixel value was applied to locate placental holes and calculate the total number of placental voxels (3D), total number of hole voxels, volume of hole voxels (mm<sup>3</sup>) and % of hole voxels/total placental voxels. Statistical analysis was performed for possible association of the above parameters with presence and grade of PAS. Intraoperative/histological findings were the standard of reference. Statistical significance (p) was set to 0.05.

#### **RESULTS**

Fifty women (mean age:37 years, mean gestational age:33 weeks) were evaluable and formed the study group. Significant differences were detected between normal placenta and presence of PAS regarding the total number of placental voxels (p=0.02), number of hole voxels (p=0.02) and volume of holes (p=0.03). Total number of hole voxels and hole volume were significantly lower in normal placentas than in accreta/increta (grade I/II, p=0.04, p=0.04) or percreta (grade III, p=0.005, p=0.01) cases. No differences were detected in the above parameters for PAS grading.

#### **CONCLUSION**

Total number of voxels and volume of intraplacental black holes on DWI, may serve as yet another prognosticator for PAS disorders.

#### **CLINICAL RELEVANCE/APPLICATION**

Quantification of placental inhomogeneity on functional MRI may enable the development of deep learning algorithms for predicting PAS disorders.

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## Abstract Archives of the RSNA, 2023

W5A-SPOB-2

### Evaluating Fetal Bowel Wall Function by Ultrasound Microvascular Flow Imaging

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Xueleli Li, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study summarized the characteristics of fetal mesenteric blood flow perfusion at various gestational weeks, and aimed to establish the feasibility of microvascular flow (MV-Flow) technology in evaluating intestinal wall blood flow and function.

#### METHODS AND MATERIALS

This retrospective study analyzed 35 meconium peritonitis (MP) fetuses and 160 healthy fetuses in our medical center from March 2020 to December 2022. The vascular index (VI) of superior mesenteric artery region obtained by automatic ellipse method and manual method were compared. The correlation between the region of interest VI and gestational weeks was analyzed. A subgroup analysis of MP operative group vs. MP non-operative group was performed, and a prediction model for surgical treatment was established.

#### RESULTS

There was no difference in VI value of the mesenteric blood perfusion region between automatic ellipse method and manual method ( $51.40 \pm 8.58\%$  vs  $50.82 \pm 8.05\%$ ,  $p=0.534$ ). There was no significant change in VI as the gestational age increased (correlation coefficient=0.005,  $p=0.946$ ). Compared with MP non-operative group, the operative group has significantly more cesarean deliveries (100% vs 52.9%,  $p=0.003$ ), shorter pregnancy duration ( $34.76 \pm 2.16w$  vs.  $37.48 \pm 1.55w$ ,  $p<0.001$ ), lower infant weight ( $2762.141 \pm 452.76kg$  vs.  $3225.88 \pm 339.98kg$ ,  $p=0.003$ ), more persistent ascites cases (92.9% vs. 52.9%,  $p=0.021$ ), more intestinal wall echo reduction cases (57.1% vs. 5.9%,  $p=0.004$ ), and lower VI ( $18.57 \pm 5.51\%$  vs.  $39.41 \pm 7.02\%$ ,  $p<0.001$ ). In risk factor analysis, VI value was significantly associated with surgical treatment after birth (OR=0.689; 95% CI: 0.511-0.929). A prediction model for surgical treatment of newborns was established: Logit (P)=8.86 - (0.37\* VI) +(1.49\* ascites). The AUC of the ROC curve of the prediction model is 0.857 (95% CI: 0.75-0.95), with 78.6% sensitivity, and 88.2% specificity.

#### CONCLUSION

MV-Flow imaging can quantify the fetus bowel wall blood flow perfusion. There is no correlation between the VI value of mesenteric regional blood flow perfusion and gestational week. In fetuses with meconium peritonitis, the VI value of mesenteric blood flow is significantly reduced, suggesting the increased possibility of intestinal wall necrosis and post-natal surgical treatment.

#### CLINICAL RELEVANCE/APPLICATION

The findings of the current study provide information about evaluating fetus bowel wall function using ultrasound MV-Flow imaging, which could improve the prenatal diagnosis of meconium peritonitis in the fetus, and predict surgical treatment after birth.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPPD-1

### Usefulness of the Air Gap Methods during Pediatric Computed Tomography

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Takanori Masuda, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Purpose: The air gap methods can be used as the primary scatter reduction method in order to reduce patient dose. The purpose of this study was to compare the radiation dose and image noise between conventional setting and air gap setting methods during the pediatric chest computed tomography (CT).

#### METHODS AND MATERIALS

We used newborn pediatric anthropomorphic phantom with a 64 detector-row CT scanner with helical scan modes from the apex of the lung to the diaphragm. Compare with the conventional setting (group A), the pediatric anthropomorphic phantom was positioned 10 cm away from the table using a plastic with low X-ray absorption in air gap methods (group B). A real-time skin dosimeter (RD - 1000; TORECK CO, Kanagawa, Japan) was placed and inserted into the phantom center of the body, the surface of the body back, and the right and left mammary glands. The phantom was then scanned 10 times using each protocol. The measured dose values of the RD - 1000 were compared for each methods.

#### RESULTS

The measured dose values of the group A were 1.44 at the center, 1.46 at the back, and 1.64 at the mammary gland, respectively. The measured dose values of the group B were 1.30 at the center, 1.35 at the back, and 1.53 at the mammary gland, respectively. Compared with the Group A, it was possible to reduce the exposure dose by approximately 10% at the group B ( $p < 0.05$ ). The image noises were 9.3 HU at the group A and 8.0 HU at the group B. Compared with the Group A, it was possible to reduce the image noise by approximately 15% at the group B ( $p < 0.05$ ).

#### CONCLUSION

By using the air gap methods, it is possible to reduce the exposure dose and image noise approximately 10 % during pediatric chest CT.

#### CLINICAL RELEVANCE/APPLICATION

The reduction of the radiation dose and image noise according to the as low as reasonably achievable (ALARA) principle requires optimizing the scan protocol by using air gap methods.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPPH-1

### Comparison of Conventional and Compressed SENSE Sequences on MRI of Brain in Paediatric Population

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Isha S. Shah, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the quality and image acquisition time between conventional and Compressed SENSE sequences on magnetic resonance imaging (MRI) of brain in paediatric population.

#### METHODS AND MATERIALS

Thirty children (below the age of 18 years) undergoing MRI of brain were included in this study after obtaining Ethical clearance from the institute. In addition to the routine clinical protocol for brain, one Compressed SENSE sequence was added. 2D - T1, T2, and FLAIR axial sequences were acquired for brain using conventional and Compressed SENSE techniques. One of each sequence was acquired in 10 patients undergoing an MRI brain study on a 3T MRI using coil 32 channel coil for adults and paediatric 8ch head coil for neonates. Two consultant radiologists (with 35 years and 5 years of experience in radiology) independently scored the image quality using the 5-point Likert scale based on resolution, visualisation of anatomical regions, grey-white matter differentiation, sharpness of the image and artefacts. The subjective criteria details for image quality as per the 5-point Likert scale were: non-diagnostic (1), poor (2), moderate (3), good (4) and excellent (5). 2D T1 sequence was acquired with parameters as FOV 230\*183\*130mm, voxel size 0.575\*0.75, TE-20ms, TR-2000ms, CS factor-2, 2D T2 sequence was acquired with parameters FOV 230\*230\*149mm, voxel size 0.55\*0.65, TE-3000ms, TR-80ms, CS factor-2.2 and 2D FLAIR was acquired with parameters FOV 210\*168\*149mm, voxel size 0.7\*1.42mm, TE-140ms, TR-11000ms, CS factor-2.

#### RESULTS

The time reduction achieved with 2D T1 at 2 reduction factor were 60 seconds(24%), with 2D T2 at reduction factor of 2.2 66 seconds(47.83%) and with 2D FLAIR at reduction factor 2 66 seconds(40%). Inter-rater agreement for overall diagnostic confidence was rated higher for Compressed SENSE (k - 0.632) than conventional (k - 0.464). Nonsignificant statistical difference was found regarding image quality and image contrast ratio between both techniques.

#### CONCLUSION

Compressed SENSE has potential in reducing the image acquisition time without compromising the image quality and diagnostic confidence. Motion artefacts are also reduced with reduction in time with the use of Compressed SENSE sequence.

#### CLINICAL RELEVANCE/APPLICATION

Acceleration achieved with compressed SENSE sequences can cause an overall reduction in the acquisition time without compromising image quality. This consequently results in reduction of anaesthetic dose administered which is of clinical concern in paediatric population.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-10

### **Preliminary Study on the Clinical Staging of Primary Lower Extremity Lymphedema by STIR Soft Tissue Radial Measurements**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

MENGKE LIU (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Exploring the value of magnetic resonance-based measurement of two-dimensional radial data of the limb in assessing the clinical staging of primary lower extremity lymphedema (PLEL)

#### **METHODS AND MATERIALS**

A retrospective collection of 132 patients diagnosed with primary LEL by our hospital was made, and all patients underwent MR examination of the lower extremities. Short Time Inversion Recovery (STIR) sequences were used to measure the total longitudinal and transverse soft tissue diameter (TD), musculoskeletal diameter (MD) and subcutaneous soft tissue diameter (S) of the lower leg, and the difference between TD and SD on the affected and the healthy side (DTD, DSD) were calculated respectively. The patients were staged according to the International Society of Lymphology (ISL) clinical staging criteria in 2020. Statistical analysis of all measurements was performed to determine the feasibility of MRI measurements for clinical staging of PLEL

#### **RESULTS**

The correlation between the transverse diameter TD ( $R=0.492$ ), SD ( $R=0.596$ ), DTD ( $R=0.608$ ), and DSD ( $R=0.620$ ) and clinical stage was significantly greater than that between the longitudinal diameter TD ( $R=0.430$ ), SD ( $R=0.532$ ), DTD ( $R=0.547$ ), and DSD ( $R=0.519$ ), and the highest correlation between the transverse diameter DSD and clinical stage. The values of TD, SD, DTD and DSD in stage I were significantly lower than those in stage II and III ( $P<0.05$ ), but there was no significant difference between stage II and III ( $P>0.05$ ). The area under the curve (AUC) of the transverse diameter to identify clinical stage was greater than that of the longitudinal diameter, with the transverse DSD (AUC=0.930) having the highest AUC value to identify stage I with stage II.

#### **CONCLUSION**

Based on the fact that MRI measurement of soft tissue trajectories can be used as a quantitative method for clinical staging of unilateral PLEL. We recommend the subcutaneous soft tissue difference of transverse diameter as the best measure to distinguish stage I from stage II lymphedema

#### **CLINICAL RELEVANCE/APPLICATION**

MRI can quantitatively assess the severity of primary lower extremity lymphedema, facilitating clinical decision making and improving prognosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPPH-11

### **Radiomics Based on MRI to Distinguish between Stage I and II Primary Lower Extremity Lymphedema**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

MENGKE LIU (*Presenter*) Nothing to Disclose

#### **PURPOSE**

A feasible and valid method for detecting and staging LEL would facilitate clinical development of appropriate treatment and management strategies. The present study aims to establish an MRI-based imaging radiomics model and a radiomics-clinical model for primary lower extremity lymphedema (LEL) and to evaluate its role in identifying the clinical stages (stages I-II) of primary LEL.

#### **METHODS AND MATERIALS**

96 patients with primary LEL were retrospectively collected (67 in the training cohort and 29 in the validation cohort) and classified into stage I and II according to the International Society of Lymphology (ISL) clinical staging criteria. Radiomics features were extracted automatically from the region of interest (ROI) manually outlined on the Short Time Inversion Recovery (STIR) sequence images by radiologists applying the Dr. Wise Multimodal Research Platform. Selected radiomics features were retained to construct the radiomics model. Clinical factors that are statistically significant in identifying stages I and II were selected, and a radiomics-clinical model combining imaging radiomics features and significant clinical factors was established. The performance of the two models was evaluated using ROC curves. The clinical usefulness of the models was assessed using decision curve analysis (DCA).

#### **RESULTS**

A total of 1743 radiomics features were extracted, then the features were filtered by F Test, and finally, 20 features were selected to construct the radiomics model. The radiomics-clinical model, which was based on the radiomics signature and 4 clinical factors, showed superior discriminatory efficacy compared with the radiomics model alone (area under the curve (AUC) in the training cohort: 0.997 vs. 0.961, the validation cohort: 0.914 vs. 0.900). The clinical usefulness of radiomics-clinical model was confirmed by DCA.

#### **CONCLUSION**

The MRI-based radiomics model was able to effectively identify the clinical stages I and II of primary LEL. The discrimination performance of the radiomics-clinical model was superior to that of the radiomics model alone.

#### **CLINICAL RELEVANCE/APPLICATION**

A MRI-based radiomics model has the ability to identify the clinical stages of LEL of primary LEL.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-13

### White Matter Clustering using Conformal Mapping

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Elena Greco, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Diffusion Tensor Imaging (DTI) facilitates the delineation of white matter fiber tracts in the brain. Clustering white matter fiber bundles by various methods has been a research focus over the past decade. We propose a deep neural network which requires a novel approach to data normalization, augmentation, and problem formulation.

#### METHODS AND MATERIALS

Conformal mapping is a technique used to establish a bijective mapping of one shape into its topologically equivalent target shape; the bijectivity ensures that the mapping is invertible and unique. We used volumetric transformations in which not only the surface of the shape is reshaped into the target shape but every point inside the shape is also transformed. Eleven epilepsy patients without structural brain abnormalities were retrospectively reviewed. Diffusion-weighted imaging was obtained with a multiband spin-echo echo planar imaging sequence on a 3 Tesla MR system (Siemens Vida or Prisma) using a 64-channel head and neck coil. A total of 64 diffusion directions were obtained. Diffusion data were preprocessed, and orientation distribution function was estimated. Whole brain tractography was then created using deterministic tracking. Fiber tracts from the 11 patients are mixed forming the dataset comprising 2469292 fiber tracts. The dataset was divided into training, test, and validation sets in a 3:1:1 ratio. The neural network classifier is based on the VGG 16 architecture and contains two convolution layers with 32 and 64 feature maps followed by two fully connected dense layers. The network uses rectified linear units as the activation function. Fiber tracts with length less than 30 mm or greater than 300 mm are filtered out, and all the fiber tracts are resampled to contain 50 points, flipped in order, and convolved with a 1D Gaussian filter for data augmentation. The fiber tracts are then mapped into a spherical space using the conformal mapping. The neural network is trained with a batch size of 500 fibers, a learning rate of 0.0001, and categorical cross-entropy is minimized using Adam optimizer in 10 epochs.

#### RESULTS

The confusion matrix for the classification is shown in figure 1. All accuracies for 26 tracts exceeded 0.890379.

#### CONCLUSION

We presented a deep learning framework for clustering white matter fibers using a volumetric conformal mapping approach and the initial experiments showed promising results.

#### CLINICAL RELEVANCE/APPLICATION

We aim to automate this process and further this algorithm such that the deep learning tools can eliminate all the noisy fibers and identify the appropriate anatomical clusters based on whole brain tractography. We also aim to expand this algorithm to identify white matter tracts in the presence of pathologies that can change the anatomy of the tracts.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-2

### Investigation of the Inherent Challenges Associated with Quantitative $^{90}\text{Y}$ PET-CT Imaging towards Improved Dosimetric Accuracy in $^{90}\text{Y}$ SIRT Therapies

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Niamh McArdle, BSc, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Yttrium-90 ( $^{90}\text{Y}$ ) PET-CT imaging for dose verification following  $^{90}\text{Y}$  selective internal radiation therapy (SIRT) has a number of associated dosimetric quantification challenges. SIRT tumours can be irregularly shaped, multi-nodular and have heterogeneous activity distributions. Partial volume effects (PVE) and high background activity due to low number of true coincidences further contribute to degradation of quantification accuracy. Accordingly, the objective of this research is to further investigate the effects of PVE, heterogeneity and background activity in  $^{90}\text{Y}$  PET-CT imaging, towards more accurate patient dosimetry for  $^{90}\text{Y}$  SIRT therapies.

#### METHODS AND MATERIALS

$^{90}\text{Y}$  PET-CT imaging datasets were acquired using a Siemens Biograph Horizon PET-CT scanner. 3D-printed non-spherical objects, representative of clinical data and designed using a novel radiomics analysis approach, were employed to assess the effects of PVEs for non-spherical lesions. Recovery Coefficient (RC) curves were generated by filling spherical and non-spherical objects with known  $^{90}\text{Y}$  activities, submerged in a water phantom for a range of object-to-background ratios (10:1, 20:1, 25:1, 30:1). The effects of tumour heterogeneity was investigated using novel 3D-printed phantoms, with phantom infills of 0%, 20%, 40% and 60%.  $^{90}\text{Y}$  sensitivity measurements and the effects of inherent background activity from the lutetium oxyorthosilicate crystals were investigated using an anthropomorphic thorax phantom, assessing noise levels in the lung and liver fields.

#### RESULTS

The effects of heterogeneous distributions and PVE for spherical and non-spherical objects on the quantitative accuracy of  $^{90}\text{Y}$  PET-CT imaging will be presented. In addition, results on the implications of background activity on quantitative  $^{90}\text{Y}$  imaging will be quantified by means of noise equivalent count rate, background variability and contrast recovery. Correction factors accounting for heterogeneity, PVE,  $^{90}\text{Y}$  activity recovery (0.84) and LSO background activity (4 - 8 kBq/ml) will be investigated and presented.

#### CONCLUSION

Inherent background activity, low PET count rate, high random fractions and PVEs at small volumes are some of the inherent challenges associated with quantitative  $^{90}\text{Y}$  PET-CT imaging following SIRT therapies. Evaluating and correcting for these limitations is necessary to improve quantification accuracy, and for identifying any mismatch between pre- and post-treatment dosimetry, thus allowing for improvements towards improved personalised dosimetry.

#### CLINICAL RELEVANCE/APPLICATION

This research aims to improve the quantitative accuracy of  $^{90}\text{Y}$  PET-CT imaging post SIRT therapy to facilitate improved accuracy in the dosimetry estimation for SIRT therapy patients.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-4

### Deep Learning Image Reconstruction Impacts on Robustness of CT Radiomics Features: Opportunity for Minimizing Radiomics Variability

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Jingyu Zhong, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the influence of deep learning image reconstruction (DLIR) on robustness of CT radiomics features.

#### METHODS AND MATERIALS

A standardized phantom with sixteen clinical-relevant densities was scanned under single-energy CT (SECT) and dual-energy CT (DECT) modes at standard and half (20 and 10 mGy) dose level. Images of SECT 120 kVp and corresponding DECT 120 kVp-like virtual monochromatic images were generated with six reconstruction algorithms: filtered back-projection (FBP), adaptive statistical iterative reconstruction-Veo at 40% (AV-40) and 100% (AV-100) blending levels, and DLIR algorithm at low (DLIR-L), medium (DLIR-M) and high (DLIR-L) strength levels, resulting twenty-four image sets. 94 radiomic features were extracted via Pyradiomics. Reproducibility of radiomic features was evaluated between SECT and DECT scan modes, between standard and half dose levels, across reconstruction algorithms in reference to FBP images, and across all image sets, using intraclass correlation coefficient (ICC) and concordance correlation coefficient (CCC).

#### RESULTS

The average percentage of features with ICC > 0.90 and CCC > 0.90 were 11.35% and 11.17% between SECT and DECT scans. The reproducibility between scan modes did not obviously changed with the increasing strength level of DLIR algorithm. The average percentage of features with ICC > 0.90 and CCC > 0.90 between images acquired at 10 and 20 mGy dose levels were 28.55% and 27.40%. The reproducibility between dose levels increased with the increasing strength level of DLIR algorithm within SECT scans, but DLIR-M images showed highest reproducibility within DECT scans. The average percentage of features with ICC > 0.90 and CCC > 0.90 in reference to FBP images decreased from 27.93% to 17.82%, and from 27.66% to 17.29%, respectively, with the increasing strength level of DLIR. The AV-40 images resulted average percentage of features with ICC > 0.90 and CCC > 0.90 of 26.06% and 25.80% in reference to FBP images, and 18.88% and 18.62% for AV-100 images, respectively. Within SECT scans, DLIR-H images at 10 mGy presented percentage of features with ICC > 0.90 and CCC > 0.90 of 79.78% and 76.60%, respectively, comparing to DLIR-M images at 20 mGy.

#### CONCLUSION

DLIR and IR algorithms potentially alters minable information in images, while DLIR algorithm provides opportunity for minimizing radiomics variability.

#### CLINICAL RELEVANCE/APPLICATION

DLIR and IR algorithms potentially alters deeper information hidden in the images, indicating that radiomics models based on images with different reconstruction algorithms must be interpreted with caution. However, DLIR algorithm has potential for minimizing radiomics variability, which opens possibility for generalizable radiomics model.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-5

### Using Fully Synthetic Training Data to Automate Clinical CT-ACR Phantom Analysis

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Morgan A. Daly, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to illustrate the feasibility of using a convolutional neural network (CNN) trained solely on simulated input data to perform meaningful clinical medical physics tasks. We demonstrate this by automating detection and alignment of the HU module of the CT-ACR phantom (Gammex 464).

#### METHODS AND MATERIALS

All training and validation data was generated on-the-fly using a computational phantom generator that uses four parameters to control phantom placement: x and y position, simulated reconstruction field of view (FOV), and rotation. These were randomly sampled in the ranges: x, y position: [-50 mm, 50 mm], FOV: [200 mm, 510 mm], and rotation: [-50°, 50°]. A ResNet50-based network was trained to predict a feature vector consisting of the x, y position, FOV, and rotation for a given input 256x256 phantom image. The model was evaluated on 5 clinical images of the HU module acquired on a Siemens Force scanner with labels manually calculated by aligning simulated phantoms with the clinical image. Mean absolute error (MAE) between the network-predicted features and manually aligned features were quantified and reported, and a visual assessment was performed.

#### RESULTS

The MAE of the features produced by the model on a computational phantom test set (n=100) were:  $x=0.90 \pm 0.6\text{mm}$ ,  $y=0.53 \pm 0.4\text{mm}$ ,  $\text{FOV}=2.81 \pm 1.9\text{mm}$ ,  $\text{rotation}=0.84 \pm 0.7$ . The MAE of the transformations produced by the CNN on the set of 5 real ACR phantom scan images:  $x = 2.77 \pm 5.0$ ,  $y = 9.72 \pm 20.3$ ,  $\text{FOV} = 17.78 \pm 24.4$ ,  $\text{rotation} = 3.52 \pm 4.2$ . In a visual assessment, the model achieves excellent agreement with clinical scans that are moderately misaligned (the likeliest to occur in routine practice). In one test case with more substantial misalignment (a large FOV) the disagreement between the input and the model prediction was apparent.

#### CONCLUSION

The trained network does an acceptable job of predicting the correct parameters to align the HU module of the CT-ACR phantom, which can be used to automate phantom analysis. Methodologically, we have illustrated that CNNs trained on fully-synthetic data can be directly applied to clinical tasks, and additional augmentation of the synthetic data (e.g., noise, table-like objects in frame) could further improve performance. Finally, we hope that interpretable feature outputs will help build confidence in the broader use of clinical AI in medical physics and quantitative imaging.

#### CLINICAL RELEVANCE/APPLICATION

These methods could generalize automated analysis to any phantom without the need for image acquisition or manual annotation. Synthetic data as ground truth could aid in training networks for more complex clinical/medical tasks.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-6

### A Comparison Among LowRes, HighRes and Cascaded CNNs for Segmentation of Cardiac CT Images in TAVR Patients

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

James W. Goldfarb, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cardiac CT is routinely used for pre-planning aortic valve repair. Segmentation of cardiac structures would enable the calculation of several quantitative values (e.g., EF, LVM). The optimal convolutional neural network (CNN) for this task can be limited by hardware memory, compute power, and segmentation speed. We compared the segmentation of cardiac CT images using three CNN architectures to determine which anatomical structures require a larger CNN.

#### METHODS AND MATERIALS

We used 56 training and 200 testing contrast CT angiograms in patients with aortic valve disease for TAVR planning. Eleven regions were annotated for training: AscAorta, DescAorta, InfVenaCava, LeftAtrium, RightAtrium, LeftVentricle, RightVentricle, LVMycardium, and aortic valve leaflets (calcified and non-calcified). We trained three CNN 3DUnet architectures with increasing memory and compute requirements: LowRes, HighRes, and Cascaded. We statistically analyzed the Dice Coefficient (DC), Intersection-over-Union (IoU), and volumes of regions at systole and diastole. Visual assessment of 3D renderings was performed to detect failed segmentations.

#### RESULTS

DC and IoU were slightly higher ( $p < 0.001$ ) for the cascaded network compared to the low and high resolution CNNs (DC: 0.93 vs 0.92, 0.92) and (IoU: 0.87 vs 0.86, 0.86). Although the segmentation volume intraclass correlation (ICC) was excellent (0.94-0.99), 10% of the HighRes segmentations had at least one region with a failed segmentation vs 2% of LowRes vs 0% of the cascaded CNN ( $p < 0.001$ ). The cascaded CNN had a small (0.6% +/- 0.58%) difference in large structures but a larger difference in smaller calcified structures (18.73% +/- 13.8%).

#### CONCLUSION

A cascaded CNN performs the best both qualitatively and quantitatively. For segmentation of large structures such as the left ventricle, small segmentation errors do not affect quantitative values. However, for finer segmentation such as aortic valve calcium or calcified leaflets, a cascaded or high-resolution network is necessary.

#### CLINICAL RELEVANCE/APPLICATION

For segmentation of large structures such as the left ventricle or left atrium, a LowRes CNN is sufficient. However, if higher resolution structures are also segmented (as is done in an aortic valve calcium score), a cascaded CNN is necessary. This has implications for the required GPU/CPU memory and compute power for timely segmentation, especially when the typical 20 cardiac phases are segmented.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-7

### High Spatial Resolution Diffusion Tensor Imaging Aided by Synthetic-MRI: An Application of Sixfold Multiparameter Quantitative MRI (MP6-qMRI)

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Hernan Jara, PhD (*Presenter*) Author with royalties, World Scientific Publishing;

#### PURPOSE

In diffusion tensor MR imaging (DTI), the spatial resolution of the mean diffusivity (MD) and fractional anisotropy (FA) maps depend on the spatial resolution of the diffusion encoded images ( $b > 0$ ) as well as the  $b_0$  images. We investigate spatial resolution improvements in DTI maps resulting from using high spatial resolution synthetic  $b_0$  images as substitute to the standard  $b_0$  images, which are acquired at lower resolution to shorten scan time.

#### METHODS AND MATERIALS

Two healthy volunteers (37yo male, and 59yo male) were scanned with local IRB approval. The modular MP6-qMRI turbo spin echo (TSE) pulse sequence was implemented on a 3T Ingenia Elition X whole body scanner (Philips Healthcare) by concatenating with same pre-scan settings high resolution Triple-TSE and half in plane spatial resolution DTI-TSE modules (Fig. 1A). All modules were implemented without fat suppression and generated 80 contiguous slices. Key scanning parameters were a) Triple-TSE modules (9.5min):  $TR_{long} = 16s$ ,  $TR_{short} = 0.5s$ ,  $TE_1 = 10ms$ ,  $TE_2 = 110ms$ , voxel =  $0.47 \times 0.47 \times 2mm^3$  and b) DTI module (11min):  $TR = 25.4s$ ,  $TE_{eff} = 72ms$ , voxel =  $0.94 \times 0.94 \times 2mm^3$ . The unified MP6-qMRI relaxometry and DTI processing pipeline was programmed in Python (version 3.9.13) with the Anaconda Navigator (version 2.3.2). The primary (nPD-T1-T2) qMRI maps were calculated according to the Bloch equation solution as applicable for the Triple-TSE pulse sequence. DTI maps were calculated according to the Bloch-Torrey equation as in DIPY tensor reconstruction (<https://dipy.org/>).

#### RESULTS

For both volunteers, the MP6-qMRI framework yielded high quality MD (Fig. 1B) and FA (Fig. 1C) maps with full head coverage and with imperceptible geometric distortion artifacts. Furthermore, MD and FA maps obtained with calibrated synthetic  $b_0$  had superior spatial resolution providing improved anatomic delineation that is most noticeable for white-to-gray matter differentiation and for improved delineation of the extra cranium.

#### CONCLUSION

Added benefits of using turbo spin echo multiparameter qMRI frameworks are the opportunities of reducing magnetic inhomogeneity distortions, and of increasing the spatial resolution of DTI maps (MD and FA) by means of Synthetic MRI. Hence, MP6-qMRI can extend the usefulness of DTI to magnetically inhomogeneous regions such as the extra-cranium and the neck and with higher spatial resolution.

#### CLINICAL RELEVANCE/APPLICATION

Use of turbo spin echo based MP6-qMRI and Synthetic MRI can extend clinical applications of diffusion tensor MRI for assessing the extra-cranium and nasal cavity structures with negligible geometric distortions.

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## Abstract Archives of the RSNA, 2023

W5A-SPPH-8

### To Biopsy or Not to Biopsy? Feasibility of Predicting Gleason Score as a Pre-biopsy Gatekeeper in Prostate Cancer Patients using Multimodal Patient Features

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Nathalie Mertens (*Presenter*) Nothing to Disclose

#### PURPOSE

The diagnosis of prostate cancer (PCa) is based on a prostate biopsy. Even though this diagnosis is important for further treatment decision, a biopsy is painful and can result in adverse effects for the patient. In this study, we aim at developing a biopsy gatekeeper by predicting the Gleason score (GS) using a machine learning (ML) classification model. Therefore, results from various diagnostic screening examinations are combined with patient-specific variables to explore the feasibility of a binary ML model to predict GS >6 and thus the need for biopsy in PCa patients.

#### METHODS AND MATERIALS

Patients screened in our hospital (n=295) underwent a digital rectal examination (DRE), transrectal ultrasound (TRUS) and a screening magnetic resonance (MR) examination. Preceding the MR examination, prostate-specific antigen (PSA) and prostate health index (PHI) blood tests were acquired on the same day. Patients obtained a TRUS-guided biopsy to detect PCa, as determined by the GS. Various classification models were explored to predict GS <7 and =7 using 7 features: TRUS- and DRE findings, PSA and PHI density results, prostate imaging-reporting and data system (PI-RADS) score, as well as patient-specific variables being age and genetic risk. 28 model architectures are constructed by combining 3 components: (1) a scaler (Robust or Standard); (2) a sampler to balance the dataset (Synthetic Minority Oversampling TEchnique or Adaptive Synthetic) and (3) a classifier (Logistic Regression - LR, Random Forest, K-Nearest Neighbours, Decision Tree, Support Vector Machine - SVM, Gaussian Naive Bayes - GNB, or Gradient Boosting). To minimize bias, a stratified 10-fold cross validation is implemented. Hyperparameter tuning for the 28 model architectures resulted in training 2188 models. All models are trained to maximize the area under the curve (AUC). The classification is done with threshold set to 0.35.

#### RESULTS

The AUC for predictions of GS is 0.77 (95% CI 0.67-0.87). 3 features, being PI-RADS, PHI density and age, were revealed as significant predictors for GS ( $p=0.006$ ,  $p=0.001$  and  $p=0.001$  respectively). This finding was confirmed by the selectKBest algorithm selecting the 3 most important features for GS prediction. Repeating the model with these 3 features resulted in LR, SVM and GNB as best classifiers, with AUC respectively 0.81 (95% CI 0.66-0.97), 0.82 (95% CI 0.66-0.98) and 0.84 (95% CI 0.68-1.0).

#### CONCLUSION

This study demonstrates the potential of using a ML algorithm to predict the need of prostate biopsy. This way, physicians could opt to eliminate a biopsy which is painful for the patients and could cause adverse effects.

#### CLINICAL RELEVANCE/APPLICATION

This study aims at developing a ML model as a pre-biopsy gatekeeper to eliminate unneeded biopsies in PCa.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPPH-9

### Quantitative Evaluation of Primary Lower Extremity Lymphedema Staging using STIR: A Preliminary Study

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

MENGKE LIU (*Presenter*) Nothing to Disclose

#### PURPOSE

The staging of primary lower extremity lymphedema (LEL) is difficult and vital in clinical work, and Short time inversion recovery (STIR) sequence of MRI can be used for quantitative assessment of primary lower extremity lymphedema due to its high soft tissue resolution. So we evaluated the value of STIR-based soft tissue area measurements for staging primary lower extremity lymphedema.

#### METHODS AND MATERIALS

90 consecutive patients with clinically diagnosed primary lower limb lymphoedema from January 2017 to December 2019 in Beijing Shijitan Hospital were enrolled retrospectively. STIR sequence was applied to measure the total, muscle, bone, and subcutaneous areas in the upper 1/3 level of the bilateral lower calf. The difference between the affected and unaffected calf regarding the subcutaneous area was obtained.  $(\text{Subcutaneous area})/(\text{bone area})$  and  $(\text{subcutaneous area})/(\text{muscle area})$  were calculated. According to the International Society of Lymphology (ISL) clinical staging standard in 2020, all patients were divided into stages I, II and III. Statistical analysis was performed to determine the validity of MRI measurements in staging LEL.

#### RESULTS

Clinical stages were I in 33 patients, II in 44 patients, and III in 13 patients. There are significant differences in the difference in subcutaneous area of limbs, subcutaneous/bone and subcutaneous/muscle between stage I and II as well as between stage I and III ( $P < 0.001$ ), but not between stage II and III ( $P = 0.706, 0.329, 0.229$ , respectively). There was a positive correlation between the clinical stage and difference in subcutaneous area of limbs ( $\rho = 0.752, P < 0.001$ ), subcutaneous/bone ( $\rho = 0.747, P < 0.001$ ) and subcutaneous/muscle ( $\rho = 0.709, P < 0.001$ ). For staging primary lower extremity lymphedema, receiver operator characteristic (ROC) curves indicated that difference in subcutaneous area of limbs had the best discrimination ability among parameters [area under the ROC curve (AUC) = 0.950; 95% Confidence Interval (CI): 0.875 - 0.987; sensitivity: 95.45%, specificity: 84.85%], followed by subcutaneous/bone [AUC = 0.930; 95%(CI): 0.848 - 0.975; sensitivity: 77.27%, specificity: 93.94%] and subcutaneous/muscle [AUC = 0.895; 95%(CI): 0.804 - 0.953; sensitivity: 77.27%, specificity: 90.91%].

#### CONCLUSION

The measurement of the soft tissue area by STIR may be used as an auxiliary method for staging primary lower extremity lymphedema. For patients with unilateral primary lower extremity lymphedema, the difference in subcutaneous area of limbs could be a specific indicator to distinguish clinical stage I from II.

#### CLINICAL RELEVANCE/APPLICATION

STIR enables quantitative assessment of primary lower extremity lymphedema.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPRO-1

### Can Serial Brain Metastases MRI Radiomics Kinetics Predict Stereotactic Radiation and Immunotherapy Outcomes?

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Hesham Elhalawani, MD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiation necrosis (RN) remains to be the primary dose-limiting toxicity of stereotactic radiosurgery (SRS), especially in combination with immunotherapy (IO). This debilitating adverse event is often confused with tumor regrowth, posing significant diagnostic and therapeutic challenges. This study employed magnetic resonance imaging (MRI) radiomics to quantify sub-acute radiation-induced changes in irradiated BM and their value in predicting treatment response.

#### METHODS AND MATERIALS

Following IRB approval, we queried our single-institution dataset to identify adult patients with brain metastases managed with SRS and IO between 2006 and 2021. We collected patient, disease, and treatment variables. Specifically, per-BM outcomes were categorized as RN (radiographic and/or symptomatic), progressive disease (PD), or neither (NA). All patients had diagnostic pre- and post-SRS contrast-enhanced T1-weighted MRIs. Individual BMs were manually segmented in MIM Software (Beachwood, OH). 1061 hand-crafted radiomic features were computed per lesion using IBEX Software. Feature reduction followed using Spearman's correlation coefficient (0.3 cut-offs). Simple then multiple nominal logistic regressions (SLR and MLR) with Bonferroni correction ensued to model the risk of RN, PD, or NA using JMP software.

#### RESULTS

92 patients with 301 BM of NSCLC, melanoma, and renal cell carcinoma primaries were included. All patients received brain SRS and IO. RN, PD, or NA occurred in 74 (24.6%), 75 (24.9%), and 152 (50.5%) BM, respectively. 39 radiomic features significantly changed post-SRS ( $p < 0.01$ ). Using MLR modeling, we created a 3-feature radiomic RN predictor (ROC AUC 0.71). The model included post-SRS BM surface area, texture (GLCM 3D Homogeneity), and pre-RT BM roundness. A 5-feature radiomic signature could predict RN and PD risk (ROC AUC 0.71) based on pre-SRS GLCM 3D texture feature, 3 post-SRS shape features (surface area, mean breadth, and roundness), in addition to delta-volume.

#### CONCLUSION

SRS and IO induce changes in BM shape, MRI texture, and signal intensity that radiomics can capture. Pre-SRS, post-SRS, and percent changes of these radiomic feature values could correlate to post-therapy tumor control or radiation necrosis. Pursuing model external validation, combination with clinical variables, and integrating other MRI sequences is imperative before larger-scale adoption of this novel diagnostic approach.

#### CLINICAL RELEVANCE/APPLICATION

The premise of our study is to employ to develop an artificial intelligence-powered MRI radiomic predictor of BM treatment outcomes. These serial 'virtual digital biopsies' could guide cost-effective follow-ups and earlier personalized interventions to improve patients' quality of life.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPVA-1

### Fast Imaging of Lenticulostriate Arteries by Combining High-Resolution Black-blood T1-weighted with Variable Flip Angles & Compressed Sensitivity Encoding

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Yukun Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To visualize and characterize lenticulostriate arteries (LSAs) in a short time on a 3.0T MR scanner, we investigated the feasibility of high-resolution black-blood T1-weighted with variable flip angles (T1w TSE-VFA) accelerated by compressed sensitivity encoding (CS-SENSE) and further identify the optimal acceleration factors (AF) for routine clinical use.

#### METHODS AND MATERIALS

Twenty-five healthy volunteers (13 males, and 12 females, the age ranged from 27 to 68 years, with a median age of 58 years) and 20 patients with cerebrovascular disease (12 males, 8 females, mean age:  $64.3 \pm 8.9$  years) were prospectively enrolled. Volunteers underwent T1w TSE-VFA sequences with different AFs, including conventional sensitivity encoding (SENSE) AF=3 and CS-SENSE AF=3, 4, 5, and 6 (The scanning time was 510s, 480s, 361s, 298s, and 245, respectively) at 3 Tesla. The image quality and the display of LSAs of T1w TSE-VFA protocols were evaluated through objective evaluation (contrast ratio [CR Callosum /WM, CR Brainstem /WM, CR Ependecephalon /WM], number of LSAs, total length of LSAs, and average length of LSAs) and subjective evaluation (overall image quality, scores on LSAs). Comparisons were performed among the 5 sequences to select the best AF. All patients underwent both T1w TSE-VFA with optimal AF and digital subtraction angiography (DSA) examination, and the number of LSAs of both was compared.

#### RESULTS

The pair-wise comparisons among CS3, CS4, and SENSE3 showed no statistically significant differences in the objective measurement and subjective evaluation in (all  $P > 0.05$ , Fig.1 and Fig.2). There was no statistically significant difference in the LSA counts on 1 side measured by DSA and CS4 in patients (3, 3 - 3 and 3, 3 - 3,  $P = 0.384$ , Fig.3).

#### CONCLUSION

CS3 can provide a better LSA display but takes a long time (480s, 6% reduction); CS4 can balance the visualization of LSAs and acquisition time (361s, a 30% reduction) and is recommended for routine clinical application.

#### CLINICAL RELEVANCE/APPLICATION

T1w TSE-VFA accelerated by CS-SENSE can be used as a non-invasive head microvasculature examination in asymptomatic subjects and patients with cerebrovascular disease, which will be an important asset in preventive medicine.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPVA-2

### Acceleration of Time-of-flight Magnetic Resonance Angiography by Intelligence-assisted Compressed Sensing

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Yukun Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the image quality of time-of-flight magnetic resonance angiography (3D TOF-MRA) accelerated by sensitivity encoding (SENSE), compressed sensing (CS), and intelligence-assisted compressed sensing (ACS) with different acceleration factors (AF) to optimize the sequence

#### METHODS AND MATERIALS

Fourteen healthy volunteers were prospectively recruited and underwent 3D TOF-MRA scans with different AFs, including SENSE AF = 3; CS AF=3; ACS AF = 3, 5, 7, and 9 (The scanning time was 189s, 170s, 165, 150s, 136, and 115, respectively) at 3.0 T. Two radiologists delineated the regions of interest (ROI) for the callosum, right and left middle cerebral artery (MCA), and adjacent white matter on raw images. The signal intensity and standard deviation were recorded for further calculation of the signal to noise ratio (SNR) and contrast to noise ratio (CNR). Meanwhile, the overall image quality of 3D TOF-MRA with different AFs and 9 pre-defined arteries structures (intracranial segment of the bilateral ICAs, the anterior cerebral artery, the MCA, the distal bilateral vertebral arteries, and the basilar artery) were scored using 4-point scale subjective criteria. The difference in measurement data and subjective score between different AFs was analyzed by pairs comparison (LSD-t test).

#### RESULTS

In the objective evaluation (Table 2), ACS7 and ACS9 had significantly lower CNR callosum than SENSE3, CS3, ACS3, and ACS5 ( $P>0.05$ ); ACS3 was significantly higher than SENSE3 in SNRR-MCA, SNRL-MCA, CNR L-MCA ( $P>0.05$ ). In the subjective evaluation (Fig.1 and Table 2), CS3, CS5, and CS9 are different from SENSE3 in overall image quality evaluation ( $P>0.05$ ); and there was no significant difference in the evaluation of arteries structures ( $P<0.05$ ).

#### CONCLUSION

Compared with SENSE and CS, the better imaging quality of craniocerebral arteries could be obtained using 3D TOF MRA based on ACS with a shorter time, especially with AF of 5

#### CLINICAL RELEVANCE/APPLICATION

Compared with SENSE and CS, 3D TOF-MRA accelerated by ACS can further shorten the scanning time while maintaining the image quality, which greatly increases the comfort and success rate of MR Scanning

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5B-SPBR-1

### Breast Cancer Risk Models: Observations From a Multi-Site Database of Women Screened for Breast Cancer

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Emily F. Conant, MD (*Presenter*) Research Grant, Hologic, Inc; Advisory Panel, Hologic, Inc; Research Grant, OM1, Inc; Research Grant, iCad, Inc; Advisory Panel, iCad, Inc; Speaker, WebMD LLC

#### PURPOSE

With emerging interest in risk-based screening strategies and known disparities in breast cancer outcomes by race, risk models need to address gaps in risk assessment. To inform questions about the inclusion of characteristics like race in these models, we explored associations between race, breast cancer risk factors (including Gail risk score) and breast cancer detection in a large, real-world cohort.

#### METHODS AND MATERIALS

This retrospective cohort study used electronic medical record, radiology, and tumor registry data from five healthcare organizations. Women 40-79 years old with no history of breast cancer, non-missing race data, and =1 screening exam between 2016-2020, were included. Cancer detection rates (CDR) were calculated per 1,000 screens. Logistic regression models were used to estimate odds ratios (OR) and 95% confidence intervals (CI) for the associations between age, race, breast density and risk status (Gail model) and CDR.

#### RESULTS

The cohort included 1,563,019 screenings (123,371 Asian, 203,412 Black, 56,961 Other, 1,179,274 White). Both Black and White women were on average  $58 \pm 10$  years of age and slightly older than Asian or women of Other race (mean age  $54 \pm 9$  years). Asian women had significantly higher breast density versus other groups (52% mostly heterogeneously dense; 15% extremely dense tissue). Elevated breast cancer risk status varied by race; 16% Asian, 23% Black, 17% Other, 31% White. Overall CDRs (per 1,000 screens) by race were; Asian 4.9 [95% CI 4.5, 5.3]; Black 5.3 [95% CI 5.0, 5.6]; Other 4.2 [95% CI 3.7, 4.7]; White 5.2 [95% CI 5.1, 5.3]. Among women identified as elevated risk, CDRs differed slightly as compared to White women: Asian 6.6 [95% CI 5.5, 7.8]  $p=0.26$ ; Black 6.7 [95% CI 6.0, 7.5]  $p=0.05$ ; Other 4.9 [95% CI 3.7, 6.5]  $p=0.20$ ; White 5.9 [95% CI 5.7, 6.2]. After adjusting for age ( $p<0.001$ ), density ( $p<0.001$ ) and risk ( $p=0.001$ ), no statistically significant association between race and CDR remained ( $p=0.25$ ) (Figure).

#### CONCLUSION

In a large real-world cohort, we observed meaningful differences in breast cancer risk factors and risk scores by race. Racial differences in cancer detection rates do not persist after adjusting for age, breast density and Gail score. Careful consideration should be given to the use of risk models in the clinical setting. The observed misalignment in risk scores and breast cancer detection rates suggest the potential for insufficient capture of risk factors and the need to better understand the drivers of racial differences in mammography outcomes.

#### CLINICAL RELEVANCE/APPLICATION

It is critical to understand which risk factors may underlie recognized racial disparities in breast cancer burden in order to optimize risk models used to support clinical decision making for screening prioritization.

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## Abstract Archives of the RSNA, 2023

W5B-SPBR-2

### Diagnostic Performance of Diffuse Optical Spectroscopic Imaging for Breast Cancer According to Clinical Factors

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Yeji Kwon (*Presenter*) Nothing to Disclose

#### PURPOSE

Although breast cancer screening programs have reduced the mortality rate of breast cancer patients by about 20%, the sensitivity of mammography decreases to 30-48% in dense breast. On the contrary, there are concerns regarding the potential elevation of false positive rates when ultrasound is employed. It has been suggested that optical imaging could enhance the specificity of breast imaging, but this has not been conclusively established. This study aims to evaluate the impact of clinical factors on the diagnostic performance of diffuse optical spectroscopic imaging/discrete multi-wavelength near-infrared spectrum (DOSI/DMW-NIRS) for breast malignancy.

#### METHODS AND MATERIALS

Our institutional review board granted approval for this investigation, and signed informed consent was obtained. From September 2021 to June 2022. In this study, 85 participants were enrolled, of which 23 participants were excluded. Among the exclusions, 4 participants refused to participate or had unavailable biopsy results, 4 participants had absent raw or chromophore data, and 15 participants were unavailable for analysis due to the subareolar location of the lesion. Total of 62 women with 62 breast lesions (37 malignant, 25 benign) biopsied under US guidance were analyzed. DOSI/DMW-NIRS was used to quantify the chromophores (HbO<sub>2</sub>, HHb, THC, StO<sub>2</sub>, water, lipid, and TOI) of lesions and then the computed chromophore ratios were compared to those of contralateral normal breasts. Lesions were categorized by demographic (age, BMI, bra cup size, and menstrual cycle phase) and sonographic variables (tumor diameter, depth, distance from nipple, vascularity, breast thickness, and BI-RADS category), and areas under the curve (AUCs) were compared between subgroups.

#### RESULTS

TOI ratio showed the highest AUC value (0.904, 95% confidence interval: 0.831-0.977), followed by water (0.836, 95% confidence interval: 0.736-0.936) for diagnosing breast malignancy among the seven chromophore values. TOI ratio demonstrated no significant difference in diagnostic performance among all subgroups ( $p$ -value $>0.05$ ). The diagnostic performance of water ratio differed according to breast thickness ( $p$ -value: 0.033) and distance from nipple ( $p$ -value: 0.011). The diagnostic performance of THC and HbO<sub>2</sub> differed according to BMI ( $p$ -value 0.0119 and 0.0056, respectively) and menstrual cycle ( $p$ -values: 0.011 and 0.006, respectively).

#### CONCLUSION

TOI ratio evaluated with DOSI/DMW-NIRS shows strong diagnostic performance regardless of demographic and sonographic parameters.

#### CLINICAL RELEVANCE/APPLICATION

TOI ratio evaluated with DOSI/DMW-NIRS has the potential to be generally applied to various clinicoradiologic condition to diagnose breast cancer.

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## Abstract Archives of the RSNA, 2023

W5B-SPBR-3

### **A Systematic Review and Meta-Analysis of Online Patient Education Materials in Breast Cancer: Is Readability the Only Story**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Joey Gu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Online patient education materials (OPEMs) are an increasingly popular resource for women seeking information about breast cancer. The AMA recommends written patient material to be at or below a 6th grade level to meet the general public's health literacy, but breast cancer readability studies have found reading levels to be much higher than the AMA's recommended level. Metrics such as quality, understandability, and actionability also heavily influence the usability of health information, and thus should be evaluated alongside readability. A systematic review and meta-analysis was conducted to determine: 1) Average readability scores and reporting methodologies of breast cancer readability studies; and 2) Inclusion frequency of additional metrics associated with health literacy.

#### **METHODS AND MATERIALS**

A registered systematic review and meta-analysis was conducted in Ovid MEDLINE, Web of Science, Embase.com, CENTRAL via Ovid, and ClinicalTrials.gov in June 2022 in adherence with the PRISMA 2020 statement. Eligible studies performed readability analyses on English-language breast cancer-related OPEMs. Study characteristics, readability data, and reporting of non-readability health literacy metrics were extracted. Meta-analysis estimates were derived from generalized linear mixed modeling.

#### **RESULTS**

The meta-analysis included 30 studies yielding 4,462 OPEMs. Overall, average readability was 11.81 (95% CI [11.14, 12.49]), with a significant difference ( $p < 0.001$ ) when grouped by OPEM categories. Commercial and government organizations had the highest average readability at 12.2 [11.3, 13.0] and 12.0 [11.3, 12.7], respectively; non-profit organizations had one of the lowest at 11.3 [10.6, 12.0]. Readability also varied by index, with New Fog, Lexile, and FORCAST having the lowest average scores (9.4, 10.4, and 10.7, respectively). Only 57% of studies calculated average readability with more than two indices. Only 60% of studies assessed other OPEM metrics associated with health literacy.

#### **CONCLUSION**

Average readability of breast cancer OPEMs is almost double the AMA's recommended 6<sup>th</sup> grade reading level. Readability reporting is currently not standardized - multiple indices should be used and averaged together with an interval estimate to capture a more comprehensive picture of reading grade level. Additional non-readability OPEM metrics are also inconsistently reported and may help convey the usefulness of information presented.

#### **CLINICAL RELEVANCE/APPLICATION**

Beyond readability, the quality, understandability, and actionability of OPEMs are important components to aid shared decision-making and may be critical to increased screening rates and breast cancer awareness.

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## Abstract Archives of the RSNA, 2023

W5B-SPBR-4

### Examining the Barriers to Breast Cancer Early Diagnosis in Uganda: A Prospective Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Adrian M. Jaramillo-Cardoso, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Women diagnosed with breast cancer (BRC) in Uganda have a 5-year mortality rate of 50%. Early diagnosis is an appropriate strategy for downstaging disease in low-resource settings, but women face significant barriers to accessing care (e.g., clinical examination, ultrasound, tissue diagnosis); assessing these barriers is a key step in designing successful programs. For the first time, we report findings from a prospective study examining the trajectory of care among Ugandan women with breast symptoms presenting for care.

#### METHODS AND MATERIALS

450 symptomatic women attending 5 community health clinics in Uganda were recruited and followed for six months. Participants completed questionnaires at baseline and six months, which collected data on demographics, barriers to care, and provider's recommendations for care (baseline), and actions taken at 6-months (follow-up). Logistic regression and multiple regression models were used to assess the relationship between delay (< or > 90 days) and sociodemographic factors. Differences in adherence to provider recommendations at 6 months were assessed via Pearson X2 test/Wilcoxon Rank Sum test.

#### RESULTS

442 (98.2%) completed follow-up. Breast lumps and pain were the main symptoms. 57.3% waited >90 d before seeking care, of whom 27.9% delayed >1 year. After multivariate analysis, rural setting (OR=13.34) and symptoms at time of presentation (OR=0.30) were significantly associated with delay. At 6 months, 184/442 (41.6%) were referred to either diagnostic imaging or tissue biopsy (+/-) imaging. 137/184 (74.5%) did not adhere to recommendations. Positive initial breast symptoms ( $\chi^2=9.3$ ,  $P=0.01$ ) and older women ( $P=0.002$ ) were more likely to follow provider's recommendations. 22/47 (46.8%) were diagnosed with breast cancer, a diagnostic yield of 46.8%. Main reasons for no action at 6 mo. for the 137 were: resolution of breast symptoms (40.0%), decision to wait for symptoms to resolve (19.2%), provider said that it was nothing to worry about (18.3%), and financial barriers (17.5%), despite 85.6% endorsing full understanding of need for follow-up. We estimated an additional 32 undiagnosed cancers in this group, a BRC rate of 12%.

#### CONCLUSION

Low adherence to follow-up recommendations for diagnostic care should be an area of focus for programs to improve BRC outcomes in Uganda.

#### CLINICAL RELEVANCE/APPLICATION

To increase effectiveness of diagnosis programs in Uganda, interventions should prioritize breast health education in the community, and removing barriers to accessing diagnostic services.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPBR-5

### Point of Care Breast Cancer Risk Assessment Increases Rates of Supplemental MRI Screening Among Women Undergoing Screening Mammography

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jocelyn Cheng (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of our study was to examine the impact of providing point of care breast cancer risk assessment (CRA) with results provided to patients at the time of annual screening mammography on rates of supplemental screening completion with MRI.

#### METHODS AND MATERIALS

We performed a retrospective review of patients who underwent breast imaging from November 2019 through May 2021. We examined the total number of screening mammograms performed one year prior to the cancer risk assessment (CRA) intervention start date ( $n=5,431$ , (epoch 1) 11/1/2019-5/1/2020), the total number of screening mammograms performed in patients who completed CRA for six months after the CRA intervention start date ( $n=1,976$ , (epoch 2) 11/1/2020-5/1/2021), and the total number of patients who underwent screening mammography but did not complete CRA intervention for six months after CRA intervention start date ( $n=4,578$ , (epoch 2) 11/1/2020-5/1/2021). We used an interrupted time series design and analysis with a natural control to evaluate rate of MRI completion before and following integration of the Tyrer-Cuzick CRA screening tool. We identified which patients underwent supplemental screening with MRI during the 12 months following each time period to calculate the change in rate of supplemental screening completion based on intervention. Supplemental imaging rates with MRI was modeled over time between pre- and post-intervention windows using a generalized linear mixed model (GLMM) with sandwich estimation and assuming binary distribution where observations are nested within patients.

#### RESULTS

The cohort included 11,985 women who underwent screening mammography during the study period. During epoch 1, no patients received CRA, 0% (0/5,431). During epoch 2, 30% (1,976/6,554) received CRA and 70% (4,578/6,554) did not. Before the implementation of CRA (epoch 1), the rate of MRI was 2.8% (152/5,431). After the implementation of CRA (epoch 2), the rate of MRI among patients who did NOT undergo CRA intervention was 3.2% (144/4,578); for those who did receive CRA, the MRI rate was 6.0% (118/1,976),  $p<.05$ .

#### CONCLUSION

Receiving point of breast care risk assessment at time of screening mammography doubled the rate of follow-up screening with MRI as compared to the rate among patients who did not receive the intervention (3.1% to 6.0%,  $p<.05$ ). Our facility reached maximum capacity for MRI screening after implementation of CRA intervention; the increased volume of follow-up screening MRI following introduction of CRA was likely limited by this constraint.

#### CLINICAL RELEVANCE/APPLICATION

Study findings will inform practices about supplemental screening yield after implementation of point of care risk assessment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPBR-7

### **Pushing the Envelope in Breast Conserving Surgery: Is Multiple-wire Localization (3 or more wires) Associated with Increased Risk of Compromised Margins**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Yoav Amitai, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In the last two decades there has been a paradigm shift with breast conserving surgery (BCS) being applied to larger and more extensive breast malignancies. The aim of this study is to examine the success of BCS being performed in patients with extensive breast malignancies requiring at least 3 wires for localization, and to assess possible risk factors for failure.

#### **METHODS AND MATERIALS**

We performed a retrospective single center review of 232 patients who underwent BCS between 2010 and 2020 requiring at least 3 wires for localization. The cohort included a control group of 232 single-wire BCS patients chronologically matched with the multiple-wire group. Patients with either invasive malignancy or ductal carcinoma in situ (DCIS) were included in the study. Clinical, radiological and pathological data was collected. Proportions of positive surgical margins, re-lumpectomies and conversion to mastectomy were calculated.

#### **RESULTS**

In the multiple-wire group the patients were younger (mean age 57 vs 63.1,  $P < 0.001$ ), had larger tumors (mean size 5.1cm vs 1.2 cm,  $p < 0.001$ ), had higher rate calcifications on mammogram (71.9% vs 17.2%,  $P < 0.001$ ) and higher rate of DCIS component (72.3% vs 38.4%,  $P < 0.001$ ); a higher proportion underwent neoadjuvant treatment (29.9% vs 9.9%,  $P = 0.001$ ). Positive surgical margins were higher in the multiple-wire group (13.4% vs 7.3%,  $P = 0.03$ ), which lead to higher proportions of re-lumpectomies or conversion to mastectomies (7.3% vs 4.3%,  $P = 0.17$ ). On multivariate analysis, patients with positive margins were more likely to have a DCIS component (77.1% vs 52.8% ,  $p = 0.006$ ) and positive ER hormonal status (93.5% vs 85.1%,  $p = 0.048$ ). The number of wires was not an independent predictor of positive margins. breast density, presence of calcifications on mammogram, type of tumor (unifocal vs multifocal/multicentric), tumor size, surgical specimen volume, undergoing Neoadjuvant treatment, undergoing magnetic resonance imaging and use of oncoplastic techniques did not predict margin status.

#### **CONCLUSION**

BCS requiring 3 or more wires is associated with a higher proportion of positive margins. The increased risk of positive margins appears to be related to type of tumor (DCIS component and ER status) rather than to the number of wires.

#### **CLINICAL RELEVANCE/APPLICATION**

This information may be useful for pretreatment planning of extensive breast malignancies, especially those suitable for BCS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPBR-8

### Upgrade Rates of Atypical Ductal Hyperplasia, Atypical Lobular Hyperplasia, and Flat Epithelial Atypia at a Community-based Breast Imaging Center

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Posy J. Seifert, DO (*Presenter*) Nothing to Disclose

#### PURPOSE

To review the prevalence of breast malignancy (invasive or noninvasive) at surgical excision in patients who had atypical ductal hyperplasia (ADH), atypical lobular hyperplasia (ALH) and flat epithelial atypia (FEA) on needle core biopsy.

#### METHODS AND MATERIALS

A retrospective chart review was performed on patients who had atypical ductal hyperplasia (ADH), atypical lobular hyperplasia (ALH) or flat epithelial atypia (FEA) on breast needle core biopsy at a community-based breast center between 1/1/2011 to 12/31/2022. There was a total of approximately 909 atypical diagnoses on core needle biopsy in 876 patients during this time (ADH, ALH or FEA). Exclusion criteria included co-existing malignancy in the ipsilateral breast, or needle core biopsy pathology demonstrating atypia bordering on DCIS. Data collected included patient demographics, lesion characteristics, and correlation with surgical biopsy or follow-up imaging.

#### RESULTS

There was a total of 909 diagnoses of ADH, ALH or FEA in 876 patients on needle core biopsy. The average patient age was 57.8 years. Diagnoses on needle core biopsy were as follows: 651 ADH, 180 ALH, 78 FEA. Collectively, the majority of ADH, ALH and FEA lesions were presented as microcalcifications (69%). Of the ADH lesions, the majority presented as microcalcifications (71%), followed by 16% masses. ALH most frequently presented as microcalcifications (56%), followed by 20% masses. Eighty-three percent of FEA presented as microcalcifications, followed by 6% architectural distortion. All were recommended for open surgical biopsy (OSB)- 46 lesions did not undergo excision. Twenty percent of the atypical lesions that underwent OSB (n=173/863) upgraded to malignancy at excision; 31% (n=53) invasive carcinoma and 69% (n=120) non-invasive. Specifically, 153/651 ADH upgraded (24%), 16/180 ALH upgraded (9%), and 4/78 FEA (5%).

#### CONCLUSION

We found that 20% of the atypical lesions evaluated in this review upgraded to carcinoma at excision; most of the upgrades were ADH lesions. While surgical excision of ALH and FEA is controversial, our data suggests that it may be warranted. More research is needed to determine the optimal follow-up protocol for ALH and FEA.

#### CLINICAL RELEVANCE/APPLICATION

ADH, ALH and FEA are some of the high-risk lesions that are frequently recommended for surgical excision when diagnosed on core needle biopsy, though controversy exists.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPCA-1

### Deep Learning for Contrast Medium and Radiation Reduction in Coronary CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Giuseppe Tremamunno, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of the study was to evaluate the performance of high-strength deep learning image reconstructions (DLIR-H) in maintaining or improving image quality of coronary CT angiography (CCTA) under the “double low” condition (reduced radiation dose and contrast medium dose), compared with conventional 100kVp - ASiR-V protocol.

#### METHODS AND MATERIALS

In this single-center study, from June to December 2022, clinically indicated CCTA of consecutive patients with BMI < 30 kg/m<sup>2</sup> were prospectively included and randomly assigned (1:1 ratio) into three groups: group A (100 kVp, ASiR-V 50% and iodine delivery rate [IDR] =1.8); group B (80 kVp, DLIR-H, and IDR =1.4), and group C (80 kVp, DLIR-H and IDR =1.2). Radiation and contrast dose, objective image quality (vascular attenuation, image noise, contrast-to noise ratio [CNR], signal-to-noise ratio [SNR]) and subjective image quality were compared among the three groups. To assess the objective image quality, regions of interest were drawn in the left pectoral muscle as a reference, in the ascending aorta and in the main coronary arteries. Subjective image quality was rated using a 4-point Likert scale.

#### RESULTS

144 CCTA were evaluated. Group B and C significantly reduced radiation dose compared to Group A ( $2.16 \pm 0.8$  mSv and  $1.99 \pm 0.6$  mSv, respectively, VS  $3.6 \pm 1$  mSv;  $P < 0.001$ ). Group B and group C outperformed group A in terms of lower contrast media dose, with a decreasing trend from group A to group C ( $57.7 \pm 6.7$  mL,  $51.5 \pm 6.3$  mL, and  $42.9 \pm 3.8$  mL, respectively); all the differences among the groups were statistically significant ( $P < 0.001$ ). Group B and C also achieved significantly higher SNR, CNR, and lower background noise compared to group A (all  $P < 0.001$ ). In terms of subjective image quality, group B obtained the highest score, significantly higher than group A ( $P < 0.001$ ) and group C ( $P < 0.05$ ).

#### CONCLUSION

In non-obese patients, “double low” CCTA protocol coupled with DLIR-H significantly reduces radiation and contrast medium dose while improving image quality, compared to conventional CCTA protocol.

#### CLINICAL RELEVANCE/APPLICATION

The “double low” CCTA protocol coupled with DLIR-H allows us to have excellent image quality while reducing radiation and contrast media burden; therefore, it can be safely implemented in non-obese patients. Further investigations focused on diagnostic accuracy are needed.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5B-SPCA-2

### Basic Verification of Myocardial Extracellular Volume Quantification by Prototype Photon Counting Detector CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to investigate the accuracy of myocardial extracellular volume (ECV) quantification by prototype photon counting detector CT (PCD-CT) and the influence of the radiation dose and spectral image settings.

#### METHODS AND MATERIALS

We used a multi-energy CT phantom simulating the blood pool and myocardium. The solid rods representing blood and soft tissue were used as pre-contrast CT. Besides, the solid rods including different iodine concentrations (2 mgI/mL and 4 mgI/mL) were used as post-contrast CT. The tube voltage was set at 120 kVp and three types of tube current (105mAs, 150mAs, 300mAs) applied. Virtual monoenergetic images (VMI) at 50-100 keV were reconstructed. The ECV value was calculated from the CT numbers between pre-contrast and post-contrast. Hematocrit of blood for ECV calculation was fixed at 0.5. We compared the accuracy of ECV values at each monoenergetic level.

#### RESULTS

There was a small but significant difference in ECV values at each keV level in each radiation dose setting. ECV tended to be overestimated at higher keV in all radiation dose settings. There was a significant difference in the variability of ECV values among keV levels in all three radiation dose settings, with higher keV having greater variability. The variation was particularly large in the low dose setting. In all radiation dose settings, the residual values were significantly larger at higher keV levels: the average residual values at 105mAs, 150mAs and 300mAs settings were 0.5%-6.1%, 0.4%-4.5% and 0.3%-4.9%, respectively. In 150mAs and 300mAs settings, the residual values were smaller at 50keV and 60keV with no significant difference.

#### CONCLUSION

When quantifying myocardial ECV with PCD-CT, it was necessary to set appropriate VMI keV and radiation dose settings because the keV levels can cause differences in the quantification value and measurement variation. This PCD-CT system enabled accurate myocardial ECV quantification at 50 and 60 keV in 150mAs and 300mAs settings.

#### CLINICAL RELEVANCE/APPLICATION

Accurate myocardial ECV quantification is feasible using PCD-CT with appropriate keV settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPCA-3

### Evaluation of Coronary Artery Stents with Ultra-High-resolution Photon-Counting CT: Analysis Of the Optimal Reconstruction Kernel

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Yue Sun (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the impact of reconstruction kernel on the image quality of coronary artery stents with ultra-high-resolution photon-counting CT (UHR-PCCT) in a phantom model

#### METHODS AND MATERIALS

Six different coronary stents in a coronary phantom were examined at a tube voltage of 120kV. Images were reconstructed using vascular kernels of 11 sharpness levels based on three matrix sizes (matrix size of 512×512 pixels: Bv44, Bv48, Bv56; matrix size of 768×768 pixels: Bv60, Bv64, Bv68; matrix size of 1024×1024 pixels: Bv72, Bv76, Bv80, Bv84 and Bv89), using quantum iterative reconstruction (QIR) at a strength level of 3, and a slice thickness of 0.2 mm. Images with the Bv44 kernel, QIR at a strength level of 3, and a slice thickness of 0.4 mm served as the reference. Image noise and signal-to-noise ratio (SNR) were measured automatically using Python (Version 3.5). The sharpness and the attenuation effects of the stents were objectively evaluated with 10%-90% edge rise distance (ERD), 10%- 90% edge rise slope (ERS) and stent lumen attenuation increase ratio (SAIR). The visible diameter of the coronary stent was measured by the peak-to-peak CT attenuation of stent strut. The overall image quality of the coronary stents was subjectively scored on a 5-point scale (1= poor [poor vessel definition, severe artifacts, diagnostic information impaired], 5= excellent [clear stent strut definition, minimal blooming artifacts from the stent, and diagnostic information sufficient]). Friedman test or Kruskal Wallis test was used to check for differences between the reconstructions as appropriate. The Benjamini-Hochberg procedure was used to adjust P values for multiple comparisons.

#### RESULTS

Reconstructions with the Bv44 kernel and a slice thickness of 0.4 mm showed lowest image quality (3[2-3]) and lowest vessel sharpness (ERD:  $0.42 \pm 0.03$  mm; ERS:  $2498.25 \pm 403.83$  HU/mm) (all  $P < 0.05$ ). Considering reconstructions with a slice thickness of 0.2 mm, reconstructions with the Bv72 to the Bv89 kernel had highest image noise and lowest SNR (all  $P < 0.05$ ). Reconstructions with the Bv44 to the Bv56 kernel demonstrated a lower stent sharpness (all  $P < 0.05$ ). No difference was demonstrated among reconstruction kernels in terms of SAIR and the ratio of the visible stent lumen diameter to the true diameter. The overall image quality of coronary stents for reconstructions with the Bv60 to the Bv68 kernel (median score of 5) were favored by the readers.

#### CONCLUSION

UHR-PCCT enables the visualization of coronary stents with an excellent image quality and high sharpness. Reconstructions with the Bv60 to the Bv68 kernel may be optimal for evaluation of coronary artery stents.

#### CLINICAL RELEVANCE/APPLICATION

UHR-PCCT with the Bv60 to the Bv68 kernel allows improvement of coronary stent evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPCA-4

### Photon-Counting Detector CT Angiography of the Coronary Arteries: Intra-Individual Comparison of Image Quality to Conventional Energy-integrating Detector CT Angiography

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Daniel Pinos, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aims of this study were to determine the objective and subjective image quality of coronary computed tomography angiography (CCTA) on a clinical dual-source photon-counting detector CT (PCD-CT) and to compare the image quality to conventional dual-source energy-integrating detector CT (EID-CT) in the same patients.

#### METHODS AND MATERIALS

Twenty prospectively enrolled patients ( $67.5 \pm 9.0$  years, 28.5 median BMI, 75% male) underwent PCD-CT and EID-CCTA at an average interval of 11 days. Contrast agent protocol and radiation dose were matched between the PCD- and EID-CCTA. Polychromatic images were reconstructed for both EID- and PCD-CT, while virtual monoenergetic images (VMI) were created at 40, 45, 50, 55, 60 and 70 keV for PCD-CT. Contrast-to-noise ratio (CNR) was calculated for each coronary artery by two blinded readers. Stratification analysis of patients was performed according to BMI [high ( $>30$  kg/m<sup>2</sup>) vs low ( $<30$  kg/m<sup>2</sup>)]. For subjective analysis, readers scored image noise, vessel attenuation, vessel sharpness and overall quality using a 1-5 Likert scale.

#### RESULTS

Compared with EID-CT, attenuation and image noise of the coronary arteries were higher for all PCD-CT VMI reconstructions (all  $p < 0.008$ ). Coronary artery CNR values from PCD-CT monoenergetic and polychromatic reconstructions were all significantly higher than CNR values from EID-CT (all  $p < 0.008$ ). A proportionally greater increase in CNR of 33.1% was found in high BMI patients averaged over all reconstructions. Subjective scores of image noise, vessel attenuation, vessel sharpness and overall quality were significantly higher for 55, 60, and 70 keV compared to EID-CT (all  $p < 0.05$ ).

#### CONCLUSION

The improved objective and subjective image quality of PCD-CCTA compared to EID-CCTA may offer better visualization of the coronary arteries for a wide array of patients, especially those with high BMI.

#### CLINICAL RELEVANCE/APPLICATION

The improved image quality of CCTA with PCD has the potential advantages of lower radiation dose, better detection of coronary artery disease, and better visualization in obese patient.

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## Abstract Archives of the RSNA, 2023

W5B-SPCA-5

### Deep Learning-Based Myocardial Strain Analysis from Cine MR Image: A Comparative Study of Unet and ResUnet

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Dayeong An, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to develop a deep learning (DL)-based network for measuring myocardial regional function from conventional cine magnetic resonance (MRI) images, combining the advantages of cardiac magnetic resonance feature tracking (CMR-FT) and MRI tagging while minimizing their respective limitations in assessing regional cardiac function.

#### METHODS AND MATERIALS

Modified Unet and ResUnet architectures were implemented and trained to handle spatiotemporal data. Deeper layers and dilated convolutional blocks were incorporated to increase the receptive field and improve multi-scale feature learning. A custom loss function was employed for better optimization. Paired cine MR images and myocardial displacement fields generated from corresponding tagged images were acquired at matching locations and timepoints. The dataset comprised 1280 images (64 MRI slices with 20 cine and tagged images per slice). Data were split into training, validation, and test datasets as 80%, 10%, and 10%, respectively. Random flip data augmentation was performed. Radial and circumferential strains at end-systolic were measured using the American Heart Association (AHA) 6-segment model.

#### RESULTS

After 100 epochs, accuracies were 87% for Unet and 86% for ResUnet with losses of 0.6% and 0.7%, respectively. Mean±SD global strains for tagging, Unet, and ResUnet were Err = 15.4±8.4, Ecc = -15.3±8.3; Err = 17.1±10.3, Ecc = -14.7±9.1; and Err = 17.8±10.2, Ecc = -15.6±9.2, respectively. Unet and ResUnet achieved mean squared errors (MSE) of 0.5 and 0.46, peak signal-to-noise ratios (PSNR) of 71.62 and 72.08, structural similarity indices (SSIM) of 91.7 and 92.4, and Pearson correlation coefficients (PCC) of 92.9 and 95.9, respectively, compared to MRI tagging. Paired t-test revealed no statistically significant differences in strains between conventional and Unet methods ( $p>0.05$ ). However, significant differences were observed in radial AHA sectors 2 and 4, and circumferential AHA sector 1 between conventional and ResUnet methods ( $p<0.05$ ).

#### CONCLUSION

The study results demonstrate the feasibility of using deep learning-based networks, particularly the modified Unet architecture adapted for spatiotemporal data analysis, for assessing regional cardiac function in a clinical setting without the need for acquiring MRI tagged images. Potentially, this network can be used to reduce MRI scan time and allow for more adoption of strain imaging for evaluating different cardiovascular diseases.

#### CLINICAL RELEVANCE/APPLICATION

The deep learning-based networks adapted for spatiotemporal data analysis provides an efficient and accurate alternative to MRI tagging for assessment of regional cardiac function for early detection of cardiovascular diseases.

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## Abstract Archives of the RSNA, 2023

W5B-SPCA-6

### Coronary Artery Calcium Quantification with Super Resolution Deep-learning Reconstruction Algorithm: An Anthropomorphic Phantom Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Shinsuke Shigematsu (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the impact of a novel super-resolution deep-learning reconstruction (SR-DLR) algorithm on coronary artery calcium (CAC) quantification in comparison with filtered back projection (FBP), hybrid iterative reconstruction (HIR), model-based iterative reconstruction (MBIR), and normal resolution deep-learning reconstruction (NR-DLR) algorithms.

#### METHODS AND MATERIALS

A QRM Thorax phantom with cardiac calcification inserts containing three different amounts of hydroxyapatite with three different diameters was used for this study. The phantom was placed inside a body ring (400×300 mm diameter) and scanned on a 320-row scanner with a tube voltage of 120 kVp. Scanning was performed with six tube currents ranging from 100 to 350 mA in 50 mA increments (CTDIvol: 1.4 to 5.1 mGy). Images were reconstructed using FBP, HIR (AIDR3D), MBIR (FIRST), NR-DLR (AiCE), and SR-DLR (PIQE) at a 3 mm slice thickness. Image noise, contrast-to-noise ratio (CNR), and task-based detectability index of calcifications were quantified. CAC volume and Agatston score were measured semi-automatically; the relative volume measurement error from the nominal CAC volume (360.6 mm<sup>3</sup>) was calculated for each reconstruction at each radiation dose level. Using the Agatston scores obtained at 350 mA as a reference for each reconstruction, the relative measurement errors at lower radiation doses (100-300 mA) were calculated. Using the Agatston scores obtained on 350-mA FBP images as a clinical reference, the relative measurement errors of each reconstruction at each radiation dose were also calculated.

#### RESULTS

SR-DLR yielded the lowest image noise, the highest CNR, and the highest CAC detectability index among all reconstructions at each radiation dose level. The lowest measurement errors in CAC volume relative to nominal volume and the Agatston score relative to reference dose (350 mA) were obtained with SR-DLR at all dose levels. When the Agatston score at 350-mA FBP was used as a reference, SR-DLR showed a systematic underestimation at all radiation doses (relative measurement error < -7.6%).

#### CONCLUSION

SR-DLR may improve image quality and facilitate accurate CAC quantification even at lower radiation doses, but its clinical application requires caution due to the deviation of the Agatston score from the conventional high-dose FBP setting.

#### CLINICAL RELEVANCE/APPLICATION

The novel SR-DLR algorithm may yield accurate detection and quantification of CAC due to its excellent noise and spatial resolution characteristics, but the clinical evaluation for potential impact on risk classification and patient management is warranted before routine clinical use.

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## Abstract Archives of the RSNA, 2023

W5B-SPCH-1

### Deep Learning-Based Prediction of Left Ventricular Ejection Fraction Using Chest Radiographs: Potential Role in Pre-Screening Individuals in Health Checkup Populations

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Hye Soo Cho (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate deep learning automatic prediction algorithms (DLLV) for left ventricular ejection fraction (LVEF) from chest radiographs (CRs), and explore its potential role as pre-screening target individuals for echocardiography in health checkup populations.

#### METHODS AND MATERIALS

To develop DLLV, patients who received CR and echocardiography at the same day at Seoul National University Hospital (SNUH) between 2016 and 2021 were retrospectively collected. 32,137 CRs from 23,616 patients (12,854 men [54%]; mean age, 69 [IQR, 62-80] years old) were included and randomly split into training (n= 25,709), validation (n= 3,214), internal test (n= 3,214) datasets. LVEF measured on echocardiogram was used as reference standard. ResNet50 was used as backbone convolutional neural network while final layers were adapted to predict LVEF in ranges of [0, 35, 50, 65, 100] (classification branch) and exact LVEF values (regression branch). For external testing, two independent cohorts were collected: 1) 5440 patients (2867 men [53%]; 66 [55-66] years old) who received same day CR and echocardiography at SNUH in 2015 (SNUH cohort) and 2) 28,034 individuals (17252 men [62%]; 56 [50-63] years old) at Healthcare System Gangnam Center between 2015-2021 (HCS health checkup cohort) were retrospectively collected. Prediction performance of DLLV was evaluated using area under the receiver operating characteristic curve (AUROC).

#### RESULTS

In internal test dataset, DLLV showed AUROCs of 0.79 (95% CI, 0.78-0.81) and 0.80 (0.79-0.81) in predicting patients with LVEF =35% and =50%, respectively. In SNUH cohort, 8% (459/5440) and 2% (123/5440) of the patients showed LVEF =35% and 50% on same day echocardiogram, and DLLV exhibited AUROC of 0.85 (0.84-0.86) in predicting LVEF =35% and 0.78 (0.77-0.80) in predicting LVEF =50%. In HCS cohort, only 0.2% (62/28,034) of the individuals showed LVEF =50%, and none showed LVEF =35%. DLLV showed AUROC of 0.74 (0.74, 0.75) in detecting those with LVEF =50%. When selective recommendation of echocardiography was assumed depending on DLLV results from CRs (i.e., those with DLLV >5%), DLLV could screen 68% (42/62) of individuals with LVEF =50% by recommending echocardiography for 8655 among 28,034 individuals (70% reduction of examinations). Only 0.1% (20/19,329) showed abnormal LVEF among individuals echocardiography was not recommended by DLLV.

#### CONCLUSION

DLLV exhibited promising performance in predicting patients' LVEF from CRs. In a health checkup cohort, DLLV showed potential in pre-screening individuals who may need echocardiography.

#### CLINICAL RELEVANCE/APPLICATION

Selective recommendation of echocardiography using DLLV may enhance chance of opportunistic screening and reduce expanse from unnecessary examinations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPCH-2

### Missed Diagnosis on Chest X-Ray: Auditing Large Volumes of Data with the Help of Comprehensive Artificial Intelligence

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Arpit Talwar, MBBS, MMed (*Presenter*) Nothing to Disclose

#### PURPOSE

Chest x-rays (CXR) are the most common imaging modality in radiology and also one of the earliest imaging modalities to be developed. Despite many decades of experience in this modality, the diagnostic error rate has remained relatively unchanged. This could partly due to the lack of consistent feedback to radiologists when reporting CXRs. The purpose of the current study was to detect the rate of missed diagnoses on CXRs reported in a busy teaching hospital environment and demonstrate an efficient method of auditing the CXRs.

#### METHODS AND MATERIALS

A consecutive cohort of adult (= 18 years) CXRs reported normal within the St. Vincent's Hospital Melbourne Imaging Department were retrospectively collected and de-identified. A commercially available system (Annalise Enterprise CXR) was applied over included studies to identify cases predicted by the AI to contain one or more of 60 findings deemed significant/critical. The discrepancy between original radiology report and AI predictions were reviewed by a radiologist with over 10 years-experience to evaluate the level of agreement between radiologists and the AI-predictions, and the number of missed findings determined through subsequent review.

#### RESULTS

A total of 1559 CXRs reported in 2016 were retrospectively collected and de-identified. All of these studies were successfully processed by the AI system. The AI detected significant abnormalities in 169 of the studies. Of these, 97 were confirmed to have significant missed findings by the reporting radiologist. The most common missed findings were pulmonary nodules (16%), pleural effusions (16%), spinal compression fractures (12%) airspace opacities (11%), acute rib fractures (9%) along with a number of other significant missed findings of hilar lymphadenopathy, pulmonary artery enlargement, bone lesions, interstitial thickening, pulmonary congestion, two shoulder dislocations and an acute clavicle fracture.

#### CONCLUSION

The study demonstrates a time-effective means for auditing CXRs in a busy radiology department within a teaching hospital in order to provide constructive feedback to radiologists and trainees. A total of 1559 CXRs were automatically processed by AI allowing the radiologist to review the findings with 97 findings deemed significant out of the 169 studies detected by AI.

#### CLINICAL RELEVANCE/APPLICATION

Integration of a comprehensive AI model in a real-world reporting environment has the potential to improve radiologist performance, ultimately improving patient care.

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## Abstract Archives of the RSNA, 2023

W5B-SPCH-3

### Assessment of Intensive Care Unit Physician Performance and Perception towards AI Utilizing a Concurrent-Read Endotracheal Tube Detection Algorithm on Portable Chest Radiographs: A Multi-Reader, Multi-Case Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Kaustav Bera, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

AI tools to detect and measure endotracheal tubes (ETT) on frontal chest radiograph (CXR) are primarily used by radiologists. The purpose of this study was to compare the interpretation time and performance improvement of ICU physicians for detection and measurement of ETT without and with concurrent AI assist. We also assessed the perception of the readers towards AI before and after the exercise in the form of multiple choice questionnaire.

#### METHODS AND MATERIALS

A fully crossed multi-reader and multi-case reader study was conducted. 34 participating physicians engaged in critical care (16 fellowship-trained attendings; 18 physicians-in-training [15 fellows; 3 residents]) were enrolled and retrospectively interpreted 100 CXRs (50 with ET tube; 50 without) in two reading scenarios (once without and once with AI assist). Readers were also asked to self-record the interpretation times. Interpretations of any given case set with and without AI would be separated by 4 weeks of washout. The physician and AI interpretations were compared to the reference standard measurements by board-certified cardiothoracic radiologist (10 years experience). Sensitivity, specificity, PPV, NPV was used to evaluate performance. Performance and time to interpretation was compared between AI assisted and unassisted scenarios using Fisher's exact test and Wilcoxon rank sum test. A pre- and post-completion survey was also administered and analyzed using the Likert scale.

#### RESULTS

We here present preliminary results for the first set before washout. Only completed surveys were taken for analysis (30%). AI had sensitivity, specificity, PPV, NPV and likelihood ratio of .98, .98, .98, .98, 49 ( $p < .001$ ) when compared to reference standard. Mean reader performance in terms of sensitivity, specificity and likelihood ratio were improved from 0.98, 0.91, 15 to 1, 0.97, 20 ( $p < .001$ ). The average interpretation time per case was significantly reduced by approximately 52% (median time 25 secs vs 16.5 secs;  $p < .01$ ). Following the completion of set 1 of the study, 75% of respondents expressed the desire to use AI in their clinical practice. Interestingly 63% of respondents had answered that they had no prior experience with AI at the beginning of the study.

#### CONCLUSION

An FDA approved AI tool for detecting and measuring ETT distance on frontal CXRs showed excellent agreement with the ground truth, and significantly improved interpretation times as well as overall performance for ICU physicians across a broad spectrum of experience levels.

#### CLINICAL RELEVANCE/APPLICATION

ETT AI tool showed excellent accuracy as well as helped ICU physicians improve their performance and time to interpretation. This paves the way for future prospective studies and ultimately bedside clinical deployment.

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## Abstract Archives of the RSNA, 2023

W5B-SPCH-4

### Consecutive Cohort Analysis with Natural Language Processing (NLP) and Multi-finding AI Algorithm for Chest Radiographs: Multidimensional Opportunity for QA/QC

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess if comprehensive discrepancy analysis of findings between NLP-based radiology reports search and a multi-finding, image-based AI algorithm can help audit quality of chest radiograph (CXR) reporting in community and quaternary healthcare settings.

#### METHODS AND MATERIALS

Our IRB-approved, HIPAA-compliant, retrospective study included 3760 consecutive CXRs (PA/AP /or lateral views) from 3760 adult patients (age>18years) in two community and quaternary care hospitals. We queried an NLP-based radiology report search engine (Microsoft Nuance) for the presence of following findings: optimal/misplaced/absent lines/tubes (endotracheal tube, esophageal tube, pulmonary arterial and central venous catheters), solitary pulmonary nodule (SPN), pneumonia, simple pneumothorax, tension pneumothorax, pneumomediastinum, pneumoperitoneum, osteopenia, and compression vertebral fractures. Each radiology report (Rad1) was manually reviewed for presence of these findings by at least 1/5 participating physicians. Each CXR was processed with a multi-finding AI algorithm (Annalise.AI) for presence of the same findings. CXRs with discrepant finding between the NLP-Rad1 and the AI was blindly assessed by either one or two thoracic radiologists (Rad2/3) based on the discrepancies to establish the standard of reference. The data were analyzed with descriptive statistics.

#### RESULTS

NLP/Rad1 and AI had high true positive and true negative concordance for CXR findings (lowest: 86.7%, 3260/3760; highest 98.8%, 3708/3760). Among the 3760 CXRs, the AI correctly identified false-negative (FNr) and false positive findings (FPr) in radiology reports for simple pneumothorax (FNr 0.4% [13/3760], FPr 0.2% [7/3760]); pneumonia (7.1% [270/3760], 1.2% [44/3760]), SPN (1.6% [60/3760], 1.7%[65/3760]), osteopenia (5.3% [200/3760], 0.2% [8/3760]), and compression fractures (3.1%, [114/3760], 0.2% [8/3760])

#### CONCLUSION

Consecutive discrepancy analysis of NLP-based radiology reports search and AI outputs can help identify a substantial proportion of missed and overcalled CXR findings with low false positive or false negative frequencies.

#### CLINICAL RELEVANCE/APPLICATION

Our proposed framework of NLP/AI for consecutive discrepancy analysis has broad applications such as a second reader to avoid missed or miscalled findings, and in peer-review and QA/QC efforts.

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## Abstract Archives of the RSNA, 2023

W5B-SPCH-5

### Glucose Metabolic Rate from Dynamic $^{18}\text{F}$ -FDG PET/CT Scan to Differentiate Sarcoid Lymph Nodes from Malignant Lesions

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Akihiro Inoue, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Long-term fasting  $^{18}\text{F}$ -Fludeoxyglucose positron emission tomography (FDG-PET) has contributed to the diagnosis of active inflammation in cardiac sarcoidosis (CS). In the diagnosis of FDG-PET, an accumulation of active sarcoid lymph nodes is often difficult to differentiate from lymphatic metastasis or lymphoma. In differentiating active sarcoid lymph nodes from malignant lesions, we investigate the potential of the glucose metabolic rate ( $\text{MR}_{\text{glc}}$ ,  $\text{mg}/\text{min}/100\text{ml}$ ) that is a new quantification of glucose metabolic kinetics derived from dynamic FDG-PET scan with a silicon photomultiplier.

#### METHODS AND MATERIALS

100 CS patients and 67 cancer-bearing patients who underwent dynamic FDG PET/CT scan with a silicon photomultiplier between March 2021 and December 2022 were enrolled. Mediastinal or hilar lymph nodes with  $\text{SUV}_{\text{max}} = 3$  in sarcoidosis patients and metastatic or primary lesions with  $\text{SUV}_{\text{max}} = 3$  in cancer-bearing patients were included in the analysis.  $\text{MR}_{\text{glc}}$  was derived from tissue and plasma blood time-activity concentration curves using the Patlak linearization approach, with data acquired between 30 and 50 min after injection in dynamic FDG-PET/CT. Then, 60 minutes later, a standard scan performed. Active lesion was defined as  $\text{SUV}_{\text{max}} > 3.0$  on standard whole body image. Use of parametric horizontal-axial image, mean value in VOI (size  $1.5\text{cm}^3$ ) was measured.

#### RESULTS

Forty-seven lymph node lesions from 25 of 100 CS patients and 39 malignant lesions from 27 of 67 cancer-bearing patients were included in the analysis. SUV and  $\text{MR}_{\text{glc}}$  for sarcoid lymph nodes were significantly lower than those for malignant lesions (SUV,  $4.93 \pm 2.09$  vs.  $5.95 \pm 2.32$ ;  $\text{MR}_{\text{glc}}$ ,  $2.42 \pm 1.26$  vs.  $3.57 \pm 1.57$ ;  $p < 0.001$ ). Receiver-operating-characteristic analysis revealed that the ability to discriminate sarcoid lymph nodes and malignant lesions was the area under the curve (AUC) of 0.71, 77% sensitivity, and 60% specificity for SUV, AUC of 0.74, 80% sensitivity, and 66% specificity for  $\text{MR}_{\text{glc}}$ , and AUC of 0.76, 90% sensitivity, and 62% specificity for the ratio of  $\text{MR}_{\text{glc}}$  to SUV, respectively.

#### CONCLUSION

$\text{MR}_{\text{glc}}$  and the ratio of  $\text{MR}_{\text{glc}}$  to SUV are significantly lower for sarcoid lymph nodules than malignant. The use of  $\text{MR}_{\text{glc}}$  improves sarcoid lymph nodes identification over SUV alone.

#### CLINICAL RELEVANCE/APPLICATION

The ability to distinguish between sarcoid and metastatic lymph nodes with FDG-PET will lead to accurate staging of malignant tumors.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPCH-6

### Incremental Prognostic Value of Deep learning-based Quantification of Macroangiopathic Aortic Changes for Cardiovascular Mortality in Heavy Smokers

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Alexander Rau, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Macroangiopathic changes of the aorta are a common manifestation of cardiovascular (CV) disease. Currently, maximum diameter is the only prognostic measure used in clinical practice, despite quantification of other macroangiopathic changes (e.g. calcification) is available on computed tomography (CT) imaging. Thus, we applied a deep learning model to automatically quantify macroangiopathic changes of the aorta and investigated their prognostic value for CV mortality in a high-risk population of heavy smokers.

#### METHODS AND MATERIALS

We used a deep learning model to automatically segment the aorta on lung screening chest CTs of participants enrolled in the National Lung Screening Trial at baseline and one-year follow-up. The following features were quantified: maximum diameter (cm), volume (deciliter) and calcifications (ml, categorized into tertiles). We assessed the association between (I) baseline features and CV and (II) the change of features within one year and CV mortality via multivariable Cox proportional hazard regression adjusted for traditional CV risk factors including smoking and hypertension. Harrel's c-index was used to compare the predictive value of the features.

#### RESULTS

Among 24,770 participants at baseline (mean age  $61.4 \pm 5.0$  years; 59.2% male) 440 (1.8%) CV deaths occurred over a mean follow-up of  $6.3 \pm 1.0$  years. In univariate models, C-index of aortic volume and calcifications were significantly higher compared to diameter (c-index 0.63 and 0.66 vs. 0.61;  $p=0.02$ ) for the prediction of CV mortality. After adjustment for traditional CV risk factors, volume (aHR: 1.04 [1.01-1.08];  $p=0.008$ ) and calcification (aHR: 2.53 [1.87-3.41];  $p<0.001$ ) remained significantly associated with CV mortality whereas the association for diameter was attenuated. In subjects with one year follow-up available ( $n=22,140$  individuals, mean age  $61.4 \pm 4.9$  years; 58.3% male with a 1.5% CV), the strongest association was found between an increase in calcifications and CV mortality (aHR highest tertile: of 1.74 [1.32-2.29],  $p<.001$ ) after multivariable adjustment for traditional CV risk factors.

#### CONCLUSION

Deep learning can automatically quantify macroangiopathic changes of the aorta on lung screening chest CTs and identify individuals at high risk of CV mortality beyond traditional risk factors.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning-based quantification of macroangiopathic aortic changes can identify individuals at risk of CV mortality beyond traditional risk factors in a high-risk population of heavy smokers. This enables opportunistic risk assessment to improve personalized prevention and treatment strategies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPCH-7

### “Dependent Contrast Layering Sign” on CT: Preliminary Cross Sectional Descriptive Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Youssef Mohsen, MD, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

CT findings of contrast layering in the dependent part of the central venous system have been reported to be associated with compromised cardiac function and imminent cardiac arrest. To the best of our knowledge, there is no systemic research on this finding and its association with cardiac arrest and mortality. Therefore we studied the radiologic findings of dependent contrast layering in vascular structures on CT and its clinical implications.

#### METHODS AND MATERIALS

This single center retrospective study involved a list of 226 patients obtained by searching PACS reports for the keywords “layering of contrast”, “pooling of contrast” or “dependent layering of contrast” in contrast enhanced CT chest and CT abdomen performed between Jan 2008 and Jan 2022. Two body radiologists reviewed for the dependent layering of contrast in vascular structures and parenchyma of abdominal organs. Clinical data were investigated from electronic medical records. The frequencies of the radiologic findings in association with clinical data were analyzed.

#### RESULTS

Dependent contrast layering in the vascular structures is demonstrated in 21 patients (9.3%, mean age:  $67.4 \pm 12.4$ ). Layering of contrast is shown in the IVC ( $n=19$ , 90.4%), hepatic vein ( $n=17$ , 80.9%), liver parenchyma ( $n=7$ , 30.3%), right atrium ( $n=5$ , 23.8%), and other organs ( $n=10$ , 47.6%). Among the 21 patients, 6 patients (28.5%) had cardiac arrest within 24 hours, all of which occurred within 2 hours. 11 patients (52.3%) died during their hospital stay. Layering in the right atrium shows the highest rate of cardiac arrest within 2 hours (4 of 5, 80%) followed by liver parenchyma (5 of 7, 71.4%). Reflux into liver parenchyma shows the highest rate of death during the same hospital stay (4 of 7, 57.1%). The mean number of involved structures per patient is  $3.29 \pm 2.0$  (range 1-9). It is higher in patients who died during the same hospital stay ( $4.25 \pm 1.15$ ) compared to those who survived ( $3.3 \pm 2.02$ ). The mean number of involved structures is similar between the cardiac arrest ( $3.29 \pm 1.98$ ) and non-cardiac arrest ( $3.28 \pm 2.08$ ) groups. The mean left ventricular ejection fraction (LVEF) was  $38 \pm 12\%$  (range 15-67). LVEF was less than 40% in 52% (10 of 19) of patients. The the shock index was 0.9 or higher in 66.6% (12 of 18) of patients and its mean was  $1.08 \pm 0.50$  (range 0.5-2.6).

#### CONCLUSION

The CT findings of dependent contrast layering in the central venous system are related to high rates of imminent cardiac arrest and mortality.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists and technicians need to recognize these findings to alert clinicians the risk of cardiac arrest. Our study provides important preliminary data for radiologists and clinicians to recognize the significance of “Dependent contrast layering sign” for clinical decision-making.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPCH-8

### Performance of a Novel Intravascular Tantalum Oxide-based CT Contrast for Enhancement and Conspicuity of Thoracic Vasculature in an Animal Model: Total and Relative Contrast Material Advantage

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Maurice M. Heimer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare a novel intravenous tantalum oxide (TaCZ) nanoparticle CT contrast agent to conventional iodinated (Iopromide) CT contrast agent for thoracic artery and vein visualization in a rabbit model.

#### METHODS AND MATERIALS

Five New Zealand White rabbits were serially placed in a human-torso-sized adipose-equivalent encasement and scanned on a clinical CT system (Philips IQon, Best, Netherlands) before and 6, 40, 75, 136, and 240 sec after IV injection of 540 mg element (Ta or I) per kilogram of body weight of TaCZ or Iopromide. Animals were scanned twice, once with each contrast agent. Absolute contrast enhancement of the aortic arch, pulmonary trunk, superior vena cava, and subclavian vein was measured in Hounsfield Units (HU) by averaging three regions of interest drawn in the center of the lumen minus corresponding non-contrast measurements. Randomized imaging series were viewed on a clinical PACS system to rate vascular conspicuity on a 5-point Likert scale (0 = no vascular enhancement; 1 = faintly seen or visible but discontinuous; 2 = adequate contrast of main vessel, not all branches seen; 3 = good contrast of main vessel and depiction of branches; 4 = excellent contrast of main vessel and deep branches).

#### RESULTS

Mean vascular enhancement was significantly higher for TaCZ in all examined blood vessels at all time points compared to Iopromide; aortic arch at 6s (263 vs. 217;  $p < 0.01$ ), at 40s (265 vs. 145;  $p < 0.01$ ), at 75s (240 vs. 119;  $p < 0.01$ ), at 136s (217 vs. 93;  $p < 0.01$ ) and at 240s (183 vs. 73;  $p < 0.01$ ), pulmonary artery at 6s (296 vs. 266;  $p < 0.01$ ), at 40s (263 vs. 138;  $p < 0.01$ ), at 75s (246 vs. 102;  $p < 0.01$ ), at 136s (213 vs. 83;  $p < 0.01$ ) and at 240s (174 vs. 64;  $p < 0.01$ ), superior vena cava at 6s (307 vs. 211;  $p < 0.01$ ), at 40s (255 vs. 127;  $p < 0.01$ ), at 75s (239 vs. 96;  $p < 0.01$ ), at 136s (196 vs. 79;  $p < 0.01$ ) and at 240s (169 vs. 49;  $p < 0.01$ ) and the subclavian vein at 6s (280 vs. 225;  $p < 0.01$ ), at 40s (254 vs. 111;  $p < 0.01$ ), at 75s (236 vs. 86;  $p < 0.01$ ), at 136s (205 vs. 67;  $p < 0.01$ ), and at 240s (170 vs. 54;  $p < 0.01$ ). The mean vascular enhancement of TaCZ at a 136s delay provided comparable results to the 6s arterial phase of Iopromide (213 vs. 223;  $p > 0.05$ ). Overall, vascular enhancement correlated well with perceived vascular conspicuity scores for both agents.

#### CONCLUSION

TaCZ provides both an absolute and relative contrast advantage compared to Iopromide for improved visualization of the thoracic arteries and veins across a broad range of timepoints after contrast injection.

#### CLINICAL RELEVANCE/APPLICATION

TaCZ gives superior prolonged thoracic vascular enhancement over iodine agents at CT and warrants clinical testing as a means to improve the quality and consistency of CT angiograms and venograms.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPER-1

### Channeling the Neuroradiology Crystal Ball: Predicting Presenting Symptoms Associated with Imaging-Proven Acute Cord Compression in the Emergency Department

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Mercy H. Mazurek (*Presenter*) Nothing to Disclose

#### PURPOSE

Spinal cord compression (CC) can result from both atraumatic and traumatic causes. CC commonly presents with back pain, urinary incontinence, lower extremity weakness, and malignancy, among others. While the occurrence of these symptoms is high, the prevalence of CC due to both atraumatic and traumatic causes is low. Understanding the clinical symptoms that are associated with CC may better inform the utilization of imaging in the emergency department (ED) to reduce costs and provide efficient care.

#### METHODS AND MATERIALS

This retrospective study analyzed patients who underwent our ED's abbreviated survey spine MRI protocol for suspected CC from 2018 to 2022. The survey protocol includes sagittal T2 and short-TI inversion-recovery (STIR), with optional axial T2. Imaging reports were reviewed by a blinded, board-certified neuroradiologist and characterized as positive or negative for CC. Demographic factors and presenting symptoms were extracted from the electronic medical record and compared among patients with imaging-positive acute CC vs negative. Univariate analysis was performed using the student's t-test and chi-squared test. A multivariate logistic regression was performed with stepwise backwards elimination where the variable with the largest P value was removed in a stepwise fashion in each iteration until all variables on the final model had a  $P < .20$ .

#### RESULTS

A total of 845 patients (mean age  $57 \pm 19$  years, 45% female) received a survey spine MRI for suspected CC during the study period. Of these, 23% presented with trauma, 55% back pain, 29% lower extremity weakness, 5.7% history of malignancy, 14% urinary incontinence, 6.0% bowel incontinence, 14% neck pain, 20% numbness, 7.3% ataxia, and 6.4% hyperreflexia. There were 725 (85%) and 120 (14%) patients negative and positive for CC, respectively. In the univariate model, trauma, back pain, numbness, ataxia, and hyperreflexia were significantly associated with having a positive study (Table 1). In the multivariate model, trauma, back pain, lower extremity weakness, urinary or bowel incontinence, numbness, ataxia, and hyperreflexia were significantly associated with being positive for acute CC (Table 2).

#### CONCLUSION

Presenting symptoms of trauma, back pain, lower extremity weakness, urinary or bowel incontinence, numbness, ataxia, and hyperreflexia were significantly associated with positive CC findings on ED survey spine evaluation in the ED. These results may inform which patients should receive triage priority in the ED.

#### CLINICAL RELEVANCE/APPLICATION

Understanding the symptoms associated with acute CC informs efficient utilization of abbreviated, CC-specific survey spine MRI protocols to limit unnecessary imaging studies thereby expediting diagnosis and emergent treatment.

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## Abstract Archives of the RSNA, 2023

W5B-SPGI-1

### Preoperative Prediction of Ki-67 Expression in Hepatocellular Carcinoma by Spectral Imaging on Dual-Energy CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Caiyun Li, BMedSc, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of quantitative spectral parameters measured on a dual-energy CT in preoperative predicting the expression level of Ki-67 in HCC.

#### METHODS AND MATERIALS

91 HCC patients underwent both pathological examination and two-phase contrast-enhanced CT scanning with spectral imaging mode were included in this study. According to Ki-67 expression determined by the Ki-67 positivity rate (Ki-67%), patients were divided into two groups: high expression group (Ki-67% > 20%, n = 51) and low expression group (Ki-67% = 20%, n = 40). CT values on 100 and 140 keV monochromatic energy images (HU<sub>100-140keV</sub>), normalized effective atomic number (Neff-Z), water density (D<sub>water</sub>), fat density (D<sub>fat</sub>) were measured and calculated. The parameters comparison between groups, receiver operation curve for prediction efficacy evaluation were conducted.

#### RESULTS

The Neff-Z, D<sub>fat</sub>, HU<sub>100-140keV</sub> and D<sub>water</sub> in high expression group were significantly higher than those in low expression group (all P < 0.05). In prediction of Ki-67 expression, the AUCs of Neff-Z, D<sub>fat</sub>, HU<sub>100-140keV</sub> and D<sub>water</sub> were 0.650, 0.677, 0.692-0.750, 0.777. The corresponding sensitivities were 0.647, 0.804, 0.529-0.824 and 0.961, respectively. The specificities were 0.600, 0.525, 0.825-0.625 and 0.475, respectively. D<sub>water</sub> showed highest Ki-67 expression prediction performance, with AUC of 0.777. The multi-variable analysis combining spectral CT parameters and morphological characteristics improved the prediction efficiency (AUC=0.814).

#### CONCLUSION

The spectral parameters (Neff-Z, D<sub>fat</sub>, HU<sub>100-140keV</sub> and D<sub>water</sub>) obtained by contrast-enhanced spectral imaging on dual-energy CT can be used to predict Ki-67 expression in HCC, the efficiency would be improved by multi-parameter analysis combining spectral CT parameters and morphologic features.

#### CLINICAL RELEVANCE/APPLICATION

Ki-67 was a significant marker for HCC prognosis and clinical decision, however current method to evaluate Ki-67 always needs surgery, which is detrimental for assessing patients who lost surgery chance. Contrast-enhanced spectral imaging on dual-energy CT provides various parameters to predict cell proliferation in HCC with good performance, shedding lights in clinical diagnosis and therapeutic strategy decision.

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## Abstract Archives of the RSNA, 2023

W5B-SPGI-2

### The Added Value of Reduced field-of-view IRIS-DWI Sequence for T2WI Sequence in T Staging of Rectal Cancer

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Ziyou Wang (*Presenter*) Nothing to Disclose

#### PURPOSE

Oblique axial high-resolution T2WI(HR-T2WI)was the recommended sequence for rectal cancer T staging.We attempted to evaluate the added value of reduced field-of-view (rFOV) IRIS-DWI sequence for T2WI sequence in evaluating T staging of rectal cancer.

#### METHODS AND MATERIALS

All patients underwent rectal MRI examinations in our institution between June 2022 and November 2022 . rFOV IRIS-DWI and oblique axial HR-T2WI images were acquired using a 3.0T MR scanner (Ingenia Elition, Philips, Best, the Netherlands) (Table 1). All patients were evaluated in two rounds by two methods. First, one senior radiologist (Y.K.M.) with more than 7 years of experience in rectal cancer MRI evaluated the T staging based on oblique axial HR-T2WI images and recorded the diagnosis confidence. Second, the same radiologist (Y.K.M.) reevaluated the T staging based on rFOV IRIS-DWI and HR-T2WI images after one-week interval.The diagnosis confidence was also recorded. The radiologist was blind to the detailed pathologic T staging. MedCalc statistical software (version 20.116) was used for data analysis. The accuracy of two diagnosis methods between oblique axial HR-T2WI and T2WI + rFov IRIS were compared by paired  $\chi^2$ -test. Paired sample t-test was used to compare the diagnosis confidence between the two diagnosis methods. ROC curve was used to evaluate the diagnostic performance for pT3 staging.  $P < 0.05$  indicated the difference was statistically significant.

#### RESULTS

Twenty-seven patients with rectal cancer were enrolled in this retrospective study. The average age was  $66.7 \pm 6.9$  years, and there were 15 (56%) males(Table 2). The diagnosis accuracy for pT1-pT2 and pT3 was 58.3% and 73.3% according to oblique axial HR-T2WI. According to the oblique axial HR-T2WI and rFOV IRIS-DWI, 11 patients (91.7%) in 12 pT1-T2 staging patients and 14 patients (93.3%) in 15 pT3 staging patients were accurately diagnosed ( $P < 0.0001$ ) (Table 3). Based on T2WI + rFOV IRIS-DWI imaging showed higher diagnosis confidence, and the diagnosis confidence were 2.9 and 2.37 in all patients ( $P < 0.001$ ) .For pT2 and pT3 staging subgroups, the diagnosis confidence based on T2WI + rFOV IRIS-DWI imaging also showed higher confidence (2.8 vs. 2.1,  $P = 0.01$ ; 2.93 vs. 2.53,  $P = 0.009$ , respectively) (Table 4). ROC analysis showed the diagnosis performance based on T2WI + rFOV IRIS-DWI imaging was superior to T2WI sequence. The AUC, sensitivity and specificity were 0.928, 93.3%, 91.7% and 0.658, 73.3%, 58.3% ,respectively(  $P = 0.002$ )(Table 5, Figure 3).

#### CONCLUSION

rFOV IRIS-DWI combined T2WI imaging provide higher diagnosis confidence and higher diagnosis accuracy for rectal cancer T staging.

#### CLINICAL RELEVANCE/APPLICATION

rFOV IRIS-DWI improved the diagnosis performance in rectal cancer T staging.

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## Abstract Archives of the RSNA, 2023

W5B-SPGI-3

### Impact of MRI after CT on the Therapeutic Decision of Pancreatic Adenocarcinoma

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Walid Tibermacine, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this work is to determine the impact of MRI after CT on the therapeutic decision of pancreatic adenocarcinoma.

#### METHODS AND MATERIALS

It's a prospective, cross-sectional and evaluative study over 24 months from January 2020 to December 2021 of patients suspected of having pancreatic cancer.

#### RESULTS

A total of 117 cases of patients were included, aged 34-91 years with an average age of  $62 \pm 11$  years and a sex ratio of 1.25. The average diameter is  $43.61 \pm 15.268$  mm. The TDM and MRI assessment of resectability was performed according to NCCN version 1.2020 criteria. 46 patients (i.e. 39.3%) were at the metastasis stage, 36 patients (i.e. 30.8%) resectable, 19 patients (i.e. 16.2%) locally advanced and 16 patients (i.e. 13.7%) borderline resectability. To determine the impact of MRI after CT on the treatment decision, we compared the staging of the resectability of each of the two techniques by referring to surgery for resectability and metastases and to MRI data for characterization of liver damage. The analysis showed that in 15 patients (i.e. 12.8%) the therapeutic approach was changed on MRI after CT.

#### CONCLUSION

Complementary MRI to CT led to changes in resectability and therapeutic management in a significant proportion of patients with ADCP

#### CLINICAL RELEVANCE/APPLICATION

Complementary MRI to CT => changed resectability and therapeutic management

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPGI-4

### Imaging Features Prognostic of Overall Survival in Patients with Advanced Hepatocellular Carcinoma Undergoing Systemic Therapy

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Kathleen Ruchalski, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Modified RECIST measures arterial enhancement of liver lesions in hepatocellular carcinoma (HCC), evaluating treatment related alterations in tumor viability not captured by size alone. However mRECIST clinical translation to advanced HCC and ability to predict response to systemic therapy is less well reported. Our objective is to evaluate for imaging features beyond RECIST 1.1 which correlate with overall survival (OS) in advanced HCC.

#### METHODS AND MATERIALS

This is a retrospective study of patients with advanced HCC at our institution enrolled in clinical trials for systemic treatment between 2015-2022. Patient characteristics and OS were obtained. Liver tumor imaging features on baseline CT or MRI chest, abdomen pelvis were analyzed. Relationship to overall survival (OS) was assessed by cox regression model and log rank test.

#### RESULTS

Of 74 patients, we identified 53 who met our criteria, enrolled in a clinical trial with baseline imaging. There were 40 (75.5%) men and 13 (24.5%) women with a mean age of 66.2 years (SD=9.5). Median OS was 31.5 months. Percent total liver tumor involvement n= (%) included: < 25% n=25 (47.2), 25-50% n=20 (37.7), 51-75% n=8 (15.1) patients. Multifocal liver disease and macrovascular invasion were present in 41 (77.4%) and 25 (47.2%) of patients respectively. Individual liver lesions measured on average 41.7mm (SD=28.2) on arterial phase. Lesion margins were characterized as infiltrative (n=14 (13.2%)), irregular (n=19 (17.9%)), well circumscribed (n=60 (56.6%)) and N/0 (n=13 (12.3%)). Arterial enhancement patterns were described as central heterogeneous in 41 (38.6%), homogeneous: 24 (22.6%), partial enhancement: 15 (14.2%), rim only: 11 (10.4%) and no enhancement in 15 (14.2%) patients respectively. Multifocal liver disease was associated with significantly increased risk of death (p=0.043). Patients with partially enhancing liver lesion had improved survival compared to those with central heterogeneously enhancing tumor (HR=0.28; p=0.044). Individual liver lesion size (p=0.399), margin (p=0.289) and % liver involvement (p=0.125) did not correlate with OS.

#### CONCLUSION

While lesion size was not prognostic, presence of multifocal liver disease and central heterogeneous tumor enhancement were poor prognostic features of OS for advanced HCC.

#### CLINICAL RELEVANCE/APPLICATION

Although further investigation is required, reporting imaging findings on multifocal liver disease and arterial enhancement pattern may provide prognostic information for patients with advanced HCC undergoing systemic therapy.

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## Abstract Archives of the RSNA, 2023

W5B-SPGU-1

### Deep Learning Prostate MRI Progression Risk Interval Prediction

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Christian Roest, MSc (*Presenter*) Grant, Siemens AG

#### PURPOSE

MRI follow up is increasingly used to manage patients with low-risk prostate cancer, (PCa) but lacks personalization of follow-up timing. Therefore, We propose a novel AI approach to predict the time to prostate cancer progression.

#### METHODS AND MATERIALS

This retrospective study was performed on a dataset of 875 patients that underwent an MRI of the prostate between 2014 and 2021. Patients received follow-up MRIs and targeted biopsy for all PI-RADS=3 lesions. This study defined progression as the detection of ISUP>1 PCa at follow-up. A novel deep learning model was developed and trained to predict progression-free survival (PFS) based on the MRI and available clinical parameters (PSA, PSA density, prostate volume, and age). Five-fold cross-validation was used to obtain likelihood scores for the three-year risk of progression in each patient. Patients were stratified into high- and low-risk groups based on their predicted likelihood of progression, with an equal number of patients in each group. Kaplan-Meier analyses validated whether the predicted likelihood accurately predicted PFS. Finally, the C-index was calculated to assess the prognostic accuracy of our model.

#### RESULTS

Our AI model's predictions were significantly associated with PFS in the test data ( $p < 0.0001$ ). The C-index was  $0.72 \pm 0.05$ , indicating that our model was a good predictor of PFS. PFS was significantly better in patients predicted to be at low-risk of disease progression, when measured after two years ( $95.3 \pm 0.04\%$  vs  $84.9 \pm 0.02\%$ ,  $p = 0.008$ ), three years ( $92.7 \pm 0.05\%$  vs  $73.3 \pm 0.04\%$ ,  $p = 0.008$ ) and four years ( $87.7 \pm 0.12\%$  vs  $62.8 \pm 0.04\%$ ,  $p = 0.008$ ).

#### CONCLUSION

Our novel AI approach accurately predicted PFS from prostate MRI and clinical information.

#### CLINICAL RELEVANCE/APPLICATION

An improved predictor for the time to progression based on MRI and clinical parameters may improve MRI follow-up protocols by enabling more personalized interval timing and decision making.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPGU-2

### Detection of Clinically Significant Prostate Cancer in Men with a Negative Initial Round of Targeted Biopsies and Highly Suspicious Multiparametric Magnetic Resonance Findings

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Debora Z. Recchimuzzi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the frequency of imaging-pathology discordance and the rate of csPCa detection on repeat TBx.

#### METHODS AND MATERIALS

This single-center, retrospective study of prospectively generated data, included all men who underwent mpMRI and had a PIRADS score 4 or 5 at our institution between Jan/2017 and Nov/2022. The frequency of imaging pathology discordance (PI-RADS score 4 or 5 lesion and no csPCa on TBx) and the rate of csPCa (grade group 2 or higher) detection on a repeat TBx (MRI-TRUS fusion or in-bore biopsy) were determined. Univariate analysis and multiple analysis with logistical regression were used to identify potential parameters associated with true-negative targeted biopsies, including PSA, PSA density, prostate volume as measured by MRI and ADC measurement.

#### RESULTS

Of the 4047 men reviewed, 63% (2581/4047) had PI-RADS 4 or 5 lesions on mpMRI followed by TBx. In 40% (1050/2581) of these men, TBx did not reveal csPCa. Among these 1050 men with discordant imaging-pathology findings, 18% (191/1050) men had a repeat targeted biopsy (MRI-TRUS fusion or MRI guided inbore), and 40 men underwent radical prostatectomy for grade group 1 disease. Repeat TBx identified csPCa in 35% (67/191) of the men who underwent a second TBx. The frequency of csPCa at repeat biopsy was significantly higher for PIRADS 5 (45%; 32/70) compared to PIRADS 4 lesions (28%; 35 of 121) ( $p=$ ).

#### CONCLUSION

A negative targeted biopsy of a highly suspicious lesion on mpMRI must be interpreted with caution and early repeat biopsy should be considered, particularly in men with PI-RADS 5 lesions.

#### CLINICAL RELEVANCE/APPLICATION

Multiple studies have demonstrated that men with highly suspicious (PI-RADS score 4 and 5) prostate lesions at multiparametric MRI (mpMRI) are highly likely to harbor clinically significant prostate cancer (csPCa). The degree of suspicion on multiparametric MRI is the strongest predictor of a positive targeted biopsy with positive rates of 70% to 90% when the MRI findings are highly suspicious for PCa. It is known that prostate biopsies - including targeted biopsies (TBx) - are vulnerable to sampling error. Discordance between histologic and imaging findings may indicate, therefore, that the lesion may not have been sampled adequately, highlighting the importance of a systematic post-biopsy imaging-pathology concordance review.

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## Abstract Archives of the RSNA, 2023

W5B-SPHN-1

### Quantitative Gland Function Analysis in Dry Mouth Patient using T1, T2 and PD Mapping based on the Multi-dynamic Multi-echo Method

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Chena Lee, DDS, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Dry mouth is a subjective complaint of dryness of intraoral cavity and the primary etiology is the hypofunction of salivary gland. Clinical diagnosis is conducted by collecting patient's whole saliva and evaluate the volume and this is a time consuming cumbersome examination. Thus, the current study aimed to utilize T1, T2 and PD mapping as diagnostic tool for parotid gland dysfunction in dry mouth patients.

#### METHODS AND MATERIALS

Dry mouth (n = 32) and control subjects (n = 30) that underwent magnetic resonance imaging (MRI) from July 2020 to December 2022 were reviewed. The T1, T2, and PD mapping of the parotid gland were evaluated simultaneously based on the multi-dynamic multi-echo (MDME) MR imaging. The values from control and dry mouth group were compared using Mann-Whitney test and receiver operating characteristic (ROC) curve analyses.

#### RESULTS

The mean of T1, T2-relaxation time and PD value of the gland in dry mouth group were 606.90 ms, 91.63 ms, and 82.37 pu, respectively. The mean of T1, T2-relaxation time and PD value of control group were 628.08 ms, 80.69 ms and 91.12 pu. The T2- relaxation time and PD value showed significant difference between the dry mouth and control group while there no significant difference between two groups in T1-relaxation value. The area under the ROC curve (AUC) was 0.8164 and 0.7564 respectively for T2-relaxation time and PD value. The diagnostic performance between T2-relaxation time and PD value were not significantly different (p-value = 0.4851).

#### CONCLUSION

The T2-relaxation time and PD value can be used as quantitative indicators of dry mouth due to hypofunction of parotid gland and the performance of T2-relaxation time presented higher diagnostic ability. Further study with large population could be led to more accurate result.

#### CLINICAL RELEVANCE/APPLICATION

T2 and PD mapping, based on the MDME technique, presented diagnostic ability for detecting parotid gland hypo function and could be utilized as quantitative tool for dry mouth diagnosis in clinic.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPHN-2

### **From Suspected to Confirmed : Intrathecal Gadolinium-Enhanced MR Cisternography as a Key Diagnostic Modality in CSF Rhinorrhoea**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Priyanka Prajapati, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish the role and diagnostic accuracy of Intrathecal gadolinium enhanced MR Cisternography in clinically suspected cases of CSF rhinorrhoea

#### **METHODS AND MATERIALS**

As of now, a total of 19 consecutive patients with active or suspected CSF rhinorrhea have been included in this study. History of trauma was present in 8 patients (42%), endoscopic surgery in 5 patients (26%), spontaneous in 6 patients (32%). Most of the patients had CT PNS which showed evidence of skull base fractures, defects or erosions. We used mixture of non-ionic iodinated contrast (5 ml of iohexol; Omnipaque 300) with Gadolinium (0.4 ml of gadobutrol; Gadovist) along with normal saline (5 ml of 0.9 % normal saline) for injecting into the intrathecal space. MR sequences were taken approximately 30-40 minutes after the contrast injection. For all patients, hemodynamic studies (heart rate, blood pressure) and evaluation of neurologic status were performed.

#### **RESULTS**

We observed objective CSF leakage in 11 of 19 patients (58%). The CSF leak was located in the cribriform plate in 7 patients (37%), in the superior wall of the sphenoid sinus/planum sphenoidale in 4 patients (21%), fovea ethmoidalis/roof of ethmoid sinus in 2 patients (11%), through the post-operative sella turcica defect in 1 patient (5%), including multiple defects identified in 4 patients (21%). No objective CSF leakage in spite of bony defect was seen in 4 patients (21%). No bony defect and no objective CSF leakage were seen in 4 patients (21%). Surgical closure of CSF leak was performed in all patients with positive findings on cisternography and the site of leak was confirmed intraoperatively. Post-procedure 6 patients (32%) had mild headache. No other adverse event were noted.

#### **CONCLUSION**

MR cisternography after the intrathecal administration of gadolinium represents an effective and minimally invasive method for evaluating suspected CSF fistulas along the skull base. It provides multiplanar capabilities and high resolution without risk of radiation exposure and is an excellent approach to depict the anatomy of CSF spaces and CSF fistulas. Furthermore, use of combination of non-ionic iodinated contrast with gadolinium increase the distribution of contrast in subarachnoid space and improve the resolution when compared with just using gadolinium No significant gross neurologic abnormalities were observed during the initial examination or during follow-up.

#### **CLINICAL RELEVANCE/APPLICATION**

CSF rhinorrhoea is potentially very serious because of the risk of an ascending infection which could produce fulminant meningitis. Exact identification of the location of the CSF fistula is important for proper surgical planning, increases the chances of dural repair and can prevent complications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPHN-3

### Tracheal Cartilage Calcification and Glucose Metabolism in Aging Adults Assessed by <sup>18</sup>F-NaF and <sup>18</sup>F-FDG PET/CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

NilooFaralsadat Motamedi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to examine if <sup>18</sup>F-sodium fluoride (<sup>18</sup>F-NaF) and <sup>18</sup>F-fluorodeoxyglucose (FDG) PET/CT can be used to measure physiological calcification and glucose metabolism of the tracheal cartilage, respectively, and whether there was any association with aging.

#### METHODS AND MATERIALS

Out of 139 healthy control subjects from the CAMONA study (NCT01724749), a total of 128 subjects in whom tracheal cartilage could be segmented on <sup>18</sup>F-NaF-PET/CT (mean age  $48.58 \pm 14.44$  years, 51.56% males) were included in the analysis. Similarly, a total of 119 subjects (mean age  $48.46 \pm 14.34$  years, 54% males) in whom tracheal cartilage could be segmented on FDG-PET/CT were included in the analysis. The PET/CT acquisitions were performed 90 minutes after <sup>18</sup>F-NaF administration and 60 minutes after FDG administration. The mean standardized uptake value (SUV<sub>mean</sub>) of both tracers was measured by assigning regions of interest (ROIs) around the cartilage using OsiriX software (Pixmeo SARL, Bernex, Switzerland). To assess the relationship of tracheal calcification and glucose metabolism with aging, Pearson correlation analysis was performed between age and the <sup>18</sup>F-NaF and FDG, respectively.

#### RESULTS

A statistically insignificant positive correlation was present between age and <sup>18</sup>F-NaF SUV<sub>mean</sub> ( $r=0.094$ ,  $p=0.28$ ) (Figure 1). Similarly, there was a statistically insignificant negative correlation observed between age and FDG SUV<sub>mean</sub> ( $r=-0.125$ ,  $p=0.17$ ) (Figure 2).

#### CONCLUSION

<sup>18</sup>F-NaF- and FDG-PET/CT can be used to measure physiological calcification and glucose metabolism of the tracheal cartilage. Although the results were statistically insignificant, there was a trend of an increase in physiological calcification and a decrease in glucose metabolism of the tracheal cartilage with aging, as assessed by <sup>18</sup>F-NaF- and FDG-PET/CT, respectively. Prospective studies with larger sample sizes and longitudinal in subjects of varying ages are needed to continue investigation into changes in tracheal cartilage calcification and metabolism with aging.

#### CLINICAL RELEVANCE/APPLICATION

To assess calcification and glucose metabolism of tracheal cartilage with aging by <sup>18</sup>F-NaF and FDG PET/CT, age-related trends were observed, and further studies are needed to confirm clinical significance.

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## Abstract Archives of the RSNA, 2023

W5B-SPHN-4

### Relationship between Cochlear Implant Patients' Auditory Outcomes and Insertion Length and Angulation

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cochlear implants are transducers that transform the acoustic waves into electrical signals to stimulate the cochlear nerve in patients that suffer unilateral or bilateral, deep or severe, neurosensorial deafness that do not benefit from an auditory prostheses. The main objective of this study was to determine whether a deeper cochlear implant insertion within the cochlea, in terms of length and grade, results in improved auditory performance.

#### METHODS AND MATERIALS

After IRB approval a cohort of 46 patients with 50 cochlear implants were prospectively reviewed. A temporal bone HRCT was performed before and after cochlear implantation. Prior and post-implantation audiometric studies and functional clinical variables such as speaking on the phone, listening to music, or time in months needed till auditory rehabilitation was optimal were recorded and correlated to the electrode insertion depth in terms of length and insertion angle grades.

#### RESULTS

21 men and 25 women (29-78 y.o) with a 2 to 63 years story of neurosensorial deafness were analyzed. 4-12 electrodes were encountered within the cochlea in HRCT. A median of 88.7% of the cochlea was covered. The insertion angle ranged between 90° and 720° with  $\mu=536^\circ$  and  $s=146.40^\circ$ . Two years after implantation, there was a median of 11 (3-12) final functioning electrodes. 76% of patients achieved >70% bisyllabic discrimination at 60 dB, 60% used phones after implantation, 26% listened to music, Less than a year was the median time to finish hearing rehabilitation for 38%, followed by 12 to 24 months for 34% and 24 months for 28%. There was a correlation between the angle of insertion and the length of the inserted implant with a correlation coefficient of 0.846 ( $p<0.01$ ). A statistical correlation between the number of electrodes, length and insertion angle within the cochlea, and audiometric values, speaking at the phone, or the number of months of rehabilitation after the procedure was found ( $p<0,01$ ) although the ability to listen to music after cochlear implantation showed no statistic correlation with radiographic variables.

#### CONCLUSION

Better auditory outcomes are obtained in terms of audiometric values and functional recovery the deeper the cochlear implants are inserted into the cochlea.

#### CLINICAL RELEVANCE/APPLICATION

The cochlear coverage of the implant should be checked using a post-operative HRCT in patients with insufficient auditory results. Since these patients' functional outcomes are suboptimal it will be necessary to intensify and optimize the implant programming strategies in those with fewer than 8 functional electrodes inside the cochlea in post-surgical HRCT, or even to consider early replacement.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5B-SPHN-6

### A New XAI Framework with Feature Explainability for Tumors Decision-making in Ultrasound Data

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Fajin Dong JR, MD,MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The value of implementing artificial intelligence (AI) on ultrasound screening for thyroid cancer has been acknowledged, with numerous early studies confirming AI might help physicians acquire more accurate diagnoses. However, the black box nature of AI decision-making process makes it difficult for users to grasp the foundation of AI's prediction. Furthermore, explainability is not only related to AI performance but also responsibility and risk in medical diagnosis. In this paper, we offer Explainer, an intrinsically explainable framework that can categorize images and create heatmaps highlighting the regions where its prediction is based on.

#### METHODS AND MATERIALS

This study included 19341 2D ultrasound images (9171 horizontal views and 10170 vertical views) of 7714 thyroid nodules obtained from 7236 individuals from October 2019 to May 2021, with pathological results and physician annotated TI-RADS features are used to train and test the robustness of the proposed framework. Then we conducted a benign-malignant classification study to whether physicians perform better under the assistance of Explainer than diagnose alone or with Gradient-weighted Class Activation Mapping (Grad-CAM).

#### RESULTS

Reader studies show that the Explainer can achieve more accurate diagnosis while providing explaining heatmaps and that physicians' performances are improved when assisted by the Explainer. Case study confirms that the Explainer can locate more reasonable and feature-related regions than the Grad-CAM.

#### CONCLUSION

The Explainer offers physicians a tool to understand the basis of AI predictions and to evaluate its reliability, which has the potential to unbox the black box of medical imaging AI.

#### CLINICAL RELEVANCE/APPLICATION

In the case study comparing heatmaps generated by Explainer and Grad-CAM, Explainer is capable of locating more reasonable and feature-related regions. Evidence proves that in ultrasound images explaining tasks, our method is more detailly.

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## Abstract Archives of the RSNA, 2023

W5B-SPHN-7

### Diagnosis of Malignancy in Surgery after Radiofrequency Ablation of Benign Thyroid Nodule

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jung Hee Shin, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Nodule regrowth after radiofrequency ablation (RFA) of symptomatic large benign thyroid nodules is sometimes diagnosed as malignancies during surgery. This study aimed to assess the ultrasound (US) characteristics of thyroid nodules later diagnosed as cancer, predictive factors for cancer after RFA, and preventive methods for these cancers to avoid RFA procedure.

#### METHODS AND MATERIALS

We reviewed the medical records of 134 consecutive patients with 148 nodules who underwent RFA between 2008 and 2016 for the debulking of symptomatic benign thyroid nodules. We investigated the pre-RFA characteristics of the thyroid nodules, changes at follow-up after RFA, and final surgical pathology.

#### RESULTS

Nodule regrowth after RFA for benign nodules was observed in 36 (24.3%) of the 148 nodules. Malignancies were confirmed in seven (19.4%) of the 36 regrown nodules. Of the 22 nodules removed surgically, pre-RFA mean maximal diameter was significantly higher for malignant nodules than for benign nodules ( $3.89 \pm 0.98$  vs  $5.23 \pm 1.52$  cm,  $P = .01$ ). There was no difference in the regrowth interval between benign and malignant nodules ( $P = .19$ ). Volume reduction rate at 12 months was lower for malignant nodules than for benign nodules ( $51.16 \pm 13.81\%$  vs  $73.68 \pm 20.15\%$ ,  $P = .02$ ). Pre-RFA benignity of all seven malignant nodules was confirmed using two ultrasound (US)-guided fine-needle aspirations (FNAs), except for one nodule confirmed using US-guided core needle biopsy (CNB). The regrown malignant nodules were diagnosed as suspicious for follicular neoplasms using CNB. Histological examination of the malignant nodules during surgery after RFA revealed follicular thyroid carcinomas, except for one follicular variant of papillary thyroid carcinoma.

#### CONCLUSION

Symptomatic large thyroid nodules confirmed to be benign prior to RFA should be considered false-negative FNA results. In RFA patients, CNB prevents delay in cancer diagnosis.

#### CLINICAL RELEVANCE/APPLICATION

Considering false-negative fine-needle aspiration results in symptomatic large benign thyroid nodules before radiofrequency ablation, core needle biopsies should be included in the revised RFA guidelines to prevent delayed cancer diagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPIN-2

### Deep Learning Based Synthetic Contrast Enhanced T1 Map for Contrast Agent-free Myocardial Extracellular Volume (ECV) Mapping in Cardiac MRI

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Sebastian Nowak, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the utility of generative adversarial networks (GAN) to generate artificial contrast enhanced (CE) T1 maps for creation of synthetic extracellular volume (ECV) maps of the myocardium.

#### METHODS AND MATERIALS

This study includes 1086 cardiac MRI exams with native and CE T1 maps in 3 short axis slices of 986 patients undergoing MRI for various clinical indications between January 2019 and August 2021. Manual myocardium segmentations of 522 slices were used to develop a U-Net for image cropping prior to rigid registration. All registered native and CE T1 map pairs were inspected and excluded if rigid registration failed due to dissimilar contraction phase, resulting in 2074 curated T1 map pairs from 827 patients (age:  $48 \pm 19$  years, 344 female). Of those, 191 native and CE T1 map pairs from 78 patients were defined as hold-out test set with hematocrit available within 48h prior to imaging, allowing for creation of reference 'real' ECV maps. With the remaining cases a U-Net generator was trained with L1 loss and 5-fold cross validation in combination with a PatchGAN discriminator to generate synthetic CE T1 maps from native T1 maps. Note that for ECV calculation, the correct enhancement ratio of blood to myocardium is crucial rather than prediction of exact CE T1 values. Two ECV maps were created for the test set: one using the real and one using the synthetic CE T1 map. The difference between the synthetic and real mean ECV (?ECV) within the myocardium was calculated, and their correlation was quantified with the Pearson correlation coefficient (R). To investigate whether the GAN simply linearly transforms the input native T1 maps, the correlation of the real mean ECV with the mean of the native T1 maps was also compared with the correlation between synthetic and real ECV. Bootstrapping with 1000 resamples were used for calculating 95% confidence intervals.

#### RESULTS

The synthetic mean ECV values in the myocardium showed a high correlation to the real ECV (R: 0.81 [0.74-0.86]), which was significantly higher compared to the correlation of the native T1 and real ECV values (R: 0.61 [0.51-0.69]). A mean ?ECV of  $2.30 \pm 2.04$  % was observed in the hold-out test set.

#### CONCLUSION

Generation of synthetic CE T1 maps from native T1 maps by GANs shows promising results for contrast agent-free estimation of myocardial ECV. The results motivate multicenter studies including more patients with appropriate MRI examination and hematocrit to also investigate direct generation of synthetic ECV without hematocrit and contrast agent use.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning based generation of synthetic CE T1 maps from native T1 maps for synthetic ECV calculation might facilitate faster cardiac MRI examinations without the use of gadolinium-based contrast agents.

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## Abstract Archives of the RSNA, 2023

W5B-SPIN-4

### Development and Validation of a CAD System with Reduced False Positives for Bone Metastasis on Chest CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Yena C. Kang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a computer-aided diagnosis (CAD) system using a deep learning (DL) with improved specificity for detecting bone metastasis on chest CT for accurate and efficient workflow in lung cancer screening.

#### METHODS AND MATERIALS

In this retrospective study, a CAD system was developed using DL algorithm trained on 3,809 chest CT scans (age  $57.7 \pm 71$ ; women 3,533) obtained from the patients who had various cancer origins (breast: 131, colorectal: 24, lung: 11 and others 34), including 825 with confirmed bone metastasis. The diagnostic performance was evaluated using both internal and external test set of 200 (age  $55.7 \pm 58$ ; women 157; 40 confirmed bone metastasis) and 50 (age  $66.1 \pm 46$ ; women 15; all confirmed bone metastasis) chest CT scans, respectively. The bone metastasis was annotated slice-by-slice indicating whether the lesion exists or not, and the confirmed bone metastasis cases included up to 63 lesions in a single scan. A DL algorithm based on DenseNet-161 was trained with axial slices from CT scans. Each slice was individually assessed whether it contains bone metastasis or not. The axial slices were converted into window level of 800 and window width of 1,500, for better visualization of the bone area. Diagnostic performance was evaluated in a patient-based manner using the maximum prediction value of all slices as the representative prediction value for the patient. For internal test, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated and for external test, only sensitivity was evaluated as positive cases were considered only. Additionally, the performance of subgroups by primary cancer was evaluated.

#### RESULTS

The DL based CAD system achieved specificity, sensitivity, PPV, and NPV of 92%, 70%, 92%, and 68% for the internal test, and sensitivity of 86% for the external test in patient-based manner. For the internal test, the specificity of subgroups by primary cancer was 90%, 100%, 88% and 93%, and the sensitivity was 63%, 100%, 100%, and 71% for breast, colorectal, lung and other origins.

#### CONCLUSION

We successfully developed and validated a CAD system with high specificity thus reducing false positive cases for bone metastasis evaluation on chest CT.

#### CLINICAL RELEVANCE/APPLICATION

The proposed system can be applied to lung cancer screening, providing a valuable tool for efficient workflow. Further studies are warranted to assess the performance in different clinical settings and malignancies.

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## Abstract Archives of the RSNA, 2023

W5B-SPIN-5

### Integrating Clinical Data with AI to Optimize Decision-making in Prostate MRI

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Nadia S. Moreira Da Silva (*Presenter*) Employee, Lucida Medical

#### PURPOSE

To determine whether combining prostate MRI AI-based decision support outputs, clinical data and PI-RADS scores in a multi-modal predictive model enhances detection of clinically significant prostate cancer.

#### METHODS AND MATERIALS

MRI, clinical history, histopathology, and PI-RADS scores were obtained retrospectively from five sites in a multi-vendor, multiple field strength study. After exclusions for AI contraindications including prior treatment and quality issues, model training used data from 352 patients and a held-out test set comprised data from 235 patients (Gleason grade group (GGG)=2, prevalence 34%). Our automated multi-stage AI-based software segments and calculates the volume of prostate whole gland and transition zone (TZ) on MRI, and segments and scores lesions/patients for GGG=2 disease likelihood. Biopsy-verified GGG=2 was used as ground truth, with MRI-negative patients not undergoing biopsy assumed negative. Sensitivity, specificity, and AUC were evaluated at patient level on the held-out test set, with 95% confidence intervals obtained through bootstrapping. Combinations of AI, clinical and PI-RADS data were tested for significant improvement to the AI score and PI-RADS assessment, at pre-determined thresholds equivalent to PI-RADS 3.

#### RESULTS

mpMRI PI-RADS scores alone detected GGG=2 with sensitivity 1.00 (95% CI 1.00-1.00), specificity 0.67 (0.61-0.75) and AUC 0.94 (0.91-0.97). GGG=2 was detected by bpMRI AI with sensitivity 0.97 (0.93-1.00), specificity 0.55 (0.47-0.62) and AUC 0.88 (0.84-0.92). Combining AI score and TZ-PSA density (PSAD) improved specificity (sensitivity 0.95 (0.90-0.99), specificity 0.70 (0.63-0.77) and AUC 0.90 (0.85-0.93)). The addition of AI and TZ-PSAD to PI-RADS scores maintained high sensitivity of 0.99 (0.96-1.00), while significantly improving specificity to 0.83 (0.77-0.89, KS p-value<0.001) and AUC to 0.96 (0.93-0.98, DeLong p-value 0.003). TZ volume based PSAD had modest additional benefit compared to whole-prostate PSAD. Other variables offered <5% specificity improvements or non-significant benefits. Findings with bpMRI and mpMRI AI models were similar. Limitations: Most MRI-negative cases did not receive biopsy in this retrospective study.

#### CONCLUSION

The use of PSAD improves the predictive accuracy of prostate MRI AI decision support, with significant improvement in specificity at similar sensitivity. Combining PI-RADS, PSAD and AI offers substantial improvement compared to AI or PI-RADS assessments alone.

#### CLINICAL RELEVANCE/APPLICATION

The improved specificity achieved through integrating patient PSAD and radiologists' PI-RADS scores with AI software can potentially reduce false positive cases, further aiding patient selection for biopsy using MRI.

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## Abstract Archives of the RSNA, 2023

W5B-SPIN-6

### Deep Learning to Predict Fat and Appendicular Skeletal Masses from Chest Radiograph

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Ki Duk Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To predict fat and appendicular skeletal muscle (ASM) masses from chest radiograph (CXR), which can be highly beneficial for analyzing the health impacts of body composition.

#### METHODS AND MATERIALS

A total of 40,369 CXRs with body composition, including fat and ASM, from a tertiary hospital's health screening center was used. Fat and ASM were acquired using bioelectrical impedance analysis (BIA). The Inception v3 architecture was used to predict body composition, and assessment to determine the impact of demographics, such as age, sex, height, and weight, on the model's performance was conducted. Deep label distribution learning with additional Mean-Variance (MV) loss was used to train the network. Two independent unseen test datasets comprising 1,000 individuals each, which follows normal distribution and uniform distribution of age, from same center were used. The mean average error (MAE) and Pearson's correlation coefficient (r) between BIA and model prediction were evaluated. Correlation analyses and Bland-Altman plots were also presented.

#### RESULTS

The age of test dataset was  $56.732 \pm 10.519$  and  $54.421 \pm 19.160$  (range from 20 to 90), respectively for test set of normal distribution and test set of uniform distribution. And the ASM was  $25.839 \pm 5.814$  and  $25.709 \pm 6.152$ , respectively. Sex was sampled evenly for both datasets. In the test set of normal distribution, MAEs of the models without information and without MV loss, without information and with MV loss, with information and without MV loss, and both with information and MV loss for predicting fat were 1.773, 1.673, 1.564, and 1.564, respectively. All model significantly correlated with BIA with decent r scores of 0.805, 0.839, 0.855, and 0.861, respectively ( $P < 0.001$  in all model). In the uniform distribution set, MAEs were 1.945, 1.844, 1.773, and 1.726 respectively, while r scores were 0.805, 0.849, 0.853, and 0.860, respectively ( $P < 0.001$  in all model). In the normal distribution set, MAEs of each model for ASM were 1.309, 1.181, 1.307, and 1.172 respectively. All model showed decent r scores of 0.927, 0.932, 0.981, and 0.940 ( $P < 0.001$  in all model) with the same order. In the uniform test dataset, MAEs were 1.424, 1.250, 1.376, and 1.278, respectively, while r scores were 0.920, 0.932, 0.930, and 0.932, respectively ( $P < 0.001$  in all model).

#### CONCLUSION

deep learning model of CXR can precisely predict fat and muscle masses. Demographics and MV loss can significantly enhance the predicting power of the model

#### CLINICAL RELEVANCE/APPLICATION

Prediction of fat and ASM from CXR can be applied to a variety of clinical fields, such as sarcopenia assessment, prognosis prediction of cancer patients, precision medicine for optimum drug dose estimation in inpatient settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPIR-1

### Long-Term Survival after Percutaneous CT and US guided Microwave Ablation of Pathologically Proven Renal Cell Carcinoma

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the long-term overall (OS), cancer-specific (CSS), and local tumor progression (LTP)-free survival of patients who underwent percutaneous microwave ablation (MWA) of pathologically proven renal cell carcinoma (RCC).

#### METHODS AND MATERIALS

This IRB-approved, HIPAA compliant study included patients who underwent percutaneous MWA between 2013 and 2017 of biopsy-proven RCCs. All patient demographics, tumor characteristics, procedural technical outcomes, and pre- and post-procedural estimated glomerular filtration rate (eGFR) were evaluated. OS, CSS, and LTP-free survival were calculated and Kaplan-Meier analysis was performed. Complications were classified per the Clavien-Dindo system.  $\chi^2$  test was used for proportions for categorical outcomes excluding repeated measures for patients and a paired t-test for differences in eGFR.

#### RESULTS

The study cohort comprised 86 biopsy-proven RCCs from 81 patients (mean age:  $67.6 \pm 16.9$ ) and were 62% male. The median follow-up period was 76.8 months (1 to 123 months). The mean tumor size was 2.8cm (0.7cm to 7.0cm) and RCC lesions were more commonly located on the right side (60.5%), anterior (41.9%), lower pole (44.2%), and endophytic (69.8%). Primary and secondary technical success was achieved in 88.4% (76/86) in a single session and 90% (9/10) in two sessions with overall technical success of 100%. The 5-year and 10-year OS, CSS, and LTP-free survival rates were 82.7%, 90.8%, and 84.3% and 75.7%, 84.7%, and 82.9%, respectively. RCC = 4cm ( $p=0.016$ ) was predictive of LTP. There were no significant changes in pre-ablation and 2-3 years post-ablation eGFR (58.5 vs 58.4 mL/min/1.73m<sup>2</sup>,  $p=0.932$ ). There was a 2% overall incidence of complications, all grade I.

#### CONCLUSION

Percutaneous CT and US guided MWA of biopsy-proven RCC was safe and effective with excellent long-term OS, CSS, and LTP-free outcomes within 10 years from initial treatment.

#### CLINICAL RELEVANCE/APPLICATION

Image-guided ablative therapies are a safe and effective treatment option for renal cell carcinoma with durable long-term survival rates.

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## Abstract Archives of the RSNA, 2023

W5B-SPIR-2

### Long-Term Survival after CT and US Guided Radiofrequency Ablations of T1a and T4 Pathologically Proven Renal Cell Carcinomas

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the long-term overall, renal cell carcinoma (RCC)-specific, and progression-free survival of patients who underwent percutaneous radiofrequency ablation (RFA) of pathologically proven RCC.

#### METHODS AND MATERIALS

This IRB-approved, HIPAA compliant study included patients who underwent percutaneous RFA between 2004 and 2015 of their biopsy-proven RCCs. All patient demographics, tumor characteristics, procedural technical outcomes, and pre- and post-procedural estimated glomerular filtration rate (eGFR) were collected. Overall survival (OS), and local tumor progression (LTP)-free survival were calculated by Kaplan-Meier survival curves. In addition, a subcohort analysis of the RCC T1a and T4 was conducted to examine the RCC-specific survival (RSS) rate with Kaplan Meier survival analysis. Complications were classified per the Clavien-Dindo system.  $\chi^2$  test was used for proportions for categorical outcomes and paired t test was used for changes in eGFR.

#### RESULTS

The study cohort comprised 129 biopsy-proven RCCs from 101 patients (mean age:  $68.5 \pm 12.4$ ). Primary technical success was achieved in 91.5% (118/129) of ablations and secondary technical success was achieved in 90.9% (10/11) of ablations with remaining one lesion requiring three ablations. The median of the follow-up period was 136 months (1 to 230 months) with mean tumor size of 2.3cm (0.5cm to 8.0cm). RCC lesions were more commonly located on the right (52.7%), in the midpole (37.2%), and were endophytic (54.3%). The study cohort comprised the following RCC subtypes: clear cell (69%), epithelial neoplasm (16%), papillary (11%), and chromophobe (5%). There was a slight decrease in preprocedure eGFR relative to 2-3 years postprocedure eGFR (59.2 vs 55.4 mL/min/1.73m<sup>2</sup>;  $p=0.003$ ). There were 6 complications mostly grade I-III. The 15-year OS and LTP-free survival rates were 63.6% and 92.2% in 101 patients and 129 lesions. The T1a and T4 subcohorts comprised 65 patients and 32 patients with a 15-year RSS rate of 96.5% and 82.7%.

#### CONCLUSION

Image-guided percutaneous RFA of RCCs was safe with durable 15-year OS rate of 63.6%, LTP-free survival rate of 92.2%, and RSS rate of 96.5% and 82.7% in the T1a and T4 subcohorts.

#### CLINICAL RELEVANCE/APPLICATION

Percutaneous CT and US guided radiofrequency ablation was safe with excellent 15-year durable responses in both T1a and T4 subcohorts.

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## Abstract Archives of the RSNA, 2023

W5B-SPIR-3

### **No-touch Radiofrequency Ablation versus Tumor Puncture Microwave Ablation for Small Hepatocellular Carcinoma: Comparison of Treatment Outcomes**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jae Hyun Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study was to compare the therapeutic outcomes between no-touch (NT) radiofrequency ablation (RFA) and tumor puncture microwave ablation (MWA) for single hepatocellular carcinomas  $\leq 4$  cm.

#### **METHODS AND MATERIALS**

A total of 335 patients who underwent NT RFA (n=155) or tumor puncture MWA (n=180) for single HCCs  $\leq 4$  cm were included in this retrospective study. A matched cohort comprising 121 patients from each group was selected after propensity score matching analysis to adjust for potential biases. This study assessed the therapeutic outcomes after ablation including technical success, local tumor progression (LTP), and major complications. Cumulative LTP rates were estimated using the Kaplan-Meier method.

#### **RESULTS**

A total of 242 patients (mean age, 66.2 years  $\pm$  9.5 [standard deviation]; 183 men) were evaluated. The technical success rates were 99.2% [120/121] vs. 100% [121/121] in the NT RFA and MWA groups, respectively ( $P>0.05$ ). The estimated 1- and 2-year cumulative LTP rates in the NT RFA were 2.2% and 3.1%, respectively, and were not significantly different from the 3.0% and 6.0% observed in the MWA group ( $P=0.279$ ). There was no significant difference in the major complication rate between the NT RFA and MWA groups (1.7% [2/121] vs. 0.8% [1/121],  $P=1.000$ ).

#### **CONCLUSION**

Tumor puncture MWA showed comparable therapeutic outcomes including LTP and major complication rates to those of NT RFA in single HCCs ( $\leq 4$  cm).

#### **CLINICAL RELEVANCE/APPLICATION**

NT RFA and tumor puncture MWA are potentially effective and safe treatment options for small HCCs ( $\leq 4$  cm).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPIR-4

### Perfusion CT for Early Prediction of Treatment Response of Cryoablation in Renal Cell Carcinoma

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Oyunbold Lamid-Ochir (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate quantitative analysis of perfusion CT (pCT) for assessment of early treatment response after cryoablation in renal tumors.

#### METHODS AND MATERIALS

A total 54 patients with renal tumors who had treated by CT-guided percutaneous cryoablation in our institution from June 2014 to August 2016. Twenty-seven patients were selected, who underwent pCT before and after within 1 week, 1, 3, 6 months and 1-year treatment. Perfusion parameters including arterial flow perfusion (AFP) as tumor maximum, minimum, average and average changes and tumor diameter, freezing time, treatment cycles and progression-free-survival were analyzed and compared. The effects of treatment response were evaluated by RECIST standards version 1.1 as a non-responder and responder.

#### RESULTS

Twenty-seven patients (22 men, 5 women: age,  $68 \pm 12$  y.o.) evaluated as quantitative analysis with pCT. Five of 27 patients were non-responders, and 22 patients were responder. The mean AFP values were significantly different between non-responder ( $46.6 \pm 25.8$ ) and responder ( $25.1 \pm 6.1$ ) at 1 month after cryoablation ( $p < 0.05$ ). ROC analysis demonstrated that tumor average (AFP) at 1 month had the cut-off of perfusion value (29.95) and area under curve (0.94), with sensitivity and specificity of 100% and 84.2%, respectively ( $p < 0.05$ ). Percent of progression free-survival was 100% (cut-off  $< 29.95$ ) and 66.7% (cut-off  $> 29.95$ ) for 32 months observation.

#### CONCLUSION

pCT was able to evaluate and predict therapeutic effects of cryoablation at 1 month after treatment. It can offer both morphologic and functional evaluation, providing a quantitative assessment of residual tumor vascularization after treatment.

#### CLINICAL RELEVANCE/APPLICATION

pCT can be predicted to responder and non-responder at 1 month after cryoablation and might be earlier than dynamic CE-CT. Also, it can detect minimal focal perfusion changes whether the tumor is shrinking or without tumor volume changes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPIR-5

### **SAR-COOL: Sarcoma Cryoablation Outcomes and Optimization of Life**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Koustav Pal, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the local tumor progression-free survival following cryoablation of recurrent or metastatic soft tissue sarcoma (STS) lesions.

#### **METHODS AND MATERIALS**

A single-institution retrospective analysis of patients with a histopathological diagnosis of metastatic STS who underwent percutaneous cryoablation (PC) from January 2022 to April 2023 was performed. . Patients with less than 60 days of follow-up and those treated for more than four lesions during one procedure were excluded. Complications were categorized based on the Common Terminology Criteria for Adverse Events (CTCAE) classification system. R software version 4.2.3 was used for analysis. (We aim to further analyze the outcomes of 239 patients with 391 procedures from Jan. 2016 to April 2023)

#### **RESULTS**

61 patients who underwent PC for 84 STS lesions met the eligibility criteria. There were 21 different histological subtypes of sarcoma in the study, with the two most common being leiomyosarcoma (20/61) and liposarcoma (16/61). The median size of sarcoma lesions was 2.1 cm (range 0.4 to 13.4). Complete response at six months was achieved in 81% of the treated lesions. Local tumor progression-free survival was 86.1% at 6 months and 77.3% at 1 year. The overall survival was 97.2% at 1 year. Chemotherapy free time for patients was 54.57% at 6 months. The complication rate was 14%, with 56.55% classified as CTCAE grade 3 or higher. Subgroup analysis for leiomyosarcoma vs. liposarcoma demonstrated an overall survival of 100% vs. 90.9% at 12 months, respectively. Local tumor-free progression was 86.7% at 6 months and 86.7% at 12 months for liposarcoma. Leiomyosarcoma demonstrated 91.97% local tumor-free progression at 6 months and 46.4% at 12 months. There was no statistically significant difference between the two groups ( $p=0.37$ ).

#### **CONCLUSION**

PC of STS and its metastases is a safe and effective treatment modality.

#### **CLINICAL RELEVANCE/APPLICATION**

Surgical resection is a cornerstone in the management of recurrent or oligometastatic soft tissue sarcoma. Percutaneous cryoablation is a minimally invasive technique that may complement surgical approaches. This study demonstrates that cryoablation can achieve high local control rates with durable responses in this patient population.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPMK-2

### The Next Frontier in Lumbar Spine MR Bone Imaging: Harnessing the Power of Super-Resolution Deep Learning Reconstruction

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Masamichi Hokamura (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to assess the effectiveness of super-resolution deep-learning-based reconstruction (SR-DLR), which leverages k-space properties, on the image quality of lumbar spine magnetic resonance (MR) bone imaging using a 3D multi-echo in-phase sequence.

#### METHODS AND MATERIALS

In this retrospective study, 29 patients who underwent lumbar spine MRI, including an MR bone imaging sequence, between January and April 2023, were analyzed. Images were reconstructed with and without SR-DLR (Matrix sizes: 960 x 960 and 320 x 320, respectively). The signal-to-noise ratio (SNR) of the vertebral body and spinal canal, along with the contrast and contrast-to-noise ratio (CNR) between the vertebral body and spinal canal, were quantitatively evaluated. Furthermore, the slope at half-peak points of the profile curve drawn across the posterior border of the vertebral body was calculated. Two radiologists independently assessed image noise, contrast, artifacts, sharpness, and overall image quality of both image types using a 4-point scale. Interobserver agreement was evaluated using weighted kappa coefficients, and quantitative and qualitative scores were compared via the Wilcoxon signed-rank test.

#### RESULTS

In this retrospective study, 29 patients who underwent lumbar spine MRI, including an MR bone imaging sequence, between January and April 2023, were analyzed. Images were reconstructed with and without SR-DLR (Matrix sizes: 960 x 960 and 320 x 320, respectively). The signal-to-noise ratio (SNR) of the vertebral body and spinal canal, along with the contrast and contrast-to-noise ratio (CNR) between the vertebral body and spinal canal, were quantitatively evaluated. Furthermore, the slope at half-peak points of the profile curve drawn across the posterior border of the vertebral body was calculated. Two radiologists independently assessed image noise, contrast, artifacts, sharpness, and overall image quality of both image types using a 4-point scale. Interobserver agreement was evaluated using weighted kappa coefficients, and quantitative and qualitative scores were compared via the Wilcoxon signed-rank test.

#### CONCLUSION

SR-DLR, which is based on k-space properties, has the potential to enhance the image quality of lumbar spine MR bone imaging utilizing a 3D gradient echo in-phase sequence.

#### CLINICAL RELEVANCE/APPLICATION

The application of SR-DLR can lead to improvements in lumbar spine MR bone imaging quality.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPMK-3

### Application of Material Decomposition Technique based on Dual-energy CT in the Differential Diagnosis of Acute and Old Thoracolumbar Fracture

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Mingyue Wang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify acute and old thoracolumbar vertebral compression fractures by using material decomposition technique based on dual-energy CT (DECT).

#### METHODS AND MATERIALS

A total of 12 patients with acute trauma or diagnosed compression fracture who underwent thoracolumbar DECT and MR scanning in Shenzhen Qianhai Shekou Free Trade Zone Hospital from June 2022 to February 2023 were retrospectively collected. 24 cases about vertebral compression fracture was found in DECT and MRI (fat suppressed T2WI). The time about patients took DECT and MRI examination from the first day they get injured to 2 weeks after they got fractured. A total of 16 vertebral bodies' data were collected, including 8 patients with old fractures. All patients had a fracture injury time of more than six months. Water (Iodine), Water (Calcium) and Water (HAP)-based on material decomposition images were reconstructed. The signals of edema area is calculated from water density values and water difference values in three material decomposition images in both area of acute fractured vertebrae and old fractured vertebrae. With reference to bone marrow edema area of fracture based on MRI. A paired T test was used to compare the difference in water density between acute vertebral fracture edema and old compression fractures. A two-factor ANOVA was used to compare the difference in water density values between edematous fractured vertebrae and old compression fractured vertebrae among three material images sets.

#### RESULTS

The water density values for Water (Iodine), Water (Calcium) and Water (HAP) images were significant higher in the acute fracture edema vertebral bodies compared to old compression fracture vertebral bodies (1147.6mg/cm<sup>3</sup> Vs 1040.9mg/cm<sup>3</sup>, 1089.4mg/cm<sup>3</sup> Vs 1014.4mg/cm<sup>3</sup> and 996.7mg/cm<sup>3</sup> Vs 972.2mg/cm<sup>3</sup>, respectively, all  $P < 0.001$ ). There was a significant statistical difference in the water difference values between the acute fractured vertebrae and the old compression fractured vertebrae ( $P < 0.001$ ), and with the largest water difference values in the Water (Iodine) image.

#### CONCLUSION

The water density values for Water (Iodine), Water (Calcium) and Water (HAP)-based material decomposition images can distinguish acute thoracolumbar fractures from old compression fractures on dual-energy CT examination. Water (Iodine) images showed the best discrimination.

#### CLINICAL RELEVANCE/APPLICATION

The measurement of water density values for material decomposition images based on dual-energy CT, can improve the clarity of diagnosis of acute thoracolumbar fractures and old compression fractures, and also avoid confusion caused by contraindications to MRI examination. This is a valuable aid for both patients and clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPMK-4

### Application of Dual-energy CT Single Energy Reconstruction Technique in Acute Fractures of Thoracolumbar Spine with Bone Marrow Edema

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Mingyue Wang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify bone marrow edema in acute thoracolumbar fractures by using single-energy reconstruction technique based on dual-energy CT (DECT).

#### METHODS AND MATERIALS

A total of 18 patients with acute trauma or diagnosed compression fracture who had thoracolumbar DECT and MR scanning in Shenzhen Qianhai Shekou Free Trade Zone Hospital from June 2022 to February 2023 were retrospectively collected. 20 cases about vertebral compression fracture was found in DECT and MRI (fat suppressed T2WI). The time about patients took DECT and MRI examination from the first day they get injured to 2 weeks after they got fractured. 40KeV images, 70KeV images, 100KeV images, 140KeV images-based on single energy reconstruction technique were reconstructed. On the median sagittal plane of the Water (Ca) pseudo-color image, the fracture bone marrow edema area was identified. According to the edema areas shown by MRI, manually delineated the region of interest. CT values of the edema area of the fractured vertebra and the normal vertebra were recorded at different Single energy. All edema areas of compression fractures were use MRI fat suppressed T2WI sequences as reference. A paired T test was used to compare the difference in CT values between the fractured edema vertebra and the normal vertebra under different single energies. A two-factor ANOVA was used to compare the difference in CT values between oedematous fractured vertebrae and normal vertebrae at four keV sets.

#### RESULTS

The CT values of vertebrae with acute fracture edema vertebral bodies compared with normal vertebral bodies measured at 40KeV, 70 KeV, 100 KeV and 140KeV were (691.5Hu Vs 252.9Hu, 319.1Hu Vs 106.1Hu, 222.4Hu Vs 67.9Hu and 183.1Hu Vs 52.5Hu, respectively, all  $P < 0.001$ ). There was a significant statistical difference in the difference in CT values between the acutely fractured vertebrae and the normal vertebrae ( $P < 0.001$ ), and with the greatest difference in CT values in the 40KeV image.

#### CONCLUSION

The single energy values of 40KeV, 70 KeV, 100 KeV and 140KeV images can differentiate bone marrow edema from normal vertebral body on acute thoracolumbar fracture dual-energy CT scan. The greatest difference in CT value is at 40KeV. Combined with Water (Ca) material density film, it can provide a more accurate diagnosis of acute thoracolumbar fracture edema.

#### CLINICAL RELEVANCE/APPLICATION

The measurement of single-energy reconstruction on dual-energy CT, combined with Water (Ca) material density picture, can improve the clarity of diagnosis of thoracolumbar fractures and bone marrow edema, and also avoid confusion caused by contraindications to MRI examination. This is a valuable aid for both patients and clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPMK-5

### Assessing the Combined Efficacy of Radiofrequency Ablation and Kyphoplasty with Radiation Treatment for Painful Spine Metastases

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Chloe Issa, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare kyphoplasty ablation with and without radiotherapy for the treatment of patients with painful metastatic neoplastic disease to the spine.

#### METHODS AND MATERIALS

Between 3/2019 and 08/2022, 59 kyphoplasty procedure were performed for palliation of metastatic spine disease. 21 patients (36.2%) with metastatic tumor received radiation in addition to kyphoplasty/RF ablation to palliate pain: 9 patients (47.4%) had prior radiation, 2 patients (10.5%) had concurrent, and 10 patients (1.4%) had radiation therapy after. 37 painful metastatic spinal tumors were treated with kyphoplasty ablation without radiation. The primary neoplastic disease was as follows: multiple myeloma (n=17, 28.8%), breast (n=15, 25.4%), lung (n=7, 11.9%), prostate (n= 6, 10.2%), lymphoma and colorectal (each n= 3, 5.1%), urothelial (n= 2, 3.4%), thyroid, pancreas adenocarcinoma, renal cell, and metastatic adenoid cystic (each n=1, 3.3%). Pain relief was evaluated by the visual analogue scale (VAS) score, disability by the Oswestry Disability Index (ODI), performance status by the Karnofsky Performance Status Scale (KPS) score and ECOG score before and within 3-months after the procedure. The highest documented VAS, ODI, KPSS, and ECOG scores pre- and post-procedure was recorded. A P value < 0.05 was considered statistically significant.

#### RESULTS

Technical success was achieved in all patients. Table 1 compares demographics, pre procedural and post procedural pain, disability, and functional scores between the two groups. The median change in VAS, ODI, KPSS, and ECOG scores from baseline to three months was not significantly different between the two groups. There were no major complications.

#### CONCLUSION

The study suggests adding radiation therapy to kyphoplasty/RFA for palliation of metastatic neoplastic disease to the spine may not significantly change pain, disability, or performance status scores. Further studies with a larger number of subjects and longer follow-up and prospective design are needed to validate these findings.

#### CLINICAL RELEVANCE/APPLICATION

MSK Interventional Radiology - Palliative Spine Intervention

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPMK-6

### Symmetry Plane Analysis for Determination of Vertebral Rotation

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Dillon Haughton, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate vertebral rotation measurements are crucial in the understanding and treating of spinal pathologies. Many methods exist to aid in determining this metric, with the most common and widely accepted method utilizing axial CT scans being the Aaro-Dahlborn method. This method is simple and accurate but is limited due to errors when used by inexperienced users. It only considers one axial cut through the vertebra limiting its accuracy when the vertebra is rotated in sagittal and coronal planes. We propose a new method using symmetry planes calculated by iterative closest point registration and pairwise assignment of curves, as an alternative to the Aaro-Dahlborn method in determining vertebral rotation. Our method considers the entire vertebra and is an automated method applied post segmentation, which would limit operator error.

#### METHODS AND MATERIALS

Our method was coded in python utilizing a Jupyter notebook compatible with 3DSlicer. It was tested on segmented vertebrae from the VERSE2020 opensource dataset. 812 vertebrae with no gross pathology were selected from the VERSE2020 database and processed utilizing our method for feasibility analysis. Out of those 812, 96 vertebrae from 8 randomly selected CT scans were divided up among two medical students who performed measurements utilizing the Aaro-Dahlborn method. Correlation-coefficients and Bland-Altman plots were calculated to determine the alignment between the two methods.

#### RESULTS

Out of 812 vertebrae analyzed, 799 had their vertebral rotation successfully calculated using our algorithm (98% success rate). Correlation coefficient was calculated at 87% amongst the 96 vertebrae whose vertebral rotation was determined manually against our method. Bland-Altman plotting showed mean difference of -0.51 degrees, a +2 standard deviation of 2.2 degrees and -2 standard deviation of -3.2 degrees.

#### CONCLUSION

Our method had similar accuracy to the Aaro-Dahlborn manual method. Our method was also demonstrated to work with a wide variety of normal vertebrae. This provides a quick and efficient means of determining vertebral rotation and can act as an objective reference due to no post-segmentation user input. As segmentation algorithms for individual vertebrae become more accessible and the process is simple manually, we don't see this as a limiting factor to the utility of our method. An extension of our method can also be applied to determining the rotation of vertebrae in both sagittal and coronal planes, which could greatly contribute to our understanding of vertebral movements.

#### CLINICAL RELEVANCE/APPLICATION

Improvement in speed and accuracy of methods of determining vertebral rotation will further our understanding of vertebral movements in pathologies such as back pain and scoliosis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5B-SPMK-7

### How Effective is Radiofrequency Ablation with Kyphoplasty at Decreasing Narcotic and Analgesic Requirements in Painful Spine Metastases

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Chloe Issa, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine the effect of radiofrequency ablation (RF) in conjunction with kyphoplasty on pain relief and analgesic requirements in patients with painful metastatic disease to the spine.

#### METHODS AND MATERIALS

Between 3/2019 and 8/2022, 59 kyphoplasty/RF ablations were performed. The median age was 63 years old (IQR, 55-69) with a male-to-female ratio of 0.97. The primary neoplastic diseases were as follows: multiple myeloma (n=17, 28.8%), breast (n=15, 25.4%), lung (n=7, 11.9%), prostate (n= 6, 10.2%), lymphoma and colorectal (each n= 3, 5.1%), urothelial (n= 2, 3.4%), thyroid, pancreas adenocarcinoma, renal cell, and metastatic adenoid cystic carcinoma (each n=1, 3.3%). Pain relief was evaluated by the highest visual analogue scale (VAS) score before and within 3-months after the procedure. The number of non-opioid and opioid pain medications that were taken before, at 1-mo, and 3-mo after the procedure was recorded. A two tailed p value < 0.05 was considered statistically significant.

#### RESULTS

Technical success was achieved in all patients. The median VAS score decreased from 10 (IQR, 8-10) to 2(IQR, 0-4) after the procedure (p< 0.001) and 2 (IQR, 2-3) at 3 months after procedure (p < 0.001). Table 1 demonstrates the number (and percentages) of patients who were taking non-opioid and opioid analgesics before the Kyphoplasty/ablation, and at 1-mo and 3-mo after the procedure. Overall, use of opioid medications decreased at 1-mo and 3-mo after the procedure.

#### CONCLUSION

RFA in conjunction with kyphoplasty appears to provide meaningful clinical improvement in VAS pain scores and decrease requirements for narcotic medications in patients with metastatic disease to the spine.

#### CLINICAL RELEVANCE/APPLICATION

MSK Interventional Radiology - Palliative Spine Intervention

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPMK-8

### How Effective is Radiofrequency Ablation with Kyphoplasty at Improving Pain Scores in Burdensome Spinal Metastases

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Chloe Issa, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the improvement in pain, performance status and disability index, and the safety of radiofrequency ablation (RFA) in conjunction with kyphoplasty for the treatment of painful metastatic neoplastic disease to the spine.

#### **METHODS AND MATERIALS**

Between 3/2019 and 8/2022, 59 kyphoplasty RFAs were performed. The median age was 63 (IQR, 55-69) with a M:F ratio of 0.97. There were 11 different primary cancers; multiple myeloma was the most prevalent (n=17, 28.8%). Pain relief was evaluated by the Visual Analog Scale (VAS); performance status by the ECOG and Karnofsky Performance Status Scale (KPS), Disability by the Oswestry Disability Index (ODI). The highest VAS, ECOG, KPS and ODI score pre- and within 3 months post-procedure were recorded. A two-tailed p value < 0.05 was considered statistically significant.

#### **RESULTS**

Technical success was achieved in all patients. Within 3 months from the procedure, the median VAS score decreased from 10 (IQR, 8-10) to 2 (IQR, 2-3,  $p < 0.001$ ). The median ECOG performance status score improved from 3 (IQR, 2-3) to 1 (IQR, 1-2) ( $p < 0.001$ ). The median KPS increased from 50 (IQR, 40-60) to 75 (IQR, 62.5-90) ( $p < 0.001$ ). The median ODI decreased from 66.5 (IQR, 49.8-80) to 20.5 (IQR, 13-26) ( $p < 0.001$ ). There were no major complications.

#### **CONCLUSION**

RFA in conjunction with kyphoplasty is safe and provides meaningful clinical improvement in VAS, ECOG, KPS, and ODI scores in patients with pain due to metastatic disease to the spine, when measured at post procedure follow-up within 3 months of the procedure.

#### **CLINICAL RELEVANCE/APPLICATION**

MSK Interventional Radiology - Palliative Spine Intervention

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPMS-1

### Value of MRI in the Staging of Klippel-Trenaunay Syndrome Complicated with Lower Extremity Lymphedema

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Xingpeng Li (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of MRI in the staging of Klippel-Trenaunay syndrome (KTS) complicated with lower extremity lymphedema.

#### METHODS AND MATERIALS

Thirty-four patients who were diagnosed as KTS complicated with lower extremity lymphedema were recruited in this retrospective study from July of 2011 to November of 2021. Referring to the clinical staging standard of lower extremity lymphedema of the international society of lymphology in 2020, all patients were divided into two groups including stable stage and advanced stage. The MRI indexes of the two groups were recorded and were statistically compared: longitudinal involvement range of lymphedema, thickened parts of skin and subcutaneous soft tissue, signs of subcutaneous soft tissue edema (parallel line sign, grid sign, band sign, honeycomb sign, lymph lake sign, crescent sign and star cloud sign).

#### RESULTS

Compared with stable stage, patients in advanced stage demonstrated older onset age ( $P < 0.05$ ). For imaging features, the proportion of honeycomb sign are higher in advanced stage than stable stage ( $P < 0.05$ ). While no statistical difference was found in the incidence of parallel line sign, grid sign, band sign, lymph lake sign, crescent sign, star cloud sign, skin and subcutaneous soft tissue thickening, range of lymphedema in lower limbs (all  $P > 0.05$ ). The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of honeycomb sign in the diagnosis of advanced lower extremity lymphedema were 55.00%, 92.86%, 91.67%, 59.09% and 70.59%, respectively.

#### CONCLUSION

MRI is of great value in KTS complicated with lower extremity lymphedema. Honeycomb sign is an important imaging index for the diagnosis of advanced KTS complicated with lower extremity lymphedema.

#### CLINICAL RELEVANCE/APPLICATION

It is necessary to evaluate the severity of edema with MR for KTS complicated with lower extremity lymphedema, which is very important for therapeutic options.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPNMMI-1

### Correlation of FLT PET Findings with Histopathology in the Assessment of Response to Neoadjuvant Chemoradiotherapy in Pancreatic Cancer: Comparison with FDG PET

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Yuka Yamamoto, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Although the role of FDG PET has been proposed in pancreatic cancer, a high percentage of patients have diabetes due to pancreatic cancer. Therefore, the rate of false negative results is high due to elevated plasma glucose levels. On the other hand, 3'-deoxy-3'-18F-fluorothymidine (FLT) is being studied to assess tumor proliferating activity. We evaluated the ability of FLT PET to predict the response to neoadjuvant chemoradiotherapy in pancreatic cancer, in comparison with FDG.

#### METHODS AND MATERIALS

FDG and FLT PET/CT studies were performed before and after neoadjuvant chemoradiotherapy in 19 patients with pancreatic cancer. The values of maximum standardized uptake value (SUV<sub>max</sub>) at the primary tumor obtained before and after neoadjuvant chemoradiotherapy are SUV<sub>before</sub> and SUV<sub>after</sub>, respectively. Percent change was calculated according to the following equation:  $(SUV_{before} - SUV_{after}) \times 100 / SUV_{before}$ . In the FDG PET analysis, patients with a blood glucose level of 200 mg/dL or higher at the time of the FDG PET/CT scan were excluded from the analysis. Based on histopathological analysis of the specimens obtained at surgery, the patients were classified as pathologic responders or pathologic non-responders.

#### RESULTS

Nine patients were found to be pathologic responders and 10 pathologic non-responders. Three patients were excluded from before therapy FDG PET analysis due to their high blood glucose levels. The FDG SUV<sub>after</sub> in pathologic responders was significantly lower than that in pathologic non-responders ( $p=0.03$ ). The FLT percent change in pathologic responders was significantly higher than that in pathologic non-responders ( $p=0.028$ ).

#### CONCLUSION

Based on the results of this preliminary study in a small patient sample, FLT PET seems to be as useful as FDG PET for predicting response to neoadjuvant chemoradiotherapy in pancreatic cancer. FLT PET does not require fasting prior to imaging and is not dependent on blood glucose levels, making it a potentially more convenient technique of evaluation in pancreatic cancer.

#### CLINICAL RELEVANCE/APPLICATION

FLT PET does not require fasting prior to imaging and is not dependent on blood glucose levels, making it a potentially more convenient technique of evaluation in pancreatic cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPNMMI-2

### Textural Indices Extracted from FMISO and FLT PET/CT for Predicting IDH1 Mutation in Newly Diagnosed High-grade Gliomas

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Yuka Yamamoto, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Tumor hypoxia and proliferation have been recognized as determinant factors characterizing tumor aggressiveness in high-grade gliomas. To clarify in vivo hypoxia and proliferation in relation to isocitrate dehydrogenase (IDH) mutation, we retrospectively analyzed texture indices extracted from 18F-fluoromisonidazole (FMISO) PET/CT and 3'-deoxy-3'-18F-fluorothymidine (FLT) PET/CT in newly diagnosed high-grade gliomas.

#### METHODS AND MATERIALS

Thirty-three patients with newly diagnosed high-grade (WHO grade III and IV) gliomas were included in this study. They underwent both PET/CT studies with FMISO and FLT before surgery. The maximal standardized uptake value (SUVmax) and 31 texture indices were measured. Texture indices were extracted from four different matrices computed for each volume of interest: gray-level co-occurrence matrix, gray-level run length matrix, neighborhood gray-level difference matrix, and gray-level zone length matrix. The PET parameters in relation to IDH1 mutation status were statistically analyzed.

#### RESULTS

The value of FMISO SUVmax and FLT SUVmax of IDH1-mutant tumors was significantly lower than the corresponding value of IDH1-wildtype tumors. Fifteen of 31 texture indices (Homogeneity, Energy, Contrast, Dissimilarity, Short-run emphasis, Long-run emphasis, Low grey-level run emphasis, High grey-level run emphasis, Short-run low grey-level emphasis, Short-run high grey-level emphasis, Long-run low grey-level emphasis, Run percentage, Low grey-level zone emphasis, High grey-level zone emphasis, and Short-zone high grey-level emphasis) extracted from both FMISO and FLT PET/CT significantly differed between IDH1-mutant tumors and IDH1-wildtype tumors. In addition, 5 texture indices (Entropy, Short-zone low grey-level emphasis, Long-zone low grey-level emphasis, Zone length non-uniformity, and Zone percentage) extracted from FLT PET/CT significantly differed between IDH1-mutant tumors and IDH1-wildtype tumors. In receiver operating characteristic analysis, Entropy extracted from FLT PET/CT was the best discriminative index for predicting IDH1 mutation status.

#### CONCLUSION

These preliminary results indicate that texture indices extracted from FMISO and FLT PET/CT, especially Entropy extracted from FLT PET/CT, seem to be useful for predicting IDH1 mutation status in patients with newly diagnosed high-grade gliomas.

#### CLINICAL RELEVANCE/APPLICATION

Texture indices extracted from FMISO and FLT PET/CT, especially Entropy extracted from FLT PET/CT, seem to be useful for predicting IDH1 mutation status in patients with newly diagnosed high-grade gliomas.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPNPM-1

### Enhancing Patient Communication with Chat-GPT in Radiology: Evaluating the Efficacy and Readability of Answers to Common Imaging-related Questions

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Emile B. Gordon, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess ChatGPT's accuracy, relevance, and readability in answering common imaging-related questions and examine the effect of a simple prompt on these parameters.

#### METHODS AND MATERIALS

22 imaging-related questions were developed based on previously described categories important to patients: safety, report, procedure, preparation, meaning, and medical staff. Each question was asked three times on the ChatGPT-3.5 platform, both with and without a short prompt which instructed the model to "provide an accurate, and easy-to-understand response that is suited for an average person". Responses were evaluated by four board-certified radiologists for accuracy, consistency and relevance. Readability was assessed by Flesch Kincaid Grade Level (FKGL). Statistical comparisons were performed using chi-square tests, paired student's t-tests.

#### RESULTS

264 answers were assessed for both unprompted and prompted queries, resulting in a total of 528 evaluations. The model demonstrated a high degree of accuracy at 83% (218/264), with no significant difference for prompted responses at 87% (229/264,  $P=.2$ ). 72% (63/88) of answers were consistent across all three repeats, increasing to 86% (76/88) when prompted ( $P=0.02$ ). Essentially no responses were irrelevant, scoring at least partially relevant for 99% (261/264) of both sets of responses. Fewer responses were considered fully relevant at 67% (176/264), though this increased significantly to 80% when prompted (210/264) ( $P=.001$ ). The average FKGL was high at 13.6 [12.9-14.2] and did not significantly change with the prompt (13.0 [12.41-13.60],  $P=.2$ ). None of the responses reached the eighth grade readability level generally recommended for patient-facing materials.

#### CONCLUSION

ChatGPT demonstrates potential for accurate, consistent, and relevant imaging-related question responses. Readability levels exceed recommendations, reflecting currently available patient education materials. Prompts reduced response variability and yielded more targeted information but did not improve readability, possibly due to limitations in deviating from pre-trained knowledge without more detailed prompting.

#### CLINICAL RELEVANCE/APPLICATION

The study demonstrates ChatGPT's potential to increase accessibility to health information and to streamline production of patient-facing educational materials. Addressing readability limitations and employing prompt engineering strategies could optimize ChatGPT for imaging-related patient concerns, but cautious implementation and further research is needed.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPNPM-2

### Evaluation of Accuracy, Completeness, and Length of Rads-Lit Outputs: A Novel Patient-Facing Artificial Intelligence Literacy Tool

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Rushabh H. Doshi, MPH, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiology reports frequently incorporate intricate medical jargon and lengthy text, which can lead to misunderstandings, anxiety, and erroneous interpretation for patients. By leveraging novel natural language processing (NLP) open-source technology, we developed a patient-centric tool aimed at simplifying radiology reports. Here, we test the accuracy, completeness, and length of the outputs from our tool.

#### METHODS AND MATERIALS

We engineered a proof-of-concept patient-facing radiology literacy website by harnessing OpenAI's application programming interface. Our model was specifically configured to optimize the readability of outputs (Flesch-Kincaid Grade Level: 6.68, Gunning Fog: 9.22, Coleman-Liau: 6.16, Automated Readability Index: 8.56). Three radiologists examined 62 radiology reports across modalities such as CT, MRI, X-Ray, PET, and U/S. For each of the 62 reports, the radiologists reviewed the clinical impressions and the corresponding simplified output, and evaluated the output for accuracy, completeness, and extraneous information using single-item Likert-type scales.

#### RESULTS

Two attending radiologists and one radiology resident assessed 62 Rads-Lit outputs using a five-level Likert scale, ranging from 1 (Strongly Disagree, 0-20% agreement) to 5 (Strongly Agree, 80-100% agreement). The evaluations demonstrated that the Rads-Lit outputs were factually accurate, with a median rating of 5 (80-100% agreement), and the first and third quartiles at 4 (60-80% agreement) and 5 (80-100% agreement), respectively. The outputs were also found to be complete in relation to the original radiologist reports, with a median rating of 5 (80-100% agreement), and the first and third quartiles at 4 (60-80% agreement) and 5 (80-100% agreement), respectively. Furthermore, the radiologists strongly disagreed that the outputs were excessively long or filled with extraneous information, as indicated by median rating, first quartile, and third quartile at 1 (0-20% agreement).

#### CONCLUSION

Our tool demonstrates promising results, showing that the Rads-Lit outputs frequently maintained factual accuracy and completeness in relation to the original radiologist reports while avoiding being lengthy or containing extraneous information. These findings suggest that the Rads-Lit tool has the potential to improve patient literacy and activation by enhancing the readability of their radiology reports. Further research is necessary to corroborate these findings and assess the broader impact of Rads-Lit on patient populations.

#### CLINICAL RELEVANCE/APPLICATION

This study evaluates the potential of novel NLP technology to improve patient literacy and health outcomes by reducing anxiety and erroneous interpretations in radiology reports.

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## Abstract Archives of the RSNA, 2023

W5B-SPNPM-3

### Which Procedures Bring in the Most Medicare Reimbursement and RVUs for the Individual Diagnostic Radiologist

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate which specific imaging examinations result in the most wRVUs and reimbursement for individual radiologists serving the US Medicare population.

#### METHODS AND MATERIALS

Imaging claims 2013-2020 submitted by diagnostic radiologists were extracted from the CMS POSPUF database outpatient imaging claims made for beneficiaries of US Medicare Part B. These data were merged with year specific CMS professional relative value unit (wRVU) files. The total number of wRVUs as well as standardized Medicare reimbursement produced by each imaging procedure, was calculated for each radiologist. For each radiologist, the imaging examination that resulted in the largest number of wRVUs and reimbursement from 2013 to 2020 was determined. The frequency in which each CPT code produced the most wRVUs or reimbursement for an individual radiologist per year was tallied.

#### RESULTS

In 2013, 5992 individual radiologists (20.3% of all radiologists) produced the largest number of imaging exam specific wRVUs interpreting screening mammography (CPT G0202), followed by CT head without contrast (CPT 70450) for 5866 radiologists (19.8%), CT abdomen and pelvis with contrast (CPT 74177) for 4475 radiologists (15.1%), single view chest radiograph (CPT 71010) for 2542 radiologists (8.6%), and CT abdomen and pelvis with and without contrast (CPT 74176) for 1387 radiologists (4.7%). In 2020, 8095 individual radiologists (25.2% of all radiologists) produced the largest number of imaging exam specific wRVUs from CT abdomen and pelvis with contrast (CPT 74177), followed by screening mammography (CPT 77067) for 5932 radiologists (18.5%), CT head without contrast (CPT 70450) for 4691 radiologists (14.6%), single view chest radiograph (CPT 71045) for 2223 radiologists (6.9%), and MRI brain without and with contrast (CPT 70553) for 1318 radiologists (4.1%). For each year evaluated the order of the five CPT codes that most frequently produced the most Medicare reimbursement for individual radiologists was constant. Screening mammography (G0202/77067) was the most frequent highest reimbursed CPT code across diagnostic radiologists, followed by CT abdomen and pelvis with contrast (CPT 74177), CT head without contrast (CPT 70450), single view chest radiograph (CPT 71010), and MRI brain without and with contrast (CPT 70553).

#### CONCLUSION

Over time, the same imaging exams have consistently brought in the most reimbursement for the individual radiologist. This study documents the procedures that are likely to be a larger proportion of any radiology practice participating in Medicare.

#### CLINICAL RELEVANCE/APPLICATION

This data shows which exams are the most important for a practice to generate revenue to maintain quality services for patients.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-1

### A Preliminary 4D Flow MRI Analysis of Blood Flow Characteristics in Cerebral Veins of Adults

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Chihang Dai, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate blood flow characteristics in the cerebral veins of adults using 4-dimensional flow magnetic resonance (4D Flow MRI).

#### METHODS AND MATERIALS

A total of 65 volunteers prospectively underwent 4D Flow MRI and 12 volunteers underwent repeated scans during one month in a single center. Velocity, average blood flow rate (Flowavg), and blood flow patterns of cerebral sinuses were evaluated for each volunteer. The mastoid emissary veins, posterior condylar emissary veins, and oblique occipital sinuses were also evaluated.

#### RESULTS

The mean age of volunteers was  $36.31 \pm 11.05$  years old, including 3 (50.8%) females and 32 (49.2%) males. 4D Flow MRI data showed good reproducibility. The velocity and Flowavg of the superior sagittal sinus increased along the direction of flow. Flowavg near torcular herophili were 3.14 times that through the straight sinus. Slight fluctuations were found within a cardiac cycle. A vortex flow pattern was shown in 12.3% of torcular herophili, 7.5% of the transverse-sigmoid junction and 51.3% of jugular bulbs and was associated with increased blood flow velocity/rate in the upstream sinuses. Mastoid emissary veins, posterior condylar emissary veins and oblique occipital sinuses were all drained in the extracranial direction.

#### CONCLUSION

Cerebral veins, including venous sinuses and emissary veins, could be measured visually and quantitatively in vivo by 4D Flow MRI. Cerebral veins' velocity varied with segments and showed slight fluctuations within a cardiac cycle. The analysis of cerebral blood flow in healthy volunteers lays the foundation for the study of cerebral venous system diseases.

#### CLINICAL RELEVANCE/APPLICATION

4D Flow MRI is a reliable method for the evaluation of hemodynamic characteristics of intracranial venous sinuses. Intracranial venous blood flow, including venous sinuses and emissary veins, could be measured visually and quantitatively in vivo. Individual segments of venous sinuses show characteristic changes in velocity and slight fluctuations within a cardiac cycle were observed. The vortex flow pattern is not uncommon in normal individuals and may be related to increased blood flow in upstream sinuses. The mastoid emissary veins, posterior condylar emissary veins, and oblique occipital sinuses were all drained in the extracranial direction. The approaches used during the current study may enable further hemodynamic research into pulsatile tinnitus, idiopathic intracranial hypertension, vascular malformation and sinus thrombosis.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-10

### **A New Era in Time-of-Flight MR Angiography: Assessing the Impact of High-Resolution Deep Learning Reconstruction on Intracranial MRA Image Quality**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Masamichi Hokamura (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to assess the effect of super-resolution deep learning-based reconstruction (SR-DLR), which uses k-space properties, on image quality of intracranial time-of-flight (TOF) magnetic resonance angiography (MRA) at 3T.

#### **METHODS AND MATERIALS**

This retrospective study involved 35 patients who underwent MRA using a 3T MRI system with SR-DLR based on k-space properties in October and November 2022. We reconstructed MRA with SR-DLR (Matrix = 1008 x 1008) and without SR-DLR (Matrix = 336 x 336). We measured the SNR, contrast, and CNR in the basilar artery (BA) and the anterior cerebral artery (ACA) and the sharpness of the posterior cerebral artery (PCA) using the slope of the signal intensity profile curve at the half-peak points. Two radiologists evaluated image noise, artifacts, contrast, sharpness, and overall image quality of the two image types using a 4-point scale. We compared quantitative and qualitative scores between images with and without SR-DLR using the Wilcoxon signed-rank test.

#### **RESULTS**

The SNRs, contrasts, and CNRs were significantly higher in images with SR-DLR than those without SR-DLR ( $p < 0.001$ ). The slope was significantly greater in images with SR-DLR than those without SR-DLR ( $p < 0.001$ ). The qualitative scores in MRAs with SR-DLR were significantly higher than MRAs without SR-DLR ( $p < 0.001$ ).

#### **CONCLUSION**

SR-DLR with k-space properties can offer the benefits of increased spatial resolution without the associated drawbacks of longer scan times and reduced SNR and CNR in intracranial MRA.

#### **CLINICAL RELEVANCE/APPLICATION**

SR-DLR can enhance the image quality of intracranial MRA.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-11

### **Super-Resolution Deep Learning-Based Reconstruction in Hippocampal MRI: A Volunteer Study Emphasizing Comparison with Actual High-Resolution Images**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Takeshi Nakaura, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The objective of this study is to compare the impact of super-resolution deep learning-based reconstruction (SR-DLR) employing k-space properties and standard-resolution DLR on image quality for thin-slice T2-weighted hippocampal magnetic resonance imaging (MRI).

#### **METHODS AND MATERIALS**

Thirteen healthy volunteers participated in this study, undergoing standard-resolution (Matrix = 320 x 320) and high-resolution thin-slice T2-weighted hippocampal MRI (Matrix = 960 x 960) on a 3-T MRI system. Standard-resolution MRI was reconstructed with and without DLR (Matrix = 320 x 320) and with SR-DLR (Matrix = 960 x 960), while high-resolution MRI was reconstructed with and without DLR (Matrix = 960 x 960). Signal-to-noise ratio (SNR), and contrast and contrast-to-noise ratio (CNR) between white and grey matter in the hippocampus, as well as the slope of the transparent septum, were measured. Two radiologists were asked to rank the image noise, contrast, artifacts, sharpness, and overall image quality of all five protocols. Results of quantitative and qualitative analyses are presented as the median and interquartile range (IQR), and those between standard-resolution MRI without DLR and other protocols were compared using the Wilcoxon signed-rank test with Holm correction.

#### **RESULTS**

The SNRs and CNRs were significantly higher in standard-resolution images with SR-DLR (SNR: 21.01 (IQR:18.17, 29.5); CNR: 7.5 (IQR:6.4, 8.37)) than those without SR-DLR (SNR: 17.22 (IQR:14.46, 19.31); CNR: 7.5 (IQR:6.4, 8.37)) ( $p < 0.001$ ). The SNRs and CNRs were significantly lower in real high-resolution MRIs with DLR (SNR: 10.4 (IQR:9.91, 11.06); CNR: 4.84 (IQR:2.99, 5.43)) or without DLR (SNR: 10.4 (IQR:9.91, 11.06); CNR: 2.24 (IQR:1.43, 2.38)) than those in standard-resolution MRIs without DLR ( $p < 0.001$ ). There were no statistically significant differences in contrast in all protocols ( $p > 0.05$ ). The best ranks were assigned for the standard-resolution images with SR-DLR in all qualitative analyses, and these were significantly better than those of the standard-resolution images without DLR in the sharpness and overall image quality ( $p < 0.01$ ).

#### **CONCLUSION**

In this volunteer study, the technique of enhancing the resolution of standard-resolution hippocampal MRI using SR-DLR demonstrated the potential to provide higher image quality in a shorter acquisition time compared to real high-resolution hippocampal MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

SR-DLR in standard-resolution hippocampal MRI improves image quality, including sharpness and overall quality, compared to actual high-resolution images. This technique offers the potential for higher image quality in a shorter acquisition time, enhancing the clinical utility of hippocampal MRI.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-12

### AI-based Virtual Synthesis of Methionine PET from Contrast-Enhanced MRI: Development and External Validation Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Hiroataka Takita, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To generate synthetic methionine PET images from contrast-enhanced MRI (CE-MRI) through an artificial intelligence (AI)-based image-to-image translation model and to compare its performance for grading and prognosis of gliomas with that of real PET.

#### METHODS AND MATERIALS

An AI-based model to generate synthetic methionine PET images from CE-MRI was developed and validated from patients who underwent both methionine PET and CE-MRI at a university hospital from January 2007 through December 2018 (Institutional set). Pearson correlation coefficients of maximum and mean tumor-to-normal background uptake (T/N<sub>max</sub>, T/N<sub>mean</sub>, respectively) ratios and lesion volume between synthetic and real PET were calculated. Two additional open-source glioma databases of preoperative CE-MRI without methionine PET were the external test set. Using the T/N ratio, the area under the curve of the receiver operating characteristic curve (AUC-ROC) for classifying high- and low-grade gliomas and an overall survival (OS) analysis was evaluated.

#### RESULTS

The institutional set included 362 patients (mean age, 49±19 years; training=294, validation=34, test=34). In the institutional test set, Pearson correlation coefficients were 0.68 (95% CI: 0.47, 0.81), 0.76 (0.59, 0.86), and 0.92 (0.85, 0.95) for T/N<sub>max</sub> ratio, T/N<sub>mean</sub> ratio, and lesion volume, respectively. The external test set included 344 patients with glioma (mean age, 53±15 years; high-grade=269). The AUC-ROC by T/N<sub>max</sub> ratio was 0.81 (95% CI: 0.75, 0.86) and the OS analysis showed a statistically significant difference between high- (two-year survival rate=27%) and low-T/N<sub>max</sub> ratio groups (two-year survival rate=71%; P<.001).

#### CONCLUSION

The AI-based model-generated synthetic methionine PET images strongly correlated with real PET, and showed good performance for glioma grading and prognostication.

#### CLINICAL RELEVANCE/APPLICATION

Methionine PET is useful for the management of glioma. But radiation exposure and a lack of molecular imaging facilities limit its use. Since CE-MRIs are generally obtained for patients with suspected brain tumors in routine clinical situations, synthetic methionine PET images can be obtained from CE-MRIs without the aforementioned inconveniences or additional examination.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-13

### Twinkling T2 STAR: Robust Radiomics Features for Reliable Cerebral Microbleeds Classifier

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Hiroki Nakajima, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

Cerebral microbleeds (MBs) have gained attention due to the increased availability of high-field-strength MR systems, as a higher microbleed burden is associated with an increased risk of ischemic stroke and cerebral hemorrhage. We aimed to identify robust Radiomics features between scans in the T2 GRE sequence and evaluate their diagnostic performance using machine learning-based classifiers.

#### METHODS AND MATERIALS

We used two cohorts of subjects who underwent T2 GRE imaging in 3T MRI systems. We retrospectively reviewed 20 cases with twice T2 GRE sequences acquired in one examination from 2021 to 2022, and prospectively collected 75 subjects as hold-out test data in 2022. We defined 16x16px regions of interest (ROIs) based on a manual radiologist's annotation of MBs and randomly set up equal numbers of ROIs in other locations. We obtained 91 Radiomics features for these ROIs and measured intra-class coefficients (ICCs) to determine robust features between imaging sessions. Then, we selected seven features with ICCs greater than 0.95 to train and validate a support vector machine (SVM) classifier with the leave-one-out method. Furthermore, a radiologist randomly displayed 16x16px images for the hold-out test group and rated MBs-likeness on a 0-100 continuous variable. We evaluated the diagnostic performance using the area under the ROC curves (AUC) for univariate logistic analysis of each Radiomics feature, SVM classifier, and radiologist.

#### RESULTS

For ICC evaluation and modeling, we used 212 MBs (432 total ROIs) and 192 MBs (387 total ROIs) for the test group. Regarding the inter-imaging reproducibility, 9 (10%) features had ICCs less than 0.8, and 26 (29%) had ICCs less than 0.9. Seven of the 32 (35%) features with ICCs greater than 0.95 were used to train SVM. In the test group, SVM's diagnostic performance was 0.96 recall, 0.67 precision, and 0.73 accuracy, with an AUC of 0.88 (0.85-0.92). The AUC for SVM was significantly higher ( $P < .01$ ) than the AUC for each feature alone (0.48-0.85) and not significantly lower than the radiologist's AUC of 0.91 (0.89-0.95) ( $P = .15$ ).

#### CONCLUSION

We identified robust Radiomic features inter-imaging of the T2 GRE sequence and demonstrated that an SVM classifier with these features had a comparable AUC to the radiologist.

#### CLINICAL RELEVANCE/APPLICATION

Assessing reproducibility of Radiomics features between two T2 GRE imaging sessions, we identified robust features and developed an SVM classifier to improve cerebral MB detection, potentially reducing stroke and hemorrhage risk.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-14

### Quantitative Multiparametric MRI and Machine Learning based Model to differentiate Progression from Pseudo-progression in Glioblastoma: Towards Precision Neuro-Oncology

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Archith Rajan, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

We hypothesize that radiomic features derived from conventional MRI sequences, diffusion tensor imaging (DTI) and dynamic susceptibility contrast (DSC)-perfusion-weighted imaging (PWI) along with molecular signatures will facilitate accurate distinction of true progression (TP) from pseudoprogression<sup>1,2</sup> (PsP) in glioblastoma (GBM) patients with high accuracy.

#### METHODS AND MATERIALS

A cohort of 75 GBM patients exhibiting new/increasing enhancing lesions within 6 months after completion of standard-of-care therapy, were included in this study. These patients were classified as TP (n=55) or PsP (n=20) based on histological features or mRANO criteria<sup>3</sup>. Motion and eddy current corrected DTI derived maps [mean diffusivity (MD), fractional isotropy (FA), coefficient of linear (CL), planar (CP) and spherical anisotropy (CS)] and DSC-PWI derived cerebral blood volume (CBV) map, FLAIR images were co-registered to post-contrast (PC) T1-weighted images. A semiautomatic approach was used to segment contrast-enhancing regions. The median values of DTI metrics and CBV were computed. The CBV values were normalized with contralateral normal brain regions to obtain relative CBV (rCBV). The top 90th percentile rCBV values were also measured (rCBV<sub>90</sub>)<sup>4,5</sup>. O6-methylguanine-DNA-methyltransferase (MGMT) promoter status was noted from all of these patients. To address the issue of imbalanced sample size between TP and PsP, synthetic-minority-oversampling-technique (SMOTE) was applied to augment PsP cases from 20 to 35 resulting in a total sample size of 110. A random forest (RF) algorithm was applied to select the optimized features using a sequential forward feature selection (SFFS) approach. The data were randomly split into training (n=90) and testing (n=20) sets. A 6-fold cross-validation approach was also applied to training dataset. To develop a robust prediction model in distinguishing TP from PsP, several machine learning classifiers were employed. Receiver operating characteristic curve analyses were performed to determine the diagnostic accuracies.

#### RESULTS

The best nine diagnostic performances of multiple machine learning algorithms, and feature selection modules are presented in Table 1. RBF support vector machine (SVM) classifier was selected to build the predictive model in distinguishing TP from PsP with a training accuracy of 90.9%, cross-validation accuracy of 85.5% and testing accuracy of 85%.

#### CONCLUSION

Machine learning model using multi-parametric MRI and molecular signatures is a promising approach to differentiate TP from PsP in GBM patients.

#### CLINICAL RELEVANCE/APPLICATION

Multiparametric MRI combined with machine learning could successfully differentiate True Progression from Pseudoprogression in Glioblastomas.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-2

### Impact of Radiographic Signs of Advanced and Severe Cerebral Venous Thrombosis on the Efficacy of Endovascular Treatments

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Mihir Khunte (*Presenter*) Nothing to Disclose

#### PURPOSE

To study the benefit of endovascular treatment (EVT) with thrombolytics and/or thrombectomy as a treatment option for cerebral venous thrombosis (CVT) in comparison with conservative medical management.

#### METHODS AND MATERIALS

The National Inpatient Sample database 2016-2020 was queried to identify adult patients (18 years or older) with CVT. Patient demographics, medical comorbidities, CVT risk factors, and CVT manifestations were identified. The presence of radiographic signs of advanced and severe CVT (venous stroke, cerebral edema, and intracranial hemorrhage) were recorded. Primary and secondary outcomes were good discharge outcomes and in-hospital mortality, respectively.

#### RESULTS

17,130 CVT patients were identified; 945 (5.5%) received EVT. EVT patients were more likely to have strokes (35.4% vs. 21.8%,  $p < 0.001$ ), edema (35.4% vs. 20.1%,  $p < 0.001$ ), and hemorrhage (37.6% vs. 19.7%,  $p < 0.001$ ). After multivariable adjustments, EVT for patients without stroke, edema, or hemorrhage was moderately associated with higher odds of good outcomes (OR 1.86 [95%CI 0.98 - 3.53],  $p = 0.059$ ) and resulted in zero deaths. However, with increasing burden of radiographic signs of advanced CVT measured by the cumulative presence of stroke, edema, and hemorrhage, EVT was associated with decreasing odds of good outcomes and increasing odds of in-hospital mortality compared to medical management (interaction  $p = 0.046$  and  $0.029$ , respectively).

#### CONCLUSION

EVT may be beneficial for patients who have not yet developed overt parenchymal manifestations of backpressure changes, and the presence of stroke, edema, and hemorrhage may diminish the comparative effectiveness of EVT over medical management.

#### CLINICAL RELEVANCE/APPLICATION

EVT may be beneficial in subset of patients with CVT who lack radiographic signs of advanced and severe CVT such as venous stroke, cerebral edema, and intracranial hemorrhage.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-3

### Associations of Quantitative and Qualitative Intracranial Aneurysm Wall Enhancement Indices to Wall Instability and Risk Stratification Scores

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Abhinav Patel, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

The mortality and morbidity among patients with ruptured Intracranial Aneurysms (IAs) remain as high as 50% despite the low incidence of IAs (3-50/100000). The PHASES score was established to quantify IA rupture risk, whereas the ELAPSS score was established to quantify risk of growth in IA size. MR-Vessel Wall Imaging (VWI) has gained popularity in assessing a number neurovascular diseases including IAs. Aneurysm wall enhancement (AWE) is utilized as a marker of wall instability. We evaluate two distinct quantified measures of post-contrast T1-SPACE AWE in conjunction with the PHASES and ELAPSS scores as a sign of wall instability.

#### METHODS AND MATERIALS

We conducted an IRB approved study of patients with unruptured IAs scanned using VWI protocol between January 2018 to December 2022. AWE was evaluated qualitatively and quantitatively on T1-SPACE sequences. IA Wall Morphology (IAWM) was evaluated on catheter angiography. Quantified AWE values were obtained using 3-point ROIs on the IA wall and normalized with white matter signal intensity obtained using 10 mm circular ROIs. Percentage change in normalized AWE from pre to post contrast imaging was calculated. Furthermore, a ratio of post-contrast quantified AWE to post-contrast pituitary infundibulum (PI) signal intensity (AWPI ratio) was also calculated. Pearson correlation test, and unpaired t-tests were used to assess statistical correlations in SPSS v28. P-value was set at 0.05.

#### RESULTS

We evaluated 271 IAs in 219 patients (Age: 63.31 +/- 13.17, 24-89, 165 female). The mean size of IAs was 5.12mm +/- 3.91 mm, 2-30 and the mean PHASES score was 4.31 +- 2.73, 0-16. Qualitatively, AWE was seen in 141 (52%) IAs and irregular IAWM in 132 (48.7%). PHASES score showed a moderately strong correlation to AWPI ratio,  $r = 0.439$ , and to percentage increase in AWE,  $r = 0.334$ . ELAPSS score also showed a moderately strong correlation to AWPI ratio,  $r = 0.487$  and percentage increase in AWE,  $r = 0.367$ . AWPI ratio showed as stronger correlation than percentage increase to both PHASES and ELAPSS scores. The mean PHASES and ELAPSS scores for IAs with AWE were 5.36 and 18.48 whereas in IAs without AWE, these scores calculated to be 3.31 and 10.93, respectively, ( $p < 0.001$ )

#### CONCLUSION

Our findings demonstrates a correlation between increased AWPI, Percentage Increase and higher PHASES score, ELAPSS score .

#### CLINICAL RELEVANCE/APPLICATION

The results of this finding suggests a possible use of both qualitative and quantitative evaluation of AWE, particularly an increased AWPI ratio as a marker of wall instability. This could be utilized to evaluate the progression of wall instability and to guide therapeutic intervention.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-4

### Impact of White Matter Hyperintensities on Structural Connectivity and Cognition in Cognitively Intact Older Adults

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Mohammad Taghvaei, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

White matter hyperintensities (WMH) on T2-weighted fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) are nearly ubiquitous in aging. Prior studies suggest that both the volume and the spatial distribution of WMH lesions are predictive of cognitive performance decrements. WMH lesion burden has also been associated with both the severity and progression rate of Alzheimer's pathology. We used indirect brain mapping with virtual lesion tractography in older control subjects from the Alzheimer's Disease Neuroimaging Initiative (ADNI) study to test the hypothesis that the extent of specific white matter (WM) tract disconnection due to WMH is associated with corresponding cognitive performance decrements.

#### METHODS AND MATERIALS

Demographic information, structural MRI data, PET imaging, neuropsychological test scores, and CSF analysis from 481 cognitively intact ADNI subjects were obtained. WMH lesions mask were extracted from the FLAIR MRI of these subjects and applied as a region of avoidance for fiber tracking in 50 Human Connectome Project (HCP) subjects' diffusion MRI data to estimate tract disconnection caused by each WMH lesion mask for 8 WM pathways. The direct relationship of global WMH lesions burden or tract disconnections with performance in specific cognitive domains, as well as the mediation effect of specific tract disconnection on WMH lesion related cognitive performance decrement in the corresponding domain were assessed.

#### RESULTS

Global WMH lesion burden was significantly associated with global cognitive measures ( $p=0.011$ ), episodic memory ( $p=0.015$ ), executive function, and processing speed ( $p=0.018$ ). Further, estimated tract disconnection in the right inferior fronto-occipital fasciculus, right frontal aslant tract, right inferior longitudinal fasciculus, and right superior longitudinal fasciculus disconnection mediated the effect of WMH lesion volume on executive function, the left uncinate fasciculus disconnection mediated the effect of WMH lesion volume on memory, and the right frontal aslant tract disconnection mediated the effect of WMH lesion volume on language.

#### CONCLUSION

Tract-specific disconnections caused by WMH lesions mediate cognitive domain-specific decrements in cognitive performance in cognitively intact older adults.

#### CLINICAL RELEVANCE/APPLICATION

The spatial distribution of WMH lesions and the extent of particular WM tracts involvement by them could predict decrement in corresponding cognitive domains.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-6

### Hyperintensities in the Anterior Portion of the Callosal Splenium on FLAIR: A Large Cohort Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Sera Kasai (*Presenter*) Nothing to Disclose

#### PURPOSE

Although hyperintensity in the anterior portion of the callosal splenium on FLAIR (aCS-hyperintensity) is a common finding in elderly adults (Figure), no previous studies with large sample sizes have examined the clinical significance of the aCS-hyperintensity. In this large elderly population study, we aimed to investigate the associations of aCS-hyperintensity with cerebro- and cardiovascular risk factors and cognitive decline. In addition, to illustrate the probable mechanism thereof, we compared the clinical significances of the aCS-hyperintensity with those of the other MRI measurements.

#### METHODS AND MATERIALS

This cross-sectional study included 2,110 participants (median age, 69 years; 61.1% females) who underwent 3T MRI. The participants were grouped as 215 with mild cognitive impairment (MCI) and 1,895 cognitively normal older adults (NOAs). Two neuroradiologists evaluated aCS-hyperintensity by using a four-point scale (none, mild, moderate, and severe) (Figure). Periventricular hyperintensities (PVHs) were also rated on a four-point scale according to the Fazekas scale. The total intracranial volume (ICV), total brain volume, choroid plexus volume (CPV), and lateral ventricle volume (LVV) were calculated.

#### RESULTS

For the cerebro- and cardiovascular risk factors, the logistic regression analysis showed that diabetes was the main predictor of aCS-hyperintensity after adjusting for potential confounders (age, sex, hypertension, hyperlipidemia, BMI, smoking status, alcohol frequency, and medical history) ( $p < 0.01$ ). On the other hand, PVH was associated with a presence of hypertension ( $p < 0.01$ ). The aCS-hyperintensity rated as "severe" was associated with a presence of MCI. The logistic regression analysis for the imaging factors showed that PVH was significant independent predictor of aCS-hyperintensity ( $p < 0.01$ ). The LVV was also an independent predictor of aCS-hyperintensity when brain volume and PVH grade was added to the analyses ( $p < 0.01$ ).

#### CONCLUSION

Cerebral small vessel disease due to diabetes is a major contributor to the development of aCS-hyperintensity. Cerebrospinal fluid clearance failure may also relate to aCS-hyperintensity, which may offer new insights into the pathologic processes underlying MCI.

#### CLINICAL RELEVANCE/APPLICATION

Although aCS-hyperintensity is a common finding in elderly adults, its severity may associate with cerebral small vessel disease due to diabetes and MCI presence.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-7

### Radiological and Clinical Characteristics of N<sub>2</sub>O Related Myeloneuropathy: A Multicenter Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Paula Heredia Cacha, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this work is to report the clinical and imaging features of nitrous oxide (N<sub>2</sub>O) recreational abuse related myeloneuropathy.

#### METHODS AND MATERIALS

We conducted a retrospective multicenter study. The inclusion criteria were: (i) neurological symptoms, (ii) history of recreational N<sub>2</sub>O abuse, (iii) myeloneuropathy on MRI. The exclusion criteria were: (i) other causes of myelopathy (ii) absence of strong temporal association with N<sub>2</sub>O consumption. Demographic, clinical and laboratory data were collected. Imaging patterns, treatments and patients' outcomes were analyzed.

#### RESULTS

We included 40 patients (age: 24 ± 4 years; 18 ?) from 8 tertiary care centers. The study period was from December 2020 to April 2023. A chronic consumption (at least weekly for = 3 months) of N<sub>2</sub>O was present in 77% of the patients (26/34). All patients (40/40) presented with paresthesia, 36/36 with distal onset. Other main complaints were unsteady gait (38/40; 95%) and limb weakness (23/40; 58%). When measured, homocysteine level was elevated (32/33; 97%), while vitamin B12 level was mostly normal (20/34; 58%). Nerve conduction studies were often altered (23/32; 72%). Typical MRI features of subacute combined degeneration (SCD) of the spinal cord in cervical and upper thoracic cord were often seen (35/40; 86%, fig. 1A). Contrast enhancement of SCD was present in 5/35 of the patients (14%, fig. 1B). In 3 patients, a brain MRI was performed in first place for ataxia and 3D-FLAIR sequence suggested upper cervical abnormalities in its lowest slices (Fig. 1C). Atypical MRI findings (5/40) consisted of (i) cone involvement associated with exclusively lateral columns involvement (1/5, fig. 1D) and (ii) abnormally extensive lesion to lower thoracic cord (4/5; fig. 1F). 20% (7/35) of patients showed cauda equina roots enhancement (Fig. 1E). Patients were treated mainly with vitamin B12 supplementation (36/38; 95%). When follow-up information was present (12/40), recovery was slowly progressive, with persistent paresthesia (10/12; 80%).

#### CONCLUSION

N<sub>2</sub>O-induced myeloneuropathy, mostly due to functional vitamin B12 deficiency, typically appears on MRI as SCD involving the cervical and upper thoracic cord. However, atypical radiological findings exist, and cauda equina roots enhancement is possible, even though not described yet in literature. In addition, cerebral MRI can pinpoint the correct diagnosis when not suspected.

#### CLINICAL RELEVANCE/APPLICATION

N<sub>2</sub>O is a popular recreational drug among young adults. Social awareness on N<sub>2</sub>O side effects is poor and clinicians lack on information on vitamin B12 deficiency-related myeloneuropathy, a common N<sub>2</sub>O toxic effect.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPNR-8

### 3D SPACE MRI of the Transverse Ligament in Whiplash Associated Disorder

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Bo Mi Chung, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To describe the 3D SPACE MRI findings of transverse ligament (TL) in whiplash associated disorder (WAD), and to compare them with nontraumatic group.

#### **METHODS AND MATERIALS**

Cervical spine MRIs were retrospectively analyzed including 46 patients with WAD and 62 patients in the nontraumatic group. Axial 2D T2-SPACE images were used for image analysis. The symmetry of lateral atlantodental interval (LADI) and the morphology grade of TL was evaluated by two radiologists, using a four-point scale (0 = homogeneous low SI with normal thickness, 1 = high SI with normal thickness, 2 = reduced thickness, 3 = full-thickness rupture or indistinguishable from surrounding structures). The presence of atlantoaxial instability and the number of cervical levels with degeneration was evaluated.

#### **RESULTS**

Among the WAD patients, 17% showed asymmetric LADI and 39% showed high-grade TL morphology grade (grade 2 or 3). The high-grade TL change group had a significantly higher mean age than the low-grade group. There was no significant difference in WAD stage or grade between the high-grade and low-grade TL change groups. High-grade TL changes were significantly more frequent in the WAD group compared to the nontraumatic group, and the number of degenerative levels was lesser in the WAD group. Logistic regression analysis revealed that a lesser number of degenerative levels and high-grade TL changes were independent predictors for WAD.

#### **CONCLUSION**

High-grade TL changes were significantly more frequent in the WAD group compared to the nontraumatic group.

#### **CLINICAL RELEVANCE/APPLICATION**

The evaluation of TL using 3D SPACE MRI sequence can be useful in the evaluation and management of the WAD patients.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR-9

### **Predicting Outcome of the Epidural Blood Patch in Spontaneous Intracranial Hypotension by using an Artificial Intelligent Aided Quantitative MRI Approach**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jyhwen Chai, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Spontaneous intracranial hypotension (SIH) is a disorder of spinal CSF leakage with uncertain pathogenesis that presents challenges in reliable diagnosis and treatment. Though epidural blood patching (EBP) is commonly used, response rates are variable and predictors are lacking. In this study, we aimed to predict the outcome of EBP treatment in SIH patients using a quantitative MRI approach aided by artificial intelligence (AI).

#### **METHODS AND MATERIALS**

We recruited 30 SIH patients with typical orthostatic headache and characteristic MRI findings of spinal CSF leakages, and 26 healthy volunteers. In addition to brain MRI, we used retrospective ECG-gated cine phase-contrast (PC) sequences to measure fluctuating CSF flow, and a heavy 3D-T2WI of the whole spine to identify CSF leakage and quantify spinal CSF volume. We used YOLO algorithms of AI models for object detection and semantic segmentation of CSF space on spine images, and a pulsatility-based segmentation (PUBS) method combined to measure CSF flow dynamics in the cine PC-MRI.

#### **RESULTS**

Our results showed that SIH patients had significantly lower mean and peak CSF flux at the level of the 2nd cervical spine and a smaller volume of whole spinal CSF compared to healthy volunteers. The optimal cut-off values to distinguish the two groups were 1.00 ml/s and 3.53 ml/s for mean and peak flux, respectively, with the best AUC of 0.821 and 0.833 ( $p < 0.001$ ). The cut-off value of whole spinal CSF volume was 64.9 ml/s with the AUC of 0.694 ( $p < 0.05$ ). Using these two cut-off values of CSF flux, we divided 25 of 30 SIH patients accepting EBP into two groups based on high and low CSF flow dynamics one week after treatment. 25 of 30 SIH patients who underwent EBP were divided into high and low CSF flow dynamics groups. Of the 13 patients with high CSF flow dynamics and much improvement in orthostatic headache, 10 received one EBP and 3 received two. Nine of the 12 patients with low flow dynamics and persistent symptoms required more than two EBPs.

#### **CONCLUSION**

Our study suggests that CSF flow parameters in the upper cervical spine are more sensitive than spinal CSF volume measurement in detecting early pathophysiological alterations in SIH patients after EBP treatment. AI-aided quantitative MRI has the potential to effectively predict the treatment response of EBP in SIH patients.

#### **CLINICAL RELEVANCE/APPLICATION**

AI-aided quantitative MRI could be an effective tool for predicting the treatment response of epidural blood patching in patients with spontaneous intracranial hypotension (SIH).

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## Abstract Archives of the RSNA, 2023

W5B-SPOB-1

### The Application of Radiomics in Predicting Intraoperative Massive Bleeding in Cesarean Scar Pregnancy Patients

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Feng Gao (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a comprehensive model based on MRI radiomics signatures and independent risk factors for predicting the risk of intraoperative massive bleeding in cesarean scar pregnancy (CSP) patients.

#### METHODS AND MATERIALS

In total, 119 patients with CSP who underwent surgery were retrospectively reviewed. According to surgical records, intraoperative bleeding greater than 100ml was defined as intraoperative massive bleeding. All subjects were randomly separated into the training and testing sets at a ratio of 7:3. The radiomics signatures from the gestational sac (GS) and decidua (DEC) regions were respectively extracted in T2WI. Variance analysis, univariate correlation analysis (cutoff = 0.7), general univariate analysis and Gradient Boosting Decision Tree (GBDT) selection were performed orderly to select features. Seven image geometric features and eight clinical features were recorded and analyzed. Information with statistically significant differences was utilized in conjunction with the selected radiomics features to construct predictive models via the logistic regression model. Models were evaluated through ROC and AUC analysis. Decision curve analysis (DCA) evaluated the clinical usefulness of the constructed models, while Delong's test compared performance differences.

#### RESULTS

Thirty-seven patients suffered intraoperative massive bleeding and 82 patients did not. Five, eight, and nine radiomics features were selected from DEC, GS, and DEC+GS cohort, respectively. Seven features were statistically differently between GS and DEC (all  $p < 0.05$ ), and were included into the model as predictive features. AUCs of test datasets were 0.856, 0.843, and 0.846 for DEC, GS, and DEC+GS, respectively. Calibration curves with H-L test  $p$  values  $> 0.05$  showed good fitness for all three models. Delong's tests revealed no statistical differences among AUCs, indicating similar predictive abilities of the models. DCA showed that blood loss prediction models are beneficial when threshold probability ranges from 0.02 to 0.78.

#### CONCLUSION

A prediction model composed of T2WI-based radiomics features, image geometric features and clinical parameters could be applied to guide the gynecologists assess the risk of intraoperative bleeding in CSP patients before surgery.

#### CLINICAL RELEVANCE/APPLICATION

CSP refers to an ectopic pregnancy in which the GS is implanted into the scar of a previous cesarean section uterine incision. It may cause uncontrollable bleeding, uterine rupture, and even require hysterectomy during surgery. Our combined prediction model can preoperatively, accurately, and noninvasively identify high-risk individuals. For these high-risk individuals, preoperative intervention can be taken to avoid the massive bleeding.

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## Abstract Archives of the RSNA, 2023

W5B-SPOB-2

### Accelerated Three-dimensional Susceptibility Weighted Imaging of the Whole Spine of Fetus at 3T

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Ziyan Sun, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aims of this study were to evaluate the image quality, vertebral visibility and diagnostic performance in suspected fetal vertebral pathologies of three-dimensional (3D) susceptibility weighted imaging (SWI) of the whole spine column at 3T magnetic resonance imaging (MRI) and compared these with those of conventional protocol and ultrasonography (US).

#### METHODS AND MATERIALS

A total of 37 pregnant women (gestation age 22 to 39 weeks, average  $29 \pm 3$  weeks) with suspected fetal vertebral anomalies by ultrasound (US) screening underwent 3.0T MR imaging with 3D SWI, conventional two-dimensional (2D) half-fourier acquisition single-shot turbo spin-echo (HASTE) and 3D true fast imaging with steady-state precession (True FISP). The acquisition time of each protocol was recorded. Signal-to-noise ratios (SNRs) and contrast-to-noise ratios (CNRs) were determined in representative interest regions of fetal thoracic vertebrae and compared among three pulse sequences. Two radiologists rated image quality independently in random order on a 5-point scale. Kappa coefficients were computed to assess inter-observer reliability. Receiver operating characteristic curves were generated, and the area under the curve (AUC) was used to compare the diagnostic performance of each protocol in vertebral deformities.

#### RESULTS

The acquisition time was 15 s for 3D-SWI and 17 s for 3D True FISP, significantly shorter than conventional HASTE (37 s; both  $P < 0.01$ ). Of the three protocols, The SNR was highest on 3D True FISP, while the CNR was highest on 3D SWI. Visualization of all segments of the whole spine by 3D SWI was comparable with 3D True FISP. In contrast, 3D SWI and 3D True FISP depicted cervical and sacrococcygeal vertebrae better than HASTE. The weighted kappa statistic was 0.70-0.89 to evaluate the image quality of all segments of the whole spine, indicating good to excellent interobserver agreement. 3D SWI had the highest diagnostic performance for detecting fetal vertebral anomalies (AUC = 0.92).

#### CONCLUSION

3D-SWI is feasible for improved visualization of the whole fetal vertebral column and their congenital malformations with adequate image quality, thereby providing a supplementary method to conventional MR imaging.

#### CLINICAL RELEVANCE/APPLICATION

Our preliminary results suggest that 3D-SWI enables superior 3D visualization of 3D sequences take an advantage in display of the overall structure of the spine compared with conventional 2D sequences. A potential use of the 3D sequence is to define the degree of scoliosis or precise localization of deformed vertebrae. 3D sequences could be a useful addition to the routine examination of the fetal vertebrae, facilitating the incorporation of this technique into routine patient studies.

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## Abstract Archives of the RSNA, 2023

W5B-SPOB-3

### Doppler Ultrasound Gated Fetal Cardiac MRI in an Unselected Population: A Clinical Feasibility Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Roland Cronenberg, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Doppler ultrasound-based gating of fetal cardiac MRI has shown promising results in late pregnancy but has not been tested in younger fetuses <26 weeks of gestation in a clinical setting yet. The aim was to investigate the feasibility of ultrasound-gated fetal cardiac imaging in clinical routine during whole-body-MRI and the association of image quality with gestational age.

#### METHODS AND MATERIALS

We included 23 singleton pregnancies with clinical indication for fetal whole-body-MRI with and without suspected cardiac anomalies. Standard protocols for body and CNS MRI were performed, followed by gated cine-balanced steady state free precession sequences of the fetal heart in three planes (four-chamber-view (4C), short (2S) and long (2L) axis two-chamber-views). Image quality was rated "good" if there was depiction of both atria and ventricles in the four-chamber-view, and of the left atrium and ventricle in the long and short axis two-chamber view without artifacts. In case of displaced planes or artifacts but possible identification of cardiac anatomic structures, image quality was rated as "moderate". If no recognizability was given, images were rated "non diagnostic". Image quality was correlated with gestational week (GW) groups (GW <26, GW 26-31, GW >31).

#### RESULTS

We evaluated a total of 69 cardiac MRI sequences in 23 fetuses (70% with and 30% without suspected cardiac anomalies; GW <26: 30.4%, GW 26-31: 30.4%, GW >31: 39.1%; mean: 28+6 GW +/-30.4 days). Overall, image quality was "good" in 31 (45%) of the cardiac sequences and "moderate" in 21 (30%). Seventeen (25%) were "non diagnostic". Differences in image quality were significant between the cardiac planes ( $p=.013$ ) with best quality of the 2S and poorest quality of the 2L. Highest image quality was found in the youngest fetuses <26 GW ("good" in 57%, "moderate" in 19%, "non diagnostic" in 24%); followed by fetuses >31 GW ("good" in 48%, "moderate" in 41%, "non diagnostic" in 11%) and fetuses between 26 and 31 GW ("good" in 29%, "moderate" in 29%, "non diagnostic" in 43%). There was no significant difference between age groups ( $p=.158$  for 4C,  $p=.595$  for 2S,  $p=.178$  for 2L).

#### CONCLUSION

Doppler ultrasound gated fetal cardiac MRI with diagnostic quality in 75% of cardiac planes is feasible during clinical routine whole-body-MRI already in the second trimester of pregnancy. Image quality is not associated with gestational age.

#### CLINICAL RELEVANCE/APPLICATION

Fetal cardiac MRI in the second and third trimester of pregnancy could be included in a whole-body MRI protocol as a complementary imaging method to echocardiography in congenital heart disease when ultrasound conditions are limited.

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## Abstract Archives of the RSNA, 2023

W5B-SPOB-4

### Automatic Quantification of Fetal Brain Gyrfication Based on MRI in Control and in Fetuses with Polymicrogyria and Lissencephaly

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Dafna Ben Bashat, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Current imaging assessment of fetal brain gyrfication is performed qualitatively and subjectively using both ultrasound and MRI. A few previous studies suggested methods for quantification of fetal gyrfication based on 3D reconstruction of MRI, which requires unique data and is time-consuming. In this study, we aimed to develop an automatic pipeline for gyrfication assessment based on routinely acquired fetal MRI 2D data, quantify normal changes with gestation, and measure differences in fetuses with lissencephaly and polymicrogyria compared with controls (fetuses with normal gyrfication).

#### METHODS AND MATERIALS

Coronal T2 weighted MRI data of 162 fetuses retrospectively collected from two clinical sites were included: 134 control fetuses, 12 with lissencephaly, 13 with polymicrogyria, and three suspected with lissencephaly based on ultrasound, yet with normal MRI diagnosis. The developed automatic pipeline included brain detection, brain component segmentation and identification of the right and left hemisphere, and calculating five gyrfication parameters separately for each hemisphere based on the area and ratio between the contours of the cerebrum and its convex hull.

#### RESULTS

In control fetuses, all parameters were changed significantly along gestational age ( $p < 0.05$ ), providing developmental curves on a wide range of gestation (27-37 weeks). Compared with controls, fetuses with lissencephaly showed significant reductions in all gyrfication parameters ( $p = 0.02$ ). Similarly, but less pronounced, significant reductions were detected for fetuses with polymicrogyria in several parameters ( $p = 0.001$ ). The three suspected fetuses showed normal gyrfication, supporting MRI diagnosis.

#### CONCLUSION

This study presents a pipeline for automatically quantifying fetal brain gyrfication and provides normal developmental curves from a large cohort. These curves differentiated fetuses with lissencephaly and polymicrogyria significantly, demonstrating lower values. The method may aid radiological assessment and improve the early identification of fetuses with cortical malformation.

#### CLINICAL RELEVANCE/APPLICATION

The method suggested in this study provides a quantitative assessment of fetal brain gyrfication, and can aid radiological diagnosis and improve early identification of fetuses with cortical malformation.

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## Abstract Archives of the RSNA, 2023

W5B-SPPD-1

### Deep-learning Reconstruction for Reducing Slice Thickness and Radiation Dose in Pediatric CT: Matched Pair Comparisons with Standard Dose Thick Slice Iterative Reconstruction

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Ryota Harai (*Presenter*) Nothing to Disclose

#### PURPOSE

Low-dose and thin-slice image acquisition is desirable for pediatric CT, but increased image noise can compromise image quality and diagnostic confidence. Deep learning reconstruction (DLR) may be a promising technique to simultaneously reduce radiation dose and slice thickness due to its excellent noise reduction performance. This study aimed to compare the image quality between standard-dose, thick-slice (3 mm) hybrid iterative reconstruction (HIR) and low-dose, thin-slice (0.5 mm) deep-learning reconstruction DLR in pediatric CT.

#### METHODS AND MATERIALS

This retrospective study included 76 children (=6 years) who underwent 80-kVp contrast-enhanced CT using standard dose (n=38) and low dose (n=38) protocols on a 320-row scanner. Patient age and body weight were matched between the standard and low dose groups. The standard dose images were reconstructed at a 3 mm slice thickness using the HIR algorithm; the lower dose images were reconstructed at a 0.5 mm slice thickness using the HIR and DLR algorithms. The size-specific dose estimate (SSDE) was compared between groups. For quantitative image analysis, image noise and contrast-to-noise ratio (CNR) at the hepatic parenchyma, abdominal aorta, and portal vein were quantified. For qualitative assessment, noise magnitude, noise texture, edge sharpness, partial volume effect, artifacts, and diagnostic confidence were subjectively rated on a four-point scale.

#### RESULTS

There were no significant differences in age ( $24.1 \pm 23.0$  vs.  $24.2 \pm 23.0$  months,  $p=0.98$ ) and body weight ( $9.9 \pm 4.6$  vs.  $10.2 \pm 5.8$  kg,  $p=0.80$ ) between the standard and low dose groups. The SSDE of the low dose group was 60% lower than that of the standard dose group ( $3.3 \pm 0.9$  vs.  $8.3 \pm 1.6$  mGy,  $p<0.01$ ). DLR considerably reduced the quantitative image noise and improved CNR and subjective image quality of the low dose 0.5 mm images compared to HIR (all,  $p<0.001$ ). Compared to the standard dose 3 mm HIR images, the low dose 0.5 mm DLR images showed significantly lower quantitative image noise ( $p=0.02$ ) and equivalent CNR in all structures analyzed (all,  $p>0.11$ ). The low dose 0.5 mm DLR images achieved superior subjective scores for diagnostic confidence compared to standard-dose 3 mm HIR images ( $p<0.01$ ).

#### CONCLUSION

In pediatric CT, the application of DLR to low-dose thin-slice (0.5 mm) images can yield equivalent or even better subjective and objective quality compared to standard-dose thick-slice (3 mm) HIR images.

#### CLINICAL RELEVANCE/APPLICATION

DLR allows reduction of both radiation dose and slice thickness in pediatric CT without increasing image noise and degrading the subjective image quality compared to the HIR algorithm.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-1

### Extending Coronary Calcium Scoring to New Protocols using a Specificity Criterion

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Scott Hsieh, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Coronary calcium is scored today using the Agatston algorithm, which was devised for 3-mm thick slices at 120 kVp. Scanners today offer protocols with thinner slices, better in-plane resolution, lower kVp, different mAs, advanced reconstruction, or new technologies such as multi-energy or photon counting detector CT. A framework is desired to adapt the Agatston algorithm threshold to these variations while maintaining an acceptable false positive rate. We propose to do this directly by imposing a specificity criterion. Because our interest is in detecting smaller calcifications, we do not impose a minimum size criterion.

#### METHODS AND MATERIALS

For each scan, we select a series of control regions (2 ml each, matching the volume of the coronary arteries) in a nearby, uniform anatomic area or in an anthropomorphic phantom of matched patient size and protocol. The 95th percentile of the maxima of these control regions is selected as the scoring threshold to ensure a Type I error rate of 5%. An adjustment is made for the mean difference in CT number between the control regions and coronary arteries, if any. We tested this framework on numerical simulations and an anthropomorphic phantom with 10 small calcifications (from 0.4 to 0.8 mm in size) that was scanned with different energy integrating detector CT (EID-CT) or photon counting detector CT (PCD-CT) protocols, all at matched dose.

#### RESULTS

In numerical simulations, our framework selected CT thresholds between 74 to 212 HU depending on the dose level and reconstruction kernel used. Higher doses improved sensitivity, but all scans had equivalent specificity. The sharper kernel increased sensitivity for small, bright calcifications but decreased sensitivity for large, less bright calcifications because the threshold increased with sharpness. In the anthropomorphic phantom, with a medium-sharp Qr54 EID-CT with 0.6 mm thick slices, a threshold of 410 HU was selected, and sensitivity was 40%. With a sharper Qr66 kernel, the threshold increased to 1015 HU and the sensitivity fell to 30%. With PCD-CT and a Qr68 kernel, the threshold decreased to 357 HU threshold because of the higher resolution capability of PCD-CT and sensitivity increased to 90%. No false positives were seen in these cases.

#### CONCLUSION

A specificity criterion provides a disciplined approach for selecting an Agatston scoring threshold. This allows objective detection of coronary calcium in new protocols and was demonstrated on high resolution protocols from PCD-CT.

#### CLINICAL RELEVANCE/APPLICATION

Coronary calcium scoring algorithms must be modified to take advantage of new scanner capabilities. We provide a general framework for making modifications that is especially useful for new, higher resolution CT protocols.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-10

### Impact of Deep Learning Reconstruction on Radiation Dose Reduction and Cancer Risk in CT Examinations: A Real-World Clinical Analysis

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Naoki Kobayashi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to estimate the degree to which the introduction of Deep Learning Reconstruction (DLR) into clinical settings may reduce the radiation dose and the risk of radiation-induced cancer from CT examinations, utilizing real-world clinical data.

#### METHODS AND MATERIALS

In our institution, we retrospectively collected scanning information for two distinct periods based on the date of DLR implementation: the 12 months immediately prior to the introduction of DLR, when iterative reconstruction (IR) was used for routine CT, and the 12 months following the implementation of DLR, when the routine CT reconstruction was switched to DLR. Inclusion criteria consisted of adult patients (aged 20 to 100 years) who underwent body CT during this period on specific CT units where DLR was introduced. The dose management system, Radimetrics™ (Bayer), was used to collect dose data and to estimate the equivalent dose for each organ and the effective dose for the whole body. From the dose data, we calculated the reduction rate of the average dose upon the implementation of the DLR. Utilizing the R package, "LARisk 1.0.0", we also estimated the lifetime attributable risk (LAR) for each CT examination based on exposure dosage estimates. We summarized the LARs by age, gender, and organ, and evaluated the degree to which the LAR was altered before and after the implementation of DLR. The number of radiation-induced cancers before and after the introduction of DLR was also estimated.

#### RESULTS

A total of 6,172 cases prior to and 6,423 cases following the implementation of DLR were incorporated into the analysis. The total effective dose in body CT was significantly lower post-DLR introduction ( $15.8 \pm 10.6$  mSv) compared to pre-DLR introduction ( $27.9 \pm 14.1$  mSv) ( $p < 0.001$ ), amounting to a 43% dose reduction. The decrease in radiation dose resulted in a substantial reduction in the risk of radiation-induced cancer, with particularly notable benefits in a group of relatively young women. The estimated annual incidence of radiation-induced cancers was 0.261% (16.1 out of 6,172) prior to the introduction of DLR and 0.139% (8.9 out of 6,423) following its implementation.

#### CONCLUSION

Our single-center study suggests that the implementation of DLR has the possibility to reduce radiation dose and radiation-induced cancers by nearly half in the clinical routine CT compared with the iterative reconstruction.

#### CLINICAL RELEVANCE/APPLICATION

This study shows the degree to which the introduction of DLR contributes to a reduction in radiation dose and thus in the incidence of radiation-induced cancer.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-11

### **A Fundamental Investigation into the Behavior of Active Collimators in Multi-detector CT Systems under Varying Imaging Conditions**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Ryo Moriwake, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to investigate that the effects with and without active collimator usage on dose profiles in the body axis direction and over-range length when scan conditions are altered.

#### **METHODS AND MATERIALS**

We used a 80-detector row CT scanner. A polymethyl methacrylate (PMMA) phantom with a diameter of 16 cm was placed at the center of the gantry rotation. The high-accuracy Thimble ionization chambers (10X6-0.6CT, Radcal) was inserted in the center of the phantom with a scan length of 10 cm to include scattered radiation. The scan parameters were set as follows: tube voltage of 120 kV, tube current and rotation speed set to 50 mAs, and various combinations of detector rows of  $0.5 \times 80$  mm,  $0.5 \times 64$  mm, and  $1.0 \times 40$  mm were used at three pitch factor levels: High Definition, Standard, and High Speed. Each measurement was performed three times, and the axial dose profiles and over-range lengths were determined for each scan condition.

#### **RESULTS**

The dose profiles in the Z axial direction with and without AC were wider in each scan condition with AC than without AC. The dose profiles in the body axial direction during the change of imaging conditions tended to differ depending on the rotation speed and the number of detector rows. The widest dose profile was observed at high speeds. The over-range length was approximately 18 to 45 mm. The over-range length was particularly large at the combination of 0.5 sec,  $1.0 \times 40$  mm, and high speed.

#### **CONCLUSION**

By comparing the dose profiles with and without AC, the operation of AC was confirmed. It was also confirmed that the operation of the AC depends on the imaging conditions. Overrange lengths ranged from about 18 to 45 mm, The overrange length was particularly large for the combination of 0.5 sec,  $1.0 \times 40$  mm, and high speed.

#### **CLINICAL RELEVANCE/APPLICATION**

The use of active collimator may reduce over-range. Since the over-range varies depending on the scan conditions, it is important to understand the effect of overrange in advance for children with a short scan range. In addition, the use of a semiconductor detector may make it possible to easily determine the effect of over-range.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-12

### Effect of Radiation Dose on CT Attenuation of Photon Counting CT Scanner: A Phantom Study

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jingjuan Liu, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

NAEOTOM Alpha is the new generation CT scanner (Siemens Healthineers, Forchheim, Germany) which epoch-makingly used the semiconductor material for detector. The new detector system could convert photons directly into electronic signals to improve the utilization of photons and result in a lower noise, a higher resolution and image quality. Compared with the mixed image in dual source system, NAEOTOM Alpha would generate a monoenergetic image of 70keV as the 'standard' image for doctors' diagnosis. In this project, we want to first evaluate the accuracy and change of CT attenuation with different mono-energetic images using a liver nodule phantom.

#### METHODS AND MATERIALS

We applied a liver nodule phantom (QRM, Möhrendorf, Germany) consisting of the anthropomorphic abdomen phantom body, the liver and spleen insert in this project. The liver insert contains multiple oval and spherical lesions of different sizes and in two kinds of densities. The phantom was scanned with the standard QuantumPlus protocol on NAEOTOM Alpha in 3 different scanning modes (Spiral, Flash and Sequence). In each mode, the tube voltage was set at 120kV and 140kV. Each scan was performed for 3 times to reduce the errors. All images were reconstructed as SPP image with a kernel of Qr40, slice thickness of 2mm and increment of 2mm and imported into the post-processing workstation (Syngo.Via VB70, Siemens Healthineers, Forchheim, Germany) for measurement. All statistical analysis was performed with Python 3.10.11. The difference between measured results and standard CT attenuation was tested with student T test. A p value smaller than 0.05 was considered as significant.

#### RESULTS

As shown in Fig.1, the CT attenuation is close to the standard value when the mono-energy is around 70keV for abdomen region, low-density and high-density lesions, with no significant difference when compared with the standard values. For liver region, for Spiral and Sequence mode, the CT values were close to the standard value when the mono-energy is around or lower than 55keV, while 60keV for Flash mode. For the spleen region, the CT attenuations are close to the standard value when the mono-energy is around 65keV.

#### CONCLUSION

From the result, we could conclude that the CT attenuations of 70keV image are close to the standard value for the abdomen region, low-density and high-density lesions in the liver. However, 65keV image for spleen and 60keV image for liver seem to be closer to standard value. This could help the doctors in clinical routines to decide the parameters.

#### CLINICAL RELEVANCE/APPLICATION

To lay the foundation for the further promotion of photon CT to clinical applications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5B-SPPH-13

### Comparison of Non-gated, High-pitch Cardiac CTA in Pediatric Patients under 1 Year of Age: Energy Integrating Detector vs Photon Counting Detector CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Scott M. Bugenhagen, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine image quality and radiation doses on photon counting detector (PCD) CT compared to conventional energy-integrated detector (EID) CT in under 1 year old congenital heart disease (CHD) patients.

#### METHODS AND MATERIALS

This study involved an Institutional-Review-Board (IRB) approved retrospective analysis of CHD patients that underwent clinically indicated CT angiography examinations using dual-source EID-CT (Siemens Healthineers, SOMATOM Force) and dual-source PCD-CT (Siemens Healthineers, NAEOTOM Alpha). All examinations, regardless of detector technologies, were acquired with non-gated, high-pitch technique (3.2) and automated exposure control. All PCD scans used 120kV and 55keV reconstructions, while EID scans used automated kV technology with tube potential of 70 and 80kV. Patient characteristics (age, body mass index, patient weight) as well as dose descriptors including volume CT dose index (CTDIvol), dose length product (DLP), and size-specific dose estimate (SSDE), were recorded and compared. Image quality assessment was based on review of the 4 major coronary arteries and was scored on an 8 point scale: 3 points for right coronary artery (RCA) (1 for origin, 2 for origin + proximal, 3 for origin + proximal + distal), 1 point for left main coronary artery (LMCA) (seen or not seen), and 2 points for the left anterior descending artery (LAD) and left circumflex artery (LCA) arteries (1 for proximal and 2 for proximal + distal). Parametric (t-test) testing was used for statistical evaluation.

#### RESULTS

29 and 24 CT examinations were included for EID and PCD, respectively. There were no overall differences in demographic characteristics including mean (standard deviation) patient age [0.137 vs 0.157 years,  $P = 0.844$ ], body mass index [14.2 (+/- 2.5) vs 13.9 (+/-2/5) kg/m<sup>2</sup>,  $P = 0.5$ ], or patient weight [3.63 vs 3.62 kg,  $P = 0.9$ ]. In comparison with EID CT, PCD CT had significantly lower mean CTDIvol [0.48 vs 0.39 mGy,  $P=0.001$ ]. SSDE [1.005 vs 0.951 mGy,  $P = 0.11$ ] and DLP [7.07 vs 5.66 mGy cm,  $P =0.06$ ] differences were non-significant. There was negligible difference in image quality (visualization of coronary arteries) ( $P = 0.19$ ).

#### CONCLUSION

Our experience indicates that radiation doses in non-gated high-pitch cardiac PCD-CT in children are similar to or lower than those of current EID-CT, while subjective image quality is maintained.

#### CLINICAL RELEVANCE/APPLICATION

Similar to lower doses in non-gated high-pitch cardiac PCD-CT compared to EID-CT supports use of PCD-CT in cardiac imaging in children.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-2

### Correlation of Human Observer Impression of X-ray Fluoroscopy and Angiography Image Quality with Technical Changes to Image Quality

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Perceived angiographic image quality is a combination of image formation technical factors and image processing. No standard methods to measure angiography quality exists due to the combination of spatio-temporal anatomical variability and non-linear image processing. However, methods to assess image quality are needed to optimize radiation dose and image quality in the clinical practice. The purpose of this work was to develop and validate methods to measure observer impression of angiographic image quality.

#### METHODS AND MATERIALS

Multi-frame images of the thorax of a euthanized pig were acquired to provide an anatomical background. Detector dose (DD) was varied from 6 to 200 nGy (increments 2x) to provide background with a wide range of quantum SNR. For each DD images with 0.6 and 1.0 mm focal spots (FS) were acquired to assess FS blur. Two stents with/without 0.5 mm separation and a synthetic right coronary artery (RCA) with spherical defects were embedded as test objects into the pig images. Embedded test objects included motion to mimic cardiac function. Quantitative observer (n=14) performance was measured through 2AFC test of whether stents were touching and by observer count of RCA defects. Subjective impressions of quality were measured through visual analog scale (VAS) response to statements assessing small object details, noise impression, and overall image quality. The paired t-test was used to describe significance of observer response changes associated with DD or FS size.

#### RESULTS

Proportion of correct responses of stent separation and number of RCA defects reported changed significantly with DD increment in the range 6-100 nGy ( $p < 0.05$ ). While there was a trend which favored the 0.6 vs. 1.0 mm FS for these quantitative assessments, this was not significant. VAS measurements changed significantly with both DD increment in the range 24-100 nGy and with FS size for a given DD ( $p < 0.05$ ). Quantitative and subjective measurements were highly correlated. The most sensitive measurement was VAS assessment of small object details.

#### CONCLUSION

Compared to quantitative human observer assessment, measurement of subjective impression of image quality demonstrated higher sensitivity for image quality changes associated with quantum SNR and focal spot size. These findings embolden future work to assess quality of fluoroscopy and angiography images using subjective measurements. Our strategy to ensure rigor is systematic, self-conscious study design, data collection, and interpretation.

#### CLINICAL RELEVANCE/APPLICATION

For cardiovascular imaging procedures, defining image quality is complex task because it relates to numerous dynamic variables. Feedback from the end user can lead to more accurate and reproducible measurements.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5B-SPPH-3

### Is it Possible to Achieve Consistent Outcomes in CT NSCLC Radiomics? An In-depth Exploration of the Sources of Uncertainties

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Gary Ge, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiomics features have been used in machine learning models to quantify tissue characteristics that are not observable by clinicians to aid in the prediction of clinical decisions and outcomes. However, there are still many uncertainties involved in this process which reduce the robustness of results and limit its clinical implementation. We investigate the impact of each component in the radiomics pipeline on predicting clinical outcomes.

#### METHODS AND MATERIALS

A thorough review of over 120 CT lung radiomics studies was conducted to examine current. Patient images were retrospectively retrieved from a GE VCT scanner. The lung nodules were manually delineated using Eclipse to define a region of interest. First-order features were extracted with IBEX and high-order features were extracted using Python. Clinical features were retrieved from the Kentucky Cancer Registry (KCR). The features were organized into five feature sets, Radiomic (low), Radiomic (high), Radiomic (high+low), Clinical, and Radiomic+Clinical. Prediction of 2-year survival was investigated. Cohort size was examined by extracting balanced sub-cohorts of the original cohort to be run in parallel to the original cohort. The included feature selection methods are: ANOVA, LASSO, MI, mRMR, and Relief. The number of selected features used for model training was also established as a variable for examination, ranging from 5 to 25 features. The included predictive models are: SVC, Naïve-Bayes, DT, RF, LR, GBoost, and kNN. Model validation methods were also examined, using 2-, 5-, and 10-fold cross-validation (CV).

#### RESULTS

496 patient image sets are retrieved for use in this analysis. CT datasets are fairly balanced, with 237 patients  $\leq$  2 years survival and 259 patients  $>$  2 years survival. A total of 1419 first-order features, 360 high-order wavelet features, and 9 clinical features are included in the feature sets. Statistical analysis is done using Kruskal-Wallis for within-group analysis and further pairwise testing establishes relative rankings. A total of 17220 AUCs involving all combinations shows certain trends. Overall CT lung cancer radiomic stability favors larger cohort size, Clinical and Radiomic+Clinical feature sets, mRMR feature selection, RF predictive model, and 10-fold CV.

#### CONCLUSION

Radiomic feature selection and machine learning methods are inter-dependent. Appropriate inclusion of different feature types and choice of feature selection can improve predictive power for clinical outcome.

#### CLINICAL RELEVANCE/APPLICATION

Conducting systematic analysis of each phase of the radiomic workflow may heighten general understanding of uncertainties that contribute to unstable outcomes, thus potentially improving the robustness of future radiomic studies.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-4

### **A Data Dashboard Approach to Improving Image Analysis: Survival Prediction of Patients with Bladder Cancer after Cystectomy based on Clinical, Radiomics, and Deep Learning Descriptors**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Di Sun, MEng, BEng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To predict the 5-year survival of bladder cancer patients after radical cystectomy by combining clinical, radiomics, and deep learning (DL) descriptors (CRD).

#### **METHODS AND MATERIALS**

With IRB approval, we collected clinical information and CTU scans from 163 patients with bladder cancer who underwent neoadjuvant chemotherapy followed by radical cystectomy. Five-year survival data were collected. We split the data into three sets: training (55 alive (A); 37 deceased (D)); validation (4 A; 3 D); and test (20 A; 44 D). The clinical information collected included post-surgery pathologic stage, lymphovascular invasion, pathologic node stage, if patients underwent chemotherapy, or adjuvant radiotherapy. The nomogram by Shariat was used to predict the survival of patients. Radiomics and DL descriptors were extracted from CTU images. Each patient had two CTU scans (before and during/after chemotherapy), forming a pre- and post-treatment pair. We used our AI-CALS algorithm to segment the lesions. To train and validate the DL convolution neural network (DL-CNN), hybrid ROIs extracted from the lesion area were used. A total of 182 radiomics features were extracted from the lesions, including grey level, morphological, and texture features from the post-treatment scans (post features) and the percentage difference between pre- and post-treatment features (difference features). Backpropagation neural network was used to classify the radiomics features. The area under receiver operating characteristic curve (AUC) and Kaplan-Meier analysis were used to evaluate the classification performance on the test set.

#### **RESULTS**

The nomogram model achieved an AUC of  $0.82 \pm 0.06$  on the test set; DL-CNN achieved an AUC of  $0.71 \pm 0.07$ ; and the classification based on radiomics features had an AUC of  $0.73 \pm 0.07$ . By combining all CRD descriptors, we obtained an AUC of  $0.87 \pm 0.05$ . The differences between any pairs of AUCs did not reach significance ( $p > 0.05$ ), which likely relates to sample size. The median survival times by Kaplan-Meier analysis for the two classes (deceased or alive) were 1.2 and 5 years ( $p < 0.001$ ) as estimated by the nomogram model, and 1.6 and 5 years ( $p = 0.007$ ) estimated based on CRD descriptors.

#### **CONCLUSION**

While larger data sets are needed, this study demonstrates that combining the radiomics and DL descriptors with clinical information holds promise for improving the prediction of the 5-year survival of bladder cancer patients after radical cystectomy.

#### **CLINICAL RELEVANCE/APPLICATION**

The CRD descriptors has the potential to improve the prediction of the 5-year survival of bladder cancer patients after radical cystectomy. Accurate assessment of 5-year survival offers potential benefits with patient counseling and postoperative surveillance strategies.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-5

### **Fissure Integrity Scores in Pre-treatment Chest CT Images as a Biomarker for Predicting a Target Lobar Collapse with Endobronchial Valve Implantation in Subjects with Emphysema**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Dallas Tada, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We propose to build an initial endobronchial valve (EBV) prediction model using quantitative CT measurements to evaluate the response of emphysema patients to EBV implantation for a targeted lobe.

#### **METHODS AND MATERIALS**

The study retrospectively collected 127 anonymized pre-treatment EBV CT scans. Selection criteria for the targeted lobe for EBV implantation is based on the highest emphysema density and largest degree of heterogenous emphysema between the targeted and the ipsilateral adjacent lobe. A fissure integrity score (FIS) is used as a primary quantitative biomarker for the development of the EBV prediction model. Previous work on fissure segmentation and integrity assessment used a deep learning approach that segments pulmonary fissure and quantifies FIS for the right horizontal fissure (RHF), right oblique fissure (ROF), and left oblique fissure (LOF). An FIS is defined as the percentage of complete fissure voxels along the surface of the interlobar region. Fissures are categorized as complete with a FIS of  $\geq 90\%$ ; otherwise, a fissure is considered incomplete. Separate FIS for the right fissures are calculated based on the targeted lobe for lobar exclusion (i.e., upper lobar boundary for a targeted right upper lobe). Successful EBV placement in a targeted lobe is described as a reduction of  $\geq 50\%$  of its total lung capacity (TLC). A reduction of less than 50% of targeted lobe volume reduction (TLVR) does not achieve the desired lobar collapse. Statistical analysis of FIS and EBV volume reduction is applied to assess the significance of fissure completeness and EBV placement.

#### **RESULTS**

FIS and TLVR comparisons are separated by total sample size and targeted lobes. For all targeted lobes, a mean ( $\pm$ SD) FIS of 0.93 ( $\pm$ 0.05) and 0.72 ( $\pm$ 0.26) was attained for successful and unsuccessful TLVR, respectively. Subjects with complete target lobe fissure are likely to experience TLVR by six-fold compared to subjects with incomplete target lobe FIS (Odds Ratio = 6.05,  $p$ -value=0.001). All targeted lobes and the right upper lobe achieved a TLVR ( $p$ -value < 0.01); the left lobes and right lower lobe did not achieve statistical significance.

#### **CONCLUSION**

Quantified fissure integrity scores are essential for the foundation of the EBV prediction model, but additional quantitative biomarkers may improve the efficacy for the model.

#### **CLINICAL RELEVANCE/APPLICATION**

The development of a prediction model that will more successfully identify emphysema patients that respond to EBV treatment helps guide treatment decisions for clinicians and manages medical resources.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-6

### Practicing Precision Medicine: Using Machine Learning to Predict Time-to-Surgery in Renal Cell Carcinoma under Active Surveillance

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

Clear cell renal carcinomas (ccRCCs) in VHL patients are typically managed with active surveillance (AS) until the tumor reaches 3 cm, when surgical resection is recommended. While current guidelines suggest annual screening with abdominal imaging, tailoring imaging frequency to each patient's tumor growth rate can reduce unnecessary radiation exposure and metastasis risk. This study aims to use MRI-based machine learning algorithms to predict the time to 3 cm threshold and design personalized imaging protocols for VHL patients.

#### METHODS AND MATERIALS

The retrospective study included 40 vHL patients with 68 histopathologically-confirmed ccRCCs (size 1-2 cm) undergoing AS according to institutional protocol. Tumor segmentation was performed on all available pre-operative scans using ITK-SNAP and radiomics features were extracted from co-registered pre-contrast and post-contrast sequences using PyRadiomics. A growth curve was plotted for each tumor, and the time taken for each tumor to grow to 3 cm (T3) from the initial time point was calculated using the respective growth curve's fitted line equation. Based on T3, the tumors were classified into three categories: aggressive (<365 days), moderate (1-3 years), and slow (>3 years). Stacked ensemble technique with random forest and XGBoost were used for training models to predict T3 based on radiomics features. Five-fold cross-validation was used and the model was benchmarked on 100 different combinations (85% train and 15% test) to find the best model which was reported with F1 score, and the area under the curve of the receiver operating characteristic curve (AUC-ROC).

#### RESULTS

A total of 40 patients (28 males) with mean age of  $44 \pm 3$  years and mean follow-up of  $2.9 \pm 1$  year were studied. Median volumetric growth rate of 1.8 cm<sup>3</sup> and diametric growth rate of 0.91 cm/year was observed. The best model showed an accuracy of 0.67 and F1-score of 0.67, 0.70 and 0.62 was observed with aggressive, moderate and slow tumor class respectively. AUC of ROC drawn for aggressive, moderate, and slow class were 0.65, 0.71 and 0.76. A Matthews Correlation Coefficient of 0.58 reveals a moderately well predicted analysis.

#### CONCLUSION

The use of MRI-based machine learning algorithms can predict the time to 3 cm threshold and classify tumors into aggressive, moderate, and slow-growing categories for VHL patients with ccRCCs, providing a personalized imaging protocol. However, moderate accuracy of the model suggests the need for large dataset and external validation to improve the performance.

#### CLINICAL RELEVANCE/APPLICATION

Tailoring imaging frequency based on the predicted time to 3 cm can reduce unnecessary radiation exposure and financial burden for slow-growing tumors as well as enables timely resection of aggressive lesion.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-7

### Deep Learning-enabled Automatic Sarcopenia Analysis in Abdominal CT: Finding an Association with Cardiovascular Disease in Korean Population

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Sihwan Kim, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Little studies have shown that sarcopenia can increase the risk of cardiovascular disease, we aimed to investigate the association between a sarcopenia and cardiovascular mortality for the Korean population.

#### METHODS AND MATERIALS

Data were retrospectively collected from non-contrast enhanced abdominal CT scans between 2005 and 2017. The number of abdominal CT scans was 641, the CT data is scanned from 352 males (54.9%) and 289 females (45.1%). Among the abdominal CT data, 141 patients (21.9%) had cardiovascular disease (CVD). Mean age of studied data was about 64 yrs (64 for male and 63 for female). The sarcopenia is defined by the sex-specific L3 skeletal muscle area (SMA) threshold referenced as 117.04 cm<sup>2</sup> for male and 71.39 cm<sup>2</sup> for female. The SMA value of L3 vertebra level was calculated using automatic body composition analysis software (ClariMetabo, ClariPi, Seoul, Republic of Korea).

#### RESULTS

In the study data (n = 641), 75 patients (11.7%) had the sarcopenia. The result showed that 46.7% of Sarcopenia group had the CVD, compared to 18.7% in the non-sarcopenia group. The odds ratio for CVD event was 3.79 [95%CI: 2.30-6.26]. However, the correlation was 0.22 (p<0.0001) in the Phi correlation coefficient analysis, indicating a weak positive correlation. Among the sarcopenia patients, the CVD risk was 2.83 [95%CI: 0.79-10.6] times higher in male than in female.

#### CONCLUSION

Automated analysis of abdominal CT imaging markers based on deep learning showed that patients with sarcopenia are more likely to have the cardiovascular disease compared to normal people in the Korean population.

#### CLINICAL RELEVANCE/APPLICATION

Deep learning-based automatic muscle mass analysis in abdominal CT is expected to contribute to improving human survival by predicting the risk of cardiovascular disease due to the sarcopenia at an early stage.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-8

### Feasibility of Artificial Intelligence-supported Assessment of Dual-energy Computed Tomography for Measuring Bone Mineral Density: Correlation with Quantitative CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Ya L. Li I (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the precision and agreement between BMD measurements performed in DECT-derived hydroxyapatite (HAP) concentration of the L1 vertebra to L3 vertebra and automated, AI-supported assessment of DECT-derived HAP concentrations with European Spine Phantom (ESP) compared with quantitative CT (QCT).

#### METHODS AND MATERIALS

Data acquisitions were performed on Revolution CT (GE Healthcare, Waukesha, WI) at 120kV with 0.8r/s and 100 and 500mA, fast tube voltage switching between high and low energy (140/80kVp) with 0.5r/s and 240 and 365mA using ESP (No. 145, Germany ORM company). Mindways QCT PRO workstation can automatically generate ROIs and analyze BMD. For DECT-derived HAP values, ROI (468.78mm<sup>2</sup>) was set as the median plane of the vertebral body avoiding cortical bone and its pedicle, and the HAP values of the L1, L2, and L3 were measured from the axial-view HAP (Water)-based material decomposition images on a dedicated GE AW 4.7 Workstation. For automated assessment of DECT-derived HAP concentration was performed by a new fully automatic BMD analysis with AI technology: Firstly, using spectral CT images as the original input, process detects, names, segments and recognizes the orientation of the vertebral body within the image; Secondly, system automatically selects the most suitable three vertebrae for evaluation, recognizes their direction and central plane, segments and extracts the three-dimensional structure of the vertebrae based on vertebral body segmentation; Thirdly, system automatically calculates ROIs in trabecular bone; Lastly, system generates personalized bone density reports. Paired t test and Pearson correlation were to determine the differences and association between two measurements.

#### RESULTS

The CTDIvol with QCT were 5.53mGy in 100mA and 27.66mGy in 500mA, whilst DECT were 5.80mGy in 240mA and 9.25mGy in 365mA. QCT-derived BMD values of the L1, L2, and L3 were 53.60±0.27, 106.25±0.11, 202.76±0.23mg/cm<sup>3</sup>, respectively. The DECT-derived HAP-Water values of the L1, L2, and L3 were 45.25±0.42, 89.2±0.86, 180.00±0.15mg/cm<sup>3</sup> with tube current of 240mA, whilst 39.46±0.51, 88.64±0.74, 170.1±0.38mg/cm<sup>3</sup> with tube current of 365mA. The DECT-derived HAP-Water values of the L1, L2, and L3 with AI were 44.2±0.87, 94.73±0.32, 173.22±0.71mg/cm<sup>3</sup> with tube current of 240mA, and 41.23±0.23, 92.03±0.74, 173.79±0.78mg/cm<sup>3</sup> with tube current of 365mA. There was a strong positive correlation between two methods ( $r=0.91$ ,  $P<0.0001$ ).

#### CONCLUSION

The automated, AI-supported assessment of DECT-derived HAP concentration of the three vertebrae is feasible to measure BMD values and potentially aid a help in opportunistic osteoporosis screening in high-risk populations.

#### CLINICAL RELEVANCE/APPLICATION

none

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## Abstract Archives of the RSNA, 2023

W5B-SPPH-9

### External Review of High CT Doses: Reasons and Improvements

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To review reasons for high CT dose cases during external review and implement improvements to improve review workflow.

#### METHODS AND MATERIALS

An in-house built external CT dose review was clinically implemented in August of 2021. Cases exceeding machine Dose Notification Values are automatically retained for review. For each case a technologist records possible reasons for the high dose and final review, updating of reasons, and sign-off is performed in-system by a qualified medical physicist or a supervisor/team lead with physicist final review. Summary statistics related to number of review cases and the reason for high doses as well as the rate of cases referred for review were calculated.

#### RESULTS

A total of 4,212 cases for 3098 unique patients were reviewed across our 21 CTAP sites. Mean CTDIvol was 62.3 Gy  $\pm$  22.9 Gy. Cases exceeded notification values by 15.5%  $\pm$  18.5% on average. 31.2% of cases exceed the notification value by less than 5%. A reason for the high dose was included in 3,994 cases (94.8%). In those that listed a reason for the high dose, 3,678 (92.1%) included large patient size at part or all of the reason for the high doses. Mean BMI of patients in reviewed cases was 42.5  $\pm$  10.9. BMI data was missing from 791 cases (18.8%). The next most frequent reasons were presence of shoulders (typically in neck scans) at 250 cases (6.3%) and misplacement of arms at 174 cases (4.4%). The presence of implants and casts was mentioned in 68 cases (1.7%) and combo scan across anatomy 46 (1.2%). No other reason exceeded 1% of the cases.

#### CONCLUSION

Most cases only exceed notification values by a small amount and represent only a small risk to the patient. The vast majority of external review cases are due to patient size and are generally considered appropriate. Other major issues include arm placement, combinations studies, and studies across the neck and into the shoulders. Our external review software lists BMI when available to improve physics workflow.

#### CLINICAL RELEVANCE/APPLICATION

Physics workflow can be improved in external review by listing indicators of patient size along with other basic demographics to reduce the need for searching for such information. It is important that size indicators are available for systems to pull and autopopulate for external review.

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## Abstract Archives of the RSNA, 2023

W5B-SPVA-2

### Low-dose 4D Head and Neck Computed Tomography Angiography Conducted via Helical Scans Jointing with ECG-gated Axial Scans: Study in Image Quality

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jinhui Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the image quality of low-dose 4D head and neck computed tomography angiography (CTA) conducted via helical scans jointing with ECG-gated axial scans, compared with conventional standard-dose spiral scanning.

#### METHODS AND MATERIALS

This study enrolled 100 patients suspected with Cerebral aneurysm and received head and neck CTA. The patients were divided into two groups according to the scanning methods. Group A (n=50) performed helical neck CTA jointing (pitch=0.992: 1) with ECG-gated axial head CTA at 20%-110% R-R interval in sequence, noise index (NI) was set as 8 HU and rotation time was 0.35 s. Group B (n=50) received normal conventional helical scanning with pitch of 0.984: 1, NI of 5 HU, rotation time of 5 s. Regions of interest were placed at the bifurcation of internal carotid artery and M1 segment of middle cerebral artery. CT values and SD values of ROIs and muscle or white matter were measured, and SNR and CNR were calculated. The overall image quality was subjectively scored using a 5-scale method. The radiation dose, subjective and objective image evaluation results were compared.

#### RESULTS

Compared with Group B, Group A had a decreased DLP by 34.6% (A vs. B:  $558.92 \pm 57.01$  vs.  $944.88 \pm 86.05$  mGy·cm,  $P < 0.001$ ). For bifurcation of internal carotid artery, the two group images showed no statistical difference in CT values (A vs. B:  $545.58 \pm 93.92$  vs.  $535.66 \pm 71.30$ ), SD ( $11.35 \pm 2.51$  vs.  $10.70 \pm 2.48$ ), SNR [ $48.16$  (20.99) vs.  $49.43$  (21.46)] and CNR ( $62.87 \pm 16.02$  vs.  $66.74 \pm 16.04$ ), with all  $P > 0.05$ . For M1 segment of middle cerebral artery, the two group images also showed no statistical difference in CT values ( $528.68 \pm 124.60$  vs.  $513.32 \pm 71.22$ ), SD [ $14.09$  (4.18) vs.  $11.94$  (3.65)], SNR [ $39.99$  (17.05) vs.  $45.57$  (17.60)] and CNR ( $54.99 \pm 14.56$  vs.  $50.83 \pm 12.76$ ), with all  $P > 0.05$ . Regarding subjective scoring, both the two-group images met diagnostic requirements and the difference was not statistically significant ( $P > 0.05$ ).

#### CONCLUSION

For head and neck CTA, low-dose helical scans jointing with ECG-gated axial scans showed comparable head and neck artery displays with standard-dose conventional helical scanning.

#### CLINICAL RELEVANCE/APPLICATION

Aneurysm is at risk of rupture, and monitoring of its pulsatility with the cardiac cycle shows predictive value, where ECG-gated 4D CTA potentially be helpful. However, 4D scans may increase the risk of radiation doses, in this study, we found that helical combined ECG-gated axial scan with exposure during 20% -110% R-R interval could obtain comparable artery visualization with conventional helical

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## Abstract Archives of the RSNA, 2023

W5-STCE1

### Science Session (Theranostics)

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 1

#### Sub-Events

#### **W5-STCE1- A <sup>18</sup>F-FDG PET Based Nomogram to Diagnose Cancer-associated Cachexia and Predict Prognosis: A Multicenter Study**

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This multi-center study attempts to develop and externally validate a nomogram that combines fluorine-18-fluorodeoxyglucose (18F-FDG) PET features and results from the routine clinical biochemistry tests to diagnose cancer-associated cachexia. Furthermore, the potential utility of this nomogram for prognostic assessment is examined.

#### **METHODS AND MATERIALS**

A retrospective analysis was conducted on 18F-FDG PET/CT data collected from 658 cancer patients in two centers. 390 patients (mean age: 61 ± 12 years; 221 men) were included in the development cohort, while 268 patients (54 ± 14; 135 men) were included in the validation cohort. The results from routine clinical tests of blood samples that are indicative of metabolic functions, as well as organ- and tissue-specific FDG uptake were obtained followed by logistic regression analyses to identify independent variables associated with cancer-associated cachexia. The area under the receiver operating characteristic curve (AUC), calibration curve, and decision curve analysis were then used to determine the diagnostic accuracy, discriminative ability, and clinical effectiveness of the nomograms. Cox regression and Kaplan-Meier curves were applied to evaluate the predictability of the nomogram on overall survival.

#### **RESULTS**

Age (odds ratio [OR], 2.219; P = 0.002), hemoglobin (OR, 1.956; P = 0.009), maximum standardized uptake value (SUV) of the liver (OR, 2.848; P < 0.001), and minimum SUV of the subcutaneous fat (OR, 3.895; P ? 0.001) were found as independent predictors of cachexia. The combined nomogram incorporating these variables achieved an AUC of 0.772 in identifying cancer-associated cachexia in the development cohort and an 0.706 in the external validation cohort, respectively. The calibration curve and decision curve analysis indicated that the combined nomogram is effective clinically in diagnosing cancer-associated cachexia. Kaplan-Meier curves analysis showed that overall survival can be categorized using the combined nomogram (P ? 0.001).

#### **CONCLUSION**

Reported nomogram combining radiological information with <sup>18</sup>F-FDG PET data of cancer patients and biochemical results in routine clinical blood tests enables diagnosing cachexia and predicting its effect on the prognosis.

#### **CLINICAL RELEVANCE/APPLICATION**

In conclusion, the combined nomogram with measurements from routine clinical blood tests and FDG PET can diagnose cancer-associated cachexia and predict clinical outcomes of patients with cachexia. This new method may provide a non-invasive and quantitative tool in oncology clinical practice.

#### **W5-STCE1- Fast Magnetic Resonance Angiography of the Cervical Arteries Without Gadolinium Contrast: Clinical Evaluation of Highly Compressed SENSE accelerated Relaxation-Enhanced Angiography without Contrast and Triggering (REACT) in Patients with Acute Ischemic Stroke**

Kenan Kaya, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Because of methodical disadvantages of Contrast-enhanced magnetic resonance angiography (CE-MRA) and potential allergic reactions to contrast agent, native MRA techniques have gained increased interest. The purpose of this study was to evaluate a highly accelerated novel 3D flow-independent MRA sequence (Relaxation-Enhanced Angiography without Contrast and Triggering (REACT)) for fast imaging of the extracranial arteries in acute ischemic stroke (AIS).

## METHODS AND MATERIALS

In this retrospective single-center study, 76 consecutive patients ( $68.2 \pm 16.4$  years, 54 males) with AIS were included. Patients received a standard protocol including Compressed SENSE (CS) accelerated (factor 7) 3D isotropic REACT (fixed scan time: 01:20 min) and CS accelerated (factor 6) 3D isotropic CE-MRA. Two radiologists independently assessed scans for the presence of extracranial internal carotid artery (ICA) stenosis with concomitant diagnostic confidence using a 5-point scale (5=excellent). Vessel quality of the cervical arteries as well as the overall presence of artifacts and image noise were subjectively scored on 5-point scales (5=excellent/none). For objective comparison, apparent signal- and contrast-to-noise ratios (aSNR/aCNR) were measured at the common carotid artery (CCA) and ICA (C1 segment).

## RESULTS

Considering CE-MRA as the standard of reference, REACT yielded a sensitivity of 84.1% and specificity of 93.5 % for any and of 88.5 % and 100 % for clinically relevant (=50%) extracranial ICA stenosis. Diagnostic confidence was comparable between both techniques ( $3.7 \pm 0.5$  in REACT vs.  $3.8 \pm 0.5$  in CE-MRA;  $P=.03$ ), REACT obtained an almost perfect accordance with CE-MRA regarding the grading of disease (Cohen's Kappa 0.84). Overall presence of artifacts and vessel quality was comparable between both techniques for the majority of analyzed segments with REACT yielding higher scores at the common carotid arteries ( $4.3 \pm 0.6$  vs.  $3.8 \pm 0.9$ ;  $P < .001$ ) whereas CE-MRA obtained higher scores at V2- and V3-segments of the vertebral arteries ( $3.9 \pm 0.8$  vs.  $3.3 \pm 0.5$ ;  $P < .001$  and  $3.9 \pm 0.8$  vs.  $3.3 \pm 0.5$ ;  $P < .001$ ). REACT showed a lower image noise ( $3.8 \pm 0.6$  vs.  $3.6 \pm 0.7$ ;  $P=0.024$ ) with higher aSNR ( $52.5 \pm 15.1$  vs.  $37.9 \pm 12.5$ ;  $P < .001$ ) and aCNR ( $49.4 \pm 15.0$  vs.  $34.7 \pm 12.3$ ;  $P < .001$ ) than CE-MRA for all vessels combined.

## CONCLUSION

In a very short scan time, highly compressed SENSE accelerated REACT provides a high sensitivity and specificity for extracranial ICA stenosis time while yielding to CE-MRA comparable vessel quality in AIS.

## CLINICAL RELEVANCE/APPLICATION

Given its short acquisition time, high diagnostic performance, and sufficient image quality, REACT proves to be a clinically applicable method to depict the extracranial arteries in acute ischemic stroke.

## W5-STCE1-3 Development of Theranostic $^{177}\text{Lu}$ -labeled Semiconducting Polymer Dots (pDots) for the Treatment of Head and Neck Cancer

Min-Tzu Ku, PhD, RT (*Presenter*) Nothing to Disclose

## PURPOSE

The superior capabilities of pDots in near-infrared II (NIR-II) imaging have been demonstrated in previous studies. This study aims to develop  $^{177}\text{Lu}$ -labeled pDots and evaluate their potential as a theranostic agent for the treatment of head and neck cancer.

## METHODS AND MATERIALS

The pDots utilized in this study were generously provided by Prof. Yang-Hsiang Chan from National Yang Ming Chiao Tung University, Taiwan. These pDots were modified with ethylenediamine through amide bond formation with carboxyl groups on their surface. Subsequently, chelates (p-SCN-Bn-DTPA) were introduced to produce DTPA-modified pDots. The radiolabeling process involved incubating  $^{177}\text{Lu}$ - $\text{LuCl}_3$  and DTPA-modified pDots in a citrate buffer solution at  $40^\circ\text{C}$  for 1 hour. To evaluate the therapeutic efficacy of  $^{177}\text{Lu}$ -pDots, SAS cells were inoculated in the right flank of nude mice. NIR-II imaging was conducted using a system equipped with a 793-nm laser generator and an InGaAs camera.

## RESULTS

The radiochemical yield of  $^{177}\text{Lu}$ -pDots was  $8 \pm 3\%$  with high radiochemical purity. Remarkably, the radiolabeling process had no adverse impact on the size distribution and light absorption/emission properties of pDots. NIR-II imaging confirmed the successful delivery of  $^{177}\text{Lu}$ -pDots to the tumor, reaching its highest uptake at 24 hours after intravenous injection. Biodistribution studies supported these findings, showing tumor uptake values of  $7.1 \pm 1.9\% \text{ID/g}$  and  $5.2 \pm 2.1\% \text{ID/g}$  at 24 and 48 hours post-injection, respectively. Upon administering  $^{177}\text{Lu}$ -pDots and performing 793-nm laser irradiation, the tumor temperature increased to approximately  $42^\circ\text{C}$ , achieving mild photothermal therapy (PTT) conditions. However, the PTT primarily induced elevated blood vessel permeability, which facilitated subsequent drug accumulation, rather than exhibiting significant therapeutic efficacy. In the treatment studies, tumor-bearing mice treated with fractionated  $^{177}\text{Lu}$ -pDots exhibited tumor growth retardation, while both the control group and mice receiving a single round of  $^{177}\text{Lu}$ -pDots

showed continuous tumor volume increase. Notably, the fractionated  $^{177}\text{Lu}$ -pDots-treated group did not experience severe body weight reduction, indicating superior biosafety.

#### **CONCLUSION**

In this study, we successfully developed theranostic  $^{177}\text{Lu}$ -pDots, functioning as a versatile agent for angiography, photothermal conversion, and radiotherapy.

#### **CLINICAL RELEVANCE/APPLICATION**

$^{177}\text{Lu}$ -pDots offer promising potential as an innovative radiopharmaceutical therapy agent for cancer treatment while also enabling noninvasive imaging for pharmacokinetic analysis. Moreover, their compatibility makes them an excellent candidate for combining radiopharmaceutical therapy with photothermal therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5-STCE1-1

### A <sup>18</sup>F-FDG PET Based Nomogram to Diagnose Cancer-associated Cachexia and Predict Prognosis: A Multicenter Study

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 1

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This multi-center study attempts to develop and externally validate a nomogram that combines fluorine-18-fluorodeoxyglucose (<sup>18</sup>F-FDG) PET features and results from the routine clinical biochemistry tests to diagnose cancer-associated cachexia. Furthermore, the potential utility of this nomogram for prognostic assessment is examined.

#### METHODS AND MATERIALS

A retrospective analysis was conducted on <sup>18</sup>F-FDG PET/CT data collected from 658 cancer patients in two centers. 390 patients (mean age: 61 ± 12 years; 221 men) were included in the development cohort, while 268 patients (54 ± 14; 135 men) were included in the validation cohort. The results from routine clinical tests of blood samples that are indicative of metabolic functions, as well as organ- and tissue-specific FDG uptake were obtained followed by logistic regression analyses to identify independent variables associated with cancer-associated cachexia. The area under the receiver operating characteristic curve (AUC), calibration curve, and decision curve analysis were then used to determine the diagnostic accuracy, discriminative ability, and clinical effectiveness of the nomograms. Cox regression and Kaplan-Meier curves were applied to evaluate the predictability of the nomogram on overall survival.

#### RESULTS

Age (odds ratio [OR], 2.219; P = 0.002), hemoglobin (OR, 1.956; P = 0.009), maximum standardized uptake value (SUV) of the liver (OR, 2.848; P < 0.001), and minimum SUV of the subcutaneous fat (OR, 3.895; P ? 0.001) were found as independent predictors of cachexia. The combined nomogram incorporating these variables achieved an AUC of 0.772 in identifying cancer-associated cachexia in the development cohort and an 0.706 in the external validation cohort, respectively. The calibration curve and decision curve analysis indicated that the combined nomogram is effective clinically in diagnosing cancer-associated cachexia. Kaplan-Meier curves analysis showed that overall survival can be categorized using the combined nomogram (P ? 0.001).

#### CONCLUSION

Reported nomogram combining radiological information with <sup>18</sup>F-FDG PET data of cancer patients and biochemical results in routine clinical blood tests enables diagnosing cachexia and predicting its effect on the prognosis.

#### CLINICAL RELEVANCE/APPLICATION

In conclusion, the combined nomogram with measurements from routine clinical blood tests and FDG PET can diagnose cancer-associated cachexia and predict clinical outcomes of patients with cachexia. This new method may provide a non-invasive and quantitative tool in oncology clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5-STCE1-2

### **Fast Magnetic Resonance Angiography of the Cervical Arteries Without Gadolinium Contrast: Clinical Evaluation of Highly Compressed SENSE accelerated Relaxation-Enhanced Angiography without Contrast and Triggering (REACT) in Patients with Acute Ischemic Stroke**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 1

Kenan Kaya, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Because of methodical disadvantages of Contrast-enhanced magnetic resonance angiography (CE-MRA) and potential allergic reactions to contrast agent, native MRA techniques have gained increased interest. The purpose of this study was to evaluate a highly accelerated novel 3D flow-independent MRA sequence (Relaxation-Enhanced Angiography without Contrast and Triggering (REACT)) for fast imaging of the extracranial arteries in acute ischemic stroke (AIS).

#### **METHODS AND MATERIALS**

In this retrospective single-center study, 76 consecutive patients ( $68.2 \pm 16.4$  years, 54 males) with AIS were included. Patients received a standard protocol including Compressed SENSE (CS) accelerated (factor 7) 3D isotropic REACT (fixed scan time: 01:20 min) and CS accelerated (factor 6) 3D isotropic CE-MRA. Two radiologists independently assessed scans for the presence of extracranial internal carotid artery (ICA) stenosis with concomitant diagnostic confidence using a 5-point scale (5=excellent). Vessel quality of the cervical arteries as well as the overall presence of artifacts and image noise were subjectively scored on 5-point scales (5=excellent/none). For objective comparison, apparent signal- and contrast-to-noise ratios (aSNR/aCNR) were measured at the common carotid artery (CCA) and ICA (C1 segment).

#### **RESULTS**

Considering CE-MRA as the standard of reference, REACT yielded a sensitivity of 84.1% and specificity of 93.5 % for any and of 88.5 % and 100 % for clinically relevant (=50%) extracranial ICA stenosis. Diagnostic confidence was comparable between both techniques ( $3.7 \pm 0.5$  in REACT vs.  $3.8 \pm 0.5$  in CE-MRA;  $P=.03$ ), REACT obtained an almost perfect accordance with CE-MRA regarding the grading of disease (Cohen's Kappa 0.84). Overall presence of artifacts and vessel quality was comparable between both techniques for the majority of analyzed segments with REACT yielding higher scores at the common carotid arteries ( $4.3 \pm 0.6$  vs.  $3.8 \pm 0.9$ ;  $P <.001$ ) whereas CE-MRA obtained higher scores at V2- and V3-segments of the vertebral arteries ( $3.9 \pm 0.8$  vs.  $3.3 \pm 0.5$ ;  $P <.001$  and  $3.9 \pm 0.8$  vs.  $3.3 \pm 0.5$ ;  $P <.001$ ). REACT showed a lower image noise ( $3.8 \pm 0.6$  vs.  $3.6 \pm 0.7$ ;  $P=0.024$ ) with higher aSNR ( $52.5 \pm 15.1$  vs.  $37.9 \pm 12.5$ ;  $P <.001$ ) and aCNR ( $49.4 \pm 15.0$  vs.  $34.7 \pm 12.3$ ;  $P <.001$ ) than CE-MRA for all vessels combined.

#### **CONCLUSION**

In a very short scan time, highly compressed SENSE accelerated REACT provides a high sensitivity and specificity for extracranial ICA stenosis time while yielding to CE-MRA comparable vessel quality in AIS.

#### **CLINICAL RELEVANCE/APPLICATION**

Given its short acquisition time, high diagnostic performance, and sufficient image quality, REACT proves to be a clinically applicable method to depict the extracranial arteries in acute ischemic stroke.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5-STCE1-3

### Development of Theranostic $^{177}\text{Lu}$ -labeled Semiconducting Polymer Dots (pDots) for the Treatment of Head and Neck Cancer

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 1

Min-Tzu Ku, PhD, RT (*Presenter*) Nothing to Disclose

#### PURPOSE

The superior capabilities of pDots in near-infrared II (NIR-II) imaging have been demonstrated in previous studies. This study aims to develop  $^{177}\text{Lu}$ -labeled pDots and evaluate their potential as a theranostic agent for the treatment of head and neck cancer.

#### METHODS AND MATERIALS

The pDots utilized in this study were generously provided by Prof. Yang-Hsiang Chan from National Yang Ming Chiao Tung University, Taiwan. These pDots were modified with ethylenediamine through amide bond formation with carboxyl groups on their surface. Subsequently, chelates (p-SCN-Bn-DTPA) were introduced to produce DTPA-modified pDots. The radiolabeling process involved incubating  $^{177}\text{Lu}$ - $\text{LuCl}_3$  and DTPA-modified pDots in a citrate buffer solution at  $40^\circ\text{C}$  for 1 hour. To evaluate the therapeutic efficacy of  $^{177}\text{Lu}$ -pDots, SAS cells were inoculated in the right flank of nude mice. NIR-II imaging was conducted using a system equipped with a 793-nm laser generator and an InGaAs camera.

#### RESULTS

The radiochemical yield of  $^{177}\text{Lu}$ -pDots was  $8 \pm 3\%$  with high radiochemical purity. Remarkably, the radiolabeling process had no adverse impact on the size distribution and light absorption/emission properties of pDots. NIR-II imaging confirmed the successful delivery of  $^{177}\text{Lu}$ -pDots to the tumor, reaching its highest uptake at 24 hours after intravenous injection. Biodistribution studies supported these findings, showing tumor uptake values of  $7.1 \pm 1.9\% \text{ID/g}$  and  $5.2 \pm 2.1\% \text{ID/g}$  at 24 and 48 hours post-injection, respectively. Upon administering  $^{177}\text{Lu}$ -pDots and performing 793-nm laser irradiation, the tumor temperature increased to approximately  $42^\circ\text{C}$ , achieving mild photothermal therapy (PTT) conditions. However, the PTT primarily induced elevated blood vessel permeability, which facilitated subsequent drug accumulation, rather than exhibiting significant therapeutic efficacy. In the treatment studies, tumor-bearing mice treated with fractionated  $^{177}\text{Lu}$ -pDots exhibited tumor growth retardation, while both the control group and mice receiving a single round of  $^{177}\text{Lu}$ -pDots showed continuous tumor volume increase. Notably, the fractionated  $^{177}\text{Lu}$ -pDots-treated group did not experience severe body weight reduction, indicating superior biosafety.

#### CONCLUSION

In this study, we successfully developed theranostic  $^{177}\text{Lu}$ -pDots, functioning as a versatile agent for angiography, photothermal conversion, and radiotherapy.

#### CLINICAL RELEVANCE/APPLICATION

$^{177}\text{Lu}$ -pDots offer promising potential as an innovative radiopharmaceutical therapy agent for cancer treatment while also enabling noninvasive imaging for pharmacokinetic analysis. Moreover, their compatibility makes them an excellent candidate for combining radiopharmaceutical therapy with photothermal therapy.

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## Abstract Archives of the RSNA, 2023

W5-STCE2

### Science Session (Generative AI)

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 2

#### Sub-Events

#### **W5-STCE2- AI chatbots' ability to provide accurate information relevant to the informed consent process 1 for musculoskeletal radiology procedures**

Nikhil Patil (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to evaluate the accuracy of ChatGPT by OpenAI and Bard by Google's responses to prompts relevant to the informed consent process prior to musculoskeletal (MSK) radiology procedures.

#### **METHODS AND MATERIALS**

In this study we chose six common MSK procedures performed by radiologists. For each procedure, five prompts relating to procedure description, risks, benefits, alternatives, and implications of not proceeding were inputted into ChatGPT-4 and Bard. Each response was graded independently on a 5-point Likert scale by two reviewers using a grading rubric designed by two musculoskeletal radiology subspecialists. Each chatbot's response length and response time were collated and compared. Kappa Cohen coefficients and paired t-tests were used to conduct statistical analysis.

#### **RESULTS**

30 prompts across six MSK procedures were assessed. ChatGPT performed superiorly to Bard based on Likert grading of responses ( $4.4 \pm 0.8$  vs  $3.8 \pm 1.0$ ,  $p < 0.01$ ). Weighted kappa Cohen coefficients were 0.799 and 0.763 for ChatGPT and Bard responses, respectively, showing substantial inter-rater reliability. There was no significant difference in response length between ChatGPT and Bard ( $2034 \pm 361$  characters vs  $2052 \pm 462$  characters,  $p = 0.84$ ). ChatGPT's response time was significantly greater than Bard's ( $34 \pm 2$  seconds vs  $6 \pm 1$  seconds,  $p < 0.0001$ ).

#### **CONCLUSION**

ChatGPT and Bard provide generally accurate information with regards to common MSK procedure descriptions, their risks and benefits, and description of alternative options. However, neither chatbot can currently consistently provide concise, error-free, and clinically comprehensive answers. Both AI chatbots frequently provide extraneous information and rarely communicated the relative probability of risks. AI chatbots may potentially have a future role in the informed consent process alongside physician involvement.

#### **CLINICAL RELEVANCE/APPLICATION**

Informed consent prior to musculoskeletal radiology procedures is essential. The effectiveness of artificial intelligence chatbots as a potential patient resource has yet to be evaluated.

#### **W5-STCE2- Artificial intelligence chatbots' understanding of the risks and benefits of computed 2 tomography and magnetic resonance imaging scenarios**

Jia Cheng Yao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Often, patients may seek online information about imaging procedures they may potentially undergo. The purpose of this study was to assess the accuracy of information that artificial intelligence (AI) chatbots provide pertaining to common imaging scenarios' risks, benefits, and alternatives.

## METHODS AND MATERIALS

14 imaging-related scenarios pertaining to computed tomography (CT) or magnetic resonance imaging (MRI) were used. Factors such as the use of contrast, the presence of renal disease, and whether the patient was pregnant were included in this analysis. For each scenario, three prompts for outlining the 1) risks, 2) benefits, and 3) alternative imaging choices were inputted into ChatGPT and Bard. Grading criteria were generated by two staff radiologists. A 5-point Likert scale was used by two independent reviewers (senior radiology residents) to grade responses.

## RESULTS

ChatGPT performed superiorly to Bard in accurately responding to prompts per Likert grading ( $4.35 \pm 0.67$  vs  $3.25 \pm 1.03$ ,  $p < 0.0001$ ). There was substantial agreement between independent reviewer grading for ChatGPT ( $\kappa = 0.621$ ) and Bard ( $\kappa = 0.684$ ). Response length was not significantly different between ChatGPT and Bard ( $2087 \pm 256$  characters vs  $2162 \pm 369$  characters,  $p = 0.24$ ). Response time was significantly longer for ChatGPT ( $34 \pm 2$  seconds vs  $8 \pm 1$  seconds,  $p < 0.0001$ ).

## CONCLUSION

ChatGPT performed superiorly to Bard in accurately outlining risks, benefits, and alternatives to common imaging scenarios that was consistent with what radiologists at a large tertiary care center would communicate. Although both chatbots generally provided accurate information, they also typically provided vast amounts of additional information that was not directly relevant to responding to the prompt. This may exacerbate patient anxiety. Due to the lack of detailed, scientific reasoning, these AI chatbots in their current form likely would not be useful for patients seeking in depth information.

## CLINICAL RELEVANCE/APPLICATION

The effectiveness of artificial intelligence chatbots such as ChatGPT and Bard in providing accurate information relevant to medical imaging informed consent has yet to be investigated.

## W5-STCE2- Top of the Class: GPT-4 Achieves Near Perfect Score and Outperforms Popular Large Language Models in Radiology Board Exam

Mahad S. Rehman, BS, BA (*Presenter*) Nothing to Disclose

## PURPOSE

Artificial intelligence (AI) and machine learning technologies continue to advance and integrate into the medical field. Among them, large language models (LLM) hold significant potential for assisting with interpreting complex information. However, limited research has been published comparing the performance of these models. This study aims to compare the results of four well known LLMs: GPT-4, GPT-3.5, Claude, and Google Bard in answering radiology board exam-style questions. The findings of this research will provide essential insights into the efficacy of these AI models in radiology and their potential application in medical education.

## METHODS AND MATERIALS

In this exploratory prospective study performed from July 12th, 2023 to July 21st, 2023, 150 multiple-choice questions designed to match the style, content, and difficulty of the American Board of Radiology examinations were compiled. Questions containing an image component were omitted. The compiled question bank was used to query LLM accuracy. Performance by each LLM was evaluated and compared. Data were analyzed using ANOVA and chi-squared analysis followed by post-hoc analysis with Bonferroni correction ( $\alpha < 0.0125$ ).

## RESULTS

On a 150-question bank of mainly higher-order diagnostic and management multiple choice questions designed for radiology qualifying board exams, GPT-4 achieved a score of 99% (148/150) and outperformed all other LLMs in this study. GPT-3.5 generated correct responses for 64% (96/150) of questions, while Claude scored 63% (94/150), and Bard scored 41% (62/150). GPT-4 performed significantly better on the question bank when compared to GPT-3.5, Claude, and Bard ( $p < 0.001$ ). Additionally, Bard performed significantly worse than GPT-3.5 and Claude ( $p < 0.001$ ). No significant difference was found between GPT-3.5 and Claude.

## CONCLUSION

Our research revealed that GPT-4 significantly outperforms GPT-3.5, Claude, and Bard in interpreting radiology board-style questions. Notably, GPT-3.5 and Claude performed comparably, while Bard was the least effective. This indicates the rapid progression of AI and LLMs in the comprehension of complex medical information. As AI and LLMs continue to improve, they have the potential to greatly contribute to the education and proficiency of radiologists. Our results suggest that newer models, such as GPT-4, could be invaluable in supplementing medical education and radiology board exam preparation, thereby advancing the field of radiology.

## CLINICAL RELEVANCE/APPLICATION



This study underscores the improving proficiency of LLMs in interpreting radiology board-style questions, suggesting its potential as a powerful educational tool, capable of enhancing clinical decision-making and patient care.

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## Abstract Archives of the RSNA, 2023

W5-STCE2-1

### AI chatbots' ability to provide accurate information relevant to the informed consent process for musculoskeletal radiology procedures

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 2

Nikhil Patil (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the accuracy of ChatGPT by OpenAI and Bard by Google's responses to prompts relevant to the informed consent process prior to musculoskeletal (MSK) radiology procedures.

#### METHODS AND MATERIALS

In this study we chose six common MSK procedures performed by radiologists. For each procedure, five prompts relating to procedure description, risks, benefits, alternatives, and implications of not proceeding were inputted into ChatGPT-4 and Bard. Each response was graded independently on a 5-point Likert scale by two reviewers using a grading rubric designed by two musculoskeletal radiology subspecialists. Each chatbot's response length and response time were collated and compared. Kappa Cohen coefficients and paired t-tests were used to conduct statistical analysis.

#### RESULTS

30 prompts across six MSK procedures were assessed. ChatGPT performed superiorly to Bard based on Likert grading of responses ( $4.4 \pm 0.8$  vs  $3.8 \pm 1.0$ ,  $p < 0.01$ ). Weighted kappa Cohen coefficients were 0.799 and 0.763 for ChatGPT and Bard responses, respectively, showing substantial inter-rater reliability. There was no significant difference in response length between ChatGPT and Bard ( $2034 \pm 361$  characters vs  $2052 \pm 462$  characters,  $p = 0.84$ ). ChatGPT's response time was significantly greater than Bard's ( $34 \pm 2$  seconds vs  $6 \pm 1$  seconds,  $p < 0.0001$ ).

#### CONCLUSION

ChatGPT and Bard provide generally accurate information with regards to common MSK procedure descriptions, their risks and benefits, and description of alternative options. However, neither chatbot can currently consistently provide concise, error-free, and clinically comprehensive answers. Both AI chatbots frequently provide extraneous information and rarely communicated the relative probability of risks. AI chatbots may potentially have a future role in the informed consent process alongside physician involvement.

#### CLINICAL RELEVANCE/APPLICATION

Informed consent prior to musculoskeletal radiology procedures is essential. The effectiveness of artificial intelligence chatbots as a potential patient resource has yet to be evaluated.

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## Abstract Archives of the RSNA, 2023

W5-STCE2-2

### Artificial intelligence chatbots' understanding of the risks and benefits of computed tomography and magnetic resonance imaging scenarios

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 2

Jia Cheng Yao, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Often, patients may seek online information about imaging procedures they may potentially undergo. The purpose of this study was to assess the accuracy of information that artificial intelligence (AI) chatbots provide pertaining to common imaging scenarios' risks, benefits, and alternatives.

#### METHODS AND MATERIALS

14 imaging-related scenarios pertaining to computed tomography (CT) or magnetic resonance imaging (MRI) were used. Factors such as the use of contrast, the presence of renal disease, and whether the patient was pregnant were included in this analysis. For each scenario, three prompts for outlining the 1) risks, 2) benefits, and 3) alternative imaging choices were inputted into ChatGPT and Bard. Grading criteria were generated by two staff radiologists. A 5-point Likert scale was used by two independent reviewers (senior radiology residents) to grade responses.

#### RESULTS

ChatGPT performed superiorly to Bard in accurately responding to prompts per Likert grading ( $4.35 \pm 0.67$  vs  $3.25 \pm 1.03$ ,  $p < 0.0001$ ). There was substantial agreement between independent reviewer grading for ChatGPT ( $\kappa = 0.621$ ) and Bard ( $\kappa = 0.684$ ). Response length was not significantly different between ChatGPT and Bard ( $2087 \pm 256$  characters vs  $2162 \pm 369$  characters,  $p = 0.24$ ). Response time was significantly longer for ChatGPT ( $34 \pm 2$  seconds vs  $8 \pm 1$  seconds,  $p < 0.0001$ ).

#### CONCLUSION

ChatGPT performed superiorly to Bard in accurately outlining risks, benefits, and alternatives to common imaging scenarios that was consistent with what radiologists at a large tertiary care center would communicate. Although both chatbots generally provided accurate information, they also typically provided vast amounts of additional information that was not directly relevant to responding to the prompt. This may exacerbate patient anxiety. Due to the lack of detailed, scientific reasoning, these AI chatbots in their current form likely would not be useful for patients seeking in depth information.

#### CLINICAL RELEVANCE/APPLICATION

The effectiveness of artificial intelligence chatbots such as ChatGPT and Bard in providing accurate information relevant to medical imaging informed consent has yet to be investigated.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5-STCE2-3

### Top of the Class: GPT-4 Achieves Near Perfect Score and Outperforms Popular Large Language Models in Radiology Board Exam

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center Theater 2

Mahad S. Rehman, BS, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

Artificial intelligence (AI) and machine learning technologies continue to advance and integrate into the medical field. Among them, large language models (LLM) hold significant potential for assisting with interpreting complex information. However, limited research has been published comparing the performance of these models. This study aims to compare the results of four well known LLMs: GPT-4, GPT-3.5, Claude, and Google Bard in answering radiology board exam-style questions. The findings of this research will provide essential insights into the efficacy of these AI models in radiology and their potential application in medical education.

#### METHODS AND MATERIALS

In this exploratory prospective study performed from July 12th, 2023 to July 21st, 2023, 150 multiple-choice questions designed to match the style, content, and difficulty of the American Board of Radiology examinations were compiled. Questions containing an image component were omitted. The compiled question bank was used to query LLM accuracy. Performance by each LLM was evaluated and compared. Data were analyzed using ANOVA and chi-squared analysis followed by post-hoc analysis with Bonferroni correction ( $\alpha < 0.0125$ ).

#### RESULTS

On a 150-question bank of mainly higher-order diagnostic and management multiple choice questions designed for radiology qualifying board exams, GPT-4 achieved a score of 99% (148/150) and outperformed all other LLMs in this study. GPT-3.5 generated correct responses for 64% (96/150) of questions, while Claude scored 63% (94/150), and Bard scored 41% (62/150). GPT-4 performed significantly better on the question bank when compared to GPT-3.5, Claude, and Bard ( $p < 0.001$ ). Additionally, Bard performed significantly worse than GPT-3.5 and Claude ( $p < 0.001$ ). No significant difference was found between GPT-3.5 and Claude.

#### CONCLUSION

Our research revealed that GPT-4 significantly outperforms GPT-3.5, Claude, and Bard in interpreting radiology board-style questions. Notably, GPT-3.5 and Claude performed comparably, while Bard was the least effective. This indicates the rapid progression of AI and LLMs in the comprehension of complex medical information. As AI and LLMs continue to improve, they have the potential to greatly contribute to the education and proficiency of radiologists. Our results suggest that newer models, such as GPT-4, could be invaluable in supplementing medical education and radiology board exam preparation, thereby advancing the field of radiology.

#### CLINICAL RELEVANCE/APPLICATION

This study underscores the improving proficiency of LLMs in interpreting radiology board-style questions, suggesting its potential as a powerful educational tool, capable of enhancing clinical decision-making and patient care.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSIR03

### Science Session with Keynote: Interventional Radiology (Preclinical Breakthroughs)

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353B

Peiman Habibollahi, MD (*Moderator*) Nothing to Disclose  
Lynn J. Savic, MD (*Moderator*) Research Grant, Guerbet SA

#### Sub-Events

#### **W6-SSIR03-1 Ultra-High-Resolution K-Edge Imaging for Assessment Of Residual Blood Flow after Embolization with Radiopaque Beads: A Feasibility Study on a Prototype Deep-Silicon Photon-Counting Scanner**

Nariman Nezami, MD (*Presenter*) Consultant, CAPS Medical Ltd

#### PURPOSE

Photon-counting detector (PCD) CT K-edge imaging enables differentiation of multiple contrast agents and can produce co-registered density maps of these agents. PCD-CT also allows for the creation of material maps with a resolution in the range of 100-200  $\mu\text{m}$ . Iodine-filled radiopaque embolization beads are commonly used for treatment of hypervascular tumors. Differentiating between iodine-filled beads and iodine-based contrast agents (IBCA) can be challenging. The goal of this study was to assess the feasibility of using K-edge imaging of gadolinium-based contrast agents (GBCA) to create density maps of iodine and Gd for the evaluation of vascular embolization and residual blood flow in ultra-high-resolution (UHR) on a clinical deep-silicon PCD-CT prototype.

#### METHODS AND MATERIALS

We 3D-printed 7 identical models of tumor vasculature. Among these, four models were filled with either IBCA or GBCA. The remaining three models were injected with iodine-filled microspheres ( $d=100\text{-}300\ \mu\text{m}$ ), to simulate tumor embolization, and then filled with GBCA. Three tumor models were placed inside a large phantom (diameter 200 mm) filled with ballistic gel, and four tumor models were placed inside an anthropomorphic chest phantom. The phantoms were scanned on a whole-body prototype deep-Si PCD-CT scanner with 8 energy bins, at 120 kVp and 255-300 mAs, with 1 s-rotation time. Virtual monoenergetic images (VMIs), I density, and water density maps were reconstructed with filtered-backprojection (FBP) using a prototype UHR kernel with 10% modulation transfer function cutoff of 21.2 lp/cm. We estimated the concentration of IBCA and GBCA in the phantom using I density and water maps generated from the 8 bin spectral projections.

#### RESULTS

We achieved clear visualization of the embolization vessel with I-filled microspheres and the residual perfusion with GBCA. We did not detect any significant cross contamination between the two contrast agents in material density maps. The error in estimating IBCA concentration was -0.7-1.1 mg I/mL for various mixtures of IBCA (0-35 mg I/mL) with GBCA and water. The error in GBCA concentration estimates was -0.3-0.7 mg Gd/mL for mixtures of GBCA (0-10 mg Gd/mL) with IBCA and water.

#### CONCLUSION

Ultra-high-resolution spectral deep-Si PCD-CT can detect and quantify concentrations of iodine- and gadolinium-based contrast agents to assess residual blood flow in models of embolized tumors. The availability of 8 energy bins allows several materials with different K-edges to be differentiated.

#### CLINICAL RELEVANCE/APPLICATION

UHR K-edge imaging of embolized vessels makes it possible to visualize iodine in the microspheres while simultaneously measuring the residual blood flow via a second K-edge contrast agent containing materials such as Gd.

#### **W6-SSIR03-2 MRI-guided Microwave Ablation using Dual Applicators with EPI-based Real-time MR Thermometry**

Aiming Lu, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To demonstrate the feasibility of using two microwave (MW) needles simultaneously to improve the treatment efficiency of MRI-guided MW ablation (MRgMWA).

## METHODS AND MATERIALS

Ex vivo tissue experiments have demonstrated MRgMWA with two MW needles can be achieved with acceptable MR thermometry (MRT). Smaller spacing between the needles resulted in consolidated tumor coverage sooner while large spacing could potentially create a larger overall treatment zone. Based on these results, a MRgMWA procedure of a hepatic tumor on a patient was performed on a 1.5T MRI scanner using two MRI-configured MWA systems (Medwaves). IRB approval was obtained. Patient was under general anesthesia and placed on the MR table in a supine position. Under ultrasound guidance, two MW needles were inserted into the hepatic lesion ~2.7cm apart and ~10cm from the skin. Using both needles simultaneously, a 4-min MWA was first performed for 4 minutes. Next, the needles were repositioned, and a 2nd ablation was performed for 7.5 minutes. Real-time MRT was obtained during the ablations using a Visualase workstation. To minimize respiratory motion artifacts, scanning was manually synchronized with the patient's respiratory cycle. With a 3s acquisition window, one frame (5 slices) was acquired in each cycle during expiration using a multiple-shot EPI sequence. The relative position of the anterior phased array coil to the needles was adjusted to reduce noise due to electromagnetic interference (EMI). In addition, a few ablations using a single needle were also performed at different locations to cover the entire tumor.

## RESULTS

Real-time temperature maps with good image quality were obtained during the majority of the first ablation using two needles, clearly demonstrating evolution of the ablation zone surrounding each needle. However, significant noise due to intermittent EMI occurred in a few frames, which compromised the usefulness of the tissue damage map. After adjusting the coil placement (slightly increasing the distance between the coil and the needles), no such noise contamination were observed and reasonable MR thermometry were obtained throughout the 2nd ablation using two needles. Contrast-enhanced images demonstrated appropriate lack of enhancement within the lesion. Patient tolerated procedure well with no immediate complications.

## CONCLUSION

This work demonstrated that acceptable real-time MRT can be obtained during MRgMWA using two MW needles simultaneously, which could significantly increase the treatment efficiency.

## CLINICAL RELEVANCE/APPLICATION

MRgMWA using a single needle can be time-consuming for large tumors. This work demonstrated that MRgMWA using two needles can be achieved with real-time MRT to improve the treatment efficiency.

## W6- SSIR03-4 In Vivo Investigation of US-Triggered Vancomycin Release from a Novel Prophylactic Spinal Device in a Sheep Model

Flemming Forsberg, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research support, Canon Medical Systems Corporation; Research support, General Electric Company; Speaker, General Electric Company; Research support, Siemens AG; Research Grant, Butterfly Network, Inc; Research support, Lantheus Medical Imaging, Inc; Research support, Bracco Group

## PURPOSE

Bacterial infection following spinal fusion is a major clinical concern, with up to 20% incidence, despite aggressive peri-operative antibiotic treatments. Thus, we have designed and evaluated an US-activated bulk release system to combat post-surgical bacterial survival.

## METHODS AND MATERIALS

Vancomycin (VAN, 400 µg/mL) and Sonazoid were reconstituted using sterile water. PLA clips (1 cm<sup>3</sup>) were 3D-printed with an interior reservoir (0.3 cm<sup>3</sup>) for carrying drug payload. Clips were loaded with ~180 µL VAN solution and 50 µL Sonazoid (~72 mg total VAN loading). Loaded clips were sealed with a hand-crafted PLA film (0.05 ± 0.01 mm thick). Under IACUC approval, clips were surgically implanted by removing the spinous process at L2 and L5 in 8 sheep (2 sites/sheep, n = 16 sites). Sheep were recovered and allowed unrestricted exercise. Two control sheep (4 sites) were sacrificed at 96 hr post-implantation for analysis. Six sheep (12 sites) were re-anesthetized at 72 hr post-implantation and each site was insonated for 20 min using a Logiq E9 scanner with a C1-6 probe in power Doppler mode (1.7 MHz frequency, 5.4 kHz PRF, 100% power, ~146 mW/cm<sup>2</sup> intensity). After 72 hr, the animals were sacrificed for analysis. Results are reported as mean ± standard deviation. Statistical analysis was performed with GraphPad Prism 8 (a < 0.05).

## RESULTS

All sheep tolerated the procedures with no adverse effects. The PLA films on all the control clips were intact (4/4, 100%). These films were then manually punctured and the fluid remaining inside the clips was collected for analysis with Nanodrop UV-Vis. The fluid inside the clips was mostly clear in nature, similar to the initial loading solution. The cranial clips contained a

VAN solution of  $295.1 \pm 36.3$   $\mu\text{g/mL}$ , while the caudal clips contained a VAN solution of  $270.4 \pm 20.3$   $\mu\text{g/mL}$  ( $p = 0.36$  between sites). Most of the VAN solution was retained within the clips ( $p = 0.12$  compared to stock solution). The PLA films on the insonated clips were all ruptured (12/12, 100%). Any remaining fluid inside the clips was collected, and was bloody and/or cloudy in nature, further supporting film compromise and fluid exchange. Due to the cloudy and bloody nature of the retrieved remnants of fluid inside the clips, these samples could not be evaluated with UV-Vis, but wound fluid analysis via LC-MS is in progress.

#### **CONCLUSION**

These results demonstrate the ability to produce US-triggered release of an encapsulated prophylactic solution, and an important proof of concept for continuing large animal model evaluations.

#### **CLINICAL RELEVANCE/APPLICATION**

Existing methods are only partially successful in preventing infection after spinal fusion surgery. We designed an US-activated system for release of prophylactics to combat post-surgical infection.

#### **W6-SSIR03-5 Keynote Speaker**

Lynn J. Savic, MD (*Presenter*) Research Grant, Guerbet SA

#### **W6-SSIR03-6 Keynote Speaker: Bio-markers Post-Ablation: Predictors of Outcome and Guides to Therapy**

S. Nahum Goldberg, MD (*Presenter*) Consultant, Cosman Medical, Inc; Consultant, Sarasota Interventional Radiology

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSIR03-1

### Ultra-High-Resolution K-Edge Imaging for Assessment Of Residual Blood Flow after Embolization with Radiopaque Beads: A Feasibility Study on a Prototype Deep-Silicon Photon-Counting Scanner

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353B

Nariman Nezami, MD (*Presenter*) Consultant, CAPS Medical Ltd

#### PURPOSE

Photon-counting detector (PCD) CT K-edge imaging enables differentiation of multiple contrast agents and can produce co-registered density maps of these agents. PCD-CT also allows for the creation of material maps with a resolution in the range of 100-200  $\mu\text{m}$ . Iodine-filled radiopaque embolization beads are commonly used for treatment of hypervascular tumors. Differentiating between iodine-filled beads and iodine-based contrast agents (IBCA) can be challenging. The goal of this study was to assess the feasibility of using K-edge imaging of gadolinium-based contrast agents (GBCA) to create density maps of iodine and Gd for the evaluation of vascular embolization and residual blood flow in ultra-high-resolution (UHR) on a clinical deep-silicon PCD-CT prototype.

#### METHODS AND MATERIALS

We 3D-printed 7 identical models of tumor vasculature. Among these, four models were filled with either IBCA or GBCA. The remaining three models were injected with iodine-filled microspheres ( $d=100\text{-}300\ \mu\text{m}$ ), to simulate tumor embolization, and then filled with GBCA. Three tumor models were placed inside a large phantom (diameter 200 mm) filled with ballistic gel, and four tumor models were placed inside an anthropomorphic chest phantom. The phantoms were scanned on a whole-body prototype deep-Si PCD-CT scanner with 8 energy bins, at 120 kVp and 255-300 mAs, with 1 s-rotation time. Virtual monoenergetic images (VMIs), I density, and water density maps were reconstructed with filtered-backprojection (FBP) using a prototype UHR kernel with 10% modulation transfer function cutoff of 21.2 lp/cm. We estimated the concentration of IBCA and GBCA in the phantom using I density and water maps generated from the 8 bin spectral projections.

#### RESULTS

We achieved clear visualization of the embolization vessel with I-filled microspheres and the residual perfusion with GBCA. We did not detect any significant cross contamination between the two contrast agents in material density maps. The error in estimating IBCA concentration was -0.7-1.1 mg I/mL for various mixtures of IBCA (0-35 mg I/mL) with GBCA and water. The error in GBCA concentration estimates was -0.3-0.7 mg Gd/mL for mixtures of GBCA (0-10 mg Gd/mL) with IBCA and water.

#### CONCLUSION

Ultra-high-resolution spectral deep-Si PCD-CT can detect and quantify concentrations of iodine- and gadolinium-based contrast agents to assess residual blood flow in models of embolized tumors. The availability of 8 energy bins allows several materials with different K-edges to be differentiated.

#### CLINICAL RELEVANCE/APPLICATION

UHR K-edge imaging of embolized vessels makes it possible to visualize iodine in the microspheres while simultaneously measuring the residual blood flow via a second K-edge contrast agent containing materials such as Gd.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-SSIR03-2

### **MRI-guided Microwave Ablation using Dual Applicators with EPI-based Real-time MR Thermometry**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353B

Aiming Lu, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To demonstrate the feasibility of using two microwave (MW) needles simultaneously to improve the treatment efficiency of MRI-guided MW ablation (MRgMWA).

#### **METHODS AND MATERIALS**

Ex vivo tissue experiments have demonstrated MRgMWA with two MW needles can be achieved with acceptable MR thermometry (MRT). Smaller spacing between the needles resulted in consolidated tumor coverage sooner while large spacing could potentially create a larger overall treatment zone. Based on these results, a MRgMWA procedure of a hepatic tumor on a patient was performed on a 1.5T MRI scanner using two MRI-configured MWA systems (Medwaves). IRB approval was obtained. Patient was under general anesthesia and placed on the MR table in a supine position. Under ultrasound guidance, two MW needles were inserted into the hepatic lesion ~2.7cm apart and ~10cm from the skin. Using both needles simultaneously, a 4-min MWA was first performed for 4 minutes. Next, the needles were repositioned, and a 2nd ablation was performed for 7.5 minutes. Real-time MRT was obtained during the ablations using a Visualase workstation. To minimize respiratory motion artifacts, scanning was manually synchronized with the patient's respiratory cycle. With a 3s acquisition window, one frame (5 slices) was acquired in each cycle during expiration using a multiple-shot EPI sequence. The relative position of the anterior phased array coil to the needles was adjusted to reduce noise due to electromagnetic interference (EMI). In addition, a few ablations using a single needle were also performed at different locations to cover the entire tumor.

#### **RESULTS**

Real-time temperature maps with good image quality were obtained during the majority of the first ablation using two needles, clearly demonstrating evolution of the ablation zone surrounding each needle. However, significant noise due to intermittent EMI occurred in a few frames, which compromised the usefulness of the tissue damage map. After adjusting the coil placement (slightly increasing the distance between the coil and the needles), no such noise contamination were observed and reasonable MR thermometry were obtained throughout the 2nd ablation using two needles. Contrast-enhanced images demonstrated appropriate lack of enhancement within the lesion. Patient tolerated procedure well with no immediate complications.

#### **CONCLUSION**

This work demonstrated that acceptable real-time MRT can be obtained during MRgMWA using two MW needles simultaneously, which could significantly increase the treatment efficiency.

#### **CLINICAL RELEVANCE/APPLICATION**

MRgMWA using a single needle can be time-consuming for large tumors. This work demonstrated that MRgMWA using two needles can be achieved with real-time MRT to improve the treatment efficiency.

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## Abstract Archives of the RSNA, 2023

W6-SSIR03-4

### In Vivo Investigation of US-Triggered Vancomycin Release from a Novel Prophylactic Spinal Device in a Sheep Model

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353B

Flemming Forsberg, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research support, Canon Medical Systems Corporation; Research support, General Electric Company; Speaker, General Electric Company; Research support, Siemens AG; Research Grant, Butterfly Network, Inc; Research support, Lantheus Medical Imaging, Inc; Research support, Bracco Group

#### PURPOSE

Bacterial infection following spinal fusion is a major clinical concern, with up to 20% incidence, despite aggressive peri-operative antibiotic treatments. Thus, we have designed and evaluated an US-activated bulk release system to combat post-surgical bacterial survival.

#### METHODS AND MATERIALS

Vancomycin (VAN, 400  $\mu\text{g}/\text{mL}$ ) and Sonazoid were reconstituted using sterile water. PLA clips (1  $\text{cm}^3$ ) were 3D-printed with an interior reservoir (0.3  $\text{cm}^3$ ) for carrying drug payload. Clips were loaded with  $\sim 180$   $\mu\text{L}$  VAN solution and 50  $\mu\text{L}$  Sonazoid ( $\sim 72$  mg total VAN loading). Loaded clips were sealed with a hand-crafted PLA film (0.05  $\pm$  0.01 mm thick). Under IACUC approval, clips were surgically implanted by removing the spinous process at L2 and L5 in 8 sheep (2 sites/sheep, n = 16 sites). Sheep were recovered and allowed unrestricted exercise. Two control sheep (4 sites) were sacrificed at 96 hr post-implantation for analysis. Six sheep (12 sites) were re-anesthetized at 72 hr post-implantation and each site was insonated for 20 min using a Logiq E9 scanner with a C1-6 probe in power Doppler mode (1.7 MHz frequency, 5.4 kHz PRF, 100% power,  $\sim 146$   $\text{mW}/\text{cm}^2$  intensity). After 72 hr, the animals were sacrificed for analysis. Results are reported as mean  $\pm$  standard deviation. Statistical analysis was performed with GraphPad Prism 8 ( $\alpha < 0.05$ ).

#### RESULTS

All sheep tolerated the procedures with no adverse effects. The PLA films on all the control clips were intact (4/4, 100%). These films were then manually punctured and the fluid remaining inside the clips was collected for analysis with Nanodrop UV-Vis. The fluid inside the clips was mostly clear in nature, similar to the initial loading solution. The cranial clips contained a VAN solution of  $295.1 \pm 36.3$   $\mu\text{g}/\text{mL}$ , while the caudal clips contained a VAN solution of  $270.4 \pm 20.3$   $\mu\text{g}/\text{mL}$  ( $p = 0.36$  between sites). Most of the VAN solution was retained within the clips ( $p = 0.12$  compared to stock solution). The PLA films on the insonated clips were all ruptured (12/12, 100%). Any remaining fluid inside the clips was collected, and was bloody and/or cloudy in nature, further supporting film compromise and fluid exchange. Due to the cloudy and bloody nature of the retrieved remnants of fluid inside the clips, these samples could not be evaluated with UV-Vis, but wound fluid analysis via LC-MS is in progress.

#### CONCLUSION

These results demonstrate the ability to produce US-triggered release of an encapsulated prophylactic solution, and an important proof of concept for continuing large animal model evaluations.

#### CLINICAL RELEVANCE/APPLICATION

Existing methods are only partially successful in preventing infection after spinal fusion surgery. We designed an US-activated system for release of prophylactics to combat post-surgical infection.

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## Abstract Archives of the RSNA, 2023

W6-SSIR03-5

### Keynote Speaker

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353B

Lynn J. Savic, MD (*Presenter*) Research Grant, Guerbet SA

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSIR03-6

**Keynote Speaker: Bio-markers Post-Ablation: Predictors of Outcome and Guides to Therapy**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353B

S. Nahum Goldberg, MD (*Presenter*) Consultant, Cosman Medical, Inc; Consultant, Sarasota Interventional Radiology

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSNMMI06

### Science Session with Keynote: Nuclear Medicine and Molecular Imaging (Advances in Innovation and AI/Deep Learning in Nuclear Medicine and PET)

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E352

Eric M. Rohren, PhD, MD (*Moderator*) Nothing to Disclose

Pedram Heidari, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

##### W6-SSNMMI06-1 Keynote Speaker

Pedram Heidari, MD (*Presenter*) Nothing to Disclose

##### W6-SSNMMI06-2 Dual-Tracer Dynamic PET Imaging on the Long-Axial Field-Of-View PennPET Explorer: A Proof-Of-Principle Study With [<sup>18</sup>F]Fluoroglutamine and [<sup>18</sup>F]Fluorodeoxyglucose

Daniel Kwon, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Multi-tracer imaging would facilitate patient logistics, while providing the most accurate complementary molecular information of the patient's disease. Taking advantage of increased sensitivity of the long axial field-of-view (AFOV) PennPET Explorer, we assessed the feasibility of a dynamic dual-PET tracer study using [<sup>18</sup>F]FDG and [<sup>18</sup>F]Fluoroglutamine (FGln) for both diagnosis and kinetic modeling in a patient with primary ER+/PR-/HER2- breast cancer.

#### METHODS AND MATERIALS

Dynamic PET imaging using a 7-10 mCi dose of [<sup>18</sup>F]FGln with a 60 min scan duration was used to determine the volume of distribution (VD) of breast tumors, an indirect measure of glutamine metabolism. By subsampling to emulate lower doses, we showed the PennPET Explorer (AFOV = 1.4 m) enables accurate calculation of the VD with a 1 mCi dose and an scan duration of 30 minutes. A patient was injected with 1.1 mCi of [<sup>18</sup>F]FGln and scanned for 29 minutes, and then was injected with 11.3 mCi of [<sup>18</sup>F]FDG and scanned for 60 minutes. Two volumes of interest were drawn over the tumor and left ventricle, representing tumor and plasma radioactivity. A one tissue-two compartment, and a two tissue-three compartment model was used to model [<sup>18</sup>F]FGln and [<sup>18</sup>F]FDG kinetics, respectively. We projected the [<sup>18</sup>F]FGln signal using Laplace transformation and Adam-Bashforth approximation. We deconvoluted the [<sup>18</sup>F]FDG signal by subtracting the absolute measured uptake by the projected [<sup>18</sup>F]FGln signal. Kinetics analyses were performed using Pmod (ver 3.7) and compared to that of mfEvolve's Multi-Tracer analysis.

#### RESULTS

We obtained diagnostic-quality PET images and kinetic parameters of both [<sup>18</sup>F]FGln and [<sup>18</sup>F]FDG in a single scanning session. The SUVMean and VD of [<sup>18</sup>F]FGln was 2.2 and 0.857 mL/cm<sup>3</sup>, respectively. [<sup>18</sup>F]FDG at 60 minutes post-injection showed a negligible difference between uncorrected SUVMean and corrected SUVMean (2.96 and 2.91). In contrast, the Ki of the uncorrected and corrected [<sup>18</sup>F]FDG kinetics were 0.0174 mL/min/cm<sup>3</sup> and 0.0154 mL/min/cm<sup>3</sup>, respectively (11.5% difference). MFEvolve multi-tracer kinetics also showed a Ki of 0.0154 mL/min/cm<sup>3</sup>.

#### CONCLUSION

We show the feasibility of dual-tracer imaging with the same radioisotope (<sup>18</sup>F) using acceptable doses of PET tracers through the PennPET Explorer. While minimal differences were found between the convoluted and deconvoluted [<sup>18</sup>F]FDG uptakes, accurate kinetics measurements require deconvolution. Future large-scale studies are required to validate this approach for clinical use using conventional PET-CT scanners.

## CLINICAL RELEVANCE/APPLICATION

We validate one of the first clinical dual-tracer PET imaging studies to facilitate patient logistics and convey the most accurate picture of the patient's disease.

### W6- SSNMMI06- LAMP-1 Targeted PET Imaging for Detection of Adenocarcinomas

3

Bahar Ataenia, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Lysosomal-associated membrane protein 1 (LAMP-1) is mainly expressed on the lysosomal membrane, and its cell surface localization is suggested to be involved in cancer progression, invasion, and metastasis. An increase in the proportion of cell surface displayed LAMP-1 compared to total cellular expression is suggested to increase the risk of metastasis. This study is the first to investigate LAMP-1 as an imaging target in cancer.

#### METHODS AND MATERIALS

Anti-LAMP-1 monoclonal antibody was conjugated to deferoxamine and labeled with <sup>89</sup>Zirconium. Pooled IgG was used as the negative control probe. MDA-MB-231 breast cancer and Caco2 colon cancer cell lines were implanted subcutaneously in nude mice. Mice underwent imaging by either the anti-LAMP-1 or the control probe. PET/CT imaging was performed 24, 72, and 168 hours post-injection. Tissue microarrays (TMAs) of breast, colon, and prostate cancer and their corresponding normal tissue were stained for LAMP-1. Pan-cancer bioinformatics analysis was performed on publicly available datasets to assess the expandability of the results to other cancers. Spatial transcriptomic analysis was performed on a breast ductal carcinoma public dataset.

#### RESULTS

Tumors were visible on PET as early as 24 hours post-injection. The LAMP-1 probe had significantly higher uptake compared to the control IgG probe in both models at all three imaging time points (MDA-MB-231 SUV<sub>max</sub> at 168h:  $12.96 \pm 5.68$  vs.  $4.39 \pm 2.41$ , p-value = 0.003 and Caco2 SUV<sub>max</sub> at 168h:  $8.53 \pm 3.03$  vs.  $3.38 \pm 1.25$ , p-value < 0.001). The mean fluorescent signal intensity of LAMP-1 in malignant TMA cores of the prostate ( $2872 \pm 1105$  vs.  $948 \pm 497.9$ , p-value < 0.05), pancreas ( $1785.8 \pm 1238.61$  vs.  $403.33 \pm 453.5$ , p-value < 0.05), colon ( $2597 \pm 1829$  vs.  $304 \pm 128$ , p-value < 0.01) and breast ( $3077 \pm 621$  vs.  $380 \pm 25$ , p-value < 0.05) were significantly higher compared to normal tissue. LAMP-1 gene expression was higher in malignant breast, colon, esophagus, stomach, pancreas, and prostate samples compared to the related normal samples (p-value < 0.0001 for all). The expression of LAMP-1 was higher in ductal regions compared to other regions of breast ductal carcinoma samples in the spatial transcriptomic analysis.

#### CONCLUSION

Imaging of the cell surface expressed LAMP-1 in breast and colon cancer is feasible by immunoPET. LAMP-1 targeting can be expanded to carcinomas of other origins based on the supporting genomic and proteomic evidence. Therefore, LAMP-1 has a strong potential as a theranostic target in cancer.

## CLINICAL RELEVANCE/APPLICATION

LAMP-1 targeted theranostics can improve patient outcomes by enabling timely diagnosis and personalized, targeted therapy for breast and colon adenocarcinomas. This approach can be expanded to other epithelial carcinomas.

### W6- SSNMMI06- Torso Synthetic CT Generation by Integrating Deep Learning and Segmentation for PET/MR

4

Jin Uk Heo, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Positron Emission Tomography (PET)/Magnetic Resonance (MR) is an imaging modality with several advantages over PET/CT, such as superior soft tissue contrast and simultaneous PET and MR acquisition. While PET/CT using fluorodeoxyglucose (FDG) is crucial in oncology for diagnosis and staging, accurate MR-based attenuation correction (MRAC) remains challenging. Consequently, Standard Uptake Values (SUVs), normalized radiotracer concentration values, are not accurate. To resolve this, using a synthetic CT (sCT) for MRAC has become the preferred approach. Nevertheless, sCT generation using deep convolutional neural networks (DCNN) for torso imaging, the most common FDG-PET field of view, has not yet been solved.

#### METHODS AND MATERIALS

Using Dixon MR data, our proposed method, URcGANmod, combines a DCNN architecture that integrates U-net Residual Network conditional Generative Adversarial Network model (URcGAN) to generate a preliminary sCT, and a segmentation technique identifying air voxels to reduce SUV error, particularly in the lung. The DCNN employs overlapping patches to allow the generalizability of applying the trained network for body-specific PET/MR applications. We recruited 29 patients undergoing clinical FDG-PET/CT scans to receive PET/MR scans. We compared our method against four methods: 1)

threshold-based segmentation, 2) machine learning-based voxel-wise segmentation (TFCALC) which was previously successful in the abdominopelvic region, 3) TFCALC with the segmentation (TFCALCmod), and 4) URcGAN.

## **RESULTS**

Using 15 training dataset, the proposed method generates superior sCT image quality than other methods with mean absolute difference of  $32 \pm 4$  HU per voxel. The DCNN-based methods (URcGAN and URcGANmod) achieve better SUV accuracy with less than 0.007 g/mL SUV mean error and less than 10% SUV error with a standard deviation of less than 6%. Our proposed method can generate sCT in approximately 30 seconds, which is clinically practical.

## **CONCLUSION**

We demonstrated the feasibility of combining DCNN and segmentation to improve MRAC accuracy in torso FDG-PET/MR. By utilizing all four Dixon sequence images, our method improves SUV accuracy in the lungs and archives less than 10% SUV error for all evaluated organs. Considering the accuracy of sCT and SUV, our proposed method warrants further studies in longitudinal multicenter trials.

## **CLINICAL RELEVANCE/APPLICATION**

Our proposed method has the potential to improve the quantitative accuracy and reliability of FDG-SUV in torso PET/MR imaging, thereby supporting quantitative monitoring of disease progression and treatment response and harmonization needed for multicenter clinical trials. Additionally, the sCT could be used to support MR-only Radiation Treatment.

## **W6-           Keynote Speaker**

**SSNMMI06-**

**6**

Eric M. Rohren, PhD, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSNMMI06-1

### Keynote Speaker

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E352

Pedram Heidari, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-SSNMMI06-2

### Dual-Tracer Dynamic PET Imaging on the Long-Axial Field-Of-View PennPET Explorer: A Proof-Of-Principle Study With [ $^{18}\text{F}$ ]Fluoroglutamine and [ $^{18}\text{F}$ ]Fluorodeoxyglucose

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E352

Daniel Kwon, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Multi-tracer imaging would facilitate patient logistics, while providing the most accurate complementary molecular information of the patient's disease. Taking advantage of increased sensitivity of the long axial field-of-view (AFOV) PennPET Explorer, we assessed the feasibility of a dynamic dual-PET tracer study using [ $^{18}\text{F}$ ]FDG and [ $^{18}\text{F}$ ]Fluoroglutamine (FGln) for both diagnosis and kinetic modeling in a patient with primary ER+/PR-/HER2- breast cancer.

#### METHODS AND MATERIALS

Dynamic PET imaging using a 7-10 mCi dose of [ $^{18}\text{F}$ ]FGln with a 60 min scan duration was used to determine the volume of distribution (VD) of breast tumors, an indirect measure of glutamine metabolism. By subsampling to emulate lower doses, we showed the PennPET Explorer (AFOV = 1.4 m) enables accurate calculation of the VD with a 1 mCi dose and an scan duration of 30 minutes. A patient was injected with 1.1 mCi of [ $^{18}\text{F}$ ]FGln and scanned for 29 minutes, and then was injected with 11.3 mCi of [ $^{18}\text{F}$ ]FDG and scanned for 60 minutes. Two volumes of interest were drawn over the tumor and left ventricle, representing tumor and plasma radioactivity. A one tissue-two compartment, and a two tissue-three compartment model was used to model [ $^{18}\text{F}$ ]FGln and [ $^{18}\text{F}$ ]FDG kinetics, respectively. We projected the [ $^{18}\text{F}$ ]FGln signal using Laplace transformation and Adam-Bashforth approximation. We deconvoluted the [ $^{18}\text{F}$ ]FDG signal by subtracting the absolute measured uptake by the projected [ $^{18}\text{F}$ ]FGln signal. Kinetics analyses were performed using Pmod (ver 3.7) and compared to that of mFEvolve's Multi-Tracer analysis.

#### RESULTS

We obtained diagnostic-quality PET images and kinetic parameters of both [ $^{18}\text{F}$ ]FGln and [ $^{18}\text{F}$ ]FDG in a single scanning session. The SUVMean and VD of [ $^{18}\text{F}$ ]FGln was 2.2 and 0.857 mL/cm<sup>3</sup>, respectively. [ $^{18}\text{F}$ ]FDG at 60 minutes post-injection showed a negligible difference between uncorrected SUVMean and corrected SUVMean (2.96 and 2.91). In contrast, the Ki of the uncorrected and corrected [ $^{18}\text{F}$ ]FDG kinetics were 0.0174 mL/min/cm<sup>3</sup> and 0.0154 mL/min/cm<sup>3</sup>, respectively (11.5% difference). MFEvolve multi-tracer kinetics also showed a Ki of 0.0154 mL/min/cm<sup>3</sup>.

#### CONCLUSION

We show the feasibility of dual-tracer imaging with the same radioisotope ( $^{18}\text{F}$ ) using acceptable doses of PET tracers through the PennPET Explorer. While minimal differences were found between the convoluted and deconvoluted [ $^{18}\text{F}$ ]FDG uptakes, accurate kinetics measurements require deconvolution. Future large-scale studies are required to validate this approach for clinical use using conventional PET-CT scanners.

#### CLINICAL RELEVANCE/APPLICATION

We validate one of the first clinical dual-tracer PET imaging studies to facilitate patient logistics and convey the most accurate picture of the patient's disease.

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## Abstract Archives of the RSNA, 2023

W6-SSNMMI06-3

### LAMP-1 Targeted PET Imaging for Detection of Adenocarcinomas

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E352

Bahar Ataeinia, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Lysosomal-associated membrane protein 1 (LAMP-1) is mainly expressed on the lysosomal membrane, and its cell surface localization is suggested to be involved in cancer progression, invasion, and metastasis. An increase in the proportion of cell surface displayed LAMP-1 compared to total cellular expression is suggested to increase the risk of metastasis. This study is the first to investigate LAMP-1 as an imaging target in cancer.

#### METHODS AND MATERIALS

Anti-LAMP-1 monoclonal antibody was conjugated to deferoxamine and labeled with <sup>89</sup>Zirconium. Pooled IgG was used as the negative control probe. MDA-MB-231 breast cancer and Caco2 colon cancer cell lines were implanted subcutaneously in nude mice. Mice underwent imaging by either the anti-LAMP-1 or the control probe. PET/CT imaging was performed 24, 72, and 168 hours post-injection. Tissue microarrays (TMAs) of breast, colon, and prostate cancer and their corresponding normal tissue were stained for LAMP-1. Pan-cancer bioinformatics analysis was performed on publicly available datasets to assess the expandability of the results to other cancers. Spatial transcriptomic analysis was performed on a breast ductal carcinoma public dataset.

#### RESULTS

Tumors were visible on PET as early as 24 hours post-injection. The LAMP-1 probe had significantly higher uptake compared to the control IgG probe in both models at all three imaging time points (MDA-MB-231 SUV<sub>max</sub> at 168h:  $12.96 \pm 5.68$  vs.  $4.39 \pm 2.41$ , p-value = 0.003 and Caco2 SUV<sub>max</sub> at 168h:  $8.53 \pm 3.03$  vs.  $3.38 \pm 1.25$ , p-value < 0.001). The mean fluorescent signal intensity of LAMP-1 in malignant TMA cores of the prostate ( $2872 \pm 1105$  vs.  $948 \pm 497.9$ , p-value < 0.05), pancreas ( $1785.8 \pm 1238.61$  vs.  $403.33 \pm 453.5$ , p-value < 0.05), colon ( $2597 \pm 1829$  vs.  $304 \pm 128$ , p-value < 0.01) and breast ( $3077 \pm 621$  vs.  $380 \pm 25$ , p-value < 0.05) were significantly higher compared to normal tissue. LAMP-1 gene expression was higher in malignant breast, colon, esophagus, stomach, pancreas, and prostate samples compared to the related normal samples (p-value < 0.0001 for all). The expression of LAMP-1 was higher in ductal regions compared to other regions of breast ductal carcinoma samples in the spatial transcriptomic analysis.

#### CONCLUSION

Imaging of the cell surface expressed LAMP-1 in breast and colon cancer is feasible by immunoPET. LAMP-1 targeting can be expanded to carcinomas of other origins based on the supporting genomic and proteomic evidence. Therefore, LAMP-1 has a strong potential as a theranostic target in cancer.

#### CLINICAL RELEVANCE/APPLICATION

LAMP-1 targeted theranostics can improve patient outcomes by enabling timely diagnosis and personalized, targeted therapy for breast and colon adenocarcinomas. This approach can be expanded to other epithelial carcinomas.

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## Abstract Archives of the RSNA, 2023

W6-SSNMMI06-4

### Torso Synthetic CT Generation by Integrating Deep Learning and Segmentation for PET/MR Attenuation Correction

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E352

Jin Uk Heo, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Positron Emission Tomography (PET)/Magnetic Resonance (MR) is an imaging modality with several advantages over PET/CT, such as superior soft tissue contrast and simultaneous PET and MR acquisition. While PET/CT using fluorodeoxyglucose (FDG) is crucial in oncology for diagnosis and staging, accurate MR-based attenuation correction (MRAC) remains challenging. Consequently, Standard Uptake Values (SUVs), normalized radiotracer concentration values, are not accurate. To resolve this, using a synthetic CT (sCT) for MRAC has become the preferred approach. Nevertheless, sCT generation using deep convolutional neural networks (DCNN) for torso imaging, the most common FDG-PET field of view, has not yet been solved.

#### METHODS AND MATERIALS

Using Dixon MR data, our proposed method, URcGANmod, combines a DCNN architecture that integrates U-net Residual Network conditional Generative Adversarial Network model (URcGAN) to generate a preliminary sCT, and a segmentation technique identifying air voxels to reduce SUV error, particularly in the lung. The DCNN employs overlapping patches to allow the generalizability of applying the trained network for body-specific PET/MR applications. We recruited 29 patients undergoing clinical FDG-PET/CT scans to receive PET/MR scans. We compared our method against four methods: 1) threshold-based segmentation, 2) machine learning-based voxel-wise segmentation (TFCALC) which was previously successful in the abdominopelvic region, 3) TFCALC with the segmentation (TFCALCmod), and 4) URcGAN.

#### RESULTS

Using 15 training dataset, the proposed method generates superior sCT image quality than other methods with mean absolute difference of  $32 \pm 4$  HU per voxel. The DCNN-based methods (URcGAN and URcGANmod) achieve better SUV accuracy with less than 0.007 g/mL SUV mean error and less than 10% SUV error with a standard deviation of less than 6%. Our proposed method can generate sCT in approximately 30 seconds, which is clinically practical.

#### CONCLUSION

We demonstrated the feasibility of combining DCNN and segmentation to improve MRAC accuracy in torso FDG-PET/MR. By utilizing all four Dixon sequence images, our method improves SUV accuracy in the lungs and archives less than 10% SUV error for all evaluated organs. Considering the accuracy of sCT and SUV, our proposed method warrants further studies in longitudinal multicenter trials.

#### CLINICAL RELEVANCE/APPLICATION

Our proposed method has the potential to improve the quantitative accuracy and reliability of FDG-SUV in torso PET/MR imaging, thereby supporting quantitative monitoring of disease progression and treatment response and harmonization needed for multicenter clinical trials. Additionally, the sCT could be used to support MR-only Radiation Treatment.

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## Abstract Archives of the RSNA, 2023

W6-SSNMMI06-6

### Keynote Speaker

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E352

Eric M. Rohren, PhD, MD (*Presenter*) Nothing to Disclose

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## Abstract Archives of the RSNA, 2023

W6-SSOB03

### OB/Gynecology (Pelvic Malignancy)

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S405

Yuliya Lakhman, MD (*Moderator*) Stockholder, Y-mAbs Therapeutics Inc; Consultant, Perceptive Informatics, LLC  
Priyanka Jha, MBBS (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W6-SSOB03-1 DWI Radiomics Model for Endometrial Cancer Risk Stratification Correlates with Tumor Choline Metabolism Using MR Spectroscopy**

Yen Po Lin, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Radiomics models offer little explainability due to a lack of biological insights. The study aims to develop a radiomics risk model using routine DW MRI to predict the high-risk group for nodal metastasis or cancer recurrence in endometrial cancer and correlate the model with the choline levels and metabolic pathways.

#### METHODS AND MATERIALS

Between August 2015 and July 2018, 356 patients with pre-treatment DWI MRI were recruited and had 105 volumetric radiomic features extracted from each tumor. A radiomic risk score (Rad-Score) was developed using the LASSO regression model to predict nodal metastasis or cancer recurrence in the training cohort (n=287) and validated in the validation cohort (n=69); furthermore, 230 patients underwent 1H MR spectroscopy to evaluate tumor choline levels, and endometrial tumors (n=70) were analyzed using a high-resolution NMR system to correlate tissue levels of choline-related metabolites. Student's-t test was used to compare high- and low-risk groups and the McNemar test to compare the performance of Rad-Score and ESMO classification.  $P < .05$  was used for statistical significance.

#### RESULTS

Seventeen selected radiomics features were further incorporated into a Rad-Signature along with pre-operative clinical parameters including age, clinical tumor size, histopathology (endometrial vs. non-endometrioid), and histological grade (1 and 2 vs. 3). The Rad-Signature accurately discriminated nodal metastasis or recurrence in the test set, with a sensitivity of 78.6%, specificity of 74.5%, and accuracy of 75.4%, showing comparable performance with the post-operatively based ESMO classification: sensitivity of 85.7%, specificity of 76.4%, and accuracy of 78.3%. Radiometabolic analysis found significant associations between Rad-Score and increased endometrial total choline levels on 1H MR spectroscopy ( $P = .034$ ) and increased in tissue levels ( $P = .019$ ).

#### CONCLUSION

High-risk patients with endometrial cancer may have increased choline metabolism that could be linked to the radiomic risk model generated from routine DWI MRI.

#### CLINICAL RELEVANCE/APPLICATION

By developing a radiomic risk score using routine DW MRI and establishing its association with increased choline metabolism, this study shows promising translational relevance in providing a personalized approach to therapy for high-risk endometrial cancer patients.

#### **W6-SSOB03-4 Performance of Preoperative Radiological Peritoneal Index and its Agreement with Laparoscopic findings to Predict Suboptimal Primary Debulking Surgery in Ovarian Cancer**

Giuseppe Avesani, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Upfront cytoreduction is considered the best therapeutic option for ovarian cancer, but only if complete; the most used tool to predict complete resection is the Peritoneal Index (PI), which is based on laparoscopic findings. Our first aim is to investigate the performance of radiological PI assessed on preoperative CTs to predict incomplete debulking; the secondary objectives are to evaluate the agreement between radiological and laparoscopic PI and the reproducibility of radiological PI among different radiologists.

## METHODS AND MATERIALS

In this IRB-approved observational study, we prospectively collected CTs of patients with ovarian cancer candidates for primary debulking surgery between January 2021 and December 2022. We analyzed the 6 parameters of PI (diaphragm, liver surface, great omentum, parietal peritoneum, stomach wall/lesser omentum and intestinal involvement); we also noted if mesenteric retraction or hepatic hilum involvement were present (absolute contraindications to surgery). The involvement of each parameter was independently assessed by two radiologists with 3 and 10 years of expertise in gynecologic imaging before surgery and compared with laparoscopic findings (standard of reference). As for the laparoscopic PI, a radiological PI=8 was considered predictive of unresectable surgery. Discrepancies were solved by consensus. The performance of radiological PI was tested by calculating sensitivity, specificity, positive and negative predictive values and accuracy. The agreement was assessed by using weighted Cohen's K coefficient.

## RESULTS

We included 145 patients. The radiological PI showed a sensitivity of 0.54 (0.95 CI 0.38-0.70), specificity of 0.93 (CI 0.88-0.97), positive predictive value of 0.68 (CI 0.50-0.83) and negative predictive value of 0.89 (CI 0.82-0.94), with an overall accuracy of 0.85 (CI 0.79-0.90). The Cohen's K coefficient of radiological and laparoscopic PI was 0.76 for diaphragm, 0.80 for liver surface, 0.90 for great omentum, 0.78 for parietal peritoneum, and 0.67 for parietal peritoneum stomach wall/lesser omentum, 0.52 for intestinal involvement and 0.47 for mesenteric involvement. The overall agreement between radiologists was 0.72.

## CONCLUSION

Radiologic PI had good overall accuracy in predicting incomplete surgical debulking and showed good reproducibility among radiologists. The agreement with laparoscopic PI was good, with the weakest agreement for mesenteric and intestinal involvement. However, its sensitivity was too low for patients' surgery selection.

## CLINICAL RELEVANCE/APPLICATION

CT is a useful tool for surgical planning; the radiological PI may help in programming the right surgical procedures but cannot be used as a screening tool for surgery selection.

## W6-SSOB03-5 Feasibility of Synthetic Magnetic Resonance Imaging for Deciding Whether Neoadjuvant Chemoradiotherapy and Predicting its Short-term Efficacy in Cervical Cancer: Comparison with High Resolution T2WI and DWI

Xiaorong Ou (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the feasibility of a synthetic MRI sequence (MAGnetic resonance imaging Compilation; MAGiC) for deciding whether neoadjuvant chemoradiotherapy (NCRT) and predicting its short-term efficacy (STE) in the cervical cancer (CC) patients, in comparison to high resolution T2-weighted imaging (hrT2WI) and diffusion weighted imaging (DWI).

## METHODS AND MATERIALS

The study protocol was approved by the local Research Ethics Committee. Informed consent was obtained from all subjects. 244 patients suspected of CC were enrolled and undergone the pre-treatment MAGIC, conventional MRI (hrT2WI) and DWI on 3.0T MRI (the parameter presented in Table 1). For those CC patients underwent NCRT, hrT2WI were performed again at 2 months after NCRT for evaluating STE (completed response (CR) and no-CR group). MAGIC can generate synthetic morphologic images (synthetic T2WI, syT2WI) and quantitative synthetic images (synthetic T1, T2 and PD maps) (Fig 1). For the syT2WI, the tumor staging was assessed and decided whether NCRT for CC patients (hrT2WI as the reference). For the quantitative synthetic images, T1, T2, PD value were measured by regions of interests (ROIs) (Fig 2) to analysis the predictive performance of STE after NCRT (apparent diffusion coefficient (ADC) as the reference). In addition, the image quality of syT2WI and hrT2WI were assessed with 4-point scale for each of anatomical details display, distortion, artifacts and lesion conspicuity.

## RESULTS

44 out of 75 confirmed CC patients were performed NCRT and followed up at least 2 months (Fig 3). For the image quality, syT2WI was no significant differences with comparison of hrT2WI in above four aspects (All  $P > 0.05$ ; Table 2, Fig 2). For deciding whether NCRT, the accuracy, sensitivity, and specificity of sy-T2WI were 0.899, 0.947 and 0.999 in CC patients (Table 3). For the quantitative synthetic images, T2, T1 and ADC values had a significant differences to identified CR from no-CR

groups ( $P < 0.05$ ) but PD ( $P > 0.05$ ; Table 4). Furthermore, T2 (AUC: 0.825) and T1 value (AUC: 0.795) had a similar predictive performance for STE after NCRT compared with ADC (AUC: 0.789, all  $P > 0.05$ ) (Table 5, Fig 4). However, T1 combined T2 could not improve the predictive performance for STE with comparison of ADC (AUC: 0.818 vs 0.789)(Table 5, Fig 4).

## CONCLUSION

MAGiC can derive synthetic morphologic images and quantitative synthetic images in one acquisition, which is a promising technique and feasibility for accurately deciding whether NCRT and predicting STE in CC patients.

## CLINICAL RELEVANCE/APPLICATION

MAGiC is a reliable technique for facilitating the synthetic morphologic images and quantitative synthetic images, which should be as an alternative of hrT2WI and DWI for deciding whether NCRT and predicting STE in CC patients.

## W6-SSOB03-6 Preoperative Staging by [<sup>18</sup>F]FDG-PET/CT in a Large Endometrial Cancer Cohort: Diagnostic Performance, Incidental Findings and Therapeutic Delay

Ankush Gulati (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the diagnostic performance of PET/CT when using FDG-positive locoregional lymph nodes and metabolic primary tumor volume (MTV) for predicting lymph node metastases (LNM) and disease-specific survival in a large endometrial cancer (EC) cohort. To assess the extent and nature of incidental PET-CT findings and their impact on therapeutic delay.

## METHODS AND MATERIALS

In 559 EC patients (among whom 58% (327/559) underwent lymphadenectomy), the preoperative FDG-PET/CT parameters FDG-positive (SUVmax  $>2.5$ ) locoregional lymph nodes (FDGposLN) and MTV (primary tumor volume with standard uptake value [SUV]  $>2.5$ ) were retrospectively recorded. The diagnostic performance of FDGposLN and MTV for predicting LNM and disease-specific survival was compared using area under the receiver operating characteristic curves (ROC AUC) and Kaplan-Meier curves with log rank test, respectively. All reported incidental FDG-PET/CT findings and results from subsequent follow-ups were recorded. Time between FDG-PET/CT and primary EC treatment was compared between groups with/without incidental FDG-PET/CT findings.

## RESULTS

FDGposLN/MTV yielded AUCs of 0.73/0.72 for predicting LNM (verified by histology). FDG positive lymph nodes and high MTV ( $>27$  ml) were significantly associated with poor disease-specific survival ( $p < 0.001$  for both). Incidental PET/CT findings were reported in 31% (172/559) of the EC cohort, which was followed by follow-up examinations in 22% (125/559). These examinations led to the diagnosis of synchronous cancers in 15/559 (2.7%) patients [breast- (n=4), thyroid- (n=4), colon- (n=1), lung- (n=2) cancers and lymphoma (n=4)], and premalignant colonic polyps in 9/563 (1.6%) patients. Among all patients undergoing PET/CT (n=559), 10% (57/559) had their follow-up examination due to incidental PET/CT finding before start of primary EC treatment. Median time between FDG-PET/CT and primary EC treatment was 28 days (inter quartile range (IQR): 21-35) in this patient group (n=57), versus 15 days (IQR 8-23) in the remaining EC cohort (n=506).

## CONCLUSION

FDG positive lymph nodes and MTV  $>27$  ml yield similar performance for predicting LNM preoperatively, and both FDG markers indicate poor prognosis. Incidental PET/CT findings requiring clarification before primary EC treatment led to a small treatment delay, while uncovering synchronous primary cancers in 2.7% of the EC patients.

## CLINICAL RELEVANCE/APPLICATION

Preoperative FDG-PET/CT is valuable for predicting metastatic lymph nodes and prognosis in EC. Incidental findings are common (in 31%) and represent synchronous cancer in 2.7%, but does not cause considerable therapeutic delay.

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## Abstract Archives of the RSNA, 2023

W6-SSOB03-1

### **DWI Radiomics Model for Endometrial Cancer Risk Stratification Correlates with Tumor Choline Metabolism Using MR Spectroscopy**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S405

Yen Po Lin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiomics models offer little explainability due to a lack of biological insights. The study aims to develop a radiomics risk model using routine DW MRI to predict the high-risk group for nodal metastasis or cancer recurrence in endometrial cancer and correlate the model with the choline levels and metabolic pathways.

#### **METHODS AND MATERIALS**

Between August 2015 and July 2018, 356 patients with pre-treatment DWI MRI were recruited and had 105 volumetric radiomic features extracted from each tumor. A radiomic risk score (Rad-Score) was developed using the LASSO regression model to predict nodal metastasis or cancer recurrence in the training cohort (n=287) and validated in the validation cohort (n=69); furthermore, 230 patients underwent 1H MR spectroscopy to evaluate tumor choline levels, and endometrial tumors (n=70) were analyzed using a high-resolution NMR system to correlate tissue levels of choline-related metabolites. Student's-t test was used to compare high- and low-risk groups and the McNemar test to compare the performance of Rad-Score and ESMO classification.  $P < .05$  was used for statistical significance.

#### **RESULTS**

Seventeen selected radiomics features were further incorporated into a Rad-Signature along with pre-operative clinical parameters including age, clinical tumor size, histopathology (endometrial vs. non-endometrioid), and histological grade (1 and 2 vs. 3). The Rad-Signature accurately discriminated nodal metastasis or recurrence in the test set, with a sensitivity of 78.6%, specificity of 74.5%, and accuracy of 75.4%, showing comparable performance with the post-operatively based ESMO classification: sensitivity of 85.7%, specificity of 76.4%, and accuracy of 78.3%. Radiometabolic analysis found significant associations between Rad-Score and increased endometrial total choline levels on 1H MR spectroscopy ( $P = .034$ ) and increased in tissue levels ( $P = .019$ ).

#### **CONCLUSION**

High-risk patients with endometrial cancer may have increased choline metabolism that could be linked to the radiomic risk model generated from routine DWI MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

By developing a radiomic risk score using routine DW MRI and establishing its association with increased choline metabolism, this study shows promising translational relevance in providing a personalized approach to therapy for high-risk endometrial cancer patients.

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## Abstract Archives of the RSNA, 2023

W6-SSOB03-4

### Performance of Preoperative Radiological Peritoneal Index and its Agreement with Laparoscopic findings to Predict Suboptimal Primary Debulking Surgery in Ovarian Cancer

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S405

Giacomo Avesani, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Upfront cytoreduction is considered the best therapeutic option for ovarian cancer, but only if complete; the most used tool to predict complete resection is the Peritoneal Index (PI), which is based on laparoscopic findings. Our first aim is to investigate the performance of radiological PI assessed on preoperative CTs to predict incomplete debulking; the secondary objectives are to evaluate the agreement between radiological and laparoscopic PI and the reproducibility of radiological PI among different radiologists.

#### METHODS AND MATERIALS

In this IRB-approved observational study, we prospectively collected CTs of patients with ovarian cancer candidates for primary debulking surgery between January 2021 and December 2022. We analyzed the 6 parameters of PI (diaphragm, liver surface, great omentum, parietal peritoneum, stomach wall/lesser omentum and intestinal involvement); we also noted if mesenteric retraction or hepatic hilum involvement were present (absolute contraindications to surgery). The involvement of each parameter was independently assessed by two radiologists with 3 and 10 years of expertise in gynecologic imaging before surgery and compared with laparoscopic findings (standard of reference). As for the laparoscopic PI, a radiological PI=8 was considered predictive of unresectable surgery. Discrepancies were solved by consensus. The performance of radiological PI was tested by calculating sensitivity, specificity, positive and negative predictive values and accuracy. The agreement was assessed by using weighted Cohen's K coefficient.

#### RESULTS

We included 145 patients. The radiological PI showed a sensitivity of 0.54 (0.95 CI 0.38-0.70), specificity of 0.93 (CI 0.88-0.97), positive predictive value of 0.68 (CI 0.50-0.83) and negative predictive value of 0.89 (CI 0.82-0.94), with an overall accuracy of 0.85 (CI 0.79-0.90). The Cohen's K coefficient of radiological and laparoscopic PI was 0.76 for diaphragm, 0.80 for liver surface, 0.90 for great omentum, 0.78 for parietal peritoneum, and 0.67 for parietal peritoneum stomach wall/lesser omentum, 0.52 for intestinal involvement and 0.47 for mesenteric involvement. The overall agreement between radiologists was 0.72.

#### CONCLUSION

Radiologic PI had good overall accuracy in predicting incomplete surgical debulking and showed good reproducibility among radiologists. The agreement with laparoscopic PI was good, with the weakest agreement for mesenteric and intestinal involvement. However, its sensitivity was too low for patients' surgery selection.

#### CLINICAL RELEVANCE/APPLICATION

CT is a useful tool for surgical planning; the radiological PI may help in programming the right surgical procedures but cannot be used as a screening tool for surgery selection.

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## Abstract Archives of the RSNA, 2023

W6-SSOB03-5

### **Feasibility of Synthetic Magnetic Resonance Imaging for Deciding Whether Neoadjuvant Chemoradiotherapy and Predicting its Short-term Efficacy in Cervical Cancer: Comparison with High Resolution T2WI and DWI**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S405

Xiaorong Ou (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the feasibility of a synthetic MRI sequence (MAGnetic resonance imaging Compilation; MAGiC) for deciding whether neoadjuvant chemoradiotherapy (NCRT) and predicting its short-term efficacy (STE) in the cervical cancer (CC) patients, in comparison to high resolution T2-weighted imaging (hrT2WI) and diffusion weighted imaging (DWI).

#### **METHODS AND MATERIALS**

The study protocol was approved by the local Research Ethics Committee. Informed consent was obtained from all subjects. 244 patients suspected of CC were enrolled and undergone the pre-treatment MAGiC, conventional MRI (hrT2WI) and DWI on 3.0T MRI (the parameter presented in Table 1). For those CC patients underwent NCRT, hrT2WI were performed again at 2 months after NCRT for evaluating STE (completed response (CR) and no-CR group). MAGiC can generate synthetic morphologic images (synthetic T2WI, syT2WI) and quantitative synthetic images (synthetic T1, T2 and PD maps) (Fig 1). For the syT2WI, the tumor staging was assessed and decided whether NCRT for CC patients (hrT2WI as the reference). For the quantitative synthetic images, T1, T2, PD value were measured by regions of interests (ROIs) (Fig 2) to analysis the predictive performance of STE after NCRT (apparent diffusion coefficient (ADC) as the reference). In addition, the image quality of syT2WI and hrT2WI were assessed with 4-point scale for each of anatomical details display, distortion, artifacts and lesion conspicuity.

#### **RESULTS**

44 out of 75 confirmed CC patients were performed NCRT and followed up at least 2 months (Fig 3). For the image quality, syT2WI was no significant differences with comparison of hrT2WI in above four aspects (All  $P > 0.05$ ; Table 2, Fig 2). For deciding whether NCRT, the accuracy, sensitivity, and specificity of sy-T2WI were 0.899, 0.947 and 0.999 in CC patients (Table 3). For the quantitative synthetic images, T2, T1 and ADC values had a significant differences to identified CR from no-CR groups ( $P < 0.05$ ) but PD ( $P > 0.05$ ; Table 4). Furthermore, T2 (AUC: 0.825) and T1 value (AUC: 0.795) had a similar predictive performance for STE after NCRT compared with ADC (AUC: 0.789, all  $P > 0.05$ ) (Table 5, Fig 4). However, T1 combined T2 could not improve the predictive performance for STE with comparison of ADC (AUC: 0.818 vs 0.789) (Table 5, Fig 4).

#### **CONCLUSION**

MAGiC can derive synthetic morphologic images and quantitative synthetic images in one acquisition, which is a promising technique and feasibility for accurately deciding whether NCRT and predicting STE in CC patients.

#### **CLINICAL RELEVANCE/APPLICATION**

MAGiC is a reliable technique for facilitating the synthetic morphologic images and quantitative synthetic images, which should be as an alternative of hrT2WI and DWI for deciding whether NCRT and predicting STE in CC patients.

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## Abstract Archives of the RSNA, 2023

W6-SSOB03-6

### Preoperative Staging by [<sup>18</sup>F]FDG-PET/CT in a Large Endometrial Cancer Cohort: Diagnostic Performance, Incidental Findings and Therapeutic Delay

Wednesday, Nov. 29 1:30PM - 2:30PM Room: S405

Ankush Gulati (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare the diagnostic performance of PET/CT when using FDG-positive locoregional lymph nodes and metabolic primary tumor volume (MTV) for predicting lymph node metastases (LNM) and disease-specific survival in a large endometrial cancer (EC) cohort. To assess the extent and nature of incidental PET-CT findings and their impact on therapeutic delay.

#### METHODS AND MATERIALS

In 559 EC patients (among whom 58% (327/559) underwent lymphadenectomy), the preoperative FDG-PET/CT parameters FDG-positive (SUV<sub>max</sub> >2.5) locoregional lymph nodes (FDGposLN) and MTV (primary tumor volume with standard uptake value [SUV] >2.5) were retrospectively recorded. The diagnostic performance of FDGposLN and MTV for predicting LNM and disease-specific survival was compared using area under the receiver operating characteristic curves (ROC AUC) and Kaplan-Meier curves with log rank test, respectively. All reported incidental FDG-PET/CT findings and results from subsequent follow-ups were recorded. Time between FDG-PET/CT and primary EC treatment was compared between groups with/without incidental FDG-PET/CT findings.

#### RESULTS

FDGposLN/MTV yielded AUCs of 0.73/0.72 for predicting LNM (verified by histology). FDG positive lymph nodes and high MTV (>27 ml) were significantly associated with poor disease-specific survival ( $p < 0.001$  for both). Incidental PET/CT findings were reported in 31% (172/559) of the EC cohort, which was followed by follow-up examinations in 22% (125/559). These examinations led to the diagnosis of synchronous cancers in 15/559 (2.7%) patients [breast- (n=4), thyroid- (n=4), colon- (n=1), lung- (n=2) cancers and lymphoma (n=4)], and premalignant colonic polyps in 9/563 (1.6%) patients. Among all patients undergoing PET/CT (n=559), 10% (57/559) had their follow-up examination due to incidental PET/CT finding before start of primary EC treatment. Median time between FDG-PET/CT and primary EC treatment was 28 days (inter quartile range (IQR): 21-35) in this patient group (n=57), versus 15 days (IQR 8-23) in the remaining EC cohort (n=506).

#### CONCLUSION

FDG positive lymph nodes and MTV >27 ml yield similar performance for predicting LNM preoperatively, and both FDG markers indicate poor prognosis. Incidental PET/CT findings requiring clarification before primary EC treatment led to a small treatment delay, while uncovering synchronous primary cancers in 2.7% of the EC patients.

#### CLINICAL RELEVANCE/APPLICATION

Preoperative FDG-PET/CT is valuable for predicting metastatic lymph nodes and prognosis in EC. Incidental findings are common (in 31%) and represent synchronous cancer in 2.7%, but does not cause considerable therapeutic delay.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSPH10

### Physics (Ultrasound)

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353C

Zheng Feng Lu, PhD (*Moderator*) Nothing to Disclose  
Ivan Rosado-Mendez, PHD (*Moderator*) Equipment support, Siemens AG; Equipment support, General Electric Company; Consultant, Siemens AG

#### Sub-Events

### **W6-SSPH10-1 Can We Improve Quantification of Slow Flow in Metastatic Renal Carcinoma with Novel Long Ensemble Power Doppler Ultrasound Sequences?**

Sergio J. Sanabria (*Presenter*) Nothing to Disclose

#### PURPOSE

To show Proof-Of-Concept of Long-Ensemble Coherence-Based Ultrasound Power Doppler sequences (LEAD) for early-stage quantification of angiogenesis changes in Metastatic Renal Carcinoma (mRCC). The current standard of care is CT/MRI at 12 weeks to determine responder/non-responder (revised RECIST v1.1.1 guideline).

#### METHODS AND MATERIALS

15 patients scheduled for a combination of antiangiogenesis and immunotherapy mRCC treatment were recruited over 24 months. Ultrasound basal exams and F/U after 6 weeks of treatment were performed. Real-time clinical Power Doppler (PD) was acquired with a Siemens S2000 system. A Verasonics research scanner with harmonic B-mode was used to reconstruct LEAD offline (ensemble length 3s, 500 Hz). A 7.5 MHz linear transducer was used for lesion depths < 40 mm and a 3.0 MHz curvilinear probe was used for larger depths. Two radiologists independently analyzed each image for internal lesion flow (1a), peripheral flow (1b) or no flow (0). Tumor size variations were quantified in B-mode images. Doppler flow surface changes were also assessed in LEAD and PD images.

#### RESULTS

The lesion diameter ranged from 0.43 to 11.22 cm, with a mean value of 3.33 cm, while lesion depth was 1 to 11 cm (mean 5 cm). From a total of 67 lesion examinations, in 25% of Doppler images, LEAD show superior diagnostic image quality than conventional Power Doppler, while no diagnostic differences were observed in 74% of the images. Eight RECIST v.1.1.1 responder cases were compared with eight RECIST v.1.1 non-responder cases. The changes in Doppler Flow Surface at 6 weeks with respect to basal exam show higher significance ( $p = 0.09$ ) than the geometric changes in lesion size ( $p = 0.67$ ).

#### CONCLUSION

Our results show potential for ultrasound as an alternative for early stage-therapy response monitoring of mRCC after 6 weeks. Ultrafast-Coherence-Based Doppler imaging sequences allow increasing ensemble length, therefore increasing flow resolution, minimizing imaging artifacts and detecting more vessels than conventional Power Doppler.

#### CLINICAL RELEVANCE/APPLICATION

mRCC is the 8th most common cancer in the U.S., with a 5-year survival rate of 12%. Since 2019, Tyrosine Kinase Inhibitors (TKI) combined with Immune Checkpoint Inhibitors (ICI) have become the standard-of-care. Currently, therapy response is monitored after 12 weeks of therapy with CT/MR according to changes in tumor diameter (RECIST v1.1.1). Ultrasound is non-invasive and well-suited for therapy monitoring. Quantitative ultrasound methods based on novel Doppler Flow sequences show potential for early stage assessment of TKI + ICI therapeutical response, thereby minimizing treatment toxicity.

### **W6-SSPH10-2 Development of Deep Learning Based Segmentation Method Using U-Net for Evaluation of Breast Density on Ultrasound Images**

Min-Ying Su, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Many research studies have been devoted to developing automatic segmentation for quantitative assessment of breast density, which may serve as a biomarker to improve the accuracy of breast cancer risk assessment. There are only few studies reporting the development of automatic segmentation for breast ultrasound (US). The purpose of this study is to develop a U-Net segmentation method for clinical US images.

## METHODS AND MATERIALS

Women with dense breasts on mammography, without pathological finding, were included. The US images from the upper outer quadrant of 110 patients were used for training. An experienced radiologist manually outlined the superficial boundary demarcating the layer of subcutaneous fat, and the deep boundary demarcating the layer of the retromammary fat and muscle, with the middle layer containing the fibroglandular tissue. Within the middle layer, the fat lobules were further outlined, so the remaining area could be assigned as the glandular tissue component (GTC, Figure 1). These 4 regions were used as the ground truth to train the U-net model. For testing, a total of 1,348 images from 337 patients were used, and the quality of segmentation was reviewed. Three radiologists interpreted the images to determine the density category, and the agreements were analyzed.

## RESULTS

In the training dataset, the U-Net model can identify the superficial and deep boundaries for most cases, and the percentage of layer- 1, 2, 3 was calculated. The correlation coefficient between the U-net output and the ground truth was  $R^2 = 0.946$ ,  $0.824$ , and  $0.866$ , respectively (Figure 2). The segmentation quality in the testing dataset was acceptable in 1,188 (88%) images, and unacceptable in 160 (12%). The failure of the deep border ( $n=117$ , 73.1%) was due to difficulties in distinguishing the retromammary fat from uninvolved GTC which has hypoechoic appearance similar to fat; the failure of both superficial and deep borders ( $n=38$ , 23.8%) was due to minimal amount of fibroglandular tissue in fatty breasts; and there were only 5 cases with failure of superficial border ( $n=5$ , 3.1%). The inter-observer agreement among radiologists was poor to moderate ( $k=0.16-0.41$ ).

## CONCLUSION

The radiologists' agreement for breast density was poor to moderate, presumably due to the limited information from a small-selected area. Deep learning based U-Net algorithm provided a promising method, which achieved acceptable segmentation in 88%. However, further segmentation of the GTC requires a large training dataset with well-defined ground truth.

## CLINICAL RELEVANCE/APPLICATION

Assessment of density on breast US by radiologists was not reliable. U-Net may provide a standardized method to determine the subcutaneous and retromammary fat layers, and the GTC within the mammary zone.

## W6- SSPH10-3 Anisotropic Stiffness Biomarkers by Torsional Wave Elastography may Non-invasively Predict the Skin Pathology: Pilot Test

Guillermo Rus (*Presenter*) Nothing to Disclose

## PURPOSE

Skin is one of the organs whose viscoelastic properties is not fully understood. Besides being highly nonlinear and dependent on the orientation of Langer's lines [Kalra, et al. 2016], they are mainly governed by the collagen, elastin and cell structure, which strongly changes under pathological conditions (Keratoacanthoma, Basal cell carcinoma, Squamous cell carcinoma, melanoma). It supports our hypothesis that elastography has the potential to noninvasively predict histopathology of skin tumors [Chang, JM, et al. 2011]. Thus, we have developed both a new concept of torsional shear waves ideally suited to interrogate surface and subsurface stiffness, as well as a new set of mechanical biomarkers.

## METHODS AND MATERIALS

24 patients were recruited for the study while 18 of them met the eligibility criteria and were enrolled for the tests. The tests were carried out after obtaining informed consent from participants and receiving ethical approval. Tests were done using a torsional wave elastography device developed in our lab generating shear elastic waves at 0.4-1 kHz frequencies. The probe provides three biomarkers: elasticity, viscosity and anisotropy [Callejas, A, et al. 2017]. Healthy tissue was tested for comparison with pathological tissue. The type of the lesions was classified through the histopathology test. The stiffness ratio was calculated by comparing shear wave velocity between pathological and healthy tissue and then compared to the histopathology result to evaluate accuracy in distinguishing between lesions.

## RESULTS

A ratio threshold of 1.9 classifies benign from malignant tumors. 13 lesions were diagnosed as malignant (melanoma, BCC, SCC) and 5 were benign. Since this is an ongoing study, a larger sample size will be presented at the conference. Some results are closely clustered together due to the proximity of the stiffness ratio, but all the results were correlated well with histopathology results.

## CONCLUSION

The promising initial results suggest TWE could be a useful tool for diagnosing skin pathologies. Further research will evaluate its robustness and reliability.

## CLINICAL RELEVANCE/APPLICATION

The TWE technology has shown potential for noninvasive screening and precise extraction of skin mechanical properties by considering four biomarkers.

### W6-SSPH10-4 **Influence of Variability in Attenuation Compensation on Quantitative Ultrasound Measurements in Heterogeneous Media**

Victor B. Barrere, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Quantitative ultrasound (QUS) applies a set of techniques to estimate acoustic parameters independent of the imaging platform with pretty good results in vivo. It remains challenging to apply in heterogeneous media, in particular because the attenuation from overlying tissues consists in a critical unpredictable bias. The purpose of this study is to investigate the effect of variability of estimated attenuation of overlying tissues on the estimation of BSC of target tissues in median nerve (MN), as it consists in a complex heterogeneous tissue overlaid by complex composite tissues already described in the literature.

#### METHODS AND MATERIALS

Several methods of attenuation estimation are compared: spectral difference method (SDM), spectral log difference method (SLDM), and methods that combine average values of tissue attenuation reported in the literature with the estimated thickness of each overlying tissue (LIBM). The variabilities of the attenuation parameters estimates are compared among the three methods in a median nerve of a single subject in vivo, and in a multi layered phantoms of well monitored properties. An estimation of the variability on BSC due to the different attenuation compensation techniques is described.

#### RESULTS

Values of attenuation were pretty variable in attenuation parameters for SDM methods in the MN (CV is over 1.3 for attenuation coefficients) and in overlying tissues but SLDM and LIBM provided pretty consistent values (CV below 0.25 for attenuation coefficients). SDM and SLDM presented important variabilities in iBSC (CV is over 104.7), though, whereas LIBM gave pretty focused iBSC values (CV is below 60).

## CONCLUSION

Accounting for the attenuation of overlying tissue layers by using the SLDM and compensating based on values from the literature reduced variability in attenuation-based outcomes, compared with SDM. However, our data also reveal that sources of variability beyond those in attenuation parameters alone also impact backscatter measurements. For the evaluation of MN at the level of the wrist, in the critical case overlying tissues couldn't be identified, we suggest to use the values obtained from SLDM ( $a=1.19 \text{ dB}\cdot\text{cm}^{-1}\cdot\text{MHz}^{-b}$  and  $b=1.13$ ) as an overall attenuation value for the composite tissue overlying the nerve at the level of the wrist.

## CLINICAL RELEVANCE/APPLICATION

This work has implications for the application of QUS to in vivo assessment of peripheral nerves and possibly other complex and heterogeneous tissue types. Directions are provided for QUS clinical studies in vivo as a function of the target tissue and the probe location. The phantom study and the model provide an indicator of the quality of the compensation and directions to improve attenuation compensation to come closer to ideal experimental conditions.

### W6-SSPH10-5 **The Development of a Kinetic Model to Estimate Uptake Rate of Microbubbles in Axillary Sentinel Lymph Nodes Using Lymphosonography**

Priscilla Machado, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

A better understanding of the lymphatic system flow kinetics may help with sentinel lymph node (SLN) evaluations. This study developed an initial kinetic model to estimate the lymphatic flow and uptake rate of the microbubbles in axillary SLNs using lymphosonography.

#### METHODS AND MATERIALS

12 female healthy-volunteers received 4 subcutaneous Sonazoid (GE HealthCare) injections around a 2-cm region in the upper-outer quadrant of the breast (total: 1.0ml). Lymphosonography was performed using a S3000 HELX scanner (Siemens Healthineers) at specific time-points. Microbubble concentration was mathematically represented using a two-compartment model that assumes concentration of microbubble in lymphatics feeding the SLN,  $C_1(t)$ , as a function of time,  $t$ :  $C_1(t) = C_0 e^{-k_1 t}$ ,  $C_0$  concentration of microbubble injected, fraction of  $C_0$  making it into afferent lymph vessels feeding the

SLN and  $k_l$  a rate constant governing rate of loss of microbubble concentration at injection site. Microbubble concentration was assumed to either internalize into macrophages, governed by a rate constant,  $k_i$ , proportional to the number of macrophages and the rate of microbubble uptake per macrophage; or be eliminated from the SLN through washout at the lymphatic flow rate,  $F_l$ . The resulting equation represents the concentration of microbubbles in a SLN,  $C_{node}(t) = C_{node}(0) e^{-(k_i + F_l)t} + \int_0^t C_{node}(\tau) e^{-(k_i + F_l)(t-\tau)} u(\tau) d\tau$ , where  $*$  represents the convolution operator, and  $u(t)$  is a step function. Eq (2) yields three parameters of fit:  $k_i$ ,  $F_l$ , and  $k_l$ , where the main parameter related to the concentration of macrophages in the SLN, which is related to the tumor burden, is  $k_i$ .  $C_{node}(t) = C_{node}(0) e^{-k_l t} + \int_0^t C_{node}(\tau) e^{-(k_i + F_l)(t-\tau)} u(\tau) d\tau$

## RESULTS

Average estimates of  $k_i$ ,  $F_l$ , and  $k_l$  were  $0.90 \pm 0.06 \text{ min}^{-1}$ ,  $2 \pm 1 \text{ min}^{-1}$ , and  $0.09 \pm 0.06 \text{ min}^{-1}$ , respectively. Large variances (>50%) were observed in  $F_l$  and  $k_l$  amongst patients. However, the variance in  $k_i$ —the main parameter of interest—was found to be less than 10% of the mean.

## CONCLUSION

Results show potential of this methodology to assess  $k_i$  as a potential non-invasive biomarker of tumor burden, with  $k_i$  expected to be lower in SLNs with cancer, which will be investigated in future research.

## CLINICAL RELEVANCE/APPLICATION

The use of flow kinetics may help with SLN evaluations in breast cancer patients where  $k_i$  is expected to be lower in SLNs with cancer owing to a lower concentration of macrophages.

## W6-SSPH10-6 Remote Ultrasound Detection using Laser Interferometry

Kaitlyn Kim, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Conventional modalities for ultrasound wave detection currently utilize piezoelectric transducers or medical ultrasound probes. However, these sensors can cause variability in image quality depending on the skill of the user or may cause discomfort to the subject, as direct contact to the skin is required with the use of ultrasonic gel. We present a laser interferometer for ultrasound detection. Through laser interferometry, remote detection of ultrasound and photoacoustics is shown, eliminating direct contact of the transducer with the skin.

## METHODS AND MATERIALS

The photoacoustic effect involves the absorption of radiant energy such as a short-pulsed laser, resulting in a thermoelastic expansion that emits wideband ultrasound waves. Using a Polytec laser vibrometer, which uses a Mach-Zehnder interferometer, we demonstrated the detection of PA generated ultrasound waves. A pulsed Alexandrite laser with a pulsewidth of 900ps was used to excite a water phantom containing an absorbing polymer. The laser vibrometer was focally aligned to capture the signal. Five runs were completed with varying pulse laser energies, each with no averaging and 200 mJ being the highest. Next, a vibrometer with scanning capabilities was used. An area was set around a water phantom, which was used as the medium, and scan points were set to provide information from multiple points on the target. A 5 MHz focused ultrasound transducer was used to send ultrasonic waves using a pulser/receiver system.

## RESULTS

The interferometer system was able to capture signals with no averaging for varied energy levels from a therapeutic laser. Even with the laser pulse energy at the lowest level, a distinct waveform can be observed. We demonstrate the results from the scanned phantom using the vibrometer, which provides a grid map demonstrating regions where the greatest amplitude is observed on the phantom surface.

## CONCLUSION

The remote detection of ultrasound waves produced by a high energy therapeutic laser and a 5 MHz ultrasound transducer is demonstrated. Scanning results show that 2D imaging with an interferometer is possible with high accuracy. Our non-contact ultrasound detection system, based on a laser interferometer, surpasses current PZT-based methods used in medical practice without patient contact. However, lengthy inspection times remain a challenge that can be resolved by adopting parallel detection and faster initial screening methods followed by localized imaging.

## CLINICAL RELEVANCE/APPLICATION

The laser vibrometer can also be applied to clinical proton beams, detecting the waves generated. Remote detection would simplify monitoring of the proton beam, as the device is simply placed towards the beam, and would not obstruct the path.



## Abstract Archives of the RSNA, 2023

W6-SSPH10-1

### Can We Improve Quantification of Slow Flow in Metastatic Renal Carcinoma with Novel Long Ensemble Power Doppler Ultrasound Sequences?

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353C

Sergio J. Sanabria (*Presenter*) Nothing to Disclose

#### PURPOSE

To show Proof-Of-Concept of Long-Ensemble Coherence-Based Ultrasound Power Doppler sequences (LEAD) for early-stage quantification of angiogenesis changes in Metastatic Renal Carcinoma (mRCC). The current standard of care is CT/MRI at 12 weeks to determine responder/non-responder (revised RECIST v1.1.1 guideline).

#### METHODS AND MATERIALS

15 patients scheduled for a combination of antiangiogenesis and immunotherapy mRCC treatment were recruited over 24 months. Ultrasound basal exams and F/U after 6 weeks of treatment were performed. Real-time clinical Power Doppler (PD) was acquired with a Siemens S2000 system. A Verasonics research scanner with harmonic B-mode was used to reconstruct LEAD offline (ensemble length 3s, 500 Hz). A 7.5 MHz linear transducer was used for lesion depths < 40 mm and a 3.0 MHz curvilinear probe was used for larger depths. Two radiologists independently analyzed each image for internal lesion flow (1a), peripheral flow (1b) or no flow (0). Tumor size variations were quantified in B-mode images. Doppler flow surface changes were also assessed in LEAD and PD images.

#### RESULTS

The lesion diameter ranged from 0.43 to 11.22 cm, with a mean value of 3.33 cm, while lesion depth was 1 to 11 cm (mean 5 cm). From a total of 67 lesion examinations, in 25% of Doppler images, LEAD show superior diagnostic image quality than conventional Power Doppler, while no diagnostic differences were observed in 74% of the images. Eight RECIST v.1.1.1 responder cases were compared with eight RECIST v.1.1 non-responder cases. The changes in Doppler Flow Surface at 6 weeks with respect to basal exam show higher significance ( $p = 0.09$ ) than the geometric changes in lesion size ( $p = 0.67$ ).

#### CONCLUSION

Our results show potential for ultrasound as an alternative for early stage-therapy response monitoring of mRCC after 6 weeks. Ultrafast-Coherence-Based Doppler imaging sequences allow increasing ensemble length, therefore increasing flow resolution, minimizing imaging artifacts and detecting more vessels than conventional Power Doppler.

#### CLINICAL RELEVANCE/APPLICATION

mRCC is the 8th most common cancer in the U.S., with a 5-year survival rate of 12%. Since 2019, Tyrosine Kinase Inhibitors (TKI) combined with Immune Checkpoint Inhibitors (ICI) have become the standard-of-care. Currently, therapy response is monitored after 12 weeks of therapy with CT/MR according to changes in tumor diameter (RECIST v1.1.1). Ultrasound is non-invasive and well-suited for therapy monitoring. Quantitative ultrasound methods based on novel Doppler Flow sequences show potential for early stage assessment of TKI + ICI therapeutical response, thereby minimizing treatment toxicity.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W6-SSPH10-2

### Development of Deep Learning Based Segmentation Method Using U-Net for Evaluation of Breast Density on Ultrasound Images

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353C

Min-Ying Su, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Many research studies have been devoted to developing automatic segmentation for quantitative assessment of breast density, which may serve as a biomarker to improve the accuracy of breast cancer risk assessment. There are only few studies reporting the development of automatic segmentation for breast ultrasound (US). The purpose of this study is to develop a U-Net segmentation method for clinical US images.

#### METHODS AND MATERIALS

Women with dense breasts on mammography, without pathological finding, were included. The US images from the upper outer quadrant of 110 patients were used for training. An experienced radiologist manually outlined the superficial boundary demarcating the layer of subcutaneous fat, and the deep boundary demarcating the layer of the retromammary fat and muscle, with the middle layer containing the fibroglandular tissue. Within the middle layer, the fat lobules were further outlined, so the remaining area could be assigned as the glandular tissue component (GTC, Figure 1). These 4 regions were used as the ground truth to train the U-net model. For testing, a total of 1,348 images from 337 patients were used, and the quality of segmentation was reviewed. Three radiologists interpreted the images to determine the density category, and the agreements were analyzed.

#### RESULTS

In the training dataset, the U-Net model can identify the superficial and deep boundaries for most cases, and the percentage of layer- 1, 2, 3 was calculated. The correlation coefficient between the U-net output and the ground truth was  $R^2 = 0.946$ ,  $0.824$ , and  $0.866$ , respectively (Figure 2). The segmentation quality in the testing dataset was acceptable in 1,188 (88%) images, and unacceptable in 160 (12%). The failure of the deep border ( $n=117$ , 73.1%) was due to difficulties in distinguishing the retromammary fat from uninvoluted GTC which has hypoechoic appearance similar to fat; the failure of both superficial and deep borders ( $n=38$ , 23.8%) was due to minimal amount of fibroglandular tissue in fatty breasts; and there were only 5 cases with failure of superficial border ( $n=5$ , 3.1%). The inter-observer agreement among radiologists was poor to moderate ( $k=0.16-0.41$ ).

#### CONCLUSION

The radiologists' agreement for breast density was poor to moderate, presumably due to the limited information from a small-selected area. Deep learning based U-Net algorithm provided a promising method, which achieved acceptable segmentation in 88%. However, further segmentation of the GTC requires a large training dataset with well-defined ground truth.

#### CLINICAL RELEVANCE/APPLICATION

Assessment of density on breast US by radiologists was not reliable. U-Net may provide a standardized method to determine the subcutaneous and retromammary fat layers, and the GTC within the mammary zone.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSPH10-3

### **Anisotropic Stiffness Biomarkers by Torsional Wave Elastography may Non-invasively Predict the Skin Pathology: Pilot Test**

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353C

Guillermo Rus (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Skin is one of the organs whose viscoelastic properties is not fully understood. Besides being highly nonlinear and dependent on the orientation of Langer's lines [Kalra, et al. 2016], they are mainly governed by the collagen, elastin and cell structure, which strongly changes under pathological conditions (Keratoacanthoma, Basal cell carcinoma, Squamous cell carcinoma, melanoma). It supports our hypothesis that elastography has the potential to noninvasively predict histopathology of skin tumors [Chang, JM, et al. 2011]. Thus, we have developed both a new concept of torsional shear waves ideally suited to interrogate surface and subsurface stiffness, as well as a new set of mechanical biomarkers.

#### **METHODS AND MATERIALS**

24 patients were recruited for the study while 18 of them met the eligibility criteria and were enrolled for the tests. The tests were carried out after obtaining informed consent from participants and receiving ethical approval. Tests were done using a torsional wave elastography device developed in our lab generating shear elastic waves at 0.4-1 kHz frequencies. The probe provides three biomarkers: elasticity, viscosity and anisotropy [Callejas, A, et al. 2017]. Healthy tissue was tested for comparison with pathological tissue. The type of the lesions was classified through the histopathology test. The stiffness ratio was calculated by comparing shear wave velocity between pathological and healthy tissue and then compared to the histopathology result to evaluate accuracy in distinguishing between lesions.

#### **RESULTS**

A ratio threshold of 1.9 classifies benign from malignant tumors. 13 lesions were diagnosed as malignant (melanoma, BCC, SCC) and 5 were benign. Since this is an ongoing study, a larger sample size will be presented at the conference. Some results are closely clustered together due to the proximity of the stiffness ratio, but all the results were correlated well with histopathology results.

#### **CONCLUSION**

The promising initial results suggest TWE could be a useful tool for diagnosing skin pathologies. Further research will evaluate its robustness and reliability.

#### **CLINICAL RELEVANCE/APPLICATION**

The TWE technology has shown potential for noninvasive screening and precise extraction of skin mechanical properties by considering four biomarkers.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSPH10-4

### Influence of Variability in Attenuation Compensation on Quantitative Ultrasound Measurements in Heterogeneous Media

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353C

Victor B. Barrere, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Quantitative ultrasound (QUS) applies a set of techniques to estimate acoustic parameters independent of the imaging platform with pretty good results in vivo. It remains challenging to apply in heterogeneous media, in particular because the attenuation from overlying tissues consists in a critical unpredictable bias. The purpose of this study is to investigate the effect of variability of estimated attenuation of overlying tissues on the estimation of BSC of target tissues in median nerve (MN), as it consists in a complex heterogeneous tissue overlaid by complex composite tissues already described in the literature.

#### METHODS AND MATERIALS

Several methods of attenuation estimation are compared: spectral difference method (SDM), spectral log difference method (SLDM), and methods that combine average values of tissue attenuation reported in the literature with the estimated thickness of each overlying tissue (LIBM). The variabilities of the attenuation parameters estimates are compared among the three methods in a median nerve of a single subject in vivo, and in a multi layered phantoms of well monitored properties. An estimation of the variability on BSC due to the different attenuation compensation techniques is described.

#### RESULTS

Values of attenuation were pretty variable in attenuation parameters for SDM methods in the MN (CV is over 1.3 for attenuation coefficients) and in overlying tissues but SLDM and LIBM provided pretty consistent values (CV below 0.25 for attenuation coefficients). SDM and SLDM presented important variabilities in iBSC (CV is over 104.7), though, whereas LIBM gave pretty focused iBSC values (CV is below 60).

#### CONCLUSION

Accounting for the attenuation of overlying tissue layers by using the SLDM and compensating based on values from the literature reduced variability in attenuation-based outcomes, compared with SDM. However, our data also reveal that sources of variability beyond those in attenuation parameters alone also impact backscatter measurements. For the evaluation of MN at the level of the wrist, in the critical case overlying tissues couldn't be identified, we suggest to use the values obtained from SLDM ( $a=1.19 \text{ dB}\cdot\text{cm}^{-1}\cdot\text{MHz}^{-b}$  and  $b=1.13$ ) as an overall attenuation value for the composite tissue overlying the nerve at the level of the wrist.

#### CLINICAL RELEVANCE/APPLICATION

This work has implications for the application of QUS to in vivo assessment of peripheral nerves and possibly other complex and heterogeneous tissue types. Directions are provided for QUS clinical studies in vivo as a function of the target tissue and the probe location. The phantom study and the model provide an indicator of the quality of the compensation and directions to improve attenuation compensation to come closer to ideal experimental conditions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSPH10-5

### The Development of a Kinetic Model to Estimate Uptake Rate of Microbubbles in Axillary Sentinel Lymph Nodes Using Lymphosonography

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353C

Priscilla Machado, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

A better understanding of the lymphatic system flow kinetics may help with sentinel lymph node (SLN) evaluations. This study developed an initial kinetic model to estimate the lymphatic flow and uptake rate of the microbubbles in axillary SLNs using lymphosonography.

#### METHODS AND MATERIALS

12 female healthy-volunteers received 4 subcutaneous Sonazoid (GE HealthCare) injections around a 2-cm region in the upper-outer quadrant of the breast (total: 1.0ml). Lymphosonography was performed using a S3000 HELX scanner (Siemens Healthineers) at specific time-points. Microbubble concentration was mathematically represented using a two-compartment model that assumes concentration of microbubble in lymphatics feeding the SLN,  $C_l$ , as a function of time,  $t$ :  $C_l(t) = C_0 e^{-k_l t}$ ,  $C_0$  concentration of microbubble injected, fraction of  $C_0$  making it into afferent lymph vessels feeding the SLN and  $k_l$  a rate constant governing rate of loss of microbubble concentration at injection site. Microbubble concentration was assumed to either internalize into macrophages, governed by a rate constant,  $k_i$ , proportional to the number of macrophages and the rate of microbubble uptake per macrophage; or be eliminated from the SLN through washout at the lymphatic flow rate,  $F_l$ . The resulting equation represents the concentration of microbubbles in a SLN,  $C_{node}(t) = \int_0^t C_0 e^{-k_l \tau} * e^{-(k_i + F_l)(t-\tau)} u(t-\tau) dt$ , where  $*$  represents the convolution operator, and  $u(t)$  is a step function. Eq (2) yields three parameters of fit:  $k_i$ ,  $F_l$ , and  $k_l$ , where the main parameter related to the concentration of macrophages in the SLN, which is related to the tumor burden, is  $k_i$ .

#### RESULTS

Average estimates of  $k_i$ ,  $F_l$ , and  $k_l$  were  $0.90 \pm 0.06 \text{ min}^{-1}$ ,  $2 \pm 1 \text{ min}^{-1}$ , and  $0.09 \pm 0.06 \text{ min}^{-1}$ , respectively. Large variances (>50%) were observed in  $F_l$  and  $k_l$  amongst patients. However, the variance in  $k_i$ —the main parameter of interest—was found to be less than 10% of the mean.

#### CONCLUSION

Results show potential of this methodology to assess  $k_i$  as a potential non-invasive biomarker of tumor burden, with  $k_i$  expected to be lower in SLNs with cancer, which will be investigated in future research.

#### CLINICAL RELEVANCE/APPLICATION

The use of flow kinetics may help with SLN evaluations in breast cancer patients where  $k_i$  is expected to be lower in SLNs with cancer owing to a lower concentration of macrophages.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-SSPH10-6

### Remote Ultrasound Detection using Laser Interferometry

Wednesday, Nov. 29 1:30PM - 2:30PM Room: E353C

Kaitlyn Kim, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Conventional modalities for ultrasound wave detection currently utilize piezoelectric transducers or medical ultrasound probes. However, these sensors can cause variability in image quality depending on the skill of the user or may cause discomfort to the subject, as direct contact to the skin is required with the use of ultrasonic gel. We present a laser interferometer for ultrasound detection. Through laser interferometry, remote detection of ultrasound and photoacoustics is shown, eliminating direct contact of the transducer with the skin.

#### METHODS AND MATERIALS

The photoacoustic effect involves the absorption of radiant energy such as a short-pulsed laser, resulting in a thermoelastic expansion that emits wideband ultrasound waves. Using a Polytec laser vibrometer, which uses a Mach-Zehnder interferometer, we demonstrated the detection of PA generated ultrasound waves. A pulsed Alexandrite laser with a pulsewidth of 900ps was used to excite a water phantom containing an absorbing polymer. The laser vibrometer was confocally aligned to capture the signal. Five runs were completed with varying pulse laser energies, each with no averaging and 200 mJ being the highest. Next, a vibrometer with scanning capabilities was used. An area was set around a water phantom, which was used as the medium, and scan points were set to provide information from multiple points on the target. A 5 MHz focused ultrasound transducer was used to send ultrasonic waves using a pulser/receiver system.

#### RESULTS

The interferometer system was able to capture signals with no averaging for varied energy levels from a therapeutic laser. Even with the laser pulse energy at the lowest level, a distinct waveform can be observed. We demonstrate the results from the scanned phantom using the vibrometer, which provides a grid map demonstrating regions where the greatest amplitude is observed on the phantom surface.

#### CONCLUSION

The remote detection of ultrasound waves produced by a high energy therapeutic laser and a 5 MHz ultrasound transducer is demonstrated. Scanning results show that 2D imaging with an interferometer is possible with high accuracy. Our non-contact ultrasound detection system, based on a laser interferometer, surpasses current PZT-based methods used in medical practice without patient contact. However, lengthy inspection times remain a challenge that can be resolved by adopting parallel detection and faster initial screening methods followed by localized imaging.

#### CLINICAL RELEVANCE/APPLICATION

The laser vibrometer can also be applied to clinical proton beams, detecting the waves generated. Remote detection would simplify monitoring of the proton beam, as the device is simply placed towards the beam, and would not obstruct the path.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-STCE1

### Science Session (Generative AI)

Wednesday, Nov. 29 1:30PM - 2:00PM Room: Learning Center Theater 1

#### Sub-Events

#### **W6-STCE1- GPT-4 Analysis of MRI Reports in Suspected Myocarditis: A Multicenter Study** 1

Kenan Kaya, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The diagnosis of myocarditis is based on clinical symptoms, laboratory results, and cardiac MRI. The correct interpretation and integration of MRI findings require radiological expertise and knowledge. The Generative Pre-trained Transformer 4 (GPT-4) is a large language model capable of generating semantically coherent responses and logical decisions on text-based inputs and requests. The aim of this study was to investigate the potential of GPT-4 for decision-making and final interpretation of MRI reports in suspected myocarditis.

#### **METHODS AND MATERIALS**

This is a retrospective study including 400 patients with suspected myocarditis from eight centers. The following text-based input information was provided to the GPT-4 network and to three radiologists with different levels of experience (R1: 1 year, R2: 2 years, and R3: 4 years): MRI reports (structured (n=100) and unstructured (n=100)), applied sequences, laboratory results, patient age, sex, and clinical symptoms. The final interpretation of the report indicating the presence or absence of myocarditis was not provided. GPT-4 and the radiologists were prompted to provide a dichotomous statement (yes/no) regarding the presence of myocarditis. The accuracy, sensitivity, and specificity of GPT-4 and the readers for the diagnosis of myocarditis were calculated by comparing their findings to the final diagnosis of an expert reader with 6 years of experience in cardiac MRI. The results were obtained using contingency tables while a  $\chi^2$ -Test was employed to compare the diagnoses of the radiologists and GPT-4. A p-value of  $<.05$  was considered statistically significant.

#### **RESULTS**

GPT-4 showed an accuracy of 82%, sensitivity of 86%, and specificity of 79%. These results did not differ significantly from the performance of radiologist R1 (accuracy=87%, sensitivity=85%, specificity=88%,  $p=.05$ ), but were inferior to radiologists R2 (accuracy=97%, sensitivity=93%, specificity=99%,  $p=.001$ ) and R3 (accuracy=89%, sensitivity=77%, specificity=98%,  $p<.0001$ ).

#### **CONCLUSION**

Using multicenter data, GPT-4 achieved good performance in interpreting heterogeneous text-based cardiac MRI findings for myocarditis diagnosis, which was in the range of the inexperienced reader. GPT-4-based analysis of text-based findings could serve as a supportive tool in interpreting and decision-making in cardiac imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

GPT-4 achieved a good performance in interpreting multicenter report-based cardiac MRI findings. Its use as a supportive tool for interpreting findings and decision-making in clinical practice, particularly for inexperienced readers, is conceivable.

#### **W6-STCE1- Exploring Racial Disparities in Imaging Datasets via Generative AI: A Path to Enhanced Model Transparency** 2

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Addressing potential biases in healthcare data is pivotal. This study leverages generative deep learning (DL) methods to identify radiographic variances related to race in patients undergoing total hip arthroplasty (THA). The study aims to demonstrate the feasibility of using generative AI on large scale imaging data to uncover anatomical differences between White and African American patients.

## METHODS AND MATERIALS

We used pelvic radiographs from an institutional THA patient registry covering the period from Jan 1997 to Oct 2021. The radiographs were characterized using proven DL models determining the projection plane, laterality, and the presence or absence of prosthesis. Patient demographics such as age, sex, self-reported race, and body mass index were also recorded. Using denoising diffusion probabilistic models (DDPM), synthetic radiographs conditioned on these demographics and image characteristics were generated. Post-model training, 60 high-resolution transformation videos were created, transitioning from a radiograph of a White patient to that of an African American patient, with all variables held constant, Figure 1. Two MSK radiologists and two orthopedic surgeons, as expert evaluators, characterized systematic differences in the images. The inter-rater agreement was assessed using Gwet's AC1 (GAC), with a value of >0.60 indicating substantial agreement.

## RESULTS

The study incorporated 480,407 pelvic radiographs from 15,127 unique patients (52% female, 1% African American). The expert panel identified six characteristics that demonstrated systematic differences between the races. African American patients displayed decreased inter-acetabular distance (GAC: 0.83), a higher degree of osteoarthritis (GAC: 0.82), a more elliptical obturator foramen (GAC: 0.80), reduced femoral neck-shaft angle (GAC: 0.76), an elongated pelvis ring (GAC: 0.61), and increased femoral metaphyseal cortical thickness (GAC: 0.60). All differences were statistically significant (p-values <0.001).

## CONCLUSION

The study demonstrates the effective use of generative AI models for detecting anatomical differences between White and African American patients. African American patients had a significantly higher osteoarthritis severity compared to White patients, suggesting healthcare access disparities at early stages of disease.

## CLINICAL RELEVANCE/APPLICATION

Generative DL models can aid in detecting previously unrecognized anatomical differences between races in medical imaging datasets. Knowledge of these variations can assist in creation of datasets that better represent the population and also detection of datasets that may contain high racial bias, leading to the development of more transparent and unbiased AI models.

## W6-STCE1- Leveraging Chat GPT-4 for Automatic Labeling of Lung Cancer Staging from Chest CT and PET-CT Reports: A Multimodal and Multilingual Approach

Jinwoo Kim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study investigated the performance of Chat GPT-4 as an automatic labeler of lung cancer staging from contrast enhanced-chest CT and F-18 FDG PET-CT free-text reports.

## METHODS AND MATERIALS

We utilized 8th edition of the TNM classification for lung cancer document as specialized knowledge base and the GPT-4 model was used to label the lung cancer staging from the contrast enhanced-chest CT and F-18 FDG PET-CT free-text reports in English or Korean. The ground truth staging labels were determined by consensus of thoracic radiologist and thoracic nuclear radiologist. Chest CT and PET/CT free-text reports were used to compare the GPT-4 model's performance against radiologist, nuclear radiologist, non-radiology physician, senior and junior radiology residents with brief training.

## RESULTS

Upon analysis of the 100 free-text reports, each representing different staging levels of lung cancer, the GPT-4 model accurately performed lung cancer staging in accordance with the 8th edition of the TNM classification. The average performance of the GPT-4 models, with an F1 score of  $0.792 \pm 0.061$ , did not exhibit significant differences compared to the average performance of human readers, which scored an F1 of  $0.849 \pm 0.106$  ( $P = .10$ ). The model demonstrated labeling performance comparable to that of the human labeling including non-radiology physician and junior radiology resident. Further, the model provided time and cost savings compared to the human labeling.

## CONCLUSION

Chat GPT-based algorithms have the potential to assist the decision-making for clinical lung cancer staging in accordance with 8<sup>th</sup> edition of the TNM classification. Notably, the model also performed well for interpretation in a variety of multimodal and multilingual imaging reports.

## CLINICAL RELEVANCE/APPLICATION

Generative AIs, like Chat GPT, possess the potential to aid in clinical lung cancer staging decision-making.

## Abstract Archives of the RSNA, 2023

W6-STCE1-1

### GPT-4 Analysis of MRI Reports in Suspected Myocarditis: A Multicenter Study

Wednesday, Nov. 29 1:30PM - 2:00PM Room: Learning Center Theater 1

Kenan Kaya, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The diagnosis of myocarditis is based on clinical symptoms, laboratory results, and cardiac MRI. The correct interpretation and integration of MRI findings require radiological expertise and knowledge. The Generative Pre-trained Transformer 4 (GPT-4) is a large language model capable of generating semantically coherent responses and logical decisions on text-based inputs and requests. The aim of this study was to investigate the potential of GPT-4 for decision-making and final interpretation of MRI reports in suspected myocarditis.

#### METHODS AND MATERIALS

This is a retrospective study including 400 patients with suspected myocarditis from eight centers. The following text-based input information was provided to the GPT-4 network and to three radiologists with different levels of experience (R1: 1 year, R2: 2 years, and R3: 4 years): MRI reports (structured (n=100) and unstructured (n=100)), applied sequences, laboratory results, patient age, sex, and clinical symptoms. The final interpretation of the report indicating the presence or absence of myocarditis was not provided. GPT-4 and the radiologists were prompted to provide a dichotomous statement (yes/no) regarding the presence of myocarditis. The accuracy, sensitivity, and specificity of GPT-4 and the readers for the diagnosis of myocarditis were calculated by comparing their findings to the final diagnosis of an expert reader with 6 years of experience in cardiac MRI. The results were obtained using contingency tables while a  $\chi^2$ -Test was employed to compare the diagnoses of the radiologists and GPT-4. A p-value of  $<.05$  was considered statistically significant.

#### RESULTS

GPT-4 showed an accuracy of 82%, sensitivity of 86%, and specificity of 79%. These results did not differ significantly from the performance of radiologist R1 (accuracy=87%, sensitivity=85%, specificity=88%,  $p=.05$ ), but were inferior to radiologists R2 (accuracy=97%, sensitivity=93%, specificity=99%,  $p=.001$ ) and R3 (accuracy=89%, sensitivity=77%, specificity=98%,  $p<.0001$ ).

#### CONCLUSION

Using multicenter data, GPT-4 achieved good performance in interpreting heterogeneous text-based cardiac MRI findings for myocarditis diagnosis, which was in the range of the inexperienced reader. GPT-4-based analysis of text-based findings could serve as a supportive tool in interpreting and decision-making in cardiac imaging.

#### CLINICAL RELEVANCE/APPLICATION

GPT-4 achieved a good performance in interpreting multicenter report-based cardiac MRI findings. Its use as a supportive tool for interpreting findings and decision-making in clinical practice, particularly for inexperienced readers, is conceivable.

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## Abstract Archives of the RSNA, 2023

W6-STCE1-2

### Exploring Racial Disparities in Imaging Datasets via Generative AI: A Path to Enhanced Model Transparency

Wednesday, Nov. 29 1:30PM - 2:00PM Room: Learning Center Theater 1

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Addressing potential biases in healthcare data is pivotal. This study leverages generative deep learning (DL) methods to identify radiographic variances related to race in patients undergoing total hip arthroplasty (THA). The study aims to demonstrate the feasibility of using generative AI on large scale imaging data to uncover anatomical differences between White and African American patients.

#### METHODS AND MATERIALS

We used pelvic radiographs from an institutional THA patient registry covering the period from Jan 1997 to Oct 2021. The radiographs were characterized using proven DL models determining the projection plane, laterality, and the presence or absence of prosthesis. Patient demographics such as age, sex, self-reported race, and body mass index were also recorded. Using denoising diffusion probabilistic models (DDPM), synthetic radiographs conditioned on these demographics and image characteristics were generated. Post-model training, 60 high-resolution transformation videos were created, transitioning from a radiograph of a White patient to that of an African American patient, with all variables held constant, Figure 1. Two MSK radiologists and two orthopedic surgeons, as expert evaluators, characterized systematic differences in the images. The inter-rater agreement was assessed using Gwet's AC1 (GAC), with a value of  $>0.60$  indicating substantial agreement.

#### RESULTS

The study incorporated 480,407 pelvic radiographs from 15,127 unique patients (52% female, 1% African American). The expert panel identified six characteristics that demonstrated systematic differences between the races. African American patients displayed decreased inter-acetabular distance (GAC: 0.83), a higher degree of osteoarthritis (GAC: 0.82), a more elliptical obturator foramen (GAC: 0.80), reduced femoral neck-shaft angle (GAC: 0.76), an elongated pelvis ring (GAC: 0.61), and increased femoral metaphyseal cortical thickness (GAC: 0.60). All differences were statistically significant ( $p$ -values  $<0.001$ ).

#### CONCLUSION

The study demonstrates the effective use of generative AI models for detecting anatomical differences between White and African American patients. African American patients had a significantly higher osteoarthritis severity compared to White patients, suggesting healthcare access disparities at early stages of disease.

#### CLINICAL RELEVANCE/APPLICATION

Generative DL models can aid in detecting previously unrecognized anatomical differences between races in medical imaging datasets. Knowledge of these variations can assist in creation of datasets that better represent the population and also detection of datasets that may contain high racial bias, leading to the development of more transparent and unbiased AI models.

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## Abstract Archives of the RSNA, 2023

W6-STCE1-3

### Leveraging Chat GPT-4 for Automatic Labeling of Lung Cancer Staging from Chest CT and PET-CT Reports: A Multimodal and Multilingual Approach

Wednesday, Nov. 29 1:30PM - 2:00PM Room: Learning Center Theater 1

Jinwoo Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study investigated the performance of Chat GPT-4 as an automatic labeler of lung cancer staging from contrast enhanced-chest CT and F-18 FDG PET-CT free-text reports.

#### METHODS AND MATERIALS

We utilized 8th edition of the TNM classification for lung cancer document as specialized knowledge base and the GPT-4 model was used to label the lung cancer staging from the contrast enhanced-chest CT and F-18 FDG PET-CT free-text reports in in English or Korean. The ground truth staging labels were determined by consensus of thoracic radiologist and thoracic nuclear radiologist. Chest CT and PET/CT free-text reports were used to compare the GPT-4 model`s performance against radiologist, nuclear radiologist, non-radiology physician, senior and junior radiology residents with brief training.

#### RESULTS

Upon analysis of the 100 free-text reports, each representing different staging levels of lung cancer, the GPT-4 model accurately performed lung cancer staging in accordance with the 8th edition of the TNM classification. The average performance of the GPT-4 models, with an F1 score of  $0.792 \pm 0.061$ , did not exhibit significant differences compared to the average performance of human readers, which scored an F1 of  $0.849 \pm 0.106$  ( $P = .10$ ). The model demonstrated labeling performance comparable to that of the human labeling including non-radiology physician and junior radiology resident. Further, the model provided time and cost savings compared to the human labeling.

#### CONCLUSION

Chat GPT-based algorithms have the potential to assist the decision-making for clinical lung cancer staging in accordance with 8<sup>th</sup> edition of the TNM classification. Notably, the model also performed well for interpretation in a variety of multimodal and multilingual imaging reports.

#### CLINICAL RELEVANCE/APPLICATION

Generative AIs, like Chat GPT, possess the potential to aid in clinical lung cancer staging decision-making.

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## Abstract Archives of the RSNA, 2023

W6-STCE2

### Science Session (Theranostics)

Wednesday, Nov. 29 1:30PM - 2:00PM Room: Learning Center Theater 2

#### Sub-Events

### **W6-STCE2- PSMA PET-Supported Differential Diagnosis of Dural-Based Intracranial Lesions in Patients with Metastatic Prostate Cancer: A Common Clinical Scenario with Implications for Theranostic Management.**

Divya Yadav, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

PSMA PET and peptide radionuclide therapy (PRRT) has emerged as a powerful theranostic tool in prostate cancer management. Dural metastases are relatively uncommon, occurring in 1-6% of cases, though probably underdiagnosed given autopsy studies. Meningiomas are the most common primary brain tumor, and thus may be encountered as an incidental finding in patients undergoing whole-body PSMA PET for prostate cancer evaluation. PSMA PET findings in meningioma have not previously been studied. We performed a comparative analysis between PSMA PET SUV in prostate cancer dural metastases and meningioma, with contrast-enhanced MRI and/or CT as reference standard.

#### **METHODS AND MATERIALS**

Retrospective report search of all [Ga68]- and [F18]-PSMA PET/CT performed at our institution for the past 3 years was performed to identify patients with 1.) calvarial/dural prostate cancer metastases and 2.) meningiomas based on MRI and/or CT appearance. Histopathological correlation and follow up imaging were also used wherever available to support the diagnosis. Maximum SUV of target lesions and the parotid were used to calculate SUV ratio (SUVR) for normalization purposes, to control for uptake differences between [Ga68]- and [F18]-PSMA. Mann-Whitney-tests and descriptive statistics were performed to compare SUVR between groups.

#### **RESULTS**

18 male patients (median age 76, range 59-96 years) with rising PSA underwent [Ga68]- and [F18]-PSMA PET/CT for prostate cancer and were found to have a total of 30 PSMA-avid calvarial/ dural-based lesions. 24 lesions were radiographically classified as prostate cancer metastases and 6 as meningioma. Metastases had significantly higher median SUV and SUVR than meningiomas (13.2 [95% CI: 8.2, 18.6] vs 2.6 [95% CI: 1.9, 4.5],  $p = 0.001$ , and 2.4 [95% CI: 0.6, 2.4] vs 0.3 [95% CI: 0.2, 0.4],  $p < 0.0001$ , respectively).

#### **CONCLUSION**

Meningiomas represent an important differential diagnosis when encountering dural-based lesions in patients with prostate cancer undergoing theranostic management. Our findings demonstrate mild PSMA avidity in meningiomas, significantly below that of prostate cancer metastases. Quantitative SUV analysis can accurately differentiate these entities and thereby optimize management.

#### **CLINICAL RELEVANCE/APPLICATION**

Intracranial metastases in prostate cancer carry poor prognosis. SUV quantification can differentiate metastases from meningiomas in prostate cancer patients undergoing theranostic evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W6-STCE2-2

### **PSMA PET-Supported Differential Diagnosis of Dural-Based Intracranial Lesions in Patients with Metastatic Prostate Cancer: A Common Clinical Scenario with Implications for Theranostic Management.**

Wednesday, Nov. 29 1:30PM - 2:00PM Room: Learning Center Theater 2

Divya Yadav, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

PSMA PET and peptide radionuclide therapy (PRRT) has emerged as a powerful theranostic tool in prostate cancer management. Dural metastases are relatively uncommon, occurring in 1-6% of cases, though probably underdiagnosed given autopsy studies. Meningiomas are the most common primary brain tumor, and thus may be encountered as an incidental finding in patients undergoing whole-body PSMA PET for prostate cancer evaluation. PSMA PET findings in meningioma have not previously been studied. We performed a comparative analysis between PSMA PET SUV in prostate cancer dural metastases and meningioma, with contrast-enhanced MRI and/or CT as reference standard.

#### **METHODS AND MATERIALS**

Retrospective report search of all [Ga68]- and [F18]-PSMA PET/CT performed at our institution for the past 3 years was performed to identify patients with 1.) calvarial/dural prostate cancer metastases and 2.) meningiomas based on MRI and/or CT appearance. Histopathological correlation and follow up imaging were also used wherever available to support the diagnosis. Maximum SUV of target lesions and the parotid were used to calculate SUV ratio (SUVr) for normalization purposes, to control for uptake differences between [Ga68]- and [F18]-PSMA. Mann-Whitney-tests and descriptive statistics were performed to compare SUVr between groups.

#### **RESULTS**

18 male patients (median age 76, range 59-96 years) with rising PSA underwent [Ga68]- and [F18]-PSMA PET/CT for prostate cancer and were found to have a total of 30 PSMA-avid calvarial/ dural-based lesions. 24 lesions were radiographically classified as prostate cancer metastases and 6 as meningioma. Metastases had significantly higher median SUV and SUVr than meningiomas (13.2 [95% CI: 8.2, 18.6] vs 2.6 [95% CI: 1.9, 4.5],  $p = 0.001$ , and 2.4 [95% CI: 0.6, 2.4] vs 0.3 [95% CI: 0.2, 0.4],  $p < 0.0001$ , respectively).

#### **CONCLUSION**

Meningiomas represent an important differential diagnosis when encountering dural-based lesions in patients with prostate cancer undergoing theranostic management. Our findings demonstrate mild PSMA avidity in meningiomas, significantly below that of prostate cancer metastases. Quantitative SUV analysis can accurately differentiate these entities and thereby optimize management.

#### **CLINICAL RELEVANCE/APPLICATION**

Intracranial metastases in prostate cancer carry poor prognosis. SUV quantification can differentiate metastases from meningiomas in prostate cancer patients undergoing theranostic evaluation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSBR09

### Breast Imaging (AI and Deep Learning Applications in Screening and Risk Assessment)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

Wendy B. Demartini, MD (*Moderator*) Advisory Board, Kheiron Medical Technologies Ltd  
Manisha Bahl, MD, MPH (*Moderator*) Consultant, Lunit Inc; Expert Advisory Committee, 2nd.MD  
Sarah Eskreis-Winkler, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W7-SSBR09-1 Performance of a Deep Learning Image-Based Five-Year Breast Cancer Risk Model in Predicting DCIS and Invasive Breast Cancer**

Wendy B. Demartini, MD (*Presenter*) Advisory Board, Kheiron Medical Technologies Ltd

#### PURPOSE

To estimate the performance of a deep learning image-based five-year breast cancer risk model in patients who develop DCIS vs. invasive breast cancer within five years of screening mammography.

#### METHODS AND MATERIALS

This retrospective, multicenter international study included 31,016 consecutive bilateral 2D full field digital screening mammograms from a U.S. screening center and 10,673 from a European screening center from January 2011 through December 2016. These exams were not part of model training. Cancer outcomes and type (pure DCIS vs any invasive breast cancer) were obtained from local tumor registries. Cancer rates were defined as total cancers diagnosed after the index mammogram/total exams and were calculated for DCIS (excluding invasive cancer cases) and invasive cancers (excluding pure DCIS cases). Model performance was compared using areas under the receiver operating characteristic curve (AUCs) ( $p < .05$ ) with 95% confidence intervals.

#### RESULTS

The U.S. center included 937 total cancers diagnosed post index mammogram, for a 3.0% cancer positive rate. Invasive cancers accounted for 60.5% (567) of total cancers; DCIS accounted for 31.4% (294); remaining 8.1% (75) were of unknown or ambiguous cancer type. The European center included 250 total five-year cancers representing a 2.3% cancer positive rate. Invasive cancers accounted for 74.4% (186) of total cancers; DCIS accounted for 22.8% (57); remaining 2.8% (7) were of unknown or ambiguous cancer type. AUC by breast cancer type: U.S. center invasive cancers 0.79 [95% CI 0.77, 0.81] ( $n = 30,646$ ) vs U.S. center DCIS 0.73 [95% CI 0.70, 0.76] ( $n = 30,373$ ) ( $p < .001$ ); European center invasive cancers 0.80 [95% CI 0.76, 0.83] ( $n = 10,609$ ) vs European center DCIS 0.75 [95% CI 0.68, 0.82] ( $n = 10,480$ ) ( $p = .253$ ).

#### CONCLUSION

The deep learning model performed consistently at or above 0.73 AUC for predicting invasive breast cancers and DCIS across multi-site centers in the U.S. and Europe. At the U.S center, predictive performance was higher for invasive cancer compared to that for DCIS.

#### CLINICAL RELEVANCE/APPLICATION

Deep-learning based five-year breast cancer risk prediction can effectively identify the risk of both invasive breast cancers and DCIS in U.S. and European screening programs.

#### **W7-SSBR09-2 Beyond Mammographic Breast Density: Superior Performance of Image-Based DL Model to Predict Breast Cancer Risk**

Christiane K. Kuhl, MD, PhD (*Presenter*) Advisory Board, Guerbet SA; Speaker, Bracco Group; Speaker, Bayer AG

## PURPOSE

To compare predictive performance of a new deep learning five-year breast cancer risk prediction model to mammographic breast density in identifying patients with a higher burden of cancer in screening programs in the U.S. and Europe.

## METHODS AND MATERIALS

This retrospective, multicenter international study included 30,198 consecutive bilateral 2D full field digital screening mammograms from a U.S. screening center and 10,672 from a European screening center from January 2011 through December 2016. Breast density assessments (dense vs not dense) were extracted from electronic medical records. Cancer outcomes were obtained from local tumor registries. Cancers included DCIS and any invasive breast cancer. NCCN thresholds were used to categorize five-year risk predictions from the calibrated DL model as follows: average risk < 1.7%, intermediate risk > 1.7% and < 3.0%, and high risk > 3.0%. We used logistic regression to model the relationship (via Odds Ratios) between positive five-year cancer outcome and the explanatory variables of predicted risk category and breast density, with an interaction term between risk category and breast density, to determine if the relationship between risk category and cancer outcome differs between those with not dense and dense breasts. We also analyzed average marginal effect (AME) of risk level and breast density. Analyses used average risk as the reference for risk category and not dense as the reference for breast density.

## RESULTS

The DL model consistently categorized exams with similar future cancer rates regardless of breast density. Odds ratios for predictors (n= 40,870): intermediate risk category 2.54 [95% CI 1.88-3.42] (p<.001); high risk category 9.60 [95% CI 7.65-12.17] (p<.001); dense breast tissue 1.16 [95% CI 0.88-1.54] (p=.301); intermediate risk category x dense breast tissue 0.93 [95% CI 0.62-1.38] (p=.703); high risk category x dense breast tissue 0.74 [95% CI 0.54-1.02] (p=.069). Average marginal effects (AME) analysis: intermediate risk category AME 2.43 [95% CI 1.99, 2.97] (p<.0001); high risk category AME 8.19 [95% CI 6.99, 9.61] (p<.0001); dense breast tissue AME 1.05 [95% CI 0.90, 1.24] (p=0.522).

## CONCLUSION

A deep-learning based model using only mammography images to predict five-year breast cancer risk effectively differentiates risk across breast density categories. Breast density is an ineffective measure to identify patients with a higher cancer burden in a mammography screening program.

## CLINICAL RELEVANCE/APPLICATION

An image based deep-learning model exceeds breast density in predicting future breast cancer risk and provides a more effective method to guide clinical decision making regarding supplemental imaging and risk reduction.

## W7-SSBR09-3 Deep Learning Model Translates Imaging Biomarkers to Predict Future DCIS vs Invasive Breast Cancer Risk Across Races

Leslie Lamb, MD, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

A deep learning (DL) algorithm was previously designed to predict a patient's risk of developing breast cancer at multiple time points using mammographic image biomarkers alone. The purpose of this study was to compare the predictive accuracy of DL image-only model to predict future DCIS vs invasive breast cancer across races.

## METHODS AND MATERIALS

This retrospective, multisite study included consecutive patients >30 years undergoing routine bilateral screening mammography from 01/10/2009 to 01/10/2018 at five facilities with at least five years of follow-up. A DL 5-year model was used to assess risk. Women with a personal history of breast cancer were excluded. No mammograms included were used for model development. Patient demographics were retrieved from electronic medical records. Cancer outcomes were obtained through linkage to a regional tumor registry. DL model performance was compared using areas under the receiver operating characteristic curve (AUCs) with DeLong test (p<0.05).

## RESULTS

83871 bilateral screening mammograms in 48984 patients met inclusion criteria. Mean patient age was 59y (IQR: 51-68y). 17013/83871 (20.3%) had a family history of breast cancer. 65660/83871 (78.3%) were in post-menopausal and 18211/83871 (21.7%) in pre-menopausal patients. 49686/83697 (59.4%) had non-dense and 34011/83697 (40.6%) had dense breasts. 68621/83871 (81.8%) of patients were White, 4376/83871 (5.2%) Asian, 4140/83871 (4.9%) Black and 5426/83871 (6.5%) were other races. The AUC of DL model in predicting DCIS was 0.71 (95% confidence interval [CI]: 0.65, 0.77) and invasive malignancy was 0.70 (95% CI: 0.67, 0.74) across all patients. The AUC in predicting DCIS was significantly higher in Black vs White patients (0.92, 95% CI: 0.87, 0.97 vs 0.70, 95% CI: 0.64, 0.77, respectively, p<0.001). There was no evidence of a significant difference in predicting DCIS in Asian vs White patients (0.66, 95% CI: 0.32, 1.00 vs 0.70, 95% CI: 0.64, 0.77, respectively, p=0.798). There was no evidence of a significant difference in

predicting invasive disease in Black vs White (0.73, 95% CI: 0.63, 0.83 vs 0.71, 95% CI: 0.67, 0.74, respectively,  $p=0.592$ ) or Asian vs White (0.68, 95% CI: 0.54, 0.83 vs 0.71, 95% CI: 0.67, 0.74, respectively,  $p=0.988$ ) patients.

## **CONCLUSION**

Mammograms contain highly predictive biomarkers of future cancer risk. A DL model using screening mammography alone can accurately discriminate patients at risk of developing DCIS and invasive disease across races.

## **CLINICAL RELEVANCE/APPLICATION**

A DL image-only risk model can provide increased access to an equitable accurate risk assessment tool for both DCIS and invasive malignancy prediction across races.

## **W7-SSBR09-4 External Evaluation of a Mammography-based Deep Learning Model for Breast Cancer Risk Prediction in a High-risk, Diverse Population**

Olasubomi J. Omoleye, MBBS (*Presenter*) Nothing to Disclose

### **PURPOSE**

To externally evaluate a mammography-based deep learning (MG-DL) model, Mirai, for breast cancer (BC) risk prediction in a high-risk, diverse population; assess its predictive performance across BC subtypes; and compare its accuracy with breast density and final BI-RADS assessment categories.

### **METHODS AND MATERIALS**

After excluding 169 exams with time-to-cancer <6 months, 6266 screening mammograms acquired from 2043 participants enrolled in a cancer risk clinic between 2006 and 2020 were retrospectively evaluated in this case-control study. Pathologically confirmed invasive carcinoma or ductal carcinoma in situ (DCIS) of the breast was the primary outcome. MG-DL risk scores were primary predictors. Breast density and final BI-RADS assessment were comparative predictors.

### **RESULTS**

The mean age at mammography was 56.4 (SD: 11.2) years. 910 participants (44.5%) were African American (AA) and 853 (41.8%) White. 15.3% had a known family history of BC, 30.5% had a history of benign breast disease (BBD), and 4.8% were known carriers of BC-predisposing gene mutations. Mirai had one- and five-year areas under the receiver operating characteristic curve (AUC) of 0.71 [95% CI: 0.68-0.74] and 0.65 [0.64-0.67] respectively. Mirai showed better near-term accuracy in non-dense vs dense breasts: 1-year AUC 0.72 [0.63-0.81] vs 0.58 [0.45-0.72], although this was not statistically significant ( $p = 0.10$ ). Mirai and BI-RADS assessment 1-year AUCs were not significantly different: 0.68 [0.61-0.75] and 0.73 [0.66-0.79] respectively,  $p = 0.34$ . However, for 2-5-year prediction, Mirai outperformed BI-RADS (5-year AUC 0.63 vs 0.54; all  $p = 0.0016$ ). Mirai also outperformed both visually assessed and AI-generated breast density categories at all time points (5-year AUC 0.62 vs 0.48 vs 0.52; all  $p < 0.0001$ ). The MG-DL model showed higher discrimination for low- and intermediate- vs high-grade cancers (5-year AUCs 0.63 [0.57-0.70] and 0.63 [0.61-0.67] vs 0.58 [0.54-0.62],  $p < 0.05$ ). In image-mirroring experiments, utilizing only images of the future-unaffected breast as model input led to significantly lower performance of the MG-DL model, suggesting that its predictions were probably based on the detection of ipsilateral premalignant patterns.

## **CONCLUSION**

We evaluated an MG-DL model in a high-risk population and suggested that an important driver of its performance may be the detection of premalignant mammographic features. Our results support further examination of MG-DL models for BC risk prediction in high-risk, diverse groups.

## **CLINICAL RELEVANCE/APPLICATION**

Externally evaluating MG-DL models in high-risk, diverse groups who stand to benefit the most from more accurate risk prediction is pertinent to inform further testing in prospective BC interception trials.

## **W7-SSBR09-5 Screening Mammography: Can a Deep Learning Model Support Expanded Screening of Patients in Their 40s**

Ray C. Mayo III, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

There is international consensus on the importance of screening patients in their 50s and 60s, but wide variation in recommendations for screening patients in their 40s. We measured the potential contribution of an image-based deep learning model to identify patients 40-49 at five-year breast cancer risk similar to that of patients aged 50-69.

### **METHODS AND MATERIALS**

This retrospective study included 30,212 consecutive bilateral 2D full field digital screening mammograms from January 2011 through December 2016 from six facilities at a U.S. screening program. Patient demographics were extracted from electronic medical records and cancer outcomes obtained from local tumor registries. Age categories included 40-49, 50-69, and >70.



Cancer positive exams were defined as exams with breast cancer diagnosed following the mammogram. Five-year calibrated risk predictions from the DL model were used to group exams as average (<1.7%), intermediate (> 1.7%) and high (> 3.0%) risk based on NCCN thresholds. We estimated the percents of exams for each threshold by age group and compared observed cancer rates (cancer positive exams/all exams) across risk and age groups. Chi-squared tests were used to measure statistical differences across independent risk and age groups.

## RESULTS

Across all ages, cancer rates were 1.0%, 5.0% and 7.0% for average, intermediate and high-risk groups (n=30,212, Chi-squared 691.50, p<.0001). Cancer rates increased with each age group: 1.6% (40-49), 3.2% (50-69), and 6.0% (>70) (n=30,212, Chi-squared 149.91, p<.0001). Within each age group, DL risk score thresholds distinguished exams in patients with lower and higher cancer rates. For patients in their 40s, cancer rates were 0.7%, 3.3% and 5.1% in average, intermediate and high-risk subgroups (n=8,208, Chi-squared 126.99, p<.0001). 37% of exams for patients in their 40s were identified as intermediate risk, with a five-year cancer rate of 3.3%, compared to a similar cancer rate of 3.2% for exams in patients 50-69. 16% of exams in patients in their 40s were identified as high risk, with a five-year cancer rate of 5.1%, compared to a similar cancer rate of 5.0% for patients aged 50-69 at intermediate risk.

## CONCLUSION

A DL image-based risk model can identify significant numbers of patients in their 40s who have five-year future breast cancer risk similar to that in patients aged 50-69 in screening programs. A DL risk model can support more informed decision making for patients 40-49 and their providers regarding when to start screening.

## CLINICAL RELEVANCE/APPLICATION

For programs that do not offer routine screening to patients aged 40-49 and for those with variable engagement of these patients in screening, a DL image-based model has the potential to support enhanced screening of this key age group.

## W7-SSBR09-6 Preliminary Results of Implementing AI into Breast Cancer Screening in the Capital Region of Denmark

Andreas D. Lauritzen, PhD (*Presenter*) (Former) Researcher, ScreenPoint Medical BV, NL Scientific Assistant at Gentofte Hospital, DK

## PURPOSE

This study assessed the screening quality before and after AI was implemented in a population-based breast cancer screening program. Based on a large prior simulation study, an AI system supporting a stratified reading protocol and decision support was implemented into screening in the Capital Region of Denmark as of November 18th 2021.

## METHODS AND MATERIALS

In the Capital Region of Denmark women aged 50-69 years are screened biennially. For women screened before AI implementation from October 1st 2020 to November 17th 2021, all screens were read independently by two breast radiologists. For women screened with AI from November 18th 2021 to December 31st 2022, all screens were assessed by the AI system Transpara (ScreenPoint Medical) producing an exam score from 1-10 reflecting the probability of breast cancer. Screens with an exam score =7 (=5 before May 3rd 2022) were read by AI and a single senior breast radiologist. The remaining women were read by two radiologists with access to decision support with markings by the AI system. Screen detected breast cancers (invasive or DCIS) were histologically confirmed. Screening quality was measured using recall rate, cancer detection rate (CDR), rate of invasive cancers, rate of small cancers (=1cm), rate of node-negative cancers, and false-positive (FP) rate. For CDR and FP rate, women screened after October 1st 2022, were excluded to allow for 90 days of follow up. For rates of invasive, small, and node-negative cancers, women screened after July 3rd 2022 were excluded to have 180 days of follow up. Outcomes were compared before and after AI (jointly for both exam score thresholds) using the Chi2 test. We further measured the reading workload reduction.

## RESULTS

59,573 women were screened before AI and 74,596 women with AI. The recall rate decreased from 3.10% to 2.42% (P < .001) in screening with AI. CDR increased from 0.69% to 0.83% (P < .01). Rate of invasive cancers decreased from 84.8% to 79.9% but not significantly (P = .10). Rate of small cancers increased from 38.9% to 48.0% (P = .04). Rate of node-negative cancers increased from 76.7% to 80.9%, but not significantly (P = .30). FP rate decreased from 2.41% to 1.66% (P < .001). Reading workload was reduced by 34.2%.

## CONCLUSION

Screening with AI in the Capital Region of Denmark increased CDR while the recall and FP rates decreased. Small invasive cancers were more often diagnosed. Rates of invasive and node-negative cancers did not significantly change. Our findings suggest that AI improved screening quality while considerably reducing radiologists' workload.



## **CLINICAL RELEVANCE/APPLICATION**

Screening with AI safely reduced both reading and clinical workload, and results indicated that invasive cancers were more frequently diagnosed while small, suggesting earlier detection.

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## Abstract Archives of the RSNA, 2023

W7-SSBR09-1

### Performance of a Deep Learning Image-Based Five-Year Breast Cancer Risk Model in Predicting DCIS and Invasive Breast Cancer

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

Wendy B. Demartini, MD (*Presenter*) Advisory Board, Kheiron Medical Technologies Ltd

#### PURPOSE

To estimate the performance of a deep learning image-based five-year breast cancer risk model in patients who develop DCIS vs. invasive breast cancer within five years of screening mammography.

#### METHODS AND MATERIALS

This retrospective, multicenter international study included 31,016 consecutive bilateral 2D full field digital screening mammograms from a U.S. screening center and 10,673 from a European screening center from January 2011 through December 2016. These exams were not part of model training. Cancer outcomes and type (pure DCIS vs any invasive breast cancer) were obtained from local tumor registries. Cancer rates were defined as total cancers diagnosed after the index mammogram/total exams and were calculated for DCIS (excluding invasive cancer cases) and invasive cancers (excluding pure DCIS cases). Model performance was compared using areas under the receiver operating characteristic curve (AUCs) ( $p < .05$ ) with 95% confidence intervals.

#### RESULTS

The U.S. center included 937 total cancers diagnosed post index mammogram, for a 3.0% cancer positive rate. Invasive cancers accounted for 60.5% (567) of total cancers; DCIS accounted for 31.4% (294); remaining 8.1% (75) were of unknown or ambiguous cancer type. The European center included 250 total five-year cancers representing a 2.3% cancer positive rate. Invasive cancers accounted for 74.4% (186) of total cancers; DCIS accounted for 22.8% (57); remaining 2.8% (7) were of unknown or ambiguous cancer type. AUC by breast cancer type: U.S. center invasive cancers 0.79 [95% CI 0.77, 0.81] ( $n = 30,646$ ) vs U.S. center DCIS 0.73 [95% CI 0.70, 0.76] ( $n = 30,373$ ) ( $p < .001$ ); European center invasive cancers 0.80 [95% CI 0.76, 0.83] ( $n = 10,609$ ) vs European center DCIS 0.75 [95% CI 0.68, 0.82] ( $n = 10,480$ ) ( $p = .253$ ).

#### CONCLUSION

The deep learning model performed consistently at or above 0.73 AUC for predicting invasive breast cancers and DCIS across multi-site centers in the U.S. and Europe. At the U.S center, predictive performance was higher for invasive cancer compared to that for DCIS.

#### CLINICAL RELEVANCE/APPLICATION

Deep-learning based five-year breast cancer risk prediction can effectively identify the risk of both invasive breast cancers and DCIS in U.S. and European screening programs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSBR09-2

### Beyond Mammographic Breast Density: Superior Performance of Image-Based DL Model to Predict Breast Cancer Risk

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

Christiane K. Kuhl, MD, PhD (*Presenter*) Advisory Board, Guerbet SA; *Speaker*, Bracco Group; *Speaker*, Bayer AG

#### PURPOSE

To compare predictive performance of a new deep learning five-year breast cancer risk prediction model to mammographic breast density in identifying patients with a higher burden of cancer in screening programs in the U.S. and Europe.

#### METHODS AND MATERIALS

This retrospective, multicenter international study included 30,198 consecutive bilateral 2D full field digital screening mammograms from a U.S. screening center and 10,672 from a European screening center from January 2011 through December 2016. Breast density assessments (dense vs not dense) were extracted from electronic medical records. Cancer outcomes were obtained from local tumor registries. Cancers included DCIS and any invasive breast cancer. NCCN thresholds were used to categorize five-year risk predictions from the calibrated DL model as follows: average risk < 1.7%, intermediate risk > 1.7% and < 3.0%, and high risk > 3.0%. We used logistic regression to model the relationship (via Odds Ratios) between positive five-year cancer outcome and the explanatory variables of predicted risk category and breast density, with an interaction term between risk category and breast density, to determine if the relationship between risk category and cancer outcome differs between those with not dense and dense breasts. We also analyzed average marginal effect (AME) of risk level and breast density. Analyses used average risk as the reference for risk category and not dense as the reference for breast density.

#### RESULTS

The DL model consistently categorized exams with similar future cancer rates regardless of breast density. Odds ratios for predictors (n= 40,870): intermediate risk category 2.54 [95% CI 1.88-3.42] (p<.001); high risk category 9.60 [95% CI 7.65-12.17] (p<.001); dense breast tissue 1.16 [95% CI 0.88-1.54] (p=.301); intermediate risk category x dense breast tissue 0.93 [95% CI 0.62-1.38] (p=.703); high risk category x dense breast tissue 0.74 [95% CI 0.54-1.02] (p=.069). Average marginal effects (AME) analysis: intermediate risk category AME 2.43 [95% CI 1.99, 2.97] (p<.0001); high risk category AME 8.19 [95% CI 6.99, 9.61] (p<.0001); dense breast tissue AME 1.05 [95% CI 0.90, 1.24] (p=0.522).

#### CONCLUSION

A deep-learning based model using only mammography images to predict five-year breast cancer risk effectively differentiates risk across breast density categories. Breast density is an ineffective measure to identify patients with a higher cancer burden in a mammography screening program.

#### CLINICAL RELEVANCE/APPLICATION

An image based deep-learning model exceeds breast density in predicting future breast cancer risk and provides a more effective method to guide clinical decision making regarding supplemental imaging and risk reduction.

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## Abstract Archives of the RSNA, 2023

W7-SSBR09-3

### Deep Learning Model Translates Imaging Biomarkers to Predict Future DCIS vs Invasive Breast Cancer Risk Across Races

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

Leslie Lamb, MD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

A deep learning (DL) algorithm was previously designed to predict a patient's risk of developing breast cancer at multiple time points using mammographic image biomarkers alone. The purpose of this study was to compare the predictive accuracy of DL image-only model to predict future DCIS vs invasive breast cancer across races.

#### METHODS AND MATERIALS

This retrospective, multisite study included consecutive patients >30 years undergoing routine bilateral screening mammography from 01/10/2009 to 01/10/2018 at five facilities with at least five years of follow-up. A DL 5-year model was used to assess risk. Women with a personal history of breast cancer were excluded. No mammograms included were used for model development. Patient demographics were retrieved from electronic medical records. Cancer outcomes were obtained through linkage to a regional tumor registry. DL model performance was compared using areas under the receiver operating characteristic curve (AUCs) with DeLong test ( $p < 0.05$ ).

#### RESULTS

83871 bilateral screening mammograms in 48984 patients met inclusion criteria. Mean patient age was 59y (IQR: 51-68y). 17013/83871 (20.3%) had a family history of breast cancer. 65660/83871 (78.3%) were in post-menopausal and 18211/83871 (21.7%) in pre-menopausal patients. 49686/83697 (59.4%) had non-dense and 34011/83697 (40.6%) had dense breasts. 68621/83871 (81.8%) of patients were White, 4376/83871 (5.2%) Asian, 4140/83871 (4.9%) Black and 5426/83871 (6.5%) were other races. The AUC of DL model in predicting DCIS was 0.71 (95% confidence interval [CI]: 0.65, 0.77) and invasive malignancy was 0.70 (95% CI: 0.67, 0.74) across all patients. The AUC in predicting DCIS was significantly higher in Black vs White patients (0.92, 95% CI: 0.87, 0.97 vs 0.70, 95% CI: 0.64, 0.77, respectively,  $p < 0.001$ ). There was no evidence of a significant difference in predicting DCIS in Asian vs White patients (0.66, 95% CI: 0.32, 1.00 vs 0.70, 95% CI: 0.64, 0.77, respectively,  $p = 0.798$ ). There was no evidence of a significant difference in predicting invasive disease in Black vs White (0.73, 95% CI: 0.63, 0.83 vs 0.71, 95% CI: 0.67, 0.74, respectively,  $p = 0.592$ ) or Asian vs White (0.68, 95% CI: 0.54, 0.83 vs 0.71, 95% CI: 0.67, 0.74, respectively,  $p = 0.988$ ) patients.

#### CONCLUSION

Mammograms contain highly predictive biomarkers of future cancer risk. A DL model using screening mammography alone can accurately discriminate patients at risk of developing DCIS and invasive disease across races.

#### CLINICAL RELEVANCE/APPLICATION

A DL image-only risk model can provide increased access to an equitable accurate risk assessment tool for both DCIS and invasive malignancy prediction across races.

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## Abstract Archives of the RSNA, 2023

W7-SSBR09-4

### External Evaluation of a Mammography-based Deep Learning Model for Breast Cancer Risk Prediction in a High-risk, Diverse Population

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

Olasubomi J. Omoleye, MBBS (*Presenter*) Nothing to Disclose

#### PURPOSE

To externally evaluate a mammography-based deep learning (MG-DL) model, Mirai, for breast cancer (BC) risk prediction in a high-risk, diverse population; assess its predictive performance across BC subtypes; and compare its accuracy with breast density and final BI-RADS assessment categories.

#### METHODS AND MATERIALS

After excluding 169 exams with time-to-cancer <6 months, 6266 screening mammograms acquired from 2043 participants enrolled in a cancer risk clinic between 2006 and 2020 were retrospectively evaluated in this case-control study. Pathologically confirmed invasive carcinoma or ductal carcinoma in situ (DCIS) of the breast was the primary outcome. MG-DL risk scores were primary predictors. Breast density and final BI-RADS assessment were comparative predictors.

#### RESULTS

The mean age at mammography was 56.4 (SD: 11.2) years. 910 participants (44.5%) were African American (AA) and 853 (41.8%) White. 15.3% had a known family history of BC, 30.5% had a history of benign breast disease (BBD), and 4.8% were known carriers of BC-predisposing gene mutations. Mirai had one- and five-year areas under the receiver operating characteristic curve (AUC) of 0.71 [95% CI: 0.68-0.74] and 0.65 [0.64-0.67] respectively. Mirai showed better near-term accuracy in non-dense vs dense breasts: 1-year AUC 0.72 [0.63-0.81] vs 0.58 [0.45-0.72], although this was not statistically significant ( $p = 0.10$ ). Mirai and BI-RADS assessment 1-year AUCs were not significantly different: 0.68 [0.61-0.75] and 0.73 [0.66-0.79] respectively,  $p = 0.34$ . However, for 2-5-year prediction, Mirai outperformed BI-RADS (5-year AUC 0.63 vs 0.54; all  $p = 0.0016$ ). Mirai also outperformed both visually assessed and AI-generated breast density categories at all time points (5-year AUC 0.62 vs 0.48 vs 0.52; all  $p < 0.0001$ ). The MG-DL model showed higher discrimination for low- and intermediate- vs high-grade cancers (5-year AUCs 0.63 [0.57-0.70] and 0.63 [0.61-0.67] vs 0.58 [0.54-0.62],  $p < 0.05$ ). In image-mirroring experiments, utilizing only images of the future-unaffected breast as model input led to significantly lower performance of the MG-DL model, suggesting that its predictions were probably based on the detection of ipsilateral premalignant patterns.

#### CONCLUSION

We evaluated an MG-DL model in a high-risk population and suggested that an important driver of its performance may be the detection of premalignant mammographic features. Our results support further examination of MG-DL models for BC risk prediction in high-risk, diverse groups.

#### CLINICAL RELEVANCE/APPLICATION

Externally evaluating MG-DL models in high-risk, diverse groups who stand to benefit the most from more accurate risk prediction is pertinent to inform further testing in prospective BC interception trials.

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## Abstract Archives of the RSNA, 2023

W7-SSBR09-5

### Screening Mammography: Can a Deep Learning Model Support Expanded Screening of Patients in Their 40s

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

Ray C. Mayo III, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

There is international consensus on the importance of screening patients in their 50s and 60s, but wide variation in recommendations for screening patients in their 40s. We measured the potential contribution of an image-based deep learning model to identify patients 40-49 at five-year breast cancer risk similar to that of patients aged 50-69.

#### METHODS AND MATERIALS

This retrospective study included 30,212 consecutive bilateral 2D full field digital screening mammograms from January 2011 through December 2016 from six facilities at a U.S. screening program. Patient demographics were extracted from electronic medical records and cancer outcomes obtained from local tumor registries. Age categories included 40-49, 50-69, and >70. Cancer positive exams were defined as exams with breast cancer diagnosed following the mammogram. Five-year calibrated risk predictions from the DL model were used to group exams as average (<1.7%), intermediate (> 1.7%) and high (> 3.0%) risk based on NCCN thresholds. We estimated the percents of exams for each threshold by age group and compared observed cancer rates (cancer positive exams/all exams) across risk and age groups. Chi-squared tests were used to measure statistical differences across independent risk and age groups.

#### RESULTS

Across all ages, cancer rates were 1.0%, 5.0% and 7.0% for average, intermediate and high-risk groups (n=30,212, Chi-squared 691.50, p<.0001). Cancer rates increased with each age group: 1.6% (40-49), 3.2% (50-69), and 6.0% (>70) (n=30,212, Chi-squared 149.91, p<.0001). Within each age group, DL risk score thresholds distinguished exams in patients with lower and higher cancer rates. For patients in their 40s, cancer rates were 0.7%, 3.3% and 5.1% in average, intermediate and high-risk subgroups (n=8,208, Chi-squared 126.99, p<.0001). 37% of exams for patients in their 40s were identified as intermediate risk, with a five-year cancer rate of 3.3%, compared to a similar cancer rate of 3.2% for exams in patients 50-69. 16% of exams in patients in their 40s were identified as high risk, with a five-year cancer rate of 5.1%, compared to a similar cancer rate of 5.0% for patients aged 50-69 at intermediate risk.

#### CONCLUSION

A DL image-based risk model can identify significant numbers of patients in their 40s who have five-year future breast cancer risk similar to that in patients aged 50-69 in screening programs. A DL risk model can support more informed decision making for patients 40-49 and their providers regarding when to start screening.

#### CLINICAL RELEVANCE/APPLICATION

For programs that do not offer routine screening to patients aged 40-49 and for those with variable engagement of these patients in screening, a DL image-based model has the potential to support enhanced screening of this key age group.

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## Abstract Archives of the RSNA, 2023

W7-SSBR09-6

### Preliminary Results of Implementing AI into Breast Cancer Screening in the Capital Region of Denmark

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S406B

Andreas D. Lauritzen, PhD (*Presenter*) (Former) Researcher, ScreenPoint Medical BV, NL Scientific Assistant at Gentofte Hospital, DK

#### PURPOSE

This study assessed the screening quality before and after AI was implemented in a population-based breast cancer screening program. Based on a large prior simulation study, an AI system supporting a stratified reading protocol and decision support was implemented into screening in the Capital Region of Denmark as of November 18th 2021.

#### METHODS AND MATERIALS

In the Capital Region of Denmark women aged 50-69 years are screened biennially. For women screened before AI implementation from October 1st 2020 to November 17th 2021, all screens were read independently by two breast radiologists. For women screened with AI from November 18th 2021 to December 31st 2022, all screens were assessed by the AI system Transpara (ScreenPoint Medical) producing an exam score from 1-10 reflecting the probability of breast cancer. Screens with an exam score =7 (=5 before May 3rd 2022) were read by AI and a single senior breast radiologist. The remaining women were read by two radiologists with access to decision support with markings by the AI system. Screen detected breast cancers (invasive or DCIS) were histologically confirmed. Screening quality was measured using recall rate, cancer detection rate (CDR), rate of invasive cancers, rate of small cancers (=1cm), rate of node-negative cancers, and false-positive (FP) rate. For CDR and FP rate, women screened after October 1st 2022, were excluded to allow for 90 days of follow up. For rates of invasive, small, and node-negative cancers, women screened after July 3rd 2022 were excluded to have 180 days of follow up. Outcomes were compared before and after AI (jointly for both exam score thresholds) using the Chi2 test. We further measured the reading workload reduction.

#### RESULTS

59,573 women were screened before AI and 74,596 women with AI. The recall rate decreased from 3.10% to 2.42% ( $P < .001$ ) in screening with AI. CDR increased from 0.69% to 0.83% ( $P < .01$ ). Rate of invasive cancers decreased from 84.8% to 79.9% but not significantly ( $P = .10$ ). Rate of small cancers increased from 38.9% to 48.0% ( $P = .04$ ). Rate of node-negative cancers increased from 76.7% to 80.9%, but not significantly ( $P = .30$ ). FP rate decreased from 2.41% to 1.66% ( $P < .001$ ). Reading workload was reduced by 34.2%.

#### CONCLUSION

Screening with AI in the Capital Region of Denmark increased CDR while the recall and FP rates decreased. Small invasive cancers were more often diagnosed. Rates of invasive and node-negative cancers did not significantly change. Our findings suggest that AI improved screening quality while considerably reducing radiologists' workload.

#### CLINICAL RELEVANCE/APPLICATION

Screening with AI safely reduced both reading and clinical workload, and results indicated that invasive cancers were more frequently diagnosed while small, suggesting earlier detection.

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## Abstract Archives of the RSNA, 2023

W7-SSCA08

### Science Session with Keynote: Cardiac Imaging (Workflow and Economics)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

Karen G. Ordovas, MD, MS (*Moderator*) Nothing to Disclose

Bradley D. Allen, MD, MS (*Moderator*) Consultant, Circle Cardiovascular Imaging Inc; Speaker, WebMD LLC

#### Sub-Events

#### W7-SSCA08-1 Trends in Medicare Utilization of Cardiac CT

Mustafa Al-Ogaili, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate provider and geographical distribution of Cardiac CT scans among the Medicare population between Radiologists and Cardiologists.

#### METHODS AND MATERIALS

All cardiac CT CPT codes were extracted from the Part B POSPUF database for the years 2013-2020. Volumes are presented by practice setting and provider type. Practice settings include facility (hospital based) and non-facility (offices). Provider types include "cardiologists" for cardiologists and electrophysiologists, "radiologists" for diagnostic and interventional radiologists, and "other" for the remaining. Market share was calculated as the % of total volumes interpreted by each provider type.

#### RESULTS

38,806 cardiac CT exams were performed in 2013, and 112,909 (+190.6%) in 2020. The cardiac CT exam utilization rate increased from 1.1/1,000 Medicare enrollees in 2013 to 3.2 (+190.9%) in 2020. In 2013, cardiologists interpreted 19,913 (49.2% market share) exams, followed by radiologists 17,306 (42.8%). In 2020, radiologists interpreted 69,552 (58.4%), followed by cardiology 44,165 (37.1%). In the facility (hospital) practice setting, 20,189 cardiac CT exams were performed in 2013, to 71,733 (+ 255.3%) in 2020. In 2013, radiologists interpreted 11,334 (52.0%) facility based exams, and cardiologists 9,332 (48%). In 2020, radiologists interpreted 44,867 (58.3%) facility based exams, and cardiologists 28,905 (41.7%). In the non-facility (office) practice setting, 18,617 cardiac CT exams were performed in 2013, to 41,176 (+121.2%) in 2020. In 2013, cardiologists interpreted 10,591 (56.8%) facility based exams, and radiologists 5,972 (32.0%). In 2020, radiologists interpreted 24,685 (58.6%) non-facility based exams, and cardiologists 15,260 (41.4%).

#### CONCLUSION

Cardiac CT utilization in the Medicare population has increased significantly in the last decade. In 2013, cardiologists interpreted the majority (49.2%) of these studies, and in 2020 radiologists interpreted the most (58.4%). The rate of growth of cardiac CT may have exceeded the capacity of cardiologists to interpret and radiologists likely developed increased capabilities to provide these services, especially in non-facility settings. Given the dramatic increases in utilization, further research is advised to ensure the appropriate use of limited imaging resources.

#### CLINICAL RELEVANCE/APPLICATION

Use of cardiac CT has increased, with radiologists increasing their market share of these studies in all practice settings.

#### W7-SSCA08-2 Trends in Medicare Utilization of Cardiac MRI

Zahra Beizavi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate provider and geographical distribution of Cardiac MRI interpretation among the Medicare population between Radiologists and Cardiologists



## METHODS AND MATERIALS

All "Cardiac MRI" CPT codes as classified by the NITOS system (a validated imaging CPT classification tool) were extracted from the Part B POSPUF database for the years 2013-2019. Interpreting providers were grouped into three, "Cardiology" for Cardiology of Electrophysiology; "Radiology" for both diagnostic and interventional, and "Other" for the remaining. Place of service was analyzed. A dichotomy between non-facility ("O") and facility ("F") charges which can be interpreted to mean hospital vs private office. Not only were absolute volumes of exams were analyzed but market share (% of total volumes) of Cardiac MRI interpretation was also analyzed between the three provider types and the place of service distinctions.

## RESULTS

13354 cardiac MRI exams were performed in 2013, and 31662 (+57.8%) in 2020. The cardiac MRI exam utilization rate increased from 3.6/10,000 Medicare enrollees in 2013 to 8.4 (+133.3%) in 2020. In 2013, cardiologists interpreted 7817 (58.5% market share) exams, followed by radiologists 4719 (35.3%). In 2020, radiologists interpreted 11422 (36.1%), followed by cardiology 18270 (57.7%). In the facility (hospital) practice setting, 10611 cardiac MRI exams were performed in 2013, to 27072 (+155.1%) in 2020. In 2013, radiologists interpreted 3600 (33.9%) facility based exams, and cardiologists 6272 (59.1%). In 2020, radiologists interpreted 9353 (34.5%) facility based exams, and cardiologists 16318 (60.3%). In the non-facility (office) practice setting, 2743 cardiac MRI exams were performed in 2013, to 4590 (+67.3%) in 2020. In 2013, cardiologists interpreted 1545 (56.3%) non-facility based exams, and radiologists 1119 (40.7%). In 2020, radiologists interpreted 2069 (45.1%) non-facility based exams, and cardiologists 1952 (42.5%).

## CONCLUSION

Nationally, the number of Cardiac MRI examinations increased annually. Cardiology consistently performed the majority of exams from 2013 to 2020.

Within the facility setting, Cardiology consistently had the majority of and increased their market share of Cardiac MRI interpretation. In the non-facility setting, Radiology had the minority of market share but overtook Cardiology from 2013-2014 and had the majority in 2020.

## CLINICAL RELEVANCE/APPLICATION

Use of cardiac MRI has increased, with radiologists increasing their market share of these studies in all practice settings.

## W7-SSCA08-3 Impact of AI Assistance on Reader Accuracy and Agreement of Plaque Assessment in Coronary Computed Tomography Angiography

Roberto Fari (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to investigate the impact of AI assistance on plaque evaluation using coronary computed tomography angiography (CCTA). For clinical implementation, inter-observer variability and diagnostic accuracy of plaque assessment without and with AI assistance is essential.

## METHODS AND MATERIALS

We included CCTA images from ten patients with suspected CAD, each divided into 17 cardiac segments resulting in 170 segments for analysis. For the reference standard, three experts independently interpreted the images per segment unaided. The majority vote was used to determine the reference standard; when no majority was reached a conflict read was performed. Three independent study readers interpreted and scored the images, providing a CAD-RADS score for each segment in two reading sessions: with and without AI assist, with a minimum of 4 weeks apart. The AI system utilized in this study was based on a deep learning algorithm specifically designed for lesion detection and quantification. Data were analysed on inter-observer agreement between study readers and on categorical CAD-RADS agreement compared to the reference standard, with and without AI assistance.

## RESULTS

Unaided readers agreed with each other about CAD-RADS in 83.7% of segments (142). When using AI assistance, the inter-reader agreement increased to 91.4% (155) ( $p=0.019$ ). When agreement is relaxed to a difference in CAD-RADS  $<1$ , unaided readers agreed with each other in 96.7% of segments, while using AI assistance significantly improved this agreement to 99.6% ( $p=0.016$ ). When considering only segments with CAD, the unaided readers agreed with each other about the CAD-RADS in 79.8% of segments, the use of AI improved this agreement to 89.3% ( $p=0.018$ ). Compared with the reference standard, unaided readers reported the correct CAD-RADS grade in 80.1% of segments, under-reported the grade by 1 in 6.3% of segments, over-reported the grade by 1 in 10.0% of segments, and had a more serious reporting inaccuracy ( $>1$  grade) in 3.6% of segments. When using AI assistance, readers reported the correct CAD-RADS grade in 83.1% of segments, under-reported the grade by 1 in 7.3% of segments, over-reported the grade by 1 in 7.3% of segments, and had a more serious reporting inaccuracy ( $>1$  grade) in 2.2% of segments.

## CONCLUSION

In this study, AI assistance has shown to significantly reduce inter-observer variability and improve the accuracy in plaque assessment when using CCTA, suggesting its potential as a valuable tool in clinical practice.

## CLINICAL RELEVANCE/APPLICATION

Implementation of AI assistance into clinical workflow significantly improved inter-reader agreement and accuracy in CCTA plaque detection and assessment. This single-centre data can serve as pilot data for a larger multi-centre study.

### W7-SSCA08-4 **Cardiac MRI Dataset Balancing using Atlas Deformations and Style Transfer**

Carles Garcia-Cabrera, BEng, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

The integration of machine learning algorithms into the analysis of Cardiac Magnetic Resonance Imaging (CMR) images holds immense promise in supporting diagnostic and treatment planning activities. However, the effectiveness of these methods is contingent on access to high quality training data, which can be problematic to obtain given the restricted availability of well-balanced datasets. In this work, we explore the problem of dataset balancing in the context of semantic segmentation for CMR. We investigated the effectiveness of synthetic dataset balancing on scans with pathologies that are unseen to the model. In particular, we made efforts on Hypertrophic Cardiomyopathies (HCM) and Dilated Right Ventricle (DRV).

#### METHODS AND MATERIALS

For this study, we trained our model on data from the MMs2 challenge, including 7 pathologies. For the training of our model, we employed just the 40 healthy subjects of MMs2. To complement this data, we added the data from a public atlas, 20 atlas deformations simulating hearts with HCM, and 20 with DRV. The addition involved deforming and slicing the atlas and then performing image-to-image style transfer, which consisted of a machine learning network that preserves the spatial consistency of the image while importing the style of a CMR image to the sliced atlas. The segmentation was performed with a standard U-Net network.

#### RESULTS

The proposed method involving adding deformations from the atlas and performing an image-to-image style transfer resulted in a significant improvement in the segmentation of myocardium, with up to a 4.63% increase in accuracy compared to the baseline method that did not use deformations. The proposed method also showed a mean improvement of 2.29% in all tissues of subjects with DRV. The proposed method outperformed the baseline method by 1.15% in the entire test set, consisting of 160 subjects, achieving a mean DICE score of 0.793.

## CONCLUSION

Incorporating deformations from a healthy atlas, which simulated morphologies from pathology datasets, improved the accuracy of automated tools that assist clinicians in diagnostics. This has the potential to expedite and facilitate the identification of pathologies, particularly in patient cohorts that are not included in the original dataset.

## CLINICAL RELEVANCE/APPLICATION

Accurate segmentation of cardiac tissues is essential for reliable Ejection Fraction calculation, improving automated tools, reducing diagnostic times, and easing the burden on healthcare professionals. Synthetic dataset balancing could lead to the development of tools that maintain performance across the diverse range of subjects in society, improving patient outcomes, increasing clinical workflow efficiency, and alleviating the strain on healthcare systems.

### W7-SSCA08-5 **Development of Artificial Intelligence-Based Approach for Automatic Classification of Cardiovascular Disease using Late Gadolinium Enhancement Imaging**

Youngjoong Yang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Late gadolinium enhancement (LGE) sequence is helpful for classifying and diagnosing various cardiovascular diseases using cardiac magnetic resonance imaging. Many studies have been incorporating artificial intelligence (AI) technology to enhance the usefulness and convenience of LGE-based diagnosis. We propose an AI-based approach in automatically classifying three kinds of non-ischemic cardiomyopathy and normal controls using LGE images.

#### METHODS AND MATERIALS

A total of 79 MRI studies were retrospectively collected, consisting of normal (n=20), hypertrophic cardiomyopathy [HCM] (n=20), dilated cardiomyopathy [DCM] (n=19), and cardiac amyloidosis [CA] (n=20). Three types of LGE images (2-chamber, 4-chamber, and short-axis series) were used for disease classification. 2-chamber and 4-chamber are single-slice, while short-axis is multi-slice. The collected data is validated by a cardiac specialist and labeled into 4 categories. The training and test data were divided in a ratio of 9:1. 2D convolutional neural network models were developed to classify the LGE

images and a separate model was created for the three types of images. The input was preprocessed with image processing technique such as cropping, normalization, and histogram equalization. We utilized the VGG16 models as the backbone network and added convolution and fully connected layers to generate an output. Additionally, heatmap was extracted from global averaging layer and overlaid to visualize the part of LGE image that contributed the most to the classification. Each model predicted whether the LGE image was to represent normal, HCM, DCM, or CA, and the final decision was determined by a decision algorithm that integrated the predictions of three models.

## **RESULTS**

The test data was randomly selected with 2 cases from each of the 4 categories. In the test, the DL models using the 2-chamber and 4-chamber images predicted disease category with an accuracy of 100% for each and the model using short-axis images showed an accuracy of 95.9%. Among the short-axis images in 49 slices, there were two cases of misclassification, with normal being predicted as DCM and normal being predicted as HCM, respectively. The final diagnosis determined by the integrated algorithm correctly identified all test cases.

## **CONCLUSION**

Our method shows a high accuracy for the classification of cardiovascular disease on LGE images.

## **CLINICAL RELEVANCE/APPLICATION**

Our AI-based approach may contribute to LGE-based automatic classification of cardiovascular diseases, if additional researches with larger subjects and external validation can address the issue of a high dependency on the dataset.

## **W7-SSCA08-6 Keynote Speaker**

Subha V. Raman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSCA08-1

### Trends in Medicare Utilization of Cardiac CT

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

Mustafa Al-Ogaili, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate provider and geographical distribution of Cardiac CT scans among the Medicare population between Radiologists and Cardiologists.

#### METHODS AND MATERIALS

All cardiac CT CPT codes were extracted from the Part B POSPUF database for the years 2013-2020. Volumes are presented by practice setting and provider type. Practice settings include facility (hospital based) and non-facility (offices). Provider types include "cardiologists" for cardiologists and electrophysiologists, "radiologists" for diagnostic and interventional radiologists, and "other" for the remaining. Market share was calculated as the % of total volumes interpreted by each provider type.

#### RESULTS

38,806 cardiac CT exams were performed in 2013, and 112,909 (+190.6%) in 2020. The cardiac CT exam utilization rate increased from 1.1/1,000 Medicare enrollees in 2013 to 3.2 (+190.9%) in 2020. In 2013, cardiologists interpreted 19,913 (49.2% market share) exams, followed by radiologists 17,306 (42.8%). In 2020, radiologists interpreted 69,552 (58.4%), followed by cardiology 44,165 (37.1%). In the facility (hospital) practice setting, 20,189 cardiac CT exams were performed in 2013, to 71,733 (+ 255.3%) in 2020. In 2013, radiologists interpreted 11,334 (52.0%) facility based exams, and cardiologists 9,332 (48%). In 2020, radiologists interpreted 44,867 (58.3%) facility based exams, and cardiologists 28,905 (41.7%). In the non-facility (office) practice setting, 18,617 cardiac CT exams were performed in 2013, to 41,176 (+121.2%) in 2020. In 2013, cardiologists interpreted 10591 (56.8%) facility based exams, and radiologists 5,972 (32.0%). In 2020, radiologists interpreted 24,685 (58.6%) non-facility based exams, and cardiologists 15,260 (41.4%).

#### CONCLUSION

Cardiac CT utilization in the Medicare population has increased significantly in the last decade. In 2013, cardiologists interpreted the majority (49.2%) of these studies, and in 2020 radiologists interpreted the most (58.4%). The rate of growth of cardiac CT may have exceeded the capacity of cardiologists to interpret and radiologists likely developed increased capabilities to provide these services, especially in non-facility settings. Given the dramatic increases in utilization, further research is advised to ensure the appropriate use of limited imaging resources.

#### CLINICAL RELEVANCE/APPLICATION

Use of cardiac CT has increased, with radiologists increasing their market share of these studies in all practice settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSCA08-2

### Trends in Medicare Utilization of Cardiac MRI

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

Zahra Beizavi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate provider and geographical distribution of Cardiac MRI interpretation among the Medicare population between Radiologists and Cardiologists

#### METHODS AND MATERIALS

All "Cardiac MRI" CPT codes as classified by the NITOS system (a validated imaging CPT classification tool) were extracted from the Part B POSPUF database for the years 2013-2019. Interpreting providers were grouped into three, "Cardiology" for Cardiology of Electrophysiology; "Radiology" for both diagnostic and interventional, and "Other" for the remaining. Place of service was analyzed. A dichotomy between non-facility ("O") and facility ("F") charges which can be interpreted to mean hospital vs private office. Not only were absolute volumes of exams were analyzed but market share (% of total volumes) of Cardiac MRI interpretation was also analyzed between the three provider types and the place of service distinctions.

#### RESULTS

13354 cardiac MRI exams were performed in 2013, and 31662 (+57.8%) in 2020. The cardiac MRI exam utilization rate increased from 3.6/10,000 Medicare enrollees in 2013 to 8.4 (+133.3%) in 2020. In 2013, cardiologists interpreted 7817 (58.5% market share) exams, followed by radiologists 4719 (35.3%). In 2020, radiologists interpreted 11422 (36.1%), followed by cardiology 18270 (57.7%). In the facility (hospital) practice setting, 10611 cardiac MRI exams were performed in 2013, to 27072 (+155.1%) in 2020. In 2013, radiologists interpreted 3600 (33.9%) facility based exams, and cardiologists 6272 (59.1%). In 2020, radiologists interpreted 9353 (34.5%) facility based exams, and cardiologists 16318 (60.3%). In the non-facility (office) practice setting, 2743 cardiac MRI exams were performed in 2013, to 4590 (+67.3%) in 2020. In 2013, cardiologists interpreted 1545 (56.3%) non-facility based exams, and radiologists 1119 (40.7%). In 2020, radiologists interpreted 2069 (45.1%) non-facility based exams, and cardiologists 1952 (42.5%).

#### CONCLUSION

Nationally, the number of Cardiac MRI examinations increased annually. Cardiology consistently performed the majority of exams from 2013 to 2020.

Within the facility setting, Cardiology consistently had the majority of and increased their market share of Cardiac MRI interpretation. In the non-facility setting, Radiology had the minority of market share but overtook Cardiology from 2013-2014 and had the majority in 2020.

#### CLINICAL RELEVANCE/APPLICATION

Use of cardiac MRI has increased, with radiologists increasing their market share of these studies in all practice settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSCA08-3

### Impact of AI Assistance on Reader Accuracy and Agreement of Plaque Assessment in Coronary Computed Tomography Angiography

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

Roberto Fari (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to investigate the impact of AI assistance on plaque evaluation using coronary computed tomography angiography (CCTA). For clinical implementation, inter-observer variability and diagnostic accuracy of plaque assessment without and with AI assistance is essential.

#### METHODS AND MATERIALS

We included CCTA images from ten patients with suspected CAD, each divided into 17 cardiac segments resulting in 170 segments for analysis. For the reference standard, three experts independently interpreted the images per segment unaided. The majority vote was used to determine the reference standard; when no majority was reached a conflict read was performed. Three independent study readers interpreted and scored the images, providing a CAD-RADS score for each segment in two reading sessions: with and without AI assist, with a minimum of 4 weeks apart. The AI system utilized in this study was based on a deep learning algorithm specifically designed for lesion detection and quantification. Data were analysed on inter-observer agreement between study readers and on categorical CAD-RADS agreement compared to the reference standard, with and without AI assistance.

#### RESULTS

Unaided readers agreed with each other about CAD-RADS in 83.7% of segments (142). When using AI assistance, the inter-reader agreement increased to 91.4% (155) ( $p=0.019$ ). When agreement is relaxed to a difference in CAD-RADS  $<1$ , unaided readers agreed with each other in 96.7% of segments, while using AI assistance significantly improved this agreement to 99.6% ( $p=0.016$ ). When considering only segments with CAD, the unaided readers agreed with each other about the CAD-RADS in 79.8% of segments, the use of AI improved this agreement to 89.3% ( $p=0.018$ ). Compared with the reference standard, unaided readers reported the correct CAD-RADS grade in 80.1% of segments, under-reported the grade by 1 in 6.3% of segments, over-reported the grade by 1 in 10.0% of segments, and had a more serious reporting inaccuracy ( $>1$  grade) in 3.6% of segments. When using AI assistance, readers reported the correct CAD-RADS grade in 83.1% of segments, under-reported the grade by 1 in 7.3% of segments, over-reported the grade by 1 in 7.3% of segments, and had a more serious reporting inaccuracy ( $>1$  grade) in 2.2% of segments.

#### CONCLUSION

In this study, AI assistance has shown to significantly reduce inter-observer variability and improve the accuracy in plaque assessment when using CCTA, suggesting its potential as a valuable tool in clinical practice.

#### CLINICAL RELEVANCE/APPLICATION

Implementation of AI assistance into clinical workflow significantly improved inter-reader agreement and accuracy in CCTA plaque detection and assessment. This single-centre data can serve as pilot data for a larger multi-centre study.

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## Abstract Archives of the RSNA, 2023

W7-SSCA08-4

### Cardiac MRI Dataset Balancing using Atlas Deformations and Style Transfer

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

Carles Garcia-Cabrera, BEng, MEng (*Presenter*) Nothing to Disclose

#### PURPOSE

The integration of machine learning algorithms into the analysis of Cardiac Magnetic Resonance Imaging (CMR) images holds immense promise in supporting diagnostic and treatment planning activities. However, the effectiveness of these methods is contingent on access to high quality training data, which can be problematic to obtain given the restricted availability of well-balanced datasets. In this work, we explore the problem of dataset balancing in the context of semantic segmentation for CMR. We investigated the effectiveness of synthetic dataset balancing on scans with pathologies that are unseen to the model. In particular, we made efforts on Hypertrophic Cardiomyopathies (HCM) and Dilated Right Ventricle (DRV).

#### METHODS AND MATERIALS

For this study, we trained our model on data from the MMs2 challenge, including 7 pathologies. For the training of our model, we employed just the 40 healthy subjects of MMs2. To complement this data, we added the data from a public atlas, 20 atlas deformations simulating hearts with HCM, and 20 with DRV. The addition involved deforming and slicing the atlas and then performing image-to-image style transfer, which consisted of a machine learning network that preserves the spatial consistency of the image while importing the style of a CMR image to the sliced atlas. The segmentation was performed with a standard U-Net network.

#### RESULTS

The proposed method involving adding deformations from the atlas and performing an image-to-image style transfer resulted in a significant improvement in the segmentation of myocardium, with up to a 4.63% increase in accuracy compared to the baseline method that did not use deformations. The proposed method also showed a mean improvement of 2.29% in all tissues of subjects with DRV. The proposed method outperformed the baseline method by 1.15% in the entire test set, consisting of 160 subjects, achieving a mean DICE score of 0.793.

#### CONCLUSION

Incorporating deformations from a healthy atlas, which simulated morphologies from pathology datasets, improved the accuracy of automated tools that assist clinicians in diagnostics. This has the potential to expedite and facilitate the identification of pathologies, particularly in patient cohorts that are not included in the original dataset.

#### CLINICAL RELEVANCE/APPLICATION

Accurate segmentation of cardiac tissues is essential for reliable Ejection Fraction calculation, improving automated tools, reducing diagnostic times, and easing the burden on healthcare professionals. Synthetic dataset balancing could lead to the development of tools that maintain performance across the diverse range of subjects in society, improving patient outcomes, increasing clinical workflow efficiency, and alleviating the strain on healthcare systems.

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## Abstract Archives of the RSNA, 2023

W7-SSCA08-5

### Development of Artificial Intelligence-Based Approach for Automatic Classification of Cardiovascular Disease using Late Gadolinium Enhancement Imaging

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

Youngjoong Yang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Late gadolinium enhancement (LGE) sequence is helpful for classifying and diagnosing various cardiovascular diseases using cardiac magnetic resonance imaging. Many studies have been incorporating artificial intelligence (AI) technology to enhance the usefulness and convenience of LGE-based diagnosis. We propose an AI-based approach in automatically classifying three kinds of non-ischemic cardiomyopathy and normal controls using LGE images.

#### METHODS AND MATERIALS

A total of 79 MRI studies were retrospectively collected, consisting of normal (n=20), hypertrophic cardiomyopathy [HCM] (n=20), dilated cardiomyopathy [DCM] (n=19), and cardiac amyloidosis [CA] (n=20). Three types of LGE images (2-chamber, 4-chamber, and short-axis series) were used for disease classification. 2-chamber and 4-chamber are single-slice, while short-axis is multi-slice. The collected data is validated by a cardiac specialist and labeled into 4 categories. The training and test data were divided in a ratio of 9:1. 2D convolutional neural network models were developed to classify the LGE images and a separate model was created for the three types of images. The input was preprocessed with image processing technique such as cropping, normalization, and histogram equalization. We utilized the VGG16 models as the backbone network and added convolution and fully connected layers to generate an output. Additionally, heatmap was extracted from global averaging layer and overlaid to visualize the part of LGE image that contributed the most to the classification. Each model predicted whether the LGE image was to represent normal, HCM, DCM, or CA, and the final decision was determined by a decision algorithm that integrated the predictions of three models.

#### RESULTS

The test data was randomly selected with 2 cases from each of the 4 categories. In the test, the DL models using the 2-chamber and 4-chamber images predicted disease category with an accuracy of 100% for each and the model using short-axis images showed an accuracy of 95.9%. Among the short-axis images in 49 slices, there were two cases of misclassification, with normal being predicted as DCM and normal being predicted as HCM, respectively. The final diagnosis determined by the integrated algorithm correctly identified all test cases.

#### CONCLUSION

Our method shows a high accuracy for the classification of cardiovascular disease on LGE images.

#### CLINICAL RELEVANCE/APPLICATION

Our AI-based approach may contribute to LGE-based automatic classification of cardiovascular diseases, if additional researches with larger subjects and external validation can address the issue of a high dependency on the dataset.

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## Abstract Archives of the RSNA, 2023

W7-SSCA08-6

### Keynote Speaker

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N226

Subha V. Raman, MD (*Presenter*) Nothing to Disclose

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSCH08

### Chest Imaging (Chest CT: Dual Energy/Spectral Imaging)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E350

Subba R. Digumarthy, MD (*Moderator*) Consultant, Merck & Co, Inc; Consultant, Pfizer Inc; Consultant, Bristol-Myers Squibb Company; Consultant, Novartis AG; Consultant, F. Hoffmann-La Roche Ltd; Consultant, Polaris; Consultant, Cascadian; Consultant, AbbVie Inc; Consultant, Gradalis, Inc; Consultant, Bayer AG; Consultant, Zai Lab Limited; Consultant, Biengen; Consultant, Riverain Technologies, LLC; Consultant, Resonance Health; Consultant, Annalise-AI Pty Ltd; Research Grant, Lunit Inc; Research Grant, General Electric Company; Research Grant, Qure.ai; Speaker, Siemens AG  
Myrna C. Godoy, MD, PhD (*Moderator*) Siemens Healthineers Research Grant

#### Sub-Events

#### **W7-SSCH08-1 Improved Pulmonary Arterial Evaluation using Photon-counting High-Pitch Multi-energy Pulmonary CTA Compared to Energy-Integrating Detector Single-energy High Pitch and Dual-energy Pulmonary CTA**

Mariana Yalon, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare image quality, iodine signal, and radiation dose of pulmonary CTA acquired to detect pulmonary embolism (PE) using photon-counting-detector CT (PCD CT) at high pitch multi-energy scanning mode (ME FLASH) compared to conventional dual-source energy-integrating-detector (EID) CT using either single-energy high pitch acquisition (SE FLASH) or dual-energy (DE) with routine pitch.

#### METHODS AND MATERIALS

This retrospective, case-control study consisted of 150 clinical pulmonary CTA exams (50 PCD ME FLASH; 50 EID FLASH; and 50 EID DE). Cases were matched by patient weight. CT number and noise measurements were measured from the main to segmental pulmonary arteries using 120 kV threshold low, 120 kV, and mixed kV images, respectively. Three readers independently reviewed anonymized, randomized exams, rating each case, using a 4-point Likert scale (1 = worst, and 4 = best) for: contrast enhancement in pulmonary arteries; motion artifacts in aorta, coronary, and lobar to subsegmental pulmonary arteries; lung image quality; pulmonary blood volume (PBV) map quality and contribution to reader confidence in diagnosis.

#### RESULTS

150 patients underwent PCD ME FLASH (n=50; mean wt. 93 kg; mean contrast 82.6 ± 3.0 cc), EID SE FLASH (n=50; mean wt. 88.6 kg; mean contrast 91.2 ± 1.7 cc), or EID DE (n=50; mean wt. 86 kg; mean contrast 75 ± 3.0 cc). For all readers, when comparing PCD to EID SE FLASH and EID DE, contrast enhancement in the pulmonary arteries was rated slightly but significantly higher at PCD (4.6 ± 0.6 vs 4.4 ± 0.7 vs 4.3 ± 0.7; p < 0.001), as was lung image quality (3.3 ± 0.5 vs 3.1 ± 0.5 vs 3.2 ± 0.6; p = 0.017). PCD ME FLASH had significantly fewer motion artifacts in the aortic root and coronary arteries (3.4 ± 0.7 vs 3.0 ± 1.0 vs 3.1 ± 0.8; p = 0.002), central to segmental pulmonary arteries (p < 0.004), and peripherally (3.9 ± 0.3 vs 3.7 ± 0.5 vs 3.7 ± 0.4; p = 0.002). PCD PBV maps had similar quality (3.1 ± 0.7 vs 3.1 ± 0.5) and contribution to reader confidence (1.3 ± 0.5 vs 1.3 ± 0.6) as EID DE. CT numbers in pulmonary arteries were significantly greater at PCD (p < 0.001 for all comparisons). PCD ME FLASH had significantly lower radiation dose (CTDIvol: 8.1 ± 2.5 vs 16.2 ± 8.5 vs 9.6 ± 6.8 mGy; p < 0.001).

#### CONCLUSION

PCD-CT ME FLASH demonstrated higher contrast enhancement in pulmonary arteries with fewer motion artifacts and improved lung image quality compared to EID DE and EID SE FLASH modes at lower radiation and contrast doses.

#### CLINICAL RELEVANCE/APPLICATION

High pitch multi-energy PCD CT can lower radiation dose while increasing iodine signal and decreasing motion artifacts for pulmonary CTA exams.

## **W7-SSCH08-2 Photon-Counting Detector CT Pulmonary Angiography for Diagnosis of Acute Pulmonary Embolism: Evaluation of Image Quality and Iodine-Distribution Maps**

Pauline Pannenbecker, MD, BA (*Presenter*) Nothing to Disclose

### **PURPOSE**

To assess objective and subjective image quality of morphologic images and associated color-coded iodine-distribution maps, as well as radiation dose of CT pulmonary angiography (CTPA) with clinical photon-counting detector CT (PCD CT) compared to standard energy-integrating detector (EID) CTPA.

### **METHODS AND MATERIALS**

120 participants receiving CTPA for suspected pulmonary embolism (PE) were prospectively enrolled into this randomized IRB-approved study. After exclusion of three participants the final collective consisted of 117 participants. Of those, 58 received CTPA on a 1st generation PCD CT scanner (Siemens Naeotom Alpha) and 59 on a 3rd generation EID CT scanner (Siemens Somatom Force). CTPA scans were performed with matched scan protocols (50 ml contrast medium, flow rate 4 ml/sec) at 120 kV (PCD) resp. 90/ Sn150 kV (EID). For PCD pitch was set at 2.0, in case of EID pitch is technically limited to 0.55 in Dual-Energy mode. Pulmonary artery CT attenuation, signal-to-noise ratio (SNR), and contrast-to-noise-ratio (CNR) were assessed as objective criteria of CTPA image quality. Perfused blood volume (PBV) values were recorded for objective image quality assessment of color-coded iodine-distribution maps. Subjective ratings of image quality were obtained by three readers (four-point scale) and were compared for morphologic images (at polychromatic standard reconstructions and at 60 keV using virtual monoenergetic imaging and ) and color-coded iodine-distribution maps. Radiation dose parameters (CTDIvol, dose length product, size specific dose estimate, effective dose [ED]) were compared between both cohorts.

### **RESULTS**

CNR and SNR within evaluated pulmonary vessels were higher in the PCD group (for 60 keV and polychromatic images respectively, all  $p < 0.05$ ). CT attenuation values and PBV values of iodine-maps were similar in both groups ( $p > 0.05$ ). Regarding subjective image quality, two of three readers preferred morphologic images obtained with PCD ( $p < 0.05$ ). For iodine maps, no significant differences were ascertained between PCD and EID ( $p > 0.05$ ). All assessed radiation dose parameters favored the PCD group (ED 2.2 [interquartile range 1.0] mSv vs. 2.8 [1.1] mSv; all  $p < 0.05$ ).

### **CONCLUSION**

With comparable input parameters, PCD CTPA provides higher subjective and objective image quality with regards to morphologic images, equal image quality of iodine-maps as well as reduced radiation dose compared to conventional dual-energy pulmonary angiography with EID technology.

### **CLINICAL RELEVANCE/APPLICATION**

PCD CT allows for spectral assessment of pulmonary vessels and parenchyma with excellent image quality at high pitch settings, which is especially beneficial in patients with suspected PE who frequently present with dyspnea.

## **W7-SSCH08-3 Chest CTA Imaging with Photon-counting CT: Comparison of Image Quality with Energy-Integrating-Detector (EID) CT in 142 Patients**

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

### **PURPOSE**

To compare the overall image quality of chest CT angiographic (CTA) examinations obtained with photon-counting-detector CT (PCD-CT) and energy-integrating-detector (EID-CT).

### **METHODS AND MATERIALS**

The study population included 71 consecutive patients (Group 1) with no infiltrative or destructive lung disease who had been referred for chest CTA obtained with PCD-CT (Naeotom Alpha; Siemens Healthineers) using the multienergy mode (collimation: 144 x 0.4mm; 120 kVp; pitch: 1.5; IQ level: 80). A paired population of 71 patients (Group 2) with no infiltrative or destructive lung disease was retrospectively selected on the basis of (a) a similar injection protocol (60 mL of a 40% contrast agent; flow rate: 4 mL/s), comparable age ( $\pm 5$  years) and weight ( $\pm 5$  kg); and (b) a chest CTA obtained with a 3rd-generation dual-source CT equipment (Somatom Force; Siemens Healthineers) using a dual-energy mode (collimation: 64x0.6x2 mm; pitch: 0.55). Morphologic imaging consisted of contiguous 1-mm thick lung and mediastinal images (Group 1 : 70 keV images; Group 2 : averaged images from both tubes) using the same kernel (Br36) and comparable levels of iterative reconstruction (QIR 3; ADMIRE 3). Perfusion imaging was obtained by subtraction of low- and high monoenergetic images using the eXamine prototype.

## RESULTS

Compared to Group 2, Group 1 examinations showed : (a) a significantly lower DLP ( $172.6 \pm 55.1$  vs  $339.4 \pm 75.6$  mGy.cm;  $p < 0.0001$ ) corresponding to a 52% dose reduction, and shorter duration of data acquisition ( $0.93 \pm 0.1s$  vs  $3.98 \pm 0.35s$ ;  $p < 0.0001$ ); (b) no significant difference in the attenuation values within central pulmonary arteries ( $372.60 \pm 55.1$  HU vs  $420.0 \pm 131.3$  HU;  $p = 0.32$ ) and aorta ( $375.2 \pm 90.3$  HU vs  $394.7 \pm 92.3$  HU;  $p = 0.15$ ); (c) a higher level of objective image noise ( $9.55 \pm 1.8$  HU vs  $6.88 \pm 1.5$  HU;  $p < 0.0001$ ), lower SNR ( $43.1 \pm 17.9$  vs  $64.6 \pm 27.6$ ;  $p < 0.0001$ ) and CNR ( $37.3 \pm 17.4$  vs  $55.7 \pm 26.5$ ;  $p < 0.0001$ ). On perfusion images (a) the mean level of attenuation did not differ ( $p = 0.05$ ) nor did the rating of subjective image noise ( $p = 0.16$ ); (b) the distribution of scores of fissure visualization differed between the 2 groups ( $p < 0.0001$ ) with a higher proportion of fissures sharply delineated in Group 1 ( $n = 60$ ; 84.5% versus  $n = 26$ ; 26.6%); (c) the rating of cardiac motion artifacts significantly differed between the 2 groups ( $p < 0.0001$ ) with a higher percentage of mild artifacts in Group 1 ( $n = 69$ ; 97.2%) than in Group 2 ( $n = 19$ ; 26.8%).

## CONCLUSION

PCD-CT provided comparable morphologic image quality at 70 keV and superior perfusion imaging with a 52% dose reduction.

## CLINICAL RELEVANCE/APPLICATION

Spectral imaging with PCD-CT provides comparable image quality between 70 keV images and averaged images of DSCT with improved quality of perfusion imaging at lower radiation dose.

## W7-SSCH08-4 DECT Material Decomposition: The Value in Detection of Lymph Nodes Metastasis in Breast Cancer

Ibrahim Yel, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the diagnostic performance of a dual-energy computed tomography (DECT)-based technique using iodine quantification and fat fraction analysis for the detection of lymph node (LN) metastases in patients with breast cancer.

## METHODS AND MATERIALS

30 female patients (mean age,  $63.12 \pm 14.2$  years) with breast cancer who underwent pre-operative dual-energy chest CT were included. Histological report after LN excision served as the reference standard. Iodine concentration and fat fraction were determined by performing region-of-interest (ROI) measurements on venous DECT iodine maps. Receiver operating characteristic (ROC) curve analysis was performed to estimate the optimal threshold for discriminating between metastatic and non-metastatic LNs.

## RESULTS

A total of 214 lymph nodes were evaluated, divided into axillary (metastatic: 46, normal: 101), mediastinal (metastatic: 20, normal: 26), and intramammary (metastatic: 10, normal: 11). DECT-based fat fraction values showed significant differences between metastatic ( $10.8 \pm 6.2$  %) and non-metastatic LNs ( $38.8 \pm 17.7$  %) ( $p < 0.0001$ ). Absolute iodine concentrations showed no significant differences ( $2.3$  vs  $2.0$  mg/dl;  $p = 0.25$ ). The optimal fat fraction threshold for the diagnosis of metastatic LNs was 17.8 % with a sensitivity of 89% and specificity of 93%.

## CONCLUSION

DECT material decomposition fat fraction can identify metastatic LNs, overtaking the morpho-volumetric limitation of conventional CT in LN assessment.

## CLINICAL RELEVANCE/APPLICATION

Lymph node (LN) involvement is a crucial prognostic factor with a 40% reduction in 5-year survival rates for those with LN metastases. With the DECT fat fraction analysis, metastatic LN can be identified regardless of the morphological appearance and can be used as a diagnostic biomarker.

## W7-SSCH08-6 Optimal Monoenergetic Levels for Osteoporosis Screening in Photon Counting Detector CT: Preliminary In Vivo and Phantom Study

Fernando U. Kay, MD, PhD (*Presenter*) Research Grant, Edwards Lifesciences Corporation

## PURPOSE

Osteoporosis often goes undetected. Trabecular bone attenuation (TBA) measurements from routine chest CT can be utilized for opportunistic detection. While photon counting detector CT (PCD-CT) has benefits over energy integrating detector CT (EID-CT), optimal virtual monoenergetic (VMI) levels for PCD-CT compatibility with EID-CT thresholds are unclear. This study aims to identify the VMI keV levels on PCD-CT that best correspond to EID-CT for osteoporosis screening to maintain backward compatibility.

## **METHODS AND MATERIALS**

IRB-approved study with 30 patients (median age 63.5 years, range 30-82) who underwent both PCD-CT (Naetom Alpha, Siemens) and EID-CT (Aquilion, Toshiba) within a median interval of 102 days (range 55-371). All CTs were obtained at the late arterial phase post contrast. PCD-CT used 120 kVp, automated exposure control (AEC), 0.8 pitch, and 0.25 s rotation time. Diagnostic images had 2-mm thick slices at 60 keV (Br44 kernel, QIR 3). Additional reconstructions ranged from 60 to 75 keV at 1 keV intervals (Qr40f kernel, QIR 3) to identify the optimal keV levels. EID-CT employed 120 kVp, AEC, 0.8 pitch, and 0.50 s rotation time, with 2-mm thick reconstructions (FC18 kernel, standard AIDR). A radiologist measured TBA using a 1.0 cm<sup>2</sup> ROI at the anterior compartment of the trabecular bone at the same level (within T12/L1) on both CTs. Cases were excluded if visible metastatic disease was present. Phantom experiments followed the same scanning protocols, using a QRM chest phantom with Gammex Rods calcium concentrations of 20, 50, and 100 mg/mL.

## **RESULTS**

Mean phantom rods CT numbers on EID-CT were  $55.4 \pm 16.0$  (20 mg/mL),  $140.4 \pm 18.7$  (50 mg/mL), and  $308.5 \pm 17.1$  HU (100 mg/mL). 73 keV had a bias of  $0.8 \pm 2.3$  HU across all rods between PCD-CT and EID-CT, which was the smallest bias, while 71 keV bias was  $8.2 \pm 2.9$  HU. The CTD<sub>divol</sub> for PCD-CT and EID-CT were  $7.8 \pm 2.1$  and  $10.7 \pm 3.5$  mGy, respectively ( $p < 0.001$ ). TBA measurements at 60 keV were significantly higher than those obtained from EID-CT, with mean values of  $212.5 \pm 63.5$  versus  $159.9 \pm 44.5$  HU, respectively ( $p < 0.001$ ). Bone density at 71 keV was  $167.6 \pm 51.3$  HU and were most comparable to EID-CT ( $P = 0.07$ ), with a bias of  $0.7 \pm 11.5$  HU.

## **CONCLUSION**

Optimized energy levels for vascular assessment and soft tissue contrast may not align with EID-CT thresholds for detecting low bone mineral density. Our study recommends a 71-73 keV range for improved backward compatibility between PCD-CT and EID-CT.

## **CLINICAL RELEVANCE/APPLICATION**

This study establishes a benchmark for the ideal energy range in PCD-CT VMI reconstructions to maintain compatibility with EID-CT-based osteoporosis detection thresholds, laying the groundwork for future research on the benefits of this novel CT technology.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSCH08-1

### Improved Pulmonary Arterial Evaluation using Photon-counting High-Pitch Multi-energy Pulmonary CTA Compared to Energy-Integrating Detector Single-energy High Pitch and Dual-energy Pulmonary CTA

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E350

Mariana Yalon, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare image quality, iodine signal, and radiation dose of pulmonary CTA acquired to detect pulmonary embolism (PE) using photon-counting-detector CT (PCD CT) at high pitch multi-energy scanning mode (ME FLASH) compared to conventional dual-source energy-integrating-detector (EID) CT using either single-energy high pitch acquisition (SE FLASH) or dual-energy (DE) with routine pitch.

#### METHODS AND MATERIALS

This retrospective, case-control study consisted of 150 clinical pulmonary CTA exams (50 PCD ME FLASH; 50 EID FLASH; and 50 EID DE). Cases were matched by patient weight. CT number and noise measurements were measured from the main to segmental pulmonary arteries using 120 kV threshold low, 120 kV, and mixed kV images, respectively. Three readers independently reviewed anonymized, randomized exams, rating each case, using a 4-point Likert scale (1 = worst, and 4 = best) for: contrast enhancement in pulmonary arteries; motion artifacts in aorta, coronary, and lobar to subsegmental pulmonary arteries; lung image quality; pulmonary blood volume (PBV) map quality and contribution to reader confidence in diagnosis.

#### RESULTS

150 patients underwent PCD ME FLASH (n=50; mean wt. 93 kg; mean contrast 82.6 ± 3.0 cc), EID SE FLASH (n=50; mean wt. 88.6 kg; mean contrast 91.2 ± 1.7 cc), or EID DE (n=50; mean wt. 86 kg; mean contrast 75 ± 3.0 cc). For all readers, when comparing PCD to EID SE FLASH and EID DE, contrast enhancement in the pulmonary arteries was rated slightly but significantly higher at PCD (4.6 ± 0.6 vs 4.4 ± 0.7 vs 4.3 ± 0.7; p < 0.001), as was lung image quality (3.3 ± 0.5 vs 3.1 ± 0.5 vs 3.2 ± 0.6; p = 0.017). PCD ME FLASH had significantly fewer motion artifacts in the aortic root and coronary arteries (3.4 ± 0.7 vs 3.0 ± 1.0 vs 3.1 ± 0.8; p = 0.002), central to segmental pulmonary arteries (p < 0.004), and peripherally (3.9 ± 0.3 vs 3.7 ± 0.5 vs 3.7 ± 0.4; p = 0.002). PCD PBV maps had similar quality (3.1 ± 0.7 vs 3.1 ± 0.5) and contribution to reader confidence (1.3 ± 0.5 vs 1.3 ± 0.6) as EID DE. CT numbers in pulmonary arteries were significantly greater at PCD (p < 0.001 for all comparisons). PCD ME FLASH had significantly lower radiation dose (CTDIvol: 8.1 ± 2.5 vs 16.2 ± 8.5 vs 9.6 ± 6.8 mGy; p < 0.001).

#### CONCLUSION

PCD-CT ME FLASH demonstrated higher contrast enhancement in pulmonary arteries with fewer motion artifacts and improved lung image quality compared to EID DE and EID SE FLASH modes at lower radiation and contrast doses.

#### CLINICAL RELEVANCE/APPLICATION

High pitch multi-energy PCD CT can lower radiation dose while increasing iodine signal and decreasing motion artifacts for pulmonary CTA exams.

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## Abstract Archives of the RSNA, 2023

W7-SSCH08-2

### Photon-Counting Detector CT Pulmonary Angiography for Diagnosis of Acute Pulmonary Embolism: Evaluation of Image Quality and Iodine-Distribution Maps

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E350

Pauline Pannenbecker, MD, BA (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess objective and subjective image quality of morphologic images and associated color-coded iodine-distribution maps, as well as radiation dose of CT pulmonary angiography (CTPA) with clinical photon-counting detector CT (PCD CT) compared to standard energy-integrating detector (EID) CTPA.

#### METHODS AND MATERIALS

120 participants receiving CTPA for suspected pulmonary embolism (PE) were prospectively enrolled into this randomized IRB-approved study. After exclusion of three participants the final collective consisted of 117 participants. Of those, 58 received CTPA on a 1st generation PCD CT scanner (Siemens Naeotom Alpha) and 59 on a 3rd generation EID CT scanner (Siemens Somatom Force). CTPA scans were performed with matched scan protocols (50 ml contrast medium, flow rate 4 ml/sec) at 120 kV (PCD) resp. 90/ Sn150 kV (EID). For PCD pitch was set at 2.0, in case of EID pitch is technically limited to 0.55 in Dual-Energy mode. Pulmonary artery CT attenuation, signal-to-noise ratio (SNR), and contrast-to-noise-ratio (CNR) were assessed as objective criteria of CTPA image quality. Perfused blood volume (PBV) values were recorded for objective image quality assessment of color-coded iodine-distribution maps. Subjective ratings of image quality were obtained by three readers (four-point scale) and were compared for morphologic images (at polychromatic standard reconstructions and at 60 keV using virtual monoenergetic imaging and ) and color-coded iodine-distribution maps. Radiation dose parameters (CTDIvol, dose length product, size specific dose estimate, effective dose [ED]) were compared between both cohorts.

#### RESULTS

CNR and SNR within evaluated pulmonary vessels were higher in the PCD group (for 60 keV and polychromatic images respectively, all  $p < 0.05$ ). CT attenuation values and PBV values of iodine-maps were similar in both groups ( $p > 0.05$ ). Regarding subjective image quality, two of three readers preferred morphologic images obtained with PCD ( $p < 0.05$ ). For iodine maps, no significant differences were ascertained between PCD and EID ( $p > 0.05$ ). All assessed radiation dose parameters favored the PCD group (ED 2.2 [interquartile range 1.0] mSv vs. 2.8 [1.1] mSv; all  $p < 0.05$ ).

#### CONCLUSION

With comparable input parameters, PCD CTPA provides higher subjective and objective image quality with regards to morphologic images, equal image quality of iodine-maps as well as reduced radiation dose compared to conventional dual-energy pulmonary angiography with EID technology.

#### CLINICAL RELEVANCE/APPLICATION

PCD CT allows for spectral assessment of pulmonary vessels and parenchyma with excellent image quality at high pitch settings, which is especially beneficial in patients with suspected PE who frequently present with dyspnea.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSCH08-3

### Chest CTA Imaging with Photon-counting CT: Comparison of Image Quality with Energy-Integrating-Detector (EID) CT in 142 Patients

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E350

Martine J. Remy-Jardin, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speaker, Siemens AG

#### PURPOSE

To compare the overall image quality of chest CT angiographic (CTA) examinations obtained with photon-counting-detector CT (PCD-CT) and energy-integrating-detector (EID-CT).

#### METHODS AND MATERIALS

The study population included 71 consecutive patients (Group 1) with no infiltrative or destructive lung disease who had been referred for chest CTA obtained with PCD-CT (Naeotom Alpha; Siemens Healthineers) using the multienergy mode (collimation: 144 x 0.4mm; 120 kVp; pitch: 1.5; IQ level: 80). A paired population of 71 patients (Group 2) with no infiltrative or destructive lung disease was retrospectively selected on the basis of (a) a similar injection protocol (60 mL of a 40% contrast agent; flow rate: 4 mL/s), comparable age ( $\pm 5$  years) and weight ( $\pm 5$  kg); and (b) a chest CTA obtained with a 3rd-generation dual-source CT equipment (Somatom Force; Siemens Healthineers) using a dual-energy mode (collimation: 64x0.6x2 mm; pitch: 0.55). Morphologic imaging consisted of contiguous 1-mm thick lung and mediastinal images (Group 1 : 70 keV images; Group 2 : averaged images from both tubes) using the same kernel (Br36) and comparable levels of iterative reconstruction (QIR 3; ADMIRE 3). Perfusion imaging was obtained by subtraction of low- and-high monoenergetic images using the eXamine prototype.

#### RESULTS

Compared to Group 2, Group 1 examinations showed : (a) a significantly lower DLP ( $172.6 \pm 55.1$  vs  $339.4 \pm 75.6$  mGy.cm;  $p < 0.0001$ ) corresponding to a 52% dose reduction, and shorter duration of data acquisition ( $0.93 \pm 0.1$ s vs  $3.98 \pm 0.35$ s;  $p < 0.0001$ ); (b) no significant difference in the attenuation values within central pulmonary arteries ( $372.60 \pm 55.1$  HU vs  $420.0 \pm 131.3$  HU;  $p = 0.32$ ) and aorta ( $375.2 \pm 90.3$  HU vs  $394.7 \pm 92.3$  HU;  $p = 0.15$ ); (c) a higher level of objective image noise ( $9.55 \pm 1.8$  HU vs  $6.88 \pm 1.5$  HU;  $p < 0.0001$ ), lower SNR ( $43.1 \pm 17.9$  vs  $64.6 \pm 27.6$ ;  $p < 0.0001$ ) and CNR ( $37.3 \pm 17.4$  vs  $55.7 \pm 26.5$ ;  $p < 0.0001$ ). On perfusion images (a) the mean level of attenuation did not differ ( $p = 0.05$ ) nor did the rating of subjective image noise ( $p = 0.16$ ); (b) the distribution of scores of fissure visualization differed between the 2 groups ( $p < 0.0001$ ) with a higher proportion of fissures sharply delineated in Group 1 ( $n = 60$ ; 84.5% versus  $n = 26$ ; 26.6%); (c) the rating of cardiac motion artifacts significantly differed between the 2 groups ( $p < 0.0001$ ) with a higher percentage of mild artifacts in Group 1 ( $n = 69$ ; 97.2%) than in Group 2 ( $n = 19$ ; 26.8%).

#### CONCLUSION

PCD-CT provided comparable morphologic image quality at 70 keV and superior perfusion imaging with a 52% dose reduction.

#### CLINICAL RELEVANCE/APPLICATION

Spectral imaging with PCD-CT provides comparable image quality between 70 keV images and averaged images of DSCT with improved quality of perfusion imaging at lower radiation dose.

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## Abstract Archives of the RSNA, 2023

W7-SSCH08-4

### DECT Material Decomposition: The Value in Detection of Lymph Nodes Metastasis in Breast Cancer

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E350

Ibrahim Yel, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance of a dual-energy computed tomography (DECT)-based technique using iodine quantification and fat fraction analysis for the detection of lymph node (LN) metastases in patients with breast cancer.

#### METHODS AND MATERIALS

30 female patients (mean age,  $63.12 \pm 14.2$  years) with breast cancer who underwent pre-operative dual-energy chest CT were included. Histological report after LN excision served as the reference standard. Iodine concentration and fat fraction were determined by performing region-of-interest (ROI) measurements on venous DECT iodine maps. Receiver operating characteristic (ROC) curve analysis was performed to estimate the optimal threshold for discriminating between metastatic and non-metastatic LNs.

#### RESULTS

A total of 214 lymph nodes were evaluated, divided into axillary (metastatic: 46, normal: 101), mediastinal (metastatic: 20, normal: 26), and intramammary (metastatic: 10, normal: 11). DECT-based fat fraction values showed significant differences between metastatic ( $10.8 \pm 6.2$  %) and non-metastatic LNs ( $38.8 \pm 17.7$  %) ( $p < 0.0001$ ). Absolute iodine concentrations showed no significant differences (2.3 vs 2.0 mg/dl;  $p = 0.25$ ). The optimal fat fraction threshold for the diagnosis of metastatic LNs was 17.8 % with a sensitivity of 89% and specificity of 93%.

#### CONCLUSION

DECT material decomposition fat fraction can identify metastatic LNs, overtaking the morpho-volumetric limitation of conventional CT in LN assessment.

#### CLINICAL RELEVANCE/APPLICATION

Lymph node (LN) involvement is a crucial prognostic factor with a 40% reduction in 5-year survival rates for those with LN metastases. With the DECT fat fraction analysis, metastatic LN can be identified regardless of the morphological appearance and can be used as a diagnostic biomarker.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSCH08-6

### Optimal Monoenergetic Levels for Osteoporosis Screening in Photon Counting Detector CT: Preliminary In Vivo and Phantom Study

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E350

Fernando U. Kay, MD, PhD (*Presenter*) Research Grant, Edwards Lifesciences Corporation

#### PURPOSE

Osteoporosis often goes undetected. Trabecular bone attenuation (TBA) measurements from routine chest CT can be utilized for opportunistic detection. While photon counting detector CT (PCD-CT) has benefits over energy integrating detector CT (EID-CT), optimal virtual monoenergetic (VMI) levels for PCD-CT compatibility with EID-CT thresholds are unclear. This study aims to identify the VMI keV levels on PCD-CT that best correspond to EID-CT for osteoporosis screening to maintain backward compatibility.

#### METHODS AND MATERIALS

IRB-approved study with 30 patients (median age 63.5 years, range 30-82) who underwent both PCD-CT (Naetom Alpha, Siemens) and EID-CT (Aquilion, Toshiba) within a median interval of 102 days (range 55-371). All CTs were obtained at the late arterial phase post contrast. PCD-CT used 120 kVp, automated exposure control (AEC), 0.8 pitch, and 0.25 s rotation time. Diagnostic images had 2-mm thick slices at 60 keV (Br44 kernel, QIR 3). Additional reconstructions ranged from 60 to 75 keV at 1 keV intervals (Qr40f kernel, QIR 3) to identify the optimal keV levels. EID-CT employed 120 kVp, AEC, 0.8 pitch, and 0.50 s rotation time, with 2-mm thick reconstructions (FC18 kernel, standard AIDR). A radiologist measured TBA using a 1.0 cm<sup>2</sup> ROI at the anterior compartment of the trabecular bone at the same level (within T12/L1) on both CTs. Cases were excluded if visible metastatic disease was present. Phantom experiments followed the same scanning protocols, using a QRM chest phantom with Gammex Rods calcium concentrations of 20, 50, and 100 mg/mL.

#### RESULTS

Mean phantom rods CT numbers on EID-CT were 55.4 ± 16.0 (20 mg/mL), 140.4 ± 18.7 (50 mg/mL), and 308.5 ± 17.1 HU (100 mg/mL). 73 keV had a bias of 0.8 ± 2.3 HU across all rods between PCD-CT and EID-CT, which was the smallest bias, while 71 keV bias was 8.2 ± 2.9 HU. The CTDIvol for PCD-CT and EID-CT were 7.8 ± 2.1 and 10.7 ± 3.5 mGy, respectively (p < 0.001). TBA measurements at 60 keV were significantly higher than those obtained from EID-CT, with mean values of 212.5 ± 63.5 versus 159.9 ± 44.5 HU, respectively (p < 0.001). Bone density at 71 keV was 167.6 ± 51.3 HU and were most comparable to EID-CT (P = 0.07), with a bias of 0.7 ± 11.5 HU.

#### CONCLUSION

Optimized energy levels for vascular assessment and soft tissue contrast may not align with EID-CT thresholds for detecting low bone mineral density. Our study recommends a 71-73 keV range for improved backward compatibility between PCD-CT and EID-CT.

#### CLINICAL RELEVANCE/APPLICATION

This study establishes a benchmark for the ideal energy range in PCD-CT VMI reconstructions to maintain compatibility with EID-CT-based osteoporosis detection thresholds, laying the groundwork for future research on the benefits of this novel CT technology.

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## Abstract Archives of the RSNA, 2023

W7-SSGI15

### Gastrointestinal Imaging (Pancreas Diffuse Disease)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S404

Kristen Olinger, MD (*Moderator*) Nothing to Disclose  
Abraham Fourie Bezuidenhout, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W7-SSGI15-2 **Paraduodenal Pancreatitis in the Covid-19 Pandemic Era**

Peter Liaw, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Paraduodenal or groove pancreatitis is an underrecognized and uncommon form of chronic pancreatitis centered in the pancreaticoduodenal groove, typically seen in middle aged males with a history of alcohol use. Although previous publications have described the impact of COVID-19 on other forms of pancreatitis, little is known about the impact of the COVID-19 pandemic on patients presenting with paraduodenal pancreatitis. Our objective was to describe the prevalence, demographics, imaging findings, and associations of paraduodenal pancreatitis before and during the COVID-19 pandemic.

#### METHODS AND MATERIALS

The radiology information system was searched for patients who underwent abdominal CT or MRI for suspected paraduodenal pancreatitis between 2017 and 2022. Patients that underwent imaging between 2017 and 2019 were designated pre-COVID-19, and those imaged between 2020 and 2022 were designated as during COVID-19 pandemic. All studies were reviewed by two fellowship trained abdominal radiologists for imaging findings of paraduodenal pancreatitis, blinded to clinical information. Concurrent imaging findings of hepatic steatosis were noted.

#### RESULTS

A total of 72 patients with suspected paraduodenal pancreatitis were identified between 2017 and 2022. Electronic medical records were reviewed for final patient diagnosis established at the pancreaticobiliary multidisciplinary conference. Subsequently, 36 patients with alternate diagnoses were excluded. 7 patients [mean age, 45±9 years; 7 men, 0 women] were diagnosed with paraduodenal pancreatitis in the pre-COVID-19 cohort. 2/7 (29%) patients had the pure form, 5/7 (71%) had the segmental form and 0 patients had concurrent hepatic steatosis. 29 patients [mean age, 56±17 years; 14 men, 15 women] were diagnosed with paraduodenal pancreatitis in the during COVID-19 cohort. 15/29 (52%) patients had the pure form, 14/29 (48%) had the segmental form and 8/29 (28%) patients had concurrent hepatic steatosis.

#### CONCLUSION

We report a four-fold increase in patients presenting with paraduodenal pancreatitis during a similar time period prior to and during the COVID-19 pandemic. The demographic of patients presenting with paraduodenal pancreatitis during the COVID-19 pandemic was no longer predominantly male, and almost one third of patients presented with concurrent hepatic steatosis.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware of the increase in incidence and change in demographics of paraduodenal pancreatitis in the COVID-19 pandemic era as well as concurrent hepatic steatosis reported in almost one third of patients.

#### W7-SSGI15-3 **Normal Pancreatic Microanatomy Visible with Photon-Counting CT**

Erik Brandt, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-Counting CT (PCCT) has the advantage of increased spatial resolution. Hence, radiologists will be able to visualize previously unseen anatomical structures. The pancreas has a complex anatomy both macroscopically and microscopically. We

aim to investigate if normal anatomical structures not visible with current generation energy integrating CT-scanners (EID CT) becomes visible with PCCT scanners.

## **METHODS AND MATERIALS**

We reviewed the literature regarding inconsistently seen macro- and micro-anatomical structures of the pancreas on EID CT systems. Afterwards we reviewed PCCT scans from 20 consecutive patients without pancreatic pathology, scanned in the workup of pancreatic cancer with a contrast enhanced multiphase protocol over the upper abdomen (late arterial phase, portal venous phase and late venous phase). A subspecialized radiologist assessed the visibility of the main and accessory pancreatic ducts, side ducts, hepatopancreatic ampulla, major papilla, minor papilla, smaller pancreatic arteries and veins, lymphatic confluence, regional lymph nodes, coeliac ganglia, and coeliac plexus. In addition, measurements were made of the size of the main, accessory, side-ducts, and ganglia. Attenuation was measured in all three contrast-phases of ganglia and two lymph nodes.

## **RESULTS**

The main duct was visible in 20 / 20 patients in the head, body, and tail of the pancreas. The average size of the accessory duct was 1,2mm and it was visible in 20 / 20 patients. More than ten side-ducts were visible in 18 / 20 patients. The average diameter of the visible side-ducts was 0,5mm. Both the major and minor papillae were visible in 20 / 20 cases. Four arteries to the pancreaticoduodenal arcade were visible in 20 / 20 patients. Lymph nodes in all regional pancreatic lymph node stations were visible in 18 / 20 patients. The lymphatic confluence was visible in 20/20 patients. The coeliac ganglion was visible on both sides in 20 / 20 patients. The ganglia showed an increasing iodine enhancement from the late arterial phase to the late venous phase. In contrast, all evaluated lymph nodes showed the highest iodine enhancement in either the late arterial or portal venous phase with washout in the late venous phase. The coeliac plexus was visible in 20 / 20 patients.

## **CONCLUSION**

In PCCT scans of the pancreas, previously unseen anatomy (side ducts, papillae, pancreaticoduodenal arteries, lymph nodes, nerve ganglia and plexus) is consistently visible in patients without pancreatic pathology.

## **CLINICAL RELEVANCE/APPLICATION**

This has important implications for the evaluation of pancreatic disease and the differentiation of pathology from normal anatomy. Normal anatomy could very likely be confused for pathology if radiologists are unaware of it.

## **W7-SSGI15-5 Association of Pancreatic Steatosis and Atrophy with Type II Diabetes Mellitus**

Ashish Dua, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Assessment of pancreatic steatosis and volume in patients with type-II diabetes mellitus and to look for association of DM with these parameters.

## **METHODS AND MATERIALS**

We prospectively evaluated 66 patients with diabetes and 47 non-diabetic patients, age group 40-65 years who underwent unenhanced Computed Tomography of abdomen for some abdominal complaints. Cases had adequately controlled blood sugar levels, none of the cases or controls had any systemic co-morbidities. Parameters noted: 1) Pancreatic steatosis indirectly, as: Difference between pancreatic and splenic attenuation (HU p-s), and ratio of pancreatic to splenic attenuation (HU p/s); and 2) Pancreatic volume (using inbuilt volume application in CT). After matching, t-test and Mann-Whitney-test were applied for calculating p-values. Receiver Operating Curves (ROC) were made for finding cut-off values of pancreatic steatosis and pancreatic volume with optimal sensitivity and specificity.

## **RESULTS**

Pancreatic fat content was significantly high ( $p < 0.001$ ) in patients with type-II diabetes (HU p-s of  $-13.2 \pm 7.9$  and HU p/s of  $0.73 \pm 0.15$ ) compared to non-diabetics (HU p-s of  $-6.7 \pm 5.9$  and HU p/s of  $0.86 \pm 0.12$ ). Pancreatic volume was significantly low ( $p < 0.001$ ) in patients with type-II DM ( $48 \pm 13.7$  cm<sup>3</sup>) compared to non-diabetic patients ( $63.6 \pm 17.3$  cm<sup>3</sup>). Thus, pancreatic steatosis and atrophy may act as surrogate marker for type-II DM.

## **CONCLUSION**

Pancreatic steatosis and atrophy are significantly associated with type-II DM. These changes if found in high-risk individual incidentally on imaging, might represent overt or impending DM. These findings should be reported as it would prompt complete biochemical work-up. Early diagnosis of DM can mitigate disabilities and complications related to it. Thus, pancreatic steatosis and atrophy may act as a surrogate biomarker for diagnosis of overt or impending type II DM.

## **CLINICAL RELEVANCE/APPLICATION**

Considering the enormous diabetic burden in the world, lab investigations alone may not suffice and an adjunct diagnostic modality might help us know the diabetic status of a lot of undiagnosed individuals. Pancreatic imaging can play a pivotal adjunct role in assessment of the diabetic status of people since imaging investigations have become rampant and people get

ultrasound, CT scan and MRI frequently for various diseases. Adequate knowledge on imaging of pancreas can help us know the diabetic status of individuals who may not be unaware of their diabetic status and have had this disease for long duration.

## **W7-SSGI15-6 MRI Quantitative Assessment of Age-related Changes in Pancreatic Margins in Subjects Without Pancreatic Disease**

Giulia A. Zamboni, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To quantitatively evaluate age-related changes of pancreatic margins on Magnetic Resonance in patients without history or signs of pancreatic pathology, as a possible reference for future studies assessing the relationship between parenchymal margins and pancreatic disease.

### **METHODS AND MATERIALS**

IRB approval was not required for this retrospective study. We included patients without history, suspicion, or imaging findings of pancreatic pathology who underwent abdominal MR scans (1.5T and 3T) between August 2021 and August 2022. A computer-assisted quantitative analysis of the pancreatic margins was performed using in-house software on Fat-Suppressed T1-Weighted images, drawing multiple ROIs on the anterior margins of the body and tail, where the pancreas abuts retroperitoneal fat. The root mean square deviation SD of the actual border from the average boundary line (Pancreatic Margin Score, PMS) was obtained. Higher mean PMS values reflect an increased lobularity of the pancreatic profile at imaging, while lower PMS values reflect a straightened profile. The population was divided into 4 groups by age (group 1: <30 years; group 2: 30-49 years; group 3: 50-69 years; group 4: ≥70 years). The PMS values were compared across groups by applying the one-way ANOVA test; a p value <0.05 was chosen as significant.

### **RESULTS**

A significant difference ( $p < 0.05$ ) across the four groups was observed of the mean PMS, with values increasing with age:  $0.315 \pm 0.0579$  in group 1,  $0.341 \pm 0.0747$  in group 2,  $0.374 \pm 0.117$  in group 3 and  $0.419 \pm 0.158$  in group 4.

### **CONCLUSION**

The analysis of the pancreatic margins revealed different results based on age, which reflects the qualitative changes seen in the morphology of the pancreas with aging, especially an increase in lobularity.

### **CLINICAL RELEVANCE/APPLICATION**

The Pancreatic Margin Score (PMS) reflects qualitative changes of the pancreatic profile at imaging. Knowing the normal values of PMS could allow to use PMS as a diagnostic tool for pancreatic diseases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSGI15-2

### Paraduodenal Pancreatitis in the Covid-19 Pandemic Era

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S404

Peter Liaw, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Paraduodenal or groove pancreatitis is an underrecognized and uncommon form of chronic pancreatitis centered in the pancreaticoduodenal groove, typically seen in middle aged males with a history of alcohol use. Although previous publications have described the impact of COVID-19 on other forms of pancreatitis, little is known about the impact of the COVID-19 pandemic on patients presenting with paraduodenal pancreatitis. Our objective was to describe the prevalence, demographics, imaging findings, and associations of paraduodenal pancreatitis before and during the COVID-19 pandemic.

#### METHODS AND MATERIALS

The radiology information system was searched for patients who underwent abdominal CT or MRI for suspected paraduodenal pancreatitis between 2017 and 2022. Patients that underwent imaging between 2017 and 2019 were designated pre-COVID-19, and those imaged between 2020 and 2022 were designated as during COVID-19 pandemic. All studies were reviewed by two fellowship trained abdominal radiologists for imaging findings of paraduodenal pancreatitis, blinded to clinical information. Concurrent imaging findings of hepatic steatosis were noted.

#### RESULTS

A total of 72 patients with suspected paraduodenal pancreatitis were identified between 2017 and 2022. Electronic medical records were reviewed for final patient diagnosis established at the pancreaticobiliary multidisciplinary conference. Subsequently, 36 patients with alternate diagnoses were excluded. 7 patients [mean age, 45±9 years; 7 men, 0 women] were diagnosed with paraduodenal pancreatitis in the pre-COVID-19 cohort. 2/7 (29%) patients had the pure form, 5/7 (71%) had the segmental form and 0 patients had concurrent hepatic steatosis. 29 patients [mean age, 56±17 years; 14 men, 15 women] were diagnosed with paraduodenal pancreatitis in the during COVID-19 cohort. 15/29 (52%) patients had the pure form, 14/29 (48%) had the segmental form and 8/29 (28%) patients had concurrent hepatic steatosis.

#### CONCLUSION

We report a four-fold increase in patients presenting with paraduodenal pancreatitis during a similar time period prior to and during the COVID-19 pandemic. The demographic of patients presenting with paraduodenal pancreatitis during the COVID-19 pandemic was no longer predominantly male, and almost one third of patients presented with concurrent hepatic steatosis.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware of the increase in incidence and change in demographics of paraduodenal pancreatitis in the COVID-19 pandemic era as well as concurrent hepatic steatosis reported in almost one third of patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSGI15-3

### Normal Pancreatic Microanatomy Visible with Photon-Counting CT

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S404

Erik Brandt, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-Counting CT (PCCT) has the advantage of increased spatial resolution. Hence, radiologists will be able to visualize previously unseen anatomical structures. The pancreas has a complex anatomy both macroscopically and microscopically. We aim to investigate if normal anatomical structures not visible with current generation energy integrating CT-scanners (EID CT) becomes visible with PCCT scanners.

#### METHODS AND MATERIALS

We reviewed the literature regarding inconsistently seen macro- and micro-anatomical structures of the pancreas on EID CT systems. Afterwards we reviewed PCCT scans from 20 consecutive patients without pancreatic pathology, scanned in the workup of pancreatic cancer with a contrast enhanced multiphase protocol over the upper abdomen (late arterial phase, portal venous phase and late venous phase). A subspecialized radiologist assessed the visibility of the main and accessory pancreatic ducts, side ducts, hepatopancreatic ampulla, major papilla, minor papilla, smaller pancreatic arteries and veins, lymphatic confluence, regional lymph nodes, coeliac ganglia, and coeliac plexus. In addition, measurements were made of the size of the main, accessory, side-ducts, and ganglia. Attenuation was measured in all three contrast-phases of ganglia and two lymph nodes.

#### RESULTS

The main duct was visible in 20 / 20 patients in the head, body, and tail of the pancreas. The average size of the accessory duct was 1,2mm and it was visible in 20 / 20 patients. More than ten side-ducts were visible in 18 / 20 patients. The average diameter of the visible side-ducts was 0,5mm. Both the major and minor papillae were visible in 20 / 20 cases. Four arteries to the pancreaticoduodenal arcade were visible in 20 / 20 patients. Lymph nodes in all regional pancreatic lymph node stations were visible in 18 / 20 patients. The lymphatic confluence was visible in 20/20 patients. The coeliac ganglion was visible on both sides in 20 / 20 patients. The ganglia showed an increasing iodine enhancement from the late arterial phase to the late venous phase. In contrast, all evaluated lymph nodes showed the highest iodine enhancement in either the late arterial or portal venous phase with washout in the late venous phase. The coeliac plexus was visible in 20 / 20 patients.

#### CONCLUSION

In PCCT scans of the pancreas, previously unseen anatomy (side ducts, papillae, pancreaticoduodenal arteries, lymph nodes, nerve ganglia and plexus) is consistently visible in patients without pancreatic pathology.

#### CLINICAL RELEVANCE/APPLICATION

This has important implications for the evaluation of pancreatic disease and the differentiation of pathology from normal anatomy. Normal anatomy could very likely be confused for pathology if radiologists are unaware of it.

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## Abstract Archives of the RSNA, 2023

W7-SSGI15-5

### Association of Pancreatic Steatosis and Atrophy with Type II Diabetes Mellitus

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S404

Ashish Dua, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assessment of pancreatic steatosis and volume in patients with type-II diabetes mellitus and to look for association of DM with these parameters.

#### METHODS AND MATERIALS

We prospectively evaluated 66 patients with diabetes and 47 non-diabetic patients, age group 40-65 years who underwent unenhanced Computed Tomography of abdomen for some abdominal complaints. Cases had adequately controlled blood sugar levels, none of the cases or controls had any systemic co-morbidities. Parameters noted: 1) Pancreatic steatosis indirectly, as: Difference between pancreatic and splenic attenuation (HU p-s), and ratio of pancreatic to splenic attenuation (HU p/s); and 2) Pancreatic volume (using inbuilt volume application in CT). After matching, t-test and Mann-Whitney-test were applied for calculating p-values. Receiver Operating Curves (ROC) were made for finding cut-off values of pancreatic steatosis and pancreatic volume with optimal sensitivity and specificity.

#### RESULTS

Pancreatic fat content was significantly high ( $p < 0.001$ ) in patients with type-II diabetes (HU p-s of  $-13.2 \pm 7.9$  and HU p/s of  $0.73 \pm 0.15$ ) compared to non-diabetics (HU p-s of  $-6.7 \pm 5.9$  and HU p/s of  $0.86 \pm 0.12$ ). Pancreatic volume was significantly low ( $p < 0.001$ ) in patients with type-II DM ( $48 \pm 13.7$  cm<sup>3</sup>) compared to non-diabetic patients ( $63.6 \pm 17.3$  cm<sup>3</sup>). Thus, pancreatic steatosis and atrophy may act as surrogate marker for type-II DM.

#### CONCLUSION

Pancreatic steatosis and atrophy are significantly associated with type-II DM. These changes if found in high-risk individual incidentally on imaging, might represent overt or impending DM. These findings should be reported as it would prompt complete biochemical work-up. Early diagnosis of DM can mitigate disabilities and complications related to it. Thus, pancreatic steatosis and atrophy may act as a surrogate biomarker for diagnosis of overt or impending type II DM.

#### CLINICAL RELEVANCE/APPLICATION

Considering the enormous diabetic burden in the world, lab investigations alone may not suffice and an adjunct diagnostic modality might help us know the diabetic status of a lot of undiagnosed individuals. Pancreatic imaging can play a pivotal adjunct role in assessment of the diabetic status of people since imaging investigations have become rampant and people get ultrasound, CT scan and MRI frequently for various diseases. Adequate knowledge on imaging of pancreas can help us know the diabetic status of individuals who may not be unaware of their diabetic status and have had this disease for long duration.

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## Abstract Archives of the RSNA, 2023

W7-SSGI15-6

### **MRI Quantitative Assessment of Age-related Changes in Pancreatic Margins in Subjects Without Pancreatic Disease**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S404

Giulia A. Zamboni, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To quantitatively evaluate age-related changes of pancreatic margins on Magnetic Resonance in patients without history or signs of pancreatic pathology, as a possible reference for future studies assessing the relationship between parenchymal margins and pancreatic disease.

#### **METHODS AND MATERIALS**

IRB approval was not required for this retrospective study. We included patients without history, suspicion, or imaging findings of pancreatic pathology who underwent abdominal MR scans (1.5T and 3T) between August 2021 and August 2022. A computer-assisted quantitative analysis of the pancreatic margins was performed using in-house software on Fat-Suppressed T1-Weighted images, drawing multiple ROIs on the anterior margins of the body and tail, where the pancreas abuts retroperitoneal fat. The root mean square deviation SD of the actual border from the average boundary line (Pancreatic Margin Score, PMS) was obtained. Higher mean PMS values reflect an increased lobularity of the pancreatic profile at imaging, while lower PMS values reflect a straightened profile. The population was divided into 4 groups by age (group 1: <30 years; group 2: 30-49 years; group 3: 50-69 years; group 4: =70 years). The PMS values were compared across groups by applying the one-way ANOVA test; a p value <0.05 was chosen as significant.

#### **RESULTS**

A significant difference ( $p < 0.05$ ) across the four groups was observed of the mean PMS, with values increasing with age:  $0.315 \pm 0.0579$  in group 1,  $0.341 \pm 0.0747$  in group 2,  $0.374 \pm 0.117$  in group 3 and  $0.419 \pm 0.158$  in group 4.

#### **CONCLUSION**

The analysis of the pancreatic margins revealed different results based on age, which reflects the qualitative changes seen in the morphology of the pancreas with aging, especially an increase in lobularity.

#### **CLINICAL RELEVANCE/APPLICATION**

The Pancreatic Margin Score (PMS) reflects qualitative changes of the pancreatic profile at imaging. Knowing the normal values of PMS could allow to use PMS as a diagnostic tool for pancreatic diseases.

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## Abstract Archives of the RSNA, 2023

W7-SSGI16

### Gastrointestinal Imaging (Spleen, Mesentery, Peritoneum, Interventions)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S405

Kumaresan Sandrasegaran, MD (*Moderator*) Nothing to Disclose  
Francesca Rigioli, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W7-SSGI16-1 CT in a Prone Position in Preoperative Evaluation of Inguinal Hernia: Comparison with CT in a Supine Position

Akitoshi Inoue, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Inguinal hernia is provoked by gravity and intraabdominal pressure. The purpose of this study was to estimate the impact of a prone position CT scan in diagnosing inguinal hernia.

#### METHODS AND MATERIALS

A total of 125 patients ( $68.0 \pm 14.0$  y.o.; female=12) treated with inguinal hernia repair scanned CT at both supine and prone positions were retrospectively enrolled. Patients were scanned for clinical abdominopelvic supine CT and subsequently underwent pelvic prone CT. The inguinal region was free by placing towels on the abdominal walls and thighs during prone CT scanning. A surgeon reviewed medical records to archive the classification based on anatomy (internal, external, or femoral) and hernial orifice diameter ( $=1.5$ ,  $1.5-3.0$ ,  $3.0=$ ). Two radiologists (R1, R2) blinded to the surgical diagnosis independently read supine or prone CT to record the confidence level of absence or presence of inguinal hernia (0=absent; 50=equivocal; 100=present) for 250 inguinal regions in separated sessions separated by at least 3 weeks. The confidence score was translated to the magnitude score which is an absolute value from 50 (range: 0--50). In another session, the readers compared supine and prone CT and recorded preference in diagnosing inguinal hernia using a 5-point Likert scale (1=prone CT is worse, 3=equal, 5=prone CT is better).

#### RESULTS

A total of 140 inguinal hernias (96 external inguinal, 41 internal inguinal, 2 mixed inguinal, and 1 femoral hernia) were surgically recorded in the enrolled patients. The diameter of the hernial orifice was  $=1.5$  ( $n=29$ ),  $1.5-3.0$  ( $n=75$ ),  $3.0=$  ( $n=25$ ), and not recorded ( $n=11$ ). Prone CT shows similar accuracy (R1—0.704 vs. 0.720; R2—0.804 vs. 0.792) with higher sensitivity (R1—0.823 vs. 0.783; R2—0.830 vs. 0.707) but lower specificity (R1—0.550 vs. 0.627; R2—0.771 vs. 0.900) than supine CT. The magnitude value of prone CT was improved in true positive (R1—40.0 vs. 37.5;  $P=0.067$ , R2—41.1 vs. 37.2;  $P=0.005$ ) and degraded in true negative (R2—41.7 vs. 44.4;  $P=0.001$ ). R1 diagnosed 10 (external [ $n=10$ ]) and R2 diagnosed 19 inguinal hernias (external [ $n=14$ ], internal [ $n=4$ ], combined [ $n=1$ ]) on prone CT but not supine CT. Two radiologists preferred prone CT (R1— $3.56 \pm 0.76$ , R2— $3.50 \pm 0.65$ ).

#### CONCLUSION

CT scan at a prone position is helpful in revealing inguinal hernias and improving radiologists' confidence level despite the increased false positive case.

#### CLINICAL RELEVANCE/APPLICATION

Prone CT facilitates delineating of clinically significant inguinal hernia by provoking inguinal hernia with gravity effect and may contribute to the surgical planning.

#### W7-SSGI16-2 Does Incidentally Detected Mesenteric Panniculitis at CT ever Represent early Lymphoma?

Geneghee Kim (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the likelihood that the characteristic CT pattern of mesenteric panniculitis with soft tissue haziness and scattered normal appearing lymph nodes of the small bowel mesentery represents early lymphoma in patients without a prior history of cancer.

## METHODS AND MATERIALS

Patients with incidentally reported mesenteric panniculitis at CT between 1/1/04-12/31/12 were identified from PACS query, excluding those with a prior diagnosis of cancer. CT images were reviewed to confirm that a characteristic pattern of mesenteric haziness and lymph nodes was present. Additional analyses of the mesenteric fat (degree/ROI measurement/presence of fat halo and/or peripheral encapsulation) and lymph nodes (presence/size) were done. Demographic characteristics (age, gender, height, and weight) were collected. Longitudinal follow up was determined by EMR review. Length of follow up and onset of any cancers/lymphoma were recorded.

## RESULTS

225 individuals (age  $57.9 \pm 12.6$ ; 163 males, 62 females) were included. BMI  $31.8 \pm 6.7$ . Mean follow-up was 9.3 years  $\pm 4.0$  with 68.4% (154/225) with follow-up = 8 years. No individuals (0/225) developed lymphoma in the small bowel mesentery over follow up. 4/225 did develop a future lymphoma but with involvement other than of the small bowel mesentery, including salivary gland, mediastinum, spleen/bone marrow, and retroperitoneum. Mesenteric ROI mean  $-67.6 \text{ HU} \pm 17.5$  with a subjective grading of mild haziness 48.9% (110/225); moderate/marked 51.1% (115/225). 69.8% (157/225) with a fat halo around mesenteric vessels and lymph nodes; 88.4% (199/225) had a thin soft tissue rim encapsulating the mesenteric fat. Mean size of largest mesenteric lymph node was  $5.8 \text{ mm} \pm 2.1$ , typically flat with a fatty hilum.

## CONCLUSION

CT findings in the small bowel mesentery characteristic of mesenteric panniculitis are unlikely to represent early lymphoma suggesting that a recommendation of imaging follow up is unnecessary.

## CLINICAL RELEVANCE/APPLICATION

Follow-up imaging is not necessary when a characteristic CT appearance of mesenteric panniculitis is present, leading to optimized utilization of finite imaging resources.

## W7-SSGI16-3 Splenic Measurement as Potential Imaging Biomarker for Infective Endocarditis in Patients with a History of Intravenous Drug Use

James Nash, MBA (*Presenter*) Nothing to Disclose

## PURPOSE

Endocardial inflammation associated with infective endocarditis (IE) is catastrophic without timely diagnosis, and often-non-specific symptoms may delay recognition. Duke Criteria is used to diagnose those suspected of having IE and relies on a constellation of pathologic, clinical and/or echocardiographic findings that do not include splenomegaly. Patients with intravenous drug use (IVDU) history are disproportionately afflicted with IE and demonstrate a higher splenomegaly prevalence. We sought to compare traditional 2D measurements and semi-automated 3D segmentation volumes from computed tomography (CT) to identify splenomegaly and consider its association with IE in this population.

## METHODS AND MATERIALS

We performed a retrospective analysis of patients treated at our institution between 4/1/11-6/5/21. We included all IVDU patients who received an abdominal CT, regardless of IE status. Of the 2,009 results, we randomly selected 117 IE-positive individuals and matched them by age and sex to those without documented IE. We then performed splenic CT measurements of these 234 patients via craniocaudal (CC) length, ellipsoid volume, and semi-automated 3D segmentation techniques.

## RESULTS

For each measurement technique, splenic size was statistically larger for IE-positive patients than for their IE-negative matches. Mean CC lengths were 13.2 (SD 3.19) and 11.2 (SD 2.39) ( $p < 0.001$ ), ellipsoid volumes were 484 (SD 336) and 297 (SD 165) ( $p < 0.001$ ), and semi-automated 3D segmentation volumes were 603 (SD 470) and 374 (SD 221) ( $p < 0.001$ ) (2D measurements were in cm, 3D volumes were in  $\text{cm}^3$ ). For ellipsoid volume, the maximum single-variable accuracy of 69% corresponded with a 400mL cutoff, with corresponding sensitivity and specificity of 56% and 82%. At 180mL, sensitivity of 90% corresponded with a specificity of 23%, with an odds ratio of 1.47 per additional 100mL increase. We observed a strong association between CC length and the two volumetric techniques, as evidenced by a Pearson correlation of 0.91. The association between ellipsoid and semi-automated 3D segmentation volumes was even stronger, with a Pearson of 0.97. Among two volumetric measurement techniques, semi-automated 3D segmentation values were consistently larger than ellipsoid.

## CONCLUSION

For patients with an IVDU history, there was an associated increase in splenic size for those with documented IE. Additionally, splenic CT measurement techniques were strongly correlated with one another, though with notable absolute differences.

## CLINICAL RELEVANCE/APPLICATION

Splenomegaly measured by CT may be an important screening tool to identify IVDU patients that have undiagnosed or underlying IE, especially as a participatory value within a multi-variable model.

### **W7-SSGI16-4 Postprandial Changes in Spleen Stiffness Assessed with Magnetic Resonance Elastography (MRE)**

Vitaliy Atamaniuk, MSc, BEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic Resonance Elastography (MRE) is a powerful imaging technique for detecting pathological changes in parenchymal organs such as the liver and spleen. However, the assessed value of tissue stiffness may be biased by various factors. This study aimed to evaluate the postprandial changes in spleen stiffness using MRE in a large sample of healthy volunteers.

#### METHODS AND MATERIALS

One hundred healthy volunteers who met inclusion criteria (mean age  $23 \pm 2$  years, 35 men and 65 women) were enrolled in this prospective, single institutional, ethics board-approved study. MRE examinations were conducted in the fasting state and 30 minutes after consuming a 1000 kcal meal. Additionally, MRE was repeated 1 hour and 30 minutes and 2 hours and 30 minutes after the meal for a randomly selected group of 14 participants. A team comprised of a radiologist and an MRE technician drew three to five regions of interest on three to five consecutive axial spleen slices to assess splenic stiffness. Statistical analyses included Mann-Whitney, Wilcoxon-signed rank, Spearman rank correlation, and Friedman tests.

#### RESULTS

The results showed a statistically significant ( $p < 0.001$ ) postprandial increase in splenic stiffness 30 minutes after the meal ( $5.47 \pm 0.66$  kPa vs.  $5.09 \pm 0.63$  kPa in the fasting state), which gradually decreased but remained higher than in the fasting state even 2 hours 30 minutes after food intake.

#### CONCLUSION

In conclusion, food intake causes a statistically significant elevation of splenic stiffness that persists for at least 2 hours and 30 minutes. The study findings support the recommendation for patients to fast for no less than 3 to 4 hours before undergoing splenic MRE examinations.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study demonstrate the statistically significant impact of meal intake on splenic stiffness, highlighting the need for patients to fast before splenic MRE to ensure accurate assessments of spleen stiffness.

### **W7-SSGI16-5 Impact of Prophylactic Platelet Transfusion in Thrombocytopenic Patients Undergoing Ultrasonography-Guided Percutaneous Liver Biopsy**

Hyeon Ji Jang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Controversy remains regarding the usefulness of prophylactic platelet concentrate (PC) transfusion in preventing bleeding after liver biopsy in thrombocytopenic patients, especially in cirrhosis. Our study aimed to determine the impact of prophylactic PC transfusion on ultrasonography (US)-guided percutaneous liver biopsies. Risk factors for post-biopsy bleeding were identified.

#### METHODS AND MATERIALS

This retrospective study analyzed US-guided liver biopsies performed at our institution from 2018 to 2022. Thrombocytopenia was classified as mild (platelet [ $\times 10^9/L$ ]  $>75$  and  $<150$ ), moderate (50-75), and severe ( $<50$ ). Bleeding was defined as major (requiring blood transfusion, radiologic/surgical intervention, or resulting in death) or minor (new intra-abdominal hematoma identified after biopsy not requiring intervention). Logistic regression analysis was conducted to evaluate the association between bleeding and demographics/imaging characteristics.

#### RESULTS

We analyzed 5337 procedures on 5240 patients, including 755 procedures in thrombocytopenia (644 mild, 76 moderate, and 35 severe). PC transfusion was given before 53 procedures (in 13 mild, 22 moderate, and 18 severe thrombocytopenia). Multivariable analysis showed that major and minor bleeding were associated with the presence and severity of

thrombocytopenia, prolonged INR, and abnormal liver function test ( $P < 0.05$ ), but not with PC transfusion. Subgroup analyses showed no association between PC transfusion and decreased bleeding incidence in thrombocytopenia, regardless of severity or cirrhosis presence. In 614 procedures performed in cirrhotic patients, the severity of thrombocytopenia was associated with bleeding ( $P = .015$ ), but the association with severe thrombocytopenia was marginally insignificant (odds ratio [OR], 3.17; 95% confidence interval [CI], 0.99-10.10). Among the imaging characteristics of targeted liver mass, mass size was associated with major bleeding (OR, 1.06; 95% CI, 1.02-1.11), and vascular abutment was associated with minor bleeding (OR, 1.46; 95% CI, 1.16-1.83).

#### **CONCLUSION**

Prophylactic PC transfusion was not associated with reduction in the bleeding incidence in thrombocytopenic patients regardless of the cirrhotic status. Severe thrombocytopenia was not associated with the occurrence of bleeding in cirrhotic patients. Prophylactic platelet transfusion may not be mandatory for thrombocytopenic patients planning percutaneous US-guided liver biopsy, even those with severe thrombocytopenia.

#### **CLINICAL RELEVANCE/APPLICATION**

PC transfusion may not be mandatory for thrombocytopenic patients undergoing US-guided percutaneous liver biopsy, regardless of the severity of thrombocytopenia or the presence of cirrhosis.

#### **W7-SSGI16-6 A Comparative Study of SonoVue and Sonazoid for Contrast-Enhanced Ultrasound CT/MRI Fusion-Guidance during Radiofrequency Ablation of Poorly Visualized Hepatic Malignancies: A Prospective Intra-Individual Analysis**

Heesoo Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The study aimed to evaluate the effectiveness of two contrast agents, SonoVue (SV) and Sonazoid (SZ), used in contrast-enhanced ultrasound (CEUS)-CT/MRI fusion imaging (FI), in improving the visibility of inconspicuous liver malignancies ( $\leq 4$  cm) on B-mode ultrasound (US) for guiding percutaneous radiofrequency ablation (RFA). Additionally, the radiologists' preference between SonoVue-CT/MRI fusion imaging (SV-FI) and Sonazoid-CT/MRI fusion imaging (SZ-FI) was determined.

#### **METHODS AND MATERIALS**

A total of 23 patients with inconspicuous hepatic malignancies on B-mode US were enrolled in this prospective study. The patients underwent real-time CEUS FI with CT/MRI on the same day, utilizing both SV and SZ. Tumor visibility and radiologists' preferences were assessed and graded using a 4-point scale during the dynamic phases of both SV-FI and SZ-FI and the Kupffer phase of SZ-FI.

#### **RESULTS**

The tumor visibility scores obtained from both CEUS-CT/MRI FI were significantly better than those obtained from US-FI. Indeed, SV-FI and SZ-FI demonstrated comparable visibility scores when corresponding phases were compared ( $p > 0.05$ ). However, the Kupffer phase images of SZ-FI displayed superior visibility scores ( $3.70 \pm 0.56$  vs  $2.96 \pm 0.88$ ;  $p = 0.002$ ) than the late vascular phase images of SV-FI. The radiologists favored SZ-FI in a higher number of cases, exhibiting moderate inter-observer agreement (Kappa value = 0.587; 95% CI, 0.403-0.772).

#### **CONCLUSION**

Although CEUS-CT/MRI FI with either SV or SZ substantially improved the visibility of tumors that were inconspicuous on US-CT/MRI FI, radiologists preferred SZ to SV to guide the RFA procedure.

#### **CLINICAL RELEVANCE/APPLICATION**

Our study highlights the benefits of incorporating CEUS into FI to improve the detection of hepatic tumors, as it provides enhanced visibility based on increased vascularity and more precise delineation of tumor margins, as previously shown in other studies. Moreover, adding CEUS to FI can correct the misregistration of US-CT/MRI FI using a rigid transformation matrix through manual co-registration of the target tumor on CEUS and CT/MRI with greater accuracy. Therefore, in the context of thermal ablation, CEUS-CT/MRI FI plays a crucial role in enabling physicians to accurately localize tumors, devise a comprehensive ablation plan, and continuously monitor the ablation process in real time.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSGI16-1

### CT in a Prone Position in Preoperative Evaluation of Inguinal Hernia: Comparison with CT in a Supine Position

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S405

Akitoshi Inoue, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Inguinal hernia is provoked by gravity and intraabdominal pressure. The purpose of this study was to estimate the impact of a prone position CT scan in diagnosing inguinal hernia.

#### METHODS AND MATERIALS

A total of 125 patients ( $68.0 \pm 14.0$  y.o.; female=12) treated with inguinal hernia repair scanned CT at both supine and prone positions were retrospectively enrolled. Patients were scanned for clinical abdominopelvic supine CT and subsequently underwent pelvic prone CT. The inguinal region was free by placing towels on the abdominal walls and thighs during prone CT scanning. A surgeon reviewed medical records to archive the classification based on anatomy (internal, external, or femoral) and hernial orifice diameter ( $=1.5$ ,  $1.5-3.0$ ,  $3.0=$ ). Two radiologists (R1, R2) blinded to the surgical diagnosis independently read supine or prone CT to record the confidence level of absence or presence of inguinal hernia (0=absent; 50=equivocal; 100=present) for 250 inguinal regions in separated sessions separated by at least 3 weeks. The confidence score was translated to the magnitude score which is an absolute value from 50 (range: 0--50). In another session, the readers compared supine and prone CT and recorded preference in diagnosing inguinal hernia using a 5-point Likert scale (1=prone CT is worse, 3=equal, 5=prone CT is better).

#### RESULTS

A total of 140 inguinal hernias (96 external inguinal, 41 internal inguinal, 2 mixed inguinal, and 1 femoral hernia) were surgically recorded in the enrolled patients. The diameter of the hernial orifice was  $=1.5$  ( $n=29$ ),  $1.5-3.0$  ( $n=75$ ),  $3.0=$  ( $n=25$ ), and not recorded ( $n=11$ ). Prone CT shows similar accuracy (R1—0.704 vs. 0.720; R2—0.804 vs. 0.792) with higher sensitivity (R1—0.823 vs. 0.783; R2—0.830 vs. 0.707) but lower specificity (R1—0.550 vs. 0.627; R2—0.771 vs. 0.900) than supine CT. The magnitude value of prone CT was improved in true positive (R1—40.0 vs. 37.5;  $P=0.067$ , R2—41.1 vs. 37.2;  $P=0.005$ ) and degraded in true negative (R2—41.7 vs. 44.4;  $P=0.001$ ). R1 diagnosed 10 (external [ $n=10$ ]) and R2 diagnosed 19 inguinal hernias (external [ $n=14$ ], internal [ $n=4$ ], combined [ $n=1$ ]) on prone CT but not supine CT. Two radiologists preferred prone CT (R1— $3.56 \pm 0.76$ , R2— $3.50 \pm 0.65$ ).

#### CONCLUSION

CT scan at a prone position is helpful in revealing inguinal hernias and improving radiologists' confidence level despite the increased false positive case.

#### CLINICAL RELEVANCE/APPLICATION

Prone CT facilitates delineating of clinically significant inguinal hernia by provoking inguinal hernia with gravity effect and may contribute to the surgical planning.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSGI16-2

### Does Incidentally Detected Mesenteric Panniculitis at CT ever Represent early Lymphoma?

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S405

Geneghee Kim (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the likelihood that the characteristic CT pattern of mesenteric panniculitis with soft tissue haziness and scattered normal appearing lymph nodes of the small bowel mesentery represents early lymphoma in patients without a prior history of cancer.

#### METHODS AND MATERIALS

Patients with incidentally reported mesenteric panniculitis at CT between 1/1/04-12/31/12 were identified from PACS query, excluding those with a prior diagnosis of cancer. CT images were reviewed to confirm that a characteristic pattern of mesenteric haziness and lymph nodes was present. Additional analyses of the mesenteric fat (degree/ROI measurement/presence of fat halo and/or peripheral encapsulation) and lymph nodes (presence/size) were done. Demographic characteristics (age, gender, height, and weight) were collected. Longitudinal follow up was determined by EMR review. Length of follow up and onset of any cancers/lymphoma were recorded.

#### RESULTS

225 individuals (age  $57.9 \pm 12.6$ ; 163 males, 62 females) were included. BMI  $31.8 \pm 6.7$ . Mean follow-up was 9.3 years  $\pm 4.0$  with 68.4% (154/225) with follow-up = 8 years. No individuals (0/225) developed lymphoma in the small bowel mesentery over follow up. 4/225 did develop a future lymphoma but with involvement other than of the small bowel mesentery, including salivary gland, mediastinum, spleen/bone marrow, and retroperitoneum. Mesenteric ROI mean  $-67.6 \text{ HU} \pm 17.5$  with a subjective grading of mild haziness 48.9% (110/225); moderate/marked 51.1% (115/225). 69.8% (157/225) with a fat halo around mesenteric vessels and lymph nodes; 88.4% (199/225) had a thin soft tissue rim encapsulating the mesenteric fat. Mean size of largest mesenteric lymph node was  $5.8 \text{ mm} \pm 2.1$ , typically flat with a fatty hilum.

#### CONCLUSION

CT findings in the small bowel mesentery characteristic of mesenteric panniculitis are unlikely to represent early lymphoma suggesting that a recommendation of imaging follow up is unnecessary.

#### CLINICAL RELEVANCE/APPLICATION

Follow-up imaging is not necessary when a characteristic CT appearance of mesenteric panniculitis is present, leading to optimized utilization of finite imaging resources.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-SSGI16-3

### Splenic Measurement as Potential Imaging Biomarker for Infective Endocarditis in Patients with a History of Intravenous Drug Use

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S405

James Nash, MBA (*Presenter*) Nothing to Disclose

#### PURPOSE

Endocardial inflammation associated with infective endocarditis (IE) is catastrophic without timely diagnosis, and often-non-specific symptoms may delay recognition. Duke Criteria is used to diagnose those suspected of having IE and relies on a constellation of pathologic, clinical and/or echocardiographic findings that do not include splenomegaly. Patients with intravenous drug use (IVDU) history are disproportionately afflicted with IE and demonstrate a higher splenomegaly prevalence. We sought to compare traditional 2D measurements and semi-automated 3D segmentation volumes from computed tomography (CT) to identify splenomegaly and consider its association with IE in this population.

#### METHODS AND MATERIALS

We performed a retrospective analysis of patients treated at our institution between 4/1/11-6/5/21. We included all IVDU patients who received an abdominal CT, regardless of IE status. Of the 2,009 results, we randomly selected 117 IE-positive individuals and matched them by age and sex to those without documented IE. We then performed splenic CT measurements of these 234 patients via craniocaudal (CC) length, ellipsoid volume, and semi-automated 3D segmentation techniques.

#### RESULTS

For each measurement technique, splenic size was statistically larger for IE-positive patients than for their IE-negative matches. Mean CC lengths were 13.2 (SD 3.19) and 11.2 (SD 2.39) ( $p < 0.001$ ), ellipsoid volumes were 484 (SD 336) and 297 (SD 165) ( $p = < 0.001$ ), and semi-automated 3D segmentation volumes were 603 (SD 470) and 374 (SD 221) ( $p < 0.001$ ) (2D measurements were in cm, 3D volumes were in  $\text{cm}^3$ ). For ellipsoid volume, the maximum single-variable accuracy of 69% corresponded with a 400mL cutoff, with corresponding sensitivity and specificity of 56% and 82%. At 180mL, sensitivity of 90% corresponded with a specificity of 23%, with an odds ratio of 1.47 per additional 100mL increase. We observed a strong association between CC length and the two volumetric techniques, as evidenced by a Pearson correlation of 0.91. The association between ellipsoid and semi-automated 3D segmentation volumes was even stronger, with a Pearson of 0.97. Among two volumetric measurement techniques, semi-automated 3D segmentation values were consistently larger than ellipsoid.

#### CONCLUSION

For patients with an IVDU history, there was an associated increase in splenic size for those with documented IE. Additionally, splenic CT measurement techniques were strongly correlated with one another, though with notable absolute differences.

#### CLINICAL RELEVANCE/APPLICATION

Splenomegaly measured by CT may be an important screening tool to identify IVDU patients that have undiagnosed or underlying IE, especially as a participatory value within a multi-variable model.

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## Abstract Archives of the RSNA, 2023

W7-SSGI16-4

### Postprandial Changes in Spleen Stiffness Assessed with Magnetic Resonance Elastography (MRE)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S405

Vitaliy Atamaniuk, MSc, BEng (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic Resonance Elastography (MRE) is a powerful imaging technique for detecting pathological changes in parenchymal organs such as the liver and spleen. However, the assessed value of tissue stiffness may be biased by various factors. This study aimed to evaluate the postprandial changes in spleen stiffness using MRE in a large sample of healthy volunteers.

#### METHODS AND MATERIALS

One hundred healthy volunteers who met inclusion criteria (mean age  $23 \pm 2$  years, 35 men and 65 women) were enrolled in this prospective, single institutional, ethics board-approved study. MRE examinations were conducted in the fasting state and 30 minutes after consuming a 1000 kcal meal. Additionally, MRE was repeated 1 hour and 30 minutes and 2 hours and 30 minutes after the meal for a randomly selected group of 14 participants. A team comprised of a radiologist and an MRE technician drew three to five regions of interest on three to five consecutive axial spleen slices to assess splenic stiffness. Statistical analyses included Mann-Whitney, Wilcoxon-signed rank, Spearman rank correlation, and Friedman tests.

#### RESULTS

The results showed a statistically significant ( $p < 0.001$ ) postprandial increase in splenic stiffness 30 minutes after the meal ( $5.47 \pm 0.66$  kPa vs.  $5.09 \pm 0.63$  kPa in the fasting state), which gradually decreased but remained higher than in the fasting state even 2 hours 30 minutes after food intake.

#### CONCLUSION

In conclusion, food intake causes a statistically significant elevation of splenic stiffness that persists for at least 2 hours and 30 minutes. The study findings support the recommendation for patients to fast for no less than 3 to 4 hours before undergoing splenic MRE examinations.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study demonstrate the statistically significant impact of meal intake on splenic stiffness, highlighting the need for patients to fast before splenic MRE to ensure accurate assessments of spleen stiffness.

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## Abstract Archives of the RSNA, 2023

W7-SSGI16-5

### Impact of Prophylactic Platelet Transfusion in Thrombocytopenic Patients Undergoing Ultrasonography-Guided Percutaneous Liver Biopsy

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S405

Hyeon Ji Jang, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Controversy remains regarding the usefulness of prophylactic platelet concentrate (PC) transfusion in preventing bleeding after liver biopsy in thrombocytopenic patients, especially in cirrhosis. Our study aimed to determine the impact of prophylactic PC transfusion on ultrasonography (US)-guided percutaneous liver biopsies. Risk factors for post-biopsy bleeding were identified.

#### METHODS AND MATERIALS

This retrospective study analyzed US-guided liver biopsies performed at our institution from 2018 to 2022. Thrombocytopenia was classified as mild (platelet [ $\times 10^9/L$ ]  $>75$  and  $<150$ ), moderate (50-75), and severe ( $<50$ ). Bleeding was defined as major (requiring blood transfusion, radiologic/surgical intervention, or resulting in death) or minor (new intra-abdominal hematoma identified after biopsy not requiring intervention). Logistic regression analysis was conducted to evaluate the association between bleeding and demographics/imaging characteristics.

#### RESULTS

We analyzed 5337 procedures on 5240 patients, including 755 procedures in thrombocytopenia (644 mild, 76 moderate, and 35 severe). PC transfusion was given before 53 procedures (in 13 mild, 22 moderate, and 18 severe thrombocytopenia). Multivariable analysis showed that major and minor bleeding were associated with the presence and severity of thrombocytopenia, prolonged INR, and abnormal liver function test ( $P < 0.05$ ), but not with PC transfusion. Subgroup analyses showed no association between PC transfusion and decreased bleeding incidence in thrombocytopenia, regardless of severity or cirrhosis presence. In 614 procedures performed in cirrhotic patients, the severity of thrombocytopenia was associated with bleeding ( $P = .015$ ), but the association with severe thrombocytopenia was marginally insignificant (odds ratio [OR], 3.17; 95% confidence interval [CI], 0.99-10.10). Among the imaging characteristics of targeted liver mass, mass size was associated with major bleeding (OR, 1.06; 95% CI, 1.02-1.11), and vascular abutment was associated with minor bleeding (OR, 1.46; 95% CI, 1.16-1.83).

#### CONCLUSION

Prophylactic PC transfusion was not associated with reduction in the bleeding incidence in thrombocytopenic patients regardless of the cirrhotic status. Severe thrombocytopenia was not associated with the occurrence of bleeding in cirrhotic patients. Prophylactic platelet transfusion may not be mandatory for thrombocytopenic patients planning percutaneous US-guided liver biopsy, even those with severe thrombocytopenia.

#### CLINICAL RELEVANCE/APPLICATION

PC transfusion may not be mandatory for thrombocytopenic patients undergoing US-guided percutaneous liver biopsy, regardless of the severity of thrombocytopenia or the presence of cirrhosis.

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## Abstract Archives of the RSNA, 2023

W7-SSGI16-6

### **A Comparative Study of SonoVue and Sonazoid for Contrast-Enhanced Ultrasound CT/MRI Fusion-Guidance during Radiofrequency Ablation of Poorly Visualized Hepatic Malignancies: A Prospective Intra-Individual Analysis**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S405

Heesoo Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The study aimed to evaluate the effectiveness of two contrast agents, SonoVue (SV) and Sonazoid (SZ), used in contrast-enhanced ultrasound (CEUS)- CT/MRI fusion imaging (FI), in improving the visibility of inconspicuous liver malignancies (= 4 cm) on B-mode ultrasound (US) for guiding percutaneous radiofrequency ablation (RFA). Additionally, the radiologists' preference between SonoVue- CT/MRI fusion imaging (SV-FI) and Sonazoid-CT/MRI fusion imaging (SZ-FI) was determined.

#### **METHODS AND MATERIALS**

A total of 23 patients with inconspicuous hepatic malignancies on B-mode US were enrolled in this prospective study. The patients underwent real-time CEUS FI with CT/MRI on the same day, utilizing both SV and SZ. Tumor visibility and radiologists' preferences were assessed and graded using a 4-point scale during the dynamic phases of both SV-FI and SZ-FI and the Kupffer phase of SZ-FI.

#### **RESULTS**

The tumor visibility scores obtained from both CEUS-CT/MRI FI were significantly better than those obtained from US-FI. Indeed, SV-FI and SZ-FI demonstrated comparable visibility scores when corresponding phases were compared ( $p > 0.05$ ). However, the Kupffer phase images of SZ-FI displayed superior visibility scores ( $3.70 \pm 0.56$  vs  $2.96 \pm 0.88$ ;  $p=0.002$ ) than the late vascular phase images of SV-FI. The radiologists favored SZ-FI in a higher number of cases, exhibiting moderate inter-observer agreement (Kappa value = 0.587; 95% CI, 0.403-0.772).

#### **CONCLUSION**

Although CEUS-CT/MRI FI with either SV or SZ substantially improved the visibility of tumors that were inconspicuous on US-CT/MRI FI, radiologists preferred SZ to SV to guide the RFA procedure.

#### **CLINICAL RELEVANCE/APPLICATION**

Our study highlights the benefits of incorporating CEUS into FI to improve the detection of hepatic tumors, as it provides enhanced visibility based on increased vascularity and more precise delineation of tumor margins, as previously shown in other studies. Moreover, adding CEUS to FI can correct the misregistration of US-CT/MRI FI using a rigid transformation matrix through manual co-registration of the target tumor on CEUS and CT/MRI with greater accuracy. Therefore, in the context of thermal ablation, CEUS-CT/MRI FI plays a crucial role in enabling physicians to accurately localize tumors, devise a comprehensive ablation plan, and continuously monitor the ablation process in real time.

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## Abstract Archives of the RSNA, 2023

W7-SSMK09

### Musculoskeletal Imaging (Muscle, Tendon and Nerve)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451A

Eric A. Bogner, MD (*Moderator*) Research Consultant, Globus Medical, Inc  
Andrew B. Ross, MD, MPH (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W7-SSMK09-1 Neck Pain and Headache Frequency are Associated with Trapezius Muscle T2 from MRI in Young Adults with Tension-type Headache**

Nico Sollmann, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Tension-type headache (TTH) is the most prevalent primary headache disorder. Neck pain is commonly associated with primary headaches and the trigeminocervical complex (TCC) refers to the convergence of trigeminal and cervical afferents onto neurons of the brainstem, thus conceptualizes the emergence of headache in relation to neck pain. However, no objective biomarkers exist for the myofascial involvement in primary headaches. This study aimed to investigate the involvement of the trapezius muscles in primary headache disorders by quantitative magnetic resonance imaging (MRI), and to explore associations between muscle T2 values and headache and neck pain frequency.

#### METHODS AND MATERIALS

Fifty participants (41 females, age range 20-31 years; 16 tension-type headache [TTH-], 12 mixed-type TTH plus migraine episodes [TTH+], and 22 healthy controls [HC]) prospectively underwent fat-suppressed T2-prepared three-dimensional (3D) turbo spin-echo MRI. The bilateral trapezius muscles were manually segmented, followed by muscle T2 extraction. Associations between muscle T2 values and the presence of neck pain, number of days with headache (considering the 30 days prior to imaging using a headache calendar), and number of myofascial trigger points (mTrPs) as determined by manual palpation of the trapezius muscles were analyzed using mixed effects and regression models (adjusting for age, sex, and body mass index).

#### RESULTS

The TTH+ group demonstrated the highest muscle T2 values (right side:  $31.4 \pm 1.2$  ms, left side:  $31.4 \pm 0.8$  ms) as compared to the TTH- group ( $p < 0.001$ ) or HC group ( $p < 0.001$ ). Muscle T2 was significantly associated with the number of headache days ( $\beta$  coefficient: 2.04,  $p = 0.04$ ) and the presence of neck pain (odds ratio: 2.26,  $p = 0.04$ ). With muscle T2 as the predictor, the area under the curve (AUC) for differentiating between HC and the TTH+ group was 0.82. There was no statistically significant association between muscle T2 and the number of mTrPs of the trapezius muscles ( $p > 0.05$ ).

#### CONCLUSION

Increased T2 values of the trapezius muscles may represent an objective imaging biomarker for myofascial involvement in primary headache disorders, which could help to improve patient phenotyping and therapy evaluation. Pathophysiologically, the increased muscle T2 values could be interpreted as a surrogate of subtle neurogenic inflammation and peripheral sensitization within myofascial tissues.

#### CLINICAL RELEVANCE/APPLICATION

Muscle T2 mapping could be used to stratify patients with primary headaches and to track potential treatment effects for monitoring (e.g., following peripheral magnetic stimulation or physiotherapy to the neck and shoulder muscles).

#### **W7-SSMK09-2 Significant Age-related Differences between Lower Leg Muscles of Elderly and Young Subjects Detected by Ultrashort Echo Time (UTE) Magnetization Transfer (MT) Modeling**

Saeed Jerban, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To determine if ultrashort echo time (UTE) magnetization transfer (MT) modeling is a sensitive MRI-based technique to detect age-related changes in muscles.

## METHODS AND MATERIALS

The lower legs of 31 healthy young (28±6 yo) and 20 elderly (75±6 yo) female volunteers were imaged using UTE-MRI sequences on a 3T MRI (MR750, GE) in a standard GE knee coil. Institutional review board approval and written informed consent was obtained for all recruited subjects. Subjects in the elderly group were active, ambulant, and had a recent bone densitometry scan in their medical records confirming no osteoporosis. The imaging slab was centered at the tibial midshaft. A 3D-UTE-Cones-MT sequence (pulse power=500°, 1000°, and 1500°; frequency offset=2, 5, 10, 20, and 50kHz; TR=100 ms; FA=7°; 9 spokes per MT preparation) was performed for the two-pool MT modeling (1, 2). Field of view, matrix dimension, in-plane pixel size, slice thickness, and total scan time were 14cm, 160×160, 0.87×0.87mm<sup>2</sup>, 5mm, and 15 mins, respectively. A T1 of 1s was used as the input for the MT modeling. Cones sequence (TR=100, TE=2.2 ms) was performed additionally to provide a high-contrast image for the selection of regions of interest (ROIs). Average macromolecular proton fraction (MMF) and T2 (T2-MM), in addition to water T2 (T2-W) and magnetization transfer ratio (MTR), were calculated for the four following muscles; anterior tibialis muscle (ATM), posterior tibialis muscle (PTM), soleus muscle (SM), and combined lateral muscles (LM, includes peroneus longus and extensor digitorum longus). The Wilcoxon rank sum test was used to compare young and elderly groups. P-values <0.05 were considered significant.

## RESULTS

Fig.1A-B show representative muscle ROIs (yellow dashed line) selected on axial images of the lower leg using the Cones UTE-MRI sequence and Cones at TE=2.2ms. Average differences in MTR and UTE-MT modeling results between young and elderly groups are presented in Fig.1C (Table1). Fig.1D shows boxplots of the MRI results for the young and elderly groups. MTR, MMF, and T2-MM were significantly lower for the muscles of the elderly group. T2-W was significantly higher in the elderly group. MMF and T2-W presented the highest age-related changes (>18% for MMF and >20% for T2-W).

## CONCLUSION

MMF obtained from UTE-MRI-MT modeling, as a surrogate measure for collagen content, showed a significant reduction in the elderly lower leg muscles while T2-W was increased. This study highlighted UTE-MRI-MT techniques as a proper quantitative method to assess the impact of aging on human muscles.

## CLINICAL RELEVANCE/APPLICATION

A UTE-MRI-based technique that can detect changes in skeletal muscles due to aging by estimating the collagen content in tendons may help diagnose and monitor age-related diseases.

## W7-SSMK09-3 The Not-So-Inferior Infraspinatus Muscle: Predictors of Infraspinatus Muscle Degeneration with an Isolated Supraspinatus Tendon Tear

Rebekah Lawrence, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Determine the demographic and clinical factors that predict infraspinatus muscle degeneration in individuals with an isolated supraspinatus tendon tear.

## METHODS AND MATERIALS

A retrospective analysis was performed using the medical records of patients who had a shoulder MRI interpreted by 1 of 3 fellowship-trained musculoskeletal radiologists since the implementation of a standardized MRI 3T protocol within our healthcare system. Demographic (e.g., age, sex) and clinical data (e.g., tear size, muscle degeneration, co-morbidities) were collected. Patients with an isolated supraspinatus tendon tear (n=121) were assigned to one of two groups based on whether any infraspinatus muscle degeneration was present. Logistic regression was used to assess the univariate relationships between infraspinatus muscle degeneration and patient and clinical data, while least absolute shrinkage and selector operator (LASSO) logistic regression was used to assess the multivariable relationship.

## RESULTS

Of the patients with an isolated supraspinatus tendon tear, 16.5% had evidence of infraspinatus muscle degeneration. The presence of infraspinatus muscle degeneration was independently associated with cardiovascular disease (P=0.01), supraspinatus muscle degeneration (P<0.01), and subscapularis muscle degeneration (P=0.01). When the multivariable relationship is assessed, supraspinatus muscle degeneration emerged as the only variable of significant importance for detecting infraspinatus muscle degeneration (specificity: 87.1%, sensitivity: 80.0%).

## CONCLUSION

Infraspinatus muscle degeneration is not uncommon in individuals with an isolated supraspinatus tear and is most associated with concomitant supraspinatus muscle degeneration. Degeneration of the infraspinatus muscle may be especially

problematic due to the muscle's crucial role supporting dynamic shoulder function. Indeed, infraspinatus muscle degeneration has been associated with higher retear rates and poorer clinical outcomes following arthroscopic rotator cuff repair. These findings highlight the need for clinicians to specifically assess the status of each rotator cuff muscle, even when the tendon itself is intact.

#### **CLINICAL RELEVANCE/APPLICATION**

Infraspinatus muscle degeneration is not uncommon with an isolated supraspinatus tendon tear and is important to identify given that specifically its presence is associated with higher retear rates and poorer clinical outcomes following arthroscopic rotator cuff repair.

#### **W7-SSMK09-6 Serial Changes of MR Neurography in the Experimental Autoimmune Neuritis: Differences between Fat Saturation T2 Weighted Image and Contrast Enhanced Fat Saturation T1 Weighted Image**

Dong-Ho Ha (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Experimental autoimmune neuritis (EAN) is the mostly used animal model of human Guillain-Barré syndrome (GBS), an inflammatory demyelinating disorder of peripheral nervous system. MRI of peripheral nerve, MR neurography (MRN), is increasingly being used for the evaluation of peripheral neuropathies directly and sequentially. Although increased signal of peripheral nerve on fat suppression T2-weighted image (FS-T2 WI) and enhanced FS T1-WI are well known in cases of EAN, time course of MRN findings have not yet been fully examined. In this study, we attempted to clarify the serial changes of MRN findings on FS T2-WI and enhanced FS T1-WI in the EAN animal model.

#### **METHODS AND MATERIALS**

Institutional Animal Care and Use Committee approval was obtained. To obtain the EAN animal model, 8 female Lewis rats (ages: 6-8 weeks, 150-180 g; Japan SLC, Japan) were immunized with subcutaneous fat injection of synthetic P2 peptide. After immunization, clinical score (neurologic status) of EAN and serial MR examinations were performed on week 1, week 2, week 3, week 4, week 5, week 6, week 7, and week 8. The changes of peripheral nerves on MRN were evaluated on lumbosacral plexus and sciatic nerves.

#### **RESULTS**

Rat EAN was induced successfully. All cases showed neurologic changes (paraplegia), and abnormal MRN findings on FS T2-WI and enhanced FS T1-WI. The clinical score, FS T2-WI MRN, and enhanced FS T1-WI MRN showed similar sequential changes (Fig 1.). At 2 weeks and 3 weeks, clinical scores, MRN grades of FS T2 WI and Enhanced FS T1W, were maximum. And then, these changes were declined over time. After 6 weeks, most of cases was returned to normal neurologic status and obtained functional recoveries. This time period was considered to be a recovery state. The enhanced FS T1-WI MRN showed normal signal intensity of peripheral nerve, but FS T2-WI MRN still noted abnormal high signal of peripheral nerves.

#### **CONCLUSION**

Both FS T2-WI and Enhanced FS T1-WI MRN were useful for the diagnosis of EAN. However, after 6 weeks, enhanced FS T1-WI MRN were more correlated with clinical score.

#### **CLINICAL RELEVANCE/APPLICATION**

The FS T2-WI is a preferred sequence to diagnosis the peripheral neuropathy owing to providing high contrast and high resolution image. Enhanced FS T1-WI with Gd-DTPA was usually used in cases suspected of tumor, infection, polyneuritis, etc. We thought that both FS T2-WI and Enhanced FS T1-WI were useful for the diagnosis of peripheral neuritis. In addition, normalized MRN findings on enhanced FS-T1 WI can be used to predict recovered clinical status of peripheral neuritis.

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## Abstract Archives of the RSNA, 2023

W7-SSMK09-1

### Neck Pain and Headache Frequency are Associated with Trapezius Muscle T2 from MRI in Young Adults with Tension-type Headache

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451A

Nico Sollmann, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Tension-type headache (TTH) is the most prevalent primary headache disorder. Neck pain is commonly associated with primary headaches and the trigeminocervical complex (TCC) refers to the convergence of trigeminal and cervical afferents onto neurons of the brainstem, thus conceptualizes the emergence of headache in relation to neck pain. However, no objective biomarkers exist for the myofascial involvement in primary headaches. This study aimed to investigate the involvement of the trapezius muscles in primary headache disorders by quantitative magnetic resonance imaging (MRI), and to explore associations between muscle T2 values and headache and neck pain frequency.

#### METHODS AND MATERIALS

Fifty participants (41 females, age range 20-31 years; 16 tension-type headache [TTH-], 12 mixed-type TTH plus migraine episodes [TTH+], and 22 healthy controls [HC]) prospectively underwent fat-suppressed T2-prepared three-dimensional (3D) turbo spin-echo MRI. The bilateral trapezius muscles were manually segmented, followed by muscle T2 extraction. Associations between muscle T2 values and the presence of neck pain, number of days with headache (considering the 30 days prior to imaging using a headache calendar), and number of myofascial trigger points (mTrPs) as determined by manual palpation of the trapezius muscles were analyzed using mixed effects and regression models (adjusting for age, sex, and body mass index).

#### RESULTS

The TTH+ group demonstrated the highest muscle T2 values (right side:  $31.4 \pm 1.2$  ms, left side:  $31.4 \pm 0.8$  ms) as compared to the TTH- group ( $p < 0.001$ ) or HC group ( $p < 0.001$ ). Muscle T2 was significantly associated with the number of headache days ( $\beta$  coefficient: 2.04,  $p = 0.04$ ) and the presence of neck pain (odds ratio: 2.26,  $p = 0.04$ ). With muscle T2 as the predictor, the area under the curve (AUC) for differentiating between HC and the TTH+ group was 0.82. There was no statistically significant association between muscle T2 and the number of mTrPs of the trapezius muscles ( $p > 0.05$ ).

#### CONCLUSION

Increased T2 values of the trapezius muscles may represent an objective imaging biomarker for myofascial involvement in primary headache disorders, which could help to improve patient phenotyping and therapy evaluation. Pathophysiologically, the increased muscle T2 values could be interpreted as a surrogate of subtle neurogenic inflammation and peripheral sensitization within myofascial tissues.

#### CLINICAL RELEVANCE/APPLICATION

Muscle T2 mapping could be used to stratify patients with primary headaches and to track potential treatment effects for monitoring (e.g., following peripheral magnetic stimulation or physiotherapy to the neck and shoulder muscles).

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## Abstract Archives of the RSNA, 2023

W7-SSMK09-2

### Significant Age-related Differences between Lower Leg Muscles of Elderly and Young Subjects Detected by Ultrashort Echo Time (UTE) Magnetization Transfer (MT) Modeling

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451A

Saeed Jerban, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To determine if ultrashort echo time (UTE) magnetization transfer (MT) modeling is a sensitive MRI-based technique to detect age-related changes in muscles.

#### METHODS AND MATERIALS

The lower legs of 31 healthy young ( $28 \pm 6$  yo) and 20 elderly ( $75 \pm 6$  yo) female volunteers were imaged using UTE-MRI sequences on a 3T MRI (MR750, GE) in a standard GE knee coil. Institutional review board approval and written informed consent was obtained for all recruited subjects. Subjects in the elderly group were active, ambulant, and had a recent bone densitometry scan in their medical records confirming no osteoporosis. The imaging slab was centered at the tibial midshaft. A 3D-UTE-Cones-MT sequence (pulse power= $500^\circ$ ,  $1000^\circ$ , and  $1500^\circ$ ; frequency offset=2, 5, 10, 20, and 50kHz; TR=100 ms; FA= $7^\circ$ ; 9 spokes per MT preparation) was performed for the two-pool MT modeling (1, 2). Field of view, matrix dimension, in-plane pixel size, slice thickness, and total scan time were 14cm,  $160 \times 160$ ,  $0.87 \times 0.87 \text{mm}^2$ , 5mm, and 15 mins, respectively. A T1 of 1s was used as the input for the MT modeling. Cones sequence (TR=100, TE=2.2 ms) was performed additionally to provide a high-contrast image for the selection of regions of interest (ROIs). Average macromolecular proton fraction (MMF) and T2 (T2-MM), in addition to water T2 (T2-W) and magnetization transfer ratio (MTR), were calculated for the four following muscles; anterior tibialis muscle (ATM), posterior tibialis muscle (PTM), soleus muscle (SM), and combined lateral muscles (LM, includes peroneus longus and extensor digitorum longus). The Wilcoxon rank sum test was used to compare young and elderly groups. P-values  $< 0.05$  were considered significant.

#### RESULTS

Fig.1A-B show representative muscle ROIs (yellow dashed line) selected on axial images of the lower leg using the Cones UTE-MRI sequence and Cones at TE=2.2ms. Average differences in MTR and UTE-MT modeling results between young and elderly groups are presented in Fig.1C (Table1). Fig.1D shows boxplots of the MRI results for the young and elderly groups. MTR, MMF, and T2-MM were significantly lower for the muscles of the elderly group. T2-W was significantly higher in the elderly group. MMF and T2-W presented the highest age-related changes ( $>18\%$  for MMF and  $>20\%$  for T2-W).

#### CONCLUSION

MMF obtained from UTE-MRI-MT modeling, as a surrogate measure for collagen content, showed a significant reduction in the elderly lower leg muscles while T2-W was increased. This study highlighted UTE-MRI-MT techniques as a proper quantitative method to assess the impact of aging on human muscles.

#### CLINICAL RELEVANCE/APPLICATION

A UTE-MRI-based technique that can detect changes in skeletal muscles due to aging by estimating the collagen content in tendons may help diagnose and monitor age-related diseases.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-SSMK09-3

### **The Not-So-Inferior Infraspinatus Muscle: Predictors of Infraspinatus Muscle Degeneration with an Isolated Supraspinatus Tendon Tear**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451A

Rebekah Lawrence, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Determine the demographic and clinical factors that predict infraspinatus muscle degeneration in individuals with an isolated supraspinatus tendon tear.

#### **METHODS AND MATERIALS**

A retrospective analysis was performed using the medical records of patients who had a shoulder MRI interpreted by 1 of 3 fellowship-trained musculoskeletal radiologists since the implementation of a standardized MRI 3T protocol within our healthcare system. Demographic (e.g., age, sex) and clinical data (e.g., tear size, muscle degeneration, co-morbidities) were collected. Patients with an isolated supraspinatus tendon tear (n=121) were assigned to one of two groups based on whether any infraspinatus muscle degeneration was present. Logistic regression was used to assess the univariate relationships between infraspinatus muscle degeneration and patient and clinical data, while least absolute shrinkage and selector operator (LASSO) logistic regression was used to assess the multivariable relationship.

#### **RESULTS**

Of the patients with an isolated supraspinatus tendon tear, 16.5% had evidence of infraspinatus muscle degeneration. The presence of infraspinatus muscle degeneration was independently associated with cardiovascular disease ( $P=0.01$ ), supraspinatus muscle degeneration ( $P<0.01$ ), and subscapularis muscle degeneration ( $P=0.01$ ). When the multivariable relationship is assessed, supraspinatus muscle degeneration emerged as the only variable of significant importance for detecting infraspinatus muscle degeneration (specificity: 87.1%, sensitivity: 80.0%).

#### **CONCLUSION**

Infraspinatus muscle degeneration is not uncommon in individuals with an isolated supraspinatus tear and is most associated with concomitant supraspinatus muscle degeneration. Degeneration of the infraspinatus muscle may be especially problematic due to the muscle's crucial role supporting dynamic shoulder function. Indeed, infraspinatus muscle degeneration has been associated with higher retear rates and poorer clinical outcomes following arthroscopic rotator cuff repair. These findings highlight the need for clinicians to specifically assess the status of each rotator cuff muscle, even when the tendon itself is intact.

#### **CLINICAL RELEVANCE/APPLICATION**

Infraspinatus muscle degeneration is not uncommon with an isolated supraspinatus tendon tear and is important to identify given that specifically its presence is associated with higher retear rates and poorer clinical outcomes following arthroscopic rotator cuff repair.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSMK09-6

### Serial Changes of MR Neurography in the Experimental Autoimmune Neuritis: Differences between Fat Saturation T2 Weighted Image and Contrast Enhanced Fat Saturation T1 Weighted Image

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451A

Dong-Ho Ha (*Presenter*) Nothing to Disclose

#### PURPOSE

Experimental autoimmune neuritis (EAN) is the mostly used animal model of human Guillain-Barré syndrome (GBS), an inflammatory demyelinating disorder of peripheral nervous system. MRI of peripheral nerve, MR neurography (MRN), is increasingly being used for the evaluation of peripheral neuropathies directly and sequentially. Although increased signal of peripheral nerve on fat suppression T2-weighted image (FS-T2 WI) and enhanced FS T1-WI are well known in cases of EAN, time course of MRN findings have not yet been fully examined. In this study, we attempted to clarify the serial changes of MRN findings on FS T2-WI and enhanced FS T1-WI in the EAN animal model.

#### METHODS AND MATERIALS

Institutional Animal Care and Use Committee approval was obtained. To obtain the EAN animal model, 8 female Lewis rats (ages: 6-8 weeks, 150-180 g; Japan SLC, Japan) were immunized with subcutaneous fat injection of synthetic P2 peptide. After immunization, clinical score (neurologic status) of EAN and serial MR examinations were performed on week 1, week 2, week 3, week 4, week 5, week 6, week 7, and week 8. The changes of peripheral nerves on MRN were evaluated on lumbosacral plexus and sciatic nerves.

#### RESULTS

Rat EAN was induced successfully. All cases showed neurologic changes (paraplegia), and abnormal MRN findings on FS T2-WI and enhanced FS T1-WI. The clinical score, FS T2-WI MRN, and enhanced FS T1-WI MRN showed similar sequential changes (Fig 1.). At 2 weeks and 3 weeks, clinical scores, MRN grades of FS T2 WI and Enhanced FS T1W, were maximum. And then, these changes were declined over time. After 6 weeks, most of cases was returned to normal neurologic status and obtained functional recoveries. This time period was considered to be a recovery state. The enhanced FS T1-WI MRN showed normal signal intensity of peripheral nerve, but FS F2-WI MRN still noted abnormal high signal of peripheral nerves.

#### CONCLUSION

Both FS T2-WI and Enhanced FS T1-WI MRN were useful for the diagnosis of EAN. However, after 6 weeks, enhanced FS T1-WI MRN were more correlated with clinical score.

#### CLINICAL RELEVANCE/APPLICATION

The FS T2-WI is a preferred sequence to diagnosis the peripheral neuropathy owing to providing high contrast and high resolution image. Enhanced FS T1-WI with Gd-DTPA was usually used in cases suspected of tumor, infection, polyneuritis, etc. We thought that both FS T2-WI and Enhanced FS T1-WI were useful for the diagnosis of peripheral neuritis. In addition, normalized MRN findings on enhanced FS-T1 WI can be used to predict recovered clinical status of peripheral neuritis.

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## Abstract Archives of the RSNA, 2023

W7-SSMK10

### Musculoskeletal Imaging (Arthritis and Cartilage, Hardware and Orthopedic Implants)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451B

Kambiz Motamedi, MD (*Moderator*) Royalties, RELX  
Kara D. Gaetke-Udager, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W7-SSMK10-1 **Enthesis Assessment Using Ultrashort Echo Time Magnetic Resonance Imaging (UTE-MRI) Adiab-T1p in Psoriatic Arthritis**

Dina Moazamian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study investigates the utility of the quantitative 3D ultrashort echo time (UTE) Adiab-T1 $\rho$  fat-sat (FS) magnetic resonance imaging (MRI) technique to quantify differences in the Achilles tendons and entheses in patients with psoriatic arthritis disease (PSA) compared with asymptomatic volunteers.

#### METHODS AND MATERIALS

Institutional review board approval and written informed consent were obtained for all recruited subjects. Achilles tendons of forty-two PSA patients (59 $\pm$ 15 years old, 38% female) and thirty-seven asymptomatic volunteers (32  $\pm$ 10 years old, 51% female) were scanned in the sagittal plane on a 3T clinical scanner (MR750, GE) employing a 3-inch surface coil. The 3D UTE-Adiab-T1 $\rho$  FS technique was used with the following parameters: TR=450ms, spin-locking time (TSL)=0, 12, 24, and 48 ms (number of adiabatic full passage (AFP) pulse=0,2,4, and 8), FA=10 $^\circ$ , number of spokes=25; bandwidth=1500, Slice thickness=2mm, Number of slices=36, FOV=12 $\times$ 12cm $^2$ , matrix size =256 $\times$ 256. The total scan time was 10 mins. Two different regions of interest (ROIs) for each participant were selected manually, one on the entheses (close to the calcaneus bone) and the other one on the pure tensile Achilles tendon (Fig.1A). UTE-MRI markers were calculated for the two groups and were compared using the Mann-Whitney-U test. P values <0.05 were considered significant.

#### RESULTS

T1 $\rho$  pixel maps of a representative patient and an asymptomatic volunteer are presented in Fig.1 B and Fig.1 C, respectively. The average and standard deviation of UTE-Adiab-T1 $\rho$  (ms) measures for entheses in patients with PSA compared to asymptomatic was 11.4 $\pm$ 2.6ms vs. 10.4 $\pm$ 2.4ms (p<0.01), respectively, and UTE-Adiab-T1 $\rho$  (ms) measures for the Achilles tendon of patients with PSA compared to the asymptomatic group was 10.2 $\pm$ 2.8ms vs. 7.7 $\pm$ 1.6ms (p<0.001) (Fig.1D-E). Significant differences in T1 $\rho$  values of entheses and tendons were found between the PSA and asymptomatic volunteers. The T1 $\rho$  differences between the asymptomatic volunteer and PSA groups were higher in the tendons (29.8%) than the entheses (9.6%).

#### CONCLUSION

The UTE-Adiab-T1 $\rho$  technique can be used as a quantitative method for assessing entheses. The significantly higher T1 $\rho$  values in the entheses of PSA patients could be due to a lower proteoglycan content or less organized fibers. The mechanisms underlying these relaxation differences should be investigated thoroughly in future studies.

#### CLINICAL RELEVANCE/APPLICATION

The UTE-Adiab-T1 $\rho$  sequence is capable of evaluating entheses and tendons and may be able to detect abnormalities in PSA patients and ultimately be used for treatment monitoring.

#### W7-SSMK10-2 **Non-invasive MRI Assessment of Infrapatellar Fat Pad in Adult Mice with Obesity and Load-induced Post-traumatic Osteoarthritis**

Aurea V. Mohana-Borges, MD, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate in a preclinical murine model of obesity and load-induced post-traumatic osteoarthritis (PTOA) 1) the volume and composition of the infrapatellar fat pad (IFP) using the quantitative MRI volumetry and T2 mapping and 2) to compare the IFP T2 mapping with subcutaneous adipose tissue (SAT).

## METHODS AND MATERIALS

In this cross-sectional study, male C57BL/6 mice were randomly assigned at 16 weeks to a high-fat diet (HFD) (n=9) or a control-fat diet (CFD) (n=7). At 36 weeks, using an ElectroForce 3100 instrument, the right limbs underwent sham in the CFD group and compression-induced ligamentous injury in the HFD group. The left limbs of the HFD mice were left unloaded and used for comparison. Four weeks post-injury (40 weeks), animals were anesthetized and sacrificed. Subsequently, MRI was performed on a 3T scanner (Bruker Biospec) using a 10 mm receiving-only surface coil. Images were acquired in the sagittal plane with a multi-slice multi-echo (MSME) sequence, with TR= 800 ms, TE1-TE10 = 6.9 - 69.0 ms, slice thickness= 0.06 mm, acquisition matrix = 333x333, bandwidth = 300 Hz/pixel, spatial resolution = 60x60x60 micron, and acquisition time = 55.5h. The first echo was used for the morphological assessment of IFP, bone, ligaments, and joint effusion, and the ten echoes for IFP T2 mappings. Two musculoskeletal radiologists independently evaluated the images. Histological reference standard was acquired. Shapiro-Wilk, ANOVA, and ICC correlation were used.

## RESULTS

After MRI evaluation, two mice were excluded from the analysis, one from each group. IFP volume and T2 values were significantly reduced in HFD-PTOA group in comparison to CFD and HFD-only groups (p=0.001). Mean IFP volume and T2 values in CFD, HFD-only, and HFD-PTOA groups were 1.05 mm<sup>3</sup> (± 0.13), 1.05 mm<sup>3</sup> (±0.10), and 0.49 mm<sup>3</sup> (±0.27), and 74.78 ms (±11.7), 66.24 ms (±11.1), and 44.33 ms (±12.8), respectively. There was a statistically significant difference between the T2 values of IFP and SAT in HFD-PTOA group (p <0.001). Hypertrophic osteophytes and joint effusion were only observed in the HFD-PTOA group. The histologic analysis performed demonstrated IFP fibrosis in HFD/PTOA group. IFP volumetry and T2 mapping were normally distributed (p>0.05). There was an excellent interobserver agreement (ICC > 0.9).

## CONCLUSION

PTOA in obese adult mice is associated with dramatic changes in IFP, characterized by decreased fat pad volume and T2 values. In addition, compositional MRI can identify differences between IFP and SAT in obese mice with PTOA.

## CLINICAL RELEVANCE/APPLICATION

There is a gap in knowledge of the characteristics of the infrapatellar fat pad and subcutaneous adipose tissue evaluated noninvasively by quantitative MRI in pre-clinical models of osteoarthritis.

## W7-SSMK10-3 Hardware Failure Detection in Spine Radiography using AI

Ji Weon Lee, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To train a deep learning (DL) model to detect hardware failure in post-operative spine radiography, using both positive and negative images of the same patients as training data to overcome the lack of data.

## METHODS AND MATERIALS

We downloaded 624K spine radiography reports from one hospital (2003 to 2022) and split them into individual words. 1768 keywords were designated as "post-operative" and "hardware failure" words. By searching for reports with two or more overlapping keywords, 316 patients were confirmed by a radiologist to have at least one image of hardware failure. From these patients, 11,321 spine radiography jpg images (75% lateral, 18% anterior, and 6% oblique views) were downloaded, including images negative for hardware failure (median 40 images/patient, over a median of 4.7 years). 5,054 images were positive for hardware failure and labeled with 7 classes of bounding boxes: ASD (Adjacent segment disease), loosening, protrusion, migration, rod fracture, screw fracture, and subsidence. Since the dataset included serial follow up images, the labels included subtle findings of hardware failure at an early phase. Label imbalance was adjusted by augmentation techniques (flip and Gaussian noise). A total of 14,919 images were used to train a Yolov5 and tested on 600 images that were not seen in the training set. The prediction was classified as correct if the predicted bounding box overlapped the ground truth by more than 50% with the correct label. An optimal confidence score threshold was selected at the maximum sensitivity of the predicted bounding boxes. Using the best-performing weights and optimal confidence score threshold, we tested the model on 10 images downloaded from Radiographics (<https://pubs.rsna.org/journal/radiographics>).

## RESULTS

The model's sensitivity in predicting any hardware failure was 88.2%, with a positive predictive value of 0.76 for the predicted bounding boxes at a confidence threshold of 0.088. The best and worst performing labels were screw fracture and protrusion: Sensitivities 98.6% and 60%. Lateral views performed better than oblique views (89.6% vs. 87.6%). Out of the 10 Radiographics images, the model predicted 4 true positives, 3 true negatives, and 3 false positive predictions.

## CONCLUSION

We trained a DL model to detect 7 types of hardware failure in post-operative spine radiography. The model correctly identified 7 out of 10 images from Radiographics.

## CLINICAL RELEVANCE/APPLICATION

1. AI can help the detection of hardware failure in post-operative spine radiography. 2. Multiple images of the same patients can be used as negative and positive training data to overcome the lack of data.

## W7-SSMK10-4 Unicompartamental Knee Arthroplasties: Radiographic Findings Associated with Conversion to Total Knee Arthroplasty

Anna L. Falkowski, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To identify radiographic findings after unicompartamental knee arthroplasty (UKA) that might lead to conversion to total knee arthroplasty (TKA).

### METHODS AND MATERIALS

IRB-approval and informed consent were obtained for this retrospective study. Radiographs of patients with UKA before conversion to TKA were compared to an asymptomatic control group without conversion. Radiographic findings like a linear osteolytic rim, circumscribed osteolysis, material integrity and positioning, periprosthetic fractures, and osteoarthritis (OA) in the lateral and patellofemoral compartments were evaluated.

### RESULTS

99 patients were included (61% male; 60/99; and 39% female; 39/99). The conversion group consisted of 42 patients, the asymptomatic control group of 57. Mean age of subjects was 67 years (range 44-88 years; standard deviation  $\pm 9.7$  years). The conversion group showed a linear osteolytic rim at the femoral component in 16.7% (versus 10.5% asymptomatic control group), and at the tibial component in 54.8% (30.7%). Circumscribed osteolysis was present in 1.2% (0%) of femoral, and 8.3% (0%) of tibial components. OA was more advanced in the conversion group for all compartments: 1.) Lateral femorotibial compartment (no OA conversion group 23.8% / asymptomatic control group 56.7%; mild OA 48.8%/38.1%; moderate OA 17.9%/5.2%; severe OA 9.5%/0%); 2.) Patellofemoral compartment (no OA 6%/11.8%; mild OA 57.1%/70.6%; moderate OA 33.3%/16.4%; severe OA 3.6%/1.2%). Statistically significant differences between the conversion group versus the asymptomatic control group were found for tibial osteolytic rim ( $p=0.014$ ) and osteolysis (0.008), femoral (0.045) material integrity, femorotibial ratio (0.040), OA of lateral femorotibial ( $<0.001$ ) and patellofemoral compartment (0.008).

### CONCLUSION

Features commonly present in patients needing a conversion from UKA to TKA were tibial osteolytic rim and osteolysis. Additionally, OA was more advanced in the conversion group at the lateral femorotibial compartment and patellofemoral compartment compared to the asymptomatic control group.

### CLINICAL RELEVANCE/APPLICATION

Survival rates of unicompartamental knee arthroplasties are known to be lower than total knee arthroplasties. The radiological features described here can be used to identify an indication for conversion to total knee arthroplasty.

## W7-SSMK10-5 Assessment of Image Quality of the Bone-implant Interface of in-vivo Acetabular Cup Implants using Photon-counting Detector CT: Effect of Tin Pre-filtration

Pauline de Klerk, MSc (*Presenter*) Nothing to Disclose

### PURPOSE

To assess the visualization of the bone-implant interface of acetabular cup implants using photon-counting detector (PCD) CT with and without additional tin filtration in a clinical setting.

### METHODS AND MATERIALS

Fourteen total hip replacements (THR) in 13 orthopedic patients (five men [age range 57 - 84 years] and eight women [age range 46 - 84 years]), underwent a clinically indicated PCD-CT (Siemens NAEOTOM Alpha). Seven patients were scanned using 140 kVp and seven patients using 140 kVp with an additional tin filtration (Sn140). All scans were acquired in ultra-high resolution mode (120x0.2mm). The image data were reconstructed with different slice thickness ([0.2mm - 0.6mm]) and kernel strengths (56, 76, 89) with and without metal artifact reduction (iMAR). Two experienced musculoskeletal radiologists assessed the ability to determine osseointegration of the cup based on four image quality criteria using a 5-point Likert scale. Bone contrast, contrast-to-noise ratio (CNR) of bone/fat and trabecular and cortical sharpness was performed as quantitative measures.

## **RESULTS**

Image quality was rated highest for 0.2 mm slice thickness and Br89 kernel across all four criteria for both the 140 kVp [2.9 - 3.4] and Sn140 kVp [3.5 - 3.9] by both radiologists. Reconstruction with 0.6mm/Qr76 and 0.6mm/Qr56/iMAR were rated with an average range of 1.4 - 2.5 for 140 kVp and 1.5 - 3.1 for Sn140 kVp. In all cases and for all image criteria the 0.2mm/Br89 was preferred above the Qr76 and Qr56/iMAR by both observers. Both radiologists preferred 0.2mm/Br89 reconstructions acquired using Sn140kVp (difference 0.3-0.7 points compared to 140kVp). Quantitative measurements confirmed significantly improved bone contrast as well as trabecular and cortical sharpness using 0.2mm/Br89. Tin pre-filtration did not affect the CNR at 0.2mm/Br89 but tended to decrease cortical sharpness.

## **CONCLUSION**

High resolution PCD-CT allows for adequate in-vivo assessment of the bone-implant interface. Additional tin filtration seems preferred by radiologists, possibly due to reduced metal artifacts.

## **CLINICAL RELEVANCE/APPLICATION**

The use of tin pre-filtration improves subjective image quality in high resolution PCD-CT assessment of osseointegration after joint replacement surgery. PCD-CT may be valuable in discriminating a loosened THR as the source of pain from other differential diagnoses such as benign musculoskeletal conditions.

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## Abstract Archives of the RSNA, 2023

W7-SSMK10-1

### Enthesis Assessment Using Ultrashort Echo Time Magnetic Resonance Imaging (UTE-MRI) Adiab-T1p in Psoriatic Arthritis

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451B

Dina Moazamian, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study investigates the utility of the quantitative 3D ultrashort echo time (UTE) Adiab-T1 $\rho$  fat-sat (FS) magnetic resonance imaging (MRI) technique to quantify differences in the Achilles tendons and entheses in patients with psoriatic arthritis disease (PSA) compared with asymptomatic volunteers.

#### METHODS AND MATERIALS

Institutional review board approval and written informed consent were obtained for all recruited subjects. Achilles tendons of forty-two PSA patients (59 $\pm$ 15 years old, 38% female) and thirty-seven asymptomatic volunteers (32  $\pm$ 10 years old, 51% female) were scanned in the sagittal plane on a 3T clinical scanner (MR750, GE) employing a 3-inch surface coil. The 3D UTE-Adiab-T1 $\rho$  FS technique was used with the following parameters: TR=450ms, spin-locking time (TSL)=0, 12, 24, and 48 ms (number of adiabatic full passage (AFP) pulse=0,2,4, and 8), FA=10 $^\circ$ , number of spokes=25; bandwidth=1500, Slice thickness=2mm, Number of slices=36, FOV=12 $\times$ 12cm<sup>2</sup>, matrix size =256 $\times$ 256. The total scan time was 10 mins. Two different regions of interest (ROIs) for each participant were selected manually, one on the entheses (close to the calcaneus bone) and the other one on the pure tensile Achilles tendon (Fig.1A). UTE-MRI markers were calculated for the two groups and were compared using the Mann-Whitney-U test. P values <0.05 were considered significant.

#### RESULTS

T1 $\rho$  pixel maps of a representative patient and an asymptomatic volunteer are presented in Fig.1 B and Fig.1 C, respectively. The average and standard deviation of UTE-Adiab-T1 $\rho$  (ms) measures for entheses in patients with PsA compared to asymptomatic was 11.4 $\pm$ 2.6ms vs. 10.4 $\pm$ 2.4ms ( $p$ <0.01), respectively, and UTE-Adiab-T1 $\rho$  (ms) measures for the Achilles tendon of patients with PsA compared to the asymptomatic group was 10.2 $\pm$ 2.8ms vs. 7.7 $\pm$ 1.6ms ( $p$ <0.001) (Fig.1D-E). Significant differences in T1 $\rho$  values of entheses and tendons were found between the PSA and asymptomatic volunteers. The T1 $\rho$  differences between the asymptomatic volunteer and PSA groups were higher in the tendons (29.8%) than the entheses (9.6%).

#### CONCLUSION

The UTE-Adiab-T1 $\rho$  technique can be used as a quantitative method for assessing entheses. The significantly higher T1 $\rho$  values in the entheses of PSA patients could be due to a lower proteoglycan content or less organized fibers. The mechanisms underlying these relaxation differences should be investigated thoroughly in future studies.

#### CLINICAL RELEVANCE/APPLICATION

The UTE-Adiab-T1 $\rho$  sequence is capable of evaluating entheses and tendons and may be able to detect abnormalities in PSA patients and ultimately be used for treatment monitoring.

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## Abstract Archives of the RSNA, 2023

W7-SSMK10-2

### Non-invasive MRI Assessment of Infrapatellar Fat Pad in Adult Mice with Obesity and Load-induced Post-traumatic Osteoarthritis

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451B

Aurea V. Mohana-Borges, MD, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate in a preclinical murine model of obesity and load-induced post-traumatic osteoarthritis (PTOA) 1) the volume and composition of the infrapatellar fat pad (IFP) using the quantitative MRI volumetry and T2 mapping and 2) to compare the IFP T2 mapping with subcutaneous adipose tissue (SAT).

#### METHODS AND MATERIALS

In this cross-sectional study, male C57BL/6 mice were randomly assigned at 16 weeks to a high-fat diet (HFD) (n=9) or a control-fat diet (CFD) (n=7). At 36 weeks, using an ElectroForce 3100 instrument, the right limbs underwent sham in the CFD group and compression-induced ligamentous injury in the HFD group. The left limbs of the HFD mice were left unloaded and used for comparison. Four weeks post-injury (40 weeks), animals were anesthetized and sacrificed. Subsequently, MRI was performed on a 3T scanner (Bruker Biospec) using a 10 mm receiving-only surface coil. Images were acquired in the sagittal plane with a multi-slice multi-echo (MSME) sequence, with TR= 800 ms, TE1-TE10 = 6.9 - 69.0 ms, slice thickness= 0.06 mm, acquisition matrix = 333x333, bandwidth = 300 Hz/pixel, spatial resolution = 60x60x60 micron, and acquisition time = 55.5h. The first echo was used for the morphological assessment of IFP, bone, ligaments, and joint effusion, and the ten echoes for IFP T2 mappings. Two musculoskeletal radiologists independently evaluated the images. Histological reference standard was acquired. Shapiro-Wilk, ANOVA, and ICC correlation were used.

#### RESULTS

After MRI evaluation, two mice were excluded from the analysis, one from each group. IFP volume and T2 values were significantly reduced in HFD-PTOA group in comparison to CFD and HFD-only groups ( $p=0.001$ ). Mean IFP volume and T2 values in CFD, HFD-only, and HFD-PTOA groups were 1.05 mm<sup>3</sup> ( $\pm 0.13$ ), 1.05 mm<sup>3</sup> ( $\pm 0.10$ ), and 0.49 mm<sup>3</sup> ( $\pm 0.27$ ), and 74.78 ms ( $\pm 11.7$ ), 66.24 ms ( $\pm 11.1$ ), and 44.33 ms ( $\pm 12.8$ ), respectively. There was a statistically significant difference between the T2 values of IFP and SAT in HFD-PTOA group ( $p < 0.001$ ). Hypertrophic osteophytes and joint effusion were only observed in the HFD-PTOA group. The histologic analysis performed demonstrated IFP fibrosis in HFD/PTOA group. IFP volumetry and T2 mapping were normally distributed ( $p > 0.05$ ). There was an excellent interobserver agreement (ICC > 0.9).

#### CONCLUSION

PTOA in obese adult mice is associated with dramatic changes in IFP, characterized by decreased fat pad volume and T2 values. In addition, compositional MRI can identify differences between IFP and SAT in obese mice with PTOA.

#### CLINICAL RELEVANCE/APPLICATION

There is a gap in knowledge of the characteristics of the infrapatellar fat pad and subcutaneous adipose tissue evaluated noninvasively by quantitative MRI in pre-clinical models of osteoarthritis.

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## Abstract Archives of the RSNA, 2023

W7-SSMK10-3

### Hardware Failure Detection in Spine Radiography using AI

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451B

Ji Weon Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To train a deep learning (DL) model to detect hardware failure in post-operative spine radiography, using both positive and negative images of the same patients as training data to overcome the lack of data.

#### METHODS AND MATERIALS

We downloaded 624K spine radiography reports from one hospital (2003 to 2022) and split them into individual words. 1768 keywords were designated as "post-operative" and "hardware failure" words. By searching for reports with two or more overlapping keywords, 316 patients were confirmed by a radiologist to have at least one image of hardware failure. From these patients, 11,321 spine radiography jpg images (75% lateral, 18% anterior, and 6% oblique views) were downloaded, including images negative for hardware failure (median 40 images/patient, over a median of 4.7 years). 5,054 images were positive for hardware failure and labeled with 7 classes of bounding boxes: ASD (Adjacent segment disease), loosening, protrusion, migration, rod fracture, screw fracture, and subsidence. Since the dataset included serial follow up images, the labels included subtle findings of hardware failure at an early phase. Label imbalance was adjusted by augmentation techniques (flip and Gaussian noise). A total of 14,919 images were used to train a Yolov5 and tested on 600 images that were not seen in the training set. The prediction was classified as correct if the predicted bounding box overlapped the ground truth by more than 50% with the correct label. An optimal confidence score threshold was selected at the maximum sensitivity of the predicted bounding boxes. Using the best-performing weights and optimal confidence score threshold, we tested the model on 10 images downloaded from Radiographics (<https://pubs.rsna.org/journal/radiographics>).

#### RESULTS

The model's sensitivity in predicting any hardware failure was 88.2%, with a positive predictive value of 0.76 for the predicted bounding boxes at a confidence threshold of 0.088. The best and worst performing labels were screw fracture and protrusion: Sensitivities 98.6% and 60%. Lateral views performed better than oblique views (89.6% vs. 87.6%). Out of the 10 Radiographics images, the model predicted 4 true positives, 3 true negatives, and 3 false positive predictions.

#### CONCLUSION

We trained a DL model to detect 7 types of hardware failure in post-operative spine radiography. The model correctly identified 7 out of 10 images from Radiographics.

#### CLINICAL RELEVANCE/APPLICATION

1. AI can help the detection of hardware failure in post-operative spine radiography. 2. Multiple images of the same patients can be used as negative and positive training data to overcome the lack of data.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSMK10-4

### Unicompartmental Knee Arthroplasties: Radiographic Findings Associated with Conversion to Total Knee Arthroplasty

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451B

Anna L. Falkowski, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To identify radiographic findings after unicompartmental knee arthroplasty (UKA) that might lead to conversion to total knee arthroplasty (TKA).

#### METHODS AND MATERIALS

IRB-approval and informed consent were obtained for this retrospective study. Radiographs of patients with UKA before conversion to TKA were compared to an asymptomatic control group without conversion. Radiographic findings like a linear osteolytic rim, circumscribed osteolysis, material integrity and positioning, periprosthetic fractures, and osteoarthritis (OA) in the lateral and patellofemoral compartments were evaluated.

#### RESULTS

99 patients were included (61% male; 60/99; and 39% female; 39/99). The conversion group consisted of 42 patients, the asymptomatic control group of 57. Mean age of subjects was 67 years (range 44-88 years; standard deviation  $\pm 9.7$  years). The conversion group showed a linear osteolytic rim at the femoral component in 16.7% (versus 10.5% asymptomatic control group), and at the tibial component in 54.8% (30.7%). Circumscribed osteolysis was present in 1.2% (0%) of femoral, and 8.3% (0%) of tibial components. OA was more advanced in the conversion group for all compartments: 1.) Lateral femorotibial compartment (no OA conversion group 23.8% / asymptomatic control group 56.7%; mild OA 48.8%/38.1%; moderate OA 17.9%/5.2%; severe OA 9.5%/0%); 2.) Patellofemoral compartment (no OA 6%/11.8%; mild OA 57.1%/70.6%; moderate OA 33.3%/16.4%; severe OA 3.6%/1.2%). Statistically significant differences between the conversion group versus the asymptomatic control group were found for tibial osteolytic rim ( $p=0.014$ ) and osteolysis (0.008), femoral (0.045) material integrity, femorotibial ratio (0.040), OA of lateral femorotibial ( $<0.001$ ) and patellofemoral compartment (0.008).

#### CONCLUSION

Features commonly present in patients needing a conversion from UKA to TKA were tibial osteolytic rim and osteolysis. Additionally, OA was more advanced in the conversion group at the lateral femorotibial compartment and patellofemoral compartment compared to the asymptomatic control group.

#### CLINICAL RELEVANCE/APPLICATION

Survival rates of unicompartmental knee arthroplasties are known to be lower than total knee arthroplasties. The radiological features described here can be used to identify an indication for conversion to total knee arthroplasty.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSMK10-5

### Assessment of Image Quality of the Bone-implant Interface of in-vivo Acetabular Cup Implants using Photon-counting Detector CT: Effect of Tin Pre-filtration

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E451B

Pauline de Klerk, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the visualization of the bone-implant interface of acetabular cup implants using photon-counting detector (PCD) CT with and without additional tin filtration in a clinical setting.

#### METHODS AND MATERIALS

Fourteen total hip replacements (THR) in 13 orthopedic patients (five men [age range 57 - 84 years] and eight women [age range 46 - 84 years]), underwent a clinically indicated PCD-CT (Siemens NAEOTOM Alpha). Seven patients were scanned using 140 kVp and seven patients using 140 kVp with an additional tin filtration (Sn140). All scans were acquired in ultra-high resolution mode (120x0.2mm). The image data were reconstructed with different slice thickness ([0.2mm - 0.6mm]) and kernel strengths (56, 76, 89) with and without metal artifact reduction (iMAR). Two experienced musculoskeletal radiologists assessed the ability to determine osseointegration of the cup based on four image quality criteria using a 5-point Likert scale. Bone contrast, contrast-to-noise ratio (CNR) of bone/fat and trabecular and cortical sharpness was performed as quantitative measures.

#### RESULTS

Image quality was rated highest for 0.2 mm slice thickness and Br89 kernel across all four criteria for both the 140 kVp [2.9 - 3.4] and Sn140 kVp [3.5 - 3.9] by both radiologists. Reconstruction with 0.6mm/Qr76 and 0.6mm/Qr56/iMAR were rated with an average range of 1.4 - 2.5 for 140 kVp and 1.5 - 3.1 for Sn140 kVp. In all cases and for all image criteria the 0.2mm/Br89 was preferred above the Qr76 and Qr56/iMAR by both observers. Both radiologists preferred 0.2mm/Br89 reconstructions acquired using Sn140kVp (difference 0.3-0.7 points compared to 140kVp). Quantitative measurements confirmed significantly improved bone contrast as well as trabecular and cortical sharpness using 0.2mm/Br89. Tin pre-filtration did not affect the CNR at 0.2mm/Br89 but tended to decrease cortical sharpness.

#### CONCLUSION

High resolution PCD-CT allows for adequate in-vivo assessment of the bone-implant interface. Additional tin filtration seems preferred by radiologists, possibly due to reduced metal artifacts.

#### CLINICAL RELEVANCE/APPLICATION

The use of tin pre-filtration improves subjective image quality in high resolution PCD-CT assessment of osseointegration after joint replacement surgery. PCD-CT may be valuable in discriminating a loosened THR as the source of pain from other differential diagnoses such as benign musculoskeletal conditions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSNR12

### Neuroradiology (Techniques and Methods: Diffusion, Perfusion, and Other Techniques)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

Nicoletta Anzalone, MD (*Moderator*) Nothing to Disclose  
Seyedmehdi Payabvash, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W7-SSNR12-1 High Resolution Neck CT Angiography for Stenosis Quantification: A Prospective Patient Study Comparing Photon-counting Detector CT and Energy-integrating Detector CT**

Felix E. Diehn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare photon-counting detector (PCD) and conventional energy-integrating detector (EID) CT for stenosis quantification on neck CTA.

#### METHODS AND MATERIALS

Adult patients with at least mild stenosis of at least one carotid bulb/proximal internal carotid artery (ICA) undergoing head/neck CTA exams at EID underwent a PCD research CTA. Dual-energy scanning protocol was used on EID-CT (100/150Sn, 192x0.6mm detector configuration) with a medium sharp kernel and iterative reconstruction (Qr54-3). High-resolution (HR) scan mode was used on PCD-CT (120 kV, 120x0.2mm). Images were reconstructed at 0.6mm slice thickness using a closely matched standard resolution kernel (Qr56-3). HR images with the sharpest kernel (Qr89) were reconstructed on PCD-CT at thinnest slice thickness, 0.2mm. A dedicated deep convolutional neural network (HR-CNN) denoising algorithm was trained using HR patient images and applied to the HR series. For each stenosis, a neuroradiology reader evaluated the 4 different series in randomized and blinded fashion. The reader scored relative preference for each series (from 1, most preferred, with greatest confidence in evaluating the stenosis, to 4, least preferred). The reader measured the stenoses on each series (minimal luminal diameter at the maximal level of stenosis). A second reader measured the maximal luminal diameter of the normal caliber more distal ICA to enable % stenosis calculations, and categorized plaque type.

#### RESULTS

10 adult patients with 14 carotid bulb/proximal ICA stenoses were included (age  $73\pm 6$  years, 3 females). PCD-HR-CNN images were most preferred and EID images least: mean preference scores were  $1.43\pm 0.65$  PCD-HR-CNN,  $3.86\pm 0.36$  EID. Stenosis measurements on PCD-HR (with or without CNN) were less severe than on EID; mean 46% PCD-HR-CNN, 45% PCD-HR, 51% EID ( $p=0.010$  PCD-HR-CNN vs. EID;  $p=0.014$  PCD-HR vs. EID). 3 stenoses harbored heavily calcified plaque and 2 additional mixed plaques demonstrated calcifications along the lumen at the maximal stenosis. In these 5 stenoses, preference for PCD including PCD-HR-CNN over EID was also strong; mean preference scores were  $1.40\pm 0.55$  PCD-HR-CNN,  $1.80\pm 0.84$  PCD-HR,  $3.60\pm 0.55$  EID. Stenosis measurements on PCD-HR (with or without CNN) were also less severe than on EID; mean 59% PCD-HR-CNN and PCD-HR, 65% EID ( $p=0.018$  PCD-HR-CNN vs. EID,  $p=0.036$  PCD-HR vs. EID).

#### CONCLUSION

PCD-CT provides preferred CTA image quality for carotid stenosis compared to EID-CT, especially when PCD-HR mode is combined with an HR-CNN denoising algorithm. EID tends to overestimate carotid stenosis, particularly in calcified plaques.

#### CLINICAL RELEVANCE/APPLICATION

PCD can facilitate CTA assessment of carotid stenoses, including when HR mode is combined with a HR-CNN denoising algorithm.

#### **W7-SSNR12-2 Unsupervised Discovery of Microstructural Deviations in Diffusion MRI Tractometry of Adolescents with ADHD**

Justin Huynh, BS, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Diagnosis of attention deficit hyperactivity disorder (ADHD) is complex, relying on criteria sensitive to subjective biases. Alternatively, structural and functional variations in imaging may reflect underlying psychopathology and etiology of ADHD and provide rich data sources enabling more objective diagnosis. Though promising, these variations are still not well understood or characterized. The purpose of this study is to discover and visualize hidden structural patterns of diffusion weighted imaging (DWI) derived white matter (WM) tractography and fractional anisotropy (FA) measurements among adolescent patients with ADHD using unsupervised deep learning.

## METHODS AND MATERIALS

Diffusion weighted imaging (DWI) from a subset of 1704 patients from the Adolescent Brain Cognitive Development (ABCD) Study was gathered. DWI was processed with Automated Fiber Quantification (AFQ) to extract individual subject white matter (WM) fiber bundles for 30 major WM tracts. Fractional anisotropy (FA) was computed at 80 equally spaced nodes along the length of each tract, and used as input for the deep learning model. An autoencoder was trained to reproduce the FA values of 1371 subjects. After training, the model was evaluated on an independent testing set of 333 patients, 193 with behavior problem monitor (BPM) greater than 70, the clinical threshold for ADHD, and 140 with BPM less than 60, no ADHD. Anomaly scores using absolute error (AE) along the WM tracts were computed between predicted and inputted FA values. Anomaly score profiles were averaged and compared between all patients with and without ADHD.

## RESULTS

Mean absolute error (MAE) between predicted and actual FA values was 0.041, significantly different between subjects with and without ADHD (0.042 vs 0.038,  $p=0.041$ ). Comparing absolute error anomaly scores between subjects with and without ADHD along 30 WM tracts reveals significant differences in 9 tracts: left arcuate fasciculus (ARC\_L,  $p=0.006$ ), left cingulum cingulate gyrus (CGC\_L,  $p=0.020$ ), left corticospinal tract (CST\_L,  $p=0.007$ ), right corticospinal tract (CST\_R,  $p=0.006$ ), frontoparietal (FP,  $p=0.0168$ ), right inferior fronto-occipital fasciculus (IFO\_R,  $p=0.033$ ), left inferior longitudinal fasciculus (ILF\_L,  $p=0.002$ ), superior parietal lobe ( $p=0.041$ ) and temporal lobe ( $p=0.008$ ).

## CONCLUSION

The unsupervised autoencoder-based approach identified anomalous FA profiles in patients with ADHD, revealing significant differences in 9 out of 30 WM tracts.

## CLINICAL RELEVANCE/APPLICATION

This method identifies microstructural deviations in patients' DWI in an unsupervised manner, providing a promising step towards finding imaging biomarkers that can be used to diagnose ADHD in a quantitative, objective diagnostic framework.

## W7-SSNR12-3 Evaluation of the Effect of Exercise on Glymphatic and Meningeal Lymphatic Vessel Flow Using Quantitative MR Imaging With Intravenous Contrast Injection

Roh-Eul Yoo, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To quantitatively evaluate the effect of physical exercise on glymphatic and meningeal lymphatic vessel flow using dynamic T1 mapping and arterial spin labeling technique in healthy normal volunteers

## METHODS AND MATERIALS

This randomized clinical trial included 37 healthy normal volunteers from March 2021 to July 2022. Subjects were randomly assigned in a 1:1 ratio to perform a single session (acute group) or a 12-week program (chronic group) of cycle ergometer exercise. Dynamic T1 mapping (baseline and 0.5h and 12 h after IV contrast injection) was performed before and after the exercise to quantify the glymphatic flow. Precontrast inversion-recovery alternate ascending/descending directional navigation (IR-ALADDIN) was obtained before and after the exercise to quantify the meningeal lymphatic vessel flow. The change in T1 values between baseline and 0.5h ( $\Delta T1$ ) at the putamen and percent signal change at meningeal lymphatic vessels adjacent to the superior sagittal sinus were measured and compared between pre-exercise and post-exercise states.

## RESULTS

$\Delta T1$  at the putamen increased from 25.7 ms (IQR, 24.3-34.2 ms) to 34.7 ms (IQR, 31.4-40.7 ms) in the chronic exercise group ( $P = .01$ ). For the chronic exercise group, the averaged percent signal changes in meningeal lymphatic vessels also increased from  $4.63\% \pm 0.38$  to  $5.81\% \pm 0.4$  after the exercise ( $P = .005$ ). However, in the acute exercise group,  $\Delta T1$  at the putamen did not significantly differ between the pre-exercise (30.3 ms [IQR, 25.4-39.6 ms]) and post-exercise states (28.4 ms [IQR, 19.4-41.4 ms]) ( $P = .72$ ). Averaged percent signal changes in meningeal lymphatic vessels also did not significantly differ between the pre-exercise ( $4.69\% \pm 0.38$ ) and the post-exercise ( $4.66\% \pm 0.31$ ) states ( $P = .95$ ).

## CONCLUSION

Chronic cycle ergometer exercise had a positive effect on the glymphatic and meningeal lymphatic vessel flow in healthy normal volunteers.

## CLINICAL RELEVANCE/APPLICATION

Increased physical exercise has been shown to slow the progression of cognitive decline in dementia and mild cognitive impairment. Our results suggest increased glymphatic and meningeal lymphatic vessel flow as the potential mechanism of the slowing effect of physical exercise in dementia and mild cognitive impairment and highlight the importance of exercise intervention in such patients.

### W7-SSNR12-4 **Ultra-High-Resolution Dual-Contrast Brain Imaging with Deep-Silicon Photon-Counting CT: A Phantom Study**

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detector (PCD) CT can distinguish two contrast agents with K-edge imaging. This enables the visualization of two different phases of perfusion at one time point via injection of two contrast agents at different times and imaging both simultaneously. Spectral information can create material density maps and allow for beam hardening and cupping artifacts corrections that are typical of conventional head CT. A new technology, edge-on-irradiated deep-Si PCD, promises improved simultaneous high spectral and spatial resolution vs existing CdTe/CdZnTe PCDs. Here we assess the performance of deep-Si PCD-CT for ultra-high-resolution (150  $\mu\text{m}$ ) dual-contrast imaging of the brain.

#### METHODS AND MATERIALS

A human skull filled with ballistic gel is used to hold 24 vials containing calibrated mixtures of iodine- and gadolinium-based contrast agents (IBCA, GBCA) with water with IBCA ranging from 0.1-35 mg I/mL and GBCA, from 0.5-10 mg Gd/mL. A water phantom with two dilutions of IBCA and GBCA, without any mixtures of the two, is used to calibrate the linear material decomposition (MD) algorithm. The phantoms are scanned on a prototype deep-Si PCD-CT scanner with 8 energy bins, at 120 kVp, 300 mAs, and 0.5 s rotation. Basis material maps are computed from the 8 energy bins and reconstructed using a filtered-backprojection (FBP) with a prototype high-resolution kernel having 10% MTF cutoff at 21.2 lp/cm, and  $117 \times 117 \times 416 \mu\text{m}^3$  voxel size. The basis material maps are then transformed to IBCA and GBCA maps using MD. The error in estimated concentrations is calculated in ROIs ( $d > 4 \text{ mm}$ ). Wilcoxon test is used to compare differences, with  $p < 0.05$  considered statistically significant.

#### RESULTS

The range of error in estimating IBCA and GBCA concentrations were -1.02-1.50 mg I/mL and -0.01-2.3 mg Gd/mL, respectively. No significant bias in error was found in vials with single contrast to mixtures of both contrast agents. Also, no significant difference in error was found with location in the skull which indicates that results are not affected by cupping artifact.

#### CONCLUSION

Deep-Si PCD-CT could quantify concentrations of IBCA and GBCA in a collection of mixtures of the two contrast agents, without being affected by cupping artifacts caused by the skull. This is a study on a prototype scanner with FBP reconstruction and linear MD. Further studies are warranted to assess the improvement in material map accuracy offered by model-based and deep-learning-based reconstruction and MD algorithms.

## CLINICAL RELEVANCE/APPLICATION

UHR dual-contrast imaging with 8 energy bin deep-Si PCD-CT makes it possible to visualize registered images of different phases of contrast enhancement e.g., arterial, venous, or delayed, of brain tissue and pathologies with high resolution ( $\sim 150 \mu\text{m}$ ).

### W7-SSNR12-5 **Point-Of-Care Brain MRI: Update on Preliminary Results From a Single-Center Retrospective Study in the Neurocritical Care Setting**

Brian G. Yep, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Point-of-care (POC) MRI is a new imaging technology that allows for bedside low field brain MRI and demonstrates promise for use in the neurocritical care setting when traditional high field MRI may be difficult obtaining. Early detection of ischemia, hemorrhage, or increased intracranial pressure can be valuable in the management of critically ill patients. The purpose of this study is to expand on prior data obtained from a 64mT POC MRI system deployed in the neuroscience ICU (NICU) department to provide further support for the application of POC MRI in the critical care setting.

#### METHODS AND MATERIALS

After IRB approval, data was collected from September 2022 to February 2023 comparing capabilities of brain POC MRI to CT and fixed MRI. An additional 21 POC MRI scans were compared to preceding CT within 72 hours, and a follow-up 1.5T or 3T

MRI within 72 hours. Turnaround time, examination limitations, and relevant findings were assessed. Descriptive statistics were employed to analyze clinical variables.

## RESULTS

A total of 22 patients who underwent POC MRI were included in this study (67% male, median age 60 years [IQR 48-71 years]). Preceding CT was performed in 19 (90%) of these patients, of which, follow-up fixed MRI was performed in 5 (26%). No acute intracranial abnormality was observed for 3 of the 19 CTs (16%), an impression that was confirmed by POC MRI. Diffusion weighted imaging was noted to be of non-diagnostic quality in 4 (19%). Of those with preceding CT, POC MRI detected acute infarct in 6 (32%), intracerebral hemorrhage in 9 (47%), and mass effect in 8 (42%). POC MRI confirmed all findings from preceding CT, without failure of detection of any abnormality. Furthermore, the 5 fixed MRI studies did not reveal any additional findings. Additionally, POC MRI demonstrated anoxic brain injury for one patient too unstable to transport to CT or fixed MRI. The median POC MRI scan time was 43 min [IQR 40-81 min], time to image was 68 min, and turnaround time (order time to scan completion) was 123 min.

## CONCLUSION

This study expands previous work demonstrating POC MRI accessibility in critically ill patients. POC MRI gives the advantage of increased speed and convenience of bedside detection of acute intracranial injury, including in this case, the ability to image a critically ill patient who was too unstable to transport out of the NICU for a CT exam.

## CLINICAL RELEVANCE/APPLICATION

This technology is promising in critically ill patients too unstable to transport where early MRI access is critical for improved survival and better patient outcomes.

## W7-SSNR12-6 Regional Cerebral Blood Flow Correlate With Transcriptional and Cellular Signatures in Tinnitus

Jixin Luan, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to examine alterations in tinnitus patients brain regional cerebral blood flow (CBF) using arterial spin labeling (ASL), and applied an integrative imaging transcriptomics approach to identify transcriptional and cellular correlates of these changes.

## METHODS AND MATERIALS

Participants included tinnitus patients (n = 56) and non-tinnitus controls (n = 62), matched for age, sex, education. CBF images were collected and analyzed using ASL. Regional microarray expression data were obtained from 6 postmortem brains provided by the Allen Human Brain Atlas (AHBA). We used the abagen toolbox to process and map the transcriptomic data from the Desikan-Killiany Atlas. To examine the association between the healthy brain transcriptome and region CBF in tinnitus, we used partial least square regression (PLS). We then used all genes in PLS1+ and PLS1- to conduct further bioinformatics analyses investigating whether these genes map to common and relevant biological pathways. We also investigated whether our PLS1+ and PLS1- subsets of genes were particularly enriched for genes of specific brain cell types. In our study, we used a spin-based method to correct for potential confounding effects of spatial autocorrelation.

## RESULTS

Compared with non-tinnitus controls, tinnitus patients exhibited increased CBF, primarily in left transverse temporal (FDR < 0.05). The first PLS component (PLS1) explained the highest proportion of CBF changes (30.29%) and did so above chance (Pboot = 0.001). Notably, we found that the PLS1 weighted gene expression map was spatially correlated with the case-control CBF t-map (Pearson's r = 0.59, pspin < 0.05). Using gene ontological (GO) analyses with the PLS1- gene list, we found enrichment for a number of GO terms-biological pathways broadly mapping to the protein phosphorylation. We found that downweighted genes were significantly associated with GABAergic neurons.

## CONCLUSION

Our findings bridge levels to connect genes, biological pathways, and cell classes to in vivo imaging correlates of tinnitus, particularly the processes involving protein phosphorylation.

## CLINICAL RELEVANCE/APPLICATION

This study provides insight into the cellular and molecular changes associated with tinnitus, and the identification of altered regional cerebral blood flow and associated gene expression patterns can guide the development of personalized therapies that target specific biological pathways and cell types implicated in tinnitus.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-SSNR12-1

### High Resolution Neck CT Angiography for Stenosis Quantification: A Prospective Patient Study Comparing Photon-counting Detector CT and Energy-integrating Detector CT

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

Felix E. Diehn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To compare photon-counting detector (PCD) and conventional energy-integrating detector (EID) CT for stenosis quantification on neck CTA.

#### METHODS AND MATERIALS

Adult patients with at least mild stenosis of at least one carotid bulb/proximal internal carotid artery (ICA) undergoing head/neck CTA exams at EID underwent a PCD research CTA. Dual-energy scanning protocol was used on EID-CT (100/150Sn, 192x0.6mm detector configuration) with a medium sharp kernel and iterative reconstruction (Qr54-3). High-resolution (HR) scan mode was used on PCD-CT (120 kV, 120x0.2mm). Images were reconstructed at 0.6mm slice thickness using a closely matched standard resolution kernel (Qr56-3). HR images with the sharpest kernel (Qr89) were reconstructed on PCD-CT at thinnest slice thickness, 0.2mm. A dedicated deep convolutional neural network (HR-CNN) denoising algorithm was trained using HR patient images and applied to the HR series. For each stenosis, a neuroradiology reader evaluated the 4 different series in randomized and blinded fashion. The reader scored relative preference for each series (from 1, most preferred, with greatest confidence in evaluating the stenosis, to 4, least preferred). The reader measured the stenoses on each series (minimal luminal diameter at the maximal level of stenosis). A second reader measured the maximal luminal diameter of the normal caliber more distal ICA to enable % stenosis calculations, and categorized plaque type.

#### RESULTS

10 adult patients with 14 carotid bulb/proximal ICA stenoses were included (age  $73\pm 6$  years, 3 females). PCD-HR-CNN images were most preferred and EID images least: mean preference scores were  $1.43\pm 0.65$  PCD-HR-CNN,  $3.86\pm 0.36$  EID. Stenosis measurements on PCD-HR (with or without CNN) were less severe than on EID; mean 46% PCD-HR-CNN, 45% PCD-HR, 51% EID ( $p=0.010$  PCD-HR-CNN vs. EID;  $p=0.014$  PCD-HR vs. EID). 3 stenoses harbored heavily calcified plaque and 2 additional mixed plaques demonstrated calcifications along the lumen at the maximal stenosis. In these 5 stenoses, preference for PCD including PCD-HR-CNN over EID was also strong; mean preference scores were  $1.40\pm 0.55$  PCD-HR-CNN,  $1.80\pm 0.84$  PCD-HR,  $3.60\pm 0.55$  EID. Stenosis measurements on PCD-HR (with or without CNN) were also less severe than on EID; mean 59% PCD-HR-CNN and PCD-HR, 65% EID ( $p=0.018$  PCD-HR-CNN vs. EID,  $p=0.036$  PCD-HR vs. EID).

#### CONCLUSION

PCD-CT provides preferred CTA image quality for carotid stenosis compared to EID-CT, especially when PCD-HR mode is combined with an HR-CNN denoising algorithm. EID tends to overestimate carotid stenosis, particularly in calcified plaques.

#### CLINICAL RELEVANCE/APPLICATION

PCD can facilitate CTA assessment of carotid stenoses, including when HR mode is combined with a HR-CNN denoising algorithm.

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## Abstract Archives of the RSNA, 2023

W7-SSNR12-2

### Unsupervised Discovery of Microstructural Deviations in Diffusion MRI Tractometry of Adolescents with ADHD

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

Justin Huynh, BS, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Diagnosis of attention deficit hyperactivity disorder (ADHD) is complex, relying on criteria sensitive to subjective biases. Alternatively, structural and functional variations in imaging may reflect underlying psychopathology and etiology of ADHD and provide rich data sources enabling more objective diagnosis. Though promising, these variations are still not well understood or characterized. The purpose of this study is to discover and visualize hidden structural patterns of diffusion weighted imaging (DWI) derived white matter (WM) tractography and fractional anisotropy (FA) measurements among adolescent patients with ADHD using unsupervised deep learning.

#### METHODS AND MATERIALS

Diffusion weighted imaging (DWI) from a subset of 1704 patients from the Adolescent Brain Cognitive Development (ABCD) Study was gathered. DWI was processed with Automated Fiber Quantification (AFQ) to extract individual subject white matter (WM) fiber bundles for 30 major WM tracts. Fractional anisotropy (FA) was computed at 80 equally spaced nodes along the length of each tract, and used as input for the deep learning model. An autoencoder was trained to reproduce the FA values of 1371 subjects. After training, the model was evaluated on an independent testing set of 333 patients, 193 with behavior problem monitor (BPM) greater than 70, the clinical threshold for ADHD, and 140 with BPM less than 60, no ADHD. Anomaly scores using absolute error (AE) along the WM tracts were computed between predicted and inputted FA values. Anomaly score profiles were averaged and compared between all patients with and without ADHD.

#### RESULTS

Mean absolute error (MAE) between predicted and actual FA values was 0.041, significantly different between subjects with and without ADHD (0.042 vs 0.038,  $p=0.041$ ). Comparing absolute error anomaly scores between subjects with and without ADHD along 30 WM tracts reveals significant differences in 9 tracts: left arcuate fasciculus (ARC\_L,  $p=0.006$ ), left cingulum cingulate gyrus (CGC\_L,  $p=0.020$ ), left corticospinal tract (CST\_L,  $p=0.007$ ), right corticospinal tract (CST\_R,  $p=0.006$ ), frontoparietal (FP,  $p=0.0168$ ), right inferior fronto-occipital fasciculus (IFO\_R,  $p=0.033$ ), left inferior longitudinal fasciculus (ILF\_L,  $p=0.002$ ), superior parietal lobe ( $p=0.041$ ) and temporal lobe ( $p=0.008$ ).

#### CONCLUSION

The unsupervised autoencoder-based approach identified anomalous FA profiles in patients with ADHD, revealing significant differences in 9 out of 30 WM tracts.

#### CLINICAL RELEVANCE/APPLICATION

This method identifies microstructural deviations in patients' DWI in an unsupervised manner, providing a promising step towards finding imaging biomarkers that can be used to diagnose ADHD in a quantitative, objective diagnostic framework.

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## Abstract Archives of the RSNA, 2023

W7-SSNR12-3

### Evaluation of the Effect of Exercise on Glymphatic and Meningeal Lymphatic Vessel Flow Using Quantitative MR Imaging With Intravenous Contrast Injection

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

Roh-Eul Yoo, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To quantitatively evaluate the effect of physical exercise on glymphatic and meningeal lymphatic vessel flow using dynamic T1 mapping and arterial spin labeling technique in healthy normal volunteers

#### METHODS AND MATERIALS

This randomized clinical trial included 37 healthy normal volunteers from March 2021 to July 2022. Subjects were randomly assigned in a 1:1 ratio to perform a single session (acute group) or a 12-week program (chronic group) of cycle ergometer exercise. Dynamic T1 mapping (baseline and 0.5h and 12 h after IV contrast injection) was performed before and after the exercise to quantify the glymphatic flow. Precontrast inversion-recovery alternate ascending/descending directional navigation (IR-ALADDIN) was obtained before and after the exercise to quantify the meningeal lymphatic vessel flow. The change in T1 values between baseline and 0.5h ( $\Delta T1$ ) at the putamen and percent signal change at meningeal lymphatic vessels adjacent to the superior sagittal sinus were measured and compared between pre-exercise and post-exercise states.

#### RESULTS

$\Delta T1$  at the putamen increased from 25.7 ms (IQR, 24.3-34.2 ms) to 34.7 ms (IQR, 31.4-40.7 ms) in the chronic exercise group ( $P = .01$ ). For the chronic exercise group, the averaged percent signal changes in meningeal lymphatic vessels also increased from  $4.63\% \pm 0.38$  to  $5.81\% \pm 0.4$  after the exercise ( $P = .005$ ). However, in the acute exercise group,  $\Delta T1$  at the putamen did not significantly differ between the pre-exercise (30.3 ms [IQR, 25.4-39.6 ms]) and post-exercise states (28.4 ms [IQR, 19.4-41.4 ms]) ( $P = .72$ ). Averaged percent signal changes in meningeal lymphatic vessels also did not significantly differ between the pre-exercise ( $4.69\% \pm 0.38$ ) and the post-exercise ( $4.66\% \pm 0.31$ ) states ( $P = .95$ ).

#### CONCLUSION

Chronic cycle ergometer exercise had a positive effect on the glymphatic and meningeal lymphatic vessel flow in healthy normal volunteers.

#### CLINICAL RELEVANCE/APPLICATION

Increased physical exercise has been shown to slow the progression of cognitive decline in dementia and mild cognitive impairment. Our results suggest increased glymphatic and meningeal lymphatic vessel flow as the potential mechanism of the slowing effect of physical exercise in dementia and mild cognitive impairment and highlight the importance of exercise intervention in such patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSNR12-4

### Ultra-High-Resolution Dual-Contrast Brain Imaging with Deep-Silicon Photon-Counting CT: A Phantom Study

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

Amir Pourmorteza, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting detector (PCD) CT can distinguish two contrast agents with K-edge imaging. This enables the visualization of two different phases of perfusion at one time point via injection of two contrast agents at different times and imaging both simultaneously. Spectral information can create material density maps and allow for beam hardening and cupping artifacts corrections that are typical of conventional head CT. A new technology, edge-on-irradiated deep-Si PCD, promises improved simultaneous high spectral and spatial resolution vs existing CdTe/CdZnTe PCDs. Here we assess the performance of deep-Si PCD-CT for ultra-high-resolution (150  $\mu\text{m}$ ) dual-contrast imaging of the brain.

#### METHODS AND MATERIALS

A human skull filled with ballistic gel is used to hold 24 vials containing calibrated mixtures of iodine- and gadolinium-based contrast agents (IBCA, GBCA) with water with IBCA ranging from 0.1-35 mg I/mL and GBCA, from 0.5-10 mg Gd/mL. A water phantom with two dilutions of IBCA and GBCA, without any mixtures of the two, is used to calibrate the linear material decomposition (MD) algorithm. The phantoms are scanned on a prototype deep-Si PCD-CT scanner with 8 energy bins, at 120 kVp, 300 mAs, and 0.5 s rotation. Basis material maps are computed from the 8 energy bins and reconstructed using a filtered-backprojection (FBP) with a prototype high-resolution kernel having 10% MTF cutoff at 21.2 lp/cm, and  $117 \times 117 \times 416 \mu\text{m}^3$  voxel size. The basis material maps are then transformed to IBCA and GBCA maps using MD. The error in estimated concentrations is calculated in ROIs ( $d > 4 \text{ mm}$ ). Wilcoxon test is used to compare differences, with  $p < 0.05$  considered statistically significant.

#### RESULTS

The range of error in estimating IBCA and GBCA concentrations were -1.02-1.50 mg I/mL and -0.01-2.3 mg Gd/mL, respectively. No significant bias in error was found in vials with single contrast to mixtures of both contrast agents. Also, no significant difference in error was found with location in the skull which indicates that results are not affected by cupping artifact.

#### CONCLUSION

Deep-Si PCD-CT could quantify concentrations of IBCA and GBCA in a collection of mixtures of the two contrast agents, without being affected by cupping artifacts caused by the skull. This is a study on a prototype scanner with FBP reconstruction and linear MD. Further studies are warranted to assess the improvement in material map accuracy offered by model-based and deep-learning-based reconstruction and MD algorithms.

#### CLINICAL RELEVANCE/APPLICATION

UHR dual-contrast imaging with 8 energy bin deep-Si PCD-CT makes it possible to visualize registered images of different phases of contrast enhancement e.g., arterial, venous, or delayed, of brain tissue and pathologies with high resolution ( $\sim 150 \mu\text{m}$ ).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSNR12-5

### Point-Of-Care Brain MRI: Update on Preliminary Results From a Single-Center Retrospective Study in the Neurocritical Care Setting

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

Brian G. Yep, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Point-of-care (POC) MRI is a new imaging technology that allows for bedside low field brain MRI and demonstrates promise for use in the neurocritical care setting when traditional high field MRI may be difficult obtaining. Early detection of ischemia, hemorrhage, or increased intracranial pressure can be valuable in the management of critically ill patients. The purpose of this study is to expand on prior data obtained from a 64mT POC MRI system deployed in the neuroscience ICU (NICU) department to provide further support for the application of POC MRI in the critical care setting.

#### METHODS AND MATERIALS

After IRB approval, data was collected from September 2022 to February 2023 comparing capabilities of brain POC MRI to CT and fixed MRI. An additional 21 POC MRI scans were compared to preceding CT within 72 hours, and a follow-up 1.5T or 3T MRI within 72 hours. Turnaround time, examination limitations, and relevant findings were assessed. Descriptive statistics were employed to analyze clinical variables.

#### RESULTS

A total of 22 patients who underwent POC MRI were included in this study (67% male, median age 60 years [IQR 48-71 years]). Preceding CT was performed in 19 (90%) of these patients, of which, follow-up fixed MRI was performed in 5 (26%). No acute intracranial abnormality was observed for 3 of the 19 CTs (16%), an impression that was confirmed by POC MRI. Diffusion weighted imaging was noted to be of non-diagnostic quality in 4 (19%). Of those with preceding CT, POC MRI detected acute infarct in 6 (32%), intracerebral hemorrhage in 9 (47%), and mass effect in 8 (42%). POC MRI confirmed all findings from preceding CT, without failure of detection of any abnormality. Furthermore, the 5 fixed MRI studies did not reveal any additional findings. Additionally, POC MRI demonstrated anoxic brain injury for one patient too unstable to transport to CT or fixed MRI. The median POC MRI scan time was 43 min [IQR 40-81 min], time to image was 68 min, and turnaround time (order time to scan completion) was 123 min.

#### CONCLUSION

This study expands previous work demonstrating POC MRI accessibility in critically ill patients. POC MRI gives the advantage of increased speed and convenience of bedside detection of acute intracranial injury, including in this case, the ability to image a critically ill patient who was too unstable to transport out of the NICU for a CT exam.

#### CLINICAL RELEVANCE/APPLICATION

This technology is promising in critically ill patients too unstable to transport where early MRI access is critical for improved survival and better patient outcomes.

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## Abstract Archives of the RSNA, 2023

W7-SSNR12-6

### Regional Cerebral Blood Flow Correlate With Transcriptional and Cellular Signatures in Tinnitus

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353B

Jixin Luan, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

We aimed to examine alterations in tinnitus patients' brain regional cerebral blood flow (CBF) using arterial spin labeling (ASL), and applied an integrative imaging transcriptomics approach to identify transcriptional and cellular correlates of these changes.

#### METHODS AND MATERIALS

Participants included tinnitus patients ( $n = 56$ ) and non-tinnitus controls ( $n = 62$ ), matched for age, sex, education. CBF images were collected and analyzed using ASL. Regional microarray expression data were obtained from 6 postmortem brains provided by the Allen Human Brain Atlas (AHBA). We used the abagen toolbox to process and map the transcriptomic data from the Desikan-Killiany Atlas. To examine the association between the healthy brain transcriptome and region CBF in tinnitus, we used partial least square regression (PLS). We then used all genes in PLS1+ and PLS1- to conduct further bioinformatics analyses investigating whether these genes map to common and relevant biological pathways. We also investigated whether our PLS1+ and PLS1- subsets of genes were particularly enriched for genes of specific brain cell types. In our study, we used a spin-based method to correct for potential confounding effects of spatial autocorrelation.

#### RESULTS

Compared with non-tinnitus controls, tinnitus patients exhibited increased CBF, primarily in left transverse temporal ( $FDR < 0.05$ ). The first PLS component (PLS1) explained the highest proportion of CBF changes (30.29%) and did so above chance ( $P_{boot} = 0.001$ ). Notably, we found that the PLS1 weighted gene expression map was spatially correlated with the case-control CBF t-map (Pearson's  $r = 0.59$ ,  $p_{spin} < 0.05$ ). Using gene ontological (GO) analyses with the PLS1- gene list, we found enrichment for a number of GO terms-biological pathways broadly mapping to the protein phosphorylation. We found that downweighted genes were significantly associated with GABAergic neurons.

#### CONCLUSION

Our findings bridge levels to connect genes, biological pathways, and cell classes to in vivo imaging correlates of tinnitus, particularly the processes involving protein phosphorylation.

#### CLINICAL RELEVANCE/APPLICATION

This study provides insight into the cellular and molecular changes associated with tinnitus, and the identification of altered regional cerebral blood flow and associated gene expression patterns can guide the development of personalized therapies that target specific biological pathways and cell types implicated in tinnitus.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSNR13

### Science Session with Keynote: Neuroradiology (Image Analysis (Non-AI))

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

Marin A. McDonald, MD, PhD (*Moderator*) Speakers Bureau, Canon Medical Systems Corporation  
Alexander M. Khalaf, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### **W7-SSNR13-1** Developing an Anatomically Valid Segmentation Protocol for Early Tau Regions in Alzheimer's Disease: The Anterior Medial Temporal Lobe Cortices

Niyousha Sadeghpour, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The anterior portion of the medial temporal lobe (MTL) is one of the earliest regions showing tau deposition in Alzheimer's disease (AD) and hence a key focus area for AD imaging biomarkers. However, the anatomical variability of the anterior MTL presents a challenge for segmentation protocols. Leveraging a novel postmortem dataset with histology and MRI, we aimed to develop a histologically-informed segmentation protocol for the anterior entorhinal cortex (ERC), Brodmann Area (BA) 35, and BA36 for in vivo 3 tesla (T) MRI.

#### METHODS AND MATERIALS

Digitized 50- $\mu$ m thick MTL Nissl-stained coronal histology sections from 20 cases were annotated by expert neuroanatomists. These cases were 61 to 97 years of age (female to male ratio of 1:1) and were with and without neurodegenerative diseases (11 vs. 9 cases) to ensure broad generalizability of the protocol. The histology sections were registered to same-subject 0.2x0.2x0.2-mm<sup>3</sup> 9.4 T postmortem MRI and were analyzed together to determine the location of the histological borders of the MTL cortices in relation to anatomical landmarks observable on MRI.

#### RESULTS

The anterior histological border distances of ERC, BA35 and BA36 were evaluated with respect to various anatomical landmarks observable on MRI, including temporal pole, the hippocampus, amygdala, collateral sulcus (CS) and limen insulae. The distance relative to the hippocampus was chosen, as there was relatively low between-subject variability in distance (comparing standard deviations) and this region is easily identifiable on MRI. The ERC starts 4.75 mm (median value) anterior to the hippocampus, BA35 9.25 mm and BA36 10.25 mm. Next, we analyzed the location of the ERC on histology sections. We determined that regardless of the depth of the CS, the inferior border of the ERC is on average at the edge of the CS and the superior border at the superior edge of the parahippocampal gyrus, but at the halfway point for the first section with ERC. We then studied histology sections for BA35 borders and determined that for sections where the inferior border of ERC serves as the medial border for BA35, the lateral border is on average located at the fundus of the CS. These segmentation rules can be applied to T1-MRI. There were no differences between the cases with and without neurodegenerative diseases in the location of these borders.

#### CONCLUSION

We are developing a histology grounded segmentation protocol for the anterior MTL cortices to add to an existing automated segmentation which already includes the posterior MTL. Segmentation rules for remaining borders are under development.

#### CLINICAL RELEVANCE/APPLICATION

This histologically-informed segmentation protocol is expected to improve the efficacy of imaging biomarkers for tau deposition in early AD.

#### **W7-SSNR13-2** Keynote Speaker

Claudia F. Kirsch, MD (*Presenter*) Consultant, Informa PLC; Royalties, Informa PLC

## **W7-SSNR13-3 Initial Deployment of a Semi-automated Pipeline Measuring Brain Structural Change for Clinical Brain MRI Reporting**

Ilya M. Nasrallah, MD, PhD (*Presenter*) Speaker, Biogen Idec Inc; Advisory Board, Eisai Co, Ltd

### **PURPOSE**

To implement and validate an image processing pipeline based on open-source resources for quantification of brain atrophy and white matter hyperintensity volume for differential diagnosis of neurodegenerative disease.

### **METHODS AND MATERIALS**

The neuroimaging pipeline uses deep learning-based skull stripping<sup>1</sup>, multi-atlas tissue segmentation<sup>2</sup>, and lesion segmentation<sup>3</sup> modules to generate tabular data comprising intracranial volume-adjusted regional and global volume measurements and machine learning metrics measuring Alzheimer's disease (AD)-typical atrophy (SPARE-AD)<sup>4</sup> and image-based brain age<sup>5</sup>. These individual measures are placed in context of age and sex-matched reference data drawn from a dataset of cognitively normal (N=2935) and AD (N=1833) participants harmonized using ComBat<sup>6</sup>. The containerized pipeline was deployed on a server running the open-source toolkit Kaapana (kaapana.ai, DKFZ, Heidelberg, Germany). Clinical studies with 1 mm isotropic T1 and T2 FLAIR DICOM images were processed. Clinical data was extracted from the electronic medical record regarding clinical diagnoses and the original radiologist report. Radiology reports were analyzed for ascertainment of the presence features indicating neurodegenerative disease. Diagnosis groups were compared using t-tests.

### **RESULTS**

The test sample comprised 11 patients aged 62-93; 6 with possible/probable AD ('AD cohort') and 5 non-AD diagnoses ('nonAD cohort'; psychiatric disease, frontotemporal lobar degeneration, and vascular dementia). The original radiology report noted medial temporal lobe/hippocampal volume (HV) loss in 17% of the AD cohort and 20% of the nonAD cohort. The AD cohort had significantly lower mean (SD) HV (6.3mL±0.8 vs 7.4mL±0.5, p=0.01) and higher mean SPARE-AD (0.3±1.3 vs -1.1±0.8, p=0.03). 67% of AD cases and 0% of nonAD had HV >1 SD below the mean; 67% of AD cases had positive SPARE-AD scores while 100% of nonAD had negative SPARE-AD scores. 90% of reports qualitatively mentioned WMH burden. Quantitation showed significantly higher mean WMH volume in the nonAD group (9.2mL±3.4 vs 3.6mL±3.4, p=0.01); WMH volumes were highest in cases with vascular dementia.

### **CONCLUSION**

A semi-automated imaging quantification pipeline based on open-source resources can produce clinically relevant biomarkers that are frequently missing from radiology reports. These measures provide personalized diagnostic information relevant on the individual level.

### **CLINICAL RELEVANCE/APPLICATION**

Open-source tools may provide broader access to quantitative measures and machine learning measures that can improve or support radiologist and referring physician diagnoses.

## **W7-SSNR13-4 International Multicenter Phase 2 Dose Finding Study of Gadoquatrane: A Dose of 0.04 mmol Gd/kg bw of Gadoquatrane Has Similar Efficacy to 0.1 mmol Gd/kg bw of Gadobutrol**

Benjamin P. Liu, MD (*Presenter*) Speakers Bureau, Guerbet SA; Research Grant, Guerbet SA; Research Grant, Bayer AG

### **PURPOSE**

To establish a dose of gadoquatrane with similar efficacy as gadobutrol for use in contrast-enhanced (CE) MRI of the CNS in adults, via an adaptive dose finding study.

### **METHODS AND MATERIALS**

This phase 2 multicenter, single-blind cross-over study included adult patients with known or highly suspected CNS lesions and aimed to investigate potentially different doses of gadoquatrane in cohorts of 50 evaluable patients per dose level. Patients received two CE MRI exams, one with gadobutrol at 0.1 mmol Gd/kg body weight (bw), the other one with gadoquatrane starting with a dose of 0.04 mmol Gd/kg bw. The primary efficacy endpoint was overall diagnostic preference based on a randomized paired blinded read. The secondary objective was to show non-inferiority of gadoquatrane to gadobutrol based on the sum of lesion visualization parameters (contrast enhancement, border delineation and internal morphology). Efficacy evaluations were performed by 3 independent central blinded readers. Signal intensity (SI), contrast to noise ratio (CNR), signal to noise ratio (SNR) at 5 min, 10 min and 15 min post injection were measured. Adverse events (AE) were monitored up to 1 day after second MRI.

### **RESULTS**

57 patients (23 men, 34 women) were enrolled in 17 sites in 4 countries (USA, Germany, Bulgaria and Japan). 50 patients were evaluable for the primary efficacy endpoint. The efficacy of gadoquatrane at a dose of 0.04 mmol Gd/kg bw was confirmed. The overall diagnostic preference was similar for gadoquatrane and gadobutrol. The sum of lesion visualization



parameter scores (border delineation + contrast enhancement + internal morphology, scale of 3-11) at 5 min post injection was similar for gadoquatrane and gadobutrol (average reader mean score +8.94 for gadoquatrane and +9.00 for gadobutrol [ $p < 0.0001$  for non-inferiority]). For all 3 visualization parameters, all 3 readers and the average reader consistently showed mean differences between gadoquatrane and gadobutrol near zero, indicating no difference in performance between agents. SI, CNR and SNR measurements confirmed that both agents at the investigated doses and time points had similar signal enhancement parameters. Four patients experienced treatment-emergent AEs, and one AE (toothache) was considered related to gadoquatrane. All AEs had a maximum intensity of mild.

#### **CONCLUSION**

A dose of 0.04 mmol Gd/kg bw of gadoquatrane has similar efficacy results to 0.1 mmol Gd/kg bw of gadobutrol and is supported for the further development of gadoquatrane.

#### **CLINICAL RELEVANCE/APPLICATION**

CE-MRI is the standard of care in diagnostic imaging procedures of the CNS. Gadoquatrane will enable lowering of the gadolinium dose by 60% compared to current standard of care macrocyclic GBCAs.

#### **W7-SSNR13-5 Development and Evaluation of High Resolution QSM Template of the Older Adult Brain**

Rasheed Abid, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Quantitative susceptibility mapping (QSM) is an important tool for studying age-related brain pathologies that can disrupt iron or calcium homeostasis or cause demyelination. However, a high-resolution QSM template of the older adult brain is not currently available. The purpose of this work is twofold: a) to construct a high resolution QSM template of the older adult brain, and b) compare the new template to existing templates in terms of image quality and representativeness of the older adult brain.

#### **METHODS AND MATERIALS**

T1-weighted MPRAGE (1x1x1 mm<sup>3</sup>) and T2\*-weighted multi-echo gradient echo (0.7x0.7x1.3 mm<sup>3</sup>) 3T MRI data collected on the 400 non-demented older adults (50% male; 64.9-98.9 years of age; 54% white, 43% black) participating in the construction of the MIITRA atlas were used for this study. MEDI toolbox was used to generate a QSM image of each of the participants from the multi-echo gradient echo data. N4bias field correction followed by upsampling was performed on the first echo of the GRE data of each of the subjects and finally converted to synthetic T1w images using `mri_synthsr`. These synthetic images were then rigidly registered to the T1w images using ANTs. The resulting transformations were combined with the non-linear transformations generated in the construction of the MIITRA T1-weighted template and the combined transform was used to forward-map susceptibility maps of each of the subjects to the MIITRA T1w template space. Finally sparse representation based data-fusion implementation was used to generate the final 0.5mm isotropic MIITRA QSM template.

#### **RESULTS**

The QSM template exhibits high image sharpness and clearly visible brain structures upon visual inspection. Higher magnetic susceptibility can be observed in the regions of basal ganglia, midbrain and cerebellum, as expected. Furthermore, magnetic susceptibility is higher in cortical gray matter compared to white matter, and also in white matter of the occipital lobe compared to prefrontal white matter, also in accordance with published literature. The MIITRA QSM template also required less deformation for spatial normalization of older adult data compared to other templates.

#### **CONCLUSION**

This work developed a high quality 0.5mm resolution QSM template for the MIITRA atlas using data from a large, diverse, community cohort of non-demented older adults, and demonstrated that the new template exhibited high image quality and is more representative of the older adult brain compared to other templates. The new template will be made available for download at [www.nitrc.org/projects/miitra](http://www.nitrc.org/projects/miitra).

#### **CLINICAL RELEVANCE/APPLICATION**

QSM templates can be used to study disruption in iron or calcium related homeostasis due to age-related brain pathologies.

#### **W7-SSNR13-6 Amide Proton Transfer Weighted Imaging Analysis of Cerebral Metabolism Changes in T2DM Patients**

Wei-wei Wang, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Amide proton transfer weighted (APT<sub>w</sub>) technology was used to analyze the metabolic changes of brain in patients with T2DM and explore the related factors.



## **METHODS AND MATERIALS**

A total of 64 subjects were prospectively collected and divided into T2DM group and control group according to grouping criteria, including 37 patients in T2DM group and 27 healthy controls. Within one week before or after the MRI scan, the clinical data, laboratory indicators and cognitive scores of the subjects were recorded. All the subjects used Philips Ingenia CX 3.0 T MR for MRI data acquisition, and the sequence included axial FFE T1 sequence, axial FFE T2 sequence, axial TSE Flair sequence, sagittal 3D T1 TFE sequence and axial 3D TSE APTw sequence. The APTw values of grey and white matter were analyzed by SPM 8 software. Independent two sample t test was used to compare the difference between two groups. Pearson correlation analysis was used to analyze the correlation between APTw values in brain regions with significant differences and demographic data, laboratory indicators and cognitive scores.  $P < 0.05$  was considered statistically significant.

## **RESULTS**

Compared with the control group, APTw of white matter was increased in T2DM group ( $0.507 \pm 0.128$ ,  $0.600 \pm 0.136$ ,  $P = 0.007$ ). No significant difference was showed in APTw of gray matter between the two groups ( $1.085 \pm 0.154$ ,  $1.099 \pm 0.113$ ,  $P = 0.668$ ). The correlation analysis found negative correlation between APTw of white matter and CVLT accuracy of long time delay selection and recognition ( $r = -0.315$ ,  $P = 0.011$ ) and visual space perception score ( $r = -0.298$ ,  $P = 0.017$ ). No correlation was found between white matter APTw values and demographic and clinical data ( $P > 0.05$ ). No correlation was found between APTw values of grey matter and demographic data, clinical data and cognitive scores ( $P > 0.05$ ).

## **CONCLUSION**

Only the increased APTw value was found, suggesting that it was related to the abnormal changes in the concentration of metabolites in the patients' white matter. However, there was no significant correlation between white matter APTw value and demographic data and clinical data. It was also found that increased white matter APTw was associated with decreased cognitive level in T2DM patients.

## **CLINICAL RELEVANCE/APPLICATION**

APTw can reflect the abnormal changes of brain metabolism in T2DM patients from the molecular level, providing new imaging evidence for understanding the neuropathological mechanism of diabetic brain injury.

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## Abstract Archives of the RSNA, 2023

W7-SSNR13-1

### Developing an Anatomically Valid Segmentation Protocol for Early Tau Regions in Alzheimer's Disease: The Anterior Medial Temporal Lobe Cortices

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

Niyousha Sadeghpour, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The anterior portion of the medial temporal lobe (MTL) is one of the earliest regions showing tau deposition in Alzheimer's disease (AD) and hence a key focus area for AD imaging biomarkers. However, the anatomical variability of the anterior MTL presents a challenge for segmentation protocols. Leveraging a novel postmortem dataset with histology and MRI, we aimed to develop a histologically-informed segmentation protocol for the anterior entorhinal cortex (ERC), Brodmann Area (BA) 35, and BA36 for in vivo 3 tesla (T) MRI.

#### METHODS AND MATERIALS

Digitized 50- $\mu$ m thick MTL Nissl-stained coronal histology sections from 20 cases were annotated by expert neuroanatomists. These cases were 61 to 97 years of age (female to male ratio of 1:1) and were with and without neurodegenerative diseases (11 vs. 9 cases) to ensure broad generalizability of the protocol. The histology sections were registered to same-subject 0.2x0.2x0.2-mm<sup>3</sup> 9.4 T postmortem MRI and were analyzed together to determine the location of the histological borders of the MTL cortices in relation to anatomical landmarks observable on MRI.

#### RESULTS

The anterior histological border distances of ERC, BA35 and BA36 were evaluated with respect to various anatomical landmarks observable on MRI, including temporal pole, the hippocampus, amygdala, collateral sulcus (CS) and limen insulae. The distance relative to the hippocampus was chosen, as there was relatively low between-subject variability in distance (comparing standard deviations) and this region is easily identifiable on MRI. The ERC starts 4.75 mm (median value) anterior to the hippocampus, BA35 9.25 mm and BA36 10.25 mm. Next, we analyzed the location of the ERC on histology sections. We determined that regardless of the depth of the CS, the inferior border of the ERC is on average at the edge of the CS and the superior border at the superior edge of the parahippocampal gyrus, but at the halfway point for the first section with ERC. We then studied histology sections for BA35 borders and determined that for sections where the inferior border of ERC serves as the medial border for BA35, the lateral border is on average located at the fundus of the CS. These segmentation rules can be applied to T1-MRI. There were no differences between the cases with and without neurodegenerative diseases in the location of these borders.

#### CONCLUSION

We are developing a histology grounded segmentation protocol for the anterior MTL cortices to add to an existing automated segmentation which already includes the posterior MTL. Segmentation rules for remaining borders are under development.

#### CLINICAL RELEVANCE/APPLICATION

This histologically-informed segmentation protocol is expected to improve the efficacy of imaging biomarkers for tau deposition in early AD.

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## Abstract Archives of the RSNA, 2023

W7-SSNR13-2

### Keynote Speaker

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

Claudia F. Kirsch, MD (*Presenter*) Consultant, Informa PLC; Royalties, Informa PLC

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## Abstract Archives of the RSNA, 2023

W7-SSNR13-3

### Initial Deployment of a Semi-automated Pipeline Measuring Brain Structural Change for Clinical Brain MRI Reporting

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

Ilya M. Nasrallah, MD, PhD (*Presenter*) Speaker, Biogen Idec Inc; Advisory Board, Eisai Co, Ltd

#### PURPOSE

To implement and validate an image processing pipeline based on open-source resources for quantification of brain atrophy and white matter hyperintensity volume for differential diagnosis of neurodegenerative disease.

#### METHODS AND MATERIALS

The neuroimaging pipeline uses deep learning-based skull stripping<sup>1</sup>, multi-atlas tissue segmentation<sup>2</sup>, and lesion segmentation<sup>3</sup> modules to generate tabular data comprising intracranial volume-adjusted regional and global volume measurements and machine learning metrics measuring Alzheimer's disease (AD)-typical atrophy (SPARE-AD)<sup>4</sup> and image-based brain age<sup>5</sup>. These individual measures are placed in context of age and sex-matched reference data drawn from a dataset of cognitively normal (N=2935) and AD (N=1833) participants harmonized using ComBat<sup>6</sup>. The containerized pipeline was deployed on a server running the open-source toolkit Kaapana (kaapana.ai, DKFZ, Heidelberg, Germany). Clinical studies with 1 mm isotropic T1 and T2 FLAIR DICOM images were processed. Clinical data was extracted from the electronic medical record regarding clinical diagnoses and the original radiologist report. Radiology reports were analyzed for ascertainment of the presence features indicating neurodegenerative disease. Diagnosis groups were compared using t-tests.

#### RESULTS

The test sample comprised 11 patients aged 62-93; 6 with possible/probable AD ('AD cohort') and 5 non-AD diagnoses ('nonAD cohort'; psychiatric disease, frontotemporal lobar degeneration, and vascular dementia). The original radiology report noted medial temporal lobe/hippocampal volume (HV) loss in 17% of the AD cohort and 20% of the nonAD cohort. The AD cohort had significantly lower mean (SD) HV (6.3mL±0.8 vs 7.4mL±0.5, p=0.01) and higher mean SPARE-AD (0.3±1.3 vs -1.1±0.8, p=0.03). 67% of AD cases and 0% of nonAD had HV >1 SD below the mean; 67% of AD cases had positive SPARE-AD scores while 100% of nonAD had negative SPARE-AD scores. 90% of reports qualitatively mentioned WMH burden. Quantitation showed significantly higher mean WMH volume in the nonAD group (9.2mL±3.4 vs 3.6mL±3.4, p=0.01); WMH volumes were highest in cases with vascular dementia.

#### CONCLUSION

A semi-automated imaging quantification pipeline based on open-source resources can produce clinically relevant biomarkers that are frequently missing from radiology reports. These measures provide personalized diagnostic information relevant on the individual level.

#### CLINICAL RELEVANCE/APPLICATION

Open-source tools may provide broader access to quantitative measures and machine learning measures that can improve or support radiologist and referring physician diagnoses.

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## Abstract Archives of the RSNA, 2023

W7-SSNR13-4

### **International Multicenter Phase 2 Dose Finding Study of Gadoquatrane: A Dose of 0.04 mmol Gd/kg bw of Gadoquatrane Has Similar Efficacy to 0.1 mmol Gd/kg bw of Gadobutrol**

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

Benjamin P. Liu, MD (*Presenter*) Speakers Bureau, Guerbet SA; Research Grant, Guerbet SA; Research Grant, Bayer AG

#### **PURPOSE**

To establish a dose of gadoquatrane with similar efficacy as gadobutrol for use in contrast-enhanced (CE) MRI of the CNS in adults, via an adaptive dose finding study.

#### **METHODS AND MATERIALS**

This phase 2 multicenter, single-blind cross-over study included adult patients with known or highly suspected CNS lesions and aimed to investigate potentially different doses of gadoquatrane in cohorts of 50 evaluable patients per dose level. Patients received two CE MRI exams, one with gadobutrol at 0.1 mmol Gd/kg body weight (bw), the other one with gadoquatrane starting with a dose of 0.04 mmol Gd/kg bw. The primary efficacy endpoint was overall diagnostic preference based on a randomized paired blinded read. The secondary objective was to show non-inferiority of gadoquatrane to gadobutrol based on the sum of lesion visualization parameters (contrast enhancement, border delineation and internal morphology). Efficacy evaluations were performed by 3 independent central blinded readers. Signal intensity (SI), contrast to noise ratio (CNR), signal to noise ratio (SNR) at 5 min, 10 min and 15 min post injection were measured. Adverse events (AE) were monitored up to 1 day after second MRI.

#### **RESULTS**

57 patients (23 men, 34 women) were enrolled in 17 sites in 4 countries (USA, Germany, Bulgaria and Japan). 50 patients were evaluable for the primary efficacy endpoint. The efficacy of gadoquatrane at a dose of 0.04 mmol Gd/kg bw was confirmed. The overall diagnostic preference was similar for gadoquatrane and gadobutrol. The sum of lesion visualization parameter scores (border delineation + contrast enhancement + internal morphology, scale of 3-11) at 5 min post injection was similar for gadoquatrane and gadobutrol (average reader mean score +8.94 for gadoquatrane and +9.00 for gadobutrol [ $p < 0.0001$  for non-inferiority]). For all 3 visualization parameters, all 3 readers and the average reader consistently showed mean differences between gadoquatrane and gadobutrol near zero, indicating no difference in performance between agents. SI, CNR and SNR measurements confirmed that both agents at the investigated doses and time points had similar signal enhancement parameters. Four patients experienced treatment-emergent AEs, and one AE (toothache) was considered related to gadoquatrane. All AEs had a maximum intensity of mild.

#### **CONCLUSION**

A dose of 0.04 mmol Gd/kg bw of gadoquatrane has similar efficacy results to 0.1 mmol Gd/kg bw of gadobutrol and is supported for the further development of gadoquatrane.

#### **CLINICAL RELEVANCE/APPLICATION**

CE-MRI is the standard of care in diagnostic imaging procedures of the CNS. Gadoquatrane will enable lowering of the gadolinium dose by 60% compared to current standard of care macrocyclic GBCAs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSNR13-5

### Development and Evaluation of High Resolution QSM Template of the Older Adult Brain

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

Rasheed Abid, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Quantitative susceptibility mapping (QSM) is an important tool for studying age-related brain pathologies that can disrupt iron or calcium homeostasis or cause demyelination. However, a high-resolution QSM template of the older adult brain is not currently available. The purpose of this work is twofold: a) to construct a high resolution QSM template of the older adult brain, and b) compare the new template to existing templates in terms of image quality and representativeness of the older adult brain.

#### METHODS AND MATERIALS

T1-weighted MPRAGE (1x1x1 mm<sup>3</sup>) and T2\*-weighted multi-echo gradient echo (0.7x0.7x1.3 mm<sup>3</sup>) 3T MRI data collected on the 400 non-demented older adults (50% male; 64.9-98.9 years of age; 54% white, 43% black) participating in the construction of the MIITRA atlas were used for this study. MEDI toolbox was used to generate a QSM image of each of the participants from the multi-echo gradient echo data. N4bias field correction followed by upsampling was performed on the first echo of the GRE data of each of the subjects and finally converted to synthetic T1w images using `mri_synthsr`. These synthetic images were then rigidly registered to the T1w images using ANTs. The resulting transformations were combined with the non-linear transformations generated in the construction of the MIITRA T1-weighted template and the combined transform was used to forward-map susceptibility maps of each of the subjects to the MIITRA T1w template space. Finally sparse representation based data-fusion implementation was used to generate the final 0.5mm isotropic MIITRA QSM template.

#### RESULTS

The QSM template exhibits high image sharpness and clearly visible brain structures upon visual inspection. Higher magnetic susceptibility can be observed in the regions of basal ganglia, midbrain and cerebellum, as expected. Furthermore, magnetic susceptibility is higher in cortical gray matter compared to white matter, and also in white matter of the occipital lobe compared to prefrontal white matter, also in accordance with published literature. The MIITRA QSM template also required less deformation for spatial normalization of older adult data compared to other templates.

#### CONCLUSION

This work developed a high quality 0.5mm resolution QSM template for the MIITRA atlas using data from a large, diverse, community cohort of non-demented older adults, and demonstrated that the new template exhibited high image quality and is more representative of the older adult brain compared to other templates. The new template will be made available for download at [www.nitrc.org/projects/miitra](http://www.nitrc.org/projects/miitra).

#### CLINICAL RELEVANCE/APPLICATION

QSM templates can be used to study disruption in iron or calcium related homeostasis due to age-related brain pathologies.

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## Abstract Archives of the RSNA, 2023

W7-SSNR13-6

### Amide Proton Transfer Weighted Imaging Analysis of Cerebral Metabolism Changes in T2DM Patients

Wednesday, Nov. 29 3:00PM - 4:00PM Room: E353C

Wei-wei Wang, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Amide proton transfer weighted (APT<sub>w</sub>) technology was used to analyze the metabolic changes of brain in patients with T2DM and explore the related factors.

#### METHODS AND MATERIALS

A total of 64 subjects were prospectively collected and divided into T2DM group and control group according to grouping criteria, including 37 patients in T2DM group and 27 healthy controls. Within one week before or after the MRI scan, the clinical data, laboratory indicators and cognitive scores of the subjects were recorded. All the subjects used Philips Ingenia CX 3.0 T MR for MRI data acquisition, and the sequence included axial FFE T1 sequence, axial FFE T2 sequence, axial TSE Flair sequence, sagittal 3D T1 TFE sequence and axial 3D TSE APT<sub>w</sub> sequence. The APT<sub>w</sub> values of grey and white matter were analyzed by SPM 8 software. Independent two sample t test was used to compare the difference between two groups. Pearson correlation analysis was used to analyze the correlation between APT<sub>w</sub> values in brain regions with significant differences and demographic data, laboratory indicators and cognitive scores.  $P < 0.05$  was considered statistically significant.

#### RESULTS

Compared with the control group, APT<sub>w</sub> of white matter was increased in T2DM group ( $0.507 \pm 0.128$ ,  $0.600 \pm 0.136$ ,  $P = 0.007$ ). No significant difference was showed in APT<sub>w</sub> of gray matter between the two groups ( $1.085 \pm 0.154$ ,  $1.099 \pm 0.113$ ,  $P = 0.668$ ). The correlation analysis found negative correlation between APT<sub>w</sub> of white matter and CVLT accuracy of long time delay selection and recognition ( $r = -0.315$ ,  $P = 0.011$ ) and visual space perception score ( $r = -0.298$ ,  $P = 0.017$ ). No correlation was found between white matter APT<sub>w</sub> values and demographic and clinical data ( $P > 0.05$ ). No correlation was found between APT<sub>w</sub> values of grey matter and demographic data, clinical data and cognitive scores ( $P > 0.05$ ).

#### CONCLUSION

Only the increased APT<sub>w</sub> value was found, suggesting that it was related to the abnormal changes in the concentration of metabolites in the patients' white matter. However, there was no significant correlation between white matter APT<sub>w</sub> value and demographic data and clinical data. It was also found that increased white matter APT<sub>w</sub> was associated with decreased cognitive level in T2DM patients.

#### CLINICAL RELEVANCE/APPLICATION

APT<sub>w</sub> can reflect the abnormal changes of brain metabolism in T2DM patients from the molecular level, providing new imaging evidence for understanding the neuropathological mechanism of diabetic brain injury.

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## Abstract Archives of the RSNA, 2023

W7-SSPD04

### Pediatric Imaging (Gastrointestinal and Genitourinary)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S402

Sudha P. Singh, MBBS, MD (*Moderator*) Nothing to Disclose  
Terry Levin, MD (*Moderator*) Nothing to Disclose

#### Sub-Events

#### W7-SSPD04-1 Feasibility of 4D Flow MRI for Quantification of Hepatic Outflow in Children After Liver Transplantation and Comparison with Color Doppler Ultrasound

Jan Moritz Seliger, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assessment of the feasibility of 4D Flow MRI to quantify hepatic outflow in children after liver transplantation and comparison with current standard bedside color Doppler ultrasound (US).

#### METHODS AND MATERIALS

We retrospectively analyzed 11 children (median age 11 years, 1 - 17 years) who underwent liver transplantation (full organ, right lateral or left lateral). All children underwent quantitative color Doppler US assessment of the hepatic vessels and 4D flow MRI at 3T. Color Doppler US and b-Mode standard transverse and longitudinal planes were recorded with full liver coverage. Intrahepatic quantitative flow measurements were performed in the main hepatic vein 1-2 cm distant to the anastomosis. Flow measurements with Doppler US were performed with angle correction for assessment of maximum and minimum velocities (US-Vmax and US-Vmin). At corresponding anatomic positions, hepatic outflow was quantified on 4D flow MRI with through plane velocities (MR-Vmin and MR-Vmax). Doppler US-derived and 4D flow-derived parameters were compared using linear regression analyses and Wilcoxon rank tests.

#### RESULTS

In all cases, the hepatic venous outflow tract was detectable on both 4D flow MRI and Doppler US. US-Vmax and US-Vmin revealed no significant differences between 4D flow MRI and Doppler US (MR-Vmax  $31.8 \pm 14.1$  cm/s vs. mean US-Vmax  $31.5 \pm 10.0$  cm/s and mean MR-Vmin  $-4.3 \pm 5.0$  cm/s vs. mean US-Vmin  $3.7 \pm 16.4$  cm/s, both  $p > 0.05$ ). Maximum and minimum velocities showed weak correlations between 4D flow MRI and Doppler US (Vmax:  $R = 0.42$ ,  $p = 0.18$  and Vmin:  $R = 0.32$ ,  $p = 0.34$ ).

#### CONCLUSION

4D flow MRI is feasible for non-invasive quantification of hepatic outflow in children after liver transplantation. Our results suggest that 4D flow MRI and color Doppler US have comparable accuracy in measuring hepatic venous flow velocities.

#### CLINICAL RELEVANCE/APPLICATION

Establishing 4D flow MRI as supplement to US assessment may improve non-invasive postoperative monitoring after liver transplantation in children, warranting further evaluation in patients with post-transplant venous stenosis.

#### W7-SSPD04-2 Reader Confidence with Use of Ferumoxytol in Liver Tumor Staging

Mara O'Connor, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic Resonance Imaging (MRI) with hepatobiliary contrast agent is important in the evaluation of pediatric liver tumors. Staging includes extent of liver involvement and annotation factors for vessel involvement. While Gadoxetate disodium (Eovist, Bayer HealthCare) is advantageous in lesion characterization, it is not a dedicated blood pool contrast agent. Ferumoxytol (Feraheme, AMAG Pharmaceuticals) is an iron oxide nanoparticle with a long intravascular half-life and strong



MRI signal. We hypothesize ferumoxytol (Fe) improves inter-reader reliability and reader confidence in evaluation for tumor involvement of the vasculature.

## **METHODS AND MATERIALS**

We identified MRIs with dual contrast (Eovist (Eo) and Fe) performed for baseline liver tumor staging. Images were uploaded into an anonymous dicom viewer as a random mix of Eo and Fe cases. The Eo cases contained 3-phase axial dynamic, 2-minute axial, and 30-minute axial and coronal sequences. The Fe set contained coronal MR-angiogram (MRA) with axial and sagittal reformats. Four reviewers rated portal and hepatic venous and inferior vena cava (IVC) involvement and their confidence level for all image sets provided in random order. Cases were re-paired after review with tabulation of changes in scores between contrasts. Inter-reader reliability was calculated using paired Cohen's kappa, intraclass correlation coefficients, and Fleiss multirater kappa.

## **RESULTS**

Eight cases (median age 3.4 (intraquartile range 0.8 - 10.3) years; 50% female; 2 hepatocellular carcinoma, 6 hepatoblastoma) were reviewed as 16 sets of images. Reviewers were unsure of 28 vessels with Eo and 2 with Fe. For Eovist cases, all 4 reviewers rated 1 case as nondiagnostic and were not confident in portal veins in 4 cases and hepatic veins in 6 cases. For Fe, 2 reviewers were not confident in portal veins in 1 case. On average, 2 reviewers changed their staging per venous structure. Reviewers changed from patent on Eo to invaded/thrombosed on Fe in 6 portal veins and 3 right hepatic veins. They changed from invaded/thrombosed on Eo to patent on Fe in 3 portal veins. Inter-reader reliability was significantly higher in all vessels with Fe ( $p < 0.003$ ). However, reliability was low in general, especially for the IVC and hepatic veins.

## **CONCLUSION**

Ferumoxytol MRA appears to increase reader confidence and inter-reader reliability in vascular staging of liver tumors. However, overall inter-reader reliability was fair to moderate at best.

## **CLINICAL RELEVANCE/APPLICATION**

Vessel assessment is important in pediatric liver tumor staging. Ferumoxytol MR angiography appears to increase inter-reader reliability and reader confidence and may be a useful addition to pediatric liver tumor staging.

## **W7-SSPD04-3 Implementation of a 4D Free-Breathing Variable Density Stack-Of-Stars Functional Magnetic Resonance Urography in Young Children Without Sedation**

Jakob Spogis, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Functional magnetic resonance urography (MRU) has been well established in the diagnostic workup of urinary tract anomalies in children. However, standard dynamic contrast-enhanced (DCE) images acquired in Cartesian order of the k-space are prone to respiratory motion artifacts. The purpose of this study was to implement and compare a newly introduced 4D free-breathing high spatiotemporal resolution DCE-MRI with radial sampling order for functional MRU (4D MRU) in pediatric patients and to compare its image quality and analyzability with Standard Cartesian MRU.

## **METHODS AND MATERIALS**

We retrospectively evaluated 4D MRU performed without general anesthesia between 09/2021 and 12/2022 and compared them with matched pairs (age, affected kidney, diagnosis) of Standard Cartesian MRU. Image analysis was performed by two radiologists independently regarding the following criteria using a 4-point Likert scale: overall image quality, diagnostic confidence, respiratory motion artifacts as well as sharpness and contrast of aorta, kidneys, and ureters. We also measured vertical kidney motion due to respiratory motion and compared the variance for each kidney using F-test. Both radiologists calculated the volume, split renal volume (vDRF), split renal Patlak function (pDRF), and split renal function considering the volume and Patlak function (vpDRF) for each kidney. Values were compared using Bland-Altman plots and F-test.

## **RESULTS**

40 children (20 for 4D and Standard Cartesian) were enrolled. 10 children of each group were examined using the feed-and-sleep technique (median age 8.9 months), 10 were awake (median age 8.6 years). Overall image quality, diagnostic confidence, respiratory motion artifacts, and sharpness and contrast of the aorta, kidneys, and ureters were rated significantly better for 4D compared to Standard Cartesian by both readers ( $p$  ranging from  $<0.0001$  to  $0.005$ ). Vertical kidney motion was significantly less pronounced in 4D for both kidneys (both  $p < 0.001$ ). There was a significantly lesser variance in the differences between the two readers for vpDRF in 4D MRU ( $p = 0.0003$ ). In contrast, no significant difference could be demonstrated for volume ( $p = 0.05$ ), vDRF ( $p = 0.93$ ), and pDRF ( $p = 0.14$ ).

## **CONCLUSION**

We demonstrated the feasibility of applying a 4D free-breathing variable density stack-of-stars imaging for functional MRU in young pediatric patients with improved image quality, fewer motion artifacts, and improved functional analyzability.

## CLINICAL RELEVANCE/APPLICATION

Respiratory motion artifacts often interfere with the analyzability of MRU in children. With 4D MRU we could implement a DCE MRI sequence with superb image quality despite free breathing significantly improving the diagnostic confidence in clinical routine.

### W7-SSPD04-4 Feasibility of Renal Artery Flow Quantitation in Pediatric Patients Using 4D Flow MRI

Tammy Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate feasibility of time-resolved flow-sensitive four-dimensional (4D) MRI for quantification of renal artery hemodynamics in a clinical pediatric population.

#### METHODS AND MATERIALS

Patients who underwent 4D flow MRI during work up of underlying abdominal pathology in the past 6 months were retrospectively identified. Flow was quantified using Arterys web-based flow analysis software in predefined anatomic regions of the abdominal aorta and renal arteries. Flow volumes and maximum velocities were recorded. Inter-observer variability was assessed using Bland-Altman and regression techniques.

#### RESULTS

15 patients (7 male, mean age 9.6 years, range [2, 17]) received 4D flow MRI. Flow averaged 0.28 L/min [0.05, 0.56], 0.29 L/min [0.07, 0.76], and 1.66 L/min [0.47, 3.29] in the left renal artery, right renal artery, and aorta respectively. Flow rate correlated moderately with age for the left renal artery ( $r=0.61$ ,  $p=0.0009$ ), right renal artery ( $r=0.41$ ,  $p=0.01$ ), and aorta ( $r=0.61$ ,  $p=0.006$ ). Bland-Altman analysis showed excellent inter-observer agreement, with mean difference of -0.01 L/min in the left renal artery, which was not significant on 1-tail t-test ( $p=0.3$ ) or regression analysis ( $r^2=0.04$ ,  $p=0.51$ ). Similarly, mean inter-observer difference was -0.03 L/min in the right renal artery, not significant on significant on 1-tail t-test ( $p=0.3$ ) or regression analysis ( $r^2=0.01$ ,  $p=0.68$ ). Finally, mean inter-observer difference was -0.02 L/min in the aorta, not significant on significant on 1-tail t-test ( $p=0.88$ ) or regression analysis ( $r^2=0$ ,  $p=0.85$ ).

#### CONCLUSION

4D flow MRI assessment of renal arteries is feasible in a pediatric population, with excellent inter-observer agreement.

## CLINICAL RELEVANCE/APPLICATION

4D flow MRI provides anatomic and functional assessment of vascular flow, and allows for evaluation of smaller, tortuous vessels, which is less reliable on 2D phase contrast MRI. Feasibility has been shown in various vessels for adults; however, renal artery applications in the pediatric population have not yet been explored. Though more studies are required to determine the clinical utility of this modality, 4D flow MRI represents a promising noninvasive, non-ionizing method of comprehensive renal vascular flow assessment.

### W7-SSPD04-5 The Differences in Diagnostic Models of NEC by Combining Radiomics Features and Non-radiomics Feature

Chaogang Lu (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a traditional radiomics model of abdominal X-ray images of NEC and a joint model of radiomics and non-radiomics feature to evaluate the differences in diagnostic efficacy of the different models on the entire data set.

#### METHODS AND MATERIALS

In this retrospective study, we collected images of 252 NEC patients ( $n=131$ ) and non-NEC patients ( $n=121$ ) who underwent abdominal X-ray in 2016-2022, and divided them into training set ( $n=146$ ), testing set ( $n=62$ ), and validation set ( $n=44$ ). Non-radiomics feature called Abdominal Chest Ratio (ACR) was calculated by measuring the length diameter of the abdominal cavity and the thoracic cavity in the thoracoabdominal anteroposterior radiograph. Radiomics features were extracted by using traditional radiomics methods and were used to construct radiomics models. The models radiomics features combined with ACR and Radscore combined with ACR were built separately by logistic regression. The area under the receiver operating characteristic curve (AUC) was used to evaluate the models' performance for the diagnosis of NEC.

#### RESULTS

ACR and Radscore independently achieved an AUC of 0.682 versus 0.885 on the whole data set. The models ACR combined with Radscore and ACR combined with feature based on the training set both achieved an AUC of 0.893 on the entire data set; based on the testing set and validation set, the models achieved an AUC of 0.885 versus 0.868 and of 0.888 versus 0.757 respectively.

## **CONCLUSION**

The diagnostic efficacy of the model which Radscore combined with the non-radiomics feature was superior to the model radiomics features combined with the non-radiomics feature.

## **CLINICAL RELEVANCE/APPLICATION**

Necrotizing enterocolitis (NEC) is one of the most common gastrointestinal emergencies in neonates, and X-ray is its preferred imaging modality. Current X-ray image diagnostic or predictive models of the disease are mainly modeled using deep learning methods. Through this study, we explored the effect of traditional radiomics methods in establishing models on X-ray images.

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## Abstract Archives of the RSNA, 2023

W7-SSPD04-1

### Feasibility of 4D Flow MRI for Quantification of Hepatic Outflow in Children After Liver Transplantation and Comparison with Color Doppler Ultrasound

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S402

Jan Moritz Seliger, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Assessment of the feasibility of 4D Flow MRI to quantify hepatic outflow in children after liver transplantation and comparison with current standard bedside color Doppler ultrasound (US).

#### METHODS AND MATERIALS

We retrospectively analyzed 11 children (median age 11 years, 1 - 17 years) who underwent liver transplantation (full organ, right lateral or left lateral). All children underwent quantitative color Doppler US assessment of the hepatic vessels and 4D flow MRI at 3T. Color Doppler US and b-Mode standard transverse and longitudinal planes were recorded with full liver coverage. Intrahepatic quantitative flow measurements were performed in the main hepatic vein 1-2 cm distant to the anastomosis. Flow measurements with Doppler US were performed with angle correction for assessment of maximum and minimum velocities (US-Vmax and US-Vmin). At corresponding anatomic positions, hepatic outflow was quantified on 4D flow MRI with through plane velocities (MR-Vmin and MR-Vmax). Doppler US-derived and 4D flow-derived parameters were compared using linear regression analyses and Wilcoxon rank tests.

#### RESULTS

In all cases, the hepatic venous outflow tract was detectable on both 4D flow MRI and Doppler US. US-Vmax and US-Vmin revealed no significant differences between 4D flow MRI and Doppler US (MR-Vmax  $31.8 \pm 14.1$  cm/s vs. mean US-Vmax  $31.5 \pm 10.0$  cm/s and mean MR-Vmin  $-4.3 \pm 5.0$  cm/s vs. mean US-Vmin  $3.7 \pm 16.4$  cm/s, both  $p > 0.05$ ). Maximum and minimum velocities showed weak correlations between 4D flow MRI and Doppler US (Vmax:  $R = 0.42$ ,  $p = 0.18$  and Vmin:  $R = 0.32$ ,  $p = 0.34$ ).

#### CONCLUSION

4D flow MRI is feasible for non-invasive quantification of hepatic outflow in children after liver transplantation. Our results suggest that 4D flow MRI and color Doppler US have comparable accuracy in measuring hepatic venous flow velocities.

#### CLINICAL RELEVANCE/APPLICATION

Establishing 4D flow MRI as supplement to US assessment may improve non-invasive postoperative monitoring after liver transplantation in children, warranting further evaluation in patients with post-transplant venous stenosis.

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## Abstract Archives of the RSNA, 2023

W7-SSPD04-2

### Reader Confidence with Use of Ferumoxytol in Liver Tumor Staging

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S402

Mara O'Connor, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Magnetic Resonance Imaging (MRI) with hepatobiliary contrast agent is important in the evaluation of pediatric liver tumors. Staging includes extent of liver involvement and annotation factors for vessel involvement. While Gadoxetate disodium (Eovist, Bayer HealthCare) is advantageous in lesion characterization, it is not a dedicated blood pool contrast agent. Ferumoxytol (Feraheme, AMAG Pharmaceuticals) is an iron oxide nanoparticle with a long intravascular half-life and strong MRI signal. We hypothesize ferumoxytol (Fe) improves inter-reader reliability and reader confidence in evaluation for tumor involvement of the vasculature.

#### METHODS AND MATERIALS

We identified MRIs with dual contrast (Eovist (Eo) and Fe) performed for baseline liver tumor staging. Images were uploaded into an anonymous dicom viewer as a random mix of Eo and Fe cases. The Eo cases contained 3-phase axial dynamic, 2-minute axial, and 30-minute axial and coronal sequences. The Fe set contained coronal MR-angiogram (MRA) with axial and sagittal reformats. Four reviewers rated portal and hepatic venous and inferior vena cava (IVC) involvement and their confidence level for all image sets provided in random order. Cases were re-paired after review with tabulation of changes in scores between contrasts. Inter-reader reliability was calculated using paired Cohen's kappa, intraclass correlation coefficients, and Fleiss multirater kappa.

#### RESULTS

Eight cases (median age 3.4 (intraquartile range 0.8 - 10.3) years; 50% female; 2 hepatocellular carcinoma, 6 hepatoblastoma) were reviewed as 16 sets of images. Reviewers were unsure of 28 vessels with Eo and 2 with Fe. For Eovist cases, all 4 reviewers rated 1 case as nondiagnostic and were not confident in portal veins in 4 cases and hepatic veins in 6 cases. For Fe, 2 reviewers were not confident in portal veins in 1 case. On average, 2 reviewers changed their staging per venous structure. Reviewers changed from patent on Eo to invaded/thrombosed on Fe in 6 portal veins and 3 right hepatic veins. They changed from invaded/thrombosed on Eo to patent on Fe in 3 portal veins. Inter-reader reliability was significantly higher in all vessels with Fe ( $p < 0.003$ ). However, reliability was low in general, especially for the IVC and hepatic veins.

#### CONCLUSION

Ferumoxytol MRA appears to increase reader confidence and inter-reader reliability in vascular staging of liver tumors. However, overall inter-reader reliability was fair to moderate at best.

#### CLINICAL RELEVANCE/APPLICATION

Vessel assessment is important in pediatric liver tumor staging. Ferumoxytol MR angiography appears to increase inter-reader reliability and reader confidence and may be a useful addition to pediatric liver tumor staging.

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## Abstract Archives of the RSNA, 2023

W7-SSPD04-3

### Implementation of a 4D Free-Breathing Variable Density Stack-Of-Stars Functional Magnetic Resonance Urography in Young Children Without Sedation

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S402

Jakob Spogis, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Functional magnetic resonance urography (MRU) has been well established in the diagnostic workup of urinary tract anomalies in children. However, standard dynamic contrast-enhanced (DCE) images acquired in Cartesian order of the k-space are prone to respiratory motion artifacts. The purpose of this study was to implement and compare a newly introduced 4D free-breathing high spatiotemporal resolution DCE-MRI with radial sampling order for functional MRU (4D MRU) in pediatric patients and to compare its image quality and analyzability with Standard Cartesian MRU.

#### METHODS AND MATERIALS

We retrospectively evaluated 4D MRU performed without general anesthesia between 09/2021 and 12/2022 and compared them with matched pairs (age, affected kidney, diagnosis) of Standard Cartesian MRU. Image analysis was performed by two radiologists independently regarding the following criteria using a 4-point Likert scale: overall image quality, diagnostic confidence, respiratory motion artifacts as well as sharpness and contrast of aorta, kidneys, and ureters. We also measured vertical kidney motion due to respiratory motion and compared the variance for each kidney using F-test. Both radiologists calculated the volume, split renal volume (vDRF), split renal Patlak function (pDRF), and split renal function considering the volume and Patlak function (vpDRF) for each kidney. Values were compared using Bland-Altman plots and F-test.

#### RESULTS

40 children (20 for 4D and Standard Cartesian) were enrolled. 10 children of each group were examined using the feed-and-sleep technique (median age 8.9 months), 10 were awake (median age 8.6 years). Overall image quality, diagnostic confidence, respiratory motion artifacts, and sharpness and contrast of the aorta, kidneys, and ureters were rated significantly better for 4D compared to Standard Cartesian by both readers (p ranging from <0.0001 to 0.005). Vertical kidney motion was significantly less pronounced in 4D for both kidneys (both  $p < 0.001$ ). There was a significantly lesser variance in the differences between the two readers for vpDRF in 4D MRU ( $p = 0.0003$ ). In contrast, no significant difference could be demonstrated for volume ( $p = 0.05$ ), vDRF ( $p = 0.93$ ), and pDRF ( $p = 0.14$ ).

#### CONCLUSION

We demonstrated the feasibility of applying a 4D free-breathing variable density stack-of-stars imaging for functional MRU in young pediatric patients with improved image quality, fewer motion artifacts, and improved functional analyzability.

#### CLINICAL RELEVANCE/APPLICATION

Respiratory motion artifacts often interfere with the analyzability of MRU in children. With 4D MRU we could implement a DCE MRI sequence with superb image quality despite free breathing significantly improving the diagnostic confidence in clinical routine.

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## Abstract Archives of the RSNA, 2023

W7-SSPD04-4

### Feasibility of Renal Artery Flow Quantitation in Pediatric Patients Using 4D Flow MRI

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S402

Tammy Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To demonstrate feasibility of time-resolved flow-sensitive four-dimensional (4D) MRI for quantification of renal artery hemodynamics in a clinical pediatric population.

#### METHODS AND MATERIALS

Patients who underwent 4D flow MRI during work up of underlying abdominal pathology in the past 6 months were retrospectively identified. Flow was quantified using Arterys web-based flow analysis software in predefined anatomic regions of the abdominal aorta and renal arteries. Flow volumes and maximum velocities were recorded. Inter-observer variability was assessed using Bland-Altman and regression techniques.

#### RESULTS

15 patients (7 male, mean age 9.6 years, range [2, 17]) received 4D flow MRI. Flow averaged 0.28 L/min [0.05, 0.56], 0.29 L/min [0.07, 0.76], and 1.66 L/min [0.47, 3.29] in the left renal artery, right renal artery, and aorta respectively. Flow rate correlated moderately with age for the left renal artery ( $r=0.61$ ,  $p=0.0009$ ), right renal artery ( $r=0.41$ ,  $p=0.01$ ), and aorta ( $r=0.61$ ,  $p=0.006$ ). Bland-Altman analysis showed excellent inter-observer agreement, with mean difference of -0.01 L/min in the left renal artery, which was not significant on 1-tail t-test ( $p=0.3$ ) or regression analysis ( $r^2=0.04$ ,  $p=0.51$ ). Similarly, mean inter-observer difference was -0.03 L/min in the right renal artery, not significant on significant on 1-tail t-test ( $p=0.3$ ) or regression analysis ( $r^2=0.01$ ,  $p=0.68$ ). Finally, mean inter-observer difference was -0.02 L/min in the aorta, not significant on significant on 1-tail t-test ( $p=0.88$ ) or regression analysis ( $r^2=0$ ,  $p=0.85$ ).

#### CONCLUSION

4D flow MRI assessment of renal arteries is feasible in a pediatric population, with excellent inter-observer agreement.

#### CLINICAL RELEVANCE/APPLICATION

4D flow MRI provides anatomic and functional assessment of vascular flow, and allows for evaluation of smaller, tortuous vessels, which is less reliable on 2D phase contrast MRI. Feasibility has been shown in various vessels for adults; however, renal artery applications in the pediatric population have not yet been explored. Though more studies are required to determine the clinical utility of this modality, 4D flow MRI represents a promising noninvasive, non-ionizing method of comprehensive renal vascular flow assessment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPD04-5

### The Differences in Diagnostic Models of NEC by Combining Radiomics Features and Non-radiomics Feature

Wednesday, Nov. 29 3:00PM - 4:00PM Room: S402

Chaogang Lu (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a traditional radiomics model of abdominal X-ray images of NEC and a joint model of radiomics and non-radiomics feature to evaluate the differences in diagnostic efficacy of the different models on the entire data set.

#### METHODS AND MATERIALS

In this retrospective study, we collected images of 252 NEC patients ( $n = 131$ ) and non-NEC patients ( $n = 121$ ) who underwent abdominal X-ray in 2016-2022, and divided them into training set ( $n = 146$ ), testing set ( $n = 62$ ), and validation set ( $n = 44$ ). Non-radiomics feature called Abdominal Chest Ratio (ACR) was calculated by measuring the length diameter of the abdominal cavity and the thoracic cavity in the thoracoabdominal anteroposterior radiograph. Radiomics features were extracted by using traditional radiomics methods and were used to construct radiomics models. The models radiomics features combined with ACR and Radscore combined with ACR were built separately by logistic regression. The area under the receiver operating characteristic curve (AUC) was used to evaluate the models' performance for the diagnosis of NEC.

#### RESULTS

ACR and Radscore independently achieved an AUC of 0.682 versus 0.885 on the whole data set. The models ACR combined with Radscore and ACR combined with feature based on the training set both achieved an AUC of 0.893 on the entire data set; based on the testing set and validation set, the models achieved an AUC of 0.885 versus 0.868 and of 0.888 versus 0.757 respectively.

#### CONCLUSION

The diagnostic efficacy of the model which Radscore combined with the non-radiomics feature was superior to the model radiomics features combined with the non-radiomics feature.

#### CLINICAL RELEVANCE/APPLICATION

Necrotizing enterocolitis (NEC) is one of the most common gastrointestinal emergencies in neonates, and X-ray is its preferred imaging modality. Current X-ray image diagnostic or predictive models of the disease are mainly modeled using deep learning methods. Through this study, we explored the effect of traditional radiomics methods in establishing models on X-ray images.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-SSPH11

### Physics (AI applications in CT)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

Guang-Hong Chen, PhD (*Moderator*) Nothing to Disclose

Hao Gong, PHD (*Moderator*) Nothing to Disclose

#### Sub-Events

### W7-SSPH11-1 Unified Spectral Processing in Photon-counting-detector CT using Bayesian Deep Learning with Explicit Uncertainty and Bias Penalty

Hao Gong, PHD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting-detector (PCD) CT provides high-quality spectral data to derive multiple image types (e.g., iodine maps, virtual monoenergetic (VMI), non-calcium (VNCa)), which assist diagnoses in many CT tasks. Conventional spectral processing methods are susceptible to amplified image noise and artifacts that impede reader interpretation. We aim to improve diagnostic image quality through unified spectral processing based on Bayesian deep learning with explicit uncertainty and bias penalty (BEACAN)

#### METHODS AND MATERIALS

BEACAN is based on a Bayesian dual-task neural network with bifurcated branches to classify types and quantify mass densities of basis materials. The network used probabilistic modeling of model likelihood and posterior distribution to re-balance its uncertainty and bias in training and characterize the statistical distribution of outputs for given inputs. Training used PCD-CT low-/high-threshold images of tissue-/contrast-mimicking inserts (e.g., hydroxyapatite (HA), iodine, muscle) and simulated random-shaped inserts. The predicted means of mass density maps were used to derive additional image types, due to improved robustness and detail preservation. Pixel-wise uncertainty was derived to support anomaly detection. Material quantification accuracy was assessed using root mean square error (RMSE) at 100% and 50% routine doses. For proof of concept, 5 patient CT cardiac angiograms were used to assess overall image quality, noise, and artifacts in material maps and VMIs. A prior-knowledge-assisted iterative material decomposition (Iter-MD; basis materials: HA, iodine, water) and commercial VMI software served as baseline methods

#### RESULTS

BEACAN improved quantification accuracy (e.g., RMSE of BEACAN vs Iter-MD: Iodinated blood 0.8 vs >1.6mgI/cc; HA <12 vs >14mgHA/cc; Fat <6 vs >70mgFat/cc), and generalized well in patients (e.g., little iodine residual in HA maps, reduced beam-hardening, and preserved details). Heteroscedastic uncertainty was observed, and tissue boundaries (e.g., plaque-lumen) tend to show higher variability. BEACAN-synthesized VMIs enhanced iodine signal, but reduced image noise (range 28% to 50% at 55keV) and blooming artifacts relative to commercial VMI. VNCa displayed at varying keVs can be derived from BEACAN, which is not commercially available on scanner

#### CONCLUSION

BEACAN provides high-quality spectral CT post-processing, showing improved material decomposition and VMI image quality in patient exams

#### CLINICAL RELEVANCE/APPLICATION

BEACAN is potential to accurately quantify target material in patients with dense calcified plaques, which could be undiagnostic in standard CT. It provides built-in uncertainty estimation to support anomaly detection and decision support

### W7-SSPH11-2 Improved Stenosis Assessment through AI-Enabled Virtual Monoenergetic Imaging on Photon Counting Detector CT in Ultra-High-Resolution Mode

Shaojie Chang, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Ultra-high-resolution (UHR) photon counting detector (PCD) CT has shown great potential in various clinical applications. However, the current commercial system lacks multi-energy capabilities in the UHR, ECG-gated cardiac scan mode. This study aims to use a convolutional neural network to generate virtual monoenergetic images (VMIs, Mono-CNN) in UHR mode to improve stenosis assessments in patients with dense calcifications.

## METHODS AND MATERIALS

Coronary CT angiography (cCTA) exams performed with standard (144x0.4 mm) multi-energy and UHR (120x0.2 mm) scan modes on a commercial dual-source PCD-CT (NAEOTOM Alpha, Siemens) were included for training and testing. VMIs at 100 keV and 70 keV (70 keV is effective energy of 120 kV beam) from the standard mode were reconstructed following the standard clinical protocol, using an iterative reconstruction (IR) algorithm at strength 4, Bv60 kernel, 0.6 mm slice thickness. A convolutional neural network (Mono-CNN) was trained using MSE loss with the 70 keV VMI as input and the 100 keV VMI as the label. The trained Mono-CNN was validated on independent multi-energy data sets (not used in training), with Mono-CNN VMI compared qualitatively and quantitatively to the true VMI. For testing, the Mono-CNN was applied to the single-energy-equivalent (T3D) cCTA patient cases (n=10) acquired with the UHR mode (no multi-energy capability), which were reconstructed using IR-4, Bv60 kernel, and 0.4 mm slice thickness. In addition to visual assessment, quantitative assessment of percent area stenosis was performed using commercial software (Syngo.Via CT Coronary Vascular Definition, Siemens). Stenosis quantification was performed for both T3D images and the Mono-CNN-generated 100 keV VMIs and the results were compared.

## RESULTS

The Mono-CNN generated high-quality images that closely resembled the true 100 keV VMIs. Mean HU differences between Mono-CNN and true VMI were 4.85 (1.6%), 8.82 (8.7%), and 1.37 (1.6%) HU for ROIs in the aorta, left ventricle, and myocardial fat, respectively. The UHR 100 keV VMIs produced by Mono-CNN demonstrated reduced blooming artifacts compared to standard T3D images. Quantitative analysis showed reduction of percent area stenosis in every patient involved in this study, with an average reduction of 12%, ranging from 4 to 20%.

## CONCLUSION

Mono-CNN provides VMI capabilities to the UHR cCTA in PCD-CT, enabling simultaneous high-resolution and multi-energy imaging, which can reduce blooming artifacts and improve stenosis assessment.

## CLINICAL RELEVANCE/APPLICATION

The Mono-CNN has the potential to improve the PCD-CT system's performance by decreasing cardiac blooming artifacts in the 100 keV images while also using the highest spatial resolution.

## W7-SSPH11-3 Deep Learning-based 4D CT and 4D CBCT Motion Compensation of Periodic and Non-Periodic Patient Motion with Single-View Temporal Resolution

Joscha Maier, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To provide cardiac- and respiratory-compensated CT and cone-beam CT (CBCT) reconstructions showing the patient in any patient motion state that had occurred during the acquisition, i.e. at the time point of any given x-ray projection of the scan.

## METHODS AND MATERIALS

Some CT and several CBCT applications rely on 4D (3D+time) reconstructions that resolve organ motion. To do so, current strategies typically synchronize the scan with an external motion monitoring device such as a breathing belt or an ECG. Subsequently, projections sharing a similar motion phase are reconstructed together to derive a set of phase-correlated (gated) reconstructions that represent different phases of the motion cycle. This strategy, that is often followed by motion compensation (MoCo), which is the determination of motion vector fields (MVFs) and the warping of the phases according to these MVFs into a target phase, implicitly assumes periodic motion and fails in case of irregular and non-periodic motion patterns. Here, we also determine MVFs, but we do no gating. Instead, each individual projection is reconstructed into a separate volume, which is referred to as partial angle reconstruction (PAR). A deep neural network is trained on simulated data to derive the desired MVFs between any two PARs of the scan. With N projections, there will be N PARs and N(N-1) MVFs. The MVFs used for the simulation serve as training labels, i.e. as ground truth (GT). Since CT reconstruction is a linear operation, a MoCo for time point n (projection n) can be performed by warping all PARs with  $n' \neq n$  into time point n and summing up the warped PARs. To evaluate the performance of the proposed approach, it was tested on simulated data as well as on real measurements of patients scanned with the on-board CBCT of a Varian TrueBeam® system.

## RESULTS

For all simulated test cases, the estimated MVFs were in good agreement with the GT MVFs. MoCo volumes based on the estimated MVFs differed by less than 12 HU on average from the respective GT. In case of measured patient data, respiratory and cardiac motion could clearly be resolved for both regular and highly irregular motion patterns. In particular, the

displacement of the diaphragm extracted from the MoCo reconstructions showed a high correlation with external respiration signals.

## **CONCLUSION**

Using the proposed approach allows to derive accurate 4D reconstructions of patients with arbitrary motion patterns without the need for external gating signals. Thereby, the temporal resolution equals the acquisition time of a single projection.

## **CLINICAL RELEVANCE/APPLICATION**

The high temporal resolution may improve 4D CBCT applications such as radiation therapy planning or tumor tracking while not requiring external gating signals simplifies patient preparation.

## **W7-SSPH11-4 Fourier Diffusion Models for CT Denoising and Restoration for Known Image Properties**

Web W. Stayman, PhD (*Presenter*) Research Grant, Fischer Medical; Research Grant, General Electric Company; Research Grant, Canon Medical Systems Corporation; Research collaboration, Koninklijke Philips NV; Research collaboration, Siemens AG; Researcher, Varex Imaging Corporation

## **PURPOSE**

Diffusions models have found widespread application in imaging applications including denoising and restoration approaches. We modify the commonly used scalar diffusion model that relies on a relatively simple stochastic process of image fading and incremental independent Gaussian noise to a process that includes spatial blur and correlated noise. Such Fourier diffusion models permit matching of this model to the image properties (i.e., spatial resolution and noise distribution) produced by a CT system for improved performance.

## **METHODS AND MATERIALS**

The Fourier diffusion model is built upon a stochastic process where an incremental spatial blur and incremental correlated noise is applied at every time step. This forward process allows for the definition of a reverse stochastic differential equation that includes a score term that can be learned and applied in a discrete update equation. We implement a score-matching neural network that is conditioned on time samples and measurements. Specifically, we trained a UNet using Lung Image Database Consortium images comprised of 8000 slices of training data, 2000 validation slices, and with 10,000 epochs, uniform time sampling, and 32 images per batch. Blur and noise emulated the modulation transfer function and noise power spectrum of a typical CT image volume. The Fourier Diffusion model was compared with a scalar diffusion model using a varied number of time steps in the discrete update equation.

## **RESULTS**

We find that the Fourier diffusion model achieves a mean squared error reduction of greater than 25% across the range of time steps investigated. Moreover, the Fourier diffusion model achieves nearly optimal performance using only 16 time steps whereas scalar diffusion appears to require about 4 times the number of time steps to achieve its optimal performance.

## **CONCLUSION**

Fourier diffusion models allows for explicit modeling of the image properties in CT data. Integration of this information into the model permits both improved restoration of image data, but also a smaller number of time steps in the iterative update equation. This addresses a commonly cited disadvantage of diffusion models - namely, the increased computation time required by fine discretization of the reverse stochastic process.

## **CLINICAL RELEVANCE/APPLICATION**

While diffusion models have already shown great promise for dose reduction and resolution improvements in x-ray computed tomography, explicit modeling of CT image properties within the diffusion framework permits both faster implementation of the data processing as well as improved imaging performance.

## **W7-SSPH11-5 Iodine Map Generation from Single-kV Contrast-enhanced CT Scan using a Conditional Diffusion Probabilistic Machine Learning (CDPML) Model**

Ran Zhang, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Iodine maps generated from dual-energy CT (DECT) have numerous clinical and pathological applications in cardiothoracic and abdominal imaging. Using the iodine maps as input, various DECT image sets such as virtual monochromatic images, virtual unenhanced images, and effective atomic number images can be derived. However, it is highly desirable to generate corresponding iodine maps from contrast-enhanced CT data acquired from scanners without dual-energy functionality. This work aims to develop a conditional diffusion probabilistic machine learning (CDPML) model for generating iodine maps from single-kV CT data.

## METHODS AND MATERIALS

Diffusion probabilistic models can be applied to learn the statistical distribution of DECT-generated iodine maps. To generate the patient-specific iodine maps from single-kV contrast-enhanced CT scans, the diffusion-reverse-diffusion process was modified to incorporate the single-kV contrast-enhanced CT image as a conditional input in the iodine map generation process, resulting in a proposed CDPML model. The training dataset included 17,284 paired (140-kV image, iodine maps) image slices from 151 subjects who underwent DECT at a single clinical center. The testing dataset had 903 image slices from 12 subjects independent of the training set. The performance of the generated iodine maps was evaluated against the corresponding DECT reference using quantitative image quality metrics, including root mean square error (RMSE) and structural similarity index measure (SSIM). Bland-Altman analysis was employed to evaluate the mean differences between the generated iodine map and the DECT reference.

## RESULTS

(1). The median [25th, 75th percentiles] of RMSE for all the test cases is 0.58 [0.52, 0.66] mg/ml, and the median [25th, 75th percentiles] of SSIM is 0.979 [0.975, 0.982]. (2). Bland-Altman analysis shows the mean bias between DECT and CDPML over the entire test cohort is -0.02 mg/ml and the agreement limits are [-0.63 mg/ml, 0.59 mg/ml]. (3). The CDPML model also facilitates uncertainty estimation, essential for establishing trust in AI for medical imaging.

## CONCLUSION

Machine learning models trained using the proposed CDPML scheme offer a new approach to generating clinically relevant iodine maps from single-kV contrast-enhanced CT exams.

## CLINICAL RELEVANCE/APPLICATION

Using machine learning models to generate iodine maps from single-kV contrast-enhanced CT images can equip many lower-end CT scanners with dual-energy CT functionality to improve their diagnostic values in clinical practice.

## W7-SSPH11-6 Automatic Liver Tumor Screening and Differential Diagnosis in CT Using Pixel-Lesion-Patient Network with Reader Study and External Validation

Ling Zhang (*Presenter*) Nothing to Disclose

## PURPOSE

We aim to build an accurate tumor segmentation and classification model to screen for liver tumors in non-contrast (NC) CTs, as well as to diagnose tumor types in multiphase contrast-enhanced (CE) CTs.

## METHODS AND MATERIALS

Our cohort contains 1790 control cases without liver tumors and 1368 patients. Among them, 1749 from one hospital are used for model development, the other 1409 from three hospitals are used for internal and external validation. We consider full-spectrum liver tumors, including seven major types (HCC, ICC, metastasis, hepatoblastoma, hemangioma, FNH, cyst) and "others". A proportion of control cases have diffuse liver diseases such as hepatitis and steatosis. Each patient has three CT scans, i.e. NC, arterial, and venous phases. A radiologist with 10 years of experience in liver imaging annotated the 3D tumor masks and types in all patients according to pathological reports. A novel algorithm called pixel-lesion-patient network is proposed. It contains three branches with bottom-up cooperation. The pixel branch produces a pixel-wise segmentation map helping to initialize the lesion branch. The lesion branch focuses on lesion-wise segmentation and classification using a mask transformer to leverage liver context information and inter-lesion relationship. The patient branch aggregates features from the whole CT and predicts image-level labels.

## RESULTS

We conduct reader study to compare our model with two radiologists on an internal test set with 150 patients and 100 normal subjects. Using NC CT, our model achieves 96.7% in sensitivity and 98.0% in specificity in patient-level tumor screening (AUC=0.985). It is on par with a senior radiologist (SR) with 16 years of experience (94.1%, 99.0%), surpassing a junior radiologist (JR) with 2 years of experience (85.5%, 99.0%). Our model can also classify NC CTs into normal, benign, and malignant with 91.3% accuracy (SR: 90.8%, JR: 72.0%). Using CE CT, the model can distinguish 8 tumor types with 75.6% accuracy (SR: 75.6%, JR: 40.5%). We further evaluate on external NC CT test sets of 279 patients with HCC and 880 normal subjects, achieving 97% sensitivity and 96.4% specificity.

## CONCLUSION

The pixel-lesion-patient network can effectively detect liver tumor patients in NC CT and classify eight types of tumors in CE CT, with similar accuracy to a senior radiologist and better than a junior one. As far as we know, in the task of differential diagnosis on CE CT, it is the first model on par with a senior radiologist specialized in liver imaging. It also generalizes well to external datasets.

## **CLINICAL RELEVANCE/APPLICATION**

Our model can be applied to screen patients with liver tumor using NC CT for early detection and triage with high accuracy. It can also help clinicians differentiate major tumor types in CE CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPH11-1

### Unified Spectral Processing in Photon-counting-detector CT using Bayesian Deep Learning with Explicit Uncertainty and Bias Penalty

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

Hao Gong, PHD (*Presenter*) Nothing to Disclose

#### PURPOSE

Photon-counting-detector (PCD) CT provides high-quality spectral data to derive multiple image types (e.g., iodine maps, virtual monoenergetic (VMI), non-calcium (VNCa)), which assist diagnoses in many CT tasks. Conventional spectral processing methods are susceptible to amplified image noise and artifacts that impede reader interpretation. We aim to improve diagnostic image quality through unified spectral processing based on Bayesian deep learning with explicit uncertainty and bias penalty (BEACAN)

#### METHODS AND MATERIALS

BEACAN is based on a Bayesian dual-task neural network with bifurcated branches to classify types and quantify mass densities of basis materials. The network used probabilistic modeling of model likelihood and posterior distribution to re-balance its uncertainty and bias in training and characterize the statistical distribution of outputs for given inputs. Training used PCD-CT low-/high-threshold images of tissue-/contrast-mimicking inserts (e.g., hydroxyapatite (HA), iodine, muscle) and simulated random-shaped inserts. The predicted means of mass density maps were used to derive additional image types, due to improved robustness and detail preservation. Pixel-wise uncertainty was derived to support anomaly detection. Material quantification accuracy was assessed using root mean square error (RMSE) at 100% and 50% routine doses. For proof of concept, 5 patient CT cardiac angiograms were used to assess overall image quality, noise, and artifacts in material maps and VMIs. A prior-knowledge-assisted iterative material decomposition (Iter-MD; basis materials: HA, iodine, water) and commercial VMI software served as baseline methods

#### RESULTS

BEACAN improved quantification accuracy (e.g., RMSE of BEACAN vs Iter-MD: Iodinated blood 0.8 vs >1.6mgI/cc; HA <12 vs >14mgHA/cc; Fat <6 vs >70mgFat/cc), and generalized well in patients (e.g., little iodine residual in HA maps, reduced beam-hardening, and preserved details). Heteroscedastic uncertainty was observed, and tissue boundaries (e.g., plaque-lumen) tend to show higher variability. BEACAN-synthesized VMIs enhanced iodine signal, but reduced image noise (range 28% to 50% at 55keV) and blooming artifacts relative to commercial VMI. VNCa displayed at varying keVs can be derived from BEACAN, which is not commercially available on scanner

#### CONCLUSION

BEACAN provides high-quality spectral CT post-processing, showing improved material decomposition and VMI image quality in patient exams

#### CLINICAL RELEVANCE/APPLICATION

BEACAN is potential to accurately quantify target material in patients with dense calcified plaques, which could be undiagnostic in standard CT. It provides built-in uncertainty estimation to support anomaly detection and decision support

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## Abstract Archives of the RSNA, 2023

W7-SSPH11-2

### Improved Stenosis Assessment through AI-Enabled Virtual Monoenergetic Imaging on Photon Counting Detector CT in Ultra-High-Resolution Mode

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

Shaojie Chang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Ultra-high-resolution (UHR) photon counting detector (PCD) CT has shown great potential in various clinical applications. However, the current commercial system lacks multi-energy capabilities in the UHR, ECG-gated cardiac scan mode. This study aims to use a convolutional neural network to generate virtual monoenergetic images (VMIs, Mono-CNN) in UHR mode to improve stenosis assessments in patients with dense calcifications.

#### METHODS AND MATERIALS

Coronary CT angiography (cCTA) exams performed with standard (144x0.4 mm) multi-energy and UHR (120x0.2 mm) scan modes on a commercial dual-source PCD-CT (NAEOTOM Alpha, Siemens) were included for training and testing. VMIs at 100 keV and 70 keV (70 keV is effective energy of 120 kV beam) from the standard mode were reconstructed following the standard clinical protocol, using an iterative reconstruction (IR) algorithm at strength 4, Bv60 kernel, 0.6 mm slice thickness. A convolutional neural network (Mono-CNN) was trained using MSE loss with the 70 keV VMI as input and the 100 keV VMI as the label. The trained Mono-CNN was validated on independent multi-energy data sets (not used in training), with Mono-CNN VMI compared qualitatively and quantitatively to the true VMI. For testing, the Mono-CNN was applied to the single-energy-equivalent (T3D) cCTA patient cases (n=10) acquired with the UHR mode (no multi-energy capability), which were reconstructed using IR-4, Bv60 kernel, and 0.4 mm slice thickness. In addition to visual assessment, quantitative assessment of percent area stenosis was performed using commercial software (Syngo.Via CT Coronary Vascular Definition, Siemens). Stenosis quantification was performed for both T3D images and the Mono-CNN-generated 100 keV VMIs and the results were compared.

#### RESULTS

The Mono-CNN generated high-quality images that closely resembled the true 100 keV VMIs. Mean HU differences between Mono-CNN and true VMI were 4.85 (1.6%), 8.82 (8.7%), and 1.37 (1.6%) HU for ROIs in the aorta, left ventricle, and myocardial fat, respectively. The UHR 100 keV VMIs produced by Mono-CNN demonstrated reduced blooming artifacts compared to standard T3D images. Quantitative analysis showed reduction of percent area stenosis in every patient involved in this study, with an average reduction of 12%, ranging from 4 to 20%.

#### CONCLUSION

Mono-CNN provides VMI capabilities to the UHR cCTA in PCD-CT, enabling simultaneous high-resolution and multi-energy imaging, which can reduce blooming artifacts and improve stenosis assessment.

#### CLINICAL RELEVANCE/APPLICATION

The Mono-CNN has the potential to improve the PCD-CT system's performance by decreasing cardiac blooming artifacts in the 100 keV images while also using the highest spatial resolution.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-SSPH11-3

### Deep Learning-based 4D CT and 4D CBCT Motion Compensation of Periodic and Non-Periodic Patient Motion with Single-View Temporal Resolution

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

Joscha Maier, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To provide cardiac- and respiratory-compensated CT and cone-beam CT (CBCT) reconstructions showing the patient in any patient motion state that had occurred during the acquisition, i.e. at the time point of any given x-ray projection of the scan.

#### METHODS AND MATERIALS

Some CT and several CBCT applications rely on 4D (3D+time) reconstructions that resolve organ motion. To do so, current strategies typically synchronize the scan with an external motion monitoring device such as a breathing belt or an ECG. Subsequently, projections sharing a similar motion phase are reconstructed together to derive a set of phase-correlated (gated) reconstructions that represent different phases of the motion cycle. This strategy, that is often followed by motion compensation (MoCo), which is the determination of motion vector fields (MVFs) and the warping of the phases according to these MVFs into a target phase, implicitly assumes periodic motion and fails in case of irregular and non-periodic motion patterns. Here, we also determine MVFs, but we do no gating. Instead, each individual projection is reconstructed into a separate volume, which is referred to as partial angle reconstruction (PAR). A deep neural network is trained on simulated data to derive the desired MVFs between any two PARs of the scan. With  $N$  projections, there will be  $N$  PARs and  $N(N-1)$  MVFs. The MVFs used for the simulation serve as training labels, i.e. as ground truth (GT). Since CT reconstruction is a linear operation, a MoCo for time point  $n$  (projection  $n$ ) can be performed by warping all PARs with  $n' \neq n$  into time point  $n$  and summing up the warped PARs. To evaluate the performance of the proposed approach, it was tested on simulated data as well as on real measurements of patients scanned with the on-board CBCT of a Varian TrueBeam® system.

#### RESULTS

For all simulated test cases, the estimated MVFs were in good agreement with the GT MVFs. MoCo volumes based on the estimated MVFs differed by less than 12 HU on average from the respective GT. In case of measured patient data, respiratory and cardiac motion could clearly be resolved for both regular and highly irregular motion patterns. In particular, the displacement of the diaphragm extracted from the MoCo reconstructions showed a high correlation with external respiration signals.

#### CONCLUSION

Using the proposed approach allows to derive accurate 4D reconstructions of patients with arbitrary motion patterns without the need for external gating signals. Thereby, the temporal resolution equals the acquisition time of a single projection.

#### CLINICAL RELEVANCE/APPLICATION

The high temporal resolution may improve 4D CBCT applications such as radiation therapy planning or tumor tracking while not requiring external gating signals simplifies patient preparation.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-SSPH11-4

### Fourier Diffusion Models for CT Denoising and Restoration for Known Image Properties

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

Web W. Stayman, PhD (*Presenter*) Research Grant, Fischer Medical; Research Grant, General Electric Company; Research Grant, Canon Medical Systems Corporation; Research collaboration, Koninklijke Philips NV; Research collaboration, Siemens AG; Researcher, Varex Imaging Corporation

#### PURPOSE

Diffusions models have found widespread application in imaging applications including denoising and restoration approaches. We modify the commonly used scalar diffusion model that relies on a relatively simple stochastic process of image fading and incremental independent Gaussian noise to a process that includes spatial blur and correlated noise. Such Fourier diffusion models permit matching of this model to the image properties (i.e., spatial resolution and noise distribution) produced by a CT system for improved performance.

#### METHODS AND MATERIALS

The Fourier diffusion model is built upon a stochastic process where an incremental spatial blur and incremental correlated noise is applied at every time step. This forward process allows for the definition of a reverse stochastic differential equation that includes a score term that can be learned and applied in a discrete update equation. We implement a score-matching neural network that is conditioned on time samples and measurements. Specifically, we trained a UNet using Lung Image Database Consortium images comprised of 8000 slices of training data, 2000 validation slices, and with 10,000 epochs, uniform time sampling, and 32 images per batch. Blur and noise emulated the modulation transfer function and noise power spectrum of a typical CT image volume. The Fourier Diffusion model was compared with a scalar diffusion model using a varied number of time steps in the discrete update equation.

#### RESULTS

We find that the Fourier diffusion model achieves a mean squared error reduction of greater than 25% across the range of time steps investigated. Moreover, the Fourier diffusion model achieves nearly optimal performance using only 16 time steps whereas scalar diffusion appears to require about 4 times the number of time steps to achieve its optimal performance.

#### CONCLUSION

Fourier diffusion models allows for explicit modeling of the image properties in CT data. Integration of this information into the model permits both improved restoration of image data, but also a smaller number of time steps in the iterative update equation. This addresses a commonly cited disadvantage of diffusion models - namely, the increased computation time required by fine discretization of the reverse stochastic process.

#### CLINICAL RELEVANCE/APPLICATION

While diffusion models have already shown great promise for dose reduction and resolution improvements in x-ray computed tomography, explicit modeling of CT image properties within the diffusion framework permits both faster implementation of the data processing as well as improved imaging performance.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPH11-5

### Iodine Map Generation from Single-kV Contrast-enhanced CT Scan using a Conditional Diffusion Probabilistic Machine Learning (CDPML) Model

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

Ran Zhang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Iodine maps generated from dual-energy CT (DECT) have numerous clinical and pathological applications in cardiothoracic and abdominal imaging. Using the iodine maps as input, various DECT image sets such as virtual monochromatic images, virtual unenhanced images, and effective atomic number images can be derived. However, it is highly desirable to generate corresponding iodine maps from contrast-enhanced CT data acquired from scanners without dual-energy functionality. This work aims to develop a conditional diffusion probabilistic machine learning (CDPML) model for generating iodine maps from single-kV CT data.

#### METHODS AND MATERIALS

Diffusion probabilistic models can be applied to learn the statistical distribution of DECT-generated iodine maps. To generate the patient-specific iodine maps from single-kV contrast-enhanced CT scans, the diffusion-reverse-diffusion process was modified to incorporate the single-kV contrast-enhanced CT image as a conditional input in the iodine map generation process, resulting in a proposed CDPML model. The training dataset included 17,284 paired (140-kV image, iodine maps) image slices from 151 subjects who underwent DECT at a single clinical center. The testing dataset had 903 image slices from 12 subjects independent of the training set. The performance of the generated iodine maps was evaluated against the corresponding DECT reference using quantitative image quality metrics, including root mean square error (RMSE) and structural similarity index measure (SSIM). Bland-Altman analysis was employed to evaluate the mean differences between the generated iodine map and the DECT reference.

#### RESULTS

(1). The median [25th, 75th percentiles] of RMSE for all the test cases is 0.58 [0.52, 0.66] mg/ml, and the median [25th, 75th percentiles] of SSIM is 0.979 [0.975, 0.982]. (2). Bland-Altman analysis shows the mean bias between DECT and CDPML over the entire test cohort is -0.02 mg/ml and the agreement limits are [-0.63 mg/ml, 0.59 mg/ml]. (3). The CDPML model also facilitates uncertainty estimation, essential for establishing trust in AI for medical imaging.

#### CONCLUSION

Machine learning models trained using the proposed CDPML scheme offer a new approach to generating clinically relevant iodine maps from single-kV contrast-enhanced CT exams.

#### CLINICAL RELEVANCE/APPLICATION

Using machine learning models to generate iodine maps from single-kV contrast-enhanced CT images can equip many lower-end CT scanners with dual-energy CT functionality to improve their diagnostic values in clinical practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPH11-6

### Automatic Liver Tumor Screening and Differential Diagnosis in CT Using Pixel-Lesion-Patient Network with Reader Study and External Validation

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N227B

Ling Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

We aim to build an accurate tumor segmentation and classification model to screen for liver tumors in non-contrast (NC) CTs, as well as to diagnose tumor types in multiphase contrast-enhanced (CE) CTs.

#### METHODS AND MATERIALS

Our cohort contains 1790 control cases without liver tumors and 1368 patients. Among them, 1749 from one hospital are used for model development, the other 1409 from three hospitals are used for internal and external validation. We consider full-spectrum liver tumors, including seven major types (HCC, ICC, metastasis, hepatoblastoma, hemangioma, FNH, cyst) and "others". A proportion of control cases have diffuse liver diseases such as hepatitis and steatosis. Each patient has three CT scans, i.e. NC, arterial, and venous phases. A radiologist with 10 years of experience in liver imaging annotated the 3D tumor masks and types in all patients according to pathological reports. A novel algorithm called pixel-lesion-patient network is proposed. It contains three branches with bottom-up cooperation. The pixel branch produces a pixel-wise segmentation map helping to initialize the lesion branch. The lesion branch focuses on lesion-wise segmentation and classification using a mask transformer to leverage liver context information and inter-lesion relationship. The patient branch aggregates features from the whole CT and predicts image-level labels.

#### RESULTS

We conduct reader study to compare our model with two radiologists on an internal test set with 150 patients and 100 normal subjects. Using NC CT, our model achieves 96.7% in sensitivity and 98.0% in specificity in patient-level tumor screening (AUC=0.985). It is on par with a senior radiologist (SR) with 16 years of experience (94.1%, 99.0%), surpassing a junior radiologist (JR) with 2 years of experience (85.5%, 99.0%). Our model can also classify NC CTs into normal, benign, and malignant with 91.3% accuracy (SR: 90.8%, JR: 72.0%). Using CE CT, the model can distinguish 8 tumor types with 75.6% accuracy (SR: 75.6%, JR: 40.5%). We further evaluate on external NC CT test sets of 279 patients with HCC and 880 normal subjects, achieving 97% sensitivity and 96.4% specificity.

#### CONCLUSION

The pixel-lesion-patient network can effectively detect liver tumor patients in NC CT and classify eight types of tumors in CE CT, with similar accuracy to a senior radiologist and better than a junior one. As far as we know, in the task of differential diagnosis on CE CT, it is the first model on par with a senior radiologist specialized in liver imaging. It also generalizes well to external datasets.

#### CLINICAL RELEVANCE/APPLICATION

Our model can be applied to screen patients with liver tumor using NC CT for early detection and triage with high accuracy. It can also help clinicians differentiate major tumor types in CE CT.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPH12

### Physics (Nuclear Medicine)

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N229

Chien-Min Kao, PhD (*Moderator*) Stockholder, Walgreens Boots Alliance, Inc  
Ke Li, PhD (*Moderator*) Research Consultant, Pulmera Inc.

#### Sub-Events

### W7-SSPH12-2 Feasibility Studies of an Ultra-low-dose, Stationary, Tomographic Molecular Breast Imaging System using 3D CZT Detectors

Alexander Cherlin, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Molecular Breast Imaging (MBI) has been shown to have high sensitivity in cancer detection, even in dense breast tissue. However, long imaging time and radiation dose that is higher than mammography impede its wide adoption. A novel ultra-low-dose stationary tomographic MBI system is being developed by Kromek and University College London. Comparing to planar MBI, the new system is expected to provide the patient dose reduction to the mammography level, better sensitivity, and improved diagnostic content by detecting smaller lesions and their 3D structure.

#### METHODS AND MATERIALS

The feasibility prototype has been built at Kromek with 2x2 array of 5 mm thick 2 mm pixel CZT detectors with 2x2 sub-pixelisation, and a densely packed multi-pinhole 3D printed tungsten collimator. The system delivers tomographic images with significant multiplexing. De-multiplexing algorithms utilise DOI information to mitigate the adverse multiplexing artefacts. GATE and MATLAB simulations were used to evaluate the design feasibility, develop new image reconstruction methods and to compare the performance of the new system to published planar MBI results. It is being evaluated using an "activity-painting" setup and a point  $^{57}\text{Co}$  source and  $^{99\text{m}}\text{Tc}$ -filled physical phantoms. Non-local means (NLM) noise filtering and a relaxation scheme were applied to the results to improve the contrast-to-noise ratio (CNR) and lesion detection uniformity across the field of view (FOV).

#### RESULTS

The images reconstructed in both simulations and phantom measurements demonstrate very effective reduction of multiplexing artefacts by using the detector DOI information. CNR of  $\sim 15$  was achieved after collimator design optimisation and image de-noising using NLM filtering. Multiple algorithms were implemented in both simulated and experimental data image reconstruction to compare their performance. The algorithms incorporating the multiplexing directly in the system matrix have shown better performance. The relaxation scheme demonstrated significant improvement of image reconstruction performance across the FOV. As the next step, Kromek is working with clinical partners on designing a full-size prototype and preparations for clinical trials.

#### CONCLUSION

Our results demonstrate the feasibility to decrease the injected patient dose to about 2 mCi/75 MBq (equiv. to mammography dose of  $\sim 0.5$  mSv), significantly decrease the scan time comparing to the current 40 min and decrease the lesion detection size to 5-6 mm across the whole FOV.

#### CLINICAL RELEVANCE/APPLICATION

The reduction of patient dose, scan time, and 3D localisation, aiding biopsy, should fulfil American College of Radiology's criteria (2018) for accepting MBI for cancer screening, especially for patients with dense breast tissue.

### W7-SSPH12-3 Development of a Novel Compton Camera for Low Dose Nuclear Medicine Imaging

Bill Kamtchou, MSc, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to develop a Compton camera for Nuclear Medicine imaging applications using Timepix technology. A Compton camera is an imaging device that can determine the direction of photons emitted by radioisotopes based on the kinematics of Compton scattering. Current gamma camera technology relies on the use of collimators to determine positional information of incident photons. Collimators, however, attenuate >99% of incident photons, requiring increased administered activities. The development of a Compton camera would negate the need for collimators, thus significantly reducing patient dose and potentially improving patient throughput.

## METHODS AND MATERIALS

A high spatial, high contrast resolution Timepix3 (55  $\mu\text{m}$  pixel pitch) device with a Cadmium Telluride sensor layer was used to acquire 2D image datasets for  $^{99\text{mTc}}$ ,  $^{131\text{I}}$  and  $^{137\text{Cs}}$  test objects. Analysis pipelines were established for identifying appropriate interaction events and clusters, with subsequent Compton cone data reconstructed onto single and multiple planes, using maximum likelihood expectation maximization (MLEM) techniques. A Monte Carlo (MC) simulation of the Timepix3 detector Compton camera was developed using the EGSnrc Monte Carlo software.

## RESULTS

The model, accounting for the Timepix3 spatial and energy resolution, in addition to Doppler broadening effects, was validated using the above experimental data. The spatial resolution, as measured by the full width half maximum (FWHM) of  $^{99\text{mTc}}$  and  $^{137\text{Cs}}$  point sources was found to be 6 and 6.6 mm, respectively, which is comparable to that of high resolution gamma cameras. Images of anthropomorphic thyroid phantoms will be presented and compared to conventional gamma cameras in terms of sensitivity and spatial resolution.

## CONCLUSION

A nuclear medicine Compton camera has been developed, with experimental data and simulations demonstrating its potential for Compton imaging applications. Future work will extend the use of the CdTe Timepix3 detector to more complex nuclear medicine imaging applications to investigate the technology's potential to significantly reduce administered patient activities and, hence, reduce patient dose.

## CLINICAL RELEVANCE/APPLICATION

The development of a Compton camera has the potential to significantly reduce the required patient radiation dose in nuclear medicine. The results demonstrate that Timepix can be effectively used for Compton imaging with a spatial resolution comparable to current state-of-the-art gamma cameras, but with an approximately 20-fold increased sensitivity. Further development of this technology could lead to a significant increase in patient throughput and the establishment of novel nuclear medicine imaging, such as low dose screening studies.

## W7- SSPH12-5 Risk Assessment for Fetal Dose

Christiane S. Burton, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Quantifying radiation risk is needed for optimizing personalized procedures involving imaging with radiation dose. There are various methods for characterizing radiation risk for CT and PET. Purpose We demonstrate the radiation risk for various tissue in fetuses for pregnant patients who underwent PET/CT examinations.

## METHODS AND MATERIALS

Nine pregnant patients underwent a PET/CT examination over an 11-year period at the University of Michigan. The gestational ages range from 12-36 weeks. The radiation risk index (RRI) was measured using the lifetime attributable risk (LAR) of cancer incidences in the US population from BEIR VII. For CT, the fetal organ tissue dose needed for RRI was calculated using the Monte Carlo simulations that utilizes the ICRP reference phantoms. For PET, the MIRD calculation was used for the RRI calculation using a low  $^{18\text{F}}$  activity of 3.5 mCi for fetuses at 12, 24 and 36 weeks of gestation.

## RESULTS

The RRI ranges from 2.1 to 85.5 cases per 100,000 patients per 100 mGy. There were also notable differences in risk index for various tissues between males and females, particularly lung and colon. The risk index for CTDIvol of 50 mGy and 100 mGy for fetuses was shown to decrease as gestational increases for 12, 24 and 36 weeks.

## CONCLUSION

The risk of PET/CT dose to fetus doses for various tissues have been reported. While maintaining fetal dose below 100 mGy is important, there are risks associated with different fetal tissues that should be considered should a pregnant patient need to undergo a diagnostic exam that involves radiation.

## CLINICAL RELEVANCE/APPLICATION

While clinical PET/CT scans are considered safe for fetuses, the SSDE is not a reliable risk estimate, and the radiation risk should be considered when modifying doses to a pregnant patient.

### W7-SSPH12-6 **Comparison of the Accuracy of an Optimised Planar Scintigraphy LSF Estimation Technique with SPECT-CT LSF: A Monte Carlo (MC) Study for a Range of Gamma Camera Systems**

Niamh McArdle, BSc, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Prior to 90Y selective internal radiation therapy (SIRT) treatment, planar 99mTc-MAA scintigraphy imaging is used in the estimation of the lung shunt fraction (LSF). Significant overestimations in the LSF using planar imaging has been well documented hence affecting the dosimetric accuracy. While this remains the manufacturer's recommended method for LSF estimation, it neglects to account for scatter radiation and respiratory motion. A scatter window based correction has been shown to significantly improve the LSF estimation accuracy. However, the technique has only been demonstrated for an average sized phantom, on a specific gamma camera type and has yet to be compared with SPECT-CT LSF estimations. Accordingly, the objective of this study was to compare the accuracy of the optimised planar LSF estimation (LSF<sub>planar</sub>) technique, with that of SPECT-CT (LSFSPECT), for a set of 4D virtual phantoms representative of a typical patient population, and applied to a range of gamma camera systems.

#### METHODS AND MATERIALS

SIMIND Monte Carlo (MC) modelling software was used to simulate planar scintigraphy and SPECT-CT images of the XCAT 4D digital anatomical phantom for clinically relevant LSFs (0-25%). MC image acquisition of different modelled anatomical phantoms (BMI of 21-38 kgm<sup>-2</sup>) were simulated on a range of systems including a GE NM gamma camera series including CZT technology, Phillips Brightspace and Siemens Symbia. The scatter corrected LSF<sub>planar</sub> technique was compared with the LSFSPECT for each gamma camera type.

#### RESULTS

The scatter correction technique significantly improved the LSF<sub>planar</sub> accuracy to within 28% across each gamma camera type, as compared with overestimations of up to 200% prior to scatter correction. The employment of an enhanced depth specific scatter correction, to account for varying patient size, further improved the LSF<sub>planar</sub> accuracy to within 19%. Spectral analysis showed a 114-126 keV scatter energy window to be optimal for sodium-iodide detectors with a scatter window of ~99-128 keV most applicable for CZT technology. A comparison between optimised LSF<sub>planar</sub> and that of LSFSPECT imaging datasets will be presented.

#### CONCLUSION

LSF<sub>planar</sub> with incorporated scatter correction can significantly improve the accuracy of the planar LSF estimation approaching that of LSF<sub>SPECT</sub>. The use of MC simulations and voxel based phantoms allowed for comparison between true and estimated LSFs in a range of phantom sizes representative of the patient population. This revised methodology facilitates improved accuracy in the dosimetry estimation using planar imaging and a more optimised prescribed patient therapy dose.

## CLINICAL RELEVANCE/APPLICATION

Accurate LSF estimations can improve the therapeutic dose calculations for SIRT patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPH12-2

### Feasibility Studies of an Ultra-low-dose, Stationary, Tomographic Molecular Breast Imaging System using 3D CZT Detectors

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N229

Alexander Cherlin, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Molecular Breast Imaging (MBI) has been shown to have high sensitivity in cancer detection, even in dense breast tissue. However, long imaging time and radiation dose that is higher than mammography impede its wide adoption. A novel ultra-low-dose stationary tomographic MBI system is being developed by Kromek and University College London. Comparing to planar MBI, the new system is expected to provide the patient dose reduction to the mammography level, better sensitivity, and improved diagnostic content by detecting smaller lesions and their 3D structure.

#### METHODS AND MATERIALS

The feasibility prototype has been built at Kromek with 2x2 array of 5 mm thick 2 mm pixel CZT detectors with 2x2 sub-pixelisation, and a densely packed multi-pinhole 3D printed tungsten collimator. The system delivers tomographic images with significant multiplexing. De-multiplexing algorithms utilise DOI information to mitigate the adverse multiplexing artefacts. GATE and MATLAB simulations were used to evaluate the design feasibility, develop new image reconstruction methods and to compare the performance of the new system to published planar MBI results. It is being evaluated using an "activity-painting" setup and a point  $^{57}\text{Co}$  source and  $^{99\text{m}}\text{Tc}$ -filled physical phantoms. Non-local means (NLM) noise filtering and a relaxation scheme were applied to the results to improve the contrast-to-noise ratio (CNR) and lesion detection uniformity across the field of view (FOV).

#### RESULTS

The images reconstructed in both simulations and phantom measurements demonstrate very effective reduction of multiplexing artefacts by using the detector DOI information. CNR of  $\sim 15$  was achieved after collimator design optimisation and image de-noising using NLM filtering. Multiple algorithms were implemented in both simulated and experimental data image reconstruction to compare their performance. The algorithms incorporating the multiplexing directly in the system matrix have shown better performance. The relaxation scheme demonstrated significant improvement of image reconstruction performance across the FOV. As the next step, Kromek is working with clinical partners on designing a full-size prototype and preparations for clinical trials.

#### CONCLUSION

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#### CLINICAL RELEVANCE/APPLICATION

The reduction of patient dose, scan time, and 3D localisation, aiding biopsy, should fulfil American College of Radiology's criteria (2018) for accepting MBI for cancer screening, especially for patients with dense breast tissue.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPH12-3

### Development of a Novel Compton Camera for Low Dose Nuclear Medicine Imaging

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N229

Bill Kamtchou, MSc, BSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to develop a Compton camera for Nuclear Medicine imaging applications using Timepix technology. A Compton camera is an imaging device that can determine the direction of photons emitted by radioisotopes based on the kinematics of Compton scattering. Current gamma camera technology relies on the use of collimators to determine positional information of incident photons. Collimators, however, attenuate >99% of incident photons, requiring increased administered activities. The development of a Compton camera would negate the need for collimators, thus significantly reducing patient dose and potentially improving patient throughput.

#### METHODS AND MATERIALS

A high spatial, high contrast resolution Timepix3 (55  $\mu\text{m}$  pixel pitch) device with a Cadmium Telluride sensor layer was used to acquire 2D image datasets for  $^{99\text{mTc}}$ ,  $^{131\text{I}}$  and  $^{137\text{Cs}}$  test objects. Analysis pipelines were established for identifying appropriate interaction events and clusters, with subsequent Compton cone data reconstructed onto single and multiple planes, using maximum likelihood expectation maximization (MLEM) techniques. A Monte Carlo (MC) simulation of the Timepix3 detector Compton camera was developed using the EGSnrc Monte Carlo software.

#### RESULTS

The model, accounting for the Timepix3 spatial and energy resolution, in addition to Doppler broadening effects, was validated using the above experimental data. The spatial resolution, as measured by the full width half maximum (FWHM) of  $^{99\text{mTc}}$  and  $^{137\text{Cs}}$  point sources was found to be 6 and 6.6 mm, respectively, which is comparable to that of high resolution gamma cameras. Images of anthropomorphic thyroid phantoms will be presented and compared to conventional gamma cameras in terms of sensitivity and spatial resolution.

#### CONCLUSION

A nuclear medicine Compton camera has been developed, with experimental data and simulations demonstrating its potential for Compton imaging applications. Future work will extend the use of the CdTe Timepix3 detector to more complex nuclear medicine imaging applications to investigate the technology's potential to significantly reduce administered patient activities and, hence, reduce patient dose.

#### CLINICAL RELEVANCE/APPLICATION

The development of a Compton camera has the potential to significantly reduce the required patient radiation dose in nuclear medicine. The results demonstrate that Timepix can be effectively used for Compton imaging with a spatial resolution comparable to current state-of-the-art gamma cameras, but with an approximately 20-fold increased sensitivity. Further development of this technology could lead to a significant increase in patient throughput and the establishment of novel nuclear medicine imaging, such as low dose screening studies.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-SSPH12-5

### Risk Assessment for Fetal Dose

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N229

Christiane S. Burton, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Quantifying radiation risk is needed for optimizing personalized procedures involving imaging with radiation dose. There are various methods for characterizing radiation risk for CT and PET. Purpose We demonstrate the radiation risk for various tissue in fetuses for pregnant patients who underwent PET/CT examinations.

#### METHODS AND MATERIALS

Nine pregnant patients underwent a PET/CT examination over an 11-year period at the University of Michigan. The gestational ages range from 12-36 weeks. The radiation risk index (RRI) was measured using the lifetime attributable risk (LAR) of cancer incidences in the US population from BEIR VII. For CT, the fetal organ tissue dose needed for RRI was calculated using the Monte Carlo simulations that utilizes the ICRP reference phantoms. For PET, the MIRD calculation was used for the RRI calculation using a low  $^{18}\text{F}$  activity of 3.5 mCi for fetuses at 12, 24 and 36 weeks of gestation.

#### RESULTS

The RRI ranges from 2.1 to 85.5 cases per 100,000 patients per 100 mGy. There were also notable differences in risk index for various tissues between males and females, particularly lung and colon. The risk index for CTDIvol of 50 mGy and 100 mGy for fetuses was shown to decrease as gestational increases for 12, 24 and 36 weeks.

#### CONCLUSION

The risk of PET/CT dose to fetus doses for various tissues have been reported. While maintaining fetal dose below 100 mGy is important, there are risks associated with different fetal tissues that should be considered should a pregnant patient need to undergo a diagnostic exam that involves radiation.

#### CLINICAL RELEVANCE/APPLICATION

While clinical PET/CT scans are considered safe for fetuses, the SSDE is not a reliable risk estimate, and the radiation risk should be considered when modifying doses to a pregnant patient.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-SSPH12-6

### Comparison of the Accuracy of an Optimised Planar Scintigraphy LSF Estimation Technique with SPECT-CT LSF: A Monte Carlo (MC) Study for a Range of Gamma Camera Systems

Wednesday, Nov. 29 3:00PM - 4:00PM Room: N229

Niamh McArdle, BSc, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

Prior to 90Y selective internal radiation therapy (SIRT) treatment, planar  $^{99m}\text{Tc}$ -MAA scintigraphy imaging is used in the estimation of the lung shunt fraction (LSF). Significant overestimations in the LSF using planar imaging has been well documented hence affecting the dosimetric accuracy. While this remains the manufacturer's recommended method for LSF estimation, it neglects to account for scatter radiation and respiratory motion. A scatter window based correction has been shown to significantly improve the LSF estimation accuracy. However, the technique has only been demonstrated for an average sized phantom, on a specific gamma camera type and has yet to be compared with SPECT-CT LSF estimations. Accordingly, the objective of this study was to compare the accuracy of the optimised planar LSF estimation (LSF<sub>planar</sub>) technique, with that of SPECT-CT (LSFSPECT), for a set of 4D virtual phantoms representative of a typical patient population, and applied to a range of gamma camera systems.

#### METHODS AND MATERIALS

SIMIND Monte Carlo (MC) modelling software was used to simulate planar scintigraphy and SPECT-CT images of the XCAT 4D digital anatomical phantom for clinically relevant LSFs (0-25%). MC image acquisition of different modelled anatomical phantoms (BMI of 21-38 kgm<sup>-2</sup>) were simulated on a range of systems including a GE NM gamma camera series including CZT technology, Phillips Brightspace and Siemens Symbia. The scatter corrected LSF<sub>planar</sub> technique was compared with the LSFSPECT for each gamma camera type.

#### RESULTS

The scatter correction technique significantly improved the LSF<sub>planar</sub> accuracy to within 28% across each gamma camera type, as compared with overestimations of up to 200% prior to scatter correction. The employment of an enhanced depth specific scatter correction, to account for varying patient size, further improved the LSF<sub>planar</sub> accuracy to within 19%. Spectral analysis showed a 114-126 keV scatter energy window to be optimal for sodium-iodide detectors with a scatter window of ~99-128 keV most applicable for CZT technology. A comparison between optimised LSF<sub>planar</sub> and that of LSFSPECT imaging datasets will be presented.

#### CONCLUSION

LSF<sub>planar</sub> with incorporated scatter correction can significantly improve the accuracy of the planar LSF estimation approaching that of LSF<sub>SPECT</sub>. The use of MC simulations and voxel based phantoms allowed for comparison between true and estimated LSFs in a range of phantom sizes representative of the patient population. This revised methodology facilitates improved accuracy in the dosimetry estimation using planar imaging and a more optimised prescribed patient therapy dose.

#### CLINICAL RELEVANCE/APPLICATION

Accurate LSF estimations can improve the therapeutic dose calculations for SIRT patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-STCE1

### Science Session (Sustainability in Imaging)

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 1

#### Sub-Events

#### **W7-STCE1- Advancing sustainability and energy efficient MRI operations through Fast Imaging 1 Techniques**

Azadeh Tabari, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Using the latest MRI systems and accelerated MRI techniques can lead to significant energy savings in radiology by reducing active scan times and optimizing resource utilization. The goal of this study was to determine the acquisition time, energy, cost, and carbon savings that could be achieved through implementing fast MRI techniques in outpatient brain imaging.

#### **METHODS AND MATERIALS**

Acquisition time (i.e. net scan time: active mode - exam preparation time) were extracted from consecutive brain MRI examinations done on 4 outpatient 3T wide-bore scanners from the same vendor (all Magnetom Vida; Siemens Healthineers), during pre-implementation (3/1/2019-3/1/2020) and post-implementation periods (3/1/2022-3/1/2023). Expected acquisition times were compared for the most frequently performed brain MRI protocols: brain without contrast (BR-) and brain with and without contrast (BR+). Power measurement logs were extracted for these protocols. Data from the scanner system-on mode were acquired from the scanner log data and was segmented into exam preparation time, net scan time and swap time (idle) for each scanner. Per-examination energy consumption, cost (assuming a mean cost of \$0.252/kWh in Massachusetts) and carbon savings were retrospectively calculated.

#### **RESULTS**

210 examinations were done during the pre-implementation period and 571 examinations were done during the post-implementation period. The median acquisition time for BR- and BR+ protocols were 16:42 and 26:15 min:sec for the pre-implementation period and 9:22 and 17:12 min:sec for the post-implementation period, respectively. The expected net scan time reductions for BR- and BR+ protocols were 7:20 min:sec (44%) and 9:03 min:sec (34.5%) for net scan time in the post-implementation period. The per-examination energy consumption for BR- and BR+ protocols using accelerated MRI sequences during net scan time were reduced by 3.53 and 6.4 kWh, respectively, translating to a potential annual savings of 2,015.6 to 3,654.4 kWh, \$508 to \$921 and 1.4 to 2.6 MTCO<sub>2</sub>eq per year.

#### **CONCLUSION**

The implementation of fast brain MRI sequences significantly reduced the acquisition times for commonly performed outpatient brain MRI protocols, leading to less energy expenditure during active net scan time and system-on modes and ultimately substantial sustainability and cost-savings potential.

#### **CLINICAL RELEVANCE/APPLICATION**

The reduction in acquisition times provided by accelerated MRI sequences translates into less energy expenditure during active scanning and ultimately substantial sustainability and cost-savings potential.

#### **W7-STCE1- Shedding Light on Sustainability for Radiologists - A Comprehensive Life Cycle Assessment 2 (LCA) of a Diagnostic Radiology Department**

Cassandra L. Thiel, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Climate change negatively impacts peoples' health, and healthcare emits 8.5% of the US's total GHGs. The urgency of the climate crisis requires coordinated action from healthcare stakeholders, including radiology. Previous radiology studies

assessed emissions per scans or omitted the production and distribution of capital equipment. This study measures the emissions associated with an entire radiology unit in an academic medical center.

## **METHODS AND MATERIALS**

This study is a partnership between a major radiology equipment manufacturer and one of the largest academic medical centers/health systems in the Southeastern USA. This study uses ISO14040-based Life Cycle Assessment (LCA), including manufacturing and distribution of capital equipment, consumable goods, and durable supplies; energy during use phase; staff and patient commuting; laundering and durable supply reprocessing; capital equipment refurbishment; and waste disposal. Results are reported in GHG emissions in kilograms of carbon dioxide equivalents (kg CO<sub>2</sub>e).

## **RESULTS**

Initial results (which currently exclude non-scanner plug loads, HVAC, cooling loads, and disposable supplies) show that the MR suite, with 2, 1.5T and 1, 3T machine generate the most emissions at an estimated 2,160,800 kg CO<sub>2</sub>e/year. The CT suite generates approximately 61,100 kg CO<sub>2</sub>e/yr (four scanners), Fluoro (99,800 with two machines), US (109,100 with two machines), and Xray (72,800 with two machines). Within the MR and CT suite, the largest source of emissions appears to be electricity use of the scanners (81% and 74% respectively). For MR, linens use represents the next largest category of GHG emissions (11%, assuming a 30 use lifespan for reusable linens) with production of the scanner accounting for 8% of emissions. For US, the linens consumption dominates emissions (75% of total), followed by electricity use (15%).

## **CONCLUSION**

Previous healthcare LCAs often omitted manufacturing of capital equipment due to a lack of data and the assumption that its impact would be minimal per patient. Here, approximately 25% of a CT scanner's lifetime GHGs come from its production; it should not be excluded from LCA studies. This study is ongoing, and the case location may not be representative of other radiology units with variables including number of scanners, scheduling, use of idle modes, and electricity sources.

## **CLINICAL RELEVANCE/APPLICATION**

Fully mitigating these impacts will require partnerships between multiple healthcare stakeholders, including manufacturers. There are many possible interventions to mitigate these emissions; given the prevalence of electricity-associated emissions, measures should be taken to reduce electricity consumption and 'decarbonize' these sources.

## **W7-STCE1- Spinning Radiology Resources: Balancing environmental and economic considerations with circular business models including extending scanner lifespan, software upgrades, repair, refurbishment, and leases**

Cassandra L. Thiel, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Human consumption of natural resources has reached unsustainable levels, in part due to a make-use-trash, or linear, product life cycle. Healthcare uses 10% of materials used globally every year, and most of this just goes to waste. Manufacturers and healthcare providers are beginning to incorporate circularity in their business models and practices, which can enable the longer use of existing materials and decrease the extraction of new materials. This study assesses the emissions materials associated with the original production and maintenance of scanners in a diagnostic radiology unit at an academic medical center. We model the financial and environmental trade-offs between maintaining or upgrading an older scanner, buying a refurbished replacement, or buying brand new with leasing models.

## **METHODS AND MATERIALS**

This study is part of a partnership between a major radiology equipment manufacturer and one of the largest academic medical centers in the Southeastern USA. The diagnostic radiology unit maintains 4 CTs, 2 DX, 3 MR, 2 US, and 3 XRays, ranging in age from 18.5 years to 3 years. This study uses ISO14040-based Life Cycle Assessment (LCA) to estimate the Greenhouse Gas (GHG) emissions from the original manufacture and distribution of capital equipment; energy during use phase; and performance impact of software upgrades improving clinical performance, life-time extensions, refurbishment, and leases.

## **RESULTS**

Initial results demonstrate that applying circular practices can reduce the GHG emissions compared to a linear manufacturing and use cycle. For annual emissions, circular business models can reduce CT emissions 5%-7% and MR 6%-8%. Most gains come from extending the lifetime of existing equipment or replacing existing equipment with a refurbished or leased one. If the equipment were run on renewable energy, reductions would be significantly higher, with CT reduced by 29%-39% and MR 29%-41%. For per patient emissions, software upgrades show the highest potential for reduction in both CT and MR, because improved clinical performance helps treat more patients daily.

## **CONCLUSION**

This manufacturer offers a variety of circularity options for capital scanning equipment, including lease or service-based contracts, software and hardware upgrades which may affect performance efficiency, end-of-life extension services, and total

refurbishment. Compared to a baseline scenario of buying new and disposing after use, most scanners perform as good as new, but in line with the previous model of the scanner.

**CLINICAL RELEVANCE/APPLICATION**

Radiologists must select equipment that meets their needs; however, they should prioritize procuring refurbished models and extending the lifespan of the equipment already on site for lower cumulative emissions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-STCE1-1

### Advancing sustainability and energy efficient MRI operations through Fast Imaging Techniques

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 1

Azadeh Tabari, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Using the latest MRI systems and accelerated MRI techniques can lead to significant energy savings in radiology by reducing active scan times and optimizing resource utilization. The goal of this study was to determine the acquisition time, energy, cost, and carbon savings that could be achieved through implementing fast MRI techniques in outpatient brain imaging.

#### METHODS AND MATERIALS

Acquisition time (i.e. net scan time: active mode - exam preparation time) were extracted from consecutive brain MRI examinations done on 4 outpatient 3T wide-bore scanners from the same vendor (all Magnetom Vida; Siemens Healthineers), during pre-implementation (3/1/2019-3/1/2020) and post-implementation periods (3/1/2022-3/1/2023). Expected acquisition times were compared for the most frequently performed brain MRI protocols: brain without contrast (BR-) and brain with and without contrast (BR+). Power measurement logs were extracted for these protocols. Data from the scanner system-on mode were acquired from the scanner log data and was segmented into exam preparation time, net scan time and swap time (idle) for each scanner. Per-examination energy consumption, cost (assuming a mean cost of \$0.252/kWh in Massachusetts) and carbon savings were retrospectively calculated.

#### RESULTS

210 examinations were done during the pre-implementation period and 571 examinations were done during the post-implementation period. The median acquisition time for BR- and BR+ protocols were 16:42 and 26:15 min:sec for the pre-implementation period and 9:22 and 17:12 min:sec for the post-implementation period, respectively. The expected net scan time reductions for BR- and BR+ protocols were 7:20 min:sec (44%) and 9:03 min:sec (34.5%) for net scan time in the post-implementation period. The per-examination energy consumption for BR- and BR+ protocols using accelerated MRI sequences during net scan time were reduced by 3.53 and 6.4 kWh, respectively, translating to a potential annual savings of 2,015.6 to 3,654.4 kWh, \$508 to \$921 and 1.4 to 2.6 MTCO<sub>2</sub>eq per year.

#### CONCLUSION

The implementation of fast brain MRI sequences significantly reduced the acquisition times for commonly performed outpatient brain MRI protocols, leading to less energy expenditure during active net scan time and system-on modes and ultimately substantial sustainability and cost-savings potential.

#### CLINICAL RELEVANCE/APPLICATION

The reduction in acquisition times provided by accelerated MRI sequences translates into less energy expenditure during active scanning and ultimately substantial sustainability and cost-savings potential.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-STCE1-2

### Shedding Light on Sustainability for Radiologists - A Comprehensive Life Cycle Assessment (LCA) of a Diagnostic Radiology Department

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 1

Cassandra L. Thiel, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Climate change negatively impacts peoples' health, and healthcare emits 8.5% of the US's total GHGs. The urgency of the climate crisis requires coordinated action from healthcare stakeholders, including radiology. Previous radiology studies assessed emissions per scans or omitted the production and distribution of capital equipment. This study measures the emissions associated with an entire radiology unit in an academic medical center.

#### METHODS AND MATERIALS

This study is a partnership between a major radiology equipment manufacturer and one of the largest academic medical centers/health systems in the Southeastern USA. This study uses ISO14040-based Life Cycle Assessment (LCA), including manufacturing and distribution of capital equipment, consumable goods, and durable supplies; energy during use phase; staff and patient commuting; laundering and durable supply reprocessing; capital equipment refurbishment; and waste disposal. Results are reported in GHG emissions in kilograms of carbon dioxide equivalents (kg CO<sub>2</sub>e).

#### RESULTS

Initial results (which currently exclude non-scanner plug loads, HVAC, cooling loads, and disposable supplies) show that the MR suite, with 2, 1.5T and 1, 3T machine generate the most emissions at an estimated 2,160,800 kg CO<sub>2</sub>e/year. The CT suite generates approximately 61,100 kg CO<sub>2</sub>e/yr (four scanners), Fluoro (99,800 with two machines), US (109,100 with two machines), and Xray (72,800 with two machines). Within the MR and CT suite, the largest source of emissions appears to be electricity use of the scanners (81% and 74% respectively). For MR, linens use represents the next largest category of GHG emissions (11%, assuming a 30 use lifespan for reusable linens) with production of the scanner accounting for 8% of emissions. For US, the linens consumption dominates emissions (75% of total), followed by electricity use (15%).

#### CONCLUSION

Previous healthcare LCAs often omitted manufacturing of capital equipment due to a lack of data and the assumption that its impact would be minimal per patient. Here, approximately 25% of a CT scanner's lifetime GHGs come from its production; it should not be excluded from LCA studies. This study is ongoing, and the case location may not be representative of other radiology units with variables including number of scanners, scheduling, use of idle modes, and electricity sources.

#### CLINICAL RELEVANCE/APPLICATION

Fully mitigating these impacts will require partnerships between multiple healthcare stakeholders, including manufacturers. There are many possible interventions to mitigate these emissions; given the prevalence of electricity-associated emissions, measures should be taken to reduce electricity consumption and 'decarbonize' these sources.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-STCE1-3

### **Spinning Radiology Resources: Balancing environmental and economic considerations with circular business models including extending scanner lifespan, software upgrades, repair, refurbishment, and leases**

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 1

Cassandra L. Thiel, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Human consumption of natural resources has reached unsustainable levels, in part due to a make-use-trash, or linear, product life cycle. Healthcare uses 10% of materials used globally every year, and most of this just goes to waste. Manufacturers and healthcare providers are beginning to incorporate circularity in their business models and practices, which can enable the longer use of existing materials and decrease the extraction of new materials. This study assesses the emissions materials associated with the original production and maintenance of scanners in a diagnostic radiology unit at an academic medical center. We model the financial and environmental trade-offs between maintaining or upgrading an older scanner, buying a refurbished replacement, or buying brand new with leasing models.

#### **METHODS AND MATERIALS**

This study is part of a partnership between a major radiology equipment manufacturer and one of the largest academic medical centers in the Southeastern USA. The diagnostic radiology unit maintains 4 CTs, 2 DX, 3 MR, 2 US, and 3 XRays, ranging in age from 18.5 years to 3 years. This study uses ISO14040-based Life Cycle Assessment (LCA) to estimate the Greenhouse Gas (GHG) emissions from the original manufacture and distribution of capital equipment; energy during use phase; and performance impact of software upgrades improving clinical performance, life-time extensions, refurbishment, and leases.

#### **RESULTS**

Initial results demonstrate that applying circular practices can reduce the GHG emissions compared to a linear manufacturing and use cycle. For annual emissions, circular business models can reduce CT emissions 5%-7% and MR 6%-8%. Most gains come from extending the lifetime of existing equipment or replacing existing equipment with a refurbished or leased one. If the equipment were run on renewable energy, reductions would be significantly higher, with CT reduced by 29%-39% and MR 29%-41%. For per patient emissions, software upgrades show the highest potential for reduction in both CT and MR, because improved clinical performance helps treat more patients daily.

#### **CONCLUSION**

This manufacturer offers a variety of circularity options for capital scanning equipment, including lease or service-based contracts, software and hardware upgrades which may affect performance efficiency, end-of-life extension services, and total refurbishment. Compared to a baseline scenario of buying new and disposing after use, most scanners perform as good as new, but in line with the previous model of the scanner.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiologists must select equipment that meets their needs; however, they should prioritize procuring refurbished models and extending the lifespan of the equipment already on site for lower cumulative emissions.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W7-STCE2

### Science Session (Generative AI)

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 2

#### Sub-Events

#### **W7-STCE2- Clinical benefit of AI-based Chest X-ray Reading Support for non-radiology physicians in clinical routine** 1

Dr. Karsten Ridder (*Presenter*) Nothing to Disclose

#### **PURPOSE**

1. Research question: How can non-radiology physicians (NRP), e.g. internists, benefit from AI-based Chest X-ray reading, especially in times when a radiologist is not around?

#### **METHODS AND MATERIALS**

We installed an AI-based CXR reading support in clinical routine in a German multi-site medical supply centre. The MVZ for radiology connects 18 institutions including hospitals and private practices. 8 of these institutions are hospitals producing CXR images in a clinical routine set-up 24/7. In total more than 57.000 cases were processed in 2022 with a success rate > 99%. AI results are generated in less than 3 min. which fully suffices the clinical need. We use the AI Rad Companion Chest X-ray from Siemens Healthineers. The AI system identifies five abnormalities on CXRs: Pneumothorax, Pleural Effusion, Pulmonary Lesions, Consolidation, and Atelectasis.

#### **RESULTS**

Method 1: In more than 80% of the cases the ad-hoc decision of the physician was confirmed by the radiologist and by the AI. In 3 cases the AI showed a result which was not seen by the NRP: one benign lesion was overlooked, one consolidation and one pleural effusion detected. In all cases the clinical ad-hoc decision was unchanged. Method 2: The AI found only in 25% of the studies an abnormality. In 90% of these studies no actionable abnormality was found afterwards by the radiologist. In the remaining 10% following abnormalities were found: strong/chronic bronchiectasis, cardiomegaly, rib fracture, emphysema.

#### **CONCLUSION**

We tested the AI system regarding the clinical benefit for NRP. AI provides benefit for NRP: - In case the AI has not found an abnormality there is a high probability for no clinical actions required, i.e. an 'extra-check' with an expert might not be needed during night shifts or week-ends - AI-based diagnostic support plays an important role since often radiology services do not cover CXR reading in extra times. - The five findings of the used product (AI Rad Companion Chest X-ray) cover a large part of radiographic findings in clinical routine

#### **CLINICAL RELEVANCE/APPLICATION**

As one of the worldwide most taken X-ray procedures, chest X-ray (CXR) is one of the most important and most demanding modalities in daily medical imaging. Due to its accessibility and fast acquisition, chest radiographs are frequently used as a first diagnostic step, deciding on further patient treatment [1,2]. Beside the radiologist, NRP often need to interpret CXR images in a timely manner and decide about the next steps with the patient. While most of the research is focused on quantitative evaluations in a retrospective and synthetic environment [3,4], this abstract is focused on the implementation of such system in a real-world clinical setup.

#### **W7-STCE2- Grounding Large Language Models in Evidence: A Systematic Approach to Mitigate Hallucination Errors in Automated Radiology Question-Answering Systems** 2

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

Large Language Models (LLMs) have recently garnered considerable interest within the healthcare sector. The impressive performance of LLMs across various applications underlines their potential use for crucial tasks such as medical question answering. However, LLMs are subject to "hallucination" errors, which involve generating overly confident responses based on insufficient facts. Our study introduces a pipeline that leverages LLMs in automated radiology question-answering systems while firmly grounding their responses to user-specified evidence.

## METHODS AND MATERIALS

We gathered a total of 10 peer-reviewed articles pertaining to "brain tumors" from RadioGraphics, specifically from the journal website's "Core Exam" section. We then derived five low-level questions (Bloom's taxonomy level 1; memorizing tasks) and five high-level questions (Bloom's taxonomy level 4; clinical scenarios) from each article. Every question was formatted as multiple-choice and scrutinized for scientific validity. First, we divided the articles' raw text into 503 sections of 1500 characters, allowing for a 200-character overlap between consecutive parts. Using OpenAI models, we then converted these text sections into 1536-dimension vectors and stored them in an in-memory database. Each question was similarly embedded, with the cosine similarity distance between it and all reference vectors computed. The ten reference vectors most similar to the question vector were identified, and corresponding text chunks were retrieved. These and the index question were inputted into a ChatGPT-3.5-Turbo model, using a carefully crafted prompt instructing the model to generate answers solely based on the given context. We then compared the accuracy of this method with a baseline method of posting the same questions to the LLM without providing any retrieved evidence.

## RESULTS

The LLM yielded an average accuracy of 80% (88% and 72% for low- and high-level questions, respectively; used 358,445 tokens) within the knowledge retrieval pipeline, signifying a notable improvement compared to the baseline method with an average accuracy of 66% (70% and 62% for low- and high-level questions, respectively; used 27,758 tokens). Our demo is available online: <http://3.18.4.242:8090>

## CONCLUSION

Our proposed pipeline could markedly enhance the performance of LLMs in medical question-answering tasks, leveraging a scalable method for storing and querying scientific evidence.

## CLINICAL RELEVANCE/APPLICATION

Given the rapidly expanding application of LLMs, it is of utmost importance to ensure robust mechanisms are in place to mitigate hallucination risks associated with these models when responding to medical inquiries from patients and healthcare personnel.

## W7-STCE2- Report Generation of Chest Radiographs Utilizing a Multimodal Transformer Model

3

Yash S. Saboo (*Presenter*) Nothing to Disclose

## PURPOSE

While uncommon, radiologists can miss significant findings in reading chest X-rays due to burnout, anchoring bias, and a distracting reading-room environment. Thus, there is a need to implement artificial intelligence to assist radiologists with a comprehensive preliminary chest X-ray reading. Currently, research in radiologist report generation using AI techniques is limited. Our study aims to develop a multimodal transformer model that generates radiology reports comparable to those from professional radiologists.

## METHODS AND MATERIALS

We used the Reports and Eye-Tracking Data for Localization of Abnormalities in Chest X-rays (REFLACX) dataset, a de-identified dataset of 2616 chest X-rays from the Medical Information Mart for Intensive Care (MIMIC-III) dataset and corresponding free-text radiology reports. We employed ChatGPT 3.5 to segment each free-text report into seven sections: cardiomeastinal, pleural space, lungs, bones, soft tissue, lines and tubes, and other. The open-source Vision Image Transformer (ViT) was fine-tuned to encode each chest X-ray and RoBERTa was fine-tuned to decode the encoding into a text description of a particular section of the radiograph. The descriptions from the seven models were compiled into one report. Outcomes were measured utilizing common language model metrics including Rouge-1, Rouge-2, and Rouge-L F1 Scores. F1 scores were used because the wide distribution of possible tokens leads to class imbalance.

## RESULTS

On the test set, The ViT Roberta Model achieved a Rouge-1 F1 Score of 51.6%, Rouge 2 F1 Score of 10.4%, and Rouge L F1 Score of 51.4%. An interactive, robust website highlights the comparability of the ViT Roberta and radiologist-generated reports. On this website, the user attempts to identify the report that was AI-generated. The purpose of the website is to assess the similarity of AI-generated reports to human reports. The website URL is <http://aiormd.com>.

## **CONCLUSION**

Our study demonstrates the potential of multimodal transformer models in assisting radiologists with automatic reporting of chest X-rays. Traditional natural language processing metrics such as Rouge may not fully assess a model's ability, as they are generally inconsiderate to semantic meaning. Further validation with larger datasets and prospective clinical settings are needed to fully establish the clinical utility and reliability of this approach.

## **CLINICAL RELEVANCE/APPLICATION**

By generating instantaneous, accurate, and comprehensive reports of chest X-rays, this transformer model has the potential to alleviate radiologist workload and improve diagnostic accuracy.

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## Abstract Archives of the RSNA, 2023

W7-STCE2-1

### Clinical benefit of AI-based Chest X-ray Reading Support for non-radiology physicians in clinical routine

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 2

Dr. Karsten Ridder (*Presenter*) Nothing to Disclose

#### PURPOSE

1. Research question: How can non-radiology physicians (NRP), e.g. internists, benefit from AI-based Chest X-ray reading, especially in times when a radiologist is not around?

#### METHODS AND MATERIALS

We installed an AI-based CXR reading support in clinical routine in a German multi-site medical supply centre. The MVZ for radiology connects 18 institutions including hospitals and private practices. 8 of these institutions are hospitals producing CXR images in a clinical routine set-up 24/7. In total more than 57.000 cases were processed in 2022 with a success rate > 99%. AI results are generated in less than 3 min. which fully suffices the clinical need. We use the AI Rad Companion Chest X-ray from Siemens Healthineers. The AI system identifies five abnormalities on CXRs: Pneumothorax, Pleural Effusion, Pulmonary Lesions, Consolidation, and Atelectasis.

#### RESULTS

Method 1: In more than 80% of the cases the ad-hoc decision of the physician was confirmed by the radiologist and by the AI. In 3 cases the AI showed a result which was not seen by the NRP: one benign lesion was overlooked, one consolidation and one pleural effusion detected. In all cases the clinical ad-hoc decision was unchanged. Method 2: The AI found only in 25% of the studies an abnormality. In 90% of these studies no actionable abnormality was found afterwards by the radiologist. In the remaining 10% following abnormalities were found: strong/chronic bronchiectasis, cardiomegaly, rib fracture, emphysema.

#### CONCLUSION

We tested the AI system regarding the clinical benefit for NRP. AI provides benefit for NRP: - In case the AI has not found an abnormality there is a high probability for no clinical actions required, i.e. an 'extra-check' with an expert might not be needed during night shifts or week-ends - AI-based diagnostic support plays an important role since often radiology services do not cover CXR reading in extra times. - The five findings of the used product (AI Rad Companion Chest X-ray) cover a large part of radiographic findings in clinical routine

#### CLINICAL RELEVANCE/APPLICATION

As one of the worldwide most taken X-ray procedures, chest X-ray (CXR) is one of the most important and most demanding modalities in daily medical imaging. Due to its accessibility and fast acquisition, chest radiographs are frequently used as a first diagnostic step, deciding on further patient treatment [1,2]. Beside the radiologist, NRP often need to interpret CXR images in a timely manner and decide about the next steps with the patient. While most of the research is focused on quantitative evaluations in a retrospective and synthetic environment [3,4], this abstract is focused on the implementation of such system in a real-world clinical setup.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-STCE2-2

### Grounding Large Language Models in Evidence: A Systematic Approach to Mitigate Hallucination Errors in Automated Radiology Question-Answering Systems

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 2

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Large Language Models (LLMs) have recently garnered considerable interest within the healthcare sector. The impressive performance of LLMs across various applications underlines their potential use for crucial tasks such as medical question answering. However, LLMs are subject to "hallucination" errors, which involve generating overly confident responses based on insufficient facts. Our study introduces a pipeline that leverages LLMs in automated radiology question-answering systems while firmly grounding their responses to user-specified evidence.

#### METHODS AND MATERIALS

We gathered a total of 10 peer-reviewed articles pertaining to "brain tumors" from RadioGraphics, specifically from the journal website's "Core Exam" section. We then derived five low-level questions (Bloom's taxonomy level 1; memorizing tasks) and five high-level questions (Bloom's taxonomy level 4; clinical scenarios) from each article. Every question was formatted as multiple-choice and scrutinized for scientific validity. First, we divided the articles' raw text into 503 sections of 1500 characters, allowing for a 200-character overlap between consecutive parts. Using OpenAI models, we then converted these text sections into 1536-dimension vectors and stored them in an in-memory database. Each question was similarly embedded, with the cosine similarity distance between it and all reference vectors computed. The ten reference vectors most similar to the question vector were identified, and corresponding text chunks were retrieved. These and the index question were inputted into a ChatGPT-3.5-Turbo model, using a carefully crafted prompt instructing the model to generate answers solely based on the given context. We then compared the accuracy of this method with a baseline method of posting the same questions to the LLM without providing any retrieved evidence.

#### RESULTS

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#### CONCLUSION

Our proposed pipeline could markedly enhance the performance of LLMs in medical question-answering tasks, leveraging a scalable method for storing and querying scientific evidence.

#### CLINICAL RELEVANCE/APPLICATION

Given the rapidly expanding application of LLMs, it is of utmost importance to ensure robust mechanisms are in place to mitigate hallucination risks associated with these models when responding to medical inquiries from patients and healthcare personnel.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W7-STCE2-3

### Report Generation of Chest Radiographs Utilizing a Multimodal Transformer Model

Wednesday, Nov. 29 2:30PM - 3:00PM Room: Learning Center Theater 2

Yash S. Saboo (*Presenter*) Nothing to Disclose

#### PURPOSE

While uncommon, radiologists can miss significant findings in reading chest X-rays due to burnout, anchoring bias, and a distracting reading-room environment. Thus, there is a need to implement artificial intelligence to assist radiologists with a comprehensive preliminary chest X-ray reading. Currently, research in radiologist report generation using AI techniques is limited. Our study aims to develop a multimodal transformer model that generates radiology reports comparable to those from professional radiologists.

#### METHODS AND MATERIALS

We used the Reports and Eye-Tracking Data for Localization of Abnormalities in Chest X-rays (REFLACX) dataset, a de-identified dataset of 2616 chest X-rays from the Medical Information Mart for Intensive Care (MIMIC-III) dataset and corresponding free-text radiology reports. We employed ChatGPT 3.5 to segment each free-text report into seven sections: cardiomeastinal, pleural space, lungs, bones, soft tissue, lines and tubes, and other. The open-source Vision Image Transformer (ViT) was fine-tuned to encode each chest X-ray and RoBERTa was fine-tuned to decode the encoding into a text description of a particular section of the radiograph. The descriptions from the seven models were compiled into one report. Outcomes were measured utilizing common language model metrics including Rouge-1, Rouge-2, and Rouge-L F1 Scores. F1 scores were used because the wide distribution of possible tokens leads to class imbalance.

#### RESULTS

On the test set, The ViT Roberta Model achieved a Rouge-1 F1 Score of 51.6%, Rouge 2 F1 Score of 10.4%, and Rouge L F1 Score of 51.4%. An interactive, robust website highlights the comparability of the ViT Roberta and radiologist-generated reports. On this website, the user attempts to identify the report that was AI-generated. The purpose of the website is to assess the similarity of AI-generated reports to human reports. The website URL is <http://aiormd.com>.

#### CONCLUSION

Our study demonstrates the potential of multimodal transformer models in assisting radiologists with automatic reporting of chest X-rays. Traditional natural language processing metrics such as Rouge may not fully assess a model's ability, as they are generally inconsiderate to semantic meaning. Further validation with larger datasets and prospective clinical settings are needed to fully establish the clinical utility and reliability of this approach.

#### CLINICAL RELEVANCE/APPLICATION

By generating instantaneous, accurate, and comprehensive reports of chest X-rays, this transformer model has the potential to alleviate radiologist workload and improve diagnostic accuracy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE

### Breast Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **BREE-1 Pathologic Nipple Discharge: Is Breast MRI a Good Option?**

Valeria Vidales (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Pathologic nipple discharge (PND) is unilateral, spontaneous, involves a single duct, and is serous or bloody in appearance. MRI is able to detect the etiology of nipple discharge in 56-61% of cases when initial imaging with mammogram and ultrasound are negative. To describe differential diagnosis and its classification in BIRADS system.

#### **TABLE OF CONTENTS/OUTLINE**

Description of the anatomy of the nipple and retroareolar Description of different types of lesions that could be found in patients with nipple discharge US, mammographic and RM principal findings and its correlations. Sample cases

#### **BREE-10 Single Duct Abnormalities: Multimodality Imaging and Assessment**

Juliana Sitta, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Ductal abnormalities entail a wide range of pathology that may present clinically or grow silently, ranging from benign to malignant processes. Solitary dilated duct is a rare mammographic finding with controversial clinical significance in the literature. Workup of the solitary dilated duct must include additional mammographic views and ultrasound to assess for additional findings that would raise suspicion for malignancy and provide a biopsy target. Ductal ectasia is the most common benign finding; however, atypical presentations such as peripheral location, wall thickening, and hypoechoic tissue should raise suspicion for secondary obstruction causes. In spissated secretions can mimic intraductal masses and may be seen in association or secondary to acute and chronic mastitis, ductal ectasia, and intraductal papilloma. Patients with papillomatosis often have associated high-risk lesions and an increased lifetime risk of breast malignancy. MRI is a great adjunct to evaluate nipple discharge, particularly when the initial workup is negative, and to exclude underlying DCIS or invasive ductal carcinoma.

#### **TABLE OF CONTENTS/OUTLINE**

Review and illustrate ductal anatomy, physiology, and normal findings on multimodality imaging, including mammography, ultrasound, galactogram, and MRI. Illustrate and discuss problem-solving for single duct findings and presentations commonly associated with single duct abnormality with interesting cases from our institution. Analyze the added value of multiple imaging modalities in assessing ductal pathology, including galactogram and MRI.

#### **BREE-100 The Leading Role of Ultrasound in Breast Implant Evaluation in Developing Countries**

Giannina M. Secco, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To illustrate ultrasound findings in breasts with implants and their comparison with those in magnetic resonance imaging. To discuss the advantages and limitations of ultrasound for breast implant evaluation and why it remains a valuable and irreplaceable tool in underdeveloped and developing countries.

#### **TABLE OF CONTENTS/OUTLINE**

Detecting a broken breast implant is essential due to the potential physical discomfort, cosmetic deformity, and health risks associated with a ruptured implant. Early detection and prompt treatment of a broken implant are crucial to prevent further

complications and ensure optimal patient outcomes. Knowledge of a ruptured implant can help patients make informed decisions about implant replacement or removal. In order to acknowledge this, we believe breast implant ultrasound is a preferable choice to MRI for breast implant evaluation in underdeveloped and developing countries. Breast implant ultrasound is more cost-effective, with often portable machines, non-invasive procedure that does not require the use of contrast agents or ionizing radiation, provides real-time imaging, does not require anesthesia and is widely available in many healthcare facilities. Ultrasound imaging can be performed and interpreted quickly, allowing clinicians to make prompt treatment decisions. Furthermore, breast implant ultrasound is safe for patients with pacemakers or other implanted devices, while MRI may not be feasible for these patients. Although ultrasound has its limitations in some cases, it remains a valuable and irreplaceable tool for breast implant evaluation in underdeveloped and developing countries.

### **BREE-101 Cystic Breast Lesions Assessment and Management: An Educational Approach for Radiology Residents**

Karina Pesce, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To recognize the spectrum of cystic breast lesions. To learn tools and tips for the sonographic evaluation of cystic lesions. To understand the importance of distinguishing benign cystic lesions from potentially malignant cystic masses To learn skills in the assessment and management of cystic breast lesions

#### **TABLE OF CONTENTS/OUTLINE**

1-Introduction: Cystic breast lesions are a common finding in breast imaging studies. Accurate characterization and precise management of these lesions are essential to avoid unnecessary biopsies and tests, as well as to timely identify which of these lesions require further diagnostic evaluation. 2- Ultrasound parameters necessary for a correct evaluation of cystic lesions. 3- Tips and tricks in the ultrasound evaluation of cystic lesions. 4- Spectrum of cystic lesions. 5- Ultrasound appearance 6-Radiological appearance of cystic breast lesions on other imaging modalities such as mammography, MRI. 7- Management. 8- Interactive clinical cases for self-evaluation. 9- Conclusions

### **BREE-102 Radiological Signs in Breast Imaging: What Should the Radiology Resident Know?**

#### **Awards**

##### **Certificate of Merit**

Karina Pesce, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1.To know recognize the different radiological signs in breast imaging.2.To learn the importance of accurate identification of the different radiological signs.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction This educational poster reviews the importance of understanding breast radiological signs. Accurate identification of different radiological signs is critical for early diagnosis and effective treatment of various medical conditions, including breast cancer. Furthermore, knowledge of clinical and radiological signs in breast imaging can help prevent diagnostic errors and reduce the number of unnecessary medical tests. Description of the radiological signs in breast imaging. Tips and techniques for identifying these signs are also provided to assist residents in their interpretation of medical images. Interactive clinical cases for self-evaluation. These cases offer residents the opportunity to apply their knowledge and receive immediate feedback, thereby strengthening their diagnostic skills and decision-making abilities. Conclusion: Radiologists residents must be familiar with different radiological signs to accurately interpret medical images and provide an accurate diagnosis.

### **BREE-103 Peer Learning in Breast Imaging: Lessons Learned in Our Institution**

Marcela C. Lauer, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

It is estimated that medical diagnostic mistakes contribute to approximately 10% of patients deaths and 17% of adverse events in hospitals. Consequently, optimal patient care is related to recognizing and preventing such errors. Strategies were developed to ensure performance standards in radiology departments, including score-based second-reader peer review systems. However, this type of strategy may be associated with subjectivity, sampling bias, underreporting of errors due to peer relationships and fear of punitive action. It may have emotional impact for radiologists and lead to feelings like anxiety, shame, and humiliation, contributing to a culture of defensiveness. On the other hand, peer learning is an strategy focused on learning and improvement that has gained momentum, as a respectful nonpunitive collaborative culture improves performance in modern radiology practice. The objective of this presentation is to show how we established peer learning in our breast imaging department, the bias that were related to the mistakes we made, how we concluded they could have been avoided and our experience with peer learning as a group. We aim that this presentation may help and encourage other services to implement peer learning in their clinical practice, and also learn from the multimodality imaging cases we provide.



## TABLE OF CONTENTS/OUTLINE

Didactic case-based reviews of breast imaging exams (including mammography, ultrasound and magnetic resonance imaging performed in our service) that were discussed in our peer learning meetings in the last 5 years, with correlation of associated cognitive bias, how the cases could have been better managed and lessons learned that changed our daily practice.

### **BREE-104 Multimodality Surveillance of Breast Implants in Asymptomatic Patients and the Potential Challenges for the Radiologist in Light of the 2022 United States Food and Drug Administration (FDA) Guidelines**

H. Carisa Le-Petross, MD, FRCPC (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recently the United States Food and Drug Administration (FDA) implemented changes to breast implant surveillance that radiologists may not be aware of<sup>1,2</sup>. At the end of this exhibit, the participant will:

- Be up-to-date on the 2022 FDA guidelines for breast implant screening.
- Learn the common signs of implant rupture on ultrasound (US).
- Learn the common signs of implant rupture on magnetic resonance imaging (MRI).
- Be familiar with implant complications and new technology to minimize some complications<sup>3</sup>.
- Be familiar with some key differences between updated FDA guidelines and the imaging recommendations from the American College of Radiology Appropriateness Criteria.

## TABLE OF CONTENTS/OUTLINE

- Discuss the changes in the 2022 FDA guidelines for breast implant screening, especially the addition of US as an alternative to MRI for initial imaging surveillance for silicone implant rupture in asymptomatic patients<sup>1-4</sup>.
- Discuss the 2022 FDA guidelines recommendation for the first screening imaging test at 5 years after implantation instead of 2 years after implantation, the lack of compliance from patients, and background behind this change<sup>1-5</sup>.
- Discuss the potential controversies regarding the imaging modality of choice to evaluate for implant rupture via case-based presentation<sup>4</sup>.
- Review the imaging signs of implant rupture on different modalities, focusing mainly on US and MRI. Review benefits and/or challenges of new implants, technology such as acellular dermal matrix (ADM), and new generation tissue expanders.

### **BREE-105 Abnormality of the Duct on Breast Ultrasound: Comparison with Multimodality, Correlation with Pathological Findings, and Assessment**

Ken Oba, MD, BArch (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The 6th edition of BI-RADS is expected to include nonmass lesions detected on breast ultrasound. In breast imaging, it is important to comprehend lesions such as ductal carcinoma in situ which do not form masses but appear as abnormalities of the ducts. Ultrasound is the best imaging tool for a detailed evaluation of the ducts. Although definitions and terminology for ductal abnormalities may vary in the literature, there is a growing interest among Asian countries regarding ultrasound findings of ductal abnormalities. In this review, we present a method for detecting and evaluating ductal abnormalities based on a detailed comparison with pathological findings. To understand and organize the terminology found in various literature and guidelines, as well as the corresponding findings. To become familiar with normal anatomy and identify findings accurately. To compare expected findings in other modalities with pathological findings. To discuss evidence-based assessment and management plan for each finding.

## TABLE OF CONTENTS/OUTLINE

Normal anatomy  
Methods of detection  
Terminology  
Comparison with multimodality and correlation with pathological findings  
Assessment and management plan of each pathological finding  
Case studies  
The included cases are as follows: Ultrasound findings  
Ductal dilatation  
Duct dilatation with internal echoes  
Duct wall thickening  
Irregularity of the ductal caliber  
Pathological diagnoses  
Duct ectasia  
Fibrocystic change  
Intraductal papilloma (IDP)  
Atypical ductal hyperplasia  
Ductal carcinoma in situ (DCIS)  
Ductal carcinoma in situ with invasive component  
Invasive ductal carcinoma (IDC)

### **BREE-106 A Review of Contrast-Enhanced Mammography in the Evaluation of Suspicious Breast Micro-Calcifications and Our Experience**

Felix Maimir Quadrado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To outline a potential indication of contrast-enhanced mammography (CEM).  
- To review the contribution to date of CEM in the evaluation of suspicious breast microcalcifications.  
- To share and discuss our initial experience using CEM in the evaluation of suspicious breast microcalcifications and their histopathologic results.  
The interpretation and description of breast microcalcifications have always posed a great challenge to breast radiologists. Due to the intrinsic relation of microcalcifications with different breast lesions, and in the case of suspicious ones with breast carcinomas, CEM has been proposed as a promising technique because of its capability to assess neoangiogenesis. We present an up-to-date revision of CEM in the evaluation of suspicious breast microcalcifications and our center's initial experience.

## TABLE OF CONTENTS/OUTLINE

- Introduction- False-positive cases- False-negative cases- What the recent literature tells us- Our experience

### **BREE-107 Diagnostic Approach and Assessment of Cystic Breast Lesion**

Hyo Soon Lim, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Cystic masses are common findings on mammography, ultrasonography, and MR imaging and a thorough understanding of their imaging findings and management is important. 2. It is important to obtain US images with meticulous technique for accurate classification and assessment of cystic breast lesions. 3. Complex cystic and solid masses may have one or all of the following characteristics: a thick wall ( $\geq 0.5$  mm), thick internal septations, an intracystic mass, and both solid and cystic components. 4. Complex cystic and solid masses are usually assessed as suspicious (BI-RADS category 4) and accompanied by a recommendation for biopsy.

## TABLE OF CONTENTS/OUTLINE

A. Definition of cystic breast lesions 1. Simple cyst 2. Complicated cyst 3. Clustered microcysts 4. Complex cystic and solid mass B. Meticulous technique in evaluating cystic breast lesions on US C. Multimodality imaging findings with important differential diagnosis 1. Simple or complicated cyst vs. Nearly anechoic solid mass on US 2. Inflamed or ruptured cyst vs. Rim enhancing mass on breast MRI D. Imaging-pathologic correlation of complex cystic and solid mass E. Diagnostic approach and BI-RADS assessment of cystic breast lesions F. Management of cystic breast lesions

### **BREE-108 Breast Malignancy: Beyond Breast Carcinoma**

Alex Gil Ordonez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To provide the basis for recognizing morphological and functional imaging findings of non-epithelial and metastatic lesions of the breast (B5d, NHSBSP).- To review the most common B5d lesions through a pictorial review of our cases.- To describe the clinical management of B5d lesions and the role of the radiologist in these cases.

## TABLE OF CONTENTS/OUTLINE

1. Introduction 1.1. NHSBSP classification. 2. B5d lesions through a pictorial review of our cases. 2.1. Metastatic disease. 2.2. Oncohematological disease. 2.3. Sarcomas 3. Imaging features 4. Management 5. Conclusions The vast majority of malignant breast neoplasms are breast carcinomas. Nevertheless, some malignant breast lesions present different histologies, which are commonly less suspicious than carcinomas on imaging techniques. Their recognition is essential to an early diagnosis and therapeutic approach.

### **BREE-109 Vague and Nebulous: Non-Mass Ultrasound Lesions**

Craig Wilsen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1.) To review descriptors of ultrasound (US) non-mass lesions. (2.) To illustrate US non-mass lesions identified as correlates for breast MRI non-mass enhancement. (3.) To demonstrate methods for locating US non-mass lesions as correlates for breast MRI non-mass enhancement.

## TABLE OF CONTENTS/OUTLINE

Introduction: Ultrasound (US) correlates of MRI-detected non-mass enhancement (NME) may have no defined mass-like sonographic margin or shape, or may show subtle disruptions of the background tissue pattern. A new US lexicon term, non-mass lesion (NML), better describes these US findings. Cases: This educational exhibit will show 10 cases of US NML corresponding to MRI NME. We will highlight methods of predicting the US appearance and location of the NML on MRI-directed US by the use of breast architecture, surrounding cysts/masses, and use of the MRI appearance to predict the size and shape of the NML. Histopathologies include breast cancer, radial scar, sclerosing adenosis, fibrocystic change and fat necrosis. Conclusion: The exhibit illustrates subtle US NML correlates to MRI NME. Techniques for successful MRI-directed ultrasound detection of these findings are described. Once correlation is confirmed, US-guided biopsy, which is more expeditious than MRI-guided biopsy, can be performed.

### **BREE-11 Male Breast Lesions: To Infinity and Beyond**

Camila F. Guimaraes, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Teaching Points: Male breast disease encompasses both benign and malignant conditions that are hormonally influenced. Gynecomastia and skin lesions are the most common conditions in symptomatic men, referred for a palpable mass, with imaging patterns that can correlate with different histopathological phases. Other benign tumors in male breasts include lipoma, pseudoangiomatous stromal hyperplasia, granular cell tumor, fibromatosis, myofibroblastoma, schwannoma, and hemangioma. The incidence of breast cancer in men is rare but has increased and accounts for 1% of all breast carcinomas, with invasive ductal carcinoma being the most common type in adult males. Other tumors that may occur include papillary carcinoma, invasive lobular carcinoma, adenoid cystic carcinoma, liposarcoma, dermatofibrosarcoma, pleomorphic hyalinizing angiectatic tumor, basal cell carcinoma of the nipple, hematopoietic malignancies, and secondary tumors. Understanding the clinical and imaging characteristics of these tumors is important for their accurate diagnosis and optimal treatment.

## TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline: This article examines the clinical, radiological, and pathological characteristics of both benign and malignant tumors of the male breast. Cases of male breast disease were selected from the file of the Breast Radiology group of our hospital showing some of these pathologies: 1. Complicated Cyst; 2. Dermoid Cyst; 3. Myxoid Liposarcoma; 4. Hybernoma.

## BREE-110 From Words to Images: Applying the Contrast Enhanced Mammography BI-RADS® Lexicon

### Awards

#### Certificate of Merit

Mitva J. Patel, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The American College of Radiology Breast Imaging Reporting and Data System (ACR BI-RADS®) lexicon is widely used in clinical practice and is a standardized nomenclature used for mammographic reporting. Recently, an extension of the lexicon was developed for the interpretation and reporting of contrast-enhanced mammography (CEM) findings. Adopting the American College of Radiology (ACR) Contrast Enhanced Mammography (CEM) Lexicon is important as standardization reduces inter-observer variability and improves the accuracy and reliability of diagnostic reporting, which ultimately leads to better patient outcomes. Education on this new topic is essential as adoption of the lexicon is critical to assist standardize reporting, improve patient care, and facilitate communication between radiologists and clinicians.

## TABLE OF CONTENTS/OUTLINE

I. CEM Lexicon classification for recombined images?A. Background parenchymal enhancement?1. Level?2. Symmetry?B. Lesion conspicuity?C. Masses?-Internal enhancement characteristics?D. Non-mass enhancement?-Distribution?E. Enhancing asymmetry?II. Interpretation?A. Findings on low energy images only?B. Areas of enhancement seen on recombined images only?C. Low energy images with associated enhancement on recombined images

## BREE-111 The Power of Contrast: Contrast Enhanced Mammography in the Diagnostic Clinic

Mitva J. Patel, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

We hope that by highlighting the practical uses of CEM and its potential to enhance breast cancer detection in the diagnostic clinic, more practices will embrace this powerful technology. Contrast enhanced mammography (CEM) is an imaging technique that combines standard mammography with iodinated contrast to improve breast cancer detection. By highlighting areas of increased vascularity associated with malignancy, CEM has been shown to improve the sensitivity of mammography, particularly in women with dense breast tissue. Despite these well-known benefits, the adoption of CEM in clinical practice has been slow, owing primarily to the difficulties establishing a CEM program and reimbursement. Despite these challenges, we believe the benefits it brings to the diagnostic clinic outweigh the additional effort. CEM may be used to: -resolve equivocal findings on mammography, and to increase confidence prior to stereotactic biopsy for vague areas of architectural distortion. -as a more efficient, accessible alternative to MRI in pre-operative extent of disease and workup of highly suspicious findings identified on screening mammography. We hope that by highlighting the practical uses of CEM and its potential to enhance breast cancer detection in the diagnostic clinic, more practices will embrace this powerful technology.

## TABLE OF CONTENTS/OUTLINE

Examples provided will demonstrate how CEM impacted these patients' management and supports the notion that CEM has a place in the diagnostic clinic as a cost-effective and time-efficient alternative to breast magnetic resonance imaging (MRI) for select patients.

## BREE-112 Common Enough to Care - Young Women with Breast Cancer: Multidisciplinary Approach and Special Considerations

Grace DeWitt, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Breast cancer in young women, widely accepted as women under 40 years of age, has a worse prognosis compared to older patients as young age is an independent predictor of adverse breast-cancer specific outcomes, including morbidity, local and systemic recurrence, and death. Historically, young women have been underrepresented in clinical trials and undergo more aggressive therapy solely based on their young age. As it is important to recognize how these women differ from older patients, the teaching points of this presentation are to: 1. Describe the epidemiology, clinical presentation, and tumor biology of young women with breast cancer. 2. Define imaging guidelines in high-risk populations and in young women after diagnosis of breast cancer. 3. Explain surgical management and surgical risk reducing strategies. 4. Highlight the special considerations unique to young women including the effects of oncology treatment on fertility and lactation and describe fertility preservation techniques.

## TABLE OF CONTENTS/OUTLINE

1. Appearance of breast cancer in young women: Epidemiology and clinical presentation, Tumor biology; 2. Imaging guidelines: Risk factors and assessment, Genetics based or calculated lifetime risk, Diagnosis and staging; 3. Surgical management: Breast conserving vs. mastectomy, Cosmetic options, Risk reducing strategies; 4. Effects of oncology treatment on fertility: Chemotherapy, Hormone therapy; 5. Fertility Preservation Techniques

### **BREE-113 Breast US: A Guide for Beginners**

Erica E. Francolin Federicci, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Ultrasonographic characterization of mammographic abnormalities and palpable lesions is indicated in the evaluation and management of breast diseases. Although in the United States breast ultrasounds (US) are performed by sonographers, in many countries it is performed by physicians. Considering that breast screening US as an adjunct to mammography will be more widely practiced in the United States, the Breast Imaging-Reporting and Data System (BI-RADS®) provides training and performance guidance as set forth in ACRIN 6666. Because the effective use of the US lexicon relies on excellent sonographic technique and understanding of breast anatomy, the objective of this presentation is to didactically illustrate how the BI-RADS® recommendations should be followed, including the most common findings, pitfalls and how to avoid them.

## TABLE OF CONTENTS/OUTLINE

We used ultrasonographic images (in correlation to mammography and magnetic resonance imaging, when appropriate) from our institution's digital archive, in order to provide a case-based didactic review of the most common findings in breast ultrasounds, including a review of the adequate technical parameters, lexicon and reporting system and tips to avoid common pitfalls, based on the BI-RADS® recommendations.

### **BREE-114 Pseudo-progression During Immunotherapy: A New Challenge for Breast Radiologists**

#### **Awards**

#### **Cum Laude**

Aline D. Guimaraes, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Immunotherapy has emerged as a promising treatment strategy for advanced breast tumors. Immune checkpoint inhibitors (ICI) such as blockades that target programmed death-1 (PD-1), programmed death-ligand 1 (PD-L1) and cytotoxic T-lymphocyte associated antigen (CTLA-4), are one of the most powerful tools in the immunotherapy armamentarium and offer a beneficial immunotherapeutic regimen for patients with breast cancer. The pattern of treatment with immunotherapy is totally different from other therapeutic modalities, thus bringing major challenges to clinicians and radiologists who are not familiar with it. One of these challenges is pseudoprogression, that can be characterized as a transient increase of tumor burden followed by tumor regression. Although rare, it is fundamental for the radiologist to be aware of this condition and to carry out studies in the direction of finding diagnostic tools that are capable of more accurately identify this phenomenon contributing for better patient outcomes. In this didactic exhibit, we will discuss the basis of immunotherapy in breast cancer, demonstrate imaging findings of cases of breast cancer pseudoprogression and discuss the current tools available to identify the possibility of this condition such as biomarkers, imaging techniques and biopsy.

## TABLE OF CONTENTS/OUTLINE

1) Basis of immunotherapy 2) Definition of pseudoprogression 3) Tools used to identify pseudoprogression 3.1) Biomarkers 3.2) Medical imaging 3.3) Biopsy 4) Cases of breast cancer pseudoprogression

### **BREE-115 Contrast-enhanced Mammography in Breast Cancers for Women with Dense Breasts: Accuracy, Value, Controversies and Solutions**

Bingmei Zhang, MBBS, MMedSc (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is: 1. To familiarize the reader to what CESM implies as an emerging modality and its implementation for breast imaging. 2. To demonstrate diagnostic accuracy and correlation in lesion size estimation of CEM against DCE-MRI in dense breast patients. 3. To illustrate value of CEM in evaluating BI-RADS 4 microcalcifications including morphology, distribution and neovascularity of microcalcifications. 4. To discuss whether CEM can be an effective imaging tool in pre-surgical planning for women with dense breast parenchyma. 5. To highlight the benefits and deficits of CEM in women with dense breast who are at an increased risk of developing breast cancer.

## TABLE OF CONTENTS/OUTLINE

1. Brief overview about the different approaches in CEM and their features in imaging interpretation (temporal subtraction and dual energy technique). 2. Cancer evaluation in the dense breast and review of cases, comparing CESM with MRI in the assessment of disease extent in breast carcinomas. 3. Practical application of CEM with illustrated clinical examples in evaluating BI-RADS 4 microcalcifications in dense breast. 4. Is CESM adequate and accurate in pre-surgical planning for women with dense breast. 5. Advantages vs. drawbacks of CEM and potential pitfalls elucidation for high risk screening for women in dense breast. 6. The future applications of CEM in breast evaluation.

## BREE-116 Preoperative Wire and Wireless Localizations Gone Wrong: How to Get Out of Trouble

Sheila S. Enamandram, MD, MBA (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Accurate, thoughtful planning of preoperative image-guided wire or wireless localizations is critical for breast conservation surgery, especially in complex imaging scenarios. Target lesion visualization and localization may require more than one imaging modality and/or a non-routine approach for difficult marker/target localizations. Understanding the differences in size, appearance, and deployment techniques of localization devices is important in accurate placement and retrieval. Targeted markers may be found in unexpected places when not seen in the initial specimen radiograph. Clear communication with surgical colleagues is paramount.

## TABLE OF CONTENTS/OUTLINE

This case-based exhibit will highlight anatomic, procedural, and technical troubleshooting steps in the following scenarios: Biopsy marker, wire, or wireless device migration; Biopsy marker non-visualization; Target not marked at time of initial biopsy; Target obscured or visible on only one imaging modality; Wireless radar reflector malfunction; Alternative imaging modalities needed for localization; Biopsy marker not seen in the specimen and ultimately found in unexpected places; Incomplete retrieval of distal hook wire in the specimen.

## BREE-12 Nipple Discharge: In the Era of Multimodality Imaging

Astrid Orfali Camez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

TEACHING POINTS 1. To remind the different etiologies responsible for nipple discharge 2. To recognize the worrisome signs of a nipple discharge that must lead to further investigation 3. To discuss imaging modalities and management

## TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS 1. Clinical history and physical examination 2. Etiologies responsible for nipple discharge a. Extra-mammary causes :- Hyperprolactinemia- Drugs- Others b. Breast lesions :- Benign lesions (infections, galactophoritis, papillomas)- Malignant lesions (intra-ductal, inflammatory) 3. Multimodality imaging approach a. Gold standard of initial evaluation of nipple discharge- Mammography + Ultrasound b. Second level of investigation :- The role of MRI and contrast-enhanced mammography 4. Diagnosis a. Cytology of the nipple discharge b. US guided micro biopsy c. MRI guided core biopsy d. Emerging role of contrast-enhanced guided core biopsy 5. Patient management flowchart a. Follow-up, what? When? b. US guided macro biopsy, when? c. Surgery

## BREE-13 Staying Vigilant: Imaging Surveillance and Risk Prediction After Breast Cancer

### Awards

### Certificate of Merit

Beatriu Reig, MD, MPH (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Patients with a personal history of breast cancer have 5-20% recurrence rates and are at increased risk of second breast cancers. 2. Risk factors for recurrent or second breast cancer include dense breasts, young age at diagnosis of the first breast cancer, omission of radiation after breast conserving therapy, and hormone receptor negative first breast cancer. 3. Imaging

biomarkers such as background parenchymal enhancement are under investigation and may permit personalized risk prediction and guide surveillance recommendations in the future.

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction (definition, statistics, localized vs metastatic recurrence, early vs late recurrence) 2) Risk factors for recurrence a) Association of molecular subtypes with risk for recurrence b) Effect of neoadjuvant chemotherapy c) Modifiable risk factors (aromatase inhibitor or tamoxifen after ER+ cancer, alcohol consumption, weight) 3) Screening methods for recurrence a) Mammography b) Ultrasound i) Inclusion of the axilla c) MRI i) Abbreviated vs full-protocol d) Contrast-enhanced mammography 4) What should be the imaging interval? 5) Post-mastectomy imaging 6) Risk models for individualized screening a) Clinicopathologic factors b) Imaging biomarkers c) Radiomics and artificial intelligence models

#### **BREE-14 Breast Cancer or Not? An Interactive Case-Based Review of FDG-PET/CT Positive Findings in the Breast**

##### **Awards**

##### **Certificate of Merit**

Emily O. Yoon, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Background Interpretation of lesions with increased FDG uptake in the breast can be challenging due to nonspecific uptake in various benign and malignant processes involving the breasts. Knowledge of this wide spectrum is essential for accurate analysis of FDG-PET/CT in conjunction with a patient's symptomology. The purpose of this educational exhibit is to illustrate the multi-modality imaging appearance of various benign and malignant processes that demonstrate hypermetabolic activity within the breast on FDG-PET/CT. Teaching Points Differentiate various benign and malignant processes that can result in hypermetabolic lesions in the breast Understand sensitivity and specificity of FDG-PET/CT for breast cancer and metastatic breast lymphadenopathy Conclusion There is a wide range of benign and malignant conditions presenting as hypermetabolic breast lesions on FDG-PET/CT. Knowledge of the various imaging features is important for accurate diagnosis and patient management.

#### **TABLE OF CONTENTS/OUTLINE**

This presentation will be case-based with review of clinical history and imaging findings (mammogram, US, MRI, PET/CT) of patients with FDG-PET positive findings in the breast. Several benign and malignant pathologies will be reviewed, as outlined below. Teaching points with recent literature review will provide guidance when non-breast cancer pathology should be suspected in cases, while also highlighted when additional dedicated breast imaging is indicated. Breast implant capsule-associated squamous cell carcinoma Reactive lymphadenopathy Metastatic disease Granulomatous mastitis Fat necrosis Inflammatory breast cancer Gynecomastia Infectious/Inflammatory changes

#### **BREE-15 The Role of DBT-Guided Biopsy for MRI/CEM Detected Lesions**

Cesar Urtasun Iriarte I, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

To emphasize the need to correlate MRI/Contrast Enhanced Mammography (CEM) findings with DBT (Digital breast tomosynthesis). To show the advantages of DBT-guided biopsy compared to MRI-guided biopsy. To consider DBT-guided biopsy as an alternative for CEM-detected lesions.

#### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION: Both MRI and CEM are morphofunctional imaging techniques based on neoangiogenesis. These techniques are more sensitive than pure morphological techniques, such as DM or DBT. ASSESSMENT OF MASS ENHANCEMENTS: Second look US is of choice to evaluate these lesions. ASSESSMENT OF NON-MASS ENHANCEMENTS: These lesions are challenging. Although US plays an important role, in many cases it is inconclusive. DBT correlation is very important, specifically using the craneocaudal (CC) view. This view is easy to compare anatomical structures with both MRI (axial) and CEM. DBT GUIDED BIOPSY: This technique offers several advantages over MRI or CEM guided biopsies: Less time consuming, widely spread technique. Not all the vendors have dedicated units to perform CEM guided biopsies. Once the lesion is located with DBT, the performance of the biopsy is easy. Usually 10G vacuum assisted biopsy devices are used. CONCLUSION: DBT guided biopsy can offer a good alternative for MRI/CEM detected lesions, specially for non-mass enhancements.

#### **BREE-16 Male Breast: Common and Rare Conditions**

Carla Sitges, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Teaching Points: To describe the spectrum of imaging features of benign and malignant lesions of the male breast from a review of pathologically-proved cases. To correlate imaging and pathological findings. To discuss the appropriate imaging workup of male breast cancer.



## TABLE OF CONTENTS/OUTLINE

Introduction  
Gynecomastia  
Benign lesions  
Imaging features on mammography, ultrasound and MRI. Radiologic-pathologic correlation.  
Malignant lesions  
Imaging features on mammography, ultrasound and MRI. Radiologic-pathologic correlation.  
Conclusions

### **BREE-17 Breast Ductal Disease: Multimodality Imaging Detection and Assessment**

Meng Hao, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review normal ductal anatomy and its imaging features. Review the broad differential of benign and malignant ductal diseases, particularly in the setting of a single dilated duct. Recognize imaging abnormalities of ductal diseases and features associated with malignancy on DBT, US, and MRI. Describe appropriate diagnostic workups and management of ductal diseases.

## TABLE OF CONTENTS/OUTLINE

Breast ductal disease is an important aspect of breast imaging and often poses challenges in diagnosis and management, particularly in the setting of a single dilated duct. Thus, radiologists should be familiar with clinical presentations, diagnostic workup, imaging features, and differentials for ductal abnormalities. Patients may present with nipple discharge, palpable abnormalities, infectious symptoms, lactational issues, or be asymptomatic. Ductal pathologies range from ductal ectasia, periductal mastitis, intraductal papillomas, to ductal carcinoma in situ, invasive ductal carcinoma, and Paget's disease. Radiologists should recognize both normal and abnormal ductal imaging features on DBT (dilated ducts, masses, and/or calcifications), on US (cystic ductal dilation, ductal wall irregularities or arborization, intraductal masses or debris), and on MRI (clustered ring non-mass enhancement, abnormal linear or segmental NME). This educational exhibit will provide a comprehensive case-based review of benign and malignant ductal diseases, their multimodality imaging features, and associated management recommendations.

### **BREE-18 Breast Surgery: Changes and Findings Multimodal Diagnosis**

Maria Jose Chico (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Identify the different post-surgical changes of breast surgery.  
2. Learn to identify which findings are suspicious and which are not.  
3. Understand and integrate the findings in the different imaging modalities.  
4. Understand the differential diagnoses

## TABLE OF CONTENTS/OUTLINE

The accurate interpretation of images of the postsurgical breast depends on the availability of high-quality imaging. These changes should be interpreted in conjunction with the clinical and surgical history. They may correspond to benign or suspected changes. It is useful to analyze them in the different imaging modalities to support or rule out a suspected diagnosis. They can appear in the post-surgical period due to both malignant and benign conditions

### **BREE-19 Beyond the Lump: Navigating the Challenges of Cystic Breast Lesions**

Maria Vitoria D. Ludwig, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Our educational exhibit is directed to review the assessment and management of cystic breast lesions through the following points: review the pathologies presented as cystic breast lesions; understand how to identify and categorize breast cysts at ultrasonography; comprehend the appropriate management according to the imaging finding, correlating with clinical history and other imaging modalities if available; enlighten biopsy modalities, indication and technique; recognize the importance of subsequent histological analysis.

## TABLE OF CONTENTS/OUTLINE

The subject will be approached in the following sequence: pathologies presented as cystic breast lesions and their malignancy risk; diagnosis, initial evaluation and ultrasound classification of breast cysts, linked with drawing representations of each type of cyst; appropriate risk assessment and management according to the imaging finding considering correlation with clinical history and other imaging modalities, namely mammography and magnetic resonance imaging; how to choose the most suitable biopsy modality and possible pitfalls; correlation of radiological findings with histopathologic analysis, followed by revision of management if required; illustrative cases in the different imaging methods.

### **BREE-2 Lipofilling: What Does Breast Radiology Need to Know?**

Karen L. Caro, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1.- Describe the imaging characteristics of the lesions in lipofilling2.- When should we consider that a lesion after a lipofilling procedure would need histological certification, in relation to the imaging findings?

## TABLE OF CONTENTS/OUTLINE

Currently fat transfer (lipofilling) is used in breast reconstruction. In this paper we will describe its advantages and how it is seen in the different imaging studies (ultrasound, mammography and MRI).It is important to identify which are the usual benign findings in the different methods and what Bi-Rads to assign, in this way we can define those cases in which their histological evaluation should be considered.Describe the advantages and disadvantages of this method in breast remodeling.The importance of recognizing radiological manifestations and the difficulties involved in detecting suspicious lesions.Knowing how to recognize that fat necrosis is a frequent lesion after lipofilling, which should be suspected in order to avoid other more complex studies such as MRI and even biopsies

## BREE-20 Not Every Ductal Ectasia Is Evil: Spectrum of Ductal Lesions

Raissa Soares, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To review the imaging appearance of normal ductal anatomy; Illustrate imaging findings of ductal ectasias using different techniques, including mammography, ultrasound and magnetic resonance imaging, providing clinical images and histopathology correlation;To discuss the appropriate management of these lesions; Review a case series of benign ductal breast diagnoses from our institute, without associated malignancy;

## TABLE OF CONTENTS/OUTLINE

Identify imaging criteria that may help in the diagnosis of ductal ectasia and, eventually, in its management;Typical multimodality imaging findings (magnetic resonance imaging, ultrasound and mammography) from cases of our radiology department;Diagnostic challenges, main differentials, and key points suspicion of this pathology;Discuss the role of percutaneous biopsy (ultrasound-guided core biopsy and vacuum - assisted biopsy) in the diagnosis of ductal ectasias;Conclusion.

## BREE-21 Understanding the BI-RADS 3 Category

Summer Joyce Batasin (*Presenter*) Nothing to Disclose

## TEACHING POINTS

By the end of this educational exhibit, learners will:1. Accurately define BI-RADS 3 and appropriate use cases.2. Explain BI-RADS 3 radiographic features and diagnostic considerations for mammography, ultrasound, and MRI.3. Demonstrate proficiency in the assessment process of a BI-RADS 3 lesions, through a case-based review.

## TABLE OF CONTENTS/OUTLINE

1. What is BI-RADS 3?a. Definitionb. Appropriate use cases2. BI-RADS 3: Mammographya. Imaging featuresb. Diagnostic considerations3. BI-RADS 3: Ultrasounda. Imaging featuresb. Diagnostic considerations4. BI-RADS 3: MRIa. Imaging featuresb. Diagnostic considerations5. Identifying BI-RADS 3 Lesions: Case-Based Walkthrougha. Classic BI-RADS 3 casesb. Special cases

## BREE-22 Back to the Tumor: Navigating Breast Cancer Recurrence Like a Pro

### Awards

### Cum Laude

Vitor C. Zanetta, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review the risk and pattern of tumor recurrence according to molecular subtypeProvide visual and data-driven insights into expected imaging changes following treatment.Highlight the role that multimodality plays in differentiating expected imaging findings from treatment and imaging findings indicative of recurrence or new breast cancer.Review current follow-up protocols after breast cancer and screening for intermediate risk patients.

## TABLE OF CONTENTS/OUTLINE

Review the influence of breast cancer subtype on the rate, timing and location of tumor recurrence.Expected imaging changes following treatment with visual and data-driven insights:Expected timeline of post-surgical changes.Details in the assessment of local recurrence in breast-conserving surgery and mastectomy.Possible changes in axillary and internal mammary lymph nodes.The role that multimodality imaging (mammogram, ultrasound, MRI and PET-CT) plays in differentiating recurrence or new breast cancer from post-treatment changes, including:Frequent dilemmas in clinical practice: evaluation of calcifications,



distortions, fat necrosis and enhancements in the surgical bed. How to deal with conflicting findings between different imaging methods to avoid unnecessary biopsies without losing sensitivity for early recognition of recurrence. Subtle recurrence and the importance of serial follow-up imaging. Examine the follow-up protocols after breast cancer and screening for intermediate-risk patients from the perspective of personalized medicine.

## **BREE-23 From Flat to Fabulous - A Radiological Guide to Breast Aesthetic Fillers and Biostimulators**

### **Awards**

#### **Certificate of Merit**

Heni D. Skaf, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To expose, through cases from our institution, manifestations of different breast filling and biostimulator materials in the most diverse imaging methods, such as: free silicone, acrylates (PMMA, PAAG), hyaluronic acid, vitamin D, calcium hydroxyapatite and fat grafting. To familiarize the breast radiologist with the radiological presentation of these materials, avoiding false positives and unnecessary investigations. To discuss the usual topography in which they are injected, as well as possible local and systemic complications of using such materials.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: The demand for percutaneous aesthetic procedures is rising in medicine, especially in the context of facial harmonization. This also applies to the breast, both for use in cancer patients, with the increase in the incidence and in diagnosis of breast cancer, as well as for purely aesthetic purposes in the breast itself or even due to migration from other injection sites. Imaging findings: on mammography, ultrasonography and magnetic resonance as well as possible complications and usual injection sites of free silicone, acrylates (PMMA, PAAG), hyaluronic acid, vitamin D, calcium hydroxyapatite and fat grafting. For the most part, non-resorbable synthetic biomaterials, fat grafting, as well as resorbable materials used recently, have radiologic representation. Conclusion: The use of aesthetic breast fillers, whether in the oncological context or not, is on the rise. Often, the patient does not have knowledge of what was used, which can limit the clinical decision of the physician. Additionally, recognition of the radiological appearance of different fillers can avoid false positives and unnecessary biopsies.

## **BREE-24 Far Beyond The Axilla, What Else do We Need to See? Tips and Pitfalls of Lymph Nodes**

Raissa Soares, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Aspects of normal images of axillary and supraclavicular lymph nodes and internal mammary in different methods and mainly in ultrasound; To present imaging cases of normal lymph nodes, as well as differential diagnoses of axillary, supraclavicular and internal mammary lymph node enlargement, from our database; Image-guided procedures; Show the importance of the radiological-pathological correlation.

#### **TABLE OF CONTENTS/OUTLINE**

Review the main spots of mammary drainage; To show imaging cases of normal findings and our histological correlation; To present some differential cases of lymph node pathologies; Discuss the types of lesions and which ones require biopsy; Conclusion.

## **BREE-25 Axillary Lymphadenopathy Induced by COVID-19 Vaccination: What Have We Learned?**

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- US features of reactive lymph nodes after COVID-19 vaccination in patients with and without previous COVID-19 infection- Nodal reactivity in young and middle-age patients vaccinated with different COVID-19 vaccine protocols- Association between the cortical thickness measurement of reactive post-vaccine lymphadenopathy and an effective humoral response in COVID-19-naïve patients

#### **TABLE OF CONTENTS/OUTLINE**

The COVID-19 pandemic led to the approval of an emerging vaccination program to contain coronavirus dissemination. One of the most commonly reported local side effects of COVID-19 vaccination has been the development of axillary lymphadenopathy. In this poster, we will discuss about this phenomenon: 1. Which ultrasound features should be evaluated? 2. Does nodal response differ if there exists a prior history of COVID-19 infection? 3. Do the ultrasound characteristics of reactive axillary nodes change depending on the administered COVID-19 vaccination? 4. What is the nodal reactivity to the COVID vaccination according to age? 5. How long does reactive lymphadenopathy last? 6. Does cortical thickness of reactive post-vaccine lymph nodes reflect a humoral response? Conclusions- Reactive lymphadenopathy is a common side effect of COVID-

19 vaccination- It is generally a harmless and temporary condition- Healthcare providers should be aware of this potential phenomenon to provide an appropriate guidance to patients

## **BREE-26 Cystic Carcinomas: Preventing Misdiagnosis and Lessons Learned**

Hemal Grover, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Simple cysts: well circumscribed isodense masses on mammogram; well circumscribed anechoic masses on ultrasound with a thin, smooth, imperceptible wall and posterior acoustic enhancement. Complicated cysts meet all criteria for simple cysts except they contain debris/echogenic intracystic contents. Necrotic tumors (rapidly growing) can present as cystic masses. They can be anechoic, demonstrate posterior acoustic enhancement and therefore often misdiagnosed as simple or complicated cysts. However, careful evaluation of the margins is imperative as it can reveal subtle irregularity and raise suspicion for malignancy. Correlation with mammogram (particularly spot compression views) can be helpful to reveal obscured or irregular margins. Cystic carcinomas often present as palpable masses. These cases should be viewed with a higher index of suspicion before being labeled as BIRADS 2. Real time physician directed ultrasound is recommended along with a bilateral mammogram with spot compression views (including in women 30-35 years old). Family history, genetic mutations and ancestry (eg Ashkenazi Jewish descent) should be considered while evaluating these patients.

### **TABLE OF CONTENTS/OUTLINE**

Imaging features of simple, complicated and complex cysts. Classification of complex cysts. Clinical history, diagnostic mammogram, ultrasound and MRI findings of authors' cases of cystic carcinomas. Errors of interpretation/misdiagnosis and lessons learnt. Differential Diagnoses.

## **BREE-27 Granulomatous Mastitis: Imaging Insights into a Benign Mimicker of Breast Infection and Malignancy**

Sravani Gampala, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Understand the etiology and clinical presentation of granulomatous mastitis. 2. Recognize the imaging findings of granulomatous mastitis across mammography, ultrasound, and MRI. 3. Appreciate the importance of correlating imaging findings with the clinical picture. 4. Acknowledge the consequences of misdiagnosing granulomatous mastitis. 5. Emphasize the role of radiologists in considering granulomatous mastitis as a differential diagnosis. 6. Discuss the importance of a multidisciplinary approach in the accurate diagnosis of granulomatous mastitis.

### **TABLE OF CONTENTS/OUTLINE**

I. Introduction to Granulomatous Mastitis A. Etiology B. Clinical presentation II. Imaging Modalities A. Mammography 1. Findings 2. Differential diagnosis B. Ultrasound 1. Findings 2. Differential diagnosis C. MRI 1. Findings 2. Differential diagnosis III. Consequences of Misdiagnosis A. Unnecessary studies B. Patient anxiety C. Invasive procedures IV. Radiologist's Role in Diagnosis A. Considering granulomatous mastitis B. Biopsy and pathological challenges V. Multidisciplinary Approach A. Collaboration in diagnosis B. Improved diagnostic accuracy.

## **BREE-28 More Than Just a Pretty Cyst - Assessment and Management of Cystic Breast Lesions**

Vivian S. Ogata, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To discuss the ultrasound imaging parameters, from B-mode adjustments, Doppler imaging, to post-processing techniques, to properly evaluate cystic breast lesions.- To present the imaging findings of the listed cystic lesions according to the BI-RADS® lexicon such as: simple cyst, complicated cyst, clustered microcysts and complex solid and cystic masses, illustrating with multimodality imaging.- To discuss each subcategory of cystic lesions, its management and follow-up, illustrating with some challenging radiologic cases.- To habituate general radiologists with these findings in order to improve the diagnostic rate of such mammary lesions, reducing unnecessary biopsies.

### **TABLE OF CONTENTS/OUTLINE**

- Introduction and epidemiology: breast cystic lesions are a common diagnosis in women and include a wide spectrum of diseases, from a simple apocrine cyst to complex solid cystic carcinomas.- Scanning techniques, ultrasound adjustment, artifacts and post-processing imaging: adjustment of ultrasonographic basic parameters and adequate scanning techniques are essential for an accurate diagnosis. We can also employ Doppler, elastography, as well as use imaging artifacts to our advantage, patient's position changes more recent post-processing techniques (harmonic and spatial compounding imaging) to better characterize cystic lesions.- Cystic lesions subcategories, classification, histological representation and multimodality imaging depiction.- Management and follow-up: adequate ACR BI-RADS® categorization of each subtype of cystic lesion, illustrating with some challenging cases, exploring some related pitfalls and discussing benign and malignant differential diagnosis.

### **BREE-29 Can Aesthetic Procedures Interfere With Breast Cancer Screening?**

Leticia T. Oliveira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The incidence of dermatological procedures to modify aesthetics in body contouring, including post-surgical reconstructions, has been increasing every year, especially minimally invasive ones with injectables. Recognizing the imaging findings provoked by these procedures will avoid possible diagnostic pitfalls and allow the radiologist to alert the dermatologist about the possible loss of breast cancer screening caused by some of these previously unregistered procedures. Further, patients should be educated about the hazards associated with improper use of injectables from non-licensed individuals. Patients must be encouraged to seek out licensed physicians who use FDA-approved products for any medical and cosmetic care.

#### **TABLE OF CONTENTS/OUTLINE**

To review literature data on aesthetic dermatological procedures in the breast and axillary region, with cases from our institution, and illustrate with imaging findings found, based on different imaging methods

### **BREE-3 It's Not the Same As It Was: Multimodal Review of Breast Cancer Recurrence and What the Radiologist Needs to Know**

Leticia T. Oliveira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Breast cancer is the most common cancer in the female population worldwide and the number of patients underwent conservative surgery is growing; - The annual risk of recurrence disease varies between 2 to 5% in 5-20 years after diagnosis; - Locoregional recurrence is defined as the detection of lesions in the ipsilateral breast, chest wall or regional lymph node. If the other parts of the body are affected, it becomes a systemic recurrence; - Some factors related to breast cancer recurrence include failure in the first treatment and non-adherence to adjuvant therapy and surgical margins, but could be related to tumor size, aggressive biology of the primary tumor, young patient age at diagnosis and presence of familial or genetic risk factors; - Tumor recurrence may or may not be similar to the primary malignancy and can simulate benign conditions; - Imaging recurrence are variable and this knowledge becomes essential in radiological practice in order to improve the diagnosis and management of the patient.

#### **TABLE OF CONTENTS/OUTLINE**

- To review the factors associated to breast cancer recurrence and the epidemiology of these cases; - To show the most common findings in breast cancer recurrence using cases of our institution; - To teach how to evaluate the different methods of imaging (mammogram, ultrasound and MRI) in these cases and give tips that may help to differentiate sequelae of treatment from suspect lesion; - Easy-to-use take home messages to facilitate the handling of challenging cases.

### **BREE-30 Demystifying Gynecomastia: A Pictorial Review**

Rocio D. Cortes Quezada, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

\*Most male breast masses are benign and the most common reason is gynecomastia. \*Forms of breast imaging in male patients are used for diagnostic purposes. \*Pseudogynecomastia and cancer are the most common differential diagnoses. \*Mammography can show increased glandular tissue and ductal dilatation in cases of gynecomastia. Masses, calcifications or signs suggestive of malignancy can also be visualized. \*Ultrasound can help distinguish true gynecomastia from pseudogynecomastia (accumulation of fatty tissue in the breast region). \* Biopsy is the only method to determine if a breast mass in a man is benign or malignant. • \*Biopsy can be guided by ultrasound or mammography

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Definition 3. Epidemiology 4. Clinical presentation 5. Etiology 6. Anatomy and embryology of the male breast 7. Types of gynecomastia 8. Imaging tests of the male breast 9. Imaging findings (mammography, ultrasound) 10. Differential diagnoses 11. Cases: a. Pseudogynecomastia. b. Lipoma. c. Epidermal inclusion cyst of the breast. d. Duct ectasia. e. Fat necrosis f. Invasive ductal carcinoma 12. Conclusions

## **BREE-31 Breast Cancer Surveillance in Patients with Prior History of Breast Cancer: Updates and Controversies**

### **Awards**

#### **Certificate of Merit**

Sona A. Chikarmane, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Patients with a prior history of breast cancer (PHBC) are at increased risk of recurrent or second breast cancers. PHBC are also living longer due to improved screening and advances in treatment. Developing optimal screening regimens are critical in detecting breast cancers in these high-risk patients. Expected post-treatment changes include architectural distortion, edema, and skin thickening, which stabilize around two years post-treatment. Multimodality breast imaging surveillance is available, with screening mammography (full field digital mammography or digital breast tomosynthesis), whole breast ultrasound, contrast-enhanced mammography, and breast MRI. The purpose of this educational exhibit will be to review breast cancer surveillance in PHBC, highlighting updates and controversies in screening guidelines.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review literature on risk of recurrent/second breast cancers in PHBC 2. Discuss optimal mammography screening regimens, including screening vs diagnostic mammography, cadence of screening, and batch vs immediate interpretation. 3. Review the current societal screening guidelines, including mammography and breast MRI. 4. Show multi-modality image-rich cases of recurrent breast cancer versus expected post-treatment changes. 5. Highlight controversies in breast cancer screening guidelines, including age when to stop screening, imaging the reconstructed breast, and compliance with screening.

## **BREE-32 Tales from the Breast: When Breast Problems Have Surprising Origins**

Natalia T. Lima (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Diseases that affect the breast, but do not originate from it, may include systemic, autoimmune, infectious or even tumoral conditions from other sites. They can cause inflammation in the breast tissue and manifest with pain, skin thickening, ulcerations and masses. It is essential to know each one of them to help the clinical practice of differentiating breast carcinoma from these pathologies.

#### **TABLE OF CONTENTS/OUTLINE**

Illustrated didactic cases from our Breast Radiology group showing some diseases and their presentation forms that can simulate breast carcinoma. They were classified into subgroups such as: 1. Related to the vasculonervous system (MAV and neurofibromatosis), 2. Systemic disorders (cutaneous lymphoma and congestive heart failure), 3. Metastasis to the breast (melanoma and adrenal cortical carcinoma), 4. Soft Tissue tumors (granular cell tumor and synovial sarcoma), 5. Infectious (tuberculosis and dermatobiosis).

## **BREE-33 Spectrum of Papillary Lesions of the Breast: Multimodality Imaging and Radiologic-Pathologic Correlation**

Janice Thai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Papillary lesions represent a heterogeneous group of entity with histologic continuum from benign, atypical to invasive and non-invasive malignant lesions. 2. To review the multimodality imaging spectrum of papillary lesions. 3. To review the unique histopathologic patterns of lesions with papillary and micropapillary features. 4. To review the clinical management algorithm for different papillary lesions diagnosed on core needle biopsy.

#### **TABLE OF CONTENTS/OUTLINE**

- Multimodality imaging review of common and uncommon imaging features of papillary lesions.
- Review of classification system according to WHO 5th Edition Breast Tumors (2019)
- Review of histopathology of papillary lesions.
- Review of current evidence-based management algorithm for benign, atypical and malignant papillary lesions.

## **BREE-34 A Guide to Cystic Breast Lesions**

Christina Le, DO (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Breast imaging is often complex and can appear difficult to understand. It is rarely explored in depth throughout medical school training and can be rather limited throughout residency, especially for those pursuing other specialties for fellowship. The purpose of this exhibit is to provide a demystified review of cystic breast lesions. This is meant to supplement a resident's knowledge of breast pathology and present the information in a concise yet comprehensive manner. Throughout the presentation, the pathophysiology and patient presentation of each entity will be discussed. This will be followed by the often variable imaging findings that can be encountered on ultrasound, mammography, and MRI. Annotated pictorial examples are provided to facilitate visualization of the specific lesion characteristics. To conclude, the exhibit will discuss treatment options and the appropriate BIRADS criteria to help standardize the severity of these lesions.

## TABLE OF CONTENTS/OUTLINE

1. Overview/educational objectives 2. BIRADS categories 3. Simple Cyst 4. Galactocele 5. Fat necrosis/oil cyst 6. Hematoma 7. Abscess 8. Intracystic papilloma 9. Necrotic neoplasm 10. Conclusion 11. References

## BREE-35 Cryoablation Therapy for Breast Cancer: Procedural Technique and Imaging Review

Janice Thai, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To review the procedural techniques for performing breast cancer cryoablation. 2. To review multimodality post procedural imaging features of cryoablation to identify normal and abnormal findings.

## TABLE OF CONTENTS/OUTLINE

- Review of proper patient selection in a multidisciplinary approach.
- Review of equipment, device and procedural technique.
- Review of post procedural imaging, including normal and abnormal findings on mammography, ultrasound, and MRI.
- Review of follow-up imaging protocol and strategies for detection of tumor recurrence.

## BREE-36 Exploding Jelly of the Breast: The Mucocele-Like Lesion (MLL)

Juan C. Vargas, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

<Mucocele-Like Lesions are considered risk injuries (B3a).Mucin in the stroma calcifies over time, showing up as such on mammography.By mammography the type of calcifications is variable.By ultrasound it appears as microcysts, complex cysts or irregular nodules.The treatment depends on the diagnostic biopsy method.>

## TABLE OF CONTENTS/OUTLINE

<Mucocele-Like Lesions were first described by Rosen in 1986 as a benign lesion "cysts containing mucin, lined by squamous or cuboid epithelium with or without extravasated mucin", currently considered a risk lesion.It is due to mucinous ducts that obstruct their contents, causing rupture with extravasation of the contents into the surrounding stroma, wich over time can form calcifications, wich are observed by mammography; less commonly, it present as a mass. By ultrasound they are observed as a cyst with thick, mucin-like content or microcystic conglomerates. The more complex the cystic lesion, the more likely it is to be associated with Ductal Carcinoma In Situ (DCIS).With core needle biopsy, the percentage of diagnostic underestimation is less than 4% if they are lesions without atypia, but amounts to approximately 20% if they are lesions with atypia, so removal by vacuum-assisted biopsy or surgery is preferred.>

## BREE-37 Rare Tumors of the Breast

Neftali A. Granados Flores, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Rare tumors of the breast: Metaplastic carcinoma of the breast and Primary signet ring cell carcinoma of the breast.Epidemiology, image presentation of cases, clinical characteristics, imaging findings

## TABLE OF CONTENTS/OUTLINE

Metaplastic breast carcinoma is a rare type of neoplasm that resembles a high-grade histological carcinoma, presents a high incidence of recurrences, poor prognosis, difficulties at the time of diagnosis, the establishment of therapeutic guidelines, and controversy regarding its nomenclature. The bibliography is very limited and the published descriptive studies have a low number of cases, making it difficult to obtain definitive and extrapolated conclusions, especially when making therapeutic decisions.Primary signet ring cell carcinoma of the breast is a rare tumor of controversial histogenesis, aggressive behavior and unusual metastatic pattern to the gastrointestinal tract and serous surfaces, posing differential diagnosis problems with metastasis of signet ring cell carcinoma of the breast. other origins, preferably gastrointestinal.

## BREE-38 AI Advancements in Breast Imaging: Transforming Radiology for Improved Patient Care

Mancino, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To explore the basic concepts of deep learning and machine learning in breast imaging. To examine AI-based tools and their applications in detection, diagnosis, and treatment planning for breast cancer. To assess AI performance compared to human experts. To discuss ethical considerations. To investigate AI future trends and developments for breast imaging.

### TABLE OF CONTENTS/OUTLINE

Introduction: presenting the fundamental principles of deep learning and machine learning in the context of breast imaging. 1. Workload to explore how AI algorithms can positively influence radiologists' workload, also triaging negative mammograms and potentially replacing second readers. 2. AI accuracy to discuss how AI-based solutions contribute to improve diagnostic accuracy in mammography and enable a more precise lesion classification. 3. Cancer-Prediction evaluating the ability of AI algorithms to identify cancer-predictive features in mammograms. 4. AI role in ultrasound and MRI to examine the development and performance of AI-based solutions for detecting and classifying breast lesions in ultrasound and MRI. 5. Ethical considerations Addressing the ethical concerns surrounding AI implementation, including data privacy, algorithm fairness, and potential biases in the development process. 6. Future trends to address the future trends of AI, contemplating the potential integration of AI with other imaging modalities, exploring the role of radiogenomics in breast imaging, and anticipating novel AI advancements.

### BREE-39 **Multimodal Imaging of Breast Tissue Expanders, Including Associated Complications and MRI Contraindications**

Almir Bitencourt, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

? To show the types of breast tissue expanders and MRI contraindications. ? To perform a multimodal review of the imaging aspects of breast tissue expanders. ? To illustrate complications associated to breast tissue expanders.

### TABLE OF CONTENTS/OUTLINE

Breast tissue expanders are temporary devices commonly used in two-stage breast reconstruction surgery. Tissue expanders are gradually filled with saline to stretch the skin and chest tissues to make room for breast reconstruction with a permanent implant. There are different types of breast tissue expanders depending on the number of lumens (one or two), filling (saline and/or silicone) and injection dome (remote or internal). Some types have metallic components that are not suitable for MRI imaging due to the potential for image distortion or dislocation. It is important to recognize the imaging features of breast tissue expanders, to avoid misdiagnosis, since tissue expanders with small filling may mimic implant rupture on imaging. Complications associated with breast tissue expanders are rare and include infection, hematoma, rupture, and displacement.

### BREE-4 **Code of Con-DUCT: An Algorithmic Approach to Multimodality Assessment and Management of Dilated Mammary Ducts**

Rajshree Singh, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- The ACR BI-RADS® 5th Edition indicates that a SDD has a > 2% likelihood of malignancy, and therefore warrants a suspicious (BI-RADS 4A) assessment. Otherwise, there are few recommendations for evaluation and management of dilated ducts found at breast imaging.
- Further evaluation with MRI and/or tissue sampling may be warranted if ductal dilation (DD) is new or increasing, symptomatic, or associated with worrisome mammographic or ultrasound (US) features.
- We propose an algorithm-based approach to assessing dilated ducts, specifying worrisome features on mammogram and targeted US to guide further workup.
- This approach may potentially reduce radiologists' uncertainty, unnecessary biopsies, missed cancers, and healthcare expenditures.

### TABLE OF CONTENTS/OUTLINE

1. Ductal anatomy 2. Definition of DD 3. Etiologies of DD 4. DD requiring further evaluation: a. New or interval change b. Patient symptoms and/or clinical findings c. Suspicious mammographic findings 5. Worrisome US findings 6. Proposed algorithm for assessment and management 7. Identification of key findings that help guide diagnostic decisions. 8. Case-based application and examples 9. Role of ductography, US with elastography, and MR

### BREE-40 **Breast Imaging Disparities in the U.S**

Dami Olufosoye, BS, MPH (*Presenter*) Nothing to Disclose

### TEACHING POINTS

This educational exhibit is a call to action for radiologists to identify racial disparities in their own practice. We will review recent studies identifying disparities individuals of color face in breast imaging and discuss successful interventions. 1. Breast



cancer is the second leading cause of cancer deaths in women in the US but the leading cause in black women. 2. Black women have less access to screening mammography 3. Black and Hispanic women have lower rates of receiving adequate breast cancer treatment and post-treatment surveillance 4. Black women have increased rates of breast cancer recurrence 5. Imaging disparities based on race and other factors can be identified by radiologists and mitigated with outreach programs

#### **TABLE OF CONTENTS/OUTLINE**

1 US Epidemiologic breast cancer data 2 Racial disparities in breast cancer screening • Decreased access to mammography centers, advanced imaging equipment, specialized physicians, genetic testing • Additional limitations: § Patient distrust § Provider-patient relationship 3 Racial disparities in diagnostic work-up • Increased time to diagnostic work-up and to biopsy • Later stage at diagnosis 4 Racial disparities after breast cancer diagnosis • Lower rates of receiving adequate breast cancer care and post-treatment surveillance • Lower rates of 5-year breast cancer survival • Higher rates of cancer recurrence 5 How radiologists can help • Identification and mitigation of imaging disparities is part of our professional responsibility to our patients • Examples of successful initiatives

#### **BREE-41 Breast Cysts: A Pictorial Exhibit of Benign and Malignant Twists**

Flavia M. Starling, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Cystic breast lesions are the most common masses found in the female breast of any age group, mainly between 30 and 50 years of age. They are derived from the terminal lobular duct unit as a result of fibrocystic change and may contain isolated liquid or even associated solid component, thus comprising a wide spectrum of variable disease entities, including benign and malignant pathologies. Simple and complicated cysts are usually benign; but on the other hand, complex cystic masses containing mixed cystic and solid components are indeterminate. Therefore, knowing that cysts are common lesions and that up to approximately 31% of complex breast cysts are associated with malignancy, the radiologist must be familiar with the main pathologies and imaging characteristics that includes this category of lesions.

#### **TABLE OF CONTENTS/OUTLINE**

- Didactically review the main cystic lesions of the breast and their characteristics through different imaging methods and case-based revision obtained from the digital archive of our institution.
- Take home message
- References

#### **BREE-42 Molecular Classification of Breast Cancer: Guide for the Radiologist**

Sandra Lara (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Breast cancer is a disease that, despite having a histopathological classification, also includes molecular and genetic subtypes, being able to carry out a molecular classification that guides the clinical behavior, prognosis and different radiological characteristics based on the expression of biomarkers (HER2, ER, PR, Ki67), this classification complements the traditional classification and adds a very useful biological approach to disease management. That is why it is important for the radiologist to know and recognize the importance of classification, as well as to identify the most common imaging characteristics in the different diagnostic methods according to each molecular subtype.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction· Breast molecular biomarkers· Revision of the classification of molecular subtypes of breast cancer· Imaging characteristics in the different methods according to each molecular subtype· Clinical cases· Conclusions

#### **BREE-43 Invasive Lobular Carcinoma (ILC): The Cancer With a Thousand Faces**

Adriana Alvarez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The Invasive Lobular Carcinoma (ILC) is the second most common type of invasive breast cancer. The incidence is increasing due to replacement therapy in postmenopausal women and diagnosis advances. There are two histologic variants: classic and pleomorphic. ILC is usually estrogen receptor positive and her2 negative. The loss of desmoplastic cell reaction and the low density of cells in this tumors make the clinical and the mammographic detection difficult. This entity has multiple imaging manifestations, being a challenge for the radiologist. ILC can be bilateral, multifocal or multicentric, with an unique metastatic pattern. Diagnosis is based in clinical and radiological tests. The most common manifestation is an irregular or spiculated mass in mammography and an hipococic irregular mass with posterior shadowing in US. MRI is the gold standard and it is used in the presence of multifocal, multicentric or bilateral disease as well as in the presence of lymphadenopathies.

#### **TABLE OF CONTENTS/OUTLINE**

This educational exhibit presents epidemiological and main ILC features. Tumor presentation and behaviour are explained. A multi-modality review of clinical and radiologic features through clinical cases, as well as pitfalls, are presented and they can help the radiologist in the diagnosis.

## **BREE-44 MRI-Detected US: How to Improve the Detection Rate of Non Mass Lesions Using Breast Anatomical Landmarks**

Ayumi Izumori (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Nonmass lesions on US are most often observed when US is used to target mammographic asymmetries, biopsy suspicious calcifications seen on screening mammography, and to biopsy abnormalities on MRI. In a meta-analysis of 2201 lesions, the success rate of targeted US after MRI was 58% (range, 23%-82%) and detection rates varied by lesion type. Nonmass enhancement lesions on MRI are less likely to be detected on targeted US than mass lesions (66% of all masses and 30% of nonmass enhancement lesions were seen). This review introduces a new viewpoint on breast ultrasound anatomy necessary to obtain a close correlation with MRI and describes a target US method with anatomical landmarks based on this viewpoint. 1. Some US images of MRI-detected lesions are more indistinct than surrounding benign lesions and need to be correlated with precision. 2. About effective anatomical landmarks for MRI correlation including surrounding tissues and vascular routes as a new anatomical landmark. 3. Pattern classification of mammary fat and mammary gland distribution for reading anatomic landmarks in MRI correlation. 4. The anatomical mechanism of deformity and how to decipher it on US. Breast deformity during ultrasound examination is not related to breast size, but varies from individual to individual.

### **TABLE OF CONTENTS/OUTLINE**

1. the identification rate of in each literature and its relationship to landmarks used 2. identification rates by anatomical landmarks and MRI images using those landmarks 3. classification of patterns of fat and mammary gland distribution in the breast based on anatomical understanding 4. anatomic mechanisms of breast deformity in MRI and US 5. US techniques considering breast deformity 6. case presentation

## **BREE-45 Unraveling the Enigma of DCIS: A Multimodality Imaging Journey**

Giselle G. Mello, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

-Definition and classification of DCIS-Epidemiology and risk factors-Clinical presentation and symptoms Imaging modalities for DCIS detection and assessment

### **TABLE OF CONTENTS/OUTLINE**

-Interpretation of mammography, ultrasound, and MRI in DCIS diagnosis-The role of breast tomosynthesis in DCIS detection-Pathologic correlation and biopsy techniques-Management options: Discuss management options for DCIS, including surgery (lumpectomy or mastectomy), radiation therapy, hormonal therapy, and surveillance.-Discuss emerging imaging technologies for DCIS detection and assessment.-Future directions: Discuss future research directions and areas of innovation in the field of DCIS detection and assessment, such as the use of artificial intelligence and machine learning in radiology, and the development of more personalized approaches.

## **BREE-46 Unveiling the Mysteries of PASH in Breast Radiology: A Cutting-Edge Approach**

Andrea Di Ninno, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Definition and classification of PASH Imaging modalities for PASH detection and characterization Differential diagnosis of PASH with other breast lesions

### **TABLE OF CONTENTS/OUTLINE**

Definition and histopathology of PASH Clinical presentation and diagnostic workup of PASH Radiologic features of PASH on mammography, ultrasound, and MRI Differential diagnosis of PASH, including benign and malignant breast lesions Radiologic-pathologic correlation of PASH Management and follow-up of patients with PASH, including surveillance imaging and surgical options Association of PASH with other breast conditions, such as atypical ductal hyperplasia and breast cancer Multi-disciplinary approach to PASH management, involving radiologists, pathologists, and clinicians.

## **BREE-47 Imaging Review of Mammography and Ultrasound Findings in Uncommon Breast Lesions: A Trainee-Focused Guide**

Thurl Hugh C. Cledera, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

Differentiating uncommon breast lesions from cancerous lesions in the breast is paramount to proper diagnosis, risk stratification, and treatment in patients presenting with a breast mass in imaging. Uncommon breast lesions may vary from those arising in the glandular parenchyma (phyllodes), inflammation (mastitis and abscess), autoimmune (granulomatous mastitis), and metabolic (diabetic mastopathy) etiologies. In centers where resources are limited, knowing the value of mammography and ultrasound findings may help guide biopsy, which in turn provides adequate treatment. At the end of this exhibit, the learner will be able to review the basic findings that are seen in breast lesions on imaging and understand the role of clinical and imaging correlation in the proper identification of these lesions.

## TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Brief review of histology of uncommon breast lesions  
3. Basic findings in mammography  
4. Basic findings in ultrasound  
5. Correlating findings in mammography and ultrasound  
6. Cases of uncommon breast lesions  
a. Lactating adenoma  
b. Intraductal papilloma  
c. Mastitis (bacterial)  
d. Granulomatous mastitis  
e. Diabetic mastopathy  
f. Mondor's disease  
g. Paget's disease  
h. Phyllodes tumor  
i. Dermatomyositis  
j. Foreign bodies

## BREE-48 Untangling the Mammary Ducts: Decoding the Complexity of Intraductal Pathology

Elsa Cecilia Molina Miranda, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

**Mammography:** Mammography can show intraductal lesions as grouped calcifications in a linear or branching pattern.  
**Breast ultrasound:** Ultrasound can identify intraductal lesions as masses or areas of ductal dilation.  
**Core needle biopsy (CNB):** This procedure is used to obtain a tissue sample from the lesion. CNB is performed guided by ultrasound or mammography.  
**Vacuum-assisted biopsy (VAB):** This procedure uses a suction device to obtain a tissue sample from the lesion. VAB is performed guided by ultrasound or mammography.  
**Contrast-enhanced mammography:** This exam uses a contrast medium to evaluate the vascularity of lesions in the breast, which may suggest the presence of a malignant lesion. Management of intraductal lesions depends on the definitive diagnosis obtained by biopsy. If the lesion is found to be malignant, treatment may include surgery, radiation therapy, and/or chemotherapy. If the lesion is benign, treatment may include observation or surgical removal.

## TABLE OF CONTENTS/OUTLINE

Table of contents: 1. Objectives 2. Anatomía y fisiopatología 3. Cases 4. Métodos diagnósticos 5. Approach 6. Conclusions  
Outline: Intraductal breast lesions are those that originate in the breast ducts and can be benign or malignant. These lesions can be detected by diagnostic methods such as mammography, breast ultrasound, core needle biopsy (CNB), vacuum-assisted biopsy (VAB), and contrast-enhanced mammography. The management of intraductal lesions depends on the definitive diagnosis obtained by biopsy, and treatment may include surgery, radiotherapy, and/or chemotherapy for malignant lesions, while benign lesions may be observed or surgically removed.

## BREE-49 Coming Out of the Bubble: Assessment and Management of Cystic Breast Lesions

Bruna P. Nantes, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

An approach to the evaluation and diagnosis of cystic lesions in the breast, with the aim of helping radiologists in their daily practice. Detail the different types of cystic breast lesions and their differential diagnoses, as well as the appropriate management of these lesions.

## TABLE OF CONTENTS/OUTLINE

**Brief introduction:** the prevalence of cystic breast lesions and the importance of adequate recognition and classification of these lesions.  
**Definition and descriptors:** detail the correct definition and description of the different types of cystic lesions.  
**Flowchart on the management of cystic breast lesions.**  
**Multiple clinical cases of the different differential diagnoses of each type of cystic breast lesion, that contemplate:**  
- Images from mammography, ultrasound and eventually MRI or CT scan;  
- Type of biopsy performed (if performed);  
- Recommendations on approaches to cystic lesions as per BI-RADS;  
- Recommendations on some special cases of cystic lesions;  
**Conclusion.**

## BREE-5 When Lightning Strikes the Same Place Twice: Detecting Ipsilateral Breast Cancer Recurrence in the Post Operative Breast

Aurela I. Clark, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Illustrate the imaging features suspicious of ipsilateral breast cancer recurrence in patients with prior lumpectomy or mastectomy. Review current literature for recommendations on adjunct imaging surveillance in women with prior history of breast cancer given their increased risk of a second breast cancer. Review imaging mimickers of breast cancer recurrence and

discuss management recommendations. Highlight teaching points for each case to increase confidence in making a timely diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Case base review We will present an image rich exhibit depicting imaging findings in ipsilateral breast cancer recurrence in the post lumpectomy patients who present for annual surveillance mammography or breast MRI, and in patients who present with clinical concerns. Cases will illustrate imaging findings, histopathology and management at the initial diagnosis and at time of recurrence. Examples of imaging mimickers of breast cancer will familiarize the learner with benign conditions in the post-surgical breast. At the end of the exhibit, teaching points will be summarized. Summary: Women with a prior personal history of breast cancer are at an increased breast cancer risk. Cumulative incidence of ipsilateral breast tumor recurrence rate has been reported at 14.3%. The image appearance of the post operative breast can make the detection of breast cancer recurrence more challenging. As a result, radiologists should be familiar with common and uncommon imaging findings of ipsilateral breast cancer recurrence. This presentation will review the current screening recommendations in this setting, expected post operative changes, breast cancer mimics, and the imaging findings of recurrence.

#### **BREE-50 New Blossoms on the Old Tree: Advancing Ductography with Digital Breast Tomosynthesis (DBT) or Contrast-enhanced Mammography (CEM)**

Juan Tao (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Ductography is a useful tool for evaluating pathologic nipple discharge, allowing for identification and localization of intraductal lesions. 2. Ductography combined with DBT or CEM can eliminate masking of small filling defects caused by overlapping ductal branches and improve visualization of the entire ductal tree, enhancing the clarity of diagnosis. 3. Fine-tuning of the procedural steps and optimization of the contrast agent concentration are necessary for the successful implementation of ductography with DBT or CEM. 4. Potential additional risks of radiation exposure associated with combining DBT or CEM should be considered, and measures should be taken to minimize radiation dose to the patient in accordance with established protocols and guidelines for radiation safety in breast imaging.

#### **TABLE OF CONTENTS/OUTLINE**

I. The Old Tree: Overview of Ductography and Its Clinical Value in Evaluating PND. II. The New Bloom on the Tree: Clinical Cases Demonstrating the Utility of Ductography combined with DBT or CEM A. Sharper Sights Case: DBT-Ductography Increased Accuracy of Diagnosis. B. Wider Insights Case: CEM-Ductography Improved Visualization of the Entire Ductal Tree. III. Technical Aspects of Ductography combined with DBT or CEM. IV. Radiation Safety Considerations with Ductography and DBT or CEM A. Potential Additional Risks of Radiation Exposure B. Strategies to Minimize Radiation Dose to the Patient C. Importance of Adherence to Established Protocols and Guidelines for Radiation Safety in Breast Imaging. V. Conclusion A. Summary of the Key Points Regarding Ductography with DBT or CEM B. Future Directions and Potential Applications of Ductography with DBT or CEM. VI. References.

#### **BREE-51 Genetic Risk Assessment in the Radiology Setting: Our Nationwide Experience in 2023**

Sean D. Raj, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review breast cancer risk assessment opportunities 2. Review key high-risk breast care and assessment considerations 3. Highlight key workflow, operational, and regulatory considerations from our practice's experience spanning multiple states on both coasts

#### **TABLE OF CONTENTS/OUTLINE**

I. Risk Assessment Guidelines a. Discuss often conflicting recommendation statements suggesting when to begin and which individuals to consider for cancer risk assessment, genetic testing, education/counseling, and modified medical management b. Spotlight recommendations for different demographics c. Examine benefits of supplemental screening II. Higher than average risk: Breast Screening Considerations a. Mammography sensitivities: general population with breakdown by demographics and women with intermediate risk, high risk, and women with genetic mutations b. ACR/SBI guidelines for those with genetically based [and/or family history and dense breast] increased risk III. Higher than average risk: Genetic Testing Considerations a. 32% of women qualify for genetic testing: a combination of hereditary and familial risk factors b. Simple multi-gene panel tests and risk assessment workflow can assess germline and polygenic risk for inherited cancer risk factors IV. Review development of Risk-Assessment ChatBot, Intake and Educational Workflow and discuss our nationwide practice's experience including pearls and pitfalls

#### **BREE-52 Vascular Mammary Lesions: Key Features to Make an Accurate Diagnosis and Avoid Unnecessary Biopsies**

Ladys J. Camargo, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Review the normal vascular anatomy of the breast  
2. Know the most frequent vascular breast lesions  
3. Know and discuss the diagnostic modalities commonly used for the diagnosis of vascular lesions  
4. What is the imaging follow-up of vascular lesions?

## TABLE OF CONTENTS/OUTLINE

There are various vascular mammary lesions, ranging from chronic systemic processes, congenital malformations, post-traumatic sequelae, benign masses, to malignant tumors. Accurate diagnosis of vascular lesions in breast images is very risky due to overlapping characteristics. This is why radiologists must be aware of the key features in the different diagnostic methods for interpreting images of vascular lesions in order to make an accurate diagnosis and avoid unnecessary biopsies and finally be able to discuss management recommendations and guidance.

Outline-Introduction-Vascular anatomy of the breast-Imaging characteristics of the most frequent vascular mammary lesions-Diagnostic methods for the diagnosis of vascular lesions-Discussion of management and monitoring-Clinical cases.-Conclusions.-Bibliography

### **BREE-53 Cyst Breast Lesions: The Good, the Bad and the Ugly**

Tatiana C. Tucunduva, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Definition of cystic breast lesions and their prevalence  
Differentiation between simple cysts, complicated cysts, and complex cystic lesions  
Imaging modalities used for the assessment of cystic breast lesions, including mammography, ultrasound, and MRI

## TABLE OF CONTENTS/OUTLINE

Symptoms and clinical presentation  
Diagnostic imaging modalities for cystic breast lesions, including mammography, ultrasound, and MRI  
Imaging features of cystic breast lesions  
Differential diagnosis of cystic breast lesions, including benign and malignant conditions  
Role of imaging-guided percutaneous biopsy techniques in the diagnosis of cystic breast lesions, including fine-needle aspiration, core needle biopsy, and vacuum-assisted biopsy, and their advantages and limitations.  
Discussion of the importance of a multidisciplinary approach in selecting the most appropriate biopsy technique based on lesion characteristics, patient factors, and imaging findings.  
Follow-up and surveillance after diagnosis and treatment of cystic breast lesions

### **BREE-54 Everything We Need to Know About Papillary Breast Carcinoma**

Lisett N. Cruzado-Quiroz, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Papillary breast carcinoma is a rare subtype of invasive ductal carcinoma with infiltrative papillary growth representing about 0,5 -0,7% of all invasive breast cancers. It is usually seen in postmenopausal in their sixth to eight decade of life. Association with carcinoma in situ is uncommon. Typically presents with bloody nipple discharge or/with slow growing palpable tumors, frequently found in the periareolar region. In general, they have better prognosis than ductal carcinoma with a 100% 10 year survival rate following treatment. Lymph node involvement and distant metastases are rare except in the invasive form. Mammography usually shows a solitary round or oval mass with circumscribed margins. Rarely they associate poorly defined margins or spiculation, given the low occurrence of desmoplastic reaction. Ultrasound generally shows a complex mass with solid and cystic components with good sound transmission. MRI may demonstrate heterogeneous lesions with septations, mural nodule and intracystic haemorrhage, the solid components typically show washout kinetics. Intracystic papillary carcinomas can occur in a pure form or may be associated with ductal carcinoma in-situ or invasive ductal carcinoma. The authors will review the clinical manifestation, imaging features and pathology correlation of this rare breast carcinoma.

## TABLE OF CONTENTS/OUTLINE

Review of the pathophysiology of papillary breast cancers (histological and molecular aspect).  
Multimodal review of imaging features of papillary cancers (mammographic, ultrasonographic, and MR findings)  
To determine the Radiology-Pathology concordance/discordance by reviewing cases.  
Update on the treatment of papillary breast cancer.

### **BREE-55 Decoding Ductal Pathology: Multimodality Approach to Nipple Discharge and Management of the Solitary Duct**

Zoya M. Patni, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Identify what differentiates physiologic nipple discharge from pathologic discharge  
2. Describe an approach to the diagnostic workup of patients with nipple discharge  
3. Discuss the clinical importance of a solitary dilated duct and describe an approach to management in these patients  
4. Implement new strategies for biopsy of hard-to-sample intraductal masses under both ultrasound and MRI-guidance

## TABLE OF CONTENTS/OUTLINE

Nipple discharge represents 2-5% of medical visits among women and is the third most common breast concern (pain > lump > nipple discharge). As radiologists our primary responsibility in assessment and management of these patients is to distinguish physiologic and pathologic causes of nipple discharge. This presentation will review the prevalence, epidemiology and pathologic subtypes of papillary lesions and other common pathologies resulting in pathologic nipple discharge and provide the reader with a diagnostic algorithm for management of these patients. Using a multimodality case-based approach, the reader will develop a differential diagnosis and management strategy for imaging findings in patients with nipple discharge, including management of the solitary dilated duct. We provide the reader with important tips and tricks for biopsy of intraductal lesions and solitary dilated ducts under ultrasound and MRI-guidance and address the potential challenges of radiology-pathology concordance in these cases.

### **BREE-56 Uncovering False Positive Lesions Through DBT**

Giovana O. D'Avila I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points Screening mammography using DBT is replacing digital mammography as the preferred imaging modality. Recognize that DBT and mammography together minimize the effects of overlapping breast tissue and improves lesion detection and localization. Identify that digital breast tomosynthesis showed lower recall, cancer detection rate, and biopsy rate. The ability to problem solve with DBT images reduces patient anxiety associated with a callback.

## TABLE OF CONTENTS/OUTLINE

Table of contents 1 - Advantages of screening mammography using DBT. 2 - Amorphous calcifications 3 - Left axillary lymphadenopathy 4 - Palpable finding 5 - Solid Mass

### **BREE-57 Ductal Carcinoma in Situ: Beyond First Impressions**

Hannah L. Chung, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

DCIS often co-exist with invasive cancers and 19-36% of DCIS after percutaneous needle biopsy are upstaged to an invasive cancer at surgical excision. Up to 3% of DCIS demonstrate axillary nodal metastases. The morphology of the calcifications are useful in predicting the nuclear grade. DCIS may also manifest as a noncalcified mass, asymmetry or distortion. Sonography demonstrates these findings as a mass, nonmass area or ductal change. MRI demonstrates the extent of DCIS better than other imaging modalities and findings correlate with high grade DCIS. Observed recurrences and lymph node metastases pose challenges to current evaluation and treatments of DCIS.

## TABLE OF CONTENTS/OUTLINE

Table of Contents 1. What is DCIS a. Significance of DCIS b. Biology and evolution of DCIS 2. Clinical Presentation of DCIS a. Asymptomatic b. Nipple discharge c. Paget's disease of the nipple d. Palpable lump 3. Imaging correlates with biology and pathology a. Mammographic i. Calcifications, mass, asymmetry, distortion b. Sonographic i. Nonmass findings 1. hypoechoic areas 2. echogenic foci 3. shadowing, 4. pseudomicrocyst ii. Ductal change c. MRI- MRI is useful to demonstrate extent of disease, exclude invasive disease, and correlates with high grade DCIS. i. nonmass enhancement ii. mass. 4. Special considerations a. Occult invasive cancers or misdiagnosis- Can imaging predict invasion? b. Axillary Staging- Is axillary ultrasound with biopsy and sentinel lymph node necessary? 5. Research: Past, now, and future endeavors a. NSABP, UKANZ, ECOG-ACRIN b. Active surveillance vs standard treatment - COMET, LORIS, LORD c. Advanced imaging techniques and artificial intelligence in both radiology and pathology

### **BREE-58 When Cysts Are Not So Simple: Tips for Complex Cystic Breast Masses Evaluation.**

Rosa M. Lorente-Ramos, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To review the different entities causing the sonographic appearance of a complex cyst. -To illustrate a series of cases of complex cystic benign and malignant lesions of the breast providing correlation with imaging (US, contrast-enhanced mammography, MRI) and pathology. - To discuss the specific management of those lesions including imaging and interventional procedures. -To emphasize pitfalls, diagnostic difficulties, and differential diagnosis.

## TABLE OF CONTENTS/OUTLINE

Cystic breast lesions are frequently detected on breast ultrasonography. Simple cysts, complicated cysts, and oil cysts do not require further invasive diagnostic procedures. However, malignant entities may present with complex cystic and solid masses. Through sample cases, a variety of imaging and pathology findings from complex cystic lesions with management discussion will be demonstrated. 1. Introduction. US findings and technical pitfalls. 2. Cystic lesions evaluation, useful findings that could be of significant diagnostic value to distinguish between confusing cysts. Classification of cysts and suspicious

findings. 3. Work-up of suspicious lesions on US: mammography/contrast-enhanced mammography (CEM) and MRI. Interventional procedures. 4. Typical benign and malignant lesions with their important findings on ultrasonography, contrast-enhanced mammography, and MRI: Benign: complicated/inflammatory cyst, seroma, oil cyst, epidermal inclusion cyst, galactocele, mucocele-like tumor, hematoma, abscess, fat necrosis, fibroadenoma, papilloma, benign Phyllodes tumor. Malignant: malignant Phyllodes tumor, papillary, medullary, colloid, and squamous cell carcinoma, sarcoma.

## **BREE-59 Differentiating Simple Cysts From Complicated Cysts, Complex Cystic and Solid Masses, and Other Cystic Breast Lesions**

Tara A. Retson, MD, PhD (*Presenter*) Research Consultant, CureMetrix, Inc Stock options, CureMetrix, Inc

### **TEACHING POINTS**

Cystic diseases of the breast are common, and confusion can occur regarding their appropriate classification and management. Distinguishing between benign cysts/cystic lesions and malignant cyst-like/fluid-containing cancers may be challenging. Specifically, triple negative breast cancers and intracystic papillary carcinomas should not be dismissed as benign/probably benign. Cystic lesions may be diagnosed accurately and managed appropriately using characteristic imaging findings. It is imperative to properly classify lesions as complex cystic and solid masses vs. complicated cysts since their management differs, and the differential of complex cystic and solid masses includes cancer. This educational exhibit will define simple cysts, teach radiologists about cystic lesions that may not be benign, review their imaging appearances, and recommend management options for complicated cysts, clustered microcysts, and complex cystic and solid breast masses.

### **TABLE OF CONTENTS/OUTLINE**

Introduction; Definitions/illustrations of simple cysts, complicated cysts, clustered microcysts and complex cystic and solid masses; Multimodality examples of cystic breast lesions, systematic approach to the characterization of cystic lesions; How to appropriately apply BI-RADS classification and management recommendations of cystic breast lesions; Utilization of a quiz at the end of the exhibit to test yourself on the systematic approach presented.

## **BREE-6 Get Your Ducts in a Row: Imaging and Management Considerations of Ductal Disease of the Breast**

### **Awards**

#### **Certificate of Merit**

Firouzeh K. Arjmandi, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

-In the imaging evaluation of spontaneous clear and/or bloody nipple discharge, negative diagnostic conventional imaging (mammogram and ultrasound) warrants further evaluation with breast MRI. -Nipple changes on physical exam even in the absence of imaging findings are suspicious. Clinical exam findings should guide next steps in management, and nipple tissue biopsy should be performed by the surgeon in the appropriate clinical setting. -In the setting of a small, subtle intraductal mass seen on diagnostic MRI and not well visualized at time of MR-guided biopsy, targeting the end of a blind-ending solitary duct can help to guide the biopsy. -The combination of findings of a palpable lump, nipple discharge, and nipple inversion, and the presence of associated coarse heterogeneous calcifications raises concern for malignancy, and biopsy should be recommended (despite the presence of more benign appearing rim calcifications). -Treatment of intraductal papillomas without atypia has become more conservative. Upgrade to DCIS or invasive carcinoma is more common in women >50 years, lesions >1 cm, palpable lesions and papillomas >5 cm from the nipple.

### **TABLE OF CONTENTS/OUTLINE**

-Overlapping imaging features of benign and malignant calcifications, including high grade versus low grade DCIS -Utility of MRI in the evaluation of extent of disease in intermediate to high grade DCIS -Multimodality imaging and clinical evaluation of pathologic nipple discharge and nipple changes (erythema and scaling) -Imaging assessment and clinical management of a solitary dilated duct and intraductal lesions -Accurate assessment of response to neoadjuvant chemotherapy in the setting of increasing calcifications post therapy

## **BREE-60 Test Your Knowledge: A Case Based Quiz of Contrast Enhanced Mammography BI-RADS Lexicon**

### **Awards**

#### **Certificate of Merit**

Daniel Sandoval, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

• To learn the descriptors published in the ACR 2022 BI-RADS supplement for contrast enhanced mammography by reviewing a series of daily case images. • As this supplement has only recently been published, this exhibit is intended to help

radiologists become familiar with the terminology and its representation on images, through an interactive and entertaining activity.

#### **TABLE OF CONTENTS/OUTLINE**

• Background Contrast enhanced mammography lexicon overview (categories, terms, features and definitions) • Illustrated case based quizzes  
Case #1: Background parenchymal enhancement - Level: Minimal, Mild, Moderate, Marked. - Symmetry: Symmetric, Asymmetric.  
Case #2: Masses - Shape: Oval, Round, Irregular.- Margin: Circumscribed, Irregular, Spiculated. - Internal enhancement characteristics: Homogeneous, Heterogeneous, Rim enhancement. - Distribution; Diffuse, Multiple regions, Regional, Focal, Linear, Segmental- Internal enhancement characteristics: Homogeneous, Heterogeneous, Clumped.  
Case #4: Enhancing asymmetry - Internal enhancement pattern: Homogeneous, Heterogeneous.  
Case #5: Lesion conspicuity - Low - Moderate - High• References

#### **BREE-61 Complex Cystic Breast Masses: An MR Imaging Review**

Jie Liu (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To define the concept of complex cystic breast masses. 2. To categorize complex cystic breast masses into three types based on the percentage and spatial distribution of cystic and solid components in the contrast-enhanced MRI. 3. In comparison with US, MRI affords superior visualisation of the proportion and distribution characteristics of solid and cystic components within complex cystic breast masses, which facilitates their differential diagnosis. Moreover, multi-parametric MRI such as T2WI, dynamic contrast-enhanced MRI (DCE-MRI) and diffusion-weighted imaging (DWI) enables the recognition of the presence and distribution characteristics of cystic and solid components, the combination of which can serve as a complementary imaging aid for accurate diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction A. Overview of complex cystic breast masses B. Importance of accurate diagnosis II. Complex cystic breast masses A. Definition of complex cystic breast masses B. Etiology of complex cystic breast masses C. Clinical manifestations of complex cystic breast masses III. Categorization of complex cystic breast masses based on MRI features Group A : thick outer wall and/or thick internal septa (> 0.5 mm). Group B: predominantly cystic component(>50%)or intracystic mural nodule. Group C:predominantly solid component and cystic component=50% IV. Comparison of MRI and ultrasound in complex cystic breast masses A. Advantages of MRI over ultrasound B. Limitations of ultrasound C. Diagnostic value of multiparametric MRI in identifying cystic components V. Conclusion A. Summary of key points B. diagnostic flow chart of complex cystic breast masses C. Future directions for research VI. References

#### **BREE-62 Trial by Priors: When to Call Back a Stable Mammographic Finding**

Samantha H. Epstein, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Comparison with multiple prior studies can help identify slowly evolving malignancies.2. Mammographic findings that warrant further evaluation include increasing number of calcifications or suspicious distributions, evolving asymmetries, architectural distortions, and slow growing or spiculated masses.3. Early recognition of these suspicious findings allows for appropriate diagnostic workup and improved diagnosis of slow growing malignancies.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introductory slide. This exhibit hopes to educate breast imagers about stable mammographic findings that require further evaluation. While stability of imaging findings over two years is often suggestive of benignity, comparison with multiple prior imaging studies can allow better evaluation of stability and identify features that are slowly evolving over time. There are also some imaging features that should be further evaluated and sampled regardless of apparent stability. This educational exhibit will discuss several cases of malignancy, highlighting the suspicious imaging features that prompted additional work up.2. List of teaching points to guide the upcoming case discussion.3. Anonymized cases demonstrating different examples of slow growing malignancies. Each case will include: Multiple prior studies to demonstrate evolution over time; Explanation of decision making that lead to diagnostic evaluation; Findings on diagnostic imaging; Pathology results after biopsy.4. Summary slide that reviews the teaching points.

#### **BREE-63 Indications and Outcomes of Cryoablation in Breast Malignancies: A Single Institution Case Review**

Sasha Kurumety, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The goal of this presentation is to educate radiology trainees on the use of cryoablation as a treatment option for breast malignancies, when cryoablation may be appropriate, and expected short and long term outcomes of the procedure. Using a series of cases from our institution, we will describe selection criteria to identify patients that may benefit from this minimally invasive cancer treatment option and demonstrate post treatment imaging findings. After this presentation, learners will be



able to describe the utility of cryoablation in treating breast malignancies and mechanisms of action, as well as understand the complications, outcomes, and future directions/ongoing trials for cryoablation.

#### **TABLE OF CONTENTS/OUTLINE**

Background:- Current FDA approved indications for cryoablation and uses of cryoablation in breast cancer- Ongoing trials: discussion of ICE3, FROST, and home institution trials and preliminary outcomes Discussion of mechanism of action:- Direct freezing and cell death, indirect immune response activation- Advantages, disadvantages, and risks/complications of cryoablation Cryoablation at our institution:- Qualifying patient and tumor characteristics, preprocedural evaluation- Interdisciplinary decision-making Institutional cryoablation cases:- Preprocedural imaging, biopsy pathology results, imaging during procedure, and post cryoablation follow up imaging/pathology Future directions: pathway to FDA approval, Medicare coverage, and increasing accessibility.

#### **BREE-64 To Treat or Not to Treat: A Review of Papillary Lesions of the Breast**

Shadan Alwan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Papillary breast lesions are a heterogeneous group of proliferative changes that occur within the epithelial lining of breast ducts. These lesions have varying presentations, pathological characteristics, and treatment options, requiring careful radiological evaluation for an accurate diagnosis. The spectrum of the lesions includes intraductal papilloma with/without atypia, intraductal papillary carcinoma, encapsulated papillary carcinoma, solid papillary carcinoma, and invasive papillary carcinoma. Radiologists must be aware of these variations to accurately identify, diagnose, and provide appropriate management recommendations. The primary objective of the exhibit is to present a comprehensive pictorial review of papillary breast lesions with radiological pathological images. We will also discuss the steps in the diagnosis and current management recommendations of these lesions. By the end of this exhibit, the audience will have a better understanding of the various papillary lesions and their clinical and imaging presentations, enabling them to provide appropriate radiologic-pathologic correlation and treatment recommendation for patients.

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction. 2) Definition of papillary breast lesions. 3) Pictorial review of the spectrum of papillary lesions. 4) Case examples of the spectrum of papillary lesions with pathological correlation. 5) Symptoms presentation of various papillary lesions. 6) Imaging techniques recommendations for diagnosis of papillary lesions. 7) Review of current BI-RADS terms in the description of these abnormalities. 8) Latest management recommendation for papillary lesions within the spectrum. 9) Conclusion/Summary.

#### **BREE-65 Case Based Review of the Modern Reconstructed Breast: Benign Imaging Findings and Complications**

Shelby Breit, BS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand imaging findings associated with modern reconstruction techniques 2. Recognize uncommon and common benign findings 3. Discuss complications

#### **TABLE OF CONTENTS/OUTLINE**

Reconstruction Methods Implants Autologous Flaps (AF) Imaging after implant reconstruction Type: silicone vs saline implant Acellular dermal matrix (ADM) Benign complications: Rupture Gel bleed Abscess/infection Hematoma Siliconoma Implant associated mesenchymal tumors (fibromatosis) Imaging after AF reconstruction Type: pedicled, free, perforator flaps Venous coupler device Benign complications: Fat necrosis/lipografting Epidermal inclusion cyst

#### **BREE-66 Breast MRI: What the Surgeon Wants to Know**

Daniella Boros, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

As there is increasing need for a multidisciplinary approach to patient care, it is important for the radiologist to understand which MRI findings change clinical management. After this presentation, participants will understand: 1. Indications for breast MRI 2. Breast cancer staging 3. Indications for different types of breast cancer treatment, including surgery, radiation, and systemic 4. Breast MRI findings that change clinical/surgical management 5. MRI correlates on mammogram and ultrasound

#### **TABLE OF CONTENTS/OUTLINE**

A. Indications for MRI a. American College of Radiology Practice Parameter b. American Society of Breast Surgeons Consensus Guidelines B. Overview of breast cancer staging C. Surgical management a. Indications b. Mastectomy vs. lumpectomy c. Types of mastectomy D. Radiation a. Indications b. Whole vs. partial breast treatment E. Systemic a. Indications for neoadjuvant chemotherapy b. Types of systemic treatment (chemotherapy, hormone blockade, biologic

therapies) F. MRI findings that impact staging and management with multimodality case examples a. Multicentric/multifocal disease b. Nodal involvement (rotter's node, level I, level II, level III, internal mammary chain node) c. Nipple enhancement d. Skin enhancement e. Chest wall involvement f. Cancer in contralateral breast g. Metastatic disease - bone/lung involvement

## **BREE-67 The Not So Simple Cyst**

Daymara Deynes-Ramos, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Cystic breast lesions are frequently encountered on ultrasound, often incidentally with a broad differential diagnosis including both benign and malignant pathology. Accurate description and classification according to the BI-RADS Lexicon based on ultrasound characteristics are essential for appropriate estimation of risk for malignancy and in turn management guidance. Emphasis on optimal ultrasound techniques, BI-RADS classification based on imaging characteristics, and correlation with example cases will be given with the purpose of helping residents and radiologists feel confident on how to proceed when faced with a cystic breast lesion.

### **TABLE OF CONTENTS/OUTLINE**

I. Introduction II. Optimal Ultrasound Technique III. BI-RADS classification of cystic lesions 1. Simple cyst 2. Complicated cyst 3. Complex cystic and solid mass (classification of complex masses) IV. Sampling techniques V. Take Away Points

## **BREE-68 The Cures Act: Challenges and Benefits in Breast Imaging**

Neda Ghassemi, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The 21st Century Cures Act is a federal law signed in 2016, aiming to remove barriers to health information exchange. The legislation includes a Final Rule, federally enforced as of April 2021, mandating patient access to electronic health information to increase transparency. Part of the mandate prohibits "information blocking," defined as a healthcare practice that is "likely to interfere with access, exchange, or use of electronic health information." For radiology practices, this means that reports are released to patients immediately when finalized. Immediate release allows for increased patient autonomy but reports often include sensitive information, especially in breast imaging, in addition to terminology that might be confusing to patients. Screening and diagnostic reports, previously held for a period of time at many institutions to allow time for direct patient communication, are now immediately released to patients. This educational exhibit reviews the impact of the Cures Act on breast imaging practices, including benefits, challenges, and potential solutions to navigate the legislation.

### **TABLE OF CONTENTS/OUTLINE**

I. Legislation II. Positive Implications and Challenges III. Evolution of Practice

## **BREE-69 How to Start Using Optoacoustic Imaging in Your Breast Practice: A Primer**

### **Awards**

#### **Certificate of Merit**

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Optoacoustic imaging (OAI) is a novel technique that uses non-ionizing lasers to detect endogenous tissue contrast. Gray scale ultrasound (GUS) is fused with parametric maps of relative light absorption for oxy/deoxyHgb in real-time, enabling simultaneous functional and anatomic imaging. The most frequently tested interpretation schema involves dividing mass into 3 internal and 2 external features. The 3 internal scores include the number of individually resolved vessels and their relative deoxygenation (vessel score), tumor blush, representing volume-averaged vessels too small to resolve individually (blush score), and Hgb amount (hemoglobin score). The 2 external scores reflect the amount and relative oxygenation of hemoglobin and vessel morphology within the boundary zone (bz, immediately surrounding the tumor, analogous to the thick echogenic rim surrounding tumors on GUS images) and the peripheral zone (pz, territory beyond the bz). Combined evaluation of GSUS and OAI features to classify benign and malignant masses have consistently shown to increase significantly (43.0% vs 28.1%,  $p < 0.001$ ) diagnostic specificity with high interreader (7 readers) agreement (mean kappa = 0.55;  $p < 0.001$ ). A study combining decision support tools with 15 fellowship-trained radiologists showed that interreader agreement [intraclass correlation coefficient (ICC) 0.80, 95%CI: 0.78, 9.82] and agreement between reader and decision support tool (95.3% of all reads) was high.

### **TABLE OF CONTENTS/OUTLINE**

1. Optoacoustic Imaging Principles 2. Equipment Types and Current Status 3. Interpreting Optoacoustic Images: A Comprehensive Guide 4. Understanding system limitations 5. Case Demonstration 6. Test Your Knowledge



## **BREE-7 Non-Malignant Papillary Lesions of the Breast: Imaging Features and Management**

Antonio Morales Rosa, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To describe the characteristics of non-malignant papillary lesions of the breast (B3) on different imaging techniques: mammography, US and MR. - To review the therapeutic algorithm of papillary B3 lesions of the breast and the role of vacuum assisted excision biopsy (VAE).

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 1.1 Intraductal papiloma without atypia. 1.2 Intraductal papiloma with atypia. 2. Imaging features. 2.1 Mammography. 2.2 US. 2.3 MR. 3. Radiopathological correlation. 4. Management of B3 papillary breast lesions. Algorithm. Role of MR. Indications of VAE. 4.1 Follow-up. 4.2 Surgery. 4.3 Vacuum assisted excisional biopsy (VAE). 5. Conclusions

## **BREE-70 What You Need to Know About the Pediatric Breast: A Review of the Normal Breast and Diagnostic Approach of Pediatric Breast Disease.**

### **Awards**

#### **Certificate of Merit**

Ilany L. Valdivia I, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is to: Describe the physiologic breast development and its variants from birth to adolescence. Review the optimal imaging modalities for evaluation of breast lesions in children and adolescents. Recognize imaging appearances of benign and malignant lesions that can affect the pediatric breast. Learn the recommendations for follow-up and management of pediatric breast lesions to avoid a delayed diagnosis or unnecessary interventions.

### **TABLE OF CONTENTS/OUTLINE**

We review: Utility of the different imaging modalities in the assessment of the pediatric breast. Breast physiologic development from birth to puberty and pathological conditions that can occur. Benign and malignant pediatric breast disease with illustrating cases. Non-mass findings: Asymmetrical breast development, accessory breast tissue, accessory nipple, pseudogynecomastia, gynecomastia, atypical ductal hyperplasia, surgical scar. Benign masses: Simple and complex cysts, retroareolar cyst, epidermal inclusion cyst, fibrocystic changes, mastitis and abscess, hematoma, intramammary lymph node, reactive lymph node to vaccines, fibroadenoma, pseudoangiomatous stromal hyperplasia, sclerosing adenosis, phyllodes tumor and tubular adenoma. Malignant masses: Metastasis and primary breast cancer. Diagnostic approach of pediatric breast disease with follow-up and management algorithm and indications for interventions such as biopsy or surgery.

## **BREE-71 Localization for Nonpalpable Breast Lesions. A Pictorial Review of Different Imaging-guided Preoperative Localization Procedures in the Breast and Axilla.**

Javier Azpeitia Arman, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

-To know the different devices employed for nonpalpable breast lesions localization. -To review the role of imaging techniques (mammogram, US, MR, CT, gamma detector) in the localization of breast lesions for breast conserving surgery. -To understand surgeon needs including technical factors of localization and communication of the relationship of the lesion and the marker. -To become familiar with the localization process, and different tips and tricks for each device.

### **TABLE OF CONTENTS/OUTLINE**

Breast-conserving surgery requires multidisciplinary communication and planning between the surgeon and the radiologist. Removal of the lesion with adequate surgical margins and avoiding resection of healthy breast tissue is essential. 1. History of wire localization, radioactive seed, and other non-needle-wire localization techniques 2. Advantages and disadvantages of using seed localization versus needle-wire localization. 3. Wire localization. 4. Non-wire devices: radioactive I125, magnetic, radar, and radiofrequency seeds 5. Technique and pitfalls. Before the procedure: review of the patient's imaging and histopathologic findings. Wire or seed placement. Preoperative detection. Operating room. Recovery. 6. Case examples of potential difficulties and problems and how to overcome them.

## **BREE-72 Is it Back? Multimodality Surveillance of Breast Cancer Recurrence: Literature Review and Case Presentation**

Mohammed A. Sabawi, MBChB (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Screening patients with previously treated breast cancer is challenging, because benign post treatment changes can obscure or resemble an underlying recurrence and due to technical limitations in performing a mammography on a treated breast. There are postoperative mammographic findings in a conservatively treated breast which follow expected time course. Any new mammographic finding (new masses, asymmetries or microcalcifications) should raise suspicion for recurrence. Abnormal screening mammogram is the most common presentation of breast cancer recurrence. Margin involvement and lack of radiotherapy and/ or chemotherapy are important prognostic factors of local recurrence. There is no clear guidelines to dictate ipsilateral breast screening after mastectomy and reconstruction with or without implant. Breast MRI is highly sensitive imaging modality to detect local recurrence in certain patient groups. It can be also utilized as problem solving to assess equivocal clinical or mammographic findings.

## TABLE OF CONTENTS/OUTLINE

Introduction Review of incidence, risk factors, diagnostic performance of multimodality surveillance and presentation of breast cancer recurrence. Review of post breast conserving treatment imaging findings and their time course of evolution. Review of available national guidelines for multimodality surveillance after curative treatment for locoregional breast cancer. Case based review of different and unusual presentations of breast cancer recurrence. Conclusion. References.

### **BREE-73 A Review of the Combined Score for Quantitative Shear Wave Elastography (SWE) and Superb Microvascular Image Vascular Index (SMI<sub>VI</sub>) to Evaluate Breast Masses**

NA YOUNG LEE (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To differentiate between benign and malignant breast masses, we propose using the combined score of quantitative parameters for shear wave elastography (SWE) and superb microvascular image (SMI) with BI-RADS. We suggest using the combined score for SWEmax, SWERatio, and SMIVI and demonstrate how it can be used to differentiate between benign and malignant breast masses. 2. We calculated the combined score by adding the BI-RADS score and each quantitative parameter (SWEmax, SWERatio, and SMIVI). The BI-RADS categories were scored on a scale of 1 to 5 (C3:1, C4a:2, C4b:3, C4c:4, and C5:5), and SWEmax, SWERatio, and SMIVI were scored as 0 or 1 based on applied cutoff values. The summed score ranged from 1 to 8. We used a cutoff value of 4 for the combined score to discriminate between benign and malignant cases based on the reported AUC values. 3. The combined score of B-mode US and quantitative parameters can improve diagnostic performance and reduce unnecessary breast biopsy. However, the combined scores should be applied with caution, considering that the quantitative parameters have limitations in assessing small-sized, pure DCIS, or low-grade invasive cancer.

## TABLE OF CONTENTS/OUTLINE

1. Review the principles of quantitative parameters for SWE (SWEmax, SWERatio) and SMIVI. 2. Review the appropriate cut off value for quantitative parameters for SWEmax, SWERatio, and SMIVI and evaluate their diagnostic performance in differentiating between benign and malignant masses. 3. Showcase the various case of combined score and pathology reviews to demonstrate how combined scores are helpful for differential diagnosis of breast masses, and which cases will be carefully applied.

### **BREE-74 Threading the Needle: The Role of Breast Radiologists in Managing Suspicious Internal Mammary Lymph Nodes**

#### **Awards**

#### **Certificate of Merit**

Megan J. Kalambo, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Examine Internal Mammary Lymph Nodes (IMLN) as an important component of breast lymphatic drainage. 2. Review the implications of metastatic IMLN adenopathy in the staging of breast cancer. 3. Provide an overview of IMLN basin anatomy, differential diagnosis of IM adenopathy, and the clinical indications for imaging and sampling. 4. Explain the tools and technical steps necessary for conducting a successful ultrasound biopsy of IMLNs. 5. Recognize ultrasound-guided Fine Needle Aspiration (FNA) biopsy as a feasible percutaneous sampling technique radiologists can use to provide treatment planning assistance to clinical teams.

## TABLE OF CONTENTS/OUTLINE

Based on our experiences at a tertiary oncologic referral center, we will provide an overview of internal mammary lymph nodes (IMLN) with regard to the anatomical, clinical, imaging and procedural considerations for radiologists. • Overview of IMLN nodal basin anatomy • Management of indeterminate and suspicious IMLNs • Differential diagnosis of abnormal/indeterminate IMLNs • Incidence and implications of IMLN adenopathy on breast cancer staging • Indications for imaging of IMLN • Multimodality identification of IMLN on Ultrasound, MRI, PET/CT • Biopsy considerations • Indications •

Tools • Technical steps • Case-based discussion of IMLNs • Tips for imaging and clinical management of patients with indeterminate/suspicious IMLN.

## **BREE-75 The State of Breast Imaging in the Caribbean**

Dami Olufosoye, BS, MPH (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Provide an overview of the current trends in incidence and mortality of breast cancer in the Caribbean 2. Discuss the state of breast services with respect to breast exams and screening 3. Discuss the challenges in breast services including infrastructure and health workforce availability 4. Recognize patient-related barriers 5. Review main points of the global breast cancer initiative and goals for breast imaging in the Caribbean

### **TABLE OF CONTENTS/OUTLINE**

- Overview of breast cancer incidence, prevalence, mortality, and stage of diagnosis in the Caribbean compared globally and to the US
- State of breast services with respect to breast exams and testing
- National guidelines on breast exams and screening
- Self-breast exams
- Clinical breast exams
- Access to mammograms
- Discuss the state of breast services pertaining to the infrastructure and health workforce availability
- Number of equipment in the region
- Type of equipment available: digital mammography vs full film digital mammography vs tomosynthesis
- Maintenance/ Audit of equipment
- Health workforce: radiologists, oncologists, physicists
- Breast treatment services
- Barriers surrounding breast cancer
- Knowledge deficits
- Patient beliefs
- 2021 Global Breast Initiative
- Key messages
- Recommendations for implementing interventions

## **BREE-76 Breast Lesions Detected on CT: When to Refer for Triple Breast Assessment**

Sharmeen Jaffer, BMBS, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Incidental breast lesions are a common finding on CT and unnecessary referrals can create a significant burden on the breast clinic.
- To evaluate imaging characteristics of incidental breast lesions identified on CT and suggest characteristics which warrant referral to the breast clinic.
- To identify imaging characteristics of breast lesion mimics or benign breast lesions; avoiding unnecessary referral to the breast clinic.
- To explore the limitations of CT with imaging breast lesions including post-contrast enhancement in benign and malignant lesions.

### **TABLE OF CONTENTS/OUTLINE**

- Variability of normal breast glandular tissue on CT including asymmetry and differences in density.
- Breast lesions with benign characteristics such as coarse or popcorn calcification or well defined cysts with homogenous fluid attenuation.
- Indeterminate breast lesions including intramammary lymph nodes, leiomyomas, papilloma, fat necrosis or lobular fibroadenomas which demonstrate post-contrast enhancement.
- Suspicious breast lesions and indicators of malignancy including irregular or spiculate margins and global or peripheral contrast enhancement; measured in Hounsfield units (HU).
- Mimics of breast malignancy including lymphoedema, post surgical changes or radiotherapy.
- Factors that negate an unnecessary referral to breast clinic include: long term stability, lesion previously assessed on mammography/ultrasound/biopsy proven benign lesion.

## **BREE-77 Multimodality Imaging of Recurrent and Residual Breast Cancer**

### **Awards**

#### **Certificate of Merit**

Victoria Domonkos (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

After this exhibit, the reader will be able to: 1. Describe the epidemiology and clinical implications of recurrent and residual breast cancer. 2. Demonstrate the importance of a multimodality approach to the detection, workup and diagnosis of recurrent and residual breast cancer. 3. Apply specific strategies to improve early detection to optimize patient outcomes.

### **TABLE OF CONTENTS/OUTLINE**

Recurrent and residual breast cancer remains a diagnostic challenge with significant clinical implications. Early and accurate detection is critical for optimizing patient outcomes. Using a case-based multi-modality approach, this exhibit will: 1. Review the epidemiology and clinical implications of recurrent and residual breast cancer. 2. Discuss current surveillance recommendations and supporting literature, including the importance of patient anxiety. 3. Review expected post-treatment findings, discussing the advantages and disadvantages of each modality (mammography, ultrasound and MRI). 4. Provide an approach to surveillance imaging and residual disease, with emphasis on the surgical pathology report, surgical margins and the importance of breast biopsy marker clips. 5. Provide tips and tricks to ensure early identification of recurrent/residual disease and avoid post-treatment surveillance pitfalls.

### **BREE-78 From Benign to Malignant: Understanding the Spectrum of Phyllodes Tumors**

Abel Gonzalez Huete, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To provide an overview of Phyllodes tumors, including their pathology features, categories and clinical presentation. 2. To discuss the role of the different imaging in the diagnosis of Phyllodes tumors. 3. To review the differential diagnosis of Phyllodes tumors and how to differentiate them from other breast tumors. 4. To highlight the importance of accurate diagnosis in the management of Phyllodes tumors.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: Breast anatomy, Fibroepithelial tumors, Epidemiology, Pathogenesis, Categories of Phyllodes Tumors (Benign, Borderline, and Malignant) 2. Clinical Presentation 3. Pathology 4. Imaging Findings: - Benign Phyllodes tumor (Mammography, Ultrasound and MRI), - Borderline Phyllodes tumor (Mammography, Ultrasound and MRI), - Malignant Phyllodes tumor (Mammography, Ultrasound and MRI). 5. Differential Diagnosis: Fibroadenoma, Primary Sarcoma of the Breast, Periductal Stromal Tumor of the Breast, Other. 6. Benign vs Malignant Phyllodes Tumors: Key Differences 7. Management, Treatment and Prognosis 8. Conclusion 9. References

### **BREE-79 A Sheep in Wolf's Clothing: The Multiple Appearances of Local Breast Cancer Recurrence After Breast Mastectomy**

Agostina B. Peralta I (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Discuss the role of the different image modalities in the surveillance of breast cancer recurrence after breast mastectomy.-Recognizing the imaging and the normal anatomic changes depending on the type of breast mastectomy performed.-Illustrate the imaging findings corresponding to a breast cancer recurrence on different image modalities.-Differentiating post-surgical benign findings from a malignant relapse.

#### **TABLE OF CONTENTS/OUTLINE**

Studies have proven that the presence of local recurrence is an independent predictor for survival this is why radiologist should be familiarized to distinguish normal or benign findings after mastectomy from a recurrence. With the main objective of early detection and treatment. -Briefly review the different surveillance recommendations for these patients given by international societies. -Description of the different surgical breast reconstruction techniques used nowadays will be performed. These include the use of prosthetic implants, autologous tissue flaps, skin and fat flaps. -Illustrations will be shown of the expected anatomic changes after mastectomy on different image modalities depending on the surgical technique. -Images showing and differentiating benign findings from a post-surgical local breast cancer recurrence will be portrait.

### **BREE-8 Comparison of Indications, Reading Time, and Work Flow of FDA Approved Supplemental Screening Automated Whole Breast Ultrasound Tomography in Women With Dense Breasts**

Mary W. Yamashita, MD (*Presenter*) Research Grant, Delphinus Medical Technologies, Inc; Consultant, Delphinus Medical Technologies, Inc

#### **TEACHING POINTS**

- Ultrasound as adjunct to screening mammography for women with dense breasts increases cancer detection. - There are new ultrasound technologies available for same day supplemental dense breast screening. - Invenia ABUS from GE and SoftVue Automated Whole Breast Ultrasound Tomography (SV) from Delphinus Medical Technologies are both PMA-approved for screening and diagnostic purposes. - In clinical practice, ABUS is time-consuming and requires significant reading time. - SV offers benefits of same day supplemental screening with mammography and, unlike other ultrasound imaging, only adds 3-4 mins of reading time per case for the radiologist.

#### **TABLE OF CONTENTS/OUTLINE**

1. Why ultrasound is important in screening women with dense breasts 2. Overview of ultrasound technologies available for dense breast screening 3. Comparison of indications for use 4. Benefits and challenges with integrating ultrasound into

practice for adjunct screening for women with dense breasts: Workflow 5. Reading time: what makes reading ABUS and HHUS challenging in clinical practice, what are the main drivers of the time it takes for radiologist to interpret images including technique and training, number of images, image quality, and artifacts 6. Overview of SV automated whole breast ultrasound 7. Image sequence and reading protocol for SV 8. Example clinical cases demonstrating SV hanging protocol 9. SV reading time study and results 10. Conclusion

## **BREE-80 Do Not Miss Architectural Distortion!**

### **Awards**

#### **Certificate of Merit**

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

### **TEACHING POINTS**

The BI-RADS 5th edition manual defines architectural distortion (AD) as “distortion of the breast parenchyma with no definite mass visible.” AD of the breast is an abnormality found in multimodality breast imaging and occurs with benign and malignant lesions. The most common cause of architectural distortion is a surgical scar. However, 4% of breast cancers present with AD. In addition to being a primary imaging finding, AD may also be an associated finding. In addition, AD is notorious for being a missed mammographic lesion. It is important for radiologists to “train their eyes” to identify AD and to know the differential considerations and pitfalls associated with AD evaluation to avoid potential missed breast cancer. The goals of this educational exhibit are to 1. recognize AD by 2D mammogram, digital breast tomosynthesis (DBT), ultrasound, and MRI, 2. review the differential considerations of AD, and 3. recommend management options and perform radiology-pathology concordance.

### **TABLE OF CONTENTS/OUTLINE**

Introduction; Definition of AD; Multimodality imaging examples of AD of the breast including mammography, sonography, and MRI; Learn a systematic approach to the characterization of AD; AD and DBT; How to appropriately apply the BI-RADS classification and management recommendations of AD; Challenging cases of AD; Pitfalls in evaluating AD: fat-containing, one view only, not seen at biopsy; Discordance in AD rad-path correlation; Sample cases; Conclusion.

## **BREE-81 Non-mass Lesion on Breast Ultrasound: Radiologic-Pathologic Correlation and a Guide to Approach**

Haejung Kim, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Unlike mass, non-mass lesion does not show a three-dimensional structure, so it is more difficult than mass to detect and make an accurate diagnosis on breast ultrasound. For this reason, non-mass lesion evaluation on breast ultrasound often follows the detection of abnormality on other imaging modalities, such as mammography or MRI. This educational exhibit was prepared to increase understanding of non-mass lesions seen on breast ultrasound and to help accurately diagnose benign and malignant non-mass lesions. 1. Review the definition of non-mass lesion on breast ultrasound, 2. Correlate radiologic and pathological findings of benign and malignant non-mass lesions, and 3. Discuss a guide to approach for evaluating non-mass lesions on breast ultrasound.

### **TABLE OF CONTENTS/OUTLINE**

1. Definition of non-mass lesion on breast ultrasound A. True non-mass lesion vs. Normal variants 2. Correlation between radiologic and pathologic findings of non-mass lesions on US A. Imaging features of non-mass lesions on US B. Pathologic features correlated with benign and malignant non-mass lesions 3. Approach for evaluating non-mass lesion on breast ultrasound

## **BREE-82 The Cyst Bang Theory: When to Biopsy**

Claudia L. Ruano, MSc (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Explain the epidemiology and pathogenesis of breast cyst. 2. Recognize the characteristics by image of breast cysts. The complex cyst is uncommon, but are suspicious of malignancy and merit biopsy. 3. Recognize criteria that will help identify a complex cyst. 4. Identify intraductal papillary nodule. Benign papillomas constitute 85% and 90%, intracystic papillary carcinomas 6% to 7%. 5. Points to help distinguish real from artifacts (echos) on ultrasonography images. 6. Recognize the most important differences in images between complicated and complex cyst. The true papillary nodules are anchored to the wall and do not move with the postural changes of the patient. 7. Analyze when to suspect malignancy in the breast cysts and categorize them based on the BIRADS.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Epidemiology and pathogenesis 3. What are complex cysts 4. What should birads assign to a complex cyst 5. Review the spectrum of findings (mammography, us and contrast-enhanced mammography) 6. When to decide biopsy, a

complex cyst 7. Let's practice (illustrative cases) 8. Conclusions

### **BREE-83 Solitary Dilated Duct in the Breast: A Multimodality Pictorial Review**

Zachary R. Zaniewski, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Solitary dilated duct is associated with benign and malignant findings and the BI-RADS classification has varied over previous editions. Solitary dilated duct has characteristic imaging features on multiple modalities. Recognizing the imaging features, particularly if new, is important for management.

#### **TABLE OF CONTENTS/OUTLINE**

Background Review of solitary dilated duct and BIRADS classification. Pictorial Review: Cases illustrating benign and malignant lesions with multiple modalities. Case 1: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound. Pathology: Papilloma without atypia. Case 2: History: Presenting with breast pain. Imaging: Mammogram, ultrasound. Pathology: Invasive ductal carcinoma. Case 3: History: 60-year-old female presenting for screening mammogram. Imaging: Mammogram, ultrasound. Pathology: Papilloma without atypia. Case 4: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound, MRI. Pathology: Papilloma with high-risk features. Case 5: History: Presenting for screening mammogram. Imaging: Mammogram, ultrasound. Pathology: Intraductal papilloma. Case 6: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound, ductogram. Pathology: DCIS. Case 7: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound, ductogram, MRI. Pathology: Multifocal DCIS with intraductal papillomatosis. Conclusion Review pearls for solitary dilated duct findings and management.

### **BREE-84 MRI Detected Lesion in Women with a Personal History of Breast Cancer, and Then?**

Ga-Eun Park, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Screening is still important for women with a history of breast cancer, because of high risk for future breast cancer. Breast MRI shows impressive resolution with high sensitivity, but specificity is relatively low.
- Second look ultrasound is a well-established approach for MRI detected lesions, and lesions found on subsequent ultrasound have a high probability of malignancy. However, second look ultrasound has limitations, such as operator dependence and the possibility of false negatives. Follow-up is required, and re-biopsy should be considered in case of image-pathology discordant.
- Correlation with mammography can sometimes be helpful. In particular, new or increasing calcifications can be objective evidence for lesion detection and confirmation of biopsy results.
- MR-guided biopsy must be considered in lesions with suspicious MRI features but occult on US or mammography.

#### **TABLE OF CONTENTS/OUTLINE**

<Representative cases of new enhancing lesion on breast MRI>• According to surgical method: op site after BCS, ipsilateral and contralateral breast after BCS, after mastectomy• According to detection modality: second look ultrasound (successful and missed), mammography, MR-guided biopsy for occult lesion• According to biopsy results: recurrence, false positive (benign), false negative (missed)

### **BREE-85 5 Years of False Negative Review from the Mammography Audit: Observations and Lessons Learned**

#### **Awards**

**Magna Cum Laude**

Heather V. Garrett, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Review of false negative (FN) cases can refine your mammography practice.-Sensitivity of mammography is limited in dense breasts.-BCT changes can make mammography difficult to interpret. ACR recommends annual screening MRI in patients with a prior history of BCT and dense breasts.-Screening MRI is more sensitive than mammography in the detection of breast cancer. High-risk patients should obtain annual mammography and annual screening MRI alternating at 6 month intervals.-Clinical symptoms (palpable breast lump, nipple discharge, skin changes and focal breast pain) should be evaluated using a multi-modality imaging approach.-BIRADS 3 cases are included in the FN review of diagnostic mammography. 0-2% of these cases may be cancers.

#### **TABLE OF CONTENTS/OUTLINE**

Background: False negative (FN) case review is mandated part of the annual mammography radiologist audit (MQSA/ACR). We are a large academic practice with dedicated breast imagers. We analyzed 135 FN cases from 5 years (2016-2020).Observations: -FN cases tended to be in patients with dense breasts, personal history of breast cancer, prior BCT, elevated life-time risk for breast cancer.-FN cases were mostly detected by presenting clinical symptom or screening MRI.-



Some FN cases were women who had been given the assessment of BIRADS 3 in the diagnostic setting. Cases: 5-10 cases to illustrate teaching points. Lessons Learned: Overall, we found that there are many reasons for FN studies, the minority of which involved "missed cancers." Review of FN cases can refine your mammography practice.

## **BREE-86 Don't Forget About the Nipple: Overview of the Anatomy and Different Lesions Involving the Nipple-areolar Complex**

Maria Guerra, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To describe the normal anatomy and some anatomic variants of the nipple-areolar complex (NAC). To review imaging anatomy of the NAC by different techniques. To present a pictorial review of commonly known benign and malignant NAC lesions.

### **TABLE OF CONTENTS/OUTLINE**

Anatomy of the nipple-areolar complex  
Retraction  
Inversion  
Imaging anatomy: mammogram, ultrasound, magnetic resonance  
Different lesions:  
Dermal lesions: nipple calcifications, Epidermal inclusion cyst  
Inflammatory lesions: duct ectasia, retroareolar cyst, periductal mastitis, abscess, Zuska disease  
Benign Tumors: Nipple adenoma  
Malignant tumors: papilloma, carcinoma, Paget's disease

## **BREE-87 The Many Faces of Invasive Lobular Carcinoma**

### **Awards**

#### **Cum Laude**

Miral M. Patel, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Invasive lobular carcinoma accounts for 5-15% of all breast cancers. 2. ILC is characterized by the lack of E-cadherin function, which explains the discohesive growth pattern and the subtle findings in imaging. 3. A review of radiologic and pathologic correlation of invasive lobular carcinoma and its morphologic variants can aid radiologists in recognizing patterns in the imaging presentation of invasive lobular carcinoma to facilitate early detection.

### **TABLE OF CONTENTS/OUTLINE**

This educational exhibit reviews: 1- Basic review of invasive lobular carcinoma 2- Case based discussion of the radiologic presentation and pathologic correlation of the variants of invasive lobular carcinoma including classic, solid, signet ring cell, and pleomorphic 3- Pattern recognition in the presentation of invasive lobular carcinoma

## **BREE-88 Breast Cancer Recurrence: Incidence and Imaging Appearance**

### **Awards**

#### **Certificate of Merit**

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

### **TEACHING POINTS**

Locoregional recurrence has been estimated to occur in 5-25% of breast cancer (BC) survivors, defined as the reappearance of the tumor at the surgical site or metastases in the regional lymph nodes. Even after mastectomy, there is a 2-10% reported lifetime risk of recurrence. Recurrence varies by molecular subtypes of BC, triple negative BC at 2-5 years after and other types at 5-15 years after treatment. Mammography remains the primary imaging modality for post-BCT surveillance. Breast MRI has the highest accuracy for differentiating post-surgical scar from recurrence. By the end of this educational exhibit, the learner will: 1. Learn the incidence, risk factors, and clinical presentation of breast cancer recurrence, 2. Review imaging recommendations for patients with a history of breast cancer and those with suspected breast cancer recurrence, 3. Recognize the common imaging appearance of recurrent breast cancer on multimodality imaging, 4. Distinguish the appearance of recurrent breast cancer from expected post-surgical changes and other differential diagnoses

### **TABLE OF CONTENTS/OUTLINE**

Introduction; Incidence and definition of breast cancer recurrence; Expected recurrence rates based on molecular subtypes of BC; Clinical presentation of breast cancer recurrence; Review imaging recommendations for patients with a history of breast cancer; Review diagnostic workup for patients with suspected breast cancer recurrence; Differential considerations of in-breast recurrence and regional nodal recurrence; A pictorial review of multimodality imaging in BC recurrence; Clinical management of recurrent BC; Algorithm for imaging patients with suspected recurrence; Conclusion

## **BREE-89 AI in Breast Imaging: Current Status and Future Directions**

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Artificial intelligence (AI) in breast imaging is being used for lesion classification, breast density and cancer risk assessment. In screening mammography setting, stand-alone sensitivity of commercially available AI system range 75-85% at radiologists' specificity of 49-79%. This indicates comparable results with radiologist performance (AUC, 0.84 vs 0.81, respectively).
- Beyond screening, a deep learning model trained on uses mammograms and traditional risk factors showed superior performance in predicting 5 year breast cancer risk compared to the Tyrer-Cuzick model. (AUC, 0.70 vs 0.62,  $p < 0.001$ ).
- Model drift is a concept that describes degradation of AI model performance as the data it is used on changes. This raises concerns regarding the performance and reliability of AI models in real-life clinical settings.
- The FDA requires manufacturers of Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD) to be transparent and monitor the real-world performance of their products to ensure the algorithm meets the standards after deployment.
- In a recent Dutch patient survey most patients (77.8%) did not support stand-alone use of AI in screening interpretation. Furthermore, 41.7% opposed the idea of using AI to select cases for second reading and 17% objected to AI as a second reader.
- The reimbursement for breast imaging AI has not yet been established, and several proposed frameworks are currently under discussion.

## TABLE OF CONTENTS/OUTLINE

Integrating AI Tools to Breast Imaging Workflow: Opportunities, Challenges and Potential Impact Patient Engagement Ethical and Regulatory Perspectives The Future of AI in Breast Imaging

### BREE-9 Navigating Mammary Ducts Pathologies and Anatomy: A Radiological Handbook

#### Awards

#### Certificate of Merit

Giovanna Andreani, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The breast is an apocrine gland that contains different types of tissue: glandular, fibrous or connective, and fatty tissue. The glandular tissue is composed of mammary lobules and ducts, the latter being a tubular structure with the function of carrying the milk produced by the gland to the nipple. There are several pathologies and variations that can affect the mammary duct, ranging from benign alterations such as ductal ectasia or papilloma to even malignant ones (ductal carcinoma in situ or invasive ductal carcinoma, among others). Knowing that the majority of breast cancer arises from the ductal epithelium, it is crucial in the diagnosis and treatment of breast cancer by detecting intraductal lesions at an early stage. The objective of this study is to didactically review the anatomy and embryology of mammary ducts, as well as the main pathologies that affect this very important structure.

## TABLE OF CONTENTS/OUTLINE

Review of the anatomy and discussion of the radiological findings in the mammary ducts, whether in their normal appearance or pathological changes through the different imaging methods obtained from the digital archive of our institution.

### BREE-90 Beyond the Norm: An Exploration of Extramammary Metastases to the Breast

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Metastases to the breast are rare, comprising 0.5-6.6% of all malignancies in the breast, and typically indicate widely disseminated disease and poor prognosis.
- Lymphoma (17-38.3%), melanoma (8.3-23.4%), lung (8-15%), gynecological carcinomas (8-12.8%), and sarcomas (2%-12%) are the most common primary tumors to metastasize to the breast.
- Imaging features can vary depending on the primary neoplasm and route of dissemination, hematogenous (more common) or lymphatic.
- Typically, metastases present as well-defined masses without calcifications or distortion on mammography and round hypoechoic masses on ultrasound. Hematogenous metastases present as solitary or multiple breast masses located in the skin, subcutaneous tissue, or the breast parenchyma.
- Breast findings should be characterized according to the BI-RADS lexicon and managed according to the most suspicious features. If metastatic disease to the breast is in the differential diagnosis based on patient history and/or clinical presentation, early confirmation of secondary involvement with pre-operative biopsy of breast lesions is crucial to direct appropriate management.
- Breast metastases can be highly vascular, and ultrasound technique should be optimized to not confuse with pseudoaneurysms or aneurysms, which could result in a delay of diagnosis.

## TABLE OF CONTENTS/OUTLINE

1. Literature review 2. Diagnostic algorithm 3. Key clinical and imaging features 4. The diagnostic and prognostic role of imaging modalities 5. Case demonstration and pathologic correlation

### BREE-91 Optimizing DWI for Improved Imaging in Breast Cancer and Beyond

Sheida Ebrahimi, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

Diffusion weighted imaging (DWI) is an advanced MRI technique that reflects water diffusion in tissues of interest and has been shown predicting pathologic response to neoadjuvant chemotherapy. It assists radiologists in better detecting and characterizing breast lesions. DWI can be challenging due to the breast morphology and introduction of artifacts. This exhibit reviews current state of DWI in breast cancer imaging including the physics of DWI, protocols utilized, advanced DWI techniques, and current indications. Strategies for optimizing DWI to improve image quality, diagnostic accuracy, and clinical utility will also be reviewed. At the end of this educational exhibit, learners will: 1. Recall the fundamentals of DWI and ADC Values; 2. Describe the correlation between ADC values and breast cancer prognostic factors; 3. Understand DWI challenges and limitations, and strategies for enhancing standard DWI; 4. Classify advanced DWI.

## TABLE OF CONTENTS/OUTLINE

1. Introduction: Overview of DWI and its importance in breast cancer; 2. Fundamentals of DWI: Explanation of water diffusion in tissues; ADC values and their significance in DWI; 3. ADC Values and prognostic factors in breast cancer; 4. Benefits and applications of DWI in breast cancer; 5. Quality control and factors influencing repeatability and reproducibility of ADC measure: Techniques to improve the quality of ADC measurements; 6. Comparison of DWI protocols: QIBA recommendations vs. our institute's approach; 7. Technical challenges and limitations of DWI: Techniques to Improve standard DWI; 8. Classification of advanced DWI: Overview of subtypes of advanced DWI, their differences, and advantages; 9. Conclusion.

## **BREE-92    Swipe Left or Right? The Multimodality Imaging Detection and Assessment of the Solitary Dilated Duct**

### Awards

#### Cum Laude

Tanya W. Moseley, MD, PhD (*Presenter*) Consultant, Hologic, Inc; Consultant, Merit Medical Systems, Inc; Owner, TW Moseley, LLC; CEO, TW Moseley, LLC

## TEACHING POINTS

- Review ductal anatomy and the epidemiology of ductal disease.
- Discuss imaging findings of benign and malignant ductal disease.
- Discuss the solitary dilated duct (SDD) and review the BI-RADS® 5th edition's recommendations for classifying and managing ductal lesions.
- Describe the role of imaging in the screening and diagnosing of ductal disease including mammography/tomosynthesis, ultrasound, magnetic resonance imaging, and galactography/ductography.
- Review methods and challenges specific to the sampling of ductal abnormalities.

## TABLE OF CONTENTS/OUTLINE

-Introduction-Anatomy-Benign ductal findings-Malignant ductal findings-Solitary dilated duct (SDD) BI-RADS® 5th edition's recommendation-Imaging's role in screening and diagnosis and the correlation with prognosis-Imaging Techniques to evaluate the ductal anatomy and pathology-Methods to sample ductal abnormalities and tips to overcome the challenges that may be encountered-Conclusion

## **BREE-93    Idiopathic Granulomatous Mastitis: A Case-Based Review**

Layne Kelley, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Idiopathic granulomatous mastitis (IGM) is estimated to affect 2.4/100,000 women, at median age of 36.5 years, and bilateral involvement in 8.8%. 2. Common symptoms are pain, erythema, palpable lump, and less frequently, fistulous drainage or nipple discharge. 3. The most common ultrasound findings are hypoechoic collection (75.9%) and skin involvement (53.5%). Mammography is often nonspecific, but common findings include focal asymmetry (51.6%), global asymmetry (18.3%), mass (17.2%), abnormal lymph nodes (8.6%). 4. IGM can mimic infectious mastitis or breast cancer on imaging and clinically. 5. Biopsy is usually required to confirm diagnosis and guide management. Often biopsy is necessary to exclude malignancy, especially inflammatory or triple-negative subtypes. Suspected IGM may be tentatively diagnosed by clinically assessing treatment response, but given overlap of imaging features and different treatment for IGM and infectious mastitis, biopsy is often needed. 6. Imaging findings often persist after resolution of clinical symptoms, thus clinical follow-up should be the mainstay for surveillance.

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Typical imaging findings on mammography and ultrasound 3. Other entities that mimic IGM 4. Case-based review of biopsy-proven cases using key images with descriptions, treatment and clinical outcome data 5. Biopsy and management considerations

## **BREE-94    Don't Be Fooled: Not Every Late-Onset Peri-Implant Effusion is Seroma! A Case-Based Review of Breast Implant-Associated Anaplastic Large Cell Lymphoma (BIA-ALCL)**

Larissa L. Botelho, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

We report the case of a female patient, with a history of mammoplasty six years ago, reporting sudden enlargement of the left breast. Imaging exams showed the presence of peri-implant fluid in the same breast, with the analysis of the fluid confirming the BIA-ALCL. Breast Implant-associated Anaplastic Large Cell Lymphoma (BIA-ALCL) is characterized by a late-onset peri-implant effusion, appearing on average 10 years after exposure to breast implants. The pathogenesis is not completely identified, but it is known that cases of BIA-ALCL are related to textured prostheses, with the surface of the prosthesis being the most important factor in inducing the disease. It may present only with the effusion (subtype of effusion) or associated with a peri-implant mass (mass-forming disease). The main associated symptoms are sudden edema secondary to the peri-implant effusion and, in case of mass-forming disease, the presence of a palpable nodule. Multiple imaging methods can be used in the evaluation of patients with suspected BIA-ALCL. However, diagnostic confirmation depends on the analysis of the fluid found. The diagnosis of BIA-ALCL is made with the characterization of morphologically atypical lymphocytes, with CD30 expression and negativity for ALK-1. The differential diagnosis of the effusion subtype is made with late seroma. Distant disease is rare, being a neoplasm with a high potential for cure, if identified in the early stages and when not associated with masses, with a surgical approach as a curative technique, in the case of the subtype of effusion.

### **TABLE OF CONTENTS/OUTLINE**

Introduction; Definition and Subtypes; Pathogenesis; Symptoms; Image Methods; Diagnosis; Differential diagnoses

### **BREE-95 Cystic Breast Lesions- What to Do When It's Not Simple**

#### **Awards**

#### **Certificate of Merit**

Laura K. Harper, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Imaging features of benign and malignant cystic lesions may overlap, causing misclassification with the potential to produce diagnostic delay and harm. The purpose of this exhibit is to review ultrasound features of benign and malignant cystic breast masses to guide appropriate characterization and management. The Breast Imaging Reporting and Data System (BIRADS) assessment categories will be reviewed as it pertains to cystic breast masses, including review of appropriate utilization of the BIRADS-3 (probably benign) assessment category. Emphasis will be placed on recognizing suspicious imaging features warranting further evaluation with percutaneous biopsy. Teaching Points: 1. Examine imaging features of various cystic breast masses (Simple cysts, complicated cysts, and complex cystic and solid mass). 2. Discuss overlap of benign and malignant complex cystic and solid masses (ex: hematoma, abscess, cancer). 3. Review appropriate BI-RADS category assessment and management for various cystic lesions

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction of the prevalence, clinical presentation and patient factors associated with cystic breast masses 2. Review distinguishing features and BI-RADS category assessments for various cystic masses 3. Multimodality (mammography, contrast-enhanced mammography, ultrasound, and magnetic resonance imaging) case-based review of benign and malignant cystic breast masses 4. Conclusion (summary of key educational points)

### **BREE-96 Patterns of Breast Cancer Recurrence in the Post-Mastectomy Breast with or without Reconstruction: A Case-Based Review**

Shannon Lanzo, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Women treated for breast cancer with mastectomy with or without reconstruction are at risk of developing loco-regional recurrence along the suture line or within residual tissue. 2. Benign post-operative findings include edema, seroma, hematoma, fat necrosis, post-operative scarring and fibrosis, which evolve over time. 3. Recurrence may be difficult to distinguish from these benign findings. 4. Biopsy is warranted when imaging findings are equivocal.

### **TABLE OF CONTENTS/OUTLINE**

1. This case-based exhibit will review the expected post-operative appearance post mastectomy without or with reconstruction using autologous tissue flaps (pedicled or free flap), and/or prosthetic implants. 2. We will illustrate typical imaging features of benign post treatment changes (fat necrosis, fibrosis, edema, skin thickening, etc.) and malignant findings on mammogram, ultrasound, and MRI. 3. We will review appropriate use of combined imaging and biopsy methods when imaging findings are equivocal.

### **BREE-98 Diagnostic Potential of Photon-Counting Detector Computed Tomography to Evaluate Breast Cancer Patients**

Misugi Urano, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Photon-counting detector computed tomography (PCD-CT) has several advantages over energy-integrating computed tomography (EID-CT). It provides high spatial resolution and improves image contrast, resulting in precise visualization of soft tissue and microstructures while reducing radiation dose. In addition, a simultaneous multi-energy acquisition offers further qualitative and quantitative information in a single scan. These benefits make PCD-CT a valuable tool for systemic staging, preoperative planning, and post-treatment monitoring of breast cancer patients due to its ability to precisely depict the local extent of tumors and the presence of small lesions. This presentation will focus on PCD-CT in initial staging workup, treatment response assessment, or recurrences monitoring in breast cancer patients, comparing to EID-CT, other image modalities, and pathological results. We will also discuss the advantages and pitfalls of PCD-CT.

## TABLE OF CONTENTS/OUTLINE

1. Current CT recommendation for breast cancer patients in guidelines 2. The potential of PCD-CT for breast cancer workup 3. Case-based review of PCD-CT in breast cancer patients compared to EID-CT, other image modalities, and pathological results. 4. Discussion of the utilities of PCD-CT for breast cancer patients, including advantages, disadvantages, and pitfalls.

## BREE-99 Breast Ultrasound Tomography: The Essentials for the Breast Radiologist

Yu Zhao, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

This educational exhibit will review the essentials of breast ultrasound tomography. 1. Understand basic concepts of breast ultrasound tomography including essential physics, the basic imaging sequences, and keys to imaging interpretation. 2. Describe the advantages of breast ultrasound tomography for evaluation of the breasts, especially in those with dense breasts. 3. Describe the specific imaging appearance on ultrasound tomography of various breast entities, benign and malignant. 4. Discuss the future practice considerations and limitations of ultrasound tomography.

## TABLE OF CONTENTS/OUTLINE

-This educational exhibit reviews the essentials of breast ultrasound tomography for the breast radiologist. This is a new imaging modality with enormous potential to add new value to breast imaging by improving diagnostic accuracy especially in patients with dense breasts. -We will describe in simple terms the physics of breast ultrasound tomography and the basic imaging sequences including Waveform Enhanced Reflection (Wafer), Reflection, Sound Speed, and Stiffness Fusion sequences in a breast ultrasound tomographic examination.-We will review with illustrative case examples of high-yield breast lesions including cysts, fibroadenomas, and cancers comparing the distinctive imaging appearance on ultrasound tomography versus other breast imaging modalities.-This will be followed by a discussion of the specific advantages of ultrasound tomography relative to other imaging modalities, such as improved lesion localization and lesion characterization. Finally, we will present the limitations of ultrasound tomography and general considerations for future practice.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-1

### Pathologic Nipple Discharge: Is Breast MRI a Good Option?

All Day Room: Learning Center

Valeria Vidales (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pathologic nipple discharge (PND) is unilateral, spontaneous, involves a single duct, and is serous or bloody in appearance. MRI is able to detect the etiology of nipple discharge in 56-61% of cases when initial imaging with mammogram and ultrasound are negative. To describe differential diagnosis and its classification in BIRADS system.

#### TABLE OF CONTENTS/OUTLINE

Description of the anatomy of the nipple and retroareolar Description of different types of lesions that could be found in patients with nipple discharge US, mammographic and RM principal findings and its correlations. Sample cases

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-10

### Single Duct Abnormalities: Multimodality Imaging and Assessment

All Day Room: Learning Center

Juliana Sitta, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ductal abnormalities entail a wide range of pathology that may present clinically or grow silently, ranging from benign to malignant processes. Solitary dilated duct is a rare mammographic finding with controversial clinical significance in the literature. Workup of the solitary dilated duct must include additional mammographic views and ultrasound to assess for additional findings that would raise suspicion for malignancy and provide a biopsy target. Ductal ectasia is the most common benign finding; however, atypical presentations such as peripheral location, wall thickening, and hypoechoic tissue should raise suspicion for secondary obstruction causes. Inspissated secretions can mimic intraductal masses and may be seen in association or secondary to acute and chronic mastitis, ductal ectasia, and intraductal papilloma. Patients with papillomatosis often have associated high-risk lesions and an increased lifetime risk of breast malignancy. MRI is a great adjunct to evaluate nipple discharge, particularly when the initial workup is negative, and to exclude underlying DCIS or invasive ductal carcinoma.

#### TABLE OF CONTENTS/OUTLINE

Review and illustrate ductal anatomy, physiology, and normal findings on multimodality imaging, including mammography, ultrasound, galactogram, and MRI. Illustrate and discuss problem-solving for single duct findings and presentations commonly associated with single duct abnormality with interesting cases from our institution. Analyze the added value of multiple imaging modalities in assessing ductal pathology, including galactogram and MRI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-100

### The Leading Role of Ultrasound in Breast Implant Evaluation in Developing Countries

All Day Room: Learning Center

Giannina M. Secco, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To illustrate ultrasound findings in breasts with implants and their comparison with those in magnetic resonance imaging. To discuss the advantages and limitations of ultrasound for breast implant evaluation and why it remains a valuable and irreplaceable tool in underdeveloped and developing countries.

#### TABLE OF CONTENTS/OUTLINE

Detecting a broken breast implant is essential due to the potential physical discomfort, cosmetic deformity, and health risks associated with a ruptured implant. Early detection and prompt treatment of a broken implant are crucial to prevent further complications and ensure optimal patient outcomes. Knowledge of a ruptured implant can help patients make informed decisions about implant replacement or removal. In order to acknowledge this, we believe breast implant ultrasound is a preferable choice to MRI for breast implant evaluation in underdeveloped and developing countries. Breast implant ultrasound is more cost-effective, with often portable machines, non-invasive procedure that does not require the use of contrast agents or ionizing radiation, provides real-time imaging, does not require anesthesia and is widely available in many healthcare facilities. Ultrasound imaging can be performed and interpreted quickly, allowing clinicians to make prompt treatment decisions. Furthermore, breast implant ultrasound is safe for patients with pacemakers or other implanted devices, while MRI may not be feasible for these patients. Although ultrasound has its limitations in some cases, it remains a valuable and irreplaceable tool for breast implant evaluation in underdeveloped and developing countries.

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## Abstract Archives of the RSNA, 2023

BREE-101

### **Cystic Breast Lesions Assessment and Management: An Educational Approach for Radiology Residents**

All Day Room: Learning Center

Karina Pesce, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To recognize the spectrum of cystic breast lesions. To learn tools and tips for the sonographic evaluation of cystic lesions. To understand the importance of distinguishing benign cystic lesions from potentially malignant cystic masses To learn skills in the assessment and management of cystic breast lesions

#### **TABLE OF CONTENTS/OUTLINE**

1-Introduction: Cystic breast lesions are a common finding in breast imaging studies. Accurate characterization and precise management of these lesions are essential to avoid unnecessary biopsies and tests, as well as to timely identify which of these lesions require further diagnostic evaluation. 2- Ultrasound parameters necessary for a correct evaluation of cystic lesions. 3- Tips and tricks in the ultrasound evaluation of cystic lesions. 4- Spectrum of cystic lesions. 5- Ultrasound appearance 6-Radiological appearance of cystic breast lesions on other imaging modalities such as mammography, MRI. 7- Management. 8- Interactive clinical cases for self-evaluation. 9- Conclusions

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## Abstract Archives of the RSNA, 2023

BREE-102

### Radiological Signs in Breast Imaging: What Should the Radiology Resident Know?

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Karina Pesce, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1.To know recognize the different radiological signs in breast imaging.2.To learn the importance of accurate identification of the different radiological signs.

#### TABLE OF CONTENTS/OUTLINE

Introduction This educational poster reviews the importance of understanding breast radiological signs. Accurate identification of different radiological signs is critical for early diagnosis and effective treatment of various medical conditions, including breast cancer. Furthermore, knowledge of clinical and radiological signs in breast imaging can help prevent diagnostic errors and reduce the number of unnecessary medical tests. Description of the radiological signs in breast imaging. Tips and techniques for identifying these signs are also provided to assist residents in their interpretation of medical images. interactive clinical cases for self-evaluation. These cases offer residents the opportunity to apply their knowledge and receive immediate feedback, thereby strengthening their diagnostic skills and decision-making abilities. Conclusion: Radiologists residents must be familiar with different radiological signs to accurately interpret medical images and provide an accurate diagnosis.

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## Abstract Archives of the RSNA, 2023

BREE-103

### Peer Learning in Breast Imaging: Lessons Learned in Our Institution

All Day Room: Learning Center

Marcela C. Lauer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

It is estimated that medical diagnostic mistakes contribute to approximately 10% of patients deaths and 17% of adverse events in hospitals. Consequently, optimal patient care is related to recognizing and preventing such errors. Strategies were developed to ensure performance standards in radiology departments, including score-based second-reader peer review systems. However, this type of strategy may be associated with subjectivity, sampling bias, underreporting of errors due to peer relationships and fear of punitive action. It may have emotional impact for radiologists and lead to feelings like anxiety, shame, and humiliation, contributing to a culture of defensiveness. On the other hand, peer learning is an strategy focused on learning and improvement that has gained momentum, as a respectful nonpunitive collaborative culture improves performance in modern radiology practice. The objective of this presentation is to show how we established peer learning in our breast imaging department, the bias that were related to the mistakes we made, how we concluded they could have been avoided and our experience with peer learning as a group. We aim that this presentation may help and encourage other services to implement peer learning in their clinical practice, and also learn from the multimodality imaging cases we provide.

#### TABLE OF CONTENTS/OUTLINE

Didactic case-based reviews of breast imaging exams (including mammography, ultrasound and magnetic resonance imaging performed in our service) that were discussed in our peer learning meetings in the last 5 years, with correlation of associated cognitive bias, how the cases could have been better managed and lessons learned that changed our daily practice.

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## Abstract Archives of the RSNA, 2023

BREE-104

### Multimodality Surveillance of Breast Implants in Asymptomatic Patients and the Potential Challenges for the Radiologist in Light of the 2022 United States Food and Drug Administration (FDA) Guidelines

All Day Room: Learning Center

H. Carisa Le-Petross, MD, FRCPC (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recently the United States Food and Drug Administration (FDA) implemented changes to breast implant surveillance that radiologists may not be aware of<sup>1,2</sup>. At the end of this exhibit, the participant will:

- Be up-to-date on the 2022 FDA guidelines for breast implant screening.
- Learn the common signs of implant rupture on ultrasound (US).
- Learn the common signs of implant rupture on magnetic resonance imaging (MRI).
- Be familiar with implant complications and new technology to minimize some complications<sup>3</sup>.
- Be familiar with some key differences between updated FDA guidelines and the imaging recommendations from the American College of Radiology Appropriateness Criteria.

#### TABLE OF CONTENTS/OUTLINE

- Discuss the changes in the 2022 FDA guidelines for breast implant screening, especially the addition of US as an alternative to MRI for initial imaging surveillance for silicone implant rupture in asymptomatic patients<sup>1-4</sup>.
- Discuss the 2022 FDA guidelines recommendation for the first screening imaging test at 5 years after implantation instead of 2 years after implantation, the lack of compliance from patients, and background behind this change<sup>1-5</sup>.
- Discuss the potential controversies regarding the imaging modality of choice to evaluate for implant rupture via case-based presentation<sup>4</sup>.
- Review the imaging signs of implant rupture on different modalities, focusing mainly on US and MRI. Review benefits and/or challenges of new implants, technology such as acellular dermal matrix (ADM), and new generation tissue expanders.

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## Abstract Archives of the RSNA, 2023

BREE-105

### Abnormality of the Duct on Breast Ultrasound: Comparison with Multimodality, Correlation with Pathological Findings, and Assessment

All Day Room: Learning Center

Ken Oba, MD, BArch (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The 6th edition of BI-RADS is expected to include nonmass lesions detected on breast ultrasound. In breast imaging, it is important to comprehend lesions such as ductal carcinoma in situ which do not form masses but appear as abnormalities of the ducts. Ultrasound is the best imaging tool for a detailed evaluation of the ducts. Although definitions and terminology for ductal abnormalities may vary in the literature, there is a growing interest among Asian countries regarding ultrasound findings of ductal abnormalities. In this review, we present a method for detecting and evaluating ductal abnormalities based on a detailed comparison with pathological findings. To understand and organize the terminology found in various literature and guidelines, as well as the corresponding findings. To become familiar with normal anatomy and identify findings accurately. To compare expected findings in other modalities with pathological findings. To discuss evidence-based assessment and management plan for each finding.

#### TABLE OF CONTENTS/OUTLINE

Normal anatomy Methods of detection Terminology Comparison with multimodality and correlation with pathological findings Assessment and management plan of each pathological finding Case studies The included cases are as follows: Ultrasound findings Ductal dilatation Duct dilatation with internal echoes Duct wall thickening Irregularity of the ductal caliber Pathological diagnoses Duct ectasia Fibrocystic change Intraductal papilloma (IDP) Atypical ductal hyperplasia Ductal carcinoma in situ (DCIS) Ductal carcinoma in situ with invasive component Invasive ductal carcinoma (IDC)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-106

### **A Review of Contrast-Enhanced Mammography in the Evaluation of Suspicious Breast Micro-Calcifications and Our Experience**

All Day Room: Learning Center

Felix Maimir Quadrado, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To outline a potential indication of contrast-enhanced mammography (CEM).- To review the contribution to date of CEM in the evaluation of suspicious breast microcalcifications.- To share and discuss our initial experience using CEM in the evaluation of suspicious breast microcalcifications and their histopathologic results.The interpretation and description of breast microcalcifications have always posed a great challenge to breast radiologists. Due to the intrinsic relation of microcalcifications with different breast lesions, and in the case of suspicious ones with breast carcinomas, CEM has been proposed as a promising technique because of its capability to assess neoangiogenesis. We present an up-to-date revision of CEM in the evaluation of suspicious breast microcalcifications and our center's initial experience.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction- False-positive cases- False-negative cases- What the recent literature tells us- Our experience

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-107

### Diagnostic Approach and Assessment of Cystic Breast Lesion

All Day Room: Learning Center

Hyo Soon Lim, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Cystic masses are common findings on mammography, ultrasonography, and MR imaging and a thorough understanding of their imaging findings and management is important. 2. It is important to obtain US images with meticulous technique for accurate classification and assessment of cystic breast lesions. 3. Complex cystic and solid masses may have one or all of the following characteristics: a thick wall ( $\geq 0.5$  mm), thick internal septations, an intracystic mass, and both solid and cystic components. 4. Complex cystic and solid masses are usually assessed as suspicious (BI-RADS category 4) and accompanied by a recommendation for biopsy.

#### TABLE OF CONTENTS/OUTLINE

A. Definition of cystic breast lesions 1. Simple cyst 2. Complicated cyst 3. Clustered microcysts 4. Complex cystic and solid mass B. Meticulous technique in evaluating cystic breast lesions on US C. Multimodality imaging findings with important differential diagnosis 1. Simple or complicated cyst vs. Nearly anechoic solid mass on US 2. Inflamed or ruptured cyst vs. Rim enhancing mass on breast MRI D. Imaging-pathologic correlation of complex cystic and solid mass E. Diagnostic approach and BI-RADS assessment of cystic breast lesions F. Management of cystic breast lesions

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## Abstract Archives of the RSNA, 2023

BREE-108

### Breast Malignancy: Beyond Breast Carcinoma

All Day Room: Learning Center

Alex Gil Ordonez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To provide the basis for recognizing morphological and functional imaging findings of non-epithelial and metastatic lesions of the breast (B5d, NHSBSP).- To review the most common B5d lesions through a pictorial review of our cases.- To describe the clinical management of B5d lesions and the role of the radiologist in these cases.

#### TABLE OF CONTENTS/OUTLINE

1.Introduction 1.1. NHSBSP classification. 2. B5d lesions through a pictorial review of our cases. 2.1. Metastatic disease. 2.2. Oncohematological disease. 2.3. Sarcomas 3. Imaging features 4. Management 5. ConclusionsThe vast majority of malignant breast neoplasms are breast carcinomas. Nevertheless, some malignant breast lesions present different histologies, which are commonly less suspicious than carcinomas on imaging techniques. Their recognition is essential to an early diagnosis and therapeutic approach.

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## Abstract Archives of the RSNA, 2023

BREE-109

### Vague and Nebulous: Non-Mass Ultrasound Lesions

All Day Room: Learning Center

Craig Wilsen, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1.) To review descriptors of ultrasound (US) non-mass lesions. (2.) To illustrate US non-mass lesions identified as correlates for breast MRI non-mass enhancement. (3.) To demonstrate methods for locating US non-mass lesions as correlates for breast MRI non-mass enhancement.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Ultrasound (US) correlates of MRI-detected non-mass enhancement (NME) may have no defined mass-like sonographic margin or shape, or may show subtle disruptions of the background tissue pattern. A new US lexicon term, non-mass lesion (NML), better describes these US findings. Cases: This educational exhibit will show 10 cases of US NML corresponding to MRI NME. We will highlight methods of predicting the US appearance and location of the NML on MRI-directed US by the use of breast architecture, surrounding cysts/masses, and use of the MRI appearance to predict the size and shape of the NML. Histopathologies include breast cancer, radial scar, sclerosing adenosis, fibrocystic change and fat necrosis. Conclusion: The exhibit illustrates subtle US NML correlates to MRI NME. Techniques for successful MRI-directed ultrasound detection of these findings are described. Once correlation is confirmed, US-guided biopsy, which is more expeditious than MRI-guided biopsy, can be performed.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-11

### Male Breast Lesions: To Infinity and Beyond

All Day Room: Learning Center

Camila F. Guimaraes, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: Male breast disease encompasses both benign and malignant conditions that are hormonally influenced. Gynecomastia and skin lesions are the most common conditions in symptomatic men, referred for a palpable mass, with imaging patterns that can correlate with different histopathological phases. Other benign tumors in male breasts include lipoma, pseudoangiomatous stromal hyperplasia, granular cell tumor, fibromatosis, myofibroblastoma, schwannoma, and hemangioma. The incidence of breast cancer in men is rare but has increased and accounts for 1% of all breast carcinomas, with invasive ductal carcinoma being the most common type in adult males. Other tumors that may occur include papillary carcinoma, invasive lobular carcinoma, adenoid cystic carcinoma, liposarcoma, dermatofibrosarcoma, pleomorphic hyalinizing angiectatic tumor, basal cell carcinoma of the nipple, hematopoietic malignancies, and secondary tumors. Understanding the clinical and imaging characteristics of these tumors is important for their accurate diagnosis and optimal treatment.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline: This article examines the clinical, radiological, and pathological characteristics of both benign and malignant tumors of the male breast. Cases of male breast disease were selected from the file of the Breast Radiology group of our hospital showing some of these pathologies: 1. Complicated Cyst; 2. Dermoid Cyst; 3. Myxoid Liposarcoma; 4. Hybernoma.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

BREE-110

### From Words to Images: Applying the Contrast Enhanced Mammography BI-RADS® Lexicon

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mitva J. Patel, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The American College of Radiology Breast Imaging Reporting and Data System (ACR BI-RADS®) lexicon is widely used in clinical practice and is a standardized nomenclature used for mammographic reporting. Recently, an extension of the lexicon was developed for the interpretation and reporting of contrast-enhanced mammography (CEM) findings. Adopting the American College of Radiology (ACR) Contrast Enhanced Mammography (CEM) Lexicon is important as standardization reduces inter-observer variability and improves the accuracy and reliability of diagnostic reporting, which ultimately leads to better patient outcomes. Education on this new topic is essential as adoption of the lexicon is critical to assist standardize reporting, improve patient care, and facilitate communication between radiologists and clinicians.

#### TABLE OF CONTENTS/OUTLINE

I. CEM Lexicon classification for recombined images?A. Background parenchymal enhancement?1. Level?2. Symmetry?B. Lesion conspicuity?C. Masses?-Internal enhancement characteristics?D. Non-mass enhancement?-Distribution?E. Enhancing asymmetry?II. Interpretation?A. Findings on low energy images only?B. Areas of enhancement seen on recombined images only?C. Low energy images with associated enhancement on recombined images

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## Abstract Archives of the RSNA, 2023

BREE-111

### The Power of Contrast: Contrast Enhanced Mammography in the Diagnostic Clinic

All Day Room: Learning Center

Mitva J. Patel, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

We hope that by highlighting the practical uses of CEM and its potential to enhance breast cancer detection in the diagnostic clinic, more practices will embrace this powerful technology. Contrast enhanced mammography (CEM) is an imaging technique that combines standard mammography with iodinated contrast to improve breast cancer detection. By highlighting areas of increased vascularity associated with malignancy, CEM has been shown to improve the sensitivity of mammography, particularly in women with dense breast tissue. Despite these well-known benefits, the adoption of CEM in clinical practice has been slow, owing primarily to the difficulties establishing a CEM program and reimbursement. Despite these challenges, we believe the benefits it brings to the diagnostic clinic outweigh the additional effort. CEM may be used to: -resolve equivocal findings on mammography, and to increase confidence prior to stereotactic biopsy for vague areas of architectural distortion. -as a more efficient, accessible alternative to MRI in pre-operative extent of disease and workup of highly suspicious findings identified on screening mammography. We hope that by highlighting the practical uses of CEM and its potential to enhance breast cancer detection in the diagnostic clinic, more practices will embrace this powerful technology.

#### TABLE OF CONTENTS/OUTLINE

Examples provided will demonstrate how CEM impacted these patients' management and supports the notion that CEM has a place in the diagnostic clinic as a cost-effective and time-efficient alternative to breast magnetic resonance imaging (MRI) for select patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-112

### **Common Enough to Care - Young Women with Breast Cancer: Multidisciplinary Approach and Special Considerations**

All Day Room: Learning Center

Grace DeWitt, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Breast cancer in young women, widely accepted as women under 40 years of age, has a worse prognosis compared to older patients as young age is an independent predictor of adverse breast-cancer specific outcomes, including morbidity, local and systemic recurrence, and death. Historically, young women have been underrepresented in clinical trials and undergo more aggressive therapy solely based on their young age. As it is important to recognize how these women differ from older patients, the teaching points of this presentation are to: 1. Describe the epidemiology, clinical presentation, and tumor biology of young women with breast cancer. 2. Define imaging guidelines in high-risk populations and in young women after diagnosis of breast cancer. 3. Explain surgical management and surgical risk reducing strategies. 4. Highlight the special considerations unique to young women including the effects of oncology treatment on fertility and lactation and describe fertility preservation techniques.

#### **TABLE OF CONTENTS/OUTLINE**

1. Appearance of breast cancer in young women: Epidemiology and clinical presentation, Tumor biology; 2. Imaging guidelines: Risk factors and assessment, Genetics based or calculated lifetime risk, Diagnosis and staging; 3. Surgical management: Breast conserving vs. mastectomy, Cosmetic options, Risk reducing strategies; 4. Effects of oncology treatment on fertility: Chemotherapy, Hormone therapy; 5. Fertility Preservation Techniques

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-113

### Breast US: A Guide for Beginners

All Day Room: Learning Center

Erica E. Francolin Federicci, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ultrasonographic characterization of mammographic abnormalities and palpable lesions is indicated in the evaluation and management of breast diseases. Although in the United States breast ultrasounds (US) are performed by sonographers, in many countries it is performed by physicians. Considering that breast screening US as an adjunct to mammography will be more widely practiced in the United States, the Breast Imaging-Reporting and Data System (BI-RADS®) provides training and performance guidance as set forth in ACRIN 6666. Because the effective use of the US lexicon relies on excellent sonographic technique and understanding of breast anatomy, the objective of this presentation is to didactically illustrate how the BI-RADS® recommendations should be followed, including the most common findings, pitfalls and how to avoid them.

#### TABLE OF CONTENTS/OUTLINE

We used ultrasonographic images (in correlation to mammography and magnetic resonance imaging, when appropriate) from our institution's digital archive, in order to provide a case-based didactic review of the most common findings in breast ultrasounds, including a review of the adequate technical parameters, lexicon and reporting system and tips to avoid common pitfalls, based on the BI-RADS® recommendations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-114

### Pseudo-progression During Immunotherapy: A New Challenge for Breast Radiologists

All Day Room: Learning Center

#### Awards

##### Cum Laude

Aline D. Guimaraes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Immunotherapy has emerged as a promising treatment strategy for advanced breast tumors. Immune checkpoint inhibitors (ICI) such as blockades that target programmed death-1 (PD-1), programmed death-ligand 1 (PD-L1) and cytotoxic T-lymphocyte associated antigen (CTLA-4), are one of the most powerful tools in the immunotherapy armamentarium and offer a beneficial immunotherapeutic regimen for patients with breast cancer. The pattern of treatment with immunotherapy is totally different from other therapeutic modalities, thus bringing major challenges to clinicians and radiologists who are not familiar with it. One of these challenges is pseudoprogression, that can be characterized as a transient increase of tumor burden followed by tumor regression. Although rare, it is fundamental for the radiologist to be aware of this condition and to carry out studies in the direction of finding diagnostic tools that are capable of more accurately identify this phenomenon contributing for better patient outcomes. In this didactic exhibit, we will discuss the basis of immunotherapy in breast cancer, demonstrate imaging findings of cases of breast cancer pseudoprogression and discuss the current tools available to identify the possibility of this condition such as biomarkers, imaging techniques and biopsy.

#### TABLE OF CONTENTS/OUTLINE

1) Basis of immunotherapy 2) Definition of pseudoprogression 3) Tools used to identify pseudoprogression 3.1) Biomarkers 3.2) Medical imaging 3.3) Biopsy 4) Cases of breast cancer pseudoprogression

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-115

### **Contrast-enhanced Mammography in Breast Cancers for Women with Dense Breasts: Accuracy, Value, Controversies and Solutions**

All Day Room: Learning Center

Bingmei Zhang, MBBS, MMedSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. To familiarize the reader to what CESM implies as an emerging modality and its implementation for breast imaging. 2. To demonstrate diagnostic accuracy and correlation in lesion size estimation of CEM against DCE-MRI in dense breast patients. 3. To illustrate value of CEM in evaluating BI-RADS 4 microcalcifications including morphology, distribution and neovascularity of microcalcifications. 4. To discuss whether CEM can be an effective imaging tool in pre-surgical planning for women with dense breast parenchyma. 5. To highlight the benefits and deficits of CEM in women with dense breast who are at an increased risk of developing breast cancer.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief overview about the different approaches in CEM and their features in imaging interpretation (temporal subtraction and dual energy technique). 2. Cancer evaluation in the dense breast and review of cases, comparing CESM with MRI in the assessment of disease extent in breast carcinomas. 3. Practical application of CEM with illustrated clinical examples in evaluating BI-RADS 4 microcalcifications in dense breast. 4. Is CESM adequate and accurate in pre-surgical planning for women with dense breast. 5. Advantages vs. drawbacks of CEM and potential pitfalls elucidation for high risk screening for women in dense breast. 6. The future applications of CEM in breast evaluation.

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## Abstract Archives of the RSNA, 2023

BREE-116

### Preoperative Wire and Wireless Localizations Gone Wrong: How to Get Out of Trouble

All Day Room: Learning Center

Sheila S. Enamandram, MD, MBA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Accurate, thoughtful planning of preoperative image-guided wire or wireless localizations is critical for breast conservation surgery, especially in complex imaging scenarios. Target lesion visualization and localization may require more than one imaging modality and/or a non-routine approach for difficult marker/target localizations. Understanding the differences in size, appearance, and deployment techniques of localization devices is important in accurate placement and retrieval. Targeted markers may be found in unexpected places when not seen in the initial specimen radiograph. Clear communication with surgical colleagues is paramount.

#### TABLE OF CONTENTS/OUTLINE

This case-based exhibit will highlight anatomic, procedural, and technical troubleshooting steps in the following scenarios: Biopsy marker, wire, or wireless device migration; Biopsy marker non-visualization; Target not marked at time of initial biopsy; Target obscured or visible on only one imaging modality; Wireless radar reflector malfunction; Alternative imaging modalities needed for localization; Biopsy marker not seen in the specimen and ultimately found in unexpected places; Incomplete retrieval of distal hook wire in the specimen.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-12

### **Nipple Discharge: In the Era of Multimodality Imaging**

All Day Room: Learning Center

Astrid Orfali Camez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

TEACHING POINTS 1. To remind the different etiologies responsible for nipple discharge2. To recognize the worrisome signs of a nipple discharge that must lead to further investigation3. To discuss imaging modalities and management

#### **TABLE OF CONTENTS/OUTLINE**

TABLE OF CONTENTS 1. Clinical history and physical examination2. Etiologies responsible for nipple dischargea. Extra-mammary causes :- Hyperprolactinemia- Drugs- Othersb. Breast lesions :- Benign lesions (infections, galactophorities, papillomas)- Malignant lesions (intra-ductal, inflammatory)3. Multimodality imaging approacha. Gold standard of initial evaluation of nipple discharge- Mammography + Ultrasoundb. Second level of investigation :- The role of MRI and contrast-enhanced mammography4. Diagnosisa. Cytology of the nipple dischargeb. US guided microbiopsyc. MRI guided core biopsyd. Emerging role of contrast-enhanced guided core biopsy5. Patient management flowcharta. Follow-up, what? When?b. US guided macrobiopsy, when?c. Surgery

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

BREE-13

### Staying Vigilant: Imaging Surveillance and Risk Prediction After Breast Cancer

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Beatriu Reig, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Patients with a personal history of breast cancer have 5-20% recurrence rates and are at increased risk of second breast cancers. 2. Risk factors for recurrent or second breast cancer include dense breasts, young age at diagnosis of the first breast cancer, omission of radiation after breast conserving therapy, and hormone receptor negative first breast cancer. 3. Imaging biomarkers such as background parenchymal enhancement are under investigation and may permit personalized risk prediction and guide surveillance recommendations in the future.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction (definition, statistics, localized vs metastatic recurrence, early vs late recurrence) 2) Risk factors for recurrence a) Association of molecular subtypes with risk for recurrence b) Effect of neoadjuvant chemotherapy c) Modifiable risk factors (aromatase inhibitor or tamoxifen after ER+ cancer, alcohol consumption, weight) 3) Screening methods for recurrence a) Mammography b) Ultrasound i) Inclusion of the axilla c) MRI i) Abbreviated vs full-protocol d) Contrast-enhanced mammography 4) What should be the imaging interval? 5) Post-mastectomy imaging 6) Risk models for individualized screening a) Clinicopathologic factors b) Imaging biomarkers c) Radiomics and artificial intelligence models

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-14

### **Breast Cancer or Not? An Interactive Case-Based Review of FDG-PET/CT Positive Findings in the Breast**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Emily O. Yoon, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Background Interpretation of lesions with increased FDG uptake in the breast can be challenging due to nonspecific uptake in various benign and malignant processes involving the breasts. Knowledge of this wide spectrum is essential for accurate analysis of FDG-PET/CT in conjunction with a patient's symptomology. The purpose of this educational exhibit is to illustrate the multi-modality imaging appearance of various benign and malignant processes that demonstrate hypermetabolic activity within the breast on FDG-PET/CT. Teaching Points Differentiate various benign and malignant processes that can result in hypermetabolic lesions in the breast Understand sensitivity and specificity of FDG-PET/CT for breast cancer and metastatic breast lymphadenopathy Conclusion There is a wide range of benign and malignant conditions presenting as hypermetabolic breast lesions on FDG-PET/CT. Knowledge of the various imaging features is important for accurate diagnosis and patient management.

#### **TABLE OF CONTENTS/OUTLINE**

This presentation will be case-based with review of clinical history and imaging findings (mammogram, US, MRI, PET/CT) of patients with FDG-PET positive findings in the breast. Several benign and malignant pathologies will be reviewed, as outlined below. Teaching points with recent literature review will provide guidance when non-breast cancer pathology should be suspected in cases, while also highlighted when additional dedicated breast imaging is indicated. Breast implant capsule-associated squamous cell carcinoma Reactive lymphadenopathy Metastatic disease Granulomatous mastitis Fat necrosis Inflammatory breast cancer Gynecomastia Infectious/Inflammatory changes

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-15

### The Role of DBT-Guided Biopsy for MRI/CEM Detected Lesions

All Day Room: Learning Center

Cesar Urtasun Iriarte I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To emphasize the need to correlate MRI/Contrast Enhanced Mammography (CEM) findings with DBT (Digital breast tomosynthesis). To show the advantages of DBT-guided biopsy compared to MRI-guided biopsy. To consider DBT-guided biopsy as an alternative for CEM-detected lesions.

#### TABLE OF CONTENTS/OUTLINE

INTRODUCTION: Both MRI and CEM are morphofunctional imaging techniques based on neoangiogenesis. These techniques are more sensitive than pure morphological techniques, such as DM or DBT. ASSESSMENT OF MASS ENHANCEMENTS: Second look US is of choice to evaluate these lesions. ASSESSMENT OF NON-MASS ENHANCEMENTS: These lesions are challenging. Although US plays an important role, in many cases it is inconclusive. DBT correlation is very important, specifically using the craneocaudal (CC) view. This view is easy to compare anatomical structures with both MRI (axial) and CEM. DBT GUIDED BIOPSY: This technique offers several advantages over MRI or CEM guided biopsies: Less time consuming, widely spread technique. Not all the vendors have dedicated units to perform CEM guided biopsies. Once the lesion is located with DBT, the performance of the biopsy is easy. Usually 10G vacuum assisted biopsy devices are used. CONCLUSION: DBT guided biopsy can offer a good alternative for MRI/CEM detected lesions, specially for non-mass enhancements.

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## Abstract Archives of the RSNA, 2023

BREE-16

### Male Breast: Common and Rare Conditions

All Day Room: Learning Center

Carla Sitges, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: To describe the spectrum of imaging features of benign and malignant lesions of the male breast from a review of pathologically-proved cases. To correlate imaging and pathological findings. To discuss the appropriate imaging workup of male breast cancer.

#### TABLE OF CONTENTS/OUTLINE

Introduction Gynecomastia Benign lesions Imaging features on mammography, ultrasound and MRI. Radiologic-pathologic correlation. Malignant lesions Imaging features on mammography, ultrasound and MRI. Radiologic-pathologic correlation. Conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-17

### Breast Ductal Disease: Multimodality Imaging Detection and Assessment

All Day Room: Learning Center

Meng Hao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review normal ductal anatomy and its imaging features. Review the broad differential of benign and malignant ductal diseases, particularly in the setting of a single dilated duct. Recognize imaging abnormalities of ductal diseases and features associated with malignancy on DBT, US, and MRI. Describe appropriate diagnostic workups and management of ductal diseases.

#### TABLE OF CONTENTS/OUTLINE

Breast ductal disease is an important aspect of breast imaging and often poses challenges in diagnosis and management, particularly in the setting of a single dilated duct. Thus, radiologists should be familiar with clinical presentations, diagnostic workup, imaging features, and differentials for ductal abnormalities. Patients may present with nipple discharge, palpable abnormalities, infectious symptoms, lactational issues, or be asymptomatic. Ductal pathologies range from ductal ectasia, periductal mastitis, intraductal papillomas, to ductal carcinoma in situ, invasive ductal carcinoma, and Paget's disease. Radiologists should recognize both normal and abnormal ductal imaging features on DBT (dilated ducts, masses, and/or calcifications), on US (cystic ductal dilation, ductal wall irregularities or arborization, intraductal masses or debris), and on MRI (clustered ring non-mass enhancement, abnormal linear or segmental NME). This educational exhibit will provide a comprehensive case-based review of benign and malignant ductal diseases, their multimodality imaging features, and associated management recommendations.

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## Abstract Archives of the RSNA, 2023

BREE-18

### **Breast Surgery: Changes and Findings Multimodal Diagnosis**

All Day Room: Learning Center

Maria Jose Chico (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Identify the different post-surgical changes of breast surgery<sup>2</sup>. Learn to identify which findings are suspicious and which are not.<sup>3</sup> Understand and integrate the findings in the different imaging modalities.<sup>4</sup> Understand the differential diagnoses

#### **TABLE OF CONTENTS/OUTLINE**

The accurate interpretation of images of the postsurgical breast depends on the availability of high-quality imaging. These changes should be interpreted in conjunction with the clinical and surgical history. They may correspond to benign or suspected changes. It is useful to analyze them in the different imaging modalities to support or rule out a suspected diagnosis. They can appear in the post-surgical period due to both malignant and benign conditions

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## Abstract Archives of the RSNA, 2023

BREE-19

### **Beyond the Lump: Navigating the Challenges of Cystic Breast Lesions**

All Day Room: Learning Center

Maria Vitoria D. Ludwig, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Our educational exhibit is directed to review the assessment and management of cystic breast lesions through the following points: review the pathologies presented as cystic breast lesions; understand how to identify and categorize breast cysts at ultrasonography; comprehend the appropriate management according to the imaging finding, correlating with clinical history and other imaging modalities if available; enlighten biopsy modalities, indication and technique; recognize the importance of subsequent histological analysis.

#### **TABLE OF CONTENTS/OUTLINE**

The subject will be approached in the following sequence: pathologies presented as cystic breast lesions and their malignancy risk; diagnosis, initial evaluation and ultrasound classification of breast cysts, linked with drawing representations of each type of cyst; appropriate risk assessment and management according to the imaging finding considering correlation with clinical history and other imaging modalities, namely mammography and magnetic resonance imaging; how to choose the most suitable biopsy modality and possible pitfalls; correlation of radiological findings with histopathologic analysis, followed by revision of management if required; illustrative cases in the different imaging methods.

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## Abstract Archives of the RSNA, 2023

BREE-2

### **Lipofilling: What Does Breast Radiology Need to Know?**

All Day Room: Learning Center

Karen L. Caro, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1.- Describe the imaging characteristics of the lesions in lipofilling  
2.- When should we consider that a lesion after a lipofilling procedure would need histological certification, in relation to the imaging findings?

#### **TABLE OF CONTENTS/OUTLINE**

Currently fat transfer (lipofilling) is used in breast reconstruction. In this paper we will describe its advantages and how it is seen in the different imaging studies (ultrasound, mammography and MRI). It is important to identify which are the usual benign findings in the different methods and what Bi-Rads to assign, in this way we can define those cases in which their histological evaluation should be considered. Describe the advantages and disadvantages of this method in breast remodeling. The importance of recognizing radiological manifestations and the difficulties involved in detecting suspicious lesions. Knowing how to recognize that fat necrosis is a frequent lesion after lipofilling, which should be suspected in order to avoid other more complex studies such as MRI and even biopsies

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## Abstract Archives of the RSNA, 2023

BREE-20

### **Not Every Ductal Ectasia Is Evil: Spectrum of Ductal Lesions**

All Day Room: Learning Center

Raissa Soares, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the imaging appearance of normal ductal anatomy; Illustrate imaging findings of ductal ectasias using different techniques, including mammography, ultrasound and magnetic resonance imaging, providing clinical images and histopathology correlation; To discuss the appropriate management of these lesions; Review a case series of benign ductal breast diagnoses from our institute, without associated malignancy;

#### **TABLE OF CONTENTS/OUTLINE**

Identify imaging criteria that may help in the diagnosis of ductal ectasia and, eventually, in its management; Typical multimodality imaging findings (magnetic resonance imaging, ultrasound and mammography) from cases of our radiology department; Diagnostic challenges, main differentials, and key points suspicion of this pathology; Discuss the role of percutaneous biopsy (ultrasound-guided core biopsy and vacuum - assisted biopsy) in the diagnosis of ductal ectasias; Conclusion.

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## Abstract Archives of the RSNA, 2023

BREE-21

### Understanding the BI-RADS 3 Category

All Day Room: Learning Center

Summer Joyce Batasin (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

By the end of this educational exhibit, learners will: 1. Accurately define BI-RADS 3 and appropriate use cases. 2. Explain BI-RADS 3 radiographic features and diagnostic considerations for mammography, ultrasound, and MRI. 3. Demonstrate proficiency in the assessment process of a BI-RADS 3 lesions, through a case-based review.

#### TABLE OF CONTENTS/OUTLINE

1. What is BI-RADS 3? a. Definition b. Appropriate use cases  
2. BI-RADS 3: Mammography a. Imaging features b. Diagnostic considerations  
3. BI-RADS 3: Ultrasound a. Imaging features b. Diagnostic considerations  
4. BI-RADS 3: MRI a. Imaging features b. Diagnostic considerations  
5. Identifying BI-RADS 3 Lesions: Case-Based Walkthrough a. Classic BI-RADS 3 cases b. Special cases

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## Abstract Archives of the RSNA, 2023

BREE-22

### Back to the Tumor: Navigating Breast Cancer Recurrence Like a Pro

All Day Room: Learning Center

#### Awards

##### Cum Laude

Vitor C. Zanetta, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the risk and pattern of tumor recurrence according to molecular subtype. Provide visual and data-driven insights into expected imaging changes following treatment. Highlight the role that multimodality plays in differentiating expected imaging findings from treatment and imaging findings indicative of recurrence or new breast cancer. Review current follow-up protocols after breast cancer and screening for intermediate risk patients.

#### TABLE OF CONTENTS/OUTLINE

Review the influence of breast cancer subtype on the rate, timing and location of tumor recurrence. Expected imaging changes following treatment with visual and data-driven insights: Expected timeline of post-surgical changes. Details in the assessment of local recurrence in breast-conserving surgery and mastectomy. Possible changes in axillary and internal mammary lymph nodes. The role that multimodality imaging (mammogram, ultrasound, MRI and PET-CT) plays in differentiating recurrence or new breast cancer from post-treatment changes, including: Frequent dilemmas in clinical practice: evaluation of calcifications, distortions, fat necrosis and enhancements in the surgical bed. How to deal with conflicting findings between different imaging methods to avoid unnecessary biopsies without losing sensitivity for early recognition of recurrence. Subtle recurrence and the importance of serial follow-up Imaging. Examine the follow-up protocols after breast cancer and screening for intermediate-risk patients from the perspective of personalized medicine.

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## Abstract Archives of the RSNA, 2023

BREE-23

### From Flat to Fabulous - A Radiological Guide to Breast Aesthetic Fillers and Biostimulators

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Heni D. Skaf, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To expose, through cases from our institution, manifestations of different breast filling and biostimulator materials in the most diverse imaging methods, such as: free silicone, acrylates (PMMA, PAAG), hyaluronic acid, vitamin D, calcium hydroxyapatite and fat grafting. To familiarize the breast radiologist with the radiological presentation of these materials, avoiding false positives and unnecessary investigations. To discuss the usual topography in which they are injected, as well as possible local and systemic complications of using such materials.

#### TABLE OF CONTENTS/OUTLINE

Introduction: The demand for percutaneous aesthetic procedures is rising in medicine, especially in the context of facial harmonization. This also applies to the breast, both for use in cancer patients, with the increase in the incidence and in diagnosis of breast cancer, as well as for purely aesthetic purposes in the breast itself or even due to migration from other injection sites. Imaging findings: on mammography, ultrasonography and magnetic resonance as well as possible complications and usual injection sites of free silicone, acrylates (PMMA, PAAG), hyaluronic acid, vitamin D, calcium hydroxyapatite and fat grafting. For the most part, non-resorbable synthetic biomaterials, fat grafting, as well as resorbable materials used recently, have radiologic representation. Conclusion: The use of aesthetic breast fillers, whether in the oncological context or not, is on the rise. Often, the patient does not have knowledge of what was used, which can limit the clinical decision of the physician. Additionally, recognition of the radiological appearance of different fillers can avoid false positives and unnecessary biopsies.

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## Abstract Archives of the RSNA, 2023

BREE-24

### Far Beyond The Axilla, What Else do We Need to See? Tips and Pitfalls of Lymph Nodes

All Day Room: Learning Center

Raissa Soares, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Aspects of normal images of axillary and supraclavicular lymph nodes and internal mammary in different methods and mainly in ultrasound; To present imaging cases of normal lymph nodes, as well as differential diagnoses of axillary, supraclavicular and internal mammary lymph node enlargement, from our database; Image-guided procedures; Show the importance of the radiological-pathological correlation.

#### TABLE OF CONTENTS/OUTLINE

Review the main spots of mammary drainage; To show imaging cases of normal findings and our histological correlation; To present some differential cases of lymph node pathologies; Discuss the types of lesions and which ones require biopsy; Conclusion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-25

### **Axillary Lymphadenopathy Induced by COVID-19 Vaccination: What Have We Learned?**

All Day Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- US features of reactive lymph nodes after COVID-19 vaccination in patients with and without previous COVID-19 infection- Nodal reactivity in young and middle-age patients vaccinated with different COVID-19 vaccine protocols- Association between the cortical thickness measurement of reactive post-vaccine lymphadenopathy and an effective humoral response in COVID-19-naïve patients

#### **TABLE OF CONTENTS/OUTLINE**

The COVID-19 pandemic led to the approval of an emerging vaccination program to contain coronavirus dissemination. One of the most commonly reported local side effects of COVID-19 vaccination has been the development of axillary lymphadenopathy. In this poster, we will discuss about this phenomenon: 1. Which ultrasound features should be evaluated? 2. Does nodal response differ if there exists a prior history of COVID-19 infection? 3. Do the ultrasound characteristics of reactive axillary nodes change depending on the administered COVID-19 vaccination? 4. What is the nodal reactivity to the COVID vaccination according to age? 5. How long does reactive lymphadenopathy last? 6. Does cortical thickness of reactive post-vaccine lymph nodes reflect a humoral response? Conclusions- Reactive lymphadenopathy is a common side effect of COVID-19 vaccination- It is generally a harmless and temporary condition- Healthcare providers should be aware of this potential phenomenon to provide an appropriate guidance to patients

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## Abstract Archives of the RSNA, 2023

BREE-26

### Cystic Carcinomas: Preventing Misdiagnosis and Lessons Learned

All Day Room: Learning Center

Hemal Grover, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Simple cysts: well circumscribed isodense masses on mammogram; well circumscribed anechoic masses on ultrasound with a thin, smooth, imperceptible wall and posterior acoustic enhancement. Complicated cysts meet all criteria for simple cysts except they contain debris/echogenic intracystic contents. Necrotic tumors (rapidly growing) can present as cystic masses. They can be anechoic, demonstrate posterior acoustic enhancement and therefore often misdiagnosed as simple or complicated cysts. However, careful evaluation of the margins is imperative as it can reveal subtle irregularity and raise suspicion for malignancy. Correlation with mammogram (particularly spot compression views) can be helpful to reveal obscured or irregular margins. Cystic carcinomas often present as palpable masses. These cases should be viewed with a higher index of suspicion before being labeled as BIRADS 2. Real time physician directed ultrasound is recommended along with a bilateral mammogram with spot compression views (including in women 30-35 years old). Family history, genetic mutations and ancestry (eg Ashkenazi Jewish descent) should be considered while evaluating these patients.

#### TABLE OF CONTENTS/OUTLINE

Imaging features of simple, complicated and complex cysts. Classification of complex cysts. Clinical history, diagnostic mammogram, ultrasound and MRI findings of authors' cases of cystic carcinomas. Errors of interpretation/misdiagnosis and lessons learnt. Differential Diagnoses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-27

### **Granulomatous Mastitis: Imaging Insights into a Benign Mimicker of Breast Infection and Malignancy**

All Day Room: Learning Center

Sravani Gampala, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the etiology and clinical presentation of granulomatous mastitis. 2. Recognize the imaging findings of granulomatous mastitis across mammography, ultrasound, and MRI. 3. Appreciate the importance of correlating imaging findings with the clinical picture. 4. Acknowledge the consequences of misdiagnosing granulomatous mastitis. 5. Emphasize the role of radiologists in considering granulomatous mastitis as a differential diagnosis. 6. Discuss the importance of a multidisciplinary approach in the accurate diagnosis of granulomatous mastitis.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction to Granulomatous Mastitis A. Etiology B. Clinical presentation II. Imaging Modalities A. Mammography 1. Findings 2. Differential diagnosis B. Ultrasound 1. Findings 2. Differential diagnosis C. MRI 1. Findings 2. Differential diagnosis III. Consequences of Misdiagnosis A. Unnecessary studies B. Patient anxiety C. Invasive procedures IV. Radiologist's Role in Diagnosis A. Considering granulomatous mastitis B. Biopsy and pathological challenges V. Multidisciplinary Approach A. Collaboration in diagnosis B. Improved diagnostic accuracy.

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## Abstract Archives of the RSNA, 2023

BREE-28

### More Than Just a Pretty Cyst - Assessment and Management of Cystic Breast Lesions

All Day Room: Learning Center

Vivian S. Ogata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To discuss the ultrasound imaging parameters, from B-mode adjustments, Doppler imaging, to post-processing techniques, to properly evaluate cystic breast lesions.- To present the imaging findings of the listed cystic lesions according to the BI-RADS® lexicon such as: simple cyst, complicated cyst, clustered microcysts and complex solid and cystic masses, illustrating with multimodality imaging.- To discuss each subcategory of cystic lesions, its management and follow-up, illustrating with some challenging radiologic cases.- To habituate general radiologists with these findings in order to improve the diagnostic rate of such mammary lesions, reducing unnecessary biopsies.

#### TABLE OF CONTENTS/OUTLINE

- Introduction and epidemiology: breast cystic lesions are a common diagnosis in women and include a wide spectrum of diseases, from a simple apocrine cyst to complex solid cystic carcinomas.- Scanning techniques, ultrasound adjustment, artifacts and post-processing imaging: adjustment of ultrasonographic basic parameters and adequate scanning techniques are essential for an accurate diagnosis. We can also employ Doppler, elastography, as well as use imaging artifacts to our advantage, patient's position changes more recent post-processing techniques (harmonic and spatial compounding imaging) to better characterize cystic lesions.- Cystic lesions subcategories, classification, histological representation and multimodality imaging depiction.- Management and follow-up: adequate ACR BI-RADS® categorization of each subtype of cystic lesion, illustrating with some challenging cases , exploring some related pitfalls and discussing benign and malignant differential diagnosis.

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## Abstract Archives of the RSNA, 2023

BREE-29

### Can Aesthetic Procedures Interfere With Breast Cancer Screening?

All Day Room: Learning Center

Leticia T. Oliveira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The incidence of dermatological procedures to modify aesthetics in body contouring, including post-surgical reconstructions, has been increasing every year, especially minimally invasive ones with injectables. Recognizing the imaging findings provoked by these procedures will avoid possible diagnostic pitfalls and allow the radiologist to alert the dermatologist about the possible loss of breast cancer screening caused by some of these previously unregistered procedures. Further, patients should be educated about the hazards associated with improper use of injectables from non-licensed individuals. Patients must be encouraged to seek out licensed physicians who use FDA-approved products for any medical and cosmetic care.

#### TABLE OF CONTENTS/OUTLINE

To review literature data on aesthetic dermatological procedures in the breast and axillary region, with cases from our institution, and illustrate with imaging findings found, based on different imaging methods

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-3

### **It's Not the Same As It Was: Multimodal Review of Breast Cancer Recurrence and What the Radiologist Needs to Know**

All Day Room: Learning Center

Leticia T. Oliveira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Breast cancer is the most common cancer in the female population worldwide and the number of patients underwent conservative surgery is growing; - The annual risk of recurrence disease varies between 2 to 5% in 5-20 years after diagnosis; - Locoregional recurrence is defined as the detection of lesions in the ipsilateral breast, chest wall or regional lymph node. If the other parts of the body are affected, it becomes a systemic recurrence; - Some factors related to breast cancer recurrence include failure in the first treatment and non-adherence to adjuvant therapy and surgical margins, but could be related to tumor size, aggressive biology of the primary tumor, young patient age at diagnosis and presence of familial or genetic risk factors; - Tumor recurrence may or may not be similar to the primary malignancy and can simulate benign conditions; - Imaging recurrence are variable and this knowledge becomes essential in radiological practice in order to improve the diagnosis and management of the patient.

#### **TABLE OF CONTENTS/OUTLINE**

- To review the factors associated to breast cancer recurrence and the epidemiology of these cases; - To show the most common findings in breast cancer recurrence using cases of our institution; - To teach how to evaluate the different methods of imaging (mammogram, ultrasound and MRI) in these cases and give tips that may help to differentiate sequelae of treatment from suspect lesion; - Easy-to-use take home messages to facilitate the handling of challenging cases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-30

### Demystifying Gynecomastia: A Pictorial Review

All Day Room: Learning Center

Rocio D. Cortes Quezada, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

\*Most male breast masses are benign and the most common reason is gynecomastia. \*Forms of breast imaging in male patients are used for diagnostic purposes. \*Pseudogynecomastia and cancer are the most common differential diagnoses. \*Mammography can show increased glandular tissue and ductal dilatation in cases of gynecomastia. Masses, calcifications or signs suggestive of malignancy can also be visualized. \*Ultrasound can help distinguish true gynecomastia from pseudogynecomastia (accumulation of fatty tissue in the breast region). \* Biopsy is the only method to determine if a breast mass in a man is benign or malignant. • \*Biopsy can be guided by ultrasound or mammography

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Definition 3. Epidemiology 4. Clinical presentation 5. Etiology 6. Anatomy and embryology of the male breast 7.Types of gynecomastia 8. Imaging tests of the male breast 9. Imaging findings (mammography, ultrasound) 10. Differential diagnoses 11. Cases: a. Pseudogynecomastia. b. Lipoma. c. Epidermal inclusion cyst of the breast. d. Duct ectasia. e. Fat necrosis f. Invasive ductal carcinoma 12. Conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-31

### Breast Cancer Surveillance in Patients with Prior History of Breast Cancer: Updates and Controversies

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Sona A. Chikarmane, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Patients with a prior history of breast cancer (PHBC) are at increased risk of recurrent or second breast cancers. PHBC are also living longer due to improved screening and advances in treatment. Developing optimal screening regimens are critical in detecting breast cancers in these high-risk patients. Expected post-treatment changes include architectural distortion, edema, and skin thickening, which stabilize around two years post-treatment. Multimodality breast imaging surveillance is available, with screening mammography (full field digital mammography or digital breast tomosynthesis), whole breast ultrasound, contrast-enhanced mammography, and breast MRI. The purpose of this educational exhibit will be to review breast cancer surveillance in PHBC, highlighting updates and controversies in screening guidelines.

#### TABLE OF CONTENTS/OUTLINE

1. Review literature on risk of recurrent/second breast cancers in PHBC 2. Discuss optimal mammography screening regimens, including screening vs diagnostic mammography, cadence of screening, and batch vs immediate interpretation. 3. Review the current societal screening guidelines, including mammography and breast MRI. 4. Show multi-modality image-rich cases of recurrent breast cancer versus expected post-treatment changes. 5. Highlight controversies in breast cancer screening guidelines, including age when to stop screening, imaging the reconstructed breast, and compliance with screening.

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## Abstract Archives of the RSNA, 2023

BREE-32

### Tales from the Breast: When Breast Problems Have Surprising Origins

All Day Room: Learning Center

Natalia T. Lima (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Diseases that affect the breast, but do not originate from it, may include systemic, autoimmune, infectious or even tumoral conditions from other sites. They can cause inflammation in the breast tissue and manifest with pain, skin thickening, ulcerations and masses. It is essential to know each one of them to help the clinical practice of differentiating breast carcinoma from these pathologies.

#### TABLE OF CONTENTS/OUTLINE

Illustrated didactic cases from our Breast Radiology group showing some diseases and their presentation forms that can simulate breast carcinoma. They were classified into subgroups such as: 1. Related to the vasculonervous system (MAV and neurofibromatosis), 2. Systemic disorders (cutaneous lymphoma and congestive heart failure) , 3. Metastasis to the breast (melanoma and adrenal cortical carcinoma), 4. Soft Tissue tumors (granular cell tumor and synovial sarcoma), 5. Infectious (tuberculosis and dermatobiosis).

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## Abstract Archives of the RSNA, 2023

BREE-33

### **Spectrum of Papillary Lesions of the Breast: Multimodality Imaging and Radiologic-Pathologic Correlation**

All Day Room: Learning Center

Janice Thai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Papillary lesions represent a heterogeneous group of entity with histologic continuum from benign, atypical to invasive and non-invasive malignant lesions. 2. To review the multimodality imaging spectrum of papillary lesions. 3. To review the unique histopathologic patterns of lesions with papillary and micropapillary features. 4. To review the clinical management algorithm for different papillary lesions diagnosed on core needle biopsy.

#### **TABLE OF CONTENTS/OUTLINE**

- Multimodality imaging review of common and uncommon imaging features of papillary lesions.
- Review of classification system according to WHO 5th Edition Breast Tumors (2019)
- Review of histopathology of papillary lesions.
- Review of current evidence-based management algorithm for benign, atypical and malignant papillary lesions.

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## Abstract Archives of the RSNA, 2023

BREE-34

### A Guide to Cystic Breast Lesions

All Day Room: Learning Center

Christina Le, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Breast imaging is often complex and can appear difficult to understand. It is rarely explored in depth throughout medical school training and can be rather limited throughout residency, especially for those pursuing other specialties for fellowship. The purpose of this exhibit is to provide a demystified review of cystic breast lesions. This is meant to supplement a resident's knowledge of breast pathology and present the information in a concise yet comprehensive manner. Throughout the presentation, the pathophysiology and patient presentation of each entity will be discussed. This will be followed by the often variable imaging findings that can be encountered on ultrasound, mammography, and MRI. Annotated pictorial examples are provided to facilitate visualization of the specific lesion characteristics. To conclude, the exhibit will discuss treatment options and the appropriate BIRADS criteria to help standardize the severity of these lesions.

#### TABLE OF CONTENTS/OUTLINE

1. Overview/educational objectives 2. BIRADS categories 3. Simple Cyst 4. Galactocele 5. Fat necrosis/oil cyst 6. Hematoma 7. Abscess 8. Intracystic papilloma 9. Necrotic neoplasm 10. Conclusion 11. References

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

BREE-35

### **Cryoablation Therapy for Breast Cancer: Procedural Technique and Imaging Review**

All Day Room: Learning Center

Janice Thai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the procedural techniques for performing breast cancer cryoablation. 2. To review multimodality post procedural imaging features of cryoablation to identify normal and abnormal findings.

#### **TABLE OF CONTENTS/OUTLINE**

- Review of proper patient selection in a multidisciplinary approach.
- Review of equipment, device and procedural technique.
- Review of post procedural imaging, including normal and abnormal findings on mammography, ultrasound, and MRI.
- Review of follow-up imaging protocol and strategies for detection of tumor recurrence.

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## Abstract Archives of the RSNA, 2023

BREE-36

### Exploding Jelly of the Breast: The Mucocele-Like Lesion (MLL)

All Day Room: Learning Center

Juan C. Vargas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

<Mucocele-Like Lesions are considered risk injuries (B3a). Mucin in the stroma calcifies over time, showing up as such on mammography. By mammography the type of calcifications is variable. By ultrasound it appears as microcysts, complex cysts or irregular nodules. The treatment depends on the diagnostic biopsy method.>

#### TABLE OF CONTENTS/OUTLINE

<Mucocele-Like Lesions were first described by Rosen in 1986 as a benign lesion "cysts containing mucin, lined by squamous or cuboid epithelium with or without extravasated mucin", currently considered a risk lesion. It is due to mucinous ducts that obstruct their contents, causing rupture with extravasation of the contents into the surrounding stroma, which over time can form calcifications, which are observed by mammography; less commonly, it presents as a mass. By ultrasound they are observed as a cyst with thick, mucin-like content or microcystic conglomerates. The more complex the cystic lesion, the more likely it is to be associated with Ductal Carcinoma In Situ (DCIS). With core needle biopsy, the percentage of diagnostic underestimation is less than 4% if they are lesions without atypia, but amounts to approximately 20% if they are lesions with atypia, so removal by vacuum-assisted biopsy or surgery is preferred.>

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## Abstract Archives of the RSNA, 2023

BREE-37

### Rare Tumors of the Breast

All Day Room: Learning Center

Neftali A. Granados Flores, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Rare tumors of the breast: Metaplastic carcinoma of the breast and Primary signet ring cell carcinoma of the breast. Epidemiology, image presentation of cases, clinical characteristics, imaging findings

#### TABLE OF CONTENTS/OUTLINE

Metaplastic breast carcinoma is a rare type of neoplasm that resembles a high-grade histological carcinoma, presents a high incidence of recurrences, poor prognosis, difficulties at the time of diagnosis, the establishment of therapeutic guidelines, and controversy regarding its nomenclature. The bibliography is very limited and the published descriptive studies have a low number of cases, making it difficult to obtain definitive and extrapolated conclusions, especially when making therapeutic decisions. Primary signet ring cell carcinoma of the breast is a rare tumor of controversial histogenesis, aggressive behavior and unusual metastatic pattern to the gastrointestinal tract and serous surfaces, posing differential diagnosis problems with metastasis of signet ring cell carcinoma of the breast. other origins, preferably gastrointestinal.

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## Abstract Archives of the RSNA, 2023

BREE-38

### AI Advancements in Breast Imaging: Transforming Radiology for Improved Patient Care

All Day Room: Learning Center

Matteo Mancino, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To explore the basic concepts of deep learning and machine learning in breast imaging. To examine AI-based tools and their applications in detection, diagnosis, and treatment planning for breast cancer. To assess AI performance compared to human experts. To discuss ethical considerations. To investigate AI future trends and developments for breast imaging.

#### TABLE OF CONTENTS/OUTLINE

Introduction: presenting the fundamental principles of deep learning and machine learning in the context of breast imaging. 1. Workload to explore how AI algorithms can positively influence radiologists' workload, also triaging negative mammograms and potentially replacing second readers. 2. AI accuracy to discuss how AI-based solutions contribute to improve diagnostic accuracy in mammography and enable a more precise lesion classification. 3. Cancer-Prediction evaluating the ability of AI algorithms to identify cancer-predictive features in mammograms. 4. AI role in ultrasound and MRI to examine the development and performance of AI-based solutions for detecting and classifying breast lesions in ultrasound and MRI. 5. Ethical considerations Addressing the ethical concerns surrounding AI implementation, including data privacy, algorithm fairness, and potential biases in the development process. 6. Future trends to address the future trends of AI, contemplating the potential integration of AI with other imaging modalities, exploring the role of radiogenomics in breast imaging, and anticipating novel AI advancements.

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## Abstract Archives of the RSNA, 2023

BREE-39

### **Multimodal Imaging of Breast Tissue Expanders, Including Associated Complications and MRI Contraindications**

All Day Room: Learning Center

Almir Bitencourt, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

? To show the types of breast tissue expanders and MRI contraindications. ? To perform a multimodal review of the imaging aspects of breast tissue expanders. ? To illustrate complications associated to breast tissue expanders.

#### **TABLE OF CONTENTS/OUTLINE**

Breast tissue expanders are temporary devices commonly used in two-stage breast reconstruction surgery. Tissue expanders are gradually filled with saline to stretch the skin and chest tissues to make room for breast reconstruction with a permanent implant. There are different types of breast tissue expanders depending on the number of lumens (one or two), filling (saline and/or silicone) and injection dome (remote or internal). Some types have metallic components that are not suitable for MRI imaging due to the potential for image distortion or dislocation. It is important to recognize the imaging features of breast tissue expanders, to avoid misdiagnosis, since tissue expanders with small filling may mimic implant rupture on imaging. Complications associated with breast tissue expanders are rare and include infection, hematoma, rupture, and displacement.

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## Abstract Archives of the RSNA, 2023

BREE-4

### **Code of Con-DUCT: An Algorithmic Approach to Multimodality Assessment and Management of Dilated Mammary Ducts**

All Day Room: Learning Center

Rajshree Singh, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- The ACR BI-RADS® 5th Edition indicates that a SDD has a > 2% likelihood of malignancy, and therefore warrants a suspicious (BI-RADS 4A) assessment. Otherwise, there are few recommendations for evaluation and management of dilated ducts found at breast imaging.
- Further evaluation with MRI and/or tissue sampling may be warranted if ductal dilation (DD) is new or increasing, symptomatic, or associated with worrisome mammographic or ultrasound (US) features.
- We propose an algorithm-based approach to assessing dilated ducts, specifying worrisome features on mammogram and targeted US to guide further workup.
- This approach may potentially reduce radiologists' uncertainty, unnecessary biopsies, missed cancers, and healthcare expenditures.

#### **TABLE OF CONTENTS/OUTLINE**

1. Ductal anatomy
2. Definition of DD
3. Etiologies of DD
4. DD requiring further evaluation:
  - a. New or interval change
  - b. Patient symptoms and/or clinical findings
  - c. Suspicious mammographic findings
5. Worrisome US findings
6. Proposed algorithm for assessment and management
7. Identification of key findings that help guide diagnostic decisions.
8. Case-based application and examples
9. Role of ductography, US with elastography, and MR

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## Abstract Archives of the RSNA, 2023

BREE-40

### Breast Imaging Disparities in the U.S

All Day Room: Learning Center

Dami Olufosoye, BS, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibit is a call to action for radiologists to identify racial disparities in their own practice. We will review recent studies identifying disparities individuals of color face in breast imaging and discuss successful interventions. 1. Breast cancer is the second leading cause of cancer deaths in women in the US but the leading cause in black women. 2. Black women have less access to screening mammography 3. Black and Hispanic women have lower rates of receiving adequate breast cancer treatment and post-treatment surveillance 4. Black women have increased rates of breast cancer recurrence 5. Imaging disparities based on race and other factors can be identified by radiologists and mitigated with outreach programs

#### TABLE OF CONTENTS/OUTLINE

1 US Epidemiologic breast cancer data 2 Racial disparities in breast cancer screening • Decreased access to mammography centers, advanced imaging equipment, specialized physicians, genetic testing • Additional limitations: § Patient distrust § Provider-patient relationship 3 Racial disparities in diagnostic work-up • Increased time to diagnostic work-up and to biopsy • Later stage at diagnosis 4 Racial disparities after breast cancer diagnosis • Lower rates of receiving adequate breast cancer care and post-treatment surveillance • Lower rates of 5-year breast cancer survival • Higher rates of cancer recurrence 5 How radiologists can help • Identification and mitigation of imaging disparities is part of our professional responsibility to our patients • Examples of successful initiatives

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## Abstract Archives of the RSNA, 2023

BREE-41

### Breast Cysts: A Pictorial Exhibit of Benign and Malignant Twists

All Day Room: Learning Center

Flavia M. Starling, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cystic breast lesions are the most common masses found in the female breast of any age group, mainly between 30 and 50 years of age. They are derived from the terminal lobular duct unit as a result of fibrocystic change and may contain isolated liquid or even associated solid component, thus comprising a wide spectrum of variable disease entities, including benign and malignant pathologies. Simple and complicated cysts are usually benign; but on the other hand, complex cystic masses containing mixed cystic and solid components are indeterminate. Therefore, knowing that cysts are common lesions and that up to approximately 31% of complex breast cysts are associated with malignancy, the radiologist must be familiar with the main pathologies and imaging characteristics that includes this category of lesions.

#### TABLE OF CONTENTS/OUTLINE

- Didactically review the main cystic lesions of the breast and their characteristics through different imaging methods and case-based revision obtained from the digital archive of our institution.
- Take home message
- References

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## Abstract Archives of the RSNA, 2023

BREE-42

### **Molecular Classification of Breast Cancer: Guide for the Radiologist**

All Day Room: Learning Center

Sandra Lara (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Breast cancer is a disease that, despite having a histopathological classification, also includes molecular and genetic subtypes, being able to carry out a molecular classification that guides the clinical behavior, prognosis and different radiological characteristics based on the expression of biomarkers (HER2, ER, PR, Ki67), this classification complements the traditional classification and adds a very useful biological approach to disease management. That is why it is important for the radiologist to know and recognize the importance of classification, as well as to identify the most common imaging characteristics in the different diagnostic methods according to each molecular subtype.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction· Breast molecular biomarkers· Revision of the classification of molecular subtypes of breast cancer· Imaging characteristics in the different methods according to each molecular subtype· Clinical cases· Conclusions

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## Abstract Archives of the RSNA, 2023

BREE-43

### **Invasive Lobular Carcinoma (ILC): The Cancer With a Thousand Faces**

All Day Room: Learning Center

Adriana Alvarez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The Invasive Lobular Carcinoma (ILC) is the second most common type of invasive breast cancer. The incidence is increasing due to replacement therapy in postmenopausal women and diagnosis advances. There are two histologic variants: classic and pleomorphic. ILC is usually estrogen receptor positive and her2 negative. The loss of desmoplastic cell reaction and the low density of cells in this tumors make the clinical and the mammographic detection difficult. This entity has multiple imaging manifestations, being a challenge for the radiologist. ILC can be bilateral, multifocal or multicentric, with a unique metastatic pattern. Diagnosis is based in clinical and radiological tests. The most common manifestation is an irregular or spiculated mass in mammography and an hypoechoic irregular mass with posterior shadowing in US. MRI is the gold standard and it is used in the presence of multifocal, multicentric or bilateral disease as well as in the presence of lymphadenopathies.

#### **TABLE OF CONTENTS/OUTLINE**

This educational exhibit presents epidemiological and main ILC features. Tumor presentation and behaviour are explained. A multi-modality review of clinical and radiologic features through clinical cases, as well as pitfalls, are presented and they can help the radiologist in the diagnosis.

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## Abstract Archives of the RSNA, 2023

BREE-44

### **MRI-Detected US: How to Improve the Detection Rate of Non Mass Lesions Using Breast Anatomical Landmarks**

All Day Room: Learning Center

Ayumi Izumori (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Nonmass lesions on US are most often observed when US is used to target mammographic asymmetries, biopsy suspicious calcifications seen on screening mammography, and to biopsy abnormalities on MRI. In a meta-analysis of 2201 lesions, the success rate of targeted US after MRI was 58% (range, 23%-82%) and detection rates varied by lesion type. Nonmass enhancement lesions on MRI are less likely to be detected on targeted US than mass lesions (66% of all masses and 30% of nonmass enhancement lesions were seen). This review introduces a new viewpoint on breast ultrasound anatomy necessary to obtain a close correlation with MRI and describes a target US method with anatomical landmarks based on this viewpoint.

1. Some US images of MRI-detected lesions are more indistinct than surrounding benign lesions and need to be correlated with precision.
2. About effective anatomical landmarks for MRI correlation including surrounding tissues and vascular routes as a new anatomical landmark.
3. Pattern classification of mammary fat and mammary gland distribution for reading anatomic landmarks in MRI correlation.
4. The anatomical mechanism of deformity and how to decipher it on US. Breast deformity during ultrasound examination is not related to breast size, but varies from individual to individual.

#### **TABLE OF CONTENTS/OUTLINE**

1. the identification rate of in each literature and its relationship to landmarks used
2. identification rates by anatomical landmarks and MRI images using those landmarks
3. classification of patterns of fat and mammary gland distribution in the breast based on anatomical understanding
4. anatomic mechanisms of breast deformity in MRI and US
5. US techniques considering breast deformity
6. case presentation

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## Abstract Archives of the RSNA, 2023

BREE-45

### Unraveling the Enigma of DCIS: A Multimodality Imaging Journey

All Day Room: Learning Center

Giselle G. Mello, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Definition and classification of DCIS-Epidemiology and risk factors-Clinical presentation and symptoms Imaging modalities for DCIS detection and assessment

#### TABLE OF CONTENTS/OUTLINE

-Interpretation of mammography, ultrasound, and MRI in DCIS diagnosis-The role of breast tomosynthesis in DCIS detection-Pathologic correlation and biopsy techniques-Management options: Discuss management options for DCIS, including surgery (lumpectomy or mastectomy), radiation therapy, hormonal therapy, and surveillance.-Discuss emerging imaging technologies for DCIS detection and assessment.-Future directions: Discuss future research directions and areas of innovation in the field of DCIS detection and assessment, such as the use of artificial intelligence and machine learning in radiology, and the development of more personalized approaches.

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## Abstract Archives of the RSNA, 2023

BREE-46

### Unveiling the Mysteries of PASH in Breast Radiology: A Cutting-Edge Approach

All Day Room: Learning Center

Andrea Di Ninno, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Definition and classification of PASH  
Imaging modalities for PASH detection and characterization  
Differential diagnosis of PASH with other breast lesions

#### TABLE OF CONTENTS/OUTLINE

Definition and histopathology of PASH  
Clinical presentation and diagnostic workup of PASH  
Radiologic features of PASH on mammography, ultrasound, and MRI  
Differential diagnosis of PASH, including benign and malignant breast lesions  
Radiologic-pathologic correlation of PASH  
Management and follow-up of patients with PASH, including surveillance imaging and surgical options  
Association of PASH with other breast conditions, such as atypical ductal hyperplasia and breast cancer  
Multi-disciplinary approach to PASH management, involving radiologists, pathologists, and clinicians.

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## Abstract Archives of the RSNA, 2023

BREE-47

### Imaging Review of Mammography and Ultrasound Findings in Uncommon Breast Lesions: A Trainee-Focused Guide

All Day Room: Learning Center

Thurl Hugh C. Cledera, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Differentiating uncommon breast lesions from cancerous lesions in the breast is paramount to proper diagnosis, risk stratification, and treatment in patients presenting with a breast mass in imaging. Uncommon breast lesions may vary from those arising in the glandular parenchyma (phyllodes), inflammation (mastitis and abscess), autoimmune (granulomatous mastitis), and metabolic (diabetic mastopathy) etiologies. In centers where resources are limited, knowing the value of mammography and ultrasound findings may help guide biopsy, which in turn provides adequate treatment. At the end of this exhibit, the learner will be able to review the basic findings that are seen in breast lesions on imaging and understand the role of clinical and imaging correlation in the proper identification of these lesions.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction
2. Brief review of histology of uncommon breast lesions
3. Basic findings in mammography
4. Basic findings in ultrasound
5. Correlating findings in mammography and ultrasound
6. Cases of uncommon breast lesions
  - a. Lactating adenoma
  - b. Intraductal papilloma
  - c. Mastitis (bacterial)
  - d. Granulomatous mastitis
  - e. Diabetic mastopathy
  - f. Mondor's disease
  - g. Paget's disease
  - h. Phyllodes tumor
  - i. Dermatomyositis
  - j. Foreign bodies

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## Abstract Archives of the RSNA, 2023

BREE-48

### Untangling the Mammary Ducts: Decoding the Complexity of Intraductal Pathology

All Day Room: Learning Center

Elsa Cecilia Molina Miranda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

**Mammography:** Mammography can show intraductal lesions as grouped calcifications in a linear or branching pattern. **Breast ultrasound:** Ultrasound can identify intraductal lesions as masses or areas of ductal dilation. **Core needle biopsy (CNB):** This procedure is used to obtain a tissue sample from the lesion. CNB is performed guided by ultrasound or mammography. **Vacuum-assisted biopsy (VAB):** This procedure uses a suction device to obtain a tissue sample from the lesion. VAB is performed guided by ultrasound or mammography. **Contrast-enhanced mammography:** This exam uses a contrast medium to evaluate the vascularity of lesions in the breast, which may suggest the presence of a malignant lesion. Management of intraductal lesions depends on the definitive diagnosis obtained by biopsy. If the lesion is found to be malignant, treatment may include surgery, radiation therapy, and/or chemotherapy. If the lesion is benign, treatment may include observation or surgical removal.

#### TABLE OF CONTENTS/OUTLINE

Table of contents: 1. Objectives 2. Anatomia y fisiopatologia 3. Cases 4. Metodos diagnosticos 5. Approach 6. Conclusions  
Outline: Intraductal breast lesions are those that originate in the breast ducts and can be benign or malignant. These lesions can be detected by diagnostic methods such as mammography, breast ultrasound, core needle biopsy (CNB), vacuum-assisted biopsy (VAB), and contrast-enhanced mammography. The management of intraductal lesions depends on the definitive diagnosis obtained by biopsy, and treatment may include surgery, radiotherapy, and/or chemotherapy for malignant lesions, while benign lesions may be observed or surgically removed.

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## Abstract Archives of the RSNA, 2023

BREE-49

### Coming Out of the Bubble: Assessment and Management of Cystic Breast Lesions

All Day Room: Learning Center

Bruna P. Nantes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

An approach to the evaluation and diagnosis of cystic lesions in the breast, with the aim of helping radiologists in their daily practice. Detail the different types of cystic breast lesions and their differential diagnoses, as well as the appropriate management of these lesions.

#### TABLE OF CONTENTS/OUTLINE

Brief introduction: the prevalence of cystic breast lesions and the importance of adequate recognition and classification of these lesions. Definition and descriptors: detail the correct definition and description of the different types of cystic lesions. Flowchart on the management of cystic breast lesions. Multiple clinical cases of the different differential diagnoses of each type of cystic breast lesion, that contemplate: - Images from mammography, ultrasound and eventually MRI or CT scan; - Type of biopsy performed (if performed); - Recommendations on approaches to cystic lesions as per BI-RADS; - Recommendations on some special cases of cystic lesions; Conclusion.

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## Abstract Archives of the RSNA, 2023

BREE-5

### When Lightning Strikes the Same Place Twice: Detecting Ipsilateral Breast Cancer Recurrence in the Post Operative Breast

All Day Room: Learning Center

Aurela I. Clark, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Illustrate the imaging features suspicious of ipsilateral breast cancer recurrence in patients with prior lumpectomy or mastectomy. Review current literature for recommendations on adjunct imaging surveillance in women with prior history of breast cancer given their increased risk of a second breast cancer. Review imaging mimickers of breast cancer recurrence and discuss management recommendations. Highlight teaching points for each case to increase confidence in making a timely diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Case base review We will present an image rich exhibit depicting imaging findings in ipsilateral breast cancer recurrence in the post lumpectomy patients who present for annual surveillance mammography or breast MRI, and in patients who present with clinical concerns. Cases will illustrate imaging findings, histopathology and management at the initial diagnosis and at time of recurrence. Examples of imaging mimickers of breast cancer will familiarize the learner with benign conditions in the post-surgical breast. At the end of the exhibit, teaching points will be summarized. Summary: Women with a prior personal history of breast cancer are at an increased breast cancer risk. Cumulative incidence of ipsilateral breast tumor recurrence rate has been reported at 14.3%. The image appearance of the post operative breast can make the detection of breast cancer recurrence more challenging. As a result, radiologists should be familiar with common and uncommon imaging findings of ipsilateral breast cancer recurrence. This presentation will review the current screening recommendations in this setting, expected post operative changes, breast cancer mimics, and the imaging findings of recurrence.

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## Abstract Archives of the RSNA, 2023

BREE-50

### **New Blossoms on the Old Tree: Advancing Ductography with Digital Breast Tomosynthesis (DBT) or Contrast-enhanced Mammography (CEM)**

All Day Room: Learning Center

Juan Tao (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Ductography is a useful tool for evaluating pathologic nipple discharge, allowing for identification and localization of intraductal lesions. 2. Ductography combined with DBT or CEM can eliminate masking of small filling defects caused by overlapping ductal branches and improve visualization of the entire ductal tree, enhancing the clarity of diagnosis. 3. Fine-tuning of the procedural steps and optimization of the contrast agent concentration are necessary for the successful implementation of ductography with DBT or CEM. 4. Potential additional risks of radiation exposure associated with combining DBT or CEM should be considered, and measures should be taken to minimize radiation dose to the patient in accordance with established protocols and guidelines for radiation safety in breast imaging.

#### **TABLE OF CONTENTS/OUTLINE**

I. The Old Tree: Overview of Ductography and Its Clinical Value in Evaluating PND. II. The New Bloom on the Tree: Clinical Cases Demonstrating the Utility of Ductography combined with DBT or CEM A. Sharper Sights Case: DBT-Ductography Increased Accuracy of Diagnosis. B. Wider Insights Case: CEM-Ductography Improved Visualization of the Entire Ductal Tree. III. Technical Aspects of Ductography combined with DBT or CEM. IV. Radiation Safety Considerations with Ductography and DBT or CEM A. Potential Additional Risks of Radiation Exposure B. Strategies to Minimize Radiation Dose to the Patient C. Importance of Adherence to Established Protocols and Guidelines for Radiation Safety in Breast Imaging. V. Conclusion A. Summary of the Key Points Regarding Ductography with DBT or CEM B. Future Directions and Potential Applications of Ductography with DBT or CEM. VI. References.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-51

### Genetic Risk Assessment in the Radiology Setting: Our Nationwide Experience in 2023

All Day Room: Learning Center

Sean D. Raj, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review breast cancer risk assessment opportunities 2. Review key high-risk breast care and assessment considerations 3. Highlight key workflow, operational, and regulatory considerations from our practice's experience spanning multiple states on both coasts

#### TABLE OF CONTENTS/OUTLINE

I. Risk Assessment Guidelines a. Discuss often conflicting recommendation statements suggesting when to begin and which individuals to consider for cancer risk assessment, genetic testing, education/counseling, and modified medical management b. Spotlight recommendations for different demographics c. Examine benefits of supplemental screeningII. Higher than average risk: Breast Screening Considerations a. Mammography sensitivities: general population with breakdown by demographics and women with intermediate risk, high risk, and women with genetic mutations b. ACR/SBI guidelines for those with genetically based [and/or family history and dense breast] increased riskIII. Higher than average risk: Genetic Testing Considerations a. 32% of women qualify for genetic testing: a combination of hereditary and familial risk factors b. Simple multi-gene panel tests and risk assessment workflow can assess germline and polygenic risk for inherited cancer risk factorsIV. Review development of Risk-Assessment ChatBot, Intake and Educational Workflow and discuss our nationwide practice's experience including pearls and pitfalls

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-52

### **Vascular Mammary Lesions: Key Features to Make an Accurate Diagnosis and Avoid Unnecessary Biopsies**

All Day Room: Learning Center

Ladys J. Camargo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the normal vascular anatomy of the breast  
2. Know the most frequent vascular breast lesions  
3. Know and discuss the diagnostic modalities commonly used for the diagnosis of vascular lesions  
4. What is the imaging follow-up of vascular lesions?

#### **TABLE OF CONTENTS/OUTLINE**

There are various vascular mammary lesions, ranging from chronic systemic processes, congenital malformations, post-traumatic sequelae, benign masses, to malignant tumors. Accurate diagnosis of vascular lesions in breast images is very risky due to overlapping characteristics. This is why radiologists must be aware of the key features in the different diagnostic methods for interpreting images of vascular lesions in order to make an accurate diagnosis and avoid unnecessary biopsies and finally be able to discuss management recommendations and guidance.

Outline-Introduction-Vascular anatomy of the breast-Imaging characteristics of the most frequent vascular mammary lesions-Diagnostic methods for the diagnosis of vascular lesions-Discussion of management and monitoring-Clinical cases.-Conclusions.-Bibliography

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-53

### Cyst Breast Lesions: The Good, the Bad and the Ugly

All Day Room: Learning Center

Tatiana C. Tucunduva, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Definition of cystic breast lesions and their prevalence  
Differentiation between simple cysts, complicated cysts, and complex cystic lesions  
Imaging modalities used for the assessment of cystic breast lesions, including mammography, ultrasound, and MRI

#### TABLE OF CONTENTS/OUTLINE

Symptoms and clinical presentation  
Diagnostic imaging modalities for cystic breast lesions, including mammography, ultrasound, and MRI  
Imaging features of cystic breast lesions  
Differential diagnosis of cystic breast lesions, including benign and malignant conditions  
Role of imaging-guided percutaneous biopsy techniques in the diagnosis of cystic breast lesions, including fine-needle aspiration, core needle biopsy, and vacuum-assisted biopsy, and their advantages and limitations.  
Discussion of the importance of a multidisciplinary approach in selecting the most appropriate biopsy technique based on lesion characteristics, patient factors, and imaging findings.  
Follow-up and surveillance after diagnosis and treatment of cystic breast lesions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-54

### Everything We Need to Know About Papillary Breast Carcinoma

All Day Room: Learning Center

Lisett N. Cruzado-Quiroz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Papillary breast carcinoma is a rare subtype of invasive ductal carcinoma with infiltrative papillary growth representing about 0,5 -0,7% of all invasive breast cancers. It is usually seen in postmenopausal in their sixth to eight decade of life. Association with carcinoma in situ is uncommon. Typically presents with bloody nipple discharge or/with slow growing palpable tumors, frequently found in the periareolar region. In general, they have better prognosis than ductal carcinoma with a 100% 10 year survival rate following treatment. Lymph node involvement and distant metastases are rare except in the invasive form. Mammography usually shows a solitary round or oval mass with circumscribed margins. Rarely they associate poorly defined margins or spiculation, given the low occurrence of desmoplastic reaction. Ultrasound generally shows a complex mass with solid and cystic components with good sound transmission. MRI may demonstrate heterogeneous lesions with septations, mural nodule and intracystic haemorrhage, the solid components typically show washout kinetics. Intracystic papillary carcinomas can occur in a pure form or may be associated with ductal carcinoma in-situ or invasive ductal carcinoma. The authors will review the clinical manifestation, imaging features and pathology correlation of this rare breast carcinoma.

#### TABLE OF CONTENTS/OUTLINE

Review of the pathophysiology of papillary breast cancers (histological and molecular aspect).Multimodal review of imaging features of papillary cancers (mammographic, ultrasonographic, and MR findings)To determine the Radiology-Pathology concordance/discordance by reviewing cases.Update on the treatment of papillary breast cancer.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-55

### **Decoding Ductal Pathology: Multimodality Approach to Nipple Discharge and Management of the Solitary Duct**

All Day Room: Learning Center

Zoya M. Patni, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Identify what differentiates physiologic nipple discharge from pathologic discharge 2. Describe an approach to the diagnostic workup of patients with nipple discharge 3. Discuss the clinical importance of a solitary dilated duct and describe an approach to management in these patients 4. Implement new strategies for biopsy of hard-to-sample intraductal masses under both ultrasound and MRI-guidance

#### **TABLE OF CONTENTS/OUTLINE**

Nipple discharge represents 2-5% of medical visits among women and is the third most common breast concern (pain > lump > nipple discharge). As radiologists our primary responsibility in assessment and management of these patients is to distinguish physiologic and pathologic causes of nipple discharge. This presentation will review the prevalence, epidemiology and pathologic subtypes of papillary lesions and other common pathologies resulting in pathologic nipple discharge and provide the reader with a diagnostic algorithm for management of these patients. Using a multimodality case-based approach, the reader will develop a differential diagnosis and management strategy for imaging findings in patients with nipple discharge, including management of the solitary dilated duct. We provide the reader with important tips and tricks for biopsy of intraductal lesions and solitary dilated ducts under ultrasound and MRI-guidance and address the potential challenges of radiology-pathology concordance in these cases.

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## Abstract Archives of the RSNA, 2023

BREE-56

### Uncovering False Positive Lesions Through DBT

All Day Room: Learning Center

Giovana O. D'Avila I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points Screening mammography using DBT is replacing digital mammography as the preferred imaging modality. Recognize that DBT and mammography together minimize the effects of overlapping breast tissue and improves lesion detection and localization. Identify that digital breast tomosynthesis showed lower recall, cancer detection rate, and biopsy rate. The ability to problem solve with DBT images reduces patient anxiety associated with a callback.

#### TABLE OF CONTENTS/OUTLINE

Table of contents  
1 - Advantages of screening mammography using DBT.  
2 - Amorphous calcifications  
3 - Left axillary lymphadenopathy  
4 - Palpable finding  
5 - Solid Mass

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

BREE-57

### Ductal Carcinoma in Situ: Beyond First Impressions

All Day Room: Learning Center

Hannah L. Chung, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

DCIS often co-exist with invasive cancers and 19-36% of DCIS after percutaneous needle biopsy are upstaged to an invasive cancer at surgical excision. Up to 3% of DCIS demonstrate axillary nodal metastases. The morphology of the calcifications are useful in predicting the nuclear grade. DCIS may also manifest as a noncalcified mass, asymmetry or distortion. Sonography demonstrates these findings as a mass, nonmass area or ductal change. MRI demonstrates the extent of DCIS better than other imaging modalities and findings correlate with high grade DCIS. Observed recurrences and lymph node metastases pose challenges to current evaluation and treatments of DCIS.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents 1. What is DCIS a. Significance of DCIS b. Biology and evolution of DCIS 2. Clinical Presentation of DCIS a. Asymptomatic b. Nipple discharge c. Paget's disease of the nipple d. Palpable lump 3. Imaging correlates with biology and pathology a. Mammographic i. Calcifications, mass, asymmetry, distortion b. Sonographic i. Nonmass findings 1. hypoechoic areas 2. echogenic foci 3. shadowing, 4. pseudomicrocyst ii. Ductal change c. MRI- MRI is useful to demonstrate extent of disease, exclude invasive disease, and correlates with high grade DCIS. i. nonmass enhancement ii. mass. 4. Special considerations a. Occult invasive cancers or misdiagnosis- Can imaging predict invasion? b. Axillary Staging- Is axillary ultrasound with biopsy and sentinel lymph node necessary? 5. Research: Past, now, and future endeavors a. NSABP, UKANZ, ECOG-ACRIN b. Active surveillance vs standard treatment - COMET, LORIS, LORD c. Advanced imaging techniques and artificial intelligence in both radiology and pathology

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-58

### When Cysts Are Not So Simple: Tips for Complex Cystic Breast Masses Evaluation.

All Day Room: Learning Center

Rosa M. Lorente-Ramos, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-To review the different entities causing the sonographic appearance of a complex cyst.-To illustrate a series of cases of complex cystic benign and malignant lesions of the breast providing correlation with imaging (US, contrast-enhanced mammography, MRI) and pathology. - To discuss the specific management of those lesions including imaging and interventional procedures. -To emphasize pitfalls, diagnostic difficulties, and differential diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Cystic breast lesions are frequently detected on breast ultrasonography. Simple cysts, complicated cysts, and oil cysts do not require further invasive diagnostic procedures. However, malignant entities may present with complex cystic and solid masses. Through sample cases, a variety of imaging and pathology findings from complex cystic lesions with management discussion will be demonstrated. 1. Introduction. US findings and technical pitfalls. 2.Cystic lesions evaluation, useful findings that could be of significant diagnostic value to distinguish between confusing cysts. Classification of cysts and suspicious findings. 3.Work-up of suspicious lesions on US: mammography/contrast-enhanced mammography (CEM) and MRI. Interventional procedures. 4. Typical benign and malignant lesions with their important findings on ultrasonography, contrast-enhanced mammography, and MRI: Benign: complicated/inflammatory cyst, seroma, oil cyst, epidermal inclusion cyst, galactocele, mucocele-like tumor, hematoma, abscess, fat necrosis, fibroadenoma, papilloma, benign Phyllodes tumor. Malignant: malignant Phyllodes tumor, papillary, medullary, colloid, and squamous cell carcinoma, sarcoma.

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## Abstract Archives of the RSNA, 2023

BREE-59

### **Differentiating Simple Cysts From Complicated Cysts, Complex Cystic and Solid Masses, and Other Cystic Breast Lesions**

All Day Room: Learning Center

Tara A. Retson, MD, PhD (*Presenter*) Research Consultant, CureMetrix, IncStock options, CureMetrix, Inc

#### **TEACHING POINTS**

Cystic diseases of the breast are common, and confusion can occur regarding their appropriate classification and management. Distinguishing between benign cysts/cystic lesions and malignant cyst-like/fluid-containing cancers may be challenging. Specifically, triple negative breast cancers and intracystic papillary carcinomas should not be dismissed as benign/probably benign. Cystic lesions may be diagnosed accurately and managed appropriately using characteristic imaging findings. It is imperative to properly classify lesions as complex cystic and solid masses vs. complicated cysts since their management differs, and the differential of complex cystic and solid masses includes cancer. This educational exhibit will define simple cysts, teach radiologists about cystic lesions that may not be benign, review their imaging appearances, and recommend management options for complicated cysts, clustered microcysts, and complex cystic and solid breast masses.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction; Definitions/illustrations of simple cysts, complicated cysts, clustered microcysts and complex cystic and solid masses; Multimodality examples of cystic breast lesions, systematic approach to the characterization of cystic lesions; How to appropriately apply BI-RADS classification and management recommendations of cystic breast lesions; Utilization of a quiz at the end of the exhibit to test yourself on the systematic approach presented.

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## Abstract Archives of the RSNA, 2023

BREE-6

### Get Your Ducts in a Row: Imaging and Management Considerations of Ductal Disease of the Breast

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Firouzeh K. Arjmandi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-In the imaging evaluation of spontaneous clear and/or bloody nipple discharge, negative diagnostic conventional imaging (mammogram and ultrasound) warrants further evaluation with breast MRI.-Nipple changes on physical exam even in the absence of imaging findings are suspicious. Clinical exam findings should guide next steps in management, and nipple tissue biopsy should be performed by the surgeon in the appropriate clinical setting.-In the setting of a small, subtle intraductal mass seen on diagnostic MRI and not well visualized at time of MR-guided biopsy, targeting the end of a blind-ending solitary duct can help to guide the biopsy.-The combination of findings of a palpable lump, nipple discharge, and nipple inversion, and the presence of associated coarse heterogeneous calcifications raises concern for malignancy, and biopsy should be recommended (despite the presence of more benign appearing rim calcifications).-Treatment of intraductal papillomas without atypia has become more conservative. Upgrade to DCIS or invasive carcinoma is more common in women >50 years, lesions >1 cm, palpable lesions and papillomas >5 cm from the nipple.

#### TABLE OF CONTENTS/OUTLINE

-Overlapping imaging features of benign and malignant calcifications, including high grade versus low grade DCIS-Utility of MRI in the evaluation of extent of disease in intermediate to high grade DCIS-Multimodality imaging and clinical evaluation of pathologic nipple discharge and nipple changes (erythema and scaling)-Imaging assessment and clinical management of a solitary dilated duct and intraductal lesions-Accurate assessment of response to neoadjuvant chemotherapy in the setting of increasing calcifications post therapy

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## Abstract Archives of the RSNA, 2023

BREE-60

### Test Your Knowledge: A Case Based Quiz of Contrast Enhanced Mammography BI-RADS Lexicon

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Daniel Sandoval, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To learn the descriptors published in the ACR 2022 BI-RADS supplement for contrast enhanced mammography by reviewing a series of daily case images.
- As this supplement has only recently been published, this exhibit is intended to help radiologists become familiar with the terminology and its representation on images, through an interactive and entertaining activity.

#### TABLE OF CONTENTS/OUTLINE

- Background Contrast enhanced mammography lexicon overview (categories, terms, features and definitions)
- Illustrated case based quizzes
  - o Case #1: Background parenchymal enhancement - Level: Minimal, Mild, Moderate, Marked. - Symmetry: Symmetric, Asymmetric.
  - o Case #2: Masses - Shape: Oval, Round, Irregular.- Margin: Circumscribed, Irregular, Spiculated. - Internal enhancement characteristics: Homogeneous, Heterogeneous, Rim enhancement.
  - o Case #3: Non mass enhancement - Distribution; Diffuse, Multiple regions, Regional, Focal, Linear, Segmental- Internal enhancement characteristics: Homogeneous, Heterogeneous, Clumped.
  - o Case #4: Enhancing asymmetry - Internal enhancement pattern: Homogeneous, Heterogeneous.
  - o Case #5: Lesion conspicuity - Low - Moderate - High
- References

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## Abstract Archives of the RSNA, 2023

BREE-61

### Complex Cystic Breast Masses: An MR Imaging Review

All Day Room: Learning Center

Jie Liu (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To define the concept of complex cystic breast masses. 2. To categorize complex cystic breast masses into three types based on the percentage and spatial distribution of cystic and solid components in the contrast-enhanced MRI. 3. In comparison with US, MRI affords superior visualisation of the proportion and distribution characteristics of solid and cystic components within complex cystic breast masses, which facilitates their differential diagnosis. Moreover, multi-parametric MRI such as T2WI, dynamic contrast-enhanced MRI (DCE-MRI) and diffusion-weighted imaging (DWI) enables the recognition of the presence and distribution characteristics of cystic and solid components, the combination of which can serve as a complementary imaging aid for accurate diagnosis.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction A. Overview of complex cystic breast masses B. Importance of accurate diagnosis II. Complex cystic breast masses A. Definition of complex cystic breast masses B. Etiology of complex cystic breast masses C. Clinical manifestations of complex cystic breast masses III. Categorization of complex cystic breast masses based on MRI features Group A : thick outer wall and/or thick internal septa (> 0.5 mm). Group B: predominantly cystic component(>50%)or intracystic mural nodule. Group C:predominantly solid component and cystic component=50% IV. Comparison of MRI and ultrasound in complex cystic breast masses A. Advantages of MRI over ultrasound B. Limitations of ultrasound C. Diagnostic value of multiparametric MRI in identifying cystic components V. Conclusion A. Summary of key points B. diagnostic flow chart of complex cystic breast masses C. Future directions for research VI. References

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## Abstract Archives of the RSNA, 2023

BREE-62

### Trial by Priors: When to Call Back a Stable Mammographic Finding

All Day Room: Learning Center

Samantha H. Epstein, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Comparison with multiple prior studies can help identify slowly evolving malignancies. 2. Mammographic findings that warrant further evaluation include increasing number of calcifications or suspicious distributions, evolving asymmetries, architectural distortions, and slow growing or spiculated masses. 3. Early recognition of these suspicious findings allows for appropriate diagnostic workup and improved diagnosis of slow growing malignancies.

#### TABLE OF CONTENTS/OUTLINE

1. Introductory slide. This exhibit hopes to educate breast imagers about stable mammographic findings that require further evaluation. While stability of imaging findings over two years is often suggestive of benignity, comparison with multiple prior imaging studies can allow better evaluation of stability and identify features that are slowly evolving over time. There are also some imaging features that should be further evaluated and sampled regardless of apparent stability. This educational exhibit will discuss several cases of malignancy, highlighting the suspicious imaging features that prompted additional work up. 2. List of teaching points to guide the upcoming case discussion. 3. Anonymized cases demonstrating different examples of slow growing malignancies. Each case will include: Multiple prior studies to demonstrate evolution over time; Explanation of decision making that lead to diagnostic evaluation; Findings on diagnostic imaging; Pathology results after biopsy. 4. Summary slide that reviews the teaching points.

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## Abstract Archives of the RSNA, 2023

BREE-63

### Indications and Outcomes of Cryoablation in Breast Malignancies: A Single Institution Case Review

All Day Room: Learning Center

Sasha Kurumety, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The goal of this presentation is to educate radiology trainees on the use of cryoablation as a treatment option for breast malignancies, when cryoablation may be appropriate, and expected short and long term outcomes of the procedure. Using a series of cases from our institution, we will describe selection criteria to identify patients that may benefit from this minimally invasive cancer treatment option and demonstrate post treatment imaging findings. After this presentation, learners will be able to describe the utility of cryoablation in treating breast malignancies and mechanisms of action, as well as understand the complications, outcomes, and future directions/ongoing trials for cryoablation.

#### TABLE OF CONTENTS/OUTLINE

Background:- Current FDA approved indications for cryoablation and uses of cryoablation in breast cancer- Ongoing trials: discussion of ICE3, FROST, and home institution trials and preliminary outcomes  
Discussion of mechanism of action:- Direct freezing and cell death, indirect immune response activation- Advantages, disadvantages, and risks/complications of cryoablation  
Cryoablation at our institution:- Qualifying patient and tumor characteristics, preprocedural evaluation- Interdisciplinary decision-making  
Institutional cryoablation cases:- Preprocedural imaging, biopsy pathology results, imaging during procedure, and post cryoablation follow up imaging/pathology  
Future directions: pathway to FDA approval, Medicare coverage, and increasing accessibility.

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## Abstract Archives of the RSNA, 2023

BREE-64

### To Treat or Not to Treat: A Review of Papillary Lesions of the Breast

All Day Room: Learning Center

Shadan Alwan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Papillary breast lesions are a heterogeneous group of proliferative changes that occur within the epithelial lining of breast ducts. These lesions have varying presentations, pathological characteristics, and treatment options, requiring careful radiological evaluation for an accurate diagnosis. The spectrum of the lesions includes intraductal papilloma with/without atypia, intraductal papillary carcinoma, encapsulated papillary carcinoma, solid papillary carcinoma, and invasive papillary carcinoma. Radiologists must be aware of these variations to accurately identify, diagnose, and provide appropriate management recommendations. The primary objective of the exhibit is to present a comprehensive pictorial review of papillary breast lesions with radiological pathological images. We will also discuss the steps in the diagnosis and current management recommendations of these lesions. By the end of this exhibit, the audience will have a better understanding of the various papillary lesions and their clinical and imaging presentations, enabling them to provide appropriate radiologic-pathologic correlation and treatment recommendation for patients.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction. 2) Definition of papillary breast lesions. 3) Pictorial review of the spectrum of papillary lesions. 4) Case examples of the spectrum of papillary lesions with pathological correlation. 5) Symptoms presentation of various papillary lesions. 6) Imaging techniques recommendations for diagnosis of papillary lesions. 7) Review of current BI-RADS terms in the description of these abnormalities. 8) Latest management recommendation for papillary lesions within the spectrum. 9) Conclusion/Summary.

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## Abstract Archives of the RSNA, 2023

BREE-65

### Case Based Review of the Modern Reconstructed Breast: Benign Imaging Findings and Complications

All Day Room: Learning Center

Shelby Breit, BS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understand imaging findings associated with modern reconstruction techniques
2. Recognize uncommon and common benign findings
3. Discuss complications

#### TABLE OF CONTENTS/OUTLINE

Reconstruction Methods  
Implants  
Autologous Flaps (AF)  
Imaging after implant reconstruction  
Type: silicone vs saline  
implant  
Acellular dermal matrix (ADM)  
Benign complications:  
Rupture  
Gel bleed  
Abscess/infection  
Hematoma  
Siliconoma  
Implant associated mesenchymal tumors (fibromatosis)  
Imaging after AF reconstruction  
Type: pedicled, free, perforator flaps  
Venous coupler device  
Benign complications:  
Fat necrosis/lipografting  
Epidermal inclusion cyst

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## Abstract Archives of the RSNA, 2023

BREE-66

### Breast MRI: What the Surgeon Wants to Know

All Day Room: Learning Center

Daniella Boros, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

As there is increasing need for a multidisciplinary approach to patient care, it is important for the radiologist to understand which MRI findings change clinical management. After this presentation, participants will understand: 1. Indications for breast MRI 2. Breast cancer staging 3. Indications for different types of breast cancer treatment, including surgery, radiation, and systemic 4. Breast MRI findings that change clinical/surgical management 5. MRI correlates on mammogram and ultrasound

#### TABLE OF CONTENTS/OUTLINE

A. Indications for MRI a. American College of Radiology Practice Parameter b. American Society of Breast Surgeons Consensus Guidelines B. Overview of breast cancer staging C. Surgical management a. Indications b. Mastectomy vs. lumpectomy c. Types of mastectomy D. Radiation a. Indications b. Whole vs. partial breast treatment E. Systemic a. Indications for neoadjuvant chemotherapy b. Types of systemic treatment (chemotherapy, hormone blockade, biologic therapies) F. MRI findings that impact staging and management with multimodality case examples a. Multicentric/multifocal disease b. Nodal involvement (rotter's node, level I, level II, level III, internal mammary chain node) c. Nipple enhancement d. Skin enhancement e. Chest wall involvement f. Cancer in contralateral breast g. Metastatic disease - bone/lung involvement

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## Abstract Archives of the RSNA, 2023

BREE-67

### The Not So Simple Cyst

All Day Room: Learning Center

Daymara Deynes-Ramos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cystic breast lesions are frequently encountered on ultrasound, often incidentally with a broad differential diagnosis including both benign and malignant pathology. Accurate description and classification according to the BI-RADS Lexicon based on ultrasound characteristics are essential for appropriate estimation of risk for malignancy and in turn management guidance. Emphasis on optimal ultrasound techniques, BI-RADS classification based on imaging characteristics, and correlation with example cases will be given with the purpose of helping residents and radiologists feel confident on how to proceed when faced with a cystic breast lesion.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction II. Optimal Ultrasound Technique III. BI-RADS classification of cystic lesions 1. Simple cyst 2. Complicated cyst 3. Complex cystic and solid mass (classification of complex masses) IV. Sampling techniques V. Take Away Points

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## Abstract Archives of the RSNA, 2023

BREE-68

### The Cures Act: Challenges and Benefits in Breast Imaging

All Day Room: Learning Center

Neda Ghassemi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The 21st Century Cures Act is a federal law signed in 2016, aiming to remove barriers to health information exchange. The legislation includes a Final Rule, federally enforced as of April 2021, mandating patient access to electronic health information to increase transparency. Part of the mandate prohibits "information blocking," defined as a healthcare practice that is "likely to interfere with access, exchange, or use of electronic health information." For radiology practices, this means that reports are released to patients immediately when finalized. Immediate release allows for increased patient autonomy but reports often include sensitive information, especially in breast imaging, in addition to terminology that might be confusing to patients. Screening and diagnostic reports, previously held for a period of time at many institutions to allow time for direct patient communication, are now immediately released to patients. This educational exhibit reviews the impact of the Cures Act on breast imaging practices, including benefits, challenges, and potential solutions to navigate the legislation.

#### TABLE OF CONTENTS/OUTLINE

I. Legislation II. Positive Implications and Challenges III. Evolution of Practice

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## Abstract Archives of the RSNA, 2023

BREE-69

### How to Start Using Optoacoustic Imaging in Your Breast Practice: A Primer

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Optoacoustic imaging (OAI) is a novel technique that uses non-ionizing lasers to detect endogenous tissue contrast. Gray scale ultrasound (GUS) is fused with parametric maps of relative light absorption for oxy/deoxyHgb in real-time, enabling simultaneous functional and anatomic imaging. The most frequently tested interpretation schema involves dividing mass into 3 internal and 2 external features. The 3 internal scores include the number of individually resolved vessels and their relative deoxygenation (vessel score), tumor blush, representing volume-averaged vessels too small to resolve individually (blush score), and Hgb amount (hemoglobin score). The 2 external scores reflect the amount and relative oxygenation of hemoglobin and vessel morphology within the boundary zone (bz, immediately surrounding the tumor, analogous to the thick echogenic rim surrounding tumors on GUS images) and the peripheral zone (pz, territory beyond the bz). Combined evaluation of GSUS and OAI features to classify benign and malignant masses have consistently shown to increase significantly (43.0% vs 28.1%,  $p < 0.001$ ) diagnostic specificity with high interreader (7 readers) agreement (mean kappa = 0.55;  $p < 0.001$ ). A study combining decision support tools with 15 fellowship-trained radiologists showed that interreader agreement [intraclass correlation coefficient (ICC) 0.80, 95%CI: 0.78, 9.82] and agreement between reader and decision support tool (95.3% of all reads) was high.

#### TABLE OF CONTENTS/OUTLINE

1. Optoacoustic Imaging Principles 2. Equipment Types and Current Status 3. Interpreting Optoacoustic Images: A Comprehensive Guide 4. Understanding system limitations 5. Case Demonstration 6. Test Your Knowledge

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## Abstract Archives of the RSNA, 2023

BREE-7

### Non-Malignant Papillary Lesions of the Breast: Imaging Features and Management

All Day Room: Learning Center

Antonio Morales Rosa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To describe the characteristics of non-malignant papillary lesions of the breast (B3) on different imaging techniques: mammography, US and MR. - To review the therapeutic algorithm of papillary B3 lesions of the breast and the role of vacuum assisted excision biopsy (VAE).

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 1.1 Intraductal papiloma without atypia. 1.2 Intraductal papiloma with atypia. 2. Imaging features. 2.1 Mammography. 2.2 US. 2.3 MR. 3. Radiopathological correlation. 4. Management of B3 papillary breast lesions. Algorithm. Role of MR. Indications of VAE. 4.1 Follow-up. 4.2 Surgery. 4.3 Vacuum assisted excisional biopsy (VAE). 5. Conclusions

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## Abstract Archives of the RSNA, 2023

BREE-70

### What You Need to Know About the Pediatric Breast: A Review of the Normal Breast and Diagnostic Approach of Pediatric Breast Disease.

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ilany L. Valdivia I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: Describe the physiologic breast development and its variants from birth to adolescence. Review the optimal imaging modalities for evaluation of breasts lesions in children and adolescents. Recognize imaging appearances of benign and malignant lesions that can affect the pediatric breast. Learn the recommendations for follow-up and management of pediatric breast lesions to avoid a delayed diagnosis or unnecessary interventions.

#### TABLE OF CONTENTS/OUTLINE

We review: Utility of the different imaging modalities in the assessment of the pediatric breast. Breast physiologic development from birth to puberty and pathological conditions that can occur. Benign and malignant pediatric breast disease with illustrating cases. Non-mass findings: Asymmetrical breast development, accessory breast tissue, accessory nipple, pseudogynecomastia, gynecomastia, atypical ductal hyperplasia, surgical scar. Benign masses: Simple and complex cysts, retroareolar cyst, epidermal inclusion cyst, fibrocystic changes, mastitis and abscess, hematoma, intramammary lymph node, reactive lymph node to vaccines, fibroadenoma, pseudoangiomatic stromal hyperplasia, sclerosing adenosis, phyllodes tumor and tubular adenoma. Malignant masses: Metastasis and primary breast cancer. Diagnostic approach of pediatric breast disease with follow-up and management algorithm and indications for interventions such as biopsy or surgery.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

BREE-71

### **Localization for Nonpalpable Breast Lesions. A Pictorial Review of Different Imaging-guided Preoperative Localization Procedures in the Breast and Axilla.**

All Day Room: Learning Center

Javier Azpeitia Arman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To know the different devices employed for nonpalpable breast lesions localization. -To review the role of imaging techniques (mammogram, US, MR, CT, gamma detector) in the localization of breast lesions for breast conserving surgery. -To understand surgeon needs including technical factors of localization and communication of the relationship of the lesion and the marker. -To become familiar with the localization process, and different tips and tricks for each device.

#### **TABLE OF CONTENTS/OUTLINE**

Breast-conserving surgery requires multidisciplinary communication and planning between the surgeon and the radiologist. Removal of the lesion with adequate surgical margins and avoiding resection of healthy breast tissue is essential. 1. History of wire localization, radioactive seed, and other non-needle-wire localization techniques 2. Advantages and disadvantages of using seed localization versus needle-wire localization. 3. Wire localization. 4. Non-wire devices: radioactive I125, magnetic, radar, and radiofrequency seeds 5. Technique and pitfalls. Before the procedure: review of the patient's imaging and histopathologic findings. Wire or seed placement. Preoperative detection. Operating room. Recovery. 6. Case examples of potential difficulties and problems and how to overcome them.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-72

### Is it Back? Multimodality Surveillance of Breast Cancer Recurrence: Literature Review and Case Presentation

All Day Room: Learning Center

Mohammed A. Sabawi, MBChB (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Screening patients with previously treated breast cancer is challenging, because benign post treatment changes can obscure or resemble an underlying recurrence and due to technical limitations in performing a mammography on a treated breast. There are postoperative mammographic findings in a conservatively treated breast which follow expected time course. Any new mammographic finding (new masses, asymmetries or microcalcifications) should raise suspicion for recurrence. Abnormal screening mammogram is the most common presentation of breast cancer recurrence. Margin involvement and lack of radiotherapy and/ or chemotherapy are important prognostic factors of local recurrence. There is no clear guidelines to dictate ipsilateral breast screening after mastectomy and reconstruction with or without implant. Breast MRI is highly sensitive imaging modality to detect local recurrence in certain patient groups. It can be also utilized as problem solving to assess equivocal clinical or mammographic findings.

#### TABLE OF CONTENTS/OUTLINE

Introduction Review of incidence, risk factors, diagnostic performance of multimodality surveillance and presentation of breast cancer recurrence. Review of post breast conserving treatment imaging findings and their time course of evolution. Review of available national guidelines for multimodality surveillance after curative treatment for locoregional breast cancer. Case based review of different and unusual presentations of breast cancer recurrence. Conclusion. References.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-73

### **A Review of the Combined Score for Quantitative Shear Wave Elastography (SWE) and Superb Microvascular Image Vascular Index ( $SMI_{VT}$ ) to Evaluate Breast Masses**

All Day Room: Learning Center

NA YOUNG LEE (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To differentiate between benign and malignant breast masses, we propose using the combined score of quantitative parameters for shear wave elastography (SWE) and superb microvascular image (SMI) with BI-RADS. We suggest using the combined score for SWEmax, SWERatio, and SMIVI and demonstrate how it can be used to differentiate between benign and malignant breast masses. 2. We calculated the combined score by adding the BI-RADS score and each quantitative parameter (SWEmax, SWERatio, and SMIVI). The BI-RADS categories were scored on a scale of 1 to 5 (C3:1, C4a:2, C4b:3, C4c:4, and C5:5), and SWEmax, SWERatio, and SMIVI were scored as 0 or 1 based on applied cutoff values. The summed score ranged from 1 to 8. We used a cutoff value of 4 for the combined score to discriminate between benign and malignant cases based on the reported AUC values. 3. The combined score of B-mode US and quantitative parameters can improve diagnostic performance and reduce unnecessary breast biopsy. However, the combined scores should be applied with caution, considering that the quantitative parameters have limitations in assessing small-sized, pure DCIS, or low-grade invasive cancer.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the principles of quantitative parameters for SWE (SWEmax, SWERatio) and SMIVI. 2. Review the appropriate cut off value for quantitative parameters for SWEmax, SWERatio, and SMIVI and evaluate their diagnostic performance in differentiating between benign and malignant masses. 3. Showcase the various case of combined score and pathology reviews to demonstrate how combined scores are helpful for differential diagnosis of breast masses, and which cases will be carefully applied.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-74

### Threading the Needle: The Role of Breast Radiologists in Managing Suspicious Internal Mammary Lymph Nodes

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Megan J. Kalambo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Examine Internal Mammary Lymph Nodes (IMLN) as an important component of breast lymphatic drainage. 2. Review the implications of metastatic IMLN adenopathy in the staging of breast cancer. 3. Provide an overview of IMLN basin anatomy, differential diagnosis of IM adenopathy, and the clinical indications for imaging and sampling. 4. Explain the tools and technical steps necessary for conducting a successful ultrasound biopsy of IMLNs. 5. Recognize ultrasound-guided Fine Needle Aspiration (FNA) biopsy as a feasible percutaneous sampling technique radiologists can use to provide treatment planning assistance to clinical teams.

#### TABLE OF CONTENTS/OUTLINE

Based on our experiences at a tertiary oncologic referral center, we will provide an overview of internal mammary lymph nodes (IMLN) with regard to the anatomical, clinical, imaging and procedural considerations for radiologists. • Overview of IM nodal basin anatomy • Management of indeterminate and suspicious IMLNs • Differential diagnosis of abnormal/indeterminate IMLNs • Incidence and implications of IMLN adenopathy on breast cancer staging • Indications for imaging of IMLN • Multimodality identification of IMLN on Ultrasound, MRI, PET/CT • Biopsy considerations • Indications • Tools • Technical steps • Case-based discussion of IMLNs • Tips for imaging and clinical management of patients with indeterminate/suspicious IMLN.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-75

### The State of Breast Imaging in the Caribbean

All Day Room: Learning Center

Dami Olufosoye, BS, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Provide an overview of the current trends in incidence and mortality of breast cancer in the Caribbean 2. Discuss the state of breast services with respect to breast exams and screening 3. Discuss the challenges in breast services including infrastructure and health workforce availability 4. Recognize patient-related barriers 5. Review main points of the global breast cancer initiative and goals for breast imaging in the Caribbean

#### TABLE OF CONTENTS/OUTLINE

- Overview of breast cancer incidence, prevalence, mortality, and stage of diagnosis in the Caribbean compared globally and to the US
- State of breast services with respect to breast exams and testing
- National guidelines on breast exams and screening
- Self-breast exams
- Clinical breast exams
- Access to mammograms
- Discuss the state of breast services pertaining to the infrastructure and health workforce availability
- Number of equipment in the region
- Type of equipment available: digital mammography vs full film digital mammography vs tomosynthesis
- Maintenance/ Audit of equipment
- Health workforce: radiologists, oncologists, physicists
- Breast treatment services
- Barriers surrounding breast cancer
- Knowledge deficits
- Patient beliefs
- 2021 Global Breast Initiative
- Key messages
- Recommendations for implementing interventions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-76

### Breast Lesions Detected on CT: When to Refer for Triple Breast Assessment

All Day Room: Learning Center

Sharmeen Jaffer, BMBS, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Incidental breast lesions are a common finding on CT and unnecessary referrals can create a significant burden on the breast clinic.
- To evaluate imaging characteristics of incidental breast lesions identified on CT and suggest characteristics which warrant referral to the breast clinic.
- To identify imaging characteristics of breast lesion mimics or benign breast lesions; avoiding unnecessary referral to the breast clinic.
- To explore the limitations of CT with imaging breast lesions including post-contrast enhancement in benign and malignant lesions.

#### TABLE OF CONTENTS/OUTLINE

- Variability of normal breast glandular tissue on CT including asymmetry and differences in density.
- Breast lesions with benign characteristics such as coarse or popcorn calcification or well defined cysts with homogenous fluid attenuation.
- Indeterminate breast lesions including intramammary lymph nodes, leiomyomas, papilloma, fat necrosis or lobular fibroadenomas which demonstrate post-contrast enhancement.
- Suspicious breast lesions and indicators of malignancy including irregular or speculate margins and global or peripheral contrast enhancement; measured in Hounsfield units (HU).
- Mimics of breast malignancy including lymphoedema, post surgical changes or radiotherapy.
- Factors that negate an unnecessary referral to breast clinic include: long term stability, lesion previously assessed on mammography/ultrasound/biopsy proven benign lesion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-77

### Multimodality Imaging of Recurrent and Residual Breast Cancer

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Victoria Domonkos (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

After this exhibit, the reader will be able to: 1. Describe the epidemiology and clinical implications of recurrent and residual breast cancer. 2. Demonstrate the importance of a multimodality approach to the detection, workup and diagnosis of recurrent and residual breast cancer. 3. Apply specific strategies to improve early detection to optimize patient outcomes.

#### TABLE OF CONTENTS/OUTLINE

Recurrent and residual breast cancer remains a diagnostic challenge with significant clinical implications. Early and accurate detection is critical for optimizing patient outcomes. Using a case-based multi-modality approach, this exhibit will: 1. Review the epidemiology and clinical implications of recurrent and residual breast cancer. 2. Discuss current surveillance recommendations and supporting literature, including the importance of patient anxiety. 3. Review expected post-treatment findings, discussing the advantages and disadvantages of each modality (mammography, ultrasound and MRI). 4. Provide an approach to surveillance imaging and residual disease, with emphasis on the surgical pathology report, surgical margins and the importance of breast biopsy marker clips. 5. Provide tips and tricks to ensure early identification of recurrent/residual disease and avoid post-treatment surveillance pitfalls.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-78

### From Benign to Malignant: Understanding the Spectrum of Phyllodes Tumors

All Day Room: Learning Center

Abel Gonzalez Huete, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To provide an overview of Phyllodes tumors, including their pathology features, categories and clinical presentation. 2. To discuss the role of the different imaging in the diagnosis of Phyllodes tumors. 3. To review the differential diagnosis of Phyllodes tumors and how to differentiate them from other breast tumors. 4. To highlight the importance of accurate diagnosis in the management of Phyllodes tumors.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: Breast anatomy, Fibroepithelial tumors, Epidemiology, Pathogenesis, Categories of Phyllodes Tumors (Benign, Borderline, and Malignant) 2. Clinical Presentation 3. Pathology 4. Imaging Findings: - Benign Phyllodes tumor (Mammography, Ultrasound and MRI), - Borderline Phyllodes tumor (Mammography, Ultrasound and MRI), - Malignant Phyllodes tumor (Mammography, Ultrasound and MRI). 5. Differential Diagnosis: Fibroadenoma, Primary Sarcoma of the Breast, Periductal Stromal Tumor of the Breast, Other. 6. Benign vs Malignant Phyllodes Tumors: Key Differences 7. Management, Treatment and Prognosis 8. Conclusion 9. References

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

BREE-79

### **A Sheep in Wolf's Clothing: The Multiple Appearances of Local Breast Cancer Recurrence After Breast Mastectomy**

All Day Room: Learning Center

Agostina B. Peralta I (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Discuss the role of the different image modalities in the surveillance of breast cancer recurrence after breast mastectomy.- Recognizing the imaging and the normal anatomic changes depending on the type of breast mastectomy performed.-Illustrate the imagen findings corresponding to a breast cancer recurrence on different image modalities.-Differentiating post-surgical benign findings from a malignant relapse.

#### **TABLE OF CONTENTS/OUTLINE**

Studies have proven that the presence of local recurrence is an independent predictor for survival this is why radiologist should be familiarized to distinguish normal or benign findings after mastectomy form a recurrence. With the main objective of early detection and treatment. -Briefly review the different surveillance recommendations for these patients given by international societies. -Description of the different surgical breast reconstruction techniques used nowadays will be performed. These include the use of prosthetic implants, autologous tissue flaps, skin and fat flaps. -Illustrations will be shown of the expected anatomic changes after mastectomy on different image modalities depending on the surgical technique. -Images showing and differentiating benign findings from a post-surgical local breast cancer recurrence will be portrait.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-8

### Comparison of Indications, Reading Time, and Work Flow of FDA Approved Supplemental Screening Automated Whole Breast Ultrasound Tomography in Women With Dense Breasts

All Day Room: Learning Center

Mary W. Yamashita, MD (*Presenter*) Research Grant, Delphinus Medical Technologies, Inc; Consultant, Delphinus Medical Technologies, Inc

#### TEACHING POINTS

- Ultrasound as adjunct to screening mammography for women with dense breasts increases cancer detection. - There are new ultrasound technologies available for same day supplemental dense breast screening. - Invenia ABUS from GE and SoftVue Automated Whole Breast Ultrasound Tomography (SV) from Delphinus Medical Technologies are both PMA-approved for screening and diagnostic purposes. - In clinical practice, ABUS is time-consuming and requires significant reading time. - SV offers benefits of same day supplemental screening with mammography and, unlike other ultrasound imaging, only adds 3-4 mins of reading time per case for the radiologist.

#### TABLE OF CONTENTS/OUTLINE

1. Why ultrasound is important in screening women with dense breasts 2. Overview of ultrasound technologies available for dense breast screening 3. Comparison of indications for use 4. Benefits and challenges with integrating ultrasound into practice for adjunct screening for women with dense breasts: Workflow 5. Reading time: what makes reading ABUS and HHUS challenging in clinical practice, what are the main drivers of the time it takes for radiologist to interpret images including technique and training, number of images, image quality, and artifacts 6. Overview of SV automated whole breast ultrasound 7. Image sequence and reading protocol for SV 8. Example clinical cases demonstrating SV hanging protocol 9. SV reading time study and results 10. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-80

### Do Not Miss Architectural Distortion!

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

#### TEACHING POINTS

The BI-RADS 5th edition manual defines architectural distortion (AD) as “distortion of the breast parenchyma with no definite mass visible.” AD of the breast is an abnormality found in multimodality breast imaging and occurs with benign and malignant lesions. The most common cause of architectural distortion is a surgical scar. However, 4% of breast cancers present with AD. In addition to being a primary imaging finding, AD may also be an associated finding. In addition, AD is notorious for being a missed mammographic lesion. It is important for radiologists to “train their eyes” to identify AD and to know the differential considerations and pitfalls associated with AD evaluation to avoid potential missed breast cancer. The goals of this educational exhibit are to 1. recognize AD by 2D mammogram, digital breast tomosynthesis (DBT), ultrasound, and MRI, 2. review the differential considerations of AD, and 3. recommend management options and perform radiology-pathology concordance.

#### TABLE OF CONTENTS/OUTLINE

Introduction; Definition of AD; Multimodality imaging examples of AD of the breast including mammography, sonography, and MRI; Learn a systematic approach to the characterization of AD; AD and DBT; How to appropriately apply the BI-RADS classification and management recommendations of AD; Challenging cases of AD; Pitfalls in evaluating AD: fat-containing, one view only, not seen at biopsy; Discordance in AD rad-path correlation; Sample cases; Conclusion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-81

### Non-mass Lesion on Breast Ultrasound: Radiologic-Pathologic Correlation and a Guide to Approach

All Day Room: Learning Center

Haejung Kim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Unlike mass, non-mass lesion does not show a three-dimensional structure, so it is more difficult than mass to detect and make an accurate diagnosis on breast ultrasound. For this reason, non-mass lesion evaluation on breast ultrasound often follows the detection of abnormality on other imaging modalities, such as mammography or MRI. This educational exhibit was prepared to increase understanding of non-mass lesions seen on breast ultrasound and to help accurately diagnose benign and malignant non-mass lesions. 1. Review the definition of non-mass lesion on breast ultrasound, 2. Correlate radiologic and pathological findings of benign and malignant non-mass lesions, and 3. Discuss a guide to approach for evaluating non-mass lesions on breast ultrasound.

#### TABLE OF CONTENTS/OUTLINE

1. Definition of non-mass lesion on breast ultrasound A. True non-mass lesion vs. Normal variants 2. Correlation between radiologic and pathologic findings of non-mass lesions on US A. Imaging features of non-mass lesions on US B. Pathologic features correlated with benign and malignant non-mass lesions 3. Approach for evaluating non-mass lesion on breast ultrasound

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-82

### The Cyst Bang Theory: When to Biopsy

All Day Room: Learning Center

Claudia L. Ruano, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Explain the epidemiology and pathogenesis of breast cyst. 2. Recognize the characteristics by image of breast cysts. The complex cyst is uncommon, but are suspicious of malignancy and merit biopsy. 3. Recognize criteria that will help identify a complex cyst. 4. Identify intraductal papillary nodule. Benign papillomas constitute 85% and 90%, intracystic papillary carcinomas 6% to 7%. 5. Points to help distinguish real from artifacts (echos) on ultrasonography images. 6. Recognize the most important differences in images between complicated and complex cyst. The true papillary nodules are anchored to the wall and do not move with the postural changes of the patient. 7. Analyze when to suspect malignancy in the breast cysts and categorize them based on the BIRADS.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Epidemiology and pathogenesis 3. What are complex cysts 4. What should birads assign to a complex cyst 5. Review the spectrum of findings (mammography, us and contrast-enhanced mammography) 6. When to decide biopsy, a complex cyst 7. Let's practice (illustrative cases) 8. Conclusions

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## Abstract Archives of the RSNA, 2023

BREE-83

### Solitary Dilated Duct in the Breast: A Multimodality Pictorial Review

All Day Room: Learning Center

Zachary R. Zaniewski, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Solitary dilated duct is associated with benign and malignant findings and the BI-RADS classification has varied over previous editions. Solitary dilated duct has characteristic imaging features on multiple modalities. Recognizing the imaging features, particularly if new, is important for management.

#### TABLE OF CONTENTS/OUTLINE

Background Review of solitary dilated duct and BIRADS classification. Pictorial Review: Cases illustrating benign and malignant lesions with multiple modalities. Case 1: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound. Pathology: Papilloma without atypia. Case 2: History: Presenting with breast pain. Imaging: Mammogram, ultrasound. Pathology: Invasive ductal carcinoma. Case 3: History: 60-year-old female presenting for screening mammogram. Imaging: Mammogram, ultrasound. Pathology: Papilloma without atypia. Case 4: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound, MRI. Pathology: Papilloma with high-risk features. Case 5: History: Presenting for screening mammogram. Imaging: Mammogram, ultrasound. Pathology: Intraductal papilloma. Case 6: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound, ductogram. Pathology: DCIS. Case 7: History: Presenting with bloody nipple discharge. Imaging: Mammogram, ultrasound, ductogram, MRI. Pathology: Multifocal DCIS with intraductal papillomatosis. Conclusion Review pearls for solitary dilated duct findings and management.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-84

### **MRI Detected Lesion in Women with a Personal History of Breast Cancer, and Then?**

All Day Room: Learning Center

Ga-Eun Park, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Screening is still important for women with a history of breast cancer, because of high risk for future breast cancer. Breast MRI shows impressive resolution with high sensitivity, but specificity is relatively low.
- Second look ultrasound is a well-established approach for MRI detected lesions, and lesions found on subsequent ultrasound have a high probability of malignancy. However, second look ultrasound has limitations, such as operator dependence and the possibility of false negatives. Follow-up is required, and re-biopsy should be considered in case of image-pathology discordant.
- Correlation with mammography can sometimes be helpful. In particular, new or increasing calcifications can be objective evidence for lesion detection and confirmation of biopsy results.
- MR-guided biopsy must be considered in lesions with suspicious MRI features but occult on US or mammography.

#### **TABLE OF CONTENTS/OUTLINE**

<Representative cases of new enhancing lesion on breast MRI>• According to surgical method: op site after BCS, ipsilateral and contralateral breast after BCS, after mastectomy• According to detection modality: second look ultrasound (successful and missed), mammography, MR-guided biopsy for occult lesion• According to biopsy results: recurrence, false positive (benign), false negative (missed)

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## Abstract Archives of the RSNA, 2023

BREE-85

### 5 Years of False Negative Review from the Mammography Audit: Observations and Lessons Learned

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Heather V. Garrett, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Review of false negative (FN) cases can refine your mammography practice.-Sensitivity of mammography is limited in dense breasts.-BCT changes can make mammography difficult to interpret. ACR recommends annual screening MRI in patients with a prior history of BCT and dense breasts.-Screening MRI is more sensitive than mammography in the detection of breast cancer. High-risk patients should obtain annual mammography and annual screening MRI alternating at 6 month intervals.-Clinical symptoms (palpable breast lump, nipple discharge, skin changes and focal breast pain) should be evaluated using a multi-modality imaging approach.-BIRADS 3 cases are included in the FN review of diagnostic mammography. 0-2% of these cases may be cancers.

#### TABLE OF CONTENTS/OUTLINE

Background: False negative (FN) case review is mandated part of the annual mammography radiologist audit (MQSA/ACR). We are a large academic practice with dedicated breast imagers. We analyzed 135 FN cases from 5 years (2016-2020).Observations: -FN cases tended to be in patients with dense breasts, personal history of breast cancer, prior BCT, elevated life-time risk for breast cancer.-FN cases were mostly detected by presenting clinical symptom or screening MRI.-Some FN cases were women who had been given the assessment of BIRADS 3 in the diagnostic setting.Cases: 5-10 cases to illustrate teaching points.Lessons Learned: Overall, we found that there are many reasons for FN studies, the minority of which involved "missed cancers." Review of FN cases can refine your mammography practice.

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## Abstract Archives of the RSNA, 2023

BREE-86

### **Don't Forget About the Nipple: Overview of the Anatomy and Different Lesions Involving the Nipple-areolar Complex**

All Day Room: Learning Center

Maria Guerra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe the normal anatomy and some anatomic variants of the nipple-areolar complex (NAC). To review imaging anatomy of the NAC by different techniques. To present a pictorial review of commonly known benign and malignant NAC lesions.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy of the nipple-areolar complex  
Retraction  
Inversion  
Imaging anatomy: mammogram, ultrasound, magnetic resonance  
Different lesions:  
Dermal lesions: nipple calcifications, Epidermal inclusion cyst  
Inflammatory lesions: duct ectasia, retroareolar cyst, periductal mastitis, abscess, Zuska disease  
Benign Tumors: Nipple adenoma  
Malignant tumors: papilloma, carcinoma, Paget's disease

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## Abstract Archives of the RSNA, 2023

BREE-87

### The Many Faces of Invasive Lobular Carcinoma

All Day Room: Learning Center

#### Awards

##### Cum Laude

Miral M. Patel, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Invasive lobular carcinoma accounts for 5-15% of all breast cancers. 2. ILC is characterized by the lack of E-cadherin function, which explains the discohesive growth pattern and the subtle findings in imaging. 3. A review of radiologic and pathologic correlation of invasive lobular carcinoma and its morphologic variants can aid radiologists in recognizing patterns in the imaging presentation of invasive lobular carcinoma to facilitate early detection.

#### TABLE OF CONTENTS/OUTLINE

This educational exhibit reviews: 1- Basic review of invasive lobular carcinoma 2- Case based discussion of the radiologic presentation and pathologic correlation of the variants of invasive lobular carcinoma including classic, solid, signet ring cell, and pleomorphic 3- Pattern recognition in the presentation of invasive lobular carcinoma

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-88

### Breast Cancer Recurrence: Incidence and Imaging Appearance

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

#### TEACHING POINTS

Locoregional recurrence has been estimated to occur in 5-25% of breast cancer (BC) survivors, defined as the reappearance of the tumor at the surgical site or metastases in the regional lymph nodes. Even after mastectomy, there is a 2-10% reported lifetime risk of recurrence. Recurrence varies by molecular subtypes of BC, triple negative BC at 2-5 years after and other types at 5-15 years after treatment. Mammography remains the primary imaging modality for post-BCT surveillance. Breast MRI has the highest accuracy for differentiating post-surgical scar from recurrence. By the end of this educational exhibit, the learner will: 1. Learn the incidence, risk factors, and clinical presentation of breast cancer recurrence, 2. Review imaging recommendations for patients with a history of breast cancer and those with suspected breast cancer recurrence, 3. Recognize the common imaging appearance of recurrent breast cancer on multimodality imaging, 4. Distinguish the appearance of recurrent breast cancer from expected post-surgical changes and other differential diagnoses

#### TABLE OF CONTENTS/OUTLINE

Introduction; Incidence and definition of breast cancer recurrence; Expected recurrence rates based on molecular subtypes of BC; Clinical presentation of breast cancer recurrence; Review imaging recommendations for patients with a history of breast cancer; Review diagnostic workup for patients with suspected breast cancer recurrence; Differential considerations of in-breast recurrence and regional nodal recurrence; A pictorial review of multimodality imaging in BC recurrence; Clinical management of recurrent BC; Algorithm for imaging patients with suspected recurrence; Conclusion

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## Abstract Archives of the RSNA, 2023

BREE-89

### AI in Breast Imaging: Current Status and Future Directions

All Day Room: Learning Center

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Artificial intelligence (AI) in breast imaging is being used for lesion classification, breast density and cancer risk assessment. In screening mammography setting, stand-alone sensitivity of commercially available AI system range 75-85% at radiologists' specificity of 49-79%. This indicates comparable results with radiologist performance (AUC, 0.84 vs 0.81, respectively).
- Beyond screening ,a deep learning model trained on uses mammograms and traditional risk factors showed superior performance in predicting 5 year breast cancer risk compared to the Tyrer-Cuzick model. (AUC, 0.70 vs 0.62,  $p < 0.001$ ).
- Model drift is a concept that describes degradation of AI model performance as the data it is used on changes. This raises concerns regarding the performance and reliability of AI models in real-life clinical settings.
- The FDA requires manufacturers of Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD) to be transparent and monitor the real-world performance of their products to ensure the algorithm meets the standards after deployment.
- In a recent Dutch patient survey most patients (77.8%) did not support stand-alone use of AI in screening interpretation. Furthermore, 41.7% opposed the idea of using AI to select cases for second reading and 17% objected to AI as a second reader.
- The reimbursement for breast imaging AI has not yet been established, and several proposed frameworks are currently under discussion.

#### TABLE OF CONTENTS/OUTLINE

Integrating AI Tools to Breast Imaging Workflow: Opportunities, Challenges and Potential Impact Patient Engagement Ethical and Regulatory Perspectives The Future of AI in Breast Imaging

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## Abstract Archives of the RSNA, 2023

BREE-9

### Navigating Mammary Ducts Pathologies and Anatomy: A Radiological Handbook

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Giovanna Andreani, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The breast is an apocrine gland that contains different types of tissue: glandular, fibrous or connective, and fatty tissue. The glandular tissue is composed of mammary lobules and ducts, the latter being a tubular structure with the function of carrying the milk produced by the gland to the nipple. There are several pathologies and variations that can affect the mammary duct, ranging from benign alterations such as ductal ectasia or papilloma to even malignant ones (ductal carcinoma in situ or invasive ductal carcinoma, among others). Knowing that the majority of breast cancer arises from the ductal epithelium, it is crucial in the diagnosis and treatment of breast cancer by detecting intraductal lesions at an early stage. The objective of this study is to didactically review the anatomy and embryology of mammary ducts, as well as the main pathologies that affect this very important structure.

#### TABLE OF CONTENTS/OUTLINE

Review of the anatomy and discussion of the radiological findings in the mammary ducts, whether in their normal appearance or pathological changes through the different imaging methods obtained from the digital archive of our institution.

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## Abstract Archives of the RSNA, 2023

BREE-90

### **Beyond the Norm: An Exploration of Extramammary Metastases to the Breast**

All Day Room: Learning Center

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Metastases to the breast are rare, comprising 0.5-6.6% of all malignancies in the breast, and typically indicate widely disseminated disease and poor prognosis.
- Lymphoma (17-38.3%), melanoma (8.3-23.4%), lung (8-15%), gynecological carcinomas (8-12.8%), and sarcomas (2%-12%) are the most common primary tumors to metastasize to the breast.
- Imaging features can vary depending on the primary neoplasm and route of dissemination, hematogenous (more common) or lymphatic.
- Typically, metastases present as well-defined masses without calcifications or distortion on mammography and round hypoechoic masses on ultrasound. Hematogenous metastases present as solitary or multiple breast masses located in the skin, subcutaneous tissue, or the breast parenchyma.
- Breast findings should be characterized according to the BI-RADS lexicon and managed according to the most suspicious features. If metastatic disease to the breast is in the differential diagnosis based on patient history and/or clinical presentation, early confirmation of secondary involvement with pre-operative biopsy of breast lesions is crucial to direct appropriate management.
- Breast metastases can be highly vascular, and ultrasound technique should be optimized to not confuse with pseudoaneurysms or aneurysms, which could result in a delay of diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Literature review 2. Diagnostic algorithm 3. Key clinical and imaging features 4. The diagnostic and prognostic role of imaging modalities 5. Case demonstration and pathologic correlation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-91

### Optimizing DWI for Improved Imaging in Breast Cancer and Beyond

All Day Room: Learning Center

Sheida Ebrahimi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Diffusion weighted imaging (DWI) is an advanced MRI technique that reflects water diffusion in tissues of interest and has been shown predicting pathologic response to neoadjuvant chemotherapy. It assists radiologists in better detecting and characterizing breast lesions. DWI can be challenging due to the breast morphology and introduction of artifacts. This exhibit reviews current state of DWI in breast cancer imaging including the physics of DWI, protocols utilized, advanced DWI techniques, and current indications. Strategies for optimizing DWI to improve image quality, diagnostic accuracy, and clinical utility will also be reviewed. At the end of this educational exhibit, learners will: 1. Recall the fundamentals of DWI and ADC Values; 2. Describe the correlation between ADC values and breast cancer prognostic factors; 3. Understand DWI challenges and limitations, and strategies for enhancing standard DWI; 4. Classify advanced DWI.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: Overview of DWI and its importance in breast cancer;
2. Fundamentals of DWI: Explanation of water diffusion in tissues; ADC values and their significance in DWI;
3. ADC Values and prognostic factors in breast cancer;
4. Benefits and applications of DWI in breast cancer;
5. Quality control and factors influencing repeatability and reproducibility of ADC measure: Techniques to improve the quality of ADC measurements;
6. Comparison of DWI protocols: QIBA recommendations vs. our institute's approach;
7. Technical challenges and limitations of DWI: Techniques to Improve standard DWI;
8. Classification of advanced DWI: Overview of subtypes of advanced DWI, their differences, and advantages;
9. Conclusion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-92

### Swipe Left or Right? The Multimodality Imaging Detection and Assessment of the Solitary Dilated Duct

All Day Room: Learning Center

#### Awards

##### Cum Laude

Tanya W. Moseley, MD, PhD (*Presenter*) Consultant, Hologic, Inc; Consultant, Merit Medical Systems, Inc; Owner, TW Moseley, LLC; CEO, TW Moseley, LLC

#### TEACHING POINTS

- Review ductal anatomy and the epidemiology of ductal disease.
- Discuss imaging findings of benign and malignant ductal disease.
- Discuss the solitary dilated duct (SDD) and review the BI-RADS® 5th edition's recommendations for classifying and managing ductal lesions.
- Describe the role of imaging in the screening and diagnosing of ductal disease including mammography/tomosynthesis, ultrasound, magnetic resonance imaging, and galactography/ductography.
- Review methods and challenges specific to the sampling of ductal abnormalities.

#### TABLE OF CONTENTS/OUTLINE

-Introduction-Anatomy-Benign ductal findings-Malignant ductal findings-Solitary dilated duct (SDD) BI-RADS® 5th edition's recommendation-Imaging's role in screening and diagnosis and the correlation with prognosis-Imaging Techniques to evaluate the ductal anatomy and pathology-Methods to sample ductal abnormalities and tips to overcome the challenges that may be encountered-Conclusion

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

BREE-93

### Idiopathic Granulomatous Mastitis: A Case-Based Review

All Day Room: Learning Center

Layne Kelley, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Idiopathic granulomatous mastitis (IGM) is estimated to affect 2.4/100,000 women, at median age of 36.5 years, and bilateral involvement in 8.8%. 2. Common symptoms are pain, erythema, palpable lump, and less frequently, fistulous drainage or nipple discharge. 3. The most common ultrasound findings are hypoechoic collection (75.9%) and skin involvement (53.5%). Mammography is often nonspecific, but common findings include focal asymmetry (51.6%), global asymmetry (18.3%), mass (17.2%), abnormal lymph nodes (8.6%). 4. IGM can mimic infectious mastitis or breast cancer on imaging and clinically. 5. Biopsy is usually required to confirm diagnosis and guide management. Often biopsy is necessary to exclude malignancy, especially inflammatory or triple-negative subtypes. Suspected IGM may be tentatively diagnosed by clinically assessing treatment response, but given overlap of imaging features and different treatment for IGM and infectious mastitis, biopsy is often needed. 6. Imaging findings often persist after resolution of clinical symptoms, thus clinical follow-up should be the mainstay for surveillance.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Typical imaging findings on mammography and ultrasound  
3. Other entities that mimic IGM  
4. Case-based review of biopsy-proven cases using key images with descriptions, treatment and clinical outcome data  
5. Biopsy and management considerations

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-94

### **Don't Be Fooled: Not Every Late-Onset Peri-Implant Effusion is Seroma! A Case-Based Review of Breast Implant-Associated Anaplastic Large Cell Lymphoma (BIA-ALCL)**

All Day Room: Learning Center

Larissa L. Botelho, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

We report the case of a female patient, with a history of mammoplasty six years ago, reporting sudden enlargement of the left breast. Imaging exams showed the presence of peri-implant fluid in the same breast, with the analysis of the fluid confirming the BIA-ALCL. Breast Implant-associated Anaplastic Large Cell Lymphoma (BIA-ALCL) is characterized by a late-onset peri-implant effusion, appearing on average 10 years after exposure to breast implants. The pathogenesis is not completely identified, but it is known that cases of BIA-ALCL are related to textured prostheses, with the surface of the prosthesis being the most important factor in inducing the disease. It may present only with the effusion (subtype of effusion) or associated with a peri-implant mass (mass-forming disease). The main associated symptoms are sudden edema secondary to the peri-implant effusion and, in case of mass-forming disease, the presence of a palpable nodule. Multiple imaging methods can be used in the evaluation of patients with suspected BIA-ALCL. However, diagnostic confirmation depends on the analysis of the fluid found. The diagnosis of BIA-ALCL is made with the characterization of morphologically atypical lymphocytes, with CD30 expression and negativity for ALK-1. The differential diagnosis of the effusion subtype is made with late seroma. Distant disease is rare, being a neoplasm with a high potential for cure, if identified in the early stages and when not associated with masses, with a surgical approach as a curative technique, in the case of the subtype of effusion.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction; Definition and Subtypes; Pathogenesis; Symptoms; Image Methods; Diagnosis; Differential diagnoses

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-95

### Cystic Breast Lesions- What to Do When It's Not Simple

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Laura K. Harper, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Imaging features of benign and malignant cystic lesions may overlap, causing misclassification with the potential to produce diagnostic delay and harm. The purpose of this exhibit is to review ultrasound features of benign and malignant cystic breast masses to guide appropriate characterization and management. The Breast Imaging Reporting and Data System (BIRADS) assessment categories will be reviewed as it pertains to cystic breast masses, including review of appropriate utilization of the BIRADS-3 (probably benign) assessment category. Emphasis will be placed on recognizing suspicious imaging features warranting further evaluation with percutaneous biopsy. Teaching Points: 1. Examine imaging features of various cystic breast masses (Simple cysts, complicated cysts, and complex cystic and solid mass). 2. Discuss overlap of benign and malignant complex cystic and solid masses (ex: hematoma, abscess, cancer). 3. Review appropriate BI-RADS category assessment and management for various cystic lesions

#### TABLE OF CONTENTS/OUTLINE

1. Introduction of the prevalence, clinical presentation and patient factors associated with cystic breast masses 2. Review distinguishing features and BI-RADS category assessments for various cystic masses 3. Multimodality (mammography, contrast-enhanced mammography, ultrasound, and magnetic resonance imaging) case-based review of benign and malignant cystic breast masses 4. Conclusion (summary of key educational points)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-96

### **Patterns of Breast Cancer Recurrence in the Post-Mastectomy Breast with or without Reconstruction: A Case-Based Review**

All Day Room: Learning Center

Shannon Lanzo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Women treated for breast cancer with mastectomy with or without reconstruction are at risk of developing loco-regional recurrence along the suture line or within residual tissue.2. Benign post-operative findings include edema, seroma, hematoma, fat necrosis, post-operative scarring and fibrosis, which evolve over time.3. Recurrence may be difficult to distinguish from these benign findings.4. Biopsy is warranted when imaging findings are equivocal.

#### **TABLE OF CONTENTS/OUTLINE**

1. This case-based exhibit will review the expected post-operative appearance post mastectomy without or with reconstruction using autologous tissue flaps (pedicled or free flap), and/or prosthetic implants.2. We will illustrate typical imaging features of benign post treatment changes (fat necrosis, fibrosis, edema, skin thickening, etc.) and malignant findings on mammogram, ultrasound, and MRI.3. We will review appropriate use of combined imaging and biopsy methods when imaging findings are equivocal.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-98

### Diagnostic Potential of Photon-Counting Detector Computed Tomography to Evaluate Breast Cancer Patients

All Day Room: Learning Center

Misugi Urano, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Photon-counting detector computed tomography (PCD-CT) has several advantages over energy-integrating computed tomography (EID-CT). It provides high spatial resolution and improves image contrast, resulting in precise visualization of soft tissue and microstructures while reducing radiation dose. In addition, a simultaneous multi-energy acquisition offers further qualitative and quantitative information in a single scan. These benefits make PCD-CT a valuable tool for systemic staging, preoperative planning, and post-treatment monitoring of breast cancer patients due to its ability to precisely depict the local extent of tumors and the presence of small lesions. This presentation will focus on PCD-CT in initial staging workup, treatment response assessment, or recurrences monitoring in breast cancer patients, comparing to EID-CT, other image modalities, and pathological results. We will also discuss the advantages and pitfalls of PCD-CT.

#### TABLE OF CONTENTS/OUTLINE

1. Current CT recommendation for breast cancer patients in guidelines
2. The potential of PCD-CT for breast cancer workup
3. Case-based review of PCD-CT in breast cancer patients compared to EID-CT, other image modalities, and pathological results.
4. Discussion of the utilities of PCD-CT for breast cancer patients, including advantages, disadvantages, and pitfalls.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

BREE-99

### **Breast Ultrasound Tomography: The Essentials for the Breast Radiologist**

All Day Room: Learning Center

Yu Zhao, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This educational exhibit will review the essentials of breast ultrasound tomography. 1. Understand basic concepts of breast ultrasound tomography including essential physics, the basic imaging sequences, and keys to imaging interpretation. 2. Describe the advantages of breast ultrasound tomography for evaluation of the breasts, especially in those with dense breasts. 3. Describe the specific imaging appearance on ultrasound tomography of various breast entities, benign and malignant. 4. Discuss the future practice considerations and limitations of ultrasound tomography.

#### **TABLE OF CONTENTS/OUTLINE**

-This educational exhibit reviews the essentials of breast ultrasound tomography for the breast radiologist. This is a new imaging modality with enormous potential to add new value to breast imaging by improving diagnostic accuracy especially in patients with dense breasts. -We will describe in simple terms the physics of breast ultrasound tomography and the basic imaging sequences including Waveform Enhanced Reflection (Wafer), Reflection, Sound Speed, and Stiffness Fusion sequences in a breast ultrasound tomographic examination.-We will review with illustrative case examples of high-yield breast lesions including cysts, fibroadenomas, and cancers comparing the distinctive imaging appearance on ultrasound tomography versus other breast imaging modalities.-This will be followed by a discussion of the specific advantages of ultrasound tomography relative to other imaging modalities, such as improved lesion localization and lesion characterization. Finally, we will present the limitations of ultrasound tomography and general considerations for future practice.

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## Abstract Archives of the RSNA, 2023

CAEE

### Cardiac Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **CAEE-1 Is It Possible to Assess Left Atrial Remodeling Using Deep Learning? An Attempt to Classify Atrial Fibrillation Types Using Contrast-Enhanced CT Images.**

Hina Kotani (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Catheter ablation therapy is one of the curative treatments for atrial fibrillation (AF). It is generally known that the recurrence rate after treatment increases as attacks persist, and the factor is related to structural remodeling of the left atrium. However, standard evaluation is difficult, and the indication for catheter ablation therapy is currently determined by the surgeon's empirical judgment and the duration of disease obtained from the patient's self-report. Therefore, this study demonstrates the possibility of assessing remodeling of the left atrium from the results of the visualization of the classification basis of the two models. The major teaching points of this exhibit are 1. Evaluation of AF types using contrast-enhanced CT imaging is difficult only for experienced physicians 2. Deep learning enables evaluation of the left atrium using features such as the structure of the left atrium and pulmonary veins obtained from images. 3. Evaluation of structural remodeling of the left atrium may be useful for AF types

#### TABLE OF CONTENTS/OUTLINE

1. About Atrial Fibrillation -Classification of Atrial Fibrillation Types -Structural remodeling of the left atrium 2. Treatment options for Atrial Fibrillation -Relationship between seizure duration and treatment outcome 3. Results of experiments -How well did you recognize the shape of the left atrium?

#### **CAEE-10 Seeing Beyond the Surface: A Radiological Exploration of Pacemakers, CRT, and ICDs**

#### Awards

#### Cum Laude

Lucas Ortiz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the relevant cardiac anatomy, the different types of devices (pacemakers, CRT, and ICDs), and the positioning and integrity of the different elements of the devices.
- Understand the importance of X-ray imaging in the diagnosis and follow-up of patients with pacemakers, CRT, and ICDs.
- Identify the normal and abnormal X-ray findings for these devices, including lead placement, device positioning, and associated complications.
- Understand how X-ray imaging is used to evaluate the function of pacemakers, CRT, and ICDs, including pacing and electrical leads, and common X-ray findings associated with device malfunction.
- Recognize the potential limitations associated with X-ray imaging of these devices and the troubleshooting strategies for addressing those limitations.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Overview of cardiac devices (pacemakers, CRT, and ICDs) 3. Anatomy and positioning of cardiac devices 4. Importance of X-ray imaging in diagnosis and follow-up 5. Differentiating between pacemakers, CRT, and ICDs on chest radiography 6. Normal and abnormal X-ray findings for pacemakers, CRT, and ICDs a. Device type and differences b. Device positioning c. Internal elements d. Lead placement e. Lead integrity f. Associated complications 7. Troubleshooting strategies for technical limitations of X-ray 8. Take home points

#### **CAEE-11 AI-Assisted Autonomous Aortic Aneurysm Analysis - Status, Strengths, Slants, and Stresses: Ut Nos Ibi Nunc?**

Roshan Fahimi, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The exhibit will help the audience understand the following aspects of multiple AI algorithms pertaining to triage, measurement, detection, and report creation for aortic aneurysm and dissection. 1. 1. Aortic evaluation with CT: Intentional and incidental 2. 2. Scientific evidence for aortic evaluation with AI 3. 3. Multi-vendor AI for aortic evaluation 4. 4. Status, strengths, slants, and stresses of AI models

## TABLE OF CONTENTS/OUTLINE

We use our multi-vendor AI experience to organize and present the exhibit content into following brackets: 1. 1. Aortic Diseases: Incidence, importance, and imaging 2. 2. AI for aortic aneurysm and dissection: Evidence in literature 3. 3. Approach of multiple AI algorithms in aortic aneurysm and dissection 4. 4. Screening and AI-based new metrics for aorta 5. 5. Status, weaknesses, and stresses of AI algorithms 6. 6. Autonomy for AI-assisted analysis: Should we be there now?

## CAEE-12 **Boost Your Imaging Skills and Help Your Interventional Cardiologists Before and After Left Atrial Appendage Occlusion**

Syedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Familiarize radiologists with available LAAO devices and their clinical applications. Review the required pre-procedural measurements for LAAO. Educate radiologists with post LAAO complications and ideal imaging techniques for their detection. Review spectrum of normal post procedural findings that should be differentiated from complications.

## TABLE OF CONTENTS/OUTLINE

1. Review the different LAAO devices (Watchman, Watchman FLX, Amulet, and Lariat), their unique features, and patient selection criteria. 2. Recognize the importance of preprocedural Image based planning in guiding device selection and placement. 3. Pictorial review of LAAO complications A) peri-device leak B) off-axis placement, and C) device-related thrombosis. 4. Review of the clinical importance of post procedural complications with focus on the role of imaging. 5. Review of the management of device-related complications with emphasis on the role of imaging. 6. Comparison between CT and other imaging modalities (Echocardiography and MRI) for LAAO planning and surveillance.

## CAEE-13 **Fibromuscular Dysplasia: a Multifaceted Vascular Disease**

Frances D. Ferreira De Deus, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Provide an overview of the pathophysiology and clinical manifestations of fibromuscular dysplasia (FMD). less prevalent, but more commonly underdiagnosed as related to this pathology.- To describe the role of imaging in the diagnosis and prevention of complications.

## TABLE OF CONTENTS/OUTLINE

Fibromuscular dysplasia (FMD) is a non-inflammatory, non-atherosclerotic, idiopathic arterial disease that primarily affects Caucasian women and medium-sized vessels. The classic finding is the beaded appearance and tortuosity of the affected vessel. However, FMD also predisposes to aneurysm formation, dissection, and stenosis, which are not always suspected to be related to FMD by the imaging community. We describe and illustrate with schematic figures and cases the main sites of vessel involvement, the variable radiological findings and the complications related to the disease. The most affected sites are the renal and cerebrovascular arteries, although the aorta and other arteries may also be involved. FMD can predispose to important complications, such as stroke, myocardial or renal infarction, aneurysm rupture and progressive dissection. FMD is often a subclinical and underdiagnosed arteriopathy with catastrophic complications. The radiological community should be familiar with the different phenotypic appearances. Invasive angiography and non-invasive vascular imaging by CT and MRI play an important role in the diagnosis and prevention of complications.

## CAEE-16 **Calcium in the Heart: A Guide to Interpret Like an Expert**

Syedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1- Reviewing various calcified cardiac lesions, including calcification of the pericardium, vascular structures, myocardium, valves, and valve annuli. 2- Reviewing the morphology, location, and extent of calcification, which are often pathognomonic features that aid in identifying each type of calcified lesion as well as conditions associated with them. 3- Exploring the clinical significance of various calcified lesions and outlining a structured clinical approach for their management. 4- Discussing differential diagnosis of cardiac calcification and evaluation of their etiologies



## TABLE OF CONTENTS/OUTLINE

1- Introduction to a systematic evaluation of calcified cardiac lesions  
2- Identifying:  
A) Pathognomonic features of pericardial calcifications and considering their underlying causes  
B) Pathognomonic features of valvular and annular calcifications based on underlying causes  
C) Myocardial calcifications associated with tumors (such as endothelioma and rhabdomyoma), trauma, or infarction.  
D) Papillary muscle calcification.  
E) Left atrial calcifications related to atrial fibrillation, congestive heart failure, and endocarditis.  
F) Intracavitary calcifications in the atria and ventricles.

### CAEE-17 Medical Terminology in Cardiothoracic Radiology

Evgenia Efthymiou, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Medical terminology includes words and phrases aiming to accurately describe anatomical structures, processes, conditions, medical procedures, and treatments. In cardiothoracic radiology, there is a plethora of words originating from Greek and they may be misused and misspelled in everyday practice. To aid colleagues in fluent and effective use of these terms, we have derived a radiologically illustrated glossary of the most frequent terms, their definitions and explanations of their origin and meaning. Typically, medical terms stemming from Greek adhere to a fixed structure of a prefix, a root, and a suffix. The prefix appears at the beginning of a medical term and usually indicates a location, direction, type, quality, or quantity. The root gives a term its essential meaning whereas the suffix appears at the end of a term and may indicate a specialty, test, procedure, function, disorder, or status.

## TABLE OF CONTENTS/OUTLINE

In a comprehensive and schematic way, words are presented alphabetically divided in two sections: anatomy and pathology and illustrated with representative radiology images, relevant findings and key imaging references. For each word the correct orthography is demonstrated along with a brief review of its history and etymology.

### CAEE-18 The One Ring to Rule Them Out: Deciphering Differential Diagnosis of Left Ventricular Ring-Like Late Gadolinium Enhancement

Andre Vaz (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Despite being initially described as a diagnostic marker for arrhythmogenic cardiomyopathy (ACM), ring-like LGE has been increasingly reported in non-genetic heart disease  
Ring-like LGE secondary to ACM may be accompanied by inverted T-waves in left precordial leads, ventricular arrhythmia with left bundle branch block morphology, and family history of premature sudden death  
Ring-like LGE secondary to Chagas disease may be accompanied by residency in south america, positive serology, right bundle branch block and left anterior fascicular block, and apical aneurysm  
Ring-like LGE secondary to viral myocarditis may be accompanied by prodromal manifestations (e.g fever, flu-like symptoms and diarrhea), and myocardial edema  
Ring-like LGE secondary to Keshan disease may be accompanied by residency in China, disabsortive syndrome, and selenium deficiency  
Ring-like LGE secondary to sarcoidosis may be accompanied by extracardiac findings, right bundle branch block, 2nd- and 3rd-degree heart block, and right ventricular free wall LGE

## TABLE OF CONTENTS/OUTLINE

Introduction: definition of left ventricular ring-like LGE, clinical significance, and objectives  
Differential diagnosis between genetic causes: left-dominant CMADifferential diagnosis between endemic causes: Chagas disease, and Keshan disease  
Differential diagnosis between inflammatory causes: viral myocarditis, sarcoidosis, and heart transplant rejection  
Differential diagnosis between causes of non-ring-like circumferential LGE: myocardial infarction, amyloidosis, and dystrophin cardiomyopathies  
Discussion: table with distinctive features of ring-like LGE differential diagnosis

### CAEE-19 Understanding Transesophageal Echocardiography: A Radiologist's Guide

#### Awards

#### Certificate of Merit

Zaid H. Khan, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

TEACHING POINTS  
1. To understand the complimentary role of transesophageal echocardiography in multi-modality cardiac imaging including indications, contra-indications and potential complications.  
2. To have an understanding of the standard trans-esophageal examination  
3. Using cross modality reference be able to identify specific pathologies on TEE, CT and MRI.

## TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS/OUTLINE  
1. Introduction: Overview of the role of TEE in multimodality cardiac imaging including indications, contraindications, and complications.  
2. The standard transesophageal examination with cross modality reference

with CT and MRI3. Specific roles of TEE in acute aortic syndromes, cardiac source of emboli, infective endocarditis and valvular assessment. Pathological appearances on TEE with cross modality reference.4. Summary.

## **CAEE-2 Role of Cardiac MRI in the Follow Up of Postoperative Congenital Heart Disease**

Harold Goerne, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To review congenital heart diseases that require imaging follow up after surgical or endovascular repair. To discuss the role of cardiac MRI in the evaluation of postoperative findings in CHD repair. To demonstrate the importance of follow up imaging for detection of postoperative complications.

### **TABLE OF CONTENTS/OUTLINE**

1) Introduction 2) Congenital heart diseases - Clinical features; embryology; pathophysiology; treatment 3) Advantages and disadvantages of imaging modalities- Echo, CT, MRI. 4) MRI 5) Discussion, illustration with case examples of postoperative findings in repaired congenital heart diseases a) TOF: 1) Total repair (Pulmonary valve regurgitation, RV dilatation, RVOT wall fibrosis/aneurysms) b) TGA: 1) Jatene / Atrial switch (stenosis, thrombosis) 2) Banding (stenosis) c) DORV 1) Jatene (coronary ostia stenosis, PA stenosis) 2) MBT 3) Rastelli (leaking, regurgitation) 6) Discussion, illustration with case examples of postoperative complications in the repair of congenital heart diseases. I. Pulmonary valve insufficiency II. Aneurysmal dilatation of patch III. Myocardial dysfunction (Structural alterations, hypertrophy and remodeling) IV. Right ventricular dysfunction

## **CAEE-20 Multimodality Imaging of the Pericardium**

Nilo Fernandes Leca Junior, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To discuss the strengths and limitations of different imaging techniques in the exploration of the pericardium. To highlight the radiological aspects of the normal pericardium and the spectrum of pathological entities such as developmental anomalies, inflammation/infection, effusion, neoplasms, iatrogenic conditions and pericardial constriction.

### **TABLE OF CONTENTS/OUTLINE**

Pericardial diseases are conditions that involve the membrane that surrounds the heart. Imaging plays a pivotal role in the assessment, which is performed by multiple non-invasive methods such as x-ray, echocardiography, CT and MRI. Echo remains as the first modality in most clinical scenarios. The most common conditions involving the pericardium are inflammation, effusions and constriction. Pericarditis is classified by symptom duration and by etiology (infection, idiopathic, neoplastic, drug related, iatrogenic and autoimmune). Pericardial constriction is a rare complication. Pericardial effusion is related to varying degrees of abnormal fluid accumulation into the pericardial space, and can evolve to tamponade. Primary and secondary masses are commonly accessed by CT and MRI. Secondary involvement is far more common than primary pericardial tumors. Congenital anomalies are relatively uncommon entities and may range from pericardial cysts to partial or total agenesis. Cardiovascular imaging plays an important role on the management of pericardial pathologies, which should be promptly recognized to help guide timely treatment.

## **CAEE-21 Utility of CT Coronary Angiography in Septal Vascular Mapping Prior to Alcohol Ablation in Hypertrophic Obstructive Cardiomyopathy**

Anjuna Reghunath, MD, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Alcohol septal ablation (ASA), an established treatment in hypertrophic obstructive cardiomyopathy (HOCM), iatrogenically induces an infarct of the target basal septum- the site of contact of mitral valve leaflet on the septum during systolic anterior motion (SAM). 2. Invasive angiography provides information about the course and size of coronary arteries but not their territorial distribution. Inaccurate infarct localisation due to alcohol injection into right ventricular side of septum and inability to identify the target vessel on invasive angiography leads to failure of ASA. 3. Computed tomography (CT) angiography has the dual benefit of detailing vascular anatomy and providing information on myocardial distribution. Mapping the septal vascular anatomy with CT coronary angiography prior to ASA improves localisation of infarct with predictable outcome and procedural success at the first attempt compared to traditional methods. The authors describe a new 5-step method of creating a CT navigational map for planning selective sub-branch micro-catheterisation.

### **TABLE OF CONTENTS/OUTLINE**

1. Mechanism and principle of ASA. 2. CT angiography protocol and 5-step mapping technique of the target basal septal vasculature. 3. Checklist of CT reporting points including the distance and angulation of the septal arteries. 4. Illustration of variant CT septal vascular anatomy. 5. Causes and demonstration of failed procedures in pre-CT traditional ASA. 6. Clinical utility of CT-guided ASA in terms of symptomatic, functional and haemodynamic improvement.

## CAEE-22 Gray Blood and Applications

### Awards

#### Certificate of Merit

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibition is: ? Review the concept and indications of the gray blood myocardial delayed enhancement (MDE) technique? Highlight the ease of execution and applicability of the method? Understand the benefits of applying gray blood in the investigation of myocardial fibrosis? Identify the radiological findings that will help in the diagnosis as well as pitfalls of this technique

#### TABLE OF CONTENTS/OUTLINE

Gray blood is a sequence in cardiac magnetic resonance imaging (CMR) obtained by partial blood signal suppression that increases the ability to identify and localize myocardial scarring near the cavity. A pictorial essay based on cases from our collection allows for a comprehensive assessment and understanding: ? Grayblood MDE technique with a tutorial video? Main indications of grayblood MDE images? Grayblood MDE radiological findings in cases of subendocardial enhancement and papillary muscles? Grayblood MDE radiological findings in cases of post-cardiac transplantation, cardiac tumor, myocarditis and hypertrophic cardiomyopathy? Cases in which grayblood MDE did not help in the diagnosis

## CAEE-23 Imaging of the Ductus Arteriosus

Kaustav Bera, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. 1. To know the embryology, physiology and modalities for evaluation of the ductus arteriosus 2. 2. To learn about the pathologies of the ductus going beyond patent ductus arteriosus 3. To review the clinical and imaging findings of the above-mentioned entities with case examples

#### TABLE OF CONTENTS/OUTLINE

1. Embryologic development of ductus arteriosus 2. Physiological significance of ductus arteriosus 3. Modalities for evaluation of pathologies of ductus arteriosus : USG, CT, MR, Invasive angiogram 4. Pathologies of Ductus: - Normal variants - Congenital/developmental o PDA § Risk factors and pathophysiology § Classification § Causes § Maintaining patency post birth for some Congenital Heart diseases § Closure of PDA o Aneurysm of DA o Congenital vascular ring o Significance in Coarctation of aorta ( Preductal versus post ductal) - Post traumatic o Mechanism of and incidence of ductal injury o Minimal aortic injury (MAI) o Ductal Pseudoaneurysm o Penetrating ulcer o Aortic dissection - Miscellaneous o Infective aortitis associated with the nonpatent remnant of a ductus arteriosus o Atherosclerotic penetrating ulcer/ pseudoaneurysm of aortic ductus. 5. Differential diagnosis/mimics: - Aortic spindle mimicking aortic ductus pseudoaneurysm/MAI - Type III ductal diverticulum mimicking Aortic ductus pseudoaneurysm - Infundibula of the aortic branch vessels mimicking Aortic ductus pseudoaneurysm - Technical mimics of MAI :Breathing, arterial pulsation and other motion artefacts, streaming/streaking of contrast mimic minimal aortic injuries) - Anatomical mimics of MAI : Noncalcified and partially calcified atheroma

## CAEE-24 The Space Between: A Roadmap to Cardiac Recesses & Grooves

Katherine A. Cheng, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The recesses, grooves, and potential spaces around the heart are defined by the vasculature and supporting fibrous structures; these areas can easily be overlooked by the radiologist. Changes in configuration and appearance of these spaces can occur with pathological processes and can be more readily identified using a standard search pattern. A structured search pattern using a vascular and fibro-skeletal based review can help the radiologist identify and differentiate pathology from normal spaces and structures.

#### TABLE OF CONTENTS/OUTLINE

1. Review the normal anatomy of the heart including the recesses and grooves as well as the supporting vascular and fibro-skeleton of the heart.2. Illustrate the common pathology that can occur in these spaces including thrombus, tumor, abscesses, and pseudoaneurysm.3. Highlight the importance of variant and abnormal processes in these spaces and the impact on medical and surgical management.

## CAEE-25 The Role of Imaging in Cardio-Oncology: Detecting, Preventing, and Managing Cardiovascular Disease in Cancer Patients and Survivors

Osamu Manabe, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Cardio-oncology is a new specialty that focuses on detecting, preventing, treating, and following up on cardiovascular disease (CVD) in cancer patients and survivors. Cancer and CVD share many risk factors, such as aging, smoking, diabetes mellitus, and genetic predisposition. Furthermore, some cancer treatments have negative effects on the cardiovascular system, leading to an increased burden of cardiac complications in survivors. Cardio-oncology aims to minimize cardiovascular complications in patients with cancer and requires close collaboration between oncologists, cardiologists, and radiologists. In this presentation, we will discuss the usefulness of various imaging modalities in the field of cardio-oncology, taking into account the latest technology available.

## TABLE OF CONTENTS/OUTLINE

Cardio-oncology is a new multidisciplinary field to institute appropriate surveillance, treatment, and follow-up strategies for CVD in patients with cancer (Fig.1). Imaging modalities such as MRI (Fig.2), CT (Fig.3), and nuclear medicine including PET (Fig.4) play a crucial role in diagnosing and monitoring CVD in cancer patients. These non-invasive methods can be used to assess cardiac function, tissue characteristics, metabolic activity, and also tumor size and extent. Using novel imaging technologies is essential for early detection, treatment, risk stratification, and survivorship in cardio-oncology (Fig 5).

### CAEE-26 Whole-body Assessment of Vasculitis and Its Complications Using CT, FDG-PET, and MRI

Noriko Oyama-Manabe, MD, PhD (*Presenter*) Grant, DAIICHI SANKYO Group; Grant, Bayer AG; Grant, Eisai Co, Ltd; Grant, Canon Medical Systems Corporation

## TEACHING POINTS

1. Overview of the etiology, pathophysiology, clinical presentation, diagnostic criteria, and therapeutic approaches for primary and secondary vasculitis 2. To compare image characteristics of specific vasculitis and its complications with CT, MRI and FDG-PET/CT 3. To describe the role of multimodality imaging in the quantitative evaluation of inflammation for the initial diagnosis and during follow-up after treatment

## TABLE OF CONTENTS/OUTLINE

Vasculitis manifests in various clinical presentations, morphologies, and prognoses, requiring a multimodal imaging approach. Radiologists can aid in the accurate diagnosis of vasculitis and its complications, treatment planning, and patient care with multimodality imaging. In this presentation, we will cover both primary and secondary vasculitis, which can be caused by various factors, including infections and drug-induced reactions. Knowledge of systemic clinical manifestations in affected patients may help establish a specific diagnosis. 1. To review the clinical features and imaging findings of the different types of vasculitis including those that primarily involve large, medium-sized, or small vessels. 2. Tips for scanning with adequate timing and reconstruction for various complications due to infectious vasculitis including secondary to TEVAR and EVAR. 3. To describe the role of these imaging modalities in the quantitative evaluation of inflammation for the initial diagnosis and during follow-up after treatment, with an emphasis on monitoring therapeutic response using quantitative parameters.

### CAEE-27 Unveiling Cardiac Intracavitary 4D flow MRI

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Reliable analysis of intracardiac flow provides important insight for the interpretation and management of cardiovascular diseases. Recently, non-invasive evaluation of intracardiac hemodynamics by 4D flow CMR constitute a reliable, robust, and reproducible method for the analysis of flow patterns in valvular diseases, cardiomyopathies, or congenital heart diseases (CHD). Furthermore, in virtue of its multidimensional/multidirectional capabilities it allows to calculate common (flow, velocities, and volumes) and advanced (kinetic energy and turbulent kinetic energy, vortical flow imaging and particle tracing) intracardiac chamber flow hemodynamic parameters. Recently, some of them have been shown to have important prognostic implications. Teaching points 1. To describe the physical basis of 4D flow, the main acquisition process, optimization techniques and advanced post-processing methods 2. To analyze the current and potential clinical applications of intracavitary 4D flow in cardiac imaging.

## TABLE OF CONTENTS/OUTLINE

1. 4D flow physical basis 2. 4D flow acquisition technique and protocol 3. Conventional intracavitary flow analysis 4. Advanced intracavitary 4D flow analysis - Kinetic Energy and Turbulent Kinetic Energy - Viscous energy loss - Vortical Flow Imaging - Particle tracing 5. Current and potential clinical applications intracavitary 4D flow - Dilated cardiomyopathy - Ischemic heart disease - Atrial fibrillation and heart failure - Valvular heart disease - Hypertrophic cardiomyopathy - Congenital heart diseases 6. Intracavitary 4D flow prognostic biomarkers: Ready to primetime? 7. Take home points

### CAEE-28 CT Imaging in Ischemic Heart Disease and Complications

Takashi Norikane, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Cardiac imaging plays a pivotal role in the diagnosis of ischemic heart disease. Echocardiogram, coronary angiography, nuclear medicine imaging and magnetic resonance imaging are common imaging modalities. However, conventional CT can provide important information about ischemic heart disease and complications. This presentation introduces the basic approaches of CT in ischemic heart disease and complications and follows with an overview of normal heart and coronary anatomy and frequently encountered pathologic conditions.

## TABLE OF CONTENTS/OUTLINE

Normal anatomy Coronary artery and territories Heart chambers Pericardium Myocardial infarction Atherosclerosis, Air embolism, Coronary artery anomaly, IgG4-related disease, Aortic dissection, thromboembolism due to essential thrombocythemia, Diaphragmatic hernia (post CABG), Post aortic valve replacement Complications Myocardial rupture, ventricular septal rupture, Dressler's syndrome, Ventricular aneurysm, Calcification Myocardial persistent enhancement after percutaneous coronary intervention Differential diagnosis Myocarditis, Takotsubo-myocardiopathy

### CAEE-29 Unravelling the Mitral Valve on CT

Vidushi Gupta JR, MD, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Assessment of normal valvular morphology and basic physiology of mitral valve on MDCT2. Discuss the pearls and pitfalls relevant to planning, acquisition and interpretation of cardiac CT images3. Enumerate various structural and functional abnormalities4. Describe the role of CT in pre and post-procedural imaging in patients with TMVR (Transcatheter mitral valve replacement).

## TABLE OF CONTENTS/OUTLINE

1. Introduction2. ECG placement with proper planning and acquisition protocol3. Pearls and pitfalls4. Post processing 5. Normal mitral valvular anatomy and function6. Assessing Structural abnormalities7. Assessing Functional abnormalities8. Role of CT in pre and post procedural imaging in TMVR9. Take home message

### CAEE-3 Robotic and Minimally Invasive Mitral Valve Surgery: Radiological Assessment and Surgery Correlation

Omer Onder, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Robotic and minimally invasive mitral valve surgery is a safe and less traumatic surgical approach compared to the open cardiac surgery. Besides, it can be regarded as a widely accepted technique given the volume of publications from numerous institutions. 2. Multimodality imaging assessment conducted before to surgery are essential for selecting appropriate patients, anatomical evaluation, surgical planning, and optimal patient outcomes. 3. Radiologists can assist in patient treatment by being knowledgeable about the variety of anticipated postoperative findings and potential complications following robotic and minimally invasive mitral valve surgery.

## TABLE OF CONTENTS/OUTLINE

A. Overview of surgical techniques: Ministernotomy, minithoracotomy, robotically assisted B. Indications and contraindications C. CT angiography for pre-operative assessment 1. Scan protocol and postprocessing technique 2. Preoperative checklist 1) Aorta and iliofemoral arteries 2) Evaluation of lung, pleural plaques 3) Chest wall, diaphragm 4) Pericardium, mediastinum 5) Aorta diameter, pulmonary artery diameter, ascending aortic calcification 6) Mitral valve geometry, calcification 7) Central veins (vena cavae, coronary sinus) 8) Coronary arteries D. Procedural considerations E. Case examples F. Postoperative assessment G. Conclusion

### CAEE-30 Need for Speed: Fast MRI in Cardiac Imaging

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Cardiac MRI has become versatile technique for normal and diseased heart. However this results in complex and slow CMR examinations, raising the perception of CMR as a high-cost imaging method. Therefore, a more rationale and question-driven protocols are increasing acceptance in order to reduce the amount of acquisition time, increase patient acceptance and clinical value of this well-known game-changer imaging method. Teaching points 1. To describe the current technical advances, drawbacks, tips and tricks available for providing fast MRI protocols in clinical practice. 2. To detail the different proposals described in the literature for optimizing CMR protocols (fast MRI) in a "question - driven" scenario and with a "building - blocks" strategy.

## TABLE OF CONTENTS/OUTLINE

1. Fast MRI concept and rationale 2. Conventional CMR protocoling problems: Knowing what I need to fix. 3. Fast MRI strategies in cardiac imaging • 3.1. Cine SSFP o Free - breathing EKG gated cine SSFP o Post-contrast cine SSFP o Sparse acquisition cine SSFP o Deep Learning (DL) cine SSFP o 3D cine SSFP • 3.2 Tissue characterization/parametric mapping o Single-Shot black blood imaging o DL acquisition and reconstruction o 3D single parameter mapping o Accelerated T1 T2 mapping • 3.3. 4D flow imaging o 4D flow EPI o Accelerated 4D flow • 3.4. MR angiography o Compressed sensing o Other strategies o Non - contrast MRA • 3.5. Late Gadolinium Enhancement o Free breathing single-shot LGE o Breathold 3D LGE o 3D PSIR LGE o DL LGE 5. Fast CMR protocols in the clinical practice: The “building - blocks” strategy - Ischemic heart disease - Non-ischemic heart disease - Valvular heart disease - Arrhythmogenic cardiomyopathy - Congenital heart disease 6. Take home points

### CAEE-31 Pulmonary Vein Anomalies Made Easy

Juliana S. Da Silveira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To overview the embryology and normal anatomy of the pulmonary veins. To discuss the spectrum of anomalous pulmonary venous connections (APVCs). To describe and illustrate with schematic figures and cases the types of APVCs. To discuss the importance of the diagnosis to allow timely treatment and a better prognosis.

## TABLE OF CONTENTS/OUTLINE

The normal PV anatomy consists of four PVs, which drain oxygenated blood from the lungs to the left atrium (LA). The LA and PVs initially develop separately, and get progressively connected during fetal development. If there is failure in any step of this embryonic process, APVCs will happen. Anomalous pulmonary venous connections are a group of abnormal drainage of one or more PVs outside of the LA and can be classified either as partial or total, depending on the number of the veins involved. We describe and illustrate with schematic figures and cases the types of anomalous pulmonary venous connections, whether partial or total, common or rare, depending on the site of pulmonary vein drainage, the number of veins involved, and the presence or absence of vein obstruction. Common and rare anatomical variations will also be demonstrated. The clinical syndromes related to abnormal pulmonary venous returns will be discussed, ranging from dramatic neonatal emergency to subclinical presentation and late development of pulmonary hypertension.

### CAEE-32 The Changing Face of Myocarditis

Matthew R. McCann, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

COVID-19 ushered in a dramatic rise in public awareness of myocarditis and related complications. Mirroring this, an unprecedented utilization of imaging for assessment of cardiac events followed. Utilization of imaging for vaccine-related cardiotoxicity has similarly risen. Synchronously, other previously unrecognized causes of myocarditis are now increasingly encountered, including drug-related cardiotoxicity, as seen with new oncologic agents. Clinical history, lab assessment, and imaging remain central to establishing a diagnosis of myocarditis. Cardiac MRI plays an integral role in diagnosis, stratification, and monitoring of recovery from this changing face of myocarditis. Recognition of the evolving etiologies, imaging techniques and revised diagnostic criteria are paramount for appropriate diagnosis.

## TABLE OF CONTENTS/OUTLINE

This exhibit outlines the timeline of awareness, specific entities and imaging features which comprise the “changing face of myocarditis” including cardiotoxicity related to COVID-19, COVID-19 vaccination, drug reactions including immune checkpoint inhibitors, and cardiotoxicity related to environmental contaminants and other exposures. Cardiac MR plays a key role in diagnosis, stratification, and monitoring of cardiotoxicity in these entities. The specific imaging features and diagnostic considerations are outlined and described in order that the radiologist gains a better understanding of this evolving diagnosis, allowing for appropriate utilization of imaging and improved diagnostic accuracy of this complex disease.

### CAEE-33 New CAD-RADS 2.0: What Has Changed from CAD-RADS 1.0

Janio De Paula Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To reinforce the importance of applying the CAD-RADS classification for a better communication with the healthcare providers. To describe the differences between CAD-RADS versions 1.0 and 2.0. To demonstrate with cases how to apply the CAD-RADS 2.0 classification.

## TABLE OF CONTENTS/OUTLINE

The Coronary Artery Disease Reporting and Data System (CAD-RADS) is a standardized guide created to categorize coronary CT angiography findings and to facilitate communication between the radiological community and referring physicians. A new



CAD-RADS classification was recently published with the objective of adding anatomical and functional data, which may offer stronger prognostic value other than just describing the presence or absence of anatomical lesions. What's the same? The main categories (0,1, 2, 3, 4, 5) based on stenosis severity (0, 1-24%, 25-49%, 50-69% 70-99%, occlusion) were maintained. Complementary modifiers "G", "S" and "N" standing for the presence of Grafts, Stents, or a Non-diagnostic study were maintained. What has changed? A grading scale for calcific plaque burden was added (P1, P2, P3 and P4). For plaques with features indicating high risk of rupture, the modifier "V" was replaced to "HRP" -> high-risk plaque. An "I" modifier was added if the investigation of ischemia was performed, either by perfusion or FFR-CT. The use of CAD-RADS to report findings provides a clinically useful categorization of CAD and standardizes the way of providing results across imaging sites, which is additionally useful for research purposes.

### **CAEE-34 Multimodality Review of Common Mitral Valve Pathology and the Current Surgical Interventions**

#### **Awards**

#### **Certificate of Merit**

Alexander Phan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

As the treatments for valvular disease have evolved over the years, the assessment of cardiac valves now often requires multiple imaging modalities, including cardiac CT, cardiac MRI, and echocardiography. The aim of this exhibit is to review the normal appearance as well as common pathologies involving the mitral valve on the various modalities discussed above. Lastly, the current available treatments for mitral valve disease will be reviewed including repairs (such as annuloplasty, valvuloplasty, and mitral valve clips) and replacements (such as surgical valve replacement and transcatheter mitral valve replacement).

#### **TABLE OF CONTENTS/OUTLINE**

1. Review of the normal appearance of mitral valve on CT, MRI, and Echo. 2. Review of common mitral valve disease including mitral regurgitation, mitral stenosis, mitral prolapse, mitral annular disjunction, flail leaflet, parachute mitral valve, mitral cleft, mitral masses (fibroelastoma, vegetations, thrombus), and mitral annular calcification. 3. Review of the current treatments. Mitral valve repairs include annuloplasty, valvuloplasty, and mitral valve clips. Mitral valve replacements including surgical and more minimally invasive techniques, such as robot-assisted or transcatheter-based TMVR.

### **CAEE-35 Visualizing the Mitral: An Imager Approach to Mitral Valve Disorders**

Mohamed K. Ibrahim, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Overview on clinical burden of Mitral valve diseases (MVDs) and pertinent anatomy.
- Familiarity with the current imaging approach to MVDs.
- Understand the role of imaging in the management of MVDs.

#### **TABLE OF CONTENTS/OUTLINE**

- Mitral valve diseases burden and pertinent anatomy
  - o Mitral valve anatomy
  - o Clinical burden of MVDs
- Current imaging approach to MVDs:
  - o Role of Echo as the main modality for early detection
  - o Complementary role of CT and MR
  - o Comprehensive evaluation of MVDs (Mechanism of abnormality, Quantification, Ventricular remodeling, Vascular changes, Risk stratification, Valve morphology)
- Where does imaging fit in MVDs management?
  - o Assessing etiology, mechanism, and grading
  - o Pre-procedural planning: § Surgery vs Transcatheter intervention § Repair vs replacement
- Surgical replacement: sternotomy vs Robotic, and the role of CTA and CMR
- Transcatheter replacement: transapical vs trans-septal approaches, and the role of Echo and CT
  - § Favorable anatomical markers, predictors of challenging procedures and contraindications
  - o Intra-procedural guidance and monitoring
  - o Post-procedural Follow up; Devices (stability, leaflet motion, leaks, vegetations/thrombus), Hemodynamics, and chamber size and function)

### **CAEE-36 Left Ventricular Hypertrophy: An Approach to Differential Diagnosis**

Rafael Perez Milan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Left ventricular hypertrophy (LVH) is a common finding in cardiac magnetic resonance (CMR) with multiple diagnostic considerations.- LVH is an independent predictor of future cardiovascular events regardless of its etiology.- LVH can be defined as follows.- LV myocardial thickness more 12 mm.- Increased LV mass: Body surface area - indexed LV mass (over 95th percentile - 91 g/m<sup>2</sup> in males; 77 g/m<sup>2</sup> in females)

#### **TABLE OF CONTENTS/OUTLINE**

- To understand basic anatomy and embryology of the left ventricle.- To define left ventricular hypertrophy (LVH) and clinical implications.- To describe the differential diagnosis of LVH.- Role of cardiac magnetic resonance (CMR) in narrowing the

differential diagnosis.

### **CAEE-37 Complications of Acute Myocardial Infarction: Infrequent but Lethal**

Francisca Aliaga, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Acute Myocardial Infarction (AMI) is a frequent pathology and one of the leading causes of death in the world. Early revascularization has become a standard of care, thus reducing the high associated morbi-mortality. 2. Although infrequent, several secondary complications can occur, particularly when treatment is delayed or inadequate. 3. These are divided into mechanical, inflammatory, arrhythmic, thrombotic, and embolic. 4. CT, and especially MRI, help us to adequately assess cardiac function, ventricular volumes and structure, myocardial viability and possible associated complications.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction- General characteristics of AMI and its complications.- Complications are divided into categories, with cases to illustrate each Mechanical complications are most frequently evaluated through CT and MR. In the acute phase, the most frequent are left ventricular free wall rupture, septal ventricular defect, and papillary muscle rupture. In a chronic phase, pseudoaneurysms and ventricular aneurysms are found.- Conclusions. Complications of AMI are infrequent, but they can be potentially lethal. An accurate and early diagnosis significantly improves the prognosis. CT and MRI are the main imaging modalities used after echocardiography.

### **CAEE-38 Imaging Features and Mimics of Primary and Metastatic Pericardial Tumors**

Aparna Singh, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the role of imaging modalities in the diagnosis and management of primary and metastatic pericardial tumors and their mimics. 2. Review the imaging features of pericardial tumors and their mimics on echocardiography, CT, MRI, and PET/CT. 3. Discuss the limitations of imaging in the diagnosis and management of pericardial tumors and their mimics.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction A. Epidemiology and clinical presentation of pericardial tumors and their mimics II. Role of Imaging Modalities A. Echocardiography B. Computed Tomography (CT) C. Magnetic Resonance Imaging (MRI) D. Positron Emission Tomography/Computed Tomography (PET/CT) III. Imaging Features of Pericardial Tumors and Their Mimics A. Primary pericardial tumors B. Metastatic pericardial tumors C. Pericardial cysts D. Lipomatous hypertrophy E. Pericardial fat pad F. Hemangioma G. Thymoma IV. Limitations of Imaging in the Diagnosis and Management of Pericardial Tumors and Their Mimics V. Conclusion

### **CAEE-39 Mitral Valve Diseases 101: A Comprehensive Case-Based Review for Radiology Trainees**

Mangun Randhawa, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe the normal anatomy of the mitral valve and imaging modalities used for its evaluation 2. Discuss various pathologies of native and prosthetic mitral valves, their implications, and their differential diagnoses 3. Review role of imaging for mitral valve interventions

#### **TABLE OF CONTENTS/OUTLINE**

1. Morphologic anatomy of the mitral valve 2. Congenital mitral valve abnormalities : parachute mitral valve, parachute-like mitral valve, Shone complex 3. Mitral valve prolapse (various types) and mitral annular dysjunction 4. Mitral annular calcifications, and complications 5. Infective endocarditis 6. Mass (different histopathologies) 7. Pre-procedural and Post-procedural evaluation of mitral valve implantation including prediction of left ventricular outflow tract obstruction post transcatheter implantation.

### **CAEE-4 It's All About the Pericardium**

Felipe Aluja, MD, MEd (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Discuss the anatomy of the pericardium and the pericardial recesses with emphasis on CT and MRI. Identify selected entities affecting the pericardium, from benign to malignant, with a brief description of their clinical characteristics. Provide a deep review of the imaging findings from the conventional radiology to MRI, with emphasis in the ancillary findings that aid in the differential diagnosis approach. Describe the pitfalls and mimics of pericardial disease in conventional radiology, CT, MRI and PET/CT.



## TABLE OF CONTENTS/OUTLINE

• Introduction • Anatomy of the pericardium and pericardial recesses: from the schemes to the imaging. • The pericardium in conventional radiology, CT, MRI and PET/CT. • Conditions of the pericardium: o Air, collections, hemorrhage, and pericardial tamponade o Acute and chronic inflammation (including constrictive pericarditis) o Benign neoplasms o Malignant primary and secondary neoplasms o Congenital lesions • Try your best? Take home points

### CAEE-40 Artificial Intelligence in Cardiac MRI- Applications, Pitfalls & Challenges

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the principles of Artificial Intelligence (AI) techniques relevant to cardiac MRI(CMR); 2. To discuss how AI can be applied to the different steps of the CMR; 3. To illustrate common applications of AI in CMR

## TABLE OF CONTENTS/OUTLINE

1. AI, MACHINE LEARNING, DEEP LEARNING; 2. CHALLENGES OF CMR- complex anatomy, pathology, planes, sequences 3. AI NETWORKS- Convolutional neuronal network (CNN), general adversarial network (GAN); 4. ILLUSTRATION OF CLINICAL APPLICATIONS OF AI IN CARDIAC MRI WITH CASE EXAMPLES AND TECHNIQUES USED A. Upstream- Protocolling, workflow management/prioritization B. Image acquisition- Plane prescription; Patient positioning; Automated cardiac MRI planes; Automated selection of inversion time; B. Image reconstruction- Decreased artifacts; Decreased noise; Decreased acquisition time; Improved resolution- Super resolution ; Virtual Native Enhancement without contrast (VNE); Synthetic strain; C. Segmentation of structures- Ventricular volumes, function, mass in SSFP, Vascular anatomy in MRA; D. Automated quantification- Volumes, mass, function, LGE, parametric mapping (T1, T2, ECV), flow, strain, aortic diameter; E. Automated post-processing- perfusion, 4D flow; F. Classification of disease- Scar from non-contrast cine, Cardiomyopathies, CAD, myocardial infarction, atherosclerotic plaque, valvular disease, heart failure G. Prognostic factors- Risk stratification- Predictive models; H. Radiomics /Textural analysis I. Automated reporting J. Automated CMR pipeline 5. CHALLENGES- Small, biased training datasets, black box, quality criteria for algorithm design; 6. PITFALLS - Inaccuracies; 7. FUTURE DIRECTIONS- Good Machine learning practices.

### CAEE-41 Emerging Applications of Non-Contrast Cardiac CT: Beyond Coronary Score

Masafumi Kidoh, MD, PhD (*Presenter*) Endowed Chair, Koninklijke Philips NV

#### TEACHING POINTS

Teaching Points 1. Non-contrast cardiac CT is widely used to detect and quantify coronary and heart valve calcium. On the other hand, detection of fat, myocardial edema, thrombus/hematoma, and subtle myocardial calcification beyond coronary and heart valve calcification using non-contrast cardiac CT has not been widely performed, possibly due to poor image quality. 2. Recent advances in CT technology (such as model-based iterative reconstruction and dual-layer spectral/photon-counting CT) have drastically improved the low-contrast resolution of CT images, allowing the detection of small differences in CT values within soft tissue on non-contrast and delayed phase cardiac CT images. Side-by-side viewing of non-contrast cardiac CT images and delayed (or arterial) phase cardiac CT images may be useful in differentiating various pathologies. 3. In this exhibit, we report that non-contrast cardiac CT is useful for the detection and characterization of cardiac low-contrast lesions (soft tissue lesions) beyond coronary and heart valve calcification.

## TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline 1. Scan and reconstruction techniques for non-contrast cardiac CT - Single-energy CT - Dual-energy CT - Photon-counting CT 2. Principle of CT number in non-contrast cardiac CT 3. Clinical applications: beyond coronary score - Calcification - Thrombus/hematoma - Anemia - Water/myocardial edema - Fat 4. Future directions 5. Summary

### CAEE-42 From Cyan to Cinnabar - The Radiologist's Role in Operative Management of Single Ventricle Congenital Heart Disease

#### Awards

#### Cum Laude

Shravan Sridhar, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Single ventricle congenital heart diseases are rare and challenging to manage. While historically, outcomes have been poor, recent advancements in surgical management have improved post-operative outcomes and long-term prognosis. Imaging has also advanced from morphologic characterization to assessment of function and flow dynamics. Here, we present a framework for understanding the pathophysiology of the single ventricle state and 3-stage palliation repair, review important imaging-informed decision points along the course of operative management, and present metrics important to long-term outcome and management.

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1. Title slide, disclosures  
2. Abbreviations  
3. Table of contents  
4. Normal physiology  
5. Single ventricle physiology  
6. Norwood/DKS  
7. mBTT and RV-PA conduit  
8. Glenn procedure, mention of Kawashima  
9. Fontan procedure  
10. Operative management, main decisions  
11. Single (SVR), biventricular (BiVR), or 1.5 ventricle (1.5VR) repair?  
12. SVR Ex) AV canal  
13. CT/MRI evaluation  
14. BiVR Ex) DORV  
15. CT/MRI evaluation  
16. 1.5VR Ex) Tricuspid atresia  
17. CT/MRI evaluation  
18. 1.5VR Ex) Ebstein anomaly  
19. CT/MRI evaluation  
20. Safe for hybrid/bridge-to-Norwood?  
21. Example  
22. Hybrid procedure, relevance of HLHS, and risk factors for retrograde aortic arch obstruction  
23. CT/MRI evaluation  
24. Safe for Glenn?  
25. Example  
26. CT/MRI evaluation  
27. What features may change Fontan approach?  
28. Pre-Fontan operative planning example  
29. CT/MRI evaluation prior to Fontan  
30. Failing Fontan and BiVR or 1.5VR conversion surgery  
31. Preop. Items (e.g. LVOT widening, valvuloplasty)  
32. CT/MRI evaluation prior to conversion surgery  
33. Summary  
34. References

### CAEE-43 Myocardial Strain Analysis Using Feature Tracking

Masaya Kisohara, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Myocardial strain refers to the deformation of the walls and chambers of the heart from a relaxed to a contracted state.  
2. Feature tracking is a technique that enables the analysis of myocardial strain.  
3. Strain analysis performed in the left ventricle and the left atrium is a better prognostic indicator for heart failure than left ventricular ejection fraction.  
4. Strain analysis by feature tracking might apply to 4D-CT images.

## TABLE OF CONTENTS/OUTLINE

1. The concept of myocardial strain and its types: Myocardial strain using feature tracking is an alteration of length in one dimension or spatial orientation. Left ventricular strain is classified as radial, circumferential, and longitudinal strain. Left atrial strain is obtained as global longitudinal strain.  
2. The principle of features tracking: Template matching is a technique that follows similar templates during the process of myocardial contraction.  
3. The importance of myocardial strain for patients with heart failure.  
4. What is left atrial strain? The left atrial strain is an index that reflects the diastolic and contractile capacity of the left atrium. Similar to the left ventricular global longitudinal strain, it is helpful in predicting prognosis in heart failure with preserved left ventricular ejection fraction.  
5. An experiment using 4D-CT for myocardial strain analysis

### CAEE-44 The Role of Gadolinium Enhancement Patterns in Diagnosing Myocardial Diseases at Cardiac MR - Enhancing Residents' Knowledge

Otavio Augusto Ferreira Dalla Pria, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The abnormal myocardium can depict different patterns of gadolinium contrast enhancement depending on the cause of the injury. Therefore, assessing enhancement patterns in Cardiac MR plays a pivotal role in diagnosing diverse myocardium diseases. Ischemic cardiomyopathies produce delayed vascular-distributed gadolinium enhancement, and non-ischemic patterns are not limited to vascular territories. Patterns of enhancement distribution are crucial in differentiating between ischemic and non-ischemic heart pathologies and narrowing differential etiologic diagnostics in both. This exhibit aims: 1. To review myocardium gadolinium enhancement MR patterns. 2. To illustrate differential diagnostics based on the type of enhancement. 3. To discuss challenges and confounder factors.

## TABLE OF CONTENTS/OUTLINE

1- Introduction/Objectives: Cardiac MRI can help diagnose a plethora of myocardial dysfunction. The gadolinium enhancement pattern is one of the characteristics that can help identify differential diagnostics. In this presentation, we summarize and illustrate the 5 types of cardiac MRI enhancement patterns and correlate findings with main differential diagnostics.  
2- Case-based approach: Present 5 Patterns of Enhancement in Cardiac MRI (Subendocardial, subepicardial, transmural, patchy, mid-myocardial/mesocardial), correlating with primary differential diagnostics through didactical cases illustration in both ischemic and non-ischemic cardiomyopathies.  
3- Limitations, Conclusion, and Take-home messages.

### CAEE-45 Role of Multi-Modality Imaging in Cardio-Obstetrics

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cardio-obstetrics is an expanding subspecialty that focuses on prevention, early detection, and management of cardiovascular disease (CVD) in pregnancy. 1. To review the cardiovascular complications in pregnancy; 2. To understand disease processes exacerbated by pregnancy; 3. To discuss the role of imaging in cardiovascular complications of pregnancy and pre-conception planning; 4. To understand the concept of pregnancy heart team and risk stratification

## TABLE OF CONTENTS/OUTLINE

1. INTRODUCTION ;2.PHYSIOLOGICAL CARDIOVASCULAR CHANGES OF PREGNANCY;3. ROLE OF IMAGING IN PREGNANCY;4. IMAGING MODALITIES;5. COMPLICATIONS RELATED TO PREGNANCY (Discussion, clinical features, imaging findings and differential diagnosis with case examples)-Cardiac- Heart failure, arrhythmia, thromboembolism;Obstetrics- hypertension, Preeclampsia, hemorrhage;Perinatal-miscarriage, premature delivery, restricted growth;Venous thromboembolism including PE;Amniotic fluid embolism;Peri-partum cardiomyopathy;Spontaneous coronary artery dissection;Pulmonary hypertension;Hypertensive disorders (Eclampsia/Pre-eclampsia);Heart failure and arrhythmias;6.EXACERBATION OF PRE-EXISTING CVD DURING PREGNANCY (Illustration with case examples)-Inherited aortic diseases;Congenital heart disease;Hereditary hemorrhagic telangiectasia;Valvular disorders;7. PRECONCEPTION PLANNING- Risk stratification;8. CARDIOVASCULAR CHANGES IN ABDOMINAL DISEASES;9. ISSUES RELATED TO IMAGING IN PREGNANCY;- CT- Radiation, contrast agents- MRI- Gadolinium10. APPROPRIATENESS CRITERIA for imaging in pregnancy; 11. FLOW-CHART SHOWING systematic approach to imaging pregnant patients.

### CAEE-46 Single Ventricle: A Radiology Primer for Pre-Procedural Evaluation

#### Awards

#### Certificate of Merit

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the spectrum of lesions that result in a single ventricle 2. To discuss the surgical options in the management of single ventricle 3. To illustrate the different types of single ventricle using case examples 4. To highlight critical imaging parameters necessary for pre-procedural planning

## TABLE OF CONTENTS/OUTLINE

1. SINGLE VENTRICLE- Definition, types 2. ROLE OF MULTIMODALITY IMAGING- Echo, CT, MRI, Cardiac cath, nuclear medicine 3. CT AND MRI- Indications, protocols, tips and tricks 4. REVIEW AND ILLUSTRATION OF PHENOTYPES OF SINGLE VENTRICLE Right dominant- Hypoplastic left heart syndrome, mitral atresia, double inlet/outlet RV; Left dominant- Hypoplastic right heart syndrome, Tricuspid atresia, Double inlet LV ; Either- unbalanced AV canal (Right/left); Functional single ventricle- TOF with pulmonary atresia, truncus, TAPVR, Severe Ebsteins anomaly, Tricuspid atresia, Double inlet LV/RV, AV canal defect (balanced/unbalanced), heterotaxy 5. ANATOMICAL CHARACTERIZATION- Atrial situs, ventricular situs, great artery relationship, morphologic LV vs RV, functioning/rudimentary ventricles 6. CRITICAL PARAMETERS NECESSARY FOR SURGICAL/INTERVENTIONAL MANAGEMENT - Ventricular function- Poor prognosis if low - Atrial septal restriction - Bulboventricular foramen in DILV or tricuspid atresia with TGA - Atrioventricular valve- Obstruction or regurgitation - Outlet obstruction- Presence and nature - Vascular resistance- Pulmonary and systemic - Patency of ductus arteriosus - Patency of aortic arch - Pulmonary artery anatomy - Venous connections 7. MIMICS- Criss-cross heart; Superior/inferior ventricle

### CAEE-47 Generating Cardiac Segmentation Datasets: Automated Segmentation and Tool-Based Manual Correction

Hirohisa Oda, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Easy label generation for custom AI: Manual correction tool for cardiac segmentation

## TABLE OF CONTENTS/OUTLINE

- Application-specific custom AI for cardiac segmentation\* Our application: Modeling patient-specific therapeutic instrument- Outline\* Step 1: AI-based segmentation with a very limited number of cases for automated segmentation on other cases\* Step 2: Manual correction with our original tool- Step 1: AI-based segmentation\* Innovations from the "U-Net era"\* Trainable with limited training datasets as "seeds" of dataset generation\* Key technologies: Swin Transformer Self-supervised training [1]\* Examples of automatic segmentation- Step 2: Manual correction with our original tool\* HeartCorrect: Our original plugin for an image visualization tool MITK-Workbench\* Utilizing MITK's interpolation feature\* Automated correction for obeying the anatomical relationships of chambers- Comparison with MONAI Label[1] Hatamizadeh, Ali, et al. "Swin UNETR: Swin transformers for semantic segmentation of brain tumors in MRI images." BrainLes 2021, LNCS 12962, 2022.

### CAEE-48 Myocardial Delayed Enhancement By Spectral CT: Our Experience

Almudena Gil Boronat, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Role of Late enhancement in cardiac dual-CT2. Show the protocol we are using in our centre.3. Present CT-MRI correlation in several pathologies, mainly in myocarditis

## TABLE OF CONTENTS/OUTLINE

1. Background Quick review of the pathophysiology and usefulness of late enhancement in cardiological studies.2. Spectral CT and acquisition protocol used in our center.3. Representative cases of different diagnoses with CT-MRI correlation.4. Conclusions.5. Bibliography.

### CAEE-49 **Mitral Valve Disjunction: The Great Unknown**

Almudena Gil Boronat, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review mitral valve disjunction (MVD)2. Role of MRI in the evaluation of radiological features associated with and pitfalls.

## TABLE OF CONTENTS/OUTLINE

1. Background Revision of mitral valve disjunction • Definition • Pathology • Classification • Location 2. Representative cases of different disjunction types. 3. Representative cases of different radiological features associated with and pitfalls. 4. Conclusion. 5. Bibliography.

### CAEE-5 **All “In Vein”? Anatomy, Variations and Abnormalities of Coronary Venous System with an Emphasis on CT Findings and Clinical Importance**

#### Awards

##### Certificate of Merit

Firat Atak, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Cardiac CT can provide substantial information regarding cardiac venous anatomy and anomalies although it is mainly used for the evaluation of coronary arterial system. 2. Radiologists can more readily identify cardiac venous anomalies on CT by having a basic knowledge of the normal venous anatomy, adding venous anomalies to the standard checklist, and being aware of the conditions in which these anomalies may be clinically significant. 3. Cardiac venous system anomalies may be vital in percutaneous interventions and surgical procedures as they may fundamentally influence the course of the procedure or change the operation plan.

## TABLE OF CONTENTS/OUTLINE

A. Overview of normal cardiac venous anatomy B. Scan protocol and postprocessing C. Coronary sinus (CS) variations and anomalies with case examples D. Other cardiac vein variations with case examples E. Clinical importance of the cardiac venous system -Cardiac shunts -Cardiac resynchronization therapy -Coronary sinus pacing -Retrograde cardioplegia - Percutaneous mitral anuloplasty -Percutaneous atriotomy (Levoatrial-to-coronary sinus shunting) for heart failure - Percutaneous in situ coronary venous arterialization (PICVA) -Enlargement of CS and clinical importance of PLSVC - Radiofrequency catheter ablation - Central venous interventions F. Conclusion

### CAEE-50 **State-of-the-Art Multimodality Imaging of Cardiac Transplant and Complications: A Practical Update**

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To discuss the normal appearances of cardiac transplant 2. To optimize the CT and MRI protocols for evaluation of patients with cardiac transplant 3. To illustrate the imaging appearances of various complications following cardiac transplant

## TABLE OF CONTENTS/OUTLINE

1.Introduction 2. Indications- Heart failure, intractable angina or arrhythmia, cardiomyopathies, congenital heart disease, cardiac tumor) 3. Cardiac transplant techniques- Orthotopic vs heterotopic, bicaval vs biatrial 4. Role of imaging in evaluation of cardiac transplant 5. Imaging techniques- Echo, CT, MRI, Cardiac catheterization, Intravascular ultrasound, Optical coherence tomography, nuclear medicine 6. Cardiac transplant follow up diagnostic pathway 7. Imaging protocols for follow up= CT-No premedications, Photon counting CT; MRI- Quantitative techniques, T2, T1 mapping; 8. Complications- Review of the following complications with illustrative case examples- Post procedural graft dysfunction; Post surgical- pericardial effusion, mediastinal hematoma; Cardiac Allograft Vasculopathy (CAV) - Diffuse, more aggressive, microvasculature-angiography vs CTA; Acute cellular rejection; Chronic rejection; Accelerated coronary atherosclerosis; Infections; Post-transplant lymphoproliferative disorder; Gout; Osteoporosis; Chronic kidney disease;

### CAEE-51 **The Heart of the Matter: Pearls and Pitfalls in Cardiac CT**

Katherine Chung, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Cardiac CT imaging is a valuable diagnostic resource for physicians to evaluate cardiac anatomy and function. The indications for CT imaging include evaluation of the coronary vessels for anomalies, presence of coronary artery disease (CAD) and calcium score, pre-TAVR evaluation, pre-ablation study for atrial fibrillation, and observing the patency of grafts, amongst other reasons as well. Although radiologists regularly read these types of images, radiologists-in-training may have variable levels of exposure and can come across cases that lead to confusion. The goal of this presentation is to elucidate the essential pearls of acquiring and evaluating cardiac CT scans, so radiologists-in-training are comfortable and confident with evaluating CT scans and providing appropriate recommendations. Furthermore, we will highlight the common areas of confusion through case-based examples of common pitfalls that may occur.

### TABLE OF CONTENTS/OUTLINE

1) Introduction 2) Indications and contraindications (Efficacy in disease diagnosis) 3) Definitions and Anatomy 4) Protocols and Techniques for acquiring images 5) Pearls and Pitfalls (Pre-ablation study for atrial fibrillation, Pre-TAVR study, Calcium Score, Coronary Artery Disease, Thoracic aortic aneurysm) 6) Artifacts (Stair Step artifact, Streak artifact from CABG or TAVR patients, Motion) 7) Conclusion

### CAEE-52 From Pumps to Waves: Understanding the Impact of Mechanical Circulatory Assist Devices on Spectral Doppler Ultrasound Analysis

Mateus K. Soares (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Heart failure (HF) is a syndrome resulting from impaired ventricular filling or ejection. Many patients with HF progress to a refractory state, regardless of advanced therapies. Cardiac transplantation remains the definitive treatment for end-stage disease. Mechanical circulatory assist devices (CAD) help support patients with cardiogenic shock or end-stage HF. It may be used as a short-term device to support hemodynamically unstable patients, including those with the possibility of heart function recovery, or as long-term device usually as a bridge to transplantation. CAD are mechanical pumps that help an impaired ventricle maintain hemodynamics and preserve satisfactory end-organ blood flow. There are commercially available devices to support both the left and right ventricle. In most cases, the spectral Doppler waveform is altered in the setting of a CAD, reflecting systemic hemodynamic changes. Despite the increasing use of these devices, there is not much information in the radiological literature about spectral Doppler changes in these patients. Accurate diagnosis requires a better understanding of CAD mechanisms and associated Doppler ultrasound findings, as well as possible vascular complications.

### TABLE OF CONTENTS/OUTLINE

Review the normal arterial Doppler waveforms in patients with preserved cardiac function. Describe the mechanisms of various CAD and their hemodynamic impacts on arterial spectral Doppler waveforms. Discuss the main vascular-related complications and the use of ultrasound in diagnosis.

### CAEE-53 Blood-Flow Volume Quantification Using Phase-contrast MRI in Congenital Heart Disease: Pre- and Post-surgical Evaluation

#### Awards

#### Certificate of Merit

Nobuko Tanitame, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Phase-contrast (PC) MRI can be used to measure blood flow in patients with congenital heart disease (CHD). Although Doppler echocardiography can provide shunt flow velocities in patients with common CHD such as atrial or ventricular septal defects, it may be limited by natural or surgical variations. On the other hand, PC MRI can provide precise blood flow analysis non-invasively for patients with complex CHDs and post-surgical anatomy. We demonstrate the principles and potential pitfalls of blood flow volume quantification using PC MRI and present some cases such as a coronary fistula, anomalous origin of one pulmonary artery from the aorta, and a patient who underwent a Blalock-Taussig shunt operation.

### TABLE OF CONTENTS/OUTLINE

1. Principles of PC flow volume measurement - A review of PC MRI technique, semi-automatically flow volume measurements 2. Pitfalls of PC flow volume measurement - Velocity encoding (VENC) selection considering aliasing and low phase shift value, spatial and temporal resolution, image plane setting, respiratory motion artifact, validation strategies 3. Blood flow volumes commonly measured in our hospital - Ascending aorta, main/right/left pulmonary artery, superior/inferior vena cava, the cross-section of mitral/tricuspid valve, right/left pulmonary vein 4. Representative cases - Right coronary artery to left ventricular fistula, right pulmonary artery from the descending aorta, post-surgical patients (modified Blalock-Taussig shunt, Glenn procedure, cardiac plug implantation, balloon angioplasty etc.)

CAEE-54 Takayoshi Yamaguchi (*Presenter*) Nothing to Disclose

## **A Novel Coronary CT Imaging Technique that Further Improves the Spatial Resolution of Super Resolution Deep Learning Reconstruction**

### **TEACHING POINTS**

1. Review the current status in coronary CT image evaluation and summarize its limitations 2. Summarize the relationship between spatial resolution and image noise in the current various CT image reconstruction methods 3. Explain the features of the new super resolution deep learning reconstruction (SR-DLR) algorithm trained using the data acquired by the super resolution CT system 4. Proposal of a new imaging method that further improves the spatial resolution of the SR-DLR algorithm and improves the visualization capabilities of coronary arteries, stent lumens, and calcified lesions 5. Comparison of image quality and exposure dose between conventional and new imaging methods

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Summarize the limitations of assessment of STENT lumens and calcified lesions using current CT imaging 3. Explains the features and usefulness of the new super resolution deep learning reconstruction (SR-DLR) algorithm trained using data acquired by a super-resolution CT system 4. Limitations of coronary CT imaging under normal scanning conditions using the SR-DLR algorithm 5. Proposal of a new imaging method that further improves the spatial resolution of the SR-DLR algorithm 6. Description of focal spot sizes used in coronary CT for super-resolution and conventional CT systems 7. Presenting the spatial resolution and image noise of small-focus imaging combined with the SR-DLR in conventional CT systems 8. Comparison of images with different focal spot size for stents and calcified lesions in the same cases, presenting the usefulness of small-focus imaging 9. Comparison of exposure dose in imaging at each focal spot size

## **CAEE-55 Cardiac CT Pearls and Pitfalls: What You Should Know About Anatomy to Avoid Catastrophes**

Amalia Aranaz Murillo, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Understanding the different visual axes in cardiac imaging is crucial for interpreting cardiac anatomy. 2. Familiarity with the characteristics and structures of the atriums and ventricles is essential for accurate diagnosis and assessment of cardiac function. 3. Knowledge of main coronary arteries and their pathways and bifurcations is vital for accurate assessment of coronary artery disease. 4. Understanding the anatomy and branches of the coronary and pulmonary veins is essential for evaluating cardiac function and assessing for potential blockages.

### **TABLE OF CONTENTS/OUTLINE**

We sometimes read a poster or a review and feel quite deceived because what you expect to learn you already know. For that reason, this poster will have at the beginning a QA. If you know all the answers, please, do not waste time on it, if not, it might teach you some anatomy tricks. It will be divided into seven blocks that detail the anatomy and structures of the heart in CT. The first block describes the different visualization axes of the heart and evaluates structures such as the anterior and inferior wall of the myocardium, the left atrial appendage, and the coronary sinus. The second block focuses on the characteristics of the right atrium and its different structures. The third describes the components of the ventricles and their structure. The fourth focuses on the major arteries of the heart, including the aorta and pulmonary artery. The fifth block details the four main coronary arteries and their paths and bifurcations. In the sixth, the coronary veins and their tributaries are explained, and finally, the anatomy of the pulmonary veins and their variability in the number and arrangement of drainage orifices to the left atrium is described.

## **CAEE-56 Complications After Cardiac and Ascending Aorta Surgery**

Maria Guerrero Martin (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To understand and distinguish the different types of ascending aorta surgeries 2. To evaluate the pathological findings after cardiovascular surgery, in order to differentiate them from the usual ones 3. To discern the most typical complications in relation to their chronological onset and their follow-up 4. To show the possible options in the management of patients with these complications 5. To emphasize the role of CT in the diagnosis of these conditions

### **TABLE OF CONTENTS/OUTLINE**

1. Background and methods 2. Findings 2.1. Techniques used to evaluate postoperative patients 2.2. Common findings after cardiovascular surgery 2.3. Complication following aortic surgery 2.3.1. Early complications: periprosthetic haematomas, pseudoaneurysm formation, distal malperfusion 2.3.2. Late complications: aortic valve regurgitation, infection, anastomotic stenosis 2.4. Complications following cardiac valve surgery: valvular/paravalvular regurgitation, endocarditis, hypoattenuating leaflet thickening, prosthesis-patient mismatch 2.5. Complications following coronary artery procedures: stenosis, thrombosis 3. Our experience 4. Conclusion

## **CAEE-57 Cardiac MRI in Adult Orthotopic Heart Transplant**

Sandra Quinn (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1. Outline unique CMR tissue characteristics of the transplanted heart 2. Discuss tissue characteristics suggestive of acute cardiac allograft rejection in the transplanted heart 3. Outline the role of quantitative myocardial stress perfusion in detection of epicardial and microvascular cardiac allograft vasculopathy 4. Provide an overview of the published data with respect to CMR and adult heart transplant

## TABLE OF CONTENTS/OUTLINE

1. Cardiac MRI in Orthotopic Heart Transplant· Overview of structural and functional CMR and its role in major complications of heart transplant, i.e., acute cardiac allograft rejection and cardiac allograft vasculopathy.2. CMR Tissue Characterization in Orthotopic Heart Transplant· Describes the general considerations and overview of published values regarding CMR myocardial tissue characterization of the transplant heart.3. Acute Cardiac Allograft Rejection (ACAR)· Outline the published CMR myocardial tissue characterization values for patients with active ACAR and ACAR previous history.4. Cardiac Allograft Vasculopathy (CAV)· Illustrate with a representative clinical case the role of CMR quantitative perfusion in the identification of CAV· Describe expected resting and stress myocardial blood flow and myocardial perfusion reserve in heart transplant recipients vs healthy volunteers· Identify the role of myocardial perfusion reserve for identification of CAV· 5. The Key Evidence in Summary· Summary table outlining the published evidence for CMR in heart transplant and complications of heart transplant.

## CAEE-58 Pre and Postoperative CT Evaluation for Robotic and Minimally Invasive Coronary Artery Bypass

Omer Onder, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Teaching points: 1. Robotic and minimally invasive coronary artery bypass is a safe and less traumatic surgical technique than open-heart surgery. It is considered the first-choice therapy for selected patients although the adoption has been slow in some institutions. 2. Imaging assessment prior to the surgery and providing relevant information to the surgeons is crucial for identifying suitable patients, anatomic assessment, surgical planning, and predicting outcomes. 3. Being familiar with the spectrum of expected postsurgical findings and complications following robotic and minimally invasive coronary artery bypass surgery is essential for radiologists to contribute to proper patient management.

## TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline: A. Overview of surgical techniques: TECAB, MIDCAB, robotic assisted B. Indications and contraindications C. CT angiography for preoperative evaluation 1. Scan protocol and postprocessing techniques 2. Preoperative checklists 1) Aorta and iliofemoral arteries 2) Evaluation of lung, pleural plaques 3) Chest wall, diaphragm 4) Heart, pericardium, mediastinum 5) Aorta diameter, pulmonary artery diameter, ascending aortic calcification 6) Internal mammary arteries 7) LAD and other coronary arteries D. Procedural considerations E. Postoperative CCTA assessment, complications F. Conclusion

## CAEE-59 Navigating the Vortex: Advancements in Turbulent Flow Detection Using Cardiovascular 4D Flow MRI

Tetsuro Sekine, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

4D flow MRI has revolutionized the assessment of in vivo flow dynamics, leading to a better understanding of physiological flow in healthy subjects and those with thoracic aortic aneurysms, chronic aortic dissection complications, and aortic prostheses. A key finding related to altered blood flow is turbulence, which can be visually detected through vortices in 4D flow MRI. However, visual assessment is subjective, prompting the need for quantitative evaluations. Recent advancements have facilitated the quantification of turbulent parameters such as vorticity, energy loss, and turbulent kinetic energy using 4D flow MRI. This presentation will explore clinical evaluation methods for these turbulence indices while discussing specific diseases as examples.

## TABLE OF CONTENTS/OUTLINE

1. The background of flow analysis a. Clinical demands for flow analysis b. 4D Flow MRI technique for flow analysis c. Primary and secondary flow in a healthy aorta d. Quantification of turbulence - vorticity, energy loss, and turbulent kinetic energy2. Thoracic aneurysm a. Helical flows in patients with bicuspid aortic valve b. Association between aneurysmal development and wall shear stress3. Aortic dissection a. Blood flow volume quantification - forward and backward flow in the false lumen b. Vortices in the false lumen4. Post-prosthetic graft replacement a. Quantification of turbulent blood flow induced by artificial aorta b. Mechanical hemolytic anemia due to aortic arch graft stenosis5. Hypertrophic cardiomyopathy a. Vortex flow in the ascending aorta b. Association between turbulent kinetic energy elevation and left ventricular mass increase

## CAEE-6 Beyond Coronary Artery Calcium: Cardiovascular Findings in Non-Gated Chest CT Scans

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To review the most common incidental cardiac findings on routine chest CT examinations. 2. To recognize which cardiac findings are relevant and can alter the clinical course and outcome of patients.

## TABLE OF CONTENTS/OUTLINE

1. Coronary arteries: a). Anatomical variants (dominance) b). Coronary anomalies (origin)-Benign-Malignant c). Coronary artery calcium d). Coronary aneurysm e). Coronary artery fistula 2. Cardiac chambers: a). Intracavitary thrombus 3. Myocardium: a). Myocardial infarction -Acute-Chronic b). Cardiomyopathy-Dilated-Hypertrophic c). Primary tumors-Fibroma-Myxoma d). Metastases-Chordoma-Lymphoma-Lung carcinoma-Melanoma e). Pseudotumors -Lipomatous hypertrophy of the interatrial septum 4. Valvular heart disease: a). Anatomical variants -Bicuspid aortic valve b). Calcifications -Mitral annulus-Aortic valve 5. Congenital heart disease and thoracic vascular disorders: a). Atrial septal defects b). Patent ductus arteriosus c). Persistent left superior vena cava d). Aortic arch anomalies-Right sided -Double aortic arch e). Anomalous pulmonary venous drainage 6. Pericardial diseases: a). Pericarditis -Infectious-Iatrogenic-Autoimmune-Constrictive b). Pericardial effusion and hematoma c). Pericardial cysts d). Malignant pericardial involvement-Direct invasion-Metastases-Venous extension e). Pericardial fat necrosis

## CAEE-60 Quantitative Stress Perfusion Cardiac Magnetic Resonance: Why, How and When?

### Awards

#### Certificate of Merit

Fai Wang Fong (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Understand differences between qualitative, semi-quantitative and quantitative stress perfusion. 2. Understand how quantitative stress cardiac MRI (QuantCMR) is performed and calculated as well as how to interpret myocardial blood flow/myocardial perfusion reserve. 3. Demonstrate clinical role of cardiac MRI quantitative stress perfusion. 4. Illustrate different pathologies and their appearances on cardiac MRI quantitative stress perfusion.

## TABLE OF CONTENTS/OUTLINE

This exhibit will explain the recent interest and development of QuantCMR and how this differs from qualitative and semi-quantitative stress perfusion. Technical details of how QuantCMR is performed and quantified will be demonstrated along with tips/ tricks of how to get high quality perfusion maps. The exhibit will explain differences between dual bolus and dual sequence techniques and issues to be aware of with different stress agents. The exhibit will discuss how QuantCMR is being increasingly recognised as being useful in patients with ischaemia and non-obstructive coronary arteries (INOCA) to diagnose coronary microvascular dysfunction (CMD) as well in standard assessment of obstructive coronary artery disease. Clinical examples of these pathologies will be illustrated. In addition, other cardiac diseases will also be demonstrated to illustrate how QuantCMR perfusion maps appear in different disease entities such as dilated cardiomyopathy and hypertrophic cardiomyopathy. Knowledge gaps and future directions will also be discussed.

## CAEE-61 State of the Art on Acute Coronary Syndrome with Negative Coronary Angiography

Cesar Urtasun Iriarte I, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To learn the definition of MINOCA and review the spectrum of causes that manifest as acute coronary syndrome with non-obstructive coronary arteries. To understand the role of cardiovascular imaging, learn about the management and, outline CT and MRI protocols.

## TABLE OF CONTENTS/OUTLINE

A. Background, diagnosis, and management B. Assessment: CT and MRI protocols C. Acute coronary syndrome with negative coronary angiography a. MINOCA entities - Coronary plaque disruption- Coronary artery vasospasm- Coronary artery dissection- Coronary artery thrombosis/embolism- Coronary microvascular disorder- Myocardial oxygen demand-supply imbalance b. MINOCA-like entities Myocardial location (Tako-Tsubo, myocarditis, hypertrophic cardiomyopathy, dilated cardiomyopathy, infiltrative cardiomyopathy) Other non-cardiac mimickers (Vasculitis, pulmonary embolism, aortic dissection) D. Take-home messages

## CAEE-62 Development in Free-Breathing Coronary CTA for Patients With High Heart Rate: Using Non-Device Respiratory Gating Method

Nobuyuki Akiyama, RT (*Presenter*) Nothing to Disclose



## TEACHING POINTS

Technological advances make Free-Breathing Coronary CTA (FB-CCTA) possible, but there are challenges for patients with higher heart rate (HR). We have developed a protocol of FB-CCTA at high HR using a non-device respiratory gating method.

## TABLE OF CONTENTS/OUTLINE

We have developed a method to reduce motion artifacts even at high HR from free-breathing images. Since multi-segment reconstruction can improve image quality and diagnostic accuracy at higher HR, Scans and post-processing were performed to allow the segment reconstruction from free breathing images. After electrocardiogram gated Dynamic Volume Scan, to avoid motion artifacts due to breathing, the non-device respiratory gating was performed. The respiratory arrest phase was analyzed using Time-Density-Curve (TDC) plotted from the region of interest drawn on the chest wall of the dynamic image. Multi-segment reconstruction used data from multiple cardiac cycles during respiratory arrest time analyzed from the TDC was performed. In addition, the reconstruction type was applied with full-iterative model-based reconstruction algorithms for improved Signal-To-Noise ratio (SNR). The resulting image was reduced motion artifacts and improved SNR. This method is feasible to provide acceptable image quality and diagnostic performance in CCTA with free-breathing and high HR.

### **CAEE-63 Effectiveness of a Contrast Enhancement Boost Technique in Cardiac CT: Improved Detection of Late Iodine Enhancement (LIE) in Non-Ischemic Cardiomyopathy**

Nobuaki Hasegawa, RT (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To learn about issues of myocardial evaluation with Single-Energy CT.
- To learn about a subtraction technique with non-rigid registration, that can be used to represent an image of the myocardium.
- To learn the principles of the contrast enhancement boost technique (CE-boost) with non-rigid registration.
- To learn about the contrast-improving effects of CE-boost and its diagnostic value in non-ischemic cardiomyopathy.

## TABLE OF CONTENTS/OUTLINE

A. Comparison of CNR between Single-Energy CT and other imaging techniques for non-ischemic cardiomyopathy. B. Advantages of non-rigid registration compared to rigid registration in subtraction techniques. C. Usefulness of non-rigid registration subtraction technique with CE-boost in LIE-CT. D. Clinical case of LIE-CT using CE-boost for preoperative CT examination for TAVI. E. Advantages of CE-boost in non-ischemic cardiomyopathy and its application in clinical imaging.

### **CAEE-64 Cardiac MRI for the Beginner: A Step by Step Approach**

Rebekah Lee, MBBS, FRCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Cardiac MRI is a non-invasive modality for anatomical, functional and myocardial tissue evaluation of the heart for a variety of cardiovascular diseases. It holds immense diagnostic potential and despite its relative high cost, it is becoming more increasingly mainstay in cardiac evaluation. Some conditions that cardiac MR renders benefits to include ischaemic heart disease, cardiomyopathy, valvular disease, congenital disease, pericardial disease and characterization of cardiac masses. It supplements the initial cardiac work-up by providing an unobstructed field of view, myocardial tissue assessment and remains the gold standard for RV and LV volumetric assessment. It is a complex study and includes an arsenal of MRI sequences including cine, myocardial perfusion, parametric mapping and flow sensitive sequences, all tailored to the specific clinical indication or question. Reading a Cardiac MR for the novice radiologist/cardiologist can be a daunting task. With the need for more Cardiac MR readers and to demystify this process, this poster will aim to provide a basic navigational chart for the novice reader which will provide a foundation for them to build upon. Teaching points: An overview of cardiac MRI sequences, basic principles and utility of each sequence An basic approach to interpreting a cardiac study An algorithm approach to common cardiac conditions with case based examples.

## TABLE OF CONTENTS/OUTLINE

Basic cardiac MR sequences and their purpose How to approach a Cardiac MR Basic techniques on qualitative and quantitative assessment with tips and tricks Algorithm for common conditions Case based discussion

### **CAEE-65 Late Iodine Enhancement of Myocardial with Deep Learning Reconstruction Under Low Radiation Doses and Low Contrast Doses: How to Get the Best Image Quality**

Yuuta Yasunaga (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Late Iodine Enhancement (LIE) of myocardium in cardiac CT has been reported to reflect fibrotic lesions in myocardium similar to Late Gadolinium Enhancement (LGE) in cardiac MRI, but requires a higher contrast dose and radiation dose due to contrast enhancement and noise effects. To solve this problem, we propose three new points in using imaging, reconstruction and subtraction technology. 1. Imaging technology: Low-voltage imaging according to BMI. 2. Reconstruction technology:

Deep Learning Reconstruction (Contrast enhancement parameters "AiCE"). 3. Subtraction technology: special contrast-enhancing subtraction technology "CE-Boost". Using the above three methods enables significant contrast enhancement and noise reduction, even with LIE at low radiation doses and low contrast doses. In addition, using DLR provides stability in the uniformity of CT values required for myocardial Extra Cellular Volume (ECV) quantification.

#### **TABLE OF CONTENTS/OUTLINE**

(1) Combination of three special technologies (2) Reconstruction and subtraction technologies (3) Deep learning reconstruction and special subtraction (4) Stable noise reduction with DLR (5) Combination of three special technologies

### **CAEE-66 Success Within Your Grasp: Planning for Mitral Valve Transcatheter Edge-to-Edge Repair**

Hyun Jung Koo, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To recap the evidence of mitral edge-to-edge repair in both primary and secondary mitral regurgitation To demonstrate preprocedural imaging modalities to help appropriate patient selection and interventional guide To understand intraprocedural imaging and post-procedural imaging findings

#### **TABLE OF CONTENTS/OUTLINE**

1. Evaluation of mitral regurgitation (MR) 1) Etiology of MR - Primary mitral regurgitation - Secondary (functional) mitral regurgitation 2) Quantification of MR 2. Types of percutaneous mitral valve repair 3. Patient selection for M-TEER - AHA/ACC Guidelines for M-TEER - Review of Trials: EVEREST II trial, COAPT trial, MITRA-FR trial - Anatomically suitable mitral valve morphology 4. Pre-procedural planning for M-TEER - Echocardiography and cardiac CT - Evaluation parameters 5. Intra-/Post-TEER imaging of M-TEER 6. Potential complications after M-TEER

### **CAEE-67 Multimodality Imaging in Sports Cardiology: New Kid on the Block**

#### **Awards**

#### **Cum Laude**

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Although athletes' have low prevalence of coronary artery disease (CAD), they are prone for other cardiovascular disorders, which should be evaluated prior to suitability for athletic activity. 1. To review the role of Sports Cardiology, a relatively new subspecialty focused on athletes 2. To discuss the role of imaging, particularly MRI in the diagnosis of athlete's heart which is a structural adaptive change that overlaps with cardiomyopathies. 3. To illustrate with case examples the various entities that are encountered in athletes.

#### **TABLE OF CONTENTS/OUTLINE**

1. SPORTS CARDIOLOGY- INTRODUCTION a. Pre-athletic activity screening for diseases that may be worsened with sports activities b. Evaluation of diseases that cause adverse events in athletes 2. ROLE OF IMAGING- Echo, MRI, CT 3. MRI SEQUENCES AND PROTOCOL 4. ADAPTIVE CHANGES IN ATHLETES= Endurance- Volume overload, increased wall stress, eccentric hypertrophy; Strength- Pressure overload, increased wall stress, concentric hypertrophy 5. MYOCARDIAL FIBROSIS IN ATHLETES- Prevalence and pattern 6. ATHLETE'S HEART (WITH CASE EXAMPLES)- Diagnostic criteria controversies; Distinguishing from mimics (Grey zone) a. Hypertrophic cardiomyopathy b. Dilated cardiomyopathy c. LV non compaction d. Arrhythmogenic cardiomyopathy 7. DISEASES CAUSING SUDDEN CARDIAC DEATH IN ATHLETES (with case examples) a. HCM b. ARVD C. Anomalous coronary arteries d. Commotio cordis e. Myocarditis 8. SCREENING STRATEGIES WITH IMAGING IN PROFESSIONAL ATHLETES 9. CTA IN RISK STRATIFICATION OF CORONARY ARTERY DISEASE 10. VETERAN ATHLETES AND MYOCARDIAL FIBROSIS- ARRHYTHMIA 11. ATHLETES AND COVID-19 12. MANAGEMENT OF INCIDENTAL FINDINGS IN ATHLETES

### **CAEE-68 The Minimal Essence of Machine Learning for Cardiovascular Diagnosis**

Ryo Ogawa, PhD, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Various information related to medical data can be obtained by machine learning. We explain how machine learning are used to cardiovascular diagnosis. 1. To review the role of machine learning. 2. To explain the application of machine learning in cardiovascular diagnosis. 3. To explain the principle of machine learning.

#### **TABLE OF CONTENTS/OUTLINE**

1. Linear regression; overview, algorithm, example (heart failure) 2. Logistic regression; overview, algorithm, example (history of heart disease) 3. Support vector machine; overview, algorithm, example (Differentiation of cardiomyopathy) 4. Random forest; overview, algorithm, example (Differentiation of cardiomyopathy) 5. Neural network; overview, algorithm,

example (Classification of myocardial infarction)6. Explainable AI; overview, algorithm, example (Gradient-weighted class activation mapping, Guided gradient-weighted class activation mapping)7. Generative AI; overview, algorithm, example (Deep convolutional generative adversarial network)

## **CAEE-69 Denoise to Visualize: The AI-Driven Post-Hoc Denoising for High-Fidelity Cardiac CT**

Tatsuya Nishii, MD, PhD (*Presenter*) Speakers Bureau, Guerbet SA;Speakers Bureau, General Electric Company;Speakers Bureau, Siemens AG;Research Grant, Canon Medical Systems Corporation

### **TEACHING POINTS**

In cardiac CT, maintenance the increased image noise from photon insufficiency is crucial while upholding high resolution. CT manufacturers have developed iterative and deep-learning reconstruction methods, but disparities exist. Advancements in AI enable image restoration, such as denoising through post-processing allowing radiologists to develop image-processing AI promoting the "democratization" of technology.This exhibit presents the development of a denoising method for high-fidelity cardiac CT using image-based deep learning and its clinical applications. Participants will learn about democratized image-processing AI and engage in its development and clinical application. In enhancement, we showcase cardiac CT images with the application of noise reduction technology, aiming to generate new ideas for diagnostic and prognostic imaging.

### **TABLE OF CONTENTS/OUTLINE**

1. Importance of noise reduction in cardiac CT 1.1 Cardiac CT imaging techniques 1.2 Noise's adverse effects2. AI denoising method differences 2.1 Deep-learning image reconstruction 2.2 Deep-learning post hoc denoising3. Denoising AI development Process 3.1 Optimal network selection 3.2 Data preparation essentials 3.3 Training, validation, and testing 3.4 Implementation highlights4. Clinical Showcases 4.1Exposure Reduction 4.1.1 1/4 dose coronary CT angiography 4.1.2 1/3 dose myocardial delayed enhancement CT 4.1.3 Low-dose pediatric cardiac CT 4.2 Image quality enhancements 4.2.1 Improved diagnostic performance of coronary CT angiography 4.2.2 Enhanced myocardial delayed enhancement CT 4.2.3 Enhanced 3D rendering images

## **CAEE-7 Atrial Septal Defects: A Multimodality Case-Based Approach**

David Gonzalez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Outline the most common atrial septal defects and their associations.Demonstrate the role of cardiac MRI and CT in the diagnosis of atrial septal defects. Illustrate, through case reviews, the imaging findings of atrial septal defects.Discuss treatment options and morphological characteristics to treatment decisions.

### **TABLE OF CONTENTS/OUTLINE**

This review presents a multimodality case-based approach to the diagnosis of Atrial Septal Defects (ASDs).ASDs are the most common congenital cardiac anomaly.Ostium secundum is the most common ASD. Some congenital syndromes, including Holt Oram Syndrome and Lutembacher Syndrome, have ostium secundum type septal defects as part of their spectrum.Sinus venosus can present as a superior or inferior defect, each with different anatomical associations.Ostium primum is within the spectrum of atrioventricular septal defects and is associated with endocardial cushion defects and Trisomy 21.Coronary sinus atrial septal defect is a rare disease presenting as permeability of the coronary sinus. Raghbi syndrome is a type of coronary sinus ASD defined as a PLSVC draining to an unroofed coronary sinus.The roles of CT and MRI offer information on coronary and pulmonary diseases, as well as other anatomical variations that can impact the patient's treatment. MRI also enables functional assessment of the flow, cardiac function, and myocardial tissue characterization.Ostium primum/atrioventricular septal defects, coronary sinus defects, and sinus venosus defects are often treated surgically, while septum secundum type defects can be treated with transcatheter closure. The decision is based on the size, number, and shape of the defects.

## **CAEE-70 Quantitative Myocardial Perfusion MR: State-of-the-Art**

### **Awards**

#### **Magna Cum Laude**

Roberta Catania, MD (*Presenter*) Institutional Research Grant, Siemens AG

### **TEACHING POINTS**

1. Quantitative perfusion MR is an objective and more reproducible tool to identify myocardial perfusion defects and differentiate artifacts compared to only qualitative assessment. 2. Quantitative perfusion MR is a non-invasive tool that can add significant value in the work-up of patients with suspected coronary artery disease and surveillance of post heart transplant patients.

### **TABLE OF CONTENTS/OUTLINE**

Introduction - Physiology of myocardial circulation at rest and stress and autoregulation - Overview of current noninvasive imaging techniques for coronary artery disease assessment and their accuracy - Clinical applications of myocardial perfusion

imaging including assessment for epicardial and microvascular coronary artery disease and heart transplant surveillance  
Imaging techniques - Pharmaceutical stress agents: mechanism of action and contraindications - Cardiac perfusion MR: physical principles, imaging sequences and protocol - Quantitative analysis:  $\emptyset$  Current quantification techniques (automated pixel-wise and dual sequence approach)  $\emptyset$  Absolute quantification and myocardial perfusion reserve (MPR)  
Imaging interpretation and case study- How to interpret quantitative perfusion and key information to be provided in radiology report - Normal quantitative myocardial perfusion MR - Atlas of different radiologic findings - Troubleshooting interpretations of complicated quantitative perfusion MR findings

## **CAEE-71 Utility of Non-contrast MRI for Preprocedural Assessment in Patients Undergoing TAVI**

Naoki Hosoda (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To learn about the pre-procedural assessment for transcatheter aortic valve implantation. To learn about the validity of non-contrast MRI assessment. To learn about non-contrast MRI imaging protocols. To learn about the benefit patient gain by alternative non-contrast MRI.

### **TABLE OF CONTENTS/OUTLINE**

A. Non-contrast MRI can be used as an alternative to contrast CT for patients with CKD and contrast allergies. B. Usefulness of non-contrast MRI to measure in the same way as contrast CT. C. Short imaging protocol focused on pre-procedural assessment of TAVI. D. Non-contrast MRI not only allows assessment comparable to contrast CT, but also avoids risks for patients with CKD and contrast allergy and allows radiation free imaging.

## **CAEE-72 Pulmonary Artery: Showcase of Congenital and Acquired Pathologies You Should Know**

Pedro L. Murra Falla, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To review the normal anatomy of the of the pulmonary artery and their branches. 2. To review the acquired and congenital causes. 3. To show the frequent findings in congenital pathologies. 4. To show the repercussion of the long-term affection of the pulmonary artery.

### **TABLE OF CONTENTS/OUTLINE**

1. introduccion. 2. Normal anatomy of the pulmonary artery and their branches. 3. Acquired pathologies: Complications of chronic Pulmonary embolism, Dilated arteries secondary to pulmonary hypertension, Pulmonary Artery Stenosis and Pulmonary Veno-occlusive Disease. 4. Congenital pathologies: Pulmonary artery agenesis associated with aortopulmonary collateral arteries (MAPCAs), Pulmonary atresia with intact ventricular septum, Anomalous Aortic Origin of Pulmonary Arteries, Aneurysm, Absent pulmonary valve syndrome, Double-Outlet Right Ventricle, Dextro-Transposition of the Great Arteries, Anomalous left coronary artery from the pulmonary artery (ALCAPA), Pulmonary Artery Sling, pulmonary arteriovenous malformations. 5. Long term repercussion in the cardiac chambers and great vessels. 6. Review of the most commons surgical options and outcomes. 7. Discussion. 8. Conclusion

## **CAEE-73 Dual-energy Late Iodine Enhancement Cardiac CT: What is Necessary to Achieve with Dual-Layer Spectral CT?**

Junji Mochizuki, MSc, RT (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

A. To learn about late iodine enhancement (LIE): Imaging technique with dual-layer spectral CT. B. To learn how spectral imaging solves conventional imaging problems. C. To learn about the use of iodine density image for myocardial extracellular volume (ECV). D. To illustrate various clinical applications of these techniques by presenting clinical images.

### **TABLE OF CONTENTS/OUTLINE**

A. Methods of scanning and contrasting late iodine enhancement (LIE) using dual-slice spectral CT. And their advantages and disadvantages. B. Advantage of spectral images over conventional CT for LIE. C. LIE image analysis. LIE by image subtraction and myocardial extracellular volume (ECV) by iodine concentration images. D. Evaluation of myocardial viability by LIE. Evaluation of OMI by subtraction-LIE. E. LIE myocardial viability evaluation. Evaluation of cardiomyopathies by ECV.

## **CAEE-74 The ABC's of ECG - Practical Tips and Tricks for Salvaging ECG-Gated Cardiac CT**

### **Awards**

#### **Certificate of Merit**

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Distinguish the various artifacts commonly encountered in ECG-gated cardiac CT 2. Recognize whether the artifact can be repaired, reduced, or read around 3. Employ ECG sync point editing and composing to salvage cardiac CTs degraded by artifacts from heart rate rhythm, and ECG-gating error

## TABLE OF CONTENTS/OUTLINE

1. Introduction Basics of ECG interpretation; ECG-gating techniques, trade-offs, applications; 2. Distinguishing respiratory/patient motion vs. gating artifact 3. ECG Gating Error: Missing Data (interpolation artifact)- Pitch too high on retro helical - data gaps; Missing Sync Points; 4. ECG Gating Error: Misplaced Data (duplication artifact)- Peaked T-waves; 5. Gating Artifact with correct ECG Gating: Tachycardia or Arrhythmia- PVCs; PACs; Long pause (PVC, PAC, dropped beat); Afib other beat-to-beat Irregularity; 6. ECG-editing options- Sync point editing-Missed a beat/tagged wrong thing/helical; Sync point composing: R wave tagged, manipulation of reconstructions to read-around; 7. A systematic approach for troubleshooting ECG-gating errors and artifacts including case examples- Respiratory motion artifact- Normal ECG; Sinus tachycardia- Multisegment reconstruction; Heart rate change- Can sometimes be read-around; PVC without pause- Eliminate PVC sync; PVC with long pause- Eliminate PVC sync; Add evenly spaced sync points in pause; PAC- eliminate PAC sync or retain it extra, even sync points in best systolic phase; Atrial tachycardia- Sync in best systolic phase; Severe bradycardia- Two separate syncs in diastole; Atrial fibrillation- Artificially space sync points at each R-R interval so they line up each beat;

## CAEE-75 Tumors of the Heart: From the Right Side to the Left Side

Felipe Aluja, MD, MEd (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Discuss the most common cardiac masses, including their typical manifestations and associations, and a brief discussion of clinical scenarios. Describe the imaging signs of cardiac tumors in computed tomography, magnetic resonance imaging and PET/CT. Identify selected cardiac tumors commonly encountered in daily practice and integrate them with the clinical manifestations.

## TABLE OF CONTENTS/OUTLINE

- Introduction
- Classification with brief but concise clinical presentation
- Imaging signs of cardiac tumors in computed tomography, magnetic resonance imaging and PET/CT.
- Selected cardiac tumors:
  - o Primary: § Myxoma § Fibroelastoma § Atrial hemangioma § Lipoma § Rhabdomyoma § Fibroma § Angiosarcoma § Lymphoma § Paraganglioma
  - o Secondary: § Metastasis
- Pitfalls in cardiac tumors:
  - o Vegetations
  - o Intracavitary thrombus
  - o Lipomatous hypertrophy
- Take a guess?
- Take home points

## CAEE-76 Solving the Mystery: Cardiac Devices on Chest Radiographs

Justin Little, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Heart disease is the leading cause of mortality in the United States. Advances in clinical care leading to new devices and treatments allow patients to live longer. Radiologists encounter chest radiographs daily, many with cardiac devices. On radiographs, devices will typically be visible, and it is essential for radiologists to recognize them, know appropriate positioning, and understand complications related to the devices to provide appropriate patient management. Inaccurate interpretation may lead to inappropriate management, delayed diagnosis, and delay of necessary or harmful interventions. The purpose of this exhibit is to walk through common and uncommon cardiac devices, their appropriate positioning, and complications related to mispositioned devices, as well as discuss pathophysiology of some devices. Cardiac rhythmic controlled devices, cardiovascular support devices, stroke prevention devices, cardiac valve support and prosthetic valves, and miscellaneous devices will be reviewed.

## TABLE OF CONTENTS/OUTLINE

1. Introduction to common cardiac devices 2. Classification of these devices 3. Expected positioning of cardiac devices 4. Visible and barely visible devices on CXR 5. Pathophysiological mechanisms of these devices 6. Examples of mispositioned devices 7. Complications related to incorrectly positioned devices 8. Less common/miscellaneous devices and their positioning 9. Flowchart of what to do with a mispositioned devices (urgent versus emergent) 10. What cardiologist expects from radiology report?

## CAEE-77 Simplifying Semantic Segmentation in Cardiac MR: An Intuitive Guide for Radiologists using Transfer Learning

A Ankush, MBBS, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Understanding the importance of semantic segmentation in cardiac MR imaging  
Review of available solutions for segmentation and evaluation metrics  
Introduction to approaches for segmentation using Transfer learning  
Guided approach to a simplified segmentation process using high-level API for low-code development.  
Best practices for achieving accurate segmentation

## TABLE OF CONTENTS/OUTLINE

I. Introduction to Segmentation in Cardiac MRI Imaging  
Definition of image segmentation and its types.  
Need for segmentation in cardiac MRI imaging  
Available solutions for image segmentation and metrics for assessing accuracy  
II. Introduction to TorchIO, MONAI and FAST AI Libraries for Medical Image Analysis  
Overview of libraries.  
Understanding the Data to Model pipeline.  
Importance of Using Transfer Learning.  
Use of High-level APIs for low-code model development. III. Step-by-Step Demonstration of Segmentation using Google Colab and the Heart MRI Dataset  
Setting up the Google Colab environment  
Introduction to the Heart MRI dataset from the Medical Segmentation Decathlon challenge provided by King's College London  
Step-by-step demonstration of target segmentation of the left atrium with minimal lines of code  
IV. Best Practices for Achieving Accurate Segmentation  
Tips for optimising segmentation accuracy  
Strategies for addressing common segmentation challenges  
V. Conclusion  
Summary of key teaching points  
Future directions in semantic segmentation in cardiac MR imaging (like use of generative adversarial network (GAN))

## CAEE-78 A Precarious Path - Complications of 3-stage Palliative Surgery for Single Ventricle Congenital Heart Disease

### Awards

#### Certificate of Merit

Shravan Sridhar, MD, MS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Single ventricle congenital heart diseases are most commonly managed with 3-stage palliation which culminates in the Fontan procedure. Post-operative imaging has been instrumental in assessing for complications both in the short term and long term and ensuring patient longevity. Here, we present some of the most commonly encountered complications associated with 3-stage palliation including early post-operative complications, features of physiologic decompensation, and late-stage downstream effects attributed to the unique physiology in these patients. Where appropriate, we review practical tips and pitfalls in imaging this unique set of patients.

## TABLE OF CONTENTS/OUTLINE

1. Title, disclosures  
2. Abbreviations  
3. Complications overview  
4. Clinical scenarios  
5. Potential workup  
6. Recent operation  
a. Mediastinal hematoma  
b. Pitfall: Surgical packing material  
c. Shunt/conduit occlusion  
d. Pitfall: Un/intentional occlusion  
7. Acute SOB/desaturation/chest pain  
a. PE  
b. MI  
c. CHF  
8. Chronic non-cyanotic SOB/desaturation  
a. Fontan thrombosis  
b. Pitfall: Pseudothrombosis  
c. Systemic AV valve dysfunction  
d. Peri-anastomotic PA stenosis  
e. Pitfall: Morphology/flow discrepancy  
9. RPA/LPA  
f. Diaphragmatic paralysis  
g. Post-Glenn SVC syndrome  
10. Recurrent cyanosis  
a. Pulmonary AVM  
b. Systemic-pulmonary venous collaterals  
c. Practical tip: Quantifying collateral circulation  
d. Patent fenestration  
e. Baffle leak  
11. Arrhythmia  
a. Myocardial LGE  
12. Weight gain  
a. Liver failure  
13. Weight loss  
a. HCC  
b. Protein-losing enteropathy  
14. Chronic cough  
a. Plastic bronchitis  
15. Unexplained pleural effusion  
a. Chylous pleural effusion  
16. Potentially helpful clinical tests  
17. References

## CAEE-8 Coronary Artery Vasculitis, Encasement, and Mimics

### Awards

#### Certificate of Merit

Claire F. Woodworth, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Coronary artery vasculitis is an inflammatory process that is often distinguished from coronary artery encasement from benign and malignant neoplasms, although imaging appearances can overlap.  
2. Coronary artery vasculitis is rare but represents an important diagnostic consideration, especially for acute coronary syndrome (ACS) patients with no traditional cardiovascular risk factors or systemic illness.  
3. There are several mimics of coronary artery vasculitis, demanding careful attention to multi-organ findings and clinical presentation.

## TABLE OF CONTENTS/OUTLINE



1. Introduction.2. Spectrum of coronary artery vasculitis and encasement.3. Review and illustration of coronary artery vasculitis, including: polyarteritis nodosa, Kawasaki's disease, Takayasu's arteritis, giant cell arteritis, HIV.4. Review and illustration of coronary artery encasement, including: malignant neoplasms (lymphoma, angiosarcoma), IgG4-related disease, Histiocytic disorders (Erdheim-Chester disease, Rosai Dorfman).5. Complications of coronary artery vasculitis: aneurysms, stenosis, CHF.5. Mimics of coronary artery vasculitis: spontaneous coronary artery dissection (SCAD), acute plaque rupture, vasospasm.

### **CAEE-80 Women's Heart: Role of Cardiac Imaging in Early Detection and Prognostication of Heart Diseases- A Primer for Cardiac Imagers**

Barun Bagga, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. The diagnosis of heart disease in women poses unique challenges and remains underdiagnosed and undertreated. 2. Understanding the different etiologies of chest pain in women focusing on Acute myocardial infarction (AMI), MINOCA (myocardial ischemia with non-obstructed coronary arteries), myocarditis, Takostubo, LV apical ballooning, and connective tissue disease-related cardiomyopathy.3. AMI has a different presentation, underlying pathophysiology, and outcomes in women compared to men.4. MINOCA is more common in women and in a younger population, with fewer traditional risk factors for coronary artery disease (CAD) and a higher prevalence of non-obstructive coronary plaques.5. MINOCA has a higher all-cause mortality at 12 months compared to stable angina and has been found to have worse quality of life compared to AMI-CAD because they are less often treated with beta-blockers and less often referred to cardiac rehabilitation.6. Cardiac MRI (CMRI) plays a crucial role in the diagnostic algorithm because of accurate myocardial characterization independent of the presence of obstructive coronary lesions.7. CMRI has been shown to provide an etiologic diagnosis in as many as 77-87 % of cases of MINOCA and offers prognostic value with the extent of LGE involvement correlated with the risk of major cardiovascular events.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Review the different causes of chest pain in women in a case-based approach: a) MINOCA; b) SCAD; c) Myocarditis; d) Takostubo; e) LV apical ballooning; f) AMI; g) Connective tissue disease-related cardiomyopathy. 3. Review the role of cardiac imaging in diagnosis and prognostication.

### **CAEE-81 Improved Assessment of Coronary Artery Calcium in Photon-Counting Detector CT: A Phantom Study with Various Imaging Modalities**

Nobuo Kitera, RT, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Accurate assessment of calcified lesions in coronary arteries can help establish better treatment strategies. 2. CT can obtain preoperative calcification. information of coronary arteries, but it is difficult to completely complement intravascular imaging due to limitations in spatial resolution and other factors. 3. Photon-counting detector (PCD) CT has higher spatial resolution than conventional energy-integrating detector CT and is expected to improve the ability to visualize microstructures. 4. PCD-CT has the potential to provide new diagnostic value as a preoperative diagnostic tool by acquiring highly accurate coronary artery calcification imaging.

#### **TABLE OF CONTENTS/OUTLINE**

1. Importance of coronary artery calcification assessment in percutaneous coronary intervention.2. Characteristics of coronary artery calcification images in various imaging modalities.3. Features of PCD-CT, including principles of high-resolution imaging, and selection of scan mode and reconstruction kernel.4. Comparison of PCD-CT images with other imaging modalities using calcified phantom.

### **CAEE-82 Congenital Mitral Valve Disease: From Embryology to Pathology to Repair**

Jonathan A. Liu, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Congenital mitral valve disease can present in a myriad of ways, often differing in morphology, age of presentation, and symptoms. By understanding the development of the mitral valve apparatus, congenital mitral valve disease can be categorized based on which underlying apparatus structure is maldeveloped. The most common and clinically relevant mitral valve pathologies are discussed. Next, the general approach to evaluation of these congenital mitral valve pathologies is reviewed, highlighting the strengths and weakness of each imaging modality (CT, MRI, and echocardiography). Methods for quantification are also reviewed. Finally, the general approach to mitral repair and replacement in the context of congenital heart disease will be discussed.

## TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Embryology and normal anatomy  
3. Anomalies based on location  
a. Supravalvular Lesions  
b. Anomalies of leaflets  
c. Anomalies of chordae  
d. Anomalies of papillary muscles  
e. Associated congenital heart diseases  
4. General approach to evaluation of congenital mitral valve disease  
a. Morphology  
i. Lesions best diagnosed by CT  
ii. Lesions best diagnosed by MRI  
iii. Lesions best diagnosed by echocardiography  
b. Flow  
i. Mitral regurgitation  
ii. Mitral stenosis  
iii. Mixed physiology  
5. Correction of congenital mitral valve disease  
a. Mitral valve repair  
b. Mitral valve replacement  
6. Conclusion

## CAEE-83 Congenital Aortic Arch Anomalies: What the Clinician Wants to Know

### Awards

#### Certificate of Merit

Muhammad Naeem, MD, MBBS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Anomalies and congenital variants of the aortic arch are important entities to be familiar with, as they are known to be associated with congenital heart disease, vascular rings, genetic syndromes, and can have significant impact in clinical management. It is postulated to occur as a result of abnormal embryonal organogenesis of the primitive aortic arches. Advanced imaging, specifically computed tomography angiography (CTA) and magnetic resonance angiography (MRA) play a crucial role in the pre-operative planning, as these cases present an anatomic challenge for surgical intervention. Imaging is essential in the diagnosis, management, surgical planning and eventual outcome in patients with congenital arch anomalies. This exhibit will outline the imaging that may be required, and the information needed by the surgeon to attain the best possible surgical outcome.

## TABLE OF CONTENTS/OUTLINE

1. Review anatomy of various congenital aortic arch anomalies, focusing on clinically significant anomalies that require surgical correction, through case-based examples.  
2. Understand what are the most salient findings that should be reported to the surgeon in these case examples, so that pre-operative planning is optimized.  
We will review the clinically significant variants of congenital arch anomalies that require surgical correction, which may be unfamiliar due to their rarity in clinical practice. We will utilize case-based examples to demonstrate what the important imaging findings the radiologist should review and report to the surgeon. Our focus will cover the impact a radiologist can have in detecting these variants and to provide all the critical information to the surgeon, before an operation occurs.

## CAEE-84 Imaging findings in Cardiac and Lung Transplant Emergencies and Urgencies

### Awards

#### Certificate of Merit

Thangalakshmi Sivathapandi, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Having comprehensive knowledge about hyperacute/acute complications of heart and lung transplants is crucial as imaging plays a vital role in the multidisciplinary management of these patients.  
2. Despite many advances, a disproportionate portion of mortality still occurs in the early post-transplant period, hence prompt recognition of these complications is essentially needed to prevent allograft failure and death.  
3. Accurate reporting by the radiologist could aid the clinician for timely intervention and appropriate patient care.

## TABLE OF CONTENTS/OUTLINE

1. Overview: To review the salient radiological findings in hyperacute and acute complications of heart and lung transplant.  
2. Heart transplant: primary graft dysfunction, post operative bleeding, pericardial tamponade, inferior and superior vena cava stenosis/injury, thromboembolism, sternal dehiscence, pseudoaneurysm, pulmonary edema, infection, and acute rejection. Highlighting the key findings of cross-sectional imaging studies including ultrasound, computed tomography, and magnetic resonance imaging with primary emphasis on CT findings.  
3. Lung transplant: chest wall/pleural defects like wound dehiscence, acute and hyperacute rejection, primary graft dysfunction, bronchovascular anastomotic complications such as lobar torsion, bronchial dehiscence, and pulmonary arterial and venous stenosis/thrombosis, as well as bacterial, viral, and fungal infections among others.

## CAEE-85 The Emerging Role of Cardiac CT in Clinical Practice of Cardiac Amyloidosis

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Recent research has revealed a considerable number of hidden cardiac amyloidosis (CA) especially in patients with heart failure with left ventricular hypertrophy. CA is, however, frequently misdiagnosed as the other hypertrophic heart disease, and delayed diagnosis results in significant consequences for patients.  
2. Current noninvasive diagnostic imaging strategies for CA



include echocardiography, cardiac MRI, and bone scintigraphy. 3. Myocardial late iodine enhancement (LIE) and extracellular volume (ECV) quantification by cardiac CT has become clinically available and clinical evidence is accumulating.4. Since CT is more practical than MRI and scintigraphy, it plays a clinically important role in the diagnosis and management of CA.

#### **TABLE OF CONTENTS/OUTLINE**

1. Basic knowledge of CA: - Classification of CA - Recent development on therapeutic agents 2. Current noninvasive diagnostic imaging strategies: - Echocardiography - Cardiac MRI - Bone scintigraphy 3. Myocardial tissue assessment using cardiac CT: - LIE imaging - ECV quantification - CT imaging protocols 4. The emerging role of cardiac CT for CA: - Efficient diagnostic flow and current evidence - Use in patients with mechanical devices - Application in patients with aortic stenosis - Application in patients with atrial fibrillation - Monitoring of therapeutic effect 5. Future directions

#### **CAEE-86 Genotype and Imaging Phenotype in Dilated and Arrhythmogenic Cardiomyopathy**

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. With the rapid increase in the number of heart failure patients worldwide, research on personalized medicine for cardiomyopathy based on genomic information is being promoted. 2. In recent years, the relationship between genotype and phenotype in dilated cardiomyopathy (DCM) and arrhythmogenic cardiomyopathy (ACM) has been clarified. 3. Important pathogenic variants include titin (TTN), filamin C (FLNC), lamin A/C (LMNA), and desmoplakin (DSP), with characteristic genotypic-imaging phenotypes.4. This presentation summarizes new findings on genotype-imaging phenotypes in DCM/ACM.

#### **TABLE OF CONTENTS/OUTLINE**

1. Evolving disease concept of DCM/ACM: - New diagnostic criteria for ACM (Padua criteria) - Arrhythmogenic right ventricular cardiomyopathy (ARVC) and arrhythmogenic left ventricular cardiomyopathy (ALVC) - Overlap of ACM and DCM 2. Genetic basis of DCM/ACM: - Genes encoding constituent proteins of cardiomyocytes - Genetic variants causing DCM/ACM 3. Genotype-imaging phenotypes in DCM/ACM: - Titin (TTN) - Filamin C (FLNC) - Lamin A/C (LMNA) - Desmoplakin (DSP) - Others 4. Important MRI, CT imaging findings: - Fibro-fatty replacement of myocardium - Ring-like delayed enhancement5. Future directions

#### **CAEE-87 Diagnosis of Coronary Microvascular Disease, Principle, Challenges, and Emerging Technologies of CT and MRI**

Takanori Kokawa, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the definition, classification, and standard diagnostic steps of coronary microvascular disease (CMD).2. To discuss the role of PET, MRI and CT in the diagnosis of CMD.3. To illustrate emerging CT and MRI technologies for characterizing CMD.

#### **TABLE OF CONTENTS/OUTLINE**

A) Definition and epidemiology of CMD.B) Pathophysiology of CMD.C) Diagnostic criteria and standard approach for CMD.D) Role of non-invasive imaging modalities including PET, MRI and CT.E) Emerging technologies for assessment of CMD. a. Myocardial blood flow quantification by MR perfusion imaging and CT perfusion imaging.(Clinical example - normal CCTA, subendocardial perfusion defect, reduced CFR by MRI) b. Coronary sinus flow assessment by phase-contrast cine MRI c. Fractal analysis of dynamic myocardial CT perfusion. d. Potential of photon-counting CT for characterizing myocardium.

#### **CAEE-88 Demystifying the Mysteries of Heart Tumors and Tumor-like Conditions: A Succinct Approach for Radiologists**

Aniket Agarwal, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Highlight the basic protocol of cardiac magnetic resonance imaging and simplifying the anatomy to help alleviate the cardiac-MR phobia. Devise an algorithmic approach to narrow down the differential for cardiac masses by using the clinical history, age, signal intensity, location and enhancement characteristics of the mass. Each sequence tells its own story. Double inversion recovery sequence, Triple inversion recovery has their own advantage. Early and late gadolinium enhancement characteristics of the mass is one of the most important features in differentiating a thrombus from a myxoma and a fibroma from a sarcoma. Rhabdomyomas are usually multi-focal non-enhancing or hypoenhancing lesions. Cine sequences provide assessment of mass mobility, its attachment points and hemodynamic impact on cardiac valves. Characterization for differentiation between benign and malignant features.

#### **TABLE OF CONTENTS/OUTLINE**

Cardiac MR protocol and basic cardiac MRI sequences. Important anatomical landmarks. Sequence wise diagnostic approach - What to look on which sequence? Algorithms- cardiac tumor classification based on benign/malignant, age, location, imaging

characteristics. Differentiating cardiac masses on MRI. Mimics of cardiac tumors including anatomical tissues. Advantages and pitfalls of cardiac MRI.

**CAEE-9 Novel Approach for Comprehensive Preoperative Assessment of Valvular Heart Disease via Four Dimensional CT Datasets in the Era of Minimum Invasive Cardiac Surgery**

Koichi Osuda, RT (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

Recent years, surgical techniques of cardiac valvuloplasty, such as minimally invasive cardiac surgery (MICS) and robotic surgery, have developed dramatically. In exchange for less invasiveness, surgical procedures turned out highly technically demanding due to narrow operative field and deep working space. Comprehensive assessment of cardiac anatomy and preoperative simulation using various modalities would be more important than ever. We summarize the usefulness of cardiac CT, especially in preoperative physiological morphology assessment.

**TABLE OF CONTENTS/OUTLINE**

In valvuloplasty, to assess physiological morphology of valve complex under beating is one of the most important factors. Utilizing CT datasets, valve complex structures consisting of leaflets, chordae tendineae, papillary muscles, and prolapsing leaflet were faithfully reproduced, and allowed surgeon to observe and measure using 3D or 4D datasets. Furthermore, preoperative simulations via life size 3D models and virtual reality simulation systems constructed from high spatial resolution datasets have reached to the stage of practical use. The learning curve would be shortened by development of these simulation technologies, though construction treatment strategy and judging surgical procedures had been largely dependent on surgeon's experience in the past. We propose a novel approach for assessment the whole aspect of valvular heart disease using appropriate imaging modalities comprehensively.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-1

### **Is It Possible to Assess Left Atrial Remodeling Using Deep Learning? An Attempt to Classify Atrial Fibrillation Types Using Contrast-Enhanced CT Images.**

All Day Room: Learning Center

Hina Kotani (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Catheter ablation therapy is one of the curative treatments for atrial fibrillation (AF). It is generally known that the recurrence rate after treatment increases as attacks persist, and the factor is related to structural remodeling of the left atrium. However, standard evaluation is difficult, and the indication for catheter ablation therapy is currently determined by the surgeon's empirical judgment and the duration of disease obtained from the patient's self-report. Therefore, this study demonstrates the possibility of assessing remodeling of the left atrium from the results of the visualization of the classification basis of the two models. The major teaching points of this exhibit are 1. Evaluation of AF types using contrast-enhanced CT imaging is difficult only for experienced physicians 2. Deep learning enables evaluation of the left atrium using features such as the structure of the left atrium and pulmonary veins obtained from images. 3. Evaluation of structural remodeling of the left atrium may be useful for AF types

#### **TABLE OF CONTENTS/OUTLINE**

1. About Atrial Fibrillation -Classification of Atrial Fibrillation Types -Structural remodeling of the left atrium 2. Treatment options for Atrial Fibrillation -Relationship between seizure duration and treatment outcome 3. Results of experiments -How well did you recognize the shape of the left atrium?

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-10

### Seeing Beyond the Surface: A Radiological Exploration of Pacemakers, CRT, and ICDs

All Day Room: Learning Center

#### Awards

##### Cum Laude

Lucas Ortiz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the relevant cardiac anatomy, the different types of devices (pacemakers, CRT, and ICDs), and the positioning and integrity of the different elements of the devices.
- Understand the importance of X-ray imaging in the diagnosis and follow-up of patients with pacemakers, CRT, and ICDs.
- Identify the normal and abnormal X-ray findings for these devices, including lead placement, device positioning, and associated complications.
- Understand how X-ray imaging is used to evaluate the function of pacemakers, CRT, and ICDs, including pacing and electrical leads, and common X-ray findings associated with device malfunction.
- Recognize the potential limitations associated with X-ray imaging of these devices and the troubleshooting strategies for addressing those limitations.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction
2. Overview of cardiac devices (pacemakers, CRT, and ICDs)
3. Anatomy and positioning of cardiac devices
4. Importance of X-ray imaging in diagnosis and follow-up
5. Differentiating between pacemakers, CRT, and ICDs on chest radiography
6. Normal and abnormal X-ray findings for pacemakers, CRT, and ICDs
  - a. Device type and differences
  - b. Device positioning
  - c. Internal elements
  - d. Lead placement
  - e. Lead integrity
  - f. Associated complications
7. Troubleshooting strategies for technical limitations of X-ray
8. Take home points

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-11

### **AI-Assisted Autonomous Aortic Aneurysm Analysis - Status, Strengths, Slants, and Stresses: Ut Nos Ibi Nunc?**

All Day Room: Learning Center

Roshan Fahimi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The exhibit will help the audience understand the following aspects of multiple AI algorithms pertaining to triage, measurement, detection, and report creation for aortic aneurysm and dissection. 1. 1. Aortic evaluation with CT: Intentional and incidental 2. 2. Scientific evidence for aortic evaluation with AI 3. 3. Multi-vendor AI for aortic evaluation 4. 4. Status, strengths, slants, and stresses of AI models

#### **TABLE OF CONTENTS/OUTLINE**

We use our multi-vendor AI experience to organize and present the exhibit content into following brackets: 1. 1. Aortic Diseases: Incidence, importance, and imaging 2. 2. AI for aortic aneurysm and dissection: Evidence in literature 3. 3. Approach of multiple AI algorithms in aortic aneurysm and dissection 4. 4. Screening and AI-based new metrics for aorta 5. 5. Status, weaknesses, and stresses of AI algorithms 6. 6. Autonomy for AI-assisted analysis: Should we be there now?

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-12

### **Boost Your Imaging Skills and Help Your Interventional Cardiologists Before and After Left Atrial Appendage Occlusion**

All Day Room: Learning Center

Seyedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Familiarize radiologists with available LAAO devices and their clinical applications. Review the required pre-procedural measurements for LAAO. Educate radiologists with post LAAO complications and ideal imaging techniques for their detection. Review spectrum of normal post procedural findings that should be differentiated from complications.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the different LAAO devices (Watchman, Watchman FLX, Amulet, and Lariat), their unique features, and patient selection criteria.
2. Recognize the importance of preprocedural Image based planning in guiding device selection and placement.
3. Pictorial review of LAAO complications A) peri-device leak B) off-axis placement, and C) device-related thrombosis.
4. Review of the clinical importance of post procedural complications with focus on the role of imaging.
5. Review of the management of device-related complications with emphasis on the role of imaging.
6. Comparison between CT and other imaging modalities (Echocardiography and MRI) for LAAO planning and surveillance.

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## Abstract Archives of the RSNA, 2023

CAEE-13

### Fibromuscular Dysplasia: a Multifaceted Vascular Disease

All Day Room: Learning Center

Frances D. Ferreira De Deus, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Provide an overview of the pathophysiology and clinical manifestations of fibromuscular dysplasia (MFD). less prevalent, but more commonly underdiagnosed as related to this pathology.- To describe the role of imaging in the diagnosis and prevention of complications.

#### TABLE OF CONTENTS/OUTLINE

Fibromuscular dysplasia (FMD) is a non-inflammatory, non-atherosclerotic, idiopathic arterial disease that primarily affects Caucasian women and medium-sized vessels. The classic finding is the beaded appearance and tortuosity of the affected vessel. However, FMD also predisposes to aneurysm formation, dissection, and stenosis, which are not always suspected to be related to FMD by the imaging community. We describe and illustrate with schematic figures and cases the main sites of vessel involvement, the variable radiological findings and the complications related to the disease. The most affected sites are the renal and cerebrovascular arteries, although the aorta and other arteries may also be involved. FMD can predispose to important complications, such as stroke, myocardial or renal infarction, aneurysm rupture and progressive dissection. FMD is often a subclinical and underdiagnosed arteriopathy with catastrophic complications. The radiological community should be familiar with the different phenotypic appearances. Invasive angiography and non-invasive vascular imaging by CT and MRI play an important role in the diagnosis and prevention of complications.

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## Abstract Archives of the RSNA, 2023

CAEE-16

### Calcium in the Heart: A Guide to Interpret Like an Expert

All Day Room: Learning Center

Syedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Reviewing various calcified cardiac lesions, including calcification of the pericardium, vascular structures, myocardium, valves, and valve annuli.2- Reviewing the morphology, location, and extent of calcification, which are often pathognomonic features that aid in identifying each type of calcified lesion as well as conditions associated with them.3- Exploring the clinical significance of various calcified lesions and outlining a structured clinical approach for their management.4- Discussing differential diagnosis of cardiac calcification and evaluation of their etiologies

#### TABLE OF CONTENTS/OUTLINE

1- Introduction to a systematic evaluation of calcified cardiac lesions2- Identifying:A) Pathognomonic features of pericardial calcifications and considering their underlying causesB) Pathognomonic features of valvular and annular calcifications based on underlying causesC) Myocardial calcifications associated with tumors (such as endothelioma and rhabdomyoma), trauma, or infarction.D) Papillary muscle calcification.E) Left atrial calcifications related to atrial fibrillation, congestive heart failure, and endocarditis.F) Intracavitary calcifications in the atria and ventricles.

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## Abstract Archives of the RSNA, 2023

CAEE-17

### Medical Terminology in Cardiothoracic Radiology

All Day Room: Learning Center

Evgenia Efthymiou, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Medical terminology includes words and phrases aiming to accurately describe anatomical structures, processes, conditions, medical procedures, and treatments. In cardiothoracic radiology, there is a plethora of words originating from Greek and they may be misused and misspelled in everyday practice. To aid colleagues in fluent and effective use of these terms, we have derived a radiologically illustrated glossary of the most frequent terms, their definitions and explanations of their origin and meaning. Typically, medical terms stemming from Greek adhere to a fixed structure of a prefix, a root, and a suffix. The prefix appears at the beginning of a medical term and usually indicates a location, direction, type, quality, or quantity. The root gives a term its essential meaning whereas the suffix appears at the end of a term and may indicate a specialty, test, procedure, function, disorder, or status.

#### TABLE OF CONTENTS/OUTLINE

In a comprehensive and schematic way, words are presented alphabetically divided in two sections: anatomy and pathology and illustrated with representative radiology images, relevant findings and key imaging references. For each word the correct orthography is demonstrated along with a brief review of its history and etymology.

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## Abstract Archives of the RSNA, 2023

CAEE-18

### **The One Ring to Rule Them Out: Deciphering Differential Diagnosis of Left Ventricular Ring-Like Late Gadolinium Enhancement**

All Day Room: Learning Center

Andre Vaz (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Despite being initially described as a diagnostic marker for arrhythmogenic cardiomyopathy (ACM), ring-like LGE has been increasingly reported in non-genetic heart disease. Ring-like LGE secondary to ACM may be accompanied by inverted T-waves in left precordial leads, ventricular arrhythmia with left bundle branch block morphology, and family history of premature sudden death. Ring-like LGE secondary to Chagas disease may be accompanied by residency in south america, positive serology, right bundle branch block and left anterior fascicular block, and apical aneurysm. Ring-like LGE secondary to viral myocarditis may be accompanied by prodromal manifestations (e.g fever, flu-like symptoms and diarrhea), and myocardial edema. Ring-like LGE secondary to Keshan disease may be accompanied by residency in China, disabsortive syndrome, and selenium deficiency. Ring-like LGE secondary to sarcoidosis may be accompanied by extracardiac findings, right bundle branch block, 2nd- and 3rd-degree heart block, and right ventricular free wall LGE.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: definition of left ventricular ring-like LGE, clinical significance, and objectives  
Differential diagnosis between genetic causes: left-dominant CMADifferential diagnosis between endemic causes: Chagas disease, and Keshan disease  
Differential diagnosis between inflammatory causes: viral myocarditis, sarcoidosis, and heart transplant rejection  
Differential diagnosis between causes of non-ring-like circumferential LGE: myocardial infarction, amyloidosis, and dystrophin cardiomyopathies  
Discussion: table with distinctive features of ring-like LGE differential diagnosis

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## Abstract Archives of the RSNA, 2023

CAEE-19

### Understanding Transesophageal Echocardiography: A Radiologist's Guide

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Zaid H. Khan, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

TEACHING POINTS1. To understand the complimentary role of transesophageal echocardiography in multi-modality cardiac imaging including indications, contra-indications and potential complications.2. To have an understanding of the standard trans-esophageal examination3. Using cross modality reference be able to identify specific pathologies on TEE, CT and MRI.

#### TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS/OUTLINE1. Introduction: Overview of the role of TEE in multimodality cardiac imaging including indications, contraindications, and complications.2. The standard transesophageal examination with cross modality reference with CT and MRI3. Specific roles of TEE in acute aortic syndromes, cardiac source of emboli, infective endocarditis and valvular assessment. Pathological appearances on TEE with cross modality reference.4. Summary.

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## Abstract Archives of the RSNA, 2023

CAEE-2

### Role of Cardiac MRI in the Follow Up of Postoperative Congenital Heart Disease

All Day Room: Learning Center

Harold Goerne, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review congenital heart diseases that require imaging follow up after surgical or endovascular repair. To discuss the role of cardiac MRI in the evaluation of postoperative findings in CHD repair. To demonstrate the importance of follow up imaging for detection of postoperative complications.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction 2) Congenital heart diseases - Clinical features; embryology; pathophysiology; treatment 3) Advantages and disadvantages of imaging modalities- Echo, CT, MRI. 4) MRI 5) Discussion, illustration with case examples of postoperative findings in repaired congenital heart diseases a) TOF: 1) Total repair (Pulmonary valve regurgitation, RV dilatation, RVOT wall fibrosis/aneurysms) b) TGA: 1) Jatene / Atrial switch (stenosis, thrombosis) 2) Banding (stenosis) c) DORV 1) Jatene (coronary ostia stenosis, PA stenosis) 2) MBT 3) Rastelli (leaking, regurgitation) 6) Discussion, illustration with case examples of postoperative complications in the repair of congenital heart diseases. I. Pulmonary valve insufficiency II. Aneurysmal dilatation of patch III. Myocardial dysfunction (Structural alterations, hypertrophy and remodeling) IV. Right ventricular dysfunction

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## Abstract Archives of the RSNA, 2023

CAEE-20

### Multimodality Imaging of the Pericardium

All Day Room: Learning Center

Nilo Fernandes Leca Junior, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To discuss the strengths and limitations of different imaging techniques in the exploration of the pericardium. To highlight the radiological aspects of the normal pericardium and the spectrum of pathological entities such as developmental anomalies, inflammation/infection, effusion, neoplasms, iatrogenic conditions and pericardial constriction.

#### TABLE OF CONTENTS/OUTLINE

Pericardial diseases are conditions that involve the membrane that surrounds the heart. Imaging plays a pivotal role in the assessment, which is performed by multiple non-invasive methods such as x-ray, echocardiography, CT and MRI. Echo remains as the first modality in most clinical scenarios. The most common conditions involving the pericardium are inflammation, effusions and constriction. Pericarditis is classified by symptom duration and by etiology (infection, idiopathic, neoplastic, drug related, iatrogenic and autoimmune). Pericardial constriction is a rare complication. Pericardial effusion is related to varying degrees of abnormal fluid accumulation into the pericardial space, and can evolve to tamponade. Primary and secondary masses are commonly accessed by CT and MRI. Secondary involvement is far more common than primary pericardial tumors. Congenital anomalies are relatively uncommon entities and may range from pericardial cysts to partial or total agenesis. Cardiovascular imaging plays an important role on the management of pericardial pathologies, which should be promptly recognized to help guide timely treatment.

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## Abstract Archives of the RSNA, 2023

CAEE-21

### Utility of CT Coronary Angiography in Septal Vascular Mapping Prior to Alcohol Ablation in Hypertrophic Obstructive Cardiomyopathy

All Day Room: Learning Center

Anjuna Reghunath, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Alcohol septal ablation (ASA), an established treatment in hypertrophic obstructive cardiomyopathy (HOCM), iatrogenically induces an infarct of the target basal septum- the site of contact of mitral valve leaflet on the septum during systolic anterior motion (SAM). 2. Invasive angiography provides information about the course and size of coronary arteries but not their territorial distribution. Inaccurate infarct localisation due to alcohol injection into right ventricular side of septum and inability to identify the target vessel on invasive angiography leads to failure of ASA. 3. Computed tomography (CT) angiography has the dual benefit of detailing vascular anatomy and providing information on myocardial distribution. Mapping the septal vascular anatomy with CT coronary angiography prior to ASA improves localisation of infarct with predictable outcome and procedural success at the first attempt compared to traditional methods. The authors describe a new 5-step method of creating a CT navigational map for planning selective sub-branch micro-catheterisation.

#### TABLE OF CONTENTS/OUTLINE

1. Mechanism and principle of ASA.2. CT angiography protocol and 5-step mapping technique of the target basal septal vasculature.3. Checklist of CT reporting points including the distance and angulation of the septal arteries.4. Illustration of variant CT septal vascular anatomy.5. Causes and demonstration of failed procedures in pre-CT traditional ASA.6. Clinical utility of CT-guided ASA in terms of symptomatic, functional and haemodynamic improvement.

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## Abstract Archives of the RSNA, 2023

CAEE-22

### Gray Blood and Applications

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibition is: ? Review the concept and indications of the gray blood myocardial delayed enhancement (MDE) technique? Highlight the ease of execution and applicability of the method? Understand the benefits of applying gray blood in the investigation of myocardial fibrosis? Identify the radiological findings that will help in the diagnosis as well as pitfalls of this technique

#### TABLE OF CONTENTS/OUTLINE

Gray blood is a sequence in cardiac magnetic resonance imaging (CMR) obtained by partial blood signal suppression that increases the ability to identify and localize myocardial scarring near the cavity. A pictorial essay based on cases from our collection allows for a comprehensive assessment and understanding: ? Grayblood MDE technique with a tutorial video? Main indications of grayblood MDE images? Grayblood MDE radiological findings in cases of subendocardial enhancement and papillary muscles? Grayblood MDE radiological findings in cases of post-cardiac transplantation, cardiac tumor, myocarditis and hypertrophic cardiomyopathy? Cases in which grayblood MDE did not help in the diagnosis

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## Abstract Archives of the RSNA, 2023

CAEE-23

### Imaging of the Ductus Arteriosus

All Day Room: Learning Center

Kaustav Bera, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. 1. To know the embryology, physiology and modalities for evaluation of the ductus arteriosus 2. 2. To learn about the pathologies of the ductus going beyond patent ductus arteriosus 3. To review the clinical and imaging findings of the above-mentioned entities with case examples

#### TABLE OF CONTENTS/OUTLINE

1. Embryologic development of ductus arteriosus 2. Physiological significance of ductus arteriosus 3. Modalities for evaluation of pathologies of ductus arteriosus : USG, CT, MR, Invasive angiogram 4. Pathologies of Ductus: - Normal variants - Congenital/developmental o PDA § Risk factors and pathophysiology § Classification § Causes § Maintaining patency post birth for some Congenital Heart diseases § Closure of PDA o Aneurysm of DA o Congenital vascular ring o Significance in Coarctation of aorta ( Preductal versus post ductal) - Post traumatic o Mechanism of and incidence of ductal injury o Minimal aortic injury (MAI) o Ductal Pseudoaneurysm o Penetrating ulcer o Aortic dissection - Miscellaneous o Infective aortitis associated with the nonpatent remnant of a ductus arteriosus o Atherosclerotic penetrating ulcer/ pseudoaneurysm of aortic ductus. 5. Differential diagnosis/mimics: - Aortic spindle mimicking aortic ductus pseudoaneurysm/MAI - Type III ductal diverticulum mimicking Aortic ductus pseudoaneurysm - Infundibula of the aortic branch vessels mimicking Aortic ductus pseudoaneurysm - Technical mimics of MAI :Breathing, arterial pulsation and other motion artefacts, streaming/streaking of contrast mimic minimal aortic injuries) - Anatomical mimics of MAI : Noncalcified and partially calcified atheroma

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## Abstract Archives of the RSNA, 2023

CAEE-24

### The Space Between: A Roadmap to Cardiac Recesses & Grooves

All Day Room: Learning Center

Katherine A. Cheng, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The recesses, grooves, and potential spaces around the heart are defined by the vasculature and supporting fibrous structures; these areas can easily be overlooked by the radiologist. Changes in configuration and appearance of these spaces can occur with pathological processes and can be more readily identified using a standard search pattern. A structured search pattern using a vascular and fibro-skeletal based review can help the radiologist identify and differentiate pathology from normal spaces and structures.

#### TABLE OF CONTENTS/OUTLINE

1. Review the normal anatomy of the heart including the recesses and grooves as well as the supporting vascular and fibro-skeleton of the heart.
2. Illustrate the common pathology that can occur in these spaces including thrombus, tumor, abscesses, and pseudoaneurysm.
3. Highlight the importance of variant and abnormal processes in these spaces and the impact on medical and surgical management.

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## Abstract Archives of the RSNA, 2023

CAEE-25

### **The Role of Imaging in Cardio-Oncology: Detecting, Preventing, and Managing Cardiovascular Disease in Cancer Patients and Survivors**

All Day Room: Learning Center

Osamu Manabe, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Cardio-oncology is a new specialty that focuses on detecting, preventing, treating, and following up on cardiovascular disease (CVD) in cancer patients and survivors. Cancer and CVD share many risk factors, such as aging, smoking, diabetes mellitus, and genetic predisposition. Furthermore, some cancer treatments have negative effects on the cardiovascular system, leading to an increased burden of cardiac complications in survivors. Cardio-oncology aims to minimize cardiovascular complications in patients with cancer and requires close collaboration between oncologists, cardiologists, and radiologists. In this presentation, we will discuss the usefulness of various imaging modalities in the field of cardio-oncology, taking into account the latest technology available.

#### **TABLE OF CONTENTS/OUTLINE**

Cardio-oncology is a new multidisciplinary field to institute appropriate surveillance, treatment, and follow-up strategies for CVD in patients with cancer (Fig.1). Imaging modalities such as MRI (Fig.2), CT (Fig.3), and nuclear medicine including PET (Fig.4) play a crucial role in diagnosing and monitoring CVD in cancer patients. These non-invasive methods can be used to assess cardiac function, tissue characteristics, metabolic activity, and also tumor size and extent. Using novel imaging technologies is essential for early detection, treatment, risk stratification, and survivorship in cardio-oncology (Fig 5).

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## Abstract Archives of the RSNA, 2023

CAEE-26

### Whole-body Assessment of Vasculitis and Its Complications Using CT, FDG-PET, and MRI

All Day Room: Learning Center

Noriko Oyama-Manabe, MD, PhD (*Presenter*) Grant, DAIICHI SANKYO Group; Grant, Bayer AG; Grant, Eisai Co, Ltd; Grant, Canon Medical Systems Corporation

#### TEACHING POINTS

1. Overview of the etiology, pathophysiology, clinical presentation, diagnostic criteria, and therapeutic approaches for primary and secondary vasculitis 2. To compare image characteristics of specific vasculitis and its complications with CT, MRI and FDG-PET/CT 3. To describe the role of multimodality imaging in the quantitative evaluation of inflammation for the initial diagnosis and during follow-up after treatment

#### TABLE OF CONTENTS/OUTLINE

Vasculitis manifests in various clinical presentations, morphologies, and prognoses, requiring a multimodal imaging approach. Radiologists can aid in the accurate diagnosis of vasculitis and its complications, treatment planning, and patient care with multimodality imaging. In this presentation, we will cover both primary and secondary vasculitis, which can be caused by various factors, including infections and drug-induced reactions. Knowledge of systemic clinical manifestations in affected patients may help establish a specific diagnosis. 1. To review the clinical features and imaging findings of the different types of vasculitis including those that primarily involve large, medium-sized, or small vessels. 2. Tips for scanning with adequate timing and reconstruction for various complications due to infectious vasculitis including secondary to TEVAR and EVAR. 3. To describe the role of these imaging modalities in the quantitative evaluation of inflammation for the initial diagnosis and during follow-up after treatment, with an emphasis on monitoring therapeutic response using quantitative parameters.

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## Abstract Archives of the RSNA, 2023

CAEE-27

### Unveiling Cardiac Intracavitary 4D flow MRI

All Day Room: Learning Center

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Reliable analysis of intracardiac flow provides important insight for the interpretation and management of cardiovascular diseases. Recently, non-invasive evaluation of intracardiac hemodynamics by 4D flow CMR constitute a reliable, robust, and reproducible method for the analysis of flow patterns in valvular diseases, cardiomyopathies, or congenital heart diseases (CHD). Furthermore, in virtue of its multidimensional/multidirectional capabilities it allows to calculated common (flow, velocities, and volumes) and advanced (kinetic energy and turbulent kinetic energy, vortical flow imaging and particle tracing) intracardiac chamber flow hemodynamic parameters. Recently, some of them have been shown to have important prognostic implications. Teaching points 1. To describe the physical basis of 4D flow, the main acquisition process, optimization techniques and advanced post-processing methods 2. To analyze the current and potential clinical applications of intracavitary 4D flow in cardiac imaging.

#### TABLE OF CONTENTS/OUTLINE

1. 4D flow physical basis 2. 4D flow acquisition technique and protocol 3. Conventional intracavitary flow analysis 4. Advanced intracavitary 4D flow analysis - Kinetic Energy and Turbulent Kinetic Energy - Viscous energy loss - Vortical Flow Imaging - Particle tracing 5. Current and potential clinical applications intracavitary 4D flow - Dilated cardiomyopathy - Ischemic heart disease - Atrial fibrillation and heart failure - Valvular heart disease - Hypertrophic cardiomyopathy - Congenital heart diseases 6. Intracavitary 4D flow prognostic biomarkers: Ready to primetime? 7. Take home points

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## Abstract Archives of the RSNA, 2023

CAEE-28

### CT Imaging in Ischemic Heart Disease and Complications

All Day Room: Learning Center

Takashi Norikane, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cardiac imaging plays a pivotal role in the diagnosis of ischemic heart disease. Echocardiogram, coronary angiography, nuclear medicine imaging and magnetic resonance imaging are common imaging modalities. However, conventional CT can provide important information about ischemic heart disease and complications. This presentation introduces the basic approaches of CT in ischemic heart disease and complications and follows with an overview of normal heart and coronary anatomy and frequently encountered pathologic conditions.

#### TABLE OF CONTENTS/OUTLINE

Normal anatomy Coronary artery and territories Heart chambers Pericardium Myocardial infarction Atherosclerosis, Air embolism, Coronary artery anomaly, IgG4-related disease, Aortic dissection, thromboembolism due to essential thrombocythemia, Diaphragmatic hernia (post CABG), Post aortic valve replacement Complications Myocardial rupture, ventricular septal rupture, Dressler's syndrome, Ventricular aneurysm, Calcification Myocardial persistent enhancement after percutaneous coronary intervention Differential diagnosis Myocarditis, Takotsubo-myocardiopathy

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## Abstract Archives of the RSNA, 2023

CAEE-29

### Unravelling the Mitral Valve on CT

All Day Room: Learning Center

Vidushi Gupta JR, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Assessment of normal valvular morphology and basic physiology of mitral valve on MDCT  
2. Discuss the pearls and pitfalls relevant to planning, acquisition and interpretation of cardiac CT images  
3. Enumerate various structural and functional abnormalities  
4. Describe the role of CT in pre and post-procedural imaging in patients with TMVR (Transcatheter mitral valve replacement).

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. ECG placement with proper planning and acquisition protocol  
3. Pearls and pitfalls  
4. Post processing  
5. Normal mitral valvular anatomy and function  
6. Assessing Structural abnormalities  
7. Assessing Functional abnormalities  
8. Role of CT in pre and post procedural imaging in TMVR  
9. Take home message

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## Abstract Archives of the RSNA, 2023

CAEE-3

### **Robotic and Minimally Invasive Mitral Valve Surgery: Radiological Assessment and Surgery Correlation**

All Day Room: Learning Center

Omer Onder, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Robotic and minimally invasive mitral valve surgery is a safe and less traumatic surgical approach compared to the open cardiac surgery. Besides, it can be regarded as a widely accepted technique given the volume of publications from numerous institutions. 2. Multimodality imaging assessment conducted before to surgery are essential for selecting appropriate patients, anatomical evaluation, surgical planning, and optimal patient outcomes. 3. Radiologists can assist in patient treatment by being knowledgeable about the variety of anticipated postoperative findings and potential complications following robotic and minimally invasive mitral valve surgery.

#### **TABLE OF CONTENTS/OUTLINE**

A. Overview of surgical techniques: Ministernotomy, minithoracotomy, robotically assisted B. Indications and contraindications C. CT angiography for pre-operative assessment 1. Scan protocol and postprocessing technique 2. Preoperative checklist 1) Aorta and iliofemoral arteries 2) Evaluation of lung, pleural plaques 3) Chest wall, diaphragm 4) Pericardium, mediastinum 5) Aorta diameter, pulmonary artery diameter, ascending aortic calcification 6) Mitral valve geometry, calcification 7) Central veins (vena cavae, coronary sinus) 8) Coronary arteries D. Procedural considerations E. Case examples F. Postoperative assessment G. Conclusion

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## Abstract Archives of the RSNA, 2023

CAEE-30

### Need for Speed: Fast MRI in Cardiac Imaging

All Day Room: Learning Center

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cardiac MRI has become versatile technique for normal and diseased heart. However this results in complex and slow CMR examinations, raising the perception of CMR as a high-cost imaging method. Therefore, a more rationale and question-driven protocols are increasing acceptance in order to reduce the amount of acquisition time, increase patient acceptance and clinical value of this well-known game-changer imaging method. Teaching points 1. To describe the current technical advances, drawbacks, tips and tricks available for providing fast MRI protocols in clinical practice. 2. To detail the different proposals described in the literature for optimizing CMR protocols (fast MRI) in a "question - driven" scenario and with a "building - blocks" strategy.

#### TABLE OF CONTENTS/OUTLINE

1. Fast MRI concept and rationale 2. Conventional CMR protocoling problems: Knowing what I need to fix. 3. Fast MRI strategies in cardiac imaging • 3.1. Cine SSFP o Free - breathing EKG gated cine SSFP o Post-contrast cine SSFP o Sparse acquisition cine SSFP o Deep Learning (DL) cine SSFP o 3D cine SSFP • 3.2 Tissue characterization/parametric mapping o Single-Shot black blood imaging o DL acquisition and reconstruction o 3D single parameter mapping o Accelerated T1 T2 mapping • 3.3. 4D flow imaging o 4D flow EPI o Accelerated 4D flow • 3.4. MR angiography o Compressed sensing o Other strategies o Non - contrast MRA • 3.5. Late Gadolinium Enhancement o Free breathing single-shot LGE o Breathold 3D LGE o 3D PSIR LGE o DL LGE 5. Fast CMR protocols in the clinical practice: The "building - blocks" strategy - Ischemic heart disease - Non-ischemic heart disease - Valvular heart disease - Arrhythmogenic cardiomyopathy - Congenital heart disease 6. Take home points

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

CAEE-31

### Pulmonary Vein Anomalies Made Easy

All Day Room: Learning Center

Juliana S. Da Silveira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To overview the embryology and normal anatomy of the pulmonary veins. To discuss the spectrum of anomalous pulmonary venous connections (APVCs). To describe and illustrate with schematic figures and cases the types of APVCs. To discuss the importance of the diagnosis to allow timely treatment and a better prognosis.

#### TABLE OF CONTENTS/OUTLINE

The normal PV anatomy consists of four PVs, which drain oxygenated blood from the lungs to the left atrium (LA). The LA and PVs initially develop separately, and get progressively connected during fetal development. If there is failure in any step of this embryonic process, APVCs will happen. Anomalous pulmonary venous connections are a group of abnormal drainage of one or more PVs outside of the LA and can be classified either as partial or total, depending on the number of the veins involved. We describe and illustrate with schematic figures and cases the types of anomalous pulmonary venous connections, whether partial or total, common or rare, depending on the site of pulmonary vein drainage, the number of veins involved, and the presence or absence of vein obstruction. Common and rare anatomical variations will also be demonstrated. The clinical syndromes related to abnormal pulmonary venous returns will be discussed, ranging from dramatic neonatal emergency to subclinical presentation and late development of pulmonary hypertension.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-32

### The Changing Face of Myocarditis

All Day Room: Learning Center

Matthew R. McCann, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

COVID-19 ushered in a dramatic rise in public awareness of myocarditis and related complications. Mirroring this, an unprecedented utilization of imaging for assessment of cardiac events followed. Utilization of imaging for vaccine-related cardiotoxicity has similarly risen. Synchronously, other previously unrecognized causes of myocarditis are now increasingly encountered, including drug-related cardiotoxicity, as seen with new oncologic agents. Clinical history, lab assessment, and imaging remain central to establishing a diagnosis of myocarditis. Cardiac MRI plays an integral role in diagnosis, stratification, and monitoring of recovery from this changing face of myocarditis. Recognition of the evolving etiologies, imaging techniques and revised diagnostic criteria are paramount for appropriate diagnosis.

#### TABLE OF CONTENTS/OUTLINE

This exhibit outlines the timeline of awareness, specific entities and imaging features which comprise the “changing face of myocarditis” including cardiotoxicity related to COVID-19, COVID-19 vaccination, drug reactions including immune checkpoint inhibitors, and cardiotoxicity related to environmental contaminants and other exposures. Cardiac MR plays a key role in diagnosis, stratification, and monitoring of cardiotoxicity in these entities. The specific imaging features and diagnostic considerations are outlined and described in order that the radiologist gains a better understanding of this evolving diagnosis, allowing for appropriate utilization of imaging and improved diagnostic accuracy of this complex disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-33

### New CAD-RADS 2.0: What Has Changed from CAD-RADs 1.0

All Day Room: Learning Center

Janio De Paula Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To reinforce the importance of applying the CAD-RADS classification for a better communication with the healthcare providers. To describe the differences between CAD-RADS versions 1.0 and 2.0. To demonstrate with cases how to apply the CAD-RADS 2.0 classification.

#### TABLE OF CONTENTS/OUTLINE

The Coronary Artery Disease Reporting and Data System (CAD-RADS) is a standardized guide created to categorize coronary CT angiography findings and to facilitate communication between the radiological community and referring physicians. A new CAD-RADS classification was recently published with the objective of adding anatomical and functional data, which may offer stronger prognostic value other than just describing the presence or absence of anatomical lesions. What's the same? The main categories (0,1, 2, 3, 4, 5) based on stenosis severity (0, 1-24%, 25-49%, 50-69% 70-99%, occlusion) were maintained. Complementary modifiers "G", "S" and "N" standing for the presence of Grafts, Stents, or a Non-diagnostic study were maintained. What has changed? A grading scale for calcific plaque burden was added (P1, P2, P3 and P4). For plaques with features indicating high risk of rupture, the modifier "V" was replaced to "HRP" -> high-risk plaque. An "I" modifier was added if the investigation of ischemia was performed, either by perfusion or FFR-CT. The use of CAD-RADS to report findings provides a clinically useful categorization of CAD and standardizes the way of providing results across imaging sites, which is additionally useful for research purposes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-34

### Multimodality Review of Common Mitral Valve Pathology and the Current Surgical Interventions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Alexander Phan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

As the treatments for valvular disease have evolved over the years, the assessment of cardiac valves now often requires multiple imaging modalities, including cardiac CT, cardiac MRI, and echocardiography. The aim of this exhibit is to review the normal appearance as well as common pathologies involving the mitral valve on the various modalities discussed above. Lastly, the current available treatments for mitral valve disease will be reviewed including repairs (such as annuloplasty, valvuloplasty, and mitral valve clips) and replacements (such as surgical valve replacement and transcatheter mitral valve replacement).

#### TABLE OF CONTENTS/OUTLINE

1. Review of the normal appearance of mitral valve on CT, MRI, and Echo. 2. Review of common mitral valve disease including mitral regurgitation, mitral stenosis, mitral prolapse, mitral annular disjunction, flail leaflet, parachute mitral valve, mitral cleft, mitral masses (fibroelastoma, vegetations, thrombus), and mitral annular calcification. 3. Review of the current treatments. Mitral valve repairs include annuloplasty, valvuloplasty, and mitral valve clips. Mitral valve replacements including surgical and more minimally invasive techniques, such as robot-assisted or transcatheter-based TMVR.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-35

### Visualizing the Mitral: An Imager Approach to Mitral Valve Disorders

All Day Room: Learning Center

Mohamed K. Ibrahim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Overview on clinical burden of Mitral valve diseases (MVDs) and pertinent anatomy.
- Familiarity with the current imaging approach to MVDs.
- Understand the role of imaging in the management of MVDs.

#### TABLE OF CONTENTS/OUTLINE

- Mitral valve diseases burden and pertinent anatomy
  - o Mitral valve anatomy
  - o Clinical burden of MVDs
- Current imaging approach to MVDs:
  - o Role of Echo as the main modality for early detection
  - o Complementary role of CT and MR
  - o Comprehensive evaluation of MVDs (Mechanism of abnormality, Quantification, Ventricular remodeling, Vascular changes, Risk stratification, Valve morphology)
- Where does imaging fit in MVDs management?
  - o Assessing etiology, mechanism, and grading
  - o Pre-procedural planning: § Surgery vs Transcatheter intervention § Repair vs replacement
- Surgical replacement:
  - o sternotomy vs Robotic, and the role of CTA and CMR
- Transcatheter replacement: transapical vs trans-septal approaches, and the role of Echo and CT
  - § Favorable anatomical markers, predictors of challenging procedures and contraindications
  - o Intra-procedural guidance and monitoring
  - o Post-procedural Follow up; Devices (stability, leaflet motion, leaks, vegetations/thrombus), Hemodynamics, and chamber size and function)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-36

### Left Ventricular Hypertrophy: An Approach to Differential Diagnosis

All Day Room: Learning Center

Rafael Perez Milan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Left ventricular hypertrophy (LVH) is a common finding in cardiac magnetic resonance (CMR) with multiple diagnostic considerations.- LVH is an independent predictor of future cardiovascular events regardless of its etiology.- LVH can be defined as follows.- LV myocardial thickness more 12 mm.- Increased LV mass: Body surface area - indexed LV mass (over 95th percentile - 91 g/m<sup>2</sup> in males; 77 g/m<sup>2</sup> in females)

#### TABLE OF CONTENTS/OUTLINE

- To understand basic anatomy and embryology of the left ventricle.- To define left ventricular hypertrophy (LVH) and clinical implications.- To describe the differential diagnosis of LVH.- Role of cardiac magnetic resonance (CMR) in narrowing the differential diagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-37

### Complications of Acute Myocardial Infarction: Infrequent but Lethal

All Day Room: Learning Center

Francisca Aliaga, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Acute Myocardial Infarction (AMI) is a frequent pathology and one of the leading causes of death in the world. Early revascularization has become a standard of care, thus reducing the high associated morbi-mortality. 2. Although infrequent, several secondary complications can occur, particularly when treatment is delayed or inadequate. 3. These are divided into mechanical, inflammatory, arrhythmic, thrombotic, and embolic. 4. CT, and especially MRI, help us to adequately assess cardiac function, ventricular volumes and structure, myocardial viability and possible associated complications.

#### TABLE OF CONTENTS/OUTLINE

- Introduction- General characteristics of AMI and its complications.- Complications are divided into categories, with cases to illustrate each Mechanical complications are most frequently evaluated through CT and MR. In the acute phase, the most frequent are left ventricular free wall rupture, septal ventricular defect, and papillary muscle rupture. In a chronic phase, pseudoaneurysms and ventricular aneurysms are found.- Conclusions. Complications of AMI are infrequent, but they can be potentially lethal. An accurate and early diagnosis significantly improves the prognosis. CT and MRI are the main imaging modalities used after echocardiography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-38

### Imaging Features and Mimics of Primary and Metastatic Pericardial Tumors

All Day Room: Learning Center

Aparna Singh, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understand the role of imaging modalities in the diagnosis and management of primary and metastatic pericardial tumors and their mimics. 2. Review the imaging features of pericardial tumors and their mimics on echocardiography, CT, MRI, and PET/CT. 3. Discuss the limitations of imaging in the diagnosis and management of pericardial tumors and their mimics.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction A. Epidemiology and clinical presentation of pericardial tumors and their mimics II. Role of Imaging Modalities A. Echocardiography B. Computed Tomography (CT) C. Magnetic Resonance Imaging (MRI) D. Positron Emission Tomography/Computed Tomography (PET/CT) III. Imaging Features of Pericardial Tumors and Their Mimics A. Primary pericardial tumors B. Metastatic pericardial tumors C. Pericardial cysts D. Lipomatous hypertrophy E. Pericardial fat pad F. Hemangioma G. Thymoma IV. Limitations of Imaging in the Diagnosis and Management of Pericardial Tumors and Their Mimics V. Conclusion

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

CAEE-39

### Mitral Valve Diseases 101: A Comprehensive Case-Based Review for Radiology Trainees

All Day Room: Learning Center

Mangun Randhawa, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the normal anatomy of the mitral valve and imaging modalities used for its evaluation  
2. Discuss various pathologies of native and prosthetic mitral valves, their implications, and their differential diagnoses  
3. Review role of imaging for mitral valve interventions

#### TABLE OF CONTENTS/OUTLINE

1. Morphologic anatomy of the mitral valve  
2. Congenital mitral valve abnormalities : parachute mitral valve, parachute-like mitral valve, Shone complex  
3. Mitral valve prolapse (various types) and mitral annular dysjunction  
4. Mitral annular calcifications, and complications  
5. Infective endocarditis  
6. Mass (different histopathologies)  
7. Pre-procedural and Post-procedural evaluation of mitral valve implantation including prediction of left ventricular outflow tract obstruction post transcatheter implantation.

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## Abstract Archives of the RSNA, 2023

CAEE-4

### It's All About the Pericardium

All Day Room: Learning Center

Felipe Aluja, MD, MEd (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Discuss the anatomy of the pericardium and the pericardial recesses with emphasis on CT and MRI. Identify selected entities affecting the pericardium, from benign to malignant, with a brief description of their clinical characteristics. Provide a deep review of the imaging findings from the conventional radiology to MRI, with emphasis in the ancillary findings that aid in the differential diagnosis approach. Describe the pitfalls and mimics of pericardial disease in conventional radiology, CT, MRI and PET/CT.

#### TABLE OF CONTENTS/OUTLINE

- Introduction
- Anatomy of the pericardium and pericardial recesses: from the schemes to the imaging.
- The pericardium in conventional radiology, CT, MRI and PET/CT.
- Conditions of the pericardium:
  - o Air, collections, hemorrhage, and pericardial tamponade
  - o Acute and chronic inflammation (including constrictive pericarditis)
  - o Benign neoplasms
  - o Malignant primary and secondary neoplasms
  - o Congenital lesions
- Try your best? Take home points

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-40

### Artificial Intelligence in Cardiac MRI- Applications, Pitfalls & Challenges

All Day Room: Learning Center

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the principles of Artificial Intelligence (AI) techniques relevant to cardiac MRI(CMR); 2. To discuss how AI can be applied to the different steps of the CMR; 3. To illustrate common applications of AI in CMR

#### TABLE OF CONTENTS/OUTLINE

1. AI, MACHINE LEARNING, DEEP LEARNING; 2. CHALLENGES OFCMR- complex anatomy, pathology, planes, sequences 3. AI NETWORKS- Convolutional neuronal network (CNN), general adversarial network (GAN); 4. ILLUSTRATION OF CLINICAL APPLICATIONS OF AI IN CARDIAC MRI WITH CASE EXAMPLES AND TECHNIQUES USED A. Upstream- Protocolling, workflow management/prioritization B. Image acquisition- Plane prescription; Patient positioning; Automated cardiac MRI planes; Automated selection of inversion time; B. Image reconstruction- Decreased artifacts; Decreased noise; Decreased acquisition time; Improved resolution- Super resolution ; Virtual Native Enhancement without contrast (VNE); Synthetic strain; C. Segmentation of structures- Ventricular volumes, function, mass in SSFP, Vascular anatomy in MRA; D. Automated quantification- Volumes, mass, function, LGE, parametric mapping (T1, T2, ECV), flow, strain, aortic diameter; E. Automated post-processing- perfusion, 4D flow; F. Classification of disease- Scar from non-contrast cine, Cardiomyopathies, CAD, myocardial infarction, atherosclerotic plaque, valvular disease, heart failure G. Prognostic factors- Risk stratification- Predictive models; H. Radiomics /Textural analysis I. Automated reporting J. Automated CMR pipeline 5. CHALLENGES- Small, biased training datasets, black box, quality criteria for algorithm design; 6. PITFALLS - Inaccuracies; 7. FUTURE DIRECTIONS- Good Machine learning practices.

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## Abstract Archives of the RSNA, 2023

CAEE-41

### Emerging Applications of Non-Contrast Cardiac CT: Beyond Coronary Score

All Day Room: Learning Center

Masafumi Kidoh, MD, PhD (*Presenter*) Endowed Chair, Koninklijke Philips NV

#### TEACHING POINTS

Teaching Points 1. Non-contrast cardiac CT is widely used to detect and quantify coronary and heart valve calcium. On the other hand, detection of fat, myocardial edema, thrombus/hematoma, and subtle myocardial calcification beyond coronary and heart valve calcification using non-contrast cardiac CT has not been widely performed, possibly due to poor image quality. 2. Recent advances in CT technology (such as model-based iterative reconstruction and dual-layer spectral/photon-counting CT) have drastically improved the low-contrast resolution of CT images, allowing the detection of small differences in CT values within soft tissue on non-contrast and delayed phase cardiac CT images. Side-by-side viewing of non-contrast cardiac CT images and delayed (or arterial) phase cardiac CT images may be useful in differentiating various pathologies. 3. In this exhibit, we report that non-contrast cardiac CT is useful for the detection and characterization of cardiac low-contrast lesions (soft tissue lesions) beyond coronary and heart valve calcification.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline 1. Scan and reconstruction techniques for non-contrast cardiac CT - Single-energy CT - Dual-energy CT - Photon-counting CT 2. Principle of CT number in non-contrast cardiac CT 3. Clinical applications: beyond coronary score - Calcification - Thrombus/hematoma - Anemia - Water/myocardial edema - Fat 4. Future directions 5. Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-42

### From Cyan to Cinnabar - The Radiologist's Role in Operative Management of Single Ventricle Congenital Heart Disease

All Day Room: Learning Center

#### Awards

##### Cum Laude

Shravan Sridhar, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Single ventricle congenital heart diseases are rare and challenging to manage. While historically, outcomes have been poor, recent advancements in surgical management have improved post-operative outcomes and long-term prognosis. Imaging has also advanced from morphologic characterization to assessment of function and flow dynamics. Here, we present a framework for understanding the pathophysiology of the single ventricle state and 3-stage palliation repair, review important imaging-informed decision points along the course of operative management, and present metrics important to long-term outcome and management.

#### TABLE OF CONTENTS/OUTLINE

1. Title slide, disclosures2. Abbreviations3. Table of contents4. Normal physiology5. Single ventricle physiology6. Norwood/DKS7. mBTT and RV-PA conduit8. Glenn procedure, mention of Kawashima9. Fontan procedure10. Operative management, main decisions11. Single (SVR), biventricular (BiVR), or 1.5 ventricle (1.5VR) repair?12. SVR Ex) AV canal13. CT/MRI evaluation14. BiVR Ex) DORV15. CT/MRI evaluation16. 1.5VR Ex) Tricuspid atresia17. CT/MRI evaluation18. 1.5VR Ex) Ebstein anomaly19. CT/MRI evaluation20. Safe for hybrid/bridge-to-Norwood?21. Example22. Hybrid procedure, relevance of HLHS, and risk factors for retrograde aortic arch obstruction23. CT/MRI evaluation24. Safe for Glenn?25. Example26. CT/MRI evaluation27. What features may change Fontan approach?28. Pre-Fontan operative planning example29. CT/MRI evaluation prior to Fontan30. Failing Fontan and BiVR or 1.5VR conversion surgery31. Preop. Items (e.g. LVOT widening, valvuloplasty)32. CT/MRI evaluation prior to conversion surgery33. Summary34. References

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## Abstract Archives of the RSNA, 2023

CAEE-43

### Myocardial Strain Analysis Using Feature Tracking

All Day Room: Learning Center

Masaya Kisojara, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Myocardial strain refers to the deformation of the walls and chambers of the heart from a relaxed to a contracted state. 2. Feature tracking is a technique that enables the analysis of myocardial strain. 3. Strain analysis performed in the left ventricle and the left atrium is a better prognostic indicator for heart failure than left ventricular ejection fraction. 4. Strain analysis by feature tracking might apply to 4D-CT images.

#### TABLE OF CONTENTS/OUTLINE

1. The concept of myocardial strain and its types: Myocardial strain using feature tracking is an alteration of length in one dimension or spatial orientation. Left ventricular strain is classified as radial, circumferential, and longitudinal strain. Left atrial strain is obtained as global longitudinal strain. 2. The principle of features tracking: Template matching is a technique that follows similar templates during the process of myocardial contraction. 3. The importance of myocardial strain for patients with heart failure. 4. What is left atrial strain? The left atrial strain is an index that reflects the diastolic and contractile capacity of the left atrium. Similar to the left ventricular global longitudinal strain, it is helpful in predicting prognosis in heart failure with preserved left ventricular ejection fraction. 5. An experiment using 4D-CT for myocardial strain analysis

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## Abstract Archives of the RSNA, 2023

CAEE-44

### **The Role of Gadolinium Enhancement Patterns in Diagnosing Myocardial Diseases at Cardiac MR - Enhancing Residents' Knowledge**

All Day Room: Learning Center

Otávio Augusto Ferreira Dalla Pria, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The abnormal myocardium can depict different patterns of gadolinium contrast enhancement depending on the cause of the injury. Therefore, assessing enhancement patterns in Cardiac MR plays a pivotal role in diagnosing diverse myocardium diseases. Ischemic cardiomyopathies produce delayed vascular-distributed gadolinium enhancement, and non-ischemic patterns are not limited to vascular territories. Patterns of enhancement distribution are crucial in differentiating between ischemic and non-ischemic heart pathologies and narrowing differential etiologic diagnostics in both. This exhibit aims: 1. To review myocardium gadolinium enhancement MR patterns. 2. To illustrate differential diagnostics based on the type of enhancement. 3. To discuss challenges and confounder factors.

#### **TABLE OF CONTENTS/OUTLINE**

1- Introduction/Objectives: Cardiac MRI can help diagnose a plethora of myocardial dysfunction. The gadolinium enhancement pattern is one of the characteristics that can help identify differential diagnostics. In this presentation, we summarize and illustrate the 5 types of cardiac MRI enhancement patterns and correlate findings with main differential diagnostics. 2- Case-based approach: Present 5 Patterns of Enhancement in Cardiac MRI (Subendocardial, subepicardial, transmural, patchy, mid-myocardial/mesocardial), correlating with primary differential diagnostics through didactical cases illustration in both ischemic and non-ischemic cardiomyopathies. 3- Limitations, Conclusion, and Take-home messages.

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## Abstract Archives of the RSNA, 2023

CAEE-45

### Role of Multi-Modality Imaging in Cardio-Obstetrics

All Day Room: Learning Center

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cardio-obstetrics is an expanding subspecialty that focuses on prevention, early detection, and management of cardiovascular disease (CVD) in pregnancy. 1. To review the cardiovascular complications in pregnancy; 2. To understand disease processes exacerbated by pregnancy; 3. To discuss the role of imaging in cardiovascular complications of pregnancy and pre-conception planning; 4. To understand the concept of pregnancy heart team and risk stratification

#### TABLE OF CONTENTS/OUTLINE

1. INTRODUCTION ;2.PHYSIOLOGICAL CARDIOVASCULAR CHANGES OF PREGNANCY;3. ROLE OF IMAGING IN PREGNANCY;4. IMAGING MODALITIES;5. COMPLICATIONS RELATED TO PREGNANCY (Discussion, clinical features, imaging findings and differential diagnosis with case examples)-Cardiac- Heart failure, arrhythmia, thromboembolism;Obstetrics- hypertension, Preeclampsia, hemorrhage;Perinatal-miscarriage, premature delivery, restricted growth;Venous thromboembolism including PE;Amniotic fluid embolism;Peri-partum cardiomyopathy;Spontaneous coronary artery dissection;Pulmonary hypertension;Hypertensive disorders (Eclampsia/Pre-eclampsia);Heart failure and arrhythmias;6.EXACERBATION OF PRE-EXISTING CVD DURING PREGNANCY (Illustration with case examples)-Inherited aortic diseases;Congenital heart disease;Hereditary hemorrhagic telangiectasia;Valvular disorders;7. PRECONCEPTION PLANNING- Risk stratification;8. CARDIOVASCULAR CHANGES IN ABDOMINAL DISEASES;9. ISSUES RELATED TO IMAGING IN PREGNANCY;- CT- Radiation, contrast agents- MRI- Gadolinium10. APPROPRIATENESS CRITERIA for imaging in pregnancy; 11. FLOW-CHART SHOWING systematic approach to imaging pregnant patients.

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## Abstract Archives of the RSNA, 2023

CAEE-46

### Single Ventricle: A Radiology Primer for Pre-Procedural Evaluation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the spectrum of lesions that result in a single ventricle 2. To discuss the surgical options in the management of single ventricle 3. To illustrate the different types of single ventricle using case examples 4. To highlight critical imaging parameters necessary for pre-procedural planning

#### TABLE OF CONTENTS/OUTLINE

1. SINGLE VENTRICLE- Definition, types 2. ROLE OF MULTIMODALITY IMAGING- Echo, CT, MRI, Cardiac cath, nuclear medicine 3. CT AND MRI- Indications, protocols, tips and tricks 4. REVIEW AND ILLUSTRATION OF PHENOTYPES OF SINGLE VENTRICLE Right dominant- Hypoplastic left heart syndrome, mitral atresia, double inlet/outlet RV; Left dominant- Hypoplastic right heart syndrome, Tricuspid atresia, Double inlet LV ; Either- unbalanced AV canal (Right/left); Functional single ventricle- TOF with pulmonary atresia, truncus, TAPVR, Severe Ebsteins anomaly, Tricuspid atresia, Double inlet LV/RV, AV canal defect (balanced/unbalanced), heterotaxy 5. ANATOMICAL CHARACTERIZATION- Atrial situs, ventricular situs, great artery relationship, morphologic LV vs RV, functioning/rudimentary ventricles 6. CRITICAL PARAMETERS NECESSARY FOR SURGICAL/INTERVENTIONAL MANAGEMENT - Ventricular function- Poor prognosis if low - Atrial septal restriction - Bulboventricular foramen in DILV or tricuspid atresia with TGA - Atrioventricular valve- Obstruction or regurgitation - Outlet obstruction- Presence and nature - Vascular resistance- Pulmonary and systemic - Patency of ductus arteriosus - Patency of aortic arch - Pulmonary artery anatomy - Venous connections 7. MIMICS- Criss-cross heart; Superoinferior ventricle

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-47

### Generating Cardiac Segmentation Datasets: Automated Segmentation and Tool-Based Manual Correction

All Day Room: Learning Center

Hirohisa Oda, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Easy label generation for custom AI: Manual correction tool for cardiac segmentation

#### TABLE OF CONTENTS/OUTLINE

- Application-specific custom AI for cardiac segmentation\* Our application: Modeling patient-specific therapeutic instrument-  
Outline\* Step 1: AI-based segmentation with a very limited number of cases for automated segmentation on other cases\*  
Step 2: Manual correction with our original tool- Step 1: AI-based segmentation\* Innovations from the "U-Net era"\* Trainable  
with limited training datasets as "seeds" of dataset generation\* Key technologies: Swin Transformer Self-supervised training  
[1]\* Examples of automatic segmentation- Step 2: Manual correction with our original tool\* HeartCorrect: Our original plugin  
for an image visualization tool MITK-Workbench\* Utilizing MITK's interpolation feature\* Automated correction for obeying the  
anatomical relationships of chambers- Comparison with MONAI Label[1] Hatamizadeh, Ali, et al. "Swin UNETR: Swin  
transformers for semantic segmentation of brain tumors in MRI images." BrainLes 2021, LNCS 12962, 2022.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-48

### Myocardial Delayed Enhancement By Spectral CT: Our Experience

All Day Room: Learning Center

Almudena Gil Boronat, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Role of Late enhancement in cardiac dual-CT. 2. Show the protocol we are using in our centre. 3. Present CT-MRI correlation in several pathologies, mainly in myocarditis

#### TABLE OF CONTENTS/OUTLINE

1. Background Quick review of the pathophysiology and usefulness of late enhancement in cardiological studies. 2. Spectral CT and acquisition protocol used in our center. 3. Representative cases of different diagnoses with CT-MRI correlation. 4. Conclusions. 5. Bibliography.

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## Abstract Archives of the RSNA, 2023

CAEE-49

### **Mitral Valve Disjunction: The Great Unknown**

All Day Room: Learning Center

Almudena Gil Boronat, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review mitral valve disjunction (MVD) 2. Role of MRI in the evaluation of radiological features associated with and pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background Revision of mitral valve disjunction • Definition • Pathology • Classification • Location 2. Representative cases of different disjunction types. 3. Representative cases of different radiological features associated with and pitfalls. 4. Conclusion. 5. Bibliography.

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## Abstract Archives of the RSNA, 2023

CAEE-5

### All “In Vein”? Anatomy, Variations and Abnormalities of Coronary Venous System with an Emphasis on CT Findings and Clinical Importance

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Firat Atak, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Cardiac CT can provide substantial information regarding cardiac venous anatomy and anomalies although it is mainly used for the evaluation of coronary arterial system. 2. Radiologists can more readily identify cardiac venous anomalies on CT by having a basic knowledge of the normal venous anatomy, adding venous anomalies to the standard checklist, and being aware of the conditions in which these anomalies may be clinically significant. 3. Cardiac venous system anomalies may be vital in percutaneous interventions and surgical procedures as they may fundamentally influence the course of the procedure or change the operation plan.

#### TABLE OF CONTENTS/OUTLINE

A. Overview of normal cardiac venous anatomy B. Scan protocol and postprocessing C. Coronary sinus (CS) variations and anomalies with case examples D. Other cardiac vein variations with case examples E. Clinical importance of the cardiac venous system -Cardiac shunts -Cardiac resynchronization therapy -Coronary sinus pacing -Retrograde cardioplegia - Percutaneous mitral anuloplasty -Percutaneous atriotomy (Levoatrial-to-coronary sinus shunting) for heart failure - Percutaneous in situ coronary venous arterialization (PICVA) -Enlargement of CS and clinical importance of PLSVC - Radiofrequency catheter ablation - Central venous interventions F. Conclusion

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## Abstract Archives of the RSNA, 2023

CAEE-50

### State-of-the-Art Multimodality Imaging of Cardiac Transplant and Complications: A Practical Update

All Day Room: Learning Center

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To discuss the normal appearances of cardiac transplant 2. To optimize the CT and MRI protocols for evaluation of patients with cardiac transplant 3. To illustrate the imaging appearances of various complications following cardiac transplant

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Indications- Heart failure, intractable angina or arrhythmia, cardiomyopathies, congenital heart disease, cardiac tumor) 3. Cardiac transplant techniques- Orthotopic vs heterotopic, bicaval vs biatrial 4. Role of imaging in evaluation of cardiac transplant 5. Imaging techniques- Echo, CT, MRI, Cardiac catheterization, Intravascular ultrasound, Optical coherence tomography, nuclear medicine 6. Cardiac transplant follow up diagnostic pathway 7. Imaging protocols for follow up= CT-No premedications, Photon counting CT; MRI- Quantitative techniques, T2, T1 mapping; 8. Complications- Review of the following complications with illustrative case examples- Post procedural graft dysfunction; Post surgical- pericardial effusion, mediastinal hematoma; Cardiac Allograft Vasculopathy (CAV) - Diffuse, more aggressive, microvasculature-angiography vs CTA; Acute cellular rejection; Chronic rejection; Accelerated coronary atherosclerosis; Infections; Post-transplant lymphoproliferative disorder; Gout; Osteoporosis; Chronic kidney disease;

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## Abstract Archives of the RSNA, 2023

CAEE-51

### The Heart of the Matter: Pearls and Pitfalls in Cardiac CT

All Day Room: Learning Center

Katherine Chung, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cardiac CT imaging is a valuable diagnostic resource for physicians to evaluate cardiac anatomy and function. The indications for CT imaging include evaluation of the coronary vessels for anomalies, presence of coronary artery disease (CAD) and calcium score, pre-TAVR evaluation, pre-ablation study for atrial fibrillation, and observing the patency of grafts, amongst other reasons as well. Although radiologists regularly read these types of images, radiologists-in-training may have variable levels of exposure and can come across cases that lead to confusion. The goal of this presentation is to elucidate the essential pearls of acquiring and evaluating cardiac CT scans, so radiologists-in-training are comfortable and confident with evaluating CT scans and providing appropriate recommendations. Furthermore, we will highlight the common areas of confusion through case-based examples of common pitfalls that may occur.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction 2) Indications and contraindications (Efficacy in disease diagnosis) 3) Definitions and Anatomy 4) Protocols and Techniques for acquiring images 5) Pearls and Pitfalls (Pre-ablation study for atrial fibrillation, Pre-TAVR study, Calcium Score, Coronary Artery Disease, Thoracic aortic aneurysm) 6) Artifacts (Stair Step artifact, Streak artifact from CABG or TAVR patients, Motion) 7) Conclusion

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## Abstract Archives of the RSNA, 2023

CAEE-52

### **From Pumps to Waves: Understanding the Impact of Mechanical Circulatory Assist Devices on Spectral Doppler Ultrasound Analysis**

All Day Room: Learning Center

Mateus K. Soares (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Heart failure (HF) is a syndrome resulting from impaired ventricular filling or ejection. Many patients with HF progress to a refractory state, regardless of advanced therapies. Cardiac transplantation remains the definitive treatment for end-stage disease. Mechanical circulatory assist devices (CAD) help support patients with cardiogenic shock or end-stage HF. It may be used as a short-term device to support hemodynamically unstable patients, including those with the possibility of heart function recovery, or as long-term device usually as a bridge to transplantation. CAD are mechanical pumps that help an impaired ventricle maintain hemodynamics and preserve satisfactory end-organ blood flow. There are commercially available devices to support both the left and right ventricle. In most cases, the spectral Doppler waveform is altered in the setting of a CAD, reflecting systemic hemodynamic changes. Despite the increasing use of these devices, there is not much information in the radiological literature about spectral Doppler changes in these patients. Accurate diagnosis requires a better understanding of CAD mechanisms and associated Doppler ultrasound findings, as well as possible vascular complications.

#### **TABLE OF CONTENTS/OUTLINE**

Review the normal arterial Doppler waveforms in patients with preserved cardiac function. Describe the mechanisms of various CAD and their hemodynamic impacts on arterial spectral Doppler waveforms. Discuss the main vascular-related complications and the use of ultrasound in diagnosis.

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## Abstract Archives of the RSNA, 2023

CAEE-53

### **Blood-Flow Volume Quantification Using Phase-contrast MRI in Congenital Heart Disease: Pre- and Post-surgical Evaluation**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Nobuko Tanitame, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Phase-contrast (PC) MRI can be used to measure blood flow in patients with congenital heart disease (CHD). Although Doppler echocardiography can provide shunt flow velocities in patients with common CHD such as atrial or ventricular septal defects, it may be limited by natural or surgical variations. On the other hand, PC MRI can provide precise blood flow analysis non-invasively for patients with complex CHDs and post-surgical anatomy. We demonstrate the principles and potential pitfalls of blood flow volume quantification using PC MRI and present some cases such as a coronary fistula, anomalous origin of one pulmonary artery from the aorta, and a patient who underwent a Blalock-Taussig shunt operation.

#### **TABLE OF CONTENTS/OUTLINE**

1. Principles of PC flow volume measurement - A review of PC MRI technique, semi-automatically flow volume measurements
2. Pitfalls of PC flow volume measurement - Velocity encoding (VENC) selection considering aliasing and low phase shift value, spatial and temporal resolution, image plane setting, respiratory motion artifact, validation strategies
3. Blood flow volumes commonly measured in our hospital - Ascending aorta, main/right/left pulmonary artery, superior/inferior vena cava, the cross-section of mitral/tricuspid valve, right/left pulmonary vein
4. Representative cases - Right coronary artery to left ventricular fistula, right pulmonary artery from the descending aorta, post-surgical patients (modified Blalock-Taussig shunt, Glenn procedure, cardiac plug implantation, balloon angioplasty etc.)

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## Abstract Archives of the RSNA, 2023

CAEE-54

### **A Novel Coronary CT Imaging Technique that Further Improves the Spatial Resolution of Super Resolution Deep Learning Reconstruction**

All Day Room: Learning Center

Takayoshi Yamaguchi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the current status in coronary CT image evaluation and summarize its limitations 2. Summarize the relationship between spatial resolution and image noise in the current various CT image reconstruction methods 3. Explain the features of the new super resolution deep learning reconstruction (SR-DLR) algorithm trained using the data acquired by the super resolution CT system 4. Proposal of a new imaging method that further improves the spatial resolution of the SR-DLR algorithm and improves the visualization capabilities of coronary arteries, stent lumens, and calcified lesions 5. Comparison of image quality and exposure dose between conventional and new imaging methods

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Summarize the limitations of assessment of STENT lumens and calcified lesions using current CT imaging 3. Explains the features and usefulness of the new super resolution deep learning reconstruction (SR-DLR) algorithm trained using data acquired by a super-resolution CT system 4. Limitations of coronary CT imaging under normal scanning conditions using the SR-DLR algorithm 5. Proposal of a new imaging method that further improves the spatial resolution of the SR-DLR algorithm 6. Description of focal spot sizes used in coronary CT for super-resolution and conventional CT systems 7. Presenting the spatial resolution and image noise of small-focus imaging combined with the SR-DLR in conventional CT systems 8. Comparison of images with different focal spot size for stents and calcified lesions in the same cases, presenting the usefulness of small-focus imaging 9. Comparison of exposure dose in imaging at each focal spot size

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## Abstract Archives of the RSNA, 2023

CAEE-55

### Cardiac CT Pearls and Pitfalls: What You Should Know About Anatomy to Avoid Catastrophes

All Day Room: Learning Center

Amalia Aranaz Murillo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understanding the different visual axes in cardiac imaging is crucial for interpreting cardiac anatomy. 2. Familiarity with the characteristics and structures of the atriums and ventricles is essential for accurate diagnosis and assessment of cardiac function. 3. Knowledge of main coronary arteries and their pathways and bifurcations is vital for accurate assessment of coronary artery disease. 4. Understanding the anatomy and branches of the coronary and pulmonary veins is essential for evaluating cardiac function and assessing for potential blockages.

#### TABLE OF CONTENTS/OUTLINE

We sometimes read a poster or a review and feel quite deceived because what you expect to learn you already know. For that reason, this poster will have at the beginning a QA. If you know all the answers, please, do not waste time on it, if not, it might teach you some anatomy tricks. It will be divided into seven blocks that detail the anatomy and structures of the heart in CT. The first block describes the different visualization axes of the heart and evaluates structures such as the anterior and inferior wall of the myocardium, the left atrial appendage, and the coronary sinus. The second block focuses on the characteristics of the right atrium and its different structures. The third describes the components of the ventricles and their structure. The fourth focuses on the major arteries of the heart, including the aorta and pulmonary artery. The fifth block details the four main coronary arteries and their paths and bifurcations. In the sixth, the coronary veins and their tributaries are explained, and finally, the anatomy of the pulmonary veins and their variability in the number and arrangement of drainage orifices to the left atrium is described.

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## Abstract Archives of the RSNA, 2023

CAEE-56

### Complications After Cardiac and Ascending Aorta Surgery

All Day Room: Learning Center

Maria Guerrero Martin (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To understand and distinguish the different types of ascending aorta surgeries 2. To evaluate the pathological findings after cardiovascular surgery, in order to differentiate them from the usual ones 3. To discern the most typical complications in relation to their chronological onset and their follow-up 4. To show the possible options in the management of patients with these complications 5. To emphasize the role of CT in the diagnosis of these conditions

#### TABLE OF CONTENTS/OUTLINE

1. Background and methods 2. Findings 2.1. Techniques used to evaluate postoperative patients 2.2. Common findings after cardiovascular surgery 2.3. Complication following aortic surgery 2.3.1. Early complications: periprosthetic haematomas, pseudoaneurysm formation, distal malperfusion 2.3.2. Late complications: aortic valve regurgitation, infection, anastomotic stenosis 2.4. Complications following cardiac valve surgery: valvular/paravalvular regurgitation, endocarditis, hypoattenuating leaflet thickening, prosthesis-patient mismatch 2.5. Complications following coronary artery procedures: stenosis, thrombosis 3. Our experience 4. Conclusion

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## Abstract Archives of the RSNA, 2023

CAEE-57

### Cardiac MRI in Adult Orthotopic Heart Transplant

All Day Room: Learning Center

Sandra Quinn (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Outline unique CMR tissue characteristics of the transplanted heart 2. Discuss tissue characteristics suggestive of acute cardiac allograft rejection in the transplanted heart 3. Outline the role of quantitative myocardial stress perfusion in detection of epicardial and microvascular cardiac allograft vasculopathy 4. Provide an overview of the published data with respect to CMR and adult heart transplant

#### TABLE OF CONTENTS/OUTLINE

1. Cardiac MRI in Orthotopic Heart Transplant· Overview of structural and functional CMR and its role in major complications of heart transplant, i.e., acute cardiac allograft rejection and cardiac allograft vasculopathy.2. CMR Tissue Characterization in Orthotopic Heart Transplant· Describes the general considerations and overview of published values regarding CMR myocardial tissue characterization of the transplant heart.3. Acute Cardiac Allograft Rejection (ACAR)· Outline the published CMR myocardial tissue characterization values for patients with active ACAR and ACAR previous history.4. Cardiac Allograft Vasculopathy (CAV)· Illustrate with a representative clinical case the role of CMR quantitative perfusion in the identification of CAV· Describe expected resting and stress myocardial blood flow and myocardial perfusion reserve in heart transplant recipients vs healthy volunteers· Identify the role of myocardial perfusion reserve for identification of CAV· 5. The Key Evidence in Summary· Summary table outlining the published evidence for CMR in heart transplant and complications of heart transplant.

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## Abstract Archives of the RSNA, 2023

CAEE-58

### Pre and Postoperative CT Evaluation for Robotic and Minimally Invasive Coronary Artery Bypass

All Day Room: Learning Center

Omer Onder, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching points: 1. Robotic and minimally invasive coronary artery bypass is a safe and less traumatic surgical technique than open-heart surgery. It is considered the first-choice therapy for selected patients although the adoption has been slow in some institutions. 2. Imaging assessment prior to the surgery and providing relevant information to the surgeons is crucial for identifying suitable patients, anatomic assessment, surgical planning, and predicting outcomes. 3. Being familiar with the spectrum of expected postsurgical findings and complications following robotic and minimally invasive coronary artery bypass surgery is essential for radiologists to contribute to proper patient management.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline: A. Overview of surgical techniques: TECAB, MIDCAB, robotic assisted B. Indications and contraindications C. CT angiography for preoperative evaluation 1. Scan protocol and postprocessing techniques 2. Preoperative checklists 1) Aorta and iliofemoral arteries 2) Evaluation of lung, pleural plaques 3) Chest wall, diaphragm 4) Heart, pericardium, mediastinum 5) Aorta diameter, pulmonary artery diameter, ascending aortic calcification 6) Internal mammary arteries 7) LAD and other coronary arteries D. Procedural considerations E. Postoperative CCTA assessment, complications F. Conclusion

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## Abstract Archives of the RSNA, 2023

CAEE-59

### Navigating the Vortex: Advancements in Turbulent Flow Detection Using Cardiovascular 4D Flow MRI

All Day Room: Learning Center

Tetsuro Sekine, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

4D flow MRI has revolutionized the assessment of in vivo flow dynamics, leading to a better understanding of physiological flow in healthy subjects and those with thoracic aortic aneurysms, chronic aortic dissection complications, and aortic prostheses. A key finding related to altered blood flow is turbulence, which can be visually detected through vortices in 4D flow MRI. However, visual assessment is subjective, prompting the need for quantitative evaluations. Recent advancements have facilitated the quantification of turbulent parameters such as vorticity, energy loss, and turbulent kinetic energy using 4D flow MRI. This presentation will explore clinical evaluation methods for these turbulence indices while discussing specific diseases as examples.

#### TABLE OF CONTENTS/OUTLINE

1. The background of flow analysis
  - a. Clinical demands for flow analysis
  - b. 4D Flow MRI technique for flow analysis
  - c. Primary and secondary flow in a healthy aorta
  - d. Quantification of turbulence - vorticity, energy loss, and turbulent kinetic energy
2. Thoracic aneurysm
  - a. Helical flows in patients with bicuspid aortic valve
  - b. Association between aneurysmal development and wall shear stress
3. Aortic dissection
  - a. Blood flow volume quantification - forward and backward flow in the false lumen
  - b. Vortices in the false lumen
4. Post-prosthetic graft replacement
  - a. Quantification of turbulent blood flow induced by artificial aorta
  - b. Mechanical hemolytic anemia due to aortic arch graft stenosis
5. Hypertrophic cardiomyopathy
  - a. Vortex flow in the ascending aorta
  - b. Association between turbulent kinetic energy elevation and left ventricular mass increase

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## Abstract Archives of the RSNA, 2023

CAEE-6

### Beyond Coronary Artery Calcium: Cardiovascular Findings in Non-Gated Chest CT Scans

All Day Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the most common incidental cardiac findings on routine chest CT examinations. 2. To recognize which cardiac findings are relevant and can alter the clinical course and outcome of patients.

#### TABLE OF CONTENTS/OUTLINE

1. Coronary arteries: a). Anatomical variants (dominance) b). Coronary anomalies (origin)-Benign-Malignant c). Coronary artery calcium d). Coronary aneurysm e). Coronary artery fistula 2. Cardiac chambers: a). Intracavitary thrombus 3. Myocardium a). Myocardial infarction -Acute-Chronic b). Cardiomyopathy-Dilated-Hypertrophic c). Primary tumors-Fibroma-Myxoma d). Metastases-Chordoma-Lymphoma-Lung carcinoma-Melanoma e). Pseudotumors -Lipomatous hypertrophy of the interatrial septum 4. Valvular heart disease a). Anatomical variants -Bicuspid aortic valve b). Calcifications -Mitral annulus-Aortic valve 5. Congenital heart disease and thoracic vascular disorders: a). Atrial septal defects b). Patent ductus arteriosus c). Persistent left superior vena cava d). Aortic arch anomalies-Right sided -Double aortic arch e). Anomalous pulmonary venous drainage 6. Pericardial diseases: a). Pericarditis -Infectious-Iatrogenic-Autoimmune-Constrictive b). Pericardial effusion and hematoma c). Pericardial cyst d). Malignant pericardial involvement-Direct invasion-Metastases-Venous extension e). Pericardial fat necrosis

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## Abstract Archives of the RSNA, 2023

CAEE-60

### Quantitative Stress Perfusion Cardiac Magnetic Resonance: Why, How and When?

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Fai Wang Fong (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understand differences between qualitative, semi-quantitative and quantitative stress perfusion. 2. Understand how quantitative stress cardiac MRI (QuantCMR) is performed and calculated as well as how to interpret myocardial blood flow/ myocardial perfusion reserve. 3. Demonstrate clinical role of cardiac MRI quantitative stress perfusion. 4. Illustrate different pathologies and their appearances on cardiac MRI quantitative stress perfusion.

#### TABLE OF CONTENTS/OUTLINE

This exhibit will explain the recent interest and development of QuantCMR and how this differs from qualitative and semi-quantitative stress perfusion. Technical details of how QuantCMR is performed and quantified will be demonstrated along with tips/ tricks of how to get high quality perfusion maps. The exhibit will explain differences between dual bolus and dual sequence techniques and issues to be aware of with different stress agents. The exhibit will discuss how QuantCMR is being increasingly recognised as being useful in patients with ischaemia and non-obstructive coronary arteries (INOCA) to diagnose coronary microvascular dysfunction (CMD) as well in standard assessment of obstructive coronary artery disease. Clinical examples of these pathologies will be illustrated. In addition, other cardiac diseases will also be demonstrated to illustrate how QuantCMR perfusion maps appear in different disease entities such as dilated cardiomyopathy and hypertrophic cardiomyopathy. Knowledge gaps and future directions will also be discussed.

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## Abstract Archives of the RSNA, 2023

CAEE-61

### State of the Art on Acute Coronary Syndrome with Negative Coronary Angiography

All Day Room: Learning Center

Cesar Urtasun Iriarte I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To learn the definition of MINOCA and review the spectrum of causes that manifest as acute coronary syndrome with non-obstructive coronary arteries. To understand the role of cardiovascular imaging, learn about the management and, outline CT and MRI protocols.

#### TABLE OF CONTENTS/OUTLINE

A. Background, diagnosis, and management B. Assessment: CT and MRI protocols C. Acute coronary syndrome with negative coronary angiography a. MINOCA entities - Coronary plaque disruption- Coronary artery vasospasm- Coronary artery dissection- Coronary artery thrombosis/embolism- Coronary microvascular disorder- Myocardial oxygen demand-supply imbalance b. MINOCA-like entities Myocardial location (Tako-Tsubo, myocarditis, hypertrophic cardiomyopathy, dilated cardiomyopathy, infiltrative cardiomyopathy) Other non-cardiac mimickers (Vasculitis, pulmonary embolism, aortic dissection) D. Take-home messages

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## Abstract Archives of the RSNA, 2023

CAEE-62

### Development in Free-Breathing Coronary CTA for Patients With High Heart Rate: Using Non-Device Respiratory Gating Method

All Day Room: Learning Center

Nobuyuki Akiyama, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Technological advances make Free-Breathing Coronary CTA (FB-CCTA) possible, but there are challenges for patients with higher heart rate (HR). We have developed a protocol of FB-CCTA at high HR using a non-device respiratory gating method.

#### TABLE OF CONTENTS/OUTLINE

We have developed a method to reduce motion artifacts even at high HR from free-breathing images. Since multi-segment reconstruction can improve image quality and diagnostic accuracy at higher HR, Scans and post-processing were performed to allow the segment reconstruction from free breathing images. After electrocardiogram gated Dynamic Volume Scan, to avoid motion artifacts due to breathing, the non-device respiratory gating was performed. The respiratory arrest phase was analyzed using Time-Density-Curve (TDC) plotted from the region of interest drawn on the chest wall of the dynamic image. Multi-segment reconstruction used data from multiple cardiac cycles during respiratory arrest time analyzed from the TDC was performed. In addition, the reconstruction type was applied with full-iterative model-based reconstruction algorithms for improved Signal-To-Noise ratio (SNR). The resulting image was reduced motion artifacts and improved SNR. This method is feasible to provide acceptable image quality and diagnostic performance in CCTA with free-breathing and high HR.

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## Abstract Archives of the RSNA, 2023

CAEE-63

### Effectiveness of a Contrast Enhancement Boost Technique in Cardiac CT: Improved Detection of Late Iodine Enhancement (LIE) in Non-Ischemic Cardiomyopathy

All Day Room: Learning Center

Nobuaki Hasegawa, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To learn about issues of myocardial evaluation with Single-Energy CT.
- To learn about a subtraction technique with non-rigid registration, that can be used to represent an image of the myocardium.
- To learn the principles of the contrast enhancement boost technique (CE-boost) with non-rigid registration.
- To learn about the contrast-improving effects of CE-boost and its diagnostic value in non-ischemic cardiomyopathy.

#### TABLE OF CONTENTS/OUTLINE

A. Comparison of CNR between Single-Energy CT and other imaging techniques for non-ischemic cardiomyopathy. B. Advantages of non-rigid registration compared to rigid registration in subtraction techniques. C. Usefulness of non-rigid registration subtraction technique with CE-boost in LIE-CT. D. Clinical case of LIE-CT using CE-boost for preoperative CT examination for TAVI. E. Advantages of CE-boost in non-ischemic cardiomyopathy and its application in clinical imaging.

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## Abstract Archives of the RSNA, 2023

CAEE-64

### Cardiac MRI for the Beginner: A Step by Step Approach

All Day Room: Learning Center

Rebekah Lee, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cardiac MRI is a non-invasive modality for anatomical, functional and myocardial tissue evaluation of the heart for a variety of cardiovascular diseases. It holds immense diagnostic potential and despite its relative high cost, it is becoming more increasingly mainstay in cardiac evaluation. Some conditions that cardiac MR renders benefits to include ischaemic heart disease, cardiomyopathy, valvular disease, congenital disease, pericardial disease and characterization of cardiac masses. It supplements the initial cardiac work-up by providing an unobstructed field of view, myocardial tissue assessment and remains the gold standard for RV and LV volumetric assessment. It is a complex study and includes an arsenal of MRI sequences including cine, myocardial perfusion, parametric mapping and flow sensitive sequences, all tailored to the specific clinical indication or question. Reading a Cardiac MR for the novice radiologist/cardiologist can be a daunting task. With the need for more Cardiac MR readers and to demystify this process, this poster will aim to provide a basic navigational chart for the novice reader which will provide a foundation for them to build upon. Teaching points: An overview of cardiac MRI sequences, basic principles and utility of each sequence An basic approach to interpreting a cardiac study An algorithm approach to common cardiac conditions with case based examples.

#### TABLE OF CONTENTS/OUTLINE

Basic cardiac MR sequences and their purpose How to approach a Cardiac MR Basic techniques on qualitative and quantitative assessment with tips and tricks Algorithm for common conditions Case based discussion

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## Abstract Archives of the RSNA, 2023

CAEE-65

### **Late Iodine Enhancement of Myocardial with Deep Learning Reconstruction Under Low Radiation Doses and Low Contrast Doses: How to Get the Best Image Quality**

All Day Room: Learning Center

Yuuta Yasunaga (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Late Iodine Enhancement (LIE) of myocardium in cardiac CT has been reported to reflect fibrotic lesions in myocardium similar to Late Gadolinium Enhancement (LGE) in cardiac MRI, but requires a higher contrast dose and radiation dose due to contrast enhancement and noise effects. To solve this problem, we propose three new points in using imaging, reconstruction and subtraction technology. 1. Imaging technology: Low-voltage imaging according to BMI. 2. Reconstruction technology: Deep Learning Reconstruction (Contrast enhancement parameters "AiCE"). 3. Subtraction technology: special contrast-enhancing subtraction technology "CE-Boost". Using the above three methods enables significant contrast enhancement and noise reduction, even with LIE at low radiation doses and low contrast doses. In addition, using DLR provides stability in the uniformity of CT values required for myocardial Extra Cellular Volume (ECV) quantification.

#### **TABLE OF CONTENTS/OUTLINE**

(1) Combination of three special technologies (2) Reconstruction and subtraction technologies (3) Deep learning reconstruction and special subtraction (4) Stable noise reduction with DLR (5) Combination of three special technologies

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## Abstract Archives of the RSNA, 2023

CAEE-66

### Success Within Your Grasp: Planning for Mitral Valve Transcatheter Edge-to-Edge Repair

All Day Room: Learning Center

Hyun Jung Koo, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To recap the evidence of mitral edge-to-edge repair in both primary and secondary mitral regurgitation To demonstrate preprocedural imaging modalities to help appropriate patient selection and interventional guide To understand intraprocedural imaging and post-procedural imaging findings

#### TABLE OF CONTENTS/OUTLINE

1. Evaluation of mitral regurgitation (MR) 1) Etiology of MR - Primary mitral regurgitation - Secondary (functional) mitral regurgitation 2) Quantification of MR 2. Types of percutaneous mitral valve repair 3. Patient selection for M-TEER - AHA/ACC Guidelines for M-TEER - Review of Trials: EVEREST II trial, COAPT trial, MITRA-FR trial - Anatomically suitable mitral valve morphology 4. Pre-procedural planning for M-TEER - Echocardiography and cardiac CT - Evaluation parameters 5. Intra-/Post-TEER imaging of M-TEER 6. Potential complications after M-TEER

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## Abstract Archives of the RSNA, 2023

CAEE-67

### Multimodality Imaging in Sports Cardiology: New Kid on the Block

All Day Room: Learning Center

#### Awards

##### Cum Laude

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Although athletes' have low prevalence of coronary artery disease (CAD), they are prone for other cardiovascular disorders, which should be evaluated prior to suitability for athletic activity. 1. To review the role of Sports Cardiology, a relatively new subspecialty focused on athletes 2. To discuss the role of imaging, particularly MRI in the diagnosis of athlete's heart which is a structural adaptive change that overlaps with cardiomyopathies. 3. To illustrate with case examples the various entities that are encountered in athletes.

#### TABLE OF CONTENTS/OUTLINE

1. SPORTS CARDIOLOGY- INTRODUCTION a. Pre-athletic activity screening for diseases that may be worsened with sports activities b. Evaluation of diseases that cause adverse events in athletes 2. ROLE OF IMAGING- Echo, MRI, CT 3. MRI SEQUENCES AND PROTOCOL 4. ADAPTATIVE CHANGES IN ATHLETES= Endurance- Volume overload, increased wall stress, eccentric hypertrophy; Strength- Pressure overload, increased wall stress, concentric hypertrophy 5. MYOCARDIAL FIBROSIS IN ATHLETES- Prevalence and pattern 6. ATHLETE'S HEART (WITH CASE EXAMPLES)- Diagnostic criteria controversies; Distinguishing from mimics (Grey zone) a. Hypertrophic cardiomyopathy b. Dilated cardiomyopathy c. LV non compaction d. Arrhythmogenic cardiomyopathy 7. DISEASES CAUSING SUDDEN CARDIAC DEATH IN ATHLETES (with case examples) a. HCM b. ARVD C. Anomalous coronary arteries d. Commotio cordis e. Myocarditis 8. SCREENING STRATEGIES WITH IMAGING IN PROFESSIONAL ATHLETES 9. CTA IN RISK STRATIFICATION OF CORONARY ARTERY DISEASE 10. VETERAN ATHLETES AND MYOCARDIAL FIBROSIS- ARRHYTHMIA 11. ATHLETES AND COVID-19 12. MANAGEMENT OF INCIDENTAL FINDINGS IN ATHLETES

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## Abstract Archives of the RSNA, 2023

CAEE-68

### The Minimal Essence of Machine Learning for Cardiovascular Diagnosis

All Day Room: Learning Center

Ryo Ogawa, PhD, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Various information related to medical data can be obtained by machine learning. We explain how machine learning are used to cardiovascular diagnosis. 1. To review the role of machine learning.2. To explain the application of machine learning in cardiovascular diagnosis.3. To explain the principle of machine learning.

#### TABLE OF CONTENTS/OUTLINE

1. Linear regression; overview, algorithm, example (heart failure)2. Logistic regression; overview, algorithm, example (history of heart disease)3. Support vector machine; overview, algorithm, example (Differentiation of cardiomyopathy)4. Random forest; overview, algorithm, example (Differentiation of cardiomyopathy)5. Neural network; overview, algorithm, example (Classification of myocardial infarction)6. Explainable AI; overview, algorithm, example (Gradient-weighted class activation mapping, Guided gradient-weighted class activation mapping)7. Generative AI; overview, algorithm, example (Deep convolutional generative adversarial network)

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## Abstract Archives of the RSNA, 2023

CAEE-69

### **Denoise to Visualize: The AI-Driven Post-Hoc Denoising for High-Fidelity Cardiac CT**

All Day Room: Learning Center

Tatsuya Nishii, MD, PhD (*Presenter*) Speakers Bureau, Guerbet SA; Speakers Bureau, General Electric Company; Speakers Bureau, Siemens AG; Research Grant, Canon Medical Systems Corporation

#### **TEACHING POINTS**

In cardiac CT, maintenance the increased image noise from photon insufficiency is crucial while upholding high resolution. CT manufacturers have developed iterative and deep-learning reconstruction methods, but disparities exist. Advancements in AI enable image restoration, such as denoising through post-processing allowing radiologists to develop image-processing AI promoting the "democratization" of technology. This exhibit presents the development of a denoising method for high-fidelity cardiac CT using image-based deep learning and its clinical applications. Participants will learn about democratized image-processing AI and engage in its development and clinical application. In enhancement, we showcase cardiac CT images with the application of noise reduction technology, aiming to generate new ideas for diagnostic and prognostic imaging.

#### **TABLE OF CONTENTS/OUTLINE**

1. Importance of noise reduction in cardiac CT 1.1 Cardiac CT imaging techniques 1.2 Noise's adverse effects 2. AI denoising method differences 2.1 Deep-learning image reconstruction 2.2 Deep-learning post hoc denoising 3. Denoising AI development Process 3.1 Optimal network selection 3.2 Data preparation essentials 3.3 Training, validation, and testing 3.4 Implementation highlights 4. Clinical Showcases 4.1 Exposure Reduction 4.1.1 1/4 dose coronary CT angiography 4.1.2 1/3 dose myocardial delayed enhancement CT 4.1.3 Low-dose pediatric cardiac CT 4.2 Image quality enhancements 4.2.1 Improved diagnostic performance of coronary CT angiography 4.2.2 Enhanced myocardial delayed enhancement CT 4.2.3 Enhanced 3D rendering images

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## Abstract Archives of the RSNA, 2023

CAEE-7

### Atrial Septal Defects: A Multimodality Case-Based Approach

All Day Room: Learning Center

David Gonzalez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Outline the most common atrial septal defects and their associations. Demonstrate the role of cardiac MRI and CT in the diagnosis of atrial septal defects. Illustrate, through case reviews, the imaging findings of atrial septal defects. Discuss treatment options and morphological characteristics to treatment decisions.

#### TABLE OF CONTENTS/OUTLINE

This review presents a multimodality case-based approach to the diagnosis of Atrial Septal Defects (ASDs). ASDs are the most common congenital cardiac anomaly. Ostium secundum is the most common ASD. Some congenital syndromes, including Holt Oram Syndrome and Lutembacher Syndrome, have ostium secundum type septal defects as part of their spectrum. Sinus venosus can present as a superior or inferior defect, each with different anatomical associations. Ostium primum is within the spectrum of atrioventricular septal defects and is associated with endocardial cushion defects and Trisomy 21. Coronary sinus atrial septal defect is a rare disease presenting as permeability of the coronary sinus. Raghbi syndrome is a type of coronary sinus ASD defined as a PLSVC draining to an unroofed coronary sinus. The roles of CT and MRI offer information on coronary and pulmonary diseases, as well as other anatomical variations that can impact the patient's treatment. MRI also enables functional assessment of the flow, cardiac function, and myocardial tissue characterization. Ostium primum/atRIOventricular septal defects, coronary sinus defects, and sinus venosus defects are often treated surgically, while septum secundum type defects can be treated with transcatheter closure. The decision is based on the size, number, and shape of the defects.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-70

### Quantitative Myocardial Perfusion MR: State-of-the-Art

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Roberta Catania, MD (*Presenter*) Institutional Research Grant, Siemens AG

#### TEACHING POINTS

1. Quantitative perfusion MR is an objective and more reproducible tool to identify myocardial perfusion defects and differentiate artifacts compared to only qualitative assessment. 2. Quantitative perfusion MR is a non-invasive tool that can add significant value in the work-up of patients with suspected coronary artery disease and surveillance of post heart transplant patients.

#### TABLE OF CONTENTS/OUTLINE

Introduction - Physiology of myocardial circulation at rest and stress and autoregulation - Overview of current noninvasive imaging techniques for coronary artery disease assessment and their accuracy - Clinical applications of myocardial perfusion imaging including assessment for epicardial and microvascular coronary artery disease and heart transplant surveillance  
Imaging techniques - Pharmaceutical stress agents: mechanism of action and contraindications - Cardiac perfusion MR: physical principles, imaging sequences and protocol - Quantitative analysis: Ø Current quantification techniques (automated pixel-wise and dual sequence approach) Ø Absolute quantification and myocardial perfusion reserve (MPR)  
Imaging interpretation and case study- How to interpret quantitative perfusion and key information to be provided in radiology report - Normal quantitative myocardial perfusion MR - Atlas of different radiologic findings - Troubleshooting interpretations of complicated quantitative perfusion MR findings

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-71

### Utility of Non-contrast MRI for Preprocedural Assessment in Patients Undergoing TAVI

All Day Room: Learning Center

Naoki Hosoda (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To learn about the pre-procedural assessment for transcatheter aortic valve implantation. To learn about the validity of non-contrast MRI assessment. To learn about non-contrast MRI imaging protocols. To learn about the benefit patient gain by alternative non-contrast MRI.

#### TABLE OF CONTENTS/OUTLINE

A. Non-contrast MRI can be used as an alternative to contrast CT for patients with CKD and contrast allergies. B. Usefulness of non-contrast MRI to measure in the same way as contrast CT. C. Short imaging protocol focused on pre-procedural assessment of TAVI. D. Non-contrast MRI not only allows assessment comparable to contrast CT, but also avoids risks for patients with CKD and contrast allergy and allows radiation free imaging.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-72

### **Pulmonary Artery: Showcase of Congenital and Acquired Pathologies You Should Know**

All Day Room: Learning Center

Pedro L. Murra Falla, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the normal anatomy of the of the pulmonary artery and their branches. 2. To review the acquired and congenital causes. 3. To show the frequent findings in congenital pathologies. 4. To show the repercussion of the long-term affection of the pulmonary artery.

#### **TABLE OF CONTENTS/OUTLINE**

1. introduccion. 2. Normal anatomy of the pulmonary artery and their branches. 3. Acquired pathologies: Complications of chronic Pulmonary embolism, Dilated arteries secondary to pulmonary hypertension, Pulmonary Artery Stenosis and Pulmonary Veno-occlusive Disease. 4. Congenital pathologies: Pulmonary artery agenesis associated with aortopulmonary collateral arteries (MAPCAs), Pulmonary atresia with intact ventricular septum, Anomalous Aortic Origin of Pulmonary Arteries, Aneurysm, Absent pulmonary valve syndrome, Double-Outlet Right Ventricle, Dextro-Transposition of the Great Arteries, Anomalous left coronary artery from the pulmonary artery (ALCAPA), Pulmonary Artery Sling, pulmonary arteriovenous malformations. 5. Long term repercussion in the cardiac chambers and great vessels. 6. Review of the most commons surgical options and outcomes. 7. Discussion. 8. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-73

### **Dual-energy Late Iodine Enhancement Cardiac CT: What is Necessary to Achieve with Dual-Layer Spectral CT?**

All Day Room: Learning Center

Junji Mochizuki, MSc, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

A. To learn about late iodine enhancement (LIE): Imaging technique with dual-layer spectral CT. B. To learn how spectral imaging solves conventional imaging problems. C. To learn about the use of iodine density image for myocardial extracellular volume (ECV). D. To illustrate various clinical applications of these techniques by presenting clinical images.

#### **TABLE OF CONTENTS/OUTLINE**

A. Methods of scanning and contrasting late iodine enhancement (LIE) using dual-slice spectral CT. And their advantages and disadvantages. B. Advantage of spectral images over conventional CT for LIE. C. LIE image analysis. LIE by image subtraction and myocardial extracellular volume (ECV) by iodine concentration images. D. Evaluation of myocardial viability by LIE. Evaluation of OMI by subtraction-LIE. E. LIE myocardial viability evaluation. Evaluation of cardiomyopathies by ECV.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-74

### The ABC's of ECG - Practical Tips and Tricks for Salvaging ECG-Gated Cardiac CT

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Distinguish the various artifacts commonly encountered in ECG-gated cardiac CT 2. Recognize whether the artifact can be repaired, reduced, or read around 3. Employ ECG sync point editing and composing to salvage cardiac CTs degraded by artifacts from heart rate rhythm, and ECG-gating error

#### TABLE OF CONTENTS/OUTLINE

1. Introduction Basics of ECG interpretation; ECG-gating techniques, trade-offs, applications; 2. Distinguishing respiratory/patient motion vs. gating artifact 3. ECG Gating Error: Missing Data (interpolation artifact)- Pitch too high on retro helical - data gaps; Missing Sync Points; 4. ECG Gating Error: Misplaced Data (duplication artifact)- Peaked T-waves; 5. Gating Artifact with correct ECG Gating: Tachycardia or Arrhythmia- PVCs; PACs; Long pause (PVC, PAC, dropped beat); Afib other beat-to-beat Irregularity; 6. ECG-editing options- Sync point editing-Missed a beat/tagged wrong thing/helical; Sync point composing: R wave tagged, manipulation of reconstructions to read-around; 7. A systematic approach for troubleshooting ECG-gating errors and artifacts including case examples- Respiratory motion artifact- Normal ECG; Sinus tachycardia- Multisegment reconstruction; Heart rate change- Can sometimes be read-around; PVC without pause- Eliminate PVC sync; PVC with long pause- Eliminate PVC sync; Add evenly spaced sync points in pause; PAC- eliminate PAC sync or retain it extra, even sync points in best systolic phase; Atrial tachycardia- Sync in best systolic phase; Severe bradycardia- Two separate syncs in diastole; Atrial fibrillation- Artificially space sync points at each R-R interval so they line up each beat;

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

CAEE-75

### Tumors of the Heart: From the Right Side to the Left Side

All Day Room: Learning Center

Felipe Aluja, MD, MEd (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Discuss the most common cardiac masses, including their typical manifestations and associations, and a brief discussion of clinical scenarios. Describe the imaging signs of cardiac tumors in computed tomography, magnetic resonance imaging and PET/CT. Identify selected cardiac tumors commonly encountered in daily practice and integrate them with the clinical manifestations.

#### TABLE OF CONTENTS/OUTLINE

- Introduction
- Classification with brief but concise clinical presentation
- Imaging signs of cardiac tumors in computed tomography, magnetic resonance imaging and PET/CT.
- Selected cardiac tumors:
  - o Primary: § Myxoma § Fibroelastoma § Atrial hemangioma § Lipoma § Rhabdomyoma § Fibroma § Angiosarcoma § Lymphoma § Paraganglioma
  - o Secondary: § Metastasis
- Pitfalls in cardiac tumors:
  - o Vegetations
  - o Intracavitary thrombus
  - o Lipomatous hypertrophy
- Take a guess?
- Take home points

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-76

### Solving the Mystery: Cardiac Devices on Chest Radiographs

All Day Room: Learning Center

Justin Little, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Heart disease is the leading cause of mortality in the United States. Advances in clinical care leading to new devices and treatments allow patients to live longer. Radiologists encounter chest radiographs daily, many with cardiac devices. On radiographs, devices will typically be visible, and it is essential for radiologists to recognize them, know appropriate positioning, and understand complications related to the devices to provide appropriate patient management. Inaccurate interpretation may lead to inappropriate management, delayed diagnosis, and delay of necessary or harmful interventions. The purpose of this exhibit is to walk through common and uncommon cardiac devices, their appropriate positioning, and complications related to mispositioned devices, as well as discuss pathophysiology of some devices. Cardiac rhythmic controlled devices, cardiovascular support devices, stroke prevention devices, cardiac valve support and prosthetic valves, and miscellaneous devices will be reviewed.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to common cardiac devices
2. Classification of these devices
3. Expected positioning of cardiac devices
4. Visible and barely visible devices on CXR
5. Pathophysiological mechanisms of these devices
6. Examples of mispositioned devices
7. Complications related to incorrectly positioned devices
8. Less common/miscellaneous devices and their positioning
9. Flowchart of what to do with a mispositioned devices (urgent versus emergent)
10. What cardiologist expects from radiology report?

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-77

### **Simplifying Semantic Segmentation in Cardiac MR: An Intuitive Guide for Radiologists using Transfer Learning**

All Day Room: Learning Center

A Ankush, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Understanding the importance of semantic segmentation in cardiac MR imaging  
Review of available solutions for segmentation and evaluation metrics  
Introduction to approaches for segmentation using Transfer learning  
Guided approach to a simplified segmentation process using high-level API for low-code development.  
Best practices for achieving accurate segmentation

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction to Segmentation in Cardiac MRI Imaging  
Definition of image segmentation and its types.  
Need for segmentation in cardiac MRI imaging  
Available solutions for image segmentation and metrics for assessing accuracy  
II. Introduction to TorchIO, MONAI and FAST AI Libraries for Medical Image Analysis  
Overview of libraries.  
Understanding the Data to Model pipeline.  
Importance of Using Transfer Learning.  
Use of High-level APIs for low-code model development. III. Step-by-Step Demonstration of Segmentation using Google Colab and the Heart MRI Dataset  
Setting up the Google Colab environment  
Introduction to the Heart MRI dataset from the Medical Segmentation Decathlon challenge provided by King's College London  
Step-by-step demonstration of target segmentation of the left atrium with minimal lines of code  
IV. Best Practices for Achieving Accurate Segmentation  
Tips for optimising segmentation accuracy  
Strategies for addressing common segmentation challenges  
V. Conclusion  
Summary of key teaching points  
Future directions in semantic segmentation in cardiac MR imaging (like use of generative adversarial network (GAN))

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-78

### **A Precarious Path - Complications of 3-stage Palliative Surgery for Single Ventricle Congenital Heart Disease**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Shravan Sridhar, MD, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Single ventricle congenital heart diseases are most commonly managed with 3-stage palliation which culminates in the Fontan procedure. Post-operative imaging has been instrumental in assessing for complications both in the short term and long term and ensuring patient longevity. Here, we present some of the most commonly encountered complications associated with 3-stage palliation including early post-operative complications, features of physiologic decompensation, and late-stage downstream effects attributed to the unique physiology in these patients. Where appropriate, we review practical tips and pitfalls in imaging this unique set of patients.

#### **TABLE OF CONTENTS/OUTLINE**

1. Title, disclosures  
2. Abbreviations  
3. Complications overview  
4. Clinical scenarios  
5. Potential workup  
6. Recent operation  
a. Mediastinal hematoma  
b. Pitfall: Surgical packing material  
c. Shunt/conduit occlusion  
d. Pitfall: Un/intentional occlusion  
7. Acute SOB/desaturation/chest pain  
a. PE  
b. MI  
c. CHF  
8. Chronic non-cyanotic SOB/desaturation  
a. Fontan thrombosis  
b. Pitfall: Pseudothrombosis  
c. Systemic AV valve dysfunction  
d. Peri-anastomotic PA stenosis  
e. Pitfall: Morphology/flow discrepancy  
9. RPA/LPA  
f. Diaphragmatic paralysis  
g. Post-Glenn SVC syndrome  
10. Recurrent cyanosis  
a. Pulmonary AVM  
b. Systemic-pulmonary venous collaterals  
c. Practical tip: Quantifying collateral circulation  
d. Patent fenestration  
e. Baffle leak  
11. Arrhythmia  
a. Myocardial LGE  
12. Weight gain  
a. Liver failure  
13. Weight loss  
a. HCC  
b. Protein-losing enteropathy  
14. Chronic cough  
a. Plastic bronchitis  
15. Unexplained pleural effusion  
a. Chylous pleural effusion  
16. Potentially helpful clinical tests  
17. References

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## Abstract Archives of the RSNA, 2023

CAEE-8

### Coronary Artery Vasculitis, Encasement, and Mimics

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Claire F. Woodworth, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Coronary artery vasculitis is an inflammatory process that is often distinguished from coronary artery encasement from benign and malignant neoplasms, although imaging appearances can overlap. 2. Coronary artery vasculitis is rare but represents an important diagnostic consideration, especially for acute coronary syndrome (ACS) patients with no traditional cardiovascular risk factors or systemic illness. 3. There are several mimics of coronary artery vasculitis, demanding careful attention to multi-organ findings and clinical presentation.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Spectrum of coronary artery vasculitis and encasement. 3. Review and illustration of coronary artery vasculitis, including: polyarteritis nodosa, Kawasaki's disease, Takayasu's arteritis, giant cell arteritis, HIV. 4. Review and illustration of coronary artery encasement, including: malignant neoplasms (lymphoma, angiosarcoma), IgG4-related disease, Histiocytic disorders (Erdheim-Chester disease, Rosai Dorfman). 5. Complications of coronary artery vasculitis: aneurysms, stenosis, CHF. 5. Mimics of coronary artery vasculitis: spontaneous coronary artery dissection (SCAD), acute plaque rupture, vasospasm.

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## Abstract Archives of the RSNA, 2023

CAEE-80

### Women's Heart: Role of Cardiac Imaging in Early Detection and Prognostication of Heart Diseases- A Primer for Cardiac Imagers

All Day Room: Learning Center

Barun Bagga, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The diagnosis of heart disease in women poses unique challenges and remains underdiagnosed and undertreated. 2. Understanding the different etiologies of chest pain in women focusing on Acute myocardial infarction (AMI), MINOCA (myocardial ischemia with non-obstructed coronary arteries), myocarditis, Takostubo, LV apical ballooning, and connective tissue disease-related cardiomyopathy.3. AMI has a different presentation, underlying pathophysiology, and outcomes in women compared to men.4. MINOCA is more common in women and in a younger population, with fewer traditional risk factors for coronary artery disease (CAD) and a higher prevalence of non-obstructive coronary plaques.5. MINOCA has a higher all-cause mortality at 12 months compared to stable angina and has been found to have worse quality of life compared to AMI-CAD because they are less often treated with beta-blockers and less often referred to cardiac rehabilitation.6. Cardiac MRI (CMRI) plays a crucial role in the diagnostic algorithm because of accurate myocardial characterization independent of the presence of obstructive coronary lesions.7. CMRI has been shown to provide an etiologic diagnosis in as many as 77-87 % of cases of MINOCA and offers prognostic value with the extent of LGE involvement correlated with the risk of major cardiovascular events.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Review the different causes of chest pain in women in a case-based approach: a) MINOCA; b) SCAD; c) Myocarditis; d) Takostubo; e) LV apical ballooning; f) AMI; g) Connective tissue disease-related cardiomyopathy. 3. Review the role of cardiac imaging in diagnosis and prognostication.

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## Abstract Archives of the RSNA, 2023

CAEE-81

### Improved Assessment of Coronary Artery Calcium in Photon-Counting Detector CT: A Phantom Study with Various Imaging Modalities

All Day Room: Learning Center

Nobuo Kitera, RT, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Accurate assessment of calcified lesions in coronary arteries can help establish better treatment strategies. 2. CT can obtain preoperative calcification. information of coronary arteries, but it is difficult to completely complement intravascular imaging due to limitations in spatial resolution and other factors. 3. Photon-counting detector (PCD) CT has higher spatial resolution than conventional energy-integrating detector CT and is expected to improve the ability to visualize microstructures. 4. PCD-CT has the potential to provide new diagnostic value as a preoperative diagnostic tool by acquiring highly accurate coronary artery calcification imaging.

#### TABLE OF CONTENTS/OUTLINE

1. Importance of coronary artery calcification assessment in percutaneous coronary intervention.2. Characteristics of coronary artery calcification images in various imaging modalities.3. Features of PCD-CT, including principles of high-resolution imaging, and selection of scan mode and reconstruction kernel.4. Comparison of PCD-CT images with other imaging modalities using calcified phantom.

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## Abstract Archives of the RSNA, 2023

CAEE-82

### **Congenital Mitral Valve Disease: From Embryology to Pathology to Repair**

All Day Room: Learning Center

Jonathan A. Liu, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Congenital mitral valve disease can present in a myriad of ways, often differing in morphology, age of presentation, and symptoms. By understanding the development of the mitral valve apparatus, congenital mitral valve disease can be categorized based on which underlying apparatus structure is maldeveloped. The most common and clinically relevant mitral valve pathologies are discussed. Next, the general approach to evaluation of these congenital mitral valve pathologies is reviewed, highlighting the strengths and weakness of each imaging modality (CT, MRI, and echocardiography). Methods for quantification are also reviewed. Finally, the general approach to mitral repair and replacement in the context of congenital heart disease will be discussed.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Embryology and normal anatomy  
3. Anomalies based on location  
a. Supravalvular Lesions  
b. Anomalies of leaflets  
c. Anomalies of chordae  
d. Anomalies of papillary muscles  
e. Associated congenital heart diseases  
4. General approach to evaluation of congenital mitral valve disease  
a. Morphology  
i. Lesions best diagnosed by CT  
ii. Lesions best diagnosed by MRI  
iii. Lesions best diagnosed by echocardiography  
b. Flow  
i. Mitral regurgitation  
ii. Mitral stenosis  
iii. Mixed physiology  
5. Correction of congenital mitral valve disease  
a. Mitral valve repair  
b. Mitral valve replacement  
6. Conclusion

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

CAEE-83

### **Congenital Aortic Arch Anomalies: What the Clinician Wants to Know**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Muhammad Naeem, MD, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Anomalies and congenital variants of the aortic arch are important entities to be familiar with, as they are known to be associated with congenital heart disease, vascular rings, genetic syndromes, and can have significant impact in clinical management. It is postulated to occur as a result of abnormal embryonal organogenesis of the primitive aortic arches. Advanced imaging, specifically computed tomography angiography (CTA) and magnetic resonance angiography (MRA) play a crucial role in the pre-operative planning, as these cases present an anatomic challenge for surgical intervention. Imaging is essential in the diagnosis, management, surgical planning and eventual outcome in patients with congenital arch anomalies. This exhibit will outline the imaging that may be required, and the information needed by the surgeon to attain the best possible surgical outcome.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review anatomy of various congenital aortic arch anomalies, focusing on clinically significant anomalies that require surgical correction, through case-based examples. 2. Understand what are the most salient findings that should be reported to the surgeon in these case examples, so that pre-operative planning is optimized. We will review the clinically significant variants of congenital arch anomalies that require surgical correction, which may be unfamiliar due to their rarity in clinical practice. We will utilize case-based examples to demonstrate what the important imaging findings the radiologist should review and report to the surgeon. Our focus will cover the impact a radiologist can have in detecting these variants and to provide all the critical information to the surgeon, before an operation occurs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-84

### Imaging findings in Cardiac and Lung Transplant Emergencies and Urgencies

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Thangalakshmi Sivathapandi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Having comprehensive knowledge about hyperacute/acute complications of heart and lung transplants is crucial as imaging plays a vital role in the multidisciplinary management of these patients. 2. Despite many advances, a disproportionate portion of mortality still occurs in the early post-transplant period, hence prompt recognition of these complications is essentially needed to prevent allograft failure and death. 3. Accurate reporting by the radiologist could aid the clinician for timely intervention and appropriate patient care.

#### TABLE OF CONTENTS/OUTLINE

1. Overview: To review the salient radiological findings in hyperacute and acute complications of heart and lung transplant. 2. Heart transplant: primary graft dysfunction, post operative bleeding, pericardial tamponade, inferior and superior vena cava stenosis/injury, thromboembolism, sternal dehiscence, pseudoaneurysm, pulmonary edema, infection, and acute rejection. Highlighting the key findings of cross-sectional imaging studies including ultrasound, computed tomography, and magnetic resonance imaging with primary emphasis on CT findings. 3. Lung transplant: chest wall/pleural defects like wound dehiscence, acute and hyperacute rejection, primary graft dysfunction, bronchovascular anastomotic complications such as lobar torsion, bronchial dehiscence, and pulmonary arterial and venous stenosis/thrombosis, as well as bacterial, viral, and fungal infections among others.

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## Abstract Archives of the RSNA, 2023

CAEE-85

### The Emerging Role of Cardiac CT in Clinical Practice of Cardiac Amyloidosis

All Day Room: Learning Center

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Recent research has revealed a considerable number of hidden cardiac amyloidosis (CA) especially in patients with heart failure with left ventricular hypertrophy. CA is, however, frequently misdiagnosed as the other hypertrophic heart disease, and delayed diagnosis results in significant consequences for patients. 2. Current noninvasive diagnostic imaging strategies for CA include echocardiography, cardiac MRI, and bone scintigraphy. 3. Myocardial late iodine enhancement (LIE) and extracellular volume (ECV) quantification by cardiac CT has become clinically available and clinical evidence is accumulating. 4. Since CT is more practical than MRI and scintigraphy, it plays a clinically important role in the diagnosis and management of CA.

#### TABLE OF CONTENTS/OUTLINE

1. Basic knowledge of CA: - Classification of CA - Recent development on therapeutic agents 2. Current noninvasive diagnostic imaging strategies: - Echocardiography - Cardiac MRI - Bone scintigraphy 3. Myocardial tissue assessment using cardiac CT: - LIE imaging - ECV quantification - CT imaging protocols 4. The emerging role of cardiac CT for CA: - Efficient diagnostic flow and current evidence - Use in patients with mechanical devices - Application in patients with aortic stenosis - Application in patients with atrial fibrillation - Monitoring of therapeutic effect 5. Future directions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-86

### Genotype and Imaging Phenotype in Dilated and Arrhythmogenic Cardiomyopathy

All Day Room: Learning Center

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. With the rapid increase in the number of heart failure patients worldwide, research on personalized medicine for cardiomyopathy based on genomic information is being promoted. 2. In recent years, the relationship between genotype and phenotype in dilated cardiomyopathy (DCM) and arrhythmogenic cardiomyopathy (ACM) has been clarified. 3. Important pathogenic variants include titin (TTN), filamin C (FLNC), lamin A/C (LMNA), and desmoplakin (DSP), with characteristic genotypic-imaging phenotypes. 4. This presentation summarizes new findings on genotype-imaging phenotypes in DCM/ACM.

#### TABLE OF CONTENTS/OUTLINE

1. Evolving disease concept of DCM/ACM: - New diagnostic criteria for ACM (Padua criteria) - Arrhythmogenic right ventricular cardiomyopathy (ARVC) and arrhythmogenic left ventricular cardiomyopathy (ALVC) - Overlap of ACM and DCM 2. Genetic basis of DCM/ACM: - Genes encoding constituent proteins of cardiomyocytes - Genetic variants causing DCM/ACM 3. Genotype-imaging phenotypes in DCM/ACM: - Titin (TTN) - Filamin C (FLNC) - Lamin A/C (LMNA) - Desmoplakin (DSP) - Others 4. Important MRI, CT imaging findings: - Fibro-fatty replacement of myocardium - Ring-like delayed enhancement 5. Future directions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CAEE-87

### **Diagnosis of Coronary Microvascular Disease, Principle, Challenges, and Emerging Technologies of CT and MRI**

All Day Room: Learning Center

Takanori Kokawa, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the definition, classification, and standard diagnostic steps of coronary microvascular disease (CMD).2. To discuss the role of PET, MRI and CT in the diagnosis of CMD.3. To illustrate emerging CT and MRI technologies for characterizing CMD.

#### **TABLE OF CONTENTS/OUTLINE**

A) Definition and epidemiology of CMD.B) Pathophysiology of CMD.C) Diagnostic criteria and standard approach for CMD.D) Role of non-invasive imaging modalities including PET, MRI and CT.E) Emerging technologies for assessment of CMD. a. Myocardial blood flow quantification by MR perfusion imaging and CT perfusion imaging.(Clinical example - normal CCTA, subendocardial perfusion defect, reduced CFR by MRI) b. Coronary sinus flow assessment by phase-contrast cine MRI c. Fractal analysis of dynamic myocardial CT perfusion. d. Potential of photon-counting CT for characterizing myocardium.

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## Abstract Archives of the RSNA, 2023

CAEE-88

### **Demystifying the Mysteries of Heart Tumors and Tumor-like Conditions: A Succinct Approach for Radiologists**

All Day Room: Learning Center

Aniket Agarwal, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Highlight the basic protocol of cardiac magnetic resonance imaging and simplifying the anatomy to help alleviate the cardiac-MR phobia. Devise an algorithmic approach to narrow down the differential for cardiac masses by using the clinical history, age, signal intensity, location and enhancement characteristics of the mass. Each sequence tells its own story. Double inversion recovery sequence, Triple inversion recovery has their own advantage. Early and late gadolinium enhancement characteristics of the mass is one of the most important features in differentiating a thrombus from a myxoma and a fibroma from a sarcoma. Rhabdomyomas are usually multi-focal non-enhancing or hypoenhancing lesions. Cine sequences provide assessment of mass mobility, its attachment points and hemodynamic impact on cardiac valves. Characterization for differentiation between benign and malignant features.

#### **TABLE OF CONTENTS/OUTLINE**

Cardiac MR protocol and basic cardiac MRI sequences. Important anatomical landmarks. Sequence wise diagnostic approach - What to look on which sequence? Algorithms- cardiac tumor classification based on benign/malignant, age, location, imaging characteristics. Differentiating cardiac masses on MRI. Mimics of cardiac tumors including anatomical tissues. Advantages and pitfalls of cardiac MRI.

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## Abstract Archives of the RSNA, 2023

CAEE-9

### **Novel Approach for Comprehensive Preoperative Assessment of Valvular Heart Disease via Four Dimensional CT Datasets in the Era of Minimum Invasive Cardiac Surgery**

All Day Room: Learning Center

Koichi Osuda, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Recent years, surgical techniques of cardiac valvuloplasty, such as minimally invasive cardiac surgery (MICS) and robotic surgery, have developed dramatically. In exchange for less invasiveness, surgical procedures turned out highly technically demanding due to narrow operative field and deep working space. Comprehensive assessment of cardiac anatomy and preoperative simulation using various modalities would be more important than ever. We summarize the usefulness of cardiac CT, especially in preoperative physiological morphology assessment.

#### **TABLE OF CONTENTS/OUTLINE**

In valvuloplasty, to assess physiological morphology of valve complex under beating is one of the most important factors. Utilizing CT datasets, valve complex structures consisting of leaflets, chordae tendineae, papillary muscles, and prolapsing leaflet were faithfully reproduced, and allowed surgeon to observe and measure using 3D or 4D datasets. Furthermore, preoperative simulations via life size 3D models and virtual reality simulation systems constructed from high spatial resolution datasets have reached to the stage of practical use. The learning curve would be shortened by development of these simulation technologies, though construction treatment strategy and judging surgical procedures had been largely dependent on surgeon's experience in the past. We propose a novel approach for assessment the whole aspect of valvular heart disease using appropriate imaging modalities comprehensively.

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## Abstract Archives of the RSNA, 2023

CHEE

### Chest Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **CHEE-1 The Phoenix Pulmonary Opacity**

Adam F. Petraglia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The waxing and waning pulmonary opacity is a common finding often hiding in plain sight, akin to the mythical phoenix, which disappears only to reveal itself again later amongst the ashes. Crucial to narrowing the differential diagnosis is a broad-based knowledge of the natural course of these diseases, their laboratory and pathologic analyses, and utilization of the multi-disciplinary team. Overlapping characteristics demonstrates the importance of looking at secondary, non-parenchymal imaging characteristics, including radiographic findings outside of the thorax. Many of these are chronic and debilitating, if not fatal, which have often become treatable with the advent of chemotherapeutics and biologics. Therefore, having a systematic approach and a relationship with our clinical colleagues is critical in treating these successfully and timely to avoid associated morbidity and mortality.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Categorizing the waxing and waning pulmonary opacity 3. Demonstrate common primary imaging findings in the thorax (e.g., nodule/opacity characteristics) 4. Demonstrate common secondary imaging findings in the thorax (e.g., esophageal, lymphatic, cardiac) 5. Laboratory and pathologic correlatives 6. Role of the multi-disciplinary team in narrowing the differential diagnosis (Rheumatology, Pulmonology)

#### **CHEE-10 The 2021 WHO Classification of Lung Tumors: Takeaways for Radiologists Regarding Epithelial and Neuroendocrine Tumors**

Maria Clara N. Lorca, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This educational exhibit will review the tumors of the lung. 1. New 2021 WHO Classification of tumors of the lung. 2. Depict radiological features of tumors of the lung. 3. Describe the importance of PET-CT in the diagnosis and follow up. 4. Describe the pearls and pitfalls that some entities demonstrate in imaging, including benign entities that can appear as a lung tumor. 5. Evaluate the sufficiency of small biopsy samples for diagnosis. 6. Discuss the spectrum of post-treatment changes of the lung.

#### **TABLE OF CONTENTS/OUTLINE**

This education exhibit reviews biopsy-proven cases of tumors of the lungs and their correlation with pathology. Review with illustrative case examples the different tumors of the lungs in a systematic fashion. Incorporate the new 2021 WHO classification of the tumors of the lung. Depict the imaging appearances of various types of the above tumors, with emphasis in epithelial, neuroendocrine, and hematolymphoid tumors. Mesenchymal tumors will not be emphasized, as they were recently described on Radiographics this year. Differentiate between the types of tumors for which small biopsy versus resection sampling are indicated for diagnosis. Depict post-treatment changes of the lung, with examples including lung toxicity, pseudo-progression, and to distinguish these changes from true tumor recurrence and their impact on future therapy.

#### **CHEE-100 Pulmonary Tuberculosis in Children and Adults: A Classic Disease with Updated Concepts. What the Clinician Needs to Know**

Marta Barrios Lopez, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1. To compare the typical appearance of pulmonary tuberculosis (TB) between adults and pediatric patients. Both the manifestations and the management differ in children and adults. 2. To review the latest evidence on pulmonary TB. Radiologists need to know what information is relevant to the clinician as well as the implications of certain imaging findings.

## TABLE OF CONTENTS/OUTLINE

1. Introduction: Epidemiology and transmission mechanism in children vs adults. 2. Pathophysiology: Traditional vs new concept. The latest evidence has shown that the radiological appearance of the disease mainly depends on the host immune response and not on the time from infection. 3. Classification of Pulmonary TB according to Clinical and Radiological factors. 3.1. Active Disease: Primary Tuberculosis: 1. Lymphadenopathy in adults/children. 2. Parenchymal disease in adults/children. 3. Pleural effusion in adults/children. 4. Miliary TB in adults/children 3.2. Active Disease: Postprimary Tuberculosis: 1. Postprimary TB in children. 2. Consolidation and cavitation. 3. Centrilobular nodules. 4. Summary of the main differences between children and adults. 5. Inactive Tuberculosis: Radiological findings and their risk of reactivation. The role of the radiology report. 6. Complications: Empyema necessitatis, Rasmussen aneurysm.

## CHEE-101 Uncommon Story of Common Entity: Tips and Tricks in Imaging of Non-Cardiogenic Pulmonary Edema

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Pulmonary edema is a most common clinical entity in both inpatient and out-patient setting. Identifying the underlying etiology of the edema is crucial to the timely implementation of appropriate therapy. Although cardiac dysfunction and volume overload are the most common etiologies routinely encountered, there are other different etiologies and presentations of pulmonary edema. Understanding the clinical context and underlying pathophysiology of these varied uncommon causes will help radiologists in narrowing differential diagnosis, therefore help clinicians to provide definitive treatment and better patient care. Furthermore, thorough knowledge about non-cardiogenic pulmonary edema reduces the rate of invasive procedures like Swan-Ganz catheterization and related complications.

## TABLE OF CONTENTS/OUTLINE

- Etiologies of non-cardiogenic pulmonary edema
- Mechanisms of non-cardiogenic edema
- Radiopathology correlation of pulmonary edema
- Pertinent role of chest x ray in initial diagnosis of cardiogenic vs non-cardiogenic pulmonary edema
- How subtle signs on chest x-ray helps to recognize uncommon etiologies of pulmonary edema
- How to differentiate different types of noncardiogenic edema on chest x ray.
- "Leave alone" type of pulmonary edema
- When should you use CT imaging
- Edema with and without diffuse alveolar damage- Does it matter on imaging?
- Short term and long -term complications of noncardiogenic pulmonary edema
- Algorithm and next step in the management of noncardiogenic pulmonary edema

## CHEE-102 An Update on the Role of Chest Imaging in Cystic Fibrosis

Scott M. Bugenhagen, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is: 1. To demonstrate the characteristic imaging findings of cystic fibrosis in the chest including a variety of commonly encountered complications through a series of clinical examples. 2. To review the latest guidelines and trends in the imaging of cystic fibrosis, with a focus on how clinical practice has changed with emerging therapies. 3. To describe the evolving role of chest radiography and cross-sectional imaging in this new clinical landscape, including a review of the most common scoring systems used in clinical practice.

## TABLE OF CONTENTS/OUTLINE

I. Review of current clinical landscape A. Summary of CF genotypes and patient specific therapy B. Advances in medical therapies C. Changes in clinical practice II. Role of chest radiography A. Characteristic findings B. Direct and follow treatment C. Radiographic scoring systems II. Role of computed tomography A. Indications a. HRCT b. Contrast enhanced CT and CTA B. Characteristic findings C. Direct and follow treatment D. CT scoring systems III. Imaging of complications A. Superinfection a. Colonization with *Pseudomonas aeruginosa* and *Staphylococcus aureus* b. Nontuberculous mycobacterial infection c. *Burkholderia cepacia* infection B. Aspergillus related lung disease a. Allergic bronchopulmonary aspergillosis b. Aspergilloma c. Semi-invasive aspergillosis C. Lobar collapse and idiopathic collapsed lung D. Pneumothorax E. Pulmonary hypertension and cor pulmonale F. Hemoptysis IV. Transplant evaluation

## CHEE-103 Upright Chest CT Imaging

Yoshitake Yamada, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purposes of our exhibit are as follows: (1) To explain the development, background, and performance of upright CT. (2) To describe the anatomical changes in each structure of the chest due to differences in body position, that is, the direction of gravity. (3) To illustrate the clinical applications of upright CT for various chest diseases with clinical case presentations, and the potential applications in particle therapy.

## TABLE OF CONTENTS/OUTLINE

(1) Development of an upright CT and its background (2) Performance of upright CT: Physical characteristics, workflow improvement, safety, and remote operation during the infectious disease pandemic (3) Effect of gravity on the lungs, lobes, airways, heart, shoulder girdle, and chest vessels (4) Clinical applications of upright CT for various diseases such as chronic obstructive pulmonary disease, interstitial lung disease, scoliosis, diaphragmatic paralysis, and funnel chest (5) Upright 4D-CT of the chest (6) Potential applications of the upright CT in particle therapy (7) Limitation (8) Conclusion

### **CHEE-104 Analysis of Fine Anatomical Structures Involved in Pulmonary Nodules by Ultra-High-Resolution CT**

Hiroshi Moriya, MD, PhD (*Presenter*) Advisor, California Capital Equity, LLC; Research Grant, Canon Medical Systems Corporation

## TEACHING POINTS

1. Spatial resolution of ultra-high-resolution CT (UHRCT) 2. Depiction of intralobular structure by UHRCT 3. MPR display of bronchus long-axis cross-section and short-axis cross-section (parallel pleural cross-section) 4. Typical cases: Analysis of fine anatomical structures involved in pulmonary nodules by UHRCT

## TABLE OF CONTENTS/OUTLINE

Ultra-high-resolution CT (UHRCT) is a CT that achieves high spatial resolution by reducing the detector size to 1/4. In the previous studies, the bronchial visualization ability of UHRCT was superior compared with conventional HRCT. In the depiction of lung field structure, bronchi with an inner diameter of 0.4 mm are delineated. Contrast enhancement and deep learning reconstruction method (DLR) enhances the contrast effect of peripheral blood vessels and improves visualization. By improving the resolution, it has become possible to display the intralobular structure. How to identify lobular structure: a. Bronchioles are centrally located in the lobules. b. Identify the blood vessels that accompany the bronchi as pulmonary artery. c. Pulmonary veins are thicker than pulmonary arteries. d. Imaging of pulmonary arteries or veins in contrast-enhanced phase. e. Confirm continuity of the target vessel to the root of the pulmonary artery and vein. Lesions that spread with regularity to the lobular structure, lesions that extend independently of the lobular unit, lesions that extend beyond the lobule, and lesions confined within the lobule are presented.

### **CHEE-105 Thoracic IgG4-Related Disease: Revealing the Diverse and Heterogeneous Imaging Manifestations**

Kyubin Kim, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. IgG4-related disease (IgG4-RD) is an immune-mediated fibroinflammatory condition characterized by dense lymphoplasmacytic infiltrations with predominant IgG4-positive plasma cells, usually accompanied by storiform fibrosis, obliterative phlebitis, and elevated serum IgG4 levels. 2. Thoracic manifestations of IgG4-RD are diverse and can mimic malignant lymphoma, infection, or other systemic autoimmune disease. The most common manifestations are mediastinal lymphadenopathy and peri-bronchovascular interstitial thickening. Other findings include pulmonary nodule or mass, interstitial lung abnormalities, pleural effusion or thickening, mediastinal or chest wall mass, and thoracic arteritis. 3. IgG4-RD can present with atypical radiologic findings such as migrating or cavitary nodules, lobar or segmental consolidation, and paravertebral mass making the diagnosis challenging. 4. Early diagnosis with clinical-radiologic-pathologic correlation is important to prevent irreversible damage due to fibrosis.

## TABLE OF CONTENTS/OUTLINE

1. Definition, pathogenesis, and histopathology of IgG4-RD 2. Clinical manifestations and diagnostic criteria for thoracic IgG4-RD 3. Imaging findings of thoracic IgG4-RD: diverse and heterogeneous findings in the lungs, airway, mediastinum, pleura, chest wall, and thoracic vessels 4. Treatment and prognosis of thoracic IgG4-RD 5. Conclusion: The importance of recognizing the diverse imaging findings of thoracic IgG4-RD and reflecting them in diagnosis and treatment

### **CHEE-106 Beyond the Black Holes: A Multidisciplinary Approach to Cystic Lung Disease**

#### **Awards**

#### **Certificate of Merit**

Lawrence Guan, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Diffuse cystic lung diseases (DCLD) are characterized by thin-walled, air-filled spaces with normal intervening lung parenchyma. Certain entities can mimic or be mistaken for lung cysts such as emphysema, cavitary lesions, honeycombing, and cystic bronchiectasis. These are a diverse group of disorders with a variety of underlying causes including hereditary, neoplastic, infectious, inflammatory, lymphoproliferative, and smoking-related. High-resolution chest CT plays a central role in the evaluation of patients with DCLD's and it is not uncommon for these disorders to be discovered during imaging for other reasons. Therefore it is important for the radiologist to be aware of these conditions and their associations, as they may be the first to suggest the diagnosis. An approach to the characterization of cystic lung disease will be reviewed including imaging and clinical clues which can aid in suggesting one diagnosis over another.

## TABLE OF CONTENTS/OUTLINE

1. Introduction.2. Examples of cases: a. Mimics of lung cysts b. Smoking-related: Pulmonary Langerhans Cell Histiocytosis, Desquamative Interstitial Pneumonia c. Inflammatory: Amyloidosis, Hypersensitivity Pneumonitis d. Hereditary: Tuberous Sclerosis/Lymphangiomyomatosis, Birt-Hogg-Dube, Neurofibromatosis, Ehlers Danlos Syndrome, Sickle Cell Disease e. Lymphoproliferative: Lymphocytic Interstitial Pneumonia, Follicular bronchiolitis f. Neoplastic: Cystic metastases, Treated metastases g. Disorders with cystic component: Bronchopulmonary sequestration, Congenital pulmonary airway malformation, Bronchogenic cyst h. Miscellaneous: Infectious/Postinfectious, Posttraumatic3. Conclusion.

## CHEE-107 Mimics of Pulmonary Embolism (PE)

Shaimaa A. Fadl, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Learn technical, anatomical, and patient-related pitfalls in the diagnosis of pulmonary embolism. Illustrate common and uncommon pulmonary artery pathologies that can mimic pulmonary embolism. Discuss an imaging approach for the diagnosis and management of patients with different pulmonary artery pathologies.

## TABLE OF CONTENTS/OUTLINE

Introduction Technical pitfalls. Anatomical pitfalls. Patient related pitfalls. Pulmonary artery malignancy (angiosarcoma, lymphoma). Pulmonary artery tumor embolism. Pulmonary artery in-situ thrombus (post-surgical, post radiotherapy). Pulmonary artery vasculitis. Atypical Infection. Granulomatous/Fibrosing mediastinitis. Role of different imaging modalities in evaluation of PE mimics. Diagnostic approach to PE mimics.

## CHEE-108 Joining the Dots in Multiple Lung Nodules

Lily Pierce, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Varying etiologies cause multiple pulmonary nodules and can be mistaken for infection or metastatic disease. 2. Ancillary CT features such as air trapping with multiple pulmonary nodules are seen in DIPNECH, or chest wall vessel calcification with centrilobular nodules in renal failure suggests metastatic calcification. 3. Small calcified pulmonary nodules seen with reticulation in the lower lobes, usually in fibrotic ILD, represents dendriform ossification.

## TABLE OF CONTENTS/OUTLINE

CT detected multiple lung nodules are most commonly due to infection, sarcoidosis, or metastasis. However, alternative etiologies causing lung nodules can be diagnosed on CT based on CT morphology or associated findings. These alternative causes of multiple lung nodules are often seen in patients with malignancies, and we must accurately diagnose these to prevent misinterpretation. Therefore, these lesser-known entities and their diagnostic CT findings are discussed. The etiologies are subclassified based on the CT appearance of nodules such as non-solid, solid, cavitary, calcified, and nodules with central air bronchograms. A case-based approach will discuss meningoendotheliomatosis, DIPNECH, amyloidosis, LIP, LCH, Dendritic Ossification, metastatic calcification, Progressive massive fibrosis in silicosis, MMPH in Tuberous Sclerosis, MALT lymphoma amongst other similar disease processes. Ancillary CT features for, e.g., the air-trapping in DIPNECH, Cheerio sign in meningoendotheliomatosis, calcification in amyloidosis, vessel wall calcification in renal failure with metastatic calcification, etc., are highlighted. In addition, the next steps in the workup for diagnosis are also highlighted.

## CHEE-109 0.55T MRI Thoracic Imaging

Jonathan A. Liu, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Low field (< 1T) MRI is an emerging technology that possesses certain advantages over other imaging modalities and higher field MRI that make imaging of the lungs more attractive. The purpose of this exhibit is to highlight the considerations involved in implementing clinical use of low field MRI for thoracic imaging, with the hope of introducing the audience to this new imaging paradigm. A wide variety of cases (with a cohort of 22 patients at the time of abstract submission) are shown

highlighting the benefits of low field MRI imaging with the Siemens Freemax system (0.55T, MAGNETOM Freemax; Siemens Healthcare, Erlangen, Germany) including ultra-short TE, diffusion weighted, and non-contrast MRI ventilation/perfusion imaging. We will also review the limitations and pitfalls of lung imaging at 0.55T MRI.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Rationale for low field MRI  
a. Advantages of low field MRI over other modalities  
i. MRI versus CT  
ii. Low field versus traditional 1.5T or 3T imaging  
b. Disadvantages of low field MRI over other modalities  
i. MRI vs CT  
ii. Low field MRI compared to 1.5/3T  
3. Imaging Protocol  
4. Clinical Indications  
a. Immediate  
b. Early  
c. Long-term  
5. Five to ten cases of 0.55T MRI images with CT correlation  
a. Normal anatomy  
b. Malignancy  
c. Inflammation  
d. Post-radiation  
e. Small airways/small vessel disease  
f. Large airways  
6. Key challenges, limitations, and pitfalls of lung imaging at 0.55T  
7. Future clinical and research directions  
8. Conclusion

### **CHEE-11 Light Up the Lungs: How Contrast Enhancement Can Help Diagnose Pulmonary Lesions**

#### **Awards**

#### **Certificate of Merit**

Agustina Picarel, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Non-contrast CT of the chest is often requested by clinicians in settings where the addition of iodinated contrast is warranted. Radiologists must be familiar with how contrast positively impacts evaluation of pulmonary pathology. This exhibit will showcase the value of iodinated contrast improving assessment of pulmonary parenchymal entities. Iodinated contrast improves differentiation of pneumonia from atelectasis, with the former lacking enhancement, while atelectasis enhances homogeneously. Addition of contrast material allows detection of complications of pulmonary infections such as necrosis, pulmonary artery pseudoaneurysm and chest wall involvement. In the setting of congenital pulmonary lesions, CT evaluation should include iodinated contrast to evaluate arterial supply and venous drainage. Nodule characterization is improved with iodinated contrast. Lesion localization improves with iodinated contrast: including discerning lesions from vascular structures, delineation of hilar lesions, and appraisal of vascular and chest wall invasion in the setting of aggressive processes.

#### **TABLE OF CONTENTS/OUTLINE**

Contrast Enhanced CT protocols and indications  
Pulmonary arterial phase  
Systemic arterial phase  
Venous phase  
Infection  
Pneumonia vs Atelectasis  
Complications of pneumonia: necrosis, abscess, pseudoaneurysm, wall involvement  
Lesion localization and assessment of complications  
Hilar lesions  
Discernment from broncho-vascular bundle  
Vascular, mediastinal, and chest wall invasion  
Nodule characterization  
Hypervascular metastasis  
Carcinoid tumor  
AVM  
Congenital lesion evaluation  
Vascular supply (eg. Sequestration)  
Venous anomalies (eg. Hypoplastic lung evaluation)

### **CHEE-110 Don't Be Blue... Here's a Clue! Tips to Assess Adult Cardiac Pathology on a Chest Radiograph Like a Pro**

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In the era where modalities such as 2-D echo, CT and MRI are being highly utilized for evaluation of cardiac pathology, a plain chest radiograph still plays a key role in contributing important information. However, the younger generation of radiologists do not seem to be optimally exposed or are unaware of the true value of a chest radiograph. Chest radiograph is convenient as it is an easily accessible, low-cost, and non-invasive diagnostic tool with minimal radiation dose. We aim to provide unique imaging clues to identify the classic signs, measurements, and differential diagnoses of various adult cardiac pathologies on a chest radiograph with confirmatory CT images. Since a chest radiograph is the first imaging modality for majority of patients with chest pain - it is very imperative for the radiologists to quickly recognize these subtle findings to provide an accurate diagnosis and proper patient management.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction to normal cardiac anatomy  
CASE BASED LEARNING:  
• How to differentiate between:- Aortic Dissection vs Aortic Aneurysm- Pneumopericardium vs Pneumomediastinum- Pericardial Effusion vs Cardiomyopathy- Intramural esophageal lesion vs LA enlargement- Enlarged azygous arch vs Paratracheal lymph node- Stages of cardiogenic pulmonary edema  
• Identify:- Pulmonary embolism- Cardiac Valves- Focal pulmonary edema- Heterotaxy syndromes- Cardiac Size: Microcardia- Pectus Excavatum- Devices  
• Compare and contrast:- Cardiomyopathies: Dilated vs Hypertrophic- Individual chamber enlargements  
• Limitations

### **CHEE-111 Aerogenous Metastasis and Spread Through The Air Spaces (STAS) - Distinct Entities or Spectrum Of The Same Process?**

Mariah K. Obino, BMBCh (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To present the proposed mechanisms and pathological findings described in aerogenous metastasis (AeM) and spread through the airways(STAS) as well as areas of uncertainty and their prognostic significance. 2. Discuss the concept of continuous and discontinuous cancer spread from the primary tumor. 2. To review the pathological and imaging characteristics of primary lung cancers with higher probability of spreading through the airspaces. 3. To describe CT features suggestive of aerogenous metastasis and their main differential diagnoses, including distinction from multiple synchronous primary adenocarcinomas.

## TABLE OF CONTENTS/OUTLINE

1. Definition and pathophysiology of STAS and aerogenous metastasis (AeM). 2. Risk factors and predisposing histological patterns. 3. Imaging predictors, diagnosis, and prognostic significance of STAS and AeM. 4. Differentiating aerogenous metastases from synchronous adenocarcinomas on CT. 5. Clinical relevance and impact on patient management. 6. Are STAS and aerogenous metastasis distinct entities or a spectrum of the same process? 7. Future directions; areas of uncertainty and further research.

## CHEE-112 Navigating the Difficult ICU Chest Radiograph: Distinguishing Non-standard Cardiovascular Device Placements from Device Malposition

Danielle Struck, BA (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Cardiovascular support devices are essential in the management of critically ill patients. While identifying malpositioned devices can often be straightforward, recognizing correctly positioned uncommon devices/non-standard placements and identifying malpositioned/incorrectly deployed devices can be difficult. Here, we present a case-based approach to distinguishing non-standard device placements from malposition and potential downstream complications, providing CT correlation where appropriate and specify lessons learned and practical tips in each case.

## TABLE OF CONTENTS/OUTLINE

1. Title slide 2. Disclosures 3. Abbreviations 4. Approach 5. Scenarios 6. Pulmonary critical care, MICUa. CVCs i. L SVC placement ii. Arterial placement b. PA catheter i. Inguinal approach ii. Peripheral placement, PA pseudoaneurysm c. ECMO i. Peripheral, situs inversus, central ii. Malposition 7. Electrophysiology, CVICUa. Pacer/ICD i. Epicardial/subcutaneous leads, patient with atrial switch ii. Lead migration/fracture, ventricular perforation b. Transcatheter LAA closure i. Watchmann vs Amplatzer ii. Embolization 8. Heart failure, CVICUa. Impella i. Impella RP (RV) ii. Access site hematoma, dissection b. LVAD i. Different models ii. Infection, trauma, suck event c. Intra-aortic balloon pump i. Upper extremity approach, adjustment ii. Malposition, visceral ischemia 9. Structural cardiology, CVICUa. ASD closure device i. PDA closure device ii. Malposition, incomplete seal b. Prosthetic valves i. Transapical mitral valve prosthesis ii. Embolization 10. CT surgery, SICUa. Pericardial drain i. Wraparound drain ii. Mediastinal placement 11. Summary - Lessons 12. Summary - Practical tips 13. References

## CHEE-113 The Radiologist's Expedition into the Intricacies of Percutaneous Lung Biopsies and Ablations

Megha Gupta (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Lung cancer (CA) is the second most common cancer in the US and is the leading cause of cancer related mortality. Surgery is the mainstay of therapy for patients with stage I lung cancer, although many patients with lung cancer are poor surgical candidates. Stereotactic radiation body therapy (SBRT) is offered to inoperable patients with lung CA, however, carries significant side effects and risk of lung function deterioration. Image guided tumor ablation (IGTA) is an alternative treatment option with proven outcomes in Stage I lung CA without the risk of lung function deterioration. Also, IGTA is not limited by segmental anatomy.

## TABLE OF CONTENTS/OUTLINE

Overview of lung cancer staging, identification of suitable patients for image guided lung ablation and discuss treatment outcomes. Understand the various modalities of lung ablation (Radio frequency, Microwave and Cryoablation). Approach to difficult biopsies and difficult needle placement including the use of hydro-dissection and artificial pneumothorax creation. Learn normal and abnormal imaging appearances post lung ablation and current follow up recommendations.

## CHEE-114 "Getting Warmer..." - Chest Radiological Findings in Patients with Fever of Unknown Origin

Alla Khashper, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Fever of unknown origin (FUO) is defined as "fever = 101°F (38.3°C) for at least 3 weeks that remains undiagnosed after 3 inpatient days or at least 3 outpatient visits". FUO is a well-known clinical problem, has multiple thoracic etiologies, and

commonly requires extensive workup. Imaging might identify the cause of FUO. However, no radiological recommendations have been established.

#### **TABLE OF CONTENTS/OUTLINE**

Historically, FUO has been divided into classic, nosocomial, immunodeficiency-related, and travel-associated categories. For imaging purposes the following classification appears more practical: infections, malignancies, inflammation and miscellaneous. The selected illustrative cases are listed in the attached presentation. The evaluation of FUO is always complex, including extended history taking, physical examination, and lab tests, followed by imaging. Chest radiography and CT are routinely performed and can usually provide putative or final diagnosis or suggest further imaging work-up, including but not limited to CT angiography, PET, MRI, and imaging-guided biopsy. This educational exhibit is a pictorial review of thoracic pathologies associated with FUO, targeting radiology trainees, general and subspecialized thoracic radiologists. It will highlight teaching points and provide clues to establish concise differential diagnosis of FUO causes.

#### **CHEE-115 Development of Color Dynamic Flow Image Using 4D-CTA for Post TEVAR Operative Case**

Hiroshi Sakuragochi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

It is common to use 3D-CTA for postoperative evaluation of TEVAR. 3D-CTA can assess postoperative complications such as endoleak and the presence or absence of stent graft induced new entry (SINE). However, since 3D-CTA is a single time phase, it is difficult to evaluate the direction of blood flow to the aneurysm and the timing of outflow. This is where 4D-CTA comes in. 4D-CTA injects a contrast medium while continuously imaging a specific area. When 4D-CTA is displayed in Volume Rendering (VR), the blood flow is easy to understand visually. Therefore, it is possible to observe end leakage and SINE around the stent graft. This time, we evaluated the blood flow when it was converted to VR using a color map. The color map was changed according to the CT value. In addition, the color map has been optimized to make 4D-CTA easier to observe. By displaying the blood flow as our original color map, it is possible to visually evaluate the direction of blood flow at the leak point and the timing of flow from the aorta into the aneurysm. This time, we take 4D-CTA scan and analyzed it with our original color map in the SINE case. By applying our method, it can be easy and visually to evaluate the entry point, blood flow direction, and outflow timing post TEVAR operation.

#### **TABLE OF CONTENTS/OUTLINE**

1. Problem analysis of conventional display method 2. Ingenuity in scanning / Exposure reduction technology 3. Ingenuity in image reconstruction 4. Evaluation by 4D-CTA 5. Creation of original color map 6. Evaluation of usefulness by clinical cases

#### **CHEE-116 Cinematic Rendering of the Thoracic Aorta: A New Look at an Old Problem**

Elliot K. Fishman, MD (*Presenter*) Co-founder, HipGraphics, Inc Stockholder, HipGraphics, Inc Institutional Grant support, Siemens AG Institutional Grant support, General Electric Company Consultant, Exact Sciences Corporation Consultant, Imaging Endpoints II LLC

#### **TEACHING POINTS**

1. 3D imaging with Cinematic rendering can play a major role in the detection of the thoracic aorta 2. Cinematic Rendering can be optimized with development of presets to improve workflow 3. Cinematic Rendering can be used in a range of applications including suspected dissection, coarctation of the aorta, vasculitis, post aorta repair and trauma 4. Cinematic Rendering will provide critical information to the referring physician for patient management 5. the radiologist needs to work closely with the referring physician and Cinematic Rendering help play a role in this interaction

#### **TABLE OF CONTENTS/OUTLINE**

a. Cinematic Rendering protocols b. CT acquisition protocols c. clinical applications with case studies-suspected dissection-post aortic aneurysm repair-coarctation of the aorta-trauma-vasculitis d. pearls and pitfall e. the literature f. future directions including AI g. bibliography

#### **CHEE-117 Current and Novel Techniques for Artifact Reduction on Chest CT**

Yoichiro Ota, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Various artifacts can be observed on chest CT. Motion artifacts are an important issue, especially in emergency cases in which patients are unable to hold their breath. Motion correction-deep learning reconstruction (MC-DLR) is a motion correction method developed using a deep learning framework to estimate patient motion in the lung region. This method comprises three major steps. First, a full-image reconstruction is decomposed into several partial-angle reconstructions. Second, a pre-trained deep convolutional neural network (DCNN) is applied to estimate the motion vector field between these partial angle reconstruction images. Finally, a motion-corrected image is reconstructed by incorporating the DCNN-predicted motion vector field (Fig. 1). An image with MC-DLR can reduce the motion artifacts in moving phantom experiments (Fig. 2) and clinical cases (Fig. 3). Radiologists should understand CT artifacts to distinguish between true lesions (Figs. 4,5). In this exhibit, we introduce the principles of CT artifacts and techniques to reduce them by presenting clinical cases.



## TABLE OF CONTENTS/OUTLINE

Motion artifact, Streak artifact, Metal artifact, Dark band artifact, Partial volume effect

### CHEE-118 Thoracic Manifestations of Autoimmune Diseases: From Suspicion to Diagnosis

#### Awards

##### Certificate of Merit

Renato T. Fujiki, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Interstitial lung disease (ILD) is the most common thoracic manifestation of autoimmune disease (AD). Each ILD pattern is more commonly associated with a specific AD, although there is an overlap between patterns. While connective tissue diseases (CTD) are commonly associated with thoracic manifestations, it is important to recognize that other AD can also affect the lungs. Besides ILD, AD can also present with airway, vascular, pleural, and mediastinal involvement. The purpose of this exhibit is - Review CT patterns of ILD more commonly associated to each specific AD and what is important to describe - Highlight the role of radiology in diagnosing and grading thoracic manifestations of AD - Discuss the new classification system known as "interstitial pneumonia with autoimmune features" (IPAF) and its relevance in patient management

## TABLE OF CONTENTS/OUTLINE

1. Introduction a. Epidemiology, physiopathology and clinical aspects of the main autoimmune diseases (AD) b. Currently available treatment options2. Role of different imaging methods in diagnosis and assessment of disease grading - advantages, limitations, usefulness a. X-ray b. Ultrasound c. CT - with protocol recommendation d. MRI3. ILD patterns associated with AD - Case-by-case discussion review a. Non-specific interstitial pneumonia b. Organizing pneumonia c. Usual interstitial pneumonia d. Hypersensitivity pneumonitis-like pattern e. Others4. Other thoracic manifestations of both CTD and non-CTD AD - including vascular, pleural, mediastinal and airway involvement.5. The new statement of interstitial pneumonia with autoimmune features (IPAF) - repercussions in clinical practice and recommendations6. Conclusions "take-home messages"

### CHEE-12 Cardiothoracic Imaging Findings in VEXAS Syndrome

Naim Qaqish, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-VEXAS Syndrome is an adult-onset autoinflammatory disorder found almost exclusively in adult men (x-linked gene mutation) first described in 2020. The disease is severe with a poor prognosis.-Systemic hematologic and inflammatory disease affecting multiple organs, most commonly the skin, lungs, cardiovascular, and cartilage.-Diagnosis is made on bone marrow aspirate.-Pulmonary imaging findings: consolidative, ground glass and reticular opacities, pulmonary vasculitis, pleural effusions, bronchial inflammation/stenosis.-VS-associated interstitial lung disease usually follows an organizing pneumonia or NSIP pattern.-Cardiovascular imaging findings: Venous and/or arterial thrombosis, pulmonary emboli, pericarditis, myocarditis, and cardiac amyloidosis.

## TABLE OF CONTENTS/OUTLINE

- Introduction to VEXAS Syndrome (VS)
- Useful Laboratory Tests
- Clinical Presentation with Common Manifestations
- Pulmonary Imaging Features
  - o Parenchymal disease (consolidation, GGO, reticulation)
  - o Pleural effusions
  - o VS-associated interstitial pneumonias § NSIP and organizing pneumonia patterns
  - o Pulmonary vasculitis
  - o Bronchial disease and stenosis
- Less common pulmonary manifestations
- Cardiovascular Imaging Features
  - o Cardiac and pericardial involvement § Typical CMR findings
  - o VS-associated vasculitis
  - o Recurrent thromboembolic disease § DVT, pulmonary emboli, and arterial thrombosis
- Differential Diagnosis
- Treatment
- Prognosis
- Summary of Cardiothoracic Imaging Findings
- References

### CHEE-120 Heavy Stuff: The Burden of High-Attenuation Lung Lesions

Iuri Shen De Lacerda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Propose a pattern-based approach to most common high-attenuating lung lesions- Review specific imaging features of each CT pattern of disease- Recognize the main differential diagnosis by section and understand the pathophysiology behind each hyperattenuating lesion through a case-based pictorial discussion- Highlight the importance of radiology in narrowing diagnostic possibilities and guiding next steps in patient management

## TABLE OF CONTENTS/OUTLINE

I - INTRODUCTION- Definition of high-attenuation lung lesions- Pattern-based approach to narrow differential diagnosisII - PATTERNS AND ASSOCIATED DIAGNOSISA - Calcified pulmonary nodules1. Dystrophic calcifications-a. Post-infectious-b. Pulmonary hemosiderosis: Idiopathic or Secondary (chronic alveolar hemorrhage)-c. Occupational disease: Silicosis, Coal

workers pneumoconiosis2. Metastatic calcification: Benign or Malignant3. Pulmonary Alveolar microlithiasisB - Non-calcified hyperattenuating nodules1. Talcosis2. Mercury embolism and vapor inhalation3. Pulmonary cement embolization after vertebroplasty4. Cyanoacrylate embolizationC - Large calcified nodules or masses1. Calcified metastasis: Medullary thyroid carcinoma, Osteosarcoma, Condrosarcoma2. Amyloidosis3. Granuloma4. Progressive massive fibrosisD - Hyperattenuating linear or reticular opacities1. Pulmonary dendriform ossification: Idiopathic or Secondary (idiopathic pulmonary fibrosis, chronic alveolar hemorrhage)2. Diffuse pulmonary amyloidosis: alveolar septal formE - High-attenuation consolidation1. Amiodarone lung2. Pulmonary Lipiodol embolismIII - CONCLUSIONS  
Summary of key points  
"Take-home" messages

## **CHEE-121 Paraneoplastic Syndromes Related to Thoracic Neoplasms: Clinical and Imaging Clues**

Alan V. Godfrey, DO (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Paraneoplastic Syndromes are systemic manifestations of neoplasia not related to metastatic disease. These rare disorders are characterized by abnormal production of proteins (i.e. antibodies), protein derivatives, or steroids generated by the immune system. The diagnosis of thoracic neoplasms associated with these syndromes often presents diagnostic challenges for radiologists and clinicians alike. Radiologists play an essential role in the identification of the specific neoplasm associated with these syndromes. Therefore, knowledge of the neoplasm associated with each paraneoplastic syndrome is valuable for quality patient care. The goals of this exhibit are to help the learner: 1. List the clinical features of specific paraneoplastic syndromes related to thoracic neoplasms 2. Identify characteristic imaging features of thoracic neoplasms associated with specific paraneoplastic syndromes

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction - Definition of paraneoplastic syndromes 2. Overview of paraneoplastic syndromes associated with specific types of thoracic neoplasms 3. Discussion of clinical and imaging features of thoracic neoplasms that may manifest with a paraneoplastic syndrome at presentation 4. Conclusion

## **CHEE-122 Usual Interstitial Pneumonia and Variants, a Pictorial Review**

Moises Jose P. Lima, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To define and illustrate the classic appearance of a UIP pattern.- To describe the HRCT diagnostic categories of Usual Interstitial Pneumonia (UIP).- To comment and review the CT findings of the main differential diagnosis of UIP. - To know the 2018 Fleischner diagnostic guidelines on the diagnosis of Idiopathic pulmonary fibrosis (IPF). - To enumerate and discuss specific and general variant patterns of fibrosis.

### **TABLE OF CONTENTS/OUTLINE**

1) Background: Interstitial lung disease concept and classification. Categorization of idiopathic interstitial pneumonias. UIP pathophysiology.2) HRCT technique in UIP3) Key features of a classic UIP pattern: honeycombing, reticular pattern, traction bronchiectasis, other findings of classic UIP pattern: GGO, mediastinal lymph node enlargement, pulmonary ossification, pleuroparenchymal elastosis.4) Diagnostic categories of UIP: UIP and uncommon presentations (asymmetric distribution, uniform craniocaudal distribution and others), probable UIP, possible UIP, a review of the main alternative diagnoses: non-specific interstitial pneumonia, fibrosing hypersensitivity pneumonitis, sarcoidosis, others.5) IPF Diagnosis: clinical history, UIP histopathology, IPF diagnostic criteria.6) Variant patterns of fibrosis: anterior upper lobe, exuberant honeycombing and straight edge signs.7) Specific variant patterns of fibrosis: scleroderma: four corners sign. Systemic lupus erythematosus: "Island-like" fibrosis and heterogeneous lung destruction.8) Summary

## **CHEE-123 NTM: What the Pulmonologist Wants to Know**

Geraldine Brusca-Augello, DO (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Classic and non-classic NTM have characteristic distribution and morphology of bronchopulmonary disease with variability in part associated with the presence of underlying lung disease, as well as other factors. Radiologists may be the first to suggest pulmonary NTM in patients that are asymptomatic or with nonspecific constitutional symptoms leading to earlier diagnosis and management. Baseline CT description should include description of disease extent, fibrocavitary or nodular bronchiectatic type, presence of atelectasis, cavities, and fibrosis. Pulmonary NTM infections are usually indolent/slowly progressive with CT findings waxing and waning over time. Follow-up imaging is performed to assess interval improvement or progression of the airways disease, cavities, nodules and consolidation. The focal mass like/nodular NTM type can pose diagnostic challenges, and must be distinguished from other infections and malignancy. Development of high-attenuation mucous (HAM) in bronchiectatic airways is pathognomonic for superimposed ABPA. New or growing nodule should raise concern for neoplasm. NTM should also be considered as an allergen to incite nonfibrotic hypersensitivity pneumonitis.



## TABLE OF CONTENTS/OUTLINE

Epidemiology. Diagnostic criteria for pulmonary NTM. CT Manifestations of pulmonary NTM. What the Radiologist needs to know. What the Pulmonologist wants to know.

### **CHEE-124 Thoracic Complications of Stanford Type A Aortic Dissection: A Review of CT Findings and Management**

James W. Hillhouse (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This presentation will serve as a review of aortic root anatomy and aortic dissection. It also includes an update to the Stanford classification system published jointly by the Society for Vascular Surgery and the Society of Thoracic Surgeons which provides a more detailed description of the dissection and is suited to sites offering endovascular repair (though likely to become more universally adopted in the future). The bulk of the exhibit is concerned with the complications of Type A dissection which occur within the thorax. A framework for classifying and subclassifying complications is described as well as a more detailed description of the pathophysiology, grading, and management of these complications. This information has previously been offered separately in review articles, case series, and case reports but will now be presented as a single resource. Detailed diagrams and representative CT images will support the information presented and will aid the viewer's understanding of the concepts. CT is often utilized for investigation of suspected acute aortic syndrome. This presentation will be useful for radiologists and radiology residents working in the acute care setting, to assist their search pattern and tailor their reports to provide more useful information to the cardiothoracic surgeon.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Risk factors and epidemiology 3. Classification of aortic dissection 4. CT imaging protocol recommendations 5. Complications and management of aortic dissection 6. Thoracic complications of Type A dissection 6.1 Rupture complications 6.2 Malperfusion complications 6.3 Aortic valve distortion/disruption with regurgitation 7. Conclusion

### **CHEE-125 From Acute to Chronic: A Comprehensive Guide to Aortic Injuries and the New Classification System**

Amr H. Wardeh, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1.) Learn to differentiate among the different types of acute aortic syndrome and understand their clinical significance.(2.) Explore the signs of instability and potential complications in acute aortic syndrome.(3.) Examine the appearance of subacute and chronic aortic dissection.(4.) Discuss the limitations of the Stanford classification system in addressing the complexities of acute aortic syndrome.(5.) Introduce the new Society of Vascular Surgeons and the Society of Thoracic Surgeons classification system (SVS/STS) and how it differs from the Stanford classification system.(6.) Illustrate the use of the new SVS/STS classification system with example cases.

#### TABLE OF CONTENTS/OUTLINE

(I.) Introduction to Acute Aortic Syndrome (A.) Definition and clinical importance (B.) Overview of the four types (1.) Aortic dissection (2.) Intramural hematoma (3.) Penetrating atherosclerotic ulcer (4.) Limited intimal tear (II.) Classification Systems (A.) Stanford Classification System and its Limitations (B.) SVS/STS Classification System (C.) Comparison of the Classification Systems (D.) Example Cases: Applying the SVS/STS Classification System.

### **CHEE-126 Reporting Response Assessment in Clinical Trials in the Era of Personalized Medicine**

Julia Cha, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Response Evaluation Criteria in Solid Tumors (RECIST) was published in 2000 and revised to RECIST 1.1 in 2009. RECIST defines lesions as measurable and non-measurable, based on whether they are quantifiable; measurable lesions consist of target, which are followed, and non-target. RECIST 1.1 includes newer technologies like FDG-PET and MRI and clarifies lymph node criteria. Target lesions must be: Easily and reproducibly measurable; Representative of the disease; Representative of distribution Progressive disease (PD) after initial response can be depicted using RECIST 1.1. Personalized therapies targeting specific receptors are in clinical trials and allow patients with slow progression to be followed long term. iRECIST criteria are used to assess response to immunotherapy. Response may vary between unidimensional and volumetric assessment methods. Genomic profiling in a lung cancer patient revealed an EGFR mutation. The tumor was successfully targeted by Erlotinib, showing 61% decrease in size at 8 weeks.

#### TABLE OF CONTENTS/OUTLINE

Illustrate response assessment in the era of personalized medicine clinical trials Depict optimal strategies for response assessment using a multimodality approach Explore novel response assessment criteria, such as volumetric and MRI based

DCE and DWI, to assess response

## **CHEE-127 Congenital Lung Anomalies in the Adult**

### **Awards**

#### **Certificate of Merit**

Marcos A. Mestas Nunez SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Although rare, congenital lung anomalies are incidentally discovered in adults and can pose a diagnostic dilemma. The radiologist must be familiar with the imaging findings and differential diagnosis. With this exhibit we will: 1) Review the typical imaging appearance of common and uncommon congenital lung anomalies as seen in the adult. 2) Review the concept of hybrid lesions. 3) Case based review of entities that can be mistaken for congenital lung anomalies, and the role of imaging in the differential diagnosis. 4) Describe complications and as well as discuss the risk of malignancy of some of these entities.

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction and embryology 2) Bronchopulmonary anomalies a) Bronchial atresia b) Lobar hyperinflation c) Bronchogenic cyst d) CPAM 3) Combined pulmonary and vascular anomalies a) Pulmonary sequestration b) Hypogenetic lung syndrome c) Thoracic Isomerism 4) "New concepts" hybrid lesions 5) Miscellaneous a) Placental transmogrification b) Proximal Interruption of the pulmonary artery 6) Differential diagnoses: Case-based approach 7) Complications a) Risk of malignancy: true or myth? b) Superimposed: a radiology challenge c) Hemoptysis and radiology in treatment

## **CHEE-128 The Family Plan: Multidisciplinary Approach to Familial Pulmonary Fibrosis (FPF)**

Katherine A. Cheng, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Familial pulmonary fibrosis (FPF), defined as pulmonary fibrosis affecting at least two first degree relatives, is a complex group of diseases caused by a variety of genetic mutations. Diagnosis of FPF is essential as these patients have a worse prognosis than their sporadic counterparts that affects management not only of the patient, but also of first-degree relatives. However, the diagnosis of FPF can be difficult for both the radiologist and clinician as imaging patterns of fibrosis are often unclassifiable; variable penetrance exists amongst family members; and new mutations are continuously being discovered. This exhibit aims to improve understanding of FPF through a multidisciplinary approach reviewing genetic, clinical, and imaging manifestations of FPF.

#### **TABLE OF CONTENTS/OUTLINE**

1. Definition and Epidemiology of FPF. 2. Overview of the Genetic Mutations Associated with FPF including telomere, surfactant, host defense 3. Illustrate the spectrum of imaging patterns for FPF and the variability that can exist even amongst family members including unclassifiable, UIP, NSIP, PPFE 4. Emphasize the importance of genetic testing

## **CHEE-129 Cardiovascular and Thoracic Imaging Manifestations of Lupus**

### **Awards**

#### **Magna Cum Laude**

Muhammad Naeem, MD, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Systemic Lupus Erythematosus (SLE), also known as Lupus is a great masquerader and being a systemic illness it virtually affects every organ in the body. Cardiovascular and Thoracic manifestations are often prevalent. Over half of the patients with lupus develop pleuropulmonary involvement. Lupus patients often get delayed diagnosis and sometime radiologists can provide clue to underlying lupus by putting all the imaging findings together. - Thrombosis is quite prevalent in lupus given the high association with Antiphospholipid antibody (APLA). Other vascular manifestations can be coronary artery disease/aneurysms, pulmonary hypertension, venous thromboembolism, pulmonary emboli and rarely aortic dissections. - Heart involvement in lupus often present with myocarditis, although pericarditis is much more common due to the high prevalence of serositis in lupus.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction - pathophysiological mechanisms in lupus - diagnostic criteria for lupus - Lung and Pleural involvement: Pleural disease, Lupus pneumonitis, Diffuse Alveolar Hemorrhage, Shrinking Lung Syndrome, Pulmonary fibrosis (along with classic patterns described in lupus) - Vascular involvement: Thrombosis/lupus anticoagulant/APLA antibodies, Venous thromboembolism, Pulmonary hypertension, Aortic dissections - Cardiac involvement: Pericardial involvement, Myocarditis and myocardial LGE pattern, Coronary artery disease and coronary vasculitis, Valvular disease (Libman-Sacks endocarditis) - Summary slide

## **CHEE-13 Ground-Glass Opacities in Thoracic CT: Beyond the Acute Disease**

Alicia Espinal Soria, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To describe the spectrum of pathologic entities that manifest as ground-glass opacities in thoracic CT. To learn that ground glass opacities are not always related to acute diseases, being associated in some cases with fibrosis signs.

### **TABLE OF CONTENTS/OUTLINE**

Ground-glass opacities (GGO) are defined as a light increase in attenuation in pulmonary parenchyma that occur when alveolar space is compromised and/or when pulmonary capillary blood volume increases. This finding is often associated with acute pathology like pulmonary edema, alveolar hemorrhage, Pneumocystis jirovecii pneumonia, COVID-19, acute interstitial pneumonia, and acute respiratory distress syndrome. But some subacute and chronic pathologies may also manifest with GGO in CT such as cryptogenic organizing pneumonia, lepidic-predominant adenocarcinoma, chronic eosinophilic pneumonia, non-specific interstitial pneumonia, and nonfibrotic hypersensitivity pneumonitis. In addition, all of these entities can be classified according to the presence or lack of fibrosis signs, which is a determinant prognosis factor for the patients. The aim of this presentation is to review these pathologies with the most common imaging findings in order to facilitate the differential diagnosis in each case. However, in many cases the imaging findings are nonspecific therefore histologic and microbiologic studies will be necessary to make a definitive diagnosis.

## **CHEE-130 ANCA-associated Vasculitis: The New 2022 ACR/EULAR Classification Criteria**

Jonghyeon Kwon, BA (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Introduction and classification of ANCA-associated small vessel vasculitis 2. Review of newly updated 2022 ACR/EULAR classification criteria and cases of ANCA-associated vasculitis 3. Role of radiologists for classification of ANCA-associated vasculitis

### **TABLE OF CONTENTS/OUTLINE**

1. Definition of ANCA-associated vasculitis 2. Classification criteria of ANCA-associated vasculitis A. 1990 American College of Rheumatology (ACR) classification criteria B. 2012 Revised Chapel Hill consensus conference (CHCC) nomenclature of systemic vasculitides C. 2022 American College of Rheumatology/European Alliance of Associations for Rheumatology (ACR/EULAR) Classification Criteria 3. Review of image findings and application of 2022 ACR/EULAR classification criteria A. Granulomatosis with polyangiitis (GPA) B. Eosinophilic granulomatosis with polyangiitis (EGPA) C. Microscopic polyangiitis (MPA) 4. Summary

## **CHEE-131 Febrile Neutropenia: A Scenario and Pattern-based Approach to a Perplexing Problem**

Adam J. Yen, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Febrile neutropenia presents a challenging clinical dilemma, and treatment success relies on early diagnosis and targeted antimicrobial therapy. Often, clinical teams look to radiologists to help narrow the differential diagnosis when a neutropenic patient's thoracic CT contains findings concerning for infection. Here, we examine the role of imaging and CT-guided biopsy in the management of febrile neutropenia, present an approach wherein clinical information is paired with a CT pattern to help the radiologist make an educated guess as to the underlying causative agent, and specify where either clinical information or imaging appearance can serve more useful.

### **TABLE OF CONTENTS/OUTLINE**

1. Clinical presentation 2. Imaging workup 3. Approach by imaging patterns a. Consolidation/nodules b. Cavitory consolidation c. GGO d. Halo e. Reverse halo f. Thoracic wall involvement 4. Helpful clinical information a. Time course b. Antimicrobial response c. Procalcitonin d. B-D-Glucan e. Galactomannan f. Serologies g. BAL aspirate microscopy h. Cultures 5. Less than 1 week from onset a. Consolidation/nodules - common bacteria i. Gram+ bacteria (MRSA, VRE) ii. Gram-bacteria (pseudomonas) b. GGO - mostly viral i. EBV, CMV, other viruses ii. PJP 6. Consolidation/nodules + non-response to broad spectrum antibiotics - fungi a. Candida b. Aspergillus c. Mucormycosis 7. Other organisms to consider - uncommon bacteria a. Nocardia b. Actinomyces 8. Utility of biopsy a. Fungal infection b. Malignancy c. Non-diagnostic biopsy d. Platelet management 9. Summary by imaging appearance 10. Summary by helpful clinical information

## **CHEE-132 Deciphering Acute Diffuse Pulmonary Lesions: Unraveling the Diagnostic Enigma**

Daisuke Yamada, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Diffuse lung diseases include a wide variety of infectious, neoplastic, and allergic diseases in addition to idiopathic interstitial pneumonia. In this presentation, we will discuss what radiologists need to know about these diseases, especially those that present with diffuse lung lesions in an acute-onset.

## TABLE OF CONTENTS/OUTLINE

Presentation goals: To explain the pathophysiological mechanisms of hydrostatic and permeability pulmonary edema and describe the imaging findings. To discuss the spectrum of acute/subacute lung injury. To present information on acute diffuse pulmonary diseases classified by cause into idiopathic, infectious, allergic, drug-induced, neoplastic, and rare diseases and to describe their characteristic imaging findings. Cases include Infectious pneumonia: COVID-19 pneumonia, Cytomegalovirus pneumonia, Varicella zoster virus pneumonia, Influenza pneumonia, Pneumocystis pneumonia, Miliary tuberculosis, Legionella pneumonia, Diffuse aspergillosis after influenza viral infection Allergic lung diseases: Acute eosinophilic pneumonia, Acute hypersensitivity pneumonitis, E-cigarette, or vaping, product use associated lung injury (EVALI), Pulmonary injury associated with inhalation Drug-induced lung injury: Caused by anti-cancer drugs and other medications Neoplastic diseases: Tumor embolism, Pulmonary tumor thrombotic microangiopathy, Carcinomatous lymphangiosis, Leukocytosis, Intravascular large B-cell lymphoma Rare diseases: Pulmonary hemorrhage, Fat embolism

## **CHEE-133 Detailed Radiologic-Pathologic Correlation in Fibrotic Hypersensitivity Pneumonitis (FHP): For Better Understanding of the HRCT Findings**

Daisuke Yamada, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Understanding the histological backgrounds is an essential clue to making a better interpretation of HRCT images. The teaching points are 1) to review the anatomical/histological basic knowledges of the lungs for HRCT diagnosis of interstitial lung diseases, 2) to recognize the meaning of representative HRCT findings in fibrotic hypersensitivity pneumonitis by precise correlation to histological findings.

## TABLE OF CONTENTS/OUTLINE

Definition and pathophysiology of fHP / Review the anatomical/histological basis of the lungs Anatomy of secondary lobule, location of the peribronchiolar region in secondary lobule Radiological and pathological findings Demonstration of typical radiological and pathological findings of fHP Essential HRCT findings to know- small airway lesion (e.g. three-density pattern, lobules with decreased attenuation), parenchymal fibrotic lesion showing random distribution or UIP/NSIP-like pattern Close correlation between radiological and pathological findings •Centrilobular ground-glass opacities on HRCT-bronchiolitis and peribronchiolar inflammation, airway-centered mild fibrosis/organization •Ground-glass opacities-diffuse parenchymal inflammation or mild alveolar septal thickening •NSIP-like pattern fibrosis showing peribronchovascular distribution on CT- can be formed by a fusion of airway-centered lesions •UIP-like pattern fibrosis showing periacinar/perilobular distribution on CT-is sometimes derived from organization along lymphatic routes result in periacinar/perilobular fibrosis Conclusion The HRCT findings of fHP are varied and complex, but can be better grasped by understanding the histological background.

## **CHEE-14 Oncologic Causes of Phrenic Nerve Palsy: Where and How to Look for**

Nivedita Chakrabarty (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To illustrate normal anatomical course of phrenic nerve from skull base to diaphragmvariant anatomy of phrenic nerve - pictorial review Imaging approach on when to suspect and how to report phrenic nerve compression/infiltrationemphasis on oncologic case based approach to phrenic nerve palsy

## TABLE OF CONTENTS/OUTLINE

IntroductionPhrenic nerve; its anatomy, normal course and variantsVarious aetiologies of phrenic nerve palsy with emphasis on malignancyPathophysiology of phrenic nerve palsy, infiltration vs compressionCT and PET CT as a diagnostic modality for assessment of phrenic nerve palsyPictorial illustration of casesTake home points

## **CHEE-15 Thoracic Involvement in Diseases Related to Dysregulated Humoral Immunity**

Jose G. Maluf, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Understand general concepts about immunity and humoral immunity
- Identify the main pathologies related to unfunctional humoral immunity
- Learn about the thoracic involvement in dysregulated humoral immunity states and how it can impact in patient's health
- Recognize the thoracic imaging findings related to a compromised humoral immunity

## TABLE OF CONTENTS/OUTLINE

- Introduction - General concepts about immunity:
  - o Main concepts and differences between cellular and humoral immunity
  - o Relation of the chest and respiratory tract with humoral immunity and the potential impacts in patient's health
  - o Thoracic imaging role in patients with dysregulated humoral immunity states
- Different thoracic findings:
  - o Airway abnormalities
  - o Infection
  - o Chronic Inflammatory and interstitial lung diseases
  - o Benign lymphoproliferative disorders
  - o Neoplasms
- Case based review - Pathologies and thoracic manifestations:
  - o Common Variable Immunodeficiency (CVID)
  - o IgG4-Related Respiratory Disease (IgG4-RRD)
  - o Respiratory amyloidosis
  - o Hypogammaglobulinemia
  - o Pulmonary Light-Chain Deposition Disease
  - o Other conditions
- Future perspectives
- Conclusions and key takeaways

### **CHEE-16 Rare Vasculitides: An Institutional Case-Based Radiological Review of Hughes-Stovin Syndrome**

Taylor K. Loon, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Describe the clinical presentation and identify the corresponding radiographic findings of Hughes-Stovin syndrome. 2) Compare and contrast the radiological and clinical findings with other vasculitides and other causes of pulmonary artery aneurysms. 3) Discuss the possible complications and highlight the medical and surgical management of Hughes-Stovin syndrome.

## TABLE OF CONTENTS/OUTLINE

1) Introduce Hughes-Stovin Syndrome, its epidemiology, the three sequential phases of clinical presentation, and its diagnostic criteria. 2) Using cases from our institution, present the common radiologic features of Hughes-Stovin on chest radiograph and CT angiography of the thorax. 3) Using 3D-rendered images from our institution, further display the pulmonary arterial findings of Hughes-Stovin Syndrome. 4) Compare and contrast the diagnostic criteria, common radiologic findings and management of Hughes-Stovin to other pulmonary vasculitides including Behçet's disease and Granulomatosis with Polyangiitis. 5) Compare and contrast Hughes-Stovin to other causes of pulmonary artery aneurysms including mycotic aneurysms. 6) Discuss unstable pulmonary aneurysms as a potential complication of Hughes-Stovin Syndrome and overview treatment algorithm based on CT pulmonary angiography findings. 7) Using digital subtraction angiography images from our institution, review embolization for unstable pulmonary artery aneurysms and potential complications of treatment.

### **CHEE-17 Childhood Interstitial Lung Disease: Stepwise Approach to Imaging Findings, Histopathologic Correlation, and Management**

Karen I. Ramirez Suarez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Childhood interstitial lung disease is rare with challenging differential diagnosis which requires a stepwise approach to diagnosis including clinical presentation, imaging, and histology leading to the correct diagnosis in most cases. - An age-based differential diagnosis is particularly helpful for infants and young children. - Imaging evaluation of lung parenchyma, primarily on CT, helps to correctly diagnose these disorders, aids in guiding biopsy when needed, and monitor treatment response or disease progression. - Radiologic pathologic correlation is an important final step in the evaluation of childhood interstitial lung disease.

## TABLE OF CONTENTS/OUTLINE

- Role of imaging of childhood interstitial lung disease with delineation of technique and pediatric protocols. - Stepwise approach to diagnosing childhood interstitial lung disease from clinical presentation to diagnostic workup including imaging, genetics, and biopsy. - Correlation of imaging findings and histology in childhood interstitial lung disease - Differential diagnosis of childhood interstitial lung disease based on clinical findings, imaging, and histology.

### **CHEE-18 Lung Cancer Interventional Oncology: Fire and Ice in the Treatment of Lung Cancer**

Kathryn G. Champ (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-CT-guided ablation is a viable option for treatment of multifocal lung carcinoma and patients with inoperable tumors, recurrence, prior surgery or radiation.-Choice of ablation modality depends on consideration of technical factors, size and location of target lesion, and patient comorbidities.-Target lesions > 3 cm confer a higher local recurrence rate than lesions < 3 cm.-Postablation features of successful ablation include ground-glass margins, which is crucial for confirming treatment success.-Follow up of postablation patients is the responsibility of the interventional oncologist with a standardized regimen of office visits and imaging.

## TABLE OF CONTENTS/OUTLINE

-Indications for ablation in lung cancer-Comparison of ablation modalities-Mechanisms of tissue injury in ablation-Indicators of successful ablation-Postablation zone imaging features-Follow up surveillance

### **CHEE-19 Breaking Through the Sternum: Expected Post-sternotomy Imaging's Findings and Complications**

#### **Awards**

#### **Certificate of Merit**

Renan Arakaki, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Median sternotomy is the incision of choice for thoracic and cardiac surgical procedures. Its incidence of complications ranges approximately between 0,5-5%, with a mortality rate reaching up to 80%. Thus, it is essential for the radiologist to recognize expected poststernotomy imaging findings and differentiate them from complications. This educational exhibit aims to illustrate the different sternal closure techniques, expected postsurgical changes and the main sternotomy complications involving hardware (wire fracture, migration, and rotation), bone (fracture, sternal dehiscence, nonunion, and osteomyelitis), and soft tissues (hematoma, gossypiboma, and abscess).

## TABLE OF CONTENTS/OUTLINE

- Sternal closure techniques- Expected postsurgical imaging findings- Acute sternotomy complications- Late sternotomy complications.

### **CHEE-2 Across the Diaphragm: Thoracic Complications of Abdominal Conditions and Percutaneous Procedures**

Elisa Antolinos Macho, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Recognize that many pathologic abdominal conditions and certain complications of percutaneous abdominal procedures may extend to the thoracic cavity -Learn the most common pathologic abdominal conditions and percutaneous procedures complications that may extend above the diaphragm -Describe the anatomical and acquired pathways through which infradiaphragmatic pathologic conditions and percutaneous procedures complications may reach the thorax -Review the appearance of these thoracic complications on different imaging modalities

## TABLE OF CONTENTS/OUTLINE

1) Anatomy and physiology of the diaphragm 2) Common abdominal pathologic conditions and percutaneous procedures complications that may extend to the thorax o Liver and biliary system conditions o Pancreatic and splenic conditions o Kidneys and adrenal glands conditions o Pelvic conditions o Complications of percutaneous abdominal procedures § External biliary drainage § Percutaneous local ablative therapies of liver lesions § Embolization of portal and hepatic veins § Vertebroplasty 3) Pleural complications o Pleural effusion o Fistulas (biliopleural fistula, pancreaticopleural fistula) 4) Pulmonary complications o Infections § TB § Other mycobacteria o Inflammation § Sarcoid reaction § Pneumonitis § Mendelson syndrome o Fistulas 5) Thoracic vascular complications o Fat embolism syndrome o Foreign body embolism

### **CHEE-20 Emerging Technology in Functional Lung Imaging: Hyperpolarized Xenon Gas MRI**

#### **Awards**

#### **Certificate of Merit**

Cody L. Thornburgh, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Hyperpolarized Xenon Gas (HXG) MRI is a new-to-market FDA approved imaging agent to evaluate lung ventilation, which offers advantages over other inhaled contrast agents.2. Compared to traditional spirometry, HXG MRI is a promising surrogate with superior reproducibility and reliability.3. Regulated by the FDA as a drug-device combination, HXG-MRI has some barriers and obstacles for adoption and implementation.4. Various airway diseases, like asthma, COPD, and Cystic Fibrosis, have MR ventilation features that increase confidence in diagnosis and assessment of disease severity.5. Ongoing investigation of HXG MRI is revealing new applications for medical imaging, which are not currently possible with existing modalities.

## TABLE OF CONTENTS/OUTLINE

1. Background/Objectives2. Techniquea. Drug Preparation---i. Supplies, Consumables---ii. Polarization---iii. Dose Administrationb. MR Scanner Configuration---i. Coil---ii. Software---iii. Hardwarec. Data Analysis---i. Quantitative methods (Ventilation defect percent, VDP)---ii. Qualitative methods3. Clinical Implementationa. Regulatoryb. Logisticalc. Financial4.



Ventilation Characteristics. Normal. Pathology disease states---i. COPD---ii. Asthma---iii. Cystic Fibrosis---iv. COVID-19 (Acute and 'Long')5. Future Frontiers. Dissolved-Phase Imaging (Barrier Tissues and RBC) in healthy and diseased states.b. Dynamic HXG-MRI ('MR Spirometry')c. Physiological response to pharmaceutical agents

## **CHEE-21 How "Holey" Art Thou: Developing a Systematic Approach to Identifying and Reporting Cystic Lung Disease**

### **Awards**

#### **Certificate of Merit**

Maria Clara N. Lorca, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Become familiarized with the different imaging appearance of cystic lung diseases and their differential diagnosis on chest CT. Differentiate true lung cysts versus their mimics: emphysema, cavities, and cystic bronchiectasis, cavitory lung metastasis. Recognize the distribution patterns of the different cystic lung diseases and formulate major differential diagnosis for solitary and multiple pulmonary cysts based on radiological appearance using a standardized approach.

#### **TABLE OF CONTENTS/OUTLINE**

Recognize primary causes of cystic lung diseases, for example: Birt-Hogg-Dube (BHD) syndrome; spontaneous and tuberous sclerosis related lymphangiomyomatosis (LAM), Pulmonary Langerhans cell histiocytosis (PLCH), Lymphocytic interstitial pneumonia (LIP) Recognize acquired cystic lung diseases, for example: Light chain deposition disease, pulmonary laceration, Pneumocystis jirovecii infection, usual interstitial pneumonia, sarcoidosis, amyloidosis. Describe the role of the radiologist in the diagnosis and follow up of cystic lung diseases by CT, and when to recommend further biopsy. Our aim is to review the terminology, distribution and imaging patterns of the most common cystic lung diseases by CT and raise attention to the various mimics of cystic lung diseases, including cavitory lung metastases. The radiologist can then use this information to describe cystic lung disease utilizing a standardized reporting template to improve communication with referring providers.

## **CHEE-22 Pulmonary Blood Volume Image with Dual-energy CT: Findings in Lung Cancer Patients**

Makiko Murota, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review how to obtain the pulmonary blood volume (PBV) images with dual-energy CT. 2. To describe the PBV imaging features and pathogenesis in lung cancer patients. 3. To discuss the importance of clinical implications and the pitfall.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. technical overview of dual-energy CT 3. CTPA techniques 4. the PBV imaging features and pathogenesis in lung cancer patients: vascular abnormalities, bronchial abnormalities, parenchymal abnormalities, artifacts and pitfall, and others 5. Summary

## **CHEE-23 Potential Applications of Photon-Counting Detector CT in Cardiothoracic Imaging**

Mauricio F. Barbosa, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Exemplify current and future applications of photon-counting detector CT (PCD-CT) in cardiothoracic imaging, including: 1. Improved image quality: PCD-CT provides higher spatial resolution and improved contrast-to-noise ratio, which enables more accurate and detailed imaging of the heart, vasculature and lungs. 2. Lower radiation dose: PCD-CT can allow for lower radiation doses than traditional CT. 3. Reduced artifacts: use of high keV imaging on PCD-CT can reduce metallic artifacts; combination of high-helical pitch imaging with PCD-CT can reduce motion artifacts. 4. Potential for new applications: PCD-CT technology offers new possibilities for functional imaging, including perfusion and multi-energy imaging, which may help in the diagnosis and management of cardiothoracic conditions.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction: ? • Explanation of physical principles? • Potential Advantages of PCD-CT over Energy-integrating detector CT (EID-CT)? • Improved image quality? • Reduction in radiation exposure? • Spectral imaging?; II. Clinical Applications of PCD-CT in Cardiothoracic Imaging?: • Coronary Artery Disease Imaging? • Lung Nodule and Mediastinal Mass Characterization? • Evaluation of Interstitial Lung Disease? • Thoracic Vascular Imaging/ Pulmonary embolism?; III. Future Possibilities: ? • Improvements in Quantitative Imaging? • Functional Imaging?; IV. Challenges and Limitations?: • Scientific and clinical validation? • Need for additional training and education?; V. Conclusion?: • Recap of current clinical applications? • Future directions for PCD-CT? • Final thoughts.

## **CHEE-24 Disorders with Hand and Thoracic Involvement**

Riddhi Borse, MBBS, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Numerous medical conditions have multiorgan imaging findings. Here, we review specifically the hand and cardiothoracic findings of selected infectious, inflammatory, connective tissue, neoplastic, and hereditary disorders. These correlations are meant to remind the astute clinician that certain hand findings should trigger a careful radiologic evaluation that includes imaging of the chest.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Examples of cases: A. Connective tissue disorders- Rheumatoid arthritis, Systemic Lupus Erythematosus, Raynaud's syndrome, Dermatomyositis. B. Hereditary Conditions: Marfan's Syndrome, Ehlers Danlos Syndrome, Sickle-cell disease. C. Metabolic conditions: Hyperparathyroidism, Renal Failure with osteodystrophy and metastatic calcification in the lungs. D. Infectious Diseases: Tuberculosis, Septic Embolism. E. Neoplastic Conditions: Lung Cancer, Melanoma. 3. Conclusion.

### **CHEE-25 Tracheobronchomalacia x Excessive Dynamic Airway Collapse: CT and Bronchoscopy Correlation**

Helena A. Pereira, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To discuss the differences between tracheobronchomalacia (TBM) and Excessive Dynamic Airway Collapse (EDAC), emphasizing their pathophysiology, anatomical aspects, clinical presentation and associated comorbidities. - To point out the challenges and controversies in its diagnosis. - To discuss the role of Flexible Dynamic Bronchoscopy and Computed Tomography in the assessment of central expiratory airway collapse (ECAC), highlighting the exam protocols and the main aspects to be evaluated. - To illustrate the imaging appearance of EDAC and TBM on bronchoscopy and CT.

### **TABLE OF CONTENTS/OUTLINE**

1 - Introduction 2 - Pathophysiology, anatomical aspects and clinical presentation of TBM and EDAC. 3 - Flexible Dynamic Bronchoscopy and Computed Tomography: techniques, protocols and main findings. 4- Cases 5- Conclusion

### **CHEE-26 "What's That in the Bone?"- Non-Traumatic Musculoskeletal Pathology on Chest/ Breast Imaging**

Tina Roa, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Understand the basic musculoskeletal anatomy seen in the chest including bones, joints, muscles, tendon insertions and major nerves (including the brachial plexus origin and long thoracic nerve). 2. Recognize MSK anatomic variants and common degenerative changes. 3. Recognize MSK manifestations of infectious, autoimmune, and other systemic pathologies on chest imaging (such as septic arthritis, sickle cell disease, rheumatoid arthritis, etc.) 4. Learn how to approach bone lesions within the chest. 5. Learn how to approach soft tissue lesions within the chest. 6. Review Bone-RADS criteria.

### **TABLE OF CONTENTS/OUTLINE**

1. Normal Anatomy: a. Osseous Structures of the Chest, b. Musculature of the Chest, c. Joints and Tendons, d. Major Nerves; 2. Orthopedic Findings: a. MSK Anatomic Variants in the Chest, b. Degenerative MSK Changes in the Chest; 3. MSK Infections/ Autoimmune/ Other Systemic Anomalies in the Chest: a. Septic Arthritis, b. Autoimmune MSK Manifestations in the Chest, c. Other Systemic Disorders; 4. MSK Tumors of the Chest: a. Benign Tumors (Osseous and Soft Tissue), b. Malignant Tumors (Osseous and Soft Tissue); 5. Algorithm to approach incidental bone lesion/ Review of Bone-RADS.

### **CHEE-27 Spotting the Airway Snags: Computer Tomography Imaging Planning For Bronchoscopy Stent and Valve Placement**

#### **Awards**

#### **Certificate of Merit**

Miriana E. Mariussi, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is to: • Review the indications for bronchoscopy stent and valve placement. • Highlight the role of Computer Tomography in the treatment of airway stenosis, air leaks and chronic obstructive pulmonary disease (COPD). • Comprehend the application of CT planning prior to the bronchoscopy. • Correlate the radiological features with bronchoscopy findings. • Identify CT image findings during follow-up after the procedure.



## TABLE OF CONTENTS/OUTLINE

Bronchoscopy stent and valve placement have been established as a safe and effective treatment alternative for airway stenosis, air leaks and COPD. A case based pictorial essay allows for a comprehensive assessment and understanding of:

- Clinical indications for bronchoscopy stent and valve placement.
- Radiological features of airway stenosis, air leaks and COPD.
- Pre-procedural CT planning for bronchoscopy airway stent placement.
- Pre-procedural CT planning for the endobronchial unidirectional valve placement.
- Imaging findings correlated with bronchoscopy.
- Expected radiological findings during the follow up.

### **CHEE-28    Trouble in the Air: Imaging Review of Early Complications Following Lung Transplantation and Our Institutional Experience**

Bob Zhang, MBBS, BMedSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Early complications following lung transplantation are a major cause of morbidity and mortality. Imaging plays a key role in their diagnosis, and it is important for radiologists to be able to recognise these complications, as well as understand the underlying cause. This exhibit aims to 1) discuss the spectrum of complications that occur within the first week following transplantation, 2) discuss preoperative factors that may predispose to complications, 3) review surgical techniques that reduce the risk of certain complications and how to recognise these on imaging, 4) discuss our institutional experience as a major transplant centre, and 5) review the imaging findings of early complications using a case based format.

## TABLE OF CONTENTS/OUTLINE

1. Overview of lung transplantation. 2. Overview of complications that occur in the first week following transplantation. 3. Preoperative factors that increase risk of complications following transplantation. 4. Surgical techniques to reduce the risk of postoperative complications and how to recognise these on imaging. 5. Review of our institutional experience as a major lung transplantation centre. 6. Case based review of imaging findings in early post-transplant complications.

### **CHEE-29    Bronchiectasis: Another Way to Approach Lung Disease**

Maria Jose Ropain, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Bronchiectasis features in a wide range of pathological processes including infectious causes, bronchial aspiration, pneumoconiosis, congenital immunodeficiencies, and cartilage development disorders, among others. The spatial distribution; is considered a key point when it comes to establishing differential diagnoses in an easier and quicker way. The upper lung zones are usually compromised by cystic fibrosis, sarcoidosis, and allergic bronchopulmonary aspergillosis noticing a more central involvement while tuberculosis has an asymmetric distribution. The middle lobe and lingula frequently show bronchiectasis secondary to infection by atypical mycobacteria or adult respiratory distress syndrome. Associated findings allow radiologists and trainees to address the diagnoses. When tree-in-bud, centrilobular ground-glass nodules and bronchial wall thickening are seen in patients with lower lung zones bilateral bronchiectasis; bronchial aspiration should be suspected. Meanwhile, the presence of architectural distortion, honeycombing, and varicoid morphology bronchiectasis are commonly found in pulmonary fibrosis.

## TABLE OF CONTENTS/OUTLINE

Location and distribution, Upper lung: Cystic fibrosis, Sarcoidosis, Allergic bronchopulmonary aspergillosis, Tuberculosis Middle/lingular: Atypical mycobacterial infection, Acute respiratory distress syndrome, Primary ciliary dyskinesia, Immunodeficiency Lower lung zone: Chronic aspiration, Pulmonary fibrosis,  $\alpha$ 1-Antitrypsin deficiency. Central: Tracheobronchomegaly, Williams Campbell syndrome Focal and diffuse: Endobronchial or peribronchial tumor, Swyer James syndrome, Bronchiolitis obliterans.

### **CHEE-3      Inside the Circuit: Radiology Insights into ECMO Placement**

Valentina Ferrer Valencia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. ECMO, or extracorporeal membrane oxygenation, is a life-support system that provides temporary respiratory or circulatory support to critically ill patients whose heart or lungs are failing. 2. Radiology plays an important role in ECMO, particularly in assessing the placement of the cannulas and monitoring for complications such as bleeding or clotting. 3. Sentinel events, such as malposition of the cannulation require rapid intervention and evaluation by the ECMO team and radiology. 4. There are different types of ECMO cannulation, including veno-arterial, veno-venous, veno-veno-arterial, and central cannulation. 5. Venous-arterial cannulation is used when the patient has both respiratory and circulatory failure, and it requires correct positioning to ensure optimal blood flow and oxygenation. Incorrect positioning can lead to complications such as limb ischemia or vessel injury. 6. Veno-venous ECMO is used when the patient has isolated respiratory failure, and it also requires correct positioning to avoid complications such as bleeding or pneumothorax.

## TABLE OF CONTENTS/OUTLINE

Introduction 1.Indications for ECMO 2.Role of Radiology in ECMO 3.Sentinel Event Types of ECMO Cannulation 1.Veno-Arterial 2.Veno-Venous 3.Veno-Veno-Arterial 4.Central Cannulation Venous-Arterial Cannula 1.Indications 2.Correct Positioning 3.Incorrect Positioning 4.Complications of Incorrect Positioning VA ECMO: Femora Cannula 1.High Arterial Cannula 2.Low Arterial Cannula 3.Low Venous Cannula 4.High Venous Cannula Veno-Venous ECMO 1.Indications 2.Correct Positioning 3.Incorrect Positioning 4.Complications of Incorrect Positioning 5.Single lumen VV ECMO Conclusions

### **CHEE-30 Chill Out! Percutaneous CT- Guided Intrathoracic Cryoablation: Applications, Imaging Appearance, and Complications**

Saumik Z. Rahman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Percutaneous cryotherapy uses liquified gases like nitrogen or argon through cryoprobes under CT guidance to create temperatures as low as - 40° C. Cytotoxic cell destruction occurs at this temperature which helps to destroy neoplastic cells. Cryotherapy allows real-time evaluation of the ablation site. It is a preferred ablation technique for central tumors close to airways, great vessels, pericardium.

## TABLE OF CONTENTS/OUTLINE

Indications for cryotherapy: Primary lung cancer (early or advanced), metastatic lesions, mediastinal lesions, post-SBRT recurrent tumors, post-surgical recurrent tumors.Post treatment appearance - Immediately after the procedure, follow-up after 1 month, 3 months, 6 months and 12 months.Complications of cryotherapy Pneumothorax, hemoptysis, pleural effusion, parenchymal hemorrhage, pneumonia, esophageal injuries, tumor implantation, tumor recurrence, nerve injury, skin injury.

### **CHEE-31 Pleuroparenchymal Fibroelastosis: Update on Imaging with Pathological Correlation**

Joel Gamble, MD,BSC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Pleuroparenchymal Fibroelastosis (PPFE) is a rare subtype of interstitial pneumonia that historically has been difficult to diagnose, particularly in its early stages, and often misdiagnosed by radiologists.2. PPFE can be associated with other fibrotic interstitial lung diseases or triggered by previous infections, chemotherapy, hematopoietic stem cell transplant, and lung transplant.3. Improving awareness of PPFE allows early recognition on CT and allows for close attention on clinical and imaging follow up, including implementation of supportive measures and potential treatment.

## TABLE OF CONTENTS/OUTLINE

1. Introduction to Pleuroparenchymal Fibroelastosis (PPFE): Definition and background; Historical context and understanding; Inclusion in American Thoracic Society/European Respiratory Society guidelines. 2. Diagnosis and Recognition of PPFE: Challenges in early-stage diagnosis; Importance of CT in the diagnosis; Pathological confirmation. 3. Causes and Associations of PPFE: Previously believed to be idiopathic; Association with other fibrotic interstitial lung diseases; triggers, including infections, chemotherapy, hematopoietic stem cell transplant, lung transplant. 4. Clinical Presentation and Prognosis: Slowly progressive or rapid clinical deterioration; Poor prognosis in most cases; Potential treatment.

### **CHEE-32 One-stop-Shop Pictorial Review of All Changes in Lung-RADS v2022**

Seyedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1- Familiarize radiologists with the latest version of the Lung-RADS criteria (Lung-RADS v2022) for lung cancer screening (LCS).2- Review the most recently added nomenclature and morphologic features that radiologists should consider determining the appropriate Lung-RADS categories.3- Review important updates on assigning Lung-RADS categories on follow up studies (stepped management).

## TABLE OF CONTENTS/OUTLINE

1- Introduction to the Lung-RADS tool and its various versions.2- Comparison of important changes between the 2022 and 2019 versions of Lung-RADS in different domains, including A) Atypical pulmonary cysts B) Juxtapleural nodules C) Inflammatory or infectious findings D) Airway nodules.3- Review of updated Lung-RADS terms and structural definitions, including the removal of the risk of malignancy table, changes in follow-up intervals, as well as reset of starting points for follow-up and different definitions for growth.4- Brief review of the effect of changes in Lung-RADS classification criteria on clinical management.

### **CHEE-33 The Many Faces of Evil: A Pictorial Review and Algorithmic Approach to Autoimmune Diseases of the Thorax**

Mahdavi Anari, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Different autoimmune diseases can involve different parts of the thorax, including but not limited to lung parenchyma, heart, esophagus, pleural and pericardial space, great vasculature, thymus gland, and thoracic chest wall.
- Patterns of lung disease could precede the development of the clinical diagnosis of autoimmune disease.
- As autoimmune disorders overlap clinically, the possibility of mixed thoracic radiological manifestations should be considered.
- Thoracic involvement in autoimmune disorders could happen due to the disease process itself, drug toxicity, or opportunistic infections from resultant immunodeficiency, which their differentiation needs meticulous clinical-radiological evaluation.
- Provide an algorithmic approach for diagnosis of autoimmune diseases with focus on intrathoracic findings.
- The European Respiratory Society/American Thoracic Society task force proposes using "Interstitial pneumonia with autoimmune features (IPAF)" for patients with idiopathic interstitial pneumonia and features suggestive of, but not definitive for a collagen vascular disease.

### TABLE OF CONTENTS/OUTLINE

- Review of the thoracic findings in autoimmune disorders of the thorax based on the involved organs.
- Evaluation of lung parenchyma findings based on the pattern and prevalence.
- Assessment of autoimmune diseases of the thorax, beyond the lung parenchyma involvement.
- Review the post-treatment changes and treatment complications in the autoimmune disorders of the thorax.
- Evaluation of the natural progression of thoracic autoimmune disorders.
- An algorithmic approach for diagnosis of autoimmune diseases.

### CHEE-34 Classical Signs on Chest Radiograph: A Primer for Residents

Furkan Ufuk, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

? Recognize the classic signs on chest radiographs. ? Describe each sign's anatomic and pathologic features and discuss their clinical importance.

### TABLE OF CONTENTS/OUTLINE

This educational exhibit provides an overview of classic signs on chest radiographs and their clinical significance. The exhibition includes a table of contents and teaching points, such as recognizing the appearance of chest radiograph signs on Chest CT and describing the anatomic and pathologic features represented by each sign. Several imaging signs on chest radiographs are described, including Air bronchogram, Bat's wing or butterfly shadow, black pleura sign, and others, with the pathophysiologic origin of each sign and the characteristic imaging features described in detail. Radiologists must recognize these signs and understand their causes to provide accurate diagnoses of abnormalities affecting the lungs, heart, mediastinum, diaphragm, and pleura. The exhibit aims to enhance radiologists' knowledge of classic signs on chest radiographs, ultimately leading to improved diagnostic accuracy and better patient care.

### CHEE-35 A Challenge in Diagnosing Benign Thymic Lesions as Benign

Tetsuro Araki, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. To understand the normal/hyperplastic spectrum of the thymus and related clinical conditions  
 2. To understand the typical and atypical appearance of benign thymic lesions  
 3. To understand mimickers of thymic lesions

### TABLE OF CONTENTS/OUTLINE

1. Importance of benign diagnosis of thymus  
 a. Avoid unnecessary thymectomy or follow-up study  
 b. Image modality selection and appropriate recommendation  
 2. Normal/hyperplastic spectrum of the thymus  
 a. Various morphology of the thymus  
 b. Demographic and clinical features related to thymic involution/hyperplasia  
 c. Thymic hyperplasia related to COVID-19 infection or vaccination  
 d. 2D and 3D analysis: Shape and measurement in size and volume  
 3. Typical appearance of common benign thymic lesions  
 a. Thymic hyperplasia: True vs lymphoid hyperplasia  
 b. Thymic cyst: Unilocular vs multilocular  
 c. Thymolipoma  
 d. Differentiation from thymic neoplasm (Thymic epithelial tumor, lymphoma)  
 4. Atypical appearance of benign thymic lesions  
 a. Nodular component within the thymus  
 b. Atypical morphologies of thymic hyperplasia (TH)  
 • Non-suppressive TH out-of-phase T1WI MRI  
 • Multinodular/multicystic TH (Sjogren's syndrome, HIV infection)  
 c. Atypical features of thymic cyst  
 • Complicated hyperattenuating cyst  
 • Thymic/pericardial cyst within TH  
 5. Mimicker of thymic lesions  
 a. Morgagni hernia  
 b. Focal fat necrosis  
 c. Ectopic thyroid lesion  
 d. Tortuous internal mammary vein  
 e. Lymph nodes  
 6. Summary

### CHEE-36 A Comprehensive Pictorial Review: Vascular Anomaly and Malformation of Thorax

Ryosuke Taiji, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is To depict anomalies and malformations of thorax To discuss the clinical feature, significance, and management for those entities.

## TABLE OF CONTENTS/OUTLINE

The mediastinum contains two distinct circulatory systems, namely the systemic and pulmonary circulations. Anomalies and malformations have been reported within the thorax. In the pediatric population, some malformations are identified promptly after birth and necessitate surgical intervention. Radiologist should be familiar with these entities. Contents 1. Pulmonary artery Absence of the right pulmonary artery, proximal interruption of the pulmonary artery, pulmonary arterial aneurysm, pulmonary sling, and Taussig-Bing syndrome, 2. Aorta Aberrant right subclavian artery, right aortic arch and Kommerell diverticulum, arterial duct (Botallo's duct), and anomalous systemic arterial supply to the basal lung 3. Pulmonary vein Partial anomalous pulmonary venous return (PAPVR); right upper and lower pulmonary vein, Scimitar syndrome, total anomalous pulmonary venous return (TAPVR); supra-cardiac, cardiac, infracardiac type, anomalous unilateral single pulmonary vein (AUSPV), and pulmonary venous aneurysm 4. Vena cava Persistent left superior vena cava, azygos continuation of inferior vena cava 5. Summary

### **CHEE-37 Granulomatosis with Polyangiitis (GPA): Thoracic Manifestations with Emphasis on Differential Diagnosis**

Roddie Moraes Neto, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review the pathophysiology and histologic features of granulomatosis with polyangiitis (GPA); review the main clinical manifestations of GPA; recognize the most common and uncommon chest imaging findings of GPA; highlight the main differential diagnosis of thoracic manifestations of GPA in a pattern-based approach, with clinical-radiological correlation.

## TABLE OF CONTENTS/OUTLINE

Introduction: definition, pathophysiology, clinical features, diagnostic criteria; case based review - pattern-based thoracic manifestations of GPA with differential diagnoses: lung nodules and masses, airspace consolidation and ground glass opacities, airway thickening, pleural involvement, rare mediastinal manifestations (lymphadenopathy, cardiac involvement, great arteries vasculitis); conclusions and key takeaways

### **CHEE-38 Clearing the Fog - What You Must Know About Smoking-related Diffuse Lung Diseases**

Gabriel N. Neumann Kuhn, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review the smoking-related diffuse lung diseases (SDLD) and its pathophysiological mechanism; Discuss the relationship between smoking and interstitial lung abnormalities (ILA) and the relevance of the imaging approach; Case-based demonstration of the main imaging findings associated in each one of the SDLD; Review the findings and implications of the combined emphysema-fibrosis syndrome.

## TABLE OF CONTENTS/OUTLINE

General facts about tobacco use; Case based examples of the main SDLD (respiratory bronchiolitis / desquamative interstitial pneumonia, smoking related interstitial fibrosis / airway enlargement with fibrosis, Langerhans cell histiocytosis); Brief up-to-date approach of combined emphysema-fibrosis syndrome; Take home messages.

### **CHEE-39 Three Steps for the Success of a Lung Segmentectomy Surgery: The Role of the Radiologist**

Maria Celia Franco Issa, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

? Review the concepts, indications and techniques of lung anatomical segmentectomy ? Describe the most relevant imaging features of the pulmonary nodule to the surgery planning ? Discuss the role of preoperative Chest Computed Tomography (CT) in the recognition of the drainage pattern of the intersegmental vein and determination of the intersegmental plane ? Recognize the anatomical features and variations of the pulmonary venous drainage with potential impact in lung segmentectomy ? Discuss the role of 3DCT in the lung segmentectomy planning

## TABLE OF CONTENTS/OUTLINE

• Introduction • The rationale of Lung Segmentectomy o Indications o Advantages and disadvantages o Minimally Invasive Techniques - Video-assisted thoracic surgery (VATS) - Robotic-assisted thoracic surgery (RATS) - Potential complications • The role of the Radiologist in three steps 1. Describe the most relevant features for anatomical segmentectomy recommendation: - Nodule size and location - Resection margin - Previous lung resection - Absence of visible regional lymph node disease 2. Identify the intersegmental vein - Delineate the intersegmental plane - Verify if the intersegmental vein is a drainage vein

from the tumor 3. Look for variations of the pulmonary venous drainage that might impact in the lung segmentectomy - Case-based review - Atypical venous outflow to the left atrium - Atypical topography of the pulmonary vein - Atypical venous vascularization of pulmonary segments • Future Directions the role of CT with 3D reconstructions and 3D printing in lung segmentectomy planning

#### **CHEE-4 Primer for Radiology Residents: Cardiothoracic Emergencies in Oncology**

Jitesh Ahuja, MD, MBBS (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Familiarize radiologists with spectrum of acute cardiothoracic complications that can occur in oncology patients.

##### **TABLE OF CONTENTS/OUTLINE**

Cancer is the second most common cause of mortality in United States. Several acute cardiothoracic complications can occur in oncology patients that can be life-threatening. These complications can occur due to tumor itself, including the extent of local invasion and metastasis. In oncology patients undergoing treatment, emergencies can be the result of complications of chemo/immunotherapy, surgery and radiation therapy. Finally, patients with cancer are at increased risk of emergencies due to systemic disease from hypercoagulable state and immunosuppression. 1. Complications due to cancer itself a. Airway obstruction b. SVC syndrome c. Esophagorespiratory fistula d. Esophagoaortic fistula e. Large pleural effusion, hemothorax or pneumothorax f. Cardiac tamponade g. Lymphangitic carcinomatosis h. Spinal cord compression 2. Complications due to cancer treatment a. Pneumothorax, hemothorax b. Mediastinal hematoma, mediastinitis c. Lobar torsion d. Cardiac herniation e. Esophageal leak f. Drug or radiation pneumonitis g. Immunotherapy associated myocarditis 3. Systemic complication a. Pulmonary embolism b. Opportunistic infections c. Stress cardiomyopathy (Takotsubo)

#### **CHEE-40 Utilization of Virtual Bronchoscopy and 3D-Multiplanar Volume Reconstruction (MPVR) Correlation to Illustrate Tracheobronchial Tree Abnormalities - An Imaging Review**

Shashank S. Pandya, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Tracheobronchial tree abnormalities can be subtle on imaging and are not always accessible via fiberoptic bronchoscopy (FB). As healthcare shifts towards value-based care, technological innovations such as virtual bronchoscopy (VB) may not only reduce overspending but also improve clinical and patient satisfaction outcomes by providing radiologists with a visually intuitive medium to show rather than only tell complex 3D radiographic findings to non-radiologist audiences. VB is rendered by processing multi-detector row CT (MDCT) volumetric data via specialized software that assumes an artificial perspective from a lumen and then assigns opacity values and full spectrum color values based off attenuation values of different tissues and abrupt changes in attenuation between adjacent voxels. VB is underutilized, and it is better than conventional FB in specific cases where higher order subsegmental bronchial branches or regions distal to an obstruction/stenosis or are inaccessible via FB. VB enables a quick, highly accurate, and, most importantly, non-invasive visual medium to evaluate the tracheobronchial tree. It can play an invaluable role in personalized pre-procedural planning and simulations as well as in educating trainees in thoracic anatomy.

##### **TABLE OF CONTENTS/OUTLINE**

1. Briefly describe how 3D-MPVR post-processing is used in creating VB. 2. Using our institutional database, present CT imaging cases with their respective 3D-MPVR and VB images, including, but not limited to, the following tracheobronchial tree abnormalities: tracheal anomalies, tracheal stenosis, tracheal enlargement, excessive central airway collapse, endobronchial lesions, and trauma.

#### **CHEE-41 A Pictorial Review: Lymphoma and Lymphoproliferative Disease of Thorax**

##### **Awards**

##### **Certificate of Merit**

Ryota Nakano (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

To depict lymphoma and lymphoproliferative disease of thorax To discuss the clinical and radiological findings and management

##### **TABLE OF CONTENTS/OUTLINE**

Lymphoma and lymphoproliferative diseases of the thorax occur primarily in the lungs, bronchus, mediastinum, and chest wall. Radiologists need to know more about each disease, as some require differentiation from lung cancer or other malignant mediastinal tumors. Contents. 1. Pulmonary lymphoproliferative disease (LPD): follicular bronchiolitis, lymphocytic interstitial pneumonia, and nodular lymphoid hyperplasia. 2. Primary pulmonary lymphoma: MALT lymphoma, diffuse large B-cell lymphoma, and Intravascular large B-cell lymphoma. 3. Primary mediastinal lymphoma: diffuse large B-cell lymphoma,

classical Hodgkin lymphoma, and T-cell lymphoblastic lymphoma. 4. Primary pleural lymphoma: pyothorax associated lymphoma, and follicular lymphoma. 5. Miscellaneous: IgG4-related disease, Uni-/Multicentric Castleman disease, and methotrexate-associated LPD.

## **CHEE-42 The Invisible Culprit: Demystifying Autoimmune Disorders of the Lungs**

Abhaya Kharat (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Autoimmune disorders affecting the lungs are a group of medical conditions characterized by the presence of autoantibodies that can cause damage to organs throughout the body. They include connective tissue diseases. CTD-ILD is defined as evidence of ILD demonstrated by CT (i.e., some combination of reticulation, ground-glass opacities, traction bronchiectasis, honeycombing, and/or cysts) in the setting of an established CTD. It includes RA, systemic sclerosis, SLE, primary Sjogren's syndrome, idiopathic inflammatory myositis, and mixed connective tissue disease. Diagnosis typically involves imaging studies such as high-resolution CT scans, lung biopsies and immunological investigations. Treatment options include corticosteroids, immunosuppressants, oxygen therapy and pulmonary rehabilitation. In severe cases, lung transplantation is considered as a last resort.

### **TABLE OF CONTENTS/OUTLINE**

1. Antisynthetase syndrome- inflammatory myositis, polyarthritis associated with ILD and anti-synthetase autoantibodies. 2. Microscopic polyangiitis- diffuse pulmonary alveolar hemorrhage is common feature. 3. RA-ILD is commonly associated with UIP. 4. SSc-ILD is commonly associated with NSIP. Risk factors- anti-topoisomerase Ab and higher skin score. 5. Sjogren's syndrome typically presents with NSIP, other patterns like UIP, LIP, focal lymphoid hyperplasia of the lung, small airways disease, and pulmonary vasculitis. 6. IIM-ILD is restricted to subsets of DM and PM. Usually manifests as NSIP with OP. Risk factors - anti-Jo1, anti-PL-7, anti-PL-12, and Black race. 7. Sarcoidosis -commonly affects the lungs and mediastinum with variable radiographic features depending on the stage of the disease.

## **CHEE-43 Pinpoint It - A Pictorial Essay on Causes of Acute Chest Pain on CT**

Murilo d. Peixoto, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Acute localized chest pain is an important and frequent complaint in patients who seek the emergency medical care and can originate from many different compartments / tissues, namely the mediastinum (including cardiovascular structures), the lungs, the pleura, the chest wall, the spine or even the upper abdomen. Placing a skin marker at the topography of pain referred by the patient is an important step in facilitating the identification of a potential cause.

### **TABLE OF CONTENTS/OUTLINE**

Numerous diseases may present as acute localized chest pain and chest computed tomography (CT) can be an important tool to detect the cause, including pulmonary infarction caused by acute thromboembolism, lobar pneumonia, pneumothorax, bone / cartilaginous fractures, acute cardiovascular pathologies, acute pericarditis, mediastinal fat necrosis, some upper abdominal pathologies, among other diseases. The placement of a skin marker in the vicinity of the potential finding, in the location pointed by the patient as painful, plays an important role in allowing for a more accurate search pattern by the radiologist. This exhibit aims to provide a pictorial essay on several findings that are consistent with the clinical presentation of acute localized chest pain as they appear on chest CT, with a special focus on cases in which the placement of a skin marker was particularly helpful.

## **CHEE-44 Showcasing Signs & Silhouettes: Assessment of Congenital Pediatric Cardiac Pathology on a Chest Radiograph**

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Even with the availability of modalities such as echo, CT, and MRI; a plain chest radiograph remains as the first and most basic modality to investigate suspected congenital cardiac conditions in the pediatric population. A chest radiograph is convenient as it is an easily accessible, low-cost, and non-invasive diagnostic tool with minimal radiation dose, giving us an opportunity to move one step closer to a "green radiology." While evaluating the chest radiograph, it is vital to recognize that classic cardiac signs and silhouettes. Additional emphasis should be given to the pulmonary blood flow, ribs, and spine. Since a chest radiograph is the starting point for majority of patients with suspected congenital heart conditions - it is very imperative for the radiologists to quickly recognize these classic findings to provide an accurate diagnosis for proper patient management.

### **TABLE OF CONTENTS/OUTLINE**

Introduction to normal pediatric cardiac silhouette  
Cyanotic Cardiac Heart disease:- Tetralogy of Fallot- Total Anomalous Pulmonary Venous Return (TAPVR)- Truncus Arteriosus- Transposition of Great Arteries- Tricuspid Atresia- Hypoplastic Left



Heart Syndrome (HLHS)- Ebstein's Anomaly• Acyanotic Cardiac Heart disease:- Atrial Septal Defect (ASD)- Ventricular Septal Defect (VSD)- Patent Ductus Arteriosus (PDA)- Coarctation of the Aorta- Aortic Stenosis- Pulmonic Stenosis• Technical factors• Limitations of Chest x-ray. Tricks and tips to radiologist for interpreting CXR.

## **CHEE-45 Caution! Lung "Fields" Ahead: Thoracic Imaging in the Agricultural Setting**

Carolina M. McShane, MD, MSc (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The agricultural sector employs 884 million workers, over a quarter of the global labor force, yet it remains one of the three most hazardous industries in the world. High morbidity and fatality rates are largely attributable to respiratory illnesses arising from unique exposures inherent in agricultural processes. Since the last comprehensive overview of radiological manifestations of agricultural-related diseases was published in 1991 by Gurney et. al, imaging technologies have modernized, allowing for more exquisite characterization of these lung disorders. Modern agricultural practices have brought about new illnesses and mechanisms of trauma, with unique radiological manifestations that have not been sufficiently characterized in the literature. In this exhibit, we provide an updated overview of the radiological manifestations of agriculture-related lung diseases and chest traumas to help with timely diagnosis and treatment for this vulnerable population.

### **TABLE OF CONTENTS/OUTLINE**

Outline: I. Agricultural workers as a vulnerable population II. Radiological manifestations from exposures to microorganisms in agriculture a. *Coxiella burnetii* (Q Fever) b. *Nocardia nova* c. Blastomycosis d. Acute histoplasmosis e. Pulmonary echinococcosis (hydatid disease) III. Radiological findings from exposures to organic compounds a. Organic dust toxic syndrome b. Nonfibrotic hypersensitivity pneumonitis c. Fibrotic hypersensitivity pneumonitis d. Silo filler's disease IV. Agricultural related trauma a. Blunt chest trauma b. Foreign body aspiration c. Deep vascular injury V. The final harvest: take home learning points

## **CHEE-46 Cardiovascular Imaging in Thoracic Neoplasms**

### **Awards**

#### **Cum Laude**

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Recent advances in chest MRI have expanded its use in the evaluation of chest tumors, not only for tissue characterization but also for precise depiction of invasion of adjacent structures, tumor staging and treatment monitoring. Moreover, depiction of cardiac involvement, either directly or indirectly, has been associated to worse prognosis in oncologic patients. Teaching points: 1. To detail the basic and advanced CMR techniques that may be incorporated to conventional chest MR protocols, as well as its indications and potential pitfalls. 2. To review the direct and indirect mechanisms of cardiovascular involvement in patients with thoracic malignancies. 3. To identify how combined hybrid cardiothoracic imaging may be useful for treatment surveillance and monitoring.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. CMR in cardio-oncology: The imaging protocol 2.1. Basic chest MR protocol (starting point) 2.2. Cardiac sequences for thoracic neoplasms evaluation - T1 black blood imaging (fat invasion) - DWI with EKG triggering - First pass perfusion - Cine SSFP - Parametric mapping (tumoral/tissue characterization) - MR angiography - 4D flow CMR (great vessels and cavitory hemodynamics) - PET/MR imaging 3. Cardiac involvement in Cardio-Oncology: Direct Mechanisms - Hematogeneous metastasis - Lymphoid metastasis - Direct involvement - Intravascular growth 4. Improving tumor staging with cardiac sequences - Cardiac/vascular/mediastinal invasion - Pleural invasion - Chest wall invasion 5. Indirect involvement of the heart in oncologic patients - Thoracic irradiation - Chemotherapeutic agents - Plasma cell dyscrasia (amyloid) 6. Use of CMR in treatment monitoring: Prognostic biomarkers 7. Take home points

## **CHEE-47 Chest Computed Tomography Angiotomography with 3D Reconstructions for Preoperative Planning**

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is to:- Review the evolution of surgical technique for pulmonary resections - Highlight the benefits of Computed Angiotomography with 3D reconstructions in surgical planning - Understand the application of CTA planning prior to segmentectomy to evaluate bronchovascular relations, anatomical variations and lung volumetry- Correlate the radiological findings with intraoperative findings - Identify the role of 3D images in facilitating communication between radiologists and surgeons

## TABLE OF CONTENTS/OUTLINE

Surgical planning using imaging methods has become increasingly relevant with the advancement of robotic thoracic surgery and sublobar resections for the treatment of lung neoplasms, which has driven the growth of 3D reconstructions. A pictorial essay based on cases from our collection allows for a comprehensive assessment and understanding of:- Historical evolution of pulmonary lobectomy and current main indications for sublobar resections.- Benefits of 3D surgical planning. - How we do our 3D reconstructions with explaining videos.- Application of 3D reconstructions in robotic surgery consoles.- Radiological findings of 3D reconstructions with surgically relevant anatomical variations and bronchovascular relationships- 3D reconstruction findings with nodule volumetric and density analysis, lung segments volumetry and intersegmental resection planes

### CHEE-48 The Role of Imaging in Bronchoscopic Lung Volume Reduction Using Endobronchial Valves

#### Awards

#### Certificate of Merit

Yogesh S. Gupta, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Provide a background on the various lung volume reduction techniques and their efficacy in the treatment of COPD with a focus on bronchoscopic lung volume reduction (BLVR) using endobronchial valves (EBV) 2. Discuss important imaging parameters in preprocedural assessment with attention to target lobe selection as well as exclusion criteria 3. Present expected postprocedural imaging findings as well as various postprocedural complications with imaging correlates

## TABLE OF CONTENTS/OUTLINE

Of the various BLVR techniques, EBVs have the largest body of scientific data to support their safety and efficacy. Imaging plays a central role both prior to the procedure - in determining the presence of contraindications and selecting the target lobe using CT -- as well as after the procedure - in determining whether the procedure was effective and characterizing potential complications using radiography and/or CT. Outline• Overview of indications and types of lung volume reduction• Background on mechanism of action of valves, valve types, and location of valve deployment• Preprocedural role of CT in characterizing emphysema, determining exclusion criteria, and target lobe selection and role of perfusion scintigraphy in further selection• CXR and CT imaging of expected postprocedural findings (i.e. lobar collapse) and potential complications (ex: pneumothorax, infection, valve migration)• Discussion of future directions

### CHEE-5 Atypical Pulmonary Metastases: Patterns and Clinical Significance

#### Awards

#### Certificate of Merit

Ioannis Vlahos, MBBS, FRCR (*Presenter*) Director, Grayscale Ltd; Co-owner, Grayscale Ltd;

#### TEACHING POINTS

Based on cases from an international cancer referral center, explain: Atypical metastases (morphology, evolution, sources) Clinical implications of atypical patterns Associated risks of mimics, misdiagnosis, delayed diagnosis

## TABLE OF CONTENTS/OUTLINE

Atypical morphology and clinical implications: Cannonball, miliary, cavitating, pneumothorax-associated, calcified, ossified, hypervascular, hemorrhagic, airspace, endobronchial, central embolized, peripheral arterial microvascular (including pulmonary tumor thrombotic microangiopathy), endovenular, perilymphatic. Atypical growth rates: Rapid: implications for incorrect pathology (e.g. rhabdoid/sarcomatoid/small cell differentiation), re-biopsy (e.g. small cell transformation), metastasectomy recurrence rates Slow: e.g. Adenoid Cystic Carcinoma Benign metastases (leiomyoma, meningioma, giant cell tumor, HPV)

### CHEE-50 Differential Diagnosis of Multiple Subsolid Pulmonary Nodules

Murilo d. Peixoto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- There are numerous etiologies to be considered in the differential diagnoses when faced with multiple subsolid nodules at high resolution computed tomography (HRCT).- Surveillance of these nodules should follow the recommendations of the Fleischner Society.- They can represent the initial manifestation of diseases that typically present with a different imaging pattern.- When discerning upon a possible infectious etiology, the status of the patient as immunocompetent or immunosuppressed is a key to the diagnosis.- There are specific imaging signs and/or association with other conditions that may help narrow the differentials.



## TABLE OF CONTENTS/OUTLINE

A pattern of multiple subsolid nodules is a diagnostic challenge. There are a plethora of conditions that can present with such characteristics on imaging, even more so when one considers that other imaging patterns may present as multiple subsolid nodules in the initial stages. It is important to understand the possible diagnoses that can present with such a pattern, as well as the recommendations for surveillance and the association with other conditions that may help narrow down the differentials, even to a single entity. In this exhibit, in the format of a pictorial essay, the HRCT pattern of multiple subsolid nodules is revised, as well as the multiple etiologies, manifestations and associations pertinent to the matter.

### CHEE-51 **Keep an Eye on Diseased Lung: What to Look for in Native Lung After Unilateral Transplantation**

Juan Facundo Arguello, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

\* One-lung transplantation is a practice aimed at improving the survival of patients with advanced stages of pulmonary disease; its most common indications include COPD, pulmonary fibrosis, and sarcoidosis (in North America). Its practice is becoming more frequent, which has led to knowing with greater certainty both the benefits and complications associated with it. However, complications that preferentially involve the native lung have received less attention.\* Radiologists should be familiar with the most frequent complications in the native lung as well as their chronology and the most frequent form of presentation in the different imaging methods (CT and X-ray).\* Make a quick review of the management and treatment of each of them.

## TABLE OF CONTENTS/OUTLINE

Introduction, classification, and chronology  
Infections  
Incidence  
Pathophysiology  
RX and CT findings  
Treatment  
Pulmonary thromboembolism  
Incidence  
Pathophysiology  
RX and CT findings  
Treatment  
Tumor  
Incidence  
Pathophysiology  
RX and CT findings  
Treatment  
Hyperinflation  
Incidence  
Pathophysiology  
RX and CT findings  
Treatment  
Pneumothorax  
Incidence  
Pathophysiology  
RX and CT findings  
Treatment

### CHEE-52 **Collateral Venous Pathways In Superior Vena Cava Obstruction**

#### Awards

#### Cum Laude

Marta Bueno, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To describe the different venous collateral routes in superior vena cava obstruction.  
2. To relate the level of obstruction with the pattern of collateral vessels.  
3. To illustrate some unusual image findings that can occur in superior vena cava syndrome

## TABLE OF CONTENTS/OUTLINE

1. Anatomy and embryology of superior vena cava  
2. Causes of superior vena cava obstruction  
3. Different patterns of venous collateral pathways depending on the level of blockage  
4. Major collateral pathways  
4.1. Azygos-Hemiazygos system  
4.2. Lateral thoracic route  
4.3. Internal mammary route  
4.4. Anterior cervical route  
4.5. Pericardiophrenic route  
4.6. Vertebral route  
5. Unusual collateral pathways  
5.1. Systemic to pulmonary shunt.  
5.1.1. Anatomic  
5.1.2. Congenital  
5.1.3. Acquired  
5.2. Cavoportal pathways  
5.2.1. Downhill varices  
5.2.2. Caval-superficial-umbilical-portal  
5.2.3. Caval-mammary-phrenic-hepatic capsule-portal  
6. Unusual imaging findings:  
6.1. Reopening of left superior vena cava.  
6.2. Pseudopathologic vertebral body enhancement

### CHEE-53 **Big Fat Truth: A Pictorial Review of Fat Containing Cardiothoracic Lesions - Practical Guide for Radiologists (Case-based)**

Iandra Pacheco, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Demonstrate a practical guideline with cases to help radiologists with the differential diagnosis of fat containing lesions of the heart and the thorax. Illustrate with didactic cases and review the typical appearance and the main radiological characteristics of cardiothoracic lesions that contain fat.

## TABLE OF CONTENTS/OUTLINE

INTRODUCTION  
IMAGING GUIDELINE  
Didactic scheme of the main sites of cardiothoracic involvement by fat containing lesions  
DEMONSTRATE DIDACTIC CASES WITH A RADIOLOGICAL REVIEW  
Thoracic duct lipoma  
Pleural lipoma  
Liposarcoma  
Lipoid pneumonia  
Pulmonary hamartoma  
Extramedullary hematopoiesis  
Lipomatous hypertrophy of the interatrial septum  
Arrhythmogenic right ventricular cardiomyopathy  
Cardiac lipoma  
Cardiac rhabdomyoma  
Mediastinal teratoma  
Mediastinal lipomatosis  
Diaphragmatic hernia  
Thymolipoma  
Epi-pericardial fat necrosis

## **CHEE-54 Unmasking the Silent Killer: Challenges in Lung Cancer Detection due to Underlying Disease, A Case Based Presentation**

### **Awards**

#### **Certificate of Merit**

Sherri E. Couillard, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Lung cancer detection can be challenging when the patient has an underlying disease. This may lead to delays in diagnosing lung cancer, which can be associated with poorer outcomes. 2. Location, shape, border, and size of abnormalities, as well as any associated features should be carefully evaluated. Continuous follow-up and comparison of serial imaging are important. 3. We present lung cancer developed in a variety of underlying diseases/conditions, emphasizing teaching points to help to differentiate lung cancer from underlying lung findings. 4. A multidisciplinary approach involving radiologists, pulmonologists, thoracic surgeons, and oncologists is necessary to ensure an accurate diagnosis and appropriate management plan.

#### **TABLE OF CONTENTS/OUTLINE**

1. Post-treatment. A) Postsurgical. B) Post-radiation. 2. Infection/inflammation. A) Tree in bud nodularity. B) Pneumonia/consolidation. 3. Aspiration. 4. Atelectasis. A) Post obstructive. B) Dependent. C) Rounded. 5. Systemic Disease. A) Pre-existing cystic lesions. B) Underlying scarring/fibrosis. 6. Normal anatomic variants. A) Lung cancer developing within/near normal variant.

## **CHEE-55 Chest X-ray and Mediastinal Abnormalities**

Antonio Nunez Soto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Plain radiography is still today the most common image technique in our hospitals. It is accessible, inexpensive, painless and non-invasive, providing much information with a great cost-effectiveness ratio. With chest X-ray we can detect and analyze mediastinal pathologies, either suspected or incidental. Recognizing normal mediastinal anatomy and anatomic variants is essential for finding out pathology.

#### **TABLE OF CONTENTS/OUTLINE**

The aim of this poster is to describe the radiological analysis of chest radiography for detecting and diagnosing mediastinal abnormalities. For this purpose, we will show normal mediastinal anatomy and mediastinal lines in chest radiographs, as well as normal changes that we can see in supine X-rays with antero-posterior view instead of postero-anterior. We will explain the radiological signs and features that can help us identify mediastinal abnormalities, with the support of several cases of different pathologies (pneumomediastinum, mediastinal masses, vascular pathologies, diaphragmatic hernia...) from a third-level-hospital. For every case, we will provide the clinical information, the X-ray image, in which we will highlight the radiological signs implicated, and a correlation with other imaging techniques. In all cases, the chest X-rays were essential in the initial management of these patients. This presentation will be of interest for radiologists, resident doctors, medical students and other healthcare professionals. The combination of the theoretical semiology with our collection of cases will provide an easy and approachable way to review the most important mediastinal pathology.

## **CHEE-56 The Sternum: The Forgotten Bone of the Thoracic Cage**

Lucas P. Farias, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1) To review the normal anatomy of the sternum. 2) To review usual and unusual cases with sternal involvement. 3) To understand the sternum (anatomy and pathologies) by associating schematic drawings with MPR and three-dimensional reconstructions (including animated gif). 4) To correlate important findings with the anatomy, embryology, and pathophysiology. 5) To discuss image findings in order to enhance radiologists' skills. 6) To review CT protocols in the evaluation of patients with suspected coronary artery anomalies. 7) To highlight their characteristics in order to familiarize radiologists with these conditions, preventing unfavorable patient outcome.

#### **TABLE OF CONTENTS/OUTLINE**

1) Imaging protocols in the evaluation of patients with suspected sternal involvement. 2) Applied embryology and anatomy of the sternum. 3) Normal sternal development. 3.1. Anatomical variations. 3.2. Metabolic. 3.3. Vascular. 3.4. Inflammation and infection. 3.5. Trauma. 3.6. Postoperative changes 3.7 Neoplasm. 4) Sample cases of pearls, pitfalls, diagnostic difficulties, and mimics. 5) Summary and take-home messages.

## **CHEE-57 Pulmonary Edema: You Better Not Drown in the Basics**

Gabriel N. Neumann Kuhn, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purposes of this exhibit are: 1. To elucidate the classification of pulmonary edema according to its pathophysiological mechanisms: - Hydrostatic edema; - Permeability edema without diffuse alveolar damage; - Permeability edema with diffuse alveolar damage; - Mixed edema. 2. Review the use and peculiarities in the main imaging methods for the evaluation of pulmonary edema: - Chest X-ray; - Computed tomography (CT). 3. Highlight the current epidemiological trends and radiological findings associated with the main causes of pulmonary edema.

### **TABLE OF CONTENTS/OUTLINE**

• Review of thoraco-pulmonary anatomy: - Cardiac silhouette; - Pulmonary interstitium; - Pulmonary vascular markings; - Costophrenic angles. • Demonstration of the main radiological findings of pulmonary edema: - Alveolar edema; - Kerley B lines; - Opacities; - Consolidations; - Ground-glass opacities. • Demonstration of common and uncommon conditions that cause pulmonary edema from our clinical case collection, such as: - Cardiogenic pulmonary edema (left heart failure, mitral regurgitation, etc.); - Postobstructive pulmonary edema; - Pulmonary edema in pulmonary thromboembolism; - Pulmonary edema in drug abuse; - Post-lung transplant pulmonary edema; - Re-expansion pulmonary edema; - Neurogenic pulmonary edema.

### **CHEE-58 Multifocal Cystic and Cavitory Lung Disease: From Thin to Thick**

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is to:- Review cystic and cavitory lung disease and a general approach to focal and multifocal/diffuse forms. - Highlight the evaluation of the wall of focal aerated lung lesions and comprehend the imaging findings in thin-walled, thick-walled cysts and cavitory lung lesions. - Correlate the radiological characteristics with the main differential diagnoses and signs of malignancy. - Identify the important imaging findings addressed in cystic lesions of the new Lung-RADS v.2022

### **TABLE OF CONTENTS/OUTLINE**

Cysts and cavities are commonly encountered abnormalities on chest CT. Occasionally, the underlying nature of the lesions can be readily apparent as in bullae associated with emphysema. Other times, cystic and cavitory lung lesions can be a diagnostic challenge. A pictorial essay based on cases from our collection allows a comprehensive evaluation and understanding of:- General approach to focal and diffuse cystic and cavitory lung diseases. - Propose an algorithm to facilitate the evaluation of focal cystic lesions and cavities. - Evaluation and differential diagnosis of focal thin-walled cystic lesions. - Evaluation and differential diagnosis of focal pulmonary thick-walled cysts and cavitations. - Imaging findings of focal cystic lesions correlated with Lung-RADS v.2022

### **CHEE-59 Imaging of the Diaphragm: Anatomy and Disorders**

Miriam Gallego Casals, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The diaphragm is the physical barrier that separates the thorax from the abdomen and is the main muscle involved in ventilation. Its dysfunction can be a cause of dyspnea, and despite its importance, it is often underrated and incompletely evaluated by clinicians as well as by radiologists. We will briefly describe the anatomy of the diaphragm, and discuss its abnormalities through cases, classified as:- Dysfunction: paralysis, weakness or eventration and consequences of diaphragmatic inversion.- Hernias: congenital (Morgagni, Bochdalek) and acquired.- Rupture: traumatic and post-surgery.- Secondary: neoplastic and infectious involvement by contiguity from the abdominal cavity.- Miscellanea: Median arcuate ligament syndrome and increased uptake on PET/CT (respiratory effort, hipo). Finally, we explain the main imaging techniques we have for both the functional and morphological study of the diaphragm, including chest radiographs, fluoroscopic tests, ultrasounds and CT.

### **TABLE OF CONTENTS/OUTLINE**

- To describe the anatomy and physiology of the diaphragm.- To review the primary diaphragm disorders.- Learn the image techniques available for its study.

### **CHEE-6 Imaging Findings of Autoimmune Disorders: A Primer for Residents**

Furkan Ufuk, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To provide an overview of autoimmune disorders, focusing on the most common conditions encountered in clinical practice.  
- To provide a primer on the imaging features of autoimmune disorders.

## TABLE OF CONTENTS/OUTLINE

Autoimmune disorders are a diverse group of conditions in which the body's immune system attacks its own tissues, resulting in inflammation and damage. The spectrum of autoimmune disorders is broad, ranging from systemic diseases such as systemic lupus erythematosus and rheumatoid arthritis to organ-specific diseases such as autoimmune pancreatitis. Imaging plays a crucial role in the diagnosis and management of autoimmune disorders. This exhibit will provide a comprehensive overview of the imaging findings of autoimmune disorders and will highlight the importance of recognizing these findings in the diagnosis and management of these conditions. By the end of the exhibit, residents will have a better understanding of the role of radiologic imaging in the diagnosis and management of autoimmune disorders.

### CHEE-60 Unmasking Septal Thickening: An Accessible Diagnostic Guide

Fernando Rodado Aranguren, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To differentiate the various patterns of septal thickening and their association with several interstitial lung diseases. To understand the pathophysiological basis of this finding. To provide a systematic and understandable guide to address the diagnostic dilemma.

## TABLE OF CONTENTS/OUTLINE

Septal thickening of the lung can be the common radiological expression for many processes of different etiologies and variable severity, including pulmonary edema, lymphangitic tumor, sarcoidosis, asbestosis, amyloidosis or Erdheim-Chester disease among others. Due to the wide differential diagnosis that it poses, its presence is often perceived as confusing and challenging. To face this crossroads we must tackle it from its origin, so both the understanding of the underlying pathophysiological fundamentals and the recognition of ancillary imaging signs must be the objective of our study and the pillar for an adequate diagnostic approach. The goal of this work is to provide a tool that may help unmask the enigma: a systematic and understandable review of the different manifestations of septal thickening, focused on the underlying physiological background and exemplified with illustrative cases from our hospital.

### CHEE-61 Take My Breath Away: MR Lungs from Maverick towards Mainstream, and Maybe Top Gun?

Nicholas Bontrager, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

MRI for evaluation of the pulmonary parenchyma and vessels is a viable alternative to CT that eliminates patient exposure to ionizing radiation, and that can be performed using the magnet you have, sequences you already use, and table times under 20 minutes per complete exam. Pulmonary MRI and MRA have been shown to be effective for evaluation of cystic fibrosis, lung cancer screening, pulmonary nodule and mass evaluation, pulmonary embolism, and more. For lung cancer screening, pulmonary MRI has been found to have equivalent life expectancy with favorable cost-effectiveness and fewer false-positives when compared to low-dose CT. Restricted diffusion is likely more specific to lung cancer than FDG avidity on PET CT. MRA for PE has similar sensitivity, specificity and patient outcomes at 6 months, when compared to CTA.

## TABLE OF CONTENTS/OUTLINE

- MR Sequence Protocol for Evaluation of Lung Parenchyma. - Cases: Primary Lung Cancer, Pulmonary Nodules, Metastases. - MRA Sequence Protocols for Pulmonary Embolism, with gadolinium-based contrast agent and with ferumoxytol (off-label). - More Cases: PE with GBCA MRA, PE in Pregnant Patient with ferumoxytol MRA, Incidental Findings. - Limitations of MR evaluation of the lungs and pulmonary vessels. - The future of MR evaluation of the lungs.

### CHEE-62 A Case Based Review of Chest Wall Masses: Multimodality Imaging and Differential Diagnosis

Sehar Salman, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The goal of this presentation is to review clinical manifestations and radiologic findings of chest wall lesions. Many of these masses are discovered incidentally on routine chest imaging, and it is important for the interpreting radiologist to be able to recognize benign, indeterminate, and malignant features in order to guide management. In a series of cases, we will present different diagnoses of chest wall masses including both common and uncommon pathologies, to illustrate the spectrum of findings. After this presentation, learners should be familiar with chest wall anatomy, be able to describe imaging characteristics of lesions on multiple modalities, provide differential diagnoses, recognize indications for biopsy, and ultimately have a framework for approaching these masses.

## TABLE OF CONTENTS/OUTLINE

Background - Chest wall anatomy on ultrasound, CT, and MRI - The spectrum of chest wall pathologies (benign, malignant)- fat, fluid, soft tissue, bone  
Cases: lipoma, hematoma, elastofibroma dorsi, neurofibroma, fibrous dysplasia, desmoid

fibromatosis, myxofibrosarcoma, metastatic disease - For each case: Clinical scenarios, multimodality imaging findings, differential - Indeterminate and malignant cases: biopsy indications, biopsy results, pathologic correlation (when available) Summarize key features and classic differential diagnoses Radiologic and clinical management of chest wall masses

### **CHEE-63 A CT Imaging Roadmap for Hemoptysis: from Etiology to Treatment Complications**

Niels Vinicius Padua Carvalho, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibition is: • To review the most common causes of hemoptysis in clinical practice; • To illustrate the role of CT imaging for the evaluation of patients with hemoptysis; • To provide a systematic approach on hemoptysis imaging evaluation, highlighting key findings for an accurate diagnosis; • To explain the main therapeutic modalities employed in the treatment of hemoptysis.

#### **TABLE OF CONTENTS/OUTLINE**

1. INTRODUCTIONa. Epidemiologyb. Vascular anatomyc. Physiopathology2. CT IMAGING: AN ETIOLOGY BASED REVIEWa. Infectiousb. Inflammatoryc. Vasculitisd. Congenitale. Neoplasticf. Other causes3. THERAPEUTIC MODALITIESa. Indicationsb. Techniquesc. Complications4. SYSTEMATIC APPROACH: A ROADMAP5. SUMMARY AND TAKE-HOME MESSAGES

### **CHEE-64 Respiratory Complications from Burns Injury: A Pictorial Review**

#### **Awards**

##### **Certificate of Merit**

Mishaal B. Patel, BMedSc, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

• Acute complications are almost always associated with smoke inhalation injury. • When acute lobar collapse cannot be explained by a malpositioned ETT, prompt bronchoscopy is required to assess for bronchial eschars or inspissated secretions from bronchorrhea. • In the subacute phase, short interval changes in heart size, parenchymal opacities and pleural effusions favors cardiogenic edema. • Expiratory CT is useful in assessing burns-induced chronic airways disease including tracheomalacia, bronchial webs and obliterative bronchiolitis.

#### **TABLE OF CONTENTS/OUTLINE**

As many as 91% of deaths in burn patients are a result of respiratory complications. Understanding the spectrum of respiratory complications, their onset and evolution of changes over time is important in early and accurate imaging interpretation. This pictorial review aims to educate and familiarize readers with common and uncommon burns-related complications that may be detected on chest imaging. As multiple disease processes have overlapping imaging appearances, we have classified complications temporally into acute, subacute and delayed phases, and spatially classified complications according to the anatomical structures affected. This structured approach to imaging interpretation serves to facilitate understanding and provide readers with a practical approach to imaging interpretation in burns patients.

### **CHEE-65 Consolidation of Post-Lung Transplant Complications, Throughout Post-operative Course**

Joshua A. Kogan, MD, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Lung transplantation is a life-saving procedure for end-stage lung diseases and has been shown to improve quality of life. Currently, the median post-lung transplant survival is roughly 6 years. However, it is associated with various complications that can significantly impact post-transplant outcomes. The purposes of this exhibit are to: (1) Recall the many pathologic complications that arise with Lung Transplantation, (2) Evaluate and identify the radiological features associated with Lung Transplant complications, (3) Review the role of imaging in the diagnosis and management of these complications.

#### **TABLE OF CONTENTS/OUTLINE**

Immediate and Early Postoperative Period (First 24 hours to First Week) Primary Graft Dysfunction Rejection Acute Rejection Hyperacute Rejection Pleural Complications Pleural Effusion Pleural Fistula Hemothorax Pneumothorax Intermediate Period (1 week to 4 months) Anastomotic (Airway) Dehiscence Stenosis Airway Stenosis Pulmonary Artery Stenosis Pulmonary Infections Candida CMV Aspergillus Late Periods (After 4 months) Pulmonary Infections Mycobacterial RSV Chronic Lung Allograft Dysfunction (CLAD) Post-Transplant Lymphoproliferative Disorder (PTLD)

### **CHEE-66 Assessment of Both Fibrosis and Vascular Disease in Systemic Sclerosis: The Pivotal Role of the Radiologist and Future Perspectives**

Carlotta Zilioli, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To be informed of the fundamental pathogenic pathways of systemic sclerosis (SSc).- To be aware that, among the autoimmune rheumatic disease, SSc has the highest mortality due to lung complications, which mainly are fibrosis and pulmonary hypertension (PH).- To illustrate the radiological spectrum of thoracic manifestations in SSc.- To be informed about the recent advances in the imaging techniques, with specific attention to quantitative analysis, to early diagnose and monitor disease activity.

## TABLE OF CONTENTS/OUTLINE

1. Introduction:- Overview of underlying pathophysiology of SSc: endothelial and fibroblast dysfunction, leading to fibrosis.- Description of pulmonary manifestations of SSc, focusing on the leading cause of death: interstitial lung disease (ILD) and pulmonary hypertension (PH). 2. The use of high-resolution CT in the diagnosis of progressive SSc, particularly to early stages of ILD:- NSIP as the main histologic pattern: key finding - Other HRCT findings: pleural and pericardial, esophageal dilatation. 3. Description of the hallmark of PH:- Key findings on HRCT - Role of dual-energy CT angiography. 4. The emerging use of automated software to perform quantitative analyses on in SSc, correlating quantitative vessel parameters with ILD features.

## CHEE-67 A Step-by-Step Approach to Pulmonary Fibrosis: What the General Radiologist Should Know

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Expose the imaging modalities used in interstitial lung disease assessment. Provide a stepwise approach to identify the features of fibrotic lung disease and categorize the pattern of fibrosis. Review the radiological features of idiopathic pulmonary fibrosis (IPF) and the principal differential diagnoses, focusing on their distinctive features based on high-resolution computed tomography (HRCT).

## TABLE OF CONTENTS/OUTLINE

Diffuse interstitial lung disease encompasses a heterogeneous group of processes characterized by a concrete pulmonary response to damage affecting the pulmonary interstitium and the secondary pulmonary lobule. IPF is a progressive chronic interstitial fibrotic lung disease of unknown etiology characterized by nonspecific clinical manifestations, a restrictive pattern in pulmonary function tests, and a poor prognosis. The morphologic hallmark in imaging and histopathology of IPF is the UIP pattern, characterized by subpleural reticulation, traction bronchiectasis, and honeycombing with an apex-to-basal gradient. However, it may also be present in several conditions, including asbestosis, chronic hypersensitivity pneumonitis, or connective tissue diseases. Definitive diagnosis requires clinical-radiological-pathological consistency, with imaging playing a pivotal role. An accurate classification based on the CT pattern enables early detection of fibrosis, distinguishing the UIP pattern from those that suggest an alternative diagnosis, determining the need for biopsy, and guiding subsequent treatment. We collected representative cases of pulmonary fibrosis from our institution to highlight the hallmark imaging findings that leads to accurate diagnosis.

## CHEE-68 Through the Eye of the Needle: An Evidence-based Approach to the Benefits, Risks, and Controversies of CT-Guided Lung Biopsy

### Awards

#### Certificate of Merit

Shravan Sridhar, MD, MS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

CT-guided lung biopsy is a vital tool in the diagnostic armamentarium of physicians involved in the workup of pulmonary lesions in a variety of clinical settings. Having a clear understanding of the benefits, yield, and risks of CT-guided lung biopsy is important in optimizing utility of this diagnostic test and minimizing adverse outcomes. We present current evidence in the literature as it relates to benefits/yield, risks and risk reduction, and controversies in lung biopsy.

## TABLE OF CONTENTS/OUTLINE

1. Title and disclosures  
2. Abbreviations  
3. Table of contents  
4. Overview  
5. Indications  
a. List of indications  
b. Pre-test probability  
c. Negative predictive value  
6. Diagnostic accuracy  
7. Risk/reduction  
a. Pneumothorax  
b. Hemorrhage  
c. Air embolism  
8. Controversies  
a. Role of CT vs bronchoscopic biopsy  
b. Appropriate needle size  
c. FNA vs core needle biopsy  
d. Biopsy of subsolid nodules  
e. Biopsy of suspected infection  
f. Biopsy of cavitary nodules  
g. Repeat biopsy after non-diagnostic result  
h. Biopsy in setting of pulmonary hypertension  
i. Biopsy in setting of fibrotic ILD  
j. Tumor seeding  
k. Techniques to avoid complications  
i. Utility of blood patch/plug  
ii. Rapid rollover  
iii. Intrapulmonary length  
8. Summary  
9. References

## CHEE-69 To Protect and to Serve: Imaging Review of the Sternum for the Thoracic Radiologist

Michelle Bondero, MD, MSc (*Presenter*) Nothing to Disclose



## TEACHING POINTS

The sternum "protects" the vital cardiovascular organs, "serves" as a mirror to reflect diffuse bone disorders, and may uncommonly be affected by isolated lesions. These conditions may present as non-specific chest pain, which is a common patient presentation in clinical practice. Furthermore, given its central location, the sternum is included on nearly all thoracic imaging, be that a radiograph, CT, or MR. Due to thoracic radiologists' predominant reliance on axial images and focus on the inner organs, it may be neglected in a speedy review and important diagnostic information may be missed. The goal is to (1) explain the anatomy and development of the sternum; (2) describe dedicated imaging approaches; as well as (3) define and depict the major disease processes that can be diagnosed on radiological imaging, as outlined below. In addition to the rich imaging illustration, multiple less common but important diseases will be included with corresponding clinical and surgico-pathologic correlation, when available. Board-exam questions will also be provided to emphasize key principles.

## TABLE OF CONTENTS/OUTLINE

1. Anatomy (bony components, articulations). 2. Imaging (XR, CT, MR, US and NM). 3. Cases: a. Congenital: variants and anomalies; b. Traumatic (fractures); c. Infectious (osteomyelitis); d. Neoplastic (primary and mets); e. Metabolic (Paget's disease, renal osteodystrophy, sickle cell disease, osteopetrosis). 4. Peri-sternal joint disease (osteoarthritis, septic arthritis, inflammatory arthritides, SAPHO). 5. Pre- and post-surgical (sternotomy, expected findings, complications, sternal measurements prior to cardiac surgery). 6. Post-radiation. 7. Artifacts.

## CHEE-7 Dual Energy Chest Radiography in Oncological Practice

### Awards Certificate of Merit

Ioannis Vlahos, MBBS, FRCR (*Presenter*) Director, Grayscale Ltd; Co-owner, Grayscale Ltd;

## TEACHING POINTS

Based on CXR implementation in a tertiary cancer center: CXR dual energy principles and techniques Practical implementation for improved detection and accuracy, characterization, increased confidence, problem solving on chest radiographs Advantages, disadvantages and limitations

## TABLE OF CONTENTS/OUTLINE

CXR Dual Energy Techniques (single exposure (SE), dual exposure (DE), weighted subtraction), new AI single exposure techniques Soft tissue and bone-selective images Advantages and disadvantages of SE DE (associated artifact recognition), dosimetry Improved lesion detection, confidence, additional lesions, growth determination Lesion characterization (soft tissue, calcification) Calcified lesions (mediastinum, lung, pleura) Bone metastases and other osseous conditions (pathological fractures, periosteal reactions, lytic lesions) Specific areas: Evaluation of the apices, cardiome-diastinum, drug induced lung disease, postoperative pneumothorax Complex evaluation: impact on accuracy, distracting pathology, missed findings, interpretation time

## CHEE-70 Targeting the Unknown: A Stepwise Approach to CT-Guided Biopsy of Cavitory Lung Nodules

Abhay Dhaliwal, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-To review categories of inciting conditions that can lead to cavitory pulmonary nodules. -To discuss the role and technique of CT guided percutaneous trans-thoracic needle biopsy (PTNB) of cavitory nodules in the aid of diagnosis, ranging from pre-biopsy workup to post biopsy care. -To review the risks and complications associated with CT guided PTNB of cavitory nodules, and methods to minimize risk and manage complications. -To illustrate and discuss the key imaging features of pathology proven cases of processes that can present with cavitory pulmonary nodules, including infections (such as actinomyces and tuberculosis), inflammatory conditions (such as granulomatosis with polyangiitis and rheumatoid arthritis), and malignancies (such as primary and metastatic processes).

## TABLE OF CONTENTS/OUTLINE

Definition of cavity, biopsy materials, pre-biopsy work up, patient counseling, biopsy set up/technique, post-biopsy care, biopsy outcomes, biopsy risks/complications, management of complications, rad path correlation

## CHEE-71 Avoiding Tunnel Vision: Looking Beyond Anatomic Specialization Boundaries

Elizabeth Lee, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. While radiological sub specialization is advantageous and has firmly integrated radiologists in multidisciplinary teams, there is a potential for missed diagnoses when various anatomic regions of a cross-sectional study are interpreted separately by specialists. This is particularly relevant for junctional regions (such as diaphragm when chest and abdomen imaging are

interpreted by chest and body radiologists).2. Variations in scan factors and contrast timing (for instance chest and abdominal imaging may be obtained at different phases of enhancement) can facilitate diagnosis.3. Even if studies are separately interpreted and dictated, it is important for specialists to avoid tunnel vision and check pertinent information.

#### **TABLE OF CONTENTS/OUTLINE**

1. No man's zone: Junctional zones between two anatomical regions can be a cause of missed opportunities. For instance, lower ribs may only be partly included in chest CT and may be overlooked on an abdominal scan.2. Integration of imaging findings from various anatomic regions can provide a unifying diagnosis: Several diseases are multisystem pathologies, and the diagnostic process is facilitated by knowledge of involvement of other anatomic regions. Examples include neurofibromatosis, Birt-Hogg-Dube syndrome, embolized fragment of a device, etc.3. Differences in phase of enhancement: This can help in localizing as well as accurately characterizing an abnormality that is better seen on a specific phase of enhancement.4. Differences in patient positioning Arms up and arms down position for two different scans can uncover an unsuspected thoracic outlet syndrome.5. Correlating with all available imaging modalities

### **CHEE-72 Noninfectious Pulmonary Complications Following Hematopoietic Stem Cell Transplant**

#### **Awards**

#### **Certificate of Merit**

Elizabeth Lee, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. There is an increase in the indications for, the potential recipient age and sources from which hematopoietic stem cell transplantation (HSCT) can be performed, with increasing numbers of the procedure performed yearly across the globe. 2. Up to one third of patients undergoing HSCT develop pulmonary complications with the rates of infectious pulmonary complications decreasing due to improvements in prophylaxis and treatment. 3. The rate of noninfectious complications has risen and now is a more common cause of death than those from infection. 4. There are a variety of noninfectious pulmonary complications which can be seen after HSCT including idiopathic pneumonia syndrome, bronchiolitis obliterans syndrome, thoracic air leak syndrome, venous thromboembolism, and pulmonary hypertension. 5. Idiopathic pneumonia syndrome has a varied presentations depending on the site of primary tissue injury which results in a varied imaging appearance such as diffuse alveolar hemorrhage or peri-engraftment respiratory distress syndrome.

#### **TABLE OF CONTENTS/OUTLINE**

1. General review of hematopoietic stem cell transplantation 2. Idiopathic Pneumonia Syndrome (Acute interstitial pneumonitis, Acute respiratory distress syndrome, Delayed pulmonary toxicity syndrome, Peri-engraftment respiratory distress syndrome, Diffuse alveolar hemorrhage) 3. Bronchiolitis obliterans syndrome 4. Interstitial lung disease 5. Pleural effusions 6. Thoracic air leak syndrome 7. Venous thromboembolism 8. Pulmonary hypertension 9. Post-transplant lymphoproliferative disorder

### **CHEE-73 Bad to the Bone: Differentiating Pulmonary Ossification from Calcification on CT**

Kendrah Osei, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. The pathogenesis of pulmonary ossification and calcification is incompletely understood.?2. Pulmonary calcification and ossification can occur in both pulmonary and non-pulmonary conditions, including benign, malignant, inflammatory, infectious, and metabolic etiologies.?3. High-resolution CT imaging is important to differentiate conditions that cause dendriform pulmonary ossification and those that do not.4. Multi-society consensus guidelines now include pulmonary ossification among high-confidence CT features of usual interstitial pneumonitis (UIP) pattern of idiopathic pulmonary fibrosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Definitions of pulmonary calcification, pulmonary ossification, and dendriform pulmonary ossification.?2. Pathogenesis of pulmonary calcification and ossification. ?3. Causes of pulmonary calcification and ossification. ?4. Imaging patterns of pulmonary calcification and ossification. ?5. Dendriform pulmonary ossification as a diagnostic imaging feature of idiopathic pulmonary fibrosis.?6. Clinical impact of recognizing dendriform pulmonary ossification.?7. References.

### **CHEE-74 Thoracic Complications of Sickle Cell Disease**

Malcolm Davidson, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1 Acute chest syndrome is a leading cause of morbidity and mortality, and is characterized by the development of a new lung opacity along with fever and/or respiratory symptoms. The most common causes include infection, fat embolism, and infarction.2 Sickle cell patients are functionally asplenic and immune compromised, making them vulnerable to pneumonia and other infections from encapsulated and atypical bacteria - a leading cause of mortality in this population.3 Repeated pulmonary insults in sickle cell patients can lead to chronic pulmonary findings, such as pulmonary fibrosis.4 Pulmonary



embolism is more common in patients with sickle cell disease and can contribute to pulmonary hypertension (PH). PH is present in approximately 10% of sickle cell patients, and is often multifactorial in etiology (WHO group 5). Pulmonary artery dilation is associated with worse outcomes in those presenting with acute chest syndrome.<sup>5</sup> Bone complications in sickle cell disease can present similarly to acute chest syndrome. Patients in this population are at higher risk for osteomyelitis, and osteomyelitis should be considered if bone pain is atypical or if there are other supporting signs, symptoms, or imaging features.

#### TABLE OF CONTENTS/OUTLINE

1. Sickle Cell Pathophysiology  
2. Acute Complications - Vaso-occlusive events, acute chest syndrome, infection  
3. Chronic Complications - Lung fibrosis, cardiomyopathy, pulmonary hypertension, bone infarction

### CHEE-75 **Embracing Automation: Designing and Implementing a Robust Continuous Monitoring System for AI-Powered Radiology Applications**

Vasanth Venugopal, MD (*Presenter*) Officer, CARPL.AI Inc

#### TEACHING POINTS

1. Continuous monitoring is vital for AI-driven radiology platform performance and reliability.  
2. Identify KPIs and benchmarks to measure AI application metrics, such as accuracy, sensitivity, and specificity in radiology.  
3. Implement automated QA/QC mechanisms, like image quality checks and data validation, ensuring consistent, complete input data following standard protocols.  
4. Use advanced monitoring techniques, like measuring model divergence, to detect and address model drift caused by input data changes or other factors.

#### TABLE OF CONTENTS/OUTLINE

I. Key Performance Indicators (KPIs) and Benchmarks  
A. Identifying relevant clinical and non-clinical KPIs  
B. Establishing performance benchmarks for AI applications  
II. Automated Quality Assurance and Quality Control  
A. Automated QA/QC mechanisms for image quality and artifacts  
B. Data validation techniques for ensuring input data integrity  
III. Performance Monitoring and Anomaly Detection  
A. Real-time monitoring of KPIs and other relevant metrics  
B. Anomaly detection algorithms for identifying unusual patterns or behaviors  
IV. Advanced Monitoring Techniques  
A. Measuring divergence between multiple models  
B. Benefits and challenges of using advanced monitoring techniques  
V. Continuous Improvement  
A. Iterative model development, performance evaluation, and updating  
B. Real-world performance data Collection  
VI. Regulatory Compliance and Periodic Reviews  
A. Ensuring monitoring system adherence to regulatory requirements  
B. Conducting periodic audits and reviews

### CHEE-76 **Imaging Findings in Bronchiectasis-Associated Diseases: A Comparison with Pathophysiology.**

Orito Ikeda (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points  
(1) Bronchiectasis is a condition characterized by irreversible dilation of the bronchi. CT imaging categorizes it into three types: cylindrical, varicose, and cystic.  
(2) Bronchiectasis can occur in various disease groups, making its diagnosis challenging due to its diversity.  
(3) Understanding the relationship between the underlying pathophysiology and imaging findings is crucial.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline  
(1) About bronchiectasis  
(2) Congenital bronchial anomalies  
(3) Mucociliary transport disorder  
(4) Immune hypersensitivity  
(5) Immune deficiency  
(6) Connective tissue disorder  
(7) Infectious disease  
(8) Others  
(9) Summary

### CHEE-77 **Manifestations of Sickle Cell Disease on Thoracic Imaging**

Hussein Alsadi, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Sickle cell disease (SCD) is a systemic disease that has a wide spectrum of pulmonary, soft tissue, skeletal, and upper abdominal findings that can be seen on thoracic imaging.  
- There is commonly an overlap between findings of the milder pneumonia and the more clinically severe acute chest syndrome. However, knowledge of some findings can favor one diagnosis over the other.  
- Over time, SCD can result in chronic changes to the lung parenchyma.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
a. Background  
b. Epidemiology, genetics, and pathogenesis of sickle cell disease  
2. Acute manifestations  
a. Spectrum of acute chest syndrome and pneumonia  
• Findings on chest radiograph and CT that could aid in the diagnosis  
• Etiologies of pneumonia (e.g, streptococcus pneumoniae, Hemophilus influenzae, etc.)  
b. Pulmonary edema  
c. Pulmonary thromboembolism  
3. Chronic manifestations  
a. Cardiomegaly  
b. Pulmonary hypertension  
c. Pulmonary fibrosis, cysts, and

mosaic attenuation<sup>4</sup>. Other manifestations seen on thoracic imaginga. Skeletal and soft tissue manifestations (avascular necrosis of humeral heads, extramedullary hematopoiesis, "H-shape" vertebrae, osteomyelitis)b. Upper abdominal manifestations (Splenic auto-infarction, cirrhosis, iron deposition)<sup>5</sup>. Prognosis and treatment<sup>6</sup>. Conclusion

## **CHEE-78 Post-treatment Thoracic Changes in Breast Cancer Patients**

Eloy Naranjo Moreno, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The goal of this exhibit is to provide an interactive and visual review of thoracic changes (surgical and after hormonal/chemotherapeutic treatments) that we can find in breast cancer patients who have undergone treatment or who are currently doing it. Nowadays, thanks to screening programs, breast cancer is a common pathology detected and treated precociously in many cases. This exhibit aims to present an illustrative compilation of thoracic and pulmonary changes in breast cancer treated patients; providing an algorithmic approach of these radiologic changes based on progression time and location in the lung; reviewing the most meaningful findings to allow radiologists to differentiate them from the general thoracic pathology. Post-treatment radiologic computed tomography (CT) changes in breast cancer include post-surgical changes (like removal and reconstruction of the affected breast), changes after and during hormonal/chemotherapy (appearance of interstitial pathology and other common signs in the lung) and post-radiotherapy changes (identifying irradiation regions and their findings correlation over time) that can be effectively identified through chest CT.

### **TABLE OF CONTENTS/OUTLINE**

Introduction and purpose / Background / Image findings: Post-surgical changes, changes after and during hormonal/chemotherapy and post-radiotherapy changes / Conclusion.

## **CHEE-79 Don't Forget to Check the Sternum After Thoracic Surgery: Expected Postsurgical Changes and Complications of Sternotomy and Sternal Wound Repair**

### **Awards**

#### **Certificate of Merit**

Zehavit E. Kirshenboim, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Various chest wall surgical methods are being used for the sternotomy for thoracic surgery.2. Identification of complications can be difficult due to a nonspecific clinical presentation which frequently overlaps with normal postsurgical changes. 3. Knowledge of expected postsurgical sternotomy imaging appearance is crucial to avoid misinterpretation and detect complications in a timely manner.

### **TABLE OF CONTENTS/OUTLINE**

1. Various sternotomy techniques, surgical methods for sternotomy wound repair and complications will be illustrated. A. Surgical techniques 1. Longitudinal vs. transverse 2. Sternal wiring vs. rigid sternal fixation 3. Debridement and sternal flap closure B. Complications 1. Pre-sternal complication - cellulitis, sinus tract 2. Sternal complication - nonunion, dehiscence, osteomyelitis, wire fracture and migration 3. Post sternal complication - mediastinitis, retrosternal abscess, empyema, retrosternal hematoma, sternal adhesion 4. Flap complication - bowel herniation, flap failure C. How to differentiate expected postsurgical appearances vs. complications 2. Strategies to detect complications, differential diagnosis - sternal metastasis, infected epicardial lead 3. Clinical implications and treatment of complications

## **CHEE-8 Into the Airway: Focal Tumors and Non-neoplastic Disorders (Detected by CT) Arising from the Bronchi**

Uxue Martinez Urabayen, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To review the multiple focal lesions that can originate in the airway, including the non-neoplastic lesions and the benign and malignant tumours. To describe and illustrate the main characteristics signs and imagine findings that may improve detection of the lesions, improving the management of this patients.

### **TABLE OF CONTENTS/OUTLINE**

**METHODS OR BACKGROUND** Neoplastic and non-neoplastic lesions of the airway track are rare. The majority are malignant. The diagnosis tends to be delayed due to the few and nonspecific symptoms. Chest radiographs are rarely diagnostic. **RESULTS OR FINDINGS** At CT benign and malignant tumours may have nonspecific characteristics, presenting as polypoid lesions or focal sessile lesions that narrow the airway lumen. Even non-neoplastic disorders may be identical. Mucus plugs have internal gas. Blood is indistinguishable from other endobronchial material. Broncholiths present calcification. Foreign bodies depend on the component of which they are made of. Lipomas have internal fat and hamartomas are characterized by "popcorn" calcifications. Leiomyomas and papillomas look very much alike. Squamous cell carcinoma is the most common

subtype of lung cancer that affects the central airway system. Carcinoid tumours tend to have intense enhancement at contrast material-enhanced CT and may present calcifications. Metastasis due to hematogenous invasion are usually multifocal. CONCLUSION The airway must be carefully evaluated on CT examinations to appreciate the slight differences in morphology of the lesions occupying the lumen. Knowing the Morphological characteristic and location of these lesions can help reduce the broad spectrum of differential diagnosis.

## **CHEE-80 Functional Lung MRI: How to Obtain Ventilation-Weighted Images from UTE MRI.**

Julius F. Heidenreich, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. The reader should learn about the prerequisites that are necessary for functional lung imaging (technical requirements, sequences, data types).2. The reader should understand that the basic post processing steps comprise (1: labelling of lung parenchyma; 2: image co-registration; 3: voxel-wise calculation of fractional ventilation.3. The reader should learn to interpret ventilation imaging and be able to distinguish ventilation maps from healthy subjects and patients with cystic fibrosis.4. The reader should know about pitfalls and limitations of UTE ventilation imaging and know about the alternative techniques.5. The exhibit should highlight the potential benefit of ventilation imaging. The reader should be able to understand its significance and the recent areas of application.

### **TABLE OF CONTENTS/OUTLINE**

A. Introduction, Background and Purpose: Why is ventilation imaging relevant? B. Technical requirements: What images have to be acquired? C. Post-processing: What are the basic steps of data processing? D. Data analysis and calculation of fractional ventilation and lung function parameters. E. Image analysis: Healthy subjects vs. patients. What is the difference? F. Pitfalls and limitations. What are the alternatives?

## **CHEE-81 No Small Matter: Thoracic Manifestations of Small Vessel Vasculitis**

Sofia D. Gambetta I, MD, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

We will review epidemiology, clinical features and imaging manifestations of ANCA associated small vessel vasculitis in the thorax. Teaching points:1. Granulomatosis with polyangiitis presents with diverse pulmonary and airway involvement: tracheobronchial wall thickening/stenosis, lung nodules and masses that cavitate or present with ground glass halo, bronchovascular thickening or alveolar hemorrhage.2. Microscopic polyangiitis can be divided into two groups: alveolar hemorrhage and interstitial lung disease. a. 4 to 36% of patients with interstitial pneumonia at presentation have MPO-ANCA antibodies. b. Up to 10% of patients with IPF seroconvert to MPO-ANCA. c. UIP and probable UIP are the most common patterns of MPO-ANCA ILD.3. EGPA patients can be ANCA negative (eosinophilic manifestations) or ANCA positive (vasculitis features). a. Cardiac manifestations are more common than in other ANCA vasculitis and indicator of poor prognosis. b. Pulmonary manifestations include migratory/peripheral consolidations, GGOs and centrilobular nodules.

### **TABLE OF CONTENTS/OUTLINE**

1. Overview of small vessel vasculitis. a. Etiology and Pathogenesis. b. Epidemiology. c. Serological findings2. GPA a. Clinical manifestations. b. Airway involvement. c. Pulmonary manifestations. d. Cardiac involvement3. MPA. a. Clinical manifestations. b. Pulmonary manifestations. i. MPO-ANCA associated ILD ii. Alveolar hemorrhage and hemosiderosis4. EGPA. a. Clinical manifestations. i. ANCA positive EGPA ii. ANCA negative EGPA. b. Pulmonary manifestations c. Cardiac manifestations. i. Myocarditis ii. Endocardial fibrosis iii. Pericarditis 5. Differential diagnosis

## **CHEE-82 Hypersensitivity Pneumonitis: Correlation of Radiologic and Pathologic Findings, Diagnostic Criteria and Recommendations According to the Latest Guidelines**

### **Awards**

#### **Cum Laude**

Belen del Rio Carrero, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To illustrate the key radiological and histological findings for the diagnosis of hypersensitivity pneumonitis and understand their correlation.- To review the hypersensitivity pneumonitis diagnostic criteria according to the latest guidelines and summarize recommendations.

### **TABLE OF CONTENTS/OUTLINE**

1. Definition and epidemiology2. Inciting agents. Exposure to inhaled agents.3. Immunopathogenesis:3.1. Immunologic mechanisms involved in the development of the disease and how they relate with the clinical and laboratory features.3.2. Risk factors: Genetic and external factors.3.3. The smoking paradox in HP.4. Clinical features.5. Non fibrotic HP:5.1. Radiologic Features: Typical and Compatible findings.5.2. Histologic Features.5.3 Radio-pathological Correlation6. Fibrotic

HP6.1 Radiologic Features: Typical, Compatible and Indeterminate findings.6.2. Histologic Features6.3. Radio-pathological Correlation.7. Diagnostic criteria in the multidisciplinary team.8. Current controversies and future directions.

### **CHEE-83 Recognizing Local Recurrence After Stereotactic Body Radiotherapy in the Lung: Imaging Appearances and Pitfalls. A Picture Essay with Diagnostic Algorithm.**

Paulina Kalinowska (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This exhibit focuses on the imaging features and differentiation of local recurrence from normal inflammatory process after stereotactic body radiotherapy (SBRT) in the lung, and provides a diagnostic algorithm to aid in accurate diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of SBRT as a treatment modality for primary lung cancer and lung metastases, including risk factors of local recurrence.2. Practical tips for interpreting post-SBRT studies, including the need to evaluate all examinations in three dimensions and to understand the dynamics of the entire process from early inflammation to residual scar tissue.3. Factors contributing to a large inflammatory reaction post-SBRT, including the target size, radiation dose, absence of emphysema or presence of interstitial lung disease, target location near large bronchi, and use of immunotherapy.4. Factors contributing to a small inflammatory reaction, such as small target size, peripheral tumor location, or the presence of emphysema.5. Key steps and features of the normal post-SBRT inflammatory-fibrotic process, including discrete diffuse signs of inflammation, formation of a fibrotic circle, gradual consolidation, and the formation of a flat scar.6. Features suggestive of local progression, including new nodular or lobular lesions with local increase in size (especially in cranio-caudal dimension), and a typical malignant contrast-enhancing pattern.7. Algorithm for investigating suspected local recurrence post-SBRT, including consideration of a PET/CT, and biopsy.

### **CHEE-84 "Dis-Discombobulating" the Current State of Interstitial Lung Disease Imaging**

#### **Awards**

##### **Magna Cum Laude**

Jonathan H. Chung, MD (*Presenter*) Speaker, Veracyte, Inc;Consultant, Veracyte, Inc;Consultant, Boehringer Ingelheim GmbH;Speaker, Boehringer Ingelheim GmbH;Consultant, F. Hoffmann-La Roche Ltd;Speaker, F. Hoffmann-La Roche Ltd

#### **TEACHING POINTS**

- A systemic approach is paramount when diagnostic ILD on chest CT.
- To aid diagnosis, radiologists should familiarize themselves with current imaging guidelines and new and emerging concepts.
- Progressive pulmonary fibrosis (PPF) refers to ILDs other than idiopathic pulmonary fibrosis (IPF) with evidence of clinical, functional and/or radiologic progression over a one-year period.
- In patients with interstitial lung abnormality (ILA), clinical correlation and imaging follow-up should be considered, particularly when high-risk features for progression are present.
- Quantitative tools are valuable in the assessment of the extent and longitudinal progression of ILD.

#### **TABLE OF CONTENTS/OUTLINE**

- Practical approach to ILD on chest CT
- Updated approach to Hypersensitivity Pneumonitis (HP)
- Definition and current concepts of Progressive Pulmonary Fibrosis
- Definition and current concepts of Interstitial Lung Abnormality
- Current state of quantitative analysis and AI in ILD

### **CHEE-85 Unusual Radiological Manifestation of Adenocarcinoma of the Lung**

Laura Marsland, MBChB (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Primary adenocarcinoma of the lung is a heterogeneous disease, varying in molecular, pathological and clinical features. Radiological features can vary from the 'typical' appearances - usually ground-glass (GGN), part-solid (PSNs) or solid nodules, or with consolidation. Awareness of atypical appearances of adenocarcinoma may result in earlier investigation and timely management.

#### **TABLE OF CONTENTS/OUTLINE**

Lung cancer remains the most common cause of cancer deaths worldwide and adenocarcinoma is the most common histologic subtype, responsible for just under half of all cases.. The majority of tumours manifest radiologically with GGNs, PSNs, solid nodules or consolidation. In this review, we document our experience of atypical radiological presentations of adenocarcinoma spectrum disease, subsequently confirmed on histopathological analysis, at two tertiary centres. We include cases of adenocarcinoma presenting as a single, solid, calcified mass, as multiple micro- and macro-nodules and as widespread cystic airspaces. We describe cases presenting with unusual patterns of metastatic disease. We describe cases of atypical volume doubling times.

## **CHEE-86 Pulmonary Hypertension: CT Signs That Point the Way**

Camilo A. Mieres, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

CT signs suggestive of pulmonary hypertension (PH) What to include in CT reports in the workup for PH Findings in entities associated with PH

### **TABLE OF CONTENTS/OUTLINE**

I. Background: -Pulmonary artery diameter can suggest PH, but the threshold differs with the clinical context. -CT findings can provide clues about the underlying cause of PH. II. Content: 1. Different pulmonary diameters should be considered in patients with low, intermediate, or high risk of PH. 2. Findings to analyze in the study of PH: Cardiac vascular anomalies (can be missed on echocardiography): -Intracardiac shunts (atrial septal defect (ASD), especially sinus venosus ASD) -Anomalous pulmonary venous return (often with ASD) -Patent ductus arteriosus Signs of obstruction of the pulmonary arteries (filling defects/vascular tree-in-bud, hypertrophied systemic arteries) -Chronic pulmonary embolism -Pulmonary tumor thrombotic microangiopathy -Exipient lung disease Signs of right ventricular repercussion. Lung anomalies (fibrosis, cysts, centrilobular nodules) -Interstitial lung disease (combined pulmonary fibrosis/emphysema, Langerhans cell histiocytosis, connective tissue disease) -Pulmonary veno-occlusive disease III. Conclusions: -CT can alert to the possibility of PH and can provide valuable clues about its etiology.

## **CHEE-87 Developmental Disorders of Lung: A Pictorial Review**

Shambo Guha Roy, MBBS, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Mounier Kuhn syndrome affects trachea and up to 4th order bronchial tree, whereas William Campbell syndrome causes dilatation distal to 4th order bronchi. 2. Congenital pulmonary airway malformation (CPAM) has 5 subtypes: Type 1 being commonest with one or more dominant large cysts. Cyst size gets smaller in type 2 and 3. Type 4 is indistinguishable from type 1 radiologically. 3. Sequestration happens in two forms: intra lobar and extra lobar depending upon its venous drainage. Extra lobar sequestration is often associated with CPAM, called the 'hybrid lesions'. 4. Pulmonary veno-lobar syndrome or Scimitar syndrome accounts for minority of partial anomalous pulmonary venous return (PAPVR). Treatment depends upon the left to right shunt, which can be quantified using phase contrast MRI.

### **TABLE OF CONTENTS/OUTLINE**

1. Normal development of the lungs. 2. Classification of developmental disorders. 3. Airway disorders: Tracheal and bronchial agenesis, Tracheobronchial branching anomaly, tracheobronchomegaly (Mounier Kuhn syndrome), bronchogenic cyst, congenital pulmonary airway malformation, bronchopulmonary sequestration. 4. Parenchymal disorders: Congenital lobar emphysema, Pulmonary hypoplasia, Pulmonary cystic mesenchymal hamartoma. 5. Vascular disorders: Pulmonary sling, absence of unilateral pulmonary artery, pulmonary veno-lobar syndrome.

## **CHEE-88 Diffuse Pulmonary Hemorrhage: A Diagnostic Challenge**

Camilo A. Mieres, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

-Review the causes, pathophysiology, and radiological signs of diffuse pulmonary hemorrhage (DPH). -Underline the importance of correlating the imaging findings with clinical and laboratory findings.

### **TABLE OF CONTENTS/OUTLINE**

I.- Background DPH is rare. It can occur in many diseases with histologic findings ranging from normal vessels (bland hemorrhage) to capillaritis. Clinical and radiological findings are nonspecific, determining the etiology is challenging. II.- Content Through a series of cases, we show how the causes of DPH relate with the histologic patterns. Pulmonary capillaritis: neutrophilic infiltration of the alveolar septa, loss of capillary integrity -Small-vessel vasculitis/Anti-GBM (Goodpasture)- Rheumatic diseases (Lupus)-Drugs Bland pulmonary hemorrhage: alveolar hemorrhage without destruction or inflammation of alveolar spaces -Anticoagulants, bleeding disorders -Heart failure (HF), mitral stenosis -Idiopathic pulmonary hemosiderosis Diffuse alveolar damage: alveolar edema and hyaline membranes -Infection -Drugs -Rheumatic diseases (Lupus) III.- Conclusions Radiologic findings of DPH are nonspecific and must be interpreted together with clinical and laboratory data.

## **CHEE-89 Chest CT Imaging in the Era of Lung-sparing Thoracic Resection**

### **Awards**

### **Cum Laude**

Farah Tamizuddin, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Chest computed tomography (CT) has a major role in planning and follow up after lung resection. Segmentectomy and sleeve resection techniques entailing anatomical lung segmental dissection are now a major method for curative surgery of early-stage lung cancer while preserving lung function. Accurate localization of pathology is essential, with clear definition of bronchial and vascular anatomy. More recently, minimally invasive approaches such as the robotic-assisted thoracoscopic surgery (RATs) and video assisted thoracoscopic surgery (VATS) techniques are options. Therefore, the objectives are: a) To review thoracic lung-resection approaches including RATs and VATs for sublobar resection and sleeve resection, b) bronchial anatomy and imaging for lesion localization, b) to discuss essential imaging findings to communicate that impact operative approach, including variant anatomy and c) to review expected postoperative imaging findings and complications.

## TABLE OF CONTENTS/OUTLINE

1. Review of lung resection approaches: a) Sublobar, sleeve, and lobe resections b) RATs, VATS, open techniques, and advanced nodule localization methods 2. CT performance and essential preoperative anatomy evaluation: intersegmental plane identification: segmental bronchial anatomy, pulmonary arteries, pulmonary veins 3. Essential imaging findings: airway variants and challenges, 3D techniques 4. Post-operative imaging challenges: granulomas, airway distortion

### **CHEE-9 Snaking the Clogged Pipes: Imaging Findings of Central Venous Occlusions and Review of Therapeutic Options**

Saumik Z. Rahman, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Central venous obstruction can occur due to extrinsic compression or intrinsic stenosis. Clinical presentation and collateral drainage pathway development depends upon the site of obstruction and speed at which the obstruction occurs. IR based measures and surgical techniques are useful to relieve the obstruction to central vessels. We describe these techniques and their complications in this paper.

## TABLE OF CONTENTS/OUTLINE

Introduction Causes of central venous obstruction • Extrinsic compression from lung cancer, lymphadenopathy, fibrosing mediastinitis • Intrinsic occlusion from catheter induced thrombosis. Imaging features of central venous obstruction- SVC narrowing, clot in the SVC, numerous chest wall collaterals, azygos vein dilatation. Collateral pathways based on the level of obstruction • pre azygos • azygos • post azygos. IR based approach for SVC recanalization- Angioplasty, stent placement. Surgical reconstruction methods for SVC- PTFE (polytetrafluoroethylene) graft, pericardial graft. Complications of reconstruction- Graft stenosis.

### **CHEE-90 Toward a New Era of CT Imaging: Current Status and Expectations of Photon Counting CT in the Thoracic Region**

Masahiro Yanagawa, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Photon counting CT (PCCT) has appeared as a new generation of CT systems in clinical setting. PCCT can measure the energy levels of photons as they pass through an object being imaged, which differs from traditional CT scanners with energy-integrating detectors. PCCT has several advantages over traditional CT, including improved spatial resolution and contrast sensitivity, reduced radiation dose to the patient, and the ability to measure the energy spectrum of the incident radiation. PCCT is expected to bring significant improvements in various clinical applications for areas including the thorax. This education exhibit focuses on PCCT imaging in the thorax including technical perspectives, image quality, and clinical imaging. It is much appreciated if our information would be useful in your clinical and research setting.

## TABLE OF CONTENTS/OUTLINE

1. Comparison of PCCT equipment specifications with the traditional CT scanner with energy-integrating detector (EID-CT). 2. Improved spatial resolution: image quality according to reconstruction kernels and radiation dose. 3. Imaging by turbo flash spiral scan: high-definition images without motion artifacts even with electrocardiogram asynchrony and spectral imaging at the same time. 4. Iodine density imaging for pulmonary embolism and thoracic tumors: improved quantification due to the absence of electrical noise 5. Virtual non-contrast CT imaging created from each dynamic phase: comparison with true non-contrast CT in cases of thymic cyst, thymoma, and lung cancer. 6. Future expectations: effects on quantitative values including radiomics analysis.

### **CHEE-91 Analysis of Solitary Lung Nodules Using Summation Images Created from Ultra-High-Resolution CT Data**

Hiroshi Moriya, MD, PhD (*Presenter*) Advisor, California Capital Equity, LLC; Research Grant, Canon Medical Systems Corporation



## TEACHING POINTS

1. Advantages of ultrahigh-resolution CT: □Ultra-high resolution CT has excellent spatial resolution in lung field analysis.□2. 3D image analysis method using ultra-high resolution CT data□: Coronal MPR and VR image are useful for chest image analysis.□ Summation image (SUM) can observe a X-ray projection image of the chest from any viewpoint.□3. There are two factors that make lung lesions difficult to detect: (1) lesions with little density difference from the surrounding lung, and (2) presence in areas where other structures are projected in the anterior-posterior direction.4. Points to note when interpreting chest radiographs in routine clinical practice.

## TABLE OF CONTENTS/OUTLINE

1.Ultra-high-resolution CT (UHRCT) is a CT that achieves high spatial resolution by reducing the detector size to 1/4 of the conventional size. The resolution can be improved by increasing the number of pixels, and the reproducibility of density can be improved by reducing the partial volume effect.2. Summation images using UHRCT data provide images similar to chest photographs. Ability to create X-ray-like images of removed lungs, enabling analysis of clinical chest radiograph findings.3. Small pulmonary nodules are not readily detectable on plain chest radiographs. The difficulty in detecting the target lesion is due to the averaging of the density due to the thickness of the lung and the overlapping projection of other structures (cardiovasculature and bone). Ground-glass density lesions are obscured, but solid components and pleural indentation findings can be pointed out.

## CHEE-92 When Lungs Turn to Stone: A Differential Diagnosis of Pulmonary Calcifications

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Review the main pathologies that can cause intrapulmonary calcifications. - Highlight the key radiological features that will allow us to establish a correct differential diagnosis.

## TABLE OF CONTENTS/OUTLINE

Pulmonary calcifications are a common imaging finding, usually seen on routine chest radiographs. Although they are usually harmless sequelae of remote processes, they provide important information for establishing a good diagnostic approach. They can be attributed to a variety of etiologies, including granulomatous disease, infection, malignancy, environmental exposure, or chronic disease. Consequently, it is necessary to correlate radiologic findings with clinical history and laboratory results. Specific radiologic features have been described, of which the appearance of pulmonary calcifications also provides valuable information regarding the underlying etiology. Therefore, a thorough differential diagnosis is necessary to identify the underlying cause and guide appropriate management. This work provides a comprehensive review of the radiologic features of pulmonary calcifications, including their distribution, size, shape, and associated findings, through cases studied at our center.

## CHEE-93 Proposals for the 9th edition TNM Staging for Lung Cancer - A Guide to Radiologists

### Awards

#### Certificate of Merit

Maximiliano Klug, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1- Unresolved issues of the 8th edition TNM staging for lung cancer are: exclusion of post neoadjuvant patients (yp) from staging analysis, absence of nodal metastatic burden quantification, lack of granularity within the M1C category. 2- Proposed T Category - remains unchanged. 3- Proposed N Category- N2 is divided into N2a as single-station N2 disease and N2b as multiple-station N2 disease - relevant to imaging interpretation; N1 and N3 remain unchanged. 4- Proposed M Category- M1C cases that are metastatic to a single organ site have a better prognosis than M1C to multiple sites- to be determined this month whether multiple single organ will be moved to M1B. The rest of M categories are unchanged. 5- The outcomes of matched ypN v pN categories differ significantly with worse survival for ypN (e.g., ypN0 vs. pN0)- caution for imaging interpretation and patient management decisions.

## TABLE OF CONTENTS/OUTLINE

1- To describe the proposals for the 9th edition TNM Staging for Lung Cancer. 2- To discuss the differences from the previous edition, remaining challenges, as they pertain to imaging evaluation and interpretation, and potential future directions.

## CHEE-94 Early and Late CT Patterns After SBRT for Lung Nodule

Ignacio Alba, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To familiarize with the different radiological patterns observed on chest CT scans after stereotactic body radiotherapy (SBRT) for lung nodules, including early changes (within the first 6 months) and late changes (after 6 months)-To recognize cases of local and/or locoregional recurrence based on findings in our sample-To recognize evolutionary differences in chest CT findings based on the histological subtype of the treated lesion-To evaluate the ultimate success of SBRT as a therapeutic technique

## TABLE OF CONTENTS/OUTLINE

We evaluated the different radiological patterns observed after SBRT for lung nodules using chest CT scans in 108 patients. Of the cases studied, 64 were primary tumors in early stages, 32 cases were lung metastases or metastases from other locations, and in 12 cases histology could not be identified. Among the primary lung tumors, 57% were adenocarcinomas, followed by 26% of squamous cell carcinomas. All chest CT scans were performed every 3 months during the first 2 years and every 6 months during the next 2 years after the completion of SBRT. The patterns observed in the first six months typically evolve progressively to a final stabilization pattern. The most frequently observed final radiological patterns were nodule-like and mass-like, followed scar-like and diffuse consolidation pattern. Thoracic recurrence was diagnosed by lack of parenchymal stabilization in 20% of cases, and locoregional lymph node involvement in the remaining cases. There were no significant differences in lung involvement based on the histology of the treated tumor

### **CHEE-95 CT Imaging of Lung Cancer: Exploring the Clinical Potential of CZT-based Photon Counting Detector CT**

Tomoaki Sasaki, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Lung cancer is the leading cause of death worldwide. CT is a powerful tool for evaluating the primary site and staging of lung cancer. On CT imaging, lung cancer appears as a subsolid nodule or solid nodule. Measuring the total tumor size and the size of the solid portion if the tumor is a subsolid nodule is the first step in both early and advanced lung cancer. Assessment of invasion to critical organs is also important in locally advanced cancer. Accurate evaluation of ipsilateral mediastinal nodal and extrathoracic metastases is required to determine treatment strategy. Photon counting detector CT (PCD-CT) has recently emerged for clinical use. Cadmium zinc telluride (CZT)-based PCD-CT, a newly developed technology, allows for more precise observation of lung cancer with lower radiation exposure, which may have a significant impact on clinical practice. This presentation aims to 1) review the clinical significance and challenges of CT evaluation in lung cancer and 2) discuss the benefits provided by CZT-based PCD-CT for lung cancer patients.

## TABLE OF CONTENTS/OUTLINE

Key features of lung cancer evaluation: primary site and staging  
1. T: size (T1-T4), chest wall invasion (T3), mediastinal invasion (T4)  
2. N: ipsilateral mediastinal node metastasis (N2)  
3. M: pleural dissemination (M1a), extra thoracic metastasis (M1b-c)  
Basic principle of CZT-based PCD-CT  
Clinical potential of lung cancer assessment using PCD-CT: super high resolution (SHR) image, multienergy spectral image, reduction of radiation exposure

### **CHEE-96 Pictorial Review of Tracheal Diseases: A Case-Based Approach for Radiologists**

Camila Gadens Zamboni, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The evaluation of the trachea by imaging is essential to diagnose various tracheal diseases and help with surgical plans, assessment of treatment responses, and understanding surrounding structural abnormalities. In this scenario, the radiologist's role rises as an unreplaceable analysis of this cartilaginous tube. This exhibit aims to summarize pertinent anatomy and review diverse tracheal diseases, congenital and acquired, through a didactic classification and presentation of the cases, including differential diagnosis, challenges, and limitations.

## TABLE OF CONTENTS/OUTLINE

This is a case-based review of pathologies of the trachea focusing on  
1- Pertinent anatomy review.  
2- Best imaging methods for tracheal evaluation.  
3- Classification of tracheal diseases with illustrative cases by focal vs. diffuse diseases, and the last by increased vs. decreased diameters.  
4- Discussion of differential diagnoses.  
5- Challenges and limitations on tracheal evaluation by imaging.  
6- Take-home messages.

### **CHEE-97 Proposals for the 9th edition TNM Staging for Thymic Epithelial Tumor - A Guide to Radiologists**

Maximiliano Klug, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1- Unresolved issues of the 8th edition TNM staging for thymic epithelial tumor (TET) are: T category refinement - focus on tumor size; granularity between N categories; better differentiation between intra and extrathoracic metastatic disease. 2- Proposed T Category- T1a ( $\leq 5$ cm) and T1b ( $> 5$ cm) regardless of involvement of mediastinal pleura; T2: invasion of the pericardium, lung, or phrenic nerve; T3: invasion of the brachiocephalic vein, superior vena cava, chest wall, or extrapericardial pulmonary arteries and veins; T4: unchanged, direct invasion of the aorta and arch vessels, intrapericardial pulmonary artery, myocardium, trachea, or esophagus. 3- Proposed N Category- The ITMIG/IASLC lymph node stations are clarified, unchanged two nodal regions: anterior (N1) and deep (N2). N1 includes the thymic bed compartment in the anterior lower neck and prevascular mediastinum. N2 includes tracheobronchial, aortopulmonary window, subcarinal, hilar, internal mammary, and the deep cervical (jugular and supraclavicular) lymph nodes. 4- Proposed M Category- Unchanged. M1a: pleural or pericardial nodules separate from the primary tumor; M1b: pulmonary intraparenchymal nodules, extrathoracic metastases, or any non-regional lymph nodes (e.g. high neck, retro-crural, axillary or extrathoracic lymph nodes).

## TABLE OF CONTENTS/OUTLINE

1- To describe the proposals for the 9th edition TNM Staging for TET. 2- To discuss the differences from the previous edition, remaining challenges as they pertain to imaging evaluation, and potential future directions.

### CHEE-98 Halo and Reversed Halo Signs in Chest CT: Are They Useful?

Adria Roset Altadill, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The halo and reversed halo signs in chest CT may be caused by infections, inflammatory and vascular disorders and neoplastic diseases. These signs combined with ancillary imaging findings, additional information from PET-CT and spectral CT and proper clinical history may help the radiologist reach the final diagnosis.

## TABLE OF CONTENTS/OUTLINE

The halo and reversed halo signs were initially described and thought to be specific for invasive pulmonary aspergillosis and cryptogenic organizing pneumonia, respectively. However, there is a broad spectrum of causes for these chest CT findings, including infections, inflammatory and vascular disorders and neoplastic diseases. The most common causes of the halo sign in the lung are adenocarcinoma, invasive aspergillosis and septic emboly. Less common causes include bacterial and viral infections, hemorrhagic metastases, vasculitis and other inflammatory disorders. The reversed halo sign is more frequently seen in organizing pneumonia, followed by pulmonary infarcts, invasive mucormycosis and other granulomatous diseases. Despite having lost their specificity, the halo and reversed halo sign combined with ancillary chest CT findings and an adequate clinical background can be useful to narrow the differential diagnosis. Special attention has to be paid to the nodule size, number and morphology in the halo sign. The thickness and distribution of the ring of consolidation and the presence of internal reticulation within the reversed halo sign also need to be evaluated. Moreover, metabolic information from PET-CT and perfusion data from spectral CT may help differentiate pulmonary infarcts from other inflammatory or infectious causes of the reversed halo sign.

### CHEE-99 Cystic Lung Disease: The Common, the Rare and the Unusual

Daniel Vargas, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

While most radiologists are aware of the most common cystic lung diseases, a group of rare and unusual diseases including genetic syndromes, lymphoproliferative disorders, environmental exposures and congenital anomalies can also result in cyst formation in the lungs. This exhibit will: 1. Review the clinical and imaging features of common and rare cystic lung diseases. 2. Discuss the underlying histopathology in each of these entities and how it translates to imaging findings. 3. Offer the radiologist an approach to help narrow the differential and guide clinical management in the multidisciplinary care of these patients. 4. Review ancillary findings and complications in patients with cystic lung disease. 5. Current concepts in amyloidosis and light chain deposition disease and their role in cyst development in lymphoid interstitial pneumonia

## TABLE OF CONTENTS/OUTLINE

1. Lung cyst and cystic lung disease definition  
2. Common Cystic Lung Diseases  
a. Lymphangioliomyomatosis. b. Birt-Hogg-Dube syndrome. c. Pulmonary Langerhans Cell Histiocytosis. d. Lymphoid Interstitial Pneumonia and Current Understanding of the role of Amyloidosis and Light Chain Deposition Disease. e. Desquamative Interstitial Pneumonia.  
2. Rare Cystic Lung Diseases. a. Neurofibromatosis type 1. b. Nieman-Pick Disease. c. Trisomy 21. d. Vascular Ehlers-Danlos Syndrome. e. Proteus Syndrome. f. Lymphomatoid Granulomatosis. g. Follicular Bronchiolitis. h. Atypical Infections (eg. P Jiroveci). i. Hydrocarbon Pneumonitis. j. Proximal Interruption of the Pulmonary Artery

## Abstract Archives of the RSNA, 2023

CHEE-1

### The Phoenix Pulmonary Opacity

All Day Room: Learning Center

Adam F. Petraglia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The waxing and waning pulmonary opacity is a common finding often hiding in plain sight, akin to the mythical phoenix, which disappears only to reveal itself again later amongst the ashes. Crucial to narrowing the differential diagnosis is a broad-based knowledge of the natural course of these diseases, their laboratory and pathologic analyses, and utilization of the multi-disciplinary team. Overlapping characteristics demonstrates the importance of looking at secondary, non-parenchymal imaging characteristics, including radiographic findings outside of the thorax. Many of these are chronic and debilitating, if not fatal, which have often become treatable with the advent of chemotherapeutics and biologics. Therefore, having a systematic approach and a relationship with our clinical colleagues is critical in treating these successfully and timely to avoid associated morbidity and mortality.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Categorizing the waxing and waning pulmonary opacity 3. Demonstrate common primary imaging findings in the thorax (e.g., nodule/opacity characteristics) 4. Demonstrate common secondary imaging findings in the thorax (e.g., esophageal, lymphatic, cardiac) 5. Laboratory and pathologic correlatives 6. Role of the multi-disciplinary team in narrowing the differential diagnosis (Rheumatology, Pulmonology)

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## Abstract Archives of the RSNA, 2023

CHEE-10

### **The 2021 WHO Classification of Lung Tumors: Takeaways for Radiologists Regarding Epithelial and Neuroendocrine Tumors**

All Day Room: Learning Center

Maria Clara N. Lorca, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This educational exhibit will review the tumors of the lung. 1. New 2021 WHO Classification of tumors of the lung. 2. Depict radiological features of tumors of the lung. 3. Describe the importance of PET-CT in the diagnosis and follow up. 4. Describe the pearls and pitfalls that some entities demonstrate in imaging, including benign entities that can appear as a lung tumor. 5. Evaluate the sufficiency of small biopsy samples for diagnosis. 6. Discuss the spectrum of post-treatment changes of the lung.

#### **TABLE OF CONTENTS/OUTLINE**

This education exhibit reviews biopsy-proven cases of tumors of the lungs and their correlation with pathology. Review with illustrative case examples the different tumors of the lungs in a systematic fashion. Incorporate the new 2021 WHO classification of the tumors of the lung. Depict the imaging appearances of various types of the above tumors, with emphasis in epithelial, neuroendocrine, and hematolymphoid tumors. Mesenchymal tumors will not be emphasized, as they were recently described on Radiographics this year. Differentiate between the types of tumors for which small biopsy versus resection sampling are indicated for diagnosis. Depict post-treatment changes of the lung, with examples including lung toxicity, pseudo-progression, and to distinguish these changes from true tumor recurrence and their impact on future therapy.

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## Abstract Archives of the RSNA, 2023

CHEE-100

### **Pulmonary Tuberculosis in Children and Adults: A Classic Disease with Updated Concepts. What the Clinician Needs to Know**

All Day Room: Learning Center

Marta Barrios Lopez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To compare the typical appearance of pulmonary tuberculosis (TB) between adults and pediatric patients. Both the manifestations and the management differ in children and adults. 2. To review the latest evidence on pulmonary TB. Radiologists need to know what information is relevant to the clinician as well as the implications of certain imaging findings.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: Epidemiology and transmission mechanism in children vs adults. 2. Pathophysiology: Traditional vs new concept. The latest evidence has shown that the radiological appearance of the disease mainly depends on the host immune response and not on the time from infection. 3. Classification of Pulmonary TB according to Clinical and Radiological factors. 3.1. Active Disease: Primary Tuberculosis: 1. Lymphadenopathy in adults/children. 2. Parenchymal disease in adults/children. 3. Pleural effusion in adults/children. 4. Miliary TB in adults/children. 3.2. Active Disease: Postprimary Tuberculosis: 1. Postprimary TB in children. 2. Consolidation and cavitation. 3. Centrilobular nodules. 4. Summary of the main differences between children and adults. 5. Inactive Tuberculosis: Radiological findings and their risk of reactivation. The role of the radiology report. 6. Complications: Empyema necessitatis, Rasmussen aneurysm.

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## Abstract Archives of the RSNA, 2023

CHEE-101

### Uncommon Story of Common Entity: Tips and Tricks in Imaging of Non-Cardiogenic Pulmonary Edema

All Day Room: Learning Center

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pulmonary edema is a most common clinical entity in both inpatient and out-patient setting. Identifying the underlying etiology of the edema is crucial to the timely implementation of appropriate therapy. Although cardiac dysfunction and volume overload are the most common etiologies routinely encountered, there are other different etiologies and presentations of pulmonary edema. Understanding the clinical context and underlying pathophysiology of these varied uncommon causes will help radiologists in narrowing differential diagnosis, therefore help clinicians to provide definitive treatment and better patient care. Furthermore, thorough knowledge about non-cardiogenic pulmonary edema reduces the rate of invasive procedures like Swan-Ganz catheterization and related complications.

#### TABLE OF CONTENTS/OUTLINE

- Etiologies of non-cardiogenic pulmonary edema
- Mechanisms of non-cardiogenic edema
- Radiopathology correlation of pulmonary edema
- Pertinent role of chest x ray in initial diagnosis of cardiogenic vs non-cardiogenic pulmonary edema
- How subtle signs on chest x-ray helps to recognize uncommon etiologies of pulmonary edema
- How to differentiate different types of noncardiogenic edema on chest x ray.
- "Leave alone" type of pulmonary edema
- When should you use CT imaging
- Edema with and without diffuse alveolar damage- Does it matter on imaging?
- Short term and long -term complications of noncardiogenic pulmonary edema
- Algorithm and next step in the management of noncardiogenic pulmonary edema

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## Abstract Archives of the RSNA, 2023

CHEE-102

### An Update on the Role of Chest Imaging in Cystic Fibrosis

All Day Room: Learning Center

Scott M. Bugenhagen, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is: 1. To demonstrate the characteristic imaging findings of cystic fibrosis in the chest including a variety of commonly encountered complications through a series of clinical examples. 2. To review the latest guidelines and trends in the imaging of cystic fibrosis, with a focus on how clinical practice has changed with emerging therapies. 3. To describe the evolving role of chest radiography and cross-sectional imaging in this new clinical landscape, including a review of the most common scoring systems used in clinical practice.

#### TABLE OF CONTENTS/OUTLINE

I. Review of current clinical landscape A. Summary of CF genotypes and patient specific therapy B. Advances in medical therapies C. Changes in clinical practice II. Role of chest radiography A. Characteristic findings B. Direct and follow treatment C. Radiographic scoring systems II. Role of computed tomography A. Indications a. HRCT b. Contrast enhanced CT and CTA B. Characteristic findings C. Direct and follow treatment D. CT scoring systems III. Imaging of complications A. Superinfection a. Colonization with pseudomonas aeruginosa and Staphylococcus aureus b. Nontuberculous mycobacterial infection c. Burkholderia cepacia infection B. Aspergillus related lung disease a. Allergic bronchopulmonary aspergillosis b. Aspergilloma c. Semi-invasive aspergillosis C. Lobar collapse and idiopathic collapsed lung D. Pneumothorax E. Pulmonary hypertension and cor pulmonale F. Hemoptysis IV. Transplant evaluation

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## Abstract Archives of the RSNA, 2023

CHEE-103

### Upright Chest CT Imaging

All Day Room: Learning Center

Yoshitake Yamada, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of our exhibit are as follows: (1) To explain the development, background, and performance of upright CT. (2) To describe the anatomical changes in each structure of the chest due to differences in body position, that is, the direction of gravity. (3) To illustrate the clinical applications of upright CT for various chest diseases with clinical case presentations, and the potential applications in particle therapy.

#### TABLE OF CONTENTS/OUTLINE

(1) Development of an upright CT and its background (2) Performance of upright CT: Physical characteristics, workflow improvement, safety, and remote operation during the infectious disease pandemic (3) Effect of gravity on the lungs, lobes, airways, heart, shoulder girdle, and chest vessels (4) Clinical applications of upright CT for various diseases such as chronic obstructive pulmonary disease, interstitial lung disease, scoliosis, diaphragmatic paralysis, and funnel chest (5) Upright 4D-CT of the chest (6) Potential applications of the upright CT in particle therapy (7) Limitation (8) Conclusion

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## Abstract Archives of the RSNA, 2023

CHEE-104

### Analysis of Fine Anatomical Structures Involved in Pulmonary Nodules by Ultra-High-Resolution CT

All Day Room: Learning Center

Hiroshi Moriya, MD, PhD (*Presenter*) Advisor, California Capital Equity, LLC; Research Grant, Canon Medical Systems Corporation

#### TEACHING POINTS

1. Spatial resolution of ultra-high-resolution CT (UHRCT)
2. Depiction of intralobular structure by UHRCT
3. MPR display of bronchus long-axis cross-section and short-axis cross-section (parallel pleural cross-section)
4. Typical cases: Analysis of fine anatomical structures involved in pulmonary nodules by UHRCT

#### TABLE OF CONTENTS/OUTLINE

Ultra-high-resolution CT (UHRCT) is a CT that achieves high spatial resolution by reducing the detector size to 1/4. In the previous studies, the bronchial visualization ability of UHRCT was superior compared with conventional HRCT. In the depiction of lung field structure, bronchi with an inner diameter of 0.4 mm are delineated. Contrast enhancement and deep learning reconstruction method (DLR) enhances the contrast effect of peripheral blood vessels and improves visualization. By improving the resolution, it has become possible to display the intralobular structure. How to identify lobular structure: a. Bronchioles are centrally located in the lobules. b. Identify the blood vessels that accompany the bronchi as pulmonary artery. c. Pulmonary veins are thicker than pulmonary arteries. d. Imaging of pulmonary arteries or veins in contrast-enhanced phase. e. Confirm continuity of the target vessel to the root of the pulmonary artery and vein. Lesions that spread with regularity to the lobular structure, lesions that extend independently of the lobular unit, lesions that extend beyond the lobule, and lesions confined within the lobule are presented.

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## Abstract Archives of the RSNA, 2023

CHEE-105

### Thoracic IgG4-Related Disease: Revealing the Diverse and Heterogeneous Imaging Manifestations

All Day Room: Learning Center

Kyubin Kim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. IgG4-related disease (IgG4-RD) is an immune-mediated fibroinflammatory condition characterized by dense lymphoplasmacytic infiltrations with predominant IgG4-positive plasma cells, usually accompanied by storiform fibrosis, obliterative phlebitis, and elevated serum IgG4 levels. 2. Thoracic manifestations of IgG4-RD are diverse and can mimic malignant lymphoma, infection, or other systemic autoimmune disease. The most common manifestations are mediastinal lymphadenopathy and peri-bronchovascular interstitial thickening. Other findings include pulmonary nodule or mass, interstitial lung abnormalities, pleural effusion or thickening, mediastinal or chest wall mass, and thoracic arteritis. 4. IgG4-RD can present with atypical radiologic findings such as migrating or cavitory nodules, lobar or segmental consolidation, and paravertebral mass making the diagnosis challenging. 5. Early diagnosis with clinical-radiologic-pathologic correlation is important to prevent irreversible damage due to fibrosis.

#### TABLE OF CONTENTS/OUTLINE

1. Definition, pathogenesis, and histopathology of IgG4-RD 2. Clinical manifestations and diagnostic criteria for thoracic IgG4-RD 3. Imaging findings of thoracic IgG4-RD: diverse and heterogeneous findings in the lungs, airway, mediastinum, pleura, chest wall, and thoracic vessels 4. Treatment and prognosis of thoracic IgG4-RD 5. Conclusion: The importance of recognizing the diverse imaging findings of thoracic IgG4-RD and reflecting them in diagnosis and treatment

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## Abstract Archives of the RSNA, 2023

CHEE-106

### Beyond the Black Holes: A Multidisciplinary Approach to Cystic Lung Disease

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Lawrence Guan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Diffuse cystic lung diseases (DCLD) are characterized by thin-walled, air-filled spaces with normal intervening lung parenchyma. Certain entities can mimic or be mistaken for lung cysts such as emphysema, cavitary lesions, honeycombing, and cystic bronchiectasis. These are a diverse group of disorders with a variety of underlying causes including hereditary, neoplastic, infectious, inflammatory, lymphoproliferative, and smoking-related. High-resolution chest CT plays a central role in the evaluation of patients with DCLD's and it is not uncommon for these disorders to be discovered during imaging for other reasons. Therefore it is important for the radiologist to be aware of these conditions and their associations, as they may be the first to suggest the diagnosis. An approach to the characterization of cystic lung disease will be reviewed including imaging and clinical clues which can aid in suggesting one diagnosis over another.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction.2. Examples of cases: a. Mimics of lung cysts b. Smoking-related: Pulmonary Langerhans Cell Histiocytosis, Desquamative Interstitial Pneumonia c. Inflammatory: Amyloidosis, Hypersensitivity Pneumonitis d. Hereditary: Tuberous Sclerosis/Lymphangiomyomatosis, Birt-Hogg-Dube, Neurofibromatosis, Ehlers Danlos Syndrome, Sickle Cell Disease e. Lymphoproliferative: Lymphocytic Interstitial Pneumonia, Follicular bronchiolitis f. Neoplastic: Cystic metastases, Treated metastases g. Disorders with cystic component: Bronchopulmonary sequestration, Congenital pulmonary airway malformation, Bronchogenic cyst h. Miscellaneous: Infectious/Postinfectious, Posttraumatic3. Conclusion.

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## Abstract Archives of the RSNA, 2023

CHEE-107

### Mimics of Pulmonary Embolism (PE)

All Day Room: Learning Center

Shaimaa A. Fadl, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Learn technical, anatomical, and patient-related pitfalls in the diagnosis of pulmonary embolism. Illustrate common and uncommon pulmonary artery pathologies that can mimic pulmonary embolism. Discuss an imaging approach for the diagnosis and management of patients with different pulmonary artery pathologies.

#### TABLE OF CONTENTS/OUTLINE

Introduction. Technical pitfalls. Anatomical pitfalls. Patient related pitfalls. Pulmonary artery malignancy (angiosarcoma, lymphoma). Pulmonary artery tumor embolism. Pulmonary artery in-situ thrombus (post-surgical, post radiotherapy). Pulmonary artery vasculitis. Atypical Infection. Granulomatous/Fibrosing mediastinitis. Role of different imaging modalities in evaluation of PE mimics. Diagnostic approach to PE mimics.

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## Abstract Archives of the RSNA, 2023

CHEE-108

### Joining the Dots in Multiple Lung Nodules

All Day Room: Learning Center

Lily Pierce, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Varying etiologies cause multiple pulmonary nodules and can be mistaken for infection or metastatic disease. 2. Ancillary CT features such as air trapping with multiple pulmonary nodules are seen in DIPNECH, or chest wall vessel calcification with centrilobular nodules in renal failure suggests metastatic calcification. 3. Small calcified pulmonary nodules seen with reticulation in the lower lobes, usually in fibrotic ILD, represents dendriform ossification.

#### TABLE OF CONTENTS/OUTLINE

CT detected multiple lung nodules are most commonly due to infection, sarcoidosis, or metastasis. However, alternative etiologies causing lung nodules can be diagnosed on CT based on CT morphology or associated findings. These alternative causes of multiple lung nodules are often seen in patients with malignancies, and we must accurately diagnose these to prevent misinterpretation. Therefore, these lesser-known entities and their diagnostic CT findings are discussed. The etiologies are subclassified based on the CT appearance of nodules such as non-solid, solid, cavitary, calcified, and nodules with central air bronchograms. A case-based approach will discuss meningoendotheliomatosis, DIPNECH, amyloidosis, LIP, LCH, Dendritic Ossification, metastatic calcification, Progressive massive fibrosis in silicosis, MMPH in Tuberos Sclerosis, MALT lymphoma amongst other similar disease processes. Ancillary CT features for, e.g., the air-trapping in DIPNECH, Cheerio sign in meningoendotheliomatosis, calcification in amyloidosis, vessel wall calcification in renal failure with metastatic calcification, etc., are highlighted. In addition, the next steps in the workup for diagnosis are also highlighted.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-109

### 0.55T MRI Thoracic Imaging

All Day Room: Learning Center

Jonathan A. Liu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Low field (< 1T) MRI is an emerging technology that possesses certain advantages over other imaging modalities and higher field MRI that make imaging of the lungs more attractive. The purpose of this exhibit is to highlight the considerations involved in implementing clinical use of low field MRI for thoracic imaging, with the hope of introducing the audience to this new imaging paradigm. A wide variety of cases (with a cohort of 22 patients at the time of abstract submission) are shown highlighting the benefits of low field MRI imaging with the Siemens Freemax system (0.55T, MAGNETOM Freemax; Siemens Healthcare, Erlangen, Germany) including ultra-short TE, diffusion weighted, and non-contrast MRI ventilation/perfusion imaging. We will also review the limitations and pitfalls of lung imaging at 0.55T MRI.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction
2. Rationale for low field MRI
  - a. Advantages of low field MRI over other modalities
    - i. MRI versus CT
    - ii. Low field versus traditional 1.5T or 3T imaging
  - b. Disadvantages of low field MRI over other modalities
    - i. MRI vs CT
    - ii. Low field MRI compared to 1.5/3T
3. Imaging Protocol
4. Clinical Indications
  - a. Immediate
  - b. Early
  - c. Long-term
5. Five to ten cases of 0.55T MRI images with CT correlation
  - a. Normal anatomy
  - b. Malignancy
  - c. Inflammation
  - d. Post-radiation
  - e. Small airways/small vessel disease
  - f. Large airways
6. Key challenges, limitations, and pitfalls of lung imaging at 0.55T
7. Future clinical and research directions
8. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-11

### Light Up the Lungs: How Contrast Enhancement Can Help Diagnose Pulmonary Lesions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Agustina Picarel, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Non-contrast CT of the chest is often requested by clinicians in settings where the addition of iodinated contrast is warranted. Radiologists must be familiar with how contrast positively impacts evaluation of pulmonary pathology. This exhibit will showcase the value of iodinated contrast improving assessment of pulmonary parenchymal entities. Iodinated contrast improves differentiation of pneumonia from atelectasis, with the former lacking enhancement, while atelectasis enhances homogeneously. Addition of contrast material allows detection of complications of pulmonary infections such as necrosis, pulmonary artery pseudoaneurysm and chest wall involvement. In the setting of congenital pulmonary lesions, CT evaluation should include iodinated contrast to evaluate arterial supply and venous drainage. Nodule characterization is improved with iodinated contrast. Lesion localization improves with iodinated contrast: including discerning lesions from vascular structures, delineation of hilar lesions, and appraisal of vascular and chest wall invasion in the setting of aggressive processes.

#### TABLE OF CONTENTS/OUTLINE

Contrast Enhanced CT protocols and indications  
Pulmonary arterial phase  
Systemic arterial phase  
Venous phase  
Infection  
Pneumonia vs Atelectasis  
Complications of pneumonia: necrosis, abscess, pseudoaneurysm, wall involvement  
Lesion localization and assessment of complications  
Hilar lesions  
Discernment from broncho-vascular bundle  
Vascular, mediastinal, and chest wall invasion  
Nodule characterization  
Hypervascular metastasis  
Carcinoid tumor  
AVM  
Congenital lesion evaluation  
Vascular supply (eg. Sequestration)  
Venous anomalies (eg. Hypoplastic lung evaluation)

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## Abstract Archives of the RSNA, 2023

CHEE-110

### Don't Be Blue... Here's a Clue! Tips to Assess Adult Cardiac Pathology on a Chest Radiograph Like a Pro

All Day Room: Learning Center

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In the era where modalities such as 2-D echo, CT and MRI are being highly utilized for evaluation of cardiac pathology, a plain chest radiograph still plays a key role in contributing important information. However, the younger generation of radiologists do not seem to be optimally exposed or are unaware of the true value of a chest radiograph. Chest radiograph is convenient as it is an easily accessible, low-cost, and non-invasive diagnostic tool with minimal radiation dose. We aim to provide unique imaging clues to identify the classic signs, measurements, and differential diagnoses of various adult cardiac pathologies on a chest radiograph with confirmatory CT images. Since a chest radiograph is the first imaging modality for majority of patients with chest pain - it is very imperative for the radiologists to quickly recognize these subtle findings to provide an accurate diagnosis and proper patient management.

#### TABLE OF CONTENTS/OUTLINE

Introduction to normal cardiac anatomy  
CASE BASED LEARNING:  
• How to differentiate between:- Aortic Dissection vs Aortic Aneurysm- Pneumopericardium vs Pneumomediastinum- Pericardial Effusion vs Cardiomyopathy- Intramural esophageal lesion vs LA enlargement- Enlarged azygous arch vs Paratracheal lymph node- Stages of cardiogenic pulmonary edema  
• Identify:- Pulmonary embolism- Cardiac Valves- Focal pulmonary edema- Heterotaxy syndromes- Cardiac Size: Microcardia- Pectus Excavatum- Devices  
• Compare and contrast:- Cardiomyopathies: Dilated vs Hypertrophic- Individual chamber enlargements  
• Limitations

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-111

### **Aerogenous Metastasis and Spread Through The Air Spaces (STAS) - Distinct Entities or Spectrum Of The Same Process?**

All Day Room: Learning Center

Mariah K. Obino, BMBCh (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To present the proposed mechanisms and pathological findings described in aerogenous metastasis (AeM) and spread through the airways (STAS) as well as areas of uncertainty and their prognostic significance. 2. Discuss the concept of continuous and discontinuous cancer spread from the primary tumor. 2. To review the pathological and imaging characteristics of primary lung cancers with higher probability of spreading through the airspaces. 3. To describe CT features suggestive of aerogenous metastasis and their main differential diagnoses, including distinction from multiple synchronous primary adenocarcinomas.

#### **TABLE OF CONTENTS/OUTLINE**

1. Definition and pathophysiology of STAS and aerogenous metastasis (AeM). 2. Risk factors and predisposing histological patterns. 3. Imaging predictors, diagnosis, and prognostic significance of STAS and AeM. 4. Differentiating aerogenous metastases from synchronous adenocarcinomas on CT. 5. Clinical relevance and impact on patient management. 6. Are STAS and aerogenous metastasis distinct entities or a spectrum of the same process? 7. Future directions; areas of uncertainty and further research.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

CHEE-112

### Navigating the Difficult ICU Chest Radiograph: Distinguishing Non-standard Cardiovascular Device Placements from Device Malposition

All Day Room: Learning Center

Danielle Struck, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cardiovascular support devices are essential in the management of critically ill patients. While identifying malpositioned devices can often be straightforward, recognizing correctly positioned uncommon devices/non-standard placements and identifying malpositioned/incorrectly deployed devices can be difficult. Here, we present a case-based approach to distinguishing non-standard device placements from malposition and potential downstream complications, providing CT correlation where appropriate and specify lessons learned and practical tips in each case.

#### TABLE OF CONTENTS/OUTLINE

1. Title slide 2. Disclosures 3. Abbreviations 4. Approach 5. Scenarios 6. Pulmonary critical care, MICUa. CVCs i. L SVC placement ii. Arterial placement b. PA catheter i. Inguinal approach ii. Peripheral placement, PA pseudoaneurysm c. ECMO i. Peripheral, situs inversus, central ii. Malposition 7. Electrophysiology, CVICUa. Pacer/ICD i. Epicardial/subcutaneous leads, patient with atrial switch ii. Lead migration/fracture, ventricular perforation b. Transcatheter LAA closure i. Watchmann vs Amplatzer ii. Embolization 8. Heart failure, CVICUa. Impella i. Impella RP (RV) ii. Access site hematoma, dissection b. LVAD i. Different models ii. Infection, trauma, suck event c. Intra-aortic balloon pump i. Upper extremity approach, adjustment ii. Malposition, visceral ischemia 9. Structural cardiology, CVICUa. ASD closure device i. PDA closure device ii. Malposition, incomplete seal b. Prosthetic valves i. Transapical mitral valve prosthesis ii. Embolization 10. CT surgery, SICUa. Pericardial drain i. Wraparound drain ii. Mediastinal placement 11. Summary - Lessons 12. Summary - Practical tips 13. References

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## Abstract Archives of the RSNA, 2023

CHEE-113

### The Radiologist's Expedition into the Intricacies of Percutaneous Lung Biopsies and Ablations

All Day Room: Learning Center

Megha Gupta (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Lung cancer (CA) is the second most common cancer in the US and is the leading cause of cancer related mortality. Surgery is the mainstay of therapy for patients with stage I lung cancer, although many patients with lung cancer are poor surgical candidates. Stereotactic radiation body therapy (SBRT) is offered to inoperable patients with lung CA, however, carries significant side effects and risk of lung function deterioration. Image guided tumor ablation (IGTA) is an alternative treatment option with proven outcomes in Stage I lung CA without the risk of lung function deterioration. Also, IGTA is not limited by segmental anatomy.

#### TABLE OF CONTENTS/OUTLINE

Overview of lung cancer staging, identification of suitable patients for image guided lung ablation and discuss treatment outcomes. Understand the various modalities of lung ablation (Radio frequency, Microwave and Cryoablation). Approach to difficult biopsies and difficult needle placement including the use of hydro-dissection and artificial pneumothorax creation. Learn normal and abnormal imaging appearances post lung ablation and current follow up recommendations.

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## Abstract Archives of the RSNA, 2023

CHEE-114

### “Getting Warmer...” - Chest Radiological Findings in Patients with Fever of Unknown Origin

All Day Room: Learning Center

Alla Khashper, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Fever of unknown origin (FUO) is defined as "fever = 101°F (38.3°C) for at least 3 weeks that remains undiagnosed after 3 inpatient days or at least 3 outpatient visits". FUO is a well-known clinical problem, has multiple thoracic etiologies, and commonly requires extensive workup. Imaging might identify the cause of FUO. However, no radiological recommendations have been established.

#### TABLE OF CONTENTS/OUTLINE

Historically, FUO has been divided into classic, nosocomial, immunodeficiency-related, and travel-associated categories. For imaging purposes the following classification appears more practical: infections, malignancies, inflammation and miscellaneous. The selected illustrative cases are listed in the attached presentation. The evaluation of FUO is always complex, including extended history taking, physical examination, and lab tests, followed by imaging. Chest radiography and CT are routinely performed and can usually provide putative or final diagnosis or suggest further imaging work-up, including but not limited to CT angiography, PET , MRI, and imaging-guided biopsy. This educational exhibit is a pictorial review of thoracic pathologies associated with FUO, targeting radiology trainees, general and subspecialized thoracic radiologists. It will highlight teaching points and provide clues to establish concise differential diagnosis of FUO causes.

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## Abstract Archives of the RSNA, 2023

CHEE-115

### Development of Color Dynamic Flow Image Using 4D-CTA for Post TEVAR Operative Case

All Day Room: Learning Center

Hiroshi Sakuragochi (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

It is common to use 3D-CTA for postoperative evaluation of TEVAR. 3D-CTA can assess postoperative complications such as endoleak and the presence or absence of stent graft induced new entry (SINE). However, since 3D-CTA is a single time phase, it is difficult to evaluate the direction of blood flow to the aneurysm and the timing of outflow. This is where 4D-CTA comes in. 4D-CTA injects a contrast medium while continuously imaging a specific area. When 4D-CTA is displayed in Volume Rendering (VR), the blood flow is easy to understand visually. Therefore, it is possible to observe end leakage and SINE around the stent graft. This time, we evaluated the blood flow when it was converted to VR using a color map. The color map was changed according to the CT value. In addition, the color map has been optimized to make 4D-CTA easier to observe. By displaying the blood flow as our original color map, it is possible to visually evaluate the direction of blood flow at the leak point and the timing of flow from the aorta into the aneurysm. This time, we take 4D-CTA scan and analyzed it with our original color map in the SINE case. By applying our method, it can be easy and visually to evaluate the entry point, blood flow direction, and outflow timing post TEVAR operation.

#### TABLE OF CONTENTS/OUTLINE

1. Problem analysis of conventional display method 2. Ingenuity in scanning / Exposure reduction technology 3. Ingenuity in image reconstruction 4. Evaluation by 4D-CTA 5. Creation of original color map 6. Evaluation of usefulness by clinical cases

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-116

### Cinematic Rendering of the Thoracic Aorta: A New Look at an Old Problem

All Day Room: Learning Center

Elliot K. Fishman, MD (*Presenter*) Co-founder, HipGraphics, Inc Stockholder, HipGraphics, Inc Institutional Grant support, Siemens AG Institutional Grant support, General Electric Company Consultant, Exact Sciences Corporation Consultant, Imaging Endpoints II LLC

#### TEACHING POINTS

1. 3D imaging with Cinematic rendering can play a major role in the detection of the thoracic aorta  
2. Cinematic Rendering can be optimized with development of presets to improve workflow  
3. Cinematic Rendering can be used in a range of applications including suspected dissection, coarctation of the aorta, vasculitis, post aorta repair and trauma  
4. Cinematic Rendering will provide critical information to the referring physician for patient management  
5. the radiologist needs to work closely with the referring physician and Cinematic Rendering help play a role in this interaction

#### TABLE OF CONTENTS/OUTLINE

a. Cinematic Rendering protocols  
b. CT acquisition protocols  
c. clinical applications with case studies-suspected dissection-post aortic aneurysm repair-coarctation of the aorta-trauma-vasculitis  
d. pearls and pitfall  
e. the literature  
f. future directions  
g. bibliography

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## Abstract Archives of the RSNA, 2023

CHEE-117

### Current and Novel Techniques for Artifact Reduction on Chest CT

All Day Room: Learning Center

Yoichiro Ota, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Various artifacts can be observed on chest CT. Motion artifacts are an important issue, especially in emergency cases in which patients are unable to hold their breath. Motion correction-deep learning reconstruction (MC-DLR) is a motion correction method developed using a deep learning framework to estimate patient motion in the lung region. This method comprises three major steps. First, a full-image reconstruction is decomposed into several partial-angle reconstructions. Second, a pre-trained deep convolutional neural network (DCNN) is applied to estimate the motion vector field between these partial angle reconstruction images. Finally, a motion-corrected image is reconstructed by incorporating the DCNN-predicted motion vector field (Fig. 1). An image with MC-DLR can reduce the motion artifacts in moving phantom experiments (Fig. 2) and clinical cases (Fig. 3). Radiologists should understand CT artifacts to distinguish between true lesions (Figs. 4,5). In this exhibit, we introduce the principles of CT artifacts and techniques to reduce them by presenting clinical cases.

#### TABLE OF CONTENTS/OUTLINE

Motion artifact, Streak artifact, Metal artifact, Dark band artifact, Partial volume effect

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-118

### Thoracic Manifestations of Autoimmune Diseases: From Suspicion to Diagnosis

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Renato T. Fujiki, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Interstitial lung disease (ILD) is the most common thoracic manifestation of autoimmune disease (AD). Each ILD pattern is more commonly associated with a specific AD, although there is an overlap between patterns. While connective tissue diseases (CTD) are commonly associated with thoracic manifestations, it is important to recognize that other AD can also affect the lungs. Besides ILD, AD can also present with airway, vascular, pleural, and mediastinal involvement. The purpose of this exhibit is - Review CT patterns of ILD more commonly associated to each specific AD and what is important to describe - Highlight the role of radiology in diagnosing and grading thoracic manifestations of AD - Discuss the new classification system known as "interstitial pneumonia with autoimmune features" (IPAF) and its relevance in patient management

#### TABLE OF CONTENTS/OUTLINE

1. Introduction
  - a. Epidemiology, pathophysiology and clinical aspects of the main autoimmune diseases (AD)
  - b. Currently available treatment options
2. Role of different imaging methods in diagnosis and assessment of disease grading - advantages, limitations, usefulness
  - a. X-ray
  - b. Ultrasound
  - c. CT - with protocol recommendation
  - d. MRI
3. ILD patterns associated with AD - Case-by-case discussion review
  - a. Non-specific interstitial pneumonia
  - b. Organizing pneumonia
  - c. Usual interstitial pneumonia
  - d. Hypersensitivity pneumonitis-like pattern
  - e. Others
4. Other thoracic manifestations of both CTD and non-CTD AD - including vascular, pleural, mediastinal and airway involvement
5. The new statement of interstitial pneumonia with autoimmune features (IPAF) - repercussions in clinical practice and recommendations
6. Conclusions "take-home messages"

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## Abstract Archives of the RSNA, 2023

CHEE-12

### Cardiothoracic Imaging Findings in VEXAS Syndrome

All Day Room: Learning Center

Naim Qaqish, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-VEXAS Syndrome is an adult-onset autoinflammatory disorder found almost exclusively in adult men (x-linked gene mutation) first described in 2020. The disease is severe with a poor prognosis.-Systemic hematologic and inflammatory disease affecting multiple organs, most commonly the skin, lungs, cardiovascular, and cartilage.-Diagnosis is made on bone marrow aspirate.-Pulmonary imaging findings: consolidative, ground glass and reticular opacities, pulmonary vasculitis, pleural effusions, bronchial inflammation/stenosis.-VS-associated interstitial lung disease usually follows an organizing pneumonia or NSIP pattern.-Cardiovascular imaging findings: Venous and/or arterial thrombosis, pulmonary emboli, pericarditis, myocarditis, and cardiac amyloidosis.

#### TABLE OF CONTENTS/OUTLINE

- Introduction to VEXAS Syndrome (VS)
- Useful Laboratory Tests
- Clinical Presentation with Common Manifestations
- Pulmonary Imaging Features
  - o Parenchymal disease (consolidation, GGO, reticulation)
  - o Pleural effusions
  - o VS-associated interstitial pneumonias § NSIP and organizing pneumonia patterns
  - o Pulmonary vasculitis
  - o Bronchial disease and stenosis
  - o Less common pulmonary manifestations
- Cardiovascular Imaging Features
  - o Cardiac and pericardial involvement § Typical CMR findings
  - o VS-associated vasculitis
  - o Recurrent thromboembolic disease § DVT, pulmonary emboli, and arterial thrombosis
- Differential Diagnosis
- Treatment
- Prognosis
- Summary of Cardiothoracic Imaging Findings
- References

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## Abstract Archives of the RSNA, 2023

CHEE-120

### Heavy Stuff: The Burden of High-Attenuation Lung Lesions

All Day Room: Learning Center

Iuri Shen De Lacerda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Propose a pattern-based approach to most common high-attenuating lung lesions- Review specific imaging features of each CT pattern of disease- Recognize the main differential diagnosis by section and understand the pathophysiology behind each hyperattenuating lesion through a case-based pictorial discussion- Highlight the importance of radiology in narrowing diagnostic possibilities and guiding next steps in patient management

#### TABLE OF CONTENTS/OUTLINE

I - INTRODUCTION- Definition of high-attenuation lung lesions- Pattern-based approach to narrow differential diagnosisII - PATTERNS AND ASSOCIATED DIAGNOSISA - Calcified pulmonary nodules1. Dystrophic calcifications-a. Post-infectious-b. Pulmonary hemosiderosis: Idiopathic or Secondary (chronic alveolar hemorrhage)-c. Occupational disease: Silicosis, Coal workers pneumoconiosis2. Metastatic calcification: Benign or Malignant3. Pulmonary Alveolar microlithiasisB - Non-calcified hyperattenuating nodules1. Talcosis2. Mercury embolism and vapor inhalation3. Pulmonary cement embolization after vertebroplasty4. Cyanoacrylate embolizationC - Large calcified nodules or masses1. Calcified metastasis: Medullary thyroid carcinoma, Osteosarcoma, Condrosarcoma2. Amyloidosis3. Granuloma4. Progressive massive fibrosisD - Hyperattenuating linear or reticular opacities1. Pulmonary dendriform ossification: Idiopathic or Secondary (idiopathic pulmonary fibrosis, chronic alveolar hemorrhage)2. Diffuse pulmonary amyloidosis: alveolar septal formE - High-attenuation consolidation1. Amiodarone lung2. Pulmonary Lipiodol embolismIII - CONCLUSIONSummary of key points"Take-home" messages

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## Abstract Archives of the RSNA, 2023

CHEE-121

### Paraneoplastic Syndromes Related to Thoracic Neoplasms: Clinical and Imaging Clues

All Day Room: Learning Center

Alan V. Godfrey, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Paraneoplastic Syndromes are systemic manifestations of neoplasia not related to metastatic disease. These rare disorders are characterized by abnormal production of proteins (i.e. antibodies), protein derivatives, or steroids generated by the immune system. The diagnosis of thoracic neoplasms associated with these syndromes often presents diagnostic challenges for radiologists and clinicians alike. Radiologists play an essential role in the identification of the specific neoplasm associated with these syndromes. Therefore, knowledge of the neoplasm associated with each paraneoplastic syndrome is valuable for quality patient care. The goals of this exhibit are to help the learner: 1. List the clinical features of specific paraneoplastic syndromes related to thoracic neoplasms 2. Identify characteristic imaging features of thoracic neoplasms associated with specific paraneoplastic syndromes

#### TABLE OF CONTENTS/OUTLINE

1. Introduction - Definition of paraneoplastic syndromes 2. Overview of paraneoplastic syndromes associated with specific types of thoracic neoplasms 3. Discussion of clinical and imaging features of thoracic neoplasms that may manifest with a paraneoplastic syndrome at presentation 4. Conclusion

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## Abstract Archives of the RSNA, 2023

CHEE-122

### Usual Interstitial Pneumonia and Variants, a Pictorial Review

All Day Room: Learning Center

Moises Jose P. Lima, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To define and illustrate the classic appearance of a UIP pattern.- To describe the HRCT diagnostic categories of Usual Interstitial Pneumonia (UIP).- To comment and review the CT findings of the main differential diagnosis of UIP. - To know the 2018 Fleischner diagnostic guidelines on the diagnosis of Idiopathic pulmonary fibrosis (IPF). - To enumerate and discuss specific and general variant patterns of fibrosis.

#### TABLE OF CONTENTS/OUTLINE

1) Background: Interstitial lung disease concept and classification. Categorization of idiopathic interstitial pneumonias. UIP pathophysiology.2) HRCT technique in UIP3) Key features of a classic UIP pattern: honeycombing, reticular pattern, traction bronchiectasis, other findings of classic UIP pattern: GGO, mediastinal lymph node enlargement, pulmonary ossification, pleuroparenchymal elastosis.4) Diagnostic categories of UIP: UIP and uncommon presentations (asymmetric distribution, uniform craniocaudal distribution and others), probable UIP, possible UIP, a review of the main alternative diagnoses: non-specific interstitial pneumonia, fibrosing hypersensitivity pneumonitis, sarcoidosis, others.5) IPF Diagnosis: clinical history, UIP histopathology, IPF diagnostic criteria.6) Variant patterns of fibrosis: anterior upper lobe, exuberant honeycombing and straight edge signs.7) Specific variant patterns of fibrosis: scleroderma: four corners sign. Systemic lupus erythematosus: "Island-like" fibrosis and heterogeneous lung destruction.8) Summary

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## Abstract Archives of the RSNA, 2023

CHEE-123

### NTM: What the Pulmonologist Wants to Know

All Day Room: Learning Center

Geraldine Brusca-Augello, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Classic and non-classic NTM have characteristic distribution and morphology of bronchopulmonary disease with variability in part associated with the presence of underlying lung disease, as well as other factors. Radiologists may be the first to suggest pulmonary NTM in patients that are asymptomatic or with nonspecific constitutional symptoms leading to earlier diagnosis and management. Baseline CT description should include description of disease extent, fibrocavitary or nodular bronchiectatic type, presence of atelectasis, cavities, and fibrosis. Pulmonary NTM infections are usually indolent/slowly progressive with CT findings waxing and waning over time. Follow-up imaging is performed to assess interval improvement or progression of the airways disease, cavities, nodules and consolidation. The focal mass like/nodular NTM type can pose diagnostic challenges, and must be distinguished from other infections and malignancy. Development of high-attenuation mucous (HAM) in bronchiectatic airways is pathognomonic for superimposed ABPA. New or growing nodule should raise concern for neoplasm. NTM should be also be considered as an allergen to incite nonfibrotic hypersensitivity pneumonitis.

#### TABLE OF CONTENTS/OUTLINE

Epidemiology. Diagnostic criteria for pulmonary NTM. CT Manifestations of pulmonary NTM. What the Radiologist needs to know. What the Pulmonologist wants to know.

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## Abstract Archives of the RSNA, 2023

CHEE-124

### Thoracic Complications of Stanford Type A Aortic Dissection: A Review of CT Findings and Management

All Day Room: Learning Center

James W. Hillhouse (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This presentation will serve as a review of aortic root anatomy and aortic dissection. It also includes an update to the Stanford classification system published jointly by the Society for Vascular Surgery and the Society of Thoracic Surgeons which provides a more detailed description of the dissection and is suited to sites offering endovascular repair (though likely to become more universally adopted in the future). The bulk of the exhibit is concerned with the complications of Type A dissection which occur within the thorax. A framework for classifying and subclassifying complications is described as well as a more detailed description of the pathophysiology, grading, and management of these complications. This information has previously been offered separately in review articles, case series, and case reports but will now presented as a single resource. Detailed diagrams and representative CT images will support the information presented and will aid the viewer's understanding of the concepts. CT is often utilised for investigation of suspected acute aortic syndrome. This presentation will be useful for radiologists and radiology residents working in the acute care setting, to assist their search pattern and tailor their reports to provide more useful information to the cardiothoracic surgeon.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Risk factors and epidemiology 3. Classification of aortic dissection 4. CT imaging protocol recommendations 5. Complications and management of aortic dissection 6. Thoracic complications of Type A dissection 6.1 Rupture complications 6.2 Malperfusion complications 6.3 Aortic valve distortion/disruption with regurgitation 7. Conclusion

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## Abstract Archives of the RSNA, 2023

CHEE-125

### From Acute to Chronic: A Comprehensive Guide to Aortic Injuries and the New Classification System

All Day Room: Learning Center

Amr H. Wardeh, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1.) Learn to differentiate among the different types of acute aortic syndrome and understand their clinical significance.(2.) Explore the signs of instability and potential complications in acute aortic syndrome.(3.) Examine the appearance of subacute and chronic aortic dissection.(4.) Discuss the limitations of the Stanford classification system in addressing the complexities of acute aortic syndrome.(5.) Introduce the new Society of Vascular Surgeons and the Society of Thoracic Surgeons classification system (SVS/STS) and how it differs from the Stanford classification system.(6.) Illustrate the use of the new SVS/STS classification system with example cases.

#### TABLE OF CONTENTS/OUTLINE

(I.) Introduction to Acute Aortic Syndrome (A.) Definition and clinical importance (B.) Overview of the four types (1.) Aortic dissection (2.) Intramural hematoma (3.) Penetrating atherosclerotic ulcer (4.) Limited intimal tear (II.) Classification Systems (A.) Stanford Classification System and its Limitations (B.) SVS/STS Classification System (C.) Comparison of the Classification Systems (D.) Example Cases: Applying the SVS/STS Classification System.

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## Abstract Archives of the RSNA, 2023

CHEE-126

### Reporting Response Assessment in Clinical Trials in the Era of Personalized Medicine

All Day Room: Learning Center

Julia Cha, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Response Evaluation Criteria in Solid Tumors (RECIST) was published in 2000 and revised to RECIST 1.1 in 2009. RECIST defines lesions as measurable and non-measurable, based on whether they are quantifiable; measurable lesions consist of target, which are followed, and non-target. RECIST 1.1 includes newer technologies like FDG-PET and MRI and clarifies lymph node criteria. Target lesions must be: Easily and reproducibly measurable; Representative of the disease; Representative of distribution. Progressive disease (PD) after initial response can be depicted using RECIST 1.1. Personalized therapies targeting specific receptors are in clinical trials and allow patients with slow progression to be followed long term. iRECIST criteria are used to assess response to immunotherapy. Response may vary between unidimensional and volumetric assessment methods. Genomic profiling in a lung cancer patient revealed an EGFR mutation. The tumor was successfully targeted by Erlotinib, showing 61% decrease in size at 8 weeks.

#### TABLE OF CONTENTS/OUTLINE

Illustrate response assessment in the era of personalized medicine clinical trials  
Depict optimal strategies for response assessment using a multimodality approach  
Explore novel response assessment criteria, such as volumetric and MRI based  
DCE and DWI, to assess response

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## Abstract Archives of the RSNA, 2023

CHEE-127

### **Congenital Lung Anomalies in the Adult**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Marcos A. Mestas Nunez SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Although rare, congenital lung anomalies are incidentally discovered in adults and can pose a diagnostic dilemma. The radiologist must be familiar with the imaging findings and differential diagnosis. With this exhibit we will: 1) Review the typical imaging appearance of common and uncommon congenital lung anomalies as seen in the adult. 2) Review the concept of hybrid lesions. 3) Case based review of entities that can be mistaken for congenital lung anomalies, and the role of imaging in the differential diagnosis. 4) Describe complications and as well as discuss the risk of malignancy of some of these entities.

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction and embryology  
2) Bronchopulmonary anomalies  
a) Bronchial atresia  
b) Lobar hyperinflation  
c) Bronchogenic cyst  
d) CPAM  
3) Combined pulmonary and vascular anomalies  
a) Pulmonary sequestration  
b) Hypogenetic lung syndrome  
c) Thoracic Isomerism  
4) "New concepts" hybrid lesions  
5) Miscellaneous  
a) Placental transmogrification  
b) Proximal Interruption of the pulmonary artery  
6) Differential diagnoses: Case-based approach  
7) Complications  
a) Risk of malignancy: true or myth?  
b) Superimposed: a radiology challenge  
c) Hemoptysis and radiology in treatment

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

CHEE-128

### The Family Plan: Multidisciplinary Approach to Familial Pulmonary Fibrosis (FPF)

All Day Room: Learning Center

Katherine A. Cheng, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Familial pulmonary fibrosis (FPF), defined as pulmonary fibrosis affecting at least two first degree relatives, is a complex group of diseases caused by a variety of genetic mutations. Diagnosis of FPF is essential as these patients have a worse prognosis than their sporadic counterparts that affects management not only of the patient, but also of first-degree relatives. However, the diagnosis of FPF can be difficult for both the radiologist and clinician as imaging patterns of fibrosis are often unclassifiable; variable penetrance exists amongst family members; and new mutations are continuously being discovered. This exhibit aims to improve understanding of FPF through a multidisciplinary approach reviewing genetic, clinical, and imaging manifestations of FPF.

#### TABLE OF CONTENTS/OUTLINE

1. Definition and Epidemiology of FPF.
2. Overview of the Genetic Mutations Associated with FPF including telomere, surfactant, host defense
3. Illustrate the spectrum of imaging patterns for FPF and the variability that can exist even amongst family members including unclassifiable, UIP, NSIP, PPFE
4. Emphasize the importance of genetic testing

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## Abstract Archives of the RSNA, 2023

CHEE-129

### Cardiovascular and Thoracic Imaging Manifestations of Lupus

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Muhammad Naeem, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Systemic Lupus Erythematosus (SLE), also known as Lupus is a great masquerader and being a systemic illness it virtually affects every organ in the body. Cardiovascular and Thoracic manifestations are often prevalent. Over half of the patients with lupus develop pleuropulmonary involvement. Lupus patients often get delayed diagnosis and sometime radiologists can provide clue to underlying lupus by putting all the imaging findings together.- Thrombosis is quite prevalent in lupus given the high association with Antiphospholipid antibody (APLA). Other vascular manifestations can be coronary artery disease/aneurysms, pulmonary hypertension, venous thromboembolism, pulmonary emboli and rarely aortic dissections.- Heart involvement in lupus often present with myocarditis, although pericarditis is much more common due to the high prevalence of serositis in lupus.

#### TABLE OF CONTENTS/OUTLINE

- Introduction- pathophysiological mechanisms in lupus- diagnostic criteria for lupus- Lung and Pleural involvement: Pleural disease, Lupus pneumonitis, Diffuse Alveolar Hemorrhage, Shrinking Lung Syndrome, Pulmonary fibrosis (along with classic patterns described in lupus)- Vascular involvement: Thrombosis/lupus anticoagulant/APLA antibodies, Venous thromboembolism, Pulmonary hypertensions, Aortic dissections- Cardiac involvement: Pericardial involvement, Myocarditis and myocardial LGE pattern, Coronary artery disease and coronary vasculitis, Valvular disease (Libman-Sacks endocarditis)- Summary slide

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## Abstract Archives of the RSNA, 2023

CHEE-13

### Ground-Glass Opacities in Thoracic CT: Beyond the Acute Disease

All Day Room: Learning Center

Alicia Espinal Soria, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe the spectrum of pathologic entities that manifest as ground-glass opacities in thoracic CT. To learn that ground glass opacities are not always related to acute diseases, being associated in some cases with fibrosis signs.

#### TABLE OF CONTENTS/OUTLINE

Ground-glass opacities (GGO) are defined as a light increase in attenuation in pulmonary parenchyma that occur when alveolar space is compromised and/or when pulmonary capillary blood volume increases. This finding is often associated with acute pathology like pulmonary edema, alveolar hemorrhage, Pneumocystis jirovecii pneumonia, COVID-19, acute interstitial pneumonia, and acute respiratory distress syndrome. But some subacute and chronic pathologies may also manifest with GGO in CT such as cryptogenic organizing pneumonia, lepidic-predominant adenocarcinoma, chronic eosinophilic pneumonia, non-specific interstitial pneumonia, and nonfibrotic hypersensitivity pneumonitis. In addition, all of these entities can be classified according to the presence or lack of fibrosis signs, which is a determinant prognosis factor for the patients. The aim of this presentation is to review these pathologies with the most common imaging findings in order to facilitate the differential diagnosis in each case. However, in many cases the imaging findings are nonspecific therefore histologic and microbiologic studies will be necessary to make a definitive diagnosis.

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## Abstract Archives of the RSNA, 2023

CHEE-130

### **ANCA-associated Vasculitis: The New 2022 ACR/EULAR Classification Criteria**

All Day Room: Learning Center

Jonghyeon Kwon, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Introduction and classification of ANCA-associated small vessel vasculitis 2. Review of newly updated 2022 ACR/EULAR classification criteria and cases of ANCA-associated vasculitis 3. Role of radiologists for classification of ANCA-associated vasculitis

#### **TABLE OF CONTENTS/OUTLINE**

1. Definition of ANCA-associated vasculitis 2. Classification criteria of ANCA-associated vasculitis A. 1990 American College of Rheumatology (ACR) classification criteria B. 2012 Revised Chapel Hill consensus conference (CHCC) nomenclature of systemic vasculitides C. 2022 American College of Rheumatology/European Alliance of Associations for Rheumatology (ACR/EULAR) Classification Criteria 3. Review of image findings and application of 2022 ACR/EULAR classification criteria A. Granulomatosis with polyangiitis (GPA) B. Eosinophilic granulomatosis with polyangiitis (EGPA) C. Microscopic polyangiitis (MPA) 4. Summary

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## Abstract Archives of the RSNA, 2023

CHEE-131

### Febrile Neutropenia: A Scenario and Pattern-based Approach to a Perplexing Problem

All Day Room: Learning Center

Adam J. Yen, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Febrile neutropenia presents a challenging clinical dilemma, and treatment success relies on early diagnosis and targeted antimicrobial therapy. Often, clinical teams look to radiologists to help narrow the differential diagnosis when a neutropenic patient's thoracic CT contains findings concerning for infection. Here, we examine the role of imaging and CT-guided biopsy in the management of febrile neutropenia, present an approach wherein clinical information is paired with a CT pattern to help the radiologist make an educated guess as to the underlying causative agent, and specify where either clinical information or imaging appearance can serve more useful.

#### TABLE OF CONTENTS/OUTLINE

1. Clinical presentation
2. Imaging workup
3. Approach by imaging patterns
  - a. Consolidation/nodules
  - b. Cavitory consolidation
  - c. GGO
  - d. Halo
  - e. Reverse halo
  - f. Thoracic wall involvement
4. Helpful clinical information
  - a. Time course
  - b. Antimicrobial response
  - c. Procalcitonin
  - d. B-D-Glucan
  - e. Galactomannan
  - f. Serologies
  - g. BAL aspirate microscopy
  - h. Cultures
5. Less than 1 week from onset
  - a. Consolidation/nodules - common bacteria
    - i. Gram+ bacteria (MRSA, VRE)
    - ii. Gram-bacteria (pseudomonas)
  - b. GGO - mostly viral
    - i. EBV, CMV, other viruses
    - ii. PJP
6. Consolidation/nodules + non-response to broad spectrum antibiotics - fungi
  - a. Candida
  - b. Aspergillus
  - c. Mucormycosis
7. Other organisms to consider - uncommon bacteria
  - a. Nocardia
  - b. Actinomyces
8. Utility of biopsy
  - a. Fungal infection
  - b. Malignancy
  - c. Non-diagnostic biopsy
  - d. Platelet management
9. Summary by imaging appearance
10. Summary by helpful clinical information

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## Abstract Archives of the RSNA, 2023

CHEE-132

### Deciphering Acute Diffuse Pulmonary Lesions: Unraveling the Diagnostic Enigma

All Day Room: Learning Center

Daisuke Yamada, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Diffuse lung diseases include a wide variety of infectious, neoplastic, and allergic diseases in addition to idiopathic interstitial pneumonia. In this presentation, we will discuss what radiologists need to know about these diseases, especially those that present with diffuse lung lesions in an acute-onset.

#### TABLE OF CONTENTS/OUTLINE

Presentation goals: To explain the pathophysiological mechanisms of hydrostatic and permeability pulmonary edema and describe the imaging findings. To discuss the spectrum of acute/subacute lung injury. To present information on acute diffuse pulmonary diseases classified by cause into idiopathic, infectious, allergic, drug-induced, neoplastic, and rare diseases and to describe their characteristic imaging findings. Cases include Infectious pneumonia: COVID-19 pneumonia, Cytomegalovirus pneumonia, Varicella zoster virus pneumonia, Influenza pneumonia, Pneumocystis pneumonia, Miliary tuberculosis, Legionella pneumonia, Diffuse aspergillosis after influenza viral infection Allergic lung diseases: Acute eosinophilic pneumonia, Acute hypersensitivity pneumonitis, E-cigarette, or vaping, product use associated lung injury (EVALI), Pulmonary injury associated with inhalation Drug-induced lung injury: Caused by anti-cancer drugs and other medications Neoplastic diseases: Tumor embolism, Pulmonary tumor thrombotic microangiopathy, Carcinomatous lymphangiosis, Leukocytosis, Intravascular large B-cell lymphoma Rare diseases: Pulmonary hemorrhage, Fat embolism

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## Abstract Archives of the RSNA, 2023

CHEE-133

### **Detailed Radiologic-Pathologic Correlation in Fibrotic Hypersensitivity Pneumonitis (FHP): For Better Understanding of the HRCT Findings**

All Day Room: Learning Center

Daisuke Yamada, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Understanding the histological backgrounds is an essential clue to making a better interpretation of HRCT images. The teaching points are 1) to review the anatomical/histological basic knowledges of the lungs for HRCT diagnosis of interstitial lung diseases, 2) to recognize the meaning of representative HRCT findings in fibrotic hypersensitivity pneumonitis by precise correlation to histological findings.

#### **TABLE OF CONTENTS/OUTLINE**

Definition and pathophysiology of fHP / Review the anatomical/histological basis of the lungs Anatomy of secondary lobule, location of the peribronchiolar region in secondary lobule Radiological and pathological findings Demonstration of typical radiological and pathological findings of fHP Essential HRCT findings to know- small airway lesion (e.g. three-density pattern, lobules with decreased attenuation), parenchymal fibrotic lesion showing random distribution or UIP/NSIP-like pattern Close correlation between radiological and pathological findings •Centrilobular ground-glass opacities on HRCT-bronchiolitis and peribronchiolar inflammation, airway-centered mild fibrosis/organization •Ground-glass opacties-diffuse parenchymal inflammation or mild alveolar septal thickening •NSIP-like pattern fibrosis showing peribronchovascular distribution on CT- can be formed by a fusion of airway-centered lesions •UIP-like pattern fibrosis showing periacinar/perilobular distribution on CT-is sometimes derived from organization along lymphatic routes result in periacinar/perilobular fibrosis Conclusion The HRCT findings of fHP are varied and complex, but can be better grasped by understanding the histological background.

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## Abstract Archives of the RSNA, 2023

CHEE-14

### **Oncologic Causes of Phrenic Nerve Palsy: Where and How to Look for**

All Day Room: Learning Center

Nivedita Chakrabarty (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To illustrate normal anatomical course of phrenic nerve from skull base to diaphragm  
variant anatomy of phrenic nerve - pictorial review  
Imaging approach on when to suspect and how to report phrenic nerve compression/infiltration  
emphasis on oncologic case based approach to phrenic nerve palsy

#### **TABLE OF CONTENTS/OUTLINE**

Introduction  
Phrenic nerve; its anatomy, normal course and variants  
Various aetiologies of phrenic nerve palsy with emphasis on malignancy  
Pathophysiology of phrenic nerve palsy, infiltration vs compression  
CT and PET CT as a diagnostic modality for assessment of phrenic nerve palsy  
Pictorial illustration of cases  
Take home points

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## Abstract Archives of the RSNA, 2023

CHEE-15

### Thoracic Involvement in Diseases Related to Dysregulated Humoral Immunity

All Day Room: Learning Center

Jose G. Maluf, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Understand general concepts about immunity and humoral immunity
- Identify the main pathologies related to unfunctional humoral immunity
- Learn about the thoracic involvement in dysregulated humoral immunity states and how it can impact in patient's health
- Recognize the thoracic imaging findings related to a compromised humoral immunity

#### TABLE OF CONTENTS/OUTLINE

- Introduction - General concepts about immunity:
  - o Main concepts and differences between cellular and humoral immunity
  - o Relation of the chest and respiratory tract with humoral immunity and the potential impacts in patient's health
  - o Thoracic imaging role in patients with dysregulated humoral immunity states
- Different thoracic findings:
  - o Airway abnormalities
  - o Infection
  - o Chronic Inflammatory and interstitial lung diseases
  - o Benign lymphoproliferative disorders
  - o Neoplasms
- Case based review - Pathologies and thoracic manifestations:
  - o Common Variable Immunodeficiency (CVID)
  - o IgG4-Related Respiratory Disease (IgG4-RRD)
  - o Respiratory amyloidosis
  - o Hypogammaglobulinemia
  - o Pulmonary Light-Chain Deposition Disease
  - o Other conditions
- Future perspectives
- Conclusions and key takeaways

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## Abstract Archives of the RSNA, 2023

CHEE-16

### Rare Vasculitides: An Institutional Case-Based Radiological Review of Hughes-Stovin Syndrome

All Day Room: Learning Center

Taylor K. Loon, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Describe the clinical presentation and identify the corresponding radiographic findings of Hughes-Stovin syndrome. 2) Compare and contrast the radiological and clinical findings with other vasculitides and other causes of pulmonary artery aneurysms. 3) Discuss the possible complications and highlight the medical and surgical management of Hughes-Stovin syndrome.

#### TABLE OF CONTENTS/OUTLINE

1) Introduce Hughes-Stovin Syndrome, its epidemiology, the three sequential phases of clinical presentation, and its diagnostic criteria. 2) Using cases from our institution, present the common radiologic features of Hughes-Stovin on chest radiograph and CT angiography of the thorax. 3) Using 3D-rendered images from our institution, further display the pulmonary arterial findings of Hughes-Stovin Syndrome. 4) Compare and contrast the diagnostic criteria, common radiologic findings and management of Hughes-Stovin to other pulmonary vasculitides including Behçet's disease and Granulomatosis with Polyangiitis. 5) Compare and contrast Hughes-Stovin to other causes of pulmonary artery aneurysms including mycotic aneurysms. 6) Discuss unstable pulmonary aneurysms as a potential complication of Hughes-Stovin Syndrome and overview treatment algorithm based on CT pulmonary angiography findings. 7) Using digital subtraction angiography images from our institution, review embolization for unstable pulmonary artery aneurysms and potential complications of treatment.

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## Abstract Archives of the RSNA, 2023

CHEE-17

### **Childhood Interstitial Lung Disease: Stepwise Approach to Imaging Findings, Histopathologic Correlation, and Management**

All Day Room: Learning Center

Karen I. Ramirez Suarez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Childhood interstitial lung disease is rare with challenging differential diagnosis which requires a stepwise approach to diagnosis including clinical presentation, imaging, and histology leading to the correct diagnosis in most cases. - An age-based differential diagnosis is particularly helpful for infants and young children. - Imaging evaluation of lung parenchyma, primarily on CT, helps to correctly diagnose these disorders, aids in guiding biopsy when needed, and monitor treatment response or disease progression. - Radiologic pathologic correlation is an important final step in the evaluation of childhood interstitial lung disease.

#### **TABLE OF CONTENTS/OUTLINE**

- Role of imaging of childhood interstitial lung disease with delineation of technique and pediatric protocols. - Stepwise approach to diagnosing childhood interstitial lung disease from clinical presentation to diagnostic workup including imaging, genetics, and biopsy.- Correlation of imaging findings and histology in childhood interstitial lung disease - Differential diagnosis of childhood interstitial lung disease based on clinical findings, imaging, and histology.

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## Abstract Archives of the RSNA, 2023

CHEE-18

### Lung Cancer Interventional Oncology: Fire and Ice in the Treatment of Lung Cancer

All Day Room: Learning Center

Kathryn G. Champ (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-CT-guided ablation is a viable option for treatment of multifocal lung carcinoma and patients with inoperable tumors, recurrence, prior surgery or radiation.-Choice of ablation modality depends on consideration of technical factors, size and location of target lesion, and patient comorbidities.-Target lesions > 3 cm confer a higher local recurrence rate than lesions < 3 cm.-Postablation features of successful ablation include ground-glass margins, which is crucial for confirming treatment success.-Follow up of postablation patients is the responsibility of the interventional oncologist with a standardized regimen of office visits and imaging.

#### TABLE OF CONTENTS/OUTLINE

-Indications for ablation in lung cancer-Comparison of ablation modalities-Mechanisms of tissue injury in ablation-Indicators of successful ablation-Postablation zone imaging features-Follow up surveillance

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## Abstract Archives of the RSNA, 2023

CHEE-19

### Breaking Through the Sternum: Expected Post-sternotomy Imaging's Findings and Complications

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Renan Arakaki, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Median sternotomy is the incision of choice for thoracic and cardiac surgical procedures. Its incidence of complications ranges approximately between 0,5-5%, with a mortality rate reaching up to 80%. Thus, it is essential for the radiologist to recognize expected poststernotomy imaging findings and differentiate them from complications. This educational exhibit aims to illustrate the different sternal closure techniques, expected postsurgical changes and the main sternotomy complications involving hardware (wire fracture, migration, and rotation), bone (fracture, sternal dehiscence, nonunion, and osteomyelitis), and soft tissues (hematoma, gossypiboma, and abscess).

#### TABLE OF CONTENTS/OUTLINE

- Sternal closure techniques- Expected postsurgical imaging findings- Acute sternotomy complications- Late sternotomy complications.

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## Abstract Archives of the RSNA, 2023

CHEE-2

### Across the Diaphragm: Thoracic Complications of Abdominal Conditions and Percutaneous Procedures

All Day Room: Learning Center

Elisa Antolinos Macho, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Recognize that many pathologic abdominal conditions and certain complications of percutaneous abdominal procedures may extend to the thoracic cavity -Learn the most common pathologic abdominal conditions and percutaneous procedures complications that may extend above the diaphragm -Describe the anatomical and acquired pathways through which infradiaphragmatic pathologic conditions and percutaneous procedures complications may reach the thorax -Review the appearance of these thoracic complications on different imaging modalities

#### TABLE OF CONTENTS/OUTLINE

1) Anatomy and physiology of the diaphragm 2) Common abdominal pathologic conditions and percutaneous procedures complications that may extend to the thorax o Liver and biliary system conditions o Pancreatic and splenic conditions o Kidneys and adrenal glands conditions o Pelvic conditions o Complications of percutaneous abdominal procedures § External biliary drainage § Percutaneous local ablative therapies of liver lesions § Embolization of portal and hepatic veins § Vertebroplasty 3) Pleural complications o Pleural effusion o Fistulas (biliopleural fistula, pancreaticopleural fistula) 4) Pulmonary complications o Infections § TB § Other mycobacteria o Inflammation § Sarcoid reaction § Pneumonitis § Mendelson syndrome o Fistulas 5) Thoracic vascular complications o Fat embolism syndrome o Foreign body embolism

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## Abstract Archives of the RSNA, 2023

CHEE-20

### Emerging Technology in Functional Lung Imaging: Hyperpolarized Xenon Gas MRI

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Cody L. Thornburgh, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Hyperpolarized Xenon Gas (HXG) MRI is a new-to-market FDA approved imaging agent to evaluate lung ventilation, which offers advantages over other inhaled contrast agents. 2. Compared to traditional spirometry, HXG MRI is a promising surrogate with superior reproducibility and reliability. 3. Regulated by the FDA as a drug-device combination, HXG-MRI has some barriers and obstacles for adoption and implementation. 4. Various airway diseases, like asthma, COPD, and Cystic Fibrosis, have MR ventilation features that increase confidence in diagnosis and assessment of disease severity. 5. Ongoing investigation of HXG MRI is revealing new applications for medical imaging, which are not currently possible with existing modalities.

#### TABLE OF CONTENTS/OUTLINE

1. Background/Objectives  
2. Technique  
a. Drug Preparation---i. Supplies, Consumables---ii. Polarization---iii. Dose Administration  
b. MR Scanner Configuration---i. Coil---ii. Software---iii. Hardware  
c. Data Analysis---i. Quantitative methods (Ventilation defect percent, VDP)---ii. Qualitative methods  
3. Clinical Implementation  
a. Regulatory  
b. Logistical  
c. Financial  
4. Ventilation Characteristics  
a. Normal  
b. Pathology disease states---i. COPD---ii. Asthma---iii. Cystic Fibrosis---iv. COVID-19 (Acute and 'Long')  
5. Future Frontiers  
a. Dissolved-Phase Imaging (Barrier Tissues and RBC) in healthy and diseased states.  
b. Dynamic HXG-MRI ('MR Spirometry')  
c. Physiological response to pharmaceutical agents

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## Abstract Archives of the RSNA, 2023

CHEE-21

### How “Holey” Art Thou: Developing a Systematic Approach to Identifying and Reporting Cystic Lung Disease

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Maria Clara N. Lorca, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Become familiarized with the different imaging appearance of cystic lung diseases and their differential diagnosis on chest CT. Differentiate true lung cysts versus their mimics: emphysema, cavities, and cystic bronchiectasis, cavitory lung metastasis. Recognize the distribution patterns of the different cystic lung diseases and formulate major differential diagnosis for solitary and multiple pulmonary cysts based on radiological appearance using a standardized approach.

#### TABLE OF CONTENTS/OUTLINE

Recognize primary causes of cystic lung diseases, for example: Birt-Hogg-Dube (BHD) syndrome; spontaneous and tuberous sclerosis related lymphangiomyomatosis (LAM), Pulmonary Langerhans cell histiocytosis (PLCH), Lymphocytic interstitial pneumonia (LIP) Recognize acquired cystic lung diseases, for example: Light chain deposition disease, pulmonary laceration, Pneumocystis jirovecii infection, usual interstitial pneumonia, sarcoidosis, amyloidosis. Describe the role of the radiologist in the diagnosis and follow up of cystic lung diseases by CT, and when to recommend further biopsy. Our aim is to review the terminology, distribution and imaging patterns of the most common cystic lung diseases by CT and raise attention to the various mimics of cystic lung diseases, including cavitory lung metastases. The radiologist can then use this information to describe cystic lung disease utilizing a standardized reporting template to improve communication with referring providers.

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## Abstract Archives of the RSNA, 2023

CHEE-22

### **Pulmonary Blood Volume Image with Dual-energy CT: Findings in Lung Cancer Patients**

All Day Room: Learning Center

Makiko Murota, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review how to obtain the pulmonary blood volume (PBV) images with dual-energy CT. 2. To describe the PBV imaging features and pathogenesis in lung cancer patients. 3. To discuss the importance of clinical implications and the pitfall.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. technical overview of dual-energy CT 3. CTPA techniques 4. the PBV imaging features and pathogenesis in lung cancer patients: vascular abnormalities, bronchial abnormalities, parenchymal abnormalities, artifacts and pitfall, and others 5. Summary

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## Abstract Archives of the RSNA, 2023

CHEE-23

### Potential Applications of Photon-Counting Detector CT in Cardiothoracic Imaging

All Day Room: Learning Center

Mauricio F. Barbosa, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Exemplify current and future applications of photon-counting detector CT (PCD-CT) in cardiothoracic imaging, including:1. Improved image quality: PCD-CT provides higher spatial resolution and improved contrast-to-noise ratio, which enables more accurate and detailed imaging of the heart, vasculature and lungs.2. Lower radiation dose: PCD-CT can allow for lower radiation doses than traditional CT.3. Reduced artifacts: use of high keV imaging on PCD-CT can reduce metallic artifacts; combination of high-helical pitch imaging with PCD-CT can reduce motion artifacts.4. Potential for new applications: PCD-CT technology offers new possibilities for functional imaging, including perfusion and multi-energy imaging, which may help in the diagnosis and management of cardiothoracic conditions.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction: ?• Explanation of physical principles?• Potential Advantages of PCD-CT over Energy-integrating detector CT (EID-CT)?• Improved image quality?• Reduction in radiation exposure?• Spectral imaging?; II. Clinical Applications of PCD-CT in Cardiothoracic Imaging?: • Coronary Artery Disease Imaging?• Lung Nodule and Mediastinal Mass Characterization?• Evaluation of Interstitial Lung Disease?• Thoracic Vascular Imaging/ Pulmonary embolism?; III. Future Possibilities: ?• Improvements in Quantitative Imaging?• Functional Imaging?; IV. Challenges and Limitations?: • Scientific and clinical validation?• Need for additional training and education?; V. Conclusion?: • Recap of current clinical applications?• Future directions for PCD-CT?• Final thoughts.

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## Abstract Archives of the RSNA, 2023

CHEE-24

### Disorders with Hand and Thoracic Involvement

All Day Room: Learning Center

Riddhi Borse, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Numerous medical conditions have multiorgan imaging findings. Here, we review specifically the hand and cardiothoracic findings of selected infectious, inflammatory, connective tissue, neoplastic, and hereditary disorders. These correlations are meant to remind the astute clinician that certain hand findings should trigger a careful radiologic evaluation that includes imaging of the chest.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction.2. Examples of cases:A. Connective tissue disorders- Rheumatoid arthritis, Systemic Lupus Erythematosus, Raynaud's syndrome, Dermatomyositis. B. Hereditary Conditions: Marfan's Syndrome, Ehlers Danlos Syndrome, Sickle-cell disease.C. Metabolic conditions: Hyperparathyroidism, Renal Failure with osteodystrophy and metastatic calcification in the lungs.D. Infectious Diseases: Tuberculosis, Septic Embolism.E. Neoplastic Conditions: Lung Cancer, Melanoma.3. Conclusion.

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## Abstract Archives of the RSNA, 2023

CHEE-25

### Tracheobronchomalacia x Excessive Dynamic Airway Collapse: CT and Bronchoscopy Correlation

All Day Room: Learning Center

Helena A. Pereira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To discuss the differences between tracheobronchomalacia (TBM) and Excessive Dynamic Airway Collapse (EDAC), emphasizing their pathophysiology, anatomical aspects, clinical presentation and associated comorbidities. - To point out the challenges and controversies in its diagnosis. - To discuss the role of Flexible Dynamic Bronchoscopy and Computed Tomography in the assessment of central expiratory airway collapse (ECAC), highlighting the exam protocols and the main aspects to be evaluated. - To illustrate the imaging appearance of EDAC and TBM on bronchoscopy and CT.

#### TABLE OF CONTENTS/OUTLINE

1 - Introduction 2 - Pathophysiology, anatomical aspects and clinical presentation of TBM and EDAC. 3 - Flexible Dynamic Bronchoscopy and Computed Tomography: techniques, protocols and main findings. 4- Cases 5- Conclusion

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## Abstract Archives of the RSNA, 2023

CHEE-26

### **“What’s That in the Bone?”- Non-Traumatic Musculoskeletal Pathology on Chest/ Breast Imaging**

All Day Room: Learning Center

Tina Roa, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the basic musculoskeletal anatomy seen in the chest including bones, joints, muscles, tendon insertions and major nerves (including the brachial plexus origin and long thoracic nerve). 2. Recognize MSK anatomic variants and common degenerative changes. 3. Recognize MSK manifestations of infectious, autoimmune, and other systemic pathologies on chest imaging (such as septic arthritis, sickle cell disease, rheumatoid arthritis, etc.) 4. Learn how to approach bone lesions within the chest. 5. Learn how to approach soft tissue lesions within the chest. 6. Review Bone-RADS criteria.

#### **TABLE OF CONTENTS/OUTLINE**

1. Normal Anatomy: a. Osseous Structures of the Chest, b. Musculature of the Chest, c. Joints and Tendons, d. Major Nerves; 2. Orthopedic Findings: a. MSK Anatomic Variants in the Chest, b. Degenerative MSK Changes in the Chest; 3. MSK Infections/ Autoimmune/ Other Systemic Anomalies in the Chest: a. Septic Arthritis, b. Autoimmune MSK Manifestations in the Chest, c. Other Systemic Disorders; 4. MSK Tumors of the Chest: a. Benign Tumors (Osseous and Soft Tissue), b. Malignant Tumors (Osseous and Soft Tissue); 5. Algorithm to approach incidental bone lesion/ Review of Bone-RADS.

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## Abstract Archives of the RSNA, 2023

CHEE-27

### Spotting the Airway Snags: Computer Tomography Imaging Planning For Bronchoscopy Stent and Valve Placement

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Miriana E. Mariussi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: • Review the indications for bronchoscopy stent and valve placement. • Highlight the role of Computer Tomography in the treatment of airway stenosis, air leaks and chronic obstructive pulmonary disease (COPD). • Comprehend the application of CT planning prior to the bronchoscopy. • Correlate the radiological features with bronchoscopy findings. • Identify CT image findings during follow-up after the procedure.

#### TABLE OF CONTENTS/OUTLINE

Bronchoscopy stent and valve placement have been established as a safe and effective treatment alternative for airway stenosis, air leaks and COPD. A case based pictorial essay allows for a comprehensive assessment and understanding of: • Clinical indications for bronchoscopy stent and valve placement. • Radiological features of airway stenosis, air leaks and COPD. • Pre-procedural CT planning for bronchoscopy airway stent placement. • Pre-procedural CT planning for the endobronchial unidirectional valve placement. • Imaging findings correlated with bronchoscopy. • Expected radiological findings during the follow up.

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## Abstract Archives of the RSNA, 2023

CHEE-28

### **Trouble in the Air: Imaging Review of Early Complications Following Lung Transplantation and Our Institutional Experience**

All Day Room: Learning Center

Bob Zhang, MBBS, BMedSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Early complications following lung transplantation are a major cause of morbidity and mortality. Imaging plays a key role in their diagnosis, and it is important for radiologists to be able to recognise these complications, as well as understand the underlying cause. This exhibit aims to 1) discuss the spectrum of complications that occur within the first week following transplantation, 2) discuss preoperative factors that may predispose to complications, 3) review surgical techniques that reduce the risk of certain complications and how to recognise these on imaging, 4) discuss our institutional experience as a major transplant centre, and 5) review the imaging findings of early complications using a case based format.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of lung transplantation. 2. Overview of complications that occur in the first week following transplantation. 3. Preoperative factors that increase risk of complications following transplantation. 4. Surgical techniques to reduce the risk of postoperative complications and how to recognise these on imaging. 5. Review of our institutional experience as a major lung transplantation centre. 6. Case based review of imaging findings in early post-transplant complications.

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## Abstract Archives of the RSNA, 2023

CHEE-29

### **Bronchiectasis: Another Way to Approach Lung Disease**

All Day Room: Learning Center

Maria Jose Ropain, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Bronchiectasis features in a wide range of pathological processes including infectious causes, bronchial aspiration, pneumoconiosis, congenital immunodeficiencies, and cartilage development disorders, among others. The spatial distribution; is considered a key point when it comes to establishing differential diagnoses in an easier and quicker way. The upper lung zones are usually compromised by cystic fibrosis, sarcoidosis, and allergic bronchopulmonary aspergillosis noticing a more central involvement while tuberculosis has an asymmetric distribution. The middle lobe and lingula frequently show bronchiectasis secondary to infection by atypical mycobacteria or adult respiratory distress syndrome. Associated findings allow radiologists and trainees to address the diagnoses. When tree-in-bud, centrilobular ground-glass nodules and bronchial wall thickening are seen in patients with lower lung zones bilateral bronchiectasis; bronchial aspiration should be suspected. Meanwhile, the presence of architectural distortion, honeycombing, and varicoid morphology bronchiectasis are commonly found in pulmonary fibrosis.

#### **TABLE OF CONTENTS/OUTLINE**

Location and distribution, Upper lung: Cystic fibrosis, Sarcoidosis, Allergic bronchopulmonary aspergillosis, Tuberculosis Middle/lingular: Atypical mycobacterial infection, Acute respiratory distress syndrome, Primary ciliary dyskinesia, Immunodeficiency Lower lung zone: Chronic aspiration, Pulmonary fibrosis,  $\alpha$ 1-Antitrypsin deficiency. Central: Tracheobronchomegaly, Williams Campbell syndrome Focal and diffuse: Endobronchial or peribronchial tumor, Swyer James syndrome, Bronchiolitis obliterans.

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## Abstract Archives of the RSNA, 2023

CHEE-3

### Inside the Circuit: Radiology Insights into ECMO Placement

All Day Room: Learning Center

Valentina Ferrer Valencia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. ECMO, or extracorporeal membrane oxygenation, is a life-support system that provides temporary respiratory or circulatory support to critically ill patients whose heart or lungs are failing. 2. Radiology plays an important role in ECMO, particularly in assessing the placement of the cannulas and monitoring for complications such as bleeding or clotting. 3. Sentinel events, such as malposition of the cannulation require rapid intervention and evaluation by the ECMO team and radiology. 4. There are different types of ECMO cannulation, including veno-arterial, veno-venous, veno-veno-arterial, and central cannulation. 5. Venous-arterial cannulation is used when the patient has both respiratory and circulatory failure, and it requires correct positioning to ensure optimal blood flow and oxygenation. Incorrect positioning can lead to complications such as limb ischemia or vessel injury. 6. Veno-venous ECMO is used when the patient has isolated respiratory failure, and it also requires correct positioning to avoid complications such as bleeding or pneumothorax.

#### TABLE OF CONTENTS/OUTLINE

Introduction 1. Indications for ECMO 2. Role of Radiology in ECMO 3. Sentinel Event Types of ECMO Cannulation 1. Veno-Arterial 2. Veno-Venous 3. Veno-Veno-Arterial 4. Central Cannulation Venous-Arterial Cannula 1. Indications 2. Correct Positioning 3. Incorrect Positioning 4. Complications of Incorrect Positioning VA ECMO: Femora Cannula 1. High Arterial Cannula 2. Low Arterial Cannula 3. Low Venous Cannula 4. High Venous Cannula Veno-Venous ECMO 1. Indications 2. Correct Positioning 3. Incorrect Positioning 4. Complications of Incorrect Positioning 5. Single lumen VV ECMO Conclusions

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## Abstract Archives of the RSNA, 2023

CHEE-30

### **Chill Out! Percutaneous CT- Guided Intrathoracic Cryoablation: Applications, Imaging Appearance, and Complications**

All Day Room: Learning Center

Saumik Z. Rahman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Percutaneous cryotherapy uses liquified gases like nitrogen or argon through cryoprobes under CT guidance to create temperatures as low as - 40° C. Cytotoxic cell destruction occurs at this temperature which helps to destroy neoplastic cells. Cryotherapy allows real-time evaluation of the ablation site. It is a preferred ablation technique for central tumors close to airways, great vessels, pericardium.

#### **TABLE OF CONTENTS/OUTLINE**

Indications for cryotherapy: Primary lung cancer (early or advanced), metastatic lesions, mediastinal lesions, post-SBRT recurrent tumors, post-surgical recurrent tumors. Post treatment appearance - Immediately after the procedure, follow-up after 1 month, 3 months, 6 months and 12 months. Complications of cryotherapy Pneumothorax, hemoptysis, pleural effusion, parenchymal hemorrhage, pneumonia, esophageal injuries, tumor implantation, tumor recurrence, nerve injury, skin injury.

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## Abstract Archives of the RSNA, 2023

CHEE-31

### **Pleuroparenchymal Fibroelastosis: Update on Imaging with Pathological Correlation**

All Day Room: Learning Center

Joel Gamble, MD,BSC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Pleuroparenchymal Fibroelastosis (PPFE) is a rare subtype of interstitial pneumonia that historically has been difficult to diagnose, particularly in its early stages, and often misdiagnosed by radiologists. 2. PPFE can be associated with other fibrotic interstitial lung diseases or triggered by previous infections, chemotherapy, hematopoietic stem cell transplant, and lung transplant. 3. Improving awareness of PPFE allows early recognition on CT and allows for close attention on clinical and imaging follow up, including implementation of supportive measures and potential treatment.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to Pleuroparenchymal Fibroelastosis (PPFE): Definition and background; Historical context and understanding; Inclusion in American Thoracic Society/European Respiratory Society guidelines. 2. Diagnosis and Recognition of PPFE: Challenges in early-stage diagnosis; Importance of CT in the diagnosis; Pathological confirmation. 3. Causes and Associations of PPFE: Previously believed to be idiopathic; Association with other fibrotic interstitial lung diseases; triggers, including infections, chemotherapy, hematopoietic stem cell transplant, lung transplant. 4. Clinical Presentation and Prognosis: Slowly progressive or rapid clinical deterioration; Poor prognosis in most cases; Potential treatment.

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## Abstract Archives of the RSNA, 2023

CHEE-32

### One-stop-Shop Pictorial Review of All Changes in Lung-RADS v2022

All Day Room: Learning Center

Seyedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Familiarize radiologists with the latest version of the Lung-RADS criteria (Lung-RADS v2022) for lung cancer screening (LCS).2- Review the most recently added nomenclature and morphologic features that radiologists should consider determining the appropriate Lung-RADS categories.3- Review important updates on assigning Lung-RADS categories on follow up studies (stepped management).

#### TABLE OF CONTENTS/OUTLINE

1- Introduction to the Lung-RADS tool and its various versions.2- Comparison of important changes between the 2022 and 2019 versions of Lung-RADS in different domains, including A) Atypical pulmonary cysts B) Juxtapleural nodules C) Inflammatory or infectious findings D) Airway nodules.3- Review of updated Lung-RADS terms and structural definitions, including the removal of the risk of malignancy table, changes in follow-up intervals, as well as reset of starting points for follow-up and different definitions for growth.4- Brief review of the effect of changes in Lung-RADS classification criteria on clinical management.

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## Abstract Archives of the RSNA, 2023

CHEE-33

### **The Many Faces of Evil: A Pictorial Review and Algorithmic Approach to Autoimmune Diseases of the Thorax**

All Day Room: Learning Center

Seyed Arash Mahdavi Anari, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Different autoimmune diseases can involve different parts of the thorax, including but not limited to lung parenchyma, heart, esophagus, pleural and pericardial space, great vasculature, thymus gland, and thoracic chest wall.
- Patterns of lung disease could precede the development of the clinical diagnosis of autoimmune disease.
- As autoimmune disorders overlap clinically, the possibility of mixed thoracic radiological manifestations should be considered.
- Thoracic involvement in autoimmune disorders could happen due to the disease process itself, drug toxicity, or opportunistic infections from resultant immunodeficiency, which their differentiation needs meticulous clinical-radiological evaluation.
- Provide an algorithmic approach for diagnosis of autoimmune diseases with focus on intrathoracic findings.
- The European Respiratory Society/American Thoracic Society task force proposes using "Interstitial pneumonia with autoimmune features (IPAF)" for patients with idiopathic interstitial pneumonia and features suggestive of, but not definitive for a collagen vascular disease.

#### **TABLE OF CONTENTS/OUTLINE**

- Review of the thoracic findings in autoimmune disorders of the thorax based on the involved organs.
- Evaluation of lung parenchyma findings based on the pattern and prevalence.
- Assessment of autoimmune diseases of the thorax, beyond the lung parenchyma involvement.
- Review the post-treatment changes and treatment complications in the autoimmune disorders of the thorax.
- Evaluation of the natural progression of thoracic autoimmune disorders.
- An algorithmic approach for diagnosis of autoimmune diseases.

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## Abstract Archives of the RSNA, 2023

CHEE-34

### Classical Signs on Chest Radiograph: A Primer for Residents

All Day Room: Learning Center

Furkan Ufuk, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? Recognize the classic signs on chest radiographs. ? Describe each sign's anatomic and pathologic features and discuss their clinical importance.

#### TABLE OF CONTENTS/OUTLINE

This educational exhibit provides an overview of classic signs on chest radiographs and their clinical significance. The exhibition includes a table of contents and teaching points, such as recognizing the appearance of chest radiograph signs on Chest CT and describing the anatomic and pathologic features represented by each sign. Several imaging signs on chest radiographs are described, including Air bronchogram, Bat's wing or butterfly shadow, black pleura sign, and others, with the pathophysiologic origin of each sign and the characteristic imaging features described in detail. Radiologists must recognize these signs and understand their causes to provide accurate diagnoses of abnormalities affecting the lungs, heart, mediastinum, diaphragm, and pleura. The exhibit aims to enhance radiologists' knowledge of classic signs on chest radiographs, ultimately leading to improved diagnostic accuracy and better patient care.

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## Abstract Archives of the RSNA, 2023

CHEE-35

### A Challenge in Diagnosing Benign Thymic Lesions as Benign

All Day Room: Learning Center

Tetsuro Araki, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To understand the normal/hyperplastic spectrum of the thymus and related clinical conditions 2. To understand the typical and atypical appearance of benign thymic lesions 3. To understand mimickers of thymic lesions

#### TABLE OF CONTENTS/OUTLINE

1. Importance of benign diagnosis of thymus a. Avoid unnecessary thymectomy or follow-up study b. Image modality selection and appropriate recommendation 2. Normal/hyperplastic spectrum of the thymus a. Various morphology of the thymus b. Demographic and clinical features related to thymic involution/hyperplasia c. Thymic hyperplasia related to COVID-19 infection or vaccination d. 2D and 3D analysis: Shape and measurement in size and volume 3. Typical appearance of common benign thymic lesions a. Thymic hyperplasia: True vs lymphoid hyperplasia b. Thymic cyst: Unilocular vs multilocular c. Thymolipoma d. Differentiation from thymic neoplasm (Thymic epithelial tumor, lymphoma) 4. Atypical appearance of benign thymic lesions a. Nodular component within the thymus b. Atypical morphologies of thymic hyperplasia (TH) • Non-suppressive TH out-of-phase T1WI MRI • Multinodular/multicystic TH (Sjogren's syndrome, HIV infection) c. Atypical features of thymic cyst • Complicated hyperattenuating cyst • Thymic/pericardial cyst within TH 5. Mimicker of thymic lesions a. Morgagni hernia b. Focal fat necrosis c. Ectopic thyroid lesion d. Tortious internal mammary vein e. Lymph nodes 6. Summary

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## Abstract Archives of the RSNA, 2023

CHEE-36

### A Comprehensive Pictorial Review: Vascular Anomaly and Malformation of Thorax

All Day Room: Learning Center

Ryosuke Taiji, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is To depict anomalies and malformations of thorax To discuss the clinical feature, significance, and management for those entities.

#### TABLE OF CONTENTS/OUTLINE

The mediastinum contains two distinct circulatory systems, namely the systemic and pulmonary circulations. Anomalies and malformations have been reported within the thorax. In the pediatric population, some malformations are identified promptly after birth and necessitate surgical intervention. Radiologist should be familiar with these entities. Contents

1. Pulmonary artery  
Absence of the right pulmonary artery, proximal interruption of the pulmonary artery, pulmonary arterial aneurysm, pulmonary sling, and Taussig-Bing syndrome,
2. Aorta  
Aberrant right subclavian artery, right aortic arch and Kommerell diverticulum, arterial duct (Botallo's duct), and anomalous systemic arterial supply to the basal lung
3. Pulmonary vein  
Partial anomalous pulmonary venous return (PAPVR); right upper and lower pulmonary vein, Scimitar syndrome, total anomalous pulmonary venous return (TAPVR); supra-cardiac, cardiac, infracardiac type, anomalous unilateral single pulmonary vein (AUSPV), and pulmonary venous aneurysm
4. Vena cava  
Persistent left superior vena cava, azygos continuation of inferior vena cava
5. Summary

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## Abstract Archives of the RSNA, 2023

CHEE-37

### **Granulomatosis with Polyangiitis (GPA): Thoracic Manifestations with Emphasis on Differential Diagnosis**

All Day Room: Learning Center

Roddie Moraes Neto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the pathophysiology and histologic features of granulomatosis with polyangiitis (GPA); review the main clinical manifestations of GPA; recognize the most common and uncommon chest imaging findings of GPA; highlight the main differential diagnosis of thoracic manifestations of GPA in a pattern-based approach, with clinical-radiological correlation.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: definition, pathophysiology, clinical features, diagnostic criteria; case based review - pattern-based thoracic manifestations of GPA with differential diagnoses: lung nodules and masses, airspace consolidation and ground glass opacities, airway thickening, pleural involvement, rare mediastinal manifestations (lymphadenopathy, cardiac involvement, great arteries vasculitis); conclusions and key takeaways

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## Abstract Archives of the RSNA, 2023

CHEE-38

### Clearing the Fog - What You Must Know About Smoking-related Diffuse Lung Diseases

All Day Room: Learning Center

Gabriel N. Neumann Kuhn, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the smoking-related diffuse lung diseases (SDLD) and its pathophysiological mechanism; Discuss the relationship between smoking and interstitial lung abnormalities (ILA) and the relevance of the imaging approach; Case-based demonstration of the main imaging findings associated in each one of the SDLD; Review the findings and implications of the combined emphysema-fibrosis syndrome.

#### TABLE OF CONTENTS/OUTLINE

General facts about tobacco use; Case based examples of the main SDLD (respiratory bronchiolitis / desquamative interstitial pneumonia, smoking related interstitial fibrosis / airway enlargement with fibrosis, Langerhans cell histiocytosis); Brief up-to-date approach of combined emphysema-fibrosis syndrome; Take home messages.

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## Abstract Archives of the RSNA, 2023

CHEE-39

### Three Steps for the Success of a Lung Segmentectomy Surgery: The Role of the Radiologist

All Day Room: Learning Center

Maria Celia Franco Issa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? Review the concepts, indications and techniques of lung anatomical segmentectomy ? Describe the most relevant imaging features of the pulmonary nodule to the surgery planning ? Discuss the role of preoperative Chest Computed Tomography (CT) in the recognition of the drainage pattern of the intersegmental vein and determination of the intersegmental plane ? Recognize the anatomical features and variations of the pulmonary venous drainage with potential impact in lung segmentectomy ? Discuss the role of 3DCT in the lung segmentectomy planning

#### TABLE OF CONTENTS/OUTLINE

- Introduction
- The rationale of Lung Segmentectomy
  - o Indications
  - o Advantages and disadvantages
  - o Minimally Invasive Techniques - Video-assisted thoracic surgery (VATS) - Robotic-assisted thoracic surgery (RATS) - Potential complications
- The role of the Radiologist in three steps
  - 1. Describe the most relevant features for anatomical segmentectomy recommendation:
    - Nodule size and location
    - Resection margin
    - Previous lung resection
    - Absence of visible regional lymph node disease
  - 2. Identify the intersegmental vein - Delineate the intersegmental plane - Verify if the intersegmental vein is a drainage vein from the tumor
  - 3. Look for variations of the pulmonary venous drainage that might impact in the lung segmentectomy
- Case-based review
- Atypical venous outflow to the left atrium
- Atypical topography of the pulmonary vein
- Atypical venous vascularization of pulmonary segments
- Future Directions the role of CT with 3D reconstructions and 3D printing in lung segmentectomy planning

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## Abstract Archives of the RSNA, 2023

CHEE-4

### Primer for Radiology Residents: Cardiothoracic Emergencies in Oncology

All Day Room: Learning Center

Jitesh Ahuja, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Familiarize radiologists with spectrum of acute cardiothoracic complications that can occur in oncology patients.

#### TABLE OF CONTENTS/OUTLINE

Cancer is the second most common cause of mortality in United States. Several acute cardiothoracic complications can occur in oncology patients that can be life-threatening. These complications can occur due to tumor itself, including the extent of local invasion and metastasis. In oncology patients undergoing treatment, emergencies can be the result of complications of chemo/immunotherapy, surgery and radiation therapy. Finally, patients with cancer are at increased risk of emergencies due to systemic disease from hypercoagulable state and immunosuppression.

1. Complications due to cancer itself
  - a. Airway obstruction
  - b. SVC syndrome
  - c. Esophagorespiratory fistula
  - d. Esophagoaortic fistula
  - e. Large pleural effusion, hemothorax or pneumothorax
  - f. Cardiac tamponade
  - g. Lymphangitic carcinomatosis
  - h. Spinal cord compression
2. Complications due to cancer treatment
  - a. Pneumothorax, hemothorax
  - b. Mediastinal hematoma, mediastinitis
  - c. Lobar torsion
  - d. Cardiac herniation
  - e. Esophageal leak
  - f. Drug or radiation pneumonitis
  - g. Immunotherapy associated myocarditis
3. Systemic complication
  - a. Pulmonary embolism
  - b. Opportunistic infections
  - c. Stress cardiomyopathy (Takotsubo)

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## Abstract Archives of the RSNA, 2023

CHEE-40

### Utilization of Virtual Bronchoscopy and 3D-Multiplanar Volume Reconstruction (MPVR) Correlation to Illustrate Tracheobronchial Tree Abnormalities - An Imaging Review

All Day Room: Learning Center

Shashank S. Pandya, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Tracheobronchial tree abnormalities can be subtle on imaging and are not always accessible via fiberoptic bronchoscopy (FB). As healthcare shifts towards value-based care, technological innovations such as virtual bronchoscopy (VB) may not only reduce overspending but also improve clinical and patient satisfaction outcomes by providing radiologists with a visually intuitive medium to show rather than only tell complex 3D radiographic findings to non-radiologist audiences. VB is rendered by processing multi-detector row CT (MDCT) volumetric data via specialized software that assumes an artificial perspective from a lumen and then assigns opacity values and full spectrum color values based off attenuation values of different tissues and abrupt changes in attenuation between adjacent voxels. VB is underutilized, and it is better than conventional FB in specific cases where higher order subsegmental bronchial branches or regions distal to an obstruction/stenosis or are inaccessible via FB. VB enables a quick, highly accurate, and, most importantly, non-invasive visual medium to evaluate the tracheobronchial tree. It can play an invaluable role in personalized pre-procedural planning and simulations as well as in educating trainees in thoracic anatomy.

#### TABLE OF CONTENTS/OUTLINE

1. Briefly describe how 3D-MPVR post-processing is used in creating VB. 2. Using our institutional database, present CT imaging cases with their respective 3D-MPVR and VB images, including, but not limited to, the following tracheobronchial tree abnormalities: tracheal anomalies, tracheal stenosis, tracheal enlargement, excessive central airway collapse, endobronchial lesions, and trauma.

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## Abstract Archives of the RSNA, 2023

CHEE-41

### A Pictorial Review: Lymphoma and Lymphoproliferative Disease of Thorax

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ryota Nakano (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To depict lymphoma and lymphoproliferative disease of thorax To discuss the clinical and radiological findings and management

#### TABLE OF CONTENTS/OUTLINE

Lymphoma and lymphoproliferative diseases of the thorax occur primarily in the lungs, bronchus, mediastinum, and chest wall. Radiologists need to know more about each disease, as some require differentiation from lung cancer or other malignant mediastinal tumors. Contents. 1. Pulmonary lymphoproliferative disease (LPD): follicular bronchiolitis, lymphocytic interstitial pneumonia, and nodular lymphoid hyperplasia. 2. Primary pulmonary lymphoma: MALT lymphoma, diffuse large B-cell lymphoma, and Intravascular large B-cell lymphoma. 3. Primary mediastinal lymphoma: diffuse large B-cell lymphoma, classical Hodgkin lymphoma, and T-cell lymphoblastic lymphoma. 4. Primary pleural lymphoma: pyothorax associated lymphoma, and follicular lymphoma. 5. Miscellaneous: IgG4-related disease, Uni-/Multicentric Castleman disease, and methotrexate-associated LPD.

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## Abstract Archives of the RSNA, 2023

CHEE-42

### The Invisible Culprit: Demystifying Autoimmune Disorders of the Lungs

All Day Room: Learning Center

Abhaya Kharat (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Autoimmune disorders affecting the lungs are a group of medical conditions characterized by the presence of autoantibodies that can cause damage to organs throughout the body. They include connective tissue diseases. CTD-ILD is defined as evidence of ILD demonstrated by CT (i.e., some combination of reticulation, ground-glass opacities, traction bronchiectasis, honeycombing, and/or cysts) in the setting of an established CTD. It includes RA, systemic sclerosis, SLE, primary Sjogren's syndrome, idiopathic inflammatory myositis, and mixed connective tissue disease. Diagnosis typically involves imaging studies such as high-resolution CT scans, lung biopsies and immunological investigations. Treatment options include corticosteroids, immunosuppressants, oxygen therapy and pulmonary rehabilitation. In severe cases, lung transplantation is considered as a last resort.

#### TABLE OF CONTENTS/OUTLINE

1. Antisynthetase syndrome- inflammatory myositis, polyarthritis associated with ILD and anti-synthetase autoantibodies. 2. Microscopic polyangiitis- diffuse pulmonary alveolar hemorrhage is common feature. 3. RA-ILD is commonly associated with UIP. 4. SSc-ILD is commonly associated with NSIP. Risk factors- anti-topoisomerase Ab and higher skin score. 5. Sjogren's syndrome typically presents with NSIP, other patterns like UIP, LIP, focal lymphoid hyperplasia of the lung, small airways disease, and pulmonary vasculitis. 6. IIM-ILD is restricted to subsets of DM and PM. Usually manifests as NSIP with OP. Risk factors - anti-Jo1, anti-PL-7, anti-PL-12, and Black race. 7. Sarcoidosis -commonly affects the lungs and mediastinum with variable radiographic features depending on the stage of the disease.

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## Abstract Archives of the RSNA, 2023

CHEE-43

### Pinpoint It - A Pictorial Essay on Causes of Acute Chest Pain on CT

All Day Room: Learning Center

Murilo d. Peixoto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Acute localized chest pain is an important and frequent complaint in patients who seek the emergency medical care and can originate from many different compartments / tissues, namely the mediastinum (including cardiovascular structures), the lungs, the pleura, the chest wall, the spine or even the upper abdomen. Placing a skin marker at the topography of pain referred by the patient is an important step in facilitating the identification of a potential cause.

#### TABLE OF CONTENTS/OUTLINE

Numerous diseases may present as acute localized chest pain and chest computed tomography (CT) can be an important tool to detect the cause, including pulmonary infarction caused by acute thromboembolism, lobarpneumonia, pneumothorax, bone / cartilaginous fractures, acute cardiovascular pathologies, acute pericarditis, mediastinal fat necrosis, some upper abdominal pathologies, among other diseases. The placement of a skin marker in the vicinity of the potential finding, in the location pointed by the patient as painful, plays an important role in allowing for a more accurate search pattern by the radiologist. This exhibit aims to provide a pictorial essay on several findings that are consistent with the clinical presentation of acute localized chest pain as they appear on chest CT, with a special focus on cases in which the placement of a skin marker was particularly helpful.

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## Abstract Archives of the RSNA, 2023

CHEE-44

### Showcasing Signs & Silhouettes: Assessment of Congenital Pediatric Cardiac Pathology on a Chest Radiograph

All Day Room: Learning Center

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Even with the availability of modalities such as echo, CT, and MRI; a plain chest radiograph remains as the first and most basic modality to investigate suspected congenital cardiac conditions in the pediatric population. A chest radiograph is convenient as it is an easily accessible, low-cost, and non-invasive diagnostic tool with minimal radiation dose, giving us an opportunity to move one step closer to a "green radiology." While evaluating the chest radiograph, it is vital to recognize that classic cardiac signs and silhouettes. Additional emphasis should be given to the pulmonary blood flow, ribs, and spine. Since a chest radiograph is the starting point for majority of patients with suspected congenital heart conditions - it is very imperative for the radiologists to quickly recognize these classic findings to provide an accurate diagnosis for proper patient management.

#### TABLE OF CONTENTS/OUTLINE

Introduction to normal pediatric cardiac silhouette  
Cyanotic Cardiac Heart disease:- Tetralogy of Fallot- Total Anomalous Pulmonary Venous Return (TAPVR)- Truncus Arteriosus- Transposition of Great Arteries- Tricuspid Atresia- Hypoplastic Left Heart Syndrome (HLHS)- Ebstein's Anomaly  
Acyanotic Cardiac Heart disease:- Atrial Septal Defect (ASD)- Ventricular Septal Defect (VSD)- Patent Ductus Arteriosus (PDA)- Coarctation of the Aorta- Aortic Stenosis- Pulmonic Stenosis  
Technical factors  
Limitations of Chest x-ray. Tricks and tips to radiologist for interpreting CXR.

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## Abstract Archives of the RSNA, 2023

CHEE-45

### Caution! Lung "Fields" Ahead: Thoracic Imaging in the Agricultural Setting

All Day Room: Learning Center

Carolina M. McShane, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The agricultural sector employs 884 million workers, over a quarter of the global labor force, yet it remains one of the three most hazardous industries in the world. High morbidity and fatality rates are largely attributable to respiratory illnesses arising from unique exposures inherent in agricultural processes. Since the last comprehensive overview of radiological manifestations of agricultural-related diseases was published in 1991 by Gurney et. al, imaging technologies have modernized, allowing for more exquisite characterization of these lung disorders. Modern agricultural practices have brought about new illnesses and mechanisms of trauma, with unique radiological manifestations that have not been sufficiently characterized in the literature. In this exhibit, we provide an updated overview of the radiological manifestations of agriculture-related lung diseases and chest traumas to help with timely diagnosis and treatment for this vulnerable population.

#### TABLE OF CONTENTS/OUTLINE

Outline: I. Agricultural workers as a vulnerable population II. Radiological manifestations from exposures to microorganisms in agriculture a. *Coxiella burnetii* (Q Fever) b. *Nocardia nova* c. Blastomycosis d. Acute histoplasmosis e. Pulmonary echinococcosis (hydatid disease) III. Radiological findings from exposures to organic compounds a. Organic dust toxic syndrome b. Nonfibrotic hypersensitivity pneumonitis c. Fibrotic hypersensitivity pneumonitis d. Silo filler's disease IV. Agricultural related trauma a. Blunt chest trauma b. Foreign body aspiration c. Deep vascular injury V. The final harvest: take home learning points

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## Abstract Archives of the RSNA, 2023

CHEE-46

### Cardiovascular Imaging in Thoracic Neoplasms

All Day Room: Learning Center

#### Awards

##### Cum Laude

Jordi Broncano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recent advances in chest MRI have expanded its use in the evaluation of chest tumors, not only for tissue characterization but also for precise depiction of invasion of adjacent structures, tumor staging and treatment monitoring. Moreover, depiction of cardiac involvement, either directly or indirectly, has been associated to worse prognosis in oncologic patients. Teaching points: 1. To detail the basic and advanced CMR techniques that may be incorporated to conventional chest MR protocols, as well as its indications and potential pitfalls. 2. To review the direct and indirect mechanisms of cardiovascular involvement in patients with thoracic malignancies. 3. To identify how combined hybrid cardiothoracic imaging may be useful for treatment surveillance and monitoring.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. CMR in cardio-oncology: The imaging protocol 2.1. Basic chest MR protocol (starting point) 2.2. Cardiac sequences for thoracic neoplasms evaluation - T1 black blood imaging (fat invasion) - DWI with EKG triggering - First pass perfusion - Cine SSFP - Parametric mapping (tumoral/tissue characterization) - MR angiography - 4D flow CMR (great vessels and cavitory hemodynamics) - PET/MR imaging 3. Cardiac involvement in Cardio-Oncology: Direct Mechanisms - Hematogeneous metastasis - Lymphoid metastasis - Direct involvement - Intravascular growth 4. Improving tumor staging with cardiac sequences - Cardiac/vascular/mediastinal invasion - Pleural invasion - Chest wall invasion 5. Indirect involvement of the heart in oncologic patients - Thoracic irradiation - Chemotherapeutic agents - Plasma cell dyscrasia (amyloid) 6. Use of CMR in treatment monitoring: Prognostic biomarkers 7. Take home points

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## Abstract Archives of the RSNA, 2023

CHEE-47

### Chest Computed Tomography Angiotomography with 3D Reconstructions for Preoperative Planning

All Day Room: Learning Center

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to:- Review the evolution of surgical technique for pulmonary resections - Highlight the benefits of Computed Angiotomography with 3D reconstructions in surgical planning - Understand the application of CTA planning prior to segmentectomy to evaluate bronchovascular relations, anatomical variations and lung volumetry- Correlate the radiological findings with intraoperative findings - Identify the role of 3D images in facilitating communication between radiologists and surgeons

#### TABLE OF CONTENTS/OUTLINE

Surgical planning using imaging methods has become increasingly relevant with the advancement of robotic thoracic surgery and sublobar resections for the treatment of lung neoplasms, which has driven the growth of 3D reconstructions. A pictorial essay based on cases from our collection allows for a comprehensive assessment and understanding of:- Historical evolution of pulmonary lobectomy and current main indications for sublobar resections.- Benefits of 3D surgical planning. - How we do our 3D reconstructions with explaining videos.- Application of 3D reconstructions in robotic surgery consoles.- Radiological findings of 3D reconstructions with surgically relevant anatomical variations and bronchovascular relationships- 3D reconstruction findings with nodule volumetric and density analysis, lung segments volumetry and intersegmental resection planes

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-48

### The Role of Imaging in Bronchoscopic Lung Volume Reduction Using Endobronchial Valves

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Yogesh S. Gupta, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Provide a background on the various lung volume reduction techniques and their efficacy in the treatment of COPD with a focus on bronchoscopic lung volume reduction (BLVR) using endobronchial valves (EBV) 2. Discuss important imaging parameters in preprocedural assessment with attention to target lobe selection as well as exclusion criteria 3. Present expected postprocedural imaging findings as well as various postprocedural complications with imaging correlates

#### TABLE OF CONTENTS/OUTLINE

Of the various BLVR techniques, EBVs have the largest body of scientific data to support their safety and efficacy. Imaging plays a central role both prior to the procedure - in determining the presence of contraindications and selecting the target lobe using CT -- as well as after the procedure - in determining whether the procedure was effective and characterizing potential complications using radiography and/or CT. Outline • Overview of indications and types of lung volume reduction • Background on mechanism of action of valves, valve types, and location of valve deployment • Preprocedural role of CT in characterizing emphysema, determining exclusion criteria, and target lobe selection and role of perfusion scintigraphy in further selection • CXR and CT imaging of expected postprocedural findings (i.e. lobar collapse) and potential complications (ex: pneumothorax, infection, valve migration) • Discussion of future directions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-5

### Atypical Pulmonary Metastases: Patterns and Clinical Significance

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ioannis Vlahos, MBBS, FRCR (*Presenter*) Director, Grayscale Ltd; Co-owner, Grayscale Ltd;

#### TEACHING POINTS

Based on cases from an international cancer referral center, explain: Atypical metastases (morphology, evolution, sources) Clinical implications of atypical patterns Associated risks of mimics, misdiagnosis, delayed diagnosis

#### TABLE OF CONTENTS/OUTLINE

Atypical morphology and clinical implications: Cannonball, miliary, cavitating, pneumothorax-associated, calcified, ossified, hypervascular, hemorrhagic, airspace, endobronchial, central embolized, peripheral arterial microvascular (including pulmonary tumor thrombotic microangiopathy), endovenular, perilymphatic. Atypical growth rates: Rapid: implications for incorrect pathology (e.g. rhabdoid/sarcomatoid/small cell differentiation), re-biopsy (e.g. small cell transformation), metastatectomy recurrence rates Slow: e.g. Adenoid Cystic Carcinoma Benign metastases (leiomyoma, meningioma, giant cell tumor, HPV)

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## Abstract Archives of the RSNA, 2023

CHEE-50

### Differential Diagnosis of Multiple Subsolid Pulmonary Nodules

All Day Room: Learning Center

Murilo d. Peixoto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- There are numerous etiologies to be considered in the differential diagnoses when faced with multiple subsolid nodules at high resolution computed tomography (HRCT).- Surveillance of these nodules should follow the recommendations of the Fleischner Society.- They can represent the initial manifestation of diseases that typically present with a different imaging pattern.- When discerning upon a possible infectious etiology, the status of the patient as immunocompetent or immunosuppressed is a key to the diagnosis.- There are specific imaging signs and/or association with other conditions that may help narrow the differentials.

#### TABLE OF CONTENTS/OUTLINE

A pattern of multiple subsolid nodules is a diagnostic challenge. There are a plethora of conditions that can present with such characteristics on imaging, even more so when one considers that other imaging patterns may present as multiple subsolid nodules in the initial stages. It is important to understand the possible diagnoses that can present with such a pattern, as well as the recommendations for surveillance and the association with other conditions that may help narrow down the differentials, even to a single entity. In this exhibit, in the format of a pictorial essay, the HRCT pattern of multiple subsolid nodules is revised, as well as the multiple etiologies, manifestations and associations pertinent to the matter.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-51

### Keep an Eye on Diseased Lung: What to Look for in Native Lung After Unilateral Transplantation

All Day Room: Learning Center

Juan Facundo Arguello, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

\* One-lung transplantation is a practice aimed at improving the survival of patients with advanced stages of pulmonary disease; its most common indications include COPD, pulmonary fibrosis, and sarcoidosis (in North America). Its practice is becoming more frequent, which has led to knowing with greater certainty both the benefits and complications associated with it. However, complications that preferentially involve the native lung have received less attention.\* Radiologists should be familiar with the most frequent complications in the native lung as well as their chronology and the most frequent form of presentation in the different imaging methods (CT and X-ray).\* Make a quick review of the management and treatment of each of them.

#### TABLE OF CONTENTS/OUTLINE

Introduction, classification, and chronology  
Infections Incidence Pathophysiology RX and CT findings Treatment  
Pulmonary thromboembolism Incidence Pathophysiology RX and CT findings Treatment  
Tumor Incidence Pathophysiology RX and CT findings Treatment  
Hyperinflation Incidence Pathophysiology RX and CT findings Treatment  
Pneumothorax Incidence Pathophysiology RX and CT findings Treatment

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

CHEE-52

### Collateral Venous Pathways In Superior Vena Cava Obstruction

All Day Room: Learning Center

#### Awards

##### Cum Laude

Marta Bueno, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To describe the different venous collateral routes in superior vena cava obstruction. 2. To relate the level of obstruction with the pattern of collateral vessels. 3. To illustrate some unusual image findings that can occur in superior vena cava syndrome

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy and embryology of superior vena cava 2. Causes of superior vena cava obstruction 3. Different patterns of venous collateral pathways depending on the level of blockage 4. Major collateral pathways 4.1. Azygos-Hemiazygos system 4.2. Lateral thoracic route 4.3. Internal mammary route 4.4. Anterior cervical route 4.5. Pericardiophrenic route 4.6. Vertebral route 5. Unusual collateral pathways 5.1. Systemic to pulmonary shunt. 5.1.1. Anatomic 5.1.2. Congenital 5.1.3. Acquired 5.2. Cavoportal pathways 5.2.1. Downhill varices 5.2.2. Caval-superficial-umbilical-portal 5.2.3. Caval-mammary-phrenic-hepatic capsule-portal 6. Unusual imaging findings: 6.1. Reopening of left superior vena cava. 6.2. Pseudopathologic vertebral body enhancement

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-53

### **Big Fat Truth: A Pictorial Review of Fat Containing Cardiothoracic Lesions - Practical Guide for Radiologists (Case-based)**

All Day Room: Learning Center

Iandra Pacheco, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Demonstrate a practical guideline with cases to help radiologists with the differential diagnosis of fat containing lesions of the heart and the thorax. Illustrate with didactic cases and review the typical appearance and the main radiological characteristics of cardiothoracic lesions that contain fat.

#### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION  
IMAGING GUIDELINE  
Didactic scheme of the main sites of cardiothoracic involvement by fat containing lesions  
DEMONSTRATE DIDACTIC CASES WITH A RADIOLOGICAL REVIEW  
Thoracic duct lipoma  
Pleural lipoma  
Liposarcoma  
Lipoid pneumonia  
Pulmonary hamartoma  
Extramedullary hematopoiesis  
Lipomatous hypertrophy of the interatrial septum  
Arrhythmogenic right ventricular cardiomyopathy  
Cardiac lipoma  
Cardiac rhabdomyoma  
Mediastinal teratoma  
Mediastinal lipomatosis  
Diaphragmatic hernia  
Thymolipoma  
Epicardial fat necrosis

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-54

### Unmasking the Silent Killer: Challenges in Lung Cancer Detection due to Underlying Disease, A Case Based Presentation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Sherri E. Couillard, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Lung cancer detection can be challenging when the patient has an underlying disease. This may lead to delays in diagnosing lung cancer, which can be associated with poorer outcomes. 2. Location, shape, border, and size of abnormalities, as well as any associated features should be carefully evaluated. Continuous follow-up and comparison of serial imaging are important. 3. We present lung cancer developed in a variety of underlying diseases/conditions, emphasizing teaching points to help to differentiate lung cancer from underlying lung findings. 4. A multidisciplinary approach involving radiologists, pulmonologists, thoracic surgeons, and oncologists is necessary to ensure an accurate diagnosis and appropriate management plan.

#### TABLE OF CONTENTS/OUTLINE

1. Post-treatment. A) Postsurgical. B) Post-radiation. 2. Infection/inflammation. A) Tree in bud nodularity. B) Pneumonia/consolidation. 3. Aspiration. 4. Atelectasis. A) Post obstructive. B) Dependent. C) Rounded. 5. Systemic Disease. A) Pre-existing cystic lesions. B) Underlying scarring/fibrosis. 6. Normal anatomic variants. A) Lung cancer developing within/near normal variant.

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## Abstract Archives of the RSNA, 2023

CHEE-55

### Chest X-ray and Mediastinal Abnormalities

All Day Room: Learning Center

Antonio Nunez Soto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Plain radiography is still today the most common image technique in our hospitals. It is accessible, inexpensive, painless and non-invasive, providing much information with a great cost-effectiveness ratio. With chest X-ray we can detect and analyze mediastinal pathologies, either suspected or incidental. Recognizing normal mediastinal anatomy and anatomic variants is essential for finding out pathology.

#### TABLE OF CONTENTS/OUTLINE

The aim of this poster is to describe the radiological analysis of chest radiography for detecting and diagnosing mediastinal abnormalities. For this purpose, we will show normal mediastinal anatomy and mediastinal lines in chest radiographs, as well as normal changes that we can see in supine X-rays with antero-posterior view instead of postero-anterior. We will explain the radiological signs and features that can help us identify mediastinal abnormalities, with the support of several cases of different pathologies (pneumomediastinum, mediastinal masses, vascular pathologies, diaphragmatic hernia...) from a third-level-hospital. For every case, we will provide the clinical information, the X-ray image, in which we will highlight the radiological signs implicated, and a correlation with other imaging techniques. In all cases, the chest X-rays were essential in the initial management of these patients. This presentation will be of interest for radiologists, resident doctors, medical students and other healthcare professionals. The combination of the theoretical semiology with our collection of cases will provide an easy and approachable way to review the most important mediastinal pathology.

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## Abstract Archives of the RSNA, 2023

CHEE-56

### The Sternum: The Forgotten Bone of the Thoracic Cage

All Day Room: Learning Center

Lucas P. Farias, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is: 1) To review the normal anatomy of the sternum. 2) To review usual and unusual cases with sternal involvement. 3) To understand the sternum (anatomy and pathologies) by associating schematic drawings with MPR and three-dimensional reconstructions (including animated gif). 4) To correlate important findings with the anatomy, embryology, and pathophysiology. 5) To discuss image findings in order to enhance radiologists' skills. 6) To review CT protocols in the evaluation of patients with suspected coronary artery anomalies. 7) To highlight their characteristics in order to familiarize radiologists with these conditions, preventing unfavorable patient outcome.

#### TABLE OF CONTENTS/OUTLINE

1) Imaging protocols in the evaluation of patients with suspected sternal involvement. 2) Applied embryology and anatomy of the sternum. 3) Normal sternal development. 3.1. Anatomical variations. 3.2. Metabolic. 3.3. Vascular. 3.4. Inflammation and infection. 3.5. Trauma. 3.6. Postoperative changes 3.7 Neoplasm. 4) Sample cases of pearls, pitfalls, diagnostic difficulties, and mimics. 5) Summary and take-home messages.

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## Abstract Archives of the RSNA, 2023

CHEE-57

### **Pulmonary Edema: You Better Not Drown in the Basics**

All Day Room: Learning Center

Gabriel N. Neumann Kuhn, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: 1. To elucidate the classification of pulmonary edema according to its pathophysiological mechanisms: - Hydrostatic edema; - Permeability edema without diffuse alveolar damage; - Permeability edema with diffuse alveolar damage; - Mixed edema. 2. Review the use and peculiarities in the main imaging methods for the evaluation of pulmonary edema: - Chest X-ray; - Computed tomography (CT). 3. Highlight the current epidemiological trends and radiological findings associated with the main causes of pulmonary edema.

#### **TABLE OF CONTENTS/OUTLINE**

- Review of thoraco-pulmonary anatomy: - Cardiac silhouette; - Pulmonary interstitium; - Pulmonary vascular markings; - Costophrenic angles.
- Demonstration of the main radiological findings of pulmonary edema: - Alveolar edema; - Kerley B lines; - Opacities; - Consolidations; - Ground-glass opacities.
- Demonstration of common and uncommon conditions that cause pulmonary edema from our clinical case collection, such as: - Cardiogenic pulmonary edema (left heart failure, mitral regurgitation, etc.); - Postobstructive pulmonary edema; - Pulmonary edema in pulmonary thromboembolism; - Pulmonary edema in drug abuse; - Post-lung transplant pulmonary edema; - Re-expansion pulmonary edema; - Neurogenic pulmonary edema.

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## Abstract Archives of the RSNA, 2023

CHEE-58

### Multifocal Cystic and Cavitory Lung Disease: From Thin to Thick

All Day Room: Learning Center

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to:- Review cystic and cavitory lung disease and a general approach to focal and multifocal/diffuse forms. - Highlight the evaluation of the wall of focal aerated lung lesions and comprehend the imaging findings in thin-walled, thick-walled cysts and cavitory lung lesions. - Correlate the radiological characteristics with the main differential diagnoses and signs of malignancy. - Identify the important imaging findings addressed in cystic lesions of the new Lung-RADS v.2022

#### TABLE OF CONTENTS/OUTLINE

Cysts and cavities are commonly encountered abnormalities on chest CT. Occasionally, the underlying nature of the lesions can be readily apparent as in bullae associated with emphysema. Other times, cystic and cavitory lung lesions can be a diagnostic challenge. A pictorial essay based on cases from our collection allows a comprehensive evaluation and understanding of:- General approach to focal and diffuse cystic and cavitory lung diseases. - Propose an algorithm to facilitate the evaluation of focal cystic lesions and cavities. - Evaluation and differential diagnosis of focal thin-walled cystic lesions. - Evaluation and differential diagnosis of focal pulmonary thick-walled cysts and cavitations. - Imaging findings of focal cystic lesions correlated with Lung-RADS v.2022

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## Abstract Archives of the RSNA, 2023

CHEE-59

### Imaging of the Diaphragm: Anatomy and Disorders

All Day Room: Learning Center

Miriam Gallego Casals, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The diaphragm is the physical barrier that separates the thorax from the abdomen and is the main muscle involved in ventilation. Its dysfunction can be a cause of dyspnea, and despite its importance, it is often underrated and incompletely evaluated by clinicians as well as by radiologists. We will briefly describe the anatomy of the diaphragm, and discuss its abnormalities through cases, classified as: - Dysfunction: paralysis, weakness or eventration and consequences of diaphragmatic inversion. - Hernias: congenital (Morgagni, Bochdalek) and acquired. - Rupture: traumatic and post-surgery. - Secondary: neoplastic and infectious involvement by contiguity from the abdominal cavity. - Miscellanea: Median arcuate ligament syndrome and increased uptake on PET/CT (respiratory effort, hipo). Finally, we explain the main imaging techniques we have for both the functional and morphological study of the diaphragm, including chest radiographs, fluoroscopic tests, ultrasounds and CT.

#### TABLE OF CONTENTS/OUTLINE

- To describe the anatomy and physiology of the diaphragm. - To review the primary diaphragm disorders. - Learn the image techniques available for its study.

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## Abstract Archives of the RSNA, 2023

CHEE-6

### Imaging Findings of Autoimmune Disorders: A Primer for Residents

All Day Room: Learning Center

Furkan Ufuk, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To provide an overview of autoimmune disorders, focusing on the most common conditions encountered in clinical practice.
- To provide a primer on the imaging features of autoimmune disorders.

#### TABLE OF CONTENTS/OUTLINE

Autoimmune disorders are a diverse group of conditions in which the body's immune system attacks its own tissues, resulting in inflammation and damage. The spectrum of autoimmune disorders is broad, ranging from systemic diseases such as systemic lupus erythematosus and rheumatoid arthritis to organ-specific diseases such as autoimmune pancreatitis. Imaging plays a crucial role in the diagnosis and management of autoimmune disorders. This exhibit will provide a comprehensive overview of the imaging findings of autoimmune disorders and will highlight the importance of recognizing these findings in the diagnosis and management of these conditions. By the end of the exhibit, residents will have a better understanding of the role of radiologic imaging in the diagnosis and management of autoimmune disorders.

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## Abstract Archives of the RSNA, 2023

CHEE-60

### Unmasking Septal Thickening: An Accessible Diagnostic Guide

All Day Room: Learning Center

Fernando Rodado Aranguren, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To differentiate the various patterns of septal thickening and their association with several interstitial lung diseases. To understand the pathophysiological basis of this finding. To provide a systematic and understandable guide to address the diagnostic dilemma.

#### TABLE OF CONTENTS/OUTLINE

Septal thickening of the lung can be the common radiological expression for many processes of different etiologies and variable severity, including pulmonary edema, lymphangitic tumor, sarcoidosis, asbestosis, amyloidosis or Erdheim-Chester disease among others. Due to the wide differential diagnosis that it poses, its presence is often perceived as confusing and challenging. To face this crossroads we must tackle it from its origin, so both the understanding of the underlying pathophysiological fundamentals and the recognition of ancillary imaging signs must be the objective of our study and the pillar for an adequate diagnostic approach. The goal of this work is to provide a tool that may help unmask the enigma: a systematic and understandable review of the different manifestations of septal thickening, focused on the underlying physiological background and exemplified with illustrative cases from our hospital.

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## Abstract Archives of the RSNA, 2023

CHEE-61

### Take My Breath Away: MR Lungs from Maverick towards Mainstream, and Maybe Top Gun?

All Day Room: Learning Center

Nicholas Bontrager, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

MRI for evaluation of the pulmonary parenchyma and vessels is a viable alternative to CT that eliminates patient exposure to ionizing radiation, and that can be performed using the magnet you have, sequences you already use, and table times under 20 minutes per complete exam. Pulmonary MRI and MRA have been shown to be effective for evaluation of cystic fibrosis, lung cancer screening, pulmonary nodule and mass evaluation, pulmonary embolism, and more. For lung cancer screening, pulmonary MRI has been found to have equivalent life expectancy with favorable cost-effectiveness and fewer false-positives when compared to low-dose CT. Restricted diffusion is likely more specific to lung cancer than FDG avidity on PET CT. MRA for PE has similar sensitivity, specificity and patient outcomes at 6 months, when compared to CTA.

#### TABLE OF CONTENTS/OUTLINE

- MR Sequence Protocol for Evaluation of Lung Parenchyma. - Cases: Primary Lung Cancer, Pulmonary Nodules, Metastases. - MRA Sequence Protocols for Pulmonary Embolism, with gadolinium-based contrast agent and with ferumoxytol (off-label). - More Cases: PE with GBCA MRA, PE in Pregnant Patient with ferumoxytol MRA, Incidental Findings. - Limitations of MR evaluation of the lungs and pulmonary vessels. - The future of MR evaluation of the lungs.

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## Abstract Archives of the RSNA, 2023

CHEE-62

### A Case Based Review of Chest Wall Masses: Multimodality Imaging and Differential Diagnosis

All Day Room: Learning Center

Sehar Salman, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The goal of this presentation is to review clinical manifestations and radiologic findings of chest wall lesions. Many of these masses are discovered incidentally on routine chest imaging, and it is important for the interpreting radiologist to be able to recognize benign, indeterminate, and malignant features in order to guide management. In a series of cases, we will present different diagnoses of chest wall masses including both common and uncommon pathologies, to illustrate the spectrum of findings. After this presentation, learners should be familiar with chest wall anatomy, be able to describe imaging characteristics of lesions on multiple modalities, provide differential diagnoses, recognize indications for biopsy, and ultimately have a framework for approaching these masses.

#### TABLE OF CONTENTS/OUTLINE

Background - Chest wall anatomy on ultrasound, CT, and MRI - The spectrum of chest wall pathologies (benign, malignant)- fat, fluid, soft tissue, bone  
Cases: lipoma, hematoma, elastofibroma dorsi, neurofibroma, fibrous dysplasia, desmoid fibromatosis, myxofibrosarcoma, metastatic disease - For each case: Clinical scenarios, multimodality imaging findings, differential - Indeterminate and malignant cases: biopsy indications, biopsy results, pathologic correlation (when available)  
Summarize key features and classic differential diagnoses  
Radiologic and clinical management of chest wall masses

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## Abstract Archives of the RSNA, 2023

CHEE-63

### A CT Imaging Roadmap for Hemoptysis: from Etiology to Treatment Complications

All Day Room: Learning Center

Niels Vinicius Padua Carvalho, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibition is: • To review the most common causes of hemoptysis in clinical practice; • To illustrate the role of CT imaging for the evaluation of patients with hemoptysis; • To provide a systematic approach on hemoptysis imaging evaluation, highlighting key findings for an accurate diagnosis; • To explain the main therapeutic modalities employed in the treatment of hemoptysis.

#### TABLE OF CONTENTS/OUTLINE

1. INTRODUCTIONa. Epidemiologyb. Vascular anatomyc. Physiopathology2. CT IMAGING: AN ETIOLOGY BASED REVIEWa. Infectiousb. Inflammatoryc. Vasculitisd. Congenitale. Neoplasticf. Other causes3. THERAPEUTIC MODALITIESa. Indicationsb. Techniquesc. Complications4. SYSTEMATIC APPROACH: A ROADMAP5. SUMMARY AND TAKE-HOME MESSAGES

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-64

### Respiratory Complications from Burns Injury: A Pictorial Review

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mishaal B. Patel, BMedSc, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Acute complications are almost always associated with smoke inhalation injury.
- When acute lobar collapse cannot be explained by a malpositioned ETT, prompt bronchoscopy is required to assess for bronchial eschars or inspissated secretions from bronchorrhea.
- In the subacute phase, short interval changes in heart size, parenchymal opacities and pleural effusions favors cardiogenic edema.
- Expiratory CT is useful in assessing burns-induced chronic airways disease including tracheomalacia, bronchial webs and obliterative bronchiolitis.

#### TABLE OF CONTENTS/OUTLINE

As many as 91% of deaths in burn patients are a result of respiratory complications. Understanding the spectrum of respiratory complications, their onset and evolution of changes over time is important in early and accurate imaging interpretation. This pictorial review aims to educate and familiarize readers with common and uncommon burns-related complications that may be detected on chest imaging. As multiple disease processes have overlapping imaging appearances, we have classified complications temporally into acute, subacute and delayed phases, and spatially classified complications according to the anatomical structures affected. This structured approach to imaging interpretation serves to facilitate understanding and provide readers with a practical approach to imaging interpretation in burns patients.

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## Abstract Archives of the RSNA, 2023

CHEE-65

### Consolidation of Post-Lung Transplant Complications, Throughout Post-operative Course

All Day Room: Learning Center

Joshua A. Kogan, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Lung transplantation is a life-saving procedure for end-stage lung diseases and has been shown to improve quality of life. Currently, the median post-lung transplant survival is roughly 6 years. However, it is associated with various complications that can significantly impact post-transplant outcomes. The purposes of this exhibit are to: (1) Recall the many pathologic complications that arise with Lung Transplantation, (2) Evaluate and identify the radiological features associated with Lung Transplant complications, (3) Review the role of imaging in the diagnosis and management of these complications.

#### TABLE OF CONTENTS/OUTLINE

Immediate and Early Postoperative Period (First 24 hours to First Week) Primary Graft Dysfunction Rejection Acute Rejection Hyperacute Rejection Pleural Complications Pleural Effusion Pleural Fistula Hemothorax Pneumothorax Intermediate Period (1 week to 4 months) Anastomotic (Airway) Dehiscence Stenosis Airway Stenosis Pulmonary Artery Stenosis Pulmonary Infections Candida CMV Aspergillus Late Periods (After 4 months) Pulmonary Infections Mycobacterial RSV Chronic Lung Allograft Dysfunction (CLAD) Post-Transplant Lymphoproliferative Disorder (PTLD)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-66

### Assessment of Both Fibrosis and Vascular Disease in Systemic Sclerosis: The Pivotal Role of the Radiologist and Future Perspectives

All Day Room: Learning Center

Carlotta Zilioli, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To be informed of the fundamental pathogenic pathways of systemic sclerosis (SSc).- To be aware that, among the autoimmune rheumatic disease, SSc has the highest mortality due to lung complications, which mainly are fibrosis and pulmonary hypertension (PH).- To illustrate the radiological spectrum of thoracic manifestations in SSc.- To be informed about the recent advances in the imaging techniques, with specific attention to quantitative analysis, to early diagnose and monitor disease activity.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction:- Overview of underlying pathophysiology of SSc: endothelial and fibroblast dysfunction, leading to fibrosis.- Description of pulmonary manifestations of SSc, focusing on the leading cause of death: interstitial lung disease (ILD) and pulmonary hypertension (PH). 2. The use of high-resolution CT in the diagnosis of progressive SSc, particularly to early stages of ILD:- NSIP as the main histologic pattern: key finding - Other HRCT findings: pleural and pericardial, esophageal dilatation. 3. Description of the hallmark of PH:- Key findings on HRCT - Role of dual-energy CT angiography. 4. The emerging use of automated software to perform quantitative analyses on in SSc, correlating quantitative vessel parameters with ILD features.

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## Abstract Archives of the RSNA, 2023

CHEE-67

### A Step-by-Step Approach to Pulmonary Fibrosis: What the General Radiologist Should Know

All Day Room: Learning Center

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Expose the imaging modalities used in interstitial lung disease assessment. Provide a stepwise approach to identify the features of fibrotic lung disease and categorize the pattern of fibrosis. Review the radiological features of idiopathic pulmonary fibrosis (IPF) and the principal differential diagnoses, focusing on their distinctive features based on high-resolution computed tomography (HRCT).

#### TABLE OF CONTENTS/OUTLINE

Diffuse interstitial lung disease encompasses a heterogeneous group of processes characterized by a concrete pulmonary response to damage affecting the pulmonary interstitium and the secondary pulmonary lobule. IPF is a progressive chronic interstitial fibrotic lung disease of unknown etiology characterized by nonspecific clinical manifestations, a restrictive pattern in pulmonary function tests, and a poor prognosis. The morphologic hallmark in imaging and histopathology of IPF is the UIP pattern, characterized by subpleural reticulation, traction bronchiectasis, and honeycombing with an apex-to-basal gradient. However, it may also be present in several conditions, including asbestosis, chronic hypersensitivity pneumonitis, or connective tissue diseases. Definitive diagnosis requires clinical-radiological-pathological consistency, with imaging playing a pivotal role. An accurate classification based on the CT pattern enables early detection of fibrosis, distinguishing the UIP pattern from those that suggest an alternative diagnosis, determining the need for biopsy, and guiding subsequent treatment. We collected representative cases of pulmonary fibrosis from our institution to highlight the hallmark imaging findings that leads to accurate diagnosis.

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## Abstract Archives of the RSNA, 2023

CHEE-68

### Through the Eye of the Needle: An Evidence-based Approach to the Benefits, Risks, and Controversies of CT-Guided Lung Biopsy

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Shravan Sridhar, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

CT-guided lung biopsy is a vital tool in the diagnostic armamentarium of physicians involved in the workup of pulmonary lesions in a variety of clinical settings. Having a clear understanding of the benefits, yield, and risks of CT-guided lung biopsy is important in optimizing utility of this diagnostic test and minimizing adverse outcomes. We present current evidence in the literature as it relates to benefits/yield, risks and risk reduction, and controversies in lung biopsy.

#### TABLE OF CONTENTS/OUTLINE

1. Title and disclosures
2. Abbreviations
3. Table of contents
4. Overview
5. Indications
  - a. List of indications
  - b. Pre-test probability
  - c. Negative predictive value
  - d. Diagnostic accuracy
6. Risk/reduction
  - a. Pneumothorax
  - b. Hemorrhage
  - c. Air embolism
7. Controversies
  - a. Role of CT vs bronchoscopic biopsy
  - b. Appropriate needle size
  - c. FNA vs core needle biopsy
  - d. Biopsy of subsolid nodules
  - e. Biopsy of suspected infection
  - f. Biopsy of cavitory nodules
  - g. Repeat biopsy after non-diagnostic result
  - h. Biopsy in setting of pulmonary hypertension
  - i. Biopsy in setting of fibrotic ILD
  - j. Tumor seeding
  - k. Techniques to avoid complications
    - i. Utility of blood patch/plug
    - ii. Rapid rollover
    - iii. Intrapulmonary length
8. Summary
9. References

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## Abstract Archives of the RSNA, 2023

CHEE-69

### To Protect and to Serve: Imaging Review of the Sternum for the Thoracic Radiologist

All Day Room: Learning Center

Michelle Bondero, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The sternum “protects” the vital cardiovascular organs, “serves” as a mirror to reflect diffuse bone disorders, and may uncommonly be affected by isolated lesions. These conditions may present as non-specific chest pain, which is a common patient presentation in clinical practice. Furthermore, given its central location, the sternum is included on nearly all thoracic imaging, be that a radiograph, CT, or MR. Due to thoracic radiologists’ predominant reliance on axial images and focus on the inner organs, it may be neglected in a speedy review and important diagnostic information may be missed. The goal is to (1) explain the anatomy and development of the sternum; (2) describe dedicated imaging approaches; as well as (3) define and depict the major disease processes that can be diagnosed on radiological imaging, as outlined below. In addition to the rich imaging illustration, multiple less common but important diseases will be included with corresponding clinical and surgico-pathologic correlation, when available. Board-exam questions will also be provided to emphasize key principles.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy (bony components, articulations). 2. Imaging (XR, CT, MR, US and NM). 3. Cases: a. Congenital: variants and anomalies; b. Traumatic (fractures); c. Infectious (osteomyelitis); d. Neoplastic (primary and mets); e. Metabolic (Paget’s disease, renal osteodystrophy, sickle cell disease, osteopetrosis). 4. Peri-sternal joint disease (osteoarthritis, septic arthritis, inflammatory arthritides, SAPHO). 5. Pre- and post-surgical (sternotomy, expected findings, complications, sternal measurements prior to cardiac surgery). 6. Post-radiation. 7. Artifacts.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-7

### Dual Energy Chest Radiography in Oncological Practice

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ioannis Vlahos, MBBS, FRCR (*Presenter*) Director, Grayscale Ltd; Co-owner, Grayscale Ltd;

#### TEACHING POINTS

Based on CXR implementation in a tertiary cancer center: CXR dual energy principles and techniques  
Practical implementation for improved detection and accuracy, characterization, increased confidence, problem solving on chest radiographs  
Advantages, disadvantages and limitations

#### TABLE OF CONTENTS/OUTLINE

CXR Dual Energy Techniques (single exposure (SE), dual exposure (DE), weighted subtraction), new AI single exposure techniques  
Soft tissue and bone-selective images  
Advantages and disadvantages of SE DE (associated artifact recognition), dosimetry  
Improved lesion detection, confidence, additional lesions, growth determination  
Lesion characterization (soft tissue, calcification)  
Calcified lesions (mediastinum, lung, pleura)  
Bone metastases and other osseous conditions (pathological fractures, periosteal reactions, lytic lesions)  
Specific areas: Evaluation of the apices, cardiomeastinum, drug induced lung disease, postoperative pneumothorax  
Complex evaluation: impact on accuracy, distracting pathology, missed findings, interpretation time

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## Abstract Archives of the RSNA, 2023

CHEE-70

### Targeting the Unknown: A Stepwise Approach to CT-Guided Biopsy of Cavitory Lung Nodules

All Day Room: Learning Center

Abhay Dhaliwal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-To review categories of inciting conditions that can lead to cavitory pulmonary nodules. -To discuss the role and technique of CT guided percutaneous trans-thoracic needle biopsy (PTNB) of cavitory nodules in the aid of diagnosis, ranging from pre-biopsy workup to post biopsy care. -To review the risks and complications associated with CT guided PTNB of cavitory nodules, and methods to minimize risk and manage complications. -To illustrate and discuss the key imaging features of pathology proven cases of processes that can present with cavitory pulmonary nodules, including infections (such as actinomyces and tuberculosis), inflammatory conditions (such as granulomatosis with polyangiitis and rheumatoid arthritis), and malignancies (such as primary and metastatic processes).

#### TABLE OF CONTENTS/OUTLINE

Definition of cavity, biopsy materials, pre-biopsy work up, patient counseling, biopsy set up/technique, post-biopsy care, biopsy outcomes, biopsy risks/complications, management of complications, rad path correlation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-71

### Avoiding Tunnel Vision: Looking Beyond Anatomic Specialization Boundaries

All Day Room: Learning Center

Elizabeth Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. While radiological sub specialization is advantageous and has firmly integrated radiologists in multidisciplinary teams, there is a potential for missed diagnoses when various anatomic regions of a cross-sectional study are interpreted separately by specialists. This is particularly relevant for junctional regions (such as diaphragm when chest and abdomen imaging are interpreted by chest and body radiologists).2. Variations in scan factors and contrast timing (for instance chest and abdominal imaging may be obtained at different phases of enhancement) can facilitate diagnosis.3. Even if studies are separately interpreted and dictated, it is important for specialists to avoid tunnel vision and check pertinent information.

#### TABLE OF CONTENTS/OUTLINE

1. No man's zone: Junctional zones between two anatomical regions can be a cause of missed opportunities. For instance, lower ribs may only be partly included in chest CT and may be overlooked on an abdominal scan.2. Integration of imaging findings from various anatomic regions can provide a unifying diagnosis: Several diseases are multisystem pathologies, and the diagnostic process is facilitated by knowledge of involvement of other anatomic regions. Examples include neurofibromatosis, Birt-Hogg-Dube syndrome, embolized fragment of a device, etc.3. Differences in phase of enhancement: This can help in localizing as well as accurately characterizing an abnormality that is better seen on a specific phase of enhancement.4. Differences in patient positioning Arms up and arms down position for two different scans can uncover an unsuspected thoracic outlet syndrome.5. Correlating with all available imaging modalities

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-72

### Noninfectious Pulmonary Complications Following Hematopoietic Stem Cell Transplant

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Elizabeth Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. There is an increase in the indications for, the potential recipient age and sources from which hematopoietic stem cell transplantation (HSCT) can be performed, with increasing numbers of the procedure performed yearly across the globe. 2. Up to one third of patients undergoing HSCT develop pulmonary complications with the rates of infectious pulmonary complications decreasing due to improvements in prophylaxis and treatment. 3. The rate of noninfectious complications has risen and now is a more common cause of death than those from infection. 4. There are a variety of noninfectious pulmonary complications which can be seen after HSCT including idiopathic pneumonia syndrome, bronchiolitis obliterans syndrome, thoracic air leak syndrome, venous thromboembolism, and pulmonary hypertension. 5. Idiopathic pneumonia syndrome has a varied presentations depending on the site of primary tissue injury which results in a varied imaging appearance such as diffuse alveolar hemorrhage or peri-engraftment respiratory distress syndrome.

#### TABLE OF CONTENTS/OUTLINE

1. General review of hematopoietic stem cell transplantation 2. Idiopathic Pneumonia Syndrome (Acute interstitial pneumonitis, Acute respiratory distress syndrome, Delayed pulmonary toxicity syndrome, Peri-engraftment respiratory distress syndrome, Diffuse alveolar hemorrhage) 3. Bronchiolitis obliterans syndrome 4. Interstitial lung disease 5. Pleural effusions 6. Thoracic air leak syndrome 7. Venous thromboembolism 8. Pulmonary hypertension 9. Post-transplant lymphoproliferative disorder

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-73

### **Bad to the Bone: Differentiating Pulmonary Ossification from Calcification on CT**

All Day Room: Learning Center

Kendrah Osei, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. The pathogenesis of pulmonary ossification and calcification is incompletely understood.?2. Pulmonary calcification and ossification can occur in both pulmonary and non-pulmonary conditions, including benign, malignant, inflammatory, infectious, and metabolic etiologies.?3. High-resolution CT imaging is important to differentiate conditions that cause dendriform pulmonary ossification and those that do not.4. Multi-society consensus guidelines now include pulmonary ossification among high-confidence CT features of usual interstitial pneumonitis (UIP) pattern of idiopathic pulmonary fibrosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Definitions of pulmonary calcification, pulmonary ossification, and dendriform pulmonary ossification.?2. Pathogenesis of pulmonary calcification and ossification. ?3. Causes of pulmonary calcification and ossification. ?4. Imaging patterns of pulmonary calcification and ossification. ?5. Dendriform pulmonary ossification as a diagnostic imaging feature of idiopathic pulmonary fibrosis.?6. Clinical impact of recognizing dendriform pulmonary ossification.?7. References.

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## Abstract Archives of the RSNA, 2023

CHEE-74

### Thoracic Complications of Sickle Cell Disease

All Day Room: Learning Center

Malcolm Davidson, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1 Acute chest syndrome is a leading cause of morbidity and mortality, and is characterized by the development of a new lung opacity along with fever and/or respiratory symptoms. The most common causes include infection, fat embolism, and infarction.2 Sickle cell patients are functionally asplenic and immune compromised, making them vulnerable to pneumonia and other infections from encapsulated and atypical bacteria - a leading cause of mortality in this population.3 Repeated pulmonary insults in sickle cell patients can lead to chronic pulmonary findings, such as pulmonary fibrosis.4 Pulmonary embolism is more common in patients with sickle cell disease and can contribute to pulmonary hypertension (PH). PH is present in approximately 10% of sickle cell patients, and is often multifactorial in etiology (WHO group 5). Pulmonary artery dilation is associated with worse outcomes in those presenting with acute chest syndrome.5 Bone complications in sickle cell disease can present similarly to acute chest syndrome. Patients in this population are at higher risk for osteomyelitis, and osteomyelitis should be considered if bone pain is atypical or if there are other supporting signs, symptoms, or imaging features.

#### TABLE OF CONTENTS/OUTLINE

1. Sickle Cell Pathophysiology2. Acute Complications - Vaso-occlusive events, acute chest syndrome, infection3. Chronic Complications - Lung fibrosis, cardiomyopathy, pulmonary hypertension, bone infarction

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-75

### Embracing Automation: Designing and Implementing a Robust Continuous Monitoring System for AI-Powered Radiology Applications

All Day Room: Learning Center

Vasanth Venugopal, MD (*Presenter*) Officer, CARPL.AI Inc

#### TEACHING POINTS

1. Continuous monitoring is vital for AI-driven radiology platform performance and reliability. 2. Identify KPIs and benchmarks to measure AI application metrics, such as accuracy, sensitivity, and specificity in radiology. 3. Implement automated QA/QC mechanisms, like image quality checks and data validation, ensuring consistent, complete input data following standard protocols. 4. Use advanced monitoring techniques, like measuring model divergence, to detect and address model drift caused by input data changes or other factors.

#### TABLE OF CONTENTS/OUTLINE

I. Key Performance Indicators (KPIs) and Benchmarks  
A. Identifying relevant clinical and non-clinical KPIs  
B. Establishing performance benchmarks for AI applications  
II. Automated Quality Assurance and Quality Control  
A. Automated QA/QC mechanisms for image quality and artifacts  
B. Data validation techniques for ensuring input data integrity  
III. Performance Monitoring and Anomaly Detection  
A. Real-time monitoring of KPIs and other relevant metrics  
B. Anomaly detection algorithms for identifying unusual patterns or behaviors  
IV. Advanced Monitoring Techniques  
A. Measuring divergence between multiple models  
B. Benefits and challenges of using advanced monitoring techniques  
V. Continuous Improvement  
A. Iterative model development, performance evaluation, and updating  
B. Real-world performance data Collection  
VI. Regulatory Compliance and Periodic Reviews  
A. Ensuring monitoring system adherence to regulatory requirements  
B. Conducting periodic audits and reviews

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## Abstract Archives of the RSNA, 2023

CHEE-76

### **Imaging Findings in Bronchiectasis-Associated Diseases: A Comparison with Pathophysiology.**

All Day Room: Learning Center

Orito Ikeda (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points(1) Bronchiectasis is a condition characterized by irreversible dilation of the bronchi. CT imaging categorizes it into three types: cylindrical, varicose, and cystic. (2) Bronchiectasis can occur in various disease groups, making its diagnosis challenging due to its diversity. (3) Understanding the relationship between the underlying pathophysiology and imaging findings is crucial.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents/Outline (1) About bronchiectasis (2) Congenital bronchial anomalies (3) Mucociliary transport disorder (4) Immune hypersensitivity (5) Immune deficiency (6) Connective tissue disorder (7) Infectious disease (8) Others (9) Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-77

### Manifestations of Sickle Cell Disease on Thoracic Imaging

All Day Room: Learning Center

Hussein Alsadi, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Sickle cell disease (SCD) is a systemic disease that has a wide spectrum of pulmonary, soft tissue, skeletal, and upper abdominal findings that can be seen on thoracic imaging.- There is commonly an overlap between findings of the milder pneumonia and the more clinically severe acute chest syndrome. However, knowledge of some findings can favor one diagnosis over the other.- Over time, SCD can result in chronic changes to the lung parenchyma.

#### TABLE OF CONTENTS/OUTLINE

1. Introductiona. Backgroundb. Epidemiology, genetics, and pathogenesis of sickle cell disease2. Acute manifestationsa. Spectrum of acute chest syndrome and pneumonia• Findings on chest radiograph and CT that could aid in the diagnosis• Etiologies of pneumonia (e.g, streptococcus pneumoniae, Hemophilus influenzae, etc.)b. Pulmonary edemac. Pulmonary thromboembolism3. Chronic manifestationsa. Cardiomegalyb. Pulmonary hypertensionc. Pulmonary fibrosis, cysts, and mosaic attenuation4. Other manifestations seen on thoracic imaginga. Skeletal and soft tissue manifestations (avascular necrosis of humeral heads, extramedullary hematopoiesis, "H-shape" vertebrae, osteomyelitis)b. Upper abdominal manifestations (Splenic auto-infarction, cirrhosis, iron deposition)5. Prognosis and treatment6. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-78

### Post-treatment Thoracic Changes in Breast Cancer Patients

All Day Room: Learning Center

Eloy Naranjo Moreno, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The goal of this exhibit is to provide an interactive and visual review of thoracic changes (surgical and after hormonal/chemotherapeutic treatments) that we can find in breast cancer patients who have undergone treatment or who are currently doing it. Nowadays, thanks to screening programs, breast cancer is a common pathology detected and treated precociously in many cases. This exhibit aims to present an illustrative compilation of thoracic and pulmonary changes in breast cancer treated patients; providing an algorithmic approach of these radiologic changes based on progression time and location in the lung; reviewing the most meaningful findings to allow radiologists to differentiate them from the general thoracic pathology. Post-treatment radiologic computed tomography (CT) changes in breast cancer include post-surgical changes (like removal and reconstruction of the affected breast), changes after and during hormonal/chemotherapy (appearance of interstitial pathology and other common signs in the lung) and post-radiotherapy changes (identifying irradiation regions and their findings correlation over time) that can be effectively identified through chest CT.

#### TABLE OF CONTENTS/OUTLINE

Introduction and purpose / Background / Image findings: Post-surgical changes, changes after and during hormonal/chemotherapy and post-radiotherapy changes / Conclusion.

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## Abstract Archives of the RSNA, 2023

CHEE-79

### **Don't Forget to Check the Sternum After Thoracic Surgery: Expected Postsurgical Changes and Complications of Sternotomy and Sternal Wound Repair**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Zehavit E. Kirshenboim, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Various chest wall surgical methods are being used for the sternotomy for thoracic surgery. 2. Identification of complications can be difficult due to a nonspecific clinical presentation which frequently overlaps with normal postsurgical changes. 3. Knowledge of expected postsurgical sternotomy imaging appearance is crucial to avoid misinterpretation and detect complications in a timely manner.

#### **TABLE OF CONTENTS/OUTLINE**

1. Various sternotomy techniques, surgical methods for sternotomy wound repair and complications will be illustrated. A. Surgical techniques 1. Longitudinal vs. transverse 2. Sternal wiring vs. rigid sternal fixation 3. Debridement and sternal flap closure B. Complications 1. Pre-sternal complication - cellulitis, sinus tract 2. Sternal complication - nonunion, dehiscence, osteomyelitis, wire fracture and migration 3. Post sternal complication - mediastinitis, retrosternal abscess, empyema, retrosternal hematoma, sternal adhesion 4. Flap complication - bowel herniation, flap failure C. How to differentiate expected postsurgical appearances vs. complications 2. Strategies to detect complications, differential diagnosis - sternal metastasis, infected epicardial lead 3. Clinical implications and treatment of complications

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-8

### **Into the Airway: Focal Tumors and Non-neoplastic Disorders (Detected by CT) Arising from the Bronchi**

All Day Room: Learning Center

Uxue Martinez Urabayen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the multiple focal lesions that can originate in the airway, including the non-neoplastic lesions and the benign and malignant tumours. To describe and illustrate the main characteristics signs and imagine findings that may improve detection of the lesions, improving the management of this patients.

#### **TABLE OF CONTENTS/OUTLINE**

**METHODS OR BACKGROUND** Neoplastic and non-neoplastic lesions of the airway track are rare. The majority are malignant. The diagnosis tends to be delayed due to the few and nonspecific symptoms. Chest radiographs are rarely diagnostic. **RESULTS OR FINDINGS** At CT benign and malignant tumours may have nonspecific characteristics, presenting as polypoid lesions or focal sessile lesions that narrow the airway lumen. Even non-neoplastic disorders may be identical. Mucus plugs have internal gas. Blood is indistinguishable from other endobronchial material. Broncholiths present calcification. Foreign bodies depend on the component of which they are made of. Lipomas have internal fat and hamartomas are characterized by "popcorn" calcifications. Leiomyomas and papillomas look very much alike. Squamous cell carcinoma is the most common subtype of lung cancer that affects the central airway system. Carcinoid tumours tend to have intense enhancement at contrast material-enhanced CT and may present calcifications. Metastasis due to hematogenous invasion are usually multifocal. **CONCLUSION** The airway must be carefully evaluated on CT examinations to appreciate the slight differences in morphology of the lesions occupying the lumen. Knowing the Morphological characteristic and location of these lesions can help reduce the broad spectrum of differential diagnosis.

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## Abstract Archives of the RSNA, 2023

CHEE-80

### Functional Lung MRI: How to Obtain Ventilation-Weighted Images from UTE MRI.

All Day Room: Learning Center

Julius F. Heidenreich, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The reader should learn about the prerequisites that are necessary for functional lung imaging (technical requirements, sequences, data types).2. The reader should understand that the basic post processing steps comprise (1: labelling of lung parenchyma; 2: image co-registration; 3: voxel-wise calculation of fractional ventilation.3. The reader should learn to interpret ventilation imaging and be able to distinguish ventilation maps from healthy subjects and patients with cystic fibrosis.4. The reader should know about pitfalls and limitations of UTE ventilation imaging and know about the alternative techniques.5. The exhibit should highlight the potential benefit of ventilation imaging. The reader should be able to understand its significance and the recent areas of application.

#### TABLE OF CONTENTS/OUTLINE

A. Introduction, Background and Purpose: Why is ventilation imaging relevant? B. Technical requirements: What images have to be acquired? C. Post-processing: What are the basic steps of data processing? D. Data analysis and calculation of fractional ventilation and lung function parameters. E. Image analysis: Healthy subjects vs. patients. What is the difference? F. Pitfalls and limitations. What are the alternatives?

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## Abstract Archives of the RSNA, 2023

CHEE-81

### No Small Matter: Thoracic Manifestations of Small Vessel Vasculitis

All Day Room: Learning Center

Sofia D. Gambetta I, MD, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

We will review epidemiology, clinical features and imaging manifestations of ANCA associated small vessel vasculitis in the thorax. Teaching points: 1. Granulomatosis with polyangiitis presents with diverse pulmonary and airway involvement: tracheobronchial wall thickening/stenosis, lung nodules and masses that cavitate or present with ground glass halo, bronchovascular thickening or alveolar hemorrhage. 2. Microscopic polyangiitis can be divided into two groups: alveolar hemorrhage and interstitial lung disease. a. 4 to 36% of patients with interstitial pneumonia at presentation have MPO-ANCA antibodies. b. Up to 10% of patients with IPF seroconvert to MPO-ANCA. c. UIP and probable UIP are the most common patterns of MPO-ANCA ILD. 3. EGPA patients can be ANCA negative (eosinophilic manifestations) or ANCA positive (vasculitis features). a. Cardiac manifestations are more common than in other ANCA vasculitis and indicator of poor prognosis. b. Pulmonary manifestations include migratory/peripheral consolidations, GGOs and centrilobular nodules.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of small vessel vasculitis. a. Etiology and Pathogenesis. b. Epidemiology. c. Serological findings 2. GPA a. Clinical manifestations. b. Airway involvement. c. Pulmonary manifestations. d. Cardiac involvement 3. MPA. a. Clinical manifestations. b. Pulmonary manifestations. i. MPO-ANCA associated ILD ii. Alveolar hemorrhage and hemosiderosis 4. EGPA. a. Clinical manifestations. i. ANCA positive EGPA ii. ANCA negative EGPA. b. Pulmonary manifestations c. Cardiac manifestations. i. Myocarditis ii. Endocardial fibrosis iii. Pericarditis 5. Differential diagnosis

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## Abstract Archives of the RSNA, 2023

CHEE-82

### **Hypersensitivity Pneumonitis: Correlation of Radiologic and Pathologic Findings, Diagnostic Criteria and Recommendations According to the Latest Guidelines**

All Day Room: Learning Center

#### **Awards**

##### **Cum Laude**

Belen del Rio Carrero, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To illustrate the key radiological and histological findings for the diagnosis of hypersensitivity pneumonitis and understand their correlation.- To review the hypersensitivity pneumonitis diagnostic criteria according to the latest guidelines and summarize recommendations.

#### **TABLE OF CONTENTS/OUTLINE**

1. Definition and epidemiology2. Inciting agents. Exposure to inhaled agents.3. Immunopathogenesis:3.1. Immunologic mechanisms involved in the development of the disease and how they relate with the clinical and laboratory features.3.2. Risk factors: Genetic and external factors.3.3. The smoking paradox in HP.4. Clinical features.5. Non fibrotic HP:5.1. Radiologic Features: Typical and Compatible findings.5.2. Histologic Features.5.3 Radio-pathological Correlation6. Fibrotic HP6.1 Radiologic Features: Typical, Compatible and Indeterminate findings.6.2. Histologic Features6.3. Radio-pathological Correlation.7. Diagnostic criteria in the multidisciplinary team.8. Current controversies and future directions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-83

### **Recognizing Local Recurrence After Stereotactic Body Radiotherapy in the Lung: Imaging Appearances and Pitfalls. A Picture Essay with Diagnostic Algorithm.**

All Day Room: Learning Center

Paulina Kalinowska (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This exhibit focuses on the imaging features and differentiation of local recurrence from normal inflammatory process after stereotactic body radiotherapy (SBRT) in the lung, and provides a diagnostic algorithm to aid in accurate diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of SBRT as a treatment modality for primary lung cancer and lung metastases, including risk factors of local recurrence.
2. Practical tips for interpreting post-SBRT studies, including the need to evaluate all examinations in three dimensions and to understand the dynamics of the entire process from early inflammation to residual scar tissue.
3. Factors contributing to a large inflammatory reaction post-SBRT, including the target size, radiation dose, absence of emphysema or presence of interstitial lung disease, target location near large bronchi, and use of immunotherapy.
4. Factors contributing to a small inflammatory reaction, such as small target size, peripheral tumor location, or the presence of emphysema.
5. Key steps and features of the normal post-SBRT inflammatory-fibrotic process, including discrete diffuse signs of inflammation, formation of a fibrotic circle, gradual consolidation, and the formation of a flat scar.
6. Features suggestive of local progression, including new nodular or lobular lesions with local increase in size (especially in cranio-caudal dimension), and a typical malignant contrast-enhancing pattern.
7. Algorithm for investigating suspected local recurrence post-SBRT, including consideration of a PET/CT, and biopsy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-84

### “Dis-Discombobulating” the Current State of Interstitial Lung Disease Imaging

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Jonathan H. Chung, MD (*Presenter*) Speaker, Veracyte, Inc;Consultant, Veracyte, Inc;Consultant, Boehringer Ingelheim GmbH;Speaker, Boehringer Ingelheim GmbH;Consultant, F. Hoffmann-La Roche Ltd;Speaker, F. Hoffmann-La Roche Ltd

#### TEACHING POINTS

- A systemic approach is paramount when diagnostic ILD on chest CT.
- To aid diagnosis, radiologists should familiarize themselves with current imaging guidelines and new and emerging concepts.
- Progressive pulmonary fibrosis (PPF) refers to ILDs other than idiopathic pulmonary fibrosis (IPF) with evidence of clinical, functional and/or radiologic progression over a one-year period.
- In patients with interstitial lung abnormality (ILA), clinical correlation and imaging follow-up should be considered, particularly when high-risk features for progression are present.
- Quantitative tools are valuable in the assessment of the extent and longitudinal progression of ILD.

#### TABLE OF CONTENTS/OUTLINE

- Practical approach to ILD on chest CT
- Updated approach to Hypersensitivity Pneumonitis (HP)
- Definition and current concepts of Progressive Pulmonary Fibrosis
- Definition and current concepts of Interstitial Lung Abnormality
- Current state of quantitative analysis and AI in ILD

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## Abstract Archives of the RSNA, 2023

CHEE-85

### Unusual Radiological Manifestation of Adenocarcinoma of the Lung

All Day Room: Learning Center

Laura Marsland, MBChB (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Primary adenocarcinoma of the lung is a heterogeneous disease, varying in molecular, pathological and clinical features. Radiological features can vary from the 'typical' appearances - usually ground-glass (GGN), part-solid (PSNs) or solid nodules, or with consolidation. Awareness of atypical appearances of adenocarcinoma may result in earlier investigation and timely management.

#### TABLE OF CONTENTS/OUTLINE

Lung cancer remains the most common cause of cancer deaths worldwide and adenocarcinoma is the most common histologic subtype, responsible for just under half of all cases.. The majority of tumours manifest radiologically with GGNs, PSNs, solid nodules or consolidation. In this review, we document our experience of atypical radiological presentations of adenocarcinoma spectrum disease, subsequently confirmed on histopathological analysis, at two tertiary centres. We include cases of adenocarcinoma presenting as a single, solid, calcified mass, as multiple micro- and macro-nodules and as widespread cystic airspaces. We describe cases presenting with unusual patterns of metastatic disease. We describe cases of atypical volume doubling times.

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## Abstract Archives of the RSNA, 2023

CHEE-86

### **Pulmonary Hypertension: CT Signs That Point the Way**

All Day Room: Learning Center

Camilo A. Mieres, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

CT signs suggestive of pulmonary hypertension (PH) What to include in CT reports in the workup for PH Findings in entities associated with PH

#### **TABLE OF CONTENTS/OUTLINE**

I. Background: -Pulmonary artery diameter can suggest PH, but the threshold differs with the clinical context. -CT findings can provide clues about the underlying cause of PH. II. Content: 1. Different pulmonary diameters should be considered in patients with low, intermediate, or high risk of PH. 2. Findings to analyze in the study of PH: Cardiac vascular anomalies (can be missed on echocardiography): -Intracardiac shunts (atrial septal defect (ASD), especially sinus venosus ASD) -Anomalous pulmonary venous return (often with ASD) -Patent ductus arteriosus Signs of obstruction of the pulmonary arteries (filling defects/vascular tree-in-bud, hypertrophied systemic arteries) -Chronic pulmonary embolism -Pulmonary tumor thrombotic microangiopathy -Extrinsic lung disease Signs of right ventricular repercussion. Lung anomalies (fibrosis, cysts, centrilobular nodules) -Interstitial lung disease (combined pulmonary fibrosis/emphysema, Langerhans cell histiocytosis, connective tissue disease) -Pulmonary veno-occlusive disease III. Conclusions: -CT can alert to the possibility of PH and can provide valuable clues about its etiology.

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## Abstract Archives of the RSNA, 2023

CHEE-87

### Developmental Disorders of Lung: A Pictorial Review

All Day Room: Learning Center

Shambo Guha Roy, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Mounier Kuhn syndrome affects trachea and up to 4th order bronchial tree, whereas William Campbell syndrome causes dilatation distal to 4th order bronchi. 2. Congenital pulmonary airway malformation (CPAM) has 5 subtypes: Type 1 being commonest with one or more dominant large cysts. Cyst size gets smaller in type 2 and 3. Type 4 is indistinguishable from type 1 radiologically. 3. Sequestration happens in two forms: intra lobar and extra lobar depending upon its venous drainage. Extra lobar sequestration is often associated with CPAM, called the 'hybrid lesions'. 4. Pulmonary veno-lobar syndrome or Scimitar syndrome accounts for minority of partial anomalous pulmonary venous return (PAPVR). Treatment depends upon the left to right shunt, which can be quantified using phase contrast MRI.

#### TABLE OF CONTENTS/OUTLINE

1. Normal development of the lungs. 2. Classification of developmental disorders. 3. Airway disorders: Tracheal and bronchial agenesis, Tracheobronchial branching anomaly, tracheobronchomegaly (Mounier Kuhn syndrome), bronchogenic cyst, congenital pulmonary airway malformation, bronchopulmonary sequestration. 4. Parenchymal disorders: Congenital lobar emphysema, Pulmonary hypoplasia, Pulmonary cystic mesenchymal hamartoma. 5. Vascular disorders: Pulmonary sling, absence of unilateral pulmonary artery, pulmonary veno-lobar syndrome.

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## Abstract Archives of the RSNA, 2023

CHEE-88

### Diffuse Pulmonary Hemorrhage: A Diagnostic Challenge

All Day Room: Learning Center

Camilo A. Mieres, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Review the causes, pathophysiology, and radiological signs of diffuse pulmonary hemorrhage (DPH).-Underline the importance of correlating the imaging findings with clinical and laboratory findings.

#### TABLE OF CONTENTS/OUTLINE

I.- BackgroundDPH is rare. It can occur in many diseases with histologic findings ranging from normal vessels (bland hemorrhage) to capillaritis.Clinical and radiological findings are nonspecific, determining the etiology is challenging. II.- ContentThrough a series of cases, we show how the causes of DPH relate with the histologic patterns.Pulmonary capillaritis: neutrophilic infiltration of the alveolar septa, loss of capillary integrity -Small-vessel vasculitis/Anti-GBM (Goodpasture)- Rheumatic diseases (Lupus)-DrugsBland pulmonary hemorrhage: alveolar hemorrhage without destruction or inflammation of alveolar spaces-Anticoagulants, bleeding disorders-Heart failure (HF), mitral stenosis-Idiopathic pulmonary hemosiderosisDiffuse alveolar damage: alveolar edema and hyaline membranes-Infection-Drugs-Rheumatic diseases (Lupus)III.-ConclusionsRadiologic findings of DPH are nonspecific and must be interpreted together with clinical and laboratory data.

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## Abstract Archives of the RSNA, 2023

CHEE-89

### Chest CT Imaging in the Era of Lung-sparing Thoracic Resection

All Day Room: Learning Center

#### Awards

##### Cum Laude

Farah Tamizuddin, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Chest computed tomography (CT) has a major role in planning and follow up after lung resection. Segmentectomy and sleeve resection techniques entailing anatomical lung segmental dissection are now a major method for curative surgery of early-stage lung cancer while preserving lung function. Accurate localization of pathology is essential, with clear definition of bronchial and vascular anatomy. More recently, minimally invasive approaches such as the robotic-assisted thoracoscopic surgery (RATS) and video assisted thoracoscopic surgery (VATS) techniques are options. Therefore, the objectives are: a) To review thoracic lung-resection approaches including RATS and VATs for sublobar resection and sleeve resection, b) bronchial anatomy and imaging for lesion localization, b) to discuss essential imaging findings to communicate that impact operative approach, including variant anatomy and c) to review expected postoperative imaging findings and complications.

#### TABLE OF CONTENTS/OUTLINE

1. Review of lung resection approaches: a) Sublobar, sleeve, and lobe resections b) RATS, VATS, open techniques, and advanced nodule localization methods
2. CT performance and essential preoperative anatomy evaluation: intersegmental plane identification: segmental bronchial anatomy, pulmonary arteries, pulmonary veins
3. Essential imaging findings: airway variants and challenges, 3D techniques
4. Post-operative imaging challenges: granulomas, airway distortion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

CHEE-9

### **Snaking the Clogged Pipes: Imaging Findings of Central Venous Occlusions and Review of Therapeutic Options**

All Day Room: Learning Center

Saumik Z. Rahman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Central venous obstruction can occur due to extrinsic compression or intrinsic stenosis. Clinical presentation and collateral drainage pathway development depends upon the site of obstruction and speed at which the obstruction occurs. IR based measures and surgical techniques are useful to relieve the obstruction to central vessels. We describe these techniques and their complications in this paper.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Causes of central venous obstruction • Extrinsic compression from lung cancer, lymphadenopathy, fibrosing mediastinitis • Intrinsic occlusion from catheter induced thrombosis. Imaging features of central venous obstruction- SVC narrowing, clot in the SVC, numerous chest wall collaterals, azygos vein dilatation. Collateral pathways based on the level of obstruction • pre azygos • azygos • post azygos. IR based approach for SVC recanalization- Angioplasty, stent placement. Surgical reconstruction methods for SVC- PFTE (polytetrafluoroethylene) graft, pericardial graft. Complications of reconstruction- Graft stenosis.

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## Abstract Archives of the RSNA, 2023

CHEE-90

### Toward a New Era of CT Imaging: Current Status and Expectations of Photon Counting CT in the Thoracic Region

All Day Room: Learning Center

Masahiro Yanagawa, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Photon counting CT (PCCT) has appeared as a new generation of CT systems in clinical setting. PCCT can measure the energy levels of photons as they pass through an object being imaged, which differs from traditional CT scanners with energy-integrating detectors. PCCT has several advantages over traditional CT, including improved spatial resolution and contrast sensitivity, reduced radiation dose to the patient, and the ability to measure the energy spectrum of the incident radiation. PCCT is expected to bring significant improvements in various clinical applications for areas including the thorax. This education exhibit focuses on PCCT imaging in the thorax including technical perspectives, image quality, and clinical imaging. It is much appreciated if our information would be useful in your clinical and research setting.

#### TABLE OF CONTENTS/OUTLINE

1. Comparison of PCCT equipment specifications with the traditional CT scanner with energy-integrating detector (EID-CT).
2. Improved spatial resolution: image quality according to reconstruction kernels and radiation dose.
3. Imaging by turbo flash spiral scan: high-definition images without motion artifacts even with electrocardiogram asynchrony and spectral imaging at the same time.
4. Iodine density imaging for pulmonary embolism and thoracic tumors: improved quantification due to the absence of electrical noise
5. Virtual non-contrast CT imaging created from each dynamic phase: comparison with true non-contrast CT in cases of thymic cyst, thymoma, and lung cancer.
6. Future expectations: effects on quantitative values including radiomics analysis.

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## Abstract Archives of the RSNA, 2023

CHEE-91

### Analysis of Solitary Lung Nodules Using Summation Images Created from Ultra-High-Resolution CT Data

All Day Room: Learning Center

Hiroshi Moriya, MD, PhD (*Presenter*) Advisor, California Capital Equity, LLC; Research Grant, Canon Medical Systems Corporation

#### TEACHING POINTS

1. Advantages of ultrahigh-resolution CT: □ Ultra-high resolution CT has excellent spatial resolution in lung field analysis. □ 2. 3D image analysis method using ultra-high resolution CT data □: Coronal MPR and VR image are useful for chest image analysis. □ Summation image (SUM) can observe a X-ray projection image of the chest from any viewpoint. □ 3. There are two factors that make lung lesions difficult to detect: (1) lesions with little density difference from the surrounding lung, and (2) presence in areas where other structures are projected in the anterior-posterior direction. 4. Points to note when interpreting chest radiographs in routine clinical practice.

#### TABLE OF CONTENTS/OUTLINE

1. Ultra-high-resolution CT (UHRCT) is a CT that achieves high spatial resolution by reducing the detector size to 1/4 of the conventional size. The resolution can be improved by increasing the number of pixels, and the reproducibility of density can be improved by reducing the partial volume effect. 2. Summation images using UHRCT data provide images similar to chest photographs. Ability to create X-ray-like images of removed lungs, enabling analysis of clinical chest radiograph findings. 3. Small pulmonary nodules are not readily detectable on plain chest radiographs. The difficulty in detecting the target lesion is due to the averaging of the density due to the thickness of the lung and the overlapping projection of other structures (cardiovasculature and bone). Ground-glass density lesions are obscured, but solid components and pleural indentation findings can be pointed out.

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## Abstract Archives of the RSNA, 2023

CHEE-92

### When Lungs Turn to Stone: A Differential Diagnosis of Pulmonary Calcifications

All Day Room: Learning Center

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the main pathologies that can cause intrapulmonary calcifications. - Highlight the key radiological features that will allow us to establish a correct differential diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Pulmonary calcifications are a common imaging finding, usually seen on routine chest radiographs. Although they are usually harmless sequelae of remote processes, they provide important information for establishing a good diagnostic approach. They can be attributed to a variety of etiologies, including granulomatous disease, infection, malignancy, environmental exposure, or chronic disease. Consequently, it is necessary to correlate radiologic findings with clinical history and laboratory results. Specific radiologic features have been described, of which the appearance of pulmonary calcifications also provides valuable information regarding the underlying etiology. Therefore, a thorough differential diagnosis is necessary to identify the underlying cause and guide appropriate management. This work provides a comprehensive review of the radiologic features of pulmonary calcifications, including their distribution, size, shape, and associated findings, through cases studied at our center.

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## Abstract Archives of the RSNA, 2023

CHEE-93

### Proposals for the 9th edition TNM Staging for Lung Cancer - A Guide to Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Maximiliano Klug, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Unresolved issues of the 8th edition TNM staging for lung cancer are: exclusion of post neoadjuvant patients (yp) from staging analysis, absence of nodal metastatic burden quantification, lack of granularity within the M1C category. 2- Proposed T Category - remains unchanged. 3- Proposed N Category- N2 is divided into N2a as single-station N2 disease and N2b as multiple-station N2 disease - relevant to imaging interpretation; N1 and N3 remain unchanged. 4- Proposed M Category- M1C cases that are metastatic to a single organ site have a better prognosis than M1C to multiple sites- to be determined this month whether multiple single organ will be moved to M1B. The rest of M categories are unchanged. 5- The outcomes of matched ypN v pN categories differ significantly with worse survival for ypN (e.g., ypN0 vs. pN0)- caution for imaging interpretation and patient management decisions.

#### TABLE OF CONTENTS/OUTLINE

1- To describe the proposals for the 9th edition TNM Staging for Lung Cancer. 2- To discuss the differences from the previous edition, remaining challenges, as they pertain to imaging evaluation and interpretation, and potential future directions.

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## Abstract Archives of the RSNA, 2023

CHEE-94

### Early and Late CT Patterns After SBRT for Lung Nodule

All Day Room: Learning Center

Ignacio Alba, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To familiarize with the different radiological patterns observed on chest CT scans after stereotactic body radiotherapy (SBRT) for lung nodules, including early changes (within the first 6 months) and late changes (after 6 months)-To recognize cases of local and/or locoregional recurrence based on findings in our sample-To recognize evolutionary differences in chest CT findings based on the histological subtype of the treated lesion-To evaluate the ultimate success of SBRT as a therapeutic technique

#### TABLE OF CONTENTS/OUTLINE

We evaluated the different radiological patterns observed after SBRT for lung nodules using chest CT scans in 108 patients. Of the cases studied, 64 were primary tumors in early stages, 32 cases were lung metastases or metastases from other locations, and in 12 cases histology could not be identified. Among the primary lung tumors, 57% were adenocarcinomas, followed by 26% of squamous cell carcinomas. All chest CT scans were performed every 3 months during the first 2 years and every 6 months during the next 2 years after the completion of SBRT. The patterns observed in the first six months typically evolve progressively to a final stabilization pattern. The most frequently observed final radiological patterns were nodule-like and mass-like, followed scar-like and diffuse consolidation pattern. Thoracic recurrence was diagnosed by lack of parenchymal stabilization in 20% of cases, and locoregional lymph node involvement in the remaining cases. There were no significant differences in lung involvement based on the histology of the treated tumor

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## Abstract Archives of the RSNA, 2023

CHEE-95

### CT Imaging of Lung Cancer: Exploring the Clinical Potential of CZT-based Photon Counting Detector CT

All Day Room: Learning Center

Tomoaki Sasaki, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Lung cancer is the leading cause of death worldwide. CT is a powerful tool for evaluating the primary site and staging of lung cancer. On CT imaging, lung cancer appears as a subsolid nodule or solid nodule. Measuring the total tumor size and the size of the solid portion if the tumor is a subsolid nodule is the first step in both early and advanced lung cancer. Assessment of invasion to critical organs is also important in locally advanced cancer. Accurate evaluation of ipsilateral mediastinal nodal and extrathoracic metastases is required to determine treatment strategy. Photon counting detector CT (PCD-CT) has recently emerged for clinical use. Cadmium zinc telluride (CZT)-based PCD-CT, a newly developed technology, allows for more precise observation of lung cancer with lower radiation exposure, which may have a significant impact on clinical practice. This presentation aims to 1) review the clinical significance and challenges of CT evaluation in lung cancer and 2) discuss the benefits provided by CZT-based PCD-CT for lung cancer patients.

#### TABLE OF CONTENTS/OUTLINE

Key features of lung cancer evaluation: primary site and staging  
1. T: size (T1-T4), chest wall invasion (T3), mediastinal invasion (T4)  
2. N: ipsilateral mediastinal node metastasis (N2)  
3. M: pleural dissemination (M1a), extra thoracic metastasis (M1b-c)  
Basic principle of CZT-based PCD-CT  
Clinical potential of lung cancer assessment using PCD-CT: super high resolution (SHR) image, multienergy spectral image, reduction of radiation exposure

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## Abstract Archives of the RSNA, 2023

CHEE-96

### **Pictorial Review of Tracheal Diseases: A Case-Based Approach for Radiologists**

All Day Room: Learning Center

Camila Gadens Zamboni, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The evaluation of the trachea by imaging is essential to diagnose various tracheal diseases and help with surgical plans, assessment of treatment responses, and understanding surrounding structural abnormalities. In this scenario, the radiologist's role rises as an unreplaceable analysis of this cartilaginous tube. This exhibit aims to summarize pertinent anatomy and review diverse tracheal diseases, congenital and acquired, through a didactic classification and presentation of the cases, including differential diagnosis, challenges, and limitations.

#### **TABLE OF CONTENTS/OUTLINE**

This is a case-based review of pathologies of the trachea focusing on 1- Pertinent anatomy review. 2- Best imaging methods for tracheal evaluation. 3- Classification of tracheal diseases with illustrative cases by focal vs. diffuse diseases, and the last by increased vs. decreased diameters. 4- Discussion of differential diagnoses. 5- Challenges and limitations on tracheal evaluation by imaging. 6- Take-home messages.

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## Abstract Archives of the RSNA, 2023

CHEE-97

### Proposals for the 9th edition TNM Staging for Thymic Epithelial Tumor - A Guide to Radiologists

All Day Room: Learning Center

Maximiliano Klug, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Unresolved issues of the 8th edition TNM staging for thymic epithelial tumor (TET) are: T category refinement - focus on tumor size; granularity between N categories; better differentiation between intra and extrathoracic metastatic disease. 2- Proposed T Category- T1a ( $\leq 5$ cm) and T1b ( $> 5$ cm) regardless of involvement of mediastinal pleura; T2: invasion of the pericardium, lung, or phrenic nerve; T3: invasion of the brachiocephalic vein, superior vena cava, chest wall, or extrapericardial pulmonary arteries and veins; T4: unchanged, direct invasion of the aorta and arch vessels, intrapericardial pulmonary artery, myocardium, trachea, or esophagus. 3- Proposed N Category- The ITMIG/IASLC lymph node stations are clarified, unchanged two nodal regions: anterior (N1) and deep (N2). N1 includes the thymic bed compartment in the anterior lower neck and prevascular mediastinum. N2 includes tracheobronchial, aortopulmonary window, subcarinal, hilar, internal mammary, and the deep cervical (jugular and supraclavicular) lymph nodes. 4- Proposed M Category- Unchanged. M1a: pleural or pericardial nodules separate from the primary tumor; M1b: pulmonary intraparenchymal nodules, extrathoracic metastases, or any non-regional lymph nodes (e.g. high neck, retro-crural, axillary or extrathoracic lymph nodes).

#### TABLE OF CONTENTS/OUTLINE

1- To describe the proposals for the 9th edition TNM Staging for TET. 2- To discuss the differences from the previous edition, remaining challenges as they pertain to imaging evaluation, and potential future directions.

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## Abstract Archives of the RSNA, 2023

CHEE-98

### Halo and Reversed Halo Signs in Chest CT: Are They Useful?

All Day Room: Learning Center

Adria Roset Altadill, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The halo and reversed halo signs in chest CT may be caused by infections, inflammatory and vascular disorders and neoplastic diseases. These signs combined with ancillary imaging findings, additional information from PET-CT and spectral CT and proper clinical history may help the radiologist reach the final diagnosis.

#### TABLE OF CONTENTS/OUTLINE

The halo and reversed halo signs were initially described and thought to be specific for invasive pulmonary aspergillosis and cryptogenic organizing pneumonia, respectively. However, there is a broad spectrum of causes for these chest CT findings, including infections, inflammatory and vascular disorders and neoplastic diseases. The most common causes of the halo sign in the lung are adenocarcinoma, invasive aspergillosis and septic emboly. Less common causes include bacterial and viral infections, hemorrhagic metastases, vasculitis and other inflammatory disorders. The reversed halo sign is more frequently seen in organizing pneumonia, followed by pulmonary infarcts, invasive mucormycosis and other granulomatous diseases. Despite having lost their specificity, the halo and reversed halo sign combined with ancillary chest CT findings and an adequate clinical background can be useful to narrow the differential diagnosis. Special attention has to be paid to the nodule size, number and morphology in the halo sign. The thickness and distribution of the ring of consolidation and the presence of internal reticulation within the reversed halo sign also need to be evaluated. Moreover, metabolic information from PET-CT and perfusion data from spectral CT may help differentiate pulmonary infarcts from other inflammatory or infectious causes of the reversed halo sign.

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## Abstract Archives of the RSNA, 2023

CHEE-99

### Cystic Lung Disease: The Common, the Rare and the Unusual

All Day Room: Learning Center

Daniel Vargas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

While most radiologists are aware of the most common cystic lung diseases, a group of rare and unusual diseases including genetic syndromes, lymphoproliferative disorders, environmental exposures and congenital anomalies can also result in cyst formation in the lungs. This exhibit will:

1. Review the clinical and imaging features of common and rare cystic lung diseases.
2. Discuss the underlying histopathology in each of these entities and how it translates to imaging findings.
3. Offer the radiologist an approach to help narrow the differential and guide clinical management in the multidisciplinary care of these patients.
4. Review ancillary findings and complications in patients with cystic lung disease.
5. Current concepts in amyloidosis and light chain deposition disease and their role in cyst development in lymphoid interstitial pneumonia.

#### TABLE OF CONTENTS/OUTLINE

1. Lung cyst and cystic lung disease definition
2. Common Cystic Lung Diseases
  - a. Lymphangioliomyomatosis.
  - b. Birt-Hogg-Dube syndrome.
  - c. Pulmonary Langerhans Cell Histiocytosis.
  - d. Lymphoid Interstitial Pneumonia and Current Understanding of the role of Amyloidosis and Light Chain Deposition Disease.
  - e. Desquamative Interstitial Pneumonia.
2. Rare Cystic Lung Diseases
  - a. Neurofibromatosis type 1.
  - b. Nieman-Pick Disease.
  - c. Trisomy 21.
  - d. Vascular Ehlers-Danlos Syndrome.
  - e. Proteus Syndrome.
  - f. Lymphomatoid Granulomatosis.
  - g. Follicular Bronchiolitis.
  - h. Atypical Infections (eg. P Jiroveci).
  - i. Hydrocarbon Pneumonitis.
  - j. Proximal Interruption of the Pulmonary Artery

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## Abstract Archives of the RSNA, 2023

EREE

### Emergency Radiology Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **EREE-1 Ankle and Foot Injuries in ER: A Checklist-Based Approach to Radiographs**

Devpriyo Pal, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To recognize various anatomic bony landmarks on ankle and foot radiographs with CT correlation.2. To understand the pathophysiology and biomechanics of injuries in ankle and foot trauma.3. To be aware of the most commonly used ankle and foot trauma classification schemes.4. To understand the need for accurate diagnosis and characterization of ankle and foot injuries to guide management decisions to ensure optimal clinical outcomes.5. To understand the role of CT in foot and ankle trauma. 6. To review the management of ankle and foot traumatic injuries.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the anatomy of the ankle and foot using illustrations, radiographs, and CT.2. Various radiographic projection series and protocols to diagnose and characterize ankle and foot injury patterns.3. The spectrum of foot and ankle injuries with key concepts in accurate characterization on radiographs with CT correlation.4. Illustrated classifications of ankle and foot traumatic injury. 5. An algorithmic approach to accurately predict and identify subtle injuries.6. Clues to avoid common pitfalls will be included.7. Troubleshooting role of CT to be elucidated.8. Focused review of the management of foot and ankle injuries.

#### **EREE-10 A Guide to Evaluating the Post-robotic and Post-laparoscopic Abdomen**

Jay Pancholi, MBChB, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) To illustrate new surgical techniques with robotic surgery including recent advances in anastomoses.2) To identify common post-operative complications in relation to timing since surgery.3) To highlight review areas for post operative scans.4) To review pearls and pitfalls in distinguishing expected appearances compared to complications.5) To explain considerations when protocolling imaging requests.

#### **TABLE OF CONTENTS/OUTLINE**

Minimally invasive surgical techniques continue to advance with robotic surgery representing one of the most recent innovations. These techniques allow previously difficult anastomoses to be more readily performed. Post operative imaging is a common challenge faced by radiologists. Knowledge of surgical technique and possible complications is important for all radiologists interpreting these scans to ensure appropriate protocolling and accurate diagnosis. The poster will show illustrations of surgical techniques, normal post operative appearances and a variety of complications presented as scrollable cases. The poster will be outlined as:--Surgical advances--Robotic surgical incision sites--New anastomotic techniques--- Minimally invasive colonial anastomosis---Kono-S anastomosis-Expected appearances--Normal free gas relative to day post op--Normal free fluid relative to day post op-Complications--Anastomotic leak--Bowel ischaemia--Vascular injury--- Pseudoaneurysm---AV fistula--Ureteric injury--Lymphatic injury--Incisional hernia

#### **EREE-11 Twisting Around: A Review of the Potential Locations of Torsions**

#### **Awards**

#### **Certificate of Merit**

Laura Cavero Barreras, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To review the pathophysiology of a torsion. - To understand which imaging modality should be ordered depending on the location of the torsion. - To know the possible sites of torsion and review the major imaging findings at each site on the different imaging techniques. - To review the radiological signs of ischemia that may appear as a consequence of torsion and may influence surgical management of the condition.

## TABLE OF CONTENTS/OUTLINE

Torsion is a broad term that describes a twisting of an organ around its mesentery or its vascular pedicle resulting in an impairment of its blood supply. The vein is usually the first vessel affected resulting in venous stasis or ischemia. If left untreated, arterial compromise can occur leading to arterial infarction. For this reason, they are usually surgical emergencies and a prompt diagnosis is essential to avoid organ necrosis or hollow organ perforation. Imaging techniques are necessary to establish the diagnosis. Although intestinal volvulus and gonadal torsion are broadly known, there are other organs that can rarely result in torsion such as the lung, the spleen, the gallbladder, and the Fallopian tube. This presentation aims to review the imaging findings of torsion in all potential locations and identify the signs of ischemia that may occur in this setting.

## EREE-12 Above the Rest: A Review of Upper Cervical Spine Injuries

Jerry Cruz-Rodriguez, BA (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-Radiologists play a crucial role in characterizing acute cervical spine injuries in the emergent trauma setting using an imaging-based morphology approach.- Jefferson fractures involve the anterior and/or posterior arch of C1, lateral mass, or transverse anterior arch, and require CT for detection.- Hangman fractures involve disruption of C2's posterior elements at the pars interarticularis and can be devastating injuries.-OCFs require CT for detection and indicate serious trauma has occurred, potentially causing instability of the atlanto-occipital joint and neurological injuries.-Dens fractures are classified into 3 types, and CT is used to determine the type and guide management decisions.-AOD involves complete separation of the upper cervical spine from the skull base and requires CT for accurate diagnosis.-Traumatic atlantoaxial instability is a potentially devastating unstable injury that can be missed without careful assessment on initial CT scan.-TRS/TRF requires CT to diagnose the degree of subluxation and assess accompanying injuries, with clinical and dynamic imaging assessments needed for rotatory fixation.

## TABLE OF CONTENTS/OUTLINE

A. Introduction  
I Overview  
II AO Spine Upper Cervical Injury Classification  
B. Upper Cervical Spine Injuries  
I Common and uncommon important injuries of the upper cervical spine  
II CT characterization and discussion of typical mechanisms  
III Image review and correlation with AO Spine Classification  
Occipital condyle fractures (OCF) Atlanto-Occipital Dissociation (AOD) Atlantoaxial instability Traumatic Rotatory Subluxation/Fixation (TRS) Atlas (Jefferson) fractures Hangman fractures Odontoid fractures  
C. Conclusion  
D. Self assessment

## EREE-13 Ultrasonographic Diagnosis of Pneumothorax: Legend or Reality?

Gabriela Merigue, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

This study aims to report the importance of chest ultrasound in the evaluation of critically ill patients with pneumothorax, highlighting the need for systematization in chest ultrasound assessment and technical recognition of pneumothorax ultrasound signs. The main echographic signs used in the detection of pneumothorax are: Absence of sliding of the two pleural leaflets, accentuated reverberation (A Lines), absence of comet tail artifacts and B lines and determination of the Pulmonary Point. In the presence of pneumothorax, trapped gas obscures visualization of the underlying pleural line, so that no pulmonary slippage is identified. The systematized technique used in chest ultrasound is based on: use of a high-frequency linear probe (5-12MHz); patient positioning in dorsal decubitus; division of each hemithorax into six quadrants. Each quadrant should be analyzed to ensure identification of the pneumothorax. The use of technically systematized chest ultrasound for the diagnosis of pneumothorax has high sensitivity, bringing a great benefit to critically ill patients, and can be used for diagnosis and decision-making quick conduct.

## TABLE OF CONTENTS/OUTLINE

- Systematization of chest ultrasound evaluation - Normal findings on chest ultrasound - Ultrasonographic findings of pneumothorax - Cases of patients with pneumothorax diagnosed by ultrasound

## EREE-14 Don't Lose Your Head -- Imaging of Atlantooccipital Dissociation and Central Skull Base Fractures

Desmin M. Milner, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Understand normal anatomy of the central/posterior skull base and craniocervical junction.2. Understand various traumatic injuries at the central/posterior skull base and craniocervical junction.3. Understand some mimics of craniocervical junction injury.

## TABLE OF CONTENTS/OUTLINE

1. Review normal anatomy of the central/posterior skull base and craniocervical junction.2. Briefly review CT and MRI imaging protocols in the setting of trauma.3. Review traumatic injuries of the central/posterior skull base and craniocervical junction including: atlantooccipital dissociation, occipital condyle fractures, clival fractures, and transsphenoidal fractures.4. Review of other ligamentous injuries at the craniocervical junction.5. Review mimics of craniocervical junction injury.

## EREE-15 Blunt Cerebrovascular Injuries (BCVI): Diagnosis, Evolution, and Complications

### Awards

#### Certificate of Merit

Elham Beheshtian, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Advances in multidetector CT angiography in the context of multitrauma have led to increased diagnosis of blunt cerebrovascular injuries (BCVI).2. Early BCVI detection and treatment can decrease the risk of complications, such as ischemic strokes, carotid cavernous fistula, and arteriovenous fistulas.3. BCVI is graded from 1-5 on the Biff Scale, based on imaging appearance. The grading system is used to guide patient management and can predict the natural evolution of an injury.

## TABLE OF CONTENTS/OUTLINE

I. Introduction - epidemiology, morbidity and mortality, mechanism, imaging modalitiesII. Biff ScaleA. Pathophysiology and imaging examples of grades 1-5 injuryB. Management implications by grade C. Natural history of an injury, including complicationsIII. Diagnostic considerations 1. Imaging modalities 2. Universal vs. selective screening 3. Imaging follow-upIV. BCVI mimics - fibromuscular dysplasia, atherosclerosis, carotid web, vasospasm, true aneurysmV. Venous injuryVI. Summary

## EREE-16 Peer Learning Pearls: The Most Commonly Missed MSK Diagnosis on the Overnight Shift - Diagnostic Errors and Great Calls

Thais S. Kuwazuru, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The aim of this exhibition is to:- Highlight the most commonly missed musculoskeletal diagnosis identified after Peer Review analysis and the great calls of difficult cases;- Demonstrate practical tips to avoid missing diagnosis;- Review the current concepts about these pathologies;- Show illustrative and didactic cases from our service, specially from emergency and urgent care units.

## TABLE OF CONTENTS/OUTLINE

INTRODUCTION- The greatest difficulties during the night shift and emergency room for the radiologist;- Impact of early accurate diagnosis of these diseases.IMAGING INTERPRETATION- The most commonly missed musculoskeletal diagnosis identified after Peer Review analysis, including:- Fractures: vertebral acute fracture, transdiscal fracture, scaphoid fracture, avulsion fracture of Chopart joint;- Infection: discitis and spondylodiscitis, abscess;- Hematoma and active bleeding;- Other causes of musculoskeletal pain such as longus colli tendinitis, disc herniation;- Great calls - difficult cases.INTERACTIVE CASE-BASED DIDACTICS- Sample cases to illustrate and solidify the concepts;- The main tips that every radiologist working the night shift should know;- Correlation with current literature data.CONCLUSION AND TAKE HOME MESSAGES- Patient assessment in emergency and urgent care scenario very often include imaging investigation;- In order to improve patient outcomes and prevent iatrogenic treatments (or lack of treatment), it is essential to know the imaging patterns of each pathology and the tips to avoid missing diagnosis.

## EREE-17 Murphy's Law: What Can Go Wrong in Robotic and Laparoscopic Surgeries

Daniel L. Cardoso, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Understand the main differences between open surgery, and minimally invasive surgery (MIS). Recognize the anatomy of the abdominal wall. Understand how the abdominal access is performed in MIS. Comprehend expected imaging patterns after MIS. Recognize the complications associated to MIS and its related imaging findings.

## TABLE OF CONTENTS/OUTLINE

INTRODUCTION: Open versus MIS. Modalities of MIS. Anatomy of the abdominal wall, and its relation to the abdominal access in MIS. Expected imaging findings after MIS COMPLICATIONS AFTER MIS: a case-based review - Laparoscopy-related: Epidemiology. Imaging findings. How to proceed? Robotic-related: Epidemiology. Imaging findings. How to proceed? SUMMARY AND SYSTEMATIC APPROACH: what to look for? Preoperative imaging / Postoperative imaging TAKE HOME MESSAGES

### **EREE-18 Don't Look Just for the Bowels: A Comprehensive Review of Noninvasive Vascular Imaging in Abdominal Solid Organ Ischemia**

#### **Awards**

#### **Certificate of Merit**

Hermes Vinicius Pedrini Pereira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the anatomy of intra-abdominal solid organs vascularization.- Expose frequent and infrequent cases of intra-visceral vasculopathies in the context of acute abdomen.- Remember the main parenchymal changes resulting from vascular events and their differential diagnoses.- Tips on how to identify critical findings and report them.

#### **TABLE OF CONTENTS/OUTLINE**

- Concepts of arterial and venous circulatory anatomy and solid organs vascularization.- Circulatory physiology and how it affects the different imaging modalities.- CT and MR protocols and reconstruction techniques, systematically mentioned in the interpretation of our cases.- Imaging aspects of acute vascular events, from the organ's pedicle to its parenchyma.- Intra-abdominal occlusive ischemic events (thromboembolism, torsions, dissections).- Non-occlusive ischemic events (hemodynamic shock, substance abuse).- Other vascular abnormalities that may have clinical repercussions (shunts and malformations).- Correlation between imaging and clinical signs.- Risk factors and pre-existing conditions that can help us think about solid organ ischemia.- Practical information for effective reporting and necessary information for intervention planning, including the critical imaging findings that needs immediate intervention.

### **EREE-19 Friendly Fire: A Rapid Review of Iatrogenic Intrathoracic Injuries Related to Support Devices**

Saumik Z. Rahman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Many common interventions performed by health care providers while placing supporting devices may lead to injuries to the lungs, pleura, heart, or mediastinal structures. These injuries may range from asymptomatic findings managed conservatively to life-threatening injuries requiring emergent surgical or percutaneous intervention. The radiographic and cross-sectional imaging appearance of malpositioned intrathoracic medical devices and complications related to iatrogenic thoracic trauma secondary to medical devices or procedures will be reviewed, and recommendations for clinical teams based upon imaging findings will be discussed.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction.2. Examples of cases:a. Chest tube placement- Pulmonary contusion, laceration, hemothorax, pneumothorax.b. Pacemaker placement- Hemopericardium, pneumomediastinum, pneumothorax, hemothorax, chest wall hematoma.c. Swan-Ganz catheter- Pulmonary artery pseudoaneurysm.d. Enteric tubes- Endobronchial course causing lung injuries, esophageal perforation.e. Central venous catheters- Vascular dissection, vascular perforation, pneumothorax, mediastinal hematoma.3. Conclusion.

### **EREE-2 MR Imaging of Pelvic Emergencies**

Gayatri Joshi, MD (*Presenter*) Royalties from Elsevier.

#### **TEACHING POINTS**

Pelvic pain is a commonly presenting symptom in the Emergency Department (ED) and while ultrasound (US) or computed tomography (CT) are often the initial imaging exam, magnetic resonance (MR) imaging plays a vital role for specific populations (such as the pregnant patient) and in clinical scenarios in which diagnosis relies on the greater sensitivity provided by MR imaging. After reviewing this exhibit, learners should be able to: 1. Understand the role of MR imaging in the emergent setting 2. Proficiently recognize emergent pelvic disorders by MR imaging 3. Utilize best practices for diagnosing pelvic emergencies in the ED, including those of infectious, inflammatory, ischemic, obstructive, traumatic, neoplastic etiologies



## TABLE OF CONTENTS/OUTLINE

This exhibit will: 1. Systematically illustrate the clinical and imaging features of pelvic emergencies that may present in the ED, particularly those of the MSK, vascular, GI GU body systems. The spectrum of pelvic emergencies discussed in this exhibit will include those of infectious, inflammatory, ischemic, obstructive, traumatic, neoplastic etiologies 2. Discuss best imaging practices of the acute pelvis in the ED, with pearls pitfalls for optimizing efficient accurate diagnosis 3. Briefly address relevant management as applicable to the Radiologist to aid in expedient, appropriate management

### **EREE-20 Imaging Features and the Role of Interventional Radiology and Radiation Therapy in Oncologic Emergency**

Akihiro Nakamata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Due to the rapidly increasing elderly population and to the advancements in oncology, there has been an increase in the diagnosis of cancer, and also a rise in oncological emergencies. In oncologic emergencies, radiologists play a major role not only in diagnosis but also in the subsequent treatment of interventional radiology and radiation therapy. Therefore, radiologists should know imaging features and the treatment of oncologic emergencies in the whole body.

## TABLE OF CONTENTS/OUTLINE

The purpose of this exhibit is: 1. To classify oncologic emergencies according to their pathology and location 2. To review oncologic emergencies in the whole body 3. To discuss the clinical and imaging features of the oncologic emergencies 4. To discuss the role of interventional radiology and radiation therapy Table of contents: 1)Subtypes based on imaging findings reflecting the background pathology. 2) Oncologic emergencies of various organs in this presentation. A) Central nervous system: Cerebral herniation Spinal cord compression B) Thoracic: Superior vena cava syndrome Airway obstruction Pericardial effusion with cardiac tamponade Pleural effusion Pulmonary thromboembolism, pulmonary tumor thrombotic microangiopathy(PTTM) Esophagorespiratory fistula Massive hemoptysis C) Abdomen: Abdominal compartment syndrome Biliary obstruction Biliary bleeding Intestinal obstruction Intestinal bleeding Bowel perforation Urinary tract obstruction Abdominal bleeding

### **EREE-22 Dental Trauma: A CT Perspective for Tooth-Saving Precautions**

#### Awards

#### Certificate of Merit

Erhan Akpinar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To provide a basic anatomical overview of dental trauma with illustration of regions susceptible to trauma. To inform which dental fractures are important to save the tooth, and what to report for clinicians to get information about treatment options with basic points. To review the common terminology and classification of dental trauma/fractures with emphasizing the conditions that create or increase the risk of tooth loss. To present basic structural report templates for dental trauma reporting To discuss the CT imaging findings related to treatment of dental trauma and complications with illustrative cases.

## TABLE OF CONTENTS/OUTLINE

1. Dental Anatomy, Weak Points and Crucial Structures to Keep The Tooth Alive / Functional 2. Terminology and Current Classification of Types of Dental Trauma 3. Fractures that require treatment within a few hours • Crown-Root Fractures • Root Fractures • Alveolar Fractures • Extrusive and Lateral Luxation • Avulsion 4. Fractures that require treatment within the first 24 hours • Complex Crown Fractures (Involving Pulp Structures) • Concussion and Subluxation • Intrusive Luxation 5. Treatment Options and Complications 6. A Structural Report Template for Dental Trauma

### **EREE-23 Ultrasound in Acute Care: Point-Of-Care**

Roddie Moraes Neto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recognize the practical applications of point of care ultrasound in emergency care; highlight patient positioning and how to acquire images in some exams performed with POCUS; learn the well-established ultrasound imaging standards in the literature.

## TABLE OF CONTENTS/OUTLINE

Introduction: thorax, heart, abdomen, vessels; case-based review: thorax (pleural effusion, consolidation, pulmonary edema, pneumothorax), heart (pericardial effusion, pericarditis, vena cava, cardiogenic shock), abdomen (cholelithiasis, appendicitis, FAST, urolithiasis, testicular torsion / epididymo-orchitis, intussusception), vessels deep vein thrombosis, jugular thrombosis, ultrasound-guided peripheral venous catheter, aorta abdominal aneurysm); conclusions and key takeaways.

## **EREE-24 Genitourinary Oncologic Emergencies: A Radiologists' Guide**

Mamie Gao, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Describe the best imaging approach for evaluating oncologic emergencies affecting the genitourinary tract. 2. Identify imaging manifestations of genitourinary oncologic emergencies. 3. Identify potential pitfalls in imaging genitourinary oncologic emergencies. 4. Recognize the important role of radiologists in the multi-disciplinary setting to communicate and collaborate findings in emergent cases.

### **TABLE OF CONTENTS/OUTLINE**

1. Genitourinary oncologic emergencies and imaging approach. 2. Multimodality imaging features of genitourinary oncologic emergencies. a) Hematuria: hemorrhagic cystitis. b) Obstructive uropathy: tumor burden and post-treatment (nephrostomy tube malfunction, ileal conduit). c) Infectious: pyelonephritis, renal abscess, prostatic abscess, cystitis related to prior treatment (BCG, ileal conduit). d) Miscellaneous Post-Treatment (radiotherapy, chemotherapy, surgery, urinary diversion): hemorrhage, fistulas. 3. Role of radiology in management. 4. Potential mimics and pitfalls (underdistended urinary bladder, residual malignancy, emergencies unrelated to malignancy, trauma).

## **EREE-25 Stercoral Colitis- Diagnosis, Complications and Management**

John J. Hines JR, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Background Information/Purpose Stercoral colitis is an inflammatory process typically involving the sigmoid colon and rectum, due to chronic constipation and rectal distention, causing increased intraluminal pressure, and eventually leading to ischemia, ulceration, perforation, peritonitis and death from feculent peritonitis and sepsis if not treated. The purpose of this exhibit is to familiarize radiologists with the spectrum of CT imaging features of uncomplicated and complicated stercoral colitis and its mimics. Key Anatomic or Pathophysiologic Issues, Imaging Findings or Imaging Technique: Common CT findings of stercoral colitis include: 1.) Stool filled and distended colon with focal colonic wall thickening 2.) Pericolonic/presacral fat stranding. 3.) Presence of localized extraluminal gas, discontinuity of the colonic or rectal wall, and extraluminal gas in cases of perforation.

### **TABLE OF CONTENTS/OUTLINE**

Educational Goals/Teaching Points 1. Review the risk factors, pathophysiology and clinical presentation of stercoral colitis. 2. Discuss the importance of early recognition of uncomplicated stercoral colitis, and the role of the radiologist in bring this diagnosis to the attention of the clinical team. 3. Illustrate the imaging findings of complicated and uncomplicated stercoral colitis on CT, including typical and atypical imaging findings, and unusual complications. 4. Review imaging mimics of stercoral colitis such as diverticulitis, infectious colitis, inflammatory bowel disease and ischemic colitis. 5. Discuss the management of complicated and uncomplicated stercoral colitis.

## **EREE-26 Typical Findings Under Atypical Lenses: When to Suspect Endometriosis on Emergency CT**

Joao J. Stern, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Illustrate the different appearances of endometriosis on CT. Share tips, pearls and pitfalls to suspect and diagnose endometriosis on pelvic computed tomography. Correlate relevant findings from computed tomography and magnetic resonance imaging of the pelvis to consolidate learning.

### **TABLE OF CONTENTS/OUTLINE**

- introduction- common sites of involvement- image translation to CT of classic sign with MR correlation- discussion of the main findings of endometriosis on CT scan of the pelvis.

## **EREE-27 Pain in the Bump: Acute Abdomen in Pregnancy - MRI Clues for On-Call Residents**

Mili Rohilla, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To acquaint on-call residents with MR imaging signs in the acute abdomen. To make residents comfortable with MR abdomen in pregnant patients

### **TABLE OF CONTENTS/OUTLINE**

Acute abdomen is a common ER presentation in pregnant patients, and can pose a diagnostic challenge due to the physiological changes during pregnancy. Magnetic resonance imaging (MRI) is a useful diagnostic tool due to its high contrast

resolution and absence of ionizing radiation. Radiology residents need to be cognizant of the MR imaging findings of acute abdomen in pregnancy and differential diagnoses to interpret them accurately and promptly. We will discuss the common system-wise presentations and MR findings: Gastrointestinal System: Appendicitis, acute pancreatitis, inflammatory bowel disease, intestinal obstruction. Hepatobiliary system: Acute cholecystitis, choledocholithiasis, HELLP syndrome. Reproductive System: Ectopic pregnancy, ovarian torsion, placental abruption, uterine rupture. Urinary System: Urolithiasis, acute pyelonephritis, renal abscess. Cardiovascular System: Ovarian vein thrombosis, Budd-Chiari syndrome, acute aortic syndrome. It is important to promptly diagnose and manage the underlying cause of acute abdomen in pregnancy to prevent adverse maternal and fetal outcomes.

### **EREE-28 Ocular Trauma: What Should We Keep In Mind?**

Omar Andres A. Pantoja Burbano I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To perform a systematic approach to the most important aspects of the ocular trauma. - Recognize the principal anatomic structures of the orbit and understand the compromise of such in the different traumatic injuries. - Identify the most relevant signs of ocular and orbit trauma in diagnostic imaging, with specific emphasis in orbit tomography. - Learn how to classify the ocular trauma according to the involvement of the anterior or posterior segments and the presence of ocular globe rupture or burst. - To consider and exclude the most relevant differential diagnoses.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Anatomy of the ocular globe. 3. Anterior segment lesions. 4. Posterior segment lesions. 5. Ocular globe rupture and foreign bodies. 6. Pitfalls and differential diagnoses. 7. Take away points. 8. References.

### **EREE-29 A Quick Guide to Pelvic Pain in the Emergency Room: MR Imaging of the Acute Female Pelvis**

Elissandra M. Lima, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the anatomy of the female pelvis on MRI- Understand the role of MR imaging in the evaluation of gynecologic emergencies- Illustrate the imaging findings non-obstetric and obstetric causes- Discuss their differential diagnosis, imaging pitfalls, and complications

#### **TABLE OF CONTENTS/OUTLINE**

1. Normal MRI anatomy of uterus and adnexa with cyclical variation 2. Advantages and disadvantages of MR Imaging 3. Non-obstetric and obstetric causes 4. Imaging assessment of critical and prevalent gynecological diseases in the emergency room 5. Pelvic inflammatory disease, including endometritis, cervicitis, salpingo-oophoritis, pyosalpinx, and tubo-ovarian abscess 6. Leiomyoma torsion and fibroid degeneration 7. Endometriosis 8. Obstetric causes, including ectopic pregnancy, molar pregnancy, retained products of conception, placenta accreta spectrum 9. Other pelvic abnormalities 10. Potential imaging pitfalls and how to avoid them 11. Complications

### **EREE-3 Shattered Chests: Lessons from Thoracic Trauma Cases**

Manuel Sebastian S. Paez Alvarez SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To present a comprehensive overview of thoracic trauma cases, highlighting the most common and not-so-common pathologies. To familiarize radiologists and radiology residents with diagnostic clues of thoracic imaging in trauma patients. To analyze key features and provide tips to identify pitfalls of traumatic chest CT.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Importance of thoracic trauma imaging and its implications in emergency settings. Pulmonary parenchymal injury: a. Pulmonary contusions b. Pulmonary lacerations c. Pulmonary hematomas d. Traumatic pulmonary hernias Pleural space injury: a. Pneumothorax b. Hemothorax Chest wall injury: a. Rib fractures b. Sternal fractures c. Chondrocostal, chondrosternal, and cartilage injuries d. Sternoclavicular dislocations Tracheobronchial injury: a. Laceration of the trachea and bronchi Other injuries: a. Boerhaave Syndrome b. Aortic injury c. Iatrogenic cardiac perforation d. Traumatic diaphragmatic hernias This educational exhibit aims to provide a comprehensive understanding of thoracic trauma cases, emphasizing the importance of recognizing imaging findings for accurate diagnosis. Radiologists and radiology residents will benefit from the illustrative cases and diagnostic tips presented, improving their skills in traumatic chest CT interpretation.

### **EREE-30 The Contrast-Enhanced FAST Exam (cFAST) In Blunt Thoracoabdominal Trauma**

Melanie P. Caserta, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The Focused Assessment with Sonography in Trauma (FAST) is one of the most frequently performed ultrasound examinations in adults and children in the acute care setting. However, it has significant limitations since intraabdominal fluid is used as a surrogate marker for intraabdominal injury (IAI). Adding an ultrasound contrast agent to the exam can substantially improve the diagnostic accuracy of identifying solid organ injuries and rapidly identify significant organ lacerations and active intraperitoneal hemorrhage. The cFAST exam is a rapid, standardized, and systematic ultrasound examination that balances a comprehensive organ survey with the time constraints of highly structured and algorithmic trauma patient care. After reviewing this case-based exhibit, the learner will: - Understand the limitations of the traditional FAST exam and advantages of adding an ultrasound contrast agent (UCA)- Describe the cFAST exam protocol and set-up as part of the trauma resuscitation team- Recognize the limitations of the cFAST exam and next steps in imaging.

## TABLE OF CONTENTS/OUTLINE

1. Objectives 2. Background a. The evolution of the FAST exam b. Contrast-enhanced ultrasound in trauma 3. Imaging a. Equipment, technical requirements, and supplies i. IV access ii. Selection of the UCA iii. Ultrasound equipment b. Integration into the trauma team c. The contrast-enhanced FAST exam protocol i. Patient population ii. Exclusion criteria iii. Special populations iv. Safety Considerations v. UCA preparation Contrast Administration vi. Imaging Protocol vii. Limitations 4. Pediatric and adult case presentations

## EREE-31 Searching for Causes of Preventable Death - Role of Early Postmortem CT in Trauma Patients

Lain Ibanez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To show an accurate protocol to perform a post-mortem CT in patients who died after severe trauma in a first-level trauma center
- To describe the main radiological features of different early deceased trauma patients and their potential relationship with the cause of death
- To identify the misplacement of medical devices in patients who died from trauma
- To determine if there was preventable death based on clinical and radiological findings

## TABLE OF CONTENTS/OUTLINE

- Performing an early post-mortem CT protocol and CT technique
- Analysis of radiological and clinical features, injuries, and medical device misplacement
- Determining causes of death and their avoidability
- Conclusions

Outline: Despite the improvement in the management of trauma patients there is still a percentage who die during or immediately before receiving hospital care and before having an imaging test. This reason jointly with an increasingly low rate of autopsies, prevents to understand the causes of death and whether or not it had been avoidable. Since June 2022 the trauma and radiology teams at our level 1 trauma center decided to carry out a program to study preventable mortality in trauma patients who died before or during initial care. In this presentation we will show the design of our project, how we accomplish post-mortem CT studies and also present our preliminary results. We will show a clinical-radiological correlation of our cases, analyze the main injuries, misplacement of medical devices, causes of death and whether its avoidability. Finally the main concerns we faced and major limitations are exposed.

## EREE-32 Beyond the Diagnosis of Appendicitis: The Role of Computed Tomography in the Nonoperative Management of Acute Appendicitis in Adults

Eliko Tanaka, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Diagnosis of acute appendicitis using computed tomography (CT) is highly accurate and established. The treatment of appendicitis includes surgery and conservative treatment, and the role of conservative treatment is expanding. However, conservative treatment has challenges, such as treatment failure and malignant tumors. CT diagnosis plays a significant role in determining the treatment plan. This presentation describes CT findings related to the indications for conservative treatment of appendicitis, as well as CT findings related to the course of conservative treatment. Additionally, it discusses challenges in CT diagnosis associated with conservative treatment, such as recurrent appendicitis or tumor complications, and presents a case series. Teaching points include: 1. Understand the indications and contraindications for conservative management of appendicitis and its CT findings 2. Familiarize CT findings related to the course of conservative treatment for appendicitis 3. Recognize the potential complications of conservative management, such as treatment failure, malignancy, recurrent appendicitis, and identify the corresponding CT findings

## TABLE OF CONTENTS/OUTLINE

1. Indications and contraindications of conservative treatment in the World Society of Emergency Surgery (WSES) guidelines 2. CT findings that suggest a high risk of failure in conservative treatment and a need for extended surgery 3. Imaging findings during the course of conservative treatment 4. Recurrent appendicitis and its CT findings 5. Differential diagnosis between tumor and non-tumor cases

EREE-33 Blanca Lumbreras-Fernandez, MD (*Presenter*) Nothing to Disclose

## Role of MR in the Diagnosis of Suspect Metastatic Spinal Cord Compression: A Pictorial Imaging Review With Medical and Radiological Scales

## TEACHING POINTS

The learning

objectives of this exhibit are: 1-To illustrate the spectrum of metastatic spinal cord compression (MSCC) and the scales and scores that should be included in the radiological report. 2- To discuss the image findings of MSCC with emphasis in epidural lesions.

### TABLE OF CONTENTS/OUTLINE

1-Pathophysiology of MSCC, including demographics. 2-Review of common imaging findings in the management guidelines for MSCC. Relevance of the inclusion in the radiological report of the Epidural Spinal Cord Compression (ESCC) Scale and Spinal Instability Neoplastic Score. 3- Evaluation of the most representative cases of MSCC collected and their differential diagnosis with other causes of cord compression, specially epidural lesions in a non-traumatic setting through imaging cases from our center. 4- Conclusions: Acute compressive myelopathy is a medical emergency. Early diagnosis and treatment improve the neurological prognosis. MR is the technique of choice to confirm the diagnosis or establish an alternative one as well as to determine the level, extension, degree of compression, stability of the spine and presence of myelopathy. The incorporation of the ESCC scale and SINS to the radiological report improves multidisciplinary communication and the adequacy of urgent treatment of MSCC.

### EREE-35 Never Fear! Peer Learning in Emergency Pelvic and First Trimester Ultrasound

#### Awards

#### Certificate of Merit

Melissa F. Tannenbaum, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Women presenting with acute pelvic pain and/or bleeding can pose a diagnostic challenge in the emergency setting. The differential diagnosis may be broad, and these symptoms are often indications for pelvic ultrasound (US). Interpretation of pelvic US may be tricky and a source of confusion and misinterpretation. Furthermore, cognitive biases in imaging interpretation can lead to diagnostic errors. Familiarity with common and uncommon pelvic US imaging findings is imperative to assist with prompt and accurate diagnosis. Awareness of potential biases when interpreting pelvic US further helps hone interpretation. This exhibit will illustrate the imaging findings of multiple causes of pelvic pain/ bleeding in non-pregnant and first trimester pregnant patients. Diagnostic errors and biases in interpretation related to these cases will also be highlighted.

### TABLE OF CONTENTS/OUTLINE

This exhibit will review pelvic US peer learning cases and highlight teaching pearls and potential pitfalls in diagnosis. 1. Review common and uncommon causes of acute pelvic pain/bleeding in non-pregnant patients, including ovarian/ fallopian tube torsion, cysts, hydrosalpinx, fibroids, benign and malignant adnexal lesions, tuboovarian abscess. 2. Review causes of pelvic pain/bleeding in first trimester pregnant patients, including ectopic pregnancy in different locations, ruptured heterotopic pregnancy, retained products of conception, uterine AVM. 3. Review non-OB/GYN causes of pelvic/abdominal pain for which pelvic US was the initial imaging modality, including appendicitis, appendiceal mucocele, diverticulitis. 4. Review potential biases in pelvic US imaging interpretation with examples from our cases.

### EREE-36 Plain Abdominal Radiography in the Emergency Room

#### Awards

#### Certificate of Merit

Carla Suarez Silva, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Plain abdominal radiographs continue to be a fundamental tool in emergency rooms.- We present abdominal X-rays performed in a third-level hospital over the last few years. In all cases, the radiographs helped guide the patient's management.- The semiology of abdominal simple radiography is presented in a didactic and interactive way to achieve an adequate interpretation.- Knowing the radiological analysis of the abdominal radiograph continues to be useful for the comprehensive management of the patient.

### TABLE OF CONTENTS/OUTLINE

This education exhibit presents a collection of 25 cases of abdominal X-rays. All cases will be presented in a structured and interactive format, beginning with an overview of the patient's clinical data, followed by the X-ray image(s), the detail of the radiological findings using visual aids, pearls and pitfalls, and the final diagnosis providing correlation with other imaging methods. Furthermore, taking advantage of the fact that all the X-rays were performed urgently, a green, yellow, or red circle will appear in the top right corner of all radiographs indicating the severity of the pathology presented by the patient. To facilitate the reading of this presentation, the name of the radiological density that will help us make an adequate interpretation of the abdominal radiograph will be displayed at the bottom of each image. The table of contents is: •

Introduction • Teaching points • Table of Contents • How to approach an abdominal X-Ray? • Check all the clinical data • Technical aspects • Radiological densities • Cases • Case 1: Patient 1 • ? • Case 25: Patient 25

### **EREE-37 DECT in the Acute Setting - Bowel Trauma**

Tanche Wang, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Highlight the value of Dual Energy CT (DECT) in traumatic bowel injury. Understand the principles of DECT and iodine overlay map. Illustrate the use of DECT and iodine overlay maps to improve diagnostic confidence and sensitivity in detecting bowel injury, contrast extravasation, free fluid, and reducing metal artifacts.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background  
2. DECT and Bowel Injury  
a. DECT Increases Conspicuity of Hyperattenuating Free Fluid  
b. Lack of Iodine Uptake in Injured Bowel  
c. Metal Artifact Reduction  
d. Contrast Extravasation  
3. Conclusion

### **EREE-38 Beyond Aortoenteric and Aortocaval Fistulas - Intraabdominal Fistulas: Imaging Findings and Importance of Early Identification**

Amalia Aranaz Murillo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Intraabdominal fistulas are uncommon but can be catastrophic if not identified and treated promptly. Multiphasic multidetector CT angiography (angio-MDCT) is the initial imaging choice for diagnosis.  
2. The imaging signs of intraabdominal fistulas can be divided into direct and indirect signs and emergency radiologists should be familiar with them and be aware of potential mimics and maskers to avoid misdiagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

This poster aims to provide an overview of intraabdominal fistulas, their imaging findings, and the importance of early identification and familiarize the radiologist with the mimics and maskers of intraabdominal fistulas. Intraabdominal fistulas are a rare but life-threatening condition if they are not identified and treated promptly. Imaging plays a crucial role, and angio-MDCT is often the initial imaging technique. The imaging signs of intraabdominal fistulas can be divided into direct and indirect signs. Direct signs include visualization of the fistula tract, extravasation of contrast medium, and aortic graft migration, but these signs are rarely observed. Indirect signs are often the only available evidence and include abnormalities of the aortic wall, irregularities of the interface between the aorta and the fistulizing entity, and the presence of gas or fluid collections. Although the most frequent intraabdominal fistulas are aortoenteric and aortocaval fistula, other types of fistulas and potential mimics can occur, and one should know and be aware of them. Familiarity with the different imaging modalities and the various mimics and maskers of fistulas can help in accurate diagnosis, ultimately leading to improved patient outcomes.

### **EREE-39 Kicking, Biting, and Screaming: Common Radiological Patterns and Mechanisms of Equine-Related Injuries Presenting to the Emergency Department**

#### **Awards**

#### **Certificate of Merit**

Trae C. Brooks, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Thoracic injuries may occur in over half of horse-related trauma cases, including clavicle and rib fractures as well as hemothoraces and pneumothoraces. Clinical and imaging evaluation is crucial to rule-out underlying thoracic trauma (Chad Ball, 2007). Children who receive an injury while unmounted are likely to have more severe injuries than those who were mounted, with most trauma localized to the abdomen (Grace Wolyncewicz, 2018). Fractures are one of the most common injuries in mounted equestrians and should be suspected in patients presenting after a fall from a horse. The initial height of the rider, velocity of travel, and vulnerable position of landing are all key factors contributing to the severity and location of the fracture and need for prompt imaging and evaluation.

#### **TABLE OF CONTENTS/OUTLINE**

We will begin with an overview of horse-related trauma from a historical and epidemiologic perspective. Using a simplified algorithm, we will then discuss the classic patterns of various trauma such as fall from or with a horse while mounted and injuries sustained from direct injury from a horse while unmounted such as bite, kick, or stomp/trample injuries. Finally, we will use case-based examples with multimodality imaging to show the broad extent of injury concerning various systems - organized into Torso, Musculoskeletal/Extremity and Central Nervous System/Spine.

### **EREE-4 CT of Appendicitis in Adults: Problematic Scans and Scenarios**



Katz, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

-A non-trivial minority of CT examinations performed for suspected appendicitis - regardless of the protocol utilized - end up being challenging to interpret for a variety of reasons, in adults -This exhibit will review problematic scenarios and situations involving CT performed for right lower quadrant pain in non-pregnant adults -Review uncommon/atypical/unusual presentations of appendicitis and its potential mimics and potential pitfalls, as well as some of the more common problematic scenarios -Demonstrate examples of these CT scenarios from our practices -Briefly overview QA and medical-legal issues in suspected appendicitis in adults with an emphasis on CT

### TABLE OF CONTENTS/OUTLINE

Outline: -Oral contrast - to use or not to use on CT? -Subtle/early findings -Perforated appendicitis- review of the literature - The right lower quadrant 'phlegmon' -Potential pitfalls and confounders - right colonic diverticulitis, 'secondary' appendicitis, distal/tip appendicitis, the non-visualized appendix, chronic/relapsing appendicitis, and resolving appendicitis -Appendicitis and rotation anomalies -Stump appendicitis -Appendicitis in hernias -Appendicitis and underlying neoplasms -Additional potential errors, quality assurance issues, and medical-legal issues

### EREE-40 Abdominal Hemorrhage on MRI: Findings and Pitfalls

Bertin Mathai, BEng, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Non-traumatic intra-abdominal hemorrhage can be due to multiple etiologies and can be a source of acute abdominal pain and life threatening blood loss. Prompt radiologic identification and localization of hemorrhage is crucial for appropriate decision-making and management. Acute intra abdominal hemorrhage is usually diagnosed by computed tomography (CT). Magnetic resonance imaging (MRI), is less frequently used in the acute setting, and radiologists may be less familiar with the appearance of blood and potential etiologies of hemorrhage, such as ruptured aneurysms and hemorrhagic masses. The signal characteristics of hemorrhage can vary depending on both the age of the hemorrhage as well as its background location. The superior soft tissue resolution of MRI can help characterize intra-abdominal blood products in cases where CT is indeterminate, and can help diagnose an underlying mass in cases where it is obscured by blood on CT. This educational exhibit will discuss the timeline of hemorrhage with respect to MRI signal, show multiple causes of spontaneous intra abdominal bleeding, and highlight scenarios where MRI can provide added value in diagnosing the source of hemorrhage.

### TABLE OF CONTENTS/OUTLINE

1) Background 2) Molecular and Magnetic Timeline of Blood 3) Optimizing MRI Protocol to Visualize Blood 4) Differential Diagnosis / Cases 5) Literature Review 6) Conclusion 7) References

### EREE-41 Pre-Hospital Emergency Medicine: A Spectrum of Imaging Findings

Ryan Whitesell, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

This educational exhibit aims to: 1) Increase awareness and understanding among radiologists of the principles of Pre-Hospital Emergency Medicine 2) Review imaging which illustrates techniques used by Emergency Medical Services (EMS) providers 3) Highlight pertinent radiologic findings which call attention to potential complications arising from pre-hospital care.

### TABLE OF CONTENTS/OUTLINE

Topics covered within this presentation include: 1) Introduction to Pre-Hospital Emergency Medicine--Including Purpose of Emergency Medical Services (EMS) and Scope of practice of EMS providers; 2) Airway Management--Including Endotracheal intubation and Surgical airways; 3) Cardiopulmonary Resuscitation--Including Use and effects of mechanically-assisted chest compressions, Radiologic findings of decompressive needle thoracostomy (DNT), and Efficacy of intraosseous vascular access for resuscitation and IV contrast administration; 4) Techniques of Patient Immobilization--Including Imaging appearance and appropriate positioning of cervical spine collars, Imaging appearance and clinical benefit of hemostatic tourniquets, and Imaging appearance and appropriate positioning of pelvic binders

### EREE-42 Immediate-CT with Hybrid Emergency Room System for Severe Trauma Patients

Naoyuki Inagaki, RT (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Several studies have shown that trauma whole-body CT has facilitated the early identification of major injuries and a reduction in mortality and morbidity.
- HERS (Hybrid-Emergency Room System) is an all-in-one concept of emergency room with the functions of CT scanner, interventional radiology and surgery, and useful in critical trauma treatment strategies.

HERS in trauma treatment can be performed from diagnosis to treatment without transporting the patient, so it is possible to significantly reduce the time.

#### **TABLE OF CONTENTS/OUTLINE**

•We devised a new trauma treatment strategy using HERS. This is "immediate CT protocol" in which CT scan is performed immediately after arrival at the hospital. •The immediate-CT(i-CT)protocol is optimized for CT scans immediately after arrival at the hospital. •This protocol enabled rapid diagnostic imaging for critical traumatized patients. And, can provide more information than ultrasound, X-ray used in "primary survey". It is also possible to find major damage earlier. •By detecting brain injury, aortic injury, retroperitoneal hematoma, lung injury, and spine injury, early activation of injuries that require referral to other departments is now possible. And we call it "BARLS". •We demonstrated that the i-CT protocol leads to reduction of the time from arrival to CT scans without adverse events. As a result, we have contributed to the planning of treatment strategies and early activation of specialized treatment. •This novel trauma treatment strategy can contribute to improving the life-saving rate

#### **EREE-43 Multiphase CT Angiography Using a Time-Variant Color Map: How Can It Contribute to the Improvement of the Diagnosis and Management of the Acute Stroke?**

Isabel Herrera (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Multiphase CT Angiography (mCTA) offers several advantages over single-phase CTA (sCTA) and contributes to improving the diagnosis and management of the acute ischemic stroke (AIS). - mCTA increases interrater agreement for both proximal and distal vessel occlusions compared with sCTA and reduces time needed to detect the occlusion. - mCTA helps to characterize the thrombus length and thrombus permeability, which may influence the treatment. - mCTA improves characterization of collateral status, that may be a useful fact in the management of some patients with AIS. - mCTA has potential value in delineating the core ischemic area and detecting tissue at risk. - mCTA can also be useful in hemorrhagic stroke. It improves prediction of intracerebral hemorrhage expansion and improves the evaluation of venous vessels and the diagnosis of vascular malformation. - mCTA may be useful in the characterization of stroke mimics.

#### **TABLE OF CONTENTS/OUTLINE**

Multiphase CTA (mCTA) provides time-resolved images of the cerebral vasculature that are useful in patients with acute stroke. An arterial (red color) and 2 venous phases are acquired ( peak venous phase in green, and late venous phase in blue) are acquired. We review the role and potential of CTA in patients with ischemic and hemorrhagic stroke, its advantages over sCTA, its limitations and its usefulness in the evaluation of stroke mimics.

#### **EREE-44 Visceral Ischemia: What Should the Emergency Radiologist Know?**

Silvia Cayon Somacarrera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe the key radiological features of visceral ischemia, including cases of liver, gallbladder, pancreas, spleen, renal, stomach and intestine ischemia. To understand the pathophysiology behind those radiological findings

#### **TABLE OF CONTENTS/OUTLINE**

The infarct's shape depends on the distribution of the vascular tree. The organs with hilum show wedge-shaped infarcts (eg. liver, kidney, spleen) while the organs without hilum show infarctions that extend through the different wall layers (eg. intestine). We collected the most illustrative cases of visceral ischemia of the last years in our institution to show the key characteristics to make a quick and accurate diagnosis. Mesenteric ischemia has a very high mortality rate if not properly treated. The key findings to evaluate are: mesenteric vessels, intestinal walls and the existence of gas (pneumatosis/pneumoperitoneum). Hepatic ischemia is uncommon due to its double vascular supply. The most typical finding is wedge-shaped hypodense areas but we can also find rounded or tubular areas parallel to the bile ducts. Renal ischemia is most often caused by renal artery embolism. Focal infarcts are depicted as hypodense triangular areas. Complete infarcts present as generalized hypoattenuation of the renal parenchyma. Splenic ischemia is relatively common. Acute infarcts are shown as triangular hypodensities, subacute infarcts as cystic images while in chronic infarcts calcifications or atrophy can be seen. Cortex preservation may be observed in complete renal/splenic infarcts due to collateral circulation.

#### **EREE-45 Evaluating Primary and Secondary Endpoints in Intracranial Hemorrhage AI Algorithms - A Review of Current Market Algorithms and a Proposed Retraining Model for Improving Patient Triage**

Raviteja Suryadevara, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The implementation of AI algorithms for intracranial hemorrhage (ICH) in the ED setting can expedite detection, triaging, and timely intervention. Most AI algorithms, in addition to their binary primary endpoint of -ICH or +ICH, also collect secondary outcome endpoint data (processing time, bleed location, bleed volume calculation) Based on trauma volume and workflow of



ED practice, these algorithms should be employed accordingly. Retrospectively retraining AI algorithms to collect data on secondary outcome endpoints should be a flexible option. Retraining AI for additional primary endpoints allows for improved triaging. Specifically, in patients with intracranial hemorrhages, additional triaging of the ED reading list based on bleed volume and subtype would allow for communication and subsequent timely treatment of patients with the highest potential morbidity or mortality first. Any proposed AI retraining model, though technically sound, has challenges with acquisition of new patient data for retraining.

#### **TABLE OF CONTENTS/OUTLINE**

Workflow in the ED for suspected traumatic/spontaneous ICH. Where AI algorithms can help in the ED setting. Currently approved 510(k) premarket cleared algorithms for ICH detection. Quantitative evaluation of ICH AI algorithms based on primary and secondary outcomes. Retraining AI algorithms for secondary endpoints: technical logistical challenges. Conclusion. References

### **EREE-46 Life-Threatening Acute Aortic Lesions Beyond Acute Aortic Syndrome**

#### **Awards**

#### **Cum Laude**

Laura Martos Ramio, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

TEACHING POINTS: - Many potentially severe acute aortic lesions exist beyond the classical spectrum of acute aortic syndrome (AAS). - Life-threatening acute aortic conditions may result from traumatic injuries, iatrogenic lesions, infectious complications or aneurismatic rupture.

#### **TABLE OF CONTENTS/OUTLINE**

TABLE OF CONTENTS: Aortic lesions can be life-threatening and require immediate medical attention. Imaging techniques play a critical role in the diagnosis because the clinical presentation is variable and nonspecific. Moreover, CT and MRI provide fundamental information for surgical planning. AAS is a well-known medical emergency with high mortality when left untreated. However, it may show an atypical appearance and many other potentially severe acute aortic lesions beyond the classical AAS also demand immediate diagnosis. These include traumatic injuries, iatrogenic lesions, infectious complications and aneurismatic rupture. Significant traumatic injuries are classified as intramural hematomas, pseudoaneurysms and aortic ruptures. Iatrogenic lesions are usually the result of invasive coronary interventions or aortic stent placement. Mycotic pseudoaneurysms are included in the spectrum of infectious aortitis. Ruptured thoracic aneurysms are rarely imaged due to their lethality. Finally, we review atypical presentations of AAS that also need to be considered, such as intimal intussusception or dissection extension into the pulmonary arteries.

### **EREE-47 Non-Obstetric Emergencies in Pregnancy: Imaging Pathway, Findings, and Special Considerations**

Isabelle D. Gauthier, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Imaging pregnant patients require special considerations and non-ionizing radiation imaging is preferred (US/MRI). However, CT in trauma and acute settings should not be delayed due to concern for radiation. 2. Knowledge of specific non-obstetric pathologies affecting pregnant patients and their imaging appearance is crucial for timely and accurate diagnoses of acute and traumatic conditions. 3. Shared decision making? with the patient is important to weight risks and benefits of imaging tests if time permits.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review risks and safety of different imaging modalities in pregnancy (dose of fetal radiation and associated risks, iodinated and gadolinium contrast agents). 2. Special considerations when imaging pregnant patients (positioning in scanner, contrast reaction and management, recommendations regarding lead shielding). 3. Trauma imaging in pregnancy: Review imaging pathway and traumatic pathologies at higher risk in pregnant patients (retroperitoneal hemorrhage?, liver, spleen, renal and bladder injuries?). 4. Acute non-traumatic pathologies: incidence and pathophysiology in pregnancy, imaging pathway and findings, for example: (a) Abdomen: Acute cholecystitis, choledocholithiasis, appendicitis, renal stone/urosepsis, bowel obstruction, colitis, (b) Chest: Pulmonary embolism, pneumonia, (c) Neuro: Cerebral venous thrombosis, seizures, stroke, (d) Vascular: Complicated AVM, deep venous thrombosis, arterial occlusion.

### **EREE-48 Pictorial Review of Orbital Emergencies**

Wen Wang, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points: 1. A simplified anatomic checklist-based approach can enable an emergency radiologist to accurately and efficiently identify acute temporal bone pathology, and this approach will be reviewed in this exhibit. 2. The radiologist plays

an important role by identifying key imaging findings and providing diagnoses that can direct treatment by prompting an emergency physician to admit a patient for inpatient management, order a surgical consult, or order further imaging to check for related complications. The absence of these findings are also pertinent negatives that enable clinicians to proceed with treatment in the ED or discharge a patient with outpatient follow-up. 3. This exhibit will review traumatic and acute non-traumatic pathology in a case-based format, with emphasis on key imaging findings that affect management and prognosis.

#### **TABLE OF CONTENTS/OUTLINE**

I. Relevant anatomic review of the orbit II. Checklist for traumatic and non-traumatic pathology III. Non-traumatic Pathologies: i. Infection Preseptal cellulitis Postseptal cellulitis Dacryocystitis Subperiosteal abscess ii. Non-infectious inflammatory pathology Sarcoidosis Optic neuritis iii. Detachment Retinal detachment Choroidal detachment IV. Traumatic pathologies: i. Fractures Blowout fractures/wall fractures Lefort II and III fractures Naso-orbito-ethmoid fractures Optic canal fracture ii. Penetrating trauma Paint gun injury Gunshot injury

#### **EREE-49 We've Got Your Back: How Radiologists Can Aid Surgical Decision Making By Using the AO Spine Classification System**

Andrew Simmerman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

AO Spine Injury Classification systems offer reliable and clinically relevant morphology descriptions for spinal trauma imaging. Subaxial cervical and thoracolumbar injuries are classified as A: compression, B: tension band/distraction, C: displacement/translational. A B have subtypes. The motion segment is the spine's functional unit, by which tension band and displacement injuries are labeled. Fracture morphology, neurologic signs, and patient factors influence conservative or surgical management. MRI and dynamic radiography help assess for ligamentous injuries. Rigid spines and osteoporosis affect treatment. Cervical spine specifics include facet injury, disc herniation, cerebrovascular injury, and unique ligamentous injuries at the occiput-C1-C2 levels.

#### **TABLE OF CONTENTS/OUTLINE**

Overview Goals of classification and radiological reporting Spinal bone and ligamentous anatomy Motion segment and tension band concepts Subaxial cervical and thoracolumbar injuries Type A: Compression Type B: Distraction Type C: Translation Type F: Facets (subaxial) Modifiers Indeterminate/incomplete tension band injuries Stiffening and metabolic bone diseases Critical disc herniation Cerebrovascular injury Upper cervical injuries A: Bone-only B: Ligamentous without complete separation C: Translation

#### **EREE-5 Broken Beauty: How Can I Make a Good Interpretation of a Facial Trauma on CT?**

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To review the facial radiological anatomy and to remember the different systems that organize it.- To propose a systematic approach for the evaluation of the facial bone mass, depending on the functional relationships between the structures.- To know the typical radiological patterns of facial fractures, taking into account some "key ideas" that we must remember, because they sometimes modify the therapeutic management.- To recognize the complications that can be associated with facial fractures depending on their location.- To emphasize the importance of making an useful radiological report for the requesting physician, with an organized description of the fractures.

#### **TABLE OF CONTENTS/OUTLINE**

1. Radiological facial anatomy: 1.1. Three thirds system: upper (frontal), middle (from upper orbital rim to upper maxilla) and lower (mandible). 1.2. Facial buttress system: there are 4 vertical and 4 horizontal buttresses that emphasize the functional relationships between the different facial bones.2. Systematic assessment of the facial mass: 2.1. Fractures of the upper third (frontal). 2.2. Fractures of the middle third: isolated (e.g, nasoseptal fractures) or complex (Le Fort fractures, fractures of the nasal-orbital-ethmoidal complex and fractures of the zygomatic-maxillary complex). 2.3. Fractures of the lower third (mandibular). Within each section, we will discuss typical radiological fracture patterns and "key ideas" to remember.3. Complications that may be associated depending on the affected buttress.4. How to make an adequate radiological report useful for the requesting physician, without falling into the error of making a "shopping list" with the affected bones.

#### **EREE-50 The Role of CT in Non-occlusive Mesenteric Occlusion for Diagnosis, Therapeutic Strategy, and Patient Management**

#### **Awards**

**Magna Cum Laude**

Akitoshi Inoue, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Non-occlusive mesenteric ischemia (NOMI) is characterized by segmental and skipped bowel ischemia caused by vasospasm without mechanical stenosis in the superior mesenteric artery (SMA). NOMI is a life-threatening condition, and the mortality is high. Even in survival cases, nutrient malabsorption called short bowel syndrome resulting from bowel resection for necrotized small bowel may require lifetime intravenous nutrition. CT depicts spastic SMA and branches and is considered a diagnostic tool instead of invasive angiography. Regarding the bowel, heterogeneous imaging findings, including absent enhancement, hemorrhagic necrosis, pneumatosis, and paper-thin wall appearance, can be observed, which reflects skip-segmental bowel necrosis on macroscopic findings. Additionally, CT plays an essential role in predicting the severity of bowel ischemia and reperfusion as the imaging findings reflect dynamic pathophysiology caused by vasospasms in the superior mesenteric region.

## TABLE OF CONTENTS/OUTLINE

1. To illustrate the etiology and pathophysiology of NOMI 2. CT image findings in the superior mesenteric artery and branches, and small bowel 3. Challenge to predict the viability of ischemic bowel on CT 4. Case presentation with tips and pitfalls for NOMI 5. Differential diagnosis (mesenteric artery occlusion, mesenteric venous occlusion, strangulated bowel obstruction, and pneumatosis intestinalis) 6. Summary

## EREE-51 **Where Is the Catheter Tip? Chest Radiograph Findings of Incorrect Placement Comparison With CT and Normal Radiographs**

Masafumi Sakai, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

In the intensive care unit, catheters and tubes are inserted into patients. Incorrect catheter placement can lead to various complications; detecting incorrect placement on chest radiographs is essential for early intervention and improved patient outcomes. However, incorrect catheter placement is easily overlooked if there is no comprehensive understanding of the three-dimensional anatomy of the chest and correct placement of the catheter on chest radiographs. Furthermore, new devices have also been introduced recently, which radiologists need to be familiar with. The purpose of this exhibit is: 1. To explain chest radiographic findings of incorrect catheter placement correlating with CT and comparison with the normal position. To explain the complications and pitfalls associated with incorrect catheter placement

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Case presentation | Central venous catheter Arterial misplacement Misplacement in small veins (azygos veins, etc.) Catheter fragmentation Pitfalls (vascular anomaly, etc.) | Swan-Ganz catheter Misplacement of the peripheral pulmonary artery (PA). Complications (pseudoaneurysm of the PA) | Subcutaneous implantable cardioverter defibrillator Misplacement in anterior mediastinum | Endotracheal tube One-lung ventilation Pitfalls (tube tip shifts in accordance with neck flexion and extension) | Chest tube Misplacement in the interlobar fissure Misplacement in the lung | Epidural catheter Misplacement outside the epidural space | Etc. 3. Summary 4. Conclusion

## EREE-52 **Dual Energy CT in Acute Inflammatory and Infectious Processes of the Head and Neck. The 4 P: Protocols, Post-processing, Pearls and Pitfalls**

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Dual energy CT (DECT) images combine data from a wide range of energy acquisitions without impacting patient dose. In contrast to single energy CT (SECT), which uses only energy around 70 keV, virtual monochromatic images (VMI) can be reconstructed at any level of energy within a 40-150 keV range. Lower energies allow better delimitation of inflammatory tissue enhancement although this increases image noise ratio. Higher energies enable the virtual subtraction of iodine contrast, which improves calcium identification and reduces metallic artifacts. Material decomposition maps allow better identification of neck abscesses. The main purposes of this exhibit are: 1- To describe the DECT image acquisition protocols and post-processing methods. 2- To illustrate DECT findings and main tips in head and neck inflammatory and infectious diseases within different locations and its SECT correspondence. 3- To outline the differential diagnosis, potential pitfalls in DECT, and how to avoid them.

## TABLE OF CONTENTS/OUTLINE

1-DECT protocol. 2-Post-processing techniques (VMI and material decomposition maps). 3-Case-based image examples of DECT and SECT correspondence for ears, orbits, paranasal sinuses, salivary glands, dental, pharyngeal, and para-pharyngeal mucosal inflammatory and infectious processes. 4- Pearls, pitfalls, and differential diagnosis in DECT images.

## EREE-53 **At Arm's Length: Upper Extremity CT Angiography and Neurovascular Pathology**

Andrew Sinensky, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1) Upper extremity (UE) vascular pathology can be conceptualized anatomically: the shoulder, arm, elbow, forearm, and hand. 2) CT angiography (CTA) and digital subtraction angiography (DSA) play a vital role in diagnosis and management of acute neurovascular pathology. 3) The thoracic outlet is the neurovascular outflow of the UE; thoracic outlet syndrome (TOS) results as the consequence of disruption of this outflow. 4) Non-traumatic vascular pathology of the UE is less common than lower extremity pathology and is often thromboembolic or anatomic in etiology. 5) Trauma of the UE has classic artery/nerve injury pair associations, such as at Guyon's canal (ulnar artery + nerve) and the mid-humerus (deep brachial artery + radial nerve).

## TABLE OF CONTENTS/OUTLINE

1) UE Anatomy A) Arterial B) Venous C) Brachial plexus D) Thoracic outlet 2) CTA and DSAA) Technical considerations B) Pitfalls 3) Other Modalities A) Ultrasound B) MR 4) Atraumatic A) Central (thromboembolic, aortic dissection) B) Peripheral (atherosclerosis, aneurysm/pseudoaneurysm, vasospasm) C) External compression (TOS, quadrilateral space syndrome) D) Systemic (vasculitis, connective tissue disorders) E) Dialysis grafts and fistulas 5) Blunt and Penetrating Trauma A) Vascular injury (pseudoaneurysm, arteriovenous fistula, laceration) B) Neurologic injury (transection, compression) C) Neurovascular injuries by region (shoulder, arm, forearm, elbow, wrist, hand) 6) Management A) Surgical B) Endovascular C) Post-operative imaging considerations D) Complications

## EREE-54 Imaging Spectrum of Extremity Vascular Emergencies: CTA-Angiographic Correlation

Christian L. Pecoraro, DO (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1) To discuss the common mechanisms for traumatic and non-traumatic peripheral vascular emergencies as well as their management 2) Differentiate pertinent imaging features of traumatic and non-traumatic peripheral vascular emergencies 3) To juxtapose CT angiography and conventional angiographic findings for each etiology

## TABLE OF CONTENTS/OUTLINE

1) Basic mechanisms of vascular injury 2) The advantages and drawback of CTA compared to conventional angiography in the setting of traumatic vascular injury 3) Common imaging features and clinical signs that suggest vascular emergency 4) CT angiographic and conventional angiographic correlation for several traumatic peripheral vascular emergencies -Laceration - Transection -Intramural Hematoma--Arteriovenous Fistula -Vasospasm -Intimal Dissection -Pseudoaneurysm -Thrombosis 5) CT angiographic and conventional angiographic correlation for several non-traumatic peripheral vascular emergencies - Embolism -Vasculitis -Acute DVT -May Thurner's Syndrome—Vessel Entrapment 6) Discussion of each etiology's pertinent imaging, clinical features, as well as their management

## EREE-55 Ischemic Bowel: A Challenging Imaging Diagnosis

Francisco Delgado (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-Briefly examine the epidemiology and common causes of ischemic bowel (IB) disease.-Master anatomic and morphologic imaging findings of IB on CT.-Understand recommendations for additional imaging to increase diagnostic certainty, including the utility of arterial phase or multiphase CT imaging.-Learn indications for surgical vs. nonsurgical management of IB and the role of the radiologist in guiding management.

## TABLE OF CONTENTS/OUTLINE

CT is the preferred imaging technique for diagnosing ischemic bowel, as it outperforms laboratory and physical exam findings in reliability and accuracy. However, CT may only detect nonspecific signs of mesenteric ischemia, bowel dilatation, bowel wall thickening, bowel obstruction, mesenteric edema, mesenteric stranding, mesenteric vascular engorgement, and ascites. In this exhibit, we review the causes of IB including vascular (thrombosis, embolism, vasculitis), anatomic (volvulus, neoplastic), and systemic (hypoperfusion). Each diagnosis is accompanied by multiple CT cases highlighting specific and subtle imaging findings with a focus on imaging findings which alter management. Follow-up via imaging (CT angiography, MRI, MR angiography) or intervention (colonoscopy, surgical, catheter based) are reviewed with multimodality cases. Timely and accurate diagnosis of IB is crucial for guiding management, preserving bowel viability, and reducing morbidity/mortality and the radiologist is central in this clinical cascade.

## EREE-56 The Diagnostic Ability of Postmortem Imaging for the Cause of Death

Yu Nakaki (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Postmortem imaging is widely used to identify the cause of death. Although postmortem imaging can help to determine the cause of death, its diagnostic ability depends on the subject and the methodology applied. In >65% of cases, postmortem CT

(PMCT) is useful for identifying the cause of unnatural deaths because traumatic changes can be detected. On the other hand, since cardiac disease, e.g. myocardial infarction, lethal arrhythmia, and pulmonary thromboembolism cannot be diagnosed by PMCT, it is useful in only 40-50% of natural deaths. Therefore, contrast-enhanced PMCT and postmortem MRI (PMMRI) have been introduced. We describe the diagnostic ability of postmortem imaging, demonstrate the causes of deaths that can be diagnosed by postmortem imaging, and alert to interpretation pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

1. Diagnostic ability of PMCT for •Unnatural deaths •Natural deaths 2. Diagnostic ability of contrast-enhanced PMCT 3. Diagnostic ability of PMMRI 4. Causes of death that can be diagnosed by postmortem imaging •Aortic dissection •Aortic aneurysm rupture •Sub-arachnoid hemorrhage •Cerebral hemorrhage •Gastrointestinal bleeding/occlusion/perforation •Pulmonary thromboembolism 5. Pitfalls of postmortem imaging

#### **EREE-57 Obstetric Ultrasound: What Not to Miss for the ER Radiologist**

Saubhagya Srivastava, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Obstetric ultrasound is an excellent tool to assess maternal, fetal, and placental parameters in all trimesters due to its noninvasive nature, ease of availability, portability, and lack of ionizing radiation. It is the first-line method used in the evaluation of pregnant patients. 2. Transvaginal ultrasound is an excellent modality in the first trimester for adequate characterization of fetal abnormalities. 3. The focus of second and third trimesters should be on the evaluation of fetal viability and potentially life-threatening abnormalities.

#### **TABLE OF CONTENTS/OUTLINE**

1. Normal pregnancy parameters to look for in emergent obstetric ultrasounds. 2. Classification of obstetric emergencies by maternal, fetal, and placental anomalies. 3. Maternal abnormalities a. First trimester i. Ectopic pregnancy 1. Adnexal 2. Abdominal ii. Interstitial and cervical implantation iii. Molar pregnancy b. Second and third trimesters i. Uterine dehiscence/rupture ii. Cervical and adnexal abnormalities 4. Fetal abnormalities a. First trimester i. Major fetal structural abnormalities ii. Nonviable pregnancy b. Second and third trimesters i. Fetal hemorrhage ii. Amniotic fluid abnormalities iii. Doppler abnormalities 5. Placental abnormalities a. Placenta Previa b. Placental abruption c. Vasa Previa d. Placenta accreta spectrum 6. Pitfalls in the diagnosis of common obstetric emergencies a. Corpus luteal cyst vs Ectopic pregnancy b. Post C-section changes vs uterine dehiscence c. Placenta previa vs contraction

#### **EREE-58 An Approach to Lateral Shoulder Impact Injuries: What the Radiologists Need to Know**

Michael K. Lee (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the normal anatomy of the shoulder using radiographs. 2. Varying injuries can be sustained from lateral shoulder impacts (LSIs), including soft-tissue and osseous injuries. 3. Systematic approach for LSIs is essential to avoid missing injuries. 4. Dual-energy computed tomography (DECT) can be used to support the radiological evaluation of LSI injuries. The shoulder girdle is often injured and requires imaging in lateral impacts (e.g. in sports or pedestrian impacts), and can account for up to 4% of emergency department visits. Injuries may involve the clavicle, humerus, scapula, rotator cuff muscles, and the acromioclavicular and glenohumeral joints. To increase diagnostic accuracy, systematic search patterns are often utilized by radiologists. A systematic approach to common injuries encountered in LSIs may be useful for radiologists and trainees who evaluate acutely presenting patients.

#### **TABLE OF CONTENTS/OUTLINE**

1. Disclosures 2. Learning Objectives 3. Shoulder Anatomy and Stability 4. Clavicular Fractures 5. Acromioclavicular Fractures 6. Scapular Fractures 7. Proximal Humeral Fractures 8. Anterior Shoulder Dislocations 9. Dual-Energy CT in LSI 10. References

#### **EREE-59 A Technical Perspective on CT Perfusion Pitfalls and Roadmap for Troubleshooting**

Ahmed W. Moawad, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Illustrate the acquisition protocols for CTP in stroke patients- Introduce the perfusion parameters and thresholds for identifying core infarction and penumbra- Highlight different image processing algorithms- Demonstrate workflow for post processing software- Case based review of technical pitfalls of CT perfusion processing and acquisition

#### **TABLE OF CONTENTS/OUTLINE**

\* Introduction about acquisition of CTP and its parameters\* Diagnostic criteria for stroke/penumbra and threshold for each parameter \* Different types of image processing: Maximum slope technique and Deconvolution. \* General workflow for automated post-processing software.\* Technical pitfalls during acquisition:# Patient motion- Effect of patient interscan

motion on image registration.- Streak artifact as a result of intrascan motion- Motion correction algorithms. # Head position- Perfusion asymmetry due to head tilt\* Types of technical pitfalls in CTP processing: # Different CT perfusion thresholds for infarction.# Image alignment and registration pitfalls- Skull stripping and brain segmentation algorithm # Arterial inflow (AIF) selection pitfalls.- Arteries to use an input Criteria of correctly selected AIF- Troubleshooting AIF selection # Region of interest (ROI) selection pitfalls- Optimum position of the venous ROI- Troubleshooting ROI selection.# Time attenuation curves (TAC) pitfalls- Normal characteristics of the TAC- Bolus arrival time and first moment time- Curve Truncation

## **EREE-60 Beyond Bones on the Trauma Spine CT: Critical Injuries in the Nonfractured Spine; a Case-based Review of Subtle But Important Nonosseous Findings the Neurosurgeon Needs to Know**

### **Awards**

#### **Certificate of Merit**

Brad Wright, PhD,MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

\* A trauma spine CT that is negative for fracture may have subtle but important traumatic findings that should prompt an MRI for further workup, because they may require surgical intervention. These findings include signs of unstable ligamentous injury and signs of potential cord compression. \* Widening of an anterior disc space suggests an unstable hyperextension injury, with rupture of the anterior longitudinal ligament.\* Widening of an interspinous distance suggests an unstable hyperflexion injury, with rupture of the posterior ligamentous complex.\* Widening of one or both atlantooccipital joints and widening of one or both C1-C2 facet joints suggests atlantooccipital subluxation and atlantoaxial subluxation, respectively, with capsular injury and potential injury to other ligaments.\* Although spinal epidural hematomas and disc herniations are better evaluated on MRI, they can often be identified on CT, especially if they are large and more likely to require surgery.

#### **TABLE OF CONTENTS/OUTLINE**

\* Introduction\* Hyperextension injuries\* Hyperflexion injuries\* Atlantooccipital and atlantoaxial subluxation\* More obvious malalignment (with fractures): distraction injuries and dislocations\* Spinal epidural hematoma and disc herniation

## **EREE-61 Mesenteric Pathologies in Emergency Imaging**

Christian Gomez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Describe the anatomy of the peritoneum, mesentery and omentum.-Review mesenteric pathologies in a systemic approach with multi-modality imaging.-Differentiate commonly encountered mesenteric pathologies according to imaging and clinical characteristics.-Understand which mesenteric pathologies require follow-up or acute intervention.

#### **TABLE OF CONTENTS/OUTLINE**

Mesenteric abnormalities are often encountered during emergency imaging. The imaging findings are often nonspecific and encompass a wide range of pathologies. In this exhibit, we review a spectrum of diseases with key imaging and clinical findings. We also highlight patient symptomology, key diagnostic features, potential acute complications, and follow up recommendations.This exhibit will review the anatomy of the peritoneal cavity, mesentery, omentum, and the peritoneal fluid circulation. Pathologies discussed include:-blunt and penetrating trauma?-secondary infiltration of the mesentery from edema or bowel inflammation?-varying stages of sclerosing mesenteritis?-sclerosing encapsulating peritonitis?-tuberculosis; omental infarct ?-primary and secondary mesenteric malignancies - carcinoid, dermoid, lymphoma, metastases, carcinomatosis, primary mesenteric mesothelioma, desmoplastic round cell, GIST, and mesenteric paraganglioma ?-cystic lesions - pseudomyxoma peritonei, inclusion cyst, duplication cyst, lymphangioma, and pseudocyst.

## **EREE-62 10 Points That Force You to Think About Intraabdominal Compartment Syndrome**

Almudena Gil Boronat, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) 2. Role of body CT in evaluation abdominal compartment syndrome

#### **TABLE OF CONTENTS/OUTLINE**

Background: Revision of intra-abdominal hypertension and intra-abdominal compartment syndrome. • Definition • Risk factors • Recognition of suspicious clinical situation and analytical findings Identification of characteristic CT features associated with IAH and ACS. • Determining the etiology • To describe the standardized measurements used in CT to radiologically suggest the diagnosis • To propose 10 key points to not miss the diagnosis • Limitations of CT Algorithm for diagnosis of this entity and management of the patients. Conclusion Bibliography.



## **EREE-63 Computed Tomographic Angiogram (CTA) of the Upper Extremities**

### **Awards**

#### **Certificate of Merit**

Richard Tsai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points: With the advancement of cross-sectional imaging and sub-mm isotropic data acquisition, computed tomographic angiography (CTA) has become an excellent non-invasive diagnostic tool for the evaluation of the upper extremity vasculature. CTA is able to evaluate for vessel patency, irregularity, and achieve the anatomic detail needed in pre-operative planning. It is generally performed in the setting of trauma, but can also be used to evaluate other causes and sources of acute limb ischemia, and vasculitides. In this review, the normal vasculature and common anatomic variations will be presented, with a focus on trauma, acute limb ischemia, and vasculitis.

#### **TABLE OF CONTENTS/OUTLINE**

This exhibit is on the RadioGraphics Needs List under Emergency Radiology: Upper extremity CT angiography. This exhibit will: 1) Discuss the imaging technique and rationale for upper extremity CTA 2) Illustrate normal anatomy and commonly encountered anatomic variants 3) Illustrate the utility of upper extremity CTA for the evaluation of trauma, vasculitis, acute limb ischemia, and pre-operative planning 4) Describe pitfalls in interpretation of upper extremity CTA Outline: Normal anatomy and common anatomic variants Imaging protocols and interpretation Pitfalls: -Streak (instrumentation, contrast bolus on ipsilateral side) -Motion -Outrunning the bolus Trauma: -Occlusion -Vasospasm -Active extravasation -Pseudoaneurysm -Arteriovenous fistula Acute limb ischemia: -Thromboembolism -Stents and complications Vasculitis: -Takayasu's -Buerger's -Scleroderma/CREST syndrome

## **EREE-64 CT of Knee Fractures and Dislocations in Adults: Diagnosis, Grading, and Management Implications**

David Dreizin, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. CT is indicated for any distal femur fracture with possible articular involvement, due to easily missed coronal plane (Hoffa) fractures which displace further if unrecognized. 2. Patellar comminution associated with transverse fracture is often missed without CT, leading to potential loss of fixation with tension band wiring. Low profile 3D matrix/basket plates are increasingly used for patellar fractures shown to be comminuted at CT. 3. Patella baja is common with early severe osteoarthritis in patients with partial patellectomy for severely comminuted inferior pole fractures. 4. Medial tibial plateau fractures are complex injuries often reflecting fracture dislocation with associated ACL and lateral collateral ligament damage and dislocation of the rest of the plateau from the femur. 5. The PTA (posterior tibial slope) and mTPA (medial tibial plateau) angles can be used to determine side of compression for primary plating.

#### **TABLE OF CONTENTS/OUTLINE**

1. Contemporary CT imaging utilization for high-energy fractures- includes comparison with x-ray and MRI 2. Distal femur. i. classification- AO/OTA system ii. Patterns of injury/biomechanics iii. CT for surgical approach and hardware selection iv. Complications 3. Patella. i. classification- AO/OTA and its limitations ii. Patterns of injury/biomechanics iii. CT for surgical approach and hardware selection iv. Complications 4. Tibia. i. classification- Schatzker and 3 column concept (Luo) ii. Patterns of injury/biomechanics iii. CT for surgical approach and hardware selection iv. Complications 5. Conclusion/summary

## **EREE-65 What You Should Know to Improve the Quality of Contrast-enhanced CT Under ECMO?**

Fuyuki Washizuka (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To learn about hemodynamics when using extracorporeal membrane oxygenation (ECMO). To understand the relationship between the degree of residual native ejection fraction and the flow rate in the ECMO system when using veno-arterial ECMO (VA-ECMO). To learn about contrast-enhanced CT precautions and contrast methods under the use of ECMO. To learn the pitfalls of contrast-enhanced CT when using veno-venous ECMO (VV-ECMO). To learn how to ensure contrast-enhanced CT under more complex assisted circulation.

#### **TABLE OF CONTENTS/OUTLINE**

A. Changes in blood flow over time during VA-ECMO use. B. ECMO is divided into two categories, with VA-ECMO subdivided into three according to left ventricular ejection fraction (LVEF) and ECMO flow rate. C. Tips for successful contrast-enhanced CT in special hemodynamic situations when using VA-ECMO. D. Secrets to ensure successful contrast-enhanced CT when using VV-ECMO.

## **EREE-66 A Hidden Killer: Abdominal Pseudoaneurysms and Their Diagnostic Challenge**

Rodado Aranguren, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To understand the pathophysiology and etiological spectrum of visceral pseudoaneurysms, as well as their potential complications that can lead to urgent abdominal pathology. To define the radiological findings that guide the diagnosis of a pseudoaneurysm and its complications in the different imaging tests.

### TABLE OF CONTENTS/OUTLINE

Pseudoaneurysms are abnormal focal dilations of the arterial vessels, generally produced by a disruption of the arterial wall that conditions the passage of blood through it, but remaining contained by the tunica adventitia or the perivascular soft tissues (unlike true aneurysms consisting of focal arterial dilations formed by all layers of the arterial wall). Among the possible causes of arterial wall damage that originates pseudoaneurysms are inflammatory processes, trauma, and iatrogenesis due to invasive procedures. Abdominal visceral pseudoaneurysms can develop a series of complications that entail high morbidity and mortality, generally divided into two large groups: those derived from compression phenomena of adjacent structures due to mass effect, and those derived from aneurysm rupture with bleeding into different spaces and structures. Through this work we will carry out an orientation to the radiological management of pseudoaneurysms and their complications, reviewing the typical findings described in the literature and illustrating them with several cases from our hospital.

### EREE-67 **Body MRI in Acute Abdomen: Primer for the On-call Radiologist and Case Based Review**

Ashlesha S. Udare, MBBS, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

-To evaluate the appropriateness of Body MRI in acute abdomen. -To understand the importance of abbreviated protocols in an emergency setting. -To know the typical and atypical imaging features of various acute abdominal emergencies and the appearance of incidental emergent findings via a case-based review.

### TABLE OF CONTENTS/OUTLINE

Acute Abdomen: When to do MRI?: Iodinated contrast contraindication-Renal insufficiency. History of serious contrast allergy. Failed contrast-enhanced study. Pregnancy-SAR, localiser planning. Problem-solving tool-Clinical Vs CT/US mismatch-Get a "better look!". ACR appropriateness guidelines. Technical Pearls for Body MRI in acute conditions: Micro-protocolling, monitoring scans, fast sequences, safety concerns. Case-based review of various acute abdomen Body MRIs: Gastro-intestinal emergencies (appendicitis, cholecystitis, cholangitis, diverticulitis, hepatic pyogenic abscess). Acute gynaecological conditions (ovarian torsion, massive ovarian edema, tube-ovarian abscess, fibroid degeneration, hemorrhagic cyst, ruptured ovarian cystic lesion) Acute pregnancy related cases (Ectopic pregnancies, placental abnormalities). Acute genito-urinary cases (Pyelonephritis/renal abscess, peniletrauma, scrotal trauma, epididymis-orchitis, priapism) Musculoskeletal injuries presenting as acute abdomen (core muscle injuries, abdominal wall hernias/hematomas, avulsion injuries). Cardiovascular cases (acute aortic syndromes, PE). Miscellaneous: Post-intervention, Post-transplant (renal vein thrombosis, GVHD), Oncological emergencies (ruptured HCC, SVC syndrome. Incidental emergent findings (pneumoperitoneum, hemoperitoneum)

### EREE-7 **Uncoupling the Forefoot From the Midfoot: Experience and Review of Lisfranc Injuries**

Victor Rodriguez-Laval, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To understand the anatomy of the Lisfranc ligament complex and its importance. To review the most prevalent injury mechanisms, classifications, and treatment options. To present the X-ray and CT findings in the emergency room, surgical procedures and post-treatment imaging.

### TABLE OF CONTENTS/OUTLINE

We reviewed the Lisfranc injuries over the previous ten years in our institution and chose the most representative cases. The normal and pathologic anatomy will be highlighted using a multimodality approach that includes plain radiographs, CT with 3D reconstructions. A case-based methodology will be used to cover the whole spectrum of injuries, from Lisfranc ligament sprains to homolateral and divergent fracture-dislocation type injuries, and this will be followed by additional discussion. Also, a brief overview of typical classification schemes, operation approaches, gradation of injury, and postoperative imaging will be presented. It is important to understand the anatomy and injury pattern to be able to diagnose Lisfranc injuries because a delay on the diagnosis increases the risk for midfoot instability, deformity and debilitating osteoarthritis. Given the often subtle initial radiographic findings, maintaining a high index of suspicion with a low threshold to obtain supplemental imaging is key in reducing miss rates. As Lisfranc injuries comprise only a small fraction of overall foot injuries, a periodic review of the salient imaging findings is essential.

### EREE-8 **Acute Large Bowel Diverticulitis: A Pictorial Review**



Sara F. Pineiro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Acute large bowel diverticulitis is a common reason of emergency department visits and when complicated it may end up in urgent gastrointestinal surgery. Computer tomography (CT) remains as the primary diagnostic tool in the diagnosis and staging of acute diverticulitis and its complications. Our radiologic report is essential for the surgeon to establish a treatment and to determine an outcome as well as for the exclusion of alternate causes of pathology. We recommend using international diverticulitis staging classifications (as WSES Classification or modified Hinchey classification) to improve our communication with surgeons. In this educational communication, we aimed to illustrate the key CT imaging features of diverticulitis and its complications including perforation, phlegmon, abscess, ascending septic thrombophlebitis (phylephlebitis), bleeding, intestinal obstruction, and fistula.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction, Reporting CT findings, Anatomy check, Complications, To take home notes

#### **FREE-9 Imaging the Acute Complications of Gender-Affirming Surgeries: A Primer in the Emergency Radiology Setting**

#### **Awards**

#### **Cum Laude**

Siddhi Hegde, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Gender-affirming surgeries (GAS) and their complications are critical for radiologists to understand. GAS is often tailored to the patient; there is a diverse spectrum of post-operative appearances and complications. Typical postoperative anatomy may imitate pathology if not identified correctly. Radiologists' diagnostic expertise, knowledge of institutional GAS and common complications, and their ability to collaborate with multidisciplinary clinical team, enables them to offer valuable insights on institutional practices and guide appropriate next steps for complications. We will highlight the diagnostic features of the acute complications that may arise following gender-affirming surgeries and provide an overview of the ideal workup in the acute setting.

#### **TABLE OF CONTENTS/OUTLINE**

Describe expected imaging appearance of post-GAS neoanatomy, including common terminology Review multi-modality emergent imaging [ultrasound, plain film, retrograde urethrogram (RUG), Computed Tomography (CT)] review of common and "can't miss" complications Neourethral- anastomotic leaks, diverticula, fistulae, stenoses/strictures Transmasculine prostheses/device/implant - abscess, hematoma, malpositioning Bladder or rectal injury after vaginectomy (leading to fistulae) Postoperative bleeding Silicone emboli Providing gender-affirming care during imaging and reporting Understand ideal workup and unique imaging protocol considerations Discuss pitfalls of imaging in the acute setting, pearls for long-term follow-up

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-1

### **Ankle and Foot Injuries in ER: A Checklist-Based Approach to Radiographs**

All Day Room: Learning Center

Devpriyo Pal, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To recognize various anatomic bony landmarks on ankle and foot radiographs with CT correlation. 2. To understand the pathophysiology and biomechanics of injuries in ankle and foot trauma. 3. To be aware of the most commonly used ankle and foot trauma classification schemes. 4. To understand the need for accurate diagnosis and characterization of ankle and foot injuries to guide management decisions to ensure optimal clinical outcomes. 5. To understand the role of CT in foot and ankle trauma. 6. To review the management of ankle and foot traumatic injuries.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the anatomy of the ankle and foot using illustrations, radiographs, and CT. 2. Various radiographic projection series and protocols to diagnose and characterize ankle and foot injury patterns. 3. The spectrum of foot and ankle injuries with key concepts in accurate characterization on radiographs with CT correlation. 4. Illustrated classifications of ankle and foot traumatic injury. 5. An algorithmic approach to accurately predict and identify subtle injuries. 6. Clues to avoid common pitfalls will be included. 7. Troubleshooting role of CT to be elucidated. 8. Focused review of the management of foot and ankle injuries.

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## Abstract Archives of the RSNA, 2023

EREE-10

### A Guide to Evaluating the Post-robotic and Post-laparoscopic Abdomen

All Day Room: Learning Center

Jay Pancholi, MBChB, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) To illustrate new surgical techniques with robotic surgery including recent advances in anastomoses. 2) To identify common post-operative complications in relation to timing since surgery. 3) To highlight review areas for post operative scans. 4) To review pearls and pitfalls in distinguishing expected appearances compared to complications. 5) To explain considerations when protocolling imaging requests.

#### TABLE OF CONTENTS/OUTLINE

Minimally invasive surgical techniques continue to advance with robotic surgery representing one of the most recent innovations. These techniques allow previously difficult anastomoses to be more readily performed. Post operative imaging is a common challenge faced by radiologists. Knowledge of surgical technique and possible complications is important for all radiologists interpreting these scans to ensure appropriate protocolling and accurate diagnosis. The poster will show illustrations of surgical techniques, normal post operative appearances and a variety of complications presented as scrollable cases. The poster will be outlined as: -Surgical advances--Robotic surgical incision sites--New anastomotic techniques--- Minimally invasive colonial anastomosis---Kono-S anastomosis-Expected appearances--Normal free gas relative to day post op--Normal free fluid relative to day post op--Complications--Anastomotic leak--Bowel ischaemia--Vascular injury--- Pseudoaneurysm---AV fistula--Ureteric injury--Lymphatic injury--Incisional hernia

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-11

### Twisting Around: A Review of the Potential Locations of Torsions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Laura Cavero Barreras, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To review the pathophysiology of a torsion. - To understand which imaging modality should be ordered depending on the location of the torsion. - To know the possible sites of torsion and review the major imaging findings at each site on the different imaging techniques. - To review the radiological signs of ischemia that may appear as a consequence of torsion and may influence surgical management of the condition.

#### TABLE OF CONTENTS/OUTLINE

Torsion is a broad term that describes a twisting of an organ around its mesentery or its vascular pedicle resulting in an impairment of its blood supply. The vein is usually the first vessel affected resulting in venous stasis or ischemia. If left untreated, arterial compromise can occur leading to arterial infarction. For this reason, they are usually surgical emergencies and a prompt diagnosis is essential to avoid organ necrosis or hollow organ perforation. Imaging techniques are necessary to establish the diagnosis. Although intestinal volvulus and gonadal torsion are broadly known, there are other organs that can rarely result in torsion such as the lung, the spleen, the gallbladder, and the Fallopian tube. This presentation aims to review the imaging findings of torsion in all potential locations and identify the signs of ischemia that may occur in this setting.

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## Abstract Archives of the RSNA, 2023

EREE-12

### Above the Rest: A Review of Upper Cervical Spine Injuries

All Day Room: Learning Center

Jerry Cruz-Rodriguez, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Radiologists play a crucial role in characterizing acute cervical spine injuries in the emergent trauma setting using an imaging-based morphology approach.- Jefferson fractures involve the anterior and/or posterior arch of C1, lateral mass, or transverse anterior arch, and require CT for detection.- Hangman fractures involve disruption of C2's posterior elements at the pars interarticularis and can be devastating injuries.-OCFs require CT for detection and indicate serious trauma has occurred, potentially causing instability of the atlanto-occipital joint and neurological injuries.-Dens fractures are classified into 3 types, and CT is used to determine the type and guide management decisions.-AOD involves complete separation of the upper cervical spine from the skull base and requires CT for accurate diagnosis.-Traumatic atlantoaxial instability is a potentially devastating unstable injury that can be missed without careful assessment on initial CT scan.-TRS/TRF requires CT to diagnose the degree of subluxation and assess accompanying injuries, with clinical and dynamic imaging assessments needed for rotatory fixation.

#### TABLE OF CONTENTS/OUTLINE

A. Introduction  
I Overview  
II AO Spine Upper Cervical Injury Classification  
B. Upper Cervical Spine Injuries  
I Common and uncommon important injuries of the upper cervical spine  
II CT characterization and discussion of typical mechanisms  
III Image review and correlation with AO Spine Classification  
Occipital condyle fractures (OCF)  
Atlanto-Occipital Dissociation (AOD)  
Atlantoaxial instability  
Traumatic Rotatory Subluxation/Fixation (TRS)  
Atlas (Jefferson) fractures  
Hangman fractures  
Odontoid fractures  
C. Conclusion  
D. Self assessment

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## Abstract Archives of the RSNA, 2023

EREE-13

### Ultrasonographic Diagnosis of Pneumothorax: Legend or Reality?

All Day Room: Learning Center

Gabriela Merigue, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This study aims to report the importance of chest ultrasound in the evaluation of critically ill patients with pneumothorax, highlighting the need for systematization in chest ultrasound assessment and technical recognition of pneumothorax ultrasound signs. The main echographic signs used in the detection of pneumothorax are: Absence of sliding of the two pleural leaflets, accentuated reverberation (A Lines), absence of comet tail artifacts and B lines and determination of the Pulmonary Point. In the presence of pneumothorax, trapped gas obscures visualization of the underlying pleural line, so that no pulmonary slippage is identified. The systematized technique used in chest ultrasound is based on: use of a high-frequency linear probe (5-12MHz); patient positioning in dorsal decubitus; division of each hemithorax into six quadrants. Each quadrant should be analyzed to ensure identification of the pneumothorax. The use of technically systematized chest ultrasound for the diagnosis of pneumothorax has high sensitivity, bringing a great benefit to critically ill patients, and can be used for diagnosis and decision-making quick conduct.

#### TABLE OF CONTENTS/OUTLINE

- Systematization of chest ultrasound evaluation - Normal findings on chest ultrasound - Ultrasonographic findings of pneumothorax - Cases of patients with pneumothorax diagnosed by ultrasound

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## Abstract Archives of the RSNA, 2023

EREE-14

### **Don't Lose Your Head -- Imaging of Atlantooccipital Dissociation and Central Skull Base Fractures**

All Day Room: Learning Center

Desmin M. Milner, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand normal anatomy of the central/posterior skull base and craniocervical junction.2. Understand various traumatic injuries at the central/posterior skull base and craniocervical junction.3. Understand some mimics of craniocervical junction injury.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review normal anatomy of the central/posterior skull base and craniocervical junction.2. Briefly review CT and MRI imaging protocols in the setting of trauma.3. Review traumatic injuries of the central/posterior skull base and craniocervical junction including: atlantooccipital dissociation, occipital condyle fractures, clival fractures, and transsphenoidal fractures.4. Review of other ligamentous injuries at the craniocervical junction.5. Review mimics of craniocervical junction injury.

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## Abstract Archives of the RSNA, 2023

EREE-15

### Blunt Cerebrovascular Injuries (BCVI): Diagnosis, Evolution, and Complications

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Elham Beheshtian, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Advances in multidetector CT angiography in the context of multitrauma have led to increased diagnosis of blunt cerebrovascular injuries (BCVI). 2. Early BCVI detection and treatment can decrease the risk of complications, such as ischemic strokes, carotid cavernous fistula, and arteriovenous fistulas. 3. BCVI is graded from 1-5 on the Biffi Scale, based on imaging appearance. The grading system is used to guide patient management and can predict the natural evolution of an injury.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction - epidemiology, morbidity and mortality, mechanism, imaging modalities  
II. Biffi Scale  
A. Pathophysiology and imaging examples of grades 1-5 injury  
B. Management implications by grade  
C. Natural history of an injury, including complications  
III. Diagnostic considerations  
1. Imaging modalities  
2. Universal vs. selective screening  
3. Imaging follow-up  
IV. BCVI mimics - fibromuscular dysplasia, atherosclerosis, carotid web, vasospasm, true aneurysm  
V. Venous injury  
VI. Summary

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## Abstract Archives of the RSNA, 2023

EREE-16

### Peer Learning Pearls: The Most Commonly Missed MSK Diagnosis on the Overnight Shift - Diagnostic Errors and Great Calls

All Day Room: Learning Center

Thais S. Kuwazuru, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this exhibition is to:- Highlight the most commonly missed musculoskeletal diagnosis identified after Peer Review analysis and the great calls of difficult cases;- Demonstrate practical tips to avoid missing diagnosis;- Review the current concepts about these pathologies;- Show illustrative and didactic cases from our service, specially from emergency and urgent care units.

#### TABLE OF CONTENTS/OUTLINE

INTRODUCTION- The greatest difficulties during the night shift and emergency room for the radiologist;- Impact of early accurate diagnosis of these diseases.IMAGING INTERPRETATION- The most commonly missed musculoskeletal diagnosis identified after Peer Review analysis, including:- Fractures: vertebral acute fracture, transdiscal fracture, scaphoid fracture, avulsion fracture of Chopart joint;- Infection: discitis and spondylodiscitis, abscess;- Hematoma and active bleeding;- Other causes of musculoskeletal pain such as longus colli tendinitis, disc herniation;- Great calls - difficult cases.INTERACTIVE CASE-BASED DIDACTICS- Sample cases to illustrate and solidify the concepts;- The main tips that every radiologist working the night shift should know;- Correlation with current literature data.CONCLUSION AND TAKE HOME MESSAGES- Patient assessment in emergency and urgent care scenario very often include imaging investigation;- In order to improve patient outcomes and prevent iatrogenic treatments (or lack of treatment), it is essential to know the imaging patterns of each pathology and the tips to avoid missing diagnosis.

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## Abstract Archives of the RSNA, 2023

EREE-17

### **Murphy's Law: What Can Go Wrong in Robotic and Laparoscopic Surgeries**

All Day Room: Learning Center

Daniel L. Cardoso, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Understand the main differences between open surgery, and minimally invasive surgery (MIS). Recognize the anatomy of the abdominal wall. Understand how the abdominal access is performed in MIS. Comprehend expected imaging patterns after MIS. Recognize the complications associated to MIS and its related imaging findings.

#### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION: Open versus MIS. Modalities of MIS. Anatomy of the abdominal wall, and its relation to the abdominal access in MIS. Expected imaging findings after MIS  
COMPLICATIONS AFTER MIS: a case-based review - Laparoscopy-related: Epidemiology. Imaging findings. How to proceed?  
Robotic-related: Epidemiology. Imaging findings. How to proceed?  
SUMMARY AND SYSTEMATIC APPROACH: what to look for? Preoperative imaging / Postoperative imaging  
TAKE HOME MESSAGES

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## Abstract Archives of the RSNA, 2023

EREE-18

### **Don't Look Just for the Bowels: A Comprehensive Review of Noninvasive Vascular Imaging in Abdominal Solid Organ Ischemia**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Hermes Vinicius Pedrini Pereira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the anatomy of intra-abdominal solid organs vascularization.- Expose frequent and infrequent cases of intra-visceral vasculopathies in the context of acute abdomen.- Remember the main parenchymal changes resulting from vascular events and their differential diagnoses.- Tips on how to identify critical findings and report them.

#### **TABLE OF CONTENTS/OUTLINE**

- Concepts of arterial and venous circulatory anatomy and solid organs vascularization.- Circulatory physiology and how it affects the different imaging modalities.- CT and MR protocols and reconstruction techniques, systematically mentioned in the interpretation of our cases.- Imaging aspects of acute vascular events, from the organ's pedicle to its parenchyma.- Intra-abdominal occlusive ischemic events (thromboembolism, torsions, dissections).- Non-occlusive ischemic events (hemodynamic shock, substance abuse).- Other vascular abnormalities that may have clinical repercussions (shunts and malformations).- Correlation between imaging and clinical signs.- Risk factors and pre-existing conditions that can help us think about solid organ ischemia.- Practical information for effective reporting and necessary information for intervention planning, including the critical imaging findings that needs immediate intervention.

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## Abstract Archives of the RSNA, 2023

EREE-19

### Friendly Fire: A Rapid Review of Iatrogenic Intrathoracic Injuries Related to Support Devices

All Day Room: Learning Center

Saumik Z. Rahman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Many common interventions performed by health care providers while placing supporting devices may lead to injuries to the lungs, pleura, heart, or mediastinal structures. These injuries may range from asymptomatic findings managed conservatively to life-threatening injuries requiring emergent surgical or percutaneous intervention. The radiographic and cross-sectional imaging appearance of malpositioned intrathoracic medical devices and complications related to iatrogenic thoracic trauma secondary to medical devices or procedures will be reviewed, and recommendations for clinical teams based upon imaging findings will be discussed.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Examples of cases: a. Chest tube placement- Pulmonary contusion, laceration, hemothorax, pneumothorax. b. Pacemaker placement- Hemopericardium, pneumomediastinum, pneumothorax, hemothorax, chest wall hematoma. c. Swan-Ganz catheter- Pulmonary artery pseudoaneurysm. d. Enteric tubes- Endobronchial course causing lung injuries, esophageal perforation. e. Central venous catheters- Vascular dissection, vascular perforation, pneumothorax, mediastinal hematoma. 3. Conclusion.

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## Abstract Archives of the RSNA, 2023

EREE-2

### MR Imaging of Pelvic Emergencies

All Day Room: Learning Center

Gayatri Joshi, MD (*Presenter*) Royalties from Elsevier.

#### TEACHING POINTS

Pelvic pain is a commonly presenting symptom in the Emergency Department (ED) and while ultrasound (US) or computed tomography (CT) are often the initial imaging exam, magnetic resonance (MR) imaging plays a vital role for specific populations (such as the pregnant patient) and in clinical scenarios in which diagnosis relies on the greater sensitivity provided by MR imaging. After reviewing this exhibit, learners should be able to: 1. Understand the role of MR imaging in the emergent setting 2. Proficiently recognize emergent pelvic disorders by MR imaging 3. Utilize best practices for diagnosing pelvic emergencies in the ED, including those of infectious, inflammatory, ischemic, obstructive, traumatic, neoplastic etiologies

#### TABLE OF CONTENTS/OUTLINE

This exhibit will: 1. Systematically illustrate the clinical and imaging features of pelvic emergencies that may present in the ED, particularly those of the MSK, vascular, GI GU body systems. The spectrum of pelvic emergencies discussed in this exhibit will include those of infectious, inflammatory, ischemic, obstructive, traumatic, neoplastic etiologies 2. Discuss best imaging practices of the acute pelvis in the ED, with pearls pitfalls for optimizing efficient accurate diagnosis 3. Briefly address relevant management as applicable to the Radiologist to aid in expedient, appropriate management

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## Abstract Archives of the RSNA, 2023

EREE-20

### Imaging Features and the Role of Interventional Radiology and Radiation Therapy in Oncologic Emergency

All Day Room: Learning Center

Akihiro Nakamata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Due to the rapidly increasing elderly population and to the advancements in oncology, there has been an increase in the diagnosis of cancer, and also a rise in oncological emergencies. In oncologic emergencies, radiologists play a major role not only in diagnosis but also in the subsequent treatment of interventional radiology and radiation therapy. Therefore, radiologists should know imaging features and the treatment of oncologic emergencies in the whole body.

#### TABLE OF CONTENTS/OUTLINE

The purpose of this exhibit is: 1. To classify oncologic emergencies according to their pathology and location 2. To review oncologic emergencies in the whole body 3. To discuss the clinical and imaging features of the oncologic emergencies 4. To discuss the role of interventional radiology and radiation therapy

Table of contents: 1) Subtypes based on imaging findings reflecting the background pathology. 2) Oncologic emergencies of various organs in this presentation. A) Central nervous system: Cerebral herniation Spinal cord compression B) Thoracic: Superior vena cava syndrome Airway obstruction Pericardial effusion with cardiac tamponade Pleural effusion Pulmonary thromboembolism, pulmonary tumor thrombotic microangiopathy (PTTM) Esophagorespiratory fistula Massive hemoptysis C) Abdomen: Abdominal compartment syndrome Biliary obstruction Biliary bleeding Intestinal obstruction Intestinal bleeding Bowel perforation Urinary tract obstruction Abdominal bleeding

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## Abstract Archives of the RSNA, 2023

EREE-22

### Dental Trauma: A CT Perspective for Tooth-Saving Precautions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Erhan Akpınar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To provide a basic anatomical overview of dental trauma with illustration of regions susceptible to trauma. To inform which dental fractures are important to save the tooth, and what to report for clinicians to get information about treatment options with basic points. To review the common terminology and classification of dental trauma/fractures with emphasizing the conditions that create or increase the risk of tooth loss. To present basic structural report templates for dental trauma reporting To discuss the CT imaging findings related to treatment of dental trauma and complications with illustrative cases.

#### TABLE OF CONTENTS/OUTLINE

1. Dental Anatomy, Weak Points and Crucial Structures to Keep The Tooth Alive / Functional 2. Terminology and Current Classification of Types of Dental Trauma 3. Fractures that require treatment within a few hours • Crown-Root Fractures • Root Fractures • Alveolar Fractures • Extrusive and Lateral Luxation • Avulsion 4. Fractures that require treatment within the first 24 hours • Complex Crown Fractures (Involving Pulp Structures) • Concussion and Subluxation • Intrusive Luxation 5. Treatment Options and Complications 6. A Structural Report Template for Dental Trauma

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## Abstract Archives of the RSNA, 2023

EREE-23

### Ultrasound in Acute Care: Point-Of-Care

All Day Room: Learning Center

Roddie Moraes Neto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recognize the practical applications of point of care ultrasound in emergency care; highlight patient positioning and how to acquire images in some exams performed with POCUS; learn the well-established ultrasound imaging standards in the literature.

#### TABLE OF CONTENTS/OUTLINE

Introduction: thorax, heart, abdomen, vessels; case-based review: thorax (pleural effusion, consolidation, pulmonary edema, pneumothorax), heart (pericardial effusion, pericarditis, vena cava, cardiogenic shock), abdomen (cholelithiasis, appendicitis, FAST, urolithiasis, testicular torsion / epididymo-orchitis, intussusception), vessels deep vein thrombosis, jugular thrombosis, ultrasound-guided peripheral venous catheter, aorta abdominal aneurysm); conclusions and key takeaways.

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## Abstract Archives of the RSNA, 2023

EREE-24

### Genitourinary Oncologic Emergencies: A Radiologists' Guide

All Day Room: Learning Center

Mamie Gao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the best imaging approach for evaluating oncologic emergencies affecting the genitourinary tract. 2. Identify imaging manifestations of genitourinary oncologic emergencies. 3. Identify potential pitfalls in imaging genitourinary oncologic emergencies. 4. Recognize the important role of radiologists in the multi-disciplinary setting to communicate and collaborate findings in emergent cases.

#### TABLE OF CONTENTS/OUTLINE

1. Genitourinary oncologic emergencies and imaging approach. 2. Multimodality imaging features of genitourinary oncologic emergencies. a) Hematuria: hemorrhagic cystitis. b) Obstructive uropathy: tumor burden and post-treatment (nephrostomy tube malfunction, ileal conduit). c) Infectious: pyelonephritis, renal abscess, prostatic abscess, cystitis related to prior treatment (BCG, ileal conduit). d) Miscellaneous Post-Treatment (radiotherapy, chemotherapy, surgery, urinary diversion): hemorrhage, fistulas. 3. Role of radiology in management. 4. Potential mimics and pitfalls (underdistended urinary bladder, residual malignancy, emergencies unrelated to malignancy, trauma).

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## Abstract Archives of the RSNA, 2023

EREE-25

### **Stercoral Colitis- Diagnosis, Complications and Management**

All Day Room: Learning Center

John J. Hines JR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Background Information/Purpose Stercoral colitis is an inflammatory process typically involving the sigmoid colon and rectum, due to chronic constipation and rectal distention, causing increased intraluminal pressure, and eventually leading to ischemia, ulceration, perforation, peritonitis and death from feculent peritonitis and sepsis if not treated. The purpose of this exhibit is to familiarize radiologists with the spectrum of CT imaging features of uncomplicated and complicated stercoral colitis and its mimics. Key Anatomic or Pathophysiologic Issues, Imaging Findings or Imaging Technique: Common CT findings of stercoral colitis include: 1.) Stool filled and distended colon with focal colonic wall thickening 2.) Pericolonic/presacral fat stranding. 3.) Presence of localized extraluminal gas, discontinuity of the colonic or rectal wall, and extraluminal gas in cases of perforation.

#### **TABLE OF CONTENTS/OUTLINE**

Educational Goals/Teaching Points 1. Review the risk factors, pathophysiology and clinical presentation of stercoral colitis.2. Discuss the importance of early recognition of uncomplicated stercoral colitis, and the role of the radiologist in bring this diagnosis to the attention of the clinical team.3. Illustrate the imaging findings of complicated and uncomplicated stercoral colitis on CT, including typical and atypical imaging findings, and unusual complications. 4.Review imaging mimics of stercoral colitis such as diverticulitis, infectious colitis, inflammatory bowel disease and ischemic colitis.5. Discuss the management of complicated and uncomplicated stercoral colitis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-26

### Typical Findings Under Atypical Lenses: When to Suspect Endometriosis on Emergency CT

All Day Room: Learning Center

Joao J. Stern, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Illustrate the different appearances of endometriosis on CTShare tips, pearls and pitfalls to suspect and diagnose endometriosis on pelvic computed tomography. Correlate relevant findings from computed tomography and magnetic resonance imaging of the pelvis to consolidate learning.

#### TABLE OF CONTENTS/OUTLINE

- introduction- common sites of involvement- image translation to CT of classic sign with MR correlation- discussion of the main findings of endometriosis on CT scan of the pelvis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-27

### **Pain in the Bump: Acute Abdomen in Pregnancy - MRI Clues for On-Call Residents**

All Day Room: Learning Center

Mili Rohilla, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To acquaint on-call residents with MR imaging signs in the acute abdomen To make residents comfortable with MR abdomen in pregnant patients

#### **TABLE OF CONTENTS/OUTLINE**

Acute abdomen is a common ER presentation in pregnant patients, and can pose a diagnostic challenge due to the physiological changes during pregnancy. Magnetic resonance imaging (MRI) is a useful diagnostic tool due to its high contrast resolution and absence of ionizing radiation. Radiology residents need to be cognizant of the MR imaging findings of acute abdomen in pregnancy and differential diagnoses to interpret them accurately and promptly. We will discuss the common system-wise presentations and MR findings: Gastrointestinal System: Appendicitis, acute pancreatitis, inflammatory bowel disease, intestinal obstruction. Hepatobiliary system: Acute cholecystitis, choledocholithiasis, HELLP syndrome. Reproductive System: Ectopic pregnancy, ovarian torsion, placental abruption, uterine rupture. Urinary System: Urolithiasis, acute pyelonephritis, renal abscess. Cardiovascular System: Ovarian vein thrombosis, Budd-Chiari syndrome, acute aortic syndrome. It is important to promptly diagnose and manage the underlying cause of acute abdomen in pregnancy to prevent adverse maternal and fetal outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-28

### Ocular Trauma: What Should We Keep In Mind?

All Day Room: Learning Center

Omar Andres A. Pantoja Burbano I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To perform a systematic approach to the most important aspects of the ocular trauma. - Recognize the principal anatomic structures of the orbit and understand the compromise of such in the different traumatic injuries. - Identify the most relevant signs of ocular and orbit trauma in diagnostic imaging, with specific emphasis in orbit tomography. - Learn how to classify the ocular trauma according to the involvement of the anterior or posterior segments and the presence of ocular globe rupture or burst. - To consider and exclude the most relevant differential diagnoses.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Anatomy of the ocular globe. 3. Anterior segment lesions. 4. Posterior segment lesions. 5. Ocular globe rupture and foreign bodies. 6. Pitfalls and differential diagnoses. 7. Take away points. 8. References.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-29

### **A Quick Guide to Pelvic Pain in the Emergency Room: MR Imaging of the Acute Female Pelvis**

All Day Room: Learning Center

Elissandra M. Lima, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the anatomy of the female pelvis on MRI- Understand the role of MR imaging in the evaluation of gynecologic emergencies- Illustrate the imaging findings non-obstetric and obstetric causes- Discuss their differential diagnosis, imaging pitfalls, and complications

#### **TABLE OF CONTENTS/OUTLINE**

1. Normal MRI anatomy of uterus and adnexa with cyclical variation 2. Advantages and disadvantages of MR Imaging 3. Non-obstetric and obstetric causes 4. Imaging assessment of critical and prevalent gynecological diseases in the emergency room 5. Pelvic inflammatory disease, including endometritis, cervicitis, salpingo-oophoritis, pyosalpinx, and tubo-ovarian abscess 6. Leiomyoma torsion and fibroid degeneration 7. Endometriosis 8. Obstetric causes, including ectopic pregnancy, molar pregnancy, retained products of conception, placenta accreta spectrum 9. Other pelvic abnormalities 10. Potential imaging pitfalls and how to avoid them 11. Complications

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-3

### Shattered Chests: Lessons from Thoracic Trauma Cases

All Day Room: Learning Center

Manuel Sebastian S. Paez Alvarez SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To present a comprehensive overview of thoracic trauma cases, highlighting the most common and not-so-common pathologies. To familiarize radiologists and radiology residents with diagnostic clues of thoracic imaging in trauma patients. To analyze key features and provide tips to identify pitfalls of traumatic chest CT.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Importance of thoracic trauma imaging and its implications in emergency settings. Pulmonary parenchymal injury: a. Pulmonary contusions b. Pulmonary lacerations c. Pulmonary hematomas d. Traumatic pulmonary hernias Pleural space injury: a. Pneumothorax b. Hemothorax Chest wall injury: a. Rib fractures b. Sternal fractures c. Chondrocostal, chondrosternal, and cartilage injuries d. Sternoclavicular dislocations Tracheobronchial injury: a. Laceration of the trachea and bronchi Other injuries: a. Boerhaave Syndrome b. Aortic injury c. Iatrogenic cardiac perforation d. Traumatic diaphragmatic hernias This educational exhibit aims to provide a comprehensive understanding of thoracic trauma cases, emphasizing the importance of recognizing imaging findings for accurate diagnosis. Radiologists and radiology residents will benefit from the illustrative cases and diagnostic tips presented, improving their skills in traumatic chest CT interpretation.

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## Abstract Archives of the RSNA, 2023

EREE-30

### The Contrast-Enhanced FAST Exam (cFAST) In Blunt Thoracoabdominal Trauma

All Day Room: Learning Center

Melanie P. Caserta, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The Focused Assessment with Sonography in Trauma (FAST) is one of the most frequently performed ultrasound examinations in adults and children in the acute care setting. However, it has significant limitations since intraabdominal fluid is used as a surrogate marker for intraabdominal injury (IAI). Adding an ultrasound contrast agent to the exam can substantially improve the diagnostic accuracy of identifying solid organ injuries and rapidly identify significant organ lacerations and active intraperitoneal hemorrhage. The cFAST exam is a rapid, standardized, and systematic ultrasound examination that balances a comprehensive organ survey with the time constraints of highly structured and algorithmic trauma patient care. After reviewing this case-based exhibit, the learner will:- Understand the limitations of the traditional FAST exam and advantages of adding an ultrasound contrast agent (UCA)- Describe the cFAST exam protocol and set-up as part of the trauma resuscitation team- Recognize the limitations of the cFAST exam and next steps in imaging.

#### TABLE OF CONTENTS/OUTLINE

1. Objectives 2. Background a. The evolution of the FAST exam b. Contrast-enhanced ultrasound in trauma 3. Imaging. Equipment, technical requirements, and supplies i. IV access ii. Selection of the UCA iii. Ultrasound equipment b. Integration into the trauma team c. The contrast-enhanced FAST exam protocol i. Patient population ii. Exclusion criteria iii. Special populations iv. Safety Considerations v. UCA preparation Contrast Administration vi. Imaging Protocol vii. Limitations 4. Pediatric and adult case presentations

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

EREE-31

### Searching for Causes of Preventable Death - Role of Early Postmortem CT in Trauma Patients

All Day Room: Learning Center

Lain Ibanez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To show an accurate protocol to perform a post-mortem CT in patients who died after severe trauma in a first-level trauma center
- To describe the main radiological features of different early deceased trauma patients and their potential relationship with the cause of death
- To identify the misplacement of medical devices in patients who died from trauma
- To determine if there was preventable death based on clinical and radiological findings

#### TABLE OF CONTENTS/OUTLINE

- Performing an early post-mortem CT protocol and CT technique
  - Analysis of radiological and clinical features, injuries, and medical device misplacement
  - Determining causes of death and their avoidability
  - Conclusions
- Outline: Despite the improvement in the management of trauma patients there is still a percentage who die during or immediately before receiving hospital care and before having an imaging test. This reason jointly with an increasingly low rate of autopsies, prevents to understand the causes of death and whether or not it had been avoidable. Since June 2022 the trauma and radiology teams at our level 1 trauma center decided to carry out a program to study preventable mortality in trauma patients who died before or during initial care. In this presentation we will show the design of our project, how we accomplish post-mortem CT studies and also present our preliminary results. We will show a clinical-radiological correlation of our cases, analyze the main injuries, misplacement of medical devices, causes of death and whether its avoidability. Finally the main concerns we faced and major limitations are exposed.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-32

### **Beyond the Diagnosis of Appendicitis: The Role of Computed Tomography in the Nonoperative Management of Acute Appendicitis in Adults**

All Day Room: Learning Center

Eliko Tanaka, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Diagnosis of acute appendicitis using computed tomography (CT) is highly accurate and established. The treatment of appendicitis includes surgery and conservative treatment, and the role of conservative treatment is expanding. However, conservative treatment has challenges, such as treatment failure and malignant tumors. CT diagnosis plays a significant role in determining the treatment plan. This presentation describes CT findings related to the indications for conservative treatment of appendicitis, as well as CT findings related to the course of conservative treatment. Additionally, it discusses challenges in CT diagnosis associated with conservative treatment, such as recurrent appendicitis or tumor complications, and presents a case series. Teaching points include: 1. Understand the indications and contraindications for conservative management of appendicitis and its CT findings 2. Familiarize CT findings related to the course of conservative treatment for appendicitis 3. Recognize the potential complications of conservative management, such as treatment failure, malignancy, recurrent appendicitis, and identify the corresponding CT findings

#### **TABLE OF CONTENTS/OUTLINE**

1. Indications and contraindications of conservative treatment in the World Society of Emergency Surgery (WSES) guidelines
2. CT findings that suggest a high risk of failure in conservative treatment and a need for extended surgery
3. Imaging findings during the course of conservative treatment
4. Recurrent appendicitis and its CT findings
5. Differential diagnosis between tumor and non-tumor cases

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-33

### **Role of MR in the Diagnosis of Suspect Metastatic Spinal Cord Compression: A Pictorial Imaging Review With Medical and Radiological Scales**

All Day Room: Learning Center

Blanca Lumbreras-Fernandez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The learning objectives of this exhibit are: 1-To illustrate the spectrum of metastatic spinal cord compression (MSCC) and the scales and scores that should be included in the radiological report. 2- To discuss the image findings of MSCC with emphasis in epidural lesions.

#### **TABLE OF CONTENTS/OUTLINE**

1-Pathophysiology of MSCC, including demographics. 2-Review of common imaging findings in the management guidelines for MSCC. Relevance of the inclusion in the radiological report of the Epidural Spinal Cord Compression (ESCC) Scale and Spinal Instability Neoplastic Score. 3- Evaluation of the most representative cases of MSCC collected and their differential diagnosis with other causes of cord compression, specially epidural lesions in a non-traumatic setting through imaging cases from our center. 4- Conclusions: Acute compressive myelopathy is a medical emergency. Early diagnosis and treatment improve the neurological prognosis. MR is the technique of choice to confirm the diagnosis or establish an alternative one as well as to determine the level, extension, degree of compression, stability of the spine and presence of myelopathy. The incorporation of the ESCC scale and SINS to the radiological report improves multidisciplinary communication and the adequacy of urgent treatment of MSCC.

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## Abstract Archives of the RSNA, 2023

EREE-35

### Never Fear! Peer Learning in Emergency Pelvic and First Trimester Ultrasound

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Melissa F. Tannenbaum, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Women presenting with acute pelvic pain and/or bleeding can pose a diagnostic challenge in the emergency setting. The differential diagnosis may be broad, and these symptoms are often indications for pelvic ultrasound (US). Interpretation of pelvic US may be tricky and a source of confusion and misinterpretation. Furthermore, cognitive biases in imaging interpretation can lead to diagnostic errors. Familiarity with common and uncommon pelvic US imaging findings is imperative to assist with prompt and accurate diagnosis. Awareness of potential biases when interpreting pelvic US further helps hone interpretation. This exhibit will illustrate the imaging findings of multiple causes of pelvic pain/ bleeding in non-pregnant and first trimester pregnant patients. Diagnostic errors and biases in interpretation related to these cases will also be highlighted.

#### TABLE OF CONTENTS/OUTLINE

This exhibit will review pelvic US peer learning cases and highlight teaching pearls and potential pitfalls in diagnosis. 1. Review common and uncommon causes of acute pelvic pain/bleeding in non-pregnant patients, including ovarian/ fallopian tube torsion, cysts, hydrosalpinx, fibroids, benign and malignant adnexal lesions, tuboovarian abscess. 2. Review causes of pelvic pain/bleeding in first trimester pregnant patients, including ectopic pregnancy in different locations, ruptured heterotopic pregnancy, retained products of conception, uterine AVM. 3. Review non-OB/GYN causes of pelvic/abdominal pain for which pelvic US was the initial imaging modality, including appendicitis, appendiceal mucocele, diverticulitis. 4. Review potential biases in pelvic US imaging interpretation with examples from our cases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-36

### Plain Abdominal Radiography in the Emergency Room

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Carla Suarez Silva, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Plain abdominal radiographs continue to be a fundamental tool in emergency rooms.- We present abdominal X-rays performed in a third-level hospital over the last few years. In all cases, the radiographs helped guide the patient's management.- The semiology of abdominal simple radiography is presented in a didactic and interactive way to achieve an adequate interpretation.- Knowing the radiological analysis of the abdominal radiograph continues to be useful for the comprehensive management of the patient.

#### TABLE OF CONTENTS/OUTLINE

This education exhibit presents a collection of 25 cases of abdominal X-rays. All cases will be presented in a structured and interactive format, beginning with an overview of the patient's clinical data, followed by the X-ray image(s), the detail of the radiological findings using visual aids, pearls and pitfalls, and the final diagnosis providing correlation with other imaging methods. Furthermore, taking advantage of the fact that all the X-rays were performed urgently, a green, yellow, or red circle will appear in the top right corner of all radiographs indicating the severity of the pathology presented by the patient. To facilitate the reading of this presentation, the name of the radiological density that will help us make an adequate interpretation of the abdominal radiograph will be displayed at the bottom of each image. The table of contents is: • Introduction • Teaching points • Table of Contents • How to approach an abdominal X-Ray? • Check all the clinical data • Technical aspects • Radiological densities • Cases • Case 1: Patient 1 • ? • Case 25: Patient 25

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-37

### **DECT in the Acute Setting - Bowel Trauma**

All Day Room: Learning Center

Tanche Wang, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Highlight the value of Dual Energy CT (DECT) in traumatic bowel injury  
Understand the principles of DECT and iodine overlay map  
Illustrate the use of DECT and iodine overlay maps to improve diagnostic confidence and sensitivity in detecting bowel injury, contrast extravasation, free fluid, and reducing metal artifacts.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background  
2. DECT and Bowel Injury  
a. DECT Increases Conspicuity of Hyperattenuating Free Fluid  
b. Lack of Iodine Uptake in Injured Bowel  
c. Metal Artifact Reduction  
d. Contrast Extravasation  
3. Conclusion

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## Abstract Archives of the RSNA, 2023

FREE-38

### **Beyond Aortoenteric and Aortocaval Fistulas - Intraabdominal Fistulas: Imaging Findings and Importance of Early Identification**

All Day Room: Learning Center

Amalia Aranaz Murillo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Intraabdominal fistulas are uncommon but can be catastrophic if not identified and treated promptly. Multiphasic multidetector CT angiography (angio-MDCT) is the initial imaging choice for diagnosis. 2. The imaging signs of intraabdominal fistulas can be divided into direct and indirect signs and emergency radiologists should be familiar with them and be aware of potential mimics and maskers to avoid misdiagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

This poster aims to provide an overview of intraabdominal fistulas, their imaging findings, and the importance of early identification and familiarize the radiologist with the mimics and maskers of intraabdominal fistulas. Intraabdominal fistulas are a rare but life-threatening condition if they are not identified and treated promptly. Imaging plays a crucial role, and angio-MDCT is often the initial imaging technique. The imaging signs of intraabdominal fistulas can be divided into direct and indirect signs. Direct signs include visualization of the fistula tract, extravasation of contrast medium, and aortic graft migration, but these signs are rarely observed. Indirect signs are often the only available evidence and include abnormalities of the aortic wall, irregularities of the interface between the aorta and the fistulizing entity, and the presence of gas or fluid collections. Although the most frequent intraabdominal fistulas are aortoenteric and aortocaval fistula, other types of fistulas and potential mimics can occur, and one should know and be aware of them. Familiarity with the different imaging modalities and the various mimics and maskers of fistulas can help in accurate diagnosis, ultimately leading to improved patient outcomes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-39

### **Kicking, Biting, and Screaming: Common Radiological Patterns and Mechanisms of Equine-Related Injuries Presenting to the Emergency Department**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Trae C. Brooks, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Thoracic injuries may occur in over half of horse-related trauma cases, including clavicle and rib fractures as well as hemothoraces and pneumothoraces. Clinical and imaging evaluation is crucial to rule-out underlying thoracic trauma (Chad Ball, 2007). Children who receive an injury while unmounted are likely to have more severe injuries than those who were mounted, with most trauma localized to the abdomen (Grace Wolyncewicz, 2018). Fractures are one of the most common injuries in mounted equestrians and should be suspected in patients presenting after a fall from a horse. The initial height of the rider, velocity of travel, and vulnerable position of landing are all key factors contributing to the severity and location of the fracture and need for prompt imaging and evaluation.

#### **TABLE OF CONTENTS/OUTLINE**

We will begin with an overview of horse-related trauma from a historical and epidemiologic perspective. Using a simplified algorithm, we will then discuss the classic patterns of various trauma such as fall from or with a horse while mounted and injuries sustained from direct injury from a horse while unmounted such as bite, kick, or stomp/trample injuries. Finally, we will use case-based examples with multimodality imaging to show the broad extent of injury concerning various systems - organized into Torso, Musculoskeletal/Extremity and Central Nervous System/Spine.

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## Abstract Archives of the RSNA, 2023

EREE-4

### CT of Appendicitis in Adults: Problematic Scans and Scenarios

All Day Room: Learning Center

Douglas S. Katz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-A non-trivial minority of CT examinations performed for suspected appendicitis - regardless of the protocol utilized - end up being challenging to interpret for a variety of reasons, in adults -This exhibit will review problematic scenarios and situations involving CT performed for right lower quadrant pain in non-pregnant adults -Review uncommon/atypical/unusual presentations of appendicitis and its potential mimics and potential pitfalls, as well as some of the more common problematic scenarios -Demonstrate examples of these CT scenarios from our practices -Briefly overview QA and medical-legal issues in suspected appendicitis in adults with an emphasis on CT

#### TABLE OF CONTENTS/OUTLINE

Outline: -Oral contrast - to use or not to use on CT? -Subtle/early findings -Perforated appendicitis- review of the literature - The right lower quadrant 'phlegmon' -Potential pitfalls and confounders - right colonic diverticulitis, 'secondary' appendicitis, distal/tip appendicitis, the non-visualized appendix, chronic/relapsing appendicitis, and resolving appendicitis -Appendicitis and rotation anomalies -Stump appendicitis -Appendicitis in hernias -Appendicitis and underlying neoplasms -Additional potential errors, quality assurance issues, and medical-legal issues

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## Abstract Archives of the RSNA, 2023

EREE-40

### Abdominal Hemorrhage on MRI: Findings and Pitfalls

All Day Room: Learning Center

Bertin Mathai, BEng, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Non-traumatic intra-abdominal hemorrhage can be due to multiple etiologies and can be a source of acute abdominal pain and life threatening blood loss. Prompt radiologic identification and localization of hemorrhage is crucial for appropriate decision-making and management. Acute intra abdominal hemorrhage is usually diagnosed by computed tomography (CT). Magnetic resonance imaging (MRI), is less frequently used in the acute setting, and radiologists may be less familiar with the appearance of blood and potential etiologies of hemorrhage, such as ruptured aneurysms and hemorrhagic masses. The signal characteristics of hemorrhage can vary depending on both the age of the hemorrhage as well as its background location. The superior soft tissue resolution of MRI can help characterize intra-abdominal blood products in cases where CT is indeterminate, and can help diagnose an underlying mass in cases where it is obscured by blood on CT. This educational exhibit will discuss the timeline of hemorrhage with respect to MRI signal, show multiple causes of spontaneous intra abdominal bleeding, and highlight scenarios where MRI can provide added value in diagnosing the source of hemorrhage.

#### TABLE OF CONTENTS/OUTLINE

1) Background 2) Molecular and Magnetic Timeline of Blood 3) Optimizing MRI Protocol to Visualize Blood 4) Differential Diagnosis / Cases 5) Literature Review 6) Conclusion 7) References

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## Abstract Archives of the RSNA, 2023

EREE-41

### Pre-Hospital Emergency Medicine: A Spectrum of Imaging Findings

All Day Room: Learning Center

Ryan Whitesell, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibit aims to: 1) Increase awareness and understanding among radiologists of the principles of Pre-Hospital Emergency Medicine 2) Review imaging which illustrates techniques used by Emergency Medical Services (EMS) providers 3) Highlight pertinent radiologic findings which call attention to potential complications arising from pre-hospital care.

#### TABLE OF CONTENTS/OUTLINE

Topics covered within this presentation include: 1) Introduction to Pre-Hospital Emergency Medicine--Including Purpose of Emergency Medical Services (EMS) and Scope of practice of EMS providers; 2) Airway Management--Including Endotracheal intubation and Surgical airways; 3) Cardiopulmonary Resuscitation--Including Use and effects of mechanically-assisted chest compressions, Radiologic findings of decompressive needle thoracostomy (DNT), and Efficacy of intraosseous vascular access for resuscitation and IV contrast administration; 4) Techniques of Patient Immobilization--Including Imaging appearance and appropriate positioning of cervical spine collars, Imaging appearance and clinical benefit of hemostatic tourniquets, and Imaging appearance and appropriate positioning of pelvic binders

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## Abstract Archives of the RSNA, 2023

EREE-42

### Immediate-CT with Hybrid Emergency Room System for Severe Trauma Patients

All Day Room: Learning Center

Naoyuki Inagaki, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Several studies have shown that trauma whole-body CT has facilitated the early identification of major injuries and a reduction in mortality and morbidity.
- HERS (Hybrid-Emergency Room System) is an all-in-one concept of emergency room with the functions of CT scanner, interventional radiology and surgery, and useful in critical trauma treatment strategies.
- HERS in trauma treatment can be performed from diagnosis to treatment without transporting the patient, so it is possible to significantly reduce the time.

#### TABLE OF CONTENTS/OUTLINE

- We devised a new trauma treatment strategy using HERS. This is "immediate CT protocol" in which CT scan is performed immediately after arrival at the hospital.
- The immediate-CT(i-CT)protocol is optimized for CT scans immediately after arrival at the hospital.
- This protocol enabled rapid diagnostic imaging for critical traumatized patients. And, can provide more information than ultrasound, X-ray used in "primary survey". It is also possible to find major damage earlier.
- By detecting brain injury, aortic injury, retroperitoneal hematoma, lung injury, and spine injury, early activation of injuries that require referral to other departments is now possible. And we call it "BARLS".
- We demonstrated that the i-CT protocol leads to reduction of the time from arrival to CT scans without adverse events. As a result, we have contributed to the planning of treatment strategies and early activation of specialized treatment.
- This novel trauma treatment strategy can contribute to improving the life-saving rate

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## Abstract Archives of the RSNA, 2023

EREE-43

### **Multiphase CT Angiography Using a Time-Variant Color Map: How Can It Contribute to the Improvement of the Diagnosis and Management of the Acute Stroke?**

All Day Room: Learning Center

Isabel Herrera (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Multiphase CT Angiography (mCTA) offers several advantages over single-phase CTA (sCTA) and contributes to improving the diagnosis and management of the acute ischemic stroke (AIS). - mCTA increases interrater agreement for both proximal and distal vessel occlusions compared with sCTA and reduces time needed to detect the occlusion. - mCTA helps to characterize the thrombus length and thrombus permeability, which may influence the treatment. - mCTA improves characterization of collateral status, that may be a useful fact in the management of some patients with AIS. - mCTA has potential value in delineating the core ischemic area and detecting tissue at risk. - mCTA can also be useful in hemorrhagic stroke. It improves prediction of intracerebral hemorrhage expansion and improves the evaluation of venous vessels and the diagnosis of vascular malformation. - mCTA may be useful in the characterization of stroke mimics.

#### **TABLE OF CONTENTS/OUTLINE**

Multiphase CTA (mCTA) provides time-resolved images of the cerebral vasculature that are useful in patients with acute stroke. An arterial (red color) and 2 venous phases are acquired ( peak venous phase in green, and late venous phase in blue) are acquired. We review the role and potential of CTA in patients with ischemic and hemorrhagic stroke, its advantages over sCTA, its limitations and its usefulness in the evaluation of stroke mimics.

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## Abstract Archives of the RSNA, 2023

EREE-44

### Visceral Ischemia: What Should the Emergency Radiologist Know?

All Day Room: Learning Center

Silvia Cayon Somacarrera, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe the key radiological features of visceral ischemia, including cases of liver, gallbladder, pancreas, spleen, renal, stomach and intestine ischemia. To understand the pathophysiology behind those radiological findings

#### TABLE OF CONTENTS/OUTLINE

The infarct's shape depends on the distribution of the vascular tree. The organs with hilum show wedge-shaped infarcts (eg. liver, kidney, spleen) while the organs without hilum show infarctions that extend through the different wall layers (eg. intestine). We collected the most illustrative cases of visceral ischemia of the last years in our institution to show the key characteristics to make a quick and accurate diagnosis. Mesenteric ischemia has a very high mortality rate if not properly treated. The key findings to evaluate are: mesenteric vessels, intestinal walls and the existence of gas (pneumatosis/pneumoperitoneum). Hepatic ischemia is uncommon due to its double vascular supply. The most typical finding is wedge-shaped hypodense areas but we can also find rounded or tubular areas parallel to the bile ducts. Renal ischemia is most often caused by renal artery embolism. Focal infarcts are depicted as hypodense triangular areas. Complete infarcts present as generalized hypoattenuation of the renal parenchyma. Splenic ischemia is relatively common. Acute infarcts are shown as triangular hypodensities, subacute infarcts as cystic images while in chronic infarcts calcifications or atrophy can be seen. Cortex preservation may be observed in complete renal/splenic infarcts due to collateral circulation.

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## Abstract Archives of the RSNA, 2023

EREE-45

### Evaluating Primary and Secondary Endpoints in Intracranial Hemorrhage AI Algorithms - A Review of Current Market Algorithms and a Proposed Retraining Model for Improving Patient Triage

All Day Room: Learning Center

Raviteja Suryadevara, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The implementation of AI algorithms for intracranial hemorrhage (ICH) in the ED setting can expedite detection, triaging, and timely intervention. Most AI algorithms, in addition to their binary primary endpoint of -ICH or +ICH, also collect secondary outcome endpoint data (processing time, bleed location, bleed volume calculation). Based on trauma volume and workflow of ED practice, these algorithms should be employed accordingly. Retrospectively retraining AI algorithms to collect data on secondary outcome endpoints should be a flexible option. Retraining AI for additional primary endpoints allows for improved triaging. Specifically, in patients with intracranial hemorrhages, additional triaging of the ED reading list based on bleed volume and subtype would allow for communication and subsequent timely treatment of patients with the highest potential morbidity or mortality first. Any proposed AI retraining model, though technically sound, has challenges with acquisition of new patient data for retraining.

#### TABLE OF CONTENTS/OUTLINE

Workflow in the ED for suspected traumatic/spontaneous ICH. Where AI algorithms can help in the ED setting. Currently approved 510(k) premarket cleared algorithms for ICH detection. Quantitative evaluation of ICH AI algorithms based on primary and secondary outcomes. Retraining AI algorithms for secondary endpoints: technical/logistical challenges. Conclusion. References

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## Abstract Archives of the RSNA, 2023

EREE-46

### Life-Threatening Acute Aortic Lesions Beyond Acute Aortic Syndrome

All Day Room: Learning Center

#### Awards

##### Cum Laude

Laura Martos Ramio, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

TEACHING POINTS: - Many potentially severe acute aortic lesions exist beyond the classical spectrum of acute aortic syndrome (AAS).- Life-threatening acute aortic conditions may result from traumatic injuries, iatrogenic lesions, infectious complications or aneurismatic rupture.

#### TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS: Aortic lesions can be life-threatening and require immediate medical attention. Imaging techniques play a critical role in the diagnosis because the clinical presentation is variable and nonspecific. Moreover, CT and MRI provide fundamental information for surgical planning. AAS is a well-known medical emergency with high mortality when left untreated. However, it may show an atypical appearance and many other potentially severe acute aortic lesions beyond the classical AAS also demand immediate diagnosis. These include traumatic injuries, iatrogenic lesions, infectious complications and aneurismatic rupture. Significant traumatic injuries are classified as intramural hematomas, pseudoaneurysms and aortic ruptures. Iatrogenic lesions are usually the result of invasive coronary interventions or aortic stent placement. Mycotic pseudoaneurysms are included in the spectrum of infectious aortitis. Ruptured thoracic aneurysms are rarely imaged due to their lethality. Finally, we review atypical presentations of AAS that also need to be considered, such as intimal intussusception or dissection extension into the pulmonary arteries.

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## Abstract Archives of the RSNA, 2023

EREE-47

### Non-Obstetric Emergencies in Pregnancy: Imaging Pathway, Findings, and Special Considerations

All Day Room: Learning Center

Isabelle D. Gauthier, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Imaging pregnant patients require special considerations and non-ionizing radiation imaging is preferred (US/MRI). However, CT in trauma and acute settings should not be delayed due to concern for radiation. 2. Knowledge of specific non-obstetric pathologies affecting pregnant patients and their imaging appearance is crucial for timely and accurate diagnoses of acute and traumatic conditions. 3. Shared decision making? with the patient is important to weight risks and benefits of imaging tests if time permits.

#### TABLE OF CONTENTS/OUTLINE

1. Review risks and safety of different imaging modalities in pregnancy (dose of fetal radiation and associated risks, iodinated and gadolinium contrast agents). 2. Special considerations when imaging pregnant patients (positioning in scanner, contrast reaction and management, recommendations regarding lead shielding). 3. Trauma imaging in pregnancy: Review imaging pathway and traumatic pathologies at higher risk in pregnant patients (retroperitoneal hemorrhage?, liver, spleen, renal and bladder injuries?). 4. Acute non-traumatic pathologies: incidence and pathophysiology in pregnancy, imaging pathway and findings, for example: (a) Abdomen: Acute cholecystitis, choledocholithiasis, appendicitis, renal stone/urosepsis, bowel obstruction, colitis, (b) Chest: Pulmonary embolism, pneumonia, (c) Neuro: Cerebral venous thrombosis, seizures, stroke, (d) Vascular: Complicated AVM, deep venous thrombosis, arterial occlusion.

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## Abstract Archives of the RSNA, 2023

FREE-48

### Pictorial Review of Orbital Emergencies

All Day Room: Learning Center

Wen Wang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: 1. A simplified anatomic checklist-based approach can enable an emergency radiologist to accurately and efficiently identify acute temporal bone pathology, and this approach will be reviewed in this exhibit. 2. The radiologist plays an important role by identifying key imaging findings and providing diagnoses that can direct treatment by prompting an emergency physician to admit a patient for inpatient management, order a surgical consult, or order further imaging to check for related complications. The absence of these findings are also pertinent negatives that enable clinicians to proceed with treatment in the ED or discharge a patient with outpatient follow-up. 3. This exhibit will review traumatic and acute non-traumatic pathology in a case-based format, with emphasis on key imaging findings that affect management and prognosis.

#### TABLE OF CONTENTS/OUTLINE

I. Relevant anatomic review of the orbit II. Checklist for traumatic and non-traumatic pathology III. Non-traumatic Pathologies: i. Infection Preseptal cellulitis Postseptal cellulitis Dacryocystitis Subperiosteal abscess ii. Non-infectious inflammatory pathology Sarcoidosis Optic neuritis iii. Detachment Retinal detachment Choroidal detachment IV. Traumatic pathologies: i. Fractures Blowout fractures/wall fractures Lefort II and III fractures Naso-orbito-ethmoid fractures Optic canal fracture ii. Penetrating trauma Paint gun injury Gunshot injury

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## Abstract Archives of the RSNA, 2023

EREE-49

### **We've Got Your Back: How Radiologists Can Aid Surgical Decision Making By Using the AO Spine Classification System**

All Day Room: Learning Center

Andrew Simmerman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

AO Spine Injury Classification systems offer reliable and clinically relevant morphology descriptions for spinal trauma imaging. Subaxial cervical and thoracolumbar injuries are classified as A: compression, B: tension band/distraction, C: displacement/translational. A B have subtypes. The motion segment is the spine's functional unit, by which tension band and displacement injuries are labeled. Fracture morphology, neurologic signs, and patient factors influence conservative or surgical management. MRI and dynamic radiography help assess for ligamentous injuries. Rigid spines and osteoporosis affect treatment. Cervical spine specifics include facet injury, disc herniation, cerebrovascular injury, and unique ligamentous injuries at the occiput-C1-C2 levels.

#### **TABLE OF CONTENTS/OUTLINE**

Overview Goals of classification and radiological reporting Spinal bone and ligamentous anatomy Motion segment and tension band concepts Subaxial cervical and thoracolumbar injuries Type A: Compression Type B: Distraction Type C: Translation Type F: Facets (subaxial) Modifiers Indeterminate/incomplete tension band injuries Stiffening and metabolic bone diseases Critical disc herniation Cerebrovascular injury Upper cervical injuries A: Bone-only B: Ligamentous without complete separation C: Translation

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## Abstract Archives of the RSNA, 2023

EREE-5

### **Broken Beauty: How Can I Make a Good Interpretation of a Facial Trauma on CT?**

All Day Room: Learning Center

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To review the facial radiological anatomy and to remember the different systems that organize it.- To propose a systematic approach for the evaluation of the facial bone mass, depending on the functional relationships between the structures.- To know the typical radiological patterns of facial fractures, taking into account some "key ideas" that we must remember, because they sometimes modify the therapeutic management.- To recognize the complications that can be associated with facial fractures depending on their location.- To emphasize the importance of making an useful radiological report for the requesting physician, with an organized description of the fractures.

#### **TABLE OF CONTENTS/OUTLINE**

1. Radiological facial anatomy: 1.1. Three thirds system: upper (frontal), middle (from upper orbital rim to upper maxilla) and lower (mandible). 1.2. Facial buttress system: there are 4 vertical and 4 horizontal buttresses that emphasize the functional relationships between the different facial bones.2. Systematic assessment of the facial mass: 2.1. Fractures of the upper third (frontal). 2.2. Fractures of the middle third: isolated (e.g, nasoseptal fractures) or complex (le Fort fractures, fractures of the nasal-orbital-ethmoidal complex and fractures of the zygomatic-maxillary complex). 2.3. Fractures of the lower third (mandibular). Within each section, we will discuss typical radiological fracture patterns and "key ideas" to remember.3. Complications that may be associated depending on the affected buttress.4. How to make an adequate radiological report useful for the requesting physician, without falling into the error of making a "shopping list" with the affected bones.

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## Abstract Archives of the RSNA, 2023

EREE-50

### **The Role of CT in Non-occlusive Mesenteric Occlusion for Diagnosis, Therapeutic Strategy, and Patient Management**

All Day Room: Learning Center

#### **Awards**

##### **Magna Cum Laude**

Akitoshi Inoue, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Non-occlusive mesenteric ischemia (NOMI) is characterized by segmental and skipped bowel ischemia caused by vasospasm without mechanical stenosis in the superior mesenteric artery (SMA). NOMI is a life-threatening condition, and the mortality is high. Even in survival cases, nutrient malabsorption called short bowel syndrome resulting from bowel resection for necrotized small bowel may require lifetime intravenous nutrition. CT depicts spastic SMA and branches and is considered a diagnostic tool instead of invasive angiography. Regarding the bowel, heterogeneous imaging findings, including absent enhancement, hemorrhagic necrosis, pneumatosis, and paper-thin wall appearance, can be observed, which reflects skip-segmental bowel necrosis on macroscopic findings. Additionally, CT plays an essential role in predicting the severity of bowel ischemia and reperfusion as the imaging findings reflect dynamic pathophysiology caused by vasospasms in the superior mesenteric region.

#### **TABLE OF CONTENTS/OUTLINE**

1. To illustrate the etiology and pathophysiology of NOMI 2. CT image findings in the superior mesenteric artery and branches, and small bowel 3. Challenge to predict the viability of ischemic bowel on CT 4. Case presentation with tips and pitfalls for NOMI 5. Differential diagnosis (mesenteric artery occlusion, mesenteric venous occlusion, strangulated bowel obstruction, and pneumatosis intestinalis) 6. Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-51

### **Where Is the Catheter Tip? Chest Radiograph Findings of Incorrect Placement Comparison With CT and Normal Radiographs**

All Day Room: Learning Center

Masafumi Sakai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In the intensive care unit, catheters and tubes are inserted into patients. Incorrect catheter placement can lead to various complications; detecting incorrect placement on chest radiographs is essential for early intervention and improved patient outcomes. However, incorrect catheter placement is easily overlooked if there is no comprehensive understanding of the three-dimensional anatomy of the chest and correct placement of the catheter on chest radiographs. Furthermore, new devices have also been introduced recently, which radiologists need to be familiar with. The purpose of this exhibit is: 1. To explain chest radiographic findings of incorrect catheter placement correlating with CT and comparison with the normal position. To explain the complications and pitfalls associated with incorrect catheter placement

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Case presentation | Central venous catheter Arterial misplacement Misplacement in small veins (azygos veins, etc.) Catheter fragmentation Pitfalls (vascular anomaly, etc.) | Swan-Ganz catheter Misplacement of the peripheral pulmonary artery (PA). Complications (pseudoaneurysm of the PA) | Subcutaneous implantable cardioverter defibrillator Misplacement in anterior mediastinum | Endotracheal tube One-lung ventilation Pitfalls (tube tip shifts in accordance with neck flexion and extension) | Chest tube Misplacement in the interlobar fissure Misplacement in the lung | Epidural catheter Misplacement outside the epidural space | Etc. 3. Summary 4. Conclusion

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## Abstract Archives of the RSNA, 2023

EREE-52

### **Dual Energy CT in Acute Inflammatory and Infectious Processes of the Head and Neck. The 4 P: Protocols, Post-processing, Pearls and Pitfalls**

All Day Room: Learning Center

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Dual energy CT (DECT) images combine data from a wide range of energy acquisitions without impacting patient dose. In contrast to single energy CT (SECT), which uses only energy around 70 keV, virtual monochromatic images (VMI) can be reconstructed at any level of energy within a 40-150 keV range. Lower energies allow better delimitation of inflammatory tissue enhancement although this increases image noise ratio. Higher energies enable the virtual subtraction of iodine contrast, which improves calcium identification and reduces metallic artifacts. Material decomposition maps allow better identification of neck abscesses. The main purposes of this exhibit are: 1- To describe the DECT image acquisition protocols and post-processing methods. 2- To illustrate DECT findings and main tips in head and neck inflammatory and infectious diseases within different locations and its SECT correspondence. 3- To outline the differential diagnosis, potential pitfalls in DECT, and how to avoid them.

#### **TABLE OF CONTENTS/OUTLINE**

1-DECT protocol. 2-Post-processing techniques (VMI and material decomposition maps). 3-Case-based image examples of DECT and SECT correspondence for ears, orbits, paranasal sinuses, salivary glands, dental, pharyngeal, and para-pharyngeal mucosal inflammatory and infectious processes. 4- Pearls, pitfalls, and differential diagnosis in DECT images.

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## Abstract Archives of the RSNA, 2023

EREE-53

### At Arm's Length: Upper Extremity CT Angiography and Neurovascular Pathology

All Day Room: Learning Center

Andrew Sinensky, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Upper extremity (UE) vascular pathology can be conceptualized anatomically: the shoulder, arm, elbow, forearm, and hand. 2) CT angiography (CTA) and digital subtraction angiography (DSA) play a vital role in diagnosis and management of acute neurovascular pathology. 3) The thoracic outlet is the neurovascular outflow of the UE; thoracic outlet syndrome (TOS) results as the consequence of disruption of this outflow. 4) Non-traumatic vascular pathology of the UE is less common than lower extremity pathology and is often thromboembolic or anatomic in etiology. 5) Trauma of the UE has classic artery/nerve injury pair associations, such as at Guyon's canal (ulnar artery + nerve) and the mid-humerus (deep brachial artery + radial nerve).

#### TABLE OF CONTENTS/OUTLINE

1) UE Anatomy  
A) Arterial  
B) Venous  
C) Brachial plexus  
D) Thoracic outlet  
2) CTA and DSAA  
A) Technical considerations  
B) Pitfalls  
3) Other Modalities  
A) Ultrasound  
B) MR  
4) Atraumatic  
A) Central (thromboembolic, aortic dissection)  
B) Peripheral (atherosclerosis, aneurysm/pseudoaneurysm, vasospasm)  
C) External compression (TOS, quadrilateral space syndrome)  
D) Systemic (vasculitis, connective tissue disorders)  
E) Dialysis grafts and fistulas  
5) Blunt and Penetrating Trauma  
A) Vascular injury (pseudoaneurysm, arteriovenous fistula, laceration)  
B) Neurologic injury (transection, compression)  
C) Neurovascular injuries by region (shoulder, arm, forearm, elbow, wrist, hand)  
6) Management  
A) Surgical  
B) Endovascular  
C) Post-operative imaging considerations  
D) Complications

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## Abstract Archives of the RSNA, 2023

EREE-54

### Imaging Spectrum of Extremity Vascular Emergencies: CTA-Angiographic Correlation

All Day Room: Learning Center

Christian L. Pecoraro, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) To discuss the common mechanisms for traumatic and non-traumatic peripheral vascular emergencies as well as their management 2) Differentiate pertinent imaging features of traumatic and non-traumatic peripheral vascular emergencies 3) To juxtapose CT angiography and conventional angiographic findings for each etiology

#### TABLE OF CONTENTS/OUTLINE

1) Basic mechanisms of vascular injury 2) The advantages and drawback of CTA compared to conventional angiography in the setting of traumatic vascular injury 3) Common imaging features and clinical signs that suggest vascular emergency 4) CT angiographic and conventional angiographic correlation for several traumatic peripheral vascular emergencies -Laceration - Transection -Intramural Hematoma--Arteriovenous Fistula -Vasospasm -Intimal Dissection -Pseudoaneurysm -Thrombosis 5) CT angiographic and conventional angiographic correlation for several non-traumatic peripheral vascular emergencies - Embolism -Vasculitis -Acute DVT -May Thurner's Syndrome—Vessel Entrapment 6) Discussion of each etiology's pertinent imaging, clinical features, as well as their management

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## Abstract Archives of the RSNA, 2023

EREE-55

### Ischemic Bowel: A Challenging Imaging Diagnosis

All Day Room: Learning Center

Francisco Delgado (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Briefly examine the epidemiology and common causes of ischemic bowel (IB) disease.-Master anatomic and morphologic imaging findings of IB on CT.-Understand recommendations for additional imaging to increase diagnostic certainty, including the utility of arterial phase or multiphasic CT imaging.-Learn indications for surgical vs. nonsurgical management of IB and the role of the radiologist in guiding management.

#### TABLE OF CONTENTS/OUTLINE

CT is the preferred imaging technique for diagnosing ischemic bowel, as it outperforms laboratory and physical exam findings in reliability and accuracy. However, CT may only detect nonspecific signs of mesenteric ischemia, bowel dilatation, bowel wall thickening, bowel obstruction, mesenteric edema, mesenteric stranding, mesenteric vascular engorgement, and ascites. In this exhibit, we review the causes of IB including vascular (thrombosis, embolism, vasculitis), anatomic (volvulus, neoplastic), and systemic (hypoperfusion). Each diagnosis is accompanied by multiple CT cases highlighting specific and subtle imaging findings with a focus on imaging findings which alter management. Follow-up via imaging (CT angiography, MRI, MR angiography) or intervention (colonoscopy, surgical, catheter based) are reviewed with multimodality cases. Timely and accurate diagnosis of IB is crucial for guiding management, preserving bowel viability, and reducing morbidity/mortality and the radiologist is central in this clinical cascade.

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## Abstract Archives of the RSNA, 2023

EREE-56

### The Diagnostic Ability of Postmortem Imaging for the Cause of Death

All Day Room: Learning Center

Yu Nakaki (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Postmortem imaging is widely used to identify the cause of death. Although postmortem imaging can help to determine the cause of death, its diagnostic ability depends on the subject and the methodology applied. In >65% of cases, postmortem CT (PMCT) is useful for identifying the cause of unnatural deaths because traumatic changes can be detected. On the other hand, since cardiac disease, e.g. myocardial infarction, lethal arrhythmia, and pulmonary thromboembolism cannot be diagnosed by PMCT, it is useful in only 40-50% of natural deaths. Therefore, contrast-enhanced PMCT and postmortem MRI (PMMRI) have been introduced. We describe the diagnostic ability of postmortem imaging, demonstrate the causes of deaths that can be diagnosed by postmortem imaging, and alert to interpretation pitfalls.

#### TABLE OF CONTENTS/OUTLINE

1. Diagnostic ability of PMCT for •Unnatural deaths •Natural deaths 2. Diagnostic ability of contrast-enhanced PMCT 3. Diagnostic ability of PMMRI 4. Causes of death that can be diagnosed by postmortem imaging •Aortic dissection •Aortic aneurysm rupture •Sub-arachnoid hemorrhage •Cerebral hemorrhage •Gastrointestinal bleeding/occlusion/perforation •Pulmonary thromboembolism 5. Pitfalls of postmortem imaging

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## Abstract Archives of the RSNA, 2023

EREE-57

### Obstetric Ultrasound: What Not to Miss for the ER Radiologist

All Day Room: Learning Center

Saubhagya Srivastava, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Obstetric ultrasound is an excellent tool to assess maternal, fetal, and placental parameters in all trimesters due to its noninvasive nature, ease of availability, portability, and lack of ionizing radiation. It is the first-line method used in the evaluation of pregnant patients. 2. Transvaginal ultrasound is an excellent modality in the first trimester for adequate characterization of fetal abnormalities. 3. The focus of second and third trimesters should be on the evaluation of fetal viability and potentially life-threatening abnormalities.

#### TABLE OF CONTENTS/OUTLINE

1. Normal pregnancy parameters to look for in emergent obstetric ultrasounds. 2. Classification of obstetric emergencies by maternal, fetal, and placental anomalies. 3. Maternal abnormalities a. First trimester i. Ectopic pregnancy 1. Adnexal 2. Abdominal ii. Interstitial and cervical implantation iii. Molar pregnancy b. Second and third trimesters i. Uterine dehiscence/rupture ii. Cervical and adnexal abnormalities 4. Fetal abnormalities a. First trimester i. Major fetal structural abnormalities ii. Nonviable pregnancy b. Second and third trimesters i. Fetal hemorrhage ii. Amniotic fluid abnormalities iii. Doppler abnormalities 5. Placental abnormalities a. Placenta Previa b. Placental abruption c. Vasa Previa d. Placenta accreta spectrum 6. Pitfalls in the diagnosis of common obstetric emergencies a. Corpus luteal cyst vs Ectopic pregnancy b. Post C-section changes vs uterine dehiscence c. Placenta previa vs contraction

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## Abstract Archives of the RSNA, 2023

EREE-58

### An Approach to Lateral Shoulder Impact Injuries: What the Radiologists Need to Know

All Day Room: Learning Center

Michael K. Lee (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the normal anatomy of the shoulder using radiographs. 2. Varying injuries can be sustained from lateral shoulder impacts (LSIs), including soft-tissue and osseous injuries. 3. Systematic approach for LSIs is essential to avoid missing injuries. 4. Dual-energy computed tomography (DECT) can be used to support the radiological evaluation of LSI injuries. The shoulder girdle is often injured and requires imaging in lateral impacts (e.g. in sports or pedestrian impacts), and can account for up to 4% of emergency department visits. Injuries may involve the clavicle, humerus, scapula, rotator cuff muscles, and the acromioclavicular and glenohumeral joints. To increase diagnostic accuracy, systematic search patterns are often utilized by radiologists. A systematic approach to common injuries encountered in LSIs may be useful for radiologists and trainees who evaluate acutely presenting patients.

#### TABLE OF CONTENTS/OUTLINE

1. Disclosures 2. Learning Objectives 3. Shoulder Anatomy and Stability 4. Clavicular Fractures 5. Acromioclavicular Fractures 6. Scapular Fractures 7. Proximal Humeral Fractures 8. Anterior Shoulder Dislocations 9. Dual-Energy CT in LSI 10. References

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## Abstract Archives of the RSNA, 2023

EREE-59

### A Technical Perspective on CT Perfusion Pitfalls and Roadmap for Troubleshooting

All Day Room: Learning Center

Ahmed W. Moawad, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Illustrate the acquisition protocols for CTP in stroke patients- Introduce the perfusion parameters and thresholds for identifying core infarction and penumbra- Highlight different image processing algorithms- Demonstrate workflow for post processing software- Case based review of technical pitfalls of CT perfusion processing and acquisition

#### TABLE OF CONTENTS/OUTLINE

\* Introduction about acquisition of CTP and its parameters\* Diagnostic criteria for stroke/penumbra and threshold for each parameter \* Different types of image processing: Maximum slope technique and Deconvolution. \* General workflow for automated post-processing software.\* Technical pitfalls during acquisition:# Patient motion- Effect of patient interscan motion on image registration.- Streak artifact as a result of intrascan motion- Motion correction algorithms. # Head position- Perfusion asymmetry due to head tilt\* Types of technical pitfalls in CTP processing:# Different CT perfusion thresholds for infarction.# Image alignment and registration pitfalls- Skull stripping and brain segmentation algorithm # Arterial inflow (AIF) selection pitfalls.- Arteries to use an input Criteria of correctly selected AIF- Troubleshooting AIF selection # Region of interest (ROI) selection pitfalls- Optimum position of the venous ROI- Troubleshooting ROI selection.# Time attenuation curves (TAC) pitfalls- Normal characteristics of the TAC- Bolus arrival time and first moment time- Curve Truncation

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## Abstract Archives of the RSNA, 2023

EREE-60

### **Beyond Bones on the Trauma Spine CT: Critical Injuries in the Nonfractured Spine; a Case-based Review of Subtle But Important Nonosseous Findings the Neurosurgeon Needs to Know**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Brad Wright, PhD,MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

\* A trauma spine CT that is negative for fracture may have subtle but important traumatic findings that should prompt an MRI for further workup, because they may require surgical intervention. These findings include signs of unstable ligamentous injury and signs of potential cord compression. \* Widening of an anterior disc space suggests an unstable hyperextension injury, with rupture of the anterior longitudinal ligament.\* Widening of an interspinous distance suggests an unstable hyperflexion injury, with rupture of the posterior ligamentous complex.\* Widening of one or both atlantooccipital joints and widening of one or both C1-C2 facet joints suggests atlantooccipital subluxation and atlantoaxial subluxation, respectively, with capsular injury and potential injury to other ligaments.\* Although spinal epidural hematomas and disc herniations are better evaluated on MRI, they can often be identified on CT, especially if they are large and more likely to require surgery.

#### **TABLE OF CONTENTS/OUTLINE**

\* Introduction\* Hyperextension injuries\* Hyperflexion injuries\* Atlantooccipital and atlantoaxial subluxation\* More obvious malalignment (with fractures): distraction injuries and dislocations\* Spinal epidural hematoma and disc herniation

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## Abstract Archives of the RSNA, 2023

EREE-61

### Mesenteric Pathologies in Emergency Imaging

All Day Room: Learning Center

Christian Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Describe the anatomy of the peritoneum, mesentery and omentum.-Review mesenteric pathologies in a systemic approach with multi-modality imaging.-Differentiate commonly encountered mesenteric pathologies according to imaging and clinical characteristics.-Understand which mesenteric pathologies require follow-up or acute intervention.

#### TABLE OF CONTENTS/OUTLINE

Mesenteric abnormalities are often encountered during emergency imaging. The imaging findings are often nonspecific and encompass a wide range of pathologies. In this exhibit, we review a spectrum of diseases with key imaging and clinical findings. We also highlight patient symptomology, key diagnostic features, potential acute complications, and follow up recommendations. This exhibit will review the anatomy of the peritoneal cavity, mesentery, omentum, and the peritoneal fluid circulation. Pathologies discussed include: -blunt and penetrating trauma?-secondary infiltration of the mesentery from edema or bowel inflammation?-varying stages of sclerosing mesenteritis?-sclerosing encapsulating peritonitis?-tuberculosis; omental infarct ?-primary and secondary mesenteric malignancies - carcinoid, dermoid, lymphoma, metastases, carcinomatosis, primary mesenteric mesothelioma, desmoplastic round cell, GIST, and mesenteric paraganglioma ?-cystic lesions - pseudomyxoma peritonei, inclusion cyst, duplication cyst, lymphangioma, and pseudocyst.

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## Abstract Archives of the RSNA, 2023

EREE-62

### 10 Points That Force You to Think About Intraabdominal Compartment Syndrome

All Day Room: Learning Center

Almudena Gil Boronat, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) 2. Role of body CT in evaluation abdominal compartment syndrome

#### TABLE OF CONTENTS/OUTLINE

Background: Revision of intra-abdominal hypertension and intra-abdominal compartment syndrome. • Definition • Risk factors • Recognition of suspicious clinical situation and analytical findings Identification of characteristic CT features associated with IAH and ACS. • Determining the etiology • To describe the standardized measurements used in CT to radiologically suggest the diagnosis • To propose 10 key points to not miss the diagnosis • Limitations of CT Algorithm for diagnosis of this entity and management of the patients. Conclusion Bibliography.

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## Abstract Archives of the RSNA, 2023

EREE-63

### Computed Tomographic Angiogram (CTA) of the Upper Extremities

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Richard Tsai, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: With the advancement of cross-sectional imaging and sub-mm isotropic data acquisition, computed tomographic angiography (CTA) has become an excellent non-invasive diagnostic tool for the evaluation of the upper extremity vasculature. CTA is able to evaluate for vessel patency, irregularity, and achieve the anatomic detail needed in pre-operative planning. It is generally performed in the setting of trauma, but can also be used to evaluate other causes and sources of acute limb ischemia, and vasculitides. In this review, the normal vasculature and common anatomic variations will be presented, with a focus on trauma, acute limb ischemia, and vasculitis.

#### TABLE OF CONTENTS/OUTLINE

This exhibit is on the RadioGraphics Needs List under Emergency Radiology: Upper extremity CT angiography. This exhibit will:

- 1) Discuss the imaging technique and rationale for upper extremity CTA
- 2) Illustrate normal anatomy and commonly encountered anatomic variants
- 3) Illustrate the utility of upper extremity CTA for the evaluation of trauma, vasculitis, acute limb ischemia, and pre-operative planning
- 4) Describe pitfalls in interpretation of upper extremity CTA

Outline: Normal anatomy and common anatomic variants  
Imaging protocols and interpretation  
Pitfalls: -Streak (instrumentation, contrast bolus on ipsilateral side)  
-Motion-  
Outrunning the bolus  
Trauma: -Occlusion-  
Vasospasm-  
Active extravasation-  
Pseudoaneurysm-  
Arteriovenous fistula  
Acute limb ischemia: -Thromboembolism-  
Stents and complications  
Vasculitis: -Takayasu's-  
Buerger's-  
Scleroderma/  
CREST syndrome

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## Abstract Archives of the RSNA, 2023

EREE-64

### CT of Knee Fractures and Dislocations in Adults: Diagnosis, Grading, and Management Implications

All Day Room: Learning Center

David Dreizin, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. CT is indicated for any distal femur fracture with possible articular involvement, due to easily missed coronal plane (Hoffa) fractures which displace further if unrecognized. 2. Patellar comminution associated with transverse fracture is often missed without CT, leading to potential loss of fixation with tension band wiring. Low profile 3D matrix/basket plates are increasingly used for patellar fractures shown to be comminuted at CT. 3. Patella baja is common with early severe osteoarthritis in patients with partial patellectomy for severely comminuted inferior pole fractures. 4. Medial tibial plateau fractures are complex injuries often reflecting fracture dislocation with associated ACL and lateral collateral ligament damage and dislocation of the rest of the plateau from the femur. 5. The PTA (posterior tibial slope) and mTPA (medial tibial plateau) angles can be used to determine side of compression for primary plating.

#### TABLE OF CONTENTS/OUTLINE

1. Contemporary CT imaging utilization for high-energy fractures- includes comparison with x-ray and MRI 2. Distal femur. i. classification- AO/OTA system ii. Patterns of injury/biomechanics iii. CT for surgical approach and hardware selection iv. Complications 3. Patella. i. classification- AO/OTA and its limitations ii. Patterns of injury/biomechanics iii. CT for surgical approach and hardware selection iv. Complications 4. Tibia. i. classification- Schatzker and 3 column concept (Luo) ii. Patterns of injury/biomechanics iii. CT for surgical approach and hardware selection iv. Complications 5. Conclusion/summary

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## Abstract Archives of the RSNA, 2023

EREE-65

### What You Should Know to Improve the Quality of Contrast-enhanced CT Under ECMO?

All Day Room: Learning Center

Fuyuki Washizuka (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To learn about hemodynamics when using extracorporeal membrane oxygenation (ECMO). To understand the relationship between the degree of residual native ejection fraction and the flow rate in the ECMO system when using veno-arterial ECMO (VA-ECMO). To learn about contrast-enhanced CT precautions and contrast methods under the use of ECMO. To learn the pitfalls of contrast-enhanced CT when using veno-venous ECMO (VV-ECMO). To learn how to ensure contrast-enhanced CT under more complex assisted circulation.

#### TABLE OF CONTENTS/OUTLINE

A. Changes in blood flow over time during VA-ECMO use. B. ECMO is divided into two categories, with VA-ECMO subdivided into three according to left ventricular ejection fraction (LVEF) and ECMO flow rate. C. Tips for successful contrast-enhanced CT in special hemodynamic situations when using VA-ECMO. D. Secrets to ensure successful contrast-enhanced CT when using VV-ECMO.

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## Abstract Archives of the RSNA, 2023

EREE-66

### **A Hidden Killer: Abdominal Pseudoaneurysms and Their Diagnostic Challenge**

All Day Room: Learning Center

Fernando Rodado Aranguren, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To understand the pathophysiology and etiological spectrum of visceral pseudoaneurysms, as well as their potential complications that can lead to urgent abdominal pathology. To define the radiological findings that guide the diagnosis of a pseudoaneurysm and its complications in the different imaging tests.

#### **TABLE OF CONTENTS/OUTLINE**

Pseudoaneurysms are abnormal focal dilations of the arterial vessels, generally produced by a disruption of the arterial wall that conditions the passage of blood through it, but remaining contained by the tunica adventitia or the perivascular soft tissues (unlike true aneurysms consisting of focal arterial dilations formed by all layers of the arterial wall). Among the possible causes of arterial wall damage that originates pseudoaneurysms are inflammatory processes, trauma, and iatrogenesis due to invasive procedures. Abdominal visceral pseudoaneurysms can develop a series of complications that entail high morbidity and mortality, generally divided into two large groups: those derived from compression phenomena of adjacent structures due to mass effect, and those derived from aneurysm rupture with bleeding into different spaces and structures. Through this work we will carry out an orientation to the radiological management of pseudoaneurysms and their complications, reviewing the typical findings described in the literature and illustrating them with several cases from our hospital.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

EREE-67

### Body MRI in Acute Abdomen: Primer for the On-call Radiologist and Case Based Review

All Day Room: Learning Center

Ashlesha S. Udare, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-To evaluate the appropriateness of Body MRI in acute abdomen.-To understand the importance of abbreviated protocols in an emergency setting.-To know the typical and atypical imaging features of various acute abdominal emergencies and the appearance of incidental emergent findings via a case-based review.

#### TABLE OF CONTENTS/OUTLINE

Acute Abdomen: When to do MRI?: Iodinated contrast contraindication-Renal insufficiency. History of serious contrast allergy.Failed contrast-enhanced study.Pregnancy-SAR, localiser planning.Problem-solving tool-Clinical Vs CT/US mismatch-Get a "better look!". ACR appropriateness guidelines.Technical Pearls for Body MRI in acute conditions: Micro-protocolling, monitoring scans, fast sequences, safety concerns.Case-based review of various acute abdomen Body MRIs: Gastro-intestinal emergencies (appendicitis, cholecystitis, cholangitis, diverticulitis, hepatic pyogenic abscess). Acute gynaecological conditions (ovarian torsion, massive ovarian edema, tube-ovarian abscess, fibroid degeneration, hemorrhagic cyst, ruptured ovarian cystic lesion) Acute pregnancy related cases (Ectopic pregnancies, placental abnormalities). Acute genito-urinary cases (Pyelonephritis/renal abscess, peniletrauma, scrotal trauma, epididymis-orchitis, priapism) Musculoskeletal injuries presenting as acute abdomen (core muscle injuries, abdominal wall hernias/hematomas, avulsion injuries). Cardiovascular cases (acute aortic syndromes, PE). Miscellaneous: Post-intervention, Post-transplant (renal vein thrombosis, GVHD), Oncological emergencies (ruptured HCC, SVC syndrome. Incidental emergent findings (pneumoperitoneum, hemoperitoneum)

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## Abstract Archives of the RSNA, 2023

EREE-7

### Uncoupling the Forefoot From the Midfoot: Experience and Review of Lisfranc Injuries

All Day Room: Learning Center

Victor Rodriguez-Laval, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To understand the anatomy of the Lisfranc ligament complex and its importance. To review the most prevalent injury mechanisms, classifications, and treatment options. To present the X-ray and CT findings in the emergency room, surgical procedures and post-treatment imaging.

#### TABLE OF CONTENTS/OUTLINE

We reviewed the Lisfranc injuries over the previous ten years in our institution and chose the most representative cases. The normal and pathologic anatomy will be highlighted using a multimodality approach that includes plain radiographs, CT with 3D reconstructions. A case-based methodology will be used to cover the whole spectrum of injuries, from Lisfranc ligament sprains to homolateral and divergent fracture-dislocation type injuries, and this will be followed by additional discussion. Also, a brief overview of typical classification schemes, operation approaches, gradation of injury, and postoperative imaging will be presented. It is important to understand the anatomy and injury pattern to be able to diagnose Lisfranc injuries because a delay on the diagnosis increases the risk for midfoot instability, deformity and debilitating osteoarthritis. Given the often subtle initial radiographic findings, maintaining a high index of suspicion with a low threshold to obtain supplemental imaging is key in reducing miss rates. As Lisfranc injuries comprise only a small fraction of overall foot injuries, a periodic review of the salient imaging findings is essential.

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## Abstract Archives of the RSNA, 2023

EREE-8

### Acute Large Bowel Diverticulitis: A Pictorial Review

All Day Room: Learning Center

Sara F. Pineiro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Acute large bowel diverticulitis is a common reason of emergency department visits and when complicated it may end up in urgent gastrointestinal surgery. Computer tomography (CT) remains as the primary diagnostic tool in the diagnosis and staging of acute diverticulitis and its complications. Our radiologic report is essential for the surgeon to establish a treatment and to determine an outcome as well as for the exclusion of alternate causes of pathology. We recommend using international diverticulitis staging classifications (as WSES Classification or modified Hinchey classification) to improve our communication with surgeons. In this educational communication, we aimed to illustrate the key CT imaging features of diverticulitis and its complications including perforation, phlegmon, abscess, ascending septic thrombophlebitis (phylephlebitis), bleeding, intestinal obstruction, and fistula.

#### TABLE OF CONTENTS/OUTLINE

Introduction, Reporting CT findings, Anatomy check, Complications, To take home notes

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

EREE-9

### Imaging the Acute Complications of Gender-Affirming Surgeries: A Primer in the Emergency Radiology Setting

All Day Room: Learning Center

#### Awards

##### Cum Laude

Siddhi Hegde, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Gender-affirming surgeries (GAS) and their complications are critical for radiologists to understand. GAS is often tailored to the patient; there is a diverse spectrum of post-operative appearances and complications. Typical postoperative anatomy may imitate pathology if not identified correctly. Radiologists' diagnostic expertise, knowledge of institutional GAS and common complications, and their ability to collaborate with multidisciplinary clinical team, enables them to offer valuable insights on institutional practices and guide appropriate next steps for complications. We will highlight the diagnostic features of the acute complications that may arise following gender-affirming surgeries and provide an overview of the ideal workup in the acute setting.

#### TABLE OF CONTENTS/OUTLINE

Describe expected imaging appearance of post-GAS neoanatomy, including common terminology Review multi-modality emergent imaging [ultrasound, plain film, retrograde urethrogram (RUG), Computed Tomography (CT)] review of common and "can't miss" complications Neourethral- anastomotic leaks, diverticula, fistulae, stenoses/strictures Transmasculine prostheses/device/implant - abscess, hematoma, malpositioning Bladder or rectal injury after vaginectomy (leading to fistulae) Postoperative bleeding Silicone emboli Providing gender-affirming care during imaging and reporting Understand ideal workup and unique imaging protocol considerations Discuss pitfalls of imaging in the acute setting, pearls for long-term follow-up

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## Abstract Archives of the RSNA, 2023

GIEE

### Gastrointestinal Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **GIEE-1 A Deep Dive into Essential Predictive Imaging Features of Abdominal Neoplasms in the Era of Personalized Therapy: Insight into the Correlation with Pathological, Molecular, and Genetic Background**

##### Awards

##### Certificate of Merit

Mariko Irizato (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

Recognizing imaging findings regarding the tumor microenvironment and molecular function of abdominal neoplasms is not only the key to appropriate diagnosis, but also to early prediction of treatment options and response to various therapies. This exhibit aims to provide a better understanding of the essential predictive imaging findings of abdominal neoplasms in correlation with their pathological, molecular, and genetic background, which has the potential to lead to personalized treatment strategies in the coming era.

##### TABLE OF CONTENTS/OUTLINE

The treatment options for abdominal malignancies have become more diverse with advances in surgery, chemo and immunotherapy, making pre-treatment risk stratification even more important. Radiologists are now required not only to diagnose but also to predict the prognosis and efficacy of treatment based on images, and to contribute to the selection of appropriate treatment. Understanding of predictive imaging findings can also help us to speculate upon the tumor microenvironment, which might be required in the future. We summarize these imaging findings for the following neoplasms; (i)HCC, (ii) Liver metastases from colorectal cancer, (iii) Pancreatic cancer, (vi) Intrahepatic cholangiocarcinoma. We also focused on the application of these findings to treatment strategies for each abdominal malignancy to explore the usefulness of these predictive findings in the era of personalized treatment.

#### **GIEE-10 Fibropolycystic Liver Disease: An MRI Review with Pearls and Pitfalls**

Jordan LeGout, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

Fibropolycystic liver disease comprises a spectrum of interrelated conditions that range from congenital hepatic fibrosis to choledochal cysts. In this exhibit we will: -Review the MRI appearance of the various fibropolycystic liver diseases and associated conditions-Highlight imaging pitfalls using real errors encountered in clinical practice-Introduce imaging pearls for the various conditions that can help arrive at the correct diagnosis-Differentiate between those conditions that are benign and incidental and those that pose risk for development of malignancy

##### TABLE OF CONTENTS/OUTLINE

I. IntroductionII. Congenital hepatic fibrosis a. Pearl: Liver morphology, segment IV hypertrophy b. Pitfall: FNH-like lesionsIII. Biliary hamartomas a. Pearl: Use high b-value diffusion to uncover lesions b. Pitfall: Polycystic liver disease, infiltrative malignancyIV. Peribiliary cysts a. Pearl: Anatomic sequences over MRCP b. Pitfall: PSCV. Polycystic liver disease a. Pearl: Use subtraction imaging b. Pitfall: Mucinous cystic neoplasmVI. Caroli Disease/Syndrome a. Pearl: Different degrees of involvement (diffuse vs. segmental) b. Pitfall: Recurrent pyogenic cholangitis VII. Choledochal cysts a. Review appearance of subtypes b. Pearl: Field defect and risk for cholangiocarcinoma c. Pitfall: Age related and cholecystectomy related ductal dilation

#### **GIEE-100 Post-neoadjuvant MRI Changes and Challenges in Rectal Adenocarcinoma: What to Look for**

Mayra V. Soares, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To understand the pivotal role of MRI in the post-neoadjuvant restaging of rectal cancer. To highlight the main imaging changes in post-neoadjuvant MRI, which reflect histopathologic changes that may occur after chemoradiation treatment. To recognize how fibrosis or increased mucin production, addressed by high-resolution MRI, impacts risk stratification post-neoadjuvant therapy. To learn about some challenges in MRI morphological and DWI evaluation regarding new treatment options. Understand the role of radiologists as part of patient care, helping to enroll patients eligible to "watch-and-wait" programs.

### **TABLE OF CONTENTS/OUTLINE**

Introduction: Primary tumor and nodal assessment with MRI. Rectal cancer treatment guidelines overview. When neoadjuvant treatment is the best approach. Neoadjuvant treatment options: CRT x TNT. Recognizing tumoral changes after CRT  
Posttreatment changes in the primary tumor - a systematic approach  
Tumor Restaging: a response classification based on histopathologic and DWI changes  
Patterns of tumor response  
MRI tumor regression grades - a risk stratification  
incomplete/poor x "near-complete"/complete responders  
"Watch-and-wait": patient selection and current controversies.  
Immunotherapy - the new kid on the block  
Future considerations: potential biomarkers in rectal cancer and game-changer?  
Conclusion.

### **GIEE-101 Getting Started in Bariatric Surgery Imaging: Postoperative Anatomy and Complications**

Jorge O. Ibarra Chairez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Review postoperative anatomy changes in bariatric procedures. Discuss the approach to postoperative evaluation. Identify imaging findings of common bariatric surgery complications.

### **TABLE OF CONTENTS/OUTLINE**

Background. Eligibility criteria. Types of bariatric surgery and techniques. Postoperative evaluation. Cased based review of common postoperative complications. Imaging findings in weight regain and insufficient weight loss after bariatric surgery.

### **GIEE-103 Beyond TNM Staging System: Evaluation of Colon Cancer Prognostic Factors by CT and MRI**

Ruggeri B. Guimaraes, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To review the diagnostic accuracy of CT and MRI for staging colon cancer. To define locally advanced colon tumors. To enumerate colon cancer prognostic factors and critical information that should be present in radiological reports in this context.

### **TABLE OF CONTENTS/OUTLINE**

1 - Anatomic considerations of colon and retroperitoneal surgical margin  
2 - TNM Staging of colon cancer  
3 - Colon cancer prognostic factors (primary tumor extramural extension, retroperitoneal surgical margin involvement, extramural vessel invasion, and lymph node metastases)  
4 - Locally advanced colon tumors  
5 - Current treatment of colon tumors  
6 - Promising treatment (neoadjuvant systemic therapy)  
7 - Role of imaging in stratification of patients with colon cancer according to their risk group, contributing to better patient selection and optimization of colon cancer treatment

### **GIEE-105 Tricks and Pitfalls of Multi-parametric MRI Restaging of Rectal Cancer After Preoperative Chemoradiotherapy**

Giovanni Sussan, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To describe the MRI protocol for rectal cancer evaluation after preoperative chemo-radiotherapy (pCRT), dealing also with the debated practices  
2. To describe the correct evaluation and the most common pitfalls of T staging after chemoradiation, using both DWI and contrast-enhanced sequences  
3. To describe the correct evaluation and the most common pitfalls of N staging after pCRT, including the MRI evaluation of the lateral pelvic lymph nodes  
4. To describe the other fundamental features that should be reported while evaluating an MRI for rectal cancer restaging (such as Mesorectal Fascia/peritoneal reflection involvement, Extramural Vascular Invasion [EMVI], etc.)

### **TABLE OF CONTENTS/OUTLINE**

1. Protocol of study  
2. Localization and Reported Template tips  
3. ycT staging MRI evaluation  
4. mrTRG evaluation of the primary lesion  
5. ycN staging MRI evaluation  
6. Mesorectal fascia (MRF) involvement  
7. Peritoneal Reflection involvement  
8. EMVI  
9. Tumor deposits

## **GIEE-107 Primary Hepatic Neuroendocrine Neoplasm (PHNEN) and Neuroendocrine Liver Metastasis (NELM): Imaging Update and Management**

Kedar G. Sharbidre, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Teaching Points Primary hepatic neuroendocrine neoplasms (PHNENs) are rare heterogeneous neoplasms arising from the intrahepatic neuroendocrine cells, ectopic pancreatic or adrenal tissue in the liver. Imaging appearances of these tumors are rarely been reported. Neuroendocrine liver metastases (NELM) are more common arising from gastro-enteropancreatic primary and are heterogeneous in clinical presentation and prognosis. After reviewing this exhibit, the learner will be able to: 1. Understand the basic pathophysiology of PHNENs and NELMs. 2. Understand the imaging diagnosis of these tumors and common differentials. 3. Get a basic understanding of principles of management of these tumors. 4. Imaging of Post-operative complications of liver directed therapy

### **TABLE OF CONTENTS/OUTLINE**

A. Pathophysiology of PHNENs and NELMs B. Clinical and biochemical assessment. C. Imaging protocol for liver disease. D. Common and uncommon imaging appearance with CT, MRI and PET-CTs E. Updated management guidelines F. Assessment of post treatment complications

## **GIEE-108 CT Imaging of Peritoneal Carcinomatosis and Its Mimics: Pictorial Review**

Irune Perez Arroyuelos (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Multidetector computed tomography (MDCT) is the most commonly used technique for the detection of peritoneal carcinomatosis and for the evaluation of the extend of the disease. The objectives of this study are: 1) Review the pathophysiologic mechanism of the tumor spread and the most common sites and forms of peritoneal involvement 2) Assessment of the peritoneal cancer index (PCI) that provides important information for the surgical planning 3) Illustrate a wide variety of tumorous and inflammatory conditions that can occur in the peritoneal surface and mimic peritoneal carcinomatosis

### **TABLE OF CONTENTS/OUTLINE**

Representative cases of peritoneal carcinomatosis and its mimics are illustrated in this exhibit, grouped according the following headings: 1) Anatomy of the peritoneum and the physiology of circulation and resorption of peritoneal fluid 2) CT imaging findings and patterns of peritoneal carcinomatosis 3) Peritoneal cancer index 4) Mimics of peritoneal carcinomatosis including tuberculous peritonitis, peritoneal lymphomatosis, pseudomyxoma peritonei, primary peritoneal mesothelioma, sclerosing peritonitis, fat saponification, leiomyomatosis 5) Take home points.

## **GIEE-109 Facing the 'Celiac Iceberg': What Role can Cross-sectional Imaging Play**

Xinyue Wang (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

As a condition described as 'celiac iceberg', celiac disease (CD) remains underdiagnosed and undertreated. Radiological evaluation of CD deserves more attention because cross-sectional imaging is helpful in clinical management of CD, including disease diagnosis, complications identification, treatment response evaluation, and prognostic prediction, which should be considered the examination of choice in patients suspected of having CD. The purpose of this exhibit is: 1. To introduce the challenges of diagnosis and treatment in CD; 2. To introduce what role of cross-sectional imaging can play in CD; 3. To introduce the imaging features of CD and its complications;

### **TABLE OF CONTENTS/OUTLINE**

-The profile of CD and the challenges facing  
1) Role of cross-sectional imaging in CD- Disease diagnosis- Complications identification- Disease activity and severity evaluation- Treatment response evaluation- Prognostic prediction  
2) Imaging features of CD- Jejunioileal fold pattern reversal- Mesenteric vascular engorgement - Enlarged mesenteric lymph nodes- A decreased size of spleen- Small bowel wall thickening- Diffusely dilated bowels with excess fluid or gas- Intramural fat deposition  
3) A complication of CD: Mesenteric lymph node cavitation syndrome- Imaging features of mesenteric lymph node cavitation syndrome - Enlarged mesenteric lymph nodes that contain fat-fluid levels

## **GIEE-11 Unveiling the Mysteries of Pancreas Transplantation through Imaging**

Lucas O. Madeira, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Understand the clinical relevance, indications, and surgical techniques of pancreas transplantation. Learn about the role of multimodality imaging (US, CT, MRI and CEUS) in the assessment and management of pancreas transplantation.

## TABLE OF CONTENTS/OUTLINE

Introduction: an overview  
Clinical importance of pancreas transplantation  
Epidemiology: United States and Global context  
Pancreas transplantation: surgical aspects  
Types of pancreas transplant: indications and outcomes  
Surgical techniques: arterial anastomosis, enteric drainage of exocrine secretions and venous anastomosis  
Multimodality imaging assessment of pancreas graft recipients  
US, CR and MRI: advantages and limitations  
Graft's normal appearance  
Complications: a case-based review  
Early versus late complications  
Rejection: radiological-pathological correlations  
Perspectives  
Artificial intelligence and novel imaging techniques  
Contrast enhanced ultrasound (CEUS): focus on graft's perfusion and rejection  
Take home messages

## GIEE-110 Abdominopelvic Actinomycosis

Yong-Soo Kim, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To review microbiological and clinical features of actinomycosis this may involve the abdominopelvic organs. To illustrate various CT features of actinomycosis involving abdominopelvic organs.

## TABLE OF CONTENTS/OUTLINE

Actinomycosis is a chronic inflammatory disease which can involve a variety of human organs. This disease commonly occurs in three distinct forms; a cervicofacial form, an abdominopelvic form and a thoracopulmonic form. After penetrating through the mucosal barrier, the route of propagation is direct spread to adjacent tissue. The aggressive nature of infiltration of actinomycosis may be confused with neoplasm and other inflammatory diseases, especially tuberculosis or fungal infection. Various abdominal organs may be infected by actinomycosis. Abdominal infection has been associated with abdominal surgery, such as appendectomy, or a perforation of the intestinal mucosa; a rupture of appendix, diverticulitis, foreign body perforation of the transverse or sigmoid colon, peptic ulcer. Pelvic actinomycosis may be associated with any type of intrauterine contraceptive device or with an intra-abdominal portal entry. Abdominal actinomycosis can present as an abscess or as a mass that is often fixed to the underlying tissue, as a sinus tract with drainage, perirectal or perianal disease.

## GIEE-111 Comprehensive Image-based Overview Of Percutaneous Enteral Access

Opeyemi Obiwumi (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Image-guided percutaneous enteral catheters offer a minimally invasive alternative to endoscopic or surgical techniques to provide patients access for important nutrition and medication administration. This exhibit discusses the indications, contraindications, techniques, and peri-procedural management of image-guided percutaneous gastrostomy, gastrojejunostomy (including AbbVie PEG-J pull-type technique for Duopa infusion), jejunostomy, and transesophageal gastrostomy.

## TABLE OF CONTENTS/OUTLINE

- Pre-Procedural Considerations
- Indications/Contraindications for percutaneous enteral catheter placement
- Image-guided technique for percutaneous gastrostomy/gastrojejunostomy
- Image-guided technique for percutaneous jejunostomy
- Image-guided technique for percutaneous transesophageal gastrostomy
- Image-guided technique for percutaneous pull-type AbbVie PEG-J
- Post-procedural evaluation and complication management

## GIEE-112 Duodenal Diseases: Illustrated Cases for Radiologists

### Awards

#### Certificate of Merit

Manuel Sebastian S. Paez Alvarez SR, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To provide a comprehensive, illustrative guide for diagnosing duodenal diseases in radiology practice. To review and emphasize the imaging characteristics of various duodenal pathologies on CT studies. To highlight the importance of recognizing subtle findings and common anatomical anomalies for accurate diagnosis.

## TABLE OF CONTENTS/OUTLINE

Duodenal diseases encompass a broad spectrum of conditions that can originate in the duodenum or result from processes involving neighboring organs. This exhibit aims to educate radiologists on various duodenal pathologies, emphasizing illustrative cases through CT studies.  
Introduction: Overview of duodenal diseases and their significance in gastrointestinal

imaging. Congenital anomalies. Inflammatory diseases. Neoplastic diseases. Vascular pathologies. Iatrogenic complications involving the duodenum. Other duodenal entities and pathologies. Conclusion. In this educational exhibit, we will provide a thorough understanding of the duodenum's anatomy and various diseases, emphasizing the importance of recognizing subtle imaging findings in the context of duodenal pathology. This resource will serve as a valuable guide for radiology residents and radiologists seeking to improve their diagnostic skills in abdominal CT imaging.

## **GIEE-113 Usual and Unusual GI Tract Diverticula, Clinical Presentation, Imaging Characteristics and Management**

### **Awards**

#### **Certificate of Merit**

Pedro A. Ferrer, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Review the pathophysiology of diverticula formation throughout the gastrointestinal tract. Describe the presentation and demonstrate the imaging characteristics of typical and atypical diverticula throughout the entire gastrointestinal tract. Discuss potential complications of diverticula, as well as their management.

### **TABLE OF CONTENTS/OUTLINE**

-Overview of the pathophysiology of diverticular disease--Overview of radiological findings, complications, and management of diverticular disease--For each type, examples from our database will be provided  
Foregut----Zenker's diverticulum----Traction and pulsion diverticulum----Pseudodiverticulum----Epiphrenic diverticulum----Gastric diverticulum----Duodenal diverticulum-----Duodenal diverticulitis-----Lemmel syndrome-----Duodenal diverticular lithiasis-----Intraluminal duodenal diverticulum  
Midgut---- Jejunum diverticulum-----Jejunum diverticulitis---- Meckel's diverticulum----Bleeding Meckel's diverticulum-----Meckel's diverticulitis  
Hindgut----Colonic diverticulum-----Right Colon-----Acute diverticulitis-----Appendiceal diverticulum-----Diverticular abscess-----Left Colon-----Acute diverticulitis-----Diverticular abscess secondary to ruptured diverticula-----Fistula-----Colo-vesical fistula-----Colo-iliopsoas fistula-----Fecal peritonitis and purulent peritonitis secondary to ruptured diverticula-----Septic Thrombophlebitis-----Bleeding colonic diverticulum-----Giant colonic diverticulum

## **GIEE-114 Infiltrative Hepatocellular Carcinoma: Challenging Cases and Its Benign Mimics**

Elhamy R. Heba, MD, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Various histopathologic and morphologic subtypes of hepatocellular carcinoma (HCC) are described throughout the literature. Among all these subtypes, the infiltrative appearance of HCC presents unique challenges in detection, both clinically and radiographically. Infiltrative appearance of HCC is characterized by diffuse permeative spread throughout the liver parenchyma, without forming a mass-like lesion, in a manner that sometimes it is difficult to detect on a background of abnormal liver parenchyma. Radiologist must distinguish the infiltrative pattern of HCC from processes that may mimic such as: confluent fibrosis, diffuse fat or iron deposition, diffuse metastatic disease, cholangiocarcinoma, and hepatic microabscesses.

### **TABLE OF CONTENTS/OUTLINE**

1. Incidence and prevalence of infiltrative HCC  
2. Review imaging features of infiltrative HCC, including multimodality case-based review of typical and challenging cases of infiltrative HCC with pathological correlation  
3. Discussion of Tumor in vein as a common imaging feature of infiltrative appearance of HCC  
4. Mimics of infiltrative appearance of HCC including confluent fibrosis, diffuse fat/iron deposition, diffuse metastatic disease, cholangiocarcinoma, and hepatic micro abscesses  
5. Review of prognosis, management and post treatment imaging of infiltrative appearance of HCC

## **GIEE-115 Autoimmune Diseases of the Liver and Biliary Tract**

### **Awards**

#### **Cum Laude**

Cody M. Anderson, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Understand mechanisms behind self-tolerance and autoimmunity  
Review spectrum of autoimmune disorders of the liver and biliary tract  
Review the typical and atypical imaging appearance of autoimmune liver and biliary disorders on CT And MRI.

### **TABLE OF CONTENTS/OUTLINE**

Autoimmune disorders involving liver and biliary tract can be broadly classified into  
Autoimmune hepatitis (AIH)- Type 1 and Type 2  
Primarily biliary cholangitis (PBC)  
Large duct and small duct primary sclerosing cholangitis (PSC)  
Overlap syndromes:

AIH+PBC; PBC+PSC; AIH+PSCIgG4 sclerosing cholangitisDrug-induced autoimmune injuryLiver involvement in systemic autoimmune disorder (SAD)Diagnostic approachRole of MRCP in the diagnosis of autoimmune biliary disordersIllustration of imaging findings ofAIHHeterogeneous enhancement of parenchymaPeriportal edemaNormal MRCPResponsive to steroidsPBCLace-like fibrosis"Periportal halo" signPortal lymphadenopathyNormal MRCP in the early stage gt pruned tree appearance in later stagePSCPredilection for peripheral intrahepatic ductsBeaded appearance of ducts on MRCPHigh risk of perihilar cholangiocarcinomaSmall duct PSCNormal MRCPTypical PSC histologyIgG4 diseaseCircumferential thickeningPredilection for extrahepatic and hilar ductsDrug-induced (biologic agents)Appropriate clinical contextRapid progressionSystemic autoimmune disorderImmune-mediated hepatitis may be seen in systemic lupus erythematosus and rheumatoid arthritis

## **GIEE-116 Gastrointestinal Pharmacoradiology: Updated Review of the Indications, Pharmacodynamics, and Adverse Effects of Bowel Preparation Agents, Gastrointestinal Contrasts and Motility-Modifying Medications**

Alberto I. Carbo, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of the exhibit is: • To review the liquid diet and different cathartics used for bowel preparation including their pharmacodynamics, mechanisms of action, dosage, contraindications, precautions and adverse reactions. • To address patients' frequent questions about bowel preparation before radiologic examinations. • To explain the chemical characteristics and non-active component of the enteric contrast agents used for fluoroscopic, CT and MRI examinations. • To discuss the indications, pros and cons, concentrations, contraindications of enteric contrast, and strategies to prevent adverse reactions and mitigate legal consequences. • To review motility-modifying agents used to optimize GI tract imaging, including their common indications, mechanisms of action, administration route, dosage, peak action, risks, and contraindications. • To describe sedative agents used for intubation.

### **TABLE OF CONTENTS/OUTLINE**

AGENTS USED FOR: Bowel preparation • Liquid diet • Action mechanisms of cathartics • Saline osmotic cathartics: magnesium citrate • Stimulant cathartics: bisacodyl GI tract endoluminal contrasts for • Fluoroscopic exams: barium sulfate, iodinated water-soluble contrasts, gas. • CT studies • MRI examinations Motility modifiers of GI tract • Antiperistalsis/hypotonia: glucagon, Buscopan • Prokinetics: metoclopramide Mild sedation • Benzodiazepines Topical anesthesia • Lidocaine Lubricants for intubation

## **GIEE-117 Oh No, I Thought It Was a Hemangioma!!!**

### **Awards**

#### **Certificate of Merit**

Matteo Bonatti, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Liver hemangiomas are frequently encountered during imaging studies and have peculiar features on US, CEUS, CT and MRI.- Various benign and malignant liver lesions may show imaging features resembling hemangiomas.- At US, echogenic liver lesions are not always hemangiomas, particularly in cirrhotic patients and in patients with known malignancies: CEUS might be helpful as a quick problem-solving technique in these cases.- Contrast enhancement pattern must be accurately evaluated: centripetal enhancement alone might be misleading if not associated with globular pattern. - On MRI, hemangiomas must show "fluid-like" T2-hyperintensity; moderately T2-hyperintense lesions are almost never hemangiomas.- Always have a look to ADC values.- Hemangiomas do not have perilesional nodules.- Hemangiomas may slowly grow over time

### **TABLE OF CONTENTS/OUTLINE**

To briefly review the typical imaging features that hemangiomas must show on US, CEUS, CT and MRI in order to confidently diagnose them.To show a series of liver hemangioma mimickers (e.g. mass forming intrahepatic cholangiocarcinoma, angiosarcoma, neuroendocrine tumor metastases, colorectal tumor metastases, mucinous tumor metastases,?) on various imaging modalities. For every case the misleading feature(s) will be highlighted.

## **GIEE-119 Imaging in Pancreas Transplantation: Conventional and Novel Approaches**

Jordan K. Swensson, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Pancreas graft location and vascular anatomy are unique and must be understood for radiologic evaluation-Ultrasound, CT, MRI all play roles in graft evaluation- Contrast enhanced ultrasound (CEUS), novel MRI techniques, graft biopsy, and alternative transplant approaches all may be part of comprehensive patient care



## TABLE OF CONTENTS/OUTLINE

-Indications for pancreas transplant- Review of expected surgical technique / post surgical anatomyo Correlation with intra-operative pictures can assist- Rationale for pancreas graft imaging ; how does radiology make a differenceo Graft parenchymal and vascular evaluationo Graft environment+Fluid collections, bowel obstruction, enteric anastomosis evaluation- Advances in Ultrasoundo Grayscale, Doppler, CEUSo CEUS novel techniques identify vascular insufficiency in grafts and change surgical managemento CEUS used to follow rejection over time- CT to Multiphase CT evaluation for graft and vesselso Examples of common pathology (vascular, pancreatitis, bowel complications)- Standard and investigational MRIo Evaluation for fluid around graft, may assess vessels with or without angiographyo Evaluation with gadolinium-based as well as iron-based contrast agents- Biopsyo Image guided percutaneous approach- Alternate transplant approacheso Islet cell transplanto Composite transplant

### **GIEE-12 A Primer for Pancreatic Head Pathologies- What the Surgeons Want to Know at the Multidisciplinary Conference**

Kazi A. Irfan, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the malignant and benign solid lesions in relation to the pancreatic head and their imaging appearance2. Differentiation of the cystic pancreatic lesions and approach to their differential diagnosis3. Discuss the NCCN guidelines for the assessment of vascular involvement to ascertain resectability4. Illustrate the surgical technique of Whipple's procedure5. Enumerate the important anatomical variants in the celiac and superior mesenteric arteries which would alter the surgical technique6. Provide a roadmap to distinguish normal post operative changes from tumor recurrence

## TABLE OF CONTENTS/OUTLINE

-Imaging appearance of mass forming lesions involving the pancreatic head\*Primary malignancies\*Metastases\*Neuroendocrine tumors\*Benign lesions\*Mass forming chronic pancreatitis-Multidisciplinary approach in the diagnosis and management of the solid lesions-Role of imaging in staging and assessment for surgical resectability-Different cystic lesions involving the pancreatic head\*IPMN\*Serous cystadenoma\*Mucinous cystadenoma\*Pseudocyst-Imaging evaluation to differentiate between the cystic pancreatic lesions-Multidisciplinary approach in the diagnosis and management the cystic pancreatic lesions- Indications of Whipple's surgery and the surgical technique-Review the anatomical variants of significance involving the celiac and superior mesenteric vasculature-Multidisciplinary approach in assessment of local tumor recurrence and distant metastases

### **GIEE-120 Deep Learning Reconstructions in the Abdomen: An Update**

#### **Awards**

#### **Magna Cum Laude**

Corey T. Jensen, MD (*Presenter*) Research Grant, General Electric Company

#### **TEACHING POINTS**

- DLR markedly reduces image noise and preserves image texture
- Increasing evidence suggests significant capacity for radiation dose reduction of 46-61% compared to hybrid IR o Including for low contrast > 5mm liver lesion detection task o Limited evidence suggests less aggressive dose reduction for lesions < 5mm
- No free lunch o Next gen DLR algorithms will address mild loss of high spatial frequency information in clinical images

## TABLE OF CONTENTS/OUTLINE

- Reconstruction Background - how did we get here? o Reconstruction history o Iterative recon (IR) limitations o Unique QA issues for IR o Case examples
- What is DLR? • Phantom Evidence Update • Clinical Evidence Update from Literature Review
- DLR Implementation o Assessing your practice baseline o Determining intended clinical tasks • DLR pitfalls • Conclusion

### **GIEE-121 Rectum, Set, Go: A Radiologist's Perspective of a New NAPRC Accredited Multidisciplinary Rectal Cancer Tumor Board at a Large Cancer Center**

Harshna V. Vadvala, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. NAPRC offers standardized, risk-adapted management of rectal cancer, while Rectal Cancer Multidisciplinary Teams (RC-MDT) provide structure and resources for accreditation and compliance.2. Radiologists will learn NAPRC standards which involve utilizing synoptic reporting formats for 95% of all staging MRI exams, having 90% of pre-treatment MRI exams read by RC-MDT member radiologists, and fulfilling minimum attendance requirements.3. Radiologists are key members of RC-MDT, meeting at least bimonthly with surgeons, pathologists, radiation oncologists, and medical oncologists. Uniform MRI image acquisition and interpretation, along with standardized reporting, are crucial for effective staging.



## TABLE OF CONTENTS/OUTLINE

A) Requirements for NAPRC-accredited RC-MDT 1. Multispecialty services and program management 2. RC-MDT meeting structure a. Radiologist's requirements i. American College of Radiology (ACR) education module ii. Radiologist's mandatory presence for all meetings with individual attendance requirements iii. Internal record review to audit MR exams iv. Measures of compliance for synoptic reports B) RC-MDT member radiologist's contributions 1. Radiologists read 90% of pre-treatment staging MRI exams. 2. Post-treatment restaging and tumor regression grading (TRG) 3. Surgical planning 4. Surveillance C) MR Rectal cancer exams 1. Technical uniqueness of acquisition 2. Imaging features of local disease 3. Standard synoptic report used in 95% of staging MR exams 4. Prediction of local recurrence and metastasis D) Secondary initiatives 1. Rectal cancer education program and goals of care 2. Data management 3. Quality improvement

## **GIEE-122 CRS (Cytoreductive surgery) + HIPEC or PIPAC: The Radiologist Verdict**

Raquel Acosta Hernandez, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The therapeutic management of peritoneal carcinomatosis (PC) and pseudomixoma peritonei (PMP) requires an assessment in multidisciplinary committees. The radiologist must report where each tumor burden is addressed using the a) PCI (peritoneal carcinomatosis index), b) presence of distant secondary disease (extraperitoneal) and c) tumor implants location in "danger zones" that would condition an incomplete CRS (Cytoreductive surgery). Not only the extent of the disease must be taken into account, but also other patients individually factors and comorbidities as well as the resources available in each center. Multidisciplinary interaction constitutes the main pillar for a correct selection of patients who are candidates for CRS and subsequent intraperitoneal chemotherapy or, given the risk of incomplete CRS, consideration of other possibilities innovative palliative therapies, such as PIPAC.

## TABLE OF CONTENTS/OUTLINE

Review the first peritoneal carcinomatosis (CP) evaluation approach: a) PCI (Peritoneal cancer index) b) Implant zones due to peritoneal fluid stasis. c) Implant zones: "Key locations" and d) Ascitis and e) Extraperitoneal disease. Illustrate the "danger zones" and unfavourable tumor implants location: beyond the first CP check-points. Update of pseudomyxoma peritonei (PMP): a misunderstanding and controversial disease. Analyze the different types of treatment (surgery, HIPEC and PIPAC): assessment in multidisciplinary committees and focus on the role of radiologist in multidisciplinary committees.

## **GIEE-123 Pre-operative Evaluation in Living Donor Liver Transplantation: A Roadmap for Radiologist**

Hande Ozen Atalay, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Liver transplantation is the most effective treatment for liver failure. Because the number of cadaveric donors is not enough considering the high demand, the number of living donor liver transplantations (LDLT) has been on the rise, and right lobe transplantation accounts for 70 % of all LDLT. In pre-transplant imaging, there are many important issues that should be evaluated and noted in the report. Radiologists play a pivotal role in a transplantation unit and surgical planning. In the pre-operative evaluation of LDLT, choosing the appropriate liver segment for the recipient (right lobe, left lateral segment, etc.) and evaluating the liver in the donor candidate in terms of parenchymal lesions and diseases constitute the initial steps. The liver segmentation should next be done; the total liver volume and the volume of the liver segment to be transplanted are calculated. This step is essential for avoiding small-for-size syndrome in the recipient as well as liver insufficiency in the donor candidate. Recognition of vascular and biliary anatomical variations is critical because certain anatomical variations are accepted as contraindications to LDLT and may cause post-operative ischemia in the donor and recipient. To conclude, radiologists must be aware of their crucial role in the pre-operative imaging of LDLT.

## TABLE OF CONTENTS/OUTLINE

-Living donor liver transplantation (LDLT) definition, types, and indications-Liver parenchymal evaluation, segmentation, and volume rendering-Important vascular and biliary variations in the LDLT-Contraindications of the right lobe and left lateral segment LDLT-Important issues to be noted in the pre-transplant radiological report -Conclusion

## **GIEE-124 Gelatinous Jigsaw: A Pictorial Review of Mucinous Cystic Pancreatic Neoplasms**

Milina N. Rana, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The goal is to educate the audience in recognizing the multi-modal imaging features of mucinous cystic pancreatic neoplasms (MCPN), with an emphasis on their clinical and pathological correlation. We will also characterize morphological features of different pancreatic cystic lesions and elucidate the imaging and histopathologic features of MCPN subtypes including mucinous cystadenoma, mucinous cystadenocarcinoma and intraductal papillary mucinous neoplasm (IPMN).

## TABLE OF CONTENTS/OUTLINE

Mucinous cystic pancreatic neoplasm (MCPN) clinical overview Epidemiology Pathophysiology Classifying non-neoplastic and neoplastic MCPN subtypes Review MCPN multi-modal imaging features on Ultrasound (US), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) Imaging and histologic features of Mucinous Cystadenoma Imaging and histologic features of Mucinous Cystadenocarcinoma Key features of differentiating Intraductal Papillary Mucinous Neoplasm (IPMN) and its subtypes Treatment and Prognosis

### **GIEE-125 CT Guided Gastrostomy Placement: An Alternative Approach without Placement of Nasogastric Tube**

Mohanad Kurdi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Computed Tomographic (CT) guided gastrostomy tube (G-tube) placement is an alternative to fluoroscopic techniques. CT guided G-tubes forego the placement of a nasogastric (NG) tube as insufflation of the stomach is performed via anterior abdominal wall percutaneous access. NG tubes cause a variety of problems, including patient discomfort, challenging placement, premature removal and malplacement. Cross sectional imaging allows for a global view of intra-abdominal structures, with more accurate localization of soft tissue structures. Compare and contrast CT and fluoroscopic guided techniques with pitfalls of both.

## TABLE OF CONTENTS/OUTLINE

Background Indications and Contraindications Gastrostomy Tube Placement Techniques Disadvantages of Nasogastric Tubes CT Guided G-Tube Overview Technical Considerations CT versus Fluoroscopy Our Experience Discussion References

### **GIEE-126 Worry or Go with the Flow: Perfusion Anomalies and Vascular Disorders of the Liver - A Primer for the Radiologist**

#### Awards

##### Certificate of Merit

Grant E. MacKinnon, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understanding the imaging appearances and physiology of transient hepatic attenuation differences (THADs) on CT and transient hepatic intensity differences (THIDs) on MRI is crucial to aid the radiologist in diagnosing hepatic disease processes.
2. Recognizing perfusion anomalies in the liver is essential to avoid misinterpretation of "pseudolesions", a common pitfall for the training radiologist.
3. Familiarity with the pathogenesis and imaging features of hepatic vascular disorders helps guide correct diagnosis and patient management.

## TABLE OF CONTENTS/OUTLINE

1. Physiology of hepatic perfusion a. Nutrient rich mesenteric venous inflow b. Compensatory nature of hepatic arterial and portal venous blood flow
2. Concept of THADs/THIDs a. Pathophysiology b. Case-based review of common etiologies: "Cs" of THAD/THID c. Strategies to avoid misinterpretation
3. Concept of streamline phenomenon a. Implications with case-based review
4. Concept of third inflow a. Implications with case-based review
5. Case-based review of miscellaneous vascular diseases a. Sinusoidal occlusion syndrome b. Budd Chiari c. Cavernous transformation and portal biliopathy d. Hepatic peliosis e. Hepatic ischemia secondary to TIPS

### **GIEE-127 Borderline Pancreatic Cancer: Role of Cross Sectional Imaging in Therapeutic Decision Making**

Diego M. Haberman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Borderline pancreatic ductal adenocarcinoma (BR-PDAC) is defined as a tumor potentially resectable but with anatomical (vascular involvement), biological (serum biomarkers) or clinical (performance status) conditions that may impact in free margin resections or postoperative outcomes. Anatomical BR-PDAC is at high risk for margin positive when surgery is upfront, so neoadjuvant chemotherapy and/or radiotherapy is considered to increase the chance of a R0 resections. Radiology is a significant tool concerning anatomical dimension, evaluating tumor - vessel relationships, being a pillar in decision making to choose the best therapeutic option for each patient. The images are also fundamental evaluating post-neoadjuvant response, contributing to evaluate tumor biology and responding patients. The objective of this exhibit is: 1) To review the role of imaging determining resectability status of tumors with detailed analysis in tumor - vessel contact of BR-PDAC. 2) To evaluate anatomical conditions that influences in surgical technique, particularly when vascular reconstructions are needed. 3) To review imaging response criteria post neoadjuvant therapy.

## TABLE OF CONTENTS/OUTLINE

a) Tumor - venous contact analysis using Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). b) Tumor - artery contact evaluation and its differences when comparing to vein analysis. c) How proper radiological identification of the characteristics of venous and/or artery involvement influence on surgical approach and vascular reconstruction techniques required for a successful surgery.

### **GIEE-128 Make it Simple-Imaging of the Postoperative Whipple**

Ali Agely, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The Whipple procedure (pancreaticoduodenectomy) is performed to resect pancreatic head or periampullary neoplasms. CT and (increasingly) MRI are performed in the acute and delayed postoperative settings, notably in patients with a complicated course. This presentation provides a comprehensive overview of various postoperative imaging findings after a Whipple procedure with emphasis on MRI. Familiarity with expected findings and postoperative complications gives the radiologist the knowledge to render a prompt and accurate diagnosis.

## TABLE OF CONTENTS/OUTLINE

1) Surgical review 2) Normal, expected findings in the acute and delayed postoperative settings 3) Complications: Pancreatic fistula, Leak (gastrojejunostomy and biliary-enteric), anastomotic strictures, pancreatitis (acute and acute on chronic), hemorrhage, abscess, portomesenteric venous thrombus, tumor recurrence, delayed gastric emptying, and stent migration

### **GIEE-129 GI and GU Fluoroscopy In Common Post-op Oncologic Surgeries: What You Need to Know About This Leaky Business**

Ahmed Taher, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe common gastrointestinal and genitourinary fluoroscopic procedures in oncology 2. Illustrate the different techniques and indications for post op fluoroscopic examinations with key teaching points 3. Demonstrate normal and abnormal fluoroscopic examinations including complications with emphasis on leaks

## TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Endoscopic evaluation versus double contrast studies. 3. Surgical techniques of Ivor Lewis esophagectomy and its complications. 4. Indications, techniques and imaging findings of single-contrast esophagram. 5. Colonic and jejunal interposition. 6. Surgical techniques for rectal surgeries and their complications. 7. Indications, technique and imaging findings on single contrast enema. 8. Indications, techniques and imaging findings of bladder surgeries and urinary diversions on cystogram, loopogram and pouchogram. 11. Take-home messages. 12. References.

### **GIEE-130 Constipation, Stercoral Colitis, Hirschsprung Disease and Complications in Adults**

Joel Gamble, MD, BSC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Imaging is unreliable in establishing the diagnosis of constipation and directing routine management. Severe or chronic constipation can lead to serious complications, for which imaging is essential. Stercoral colitis is a potentially fatal complication of fecal impaction. High attenuation mucosa and perfusion defect are the most accurate features for fatal cases. The natural history of Hirschsprung disease epitomizes the complications of constipation. Despite surgical resection, many adults have chronic constipation, and a subset have serious constipation-related complications.

## TABLE OF CONTENTS/OUTLINE

Constipation: Clinical diagnosis; recent literature that imaging does not correlate with bowel habit, predict symptoms of constipation, or reliably direct management decisions; imaging for complications of constipation. Stercoral colitis: Mucosal ulceration due to pressure ischemia, possible perforation; spectrum of findings severity. Hirschsprung disease: Absent ganglion cells in the submucosal and myenteric plexuses; symptoms into adulthood include constipation, straining, incomplete evacuation. Various mechanisms of chronic constipation; late presentation of Hirschsprung in adulthood; complications include adhesional obstruction; fistula formation; obstruction; perforation

### **GIEE-131 The Pinch and the Squeeze: A Review of Vascular Compression Syndromes**

Hannah Lamberg, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Diagnosis of almost all vascular compression syndromes is largely clinically based. However, certain imaging findings can be suggestive of these syndromes, aiding in diagnosis and treatment. 2. Findings suggestive of a vascular compression syndrome include pre-stenotic vessel dilation, formation of varices, and compression of other structures (e.g. ureter, duodenum).

## TABLE OF CONTENTS/OUTLINE

1. Brief introduction of vascular compression syndromes 2. Radiologic findings with accompanying CT examples including:- Nutcracker Syndrome- May-Thurner Syndrome- Pelvic Venous Congestion Syndrome (non-vascular compression syndrome)- Median Arcuate Ligament Syndrome- Superior Mesenteric Artery Syndrome- Chronic Ureteropelvic Junction Obstruction by crossing vessels- Ovarian vein syndrome. 3. Summary/Conclusions: Review of high-yield teaching points

## GIEE-132 Imaging of Gallstones and Complications

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is to: 1. Identify various types of gallstones and discuss imaging techniques 2. Multimodality imaging review of the features of gallstones and their complications 3. Discuss pitfalls and mimics of gallstones.

## TABLE OF CONTENTS/OUTLINE

There are three main types of gallstones: Cholesterol (10%), Pigmented (10%) and mixed (80%). Ultrasound is the superior imaging modality for detection of gallstones as up to 20% stones are not calcified and CT occult. CT is better to detect gallstone complications. Dual Energy CT utilizes low KV, calcium-based and lipid-based imaging and more sensitive than single energy CT to detect gallstones. Gallstone complications: Acute cholecystitis; Acute cholangitis; Mirizzi Syndrome; Biliary-enteric fistulae; infected fallen gallstones; post-cholecystectomy syndrome. Pitfalls and Mimics: Assessment of stone impaction; gallbladder polyps; cystic artery pseudoaneurysm, enteroliths. Summary: Gallstones are common seen on imaging and can serve as a nidus for infection/inflammation; cause biliary outflow obstruction or fistulize to adjacent structures necessitating prompt diagnosis sometimes utilizing multimodality imaging, treatment and intervention.

## GIEE-133 Don't Judge a Gallbladder by Its Wall

Sara Siguenza-Gonzalez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Radiologists are very used to cholecystitis in daily clinical practice, but there are other entities that affect the gallbladder (GB): Classification and description of those entities according to a pathological point of view. Principal radiographic features of each disorder in ultrasound (without and with contrast), CT (including spectral CT) and MRI. Key points to guide the differential diagnosis of the main pathology of the GB.

## TABLE OF CONTENTS/OUTLINE

1. An approach to the anatomy and physiology of the GB. Description of normal anatomy, anatomic variants and congenital features. 2. Describe benign entities, idiopathic diseases (cholesterolosis and adenomyomatosis) and bile stasis diseases. 3. An update of premalignant gallbladder polyps. 4. Analyze malignant pathology, including primary tumours (gallbladder carcinoma and cholangiocarcinoma) and secondary tumours (metastasis and lymphoma). 5. A portrayal of others disorders in the GB: traumatic pathology, secondary causes of diffuse gallbladder wall thickening and inflammatory diseases beyond acute cholecystitis.

## GIEE-134 Hepatobiliary and Pancreatic Manifestations of Immunochemotherapy: A Practical Guide

Soumyadeep Ghosh, MBBS, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. An update on the commonly used cancer immunotherapy and chemotherapy agents that affect the liver, biliary system and pancreas. 2. Delve into the pathogenesis of these therapy-related hepatobiliary and pancreatic manifestations. 3. Illustrate the role of imaging in diagnosis of these therapy-related manifestations in the context of cancer.

## TABLE OF CONTENTS/OUTLINE

1. Background 2. Cancer immunotherapy and chemotherapy agents that can affect the liver, biliary system and pancreas a) CTLA-4 inhibitor - Ipilimumab b) PD-1 inhibitor- Nivolumab, Pembrolizumab c) PD-L1 inhibitor - Durvalumab, Atezolizumab d) Alkylating agents - Oxaliplatin e) Anti-metabolites - Pyrimidine analogues (5-fluorouracil, Gemcitabine), 6-mercaptopurine, methotrexate f) Vinca alkaloids - Vincristine, Vinblastine g) Topoisomerase I inhibitors - Irinotecan 3.) Therapy related adverse effects - Hepatic - Biliary - Pancreatic 4. Steatosis 5. Diffuse hepatitis 6. Fibrosis 7. Pseudocirrhosis 8. Sinusoidal obstruction syndrome 9. Focal nodular hyperplasia - like lesions 10. Nodular regenerative hyperplasia

### **GIEE-135 Primary Peritoneal Malignant Mesothelioma: Everything a Resident Needs to Know**

Soumyadeep Ghosh, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Distinguish the various subtypes of mesothelioma based on clinical and radiological features. Illustrate the spectrum of imaging features of primary peritoneal mesothelioma. Be cognizant of the mimics of primary peritoneal malignant mesothelioma in our daily reporting.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background on mesothelioma 2. Subtypes of peritoneal mesothelioma a) Cystic mesothelioma b) Primary peritoneal malignant mesothelioma (PPMM) c) Well-differentiated papillary mesothelioma 3. Spectrum of imaging features of primary peritoneal malignant mesothelioma 4. Cases - a) Peritoneal thickening b) Peritoneal masses c) Omental fat stranding and nodularity d) Extensive disease 5. Mimics a) Peritoneal carcinomatosis b) Lymphoma c) Tuberculous peritonitis

### **GIEE-136 All About the Gallbladder: From Normal to Rare**

#### **Awards**

#### **Certificate of Merit**

Vivianne De Paula Reis Guimaraes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review of normal anatomy and common conditions of the gallbladder, demonstrating the role of the available imaging methods. Illustrate unusual cases of the gallbladder, highlighting the main imaging findings for the correct approach and diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Brief demonstration of the gallbladder anatomy as well the imaging findings related to its most frequent conditions. Case-based illustration of multiple uncommon gallbladder pathologies according to their nature: - Anatomical variants and malformations; - Inflammation; - Neoplasms; - Others (trauma, torsion etc.).

### **GIEE-137 Imaging Characteristics of Pancreatic Serous Cystadenoma and Common Imitators**

#### **Awards**

#### **Certificate of Merit**

Nikolas Brozovich, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Pathophysiology of Pancreatic serous cystadenoma. 2) MR characteristics of Pancreatic serous cystadenoma and its subtypes. 3) Cystic pancreatic lesions mimicking serous cystadenoma. 4) Aggressive features of atypical serous cystadenomas. 5) Utility of endoscopic ultrasound and fluid aspiration for definitive diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Pancreatic cystic neoplasms are commonly encountered in practice and reported on 20-40% of abdominal MRI scans compared to only 3% of CT scans. Serous cystadenoma of the pancreas can have similar characteristics to other benign and malignant pancreatic lesions. The microcystic form of Pancreatic serous cystadenoma has classic features with a pathognomonic enhancing scar and stellate calcifications seen in 30% of cases. 1) MR features of microcystic, macrocystic, oligocystic, and solid pancreatic serous cystadenoma subtypes. 2) Atypical aggressive features including parenchymal atrophy, ductal dilatation, and vascular/local invasion. 3) Common mimics including Mucinous cystic pancreatic neoplasm (MCPN), Solid pseudopapillary epithelial neoplasm (SPEN), Intraductal papillary mucinous neoplasm (IPMN), pseudocyst, lymphoepithelial cyst, cystic neuroendocrine tumor (NET), and adenocarcinoma. 4) Von Hippel-Lindau syndrome- Increased incidence of developing Pancreatic serous cystadenoma and other benign and malignant tumors of various organs.

### **GIEE-138 Barriers to Adopting LI-RADS and Steps to Overcome**

James T. Lee, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1) The Liver Imaging Reporting and Data System (LI-RADS) is a reporting system for the classification of hepatocellular carcinoma (HCC) that continues to grow in adoption throughout North America including important steps of alignment with both the American Association for the Study of Liver Disease (AASLD 2018) and the Organ Procurement Transplant Network (OPTN 2022) 2) Despite growing adoption, radiologist still encounter barriers to implementation within their own clinical academic departments, from referring physicians and surround community practices.3) An understanding of different barriers that may face radiologists and referrers towards the adoption of LI-RADS is an important step to overcoming these obstacles.

## TABLE OF CONTENTS/OUTLINE

I. Review LI-RADS purpose to standardize reporting and data collection for patients at risk for developing HCCII. Illustrate the growth of LI-RADS adoption over the past decadeIII. Describe the barriers to adoption of LI-RADS from both the radiologist and referring providers point of viewIV. Explain how to overcome barriers from the experiences encountered from our multiple (12) institution collaborative.

## GIEE-139 Crohn's Disease: Step by Step in MRI

Natalia Y. Zuniga, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Active disease is characterized by wall thickening and edema and or ulceration. Wall thickening alone, without the supporting features of oedema or ulceration, often indicates inactive disease, particularly if the wall is dark on fat-suppressed T2WI.Functional techniques such as DWI and motility imaging provide ways to quantify disease activity, monitor, and even predict therapeutic response.Complications can be divided into stricturing, penetrating, related to short bowel and development of malignancy.Characterization of strictures requires a fixed luminal narrowing with upstream dilatation greater than 3 cm.The strictures should be differentiated between inflammatory luminal narrowing or fixed fibrosis, and should be measured the length of the stricture.Contrast enhancement may be useful, but active and fibrotic disease both enhance. Early enhancement is more typical for active CD whereas delayed enhancement may indicate established fibrosis.It is useful to distinguish between response to treatment and imaging remission. Response implies a significant reduction of the inflammatory burden, and imaging remission implies the abolition of all activity.Scores are not routinely applied in clinical practice, however their knowledge is necessary for the description of mild, moderate and severe disease, which is sufficient.

## TABLE OF CONTENTS/OUTLINE

Definition and initial diagnosis. Disease Activity. Disease phenotype. Non-stricturing, non-penetrating (inflammatory). Stricturing Disease. Penetrating Disease. Depict and quantify the degree of inflammatory activity. Severity. Therapeutic monitoring and response to treatment. Preoperative mapping. Postoperative recurrence

## GIEE-14 What Goes Up Must Come Down: Multimodality Imaging Evaluation of Reflux Disease, Related Surgeries and Complications

Moataz Ahmed Sayed Mohammed Soliman, MD, MSc (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Explain the causes and mechanisms of reflux disease and its effects on the esophagus and stomach Review imaging modalities and findings for diagnosis and assessment of reflux severity Describe the surgical procedures utilized for treatment of reflux disease, their advantages and disadvantages Recognize the post-operative imaging findings and potential complications of reflux surgery with possible management options

## TABLE OF CONTENTS/OUTLINE

Introduction: Define reflux disease Epidemiology Complications Pathophysiology: Role of the lower esophageal sphincter, hiatal hernia, gastric acid, and other factors in reflux disease Diagnostic tests: Upper endoscopy, pH monitoring, manometry Review the indications, techniques, and findings of different imaging modalities for reflux disease Imaging possible disease complications Treatment Medical therapy (prescription and non-prescription medications) Surgery: Compare types, outcomes, and risks of different surgical options for reflux disease, such as Fundoplication LINX Device Transoral incisionless fundoplication (TIF) Stretta procedure Post-operative imaging: Expected post-operative imaging findings Complications: Identify the common and rare complications of reflux surgery and their imaging features and management strategies Dysphagia and difficult Infection Bleeding Esophagogastric perforation, leakage Fistula Unwrapping of fundoplication LINX device migration Conclusion:An algorithmic approach to imaging evaluation

## GIEE-140 Abdominal Tuberculosis: Think About It

Nerea Torena (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1. Review abdominal tuberculosis, findings, and possible differential diagnoses. 2. To present cases of abdominal tuberculosis diagnosed at our centre in the last 5 years.

## TABLE OF CONTENTS/OUTLINE

In Europe Tuberculosis has an average incidence of 26 cases per 100000 inhabitants. Pulmonary disease is the most frequent, abdominal involvement occurs in 11-12% of patients with extrapulmonary tuberculosis. Most frequently it affects the genitourinary tract, lymph nodes, peritoneum, and solid viscera, mainly the liver, spleen, and pancreas. Symptoms can be nonspecific; most commonly fever, abdominal pain, and weight loss. The radiological findings are not pathognomonic, but may be suggestive if considered with clinical, immunological status, and demographic origin. Abdominal disease can simulate multiple conditions: lymphoma, Crohn's disease, adenocarcinoma, carcinomatosis, etc. Tuberculosis cases diagnosed at our hospital in the last 5 years have been reviewed, 262 cases. 18 patients (6.8%) with abdominal involvement detected by imaging techniques. Radiological findings of each location will be discussed and depicted. Genitourinary, hepato-splenic, peritoneal, intestinal, lymph node and pancreatic tuberculosis will be shown. Differential diagnoses of each location will be reviewed. Abdominal tuberculosis diagnosis is complicated. Imaging findings are usually nonspecific and present in a very diverse way mimicking different diseases. It is important to suspect this pathology and establish its diagnosis to start the most appropriate treatment as soon as possible.

## GIEE-141 Post-operative Complications of Cholecystectomy: What the Radiologist Needs to Know

Kazi A. Irfan, MD, FRCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Surgical anatomy of the gall bladder fossa. 2. Variants in the vasculature and biliary anatomy predisposing to injuries. 3. Types of cholecystectomy surgical approaches. 4. Imaging overview of indications of cholecystectomy. 5. Algorithm for imaging approach to diagnose acute cholecystitis. 6. Appropriate use of multimodality imaging in the diagnosis of post-operative complications. 7. Expected post-surgical changes. 8. Spectrum of post-surgical complications

## TABLE OF CONTENTS/OUTLINE

Introduction: -Cholecystectomy is among the most commonly performed abdominal surgeries -Can be performed by either laparoscopic or open approaches  
Common indications for cholecystectomy: Acute/chronic cholecystitis, symptomatic cholelithiasis, gallstone pancreatitis, gall bladder masses/ polyps  
Multimodality imaging in diagnosis and management of post-surgical complications: -Computed Tomography (CT): primary imaging modality -Magnetic resonance Imaging (MRI): Ideal for biliary anatomy. Hepatobiliary excreted contrast (Eovist) can confirm bile leak -Ultrasound -Hepatobiliary scintigraphy -Fluoroscopy: Transhepatic and T-tube cholangiograms -Angiography  
Postsurgical complications of cholecystectomy: - Collections? \*Expected postsurgical seroma/hematoma? \*Bile leak or biloma (can be secondarily infected)? \*Hematoma? \*Abscess? -Bile duct injuries (can be associated with bile leak or biloma)? \*Stricture? \*Ligation or transection? -Gallstone related? \*Retained or new gallstones in CBD or remnant cystic duct? \*Dropped gallstones? -Vascular? \*Active bleed? \*Pseudoaneurysms? \*Vascular occlusions? -Other? \*Cholecystitis in residual gall bladder? \*Bowel injury? \*Clip migration?

## GIEE-142 Navigating the Labyrinth of Peritoneal and Retroperitoneal Anatomy: Abdominal Disease Spread Made Easy

### Awards

### Certificate of Merit

Janardhana Ponnathapura, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Essential to understanding disease spread in abdomen is to separate the peritoneum from the retroperitoneum. These areas have distinct anatomy with well-defined separate pathways. The peritoneum is comprised of connected recesses that are potential spaces, normally not imaged except when containing excess fluid or air. Peritoneal recesses are formed by the opposing peritoneal surfaces and subdivided by the attachments of the ligaments and mesenteries to the parietal peritoneum. Disease flows within the recesses by changes in abdominal pressure. This forms a distinct spread pattern. The retroperitoneum is stratified by the renal fascia into the anterior and posterior pararenal spaces and the perirenal space. The fascia contains and directs spread from the contained organs with the compartments. Each space has a unique spread pattern defined by the containing fascia. The anterior pararenal space is connected to the mesenteries and ligaments forming the subperitoneal space. This space interconnects the retroperitoneum with the mesenteries allowing for the normal continuum of blood vessels, lymphatics, and nerves but also forms the pathways for bidirectional spread of disease.

## TABLE OF CONTENTS/OUTLINE

• Anatomy• Clinical embryology• Fundamental concept of the subperitoneal space• Distinguishing intraperitoneal spread from subperitoneal spread• New planes of retroperitoneum• Patterns of spread of disease from the;-Liver-Distal esophagus and stomach-Pancreas-Small intestine-Large intestine-Renal and adrenal• Mechanisms of spread of disease (fluid, gas and soft tissue)-Subperitoneal-Intraperitoneal-Contiguous invasion• Clinical and radiological applications

#### **GIEE-144 Head with Two Tales: Early Spread of Disease from the Pancreas**

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

The head of the pancreas can be considered as two separate entity with distinct embryological variations. During embryology the ventral pancreatic bud becomes the caudal portion and the uncinate process of the head of the pancreas, while the dorsal bud becomes the cranial portion of the head. This embryology results in anterior and posterior components of the head of the pancreas each having their distinct vascular supply, nerve supply and lymphatic drainage. It is essential for the radiologist to appreciate that this results in two distinct spread patterns from the head of the pancreas. This knowledge about the early disease spread from the head of the pancreas becomes important particularly in the case of tumor as the radiologist can confidently predict, and diagnose the metastatic spread knowing the origin of the tumor.

##### **TABLE OF CONTENTS/OUTLINE**

• Anatomy of the pancreas• Clinical embryology of the head of the pancreas• Fundamental concept of the two heads of the pancreas• Distinct vascular supply• Distinct nerve supply• Distinct lymphatic supply• Distinguishing the different disease spread from the anterior head and posterior head• How imaging helps in successfully identifying the early spread• Important anatomical landmarks to help recognizing the spread of the disease• Patterns and mechanisms of early spread of the tumor• Clinical and radiological applications• Algorithm to predict the spread of metastatic disease from the head of the pancreas

#### **GIEE-145 The 'New' 2023 American Association for the Study of the Liver Disease (AASLD) Practice Guidance on the Diagnosis and Management of Nonalcoholic Fatty Liver Disease (NAFLD): Radiologists' Perspective**

Eri Osta, BS (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

• Familiarize audience with 2023 AASLD practice guidance statement for diagnosis management of Nonalcoholic fatty liver disease (NAFLD) with special emphasis on imaging-related statements. • Discuss imaging biomarkers other non-invasive tests in risk assessment of NAFLD patients. • Review complementary roles of liver function tests, Fibroscan, shear wave Elastography MRI PDFF in assessing hepatic steatosis, fibrosis "at-risk" nonalcoholic steatohepatitis (NASH). • Discuss ongoing research advances role of AI-based tests in NAFLD

##### **TABLE OF CONTENTS/OUTLINE**

• Introduction • Epidemiology: Prevalence and demographics of NAFLD. • Spectrum of NAFLD: Pathophysiology, stages, and progression - Nonalcoholic fatty liver (NAFL), Nonalcoholic steatohepatitis (NASH), at-risk NASH, advanced fibrosis cirrhosis • Predictors of clinical outcomes in NAFLD: Identifying high-risk patients: fibrosis-4 (FIB-4) scoring system • Diagnosis and Assessment of NAFLD • Hepatic steatosis: Ultrasound, Fibroscan/Controlled attenuation parameters (CAP) MRI-PDFF techniques • "At-risk" NASH Evaluating FAST (Fibroscan + AST levels), MAST (MRE + AST levels), MEFIB (MRE + FIB-4) scoring systems. • Advanced fibrosis: Assessing extent of fibrosis with Fibroscan/VCTE MRE • Cirrhosis Rule in/out irreversible fibrosis • Future directions Ongoing research • Conclusion Recent developments in NAFLD have led to substantial advancements in biomarkers therapeutics, with significant implications for radiologists collaborating with multidisciplinary care teams. Emerging imaging non-imaging biomarkers can exclude advanced liver disease or identify patients at an increased risk for cirrhosis.

#### **GIEE-146 Pancreatic Duct Anomalies: A Primer for Trainees**

Hatem Al Kashroom, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

1. Pancreatic duct anomalies are rare but can cause significant health problems if not detected early. 2. The two main types of congenital pancreatic duct anomalies are pancreas divisum and annular pancreas. 3. Symptoms of pancreatic duct anomalies may include abdominal pain, nausea, vomiting, and weight loss. 4. Diagnosis usually involves imaging tests such as MRI (MRCP) and/or CT scan. 5. Overview of the acquired pancreatic duct anomalies 6. Patients with a family history of pancreatic duct anomalies or pancreatitis may be at higher risk and should discuss screening options with their healthcare provider.

##### **TABLE OF CONTENTS/OUTLINE**



1. Introduction to normal pancreatic anatomy and embryology  
2. Pancreatic divisum and divisum types  
3. Annular pancreas  
4. Acquired pancreatic duct anomalies  
5. Diagnostic tests and preferred imaging modalities

## **GIEE-147 What The Radiologist Needs To Know About Pseudomyxoma Peritonei And HIPEC**

Natalia Y. Zuniga, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The mucinous deposits tend to follow routes of normal peritoneal fluid flow, there are watershed regions in the peritoneal cavity where cells can be deposited to form implants. Signs of peritoneal metastases include the presence of peritoneal nodules, thickening, or fat stranding. A peritoneal cancer index greater than 20 is considered a poor prognostic factor. CT provides anatomic imaging. MRI provides a combination of anatomic imaging and tumor functional imaging. PET imaging provides functional imaging based upon an assessment of the tumor's metabolism of glucose. T1WI and T2WI sequences provide anatomic details to precisely localize the larger peritoneal tumors and nodules, but are relatively insensitive for depicting small peritoneal tumors and subtle fat stranding. DWI are particularly useful for depicting mucinous lesions due to the conspicuity of high signal intensity mucin and fluid within these tumors. Peritoneal tumors enhance with intravenous gadolinium increasing their conspicuity. The combination of hyperthermia and high concentration chemotherapy used in HIPEC can also alter physiological healing, which may increase the incidence of vascular, lymphatic, gastrointestinal, urological and diaphragmatic complications.

### **TABLE OF CONTENTS/OUTLINE**

Terminology. Pseudomyxoma peritonei. Hyperthermic Intraperitoneal Chemotherapy (HIPEC). Peritoneal anatomy and physiology. Preoperative imaging. Establish the presence or absence of peritoneal metastases. Quantitation of the radiologic Peritoneal Cancer Index. Description of extraperitoneal metastases. Postoperative imaging. Normal findings. Features indicative of complications.

## **GIEE-148 Off the Wall: Incidental Muscle Pathology on Abdominopelvic Imaging**

### **Awards**

#### **Cum Laude**

Benjamin E. Northrup, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The use of cross-sectional imaging has increased exponentially, and incidental musculoskeletal findings have become commonplace. These are frequently referred to as "the radiologist's blind spot." Recent publications offer detailed review of abdominal wall pathology. However, the differential diagnosis for abnormalities of the paraspinal and pelvic musculature is often distinct. This review will familiarize radiologists with these unique and often overlooked pathologies and with management recommendations.

### **TABLE OF CONTENTS/OUTLINE**

1. Abdominopelvic muscle anatomy  
2. Congenital and structural abnormalities  
3. Metabolic abnormalities (diabetic myonecrosis, rhabdomyolysis, hyperparathyroidism)  
4. Vascular (arteriovenous malformations, ischemic myonecrosis)  
5. Inflammatory myopathy (inflammatory myositis, sarcoidosis, drug-related, HIV, radiation, crystalline)  
6. Infectious (poliomyelitis, cysticercosis, infectious myositis)  
7. Sequelae of injury and trauma (DOMS, tears, hematoma, bursitis, heterotopic ossification, myositis ossificans)  
8. Neoplasia (primary and metastatic malignant neoplasms, benign neoplasms)  
9. Atrophy (denervation myopathy, end-stage inflammation, sarcopenia)  
10. Normal variants and pitfalls (accessory and anomalous muscles, injection granulomata, lipohypertrophy)  
11. An algorithmic approach to incidental musculoskeletal abdominal findings

## **GIEE-149 Peritoneal Carcinomatosis and HIPEC**

### **Awards**

#### **Certificate of Merit**

Victoria John, MBChB (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Peritoneal carcinomatosis occurs from spread of a primary cancer to the peritoneum, most commonly from the gastrointestinal tract and ovary. Pseudomyxoma peritonei is a rare type of peritoneal carcinomatosis characterised by accumulation of mucinous ascites and mucinous peritoneal deposits secondary to intraperitoneal spread of a mucin-producing primary tumour. Cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) in suitable patients offers a chance for cure and is the mainstay of treatment in lower grades tumours, for which current chemotherapy regimes are of limited effect. Pre-operative imaging is key in determining patients' suitability for CRS/HIPEC with regards to tumour burden. Factors include the Sugarbaker Peritoneal Cancer Index (PCI), ascites and abdominal wall involvement, unfavourable sites of disease, presence of small bowel and mesenteric disease, as well as extra-peritoneal metastases. The most commonly

used imaging modalities are CT and dedicated abdominal MRI. It is recognised that CT may underestimate the degree of disease, whilst MRI with peritoneal protocol has a higher sensitivity and may provide more accurate description of disease extent for the operating surgeon.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Peritoneal Anatomy. 3. Imaging techniques in peritoneal carcinomatosis including recommended protocols in CT and MRI. 4. Types of peritoneal carcinomatosis including pseudomyxoma peritonei. 5. Treatment of peritoneal carcinomatosis with cytoreductive surgery and HIPEC. 6. Adverse sites of disease on imaging. 7. Summary.

#### **GIEE-15 Contrast-enhanced Ultrasound (CEUS), More Than Just Bubbles: Diagnostic and Interventional Applications in Daily Clinical Practice**

Paul Lopez, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To learn the potential applications of CEUS throughout the body. -To understand the value of CEUS both in diagnostic and interventional procedures.

#### **TABLE OF CONTENTS/OUTLINE**

Since its introduction into clinical practice in the late 1990s, CEUS has gained popularity among radiologists as a diagnostic tool in multiple organ systems, and more recently in radiological interventionism. This is due to its great advantages, which include real-time imaging, high contrast resolution and absence of nephrotoxicity among others. This work will review the potential applications of CEUS in daily clinical practice based on cases of our center. -Liver: characterization of benign and malignant focal lesions, role in hepatocellular carcinoma, interventional procedures. -Gallbladder: tumor versus inflammatory process and biliary mold. -Kidney: complex cystic lesions and tumors, interventional procedures. -Urinary tract and bladder: tumor versus clot, grading vesicoureteral reflux in children. -Thyroid: ablation procedures. -Inflammatory bowel disease: evaluation of inflammatory activity, treatment monitoring, fibrous versus inflammatory strictures? -Interventional radiology: guide for percutaneous biopsies, tumor ablations and drain placement, post-ablation surveillance? -Vascular applications: thrombus detection and evaluation, hemorrhage detection?

#### **GIEE-150 Metastatic Lobular Breast Cancer: What the Abdominal Radiologist Needs to Know**

David Fidler, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Invasive lobular breast carcinoma (ILC) has a predilection for abdominal and pelvic metastases, with a distinctive distribution and distinctive imaging features. -Three important patterns of abdominal metastasis: Infiltrative submucosal and subserosal metastasis to abdominal and pelvic viscera, mimicking primary abdominal and pelvic malignancy, for example stomach carcinoma (linitis plastica type), colonic carcinoma, uterine and bladder carcinoma; Diffuse peritoneal metastasis, mimicking metastatic ovarian cancer/primary peritoneal neoplasm; Retroperitoneal metastasis, mimicking lymphoma or retroperitoneal fibrosis. -Appears on imaging as smooth, infiltrative lesions, without extramural extension and without desmoplastic reaction. Long segment and multi-organ involvement is typical. MRI signal partially reflects the target organ. - Metastases can occur many years after primary malignancy, and therefore may not be clinically suspected. The radiologist at the MDT may be the first to suggest the diagnosis. -The lesions may not be evident at endoscopy and may be missed on superficial biopsy, therefore radiological suspicion is key

#### **TABLE OF CONTENTS/OUTLINE**

-Patterns of abdominal metastasis: GI and GU tract; Peritoneum; Retroperitoneum. -Imaging features. -Why is this important to me?

#### **GIEE-151 Transplantation for Type 1 Diabetes: Radiologist's Primer on Pancreatic, Pancreatic-kidney and Islet Cell Transplantation Imaging**

#### **Awards**

#### **Certificate of Merit**

Priya O. Pathak, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Overview of transplantation procedures for type 1 diabetes with imaging of pancreatic, pancreatic-kidney and novel strategy of islet cell transplantation. 2) Highlight the clinical indications, surgical anatomy, procedure techniques, pre and post-transplantation imaging. 3) Review expected imaging acquisition parameters for US, CT and MRI. 4) Describe immediate, early and delayed complications of pancreatic, pancreatic kidney and islet cell transplantation.

## TABLE OF CONTENTS/OUTLINE

- Introduction: Multimodality imaging of pancreatic, pancreatic-kidney and islet cell transplantation with emphasis on transplantation-related complications. Outline • Pancreatic and pancreatic-kidney transplant-Assessment of donor pancreas and graft implantation.-Imaging modalities: US, CT, MRI, angiography.-Complications: Vascular (Thrombosis, Pseudoaneurysm), transplant pancreatitis, intestinal complications (Leak, Bowel obstruction, Fistula). • Islet cell transplantation-Pretransplant imaging: Chest x ray, abdominal US-Technique: Portal venogram, islet cell infusion, tract embolization.-Post-transplant imaging: Ultrasound, PET, SPIO MR imaging-Complications: Early (Hemorrhage, Portal vein thrombosis, Arterioportal fistula) and delayed (Heterogenous hepatic steatosis, Immunosuppression related effects).

### **GIEE-152 Mucking Up the Abdomen: Common and Uncommon Presentations of Pseudomyxoma Peritonei**

Ethan Zaccagnino, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pseudomyxoma Peritonei (PMP) is an entity characterized by mucinous ascites due to the spread of mucin producing neoplasms. It commonly presents as acute appendicitis or RLQ pain with imaging revealing a mucocele of the appendix. Mucocele rupture may cause spread of tumor into the abdomen resulting in peritoneal implantation. Less common sites of origin include gallbladder, small intestine, pancreas, breast and ovary/fallopian tubes. Imaging findings include mucinous or soft-tissue peritoneal implantations and mass effect or scalloping of the abdominal viscera. Ultrasound may detect mucinous ascites or discrete tumors, however cross-sectional imaging with CT or MR is preferred to characterize PMP. Treatment options include surgical debulking and Hyperthermic Intraperitoneal Chemotherapy (HIPEC). Serial imaging is often warranted, as recurrence is common.

## TABLE OF CONTENTS/OUTLINE

1. Intro to pseudomyxoma peritonei (PMP).
2. Mucinous tumors (low and high grade appendiceal mucinous neoplasms, as well as mucinous adenocarcinoma) and sites of origin.
3. Epidemiology of mucinous tumors and PMP.
4. Multimodality imaging features of mucinous tumors and PMP.
5. Treatment (HIPEC and surgical debulking) and complications (mucinous ascites and recurrence) of PMP.
6. Mimics of PMP as well as situations in which mucinous tumors and PMP can mimic non-neoplastic entities.
7. Common and uncommon presentations.
8. Summary and conclusion.

### **GIEE-153 Diagnosis of Biliary Atresia: Featured Images for the Radiologist**

Yady V. Hurtado Burbano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- -Identify the normal liver and bile duct findings in different imaging modalities and the main characteristics and classification of biliary atresia.
- -Illustrate the featured signs and imaging data in the diagnosis of biliary atresia and their post-operative complications.

## TABLE OF CONTENTS/OUTLINE

- Normal pediatric liver ultrasound.
- Some facts about biliary atresia.
- Ultrasound findings.
- Normal and pathological hepatobiliary scintigraphy.
- Findings in percutaneous procedures.
- Imaging in post-operative complications.

### **GIEE-154 Integrating Intestinal Ultrasound (IUS) into an Inflammatory Bowel Disease (IBD) Imaging Service**

Saigeet Eleti, FRCR, MBBChir (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Successful control of Crohn's Disease (CD) relies on effectively suppressing inflammation which requires ongoing monitoring.
- A number of trials have validated intestinal ultrasound (IUS) as having excellent diagnostic accuracy in patients with CD, performing comparably to established modalities such as MRI. International guidelines recommend that newly diagnosed CD patients undergo small bowel assessment with IUS or MR enterography.
- Additionally, ultrasound is cost-effective, widely available and better tolerated by patients which is crucial when regular monitoring is required.
- A one-stop clinic where patients undergo IUS with subsequent assessment by a gastroenterologist enables timely implementation of a targeted management plan for better disease control.
- Operators must have appropriate training and experience with IUS as well as a methodical and reproducible technique for accurate disease assessment.
- With sufficient operators trained in IUS, it may also be offered as a point-of-care test in the emergency department.
- Oral and intravenous contrast may be used in IUS selectively to provide additional information.
- A reporting template can serve as a useful aid to performing a comprehensive study. Successful implementation requires multidisciplinary input involving radiology, gastroenterology, and surgery.

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. One-stop clinic 3. Resources 4. Technique 5. Sonographic appearances of IBD: Case Studies 6. Summary

## **GIEE-155 The Hepatic Angiomyolipoma: A Guide to Avoiding a Big Fat Mistake**

Ana Paula Fraga Cintra Gonzaga (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Provide an overview of hepatic angiomyolipoma (HAML). Discuss typical and atypical cases of HAML with an emphasis on imaging features. Review the main differential diagnoses of HAML with a didactic approach. Offer useful tips for challenging cases to enhance accurate diagnosis and patient outcomes. Develop a radiological survival guide for interpreting fat hepatic nodules.

### **TABLE OF CONTENTS/OUTLINE**

HAML is a rare tumor with a combination of blood vessels, smooth muscle, and varying degrees of mature fat. Despite limited research on HAML, this presentation aims to offer a comprehensive overview of the key features of this lesion, including epidemiology, associations (such as tuberous sclerosis), pathology, radiographic features, prognosis, and treatment. Using case-based presentations, we will explore both classical and uncommon imaging manifestations of HAML, including potential malignant behavior. Additionally, the presentation will discuss the differential diagnosis of HAML, ranging from benign lesions (lipoma, nodular hepatic steatosis, steatotic adenoma, and focal nodular hyperplasia) to malignant neoplasms (HCC and metastasis). Tips for differentiating these diagnoses based on imaging and other clinical factors will be provided. Provide tips for challenging cases where the diagnosis may not be apparent from imaging alone, and radiologists can still play a critical role in contributing to better patient outcomes. Propose a radiological survival guide. This guide will summarize key radiographic and non-radiographic features of HAML, along with differential diagnoses and important clinical considerations, to assist radiologists in accurate diagnosis and appropriate patient management.

## **GIEE-156 Bariatric Surgery: A Pictorial Review. From Post-Surgical Anatomy to Complications**

Maria J. Galante I, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To describe the normal postsurgical anatomy of the most common bariatric surgery techniques.- To analyze the most frequent complications of each of them, with CT and fluoroscopic imaging.- To present CT images of interesting cases of patients that have undergone bariatric surgery procedures. In this exhibit we will review the most frequent bariatric techniques and their complications, that are divided in late and early depending on the postoperative period in which that may appear (more or less than one month). Older procedures such as vertical-banded gastroplasty and jejunio-ileal bypass will not be assessed.

### **TABLE OF CONTENTS/OUTLINE**

1. Generalities and indications of bariatric surgery 2. Classification 3. Post- surgical imaging control protocol 4. Restrictive Surgeries: Anatomical imaging features and main complications 4.1 Adjustable Gastric Banding 4.2 Sleeve Gastrectomy 5. Restrictive and Malabsorptive Procedures: Anatomical imaging features and main complications 5.1 Roux-en-Y- Gastric Bypass 5.2 Anastomosis duodenoileal bypass (SADI-s), minigastric bypass, duodenal switch 6. Conclusions

## **GIEE-157 Tricky abdominal cases: Practical approach using Spectral CT**

### **Awards**

#### **Certificate of Merit**

Ana Villanueva, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To learn the benefits of spectral CT applications in challenging abdominal imaging cases 2. Role of spectral CT in patient's care, how we can change management decisions

### **TABLE OF CONTENTS/OUTLINE**

1. Background: Revision of basic concepts of spectral CT. • Definition • Types of Spectral CT available in the market • Review of different material decomposition applications 2. Review of challenging abdominal and pelvic cases. • Case-based and interactive format- The reader will be able to click on different stories to go through broad spectrum of cases covering most of abdominal and pelvic organs- We will display daily situations where the radiologist could feel stuck while reporting the CT- Companion quiz questions and teaching points/tips will be shown- Updated literature will be provided for each case. By clicking on each reference, the reader will be redirected straight to the actual paper • To propose an algorithm to guide the radiologist to accurately reach the diagnosis • To demonstrate how spectral CT is useful for problem solving and the radiologist could aid in successful decision-making and avoid additional imaging or procedures 3. Limitations of spectral CT 4. Conclusion

## **GIEE-158 Don't Be Thrown for a Loop! A Review of Internal Hernias for the Abdominal Imager**

Golden, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Internal hernias are herniations of abdominal viscera, usually small bowel, through congenital or acquired openings of the peritoneum or mesentery. Internal hernias can obstruct and are considered surgical emergencies due to the high risk of bowel strangulation. If complications such as bowel obstruction or ischemia are not present, then imaging findings of internal hernia will consist primarily of displacement of normal abdominal structures. After reviewing this exhibit, the viewer will be familiar with the various kinds of congenital and acquired hernias, as well as the epidemiology, surgical risk factors, imaging appearance, and complications associated with internal hernias.

### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Congenital Hernias 2a. Brief review of embryology and general anatomy Types of Hernias with accompanying cases. 2b. Lesser Sac (Foramen of Winslow). 2c. Left paraduodenal (Fossa of Landzert). 2d. Right paraduodenal (Fossa of Waldeyer) 2e. Pericecal 2f. Transomental: Greater Omentum and Lesser Omentum 2g. Sigmoid 2h. Broad Ligament 3. Acquired/Iatrogenic 3a. Introduction to Acquired Hernias and commonly associated surgeries 3b. Roux en Y/ Gastric Bypass: Description of Procedure and Associated Hernias 3c and d. Epidemiology, Anatomy, and Imaging appearance of: transmesenteric and jejuno-jejunostomy hernias 3e. Left colectomy and low anterior resection 3f. Epidemiology, Anatomy, and Imaging appearance of the following: herniation of the small bowel inferior to the neorectum. 4. Complications 4a. Bowel obstruction, including closed loop 4b. Strangulation and Ischemia 5. Summary

### GIEE-159 Periportal Lesions - Tiny Space, Huge Possibilities

Cynthia L. Borborema, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To review the anatomy of the periportal space and its pathophysiology;
- To present the most relevant anatomical variants.
- To compartmentalize the periportal lesions through a series of cases.
- To introduce the disorders that may affect that space with a brief review of the clinical context and imaging findings.

### TABLE OF CONTENTS/OUTLINE

- The periportal region is the anatomic space around the portal vein and its intrahepatic branches composed of hepatic artery branches, bile duct branches, lymphatics, and nerves that can be affected by a variety of pathological conditions. Due to its complex anatomical architecture and the wide possibility of lesion natures, involvement of the periportal space can be a diagnostic challenge for radiologists.
- Review of periportal anatomy with didactic illustrations of the main anatomical variants.
- In this presentation periportal lesions will be divided into the following categories: vascular (pathologies of the portal vein and hepatic artery), lymphatic (pathologies of periportal lymphatics), neural (pathologies of periportal nerves), periportal space as a pathway for diseases to spread and miscellaneous.
- A complete case-based review of common (periportal edema, portal biliopathy, peribiliary cysts, infectious diseases) and unusual disorders involving the periportal space, such as segmental arterial mediolysis, metastatic calcifications, plexiform neurofibroma, extramedullary hematopoiesis, amyloidosis, lymphangioma, hepatic artery giant pseudoaneurysm, ganglioneuroma, schwannoma.

### GIEE-16 Imaging of Pancreas Transplants: A Comprehensive, Multimodality Review

Rachel Perez, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Anatomy and surgical technique 2. Key imaging features and techniques 3. Pancreas transplant complications

### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Review of normal/donor pancreatic anatomy 2a. Donor arterial supply, venous drainage, and exocrine drainage 3. Surgical technique/transplant anatomy 3a. Systemic-venous drainage 3b. Portal-venous drainage 3c. Exocrine Bowel drainage 3d. Exocrine Bladder drainage 3e. Stepwise approach to identifying anatomy 4. Imaging 4a. Ultrasound and Contrast-Enhanced Ultrasound 4b. CT/CTA 4c. MRI/MRA (including ferumoxytol) 5. Biopsy technique 6. Complications 6a. Parenchymal 6a1. Rejection 6a2. Pancreatitis 6b. Vascular 6b1. Thrombosis 6b2. Stenosis 6b3. Hemorrhage 6b4. Pseudoaneurysm 6b5. Arteriovenous Fistula 6c. Bowel 6c1. Small Bowel Obstruction 6c2. Exocrine leak 7. Summary of key learning points

### GIEE-160 The Anatomy of Normal and Abnormal Swallowing

Nancy J. McNulty, MD (*Presenter*) Book contract, Oxford University Press

### TEACHING POINTS

The oral cavity, pharynx, larynx, and surrounding muscles, bones and cartilaginous structures work together in a sophisticated and coordinated way to achieve normal swallowing. Accurate diagnosis of swallowing dysfunction requires a

comprehensive understanding of what is normal, and how normal structures work in a coordinated fashion to achieve deglutition. This exhibit will review the components of swallowing that are voluntary, such as chewing, forming a bolus of food on the tongue, and initiating deglutition, and the involuntary reflexes that are initiated by stimulation of the palate or touch receptors in the pharynx. The pertinent anatomy, including muscles and their innervation, will be highlighted and reinforced. Clinically, swallowing dysfunction can be assessed with a video fluoroscopic barium swallow study. Normal swallowing exams will be used to demonstrate normal function, and highlight the components of a normal swallow.

#### **TABLE OF CONTENTS/OUTLINE**

Outline the sequence of events that occur during normal swallowing. Explain the muscles involved in the voluntary and involuntary tasks of swallowing and their innervation. Identify the anatomy and the role of structures of the head and neck during normal swallowing, and how they work to prevent nasopharyngeal regurgitation and aspiration. Review components of normal swallowing function on video swallowing examinations with audio narration. Observe video swallowing examinations with audio narration highlighting commonly encountered types of swallowing dysfunction.

### **GIEE-161 The Invaluable Role of CEUS in HCC imaging: Planning and Guidance of Ablative Therapy and Secondary Surveillance Following Treatment**

#### **Awards**

##### **Certificate of Merit**

Shayan Hemmati, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) The unique benefits of hepatocellular carcinoma (HCC) diagnosis with contrast enhanced ultrasound (CEUS) include dynamic real time imaging and bubble tracking techniques, along with exquisite sensitivity for detection of arterial phase hyperenhancement (APHE) and washout (WO). (2) The advantages of performing CEUS prior to ultrasound guided ablative therapy for HCC include accurate identification of the nodule and grayscale occult lesions, determination of the best ultrasound technique (probe selection, patient positioning/ breath hold), and identification of any unexpected findings that would alter or preclude ablative therapy (ex. additional lesions or tumour in vein). (3) Performance of CEUS at the time of ablation is essential to guide probe placement for grayscale occult or difficult to visualize nodules allowing the interventionalist to target either foci of APHE or areas of WO. (4) Performance of immediate post ablation CEUS to assess for completeness of ablation increases the number of successful ablations by allowing immediate identification and re-treatment of residual tumour or non-target ablations. (5) Inclusion of CEUS in secondary surveillance optimally resolves indeterminate or equivocal MRI results. Recognition of non-linear artifact on CEUS, arising from the microwave ablation probe tract, is essential to avoid misdiagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

- Background - Diagnosis of HCC with CEUS - Ablation Planning with CEUS - Ablation Targeting with CEUS - Immediate Post-ablation Assessment with CEUS - Secondary Surveillance with CEUS - Conclusion - References

### **GIEE-162 Role of Imaging in Systemic Therapy for HCC**

Kevin A. Zand, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Multiple combined and single systemic therapies are currently FDA approved for intermediate and advanced stage HCC. 2. Systemic therapy for HCC improves overall survival in patients who are not candidates for curative or locoregional therapies or who have failed locoregional therapy. 3. Imaging has a key role in the post treatment evaluation, response assessment, and diagnosis of potential complications. 4. LI-RADS treatment response algorithm is not applicable to the systemically treated HCC. 5. HCC response to immunotherapy is different compared to chemotherapy, and should be considered in tumor response assessment by imaging.

#### **TABLE OF CONTENTS/OUTLINE**

1. The current role and survival benefit of immunotherapy for HCC 2. Review of response assessment criteria in the systemically treated HCC (RECIST, mRECIST, and other criteria) and their use in clinical trials that lead to FDA approval of the new agents 3. Post treatment imaging assessment. Representative cases will illustrate the imaging before and after systemic therapy (at multiple time points when relevant) with correlation with the clinical course and overall outcomes. (a) Representative cases from patients with favorable/stable outcomes. (b) Representative cases from patients with poor outcome. (c) Representative cases showing treatment related complications 4. Review of emerging literature on combined immunotherapy with locoregional therapy 5. Limitations of treatment response assessment after systemic therapy for HCC and future directions

### **GIEE-163 Hypointense Hepatic Findings on Hepatobiliary Phase Imaging**

#### **Awards**

##### **Certificate of Merit**



Kelly C. Harper, MD, FRCPC (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Review the mechanism of hepatocellular contrast agent uptake and factors affecting it - Liver parenchyma hypointensities in hepatobiliary phase (HBP) can be diffuse, regional, and focal - Parenchymal hypointensities can be due to technical, parenchymal, vascular, and biliary causes - Both hepatocellular and non-hepatocellular lesions can show hypointensity - Hypointensity of a lesion is useful for its characterization - Hypointensity around a neoplasm may be associated with aggressive nature with management implications

## TABLE OF CONTENTS/OUTLINE

- Parenchymal hypointensity
  - o Diffuse
    - o Technical- timing; opposed phase imaging; no fat suppression, low flip angle.
    - o Parenchymal § Poor hepatocyte function-chronic liver disease § Diffuse hepatic steatosis. § Iron overload § Infiltrative disorders- fibrosis, amyloidosis, malignancy etc § Drug injury § Genetic polymorphism of OATPB1
    - o Vascular § Acute portal vein-narrowing or occlusion § Portal hypertension Sinusoidal obstruction syndrome
    - o Distal biliary obstruction- common bile duct
    - o Regional (lobar/segmental/geographical) § Parenchymal § Radiation- SBRT
    - o Vascular § Acute portal vein branch occlusion § Portal vein embolization § Hepatic vein occlusion
    - o Bile duct branch occlusion
    - o Focal
      - o Focal fat deposits
      - o Focal confluent fibrosis
      - o Arterioportal shunts
      - o Infective/inflammatory- cholangitis
  - Hypointense lesions
  - Hepatocellular lesions
    - o Hepatocellular carcinoma
    - o Hepatic adenoma
  - Non hepatocellular lesions
    - o Cysts
    - o Metastases
    - o Hemangioma
    - o Cholangiocarcinoma

## GIEE-164 Inclusion of Liver CEUS in Current Practice Guidelines

Stephanie R. Wilson, MD (*Presenter*) Equipment support, Koninklijke Philips NV; Equipment support, Siemens AG; Equipment support, Samsung Electronics Co, Ltd; Research support, Samsung Electronics Co, Ltd;

## TEACHING POINTS

(1) Current North American guidelines of relevance for liver imaging with CEUS include those from AASLD, American Association for the Study of Liver Disease; NCCN, National Comprehensive Cancer Network; and LI-RADS, Liver Imaging Reporting and Data Systems, a classification for those at risk for HCC including an algorithm for categorization of nodules shown on imaging. (2) CEUS was originally not favored for liver imaging because of misconceptions about its ability to differentiate hepatocellular carcinoma from cholangiocarcinoma. (3) Current data shows CEUS performs equivalent and often superior to CT/MR for characterization of liver nodules. (4) CEUS techniques for metastasis detection and diagnosis include sweeping the liver in the portal venous phase to show washout zones and on top injections to show the arterial enhancement of washout lesions. (5) CEUS STRENGTHS include: -Resolution of indeterminate nodules from CT/MRI, with reduction of biopsy -High specificity for HCC within LI-RADS allowing treatment of HCC following CEUS without biopsy. -Accurate characterization of nodules found on surveillance US for HCC. -Better correlation of nodules from surveillance US than shown with MRI, making CEUS the modality of choice as the first test following positive surveillance US. - Optimal diagnosis of small metastases

## TABLE OF CONTENTS/OUTLINE

-Introduction of Guidelines for Liver Imaging -AASLD emphasizing imaging for suspect or confirmed HCC. -NCCN emphasizing long-term surveillance of patients at risk for development of metastases. -LI-RADS and its algorithm for categorization of liver nodules, with integration of CEUS LI-RADS with LI-RADS for CT/MRI. -Our perspective on Liver Imaging with CEUS.

## GIEE-165 Recognizing Benign Lesions in Cirrhotic Liver: Moving Beyond Odds and Enhancing Interpretation

Alexandre K. Wakote Teruya, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1 - This review aims to enhance the recognition and interpretation of benign lesions in patients with cirrhotic liver that may arise due to underlying cirrhosis or occur incidentally. 2 - Illustrate with cases the typical and atypical features of these lesions using computed tomography (CT) and magnetic resonance imaging (MRI). 3 - Provide practical considerations and diagnostic clues to minimize misunderstandings in interpretation and ensure accurate assignment of the Liver Imaging Reporting and Data System (LI-RADS®) category.

## TABLE OF CONTENTS/OUTLINE

1 - Definition of cirrhosis and its impact on the appearance of benign lesions. 2 - Describing the imaging presentations of various benign entities in cirrhotic liver on CT and MRI, distinguishing between their typical and atypical features. 3 - Practical considerations and diagnostic clues to differentiate from malignancy and how to assign the correct LI-RADS® category.

## GIEE-166 What's New in Classification, Pathology, Imaging Findings, and Management of Cystic Liver Diseases: 2023 Update

Sriram Jaganathan, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Discuss 2023 updates on the classification, nomenclature, and pathology of developmental, non-neoplastic neoplastic cystic liver disease
- Review spectrum of imaging findings role of different imaging modalities in diagnosis management
- Discuss current updates in management strategies with special emphasis on the 2022 European Association for the Study of the Liver (EASL) clinical practice guidelines

## TABLE OF CONTENTS/OUTLINE

Introduction Classification Nomenclature of hepatic cystic diseases Molecular pathogenesis hepatic cystogenesis updates Imaging Techniques: US/CT/MRI PET/CT Polycystic liver disease (PLD) Role of imaging in assessing cyst volumes, total liver volumes treatment follow-up; Gigot Schnellendorfer classifications; Complications Management Non-neoplastic Cysts Simple hepatic cysts (malformation of the ductal plate): cystic bile duct hamartoma; Infections: Abscess, Echinococcal cyst; Congenital: choledochal cyst Caroli disease, foregut cyst, von Meyenber complex; Miscellaneous: peribiliary cysts, organizing hematoma, fibrous cyst pseudocyst Cystic Neoplasms Mucinous cystic neoplasms, Intraductal papillary neoplasm, tubulopapillary oncocytic papillary neoplasms, cystic metastases, HCC, cholangiocarcinoma rare tumors. Imaging spectrum of cystic liver diseases Management: EASL 2022 clinical practice guidelines with the central role of imaging Conclusion Imaging is pivotal in diagnosing, guiding appropriate treatment, and assessing complications for cystic liver diseases. By emphasizing up-to-date imaging findings and recommendations, radiologists are better equipped to provide effective patient care.

## GIEE-167 Liver Transplant Complications; Case Review from Our Hospital

Iskander A. Artech Arnaiz, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Get to know the normal findings of the immediate postoperative period of liver transplantation. Mention the most frequent complications classified into arterial, venous and biliary based on cases seen in our Hospital.

## TABLE OF CONTENTS/OUTLINE

OLT (orthotopic liver transplantation) is the definitive treatment for patients with end-stage liver disease, acute fulminant liver failure, some neoplasms (HCC, metastases...increasingly broad indications). The surgical technique consists of extracting the donor (dissection of the hepatic hilum on a bench +- arterial reconstruction if variants) and subsequent implantation. The first step to take when evaluating a liver graft will be to read the surgical report to later understand the images. An ultrasound is mainly performed 24 hours after the transplant, in which we assess the parenchyma, the bile duct, and the flow of the arterial and venous vessels. It will be important to know the normal ultrasound findings. Complications are divided into arterial, venous and biliary. Regarding arterial complications, we have occlusion of the hepatic artery due to dissection/thrombosis of the latter (the most serious complication), hepatic artery stenosis, and pseudoaneurysms. Regarding biliary complications, we have, on the one hand, biliary strictures, most of them anastomotic (they may be non-anastomotic in the intrahepatic bile duct but are related to other causes such as ischemia) and on the other hand the bile leakage. Venous complications are the least frequent, and can affect both the suprahepatic veins and the portal vein, and consist mainly of thrombosis and stenosis.

## GIEE-168 Uncommon Pancreas Solid Lesions: Spectrum of Imaging Appearance and Radiologic-Pathologic Correlation

Yoshihiko Fukukura, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

TEACHING POINTS Pancreatic solid lesions display a wide spectrum of histology, including exocrine and endocrine tumors. The most common tumors of exocrine and endocrine tumors of the pancreas are ductal adenocarcinoma and neuroendocrine tumor, respectively. Uncommon tumors that need to be differentiated from the common pancreas solid tumors include adenosquamous carcinoma, colloid carcinoma, undifferentiated carcinoma, acinar cell carcinoma, solid-pseudopapillary neoplasm, etc. Familiarity of imaging findings of the uncommon tumors is important to arrive at the correct diagnosis of pancreas solid lesions because a precise diagnosis determines the treatment and surgical approach. The purpose of this exhibit is: 1. To describe the imaging and histopathologic features of uncommon pancreas solid tumors 2. To recognize and describe the imaging appearance of some mimics of pancreas solid tumors 3. To discuss the imaging differential diagnosis of pancreas solid tumors

## TABLE OF CONTENTS/OUTLINE

1. Review of CT and MR imaging findings of uncommon pancreas solid tumors, with histopathological correlation.
2. Highlight key differential diagnostic points of pancreas solid tumors.
3. Summary: Awareness of radiological findings of uncommon pancreas solid tumor is important to arrive at the correct diagnosis of pancreas tumors.

## GIEE-169 Non-contrast Vascular Reconstruction in Patients with a History of Contrast Agent Allergy

Toru Iwasaka (*Presenter*) Nothing to Disclose



## TEACHING POINTS

Depiction of vascular information by contrast-enhanced CT is required for preoperative examination of surgery. However, there are often cases where it is difficult to use a contrast medium due to allergies to the contrast medium. We have developed a virtual abdominal contrast CT image as a preoperative vascular image by non-contrast CT image for such cases. We performed CT without contrast medium infusion in the abdomen. High-definition scanning conditions were set for image reconstruction. Vascular extraction was performed on the obtained CT volume data using workstation automatic tracking. After that, the multi-planar reconstruction display (MPR) was created from the CT image. By combining the blood vessel information and the MPR display, it was possible to create a virtual abdominal contrast CT image similar to the conventional contrast CT without injecting a contrast medium. The images we developed were evaluated to have important information for the surgeon.

## TABLE OF CONTENTS/OUTLINE

1. Necessity of vascular information and problems of contrast agent allergy 2. Scan technique for blood vessel extraction 3. Extraction of abdominal blood vessels using automatic tracking 4. Creating an MPR display 5. Composite display of blood vessel image MPR display 6. Clinical significance of virtual abdominal contrast CT images

## GIEE-17 Misdiagnosis of Pancreatic Intraductal Papillary Mucinous Neoplasms and the Challenge of Mimicking Lesions: Imaging Diagnosis and Differentiation Strategies

Stephen J. Kwak, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Accurate diagnosis of lesions that mimic IPMNs is crucial to determine appropriate surveillance or resection. 2. There is a risk of overdiagnosis and overtreatment of potentially neoplastic lesions with up to half of cystic lesions mischaracterized on imaging. 3. Using dedicated pancreatic protocol CT and noting unique features such as a bulging ampulla for IPMNs or the extracapsular cystic sign of SCAs can aid in distinguishing subtle differences. Additionally, a "cysts-within-a-cyst" appearance is often present in MCN, giving them a multilocular appearance, as opposed to the "cyst-by-cyst" presentation of IPMNs. 4. Cystic pancreatic neuroendocrine tumors have peripheral hypervascular rim on arterial phase CT. 5. Lymphoepithelial cysts have a cheerios-like appearance with signal drop out on out of phase images. 6. Pancreatic schwannoma has progressive homogeneous enhancement with areas of necrosis. 7. Chronic pancreatitis has a chain of lake appearance with strictures, intraductal calculi, and parenchymal calcifications. 8. EUS, FNA, fluid analysis, cytology, radiomics, and artificial intelligence are all useful tools for definitive diagnosis when CT and MRI are not specific enough.

## TABLE OF CONTENTS/OUTLINE

1. IPMN diagnosis and misdiagnosis 2. Misdiagnosis of mimicking lesions and strategies to accurate diagnosis-Macrocytic Serous Cystadenoma-Cystic Pancreatic Neuroendocrine Tumor-Mucinous Cystic Neoplasm-Lymphoepithelial Cyst-Duodenal Diverticulum-Pancreatic Schwannoma-Chronic Pancreatitis-Retention Cyst and Cystic Fibrosis-Intrapancreatic Accessory Spleen and Epidermoid Cyst-Pancreatic Lipoma or Interdigitating Fat-Choledochal Cyst 3. Conclusion

## GIEE-170 Advanced Ultrasound Techniques for Liver Transplantation Evaluation

Gonzalo Martin Ordonez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To describe the usual Doppler technique for liver graft follow-up and for evaluation of complications. To describe the use of contrast enhanced ultrasound (CEUS) in the evaluation of vascular complications and graft ischaemia. To describe the use of shear wave elastography in the evaluation of medical complications.

## TABLE OF CONTENTS/OUTLINE

Liver transplantation is the treatment of multiple end-stage liver diseases. Medical and surgical complications are an important source of morbidity and mortality, and radiological examinations are essential for their early detection. Doppler ultrasound is the preferred imaging technique in the initial evaluation of the liver graft and during follow-up due to its portability and the unique hemodynamic information it provides. The use of CEUS allows to confirm vascular complications to define the location and the extension of ischemic areas, and to ascertain biliary tract ischemic involvement, what that is key for deciding the optimal treatment. Shear-wave elastography provides a non-specific but interesting quantitative information that allows for a sequential evaluation of the liver parenchyma. It is useful in the diagnosis and follow-up of medical complications including rejection and the rarer obstructive sinusoidal syndrome. The liver rigidity also aids to decide in which patients a biopsy should be done. We show a pictorial review of cases from our institution to illustrate the vascular, biliary and medical complications that can be evaluated with these techniques.

## GIEE-171 Advanced Abdominal MRI Techniques and Problem-solving Strategies

### Awards

Certificate of Merit

Yoonhee Lee, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Magnetic resonance imaging (MRI) plays an important role in abdominal imaging owing to its ability of detection and characterization of focal lesions. Nowadays, techniques for reducing scan time with an acceptable image quality such as parallel imaging, compressed sensing (CS) technique, and nowadays cutting edge deep learning (DL) techniques have arisen for problem solving strategies. Also free breathing techniques using dynamic phase involving extra-dimensional (XD)-volumetric interpolated breath-hold examination (VIBE), and golden-angle radial sparse parallel (GRASP) can help patients with severe dyspnea or under sedation perform abdomen MRI. Therefore, this pictorial review aims to show various advanced abdomen MRI techniques for reducing scan time with maintaining image quality and free breathing techniques during dynamic phase, and representative cases with aforementioned techniques.

## TABLE OF CONTENTS/OUTLINE

•I. Reducing scan time and improving image quality 1.Parallel imaging : Dynamic phase (Controlled Aliasing in Parallel Imaging Results in Higher Acceleration), Half-Fourier-acquisition single-shot turbo spin-echo (HASTE) 2.Compressed sensing technique : Dynamic phase, Magnetic resonance cholangiopancreatography 3.Deep learning (DL) : T2 weighted image, Diffusion weighted image •Strength and pitfalls of DL while radiologists interpreting lesions 4.Motion corrected diffusion weighted image ••II. Free breathing technique during dynamic phase 1.Stack of Stars volumetric interpolated breath-hold examination (StarVIBE) 2.Extra-dimensional (XD)-VIBE 3.Golden-angle radial sparse parallel (GRASP)

## GIEE-172 Imaging of Pancreatic Cystic Lesions: What Radiologists Should Know

Akihiko Kanki, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this presentation is:1) To demonstrate the common and uncommon computed tomography and magnetic resonance imaging findings of neoplastic pancreatic cystic lesions, including the radiologic-pathologic correlation.2) To learn about the non-neoplastic and cyst-like lesions of the pancreas that can mimic pancreatic cystic neoplasms.

## TABLE OF CONTENTS/OUTLINE

Classification of Pancreatic Cystic LesionsImaging findings of common pancreatic cystic lesionsNeoplastic pancreatic cystic lesions•Mucinous cystic neoplasm•Serous neoplasm•Intraductal papillary mucinous neoplasm•Intraductal tubulopapillary neoplasm•Intraductal oncocytic papillary neoplasmImaging findings of uncommon pancreatic cystic lesions•Intraductal papillary mucinous neoplasm complicated with intraductal hemorrhage, perforation and fistula formation•Mucinous cystic neoplasm occurring with side branch-type intraductal papillary mucinous neoplasmNon-neoplastic and cyst-like lesions of the pancreas that can mimic pancreatic cystic neoplasmsNon-neoplastic pancreatic cystic lesions•Squamous lined cyst•Acinar cystic transformationVarious pancreatic tumors with cystic degeneration•Solid pseudopapillary neoplasm•Others

## GIEE-173 Pseudomyxoma Peritonei: Imaging Features and Current Therapies

### Awards

#### Certificate of Merit

Laura Jorgenson (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Define pseudomyxoma peritonei. Understand and describe the histopathology, pathophysiology, and etiologies of PMP, with a focus on appendiceal and ovarian neoplasms. Describe the multimodality imaging features of pseudomyxoma peritonei. Recognize complications related to PMP, mucinous tumor burden, and cytoreductive surgery. Discuss specific imaging findings which are essential to the surgical oncologist in determining resectability and cytoreductive surgery planning. Review current therapies available to patients with PMP.

## TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS/OUTLINE 1. Definition of PMP and imaging featuresDefineOptimizing US, CT, MR, and PET image acquisitionImaging features on different modalitiesNatural History 2. Tumor OriginAppendicealOvarianNon-malignant causesDifferentiation from multicystic mesotheliomaBrief review of pathologies of peritoneal surface malignancies 3. Potential Complications and related imaging features4. Example reporting template5. What the surgeon needs to know and current therapiesPeritoneal Carcinomatosis Index (PCI)Cytoreductive SurgeryHIPECSystemic chemotherapy - understanding response to therapy vs. progression

## GIEE-175 Ancillary Features Are Coming to LI-RADS Treatment Response Algorithm: Let's Get You Ready

Marisa Martin, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- The LI-RADS Treatment Response Algorithm (LR-TRA) is a standardized system for assessing and reporting treatment response after locoregional therapy (LRT) for hepatocellular carcinoma (HCC).- Emerging radiology-pathology and inter-reader studies have highlighted the potential for ancillary features to improve detection of incomplete necrosis with greater radiology-pathology concordance.- This exhibit highlights the updates in the LR-TRA v2023 (compared to v2018), especially pertaining to the role of newly incorporated ancillary features. The overall objective of the changes is to improve diagnostic accuracy of post-treatment imaging assessment.

## TABLE OF CONTENTS/OUTLINE

- Summarize the role of the TRA in the context of the currently used treatments for HCC.- Provide an evidence-based review of current literature highlighting the value of incorporating ancillary features in treatment response assessment after locoregional therapy in HCC.- Highlight key updates of the LI-RADS v2023 TRA pertaining to use of ancillary features after various forms of LRT for response assessment, using a case-based and illustrative approach.

## **GIEE-176 Ischemic Cholangiopathy: Imaging Patterns and Other Biliary Complications Following DCD Liver Transplant**

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is to: 1. Describe various imaging patterns of ischemic cholangiopathy post DCD liver transplant on MRI/MRCP2. Elaborate prognostic significance of these imaging patterns. 3. Discuss additional biliary complications post liver transplant.

## TABLE OF CONTENTS/OUTLINE

Four different patterns of IC: have been identified, each correlating with DCD allograft prognosis. • Diffuse necrosis: Most severe form with nearly 100% need for retransplant, characterized by multifocal biliary strictures, wall necrosis and bile lakes. Usually, hepatic artery is severely stenosed or occluded. • Multifocal progressive: Starts as mild to moderate multifocal stricturing cholangiopathy that progresses in a few months to more severe form with worsening strictures or even biliary necrosis. >50% need for retransplant. • Confluence dominant: Mild to moderate cholangiopathy that involves the biliary confluence. Most cases can be managed without need for retransplant. • Minor Form: Mild areas of multifocal stricturing that remain stable or resolve. Other liver transplant biliary complications: • Anastomotic stricture • Bile leak/anastomotic dehiscence • Vanishing bile duct syndrome (ductopenia) • Biliary stones; Biliary cast syndrome; hemobilia • Cystic duct remnant mucocele • Roux limb bleeding, Roux limb stasis or obstruction. Summary IC post DCD liver transplant is a major source of allograft complications. Identifying different patterns of IC can help stratify need for stenting and predict allograft prognosis.

## **GIEE-177 Multimodality Imaging Biomarkers for Crohn's Disease Strictures**

Safa Hoodeshenas, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To understand the role and characteristics of existing and future biomarkers in Crohn's disease strictures
- To review existing diagnostic and prognostic Crohn's imaging biomarkers and potential surrogate clinical endpoints
- To describe potential imaging biomarkers that reflect stricture histopathology or pathophysiology
- To describe the strengths and weaknesses of existing and future biomarkers for Crohn's disease strictures.

## TABLE OF CONTENTS/OUTLINE

- Existing diagnostic and prognostic biomarkers of Crohn's disease strictures
- Using CT or MR enterography to measure response biomarkers and/or efficacy endpoints for Crohn's strictures
- Stiffness, fibrosis, and smooth muscle hypertrophy are histopathologic and physiologic targets for an emerging array of MR, ultrasound, and PET biomarkers
- MRI-based biomarkers include delayed gadolinium enhancement, normalized magnetization transfer, DWI and intravoxel incoherent motion, T1 mapping, intramural T2 signal, and quantified small bowel motility
- Ultrasound-based biomarkers include wall thickness, elastography to measure shear stiffness, contrast-enhanced ultrasound, and ultrasensitive microvessel imaging
- Molecular imaging targets at PET-MRE include inflammation and fibrosis

## **GIEE-178 Kidney Pancreatic Transplantation: Anatomy and Surgical Technique Guide for Residents**

Juan Bautista Rolla, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Pancreas transplant is a complex procedure which represents a surgical alternative for the treatment of diabetic patients with the goal of avoiding the systemic complications associated with the disease. The most frequent approach is the SPK transplant in which both grafts of a single donor are inserted in one surgical act, on the right and the left fossa

respectively. Transplanted kidney is implanted extraperitoneally in an iliac fossa. The most widely used technique is end-to-side anastomosis of the donor's renal artery to the recipient's external iliac artery. Transplantation of the pancreatic graft is performed together with a duodenal segment. Enteric exocrine drainage will be through anastomosis of the donor duodenal segment to a small bowel loop of the recipient whereas systemic endocrine drainage will be through the portal vein of the graft which is anastomosed directly to the primitive iliac vein. To learn surgical technique and post-operative anatomy. To know normal postoperative imaging assessment. To recognize all the complications.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction and normal anatomy Surgical techniques Normal post-operative imaging appearance Complications Take-home messages

### **GIEE-179 Hepatic Sinusoidal Disorders**

#### **Awards**

#### **Certificate of Merit**

Sudhakar K. Venkatesh, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Understand pathophysiology behind hepatic sinusoidal disorders
- Review the typical imaging appearances sinusoidal obstruction caused by different etiologies and characteristic findings for differentiation of etiologies.
- Review conditions that cause sinusoidal and perisinusoidal infiltration and may mimic sinusoidal obstruction.

#### **TABLE OF CONTENTS/OUTLINE**

- Normal hepatic sinusoid structure and physiology
- Mechanisms causing sinusoidal dilatation and/or obstruction.
- Histopathological correlation of imaging findings
- Sinusoidal dilatation
  - o Outflow obstruction
  - § Post sinusoidal causes.
  - Congestive hepatopathy
  - Heart failure
  - Pericarditis
  - Congenital heart diseases
  - Budd-Chiari syndrome
  - Sinusoidal obstruction syndrome
  - o Myeloablative conditioning for stem cell transplantation.
  - § Utility of ultrasound in diagnosis of SOS in children
  - o Chemotherapy- oxaliplatin based therapies, immunotherapy.
  - o Radiotherapy
  - Sinusoidal dilatation without obstruction
  - o Vascular disorders
  - § Arterioportal shunts
  - § Decreased portal flow.
  - § Porto-sinusoidal vascular disorder
  - o Extrahepatic acute inflammatory/infective conditions
  - o Use of oral contraceptives or hormones
  - o Hepatic peliosis
  - o Extrahepatic malignancy without liver infiltration
  - Sinusoidal and/or perisinusoidal infiltration with or without dilatation
  - o Perisinusoidal fibrosis
  - o Amyloidosis
  - o Myeloproliferative disorders
  - o Malignancy

### **GIEE-18 The Dark Side of the Bowel Disease: Algorithmic Approach Step by Step**

America Hernandez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review through different imaging modalities the evaluation of the intestinal wall. To revise the general features of the normal bowel wall. Create an algorithm that allows quick < easy evaluation to guide the diagnosis. To discuss the different imaging findings we may see in different pathologies. To study different pathologic entities that present with bowel wall thickening.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Anatomy basic bowel wall. Step by step > interpretation of < analyzed by categorizing attenuation changes in the intestinal wall. Diagnostic Algorithm description. Descriptions of the commonest causes Key points. Conclusions References

### **GIEE-180 CT Approach to Acute Mesenteric Ischemia**

Daniel Sebastian Chaves Burbano, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Acute mesenteric ischemia it's an infrequent pathology, but the mortality rate is high because of the nonspecific symptoms and the delayed diagnosis, so the role of the imaging and the radiologist are fundamental to reduce the mortality rates.- Appropriate protocols of CT imaging should be used to optimize the radiation and contrast medium use, because there is a disbalance in the homeostasis of the patient and every minute counts to make de diagnosis.-If there is a kidney failure, there are protocols for a safety use of the iodinated contrast medium.-To establish an adequate diagnosis, the histopathology and anatomy of the arteries and the bowel should be evaluated.-There are three main structures that we must evaluate to have an adequate approach to mesenteric ischemia: bowel lumen, bowel walls and abdominal localization.-When there is an acute mesenteric ischemia, other abdominal organs like adrenal glands, inferior cava vein, aorta, liver, spleen, and kidneys have changes and findings that can predict complications and mortality.

## TABLE OF CONTENTS/OUTLINE

Gross anatomy Abdominal artery anatomy. Relevant anastomoses. Abdominal vein anatomy. Histology of the bowel. Pathophysiology of acute mesenteric ischemia. CT imaging protocols. Indications, Simple, artery and portal phases with timing and technique (kVp, mA, rotation, PITCH). What to do if there is an acute kidney failure Classification of the acute mesenteric ischemia. Systematic approach to acute mesenteric ischemia. Bowel Wall thickness. Diameter. Wall enhancement. Mesentery Fat. Liquid. Localization. Vessels. Artery. Vein. Other abdominal organs Liver. Kidneys. Adrenal glands. Pulmonary embolism. Conclusions. Bibliography.

### **GIEE-181 Gastric Cancer CT Staging: Radiologic Patterns with Radiologic-Pathologic Correlation**

#### **Awards**

#### **Magna Cum Laude**

Maria Agostina Giallorenzi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

State of the art treatment of locally advanced gastric cancer is multimodal and involves combined surgical and medical therapy. CT has a central role in the staging of gastric cancer, being the method of choice for this purpose; a local and distant staging as accurate as possible is crucial for a correct treatment planning, avoiding under- or over-treatment of the Patient. To obtain a correct staging, a thorough knowledge of normal and pathologic gastric radiological anatomy and the pathways of tumor spread is crucial. Through the analysis of illustrative cases: To know the normal and pathologic gastric radiologic anatomy and the lymphatic and hematogenous pathways of spread of gastric cancer. To know the TNM classification (8th edition) for gastric cancer and correctly use the CT criteria necessary for its application. To correlate radiologic patterns of gastric cancer with macroscopic and microscopic pathologic patterns. To correlate clinical CT staging and pathologic staging with regard to T and N parameters. To understand the limitations and pitfalls of imaging and the causes of radiological overstaging and understaging.

## TABLE OF CONTENTS/OUTLINE

1. Concepts of normal and pathologic gastric radiologic anatomy and lymphatic and hematogenous tumor spread pathways are explained. 2. Some illustrative cases of early-stage, locally advanced and oligometastatic gastric cancer are presented, with clinical staging obtained by CT imaging applying the TNM 8th edition classification. Correlation of CT images with macroscopic and microscopic pathologic findings is shown by detailed explanation of the findings. 3. Some examples of CT understaging and overstaging and their possible explanations are presented.

### **GIEE-182 Abdominal Inflammatory Lesions Unmasked: A Radiological Hunt for Tumor Impostors!**

Abrahamo Elias Neto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the abdominal inflammatory diseases which mimic tumor-like lesions. To present diagnostic challenging cases of inflammatory diseases that can mimic tumoral lesions. To be aware of non-malignant conditions as differential diagnoses at the initial presentation of lesions suspicious for neoplasms, and which imaging features may help in the differentiation. To highlight clinical and laboratory data that can help the radiologist not fall into pitfalls.

## TABLE OF CONTENTS/OUTLINE

Abdominopelvic inflammatory lesions can present a diagnostic challenge for radiologists, particularly when distinguishing between tumor and non-tumor involvement. This can have a significant impact on patient outcomes, as the management and prognosis of these conditions can vary dramatically. Overview of the main inflammatory diseases that mimic neoplasms. Key radiological findings in cross-section abdominal images that aid in distinguishing between tumor and non-tumor lesions. The role of clinical and laboratory information in the differential diagnosis of inflammatory lesions. Didactic exposition of illustrative cases in which inflammatory diseases mimic neoplasms, such as rectal syphilis, peritoneal tuberculosis, focal pyelonephritis, glandular cystitis, hepatic inflammatory pseudotumor, xanthogranulomatous cholecystitis, complicated appendicitis, focal pancreatitis, vaginal vault abscess, and lobular endocervical glandular hyperplasia. Recap of the importance of accurately differentiating between tumor and non-tumor involvement in abdominopelvic inflammatory lesions, with the key takeaways from this educational exhibition.

### **GIEE-183 Expanding the Role for Biopsy in HCC: It's Not Just About Diagnosis**

Mansur A. Ghani, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Traditionally, clinical indications for biopsy of hepatocellular carcinoma (HCC) have included circumstances when imaging diagnosis is uncertain or for HCC that does not respond as expected to therapy. 2. More recently, developments in the understanding of pathological and molecular alterations in HCC at the cellular level have created additional opportunities for biopsy for the purposes of prognosis, treatment selection and treatment monitoring.

## TABLE OF CONTENTS/OUTLINE

Review of traditional indications for biopsy in HCC (Fig. 1)- Diagnosis in the case of LR-4 (Fig. 2), LR-M (Fig. 3) and LR-TIV- Lesions that do not respond as expected to therapy Additional potential roles for biopsy in HCC- Diagnosis- Lesions in non-cirrhotic livers or scenarios where LI-RADS currently cannot be applied (e.g. cardiac cirrhosis and Fontan related liver disease)- LR-3 lesions (Fig. 4)- Prognosis- There are several histological HCC sub-classes, each with distinct molecular patterns and prognostic implications (Fig. 5)- Microscopic vascular invasion (MVI) can be incidentally detected on biopsy, and surrogate molecular markers can be used to predict MVI- Stemness-related biomarkers are associated with more aggressive clinical behavior- Treatment selection- Potentially targetable genetic alterations are found in approximately 24% of HCC.- Treatment monitoring- Genetic sequencing of biopsy tissue can be performed to design specific liquid biopsy panels to monitor efficacy of treatment.- Biopsy Techniques- Biopsy types: fine-needle aspiration, needle-core biopsy, micro-histology, liquid biopsy- Types of image guidance- Ultrasound with an emphasis on the emerging role of contrast-enhanced ultrasound- CT-guided

## **GIEE-184 Getting to the Bottom of the Pelvic Floor: A Primer on MR Defecography Technique, Reporting and Implications for Surgical Management**

### **Awards**

#### **Certificate of Merit**

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Indications for MR defecography (MRD); advantages over fluoroscopic defecography and correlation of both techniques
- Anatomic considerations: compartments, measurements, pathophysiology of the pelvic floor
- Technique and phases of examination for functional assessment
- Standardized terminology and reporting
- Imaging findings of common and rare diagnoses
- Surgical management of pelvic organ prolapse: choice of procedure, techniques and post-op imaging findings

## TABLE OF CONTENTS/OUTLINE

Review pelvic compartmental anatomy, important lines and measurements:- Pubococcygeal line- H-line- M-line- Urethral axis- Vaginal axis Variations of technique and equipment:- Phases: rest, contraction, defecation- Sequences- Open vs. closed MRI technique- Coil design Standardized terminology and reporting, consensus guidelines by SAR and AJR. Step by step interpretation of a case with sample reporting template. Entities discussed:- Peritoneocele, Enterocoele, Sigmoidocele- Cystocele- Urethral Hypermobility- Uterine/Vaginal prolapse- Descending perineal syndrome- Structural Outlet Obstruction: Rectocele, Rectal prolapse, Intussusception, Rectal mass- Functional Outlet Obstruction: Puborectalis dyskinesia, Anismus anorectal incontinence- Spastic pelvic floor syndrome Surgical management of pelvic descent- Pre-op considerationso Obliterative vs. reconstructive techniqueso Abdominal vs. vaginal approacho Concomitant urinary or fecal incontinence repair, colporrhaphyo Hysterectomy vs. uterine-sparingo Risk calculator for prophylactic urinary incontinence preventiono Indications for mesh augmentation- Post-op imaging findings and complications

## **GIEE-185 MRI-Based Body Composition Analysis: We Can See the Fat That Hides Inside You**

### **Awards**

#### **Certificate of Merit**

Luciana C. Belem, MD, MSc (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Review how MRI of the abdomen may help identify high-risk adiposity phenotypes in the obesity context.- Review the literature on obesity, addressing the impact of visceral and ectopic fat in health.- Discuss which measurements can be made on MRI of the abdomen to assess visceral and ectopic fat.- Teach how to measure visceral and ectopic fat on MRI of the abdomen.

## TABLE OF CONTENTS/OUTLINE

- Definition: what is visceral and ectopic fat.- Review the pathophysiology of obesity and discuss how to differentiate the adiposity phenotypes on MRI.- Body composition measures on MRI: Visceral adipose tissue, subcutaneous adipose tissue and skeletal muscle. Area or volume? If area, which level? Which muscle groups to include in skeletal muscle quantity assessment.- Protocol: which sequences use to assess body composition parameters and quantify ectopic fat.- Chemical shift-encoded (CSE) MRI with estimation of proton density fat fraction (PDFF): potential biomarker in obesity.- Ectopic fat measures on MRI: Muscle fat: which abdominal muscle group to measure? Pancreas fat: where and how to measure? Liver fat: where and how to measure?

## **GIEE-186 Mind The gap! The Tubes and Pipes in Crohn's Disease: Technical Aspects and Diagnostic Findings of CT and MRI-Enterography**

Mayra V. Soares, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

To review relevant points in the anatomy of the small intestine, in the context of Crohn's Disease, highlighting the main sites of involvement. To review the indications, protocol, and technical aspects of CT and MR-enterography (CT-e and MR-e). To point out differences and similarities, advantages and disadvantages between CT-e and MR-e. To show typical and atypical imaging findings of Crohn's disease and main complications. To distinguish phenotypic patterns of presentation of Crohn's disease in CT-e and MR-e.

## TABLE OF CONTENTS/OUTLINE

Introduction Review of the anatomy of the small intestine Review of the typical and atypical imaging findings of Crohn's disease and its phenotypes CT-e and MR-e protocols Main diagnostic findings in Crohn's disease: Segmental mural enhancement mural thickening stenosis ulcerations vasa recta ingurgitation lymph node enlargement Complications related to Crohn's Disease: fistulas inflammatory mass Abscess

## GIEE-187 The Mystery of Internal Hernias: What Should the Radiologists Know?

Basem Jaber, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Reviewing the different types of the internal hernias- Discussing the imaging features of various types of internal hernias- Identifying possible complications of internal hernias- Providing case-based review of common and uncommon pathologies

## TABLE OF CONTENTS/OUTLINE

Internal hernias are defined as protrusion of small bowel loops through normal apertures and/or defects in the peritoneum or mesentery into a compartment within the abdominal cavity, commonly presenting as an acute intestinal obstruction. The incidence of internal hernias is increasing with the new surgical procedures now being performed. It is crucial for radiologists to be familiar with and understand the different types of internal hernias and the possible complications since they have high mortality rate and they are often challenging to recognize. Key points:- Introduction to peritoneum anatomy- Internal hernia different types- The diagnostic approach for internal hernias- Pearls and pitfalls for recognizing internal hernias complications imaging features

## GIEE-188 Just Not GIST: Non-GIST Mesenchymal Neoplasms of the Alimentary Tract

Rashmi Balasubramanya, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

There is a heterogeneous group of non-GIST, mesenchymal neoplasms of the gastrointestinal tract that are characterized by distinctive histopathology tumor genetics as well as variable clinico-biological profiles and imaging findings. Characteristic disease distribution: While glomus tumors and plexiform fibromyxomas display distinct predilection for the gastric antrum, smooth muscle tumors of the gut preferentially occur in the esophagus and colorectum. Distinctive genetic markers: Based on MDM2 gene amplifications, esophageal giant fibrovascular polyps are now considered well-differentiated liposarcomas. Other tumors with distinctive cytogenetics include lipomas (HMGA2 gene rearrangements), granular cell tumors (inactivating AP6AP gene mutations), gastroblastomas (MALAT1-GLI1 fusions), plexiform fibromyxomas (GLI activating mutations), malignant neuroectodermal tumors (EWSR1-ATF1 gene fusions), IMTs (ALK gene rearrangements) and SFTs (STAT6 NAB2 gene fusions).

## TABLE OF CONTENTS/OUTLINE

Introduction, taxonomy, demographics, clinical manifestations, pathological features, Multimodality cross sectional imaging findings on CT, MRI, PET-CT, management, prognosis, conclusion. Entities discussed: Esophageal granular tumor and well-differentiated liposarcoma; distinctive gastric tumors such as synovial sarcoma, IMT, plexiform fibromyxoma, and glomus tumor; smooth muscle tumors, lipomatous/neurogenic tumors, malignant neuroectodermal tumor, Kaposi sarcoma, sclerosing epithelioid fibrosarcoma.

## GIEE-189 Not Always What It Seems: Exploring Mimickers of Liver Malignancy

Kumi Ozaki, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

· Review of several mimickers of liver malignancy based on characteristic imaging findings. · Comprehension of key clinical and imaging findings that may help distinguishing mimickers from malignant liver lesions.

## TABLE OF CONTENTS/OUTLINE

1. Overview of characteristic imaging and clinical features of typical liver malignancy. 2. Overview of mimickers of liver malignancy based on each characteristic imaging findings; patterns of enhancement (early staining and prolonged enhancement, early staining and wash-out, gradual enhancement, peripheral enhancement), fat component, lower ADC

values, growth rate, cystic lesion with mural nodule, periportal lesion and so on.3. Overview of mimickers of liver malignancy in the patients with chronic liver disease or cirrhosis.4. Overview of mimickers of liver malignancy in the patients with a known malignancy.5. Undistinguishable mimickers from liver malignancy.6. Take home points

### **GIEE-19 Precision Medicine and Early Detection of Pancreatic Cancer**

Linda C. Chu, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Patients with pancreatic cancer often present with non-specific clinical symptoms and are diagnosed at advanced disease stage. Recent advances in imaging techniques, molecular analysis, and artificial intelligence can lead to earlier detection of pancreatic cancer, which can significantly improve patient outcomes. The purposes of this exhibit are to review the current guidelines in high-risk screening of pancreatic cancer, review the role of liquid biopsy and pancreatic cyst fluid molecular markers in earlier detection, and the potential role of artificial intelligence in automated detection of pancreatic cancer.

#### **TABLE OF CONTENTS/OUTLINE**

Current guidelines in high-risk screening of pancreatic cancer. Role of liquid biopsy and pancreatic cyst fluid molecular markers in early detection. Artificial intelligence assisted automated detection of pancreatic cancer.

### **GIEE-190 CT Imaging for Assessment of Hepatic Steatosis**

Tomoko Hyodo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To illustrate a pictorial review of focal and diffuse steatosis in the liver. 2. To explain the principles of quantitative assessment of liver fat using CT. 3. To review the accuracy of fat quantification by using single-energy CT (including quantitative CT) and dual/multienergy CT. 4. To demonstrate application to visual display of quantitative results.

#### **TABLE OF CONTENTS/OUTLINE**

1. Clinical significance 2. Etiology of diffuse fatty liver diseases 3. Beware of localized fat: neoplastic and non-neoplastic lesions 4. CT techniques for quantification. 4-1. Conventional single-energy CT and quantitative CT 4-2. Dual-energy CT a) CT attenuation value b) Fat fraction c) Electron density d) Virtual non-contrast imaging 4-3. Photon-counting CT 5. Visual tools for pre- and post-therapy assessment 5-1. Fat quantification of each liver lobe/segment 5-2. Fat distribution and its statistics

### **GIEE-191 Computer-Aided Diagnosis for Hepatic MRI: What is Needed and Expected**

Shogo Maeda (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

a. As gadoteric acid-enhanced MRI has combined perfusion and hepatocyte-selective properties, it is widely used to detect and diagnose focal hepatic lesions. b. Gadoteric acid-enhanced hepatobiliary phase (HBP) images are highly sensitive for the detection of hepatic lesions. However, small lesions, especially those near hepatic vessels, may be missed because they and the vessels are low signal-intense on HBP images. Computer-Aided Diagnosis (CAD) may be effective, especially for detecting small lesions on HBP images. c. Because many hepatic lesions, benign or malignant, are low signal-intense on HBP images, a differential diagnosis requires comprehensive evaluation with other sequences. CAD can differentiate between benign and malignant lesions by integrating information from EOB-MRI and sequences such as T2- and diffusion-weighted scans. Therefore, CAD is particularly useful for differential diagnosis in a single case of mixed benign and malignant lesions. d. A diagnosis of hepatic lesions is reached by integrating findings from various modalities and clinical information. A CAD that integrates all information is required.

#### **TABLE OF CONTENTS/OUTLINE**

a. History and classification of CAD in radiology b. Possibility of CAD for detecting hepatic lesions on MR images c. Possibility of CAD for diagnosis of hepatic lesions on MR images d. Future prospects of CAD for diagnosing hepatic lesions

### **GIEE-192 Update on Histology, Staging, and Treatment of Intrahepatic Cholangiocarcinoma: The Role of the Radiologist**

Wyanne Law, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe the morphologic and histopathologic classification of intrahepatic cholangiocarcinoma (ICC) 2. Discuss differential diagnosis of ICC, including hepatocellular carcinoma (HCC), metastasis and benign entities 3. Describe American Joint Committee on Cancer (AJCC) 8TH edition staging for ICC and resection criteria 4. Discuss non-surgical options and recognize response/progression disease and complications



## TABLE OF CONTENTS/OUTLINE

Classification Location: intrahepatic 10% vs perihilar 50- 60% vs distal 20-30% Morphologic: periductal infiltrating, mass forming, intraductal growing-Histopathologic: large duct vs small duct Imaging characteristics of ICC Peripherally enhancing, hypervascular, delayed enhancement Update on staging AJCC 8th edition for ICC TNM Surgical Resection Adequate future liver remnant (FLR) with intact hepatic arterial, portal venous, hepatic venous, and biliary drainage, excluding distant metastases, bilobar tumor and nonregional nodes Chemotherapy Gemcitabine + cisplatin Response: RECIST Immunotherapy TOPAZ-1 trial - Durvalumab -New inhibitors targeting genetic alterations in small duct, Pemigatinib, infigratinib Response: iRECIST-Complications: colitis, hepatitis, pneumonitis, renal failure, myocarditis Hepatic arterial infusion pump Floxuridine-Complications: gastroduodenal artery aneurysm, extravasation from catheter Ablative radiotherapy Complications: Radiation-based liver parenchymal changes (RILD), delayed onset of radiation necrosis Transarterial radioembolization (TARE) Yttrium 90 Complications: Post-radioembolization syndrome, gastroduodenal ulcer, cholecystitis

### **GIEE-193 Gastrointestinal Ectopic Pancreas: Cross-sectional Imaging Spectrum and Differential Diagnosis**

Xueying Long, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe the clinical manifestations and the spectrum of cross-sectional imaging findings of the ectopic pancreas (EP) in the gastrointestinal tract. 2. Discuss the diagnosis of the gastrointestinal EP with emphasis to formulate a differential diagnosis for gastrointestinal submucosal tumors.

#### **TABLE OF CONTENTS/OUTLINE**

1. The definition and overview of clinical manifestations of gastrointestinal ectopic pancreas (EP). 2. The pathologic gross manifestation and histological classification of EP. 3. A list of the common morphological manifestations of EP on cross-sectional images including sites and incidences, location, size, shape, contour, margin, attenuation/intensity signals, growth pattern, enhancement pattern, picking out those specific signs which are essential clues to indicate the diagnosis, such as duct-like structure in the lesion, hyperenhancement of the overlying mucosa, central umbilication, perilesional fat or low attenuation. 4. Describe the uncommon findings of EP with a comprehensive case series, including rare histological types and with secondary complications, including pancreatitis, pseudocyst formation, malignant degeneration, gastrointestinal bleeding, bowel obstruction. 5. Differential diagnosis between EP and other gastrointestinal submucosal tumors, such as gastrointestinal stromal tumors (GISTs), gastroduodenal glomus tumors, neuroendocrine tumor, leiomyomas and schwannomas. 6. Summary 7. Suggesting reading

### **GIEE-2 Squamoid Cyst of Pancreatic Ducts: Rare Cystic Lesion of Pancreas**

Duygu Cengiz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Develop an awareness of squamoid cyst of pancreatic ducts (SCOP) Learn imaging features of SCOP Compare SCOP to other similar cystic lesions to make differential diagnosis. Discuss relation of SCOP and PDAC

#### **TABLE OF CONTENTS/OUTLINE**

Cystic lesions of pancreas Rare pancreatic cystic lesion: Squamoid cyst of Pancreatic Ducts (SCOP) Pathologic definition of SCOP Misnomer or not: Is SCOP really related to pancreatic ducts? Imaging features of SCOP Differential diagnosis of SCOP Simple Mucinous Cyst (SMC): Is it possible to differentiate SMC from SCOP? SCOP and PDAC: Is there a relation?

### **GIEE-20 Distinguishing Inflammatory Conditions from Cancer of the Gastrointestinal Tract: What Radiologists Should Know**

Camila L. Vendrami, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review imaging technique to assess gastrointestinal (GI) inflammatory conditions and cancer
- Review and illustrate the typical imaging appearances that allow differentiation of these inflammatory conditions and cancer
- Review and illustrate potential complications from these entities

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction: overview of GI inflammatory conditions and tumors
- Imaging techniques: US, CT, MR including enterography
- Gastric inflammation and gastric tumors
  - o Clinical findings, detection and imaging features to differentiate the entities
- Small bowel enteritis and other small bowel pathology and SB cancers (adenocarcinoma, carcinoid, lymphoma, GIST, metastases etc.)
  - o Clinical findings, detection and imaging features to differentiate the entities
- Diverticulitis and colon cancer
  - o Clinical findings, detection and imaging features to differentiate the entities
- Appendicitis and appendiceal cancers [adenocarcinoma, neuroendocrine (carcinoid), lymphoma and colon cancer associated with appendicitis], endometriosis of

appendix o Clinical findings, detection and imaging features to differentiate the entities • Potential complications such as perforation and fistulas • Conclusion

## **GIEE-21 It's Not Just a Question of Size: Unveiling the Secret World of Abdominopelvic Lymph Nodes for a Proper Radiological Assessment**

Ana L. Lopes Potente, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Review individual lymph node anatomy, names, and abdominal and pelvic lymph node group locations. Demonstrate through illustrative cases which clues the lymph nodes can reveal to us about diagnostic possibilities.

### **TABLE OF CONTENTS/OUTLINE**

- Importance of lymph node evaluation. Limitations of size-based evaluation. - Didactic drawings to review anatomy and pathophysiology. - Review of updated literature on normal dimensions of lymph nodes. - Video map to point out nomenclature and location of abdominal and pelvic lymph node chains, such as (but not limited to) retrocrural, retroperitoneal, gastrohepatic ligament, porta hepatis, celiac and superior mesenteric artery, pancreaticoduodenal, perisplenic, mesenteric, and pelvic nodes. - Demonstration of the main imaging techniques for lymph node evaluation. Importance of adequate protocols. Discussion of benefits and limitations of each method. - Case studies to highlight pitfalls and findings that may simulate lymphadenopathy, such as splenosis, accessory spleen, papillary process of the caudate lobe, vascular anomalies, prominent vascular structures like gonadal veins, and scalloped diaphragmatic crus. Tips to avoid misdiagnosis. - Special cases in which lymph node morphology can point to specific diagnoses. - Importance of lymph node features beyond size in diagnosis. - Exposition of rare cases where lymph node enlargement causes vascular and nervous complications. Discussion of diagnosis and management. - Summary of teaching points.

## **GIEE-22 Spectrum of Heterotopic & Ectopic Splenic Conditions**

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group; Advisor, Zebra Medical Vision Ltd; Advisor, Nano X Imaging;

### **TEACHING POINTS**

1. To describe the spectrum of heterotopic and ectopic splenic conditions, including the underlying embryologic basis. 2. To demonstrate the role of cross-sectional and imaging and scintigraphy in asymptomatic detection and symptomatic diagnosis of these splenic-related conditions, through a series of clinical examples.

### **TABLE OF CONTENTS/OUTLINE**

- Introduction- Embryologic development of the spleen o Normal splenic development o Spectrum of abnormal development - Splenic-specific imaging techniques o Nuclear medicine (heat-treated RBC > sulfur colloid scans) o MRI (ferumoxytol) - Heterotopic splenic conditions o Splenules § Pancreatic tail splenules o Splenogonadal fusion § Discontinuous form § Continuous form - Ectopic splenic conditions o Splenosis o Wandering spleen § Incidental asymptomatic detection § Symptomatic torsion o Polysplenia (heterotaxy) § Associated findings- Concluding remarks

## **GIEE-23 Peritoneal Carcinomatosis: The Role of the Radiologist in Selecting Patients for Curative Treatment**

Alicia Espinal Soria, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To know the different presentations of the peritoneal carcinomatosis in CT. To get familiar with the term Peritoneal Cancer Index and the website used to calculate it "e-Promise". To make a differential diagnosis with the pathologies that may mimic peritoneal implants.

### **TABLE OF CONTENTS/OUTLINE**

Intraabdominal malignancies often spread to peritoneal cavity causing peritoneal carcinomatosis. The most common primary neoplasms are colorectal, small bowel, stomach, ovaries and pancreas. Peritoneal carcinomatosis (PC) may present in CT like ascites, peritoneal thickening, peritoneal nodules or masses, "omental cake" pattern or pseudomyxoma peritonei. This presentation forms in CT are also seen in other pathologies such as peritoneal tuberculosis, acute peritonitis, splenosis, peritoneal lymphomatosis, and peritoneal mesothelioma. Histologic analysis must be made to obtain a definitive diagnosis in doubtful cases. Until recently, PC was considered an end-stage disease where supportive care was the only possible treatment. The cytoreductive surgery (CRS) followed by Hypertermic intraperitoneal chemotherapy (HIPEC) is a combined treatment that has given a curative option to properly selected patients. It is important to know the most frequent shapes and locations of peritoneal implants to calculate the Peritoneal Cancer Index (PCI) using CT imaging, which is part of the selection criteria. The website "e-Promise.org" is useful to calculate this Index and help the clinician deciding the most suitable treatment for each patient.

**GIEE-24** Shravya Srinivas Rao, MD (*Presenter*) Nothing to Disclose

## Comprehensive Review of Imaging in Pancreatic Transplantation: A Panorama of Good and Bad! TEACHING POINTS

pancreas transplant- indications, types, surgical procedure- To discuss post-transplant imaging surveillance of pancreas - To review the spectrum of post-transplant complications- visceral, vascular, intestinal\*  
1. Pancreas transplantation procedure- Indications- Types of transplantation (whole organ vs islet cell)- Surgical procedures2. Role of imaging in pancreas transplantation- Preoperative imaging- Imaging modalities- Technique and protocol- Post-operative surveillance3. Imaging manifestations after pancreas transplantation- Normal appearance- Post-operative complications- Differential diagnosis- Radio-pathologic correlation- Pitfalls and challenges

### GIEE-25 **Rectum MRI: Beyond the basics**

#### **Awards** **Cum Laude**

Thiago Jose Pinheiro Lopes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- High-resolution MRI is a cornerstone in the evaluation of the rectum, notably for cancer. In the past years, its use has been expanded far beyond TNM staging, enabling post-neoadjuvant therapy follow-up, patient selection for the "Watch and Wait" approach, predicting response to Total Neoadjuvant Treatment (TNT), and much more. - MRI imaging has enabled less invasive treatment approaches, with improved quality of life for patients and similar outcomes, and radiologists should be aware of these developments. - Our purpose is to review emerging applications of rectal resonance in the radiological routine and bring tips for deepening the anatomy of the rectum.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Delving into the anatomy of the rectum. 3. Recognizing post-CRT changes in rectum cancer. 4. Selecting patients for the "Watch and Wait" approach. 5. Using MRI to predict response to Total Neoadjuvant Treatment (TNT). 6. Identifying mucinous tumors. 7. Recognizing mesorectal fascia involvement. 8. Evaluating sphincter invasion in low rectal cancer. 9. Future directions. 10. Take home messages.

### GIEE-26 **Quantitative CT for Diffuse Liver Diseases: Steatosis, Iron, and Fibrosis**

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group; Advisor, Zebra Medical Vision Ltd; Advisor, Nano X Imaging;

#### **TEACHING POINTS**

1. 1. To demonstrate the ability of CT to quantify fat, iron, and fibrosis content within the liver, analogous to MRI approaches. 2. Explain the rationale for opportunistic screening at abdominal CT for detecting unsuspected diffuse liver disease, including steatosis, hemochromatosis, and compensated cirrhosis. 3. Describe a battery of CT-based liver biomarkers that can now be obtained in a fully-automated fashion using AI-based methodology.

#### **TABLE OF CONTENTS/OUTLINE**

- Overview of diffuse liver diseases o Hepatic steatosis and NAFLD o Hepatic iron overload and hemochromatosis o Hepatic fibrosis and cirrhosis - Quantification methods for hepatic fat, iron, and fibrosis content: o Liver biopsy o Advanced MRI methods o CT-based biomarkers - Opportunistic CT-based screening for diffuse liver disease o Rationale o Manual and automated techniques o Brief review of evidence to date o Pitfalls o Prospects for the (near) future - Concluding remarks

### GIEE-27 **Imaging in HIPEC- All You Need To Know!**

Shravya Srinivas Rao, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Peritoneal malignancies like pseudomyxoma peritonei, metastatic carcinomatosis from colon adenocarcinoma, mucinous carcinomas of ovary, stomach, pancreas etc., can be treated with cytoreduction surgery and hyperthermic intraperitoneal chemotherapy (HIPEC) or early postoperative intraperitoneal chemotherapy (EPIC). Objectives of this exhibit are:- To discuss imaging manifestations of peritoneal malignancies - To review the technique, principles, and complications of HIPEC therapy- To learn the role of imaging in the assessment of HIPEC patients before and after therapy

#### **TABLE OF CONTENTS/OUTLINE**

1. HIPEC- technique and principles2. Peritoneal tumors- classification and imaging features3. Radiological, surgical and pathological correlation 4. Criteria for CRS and HIPEC- selection of patients for HIPEC5. Calculation of Peritoneal Cancer Index: principles and method of estimation6. Imaging in response assessment

### GIEE-28 **Peritoneal Carcinomatosis Versus Primary and Secondary Peritoneal Tumors and Other Traps**

Jardali, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Review of the imaging features of common and uncommon peritoneal diseases, neoplastic (such as pseudomyxoma peritonei) and non-neoplastic, that mimic peritoneal carcinomatosis. • Emphasis on the CT/MRI findings and the additional imaging clues that may allow the radiologist to appropriately narrow the differential diagnosis and, in some cases, make an imaging-specific diagnosis.

### TABLE OF CONTENTS/OUTLINE

I. Imaging appearance of peritoneal carcinomatosis II. Imaging clues to the diagnosis of differential diagnosis: a. Secondary peritoneal-based neoplasms i. Pseudomyxoma peritonei b. Primary peritoneal neoplasms i. Malignant peritoneal mesothelioma c. Primary peritoneal mesenchymal tumors i. Gastrointestinal stromal tumor (GIST) with peritoneal sarcomatosis ii. Fibromatosis (Desmoid tumor) d. Non-neoplastic mimics of peritoneal carcinomatosis: i. Mesothelial cysts ii. Cystic lymphangioma iii. Lymphangiomyomatosis iv. Mesenteric fat necrosis / lipophagic granuloma v. Atypical infections: Tuberculosis, Actinomycosis

### GIEE-29 Gastro-Intestinal Devices: from Esophagus to Anus. Imaging Appearance Review of Common and Less Common GI Foreign Bodies

Emre Aslan, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- 1) Review of imaging appearance of common and less common gastrointestinal (GI) devices.
- 2) Summarize common device-specific complications.
- 3) Review of MRI safety profiles for each GI device.

### TABLE OF CONTENTS/OUTLINE

1) Introduction: As minimally invasive procedures become more ubiquitous and technology keeps advancing, new GI devices are being used by interventional radiologists and interventional gastroenterologists. 2) Clinical use Radiologists and radiology trainees must stay up to date with new GI devices to recognize and prevent complications whenever possible. Each device's indications, normal imaging appearances, potential complications and MRI safety profiles will be discussed. 3) Endoscopically placed devices esophageal, duodenal, rectal stents, AXIOS stent, and Ovesco device. 4) Surgically placed devices LINX reflux management system, gastric pacemaker, gastric band, Ray-Tec X-rayable sponge and laparotomy sponge. 5) Tubes and balloons Blakemore tube, cecostomy tube, intragastric balloon, and Minnesota tube. 6) Other Amplatzer plug and capsule endoscopy device. 7) Conclusion Summary of key teaching points.

### GIEE-3 The Washout of Hepatocellular Carcinoma at Portal Venous Phase versus Equilibrium Phase: Radiological and Clinicopathological Implication

#### Awards

#### Certificate of Merit

Kengo Yoshimitsu, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To learn that there are two distinct types of hepatocellular carcinoma (HCC) washout to be recognized: one at the portal venous phase (PVP) and the other at the equilibrium phase (EqP).
- To learn that these two represents two different phenomena; a dynamic, and a static one, respectively.
- To learn that PVP washout is a consequence of rapid hemodynamic change of HCC and background liver (BGL).
- To learn that EqP washout represents static condition of contrast medium distribution in the extracellular space of HCC and BGL.
- To learn that PVP washout is significantly related to histological grades of HCC, or its status of microvascular invasion.
- To learn that EqP washout might be related to immunohistochemical subgroup of HCC.

### TABLE OF CONTENTS/OUTLINE

1. Basic concept of two types of "WASHOUT" of HCC 2. Washout at PVP: radiological consideration 3. Washout at PVP: clinicopathological implication 4. Washout at EqP: radiological consideration 5. Washout at EqP: clinicopathological implication 6. Washout on dynamic MRI using extracellular contrast medium or gadoxetate 7. Summary

### GIEE-30 Focal Liver Lesions: A Case-based Quiz

Laura Cavero Barreras, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To highlight the importance of the clinical context of patients with focal liver lesions.
- To review the typical and atypical imaging findings of focal liver lesions in multimodality imaging techniques through cases studied in our center.
- To know the

current guidelines and define a practical approach to the radiologic management of liver lesions. - To identify potential pitfalls and key imaging findings to make the correct diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Focal liver lesions represent a widespread, heterogeneous group of disorders that can be benign or malignant, solitary or multiple. Diagnosis is usually challenging as many lesions may mimic each other. Radiologists must consider the appearance and the enhancement pattern of the nodule on different imaging techniques, such as US, CT, and MRI. Moreover, contrast-enhanced US (CEUS) can help to resolve doubts and establish the diagnosis in cases where other imaging techniques do not provide a definite diagnosis. On the other hand, it is necessary to consider the clinical context of the patient, as this will determine the further management of the lesion. This presentation will take the form of a quiz to discuss the typical and atypical imaging findings and the management of focal liver lesions based on current guidelines.

### **GIEE-31 Laxative-free Photon-counting CT Colonography for Colorectal Cancer Screening**

Yasuji Ryu, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The teaching points of this exhibit are to (1) explain the emerging role of laxative-free CT colonography in colorectal cancer (CRC) screening, (2) explain the role of photon-counting CT in addressing the challenges of conventional CT colonography, and (3) explain the role of artificial intelligence (AI) in unlocking the potential of laxative-free photon-counting CT colonography as a CRC screening test.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: the importance of CRC screening; the emerging role and challenges of laxative-free CT colonography. 2. Photon-counting CT: benefits over conventional CT; how photon-counting CT addresses the challenges of laxative-free CT colonography. 3. AI enables an effective laxative-free photon-counting CT colonography examination: computer-aided detection; virtual bowel cleansing; risk assessment; putting it all together. 4. What we know and don't know: outcomes from clinical laxative-free CT colonography trials; initial observations from photon-counting CT colonography studies. 5. Summary.

### **GIEE-33 Pancreas Transplantation: What Should the Radiologist Know?**

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To expose the existing surgical techniques in pancreatic transplantation. To highlight the role of the different imaging tests in graft evaluation. To make a pictorial review of the postoperative complications according to the time after transplantation.

#### **TABLE OF CONTENTS/OUTLINE**

Pancreatic transplantation is a valid therapeutic option for poorly controlled diabetes mellitus and advanced diabetic nephropathy. Knowledge of the surgical techniques, location of the anastomoses and related complications will assist the radiologist in performing an accurate assessment that leads to adequate management and long-term survival of pancreatic grafts. There are three types of pancreas transplantations regarding the drainage method: systemic venous and bladder exocrine drainage, systemic venous and enteric exocrine drainage, and portal venous and enteric exocrine drainage. Radiological assessment of the pancreas graft is usually multimodal. Ultrasound is the first-line imaging modality for the initial post-surgical evaluation performed within the first 24 hours. CT is preferred if complications are presumed. Postoperative complications include parenchymal, infectious, enteric or vascular disorders, which can be classified according to the time lapse after transplantation in which they occur: immediate (< 24 hours), early (24-72 hours), intermediate (72 hours-weeks) and late (months). We gathered the most illustrative cases of postoperative complications from recent years at our institution to show the key features of imaging that enable rapid and accurate management.

### **GIEE-34 Retrospectively Defined Missed Early Signs of Pancreatic Cancer on CT**

#### **Awards**

#### **Certificate of Merit**

Satomi Kawamoto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review cases of missed early pancreatic ductal adenocarcinoma (PDAC) and early changes of PDAC on CT. 2. Small, isoattenuating PDAC without contour deformity can be easily missed. 3. CT findings to suggest early PDAC include pancreatic duct dilatation with or without abrupt duct cutoff, vascular invasion, focal parenchymal atrophy, and focal enhancement.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background: Delay in diagnosis can contribute to poor outcomes in PDAC, and imaging plays a crucial role in the diagnosis of early PDAC. 2. Review of cases of missed early PDAC and early changes of PDAC before clinical diagnosis on CT. (1) Small,

isoattenuating PDAC without contour deformity. (2) Pancreatic duct dilatation is most common secondary finding (3) Abrupt pancreatic duct cut-off (4) Vascular invasion is not a common finding but high likelihood of missing (5) Parenchymal atrophy (6) Focal enhancement. 3. Cognitive errors (1) Underlying pancreatitis (2) Unexpected finding. 4. Discussion of future direction

### **GIEE-35 Plan to Scan the Pancreas Transplant: A Sweet Review of Anatomy, Imaging Technique, and Complications**

Maham Siddique, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points: • Pancreas transplant aims to restore normal glycemic control, often in young patients with diabetes and manifesting end-stage renal disease. • Ultrasound is performed to evaluate the pancreas and transplant vessels in the perioperative period. • Ultrasound, CT, and MRI can diagnose transplant-related complications. Common vascular complications include arterial and venous thrombosis and arterial pseudoaneurysm. Transplant pancreatitis has similar complications to inflammation of the native pancreas and can impact the renal transplant. • Radiologists should be familiar with normal pancreas transplant anatomy, vascular and non-vascular complications of pancreas transplants, as early recognition of these entities may improve outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

Outline: Pancreas transplant background and demographics, Normal pancreas transplant anatomy and surgical technique, Normal transplant evaluation on ultrasound and reporting template, Acute and necrotizing graft pancreatitis, Vascular complications: arterial and venous stenosis and thrombosis, pseudoaneurysm, acute arterial bleeding, Non-vascular complications: Peripancreatic collections, hematoma, post-transplant lymphoproliferative disease.

### **GIEE-36 Why Oh Y-Grafts: Understanding the Anatomy, Imaging, and Complications of Pancreas Transplantation**

Melanie P. Caserta, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Pancreas transplant is the treatment for severe Type I diabetes mellitus complicated by end stage renal disease, poorly controlled Type I or II diabetes, and cystic fibrosis. Pancreas transplantation is most commonly performed simultaneously with kidney transplantation (80%) or following kidney transplantation (16%), and least commonly performed alone. Ultrasound is the first line modality for evaluating the allograft and vasculature and to look for complications. Contrast enhanced ultrasound, CT and MRI can be used as problem solving tools to further evaluate complications. After reviewing this case-based exhibit, the learner will: - Understand indications for pancreas transplantation - Describe the surgical anatomy of pancreas transplants - Describe ultrasound technique for evaluating the transplant pancreas - Recognize complications of pancreas transplant - Determine when additional imaging of the pancreas transplant is needed

#### **TABLE OF CONTENTS/OUTLINE**

Outline: 1. Objectives 2. Background - Pancreas Transplant a. Benefits of pancreas transplantation b. Review of surgical technique 3. Imaging a. Ultrasound - First line imaging i. Ultrasound protocol ii. Normal appearance iii. Complications 1. Vascular 2. Parenchymal 3. Perigraft 4. Bowel b. Problem solving i. Contrast enhanced ultrasound to assess allograft perfusion and vascular complications ii. CT - peripancreatic fluid collections, suspected intestinal obstruction, multiphase evaluation to assess graft and vasculature iii. MRI - Ferumoxytol MRI to assess transplant vasculature 4. Treatment and Intervention a. Medical b. Ultrasound guided c. Endovascular d. Surgical

### **GIEE-37 Navigating Through the Esophageal Disorders in Chest CT Scans: What Radiologists Should Know**

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To know basic anatomy and histology of the esophagus To learn the role of CT imaging in the detection and characterization of esophageal pathology. To recognize the most important imaging findings of non-malignant and malignant esophageal diseases.

#### **TABLE OF CONTENTS/OUTLINE**

1. Esophageal anatomy and histology 2. Benign esophageal disorders a). Benign esophageal tumors - Leiomyoma - Fibrovascular polyps - Esophageal schwannoma b). Congenital lesions: - Duplication cysts c). Esophageal diverticula - Pharyngo-esophageal junction: Zenker diverticula - Middle esophagus diverticulum - Epiphrenic diverticulum d). Infectious diseases - Candida - HIV - CMV - Herpes simplex virus - Chagas e). Inflammatory disorders - Reflux esophagitis and Barrett's esophagus - Eosinophilic esophagitis (EoE) f). Radiotherapy-induced esophagitis - Scleroderma - CREST f). Traumatic and fistulas - Esophageal impaction - Hematoma - Perforation - Actinic - Esophageal-airway fistula - Esophageal mediastinal fistula g). Others - Achalasia - Acute



esophageal necrosis(AEN)-Hiatal hernia-Esophageal and para-esophageal varices 3. Primary malignant esophageal tumors a). Squamous carcinoma(SCC) b). Adenocarcinoma c). Lymphoma d). Primary malignant melanoma

### **GIEE-38 Diffuse and Focal Liver Fat: Pearls and Pitfalls**

Lidiamara Van Der Zwaag, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the imaging features of liver fat in different methods.To discuss and illustrate the main causes and consequences of fatty liver disease, as well as its associated conditionsTo demonstrate common and uncommon patterns of liver fat distribution and discuss the underlying pathophysiology.To recognize that classic liver lesions can have different patterns of imaging presentation in the setting of steatosis.To present challenging cases and mimic lesions, highlighting the clues that can be helpful for the correct diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Liver fat in different imaging methods (US, CT and MRI).Main findings of several causes of fatty liver disease (alcoholism, metabolic syndrome, chemotherapy, drug toxicity, infection, PCOS).Patterns of liver fat distribution (diffuse, focal, geographic, multinodular, perivascular), including uncommon oncologic and cirrhotic cases.Patterns of presentation of the classic liver lesions in the setting of steatosis (FNH, hemangioma etc).Differential diagnosis between true lesions and pseudolesions.

### **GIEE-39 Ultrasound Of the Gastrointestinal Tract: Contributions of Ancillary Ultrasound Techniques**

Nameerah Wajahat (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1.) Greyscale ultrasound evaluation comprises the fundamental basis of diagnostic evaluation of the bowel in inflammatory bowel disease (IBD) (2.) Wall thickness, inflammatory fat and signal on color doppler imaging (CDI) are the markers which increase in proportion to active inflammation. (3.) Ancillary Ultrasound techniques including: endovaginal sonography (EVS), contrast enhanced ultrasound (CEUS) and shear wave elastography (SWE) contribute greatly to final diagnosis and patient outcome. (4.) EVS provides information about anatomy and pathology in the deep pelvis with high resolution. (5.) CEUS allows for subjective and objective information about blood flow at the capillary level, allowing characterization of inflammatory masses as representative of active inflammation (phlegmon) or abscess formation (liquid pus) (6.) SWE measures bowel wall stiffness aiding with characterization of strictures. Soft inflammatory strictures- medical management. Stiff chronic strictures - surgical management

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction to ultrasound of the bowel with emphasis on greyscale imaging - Ancillary features what are they and what do they do? - Endovaginal Sonography and its role in deep bowel evaluation - CEUS (Contrast Enhanced Ultrasound) and its contribution to activity assessment - SWE (Shear wave elastography) and its contribution to stricture assessment - Change of management with ancillary techniques

### **GIEE-4 Comprehensive Review of Abdominal Manifestations of Melanoma with Emphasis on Liver Metastasis**

Hyun Jung Chung, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is 1. To review imaging findings of primary and secondary melanoma in the abdomen and pelvis 2. To discuss multimodality imaging of liver metastasis from melanoma 3. To present an imaging atlas of gadoxetic acid-enhanced MRI for liver metastasis and to discuss its potential value 4. To discuss surveillance protocols for intraabdominal metastasis of melanoma

#### **TABLE OF CONTENTS/OUTLINE**

1. Clinical aspects of melanoma (1) Epidemiology (2) Staging (3) Treatment and prognosis 2. Primary melanoma in the abdomen 3. Metastatic melanoma in the abdomen (1) Liver (2) Pancreaticobiliary system (3) Gastrointestinal tract (4) Other involvement 4. Multimodality imaging of liver metastasis (1) Ultrasound (2) CT (3) MRI i. Lesion detection and characterization ii. Special considerations for gadoxetic acid-enhanced MRI for melanoma iii. MR findings of liver metastasis according to the primary origin of melanoma 5. Surveillance and prognosis (1) Surveillance protocol for metastatic melanoma in the abdomen (2) Prognostic implications of imaging features

### **GIEE-40 Step-by-step Assessment in Colon Cancer Risk Stratification. Assessment by Virtual Colonography and Dual Energy Support**

Omar A. Gamboa Abundis, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Colorectal cancer represents the third most diagnosed cancer and corresponds to the second cause of death in the world. The recognized precursor lesion is the adenoma, and the risk of malignant transformation is significantly increased. Virtual colonography is a noninvasive screening method for colon cancer and avoids the unnecessary risk of bleeding or perforation present in colonoscopy. Learn to describe and categorize the findings and pitfalls in lesions found during image processing and viewing.

## TABLE OF CONTENTS/OUTLINE

Table of Contents: Teaching points. Introduction. What is CRADS. Virtual colonography acquisition protocol. Image processing and anatomical considerations. Description of the results. CRADS categories. CRADS 1 to 4. Extracolonic findings. E0 to E4. Main pitfalls to consider. Conclusions. References. Outline: Colorectal cancer is the third most common cancer and is the second leading cause of cancer death in the world. It is important to carry out a screening test in patients over 45 years of age and even more so in those who present a high risk of suffering from this disease. Virtual colonography provides an excellent alternative with rapid acquisition protocols and high sensitivity and specificity. Useful in high-risk patients during the colonoscopy intervention, also avoiding the possible risk of perforation and bleeding.

## GIEE-41 Deep Learning for Electronic Cleansing in Fecal-tagging CT Colonography

Wenli Cai, PhD (*Presenter*) Stockholder, IQ Medical Imaging LLC

## TEACHING POINTS

This exhibit reviews the historical perspectives of Electronic Cleansing (EC), the major cleansing artifacts and pitfalls in the conventional deterministic EC methods, the recent technical advances of deep-learning based EC (Deep-EC) methods, comparison between Deep-EC and conventional deterministic EC, and the future trend of Deep-EC development fecal-tagging CT Colonography (CTC). The teaching points of this exhibit are: 1. EC requires accurate classification or segmentation of tagging fecal residuals and their mixtures. Conventional deterministic EC methods exhibit various artifacts and pitfalls. 2. State-of-the-art deep-learning models and training techniques provide an effective solution to reduction of EC artifacts and pitfalls. 3. Intracolonic lumen segmentation (ILS), which combines EC and colon segmentation into a single procedure in the CTC workflow, is a promising Deep-EC method in CTC.

## TABLE OF CONTENTS/OUTLINE

1. Review of deterministic EC methods with discussion of the limitations and clinical challenges. 2. Describe the challenges of building a large-scale CTC dataset for EC. 3. Present recent technical advances of Deep-EC by applying deeper and larger Convolutional Neural Network (CNN) and various model training techniques to reduce EC artifacts. 4. Present a cutting-edge Deep-EC procedure, Intracolonic lumen segmentation, built on the two-stream U-Net (BiS-UNet) model. 5. Compare the image quality of EC and Deep-EC in 3D visualization of cleansed colon in non-cathartic fecal-tagging CTC. 6. Discuss the technique trend and future developments of Deep-EC.

## GIEE-43 Peribiliary Cystic Lesions: Uncommon Mimickers of Hepatic and Biliary Cystic Lesions

### Awards

### Certificate of Merit

Ana Claudia V. Uski SR, MD, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To describe and demonstrate with radiological cases the common and uncommon peri-biliary entities. To identify the imaging features indicative of pathologies of the peri-biliary space and emphasize the radiological differences with hepatic and biliary lesions. To propose a practical systematization in the evaluation of intrahepatic peri-biliary cystic lesions. To suggest a step-by-step guide for clinical-radiological reasoning.

## TABLE OF CONTENTS/OUTLINE

Intrahepatic peribiliary cystic lesions are usually benign and result from cystic dilatation of tubule-alveolar glands with acini of serous and mucinous cholangio-cytes with various stages of maturation. The term intrahepatic refers to cystic changes located above the hepatic hilum that have the portal vein, hepatic artery, and portal neurovascular bundle as anatomical landmarks. They are usually multiple, small, thin-walled, serous content, and by definition do not exhibit communication with adjacent bile ducts. They may take on a confluent appearance resembling multiloculated malignancies or even mimic intraductal biliary pathologies. This intrahepatic peri-biliary region is susceptible to several pathologies that include inflammatory, infectious, neoplastic, congenital and acquired nature. The objective of this review is to systematize the evaluation of peribiliary cystic lesions taking into consideration their intrahepatic location and their radiological aspects that may have some peculiar characteristics.

## GIEE-44 More Than Atlanta... The Entire Acute Pancreatitis Map. A Comprehensive Review Of Acute Pancreatitis Complications



Lucia A. Chagas, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the concepts of the Atlanta criteria, both related to the initial diagnosis (edematous interstitial pancreatitis / necrotizing pancreatitis) and their complications (pancreatic pseudocyst / walled-off necrosis). To provide context for other complications of acute pancreatitis, such as thrombosis, pseudoaneurysm, hemorrhage, infection and ductal disconnected syndrome, regarding the associated risk for their development and diagnosis on imaging exams.

#### **TABLE OF CONTENTS/OUTLINE**

Schematic drawings and computed tomography and magnetic resonance images aimed at understanding imaging findings that precede certain complications, as well as aspects related to their diagnosis. Differential diagnosis approach between edematous interstitial and necrotizing pancreatitis, as well as the complications that may arise from each of them.

#### **GIEE-45 LI-RADS Treatment Response Algorithm v2023: Roadmap for Post Radiation Treatment Response**

Aadithya S. Nalla (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. The LI-RADS Treatment Response Algorithm (LR-TRA) is a standardized system for assessing and reporting treatment response after locoregional therapy (LRT) for hepatocellular carcinoma (HCC).2. When compared to other LRTs, radiation-based therapies (transarterial radioembolization (TARE) and stereotactic beam radiation therapy (SBRT)) have distinct post-treatment imaging appearances, including persistence of arterial phase hyperenhancement (APHE), which makes response assessment challenging using the current TRAs which use APHE as a surrogate imaging biomarker for viability. Changes in the LR-TRA v2023 are intended to address this challenge.3. This exhibit highlights the updates in the LR-TRA v2023, including the correct application of the new algorithm after radiation therapy to HCC, with the overall objective of improving diagnostic accuracy of post-treatment imaging assessment.

#### **TABLE OF CONTENTS/OUTLINE**

1. Summarize the role of the TRA in the context of radiation therapy for HCC.2. Case-based and illustrative review of expected imaging features after radiation-based treatments to HCC and identify pitfalls in response assessment.3. Introduce and highlight key updates of the new component of the LR-TRA v2023 pertaining to its application after radiation-based treatments for response assessment using a case-based review.

#### **GIEE-46 From Guidelines to Radiology Practice: Navigating the 2023 ASCO Guidelines for Advanced Gastroesophageal Cancer**

Charit R. Tippareddy, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Discuss new 2023 ASCO guidelines for advanced gastroesophageal cancer therapies2. Radiologic imaging findings related to treatment sequelae3. Differentiate treatment related response versus disease progression on radiologic imaging

#### **TABLE OF CONTENTS/OUTLINE**

1. Pathophysiology, demographics, risk factors of gastroesophageal cancer2. New 2023 ASCO Guidelines and their implications for treatment3. Imaging modalities used in diagnosis and staging of advanced gastroesophageal cancer4. Role of imaging in staging and management of advanced gastroesophageal cancer5. Demonstrate patient imaging cases that relate to the following:5a. Treatment related effects of immune checkpoint inhibitors5b. Treatment related effects of platinum-based chemotherapy5c. Treatment related effects of fluoropyrimidines5d. Treatment related effects of tyrosine kinase inhibitors5e. Post-radiation effects5f. Post-esophagectomy complications6. Conclusions

#### **GIEE-47 Internalize It!: An Insider's Case-Based Guide to Internal Hernias**

Collin R. Edwards, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Internal hernias occur due to herniation of viscera, most often small bowel, through the mesentery or peritoneum, and considered in the differential for intestinal obstruction. - Internal hernias are classified by different systems based on distribution of bowel loops in the abdomen and pelvis. - Post-operative internal hernias occur after roux-en-Y anastomosis for gastric bypass and liver transplant. - CT with IV and PO contrast is the imaging modality of choice for evaluating internal hernias. - "Sac-like" appearance of dilated small bowel loops on imaging should raise concern for internal hernia. - Radiologists should have a clear understanding of normal peritoneal anatomy, surgical history, and the characteristic location of common and uncommon internal hernias on imaging.

## TABLE OF CONTENTS/OUTLINE

- Introduction and background - Normal peritoneal anatomy and boundaries - Case-based review, management, and surgical outcome - Paraduodenal hernia - Lesser Sac/Foramen of Winslow hernia - Pericecal hernia - Intersigmoid hernia - Transmesenteric hernia - Pelvic and broad ligament hernia - Post Roux-en-Y hernias: Petersen's, Roux limb mesentery, enteroenterostomy

### **GIEE-48 Islet Insurgents: A Radio-Pathologic Review of Pancreatic Neuroendocrine Tumors**

David A. Mata, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Purpose/Aim: The goal is to educate the audience in recognizing the multi-modal imaging features of pancreatic neuroendocrine tumors (pNET), with an emphasis on clinical and pathological correlation. We will also elucidate the histopathologic features of pancreatic neuroendocrine neoplasm subtypes.

## TABLE OF CONTENTS/OUTLINE

Content organization: 1. Pancreatic Neuroendocrine neoplasm clinical overview. 2. Differentiating syndromic vs nonsyndromic subtypes. 3. Multi-modal radiographic features on Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). 4. Histopathological and gross pathologic characteristics of pNET. 5. Treatment and Prognosis. 6. Summary.

### **GIEE-49 Have you Ever Seen the Rain? Cross-sectional Imaging of Pancreatic Leak**

#### **Awards**

#### **Cum Laude**

Daniel L. Cardoso, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Recognize the pancreatic anatomy and its relation to other structures. Understand what can cause a pancreatic fistula (PF) and its mechanisms. Comprehend the imaging patterns of PF. Recognize the potential pitfalls of PF.

## TABLE OF CONTENTS/OUTLINE

INTRODUCTION: Pancreatic anatomy and relationship with other abdominal structures. Pancreas imaging patterns on Computed Tomography (CT), and Magnetic Resonance Imaging (MRI). Pancreas patterns after surgery (gastroduodenopancreatectomy, and distal pancreatectomy). Epidemiology of PF, and its causes. DIAGNOSIS AND IMAGING FINDINGS: PF - How to identify on CT? How to identify on MRI? How to proceed? Potential pitfalls of PF, don't get caught! SUMMARY AND SYSTEMATIC APPROACH. TAKE HOME MESSAGES.

### **GIEE-5 Selected Portal Venous Anomalies: An Institutional Multimodality Case-based Review of Portal Varices and Intrahepatic Congenital Shunts**

Abtin Jafroodifar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review portal venous (PV) varices and aneurysms, including congenital, acquired, true and pseudoaneurysms, with review of extrahepatic and intrahepatic classifications. Learn to properly communicate and report PV varices and aneurysms and their complications such as thrombosis, portal hypertension, or compressive syndromes. Discuss congenital intrahepatic portosystemic shunts subtypes. Review PV embryological development as it relates to a radiologist's practice. Explore the diagnostic clues to recognize PV varices, aneurysms, and intrahepatic shunts using multimodality imaging including ultrasound, CT, MR, and cinematic 3D rendering.

## TABLE OF CONTENTS/OUTLINE

(1) Review normal and variant portal vein anatomy using CT, MR, angiography, and original diagrams. Briefly review portal vein embryological development from the vitelline and umbilical venous systems. (2) Discuss the diagnostic criteria, relevant presentation, and epidemiology of PV varices and aneurysms. Optimal imaging protocols will be outlined. (3) A case-based review of different types of PV varices, including congenital, acquired, and isolated subtypes. Case-based review of intrahepatic portal vein aneurysms and eventual thrombosis. (4) A case-based review of five types of congenital intrahepatic portosystemic shunts classified by Park et al. (AJR, 1990). Present pre- and post closure of a congenital intrahepatic shunt case in a patient with bilateral Wilms' tumors. (5) Present a rare case of splenic vein aneurysm with eventual thrombosis and recanalization using cross-sectional imaging; of note, splenic vein aneurysms are so rare that a true prevalence has not been reported. Discuss mesenteric and splenic vein aneurysms.

### **GIEE-50 Ensuring High-Reliability Anatomic Evaluation for Living Liver Donors Using Multi-Contrast-Agent MRCP**

Chahine, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Living donor liver transplantation (LDLT) expands access to transplantation but has the challenges of substantial technical complexity and simultaneous risk for both donor and recipient. 2. Precise understanding of the anatomy of the central liver (biliary drainage, hepatic venous drainage, arterial and venous anomalies) and segment 4 is critical to living donor success. 3. Contrast-enhanced MRCP is used to assess anatomy but suffers from suboptimal reliability due to motion artifacts (eg, respiratory motion at MRCP, arterial phase tachypnea with gadoxetate disodium) and technical factors. 4. We implemented a multi-contrast agent MRCP imaging protocol using gadoxetate disodium and gadobenate dimeglumine to enable high-reliability imaging in the arterial phase (gadobenate) and of the bile ducts (non-contrast MRCP + gadoxetate hepatobiliary phase) and prevent the need for repeat or adjunctive imaging (eg, CTA).

### TABLE OF CONTENTS/OUTLINE

1. Background on LDLT 2. Highlight key anatomic considerations for assessing eligibility for donation 3. Targeted review of conventional single-contrast agent MRCP imaging protocols for living liver donor evaluation a. MRCP with extracellular gadolinium-based contrast material b. MRCP with gadoxetate disodium c. Single contrast agent MRCP followed by CTA 4. Demonstration of successful multi-contrast agent MRCP for assessing living liver donor eligibility a. Protocol b. Technical considerations c. Advantages d. Pictorial review e. Limitations

## GIEE-51 **MR Imaging Biomarkers: Can Aggressive Imaging Features of Hepatocellular Carcinoma Predict Early Post-Treatment Recurrence?**

Kayli Lala (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Hepatocellular carcinoma (HCC) diagnosis and management is almost exclusively imaging based without the need for pathologic confirmation. 2. Certain MR imaging features have shown to be predictive of more aggressive biologic subtypes of HCC, resulting in increased likelihood of early post-treatment recurrence and worse overall survival. 3. In order to optimally treat HCC, it is important to recognize the multifactorial etiology for tumor recurrence and/or progression including a basic understanding of the complex immunologic tumor microenvironment.

### TABLE OF CONTENTS/OUTLINE

1. Review the histopathology of HCC, including the histologic variants using a pictorial representation of the heterogeneity in the histology and biology of HCC. 2. Pictorial review of MR imaging biomarkers predictive of aggressive tumor biology. 3. Review of the hepatic and tumor microenvironment and its role in treatment response after locoregional therapy. 4. Review clinical outcomes after locoregional therapy to HCC by various locoregional modalities with an emphasis on HCC with aggressive pre-treatment imaging features by using a case-based approach. 5. Demonstrate a proposed mechanism to use various MR imaging biomarkers to risk stratify patients with aggressive versus less-aggressive HCC to reduce the chance of early post-treatment progression and improve overall management.

## GIEE-52 **Solid Pseudopapillary Tumors of the Pancreas: Old Friend, New Meme**

David A. Mata, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

This educational exhibit will depict typical image findings of solid pseudopapillary tumors (SPT) of the pancreas, with an emphasis of epidemiological, clinical, and pathological correlation. Illustrated as well are common mimics of SPT, including neuroendocrine and malignant tumors of the pancreas. A review of epidemiology and clinical features of SPT. Identify relevant Ultrasound (US), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) appearances of typical SPT. Correlate morphologic findings with Positron Emission Tomography (PET), pathologic microscopy, and gross surgical specimens. Provide key features to differentiate SPT from other retroperitoneal tumors.

### TABLE OF CONTENTS/OUTLINE

SPT are rare epithelial tumors of exocrine pancreas with low malignant potential and overall good prognosis. Mostly found in young adults and Caucasian women, these tumors are often asymptomatic but can present with abdominal pain and a palpable mass. Since there are SPT mimics, it is important to obtain clinical history and know the epidemiology of SPT. Upon diagnosis, SPT are normally large, circumscribed masses comprised of both solid, hemorrhagic, and necrotic components with no associated ductal dilation. It is important to note, smaller presenting SPT (< 3cm) often have image findings of a solid, homogenous appearance. The intralesional appearance depends on the degree of hemorrhage, calcification, tumor necrosis, or cystic degeneration. These tumors are commonly found in the body and tail of the pancreas. To avoid erroneous interpretation or delay in diagnosis, appropriate knowledge of SPT imaging patterns and presentations is required.

## GIEE-53 **Mimics of Inflammatory Bowel Disease: Not everything is Crohn's or Ulcerative Colitis**

Belinda A. Asare, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Inflammatory bowel disease (IBD; Crohn's disease and Ulcerative colitis) represents a group of diseases characterized by chronic inflammation of the gastrointestinal tract. 2. Patients frequently present with nonspecific symptoms such as abdominal pain, weight loss, diarrhea, nausea, vomiting and obstruction. 3. Various infectious and non-infectious diseases can mimic IBD including malabsorption syndromes, autoimmune diseases, drug-induced conditions, diverticulitis, appendicitis, vascular etiologies and malignancy. 4. Imaging is a crucial tool in identifying IBD mimics as it helps clinicians in making accurate diagnoses and implementing appropriate treatment strategies.

## TABLE OF CONTENTS/OUTLINE

1. Typical imaging characteristics of IBD (Crohn's disease and Ulcerative colitis). 2. Differential diagnoses of infectious causes with common imaging features and corresponding cases. 3. Differential diagnoses of non-infectious causes with common imaging features and corresponding cases.

## GIEE-54 Unveiling Internal Hernias A Comprehensive Review of CT Imaging Patterns

Patricia P. Dantas I, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is: Review peritoneal cavity anatomy with emphasis on the most common internal hernia sites. Discuss the role of computed tomography (CT) in the diagnosis and management of patients. Illustrate imaging patterns of the main types of internal hernia, highlighting the specific characteristics of congenital, oncologic and bariatric surgery cases. Identify key CT features that help differentiate open-loop from closed-loop obstruction and those that may predict ischemic injury of the small bowel loops. Recognize the main differential diagnoses and pitfalls of internal hernias, addressing diagnostic challenges. Propose an algorithm to aid in the interpretation of CT images in cases of intestinal obstruction.

## TABLE OF CONTENTS/OUTLINE

1) Introduction: epidemiology, clinical and pathophysiological aspects of bowel obstruction 2) Role of CT in the evaluation of obstructive acute abdomen, including CT protocol recommendations. 3) Review of peritoneal cavity anatomy: - Main peritoneal spaces; - Ligaments; - Normal recesses and foramina. 4) To demonstrate, through a case-based review, the imaging patterns of the following types of internal hernias: - Paraduodenal Through foramen of Winslow - Intersigmoid - Falciform ligament - Pericecal - Supravesical - Transmesenteric / Transomental - Acquired (postoperative/trauma). 5) To discuss and illustrate major complications of internal hernias: - Ischaemia - Perforation - Illustrative key points. 6) Differential diagnosis and pitfalls. 7) Relevant imaging findings that aid surgical decisions. 8) Algorithm for the diagnosis of internal hernias. 9) Conclusions and "take-home messages".

## GIEE-55 Preoperative Assessment in Pancreatic Ductal Adenocarcinoma: Understanding the Impact of Staging and Anatomical Variants on Surgical Planning

Davi D. Romao, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

It is critical to understand the radiologic features of pancreatic ductal adenocarcinoma and how they affect surgical planning. In this pictorial review, we will focus on the assessment of vascular invasion and its impact on surgical planning. We will also review the major anatomic variants associated with the vascular anatomy of the celiac trunk, superior mesenteric artery and its branches.

## TABLE OF CONTENTS/OUTLINE

1. Review of pancreatic adenocarcinoma staging 2. Assessment of vascular invasion in pancreatic adenocarcinoma 2a. Venous involvement 2b. Artery involvement 3. Anatomical variants 3a. Celiac trunk variants 3b. Superior mesenteric artery variants 3c. Venous variants 4. Surgical Technique 4a. Cephalic pancreaticoduodenectomy 4b. Distal pancreatectomy 4c. Types of venous reconstruction 4d. Celiac axis resection - when is this feasible?

## GIEE-56 Learning From Failure: Non-Target Embolization with Yttrium-90 in the Treatment of Hepatic Tumors

Andy Mew, BA (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. The role of hepatic trans-arterial radioembolization (TARE) loco-regional therapy is expanding with new applications particularly in earlier stages of disease 2. Optimized TARE workflow involves careful pre-procedural selection, peri-procedural monitoring, and post-procedural evaluation 3. Peri-procedural imaging and dosimetry allows identification of non-target intra- and extra-hepatic dose delivery as well as target dose estimation 4. Identifying potential causes of discordance between Y-90 microsphere delivery and intended target with multi-modality imaging can impact patient outcomes and may be a valuable area of future research

## TABLE OF CONTENTS/OUTLINE

1. Introduction to transarterial radioembolization (TARE) 2. Indications and approaches to Y90 radioembolization in hepatic tumors 3. Workflow and evaluation of Y90 Treatment (Pre-, peri- and post-procedural) 4. Examples of non-target delivery, complications, and clinical outcome based on peri-therapy scans 5. Potential causes of non-target delivery 6. Future directions of research

### GIEE-57 Update on Multi Energy CT Applications for Pancreatic Diseases

Yasunori Nagayama, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Multi-energy CT provides spectral-based imaging such as virtual non-contrast imaging (VNC), virtual monochromatic imaging (VMI), and material density maps, potentially facilitating the optimal lesion assessment and management for patients with pancreatic diseases. The aim of this presentation is to provide the state-of-the-art clinical applications of multi-energy CT technologies for pancreatic imaging by presenting the numerous representative examples.

## TABLE OF CONTENTS/OUTLINE

I. Principle of multi-energy CT technology II. Multi-energy CT systems III. Post-processed spectral CT imaging IV. Clinical applications of spectral imaging in pancreatic diseases A) Improved lesion delineation 1. Iso-attenuating pancreatic ductal adenocarcinoma (PDAC) 2. Incidental PDAC on routine abdominal CT 3. Staging of PDAC on routine portal-venous phase CT 4. Neuroendocrine tumor (NET) 5. Acute pancreatitis B) Spectral-based lesion characterization 1. Chronic mass forming pancreatitis vs. PDAC 2. NET vs. intrapancreatic accessory spleen 3. Local recurrence of PDAC vs. post-operative perivascular fibrosis 4. Pancreatic cyst C) Prediction of clinical outcome 1. Chemotherapy response for PDAC 2. Risk stratification for post-operative pancreatic fistula (POPF) 3. Prediction of future PDAC development D) Improve patient safety by reducing radiation dose and iodine doses

### GIEE-58 Gastrointestinal Oncologic Emergencies: A Radiologists' Guide

#### Awards

#### Certificate of Merit

Mindy X. Wang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Describe the imaging approach for evaluating oncologic emergencies affecting gastrointestinal tract.
- Identify imaging manifestations of gastrointestinal oncologic emergencies.
- Identify potential pitfalls in imaging of gastrointestinal oncologic emergencies.

## TABLE OF CONTENTS/OUTLINE

- Gastrointestinal oncologic emergencies and imaging approach
- Multimodality imaging features of gastrointestinal oncologic emergencies
  - o Intestinal obstruction
  - o Intestinal ischemia
  - o Intestinal perforation
  - o Intussusception
  - o Inflammatory/infectious changes (including superinfection of tumor necrosis/abscess formation)
  - o Graft versus host disease
  - o Tumor torsion/volvulus
  - o Peritonitis
  - o Lymphatic obstruction
  - o Vascular complications
    - § Hemorrhage (including active extravasation and intramural hematoma)
    - § Thrombosis (microangiopathy, venous and arterial thrombosis or thrombophlebitis)
    - § Arteritis
    - § Aneurysm/pseudoaneurysm
  - o Emergencies related to paraneoplastic syndrome
- Management
- Mimics and potential pitfalls

### GIEE-59 Hepatic Artery Infusion Pump: A Multi-institutional Comprehensive Case-based Review

Harit Kapoor, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) HAIP is a novel surgically placed intraarterial pharmacotherapeutic option with three salient indications: unresectable burden of colorectal liver metastases (CRLM), adjuvant therapy post CRLM resection and in unresectable intrahepatic cholangiocarcinoma (ICC).2) Post-procedure Tc-MAA SPECT are vital to ensure isolated and maximal bilobar hepatic perfusion for safe and efficacious drug delivery.3) Patient selection is multi-factorial including presence of intra- and extrahepatic disease, anatomy and patency of vasculature, hepatic function, extent of prior chemotherapy treatment, and performance status.4) All HAI devices are MRI conditional however the Medtronic SynchroMed II device is set to automatically stall while in the scanner and must be interrogated post-scan to assure the motor has restarted.5) HAIP therapy is associated with unique complications, many of which are delayed and unsuspected. Meticulous interrogation of the catheter tip position and a low threshold for further investigations on follow-up imaging can help decrease complication rates.

## TABLE OF CONTENTS/OUTLINE

1) Role of HAIP therapy for different clinical indications.2) Technical aspects of HAIP placement and trouble shooting in extrahepatic perfusion3) Expected imaging appearances of HAIP devices in both normal and variant anatomic situations4) Role, interpretation and management implications of Tc-MAA SPECT pump perfusion imaging5) Tabulated overview and Case-based examples of HAIP complications (Pump pocket-related, Catheter-related and Hepatobiliary).6) Summary

### **GIEE-6 Improving the Gall Stone Detectability by Using the Monochromatic Images with a Fast kVp-Switching Single-Source Spectral Computed Tomography: A Phantom Experiment with Gall Stone Specimen**

Tomokatsu Tsukamoto, MS, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. In the conventional polychromatic (kVp) scan mode, gall stones detectability such as the cholesterol, pigment, and rare were lower because the small difference of computed tomography (CT) value (hounsfield unit: HU).2. Nowadays, with the application of fast kVp switching single source dual energy scan, its spectral mode enables the ability to reconstruct monochromatic images at different energy level. The purpose of this study is to compare the gall stones detectability between the dual energy scan mode and conventional polychromatic scan mode during a phantom study. 3.The monochromatic display method (cine display mode and spectral HU curve) with dual energy scan mode was possible for improving the detection of various gallstones compare with the conventional polychromatic scan mode (kVp).

## TABLE OF CONTENTS/OUTLINE

CONTENT ORGANIZATION 1: Clinical case (Cholelithiasis) :MRI and CT images 2: Gall stone specimens :dual energy CT scan mode images(keV) and conventional scan mode images (kVp). 3: Spectral HU curve 4: Gall stone specimens (cholesterol): cine display mode 5: Clinical case (Cholelithiasis): performed dual energy CT

### **GIEE-60 A "Cyst"ematic Approach to Cystic Pancreatic Lesions**

Anjelica C. Abate, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The target audience of this educational activity is for all radiologists who read CT or MR imaging of the abdomen.1. Demonstrate multimodality imaging features and patterns of common cystic pancreatic lesions2. Illustrate a systematic approach to distinguishing between pancreatic cystic lesions3. Review case-based clinical management including histopathologic correlation

## TABLE OF CONTENTS/OUTLINE

Content: A systematic multi-modality imaging review of pancreatic cystic lesions will be included including an explanation for key diagnostic features, differentiation between lesions, histopathologic correlation, and review of management.The case selection includes:1. Mucinous cystic neoplasms2. Serous cystadenomas3. Solid pseudopapillary epithelial neoplasms4. Intraductal papillary mucinous neoplasms5. Cystic neuroendocrine tumors6. Sequela of pancreatitis (pseudocysts and walled off necrosis)

### **GIEE-61 Exploring the Uncommon: Lesser-Known Abdominal Syndromes and Their Presentation**

Priyanka Prajapati, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points1. Illustrate rare abdominal syndromes with clinical and radiological features.Highlight the constellation of associated findings and complications.3. Emphasize the importance of a multimodality approach when diagnosing rare abdominal syndromes.

## TABLE OF CONTENTS/OUTLINE

Table of contents1. Background2. Normal anatomy relevant to the syndromes3. Importance of Pathology, Molecular tests, Imaging, Laboratory tests4. Case based illustrations of:a)TEMPI Syndromeb)Abernethy Syndrome c)DRESS Syndrome d)Li-Fraumeni Syndrome 5. Classical clinical presentation and laboratory findings 6. Pertinent Imaging findings of the syndromes 7. Associated pathologies found 8. Other Rare Abdominal Syndromes

### **GIEE-62 Imaging Overview of Peritoneal Mesothelioma**

Suren Reddy Satti (*Presenter*) Nothing to Disclose



## TEACHING POINTS

A comprehensive overview of peritoneal mesothelioma with a focus on the histological subtypes, key distinguishing imaging features and understanding the common pitfalls involved in diagnosis.

## TABLE OF CONTENTS/OUTLINE

The aim is to improve understanding of peritoneal mesothelioma and the subtypes to aid with diagnosis and subsequent management. We present a radiological case-based review of the subtypes of peritoneal mesothelioma with accompanying histological and intra operative findings. Clinical features along with specific imaging findings for each subtype will be shown along with some pitfalls in interpretation. Subtypes of peritoneal mesothelioma: 1. Multicystic mesothelioma 2. Well differentiated papillary mesothelioma 3. Epithelioid mesothelioma 4. Sarcomatoid mesothelioma 5. Biphasic mesothelioma Mimics of mesothelioma - Lymphangioma - IgG4 peritoneal disease - Tuberculosis

## GIEE-63 Burn the Cake: The Role of HIPEC in Pseudomyxoma Peritonei

Vitor D. Bichuette, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

? To review concepts involving epidemiology, imaging findings and surgical techniques used in the treatment of pseudomyxoma peritonei (PP). ? To illustrate the use of peritoneal cancer index (PCI) to assess the peritoneal cavity. ? To review how hyperthermic Intraperitoneal chemotherapy (HIPEC) is performed, the techniques involved, indications and contraindications, and related complications. ? To discuss how radiologists can help surgeons in the management of PP.

## TABLE OF CONTENTS/OUTLINE

- Introduction - General concepts
  - o The use of CT to assess the PCI
- Pseudomyxoma peritonei:
  - o Definition, clinical presentation, imaging features and treatment.
  - o Imaging aspects of peritoneal pseudomyxoma and peritoneal carcinomatosis: how to differentiate
  - o Surgical treatment
- HIPEC:
  - o A step-by-step explanation of how HIPEC is performed.
  - o Advantages, indications and contraindications.
  - o Most common outcomes and complications.
- Case-Based Review:
  - o Sample cases explaining and demonstrating image findings of PP and how CT can be used before and after the surgery
  - o Assessment of PCI
  - o HIPEC: normal and abnormal findings
- Future Directions: new perspectives in the use of HIPEC to treat peritoneal tumors.
- Conclusion and key takeaways.

## GIEE-64 Sonazoid-Enhanced Ultrasonography: What Can We Do in Abdominal Radiology and Intervention?

Jae Woong Choi, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Sonazoid-enhanced ultrasonography (SEUS) is recently introduced contrast-enhanced ultrasonography using Sonazoid (GE Healthcare) offering the vascular phase and the unique post-vascular Kupffer phase for helping diagnose focal liver lesions (FLL). Its role has been primarily focused on differentiating benign and malignant FLLs. However SEUS can be used in diverse clinical settings such as evaluating the hepatic vasculature, and a guiding tool for interventional procedures of the liver. In conclusion, we believe that CEUS can be applied to diverse clinical settings, not only for the diagnostic purposes but also for the interventional procedures as an excellent guiding tool.

## TABLE OF CONTENTS/OUTLINE

1) Physics of SEUS, 2) Diagnostic roles of SEUS, 3) Application of SEUS in evaluation of hepatic vasculature, 4) Introduction of SEUS during liver biopsy, 5) SEUS as a guidance tool for radiofrequency ablation, 6) Tips and limitations of SEUS.

## GIEE-65 Fundamental of Pancreatic Adenocarcinoma Imaging on CT: What a Resident Should Know

Carlos M. Campana SR, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Review the anatomy of the pancreas, its vasculature and lymphatic drainage.- Illustrate the CT features of pancreatic adenocarcinoma. - Understand the staging of the pancreatic adenocarcinoma and the surgical criteria.

## TABLE OF CONTENTS/OUTLINE

- Introduction.- Anatomic considerations.- Teaching points.- CT features of pancreatic adenocarcinoma.- Case based approach.- Staging and surgical criteria.- Conclusions.

## GIEE-66 Fake Liver Lesions: Can You Help Me? An Illustrative Guide to Liver Pseudo-lesions and Tumor Mimickers

Roberta R. Sasso, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review importance of epidemiology for diagnosis of liver lesions. Illustrate clinical and imaging findings that might help distinguishing benign and malignant liver lesions. Practical tips and imaging features that could help achieve an accurate diagnosis and avoid unnecessary procedures. Highlight potential pitfalls related to different treatments that may mimic liver lesions.

## TABLE OF CONTENTS/OUTLINE

Introduction - General concepts: epidemiology of liver lesions, including risk factors, incidence, and mortality. Imaging findings on CT and MRI of several liver lesions. Liver lesions: illustrative cases of different benign hepatic lesions and pseudolesions that mimic malignant hepatic lesions. Pitfalls: expected post-treatment changes that might be confused with true lesions. Normal findings after surgery, transplant, ablation, embolization, radiation and immunotherapy are reviewed. Case-Based Review: series of cases demonstrating imaging findings of liver lesions and how different modalities can be used. Conclusion and key takeaways.

## GIEE-67 Imaging Review of Pseudomyxoma Peritonei

Ogbeide Evbuomwan, MBBS, FRCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Comprehensive radiological overview of pseudomyxoma peritonei (PMP), and its patterns of disease spread. Common appearances of appendix mucinous tumours and frequently encountered interpretation pitfalls leading to misdiagnosis.

## TABLE OF CONTENTS/OUTLINE

Diagnosis of PMP is often delayed in the non-specialist setting due to minimal exposure to appendix tumours and a lack of awareness. The aim is to improve the knowledge of pseudomyxoma peritonei and aid in the radiological diagnosis through understanding of its various aetiologies and the common pitfalls in imaging diagnosis. We present a case-based exhibit of PMP with reference to histology and intra-operative findings. To include: • Common radiologic findings at presentation, predominant patterns of disease spread and complications of PMP with key review areas when reporting. • Examples of delayed diagnosis from misinterpretation with tips and tricks to aid with accurate diagnosis. The cases include: o Primary appendix tumours, misdiagnosed as an abnormal ovary or fallopian tube. o Krukenberg tumours reported as a primary ovarian tumour. o Diffuse peritoneal disease with a primary appendix tumour (initially not identified). o Complicated appendicitis with an underlying tumour. • Other origins of pseudomyxoma other than the appendix, such as urachus and mature teratoma of the ovary. • How to optimize imaging to aid with diagnosis, utilizing positive oral contrast in computed tomography (CT) imaging of pseudomyxoma peritonei, use of MRP re-formats and MRI protocols.

## GIEE-68 Role of Radiological Imaging in the Diagnosis and Management of ERCP Complications

Mehmet Simsar, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- What is Endoscopic Retrograde Cholangiopancreatography (ERCP), and in which situations is it performed?
- What are the complications of ERCP and how often do we encounter them?
- Diagnosis of ERCP complications with the help of imaging methods. Tips for radiologists
- The importance of imaging methods in the early diagnosis of complications
- The role of imaging in management of complications

## TABLE OF CONTENTS/OUTLINE

Table of Contents • Terminology and anatomy of the bile ducts and pancreatic duct • Post-ERCP expected imaging findings • Complications of ERCP • Demonstration of pathologies in imaging methods for the diagnosis of complications • The importance of early diagnosis in case of complications and correlation of imaging finding with clinical symptoms and signs • Demonstration of possible complications with sample cases • Follow up imaging findings during the treatment process of patients with complications

Outline • Endoscopic retrograde cholangiopancreatography (ERCP) is an application that is increasingly used to treat biliopancreatic disorders. This situation leads to a rise in the number of cases with complications. • It is important to distinguish between expected findings and pathological findings in post ERCP images. • It is important to evaluate the history and physical examination together with imaging methods for early diagnosis of complications and to decrease morbidity. • Imaging methods play a guiding role in the classification of complications.

## GIEE-69 Multimodality Imaging in the Detection and Characterization of Anatomic Variants, Benign, and Malignant Conditions of the Peri-Ampullary Region

Kelvin Cortis, MD, FRCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To illustrate the conventional and variant anatomy of the ampullary and periampullary region. To provide a structured differential of the various conditions that may present at the ampullary and peri-ampullary regions. To describe the imaging



features of pathologies at these regions.

#### **TABLE OF CONTENTS/OUTLINE**

The periampullary region is an anatomically and pathologically complex region. It encompasses the pancreatic head, second part of the duodenum, pancreatico-biliary junction, and associated neurovascular structures. All these structures are within a 2cm radius from the major duodenal papilla. Familiarity with this area and its variants will increase diagnostic accuracy and recognition of associated complications, thereby guiding proper management. This pictorial exhibit will display the multimodality imaging findings of developmental, benign, and neoplastic entities that may arise at the ampullary and periampullary regions. Developmental entities include duodenal webs, pancreas divisum, pancreaticobiliary malunion, and annular pancreas. Para-duodenal pancreatitis, papillitis, Lemmel's syndrome, choledocholithiasis, and vascular abnormalities, are benign conditions that might involve the ampullary region. Neoplastic conditions that can involve the periampullary region include ampullary carcinoma, periampullary duodenal carcinoma, pancreatic tumours, distal common bile duct tumours, gastrointestinal stromal tumours, and neuroendocrine tumours. Abdominal radiologists should have a thorough anatomical understanding of the ampullary region in order to formulate a structured differential diagnosis that will lead to timely and precise diagnosis and management.

#### **GIEE-7 Anorectal Fistula - Detection, Classification, and Post Treatment Follow-up**

Joseph W. Owen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Identify and describe anorectal fistula based on the Parks classification system on MR2. Explain the options for treatment of anorectal fistula and associated complications based on their classification3. Recognize and describe the post treatment appearance of anorectal fistula and abscesses on CT and MR

#### **TABLE OF CONTENTS/OUTLINE**

The predisposing factors for development of anorectal fistula: Crohn's Disease; Prior pelvic radiation; Obstetric injuries; Infection; Foreign body insertio; MalignancyDiagnoses and characterization: MR; Exam under anesthesiaClassification of anorectal fistula with the Parks classification Inter-sphincteric; Trans-sphincteric; Supra-sphincteric; Extra-sphinctericClassification of Anorectal Abscess: Ischiorectal; Inter-sphincteric; Supra-levator; HorseshoeTreatment Abscess-Incision and drainage; Simple fistula - Primary fistulotomy; Complex fistula - Sphincter-sparing staged treatmentPost-treatment imaging appearance and characterization Seton; Endoanal advancement flap; Residual scar tissue; and inflammation; Recurrent fistula; Recurrent abscess

#### **GIEE-70 Advanced Pancreatic Imaging: 10 Tips and Tricks**

Mariana B. Peleja, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Pancreatic ductal adenocarcinoma (PDAC) and other pancreatic conditions can be very difficult to diagnose and be a real challenge even to an experienced radiologist.The purpose of this exhibit is to present, through a serie of challenging cases, the direct and indirect signs of focal and diffuse pancreatic disease, and how can the radiologist help to establish the correct diagnosis using different imaging methods, such as Ultrasound (US), Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) CT. Some of the presented tips include:- Careful evaluation of main pancreatic duct or biliary tree dilation;- Importance of the T1-weighted images to evaluate the pancreatic parenchyma;- Look for asymmetrical parenchyma atrophy;- Pay attention to abnormalities involving the surrounding vessels;- Search for secondary lesions if uncertain about malignancy (such as liver and lymph nodes).

#### **TABLE OF CONTENTS/OUTLINE**

- Cases of pancreatic neoplasms and inflammatory conditions, with subtle findings that should raise a suspicion for a pancreatic disease;- Brief Review of pancreatic anatomy with multimodality imaging;- Image assessment of PDAC, with its features spectrum and tricky findings;- Importance of imaging for staging and resectability evaluation;- Other challenging cases in pancreatic cancer imaging, which the radiologist expertise is crucial to the correct management of disease.

#### **GIEE-71 Peritoneal carcinomatosis: A Comprehensive Review of Peritoneal MRI. Primer for Residents**

Anna F. Garcia Herrmann, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Peritoneal carcinomatosis is a common metastatic manifestation in several malignancies, with a higher incidence in gastrointestinal and gynecological tumors. Imaging techniques are essential in assessing the extent of the disease and guiding treatment decisionsPeritoneal MRI is a noninvasive technique that provides high-quality imaging of the peritoneum with excellent soft tissue contrast and high spatial resolution, with no exposure to ionizing radiation. Specific imaging protocols with DCE and DWI sequences allow a better assessment of peritoneal disease, especially unfavorable sites such as mesenteric and intestinal involvement, with enhanced sensitivity for detecting small lesionsClinical applications of peritoneal MRI include diagnosis, staging, and monitoring of peritoneal metastases, with a crucial role in guiding therapeutic strategies

and prognostic utility in patients undergoing cytoreductive surgery or HIPEC. The "PAUSE" method offers a structured approach to reporting peritoneal involvement, providing a precise description of the location and extent of the disease, serving as a road map for the surgeon and facilitating surgical planning.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Peritoneal metastases and diagnostic challenges. Advantages over CT and PET/CT. Peritoneal MRI: Dedicated protocol. Clinical applications: Diagnosis, staging, and monitoring of peritoneal metastases. Advantages and limitations. The "PAUSE" method: A structured reporting tool. Case examples. Conclusions. References

### **GIEE-72 Photon-counting CT: Technical Features and Clinical Impact on Abdominal Imaging**

Hiromitsu Onishi, MD, PhD (*Presenter*) Research Grant, General Electric Company; Speakers Bureau, General Electric Company

#### **TEACHING POINTS**

The photon-counting CT system is equipped with a photon-counting detector that can measure the number of photons and the energy of each photon, allowing the acquisition of images with high spatial resolution and virtual monochromatic contrast. One of the major advantages of photon-counting CT in abdominal examinations is that it provides virtual monochromatic images with high image quality and high spatial resolution. The purpose of this presentation is: 1. To illustrate the technical features of photon-counting CT system compared with conventional CT system with energy integrating detector, 2. To introduce the effective use of photon-counting CT for the evaluation of abdominal diseases, and 3. To discuss the clinical impact of photon-counting CT on the diagnosis of abdominal diseases.

#### **TABLE OF CONTENTS/OUTLINE**

1. Technical overview of photon-counting CT; 2. Scan modes; ultra-high resolution mode, multi-energy mode, and dual source mode; 3. A variety of image reconstruction kernels; 4. Quantum iterative reconstruction algorithm; 5. High spatial resolution; 6. Valuable virtual monochromatic imaging; 7. Possibility of radiation dose reduction; 8. Scanning protocols optimized for the abdominal diseases; 9. Clinical implications for the diagnosis of abdominal diseases; 10. Summary

### **GIEE-73 Pearls and Pitfalls of Rectal MRI: The Only Stool You Need**

Hala A. Khasawneh, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Highlight essential imaging findings in staging. Illustrate essential key points and common pitfalls to serve as a guiding tool for radiologists through an interactive approach. Overview of current treatment options including surgical and nonsurgical approaches, such as "watch and wait" will be discussed.

#### **TABLE OF CONTENTS/OUTLINE**

Over the past few decades, rectal MRI has created a paradigm shift in the management options of rectal cancer by providing accurate TNM staging and restaging as well as post-treatment assessment. However, a few controversies remain in reporting TNM staging for rectal cancer which radiologists need to be aware of to provide more reproducible and standardized reporting. The benefit of rectal MRI in guiding disease management relies on obtaining high-quality scan for accurate TNM staging, assessment of Circumferential Resection Margin, Extramural Vascular Invasion, anal canal involvement and tumor relation with surrounding pelvic structures. Using an evidence-based approach, we aim to clarify controversial key points in reporting rectal MRI, including staging of T4b tumor, utilizing diffusion weighted imaging in restaging, evaluation of mucinous lesions, differentiating lymph nodes from tumor deposits, and morphological assessment and localization of lateral pelvic lymph nodes in staging and restaging. Rectal MRI is essential for tailoring treatment plans in rectal cancer. Therefore, it is paramount to have standardized and reproducible interpretation of scans to enhance consistency in disease staging.

### **GIEE-74 The Magic Eye: Advantages of Spectral CT Imaging over Conventional CT in Liver and Pancreatic Pathology**

Antonio Michael-Fernandez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To review the most important spectral CT reconstructions for abdominal imaging and the improvement in material differentiation with this technique. - To show Spectral CT imaging advantages over conventional CT through some cases of liver and pancreatic pathologies.

#### **TABLE OF CONTENTS/OUTLINE**

Background: Spectral CT is gaining increasing clinical importance with multiple potential applications including abdominal and oncology imaging. We present different cases with liver and pancreatic pathologies where spectral CT images offer multiple advantages over conventional CT, as low-energy virtual monoenergetic images and iodine maps for the detection of hyper- and hypovascularized liver lesions. The purpose of this review is to provide an overview of potential useful abdominal

applications of spectral CT focused on liver and pancreatic pathology. Details of content: We present different types of cases (such as characterization of liver and pancreatic lesions, improving vascular contrast for surgical planning or evaluation the response of tumour therapy) and review and analyze the most important spectral CT reconstructions for each case (virtual unenhanced, iodine maps and virtual monochromatic reconstructions). These reconstructions allow better detection and characterizations of findings and reduce the need for correlative or follow-up imaging. Conclusion: Spectral TC imaging offers multiple advantages in the abdominal area. The combination of different types of spectral reconstructions improves better detection and characterization of liver and pancreatic lesions. It also allows precise treatment planning and could be a potential therapy monitoring parameter.

## **GIEE-75    Going, Going, Gone: Case-Based Review of Sclerosing Hemangiomas**

Bryson Jones, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) Hepatic hemangiomas are the most common benign neoplasm encounter in the liver and most are discovered incidentally. 2) The appearance of hemangiomas may change over time and may be influenced by senescent changes of the liver or diffuse disease of the surrounding hepatic parenchyma. 3) Hemangiomas undergoing degeneration has been described as sclerosing/sclerosed, hyalinized, or thrombosed and present a diagnostic dilemma for radiologist 4) Understanding the imaging appearance and crucial importance of prior comparative imaging is key to making the diagnosis and avoiding unnecessary additional imaging and invasive procedures.

### **TABLE OF CONTENTS/OUTLINE**

I. Briefly review the classic appearance of hepatic hemangiomas, incidence and natural history, as well as illustrative pathological changes that are proposed to occur as hemangiomas sclerose. II. Propose a diagnostic algorithmic approach to a suspected sclerosing/sclerosed hemangioma. III. Provide case-based imaging examples of hemangiomas as they evolve over time, including US, CT, MRI and CEUS. IV. Provide case-based imaging example of pitfalls in attempting to prospectively diagnose sclerosing hemangiomas.

## **GIEE-76    Pitfalls of Contrast-enhanced Ultrasound (CEUS) in Liver Lesions: Early Arterial Enhancement Patterns and Washout**

Elhamy R. Heba, MD, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Understand the utility of CEUS in a patient population in which CT and MRI contrast agents are contraindicated. 2. Discuss different enhancement patterns of benign and malignant liver lesions. 3. Explain pitfalls in interpreting washout (most associated with malignancy) including understanding true intravascular nature of microbubbles contrast agent and that additional factors related to technique can lead to early bubble rupture and appearance of false washout in benign lesions. 4. Discuss possible pathophysiology of earlier rupture of the microbubbles in benign subcapsular liver lesions compared to lesions located deeper in the liver. 5. Discuss potential false positive washout scenarios in benign liver lesions on a background of hepatic steatosis due to echogenic liver parenchyma resulting in lesion appearing relatively hypoechoic compared to adjacent liver parenchyma.

### **TABLE OF CONTENTS/OUTLINE**

1. Overview: review of the utility of CEUS and mention the advantages, disadvantages and indications in liver imaging. 2. Understanding the mechanism of CEUS agent (microbubbles), explaining how that might contribute to false washout in different circumstances. 3. Different enhancement pattern of benign and malignant liver lesion with emphasis on washout as an important feature to suggest malignancy of liver lesion. 4. False washout in benign liver lesions as a pitfall of CEUS, case-based approach. 5. True washout in cases of hepatocellular carcinoma, metastases, and cholangiocarcinoma for comparison.

## **GIEE-77    Imaging Evaluation in Living Liver and Kidney Donors: What to Report**

Thamy Carvalho, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1- Illustrate the main imaging standards in the pre-transplant evaluation of live liver and kidney donors through conventional radiology images, such as computed tomography (CT) and magnetic resonance imaging (MRI), from the digital archive of our institution. 2- Improve the understanding of vascular variants (arterial and venous) and their implications in the pre-renal and liver transplant evaluation of potential living donors using a didactic approach, through illustrations. 3- Evaluation of donors' pre-transplant images, understanding the procedure and identification of anatomical variants that may interfere with the surgical technique, in addition to possible pathologies that may prevent a possible transplant. 4- Describe and prepare a structured report of the main findings that may contraindicate the candidate for transplants, in addition to assisting in the surgical technique to be performed.

## TABLE OF CONTENTS/OUTLINE

1 - Review of vascular variants, pathologies and anatomical reconstructions of candidates for pre-transplantation of live liver and kidney donors through illustrative images. 2 - Illustration of vascular variants and pathologies supported by the use of illustrative images that may imply or prevent transplantation. 3 - Preoperative knowledge of hepatic and renal vascular anatomical variants is mandatory for surgical planning and to help reduce postoperative complications. This information must pertain to the structured report. 4 - Summary and messages to take home.

### GIEE-78 The Many Faces of FNH: MRI Findings

Enzo E. Casali SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the typical presentation of FNH. Analyze uncommon MRI findings in FNH. Evaluate the importance of liver-specific contrast agents in achieving correct diagnosis.

## TABLE OF CONTENTS/OUTLINE

Focal nodular hyperplasia (FNH) is the second most common benign liver tumor after hemangioma. Magnetic Resonance (MRI) is an extremely useful tool for the diagnosis of FNH due to its high sensitivity and specificity. The correct diagnosis of FNH and its distinction from other differential diagnoses is essential because asymptomatic patients with FNH do not require treatment. FNH is classified as classic or nonclassic and MRI findings vary according to this. Lesions typically shows iso or hypointense signal on T1-weighted images, slightly hyper or isointense signal on T2-weighted images, an hyperintense central scar on T2-weighted images, an intense homogeneous enhancement during the arterial phase of gadolinium-enhanced imaging and enhancement of the central scar during later phases. Other more infrequent findings are: increase in size, T1 hyperintensity, the presence of a pseudocapsule, the appearance of multiple FNH all at once and the association with other benign liver lesions. Using liver-specific contrast agents may facilitate the diagnosis in these cases. Recognizing these different MRI patterns allows us to establish a correct diagnosis of FNH, preventing treatment in asymptomatic patients.

### GIEE-79 Abbreviated MRI Techniques for HCC Screening

Diana Kadi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. US has low sensitivity for HCC, especially in early-stage tumors, cirrhosis and obesity. 2. To improve sensitivity over US for early detection of HCC, while remaining cost-effective, Abbreviated MRI (AMRI) protocols have been developed. 3. This exhibit will review emerging concepts in AMRI-based HCC surveillance, including technical aspects, diagnostic performance, current gaps in knowledge, and future directions.

## TABLE OF CONTENTS/OUTLINE

1. Current guidelines for HCC surveillance 2. Limitations of US 3. CT and MRI a. Superior reported diagnostic sensitivity, especially for small and early HCC b. Limitations 4. Three general AMRI approaches a. Non-contrast AMRI i. Technique o T1 weighted imaging a. Low sensitivity for early-stage HCC o T2 weighted imaging a. Help differentiate suspicious/benign lesions b. Higher lesion conspicuity ii. Reporting iii. Advantages iv. Disadvantages b. Dynamic AMRI i. Technique o Pre-contrast o Arterial phase a. Assess APHE o Portal venous and delayed phases a. Washout b. Capsule ii. Reporting iii. Advantages iv. Disadvantages 5. Hepatobiliary Phase AMRI a. Technique i. Hepatobiliary phase imaging o High liver to lesion contrast ii. T2 weighted imaging o Excludes some benign lesions iii. DWI o Mixed data regarding benefit of DWI b. Reporting c. Advantages d. Disadvantages 6. Gaps and current needs a. Prospective studies are needed to implement AMRI in guidelines b. Current utilization should be in patients whose US-based HCC surveillance is compromised SUMMARY AMRI is a high-sensitivity alternative to US for surveillance of early-stage HCC in patients at risk for HCC.

### GIEE-8 Intrahepatic Cholangiocarcinoma: A Review of Current and Emerging Imaging Techniques and Treatment Options

Julia A. Saltalamacchia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Intrahepatic cholangiocarcinoma makes up a small percentage of total CCA cases, but treatment and surgical options differ from extrahepatic cholangiocarcinoma 2. Improvements in MRCP imaging and PET/MRI serve as complimentary modalities to standard MR and CT imaging for staging, problem solving, and follow up. 3. Recent developments in systemic and locoregional therapies have expanded treatment options and therapy considerations including radiation therapy, interventional oncology, expanded neoadjuvant therapies, and expanded surgical resectability (including transplantation)

## TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Intrahepatic cholangiocarcinoma work-up a. NCCN guidelines  
3. Imaging considerations a. Characteristic findings b. Mimics and pitfalls c. The emerging role of FDG PET MRI  
4. Treatment options a. General principles - locoregional and systemic options b. Chemotherapy  
1. Systemic therapy  
2. Targeted a. Transarterial chemoembolization b. Hepatic arterial infusion pump  
3. Downstaging after neoadjuvant therapy  
c. Radiation  
1. External beam radiation therapy  
2. Y-90 radioembolization (lobar and radiation segmentectomy)  
d. Surgical  
1. Preoperative considerations  
2. Patient selection  
3. Surgical options a. Wedge resection b. Segmentectomy +/- hepaticojejunostomy (HJ) c. Hepatectomy +/- HJ d. Transplantation

## GIEE-80 Role of Radiology in a Multidisciplinary Approach of Hepatocellular Carcinoma

Elissandra M. Lima, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To review international diagnostic HCC guidelines and LI-RADS with examples  
- To review the classical imaging appearance and patterns of HCC  
- To understand imaging features that correlate with favorable versus poor outcome and those associated with post-treatment response and recurrence

## TABLE OF CONTENTS/OUTLINE

1. Background  
2. When to use each imaging modality?  
3. Optimal study protocol of the liver  
4. What contrast agent to use? Hepatobiliary versus extracellular contrast agent  
5. Characterization of hepatocarcinoma nodules  
6. How to use LI-RADS?  
7. International diagnostic HCC guidelines  
8. Mimickers and Overdiagnosis of HCC: Flash-filling hemangioma, focal confluent fibrosis, intrahepatic cholangiocarcinoma, hepatic lymphoma  
9. Staging, treatment decision-making, and follow-up of HCC  
10. Evaluating beyond the liver: Common sites of extrahepatic metastasis  
11. How to select patients with HCC for liver transplantation, resection or locoregional treatment?  
12. Advanced disease: Locoregional therapies or systemic therapies

## GIEE-81 Pseudomyxoma Peritonei: Concepts, Classification, Imaging Spectrum and HIPEC

Ana Claudia V. Uski SR, MD,MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To describe and demonstrate the imaging features of pseudomyxoma peritonei in the various diagnostic modalities. To propose a systematization of the evaluation of pseudomyxoma peritonei. Contextualize the role of imaging to predict the extent and quantification of disease that may result in a more aggressive surgical approach combined with or without HIPEC.

## TABLE OF CONTENTS/OUTLINE

Peritoneal pseudomyxoma (PPM) is a clinical syndrome characterized by the accumulation of mucinous ascites in the peritoneal cavity. The most common cause of peritoneal pseudomyxoma is mucinous neoplasms in the appendix and according to the new consensus statement, PPM is classified based on the histology of the peritoneal disease and not based on the primary neoplasm. Peritoneal pseudomyxoma is classified into: acellular mucin, low-grade mucinous carcinoma peritonei (G1), high-grade mucinous carcinoma peritonei (G2) and high-grade mucinous carcinoma peritonei with signet ring cells (G3). The imaging spectrum of PPM is variable and suggestive findings include mucinous ascites, peritoneal nodules and omental. It is essential to be familiar with this pathology since accurate staging, with details of the sites affected, is essential to define therapy which may include cytoreductive surgery and hyperthermic intraperitoneal chemotherapy (HIPEC). The role of imaging is well documented and each diagnostic modality has its indications and limitations in the staging and follow-up of PPM. This review provides an updated and comprehensive summary of the histologic classification of PPM, imaging findings, and describes the role of the radiologist in the multidisciplinary setting to predict the extent and quantification of disease.

## GIEE-82 Peeking Inside the Pancreas: A Radiological Journey through Imaging of Unusual and Rare Pancreatic Tumors

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Describe the imaging approach for evaluating unusual and rare pancreatic tumors.  
2. Identify imaging manifestations of unusual and rare pancreatic tumors.  
3. Identify potential pitfalls in imaging of unusual and rare pancreatic tumors.

## TABLE OF CONTENTS/OUTLINE

1. Unusual and rare pancreatic tumors and imaging approach  
2. Multimodality imaging features of unusual and rare pancreatic tumors  
a. Primary malignant tumors:  
i. Acinar cell adenocarcinoma  
ii. Pancreatic small cell carcinoma  
iii. Pancreatic adenosquamous carcinoma  
iv. Pancreatic lymphoma  
v. Hepatoid pancreatic adenocarcinoma  
vi. Pancreatic mucinous carcinoma  
vii. Pancreatic primary lymphoma  
viii. Clear cell acinar cell carcinoma  
ix. Pancreatic carcinosarcoma  
x. Pancreatic hemangiopericytoma  
xi. Pancreatic rhabdomyosarcoma  
b. Primary tumors with malignant potential:  
i. Solid pseudopapillary tumor  
ii. Intraductal tubulopapillary neoplasm  
iii. Teratoma  
iv. Solid serous cystadenoma  
c. Secondary

Malignant Tumors i. Unusual metastases to pancreas d. Benign Tumors i. Pancreatic lipoma ii. Intraductal papillary neoplasm (IPMN) iii. Lymphoepithelial cysts iv. Focal pancreatitis 3. Mimics and Pitfalls (tumor like conditions; IgG4-RD; biliary tract tumors; duodenal tumors (duodenal dystrophy, gastrointestinal stromal tumor (von Recklinghausen), Brunner's duodenal hamartoma)

### **GIEE-83 Adding Insult to Injury: Unexpected Gastric Cancer Presentations That Can Make Radiologist's Life Difficult**

Dequitier C. Machado, DC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To demonstrate the variability in presentations of gastric carcinoma and the dissemination patterns. 2. To understand and learn how to differentiate fibrosis from disease progression and primary tumor involvement. 3. To identify recurrence in the esophagus-gastric junction 4. To illustrate the role of radiology in the differential diagnosis, staging, and surveillance of patients with gastric carcinoma.

#### **TABLE OF CONTENTS/OUTLINE**

- Gastric normal anatomy and possible secondary implant pathways . Epidemiology of gastric cancer . Variability in presentations in gastric adenocarcinoma.- Rare patterns of tumor recurrence, that we should not miss.

### **GIEE-84 The Solution is Right at Your Fingertips: Linear Probe and Improvement of US Gallbladder Evaluation**

Pilar Navarro Azurmendi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1 To analyze the benefits and limitations of linear and curved transducers used in US evaluation of the gallbladder with cine and imaging findings throughout different cases. 2 To review the most advantageous sonographic technique and knobology optimization. 3 To identify potential pitfalls in US evaluation and the technics to prevent them. 4 To assess the available tools to minimize the risk of misinterpretation in biliary pathology imaging.

#### **TABLE OF CONTENTS/OUTLINE**

1 Types of transducers used for gallbladder evaluation. Characteristics, benefits and limitations. 2 Sonographic technique and knobology optimization through cine videos and images. 3 Anatomy, useful landmarks and choice of sonographic window. 4 Ultrasound artifacts: making use of imaging artifacts to aid in diagnosis. 5 Identify potential pitfalls in gallbladder ultrasound evaluation and how to avoid them. 6 Diagnostic criteria for gallbladder wall pathologies. 7 Test your knowledge: interactive review for integration of clinical cases with imaging findings. 8 Take-home messages.

### **GIEE-85 Lymphoma: What to Expect from the Unexpected**

Fabio Yoshimura (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Lymphoma is a disease that can manifest itself in multiple ways. It is important to know the sites of involvement in its most varied forms and the possible imaging characteristics. This work aims to improve the literature with illustrated teaching cases from our department about suspicious lesions, allowing for early diagnosis and adequate follow-up.

#### **TABLE OF CONTENTS/OUTLINE**

This work aims to review with illustrated cases and their characteristic images from main abdominal organs affected by Lymphoma:- Liver;- Spleen;- Gastrointestinal tract;- Pancreas;- Kidney;- Peritoneal cavity.

### **GIEE-86 Uses, Finding, Pitfalls, and Advanced Applications in Gadoteric Acid-Enhanced MR Imaging of the Liver**

Elissandra M. Lima, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To understand the Pharmacokinetics of gadoteric acid- To review clinical applications, pitfalls and of gadoteric acid-enhanced MRI- To discuss advanced and future applications such as multiparametric liver MRI, magnetic resonance cholangiography, and liver function assessment

#### **TABLE OF CONTENTS/OUTLINE**

1. Background 2. Pharmacokinetics of gadoteric acid 3. Magnetic resonance protocol and technique: abbreviated and multiparametric protocols 4. Optimizing the workflow 5. Clinical applications of gadoteric acid-enhanced MRI: Focal nodular



hyperplasia, hepatocellular adenomas, hepatocellular carcinoma, cholangiocellular carcinoma, liver metastases, hepatic fibrosis, biliary imaging 6. Evaluation of treatment response of liver metastases 7. Gadoteric acid-enhanced MRI for staging treatment decision-making, and follow-up of HCC 8. Incidental discovery of focal liver lesions 9. Pitfalls and solutions: arterial phase limitations, hepatobiliary phase limitations, focal nodular hyperplasia, "pseudowashout", uptake in lesions other than FNH. 10. Advanced and future applications

## **GIEE-87 Bad Connections: Review of Intestinal Fistulae**

Allison Forrest, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Intestinal fistulae in the abdomen and pelvis are common and result in significant morbidity. Fistulae occur between hollow viscous organs and can occur in the setting of surgery, trauma, inflammation, and malignancy. Multiple imaging modalities are used for both initial evaluation and follow up, with selection of technique depending on the anatomy involved. Fluoroscopic evaluation is often helpful in the evaluation as it provides real-time, dynamic evaluation of fistulae and can further delineate complex anatomy in conjunction with cross-sectional imaging. Selection of route of contrast administration and catheter selection for evaluation of enterocutaneous fistulae are particularly important for successful fluoroscopic evaluation. An understanding of the spectrum of fistulae and the tools available to radiologists are critical for accurate characterization of fistulae.

### **TABLE OF CONTENTS/OUTLINE**

1. Review the pathophysiology of intestinal fistulae. 2. Provide an overview of indications and protocols for imaging evaluation of fistulae, with emphasis on fluoroscopic evaluation with cross-sectional correlation. Specific tips for evaluation of enterocutaneous, esophageal, small bowel, and colonic fistulae will be discussed. 3. Display case examples of common and uncommon intestinal fistulae, including those due to surgery, malignancy, inflammation, and trauma. 4. Review factors that are commonly implicated in delayed fistulae healing. 5. Brief overview of treatment principles and available therapies.

## **GIEE-88 Fibro-polycystic Liver Disease: What Radiologists Need to Know**

Lautaro M. Florentin, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Fibropolycystic liver disease refers to a group of different liver and biliary anomalies caused by abnormal embryologic development of ductal plates. Congenital hepatic fibrosis, biliary hamartomas, autosomal dominant polycystic disease, Caroli disease, and choledochal cysts are included in this group. Fibropolycystic liver diseases usually do not exist as single entities and can be found in combined forms. Each entity shows characteristic imaging findings, specially at computed tomography (CT) and magnetic resonance (MR). Radiologists should be familiar with this spectrum of lesions to properly guide the management of these patients.

### **TABLE OF CONTENTS/OUTLINE**

Introduction  
What is fibropolycystic liver disease?  
Embryologic development  
Congenital hepatic fibrosis  
What is? Imaging findings  
Biliary hamartomas (Von Meyenburg complex)  
What is? Imaging findings  
Autosomal dominant polycystic disease  
What is? Imaging findings  
Complications  
Caroli Disease  
What is? Caroli disease vs. Caroli Syndrome  
Imaging findings  
Choledochal cysts  
Pathogenesis controversy. Bilio-pancreatic maljunction association. Todani's Classification  
Imaging findings

## **GIEE-89 New Concepts in Staging and Treatment of Colon Cancer: What the Radiologist Needs to Know**

Amit J. Choudhari, MBBS, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Understand types of colon cancer surgeries, including multivisceral resection
- Comprehend the elements which need to be covered while reporting a clinically relevant colon cancer staging CT report
- Review the questions asked in multidisciplinary tumor boards
- Updates on the recent advances in colon cancer management
- Discuss the advantages of neoadjuvant chemotherapy prior to surgery as per recent literature

### **TABLE OF CONTENTS/OUTLINE**

- Pathophysiology of colon cancer
- Types of colon cancer surgeries and nodal resections
- Discuss common and uncommon presentations in colon cancer (extramural vascular invasion, aneurysmal dilatation, vascular involvement, tumor bowel fistula, uncommon pathologies)
- What the surgeon wants to know from the radiologist for planning surgery; e.g., a patient with ascending colon cancer with duodenal involvement can undergo colo-pancreaticoduodenectomy
- dMMR/MSI-H, ctDNA, FoxTROT, Niche-2: What they mean and why do we need to know about them

## **GIEE-9 Internal Hernia after Roux-en-Y Gastric Bypass: Clues to a Challenging Diagnosis**

Cecil G. Wood III, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Internal hernias are a complication in up to 10% of patients after Roux-en-Y gastric bypass (RYGB).
- Risk factors for internal hernia after RYGB include retrocolic technique, non-closure of mesenteric defects and amount of weight loss after surgery.
- Untreated internal hernias place the patient at risk for bowel ischemia.
- Several signs of varying sensitivity and specificity have been described for internal hernias after RYGB.
- A structured approach should be taken to assess for internal hernias in all patients who have undergone RYGB—especially those who are presenting with abdominal pain.

### TABLE OF CONTENTS/OUTLINE

- Description of RYGB procedure.
- Three types of internal hernia after RYGB: Transmesocolic, Petersen and jejuno-jejunosomy hernias.
- Incidence of internal hernia after RYGB.
- Risk factors for internal hernia after RYGB.
- Clinical presentation of internal hernias after RYGB.
- Prognosis of untreated internal hernia after RYGB.
- Treatment of internal hernia after RYGB.
- Accuracy of CT in diagnosing internal hernia after RYGB.
- CT findings of internal hernia after RYGB and their sensitivity and specificity in detecting internal hernias. All signs will be accompanied by example images and/or image stacks.
- Vascular Signs: SMV beaking sign, vascular swirl sign and hooking intestine sign.
- Mesenteric Signs: Mesenteric edema, mesenteric lymph nodes and eye of the hurricane sign.
- Bowel signs: Small bowel obstruction, right sided jejunojejunal anastomosis, mushroom sign, small bowel behind SMA, small bowel between transverse colon and stomach and clustered loops of small bowel.
- Structured approach to assessing the presence of internal hernia in patients with RYGB.

### GIEE-90 **Tips for Differentiation Between Pancreatic Ductal Adenocarcinoma with Bile duct Invasion and Cholangiocarcinoma with Pancreas Invasion**

Shintaro Ichikawa, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Both pancreatic ductal adenocarcinoma (PDAC) and cholangiocarcinoma are mostly adenocarcinomas and share common pathological features. Therefore, their imaging findings are similar, and when a mass stretching from the head of the pancreas to the distal common bile duct is found, it may be difficult to distinguish whether it is bile duct invasion from PDAC or pancreatic invasion from cholangiocarcinoma. To differentiate between the two, it may be useful to focus on whether the pancreatic or bile duct lesion is the predominant finding and whether the main pancreatic duct is dilated.

### TABLE OF CONTENTS/OUTLINE

The following tips for differentiating between PDAC with bile duct invasion and cholangiocarcinoma with pancreatic invasion are discussed along with their key imaging findings:

1. Predominant lesion Pancreatic lesions of PDAC are larger than those of cholangiocarcinoma. The range of common bile duct lesions in cholangiocarcinomas is greater than that of lesions in PDAC.
2. Double-duct sign Both the main pancreatic and common bile ducts are often dilated in PDAC, whereas the main pancreatic duct is rarely dilated in cholangiocarcinoma.

The following differential diagnoses are discussed along with their key imaging findings:

1. Ampullary masses (adenoma, adenocarcinoma, and neuroendocrine neoplasms)
2. Pancreatic groove cancer
3. Groove pancreatitis
4. Mass-forming pancreatitis
5. Sclerosing cholangitis

### GIEE-91 **Complications of Colorectal Cancer Treatment**

Kelly L. Cox, DO (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Teaching Points: Colorectal cancer remains the third most common cancer and is the second leading cause for cancer related deaths in the United States. Colorectal cancer is highly treatable and often curable with early detection. After a quick review of colorectal cancer and its most current treatment algorithms, we will take an in depth look at the complications of treatment including those related to surgery, liver directed therapy, chemotherapy and immune checkpoint inhibitors. As colorectal cancer treatment has rapidly changed in recent years, new and unexpected imaging complications of treatment must be recognized in our daily practice to direct immediate patient care and future colorectal cancer treatment.

### TABLE OF CONTENTS/OUTLINE

1. Review of colorectal cancer and its most current treatment algorithms
2. Surgical Complications
  - a. Perforation/Anastomotic Leak
  - b. Abscess
  - c. Fistula
  - d. Local recurrence with and without obstruction
3. Liver Directed Therapies
  - a. Intrahepatic artery infusion chemotherapy - biliary strictures
  - b. Radiofrequency ablation
    - i. Thermal injury
    - ii. Injury to adjacent organs
  - c. Radioembolization
4. Chemotherapy Induced Injuries
  - a. Steatohepatitis
  - b. FNH-like lesions
5. Checkpoint Inhibitor complications
  - a. Pseudoprogression
  - b. Pneumonitis
  - c. Diarrhea, enteritis and colitis
  - d. Bowel perforation
  - e. Pancreatitis

### GIEE-92 **Deep-learning CT Reconstruction in the Abdomen: Principles, Techniques, Current Practice and Future Perspective**

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1. Understanding the background and important principles of image reconstruction methods in CT with the advantages and disadvantages of each modality 2. Comprehensive review on the deep learning imaging reconstruction and why it outperforms other modalities 3. To discuss clinical impact of deep-learning CT reconstruction in abdominal imaging 4. Future perspective and implementation

## TABLE OF CONTENTS/OUTLINE

1. CT image reconstruction and deep learning a. Definition principles of CT image reconstruction b. History and advances of CT image reconstruction until now c. Common quantitative and qualitative parameters for image quality d. Explain the advantages and disadvantages of each reconstruction technique (filtered back projection, iterative reconstruction, full model-based iterative reconstruction, hybrid iterative reconstruction) 2. Deep-learning image reconstruction (DLIR) in the abdomen CT a. Understanding the basics of convolutional neural networks (CNNs) b. The role of DLIR in CT image quality improvement and noise reduction c. Factors influencing the performance of deep-learning CT reconstruction 3. Where DLIR in CT abdomen now a. DLIR algorithms available b. Current evidence and practice of deep-learning CT reconstruction in the abdomen c. Clinical impact on the diagnosis of abdominal organs diseases 4. DLIR limitations and potential future developments

## GIEE-93 Radiologic Features of Abdominal Multimodality Imaging Related to Cardiovascular Disorders

Yeju Kang, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To classify various cardiovascular disorders causing changes on abdominal multimodality imaging. 2. To comprehensively review the pathophysiology of intra-abdominal changes caused by cardiovascular disorders. 3. To present various radiologic features of abdominal multimodality imaging in patients with cardiovascular disorders.

## TABLE OF CONTENTS/OUTLINE

1. Cardiac disorders-related changes: Congestive heart failure: hepatic congestion, cardiac cirrhosis/Infective endocarditis: infection due to septic embolism, infarction, mesenteric ischemia/Atrial fibrillation: infarction, mesenteric ischemia/Valvular heart disease: hemosiderin deposition due to mechanical cardiac valve/Cardiac arrest: cardiopulmonary resuscitation-related change 2. Vascular disorders-related changes: Obstruction of the vena cava: liver cirrhosis due to membranous obstruction of inferior vena cava, hepatic neoplasm, third flow due to superior vena cava obstruction/Vasculitis: systemic lupus erythematosus, IgA vasculitis, Behcet disease, etc. 3. Cardiovascular drug-related changes: anticoagulants-related changes, anti-arrhythmic agents-related changes

## GIEE-94 Signet Ring Cell Adenocarcinomas of the GI Tract: Clinical, Radiological, and Pathological Correlation

### Awards

#### Certificate of Merit

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group; Advisor, Zebra Medical Vision Ltd; Advisor, Nano X Imaging;

## TEACHING POINTS

1 T1. To describe the key epidemiological, clinical, radiological, and pathological features of signet ring cell adenocarcinomas of the GI tract. 2. To review the specific features of gastric, colorectal, esophageal, appendiceal, and pancreaticobiliary signet ring cancers, with radiologic-pathologic correlation. 3. To illustrate linitis plastica, scirrhous tumors, and the "malignant target sign" associated with these aggressive cancers.

## TABLE OF CONTENTS/OUTLINE

- Introduction - Signet ring cell adenocarcinomas of the GI tract o Histopathological definition o Epidemiology and prognosis o The malignant target sign - Clinical-Pathological-Radiological correlation o Gastric signet ring cell adenocarcinoma (linitis plastica) o Colorectal signet ring cell adenocarcinoma o Esophageal signet ring cell adenocarcinoma o Appendiceal signet ring cell adenocarcinoma o Pancreaticobiliary signet ring cell adenocarcinoma o Metastatic signet ring cell adenocarcinoma - Concluding remarks

## GIEE-95 The Many Forms of Acute Pancreatitis

### Awards

#### Cum Laude

Maria G. Gracia Munoz, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The morphological expression of acute pancreatitis (AP) is highly variable and in its more complex forms it can be a difficult challenge for the radiologist in training to decipher. Therefore, the main objective of this paper is to present a guide for understanding the morphological classification of AP, related complications and differential diagnoses using the standardized terminology established in the revised Atlanta classification system. Other objectives are: To recognize the general clinical features of AP and the bases of the Atlanta classification system. To understand the current role of the radiologist in the diagnosis and treatment of acute pancreatitis. To emphasize the importance of the implementation of standardized reporting schemas and a well-defined lexicon into the radiology practice to facilitate accurate communication among members of a multidisciplinary team.

## TABLE OF CONTENTS/OUTLINE

Introduction. Clinical overview: diagnostic criteria, pathogenesis and etiology, disease severity and risk stratification, clinical classification according to the revised Atlanta classification (RAC): phases of evolution and severity. Imaging guidelines: how, when and why to image. General overview of the RAC system. Morphologic classification interstitial edematous pancreatitis (IEP) vs necrotizing pancreatitis (NP). Pancreatic and peripancreatic collections APFC, pseudocyst, ANC and WON. Local complications: Infection, inflammation and mass effect on adjacent organs, biliary obstruction, pancreatic duct stricture, disconnected pancreatic duct, vascular complications (hemorrhage, venous thrombosis, pseudoaneurysm). Other complications. Imaging mimics of AP.

## GIEE-96 Pseudomyxoma Peritonei and HIPEC: What Am I Missing?

Matheus M. Gomes SR, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Pseudomyxoma peritonei (PMP) is a rare and complex clinical syndrome characterized by the intraperitoneal accumulation of mucinous material, which arises from a variety of neoplasms, mainly from appendiceal mucinous neoplasm. The purpose of this exhibit is • Review the main CT and MRI imaging findings of PMP. • Recognize the most common tumor sites which may cause pseudomyxoma peritonei • Illustrate through a diagram the pathways of disease spread into peritoneal spaces • Discuss HIPEC therapy and surgery indications, different outcomes and complications • Highlight the radiologist role in decision-making in a multidisciplinary team

## TABLE OF CONTENTS/OUTLINE

1. Introduction- Epidemiology, clinical and pathophysiological aspects of pseudomyxoma peritonei- CT and MRI protocol recommendation 2. Current treatment options- To discuss for each of the following treatment modalities indications, contraindications, advantages and limitations (HIPEC, Surgical treatment and Systemic treatment)- To review through illustrative clinical cases the main CT and MRI findings of: Initial assessment of disease • Most common sites of disease • Hints at first evaluation of images • Difficult sites of resection • Potential "blind spots" Evaluation of treatment response • Disease progression • Stable disease / No evidence of disease • Response to treatment 3. "Take-home messages": To improve radiology communication with the multidisciplinary team and ensure prompt diagnosis and proper treatment of PMP, it is essential to understand the major clinical and imaging aspects of the disease and its treatment options.

## GIEE-97 Non-cirrhotic Portal Hypertension: Etiologies and Workup

Alba R. Pugliesi, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Noncirrhotic portal hypertension (NCPH), defined as elevated portal pressures in absence of advanced hepatic fibrosis, can be seen in association with multiple pre-sinusoidal, sinusoidal, and post-sinusoidal pathologic conditions. 2. Many of the aforementioned etiologies can result in liver dysmorphism (despite the absence of advanced hepatic fibrosis), resulting in incorrect diagnosis of cirrhosis.

## TABLE OF CONTENTS/OUTLINE

Introduction • Definition and review of mechanisms of portal hypertension Pre-hepatic etiologies of NCPH • Case-based review of pre-hepatic etiologies of NCPH with emphasis on chronic inflow obstruction Intrahepatic etiologies of NCPH • Case-based review of pre-sinusoidal, sinusoidal, and post-sinusoidal etiologies of NCPH. Post-hepatic etiologies of NCPH • Case-based review of post-hepatic etiologies of NCPH with emphasis on outflow obstruction and cardiac etiologies (including Fontan-associated liver disease). Architectural and morphological changes of liver • Review of non-fibrotic pathways of response to injury by hepatocytes, with focus on regenerative nodular hyperplasia Diagnostic Workup, Challenges and Pitfalls • Discussing role of biopsy, hepatic venous wedge pressure, and elastography Conclusion

## GIEE-98 Tips and Tricks for CT Optimization of the Abdomen

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The educational exhibit discusses CT dose optimization in abdominal imaging, and how it is important to reduce radiation exposure while maintaining diagnostic accuracy. Strategies for reducing radiation dose and optimizing contrast media administration, managing image artifacts and noise, and incorporating AI-based deep learning image reconstruction (DLIR) can also contribute to dose optimization. Tailoring the imaging protocol based on the clinical indication, patient age, medical history, and comorbidities is crucial for achieving the best diagnostic outcome. Advice from the experts and emphasizing the importance of staff education and collaboration in CT optimization.

## TABLE OF CONTENTS/OUTLINE

Review the background and understand the basic principles of the CT optimization in abdominal imaging  
Strategies for reducing radiation dose in abdominal CT  
Methods used to optimize the dose in abdominal CT  
Future directions of embedding AI into abdominal imaging CT optimization  
Tailoring the imaging protocol to the clinical question and patient presentation  
Factors to be considered when tailoring imaging protocol (the clinical indication, patient age, medical history, and comorbidities)  
Electing the appropriate imaging protocol for achieving the best diagnostic outcome  
Unlocking the Secrets of the CT optimization of the Abdomen: Tips and Tricks from the Pros  
a. Port injections - "How to inject like the pros"  
b. Helical pitch- "Low pitch isn't what it used to be"

## GIEE-99 Clinical Application of Artificial Intelligence (AI) in Chronic Liver Diseases Management

Mohamed Eltahir, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Understand the function of artificial intelligence (AI) in tumor segmentation. 2. Review the existing medical uses of liver segmentation. 3. Grasp the advantages and disadvantages of different methods for segmenting liver tissues. 4. Understand the imaging criteria that must be met for a liver segmentation project to be successful. 5. Explore possible future developments in liver segmentation.

## TABLE OF CONTENTS/OUTLINE

1. Brief introduction to artificial intelligence (AI). 2. Overview of different architectures used in deep learning methods. 3. Application of AI in the medical field. a new era of healthcare services. 4. Available Liver segmentation methods and techniques. 5. Advantages and disadvantages of different segmentation methods. 6. Challenges facing manual and automated liver segmentation. 7. Current uses of liver volumetry: a) assessment of response to intervention or surgery in liver malignancy. b) prediction of clinical outcomes in including disease behavior, overall survival. C) virtual surgical planning. d) prediction of future liver remnant volume after hepatectomy surgery. 8. Future directions: a) Vascular sub-segmentation. b) Radiogenomics. c) Fully automated segmental volumetry. d) Automated volumetric RECIST measurements.

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## Abstract Archives of the RSNA, 2023

GIEE-1

### **A Deep Dive into Essential Predictive Imaging Features of Abdominal Neoplasms in the Era of Personalized Therapy: Insight into the Correlation with Pathological, Molecular, and Genetic Background**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Mariko Irizato (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Recognizing imaging findings regarding the tumor microenvironment and molecular function of abdominal neoplasms is not only the key to appropriate diagnosis, but also to early prediction of treatment options and response to various therapies. This exhibit aims to provide a better understanding of the essential predictive imaging findings of abdominal neoplasms in correlation with their pathological, molecular, and genetic background, which has the potential to lead to personalized treatment strategies in the coming era.

#### **TABLE OF CONTENTS/OUTLINE**

The treatment options for abdominal malignancies have become more diverse with advances in surgery, chemo and immunotherapy, making pre-treatment risk stratification even more important. Radiologists are now required not only to diagnose but also to predict the prognosis and efficacy of treatment based on images, and to contribute to the selection of appropriate treatment. Understanding of predictive imaging findings can also help us to speculate upon the tumor microenvironment, which might be required in the future. We summarize these imaging findings for the following neoplasms; (i)HCC, (ii) Liver metastases from colorectal cancer, (iii) Pancreatic cancer, (vi) Intrahepatic cholangiocarcinoma. We also focused on the application of these findings to treatment strategies for each abdominal malignancy to explore the usefulness of these predictive findings in the era of personalized treatment.

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## Abstract Archives of the RSNA, 2023

GIEE-10

### Fibropolycystic Liver Disease: An MRI Review with Pearls and Pitfalls

All Day Room: Learning Center

Jordan LeGout, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Fibropolycystic liver disease comprises a spectrum of interrelated conditions that range from congenital hepatic fibrosis to choledochal cysts. In this exhibit we will: -Review the MRI appearance of the various fibropolycystic liver diseases and associated conditions-Highlight imaging pitfalls using real errors encountered in clinical practice-Introduce imaging pearls for the various conditions that can help arrive at the correct diagnosis-Differentiate between those conditions that are benign and incidental and those that pose risk for development of malignancy

#### TABLE OF CONTENTS/OUTLINE

I. IntroductionII. Congenital hepatic fibrosis a. Pearl: Liver morphology, segment IV hypertrophy b. Pitfall: FNH-like lesionsIII. Biliary hamartomas a. Pearl: Use high b-value diffusion to uncover lesions b. Pitfall: Polycystic liver disease, infiltrative malignancyIV. Peribiliary cysts a. Pearl: Anatomic sequences over MRCP b. Pitfall: PSCV. Polycystic liver disease a. Pearl: Use subtraction imaging b. Pitfall: Mucinous cystic neoplasmVI. Caroli Disease/Syndrome a. Pearl: Different degrees of involvement (diffuse vs. segmental) b. Pitfall: Recurrent pyogenic cholangitis VII. Choledochal cysts a. Review appearance of subtypes b. Pearl: Field defect and risk for cholangiocarcinoma c. Pitfall: Age related and cholecystectomy related ductal dilation

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## Abstract Archives of the RSNA, 2023

GIEE-100

### Post-neoadjuvant MRI Changes and Challenges in Rectal Adenocarcinoma: What to Look for

All Day Room: Learning Center

Mayra V. Soares, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To understand the pivotal role of MRI in the post-neoadjuvant restaging of rectal cancer. To highlight the main imaging changes in post-neoadjuvant MRI, which reflect histopathologic changes that may occur after chemoradiation treatment. To recognize how fibrosis or increased mucin production, addressed by high-resolution MRI, impacts risk stratification post-neoadjuvant therapy. To learn about some challenges in MRI morphological and DWI evaluation regarding new treatment options. Understand the role of radiologists as part of patient care, helping to enroll patients eligible to "watch-and-wait" programs.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Primary tumor and nodal assessment with MRI. Rectal cancer treatment guidelines overview. When neoadjuvant treatment is the best approach. Neoadjuvant treatment options: CRT x TNT. Recognizing tumoral changes after CRT  
Posttreatment changes in the primary tumor - a systematic approach  
Tumor Restaging: a response classification based on histopathologic and DWI changes  
Patterns of tumor response  
MRI tumor regression grades - a risk stratification  
incomplete/poor x "near-complete"/complete responders  
"Watch-and-wait": patient selection and current controversies.  
Immunotherapy - the new kid on the block  
Future considerations: potential biomarkers in rectal cancer and game-changer?  
Conclusion.

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## Abstract Archives of the RSNA, 2023

GIEE-101

### Getting Started in Bariatric Surgery Imaging: Postoperative Anatomy and Complications

All Day Room: Learning Center

Jorge O. Ibarra Chairez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review postoperative anatomy changes in bariatric procedures. Discuss the approach to postoperative evaluation. Identify imaging findings of common bariatric surgery complications.

#### TABLE OF CONTENTS/OUTLINE

Background. Eligibility criteria. Types of bariatric surgery and techniques. Postoperative evaluation. Cased based review of common postoperative complications. Imaging findings in weight regain and insufficient weight loss after bariatric surgery.

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## Abstract Archives of the RSNA, 2023

GIEE-103

### **Beyond TNM Staging System: Evaluation of Colon Cancer Prognostic Factors by CT and MRI**

All Day Room: Learning Center

Ruggeri B. Guimaraes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the diagnostic accuracy of CT and MRI for staging colon cancer. To define locally advanced colon tumors. To enumerate colon cancer prognostic factors and critical information that should be present in radiological reports in this context.

#### **TABLE OF CONTENTS/OUTLINE**

1 - Anatomic considerations of colon and retroperitoneal surgical margin 2 - TNM Staging of colon cancer 3 - Colon cancer prognostic factors (primary tumor extramural extension, retroperitoneal surgical margin involvement, extramural vessel invasion, and lymph node metastases) 4 - Locally advanced colon tumors 5 - Current treatment of colon tumors 6 - Promising treatment (neoadjuvant systemic therapy) 7 - Role of imaging in stratification of patients with colon cancer according to their risk group, contributing to better patient selection and optimization of colon cancer treatment

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## Abstract Archives of the RSNA, 2023

GIEE-105

### Tricks and Pitfalls of Multi-parametric MRI Restaging of Rectal Cancer After Preoperative Chemoradiotherapy

All Day Room: Learning Center

Giovanni Sussan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To describe the MRI protocol for rectal cancer evaluation after preoperative chemo-radiotherapy (pCRT), dealing also with the debated practices  
2. To describe the correct evaluation and the most common pitfalls of T staging after chemoradiation, using both DWI and contrast-enhanced sequences  
3. To describe the correct evaluation and the most common pitfalls of N staging after pCRT, including the MRI evaluation of the lateral pelvic lymph nodes  
4. To describe the other fundamental features that should be reported while evaluating an MRI for rectal cancer restaging (such as Mesorectal Fascia/peritoneal reflection involvement, Extramural Vascular Invasion [EMVI], etc.)

#### TABLE OF CONTENTS/OUTLINE

1. Protocol of study  
2. Localization and Reported Template tips  
3. ycT staging MRI evaluation  
4. mrTRG evaluation of the primary lesion  
5. ycN staging MRI evaluation  
6. Mesorectal fascia (MRF) involvement  
7. Peritoneal Reflection involvement  
8. EMVI  
9. Tumor deposits

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## Abstract Archives of the RSNA, 2023

GIEE-107

### **Primary Hepatic Neuroendocrine Neoplasm (PHNEN) and Neuroendocrine Liver Metastasis (NELM): Imaging Update and Management**

All Day Room: Learning Center

Kedar G. Sharbidre, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points Primary hepatic neuroendocrine neoplasms (PHNENs) are rare heterogeneous neoplasms arising from the intrahepatic neuroendocrine cells, ectopic pancreatic or adrenal tissue in the liver. Imaging appearances of these tumors are rarely been reported. Neuroendocrine liver metastases (NELM) are more common arising from gastro-enteropancreatic primary and are heterogeneous in clinical presentation and prognosis. After reviewing this exhibit, the learner will be able to:

1. Understand the basic pathophysiology of PHNENs and NELMs.
2. Understand the imaging diagnosis of these tumors and common differentials.
3. Get a basic understanding of principles of management of these tumors.
4. Imaging of Post-operative complications of liver directed therapy

#### **TABLE OF CONTENTS/OUTLINE**

A. Pathophysiology of PHNENs and NELMs B. Clinical and biochemical assessment. C. Imaging protocol for liver disease. D. Common and uncommon imaging appearance with CT, MRI and PET-CTs E. Updated management guidelines F. Assessment of post treatment complications

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## Abstract Archives of the RSNA, 2023

GIEE-108

### CT Imaging of Peritoneal Carcinomatosis and Its Mimics: Pictorial Review

All Day Room: Learning Center

Irune Perez Arroyuelos (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Multidetector computed tomography (MDCT) is the most commonly used technique for the detection of peritoneal carcinomatosis and for the evaluation of the extend of the disease. The objectives of this study are: 1) Review the pathophysiologic mechanism of the tumor spread and the most common sites and forms of peritoneal involvement 2) Assessment of the peritoneal cancer index (PCI) that provides important information for the surgical planning 3) Illustrate a wide variety of tumorous and inflammatory conditions that can occur in the peritoneal surface and mimic peritoneal carcinomatosis

#### TABLE OF CONTENTS/OUTLINE

Representative cases of peritoneal carcinomatosis and its mimics are illustrated in this exhibit, grouped according the following headings: 1) Anatomy of the peritoneum and the physiology of circulation and resorption of peritoneal fluid 2) CT imaging findings and patterns of peritoneal carcinomatosis 3) Peritoneal cancer index 4) Mimics of peritoneal carcinomatosis including tuberculous peritonitis, peritoneal lymphomatosis, pseudomyxoma peritonei, primary peritoneal mesothelioma, sclerosing peritonitis, fat saponification, leiomyomatosis 5) Take home points.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-109

### Facing the 'Celiac Iceberg': What Role can Cross-sectional Imaging Play

All Day Room: Learning Center

Xinyue Wang (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

As a condition described as 'celiac iceberg', celiac disease (CD) remains underdiagnosed and undertreated. Radiological evaluation of CD deserves more attention because cross-sectional imaging is helpful in clinical management of CD, including disease diagnosis, complications identification, treatment response evaluation, and prognostic prediction, which should be considered the examination of choice in patients suspected of having CD. The purpose of this exhibit is: 1. To introduce the challenges of diagnosis and treatment in CD; 2. To introduce what role of cross-sectional imaging can play in CD; 3. To introduce the imaging features of CD and its complications;

#### TABLE OF CONTENTS/OUTLINE

-The profile of CD and the challenges facing  
Role of cross-sectional imaging in CD- Disease diagnosis- Complications identification- Disease activity and severity evaluation- Treatment response evaluation- Prognostic prediction  
Imaging features of CD- Jejunoleal fold pattern reversal- Mesenteric vascular engorgement - Enlarged mesenteric lymph nodes- A decreased size of spleen- Small bowel wall thickening- Diffusely dilated bowels with excess fluid or gas- Intramural fat deposition  
A complication of CD: Mesenteric lymph node cavitation syndrome- Imaging features of mesenteric lymph node cavitation syndrome - Enlarged mesenteric lymph nodes that contain fat-fluid levels

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-11

### Unveiling the Mysteries of Pancreas Transplantation through Imaging

All Day Room: Learning Center

Lucas O. Madeira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understand the clinical relevance, indications, and surgical techniques of pancreas transplantation. Learn about the role of multimodality imaging (US, CT, MRI and CEUS) in the assessment and management of pancreas transplantation.

#### TABLE OF CONTENTS/OUTLINE

Introduction: an overview  
Clinical importance of pancreas transplantation  
Epidemiology: United States and Global context  
Pancreas transplantation: surgical aspects  
Types of pancreas transplant: indications and outcomes  
Surgical techniques: arterial anastomosis, enteric drainage of exocrine secretions and venous anastomosis  
Multimodality imaging assessment of pancreas graft recipients  
US, CR and MRI: advantages and limitations  
Graft's normal appearance  
Complications: a case-based review  
Early versus late complications  
Rejection: radiological-pathological correlations  
Perspectives  
Artificial intelligence and novel imaging techniques  
Contrast enhanced ultrasound (CEUS): focus on graft's perfusion and rejection  
Take home messages

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-110

### Abdominopelvic Actinomycosis

All Day Room: Learning Center

Yong-Soo Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review microbiological and clinical features of actinomycosis this may involve the abdominopelvic organs. To illustrate various CT features of actinomycosis involving abdominopelvic organs.

#### TABLE OF CONTENTS/OUTLINE

Actinomycosis is a chronic inflammatory disease which can involve a variety of human organs. This disease commonly occurs in three distinct forms; a cervicofacial form, an abdominopelvic form and a thoracopulmonic form. After penetrating through the mucosal barrier, the route of propagation is direct spread to adjacent tissue. The aggressive nature of infiltration of actinomycosis may be confused with neoplasm and other inflammatory diseases, especially tuberculosis or fungal infection. Various abdominal organs may be infected by actinomycosis. Abdominal infection has been associated with abdominal surgery, such as appendectomy, or a perforation of the intestinal mucosa; a rupture of appendix, diverticulitis, foreign body perforation of the transverse or sigmoid colon, peptic ulcer. Pelvic actinomycosis may be associated with any type of intrauterine contraceptive device or with an intra-abdominal portal entry. Abdominal actinomycosis can present as an abscess or as a mass that is often fixed to the underlying tissue, as a sinus tract with drainage, perirectal or perianal disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-111

### **Comprehensive Image-based Overview Of Percutaneous Enteral Access**

All Day Room: Learning Center

Opeyemi Obiwumi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Image-guided percutaneous enteral catheters offer a minimally invasive alternative to endoscopic or surgical techniques to provide patients access for important nutrition and medication administration. This exhibit discusses the indications, contraindications, techniques, and peri-procedural management of image-guided percutaneous gastrostomy, gastrojejunostomy (including AbbVie PEG-J pull-type technique for Duopa infusion), jejunostomy, and transesophageal gastrostomy.

#### **TABLE OF CONTENTS/OUTLINE**

- Pre-Procedural Considerations
- Indications/Contraindications for percutaneous enteral catheter placement
- Image-guided technique for percutaneous gastrostomy/gastrojejunostomy
- Image-guided technique for percutaneous jejunostomy
- Image-guided technique for percutaneous transesophageal gastrostomy
- Image-guided technique for percutaneous pull-type AbbVie PEG-J
- Post-procedural evaluation and complication management

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-112

### Duodenal Diseases: Illustrated Cases for Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Manuel Sebastian S. Paez Alvarez SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To provide a comprehensive, illustrative guide for diagnosing duodenal diseases in radiology practice. To review and emphasize the imaging characteristics of various duodenal pathologies on CT studies. To highlight the importance of recognizing subtle findings and common anatomical anomalies for accurate diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Duodenal diseases encompass a broad spectrum of conditions that can originate in the duodenum or result from processes involving neighboring organs. This exhibit aims to educate radiologists on various duodenal pathologies, emphasizing illustrative cases through CT studies. Introduction: Overview of duodenal diseases and their significance in gastrointestinal imaging. Congenital anomalies. Inflammatory diseases. Neoplastic diseases. Vascular pathologies. Iatrogenic complications involving the duodenum. Other duodenal entities and pathologies. Conclusion. In this educational exhibit, we will provide a thorough understanding of the duodenum's anatomy and various diseases, emphasizing the importance of recognizing subtle imaging findings in the context of duodenal pathology. This resource will serve as a valuable guide for radiology residents and radiologists seeking to improve their diagnostic skills in abdominal CT imaging.

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## Abstract Archives of the RSNA, 2023

GIEE-114

### **Infiltrative Hepatocellular Carcinoma: Challenging Cases and Its Benign Mimics**

All Day Room: Learning Center

Elhamy R. Heba, MD, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Various histopathologic and morphologic subtypes of hepatocellular carcinoma (HCC) are described throughout the literature. Among all these subtypes, the infiltrative appearance of HCC presents unique challenges in detection, both clinically and radiographically. Infiltrative appearance of HCC is characterized by diffuse permeative spread throughout the liver parenchyma, without forming a mass-like lesion, in a manner that sometimes it is difficult to detect on a background abnormal liver parenchyma. Radiologist must distinguish the infiltrative pattern of HCC from processes that may mimic such as: confluent fibrosis, diffuse fat or iron deposition, diffuse metastatic disease, cholangiocarcinoma, and hepatic microabscesses.

#### **TABLE OF CONTENTS/OUTLINE**

1. Incidence and prevalence of infiltrative HCC
2. Review imaging features of infiltrative HCC, including multimodality case-based review of typical and challenging cases of infiltrative HCC with pathological correlation
3. Discussion of Tumor in vein as a common imaging feature of infiltrative appearance of HCC
4. Mimics of infiltrative appearance of HCC including confluent fibrosis, diffuse fat/iron deposition, diffuse metastatic disease, cholangiocarcinoma, and hepatic micro abscesses
5. Review of prognosis, management and post treatment imaging of infiltrative appearance of HCC

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## Abstract Archives of the RSNA, 2023

GIEE-115

### Autoimmune Diseases of the Liver and Biliary Tract

All Day Room: Learning Center

#### Awards

##### Cum Laude

Cody M. Anderson, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understand mechanisms behind self-tolerance and autoimmunity  
Review spectrum of autoimmune disorders of the liver and biliary tract  
Review the typical and atypical imaging appearance of autoimmune liver and biliary disorders on CT And MRI.

#### TABLE OF CONTENTS/OUTLINE

Autoimmune disorders involving liver and biliary tract can be broadly classified into  
Autoimmune hepatitis (AIH)- Type 1 and Type 2  
Primarily biliary cholangitis (PBC)  
Large duct and small duct primary sclerosing cholangitis (PSC)  
Overlap syndromes: AIH+PBC; PBC+PSC; AIH+PSC  
IgG4 sclerosing cholangitis  
Drug-induced autoimmune injury  
Liver involvement in systemic autoimmune disorder (SAD)  
Diagnostic approach  
Role of MRCP in the diagnosis of autoimmune biliary disorders  
Illustration of imaging findings of AIH  
Heterogeneous enhancement of parenchyma  
Periportal edema  
Normal MRCP  
Responsive to steroids  
PBC  
Lace-like fibrosis  
"Periportal halo" sign  
Portal lymphadenopathy  
Normal MRCP in the early stage  
gt pruned tree appearance in later stage  
PSC  
Predilection for peripheral intrahepatic ducts  
Beaded appearance of ducts on MRCP  
High risk of perihilar cholangiocarcinoma  
Small duct PSC  
Normal MRCP  
Typical PSC histology  
IgG4 disease  
Circumferential thickening  
Predilection for extrahepatic and hilar ducts  
Drug-induced (biologic agents)  
Appropriate clinical context  
Rapid progression  
Systemic autoimmune disorder  
Immune-mediated hepatitis may be seen in systemic lupus erythematosus and rheumatoid arthritis

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## Abstract Archives of the RSNA, 2023

GIEE-116

### **Gastrointestinal Pharmacoradiology: Updated Review of the Indications, Pharmacodynamics, and Adverse Effects of Bowel Preparation Agents, Gastrointestinal Contrasts and Motility-Modifying Medications**

All Day Room: Learning Center

Alberto I. Carbo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of the exhibit is: • To review the liquid diet and different cathartics used for bowel preparation including their pharmacodynamics, mechanisms of action, dosage, contraindications, precautions and adverse reactions. • To address patients' frequent questions about bowel preparation before radiologic examinations. • To explain the chemical characteristics and non-active component of the enteric contrast agents used for fluoroscopic, CT and MRI examinations. • To discuss the indications, pros and cons, concentrations, contraindications of enteric contrast, and strategies to prevent adverse reactions and mitigate legal consequences. • To review motility-modifying agents used to optimize GI tract imaging, including their common indications, mechanisms of action, administration route, dosage, peak action, risks, and contraindications. • To describe sedative agents used for intubation.

#### **TABLE OF CONTENTS/OUTLINE**

AGENTS USED FOR: Bowel preparation • Liquid diet • Action mechanisms of cathartics • Saline osmotic cathartics: magnesium citrate • Stimulant cathartics: bisacodyl GI tract endoluminal contrasts for • Fluoroscopic exams: barium sulfate, iodinated water-soluble contrasts, gas. • CT studies • MRI examinations Motility modifiers of GI tract • Antiperistalsis/hypotonia: glucagon, Buscopan • Prokinetics: metoclopramide Mild sedation • Benzodiazepines Topical anesthesia • Lidocaine Lubricants for intubation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-117

### Oh No, I Thought It Was a Hemangioma!!!

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Matteo Bonatti, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Liver hemangiomas are frequently encountered during imaging studies and have peculiar features on US, CEUS, CT and MRI.- Various benign and malignant liver lesions may show imaging features resembling hemangiomas.- At US, echogenic liver lesions are not always hemangiomas, particularly in cirrhotic patients and in patients with known malignancies: CEUS might be helpful as a quick problem-solving technique in these cases.- Contrast enhancement pattern must be accurately evaluated: centripetal enhancement alone might be misleading if not associated with globular pattern. - On MRI, hemangiomas must show "fluid-like" T2-hyperintensity; moderately T2-hyperintense lesions are almost never hemangiomas.- Always have a look to ADC values.- Hemangiomas do not have perilesional nodules.- Hemangiomas may slowly grow over time

#### TABLE OF CONTENTS/OUTLINE

To briefly review the typical imaging features that hemangiomas must show on US, CEUS, CT and MRI in order to confidently diagnose them.To show a series of liver hemangioma mimickers (e.g. mass forming intrahepatic cholangiocarcinoma, angiosarcoma, neuroendocrine tumor metastases, colorectal tumor metastases, mucinous tumor metastases,?) on various imaging modalities. For every case the misleading feature(s) will be highlighted.

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## Abstract Archives of the RSNA, 2023

GIEE-119

### Imaging in Pancreas Transplantation: Conventional and Novel Approaches

All Day Room: Learning Center

Jordan K. Swenson, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Pancreas graft location and vascular anatomy are unique and must be understood for radiologic evaluation-Ultrasound, CT, MRI all play roles in graft evaluation- Contrast enhanced ultrasound (CEUS), novel MRI techniques, graft biopsy, and alternative transplant approaches all may be part of comprehensive patient care

#### TABLE OF CONTENTS/OUTLINE

-Indications for pancreas transplant- Review of expected surgical technique / post surgical anatomyo Correlation with intra-operative pictures can assist- Rationale for pancreas graft imaging ; how does radiology make a differenceo Graft parenchymal and vascular evaluationo Graft environment+Fluid collections, bowel obstruction, enteric anastomosis evaluation- Advances in Ultrasoundo Grayscale, Doppler, CEUSo CEUS novel techniques identify vascular insufficiency in grafts and change surgical managemento CEUS used to follow rejection over time- CTo Multiphase CT evaluation for graft and vesselso Examples of common pathology (vascular, pancreatitis, bowel complications)- Standard and investigational MRIO Evaluation for fluid around graft, may assess vessels with or without angiographyo Evaluation with gadolinium-based as well as iron-based contrast agents- Biopsy Image guided percutaneous approach- Alternate transplant approacheso Islet cell transplanto Composite transplant

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## Abstract Archives of the RSNA, 2023

GIEE-12

### **A Primer for Pancreatic Head Pathologies- What the Surgeons Want to Know at the Multidisciplinary Conference**

All Day Room: Learning Center

Kazi A. Irfan, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the malignant and benign solid lesions in relation to the pancreatic head and their imaging appearance2. Differentiation of the cystic pancreatic lesions and approach to their differential diagnosis3. Discuss the NCCN guidelines for the assessment of vascular involvement to ascertain resectability4. Illustrate the surgical technique of Whipple's procedure5. Enumerate the important anatomical variants in the celiac and superior mesenteric arteries which would alter the surgical technique6. Provide a roadmap to distinguish normal post operative changes from tumor recurrence

#### **TABLE OF CONTENTS/OUTLINE**

-Imaging appearance of mass forming lesions involving the pancreatic head\*Primary malignancies\*Metastases\*Neuroendocrine tumors\*Benign lesions\*Mass forming chronic pancreatitis-Multidisciplinary approach in the diagnosis and management of the solid lesions-Role of imaging in staging and assessment for surgical resectability-Different cystic lesions involving the pancreatic head\*IPMN\*Serous cystadenoma\*Mucinous cystadenoma\*Pseudocyst-Imaging evaluation to differentiate between the cystic pancreatic lesions-Multidisciplinary approach in the diagnosis and management the cystic pancreatic lesions- Indications of Whipple's surgery and the surgical technique- Review the anatomical variants of significance involving the celiac and superior mesenteric vasculature-Multidisciplinary approach in assessment of local tumor recurrence and distant metastases

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## Abstract Archives of the RSNA, 2023

GIEE-120

### Deep Learning Reconstructions in the Abdomen: An Update

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Corey T. Jensen, MD (*Presenter*) Research Grant, General Electric Company

#### TEACHING POINTS

- DLR markedly reduces image noise and preserves image texture
- Increasing evidence suggests significant capacity for radiation dose reduction of 46-61% compared to hybrid IR
  - o Including for low contrast > 5mm liver lesion detection task
  - o Limited evidence suggests less aggressive dose reduction for lesions < 5mm
  - No free lunch
  - o Next gen DLR algorithms will address mild loss of high spatial frequency information in clinical images

#### TABLE OF CONTENTS/OUTLINE

- Reconstruction Background - how did we get here?
  - o Reconstruction history
  - o Iterative recon (IR) limitations
  - o Unique QA issues for IR
  - o Case examples
- What is DLR?
- Phantom Evidence Update
- Clinical Evidence Update from Literature Review
- DLR Implementation
  - o Assessing your practice baseline
  - o Determining intended clinical tasks
  - DLR pitfalls
  - Conclusion

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## Abstract Archives of the RSNA, 2023

GIEE-121

### **Rectum, Set, Go: A Radiologist's Perspective of a New NAPRC Accredited Multidisciplinary Rectal Cancer Tumor Board at a Large Cancer Center**

All Day Room: Learning Center

Harshna V. Vadvala, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. NAPRC offers standardized, risk-adapted management of rectal cancer, while Rectal Cancer Multidisciplinary Teams (RC-MDT) provide structure and resources for accreditation and compliance. 2. Radiologists will learn NAPRC standards which involve utilizing synoptic reporting formats for 95% of all staging MRI exams, having 90% of pre-treatment MRI exams read by RC-MDT member radiologists, and fulfilling minimum attendance requirements. 3. Radiologists are key members of RC-MDT, meeting at least bimonthly with surgeons, pathologists, radiation oncologists, and medical oncologists. Uniform MRI image acquisition and interpretation, along with standardized reporting, are crucial for effective staging.

#### **TABLE OF CONTENTS/OUTLINE**

A) Requirements for NAPRC-accredited RC-MDT 1. Multispecialty services and program management 2. RC-MDT meeting structure a. Radiologist's requirements i. American College of Radiology (ACR) education module ii. Radiologist's mandatory presence for all meetings with individual attendance requirements iii. Internal record review to audit MR exams iv. Measures of compliance for synoptic reports B) RC-MDT member radiologist's contributions 1. Radiologists read 90% of pre-treatment staging MRI exams. 2. Post-treatment restaging and tumor regression grading (TRG) 3. Surgical planning 4. Surveillance C) MR Rectal cancer exams 1. Technical uniqueness of acquisition 2. Imaging features of local disease 3. Standard synoptic report used in 95% of staging MR exams 4. Prediction of local recurrence and metastasis D) Secondary initiatives 1. Rectal cancer education program and goals of care 2. Data management 3. Quality improvement

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## Abstract Archives of the RSNA, 2023

GIEE-122

### CRS (Cytoreductive surgery) + HIPEC or PIPAC: The Radiologist Verdict

All Day Room: Learning Center

Raquel Acosta Hernandez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The therapeutic management of peritoneal carcinomatosis (PC) and pseudomixoma peritonei (PMP) requires an assessment in multidisciplinary committees. The radiologist must report where each tumor burden is addressed using the a) PCI (peritoneal carcinomatosis index), b) presence of distant secondary disease (extraperitoneal) and c) tumor implants location in "danger zones" that would condition an incomplete CRS (Cytoreductive surgery). Not only the extent of the disease must be taken into account, but also other patients' individual factors and comorbidities as well as the resources available in each center. Multidisciplinary interaction constitutes the main pillar for a correct selection of patients who are candidates for CRS and subsequent intraperitoneal chemotherapy or, given the risk of incomplete CRS, consideration of other possibilities innovative palliative therapies, such as PIPAC.

#### TABLE OF CONTENTS/OUTLINE

Review the first peritoneal carcinomatosis (CP) evaluation approach: a) PCI (Peritoneal cancer index) b) Implant zones due to peritoneal fluid stasis. c) Implant zones: "Key locations" and d) Ascites and e) Extraperitoneal disease. Illustrate the "danger zones" and unfavourable tumor implants location: beyond the first CP check-points. Update of pseudomyxoma peritonei (PMP): a misunderstanding and controversial disease. Analyze the different types of treatment (surgery, HIPEC and PIPAC): assessment in multidisciplinary committees and focus on the role of radiologist in multidisciplinary committees.

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## Abstract Archives of the RSNA, 2023

GIEE-123

### Pre-operative Evaluation in Living Donor Liver Transplantation: A Roadmap for Radiologist

All Day Room: Learning Center

Hande Ozen Atalay, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Liver transplantation is the most effective treatment for liver failure. Because the number of cadaveric donors is not enough considering the high demand, the number of living donor liver transplantations (LDLT) has been on the rise, and right lobe transplantation accounts for 70 % of all LDLT. In pre-transplant imaging, there are many important issues that should be evaluated and noted in the report. Radiologists play a pivotal role in a transplantation unit and surgical planning. In the pre-operative evaluation of LDLT, choosing the appropriate liver segment for the recipient (right lobe, left lateral segment, etc.) and evaluating the liver in the donor candidate in terms of parenchymal lesions and diseases constitute the initial steps. The liver segmentation should next be done; the total liver volume and the volume of the liver segment to be transplanted are calculated. This step is essential for avoiding small-for-size syndrome in the recipient as well as liver insufficiency in the donor candidate. Recognition of vascular and biliary anatomical variations is critical because certain anatomical variations are accepted as contraindications to LDLT and may cause post-operative ischemia in the donor and recipient. To conclude, radiologists must be aware of their crucial role in the pre-operative imaging of LDLT.

#### TABLE OF CONTENTS/OUTLINE

-Living donor liver transplantation (LDLT) definition, types, and indications-Liver parenchymal evaluation, segmentation, and volume rendering-Important vascular and biliary variations in the LDLT-Contraindications of the right lobe and left lateral segment LDLT-Important issues to be noted in the pre-transplant radiological report -Conclusion

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## Abstract Archives of the RSNA, 2023

GIEE-124

### **Gelatinous Jigsaw: A Pictorial Review of Mucinous Cystic Pancreatic Neoplasms**

All Day Room: Learning Center

Milin N. Rana, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The goal is to educate the audience in recognizing the multi-modal imaging features of mucinous cystic pancreatic neoplasms (MCPN), with an emphasis on their clinical and pathological correlation. We will also characterize morphological features of different pancreatic cystic lesions and elucidate the imaging and histopathologic features of MCPN subtypes including mucinous cystadenoma, mucinous cystadenocarcinoma and intraductal papillary mucinous neoplasm (IPMN).

#### **TABLE OF CONTENTS/OUTLINE**

Mucinous cystic pancreatic neoplasm (MCPN) clinical overview Epidemiology Pathophysiology Classifying non-neoplastic and neoplastic MCPN subtypes Review MCPN multi-modal imaging features on Ultrasound (US), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) Imaging and histologic features of Mucinous Cystadenoma Imaging and histologic features of Mucinous Cystadenocarcinoma Key features of differentiating Intraductal Papillary Mucinous Neoplasm (IPMN) and its subtypes Treatment and Prognosis

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## Abstract Archives of the RSNA, 2023

GIEE-125

### CT Guided Gastrostomy Placement: An Alternative Approach without Placement of Nasogastric Tube

All Day Room: Learning Center

Mohanad Kurdi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Computed Tomographic (CT) guided gastrostomy tube (G-tube) placement is an alternative to fluoroscopic techniques. CT guided G-tubes forego the placement of a nasogastric (NG) tube as insufflation of the stomach is performed via anterior abdominal wall percutaneous access. NG tubes cause a variety of problems, including patient discomfort, challenging placement, premature removal and malplacement. Cross sectional imaging allows for a global view of intra-abdominal structures, with more accurate localization of soft tissue structures. Compare and contrast CT and fluoroscopic guided techniques with pitfalls of both.

#### TABLE OF CONTENTS/OUTLINE

Background  
Indications and Contraindications  
Gastrostomy Tube Placement Techniques  
Disadvantages of Nasogastric Tubes  
CT Guided G-Tube Overview  
Technical Considerations  
CT versus Fluoroscopy  
Our Experience  
Discussion  
References

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## Abstract Archives of the RSNA, 2023

GIEE-126

### **Worry or Go with the Flow: Perfusion Anomalies and Vascular Disorders of the Liver - A Primer for the Radiologist**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Grant E. MacKinnon, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understanding the imaging appearances and physiology of transient hepatic attenuation differences (THADs) on CT and transient hepatic intensity differences (THIDs) on MRI is crucial to aid the radiologist in diagnosing hepatic disease processes. 2. Recognizing perfusion anomalies in the liver is essential to avoid misinterpretation of "pseudolesions", a common pitfall for the training radiologist. 3. Familiarity with the pathogenesis and imaging features of hepatic vascular disorders helps guide correct diagnosis and patient management.

#### **TABLE OF CONTENTS/OUTLINE**

1. Physiology of hepatic perfusion  
a. Nutrient rich mesenteric venous inflow  
b. Compensatory nature of hepatic arterial and portal venous blood flow  
2. Concept of THADs/THIDs  
a. Pathophysiology  
b. Case-based review of common etiologies: "Cs" of THAD/THID  
c. Strategies to avoid misinterpretation  
3. Concept of streamline phenomenon  
a. Implications with case-based review  
4. Concept of third inflow  
a. Implications with case-based review  
5. Case-based review of miscellaneous vascular diseases  
a. Sinusoidal occlusion syndrome  
b. Budd Chiari  
c. Cavernous transformation and portal biliopathy  
d. Hepatic peliosis  
e. Hepatic ischemia secondary to TIPS

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## Abstract Archives of the RSNA, 2023

GIEE-127

### Borderline Pancreatic Cancer: Role of Cross Sectional Imaging in Therapeutic Decision Making

All Day Room: Learning Center

Diego M. Haberman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Borderline pancreatic ductal adenocarcinoma (BR-PDAC) is defined as a tumor potentially resectable but with anatomical (vascular involvement), biological (serum biomarkers) or clinical (performance status) conditions that may impact in free margin resections or postoperative outcomes. Anatomical BR-PDAC is at high risk for margin positive when surgery is upfront, so neoadjuvant chemotherapy and/or radiotherapy is considered to increase the chance of a R0 resections. Radiology is a significant tool concerning anatomical dimension, evaluating tumor - vessel relationships, being a pillar in decision making to choose the best therapeutic option for each patient. The images are also fundamental evaluating post-neoadjuvant response, contributing to evaluate tumor biology and responding patients. The objective of this exhibit is: 1) To review the role of imaging determining resectability status of tumors with detailed analysis in tumor - vessel contact of BR-PDAC. 2) To evaluate anatomical conditions that influences in surgical technique, particularly when vascular reconstructions are needed. 3) To review imaging response criteria post neoadjuvant therapy.

#### TABLE OF CONTENTS/OUTLINE

a) Tumor - venous contact analysis using Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). b) Tumor - artery contact evaluation and its differences when comparing to vein analysis. c) How proper radiological identification of the characteristics of venous and/or artery involvement influence on surgical approach and vascular reconstruction techniques required for a successful surgery.

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## Abstract Archives of the RSNA, 2023

GIEE-128

### Make it Simple-Imaging of the Postoperative Whipple

All Day Room: Learning Center

Ali Agely, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The Whipple procedure (pancreaticoduodenectomy) is performed to resect pancreatic head or periampullary neoplasms. CT and (increasingly) MRI are performed in the acute and delayed postoperative settings, notably in patients with a complicated course. This presentation provides a comprehensive overview of various postoperative imaging findings after a Whipple procedure with emphasis on MRI. Familiarity with expected findings and postoperative complications gives the radiologist the knowledge to render a prompt and accurate diagnosis.

#### TABLE OF CONTENTS/OUTLINE

1) Surgical review 2) Normal, expected findings in the acute and delayed postoperative settings 3) Complications: Pancreatic fistula, Leak (gastrojejunostomy and biliary-enteric), anastomotic strictures, pancreatitis (acute and acute on chronic), hemorrhage, abscess, portomesenteric venous thrombus, tumor recurrence, delayed gastric emptying, and stent migration

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## Abstract Archives of the RSNA, 2023

GIEE-129

### **GI and GU Fluoroscopy In Common Post-op Oncologic Surgeries: What You Need to Know About This Leaky Business**

All Day Room: Learning Center

Ahmed Taher, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe common gastrointestinal and genitourinary fluoroscopic procedures in oncology  
2. Illustrate the different techniques and indications for post op fluoroscopic examinations with key teaching points  
3. Demonstrate normal and abnormal fluoroscopic examinations including complications with emphasis on leaks

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction.  
2. Endoscopic evaluation versus double contrast studies.  
3. Surgical techniques of Ivor Lewis esophagectomy and its complications.  
4. Indications, techniques and imaging findings of single-contrast esophagram.  
5. Colonic and jejunal interposition.  
6. Surgical techniques for rectal surgeries and their complications.  
7. Indications, technique and imaging findings on single contrast enema.  
8. Indications, techniques and imaging findings of bladder surgeries and urinary diversions on cystogram, loopogram and pouchogram.  
11. Take-home messages.  
12. References.

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## Abstract Archives of the RSNA, 2023

GIEE-130

### Constipation, Stercoral Colitis, Hirschsprung Disease and Complications in Adults

All Day Room: Learning Center

Joel Gamble, MD,BSC (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Imaging is unreliable in establishing the diagnosis of constipation and directing routine management. Severe or chronic constipation can lead to serious complications, for which imaging is essential. Stercoral colitis is a potentially fatal complication of fecal impaction. High attenuation mucosa and perfusion defect are the most accurate features for fatal cases. The natural history of Hirschsprung disease epitomizes the complications of constipation. Despite surgical resection, many adults have chronic constipation, and a subset have serious constipation-related complications.

#### TABLE OF CONTENTS/OUTLINE

Constipation: Clinical diagnosis; recent literature that imaging does not correlate with bowel habit, predict symptoms of constipation, or reliably direct management decisions; imaging for complications of constipation. Stercoral colitis: Mucosal ulceration due to pressure ischemia, possible perforation; spectrum of findings severity. Hirschsprung disease: Absent ganglion cells in the submucosal and myenteric plexuses; symptoms into adulthood include constipation, straining, incomplete evacuation. various mechanisms of chronic constipation; late presentation of Hirschsprung in adulthood; complications include adhesional obstruction; fistula formation; obstipation; perforation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-131

### **The Pinch and the Squeeze: A Review of Vascular Compression Syndromes**

All Day Room: Learning Center

Hannah Lamberg, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Diagnosis of almost all vascular compression syndromes is largely clinically based. However, certain imaging findings can be suggestive of these syndromes, aiding in diagnosis and treatment. 2. Findings suggestive of a vascular compression syndrome include pre-stenotic vessel dilation, formation of varices, and compression of other structures (e.g. ureter, duodenum).

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief introduction of vascular compression syndromes 2. Radiologic findings with accompanying CT examples including:- Nutcracker Syndrome- May-Thurner Syndrome- Pelvic Venous Congestion Syndrome (non-vascular compression syndrome)- Median Arcuate Ligament Syndrome- Superior Mesenteric Artery Syndrome- Chronic Ureteropelvic Junction Obstruction by crossing vessels- Ovarian vein syndrome. 3. Summary/Conclusions: Review of high-yield teaching points

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-132

### Imaging of Gallstones and Complications

All Day Room: Learning Center

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: 1. Identify various types of gallstones and discuss imaging techniques 2. Multimodality imaging review of the features of gallstones and their complications 3. Discuss pitfalls and mimics of gallstones.

#### TABLE OF CONTENTS/OUTLINE

There are three main types of gallstones: Cholesterol (10%), Pigmented (10%) and mixed (80%). Ultrasound is the superior imaging modality for detection of gallstones as up to 20% stones are not calcified and CT occult. CT is better to detect gallstone complications. Dual Energy CT utilizes low KV, calcium-based and lipid-based imaging and more sensitive than single energy CT to detect gallstones. Gallstone complications: Acute cholecystitis; Acute cholangitis; Mirrizi Syndrome; Biliary-enteric fistulae; infected fallen gallstones; post-cholecystectomy syndrome. Pitfalls and Mimics: Assessment of stone impaction; gallbladder polyps; cystic artery pseudoaneurysm, enteroliths. Summary: Gallstones are common seen on imaging and can serve as a nidus for infection/inflammation; cause biliary outflow obstruction or fistulize to adjacent structures necessitating prompt diagnosis sometimes utilizing multimodality imaging, treatment and intervention.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-133

### Don't Judge a Gallbladder by Its Wall

All Day Room: Learning Center

Sara Siguenza-Gonzalez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiologists are very used to cholecystitis in daily clinical practice, but there are other entities that affect the gallbladder (GB): Classification and description of those entities according to a pathological point of view. Principal radiographic features of each disorder in ultrasound (without and with contrast), CT (including spectral CT) and MRI. Key points to guide the differential diagnosis of the main pathology of the GB.

#### TABLE OF CONTENTS/OUTLINE

1. An approach to the anatomy and physiology of the GB. Description of normal anatomy, anatomic variants and congenital features.
2. Describe benign entities, idiopathic diseases (cholesterolosis and adenomyomatosis) and bile stasis diseases.
3. An update of premalignant gallbladder polyps.
4. Analyze malignant pathology, including primary tumours (gallbladder carcinoma and cholangiocarcinoma) and secondary tumours (metastasis and lymphoma).
5. A portrayal of others disorders in the GB: traumatic pathology, secondary causes of diffuse gallbladder wall thickening and inflammatory diseases beyond acute cholecystitis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-134

### Hepatobiliary and Pancreatic Manifestations of Immunochemotherapy: A Practical Guide

All Day Room: Learning Center

Soumyadeep Ghosh, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. An update on the commonly used cancer immunotherapy and chemotherapy agents that affect the liver, biliary system and pancreas. 2. Delve into the pathogenesis of these therapy-related hepatobiliary and pancreatic manifestations. 3. Illustrate the role of imaging in diagnosis of these therapy-related manifestations in the context of cancer.

#### TABLE OF CONTENTS/OUTLINE

1. Background 2. Cancer immunotherapy and chemotherapy agents that can affect the liver, biliary system and pancreas a) CTLA-4 inhibitor - Ipilimumab b) PD-1 inhibitor- Nivolumab, Pembrolizumab c) PD-L1 inhibitor - Durvalumab, Atezolizumab d) Alkylating agents - Oxaliplatin e) Anti-metabolites - Pyrimidine analogues (5-fluorouracil, Gemcitabine), 6-mercaptopurine, methotrexate f) Vinca alkaloids - Vincristine, Vinblastine g) Topoisomerase I inhibitors - Irinotecan 3.) Therapy related adverse effects - Hepatic - Biliary - Pancreatic 4. Steatosis 5. Diffuse hepatitis 6. Fibrosis 7. Pseudocirrhosis 8. Sinusoidal obstruction syndrome 9. Focal nodular hyperplasia - like lesions 10. Nodular regenerative hyperplasia

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## Abstract Archives of the RSNA, 2023

GIEE-135

### Primary Peritoneal Malignant Mesothelioma: Everything a Resident Needs to Know

All Day Room: Learning Center

Soumyadeep Ghosh, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Distinguish the various subtypes of mesothelioma based on clinical and radiological features. Illustrate the spectrum of imaging features of primary peritoneal mesothelioma. Be cognizant of the mimics of primary peritoneal malignant mesothelioma in our daily reporting.

#### TABLE OF CONTENTS/OUTLINE

1. Background on mesothelioma 2. Subtypes of peritoneal mesothelioma a) Cystic mesothelioma b) Primary peritoneal malignant mesothelioma (PPMM) c) Well-differentiated papillary mesothelioma 3. Spectrum of imaging features of primary peritoneal malignant mesothelioma 4. Cases - a) Peritoneal thickening b) Peritoneal masses c) Omental fat stranding and nodularity d) Extensive disease 5. Mimics a) Peritoneal carcinomatosis b) Lymphoma c) Tuberculous peritonitis

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-136

### All About the Gallbladder: From Normal to Rare

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Vivianne De Paula Reis Guimaraes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review of normal anatomy and common conditions of the gallbladder, demonstrating the role of the available imaging methods. Illustrate unusual cases of the gallbladder, highlighting the main imaging findings for the correct approach and diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Brief demonstration of the gallbladder anatomy as well the imaging findings related to its most frequent conditions. Case-based illustration of multiple uncommon gallbladder pathologies according to their nature: - Anatomical variants and malformations; - Inflammation; - Neoplasms; - Others (trauma, torsion etc.).

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## Abstract Archives of the RSNA, 2023

GIEE-137

### Imaging Characteristics of Pancreatic Serous Cystadenoma and Common Imitators

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Nikolas Brozovich, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Pathophysiology of Pancreatic serous cystadenoma.2) MR characteristics of Pancreatic serous cystadenoma and its subtypes.3) Cystic pancreatic lesions mimicking serous cystadenoma.4) Aggressive features of atypical serous cystadenomas.5) Utility of endoscopic ultrasound and fluid aspiration for definitive diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Pancreatic cystic neoplasms are commonly encountered in practice and reported on 20-40% of abdominal MRI scans compared to only 3% of CT scans. Serous cystadenoma of the pancreas can have similar characteristics to other benign and malignant pancreatic lesions. The microcystic form of Pancreatic serous cystadenoma has classic features with a pathognomonic enhancing scar and stellate calcifications seen in 30% of cases.1) MR features of microcystic, macrocystic, oligocystic, and solid pancreatic serous cystadenoma subtypes.2) Atypical aggressive features including parenchymal atrophy, ductal dilatation, and vascular/local invasion.3) Common mimics including Mucinous cystic pancreatic neoplasm(MCPN), Solid pseudopapillary epithelial neoplasm(SPEN), Intraductal papillary mucinous neoplasm(IPMN), pseudocyst, lymphoepithelial cyst, cystic neuroendocrine tumor(NET), and adenocarcinoma.4) Von Hippel-Lindau syndrome- Increased incidence of developing Pancreatic serous cystadenoma and other benign and malignant tumors of various organs.

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## Abstract Archives of the RSNA, 2023

GIEE-138

### Barriers to Adopting LI-RADS and Steps to Overcome

All Day Room: Learning Center

James T. Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) The Liver Imaging Reporting and Data System (LI-RADS) is a reporting system for the classification of hepatocellular carcinoma (HCC) that continues to grow in adoption throughout North America including important steps of alignment with both the American Association for the Study of Liver Disease (AASLD 2018) and the Organ Procurement Transplant Network (OPTN 2022) 2) Despite growing adoption, radiologist still encounter barriers to implementation within their own clinical academic departments, from referring physicians and surround community practices.3) An understanding of different barriers that may face radiologists and referrers towards the adoption of LI-RADS is an important step to overcoming these obstacles.

#### TABLE OF CONTENTS/OUTLINE

I. Review LI-RADS purpose to standardize reporting and data collection for patients at risk for developing HCCII. Illustrate the growth of LI-RADS adoption over the past decadeIII. Describe the barriers to adoption of LI-RADS from both the radiologist and referring providers point of viewIV. Explain how to overcome barriers from the experiences encountered from our multiple (12) institution collaborative.

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## Abstract Archives of the RSNA, 2023

GIEE-139

### Crohn's Disease: Step by Step in MRI

All Day Room: Learning Center

Natalia Y. Zuniga, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Active disease is characterized by wall thickening and edema and or ulceration. Wall thickening alone, without the supporting features of oedema or ulceration, often indicates inactive disease, particularly if the wall is dark on fat-suppressed T2WI. Functional techniques such as DWI and motility imaging provide ways to quantify disease activity, monitor, and even predict therapeutic response. Complications can be divided into stricturing, penetrating, related to short bowel and development of malignancy. Characterization of strictures requires a fixed luminal narrowing with upstream dilatation greater than 3 cm. The strictures should be differentiated between inflammatory luminal narrowing or fixed fibrosis, and should be measured the length of the stricture. Contrast enhancement may be useful, but active and fibrotic disease both enhance. Early enhancement is more typical for active CD whereas delayed enhancement may indicate established fibrosis. It is useful to distinguish between response to treatment and imaging remission. Response implies a significant reduction of the inflammatory burden, and imaging remission implies the abolition of all activity. Scores are not routinely applied in clinical practice, however their knowledge is necessary for the description of mild, moderate and severe disease, which is sufficient.

#### TABLE OF CONTENTS/OUTLINE

Definition and initial diagnosis. Disease Activity. Disease phenotype. Non-stricturing, non-penetrating (inflammatory). Stricturing Disease. Penetrating Disease. Depict and quantify the degree of inflammatory activity. Severity. Therapeutic monitoring and response to treatment. Preoperative mapping. Postoperative recurrence

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## Abstract Archives of the RSNA, 2023

GIEE-14

### What Goes Up Must Come Down: Multimodality Imaging Evaluation of Reflux Disease, Related Surgeries and Complications

All Day Room: Learning Center

Moataz Ahmed Sayed Mohammed Soliman, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Explain the causes and mechanisms of reflux disease and its effects on the esophagus and stomach Review imaging modalities and findings for diagnosis and assessment of reflux severity Describe the surgical procedures utilized for treatment of reflux disease, their advantages and disadvantages Recognize the post-operative imaging findings and potential complications of reflux surgery with possible management options

#### TABLE OF CONTENTS/OUTLINE

Introduction: Define reflux disease Epidemiology Complications Pathophysiology: Role of the lower esophageal sphincter, hiatal hernia, gastric acid, and other factors in reflux disease Diagnostic tests: Upper endoscopy, pH monitoring, manometry Review the indications, techniques, and findings of different imaging modalities for reflux disease Imaging possible disease complications Treatment Medical therapy (prescription and non-prescription medications) Surgery: Compare types, outcomes, and risks of different surgical options for reflux disease, such as Fundoplication LINX Device Transoral incisionless fundoplication (TIF) Stretta procedure Post-operative imaging: Expected post-operative imaging findings Complications: Identify the common and rare complications of reflux surgery and their imaging features and management strategies Dysphagia and difficult Infection Bleeding Esophagogastric perforation, leakage Fistula Unwrapping of fundoplication LINX device migration Conclusion: An algorithmic approach to imaging evaluation

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## Abstract Archives of the RSNA, 2023

GIEE-140

### Abdominal Tuberculosis: Think About It

All Day Room: Learning Center

Nerea Torena (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review abdominal tuberculosis, findings, and possible differential diagnoses. 2. To present cases of abdominal tuberculosis diagnosed at our centre in the last 5 years.

#### TABLE OF CONTENTS/OUTLINE

In Europe Tuberculosis has an average incidence of 26 cases per 100000 inhabitants. Pulmonary disease is the most frequent, abdominal involvement occurs in 11-12% of patients with extrapulmonary tuberculosis. Most frequently it affects the genitourinary tract, lymph nodes, peritoneum, and solid viscera, mainly the liver, spleen, and pancreas. Symptoms can be nonspecific; most commonly fever, abdominal pain, and weight loss. The radiological findings are not pathognomonic, but may be suggestive if considered with clinical, immunological status, and demographic origin. Abdominal disease can simulate multiple conditions: lymphoma, Crohn's disease, adenocarcinoma, carcinomatosis, etc. Tuberculosis cases diagnosed at our hospital in the last 5 years have been reviewed, 262 cases. 18 patients (6.8%) with abdominal involvement detected by imaging techniques. Radiological findings of each location will be discussed and depicted. Genitourinary, hepato-splenic, peritoneal, intestinal, lymph node and pancreatic tuberculosis will be shown. Differential diagnoses of each location will be reviewed. Abdominal tuberculosis diagnosis is complicated. Imaging findings are usually nonspecific and present in a very diverse way mimicking different diseases. It is important to suspect this pathology and establish its diagnosis to start the most appropriate treatment as soon as possible.

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## Abstract Archives of the RSNA, 2023

GIEE-141

### Post-operative Complications of Cholecystectomy: What the Radiologist Needs to Know

All Day Room: Learning Center

Kazi A. Irfan, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Surgical anatomy of the gall bladder fossa.2. Variants in the vasculature and biliary anatomy predisposing to injuries.3. Types of cholecystectomy surgical approaches.4. Imaging overview of indications of cholecystectomy.5. Algorithm for imaging approach to diagnose acute cholecystitis.6. Appropriate use of multimodality imaging in the diagnosis of post-operative complications.7. Expected post-surgical changes.8. Spectrum of post-surgical complications

#### TABLE OF CONTENTS/OUTLINE

Introduction:-Cholecystectomy is among the most commonly performed abdominal surgeries-Can be performed by either laparoscopic or open approaches  
Common indications for cholecystectomy: Acute/chronic cholecystitis, symptomatic cholelithiasis, gallstone pancreatitis, gall bladder masses/ polyps  
Multimodality imaging in diagnosis and management of post-surgical complications:-  
Computed Tomography (CT): primary imaging modality-Magnetic resonance Imaging (MRI): Ideal for biliary anatomy. Hepatobiliary excreted contrast (Eovist) can confirm bile leak-Ultrasound-Hepatobiliary scintigraphy-Fluoroscopy: Transhepatic and T-tube cholangiograms-Angiography  
Postsurgical complications of cholecystectomy:-  
Collections? \*Expected postsurgical seroma/hematoma? \*Bile leak or biloma (can be secondarily infected)? \*Hematoma? \*Abscess?-Bile duct injuries (can be associated with bile leak or biloma)? \*Stricture? \*Ligation or transection?-Gallstone related? \*Retained or new gallstones in CBD or remnant cystic duct? \*Dropped gallstones?-Vascular? \*Active bleed? \*Pseudoaneurysms? \*Vascular occlusions?-Other? \*Cholecystitis in residual gall bladder? \*Bowel injury? \*Clip migration?

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## Abstract Archives of the RSNA, 2023

GIEE-142

### **Navigating the Labyrinth of Peritoneal and Retroperitoneal Anatomy: Abdominal Disease Spread Made Easy**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Essential to understanding disease spread in abdomen is to separate the peritoneum from the retroperitoneum. These areas have distinct anatomy with well-define separate pathways. The peritoneum is comprised of connected recesses that are potential spaces, normally not imaged except when containing excess fluid or air. Peritoneal recesses are formed by the opposing peritoneal surfaces and subdivided by the attachments of the ligaments and mesenteries to the parietal peritoneum. Disease flows within the recesses by changes in abdominal pressure. This forms a distinct spread pattern. The retroperitoneum is stratified by the renal fascia into the anterior and posterior pararenal spaces and the perirenal space. The fascia contains and directs spread from the contained organs with the compartments. Each space has a unique spread pattern defined by the containing fascia. The anterior pararenal space is connected to the mesenteries and ligaments forming the subperitoneal space. This space interconnects the retroperitoneum with the mesenteries allowing for the normal continuum of blood vessels, lymphatics, and nerves but also forms the pathways for bidirectional spread of disease.

#### **TABLE OF CONTENTS/OUTLINE**

- Anatomy
- Clinical embryology
- Fundamental concept of the subperitoneal space
- Distinguishing intraperitoneal spread from subperitoneal spread
- New planes of retroperitoneum
- Patterns of spread of disease from the;-Liver-Distal esophagus and stomach-Pancreas-Small intestine-Large intestine-Renal and adrenal
- Mechanisms of spread of disease (fluid, gas and soft tissue)-Subperitoneal-Intraperitoneal-Contiguous invasion
- Clinical and radiological applications

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## Abstract Archives of the RSNA, 2023

GIEE-144

### Head with Two Tales: Early Spread of Disease from the Pancreas

All Day Room: Learning Center

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The head of the pancreas can be considered as two separate entity with distinct embryological variations. During embryology the ventral pancreatic bud becomes the caudal portion and the uncinata process of the head of the pancreas, while the dorsal bud becomes the cranial portion of the head. This embryology results in anterior and posterior components of the head of the pancreas each having their distinct vascular supply, nerve supply and lymphatic drainage. It is essential for the radiologist to appreciate that this results in two distinct spread patterns from the head of the pancreas. This knowledge about the early disease spread from the head of the pancreas becomes important particularly in the case of tumor as the radiologist can confidently predict, and diagnose the metastatic spread knowing the origin of the tumor.

#### TABLE OF CONTENTS/OUTLINE

- Anatomy of the pancreas
- Clinical embryology of the head of the pancreas
- Fundamental concept of the two heads of the pancreas
- Distinct vascular supply
- Distinct nerve supply
- Distinct lymphatic supply
- Distinguishing the different disease spread from the anterior head and posterior head
- How imaging helps in successfully identifying the early spread
- Important anatomical landmarks to help recognizing the spread of the disease
- Patterns and mechanisms of early spread of the tumor
- Clinical and radiological applications
- Algorithm to predict the spread of metastatic disease from the head of the pancreas

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## Abstract Archives of the RSNA, 2023

GIEE-145

### The 'New' 2023 American Association for the Study of the Liver Disease (AASLD) Practice Guidance on the Diagnosis and Management of Nonalcoholic Fatty Liver Disease (NAFLD): Radiologists' Perspective

All Day Room: Learning Center

Eri Osta, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Familiarize audience with 2023 AASLD practice guidance statement for diagnosis management of Nonalcoholic fatty liver disease (NAFLD) with special emphasis on imaging-related statements.
- Discuss imaging biomarkers other non-invasive tests in risk assessment of NAFLD patients.
- Review complementary roles of liver function tests, Fibroscan, shear wave Elastography MRI PDFF in assessing hepatic steatosis, fibrosis "at-risk" nonalcoholic steatohepatitis (NASH).
- Discuss ongoing research advances role of AI-based tests in NAFLD

#### TABLE OF CONTENTS/OUTLINE

- Introduction
- Epidemiology: Prevalence and demographics of NAFLD.
- Spectrum of NAFLD: Pathophysiology, stages, and progression - Nonalcoholic fatty liver (NAFL), Nonalcoholic steatohepatitis (NASH), at-risk NASH, advanced fibrosis cirrhosis
- Predictors of clinical outcomes in NAFLD: Identifying high-risk patients: fibrosis-4 (FIB-4) scoring system
- Diagnosis and Assessment of NAFLD
- Hepatic steatosis: Ultrasound, Fibroscan/Controlled attenuation parameters (CAP) MRI-PDFF techniques
- "At-risk" NASH Evaluating FAST (Fibroscan + AST levels), MAST (MRE + AST levels), MEFIB (MRE + FIB-4) scoring systems.
- Advanced fibrosis: Assessing extent of fibrosis with Fibroscan/VCTE MRE
- Cirrhosis Rule in/out irreversible fibrosis
- Future directions Ongoing research
- Conclusion Recent developments in NAFLD have led to substantial advancements in biomarkers therapeutics, with significant implications for radiologists collaborating with multidisciplinary care teams. Emerging imaging non-imaging biomarkers can exclude advanced liver disease or identify patients at an increased risk for cirrhosis.

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## Abstract Archives of the RSNA, 2023

GIEE-146

### **Pancreatic Duct Anomalies: A Primer for Trainees**

All Day Room: Learning Center

Hatem Al Kashroom, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Pancreatic duct anomalies are rare but can cause significant health problems if not detected early. 2. The two main types of congenital pancreatic duct anomalies are pancreas divisum and annular pancreas. 3. Symptoms of pancreatic duct anomalies may include abdominal pain, nausea, vomiting, and weight loss. 4. Diagnosis usually involves imaging tests such as MRI (MRCP) and/or CT scan. 5. Overview of the acquired pancreatic duct anomalies 6. Patients with a family history of pancreatic duct anomalies or pancreatitis may be at higher risk and should discuss screening options with their healthcare provider.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to normal pancreatic anatomy and embryology 2. Pancreatic divisum and divisum types 3. Annular pancreas 4. Acquired pancreatic duct anomalies 5. Diagnostic tests and preferred imaging modalities

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## Abstract Archives of the RSNA, 2023

GIEE-147

### What The Radiologist Needs To Know About Pseudomyxoma Peritonei And HIPEC

All Day Room: Learning Center

Natalia Y. Zuniga, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The mucinous deposits tend to follow routes of normal peritoneal fluid flow, there are watershed regions in the peritoneal cavity where cells can be deposited to form implants. Signs of peritoneal metastases include the presence of peritoneal nodules, thickening, or fat stranding. A peritoneal cancer index greater than 20 is considered a poor prognostic factor. CT provides anatomic imaging. MRI provides a combination of anatomic imaging and tumor functional imaging. PET imaging provides functional imaging based upon an assessment of the tumor's metabolism of glucose. T1WI and T2WI sequences provide anatomic details to precisely localize the larger peritoneal tumors and nodules, but are relatively insensitive for depicting small peritoneal tumors and subtle fat stranding. DWI are particularly useful for depicting mucinous lesions due to the conspicuity of high signal intensity mucin and fluid within these tumors. Peritoneal tumors enhance with intravenous gadolinium increasing their conspicuity. The combination of hyperthermia and high concentration chemotherapy used in HIPEC can also alter physiological healing, which may increase the incidence of vascular, lymphatic, gastrointestinal, urological and diaphragmatic complications.

#### TABLE OF CONTENTS/OUTLINE

Terminology. Pseudomyxoma peritonei. Hyperthermic Intraperitoneal Chemotherapy (HIPEC). Peritoneal anatomy and physiology. Preoperative imaging. Establish the presence or absence of peritoneal metastases. Quantitation of the radiologic Peritoneal Cancer Index. Description of extraperitoneal metastases. Postoperative imaging. Normal findings. Features indicative of complications.

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## Abstract Archives of the RSNA, 2023

GIEE-148

### Off the Wall: Incidental Muscle Pathology on Abdominopelvic Imaging

All Day Room: Learning Center

#### Awards

##### Cum Laude

Benjamin E. Northrup, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The use of cross-sectional imaging has increased exponentially, and incidental musculoskeletal findings have become commonplace. These are frequently referred to as "the radiologist's blind spot." Recent publications offer detailed review of abdominal wall pathology. However, the differential diagnosis for abnormalities of the paraspinal and pelvic musculature is often distinct. This review will familiarize radiologists with these unique and often overlooked pathologies and with management recommendations.

#### TABLE OF CONTENTS/OUTLINE

1. Abdominopelvic muscle anatomy
2. Congenital and structural abnormalities
3. Metabolic abnormalities (diabetic myonecrosis, rhabdomyolysis, hyperparathyroidism)
4. Vascular (arteriovenous malformations, ischemic myonecrosis)
5. Inflammatory myopathy (inflammatory myositis, sarcoidosis, drug-related, HIV, radiation, crystalline)
6. Infectious (poliomyelitis, cysticercosis, infectious myositis)
7. Sequelae of injury and trauma (DOMS, tears, hematoma, bursitis, heterotopic ossification, myositis ossificans)
8. Neoplasia (primary and metastatic malignant neoplasms, benign neoplasms)
9. Atrophy (denervation myopathy, end-stage inflammation, sarcopenia)
10. Normal variants and pitfalls (accessory and anomalous muscles, injection granulomata, lipohypertrophy)
11. An algorithmic approach to incidental musculoskeletal abdominal findings

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## Abstract Archives of the RSNA, 2023

GIEE-149

### Peritoneal Carcinomatosis and HIPEC

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Victoria John, MBChB (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Peritoneal carcinomatosis occurs from spread of a primary cancer to the peritoneum, most commonly from the gastrointestinal tract and ovary. Pseudomyxoma peritonei is a rare type of peritoneal carcinomatosis characterised by accumulation of mucinous ascites and mucinous peritoneal deposits secondary to intraperitoneal spread of a mucin-producing primary tumour. Cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) in suitable patients offers a chance for cure and is the mainstay of treatment in lower grades tumours, for which current chemotherapy regimes are of limited effect. Pre-operative imaging is key in determining patients' suitability for CRS/HIPEC with regards to tumour burden. Factors include the Sugarbaker Peritoneal Cancer Index (PCI), ascites and abdominal wall involvement, unfavourable sites of disease, presence of small bowel and mesenteric disease, as well as extra-peritoneal metastases. The most commonly used imaging modalities are CT and dedicated abdominal MRI. It is recognised that CT may underestimate the degree of disease, whilst MRI with peritoneal protocol has a higher sensitivity and may provide more accurate description of disease extent for the operating surgeon.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Peritoneal Anatomy. 3. Imaging techniques in peritoneal carcinomatosis including recommended protocols in CT and MRI. 4. Types of peritoneal carcinomatosis including pseudomyxoma peritonei. 5. Treatment of peritoneal carcinomatosis with cytoreductive surgery and HIPEC. 6. Adverse sites of disease on imaging. 7. Summary.

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## Abstract Archives of the RSNA, 2023

GIEE-15

### **Contrast-enhanced Ultrasound (CEUS), More Than Just Bubbles: Diagnostic and Interventional Applications in Daily Clinical Practice**

All Day Room: Learning Center

Paul Lopez, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To learn the potential applications of CEUS throughout the body. -To understand the value of CEUS both in diagnostic and interventional procedures.

#### **TABLE OF CONTENTS/OUTLINE**

Since its introduction into clinical practice in the late 1990s, CEUS has gained popularity among radiologists as a diagnostic tool in multiple organ systems, and more recently in radiological interventionism. This is due to its great advantages, which include real-time imaging, high contrast resolution and absence of nephrotoxicity among others. This work will review the potential applications of CEUS in daily clinical practice based on cases of our center. -Liver: characterization of benign and malignant focal lesions, role in hepatocellular carcinoma, interventional procedures. -Gallbladder: tumor versus inflammatory process and biliary mold. -Kidney: complex cystic lesions and tumors, interventional procedures. -Urinary tract and bladder: tumor versus clot, grading vesicoureteral reflux in children. -Thyroid: ablation procedures. -Inflammatory bowel disease: evaluation of inflammatory activity, treatment monitoring, fibrous versus inflammatory strictures? -Interventional radiology: guide for percutaneous biopsies, tumor ablations and drain placement, post-ablation surveillance? -Vascular applications: thrombus detection and evaluation, hemorrhage detection?

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## Abstract Archives of the RSNA, 2023

GIEE-150

### Metastatic Lobular Breast Cancer: What the Abdominal Radiologist Needs to Know

All Day Room: Learning Center

David Fidler, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Invasive lobular breast carcinoma (ILC) has a predilection for abdominal and pelvic metastases, with a distinctive distribution and distinctive imaging features. -Three important patterns of abdominal metastasis: Infiltrative submucosal and subserosal metastasis to abdominal and pelvic viscera, mimicking primary abdominal and pelvic malignancy, for example stomach carcinoma (linitis plastica type), colonic carcinoma, uterine and bladder carcinoma; Diffuse peritoneal metastasis, mimicking metastatic ovarian cancer/primary peritoneal neoplasm; Retroperitoneal metastasis, mimicking lymphoma or retroperitoneal fibrosis. -Appears on imaging as smooth, infiltrative lesions, without extramural extension and without desmoplastic reaction. Long segment and multi-organ involvement is typical. MRI signal partially reflects the target organ. - Metastases can occur many years after primary malignancy, and therefore may not be clinically suspected. The radiologist at the MDT may be the first to suggest the diagnosis. -The lesions may not be evident at endoscopy and may be missed on superficial biopsy, therefore radiological suspicion is key

#### TABLE OF CONTENTS/OUTLINE

-Patterns of abdominal metastasis: GI and GU tract; Peritoneum; Retroperitoneum. -Imaging features. -Why is this important to me?

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## Abstract Archives of the RSNA, 2023

GIEE-151

### Transplantation for Type 1 Diabetes: Radiologist's Primer on Pancreatic, Pancreatic-kidney and Islet Cell Transplantation Imaging

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Priya O. Pathak, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Overview of transplantation procedures for type 1 diabetes with imaging of pancreatic, pancreatic-kidney and novel strategy of islet cell transplantation. 2) Highlight the clinical indications, surgical anatomy, procedure techniques, pre and post-transplantation imaging. 3) Review expected imaging acquisition parameters for US, CT and MRI. 4) Describe immediate, early and delayed complications of pancreatic, pancreatic kidney and islet cell transplantation.

#### TABLE OF CONTENTS/OUTLINE

- Introduction: Multimodality imaging of pancreatic, pancreatic-kidney and islet cell transplantation with emphasis on transplantation-related complications. Outline
- Pancreatic and pancreatic-kidney transplant-Assessment of donor pancreas and graft implantation.-Imaging modalities: US, CT, MRI, angiography.-Complications: Vascular (Thrombosis, Pseudoaneurysm), transplant pancreatitis, intestinal complications (Leak, Bowel obstruction, Fistula).
- Islet cell transplantation-Pretransplant imaging: Chest x ray, abdominal US-Technique: Portal venogram, islet cell infusion, tract embolization.-Post-transplant imaging: Ultrasound, PET, SPIO MR imaging-Complications: Early (Hemorrhage, Portal vein thrombosis, Arterioportal fistula) and delayed (Heterogenous hepatic steatosis, Immunosuppression related effects).

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

GIEE-152

### **Mucking Up the Abdomen: Common and Uncommon Presentations of Pseudomyxoma Peritonei**

All Day Room: Learning Center

Ethan Zaccagnino, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Pseudomyxoma Peritonei (PMP) is an entity characterized by mucinous ascites due to the spread of mucin producing neoplasms. It commonly presents as acute appendicitis or RLQ pain with imaging revealing a mucocele of the appendix. Mucocele rupture may cause spread of tumor into the abdomen resulting in peritoneal implantation. Less common sites of origin include gallbladder, small intestine, pancreas, breast and ovary/fallopian tubes. Imaging findings include mucinous or soft-tissue peritoneal implantations and mass effect or scalloping of the abdominal viscera. Ultrasound may detect mucinous ascites or discrete tumors, however cross-sectional imaging with CT or MR is preferred to characterize PMP. Treatment options include surgical debulking and Hyperthermic Intraperitoneal Chemotherapy (HIPEC). Serial imaging is often warranted, as recurrence is common.

#### **TABLE OF CONTENTS/OUTLINE**

1. Intro to pseudomyxoma peritonei (PMP). 2. Mucinous tumors (low and high grade appendiceal mucinous neoplasms, as well as mucinous adenocarcinoma) and sites of origin. 3. Epidemiology of mucinous tumors and PMP. 4. Multimodality imaging features of mucinous tumors and PMP. 5. Treatment (HIPEC and surgical debulking) and complications (mucinous ascites and recurrence) of PMP. 6. Mimics of PMP as well as situations in which mucinous tumors and PMP can mimic non-neoplastic entities. 7. Common and uncommon presentations. 8. Summary and conclusion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-153

### Diagnosis of Biliary Atresia: Featured Images for the Radiologist

All Day Room: Learning Center

Yady V. Hurtado Burbano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- -Identify the normal liver and bile duct findings in different imaging modalities and the main characteristics and classification of biliary atresia.
- -Illustrate the featured signs and imaging data in the diagnosis of biliary atresia and their post-operative complications.

#### TABLE OF CONTENTS/OUTLINE

- Normal pediatric liver ultrasound.
- Some facts about biliary atresia.
- Ultrasound findings.
- Normal and pathological hepatobiliary scintigraphy.
- Findings in percutaneous procedures.
- Imaging in post-operative complications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-154

### **Integrating Intestinal Ultrasound (IUS) into an Inflammatory Bowel Disease (IBD) Imaging Service**

All Day Room: Learning Center

Saigeet Eleti, FRCR, MBBChir (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Successful control of Crohn's Disease (CD) relies on effectively suppressing inflammation which requires ongoing monitoring. - A number of trials have validated intestinal ultrasound (IUS) as having excellent diagnostic accuracy in patients with CD, performing comparably to established modalities such as MRI. International guidelines recommend that newly diagnosed CD patients undergo small bowel assessment with IUS or MR enterography. - Additionally, ultrasound is cost-effective, widely available and better tolerated by patients which is crucial when regular monitoring is required. - A one-stop clinic where patients undergo IUS with subsequent assessment by a gastroenterologist enables timely implementation of a targeted management plan for better disease control. - Operators must have appropriate training and experience with IUS as well as a methodical and reproducible technique for accurate disease assessment. - With sufficient operators trained in IUS, it may also be offered as a point-of-care test in the emergency department. - Oral and intravenous contrast may be used in IUS selectively to provide additional information. - A reporting template can serve as a useful aid to performing a comprehensive study. Successful implementation requires multidisciplinary input involving radiology, gastroenterology, and surgery.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. One-stop clinic 3. Resources 4. Technique 5. Sonographic appearances of IBD: Case Studies 6. Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-155

### The Hepatic Angiomyolipoma: A Guide to Avoiding a Big Fat Mistake

All Day Room: Learning Center

Ana Paula Fraga Cintra Gonzaga (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Provide an overview of hepatic angiomyolipoma (HAML). Discuss typical and atypical cases of HAML with an emphasis on imaging features. Review the main differential diagnoses of HAML with a didactic approach. Offer useful tips for challenging cases to enhance accurate diagnosis and patient outcomes. Develop a radiological survival guide for interpreting fat hepatic nodules.

#### TABLE OF CONTENTS/OUTLINE

HAML is a rare tumor with a combination of blood vessels, smooth muscle, and varying degrees of mature fat. Despite limited research on HAML, this presentation aims to offer a comprehensive overview of the key features of this lesion, including epidemiology, associations (such as tuberous sclerosis), pathology, radiographic features, prognosis, and treatment. Using case-based presentations, we will explore both classical and uncommon imaging manifestations of HAML, including potential malignant behavior. Additionally, the presentation will discuss the differential diagnosis of HAML, ranging from benign lesions (lipoma, nodular hepatic steatosis, steatotic adenoma, and focal nodular hyperplasia) to malignant neoplasms (HCC and metastasis). Tips for differentiating these diagnoses based on imaging and other clinical factors will be provided. Provide tips for challenging cases where the diagnosis may not be apparent from imaging alone, and radiologists can still play a critical role in contributing to better patient outcomes. Propose a radiological survival guide. This guide will summarize key radiographic and non-radiographic features of HAML, along with differential diagnoses and important clinical considerations, to assist radiologists in accurate diagnosis and appropriate patient management.

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## Abstract Archives of the RSNA, 2023

GIEE-156

### **Bariatric Surgery: A Pictorial Review. From Post-Surgical Anatomy to Complications**

All Day Room: Learning Center

Maria J. Galante I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To describe the normal postsurgical anatomy of the most common bariatric surgery techniques.- To analyze the most frequent complications of each of them, with CT and fluoroscopic imaging.- To present CT images of interesting cases of patients that have undergone bariatric surgery procedures.In this exhibit we will review the most frequent bariatric techniques and their complications, that are divided in late and early depending on the postoperative period in which that may appear (more or less than one month). Older procedures such as vertical-banded gastroplasty and jejuno-ileal bypass will not be assessed.

#### **TABLE OF CONTENTS/OUTLINE**

1. Generalities and indications of bariatric surgery  
2. Classification  
3. Post- surgical imaging control protocol  
4. Restrictive Surgeries: Anatomical imaging features and main complications  
4.1 Adjustable Gastric Banding  
4.2 Sleeve Gastrectomy  
5. Restrictive and Malabsorptive Procedures: Anatomical imaging features and main complications  
5.1 Roux-en-Y- Gastric Bypass  
5.2 Anastomosis duodenoileal bypass (SADI-s), minigastric bypass, duodenal switch  
6. Conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-157

### Tricky abdominal cases: Practical approach using Spectral CT

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ana Villanueva, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To learn the benefits of spectral CT applications in challenging abdominal imaging cases  
2. Role of spectral CT in patient's care, how we can change management decisions

#### TABLE OF CONTENTS/OUTLINE

1. Background: Revision of basic concepts of spectral CT.  
• Definition  
• Types of Spectral CT available in the market  
• Review of different material decomposition applications  
2. Review of challenging abdominal and pelvic cases.  
• Case-based and interactive format- The reader will be able to click on different stories to go through broad spectrum of cases covering most of abdominal and pelvic organs- We will display daily situations where the radiologist could feel stuck while reporting the CT- Companion quiz questions and teaching points/tips will be shown- Updated literature will be provided for each case. By clicking on each reference, the reader will be redirected straight to the actual paper  
• To propose an algorithm to guide the radiologist to accurately reach the diagnosis  
• To demonstrate how spectral CT is useful for problem solving and the radiologist could aid in successful decision-making and avoid additional imaging or procedures  
3. Limitations of spectral CT  
4. Conclusion

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## Abstract Archives of the RSNA, 2023

GIEE-158

### Don't Be Thrown for a Loop! A Review of Internal Hernias for the Abdominal Imager

All Day Room: Learning Center

Edwarda Golden, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Internal hernias are herniations of abdominal viscera, usually small bowel, through congenital or acquired openings of the peritoneum or mesentery. Internal hernias can obstruct and are considered surgical emergencies due to the high risk of bowel strangulation. If complications such as bowel obstruction or ischemia are not present, then imaging findings of internal hernia will consist primarily of displacement of normal abdominal structures. After reviewing this exhibit, the viewer will be familiar with the various kinds of congenital and acquired hernias, as well as the epidemiology, surgical risk factors, imaging appearance, and complications associated with internal hernias.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Congenital Hernias 2a. Brief review of embryology and general anatomy Types of Hernias with accompanying cases. 2b. Lesser Sac (Foramen of Winslow). 2c. Left paraduodenal (Fossa of Landzert). 2d. Right paraduodenal (Fossa of Waldeyer) 2e. Pericecal 2f. Transomental: Greater Omentum and Lesser Omentum 2g. Sigmoid 2h. Broad Ligament 3. Acquired/Iatrogenic 3a. Introduction to Acquired Hernias and commonly associated surgeries 3b. Roux en Y/ Gastric Bypass: Description of Procedure and Associated Hernias 3c and d. Epidemiology, Anatomy, and Imaging appearance of: transmesenteric and jejuno-jejunostomy hernias 3e. Left colectomy and low anterior resection 3f. Epidemiology, Anatomy, and Imaging appearance of the following: herniation of the small bowel inferior to the neorectum. 4. Complications 4a. Bowel obstruction, including closed loop 4b. Strangulation and Ischemia 5. Summary

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## Abstract Archives of the RSNA, 2023

GIEE-159

### Periportal Lesions - Tiny Space, Huge Possibilities

All Day Room: Learning Center

Cynthia L. Borborema, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To review the anatomy of the periportal space and its pathophysiology;
- To present the most relevant anatomical variants.
- To compartmentalize the periportal lesions through a series of cases.
- To introduce the disorders that may affect that space with a brief review of the clinical context and imaging findings.

#### TABLE OF CONTENTS/OUTLINE

- The periportal region is the anatomic space around the portal vein and its intrahepatic branches composed of hepatic artery branches, bile duct branches, lymphatics, and nerves that can be affected by a variety of pathological conditions. Due to its complex anatomical architecture and the wide possibility of lesion natures, involvement of the periportal space can be a diagnostic challenge for radiologists.
- Review of periportal anatomy with didactic illustrations of the main anatomical variants.
- In this presentation periportal lesions will be divided into the following categories: vascular (pathologies of the portal vein and hepatic artery), lymphatic (pathologies of periportal lymphatics), neural (pathologies of periportal nerves), periportal space as a pathway for diseases to spread and miscellaneous.
- A complete case-based review of common (periportal edema, portal biliopathy, peribiliary cysts, infectious diseases) and unusual disorders involving the periportal space, such as segmental arterial mediolysis, metastatic calcifications, plexiform neurofibroma, extramedullary hematopoiesis, amyloidosis, lymphangioma, hepatic artery giant pseudoaneurysm, ganglioneuroma, schwannoma.

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## Abstract Archives of the RSNA, 2023

GIEE-16

### Imaging of Pancreas Transplants: A Comprehensive, Multimodality Review

All Day Room: Learning Center

Rachel Perez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Anatomy and surgical technique 2. Key imaging features and techniques 3. Pancreas transplant complications

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Review of normal/donor pancreatic anatomy 2a. Donor arterial supply, venous drainage, and exocrine drainage 3. Surgical technique/transplant anatomy 3a. Systemic-venous drainage 3b. Portal-venous drainage 3c. Exocrine Bowel drainage 3d. Exocrine Bladder drainage 3e. Stepwise approach to identifying anatomy 4. Imaging 4a. Ultrasound and Contrast-Enhanced Ultrasound 4b. CT/CTA 4c. MRI/MRA (including ferumoxytol) 5. Biopsy technique 6. Complications 6a. Parenchymal 6a1. Rejection 6a2. Pancreatitis 6b. Vascular 6b1. Thrombosis 6b2. Stenosis 6b3. Hemorrhage 6b4. Pseudoaneurysm 6b5. Arteriovenous Fistula 6c. Bowel 6c1. Small Bowel Obstruction 6c2. Exocrine leak 7. Summary of key learning points

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## Abstract Archives of the RSNA, 2023

GIEE-160

### The Anatomy of Normal and Abnormal Swallowing

All Day Room: Learning Center

Nancy J. McNulty, MD (*Presenter*) Book contract, Oxford University Press

#### TEACHING POINTS

The oral cavity, pharynx, larynx, and surrounding muscles, bones and cartilaginous structures work together in a sophisticated and coordinated way to achieve normal swallowing. Accurate diagnosis of swallowing dysfunction requires a comprehensive understanding of what is normal, and how normal structures work in a coordinated fashion to achieve deglutition. This exhibit will review the components of swallowing that are voluntary, such as chewing, forming a bolus of food on the tongue, and initiating deglutition, and the involuntary reflexes that are initiated by stimulation of the palate or touch receptors in the pharynx. The pertinent anatomy, including muscles and their innervation, will be highlighted and reinforced. Clinically, swallowing dysfunction can be assessed with a video fluoroscopic barium swallow study. Normal swallowing exams will be used to demonstrate normal function, and highlight the components of a normal swallow.

#### TABLE OF CONTENTS/OUTLINE

Outline the sequence of events that occur during normal swallowing. Explain the muscles involved in the voluntary and involuntary tasks of swallowing and their innervation. Identify the anatomy and the role of structures of the head and neck during normal swallowing, and how they work to prevent nasopharyngeal regurgitation and aspiration. Review components of normal swallowing function on video swallowing examinations with audio narration. Observe video swallowing examinations with audio narration highlighting commonly encountered types of swallowing dysfunction.

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## Abstract Archives of the RSNA, 2023

GIEE-161

### **The Invaluable Role of CEUS in HCC imaging: Planning and Guidance of Ablative Therapy and Secondary Surveillance Following Treatment**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Shayan Hemmati, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) The unique benefits of hepatocellular carcinoma (HCC) diagnosis with contrast enhanced ultrasound (CEUS) include dynamic real time imaging and bubble tracking techniques, along with exquisite sensitivity for detection of arterial phase hyperenhancement (APHE) and washout (WO).(2) The advantages of performing CEUS prior to ultrasound guided ablative therapy for HCC include accurate identification of the nodule and grayscale occult lesions, determination of the best ultrasound technique (probe selection, patient positioning/breath hold), and identification of any unexpected findings that would alter or preclude ablative therapy (ex. additional lesions or tumour in vein).(3) Performance of CEUS at the time of ablation is essential to guide probe placement for grayscale occult or difficult to visualize nodules allowing the interventionalist to target either foci of APHE or areas of WO.(4) Performance of immediate post ablation CEUS to assess for completeness of ablation increases the number of successful ablations by allowing immediate identification and re-treatment of residual tumour or non-target ablations.(5) Inclusion of CEUS in secondary surveillance optimally resolves indeterminate or equivocal MRI results. Recognition of non-linear artifact on CEUS, arising from the microwave ablation probe tract, is essential to avoid misdiagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

- Background - Diagnosis of HCC with CEUS - Ablation Planning with CEUS - Ablation Targeting with CEUS - Immediate Post-ablation Assessment with CEUS - Secondary Surveillance with CEUS - Conclusion - References

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-162

### Role of Imaging in Systemic Therapy for HCC

All Day Room: Learning Center

Kevin A. Zand, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Multiple combined and single systemic therapies are currently FDA approved for intermediate and advanced stage HCC.2. Systemic therapy for HCC improves overall survival in patients who are not candidates for curative or locoregional therapies or who have failed locoregional therapy.3. Imaging has a key role in the post treatment evaluation, response assessment, and diagnosis of potential complications.4. LI-RADS treatment response algorithm is not applicable to the systemically treated HCC.5. HCC response to immunotherapy is different compared to chemotherapy, and should be considered in tumor response assessment by imaging.

#### TABLE OF CONTENTS/OUTLINE

1. The current role and survival benefit of immunotherapy for HCC2. Review of response assessment criteria in the systemically treated HCC (RECIST, mRECIST, and other criteria) and their use in clinical trials that lead to FDA approval of the new agents3. Post treatment imaging assessment. Representative cases will illustrate the imaging before and after systemic therapy (at multiple time points when relevant) with correlation with the clinical course and overall outcomes.(a) Representative cases from patients with favorable/stable outcomes.(b) Representative cases from patients with poor outcome.(c) Representative cases showing treatment related complications4. Review of emerging literature on combined immunotherapy with locoregional therapy 5. Limitations of treatment response assessment after systemic therapy for HCC and future directions

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## Abstract Archives of the RSNA, 2023

GIEE-163

### Hypointense Hepatic Findings on Hepatobiliary Phase Imaging

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Kelly C. Harper, MD, FRCPC (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the mechanism of hepatocellular contrast agent uptake and factors affecting it - Liver parenchyma hypointensities in hepatobiliary phase (HBP) can be diffuse, regional, and focal - Parenchymal hypointensities can be due to technical, parenchymal, vascular, and biliary causes - Both hepatocellular and non-hepatocellular lesions can show hypointensity - Hypointensity of a lesion is useful for its characterization - Hypointensity around a neoplasm may be associated with aggressive nature with management implications

#### TABLE OF CONTENTS/OUTLINE

- Parenchymal hypointensity
  - o Diffuse
    - o Technical- timing; opposed phase imaging; no fat suppression, low flip angle.
    - o Parenchymal
      - § Poor hepatocyte function-chronic liver disease
      - § Diffuse hepatic steatosis.
      - § Iron overload
      - § Infiltrative disorders- fibrosis, amyloidosis, malignancy etc
      - § Drug injury
      - § Genetic polymorphism of OATP1
    - o Vascular
      - § Acute portal vein-narrowing or occlusion
      - § Portal hypertension
      - § Sinusoidal obstruction syndrome
      - o Distal biliary obstruction- common bile duct
      - o Regional (lobar/segmental/geographical)
      - o Parenchymal
        - § Radiation- SBRT
        - o Vascular
          - § Acute portal vein branch occlusion
          - § Portal vein embolization
          - § Hepatic vein occlusion
          - o Bile duct branch occlusion
          - o Focal
            - o Focal fat deposits
            - o Focal confluent fibrosis
            - o Arteriportal shunts
            - o Infective/inflammatory- cholangitis
  - Hypointense lesions
  - Hepatocellular lesions
    - o Hepatocellular carcinoma
    - o Hepatic adenoma
  - Non hepatocellular lesions
    - o Cysts
    - o Metastases
    - o Hemangioma
    - o Cholangiocarcinoma

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## Abstract Archives of the RSNA, 2023

GIEE-164

### Inclusion of Liver CEUS in Current Practice Guidelines

All Day Room: Learning Center

Stephanie R. Wilson, MD (*Presenter*) Equipment support, Koninklijke Philips NV; Equipment support, Siemens AG; Equipment support, Samsung Electronics Co, Ltd; Research support, Samsung Electronics Co, Ltd;

#### TEACHING POINTS

(1) Current North American guidelines of relevance for liver imaging with CEUS include those from AASLD, American Association for the Study of Liver Disease; NCCN, National Comprehensive Cancer Network; and LI-RADS, Liver Imaging Reporting and Data Systems, a classification for those at risk for HCC including an algorithm for categorization of nodules shown on imaging. (2) CEUS was originally not favored for liver imaging because of misconceptions about its ability to differentiate hepatocellular carcinoma from cholangiocarcinoma. (3) Current data shows CEUS performs equivalent and often superior to CT/MR for characterization of liver nodules. (4) CEUS techniques for metastasis detection and diagnosis include sweeping the liver in the portal venous phase to show washout zones and on top injections to show the arterial enhancement of washout lesions. (5) CEUS STRENGTHS include: -Resolution of indeterminate nodules from CT/MRI, with reduction of biopsy -High specificity for HCC within LI-RADS allowing treatment of HCC following CEUS without biopsy. -Accurate characterization of nodules found on surveillance US for HCC. -Better correlation of nodules from surveillance US than shown with MRI, making CEUS the modality of choice as the first test following positive surveillance US. - Optimal diagnosis of small metastases

#### TABLE OF CONTENTS/OUTLINE

-Introduction of Guidelines for Liver Imaging -AASLD emphasizing imaging for suspect or confirmed HCC. -NCCN emphasizing long-term surveillance of patients at risk for development of metastases. -LI-RADS and its algorithm for categorization of liver nodules, with integration of CEUS LI-RADS with LI-RADS for CT/MRI. -Our perspective on Liver Imaging with CEUS.

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## Abstract Archives of the RSNA, 2023

GIEE-165

### Recognizing Benign Lesions in Cirrhotic Liver: Moving Beyond Odds and Enhancing Interpretation

All Day Room: Learning Center

Alexandre K. Wakote Teruya, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1 - This review aims to enhance the recognition and interpretation of benign lesions in patients with cirrhotic liver that may arise due to underlying cirrhosis or occur incidentally.2 - Illustrate with cases the typical and atypical features of these lesions using computed tomography (CT) and magnetic resonance imaging (MRI).3 - Provide practical considerations and diagnostic clues to minimize misunderstandings in interpretation and ensure accurate assignment of the Liver Imaging Reporting and Data System (LI-RADS®) category.

#### TABLE OF CONTENTS/OUTLINE

1 - Definition of cirrhosis and its impact on the appearance of benign lesions.2 - Describing the imaging presentations of various benign entities in cirrhotic liver on CT and MRI, distinguishing between their typical and atypical features.3 - Practical considerations and diagnostic clues to differentiate from malignancy and how to assign the correct LI-RADS® category.

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## Abstract Archives of the RSNA, 2023

GIEE-166

### What's New in Classification, Pathology, Imaging Findings, and Management of Cystic Liver Diseases: 2023 Update

All Day Room: Learning Center

Sriram Jaganathan, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Discuss 2023 updates on the classification, nomenclature, and pathology of developmental, non-neoplastic neoplastic cystic liver disease
- Review spectrum of imaging findings role of different imaging modalities in diagnosis management
- Discuss current updates in management strategies with special emphasis on the 2022 European Association for the Study of the Liver (EASL) clinical practice guidelines

#### TABLE OF CONTENTS/OUTLINE

Introduction Classification Nomenclature of hepatic cystic diseases Molecular pathogenesis hepatic cystogenesis updates Imaging Techniques: US/CT/MRI PET/CT Polycystic liver disease (PLD) Role of imaging in assessing cyst volumes, total liver volumes treatment follow-up; Gigot Schnellendorfer classifications; Complications Management Non-neoplastic Cysts Simple hepatic cysts (malformation of the ductal plate): cystic bile duct hamartoma; Infections: Abscess, Echinococcal cyst; Congenital: choledochal cyst Caroli disease, foregut cyst, von Meyenberg complex; Miscellaneous: peribiliary cysts, organizing hematoma, fibrous cyst pseudocyst Cystic Neoplasms Mucinous cystic neoplasms, Intraductal papillary neoplasm, tubulopapillary oncocytic papillary neoplasms, cystic metastases, HCC, cholangiocarcinoma rare tumors. Imaging spectrum of cystic liver diseases Management: EASL 2022 clinical practice guidelines with the central role of imaging Conclusion Imaging is pivotal in diagnosing, guiding appropriate treatment, and assessing complications for cystic liver diseases. By emphasizing up-to-date imaging findings and recommendations, radiologists are better equipped to provide effective patient care.

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## Abstract Archives of the RSNA, 2023

GIEE-167

### Liver Transplant Complications; Case Review from Our Hospital

All Day Room: Learning Center

Iskander A. Arteche Arnaiz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Get to know the normal findings of the immediate postoperative period of liver transplantation. Mention the most frequent complications classified into arterial, venous and biliary based on cases seen in our Hospital.

#### TABLE OF CONTENTS/OUTLINE

OLT (orthotopic liver transplantation) is the definitive treatment for patients with end-stage liver disease, acute fulminant liver failure, some neoplasms (HCC, metastases...increasingly broad indications). The surgical technique consists of extracting the donor (dissection of the hepatic hilum on a bench +- arterial reconstruction if variants) and subsequent implantation. The first step to take when evaluating a liver graft will be to read the surgical report to later understand the images. An ultrasound is mainly performed 24 hours after the transplant, in which we assess the parenchyma, the bile duct, and the flow of the arterial and venous vessels. It will be important to know the normal ultrasound findings. Complications are divided into arterial, venous and biliary. Regarding arterial complications, we have occlusion of the hepatic artery due to dissection/thrombosis of the latter (the most serious complication), hepatic artery stenosis, and pseudoaneurysms. Regarding biliary complications, we have, on the one hand, biliary strictures, most of them anastomotic (they may be non-anastomotic in the intrahepatic bile duct but are related to other causes such as ischemia) and on the other hand the bile leakage. Venous complications are the least frequent, and can affect both the suprahepatic veins and the portal vein, and consist mainly of thrombosis and stenosis.

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## Abstract Archives of the RSNA, 2023

GIEE-168

### Uncommon Pancreas Solid Lesions: Spectrum of Imaging Appearance and Radiologic-Pathologic Correlation

All Day Room: Learning Center

Yoshihiko Fukukura, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

TEACHING POINTS Pancreatic solid lesions display a wide spectrum of histology, including exocrine and endocrine tumors. The most common tumors of exocrine and endocrine tumors of the pancreas are ductal adenocarcinoma and neuroendocrine tumor, respectively. Uncommon tumors that need to be differentiated from the common pancreas solid tumors include adenosquamous carcinoma, colloid carcinoma, undifferentiated carcinoma, acinar cell carcinoma, solid-pseudopapillary neoplasm, etc. Familiarity of imaging findings of the uncommon tumors is important to arrive at the correct diagnosis of pancreas solid lesions because a precise diagnosis determines the treatment and surgical approach. The purpose of this exhibit is: 1. To describe the imaging and histopathologic features of uncommon pancreas solid tumors 2. To recognize and describe the imaging appearance of some mimics of pancreas solid tumors 3. To discuss the imaging differential diagnosis of pancreas solid tumors

#### TABLE OF CONTENTS/OUTLINE

1. Review of CT and MR imaging findings of uncommon pancreas solid tumors, with histopathological correlation. 2. Highlight key differential diagnostic points of pancreas solid tumors. 3. Summary: Awareness of radiological findings of uncommon pancreas solid tumor is important to arrive at the correct diagnosis of pancreas tumors.

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## Abstract Archives of the RSNA, 2023

GIEE-169

### Non-contrast Vascular Reconstruction in Patients with a History of Contrast Agent Allergy

All Day Room: Learning Center

Toru Iwasaka (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Depiction of vascular information by contrast-enhanced CT is required for preoperative examination of surgery. However, there are often cases where it is difficult to use a contrast medium due to allergies to the contrast medium. We have developed a virtual abdominal contrast CT image as a preoperative vascular image by non-contrast CT image for such cases. We performed CT without contrast medium infusion in the abdomen. High-definition scanning conditions were set for image reconstruction. Vascular extraction was performed on the obtained CT volume data using workstation automatic tracking. After that, the multi-planar reconstruction display (MPR) was created from the CT image. By combining the blood vessel information and the MPR display, it was possible to create a virtual abdominal contrast CT image similar to the conventional contrast CT without injecting a contrast medium. The images we developed were evaluated to have important information for the surgeon.

#### TABLE OF CONTENTS/OUTLINE

1. Necessity of vascular information and problems of contrast agent allergy 2. Scan technique for blood vessel extraction 3. Extraction of abdominal blood vessels using automatic tracking 4. Creating an MPR display 5. Composite display of blood vessel image MPR display 6. Clinical significance of virtual abdominal contrast CT images

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## Abstract Archives of the RSNA, 2023

GIEE-17

### **Misdiagnosis of Pancreatic Intraductal Papillary Mucinous Neoplasms and the Challenge of Mimicking Lesions: Imaging Diagnosis and Differentiation Strategies**

All Day Room: Learning Center

Stephen J. Kwak, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Accurate diagnosis of lesions that mimic IPMNs is crucial to determine appropriate surveillance or resection. 2. There is a risk of overdiagnosis and overtreatment of potentially neoplastic lesions with up to half of cystic lesions mischaracterized on imaging. 3. Using dedicated pancreatic protocol CT and noting unique features such as a bulging ampulla for IPMNs or the extracapsular cystic sign of SCAs can aid in distinguishing subtle differences. Additionally, a "cysts-within-a-cyst" appearance is often present in MCN, giving them an multilocular appearance, as opposed to the "cyst-by-cyst" presentation of IPMNs. 4. Cystic pancreatic neuroendocrine tumors have peripheral hypervascular rim on arterial phase CT. 5. Lymphoepithelial cysts have a cheerios-like appearance with signal drop out on out of phase images. 6. Pancreatic schwannoma has progressive homogeneous enhancement with areas of necrosis. 7. Chronic pancreatitis has a chain of lake appearance with strictures, intraductal calculi, and parenchymal calcifications. 8. EUS, FNA, fluid analysis, cytology, radiomics, and artificial intelligence are all useful tools for definitive diagnosis when CT and MRI are not specific enough.

#### **TABLE OF CONTENTS/OUTLINE**

1. IPMN diagnosis and misdiagnosis 2. Misdiagnosis of mimicking lesions and strategies to accurate diagnosis-Macrocystic Serous Cystadenoma-Cystic Pancreatic Neuroendocrine Tumor-Mucinous Cystic Neoplasm-Lymphoepithelial Cyst-Duodenal Diverticulum-Pancreatic Schwannoma-Chronic Pancreatitis-Retention Cyst and Cystic Fibrosis-Intrapancreatic Accessory Spleen and Epidermoid Cyst-Pancreatic Lipoma or Interdigitating Fat-Choledochal Cyst 3. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-170

### Advanced Ultrasound Techniques for Liver Transplantation Evaluation

All Day Room: Learning Center

Gonzalo Martin Ordonez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe the usual Doppler technique for liver graft follow-up and for evaluation of complications. To describe the use of contrast enhanced ultrasound (CEUS) in the evaluation of vascular complications and graft ischaemia. To describe the use of shear wave elastography in the evaluation of medical complications.

#### TABLE OF CONTENTS/OUTLINE

Liver transplantation is the treatment of multiple end-stage liver diseases. Medical and surgical complications are an important source of morbidity and mortality, and radiological examinations are essential for their early detection. Doppler ultrasound is the preferred imaging technique in the initial evaluation of the liver graft and during follow-up due to its portability and the unique hemodynamic information it provides. The use of CEUS allows to confirm vascular complications to define the location and the extension of ischemic areas, and to ascertain biliary tract ischemic involvement, what that is key for deciding the optimal treatment. Shear-wave elastography provides a non-specific but interesting quantitative information that allows for a sequential evaluation of the liver parenchyma. It is useful in the diagnosis and follow-up of medical complications including rejection and the rarer obstructive sinusoidal syndrome. The liver rigidity also aids to decide in which patients a biopsy should be done. We show a pictorial review of cases from our institution to illustrate the vascular, biliary and medical complications that can be evaluated with these techniques.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-171

### Advanced Abdominal MRI Techniques and Problem-solving Strategies

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Yoonhee Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Magnetic resonance imaging (MRI) plays an important role in abdominal imaging owing to its ability of detection and characterization of focal lesions. Nowadays, techniques for reducing scan time with an acceptable image quality such as parallel imaging, compressed sensing (CS) technique, and nowadays cutting edge deep learning (DL) techniques have arisen for problem solving strategies. Also free breathing techniques using dynamic phase involving extra-dimensional (XD)-volumetric interpolated breath-hold examination (VIBE), and golden-angle radial sparse parallel (GRASP) can help patients with severe dyspnea or under sedation perform abdomen MRI. Therefore, this pictorial review aims to show various advanced abdomen MRI techniques for reducing scan time with maintaining image quality and free breathing techniques during dynamic phase, and representative cases with aforementioned techniques.

#### TABLE OF CONTENTS/OUTLINE

•I. Reducing scan time and improving image quality  
1.Parallel imaging : Dynamic phase (Controlled Aliasing in Parallel Imaging Results in Higher Acceleration), Half-Fourier-acquisition single-shot turbo spin-echo (HASTE)  
2.Compressed sensing technique : Dynamic phase, Magnetic resonance cholangiopancreatography  
3.Deep learning (DL) : T2 weighted image, Diffusion weighted image  
•Strength and pitfalls of DL while radiologists interpreting lesions  
4.Motion corrected diffusion weighted image  
•II. Free breathing technique during dynamic phase  
1.Stack of Stars volumetric interpolated breath-hold examination (StarVIBE)  
2.Extra-dimensional (XD)-VIBE  
3.Golden-angle radial sparse parallel (GRASP)

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## Abstract Archives of the RSNA, 2023

GIEE-172

### Imaging of Pancreatic Cystic Lesions: What Radiologists Should Know

All Day Room: Learning Center

Akihiko Kanki, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this presentation is: 1) To demonstrate the common and uncommon computed tomography and magnetic resonance imaging findings of neoplastic pancreatic cystic lesions, including the radiologic-pathologic correlation. 2) To learn about the non-neoplastic and cyst-like lesions of the pancreas that can mimic pancreatic cystic neoplasms.

#### TABLE OF CONTENTS/OUTLINE

Classification of Pancreatic Cystic Lesions  
Imaging findings of common pancreatic cystic lesions  
Neoplastic pancreatic cystic lesions  
• Mucinous cystic neoplasm  
• Serous neoplasm  
• Intraductal papillary mucinous neoplasm  
• Intraductal tubulopapillary neoplasm  
• Intraductal oncocytic papillary neoplasm  
Imaging findings of uncommon pancreatic cystic lesions  
• Intraductal papillary mucinous neoplasm complicated with intraductal hemorrhage, perforation and fistula formation  
• Mucinous cystic neoplasm occurring with side branch-type intraductal papillary mucinous neoplasm  
Non-neoplastic and cyst-like lesions of the pancreas that can mimic pancreatic cystic neoplasms  
Non-neoplastic pancreatic cystic lesions  
• Squamous lined cyst  
• Acinar cystic transformation  
Various pancreatic tumors with cystic degeneration  
• Solid pseudopapillary neoplasm  
• Others

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-173

### **Pseudomyxoma Peritonei: Imaging Features and Current Therapies**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Laura Jorgenson (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Define pseudomyxoma peritonei. Understand and describe the histopathology, pathophysiology, and etiologies of PMP, with a focus on appendiceal and ovarian neoplasms. Describe the multimodality imaging features of pseudomyxoma peritonei. Recognize complications related to PMP, mucinous tumor burden, and cytoreductive surgery. Discuss specific imaging findings which are essential to the surgical oncologist in determining resectability and cytoreductive surgery planning. Review current therapies available to patients with PMP.

#### **TABLE OF CONTENTS/OUTLINE**

TABLE OF CONTENTS/OUTLINE 1. Definition of PMP and imaging features  
Define Optimizing US, CT, MR, and PET image acquisition  
Imaging features on different modalities  
Natural History 2. Tumor Origin  
Appendiceal  
Ovarian  
Non-malignant causes  
Differentiation from multicystic mesothelioma  
Brief review of pathologies of peritoneal surface malignancies 3. Potential Complications and related imaging features 4. Example reporting template 5. What the surgeon needs to know and current therapies  
Peritoneal Carcinomatosis Index (PCI)  
Cytoreductive Surgery  
HIPEC  
Systemic chemotherapy - understanding response to therapy vs. progression

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

GIEE-175

### **Ancillary Features Are Coming to LI-RADS Treatment Response Algorithm: Let's Get You Ready**

All Day Room: Learning Center

Marisa Martin, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- The LI-RADS Treatment Response Algorithm (LR-TRA) is a standardized system for assessing and reporting treatment response after locoregional therapy (LRT) for hepatocellular carcinoma (HCC).- Emerging radiology-pathology and inter-reader studies have highlight the potential for ancillary features to improve detection of incomplete necrosis with greater radiology-pathology concordance.- This exhibit highlights the updates in the LR-TRA v2023 (compared to v2018), especially pertaining to the role of newly incorporated ancillary features. The overall objective of the changes is to improve diagnostic accuracy of post-treatment imaging assessment.

#### **TABLE OF CONTENTS/OUTLINE**

- Summarize the role of the TRA in the context of the currently used treatments for HCC.- Provide an evidence-based review of current literature highlighting the value of incorporating ancillary features in treatment response assessment after locoregional therapy in HCC.- Highlight key updates of the LI-RADS v2023 TRA pertaining to use of ancillary features after various forms of LRT for response assessment, using a case-based and illustrative approach.

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## Abstract Archives of the RSNA, 2023

GIEE-176

### **Ischemic Cholangiopathy: Imaging Patterns and Other Biliary Complications Following DCD Liver Transplant**

All Day Room: Learning Center

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to: 1. Describe various imaging patterns of ischemic cholangiopathy post DCD liver transplant on MRI/MRCP2. Elaborate prognostic significance of these imaging patterns. 3. Discuss additional biliary complications post liver transplant.

#### **TABLE OF CONTENTS/OUTLINE**

Four different patterns of IC: have been identified, each correlating with DCD allograft prognosis. • Diffuse necrosis: Most severe form with nearly 100% need for retransplant, characterized by multifocal biliary strictures, wall necrosis and bile lakes. Usually, hepatic artery is severely stenosed or occluded. • Multifocal progressive: Starts as mild to moderate multifocal stricturing cholangiopathy that progresses in a few months to more severe form with worsening strictures or even biliary necrosis. >50% need for retransplant. • Confluence dominant: Mild to moderate cholangiopathy that involves the biliary confluence. Most cases can be managed without need for retransplant. • Minor Form: Mild areas of multifocal stricturing that remain stable or resolve. Other liver transplant biliary complications: • Anastomotic stricture • Bile leak/anastomotic dehiscence • Vanishing bile duct syndrome (ductopenia) • Biliary stones; Biliary cast syndrome; hemobilia • Cystic duct remnant mucocele • Roux limb bleeding, Roux limb stasis or obstruction. Summary IC post DCD liver transplant is a major source of allograft complications. Identifying different patterns of IC can help stratify need for stenting and predict allograft prognosis.

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## Abstract Archives of the RSNA, 2023

GIEE-177

### Multimodality Imaging Biomarkers for Crohn's Disease Strictures

All Day Room: Learning Center

Safa Hoodeshenas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To understand the role and characteristics of existing and future biomarkers in Crohn's disease strictures
- To review existing diagnostic and prognostic Crohn's imaging biomarkers and potential surrogate clinical endpoints
- To describe potential imaging biomarkers that reflect stricture histopathology or pathophysiology
- To describe the strengths and weaknesses of existing and future biomarkers for Crohn's disease strictures.

#### TABLE OF CONTENTS/OUTLINE

- Existing diagnostic and prognostic biomarkers of Crohn's disease strictures
- Using CT or MR enterography to measure response biomarkers and/or efficacy endpoints for Crohn's strictures
- Stiffness, fibrosis, and smooth muscle hypertrophy are histopathologic and physiologic targets for an emerging array of MR, ultrasound, and PET biomarkers
- MRI-based biomarkers include delayed gadolinium enhancement, normalized magnetization transfer, DWI and intravoxel incoherent motion, T1 mapping, intramural T2 signal, and quantified small bowel motility
- Ultrasound-based biomarkers include wall thickness, elastography to measure shear stiffness, contrast-enhanced ultrasound, and ultrasensitive microvessel imaging
- Molecular imaging targets at PET-MRE include inflammation and fibrosis

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## Abstract Archives of the RSNA, 2023

GIEE-178

### **Kidney Pancreatic Transplantation: Anatomy and Surgical Technique Guide for Residents**

All Day Room: Learning Center

Juan Bautista Rolla, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Pancreas transplant is a complex procedure which represents a surgical alternative for the treatment of diabetic patients with the goal of avoiding the systemic complications associated with the disease. The most frequent approach is the SPK transplant in which both grafts of a single donor are inserted in one surgical act, on the right and the left fossa respectively. Transplanted kidney is implanted extraperitoneally in an iliac fossa. The most widely used technique is end-to-side anastomosis of the donor's renal artery to the recipient's external iliac artery. Transplantation of the pancreatic graft is performed together with a duodenal segment. Enteric exocrine drainage will be through anastomosis of the donor duodenal segment to a small bowel loop of the recipient whereas systemic endocrine drainage will be through the portal vein of the graft which is anastomosed directly to the primitive iliac vein. To learn surgical technique and post-operative anatomy. To know normal postoperative imaging assessment. To recognize all the complications.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction and normal anatomy Surgical techniques Normal post-operative imaging appearance Complications Take-home messages

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-179

### Hepatic Sinusoidal Disorders

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Sudhakar K. Venkatesh, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Understand pathophysiology behind hepatic sinusoidal disorders
- Review the typical imaging appearances sinusoidal obstruction caused by different etiologies and characteristic findings for differentiation of etiologies.
- Review conditions that cause sinusoidal and perisinusoidal infiltration and may mimic sinusoidal obstruction.

#### TABLE OF CONTENTS/OUTLINE

- Normal hepatic sinusoid structure and physiology
- Mechanisms causing sinusoidal dilatation and/or obstruction.
- Histopathological correlation of imaging findings
- Sinusoidal dilatation o Outflow obstruction § Post sinusoidal causes.
- Congestive hepatopathy · Heart failure · Pericarditis · Congenital heart diseases
- Budd-Chiari syndrome
- Sinusoidal obstruction syndrome o Myeloablative conditioning for stem cell transplantation. § Utility of ultrasound in diagnosis of SOS in children o Chemotherapy- oxaliplatin based therapies, immunotherapy. o Radiotherapy
- Sinusoidal dilatation without obstruction o Vascular disorders § Arterioportal shunts § Decreased portal flow. § Porto-sinusoidal vascular disorder o Extrahepatic acute inflammatory/infective conditions o Use of oral contraceptives or hormones o Hepatic peliosis o Extrahepatic malignancy without liver infiltration
- Sinusoidal and/or perisinusoidal infiltration with or without dilatation o Perisinusoidal fibrosis o Amyloidosis o Myeloproliferative disorders o Malignancy

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## Abstract Archives of the RSNA, 2023

GIEE-18

### **The Dark Side of the Bowel Disease: Algorithmic Approach Step by Step**

All Day Room: Learning Center

America Hernandez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review through different imaging modalities the evaluation of the intestinal wall. To revise the general features of the normal bowel wall. Create an algorithm that allows quick < easy evaluation to guide the diagnosis. To discuss the different imaging findings we may see in different pathologies. To study different pathologic entities that present with bowel wall thickening.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Anatomy basic bowel wall. Step by step > interpretation of < analyzed by categorizing attenuation changes in the intestinal wall. Diagnostic Algorithm description. Descriptions of the commonest causes Key points. Conclusions  
References

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## Abstract Archives of the RSNA, 2023

GIEE-180

### CT Approach to Acute Mesenteric Ischemia

All Day Room: Learning Center

Daniel Sebastian Chaves Burbano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Acute mesenteric ischemia it's an infrequent pathology, but the mortality rate is high because of the nonspecific symptoms and the delayed diagnosis, so the role of the imaging and the radiologist are fundamental to reduce the mortality rates.- Appropriate protocols of CT imaging should be used to optimize the radiation and contrast medium use, because there is a disbalance in the homeostasis of the patient and every minute counts to make de diagnosis.-If there is a kidney failure, there are protocols for a safety use of the iodinated contrast medium.-To establish an adequate diagnosis, the histopathology and anatomy of the arteries and the bowel should be evaluated.-There are three main structures that we must evaluate to have an adequate approach to mesenteric ischemia: bowel lumen, bowel walls and abdominal localization.-When there is an acute mesenteric ischemia, other abdominal organs like adrenal glands, inferior cava vein, aorta, liver, spleen, and kidneys have changes and findings that can predict complications and mortality.

#### TABLE OF CONTENTS/OUTLINE

Gross anatomy Abdominal artery anatomy. Relevant anastomoses. Abdominal vein anatomy. Histology of the bowel. Pathophysiology of acute mesenteric ischemia. CT imaging protocols. Indications, Simple, artery and portal phases with timing and technique (kVp, mA, rotation, PITCH). What to do if there is an acute kidney failure Classification of the acute mesenteric ischemia. Systematic approach to acute mesenteric ischemia. Bowel Wall thickness. Diameter. Wall enhancement. Mesentery Fat. Liquid. Localization. Vessels. Artery. Vein. Other abdominal organs Liver. Kidneys. Adrenal glands. Pulmonary embolism. Conclusions. Bibliography.

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## Abstract Archives of the RSNA, 2023

GIEE-181

### Gastric Cancer CT Staging: Radiologic Patterns with Radiologic-Pathologic Correlation

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Maria Agostina Giallorenzi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

State of the art treatment of locally advanced gastric cancer is multimodal and involves combined surgical and medical therapy. CT has a central role in the staging of gastric cancer, being the method of choice for this purpose; a local and distant staging as accurate as possible is crucial for a correct treatment planning, avoiding under- or over-treatment of the Patient. To obtain a correct staging, a thorough knowledge of normal and pathologic gastric radiological anatomy and the pathways of tumor spread is crucial. Through the analysis of illustrative cases: To know the normal and pathologic gastric radiologic anatomy and the lymphatic and hematogenous pathways of spread of gastric cancer. To know the TNM classification (8th edition) for gastric cancer and correctly use the CT criteria necessary for its application. To correlate radiologic patterns of gastric cancer with macroscopic and microscopic pathologic patterns. To correlate clinical CT staging and pathologic staging with regard to T and N parameters. To understand the limitations and pitfalls of imaging and the causes of radiological overstaging and understaging.

#### TABLE OF CONTENTS/OUTLINE

1. Concepts of normal and pathologic gastric radiologic anatomy and lymphatic and hematogenous tumor spread pathways are explained. 2. Some illustrative cases of early-stage, locally advanced and oligometastatic gastric cancer are presented, with clinical staging obtained by CT imaging applying the TNM 8th edition classification. Correlation of CT images with macroscopic and microscopic pathologic findings is shown by detailed explanation of the findings. 3. Some examples of CT understaging and overstaging and their possible explanations are presented.

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## Abstract Archives of the RSNA, 2023

GIEE-182

### **Abdominal Inflammatory Lesions Unmasked: A Radiological Hunt for Tumor Impostors!**

All Day Room: Learning Center

Abrahamo Elias Neto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the abdominal inflammatory diseases which mimic tumor-like lesions. To present diagnostic challenging cases of inflammatory diseases that can mimic tumoral lesions. To be aware of non-malignant conditions as differential diagnoses at the initial presentation of lesions suspicious for neoplasms, and which imaging features may help in the differentiation. To highlight clinical and laboratory data that can help the radiologist not fall into pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

Abdominopelvic inflammatory lesions can present a diagnostic challenge for radiologists, particularly when distinguishing between tumor and non-tumor involvement. This can have a significant impact on patient outcomes, as the management and prognosis of these conditions can vary dramatically. Overview of the main inflammatory diseases that mimic neoplasms. Key radiological findings in cross-section abdominal images that aid in distinguishing between tumor and non-tumor lesions. The role of clinical and laboratory information in the differential diagnosis of inflammatory lesions. Didactic exposition of illustrative cases in which inflammatory diseases mimic neoplasms, such as rectal syphilis, peritoneal tuberculosis, focal pyelonephritis, glandular cystitis, hepatic inflammatory pseudotumor, xanthogranulomatous cholecystitis, complicated appendicitis, focal pancreatitis, vaginal vault abscess, and lobular endocervical glandular hyperplasia. Recap of the importance of accurately differentiating between tumor and non-tumor involvement in abdominopelvic inflammatory lesions, with the key takeaways from this educational exhibition.

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## Abstract Archives of the RSNA, 2023

GIEE-183

### Expanding the Role for Biopsy in HCC: It's Not Just About Diagnosis

All Day Room: Learning Center

Mansur A. Ghani, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Traditionally, clinical indications for biopsy of hepatocellular carcinoma (HCC) have included circumstances when imaging diagnosis is uncertain or for HCC that does not respond as expected to therapy. 2. More recently, developments in the understanding of pathological and molecular alterations in HCC at the cellular level have created additional opportunities for biopsy for the purposes of prognosis, treatment selection and treatment monitoring.

#### TABLE OF CONTENTS/OUTLINE

Review of traditional indications for biopsy in HCC (Fig. 1)- Diagnosis in the case of LR-4 (Fig. 2), LR-M (Fig. 3) and LR-TIV- Lesions that do not respond as expected to therapy Additional potential roles for biopsy in HCC- Diagnosis- Lesions in non-cirrhotic livers or scenarios where LI-RADS currently cannot be applied (e.g. cardiac cirrhosis and Fontan related liver disease)- LR-3 lesions (Fig. 4)- Prognosis- There are several histological HCC sub-classes, each with distinct molecular patterns and prognostic implications (Fig. 5)- Microscopic vascular invasion (MVI) can be incidentally detected on biopsy, and surrogate molecular markers can be used to predict MVI- Stemness-related biomarkers are associated with more aggressive clinical behavior- Treatment selection- Potentially targetable genetic alterations are found in approximately 24% of HCC.- Treatment monitoring- Genetic sequencing of biopsy tissue can be performed to design specific liquid biopsy panels to monitor efficacy of treatment.- Biopsy Techniques- Biopsy types: fine-needle aspiration, needle-core biopsy, micro-histology, liquid biopsy- Types of image guidance- Ultrasound with an emphasis on the emerging role of contrast-enhanced ultrasound- CT-guided

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## Abstract Archives of the RSNA, 2023

GIEE-184

### Getting to the Bottom of the Pelvic Floor: A Primer on MR Defecography Technique, Reporting and Implications for Surgical Management

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Indications for MR defecography (MRD); advantages over fluoroscopic defecography and correlation of both techniques
- Anatomic considerations: compartments, measurements, pathophysiology of the pelvic floor
- Technique and phases of examination for functional assessment
- Standardized terminology and reporting
- Imaging findings of common and rare diagnoses
- Surgical management of pelvic organ prolapse: choice of procedure, techniques and post-op imaging findings

#### TABLE OF CONTENTS/OUTLINE

Review pelvic compartmental anatomy, important lines and measurements:- Pubococcygeal line- H-line- M-line- Urethral axis- Vaginal axis  
Variations of technique and equipment:- Phases: rest, contraction, defecation- Sequences- Open vs. closed  
MRI technique- Coil design  
Standardized terminology and reporting, consensus guidelines by SAR and AJR. Step by step interpretation of a case with sample reporting template.  
Entities discussed:- Peritoneocele, Enterocoele, Sigmoidocele- Cystocele- Urethral Hypermobility- Uterine/Vaginal prolapse- Descending perineal syndrome- Structural Outlet Obstruction: Rectocele, Rectal prolapse, Intussusception, Rectal mass- Functional Outlet Obstruction: Puborectalis dyskinesia, Anismus  
anorectal incontinence- Spastic pelvic floor syndrome  
Surgical management of pelvic descent- Pre-op considerationso Obliterative vs. reconstructive techniqueso Abdominal vs. vaginal approacho Concomitant urinary or fecal incontinence repair, colporrhaphyo Hysterectomy vs. uterine-sparingo Risk calculator for prophylactic urinary incontinence preventiono Indications for mesh augmentation- Post-op imaging findings and complications

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## Abstract Archives of the RSNA, 2023

GIEE-185

### **MRI-Based Body Composition Analysis: We Can See the Fat That Hides Inside You**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Luciana C. Belem, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review how MRI of the abdomen may help identify high-risk adiposity phenotypes in the obesity context.- Review the literature on obesity, addressing the impact of visceral and ectopic fat in health.- Discuss which measurements can be made on MRI of the abdomen to assess visceral and ectopic fat.- Teach how to measure visceral and ectopic fat on MRI of the abdomen.

#### **TABLE OF CONTENTS/OUTLINE**

- Definition: what is visceral and ectopic fat.- Review the pathophysiology of obesity and discuss how to differentiate the adiposity phenotypes on MRI.- Body composition measures on MRI: Visceral adipose tissue, subcutaneous adipose tissue and skeletal muscle. Area or volume? If area, which level? Which muscle groups to include in skeletal muscle quantity assessment.- Protocol: which sequences use to assess body composition parameters and quantify ectopic fat.- Chemical shift-encoded (CSE) MRI with estimation of proton density fat fraction (PDFF): potential biomarker in obesity.- Ectopic fat measures on MRI: Muscle fat: which abdominal muscle group to measure? Pancreas fat: where and how to measure? Liver fat: where and how to measure?

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## Abstract Archives of the RSNA, 2023

GIEE-186

### **Mind The gap! The Tubes and Pipes in Crohn's Disease: Technical Aspects and Diagnostic Findings of CT and MRI-Enterography**

All Day Room: Learning Center

Mayra V. Soares, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review relevant points in the anatomy of the small intestine, in the context of Crohn's Disease, highlighting the main sites of involvement. To review the indications, protocol, and technical aspects of CT and RM-enterography (CT-e and MR-e). To point out differences and similarities, advantages and disadvantages between CT-e and RM-e. To show typical and atypical imaging findings of Crohn's disease and main complications. To distinguish phenotypic patterns of presentation of Crohn's disease in CT-e and RM-e.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Review of the anatomy of the small intestine Review of the typical and atypical imaging findings of Crohn's disease and its phenotypes CT-e and MR-e protocols Main diagnostic findings in Crohn's disease: Segmental mural enhancement mural thickening stenosis ulcerations vasa recta ingurgitation lymph node enlargement Complications related to Crohn's Disease: fistulas inflammatory mass Abscess

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## Abstract Archives of the RSNA, 2023

GIEE-187

### **The Mystery of Internal Hernias: What Should the Radiologists Know?**

All Day Room: Learning Center

Basem Jaber, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Reviewing the different types of the internal hernias- Discussing the imaging features of various types of internal hernias- Identifying possible complications of internal hernias- Providing case-based review of common and uncommon pathologies

#### **TABLE OF CONTENTS/OUTLINE**

Internal hernias are defined as protrusion of small bowel loops through normal apertures and/or defects in the peritoneum or mesentery into a compartment within the abdominal cavity, commonly presenting as an acute intestinal obstruction. The incidence of internal hernias is increasing with the new surgical procedures now being performed. It is crucial for radiologists to be familiar with and understand the different types of internal hernias and the possible complications since they have high mortality rate and they are often challenging to recognize. Key points:- Introduction to peritoneum anatomy- Internal hernia different types- The diagnostic approach for internal hernias- Pearls and pitfalls for recognizing internal hernias complications imaging features

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## Abstract Archives of the RSNA, 2023

GIEE-188

### Just Not GIST: Non-GIST Mesenchymal Neoplasms of the Alimentary Tract

All Day Room: Learning Center

Rashmi Balasubramanya, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

There is a heterogeneous group of non-GIST, mesenchymal neoplasms of the gastrointestinal tract that are characterized by distinctive histopathology tumor genetics as well as variable clinico-biological profiles and imaging findings. Characteristic disease distribution: While glomus tumors and plexiform fibromyxomas display distinct predilection for the gastric antrum, smooth muscle tumors of the gut preferentially occur in the esophagus and colorectum. Distinctive genetic markers: Based on MDM2 gene amplifications, esophageal giant fibrovascular polyps are now considered well-differentiated liposarcomas. Other tumors with distinctive cytogenetics include lipomas (HMGA2 gene rearrangements), granular cell tumors (inactivating AP6AP gene mutations), gastroblastomas (MALAT1-GLI1 fusions), plexiform fibromyxomas (GLI activating mutations), malignant neuroectodermal tumors (EWSR1-ATF1 gene fusions), IMTs (ALK gene rearrangements) and SFTs (STAT6 NAB2 gene fusions).

#### TABLE OF CONTENTS/OUTLINE

Introduction, taxonomy, demographics, clinical manifestations, pathological features, Multimodality cross sectional imaging findings on CT, MRI, PET-CT, management, prognosis, conclusion. Entities discussed: Esophageal granular tumor and well-differentiated liposarcoma; distinctive gastric tumors such as synovial sarcoma, IMT, plexiform fibromyxoma, and glomus tumor; smooth muscle tumors, lipomatous/neurogenic tumors, malignant neuroectodermal tumor, Kaposi sarcoma, sclerosing epithelioid fibrosarcoma.

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## Abstract Archives of the RSNA, 2023

GIEE-189

### Not Always What It Seems: Exploring Mimickers of Liver Malignancy

All Day Room: Learning Center

Kumi Ozaki, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

· Review of several mimickers of liver malignancy based on characteristic imaging findings. · Comprehension of key clinical and imaging findings that may help distinguishing mimickers from malignant liver lesions.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of characteristic imaging and clinical features of typical liver malignancy.
2. Overview of mimickers of liver malignancy based on each characteristic imaging findings; patterns of enhancement (early staining and prolonged enhancement, early staining and wash-out, gradual enhancement, peripheral enhancement), fat component, lower ADC values, growth rate, cystic lesion with mural nodule, periportal lesion and so on.
3. Overview of mimickers of liver malignancy in the patients with chronic liver disease or cirrhosis.
4. Overview of mimickers of liver malignancy in the patients with a known malignancy.
5. Undistinguishable mimickers from liver malignancy.
6. Take home points

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## Abstract Archives of the RSNA, 2023

GIEE-19

### Precision Medicine and Early Detection of Pancreatic Cancer

All Day Room: Learning Center

Linda C. Chu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Patients with pancreatic cancer often present with non-specific clinical symptoms and are diagnosed at advanced disease stage. Recent advances in imaging techniques, molecular analysis, and artificial intelligence can lead to earlier detection of pancreatic cancer, which can significantly improve patient outcomes. The purposes of this exhibit are to review the current guidelines in high-risk screening of pancreatic cancer, review the role of liquid biopsy and pancreatic cyst fluid molecular markers in earlier detection, and the potential role of artificial intelligence in automated detection of pancreatic cancer.

#### TABLE OF CONTENTS/OUTLINE

Current guidelines in high-risk screening of pancreatic cancer. Role of liquid biopsy and pancreatic cyst fluid molecular markers in early detection. Artificial intelligence assisted automated detection of pancreatic cancer.

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## Abstract Archives of the RSNA, 2023

GIEE-190

### CT Imaging for Assessment of Hepatic Steatosis

All Day Room: Learning Center

Tomoko Hyodo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To illustrate a pictorial review of focal and diffuse steatosis in the liver. 2. To explain the principles of quantitative assessment of liver fat using CT. 3. To review the accuracy of fat quantification by using single-energy CT (including quantitative CT) and dual/multienergy CT. 4. To demonstrate application to visual display of quantitative results.

#### TABLE OF CONTENTS/OUTLINE

1. Clinical significance 2. Etiology of diffuse fatty liver diseases 3. Beware of localized fat: neoplastic and non-neoplastic lesions 4. CT techniques for quantification. 4-1. Conventional single-energy CT and quantitative CT 4-2. Dual-energy CT a) CT attenuation value b) Fat fraction c) Electron density d) Virtual non-contrast imaging 4-3. Photon-counting CT 5. Visual tools for pre- and post-therapy assessment 5-1. Fat quantification of each liver lobe/segment 5-2. Fat distribution and its statistics

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-191

### Computer-Aided Diagnosis for Hepatic MRI: What is Needed and Expected

All Day Room: Learning Center

Shogo Maeda (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

a. As gadoteric acid-enhanced MRI has combined perfusion and hepatocyte-selective properties, it is widely used to detect and diagnose focal hepatic lesions. b. Gadoteric acid-enhanced hepatobiliary phase (HBP) images are highly sensitive for the detection of hepatic lesions. However, small lesions, especially those near hepatic vessels, may be missed because they and the vessels are low signal-intense on HBP images. Computer-Aided Diagnosis (CAD) may be effective, especially for detecting small lesions on HBP images. c. Because many hepatic lesions, benign or malignant, are low signal-intense on HBP images, a differential diagnosis requires comprehensive evaluation with other sequences. CAD can differentiate between benign and malignant lesions by integrating information from EOB-MRI and sequences such as T2- and diffusion-weighted scans. Therefore, CAD is particularly useful for differential diagnosis in a single case of mixed benign and malignant lesions. d. A diagnosis of hepatic lesions is reached by integrating findings from various modalities and clinical information. A CAD that integrates all information is required.

#### TABLE OF CONTENTS/OUTLINE

a. History and classification of CAD in radiology b. Possibility of CAD for detecting hepatic lesions on MR images c. Possibility of CAD for diagnosis of hepatic lesions on MR images d. Future prospects of CAD for diagnosing hepatic lesions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-192

### Update on Histology, Staging, and Treatment of Intrahepatic Cholangiocarcinoma: The Role of the Radiologist

All Day Room: Learning Center

Wyanne Law, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the morphologic and histopathologic classification of intrahepatic cholangiocarcinoma (ICC) 2. Discuss differential diagnosis of ICC, including hepatocellular carcinoma (HCC), metastasis and benign entities 3. Describe American Joint Committee on Cancer (AJCC) 8TH edition staging for ICC and resection criteria 4. Discuss non-surgical options and recognize response/progression disease and complications

#### TABLE OF CONTENTS/OUTLINE

Classification Location: intrahepatic 10% vs perihilar 50- 60% vs distal 20-30% Morphologic: periductal infiltrating, mass forming, intraductal growing-Histopathologic: large duct vs small duct Imaging characteristics of ICC Peripherally enhancing, hypervascular, delayed enhancement Update on staging AJCC 8th edition for ICC TNM Surgical Resection Adequate future liver remnant (FLR) with intact hepatic arterial, portal venous, hepatic venous, and biliary drainage, excluding distant metastases, bilobar tumor and nonregional nodes Chemotherapy Gemcitabine + cisplatin Response: RECIST Immunotherapy TOPAZ-1 trial - Durvalumab -New inhibitors targeting genetic alterations in small duct, Pemigatinib, infigratinib Response: iRECIST- Complications: colitis, hepatitis, pneumonitis, renal failure, myocarditis Hepatic arterial infusion pump Floxuridine- Complications: gastroduodenal artery aneurysm, extravasation from catheter Ablative radiotherapy Complications: Radiation-based liver parenchymal changes (RILD), delayed onset of radiation necrosis Transarterial radioembolization (TARE) Yttrium 90 Complications: Post-radioembolization syndrome, gastroduodenal ulcer, cholecystitis

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## Abstract Archives of the RSNA, 2023

GIEE-193

### Gastrointestinal Ectopic Pancreas: Cross-sectional Imaging Spectrum and Differential Diagnosis

All Day Room: Learning Center

Xueying Long, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the clinical manifestations and the spectrum of cross-sectional imaging findings of the ectopic pancreas (EP) in the gastrointestinal tract. 2. Discuss the diagnosis of the gastrointestinal EP with emphasis to formulate a differential diagnosis for gastrointestinal submucosal tumors.

#### TABLE OF CONTENTS/OUTLINE

1. The definition and overview of clinical manifestations of gastrointestinal ectopic pancreas (EP). 2. The pathologic gross manifestation and histological classification of EP. 3. A list of the common morphological manifestations of EP on cross-sectional images including sites and incidences, location, size, shape, contour, margin, attenuation/intensity signals, growth pattern, enhancement pattern, picking out those specific signs which are essential clues to indicate the diagnosis, such as duct-like structure in the lesion, hyperenhancement of the overlying mucosa, central umbilication, perilesional fat or low attenuation. 4. Describe the uncommon findings of EP with a comprehensive case series, including rare histological types and with secondary complications, including pancreatitis, pseudocyst formation, malignant degeneration, gastrointestinal bleeding, bowel obstruction. 5. Differential diagnosis between EP and other gastrointestinal submucosal tumors, such as gastrointestinal stromal tumors (GISTs), gastroduodenal glomus tumors, neuroendocrine tumor, leiomyomas and schwannomas. 6. Summary 7. Suggesting reading

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## Abstract Archives of the RSNA, 2023

GIEE-2

### **Squamoid Cyst of Pancreatic Ducts: Rare Cystic Lesion of Pancreas**

All Day Room: Learning Center

Duygu Cengiz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Develop an awareness of squamoid cyst of pancreatic ducts (SCOP) Learn imaging features of SCOP Compare SCOP to other similar cystic lesions to make differential diagnosis. Discuss relation of SCOP and PDAC

#### **TABLE OF CONTENTS/OUTLINE**

Cystic lesions of pancreas Rare pancreatic cystic lesion: Squamoid cyst of Pancreatic Ducts (SCOP) Pathologic definition of SCOP Misnomer or not: Is SCOP really related to pancreatic ducts? Imaging features of SCOP Differential diagnosis of SCOP Simple Mucinous Cyst (SMC): Is it possible to differentiate SMC from SCOP? SCOP and PDAC: Is there a relation?

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## Abstract Archives of the RSNA, 2023

GIEE-20

### **Distinguishing Inflammatory Conditions from Cancer of the Gastrointestinal Tract: What Radiologists Should Know**

All Day Room: Learning Center

Camila L. Vendrami, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review imaging technique to assess gastrointestinal (GI) inflammatory conditions and cancer
- Review and illustrate the typical imaging appearances that allow differentiation of these inflammatory conditions and cancer
- Review and illustrate potential complications from these entities

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction: overview of GI inflammatory conditions and tumors
- Imaging techniques: US, CT, MR including enterography
- Gastric inflammation and gastric tumors
  - o Clinical findings, detection and imaging features to differentiate the entities
- Small bowel enteritis and other small bowel pathology and SB cancers (adenocarcinoma, carcinoid, lymphoma, GIST, metastases etc.)
  - o Clinical findings, detection and imaging features to differentiate the entities
- Diverticulitis and colon cancer
  - o Clinical findings, detection and imaging features to differentiate the entities
- Appendicitis and appendiceal cancers [adenocarcinoma, neuroendocrine (carcinoid), lymphoma and colon cancer associated with appendicitis], endometriosis of appendix
  - o Clinical findings, detection and imaging features to differentiate the entities
- Potential complications such as perforation and fistulas
- Conclusion

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## Abstract Archives of the RSNA, 2023

GIEE-21

### **It's Not Just a Question of Size: Unveiling the Secret World of Abdominopelvic Lymph Nodes for a Proper Radiological Assessment**

All Day Room: Learning Center

Ana L. Lopes Potente, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review individual lymph node anatomy, names, and abdominal and pelvic lymph node group locations. Demonstrate through illustrative cases which clues the lymph nodes can reveal to us about diagnostic possibilities.

#### **TABLE OF CONTENTS/OUTLINE**

- Importance of lymph node evaluation. Limitations of size-based evaluation. - Didactic drawings to review anatomy and pathophysiology. - Review of updated literature on normal dimensions of lymph nodes. - Video map to point out nomenclature and location of abdominal and pelvic lymph node chains, such as (but not limited to) retrocrural, retroperitoneal, gastrohepatic ligament, porta hepatis, celiac and superior mesenteric artery, pancreaticoduodenal, perisplenic, mesenteric, and pelvic nodes. - Demonstration of the main imaging techniques for lymph node evaluation. Importance of adequate protocols. Discussion of benefits and limitations of each method. - Case studies to highlight pitfalls and findings that may simulate lymphadenopathy, such as splenosis, accessory spleen, papillary process of the caudate lobe, vascular anomalies, prominent vascular structures like gonadal veins, and scalloped diaphragmatic crus. Tips to avoid misdiagnosis. - Special cases in which lymph node morphology can point to specific diagnoses. - Importance of lymph node features beyond size in diagnosis. - Exposition of rare cases where lymph node enlargement causes vascular and nervous complications. Discussion of diagnosis and management. - Summary of teaching points.

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## Abstract Archives of the RSNA, 2023

GIEE-22

### Spectrum of Heterotopic & Ectopic Splenic Conditions

All Day Room: Learning Center

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group; Advisor, Zebra Medical Vision Ltd; Advisor, Nano X Imaging;

#### TEACHING POINTS

1. To describe the spectrum of heterotopic and ectopic splenic conditions, including the underlying embryologic basis. 2. To demonstrate the role of cross-sectional and imaging and scintigraphy in asymptomatic detection and symptomatic diagnosis of these splenic-related conditions, through a series of clinical examples.

#### TABLE OF CONTENTS/OUTLINE

- Introduction- Embryologic development of the spleen o Normal splenic development o Spectrum of abnormal development - Splenic-specific imaging techniques o Nuclear medicine (heat-treated RBC > sulfur colloid scans) o MRI (ferumoxytol) - Heterotopic splenic conditions o Splenules § Pancreatic tail splenules o Splenogonadal fusion § Discontinuous form § Continuous form - Ectopic splenic conditions o Splenosis o Wandering spleen § Incidental asymptomatic detection § Symptomatic torsion o Polysplenia (heterotaxy) § Associated findings- Concluding remarks

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## Abstract Archives of the RSNA, 2023

GIEE-23

### Peritoneal Carcinomatosis: The Role of the Radiologist in Selecting Patients for Curative Treatment

All Day Room: Learning Center

Alicia Espinal Soria, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To know the different presentations of the peritoneal carcinomatosis in CT. To get familiar with the term Peritoneal Cancer Index and the website used to calculate it "e-Promise". To make a differential diagnosis with the pathologies that may mimic peritoneal implants.

#### TABLE OF CONTENTS/OUTLINE

Intraabdominal malignancies often spread to peritoneal cavity causing peritoneal carcinomatosis. The most common primary neoplasms are colorectal, small bowel, stomach, ovaries and pancreas. Peritoneal carcinomatosis (PC) may present in CT like ascites, peritoneal thickening, peritoneal nodules or masses, "omental cake" pattern or pseudomyxoma peritonei. This presentation forms in CT are also seen in other pathologies such as peritoneal tuberculosis, acute peritonitis, splenosis, peritoneal lymphomatosis, and peritoneal mesothelioma. Histologic analysis must be made to obtain a definitive diagnosis in doubtful cases. Until recently, PC was considered an end-stage disease where supportive care was the only possible treatment. The cytoreductive surgery (CRS) followed by Hypertermic intraperitoneal chemotherapy (HIPEC) is a combined treatment that has given a curative option to properly selected patients. It is important to know the most frequent shapes and locations of peritoneal implants to calculate the Peritoneal Cancer Index (PCI) using CT imaging, which is part of the selection criteria. The website "e-Promise.org" is useful to calculate this Index and help the clinician deciding the most suitable treatment for each patient.

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## Abstract Archives of the RSNA, 2023

GIEE-24

### Comprehensive Review of Imaging in Pancreatic Transplantation: A Panorama of Good and Bad!

All Day Room: Learning Center

Shravya Srinivas Rao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To learn pancreas transplant- indications, types, surgical procedure- To discuss post-transplant imaging surveillance of pancreas - To review the spectrum of post-transplant complications- visceral, vascular, intestinal\*?aβ?e ?? ???te?ts/??t???e 1. Pancreas transplantation procedure- Indications- Types of transplantation (whole organ vs islet cell)- Surgical procedures2. Role of imaging in pancreas transplantation- Preoperative imaging- Imaging modalities- Technique and protocol- Post-operative surveillance3. Imaging manifestations after pancreas transplantation- Normal appearance- Post-operative complications- Differential diagnosis- Radio-pathologic correlation- Pitfalls and challenges

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## Abstract Archives of the RSNA, 2023

GIEE-25

### Rectum MRI: Beyond the basics

All Day Room: Learning Center

#### Awards

##### Cum Laude

Thiago Jose Pinheiro Lopes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- High-resolution MRI is a cornerstone in the evaluation of the rectum, notably for cancer. In the past years, its use has been expanded far beyond TNM staging, enabling post-neoadjuvant therapy follow-up, patient selection for the "Watch and Wait" approach, predicting response to Total Neoadjuvant Treatment (TNT), and much more. - MRI imaging has enabled less invasive treatment approaches, with improved quality of life for patients and similar outcomes, and radiologists should be aware of these developments. - Our purpose is to review emerging applications of rectal resonance in the radiological routine and bring tips for deepening the anatomy of the rectum.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Delving into the anatomy of the rectum. 3. Recognizing post-CRT changes in rectum cancer. 4. Selecting patients for the "Watch and Wait" approach. 5. Using MRI to predict response to Total Neoadjuvant Treatment (TNT). 6. Identifying mucinous tumors. 7. Recognizing mesorectal fascia involvement. 8. Evaluating sphincter invasion in low rectal cancer. 9. Future directions. 10. Take home messages.

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## Abstract Archives of the RSNA, 2023

GIEE-26

### Quantitative CT for Diffuse Liver Diseases: Steatosis, Iron, and Fibrosis

All Day Room: Learning Center

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group; Advisor, Zebra Medical Vision Ltd; Advisor, Nano X Imaging;

#### TEACHING POINTS

1. To demonstrate the ability of CT to quantify fat, iron, and fibrosis content within the liver, analogous to MRI approaches.
2. Explain the rationale for opportunistic screening at abdominal CT for detecting unsuspected diffuse liver disease, including steatosis, hemochromatosis, and compensated cirrhosis.
3. Describe a battery of CT-based liver biomarkers that can now be obtained in a fully-automated fashion using AI-based methodology.

#### TABLE OF CONTENTS/OUTLINE

- Overview of diffuse liver diseases
  - o Hepatic steatosis and NAFLD
  - o Hepatic iron overload and hemochromatosis
  - o Hepatic fibrosis and cirrhosis
- Quantification methods for hepatic fat, iron, and fibrosis content:
  - o Liver biopsy
  - o Advanced MRI methods
  - o CT-based biomarkers
- Opportunistic CT-based screening for diffuse liver disease
  - o Rationale
  - o Manual and automated techniques
  - o Brief review of evidence to date
  - o Pitfalls
  - o Prospects for the (near) future
- Concluding remarks

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## Abstract Archives of the RSNA, 2023

GIEE-27

### Imaging in HIPEC- All You Need To Know!

All Day Room: Learning Center

Shravya Srinivas Rao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Peritoneal malignancies like pseudomyxoma peritonei, metastatic carcinomatosis from colon adenocarcinoma, mucinous carcinomas of ovary, stomach, pancreas etc., can be treated with cytoreduction surgery and hyperthermic intraperitoneal chemotherapy (HIPEC) or early postoperative intraperitoneal chemotherapy (EPIC). Objectives of this exhibit are:- To discuss imaging manifestations of peritoneal malignancies - To review the technique, principles, and complications of HIPEC therapy- To learn the role of imaging in the assessment of HIPEC patients before and after therapy

#### TABLE OF CONTENTS/OUTLINE

1. HIPEC- technique and principles
2. Peritoneal tumors- classification and imaging features
3. Radiological, surgical and pathological correlation
4. Criteria for CRS and HIPEC- selection of patients for HIPEC
5. Calculation of Peritoneal Cancer Index: principles and method of estimation
6. Imaging in response assessment

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## Abstract Archives of the RSNA, 2023

GIEE-28

### Peritoneal Carcinomatosis Versus Primary and Secondary Peritoneal Tumors and Other Traps

All Day Room: Learning Center

Ghina Jardali, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review of the imaging features of common and uncommon peritoneal diseases, neoplastic (such as pseudomyxoma peritonei) and non-neoplastic, that mimic peritoneal carcinomatosis.
- Emphasis on the CT/MRI findings and the additional imaging clues that may allow the radiologist to appropriately narrow the differential diagnosis and, in some cases, make an imaging-specific diagnosis.

#### TABLE OF CONTENTS/OUTLINE

I. Imaging appearance of peritoneal carcinomatosis II. Imaging clues to the diagnosis of differential diagnosis: a. Secondary peritoneal-based neoplasms i. Pseudomyxoma peritonei b. Primary peritoneal neoplasms i. Malignant peritoneal mesothelioma c. Primary peritoneal mesenchymal tumors i. Gastrointestinal stromal tumor (GIST) with peritoneal sarcomatosis ii. Fibromatosis (Desmoid tumor) d. Non-neoplastic mimics of peritoneal carcinomatosis: i. Mesothelial cysts ii. Cystic lymphangioma iii. Lymphangiomyomatosis iv. Mesenteric fat necrosis / lipophagic granuloma v. Atypical infections: Tuberculosis, Actinomycosis

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## Abstract Archives of the RSNA, 2023

GIEE-29

### **Gastro-Intestinal Devices: from Esophagus to Anus. Imaging Appearance Review of Common and Less Common GI Foreign Bodies**

All Day Room: Learning Center

Emre Aslan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Review of imaging appearance of common and less common gastrointestinal (GI) devices.2) Summarize common device-specific complications.3) Review of MRI safety profiles for each GI device.

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction: As minimally invasive procedures become more ubiquitous and technology keeps advancing, new GI devices are being used by interventional radiologists and interventional gastroenterologists.2) Clinical use Radiologists and radiology trainees must stay up to date with new GI devices to recognize and prevent complications whenever possible. Each device's indications, normal imaging appearances, potential complications and MRI safety profiles will be discussed.3) Endoscopically placed devices esophageal, duodenal, rectal stents, AXIOS stent, and Ovesco device.4) Surgically placed devices LINX reflux management system, gastric pacemaker, gastric band, Ray-Tec X-rayable sponge and laparotomy sponge.5) Tubes and balloons Blakemore tube, cecostomy tube, intragastric balloon, and Minnesota tube.6) Other Amplatzer plug and capsule endoscopy device.7) Conclusion Summary of key teaching points.

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## Abstract Archives of the RSNA, 2023

GIEE-3

### **The Washout of Hepatocellular Carcinoma at Portal Venous Phase versus Equilibrium Phase: Radiological and Clinicopathological Implication**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Kengo Yoshimitsu, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To learn that there are two distinct types of hepatocellular carcinoma (HCC) washout to be recognized: one at the portal venous phase (PVP) and the other at the equilibrium phase (EqP).
- To learn that these two represents two different phenomena; a dynamic, and a static one, respectively.
- To learn that PVP washout is a consequence of rapid hemodynamic change of HCC and background liver (BGL).
- To learn that EqP washout represents static condition of contrast medium distribution in the extracellular space of HCC and BGL.
- To learn that PVP washout is significantly related to histological grades of HCC, or its status of microvascular invasion.
- To learn that EqP washout might be related to immunohistochemical subgroup of HCC.

#### **TABLE OF CONTENTS/OUTLINE**

1. Basic concept of two types of "WASHOUT" of HCC
2. Washout at PVP: radiological consideration
3. Washout at PVP: clinicopathological implication
4. Washout at EqP: radiological consideration
5. Washout at EqP: clinicopathological implication
6. Washout on dynamic MRI using extracellular contrast medium or gadoxetate
7. Summary

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## Abstract Archives of the RSNA, 2023

GIEE-30

### Focal Liver Lesions: A Case-based Quiz

All Day Room: Learning Center

Laura Cavero Barreras, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To highlight the importance of the clinical context of patients with focal liver lesions. - To review the typical and atypical imaging findings of focal liver lesions in multimodality imaging techniques through cases studied in our center. - To know the current guidelines and define a practical approach to the radiologic management of liver lesions. - To identify potential pitfalls and key imaging findings to make the correct diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Focal liver lesions represent a widespread, heterogeneous group of disorders that can be benign or malignant, solitary or multiple. Diagnosis is usually challenging as many lesions may mimic each other. Radiologists must consider the appearance and the enhancement pattern of the nodule on different imaging techniques, such as US, CT, and MRI. Moreover, contrast-enhanced US (CEUS) can help to resolve doubts and establish the diagnosis in cases where other imaging techniques do not provide a definite diagnosis. On the other hand, it is necessary to consider the clinical context of the patient, as this will determine the further management of the lesion. This presentation will take the form of a quiz to discuss the typical and atypical imaging findings and the management of focal liver lesions based on current guidelines.

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## Abstract Archives of the RSNA, 2023

GIEE-31

### Laxative-free Photon-counting CT Colonography for Colorectal Cancer Screening

All Day Room: Learning Center

Yasuji Ryu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The teaching points of this exhibit are to (1) explain the emerging role of laxative-free CT colonography in colorectal cancer (CRC) screening, (2) explain the role of photon-counting CT in addressing the challenges of conventional CT colonography, and (3) explain the role of artificial intelligence (AI) in unlocking the potential of laxative-free photon-counting CT colonography as a CRC screening test.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: the importance of CRC screening; the emerging role and challenges of laxative-free CT colonography. 2. Photon-counting CT: benefits over conventional CT; how photon-counting CT addresses the challenges of laxative-free CT colonography. 3. AI enables an effective laxative-free photon-counting CT colonography examination: computer-aided detection; virtual bowel cleansing; risk assessment; putting it all together. 4. What we know and don't know: outcomes from clinical laxative-free CT colonography trials; initial observations from photon-counting CT colonography studies. 5. Summary.

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## Abstract Archives of the RSNA, 2023

GIEE-33

### **Pancreas Transplantation: What Should the Radiologist Know?**

All Day Room: Learning Center

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To expose the existing surgical techniques in pancreatic transplantation. To highlight the role of the different imaging tests in graft evaluation. To make a pictorial review of the postoperative complications according to the time after transplantation.

#### **TABLE OF CONTENTS/OUTLINE**

Pancreatic transplantation is a valid therapeutic option for poorly controlled diabetes mellitus and advanced diabetic nephropathy. Knowledge of the surgical techniques, location of the anastomoses and related complications will assist the radiologist in performing an accurate assessment that leads to adequate management and long-term survival of pancreatic grafts. There are three types of pancreas transplantations regarding the drainage method: systemic venous and bladder exocrine drainage, systemic venous and enteric exocrine drainage, and portal venous and enteric exocrine drainage. Radiological assessment of the pancreas graft is usually multimodal. Ultrasound is the first-line imaging modality for the initial post-surgical evaluation performed within the first 24 hours. CT is preferred if complications are presumed. Postoperative complications include parenchymal, infectious, enteric or vascular disorders, which can be classified according to the time lapse after transplantation in which they occur: immediate (< 24 hours), early (24-72 hours), intermediate (72 hours-weeks) and late (months). We gathered the most illustrative cases of postoperative complications from recent years at our institution to show the key features of imaging that enable rapid and accurate management.

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## Abstract Archives of the RSNA, 2023

GIEE-34

### Retrospectively Defined Missed Early Signs of Pancreatic Cancer on CT

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Satomi Kawamoto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review cases of missed early pancreatic ductal adenocarcinoma (PDAC) and early changes of PDAC on CT. 2. Small, isoattenuating PDAC without contour deformity can be easily missed. 3. CT findings to suggest early PDAC include pancreatic duct dilatation with or without abrupt duct cutoff, vascular invasion, focal parenchymal atrophy, and focal enhancement.

#### TABLE OF CONTENTS/OUTLINE

1. Background: Delay in diagnosis can contribute to poor outcomes in PDAC, and imaging plays a crucial role in the diagnosis of early PDAC. 2. Review of cases of missed early PDAC and early changes of PDAC before clinical diagnosis on CT. (1) Small, isoattenuating PDAC without contour deformity. (2) Pancreatic duct dilatation is most common secondary finding (3) Abrupt pancreatic duct cut-off (4) Vascular invasion is not a common finding but high likelihood of missing (5) Parenchymal atrophy (6) Focal enhancement. 3. Cognitive errors (1) Underlying pancreatitis (2) Unexpected finding. 4. Discussion of future direction

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## Abstract Archives of the RSNA, 2023

GIEE-35

### Plan to Scan the Pancreas Transplant: A Sweet Review of Anatomy, Imaging Technique, and Complications

All Day Room: Learning Center

Maham Siddique, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: • Pancreas transplant aims to restore normal glycemic control, often in young patients with diabetes and manifesting end-stage renal disease. • Ultrasound is performed to evaluate the pancreas and transplant vessels in the perioperative period. • Ultrasound, CT, and MRI can diagnose transplant-related complications. Common vascular complications include arterial and venous thrombosis and arterial pseudoaneurysm. Transplant pancreatitis has similar complications to inflammation of the native pancreas and can impact the renal transplant. • Radiologists should be familiar with normal pancreas transplant anatomy, vascular and non-vascular complications of pancreas transplants, as early recognition of these entities may improve outcomes.

#### TABLE OF CONTENTS/OUTLINE

Outline: Pancreas transplant background and demographics, Normal pancreas transplant anatomy and surgical technique, Normal transplant evaluation on ultrasound and reporting template, Acute and necrotizing graft pancreatitis, Vascular complications: arterial and venous stenosis and thrombosis, pseudoaneurysm, acute arterial bleeding, Non-vascular complications: Peripancreatic collections, hematoma, post-transplant lymphoproliferative disease.

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## Abstract Archives of the RSNA, 2023

GIEE-36

### Why Oh Y-Grafts: Understanding the Anatomy, Imaging, and Complications of Pancreas Transplantation

All Day Room: Learning Center

Melanie P. Caserta, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pancreas transplant is the treatment for severe Type I diabetes mellitus complicated by end stage renal disease, poorly controlled Type I or II diabetes, and cystic fibrosis. Pancreas transplantation is most commonly performed simultaneously with kidney transplantation (80%) or following kidney transplantation (16%), and least commonly performed alone. Ultrasound is the first line modality for evaluating the allograft and vasculature and to look for complications. Contrast enhanced ultrasound, CT and MRI can be used as problem solving tools to further evaluate complications. After reviewing this case-based exhibit, the learner will: - Understand indications for pancreas transplantation - Describe the surgical anatomy of pancreas transplants - Describe ultrasound technique for evaluating the transplant pancreas - Recognize complications of pancreas transplant - Determine when additional imaging of the pancreas transplant is needed

#### TABLE OF CONTENTS/OUTLINE

Outline: 1. Objectives 2. Background - Pancreas Transplant a. Benefits of pancreas transplantation b. Review of surgical technique 3. Imaging a. Ultrasound - First line imaging i. Ultrasound protocol ii. Normal appearance iii. Complications 1. Vascular 2. Parenchymal 3. Perigraft 4. Bowel b. Problem solving i. Contrast enhanced ultrasound to assess allograft perfusion and vascular complications ii. CT - peripancreatic fluid collections, suspected intestinal obstruction, multiphase evaluation to assess graft and vasculature iii. MRI - Ferumoxytol MRI to assess transplant vasculature 4. Treatment and Intervention a. Medical b. Ultrasound guided c. Endovascular d. Surgical

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## Abstract Archives of the RSNA, 2023

GIEE-37

### Navigating Through the Esophageal Disorders in Chest CT Scans: What Radiologists Should Know

All Day Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To know basic anatomy and histology of the esophagus To learn the role of CT imaging in the detection and characterization of esophageal pathology. To recognize the most important imaging findings of non-malignant and malignant esophageal diseases.

#### TABLE OF CONTENTS/OUTLINE

1. Esophageal anatomy and histology 2. Benign esophageal disorders a). Benign esophageal tumors - Leiomyoma - Fibrovascular polyps - Esophageal schwannoma b). Congenital lesions: - Duplication cysts c). Esophageal diverticula - Pharyngoesophageal junction: Zenker diverticula - Middle esophagus diverticulum - Epiphrenic diverticulum d). Infectious diseases - Candida - HIV - CMV - Herpes simplex virus - Chagas e). Inflammatory disorders - Reflux esophagitis and Barrett's esophagus - Eosinophilic esophagitis (EoE) f). Radiotherapy-induced esophagitis - Scleroderma - CREST g). Traumatic and fistulas - Esophageal impactation - Hematoma - Perforation - Actinic - Esophageal-airway fistula - Esophageal mediastinal fistula h). Others - Achalasia - Acute esophageal necrosis (AEN) - Hiatal hernia - Esophageal and para-esophageal varices 3. Primary malignant esophageal tumors a). Squamous carcinoma (SCC) b). Adenocarcinoma c). Lymphoma d). Primary malignant melanoma

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## Abstract Archives of the RSNA, 2023

GIEE-38

### Diffuse and Focal Liver Fat: Pearls and Pitfalls

All Day Room: Learning Center

Lidiamara Van Der Zwaag, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review the imaging features of liver fat in different methods. To discuss and illustrate the main causes and consequences of fatty liver disease, as well as its associated conditions. To demonstrate common and uncommon patterns of liver fat distribution and discuss the underlying pathophysiology. To recognize that classic liver lesions can have different patterns of imaging presentation in the setting of steatosis. To present challenging cases and mimic lesions, highlighting the clues that can be helpful for the correct diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Liver fat in different imaging methods (US, CT and MRI). Main findings of several causes of fatty liver disease (alcoholism, metabolic syndrome, chemotherapy, drug toxicity, infection, PCOS). Patterns of liver fat distribution (diffuse, focal, geographic, multinodular, perivascular), including uncommon oncologic and cirrhotic cases. Patterns of presentation of the classic liver lesions in the setting of steatosis (FNH, hemangioma etc). Differential diagnosis between true lesions and pseudolesions.

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## Abstract Archives of the RSNA, 2023

GIEE-39

### Ultrasound Of the Gastrointestinal Tract: Contributions of Ancillary Ultrasound Techniques

All Day Room: Learning Center

Nameerah Wajahat (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1.) Greyscale ultrasound evaluation comprises the fundamental basis of diagnostic evaluation of the bowel in inflammatory bowel disease (IBD) (2.) Wall thickness, inflammatory fat and signal on color doppler imaging (CDI) are the markers which increase in proportion to active inflammation. (3.) Ancillary Ultrasound techniques including: endovaginal sonography (EVS), contrast enhanced ultrasound (CEUS) and shear wave elastography (SWE) contribute greatly to final diagnosis and patient outcome. (4.) EVS provides information about anatomy and pathology in the deep pelvis with high resolution. (5.) CEUS allows for subjective and objective information about blood flow at the capillary level, allowing characterization of inflammatory masses as representative of active inflammation (phlegmon) or abscess formation (liquid pus) (6.) SWE measures bowel wall stiffness aiding with characterization of strictures. Soft inflammatory strictures- medical management. Stiff chronic strictures - surgical management

#### TABLE OF CONTENTS/OUTLINE

- Introduction to ultrasound of the bowel with emphasis on greyscale imaging - Ancillary features what are they and what do they do? - Endovaginal Sonography and its role in deep bowel evaluation - CEUS (Contrast Enhanced Ultrasound) and its contribution to activity assessment - SWE (Shear wave elastography) and its contribution to stricture assessment - Change of management with ancillary techniques

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-4

### Comprehensive Review of Abdominal Manifestations of Melanoma with Emphasis on Liver Metastasis

All Day Room: Learning Center

Hyun Jung Chung, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is 1. To review imaging findings of primary and secondary melanoma in the abdomen and pelvis 2. To discuss multimodality imaging of liver metastasis from melanoma 3. To present an imaging atlas of gadoxetic acid-enhanced MRI for liver metastasis and to discuss its potential value 4. To discuss surveillance protocols for intraabdominal metastasis of melanoma

#### TABLE OF CONTENTS/OUTLINE

1. Clinical aspects of melanoma (1) Epidemiology (2) Staging (3) Treatment and prognosis 2. Primary melanoma in the abdomen 3. Metastatic melanoma in the abdomen (1) Liver (2) Pancreaticobiliary system (3) Gastrointestinal tract (4) Other involvement 4. Multimodality imaging of liver metastasis (1) Ultrasound (2) CT (3) MRI i. Lesion detection and characterization ii. Special considerations for gadoxetic acid-enhanced MRI for melanoma iii. MR findings of liver metastasis according to the primary origin of melanoma 5. Surveillance and prognosis (1) Surveillance protocol for metastatic melanoma in the abdomen (2) Prognostic implications of imaging features

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-40

### Step-by-step Assessment in Colon Cancer Risk Stratification. Assessment by Virtual Colonography and Dual Energy Support

All Day Room: Learning Center

Omar A. Gamboa Abundis, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Colorectal cancer represents the third most diagnosed cancer and corresponds to the second cause of death in the world. The recognized precursor lesion is the adenoma, and the risk of malignant transformation is significantly increased. Virtual colonography is a noninvasive screening method for colon cancer and avoids the unnecessary risk of bleeding or perforation present in colonoscopy. Learn to describe and categorize the findings and pitfalls in lesions found during image processing and viewing.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents: Teaching points. Introduction. What is CRADS. Virtual colonography acquisition protocol. Image processing and anatomical considerations. Description of the results. CRADS categories. CRADS 1 to 4. Extracolonic findings. E0 to E4. Main pitfalls to consider. Conclusions. References. Outline: Colorectal cancer is the third most common cancer and is the second leading cause of cancer death in the world. It is important to carry out a screening test in patients over 45 years of age and even more so in those who present a high risk of suffering from this disease. Virtual colonography provides an excellent alternative with rapid acquisition protocols and high sensitivity and specificity. Useful in highrisk patients during the colonoscopy intervention, also avoiding the possible risk of perforation and bleeding.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-41

### Deep Learning for Electronic Cleansing in Fecal-tagging CT Colonography

All Day Room: Learning Center

Wenli Cai, PhD (*Presenter*) Stockholder, IQ Medical Imaging LLC

#### TEACHING POINTS

This exhibit reviews the historical perspectives of Electronic Cleansing (EC), the major cleansing artifacts and pitfalls in the conventional deterministic EC methods, the recent technical advances of deep-learning based EC (Deep-EC) methods, comparison between Deep-EC and conventional deterministic EC, and the future trend of Deep-EC development fecal-tagging CT Colonography (CTC). The teaching points of this exhibit are: 1. EC requires accurate classification or segmentation of tagging fecal residuals and their mixtures. Conventional deterministic EC methods exhibit various artifacts and pitfalls. 2. State-of-the-art deep-learning models and training techniques provide an effective solution to reduction of EC artifacts and pitfalls. 3. Intracolonic lumen segmentation (ILS), which combines EC and colon segmentation into a single procedure in the CTC workflow, is a promising Deep-EC method in CTC.

#### TABLE OF CONTENTS/OUTLINE

1. Review of deterministic EC methods with discussion of the limitations and clinical challenges.
2. Describe the challenges of building a large-scale CTC dataset for EC.
3. Present recent technical advances of Deep-EC by applying deeper and larger Convolutional Neural Network (CNN) and various model training techniques to reduce EC artifacts.
4. Present a cutting-edge Deep-EC procedure, Intracolonic lumen segmentation, built on the two-stream U-Net (BiS-UNet) model.
5. Compare the image quality of EC and Deep-EC in 3D visualization of cleansed colon in non-cathartic fecal-tagging CTC.
6. Discuss the technique trend and future developments of Deep-EC.

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## Abstract Archives of the RSNA, 2023

GIEE-43

### Peribiliary Cystic Lesions: Uncommon Mimickers of Hepatic and Biliary Cystic Lesions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ana Claudia V. Uski SR, MD,MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe and demonstrate with radiological cases the common and uncommon peri-biliary entities. To identify the imaging features indicative of pathologies of the peri-biliary space and emphasize the radiological differences with hepatic and biliary lesions. To propose a practical systematization in the evaluation of intrahepatic peri-biliary cystic lesions. To suggest a step-by-step guide for clinical-radiological reasoning.

#### TABLE OF CONTENTS/OUTLINE

Intrahepatic peribiliary cystic lesions are usually benign and result from cystic dilatation of tubule-alveolar glands with acini of serous and mucinous cholangio-cytes with various stages of maturation. The term intrahepatic refers to cystic changes located above the hepatic hilum that have the portal vein, hepatic artery, and portal neurovascular bundle as anatomical landmarks. They are usually multiple, small, thin-walled, serous content, and by definition do not exhibit communication with adjacent bile ducts. They may take on a confluent appearance resembling multiloculated malignancies or even mimic intraductal biliary pathologies. This intrahepatic peri-biliary region is susceptible to several pathologies that include inflammatory, infectious, neoplastic, congenital and acquired nature. The objective of this review is to systematize the evaluation of peribiliary cystic lesions taking into consideration their intrahepatic location and their radiological aspects that may have some peculiar characteristics.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-44

### **More Than Atlanta... The Entire Acute Pancreatitis Map. A Comprehensive Review Of Acute Pancreatitis Complications**

All Day Room: Learning Center

Lucia A. Chagas, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the concepts of the Atlanta criteria, both related to the initial diagnosis (edematous interstitial pancreatitis / necrotizing pancreatitis) and their complications (pancreatic pseudocyst / walled-off necrosis). To provide context for other complications of acute pancreatitis, such as thrombosis, pseudoaneurysm, hemorrhage, infection and ductal disconnected syndrome, regarding the associated risk for their development and diagnosis on imaging exams.

#### **TABLE OF CONTENTS/OUTLINE**

Schematic drawings and computed tomography and magnetic resonance images aimed at understanding imaging findings that precede certain complications, as well as aspects related to their diagnosis. Differential diagnosis approach between edematous interstitial and necrotizing pancreatitis, as well as the complications that may arise from each of them.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-45

### LI-RADS Treatment Response Algorithm v2023: Roadmap for Post Radiation Treatment Response

All Day Room: Learning Center

Aadithya S. Nalla (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The LI-RADS Treatment Response Algorithm (LR-TRA) is a standardized system for assessing and reporting treatment response after locoregional therapy (LRT) for hepatocellular carcinoma (HCC).2. When compared to other LRTs, radiation-based therapies (transarterial radioembolization (TARE) and stereotactic beam radiation therapy (SBRT)) have distinct post-treatment imaging appearances, including persistence of arterial phase hyperenhancement (APHE), which makes response assessment challenging using the current TRAs which use APHE as a surrogate imaging biomarker for viability. Changes in the LR-TRA v2023 are intended to address this challenge.3. This exhibit highlights the updates in the LR-TRA v2023, including the correct application of the new algorithm after radiation therapy to HCC, with the overall objective of improving diagnostic accuracy of post-treatment imaging assessment.

#### TABLE OF CONTENTS/OUTLINE

1. Summarize the role of the TRA in the context of radiation therapy for HCC.2. Case-based and illustrative review of expected imaging features after radiation-based treatments to HCC and identify pitfalls in response assessment.3. Introduce and highlight key updates of the new component of the LR-TRA v2023 pertaining to its application after radiation-based treatments for response assessment using a case-based review.

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## Abstract Archives of the RSNA, 2023

GIEE-46

### **From Guidelines to Radiology Practice: Navigating the 2023 ASCO Guidelines for Advanced Gastroesophageal Cancer**

All Day Room: Learning Center

Charit R. Tippareddy, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Discuss new 2023 ASCO guidelines for advanced gastroesophageal cancer therapies  
2. Radiologic imaging findings related to treatment sequelae  
3. Differentiate treatment related response versus disease progression on radiologic imaging

#### **TABLE OF CONTENTS/OUTLINE**

1. Pathophysiology, demographics, risk factors of gastroesophageal cancer  
2. New 2023 ASCO Guidelines and their implications for treatment  
3. Imaging modalities used in diagnosis and staging of advanced gastroesophageal cancer  
4. Role of imaging in staging and management of advanced gastroesophageal cancer  
5. Demonstrate patient imaging cases that relate to the following:  
5a. Treatment related effects of immune checkpoint inhibitors  
5b. Treatment related effects of platinum-based chemotherapy  
5c. Treatment related effects of fluoropyrimidines  
5d. Treatment related effects of tyrosine kinase inhibitors  
5e. Post-radiation effects  
5f. Post-esophagectomy complications  
6. Conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-47

### Internalize It!: An Insider's Case-Based Guide to Internal Hernias

All Day Room: Learning Center

Collin R. Edwards, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Internal hernias occur due to herniation of viscera, most often small bowel, through the mesentery or peritoneum, and considered in the differential for intestinal obstruction. - Internal hernias are classified by different systems based on distribution of bowel loops in the abdomen and pelvis. - Post-operative internal hernias occur after roux-en-Y anastomosis for gastric bypass and liver transplant. - CT with IV and PO contrast is the imaging modality of choice for evaluating internal hernias. - "Sac-like" appearance of dilated small bowel loops on imaging should raise concern for internal hernia. - Radiologists should have a clear understanding of normal peritoneal anatomy, surgical history, and the characteristic location of common and uncommon internal hernias on imaging.

#### TABLE OF CONTENTS/OUTLINE

- Introduction and background - Normal peritoneal anatomy and boundaries - Case-based review, management, and surgical outcome - Paraduodenal hernia - Lesser Sac/Foramen of Winslow hernia - Pericecal hernia - Intersigmoid hernia - Transmesenteric hernia - Pelvic and broad ligament hernia - Post Roux-en-Y hernias: Petersen's, Roux limb mesentery, enteroenterostomy

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-48

### **Islet Insurgents: A Radio-Pathologic Review of Pancreatic Neuroendocrine Tumors**

All Day Room: Learning Center

David A. Mata, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

**Purpose/Aim:**The goal is to educate the audience in recognizing the multi-modal imaging features of pancreatic neuroendocrine tumors (pNET), with an emphasis on clinical and pathological correlation. We will also elucidate the histopathologic features of pancreatic neuroendocrine neoplasm subtypes.

#### **TABLE OF CONTENTS/OUTLINE**

**Content organization:**1. Pancreatic Neuroendocrine neoplasm clinical overview. 2. Differentiating syndromic vs nonsyndromic subtypes. 3. Multi-modal radiographic features on Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). 4. Histopathological and gross pathologic characteristics of pNET. 5. Treatment and Prognosis. 6. Summary.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-49

### Have you Ever Seen the Rain? Cross-sectional Imaging of Pancreatic Leak

All Day Room: Learning Center

#### Awards

##### Cum Laude

Daniel L. Cardoso, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recognize the pancreatic anatomy and its relation to other structures. Understand what can cause a pancreatic fistula (PF) and its mechanisms . Comprehend the imaging patterns of PF. Recognize the potential pitfalls of PF.

#### TABLE OF CONTENTS/OUTLINE

INTRODUCTION: Pancreatic anatomy and relationship with other abdominal structures. Pancreas imaging patterns on Computed Tomography (CT), and Magnetic Resonance Imaging (MRI). Pancreas patterns after surgery (gastroduodenopancreatectomy, and distal pancreatectomy). Epidemiology of PF, and its causes. DIAGNOSIS AND IMAGING FINDINGS: PF - How to identify on CT? How to identify on MRI? How to proceed? Potential pitfalls of PF, don't get caught! SUMMARY AND SYSTEMATIC APPROACH. TAKE HOME MESSAGES.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-5

### **Selected Portal Venous Anomalies: An Institutional Multimodality Case-based Review of Portal Varices and Intrahepatic Congenital Shunts**

All Day Room: Learning Center

Abtin Jafroodifar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review portal venous (PV) varices and aneurysms, including congenital, acquired, true and pseudoaneurysms, with review of extrahepatic and intrahepatic classifications. Learn to properly communicate and report PV varices and aneurysms and their complications such as thrombosis, portal hypertension, or compressive syndromes. Discuss congenital intrahepatic portosystemic shunts subtypes. Review PV embryological development as it relates to a radiologist's practice. Explore the diagnostic clues to recognize PV varices, aneurysms, and intrahepatic shunts using multimodality imaging including ultrasound, CT, MR, and cinematic 3D rendering.

#### **TABLE OF CONTENTS/OUTLINE**

(1)Review normal and variant portal vein anatomy using CT, MR, angiography, and original diagrams. Briefly review portal vein embryological development from the vitelline and umbilical venous systems.(2)Discuss the diagnostic criteria, relevant presentation, and epidemiology of PV varices and aneurysms. Optimal imaging protocols will be outlined.(3)A case-based review of different types of PV varices, including congenital, acquired, and isolated subtypes. Case-based review of intrahepatic portal vein aneurysms and eventual thrombosis.(4)A case-based review of five types of congenital intrahepatic portosystemic shunts classified by Park et al. (AJR, 1990). Present pre- and post closure of a congenital intrahepatic shunt case in a patient with bilateral Wilm's tumors.(5)Present a rare case of splenic vein aneurysm with eventual thrombosis and recanalization using cross-sectional imaging; of note, splenic vein aneurysms are so rare that a true prevalence has not been reported. Discuss mesenteric and splenic vein aneurysms.

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## Abstract Archives of the RSNA, 2023

GIEE-50

### Ensuring High-Reliability Anatomic Evaluation for Living Liver Donors Using Multi-Contrast-Agent MRCP

All Day Room: Learning Center

Reve Chahine, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Living donor liver transplantation (LDLT) expands access to transplantation but has the challenges of substantial technical complexity and simultaneous risk for both donor and recipient. 2. Precise understanding of the anatomy of the central liver (biliary drainage, hepatic venous drainage, arterial and venous anomalies) and segment 4 is critical to living donor success. 3. Contrast-enhanced MRCP is used to assess anatomy but suffers from suboptimal reliability due to motion artifacts (eg, respiratory motion at MRCP, arterial phase tachypnea with gadoxetate disodium) and technical factors. 4. We implemented a multi-contrast agent MRCP imaging protocol using gadoxetate disodium and gadobenate dimeglumine to enable high-reliability imaging in the arterial phase (gadobenate) and of the bile ducts (non-contrast MRCP + gadoxetate hepatobiliary phase) and prevent the need for repeat or adjunctive imaging (eg, CTA).

#### TABLE OF CONTENTS/OUTLINE

1. Background on LDLT 2. Highlight key anatomic considerations for assessing eligibility for donation 3. Targeted review of conventional single-contrast agent MRCP imaging protocols for living liver donor evaluation a. MRCP with extracellular gadolinium-based contrast material b. MRCP with gadoxetate disodium c. Single contrast agent MRCP followed by CTA 4. Demonstration of successful multi-contrast agent MRCP for assessing living liver donor eligibility a. Protocol b. Technical considerations c. Advantages d. Pictorial review e. Limitations

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## Abstract Archives of the RSNA, 2023

GIEE-51

### **MR Imaging Biomarkers: Can Aggressive Imaging Features of Hepatocellular Carcinoma Predict Early Post-Treatment Recurrence?**

All Day Room: Learning Center

Kayli Lala (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Hepatocellular carcinoma (HCC) diagnosis and management is almost exclusively imaging based without the need for pathologic confirmation. 2. Certain MR imaging features have shown to be predictive of more aggressive biologic subtypes of HCC, resulting in increased likelihood of early post-treatment recurrence and worse overall survival. 3. In order to optimally treat HCC, it is important to recognize the multifactorial etiology for tumor recurrence and/or progression including a basic understanding of the complex immunologic tumor microenvironment.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the histopathology of HCC, including the histologic variants using a pictorial representation of the heterogeneity in the histology and biology of HCC. 2. Pictorial review of MR imaging biomarkers predictive of aggressive tumor biology. 3. Review of the hepatic and tumor microenvironment and its role in treatment response after locoregional therapy. 4. Review clinical outcomes after locoregional therapy to HCC by various locoregional modalities with an emphasis on HCC with aggressive pre-treatment imaging features by using a case-based approach. 5. Demonstrate a proposed mechanism to use various MR imaging biomarkers to risk stratify patients with aggressive versus less-aggressive HCC to reduce the chance of early post-treatment progression and improve overall management.

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## Abstract Archives of the RSNA, 2023

GIEE-52

### Solid Pseudopapillary Tumors of the Pancreas: Old Friend, New Meme

All Day Room: Learning Center

David A. Mata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibit will depict typical image findings of solid pseudopapillary tumors (SPT) of the pancreas, with an emphasis of epidemiological, clinical, and pathological correlation. Illustrated as well are common mimics of SPT, including neuroendocrine and malignant tumors of the pancreas. A review of epidemiology and clinical features of SPT. Identify relevant Ultrasound (US), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) appearances of typical SPT. Correlate morphologic findings with Positron Emission Tomography (PET), pathologic microscopy, and gross surgical specimens. Provide key features to differentiate SPT from other retroperitoneal tumors.

#### TABLE OF CONTENTS/OUTLINE

SPT are rare epithelial tumors of exocrine pancreas with low malignant potential and overall good prognosis. Mostly found in young adults and Caucasian women, these tumors are often asymptomatic but can present with abdominal pain and a palpable mass. Since there are SPT mimics, it is important to obtain clinical history and know the epidemiology of SPT. Upon diagnosis, SPT are normally large, circumscribed masses comprised of both solid, hemorrhagic, and necrotic components with no associated ductal dilation. It is important to note, smaller presenting SPT (< 3cm) often have image findings of a solid, homogenous appearance. The intralesional appearance depends on the degree of hemorrhage, calcification, tumor necrosis, or cystic degeneration. These tumors are commonly found in the body and tail of the pancreas. To avoid erroneous interpretation or delay in diagnosis, appropriate knowledge of SPT imaging patterns and presentations is required.

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## Abstract Archives of the RSNA, 2023

GIEE-53

### **Mimics of Inflammatory Bowel Disease: Not everything is Crohn's or Ulcerative Colitis**

All Day Room: Learning Center

Belinda A. Asare, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Inflammatory bowel disease (IBD; Crohn's disease and Ulcerative colitis) represents a group of diseases characterized by chronic inflammation of the gastrointestinal tract. 2. Patients frequently present with nonspecific symptoms such as abdominal pain, weight loss, diarrhea, nausea, vomiting and obstruction. 3. Various infectious and non-infectious diseases can mimic IBD including malabsorption syndromes, autoimmune diseases, drug-induced conditions, diverticulitis, appendicitis, vascular etiologies and malignancy. 4. Imaging is a crucial tool in identifying IBD mimics as it helps clinicians in making accurate diagnoses and implementing appropriate treatment strategies.

#### **TABLE OF CONTENTS/OUTLINE**

1. Typical imaging characteristics of IBD (Crohn's disease and Ulcerative colitis). 2. Differential diagnoses of infectious causes with common imaging features and corresponding cases. 3. Differential diagnoses of non-infectious causes with common imaging features and corresponding cases.

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## Abstract Archives of the RSNA, 2023

GIEE-54

### Unveiling Internal Hernias A Comprehensive Review of CT Imaging Patterns

All Day Room: Learning Center

Patricia P. Dantas I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is: Review peritoneal cavity anatomy with emphasis on the most common internal hernia sites. Discuss the role of computed tomography (CT) in the diagnosis and management of patients. Illustrate imaging patterns of the main types of internal hernia, highlighting the specific characteristics of congenital, oncologic and bariatric surgery cases. Identify key CT features that help differentiate open-loop from closed-loop obstruction and those that may predict ischemic injury of the small bowel loops. Recognize the main differential diagnoses and pitfalls of internal hernias, addressing diagnostic challenges. Propose an algorithm to aid in the interpretation of CT images in cases of intestinal obstruction.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction: epidemiology, clinical and pathophysiological aspects of bowel obstruction 2) Role of CT in the evaluation of obstructive acute abdomen, including CT protocol recommendations. 3) Review of peritoneal cavity anatomy: - Main peritoneal spaces; - Ligaments; - Normal recesses and foramina. 4) To demonstrate, through a case-based review, the imaging patterns of the following types of internal hernias: - Paraduodenal Through foramen of Winslow - Intersigmoid - Falciform ligament - Pericecal - Supravesical - Transmesenteric / Transomental - Acquired (postoperative/trauma). 5) To discuss and illustrate major complications of internal hernias: - Ischaemia - Perforation - Illustrative key points. 6) Differential diagnosis and pitfalls. 7) Relevant imaging findings that aid surgical decisions. 8) Algorithm for the diagnosis of internal hernias. 9) Conclusions and "take-home messages".

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## Abstract Archives of the RSNA, 2023

GIEE-55

### **Preoperative Assessment in Pancreatic Ductal Adenocarcinoma: Understanding the Impact of Staging and Anatomical Variants on Surgical Planning**

All Day Room: Learning Center

Davi D. Romao, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

It is critical to understand the radiologic features of pancreatic ductal adenocarcinoma and how they affect surgical planning. In this pictorial review, we will focus on the assessment of vascular invasion and its impact on surgical planning. We will also review the major anatomic variants associated with the vascular anatomy of the celiac trunk, superior mesenteric artery and its branches.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review of pancreatic adenocarcinoma staging
2. Assessment of vascular invasion in pancreatic adenocarcinoma
  - 2a. Venous involvement
  - 2b. Artery involvement
3. Anatomical variants
  - 3a. Celiac trunk variants
  - 3b. Superior mesenteric artery variants
  - 3c. Venous variants
4. Surgical Technique
  - 4a. Cephalic pancreaticoduodenectomy
  - 4b. Distal pancreatectomy
  - 4c. Types of venous reconstruction
  - 4d. Celiac axis resection - when is this feasible?

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## Abstract Archives of the RSNA, 2023

GIEE-56

### Learning From Failure: Non-Target Embolization with Yttrium-90 in the Treatment of Hepatic Tumors

All Day Room: Learning Center

Andy Mew, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The role of hepatic trans-arterial radioembolization (TARE) loco-regional therapy is expanding with new applications particularly in earlier stages of disease 2. Optimized TARE workflow involves careful pre-procedural selection, peri-procedural monitoring, and post-procedural evaluation 3. Peri-procedural imaging and dosimetry allows identification of non-target intra- and extra-hepatic dose delivery as well as target dose estimation 4. Identifying potential causes of discordance between Y-90 microsphere delivery and intended target with multi-modality imaging can impact patient outcomes and may be a valuable area of future research

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to transarterial radioembolization (TARE) 2. Indications and approaches to Y90 radioembolization in hepatic tumors 3. Workflow and evaluation of Y90 Treatment (Pre-, peri- and post-procedural) 4. Examples of non-target delivery, complications, and clinical outcome based on peri-therapy scans 5. Potential causes of non-target delivery 6. Future directions of research

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## Abstract Archives of the RSNA, 2023

GIEE-57

### Update on Multi Energy CT Applications for Pancreatic Diseases

All Day Room: Learning Center

Yasunori Nagayama, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Multi-energy CT provides spectral-based imaging such as virtual non-contrast imaging (VNC), virtual monochromatic imaging (VMI), and material density maps, potentially facilitating the optimal lesion assessment and management for patients with pancreatic diseases. The aim of this presentation is to provide the state-of-the-art clinical applications of multi-energy CT technologies for pancreatic imaging by presenting the numerous representative examples.

#### TABLE OF CONTENTS/OUTLINE

I. Principle of multi-energy CT technology II. Multi-energy CT systems III. Post-processed spectral CT imaging IV. Clinical applications of spectral imaging in pancreatic diseases A) Improved lesion delineation 1. Iso-attenuating pancreatic ductal adenocarcinoma (PDAC) 2. Incidental PDAC on routine abdominal CT 3. Staging of PDAC on routine portal-venous phase CT 4. Neuroendocrine tumor (NET) 5. Acute pancreatitis B) Spectral-based lesion characterization 1. Chronic mass forming pancreatitis vs. PDAC 2. NET vs. intrapancreatic accessory spleen 3. Local recurrence of PDAC vs. post-operative perivascular fibrosis 4. Pancreatic cyst C) Prediction of clinical outcome 1. Chemotherapy response for PDAC 2. Risk stratification for post-operative pancreatic fistula (POPF) 3. Prediction of future PDAC development D) Improve patient safety by reducing radiation dose and iodine doses

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## Abstract Archives of the RSNA, 2023

GIEE-58

### Gastrointestinal Oncologic Emergencies: A Radiologists' Guide

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mindy X. Wang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Describe the imaging approach for evaluating oncologic emergencies affecting gastrointestinal tract.
- Identify imaging manifestations of gastrointestinal oncologic emergencies.
- Identify potential pitfalls in imaging of gastrointestinal oncologic emergencies.

#### TABLE OF CONTENTS/OUTLINE

- Gastrointestinal oncologic emergencies and imaging approach
- Multimodality imaging features of gastrointestinal oncologic emergencies
  - o Intestinal obstruction
  - o Intestinal ischemia
  - o Intestinal perforation
  - o Intussusception
  - o Inflammatory/infectious changes (including superinfection of tumor necrosis/abscess formation)
  - o Graft versus host disease
  - o Tumor torsion/volvulus
  - o Peritonitis
  - o Lymphatic obstruction
  - o Vascular complications
    - § Hemorrhage (including active extravasation and intramural hematoma)
    - § Thrombosis (microangiopathy, venous and arterial thrombosis or thrombophlebitis)
    - § Arteritis
    - § Aneurysm/pseudoaneurysm
  - o Emergencies related to paraneoplastic syndrome
- Management
- Mimics and potential pitfalls

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## Abstract Archives of the RSNA, 2023

GIEE-59

### Hepatic Artery Infusion Pump: A Multi-institutional Comprehensive Case-based Review

All Day Room: Learning Center

Harit Kapoor, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) HAIP is a novel surgically placed intraarterial pharmacotherapeutic option with three salient indications: unresectable burden of colorectal liver metastases (CRLM), adjuvant therapy post CRLM resection and in unresectable intrahepatic cholangiocarcinoma (ICC).2) Post-procedure Tc-MAA SPECT are vital to ensure isolated and maximal bilobar hepatic perfusion for safe and efficacious drug delivery.3) Patient selection is multi-factorial including presence of intra- and extrahepatic disease, anatomy and patency of vasculature, hepatic function, extent of prior chemotherapy treatment, and performance status.4) All HAI devices are MRI conditional however the Medtronic SynchroMed II device is set to automatically stall while in the scanner and must be interrogated post-scan to assure the motor has restarted.5) HAIP therapy is associated with unique complications, many of which are delayed and unsuspected. Meticulous interrogation of the catheter tip position and a low threshold for further investigations on follow-up imaging can help decrease complication rates.

#### TABLE OF CONTENTS/OUTLINE

1) Role of HAIP therapy for different clinical indications.2) Technical aspects of HAIP placement and trouble shooting in extrahepatic perfusion3) Expected imaging appearances of HAIP devices in both normal and variant anatomic situations4) Role, interpretation and management implications of Tc-MAA SPECT pump perfusion imaging5) Tabulated overview and Case-based examples of HAIP complications (Pump pocket-related, Catheter-related and Hepatobiliary).6) Summary

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## Abstract Archives of the RSNA, 2023

GIEE-6

### **Improving the Gall Stone Detectability by Using the Monochromatic Images with a Fast kVp-Switching Single-Source Spectral Computed Tomography: A Phantom Experiment with Gall Stone Specimen**

All Day Room: Learning Center

Tomokatsu Tsukamoto, MS, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. In the conventional polychromatic (kVp) scan mode, gall stones detectability such as the cholesterol, pigment, and rare were lower because the small difference of computed tomography (CT) value (hounsfield unit: HU). 2. Nowadays, with the application of fast kVp switching single source dual energy scan, its spectral mode enables the ability to reconstruct monochromatic images at different energy level. The purpose of this study is to compare the gall stones detectability between the dual energy scan mode and conventional polychromatic scan mode during a phantom study. 3. The monochromatic display method (cine display mode and spectral HU curve) with dual energy scan mode was possible for improving the detection of various gallstones compare with the conventional polychromatic scan mode (kVp).

#### **TABLE OF CONTENTS/OUTLINE**

CONTENT ORGANIZATION 1: Clinical case (Cholelithiasis) :MRI and CT images 2: Gall stone specimens :dual energy CT scan mode images(keV) and conventional scan mode images (kVp). 3: Spectral HU curve 4: Gall stone specimens (cholesterol): cine display mode 5: Clinical case (Cholelithiasis): performed dual energy CT

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

GIEE-60

### A "Cyst"ematic Approach to Cystic Pancreatic Lesions

All Day Room: Learning Center

Anjelica C. Abate, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The target audience of this educational activity is for all radiologists who read CT or MR imaging of the abdomen.1. Demonstrate multimodality imaging features and patterns of common cystic pancreatic lesions2. Illustrate a systematic approach to distinguishing between pancreatic cystic lesions3. Review case-based clinical management including histopathologic correlation

#### TABLE OF CONTENTS/OUTLINE

Content: A systematic multi-modality imaging review of pancreatic cystic lesions will be included including an explanation for key diagnostic features, differentiation between lesions, histopathologic correlation, and review of management. The case selection includes:1. Mucinous cystic neoplasms2. Serous cystadenomas3. Solid pseudopapillary epithelial neoplasms4. Intraductal papillary mucinous neoplasms5. Cystic neuroendocrine tumors6. Sequela of pancreatitis (pseudocysts and walled off necrosis)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-61

### Exploring the Uncommon: Lesser-Known Abdominal Syndromes and Their Presentation

All Day Room: Learning Center

Priyanka Prajapati, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points  
1. Illustrate rare abdominal syndromes with clinical and radiological features. Highlight the constellation of associated findings and complications.  
3. Emphasize the importance of a multimodality approach when diagnosing rare abdominal syndromes.

#### TABLE OF CONTENTS/OUTLINE

Table of contents  
1. Background  
2. Normal anatomy relevant to the syndromes  
3. Importance of Pathology, Molecular tests, Imaging, Laboratory tests  
4. Case based illustrations of:  
a) TEMPI Syndrome  
b) Abernethy Syndrome  
c) DRESS Syndrome  
d) Li-Fraumeni Syndrome  
5. Classical clinical presentation and laboratory findings  
6. Pertinent Imaging findings of the syndromes  
7. Associated pathologies found  
8. Other Rare Abdominal Syndromes

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## Abstract Archives of the RSNA, 2023

GIEE-62

### Imaging Overview of Peritoneal Mesothelioma

All Day Room: Learning Center

Suren Reddy Satti (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

A comprehensive overview of peritoneal mesothelioma with a focus on the histological subtypes, key distinguishing imaging features and understanding the common pitfalls involved in diagnosis.

#### TABLE OF CONTENTS/OUTLINE

The aim is to improve understanding of peritoneal mesothelioma and the subtypes to aid with diagnosis and subsequent management. We present a radiological case-based review of the subtypes of peritoneal mesothelioma with accompanying histological and intra operative findings. Clinical features along with specific imaging findings for each subtype will be shown along with some pitfalls in interpretation. Subtypes of peritoneal mesothelioma: 1. Multicystic mesothelioma 2. Well differentiated papillary mesothelioma 3. Epithelioid mesothelioma 4. Sarcomatoid mesothelioma 5. Biphasic mesothelioma  
Mimics of mesothelioma - Lymphangioma - IgG4 peritoneal disease - Tuberculosis

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## Abstract Archives of the RSNA, 2023

GIEE-63

### **Burn the Cake: The Role of HIPEC in Pseudomyxoma Peritonei**

All Day Room: Learning Center

Vitor D. Bichuette, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

? To review concepts involving epidemiology, imaging findings and surgical techniques used in the treatment of pseudomyxoma peritonei (PP). ? To illustrate the use of peritoneal cancer index (PCI) to assess the peritoneal cavity. ? To review how hyperthermic Intraperitoneal chemotherapy (HIPEC) is performed, the techniques involved, indications and contraindications, and related complications. ? To discuss how radiologists can help surgeons in the management of PP.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction - General concepts
  - o The use of CT to assess the PCI
- Pseudomyxoma peritonei:
  - o Definition, clinical presentation, imaging features and treatment.
  - o Imaging aspects of peritoneal pseudomyxoma and peritoneal carcinomatosis: how to differentiate
  - o Surgical treatment
- HIPEC:
  - o A step-by-step explanation of how HIPEC is performed.
  - o Advantages, indications and contraindications.
  - o Most common outcomes and complications.
- Case-Based Review:
  - o Sample cases explaining and demonstrating image findings of PP and how CT can be used before and after the surgery
  - o Assessment of PCI
  - o HIPEC: normal and abnormal findings
- Future Directions: new perspectives in the use of HIPEC to treat peritoneal tumors.
- Conclusion and key takeaways.

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## Abstract Archives of the RSNA, 2023

GIEE-64

### **Sonazoid-Enhanced Ultrasonography: What Can We Do in Abdominal Radiology and Intervention?**

All Day Room: Learning Center

Jae Woong Choi, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Sonazoid-enhanced ultrasonography (SEUS) is recently introduced contrast-enhanced ultrasonography using Sonazoid (GE Healthcare) offering the vascular phase and the unique post-vascular Kupffer phase for helping diagnose focal liver lesions (FLL). Its role has been primarily focused on differentiating benign and malignant FLLs. However SEUS can be used in diverse clinical settings such as evaluating the hepatic vasculature, and a guiding tool for interventional procedures of the liver. In conclusion, we believe that CEUS can be applied to diverse clinical settings, not only for the diagnostic purposes but also for the interventional procedures as an excellent guiding tool.

#### **TABLE OF CONTENTS/OUTLINE**

1) Physics of SEUS, 2) Diagnostic roles of SEUS, 3) Application of SEUS in evaluation of hepatic vasculature, 4) Introduction of SEUS during liver biopsy, 5) SEUS as a guidance tool for radiofrequency ablation, 6) Tips and limitations of SEUS.

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## Abstract Archives of the RSNA, 2023

GIEE-65

### **Fundamental of Pancreatic Adenocarcinoma Imaging on CT: What a Resident Should Know**

All Day Room: Learning Center

Carlos M. Campana SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the anatomy of the pancreas, its vasculature and lymphatic drainage.- Illustrate the CT features of pancreatic adenocarcinoma. - Understand the staging of the pancreatic adenocarcinoma and the surgical criteria.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction.- Anatomic considerations.- Teaching points.- CT features of pancreatic adenocarcinoma.- Case based approach.- Staging and surgical criteria.- Conclusions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-66

### **Fake Liver Lesions: Can You Help Me? An Illustrative Guide to Liver Pseudo-lesions and Tumor Mimickers**

All Day Room: Learning Center

Roberta R. Sasso, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review importance of epidemiology for diagnosis of liver lesions. Illustrate clinical and imaging findings that might help distinguishing benign and malignant liver lesions. Practical tips and imaging features that could help achieve an accurate diagnosis and avoid unnecessary procedures. Highlight potential pitfalls related to different treatments that may mimic liver lesions.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction - General concepts: epidemiology of liver lesions, including risk factors, incidence, and mortality. Imaging findings on CT and MRI of several liver lesions. Liver lesions: illustrative cases of different benign hepatic lesions and pseudolesions that mimic malignant hepatic lesions. Pitfalls: expected post-treatment changes that might be confused with true lesions. Normal findings after surgery, transplant, ablation, embolization, radiation and immunotherapy are reviewed. Case-Based Review: series of cases demonstrating imaging findings of liver lesions and how different modalities can be used. Conclusion and key takeaways.

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## Abstract Archives of the RSNA, 2023

GIEE-67

### Imaging Review of Pseudomyxoma Peritonei

All Day Room: Learning Center

Ogbeide Evbuomwan, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Comprehensive radiological overview of pseudomyxoma peritonei (PMP), and its patterns of disease spread. Common appearances of appendix mucinous tumours and frequently encountered interpretation pitfalls leading to misdiagnosis.

#### TABLE OF CONTENTS/OUTLINE

Diagnosis of PMP is often delayed in the non-specialist setting due to minimal exposure to appendix tumours and a lack of awareness. The aim is to improve the knowledge of pseudomyxoma peritonei and aid in the radiological diagnosis through understanding of its various aetiologies and the common pitfalls in imaging diagnosis. We present a case-based exhibit of PMP with reference to histology and intra-operative findings. To include:

- Common radiologic findings at presentation, predominant patterns of disease spread and complications of PMP with key review areas when reporting.
- Examples of delayed diagnosis from misinterpretation with tips and tricks to aid with accurate diagnosis. The cases include:
  - o Primary appendix tumours, misdiagnosed as an abnormal ovary or fallopian tube.
  - o Krukenberg tumours reported as a primary ovarian tumour.
  - o Diffuse peritoneal disease with a primary appendix tumour (initially not identified).
  - o Complicated appendicitis with an underlying tumour.
- Other origins of pseudomyxoma other than the appendix, such as urachus and mature teratoma of the ovary.
- How to optimize imaging to aid with diagnosis, utilizing positive oral contrast in computed tomography (CT) imaging of pseudomyxoma peritonei, use of MRP re-formats and MRI protocols.

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## Abstract Archives of the RSNA, 2023

GIEE-68

### Role of Radiological Imaging in the Diagnosis and Management of ERCP Complications

All Day Room: Learning Center

Mehmet Simsar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- What is Endoscopic Retrograde Cholangiopancreatography (ERCP), and in which situations is it performed?
- What are the complications of ERCP and how often do we encounter them?
- Diagnosis of ERCP complications with the help of imaging methods. Tips for radiologists
- The importance of imaging methods in the early diagnosis of complications
- The role of imaging in management of complications

#### TABLE OF CONTENTS/OUTLINE

Table of Contents

- Terminology and anatomy of the bile ducts and pancreatic duct
- Post-ERCP expected imaging findings
- Complications of ERCP
- Demonstration of pathologies in imaging methods for the diagnosis of complications
- The importance of early diagnosis in case of complications and correlation of imaging finding with clinical symptoms and signs
- Demonstration of possible complications with sample cases
- Follow up imaging findings during the treatment process of patients with complications

Outline

- Endoscopic retrograde cholangiopancreatography (ERCP) is an application that is increasingly used to treat biliopancreatic disorders. This situation leads to a rise in the number of cases with complications.
- It is important to distinguish between expected findings and pathological findings in post ERCP images.
- It is important to evaluate the history and physical examination together with imaging methods for early diagnosis of complications and to decrease morbidity.
- Imaging methods play a guiding role in the classification of complications.

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## Abstract Archives of the RSNA, 2023

GIEE-69

### **Multimodality Imaging in the Detection and Characterization of Anatomic Variants, Benign, and Malignant Conditions of the Peri-Ampullary Region**

All Day Room: Learning Center

Kelvin Cortis, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To illustrate the conventional and variant anatomy of the ampullary and periampullary region. To provide a structured differential of the various conditions that may present at the ampullary and peri-ampullary regions. To describe the imaging features of pathologies at these regions.

#### **TABLE OF CONTENTS/OUTLINE**

The periampullary region is an anatomically and pathologically complex region. It encompasses the pancreatic head, second part of the duodenum, pancreato-biliary junction, and associated neurovascular structures. All these structures are within a 2cm radius from the major duodenal papilla. Familiarity with this area and its variants will increase diagnostic accuracy and recognition of associated complications, thereby guiding proper management. This pictorial exhibit will display the multimodality imaging findings of developmental, benign, and neoplastic entities that may arise at the ampullary and peri-ampullary regions. Developmental entities include duodenal webs, pancreas divisum, pancreaticobiliary malunion, and annular pancreas. Para-duodenal pancreatitis, papillitis, Lemmel's syndrome, choledocholithiasis, and vascular abnormalities, are benign conditions that might involve the ampullary region. Neoplastic conditions that can involve the periampullary region include ampullary carcinoma, periampullary duodenal carcinoma, pancreatic tumours, distal common bile duct tumours, gastrointestinal stromal tumours, and neuroendocrine tumours. Abdominal radiologists should have a thorough anatomical understanding of the ampullary region in order to formulate a structured differential diagnosis that will lead to timely and precise diagnosis and management.

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## Abstract Archives of the RSNA, 2023

GIEE-7

### **Anorectal Fistula - Detection, Classification, and Post Treatment Follow-up**

All Day Room: Learning Center

Joseph W. Owen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Identify and describe anorectal fistula based on the Parks classification system on MR2. Explain the options for treatment of anorectal fistula and associated complications based on their classification3. Recognize and describe the post treatment appearance of anorectal fistula and abscesses on CT and MR

#### **TABLE OF CONTENTS/OUTLINE**

The predisposing factors for development of anorectal fistula: Crohn's Disease; Prior pelvic radiation; Obstetric injuries; Infection; Foreign body insertio; MalignancyDiagnoses and characterization: MR; Exam under anesthesiaClassification of anorectal fistula with the Parks classification Inter-sphincteric; Trans-sphincteric; Supra-sphincteric; Extra-sphinctericClassification of Anorectal Abscess: Ischiorectal; Inter-sphincteric; Supra-levator; HorseshoeTreatment Abscess-Incision and drainage; Simple fistula - Primary fistulotomy; Complex fistula - Sphincter-sparing staged treatmentPost-treatment imaging appearance and characterization Seton; Endoanal advancement flap; Residual scar tissue; and inflammation; Recurrent fistula; Recurrent abscess

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## Abstract Archives of the RSNA, 2023

GIEE-70

### Advanced Pancreatic Imaging: 10 Tips and Tricks

All Day Room: Learning Center

Mariana B. Peleja, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pancreatic ductal adenocarcinoma (PDAC) and other pancreatic conditions can be very difficult to diagnose and be a real challenge even to an experienced radiologist. The purpose of this exhibit is to present, through a series of challenging cases, the direct and indirect signs of focal and diffuse pancreatic disease, and how can the radiologist help to establish the correct diagnosis using different imaging methods, such as Ultrasound (US), Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) CT. Some of the presented tips include:- Careful evaluation of main pancreatic duct or biliary tree dilation;- Importance of the T1-weighted images to evaluate the pancreatic parenchyma;- Look for asymmetrical parenchyma atrophy;- Pay attention to abnormalities involving the surrounding vessels;- Search for secondary lesions if uncertain about malignancy (such as liver and lymph nodes).

#### TABLE OF CONTENTS/OUTLINE

- Cases of pancreatic neoplasms and inflammatory conditions, with subtle findings that should raise a suspicion for a pancreatic disease;- Brief Review of pancreatic anatomy with multimodality imaging;- Image assessment of PDAC, with its features spectrum and tricky findings;- Importance of imaging for staging and resectability evaluation;- Other challenging cases in pancreatic cancer imaging, which the radiologist expertise is crucial to the correct management of disease.

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## Abstract Archives of the RSNA, 2023

GIEE-71

### Peritoneal carcinomatosis: A Comprehensive Review of Peritoneal MRI. Primer for Residents

All Day Room: Learning Center

Anna F. Garcia Herrmann, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Peritoneal carcinomatosis is a common metastatic manifestation in several malignancies, with a higher incidence in gastrointestinal and gynecological tumors. Imaging techniques are essential in assessing the extent of the disease and guiding treatment decisions. Peritoneal MRI is a noninvasive technique that provides high-quality imaging of the peritoneum with excellent soft tissue contrast and high spatial resolution, with no exposure to ionizing radiation. Specific imaging protocols with DCE and DWI sequences allow a better assessment of peritoneal disease, especially unfavorable sites such as mesenteric and intestinal involvement, with enhanced sensitivity for detecting small lesions. Clinical applications of peritoneal MRI include diagnosis, staging, and monitoring of peritoneal metastases, with a crucial role in guiding therapeutic strategies and prognostic utility in patients undergoing cytoreductive surgery or HIPEC. The "PAUSE" method offers a structured approach to reporting peritoneal involvement, providing a precise description of the location and extent of the disease, serving as a road map for the surgeon and facilitating surgical planning.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Peritoneal metastases and diagnostic challenges. Advantages over CT and PET/CT. Peritoneal MRI: Dedicated protocol. Clinical applications: Diagnosis, staging, and monitoring of peritoneal metastases. Advantages and limitations. The "PAUSE" method: A structured reporting tool. Case examples. Conclusions. References

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## Abstract Archives of the RSNA, 2023

GIEE-72

### Photon-counting CT: Technical Features and Clinical Impact on Abdominal Imaging

All Day Room: Learning Center

Hiromitsu Onishi, MD, PhD (*Presenter*) Research Grant, General Electric Company; Speakers Bureau, General Electric Company

#### TEACHING POINTS

The photon-counting CT system is equipped with a photon-counting detector that can measure the number of photons and the energy of each photon, allowing the acquisition of images with high spatial resolution and virtual monochromatic contrast. One of the major advantages of photon-counting CT in abdominal examinations is that it provides virtual monochromatic images with high image quality and high spatial resolution. The purpose of this presentation is: 1. To illustrate the technical features of photon-counting CT system compared with conventional CT system with energy integrating detector, 2. To introduce the effective use of photon-counting CT for the evaluation of abdominal diseases, and 3. To discuss the clinical impact of photon-counting CT on the diagnosis of abdominal diseases.

#### TABLE OF CONTENTS/OUTLINE

1. Technical overview of photon-counting CT; 2. Scan modes; ultra-high resolution mode, multi-energy mode, and dual source mode; 3. A variety of image reconstruction kernels; 4. Quantum iterative reconstruction algorithm; 5. High spatial resolution; 6. Valuable virtual monochromatic imaging; 7. Possibility of radiation dose reduction; 8. Scanning protocols optimized for the abdominal diseases; 9. Clinical implications for the diagnosis of abdominal diseases; 10. Summary

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## Abstract Archives of the RSNA, 2023

GIEE-73

### **Pearls and Pitfalls of Rectal MRI: The Only Stool You Need**

All Day Room: Learning Center

Hala A. Khasawneh, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Highlight essential imaging findings in staging. Illustrate essential keys points and common pitfalls to serve as a guiding tool for radiologists through an interactive approach. Overview of current treatment options including surgical and nonsurgical approaches, such as “watch and wait” will be discussed.

#### **TABLE OF CONTENTS/OUTLINE**

Over the past few decades, rectal MRI has created a paradigm shift in the management options of rectal cancer by providing accurate TNM staging and restaging as well as post-treatment assessment. However, a few controversies remain in reporting TNM staging for rectal cancer which radiologists need to be aware of to provide more reproducible and standardized reporting. The benefit of rectal MRI in guiding disease management relies on obtaining high-quality scan for accurate TNM staging, assessment of Circumferential Resection Margin, Extramural Vascular Invasion, anal canal involvement and tumor relation with surrounding pelvic structures. Using an evidence-based approach, we aim to clarify controversial key points in reporting rectal MRI, including staging of T4b tumor, utilizing diffusion weighted imaging in restaging, evaluation of mucinous lesions, differentiating lymph nodes from tumor deposits, and morphological assessment and localization of lateral pelvic lymph nodes in staging and restaging. Rectal MRI is essential for tailoring treatment plans in rectal cancer. Therefore, it is paramount to have standardized and reproducible interpretation of scans to enhance consistency in disease staging.

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## Abstract Archives of the RSNA, 2023

GIEE-74

### The Magic Eye: Advantages of Spectral CT Imaging over Conventional CT in Liver and Pancreatic Pathology

All Day Room: Learning Center

Antonio Michael-Fernandez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To review the most important spectral CT reconstructions for abdominal imaging and the improvement in material differentiation with this technique. - To show Spectral CT imaging advantages over conventional CT through some cases of liver and pancreatic pathologies.

#### TABLE OF CONTENTS/OUTLINE

Background: Spectral CT is gaining increasing clinical importance with multiple potential applications including abdominal and oncology imaging. We present different cases with liver and pancreatic pathologies where spectral CT images offer multiple advantages over conventional CT, as low-energy virtual monoenergetic images and iodine maps for the detection of hyper- and hypovascularized liver lesions. The purpose of this review is to provide an overview of potential useful abdominal applications of spectral CT focused on liver and pancreatic pathology. Details of content: We present different types of cases (such as characterization of liver and pancreatic lesions, improving vascular contrast for surgical planning or evaluation the response of tumour therapy) and review and analyze the most important spectral CT reconstructions for each case (virtual unenhanced, iodine maps and virtual monochromatic reconstructions). These reconstructions allow better detection and characterizations of findings and reduce the need for correlative or follow-up imaging. Conclusion: Spectral TC imaging offers multiple advantages in the abdominal area. The combination of different types of spectral reconstructions improves better detection and characterization of liver and pancreatic lesions. It also allows precise treatment planning and could be a potential therapy monitoring parameter.

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## Abstract Archives of the RSNA, 2023

GIEE-75

### Going, Going, Gone: Case-Based Review of Sclerosing Hemangiomas

All Day Room: Learning Center

Bryson Jones, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Hepatic hemangiomas are the most common benign neoplasm encounter in the liver and most are discovered incidentally. 2) The appearance of hemangiomas may change over time and may be influenced by senescent changes of the liver or diffuse disease of the surrounding hepatic parenchyma. 3) Hemangiomas undergoing degeneration has been described as sclerosing/sclerosed, hyalinized, or thrombosed and present a diagnostic dilemma for radiologist 4) Understanding the imaging appearance and crucial importance of prior comparative imaging is key to making the diagnosis and avoiding unnecessary additional imaging and invasive procedures.

#### TABLE OF CONTENTS/OUTLINE

I. Briefly review the classic appearance of hepatic hemangiomas, incidence and natural history, as well as illustrative pathological changes that are proposed to occur as hemangiomas sclerose. II. Propose a diagnostic algorithmic approach to a suspected sclerosing/sclerosed hemangioma. III. Provide case-based imaging examples of hemangiomas as they evolve over time, including US, CT, MRI and CEUS. IV. Provide case-based imaging example of pitfalls in attempting to prospectively diagnose sclerosing hemangiomas.

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## Abstract Archives of the RSNA, 2023

GIEE-76

### **Pitfalls of Contrast-enhanced Ultrasound (CEUS) in Liver Lesions: Early Arterial Enhancement Patterns and Washout**

All Day Room: Learning Center

Elhamy R. Heba, MD, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the utility of CEUS in a patient population in which CT and MRI contrast agents are contraindicated. 2. Discuss different enhancement patterns of benign and malignant liver lesions. 3. Explain pitfalls in interpreting washout (most associated with malignancy) including understanding true intravascular nature of microbubbles contrast agent and that additional factors related to technique can lead to early bubble rupture and appearance of false washout in benign lesions. 4. Discuss possible pathophysiology of earlier rupture of the microbubbles in benign subcapsular liver lesions compared to lesions located deeper in the liver. 5. Discuss potential false positive washout scenarios in benign liver lesions on a background of hepatic steatosis due to echogenic liver parenchyma resulting in lesion appearing relatively hypoechoic compared to adjacent liver parenchyma.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview: review of the utility of CEUS and mention the advantages, disadvantages and indications in liver imaging. 2. Understanding the mechanism of CEUS agent (microbubbles), explaining how that might contribute to false washout in different circumstances. 3. Different enhancement pattern of benign and malignant liver lesion with emphasis on washout as an important feature to suggest malignancy of liver lesion. 4. False washout in benign liver lesions as a pitfall of CEUS, case-based approach. 5. True washout in cases of hepatocellular carcinoma, metastases, and cholangiocarcinoma for comparison.

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## Abstract Archives of the RSNA, 2023

GIEE-77

### Imaging Evaluation in Living Liver and Kidney Donors: What to Report

All Day Room: Learning Center

Thamy Carvalho, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Illustrate the main imaging standards in the pre-transplant evaluation of live liver and kidney donors through conventional radiology images, such as computed tomography (CT) and magnetic resonance imaging (MRI), from the digital archive of our institution.2- Improve the understanding of vascular variants (arterial and venous) and their implications in the pre-renal and liver transplant evaluation of potential living donors using a didactic approach, through illustrations.3- Evaluation of donors' pre-transplant images, understanding the procedure and identification of anatomical variants that may interfere with the surgical technique, in addition to possible pathologies that may prevent a possible transplant.4- Describe and prepare a structured report of the main findings that may contraindicate the candidate for transplants, in addition to assisting in the surgical technique to be performed.

#### TABLE OF CONTENTS/OUTLINE

1 - Review of vascular variants, pathologies and anatomical reconstructions of candidates for pre-transplantation of live liver and kidney donors through illustrative images.2 - Illustration of vascular variants and pathologies supported by the use of illustrative images that may imply or prevent transplantation.3 - Preoperative knowledge of hepatic and renal vascular anatomical variants is mandatory for surgical planning and to help reduce postoperative complications. This information must pertain to the structured report.4 - Summary and messages to take home.

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## Abstract Archives of the RSNA, 2023

GIEE-78

### The Many Faces of FNH: MRI Findings

All Day Room: Learning Center

Enzo E. Casali SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the typical presentation of FNH. Analyze uncommon MRI findings in FNH. Evaluate the importance of liver-specific contrast agents in achieving correct diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Focal nodular hyperplasia (FNH) is the second most common benign liver tumor after hemangioma. Magnetic Resonance (MRI) is an extremely useful tool for the diagnosis of FNH due to its high sensitivity and specificity. The correct diagnosis of FNH and its distinction from other differential diagnoses is essential because asymptomatic patients with FNH do not require treatment. FNH is classified as classic or nonclassic and MRI findings vary according to this. Lesions typically shows iso or hypointense signal on T1-weighted images, slightly hyper or isointense signal on T2-weighted images, an hyperintense central scar on T2-weighted images, an intense homogeneous enhancement during the arterial phase of gadolinium-enhanced imaging and enhancement of the central scar during later phases. Other more infrequent findings are: increase in size, T1 hyperintensity, the presence of a pseudocapsule, the appearance of multiple HNF all at once and the association with other benign liver lesions. Using liver-specific contrast agents may facilitate the diagnosis in these cases. Recognizing these different MRI patterns allows us to establish a correct diagnosis of FNH, preventing treatment in asymptomatic patients.

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## Abstract Archives of the RSNA, 2023

GIEE-79

### Abbreviated MRI Techniques for HCC Screening

All Day Room: Learning Center

Diana Kadi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. US has low sensitivity for HCC, especially in early-stage tumors, cirrhosis and obesity. 2. To improve sensitivity over US for early detection of HCC, while remaining cost-effective, Abbreviated MRI (AMRI) protocols have been developed. 3. This exhibit will review emerging concepts in AMRI-based HCC surveillance, including technical aspects, diagnostic performance, current gaps in knowledge, and future directions.

#### TABLE OF CONTENTS/OUTLINE

1. Current guidelines for HCC surveillance 2. Limitations of US 3. CT and MRI a. Superior reported diagnostic sensitivity, especially for small and early HCC b. Limitations 4. Three general AMRI approaches a. Non-contrast AMRI i. Technique o T1 weighted imaging a. Low sensitivity for early-stage HCC o T2 weighted imaging a. Help differentiate suspicious/benign lesions b. Low sensitivity for small HCC o Diffusion weighted imaging a. Restricted diffusion favors malignancy b. Higher lesion conspicuity ii. Reporting iii. Advantages iv. Disadvantages b. Dynamic AMRI i. Technique o Pre-contrast o Arterial phase a. Assess APHE o Portal venous and delayed phases a. Washout b. Capsule ii. Reporting iii. Advantages iv. Disadvantages 5. Hepatobiliary Phase AMRI a. Technique i. Hepatobiliary phase imaging o High liver to lesion contrast ii. T2 weighted imaging o Excludes some benign lesions iii. DWI o Mixed data regarding benefit of DWI b. Reporting c. Advantages d. Disadvantages 6. Gaps and current needs a. Prospective studies are needed to implement AMRI in guidelines b. Current utilization should be in patients whose US-based HCC surveillance is compromised SUMMARY AMRI is a high-sensitivity alternative to US for surveillance of early-stage HCC in patients at risk for HCC.

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## Abstract Archives of the RSNA, 2023

GIEE-8

### **Intrahepatic Cholangiocarcinoma: A Review of Current and Emerging Imaging Techniques and Treatment Options**

All Day Room: Learning Center

Julia A. Saltalamacchia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Intrahepatic cholangiocarcinoma makes up a small percentage of total CCA cases, but treatment and surgical options differ from extrahepatic cholangiocarcinoma  
2. Improvements in MRCP imaging and PET/MRI serve as complimentary modalities to standard MR and CT imaging for staging, problem solving, and follow up.  
3. Recent developments in systemic and locoregional therapies have expanded treatment options and therapy considerations including radiation therapy, interventional oncology, expanded neoadjuvant therapies, and expanded surgical resectability (including transplantation)

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Intrahepatic cholangiocarcinoma work-up  
a. NCCN guidelines  
3. Imaging considerations  
a. Characteristic findings  
b. Mimics and pitfalls  
c. The emerging role of FDG PET MRI  
4. Treatment options  
a. General principles - locoregional and systemic options  
b. Chemotherapy  
1. Systemic therapy  
2. Targeted  
a. Transarterial chemoembolization  
b. Hepatic arterial infusion pump  
3. Downstaging after neoadjuvant therapy  
c. Radiation  
1. External beam radiation therapy  
2. Y-90 radioembolization (lobar and radiation segmentectomy)  
d. Surgical  
1. Preoperative considerations  
2. Patient selection  
3. Surgical options  
a. Wedge resection  
b. Segmentectomy +/- hepaticojejunostomy (HJ)  
c. Hepatectomy +/- HJ  
d. Transplantation

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## Abstract Archives of the RSNA, 2023

GIEE-80

### Role of Radiology in a Multidisciplinary Approach of Hepatocellular Carcinoma

All Day Room: Learning Center

Elissandra M. Lima, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To review international diagnostic HCC guidelines and LI-RADS with examples- To review the classical imaging appearance and patterns of HCC- To understand imaging features that correlate with favorable versus poor outcome and those associated with post-treatment response and recurrence

#### TABLE OF CONTENTS/OUTLINE

1. Background 2. When to use each imaging modality? 3. Optimal study protocol of the liver 4. What contrast agent to use? Hepatobiliary versus extracellular contrast agent 5. Characterization of hepatocarcinoma nodules 6. How to use LI-RADS? 7. International diagnostic HCC guidelines 8. Mimickers and Overdiagnosis of HCC: Flash-filling hemangioma, focal confluent fibrosis, intrahepatic cholangiocarcinoma, hepatic lymphoma 9. Staging, treatment decision-making, and follow-up of HCC 10. Evaluating beyond the liver: Common sites of extrahepatic metastasis 11. How to select patients with HCC for liver transplantation, resection or locoregional treatment? 12. Advanced disease: Locoregional therapies or systemic therapies

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-81

### **Pseudomyxoma Peritonei: Concepts, Classification, Imaging Spectrum and HIPEC**

All Day Room: Learning Center

Ana Claudia V. Uski SR, MD,MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe and demonstrate the imaging features of pseudomyxoma peritonei in the various diagnostic modalities. To propose a systematization of the evaluation of pseudomyxoma peritonei. Contextualize the role of imaging to predict the extent and quantification of disease that may result in a more aggressive surgical approach combined with or without HIPEC.

#### **TABLE OF CONTENTS/OUTLINE**

Peritoneal pseudomyxoma (PPM) is a clinical syndrome characterized by the accumulation of mucinous ascites in the peritoneal cavity. The most common cause of peritoneal pseudomyxoma is mucinous neoplasms in the appendix and according to the new consensus statement, PPM is classified based on the histology of the peritoneal disease and not based on the primary neoplasm. Peritoneal pseudomyxoma is classified into: acellular mucin, low-grade mucinous carcinoma peritonei (G1), high-grade mucinous carcinoma peritonei (G2) and high-grade mucinous carcinoma peritonei with signet ring cells (G3). The imaging spectrum of PPM is variable and suggestive findings include mucinous ascites, peritoneal nodules and omental. It is essential to be familiar with this pathology since accurate staging, with details of the sites affected, is essential to define therapy which may include cytoreductive surgery and hyperthermic intraperitoneal chemotherapy (HIPEC). The role of imaging is well documented and each diagnostic modality has its indications and limitations in the staging and follow-up of PPM. This review provides an updated and comprehensive summary of the histologic classification of PPM, imaging findings, and describes the role of the radiologist in the multidisciplinary setting to predict the extent and quantification of disease.

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## Abstract Archives of the RSNA, 2023

GIEE-82

### Peeking Inside the Pancreas: A Radiological Journey through Imaging of Unusual and Rare Pancreatic Tumors

All Day Room: Learning Center

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the imaging approach for evaluating unusual and rare pancreatic tumors. 2. Identify imaging manifestations of unusual and rare pancreatic tumors. 3. Identify potential pitfalls in imaging of unusual and rare pancreatic tumors.

#### TABLE OF CONTENTS/OUTLINE

1. Unusual and rare pancreatic tumors and imaging approach 2. Multimodality imaging features of unusual and rare pancreatic tumors a. Primary malignant tumors: i. Acinar cell adenocarcinoma ii. Pancreatic small cell carcinoma iii. Pancreatic adenosquamous carcinoma iv. Pancreatic lymphoma v. Hepatoid pancreatic adenocarcinoma vi. Pancreatic mucinous carcinoma vii. Pancreatic primary lymphoma viii. Clear cell acinar cell carcinoma ix. Pancreatic carcinosarcoma x. Pancreatic hemangiopericytoma xi. Pancreatic rhabdomyosarcoma b. Primary tumors with malignant potential: i. Solid pseudopapillary tumor ii. Intraductal tubulopapillary neoplasm iii. Teratoma iv. Solid serous cystadenoma c. Secondary Malignant Tumors i. Unusual metastases to pancreas d. Benign Tumors i. Pancreatic lipoma ii. Intraductal papillary neoplasm (IPMN) iii. Lymphoepithelial cysts iv. Focal pancreatitis 3. Mimics and Pitfalls (tumor like conditions; IgG4-RD; biliary tract tumors; duodenal tumors (duodenal dystrophy, gastrointestinal stromal tumor (von Recklinghausen), Brunner's duodenal hamartoma)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-83

### **Adding Insult to Injury: Unexpected Gastric Cancer Presentations That Can Make Radiologist's Life Difficult**

All Day Room: Learning Center

Dequitier C. Machado, DC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To demonstrate the variability in presentations of gastric carcinoma and the dissemination patterns. 2. To understand and learn how to differentiate fibrosis from disease progression and primary tumor involvement. 3. To identify recurrence in the esophagus-gastric junction 4. To illustrate the role of radiology in the differential diagnosis, staging, and surveillance of patients with gastric carcinoma.

#### **TABLE OF CONTENTS/OUTLINE**

- Gastric normal anatomy and possible secondary implant pathways . Epidemiology of gastric cancer . Variability in presentations in gastric adenocarcinoma.- Rare patterns of tumor recurrence, that we should not miss.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-84

### **The Solution is Right at Your Fingertips: Linear Probe and Improvement of US Gallbladder Evaluation**

All Day Room: Learning Center

Pilar Navarro Azurmendi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1 To analyze the benefits and limitations of linear and curved transducers used in US evaluation of the gallbladder with cine and imaging findings throughout different cases. 2 To review the most advantageous sonographic technique and knobology optimization. 3 To identify potential pitfalls in US evaluation and the technics to prevent them. 4 To assess the available tools to minimize the risk of misinterpretation in biliary pathology imaging.

#### **TABLE OF CONTENTS/OUTLINE**

1 Types of transducers used for gallbladder evaluation. Characteristics, benefits and limitations. 2 Sonographic technique and knobology optimization through cine videos and images. 3 Anatomy, useful landmarks and choice of sonographic window. 4 Ultrasound artifacts: making use of imaging artifacts to aid in diagnosis. 5 Identify potential pitfalls in gallbladder ultrasound evaluation and how to avoid them. 6 Diagnostic criteria for gallbladder wall pathologies. 7 Test your knowledge: interactive review for integration of clinical cases with imaging findings. 8 Take-home messages.

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## Abstract Archives of the RSNA, 2023

GIEE-85

### **Lymphoma: What to Expect from the Unexpected**

All Day Room: Learning Center

Fabio Yoshimura (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Lymphoma is a disease that can manifest itself in multiple ways. It is important to know the sites of involvement in its most varied forms and the possible imaging characteristics. This work aims to improve the literature with illustrated teaching cases from our department about suspicious lesions, allowing for early diagnosis and adequate follow-up.

#### **TABLE OF CONTENTS/OUTLINE**

This work aims to review with illustrated cases and their characteristic images from main abdominal organs affected by Lymphoma:- Liver;- Spleen;- Gastrointestinal tract;- Pancreas;- Kidney;- Peritoneal cavity.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-86

### **Uses, Finding, Pitfalls, and Advanced Applications in Gadoteric Acid-Enhanced MR Imaging of the Liver**

All Day Room: Learning Center

Elissandra M. Lima, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To understand the Pharmacokinetics of gadoteric acid- To review clinical applications, pitfalls and of gadoteric acid-enhanced MRI- To discuss advanced and future applications such as multiparametric liver MRI, magnetic resonance cholangiography, and liver function assessment

#### **TABLE OF CONTENTS/OUTLINE**

1. Background 2. Pharmacokinetics of gadoteric acid 3. Magnetic resonance protocol and technique: abbreviated and multiparametric protocols 4. Optimizing the workflow 5. Clinical applications of gadoteric acid-enhanced MRI: Focal nodular hyperplasia, hepatocellular adenomas, hepatocellular carcinoma, cholangiocellular carcinoma, liver metastases, hepatic fibrosis, biliary imaging 6. Evaluation of treatment response of liver metastases 7. Gadoteric acid-enhanced MRI for staging treatment decision-making, and follow-up of HCC 8. Incidental discovery of focal liver lesions 9. Pitfalls and solutions: arterial phase limitations, hepatobiliary phase limitations, focal nodular hyperplasia, "pseudowashout", uptake in lesions other than FNH. 10. Advanced and future applications

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-87

### Bad Connections: Review of Intestinal Fistulae

All Day Room: Learning Center

Allison Forrest, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Intestinal fistulae in the abdomen and pelvis are common and result in significant morbidity. Fistulae occur between hollow viscous organs and can occur in the setting of surgery, trauma, inflammation, and malignancy. Multiple imaging modalities are used for both initial evaluation and follow up, with selection of technique depending on the anatomy involved. Fluoroscopic evaluation is often helpful in the evaluation as it provides real-time, dynamic evaluation of fistulae and can further delineate complex anatomy in conjunction with cross-sectional imaging. Selection of route of contrast administration and catheter selection for evaluation of enterocutaneous fistulae are particularly important for successful fluoroscopic evaluation. An understanding of the spectrum of fistulae and the tools available to radiologists are critical for accurate characterization of fistulae.

#### TABLE OF CONTENTS/OUTLINE

1. Review the pathophysiology of intestinal fistulae.
2. Provide an overview of indications and protocols for imaging evaluation of fistulae, with emphasis on fluoroscopic evaluation with cross-sectional correlation. Specific tips for evaluation of enterocutaneous, esophageal, small bowel, and colonic fistulae will be discussed.
3. Display case examples of common and uncommon intestinal fistulae, including those due to surgery, malignancy, inflammation, and trauma.
4. Review factors that are commonly implicated in delayed fistulae healing.
5. Brief overview of treatment principles and available therapies.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GIEE-88

### Fibro-polycystic Liver Disease: What Radiologists Need to Know

All Day Room: Learning Center

Lautaro M. Florentin, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Fibropolycystic liver disease refers to a group of different liver and biliary anomalies caused by abnormal embryologic development of ductal plates. Congenital hepatic fibrosis, biliary hamartomas, autosomal dominant polycystic disease, Caroli disease, and choledochal cysts are included in this group. Fibropolycystic liver diseases usually do not exist as single entities and can be found in combined forms. Each entity shows characteristic imaging findings, specially at computed tomography (CT) and magnetic resonance (MR). Radiologists should be familiar with this spectrum of lesions to proper guide the management of these patients.

#### TABLE OF CONTENTS/OUTLINE

Introduction  
What is fibropolycystic liver disease?  
Embryologic development  
Congenital hepatic fibrosis  
What is? Imaging findings  
Biliary hamartomas (Von Meyenburg complex)  
What is? Imaging findings  
Autosomal dominant polycystic disease  
What is? Imaging findings  
Complications  
Caroli Disease  
What is? Caroli disease vs. Caroli Syndrome  
Imaging findings  
Choledochal cysts  
Pathogenesis controversy. Bilio-pancreatic maljunction association. Todani's Classification  
Imaging findings

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## Abstract Archives of the RSNA, 2023

GIEE-89

### New Concepts in Staging and Treatment of Colon Cancer: What the Radiologist Needs to Know

All Day Room: Learning Center

Amit J. Choudhari, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Understand types of colon cancer surgeries, including multivisceral resection
- Comprehend the elements which need to be covered while reporting a clinically relevant colon cancer staging CT report
- Review the questions asked in multidisciplinary tumor boards
- Updates on the recent advances in colon cancer management
- Discuss the advantages of neoadjuvant chemotherapy prior to surgery as per recent literature

#### TABLE OF CONTENTS/OUTLINE

- Pathophysiology of colon cancer
- Types of colon cancer surgeries and nodal resections
- Discuss common and uncommon presentations in colon cancer (extramural vascular invasion, aneurysmal dilatation, vascular involvement, tumor bowel fistula, uncommon pathologies)
- What the surgeon wants to know from the radiologist for planning surgery; e.g., a patient with ascending colon cancer with duodenal involvement can undergo colo-pancreaticoduodenectomy
- dMMR/MSI-H, ctDNA, FoxTROT, Niche-2: What they mean and why do we need to know about them

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## Abstract Archives of the RSNA, 2023

GIEE-9

### Internal Hernia after Roux-en-Y Gastric Bypass: Clues to a Challenging Diagnosis

All Day Room: Learning Center

Cecil G. Wood III, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Internal hernias are a complication in up to 10% of patients after Roux-en-Y gastric bypass (RYGB).
- Risk factors for internal hernia after RYGB include retrocolic technique, non-closure of mesenteric defects and amount of weight loss after surgery.
- Untreated internal hernias place the patient at risk for bowel ischemia.
- Several signs of varying sensitivity and specificity have been described for internal hernias after RYGB.
- A structured approach should be taken to assess for internal hernias in all patients who have undergone RYGB—especially those who are presenting with abdominal pain.

#### TABLE OF CONTENTS/OUTLINE

- Description of RYGB procedure.
- Three types of internal hernia after RYGB: Transmesocolic, Petersen and jejuno-jejunosotomy hernias.
- Incidence of internal hernia after RYGB.
- Risk factors for internal hernia after RYGB.
- Clinical presentation of internal hernias after RYGB.
- Prognosis of untreated internal hernia after RYGB.
- Treatment of internal hernia after RYGB.
- Accuracy of CT in diagnosing internal hernia after RYGB.
- CT findings of internal hernia after RYGB and their sensitivity and specificity in detecting internal hernias. All signs will be accompanied by example images and/or image stacks.
- Vascular Signs: SMV beaking sign, vascular swirl sign and hooking intestine sign.
- Mesenteric Signs: Mesenteric edema, mesenteric lymph nodes and eye of the hurricane sign.
- Bowel signs: Small bowel obstruction, right sided jejunojejunal anastomosis, mushroom sign, small bowel behind SMA, small bowel between transverse colon and stomach and clustered loops of small bowel.
- Structured approach to assessing the presence of internal hernia in patients with RYGB.

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## Abstract Archives of the RSNA, 2023

GIEE-90

### Tips for Differentiation Between Pancreatic Ductal Adenocarcinoma with Bile duct Invasion and Cholangiocarcinoma with Pancreas Invasion

All Day Room: Learning Center

Shintaro Ichikawa, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Both pancreatic ductal adenocarcinoma (PDAC) and cholangiocarcinoma are mostly adenocarcinomas and share common pathological features. Therefore, their imaging findings are similar, and when a mass stretching from the head of the pancreas to the distal common bile duct is found, it may be difficult to distinguish whether it is bile duct invasion from PDAC or pancreatic invasion from cholangiocarcinoma. To differentiate between the two, it may be useful to focus on whether the pancreatic or bile duct lesion is the predominant finding and whether the main pancreatic duct is dilated.

#### TABLE OF CONTENTS/OUTLINE

The following tips for differentiating between PDAC with bile duct invasion and cholangiocarcinoma with pancreatic invasion are discussed along with their key imaging findings:

1. Predominant lesion: Pancreatic lesions of PDAC are larger than those of cholangiocarcinoma. The range of common bile duct lesions in cholangiocarcinomas is greater than that of lesions in PDAC.
2. Double-duct sign: Both the main pancreatic and common bile ducts are often dilated in PDAC, whereas the main pancreatic duct is rarely dilated in cholangiocarcinoma.

The following differential diagnoses are discussed along with their key imaging findings:

1. Ampullary masses (adenoma, adenocarcinoma, and neuroendocrine neoplasms)
2. Pancreatic groove cancer
3. Groove pancreatitis
4. Mass-forming pancreatitis
5. Sclerosing cholangitis

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## Abstract Archives of the RSNA, 2023

GIEE-91

### Complications of Colorectal Cancer Treatment

All Day Room: Learning Center

Kelly L. Cox, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: Colorectal cancer remains the third most common cancer and is the second leading cause for cancer related deaths in the United States. Colorectal cancer is highly treatable and often curable with early detection. After a quick review of colorectal cancer and its most current treatment algorithms, we will take an in depth look at the complications of treatment including those related to surgery, liver directed therapy, chemotherapy and immune checkpoint inhibitors. As colorectal cancer treatment has rapidly changed in recent years, new and unexpected imaging complications of treatment must be recognized in our daily practice to direct immediate patient care and future colorectal cancer treatment.

#### TABLE OF CONTENTS/OUTLINE

1. Review of colorectal cancer and its most current treatment algorithms 2. Surgical Complications a. Perforation/Anastomotic Leak b. Abscess c. Fistula d. Local recurrence with and without obstruction 3. Liver Directed Therapies a. Intrahepatic artery infusion chemotherapy - biliary strictures b. Radiofrequency ablation i. Thermal injury ii. Injury to adjacent organs c. Radioembolization 4. Chemotherapy Induced Injuries a. Steatohepatitis b. FNH-like lesions 5. Checkpoint Inhibitor complications a. Pseudoprogression b. Pneumonitis c. Diarrhea, enteritis and colitis d. Bowel perforation e. Pancreatitis

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## Abstract Archives of the RSNA, 2023

GIEE-92

### Deep-learning CT Reconstruction in the Abdomen: Principles, Techniques, Current Practice and Future Perspective

All Day Room: Learning Center

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understanding the background and important principles of image reconstruction methods in CT with the advantages and disadvantages of each modality 2. Comprehensive review on the deep learning imaging reconstruction and why it outperforms other modalities 3. To discuss clinical impact of deep-learning CT reconstruction in abdominal imaging 4. Future perspective and implementation

#### TABLE OF CONTENTS/OUTLINE

1. CT image reconstruction and deep learning a. Definition principles of CT image reconstruction b. History and advances of CT image reconstruction until now c. Common quantitative and qualitative parameters for image quality d. Explain the advantages and disadvantages of each reconstruction technique (filtered back projection, iterative reconstruction, full model-based iterative reconstruction, hybrid iterative reconstruction)2. Deep-learning image reconstruction (DLIR) in the abdomen CT a. Understanding the basics of convolutional neural networks (CNNs) b. The role of DLIR in CT image quality improvement and noise reduction c. Factors influencing the performance of deep-learning CT reconstruction3. Where DLIR in CT abdomen now a. DLIR algorithms available b. Current evidence and practice of deep-learning CT reconstruction in the abdomen c. Clinical impact on the diagnosis of abdominal organs diseases4. DLIR limitations and potential future developments

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## Abstract Archives of the RSNA, 2023

GIEE-93

### Radiologic Features of Abdominal Multimodality Imaging Related to Cardiovascular Disorders

All Day Room: Learning Center

Yeju Kang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To classify various cardiovascular disorders causing changes on abdominal multimodality imaging. 2. To comprehensively review the pathophysiology of intra-abdominal changes caused by cardiovascular disorders. 3. To present various radiologic features of abdominal multimodality imaging in patients with cardiovascular disorders.

#### TABLE OF CONTENTS/OUTLINE

1. Cardiac disorders-related changes: Congestive heart failure: hepatic congestion, cardiac cirrhosis/Infective endocarditis: infection due to septic embolism, infarction, mesenteric ischemia/Atrial fibrillation: infarction, mesenteric ischemia/Valvular heart disease: hemosiderin deposition due to mechanical cardiac valve/Cardiac arrest: cardiopulmonary resuscitation-related change 2. Vascular disorders-related changes: Obstruction of the vena cava: liver cirrhosis due to membranous obstruction of inferior vena cava, hepatic neoplasm, third flow due to superior vena cava obstruction/Vasculitis: systemic lupus erythematosus, IgA vasculitis, Behcet disease, etc. 3. Cardiovascular drug-related changes: anticoagulants-related changes, anti-arrhythmic agents-related changes

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## Abstract Archives of the RSNA, 2023

GIEE-94

### Signet Ring Cell Adenocarcinomas of the GI Tract: Clinical, Radiological, and Pathological Correlation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Perry J. Pickhardt, MD (*Presenter*) Advisor, Bracco Group;Advisor, Zebra Medical Vision Ltd;Advisor, Nano X Imaging;

#### TEACHING POINTS

1 T1. To describe the key epidemiological, clinical, radiological, and pathological features of signet ring cell adenocarcinomas of the GI tract. 2. To review the specific features of gastric, colorectal, esophageal, appendiceal, and pancreaticobiliary signet ring cancers, with radiologic-pathologic correlation. 3. To illustrate linitis plastica, scirrhous tumors, and the “malignant target sign” associated with these aggressive cancers.

#### TABLE OF CONTENTS/OUTLINE

- Introduction - Signet ring cell adenocarcinomas of the GI tract o Histopathological definition o Epidemiology and prognosis o The malignant target sign - Clinical-Pathological-Radiological correlation o Gastric signet ring cell adenocarcinoma (linitis plastica) o Colorectal signet ring cell adenocarcinoma o Esophageal signet ring cell adenocarcinoma o Appendiceal signet ring cell adenocarcinoma o Pancreaticobiliary signet ring cell adenocarcinoma o Metastatic signet ring cell adenocarcinoma - Concluding remarks

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## Abstract Archives of the RSNA, 2023

GIEE-95

### The Many Forms of Acute Pancreatitis

All Day Room: Learning Center

#### Awards

##### Cum Laude

Maria G. Gracia Munoz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The morphological expression of acute pancreatitis (AP) is highly variable and in its more complex forms it can be a difficult challenge for the radiologist in training to decipher. Therefore, the main objective of this paper is to present a guide for understanding the morphological classification of AP, related complications and differential diagnoses using the standardized terminology established in the revised Atlanta classification system. Other objectives are: To recognize the general clinical features of AP and the bases of the Atlanta classification system. To understand the current role of the radiologist in the diagnosis and treatment of acute pancreatitis. To emphasize the importance of the implementation of standardized reporting schemas and a well-defined lexicon into the radiology practice to facilitate accurate communication among members of a multidisciplinary team.

#### TABLE OF CONTENTS/OUTLINE

Introduction. Clinical overview: diagnostic criteria, pathogenesis and etiology, disease severity and risk stratification, clinical classification according to the revised Atlanta classification (RAC): phases of evolution and severity. Imaging guidelines: how, when and why to image. General overview of the RAC system. Morphologic classification interstitial edematous pancreatitis (IEP) vs necrotizing pancreatitis (NP). Pancreatic and peripancreatic collections APFC, pseudocyst, ANC and WON. Local complications: Infection, inflammation and mass effect on adjacent organs, biliary obstruction, pancreatic duct stricture, disconnected pancreatic duct, vascular complications (hemorrhage, venous thrombosis, pseudoaneurysm). Other complications. Imaging mimics of AP.

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## Abstract Archives of the RSNA, 2023

GIEE-96

### **Pseudomyxoma Peritonei and HIPEC: What Am I Missing?**

All Day Room: Learning Center

Matheus M. Gomes SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Pseudomyxoma peritonei (PMP) is a rare and complex clinical syndrome characterized by the intraperitoneal accumulation of mucinous material, which arises from a variety of neoplasms, mainly from appendiceal mucinous neoplasm. The purpose of this exhibit is • Review the main CT and MRI imaging findings of PMP. • Recognize the most common tumor sites which may cause pseudomyxoma peritonei • Illustrate through a diagram the pathways of disease spread into peritoneal spaces • Discuss HIPEC therapy and surgery indications, different outcomes and complications • Highlight the radiologist role in decision-making in a multidisciplinary team

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction- Epidemiology, clinical and pathophysiological aspects of pseudomyxoma peritonei- CT and MRI protocol recommendation 2. Current treatment options- To discuss for each of the following treatment modalities indications, contraindications, advantages and limitations (HIPEC, Surgical treatment and Systemic treatment)- To review through illustrative clinical cases the main CT and MRI findings of: Initial assessment of disease • Most common sites of disease • Hints at first evaluation of images • Difficult sites of resection • Potential "blind spots" Evaluation of treatment response • Disease progression • Stable disease / No evidence of disease • Response to treatment 3. "Take-home messages": To improve radiology communication with the multidisciplinary team and ensure prompt diagnosis and proper treatment of PMP, it is essential to understand the major clinical and imaging aspects of the disease and its treatment options.

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## Abstract Archives of the RSNA, 2023

GIEE-97

### Non-cirrhotic Portal Hypertension: Etiologies and Workup

All Day Room: Learning Center

Alba R. Pugliesi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Noncirrhotic portal hypertension (NCPH), defined as elevated portal pressures in absence of advanced hepatic fibrosis, can be seen in association with multiple pre-sinusoidal, sinusoidal, and post-sinusoidal pathologic conditions. 2. Many of the aforementioned etiologies can result in liver dysmorphism (despite the absence of advanced hepatic fibrosis), resulting in incorrect diagnosis of cirrhosis.

#### TABLE OF CONTENTS/OUTLINE

Introduction • Definition and review of mechanisms of portal hypertension Pre-hepatic etiologies of NCPH • Case-based review of pre-hepatic etiologies of NCPH with emphasis on chronic inflow obstruction Intrahepatic etiologies of NCPH • Case-based review of pre-sinusoidal, sinusoidal, and post-sinusoidal etiologies of NCPH. Post-hepatic etiologies of NCPH • Case-based review of post-hepatic etiologies of NCPH with emphasis on outflow obstruction and cardiac etiologies (including Fontan-associated liver disease). Architectural and morphological changes of liver • Review of non-fibrotic pathways of response to injury by hepatocytes, with focus on regenerative nodular hyperplasia Diagnostic Workup, Challenges and Pitfalls • Discussing role of biopsy, hepatic venous wedge pressure, and elastography Conclusion

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## Abstract Archives of the RSNA, 2023

GIEE-98

### Tips and Tricks for CT Optimization of the Abdomen

All Day Room: Learning Center

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The educational exhibit discusses CT dose optimization in abdominal imaging, and how it is important to reduce radiation exposure while maintaining diagnostic accuracy. Strategies for reducing radiation dose and optimizing contrast media administration, managing image artifacts and noise, and incorporating AI-based deep learning image reconstruction (DLIR) can also contribute to dose optimization. Tailoring the imaging protocol based on the clinical indication, patient age, medical history, and comorbidities is crucial for achieving the best diagnostic outcome. Advice from the experts and emphasizing the importance of staff education and collaboration in CT optimization.

#### TABLE OF CONTENTS/OUTLINE

Review the background and understand the basic principles of the CT optimization in abdominal imaging  
Strategies for reducing radiation dose in abdominal CT  
Methods used to optimize the dose in abdominal CT  
Future directions of embedding AI into abdominal imaging  
CT optimization  
Tailoring the imaging protocol to the clinical question and patient presentation  
Factors to be considered when tailoring imaging protocol (the clinical indication, patient age, medical history, and comorbidities)  
Electing the appropriate imaging protocol for achieving the best diagnostic outcome  
Unlocking the Secrets of the CT optimization of the Abdomen: Tips and Tricks from the Pros  
a. Port injections - "How to inject like the pros"  
b. Helical pitch- "Low pitch isn't what it used to be"

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## Abstract Archives of the RSNA, 2023

GIEE-99

### Clinical Application of Artificial Intelligence (AI) in Chronic Liver Diseases Management

All Day Room: Learning Center

Mohamed Eltaher, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understand the function of artificial intelligence (AI) in tumor segmentation. 2. Review the existing medical uses of liver segmentation. 3. Grasp the advantages and disadvantages of different methods for segmenting liver tissues. 4. Understand the imaging criteria that must be met for a liver segmentation project to be successful. 5. Explore possible future developments in liver segmentation.

#### TABLE OF CONTENTS/OUTLINE

1. Brief introduction to artificial intelligence (AI). 2. Overview of different architectures used in deep learning methods. 3. Application of AI in the medical field. a new era of healthcare services. 4. Available Liver segmentation methods and techniques. 5. Advantages and disadvantages of different segmentation methods. 6. Challenges facing manual and automated liver segmentation. 7. Current uses of liver volumetry: a) assessment of response to intervention or surgery in liver malignancy. b) prediction of clinical outcomes in including disease behavior, overall survival. C) virtual surgical planning. d) prediction of future liver remnant volume after hepatectomy surgery. 8. Future directions: a) Vascular sub-segmentation. b) Radiogenomics. c) Fully automated segmental volumetry. d) Automated volumetric RECIST measurements.

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## Abstract Archives of the RSNA, 2023

GUEE

### Genitourinary Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **GUEE-1 Zinner Syndrome: A Radiological Journey Through a Little Known Condition**

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the embryology and anatomy of the male urogenital system. 2. To describe the radiological findings of typical Zinner syndrome and its variants, through a series of 10 patients from our institution whose images are representative. 3. To perform a differential diagnosis with other pelvis cystic lesions, providing an algorithm that helps us to distinguish them depending on their location and their relationship with adjacent structures, including radiological images belonging to our institution.

#### **TABLE OF CONTENTS/OUTLINE**

1. Embryology and anatomy of the male urogenital system the role of the mesonephric (Wolffian) duct and the ureteral bud in the formation of the different male urogenital structures. 2. Zinner syndrome: a rare congenital urogenital entity due to an alteration in embryogenesis between 4th and 13th weeks of gestation, characterized by unilateral renal agenesis, cystic dilatation of the ipsilateral seminal vesicle and obstruction of the ejaculatory duct. - Definition. - Pathophysiology. - Clinical manifestations. - Diagnosis: the role of different imaging tests in its diagnosis, specifically pelvic MRI, which is considered the Gold Standard technique due to its excellent soft-tissue resolution. - Treatment. 3. Differential diagnosis with other pelvic cystic lesions (intra- and extraprostatic) according to their location and relationship with neighboring structures. This work is illustrated with representative radiological images of cases belonging to our institution.

#### **GUEE-10 Thingamajigs, Thingabobs, and Doohickeys: A Comprehensive Imaging Review of Pelvic Medical Devices**

#### **Awards**

#### **Certificate of Merit**

Amanda C. Gibson, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Given the ever-increasing number of imaging examinations performed and the continuous development and refinement of medical devices, radiologists commonly encounter such devices in clinical practice. 2. Pelvic medical devices may be detected incidentally on imaging examinations or imaging may be performed specifically to evaluate for device complication. 3. Knowledge of device indication and function may provide important clues to patient history that might not otherwise be available at the time of image interpretation. 4. Medical device complications are typically related to infection, malposition, and/or suboptimal device function. 5. A comprehensive knowledge of device indication, function, structure, imaging appearance, and associated complications is necessary to provide accurate and timely assessment of pelvic medical devices.

#### **TABLE OF CONTENTS/OUTLINE**

1. Succinct description of pelvic medical device structure, function, and indications for use in both women and men 2. Illustration of imaging features of pelvic medical devices, including normal findings, imaging artifacts, and device-related complications, across both planar and cross-sectional studies, with emphasis on key findings to report 3. Discussion of MRI safety issues related to pelvic medical devices

#### **GUEE-100 Feel the Burn: Imaging Infections of the Male and Female Reproductive Tract**

#### **Awards**

#### **Certificate of Merit**

Alexander Kuehne, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Familiarize the radiologist with the spectrum of reproductive tract infections, focusing on some of their more unusual etiologies and presentations.
- Review imaging of male and female reproductive tract infections in case-based format.
- Highlight key imaging features of specific infections, atypical presentations, and common mimics.
- Review imaging characteristics that would help to narrow the differential diagnosis.
- Provide an overview of management and treatment of reproductive tract infections, their sequelae, and complications.

#### **TABLE OF CONTENTS/OUTLINE**

- Classification of reproductive tract infections: sexually transmitted diseases; endogenous infections; iatrogenic infections.
- Review of infections by anatomic region, particularly unusual infections/presentations: uterus and adnexa; vagina and vulva; prostate and penis; spermatic cord and scrotum; perineum.
- Management of infections, their sequelae, and their complications.

### **GUEE-102 Imaging of Inferior Vena Cava Wall Invasion in Renal Cell Carcinoma with Tumor Thrombus**

Haiyi Wang, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Locally advanced renal cell carcinoma with inferior vena cava (IVC) tumor thrombus is one of the most challenging diseases in urology. T3c disease is diagnosed when a tumor thrombus invades the IVC wall. The presence or absence of IVC wall invasion has a significant impact on the selection of surgical protocols, which include IVC incision thrombectomy, IVC segmental resection, and IVC resection. Higher morbidity and mortality rates occur when a tumor thrombus invades the IVC wall. Tumor thrombus invading the IVC wall is associated with poor postoperative survival. The purposes of this exhibit are: 1) Discuss the role of IVC wall invasion in the surgical treatment of renal cell carcinoma and tumor thrombus. 2) Clarify significant image findings of IVC wall invasion. 3) Illustrate meaningful information and pitfalls of diagnosing IVC wall invasion in radiology reports.

#### **TABLE OF CONTENTS/OUTLINE**

1) Overview of anatomy and physiology of the inferior vena cava system. 2) Introduction of the mechanism of IVC tumor thrombosis formation in renal cell carcinoma. 3) Describe surgical management of different types of tumor thrombectomy: a. IVC incision thrombectomy; b. IVC segmental resection; c. IVC resection. 4) Imaging methods selection: a. contrast-enhanced ultrasound (CEUS); b. CT; c. MRI. 5) Imaging findings of IVC wall invasion in case-based imaging. 6) Illustrate key signs and pitfalls in diagnosing IVC wall invasion. 7). Build a scoring system: inferior vena cava wall invasion likelihood scores (IVC WAILS). 8) Consolidate the acquired knowledge: Review preoperative imaging findings of IVC invasion that aid in surgical decisions. 9) Conclusions.

### **GUEE-103 Spectrum of Male and Female Urethral and Periurethral Pathologies at Imaging**

Nikolas Brozovich, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Role of imaging in the evaluation of the urethra. 2) Review of relevant male and female urethral anatomy. 3) Recognize a variety of urological conditions in males and females at imaging.

#### **TABLE OF CONTENTS/OUTLINE**

Conventional imaging studies such as retrograde urethrography (RUG), voiding cystourethrography (VCUG), and Ultrasonography (US) are limited in the evaluation of the periurethral tissues. MR imaging serves as an important noninvasive imaging modality that can provide anatomic detail of the urethra and periurethral tissue due to excellent tissue contrast and multiplanar capability. 1) Detailed male and female urethral and periurethral anatomy. 2) MR technique for urethral evaluation. 3) Female urethral pathology including urethral diverticulum and associated pathology, urethral leiomyoma, periurethral/paravaginal cysts, bulking agents, urethral prolapse, periurethral hemangioma, and neoplasms. 4) Male urethral pathology including urethral calculi, Peyronie's disease, artificial sphincter, infection, and neoplasms.

### **GUEE-104 Radiologic Feature of Complications after Artificial Urinary Sphincter Implantation Following Total Prostatectomy**

Shioto Oda, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Artificial urinary sphincter (AUS) is an implanted device used for the treatment of urinary incontinence, commonly following prostatectomy. Despite increasing reports of device failure and postoperative complications, comprehensive reports on imaging have yet to be compiled. When complications occur after AUS surgery, entire device replacement may be necessary,

which can be burdensome for the patient. However, with precise identification of the malfunctioning part, partial replacement has been possible in some cases. This presentation will exhibit imaging findings of malfunction and postoperative complications after AUS implantation at our hospital, together with anatomical findings, to contribute towards appropriate device management. The purpose of this exhibit is: 1) To provide a comprehensive review of the normal appearance of AUS, along with an analysis of the parts that are commonly associated with complications 2) To exhibit the various complications related to device failure and surgery on a case-by-case basis.

#### **TABLE OF CONTENTS/OUTLINE**

1) Normal Appearance of AUS 2) Malfunction of AUS 2.1) Circuit Leakage 2.2) Pump Malfunction 3) Complications Directly Related to the Procedure 3.1) Urinary Injury During Replacement of AUS 3.2) Hematomas and Infections Occurring in the Subacute Period

#### **GUEE-11 Imaging of upper urinary tract neoplasms**

Kyungmin Kim, BMBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Neoplasms of the upper urinary tract can be investigated with different imaging modalities such as CT, MRI and ultrasound. In certain cases, nuclear medicine studies, such as PET-CT or DMSA can aid with detection of occult bone metastasis or determining the best treatment option. The traditional CT protocol for visualizing renal parenchymal abnormalities is a triple phase study. Alternatively, a split bolus urography protocol also provides good visualization of the renal parenchyma and the collecting systems with a reduced radiation dose. Renal cell carcinoma (RCC) is the most common type of upper urinary tract neoplasm with a wide range of phenotypes from homogeneous solid mass to heterogeneous multi-cystic or necrotic lesions. Differentiating between benign and malignant renal neoplasms can be challenging and histopathological evaluation may be required to confirm the diagnosis. A wide range of conditions ranging from developmental, infectious, granulomatous and vascular causes can mimic upper urinary tract neoplasms.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Imaging modalities for investigation of upper tract neoplasms 2.1 CT 2.2 MRI 2.3 Ultrasound 2.3.1 Contrast enhanced ultrasound 2.4 Nuclear medicine 3. Imaging features of upper tract neoplasms 3.1 Malignant 3.1.1 RCC 3.1.2 TCC 3.1.3 Lymphoma 3.1.4 Wilm's tumor 3.1.5 Miscellaneous 3.2 Benign 3.2.1 Oncocytoma 3.2.2 Angiomyolipoma 4. Upper urinary tract pseudotumors 4.1 Developmental 4.2 Infectious 4.3 Granulomatous 4.4 Vascular 4.5 Miscellaneous 5. Summary

#### **GUEE-12 Not Only Prostate Adenocarcinoma is Present in the Interpretation of Multiparametric Prostate MRI**

Alfonso Iglesias, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Knowledge of normal anatomic structures and physiological changes that may simulate prostate adenocarcinoma in prostate multiparametric magnetic resonance imaging (mpMRI) Clinical presentation MRI characteristics with pathological correlation can help us to accurately characterize benign and malignant diseases, that can mimic prostate adenocarcinoma in mpMRI resulting in appropriate patient management.

#### **TABLE OF CONTENTS/OUTLINE**

Review and identify normal prostatic anatomic structures that can affect mpMRI interpretation because they may simulate prostate adenocarcinoma: hypertrophic anterior fibromuscular stroma, asymmetrical and focal thickening of the surgical capsule, congested appearance of periprostatic vascular plexus normal Review the clinical manifestations and mpMRI characteristics with pathological correlation of prostatic and periprostatic benign process: congenital anomalies (Zinner's syndrome), prostatic abscess, infective or inflammatory prostatitis (bacterial, granulomatous, IgG4-related disease), prostatic hemorrhage, ectopic stromal benign prostatic hyperplasia nodule, periprostatic lymph nodes, osteochondroma of the pubic symphysis, neoplasms with unpredictable clinical course (stromal neoplasm of uncertain malignant potential), direct neoplastic invasion of malignant tumors in adjacent organs (diffuse large B-cell lymphoma of the rectum), that can mimic prostate adenocarcinoma in mpMRI

#### **GUEE-13 MRI-Based VI-RADS for Bladder Cancer: Enhancing Accuracy and Consistency in Reporting**

Sina Houshmand, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review imaging findings of bladder cancer with emphasis on the importance of differentiation between muscle-invasive and non-muscle invasive disease and impact of imaging on clinical management. 2. Review technical aspects of multiparametric MRI for bladder cancer. 3. A pictorial review and step-by-step tutorial on Vesical Imaging-Reporting and Data System (VI-RADS).

## TABLE OF CONTENTS/OUTLINE

1. Introduction to bladder cancer. Types and relevant pathology  
b. Diagnosis, staging, treatment  
c. Role of imaging in clinical management  
d. Imaging of bladder cancer  
2. VIRADSa. Definitions and categories  
b. MRI scoring  
c. Examples  
3. Technical aspects  
a. Patient preparation  
b. MR protocol  
4. Pitfalls and mimics  
5. Case review

### **GUEE-14 Male Pelvic Floor: Anatomical Particularities and Dysfunctions**

Ana Claudia V. Uski SR, MD,MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review some aspects of normal anatomy that are relevant in the context of male pelvic floor dysfunction. To demonstrate the differences between the male and female pelvic floor by comparing the reference values provided. To identify changes in male pelvic floor structures during micturition and defecation. To review the examination protocols for functional assessment. To systematize the evaluation of male pelvic floor dysfunctions with clinical cases and flowcharts.

## TABLE OF CONTENTS/OUTLINE

The male pelvic floor has specific anatomical differences and pathophysiological peculiarities. The most important risk factors for its dysfunction include surgical procedures and radiotherapy. Pelvic floor dysfunctions can be grouped into three major categories (gastrointestinal, urinary, and sexual dysfunctions) and the best modality for this evaluation is dedicated magnetic resonance imaging (MRI). There is a paucity of literature related to imaging evaluation of the male pelvic floor. Typical markers used refer to the pubococcygeal line (PCL), the H line, the M line, and anorectal angle. Specific markers include the puboprostic angle and the prostatic-urethral angle. Radiologists should recognize these particularities, the potential risk factors leading to these dysfunctions, and which landmarks are used in functional assessment.

### **GUEE-15 No Need to Go Nuts: Simplified Testicular Neoplasms Sonographic Analysis**

Fabio Yoshimura (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are:  
To review the scrotum and adjacent structures anatomy in ultrasound;  
To emphasize the importance of adequate sonographic technique evaluation;  
To review most common testicular neoplasms;  
To present a metastasis case, a rare entity;  
To show ultrasound features of these neoplasms.

## TABLE OF CONTENTS/OUTLINE

1. To review the scrotum anatomy in ultrasound: Testicles; Ductus deferens; Pampiniform plexus; Epididymis; Tunica vaginalis; Tunica albuginea.  
2. Examination technique in ultrasound;  
3. Illustrated teaching cases from our department showing the main testicular neoplasms:- Seminoma- Non-seminomatous germ cell tumors- Testicular lymphoma- Metastases to testis

### **GUEE-16 Don't Forget the Female Urethra: An Approach for Radiologists**

#### **Awards**

#### **Certificate of Merit**

Julia M. Saidman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The female urethra can be adequately studied by static or/otr dynamic imaging methods. The spectrum of pathologies is wide, from the complexity of finding direct signs in a urethral diverticulum to the challenge of providing the necessary information for an adequate treatment of solid masses of undetermined origin. In recent years, the use of minimally invasive surgical techniques for the urinary incontinence/pelvic prolapse approach has raised the need to be familiar with the radiological features pre and post treatment for proper patient counseling.

## TABLE OF CONTENTS/OUTLINE

-Review of the anatomy of the female urethra-Imaging methods-acquisition protocols  
Ultrasound (focused on static technique)  
Magnetic Resonance  
Voiding Cystourethrography  
Retrograde double-balloon positive-pressure urethrography-  
Pathology of the female urethra  
Malformaciones  
Cystic pathology: diverticulum versus urethral cyst  
Solid pathology  
Benign: abscess; myoma  
Malignant: Primary: urothelial carcinoma, squamous cell carcinoma, adenocarcinoma, Aggressive angiomyxoma  
Secondary: contiguous invasion versus metastatic lesions  
Pre-posttreatment imaging in minimally invasive surgical techniques for stress-mixed urinary incontinence (synthetic midurethral slings and bulking agents)-  
Differential diagnosis of urethral cystic from periurethral cystic pathologies-  
Conclusions

### **GUEE-17 Predominantly Non-Cystic Multiple Focal Renal Lesions: An Imaging Approach**

Mario G. Santamarina, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To review causes of predominantly non-cystic multiple focal renal lesions. 2. To discuss imaging findings of the different entities. 3. To provide imaging-based clues useful to focus and to guide to the correct diagnosis.

## TABLE OF CONTENTS/OUTLINE

The presence of multiple focal renal lesions may be an isolated or dominant imaging finding as well as an additional abnormality in the setting of multiorgan involvement. An imaging-based approach may be crucial in the differential diagnosis process as well as in patient management. Knowledge of the imaging appearance of the various causes and integration with other findings may result in a correct diagnosis in most cases as well as in assisting in proper patient work-up and management. Table of Contents: I- Overview; II- Main causes of multiple focal renal lesions 1. Infectious, 2. Inflammatory, 3. Vascular, 4. Related to neoplasm (main hereditary renal cancer syndromes, renal metastases, lymphoproliferative disorders, renal oncocytosis).; III- Summary.

## GUEE-18 Medical Devices in the Pelvis: The Good, the Bad, and the Ugly

Jennifer A. Clark, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Understand that a variety of devices may reside in the pelvis. 2. Recognize the multimodality imaging features of different devices to include expected location and malposition/migration and their potential associated complications. 3. Emphasize the importance of detecting malpositioned/migrated devices to facilitate treatment.

## TABLE OF CONTENTS/OUTLINE

Medical Devices divided by biological sex where applicable. o Biological Female: § Intrauterine Device • Hormonal (e.g., Mirena) • Non-hormonal (e.g., Copper, Lippes Loop) • Sterilization Device (e.g., Essure) o Biological Male: § Penile Prosthesis o Devices found in both sexes: § Artificial Urinary Sphincter § Suprapubic Catheter and Foley Catheter § Ureteral Stents § Pessary § Peritoneal Dialysis Catheter 1. The following will be discussed for the devices where applicable: a. Indication b. Types c. Multimodality imaging features of the device in its expected position. d. Multimodality imaging features of the device in an abnormal position. e. Complications from malposition or migration of the device f. Treatment 2. Highlight the importance of familiarity with the multimodality imaging features of the wide variety of medical devices in the pelvis so that a malpositioned or migrated device can be easily recognized and brought to the attention of the referring physician to facilitate the patient receiving treatment.

## GUEE-19 Revisiting Voiding Cystourethrography (VCUG) and Retrograde Urethrogram (RUG).

Gabriela Lavar, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Voiding cystourethrography (VCUG) and retrograde urethrogram (RUG) are fluoroscopic classic examinations performed by radiologist even in the present days, despite becoming increasingly scarce, still has its diagnostic value. Iodine contrast and x-ray equipment are required to perform the exam. Indications may vary according to gender, age, and clinical history. The findings can be divided between congenital and acquired at bladder and urethral lesions. VCUG and RUG are complementary tests to urethroscopy, as they can detect pathologies that were not previously visible. Other exams can offer adjunct information, such as sonography and MRI, but this can provide unique diagnoses or inspire the development of new professionals or new techniques such as urethral resonance.

## TABLE OF CONTENTS/OUTLINE

This pictorial study aims to review, describe and illustrate the examination and findings of RUG and VCUG in male and female patients that cannot go unnoticed in our reports. We have selected images of cases from our service that may raise suspicion or confirm the disease. We separate the cases according to anatomy and gender. The pathologies we will explore are divided into bladder, urethra findings, as well as prostate-related.. Quick and correct diagnosis can be crucial for the treatment of our patients.

## GUEE-2 Dose Reduction Strategies in CTKUB for Urolithiasis

Sung Bin Park, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. It is critical for radiologists to understand CTKUB dose reduction strategies and successfully optimize protocols that produce high image quality with minimal dosage. 2. Familiarity with the practical approach in CTKUB will both decrease radiation dose and optimize imaging quality for the specific clinical indication.



## TABLE OF CONTENTS/OUTLINE

The purpose of this exhibit is: 1. To discuss the relationship between radiation dose and image quality 2. To assess radiation dose reduction strategy with preserving image quality in CT. Introduction- Radiation exposure and CT- Urolithiasis and CT. Low dose and ultralow dose CT- ALARA principle "As Low As Reasonably Achievable" Optimization for Scans Reconstruction Parameters - CT radiation dose Estimate- CT radiation dose affecting factors- Control Z-Axis: Scan Range - Lower mAs- Lowering kVp- kVp mAs Settings- Automatic Tube Current Modulation (ATCM)- Noise Reduction Technique including deep learning-based image reconstruction Practical Approach: Decreased radiation dose and improved image quality- Dose justification: Risk vs. Benefit - ALARA (As Low As Reasonably Achievable) principle- Optimization for Scans Reconstruction Parameters - Dose Management: Monitoring, Radiation tracking- Educating requesting physicians and CT technicians

### **GUEE-20 Decoding the cLS Score: A Game-Changer in the Diagnosis and Management of Renal Masses**

Daniella B. Parente, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the classification and epidemiology of the most common upper urinary tract neoplasms. Understand the importance of cLS score in the management of incidental renal lesions. Explore nephrometry as a tool for assessing the surgical complexity of renal masses.

#### **TABLE OF CONTENTS/OUTLINE**

I. INTRODUCTION - Overview of upper urinary tract neoplasms and their epidemiology II. IMAGING TECHNIQUE - Overview of imaging modalities for renal mass detection and characterization - Best practices for imaging protocol III. IMAGING INTERPRETATION - Typical imaging features of common renal tumors - Explanation of cLS score and its significance in the diagnosis of renal masses - Overview of nephrometry score and its role in assessing surgical complexity - Importance of CT and MRI in staging renal masses - Utilization of structured reports IV. QUICK REVIEW OF TREATMENT OPTIONS Overview of different treatment modalities for renal masses Pros and cons of each treatment option V. INTERACTIVE CASE-BASED DIDACTICS - Presentation of illustrative cases demonstrating the utility of cLS score in diagnosis and management of renal masses

### **GUEE-21 Imaging of Upper Tract Urothelial Neoplasms: Pearls and Pitfalls**

Claire Brookmeyer, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the staging of upper urinary tract urothelial carcinoma (UTUC) which is critical for treatment decisions and surgical planning. Discuss the role of different imaging exams in the diagnosis of UTUC with a focus on CT and MR urogram protocols. Provide an evidence-based approach to critical T-staging. Highlight nuances in staging unique to UTUCs. Identify important pitfalls in the diagnosis of UTUC including benign neoplastic, infectious, and inflammatory etiologies.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Epidemiology, prevalence, risk factors, Clinical presentation, TNM Staging. Exam protocols Value of multi-phasic exams, CT urogram dose reduction techniques including split bolus and virtual non-contrast, MR urogram. Staging: Tumor location: renal calyx or pelvis, ureter. Multifocality, Evidence based approach to critical T-staging T2 vs T3: ureteral border analysis, Hydronephrosis severity, Evaluation of contralateral urinary tract and bladder, Role of renal function evaluation, Nodal disease and distant metastases, Critical findings for treatment decision making and surgical planning. Pitfalls: Endometriosis, Infection, Malakoplakia. Post-treatment Surveillance imaging: Post-surgical appearance, Local recurrence, Risk of metachronous UTUC in contralateral urinary tract or bladder. Conclusion.

### **GUEE-22 Go with the Flow: Imaging of Urinary Tract Augments, Reconstructions, and Non-Cystectomy Diversions in Adult Patients**

Ryan D. Clayton, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- A variety of surgical techniques are utilized to augment, reconstruct or reroute the urine stream and these procedures often utilize other segments of the GU or GI tract
- Findings from these procedures may be found on imaging studies during routine practice. Surgical records may not be available for many adult patients, especially for those with remote procedures performed in childhood
- Postsurgical anatomy must be appropriately recognized for accurate diagnoses
- Radiologists should be aware of surgical techniques and potential alterations made to the GU and GI tracts to help recognize expected postoperative anatomy, to facilitate greater diagnostic accuracy of postoperative complications, and avoid potential pitfalls

## TABLE OF CONTENTS/OUTLINE

• Review indications for bladder augments, reconstructions and non-cystectomy urinary diversions• Describe common surgical procedures performed for bladder augmentation, ureteral reconstructions and non-cystectomy diversions, including continent and non-continent diversions- Bladder augments: gastrocystoplasty, ileocystoplasty, sigmoid cystoplasty- Reconstructions: psoas hitch, Boari flap, ileal interposition, uretero-ureterostomy, ureteroneocystectomy- Diversions: ileovesicostomy, appendicovesicostomy, Monti procedure• Discuss appropriate imaging techniques and radiologic evaluation, including how to recognize the postoperative anatomy and expected findings• Describe the imaging findings of postoperative complications including leak, fistula, abscess, mucus formation, stones, GU and GI obstruction

### **GUEE-23 Periprostatic Anatomy: An Illustrated Review and Implications for Treatment Planning**

Jason C. Chandrapal (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Identify clinically relevant normal anatomy of periprostatic structures with imaging (MRI, CT, and angiography) correlation
2. Recognize periprostatic anatomic variations and implications to treatment planning

## TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline 1. Introduction 2. Prostatic pseudocapsule -Discussion of periprostatic fascial anatomy and composition -Implications for prostate cancer (PCa) staging and treatment -Preoperative MRI criteria for the diagnosis of extraprostatic PCa extension 3. Neurovascular Bundle -Normal anatomy with surgical correlation -Imaging identification and implications on prostate biopsy, PCa surgical and image-guided focal treatment planning. 4. Rectoprostatic space and Denonvilliers' Fascia -Discussion of rectoprostatic space and fascial anatomy with surgical correlation -Implication on PCa local dissemination in the pelvis -Hydrogel spacer placement for rectal wall protection during radiation therapy - normal and abnormal gel distribution 5. Membranous Urethra and External Urethral Sphincter -Normal membranous urethra and external urethral sphincter anatomy -Relationship to incontinence prediction post prostatectomy? -Imaging identification of external sphincter and relevance for eligibility and planning of image-guided focal treatment 6. Vascular anatomy -Normal anatomy and common variants -Importance for prostatic embolization procedures in the treatment of benign prostatic hyperplasia

### **GUEE-24 Renal and Upper Urinary Tract Tumors: How to Effectively Report and Impact Surgical Management**

Monick T. Nakayama, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Upper urinary tract masses (UTMs) have been increasingly detected by imaging cross-sectional techniques, either as an incidental finding or in the context of a specific investigation, leading to the discovery of renal tumors of smaller dimensions, for whom adequate characterization is mandatory. Correct assignments of malignant and potential benign UTMs are imperative to avoid unnecessary surgical procedures and even biopsies. Nonetheless, the number of benign masses that are surgically approached is still high and prediction of the risk of malignancy is challenging. For UTMs, the lack of well-established scores or specific signs makes imaging evaluation even more difficult but essential for therapeutic definition, and reporting key imaging findings with aggressive lesions is crucial.

## TABLE OF CONTENTS/OUTLINE

IntroductionIllustrative summary of the anatomy and histology of the kidney and upper urinary tract and histological origin of UTMsSummary of the main image findings in malignant tumors with pathological correlation, including:Tumors of the renal parenchymaTumors of the collecting system and uretersLymphoproliferative disordersMetastasesOverview of main benign tumors and their essential imaging findingsTricks in upper urinary tract imaging including pseudotumoral lesionsHow to report the imaging findings for helping in surgical planningConclusion

### **GUEE-25 Above and Beyond the Imaging Features of Urolithiasis: What the Radiologist Needs to Know**

Juan Francisco F. Santoscoy Gutierrez JR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- a) Review the pathophysiology of kidney stone formation, types of calculi and clinical presentation.
- b) Discuss the general evaluation of urolithiasis with emphasis on the characteristic imaging features of different urinary calculi and specific imaging findings focusing on the clinically relevant information that can affect management by the urologist.
- c) Describe the standard of care of nephrolithiasis focusing on the current non-invasive options, minimally invasive options and invasive options performed by the urology surgeon.
- d) List the anticipated post-treatment follow-up, complications and prognosis of urolithiasis.

## TABLE OF CONTENTS/OUTLINE

I. General overview: epidemiology, pathophysiology, clinical presentation  
II. Evaluation and management:  
a) General laboratory work and urinary tests  
b) Imaging and clinically relevant reporting: non-contrast CT, CT urography, dual energy CT, ultrasonography, radiography, MRI  
III. Treatment:  
a) Non-invasive options: observation, medical expulsion therapy, oral medication for dissolution  
b) Minimally invasive options: extracorporeal shockwave lithotripsy, ureteroscopy, percutaneous nephrolithotomy  
c) Invasive options: laparoscopy and open surgery  
IV. Post-treatment follow-up, complications and prognosis

### **GUEE-26 Hematuria Beyond Infection, Stones and Cancer: An Imaging and Evaluation Guide of Unusual Cases**

Eduardo B. Zukovski, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- It is essential that radiologists know how to investigate hematuria, indications and limitations of each imaging option and recommendations for follow-up;
- All the examination protocols should be adapted to the patient while optimizing radiation dose;
- CT urography performs better than conventional radiography, ultrasound and intravenous urography in the detection of renal parenchymal masses and urinary tract calculi;
- Patients are now categorized into risk categories according to their clinical presentation and risk factors, and the workup is adapted to that category;

## TABLE OF CONTENTS/OUTLINE

Hematuria is one of the most common urologic diagnoses, estimate to account for over 20% of urology evaluations; It is defined as the presence of three or more red blood cells per high-powered field in two of three properly collected urinalysis specimens; It can be classified as gross hematuria or microhematuria; The differential diagnosis encompasses a wide range of conditions and the risk of detecting an underlying cancer has been found to be highly dependent on which risk factors are present; More common causes of hematuria include urinary tract infection, urolithiasis, trauma, renal parenchymal disease, and malignancy;

### **GUEE-27 Insights into Renal Cell Carcinoma with Novel Imaging Approaches**

Khoschy Schawkat, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- The updated Bosniak Classification, version 2019, predicts the likelihood of malignancy in cystic renal masses, with improved specificity of the higher risk categories, thereby expanding the number of masses that can be monitored.
- In the clear cell likelihood score (ccLS), version 2.0, multiparametric MRI features of small renal masses without macroscopic fat are sequentially analyzed to determine the likelihood of clear cell renal cell carcinoma.
- Contrast-enhanced ultrasound and dual energy CT are useful in identification and characterization of solid and cystic renal masses.
- Several radiopharmaceuticals may contribute to the characterization of renal masses, such as <sup>99m</sup>Tc-sestamibi, radiolabeled girentuximab and <sup>68</sup>Ga-prostate-specific membrane antigen.
- In the future, RCC may be diagnosed, managed, and treated more effectively using radiomics and artificial intelligence (AI).

## TABLE OF CONTENTS/OUTLINE

1) New Imaging Algorithms Using Established Imaging Techniques (Bosniak classification, version 2019, and clear cell likelihood score version 2.0). 2) Novel Modalities (Contrast-enhanced ultrasound, dual energy CT, and molecular imaging including Sestamibi, Girentuximab, and PSMA). 3) Radiomic and artificial intelligence.

### **GUEE-28 Penile MRI: A Multi-institutional Case-based Review of Anatomy, Spectrum of Pathologies and Prosthetic Complications**

#### Awards

##### Certificate of Merit

Harit Kapoor, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Penile MRI provides invaluable clinical information in a wide array of pathologies. However, given the infrequent use, contemporary radiology residency and fellowship training provides insufficient exposure to penile MRI.  
2) After reviewing this presentation, the learner will be able to:  
a. Understand normal penile anatomy including prosthetic anatomy;  
b. Describe indications for penile MRI and key aspects for image acquisition;  
c. Diagnose various penile pathologies based on characteristic imaging findings;  
d. Understand the basis for differences in management and tenets of surgical planning for various disease entities;  
e. Describe indications for penile prosthesis implantation and diagnose common implant complications.

## TABLE OF CONTENTS/OUTLINE

1) Overview of penile MRI technique, indications, and normal anatomy. 2) Tabulated summary of various penile diseases with classic MRI appearances. 3) Case examples (with differentials, pearls and pitfalls) including but not limited to: (i) Penile trauma (contusion, fractures); (ii) Corrected anomalous genitalia; (iii) Cowper's gland pathology (retention cysts and syringocele); (iv) Penile malignancy (primary staging, post-penectomy recurrence, metastases); (v) Penile implant complications (malpositioning, infection and erosion/extrusion); (vi) Priapism (types, post-treatment imaging); (vii) Periurethral and perineal sepsis.

### **GUEE-29 Upper Tract Urothelial Neoplasms and Mimics**

Murray Di Loreto, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the methods and techniques for the optimal evaluation of the urothelium.
- Identify role of imaging in diagnosis and staging of upper tract urothelial cancer.
- Identify imaging features with radiology-pathology correlation of lesions involving the urothelium in a quiz-based format.

## TABLE OF CONTENTS/OUTLINE

- Is there still a role of conventional urography? Which is better - retrograde urography? antegrade urography? intravenous pyelourography?
- CT urography - what is the ideal urothelial phase? should arterial phase be included? split-bolus technique vs dedicated delayed phase?
- When is MR urography preferred over CT urography- improvements in MR sequences (including compressed sensing, k-space undersampling, parallel imaging and AI). Is Lasix injection needed? Prone vs supine patient positioning? Wide vs narrow FOV how to optimize? Are cine-T2 images useful? T2 based or gadolinium based? Pitfalls, artifacts simulating urothelial disease will be discussed (especially pertaining to MR urography) and solutions will be presented (flow voids on T2? T1\* effects due to concentrated gadolinium).
- What is multiparametric MR Urography - what are the various components of multiparametric MR urography, and how does it improve diagnosis? What is the literature evidence for multiparametric MR urography?
- How does imaging help in diagnosis and staging of upper tract urothelial neoplasms? What are the key findings impacting management of upper tract urothelial neoplasms?
- Approach towards differential diagnosis of these lesions (including common, uncommon and rare mimics) with tips and tricks and imaging pearls as to when to suspect a diagnosis other than UCC, and optimal follow-up/referral strategy.

### **GUEE-3 Lost Without Bosniak: Overcoming the Challenges of Non-Classifiable Renal Cystic Masses**

Jhonata Soares Da Silva (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

A comprehensive review of situations where the Bosniak classification for renal cystic masses is not applicable, emphasizing the importance of being aware of these contexts and how to manage cases where the classification is not useful. Challenging Cases: The exhibition will showcase various challenging cases of renal cystic masses where the Bosniak classification may not be applied. These cases will test participants' knowledge and critical thinking.

## TABLE OF CONTENTS/OUTLINE

Overview of cystic renal lesions in daily practice and the importance of differential diagnoses. Brief mention of the Bosniak classification system and its limitations. Situations where the Bosniak Classification is not applicable, such as inflammatory/infectious conditions, vascular diseases, calyceal diverticula, polycystic kidney disease, Birt-Hogg-Dubé, Von Hippel-Lindau, Tuberous Sclerosis, pelvic cysts, and cystic metastasis are all conditions that can mimic renal cystic masses and are not included in the Bosniak classification system. In this section, we will review each of these conditions, their presentation, and management. Case-based review of concepts and tips: Practical tips and case-based reviews of concepts to help manage renal cystic masses that cannot be classified by the Bosniak system. Helping assistant doctors for better outcomes: discussion of how to assist and guide assistant doctors in managing challenging cases of renal cystic masses. Key take-home messages: summary of the important points discussed during the presentation, with practical advice on how to incorporate the acquired knowledge into clinical practice.

### **GUEE-30 Imaging and Interventional Management in Different Conditions Underlying Renovascular Hypertension**

Eric Castane, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the imaging study of the arterial renal system both in normal and in renal artery stenosis.
2. Describe the vascular radiology management of the renovascular hypertension.

## TABLE OF CONTENTS/OUTLINE

1. Material and methods / Background. 2. Arterial hypertension and renovascular hypertension: definitions and clinical features. 3. Imaging study of the renal arteries: normal, anatomic variants and pathological findings. 3.1. US assessment (evaluation points, technique, signs). 3.2. CT. 3.3. MRI. 3.4. Angiography. 3.5. Algorithmic approach to renal artery stenosis. 4. Interventional radiology management: therapeutic options and post procedure imaging criteria. 5. RAS: etiologies pictorial review (atherosclerosis, fibromuscular dysplasia, vasculitis, others). 6. RAS after renal transplantation (diagnosis and interventions). 7. Conclusions.

### **GUEE-31 Imaging of the Urachus**

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to: 1. Illustrate normal urachal anatomy on imaging and discuss urachal embryogenesis. 2. Provide case-based review of the imaging features of various urachal non-neoplastic and neoplastic entities.

## TABLE OF CONTENTS/OUTLINE

Embryogenesis: Urachus is an embryonic ductal remnant of the allantois and cloaca extending from the bladder dome to the umbilicus. Imaging modalities: US is usually the imaging modality of choice, especially in the pediatric population. CT and MR carry higher temporal and spatial resolution with added benefit of staging malignancy when present. • Congenital: Patent urachus (urachal fistula); Umbilical-urachal sinus tract; Vesicourachal diverticulum; Urachal cyst • Infections/inflammation: Urachal stone/calcification; abscess. • Urachal neoplasms: Benign Adenoma; Cystadenoma, fibroma. Malignant Mucinous adenocarcinoma; Nonmucinous adenocarcinoma; Urothelial; Squamous; Sarcomatoid; Metastatic. • Non-neoplastic masses: Endometriosis; Hemorrhage. Summary Urachal pathology is often discovered incidentally on imaging and presents with nonspecific urinary symptoms. Early detection of urachal pathology and identification of complications such as infection and malignancy are imperative to prevent significant patient morbidity.

### **GUEE-32 Testicular Cancer: What the Radiologist Needs to Know**

Ingrid Alonso Ramon, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the general characteristics of testicular cancer including the different types and their incidence. To describe the different features of multimodality imaging (ultrasound, CT, PET/CT) including the expected findings depending on histologic type and their utility of each in TNMS. Recognize the importance of diagnosis, treatment and follow-up.

## TABLE OF CONTENTS/OUTLINE

Description of the general characteristics of testicular cancers including (a) embryology (b) incidence (c) detailed pathologic features. (d) Clinical presentation To review of multimodality imaging findings including expected findings. To establish the usefulness of the different imaging methods for diagnosis, follow-up, complications and stratification of each one. To Discuss clinical scenarios to establish the best course of action.

### **GUEE-33 Penile Ultrasound: An Updated Pictorial Review for Residents**

Hugo E. Velazquez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To illustrate the anatomical structures of the penis by sonography. -To determine the protocol used at our center. -To show the main indications for penile Doppler ultrasound with and without vasoactive drug. -To list the normal parameters in the Doppler evaluation and their pathological correlation. -To review the main sonographic findings in different conditions.

## TABLE OF CONTENTS/OUTLINE

1. A pictorial review of the anatomy of the penis structures by ultrasound. 2. Penis ultrasound protocol and technical parameters. 3. Indications and use of vasoactive drug. 4. Examples of different conditions with sonographic findings.

### **GUEE-34 Contrast-Enhanced Ultrasound (CEUS): Vascular Applications from the Kidneys to the Bladder**

#### **Awards**

#### **Certificate of Merit**

Saubhagya Srivastava, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. CEUS is a very useful imaging modality in patients with poor renal function due to the non-nephrotoxic nature of the ultrasound contrast agents. 2. In the kidneys, CEUS is accurate in characterizing indeterminate lesions, characterizing complex cysts according to the Bosniak criteria, differentiating solid renal tumors from pseudotumors, identifying renal infarction, abscesses, and for the follow-up of non-surgical renal lesions. 3. CEUS is also used in renal transplant patients to look for masses, cysts, and other vascular problems. 4. In the bladder, CEUS is excellent in differentiating bladder cancer from benign pathologies such as a hematoma in patients with hematuria. It also aids in differentiating non-muscle invasive bladder cancers (NMIBC) from muscle-invasive bladder cancers (MIBCs), thereby guiding appropriate management. 5. CEUS can also detect primary tumors of the ureter or tumors extending from the bladder into the ureter by means of enhancement patterns.

## TABLE OF CONTENTS/OUTLINE

1. Overview of vascular applications of CEUS in the urinary system. 2. The technique of performing CEUS. 3. Microbubbles as non-nephrotoxic blood pool contrast agents. 4. Renal applications of CEUS. i. Renal infarction ii. Renal abscess iii. Characterization of cystic renal masses iv. Solid renal tumors vs pseudotumors v. Angiomyolipoma vs renal cell carcinoma 5. Renal transplant applications 6. Bladder application of CEUS. i. Bladder cancer vs Hematoma ii. Staging of bladder cancer iii. NMIBC vs MIBC iv. Ureteral tumor

## GUEE-35 Imaging Findings of Upper Tract Urothelial Carcinoma (UTUC) and Its Mimickers

Marina C. Farani, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To review the characteristic imaging findings of upper tract urothelial carcinoma. To outline the role of imaging in diagnosis and staging of carcinoma of the renal pelvis and the ureter. To discuss different diagnostic imaging modalities in the context of upper tract urothelial carcinomas. To make differential diagnosis of upper urinary tract neoplasms from other lesions, including benign lesions.

## TABLE OF CONTENTS/OUTLINE

Introduction: Epidemiology, risk factors, signal and symptoms and pathogenesis about carcinoma of upper urinary tract. Diagnosis: A step-by-step explanation of how to characterize and diagnostic a upper tract urothelial neoplasm. The use of computed tomography and the magnetic resonance to describe the different imaging patterns of tumors (papillary and infiltrating) and to staging urothelial carcinoma of upper urinary tract. Case-Based Review: Sample cases explaining and demonstrating different imaging patterns about upper tract urothelial carcinoma in different imaging modalities. This section will present illustrative cases of carcinoma urothelial infiltrating renal parenchyma, limited at renal pelvis and calyceal infundibulum and distal ureter. This section will present illustrative cases of diagnostic differential/mimickers of urothelial neoplasm, like inflammation, blood clots, endometriosis and renal lymphoma. Conclusion and key takeaways.

## GUEE-36 Bladder Neoplasm: A Practical Guide for Residents

Vitor C. Romano, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purposes of this exhibit are: Provide a practical guide for residents on how to perform a bladder cancer screening. Systematize the evaluation of bladder cancer. Introduce and exemplify the VI-RADS classification. Demonstrate how muscle layer invasion should be evaluated according to the VI-RADS classification.

## TABLE OF CONTENTS/OUTLINE

We will discuss the following topics and focus on the VI-RADS classification. Introduction: Epidemiology; Pathophysiology. Subtypes of bladder cancer. Urothelial carcinoma; Urachal adenocarcinoma. Imaging methods. TNM grading. VI-RADS classification. Imaging acquisition; Analysis; Examples. Evaluation of the metastatic disease. Management and followup.

## GUEE-37 Evaluation of Trauma-Related Kidney Injuries

Vitor C. Romano, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purposes of this exhibit are: Provide a guide on how to assess kidney injuries related to blunt trauma. Indications for radiological evaluation of renal injury. Role of various imaging modalities (computed tomography, excretory urography, angiography, retrograde pyelography, ultrasonography and magnetic resonance imaging). Give a context of the conduct according to the kidney injury.



## TABLE OF CONTENTS/OUTLINE

Introduction:Epidemiology;Pathophysiology.Imaging methods.Computed tomography images acquisition protocol.AAST classification for renal trauma.Examples.Overview.

### **GUEE-38 Atypical Prostatic Cancer Metastases & Recurrence: A Pictorial Review**

Murilo d. Peixoto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Prostate cancer is one of the most common malignancies in men worldwide. It has a recognizable pattern of metastatic spread, most frequently to regional lymph nodes and bone, as well as a typical recurrence pattern to pelvic lymph nodes, vesicourethral anastomosis, and bed of seminal vesicles and vas deferens. However, there are different patterns of metastases and recurrence that must be recognized.

## TABLE OF CONTENTS/OUTLINE

Atypical metastatic disease occurs in less than 5% of patients. Atypical lymph node involvement includes the supradiaphragmatic chains, most commonly the retrocaval, hilar, and supraclavicular ones. Extranodal involvement can occur in the lung and pleura, abdominal viscera, breast, orbit, brain/meninges and soft tissues. Interestingly, atypical distant metastases rarely occur in isolation and PET-PSMA usually demonstrates multiple simultaneous lesions. A higher Gleason score has also been reported to be associated with a greater likelihood of atypical metastases. When evaluating for recurrence, the atypical sites that need to be part of the routine imaging evaluation include anterior portions of the urethra, ureteral meatus (associated with poor prognosis), urinary bladder (distant from the anastomotic area), rectum, mesorectum and compromised retroperitoneal lymph nodes with preservation of the pelvic chains. This exhibit aims to review the locations and atypical patterns of manifestation of this neoplasm according to the different diagnostic modalities, focusing on multiparametric magnetic resonance imaging (MRI) and PET-PSMA.

### **GUEE-39 Clinical Utility of the Vesical Imaging-Reporting and Data System for Histological Variants and Non-Urothelial Bladder Cancer**

Yuki Arita, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Histological variants (VUC) and non-urothelial bladder cancer (NUC) are relatively rare bladder cancer subtypes. These subtypes have a high malignant potential, aggressive advanced tumor features, and an increased risk of disease recurrence compared to pure urothelial bladder cancer (PUC). Accurate preoperative muscle invasion assessment and subsequent immediate surgical intervention are warranted in these patients. The usefulness of the Vesical Imaging-Reporting and Data System (VI-RADS) has been established for PUC by several previous studies. However, the validity of VI-RADS for VUC and NUC still has to be established. This exhibit aims to clarify MRI features of VUC and NUC with histological correlation, demonstrate VI-RADS scoring of VUC and NUC, and discuss the feasibility of biparametric MRI for VUC and NUC compared to PUC.

## TABLE OF CONTENTS/OUTLINE

1, VI-RADS and histological classification of bladder cancer, 2, VUC with VI-RADS scoring (squamous differentiation, glandular differentiation, sarcomatoid variant, plasmacytoid variant, micropapillary variant, and nested variant), 3, NUC and other bladder malignant tumors with VI-RADS scoring (squamous cell carcinoma, adenocarcinoma, small cell carcinoma, lymphoma, urachal adenocarcinoma, and bladder metastasis), 4, Risk of underestimation of muscle invasion in VUC and NUC at biparametric MRI and its clinical implications, 5, Summary.

### **GUEE-4 Use of 3D Printed Models to Guide Surgical Resection of Renal Masses**

Mujtaba A. Hameed, BS, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. 3D modeling and printing has been increasingly utilized in recent years to guide improvements and new applications for medical diagnosis and treatment planning.2. 3D models provide a unique degree of tactile and visual information, especially anatomopathological information that would be particularly relevant in surgical planning of tumor resection (e.g., renal masses).3. 3D modeling can improve the characterization and treatment of renal masses at multiple stages, including segmentation, modeling, printing, preoperative planning, patient consent and education, intraoperative reference, and ultimately surgical removal.

## TABLE OF CONTENTS/OUTLINE

1. Introduction characterizing the background of 3D modeling and printing in medical diagnosis and treatment, as well as review of relevant examples in the literature and within our institutional experience.2. Description of initial case presentation and pertinent clinical workup.3. Review of CT images, process of segmentation, and creation of 3D printed models utilizing

clinical 3D visualization software.4. Description of technique used in editing of 3D models via 3D printing software, including model video.5. Creation of 3D model of the patient's left kidney (with mass demarcated), description of the utility of the modeling process both preoperative and intraoperatively.

#### **GUEE-40 A Practical Guide for Evaluating Renal Masses: Didactic Case-Based Review**

Fernanda L. Limonge, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Discuss and illustrate the cystic lesions of the kidney, emphasizing Bosniak v2019 classification. Describe the features of solid renal masses. Review the TNM system for renal cell carcinoma (RCC). Discuss the active surveillance of renal masses as an alternative to immediate treatment. Review the imaging findings in the context of post-treatment.

##### **TABLE OF CONTENTS/OUTLINE**

Cystic lesions- Illustrate the Bosniak classification- Tips on how to interpret a cystic renal mass Didactic approach for evaluating solid renal masses- Ball versus bean patterns- Clear cell likelihood score (ccLS) Describe and review renal masses and histological subtypes- Angiomyolipoma- Oncocytoma- Clear cell RCC- Papillary RCC- Chromophobe RCC- Collecting duct carcinoma- Medullary carcinoma- Urothelial carcinoma- Lymphoma- Metastasis Local/regional risk stratification- Tumor size- Axial location (anterior/posterior; endophytic/exophytic)- Longitudinal location (relationship with the polar lines)- Hilar proximity (vessels/collecting system) Distant disease assessment- Metastatic disease (bone, liver, lung, lymph nodes)- Synchronous urothelial carcinoma Active surveillance Post-treatment complications- Relapse- Hematoma- Urinoma- Arteriovenous complications

#### **GUEE-41 Male Urethral Anatomy Revealed: Navigating Anatomical Variations and Complications**

Helen Ribeiro De Oliveira, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

The purposes of this exhibit is: Illustrate the main anatomical landmarks of the male urethra according to imaging methods Review the imaging modalities useful to evaluate the male urethra Propose a differential diagnosis of lesions according to localization and congenital or acquired, traumatic, infectious, and neoplastic etiologies and highlight the imaging features of each one To evaluate the postoperative findings and complications

##### **TABLE OF CONTENTS/OUTLINE**

- Introduction- Main anatomical landmarks- Imaging methods- Differential diagnosis and clues to diagnosis- Practical tips and Pitfalls- Normal postoperative findings and complications- Conclusion/Take home message

#### **GUEE-43 Practical Guideline for Adrenal Incidentalomas: A Case-Based Review**

Iandra Pacheco, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Demonstrate a practical guideline with cases to help radiologists with the differential diagnosis of adrenal incidentalomas. Illustrate with didactic cases the European Society of Endocrinology Clinical Practice Guideline in collaboration with the European Network for the Study of Adrenal Tumors and the White Paper of the ACR Incidental Findings Committee. Review the typical image appearance of adrenal incidentalomas.

##### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION IMAGING PROTOCOL CT and MRI REVIEW INCIDENTALOMAS GUIDELINES White paper of ACR European Society of Endocrinology Clinical Practice DEMONSTRATE DIDACTIC CASES- Adenoma - Myelolipoma - Cyst or hemorrhage - Prior granulomatous infection or hematoma- Indeterminate adrenal incidentalomas (= 1 - < 4 cm with prior imaging) . With cancer history: new or enlarging mass. No cancer history: enlarging indeterminate adrenal masses- Indeterminate adrenal incidentalomas (= 1 - < 4 cm without prior imaging) . No cancer history: 1 - 2 cm 2 - 4 cm. Cancer history- With history of cancer (= 1 - < 4 cm). Without known metastatic disease or prior exam. Central necrosis

#### **GUEE-44 How to Improve Surgical Management in Penile Cancer: An MRI and Pathology Correlation**

Thiago d. Caetano, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Describe the protocol and main sequences used in magnetic resonance imaging for optimal imaging of the penis. Comment on the main penile cancer subtypes based on MR imaging features and correlate with the pathological diagnosis. Discuss the importance of MR imaging in the staging of penile cancer, as well as its potential to aid in surgical management.



## TABLE OF CONTENTS/OUTLINE

Introduction: Relevant anatomy of the penis  
Definition and main types of penile cancer  
Epidemiology and risk factors  
MR technique and discussion: Describe the main protocol and sequences used in penile cancer MR imaging  
Staging, imaging features and pathology correlation: Discuss the major changes in the 8th AJCC Cancer Staging Manual  
Demonstrate imaging features of the main types of penile cancer and correlate with pathology  
Conclusion: Discuss its usefulness in local staging and locoregional lymph nodal metastasis and comment on future directions

### **GUEE-45 Space OAR in Prostate Cancer - the What, the How, and Beyond: A Primer for Radiologists**

Nabih Nakrou, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this presentation is to:

- Review the role of SpaceOAR hydrogel spacer in prostate cancer treatment and placement techniques.
- Discuss imaging findings and mimics on different modalities via variable cases.
- Recognize radiologic findings of SpaceOAR complications and malfunction.

## TABLE OF CONTENTS/OUTLINE

We will address the following:

- SpaceOAR composition
- SpaceOAR placement and anatomy
- Indications and roles of SpaceOAR in prostate cancer radiotherapy, including companion cases for treatment and follow-up
- Common pitfalls and mimics of hydrogel spacers
- Rare SpaceOAR-related complications

### **GUEE-46 The Female Urethra: A Practical Guide**

Louise L. Cavalcanti, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe embryology and anatomy of the female urethra highlighting the anatomical landmarks for diagnoses and surgical planning. 2. The intention of this pictorial review is to describe the most important imaging methods and their contribution to the diagnosis of the main pathologies. 3. Discuss the main pathologies of the female urethra, through richly illustrated clinical cases, correlating with the symptoms and emphasizing the learning points.

## TABLE OF CONTENTS/OUTLINE

a. Introduction. b. Embryology: Brief description of embryology. c. Anatomy: Important landmarks. d. Imaging methods: Sonography, MRI, Urethrography. e. Pathology: Discuss the most significant pathologies with key points and possible differential diagnoses. f. Cases: Illustrate the most frequent pathologies with clinical cases. g. Take home messages.

### **GUEE-47 Renal Vascular Hypertension: A Primer for the Radiologist**

Justin Sindoni, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the etiology, pathophysiology, classification and diagnosis of renal vascular hypertension  
2. Review contemporary ultrasound, CT and MR angiography techniques and findings of renal vascular hypertension  
3. Summarize modern treatment recommendations

## TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Etiology and pathophysiology of renal vascular hypertension  
3. Modality selection and protocol optimization  
4. Imaging features of renal artery narrowing including a) etiology b) flow dynamics c) renal perfusion d) post-intervention appearance e) complications  
5. Summary of treatment recommendations with emphasis on the impact of specific imaging findings on therapy

### **GUEE-48 Penile Pathology Prep: A Quiz-based Review of Penile Ultrasound for Trainees**

Ashley K. Yearwood (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

By the end of the presentation, the learner will be able to

1. Interpret the imaging and relevant anatomy for penile ultrasound.
2. Understand the role of ultrasound in diagnosis and management of penile pathologies and discern when to use ultrasound as an adjunct or in lieu of other modalities.
3. Describe the ultrasound findings for penile pathologies focusing on emergent and commonly encountered cases.
4. Identify normal and abnormal ultrasound Doppler flow parameters in various conditions that may aid in diagnosis.
5. Raise awareness of the clinical utility of penile ultrasound in certain penile pathologies given the safety profile and wide accessibility of this modality.

Target Audience: Trainees.

## TABLE OF CONTENTS/OUTLINE

We present a case-based quiz of various penile pathologies as seen on ultrasound. Each case will be associated with pertinent symptoms and unlabeled ultrasound images. The diagnosis will be revealed, along with description of the imaging findings followed by relevant educational content for each diagnosis such as: defining relevant pathophysiology, explaining key findings/associations, the clinical significance, and the uses/limitations of ultrasound related to that diagnosis. An introductory overview of normal anatomy and Doppler parameters will also be provided. Diagnoses include: 1. Erectile dysfunction - Arteriogenic 2. Erectile dysfunction - Venogenic 3. Priapism - High-flow 4. Priapism - Low-flow 5. Peyronie's disease 6. Mondor's disease 7. Penile fracture 8. Penis infection/abscess 9. Penile mass - Squamous cell carcinoma 10. Penile foreign body

### **GUEE-49 Now Streaming: Review of Male Urethral Imaging with Focus on MRI**

Milana Flusberg, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Proper technique and understanding of normal male urethral anatomy on retrograde urethrography aids in interpretation of scans for trauma and strictures. Differential diagnosis of periurethral cysts in men includes utricle, Mullerian duct cyst, Cowper's duct/gland cyst, diverticulum, and collections (urinoma/abscess). MRI is used for local staging of male urethral cancer. Radiologists should be familiar with the appearance of urethral procedures including artificial sphincter and Urolift.

## TABLE OF CONTENTS/OUTLINE

Performance of retrograde urethrography; Normal male urethral anatomy and normal variants; Urethral strictures: inflammatory, post-traumatic, neoplastic; Urethral trauma: mechanisms, grading, associated findings; Peri-urethral cysts and collections: utricle, Mullerian duct cyst, Cowper's duct/gland cyst, diverticulum, urinoma, abscess; Urethral cancer: background, imaging appearance, staging; Post-procedural urethra

### **GUEE-5 Overview of Tumor Thrombus in Renal Cell Carcinoma**

Eduardo M. Miranda Mora (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Renal cell carcinoma (RCC) invades into the vasculature in approximately 10% of patients. Tumor thrombus is most commonly associated with clear cell RCC but it can also occur due to other entities, such as papillary RCC. This educational exhibit will: (1) Review the incidence, prognosis, and classification system of tumor thrombus in RCC. (2) Review the imaging features of tumor thrombus. (3) Discuss the role of imaging in guiding surgical treatment of tumor thrombus.

## TABLE OF CONTENTS/OUTLINE

(1) Incidence, clinical presentation, and prognosis of tumor thrombus in RCC. (2) Review the T staging of RCC with tumor thrombus according to the 2010 AJCC clinical staging and Mayo Clinic RCC tumor thrombus level classification system. (3) CT and MRI imaging features of tumor thrombus with case-based pictorial review. (4) Treatment of RCC with tumor thrombus. (5) Potential surgical approach for varying levels of tumor thrombus and post-operative imaging. (6) Summary of teaching points.

### **GUEE-50 Genitourinary Tract Infections and Inflammatory Conditions: Spectrum of Imaging Features, Pitfalls and Mimics**

Ayman H. Gaballah, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Illustrate the etiology, pathogenesis, and clinical presentation of genitourinary (GU) tract infections 2. Review the appropriate imaging workup and imaging features of GU infections 3. Discuss mimics and pitfalls of GU infections Highlight management options

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Anatomic illustrations 3. Classification of genitourinary tract infections • Urinary tract infections: i. Upper urinary tract (kidney and ureter): 1. Focal/diffuse pyelonephritis 2. Emphysematous pyelitis/pyelonephritis 3. Renal/perinephric abscesses 4. Hydronephrosis and pyonephrosis 5. Xanthogranulomatous pyelonephritis 6. Parasitic infection (hydatid infection) 7. Other infections such as T.B 8. Ureteritis cystica ii. Lower urinary tract (urinary bladder and urethra): 1. Cystitis 2. Emphysematous cystitis 3. Diverticulitis of urinary bladder/urethra 4. Parasitic infection (Schistosomiasis) 5. Fungal infections (actinomycosis, candidiasis) 6. Cystitis cystica 7. Radiation and chemotherapy cystitis 8. iii. Urachal Inflammatory and Infectious Conditions • Genital infections: i. Female genital system: 1. Pelvic inflammatory disease (e.g., cervicitis, endometritis, pyosalpinx, etc.) 2. Tubo-ovarian abscess 3. Pelvic actinomycosis 4. Necrotizing fasciitis 5. Other rare infections ii. Male genital system: 1. Infectious and granulomatous prostatitis 2. Prostatic abscess 3. Epididymo-orchitis and abscess 4. Scrotal wall cellulitis, abscess 5. Fournier gangrene iii. Sexually transmitted infections 4. Predisposing factors and

complications of GU infection 5. Imaging features and case presentation 6. Mimics and pitfalls 7. Updates on management options 8. Conclusion

### **GUEE-51 Urologic Prosthetics: An Imaging Review of Short-term and Long-term Complications**

Mary M. Woodruff, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Urologic prosthetics are commonly encountered in everyday practice. As with any surgical procedure and implantable device, there are complications, both short-term and longer term. With contribution from the urology team, we have selected a case collection to highlight these complications with both imaging findings and gross anatomic photos. The addition of gross anatomic and surgical photos complement the imaging findings and provide a better understanding of the clinical perspective. In reviewing these cases, the radiologist may better recognize and accurately diagnose complications related to urologic prosthetics.

#### **TABLE OF CONTENTS/OUTLINE**

A review of the urologic prosthetics and implant components. Normal orthotopic positioning of urologic prosthetics anatomically and in imaging. Selection of cases with imaging and pictorial findings Selected cases include: Urethral cuff erosion of artificial urinary sphincter. Postoperative pelvic/scrotal hematoma. Scrotal abscess. Penile prosthesis scrotal pump erosion. Herniation of prosthesis reservoir into the inguinal canal. Reservoir leak. Fracture of malleable penile prosthesis.

### **GUEE-52 How We Do It: A Diagnostic Approach to Avoid Overtreatment in Management of Centrally Located Renal Masses**

Layra R. Leao (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review imaging features of the differential diagnosis of centrally located renal masses.- Illustrate diagnostic clues related to common and uncommon mimickers of upper tract urothelial carcinoma.- Highlight the importance of the tumor board approach in managing challenging cases as a platform for care coordination and a tool to optimize decision-making.

#### **TABLE OF CONTENTS/OUTLINE**

Imaging diagnostic differentiation of upper tract urothelial carcinomas (UTUC) and other centrally located renal tumors can be challenging; management patterns vary considerably due to the different oncologic behavior of these lesions. Misinterpretation in imaging studies could lead to unnecessary aggressive approaches. Some radiological features can help to predict the histology or pathologic aggressiveness of renal tumors, providing optimal and safe management. The presence of an infiltrative or nodular expansile pattern of growth is the first step in the differentiation of conditions that may simulate UTUC. Benign and malignant mimickers include renal cell carcinomas, metastasis, lymphoma, pseudotumors, and infection. Standardization of imaging protocols and reporting can help to differentiate these entities. The multidisciplinary discussion of challenging cases in the tumor board meetings should be included in the medical practice to identify interpretation mistakes and avoid unnecessary patient damage.

### **GUEE-53 MRI Clear Cell Likelihood Score (ccL): A Great Mechanism to Managing the Indeterminate Renal Masses**

RODRIGO OKAMURA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1 - To understand the different aspects of renal lesions and the importance of classifying those with a higher risk of clear cell carcinoma. 2 - Through practical cases and interactive quizzes, demonstrate how to use the clear cell likelihood score (ccLs). 3 - Present some cases with limitations of ccLs applicability. 4- Expose some pitfalls and challenging cases.

#### **TABLE OF CONTENTS/OUTLINE**

1 - Introduction on renal carcinomas subtypes and ccLs score creation.. 2 - Demonstate how to use the ccLs. 3 - Quiz case studies with practical use of ccLs. 4 - Answer each case with the corresponding pathological resulrs. 5 - Challenging cases with limitations of the ccLs algorithm. 6 - Pitfalls that can lead to erroneous diagnosis. 7 - Summary and take home notes.

### **GUEE-54 Female Lower Genitourinary Tract: Imaging Evaluation of the Most Common Alterations of Interest in Female Urology**

Alice Schuch, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

? Identify the anatomical landmarks of the female pelvic floor and perineum which can guide the radiologist to the correct diagnosis.? Point out the best imaging method for the diagnosis.? Review imaging features of the most common abnormalities of the female lower genitourinary tract.? List complicating features that may be seen by imaging and some rarer lesions that may be included in the differential diagnosis.

## TABLE OF CONTENTS/OUTLINE

Imaging methods Retrograde urethrocytography and computed tomography are limited imaging methods for the evaluation of female lower genitourinary changes. Ultrasound plays a role in more specific indications. However, magnetic resonance imaging is usually the method of choice and provides the best identification of the anatomical structures for the diagnosis. Imaging evaluation common alterations will be characterized especially on MRI, as cystic lesions, including Bartholin's gland cyst and urethral diverticulum, as well as prolapses, such as urethral caruncle. Some complications of the common lesions will be included, in addition to tumors or tumor-like lesions, to provide the radiologist ability to perform differential diagnosis. Conclusion MRI is an ideal imaging method to evaluate female lower genitourinary changes, and it is essential that radiologists know how to detect and characterize these lesions, since, even when benign, they can be quite symptomatic.

## GUEE-55 Pitfalls of Renal Transplant Imaging

Reece J. Goiffon, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

TEACHING POINTS1. Discuss the relevant anatomic/imaging considerations, criteria, and imaging techniques for pre-renal donor work-up.2. Become familiar with the normal anatomic features, including location, surgical technique, and relevant hilar anastomoses following renal transplantation as well as the normal grayscale and color/power Doppler imaging features of a renal allograft.3. Review common pitfalls encountered both during pre-renal transplantation work-up and during evaluation of the renal allograft post-transplantation with particular attention to accurate diagnosis of post-transplant complications.4. Highlight the important roles of both computed tomography (CT) and ultrasound (US) in pre- and post-renal transplant evaluation.

## TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS/OUTLINEWe present a comprehensive review of normal pre- and post-renal transplant imaging as well as a review of potential pitfalls in both the pre-transplant imaging work-up and post-transplant allograft evaluation. Pre-renal transplant pitfalls may include:• Incidental arteriopathies (e.g. fibromuscular dysplasia)• Aberrant vascular anatomy• Incidental primary renal neoplasms• Other incidental malignancy Post-renal transplant pitfalls may include:• Postoperative edema at the arterial anastomosis• Renal vein thrombosis with diastolic flow reversal in the transplant renal artery• Postoperative fluid collections (seroma vs hematoma vs urinoma vs lymphocele)• Allograft malignancy

## GUEE-56 Imaging of Upper Urinary Tract Neoplasms

Miriam Gallego Casals, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Upper urinary tract urothelial carcinoma (UTUC) stands for only 5-10% of all urinary tract tumors and is mainly represented by transitional cell carcinoma (TCC, >95%). TCC usually develops in males around 65 and is related with many chemical compounds and urinary stasis (that is why it is more common in the bladder rather than on the ureter). Haematuria is the most frequent symptom, although non-specific, and urine cytology is usually negative. Commonly multifocal, with a high incidence of early recurrence, requires rigorous urothelial surveillance. CT urography has largely replaced any other imaging techniques, using contrast media to outline the collecting system. As UTUC can be challenging to identify on routine imaging, we use a series of cases to illustrate the most common patterns and signs that help us identify these tumors: a soft tissue density filling defect that enhances lightly is the most typical finding. Other types such as the non-papillary is infiltrative and harder to detect, often invading beyond the mucosa at the time of diagnosis. In the renal pelvis, these tumors do not change renal contours even when large. Instead, small ureteral tumors are more likely to obstruct the kidney and cause renal malfunction. We explain through several cases how to distinguish UTUC from other neoplasms or benign processes, dividing these UTUC mimickers in two groups: - Filling defects pitfalls: clots, calculi, mycetomas, etc- Urothelial thickenings: lymphoma, tuberculosis, schistosomiasis, etc

## TABLE OF CONTENTS/OUTLINE

Brief description of epidemiologic and pathologic characteristics of the tumors of the upper urinary tract. Discussion of patterns and signs that indicate their presence, and some pitfalls.

## GUEE-57 Imaging Assessment for Penile Prosthesis Complications: What the Radiologists Should Know

Sofia M. Bretos Azcona, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To review the types of penile prostheses and their components and findings on imaging techniques. To review the possible complications associated with penile prostheses and the role of imaging in their assessment and surgical planning.

## TABLE OF CONTENTS/OUTLINE

1. Types of penile prostheses 1.1. Semi-rigid/maleable prostheses. 1.2. Hydraulic prostheses. 1.2.1. Two pieces hydraulic prosthesis 1.2.2. Three pieces hydraulic prosthesis 1.2.3. Low-profile reservoir three pieces hydraulic prosthesis. 2. Radiological evaluation of penile prostheses. 2.1. Radiography 2.2. Ultrasound 2.3. CT scan 2.4. MRI 3. Expected imaging findings on complications related to penile prostheses and the role of imaging in their assessment. 3.1. Immediate surgical complications 3.2. Related to mechanical failure 3.2.1. Autoinflation of cylinders 3.2.2. Leakage 3.2.3. Fractures 3.2.4. Aneurysm of cylinders 3.2.5. Reservoir complications 3.3. Related to malposition of the prostheses components. 3.3.1. Erosion 3.3.2. Migration 3.3.3. Crossover 3.3.4. Buckling 3.3.5. Floppy glans syndrome 3.4. Imaging findings on infected prostheses 3.4.1. Early infection 3.4.2. Late infection 4. Conclusion

## **GUEE-58 Urothelial-phase CT Urography for Diagnosing Urothelial Tumors: A Paradigm Shift for Investigating Hematuria**

Nigel C. Cowan, PhD, FRCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Urothelial-phase CT urography (25-50 s post contrast administration) is considered a paradigm shift in the development of CT urography for diagnosing urothelial tumors and investigating hematuria. Urothelial tumours are hypervascular and display early hyperenhancement following contrast administration. Familiarity with the signs of urothelial tumours on urothelial-phase CT enables radiologists to make the diagnosis on both GU and non-GU studies. Urothelial-phase compared with excretory-phase CT urography has many advantages. These include shorter examination time, increased patient throughput, no need for complicated patient related manoeuvres to promote full opacification, improved tumour visualisation in cases of hydronephrosis, hydroureter and contrast layering and reduced false positive diagnoses. The diagnostic accuracy of urothelial-phase imaging for urothelial tumors is high. Diagnosis of urothelial tumors using urothelial-phase CT urography makes the excretory-phase redundant.

## TABLE OF CONTENTS/OUTLINE

A brief 25 year history of CT urography for investigating hematuria. The evolution of CT urography techniques. A comparison of urothelial-phase with excretory-phase CT urography for diagnosing urothelial tumors. Definition description of the techniques. Advantages and disadvantages. An atlas of urothelial tumors showing the signs of urothelial tumours on the urothelial-phase and examples of true positive, false negative and false positive results. Development of a confidence scoring system based on urothelial-phase imaging findings to improve report clarification and direct management: straight to surgery, ureteroscopy +/- biopsy or follow-up. Conclusion References

## **GUEE-59 New Method for Differentiating Stents from Adjacent Urinary Stone Using Dual Energy Spectral CT with Advanced Post-processing**

Yannan Cheng, BS,BS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1) To illustrate the limitations of conventional CT imaging in differentiating urinary stones and stents. 2) To illustrate novel techniques and approaches using dual energy spectral CT (DEsCT) to differentiate urinary stones from stents. 3) To demonstrate strategies of selecting appropriate image types with advanced post-processing.

## TABLE OF CONTENTS/OUTLINE

1) Conventional CT and its limitations • Fixed tube voltage of 120kVp with mA modulation and helical scanning mode. • CT value alone lacks the power to differentiate stones and stents. 2) Advanced CT imaging technologies • Dual-energy CT (80/140kVp) with preset dose levels and Adaptive Statistical Iterative Reconstruction-V (ASiR-V). • Different energy levels, material decomposition (MD) images and effective atomic number (Zeff). 3) Optimal strategies using these technologies • Select appropriate MD basis material pairs such as Calcium/Iodine, Fat/ Calcium, Fat/ Iodine, or Iodine/HAP. • Apply Zeff, Calcium/Iodine and CT value at 70 keV to better differentiate urinary stones and stents.

## **GUEE-6 The Spectrum of Renal Angiomyolipoma with Radiologic Pathologic Correlation**

### Awards

### Certificate of Merit

Jamie Marko, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Renal angiomyolipoma (AML) is a benign mesenchymal neoplasm composed of an admixture of thick-walled dysmorphic blood vessels, smooth muscle cells and adipose tissue. Angiomyolipomas belong to the perivascular epithelioid cell (PEComa) tumor family. 2. Variants of angiomyolipoma include the classic AML, fat-poor AML, epithelioid AML, and AML with epithelial cysts. Angiomyolipoma may occur sporadically or with tuberous sclerosis. 3. The classic variant, which accounts for more than 90% of cases, is confidently diagnosed at imaging by detecting macroscopic fat. Fat is hyperechoic at ultrasound. It has an attenuation < -20 Hounsfield Units at CT and matches the appearance of subcutaneous fat. Fat is T1 hyperintense with loss of signal with fat suppression at MRI. Small areas of fat are detected with chemical shift imaging. 4. Most angiomyolipomas have a benign clinical course. The most frequent complication is retroperitoneal hemorrhage, most common with tumors > 4 cm. Less commonly, angiomyolipoma may invade the renal vein and inferior vena cava. Epithelioid angiomyolipoma has malignant potential and may recur and metastasize.

## TABLE OF CONTENTS/OUTLINE

1. Review the gross, histologic, and immunohistochemical pathologic features of renal AML, including the uncommon variants. 2. Describe the multimodality imaging features of renal AML, including the uncommon variants. 3. Describe the pathologic basis of the imaging findings associated with each variant. 4. Illustrate the spectrum of renal AML including its variants. Will include important complications including retroperitoneal hemorrhage and vascular involvement.

## GUEE-60 Prostate Imaging for Recurrent Reporting (PI-RR): A User Guide

Anup S. Shetty, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The Prostate imaging for Recurrence Reporting (PI-RR) system was introduced in 2021 to create standards for reporting pelvic MRI after radical prostatectomy or radiation for treatment of prostate cancer. Using a similar nomenclature as PI-RADS v2.1, PI-RR uses established knowledge of MRI features of recurrent prostate cancer and codifies it systematically to be accessible to prostate MR readers of all experience levels. This exhibit is on the RadioGraphics Needs List under Genitourinary Imaging: Pictorial on Guidelines and Reporting Systems. This exhibit will: 1) Discuss the rationale for PI-RR 2) Describe technical standards and reporting guidelines 3) Illustrate the use of PI-RR to assess for recurrent prostate cancer after radical prostatectomy and radiation therapy through a series of instructive cases 4) Describe pitfalls of the current version, including non-applicability for focal therapies 5) Detail areas for future development of PI-RR

## TABLE OF CONTENTS/OUTLINE

\* Background: Why PI-RR, including the benefits of standardizing post-treatment prostate MRI\* Technical Standards: Requirements, extras (subtraction imaging, 3D volumetric T2 for MPR)\* Reporting: Component scores in the PI-RR system shown in a pictorial format\* Case Examples: Prostatectomy, external beam radiation, brachytherapy\* Pitfalls: Definitions of PI-RR 4/5 for post-prostatectomy based on laterality; susceptibility artifact from brachytherapy seeds and surgical clips; residual prostate tissue after prostatectomy\* Future Development: Focal therapy (cryoablation, HIFU, etc.); Integrating PSMA-PET/CT

## GUEE-61 Don't Stress, Just Study With Care, Renovascular Hypertension Will Be Conquered, in Your Test

Eduardo M. Gomes De Menezes, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Renovascular hypertension (RH) is the most common and potentially reversible cause of secondary hypertension. However, renal artery stenosis is often found as an incidental finding on routine examinations. Thus, knowledge of the clinical aspects of this pathology is necessary to increase the pre-test probability and the different diagnostic imaging modalities provide subsidies for better therapeutic decisions. 2. Revisit the multiple imaging methods used in the diagnosis of RH (Duplex Doppler Ultrasonography, CT Angiography, MRI Angiography and Renography): protocols, advantages, limitations and the main causes of RH as well as its imaging aspects. 3. Knowledge of invasive treatment options (Percutaneous transluminal renal angioplasty and surgery) and their respective technical aspects, indications and procedural complications.

## TABLE OF CONTENTS/OUTLINE

1. Overview of Renovascular Hypertension (RH) A. Epidemiology B. Physiopathology C. Causes 2. Indications for Testing a Patient for RH: A. Clinical Clues to Enhance the Pre-Test Probability B. Renal Artery Stenosis as an Incidental finding 3. Non Invasive Diagnostic Testing for RH and Expected Findings: A. Duplex Doppler Ultrasonography B. CT Angiography C. MRI Angiography D. Renography E. Contrast-Related Kidney Injury 4. Determining the appropriate time to combine different diagnostic methods 5. Reporting of RH Patient Examination: A. Anatomical Variants B. Most Common Lesion Aspects C. Atherosclerosis D. Fibromuscular Dysplasia E. Complex Lesions 6. Overview of RH Management: A. Percutaneous Transluminal Renal Angioplasty B. Surgery C. Procedural Complications

## GUEE-62 Prostate MRI Pitfalls and Confounders: A Case-based Approach



Eduardo Thadeu De Oliveira Correia, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Prostate MRI is widely used for the detection and characterization of prostate cancer. Nonetheless, many conditions can mimic prostate cancer lesions, leading to false positive MRI results. This educational exhibit employs a case-based approach to explore the pitfalls and confounders that arise during the assessment of prostate MRI and guide readers on how to distinguish these benign mimickers from malignant lesions.

### **TABLE OF CONTENTS/OUTLINE**

1. A prostate MRI with too many findings a. Case 1: prostate cancer in a MRI done within 4 weeks of prostate biopsy b. Teaching points 2. A must-known confounder a. Case 2: extruded benign prostatic hyperplasia b. Teaching points 3. The importance of clinical history a. Case 3: granulomatous prostatitis b. Teaching points 4. The role of Delayed Contrast Enhancement a. Case 4: prostate abscess b. Teaching points 5. An extremely rare case: know the boundaries! a. Case 5: malakoplakia b. Teaching points 6. Prostate MRI is more than just PI-RADS: check the surroundings! a. Case 6: PI-RADS 5 lesion, ureteral stone and ileo-ileal intussusception b. Teaching points

### **GUEE-63 Factors that Influence Prostate Cancer Visibility on Multiparametric MRI**

Eduardo Thadeu De Oliveira Correia, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Multiparametric MRI (mpMRI) is endorsed by guidelines worldwide as a fundamental tool for the detection and characterization of prostate cancer. Nonetheless, still, 10-20% of patients with clinically significant prostate cancer have a false negative result in mpMRI. In this exhibit, we will review factors that can decrease lesion conspicuity and reduce the detectability of malignant lesions.

### **TABLE OF CONTENTS/OUTLINE**

1. What factors can influence Prostate Cancer visibility on mpMRI? a. Histology b. Background Signal Changes c. Image quality 2. Histological determinants of lesion visibility on mpMRI a. Tumor volume b. Gleason/ISUP score c. Epithelium, stroma, and lumen fraction 3. The effect of background signal changes of the peripheral zone on lesion visibility a. Diffusely hypointense peripheral zone on T2WI b. Heterogenous hypointensity in the peripheral zone on T2WI c. Background signal changes in DWI and DCE d. Associated clinical factors and conditions 4. Benign mimickers of prostate cancer on mpMRI a. Prostatitis b. BPH c. Adenosis d. Necrosis e. Focal atrophy 5. Image quality: patient and scanner factors that can decrease lesion conspicuity

### **GUEE-64 Update on Hereditary Renal Mass Syndromes: Genetics, Renal, and Extrarenal Imaging Findings**

Acacia Yoon (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Review hereditary renal mass syndromes in the context of the 2022 World Health Organization update, which has a stronger emphasis on genetic alterations. 2. Review extrarenal findings associated with each syndromes. A diagnostic approach will be proposed. 3. Understand the role of the radiologist in diagnosis and management. Genetic testing may not be necessary or even specific for certain syndromes; thus, radiologists may be the first to suggest the diagnosis.

### **TABLE OF CONTENTS/OUTLINE**

1. Hereditary renal mass syndromes with multimodality imaging correlates: genetic mutation, inheritance pattern, diagnostic criteria, renal mass subtype(s), extrarenal findings, and management: Birt-Hogg-Dubé, von Hippel-Lindau, tuberous sclerosis complex, succinate dehydrogenase deficiency, fumarate hydratase deficiency, hereditary papillary renal cell carcinoma, PTEN hamartoma syndrome, BAP1 tumor predisposition syndrome, chromosome 3 translocation. 2. Role of the radiologist in diagnosis and management. 3. Diagnostic approach for the radiologist.

### **GUEE-65 Abnormal Testicular Waveforms: What Do They Mean**

Yashant Aswani, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To identify typical and atypical waveforms of testicular torsion 2. To understand and describe the difference between partial and complete testicular torsion 3. To describe the features of torsion-detorsion syndrome 4. To understand the mimics of testicular torsion

### **TABLE OF CONTENTS/OUTLINE**

1. Normal testicular blood supply with normal spectral Doppler explained with image and line diagram 2. To illustrate testicular torsion with various examples for clear understanding and interpretation 3. To illustrate examples of partial torsion

with various spectral Doppler variations including amplitude of the waveforms, parvus tardus pattern, monophasic waveform and reversal of diastolic flow 4. To illustrate torsion-detorsion with multiple examples. Spermatic knot sign will also be illustrated in detail with images and cine clips 5. To illustrate mimics of testicular torsion such as patients with vasculitis and drug-induced spectral Doppler abnormalities with histopathology correlation

## **GUEE-66 Magnetic Resonance Imaging for Non-Oncologic Penile Pathology: It's Not that Hard**

Daniel Corominas, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The use of Magnetic Resonance Imaging is widespread for oncological pathology of the penis, but its use is of much importance in non-oncological pathology such as Peyronie's disease, penile fracture, and priapism. Intracavernosal drug injection is an option for the treatment of erectile dysfunction, but it is also important for conducting erection imaging studies, so the radiologist must be aware of its method of administration, possible complications, and how to prevent and treat them. Treatment of non-oncological diseases of the penis using penile prostheses has expanded recently. MRI MRIs the method of choice for evaluating their proper functioning, as it provides high-resolution spatial images and it is key to helping urologists determine the need for replacements and repairs.

### **TABLE OF CONTENTS/OUTLINE**

1) MRI protocol for non-oncological pathology of the penis. 2) Intracavernosal drug injection: a basic guide for radiologists. 3) Penile anatomy on MRI. 4) Non-oncological pathology of the penis. 4.1) Erectile dysfunction 4.2) Peyronie's disease 4.3) Priapism 4.4) Penile fracture 5) Penile prosthesis. 5.1) Indications and types of surgery 5.2) Types of penile prostheses and their components 5.3) Imaging evaluation of the penile prosthesis: importance of MRI 5.4) Evaluation of the penile prosthesis complications. 5.4.1) Cylinders and shafts complications 5.4.2) Glans mobility alterations 5.4.3) Reservoir malposition 5.4.4) Circuit rupture and prosthesis malfunction 6) Conclusions and future directions.

## **GUEE-67 Urethral Pathologies in Male Patients: Evaluation with Magnetic Resonance Urethrography - A Pictorial Essay**

Vinicius C. Serra, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

TP1 Magnetic resonance imaging (MRI) is a promising imaging modality for the comprehensive evaluation of urethral pathologies, providing high resolution and multiplanar imaging capabilities without the need for radiation or invasive procedures. TP2 MRI can accurately identify and assess the extent of anterior and posterior urethral strictures, as well as fistulous tracts with adjacent organs, and can aid in the evaluation of postoperative complications. TP3 Urethral strictures can result from traumatic or inflammatory causes and can lead to obstructive uropathy. Posterior urethral injuries commonly result from pelvic trauma, while anterior urethral strictures can result from instrumentation or inflammation. TP4 MRI provides a non-invasive and radiation-free alternative to traditional imaging techniques, such as urethrocytography, which can be limited by poor visualization of urethral strictures and invasiveness. TP5 MRI can also be used to evaluate other pathologies of the male genitourinary tract, including prostate cancer and penile cancer.

### **TABLE OF CONTENTS/OUTLINE**

I. Introduction A. Overview of traditional urethral imaging techniques B. Advantages of MRI for comprehensive evaluation of urethral pathologies II. Methodology A. Patient selection and imaging protocol B. MRI findings in anterior and posterior urethral strictures and fistulas III. Discussion A. Traumatic and inflammatory causes of urethral strictures B. MRI evaluation of postoperative complications C. Comparison of MRI with traditional urethral imaging techniques IV. Conclusion A. Summary of the advantages of MRI in the evaluation of urethral pathologies B. Potential implications for clinical practice and patient outcomes

## **GUEE-68 Unveiling the Masked Masqueraders: Navigating Anatomical Variations and Adenocarcinoma Mimickers in Prostate Multiparametric MRI**

Enis C. Yilmaz, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Multiparametric MRI (mpMRI) is the imaging modality of choice in assessment of prostate adenocarcinoma (PCa). However, various conditions involving the prostate might resemble PCa due to their imaging characteristics and these patients might undergo unnecessary biopsy procedures. Our aim is to review some of the entities that could be a pitfall for readers and outline their key imaging findings to differentiate them from PCa.

### **TABLE OF CONTENTS/OUTLINE**

(1) Overview of prostate anatomy and typical imaging characteristics of PCa. (a) Central Zone (b) Anterior fibromuscular stroma (c) Bulbourethral glands (Cowper's glands) (2) Conditions that may mimic PCa and their appearance at mpMRI: (a) Acute and chronic bacterial prostatitis (b) Tuberculous prostatitis (c) Granulomatous prostatitis (d) Prostate abscess (e)



Intraprostatic calcification (f) Mucinous neoplasm of prostate (g) Stromal Tumor of Uncertain Malignant Potential of the Prostate (STUMP) (h) Biopsy related hemorrhage (i) Post-focal treatment prostate (j) Exophytic BPH nodule (k) Small cell carcinoma of the prostate (3) Hints that could be helpful in differentiation of PCa and PCa mimickers (4) Summary of findings

## **GUEE-69 Practical Approach to Primary Retroperitoneal Tumors: Tips for An Imaging Diagnosis**

Shota Kondo (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

a. For a differential imaging diagnosis of primary retroperitoneal tumors, a focus on the principal tumor features, e.g. fat, cystic components, a mucinous matrix, and necrosis is important. b. On images of well-differentiated liposarcomas the fat component predominates. In other histological types of liposarcomas it is not large and it may not be identifiable. c. High signal intensity on T2-weighted MRI scans with delayed contrast enhancement indicates a myxoid stroma that may be, for example, myxoid liposarcoma, schwannoma, or myxofibrosarcoma. d. Retroperitoneal tumors with a predominantly cystic component commonly include benign lesions such as lymphatic malformations, tail gut cysts, and ancient schwannomas. e. Common primary retroperitoneal malignancies such as leiomyosarcoma, undifferentiated pleomorphic sarcoma, and liposarcoma often have a necrotic appearance, suggesting a poor prognosis.

### **TABLE OF CONTENTS/OUTLINE**

1. Retroperitoneal anatomy 2. Diagnostic algorithm and clinical management of primary retroperitoneal tumors 3. Imaging findings of various primary retroperitoneal tumors 4. Utility of 18F-FDG-PET/CT for diagnosing primary retroperitoneal tumors 5. Tips for avoiding diagnostic pitfalls and for clinical management

## **GUEE-7 Multiparametric MR Urethrography (MRU): Dynamic Comprehensive Evaluation of the Male Urethra**

### **Awards**

#### **Certificate of Merit**

Alice Schuch, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Describe the optimal technique for a comprehensive MRU protocol including the instillation of sterile urethral jelly, multiparametric sequences, and dynamic maneuvers. Identification of normal urethral anatomy on MRU including evaluation of periurethral compartments in both static and dynamic images. Describe how each component of MRU is crucial for the evaluation of common, uncommon, and rare urethral pathology.

### **TABLE OF CONTENTS/OUTLINE**

MRU has revolutionized the imaging of the male urethra. Patient preparation: in the supine position and the penis in the anatomic position with an injection of lidocaine gel for urethral distension. Imaging protocol and interpretation high-spatial resolution, small FOV, multiplanar T2WI, to provide the best anatomic overview. T1WI is useful for assessing hemorrhage and vascular thrombosis, while the DCE is useful in evaluating masses and differentiation between fibrosis and inflammation. DWI assists in the depiction of a urethral mass and skips lesions. Dynamic maneuvers, with Valsalva and urination, are also performed to assess the sphincters and pelvic floor. Clinical applications: value of MRU in multiple specific clinical indications will be discussed, including urethral strictures, diverticula, fistulas, trauma, cancer staging, infections/inflammation. Conclusion MRU is an ideal one-stop replacement for traditional fluoroscopic urethrography, with growing data in the literature in recent years.

## **GUEE-70 Prostate Cancer Strikes Back! A Pictorial Review of Local Recurrence and the PI-RR Score**

Bernardo S. Oliveira, MD, MBA (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To understand the main finding of prostate local recurrence on magnetic resonance imaging. To review the new PI-RR score and learn how to apply it. To gain experience in prostate recurrence MR evaluation through clinical cases.

### **TABLE OF CONTENTS/OUTLINE**

Introduction - First Things First Basic clinical concepts you should know before reading the MR imaging (PSAd, PSA doubling time, and more). Getting familiarized with the normal male pelvis after radical prostatectomy and radiotherapy. A brief review about the new PI-RR score system. Discussion - Prostate Cancer Strikes Back A prostate cancer local recurrence case collection, focusing on MR imaging. Summary - It's your turn to strike back! Learn tips and tricks to enhance your skills.

## **GUEE-71 The 'New' 2022 World Health Organization (WHO) Classification of Adrenal Cortical Tumors: A Primer for Radiologists**

Nuray Bakal, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Familiarize audience with 'new' 2022 World Health Organization (WHO) classification of adrenal cortical tumors (ACTs) Describe the pathology, genetics, molecular biology natural history of ACTs. Review imaging spectrum of benign malignant ACTs discuss the role of imaging in the screening, diagnosis, staging, and surveillance Discuss the potential diagnostic management implications of the current classification

### **TABLE OF CONTENTS/OUTLINE**

Introduction The spectrum of adrenal cortical lesions Updates in WHO classification Pathology, Genetics Molecular Biology Genetic Syndromes: Li-Fraumeni, Lynch, MEN1. Imaging Techniques: US, CT, MRI PET-CT Congenital adrenal hyperplasia Adrenocortical nodular disease: Sporadic nodular, Bilateral micronodular, Bilateral macronodular Cortical adenomas: typical/atypical imaging findings Primary aldosteronism: HISTALDO classification imaging findings Cortisol-producing adenomas Cortical carcinoma: imaging spectrum Adrenal Myelolipoma Adrenal rests, adrenal Cysts. Rare tumors: melanoma, adenomatoid tumors sex cord-stromal tumors Role of imaging in screening surveillance of ACTs other lesions Diagnostic Management Implications of 2022 WHO Classification Imaging biomarkers. Conclusion The new 2022 WHO classification of ACTs highlights the importance of molecular genetic features in characterizing classifying ACTs and updated terminology for select pathologies. The pivotal role of CT/MRI/PET-CT imaging features in the diagnosis, treatment surveillance of cortical tumors is discussed. Familiarity of radiologists with new ACTs subtypes associated imaging findings helps to accurately identify and characterize ACTs.

### **GUEE-72 Pictorial Review of the Diagnosis of Muscle-Invasive Bladder Cancer Using Vesical Imaging-Reporting and Data System (VI-RADS)**

#### **Awards**

#### **Certificate of Merit**

Mitsuru Takeuchi, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The Vesical Imaging-Reporting and Data System (VI-RADS) is a standard MRI imaging and diagnostic method for muscle-invasive bladder cancer that was published in 2018. As a member of the VI-RADS committee, I was involved in the development of the diagnostic criteria. Several studies have demonstrated that VI-RADS has excellent sensitivity and specificity for muscle-invasive bladder cancer. However, reading VI-RADS requires some expertise, and there are various pitfalls. Therefore, this exhibition will first explain the basic MRI reading procedure for bladder cancer. Then, based on my experience of reviewing MRI images of approximately 300 cases of bladder cancer with trainees, we will discuss the causes of misdiagnosis and precautions to prevent misdiagnosis by presenting case images. Furthermore, limitations of the current VI-RADS diagnostic criteria will also be addressed.

### **TABLE OF CONTENTS/OUTLINE**

1) Basic procedure for reading bladder MRI 1-a) Role of multiparametric MRI 1-b) Imaging findings of tumor stalk and thickened submucosa 1-c) Categorizing bladder cancer according to VI-RADS diagnostic criteria 2) Teaching file, misdiagnosed cases by trainee, consideration of the cause and suggestions for improvement 2-a) Problems with the patient's condition or imaging 2-b) Misdiagnosis due to insufficient reading skill 2-c) Misdiagnosed cases caused by the limitation of current VI-RADS diagnostic criteria 2-d) Difficult to diagnose bladder cancer with atypical histology and imaging findings

### **GUEE-73 Visualizing Dynamic Mechanisms of Lower Urinary Tract Symptoms (LUTS): Usefulness of Urodynamic 4D-CT**

Wataru Fujishiro, RT (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Providing required items for LUTS surgery
- CT Scanning technique for LUTS
- Benefits of 4D-CT scanning for urination evaluation
- Morphological Evaluation before after surgery

### **TABLE OF CONTENTS/OUTLINE**

A. Morphological and functional evaluations are important. B. Morphological evaluation is required for bladder, urethra, prostate. Scanning is performed in a semi-seated position to reproduce a physiological urination state. 4D-CT uses intermittent scanning to reduce radiation exposure from the beginning to the end of urination. C. "Using 4D-CT can evaluate morphological changes in the bladder, prostate, and urethra and the location and timing of bladder outlet obstruction that occurs at the start of urinary flow, and urodynamic information." D. Analysis of the volume data enables pre and post operative comparisons. Evaluation using CT can show the effectiveness of quantitative evaluation. Outline "4D-CT is particularly effective in judging the applicability of operation and evaluating kinetic and morphological data in cases of prostate problems without morphological changes and dysuria due to a small decrease in uroflow intensity due to insufficient strength of the urethral sphincter muscle." There are cases in which surgery was indicated for patients whose anatomical

structure deviated from the ideal. 4D-CT can evaluate morphology and function. So, it is useful for surgical indication and surgical planning.

## **GUEE-74 The Role of Imaging Techniques in Penile Lesions: When and How to Use Them**

Sandra Baleato Gonzalez, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To illustrate normal US and MR penile anatomy. 2. To review the spectrum of traumatic and atraumatic lesions involving the penis highlighting the typical and atypical sonographic and MR appearances of pathologic disorders, with special emphasis on distinctive and subtle findings that may clarify the diagnosis. 3. To discuss the value of other imaging techniques (CT, PET-CT, arteriography, urethrography) in penile pathology.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. General features and basic concepts. 2. Anatomy. US and MR anatomy and imaging protocol. 3. Vascular disorders (Mondor disease, partial thrombosis of the corpus cavernosum, high flow and low-flow priapism). 4. Trauma. (Penile fracture, urethral injury, post-traumatic arterial penile fistula, extratunical hematoma and intracavernosal hematoma). 5. Inflammation (Cellulitis, abscess, fistula and gangrenous cavernositis). 6. Benign lesions (Peyronie disease, cavernous hemangioma, median raphe cyst, epidermoid cyst and so on). 7. Malignant lesions (Primary penile cancer and penile metastasis). 8. Summary.

## **GUEE-75 The Perils of Prostate MRI: How to Best Avoid Common Imaging Pitfalls**

Amanda C. Gibson, DO (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Prostate MR is a robust imaging modality with emerging utilization in screening, tumor characterization, surveillance, risk stratification, and local staging of prostate cancer. 2. The inherent complex anatomy of the prostate gland, coupled with advancements in MRI technology and varied pathologies affecting the prostate, result in several potential pitfalls in MR image interpretation. 3. To ensure accurate interpretation, the radiologist must be familiar with the appearance of normal prostate anatomy, as normal variations can mimic clinically significant cancer, as well as benign entities which could simulate or mask cancer.

### **TABLE OF CONTENTS/OUTLINE**

1. Review normal anatomy of the prostate on MR with focus on central zone and anterior fibromuscular stroma 2. Illustrate benign prostatic pathologies and ways in which their imaging may mimic prostate cancer - Normal anatomic structures and expected postprocedural sequela that mimic cancer - Noncancerous abnormalities that may mimic cancer - Artifacts which may mimic or mask cancer 3. Describe locoregional invasion of prostate cancer beyond neurovascular bundles and capsular disruption 4. Highlight case-based teaching points with normal and abnormal prostate MRI 5. Provide flowchart guide on different interpretation pathways when reading prostate MRI for both junior and seasoned radiologists

## **GUEE-76 Imaging and Management of Renovascular Hypertension: State-of-the-Art**

### **Awards**

#### **Certificate of Merit**

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To review the pathophysiology of renovascular hypertension (RHT) 2. To discuss the role of multimodality imaging in the diagnostic pathway of RHT 3. To illustrate the imaging appearances of various causes of RHT 4. To review the role of interventional management of RHT.

### **TABLE OF CONTENTS/OUTLINE**

1. RENOVASCULAR HYPERTENSION- DEFINITION 2 .IMAGING MODALITIES- Ultrasound, doppler; CTA, Photon counting CT; MRA- Contrast and non contrast techniques (3D SSFP, Phase contrast), 4D flow; Catheter angiography; Nuclear medicine; 3. DISCUSSION OF ETIOLOGIES OF RENAL HYPERTENSION WITH MULTIPLE CASE EXAMPLES - Non-stenotic lesions (via renal artery compression and/or changes in renal perfusion) o Renal artery aneurysm o Renal arteriovenous fistula - Stenotic lesions (via renal artery compression/occlusion) o Atherosclerotic disease o Fibromuscular dysplasia o Neurofibromatosis type 1 o Midaortic syndrome o Dissection o Vasculitis (Polyarteritis nodosa ,Takayasu arteritis) o Trauma o Retroperitoneal fibrosis/radiation o Thromboembolism 4. ROLE OF IMAGING IN EXCLUDING OTHER CAUSES OF REFRACTORY HYPERTENSION- Endocrine- pheochromocytoma, hyperaldosteronism, Cushing's, thyroid dysfunction, hyperparathyroidism; Renal parenchymal disease; Mid aortic syndrome, coarctation; 5. IMAGING APPROACH FOR RHT 6. END-ORGAN ASSESSMENT- Kidneys, Heart, brain 7. TREATMENT- Optimal management is individualized to patient clinical context and

dependent on etiology of renovascular hypertension; Medical - antihypertensives (i.e. ACE inhibitors/ARBs); Interventional-Angioplasty, stenting; Surgical

## **GUEE-77 Bosniak IV Cystic Masses: A Tough Nut to Crack**

### **Awards**

#### **Certificate of Merit**

Ignacio De Garcillan, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To revise Bosniak IV cystic mass v 2019 CT and MRI features.- To review possible pitfalls: interpretative, technical, and mass related.- To illustrate several Bosniak IV cases from our hospital.

### **TABLE OF CONTENTS/OUTLINE**

In 2019 a new Bosniak classification version was published providing a detailed description of Bosniak IV category features. Its main objective was to increase specificity. Nevertheless, interpretation and classification of septa and nodule in each category remains challenging. In this exhibition we will focus on Bosniak IV cystic masses. Each feature will be revised and discussed to avoid misinterpretation. Potential pitfalls will be reviewed: interpretative quantitative and qualitative features, technical concerns, and mass related issues. Examples of these pitfalls will be exhibited with several recommendations to avoid them: zooming, multiplanar reconstruction, exclusive enhancing septa measuring, subtraction imaging, best quality sequence and examination selection, temporal evolution, employing Bosniak classification when applicable etc. Bosniak IV cystic masses diagnosed at our centre will be illustrated with different imaging techniques. Several clear cell renal carcinomas with cystic transformation, papillary carcinoma, clear cell papillary renal cell tumour, multilocular cystic neoplasm, fumarate hydratase- deficient renal carcinoma and unclassifiable renal carcinoma will be shown.

## **GUEE-78 What Can Go Wrong When Doing Right? Iatrogenic Genitourinary Complications**

### **Awards**

#### **Certificate of Merit**

Jeffrey Wang, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. A growing number of systemic, minimally invasive, and surgical treatment modalities for various genitourinary (GU) pathologies may lead to various unique iatrogenic complications. Diagnostic imaging plays an essential role in detection and subsequent management. 2. A multimodality approach to identifying iatrogenic GU complications is key for prompt diagnosis to prevent morbidity. For example, both multiphase CT urogram and fluoroscopic antegrade nephrostogram can be utilized to confirm ureteral injury. 3. Knowledge of key imaging findings and mimics of complications are important to prevent misdiagnosis and mistreatment as well as to distinguish expected post treatment appearance from complication.

### **TABLE OF CONTENTS/OUTLINE**

A. Introduction 1. Review of treatment modality types for various GU pathologies (both benign and malignant) 2. Pictorial review of genitourinary anatomy and areas prone for iatrogenic injury • Essential GU anatomical structures • Common postsurgical anatomy • Discussion on the radiosensitivity of the GU system B. Multimodality approach to identifying GU complications 1. Decision tree on selecting the most optimal imaging type for common complications C. Case-based imaging review of iatrogenic GU complications 1. Systemic treatment 2. Minimally invasive interventions 3. Surgical intervention

## **GUEE-79 Magnetic Resonance Imaging Review and Virtual Biopsy of Common Solid Renal Masses**

Luis F. Calimano-Ramirez (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Relevant anatomic review of the renal system. 2. Review multiple cases with magnetic resonance imaging features of neoplastic pathology. 3. Review correlation with pathology result to examine the function of magnetic resonance imaging as means of virtual biopsy toward identifying renal mass characteristics in selected cases.

### **TABLE OF CONTENTS/OUTLINE**

1. Neoplastic pathologies: I. Benign etiology: a. Renal leiomyoma b. Renal Angiomyolipoma c. Renal Oncocytoma d. Renal plasmacytoma e. Solitary fibrous tumor. II. Malignant etiology: a. Clear Cell Renal cell Carcinoma b. Papillary Cell Carcinoma c. Medullary Renal Cell Carcinoma d. Collecting Duct Carcinoma e. Urothelial Cell Carcinoma f. Renal Lymphoma. 2. Inflammatory etiology: a. Xanthogranulomatous Pyelonephritis.

## **GUEE-8 Imaging of Renal Cancer: The Past, The Present, and The Future**

Alex Chung, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-Many benign cystic and solid renal lesions can be reliably distinguished on multiple imaging modalities such as US, contrast-enhanced US (CEUS), CT and MRI, including Bosniak I/II cysts and fat-rich angiomyolipoma (F-AML).-Among indeterminate renal lesions such as clear cell renal cell carcinoma (ccRCC), papillary renal cell carcinoma (pRCC), chromophobe renal cell carcinoma (chrRCC), oncocytoma (Onc) and fat-poor angiomyolipoma (FP-AML), the enhancement characteristics and other parameters can further characterize the renal lesions.-Likert-based CT and MR likelihood scores for renal masses can help stratify the risk of indeterminate renal lesion for active surveillance or surgical management.-Novel imaging parameters and artificial intelligence will further assist in imaging characterization of indeterminate renal lesions.

## TABLE OF CONTENTS/OUTLINE

-Introduction.-Normal Anatomy and Conventional Imaging Technique.-Imaging Findings/Pathology.-Enhancement characteristics including Mean Enhancement, Absolute Enhancement, Relative Enhancement, Absolute De-enhancement and Relative Washout.-Likelihood scores to aid risk stratification.-Novel imaging parameters and artificial intelligence, including 99mTc-sestamibi SPECT, Perfusion, Radiogenomics and Machine/Deep learning.-Biopsy of Renal Masses

## **GUEE-80 Urine the Wrong Place - When Urine Leaves the Urinary Tract. A Review of Urine Leaks and Urinary Tract Fistulas**

Emily R. Convery, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The presentation of urine leaks and fistulas can be variable; however, a good patient history will usually raise suspicion for these entities. It is important to understand the pathology of urinary leaks and fistulas as well as the expected anatomy, including normal and post-operative, to understand the imaging findings. Familiarity with the principles of CT urogram is crucial in distinguishing blood from urine in trauma and post-operative patients to accurately make a diagnosis. The radiologist plays a vital role in these cases in recommending and troubleshooting follow up imaging as well as in guiding clinicians in their management. Management usually involves urinary diversion, which interventional radiology plays a large role in.

## TABLE OF CONTENTS/OUTLINE

1) Review of normal male and female urinary tract anatomy and expected post-operative findings 2) Review of urinary tract imaging protocols - CT urogram, cystograms 3) Renal leaks - traumatic, spontaneous 4) Ureteral leaks - traumatic, iatrogenic 5) Bladder leaks - traumatic, iatrogenic, spontaneous 6) Urinary tract fistulas 7) Treatment/management options - IR interventions for urinary diversion

## **GUEE-81 MRI after Focal Therapy for Prostate Cancer: What Radiologists Must Know**

Rozita Jalilianhasanpour, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-Overview of the currently available focal treatments for prostate cancer: indications, contraindications, and techniques.-Review of potential complications of each procedure: frequency, diagnosis, and management.-Discussion of expected postoperative MRI findings of each procedure: early and late.-Review of imaging findings of recurrent prostate cancer post focal treatment: diagnosis, mimics, and management.-Discussion of potential pitfalls.

## TABLE OF CONTENTS/OUTLINE

Introduction-Rationale for focal therapy.-Potential benefits.-Criticisms to focal therapy.-Importance for radiologists and urologists.Treatment options-Electroporation (NanoKnife): Technique, Post-op appearance (Early and Late), Complications, Recurrence.-HIFU (FocalOne and TULSA): Technique, Post-op appearance (Early and Late), Complications, Recurrence.-Cryoablation: Technique, Post-op appearance (Early and Late), Complications, Recurrence.-Laser Ablation: Technique, Post-op appearance (Early and Late), Complications, Recurrence.

## **GUEE-82 Advances in MRI Techniques for Evaluation of Upper Urinary Tract Neoplasms: A Comprehensive Review**

Mohamed A. El-Ghar, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Familiarizing with the different advanced MRI techniques used in the evaluation of renal neoplasms, including diffusion-weighted imaging (DWI), intravoxel incoherent motion (IVIM) MRI, Diffusion Tensor Imaging (DTI), Blood oxygen level dependent (BOLD) MRI and Arterial spin labeling (ASL). 2. Identifying the advantages and limitations of conventional and advanced MRI techniques in the evaluation of renal neoplasms, how they can improve diagnostic accuracy, characterization of the masses and treatment planning. 3. Understanding the role of MRI in the staging renal neoplasms, and if their role for the new techniques. 4. Familiarizing with the current guidelines and recommendations for the use of MRI in the evaluation of

renal neoplasms. 5. Identifying potential areas for future research and development in the field of MRI for the evaluation of renal neoplasms, including the use of artificial intelligence and machine learning algorithms to improve diagnostic accuracy and reduce interpretation variability.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction - Definition and incidence of upper urinary tract neoplasms - Importance of accurate diagnosis and staging - Overview of MRI techniques for evaluation II. Conventional MRI Techniques -T1- and T2-weighted imaging -Contrast-enhanced imaging -Limitations and challenges III. Advanced MRI; DWI MRI, IVIM-MRI,DTI-MRI, BOLD-MRI, ASL, Comparative advantages of advanced techniques • IV. Applications in Upper Urinary Tract Neoplasms • Diagnosis and characterization of renal masses • Differentiation between benign and malignant tumors • Staging of malignant masses • V. Clinical Implications and Future Directions • VI. Conclusion

#### **GUEE-83 How to Do a Urethrogram... in Less than 15 Minutes and with No Special Equipment**

Connor Cummings, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Urethrograms are nothing to be afraid of;
- We have developed a technique that is well-tolerated, can be performed in less than 15 minutes, and requires no specialist equipment;
- This exhibit explains how to perform our technique for both males and females;
- We also illustrate the important anatomical structures, pitfalls, and complications of this technique.

#### **TABLE OF CONTENTS/OUTLINE**

The ideal urethrogram should be quick, well-tolerated, provide high-quality diagnostic images and, if possible, not require any special equipment. At our institution, we have stopped using Knutson's clamps and balloon-occlusion catheters, and now perform approximately 15 studies per week with just 6Fr and 10Fr catheters. The technique we have developed is quick, well-tolerated and provides diagnostic images of the whole (a) anterior and (b) posterior urethra: a) A 10Fr catheter is inserted into anterior urethra. The patient compresses the distal penile shaft while the anterior urethra is imaged in two oblique planes. A release view (with hand suddenly removed) allows the urethra to decompress and distends the submeatal urethra, visualised on fluoroscopy at 3-4 frames/sec; b) The bladder is filled via a catheter or via retrograde instillation (we discuss both methods). The patient voids for a descending study in the oblique plane. We also discuss a rapid '5min urethrogram' in patients without tight strictures, which only requires inserting a catheter once. Adaptions are covered for the following scenarios: i) Tight strictures; ii) Occlusive segments; iii) The female urethra; iv) Pericatheter studies. The relevant common pitfalls and uncommon complications of this technique are also discussed.

#### **GUEE-84 Evolving Role of Conventional Imaging for Prostate Cancer in the Era of PSMA PET**

##### **Awards**

##### **Cum Laude**

Hiroaki Takahashi, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Prostate-Specific Membrane Antigen (PSMA)-targeted positron emission tomography (PET) imaging is increasingly utilized for evaluating patients with high-risk prostate cancer (PCa) or recurrent PCa. The current National Comprehensive Cancer Network (NCCN) guidelines describe that conventional imaging is not a prerequisite to PSMA-PET for PCa staging. However, we have witnessed growing demand for conventional imaging as a confirmatory test for indeterminate findings on PSMA PET. PSMA-avid lesions other than PCa metastasis may cause false-positive observations, whereas PCa metastases to PSMA avid organs result in false-negative observations. Further, in conjunction with PSMA PET, prostate MRI has better performance in assessing the primary PCa, as well as local recurrence. In this context, PSMA PET does not replace conventional imaging, but does change the way in which conventional imaging is used. This exhibit will discuss the strategic approach of conventional PCa imaging in the era of PSMA PET. The purposes of this exhibit are: 1. To review the evolving role of conventional PCa imaging in the era of PSMA PET. 2. To discuss strategies to address recently recognized PSMA PET imaging pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

1. Fundamental mechanism and imaging interpretation of PSMA PET. 2. Role of conventional PCa imaging: focusing on imaging pitfalls of indeterminate findings on PSMA PET.- Assessment of primary PCa.- Assessment of local recurrence.- Assessment of metastases involving lymph nodes, bones, and solid organs. 3. Summary.

#### **GUEE-85 Urinary Bladder Diverticula: Imaging Features and Complications**

Grace G. Zhu, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe different categories of urinary bladder diverticula with comparison to normal urinary bladder. 2. Discuss urinary bladder diverticula multimodal imaging features. 3. Provide a case-based review of urinary bladder diverticula complications.



## TABLE OF CONTENTS/OUTLINE

1. Description of the different types of urinary diverticulaA. Describe histology of normal urinary bladder and diverticulaB. Highlight features of true and false urinary bladder diverticula2. Imaging of urinary bladder diverticulaA. Describe features of uncomplicated urinary bladder diverticulaB. Identify pitfalls that prevent optimal imaging 3C. Provide examples of diverticula mimics3. Case based review of urinary bladder diverticula complicationsA. Urine stasis and urinary bladder diverticula pathologyB. Diverticular stonesC. Diverticula and urinary tract infectionD. Cancer and staging consideration in diverticulaE. Incomplete voiding and obstruction

## GUEE-86 The Crucial Role of Ultrasound in the Detection of Renal Transplantation Complications

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To know the essential role of ultrasound in the detection of renal transplant complications. - To describe the systematic to follow when performing an ultrasound of renal transplantation. - To learn the typical ultrasound findings of renal transplant complications. - To be able to recognize those cases in which it will be necessary to complete the study with another tests in order to confirm the suspected diagnosis.

## TABLE OF CONTENTS/OUTLINE

Doppler ultrasound is one of the control tests routinely performed on all patients 24-48 hours after renal transplantation, as well as subsequently according to their evolution.Thanks to ultrasound, we can assess the state of the renal graft and rule out the existence of associated complications, which may be divided into:1. Vascular complications: - Renal artery stenosis. - Renal artery thrombosis. - Renal vein thrombosis. - Pseudoaneurysm.- Arterio-venous fistula. 2. Urological complications: - Ureteral obstruction. 3. Perirenal collections: - Hematoma. - Urinoma. - Abscess.- Lymphocele. 4. Parenchymal complications: - Acute tubular necrosis. - Acute rejection. - Immunosuppressant toxicity. 5. Other complications: - Lithiasis. - Renal graft infections (early and late). - Chronic rejection.In this paper we will detail the ultrasound findings that characterize these complications, through representative images of cases belonging to our institution. We will also explain those patients in which it was necessary to perform additional studies to confirm the suspected diagnosis.

## GUEE-87 Penile Ultrasound: A Pictorial Review of the Anatomy and the Most Relevant Pathologies

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To become familiar with the normal sonographic appearance of the penile structures, as well as to know its arterial and venous vascularization.- To understand the technique of intracavernous injection of vasoactive substances, along with the normal response of vascular structures.- To review the main pathologies affecting the penis and their sonographic findings.

## TABLE OF CONTENTS/OUTLINE

1. Penile anatomy by ultrasound: to recognize the anatomical structures in conjunction with the arterial and venous vascularization.2. Main penile pathologies: - Peyronie disease: its diagnosis is clinical, but ultrasound can confirm its presence, determine the extent of plaques and rule out a possible associated erectile dysfunction. - Erectile dysfunction: through intracavernous injection of vasoactive agents (PGE1) it is assessed whether there is a vascular (arterial or veno-occlusive) cause of erectile dysfunction. - Priapism: to evaluate ischemic, non-ischemic or metastatic causes. - Penile inflammation (e.g. cellulitis, balanitis, cavernositis,...): the main usefulness of ultrasound is to estimate the extension of inflammation and rule out abscess formation. - Trauma: in case of suspected penile rupture, ultrasound is especially helpful in doubtful cases or to locate the fracture line, as well as to assess long-term complications. - Benign entities: including cystic lesions (raphe cysts, epidermoid, dermoid,...), sclerosing lymphangitis, segmental thrombosis of the corpus cavernosum, calciphylaxis,...- Tumors: ultrasound is appropriate to determine the depth of the tumor and its spread to the corpus cavernosum.

## GUEE-88 Unmuddling the Middle: a Guide to Central Renal Abnormalities

### Awards

#### Certificate of Merit

Wendy Tu, MD, FRCPC (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Central renal pathologies can originate from all of the complex constituent structures of the kidney: the renal parenchyma, predominantly the medulla; collecting structures; sinus including fat and neural structures; vessels; lymphatics; and extension of retroperitoneal processes. Parenchymal and medullary pathologies can include benign or malignant tumors, from the common renal cell carcinoma to rare primary sarcomas. Both tumorous and nontumorous pathologies can occur in the renal pelvis, such as papillary necrosis or blood clot. Vascular lesions include renal arteriovenous fistula or renal artery aneurysms, which can mimic other pathologies. Retroperitoneal lymphoma, fibrosis, histiocytosis, or lymphangiomatosis can

involve the renal sinus. Multimodality imaging with ultrasound, CT, MRI, and angiography is important for differentiation of pathologies. Imaging is crucial to predict partial nephrectomy complexity with use of nephrometry scores.

#### **TABLE OF CONTENTS/OUTLINE**

1) Parenchymal tumors invading the renal sinus such as renal cell carcinoma and mixed epithelial and stromal tumor family tumors 2) Benign and malignant medullary tumors such as hemangioma, primary sarcoma, and medullary carcinoma 3) Sinus and medullary pathologies such as mesenchymal tumors, retroperitoneal fibrosis, and histiocytosis 4) Collecting system processes including urothelial carcinoma, papillary necrosis, calcifications, and clots 5) Vascular anomalies such as arteriovenous malformations, renal artery aneurysm, and renal vein varix

#### **GUEE-89 The Body Meets the Adrenal: Adrenal Manifestations of Systemic Disorders**

Wendy Tu, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe imaging manifestations of adrenal gland involvement by common and uncommon systemic disorders. Paired organs of the endocrine system, the adrenal glands have important roles in production of cortical and medullary hormones and catecholamines. The glands can be affected by a variety of neoplastic and non-neoplastic systemic disorders, some with life-threatening consequences such as in cases of adrenal hemorrhage and shock. Radiologists should be familiar with imaging manifestations along with potential associated laboratory abnormalities to ensure correct characterization and diagnosis for guidance on management. It is essential to distinguish adrenal manifestations of systemic disorders from other primary benign and malignant adrenal lesions.

#### **TABLE OF CONTENTS/OUTLINE**

Entities discussed will include: 1) Hemorrhagic conditions such as stress-related hemorrhage. 2) Hematologic diseases such as lymphoma. 3) Autoimmune conditions leading to adrenalitis such as Ipilimumab-induced adrenalitis. 4) Conditions leading to adrenal hyperplasia such as paraneoplastic syndromes. 5) Hereditary syndromes such as Von Hippel-Lindau disease and Neurofibromatosis. 6) Granulomatous diseases such as tuberculosis. 7) Infiltrative disorders such as amyloidosis. 8) Adrenal hyperenhancement in the setting of systemic hypoperfusion.

#### **GUEE-9 Urine Trouble! An Interactive Review of Multiparametric MR Urography & It's Pitfalls**

Jay A. Karajgikar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the MR techniques for optimizing multi-parametric MR urography with attention to pitfalls 2. Identify advantages over CT Urography 3. Identify imaging features of lesions involving the urothelium in a quiz-based format with radiology-pathology correlation

#### **TABLE OF CONTENTS/OUTLINE**

1. What is multi-parametric MR Urography and how does it improve diagnosis? 2. Why would MR Urography be preferred over CT Urography? What are the benefits and limitations? 3. Improvements in MR sequences (including compressed sensing, k-space under-sampling, parallel imaging, and AI), which allow unprecedented improvement in image quality. 4. Dilemmas in technique - is Lasix injection needed? Prone versus supine patient positioning? Wide vs narrow FOV? Are cine-T2 images useful? 5. How to identify and avoid pitfalls and artifacts - flow voids on T2? T1\* effects due to concentrated gadolinium? 6. How does MR urography help in identification and staging of urothelial neoplasms? 7. How can MR urography help identify common, uncommon, and rare mimics of urothelial lesions using a rad-path quiz-based format?

#### **GUEE-90 2022 WHO Classification of Adrenal Tumors Revisited: Atlas of Diseases with Pathological Insights**

#### **Awards**

#### **Certificate of Merit**

Adriano Basso Dias, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the update 2022 WHO Classification of Adrenal Cortical Tumors Review the update 2022 WHO Classification of Pheochromocytoma and Paragangliomas Identify imaging features with radiologic-pathologic correlation of common and uncommon adrenal lesions

#### **TABLE OF CONTENTS/OUTLINE**

Are There Any Nomenclature Changes or Any New Diagnostic Categories in the New WHO Classification of Adrenal Cortical Proliferations? What are the Radiological and Pathological Correlates of Adrenal Cysts? What Should a Radiologist Know about Adrenal Cortical Carcinoma? Why Do Radiologists and Pathologists Need to Know Ectopic or Heterotopic Locations for Adrenal



Cortical Tissue?What are the Highlights in the New WHO 2022 Classification of Pheochromocytoma and ParagangliomasMiscellaneous (Including Mesenchymal and Stromal Tumors)

## **GUEE-91 Focal Therapy of Prostate Cancer: A Primer for Radiologists**

### **Awards**

**Magna Cum Laude**

Adriano Basso Dias, MD, MSc (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Understand the current concepts of prostate focal therapyRecognize the most important MRI features to report pre and post focal therapyKnown the role and limitations of prostate MRI for patient selection for focal therapyBe familiar with future directions of imaging techniques in focal therapy

### **TABLE OF CONTENTS/OUTLINE**

Introduction - Indications, energy sources and templates available for focal therapy (FT)Role of imaging in the pre treatment assessment- MRI for diagnosis, staging and patient selection for FTRole of imaging in the post treatment assessment- MRI findings post FT- Types of recurrence- PitfallsFuture Perspectives- What imaging modalities are on the horizon for patient selection for focal therapy and treatment guidance

## **GUEE-92 The Extraperitoneal Cavity: Gaining Understanding through Surgical Procedures**

Kiyoko Mukai (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The extraperitoneal cavity has a complex anatomy, and furthermore, there is limited opportunity to understand this invisible anatomy on imaging. In this presentation, we will discuss the anatomy of the extraperitoneal cavity and the importance of preoperative imaging in surgical planning, using the surgical technique for prostatectomy as a guide.

### **TABLE OF CONTENTS/OUTLINE**

Learn basic techniques and anatomy in standard surgical procedures1. Intra-abdominal observation2. Dissection of the retropubic space/Retzius cavity3. Lymph node dissection4. Incision of the endopelvic fascia5. Dissection of the bladder neck6. Dissection of the seminal vesicles7. Management of the prostate pedicles8. Dissection of the posterior aspect of the prostate9. Management of the lateral aspect of the prostate10. Division of the urethra11. Reconstruction (including urethral anastomosis)A collection of casesCase1: Benign prostatic hyperplasiaCase2: Enlargement of the middle lobeCase3: Previous transurethral resection of the prostate (TURP)Case4: T3 prostate cancerCase5: ProstatitisCase6: Vascular anomaly

## **GUEE-93 Insights into Urethra: A Diagnostic Approach and Comprehensive Guide to Multimodal Imaging in Urethral Lesions**

### **Awards**

**Cum Laude**

Koichiro Kimura, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Urethral lesions can range from common to rarely encountered in clinical practice. Imaging modality plays a key role in evaluating the variety of urethral conditions because of its high objectivity and utility.This exhibit aims to introduce the multimodal imaging spectrum of urethral lesions, from traumatic change to neoplasms, and demonstrate the diagnostic approach to becoming familiar with urethral lesions.

### **TABLE OF CONTENTS/OUTLINE**

Presentation goals:1. To demonstrate the normal anatomy of the male and female urethra.2. To demonstrate the step-by-step diagnostic approach to the urethral lesions3. To demonstrate multimodality imaging findings of various urethral lesionsIllustrative imaging/cases include: (i) Traumatic and post-treatment changes & 1;Urethral injury, & 1;Urethral foreign body, & 1;Iatrogenic changes (& 1;Radiation therapy induced urethritis, & 1;Changes after transurethral injection therapy, & 1;Operative complications)(ii) Intra- or peri-urethral lesions - Intra-urethra & 1;Urethral stones, & 1;Urethral caruncle, & 1;Fibroepithelial polyp, & 1;Primary urethral carcinoma, & 1;Malignant melanoma, & 1;Lymphoma, & 1;Sarcoma- Peri-urethra & 1;Urethral diverticulum, & 1;Periurethral cyst, & 1;Peyronie's disease, & 1;Leiomyoma, & 1;Tumors arising from urethral diverticulum- Both intra- and peri-urethra & 1;Urethral cellulitis, & 1;Urethral abscess(iii) Non-urethral origin neoplastic lesions & 1;Direct invasion from pelvic and genital tumors, & 1;Metastatic tumors

## **GUEE-94 Standardized, Vesical Imaging Reporting and Data System (VI-RADS) - Compliant, Acquisition and Interpretation of Multiparametric Magnetic Resonance of the Bladder: A**

(Presenter) Nothing to Disclose

**TEACHING POINTS**

1. Bladder multiparametric MRI is the most accurate imaging test for local staging of bladder cancer. 2. The Vesical Imaging Reporting and Data System (VI-RADS) has standardized the acquisition protocol of bladder MRI and created a 5-point scoring system to differentiate muscle invasive from non-muscle invasive bladder cancer. 3. The use of VI-RADS for bladder cancer local staging has shown excellent diagnostic performance and inter-reader reproducibility in multiple studies. 4. High diagnostic accuracy of bladder MRI and VI-RADS is dependent on proper patient preparation and implementation of the imaging protocol. 5. Pitfalls in evaluating bladder MRI can occur and needs to be acknowledged

**TABLE OF CONTENTS/OUTLINE**

MRI of the bladder with the use of VI-RADS is a powerful diagnostic tool for the local assessment of bladder cancer, but it requires the radiologist to implement a specific acquisition protocol and image interpretation standards to achieve optimal diagnostic accuracy and reproducibility. In this educational exhibit we discuss with a practical approach the technical aspects to follow for the correct acquisition of VI-RADS compliant bladder MRI studies. Furthermore, we provide a practical approach to the assessment, scoring, and reporting of bladder lesions according to the VI-RADS scoring system. Also, we provide details on what is beyond VI-RADS 1.0 concerning Pitfalls and Tips and Tricks: details will cover bladder distension and how to handle with it, pitfalls in staging cancers located at ureteral orifices, at folded bladder walls (e.g anterior bladder wall), at diverticula, and after previous tumor resection. To conclude we will provide insights on training and VI-RADS learning curve.

**GUEE-95 Everything a Radiologist Needs to Know About the Diagnosis and Treatment of Renal Angiomyolipomas**

Brendan Ryu, BS (Presenter) Nothing to Disclose

**TEACHING POINTS**

(1) To review the epidemiology, pathophysiology, and genetic associations of renal AMLs. (2) To highlight the clinical presentation and imaging characteristics of renal AMLs. (3) To discuss the utility and efficacy of the various treatment options for renal AMLs.

**TABLE OF CONTENTS/OUTLINE**

Introduction and Associations - Overview- Normal Renal Anatomy and Vasculature - Epidemiology and Pathophysiology of Renal AMLs- Association with Tuberous Sclerosis Complex (TSC) Diagnosis- Clinical Presentation- Incidental Secondary to Complications (bleeding, etc.)- Imaging Modalities- Ultrasound/Doppler- Computed Tomography/Angiography- Magnetic Resonance Imaging/Angiography- Direct Angiography Treatment and Management - Active Surveillance- Criteria for Intervention- Medical Management- mTOR inhibitors- Embolization- Glue- Particles- Coils- Other materials- Ablation- Surgery- Potential Treatment Complications- Bleeding- Non-target embolization- Post-operative collection Post-Treatment Imaging Appearance

**GUEE-96 Pre- and Post-treatment Imaging of Upper Urinary Tract Urothelial Cancer (UTUC): National Comprehensive Cancer Network and European Association of Urology UTUC Guidelines in 2023****Awards****Certificate of Merit**

Hirotsugu Nakai, MD (Presenter) Nothing to Disclose

**TEACHING POINTS**

Upper tract urothelial cancer (UTUC) accounts for 5-10% of UCs. However, 60% of UTUC are invasive at the diagnosis, and multiplicity of disease is common. Therefore, lifelong surveillance is required. Imaging and image-guided biopsy and intervention play an important role in the diagnosis and management of patients with UTUC. CT urography (CTU), MR urography (MRU), and retrograde ureteropyelography with CT or US are used for detection, localization, staging and follow-up of patients with UTUC. FDG PET/CT and chest imaging are useful for staging and re-staging when metastasis is suspected. This is a comprehensive review of the spectrum of clinical and imaging findings of pre- and post-treatment UTUC with illustration of key multimodality imaging findings in representative cases.

**TABLE OF CONTENTS/OUTLINE**

1) Background of UTUC; epidemiology, risk factors, manifestations, pathology, and staging. 2) Review of National Comprehensive Cancer Network (NCCN) and European Association of Urology (EAU) UTUC guidelines, version 2023. 3) Technique and utility of imaging modality including CTU, MRU, retrograde ureteropyelography with CT or US, FDG PET/CT, chest CT and radiography, and image guided biopsy and intervention. 4) Imaging findings of urothelial cancer of the pelvicaliceal systems and ureters before and after treatment. 5) Conditions mimicking UTUC including lymphoma, primary

renal neoplasms, metastasis, sarcoma, fibroepithelial polyp, inverted papilloma, ureteritis, amyloidosis, and suburothelial hemorrhage.6) Summary

## **GUEE-97 A Spectrum of LUT Pathologies in Males: A Pictorial Review**

Maria M. Salazar Osorio, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To explain a general review of the male lower urinary tract (LUT) anatomy through diagrams and multimodal images.- To review the most common pathologies and their diagnosis by multiple imaging techniques.- To discuss through real cases common and not-so-common presentations of the pathologies of male LUT.

### **TABLE OF CONTENTS/OUTLINE**

- Introduction- Anatomy- Imaging techniques- Main indications- Clinical findings and characteristic features of each presentation (congenital anomalies, benign and malignant pathologies of the urethra, bladder, and prostate)- Conclusions

## **GUEE-98 Are We Talking About the Same Thing? How EPE is Scored**

Andre De Freitas Secaf, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Prostate cancer is the second most common cause of cancer-related deaths in men. The first option for treating intermediate and high-risk disease is radiotherapy or radical prostatectomy, however, this choice heavily relies on the presence of extraprostatic extension (EPE). EPE is associated with a higher risk of positive surgical margins, biochemical recurrence, metastatic disease and shorter overall survival. For better surgical planning, the evaluation of EPE using multiparametric magnetic resonance imaging (mpMRI) is essential. There are two major criteria for assessing EPE, through mpMRI, one from National Cancer Institute (NCI) and one from the European Society of Urogenital Radiology (ESUR). The NCI score can be classified as 0- no suspected pathological EPE; 1- curvilinear contact length or capsular irregularity and bulge; 2- curvilinear contact length and capsular irregularity and protuberance; 3- EPE visible on MRI or invasion of adjacent anatomical structures. The ESUR score uses a five-point scale (1 = capsular abutment; 2 = not specified; 3 = capsular irregularity; 4 = neurovascular bundle thickening, bulge, or loss of capsule; 5 = measurable extracapsular disease). We aim to discuss the imaging findings of EPE and how to score them according to the NCI and ESUR criteria, emphasizing their strengths and limitations. These scores should be familiar for any radiologist working in the prostate field, as a more accurate diagnosis of EPE can significantly impact the patient's management and outcomes.

### **TABLE OF CONTENTS/OUTLINE**

Introduction; NCI and ESUR scores; Cases of EPE using both scores; Discussion.

## **GUEE-99 Spectrum of Fat Containing Lesions in the Adrenal Gland: Tips, Tricks and Mimics**

Jorge A. Abreu Gomez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Identify the role of CT and MRI in identification of macroscopic and microscopic fat - including pitfalls, and newer entities including radiomics, histogram analysis, dual-energy decomposition and AI techniques  
2. Describe the common, and uncommon adrenal nodules which present with fat, with an algorithmic approach as to how the type (macroscopic vs microscopic), amount (small vs large), distribution (homogeneous vs heterogeneous), helps arrive at the right diagnosis.

### **TABLE OF CONTENTS/OUTLINE**

- Adrenal nodules can have microscopic (intravoxel) fat or macroscopic (bulk fat), or both. However, they often mimic each other.- What is the role of CT in detection of microscopic fat? Does an attenuation of <10HU always mean microscopic fat? What are the pitfalls of detecting macroscopic fat with CT - increased noise, small ROI? Can histogram analysis improve CT performance? How can dual energy CT improve fat-detection and fat quantification?- What is the role of MRI in detecting microscopic fat? Is MRI only useful when non-contrast CT attenuation is between 10-30HU? Which is better to depict fat - 2D sequences or 3D sequences? How can flip-angles be optimized to improve detection of fat? How are MRI fat quantification methods applicable to focal adrenal lesions?- Amount of bulk fat in adrenal lesions matters - Masses with >50% of bulk fat are myelolipomas; < 50% - can represent myelolipomas or myelolipomatous degeneration which could occur in either an adrenal adenoma or adrenocortical carcinoma.- How to approach diagnosis of lipid poor adenoma with cross sectional imaging.- What are the different patterns of signal loss on out of phase T1w in the diagnosis of adrenal adenoma, when to suspect malignancy?

## Abstract Archives of the RSNA, 2023

GUEE-1

### Zinner Syndrome: A Radiological Journey Through a Little Known Condition

All Day Room: Learning Center

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the embryology and anatomy of the male urogenital system. 2. To describe the radiological findings of typical Zinner syndrome and its variants, through a series of 10 patients from our institution whose images are representative. 3. To perform a differential diagnosis with other pelvis cystic lesions, providing an algorithm that helps us to distinguish them depending on their location and their relationship with adjacent structures, including radiological images belonging to our institution.

#### TABLE OF CONTENTS/OUTLINE

1. Embryology and anatomy of the male urogenital system the role of the mesonephric (Wolffian) duct and the ureteral bud in the formation of the different male urogenital structures. 2. Zinner syndrome: a rare congenital urogenital entity due to an alteration in embryogenesis between 4th and 13th weeks of gestation, characterized by unilateral renal agenesis, cystic dilatation of the ipsilateral seminal vesicle and obstruction of the ejaculatory duct. - Definition. - Pathophysiology. - Clinical manifestations. - Diagnosis: the role of different imaging tests in its diagnosis, specifically pelvic MRI, which is considered the Gold Standard technique due to its excellent soft-tissue resolution. - Treatment. 3. Differential diagnosis with other pelvic cystic lesions (intra- and extraprostatic) according to their location and relationship with neighboring structures. This work is illustrated with representative radiological images of cases belonging to our institution.

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## Abstract Archives of the RSNA, 2023

GUEE-10

### **Thingamajigs, Thingamabobs, and Doohickeys: A Comprehensive Imaging Review of Pelvic Medical Devices**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Amanda C. Gibson, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Given the ever-increasing number of imaging examinations performed and the continuous development and refinement of medical devices, radiologists commonly encounter such devices in clinical practice. 2. Pelvic medical devices may be detected incidentally on imaging examinations or imaging may be performed specifically to evaluate for device complication. 3. Knowledge of device indication and function may provide important clues to patient history that might not otherwise be available at the time of image interpretation. 4. Medical device complications are typically related to infection, malposition, and/or suboptimal device function. 5. A comprehensive knowledge of device indication, function, structure, imaging appearance, and associated complications is necessary to provide accurate and timely assessment of pelvic medical devices.

#### **TABLE OF CONTENTS/OUTLINE**

1. Succinct description of pelvic medical device structure, function, and indications for use in both women and men 2. Illustration of imaging features of pelvic medical devices, including normal findings, imaging artifacts, and device-related complications, across both planar and cross-sectional studies, with emphasis on key findings to report 3. Discussion of MRI safety issues related to pelvic medical devices

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-100

### Feel the Burn: Imaging Infections of the Male and Female Reproductive Tract

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Alexander Kuehne, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Familiarize the radiologist with the spectrum of reproductive tract infections, focusing on some of their more unusual etiologies and presentations.
- Review imaging of male and female reproductive tract infections in case-based format.
- Highlight key imaging features of specific infections, atypical presentations, and common mimics.
- Review imaging characteristics that would help to narrow the differential diagnosis.
- Provide an overview of management and treatment of reproductive tract infections, their sequelae, and complications.

#### TABLE OF CONTENTS/OUTLINE

- Classification of reproductive tract infections: sexually transmitted diseases; endogenous infections; iatrogenic infections.
- Review of infections by anatomic region, particularly unusual infections/presentations: uterus and adnexa; vagina and vulva; prostate and penis; spermatic cord and scrotum; perineum.
- Management of infections, their sequelae, and their complications.

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## Abstract Archives of the RSNA, 2023

GUEE-102

### Imaging of Inferior Vena Cava Wall Invasion in Renal Cell Carcinoma with Tumor Thrombus

All Day Room: Learning Center

Haiyi Wang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Locally advanced renal cell carcinoma with inferior vena cava (IVC) tumor thrombus is one of the most challenging diseases in urology. T3c disease is diagnosed when a tumor thrombus invades the IVC wall. The presence or absence of IVC wall invasion has a significant impact on the selection of surgical protocols, which include IVC incision thrombectomy, IVC segmental resection, and IVC resection. Higher morbidity and mortality rates occur when a tumor thrombus invades the IVC wall. Tumor thrombus invading the IVC wall is associated with poor postoperative survival. The purposes of this exhibit are: 1) Discuss the role of IVC wall invasion in the surgical treatment of renal cell carcinoma and tumor thrombus. 2) Clarify significant image findings of IVC wall invasion. 3) Illustrate meaningful information and pitfalls of diagnosing IVC wall invasion in radiology reports.

#### TABLE OF CONTENTS/OUTLINE

1) Overview of anatomy and physiology of the inferior vena cava system. 2) Introduction of the mechanism of IVC tumor thrombosis formation in renal cell carcinoma. 3) Describe surgical management of different types of tumor thrombectomy: a. IVC incision thrombectomy; b. IVC segmental resection; c. IVC resection. 4) Imaging methods selection: a. contrast-enhanced ultrasound (CEUS); b. CT; c. MRI. 5) Imaging findings of IVC wall invasion in case-based imaging. 6) Illustrate key signs and pitfalls in diagnosing IVC wall invasion. 7). Build a scoring system: inferior vena cava wall invasion likelihood scores (IVC WAILS). 8) Consolidate the acquired knowledge: Review preoperative imaging findings of IVC invasion that aid in surgical decisions. 9) Conclusions.

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## Abstract Archives of the RSNA, 2023

GUEE-103

### Spectrum of Male and Female Urethral and Periurethral Pathologies at Imaging

All Day Room: Learning Center

Nikolas Brozovich, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Role of imaging in the evaluation of the urethra. 2) Review of relevant male and female urethral anatomy. 3) Recognize a variety of urological conditions in males and females at imaging.

#### TABLE OF CONTENTS/OUTLINE

Conventional imaging studies such as retrograde urethrography (RUG), voiding cystourethrography (VCUG), and Ultrasonography (US) are limited in the evaluation of the periurethral tissues. MR imaging serves as an important noninvasive imaging modality that can provide anatomic detail of the urethra and periurethral tissue due to excellent tissue contrast and multiplanar capability. 1) Detailed male and female urethral and periurethral anatomy. 2) MR technique for urethral evaluation. 3) Female urethral pathology including urethral diverticulum and associated pathology, urethral leiomyoma, periurethral/paravaginal cysts, bulking agents, urethral prolapse, periurethral hemangioma, and neoplasms. 4) Male urethral pathology including urethral calculi, Peyronie's disease, artificial sphincter, infection, and neoplasms.

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## Abstract Archives of the RSNA, 2023

GUEE-104

### **Radiologic Feature of Complications after Artificial Urinary Sphincter Implantation Following Total Prostatectomy**

All Day Room: Learning Center

Shioto Oda, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Artificial urinary sphincter (AUS) is an implanted device used for the treatment of urinary incontinence, commonly following prostatectomy. Despite increasing reports of device failure and postoperative complications, comprehensive reports on imaging have yet to be compiled. When complications occur after AUS surgery, entire device replacement may be necessary, which can be burdensome for the patient. However, with precise identification of the malfunctioning part, partial replacement has been possible in some cases. This presentation will exhibit imaging findings of malfunction and postoperative complications after AUS implantation at our hospital, together with anatomical findings, to contribute towards appropriate device management. The purpose of this exhibit is: 1) To provide a comprehensive review of the normal appearance of AUS, along with an analysis of the parts that are commonly associated with complications 2) To exhibit the various complications related to device failure and surgery on a case-by-case basis.

#### **TABLE OF CONTENTS/OUTLINE**

1) Normal Appearance of AUS 2) Malfunction of AUS 2.1) Circuit Leakage 2.2) Pump Malfunction 3) Complications Directly Related to the Procedure 3.1) Urinary Injury During Replacement of AUS 3.2) Hematomas and Infections Occurring in the Subacute Period

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## Abstract Archives of the RSNA, 2023

GUEE-11

### Imaging of upper urinary tract neoplasms

All Day Room: Learning Center

Kyungmin Kim, BMBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Neoplasms of the upper urinary tract can be investigated with different imaging modalities such as CT, MRI and ultrasound. In certain cases, nuclear medicine studies, such as PET-CT or DMSA can aid with detection of occult bone metastasis or determining the best treatment option. The traditional CT protocol for visualizing renal parenchymal abnormalities is a triple phase study. Alternatively, a split bolus urography protocol also provides good visualization of the renal parenchyma and the collecting systems with a reduced radiation dose. Renal cell carcinoma (RCC) is the most common type of upper urinary tract neoplasm with a wide range of phenotypes from homogeneous solid mass to heterogeneous multi-cystic or necrotic lesions. Differentiating between benign and malignant renal neoplasms can be challenging and histopathological evaluation may be required to confirm the diagnosis. A wide range of conditions ranging from developmental, infectious, granulomatous and vascular causes can mimic upper urinary tract neoplasms.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Imaging modalities for investigation of upper tract neoplasms  
2.1 CT  
2.2 MRI  
2.3 Ultrasound  
2.3.1 Contrast enhanced ultrasound  
2.4 Nuclear medicine  
3. Imaging features of upper tract neoplasms  
3.1 Malignant  
3.1.1 RCC  
3.1.2 TCC  
3.1.3 Lymphoma  
3.1.4 Wilm's tumor  
3.1.5 Miscellaneous  
3.2 Benign  
3.2.1 Oncocytoma  
3.2.2 Angiomyolipoma  
4. Upper urinary tract pseudotumors  
4.1 Developmental  
4.2 Infectious  
4.3 Granulomatous  
4.4 Vascular  
4.5 Miscellaneous  
5. Summary

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## Abstract Archives of the RSNA, 2023

GUEE-12

### **Not Only Prostate Adenocarcinoma is Present in the Interpretation of Multiparametric Prostate MRI**

All Day Room: Learning Center

Alfonso Iglesias, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Knowledge of normal anatomic structures and physiological changes that may simulate prostate adenocarcinoma in prostate multiparametric magnetic resonance imaging (mpMRI) Clinical presentation MRI characteristics with pathological correlation can help us to accurately characterize benign and malignant diseases, that can mimic prostate adenocarcinoma in mpMRI resulting in appropriate patient management.

#### **TABLE OF CONTENTS/OUTLINE**

Review and identify normal prostatic anatomic structures that can affect mpMRI interpretation because may simulate prostate adenocarcinoma: hypertrophic anterior fibromuscular stroma, asymmetrical and focal thickening of the surgical capsule, congested appearance of periprostatic vascular plexus normal Review the clinical manifestations and mpMRI characteristics with pathological correlation of prostatic and periprostatic benign process: congenital anomalies (Zinner's syndrome), prostatic abscess, infective or inflammatory prostatitis (bacterial, granulomatous, IgG4-related disease), prostatic hemorrhage, ectopic stromal benign prostatic hyperplasia nodule, periprostatic lymph nodes, osteochondroma of the pubic symphysis, neoplasms with unpredictable clinical course (stromal neoplasm of uncertain malignant potential), direct neoplastic invasion of malignant tumors in adjacent organs (diffuse large B-cell lymphoma of the rectum), that can mimic prostate adenocarcinoma in mpMRI

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## Abstract Archives of the RSNA, 2023

GUEE-13

### **MRI-Based VI-RADS for Bladder Cancer: Enhancing Accuracy and Consistency in Reporting**

All Day Room: Learning Center

Sina Houshmand, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review imaging findings of bladder cancer with emphasis on the importance of differentiation between muscle-invasive and non-muscle invasive disease and impact of imaging on clinical management. 2. Review technical aspects of multiparametric MRI for bladder cancer. 3. A pictorial review and step-by-step tutorial on Vesical Imaging-Reporting and Data System (VI-RADS).

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to bladder cancer. a. Types and relevant pathology. b. Diagnosis, staging, treatment. c. Role of imaging in clinical management. d. Imaging of bladder cancer. 2. VI-RADS. a. Definitions and categories. b. MRI scoring. c. Examples. 3. Technical aspects. a. Patient preparation. b. MR protocol. 4. Pitfalls and mimics. 5. Case review

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## Abstract Archives of the RSNA, 2023

GUEE-14

### Male Pelvic Floor: Anatomical Particularities and Dysfunctions

All Day Room: Learning Center

Ana Claudia V. Uski SR, MD,MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review some aspects of normal anatomy that are relevant in the context of male pelvic floor dysfunction. To demonstrate the differences between the male and female pelvic floor by comparing the reference values provided. To identify changes in male pelvic floor structures during micturition and defecation. To review the examination protocols for functional assessment. To systematize the evaluation of male pelvic floor dysfunctions with clinical cases and flowcharts.

#### TABLE OF CONTENTS/OUTLINE

The male pelvic floor has specific anatomical differences and pathophysiological peculiarities. The most important risk factors for its dysfunction include surgical procedures and radiotherapy. Pelvic floor dysfunctions can be grouped into three major categories (gastrointestinal, urinary, and sexual dysfunctions) and the best modality for this evaluation is dedicated magnetic resonance imaging (MRI). There is a paucity of literature related to imaging evaluation of the male pelvic floor. Typical markers used refer to the pubococcygeal line (PCL), the H line, the M line, and anorectal angle. Specific markers include the puboprostatic angle and the prostatic-urethral angle. Radiologists should recognize these particularities, the potential risk factors leading to these dysfunctions, and which landmarks are used in functional assessment.

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## Abstract Archives of the RSNA, 2023

GUEE-15

### **No Need to Go Nuts: Simplified Testicular Neoplasms Sonographic Analysis**

All Day Room: Learning Center

Fabio Yoshimura (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: To review the scrotum and adjacent structures anatomy in ultrasound; To emphasize the importance of adequate sonographic technique evaluation; To review most common testicular neoplasms; To present a metastasis case, a rare entity; To show ultrasound features of these neoplasms.

#### **TABLE OF CONTENTS/OUTLINE**

1. To review the scrotum anatomy in ultrasound: Testicles; Ductus deferens; Pampiniform plexus; Epididymis; Tunica vaginalis; Tunica albuginea. 2. Examination technique in ultrasound; 3. Illustrated teaching cases from our department showing the main testicular neoplasms: - Seminoma- Non-seminomatous germ cell tumors- Testicular lymphoma- Metastases to testis

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## Abstract Archives of the RSNA, 2023

GUEE-16

### Don't Forget the Female Urethra: An Approach for Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Julia M. Saidman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The female urethra can be adequately studied by static or/otr dynamic imaging methods. The spectrum of pathologies is wide, from the complexity of finding direct signs in a urethral diverticulum to the challenge of providing the necessary information for an adequate treatment of solid masses of undetermined origin. In recent years, the use of minimally invasive surgical techniques for the urinary incontinence/pelvic prolapse approach has raised the need to be familiar with the radiological features pre and post treatment for proper patient counseling.

#### TABLE OF CONTENTS/OUTLINE

-Review of the anatomy of the female urethra-Imaging methods-acquisition protocols  
Ultrasound (focused on static technique)  
Magnetic Resonance  
Voiding Cystourethrography  
Retrograde double-balloon positive-pressure urethrography-  
Pathology of the female urethra  
Malformaciones  
Cystic pathology: diverticulum versus urethral cyst  
Solid pathology  
Benign: abscess; myoma  
Malignant: Primary: urothelial carcinoma, squamous cell carcinoma, adenocarcinoma, Aggressive  
angiomyxoma  
Secondary: contiguous invasion versus metastatic lesions  
Pre-posttreatment imaging in minimally invasive surgical techniques for stress-mixed urinary incontinence (synthetic midurethral slings and bulking agents)-  
Differential diagnosis of urethral cystic from periurethral cystic pathologies-  
Conclusions

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## Abstract Archives of the RSNA, 2023

GUEE-17

### **Predominantly Non-Cystic Multiple Focal Renal Lesions: An Imaging Approach**

All Day Room: Learning Center

Mario G. Santamarina, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review causes of predominantly non-cystic multiple focal renal lesions. 2. To discuss imaging findings of the different entities. 3. To provide imaging-based clues useful to focus and to guide to the correct diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

The presence of multiple focal renal lesions may be an isolated or dominant imaging finding as well as an additional abnormality in the setting of multiorgan involvement. An imaging-based approach may be crucial in the differential diagnosis process as well as in patient management. Knowledge of the imaging appearance of the various causes and integration with other findings may result in a correct diagnosis in most cases as well as in assisting in proper patient work-up and management. Table of Contents: I- Overview; II- Main causes of multiple focal renal lesions 1. Infectious, 2. Inflammatory, 3. Vascular, 4. Related to neoplasm (main hereditary renal cancer syndromes, renal metastases, lymphoproliferative disorders, renal oncocytosis).; III- Summary.

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## Abstract Archives of the RSNA, 2023

GUEE-18

### Medical Devices in the Pelvis: The Good, the Bad, and the Ugly

All Day Room: Learning Center

Jennifer A. Clark, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understand that a variety of devices may reside in the pelvis. 2. Recognize the multimodality imaging features of different devices to include expected location and malposition/migration and their potential associated complications. 3. Emphasize the importance of detecting malpositioned/migrated devices to facilitate treatment.

#### TABLE OF CONTENTS/OUTLINE

Medical Devices divided by biological sex where applicable. o Biological Female: § Intrauterine Device • Hormonal (e.g., Mirena) • Non-hormonal (e.g., Copper, Lippes Loop) • Sterilization Device (e.g., Essure) o Biological Male: § Penile Prosthesis o Devices found in both sexes: § Artificial Urinary Sphincter § Suprapubic Catheter and Foley Catheter § Ureteral Stents § Pessary § Peritoneal Dialysis Catheter 1. The following will be discussed for the devices where applicable: a. Indication b. Types c. Multimodality imaging features of the device in its expected position. d. Multimodality imaging features of the device in an abnormal position. e. Complications from malposition or migration of the device f. Treatment 2. Highlight the importance of familiarity with the multimodality imaging features of the wide variety of medical devices in the pelvis so that a malpositioned or migrated device can be easily recognized and brought to the attention of the referring physician to facilitate the patient receiving treatment.

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## Abstract Archives of the RSNA, 2023

GUEE-19

### Revisiting Voiding Cystourethrography (VCUG) and Retrograde Urethrogram (RUG).

All Day Room: Learning Center

Gabriela Lumar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Voiding cystourethrography (VCUG) and retrograde urethrogram (RUG) are fluoroscopic classic examinations performed by radiologist even in the present days, despite becoming increasingly scarce, still has its diagnostic value. Iodine contrast and x-ray equipment are required to perform the exam. Indications may vary according to venter, age, and clinical history. The findings can be divided between congenital and acquired at bladder and urethral lesions. VCUG and RUG are complementary tests to urethroscopy, as they can detect pathologies that were not previously visible. Other exams can offer adjunct informations, such as sonography and MRI, but this can provide unique diagnoses or inspire the development of new professionals or new techniques such as urethral resonance.

#### TABLE OF CONTENTS/OUTLINE

This pictorial study aims to review, describe and illustrate the examination and findings of RUG and VCUG in male and female patients that cannot go unnoticed in our reports. We have selected images of cases from our service that may raise suspicion or confirm the disease. We separate the cases according to anatomy and gender. The pathologies we will explore are divided into bladder, urethra findings, as well as prostate-related.. Quick and correct diagnosis can be crucial for the treatment of our patients.

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## Abstract Archives of the RSNA, 2023

GUEE-2

### Dose Reduction Strategies in CTKUB for Urolithiasis

All Day Room: Learning Center

Sung Bin Park, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. It is critical for radiologists to understand CTKUB dose reduction strategies and successfully optimize protocols that produce high image quality with minimal dosage. 2. Familiarity with the practical approach in CTKUB will both decrease radiation dose and optimize imaging quality for the specific clinical indication.

#### TABLE OF CONTENTS/OUTLINE

The purpose of this exhibit is: 1. To discuss the relationship between radiation dose and image quality 2. To assess radiation dose reduction strategy with preserving image quality in CTKUB. Introduction- Radiation exposure and CT- Urolithiasis and CTKUB: Low dose and ultralow dose CT- ALARA principle "As Low As Reasonably Achievable" Optimization for Scans Reconstruction Parameters - CT radiation dose Estimate- CT radiation dose affecting factors- Control Z-Axis: Scan Range - Lower mAs- Lowering kVp- kVp mAs Settings- Automatic Tube Current Modulation (ATCM)- Noise Reduction Technique including deep learning-based image reconstruction Practical Approach: Decreased radiation dose and improved image quality- Dose justification: Risk vs. Benefit - ALARA (As Low As Reasonably Achievable) principle- Optimization for Scans Reconstruction Parameters - Dose Management: Monitoring, Radiation tracking- Educating requesting physicians and CT technicians

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## Abstract Archives of the RSNA, 2023

GUEE-20

### Decoding the cCLs Score: A Game-Changer in the Diagnosis and Management of Renal Masses

All Day Room: Learning Center

Daniella B. Parente, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the classification and epidemiology of the most common upper urinary tract neoplasms. Understand the importance of cCLs score in the management of incidental renal lesions. Explore nephrometry as a tool for assessing the surgical complexity of renal masses.

#### TABLE OF CONTENTS/OUTLINE

I. INTRODUCTION - Overview of upper urinary tract neoplasms and their epidemiology II. IMAGING TECHNIQUE - Overview of imaging modalities for renal mass detection and characterization - Best practices for imaging protocol III. IMAGING INTERPRETATION - Typical imaging features of common renal tumors - Explanation of cCLs score and its significance in the diagnosis of renal masses - Overview of nephrometry score and its role in assessing surgical complexity - Importance of CT and MRI in staging renal masses - Utilization of structured reports IV. QUICK REVIEW OF TREATMENT OPTIONS Overview of different treatment modalities for renal masses Pros and cons of each treatment option V. INTERACTIVE CASE-BASED DIDACTICS - Presentation of illustrative cases demonstrating the utility of cCLs score in diagnosis and management of renal masses

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## Abstract Archives of the RSNA, 2023

GUEE-21

### Imaging of Upper Tract Urothelial Neoplasms: Pearls and Pitfalls

All Day Room: Learning Center

Claire Brookmeyer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the staging of upper urinary tract urothelial carcinoma (UTUC) which is critical for treatment decisions and surgical planning. Discuss the role of different imaging exams in the diagnosis of UTUC with a focus on CT and MR urogram protocols. Provide an evidence-based approach to critical T-staging. Highlight nuances in staging unique to UTUCs. Identify important pitfalls in the diagnosis of UTUC including benign neoplastic, infectious, and inflammatory etiologies.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Epidemiology, prevalence, risk factors, Clinical presentation, TNM Staging. Exam protocols Value of multi-phasic exams, CT urogram dose reduction techniques including split bolus and virtual non-contrast, MR urogram. Staging: Tumor location: renal calyx or pelvis, ureter. Multifocality, Evidence based approach to critical T-staging T2 vs T3: ureteral border analysis, Hydronephrosis severity, Evaluation of contralateral urinary tract and bladder, Role of renal function evaluation, Nodal disease and distant metastases, Critical findings for treatment decision making and surgical planning. Pitfalls: Endometriosis, Infection, Malakoplakia. Post-treatment Surveillance imaging: Post-surgical appearance, Local recurrence, Risk of metachronous UTUC in contralateral urinary tract or bladder. Conclusion.

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## Abstract Archives of the RSNA, 2023

GUEE-22

### Go with the Flow: Imaging of Urinary Tract Augments, Reconstructions, and Non-Cystectomy Diversions in Adult Patients

All Day Room: Learning Center

Ryan D. Clayton, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- A variety of surgical techniques are utilized to augment, reconstruct or reroute the urine stream and these procedures often utilize other segments of the GU or GI tract
- Findings from these procedures may be found on imaging studies during routine practice. Surgical records may not be available for many adult patients, especially for those with remote procedures performed in childhood
- Postsurgical anatomy must be appropriately recognized for accurate diagnoses
- Radiologists should be aware of surgical techniques and potential alterations made to the GU and GI tracts to help recognize expected postoperative anatomy, to facilitate greater diagnostic accuracy of postoperative complications, and avoid potential pitfalls

#### TABLE OF CONTENTS/OUTLINE

- Review indications for bladder augments, reconstructions and non-cystectomy urinary diversions
- Describe common surgical procedures performed for bladder augmentation, ureteral reconstructions and non-cystectomy diversions, including continent and non-continent diversions- Bladder augments: gastrocystoplasty, ileocystoplasty, sigmoid cystoplasty- Reconstructions: psoas hitch, Boari flap, ileal interposition, uretero-ureterostomy, ureteroneocystectomy- Diversions: ileovesicostomy, appendicovesicostomy, Monti procedure
- Discuss appropriate imaging techniques and radiologic evaluation, including how to recognize the postoperative anatomy and expected findings
- Describe the imaging findings of postoperative complications including leak, fistula, abscess, mucus formation, stones, GU and GI obstruction

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## Abstract Archives of the RSNA, 2023

GUEE-23

### Periprostatic Anatomy: An Illustrated Review and Implications for Treatment Planning

All Day Room: Learning Center

Jason C. Chandrapal (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Identify clinically relevant normal anatomy of periprostatic structures with imaging (MRI, CT, and angiography) correlation
2. Recognize periprostatic anatomic variations and implications to treatment planning

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline 1. Introduction 2. Prostatic pseudocapsule -Discussion of periprostatic fascial anatomy and composition -Implications for prostate cancer (PCa) staging and treatment -Preoperative MRI criteria for the diagnosis of extraprostatic PCa extension 3. Neurovascular Bundle -Normal anatomy with surgical correlation -Imaging identification and implications on prostate biopsy, PCa surgical and image-guided focal treatment planning. 4. Rectoprostatic space and Denonvilliers' Fascia -Discussion of rectoprostatic space and fascial anatomy with surgical correlation -Implication on PCa local dissemination in the pelvis -Hydrogel spacer placement for rectal wall protection during radiation therapy - normal and abnormal gel distribution 5. Membranous Urethra and External Urethral Sphincter -Normal membranous urethra and external urethral sphincter anatomy -Relationship to incontinence prediction post prostatectomy? -Imaging identification of external sphincter and relevance for eligibility and planning of image-guided focal treatment 6. Vascular anatomy -Normal anatomy and common variants -Importance for prostatic embolization procedures in the treatment of benign prostatic hyperplasia

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-24

### Renal and Upper Urinary Tract Tumors: How to Effectively Report and Impact Surgical Management

All Day Room: Learning Center

Monick T. Nakayama, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Upper urinary tract masses (UTMs) have been increasingly detected by imaging cross-sectional techniques, either as an incidental finding or in the context of a specific investigation, leading to the discovery of renal tumors of smaller dimensions, for whom adequate characterization is mandatory. Correct assignments of malignant and potential benign UTMs are imperative to avoid unnecessary surgical procedures and even biopsies. Nonetheless, the number of benign masses that are surgically approached is still high and prediction of the risk of malignancy is challenging. For UTMs, the lack of well-established scores or specific signs makes imaging evaluation even more difficult but essential for therapeutic definition, and reporting key imaging findings with aggressive lesions is crucial.

#### TABLE OF CONTENTS/OUTLINE

Introduction  
Illustrative summary of the anatomy and histology of the kidney and upper urinary tract and histological origin of UTMs  
Summary of the main image findings in malignant tumors with pathological correlation, including:  
Tumors of the renal parenchyma  
Tumors of the collecting system and ureters  
Lymphoproliferative disorders  
Metastases  
Overview of main benign tumors and their essential imaging findings  
Tricks in upper urinary tract imaging including pseudotumoral lesions  
How to report the imaging findings for helping in surgical planning  
Conclusion

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

GUEE-25

### Above and Beyond the Imaging Features of Urolithiasis: What the Radiologist Needs to Know

All Day Room: Learning Center

Juan Francisco F. Santoscoy Gutierrez JR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

a) Review the pathophysiology of kidney stone formation, types of calculi and clinical presentation. b) Discuss the general evaluation of urolithiasis with emphasis on the characteristic imaging features of different urinary calculi and specific imaging findings focusing on the clinically relevant information that can affect management by the urologist. c) Describe the standard of care of nephrolithiasis focusing on the current non-invasive options, minimally invasive options and invasive options performed by the urology surgeon. d) List the anticipated post-treatment follow-up, complications and prognosis of urolithiasis.

#### TABLE OF CONTENTS/OUTLINE

I. General overview: epidemiology, pathophysiology, clinical presentation  
II. Evaluation and management: a) General laboratory work and urinary tests b) Imaging and clinically relevant reporting: non-contrast CT, CT urography, dual energy CT, ultrasonography, radiography, MRI  
III. Treatment: a) Non-invasive options: observation, medical expulsion therapy, oral medication for dissolution b) Minimally invasive options: extracorporeal shockwave lithotripsy, ureteroscopy, percutaneous nephrolithotomy c) Invasive options: laparoscopy and open surgery  
IV. Post-treatment follow-up, complications and prognosis

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## Abstract Archives of the RSNA, 2023

GUEE-26

### **Hematuria Beyond Infection, Stones and Cancer: An Imaging and Evaluation Guide of Unusual Cases**

All Day Room: Learning Center

Eduardo B. Zukovski, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- It is essential that radiologists know how to investigate hematuria, indications and limitations of each imaging option and recommendations for follow-up;
- All the examination protocols should be adapted to the patient while optimizing radiation dose;
- CT urography performs better than conventional radiography, ultrasound and intravenous urography in the detection of renal parenchymal masses and urinary tract calculi;
- Patients are now categorized into risk categories according to their clinical presentation and risk factors, and the workup is adapted to that category;

#### **TABLE OF CONTENTS/OUTLINE**

Hematuria is one of the most common urologic diagnoses, estimate to account for over 20% of urology evaluations; It is defined as the presence of three or more red blood cells per high-powered field in two of three properly collected urinalysis specimens; It can be classified as gross hematuria or microhematuria; The differential diagnosis encompasses a wide range of conditions and the risk of detecting an underlying cancer has been found to be highly dependent on which risk factors are present; More common causes of hematuria include urinary tract infection, urolithiasis, trauma, renal parenchymal disease, and malignancy;

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## Abstract Archives of the RSNA, 2023

GUEE-27

### Insights into Renal Cell Carcinoma with Novel Imaging Approaches

All Day Room: Learning Center

Khoschy Schawkat, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

· The updated Bosniak Classification, version 2019, predicts the likelihood of malignancy in cystic renal masses, with improved specificity of the higher risk categories, thereby expanding the number of masses that can be monitored.· In the clear cell likelihood score (ccLS), version 2.0, multiparametric MRI features of small renal masses without macroscopic fat are sequentially analyzed to determine the likelihood of clear cell renal cell carcinoma.· Contrast-enhanced ultrasound and dual energy CT are useful in identification and characterization of solid and cystic renal masses.· Several radiopharmaceuticals may contribute to the characterization of renal masses, such as 99m-technetium sestamibi, radiolabeled girentuximab and 68Ga-prostate-specific membrane antigen.· In the future, RCC may be diagnosed, managed, and treated more effectively using radiomics and artificial intelligence (AI).

#### TABLE OF CONTENTS/OUTLINE

1) New Imaging Algorithms Using Established Imaging Techniques (Bosniak classification, version 2019, and clear cell likelihood score version 2.0). 2) Novel Modalities (Contrast-enhanced ultrasound, dual energy CT, and molecular imaging including Sestamibi, Girentuximab, and PSMA). 3) Radiomic and artificial intelligence.

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## Abstract Archives of the RSNA, 2023

GUEE-28

### Penile MRI: A Multi-institutional Case-based Review of Anatomy, Spectrum of Pathologies and Prosthetic Complications

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Harit Kapoor, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Penile MRI provides invaluable clinical information in a wide array of pathologies. However, given the infrequent use, contemporary radiology residency and fellowship training provides insufficient exposure to penile MRI. 2) After reviewing this presentation, the learner will be able to: a. Understand normal penile anatomy including prosthetic anatomy; b. Describe indications for penile MRI and key aspects for image acquisition; c. Diagnose various penile pathologies based on characteristic imaging findings; d. Understand the basis for differences in management and tenets of surgical planning for various disease entities; e. Describe indications for penile prosthesis implantation and diagnose common implant complications.

#### TABLE OF CONTENTS/OUTLINE

1) Overview of penile MRI technique, indications, and normal anatomy. 2) Tabulated summary of various penile diseases with classic MRI appearances. 3) Case examples (with differentials, pearls and pitfalls) including but not limited to: (i) Penile trauma (contusion, fractures); (ii) Corrected anomalous genitalia; (iii) Cowper's gland pathology (retention cysts and syringocele); (iv) Penile malignancy (primary staging, post-penectomy recurrence, metastases); (v) Penile implant complications (malpositioning, infection and erosion/extrusion); (vi) Priapism (types, post-treatment imaging); (vii) Periurethral and perineal sepsis.

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## Abstract Archives of the RSNA, 2023

GUEE-29

### Upper Tract Urothelial Neoplasms and Mimics

All Day Room: Learning Center

Murray Di Loreto, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the methods and techniques for the optimal evaluation of the urothelium.
- Identify role of imaging in diagnosis and staging of upper tract urothelial cancer.
- Identify imaging features with radiology-pathology correlation of lesions involving the urothelium in a quiz-based format.

#### TABLE OF CONTENTS/OUTLINE

- Is there still a role of conventional urography? Which is better - retrograde urography? antegrade urography? intravenous pyelourography?
- CT urography - what is the ideal urothelial phase? should arterial phase be included ? split-bolus technique vs dedicated delayed phase?
- When is MR urography preferred over CT urography- improvements in MR sequences (including compressed sensing, k-space undersampling, parallel imaging and AI). Is Lasix injection needed? Prone vs supine patient positioning? Wide vs narrow FOV how to optimize? Are cine-T2 images useful? T2 based or gadolinium based ? Pitfalls, artifacts simulating urothelial disease will be discussed (especially pertaining to MR urography) and solutions will be presented (flow voids on T2? T1\* effects due to concentrated gadolinium).
- What is multiparametric MR Urography - what are the various components of multiparametric MR urography, and how does it improve diagnosis? What is the literature evidence for multiparametric MR urography?
- How does imaging help in diagnosis and staging of upper tract urothelial neoplasms? What are the key findings impacting management of upper tract urothelial neoplasms?
- Approach towards differential diagnosis of these lesions (including common, uncommon and rare mimics) with tips and tricks and imaging pearls as to when to suspect a diagnosis other than UCC, and optimal follow-up/referral strategy.

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## Abstract Archives of the RSNA, 2023

GUEE-3

### Lost Without Bosniak: Overcoming the Challenges of Non-Classifiable Renal Cystic Masses

All Day Room: Learning Center

Jhonata Soares Da Silva (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

A comprehensive review of situations where the Bosniak classification for renal cystic masses is not applicable, emphasizing the importance of being aware of these contexts and how to manage cases where the classification is not useful. Challenging Cases: The exhibition will showcase various challenging cases of renal cystic masses where the Bosniak classification may not be applied. These cases will test participants' knowledge and critical thinking.

#### TABLE OF CONTENTS/OUTLINE

Overview of cystic renal lesions in daily practice and the importance of differential diagnoses. Brief mention of the Bosniak classification system and its limitations. Situations where the Bosniak Classification is not applicable, such as inflammatory/infectious conditions, vascular diseases, calyceal diverticula, polycystic kidney disease, Birt-Hogg-Dubé, Von Hippel-Lindau, Tuberous Sclerosis, pelvic cysts, and cystic metastasis are all conditions that can mimic renal cystic masses and are not included in the Bosniak classification system. In this section, we will review each of these conditions, their presentation, and management. Case-based review of concepts and tips: Practical tips and case-based reviews of concepts to help manage renal cystic masses that cannot be classified by the Bosniak system. Helping assistant doctors for better outcomes: discussion of how to assist and guide assistant doctors in managing challenging cases of renal cystic masses. Key take-home messages: summary of the important points discussed during the presentation, with practical advice on how to incorporate the acquired knowledge into clinical practice.

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## Abstract Archives of the RSNA, 2023

GUEE-30

### Imaging and Interventional Management in Different Conditions Underlying Renovascular Hypertension

All Day Room: Learning Center

Eric Castane, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the imaging study of the arterial renal system both in normal and in renal artery stenosis. 2. Describe the vascular radiology management of the renovascular hypertension.

#### TABLE OF CONTENTS/OUTLINE

1. Material and methods / Background. 2. Arterial hypertension and renovascular hypertension: definitions and clinical features. 3. Imaging study of the renal arteries: normal, anatomic variants and pathological findings. 3.1. US assessment (evaluation points, technique, signs). 3.2. CT. 3.3. MRI. 3.4. Angiography. 3.5. Algorithmic approach to renal artery stenosis. 4. Interventional radiology management: therapeutic options and post procedure imaging criteria. 5. RAS: etiologies pictorial review (atherosclerosis, fibromuscular dysplasia, vasculitis, others). 6. RAS after renal transplantation (diagnosis and interventions). 7. Conclusions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-31

### Imaging of the Urachus

All Day Room: Learning Center

Maria Zulfiqar, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: 1. Illustrate normal urachal anatomy on imaging and discuss urachal embryogenesis. 2. Provide case-based review of the imaging features of various urachal non-neoplastic and neoplastic entities.

#### TABLE OF CONTENTS/OUTLINE

Embryogenesis: Urachus is an embryonic ductal remnant of the allantois and cloaca extending from the bladder dome to the umbilicus. Imaging modalities: US is usually the imaging modality of choice, especially in the pediatric population. CT and MR carry higher temporal and spatial resolution with added benefit of staging malignancy when present.

- Congenital: Patent urachus (urachal fistula); Umbilical-urachal sinus tract; Vesicourachal diverticulum; Urachal cyst
- Infections/inflammation: Urachal stone/calcification; abscess.
- Urachal neoplasms: Benign Adenoma; Cystadenoma, fibroma. Malignant Mucinous adenocarcinoma; Nonmucinous adenocarcinoma; Urothelial; Squamous; Sarcomatoid; Metastatic.
- Non-neoplastic masses: Endometriosis; Hemorrhage.

Summary Urachal pathology is often discovered incidentally on imaging and presents with nonspecific urinary symptoms. Early detection of urachal pathology and identification of complications such as infection and malignancy are imperative to prevent significant patient morbidity.

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## Abstract Archives of the RSNA, 2023

GUEE-32

### Testicular Cancer: What the Radiologist Needs to Know

All Day Room: Learning Center

Ingrid Alonso Ramon, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review the general characteristics of testicular cancer including the different types and their incidence. To describe the different features of multimodality imaging (ultrasound, CT, PET/CT) including the expected findings depending on histologic type and their utility of each in TNMS. Recognize the importance of diagnosis, treatment and follow-up.

#### TABLE OF CONTENTS/OUTLINE

Description of the general characteristics of testicular cancers including (a) embryology (b) incidence (c) detailed pathologic features. d) Clinical presentation To review of multimodality imaging findings including expected findings. To establish the usefulness of the different imaging methods for diagnosis, follow-up, complications and stratification of each one. To Discuss clinical scenarios to establish the best course of action.

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## Abstract Archives of the RSNA, 2023

GUEE-33

### **Penile Ultrasound: An Updated Pictorial Review for Residents**

All Day Room: Learning Center

Hugo E. Velazquez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To illustrate the anatomical structures of the penis by sonography. -To determine the protocol used at our center. -To show the main indications for penile Doppler ultrasound with and without vasoactive drug. -To list the normal parameters in the Doppler evaluation and their pathological correlation. -To review the main sonographic findings in different conditions.

#### **TABLE OF CONTENTS/OUTLINE**

1. A pictorial review of the anatomy of the penis structures by ultrasound. 2. Penis ultrasound protocol and technical parameters. 3. Indications and use of vasoactive drug. 4. Examples of different conditions with sonographic findings.

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## Abstract Archives of the RSNA, 2023

GUEE-34

### Contrast-Enhanced Ultrasound (CEUS): Vascular Applications from the Kidneys to the Bladder

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Saubhagya Srivastava, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. CEUS is a very useful imaging modality in patients with poor renal function due to the non-nephrotoxic nature of the ultrasound contrast agents. 2. In the kidneys, CEUS is accurate in characterizing indeterminate lesions, characterizing complex cysts according to the Bosniak criteria, differentiating solid renal tumors from pseudotumors, identifying renal infarction, abscesses, and for the follow-up of non-surgical renal lesions. 3. CEUS is also used in renal transplant patients to look for masses, cysts, and other vascular problems. 4. In the bladder, CEUS is excellent in differentiating bladder cancer from benign pathologies such as a hematoma in patients with hematuria. It also aids in differentiating non-muscle invasive bladder cancers (NMIBC) from muscle-invasive bladder cancers (MIBCs), thereby guiding appropriate management. 5. CEUS can also detect primary tumors of the ureter or tumors extending from the bladder into the ureter by means of enhancement patterns.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of vascular applications of CEUS in the urinary system. 2. The technique of performing CEUS. 3. Microbubbles as non-nephrotoxic blood pool contrast agents. 4. Renal applications of CEUS. i. Renal infarction ii. Renal abscess iii. Characterization of cystic renal masses iv. Solid renal tumors vs pseudotumors v. Angiomyolipoma vs renal cell carcinoma 5. Renal transplant applications 6. Bladder application of CEUS. i. Bladder cancer vs Hematoma ii. Staging of bladder cancer iii. NMIBC vs MIBC iv. Ureteral tumor

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## Abstract Archives of the RSNA, 2023

GUEE-35

### Imaging Findings of Upper Tract Urothelial Carcinoma (UTUC) and Its Mimickers

All Day Room: Learning Center

Marina C. Farani, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review the characteristic imaging findings of upper tract urothelial carcinoma. To outline the role of imaging in diagnosis and staging of carcinoma of the renal pelvis and the ureter. To discuss different diagnostic imaging modalities in the context of upper tract urothelial carcinomas. To make differential diagnosis of upper urinary tract neoplasms from other lesions, including benign lesions.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Epidemiology, risk factors, signs and symptoms and pathogenesis about carcinoma of upper urinary tract. Diagnosis: A step-by-step explanation of how to characterize and diagnostic a upper tract urothelial neoplasm. The use of computed tomography and the magnetic resonance to describe the different imaging patterns of tumors (papillary and infiltrating) and to staging urothelial carcinoma of upper urinary tract. Case-Based Review: Sample cases explaining and demonstrating different imaging patterns about upper tract urothelial carcinoma in different imaging modalities. This section will present illustrative cases of carcinoma urothelial infiltrating renal parenchyma, limited at renal pelvis and calyceal infundibulum and distal ureter. This section will present illustrative cases of diagnostic differential/mimickers of urothelial neoplasm, like inflammation, blood clots, endometriosis and renal lymphoma. Conclusion and key takeaways.

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## Abstract Archives of the RSNA, 2023

GUEE-36

### Bladder Neoplasm: A Practical Guide for Residents

All Day Room: Learning Center

Vitor C. Romano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: Provide a practical guide for residents on how to perform a bladder cancer screening. Systematize the evaluation of bladder cancer. Introduce and exemplify the VI-RADS classification. Demonstrate how muscle layer invasion should be evaluated according to the VI-RADS classification.

#### TABLE OF CONTENTS/OUTLINE

We will discuss the following topics and focus on the VI-RADS classification: Introduction: Epidemiology; Pathophysiology. Subtypes of bladder cancer: Urothelial carcinoma; Urachal adenocarcinoma. Imaging methods. TNM grading. VI-RADS classification. Imaging acquisition; Analysis; Examples. Evaluation of the metastatic disease. Management and followup.

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## Abstract Archives of the RSNA, 2023

GUEE-37

### Evaluation of Trauma-Related Kidney Injuries

All Day Room: Learning Center

Vitor C. Romano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: Provide a guide on how to assess kidney injuries related to blunt trauma. Indications for radiological evaluation of renal injury. Role of various imaging modalities (computed tomography, excretory urography, angiography, retrograde pyelography, ultrasonography and magnetic resonance imaging). Give a context of the conduct according to the kidney injury.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Epidemiology; Pathophysiology. Imaging methods. Computed tomography images acquisition protocol. AAST classification for renal trauma. Examples. Overview.

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## Abstract Archives of the RSNA, 2023

GUEE-38

### Atypical Prostatic Cancer Metastases & Recurrence: A Pictorial Review

All Day Room: Learning Center

Murilo d. Peixoto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Prostate cancer is one of the most common malignancies in men worldwide. It has a recognizable pattern of metastatic spread, most frequently to regional lymph nodes and bone, as well as a typical recurrence pattern to pelvic lymph nodes, vesicourethral anastomosis, and bed of seminal vesicles and vas deferens. However, there are different patterns of metastases and recurrence that must be recognized.

#### TABLE OF CONTENTS/OUTLINE

Atypical metastatic disease occurs in less than 5% of patients. Atypical lymph node involvement includes the supradiaphragmatic chains, most commonly the retrocaval, hilar, and supraclavicular ones. Extranodal involvement can occur in the lung and pleura, abdominal viscera, breast, orbit, brain/meninges and soft tissues. Interestingly, atypical distant metastases rarely occur in isolation and PET-PSMA usually demonstrates multiple simultaneous lesions. A higher Gleason score has also been reported to be associated with a greater likelihood of atypical metastases. When evaluating for recurrence, the atypical sites that need to be part of the routine imaging evaluation include anterior portions of the urethra, ureteral meatus (associated with poor prognosis), urinary bladder (distant from the anastomotic area), rectum, mesorectum and compromised retroperitoneal lymph nodes with preservation of the pelvic chains. This exhibit aims to review the locations and atypical patterns of manifestation of this neoplasm according to the different diagnostic modalities, focusing on multiparametric magnetic resonance imaging (MRI) and PET-PSMA.

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## Abstract Archives of the RSNA, 2023

GUEE-39

### Clinical Utility of the Vesical Imaging-Reporting and Data System for Histological Variants and Non-Urothelial Bladder Cancer

All Day Room: Learning Center

Yuki Arita, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Histological variants (VUC) and non-urothelial bladder cancer (NUC) are relatively rare bladder cancer subtypes. These subtypes have a high malignant potential, aggressive advanced tumor features, and an increased risk of disease recurrence compared to pure urothelial bladder cancer (PUC). Accurate preoperative muscle invasion assessment and subsequent immediate surgical intervention are warranted in these patients. The usefulness of the Vesical Imaging-Reporting and Data System (VI-RADS) has been established for PUC by several previous studies. However, the validity of VI-RADS for VUC and NUC still has to be established. This exhibit aims to clarify MRI features of VUC and NUC with histological correlation, demonstrate VI-RADS scoring of VUC and NUC, and discuss the feasibility of biparametric MRI for VUC and NUC compared to PUC.

#### TABLE OF CONTENTS/OUTLINE

1, VI-RADS and histological classification of bladder cancer, 2, VUC with VI-RADS scoring (squamous differentiation, glandular differentiation, sarcomatoid variant, plasmacytoid variant, micropapillary variant, and nested variant), 3, NUC and other bladder malignant tumors with VI-RADS scoring (squamous cell carcinoma, adenocarcinoma, small cell carcinoma, lymphoma, urachal adenocarcinoma, and bladder metastasis), 4, Risk of underestimation of muscle invasion in VUC and NUC at biparametric MRI and its clinical implications, 5, Summary.

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## Abstract Archives of the RSNA, 2023

GUEE-4

### Use of 3D Printed Models to Guide Surgical Resection of Renal Masses

All Day Room: Learning Center

Mujtaba A. Hameed, BS, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. 3D modeling and printing has been increasingly utilized in recent years to guide improvements and new applications for medical diagnosis and treatment planning. 2. 3D models provide a unique degree of tactile and visual information, especially anatomopathological information that would be particularly relevant in surgical planning of tumor resection (e.g., renal masses). 3. 3D modeling can improve the characterization and treatment of renal masses at multiple stages, including segmentation, modeling, printing, preoperative planning, patient consent and education, intraoperative reference, and ultimately surgical removal.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction characterizing the background of 3D modeling and printing in medical diagnosis and treatment, as well as review of relevant examples in the literature and within our institutional experience. 2. Description of initial case presentation and pertinent clinical workup. 3. Review of CT images, process of segmentation, and creation of 3D printed models utilizing clinical 3D visualization software. 4. Description of technique used in editing of 3D models via 3D printing software, including model video. 5. Creation of 3D model of the patient's left kidney (with mass demarcated), description of the utility of the modeling process both preoperative and intraoperatively.

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## Abstract Archives of the RSNA, 2023

GUEE-40

### A Practical Guide for Evaluating Renal Masses: Didactic Case-Based Review

All Day Room: Learning Center

Fernanda L. Limonge, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Discuss and illustrate the cystic lesions of the kidney, emphasizing Bosniak v2019 classification. Describe the features of solid renal masses. Review the TNM system for renal cell carcinoma (RCC). Discuss the active surveillance of renal masses as an alternative to immediate treatment. Review the imaging findings in the context of post-treatment.

#### TABLE OF CONTENTS/OUTLINE

Cystic lesions- Illustrate the Bosniak classification- Tips on how to interpret a cystic renal mass  
Didactic approach for evaluating solid renal masses- Ball versus bean patterns- Clear cell likelihood score (ccLS)  
Describe and review renal masses and histological subtypes- Angiomyolipoma- Oncocytoma- Clear cell RCC- Papillary RCC- Chromophobe RCC- Collecting duct carcinoma- Medullary carcinoma- Urothelial carcinoma- Lymphoma- Metastasis  
Local/regional risk stratification- Tumor size- Axial location (anterior/posterior; endophytic/exophytic)- Longitudinal location (relationship with the polar lines)- Hilar proximity (vessels/collecting system)  
Distant disease assessment- Metastatic disease (bone, liver, lung, lymph nodes)- Synchronous urothelial carcinoma  
Active surveillance  
Post-treatment complications- Relapse- Hematoma- Urinoma- Arteriovenous complications

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## Abstract Archives of the RSNA, 2023

GUEE-41

### Male Urethral Anatomy Revealed: Navigating Anatomical Variations and Complications

All Day Room: Learning Center

Helen Ribeiro De Oliveira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit is: Illustrate the main anatomical landmarks of the male urethra according to imaging methods  
Review the imaging modalities useful to evaluate the male urethra  
Propose a differential diagnosis of lesions according to localization and congenital or acquired, traumatic, infectious, and neoplastic etiologies and highlight the imaging features of each one  
To evaluate the postoperative findings and complications

#### TABLE OF CONTENTS/OUTLINE

- Introduction- Main anatomical landmarks- Imaging methods- Differential diagnosis and clues to diagnosis- Practical tips and Pitfalls- Normal postoperative findings and complications- Conclusion/Take home message

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## Abstract Archives of the RSNA, 2023

GUEE-43

### Practical Guideline for Adrenal Incidentalomas: A Case-Based Review

All Day Room: Learning Center

Iandra Pacheco, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Demonstrate a practical guideline with cases to help radiologists with the differential diagnosis of adrenal incidentalomas. Illustrate with didactic cases the European Society of Endocrinology Clinical Practice Guideline in collaboration with the European Network for the Study of Adrenal Tumors and the White Paper of the ACR Incidental Findings Committee. Review the typical image appearance of adrenal incidentalomas.

#### TABLE OF CONTENTS/OUTLINE

INTRODUCTION IMAGING PROTOCOL CT and MRI REVIEW INCIDENTALOMAS GUIDELINES White paper of ACR European Society of Endocrinology Clinical Practice DEMONSTRATE DIDACTIC CASES- Adenoma - Myelolipoma - Cyst or hemorrhage - Prior granulomatous infection or hematoma- Indeterminate adrenal incidentalomas (= 1 - < 4 cm with prior imaging) . With cancer history: new or enlarging mass. No cancer history: enlarging indeterminate adrenal masses- Indeterminate adrenal incidentalomas (= 1 - < 4 cm without prior imaging) . No cancer history: 1 - 2 cm 2 - 4 cm. Cancer history- With history of cancer (= 1 - < 4 cm). Without known metastatic disease or prior exam. Central necrosis

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## Abstract Archives of the RSNA, 2023

GUEE-44

### How to Improve Surgical Management in Penile Cancer: An MRI and Pathology Correlation

All Day Room: Learning Center

Thiago d. Caetano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the protocol and main sequences used in magnetic resonance imaging for optimal imaging of the penis. Comment on the main penile cancer subtypes based on MR imaging features and correlate with the pathological diagnosis. Discuss the importance of MR imaging in the staging of penile cancer, as well as its potential to aid in surgical management.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Relevant anatomy of the penis  
Definition and main types of penile cancer  
Epidemiology and risk factors  
MR technique and discussion: Describe the main protocol and sequences used in penile cancer MR imaging  
Staging, imaging features and pathology correlation: Discuss the major changes in the 8th AJCC Cancer Staging Manual  
Demonstrate imaging features of the main types of penile cancer and correlate with pathology  
Conclusion: Discuss its usefulness in local staging and locoregional lymph nodal metastasis and comment on future directions

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## Abstract Archives of the RSNA, 2023

GUEE-45

### Space OAR in Prostate Cancer - the What, the How, and Beyond: A Primer for Radiologists

All Day Room: Learning Center

Nabih Nakrou, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this presentation is to: • Review the role of SpaceOAR hydrogel spacer in prostate cancer treatment and placement techniques. • Discuss imaging findings and mimics on different modalities via variable cases. • Recognize radiologic findings of SpaceOAR complications and malfunction.

#### TABLE OF CONTENTS/OUTLINE

We will address the following: • SpaceOAR composition • SpaceOAR placement and anatomy • Indications and roles of SpaceOAR in prostate cancer radiotherapy, including companion cases for treatment and follow-up • Common pitfalls and mimics of hydrogel spacers • Rare SpaceOAR-related complications

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## Abstract Archives of the RSNA, 2023

GUEE-46

### The Female Urethra: A Practical Guide

All Day Room: Learning Center

Louise L. Cavalcanti, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe embryology and anatomy of the female urethra highlighting the anatomical landmarks for diagnoses and surgical planning. 2. The intention of this pictorial review is to describe the most important imaging methods and their contribution to the diagnosis of the main pathologies. 3. Discuss the main pathologies of the female urethra, through richly illustrated clinical cases, correlating with the symptoms and emphasizing the learning points.

#### TABLE OF CONTENTS/OUTLINE

a. Introduction. b. Embryology: Brief description of embryology. c. Anatomy: Important landmarks. d. Imaging methods: Sonography, MRI, Urethrography. e. Pathology: Discuss the most significant pathologies with key points and possible differential diagnoses. f. Cases: Illustrate the most frequent pathologies with clinical cases. g. Take home messages.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-47

### Renal Vascular Hypertension: A Primer for the Radiologist

All Day Room: Learning Center

Justin Sindoni, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the etiology, pathophysiology, classification and diagnosis of renal vascular hypertension  
2. Review contemporary ultrasound, CT and MR angiography techniques and findings of renal vascular hypertension  
3. Summarize modern treatment recommendations

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Etiology and pathophysiology of renal vascular hypertension  
3. Modality selection and protocol optimization  
4. Imaging features of renal artery narrowing including a) etiology b) flow dynamics c) renal perfusion d) post-intervention appearance e) complications  
5. Summary of treatment recommendations with emphasis on the impact of specific imaging findings on therapy

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## Abstract Archives of the RSNA, 2023

GUEE-48

### Penile Pathology Prep: A Quiz-based Review of Penile Ultrasound for Trainees

All Day Room: Learning Center

Ashley K. Yearwood (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

By the end of the presentation, the learner will be able to:

1. Interpret the imaging and relevant anatomy for penile ultrasound.
2. Understand the role of ultrasound in diagnosis and management of penile pathologies and discern when to use ultrasound as an adjunct or in lieu of other modalities.
3. Describe the ultrasound findings for penile pathologies focusing on emergent and commonly encountered cases.
4. Identify normal and abnormal ultrasound Doppler flow parameters in various conditions that may aid in diagnosis.
5. Raise awareness of the clinical utility of penile ultrasound in certain penile pathologies given the safety profile and wide accessibility of this modality.

Target Audience: Trainees.

#### TABLE OF CONTENTS/OUTLINE

We present a case-based quiz of various penile pathologies as seen on ultrasound. Each case will be associated with pertinent symptoms and unlabeled ultrasound images. The diagnosis will be revealed, along with description of the imaging findings followed by relevant educational content for each diagnosis such as: defining relevant pathophysiology, explaining key findings/associations, the clinical significance, and the uses/limitations of ultrasound related to that diagnosis. An introductory overview of normal anatomy and Doppler parameters will also be provided.

Diagnoses include:

1. Erectile dysfunction - Arteriogenic
2. Erectile dysfunction - Venogenic
3. Priapism - High-flow
4. Priapism - Low-flow
5. Peyronie's disease
6. Mondor's disease
7. Penile fracture
8. Penis infection/abscess
9. Penile mass - Squamous cell carcinoma
10. Penile foreign body

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## Abstract Archives of the RSNA, 2023

GUEE-49

### Now Streaming: Review of Male Urethral Imaging with Focus on MRI

All Day Room: Learning Center

Milana Flusberg, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Proper technique and understanding of normal male urethral anatomy on retrograde urethrography aids in interpretation of scans for trauma and strictures. Differential diagnosis of periurethral cysts in men includes utricle, Mullerian duct cyst, Cowper's duct/gland cyst, diverticulum, and collections (urinoma/abscess). MRI is used for local staging of male urethral cancer. Radiologists should be familiar with the appearance of urethral procedures including artificial sphincter and Urolift.

#### TABLE OF CONTENTS/OUTLINE

Performance of retrograde urethrography; Normal male urethral anatomy and normal variants; Urethral strictures: inflammatory, post-traumatic, neoplastic; Urethral trauma: mechanisms, grading, associated findings; Peri-urethral cysts and collections: utricle, Mullerian duct cyst, Cowper's duct/gland cyst, diverticulum, urinoma, abscess; Urethral cancer: background, imaging appearance, staging; Post-procedural urethra

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## Abstract Archives of the RSNA, 2023

GUEE-5

### Overview of Tumor Thrombus in Renal Cell Carcinoma

All Day Room: Learning Center

Eduardo M. Miranda Mora (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Renal cell carcinoma (RCC) invades into the vasculature in approximately 10% of patients. Tumor thrombus is most commonly associated with clear cell RCC but it can also occur due to other entities, such as papillary RCC. This educational exhibit will: (1) Review the incidence, prognosis, and classification system of tumor thrombus in RCC. (2) Review the imaging features of tumor thrombus. (3) Discuss the role of imaging in guiding surgical treatment of tumor thrombus.

#### TABLE OF CONTENTS/OUTLINE

(1) Incidence, clinical presentation, and prognosis of tumor thrombus in RCC. (2) Review the T staging of RCC with tumor thrombus according to the 2010 AJCC clinical staging and Mayo Clinic RCC tumor thrombus level classification system. (3) CT and MRI imaging features of tumor thrombus with case-based pictorial review. (4) Treatment of RCC with tumor thrombus. (5) Potential surgical approach for varying levels of tumor thrombus and post-operative imaging. (6) Summary of teaching points.

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## Abstract Archives of the RSNA, 2023

GUEE-50

### Genitourinary Tract Infections and Inflammatory Conditions: Spectrum of Imaging Features, Pitfalls and Mimics

All Day Room: Learning Center

Ayman H. Gaballah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Illustrate the etiology, pathogenesis, and clinical presentation of genitourinary (GU) tract infections 2. Review the appropriate imaging workup and imaging features of GU infections 3. Discuss mimics and pitfalls of GU infections Highlight management options

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Anatomic illustrations 3. Classification of genitourinary tract infections • Urinary tract infections: i. Upper urinary tract (kidney and ureter): 1. Focal/diffuse pyelonephritis 2. Emphysematous pyelitis/pyelonephritis 3. Renal/perinephric abscesses 4. Hydronephrosis and pyonephrosis 5. Xanthogranulomatous pyelonephritis 6. Parasitic infection (hydatid infection) 7. Other infections such as T.B 8. Ureteritis cystica ii. Lower urinary tract (urinary bladder and urethra): 1. Cystitis 2. Emphysematous cystitis 3. Diverticulitis of urinary bladder/urethra 4. Parasitic infection (Schistosomiasis) 5. Fungal infections (actinomycosis, candidiasis) 6. Cystitis cystica 7. Radiation and chemotherapy cystitis 8. iii. Urachal Inflammatory and Infectious Conditions • Genital infections: i. Female genital system: 1. Pelvic inflammatory disease (e.g., cervicitis, endometritis, pyosalpinx, etc.) 2. Tubo-ovarian abscess 3. Pelvic actinomycosis 4. Necrotizing fasciitis 5. Other rare infections ii. Male genital system: 1. Infectious and granulomatous prostatitis 2. Prostatic abscess 3. Epididymo-orchitis and abscess 4. Scrotal wall cellulitis, abscess 5. Fournier gangrene iii. Sexually transmitted infections 4. Predisposing factors and complications of GU infection 5. Imaging features and case presentation 6. Mimics and pitfalls 7. Updates on management options 8. Conclusion

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## Abstract Archives of the RSNA, 2023

GUEE-51

### **Urologic Prosthetics: An Imaging Review of Short-term and Long-term Complications**

All Day Room: Learning Center

Mary M. Woodruff, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Urologic prosthetics are commonly encountered in everyday practice. As with any surgical procedure and implantable device, there are complications, both short-term and longer term. With contribution from the urology team, we have selected a case collection to highlight these complications with both imaging findings and gross anatomic photos. The addition of gross anatomic and surgical photos complement the imaging findings and provide a better understanding of the clinical perspective. In reviewing these cases, the radiologist may better recognize and accurately diagnose complications related to urologic prosthetics.

#### **TABLE OF CONTENTS/OUTLINE**

A review of the urologic prosthetics and implant components. Normal orthotopic positioning of urologic prosthetics anatomically and in imaging. Selection of cases with imaging and pictorial findings Selected cases include: Urethral cuff erosion of artificial urinary sphincter. Postoperative pelvic/scrotal hematoma. Scrotal abscess. Penile prosthesis scrotal pump erosion. Herniation of prosthesis reservoir into the inguinal canal. Reservoir leak. Fracture of malleable penile prosthesis.

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## Abstract Archives of the RSNA, 2023

GUEE-52

### **How We Do It: A Diagnostic Approach to Avoid Overtreatment in Management of Centrally Located Renal Masses**

All Day Room: Learning Center

Layra R. Leao (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review imaging features of the differential diagnosis of centrally located renal masses.- Illustrate diagnostic clues related to common and uncommon mimickers of upper tract urothelial carcinoma.- Highlight the importance of the tumor board approach in managing challenging cases as a platform for care coordination and a tool to optimize decision-making.

#### **TABLE OF CONTENTS/OUTLINE**

Imaging diagnostic differentiation of upper tract urothelial carcinomas (UTUC) and other centrally located renal tumors can be challenging; management patterns vary considerably due to the different oncologic behavior of these lesions. Misinterpretation in imaging studies could lead to unnecessary aggressive approaches. Some radiological features can help to predict the histology or pathologic aggressiveness of renal tumors, providing optimal and safe management. The presence of an infiltrative or nodular expansile pattern of growth is the first step in the differentiation of conditions that may simulate UTUC. Benign and malignant mimickers include renal cell carcinomas, metastasis, lymphoma, pseudotumors, and infection. Standardization of imaging protocols and reporting can help to differentiate these entities. The multidisciplinary discussion of challenging cases in the tumor board meetings should be included in the medical practice to identify interpretation mistakes and avoid unnecessary patient damage.

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## Abstract Archives of the RSNA, 2023

GUEE-53

### **MRI Clear Cell Likelihood Score (ccL): A Great Mechanism to Managing the Indeterminate Renal Masses**

All Day Room: Learning Center

RODRIGO OKAMURA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1 - To understand the different aspects of renal lesions and the importance of classifying those with a higher risk of clear cell carcinoma. 2 - Through practical cases and interactive quizzes, demonstrate how to use the clear cell likelihood score (ccLs). 3 - Present some cases with limitations of ccLs applicability. 4- Expose some pitfalls and challenging cases.

#### **TABLE OF CONTENTS/OUTLINE**

1 - Introduction on renal carcinomas subtypes and ccLs score creation.. 2 - Demonstate how to use the ccLs. 3 - Quiz case studies with practical use of ccLs. 4 - Answer each case with the corresponding pathological resulrs. 5 - Challenging cases with limitations of the ccLs algorithm. 6 - Pitfalls that can lead to erroneous diagnosis. 7 - Summary and take home notes.

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## Abstract Archives of the RSNA, 2023

GUEE-54

### **Female Lower Genitourinary Tract: Imaging Evaluation of the Most Common Alterations of Interest in Female Urology**

All Day Room: Learning Center

Alice Schuch, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

? Identify the anatomical landmarks of the female pelvic floor and perineum which can guide the radiologist to the correct diagnosis.? Point out the best imaging method for the diagnosis.? Review imaging features of the most common abnormalities of the female lower genitourinary tract.? List complicating features that may be seen by imaging and some rarer lesions that may be included in the differential diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Imaging methods Retrograde urethrocytography and computed tomography are limited imaging methods for the evaluation of female lower genitourinary changes. Ultrasound plays a role in more specific indications. However, magnetic resonance imaging is usually the method of choice and provides the best identification of the anatomical structures for the diagnosis. Imaging evaluation common alterations will be characterized especially on MRI, as cystic lesions, including Bartholin's gland cyst and urethral diverticulum, as well as prolapses, such as urethral caruncle. Some complications of the common lesions will be included, in addition to tumors or tumor-like lesions, to provide the radiologist ability to perform differential diagnosis. Conclusion MRI is an ideal imaging method to evaluate female lower genitourinary changes, and it is essential that radiologists know how to detect and characterize these lesions, since, even when benign, they can be quite symptomatic.

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## Abstract Archives of the RSNA, 2023

GUEE-55

### Pitfalls of Renal Transplant Imaging

All Day Room: Learning Center

Reece J. Goiffon, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

TEACHING POINTS1. Discuss the relevant anatomic/imaging considerations, criteria, and imaging techniques for pre-renal donor work-up.2. Become familiar with the normal anatomic features, including location, surgical technique, and relevant hilar anastomoses following renal transplantation as well as the normal grayscale and color/power Doppler imaging features of a renal allograft.3. Review common pitfalls encountered both during pre-renal transplantation work-up and during evaluation of the renal allograft post-transplantation with particular attention to accurate diagnosis of post-transplant complications.4. Highlight the important roles of both computed tomography (CT) and ultrasound (US) in pre- and post-renal transplant evaluation.

#### TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS/OUTLINEWe present a comprehensive review of normal pre- and post-renal transplant imaging as well as a review of potential pitfalls in both the pre-transplant imaging work-up and post-transplant allograft evaluation.Pre-renal transplant pitfalls may include:• Incidental arteriopathies (e.g. fibromuscular dysplasia)• Aberrant vascular anatomy• Incidental primary renal neoplasms• Other incidental malignancyPost-renal transplant pitfalls may include:• Postoperative edema at the arterial anastomosis• Renal vein thrombosis with diastolic flow reversal in the transplant renal artery• Postoperative fluid collections (seroma vs hematoma vs urinoma vs lymphocele)• Allograft malignancy

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## Abstract Archives of the RSNA, 2023

GUEE-56

### Imaging of Upper Urinary Tract Neoplasms

All Day Room: Learning Center

Miriam Gallego Casals, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Upper urinary tract urothelial carcinoma (UTUC) stands for only 5-10% of all urinary tract tumors and is mainly represented by transitional cell carcinoma (TCC, >95%). TCC usually develops in males around 65 and is related with many chemical compounds and urinary stasis (that is why it is more common in the bladder rather than on the ureter). Haematuria is the most frequent symptom, although non-specific, and urine cytology is usually negative. Commonly multifocal, with a high incidence of early recurrence, requires rigorous urothelial surveillance. CT urography has largely replaced any other imaging techniques, using contrast media to outline the collecting system. As UTUC can be challenging to identify on routine imaging, we use a series of cases to illustrate the most common patterns and signs that help us identify these tumors: a soft tissue density filling defect that enhances lightly is the most typical finding. Other types such as the non-papillary is infiltrative and harder to detect, often invading beyond the mucosa at the time of diagnosis. In the renal pelvis, these tumors do not change renal contours even when large. Instead, small ureteral tumors are more likely to obstruct the kidney and cause renal malfunction. We explain through several cases how to distinguish UTUC from other neoplasms or benign processes, dividing these UTUC mimickers in two groups: - Filling defects pitfalls: clots, calculi, mycetomas, etc- Urothelial thickenings: lymphoma, tuberculosis, schistosomiasis, etc

#### TABLE OF CONTENTS/OUTLINE

Brief description of epidemiologic and pathologic characteristics of the tumors of the upper urinary tract. Discussion of patterns and signs that indicate their presence, and some pitfalls.

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## Abstract Archives of the RSNA, 2023

GUEE-57

### Imaging Assessment for Penile Prosthesis Complications: What the Radiologists Should Know

All Day Room: Learning Center

Sofia M. Bretos Azcona, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review the types of penile prostheses and their components and findings on imaging techniques. To review the possible complications associated with penile prostheses and the role of imaging in their assessment and surgical planning.

#### TABLE OF CONTENTS/OUTLINE

1. Types of penile prostheses 1.1. Semi-rigid/maleable prostheses. 1.2. Hydraulic prostheses. 1.2.1. Two pieces hydraulic prosthesis 1.2.2. Three pieces hydraulic prosthesis 1.2.3. Low-profile reservoir three pieces hydraulic prosthesis. 2. Radiological evaluation of penile prostheses. 2.1. Radiography 2.2. Ultrasound 2.3. CT scan 2.4. MRI 3. Expected imaging findings on complications related to penile prostheses and the role of imaging in their assessment. 3.1. Immediate surgical complications 3.2. Related to mechanical failure 3.2.1. Autoinflation of cylinders 3.2.2. Leakage 3.2.3. Fractures 3.2.4. Aneurysm of cylinders 3.2.5. Reservoir complications 3.3. Related to malposition of the prostheses components. 3.3.1. Erosion 3.3.2. Migration 3.3.3. Crossover 3.3.4. Buckling 3.3.5. Floppy glans syndrome 3.4. Imaging findings on infected prostheses 3.4.1. Early infection 3.4.2. Late infection 4. Conclusion

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## Abstract Archives of the RSNA, 2023

GUEE-58

### **Urothelial-phase CT Urography for Diagnosing Urothelial Tumors: A Paradigm Shift for Investigating Hematuria**

All Day Room: Learning Center

Nigel C. Cowan, PhD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Urothelial-phase CT urography (25-50 s post contrast administration) is considered a paradigm shift in the development of CT urography for diagnosing urothelial tumors and investigating hematuria. Urothelial tumours are hypervascular and display early hyperenhancement following contrast administration. Familiarity with the signs of urothelial tumours on urothelial-phase CT enables radiologists to make the diagnosis on both GU and non-GU studies. Urothelial-phase compared with excretory-phase CT urography has many advantages. These include shorter examination time, increased patient throughput, no need for complicated patient related manoeuvres to promote full opacification, improved tumour visualisation in cases of hydronephrosis, hydroureter and contrast layering and reduced false positive diagnoses. The diagnostic accuracy of urothelial-phase imaging for urothelial tumors is high. Diagnosis of urothelial tumors using urothelial-phase CT urography makes the excretory-phase redundant.

#### **TABLE OF CONTENTS/OUTLINE**

A brief 25 year history of CT urography for investigating hematuria. The evolution of CT urography techniques. A comparison of urothelial-phase with excretory-phase CT urography for diagnosing urothelial tumors. Definition description of the techniques. Advantages and disadvantages. An atlas of urothelial tumors showing the signs of urothelial tumours on the urothelial-phase and examples of true positive, false negative and false positive results. Development of a confidence scoring system based on urothelial-phase imaging findings to improve report clarification and direct management: straight to surgery, ureteroscopy +/- biopsy or follow-up. Conclusion References

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## Abstract Archives of the RSNA, 2023

GUEE-59

### **New Method for Differentiating Stents from Adjacent Urinary Stone Using Dual Energy Spectral CT with Advanced Post-processing**

All Day Room: Learning Center

Yannan Cheng, BS,BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) To illustrate the limitations of conventional CT imaging in differentiating urinary stones and stents. 2) To illustrate novel techniques and approaches using dual energy spectral CT (DEsCT) to differentiate urinary stones from stents. 3) To demonstrate strategies of selecting appropriate image types with advanced post-processing.

#### **TABLE OF CONTENTS/OUTLINE**

1) Conventional CT and its limitations • Fixed tube voltage of 120kVp with mA modulation and helical scanning mode. • CT value alone lacks the power to differentiate stones and stents. 2) Advanced CT imaging technologies • Dual-energy CT (80/140kVp) with preset dose levels and Adaptive Statistical Iterative Reconstruction-V (ASiR-V). • Different energy levels, material decomposition (MD) images and effective atomic number (Zeff). 3) Optimal strategies using these technologies • Select appropriate MD basis material pairs such as Calcium/Iodine, Fat/ Calcium, Fat/ Iodine, or Iodine/HAP. • Apply Zeff, Calcium/Iodine and CT value at 70 keV to better differentiate urinary stones and stents.

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## Abstract Archives of the RSNA, 2023

GUEE-6

### The Spectrum of Renal Angiomyolipoma with Radiologic Pathologic Correlation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jamie Marko, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Renal angiomyolipoma (AML) is a benign mesenchymal neoplasm composed of an admixture of thick-walled dysmorphic blood vessels, smooth muscle cells and adipose tissue. Angiomyolipomas belong to the perivascular epithelioid cell (PEComa) tumor family. 2. Variants of angiomyolipoma include the classic AML, fat-poor AML, epithelioid AML, and AML with epithelial cysts. Angiomyolipoma may occur sporadically or with tuberous sclerosis. 3. The classic variant, which accounts for more than 90% of cases, is confidently diagnosed at imaging by detecting macroscopic fat. Fat is hyperechoic at ultrasound. It has an attenuation  $< -20$  Hounsfield Units at CT and matches the appearance of subcutaneous fat. Fat is T1 hyperintense with loss of signal with fat suppression at MRI. Small areas of fat are detected with chemical shift imaging. 4. Most angiomyolipomas have a benign clinical course. The most frequent complication is retroperitoneal hemorrhage, most common with tumors  $> 4$  cm. Less commonly, angiomyolipoma may invade the renal vein and inferior vena cava. Epithelioid angiomyolipoma has malignant potential and may recur and metastasize.

#### TABLE OF CONTENTS/OUTLINE

1. Review the gross, histologic, and immunohistochemical pathologic features of renal AML, including the uncommon variants. 2. Describe the multimodality imaging features of renal AML, including the uncommon variants. 3. Describe the pathologic basis of the imaging findings associated with each variant. 4. Illustrate the spectrum of renal AML including its variants. Will include important complications including retroperitoneal hemorrhage and vascular involvement.

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## Abstract Archives of the RSNA, 2023

GUEE-60

### Prostate Imaging for Recurrent Reporting (PI-RR): A User Guide

All Day Room: Learning Center

Anup S. Shetty, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The Prostate imaging for Recurrence Reporting (PI-RR) system was introduced in 2021 to create standards for reporting pelvic MRI after radical prostatectomy or radiation for treatment of prostate cancer. Using a similar nomenclature as PI-RADS v2.1, PI-RR uses established knowledge of MRI features of recurrent prostate cancer and codifies it systematically to be accessible to prostate MR readers of all experience levels. This exhibit is on the RadioGraphics Needs List under Genitourinary Imaging: Pictorial on Guidelines and Reporting Systems. This exhibit will: 1) Discuss the rationale for PI-RR 2) Describe technical standards and reporting guidelines 3) Illustrate the use of PI-RR to assess for recurrent prostate cancer after radical prostatectomy and radiation therapy through a series of instructive cases 4) Describe pitfalls of the current version, including non-applicability for focal therapies 5) Detail areas for future development of PI-RR

#### TABLE OF CONTENTS/OUTLINE

\* Background: Why PI-RR, including the benefits of standardizing post-treatment prostate MRI\* Technical Standards: Requirements, extras (subtraction imaging, 3D volumetric T2 for MPR)\* Reporting: Component scores in the PI-RR system shown in a pictorial format\* Case Examples: Prostatectomy, external beam radiation, brachytherapy\* Pitfalls: Definitions of PI-RR 4/5 for post-prostatectomy based on laterality; susceptibility artifact from brachytherapy seeds and surgical clips; residual prostate tissue after prostatectomy\* Future Development: Focal therapy (cryoablation, HIFU, etc.); Integrating PSMA-PET/CT

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## Abstract Archives of the RSNA, 2023

GUEE-61

### Don't Stress, Just Study With Care, Renovascular Hypertension Will Be Conquered, in Your Test

All Day Room: Learning Center

Eduardo M. Gomes De Menezes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Renovascular hypertension (RH) is the most common and potentially reversible cause of secondary hypertension. However, renal artery stenosis is often found as an incidental finding on routine examinations. Thus, knowledge of the clinical aspects of this pathology is necessary to increase the pre-test probability and the different diagnostic imaging modalities provide subsidies for better therapeutic decisions. 2. Revisit the multiple imaging methods used in the diagnosis of RH (Duplex Doppler Ultrasonography, CT Angiography, MRI Angiography and Renography): protocols, advantages, limitations and the main causes of RH as well as its imaging aspects. 3. Knowledge of invasive treatment options (Percutaneous transluminal renal angioplasty and surgery) and their respective technical aspects, indications and procedural complications.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of Renovascular Hypertension (RH) A. Epidemiology B. Pathophysiology C. Causes 2. Indications for Testing a Patient for RH: A. Clinical Clues to Enhance the Pre-Test Probability B. Renal Artery Stenosis as an Incidental finding 3. Non Invasive Diagnostic Testing for RH and Expected Findings: A. Duplex Doppler Ultrasonography B. CT Angiography C. MRI Angiography D. Renography E. Contrast-Related Kidney Injury 4. Determining the appropriate time to combine different diagnostic methods 5. Reporting of RH Patient Examination: A. Anatomical Variants B. Most Common Lesion Aspects C. Atherosclerosis D. Fibromuscular Dysplasia E. Complex Lesions 6. Overview of RH Management: A. Percutaneous Transluminal Renal Angioplasty B. Surgery C. Procedural Complications

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## Abstract Archives of the RSNA, 2023

GUEE-62

### Prostate MRI Pitfalls and Confounders: A Case-based Approach

All Day Room: Learning Center

Eduardo Thadeu De Oliveira Correia, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Prostate MRI is widely used for the detection and characterization of prostate cancer. Nonetheless, many conditions can mimic prostate cancer lesions, leading to false positive MRI results. This educational exhibit employs a case-based approach to explore the pitfalls and confounders that arise during the assessment of prostate MRI and guide readers on how to distinguish these benign mimickers from malignant lesions.

#### TABLE OF CONTENTS/OUTLINE

1. A prostate MRI with too many findings a. Case 1: prostate cancer in a MRI done within 4 weeks of prostate biopsy b. Teaching points 2. A must-known confounder a. Case 2: extruded benign prostatic hyperplasia b. Teaching points 3. The importance of clinical history a. Case 3: granulomatous prostatitis b. Teaching points 4. The role of Delayed Contrast Enhancement a. Case 4: prostate abscess b. Teaching points 5. An extremely rare case: know the boundaries! a. Case 5: malakoplakia b. Teaching points 6. Prostate MRI is more than just PI-RADS: check the surroundings! a. Case 6: PI-RADS 5 lesion, ureteral stone and ileo-ileal intussusception b. Teaching points

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## Abstract Archives of the RSNA, 2023

GUEE-63

### Factors that Influence Prostate Cancer Visibility on Multiparametric MRI

All Day Room: Learning Center

Eduardo Thadeu De Oliveira Correia, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Multiparametric MRI (mpMRI) is endorsed by guidelines worldwide as a fundamental tool for the detection and characterization of prostate cancer. Nonetheless, still, 10-20% of patients with clinically significant prostate cancer have a false negative result in mpMRI. In this exhibit, we will review factors that can decrease lesion conspicuity and reduce the detectability of malignant lesions.

#### TABLE OF CONTENTS/OUTLINE

1. What factors can influence Prostate Cancer visibility on mpMRI? a. Histology b. Background Signal Changes c. Image quality  
2. Histological determinants of lesion visibility on mpMRI a. Tumor volume b. Gleason/ISUP score c. Epithelium, stroma, and lumen fraction  
3. The effect of background signal changes of the peripheral zone on lesion visibility a. Diffusely hypointense peripheral zone on T2WI b. Heterogenous hypointensity in the peripheral zone on T2WI c. Background signal changes in DWI and DCE d. Associated clinical factors and conditions  
4. Benign mimickers of prostate cancer on mpMRI a. Prostatitis b. BPH c. Adenosis d. Necrosis e. Focal atrophy  
5. Image quality: patient and scanner factors that can decrease lesion conspicuity

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## Abstract Archives of the RSNA, 2023

GUEE-64

### Update on Hereditary Renal Mass Syndromes: Genetics, Renal, and Extrarenal Imaging Findings

All Day Room: Learning Center

Acacia Yoon (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review hereditary renal mass syndromes in the context of the 2022 World Health Organization update, which has a stronger emphasis on genetic alterations. 2. Review extrarenal findings associated with each syndromes. A diagnostic approach will be proposed. 3. Understand the role of the radiologist in diagnosis and management. Genetic testing may not be necessary or even specific for certain syndromes; thus, radiologists may be the first to suggest the diagnosis.

#### TABLE OF CONTENTS/OUTLINE

1. Hereditary renal mass syndromes with multimodality imaging correlates: genetic mutation, inheritance pattern, diagnostic criteria, renal mass subtype(s), extrarenal findings, and management: Birt-Hogg-Dubé, von Hippel-Lindau, tuberous sclerosis complex, succinate dehydrogenase deficiency, fumarate hydratase deficiency, hereditary papillary renal cell carcinoma, PTEN hamartoma syndrome, BAP1 tumor predisposition syndrome, chromosome 3 translocation. 2. Role of the radiologist in diagnosis and management. 3. Diagnostic approach for the radiologist.

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## Abstract Archives of the RSNA, 2023

GUEE-65

### Abnormal Testicular Waveforms: What Do They Mean

All Day Room: Learning Center

Yashant Aswani, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To identify typical and atypical waveforms of testicular torsion 2. To understand and describe the difference between partial and complete testicular torsion 3. To describe the features of torsion-detorsion syndrome 4. To understand the mimics of testicular torsion

#### TABLE OF CONTENTS/OUTLINE

1. Normal testicular blood supply with normal spectral Doppler explained with image and line diagram 2. To illustrate testicular torsion with various examples for clear understanding and interpretation 3. To illustrate examples of partial torsion with various spectral Doppler variations including amplitude of the waveforms, parvus tardus pattern, monophasic waveform and reversal of diastolic flow 4. To illustrate torsion-detorsion with multiple examples. Spermatic knot sign will also be illustrated in detail with images and cine clips 5. To illustrate mimics of testicular torsion such as patients with vasculitis and drug-induced spectral Doppler abnormalities with histopathology correlation

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## Abstract Archives of the RSNA, 2023

GUEE-66

### Magnetic Resonance Imaging for Non-Oncologic Penile Pathology: It's Not that Hard

All Day Room: Learning Center

Daniel Corominas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The use of Magnetic Resonance Imaging is widespread for oncological pathology of the penis, but its use is of much importance in non-oncological pathology such as Peyronie's disease, penile fracture, and priapism. Intracavernosal drug injection is an option for the treatment of erectile dysfunction, but it is also important for conducting erection imaging studies, so the radiologist must be aware of its method of administration, possible complications, and how to prevent and treat them. Treatment of non-oncological diseases of the penis using penile prostheses has expanded recently. MRI is the method of choice for evaluating their proper functioning, as it provides high-resolution spatial images and it is key to helping urologists determine the need for replacements and repairs.

#### TABLE OF CONTENTS/OUTLINE

1) MRI protocol for non-oncological pathology of the penis. 2) Intracavernosal drug injection: a basic guide for radiologists. 3) Penile anatomy on MRI. 4) Non-oncological pathology of the penis. 4.1) Erectile dysfunction. 4.2) Peyronie's disease. 4.3) Priapism. 4.4) Penile fracture. 5) Penile prosthesis. 5.1) Indications and types of surgery. 5.2) Types of penile prostheses and their components. 5.3) Imaging evaluation of the penile prosthesis: importance of MRI. 5.4) Evaluation of the penile prosthesis complications. 5.4.1) Cylinders and shafts complications. 5.4.2) Glans mobility alterations. 5.4.3) Reservoir malposition. 5.4.4) Circuit rupture and prosthesis malfunction. 6) Conclusions and future directions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-67

### Urethral Pathologies in Male Patients: Evaluation with Magnetic Resonance Urethrography - A Pictorial Essay

All Day Room: Learning Center

Vinicius C. Serra, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

TP1 Magnetic resonance imaging (MRI) is a promising imaging modality for the comprehensive evaluation of urethral pathologies, providing high resolution and multiplanar imaging capabilities without the need for radiation or invasive procedures. TP2 MRI can accurately identify and assess the extent of anterior and posterior urethral strictures, as well as fistulous tracts with adjacent organs, and can aid in the evaluation of postoperative complications. TP3 Urethral strictures can result from traumatic or inflammatory causes and can lead to obstructive uropathy. Posterior urethral injuries commonly result from pelvic trauma, while anterior urethral strictures can result from instrumentation or inflammation. TP4 MRI provides a non-invasive and radiation-free alternative to traditional imaging techniques, such as urethrocytography, which can be limited by poor visualization of urethral strictures and invasiveness. TP5 MRI can also be used to evaluate other pathologies of the male genitourinary tract, including prostate cancer and penile cancer.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction A. Overview of traditional urethral imaging techniques B. Advantages of MRI for comprehensive evaluation of urethral pathologies II. Methodology A. Patient selection and imaging protocol B. MRI findings in anterior and posterior urethral strictures and fistulas III. Discussion A. Traumatic and inflammatory causes of urethral strictures B. MRI evaluation of postoperative complications C. Comparison of MRI with traditional urethral imaging techniques IV. Conclusion A. Summary of the advantages of MRI in the evaluation of urethral pathologies B. Potential implications for clinical practice and patient outcomes

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-68

### **Unveiling the Masked Masqueraders: Navigating Anatomical Variations and Adenocarcinoma Mimickers in Prostate Multiparametric MRI**

All Day Room: Learning Center

Enis C. Yilmaz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Multiparametric MRI (mpMRI) is the imaging modality of choice in assessment of prostate adenocarcinoma (PCa). However, various conditions involving the prostate might resemble PCa due to their imaging characteristics and these patients might undergo unnecessary biopsy procedures. Our aim is to review some of the entities that could be a pitfall for readers and outline their key imaging findings to differentiate them from PCa.

#### **TABLE OF CONTENTS/OUTLINE**

(1) Overview of prostate anatomy and typical imaging characteristics of PCa. (a) Central Zone (b) Anterior fibromuscular stroma (c) Bulbourethral glands (Cowper's glands) (2) Conditions that may mimic PCa and their appearance at mpMRI: (a) Acute and chronic bacterial prostatitis (b) Tuberculous prostatitis (c) Granulomatous prostatitis (d) Prostate abscess (e) Intraprostatic calcification (f) Mucinous neoplasm of prostate (g) Stromal Tumor of Uncertain Malignant Potential of the Prostate (STUMP) (h) Biopsy related hemorrhage (i) Post-focal treatment prostate (j) Exophytic BPH nodule (k) Small cell carcinoma of the prostate (3) Hints that could be helpful in differentiation of PCa and PCa mimickers (4) Summary of findings

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## Abstract Archives of the RSNA, 2023

GUEE-69

### Practical Approach to Primary Retroperitoneal Tumors: Tips for An Imaging Diagnosis

All Day Room: Learning Center

Shota Kondo (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

a. For a differential imaging diagnosis of primary retroperitoneal tumors, a focus on the principal tumor features, e.g. fat, cystic components, a mucinous matrix, and necrosis is important. b. On images of well-differentiated liposarcomas the fat component predominates. In other histological types of liposarcomas it is not large and it may not be identifiable. c. High signal intensity on T2-weighted MRI scans with delayed contrast enhancement indicates a myxoid stroma that may be, for example, myxoid liposarcoma, schwannoma, or myxofibrosarcoma. d. Retroperitoneal tumors with a predominantly cystic component commonly include benign lesions such as lymphatic malformations, tail gut cysts, and ancient schwannomas. e. Common primary retroperitoneal malignancies such as leiomyosarcoma, undifferentiated pleomorphic sarcoma, and liposarcoma often have a necrotic appearance, suggesting a poor prognosis.

#### TABLE OF CONTENTS/OUTLINE

1. Retroperitoneal anatomy
2. Diagnostic algorithm and clinical management of primary retroperitoneal tumors
3. Imaging findings of various primary retroperitoneal tumors
4. Utility of 18F-FDG-PET/CT for diagnosing primary retroperitoneal tumors
5. Tips for avoiding diagnostic pitfalls and for clinical management

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## Abstract Archives of the RSNA, 2023

GUEE-7

### Multiparametric MR Urethrography (MRU): Dynamic Comprehensive Evaluation of the Male Urethra

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Alice Schuch, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the optimal technique for a comprehensive MRU protocol including the instillation of sterile urethral jelly, multiparametric sequences, and dynamic maneuvers. Identification of normal urethral anatomy on MRU including evaluation of periurethral compartments in both static and dynamic images. Describe how each component of MRU is crucial for the evaluation of common, uncommon, and rare urethral pathology.

#### TABLE OF CONTENTS/OUTLINE

MRU has revolutionized the imaging of the male urethra. Patient preparation: in the supine position and the penis in the anatomic position with an injection of lidocaine gel for urethral distension. Imaging protocol and interpretation high-spatial resolution, small FOV, multiplanar T2WI, to provide the best anatomic overview. T1WI is useful for assessing hemorrhage and vascular thrombosis, while the DCE is useful in evaluating masses and differentiation between fibrosis and inflammation. DWI assists in the depiction of a urethral mass and skips lesions. Dynamic maneuvers, with Valsalva and urination, are also performed to assess the sphincters and pelvic floor. Clinical applications: value of MRU in multiple specific clinical indications will be discussed, including urethral strictures, diverticula, fistulas, trauma, cancer staging, infections/inflammation. Conclusion MRU is an ideal one-stop replacement for traditional fluoroscopic urethrography, with growing data in the literature in recent years.

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## Abstract Archives of the RSNA, 2023

GUEE-70

### Prostate Cancer Strikes Back! A Pictorial Review of Local Recurrence and the PI-RR Score

All Day Room: Learning Center

Bernardo S. Oliveira, MD, MBA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To understand the main finding of prostate local recurrence on magnetic resonance imaging. To review the new PI-RR score and learn how to apply it. To gain experience in prostate recurrence MR evaluation through clinical cases.

#### TABLE OF CONTENTS/OUTLINE

Introduction - First Things First Basic clinical concepts you should know before reading the MR imaging (PSAd, PSA doubling time, and more). Getting familiarized with the normal male pelvis after radical prostatectomy and radiotherapy. A brief review about the new PI-RR score system. Discussion - Prostate Cancer Strikes Back A prostate cancer local recurrence case collection, focusing on MR imaging. Summary - It's your turn to strike back! Learn tips and tricks to enhance your skills.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-71

### The 'New' 2022 World Health Organization (WHO) Classification of Adrenal Cortical Tumors: A Primer for Radiologists

All Day Room: Learning Center

Nuray Bakal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Familiarize audience with 'new' 2022 World Health Organization (WHO) classification of adrenal cortical tumors (ACTs) Describe the pathology, genetics, molecular biology natural history of ACTs. Review imaging spectrum of benign malignant ACTs discuss the role of imaging in the screening, diagnosis, staging, and surveillance Discuss the potential diagnostic management implications of the current classification

#### TABLE OF CONTENTS/OUTLINE

Introduction The spectrum of adrenal cortical lesions Updates in WHO classification Pathology, Genetics Molecular Biology Genetic Syndromes: Li-Fraumeni, Lynch, MEN1. Imaging Techniques: US, CT, MRI PET-CT Congenital adrenal hyperplasia Adrenocortical nodular disease: Sporadic nodular, Bilateral micronodular, Bilateral macronodular Cortical adenomas: typical/atypical imaging findings Primary aldosteronism: HISTAALDO classification imaging findings Cortisol-producing adenomas Cortical carcinoma: imaging spectrum Adrenal Myelolipoma Adrenal rests, adrenal Cysts. Rare tumors: melanoma, adenomatoid tumors sex cord-stromal tumors Role of imaging in screening surveillance of ACTs other lesions Diagnostic Management Implications of 2022 WHO Classification Imaging biomarkers. Conclusion The new 2022 WHO classification of ACTs highlights the importance of molecular genetic features in characterizing classifying ACTs and updated terminology for select pathologies. The pivotal role of CT/MRI/PET-CT imaging features in the diagnosis, treatment surveillance of cortical tumors is discussed. Familiarity of radiologists with new ACTs subtypes associated imaging findings helps to accurately identify and characterize ACTs.

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## Abstract Archives of the RSNA, 2023

GUEE-72

### **Pictorial Review of the Diagnosis of Muscle-Invasive Bladder Cancer Using Vesical Imaging-Reporting and Data System (VI-RADS)**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Mitsuru Takeuchi, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The Vesical Imaging-Reporting and Data System (VI-RADS) is a standard MRI imaging and diagnostic method for muscle-invasive bladder cancer that was published in 2018. As a member of the VI-RADS committee, I was involved in the development of the diagnostic criteria. Several studies have demonstrated that VI-RADS has excellent sensitivity and specificity for muscle-invasive bladder cancer. However, reading VI-RADS requires some expertise, and there are various pitfalls. Therefore, this exhibition will first explain the basic MRI reading procedure for bladder cancer. Then, based on my experience of reviewing MRI images of approximately 300 cases of bladder cancer with trainees, we will discuss the causes of misdiagnosis and precautions to prevent misdiagnosis by presenting case images. Furthermore, limitations of the current VI-RADS diagnostic criteria will also be addressed.

#### **TABLE OF CONTENTS/OUTLINE**

1) Basic procedure for reading bladder MRI 1-a) Role of multiparametric MRI 1-b) Imaging findings of tumor stalk and thickened submucosa 1-c) Categorizing bladder cancer according to VI-RADS diagnostic criteria 2) Teaching file, misdiagnosed cases by trainee, consideration of the cause and suggestions for improvement 2-a) Problems with the patient's condition or imaging 2-b) Misdiagnosis due to insufficient reading skill 2-c) Misdiagnosed cases caused by the limitation of current VI-RADS diagnostic criteria 2-d) Difficult to diagnose bladder cancer with atypical histology and imaging findings

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## Abstract Archives of the RSNA, 2023

GUEE-73

### Visualizing Dynamic Mechanisms of Lower Urinary Tract Symptoms (LUTS): Usefulness of Urodynamic 4D-CT

All Day Room: Learning Center

Wataru Fujishiro, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Providing required items for LUTS surgery
- CT Scanning technique for LUTS
- Benefits of 4D-CT scanning for urination evaluation
- Morphological Evaluation before after surgery

#### TABLE OF CONTENTS/OUTLINE

A. Morphological and functional evaluations are important. B. Morphological evaluation is required for bladder, urethra, prostate. Scanning is performed in a semi-seated position to reproduce a physiological urination state. 4D-CT uses intermittent scanning to reduce radiation exposure from the beginning to the end of urination. C. "Using 4D-CT can evaluate morphological changes in the bladder, prostate, and urethra and the location and timing of bladder outlet obstruction that occurs at the start of urinary flow, and urodynamic information." D. Analysis of the volume data enables pre and post operative comparisons. Evaluation using CT can show the effectiveness of quantitative evaluation. Outline "4D-CT is particularly effective in judging the applicability of operation and evaluating kinetic and morphological data in cases of prostate problems without morphological changes and dysuria due to a small decrease in uroflow intensity due to insufficient strength of the urethral sphincter muscle." There are cases in which surgery was indicated for patients whose anatomical structure deviated from the ideal. 4D-CT can evaluate morphology and function. So, it is useful for surgical indication and surgical planning.

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## Abstract Archives of the RSNA, 2023

GUEE-74

### The Role of Imaging Techniques in Penile Lesions: When and How to Use Them

All Day Room: Learning Center

Sandra Baleato Gonzalez, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To illustrate normal US and MR penile anatomy. 2. To review the spectrum of traumatic and atraumatic lesions involving the penis highlighting the typical and atypical sonographic and MR appearances of pathologic disorders, with special emphasis on distinctive and subtle findings that may clarify the diagnosis. 3. To discuss the value of other imaging techniques (CT, PET-CT, arteriography, urethrography) in penile pathology.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. General features and basic concepts. 2. Anatomy. US and MR anatomy and imaging protocol. 3. Vascular disorders (Mondor disease, partial thrombosis of the corpus cavernosum, high flow and low-flow priapism). 4. Trauma. (Penile fracture, urethral injury, post-traumatic arterial penile fistula, extratunical hematoma and intracavernosal hematoma). 5. Inflammation (Cellulitis, abscess, fistula and gangrenous cavernositis). 6. Benign lesions (Peyronie disease, cavernous hemangioma, median raphe cyst, epidermoid cyst and so on). 7. Malignant lesions (Primary penile cancer and penile metastasis). 8. Summary.

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## Abstract Archives of the RSNA, 2023

GUEE-75

### **The Perils of Prostate MRI: How to Best Avoid Common Imaging Pitfalls**

All Day Room: Learning Center

Amanda C. Gibson, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Prostate MR is a robust imaging modality with emerging utilization in screening, tumor characterization, surveillance, risk stratification, and local staging of prostate cancer. 2. The inherent complex anatomy of the prostate gland, coupled with advancements in MRI technology and varied pathologies affecting the prostate, result in several potential pitfalls in MR image interpretation. 3. To ensure accurate interpretation, the radiologist must be familiar with the appearance of normal prostate anatomy, as normal variations can mimic clinically significant cancer, as well as benign entities which could simulate or mask cancer.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review normal anatomy of the prostate on MR with focus on central zone and anterior fibromuscular stroma 2. Illustrate benign prostatic pathologies and ways in which their imaging may mimic prostate cancer - Normal anatomic structures and expected postprocedural sequela that mimic cancer - Noncancerous abnormalities that may mimic cancer - Artifacts which may mimic or mask cancer 3. Describe locoregional invasion of prostate cancer beyond neurovascular bundles and capsular disruption 4. Highlight case-based teaching points with normal and abnormal prostate MRI 5. Provide flowchart guide on different interpretation pathways when reading prostate MRI for both junior and seasoned radiologists

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## Abstract Archives of the RSNA, 2023

GUEE-76

### Imaging and Management of Renovascular Hypertension: State-of-the-Art

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the pathophysiology of renovascular hypertension (RHT) 2. To discuss the role of multimodality imaging in the diagnostic pathway of RHT 3. To illustrate the imaging appearances of various causes of RHT 4. To review the role of interventional management of RHT.

#### TABLE OF CONTENTS/OUTLINE

1. RENOVASCULAR HYPERTENSION- DEFINITION 2 .IMAGING MODALITIES- Ultrasound, doppler; CTA, Photon counting CT; MRA- Contrast and non contrast techniques (3D SSFP, Phase contrast), 4D flow; Catheter angiography; Nuclear medicine; 3. DISCUSSION OF ETIOLOGIES OF RENAL HYPERTENSION WITH MULTIPLE CASE EXAMPLES - Non-stenotic lesions (via renal artery compression and/or changes in renal perfusion) o Renal artery aneurysm o Renal arteriovenous fistula - Stenotic lesions (via renal artery compression/occlusion) o Atherosclerotic disease o Fibromuscular dysplasia o Neurofibromatosis type 1 o Midaortic syndrome o Dissection o Vasculitis (Polyarteritis nodosa ,Takayasu arteritis) o Trauma o Retroperitoneal fibrosis/radiation o Thromboembolism 4. ROLE OF IMAGING IN EXCLUDING OTHER CAUSES OF REFRACTORY HYPERTENSION- Endocrine- pheochromocytoma, hyperaldosteronism, Cushing's, thyroid dysfunction, hyperparathyroidism; Renal parenchymal disease; Mid aortic syndrome, coarctation; 5. IMAGING APPROACH FOR RHT 6. END-ORGAN ASSESSMENT- Kidneys, Heart, brain 7. TREATMENT- Optimal management is individualized to patient clinical context and dependent on etiology of renovascular hypertension; Medical - antihypertensives (i.e. ACE inhibitors/ARBs); Interventional- Angioplasty, stenting; Surgical

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

GUEE-77

### **Bosniak IV Cystic Masses: A Tough Nut to Crack**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Ignacio De Garcillan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To revise Bosniak IV cystic mass v 2019 CT and MRI features.- To review possible pitfalls: interpretative, technical, and mass related.- To illustrate several Bosniak IV cases from our hospital.

#### **TABLE OF CONTENTS/OUTLINE**

In 2019 a new Bosniak classification version was published providing a detailed description of Bosniak IV category features. Its main objective was to increase specificity. Nevertheless, interpretation and classification of septa and nodule in each category remains challenging. In this exhibition we will focus on Bosniak IV cystic masses. Each feature will be revised and discussed to avoid misinterpretation. Potential pitfalls will be reviewed: interpretative quantitative and qualitative features, technical concerns, and mass related issues. Examples of these pitfalls will be exhibited with several recommendations to avoid them: zooming, multiplanar reconstruction, exclusive enhancing septa measuring, subtraction imaging, best quality sequence and examination selection, temporal evolution, employing Bosniak classification when applicable etc. Bosniak IV cystic masses diagnosed at our centre will be illustrated with different imaging techniques. Several clear cell renal carcinomas with cystic transformation, papillary carcinoma, clear cell papillary renal cell tumour, multilocular cystic neoplasm, fumarate hydratase- deficient renal carcinoma and unclassifiable renal carcinoma will be shown.

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## Abstract Archives of the RSNA, 2023

GUEE-78

### What Can Go Wrong When Doing Right? Iatrogenic Genitourinary Complications

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jeffrey Wang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. A growing number of systemic, minimally invasive, and surgical treatment modalities for various genitourinary (GU) pathologies may lead to various unique iatrogenic complications. Diagnostic imaging plays an essential role in detection and subsequent management. 2. A multimodality approach to identifying iatrogenic GU complications is key for prompt diagnosis to prevent morbidity. For example, both multiphasic CT urogram and fluoroscopic antegrade nephrostogram can be utilized to confirm ureteral injury. 3. Knowledge of key imaging findings and mimics of complications are important to prevent misdiagnosis and mistreatment as well as to distinguish expected post treatment appearance from complication.

#### TABLE OF CONTENTS/OUTLINE

A. Introduction 1. Review of treatment modality types for various GU pathologies (both benign and malignant) 2. Pictorial review of genitourinary anatomy and areas prone for iatrogenic injury • Essential GU anatomical structures • Common postsurgical anatomy • Discussion on the radiosensitivity of the GU system B. Multimodality approach to identifying GU complications 1. Decision tree on selecting the most optimal imaging type for common complications C. Case-based imaging review of iatrogenic GU complications 1. Systemic treatment 2. Minimally invasive interventions 3. Surgical intervention

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## Abstract Archives of the RSNA, 2023

GUEE-79

### Magnetic Resonance Imaging Review and Virtual Biopsy of Common Solid Renal Masses

All Day Room: Learning Center

Luis F. Calimano-Ramirez (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Relevant anatomic review of the renal system. 2. Review multiple cases with magnetic resonance imaging features of neoplastic pathology. 3. Review correlation with pathology result to examine the function of magnetic resonance imaging as means of virtual biopsy toward identifying renal mass characteristics in selected cases.

#### TABLE OF CONTENTS/OUTLINE

1. Neoplastic pathologies: I. Benign etiology: a. Renal leiomyoma b. Renal Angiomyolipoma c. Renal Oncocytoma d. Renal plamacytoma e. Solitary fibrous tumor. II. Malignant etiology: a. Clear Cell Renal cell Carcinoma b. Papillary Cell Carcinoma c. Medullary Renal Cell Carcinoma d. Collecting Duct Carcinoma e. Urothelial Cell Carcinoma f. Renal Lymphoma.2. Inflammatory etiology: a. Xanthogranulomatous Pyelonephritis.

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## Abstract Archives of the RSNA, 2023

GUEE-8

### Imaging of Renal Cancer: The Past, The Present, and The Future

All Day Room: Learning Center

Alex Chung, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Many benign cystic and solid renal lesions can be reliably distinguished on multiple imaging modalities such as US, contrast-enhanced US (CEUS), CT and MRI, including Bosniak I/II cysts and fat-rich angiomyolipoma (F-AML).-Among indeterminate renal lesions such as clear cell renal cell carcinoma (ccRCC), papillary renal cell carcinoma (pRCC), chromophobe renal cell carcinoma (chrRCC), oncocytoma (Onc) and fat-poor angiomyolipoma (FP-AML), the enhancement characteristics and other parameters can further characterize the renal lesions.-Likert-based CT and MR likelihood scores for renal masses can help stratify the risk of indeterminate renal lesion for active surveillance or surgical management.-Novel imaging parameters and artificial intelligence will further assist in imaging characterization of indeterminate renal lesions.

#### TABLE OF CONTENTS/OUTLINE

-Introduction.-Normal Anatomy and Conventional Imaging Technique.-Imaging Findings/Pathology.-Enhancement characteristics including Mean Enhancement, Absolute Enhancement, Relative Enhancement, Absolute De-enhancement and Relative Washout.-Likelihood scores to aid risk stratification.-Novel imaging parameters and artificial intelligence, including 99mTc-sestamibi SPECT, Perfusion, Radiogenomics and Machine/Deep learning.-Biopsy of Renal Masses

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## Abstract Archives of the RSNA, 2023

GUEE-80

### Urine the Wrong Place - When Urine Leaves the Urinary Tract. A Review of Urine Leaks and Urinary Tract Fistulas

All Day Room: Learning Center

Emily R. Convery, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The presentation of urine leaks and fistulas can be variable; however, a good patient history will usually raise suspicion for these entities. It is important to understand the pathology of urinary leaks and fistulas as well as the expected anatomy, including normal and post-operative, to understand the imaging findings. Familiarity with the principles of CT urogram is crucial in distinguishing blood from urine in trauma and post-operative patients to accurately make a diagnosis. The radiologist plays a vital role in these cases in recommending and troubleshooting follow up imaging as well as in guiding clinicians in their management. Management usually involves urinary diversion, which interventional radiology plays a large role in.

#### TABLE OF CONTENTS/OUTLINE

1) Review of normal male and female urinary tract anatomy and expected post-operative findings 2) Review of urinary tract imaging protocols - CT urogram, cystograms 3) Renal leaks - traumatic, spontaneous 4) Ureteral leaks - traumatic, iatrogenic 5) Bladder leaks - traumatic, iatrogenic, spontaneous 6) Urinary tract fistulas 7) Treatment/management options - IR interventions for urinary diversion

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## Abstract Archives of the RSNA, 2023

GUEE-81

### **MRI after Focal Therapy for Prostate Cancer: What Radiologists Must Know**

All Day Room: Learning Center

Rozita Jalilianhasanpour, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Overview of the currently available focal treatments for prostate cancer: indications, contraindications, and techniques.-  
Review of potential complications of each procedure: frequency, diagnosis, and management.-Discussion of expected  
postoperative MRI findings of each procedure: early and late.-Review of imaging findings of recurrent prostate cancer post  
focal treatment: diagnosis, mimics, and management.-Discussion of potential pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction-Rationale for focal therapy.-Potential benefits.-Criticisms to focal therapy.-Importance for radiologists and  
urologists.Treatment options-Electroporation (NanoKnife): Technique, Post-op appearance (Early and Late), Complications,  
Recurrence.-HIFU (FocalOne and TULSA): Technique, Post-op appearance (Early and Late), Complications, Recurrence.-  
Cryoablation: Technique, Post-op appearance (Early and Late), Complications, Recurrence.-Laser Ablation: Technique, Post-op  
appearance (Early and Late), Complications, Recurrence.

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## Abstract Archives of the RSNA, 2023

GUEE-82

### Advances in MRI Techniques for Evaluation of Upper Urinary Tract Neoplasms: A Comprehensive Review

All Day Room: Learning Center

Mohamed A. El-Ghar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Familiarizing with the different advanced MRI techniques used in the evaluation of renal neoplasms, including diffusion-weighted imaging (DWI), intravoxel incoherent motion (IVIM) MRI, Diffusion Tensor Imaging (DTI), Blood oxygen level dependent (BOLD) MRI and Arterial spin labeling (ASL). 2. Identifying the advantages and limitations of conventional and advanced MRI techniques in the evaluation of renal neoplasms, how they can improve diagnostic accuracy, characterization of the masses and treatment planning. 3. Understanding the role of MRI in the staging renal neoplasms, and if their role for the new techniques. 4. Familiarizing with the current guidelines and recommendations for the use of MRI in the evaluation of renal neoplasms. 5. Identifying potential areas for future research and development in the field of MRI for the evaluation of renal neoplasms, including the use of artificial intelligence and machine learning algorithms to improve diagnostic accuracy and reduce interpretation variability.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction - Definition and incidence of upper urinary tract neoplasms - Importance of accurate diagnosis and staging - Overview of MRI techniques for evaluation II. Conventional MRI Techniques -T1- and T2-weighted imaging -Contrast-enhanced imaging -Limitations and challenges III. Advanced MRI; DWI MRI, IVIM-MRI,DTI-MRI, BOLD-MRI, ASL, Comparative advantages of advanced techniques • IV. Applications in Upper Urinary Tract Neoplasms • Diagnosis and characterization of renal masses • Differentiation between benign and malignant tumors • Staging of malignant masses • V. Clinical Implications and Future Directions • VI. Conclusion

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## Abstract Archives of the RSNA, 2023

GUEE-83

### How to Do a Urethrogram... in Less than 15 Minutes and with No Special Equipment

All Day Room: Learning Center

Connor Cummings, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Urethrograms are nothing to be afraid of;
- We have developed a technique that is well-tolerated, can be performed in less than 15 minutes, and requires no specialist equipment;
- This exhibit explains how to perform our technique for both males and females;
- We also illustrate the important anatomical structures, pitfalls, and complications of this technique.

#### TABLE OF CONTENTS/OUTLINE

The ideal urethrogram should be quick, well-tolerated, provide high-quality diagnostic images and, if possible, not require any special equipment. At our institution, we have stopped using Knutson's clamps and balloon-occlusion catheters, and now perform approximately 15 studies per week with just 6Fr and 10Fr catheters. The technique we have developed is quick, well-tolerated and provides diagnostic images of the whole (a) anterior and (b) posterior urethra: a) A 10Fr catheter is inserted into anterior urethra. The patient compresses the distal penile shaft while the anterior urethra is imaged in two oblique planes. A release view (with hand suddenly removed) allows the urethra to decompress and distends the submeatal urethra, visualised on fluoroscopy at 3-4 frames/sec; b) The bladder is filled via a catheter or via retrograde instillation (we discuss both methods). The patient voids for a descending study in the oblique plane. We also discuss a rapid '5min urethrogram' in patients without tight strictures, which only requires inserting a catheter once. Adaptions are covered for the following scenarios: i) Tight strictures; ii) Occlusive segments; iii) The female urethra; iv) Pericatheter studies. The relevant common pitfalls and uncommon complications of this technique are also discussed.

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## Abstract Archives of the RSNA, 2023

GUEE-84

### Evolving Role of Conventional Imaging for Prostate Cancer in the Era of PSMA PET

All Day Room: Learning Center

#### Awards

##### Cum Laude

Hiroaki Takahashi, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Prostate-Specific Membrane Antigen (PSMA)-targeted positron emission tomography (PET) imaging is increasingly utilized for evaluating patients with high-risk prostate cancer (PCa) or recurrent PCa. The current National Comprehensive Cancer Network (NCCN) guidelines describe that conventional imaging is not a prerequisite to PSMA-PET for PCa staging. However, we have witnessed growing demand for conventional imaging as a confirmatory test for indeterminate findings on PSMA PET. PSMA-avid lesions other than PCa metastasis may cause false-positive observations, whereas PCa metastases to PSMA avid organs result in false-negative observations. Further, in conjunction with PSMA PET, prostate MRI has better performance in assessing the primary PCa, as well as local recurrence. In this context, PSMA PET does not replace conventional imaging, but does change the way in which conventional imaging is used. This exhibit will discuss the strategic approach of conventional PCa imaging in the era of PSMA PET. The purposes of this exhibit are: 1. To review the evolving role of conventional PCa imaging in the era of PSMA PET. 2. To discuss strategies to address recently recognized PSMA PET imaging pitfalls.

#### TABLE OF CONTENTS/OUTLINE

1. Fundamental mechanism and imaging interpretation of PSMA PET. 2. Role of conventional PCa imaging: focusing on imaging pitfalls of indeterminate findings on PSMA PET.- Assessment of primary PCa.- Assessment of local recurrence.- Assessment of metastases involving lymph nodes, bones, and solid organs. 3. Summary.

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## Abstract Archives of the RSNA, 2023

GUEE-85

### Urinary Bladder Diverticula: Imaging Features and Complications

All Day Room: Learning Center

Grace G. Zhu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe different categories of urinary bladder diverticula with comparison to normal urinary bladder.  
2. Discuss urinary bladder diverticula multimodal imaging features  
3. Provide a case-based review of urinary bladder diverticula complications

#### TABLE OF CONTENTS/OUTLINE

1. Description of the different types of urinary diverticula  
A. Describe histology of normal urinary bladder and diverticula  
B. Highlight features of true and false urinary bladder diverticula  
2. Imaging of urinary bladder diverticula  
A. Describe features of uncomplicated urinary bladder diverticula  
B. Identify pitfalls that prevent optimal imaging  
3. Provide examples of diverticula mimics  
3. Case based review of urinary bladder diverticula complications  
A. Urine stasis and urinary bladder diverticula pathology  
B. Diverticular stones  
C. Diverticula and urinary tract infection  
D. Cancer and staging consideration in diverticula  
E. Incomplete voiding and obstruction

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-86

### The Crucial Role of Ultrasound in the Detection of Renal Transplantation Complications

All Day Room: Learning Center

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To know the essential role of ultrasound in the detection of renal transplant complications. - To describe the systematic to follow when performing an ultrasound of renal transplantation. - To learn the typical ultrasound findings of renal transplant complications. - To be able to recognize those cases in which it will be necessary to complete the study with another tests in order to confirm the suspected diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Doppler ultrasound is one of the control tests routinely performed on all patients 24-48 hours after renal transplantation, as well as subsequently according to their evolution. Thanks to ultrasound, we can assess the state of the renal graft and rule out the existence of associated complications, which may be divided into: 1. Vascular complications: - Renal artery stenosis. - Renal artery thrombosis. - Renal vein thrombosis. - Pseudoaneurysm. - Arterio-venous fistula. 2. Urological complications: - Ureteral obstruction. 3. Perirenal collections: - Hematoma. - Urinoma. - Abscess. - Lymphocele. 4. Parenchymal complications: - Acute tubular necrosis. - Acute rejection. - Immunosuppressant toxicity. 5. Other complications: - Lithiasis. - Renal graft infections (early and late). - Chronic rejection. In this paper we will detail the ultrasound findings that characterize these complications, through representative images of cases belonging to our institution. We will also explain those patients in which it was necessary to perform additional studies to confirm the suspected diagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-87

### Penile Ultrasound: A Pictorial Review of the Anatomy and the Most Relevant Pathologies

All Day Room: Learning Center

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To become familiar with the normal sonographic appearance of the penile structures, as well as to know its arterial and venous vascularization.- To understand the technique of intracavernous injection of vasoactive substances, along with the normal response of vascular structures.- To review the main pathologies affecting the penis and their sonographic findings.

#### TABLE OF CONTENTS/OUTLINE

1. Penile anatomy by ultrasound: to recognize the anatomical structures in conjunction with the arterial and venous vascularization.2. Main penile pathologies: - Peyronie disease: its diagnosis is clinical, but ultrasound can confirm its presence, determine the extent of plaques and rule out a possible associated erectile dysfunction. - Erectile dysfunction: through intracavernous injection of vasoactive agents (PGE1) it is assessed whether there is a vascular (arterial or veno-occlusive) cause of erectile dysfunction. - Priapism: to evaluate ischemic, non-ischemic or metastatic causes. - Penile inflammation (e.g. cellulitis, balanitis, cavernositis,...): the main usefulness of ultrasound is to estimate the extension of inflammation and rule out abscess formation. - Trauma: in case of suspected penile rupture, ultrasound is especially helpful in doubtful cases or to locate the fracture line, as well as to assess long-term complications. - Benign entities: including cystic lesions (raphe cysts, epidermoid, dermoid,...), sclerosing lymphangitis, segmental thrombosis of the corpus cavernosum, calciphylaxis,...- Tumors: ultrasound is appropriate to determine the depth of the tumor and its spread to the corpus cavernosum.

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## Abstract Archives of the RSNA, 2023

GUEE-88

### Unmuddling the Middle: a Guide to Central Renal Abnormalities

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Wendy Tu, MD, FRCPC (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Central renal pathologies can originate from all of the complex constituent structures of the kidney: the renal parenchyma, predominantly the medulla; collecting structures; sinus including fat and neural structures; vessels; lymphatics; and extension of retroperitoneal processes. Parenchymal and medullary pathologies can include benign or malignant tumors, from the common renal cell carcinoma to rare primary sarcomas. Both tumorous and nontumorous pathologies can occur in the renal pelvis, such as papillary necrosis or blood clot. Vascular lesions include renal arteriovenous fistula or renal artery aneurysms, which can mimic other pathologies. Retroperitoneal lymphoma, fibrosis, histiocytosis, or lymphangiomatosis can involve the renal sinus. Multimodality imaging with ultrasound, CT, MRI, and angiography is important for differentiation of pathologies. Imaging is crucial to predict partial nephrectomy complexity with use of nephrometry scores.

#### TABLE OF CONTENTS/OUTLINE

1) Parenchymal tumors invading the renal sinus such as renal cell carcinoma and mixed epithelial and stromal tumor family tumors 2) Benign and malignant medullary tumors such as hemangioma, primary sarcoma, and medullary carcinoma 3) Sinus and medullary pathologies such as mesenchymal tumors, retroperitoneal fibrosis, and histiocytosis 4) Collecting system processes including urothelial carcinoma, papillary necrosis, calcifications, and clots 5) Vascular anomalies such as arteriovenous malformations, renal artery aneurysm, and renal vein varix

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## Abstract Archives of the RSNA, 2023

GUEE-89

### The Body Meets the Adrenal: Adrenal Manifestations of Systemic Disorders

All Day Room: Learning Center

Wendy Tu, MD, FRCPC (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe imaging manifestations of adrenal gland involvement by common and uncommon systemic disorders. Paired organs of the endocrine system, the adrenal glands have important roles in production of cortical and medullary hormones and catecholamines. The glands can be affected by a variety of neoplastic and non-neoplastic systemic disorders, some with life-threatening consequences such as in cases of adrenal hemorrhage and shock. Radiologists should be familiar with imaging manifestations along with potential associated laboratory abnormalities to ensure correct characterization and diagnosis for guidance on management. It is essential to distinguish adrenal manifestations of systemic disorders from other primary benign and malignant adrenal lesions.

#### TABLE OF CONTENTS/OUTLINE

Entities discussed will include: 1) Hemorrhagic conditions such as stress-related hemorrhage. 2) Hematologic diseases such as lymphoma. 3) Autoimmune conditions leading to adrenalitis such as Ipilimumab-induced adrenalitis. 4) Conditions leading to adrenal hyperplasia such as paraneoplastic syndromes. 5) Hereditary syndromes such as Von Hippel-Lindau disease and Neurofibromatosis. 6) Granulomatous diseases such as tuberculosis. 7) Infiltrative disorders such as amyloidosis. 8) Adrenal hyperenhancement in the setting of systemic hypoperfusion.

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## Abstract Archives of the RSNA, 2023

GUEE-9

### Urine Trouble! An Interactive Review of Multiparametric MR Urography & It's Pitfalls

All Day Room: Learning Center

Jay A. Karajgikar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the MR techniques for optimizing multi-parametric MR urography with attention to pitfalls  
2. Identify advantages over CT Urography  
3. Identify imaging features of lesions involving the urothelium in a quiz-based format with radiology-pathology correlation

#### TABLE OF CONTENTS/OUTLINE

1. What is multi-parametric MR Urography and how does it improve diagnosis?  
2. Why would MR Urography be preferred over CT Urography? What are the benefits and limitations?  
3. Improvements in MR sequences (including compressed sensing, k-space under-sampling, parallel imaging, and AI), which allow unprecedented improvement in image quality.  
4. Dilemmas in technique - is Lasix injection needed? Prone versus supine patient positioning? Wide vs narrow FOV? Are cine-T2 images useful?  
5. How to identify and avoid pitfalls and artifacts - flow voids on T2? T1\* effects due to concentrated gadolinium?  
6. How does MR urography help in identification and staging of urothelial neoplasms?  
7. How can MR urography help identify common, uncommon, and rare mimics of urothelial lesions using a rad-path quiz-based format?

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## Abstract Archives of the RSNA, 2023

GUEE-90

### 2022 WHO Classification of Adrenal Tumors Revisited: Atlas of Diseases with Pathological Insights

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Adriano Basso Dias, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the update 2022 WHO Classification of Adrenal Cortical Tumors  
Review the update 2022 WHO Classification of Pheochromocytoma and Paragangliomas  
Identify imaging features with radiologic-pathologic correlation of common and uncommon adrenal lesions

#### TABLE OF CONTENTS/OUTLINE

Are There Any Nomenclature Changes or Any New Diagnostic Categories in the New WHO Classification of Adrenal Cortical Proliferations?  
What are the Radiological and Pathological Correlates of Adrenal Cysts?  
What Should a Radiologist Know about Adrenal Cortical Carcinoma?  
Why Do Radiologists and Pathologists Need to Know Ectopic or Heterotopic Locations for Adrenal Cortical Tissue?  
What are the Highlights in the New WHO 2022 Classification of Pheochromocytoma and Paragangliomas  
Miscellaneous (Including Mesenchymal and Stromal Tumors)

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

GUEE-91

### Focal Therapy of Prostate Cancer: A Primer for Radiologists

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Adriano Basso Dias, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understand the current concepts of prostate focal therapy  
Recognize the most important MRI features to report pre and post focal therapy  
Known the role and limitations of prostate MRI for patient selection for focal therapy  
Be familiar with future directions of imaging techniques in focal therapy

#### TABLE OF CONTENTS/OUTLINE

Introduction - Indications, energy sources and templates available for focal therapy (FT)  
Role of imaging in the pre treatment assessment- MRI for diagnosis, staging and patient selection for FT  
Role of imaging in the post treatment assessment- MRI findings post FT- Types of recurrence- Pitfalls  
Future Perspectives- What imaging modalities are on the horizon for patient selection for focal therapy and treatment guidance

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-92

### The Extraperitoneal Cavity: Gaining Understanding through Surgical Procedures

All Day Room: Learning Center

Kiyoko Mukai (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The extraperitoneal cavity has a complex anatomy, and furthermore, there is limited opportunity to understand this invisible anatomy on imaging. In this presentation, we will discuss the anatomy of the extraperitoneal cavity and the importance of preoperative imaging in surgical planning, using the surgical technique for prostatectomy as a guide.

#### TABLE OF CONTENTS/OUTLINE

Learn basic techniques and anatomy in standard surgical procedures

1. Intra-abdominal observation
2. Dissection of the retroperitoneal space/Retzius cavity
3. Lymph node dissection
4. Incision of the endopelvic fascia
5. Dissection of the bladder neck
6. Dissection of the seminal vesicles
7. Management of the prostate pedicles
8. Dissection of the posterior aspect of the prostate
9. Management of the lateral aspect of the prostate
10. Division of the urethra
11. Reconstruction (including urethral anastomosis)

A collection of cases

- Case1: Benign prostatic hyperplasia
- Case2: Enlargement of the middle lobe
- Case3: Previous transurethral resection of the prostate (TURP)
- Case4: T3 prostate cancer
- Case5: Prostatitis
- Case6: Vascular anomaly

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-93

### Insights into Urethra: A Diagnostic Approach and Comprehensive Guide to Multimodal Imaging in Urethral Lesions

All Day Room: Learning Center

#### Awards

##### Cum Laude

Koichiro Kimura, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Urethral lesions can range from common to rarely encountered in clinical practice. Imaging modality plays a key role in evaluating the variety of urethral conditions because of its high objectivity and utility. This exhibit aims to introduce the multimodal imaging spectrum of urethral lesions, from traumatic change to neoplasms, and demonstrate the diagnostic approach to becoming familiar with urethral lesions.

#### TABLE OF CONTENTS/OUTLINE

Presentation goals: 1. To demonstrate the normal anatomy of the male and female urethra. 2. To demonstrate the step-by-step diagnostic approach to the urethral lesions. 3. To demonstrate multimodality imaging findings of various urethral lesions. Illustrative imaging/cases include: (i) Traumatic and post-treatment changes & 1; Urethral injury, & 1; Urethral foreign body, & 1; Iatrogenic changes (& 1; Radiation therapy induced urethritis, & 1; Changes after transurethral injection therapy, & 1; Operative complications) (ii) Intra- or peri-urethral lesions - Intra-urethra & 1; Urethral stones, & 1; Urethral caruncle, & 1; Fibroepithelial polyp, & 1; Primary urethral carcinoma, & 1; Malignant melanoma, & 1; Lymphoma, & 1; Sarcoma- Peri-urethra & 1; Urethral diverticulum, & 1; Periurethral cyst, & 1; Peyronie's disease, & 1; Leiomyoma, & 1; Tumors arising from urethral diverticulum- Both intra- and peri-urethra & 1; Urethral cellulitis, & 1; Urethral abscess (iii) Non-urethral origin neoplastic lesions & 1; Direct invasion from pelvic and genital tumors, & 1; Metastatic tumors

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

GUEE-94

### **Standardized, Vesical Imaging Reporting and Data System (VI-RADS) - Compliant, Acquisition and Interpretation of Multiparametric Magnetic Resonance of the Bladder: A Practical Guide**

All Day Room: Learning Center

Martina Pecoraro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Bladder multiparametric MRI is the most accurate imaging test for local staging of bladder cancer. 2. The Vesical Imaging Reporting and Data System (VI-RADS) has standardized the acquisition protocol of bladder MRI and created a 5-point scoring system to differentiate muscle invasive from non-muscle invasive bladder cancer. 3. The use of VI-RADS for bladder cancer local staging has shown excellent diagnostic performance and inter-reader reproducibility in multiple studies. 4. High diagnostic accuracy of bladder MRI and VI-RADS is dependent on proper patient preparation and implementation of the imaging protocol. 5. Pitfalls in evaluating bladder MRI can occur and needs to be acknowledged

#### **TABLE OF CONTENTS/OUTLINE**

MRI of the bladder with the use of VI-RADS is a powerful diagnostic tool for the local assessment of bladder cancer, but it requires the radiologist to implement a specific acquisition protocol and image interpretation standards to achieve optimal diagnostic accuracy and reproducibility. In this educational exhibit we discuss with a practical approach the technical aspects to follow for the correct acquisition of VI-RADS compliant bladder MRI studies. Furthermore, we provide a practical approach to the assessment, scoring, and reporting of bladder lesions according to the VI-RADS scoring system. Also, we provide details on what is beyond VI-RADS 1.0 concerning Pitfalls and Tips and Tricks: details will cover bladder distension and how to handle with it, pitfalls in staging cancers located at ureteral orifices, at folded bladder walls (e.g anterior bladder wall), at diverticula, and after previous tumor resection. To conclude we will provide insights on training and VI-RADS learning curve.

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## Abstract Archives of the RSNA, 2023

GUEE-95

### Everything a Radiologist Needs to Know About the Diagnosis and Treatment of Renal Angiomyolipomas

All Day Room: Learning Center

Brendan Ryu, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) To review the epidemiology, pathophysiology, and genetic associations of renal AMLs. (2) To highlight the clinical presentation and imaging characteristics of renal AMLs. (3) To discuss the utility and efficacy of the various treatment options for renal AMLs.

#### TABLE OF CONTENTS/OUTLINE

Introduction and Associations - Overview- Normal Renal Anatomy and Vasculature - Epidemiology and Pathophysiology of Renal AMLs- Association with Tuberous Sclerosis Complex (TSC)Diagnosis- Clinical Presentation- Incidental Secondary to Complications (bleeding, etc.)- Imaging Modalities- Ultrasound/Doppler- Computed Tomography/Angiography- Magnetic Resonance Imaging/Angiography- Direct AngiographyTreatment and Management - Active Surveillance- Criteria for Intervention- Medical Management- mTOR inhibitors- Embolization- Glue- Particles- Coils- Other materials- Ablation- Surgery- Potential Treatment Complications- Bleeding- Non-target embolization- Post-operative collectionPost-Treatment Imaging Appearance

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## Abstract Archives of the RSNA, 2023

GUEE-96

### **Pre- and Post-treatment Imaging of Upper Urinary Tract Urothelial Cancer (UTUC): National Comprehensive Cancer Network and European Association of Urology UTUC Guidelines in 2023**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Hirotsugu Nakai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Upper tract urothelial cancer (UTUC) accounts for 5-10% of UCs. However, 60% of UTUC are invasive at the diagnosis, and multiplicity of disease is common. Therefore, lifelong surveillance is required. Imaging and image-guided biopsy and intervention play an important role in the diagnosis and management of patients with UTUC. CT urography (CTU), MR urography (MRU), and retrograde ureteropyelography with CT or US are used for detection, localization, staging and follow-up of patients with UTUC. FDG PET/CT and chest imaging are useful for staging and re-staging when metastasis is suspected. This is a comprehensive review of the spectrum of clinical and imaging findings of pre- and post-treatment UTUC with illustration of key multimodality imaging findings in representative cases.

#### **TABLE OF CONTENTS/OUTLINE**

1) Background of UTUC; epidemiology, risk factors, manifestations, pathology, and staging.2) Review of National Comprehensive Cancer Network (NCCN) and European Association of Urology (EAU) UTUC guidelines, version 2023.3) Technique and utility of imaging modality including CTU, MRU, retrograde ureteropyelography with CT or US, FDG PET/CT, chest CT and radiography, and image guided biopsy and intervention.4) Imaging findings of urothelial cancer of the pelvicaliceal systems and ureters before and after treatment.5) Conditions mimicking UTUC including lymphoma, primary renal neoplasms, metastasis, sarcoma, fibroepithelial polyp, inverted papilloma, ureteritis, amyloidosis, and suburothelial hemorrhage.6) Summary

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## Abstract Archives of the RSNA, 2023

GUEE-97

### **A Spectrum of LUT Pathologies in Males: A Pictorial Review**

All Day Room: Learning Center

Maria M. Salazar Osorio, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To explain a general review of the male lower urinary tract (LUT) anatomy through diagrams and multimodal images.- To review the most common pathologies and their diagnosis by multiple imaging techniques.- To discuss through real cases common and not-so-common presentations of the pathologies of male LUT.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction- Anatomy- Imaging techniques- Main indications- Clinical findings and characteristic features of each presentation (congenital anomalies, benign and malignant pathologies of the urethra, bladder, and prostate)- Conclusions

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## Abstract Archives of the RSNA, 2023

GUEE-98

### Are We Talking About the Same Thing? How EPE is Scored

All Day Room: Learning Center

Andre De Freitas Secaf, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Prostate cancer is the second most common cause of cancer-related deaths in men. The first option for treating intermediate and high-risk disease is radiotherapy or radical prostatectomy, however, this choice heavily relies on the presence of extraprostatic extension (EPE). EPE is associated with a higher risk of positive surgical margins, biochemical recurrence, metastatic disease and shorter overall survival. For better surgical planning, the evaluation of EPE using multiparametric magnetic resonance imaging (mpMRI) is essential. There are two major criteria for assessing EPE, through mpMRI, one from National Cancer Institute (NCI) and one from the European Society of Urogenital Radiology (ESUR). The NCI score can be classified as 0- no suspected pathological EPE; 1- curvilinear contact length or capsular irregularity and bulge; 2- curvilinear contact length and capsular irregularity and protuberance; 3- EPE visible on MRI or invasion of adjacent anatomical structures. The ESUR score uses a five-point scale (1 = capsular abutment; 2 = not specified; 3 = capsular irregularity; 4 = neurovascular bundle thickening, bulge, or loss of capsule; 5 = measurable extracapsular disease). We aim to discuss the imaging findings of EPE and how to score them according to the NCI and ESUR criteria, emphasizing their strengths and limitations. These scores should be familiar for any radiologist working in the prostate field, as a more accurate diagnosis of EPE can significantly impact the patient's management and outcomes.

#### TABLE OF CONTENTS/OUTLINE

Introduction; NCI and ESUR scores; Cases of EPE using both scores; Discussion.

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## Abstract Archives of the RSNA, 2023

GUEE-99

### Spectrum of Fat Containing Lesions in the Adrenal Gland: Tips, Tricks and Mimics

All Day Room: Learning Center

Jorge A. Abreu Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Identify the role of CT and MRI in identification of macroscopic and microscopic fat - including pitfalls, and newer entities including radiomics, histogram analysis, dual-energy decomposition and AI techniques  
2. Describe the common, and uncommon adrenal nodules which present with fat, with an algorithmic approach as to how the type (macroscopic vs microscopic), amount (small vs large), distribution (homogeneous vs heterogeneous), helps arrive at the right diagnosis.

#### TABLE OF CONTENTS/OUTLINE

- Adrenal nodules can have microscopic (intravoxel) fat or macroscopic (bulk fat), or both. However, they often mimic each other.  
- What is the role of CT in detection of microscopic fat? Does an attenuation of <10HU always mean microscopic fat? What are the pitfalls of detecting macroscopic fat with CT - increased noise, small ROI? Can histogram analysis improve CT performance? How can dual energy CT improve fat-detection and fat quantification?  
- What is the role of MRI in detecting microscopic fat? Is MRI only useful when non-contrast CT attenuation is between 10-30HU? Which is better to depict fat - 2D sequences or 3D sequences? How can flip-angles be optimized to improve detection of fat? How are MRI fat quantification methods applicable to focal adrenal lesions?  
- Amount of bulk fat in adrenal lesions matters - Masses with >50% of bulk fat are myelolipomas; < 50% - can represent myelolipomas or myelolipomatous degeneration which could occur in either an adrenal adenoma or adrenocortical carcinoma.  
- How to approach diagnosis of lipid poor adenoma with cross sectional imaging.  
- What are the different patterns of signal loss on out of phase T1w in the diagnosis of adrenal adenoma, when to suspect malignancy?

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## Abstract Archives of the RSNA, 2023

HNEE

### Head & Neck Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **HNEE-1 Don't Lose Your Nerve: Pictorial Review of Cranial Nerve Denervation in the Head and Neck**

##### Awards

##### Certificate of Merit

Rachel Saks, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

1. Review the pathophysiology of denervation and the subsequent imaging changes that occur within the muscle over time. 2. Review the anatomy of the cranial nerves with motor function, particularly focussing on the muscles innervated by each nerve and their appearances with acute and chronic denervation. 3. Review potential imaging pitfalls due to denervation changes, such as misinterpretation of contralateral FDG uptake in the setting of vocal cord palsy.

##### TABLE OF CONTENTS/OUTLINE

1. Pathophysiology of denervation 2. Imaging findings in acute, subacute and late denervation 3. Cranial nerve anatomy and appearances of denervation of the muscles innervated by the specific nerve- Oculomotor nerve- Trochlear nerve- Abducens nerve- Trigeminal nerve- Facial nerve- Glossopharyngeal nerve- Vagus nerve- Spinal Accessory nerve- Hypoglossal nerve 4. Imaging pitfalls

#### **HNEE-10 Don't Get Trapped: Diagnostic Errors in Emergency Head and Neck Radiology**

Thiago Jose Pinheiro Lopes, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

- An incidence of 3-4% of errors in the radiological routine is estimated. In the emergency room, the accuracy of the diagnosis becomes even more relevant, considering the need to take more immediate measures depending on the imaging findings. - Errors in diagnostic radiology can occur for a variety of reasons. Recognizing the cognitive views that favor their occurrence is important to prevent them. - Our objective is to present a series of head and neck radiological cases, unraveling the causes of errors and then providing strategies to be followed to minimize them during radiological interpretation.

##### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Types of errors in diagnostic radiology (Renfrew Classification). 3. Series of misdiagnosis real cases in emergency room head and neck radiology, including: a) Case discussion: anatomy review, possible complications related to an error in image interpretation. b) Identification of the error causes. c) Tips on how to avoid them. 4. Challenges, pearls and pitfalls when interpreting a head and neck radiological exam. 5. Take home messages.

#### **HNEE-11 Basic Principles of Nasal Imaging**

##### Awards

##### Certificate of Merit

Mina Al-Ani, MBBCh (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

Nasal masses can originate in the nasal cavity or adjacent structures. Utilizing a systematic approach for evaluating nasal imaging plays a crucial role in establishing a differential diagnosis, treatment, and surgical planning. After a review of nasal anatomy using illustrations and cross-sectional images, we discuss the fundamental principles of nasal imaging and their

application in the analysis of a broad spectrum of nasal abnormalities. Imaging features and clinical findings of these lesions are discussed.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief introduction emphasizing the role of imaging in diagnosing nasal lesions.2. Illustration of nasal anatomy.3. Principles of nasal imaging used in the evaluation of a wide range of nasal lesions, including but not limited to:a. Congenital lesions (e.g., encephalocele, supernumerary tooth, and nasolabial cyst)b. Benign masses (e.g., schwannoma, paraganglioma, and inverted papilloma)c. Malignant masses (e.g., squamous cell carcinoma, esthesioneuroblastoma, and nasal metastasis)d. Infectious and inflammatory lesions (e.g., fungal sinusitis, granulomatosis with polyangiitis, and rhinoscleroma)e. Pseudomasses (e.g., pneumosinus dilatans, septal hematoma, and rhinolith).4. Conclusion.

#### **HNEE-12 Orthognathic Imaging: Pre- and Post-Surgical Considerations for Craniofacial Reconstruction**

Jeffers Nguyen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The interpretation of orthognathic imaging studies is a growing part of both general and subspecialty neuroradiology practice. These studies are performed to evaluate a wide range of conditions, including congenital anomalies, traumatic injuries, neoplastic growth, and iatrogenic complications. They are necessary for successful craniofacial reconstruction. Surgical planning and post-surgical follow-up studies are used to evaluate for appropriate jaw alignment and bite and to assess for complications. These topics may not be covered in depth by educational materials at the residency and fellowship levels. We hope to provide an accessible, illustrative review at graded levels of orthognathic imaging for the trainee, general radiologist, and neuroradiologist. Finally, we will also briefly touch on principles related to imaging for an increasingly prevalent procedure, facial feminization surgery, and we will share cases related to our institution experience.

#### **TABLE OF CONTENTS/OUTLINE**

1) Etiologies of Maxillofacial Deformities;2) Important Orthognathic Terms and Concepts;3) Orthognathic Surgical Procedures and their Indications;4) Pre- and Post-Surgical Orthognathic Imaging Considerations;5) Overview of Facial Feminization Surgery (FFS);6) Utility of Orthognathic and FFS Presurgical Planning Macros and Reporting Checklists

#### **HNEE-13 Hypervascular Neck Lesions: From the Most Common to Uncommon Pathology**

Hugo E. Velazquez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To describe the anatomy of the neck spaces and its contents. -To determine the protocols used in suspected neck lesions by CTA and MRA. -To list the most common and uncommon neck lesions with a hypervascular pattern enhancement. -To illustrate clinical scenarios of these lesions.

#### **TABLE OF CONTENTS/OUTLINE**

1. A pictorial review of the anatomy of the neck spaces and its contents. 2. CTA and MRA protocols for the approach of neck lesions. 3. Key points of the most common vascular neck lesions. 4. Examples of uncommon vascular lesions of the neck to keep in mind.

#### **HNEE-14 Breaking the Ultrasound Barrier: Review of Sonographic Imaging of the Neck**

##### **Awards**

##### **Certificate of Merit**

Anu Kamalasanan, FRCR, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Tongue pathology can be assessed, characterized and staged with USS.2) Thyroglossal duct pathology are better assessed with USS as avascular cystic structure in infrahyoid midline anterior to the pre epiglottic space and cranially extending deep to the hyoid towards the midline posterior tongue which move dynamically with deglutition and protrusion of tongue. 3) Tonsils are seen as predominantly hypoechoic regions of alternating hyper and hypoechoic striations in the oropharynx, at the level of and deep to submandibular gland. 4) Pre epiglottic and paraglottic fat spaces are visualized as homogeneously hyperechoic avascular fat filled spaces with pathology presenting as hypoechoic mass. 5) Thyroid cartilage involvement presents with dehiscence of the hyperechoic cortex and infiltration of medulla and extra laryngeal tissues.

#### **TABLE OF CONTENTS/OUTLINE**

1) Illustrate with examples the normal sonographic appearance and contents of surgical triangles of the neck. 2) Illustrate with examples the sonographic cervical lymph nodal stations, normal and pathological sonographic appearance of lymph nodes. 3) Illustrate with example the normal sonographic appearance of the soft tissues of the neck, including sonographic

appearance of tongue, oropharynx, supraglottis and larynx. 4) Illustrate with examples the pathological sonographic appearance of the soft tissues of the neck, including pathology of tongue, oropharynx, supraglottis and larynx.

### **HNEE-15 Imaging of Nasal, Paranasal, and Skull Base Lesions: A Comprehensive Review**

Kota Yokoyama, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The World Health Organization's (WHO) Classification of Head and Neck Tumors, Fifth Edition, is now available in 2022. This book is essential for radiologists to consider differential diagnosis and to obtain clinical information. On the other hand, the classification is based on the origin of the lesion and the genes, which makes it inconvenient as a guide for specific anatomical sites. For example, bone and soft tissue tumors, hematologic tumors, melanotic tumors, minor salivary gland tumors, germ cell tumors, and neuroendocrine tumors which can occur anywhere in the head and neck region, are classified in their own category, creating unexpected pitfalls when considering the differential diagnosis of nasal, paranasal, and skull base lesions. In addition, since the book is not intended for radiologists only, it does not cover a wide range of useful diagnostic imaging findings. Focusing on the radiologist, this exhibition will provide a comprehensive review of CT, MRI, and nuclear medicine imaging findings of lesions that can occur in the nasal, paranasal, and skull base.

#### **TABLE OF CONTENTS/OUTLINE**

1. Anatomy of nasal, paranasal, skull base  
2. Sinonasal tract (nasal, paranasal, skull base) origin tumors  
3. Other origin tumors involving the sinonasal tract  
4. Inflammation involving the sinonasal tract  
5. Infections involving the sinonasal tract

### **HNEE-16 Clinical-radiologic Correlation of Acute Disorders of the Afferent Visual Pathway**

#### **Awards**

#### **Certificate of Merit**

Kyle Robey, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The afferent visual pathway includes structures that perceive and process visual information, as well as the intervening nerves and white matter tracts. Acute processes affecting the globes, optic nerves, optic tracts, optic radiations, and occipital cortices may result in sudden onset of vision loss. Given the relatively large anatomical area over which the afferent visual pathway is distributed, the insults which can occur are diverse in etiology. A broad differential should initially be considered, which can be focused by relevant history. Moreover, though the entire afferent visual pathway should be scrutinized in the setting of an acute visual deficit, an ocular examination and visual field campimetry may further localize the affected anatomical structure. Therefore, familiarity with the clinical presentation and neuro-ophthalmological exam can guide the radiologist in evaluating and interpreting CT and MR images.

#### **TABLE OF CONTENTS/OUTLINE**

1) Review of the anatomy of the afferent visual pathway  
2) Analyze and understand the main elements of a basic eye exam and correlate the findings with the affected anatomical area  
3) Review common and uncommon conditions of acute vision loss which span the afferent visual pathway

### **HNEE-17 Open Your Eyes! What Every Radiologist Should Know About Orbit Vascular Lesions**

Marcella N. Brandao, MD, MEd (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Understand well the anatomy of the orbit and dominate the normal in the image;  
Distinguish the pathologies that affect the extraconal, intraconal and both compartments;  
Recognize and review the particularities of the main diseases in the illustrative cases, both in Computed Tomography and Magnetic Resonance;

#### **TABLE OF CONTENTS/OUTLINE**

Every radiologist needs to be attentive to the details involving vascular lesions of the orbit. These diseases are infrequent, some extremely rare, but they cannot go unnoticed in differential imaging diagnoses. In addition, the natural history, growth pattern and histological composition of each lesion must be taken into account for the correct diagnosis. It is essential to recognize and keep in mind the diagnosis of: capillary hemangioma; venous lymphatic malformation; arteriovenous fistula; venous cavernous malformation; cavernous carotid fistula; ophthalmic artery aneurysm. Each image finding in the different modalities will be exemplified in detail through figures, descriptions and tables. Furthermore, the present study will make you a more complete radiologist, as it will explain the anatomy of the orbit relating it to each lesion in a direct, simple and intuitive way, making your diagnosis accurate and fast. In addition to serving as a guide for quick reference on the topic.

### **HNEE-18 Multimodality Imaging of Salivary Glands**

Kanupriya Vijay, MBBS, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. To discuss the anatomy of major salivary glands 2. To review salivary gland pathology categories and associated epidemiology 3. To describe ultrasound, CT/MRI features of common pathologies with pathologic correlation 4. To introduce newly described entities in salivary gland pathology 5. To highlight the utility of percutaneous biopsy, with technical considerations

### TABLE OF CONTENTS/OUTLINE

1. Normal anatomy a. Parotid b. Submandibular c. Sublingual 2. Common salivary gland pathologies a. Sialolithiasis b. Sjogren syndrome c. Infectious/Inflammatory conditions d. Cysts e. Neoplasms (with hints based on patient demographics and risk factors) i. Benign 1. Pleomorphic adenoma 2. Warthin's Tumor 3. Cystadenolymphoma 4. Other- Hemangioma, Oncocytoma, Basal Cell Adenoma ii. Malignant 1. Mucoepidermoid carcinoma 2. Adenocystic carcinoma 3. Squamous cell carcinoma 4. Adenocarcinoma 5. Acinic cell carcinoma 6. Lymphoma iii. Metastases 3. Newly described salivary gland pathology a. Sclerosing polycystic adenoma b. Mucinous/secretory variant of myoepithelioma c. Mammary analog secretory carcinoma d. Cribriform adenocarcinoma e. IgG4-related disease 4. Pitfalls 5. Percutaneous biopsy a. Approach and anatomical considerations b. FNA versus Core c. US vs CT guidance d. Complications 6. Summary/conclusion

### HNEE-19 Pediatric Head and Neck: On Call Resource

Alexandra M. Foust, DO (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. The spectrum of acute non-traumatic disease in the pediatric head and neck differs from that in adults. 2. Consider foreign body ingestion or aspiration in young child with sudden-onset respiratory distress or paroxysmal cough. 3. Meningitis, empyema, and venous sinus thrombosis are important complications of pediatric sinusitis or otomastoiditis cases.

### TABLE OF CONTENTS/OUTLINE

The vast array of acute non-traumatic pathologies encountered in the pediatric head and neck can be an intimidating subject for residents on busy call rotations with limited time to look up information. Although there is some overlap with adult diseases, many entities are more common in the pediatric population and, thus, it is important for radiologists caring for children to be well-versed in this topic. This multi-institutional, multimodality exhibit will be structured as an on-call resource for trainees, organized by anatomic location and highlighting key points, pearls, pitfalls, and mimics of many acute non-traumatic pathologies in the pediatric head and neck: Selected Examples: 1. Orbit: peri-orbital and orbital cellulitis, dacryocystitis, optic neuritis, proptosis 2. Sinonasal: complicated sinusitis 3. Ear: labyrinthitis, otomastoiditis, petrous apicitis 4. Oral/airway: epiglottitis, laryngotracheobronchitis, tonsillitis and peritonsillar abscess, Ludwig angina 5. Neck/spine: Grisel syndrome, retropharyngeal abscess, lymphadenitis, sialadenitis, torticollis, infection of congenital cysts, osteomyelitis 6. Variable: foreign body insertion (oral/nasal), angioedema 7. Vascular: Lemierre syndrome, vasculitis, nontraumatic dissection, and complicated vascular malformations

### HNEE-2 Proton Beam Therapy for Skull Base Chordoma and Chondrosarcoma: A Guide for the Radiologist

Gillian M. Potter, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- High-quality CT and MRI are critical for optimising surgical and radiotherapy decision-making and treatment in skull base chordoma and chondrosarcoma
- A detailed radiology report at the time of proton planning is essential for assessment of baseline and postoperative tumor sites, including distance to critical structures, with a required gap of =3mm from brainstem and =5mm from the optic apparatus
- Radiologists should be aware of surgical approaches to skull base tumors
- Radiologists should understand imaging appearances following multilayer endoscopic skull base repair and be aware of their evolution over time

### TABLE OF CONTENTS/OUTLINE

Skull base chordoma and chondrosarcoma are rare, locally aggressive tumors. Treatment consists of maximal surgical resection and postoperative adjuvant therapy. Proton beam therapy enables dose escalation to tumor while limiting exposure dose to critical neurologic structures (brainstem, optic apparatus). High-quality pre-operative CT and MRI are critical for proton planning. MRI should include T2, T2 fat saturation, T1, volume FLAIR, FIESTA and postcontrast T1 fat saturation, with at least one volume sequence. Preoperative CTA BrainLab with bone reconstructions enables assessment of bone erosion, vascular relations and anatomical assessment for endoscopic-approach surgery. Intraoperative MRI should be considered to confirm clearance from dose-limiting structures. Post-operative MRI is optimally performed at <48 hours to enable optimal distinction between post-operative changes relating to multilayer skull base repair and tumor residuum.

### HNEE-20 Congenital and Infantile Masses of the Head and Neck

Alexandra M. Foust, DO (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. A rapidly growing mass lacking high vessel density (Doppler US), internal flow-voids (MRI), and arterial-phase enhancement (MRI) should raise concern for lesions other than hemangioma. 2. It is important to describe the relationship of fetal head and neck masses to the airway so that appropriate delivery plans (EXIT procedure) can be made.

## TABLE OF CONTENTS/OUTLINE

The spectrum of congenital and infantile head and neck soft tissue masses is broad, including developmental structural deformities/deficiencies, ectopic tissues, and benign and malignant neoplasms. It is important for radiologists to be aware of the imaging features of these lesions so that timely and appropriate management can be pursued. This multi-institutional, multimodality exhibit highlights pearls and pitfalls from fetal and post-natal cases encountered during clinical practice to illustrate the imaging appearance of numerous common and rare infantile masses in the head and neck using an anatomic approach. Selected Examples: 1. Skull/scalp: Cephalohematoma and other collections 2. Nasal: nasal glial heterotopia, cephalocele 3. Orbital: dacryocystocele, orbital varix 4. Oral/airway: epulis, epignathus, nasopalatine duct cyst, vallecular cyst, hairy polyp, sialoblastoma 5. Ear: cholesteatoma 6. Neck: thyroglossal duct cyst, ectopic thyroid or thymus, fibromatosis coli 7. Variable: dermoid/epidermoid, branchial apparatus anomaly, vascular anomalies, neuroblastoma, rhabdomyosarcoma, infantile fibrosarcoma, melanotic ectodermal tumor of infancy.

## HNEE-21 Post-operative Imaging in Oncologic Skull Base Surgery Reconstructions

Bernardo C. Teixeira, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

? There is a broad spectrum of surgical techniques in resection of skull base tumors. ? Recognizing normal aspects of post-surgical grafts is important to differentiate from recurrent disease in skull base surgery. ? Radiologist plays an important role in preoperative and post-surgical management of this lesions.

## TABLE OF CONTENTS/OUTLINE

Anatomy and normal variants Skull base surgery is a complex procedure that involves accessing and operating on the delicate structures and the anatomical complex area at the base of the skull. It is challenging even for experienced surgeons and radiologists. It forms the floor of the cranial cavity and separates the brain from other facial and neck structures. It is divided into three regions: the anterior skull base, the middle skull base, and the posterior skull base. Each of these regions has its own unique anatomy and challenges when it comes to surgery. For a successful surgery, knowledge of the normal variants of the anatomy is crucial to avoid iatrogenic lesions during surgery. Some important normal variants include the pneumatization of the anterior clinoid process, sphenoidal (Onodi) cells, and postsellar pneumatization from the sphenoid sinus. These variants are associated with a greater risk for carotid and optic nerve injuries as well as cerebrospinal fluid (CSF) rhinorrhea. Neurosurgical options in accessing the skull base ? Frontotemporal ? Subfrontal ? Transpetrosal ? Lateral ? Endoscopic endonasal Common Neoplasms ? Pituitary adenoma ? Schwannoma ? Meningioma ? Olfactory neuroblastoma ? Skull base invasion from head and neck tumor Normal imaging characteristics of post-surgical grafts When to suspect a recurrent tumor?

## HNEE-22 Complications of Paranasal Sinus Mucoceles: A Pictorial Review

Joseph Carbone, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Teaching Points: 1. Review mucocele CT and MR imaging characteristics and their variance, as well as potential locations to be aware of with a highlight on important adjacent structures. 2. Describe complications of mucoceles with CT and MR correlates with a focus on findings requiring urgent management. 3. Provide radiologists with a framework for reporting when discussing mucoceles, adjacent structures, and their pertinent negatives as it relates to mucocele complications.

## TABLE OF CONTENTS/OUTLINE

Mucoceles are slow-growing lesions that result from obstruction of the facial paranasal sinuses. While they are most often benign, they can sometimes lead to urgent or severe pathology in nearby structures. The severity of clinical presentation varies depending on the sinus involved, ranging from asymptomatic to intracranial extension resulting in blindness. Further, radiologists should be aware for their potential for aggressive behavior and have an understanding for relevant reportable findings when describing mucoceles pertaining to mass effect and the location of adjacent structures, superimposed infection, and intracranial extension. This educational exhibit aims to review varying imaging characteristics of mucoceles and their potential locations using CT and MRI correlates. A pictorial review of mucoceles and their severe complications will be used to highlight key reportable imaging findings for radiologists when describing mucoceles and their involvement with adjacent structures.

## HNEE-23 Imaging of the Skull and Facial Bones for Pediatric and Adult Patients

Minako Azuma, MD, PhD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1. In pediatric and adult patients, a wide variety of abnormalities are found in the skull and facial bones, including tumors, inflammations, congenital disease, and so on. Additionally, there are also secondary changes in bone associated with some diseases. 2. It is necessary for radiologists to know radiological findings of the skull and facial bone disorders. 3. Radiologists also have to know normal variations that have no pathological significance.

## TABLE OF CONTENTS/OUTLINE

1. Anatomy and normal development of the skull and facial bones 2. Techniques for the imaging of the skull and facial bones (1) CT (2) MRI (3) CT like bone imaging in MRI 3. Normal variants of the skull and facial bones (1) Shape and thickness (2) Bone marrow (3) Pneumatization 4. Disorders of the skull and facial bones (1) Abnormality associated with suture (craniosynostosis) (2) Tumors and allied diseases a) Benign: Chordoma, osteoma, meningioma, and so on b) Malignant: chondrosarcoma, rhabdomyosarcoma, metastasis c) Allied diseases: Epidermoid cyst, hemangioma, Langerhans Cell Histiocytosis, and so on (3) Systematic disease a) Hematologic disorders: leukemia, multiple myeloma, anemias b) Metabolic and endocrine disorders (4) Metabolic and endocrine disorders: primary hyperparathyroidism (5) Inflammation and infection: osteomyelitis (5) Secondary changes in bone: Hyperostosis, blistering 3. Take home points 4. References

## HNEE-24 Sonographic Evaluation of Major Salivary Glands: A Pictorial Review

Rachita Khot, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

High-resolution ultrasound imaging plays a key role in evaluating focal versus diffuse salivary gland diseases and differentiating benign versus malignant lesions. This exhibit will discuss approaches to diagnosis and 1. Review the typical and uncommon sonographic appearances of pathologies involving the salivary glands 2. Discuss the OMERACT Ultrasound Scoring System in primary Sjögren's Syndrome 3. Discuss the next step in the management of the pathologies

## TABLE OF CONTENTS/OUTLINE

1. Illustration of major salivary gland and surrounding structures 2. Ultrasound imaging techniques, sonographic landmarks, and normal anatomy 3. Approach to diagnosis 4. OMERACT Ultrasound Scoring System in Sjögren's Syndrome • Background • Grey-scale scoring with imaging examples: Grade 0, normal parenchyma; Grade 1, mild inhomogeneity without anechoic or hypoechoic areas and hyperechogenic bands; Grade 2, moderate inhomogeneity with focal anechoic or hypoechoic areas; Grade 3, severe inhomogeneity with diffuse anechoic or hypoechoic areas occupying the entire gland 5. Pathologies of the major salivary glands • Congenital: Lymphoepithelial cysts, Epidermoid cyst • Sialadenitis: Acute and chronic; Abscess • Sialolithiasis: Obstructing and non-obstructing stones in the duct • Sialectasis • Neoplasms: Hemangioma, Lymphangioma, Lipoma, Adenomas (Pleomorphic, Basal cell, Warthin's), Carcinoma (Adenoid cystic carcinoma (Ca), Mucoepidermoid Ca, Acinar cell Ca, Squamous cell Ca), Lymphoma, Metastasis • Others: Intraglandular lymph nodes, Trauma, AV fistula 6. Management and follow-up • Role of CT and MRI in the further workup • Role of biopsy 7. Conclusion

## HNEE-25 Decoding Cystic and Cyst-Like Lesions in the Head and Neck: A Comprehensive Imaging Guide

Maria Lucia Brun, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To identify the relevant imaging features of cystic and cyst-like lesions of the head and neck. - To describe the differential diagnosis of cystic and cyst-like lesions of the head and neck, based on imaging and anatomical location. - To learn the importance of incorporating relevant/pertinent clinical information in narrowing the differential diagnoses. - To recognize the course and potential complications associated with cystic and cyst-like lesions. - To suggest appropriate follow-up and recommend effective diagnostic workup.

## TABLE OF CONTENTS/OUTLINE

1. Introduction/Background 2. Role of Diagnostic Imaging- Ultrasound- CT - MRI 3. Approach based on location Once the cystic nature is confirmed? evaluate differential diagnosis according to location:- Anterior neck - Midline lesions: Parapharyngeal/pharyngeal cysts, Ranula, Thyroid cysts, Parathyroid cysts, thyroglossal duct cyst, thymic cyst, dermoid/epidermoid cyst.- Lateral - Paramedian lesions: Branchial cleft cysts, Lymphatic malformations, suppurative/caseating adenopathy (infectious/inflammatory), cystic adenopathy (thyroid cancer and HPV-related SCC).- Specific spaces: Salivary glands; entities which may present as a cyst in the salivary glands: Lymphoepithelial cysts, Epidermal inclusion cysts, Warthin tumor, Mucocele, etc. 4. Others- Not location-dependent: Lymphocele, Seroma, Abscesses. 5. Conclusion

## HNEE-26 Chew It All Up! Everything You Need to Know About Teeth

Bruna E. Gherardi, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The high prevalence of craniofacial trauma, sinus infection disease, and maxillomandibular procedures, among other conditions, frequently requires the interpretation of dental images in daily practice. Teeth can be the source or the extension of a pathologic process and therefore must not be overlooked by radiologists. Radiologists can use their knowledge of the main dental imaging findings in emergency radiology to add great value to image interpretation. In this study we will describe the anatomy of the structures surrounding the teeth. Identify the main dental alterations in the emergency or outpatient setting. Train the radiologist to look accurately at lesions, mainly inflammatory ones related to dental disorders.

## TABLE OF CONTENTS/OUTLINE

General and dental anatomy. Inflammatory conditions related to teeth as pericoronitis, periodontal disease, periapical abscess, dental sinusitis, facial cellulitis and abscess, orbital cellulitis, Ludwig's angina, dental trauma, complications of dental procedures like dental implants and extraction. Most common tumor and tumor-like lesions related to teeth. Take home messages.

### HNEE-27 The Jugular Foramen: Approach to Tumoral and Non-tumoral Pathologies

Yasovineeth Bhogadi, BSc, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Review the anatomy of the Jugular foramen- Understand the clinical presentations of various pathologies- Differential diagnosis to tumoral disease and approach- Non-tumoral disease entities

## TABLE OF CONTENTS/OUTLINE

- Review the anatomy of the Jugular foramen- Differential diagnosis of masses- Approach to tumoral masses- Non-tumoral disease entities

### HNEE-29 Parry-Romberg Syndrome and En Coup De Sabre: A Pictorial Review

Vineet V. Gorolay I, MD, FRANZCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

(1) Parry-Romberg Syndrome [PRS] and En Coup De Sabre [ECDS] are defined by acquired progressive hemifacial atrophy. (2) Patients may present with headache, facial pain/paresthesia, or epilepsy. (3) Atrophy can affect unilateral periorbital, midface bones and soft tissues. (4) Atrophic tissue does not demonstrate signal change or enhancement as might be seen with denervation. (5) Intracranial manifestations may also be present, although facial involvement does not predict intracranial lesion severity.

## TABLE OF CONTENTS/OUTLINE

(1) Review definition, clinical symptomatology, expected course, and hypothesized etiologies of Parry-Romberg Syndrome (PRS) and linear scleroderma/En Coup De Sabre (ECDS), disease processes characterized by progressive hemifacial atrophy. (2) Review imaging findings of facial soft tissue atrophy and intracranial abnormalities in PRS and ECDS, as derived from a review of 40 PRS patients at a single institution, including brain, neck and face CTs and MRs. (3) Atrophy in PRS and ECDS predominantly affects periorbital, midface and scalp soft tissues, typically without MR signal intensity change, distinguishing it from denervation atrophy. (4) Clinical severity of facial soft tissue atrophy does not predict intracranial lesion severity.

### HNEE-3 Revisiting Distant Metastasis in Head and Neck Cancer

#### Awards

#### Certificate of Merit

Naoko Saito, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Distant metastasis (DM) in head and neck cancer (HNC) is relatively uncommon. When DM occurs, the prognosis is considered miserable, with median overall survival of under one year. Although little attention has been focused on the treatment of DM, recent reports on oligometastasis have changed the therapeutic approach to DM. For patients with oligometastasis, aggressive local treatment of metastatic sites may achieve prolonged survival. This educational exhibit reviews the epidemiology, imaging findings, and risk factors of DM of HNC and summarizes the current knowledge of the oligometastasis of HNC. The teaching points are: 1. To understand the mechanisms and patterns of DM of HNC. 2. To learn the characteristic imaging findings of DM based on the site and histopathology. 3. To learn the current knowledge about the characteristics and the therapy of oligometastasis in HNC.



## TABLE OF CONTENTS/OUTLINE

1. The definition of DM: the pathophysiology (hematogenous, lymphatic spread), the timing (synchronous, metachronous), the spectrum of metastasis (polymetastasis, oligometastasis, oligorecurrence, oligoprogression) 2. The site-based approach of DM (lung, bone, liver, brain, skin, etc.): pathophysiology, incidence, imaging findings 3. The cancer-based approach of DM: histopathology (SCC, EBV/HPV associated SCC, thyroid cancer, salivary gland cancer, neuroendocrine tumor, melanoma, etc.): incidence, imaging findings 4. Summary of the risk factors for DM: literature review 5. Therapy: current concepts

### HNEE-30 Nasolacrimal System Pathologies: What a Radiologist Needs to Know

Janani Baradwaj, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- While reading a CT, deliberate consideration should be given to the density of the contents within the nasolacrimal duct and for the evaluation of wall thinning.
- The extent of soft tissue disease is evaluated using magnetic resonance imaging (MRI), and contrast-enhanced MR is particularly helpful in distinguishing soft tissue from fluid.
- Nasolacrimal duct may act as a conduit for the transmission of pathologies from the orbit to the sinonasal cavity and vice-versa.
- Primary nasolacrimal malignancies are rare and often have delayed diagnosis due to presentation mimicking benign aetiology.

#### TABLE OF CONTENTS/OUTLINE

?Describe normal Nasolacrimal duct anatomy with images. ?Illustrate with images the Nasolacrimal duct pathologies. ? Discuss management pathway.

### HNEE-31 Hyoid Bone: Anatomy, Embriology, Developmental Malformations and Symptomatic Cases

Beatriz D. Prado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This panel aims to: Review the structure and function, embriology, anatomy and physiologic variants of the hyoid bone Discuss and describe through illustrative cases the imaging patterns of the main pathologies involving the hyoid bone.

#### TABLE OF CONTENTS/OUTLINE

Review of the hyoid bone structure and function Review of the hyoid bone anatomy, including suprahyoid and infrahyoid muscles, relation to blood vessels and nerves. Physiologic variants Clinical cases involving the hyoid bone: -Hyoid bone insertion tendinitis (hyoid bone syndrome) -Calcified stylohyoid ligament and Eagle syndrome -Traumatic lesions, including body and greater horn luxation and hyoid fracture -Triticeal cartilage ankylosis in the hyoid -Thyroid lamina ankylosis in the hyoid -Ectopic thyroid gland adjacent to the hyoid bone -Vascular compression -Sistrunk procedure -Ectopic thyroid gland adjacent to the hyoid bone Final remarks

### HNEE-32 How to Find CHD7 Disorder: Beyond CHARGE Syndrome

#### Awards

#### Certificate of Merit

Shinya Hattori, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

CHARGE syndrome is named after an acronym for the characteristic signs (coloboma, heart defect, atresia choanae, retarded growth and development, genital hypoplasia, ear anomalies/deafness). CHD7 is the causative gene for CHARGE syndrome. Recently, CHD7 mutations have been detected in cases that do not show typical signs of CHARGE syndrome, and the concept of CHD7 disorder has been proposed to include the broader spectrum of CHD7 mutations. Even in such atypical cases, the characteristic imaging findings of CHARGE syndrome are detected. The purpose of this educational exhibit is to: 1. Present the disease concept of CHARGE syndrome 2. Detail the characteristic imaging findings of CHARGE syndrome 3. Outline the broader spectrum of CHD7 disorders and provide cases in which imaging findings help identify CHD7 mutations, even in atypical CHARGE syndrome

#### TABLE OF CONTENTS/OUTLINE

1. CHARGE syndrome a. Concept b. Clinical presentation c. Causative gene -CHD7- 2. Imaging findings a. Key finding - semicircular canal hypoplasia- b. Additional findings of the face and skull base 1) Auditory system and temporal bone 2) Eye, palate, and olfactory system 3) Clivus c. Others 3. CHD7 disorder a. Concept b. Cases that the imaging findings implicate CHD7 mutations 1) Severe combined immunodeficiency 2) Mild phenotype 3) Kallmann syndrome

### HNEE-33 A Particular Pain in the Neck: Taking a Radiology's Journey from Imaging to Immunohistochemistry

Karla Anabel Borgna, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Reviewing the variability of head and neck tumor entities and their mode of presentation, excluding squamous Cell Carcinoma. Identifying radiological signs, anatomical relationships and learning how to report them. Correlating the radiological features of head and neck tumors (non-squamous cell carcinoma) with immunohistochemistry and histological findings. Emphasize the role of the radiologist as a key contributor to the orientation of the tumor's etiology.

## TABLE OF CONTENTS/OUTLINE

Introduction  
Case-based approach with radiologic correlation  
Imaging findings with histologic and immunohistochemical correlation  
Take-home message  
References

### HNEE-34 3N: Not Common Nose, Nasal Cavity and Nasopharynx Tumors

Marycarmen E. Flores Duenas, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Sinonasal neoplasms are rare, accounting for only 3 % of head and neck malignancies, among the most frequent tumors reported are adenocarcinoma, squamous cell carcinoma, undifferentiated carcinoma, olfactory neuroblastoma, sinonasal lymphoma, and sinonasal mucosa melanoma. The complex anatomy and histology of this region make evaluation a challenge for the clinician. Fortunately, in these kinds of tumors, Computed tomography and magnetic resonance imaging, plays an important role in surgical and therapeutic planning, especially in the involvement of those small parts such as involvement of the anterior and middle cranial fossae, pterygopalatine fossa, pterygomaxillary fissure, foramen rotundum, vidian canal, inferior orbital fissure, orbital apex, and perineural involvement, therefore some distinguishing features can help narrow the differential diagnosis and assess the true extent of the disease.

## TABLE OF CONTENTS/OUTLINE

Epidermoid carcinoma, Carcinoid tumor, Peripheral nerve sheath tumor, Rhabdomyosarcoma, Sinonasal undifferentiated carcinoma, Ewing sarcoma, Sinonasal Melanoma, Lymphoma, Esthesioneuroblastoma and sinonasal juvenile angiofibroma

### HNEE-35 Sinonasal Tumors: What the Tumor Board Wants to Know

#### Awards

#### Certificate of Merit

Alexander R. Moeller, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. There is a long differential diagnosis for tumors occurring within the sinonasal cavity with overlapping imaging features. 2. Pathology is critical in diagnosis and determining treatment. 3. Most primary tumors are staged based on the TNM classification. TNM tumor staging is predominantly based on tumor location and tumor extension, which differs between lesions that arise from the maxillary sinus and those that occur within the ethmoid/nasal cavity. 4. Esthesioneuroblastomas are staged based on the Kadish classification system. 5. Sinonasal tumors are primarily treated with surgical resection. 6. Chemotherapy and radiation may be administered prior to surgery for larger lesions, following surgery for residual or recurrent disease or in place of surgery for a palliative approach.

## TABLE OF CONTENTS/OUTLINE

1. Review the differential diagnosis of sinonasal tumors based on the updated WHO classification system. 2. Discuss pathology of sinonasal tumors, incorporating molecular features. 3. Discuss the TNM staging of sinonasal tumors for lesions arising from the maxillary sinus and ethmoid/nasal cavity. 4. Review staging of esthesioneuroblastoma. 5. Treatment strategies of Sinonasal tumors: Indications for surgery, chemotherapy and radiation using a multidisciplinary approach. 6. Review imaging features of lesions that will affect treatment decisions: what the surgeon wants to know, what the medical oncologist wants to know and what the radiation oncologist wants to know.

### HNEE-36 Face to Face: Reviewing Facial Malformations

Danielly V. Santos SR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

This pictorial essay aims to review and synthesize the main facial malformations. The purposes of this submission are: - To review the developmental anatomy and normal embryogenesis of facial structures; - To discuss imaging features of facial malformations related to nasal cavity, frontonasal region, nasolacrimal apparatus, labiopalatine complex and craniofacial syndromes; - To present a compendium of cases involving facial malformations to exemplify;

## TABLE OF CONTENTS/OUTLINE

There are a wide variety of congenital face abnormalities that originate during transformation of the first pair of pharyngeal arches into adult structures. Computed tomography and magnetic resonance imaging are important components in the comprehensive evaluation of these lesions. A detailed understanding of face embryogenesis and developmental anatomy is important in directing appropriate patient management. Familiarity with the characteristic imaging features of these anomalies along with knowledge of midface embryogenesis and normal developmental anatomy is essential to prevent misinterpretation of anatomic variations that may simulate disease.

### **HNEE-37 Scars and Lumps Shrinking the Tunnel: Radiological Evaluation of Laryngotracheal Stenosis**

#### **Awards**

#### **Certificate of Merit**

Kristina Ramirez Garcia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

At the end of this exhibit, the attendees would be able to: 1. Identify laryngotracheal stenosis etiologies. 2. Describe the clinical and radiological classifications of laryngotracheal stenosis. 3. Recognize the key imaging findings encountered in the different entities of laryngotracheal stenosis

## TABLE OF CONTENTS/OUTLINE

1) Introduction. 2) Anatomical Review: Imaging of the Larynx and Trachea. 3) Diagnostic and Radiological Approach to Laryngotracheal Stenosis. 4) Laryngotracheal Stenosis Measurement. 5) Laryngotracheal Stenosis: Key Imaging and Clinical Findings through Case Presentation. a) Laryngotracheal Trauma/Iatrogenic. b) Laryngotracheal Compression. c) Infiltrative Lesions. d) Laryngotracheal Inflammation/infection. e) Laryngotracheal Autoimmune Lesions. 6) Conclusion

### **HNEE-38 A Nod to the Nodes In Children: A Practical Clinical Approach to Pediatric Cervical Lymphadenopathy**

Elizabeth J. Snyder, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Cervical adenopathy is a common clinical scenario in children. - A wide variety of entities can present with cervical adenopathy; importantly, the spectrum of pathology and imaging appearance differs in many cases from that seen in adults. - While US is typically the first line imaging modality, CT, MRI and NM studies may all have a role in the workup of cervical adenopathy, with different strengths and limitations. - Radiologists must know when and with which modality to image. - This multi-institutional collaboration highlights imaging appearances of both common and uncommon disorders affecting cervical nodes in children in order to aid radiologists in their clinical practice. Pearls, pitfalls, and mimics will be included.

## TABLE OF CONTENTS/OUTLINE

1. Introduction. a. Anatomy of cervical lymph nodes (levels, etc.) b. Normal imaging appearance. 2. Imaging approach. a. Modality selection and benefits/limitations of US, CT, MRI, NM studies. b. Systematic approach diagram highlighting helpful features (e.g., cystic, hyperenhancing, calcified, etc.) 3. Infectious lymphadenopathy. a. Imaging appearance. b. Complications: necrosis, abscess. c. Specific infectious processes: e.g., bacterial, TB, MAI, cat scratch disease. 4. Neoplasm. a. Lymphoma. b. Metastasis: e.g., thyroid cancer, NPC, SCC. 5. Histiocytosis. a. LCH. b. Rosai-Dorfman disease. 6. Lymphoproliferative disorders: e.g., Castleman, HLH. 7. Unusual entities: Kawasaki, Kikuchi, MIS-C, HIV. 8. Mimics (lymphatic malformations, branchial cleft cysts, parotid neoplasms, etc.) 9. DDx of common imaging findings: calcifications, cystic nodes. 10. Summary and conclusion

### **HNEE-39 Don't Miss the Forest for the Trees: Parathyroid Ultrasound - Anatomy, Technique, Pearls and Pitfalls**

Alex C. Dias, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review key aspects of the clinical, laboratorial, and imaging assessment of patients with primary hyperparathyroidism. Illustrate the role of ultrasound (US) for preoperative evaluation of parathyroid glands, including their localization, normal and pathological findings, with multimodality imaging correlations. Summarize in a practical approach the most important pearls and pitfalls for the accurate US assessment of parathyroid glands, highlighting the use of high-frequency transducers.

## TABLE OF CONTENTS/OUTLINE

Introduction  
Anatomy of the parathyroid and adjacent structures  
Primary Hyperparathyroidism: pathophysiology and clinical aspects  
Parathyroid preoperative evaluation  
Laboratorial workup for hyperparathyroidism  
Multimodality imaging for surgical planning: US, computed tomography, magnetic resonance, and scintigraphy  
Ultrasound of the parathyroid glands  
Positioning,

technique, transducers Typical and atypical imaging findings (B-mode, Doppler and elastography) US guided fine-needle aspiration (radiologic-pathologic correlations) Case-based review with multimodality imaging Pearls: novel approaches for improvement (high-frequency transducers and other strategies) Pitfalls: lesions of the esophagus, lymph nodes, soft tissues, and thyroid Take home messages

#### **HNEE-4 Look out! Conditions that Cause Proptosis**

Erica A. Naves, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Teaching Points The purposes of this exhibit are to review the anatomy of the orbit, including the orbital content and bone structures that delimit it. Also, to demonstrate that, due to its osseous limitations, the orbit is limited to expand if any expansive process is within its limits. Therefore, several types of expansive processes manifest with proptosis. The exhibit demonstrates through illustrative cases the different scenarios that manifest with proptosis, in the context of metabolic disorder, trauma, infection, inflammatory process, vascular lesions, primary neoplasms, metastasis, among others.

##### **TABLE OF CONTENTS/OUTLINE**

Table of Contents / Outline The exhibit initiates with annotated images of the anatomy of the orbit, including the bone limits and contents, to demonstrate the normal appearance on computed tomography and magnetic resonance imaging. The next slides include the diagnostic criteria of proptosis, and exemplifying annotated images. The majority of the presentation include illustrative cases presenting with proptosis divided by metabolic, trauma, infection, inflammatory, vascular and neoplastic sections. Cases of thyroid-associated orbitopathy, bone fracture, orbital muscle lesion, subperiosteal abscess, idiopathic orbital inflammation, IgG4-related disease, granulomatosis with polyangiitis, carotid-cavernous fistula, venous malformation, lymphangioma, optic nerve glioma, optic nerve meningioma, orbital lymphoma, rhabdomyosarcoma, sphenoid wing meningioma, metastatic melanoma, extramedullary plasmacytoma and bone metastasis are displayed. The presentation closure contains take-home messages.

#### **HNEE-40 Save Your Own Neck: A Neck Muscles Guide for Daily Practice - Anatomy, Variations, and Pathologies**

Lucas S. Souza, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

The purposes of this exhibit are:- Review and illustrate the anatomy and innervation of head and neck muscles, and its correlation with the cervical spaces, emphasizing the importance of understanding for the delimitation of lesions found in daily routine exams.- Describe the anatomical variations of the cervical muscles and the possible pitfalls they can cause, simulating diseases.- Determine the great injuries, separating them by their etiology, and propose an algorithm for their evaluation in cases of technical limitation.

##### **TABLE OF CONTENTS/OUTLINE**

- Cervical muscles: 1) Division by compartments- masticatory.- pharynx (circular and longitudinal) and larynx.- front of the neck (suprahyoid and infrahyoid).- prevertebral (prevertebral and scalene).- paraspinal (suboccipital, extrinsic back, and intrinsic back (superficial, intermediate, and deep layer)). 2) injuries:- congenital (agenesis, torticollis, and syndromes)- infectious/inflammatory (phlegmon, abscess, tropical myositis, necrotizing fasciitis)- trauma or surgery (denervation, myositis ossificans)- vascular anomalies.- tumors (benign, malignant, and metastasis).- Diagnostic Algorithm- Final remarks

#### **HNEE-41 Practical Approach to Orbital Lesions by Anatomical Compartments**

Guilherme Naves (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

The purposes of this exhibit are:- Classify the different pathologies in each of the orbital compartments.- Present the essential imaging features of the main orbital lesions.- Highlight the importance of knowing the location of pathologies in the orbital compartments to facilitate the diagnosis and narrow the differential diagnoses.

##### **TABLE OF CONTENTS/OUTLINE**

? Introduction : ? Review of the anatomy of the orbital compartments ? Compartment of the optic nerve/sheath complex : ? ? Ischemic optic neuritis ? Optic nerve glioma (NF1) ? Optic nerve glioma (sporadic) ? Optic nerve meningioma ? Conal/muscular compartment : ? Graves orbitopathy ? Left sixth cranial nerve palsy ? Orbital pseudotumor ? Myositis by IgG4 ? Intraconal compartment : ? Colobomatous malformation ? Venolymphatic vascular malformation ? Cavernous hemangioma ? Extraconal compartment : ? Dermoid cyst ? Subperiosteal abscess ? Preseptal cellulitis ? Nasolacrimal apparatus : ? Non-Hodgkin lymphoma of the lacrimal glands ? Infected dacriocystocele

#### **HNEE-42 Unilateral Sinusitis: What Radiologists Should be Aware of**

Janani Asogan Vaishnavi, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Rhinorrhoea and foul smelling discharge are the common clinical presentations in inflammatory / infective disease while epistaxis and/or mass effect in the cheek / palate / orbit are the common presenting features in malignancy. 2. Odontogenic sinusitis is one of the most common causes of unilateral sinus opacification followed by fungal ball and antrochoanal polyp. Inverted papilloma is the most common benign pathology, while squamous cell carcinoma is the most common malignant pathology. 3. Incidence of neoplastic disease is much higher in the presence of unilateral sinus opacification, with rise in incidence with increasing age. 4. Site of origin of inverted papilloma is often seen as focal area of hyperostosis on CT. This can be useful identifying recurrence and malignant transformation which are frequent with inadequate excision. 5. Aggressive bone destruction, especially erosion of the posterolateral wall of the maxillary sinus and extra-sinus extension is often seen in malignancy.

#### **TABLE OF CONTENTS/OUTLINE**

1. Radiological anatomy of paranasal sinuses including drainage pathways 2. Explain various causes of unilateral sinus opacification 3. Illustrate with images, the key radiological and pathognomonic findings to be looked for in unilateral sinus opacification 4. Provide a pictorial review of unilateral sinus opacification encountered in our centre 5. Briefly describe how to approach a case of unilateral sinus opacification

#### **HNEE-43 What is this Bump on the Face, Radiology? Medial Canthal Swelling, Differential Diagnosis of Angular Vein Thrombosis Radiologists Should Know**

Nahyun Jo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The face is the first body part a physician sees when they meet a patient; it is often diagnosed and followed clinically. With the advances in imaging and increase in utilization, radiologic evaluation of facial masses is becoming more common. In certain cases, radiology plays a crucial role. Facial vein thrombosis presents as a focal facial mass-like lesion due to engorged veins. This is well-known in the traditional anatomy literature related to the "danger triangle" of the face. While thrombophlebitis is a more common etiology, more recently, facial/angular vein thrombosis secondary to periorbital cosmetic botulinum toxin injections has been reported by ophthalmologists and plastic surgeons. Due to its proximity to the sinuses, sinus-related diseases such as dacryocystocele or nasolacrimal duct obstruction often mimic angular vein pathologies. Vascular malformations such as an ophthalmic artery arteriovenous fistula, carotid-cavernous fistula, or lymphovenous malformation may also present as periorbital mass or proptosis. Other etiologies of soft tissue masses, such as skin tumors or benign masses, should also be considered.

#### **TABLE OF CONTENTS/OUTLINE**

We discuss the basic anatomical structures in the face that radiology trainees should know. Then we further discuss the imaging findings of facial masses ranging from the most common lipoma to uncommon lymphovascular malformations. Each of the common and unique cases is presented for each pathology with teaching points. - Introduction to facial anatomy- Infection-Trauma-Venous thrombosis-Vascular malformations-Sinus related-Benign cluster of tissues-Tumor-Foreign body and cosmetic injections

#### **HNEE-44 Node More Tears: Unraveling the Etiologies and Imaging of Lymph Nodes Diseases**

##### **Awards**

##### **Certificate of Merit**

Luis E. Souza, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To understand patterns of lymphadenopathy in imaging methods. To illustrate the most common imaging findings of lymph nodes diseases and the useful hallmarks that help in differential diagnosis. To learn about advanced imaging methods and how they can help in the evaluation of lymphadenopathy.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy of lymph node Patterns of lymph nodes diseases - Hypervascular - Cystic or necrotic - Calcified Main imaging characteristics and differential diagnosis of the different etiologies.- Inflammatory / Infectious (Viral, Bacterian, Fungal and others). - Lymphomas - Castleman Disease - Neoplastic Metastasis ( Eg. Squamous cell carcinoma; Kaposi sarcoma)- Lymphadenopathy associated with systemic syndromes (eg. Kikuchi-Fujimoto Disease, Kimura, systemic lupus erythematosus) Take-home messages and tips and tricks to differential diagnosis.

#### **HNEE-45 Advanced Neck Ultrasound: Pearls and Pitfalls Using High-Frequency Transducers**

Alex C. Dias, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review key findings in neck ultrasound using high-frequency transducers (24-33MHz). Illustrate clinical situations where the use of high-frequency transducers was decisive for the characterization of imaging findings in neck region, including skin, thyroid, parathyroid, salivary glands and lymph nodes lesions. Provide tips and tricks in a practical approach to a successful clinical practice integration.

## TABLE OF CONTENTS/OUTLINE

Introduction  
US transducer types: an overview  
Applications: a case-based review  
Skin US: benign and malignant lesions  
Thyroid US: focal and diffuse disease  
Parathyroid US: normal and abnormal findings  
Lymph node US: beyond metastatic disease  
Salivary gland US: pearls and pitfalls  
Other challenging applications  
Practical approach: tips and tricks for clinical practice integration  
Future perspectives: ultra-high frequency US  
Take home messages

### **HNEE-46 To Infinity And Beyond: A Primer Review Of The Uncommon Disorders Of The Temporomandibular Joint Besides Internal Derangement**

Izaely R. Prates, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Review the normal anatomy of the temporomandibular joint and its relationship to adjacent structures- To illustrate a variety of rare cases in order to avoid misinterpretations and pitfalls;

## TABLE OF CONTENTS/OUTLINE

INTRODUCTION:RELEVANT IMAGING ANATOMY:TEMPOROMANDIBULAR LESIONS AND ALTERATIONS: Clinical cases illustrating the spectrum of uncommon TMJ findings in CT and MRI.Condylar pathologies;Coronoid process pathologies;Extension of TMJ pathological processes to adjacent structures;Inflammations non-infectious;Infectious Other pathologies.TAKE-HOME MESSAGESREFERENCES

### **HNEE-47 The Tongue Has People Talking**

Fernando Diego Choque Chavez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Show the anatomy of the tongue through schematic illustrations and its correlation with radiological images, indicating anatomical reference points.Determine the role of each imaging technique in the analysis of the pathology of the tongue.Review the most frequent pathology of the tongue, mainly tumors outlining the radiological findings with therapeutic implications.

## TABLE OF CONTENTS/OUTLINE

BackgroundEmbriology and Anatomy of the tongueImaging techniqueImaging findings- Oncological tongue Radiolical findings with therapeutic implications- Congenital anomalies- Inflamed tongues- Lingual denervation.The tongue is the central part of the oral cavity and the oropharynx. It is the organ of taste, plays an essential role in the formation of the alimentary bolus and in swallowing and forms part of the phonatory system. Given the importance the role of the tongue plays in the patient's quality of life, the radiologist of the head and neck should be familiar with its anatomy, the optimum imaging techniques for its evaluation, as well as its spectrum of pathologies. In this way the radiological description will reflect reliably and with anatomical detail the extent of a lesion, particularly in the area of oncology, and it will be possible to select the most appropriate treatment for each patient so as to preserve function to the maximum extent possible. The radiological evaluation will also be of special significance during the surveillance period following treatment, so the radiologist should be familiar with the main therapeutic strategies and be accustomed to the image of the treated patient as well as the most appropriate techniques for detecting tumor recurrence.

### **HNEE-48 Look on the Bright Sign: Shedding Light on Mysteries of Optic Neuropathy**

Alice M. Abreu Mota, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Optic neuropathy:It may be the only manifestation of Behçet's disease in the central nervous system.Diffusion restriction may be seen in trauma and ischemia.In induced cocaine cases, it is often unilateral, due to compression or ischemia. Methanol intoxication findings included bilateral optic nerve enhancement, putamen and caudate necrosis.Leber's hereditary optic neuropathy may show increased T2 signal in the optic nerves, chiasm, and tracts.Neuritis can also simulate a tumor.The short-segment enhancement at the optic nerve-globe junction is seen on cat scratch disease. Granulomatosis with polyangiitis (GPA) is often hypointense on T2. Direct granulomatous infiltration is one of the triggers of sarcoidosis.MOG-IgG+ exhibit long-length, bilateral, and anterior optic nerve involvement.Unilateral and short-segment involvement is seen in Multiple Sclerosis.In Neuromyelitis Optica (NMO) the impairment is bilateral on posterior optic nerves and chiasm.



## TABLE OF CONTENTS/OUTLINE

ToxicMetanol Cocaine MedicineGranulomatosisSarcoidosis; GPA; Tolosa Hunt; IgG4 Related Disease; Cat scratch disease; Tuberculosis.Non-demyelinatingVogt-Koyanagi-Harada; Behçet 's Disease.Demyelinating Multiple Sclerosis; NMO; MOG-IgG+.OthersIschemic; Trauma; Tumor.

### **HNEE-49   Cavernous Sinus Imaging: Anatomy, Pathology and Warning Signs for Daily Practice**

Teresa A. Garcia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the anatomy and study protocol of the cavernous sinus.Provide warning signs to quickly recognize cavernous sinus involvement and asses patient treatment.Discuss clinical cases of our Department and relevant imaging findings.

## TABLE OF CONTENTS/OUTLINE

AnatomyStudy protocolWarning Signs: Enlargement of superior ophthalmic vein/s. Morphological change. Finding Density/Signal — Flow void. Clinical exam — multiple cranial nerve deficit. Red bulging eye. Restricted diffusion.Clinical cases: Neoplasms: meningioma, hemangioma, macroadenoma, chordoma. Inflammatory: Tolosa Hunt Syndrome. Vascular: aneurysm, carotid-cavernous fistula. Miscellaneous: intracavernous arachnoid cyst, air/fat in the cavernous sinus.References

### **HNEE-5    Facial Retaining Ligaments: Can We See It**

Luciana C. Zattar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

A thorough investigation of the layers and structures of facial anatomy is crucial when performing facial surgery and aesthetic procedures. The retaining ligaments of the face represent additional information of this anatomy and are essential in understanding principles of facial aging and rejuvenation. They are located in constant anatomic locations where they separate facial spaces and compartments. Their main significance relates to their anatomical understanding in fillers procedures and in surgical release in order to achieve the desired aesthetic outcome. Furthermore, they have a sentinel role in their anatomic relationship to facial nerve branches. Descriptions of the retaining ligaments are variable in the literature; due to different interpretations of anatomy, several classifications, locations, and nomenclature systems have been proposed, but there is no description of imaging findings. This study will review and clarify the anatomy and imaging aspects of the retaining ligaments of the face using High frequency ultrasound (HFUS/24-33MHz). The purpose of this exhibit is: (1)To illustrate the anatomy of the facial retaining ligaments with fresh-frozen specimen correlation; (2)To describe the correct examination technique; (3)To highlight the importance of HFUS in facial ligaments and nerves characterization; (4)To show the dynamic evaluation and characterization of facial ligaments with HFUS; (5)To describe the most important related facial ageing changes and aesthetic importance

## TABLE OF CONTENTS/OUTLINE

1. INTRODUCTION; 2. ANATOMY; 3. FACIAL AGEING PROCESS; 3. HFUS EVALUATION TECHNIQUE; 4. UNDERSTANDING AESTHETIC PROCEDURES; 5. CONCLUSION

### **HNEE-51   Paranasal Sinuses Computed Tomography: Read It Like an Expert**

Michaela Cellina (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Learn the acquisition protocols and become familiar with the anatomy and anatomical variations of the paranasal sinuses to guide the endoscopic sinus surgeon

## TABLE OF CONTENTS/OUTLINE

Nose and paranasal sinuses anatomy is highly variable and some anatomic variants can result in complications in FESS.The nasal septum is made up of an anterior cartilaginous component and a posterior bony component including the vomer and the perpendicular plate of the ethmoid.Septum anatomic variations include septal deviation that can cause a middle turbinate displacement and interfere with surgical access to the middle meatus; septal pneumatization may narrow the sphenoethmoidal recess and impede access to the sphenoid ostium. The middle turbinate is the site of different variations, including concha bullosa (pneumatization of the inferior bulbous portion of the middle turbinate, or "cell of Grunwald" if pneumatization is limited to the vertical lamella above the level of the ostiomeatal complex), that can obstruct the ethmoidal infundibulum, and paradoxical middle turbinate, when the turbinate shows a paradoxical lateral convexity, which can impede surgical access to the ostiomeatal complex and contribute to recurrent rhinosinusitis. Haller cells are ethmoid cells extending into the orbital floor, with variable sizes that can narrow the ostia of the maxillary sinus or ethmoid infundibulum.Onodi cells are posterior ethmoid cells extending to the sphenoid sinus, placed medially to the optic nerve, These cells can also surround the optic nerve places the nerve and are linked with increased risk of nerve damage during sinus surgery.

## **HNEE-52 Approach to Jaw Lesions**

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

### **TEACHING POINTS**

CT and MR can characterize jaw lesion location, composition, margins, and extent. Jaw lesions are classified into odontogenic vs. non-odontogenic, and simple/complex lytic or sclerotic. Key etiologies include developmental, inflammatory, traumatic, and neoplastic. Patient age, symptoms, and systemic findings help narrow the differential. For suspected neoplasms, biopsy helps confirm the diagnosis. The range of potential approaches includes watchful waiting, sclerotherapy, ablation, curettage, subtotal resection, and radical excision. Genetic testing is important when certain histologies and syndromes are suspected.

### **TABLE OF CONTENTS/OUTLINE**

1. Dentistry 101 Jaw/tooth development Anatomy eruption Imaging modalities 2. Classification Odontogenic, non-odontogenic Developmental, inflammatory, traumatic, neoplastic 3. Simple Cystic Radicular Dentigerous Buccal bifurcation Lateral periodontal Fissural Stafne Simple 4. Complex Cystic Aneurysmal bone cyst / Giant cell granuloma Langerhans cell histiocytosis Ameloblastoma Odontogenic myxoma Odontogenic fibroma Mixed odontogenic tumors 5. Sclerotic/Mixed Tori Odontomas Fibro-osseous lesions Cemento-osseous dysplasia Cementoblastoma Osteomyelitis: acute, chronic (Garré), nonbacterial (CRMO, SAPHO) Osteonecrosis 6. Syndromic Odontogenic keratocyst (Gorlin) Brown tumors (hyperparathyroidism) Gardner syndrome Cherubism Desmoplastic fibroma (TS, fibromatoses) Gorham disease

## **HNEE-53 Advanced MRI of the Head and Neck**

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

### **TEACHING POINTS**

Advanced MRI techniques utilized in the head neck include anatomic, diffusion, perfusion, vascular, elastography, functional, and metabolic. Understanding of fundamental physical principles enables optimal utilization interpretation. Informed clinical use improves patient diagnosis management. Clinical applications exist for congenital, neoplastic, vascular, metabolic, and traumatic etiologies.

### **TABLE OF CONTENTS/OUTLINE**

1. High-resolution: T2, T1, 7 Tesla Cranial nerve lesions Midface anomalies Meningoceles Inner ear anomalies Orbital malformations, tumors 2. Phase-contrast: 2D, 3D CSF flow Angiography 3. Diffusion: non-echo-planar, intravoxel incoherent motion, diffusion tensor imaging Skull base tumor, infection Pott's puffy tumor Cord/nerve fibers 4. Perfusion: arterial spin labeling, dynamic susceptibility contrast, dynamic contrast-enhanced Vascular tumors Vascular malformations Skull base tumors Pituitary lesions Face transplant 5. Vascular: time-of-flight, phase-contrast, time-resolved, ferumoxytol, vessel wall imaging PHACES association Vasculopathies 6. Ultrashort- and zero-echo-time imaging Malformations Trauma Tumors Postoperative 7. Elastography Pituitary adenoma Vestibular schwannoma 8. Spectroscopy 9. PET/MR Epilepsy HN tumors 10. Chemical exchange saturation transfer 11. Anatomic modeling

## **HNEE-54 Zero Echo-Time MRI of the Head and Neck**

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

### **TEACHING POINTS**

- Cortical bone MRI utilizes short-TE techniques such as gradient, ultrashort, and zero echo-time.
- Short-T2 tissues appear dark, hence the term "black-bone" MRI.
- Use cases include plagiocephaly, craniosynostosis, calvarial lesions, sinonasal disease, head neck tumors, jaw lesions, trauma, surgical navigation, and postoperative evaluation.
- Postprocessing advances using point reconstructions and deep learning facilitate synthetic ("bright-bone") CT generation, 3D visualization, and surgical planning.

### **TABLE OF CONTENTS/OUTLINE**

1. Technique• Gradient, ultrashort, zero echo-time• Workflow sequence options• Interpretation and pitfalls2. Clinical Cases• Plagiocephaly• Simple craniosynostosis: metopic, sagittal, coronal• Genetic syndromes: Apert, Saethre-Chotzen, achondroplasia• Skull: ecchordosis physaliphora, dermoid cysts, LCH, fibrous dysplasia• Sinonasal: midnasal stenosis, pneumosinus dilatans, sinusitis• Tumors: orbitotemporal NF1, rhabdomyosarcoma, chordoma• Jaw lesions: ameloblastoma, desmoplastic fibroma• Trauma: abusive head trauma, TBI, leptomenigeal cyst, cephalohematoma• Surgical planning: arachnoid cyst, hydrocephalus• Shunt evaluation: tumor, craniosynostosis, overshunting• Postoperative evaluation: craniotomy, cranioplasty, ZMC, orbital blowout, cephalocele3. Postprocessing• Point processing• Deep learning: models, loss functions, generalizability• Diagnostic use• Surgical planning

## **HNEE-55 Fetal Head and Neck Imaging**



**TEACHING POINTS**

Fetal HN anomalies can be classified into congenital, genetic, vascular, neoplastic, traumatic, and endocrine etiologies. Major diagnoses include micrognathia, facial clefts, craniosynostosis, meningocele, vascular malformations, teratoma, and airway obstruction. US and MRI have complementary roles for prenatal screening and detailed workup. Each technique has specific clinical indications and technical limitations. Fetal MRI protocols should include 3-plane ssFSE with optional balanced SSFP, diffusion, and T1. The radiology report should address brain, face, neck, and airway, along with secondary complications and multisystem associations. Several qualitative features and quantitative metrics can be applied. For at-risk patients, serial imaging can improve diagnostic yield and interventional planning. Postnatal imaging is important for confirmation of prenatal findings.

**TABLE OF CONTENTS/OUTLINE**

1. Craniofacial Malformations Oro/craniofacial clefts Micrognathia, Pierre-Robin Beckwith-Wiedemann Orbital telorism, malformations Craniosynostosis Cephaloceles, meningoceles Acrania-exencephaly-anencephaly Amniotic band syndrome 2. Genetic Syndromes Apert Pfeiffer Frontonasal dysplasia DiGeorge Fraser 3. Cervicofacial Masses Vascular anomalies Hemangioma Lymphatic malformation Vein of Galen malformation Arteriovenous malformation Teratoma Goiter 4. Upper Airway Congenital high airway obstruction syndrome Laryngeal stenosis/atresia Tracheal stenosis/atresia Tracheo-esophageal fistula (VACTERL)

**HNEE-56 Pediatric Cutaneous Lesions: Below the Surface**

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

**TEACHING POINTS**

Pediatric skin lesions are often harbingers of more extensive or systemic disease. Unique cutaneous stigmata are seen in vascular anomalies and phakomatoses. Radiologic imaging is needed to characterize deep or multisystem involvement. Understanding of genetics helps to explain disease pathogenesis and develop targeted therapies.

**TABLE OF CONTENTS/OUTLINE**

1. Background Genetic advances Ras and mTOR pathways Targeted therapies Critical point for intervention 2. Vascular Anomalies Malformations Low-flow Lymphatic (syndrome: GLA) Venous (syndromes: VMCM, BRBNS, KTW) Capillary (syndromes: M-CM, CLAPO) High-flow AVM AVF Syndromes: HHT, CM-AVM, PWS, CAMS Tumors Benign Congenital hemangioma Infantile hemangioma Syndromes: hemangiomatosis, PHACES Borderline Juvenile nasopharyngeal angiofibroma Kaposiform hemangioendothelioma Malignant 3. Phakomatoses Dysplastic NF1 NF2 NF3 Tuberous sclerosis Gorlin Cowden Proteus Encephalocraniocutaneous lipomatosis Vascular Von Hippel-Lindau Sturge-Weber Ataxia-telangiectasia Pigmentary Neurocutaneous melanosis Pigmentary mosaicism

**HNEE-57 Pediatric Orbital Lesions**

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

**TEACHING POINTS**

Pediatric orbital lesions can be classified into congenital, CSF, traumatic, vascular, endocrine, inflammatory, and neoplastic. Radiologic evaluation evaluates intraorbital compartments and extraorbital structures. Correlate imaging findings with ophthalmologic exam and imaging.

**TABLE OF CONTENTS/OUTLINE**

1. Background Orbital anatomy development Ophthalmology: fundoscopy, US, OCT Radiology: CT, MR, XA 2. Congenital Small eye: anophthalmia, microphthalmia, phthisis bulbi Big eye: buphthalmos, staphylomas, colobomas Germ layer derivatives Syndromes: NF1, NF2, Aicardi, CHARGE, morning glory, Walker-Warburg Cranial dysinnervation 3. CSF Papilledema vs. pseudopapilledema Cephalocele Exorbitism 4. Trauma Anterior segment Posterior segment Globe rupture Fractures 5. Vascular anomalies Low-flow malformations Varix Venous Lymphatic Sturge-Weber Coats disease High-flow malformations Carotid-cavernous fistula Wyburn-Mason Vascular tumors Hemangiomas PHACES Von Hippel-Lindau 6. Endocrine Pediatric Graves 7. Inflammation Pott's puffy tumor Aspergillosis COVID-19 Demyelination MS NMO ADEM Histiocytosis LCH JXG Granulomatosis IgG4 CRION 8. Neoplasia Intraocular Retinoblastoma Medulloepithelioma Periorbital Adenoid cystic carcinoma Hidradenocarcinoma Benign Solitary fibrous tumor Pituitary macroadenoma Small round cell Rhabdomyosarcoma Neuroblastoma Leukemia Desmoplastic sarcoma Bone lesions Osteoma Fibrous dysplasia Sickle cell infarcts

## **HNEE-58 Head & Neck Vascular Anomalies and Syndromes**

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

### **TEACHING POINTS**

The ISSVA classification divides vascular anomalies into vascular malformations (vasculogenesis) and vascular tumors (angiogenesis). Radiology plays an important role in diagnosis and treatment of HN vascular anomalies. Major imaging approaches include US, CT, and MR. Each modality has specific clinical indications and limitations. Imaging findings should be correlated with dermatologic examination and other clinical information. There is an emerging focus on genetic causality and targeted therapies.

### **TABLE OF CONTENTS/OUTLINE**

1. ISSVA Classification Vascular neoplasms: benign, borderline, malignant Vascular malformations: simple, combined, syndromic Genetics and targeted therapies 2. Imaging Modalities USXRCTMRXA 3. Malformations Low-flow Capillary, venous, lymphatic Syndromes: Sturge-Weber, blue rubber bleb nevus, megalencephaly-capillary malformation, CLAPO, Gorham-Stout, generalized lymphatic anomaly High-flow Arteriovenous malformation, arteriovenous fistula Syndromes: cerebral arteriovenous metamerism syndrome, hereditary hemorrhagic telangiectasia, CM-AVM 4. Tumors Congenital hemangioma RICH, NICH, PICH Infantile hemangioma Hemangiomatosis, PHACES Kaposiform hemangioendothelioma / Tufted angioma Epithelioid hemangioendothelioma Kaposi sarcoma Angiosarcoma 5. Overgrowth Facial infiltrating lipomatosis Epidermal nevus Megalencephaly-capillary malformation: MCAP, MPPH Proteus Cowden

## **HNEE-59 Approach to Pediatric Face and Neck Masses**

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

### **TEACHING POINTS**

Evaluation of pediatric face neck masses includes clinical history, physical exam, lab values, and radiology. Diagnostic imaging can be performed with US, CT, or MR to characterize lesion location, composition, and extent. Diagnostic categories include congenital, vascular, inflammatory, and neoplastic.

### **TABLE OF CONTENTS/OUTLINE**

1. Congenital Midface Dermal sinus Glial heterotopia Encephalocele Branchial clefts Types 1-4 Branchial pouches Thymus Parathyroid Thyroid 2. Vascular Vascular malformations Low-flow syndromes Lymphatic (generalized lymphatic anomaly) Venous (blue rubber bleb nevus) Capillary (megalencephaly-capillary malformation) High-flow syndromes HHT CM-AVM CAMS Vascular tumors Congenital hemangioma Infantile hemangioma: hemangiomatosis, PHACES Borderline tumors Juvenile nasopharyngeal angiofibroma Kaposiform hemangioendothelioma 3. Inflammatory Tonsillar vs. peritonsillar abscess Retropharyngeal edema vs. abscess Pott's puffy tumor Salivary glands Sialosis Sialadenitis Pneumoparotitis Mucocele / Ranula Autoimmune 4. Neoplastic Lipomatous lesions Congenital infiltrating lipomatosis Lipoblastoma Teratoma Fibrous lesions Fibromatosis colli Myofibromatosis Leiomyoma Desmoplastic fibroma (tuberous sclerosis) Desmoid fibromatosis (Gardner) Sarcoma Rhabdomyosarcoma Ewing Fibrosarcoma Synovial sarcoma Neuroblastoma Primary Secondary Nerve sheath tumors NF1 NF2 NF3 Neuroendocrine tumors Glomus (SDH, NF1, VHL, MEN) Thyroid Thyroiditis Thyroid CA

## **HNEE-6 Differentiating Malignant Parotid Tumors From Pleomorphic Adenomas and Warthin's Tumors: The Benefits of Tumor Blood Flow and Apparent Diffusion Coefficient Histogram Analysis**

Fumine Tanaka, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

It is occasionally difficult to differentiate malignant parotid tumors (MTs) from two major benign tumors such as pleomorphic adenomas (PAs) and Warthin's tumors (WTs). Here, we review how to diagnose parotid tumors by the use of apparent diffusion coefficient (ADC) and tumor blood flow (TBF) obtained by pseudocontinuous arterial spin labeling (pCASL), comparing conventional methods such as tumor-to-parotid gland signal intensity ratios with histogram analysis for the following reasons: 1. to understand principle of pCASL; 2. to review conventional methods to evaluate parotid tumors by TBF and ADC; and 3. to understand the benefits of TBF and ADC histogram analysis for differentiating MTs from PAs and WTs.

### **TABLE OF CONTENTS/OUTLINE**

1. Essential knowledge of parotid tumors such as incidence rate, and major tumor types 2. Principle of pCASL 3. Conventional methods for differentiating MTs from PAs and WTs 1. TBF and ADC histogram analysis for differentiating MTs from PAs and WTs 2. Conclusion: The combination of TBF and ADC evaluated by histogram analysis may enhance the diagnostic performance for differentiating parotid MTs from PAs and WTs.

## **HNEE-60 Opportunistic Assessment for Parathyroid Adenomas: How We Do It and Why**

Cardenas, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

There are well-documented shortcomings in the diagnosis and treatment of primary hyperparathyroidism (PHPT). These gaps have prompted calls for innovative changes to how health systems approach this disease. One proposed change is for radiologists to assess for enlarged parathyroid glands on routine imaging studies with the goal of identifying individuals with undiagnosed PHPT. This exhibit will 1) review relevant PHPT background, 2) summarize existing evidence related to opportunistic parathyroid assessment, and 3) share a practical, step-by-step approach to opportunistically screening for parathyroid adenomas (i.e., "how we do it") with illustrative case examples.

### TABLE OF CONTENTS/OUTLINE

1. Opportunistic Screening - definition; potential benefits and risks  
2. PHPT Background - epidemiology, pathophysiology, diagnosis, treatment, accepted imaging role  
3. Existing Gaps - failure to diagnose, failure to treat, morbidity of untreated disease  
4. Opportunistic Assessment for Parathyroid Adenomas - anatomy, size criteria, imaging characteristics, review of the evidence, relevant aspects of Fifth International Workshop clinical guidelines, how we do it (search pattern, imaging evaluation, reporting)  
5. Illustrative Examples - opportunistically identifying parathyroid adenomas on CT, MR, US; differentiating from mimics (exophytic thyroid tissue, thyroid nodule, lymph node)  
6. Proposed Best Practices Decision Tree for "Should I Recommend Biochemical Testing for Possible PHPT?"  
7. Summary and Conclusion

## HNEE-61 **Hmm...Is That Normal? Pediatric Skull Base Variants With A Focus on the Temporal Bone**

### Awards

#### Cum Laude

Asha Sarma, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

-Radiologists must recognize many normal skull base variants that may be mistaken for disease in pediatric patients.- Differentiating normal variants from disease may be especially challenging in the temporal bone, given complex anatomy and frequently incomplete ossification.-This multi-institutional exhibit will provide a detailed case-based review of pediatric skull base variants including relevant companion cases, pearls, pitfalls, and mimics.-After viewing this exhibit, radiologists will have practical tools for differentiating normal skull base variants from disease and strategies for troubleshooting difficult cases.- This exhibit aims to: 1) describe relevant anatomy, embryology, and post-natal development of the skull base and temporal bones, 2) identify CT and MRI findings of common and uncommon developmental findings and variants, 3) contrast these variants with similar-appearing disease states, and 4) explain strategies for troubleshooting difficult cases.

### TABLE OF CONTENTS/OUTLINE

1) Normal anterior skull base ossification and variants (e.g., skull base synchondroses, craniopharyngeal canal) 2) Normal temporal bone development and variants (e.g., cochlear cleft, incomplete ossification of the semicircular canals) 3) Variant middle ear findings (e.g., ossicular pneumatization, suspensory ligament calcification) 4) Vascular variants (e.g., emissary venous channels mimicking fracture, aplastic petrous carotid canal); 5) Skull base pneumatization variants; 6) Other salient findings (e.g., skull base sutures, foramen tympanicum)

## HNEE-62 **Pictorial Overview of Temporomandibular Joint Pathologies**

Wen Wang, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Review the anatomy of TMJ. Provide illustrative cases and clinical scenarios depicting common and rare pathologies involving TMJ.

### TABLE OF CONTENTS/OUTLINE

1. Relevant anatomic review of the temporomandibular joint. 2. Check list/Search pattern for TMJ pathologies. 3. Congenital anomalies: i. Congenital hypoplasia ii. Ankylosis of TMJ. 4. Infectious pathology: i. Septic arthritis of TMJ ii. Post-operative infection 5. Degenerative disease: i. Osteoarthritis of TMJ ii. TMJ disc dislocation and subluxation. 6. Neoplastic disease: i. Osteochondromatosis of TMJ ii. Ameloblastoma iii. Metastatic disease. 7 Other pathologies: osteonecrosis.

## HNEE-63 **Practical Tips for Hypopharyngeal Carcinoma Staging**

Carlos Alberto F. Coelho Neto, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The hypopharynx represents the lowest portion of the pharynx and can be affected by neoplastic and non-neoplastic diseases. Squamous cell carcinoma is the most common neoplasm in this region and can affect one of its three main

subsites: pyriform sinuses, posterior wall and post-cricoid region. Imaging evaluation is essential in the staging of these patients, along with clinical and endoscopic examination. The objective of this presentation is to help the radiologist in the evaluation of neoplastic lesions of the hypopharynx, with images and tips for the evaluation of primary lesions and lymph node enlargement, contributing to the TNM classification.

#### **TABLE OF CONTENTS/OUTLINE**

Discussion of imaging tips in staging the hypopharynx neoplasms by showing clinical cases with MRI and CT images. We start this presentation by detailing the anatomical limits of the hypopharynx. We will detail the three main subsites of hypopharyngeal neoplasms: pyriform sinuses, posterior wall and postcricoid region. We highlight the main points of the TNM classification and, through cases, we demonstrate the main anatomical landmarks, how to measure the lesions, besides tumor extension pathways. Lymph node aspects will also be discussed, such as dimensions, dissemination routes, extranodal extension and necrosis. The conclusion of this presentation shows that hypopharyngeal neoplasms are part of the daily clinical routine of general and head and neck radiologists. Therefore, the anatomy of the pharynx must be well known, as well as the main subsites of the hypopharynx. We also show that it is not necessary to memorize the TNM staging, but the radiologist must know how to evaluate its most important points and landmarks.

#### **HNEE-64 Orbital Trauma: A Pictorial Review**

Junaid Kalair, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Discuss the role of imaging in evaluation of orbital trauma  
2. Recognized normal orbital anatomy on CT and MRI  
3. Describe the spectrum of orbital trauma injuries seen on imaging  
4. Recognize mimics of orbital injuries

#### **TABLE OF CONTENTS/OUTLINE**

Roles of radiographs, ultrasound, CT, and MRI in orbital trauma imaging  
Normal bony and soft tissue anatomy of the orbit on CT MRI including orbital compartments  
Pictorial Review of orbital injuries including: Extra-global injuries  
Preseptal vs. post-septal hemorrhage  
Intra-conal vs. Extra-conal hemorrhage  
Traumatic exophthalmos vs. enophthalmos  
Ocular muscle injury/entrapment  
Foreign bodies  
Globe injuries  
Anterior segment  
Aqueous humor hemorrhage  
Uveal Prolapse  
Lens Dislocation  
Ejection  
Posterior segment  
Vitreous humor hemorrhage  
Subretinal hemorrhage  
Subchoroidal hemorrhage  
Open globe  
Imaging findings  
Foreign bodies  
Orbital trauma mimics  
Iatrogenic intraocular gas  
Medical implants

#### **HNEE-65 Internal Cacophony of Heartbeats: Rhythmic Whooshing and Buzzing in the Ear - Maddening Patient and Physician**

#### **Awards**

#### **Certificate of Merit**

Suehyb G. Alkhatib, MD, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review common and uncommon etiologies of pulsatile tinnitus including vascular, structural and neoplasms.  
2. Multimodality imaging assessment and diagnostic workup.  
3. Current concepts in management and review of treatment options.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background introduction of pulsatile tinnitus  
2. Review of common and uncommon etiologies of pulsatile tinnitus  
a. Vascular:  
i. Venous: Idiopathic intracranial hypertension, jugular bulb diverticulum, and emissary veins  
ii. Arterial: arteriovenous fistula and malformations, aberrant carotid artery, fibromuscular dysplasia and carotid dissections  
b. Structural:  
i. Skull base dehiscence, internal jugular vein compression  
ii. Conductive hearing loss, e.g. otosclerosis  
c. Tumor: Paraganglioma, meningioma, low flow vascular malformations (Hemangiomas)  
3. Diagnostic Imaging QR codes with scrollable imaging data sets will be provided, with practical clues for making the diagnosis, and will include high-resolution flat panel CT  
a. Idiopathic intracranial hypertension CTV, MRV, and DSA  
b. High riding jugular bulb and diverticulum CTV and DSA, and vascular Eagle syndrome  
c. Dural arteriovenous fistula CTA, MRA, and DSA Including high resolution 14 second magnified flat-panel computed tomography  
d. Aberrant carotid artery CTA and DSA  
e. Paraganglioma MRI, MRA, and DSA  
f. Meningioma MRI  
g. Sigmoid sinus wall dehiscence and emissary veins CTA including treatment DSA  
h. Otosclerosis CT  
4. Review of treatment options  
a. Transverse sinus stenosis stenting  
b. Arteriovenous fistula embolization  
c. Jugular vein decompression  
d. Bony dehiscence resurfacing  
5. Diagnostic algorithm summary

#### **HNEE-66 Imaging Evaluation of Hearing Loss: Understanding Audiograms to Refine Interpretation**

William Malouf, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Prior to imaging, patients with hearing loss undergo audiometric assessment, which categorizes hearing loss as conductive, sensorineural, or mixed.  
2) CT is the first-line imaging modality for patients with conductive hearing loss (CHL),

and an understanding of prior audiometric testing results can benefit the radiologist's temporal bone CT interpretation.3) Pure-tone hearing test results may be the most relevant component of the audiogram report for radiologists and are often viewable in the electronic medical record at the time of CT interpretation.4) Recognizing specific CHL patterns in audiograms can increase confidence and accuracy of CT interpretations.5) The presence or absence of the acoustic reflex informs likelihood of a third window phenomenon.

#### **TABLE OF CONTENTS/OUTLINE**

I. Evaluation of the patient with hearing lossa. Clinical assessmentb. Audiometric evaluationc. Role of imagingi. Indications for CTii. Indications for MRII. Review of audiometric testinga. Pure-tone hearing testi. Basic interpretationii. Patterns of conductive hearing lossb. Acoustic reflexi. Principlesii. Acoustic reflex testingIII. Illustrative Casesa. Pattern 1: Low frequency CHL closing in at higher frequenciesb. Pattern 2: Flat CHLc. Pattern 3: The Carhart notchd. Absent acoustic reflex

### **HNEE-67    Ultrasound Assessment of Parathyroid Disease: The Latest and Greatest**

Axel A. Torres Monarrez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Provide an overview of the anatomy, function, and embryology of the parathyroid gland.
- Emphasize the indications, limitations, and benefits of ultrasound in evaluating the parathyroid gland.
- Compare different imaging techniques for the parathyroid gland.
- Discuss the ultrasound protocol for evaluating the parathyroid gland.
- Become familiar with descriptive terms for normal parathyroid gland anatomy.
- Review the most common pathologies and provide case studies to illustrate the practical application of theoretical concepts.
- Analyze differential diagnoses, tips, and tricks.
- Discuss updates in ultrasound evaluation for parathyroid gland pathology.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of the parathyroid gland 1.1 Anatomy 1.2 Function 1.3. Embryology2. Ultrasound evaluation of the parathyroid gland 2.1 Indications 2.2 Limitations 2.3 Benefits3. Comparison of imaging techniques for the parathyroid gland: ultrasound, 4DCT, and SPECT.4. Ultrasound and CEUS protocol for evaluating the parathyroid gland.5. Descriptive terms for normal parathyroid gland anatomy6. Common pathologies in the parathyroid gland: parathyroid adenoma, parathyroid hyperplasia, parathyroid carcinoma, atypical parathyroid adenoma/atypical parathyroid tumor.7. Differential diagnoses: thyroid nodules and cervical adenopathies, tips and tricks for improving radiology reports.8. Updates in ultrasound evaluation for parathyroid gland pathology: elastography and CEUS.9. Conclusion.

### **HNEE-68    Molecular Markers of Head and Neck Tumors**

Amit K. Agarwal, MD, MBBS (*Presenter*) Stockholder, Gilead Sciences, Inc

#### **TEACHING POINTS**

1. To understand the basics of neuropathology and genetics2. Review the molecular markers genetics of head and neck tumors3. Discuss reclassified and newly recognized head and neck tumors

#### **TABLE OF CONTENTS/OUTLINE**

1. Neuropathology for the Neuroradiologist a. Basic histopathology (H E stains)b. Immunohistochemistry (immunocytology)c. Genetic analysis (FISH, PCR, Next-generation sequencing,) d. Liquid biopsy2. Markers for squamous cell carcinomas (SCCa) of the head and necka. HPV (p16+ tumors) b. EBV positive tumors c. Circulating-tumor DNA (ct-DNA) for tumor surveillance3. Molecular markers for non-SCCa tumors of head and neck a. Muscle differentiation (actin, desmin) b. Neural differentiation (S100, GFAP) c. Vascular differentiation (CD markers) d. Epithelial differentiation (cytokeratin, EMA)4. Reclassified and newly recognized tumors a. SDH deficient paragangliomas b. EBV-related smooth muscle tumors c. Mammary analogue secretory carcinoma (MASC) 5. Therapeutic advances in head and neck oncology (focus on immunotherapy) 6. Summary/conclusion

### **HNEE-69    A Practical Guide for Radiologists: Localizing and Diagnosing Pathologies in the Carotid and Parapharyngeal Spaces**

Yesim Y. Yuruk, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Provides a comprehensive overview of the radiologic anatomy of the carotid and parapharyngeal space (PPS)
- Describes a practical approach for localizing the pathologies affecting the carotid and PPS.
- Reviews common and rare pathologies in the carotid and PPS using case-based examples, highlighting distinctive clinical and imaging features that can aid in the best differential diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents 1. Terminology of the Carotid and PPS 2. Anatomy and Contents of the Carotid and PPS 3. Practical approach to Diagnosing Pathologies in the Carotid and PPS 4. Displacement Pattern of PPS Fat for Localizing Masses. 5. Case-

Based Review of Primary and Secondary Pathologies in the PPS 6. Case-Based Review of Primary and Secondary Pathologies in the Carotid Space Outline • Knowledge of anatomy is essential for localizing a lesion in the Carotid or PPS. • Displacement patterns of PPS fat can aid in identifying the space of origin. • Understanding the contents and common/rare lesions of these spaces is the first step in generating a differential diagnosis. • Obtaining relevant clinical history and recognizing specific imaging appearances can help provide the best differential diagnosis.

## **HNEE-7 Hypervascular Head and Neck Tumors: Image Aspects**

Fernanda B. Guedes, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Hypervascular tumors, by definition, are arterialized and present intense and early contrast enhancement. They comprise a wide variety of pathologies, which can be didactically divided into five major groups: neuroendocrine tumors, vascular tumors, primary lymphadenopathy, metastatic lymphadenopathy and other hypervascular tumors.

### **TABLE OF CONTENTS/OUTLINE**

In this presentation we are going to review hypervascular head and neck tumors and characterize their imaging features on computed tomography (CT) and magnetic resonance imaging (MRI), focusing on features that aid in the differential diagnosis through flowcharts. Images will be presented comparing the different locations of the paragangliomas and the various patterns of growth of the Juvenile nasopharyngeal angiofibroma. Metastatic and primary lymphadenopathy will be differentiated through tables.

## **HNEE-70 Update in Imaging of Parotid Lesions and Treatment-related Findings**

Ewa Joanna Maciag (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Parotid gland tumors are a rare entity among the neoplasms of the head and neck. In adults, most encountered lesions are benign, being only 10% of parotid tumors malignant. Radiological assessment of these lesions includes ultrasound (US), computed tomography (CT), and morphological and functional magnetic resonance imaging (MRI). The definition of the nature of the lesion is essential for the election of treatment methods. Benign neoplasms may be destined for follow-up or managed surgically by gland-sparing techniques with facial nerve preservation. On the contrary, malignant lesions are treated frequently with total gland resection and sacrifice of the facial nerve with corresponding posterior morbidity. The exhibit aims to present the gamut of parotid neoplasms according to their imaging characteristics in the initial study and to stress the importance of radiological support in the follow-up. Treatment options including different surgical approaches and the correlation between applied technique and imaging will be provided.

### **TABLE OF CONTENTS/OUTLINE**

1. Parotid anatomy. 2. Imaging modalities: US, CT, morphological, and functional MRI. Applications. 3. Primary and secondary parotid lesions. 4. Different types of surgical approaches. 5. Follow-up findings.

## **HNEE-71 Bone Metabolic Disorders in Pediatric Patients: Key Clues for Early Detection in Dental Imaging**

Jo-Eun Kim, DDS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Bone metabolic disorder refers to a disease caused by a variety of causes that break the balance between bone-forming and bone-removing activities. Bone metabolic disorders can affect pediatric patients and impact their oral health. Dental imaging, such as panoramic radiographs and cone-beam computed tomography (CBCT), can provide key clues for early detection of these disorders. - Generalized loss of follicular cortex or lamina dura of tooth - Generalized widening or obliteration of pulp chamber - Generalized sclerotic or osteopenic change of trabecular bone Understanding the imaging features of bone metabolic disorders is essential for dental practitioners to identify and refer patients for appropriate medical care. Especially, it is important to distinguish it from hematopoietic malignancy (such as leukemia, or lymphoma), which can appear similar and requires urgent treatment. Collaboration between dental and medical professionals is crucial for the management and treatment of bone metabolic disorders in pediatric patients.

### **TABLE OF CONTENTS/OUTLINE**

1. Meaning of dental imaging in pediatrics 2. Schematic explanation of bone mineral metabolic disorder 3. Bone metabolic disorders which impact on teeth and jaw bone structures (summary table) 4. Example of panoramic radiographs of the pediatric patients affected by metabolic disorder 5. Differential diagnosis from hematopoietic malignancy of pediatric patients (Importance of detecting changes on dental radiography)

## **HNEE-72 There's Something In Your Teeth! Dental Panoramic Radiology for Radiologists**



Logan M. Ryals, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review normal dental anatomy and imaging features, highlighting digital panoramic radiography (Panorex) cross-sectional imaging correlates. Discuss the differential diagnosis of oral maxillofacial/dental pathology on Panorex and cross-sectional imaging. Recognize the importance of systematic dental imaging interpretation in the diagnosis of oral and maxillofacial diseases.

#### **TABLE OF CONTENTS/OUTLINE**

The oral cavity is the intersection of dentistry and medicine. However, the relationship of oral and systemic conditions is not fully appreciated. Modalities used in dental radiology include periapical and bitewing radiography, digital panoramic radiography, and cone-beam computed tomography. Panoramic radiography is most widely encountered by radiologists, but few receive formal training, and many are uncomfortable interpreting these studies despite frequent expectations to do so. Early detection of intraoral pathologies by radiologists may improve patient care and alert clinicians to the need for dental consultation. Familiarity with the anatomy and pathology of the oral and maxillofacial region will improve radiologists' diagnostic confidence and allow for the synthesis of a timely and detailed differential diagnosis. We will review dental imaging protocols, normal dental anatomy, and common findings of oral and maxillofacial pathology. A wide range of pathology will be discussed, emphasizing their appearances on panoramic radiographs with cross-sectional imaging correlates. Pathologies to be discussed include infectious and inflammatory lesions, periodontal diseases, cystic, benign and malignant masses, sinus pathology, and bone and temporomandibular joint disorders.

#### **HNEE-73 Unlocking the Temporomandibular Joint: CT, MRI and Arthroscopic Correlation**

Silvia Cayon Somacarrera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To illustrate the spectrum of findings in temporomandibular joint derangement on MR and its correlation with arthroscopic findings when available  
To highlight the role of CT in temporomandibular joint derangement  
To show the different surgical therapeutic approaches of temporomandibular pathology

#### **TABLE OF CONTENTS/OUTLINE**

The most important anatomic structure of the temporomandibular joint is the articular meniscus, therefore it is the main element to be evaluated. We must study its morphology along with its location relative to the condyle in both closed- and open-mouth positions. However, we must bear in mind that meniscus aberrant displacement is also frequently seen in asymptomatic volunteers so that other findings such as joint effusion, retrodiskal layer rupture, lateral pterygoid muscle attachments thickening, degenerative changes, osteochondromatosis and ankylosis, may be required to help guide the diagnosis. It is important for the radiologists to detect early MR imaging signs of temporomandibular dysfunction, thereby avoiding its evolution to osteoarthritis. Nevertheless, it is important to know that the therapeutic approach is made by assessing both the clinical situation of the patient and the imaging. We have selected a wide variety of temporomandibular joint derangement cases in order to show the different imaging findings as well as the arthroscopic correlation when available. We also include a description of the different treatment approaches carried out in our institution.

#### **HNEE-74 Lesions in the Optic Tracts: Clinical-radiological Manifestations**

Maria E. Rocha, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the basic anatomy of the visual pathway and correlation with clinical manifestations.- Present the most frequent lesions in each region of the optic tract and review the main differential diagnoses.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Anatomy review 3. Correlation the anatomy with clinical manifestations 4. Most frequent lesion in each topography

#### **HNEE-75 Temporal Bone Anatomy on Photon Counting CT: Beyond the Obvious**

#### **Awards**

#### **Certificate of Merit**

Shehbaz M. Ansari, MD, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe the concept and design of photon counting CT scanners and understand its advantages over conventional CT scanners with energy integrating detectors. 2. Illustrate temporal bone anatomy with emphasis on structures that were

previously not reliably or less vividly identifiable. 3. Develop a system-based approach to temporal bone radiological anatomy.

#### **TABLE OF CONTENTS/OUTLINE**

The imaging anatomy of the temporal bone has seen little progress in the last decade owing to the limited progress in the detector technology. Conventional detectors suffer from the inverse relation between radiation dose and image noise along with a limit to image resolution. Photon counting detectors (PCDs) have improved contrast to noise ratio with twice the resolution at nearly half the radiation dose. The basic physics of these detectors and their potential uses will be first discussed. To highlight the advantages of PCDs, we depict temporal bone anatomy including small structures not previously identifiable on imaging. Historically, advances in imaging to clarify anatomy has led to a deeper understanding of and elucidation of new pathologies associated with these structures. We also put forward a system-based approach to the anatomy of this region along with the conventional section-based anatomy. This system-based approach, aided by diagrammatic illustrations, will aid in understanding the complex anatomy of minute neural structures and communications around the ear, the delicate ossicular support system, neural and vascular supply of the labyrinth, and minor adjacent fissures among others.

#### **HNEE-76 Feast Your Eyes on US of the Eye: A Guide to Ophthalmic Sonography**

Pedro A. Daza, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The eye needs a gel pillow. Acquired planes must evaluate anterior and posterior chambers. The optic nerve must be acquired on its own, using Doppler. Extraocular structures are important. Dynamic images are strong points of the sonography.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy and radiological anatomy of eye. Technique and recommendations. Pathology with case review. Conclusions.

#### **HNEE-77 Imaging of Post-dental Treatment: What Radiologists Need to Know in Common and Advanced Dental Procedures**

#### **Awards**

#### **Cum Laude**

Kotaro Ito, DDS, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

With recent advancements in dentistry, various new treatment methods have been clinically introduced, and many new materials are being used for treatments. Post-dental treatment CT and MR images reveal a variety of hard tissue and soft tissue changes and used dental materials which often associate image artifacts. Therefore, familiarity with post-treatment changes and dental materials is crucial to avoid misinterpretation as true pathologies, identify complications and evaluate for recurrent disease. The purpose of this exhibit is 1) to review common and uncommon dental treatments with an emphasis on recently introduced treatment and procedures, 2) to review expected and unexpected post-dental treatment changes and dental materials on CT and MR images, and 3) to discuss imaging approach to identify complications and disease recurrence or progression.

#### **TABLE OF CONTENTS/OUTLINE**

1) Review of common and uncommon dental treatments, with an emphasis on recently introduced treatments and dental materials  
2) Review of expected and unexpected post-dental treatment changes and dental materials on CT and MR images  
3) Discussion on imaging approach to identify complications and disease recurrence or progression

#### **HNEE-78 PET/MRI In Head and Neck Cancer: Ready For Primetime?**

Craig Foote, MD, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

PET/MR is a relatively new modality poised to provide considerable, novel clinical value in the field of head and neck oncology by combining the functional evaluation of FDG PET with the exquisite soft tissue resolution of MR imaging. Patients with head and neck cancers already requiring MRI for TNM staging may stand to benefit the most from the use of PET/MR, which offers the ability to simultaneously acquire the optimal regional and distant metastatic evaluation offered by PET in addition to MR, as opposed to separately by MR and PET/CT. This educational exhibit will provide an overview of PET/MR and its current role in head and neck cancer, as well as discuss barriers to its widespread acceptance and predictions for the future.

#### **TABLE OF CONTENTS/OUTLINE**

1) Overview of PET/MR a) Evolution of PET/MR b) Advancements in hardware c) Physics d) Coregistration  
2) Advantages of PET/MR a) Comparison to PET/CT i) Radiation dose reduction, longer acquisition times, improved radiation planning, etc. ii)



Lung nodule detection compared to PET CTb) MRI for more accurate T stagingc) Application of NIRADS (Neck imaging reporting and data system) in PET/MR3) Examples of PET/MR in head and neck cancera) Evaluation of post-treatment change versus recurrenceb) Head and neck cancer of unknown primaryc) Orbital malignancyd) Perineural Spread4) Barriers to usea) Costsb) Lack of trial data showing distinct advantages5) Recent developments/future predictionsa) Multi-parametric imagingb) Innovative radiotracers

## **HNEE-79 Laryngeal Carcinoma Evaluation with Dual Energy CT (DECT)**

### **Awards**

#### **Cum Laude**

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Dual-energy CT (DECT) can be used in laryngeal carcinoma (LC) evaluation. Based on the decomposition of different materials, DECT can distinguish tissues with similar Hounsfield Unit attenuations assessed in simple energy CT (SECT). The size, the identification of the margins of LC, and the evaluation of adjacent structures invasion, which could change the LC staging, is not always easy due to the small size occupied by the complex laryngeal structures in the visceral compartment and their similar attenuation values. A more accurate diagnosis can be made with DECT. The main objectives of this exhibit are: 1. To describe DECT image acquisition protocols and post-processing techniques related to the evaluation of LC. 2. To illustrate DECT findings in LC by TNM staging and its SECT correspondence.3. To expose the differential diagnosis and potential pitfalls of LC in DECT and how to try to avoid them.

### **TABLE OF CONTENTS/OUTLINE**

1. Overview review of LC. 2. Diagnostic clinical and imaging strategies to evaluate LC.3. DECT protocol for LC evaluation and post-processing techniques related to imaging of LC such as virtual monochromatic and material decomposition images.4. Case-based cancer image examples with DECT and SECT correspondence for each TNM stage.5. LC pitfalls and differential diagnosis of LC in DECT images.

## **HNEE-8 Ultrasound of Ocular Globe: Revealing What Lies Below**

Ingrid D. Caridade, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Ultrasound (US) of the eye has become increasingly popular in clinical practice as a complementary tool to ophthalmoscopy, as it is a dependable and secure diagnostic technique for assessing and monitoring various ophthalmic conditions, including inflammation, tumors, and traumatic injuries, as well as measure the optic nerve and detect intracranial hypertension. The method is accessible, non-invasive, and relatively low-cost, with few contraindications. The eye's superficial location and structure make the US an ideal examination option, particularly in emergency situations. It is typically recommended when it is challenging to examine the fundus of the eye due to conditions that cause opacity of the ocular globe. In pediatrics, US can be performed without sedation or radiation, making it an especially valuable tool. Radiologists should be familiar with the basic anatomy of the eye, as well as the examination technique and ultrasonographic findings of the entities that frequently affect the ocular globe. In this presentation, we show a literature review and case analysis performed using high-frequency linear transducers with B-mode ultrasonography and color Doppler. Subsequently, the findings are compared to imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI).

### **TABLE OF CONTENTS/OUTLINE**

Review the normal eye anatomy.Demonstrate the US examination technique. Discuss some pathologies of the eye and its main ultrasonographic image features.

## **HNEE-80 Delayed Gadolinium-enhanced MRI in Ménière's Disease: Imaging Findings and Clinical Application**

Lisa M. De Pont, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is to summarise current MRI techniques for hydrops imaging; to describe current diagnostic MRI criteria for Ménière's disease; and to discuss clinical application of hydrops imaging

### **TABLE OF CONTENTS/OUTLINE**

Anatomy of inner ear structures; delayed gadolinium-enhanced inner ear MRI; MRI assessment; review of imaging findings; clinical utility

## **HNEE-81 Mimics of Ménière's disease on delayed gadolinium-enhanced MRI**

Lisa M. De Pont, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is (1) to review imaging features of several peripheral vertigo-associated diseases on delayed gadolinium-enhanced MRI and (2) to describe the current role of MRI in differentiating Ménière's disease from other vertigo-associated diseases.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy of inner ear structures; delayed gadolinium-enhanced inner ear MRI; review of imaging findings in Ménière's disease, intralabyrinthine fistula, perilymphatic fistula, labyrinthitis, sudden sensorineural hearing loss, vestibular neuritis, vestibular migraine, vestibular schwannoma; summary of MRI findings and differentiating features.

#### **HNEE-82 Imaging Considerations for Transoral Robotic Surgery (TORS) Planning**

Niedja Santos Goncalves Tsuno (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To learn the radiological imaging findings that represent indications and contraindications for Transoral Robotic Surgery (TORS), focusing on Head and Neck oncology. - To identify expected postsurgical status of tumors resected by TORS.

#### **TABLE OF CONTENTS/OUTLINE**

1. Simplify the anatomy of the oropharynx, hypopharynx, and larynx, with emphasis on the tonsillar regions, base of the tongue, supraglottis, hypopharynx (pyriform sinus), and also the pre-styloid parapharyngeal and retropharyngeal spaces. 2. Summarize classical TORS ideal indications for treatment of head and neck neoplasms, focusing on the role of CT and MR imaging to determine the size of the tumor, its location and relationship with adjacent structures. 3. Summarize and exemplify the major general contraindications for TORS related to the primary tumor (internal carotid artery entrapment, invasion of the prevertebral space, massive extension into the masticatory space, bone involvement) and those not related to the primary tumor (unresectable cervical nodal disease, metastases and high surgical-anesthetic risk), in addition to reviewing site-specific contraindications. 4. Conclusion.

#### **HNEE-83 What, Where and When of Imaging in Spontaneous Skull Base CSF Fistulas**

Sanchita Gupta, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Understand the anatomical basis and pathophysiology of spontaneously developing CSF fistulas 2) Approach to imaging in patients with skull base fistula 3) Identify the imaging appearance of lesions, and features to differentiate these from potential mimics 4) To extract clinically relevant imaging information which translates into improved decision-making and ease during the surgical procedure

#### **TABLE OF CONTENTS/OUTLINE**

1) What is a Spontaneous Skull base CSF fistula? 2) Pathophysiology of a CSF leak 3) Anatomical considerations - Common sites - Cribriform plate - Sphenoid bone - Perisellar and Lateral recess - Temporal bone - Tegmen tympani and mastoid 4) History and Clinical Presentation 5) Imaging modalities for assessment - Indications and Technique - High-resolution Computed Tomography (HRCT) - Magnetic resonance Cisternography - Contrast-enhanced CT Cisternography - Gadolinium-enhanced MR Cisternography 6) Imaging features of spontaneous skull base CSF fistula 7) Associated features of Idiopathic Intracranial Hypertension 8) Structured reporting format for the pre-surgical evaluation of skull base CSF fistula - What the Surgeon Wants to Know.

#### **HNEE-84 The External Carotid Artery: The Forgotten Carotid Branch. Tips and Tricks for the Evaluation in Different Imaging Techniques.**

Maria J. Galante I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To review the pathway, anatomical relationships and areas supplied by the external carotid artery. -To describe the anatomy of the artery and the relationship with other structures in the different techniques, including CTA, MRA, US and DSA. -To give some tips to achieve an accurate evaluation of the artery and its main pathologies, especially while performing a diagnostic US. -To offer a US protocol for the assessment of these artery. The external carotid artery is one of the main vascular structures of the head and neck region, not only because it irrigates this area, but also because some of its branches anastomose with the internal carotid and posterior cerebral arteries, becoming an important source of collateral supply. Besides, it is well known that the number of interventional and surgical procedures has massively increased. So, being the territory supplied by this artery so extensive and sometimes tricky, it could get affected whenever any of these procedures are performed, or in the case of tumors of the head and neck region, and traumatic injuries. In this exhibit we will analyze the anatomical pathway, territory, and relations of this artery.

## TABLE OF CONTENTS/OUTLINE

1) General Anatomical Description 2) The external carotid artery in Imaging Techniques: US, CTA, MRI, DSA 3) Tips and Tricks for the evaluation in US technique: Protocol 4) Superior thyroid artery 5) Ascending pharyngeal artery 6) Lingual artery 7) Facial artery 8) Occipital artery 9) Posterior auricular artery 10) Maxillary artery 11) Superficial temporal artery

### **HNEE-85 Algorithmic Approach to Head and Neck Emergency Neuroradiology**

Blake Marmie, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Discuss common neuroradiology examinations of the head and neck region from the emergency department. 2. Outline key anatomic structures and common emergent diagnoses of the head and neck. 3. Provide algorithmic approaches for interpreting neuroradiology examinations of the neck soft tissues, skull base, face, and orbits. 4. Display image rich case examples of head and neck neuroradiology emergent diagnoses which outline key features for high quality reports.

## TABLE OF CONTENTS/OUTLINE

1) Neuroradiology examinations of the head and neck commonly ordered in the emergency department i) CT: neck soft tissues, maxillofacial, temporal bone, orbits, cervical spine, CTA ii) MRI: neck soft tissues, face, orbits, IAC, cervical spine, MRA iii) Radiographs: Neck soft tissue, cervical spine, face, mandible 2) Neck soft tissue Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Ludwig's Angina, Tracheal Fractures etc. 3) Skull base Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Ossicular dislocation, Bezold abscess etc. 4) Face Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Le Fort Fractures, Fungal sinusitis etc. 5) Orbit Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Globe rupture, Retrobulbar hemorrhage etc.

### **HNEE-86 Breathe Easier: A Guide for Imaging Obstructive Sleep Apnea (OSA)**

Mathew Illimoottil (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Obstructive Sleep Apnea (OSA) is a common condition characterized by repetitive episodes of partial or complete upper airway obstruction during sleep, leading to disrupted breathing and decreased oxygen levels. Imaging techniques, such as computed tomography (CT) can provide valuable information for the diagnosis of OSA and surgical planning. CT is particularly useful for assessing the upper airway anatomy and identifying anatomical factors contributing to airway obstruction. A standardized approach for evaluating CT, including measurements of relevant landmarks is useful for communicating the findings to the referring surgeon.

## TABLE OF CONTENTS/OUTLINE

I. Introduction Definition and epidemiology of OSA Scanning Protocol II. Imaging Techniques for OSA Computed Tomography (CT) Magnetic Resonance Imaging (MRI) III. Role of Imaging in OSA Diagnosis and Management Upper Airway Anatomy Assessment Soft Tissue Structure Evaluation Functional Changes Detection Complications Identification Treatment Guidance Anatomical Measurements on CT Implantable Neurostimulator to Treat Obstructive Sleep Apnea IV. Conclusion Summary of key points Future directions and challenges in OSA imaging research

### **HNEE-87 Dacryocystography using Computed Tomography: What a Radiologist Needs to Know**

Tany Chandra, MD, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Computed Tomography Dacryocystography (CT DCG) is a valuable technique to evaluate the nasolacrimal drainage system in epiphora. It allows unequivocal demonstration of the level and causes of obstruction that include inflammatory, traumatic (fractures and iatrogenic), developmental stenosis of the bony lacrimal canal, and an occasional lacrimal sac tumor, etc. It also provides useful information about the degree of obstruction, whether obstruction is anatomical or functional, insight into reasons for failed dacryocystorhinostomy, and other useful findings like sac size, diverticuli, fistulae, etc. The technique, therefore, provides a one-stop shop for all necessary information for the diagnosis, treatment planning, and follow-up in epiphora.

## TABLE OF CONTENTS/OUTLINE

1) Indications 2) Technique 3) Interpretation 4) Etiologies with illustrative cases 5) Ancillary findings aided and detected by CT 5) Limitations 6) Conclusions

### **HNEE-88 Liptology or the Science Behind Beautiful Lips**

Slavina Mancheva, MD, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To describe the anatomy of lips and perioral region- What ultrasound technique is used to depict anatomy and tips to perform the exam- To assess any anatomical variants or physiological changes that affect the lips ?- To describe optimal prognostic tools during the ultrasound exam that might prevent any adverse event and also to define some common complications.

## TABLE OF CONTENTS/OUTLINE

The main focus is to describe the anatomy of simple but yet complicate organ that recently has been exposed to much attention. The other important part is to learn what anatomical variations are common and what pathological or physiological changes could be defined using Ultrasound. Due to the fact that there is unabated trend of aesthetic procedures in which complications are becoming more and more prominent, the radiologist must become familiar of them. Together we will identify what might be the ingredients of beautiful lips and their aging changes. The last but not least we will describe what the overfilled syndrome looks like and how it might affect the oral and perioral region.

## HNEE-89 Diagnostic Imaging of Enophthalmos: A Practical Approach

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Describe measures used to evaluate the normal globe position in cross-sectional imaging.- Discuss the main imaging features of entities that lead to enophthalmos and its mimics.- Demonstrate the utility of CT and MRI in the differential diagnosis of patients with enophthalmos.

## TABLE OF CONTENTS/OUTLINE

Enophthalmos, defined as inward displacement of a normal-sized globe within the orbit, can occur unilaterally or bilaterally and is relatively common. If the displacement is minimal, the diagnosis may not always be based on physical examination and these patients may be initially misdiagnosed as having contralateral exophthalmos. Various etiologies cause enophthalmos and trauma is the leading cause. CT and MRI are the imaging techniques of choice for evaluating enophthalmos, and each have distinct advantages. While CT is useful for the detailed assessment of bone structures, MRI is better suited for analyzing orbital soft tissues. Our purpose is to present an overview of the imaging characteristics of entities that can cause enophthalmos based on various mechanisms, including structural abnormalities, fat atrophy, retraction, mixed, uni- vs. bilateral, and pseudoenophthalmos.

## HNEE-90 US of the Neck Beyond the Thyroid: Parathyroids, Salivary Glands, Adenopathy, Trachea

Matheus Marcelino Dias, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purposes of this exhibit are:-Make a multimodality-based didactic review to elucidate multiples cervical conditions at neck ultrasound;-Propose a didactic categorization of these conditions: .Gastrointestinal malformations.Congenit malformations.Infectious causes.Oncology causes.Post operative conditions-Correlate those findings with other exams;- Illustrate those conditions based on cases from our radiology group.

## TABLE OF CONTENTS/OUTLINE

We will elucidate multiples cervical conditions at neck ultrasound and focus on their imaging features using a multimodality approach in this exhibit. Gastrointestinal malformations Zenker diverticulum Congenit malformations Cystic Thyroglossal duct cyst Branquial cyst Lymphangioma Ranula Solid Teratoma Glioma Vascular Hemangioma Arteriovenous malfomation Infectious causes Sialadenitis Parotitis Abscess Lymph node abscess Carotidynia Oncology Linfoma Parotid Submandibular gland Oropharynx Post operative conditions

## HNEE-90 A Practical Guide to Reporting an Oropharyngeal Videofluoroscopic Swallow Study: Anatomical Landmarks, Tips, and Tricks

### Awards

#### Certificate of Merit

Javier Azpeitia Arman, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-To describe oropharyngeal region anatomy and mechanism of swallowing. -To review the study protocols of oropharyngeal videofluoroscopic swallow study (VFSS) in the evaluation of different clinical conditions and endoscopic findings. -To illustrate the most important anatomic landmarks and signs to evaluate in different phases of a swallowing videofluoroscopy. - To analyze steps in interpretation of an VFSS, report structure and essential points in reporting.

## TABLE OF CONTENTS/OUTLINE

Oropharyngeal videofluoroscopic swallow study is the technique of choice in the diagnosis of oropharyngeal dysphagia causes. The study protocol should be tailored according to the specific clinical symptoms and endoscopic findings in each patient. Reporting an VFSS requires knowledge of the most important anatomic landmarks and a detailed report structure including findings in the different phases of deglutition. We present: -Normal anatomy of the oropharynx and mechanism of swallowing. - Study protocol: Contrast agent preparation. Swallowing protocol: bolus volumes (small or large) consistency (liquid to semisolid). Patient positioning. Image requirements. Recording. -Study evaluation. Anatomical landmarks. Deglutition phases. Implications for treatment. Meal consistency. Different manoeuvres improving swallowing. -Report: Systematic analysis of imaging findings. Motility disorders: Bolus transport from oral cavity, Laryngeal vestibular penetration, Pharynx residue, Transglottic aspiration; Intrinsic causes: cricopharyngeal bar (prominent cricopharyngeal muscle), diverticulum, web. Extrinsic compression: osteophytes, thyroid gland. Surgery (laryngectomy).

### HNEE-91 Head and Neck: It's Not a Tumor

Brian G. Yep, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe imaging features of head and neck lesions that should raise the concern for oncologic processes. 2. Provide non-neoplastic differential considerations for head and neck lesions.

## TABLE OF CONTENTS/OUTLINE

One of the major questions that arise when encountering a head and neck lesion is to discern if it is a neoplastic or non-neoplastic process. This educational exhibit will first highlight imaging features that should raise the concern for an aggressive neoplastic head and neck process. Then, through a case-based style, non-oncologic mimics will be presented to provide alternative benign differential diagnostic considerations including infectious, inflammatory, and variant congenital/developmental etiologies. Finally, one can put this knowledge to the test through a series of quiz questions.

### HNEE-92 Imaging of Facial Pain and Numbness: Trigeminal Neuralgia and Neuropathy

Gabriel Virador, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the normal anatomy of the trigeminal nerve, its branches and structures normally present along its anatomic course. A combination of 2D and 3D rendered images will be used, as well as CT/MRI imaging examples. 2. Discuss the pathophysiology of classic and secondary causes of trigeminal neuralgia. 3. Present a case-based review illustrating different examples of classic and secondary trigeminal neuralgia on CT/MRI images. 4. Provide a step-by-step search pattern for trigeminal pain

## TABLE OF CONTENTS/OUTLINE

I. Introduction II. Normal trigeminal nerve and skull base anatomy III. Classification of common sources of trigeminal pain. Imaging review, pathophysiology, symptoms, and management will be reviewed. Cases will include but are not limited to: a. Trigeminal Neuralgia: neurovascular compression, demyelination, tumoral compression. b. Trigeminal Perineural Tumor Spread c. Post-Herpetic Neuralgia d. Post-Traumatic Trigeminal Neuropathy e. Trigeminal Trophic Syndrome: iatrogenic, brainstem infarction f. Anesthesia Dolorosa g. Trigeminal Tic Syndrome IV. Differential Diagnosis for non-trigeminal sources of facial pain: optic neuritis, nervus intermedius neuralgia, glossopharyngeal neuralgia. V. Simplified search pattern for trigeminal pain VI. Conclusion

### HNEE-93 Dysphagia: A Pictorial Review of Common and Uncommon Causes

Selima Siala, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Illustrate a large spectrum of diseases causing dysphagia. Highlight key imaging findings of common diseases of the pharynx and esophagus.

## TABLE OF CONTENTS/OUTLINE

Dysphagia is a broad term used to describe a subjective sensation of difficulty when swallowing. Causes of dysphagia can be divided into structural and functional. Structural dysphagia includes lesions that compromise the esophageal lumen typically leading to difficulty swallowing solid food prior to liquids. Examples of structural dysphagia include congenital anomalies (esophageal web and vascular entities), acquired (Zenker's diverticulum, Longus coli tendonitis, goiter, and aortic dissection), neoplasms, inflammation (esophagitis, felinization of the esophagus, Barrett's esophagus, and scleroderma), infection (abscess and Candidiasis), iatrogenic (surgically induced) and foreign bodies. Functional dysphagia is caused by conditions that interfere with normal peristalsis including diffuse esophageal spasm and achalasia. Hence the swallowing of both solid foods and liquid is compromised at the same time. Dysphagia can also be classified based on location as oropharyngeal or

substernal. Oropharyngeal dysphagia is defined as a sensation of blockage in the throat, while substernal dysphagia presents as a sensation of blockage between the thoracic inlet and the xiphoid process. The evaluation of dysphagia heavily relies on imaging, particularly fluoroscopy studies including modified barium swallow and esophagography as well as CT. Fluoroscopy studies provide an evaluation of both anatomic structure and function of the pharynx and esophagus while CT provides better anatomic evaluation outside of the lumen.

## **HNEE-94 Decoding the Language of Neoplastic Cells: Molecular Markers as Prognostic and Diagnostic Tools for Oral Squamous Cell Carcinoma**

Laura C. Magalhaes, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To illustrate the most recent genetic alterations described in Oral Squamous Cell Carcinoma (OSCC) and correlate with the pathology, imaging, and prognosis. To show that molecular analysis can provide information on tumor biological behavior. To demonstrate the importance of incorporating molecular analysis of OSCC.

### **TABLE OF CONTENTS/OUTLINE**

1. Revision of the anatomy of the oral cavity. 2. Epidemiology, pathology, and demographics of OSCC. 3. Recent advances in molecular biology. 4. Specific genetic mutations, amplifications, or deletions associated with tumor progression, recurrence, and response to therapy. 5. Identification of human papillomavirus (HPV) leading to improved prognosis and targeted therapy. 6. Imaging strategies to depict the correct diagnosis based on the genetic profile. 7. Targeted therapies or immunotherapies. 8. Flowchart of the changes and last updates based on the neoplastic molecular profile. 9. Take-home messages.

## **HNEE-95 Lessons About Cholesteatomas. Keratinize Radiological Knowledge**

Bruna E. Gherardi, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Teaching points To demonstrate the features of cross-sectional imaging cholesteatomas, indications and limitations of HRCT and MRI. To illustrate the main complications of cholesteatomas and post-operative assessment.

### **TABLE OF CONTENTS/OUTLINE**

Table of contents / Outline Background. Imaging protocol. Basic anatomy: middle and inner ear. Features of external and middle ear cholesteatomas. The role of CT and MRI in the diagnosis of cholesteatoma. Extra auricular cholesteatoma. Complications of cholesteatoma. Assessment of recurrence and postoperative findings through CT and MRI. Take home messages.

## **HNEE-96 What a Pain in the... Imaging Findings of the Painful Ear**

Bruna E. Gherardi, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Teaching points To detect the imaging features of the painful ear. To identify the main CT features of incipient and coalescent acute mastoiditis as a basis for recommending conservative or surgical management. To detect intracranial complications of acute inflammatory diseases.

### **TABLE OF CONTENTS/OUTLINE**

Table of Contents/Outline Background. Basic anatomy of the external, middle and inner ear. HRCT and MRI imaging protocol. The role of CT and MRI in the diagnosis of mastoiditis. Necrotizing external otitis. Local complications: Myringosclerosis / tympanosclerosis, Ossicular fixation and erosion, Labyrinthine fistula, Labyrinthitis, Periosteal / Bezold's abscess. Extensive complications: Dural sinus thrombosis, Meningitis, Subdural effusion, Brain abscess, Petrous apicitis.

## **HNEE-97 Nose Job: A Work in Progress... Aesthetic Procedures of the Nose - Pre and Postoperative**

### **Awards**

#### **Certificate of Merit**

Raphael M. Reali, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Review the structural anatomy of the nasal region. 2. Detail the nasal functional anatomy for a successful rhinoplasty surgery. 3. Guide the radiologist to detail anatomical changes relevant to the surgical procedure. 4. To evaluate the computed tomography (CT) imaging as a tool for developing approaches or strategies for leading aesthetic nasal surgical procedures. 5.

To evaluate the postoperative CT images as a tool for evaluating changes, sequels and complications after the aesthetic surgical procedure.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introductiona. Nasal anatomyb. Nasal functional anatomyc. Nasal deformitiesd. Clinical application of CT to aesthetic procedures of the nose 2. Preoperative CT imagea. What should be evaluated: bony pyramid, cartilaginous pyramid, nasal valves, nasal deformities 3. Postoperative CT imagea. Surgical techniques and imaging findings: rhinoplasty, septoplasty, rhinectomy, maxillary antrostomy and uncinectomy, nasal turbinate surgery, ethmoidectomy, nasal prosthesisb. Complicationsc. Sequels 4. Take-home messages

#### **HNEE-98 Precision Imaging of Diplopia: MRI Protocol and Various Diseases**

Sang Ah Cho (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Diplopia is a relatively common neuro-ophthalmological symptom and has a variety of causes. Here, a high-resolution MRI protocol specialized for diplopia is introduced, and various imaging findings related to diplopia are presented.

#### **TABLE OF CONTENTS/OUTLINE**

Diplopia MRI should be designed to include the entire pathway of cranial nerve(CN) III, IV, and VI, and the orbit. In general, 3D heavily T2-weighted images or 3D proton-density weighted images are often used for evaluation of the cisternal segment of CNs. However, the cisternal segment of CN4 is so small that high resolution 3D true fast imaging with steady-state free precession (Trufi) is required: a slice thickness of 0.3mm, and a scan range acquired above and below of the junction of inferior colliculus and superior medullary velum in the brainstem (figure 1). For the cavernous segment of CNs, contrast-enhanced 3D T1 Volumetric interpolated breath-hold examination (VIBE) image with fat-suppression allow us to identify normal CNs located therein (figure 2). The anatomical classification of etiologies associated with diplopia can be divided into brainstem lesions (figure 3), cistern (figure 4), cavernous (figure 5), and orbital regions. Causes that can cause diplopia include congenital diseases, vascular lesion, tumor, inflammation, infection, and trauma, etc.

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## Abstract Archives of the RSNA, 2023

HNEE-1

### Don't Lose Your Nerve: Pictorial Review of Cranial Nerve Denervation in the Head and Neck

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Rachel Saks, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the pathophysiology of denervation and the subsequent imaging changes that occur within the muscle over time.2. Review the anatomy of the cranial nerves with motor function, particularly focussing on the muscles innervated by each nerve and their appearances with acute and chronic denervation.3. Review potential imaging pitfalls due to denervation changes, such as misinterpretation of contralateral FDG uptake in the setting of vocal cord palsy.

#### TABLE OF CONTENTS/OUTLINE

1. Pathophysiology of denervation2. Imaging findings in acute, subacute and late denervation3. Cranial nerve anatomy and appearances of denervation of the muscles innervated by the specific nerve- Oculomotor nerve- Trochlear nerve- Abducens nerve- Trigeminal nerve- Facial nerve- Glossopharyngeal nerve- Vagus nerve- Spinal Accessory nerve- Hypoglossal nerve4. Imaging pitfalls

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## Abstract Archives of the RSNA, 2023

HNEE-10

### **Don't Get Trapped: Diagnostic Errors in Emergency Head and Neck Radiology**

All Day Room: Learning Center

Thiago Jose Pinheiro Lopes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- An incidence of 3-4% of errors in the radiological routine is estimated. In the emergency room, the accuracy of the diagnosis becomes even more relevant, considering the need to take more immediate measures depending on the imaging findings. - Errors in diagnostic radiology can occur for a variety of reasons. Recognizing the cognitive views that favor their occurrence is important to prevent them. - Our objective is to present a series of head and neck radiological cases, unraveling the causes of errors and then providing strategies to be followed to minimize them during radiological interpretation.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Types of errors in diagnostic radiology (Renfrew Classification). 3. Series of misdiagnosis real cases in emergency room head and neck radiology, including: a) Case discussion: anatomy review, possible complications related to an error in image interpretation. b) Identification of the error causes. c) Tips on how to avoid them. 4. Challenges, pearls and pitfalls when interpreting a head and neck radiological exam. 5. Take home messages.

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## Abstract Archives of the RSNA, 2023

HNEE-11

### Basic Principles of Nasal Imaging

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mina Al-Ani, MBChB (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Nasal masses can originate in the nasal cavity or adjacent structures. Utilizing a systematic approach for evaluating nasal imaging plays a crucial role in establishing a differential diagnosis, treatment, and surgical planning. After a review of nasal anatomy using illustrations and cross-sectional images, we discuss the fundamental principles of nasal imaging and their application in the analysis of a broad spectrum of nasal abnormalities. Imaging features and clinical findings of these lesions are discussed.

#### TABLE OF CONTENTS/OUTLINE

1. Brief introduction emphasizing the role of imaging in diagnosing nasal lesions.
2. Illustration of nasal anatomy.
3. Principles of nasal imaging used in the evaluation of a wide range of nasal lesions, including but not limited to:
  - a. Congenital lesions (e.g., encephalocele, supernumerary tooth, and nasolabial cyst)
  - b. Benign masses (e.g., schwannoma, paraganglioma, and inverted papilloma)
  - c. Malignant masses (e.g., squamous cell carcinoma, esthesioneuroblastoma, and nasal metastasis)
  - d. Infectious and inflammatory lesions (e.g., fungal sinusitis, granulomatosis with polyangiitis, and rhinoscleroma)
  - e. Pseudomasses (e.g., pneumosinus dilatans, septal hematoma, and rhinolith)
4. Conclusion.

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## Abstract Archives of the RSNA, 2023

HNEE-12

### Orthognathic Imaging: Pre- and Post-Surgical Considerations for Craniofacial Reconstruction

All Day Room: Learning Center

Jeffers Nguyen, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The interpretation of orthognathic imaging studies is a growing part of both general and subspecialty neuroradiology practice. These studies are performed to evaluate a wide range of conditions, including congenital anomalies, traumatic injuries, neoplastic growth, and iatrogenic complications. They are necessary for successful craniofacial reconstruction. Surgical planning and post-surgical follow-up studies are used to evaluate for appropriate jaw alignment and bite and to assess for complications. These topics may not be covered in depth by educational materials at the residency and fellowship levels. We hope to provide an accessible, illustrative review at graded levels of orthognathic imaging for the trainee, general radiologist, and neuroradiologist. Finally, we will also briefly touch on principles related to imaging for an increasingly prevalent procedure, facial feminization surgery, and we will share cases related to our institution experience.

#### TABLE OF CONTENTS/OUTLINE

1) Etiologies of Maxillofacial Deformities; 2) Important Orthognathic Terms and Concepts; 3) Orthognathic Surgical Procedures and their Indications; 4) Pre- and Post-Surgical Orthognathic Imaging Considerations; 5) Overview of Facial Feminization Surgery (FFS); 6) Utility of Orthognathic and FFS Presurgical Planning Macros and Reporting Checklists

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## Abstract Archives of the RSNA, 2023

HNEE-13

### **Hypervascular Neck Lesions: From the Most Common to Uncommon Pathology**

All Day Room: Learning Center

Hugo E. Velazquez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To describe the anatomy of the neck spaces and its contents. -To determine the protocols used in suspected neck lesions by CTA and MRA. -To list the most common and uncommon neck lesions with a hypervascular pattern enhancement. -To illustrate clinical scenarios of these lesions.

#### **TABLE OF CONTENTS/OUTLINE**

1. A pictorial review of the anatomy of the neck spaces and its contents. 2. CTA and MRA protocols for the approach of neck lesions. 3. Key points of the most common vascular neck lesions. 4. Examples of uncommon vascular lesions of the neck to keep in mind.

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## Abstract Archives of the RSNA, 2023

HNEE-14

### Breaking the Ultrasound Barrier: Review of Sonographic Imaging of the Neck

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Anu Kamalasanan, FRCR, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Tongue pathology can be assessed, characterized and staged with USS. 2) Thyroglossal duct pathology are better assessed with USS as avascular cystic structure in infrahyoid midline anterior to the pre epiglottic space and cranially extending deep to the hyoid towards the midline posterior tongue which move dynamically with deglutition and protrusion of tongue. 3) Tonsils are seen as predominantly hypoechoic regions of alternating hyper and hypoechoic striations in the oropharynx, at the level of and deep to submandibular gland. 4) Pre epiglottic and paraglottic fat spaces are visualized as homogeneously hyperechoic avascular fat filled spaces with pathology presenting as hypoechoic mass. 5) Thyroid cartilage involvement presents with dehiscence of the hyperechoic cortex and infiltration of medulla and extra laryngeal tissues.

#### TABLE OF CONTENTS/OUTLINE

1) Illustrate with examples the normal sonographic appearance and contents of surgical triangles of the neck. 2) Illustrate with examples the sonographic cervical lymph nodal stations, normal and pathological sonographic appearance of lymph nodes. 3) Illustrate with example the normal sonographic appearance of the soft tissues of the neck, including sonographic appearance of tongue, oropharynx, supraglottis and larynx. 4) Illustrate with examples the pathological sonographic appearance of the soft tissues of the neck, including pathology of tongue, oropharynx, supraglottis and larynx.

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## Abstract Archives of the RSNA, 2023

HNEE-15

### Imaging of Nasal, Paranasal, and Skull Base Lesions: A Comprehensive Review

All Day Room: Learning Center

Kota Yokoyama, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The World Health Organization's (WHO) Classification of Head and Neck Tumors, Fifth Edition, is now available in 2022. This book is essential for radiologists to consider differential diagnosis and to obtain clinical information. On the other hand, the classification is based on the origin of the lesion and the genes, which makes it inconvenient as a guide for specific anatomical sites. For example, bone and soft tissue tumors, hematologic tumors, melanotic tumors, minor salivary gland tumors, germ cell tumors, and neuroendocrine tumors which can occur anywhere in the head and neck region, are classified in their own category, creating unexpected pitfalls when considering the differential diagnosis of nasal, paranasal, and skull base lesions. In addition, since the book is not intended for radiologists only, it does not cover a wide range of useful diagnostic imaging findings. Focusing on the radiologist, this exhibition will provide a comprehensive review of CT, MRI, and nuclear medicine imaging findings of lesions that can occur in the nasal, paranasal, and skull base.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy of nasal, paranasal, skull base
2. Sinonasal tract (nasal, paranasal, skull base) origin tumors
3. Other origin tumors involving the sinonasal tract
4. Inflammation involving the sinonasal tract
5. Infections involving the sinonasal tract

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## Abstract Archives of the RSNA, 2023

HNEE-16

### Clinical-radiologic Correlation of Acute Disorders of the Afferent Visual Pathway

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Kyle Robey, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The afferent visual pathway includes structures that perceive and process visual information, as well as the intervening nerves and white matter tracts. Acute processes affecting the globes, optic nerves, optic tracts, optic radiations, and occipital cortices may result in sudden onset of vision loss. Given the relatively large anatomical area over which the afferent visual pathway is distributed, the insults which can occur are diverse in etiology. A broad differential should initially be considered, which can be focused by relevant history. Moreover, though the entire afferent visual pathway should be scrutinized in the setting of an acute visual deficit, an ocular examination and visual field campimetry may further localize the affected anatomical structure. Therefore, familiarity with the clinical presentation and neuro-ophthalmological exam can guide the radiologist in evaluating and interpreting CT and MR images.

#### TABLE OF CONTENTS/OUTLINE

1) Review of the anatomy of the afferent visual pathway 2) Analyze and understand the main elements of a basic eye exam and correlate the findings with the affected anatomical area 3) Review common and uncommon conditions of acute vision loss which span the afferent visual pathway

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## Abstract Archives of the RSNA, 2023

HNEE-17

### Open Your Eyes! What Every Radiologist Should Know About Orbit Vascular Lesions

All Day Room: Learning Center

Marcella N. Brandao, MD, MEd (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understand well the anatomy of the orbit and dominate the normal in the image; Distinguish the pathologies that affect the extraconal, intraconal and both compartments; Recognize and review the particularities of the main diseases in the illustrative cases, both in Computed Tomography and Magnetic Resonance;

#### TABLE OF CONTENTS/OUTLINE

Every radiologist needs to be attentive to the details involving vascular lesions of the orbit. These diseases are infrequent, some extremely rare, but they cannot go unnoticed in differential imaging diagnoses. In addition, the natural history, growth pattern and histological composition of each lesion must be taken into account for the correct diagnosis. It is essential to recognize and keep in mind the diagnosis of: capillary hemangioma; venous lymphatic malformation; arteriovenous fistula; venous cavernous malformation; cavernous carotid fistula; ophthalmic artery aneurysm. Each image finding in the different modalities will be exemplified in detail through figures, descriptions and tables. Furthermore, the present study will make you a more complete radiologist, as it will explain the anatomy of the orbit relating it to each lesion in a direct, simple and intuitive way, making your diagnosis accurate and fast. In addition to serving as a guide for quick reference on the topic.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

HNEE-18

### Multimodality Imaging of Salivary Glands

All Day Room: Learning Center

Kanupriya Vijay, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To discuss the anatomy of major salivary glands 2. To review salivary gland pathology categories and associated epidemiology 3. To describe ultrasound, CT/MRI features of common pathologies with pathologic correlation 4. To introduce newly described entities in salivary gland pathology 5. To highlight the utility of percutaneous biopsy, with technical considerations

#### TABLE OF CONTENTS/OUTLINE

1. Normal anatomy a. Parotid b. Submandibular c. Sublingual 2. Common salivary gland pathologies a. Sialolithiasis b. Sjogren syndrome c. Infectious/Inflammatory conditions d. Cysts e. Neoplasms (with hints based on patient demographics and risk factors) i. Benign 1. Pleomorphic adenoma 2. Warthin's Tumor 3. Cystadenolymphoma 4. Other- Hemangioma, Oncocytoma, Basal Cell Adenoma ii. Malignant 1. Mucoepidermoid carcinoma 2. Adenocystic carcinoma 3. Squamous cell carcinoma 4. Adenocarcinoma 5. Acinic cell carcinoma 6. Lymphoma iii. Metastases 3. Newly described salivary gland pathology a. Sclerosing polycystic adenoma b. Mucinous/secretory variant of myoepithelioma c. Mammary analog secretory carcinoma d. Cribriform adenocarcinoma e. IgG4-related disease 4. Pitfalls 5. Percutaneous biopsy a. Approach and anatomical considerations b. FNA versus Core c. US vs CT guidance d. Complications 6. Summary/conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-19

### Pediatric Head and Neck: On Call Resource

All Day Room: Learning Center

Alexandra M. Foust, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The spectrum of acute non-traumatic disease in the pediatric head and neck differs from that in adults. 2. Consider foreign body ingestion or aspiration in young child with sudden-onset respiratory distress or paroxysmal cough. 3. Meningitis, empyema, and venous sinus thrombosis are important complications of pediatric sinusitis or otomastoiditis cases.

#### TABLE OF CONTENTS/OUTLINE

The vast array of acute non-traumatic pathologies encountered in the pediatric head and neck can be an intimidating subject for residents on busy call rotations with limited time to look up information. Although there is some overlap with adult diseases, many entities are more common in the pediatric population and, thus, it is important for radiologists caring for children to be well-versed in this topic. This multi-institutional, multimodality exhibit will be structured as an on-call resource for trainees, organized by anatomic location and highlighting key points, pearls, pitfalls, and mimics of many acute non-traumatic pathologies in the pediatric head and neck: Selected Examples: 1. Orbit: peri-orbital and orbital cellulitis, dacryocystitis, optic neuritis, proptosis 2. Sinonasal: complicated sinusitis 3. Ear: labyrinthitis, otomastoiditis, petrous apicitis 4. Oral/airway: epiglottitis, laryngotracheobronchitis, tonsillitis and peritonsillar abscess, Ludwig angina 5. Neck/spine: Grisel syndrome, retropharyngeal abscess, lymphadenitis, sialadenitis, torticollis, infection of congenital cysts, osteomyelitis 6. Variable: foreign body insertion (oral/nasal), angioedema 7. Vascular: Lemierre syndrome, vasculitis, nontraumatic dissection, and complicated vascular malformations

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## Abstract Archives of the RSNA, 2023

HNEE-2

### Proton Beam Therapy for Skull Base Chordoma and Chondrosarcoma: A Guide for the Radiologist

All Day Room: Learning Center

Gillian M. Potter, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- High-quality CT and MRI are critical for optimising surgical and radiotherapy decision-making and treatment in skull base chordoma and chondrosarcoma
- A detailed radiology report at the time of proton planning is essential for assessment of baseline and postoperative tumor sites, including distance to critical structures, with a required gap of =3mm from brainstem and =5mm from the optic apparatus
- Radiologists should be aware of surgical approaches to skull base tumors
- Radiologists should understand imaging appearances following multilayer endoscopic skull base repair and be aware of their evolution over time

#### TABLE OF CONTENTS/OUTLINE

Skull base chordoma and chondrosarcoma are rare, locally aggressive tumors. Treatment consists of maximal surgical resection and postoperative adjuvant therapy. Proton beam therapy enables dose escalation to tumor while limiting exposure dose to critical neurologic structures (brainstem, optic apparatus). High-quality pre-operative CT and MRI are critical for proton planning. MRI should include T2, T2 fat saturation, T1, volume FLAIR, FIESTA and postcontrast T1 fat saturation, with at least one volume sequence. Preoperative CTA BrainLab with bone reconstructions enables assessment of bone erosion, vascular relations and anatomical assessment for endoscopic-approach surgery. Intraoperative MRI should be considered to confirm clearance from dose-limiting structures. Post-operative MRI is optimally performed at <48 hours to enable optimal distinction between post-operative changes relating to multilayer skull base repair and tumor residuum.

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## Abstract Archives of the RSNA, 2023

HNEE-20

### **Congenital and Infantile Masses of the Head and Neck**

All Day Room: Learning Center

Alexandra M. Foust, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. A rapidly growing mass lacking high vessel density (Doppler US), internal flow-voids (MRI), and arterial-phase enhancement (MRI) should raise concern for lesions other than hemangioma. 2. It is important to describe the relationship of fetal head and neck masses to the airway so that appropriate delivery plans (EXIT procedure) can be made.

#### **TABLE OF CONTENTS/OUTLINE**

The spectrum of congenital and infantile head and neck soft tissue masses is broad, including developmental structural deformities/deficiencies, ectopic tissues, and benign and malignant neoplasms. It is important for radiologists to be aware of the imaging features of these lesions so that timely and appropriate management can be pursued. This multi-institutional, multimodality exhibit highlights pearls and pitfalls from fetal and post-natal cases encountered during clinical practice to illustrate the imaging appearance of numerous common and rare infantile masses in the head and neck using an anatomic approach. Selected Examples: 1. Skull/scalp: Cephalohematoma and other collections 2. Nasal: nasal glial heterotopia, cephalocele 3. Orbital: dacryocystocele, orbital varix 4. Oral/airway: epulis, epignathus, nasopalatine duct cyst, vallecular cyst, hairy polyp, sialoblastoma 5. Ear: cholesteatoma 6. Neck: thyroglossal duct cyst, ectopic thyroid or thymus, fibromatosis coli 7. Variable: dermoid/epidermoid, branchial apparatus anomaly, vascular anomalies, neuroblastoma, rhabdomyosarcoma, infantile fibrosarcoma, melanotic ectodermal tumor of infancy.

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## Abstract Archives of the RSNA, 2023

HNEE-21

### Post-operative Imaging in Oncologic Skull Base Surgery Reconstructions

All Day Room: Learning Center

Bernardo C. Teixeira, MD,PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? There is a broad spectrum of surgical techniques in resection of skull base tumors. ? Recognizing normal aspects of post-surgical grafts is important to differentiate from recurrent disease in skull base surgery. ? Radiologist plays an important role in preoperative and post-surgical management of this lesions.

#### TABLE OF CONTENTS/OUTLINE

Anatomy and normal variants Skull base surgery is a complex procedure that involves accessing and operating on the delicate structures and the anatomical complex area at the base of the skull. It is challenging even for experienced surgeons and radiologists. It forms the floor of the cranial cavity and separates the brain from other facial and neck structures. It is divided into three regions: the anterior skull base, the middle skull base, and the posterior skull base. Each of these regions has its own unique anatomy and challenges when it comes to surgery. For a successful surgery, knowledge of the normal variants of the anatomy is crucial to avoid iatrogenic lesions during surgery. Some important normal variants include the pneumatization of the anterior clinoid process, sphenoidal (Onodi) cells, and postsellar pneumatization from the sphenoid sinus. These variants are associated with a greater risk for carotid and optic nerve injuries as well as cerebrospinal fluid (CSF) rhinorrhea. Neurosurgical options in accessing the skull base ? Frontotemporal ? Subfrontal ? Transpetrosal ? Lateral ? Endoscopic endonasal Common Neoplasms ? Pituitary adenoma ? Schwannoma ? Meningioma ? Olfactory neuroblastoma ? Skull base invasion from head and neck tumor Normal imaging characteristics of post-surgical grafts When to suspect a recurrent tumor?

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## Abstract Archives of the RSNA, 2023

HNEE-22

### Complications of Paranasal Sinus Mucoceles: A Pictorial Review

All Day Room: Learning Center

Joseph Carbone, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: 1. Review mucocele CT and MR imaging characteristics and their variance, as well as potential locations to be aware of with a highlight on important adjacent structures. 2. Describe complications of mucoceles with CT and MR correlates with a focus on findings requiring urgent management. 3. Provide radiologists with a framework for reporting when discussing mucoceles, adjacent structures, and their pertinent negatives as it relates to mucocele complications.

#### TABLE OF CONTENTS/OUTLINE

Mucoceles are slow-growing lesions that result from obstruction of the facial paranasal sinuses. While they are most often benign, they can sometimes lead to urgent or severe pathology in nearby structures. The severity of clinical presentation varies depending on the sinus involved, ranging from asymptomatic to intracranial extension resulting in blindness. Further, radiologists should be aware for their potential for aggressive behavior and have an understanding for relevant reportable findings when describing mucoceles pertaining to mass effect and the location of adjacent structures, superimposed infection, and intracranial extension. This educational exhibit aims to review varying imaging characteristics of mucoceles and their potential locations using CT and MRI correlates. A pictorial review of mucoceles and their severe complications will be used to highlight key reportable imaging findings for radiologists when describing mucoceles and their involvement with adjacent structures.

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## Abstract Archives of the RSNA, 2023

HNEE-23

### Imaging of the Skull and Facial Bones for Pediatric and Adult Patients

All Day Room: Learning Center

Minako Azuma, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. In pediatric and adult patients, a wide variety of abnormalities are found in the skull and facial bones, including tumors, inflammations, congenital disease, and so on. Additionally, there are also secondary changes in bone associated with some diseases. 2. It is necessary for radiologists to know radiological findings of the skull and facial bone disorders. 3. Radiologists also have to know normal variations that have no pathological significance.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy and normal development of the skull and facial bones 2. Techniques for the imaging of the skull and facial bones (1) CT (2) MRI (3) CT like bone imaging in MRI 3. Normal variants of the skull and facial bones (1) Shape and thickness (2) Bone marrow (3) Pneumatization 4. Disorders of the skull and facial bones (1) Abnormality associated with suture (craniosynostosis) (2) Tumors and allied diseases a) Benign: Chordoma, osteoma, meningioma, and so on b) Malignant: chondrosarcoma, rhabdomyosarcoma, metastasis c) Allied diseases: Epidermoid cyst, hemangioma, Langerhans Cell Histiocytosis, and so on (3) Systematic disease a) Hematologic disorders: leukemia, multiple myeloma, anemias b) Metabolic and endocrine disorders (4) Metabolic and endocrine disorders: primary hyperparathyroidism (5) Inflammation and infection: osteomyelitis (5) Secondary changes in bone: Hyperostosis, blistering 3. Take home points 4. References

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## Abstract Archives of the RSNA, 2023

HNEE-24

### Sonographic Evaluation of Major Salivary Glands: A Pictorial Review

All Day Room: Learning Center

Rachita Khot, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

High-resolution ultrasound imaging plays a key role in evaluating focal versus diffuse salivary gland diseases and differentiating benign versus malignant lesions. This exhibit will discuss approaches to diagnosis and 1. Review the typical and uncommon sonographic appearances of pathologies involving the salivary glands2. Discuss the OMERACT Ultrasound Scoring System in primary Sjögren's Syndrome3. Discuss the next step in the management of the pathologies

#### TABLE OF CONTENTS/OUTLINE

1. Illustration of major salivary gland and surrounding structures2. Ultrasound imaging techniques, sonographic landmarks, and normal anatomy 3. Approach to diagnosis4. OMERACT Ultrasound Scoring System in Sjögren's Syndrome• Background• Grey-scale scoring with imaging examples: Grade 0, normal parenchyma; Grade 1, mild inhomogeneity without anechoic or hypoechoic areas and hyperechogenic bands; Grade 2, moderate inhomogeneity with focal anechoic or hypoechoic areas; Grade 3, severe inhomogeneity with diffuse anechoic or hypoechoic areas occupying the entire gland 5. Pathologies of the major salivary glands • Congenital: Lymphoepithelial cysts, Epidermoid cyst• Sialadenitis: Acute and chronic; Abscess• Sialolithiasis: Obstructing and non-obstructing stones in the duct• Sialectasis• Neoplasms: Hemangioma, Lymphangioma, Lipoma, Adenomas (Pleomorphic, Basal cell, Warthin's), Carcinoma (Adenoid cystic carcinoma (Ca), Mucoepidermoid Ca, Acinar cell Ca, Squamous cell Ca), Lymphoma, Metastasis• Others: Intraglandular lymph nodes, Trauma, AV fistula6. Management and follow-up• Role of CT and MRI in the further workup• Role of biopsy7. Conclusion

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## Abstract Archives of the RSNA, 2023

HNEE-25

### Decoding Cystic and Cyst-Like Lesions in the Head and Neck: A Comprehensive Imaging Guide

All Day Room: Learning Center

Maria Lucia Brun, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To identify the relevant imaging features of cystic and cyst-like lesions of the head and neck. - To describe the differential diagnosis of cystic and cyst-like lesions of the head and neck, based on imaging and anatomical location.- To learn the importance of incorporating relevant/pertinent clinical information in narrowing the differential diagnoses. - To recognize the course and potential complications associated with cystic and cyst-like lesions.- To suggest appropriate follow-up and recommend effective diagnostic workup.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction/Background  
2. Role of Diagnostic Imaging- Ultrasound- CT - MRI  
3. Approach based on location  
Once the cystic nature is confirmed ? evaluate differential diagnosis according to location:- Anterior neck - Midline lesions: Parapharyngeal/pharyngeal cysts, Ranula, Thyroid cysts, Parathyroid cysts, thyroglossal duct cyst, thymic cyst, dermoid/epidermoid cyst.- Lateral - Paramedian lesions: Branchial cleft cysts, Lymphatic malformations, suppurative/caseating adenopathy (infectious/inflammatory), cystic adenopathy (thyroid cancer and HPV-related SCC).- Specific spaces: Salivary glands; entities which may present as a cyst in the salivary glands: Lymphoepithelial cysts, Epidermal inclusion cysts, Warthin tumor, Mucocele, etc.  
4. Others- Not location-dependent: Lymphocele, Seroma, Abscesses.  
5. Conclusion

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## Abstract Archives of the RSNA, 2023

HNEE-26

### **Chew It All Up! Everything You Need to Know About Teeth**

All Day Room: Learning Center

Bruna E. Gherardi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The high prevalence of craniofacial trauma, sinus infection disease, and maxillomandibular procedures, among other conditions, frequently requires the interpretation of dental images in daily practice. Teeth can be the source or the extension of a pathologic process and therefore must not be overlooked by radiologists. Radiologists can use their knowledge of the main dental imaging findings in emergency radiology to add great value to image interpretation. In this study we will describe the anatomy of the structures surrounding the teeth. Identify the main dental alterations in the emergency or outpatient setting. Train the radiologist to look accurately at lesions, mainly inflammatory ones related to dental disorders.

#### **TABLE OF CONTENTS/OUTLINE**

General and dental anatomy. Inflammatory conditions related to teeth as pericoronitis, periodontal disease, periapical abscess, dental sinusitis, facial cellulitis and abscess, orbital cellulitis, Ludwig's angina, dental trauma, complications of dental procedures like dental implants and extraction. Most common tumor and tumor-like lesions related to teeth. Take home messages.

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## Abstract Archives of the RSNA, 2023

HNEE-27

### **The Jugular Foramen: Approach to Tumoral and Non-tumoral Pathologies**

All Day Room: Learning Center

Yasovineeth Bhogadi, BSc, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the anatomy of the Jugular foramen- Understand the clinical presentations of various pathologies- Differential diagnosis to tumoral disease and approach- Non-tumoral disease entities

#### **TABLE OF CONTENTS/OUTLINE**

- Review the anatomy of the Jugular foramen- Differential diagnosis of masses- Approach to tumoral masses- Non-tumoral disease entities

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## Abstract Archives of the RSNA, 2023

HNEE-29

### Parry-Romberg Syndrome and En Coup De Sabre: A Pictorial Review

All Day Room: Learning Center

Vineet V. Gorolay I, MD, FRANZCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) Parry-Romberg Syndrome [PRS] and En Coup De Sabre [ECDS] are defined by acquired progressive hemifacial atrophy. (2) Patients may present with headache, facial pain/paresthesia, or epilepsy. (3) Atrophy can affect unilateral periorbital, midface bones and soft tissues. (4) Atrophic tissue does not demonstrate signal change or enhancement as might be seen with denervation. (5) Intracranial manifestations may also be present, although facial involvement does not predict intracranial lesion severity.

#### TABLE OF CONTENTS/OUTLINE

(1) Review definition, clinical symptomatology, expected course, and hypothesized etiologies of Parry-Romberg Syndrome (PRS) and linear scleroderma/En Coup De Sabre (ECDS), disease processes characterized by progressive hemifacial atrophy. (2) Review imaging findings of facial soft tissue atrophy and intracranial abnormalities in PRS and ECDS, as derived from a review of 40 PRS patients at a single institution, including brain, neck and face CTs and MRs. (3) Atrophy in PRS and ECDS predominantly affects periorbital, midface and scalp soft tissues, typically without MR signal intensity change, distinguishing it from denervation atrophy. (4) Clinical severity of facial soft tissue atrophy does not predict intracranial lesion severity.

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## Abstract Archives of the RSNA, 2023

HNEE-3

### Revisiting Distant Metastasis in Head and Neck Cancer

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Naoko Saito, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Distant metastasis (DM) in head and neck cancer (HNC) is relatively uncommon. When DM occurs, the prognosis is considered miserable, with median overall survival of under one year. Although little attention has been focused on the treatment of DM, recent reports on oligometastasis have changed the therapeutic approach to DM. For patients with oligometastasis, aggressive local treatment of metastatic sites may achieve prolonged survival. This educational exhibit reviews the epidemiology, imaging findings, and risk factors of DM of HNC and summarizes the current knowledge of the oligometastasis of HNC. The teaching points are: 1. To understand the mechanisms and patterns of DM of HNC. 2. To learn the characteristic imaging findings of DM based on the site and histopathology. 3. To learn the current knowledge about the characteristics and the therapy of oligometastasis in HNC.

#### TABLE OF CONTENTS/OUTLINE

1. The definition of DM: the pathophysiology (hematogenous, lymphatic spread), the timing (synchronous, metachronous), the spectrum of metastasis (polymetastasis, oligometastasis, oligorecurrence, oligoprogression) 2. The site-based approach of DM (lung, bone, liver, brain, skin, etc.): pathophysiology, incidence, imaging findings 3. The cancer-based approach of DM: histopathology (SCC, EBV/HPV associated SCC, thyroid cancer, salivary gland cancer, neuroendocrine tumor, melanoma, etc.): incidence, imaging findings 4. Summary of the risk factors for DM: literature review 5. Therapy: current concepts

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## Abstract Archives of the RSNA, 2023

HNEE-30

### **Nasolacrimal System Pathologies: What a Radiologist Needs to Know**

All Day Room: Learning Center

Janani Baradwaj, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- While reading a CT, deliberate consideration should be given to the density of the contents within the nasolacrimal duct and for the evaluation of wall thinning.
- The extent of soft tissue disease is evaluated using magnetic resonance imaging (MRI), and contrast-enhanced MR is particularly helpful in distinguishing soft tissue from fluid.
- Nasolacrimal duct may act as a conduit for the transmission of pathologies from the orbit to the sinonasal cavity and vice-versa.
- Primary nasolacrimal malignancies are rare and often have delayed diagnosis due to presentation mimicking benign aetiology.

#### **TABLE OF CONTENTS/OUTLINE**

?Describe normal Nasolacrimal duct anatomy with images. ?Illustrate with images the Nasolacrimal duct pathologies. ? Discuss management pathway.

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## Abstract Archives of the RSNA, 2023

HNEE-31

### Hyoid Bone: Anatomy, Embriology, Developmental Malformations and Symptomatic Cases

All Day Room: Learning Center

Beatriz D. Prado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This panel aims to: Review the structure and function, embriology, anatomy and physiologic variants of the hyoid bone. Discuss and describe through illustrative cases the imaging patterns of the main pathologies involving the hyoid bone.

#### TABLE OF CONTENTS/OUTLINE

Review of the hyoid bone structure and function  
Review of the hyoid bone anatomy, including suprahyoid and infrahyoid muscles, relation to blood vessels and nerves.  
Physiologic variants  
Clinical cases involving the hyoid bone:  
-Hyoid bone insertion tendinitis (hyoid bone syndrome)  
-Calcified stylohyoid ligament and Eagle syndrome  
-Traumatic lesions, including body and greater horn luxation and hyoid fracture  
-Triticeal cartilage ankylosis in the hyoid  
-Thyroid lamina ankylosis in the hyoid  
-Ectopic thyroid gland adjacent to the hyoid bone  
-Vascular compression  
-Sistrunk procedure  
-Ectopic thyroid gland adjacent to the hyoid bone  
Final remarks

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## Abstract Archives of the RSNA, 2023

HNEE-32

### How to Find CHD7 Disorder: Beyond CHARGE Syndrome

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Shinya Hattori, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

CHARGE syndrome is named after an acronym for the characteristic signs (coloboma, heart defect, atresia choanae, retarded growth and development, genital hypoplasia, ear anomalies/deafness). CHD7 is the causative gene for CHARGE syndrome. Recently, CHD7 mutations have been detected in cases that do not show typical signs of CHARGE syndrome, and the concept of CHD7 disorder has been proposed to include the broader spectrum of CHD7 mutations. Even in such atypical cases, the characteristic imaging findings of CHARGE syndrome are detected. The purpose of this educational exhibit is to: 1. Present the disease concept of CHARGE syndrome. 2. Detail the characteristic imaging findings of CHARGE syndrome. 3. Outline the broader spectrum of CHD7 disorders and provide cases in which imaging findings help identify CHD7 mutations, even in atypical CHARGE syndrome.

#### TABLE OF CONTENTS/OUTLINE

1. CHARGE syndrome a. Concept b. Clinical presentation c. Causative gene -CHD7- 2. Imaging findings a. Key finding - semicircular canal hypoplasia- b. Additional findings of the face and skull base 1) Auditory system and temporal bone 2) Eye, palate, and olfactory system 3) Clivus c. Others 3. CHD7 disorder a. Concept b. Cases that the imaging findings implicate CHD7 mutations 1) Severe combined immunodeficiency 2) Mild phenotype 3) Kallmann syndrome

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## Abstract Archives of the RSNA, 2023

HNEE-33

### **A Particular Pain in the Neck: Taking a Radiology's Journey from Imaging to Immunohistochemistry**

All Day Room: Learning Center

Karla Anabel Borgna, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Reviewing the variability of head and neck tumor entities and their mode of presentation, excluding squamous Cell Carcinoma. Identifying radiological signs, anatomical relationships and learning how to report them. Correlating the radiological features of head and neck tumors (non-squamous cell carcinoma) with immunohistochemistry and histological findings. Emphasize the role of the radiologist as a key contributor to the orientation of the tumor's etiology.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction  
Case-based approach with radiologic correlation  
Imaging findings with histologic and immunohistochemical correlation  
Take-home message  
References

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## Abstract Archives of the RSNA, 2023

HNEE-34

### **3N: Not Common Nose, Nasal Cavity and Nasopharynx Tumors**

All Day Room: Learning Center

Marycarmen E. Flores Duenas, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Sinonasal neoplasms are rare, accounting for only 3 % of head and neck malignancies, among the most frequent tumors reported are adenocarcinoma, squamous cell carcinoma, undifferentiated carcinoma, olfactory neuroblastoma, sinonasal lymphoma, and sinonasal mucosa melanoma. The complex anatomy and histology of this region make evaluation a challenge for the clinician. Fortunately, in these kinds of tumors, Computed tomography and magnetic resonance imaging, plays an important role in surgical and therapeutic planning, especially in the involvement of those small parts such as involvement of the anterior and middle cranial fossae, pterygopalatine fossa, pterygomaxillary fissure, foramen rotundum, vidian canal, inferior orbital fissure, orbital apex, and perineural involvement, therefore some distinguishing features can help narrow the differential diagnosis and assess the true extent of the disease.

#### **TABLE OF CONTENTS/OUTLINE**

Epidermoid carcinoma, Carcinoid tumor, Peripheral nerve sheath tumor, Rhabdomyosarcoma, Sinonasal undifferentiated carcinoma, Ewing sarcoma, Sinonasal Melanoma, Lymphoma, Esthesioneuroblastoma andsinonasal juvenile angiofibroma

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## Abstract Archives of the RSNA, 2023

HNEE-35

### Sinonasal Tumors: What the Tumor Board Wants to Know

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Alexander R. Moeller, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. There is a long differential diagnosis for tumors occurring within the sinonasal cavity with overlapping imaging features. 2. Pathology is critical in diagnosis and determining treatment. 3. Most primary tumors are staged based on the TNM classification. TNM tumor staging is predominantly based on tumor location and tumor extension, which differs between lesions that arise from the maxillary sinus and those that occur within the ethmoid/nasal cavity. 4. Esthesioneuroblastomas are staged based on the Kadish classification system. 5. Sinonasal tumors are primarily treated with surgical resection. 6. Chemotherapy and radiation may be administered prior to surgery for larger lesions, following surgery for residual or recurrent disease or in place of surgery for a palliative approach.

#### TABLE OF CONTENTS/OUTLINE

1. Review the differential diagnosis of sinonasal tumors based on the updated WHO classification system. 2. Discuss pathology of sinonasal tumors, incorporating molecular features. 3. Discuss the TNM staging of sinonasal tumors for lesions arising from the maxillary sinus and ethmoid/nasal cavity. 4. Review staging of esthesioneuroblastoma. 5. Treatment strategies of Sinonasal tumors: Indications for surgery, chemotherapy and radiation using a multidisciplinary approach. 6. Review imaging features of lesions that will affect treatment decisions: what the surgeon wants to know, what the medical oncologist wants to know and what the radiation oncologist wants to know.

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## Abstract Archives of the RSNA, 2023

HNEE-36

### Face to Face: Reviewing Facial Malformations

All Day Room: Learning Center

Danielly V. Santos SR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This pictorial essay aims to review and synthesize the main facial malformations. The purposes of this submission are: - To review the developmental anatomy and normal embryogenesis of facial structures; - To discuss imaging features of facial malformations related to nasal cavity, frontonasal region, nasolacrimal apparatus, labiopalatine complex and craniofacial syndromes; - To present a compendium of cases involving facial malformations to exemplify;

#### TABLE OF CONTENTS/OUTLINE

There are a wide variety of congenital face abnormalities that originate during transformation of the first pair of pharyngeal arches into adult structures. Computed tomography and magnetic resonance imaging are important components in the comprehensive evaluation of these lesions. A detailed understanding of face embryogenesis and developmental anatomy is important in directing appropriate patient management. Familiarity with the characteristic imaging features of these anomalies along with knowledge of midface embryogenesis and normal developmental anatomy is essential to prevent misinterpretation of anatomic variations that may simulate disease.

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## Abstract Archives of the RSNA, 2023

HNEE-37

### Scars and Lumps Shrinking the Tunnel: Radiological Evaluation of Laryngotracheal Stenosis

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Kristina Ramirez Garcia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

At the end of this exhibit, the attendees would be able to: 1. Identify laryngotracheal stenosis etiologies. 2. Describe the clinical and radiological classifications of laryngotracheal stenosis. 3. Recognize the key imaging findings encountered in the different entities of laryngotracheal stenosis.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction. 2) Anatomical Review: Imaging of the Larynx and Trachea. 3) Diagnostic and Radiological Approach to Laryngotracheal Stenosis. 4) Laryngotracheal Stenosis Measurement. 5) Laryngotracheal Stenosis: Key Imaging and Clinical Findings through Case Presentation. a) Laryngotracheal Trauma/Iatrogenic. b) Laryngotracheal Compression. c) Infiltrative Lesions. d) Laryngotracheal Inflammation/infection. e) Laryngotracheal Autoimmune Lesions. 6) Conclusion.

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## Abstract Archives of the RSNA, 2023

HNEE-38

### **A Nod to the Nodes In Children: A Practical Clinical Approach to Pediatric Cervical Lymphadenopathy**

All Day Room: Learning Center

Elizabeth J. Snyder, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Cervical adenopathy is a common clinical scenario in children.- A wide variety of entities can present with cervical adenopathy; importantly, the spectrum of pathology and imaging appearance differs in many cases from that seen in adults.- While US is typically the first line imaging modality, CT, MRI and NM studies may all have a role in the workup of cervical adenopathy, with different strengths and limitations.- Radiologists must know when and with which modality to image.- This multi-institutional collaboration highlights imaging appearances of both common and uncommon disorders affecting cervical nodes in children in order to aid radiologists in their clinical practice. Pearls, pitfalls, and mimics will be included.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction
  - a. Anatomy of cervical lymph nodes (levels, etc.)
  - b. Normal imaging appearance
2. Imaging approach
  - a. Modality selection and benefits/limitations of US, CT, MRI, NM studies
  - b. Systematic approach diagram highlighting helpful features (e.g., cystic, hyperenhancing, calcified, etc.)
3. Infectious lymphadenopathy
  - a. Imaging appearance
  - b. Complications: necrosis, abscess
  - c. Specific infectious processes: e.g., bacterial, TB, MAI, cat scratch disease
4. Neoplasm
  - a. Lymphoma
  - b. Metastasis: e.g., thyroid cancer, NPC, SCC
5. Histiocytosis
  - a. LCH
  - b. Rosai-Dorfman disease
6. Lymphoproliferative disorders: e.g., Castleman, HLH
7. Unusual entities: Kawasaki, Kikuchi, MIS-C, HIV
8. Mimics (lymphatic malformations, branchial cleft cysts, parotid neoplasms, etc.)
9. DDx of common imaging findings: calcifications, cystic nodes
10. Summary and conclusion

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## Abstract Archives of the RSNA, 2023

HNEE-39

### **Don't Miss the Forest for the Trees: Parathyroid Ultrasound - Anatomy, Technique, Pearls and Pitfalls**

All Day Room: Learning Center

Alex C. Dias, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review key aspects of the clinical, laboratorial, and imaging assessment of patients with primary hyperparathyroidism. Illustrate the role of ultrasound (US) for preoperative evaluation of parathyroid glands, including their localization, normal and pathological findings, with multimodality imaging correlations. Summarize in a practical approach the most important pearls and pitfalls for the accurate US assessment of parathyroid glands, highlighting the use of high-frequency transducers.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction  
Anatomy of the parathyroid and adjacent structures  
Primary Hyperparathyroidism: pathophysiology and clinical aspects  
Parathyroid preoperative evaluation  
Laboratorial workup for hyperparathyroidism  
Multimodality imaging for surgical planning: US, computed tomography, magnetic resonance, and scintigraphy  
Ultrasound of the parathyroid glands  
Positioning, technique, transducers  
Typical and atypical imaging findings (B-mode, Doppler and elastography)  
US guided fine-needle aspiration (radiologic-pathologic correlations)  
Case-based review with multimodality imaging  
Pearls: novel approaches for improvement (high-frequency transducers and other strategies)  
Pitfalls: lesions of the esophagus, lymph nodes, soft tissues, and thyroid  
Take home messages

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## Abstract Archives of the RSNA, 2023

HNEE-4

### Look out! Conditions that Cause Proptosis

All Day Room: Learning Center

Erica A. Naves, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points The purposes of this exhibit are to review the anatomy of the orbit, including the orbital content and bone structures that delimit it. Also, to demonstrate that, due to its osseous limitations, the orbit is limited to expand if any expansive process is within its limits. Therefore, several types of expansive processes manifest with proptosis. The exhibit demonstrates through illustrative cases the different scenarios that manifest with proptosis, in the context of metabolic disorder, trauma, infection, inflammatory process, vascular lesions, primary neoplasms, metastasis, among others.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents / Outline The exhibit initiates with annotated images of the anatomy of the orbit, including the bone limits and contents, to demonstrate the normal appearance on computed tomography and magnetic resonance imaging. The next slides include the diagnostic criteria of proptosis, and exemplifying annotated images. The majority of the presentation include illustrative cases presenting with proptosis divided by metabolic, trauma, infection, inflammatory, vascular and neoplastic sections. Cases of thyroid-associated orbitopathy, bone fracture, orbital muscle lesion, subperiosteal abscess, idiopathic orbital inflammation, IgG4-related disease, granulomatosis with polyangiitis, carotid-cavernous fistula, venous malformation, lymphangioma, optic nerve glioma, optic nerve meningioma, orbital lymphoma, rhabdomyosarcoma, sphenoid wing meningioma, metastatic melanoma, extramedullary plasmacytoma and bone metastasis are displayed. The presentation closure contains take-home messages.

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## Abstract Archives of the RSNA, 2023

HNEE-40

### **Save Your Own Neck: A Neck Muscles Guide for Daily Practice - Anatomy, Variations, and Pathologies**

All Day Room: Learning Center

Lucas S. Souza, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are:- Review and illustrate the anatomy and innervation of head and neck muscles, and its correlation with the cervical spaces, emphasizing the importance of understanding for the delimitation of lesions found in daily routine exams.- Describe the anatomical variations of the cervical muscles and the possible pitfalls they can cause, simulating diseases.- Determine the great injuries, separating them by their etiology, and propose an algorithm for their evaluation in cases of technical limitation.

#### **TABLE OF CONTENTS/OUTLINE**

- Cervical muscles:1) Division by compartments- masticatory.- pharynx (circular and longitudinal) and larynx.- front of the neck (suprahyoid and infrahyoid).- prevertebral (prevertebral and scalene).- paraspinal (suboccipital, extrinsic back, and intrinsic back (superficial, intermediate, and deep layer)).2) injuries:- congenital (agenesis, torticollis, and syndromes)- infectious/inflammatory (phlegmon, abscess, tropical myositis, necrotizing fasciitis)- trauma or surgery (denervation, myositis ossificans)- vascular anomalies.- tumors (benign, malignant, and metastasis).- Diagnostic Algorithm- Final remarks

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## Abstract Archives of the RSNA, 2023

HNEE-41

### Practical Approach to Orbital Lesions by Anatomical Compartments

All Day Room: Learning Center

Guilherme Naves (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are:- Classify the different pathologies in each of the orbital compartments.- Present the essential imaging features of the main orbital lesions.- Highlight the importance of knowing the location of pathologies in the orbital compartments to facilitate the diagnosis and narrow the differential diagnoses.

#### TABLE OF CONTENTS/OUTLINE

? Introduction : ? Review of the anatomy of the orbital compartments ? Compartment of the optic nerve/sheath complex :? ? Ischemic optic neuritis ? Optic nerve glioma (NF1) ? Optic nerve glioma (sporadic) ? Optic nerve meningioma ? Conal/muscular compartment : ? Graves orbitopathy ? Left sixth cranial nerve palsy ? Orbital pseudotumor ? Myositis by IgG4 ? Intraconal compartment : ? Colobomatous malformation ? Venolymphatic vascular malformation ? Cavernous hemangioma ? Extraconal compartment :? Dermoid cyst ? Subperiosteal abscess ? Preseptal cellulitis ? Nasolacrimal apparatus : ? Non-Hodgkin lymphoma of the lacrimal glands ? Infected dacriocystocele

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## Abstract Archives of the RSNA, 2023

HNEE-42

### Unilateral Sinusitis: What Radiologists Should be Aware of

All Day Room: Learning Center

Janani Asogan Vaishnavi, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Rhinorrhoea and foul smelling discharge are the common clinical presentations in inflammatory / infective disease while epistaxis and/or mass effect in the cheek / palate / orbit are the common presenting features in malignancy.2. Odontogenic sinusitis is one of the most common causes of unilateral sinus opacification followed by fungal ball and antrochoanal polyp. Inverted papilloma is the most common benign pathology, while squamous cell carcinoma is the most common malignant pathology.3. Incidence of neoplastic disease is much higher in the presence of unilateral sinus opacification, with rise in incidence with increasing age.4. Site of origin of inverted papilloma is often seen as focal area of hyperostosis on CT. This can be useful identifying recurrence and malignant transformation which are frequent with inadequate excision.5. Aggressive bone destruction, especially erosion of the posterolateral wall of the maxillary sinus and extra-sinus extension is often seen in malignancy.

#### TABLE OF CONTENTS/OUTLINE

1. Radiological anatomy of paranasal sinuses including drainage pathways2. Explain various causes of unilateral sinus opacification3. Illustrate with images, the key radiological and pathognomonic findings to be looked for in unilateral sinus opacification4. Provide a pictorial review of unilateral sinus opacification encountered in our centre5. Briefly describe how to approach a case of unilateral sinus opacification

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## Abstract Archives of the RSNA, 2023

HNEE-43

### **What is this Bump on the Face, Radiology? Medial Canthal Swelling, Differential Diagnosis of Angular Vein Thrombosis Radiologists Should Know**

All Day Room: Learning Center

Nahyun Jo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The face is the first body part a physician sees when they meet a patient; it is often diagnosed and followed clinically. With the advances in imaging and increase in utilization, radiologic evaluation of facial masses is becoming more common. In certain cases, radiology plays a crucial role. Facial vein thrombosis presents as a focal facial mass-like lesion due to engorged veins. This is well-known in the traditional anatomy literature related to the "danger triangle" of the face. While thrombophlebitis is a more common etiology, more recently, facial/angular vein thrombosis secondary to periorbital cosmetic botulinum toxin injections has been reported by ophthalmologists and plastic surgeons. Due to its proximity to the sinuses, sinus-related diseases such as dacryocystocele or nasolacrimal duct obstruction often mimic angular vein pathologies. Vascular malformations such as an ophthalmic artery arteriovenous fistula, carotid-cavernous fistula, or lymphovenous malformation may also present as periorbital mass or proptosis. Other etiologies of soft tissue masses, such as skin tumors or benign masses, should also be considered.

#### **TABLE OF CONTENTS/OUTLINE**

We discuss the basic anatomical structures in the face that radiology trainees should know. Then we further discuss the imaging findings of facial masses ranging from the most common lipoma to uncommon lymphovascular malformations. Each of the common and unique cases is presented for each pathology with teaching points. - Introduction to facial anatomy- Infection-Trauma-Venous thrombosis-Vascular malformations-Sinus related-Benign cluster of tissues-Tumor-Foreign body and cosmetic injections

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## Abstract Archives of the RSNA, 2023

HNEE-44

### Node More Tears: Unraveling the Etiologies and Imaging of Lymph Nodes Diseases

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Luis E. Souza, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To understand patterns of lymphadenopathy in imaging methods. To illustrate the most common imaging findings of lymph nodes diseases and the useful hallmarks that help in differential diagnosis. To learn about advanced imaging methods and how they can help in the evaluation of lymphadenopathy.

#### TABLE OF CONTENTS/OUTLINE

Anatomy of lymph node  
Patterns of lymph nodes diseases - Hypervascular - Cystic or necrotic - Calcified  
Main imaging characteristics and differential diagnosis of the different etiologies.- Inflammatory / Infectious (Viral, Bacterian, Fungal and others). - Lymphomas - Castleman Disease - Neoplastic Metastasis ( Eg. Squamous cell carcinoma; Kaposi sarcoma)- Lymphadenopathy associated with systemic syndromes (eg. Kikuchi-Fujimoto Disease, Kimura, systemic lupus erythematosus)  
Take-home messages and tips and tricks to differential diagnosis.

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## Abstract Archives of the RSNA, 2023

HNEE-45

### Advanced Neck Ultrasound: Pearls and Pitfalls Using High-Frequency Transducers

All Day Room: Learning Center

Alex C. Dias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review key findings in neck ultrasound using high-frequency transducers (24-33MHz). Illustrate clinical situations where the use of high-frequency transducers was decisive for the characterization of imaging findings in neck region, including skin, thyroid, parathyroid, salivary glands and lymph nodes lesions. Provide tips and tricks in a practical approach to a successful clinical practice integration.

#### TABLE OF CONTENTS/OUTLINE

Introduction  
US transducer types: an overview  
Applications: a case-based review  
Skin US: benign and malignant lesions  
Thyroid US: focal and diffuse disease  
Parathyroid US: normal and abnormal findings  
Lymph node US: beyond metastatic disease  
Salivary gland US: pearls and pitfalls  
Other challenging applications  
Practical approach: tips and tricks for clinical practice integration  
Future perspectives: ultra-high frequency US  
Take home messages

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## Abstract Archives of the RSNA, 2023

HNEE-46

### **To Infinity And Beyond: A Primer Review Of The Uncommon Disorders Of The Temporomandibular Joint Besides Internal Derangement**

All Day Room: Learning Center

Izaely R. Prates, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the normal anatomy of the temporomandibular joint and its relationship to adjacent structures- To illustrate a variety of rare cases in order to avoid misinterpretations and pitfalls;

#### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION:RELEVANT IMAGING ANATOMY:TEMPOROMANDIBULAR LESIONS AND ALTERATIONS: Clinical cases illustrating the spectrum of uncommon TMJ findings in CT and MRI.Condylar pathologies;Coronoid process pathologies;Extension of TMJ pathological processes to adjacent structures;Inflammmations non-infectious;Infectious Other pathologies.TAKE-HOME MESSAGESREFERENCES

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## Abstract Archives of the RSNA, 2023

HNEE-47

### The Tongue Has People Talking

All Day Room: Learning Center

Fernando Diego Choque Chavez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Show the anatomy of the tongue through schematic illustrations and its correlation with radiological images, indicating anatomical reference points. Determine the role of each imaging technique in the analysis of the pathology of the tongue. Review the most frequent pathology of the tongue, mainly tumors outlining the radiological findings with therapeutic implications.

#### TABLE OF CONTENTS/OUTLINE

Background Embryology and Anatomy of the tongue Imaging technique Imaging findings- Oncological tongue Radiological findings with therapeutic implications- Congenital anomalies- Inflamed tongues- Lingual denervation. The tongue is the central part of the oral cavity and the oropharynx. It is the organ of taste, plays an essential role in the formation of the alimentary bolus and in swallowing and forms part of the phonatory system. Given the importance the role of the tongue plays in the patient's quality of life, the radiologist of the head and neck should be familiar with its anatomy, the optimum imaging techniques for its evaluation, as well as its spectrum of pathologies. In this way the radiological description will reflect reliably and with anatomical detail the extent of a lesion, particularly in the area of oncology, and it will be possible to select the most appropriate treatment for each patient so as to preserve function to the maximum extent possible. The radiological evaluation will also be of special significance during the surveillance period following treatment, so the radiologist should be familiar with the main therapeutic strategies and be accustomed to the image of the treated patient as well as the most appropriate techniques for detecting tumor recurrence.

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## Abstract Archives of the RSNA, 2023

HNEE-48

### Look on the Bright Sign: Shedding Light on Mysteries of Optic Neuropathy

All Day Room: Learning Center

Alice M. Abreu Mota, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Optic neuropathy: It may be the only manifestation of Behçet's disease in the central nervous system. Diffusion restriction may be seen in trauma and ischemia. In induced cocaine cases, it is often unilateral, due to compression or ischemia. Methanol intoxication findings included bilateral optic nerve enhancement, putamen and caudate necrosis. Leber's hereditary optic neuropathy may show increased T2 signal in the optic nerves, chiasm, and tracts. Neuritis can also simulate a tumor. The short-segment enhancement at the optic nerve-globe junction is seen on cat scratch disease. Granulomatosis with polyangiitis (GPA) is often hypointense on T2. Direct granulomatous infiltration is one of the triggers of sarcoidosis. MOG-IgG+ exhibit long-length, bilateral, and anterior optic nerve involvement. Unilateral and short-segment involvement is seen in Multiple Sclerosis. In Neuromyelitis Optica (NMO) the impairment is bilateral on posterior optic nerves and chiasm.

#### TABLE OF CONTENTS/OUTLINE

Toxic Metanol Cocaine Medicine Granulomatosis Sarcoidosis; GPA; Tolosa Hunt; IgG4 Related Disease; Cat scratch disease; Tuberculosis. Non-demyelinating Vogt-Koyanagi-Harada; Behçet's Disease. Demyelinating Multiple Sclerosis; NMO; MOG-IgG+. Others Ischemic; Trauma; Tumor.

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## Abstract Archives of the RSNA, 2023

HNEE-49

### **Cavernous Sinus Imaging: Anatomy, Pathology and Warning Signs for Daily Practice**

All Day Room: Learning Center

Teresa A. Garcia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the anatomy and study protocol of the cavernous sinus. Provide warning signs to quickly recognize cavernous sinus involvement and assess patient treatment. Discuss clinical cases of our Department and relevant imaging findings.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy Study protocol Warning Signs: Enlargement of superior ophthalmic vein/s. Morphological change. Finding Density/Signal — Flow void. Clinical exam — multiple cranial nerve deficit. Red bulging eye. Restricted diffusion. Clinical cases: Neoplasms: meningioma, hemangioma, macroadenoma, chordoma. Inflammatory: Tolosa Hunt Syndrome. Vascular: aneurysm, carotid-cavernous fistula. Miscellaneous: intracavernous arachnoid cyst, air/fat in the cavernous sinus. References

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## Abstract Archives of the RSNA, 2023

HNEE-5

### Facial Retaining Ligaments: Can We See It

All Day Room: Learning Center

Luciana C. Zattar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

A thorough investigation of the layers and structures of facial anatomy is crucial when performing facial surgery and aesthetic procedures. The retaining ligaments of the face represent additional information of this anatomy and are essential in understanding principles of facial aging and rejuvenation. They are located in constant anatomic locations where they separate facial spaces and compartments. Their main significance relates to their anatomical understanding in fillers procedures and in surgical release in order to achieve the desired aesthetic outcome. Furthermore, they have a sentinel role in their anatomic relationship to facial nerve branches. Descriptions of the retaining ligaments are variable in the literature; due to different interpretations of anatomy, several classifications, locations, and nomenclature systems have been proposed, but there is no description of imaging findings. This study will review and clarify the anatomy and imaging aspects of the retaining ligaments of the face using High frequency ultrasound (HFUS/24-33MHz). The purpose of this exhibit is: (1)To illustrate the anatomy of the facial retaining ligaments with fresh-frozen specimen correlation; (2)To describe the correct examination technique; (3)To highlight the importance of HFUS in facial ligaments and nerves characterization; (4)To show the dynamic evaluation and characterization of facial ligaments with HFUS; (5)To describe the most important related facial ageing changes and aesthetic importance

#### TABLE OF CONTENTS/OUTLINE

1. INTRODUCTION; 2. ANATOMY; 3. FACIAL AGEING PROCESS; 3. HFUS EVALUATION TECHNIQUE; 4. UNDERSTANDING AESTHETIC PROCEDURES; 5. CONCLUSION

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## Abstract Archives of the RSNA, 2023

HNEE-51

### Paranasal Sinuses Computed Tomography: Read It Like an Expert

All Day Room: Learning Center

Michaela Cellina (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Learn the acquisition protocols and become familiar with the anatomy and anatomical variations of the paranasal sinuses to guide the endoscopic sinus surgeon

#### TABLE OF CONTENTS/OUTLINE

Nose and paranasal sinuses anatomy is highly variable and some anatomic variants can result in complications in FESS. The nasal septum is made up of an anterior cartilaginous component and a posterior bony component including the vomer and the perpendicular plate of the ethmoid. Septum anatomic variations include septal deviation that can cause a middle turbinate displacement and interfere with surgical access to the middle meatus; septal pneumatization may narrow the sphenoidal recess and impede access to the sphenoid ostium. The middle turbinate is the site of different variations, including concha bullosa (pneumatization of the inferior bulbous portion of the middle turbinate, or "cell of Grunwald" if pneumatization is limited to the vertical lamella above the level of the ostiomeatal complex), that can obstruct the ethmoidal infundibulum, and paradoxical middle turbinate, when the turbinate shows a paradoxical lateral convexity, which can impede surgical access to the ostiomeatal complex and contribute to recurrent rhinosinusitis. Haller cells are ethmoid cells extending into the orbital floor, with variable sizes that can narrow the ostia of the maxillary sinus or ethmoid infundibulum. Onodi cells are posterior ethmoid cells extending to the sphenoid sinus, placed medially to the optic nerve, These cells can also surround the optic nerve places the nerve and are linked with increased risk of nerve damage during sinus surgery.

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## Abstract Archives of the RSNA, 2023

HNEE-52

### Approach to Jaw Lesions

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

CT and MR can characterize jaw lesion location, composition, margins, and extent. Jaw lesions are classified into odontogenic vs. non-odontogenic, and simple/complex lytic or sclerotic. Key etiologies include developmental, inflammatory, traumatic, and neoplastic. Patient age, symptoms, and systemic findings help narrow the differential. For suspected neoplasms, biopsy helps confirm the diagnosis. The range of potential approaches includes watchful waiting, sclerotherapy, ablation, curettage, subtotal resection, and radical excision. Genetic testing is important when certain histologies and syndromes are suspected.

#### TABLE OF CONTENTS/OUTLINE

1. Dentistry 101 Jaw/tooth development Anatomy eruption Imaging modalities 2. Classification Odontogenic, non-odontogenic Developmental, inflammatory, traumatic, neoplastic 3. Simple Cystic Radicular Dentigerous Buccal bifurcation Lateral periodontal Fissural Stafne Simple 4. Complex Cystic Aneurysmal bone cyst / Giant cell granuloma Langerhans cell histiocytosis Ameloblastoma Odontogenic myxoma Odontogenic fibroma Mixed odontogenic tumors 5. Sclerotic/Mixed Tori Odontomas Fibro-osseous lesions Cemento-osseous dysplasia Cementoblastoma Osteomyelitis: acute, chronic (Garré), nonbacterial (CRMO, SAPHO) Osteonecrosis 6. Syndromic Odontogenic keratocyst (Gorlin) Brown tumors (hyperparathyroidism) Gardner syndrome Cherubism Desmoplastic fibroma (TS, fibromatoses) Gorham disease

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## Abstract Archives of the RSNA, 2023

HNEE-53

### Advanced MRI of the Head and Neck

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

Advanced MRI techniques utilized in the head neck include anatomic, diffusion, perfusion, vascular, elastography, functional, and metabolic. Understanding of fundamental physical principles enables optimal utilization interpretation. Informed clinical use improves patient diagnosis management. Clinical applications exist for congenital, neoplastic, vascular, metabolic, and traumatic etiologies.

#### TABLE OF CONTENTS/OUTLINE

1. High-resolution: T2, T1, 7 Tesla Cranial nerve lesions Midface anomalies Meningoceles Inner ear anomalies Orbital malformations, tumors 2. Phase-contrast: 2D, 3D CSF flow Angiography 3. Diffusion: non-echo-planar, intravoxel incoherent motion, diffusion tensor imaging Skull base tumor, infection Pott's puffy tumor Cord/nerve fibers 4. Perfusion: arterial spin labeling, dynamic susceptibility contrast, dynamic contrast-enhanced Vascular tumors Vascular malformations Skull base tumors Pituitary lesions Face transplant 5. Vascular: time-of-flight, phase-contrast, time-resolved, ferumoxytol, vessel wall imaging PHACES association Vasculopathies 6. Ultrashort- and zero-echo-time imaging Malformations Trauma Tumors Postoperative 7. Elastography Pituitary adenoma Vestibular schwannoma 8. Spectroscopy 9. PET/MR Epilepsy HN tumors 10. Chemical exchange saturation transfer 11. Anatomic modeling

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## Abstract Archives of the RSNA, 2023

HNEE-54

### Zero Echo-Time MRI of the Head and Neck

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

- Cortical bone MRI utilizes short-TE techniques such as gradient, ultrashort, and zero echo-time.
- Short-T2 tissues appear dark, hence the term "black-bone" MRI.
- Use cases include plagiocephaly, craniosynostosis, calvarial lesions, sinonasal disease, head neck tumors, jaw lesions, trauma, surgical navigation, and postoperative evaluation.
- Postprocessing advances using point reconstructions and deep learning facilitate synthetic ("bright-bone") CT generation, 3D visualization, and surgical planning.

#### TABLE OF CONTENTS/OUTLINE

1. Technique• Gradient, ultrashort, zero echo-time• Workflow sequence options• Interpretation and pitfalls2. Clinical Cases• Plagiocephaly• Simple craniosynostosis: metopic, sagittal, coronal• Genetic syndromes: Apert, Saethre-Chotzen, achondroplasia• Skull: ecchordosis physaliphora, dermoid cysts, LCH, fibrous dysplasia• Sinonasal: midnasal stenosis, pneumosinus dilatans, sinusitis• Tumors: orbitotemporal NF1, rhabdomyosarcoma, chordoma• Jaw lesions: ameloblastoma, desmoplastic fibroma• Trauma: abusive head trauma, TBI, leptomenigeal cyst, cephalohematoma• Surgical planning: arachnoid cyst, hydrocephalus• Shunt evaluation: tumor, craniosynostosis, overshunting• Postoperative evaluation: craniotomy, cranioplasty, ZMC, orbital blowout, cephalocele3. Postprocessing• Point processing• Deep learning: models, loss functions, generalizability• Diagnostic use• Surgical planning

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## Abstract Archives of the RSNA, 2023

HNEE-55

### Fetal Head and Neck Imaging

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

Fetal HN anomalies can be classified into congenital, genetic, vascular, neoplastic, traumatic, and endocrine etiologies. Major diagnoses include micrognathia, facial clefts, craniosynostosis, meningocele, vascular malformations, teratoma, and airway obstruction. US and MRI have complementary roles for prenatal screening and detailed workup. Each technique has specific clinical indications and technical limitations. Fetal MRI protocols should include 3-plane ssFSE with optional balanced SSFP, diffusion, and T1. The radiology report should address brain, face, neck, and airway, along with secondary complications and multisystem associations. Several qualitative features and quantitative metrics can be applied. For at-risk patients, serial imaging can improve diagnostic yield and interventional planning. Postnatal imaging is important for confirmation of prenatal findings.

#### TABLE OF CONTENTS/OUTLINE

1. Craniofacial Malformations Oro/craniofacial clefts Micrognathia, Pierre-Robin Beckwith-Wiedemann Orbital telorism, malformations Craniosynostosis Cephaloceles, meningoceles Acrania-exencephaly-anencephaly Amniotic band syndrome 2. Genetic Syndromes Apert Pfeiffer Frontonasal dysplasia DiGeorge Fraser 3. Cervicofacial Masses Vascular anomalies Hemangioma Lymphatic malformation Vein of Galen malformation Arteriovenous malformation Teratoma Goiter 4. Upper Airway Congenital high airway obstruction syndrome Laryngeal stenosis/atresia Tracheal stenosis/atresia Tracheo-esophageal fistula (VACTERL)

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## Abstract Archives of the RSNA, 2023

HNEE-56

### Pediatric Cutaneous Lesions: Below the Surface

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

Pediatric skin lesions are often harbingers of more extensive or systemic disease. Unique cutaneous stigmata are seen in vascular anomalies and phakomatoses. Radiologic imaging is needed to characterize deep or multisystem involvement. Understanding of genetics helps to explain disease pathogenesis and develop targeted therapies.

#### TABLE OF CONTENTS/OUTLINE

1. Background Genetic advances Ras and mTOR pathways Targeted therapies Critical point for intervention 2. Vascular Anomalies Malformations Low-flow Lymphatic (syndrome: GLA) Venous (syndromes: VMCM, BRBNS, KTW) Capillary (syndromes: M-CM, CLAPO) High-flow AVM AVF Syndromes: HHT, CM-AVM, PWS, CAMS Tumors Benign Congenital hemangioma Infantile hemangioma Syndromes: hemangiomatosis, PHACES Borderline Juvenile nasopharyngeal angiofibroma Kaposiform hemangioendothelioma Malignant 3. Phakomatoses Dysplastic NF1 NF2 NF3 Tuberosus sclerosis Gorlin Cowden Proteus Encephalocraniocutaneous lipomatosis Vascular Von Hippel-Lindau Sturge-Weber Ataxia-telangiectasia Pigmentary Neurocutaneous melanosis Pigmentary mosaicism

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## Abstract Archives of the RSNA, 2023

HNEE-57

### Pediatric Orbital Lesions

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

Pediatric orbital lesions can be classified into congenital, CSF, traumatic, vascular, endocrine, inflammatory, and neoplastic. Radiologic evaluation evaluates intraorbital compartments and extraorbital structures. Correlate imaging findings with ophthalmologic exam and imaging.

#### TABLE OF CONTENTS/OUTLINE

1. Background Orbital anatomy development Ophthalmology: funduscopy, US, OCT Radiology: CT, MR, XA 2. Congenital Small eye: anophthalmia, microphthalmia, phthisis bulbi Big eye: buphthalmos, staphylomas, colobomas Germ layer derivatives Syndromes: NF1, NF2, Aicardi, CHARGE, morning glory, Walker-Warburg Cranial dysinnervation 3. CSF Papilledema vs. pseudopapilledema Cephalocele Exorbitism 4. Trauma Anterior segment Posterior segment Globe rupture Fractures 5. Vascular anomalies Low-flow malformations Varix Venous Lymphatic Sturge-Weber Coats disease High-flow malformations Carotid-cavernous fistula Wyburn-Mason Vascular tumors Hemangiomas PHACES Von Hippel-Lindau 6. Endocrine Pediatric Graves 7. Inflammation Pott's puffy tumor Aspergillosis COVID-19 Demyelination MS NMO ADEM Histiocytosis LCH JXG Granulomatosis IgG4 CRION 8. Neoplasia Intraocular Retinoblastoma Medulloepithelioma Periorbital Adenoid cystic carcinoma Hidradenocarcinoma Benign Solitary fibrous tumor Pituitary macroadenoma Small round cell Rhabdomyosarcoma Neuroblastoma Leukemia Desmoplastic sarcoma Bone lesions Osteoma Fibrous dysplasia Sickle cell infarcts

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## Abstract Archives of the RSNA, 2023

HNEE-58

### Head & Neck Vascular Anomalies and Syndromes

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

The ISSVA classification divides vascular anomalies into vascular malformations (vasculogenesis) and vascular tumors (angiogenesis). Radiology plays an important role in diagnosis and treatment of HN vascular anomalies. Major imaging approaches include US, CT, and MR. Each modality has specific clinical indications and limitations. Imaging findings should be correlated with dermatologic examination and other clinical information. There is an emerging focus on genetic causality and targeted therapies.

#### TABLE OF CONTENTS/OUTLINE

1. ISSVA Classification Vascular neoplasms: benign, borderline, malignant Vascular malformations: simple, combined, syndromic Genetics and targeted therapies 2. Imaging Modalities USXRCTMRXA 3. Malformations Low-flow Capillary, venous, lymphatic Syndromes: Sturge-Weber, blue rubber bleb nevus, megalencephaly-capillary malformation, CLAPO, Gorham-Stout, generalized lymphatic anomaly High-flow Arteriovenous malformation, arteriovenous fistula Syndromes: cerebral arteriovenous metamerism syndrome, hereditary hemorrhagic telangiectasia, CM-AVM 4. Tumors Congenital hemangioma RICH, NICH, PICH Infantile hemangioma Hemangiomas, PHACES Kaposiform hemangioendothelioma / Tufted angioma Epithelioid hemangioendothelioma Kaposi sarcoma Angiosarcoma 5. Overgrowth Facial infiltrating lipomatosis Epidermal nevus Megalencephaly-capillary malformation: MCAP, MPPH Proteus Cowden

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## Abstract Archives of the RSNA, 2023

HNEE-59

### Approach to Pediatric Face and Neck Masses

All Day Room: Learning Center

Mai-Lan Ho, MD (*Presenter*) Research Grant, Siemens AG; Research Grant, Cardinal Health, Inc; Research Grant, Italfarmaco SpA

#### TEACHING POINTS

Evaluation of pediatric face neck masses includes clinical history, physical exam, lab values, and radiology. Diagnostic imaging can be performed with US, CT, or MR to characterize lesion location, composition, and extent. Diagnostic categories include congenital, vascular, inflammatory, and neoplastic.

#### TABLE OF CONTENTS/OUTLINE

1. Congenital Midface Dermal sinus Glial heterotopia Encephalocele Branchial clefts Types 1-4 Branchial pouches Thymus Parathyroid Thyroid 2. Vascular Vascular malformations Low-flow syndromes Lymphatic (generalize lymphatic anomaly) Venous (blue rubber bleb nevus) Capillary (megalencephaly-capillary malformation) High-flow syndromes HHT CM-AVM CAMS Vascular tumors Congenital hemangioma Infantile hemangioma: hemangiomatosis, PHACES Borderline tumors Juvenile nasopharyngeal angiofibroma Kaposiform hemangioendothelioma 3. Inflammatory Tonsillar vs. peritonsillar abscess Retropharyngeal edema vs. abscess Pott's puffy tumor Salivary glands Sialosis Sialadenitis Pneumoparotitis Mucocele / Ranula Autoimmune 4. Neoplastic Lipomatous lesions Congenital infiltrating lipomatosis Lipoblastoma Teratoma Fibrous lesions Fibromatosis colli Myofibromatosis Leiomyoma Desmoplastic fibroma (tuberous sclerosis) Desmoid fibromatosis (Gardner) Sarcoma Rhabdomyosarcoma Ewing Fibrosarcoma Synovial sarcoma Neuroblastoma Primary Secondary Nerve sheath tumors NF1 NF2 NF3 Neuroendocrine tumors Glomus (SDH, NF1, VHL, MEN) Thyroid Thyroiditis Thyroid CA

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## Abstract Archives of the RSNA, 2023

HNEE-6

### **Differentiating Malignant Parotid Tumors From Pleomorphic Adenomas and Warthin's Tumors: The Benefits of Tumor Blood Flow and Apparent Diffusion Coefficient Histogram Analysis**

All Day Room: Learning Center

Fumine Tanaka, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

It is occasionally difficult to differentiate malignant parotid tumors (MTs) from two major benign tumors such as pleomorphic adenomas (PAs) and Warthin's tumors (WTs). Here, we review how to diagnose parotid tumors by the use of apparent diffusion coefficient (ADC) and tumor blood flow (TBF) obtained by pseudocontinuous arterial spin labeling (pCASL), comparing conventional methods such as tumor-to-parotid gland signal intensity ratios with histogram analysis for the following reasons: 1. to understand principle of pCASL; 2. to review conventional methods to evaluate parotid tumors by TBF and ADC; and 3. to understand the benefits of TBF and ADC histogram analysis for differentiating MTs from PAs and WTs.

#### **TABLE OF CONTENTS/OUTLINE**

1. Essential knowledge of parotid tumors such as incidence rate, and major tumor types 2. Principle of pCASL 3. Conventional methods for differentiating MTs from PAs and WTs 1. TBF and ADC histogram analysis for differentiating MTs from PAs and WTs 2. Conclusion: The combination of TBF and ADC evaluated by histogram analysis may enhance the diagnostic performance for differentiating parotid MTs from PAs and WTs.

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## Abstract Archives of the RSNA, 2023

HNEE-60

### Opportunistic Assessment for Parathyroid Adenomas: How We Do It and Why

All Day Room: Learning Center

Karol L. Cardenas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

There are well-documented shortcomings in the diagnosis and treatment of primary hyperparathyroidism (PHPT). These gaps have prompted calls for innovative changes to how health systems approach this disease. One proposed change is for radiologists to assess for enlarged parathyroid glands on routine imaging studies with the goal of identifying individuals with undiagnosed PHPT. This exhibit will 1) review relevant PHPT background, 2) summarize existing evidence related to opportunistic parathyroid assessment, and 3) share a practical, step-by-step approach to opportunistically screening for parathyroid adenomas (i.e., "how we do it") with illustrative case examples.

#### TABLE OF CONTENTS/OUTLINE

1. Opportunistic Screening - definition; potential benefits and risks
2. PHPT Background - epidemiology, pathophysiology, diagnosis, treatment, accepted imaging role
3. Existing Gaps - failure to diagnose, failure to treat, morbidity of untreated disease
4. Opportunistic Assessment for Parathyroid Adenomas - anatomy, size criteria, imaging characteristics, review of the evidence, relevant aspects of Fifth International Workshop clinical guidelines, how we do it (search pattern, imaging evaluation, reporting)
5. Illustrative Examples - opportunistically identifying parathyroid adenomas on CT, MR, US; differentiating from mimics (exophytic thyroid tissue, thyroid nodule, lymph node)
6. Proposed Best Practices Decision Tree for "Should I Recommend Biochemical Testing for Possible PHPT?"
7. Summary and Conclusion

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## Abstract Archives of the RSNA, 2023

HNEE-61

### Hmm...Is That Normal? Pediatric Skull Base Variants With A Focus on the Temporal Bone

All Day Room: Learning Center

#### Awards

##### Cum Laude

Asha Sarma, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Radiologists must recognize many normal skull base variants that may be mistaken for disease in pediatric patients.- Differentiating normal variants from disease may be especially challenging in the temporal bone, given complex anatomy and frequently incomplete ossification.-This multi-institutional exhibit will provide a detailed case-based review of pediatric skull base variants including relevant companion cases, pearls, pitfalls, and mimics.-After viewing this exhibit, radiologists will have practical tools for differentiating normal skull base variants from disease and strategies for troubleshooting difficult cases.- This exhibit aims to: 1) describe relevant anatomy, embryology, and post-natal development of the skull base and temporal bones, 2) identify CT and MRI findings of common and uncommon developmental findings and variants, 3) contrast these variants with similar-appearing disease states, and 4) explain strategies for troubleshooting difficult cases.

#### TABLE OF CONTENTS/OUTLINE

1) Normal anterior skull base ossification and variants (e.g., skull base synchondroses, craniopharyngeal canal) 2) Normal temporal bone development and variants (e.g., cochlear cleft, incomplete ossification of the semicircular canals) 3) Variant middle ear findings (e.g., ossicular pneumatization, suspensory ligament calcification) 4) Vascular variants (e.g., emissary venous channels mimicking fracture, aplastic petrous carotid canal); 5) Skull base pneumatization variants; 6) Other salient findings (e.g., skull base sutures, foramen tympanicum)

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## Abstract Archives of the RSNA, 2023

HNEE-62

### **Pictorial Overview of Temporomandibular Joint Pathologies**

All Day Room: Learning Center

Wen Wang, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the anatomy of TMJ. Provide illustrative cases and clinical scenarios depicting common and rare pathologies involving TMJ.

#### **TABLE OF CONTENTS/OUTLINE**

1. Relevant anatomic review of the temporomandibular joint. 2. Check list/Search pattern for TMJ pathologies. 3. Congenital anomalies: i. Congenital hypoplasia ii. Ankylosis of TMJ. 4. Infectious pathology: i. Septic arthritis of TMJ ii. Post-operative infection 5. Degenerative disease: i. Osteoarthritis of TMJ ii. TMJ disc dislocation and subluxation. 6. Neoplastic disease: i. Osteochondromatosis of TMJ ii. Ameloblastoma iii. Metastatic disease. 7 Other pathologies: osteonecrosis.

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## Abstract Archives of the RSNA, 2023

HNEE-63

### Practical Tips for Hypopharyngeal Carcinoma Staging

All Day Room: Learning Center

Carlos Alberto F. Coelho Neto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The hypopharynx represents the lowest portion of the pharynx and can be affected by neoplastic and non-neoplastic diseases. Squamous cell carcinoma is the most common neoplasm in this region and can affect one of its three main subsites: pyriform sinuses, posterior wall and post-cricoid region. Imaging evaluation is essential in the staging of these patients, along with clinical and endoscopic examination. The objective of this presentation is to help the radiologist in the evaluation of neoplastic lesions of the hypopharynx, with images and tips for the evaluation of primary lesions and lymph node enlargement, contributing to the TNM classification.

#### TABLE OF CONTENTS/OUTLINE

Discussion of imaging tips in staging the hypopharynx neoplasms by showing clinical cases with MRI and CT images. We start this presentation by detailing the anatomical limits of the hypopharynx. We will detail the three main subsites of hypopharyngeal neoplasms: pyriform sinuses, posterior wall and postcricoid region. We highlight the main points of the TNM classification and, through cases, we demonstrate the main anatomical landmarks, how to measure the lesions, besides tumor extension pathways. Lymph node aspects will also be discussed, such as dimensions, dissemination routes, extranodal extension and necrosis. The conclusion of this presentation shows that hypopharyngeal neoplasms are part of the daily clinical routine of general and head and neck radiologists. Therefore, the anatomy of the pharynx must be well known, as well as the main subsites of the hypopharynx. We also show that it is not necessary to memorize the TNM staging, but the radiologist must know how to evaluate its most important points and landmarks.

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## Abstract Archives of the RSNA, 2023

HNEE-64

### Orbital Trauma: A Pictorial Review

All Day Room: Learning Center

Junaid Kalair, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Discuss the role of imaging in evaluation of orbital trauma
2. Recognized normal orbital anatomy on CT and MRI
3. Describe the spectrum of orbital trauma injuries seen on imaging
4. Recognize mimics of orbital injuries

#### TABLE OF CONTENTS/OUTLINE

Roles of radiographs, ultrasound, CT, and MRI in orbital trauma imaging  
Normal bony and soft tissue anatomy of the orbit on CT MRI including orbital compartments  
Pictorial Review of orbital injuries including: Extra-globe injuries Preseptal vs. post-septal hemorrhage Intra-conal vs. Extra-conal hemorrhage Traumatic exophthalmos vs. enophthalmos Ocular muscle injury/entrapment Foreign bodies Globe injuries Anterior segment Aqueous humor hemorrhage Uveal Prolapse Lens Dislocation Ejection Posterior segment Vitreous humor hemorrhage Subretinal hemorrhage Subchoroidal hemorrhage Open globe Imaging findings Foreign bodies Orbital trauma mimics Iatrogenic intraocular gas Medical implants

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## Abstract Archives of the RSNA, 2023

HNEE-65

### Internal Cacophony of Heartbeats: Rhythmic Whooshing and Buzzing in the Ear - Maddening Patient and Physician

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Suehyb G. Alkhatib, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review common and uncommon etiologies of pulsatile tinnitus including vascular, structural and neoplasms.2. Multimodality imaging assessment and diagnostic workup.3. Current concepts in management and review of treatment options.

#### TABLE OF CONTENTS/OUTLINE

1. Background introduction of pulsatile tinnitus2. Review of common and uncommon etiologies of pulsatile tinnitusa. Vascular:i. Venous: Idiopathic intracranial hypertension, jugular bulb diverticulum, and emissary veinsii. Arterial: arteriovenous fistula and malformations, aberrant carotid artery, fibromuscular dysplasia and carotid dissectionsb. Structural:i. Skull base dehiscence, internal jugular vein compressionii. Conductive hearing loss, e.g. otosclerosis3. Tumor: Paraganglioma, meningioma, low flow vascular malformations (Hemangiomas)3. Diagnostic Imaging QR codes with scrollable imaging data sets will be provided, with practical clues for making the diagnosis, and will include high-resolution flat panel CT.a. Idiopathic intracranial hypertension CTV, MRV, and DSA.b. High riding jugular bulb and diverticulum CTV and DSA, and vascular Eagle syndrome.c. Dural arteriovenous fistula CTA, MRA, and DSA Including high resolution 14 second magnified flat-panel computed tomographyd. Aberrant carotid artery CTA and DSAe. Paraganglioma MRI, MRA, and DS Af. Meningioma MRIg. Sigmoid sinus wall dehiscence and emissary veins CTA including treatment DSA.h. Otosclerosis CT4. Review of treatment optionsa. Transverse sinus stenosis stenting.b. Arteriovenous fistula embolization.c. Jugular vein decompression.d. Bony dehiscence resurfacing.5. Diagnostic algorithm summary

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## Abstract Archives of the RSNA, 2023

HNEE-66

### Imaging Evaluation of Hearing Loss: Understanding Audiograms to Refine Interpretation

All Day Room: Learning Center

William Malouf, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Prior to imaging, patients with hearing loss undergo audiometric assessment, which categorizes hearing loss as conductive, sensorineural, or mixed. 2) CT is the first-line imaging modality for patients with conductive hearing loss (CHL), and an understanding of prior audiometric testing results can benefit the radiologist's temporal bone CT interpretation. 3) Pure-tone hearing test results may be the most relevant component of the audiogram report for radiologists and are often viewable in the electronic medical record at the time of CT interpretation. 4) Recognizing specific CHL patterns in audiograms can increase confidence and accuracy of CT interpretations. 5) The presence or absence of the acoustic reflex informs likelihood of a third window phenomenon.

#### TABLE OF CONTENTS/OUTLINE

I. Evaluation of the patient with hearing lossa. Clinical assessmentb. Audiometric evaluationc. Role of imagingi. Indications for CTii. Indications for MRII. Review of audiometric testinga. Pure-tone hearing testi. Basic interpretationii. Patterns of conductive hearing lossb. Acoustic reflexi. Principlesii. Acoustic reflex testingIII. Illustrative Casesa. Pattern 1: Low frequency CHL closing in at higher frequenciesb. Pattern 2: Flat CHLc. Pattern 3: The Carhart notchd. Absent acoustic reflex

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## Abstract Archives of the RSNA, 2023

HNEE-67

### Ultrasound Assessment of Parathyroid Disease: The Latest and Greatest

All Day Room: Learning Center

Axel A. Torres Monarrez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Provide an overview of the anatomy, function, and embryology of the parathyroid gland.
- Emphasize the indications, limitations, and benefits of ultrasound in evaluating the parathyroid gland.
- Compare different imaging techniques for the parathyroid gland.
- Discuss the ultrasound protocol for evaluating the parathyroid gland.
- Become familiar with descriptive terms for normal parathyroid gland anatomy.
- Review the most common pathologies and provide case studies to illustrate the practical application of theoretical concepts.
- Analyze differential diagnoses, tips, and tricks.
- Discuss updates in ultrasound evaluation for parathyroid gland pathology.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of the parathyroid gland
  - 1.1 Anatomy
  - 1.2 Function
  - 1.3. Embryology
2. Ultrasound evaluation of the parathyroid gland
  - 2.1 Indications
  - 2.2 Limitations
  - 2.3 Benefits
3. Comparison of imaging techniques for the parathyroid gland: ultrasound, 4DCT, and SPECT.
4. Ultrasound and CEUS protocol for evaluating the parathyroid gland.
5. Descriptive terms for normal parathyroid gland anatomy
6. Common pathologies in the parathyroid gland: parathyroid adenoma, parathyroid hyperplasia, parathyroid carcinoma, atypical parathyroid adenoma/atypical parathyroid tumor.
7. Differential diagnoses: thyroid nodules and cervical adenopathies, tips and tricks for improving radiology reports.
8. Updates in ultrasound evaluation for parathyroid gland pathology: elastography and CEUS.
9. Conclusion.

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## Abstract Archives of the RSNA, 2023

HNEE-68

### Molecular Markers of Head and Neck Tumors

All Day Room: Learning Center

Amit K. Agarwal, MD, MBBS (*Presenter*) Stockholder, Gilead Sciences, Inc

#### TEACHING POINTS

1. To understand the basics of neuropathology and genetics  
2. Review the molecular markers genetics of head and neck tumors  
3. Discuss reclassified and newly recognized head and neck tumors

#### TABLE OF CONTENTS/OUTLINE

1. Neuropathology for the Neuroradiologist  
a. Basic histopathology (H E stains)  
b. Immunohistochemistry (immunocytology)  
c. Genetic analysis (FISH, PCR, Next-generation sequencing,) d. Liquid biopsy  
2. Markers for squamous cell carcinomas (SCCa) of the head and neck  
a. HPV (p16+ tumors) b. EBV positive tumors c. Circulating-tumor DNA (ct-DNA) for tumor surveillance  
3. Molecular markers for non-SCCa tumors of head and neck  
a. Muscle differentiation (actin, desmin) b. Neural differentiation (S100, GFAP) c. Vascular differentiation (CD markers) d. Epithelial differentiation (cytokeratin, EMA)  
4. Reclassified and newly recognized tumors  
a. SDH deficient paragangliomas b. EBV-related smooth muscle tumors c. Mammary analogue secretory carcinoma (MASC)  
5. Therapeutic advances in head and neck oncology (focus on immunotherapy)  
6. Summary/conclusion

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## Abstract Archives of the RSNA, 2023

HNEE-69

### **A Practical Guide for Radiologists: Localizing and Diagnosing Pathologies in the Carotid and Parapharyngeal Spaces**

All Day Room: Learning Center

Yesim Y. Yuruk, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Provides a comprehensive overview of the radiologic anatomy of the carotid and parapharyngeal space (PPS)
- Describes a practical approach for localizing the pathologies affecting the carotid and PPS.
- Reviews common and rare pathologies in the carotid and PPS using case-based examples, highlighting distinctive clinical and imaging features that can aid in the best differential diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents 1. Terminology of the Carotid and PPS 2. Anatomy and Contents of the Carotid and PPS 3. Practical approach to Diagnosing Pathologies in the Carotid and PPS 4. Displacement Pattern of PPS Fat for Localizing Masses. 5. Case-Based Review of Primary and Secondary Pathologies in the PPS 6. Case-Based Review of Primary and Secondary Pathologies in the Carotid Space Outline

- Knowledge of anatomy is essential for localizing a lesion in the Carotid or PPS.
- Displacement patterns of PPS fat can aid in identifying the space of origin.
- Understanding the contents and common/rare lesions of these spaces is the first step in generating a differential diagnosis.
- Obtaining relevant clinical history and recognizing specific imaging appearances can help provide the best differential diagnosis.

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## Abstract Archives of the RSNA, 2023

HNEE-7

### Hypervascular Head and Neck Tumors: Image Aspects

All Day Room: Learning Center

Fernanda B. Guedes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Hypervascular tumors, by definition, are arterialized and present intense and early contrast enhancement. They comprise a wide variety of pathologies, which can be didactically divided into five major groups: neuroendocrine tumors, vascular tumors, primary lymphadenopathy, metastatic lymphadenopathy and other hypervascular tumors.

#### TABLE OF CONTENTS/OUTLINE

In this presentation we are going to review hypervascular head and neck tumors and characterize their imaging features on computed tomography (CT) and magnetic resonance imaging (MRI), focusing on features that aid in the differential diagnosis through flowcharts. Images will be presented comparing the different locations of the paragangliomas and the various patterns of growth of the Juvenile nasopharyngeal angiofibroma. Metastatic and primary lymphadenopathy will be differentiated through tables.

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## Abstract Archives of the RSNA, 2023

HNEE-70

### Update in Imaging of Parotid Lesions and Treatment-related Findings

All Day Room: Learning Center

Ewa Joanna Maciag (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Parotid gland tumors are a rare entity among the neoplasms of the head and neck. In adults, most encountered lesions are benign, being only 10% of parotid tumors malignant. Radiological assessment of these lesions includes ultrasound (US), computed tomography (CT), and morphological and functional magnetic resonance imaging (MRI). The definition of the nature of the lesion is essential for the election of treatment methods. Benign neoplasms may be destined for follow-up or managed surgically by gland-sparing techniques with facial nerve preservation. On the contrary, malignant lesions are treated frequently with total gland resection and sacrifice of the facial nerve with corresponding posterior morbidity. The exhibit aims to present the gamut of parotid neoplasms according to their imaging characteristics in the initial study and to stress the importance of radiological support in the follow-up. Treatment options including different surgical approaches and the correlation between applied technique and imaging will be provided.

#### TABLE OF CONTENTS/OUTLINE

1. Parotid anatomy. 2. Imaging modalities: US, CT, morphological, and functional MRI. Applications. 3. Primary and secondary parotid lesions. 4. Different types of surgical approaches. 5. Follow-up findings.

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## Abstract Archives of the RSNA, 2023

HNEE-71

### **Bone Metabolic Disorders in Pediatric Patients: Key Clues for Early Detection in Dental Imaging**

All Day Room: Learning Center

Jo-Eun Kim, DDS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Bone metabolic disorder refers to a disease caused by a variety of causes that break the balance between bone-forming and bone-removing activities. Bone metabolic disorders can affect pediatric patients and impact their oral health. Dental imaging, such as panoramic radiographs and cone-beam computed tomography (CBCT), can provide key clues for early detection of these disorders. - Generalized loss of follicular cortex or lamina dura of tooth - Generalized widening or obliteration of pulp chamber - Generalized sclerotic or osteopenic change of trabecular bone Understanding the imaging features of bone metabolic disorders is essential for dental practitioners to identify and refer patients for appropriate medical care. Especially, it is important to distinguish it from hematopoietic malignancy (such as leukemia, or lymphoma), which can appear similar and requires urgent treatment. Collaboration between dental and medical professionals is crucial for the management and treatment of bone metabolic disorders in pediatric patients.

#### **TABLE OF CONTENTS/OUTLINE**

1. Meaning of dental imaging in pediatrics 2. Schematic explanation of bone mineral metabolic disorder 3. Bone metabolic disorders which impact on teeth and jaw bone structures (summary table) 4. Example of panoramic radiographs of the pediatric patients affected by metabolic disorder 5. Differential diagnosis from hematopoietic malignancy of pediatric patients (Importance of detecting changes on dental radiography)

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## Abstract Archives of the RSNA, 2023

HNEE-72

### There's Something In Your Teeth! Dental Panoramic Radiology for Radiologists

All Day Room: Learning Center

Logan M. Ryals, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review normal dental anatomy and imaging features, highlighting digital panoramic radiography (Panorex) cross-sectional imaging correlates. Discuss the differential diagnosis of oral maxillofacial/dental pathology on Panorex and cross-sectional imaging. Recognize the importance of systematic dental imaging interpretation in the diagnosis of oral and maxillofacial diseases.

#### TABLE OF CONTENTS/OUTLINE

The oral cavity is the intersection of dentistry and medicine. However, the relationship of oral and systemic conditions is not fully appreciated. Modalities used in dental radiology include periapical and bitewing radiography, digital panoramic radiography, and cone-beam computed tomography. Panoramic radiography is most widely encountered by radiologists, but few receive formal training, and many are uncomfortable interpreting these studies despite frequent expectations to do so. Early detection of intraoral pathologies by radiologists may improve patient care and alert clinicians to the need for dental consultation. Familiarity with the anatomy and pathology of the oral and maxillofacial region will improve radiologists' diagnostic confidence and allow for the synthesis of a timely and detailed differential diagnosis. We will review dental imaging protocols, normal dental anatomy, and common findings of oral and maxillofacial pathology. A wide range of pathology will be discussed, emphasizing their appearances on panoramic radiographs with cross-sectional imaging correlates. Pathologies to be discussed include infectious and inflammatory lesions, periodontal diseases, cystic, benign and malignant masses, sinus pathology, and bone and temporomandibular joint disorders.

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## Abstract Archives of the RSNA, 2023

HNEE-73

### Unlocking the Temporomandibular Joint: CT, MRI and Arthroscopic Correlation

All Day Room: Learning Center

Silvia Cayon Somacarrera, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To illustrate the spectrum of findings in temporomandibular joint derangement on MR and its correlation with arthroscopic findings when available  
To highlight the role of CT in temporomandibular joint derangement  
To show the different surgical therapeutic approaches of temporomandibular pathology

#### TABLE OF CONTENTS/OUTLINE

The most important anatomic structure of the temporomandibular joint is the articular meniscus, therefore it is the main element to be evaluated. We must study its morphology along with its location relative to the condyle in both closed- and open-mouth positions. However, we must bear in mind that meniscus aberrant displacement is also frequently seen in asymptomatic volunteers so that other findings such as joint effusion, retrodiskal layer rupture, lateral pterygoid muscle attachments thickening, degenerative changes, osteochondromatosis and ankylosis, may be required to help guide the diagnosis. It is important for the radiologists to detect early MR imaging signs of temporomandibular dysfunction, thereby avoiding its evolution to osteoarthritis. Nevertheless, it is important to know that the therapeutic approach is made by assessing both the clinical situation of the patient and the imaging. We have selected a wide variety of temporomandibular joint derangement cases in order to show the different imaging findings as well as the arthroscopic correlation when available. We also include a description of the different treatment approaches carried out in our institution.

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## Abstract Archives of the RSNA, 2023

HNEE-74

### Lesions in the Optic Tracts: Clinical-radiological Manifestations

All Day Room: Learning Center

Maria E. Rocha, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the basic anatomy of the visual pathway and correlation with clinical manifestations.- Present the most frequent lesions in each region of the optic tract and review the main differential diagnoses.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Anatomy review 3. Correlation the anatomy with clinical manifestations4. Most frequent lesion in each topography

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## Abstract Archives of the RSNA, 2023

HNEE-75

### Temporal Bone Anatomy on Photon Counting CT: Beyond the Obvious

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Shehbaz M. Ansari, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the concept and design of photon counting CT scanners and understand its advantages over conventional CT scanners with energy integrating detectors. 2. Illustrate temporal bone anatomy with emphasis on structures that were previously not reliably or less vividly identifiable. 3. Develop a system-based approach to temporal bone radiological anatomy.

#### TABLE OF CONTENTS/OUTLINE

The imaging anatomy of the temporal bone has seen little progress in the last decade owing to the limited progress in the detector technology. Conventional detectors suffer from the inverse relation between radiation dose and image noise along with a limit to image resolution. Photon counting detectors (PCDs) have improved contrast to noise ratio with twice the resolution at nearly half the radiation dose. The basic physics of these detectors and their potential uses will be first discussed. To highlight the advantages of PCDs, we depict temporal bone anatomy including small structures not previously identifiable on imaging. Historically, advances in imaging to clarify anatomy has led to a deeper understanding of and elucidation of new pathologies associated with these structures. We also put forward a system-based approach to the anatomy of this region along with the conventional section-based anatomy. This system-based approach, aided by diagrammatic illustrations, will aid in understanding the complex anatomy of minute neural structures and communications around the ear, the delicate ossicular support system, neural and vascular supply of the labyrinth, and minor adjacent fissures among others.

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## Abstract Archives of the RSNA, 2023

HNEE-76

### **Feast Your Eyes on US of the Eye: A Guide to Ophthalmic Sonography**

All Day Room: Learning Center

Pedro A. Daza, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The eye needs a gel pillow. Acquired planes must evaluate anterior and posterior chambers. The optic nerve must be acquired on its own, using Doppler. Extraocular structures are important. Dynamic images are strong points of the sonography.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy and radiological anatomy of eye. Technique and recommendations. Pathology with case review. Conclusions.

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## Abstract Archives of the RSNA, 2023

HNEE-77

### Imaging of Post-dental Treatment: What Radiologists Need to Know in Common and Advanced Dental Procedures

All Day Room: Learning Center

#### Awards

##### Cum Laude

Kotaro Ito, DDS, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

With recent advancements in dentistry, various new treatment methods have been clinically introduced, and many new materials are being used for treatments. Post-dental treatment CT and MR images reveal a variety of hard tissue and soft tissue changes and used dental materials which often associate image artifacts. Therefore, familiarity with post-treatment changes and dental materials is crucial to avoid misinterpretation as true pathologies, identify complications and evaluate for recurrent disease. The purpose of this exhibit is 1) to review common and uncommon dental treatments with an emphasis on recently introduced treatment and procedures, 2) to review expected and unexpected post-dental treatment changes and dental materials on CT and MR images, and 3) to discuss imaging approach to identify complications and disease recurrence or progression.

#### TABLE OF CONTENTS/OUTLINE

- 1) Review of common and uncommon dental treatments, with an emphasis on recently introduced treatments and dental materials
- 2) Review of expected and unexpected post-dental treatment changes and dental materials on CT and MR images
- 3) Discussion on imaging approach to identify complications and disease recurrence or progression

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## Abstract Archives of the RSNA, 2023

HNEE-78

### **PET/MRI In Head and Neck Cancer: Ready For Primetime?**

All Day Room: Learning Center

Craig Foote, MD, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

PET/MR is a relatively new modality poised to provide considerable, novel clinical value in the field of head and neck oncology by combining the functional evaluation of FDG PET with the exquisite soft tissue resolution of MR imaging. Patients with head and neck cancers already requiring MRI for TNM staging may stand to benefit the most from the use of PET/MR, which offers the ability to simultaneously acquire the optimal regional and distant metastatic evaluation offered by PET in addition to MR, as opposed to separately by MR and PET/CT. This educational exhibit will provide an overview of PET/MR and its current role in head and neck cancer, as well as discuss barriers to its widespread acceptance and predictions for the future.

#### **TABLE OF CONTENTS/OUTLINE**

1) Overview of PET/MR  
a) Evolution of PET/MR  
b) Advancements in hardware  
c) Physics  
d) Coregistration  
2) Advantages of PET/MR  
a) Comparison to PET/CT  
i) Radiation dose reduction, longer acquisition times, improved radiation planning, etc.  
ii) Lung nodule detection compared to PET CT  
b) MRI for more accurate T staging  
c) Application of NIRADS (Neck imaging reporting and data system) in PET/MR  
3) Examples of PET/MR in head and neck cancer  
a) Evaluation of post-treatment change versus recurrence  
b) Head and neck cancer of unknown primary  
c) Orbital malignancy  
d) Perineural Spread  
4) Barriers to use  
a) Costs  
b) Lack of trial data showing distinct advantages  
5) Recent developments/future predictions  
a) Multi-parametric imaging  
b) Innovative radiotracers

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-79

### Laryngeal Carcinoma Evaluation with Dual Energy CT (DECT)

All Day Room: Learning Center

#### Awards

##### Cum Laude

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Dual-energy CT (DECT) can be used in laryngeal carcinoma (LC) evaluation. Based on the decomposition of different materials, DECT can distinguish tissues with similar Hounsfield Unit attenuations assessed in simple energy CT (SECT). The size, the identification of the margins of LC, and the evaluation of adjacent structures invasion, which could change the LC staging, is not always easy due to the small size occupied by the complex laryngeal structures in the visceral compartment and their similar attenuation values. A more accurate diagnosis can be made with DECT. The main objectives of this exhibit are: 1. To describe DECT image acquisition protocols and post-processing techniques related to the evaluation of LC. 2. To illustrate DECT findings in LC by TNM staging and its SECT correspondence. 3. To expose the differential diagnosis and potential pitfalls of LC in DECT and how to try to avoid them.

#### TABLE OF CONTENTS/OUTLINE

1. Overview review of LC. 2. Diagnostic clinical and imaging strategies to evaluate LC. 3. DECT protocol for LC evaluation and post-processing techniques related to imaging of LC such as virtual monochromatic and material decomposition images. 4. Case-based cancer image examples with DECT and SECT correspondence for each TNM stage. 5. LC pitfalls and differential diagnosis of LC in DECT images.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-8

### Ultrasound of Ocular Globe: Revealing What Lies Below

All Day Room: Learning Center

Ingrid D. Caridade, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ultrasound (US) of the eye has become increasingly popular in clinical practice as a complementary tool to ophthalmoscopy, as it is a dependable and secure diagnostic technique for assessing and monitoring various ophthalmic conditions, including inflammation, tumors, and traumatic injuries, as well as measure the optic nerve and detect intracranial hypertension. The method is accessible, non-invasive, and relatively low-cost, with few contraindications. The eye's superficial location and structure make the US an ideal examination option, particularly in emergency situations. It is typically recommended when it is challenging to examine the fundus of the eye due to conditions that cause opacity of the ocular globe. In pediatrics, US can be performed without sedation or radiation, making it an especially valuable tool. Radiologists should be familiar with the basic anatomy of the eye, as well as the examination technique and ultrasonographic findings of the entities that frequently affect the ocular globe. In this presentation, we show a literature review and case analysis performed using high-frequency linear transducers with B-mode ultrasonography and color Doppler. Subsequently, the findings are compared to imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI).

#### TABLE OF CONTENTS/OUTLINE

Review the normal eye anatomy. Demonstrate the US examination technique. Discuss some pathologies of the eye and its main ultrasonographic image features.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-80

### **Delayed Gadolinium-enhanced MRI in Ménière's Disease: Imaging Findings and Clinical Application**

All Day Room: Learning Center

Lisa M. De Pont, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to summarise current MRI techniques for hydrops imaging; to describe current diagnostic MRI criteria for Ménière's disease; and to discuss clinical application of hydrops imaging

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy of inner ear structures; delayed gadolinium-enhanced inner ear MRI; MRI assessment; review of imaging findings; clinical utility

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## Abstract Archives of the RSNA, 2023

HNEE-81

### Mimics of Ménière's disease on delayed gadolinium-enhanced MRI

All Day Room: Learning Center

Lisa M. De Pont, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is (1) to review imaging features of several peripheral vertigo-associated diseases on delayed gadolinium-enhanced MRI and (2) to describe the current role of MRI in differentiating Ménière's disease from other vertigo-associated diseases.

#### TABLE OF CONTENTS/OUTLINE

Anatomy of inner ear structures; delayed gadolinium-enhanced inner ear MRI; review of imaging findings in Ménière's disease, intralabyrinthine fistula, perilymphatic fistula, labyrinthitis, sudden sensorineural hearing loss, vestibular neuritis, vestibular migraine, vestibular schwannoma; summary of MRI findings and differentiating features.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-82

### Imaging Considerations for Transoral Robotic Surgery (TORS) Planning

All Day Room: Learning Center

Niedja Santos Goncalves Tsuno (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To learn the radiological imaging findings that represent indications and contraindications for Transoral Robotic Surgery (TORS), focusing on Head and Neck oncology. - To identify expected postsurgical status of tumors resected by TORS.

#### TABLE OF CONTENTS/OUTLINE

1. Simplify the anatomy of the oropharynx, hypopharynx, and larynx, with emphasis on the tonsillar regions, base of the tongue, supraglottis, hypopharynx (pyriform sinus), and also the pre-styloid parapharyngeal and retropharyngeal spaces. 2. Summarize classical TORS ideal indications for treatment of head and neck neoplasms, focusing on the role of CT and MR imaging to determine the size of the tumor, its location and relationship with adjacent structures. 3. Summarize and exemplify the major general contraindications for TORS related to the primary tumor (internal carotid artery entrapment, invasion of the prevertebral space, massive extension into the masticatory space, bone involvement) and those not related to the primary tumor (unresectable cervical nodal disease, metastases and high surgical-anesthetic risk), in addition to reviewing site-specific contraindications. 4. Conclusion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-83

### What, Where and When of Imaging in Spontaneous Skull Base CSF Fistulas

All Day Room: Learning Center

Sanchita Gupta, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Understand the anatomical basis and pathophysiology of spontaneously developing CSF fistulas  
2) Approach to imaging in patients with skull base fistula  
3) Identify the imaging appearance of lesions, and features to differentiate these from potential mimics  
4) To extract clinically relevant imaging information which translates into improved decision-making and ease during the surgical procedure

#### TABLE OF CONTENTS/OUTLINE

1) What is a Spontaneous Skull base CSF fistula?  
2) Pathophysiology of a CSF leak  
3) Anatomical considerations - Common sites - Cribriform plate- Sphenoid bone - Perisellar and Lateral recess- Temporal bone - Tegmen tympani and mastoidium  
4) History and Clinical Presentation  
5) Imaging modalities for assessment - Indications and Technique - High-resolution Computed Tomography (HRCT)- Magnetic resonance Cisternography- Contrast-enhanced CT Cisternography- Gadolinium-enhanced MR Cisternography  
6) Imaging features of spontaneous skull base CSF fistula  
7) Associated features of Idiopathic Intracranial Hypertension  
8) Structured reporting format for the pre-surgical evaluation of skull base CSF fistula - What the Surgeon Wants to Know.

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## Abstract Archives of the RSNA, 2023

HNEE-84

### **The External Carotid Artery: The Forgotten Carotid Branch. Tips and Tricks for the Evaluation in Different Imaging Techniques.**

All Day Room: Learning Center

Maria J. Galante I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To review the pathway, anatomical relationships and areas supplied by the external carotid artery.-To describe the anatomy of the artery and the relationship with other structures in the different techniques, including CTA, MRA, US and DSA.-To give some tips to achieve an accurate evaluation of the artery and its main pathologies, especially while performing a diagnostic US.- To offer a US protocol for the assesment of these artery.The external carotid artery is one of the main vascular structures of the head and neck region, not only because it irrigates this area, but also because some of its branches anastomose with the internal carotid and posterior cerebral arteries, becoming an important source of collateral supply. Besides, it is well known that the number of interventional and surgical procedures has massively increased . So, being the territory supplied by this artery so extensive and sometimes tricky, it could get affected whenever any of these procedures are performed, or in the case of tumors of the head and neck region, and traumatic injuries. In this exhibit we will analyze the anatomical pathway, territory, and relations of this artery.

#### **TABLE OF CONTENTS/OUTLINE**

1) General Anatomical Description2) The external carotid artery in Imaging Techiques: US, CTA, MRI , DSA3) Tips and Tricks for the evaluation in US technique: Protocol4) Superior thyroid artery5) Ascending pharyngeal artery6) Lingual artery7) Facial artery8) Occipital artery9) Posterior auricular artery10) Maxillary artery11) Superficial temporal artery

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

HNEE-85

### Algorithmic Approach to Head and Neck Emergency Neuroradiology

All Day Room: Learning Center

Blake Marmie, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Discuss common neuroradiology examinations of the head and neck region from the emergency department. 2. Outline key anatomic structures and common emergent diagnoses of the head and neck. 3. Provide algorithmic approaches for interpreting neuroradiology examinations of the neck soft tissues, skull base, face, and orbits. 4. Display image rich case examples of head and neck neuroradiology emergent diagnoses which outline key features for high quality reports.

#### TABLE OF CONTENTS/OUTLINE

1) Neuroradiology examinations of the head and neck commonly ordered in the emergency department i) CT: neck soft tissues, maxillofacial, temporal bone, orbits, cervical spine, CTA ii) MRI: neck soft tissues, face, orbits, IAC, cervical spine, MRA iii) Radiographs: Neck soft tissue, cervical spine, face, mandible 2) Neck soft tissue Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Ludwig's Angina, Tracheal Fractures etc. 3) Skull base Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Ossicular dislocation, Bezold abscess etc. 4) Face Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Le Fort Fractures, Fungal sinusitis etc. 5) Orbit Algorithm i) Structured diagnostic strategy (1) Key anatomy and diagnoses ii) Case examples (1) Globe rupture, Retrobulbar hemorrhage etc.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-86

### Breathe Easier: A Guide for Imaging Obstructive Sleep Apnea (OSA)

All Day Room: Learning Center

Mathew Illimoottil (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Obstructive Sleep Apnea (OSA) is a common condition characterized by repetitive episodes of partial or complete upper airway obstruction during sleep, leading to disrupted breathing and decreased oxygen levels. Imaging techniques, such as computed tomography (CT) can provide valuable information for the diagnosis of OSA and surgical planning. CT is particularly useful for assessing the upper airway anatomy and identifying anatomical factors contributing to airway obstruction. A standardized approach for evaluating CT, including measurements of relevant landmarks is useful for communicating the findings to the referring surgeon.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction  
Definition and epidemiology of OSA  
Scanning Protocol  
II. Imaging Techniques for OSA  
Computed Tomography (CT)  
Magnetic Resonance Imaging (MRI)  
III. Role of Imaging in OSA Diagnosis and Management  
Upper Airway Anatomy  
Assessment  
Soft Tissue Structure Evaluation  
Functional Changes  
Detection  
Complications Identification  
Treatment Guidance  
Anatomical Measurements on CT  
Implantable Neurostimulator to Treat Obstructive Sleep Apnea  
IV. Conclusion  
Summary of key points  
Future directions and challenges in OSA imaging research

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## Abstract Archives of the RSNA, 2023

HNEE-87

### Dacryocystography using Computed Tomography: What a Radiologist Needs to Know

All Day Room: Learning Center

Tany Chandra, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Computed Tomography Dacryocystography (CT DCG) is a valuable technique to evaluate the nasolacrimal drainage system in epiphora. It allows unequivocal demonstration of the level and causes of obstruction that include inflammatory, traumatic (fractures and iatrogenic), developmental stenosis of the bony lacrimal canal, and an occasional lacrimal sac tumor, etc. It also provides useful information about the degree of obstruction, whether obstruction is anatomical or functional, insight into reasons for failed dacryocystorhinostomy, and other useful findings like sac size, diverticuli, fistulae, etc. The technique, therefore, provides a one-stop shop for all necessary information for the diagnosis, treatment planning, and follow-up in epiphora.

#### TABLE OF CONTENTS/OUTLINE

1)Indications 2)Technique 3)Interpretation 4)Etiologies with illustrative cases 5)Ancillary findings aided and detected by CT 5)Limitations 6)Conclusions

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## Abstract Archives of the RSNA, 2023

HNEE-88

### Liptology or the Science Behind Beautiful Lips

All Day Room: Learning Center

Slavina Mancheva, MD, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To describe the anatomy of lips and perioral region- What ultrasound technique is used to depict anatomy and tips to perform the exam- To assess any anatomical variants or physiological changes that affect the lips ?- To describe optimal prognostic tools during the ultrasound exam that might prevent any adverse event and also to define some common complications.

#### TABLE OF CONTENTS/OUTLINE

The main focus is to describe the anatomy of simple but yet complicate organ that recently has been exposed to much attention. The other important part is to learn what anatomical variations are common and what pathological or physiological changes could be defined using Ultrasound. Due to the fact that there is unabated trend of aesthetic procedures in which complications are becoming more and more prominent, the radiologist must become familiar of them. Together we will identify what might be the ingredients of beautiful lips and their aging changes. The last but not least we will describe what the overfilled syndrome looks like and how it might affect the oral and perioral region.

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## Abstract Archives of the RSNA, 2023

HNEE-89

### Diagnostic Imaging of Enophthalmos: A Practical Approach

All Day Room: Learning Center

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Describe measures used to evaluate the normal globe position in cross-sectional imaging.- Discuss the main imaging features of entities that lead to enophthalmos and its mimics.- Demonstrate the utility of CT and MRI in the differential diagnosis of patients with enophthalmos.

#### TABLE OF CONTENTS/OUTLINE

Enophthalmos, defined as inward displacement of a normal-sized globe within the orbit, can occur unilaterally or bilaterally and is relatively common. If the displacement is minimal, the diagnosis may not always be based on physical examination and these patients may be initially misdiagnosed as having contralateral exophthalmos. Various etiologies cause enophthalmos and trauma is the leading cause. CT and MRI are the imaging techniques of choice for evaluating enophthalmos, and each have distinct advantages. While CT is useful for the detailed assessment of bone structures, MRI is better suited for analyzing orbital soft tissues. Our purpose is to present an overview of the imaging characteristics of entities that can cause enophthalmos based on various mechanisms, including structural abnormalities, fat atrophy, retraction, mixed, uni- vs. bilateral, and pseudoenophthalmos.

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## Abstract Archives of the RSNA, 2023

HNEE-9

### **US of the Neck Beyond the Thyroid: Parathyroids, Salivary Glands, Adenopathy, Trachea**

All Day Room: Learning Center

Matheus Marcelino Dias, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are:-Make a multimodality-based didactic review to elucidate multiples cervical conditions at neck ultrasound;-Propose a didactic categorization of these conditions: .Gastrointestinal malformations.Congenit malformations.Infectious causes.Oncology causes.Post operative conditions-Correlate those findings with other exams;- Illustrate those conditions based on cases from our radiology group.

#### **TABLE OF CONTENTS/OUTLINE**

We will elucidate multiples cervical conditions at neck ultrasound and focus on their imaging features using a multimodality approach in this exhibit.Gastrointestinal malformations Zenker diverticulumCongenit malformationsCysticThyroglossal duct cyst Branquial cyst Lymphangioma Ranula Solid TeratomaGlioma Vascular Hemangioma Arteriovenous malfomation Infectious causesSialadenitisParotitisAbcessLymph node abscessCarotidyniaOncologyLinfomaParotid Submandibular gland Oropharynx Post operative conditions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

HNEE-90

### **A Practical Guide to Reporting an Oropharyngeal Videofluoroscopic Swallow Study: Anatomical Landmarks, Tips, and Tricks**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Javier Azpeitia Arman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To describe oropharyngeal region anatomy and mechanism of swallowing. -To review the study protocols of oropharyngeal videofluoroscopic swallow study (VFSS) in the evaluation of different clinical conditions and endoscopic findings. -To illustrate the most important anatomic landmarks and signs to evaluate in different phases of a swallowing videofluoroscopy. - To analyze steps in interpretation of an VFSS, report structure and essential points in reporting.

#### **TABLE OF CONTENTS/OUTLINE**

Oropharyngeal videofluoroscopic swallow study is the technique of choice in the diagnosis of oropharyngeal dysphagia causes. The study protocol should be tailored according to the specific clinical symptoms and endoscopic findings in each patient. Reporting an VFSS requires knowledge of the most important anatomic landmarks and a detailed report structure including findings in the different phases of deglutition. We present: -Normal anatomy of the oropharynx and mechanism of swallowing. - Study protocol: Contrast agent preparation. Swallowing protocol: bolus volumes (small or large) consistency (liquid to semisolid). Patient positioning. Image requirements. Recording. -Study evaluation. Anatomical landmarks. Deglutition phases. Implications for treatment. Meal consistency. Different manoeuvres improving swallowing. -Report: Systematic analysis of imaging findings. Motility disorders: Bolus transport from oral cavity, Laryngeal vestibular penetration, Pharynx residue, Transglottic aspiration; Intrinsic causes: cricopharyngeal bar (prominent cricopharyngeal muscle), diverticulum, web. Extrinsic compression: osteophytes, thyroid gland. Surgery (laryngectomy).

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## Abstract Archives of the RSNA, 2023

HNEE-91

### Head and Neck: It's Not a Tumor

All Day Room: Learning Center

Brian G. Yep, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe imaging features of head and neck lesions that should raise the concern for oncologic processes. 2. Provide non-neoplastic differential considerations for head and neck lesions.

#### TABLE OF CONTENTS/OUTLINE

One of the major questions that arise when encountering a head and neck lesion is to discern if it is a neoplastic or non-neoplastic process. This educational exhibit will first highlight imaging features that should raise the concern for an aggressive neoplastic head and neck process. Then, through a case-based style, non-oncologic mimics will be presented to provide alternative benign differential diagnostic considerations including infectious, inflammatory, and variant congenital/developmental etiologies. Finally, one can put this knowledge to the test through a series of quiz questions.

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## Abstract Archives of the RSNA, 2023

HNEE-92

### Imaging of Facial Pain and Numbness: Trigeminal Neuralgia and Neuropathy

All Day Room: Learning Center

Gabriel Virador, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the normal anatomy of the trigeminal nerve, its branches and structures normally present along its anatomic course. A combination of 2D and 3D rendered images will be used, as well as CT/MRI imaging examples. 2. Discuss the pathophysiology of classic and secondary causes of trigeminal neuralgia. 3. Present a case-based review illustrating different examples of classic and secondary trigeminal neuralgia on CT/MRI images. 4. Provide a step-by-step search pattern for trigeminal pain

#### TABLE OF CONTENTS/OUTLINE

I. Introduction II. Normal trigeminal nerve and skull base anatomy III. Classification of common sources of trigeminal pain. Imaging review, pathophysiology, symptoms, and management will be reviewed. Cases will include but are not limited to: a. Trigeminal Neuralgia: neurovascular compression, demyelination, tumoral compression. b. Trigeminal Perineural Tumor Spread c. Post-Herpetic Neuralgia d. Post-Traumatic Trigeminal Neuropathy e. Trigeminal Trophic Syndrome: iatrogenic, brainstem infarction f. Anesthesia Dolorosa g. Trigeminal Tic Syndrome IV. Differential Diagnosis for non-trigeminal sources of facial pain: optic neuritis, nervus intermedius neuralgia, glossopharyngeal neuralgia. V. Simplified search pattern for trigeminal pain VI. Conclusion

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## Abstract Archives of the RSNA, 2023

HNEE-93

### Dysphagia: A Pictorial Review of Common and Uncommon Causes

All Day Room: Learning Center

Selima Siala, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Illustrate a large spectrum of diseases causing dysphagia. Highlight key imaging findings of common diseases of the pharynx and esophagus.

#### TABLE OF CONTENTS/OUTLINE

Dysphagia is a broad term used to describe a subjective sensation of difficulty when swallowing. Causes of dysphagia can be divided into structural and functional. Structural dysphagia includes lesions that compromise the esophageal lumen typically leading to difficulty swallowing solid food prior to liquids. Examples of structural dysphagia include congenital anomalies (esophageal web and vascular entities), acquired (Zenker's diverticulum, Longus coli tendonitis, goiter, and aortic dissection), neoplasms, inflammation (esophagitis, felonization of the esophagus, Barrett's esophagus, and scleroderma), infection (abscess and Candidiasis), iatrogenic (surgically induced) and foreign bodies. Functional dysphagia is caused by conditions that interfere with normal peristalsis including diffuse esophageal spasm and achalasia. Hence the swallowing of both solid foods and liquid is compromised at the same time. Dysphagia can also be classified based on location as oropharyngeal or substernal. Oropharyngeal dysphagia is defined as a sensation of blockage in the throat, while substernal dysphagia presents as a sensation of blockage between the thoracic inlet and the xiphoid process. The evaluation of dysphagia heavily relies on imaging, particularly fluoroscopy studies including modified barium swallow and esophagography as well as CT. Fluoroscopy studies provide an evaluation of both anatomic structure and function of the pharynx and esophagus while CT provides better anatomic evaluation outside of the lumen.

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## Abstract Archives of the RSNA, 2023

HNEE-94

### **Decoding the Language of Neoplastic Cells: Molecular Markers as Prognostic and Diagnostic Tools for Oral Squamous Cell Carcinoma**

All Day Room: Learning Center

Laura C. Magalhaes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To illustrate the most recent genetic alterations described in Oral Squamous Cell Carcinoma (OSCC) and correlate with the pathology, imaging, and prognosis. To show that molecular analysis can provide information on tumor biological behavior. To demonstrate the importance of incorporating molecular analysis of OSCC.

#### **TABLE OF CONTENTS/OUTLINE**

1. Revision of the anatomy of the oral cavity. 2. Epidemiology, pathology, and demographics of OSCC. 3. Recent advances in molecular biology. 4. Specific genetic mutations, amplifications, or deletions associated with tumor progression, recurrence, and response to therapy. 5. Identification of human papillomavirus (HPV) leading to improved prognosis and targeted therapy. 6. Imaging strategies to depict the correct diagnosis based on the genetic profile. 7. Targeted therapies or immunotherapies. 8. Flowchart of the changes and last updates based on the neoplastic molecular profile. 9. Take-home messages.

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## Abstract Archives of the RSNA, 2023

HNEE-95

### Lessons About Cholesteatomas. Keratinize Radiological Knowledge

All Day Room: Learning Center

Bruna E. Gherardi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching points To demonstrate the features of cross-sectional imaging cholesteatomas, indications and limitations of HRCT and MRI. To illustrate the main complications of cholesteatomas and post-operative assessment.

#### TABLE OF CONTENTS/OUTLINE

Table of contents / OutlineBackground. Imaging protocol. Basic anatomy: middle and inner ear. Features of external and middle ear cholesteatomas. The role of CT and MRI in the diagnosis of cholesteatoma. Extra auricular cholesteatoma. Complications of cholesteatoma. Assessment of recurrence and postoperative findings through CT and MRI. Take home messages.

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## Abstract Archives of the RSNA, 2023

HNEE-96

### What a Pain in the... Imaging Findings of the Painful Ear

All Day Room: Learning Center

Bruna E. Gherardi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching points To detect the imaging features of the painful ear. To identify the main CT features of incipient and coalescent acute mastoiditis as a basis for recommending conservative or surgical management. To detect intracranial complications of acute inflammatory diseases.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/OutlineBackground. Basic anatomy of the external, middle and inner ear. HRCT and MRI imaging protocol. The role of CT and MRI in the diagnosis of mastoiditis. Necrotizing external otitis.Local complications: Myringosclerosis / tympanosclerosis, Ossicular fixation and erosion, Labyrinthine fistula, Labyrinthitis, Periosteal / Bezold's abscess.Extensive complications: Dural sinus thrombosis, Meningitis, Subdural effusion, Brain abscess, Petrous apicitis.

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## Abstract Archives of the RSNA, 2023

HNEE-97

### **Nose Job: A Work in Progress... Aesthetic Procedures of the Nose - Pre and Postoperative**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Raphael M. Reali, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the structural anatomy of the nasal region  
2. Detail the nasal functional anatomy for a successful rhinoplasty surgery  
3. Guide the radiologist to detail anatomical changes relevant to the surgical procedure  
4. To evaluate the computed tomography (CT) imaging as a tool for developing approaches or strategies for leading aesthetic nasal surgical procedures  
5. To evaluate the postoperative CT images as a tool for evaluating changes, sequels and complications after the aesthetic surgical procedure.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
a. Nasal anatomy  
b. Nasal functional anatomy  
c. Nasal deformities  
d. Clinical application of CT to aesthetic procedures of the nose  
2. Preoperative CT image  
a. What should be evaluated: bony pyramid, cartilaginous pyramid, nasal valves, nasal deformities  
3. Postoperative CT image  
a. Surgical techniques and imaging findings: rhinoplasty, septoplasty, rhinectomy, maxillary antrostomy and uncinectomy, nasal turbinate surgery, ethmoidectomy, nasal prosthesis  
b. Complications  
c. Sequels  
4. Take-home messages

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## Abstract Archives of the RSNA, 2023

HNEE-98

### Precision Imaging of Diplopia: MRI Protocol and Various Diseases

All Day Room: Learning Center

Sang Ah Cho (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Diplopia is a relatively common neuro-ophthalmological symptom and has a variety of causes. Here, a high-resolution MRI protocol specialized for diplopia is introduced, and various imaging findings related to diplopia are presented.

#### TABLE OF CONTENTS/OUTLINE

Diplopia MRI should be designed to include the entire pathway of cranial nerve(CN) III, IV, and VI, and the orbit. In general, 3D heavily T2-weighted images or 3D proton-density weighted images are often used for evaluation of the cisternal segment of CNs. However, the cisternal segment of CN4 is so small that high resolution 3D true fast imaging with steady-state free precession (Trufi) is required: a slice thickness of 0.3mm, and a scan range acquired above and below of the junction of inferior colliculus and superior medullary velum in the brainstem (figure 1). For the cavernous segment of CNs, contrast-enhanced 3D T1 Volumetric interpolated breath-hold examination (VIBE) image with fat-suppression allow us to identify normal CNs located therein (figure 2). The anatomical classification of etiologies associated with diplopia can be divided into brainstem lesions (figure 3), cistern (figure 4), cavernous (figure 5), and orbital regions. Causes that can cause diplopia include congenital diseases, vascular lesion, tumor, inflammation, infection, and trauma, etc.

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## Abstract Archives of the RSNA, 2023

INEE

### Imaging Informatics Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **INEE-1 What Will Happen to AI Technology in Radiology? Systematic Review of Natural Language Processing for Radiological Image Processing**

Hina Kotani (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

In recent years, the application of artificial intelligence (AI) technology in the medical field has been advancing rapidly. In radiology, AI technology is expected to improve the accuracy of physician diagnosis through image analysis and automated diagnosis. Specifically, these include automated diagnostic technologies using deep learning and the prediction of patient health status. Many of the technologies that use AI include systems that use Natural Language Processing (NLP). Improvements in NLP models have made it possible to handle not only text data but also image data, and many applications in the medical field have been reported. The purpose of this exhibit is to show the application of NLP model in radiology and our work applying the Vision Transformer to atrial fibrillation types classification. The major teaching points of this exhibit are 1.AI technology in radiology is expected to improve the accuracy of physician diagnosis through image analysis and automated diagnosis. 2.NLP enables the processing and extraction of large amounts of natural language generated in the medical field. 3.How can NLP be used for medical imaging?

##### TABLE OF CONTENTS/OUTLINE

1. AI Technology in Radiology 2. What is NLP? -Familiar Applications of NLP Models -Typical models used for NLP -Examples of Image Applications of NLP Models 3. Introduction to this study -Atrial Fibrillation Types Classification Using the Vision Transformer

#### **INEE-10 Establishing a Radiology Research Laboratory, from A-Z**

Hussain Al Yousif, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

Quantitative image analysis for clinical trials is poorly managed using standard clinical workflows. Radiology Research laboratories standardize the workflows for trials that use imaging endpoints. Radiology Research laboratories can provide more value to support institutional research objectives beyond image interpretation and should be set up to serve as central point of contact for all clinical researchers and medical imaging.

##### TABLE OF CONTENTS/OUTLINE

Defining the problem - addressing the need Value of radiologists and medical imaging personnel at the various stages of clinical research: • Research protocol development • Feasibility assessments • Access to radiologists and technical resources Partnering for success - working with your customers and end users to know what service are needed: • Image review with quality quantitative image assessment • Image transfer • Protocol review • Feasibility assessments • Trial budget development Take advantage of existing institutional core lab infrastructure: • List of provided services accessible via website. • Billing for services • Operations Identify the key components and personnel required for functioning of the lab: • Hardware and software • Personnel Developing a budget and list of provided services. Research lab operational workflow in context of clinical operations Annual reviews, with budget and performance adjustments.

#### **INEE-11 Lung Cancer Screening and AI: Challenges and Opportunities**

Leonardo Rosolen Iunes, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

To discuss the potential role of artificial intelligence (AI) in lung cancer screening (LCS), highlighting: - AI applications in LCS: machine learning versus deep learning strategies - AI limitations in LCS: data collection, reproducibility, generalizability, validation - Responsible AI: fairness, accountability, and transparency - Addressing gender and racial bias in LCS programs - Future perspectives: combining the strengths of radiologists and AI for best LCS practices

## TABLE OF CONTENTS/OUTLINE

1. Introduction a. Ongoing challenges in implementation of LCS b. AI in healthcare: basic concepts 2. AI and lung cancer: an overview a. Screening b. Radiomics and Radiogenomics c. Decision making and prognosis prediction 3. AI in LCS: potential applications a. Early detection b. Nodule classification c. Radiography versus Computed tomography d. Retrospective versus Prospective Studies 4. Limitations and Challenges: AI in the real world a. Bias in underserved and underrepresented populations 5. Responsible AI: transparency and regulation 6. Future perspectives 7. Take home messages

## INEE-12 **AI-Driven Tools and Techniques in Radiology Education: Empowering the Next Generation of Radiologists**

Matteo Mancino, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The integration of AI into radiology education is crucial, as state-of-art AI applications such as deep learning and machine learning are transforming decision making and patient care. Radiology trainees must be well-versed in AI technologies to effectively leverage their potential in delivering value-based clinical practice. The aim of this poster is to provide an overview of AI's role in radiology trainee education, addressing challenges, state-of-art resources and future directions.

## TABLE OF CONTENTS/OUTLINE

1. Curriculum development Building an AI curriculum including ethics, data quality, privacy, and AI's impact on clinical workflows. 2. Interdisciplinary learning: Encouraging trainees to collaborate with other medical specialties to understand AI's broader implications in healthcare. 3. Collaboration Encouraging cooperation between radiology departments, AI experts, and industry partners to develop tailored educational content and resources. 4. Assessments: Leveraging AI for performance assessment in radiology board examinations and multidisciplinary meetings to enhance clinical decision-making skills. 5. AI-augmented education Using AI to provide learning experiences, such as personalized case selection. 6. Barriers and challenges: Addressing barriers to AI education, and developing strategies to overcome these challenges. 7. Future directions: Exploring innovative ways to integrate AI into radiology education, such as AI-driven simulations, virtual reality, and gamification.

## INEE-13 **Generative AI Predicts the Survival of Patients with Progressive Fibrosing Interstitial Lung Disease**

Masaki Okamoto (*Presenter*) Stockholder, TOKYO analytica

## TEACHING POINTS

Progressive fibrosing interstitial lung disease (PF-ILD) is a group of diseases characterized by increasing self-sustaining fibrosis, progressive decline in lung function, and high mortality. Due to the highly variable rates of decline and poor prognosis of PF-ILD, accurate, individualized mortality prediction is crucial for therapeutic decision-making and management of the patients. However, PF-ILD does not have any formal prognosis-based staging system, and none of the developed existing prognostic biomarkers have been considered accurate enough for establishing such a system. The teaching points of this exhibit are to (1) review currently available clinical prognostic biomarkers for PF-ILD, (2) review an emerging generative AI-based biomarker for imaging-based prediction of survival in PF-ILD, and (3) review the comparative performance between the clinical and generative-AI-based prognostic biomarkers in the prediction of the survival in PF-ILD.

## TABLE OF CONTENTS/OUTLINE

(1) Unmet need for accurate prognostic biomarkers for PF-ILD. (2) Clinically established prognostic biomarkers for PF-ILD (gender, age, and physiology (GAP) index; composite physiologic index (CPI); visual high-resolution CT pattern). (3) Radiomic biomarkers (traditional radiomics; hyper-curvature features) for survival analysis. (4) Emerging generative AI-based imaging biomarker (gen2surv). (5) Comparative performance of biomarkers in terms of survival prediction and Kaplan-Meier survival curves. (6) Clinical case studies.

## INEE-14 **AI as a Medical Device: Demystifying FDA Regulation for AI Tools in Clinical Radiology Practice**

Anjali Patel (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Understand the FDA's role in regulating AI radiology tools categorized as software as a medical device. Gain a fundamental understanding of FDA regulations, crucial for algorithm developers and end users to ensure appropriate and optimal use. Distinguish between FDA clearance and different classifications for radiological software as a medical device. Appreciate the importance of various classifications concerning algorithm development, validation rigor, and intended use. Assess the real-world implications of device classifications on the adoption of AI tools in clinical radiology practice. Explore ongoing debates and potential future developments in FDA regulation of AI radiology tools.

## TABLE OF CONTENTS/OUTLINE

Introduction Overview of FDA classifications for AI medical software Class I devices Class II devices Class III devices Discerning intended use and its influence on device classification Motivations behind seeking lower category classifications and potential pitfalls in clinical practice Different category FDA classifications and impact on AI tool adoption and usability in clinical practice Controversial aspects and future optimization of FDA regulation in AI radiology tools Conclusions

### **INEE-15 Streamlining Emergency and General Radiology Reporting Through Customized Macros for Incidental Findings: A Primer and Online Repository**

Jeffers Nguyen, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Modern radiologic practice demands higher volume study interpretation, which may be facilitated by improvements in dictation workflow. There is a large variety of incidental findings that may be made during the course of general, multi-modality, or emergency radiologic practice whose accepted follow-up recommendations may be difficult to recall for general radiologists, or those practicing outside of a subspecialty area. Furthermore, existing solutions to streamline the reporting of incidental findings are cumbersome and require too many clicks or keystrokes to rapidly implement. We present customized, pick list type macros that allow easy selection of up-to-date recommendations for the most common incidental findings that may be encountered in routine practice. We demonstrate how these may be used and provide an online repository from which they may be downloaded and imported for personal use.

## TABLE OF CONTENTS/OUTLINE

1) A brief review of incidental findings; 2) How to create, export, and import pick list macros (PowerScribe); 3) How to use pick list macros (video demonstration); 4) Demonstrating the value of pick list macros for incidentally detected lesions, including adnexal masses, pituitary lesions, pulmonary nodules, liver lesions, pancreatic cystic lesions, renal masses, and more; 5) URL for online repository of macro resources

### **INEE-17 Improving Workstation Ergonomics and Productivity with Input Devices: Saving Time and Your Wrists**

#### **Awards**

#### **Certificate of Merit**

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Discuss the biomechanics and ergonomic factors affecting radiology input devices.- Review common repetitive stress injuries experienced by radiologists caused by input device use.- Systematic product review with pros and cons of popular computer mice, dictation devices and non-traditional input devices (named below) in terms of ergonomics, effectiveness and programmability.- Tutorial on how to customize commonly available input devices with recommended profiles.

## TABLE OF CONTENTS/OUTLINE

Radiologist's productivity and wellness are influenced by tools used to interact with clinical images. Software and hardware can augment efficiency but also have the potential to lead to burnout via poor ergonomics. We review the relevant biomechanics and anatomy involved in using computer mice and dictaphones with review of primary literature and of common repetitive stress injuries experienced by radiologists. We offer alternatives to commonly used input devices (mouse, keyboard, handheld dictaphone) used to review clinical images. We share the factors important in choosing a device (e.g. on-board memory) and the results of a systematic review of devices that could augment radiologists' productivity and improve ergonomics including: A) Pointing Devices: - Gaming mice- Ergonomic mice- Trackballs/Trackpads B) Dictation Devices: - Traditional Nuance PowerMic-style- Wearable headsets- Table-top microphones (e.g. podcasting microphone) C) Non-traditional input devices for example: - Elgato stream deck- Contour ShuttlePro- Contour Roller Mouse Finally, we provide tested templates for the above programmable devices to get a new user started with improving their ergonomics and efficiency in the reading room.

### **INEE-18 Transforming Radiology with Large Language Models: Opportunities and Challenges**

Satvik Tripathi (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Personalizing Imaging Examinations LLMs can guide patients through imaging procedures based on medical history, including preparation and potential risks. Improving Clinical Documentation LLMs can flag discrepancies and provide decision support, improving accuracy and reducing errors in medical records. Streamlining Insurance Prior Authorization LLMs can assist clinicians in submitting complete prior authorization requests and automating insurance review, reducing manual review time. Increasing Patient Engagement LLMs can convert complex medical information into easily understandable language and provide personalized education, increasing patient engagement. Decreasing Barriers to Access to Healthcare: LLMs can facilitate remote consultations, appointment scheduling, and educational resources, overcoming barriers to healthcare access. Security and Privacy Considerations The use of LLMs in healthcare raises privacy and cybersecurity concerns that must be addressed to protect patient data and comply with laws and regulations.

## TABLE OF CONTENTS/OUTLINE

1. Introduction to Large Language Models (LLMs) 2. The Current State of LLMs 3. Compliance and Security 4. Aid in Patient Care 4.1. Personalizing Information for Imaging Examinations 4.2. Decreasing Barriers to Access to Healthcare 4.3. Personalizing Imaging Examinations Resources 4.3. Increasing Patient Engagement 5. Aid in Radiology Workflow 5.1. Automating Routine Tasks (such as appointment scheduling and reminder notifications) 5.2. Facilitating Insurance Prior Authorization 5.3. Improving Clinical Documentation 5.4. Easier EMR Transfer from Different Facility 6. Future Directions 7. Conclusions

## INEE-19 Unlocking a New Era in Radiology: Leveraging GPT for Accurate Diagnosis of Diseases

Matheus Fritzen, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Understanding the role of ChatGPT in radiologic diagnosis through real-world cases; Evaluating the impact of ChatGPT on hypothesis formulation and diagnostic accuracy; Analyzing ChatGPT's role in providing diagnostic tips and guidance; Assessing the potential of ChatGPT for improved clinical decision-making

## TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline: I. Introduction to ChatGPT in Radiologic Diagnosis A. Overview of ChatGPT's capabilities B. The potential for AI-assisted diagnosis II. Case Studies: ChatGPT in Diagnostic Process A. Real-world examples of ChatGPT-enhanced diagnoses B. Hypothesis formulation and diagnostic accuracy improvements III. ChatGPT's Role in Providing Diagnostic Tips and Guidance A. Case examples illustrating diagnostic assistance B. The impact of ChatGPT on radiologists' decision-making process IV. Assessing ChatGPT's Potential for Clinical Decision Support A. Evaluation of case study outcomes B. Implications for radiology practice V. Conclusion A. The real-world impact of ChatGPT on radiologic diagnosis B. Future advancements and integration in radiology practice This abstract presents a series of case studies that demonstrate the practical applications of ChatGPT in radiologic diagnosis, hypothesis formulation, and clinical decision support. The guide provides an in-depth analysis of how ChatGPT can be utilized to enhance diagnostic accuracy, offer diagnostic tips and guidance, and improve clinical decision-making in real-world scenarios. By showcasing the tangible benefits of ChatGPT through these case studies, the presentation aims to highlight the potential of AI-assisted diagnosis in revolutionizing radiology practice.

## INEE-2 Anatomy of an Ontology

David J. Vining, MD (*Presenter*) Royalties, Bracco Group; CEO, VisionSR, Inc; Stockholder, VisionSR, Inc

## TEACHING POINTS

1. Understand the distinction between a taxonomy and an ontology. 2. Comprehend the need for ontologies in medical reporting and electronic records to support interoperability. 3. Survey the strengths and weaknesses of existing medical ontologies applicable to radiology reporting. 4. Learn about an effort to create an ontology that has evolved from the concept of the now antiquated American College of Radiology's Index of Radiological Diagnoses.

## TABLE OF CONTENTS/OUTLINE

1. Define what is a taxonomy and what is an ontology. 1a. Illustrate the concepts of CUI, AUI, TUI, and SUI. 2. Demonstrate why an ontology is important for use in radiology reporting. 2a. Illustrate how an ontology is essential for natural language processing and the creation of mineable, structured data. 3. Provide an overview of the major medical ontologies applicable to radiology reporting, including SNOMED, RadLex, ICD-10, FMA, MedDRA, and others. 3a. Show where there are deficiencies in the major ontologies, including knowledge gaps pertinent to diagnostic radiology reporting. 4. Review the original concept of the American College of Radiology's Index of Radiological Diagnoses and how it was used to create teaching files before the existence of desktop computers. 5. Illustrate how a new ontology is being constructed inspired by the Index of Radiological Diagnoses but in a more pragmatic fashion to accommodate interactive multimedia reporting. 5a. Show cross-mappings between this new ontology and existing ontologies. 5b. Demonstrate the importance of incorporating synoptic phrase for use in radiology reporting.

INEE-20 Ali Ganjizadeh, MD (*Presenter*) Nothing to Disclose

## Using a Workflow Engine to Improve Data Retrieval and Curation in Multi-modal Research Studies

### TEACHING POINTS

1.Introduction to workflow concepts and their importance in research studies2.Overview of the technologies used in the retrieval system: MongoDB, FastAPI, Camunda and NextJS3.Understanding the retrieval system architecture3a.A modular data retrieval browser-based program to collect multiple data types from multiple data sources3b.Setting up a browser-based user interface to create and execute tasks for each subject to retrieve its data from servers4.Handling errors and failures in retrieving data using the workflow engine5.Additional steps in the workflow system, such as de-identification and data storage6.Conclusion and impact of the workflow system on research studies

### TABLE OF CONTENTS/OUTLINE

1.Introduction1a.Overview of workflow systems1b.Importance of workflow-based systems in research studies2.Technologies Used2a. MongoDB2b. FastAPI2c. NextJS2d. Tailwind CSS2e. Camunda3.Workflow System Architecture 3a. Overview of the system architecture3b. Explanation of the workflow engine4.Modular Data Retrieval Program4a. Setting up the program to collect multiple data types from multiple sources4b. Creating tasks for each subject to retrieve data5.Browser-Based User Interface 5a. Designing a user interface to execute tasks for data retrieval5b. Graphical user interface for selecting patients to include in the study6.Handling Errors and Failures6a. How the workflow engine handles errors and failures in data retrieval7.Conclusion and Impact7a. Significance of the workflow system in research studies7b. Lessons learned from the development and implementation of the system

## INEE-21 Use of Chat GPT in Radiology Research

Andrew R. Benza, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Highlight unique and generalizable prompts to leverage large language models in research.- Discuss the art of prompt engineering and key phrases to improve outputs.- Demonstrate the variety of functionalities of ChatGPT and Bing AI Search and how it pertains to research.-Discuss the future of research with AI as a supplemental tool.

### TABLE OF CONTENTS/OUTLINE

1. History of AI.2. New AI systems and their functionalities.3. Prompt engineering and key phrases to leverage ChatGPT.4. Illustrate how ChatGPT can be used throughout the entire research process for example during the following stages: a. Formulate the idea b. Write an IRB proposal c. Design a research study d. Analyze data e. Interpret results f. Prepare publication5. The future of AI and what it means for research/education.

## INEE-22 Beyond Writing and Reporting: Opportunities and Challenges of GPT-based Models in Radiology

Jose G. Maluf, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To learn definitions and basic concepts of generative AI, natural language processing (NLP) and large language models (LLM) applied to healthcare; - To understand the potential impact of generative pre-trained transformer (GPT)-based models in the radiology practice; - To be familiar with some potential applications of GPT-based models in radiology, including image manipulation, report generation, educational support, clinical decision support, and data analysis; - To emphasize the challenges and limitations before implementation of these models in clinical practice, with focus on ethical and regulatory issues.

### TABLE OF CONTENTS/OUTLINE

Introduction: AI in healthcare Generative AI, NLP and LLM: Definitions and Basic Concepts Applications in Radiology Image manipulation and improving Medical writing and reporting Clinical decision support Health insurance and advocacy issues Education Other emerging applications Limitations and Challenges Hallucinations and other common mistakes Privacy, security and other risks on clinical implementation Ethical issues: Transparency, bias and discrimination Regulation Future perspectives: what is next? Take home messages

## INEE-23 Artificial Intelligence: Missed steps and a double edge sword

Anisa A. Chowdhary, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Radiologists should be vigilant and careful as AI can certainly make incorrect diagnosis or miss the diagnosis in certain case scenarios.
- Radiologists should use AI as a secondary adjunct. AI can underperform in specific subset of patients where a radiologist approach is crucial to avoid any diagnostic error.
- AI will continue to serve as a secondary adjunct rather than an alternative to a radiologist.
- AI can certainly help improve work flow and patient care by looking at flagged cases to do a quick triage of which cases to dictate first.

## TABLE OF CONTENTS/OUTLINE

• Introduction • Overview • Missed diagnosis and missed cases by Artificial intelligence • Teaching points

### **INEE-24 How Federated Learning Improves Pancreatic Segmentation Using Three Distributed Training**

Chen Shen (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To learn Federated Learning, a method for learning from several remote datasets without centralized processing. 2. To learn a new robust aggregation method for Federated Learning. 3. To learn the effectiveness of using Federated Learning for pancreatic segmentation.

## TABLE OF CONTENTS/OUTLINE

Why Federated Learning is useful in healthcare applications? - Distinct from natural images, collecting data from various resources may lead to multiple technical, legal, and privacy issues. - Can produce a model with features from several dispersed sources without requiring the training data to be centralized. Demonstrate the pancreatic segmentation process using Federated Learning. - How does Federated Learning work? - How does the server use FedAvg, a standard aggregation method, to aggregate models from multiple clients? - Introduce a dynamic weight aggregation method to aggregate the model updates properly. A comparison of the pancreatic segmentation performance. - Introduce the datasets and the segmentation models. - Compares the performance of Federated Learning over standalone training on three pancreas datasets. - Compares the effectiveness of dynamic weight aggregation with the original FedAvg algorithm. 1. Qualitative evaluation results. 2. Quantitative segmentation accuracy to show the Federated Learning and our proposed aggregation method improve the segmentation performance on pancreas.

### **INEE-25 Achieving Trustworthy Artificial Intelligence in Clinical Applications: A Comprehensive Review of Key Concepts and Solutions in Medical Imaging**

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In this exhibit, radiologists will learn to: 1) Understand why predictive power doesn't ensure AI models' clinical trustworthiness; 2) name and describe methods to explain AI models, quantify their uncertainty, and detect outlier data for their predictions; 3) analyze the clinical trustworthiness of AI models introduced in scientific studies or commercial products.

## TABLE OF CONTENTS/OUTLINE

Problem Statement: Is predictive power (e.g., accuracy) all we need?; A review of scenarios where AI fails in clinical deployment. The Triangle of Trustworthiness: Model explainability; Uncertainty quantification; Out-of-distribution detection. Model Explainability: Can we explain the black box of AI models?; A review of interpretation maps (e.g., saliency maps, occlusion sensitivity, integrated maps, etc.) and their use cases; A review of SHAP values and their use cases; Limitations of model explainability. Uncertainty Quantification (UQ): What is vs. what is not model uncertainty?; Where do we expect AI to be uncertain?; UQ methods (Bayesian methods, evidential deep learning methods, posthoc calibration methods); Pros and cons of UQ Methods. Outlier Detection: Out-of-distribution vs. out-of-domain data: what's the difference?; How can outlier data harm your model?; Potential sources of outlier data (covariate drift, dataset drift, concept drift); a review of outlier detection methods (threshold-based, classifier-based, generative AI-based, distance-based, Nearest-neighbor-based); Pros and cons of outlier detection methods. How to shift gears toward trustworthy AI in radiology? Recommendations for AI developers, scientific journals/reviewers, and end-user organizations/radiologists.

### **INEE-26 From Pixels to Diagnosis: Unleashing the Power of Generative AI in Radiology**

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understand basic concepts of image-based neural networks in radiology. Understand how generative AI models architecture and how they are built and trained on radiological images. Most notable applications of Generative AI in radiology. Impact of Generative AI on radiology practice.

## TABLE OF CONTENTS/OUTLINE

1- Understand basic concepts of deep learning and image-based neural networks. a) What is deep learning? b) How neural networks train and Backpropagation c) The significance of convolutional neural networks d) Dissection of a basic convolutional neural network architecture 2- Understand how generative AI models architecture and how they are built and trained on radiological images. a) generator models architectures b) How are generative models trained to create radiology images? c) Emphasis on CycleGan models d) What are diffusion models and their potential in imaging? 3- Provide examples of current and possible applications of generative AI in abdominal radiology a) Synthesizing CT images from MRI b) Image

segmentation c) Image reconstruction from image space4- Impact of Generative AI on radiology practice with different applications of generative models in abdominal imaging ( image synthesis from noise, CT synthesis from MRI, image reconstruction, segmentation)

### **INEE-27 3D Printing in Pectus Excavatum Surgical Planning**

Mikel Garcia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Pectus excavatum is the most common deformity of the chest wall, characterized by a concave depression of the sternum.- While diagnosis can often be made without imaging, chest radiographs and CT scans can be useful in cases where the diagnosis is uncertain or to assess the severity of the deformity. Haller's index is commonly used in this evaluation. - The Nuss procedure is a minimally invasive technique used to treat pectus excavatum. It involves inserting a metal bar behind the sternum to correct the deformity, with the bar typically being shaped during the operation based on the patient's chest.- By utilizing 3D printing of the patient's chest CT, the bar can be shaped prior to the surgery, which can help decrease the duration of the operation.

#### **TABLE OF CONTENTS/OUTLINE**

- Imaging of pectus excavatum- Nuss procedure- 3D reconstruction and segmentation- 3D printing- Presurgical planning using a 3D printed model

### **INEE-28 Promoting Equitable AI in Radiology: Harnessing Open Source Tools for Bias and Fairness Estimation**

Henrique M. Lee, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Identifying and addressing biases in AI radiology applications is crucial for promoting equitable healthcare and accurate patient outcomes.2. Open-source tools such as AI Fairness 360, Fairlearn, What-If Tool, and Scikit offer tailored techniques for bias estimation and fairness assessment in radiology. 3. Implementing bias mitigation strategies in AI radiology applications can help reduce disparities in diagnoses and treatment recommendations4. Collaborative efforts within the radiology and AI research community are essential for developing robust, up-to-date tools and methodologies5. Integrating multiple tools enables comprehensive evaluations across diverse radiological scenarios and patient demographics.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction - Importance of assessing bias and fairness in AI radiology applications A. Equitable patient outcomes B. Open source tools for evaluationII. Variety of Open Source Tools A. Comprehensive fairness evaluation B. Identification of potential biasesIII. Available Packages for Bias EstimationScikit-fairness/scikit-legoIBM Fairness 360AequitasGoogle What-if toolPyMetrics audit-aiMicrosoft FairlearnIV. Comparison and integration of toolsIV. Assessing Fairness Across Multiple DimensionsA. Demographic attributesB. Clinical attributesC. Mitigating disparities in AI radiology systemsV. Collaboration and Regular Updates A. Engaging with the research community B. Addressing evolving fairness challenges C. Ensuring up-to-date tools and methodologiesVI. Conclusion - The critical role of open source tools for bias and fairness estimation in radiology AI

### **INEE-29 Effective Program Management for an Artificial Intelligence Team: Optimizing Performance and Productivity**

Holly Meyer, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Provide insight on how to effectively build, recruit and manage multidisciplinary teams whose collective goal is to deliver AI solutions to the radiology practice.2. Share lessons learned from the challenges encountered when trying to optimize an AI program management structure.

#### **TABLE OF CONTENTS/OUTLINE**

1. Purpose a. Provide requirements for creating an effective program management structure that optimizes team performance and productivity. 2. Building a Radiology AI Team a. Master FTE Plan b. Job Descriptions c. Roles and Responsibilities d. Org Chart e. Governance f. Recruitment g. Training Education 3. Program/Project Management a. Organization b. Methodology i. Hybrid c. Electronic Tools i. Monday.com ii. Azure Dev Ops iii. Microsoft Teams iv. OneNote v. SharePoint d. Quality Management System (QMS) Compliance e. Meeting Structure f. Communication 4. Lessons Learned a. Challenges b. Successes 5. Conclusion a. Building and managing a multidisciplinary team of individuals whose goal is to deliver AI solutions to the radiology practice in a safe and efficient manner requires careful consideration to the overall program management structure and associated tool sets. PDF Upload \*See attached ppt

### **INEE-3 Generative AI (Gen AI) Based Electronic Cleansing: Unlocking the Potential of Photon-counting CT Colonography**



**Certificate of Merit**

Rie Tachibana, PhD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

Electronic cleansing (EC) plays a crucial role in enhancing the sensitivity of polyp detection during virtual endoscopic fly-through reading in CT colonography (CTC) by subtracting orally tagged residual materials from the images. This exhibit aims to (1) provide insights into recent advances in generative AI (GenAI) based EC for CTC; (2) explore the benefits and potential applications of photon-counting CTC; and (3) present clinical outcomes.

**TABLE OF CONTENTS/OUTLINE**

1. Introduction: Review the history and recent developments in GenAI-based EC for CTC, including the emergence of photon-counting CT technology. 2. How GenAI-based EC works: (2.1) Explain the basic ideas of GenAI; (2.2) Discuss how self-supervised GenAI-based EC differs from traditional EC; (2.3) Explain diffusion-based EC. 3. Photon-counting CT colonography: (3.1) Provide overview of photon-counting CT; (3.2) Discuss advantages and potential applications in CTC; (3.3) Explain Gen AI-based EC for photon-counting CTC. 4. Case studies: (4.1) Compare the image quality and outcomes of various GenAI-based EC techniques in clinical conventional and photon-counting CTC cases; (4.2) Review potential diagnostic challenges.

**INEE-30 Take the Right Path: Overview of Artificial Intelligence Guidelines**

Carlos Felipe D. Reyna, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

Present the different kinds of guidelines. Describe guidelines for development, application and implementation, and evaluation of Artificial Intelligence (AI), created to direct and conduct research in a standardized way, avoiding process errors. To evaluate which of these guidelines is more useful for a specific interest.

**TABLE OF CONTENTS/OUTLINE**

Describe and compare such guides in terms of: purpose and format. Which contexts they fit using flowcharts and schematic images.

**INEE-31 Federated Learning - Game Changing AI Concept to Train AI without Sending Patient Data Out from Hospitals**

Yuqiao Yang, MS (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

(1) To understand the concept of federated learning to address data security and privacy concerns. (2) To learn the application and advantages of federated learning for liver tumor segmentation in hepatic CT. (3) To study the process of the development and performance of federated learning with a patch-wise massive-training artificial neural network (MTANN) model for liver tumor segmentation.

**TABLE OF CONTENTS/OUTLINE**

A. Introduction to Federated Learning - Challenges in acquiring extensive training datasets for a deep learning model from multiple hospitals - Role of federated learning in collaborative learning without sharing data - Issues of federated learning: 1) small local training data, 2) high computational demands, and 3) heavy network loads B. Federated Learning for Tumor Segmentation in Medical Imaging - Overview of federated learning models and their applications to tumor segmentation in medical imaging - Federated learning coupled with MTANN models for addressing the above three issues of the current federated learning C. Clinical Relevance and Performance of Federated Learning for Tumor Segmentation - Ensuring data privacy while achieving accurate tumor segmentation - Performance of federated learning for tumor segmentation - Comparisons with the current-state-of-the-art model and "gold-standard" centralized training model

**INEE-32 Use of Generative AI for Non-interpretative Tasks in Radiology**

Vinit Baliyan, MBBS, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

1. To provide an overview of the current state-of-the-art in generative artificial intelligence (AI) and its applications for non-interpretative tasks in radiology. 2. To showcase examples of how generative AI is being used in radiology today. 3. To highlight the challenges associated with using generative AI in radiology. 4. To touch upon the potential future developments in the field of generative AI and their potential impact on radiology.

## TABLE OF CONTENTS/OUTLINE

1. Introduction to Generative AI Key concepts and applications 2. Specific ways in which generative AI can be used used in for non-interpretative tasks in radiology, including: a. Reporting; checking grammar and syntax, generating summary, making reports more readable for non-specialists/patients b. Communication of important findings c. Managing work scheduled. Writing emails 3. Real-world examples of how generative AI has been used to enhance the accuracy and speed of radiological diagnoses 4. Challenges associated with using generative AI in radiology, including Data privacy and security concerns, Ethical considerations, The need for human oversight 5. Potential future developments in the field of generative AI and their potential impact on radiology Conclusion: Overall, the exhibit aims to educate and inform visitors about the latest advances in generative AI and its potential applications in radiology. By providing real-world examples and highlighting the challenges associated with using generative AI in radiology, the exhibit offers an opportunity for visitors to learn about cutting-edge technology that could help improve the efficiency of radiologists, ultimately benefiting patients and medical professionals alike.

### INEE-33 R Programming Language Basics for Radiologists

Srinivas Kolla, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Learn how to install R 2. Know how to import and process data 3. Run common statistical tests 4. Explore and understand large datasets better

## TABLE OF CONTENTS/OUTLINE

The R programming language serves as an invaluable resource for managing and analyzing large datasets effectively and efficiently. As a free and open-source software, R presents a cost-effective solution for performing common statistical tests, crafting visualizations, and even implementing machine learning algorithms. Exhibit Outline: Software installation: -Installing the R programming language -Setting up an Integrated Development Environment (IDE) -Installing essential packages Data import and processing: -File handling and manipulation -Data cleaning and preprocessing -Data transformation and aggregation Common statistical tests in radiology: Sample code and examples for: - Descriptive statistics -T-test -Analysis of Variance (ANOVA) -Pearson's correlation coefficient -Spearman's rank correlation coefficient -Chi-square test -Logistic regression and more. Large dataset analysis: -Data visualization techniques - Exploratory data analysis (EDA) -Machine learning and predictive modeling -Text mining and natural language processing (NLP)

### INEE-34 Leveraging Medical Image Annotation with Practical Annotation Quality Check Tools

Henrique M. Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Prepare the data for an artificial intelligence (AI) models often involves intensive annotation work to ensure accurate ground truth. However, radiologists who participate in AI projects may lack practical training in annotation, leading to doubts that increase the variability of annotations. To address this, we developed an automated tool that evaluates bounding box and segmentation annotations and provides feedback to the annotator. The tool uses .json files for bounding box annotations and NifTYP files for segmentation annotations, both exported from 3D Slicer. Python scripts compare the locations and categories of findings in the bounding box annotations, as well as the distance and similarity of binary masks in the segmentation annotations with those generated by experts. Results are presented in an HTML report. In a pilot study, we used 5 chest radiographs and 2 head CT scans from publicly available datasets (Montgomery and CQ-500) previously annotated by experts. The availability of reports in an introductory AI course for medical radiologists allowed instructors to monitor participants' progress and identify areas for further emphasis.

## TABLE OF CONTENTS/OUTLINE

Our workflow resulted improved the overall quality of instruction, enhancing the professionalism of the annotations. Annotation tools can increase student engagement and productivity, with teacher supervision facilitating consensus-building and optimizing the laborious task of annotation. Our solution can be applied to various 2D and 3D images studied by radiologists. User-friendly applications that facilitate the teaching of high-quality image annotation are crucial for fostering the development and validation of novel AI models.

### INEE-35 Automatic Detection of Contrast Enhancement in T1-weighted Brain MRI Images Using Artificial Intelligence

Victor G. Martins, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: . Development and validation of a tool for post-contrast enhancement detection in T1-weighted MRI images. . Implementation of this tool in the clinical routine of the radiology and diagnostic imaging service of Clinical Hospital of Ribeirao Preto.



## TABLE OF CONTENTS/OUTLINE

The use of magnetic resonance imaging (MRI) in medical practice is extensive and encompasses the diagnosis of multiple conditions such as neoplasms, infections, inflammatory diseases, among others. In these contexts, the analysis of post-contrast enhancement is essential. The detection and quantification of enhancement in T1-weighted cerebral MRI images is a challenging task due to the complexity of the images and the variability in the appearance of contrast enhancement. Artificial intelligence (AI) techniques have the potential to improve the efficiency and accuracy of this process, but the development and evaluation of AI-based approaches for this purpose is a laborious task.

### **INEE-36 A Practical Primer on the Radiomics Quality Score: How to Interpret the Results of Radiomics Studies**

Mohammad Mirza-aghazadeh-Attari, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiomics quality scores are used to assess the quality of radiomics studies and are based on a set of criteria related to study design, image acquisition, segmentation, feature extraction, and statistical analysis. The purpose of a radiomics quality score is to provide a standardized method for evaluating the quality of radiomics studies and to aid in the interpretation and comparison of study results. Interpreting a radiomics quality score involves understanding the specific criteria used to evaluate the study and the scoring system employed. Typically, a higher score indicates a higher quality study that is more likely to produce reliable and reproducible results. It is important to note that a radiomics quality score is just one factor to consider when evaluating the results of a radiomics study. Other factors such as sample size, patient demographics, and clinical relevance of the results should also be taken into account. Ultimately, the interpretation of radiomics study results should be made in the context of the specific clinical question being addressed and in consultation with a radiologist or other medical expert. Here we present a step by step approach to understanding and applying the RQS.

## TABLE OF CONTENTS/OUTLINE

1- Radiomics Quality Score: A short introduction on its History 2- Methodologic considerations covered in RQS: - 2.1 Extraction of features -2.2 Development of predictive models and classifiers - 2.3 Performance evaluation of models - 2.4 Utility considerations 3- Reporting RQS results 4-Applications of RQS in clinical practice and research 5-Prospectives to enhancing RQS: RQS V2 6- useful tools

### **INEE-37 From Models to Masks, Barriers to Roadblocks, Posters to Presentations: Experience in Forming Cross Institutional Collaborations for Artificial Intelligence Research**

Nader A. Refai, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review of key collaborations necessary for AI related research. 2. Review of potential roadblocks and barriers during project creation and execution. 3. Infrastructure considerations needed for a successful project.

## TABLE OF CONTENTS/OUTLINE

-Review of key collaborations which facilitate AI research--Domain Experts---Subspecialty radiologist involvement---Trainee involvement (resident/medical student)--AI Expertise---Programmers, data scientists--IT support--Graduate Students--Potential Roadblocks and Barriers--IRB and Data use agreements--DICOM de-identification at scale--De-identified DICOM storage--Image transfer between institutions--EHR data extraction at scale--Infrastructure considerations needed for a successful project.--Image or Data labeling---Example of open-source solutions for DICOM labeling/masking--GPU processing for model creation and testing--Project Management--Conclusion/Summary

### **INEE-38 Imaging Feature as a Function: A Novel Radiomics Framework**

#### Awards

#### Certificate of Merit

Nicolo Gennaro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiomic features exhibit functional correlation with tumor size. Large datasets of pre-treatment scans of liver metastasis can uncover the functional association between tumor size and heterogeneity, providing potential insights into tumor growth and treatment. Harmonization allows to remove scanner-associated effects while preserving cancer-specific functional dependence. Texture features show functional size-dependence that allow to generate delta-radiomics data by utilizing post-treatment imaging data only.

## TABLE OF CONTENTS/OUTLINE

Introduction: Size measurement is a critical task for radiology and represents the pillar of response assessment to antitumor therapies. Size-dependence of radiomic features: We illustrate why radiomics features are affected by tumor size and how radiomic features might not be comparable even within ROIs of the same tumor but manually delineated by different operators. Harmonization in radiomics: The importance of feature harmonization to remove scanner-related biases and preserve size-dependence. Response Assessment: How size-dependence of texture features can be exploited to obtain delta-radiomics without baseline imaging.

### **INEE-39 The Comprehensive Open Federated Ecosystem (COFE): Enabling Impactful Healthcare Studies**

Sarthak Pati, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

There is a growing body of literature offering evidence of the potential impact that artificial intelligence (AI) methods can have on healthcare. To ensure robustness evaluate generalizability of AI methods, ample diverse multi-site patient datasets are desired. However, there are various factors that hinder access to such data in the current paradigm of multi-site collaborations, which include the tedious bureaucratic processes, data ownership concerns, legal considerations reflected in patient privacy regulations. To tackle these issues, we introduce the community-driven Comprehensive Open Federated Ecosystem (COFE), which includes multiple open-source software tools to make distributed healthcare AI more accessible by leveraging zero/low code principles to get models to learn across data silos using Federated Learning (FL), to evaluate their performance on diverse datasets that they were not used to train with using Federated Evaluation (FE). The goals of the exhibit are to: broaden the understanding of the general community regarding FL FE, showcase how a user can leverage FL to train a model across various sites, present results of the first real-world federation across 71 collaborating sites, focusing on brain tumors, discuss privacy data protection concerns how COFE hopes to solve it, showcase how a user can leverage FE to generate generalizable statistics for AI methods.

## TABLE OF CONTENTS/OUTLINE

This exhibit will present a community-driven open-source ecosystem to train evaluate AI models across multiple clinical sites in a data-private paradigm. Specific principles to protect data privacy will be described, along with common pitfalls to avoid when performing FL-based studies.

### **INEE-4 Data Curation in Minutes not Days: Efficient Large Scale Dataset Preparation for Machine Learning Applications in Kaapana**

Stefan Denner (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In the era of rapidly growing medical imaging datasets and federated learning, efficient management and processing of medical images is crucial. Current medical image viewers, however, lack the capability for large-scale dataset curation. To address this, we introduce a data curation tool integrated into the Kaapana open-source framework, designed to streamline organization, management, and processing of extensive medical imaging datasets. Radiologists can easily filter for metadata, annotate and structure datasets, visualize dataset distributions, and quickly inspect individual studies. State-of-the-art machine learning algorithms, such as body part regression, nnUNet, and TotalSegmentator, can be applied to automatically annotate studies based on algorithm outcomes, which can accelerate the curation workflow by allowing filtering for specific organs, bone structures and body parts. This tool fosters collaboration between multidisciplinary teams, with machine learning researchers creating algorithms to support radiologists, who in turn annotate and curate the data. In conclusion, the proposed tool offers an intuitive interface for radiologists to efficiently curate datasets for use in machine learning algorithms.

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Data Curation Tool 2.1. Features 2.2. Metadata Annotation 2.3. Structuring Visualization 3. ML Algorithm Integrations 4. Conclusion Future Directions

### **INEE-40 Beyond the Hype: The Power of GANs in Restoring MRI Texture**

#### Awards

##### Certificate of Merit

Kensuke Umehara, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Generative adversarial networks (GANs) are one of the deep learning-based image generation models that have been widely used in medical imaging research, such as modality conversion and data augmentation. However, their application in diagnostic imaging is still met with resistance due to the perception that "GANs easily generate fake images." On the other hand, it is not widely known that with proper model selection and training, GANs can be a useful tool for generating high-

quality images from low-quality ones. The teaching points of this exhibit are to 1) provide an overview of GANs using supervised learning, 2) showcase the application of one of the representative supervised GANs, super-resolution GAN, to MRI images, achieving high-quality imaging while enabling short-time imaging, and 3) demonstrate the high-accuracy restoration of the texture of MRI images by applying super-resolution GAN.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Super-resolution GAN for Accelerating MRI 3. Radiomics Analysis 4. Clinical Showcases

### **INEE-41 Accelerating Machine Learning for Medical Imaging by Integrating AIM and AI Federated Learning into Clinical Workflow**

Pattanasak Mongkolwat, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. The incorporation of Annotation and Image Markup (AIM) and AI Federated Learning (FL) framework into an imaging workflow can expedite the creation of deep neural network models without compromising the confidentiality and sharing of imaging data. Furthermore, this integration can standardize the creation of annotations for supervised or semi-supervised deep learning approaches in annotated images. 2. Integrating an AIM image annotation tool into clinical workflows can speed up the process of creating annotated images based on an AIM template. The user wants to make simple and constrained annotations. The annotation results can be stored as an AIM XML document, JSON object, or DICOM SR PS3.21 object. Combining the AIM information with corresponding image can facilitate the development and training of multimodal deep learning models. 3. The proposed software tools in this framework simplify the setup and usage of FL and enable the creation of standardized annotations, allowing radiologists and AI researchers to focus on data quality and deep learning model development.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of AIM, AI Federated Learning, and Multimodal Deep Learning 2. Imaging Workflow Architecture and Tools: modified ePAD, Fuji Synapse (example integration), DICOM anonymizer, Mini-PACS, AIM database, AI image inference, cohort creator, image and AIM staging location, Cohort worklist, DICOM reader, AIM transform, FL Web Admin Management, web-based AIM template builder. 3. Framework and Software Tool Requirements 4. Installation and Configuration Guide for Participating Institutions 5. Preparing Your DL Model and Data for AI Training 6. Live and Video Demonstration of the Installed Environments

### **INEE-42 AI-assisted Decision Making for Prostate Cancer Diagnosis**

Chacha Chen, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The interpretation of prostate multiparametric MRI is challenging. Up to 30% of clinically significant cancers (PCa) are missed even by expert, and there is large inter-reader variation. Artificial intelligence (AI) shows promise in diagnosing PCa using MR images. To leverage the power of AI, it is crucial to determine if AI can assist radiologists in the diagnostic process and if radiology trainees can learn from AI-generated insights. We trained a state-of-the-art AI model (nnUnet) on a large-scale MRI dataset for PCa diagnosis. We have developed a web-based system for interactive and learning resources, incorporating the AI. This system assists radiologists in PCa diagnosis by providing AI-generated predictions (lesion maps). With this information at their disposal, radiologists make their own predictions and annotations using our web application. We will compare the diagnostic performance of human-only, AI-only, and human+AI. We will also examine the interaction between radiologists and AI to inform better teaching processes. Ultimately, we hope the tool will improve radiologists diagnostic performance and patient outcomes by leveraging the power of AI.

#### **TABLE OF CONTENTS/OUTLINE**

Preliminary teaching results on simple AI assisted reader tasks. An AI model (nnUnet) trained on PI-CAI dataset: mpMRI images - T2W, DWI/ADC, DCE for human-only reader performance (we random sampled 80 cases for testing purposes). AI-assisted decision making: AI predicted lesion maps. Annotation tool: radiologists annotate prostate cancer with AI assistance at their disposal. Assessment: the performance of human-only, AI-only, and human+AI will be analyzed to generate insights to improve the task performance and teaching.

### **INEE-43 Harnessing AI for Improved Workflow in Radiology: Beyond Image Analysis**

Kevin Pierre (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

AI can be employed in numerous aspects of the radiology exam's electronic roundtrip, extending beyond image interpretation. This technology holds the potential to increase efficiency, reduce unnecessary scans, improve image quality and patient safety, and expedite the interpretation process. AI assisted reporting has tremendous potential to enhance practice and efficiency. By leveraging AI in these areas, healthcare professionals can save time and resources while enhancing the overall quality of patient care.

## TABLE OF CONTENTS/OUTLINE

1) Introduction  
2) AI Applications Prior to Image Acquisition • Scan Ordering Optimization • Pre-exam Screening • Protocols Scheduling  
3) AI Applications During Image Acquisition • Patient Positioning • Contrast and Radiation Dosimetry • Scan Time Reduction • Image Reconstruction and Postprocessing  
4) AI Applications Following Image Acquisition • Worklist Prioritization • Urgent Finding Notification • Hanging Protocol Optimization • Assisted Reporting  
a) Next generation reporting  
b) AI-generated preliminary reporting  
5) Other Applications • Resident Education • Quality Assurance and Patient Safety • Billing and Compliance  
6) Conclusion

### **INEE-44 Designing and Implementing a DICOM Collector for Analytics, Quality Improvement, and Regulatory Compliance**

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Understand the magnitude of DICOM data and architecture necessary to handle such large volumes, 2) Describe the utility that can be derived from DICOM data through additional applications, 3) Understand the pitfalls of naively scraping data without expert input

## TABLE OF CONTENTS/OUTLINE

1) What are you collecting and why?, 2) How much data are we talking about?, 3) what kind of architecture do you need?, 4) You collected it, now what do you do with it? (applications), 5) Why is a team necessary for what database - seems like a summer project for a graduate computer science student?, 6) Does use justify the effort expended?

### **INEE-45 NCI Imaging Data Commons: Towards Transparency and Reproducibility in Imaging AI**

Andriy Fedorov, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

NCI Imaging Data Commons (IDC) is a cloud-based repository of publicly available cancer imaging data co-located with analysis and exploration tools and resources. IDC, part of the NCI Cancer Research Data Commons (CRDC), provides secure access to a large, comprehensive, and expanding collection of cancer research data. IDC uses a combination of commercially available (Google Cloud Platform (GCP), Amazon Web Services (AWS)) and open source components. The IDC portal (<https://imaging.datacommons.cancer.gov>) and SQL interface enable exploration and visualization of data and cohort building. As of Spring 2023, IDC hosts over 40 TB of radiology and digital pathology image data encoded using the DICOM standard, and available in both GCP and AWS. While the IDC is intended for cloud-based data processing, data can be freely downloaded for on-premise analysis. Cloud-based workflows enable reproducible analysis and results. We will present the scope and status of IDC (e.g., new datasets and features), learning resources (e.g., interactive notebooks with reproducible AI workflows applied to the data within IDC), use cases (including those demonstrating large scale time- and cost-efficient analysis workflows) and plans for future development, along with live interactive demonstrations.

## TABLE OF CONTENTS/OUTLINE

Overview of CRDC and IDC; Data curation and the role of The Cancer Imaging Archive; Portal; Viewer; Organization of data; Integration of tools; Use case development; Documentation and user support resources; Large scale computing using CRDC Cloud Resources; IDC cloud credit program; Status update and plans for future development.

### **INEE-46 Image-to-text and Text-to-image Models: A Primer for Radiologists**

#### Awards

#### Certificate of Merit

An Ni Wu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review key concepts of neural network models connecting text and images;  
2. Discuss potential applications of image-to-text and text-to-image models in medical imaging;  
3. Illustrate key components involved in zero-shot prediction models;  
4. Understand the overall design and architectures of text-to-image models;  
5. Discuss future directions applicable in radiology.

## TABLE OF CONTENTS/OUTLINE

1. Trend: groundbreaking emergence of neural network models connecting text and images.  
2. Relevance for radiology: a discipline connecting text reports with medical images.  
3. Illustration of key components involved in zero-shot prediction models: text vectorization, image vectorization, vector-space, attribute predictions, image attribute mapping, text classifier, and zero-shot prediction.  
4. Illustration of recent models connecting image to text (i.e., CLIP) and text to images (i.e., DALL-E, Stable Diffusion, Imagen).  
5. Architecture of CLIP and key messages: convolutional neural networks for text and image encoding, dataset classifier creation, zero-shot prediction model, transfer learning, natural language supervision,

generalization, efficiency, flexibility, and limitations.6. Applications of text-to-image models in radiology: image classification, automated caption generation, synthetic image generation.7. Future directions: new applications in radiology and technical innovations.

## **INEE-47 Rapid Clinical Deployment of AI Applications for Radiology Using Mercure - An Open Source DICOM Orchestration Platform**

### **Awards**

#### **Cum Laude**

James O'Callaghan, PhD, MEng (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The aim of this presentation is to inform the audience of available open-source software that can be used to rapidly integrate Radiology Artificial Intelligence (AI) applications into their clinical infrastructure. We will outline the need for software tools to address practical challenges in translating medical imaging research techniques into real world settings. This will be followed by a description of DICOM orchestrators and how they can help to bridge this gap by handling interactions and requirements of clinical environments. Mercure - an open-source and freely available DICOM orchestrator, will be used to demonstrate how attendees can easily integrate AI applications into their clinical workflow using an intuitive web-based user interface. MONAI (Medical Open Network for Artificial Intelligence) is a popular open-source framework for medical imaging AI. In the concluding section, we will give guidance on how MONAI can be used with Mercure to deploy AI applications for Radiology in a rapid and standardized manner.

### **TABLE OF CONTENTS/OUTLINE**

1. The increasing demand for Artificial Intelligence in Radiology 2. Challenges in clinical translation of AI 3. Integration of AI applications into clinical environments using Mercure 4. Standardization and rapid deployment of AI applications

## **INEE-48 AI Adoption in Clinical Practice: A Practical Guide for the Practicing Radiologist**

Kevin Pierre (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- There is an increasing number of commercial AI algorithms. However, the actual value and useability of these algorithms requires more than evaluation of diagnostic performance metrics alone.
- We will review and provide practical suggestions for radiologists to use when evaluating AI software for their clinical practice.
- We will discuss important practical barriers that should be considered in order to properly assess useability and seamless integration into radiological practice.
- We will discuss pitfalls and opportunities for the use of AI to enhance clinical practice, including efficiency.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Discuss basic diagnostic metrics, relevance, and why diagnostic performance alone will not ensure impactful adoption 3. Importance of seamless workflow integration and avoiding pitfalls a. Time to image processing and transfer to viewer b. Pitfalls for algorithms requiring expert-viewer interactions c. AI data transfer and reporting module 4. Importance of seamless workflow integration: Opportunities a. Review increasing number of report augmentation and semi-automated reporting tools providing opportunities for reporting efficiency b. Future areas of efficiency improvement 5. Algorithm testing and deployment challenges and opportunities 6. Non-interpretive AI applications 7. Conclusions

## **INEE-49 Prompting Language Models 101: A Primer for Radiologists**

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Large language model (LLMs) inception was four years ago; however, the advent of ChatGPT provides a unique user experience, showcasing the power of LLMs. Although the chat interface is exceedingly helpful, some nuances exist in creating a correctly structured prompt for a better answer, with less back and forth. This exhibit will cover three main points: 1. Introduction to Language Models 2. The Importance of Prompting 3. Popular Prompting Strategies

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to Language Models: This section covers large language model basics. What makes them a significant breakthrough in the natural language processing domain? We will focus on some of the applications of LLMs in radiology, specifically in report structuring. 2. The Importance of Prompting: The chat interface of LLMs, like ChatGPT, can cover many personal use cases. On the contrary, this interface may not be helpful for automated information extraction. Additionally, using open source LLMs (as an alternative to ChatGPT, which requires sending data outside of the institution), requires proper prompting to guide the LLM to output the desired results with only one question asked. 3. Popular Prompting Strategies: This section will cover three main prompting strategies: (a) zero-shot prompting, (b) few-shot prompting, (c) chain-of-thought

prompting. We use the example of abstracting cervical vertebral fractures from radiology reports. We will provide examples of the model's output based on each prompt to give a better understanding of the importance of prompt engineering.

## **INEE-50 Further Possibilities of Deep Learning in the Ultrasound Field**

Gakuto Hirano (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

In recent years, deep learning technology has become a necessity in the medical field. These technologies have been widely used in mammography, CT, and MRI in clinical applications. In the ultrasound field, a wide range of techniques using deep learning, such as noise reduction and automated detection, have been reported. However, it is clear that deep learning is still in its developing stage compared to other modalities. Why is this? The purpose of this exhibition is to describe the current situation, challenges, and future possibilities of deep learning applications in the ultrasound field. As an example of research using deep learning, we will go into deep learning in the ultrasound field from our research on carotid plaque region extraction and composition differentiation using ultrasound images. The major teaching points of this exhibit are: 1. Introduction of research on deep learning in the ultrasound field 2. Current situation and challenges of deep learning in the ultrasound field 3. Future possibilities with deep learning

### **TABLE OF CONTENTS/OUTLINE**

1. Current situation of AI application to the ultrasound field -Noise Reduction -Segmentation -Classification 2. Introduction of our study 3. Potential AI applications in the ultrasound field

## **INEE-51 How Nationwide Medical Image Database and AI-based Image and Finding-text Analysis Work for Nation-wide Disease Spread Surveillance: Three years of experience on CT Image-based COVID-19 Monitoring**

Kensaku Mori, PhD (*Presenter*) Research Grant, Cybernet Systems Co, Ltd; Intellectual Property, Cybernet Systems Co, Ltd; Research Grant, J Morita Corporation; Intellectual Property, J Morita Corporation; Developer, J Morita Corporation

### **TEACHING POINTS**

- To understand how nation-wide medical image database works for nationwide disease surveillance using AI-based medical image and finding-text analysis- To understand how national medical image database collects medical images from participating hospitals- To understand how AI analyzes national medical image database on a cloud computing platform- To understand what kind of data are stored on national medical image database- To understand how COVID-19 infection spread monitoring are performed on national medical image database

### **TABLE OF CONTENTS/OUTLINE**

National medical image database- National Institute of Informatics, Japan, hosts the National Medical Image Database (NII-MID).- Participating hospitals automate daily image transfers to NII-MID.- AI-image and findings-text analyses are performed on incoming medical images.- Daily analysis utilizes AI-based methods.COVID-19 surveillance using CT images- AI -based (Convolutional Neural Network) analysis of CT images following RSNA COVID-19 CT scan classification guideline for images sent to NII-MID.- Automated data selection of CT images for analysis from NII-MID, using findings-texts.- COVID-19-related word analysis from findings-texts.- Calculation of daily COVID-19 suspicious image rates from data transfers.- Three years of experience monitoring COVID-19 cases through NII-MID.- Demonstrating the relationship between COVID-19 suspicious CT image rates and the daily number of COVID-19 related deaths.Future outlook- Expanding the functionality of NII-MID as a nationwide disease monitoring tool.- Broadening the scope of AI-based analysis targets.- Preparing for the prediction of the next unknown pandemic.

## **INEE-52 Advanced and Versatile AI System for 3D Medical Image Super-resolution**

Tong Zheng (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Gain an understanding of the concept of super-resolution (SR) and the differences between SR in RGB color images and medical images. 2. Identify the main challenges involved in performing SR on medical images. 3. Learn about a specialized AI system designed to overcome these challenges in medical image SR. 4. Explore the exceptional performance of our SR AI on two medical image datasets and its potential in aiding radiologists' diagnoses.

### **TABLE OF CONTENTS/OUTLINE**

1. AI-based super-resolution (SR): fundamental concepts -SR is a technique that enhances the resolution of an image. -In medical imaging, SR can help radiologists observe precise anatomical structures in low-resolution (LR) images. 2. Challenges of medical image SR -AI for RGB image SR is typically trained using LR-high-resolution (HR) image pairs. - It is difficult to use AI for medical images' SR: LR and HR medical images are often acquired from different devices or scanning conditions. 3. Our specialized AI for medical image SR -We use a real-time registration network to minimize coordinate differences between LR and HR images. -We use a pre-trained generative model to minimize differences in intensity and scanning devices. 4. Two



original medical image datasets to validate our SR AI -Dataset-A: micro CT (HR) - clinical CT (LR) dataset. LR-HR images differ in intensity, coordinate, and scanning device. -Dataset-B: Brain MRI dataset. LR-HR images differ in coordinate. 5. Radiologists' diagnostic process is aided by our SR AI -Our AI successfully performed SR on both medical image datasets, making it easier for radiologists to observe precise anatomical structures and make diagnosis. -Statistical analysis showed that our AI outperformed other recent AIs.

### **INEE-53 Preparing for the (Un)Expected: Preventing Ransomware Attacks Before They Happen**

John Gaede (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Cyberattacks continue to be one of the toughest problems and biggest threats to have hit the healthcare industry in recent years. When hackers gain entry into a hospital's computer network, not only are the hospital operations, financials and data in jeopardy, but there is a direct threat to patient care and safety. As reported by SOPHOS, 34% of hospitals were hit by ransomware in the last year alone. With many hospitals expanding their digital landscape to include cloud computing, telemedicine and remote work, the vulnerability of being a target of an attack remains a risk. Sky Lakes Medical Center fell victim to a ransomware attack in October 2020. In this session, the director of information systems will discuss how his team was able to successfully recover 650 servers and 150 applications in just four weeks' time. He will share best practices of lessons learned and outline the necessary infrastructure and technology systems to have in place so other organizations can prevent disaster before it happens and ultimately help to reduce the number of ransomware attacks in healthcare.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Ransomware numbers within healthcare 3. Top vulnerabilities within healthcare organizations 4. Necessary informatics, infrastructure, and technologies to have in place 5. Key priorities and step by step on how to recover if it does happen to you 6. Conclusion

### **INEE-54 Collaborative Development of a PACS-Integrated Quality Control Dashboard : A Single Institutional Experience**

Vijaya K. Kosaraju, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) Designing and implementing a Technologist Quality assessment (Tech QA) dashboard that is integrated with PACS (2) Determine the appropriate QA metrics over a period of time to set up the baseline and target areas for improvement (3) Design a way to deploy the right interventions and measure the resulting response (4) Analyze the intervention response to measure improvement over baseline as a way to improve patient care and radiologist satisfaction.

#### **TABLE OF CONTENTS/OUTLINE**

(1) Introduction to Tech QA (2) How we did it over time (3) Developing the current PACS integrated QA system (4) Challenges associated with implementation and deployment a) Challenges in the backend b) Challenges to educate radiologists and technologists c) Make an efficient path for review of the QAs d) Design a closed feedback loop for efficient processing (5) Initial results of the Tech QA process (6) Interventions deployed as a result of baseline metrics (7) Analyzing the results of the interventions (8) Conclusion (9) Future goals

### **INEE-55 Programmatically Generating Radiology Report Fields to Facilitate Structured Reporting Utilizing RadElements.org**

Andrew A. Gomella, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-A significant barrier to adoption of structured reporting and use of standardized data elements is the need for each element/concept to be manually created within individual institution's production reporting software-The ability to programmatically create complex report fields and templates helps reduce the barrier to entry-With a relatively short python script the entirety of the RSNA/ACR RadElement.org common data element library can be converted to Powerscribe macros, which can be dragged-and-dropped into reports or batch loaded into the dictation system for department wide use

#### **TABLE OF CONTENTS/OUTLINE**

1. Motivation for creating a programmatic interface for generating radiology report fields and reports 2. Reverse engineering the structure of a standard radiology report file (from Powerscribe) 3. Approach to generating the report fields and templates in python utilizing XML (Extensible Markup Language) and raw text functions 4. Generating autotext snippets for use in reports from RSNA's radelement.org 5. Demo of drag and drop functionality adding rad elements or rad element sets to a report template

### **INEE-56 How Graph Neural Network Works for Automated Nomenclature of Abdominal Blood Vessels**

Kensaku Mori, PhD (*Presenter*) Research Grant, Cybernet Systems Co, Ltd;Intellectual Property, Cybernet Systems Co, Ltd;Research Grant, J Morita Corporation;Intellectual Property, J Morita Corporation;Developer, J Morita Corporation

### TEACHING POINTS

- To understand what is graph convolutional network (GCN)- To understand how GCN is applied for vasculature nomenclature- To understand automated nomenclature performance by GCN- To understand anatomical annotation for 3D blood vessel regions by GCN-based automated nomenclature

### TABLE OF CONTENTS/OUTLINE

Introduction- The importance of automated vasculature nomenclature as a key function in future CAD systems.- Enhancing CT image reading workflow with automated vasculature nomenclature.- Overview of abdominal vasculature systems and their anatomical names.Spectral based graph convolution and graph convolutional network- Review of the theoretical aspects of Graph Convolutional Networks (GCN).-Review of spectral-based graph convolution operations in GCN and their computer implementation.How to apply GCN for automated nomenclature of abdominal blood vessels- Extracting blood vessel tree structures from CT images.- Feature extraction from tree structure.- GCN training methodology.- Automated nomenclature using GCN.Experiments- Configuration of training data.- Annotation of training data.- Evaluating nomenclature performance.- Automated annotation of 3D-rendered blood vessels based on automated nomenclature.- Performance changes for different convolutional areas.Discussion- Limitations of GNN-based automated nomenclature for blood vessels.- Enhancing radiological and surgical readings of CT images with automated nomenclature.- The effectiveness of automated nomenclature in constructing symbolic logic-based CAD systems.

### INEE-6 Designing a Radiomics study: Hurdles and Pitfalls

Adarsh Ghosh, MD, MBBS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Radiomic studies are complex, requiring a unique trial design, data preparation, informatics tools, and infrastructure.2. Radiomic studies are often designed to be hypothesis-generating rather than to answer a hypothesis. This difference in study design requires researchers to identify key comparative data such as patient outcome or histologic diagnosis before the study begins.3. Because radiomics is still a nascent field of imaging research, there are unique challenges and potential pitfalls at every step of the research process.

### TABLE OF CONTENTS/OUTLINE

Radiomics 101 Tools needed to perform a radiomics study Steps of a radiomics study Asking the right questions: -- Is there clinical value? -- Finding the right comparative measure Data curation: the curse and blessing of electronic medical records Imaging data: -- Not all data is created equally: Data Preparation -- Managing multi-institutional data Image segmentation: - - So many circles, so much time -- Managing multiple series Feature extraction: IBSI and open source -- Pyradiomics and more Data modelling: Feature selection and dimensional reduction Data analysis and validation: Finding signal in the noise Common errors in study design and strategies to avoid them: -- Overfitting -- Data leakage -- Data peeking Significance does not equal importance

### INEE-7 Fight for Fairness in AI for Medical Imaging

Po-Chih Kuo, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. To highlight the critical importance of fairness in AI for medical imaging, emphasizing the negative impacts of biased algorithms on patient outcomes.2. To provide an overview of various evaluation metrics that can be used to assess fairness in AI models, including equality of opportunity and demographic parity, with a particular focus on their application in medical imaging.3. To introduce debiasing methods such as pre-processing techniques and adversarial training, and discuss their effectiveness in addressing bias in AI models for medical imaging.4. To encourage ongoing discussion and action to promote fairness and equity in healthcare AI and identify future challenges in this rapidly evolving field.

### TABLE OF CONTENTS/OUTLINE

1. Introduction1.1. Importance of fairness and bias in AI for medical imaging1.2. Brief review of previous studies addressing fairness issues2. Definitions of fairness and bias2.1. Explanation of fairness and bias2.2. Types of bias3. Methods to mitigate bias3.1. Pre-processing techniques (e.g., data cleaning, re-sampling, feature selection)3.2. In-processing techniques (e.g., pruning, contrastive learning, adversarial training)3.3. Post-processing techniques (e.g., calibration)4. Evaluation metrics for fairness4.1. Explanation of evaluation metrics used to assess fairness: demographic parity, equalized odds, and equality of opportunity4.2. Advantages and limitations of each metric5. Challenges5.1. Lack of diversity and representation in healthcare data5.2. Technical limitations of current debiasing methods5.3. Action to promote fairness and equity in AI for healthcare

### INEE-8 Approaches to Writing and Implementing Custom Software as a Trainee at a Large Academic Health Center

Andrew A. Gomella, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

- Coding is an increasingly popular and important skill, with more non-career programmers picking up coding skills.- Recently released large language models have decreased the entry barrier for coding by demonstrating the possibility of generating complex software from natural language prompts.- Writing, implementing, and testing code in a health system presents unique barriers and challenges, but it is possible even as a trainee.- Significant variation in practice/hospital IT infrastructure, security policies, and the suite of radiology/EHR combinations unfortunately limits cross-institutional development of software.- The software approach, including whether to use a specific language, how to distribute to colleagues, and attention to IT security, depends on the specific problem at hand and can range from surprisingly trivial to prohibitively complex.

## TABLE OF CONTENTS/OUTLINE

- Motivation- A general approach to tackling software ideas, from feasibility to production- Is there an API(Application Programming Interface)? and what can be done if there isn't?- Institutional variation in IT and software suites, and why it matters- Security considerations- Low code solutions: Example of a program that can be completely run within our hospital infrastructure without any installation or 'writing' code.- Scripting solutions: Example of AutoHotKey scripts including a few line solutions, to dynamically modify open radiology report text.- Python: Swiss army knife, with limitless possibilities and vast online community- Browser plugins: Example of a Chrome plugin used to add features to intranet web pages.- PACS and EHR plugins

## INEE-9 Maximizing Generative AI's Potential in Radiology: Fine-Tuning and Prompt Engineering

Theodore T. Kim, BA (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- ChatGPT and other generative AI tools have the potential to play significant roles in education, research and clinical practice for diagnostic radiology- One way to maximize their use and potential is by focusing on improving the quality of its output through the processes of fine-tuning and prompt engineering- Fine-tuning is the process of training a pre-trained model on a smaller, task-specific datasets to improve its performance on that task. For example, training a model with specific terminology and recommendations associated with updated Fleischner criteria to guide management of pulmonary nodules on a model already trained on a larger dataset of radiologic imaging- Prompt engineering focuses on designing and refining input queries to obtain the most accurate and relevant desired output. These methods can include using radiology-specific terminology, providing necessary medical context, crafting precise prompts with specific constraints, and using iterative processes to identify and develop the most effective prompt structures.

## TABLE OF CONTENTS/OUTLINE

1. Principles of Fine Tuning2. Commonly used Algorithms for Fine Tuning3. Fine Tuning in ChatGPT4. Principles of Prompt Engineering5. Prompt Engineering in ChatGPT

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-1

### What Will Happen to AI Technology in Radiology? Systematic Review of Natural Language Processing for Radiological Image Processing

All Day Room: Learning Center

Hina Kotani (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In recent years, the application of artificial intelligence (AI) technology in the medical field has been advancing rapidly. In radiology, AI technology is expected to improve the accuracy of physician diagnosis through image analysis and automated diagnosis. Specifically, these include automated diagnostic technologies using deep learning and the prediction of patient health status. Many of the technologies that use AI include systems that use Natural Language Processing (NLP). Improvements in NLP models have made it possible to handle not only text data but also image data, and many applications in the medical field have been reported. The purpose of this exhibit is to show the application of NLP model in radiology and our work applying the Vision Transformer to atrial fibrillation types classification. The major teaching points of this exhibit are 1.AI technology in radiology is expected to improve the accuracy of physician diagnosis through image analysis and automated diagnosis. 2.NLP enables the processing and extraction of large amounts of natural language generated in the medical field. 3.How can NLP be used for medical imaging?

#### TABLE OF CONTENTS/OUTLINE

1. AI Technology in Radiology 2. What is NLP? -Familiar Applications of NLP Models -Typical models used for NLP -Examples of Image Applications of NLP Models 3. Introduction to this study -Atrial Fibrillation Types Classification Using the Vision Transformer

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-10

### Establishing a Radiology Research Laboratory, from A-Z

All Day Room: Learning Center

Hussain Al Yousif, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Quantitative image analysis for clinical trials is poorly managed using standard clinical workflows. Radiology Research laboratories standardize the workflows for trials that use imaging endpoints. Radiology Research laboratories can provide more value to support institutional research objectives beyond image interpretation and should be set up to serve as central point of contact for all clinical researchers and medical imaging.

#### TABLE OF CONTENTS/OUTLINE

Defining the problem - addressing the needValue of radiologists and medical imaging personnel at the various stages of clinical research:

- Research protocol development
- Feasibility assessments
- Access to radiologists and technical resources

Partnering for success - working with your customers and end users to know what service are needed:

- Image review with quality quantitative image assessment
- Image transfer
- Protocol review
- Feasibility assessments
- Trial budget development

Take advantage of existing institutional core lab infrastructure:

- List of provided services accessible via website.
- Billing for services
- Operations

Identify the key components and personnel required for functioning of the lab:

- Hardware and software
- Personnel

Developing a budget and list of provided services. Research lab operational workflow in context of clinical operationsAnnual reviews, with budget and performance adjustments.

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## Abstract Archives of the RSNA, 2023

INEE-11

### Lung Cancer Screening and AI: Challenges and Opportunities

All Day Room: Learning Center

Leonardo Rosolen Iunes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To discuss the potential role of artificial intelligence (AI) in lung cancer screening (LCS), highlighting: - AI applications in LCS: machine learning versus deep learning strategies - AI limitations in LCS: data collection, reproducibility, generalizability, validation - Responsible AI: fairness, accountability, and transparency - Addressing gender and racial bias in LCS programs - Future perspectives: combining the strengths of radiologists and AI for best LCS practices

#### TABLE OF CONTENTS/OUTLINE

1. Introduction
  - a. Ongoing challenges in implementation of LCS
  - b. AI in healthcare: basic concepts
2. AI and lung cancer: an overview
  - a. Screening
  - b. Radiomics and Radiogenomics
  - c. Decision making and prognosis prediction
3. AI in LCS: potential applications
  - a. Early detection
  - b. Nodule classification
  - c. Radiography versus Computed tomography
  - d. Retrospective versus Prospective Studies
4. Limitations and Challenges: AI in the real world
  - a. Bias in underserved and underrepresented populations
5. Responsible AI: transparency and regulation
6. Future perspectives
7. Take home messages

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## Abstract Archives of the RSNA, 2023

INEE-12

### AI-Driven Tools and Techniques in Radiology Education: Empowering the Next Generation of Radiologists

All Day Room: Learning Center

Matteo Mancino, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The integration of AI into radiology education is crucial, as state-of-art AI applications such as deep learning and machine learning are transforming decision making and patient care. Radiology trainees must be well-versed in AI technologies to effectively leverage their potential in delivering value-based clinical practice. The aim of this poster is to provide an overview of AI's role in radiology trainee education, addressing challenges, state-of-art resources and future directions.

#### TABLE OF CONTENTS/OUTLINE

1. Curriculum development Building an AI curriculum including ethics, data quality, privacy, and AI's impact on clinical workflows. 2. Interdisciplinary learning: Encouraging trainees to collaborate with other medical specialties to understand AI's broader implications in healthcare. 3. Collaboration Encouraging cooperation between radiology departments, AI experts, and industry partners to develop tailored educational content and resources. 4. Assessments: Leveraging AI for performance assessment in radiology board examinations and multidisciplinary meetings to enhance clinical decision-making skills. 5. AI-augmented education Using AI to provide learning experiences, such as personalized case selection. 6. Barriers and challenges: Addressing barriers to AI education, and developing strategies to overcome these challenges. 7. Future directions: Exploring innovative ways to integrate AI into radiology education, such as AI-driven simulations, virtual reality, and gamification.

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## Abstract Archives of the RSNA, 2023

INEE-13

### Generative AI Predicts the Survival of Patients with Progressive Fibrosing Interstitial Lung Disease

All Day Room: Learning Center

Masaki Okamoto (*Presenter*) Stockholder, TOKYO analytica

#### TEACHING POINTS

Progressive fibrosing interstitial lung disease (PF-ILD) is a group of diseases characterized by increasing self-sustaining fibrosis, progressive decline in lung function, and high mortality. Due to the highly variable rates of decline and poor prognosis of PF-ILD, accurate, individualized mortality prediction is crucial for therapeutic decision-making and management of the patients. However, PF-ILD does not have any formal prognosis-based staging system, and none of the developed existing prognostic biomarkers have been considered accurate enough for establishing such a system. The teaching points of this exhibit are to (1) review currently available clinical prognostic biomarkers for PF-ILD, (2) review an emerging generative AI-based biomarker for imaging-based prediction of survival in PF-ILD, and (3) review the comparative performance between the clinical and generative-AI-based prognostic biomarkers in the prediction of the survival in PF-ILD.

#### TABLE OF CONTENTS/OUTLINE

(1) Unmet need for accurate prognostic biomarkers for PF-ILD. (2) Clinically established prognostic biomarkers for PF-ILD (gender, age, and physiology (GAP) index; composite physiologic index (CPI); visual high-resolution CT pattern). (3) Radiomic biomarkers (traditional radiomics; hyper-curvature features) for survival analysis. (4) Emerging generative AI-based imaging biomarker (gen2surv). (5) Comparative performance of biomarkers in terms of survival prediction and Kaplan-Meier survival curves. (6) Clinical case studies.

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## Abstract Archives of the RSNA, 2023

INEE-14

### AI as a Medical Device: Demystifying FDA Regulation for AI Tools in Clinical Radiology Practice

All Day Room: Learning Center

Anjali Patel (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understand the FDA's role in regulating AI radiology tools categorized as software as a medical device. Gain a fundamental understanding of FDA regulations, crucial for algorithm developers and end users to ensure appropriate and optimal use. Distinguish between FDA clearance and different classifications for radiological software as a medical device. Appreciate the importance of various classifications concerning algorithm development, validation rigor, and intended use. Assess the real-world implications of device classifications on the adoption of AI tools in clinical radiology practice. Explore ongoing debates and potential future developments in FDA regulation of AI radiology tools.

#### TABLE OF CONTENTS/OUTLINE

Introduction Overview of FDA classifications for AI medical software Class I devices Class II devices Class III devices  
Discerning intended use and its influence on device classification Motivations behind seeking lower category classifications and potential pitfalls in clinical practice Different category FDA classifications and impact on AI tool adoption and usability in clinical practice Controversial aspects and future optimization of FDA regulation in AI radiology tools Conclusions

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## Abstract Archives of the RSNA, 2023

INEE-15

### Streamlining Emergency and General Radiology Reporting Through Customized Macros for Incidental Findings: A Primer and Online Repository

All Day Room: Learning Center

Jeffers Nguyen, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Modern radiologic practice demands higher volume study interpretation, which may be facilitated by improvements in dictation workflow. There is a large variety of incidental findings that may be made during the course of general, multi-modality, or emergency radiologic practice whose accepted follow-up recommendations may be difficult to recall for general radiologists, or those practicing outside of a subspecialty area. Furthermore, existing solutions to streamline the reporting of incidental findings are cumbersome and require too many clicks or keystrokes to rapidly implement. We present customized, pick list type macros that allow easy selection of up-to-date recommendations for the most common incidental findings that may be encountered in routine practice. We demonstrate how these may be used and provide an online repository from which they may be downloaded and imported for personal use.

#### TABLE OF CONTENTS/OUTLINE

1) A brief review of incidental findings; 2) How to create, export, and import pick list macros (PowerScribe); 3) How to use pick list macros (video demonstration); 4) Demonstrating the value of pick list macros for incidentally detected lesions, including adnexal masses, pituitary lesions, pulmonary nodules, liver lesions, pancreatic cystic lesions, renal masses, and more; 5) URL for online repository of macro resources

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## Abstract Archives of the RSNA, 2023

INEE-17

### Improving Workstation Ergonomics and Productivity with Input Devices: Saving Time and Your Wrists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Discuss the biomechanics and ergonomic factors affecting radiology input devices.- Review common repetitive stress injuries experienced by radiologists caused by input device use.- Systematic product review with pros and cons of popular computer mice, dictation devices and non-traditional input devices (named below) in terms of ergonomics, effectiveness and programmability.- Tutorial on how to customize commonly available input devices with recommended profiles.

#### TABLE OF CONTENTS/OUTLINE

Radiologist's productivity and wellness are influenced by tools used to interact with clinical images. Software and hardware can augment efficiency but also have the potential to lead to burnout via poor ergonomics. We review the relevant biomechanics and anatomy involved in using computer mice and dictaphones with review of primary literature and of common repetitive stress injuries experienced by radiologists. We offer alternatives to commonly used input devices (mouse, keyboard, handheld dictaphone) used to review clinical images. We share the factors important in choosing a device (e.g. on-board memory) and the results of a systematic review of devices that could augment radiologists' productivity and improve ergonomics including: A) Pointing Devices:- Gaming mice- Ergonomic mice- Trackballs/Trackpads B) Dictation Devices:- Traditional Nuance PowerMic-style- Wearable headsets- Table-top microphones (e.g. podcasting microphone) C) Non-traditional input devices for example:- Elgato stream deck- Contour ShuttlePro- Contour Roller Mouse Finally, we provide tested templates for the above programmable devices to get a new user started with improving their ergonomics and efficiency in the reading room.

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## Abstract Archives of the RSNA, 2023

INEE-18

### Transforming Radiology with Large Language Models: Opportunities and Challenges

All Day Room: Learning Center

Satvik Tripathi (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Personalizing Imaging Examinations LLMs can guide patients through imaging procedures based on medical history, including preparation and potential risks. Improving Clinical Documentation LLMs can flag discrepancies and provide decision support, improving accuracy and reducing errors in medical records. Streamlining Insurance Prior Authorization LLMs can assist clinicians in submitting complete prior authorization requests and automating insurance review, reducing manual review time. Increasing Patient Engagement LLMs can convert complex medical information into easily understandable language and provide personalized education, increasing patient engagement. Decreasing Barriers to Access to Healthcare: LLMs can facilitate remote consultations, appointment scheduling, and educational resources, overcoming barriers to healthcare access. Security and Privacy Considerations The use of LLMs in healthcare raises privacy and cybersecurity concerns that must be addressed to protect patient data and comply with laws and regulations.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to Large Language Models (LLMs) 2. The Current State of LLMs 3. Compliance and Security 4. Aid in Patient Care 4.1. Personalizing Information for Imaging Examinations 4.2. Decreasing Barriers to Access to Healthcare 4.3. Personalizing Imaging Examinations Resources 4.3. Increasing Patient Engagement 5. Aid in Radiology Workflow 5.1. Automating Routine Tasks (such as appointment scheduling and reminder notifications) 5.2. Facilitating Insurance Prior Authorization 5.3. Improving Clinical Documentation 5.4. Easier EMR Transfer from Different Facility 6. Future Directions 7. Conclusions

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## Abstract Archives of the RSNA, 2023

INEE-19

### Unlocking a New Era in Radiology: Leveraging GPT for Accurate Diagnosis of Diseases

All Day Room: Learning Center

Matheus Fritzen, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understanding the role of ChatGPT in radiologic diagnosis through real-world cases; Evaluating the impact of ChatGPT on hypothesis formulation and diagnostic accuracy; Analyzing ChatGPT's role in providing diagnostic tips and guidance; Assessing the potential of ChatGPT for improved clinical decision-making

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline:  
I. Introduction to ChatGPT in Radiologic Diagnosis  
A. Overview of ChatGPT's capabilities  
B. The potential for AI-assisted diagnosis  
II. Case Studies: ChatGPT in Diagnostic Process  
A. Real-world examples of ChatGPT-enhanced diagnoses  
B. Hypothesis formulation and diagnostic accuracy improvements  
III. ChatGPT's Role in Providing Diagnostic Tips and Guidance  
A. Case examples illustrating diagnostic assistance  
B. The impact of ChatGPT on radiologists' decision-making process  
IV. Assessing ChatGPT's Potential for Clinical Decision Support  
A. Evaluation of case study outcomes  
B. Implications for radiology practice  
V. Conclusion  
A. The real-world impact of ChatGPT on radiologic diagnosis  
B. Future advancements and integration in radiology practice  
This abstract presents a series of case studies that demonstrate the practical applications of ChatGPT in radiologic diagnosis, hypothesis formulation, and clinical decision support. The guide provides an in-depth analysis of how ChatGPT can be utilized to enhance diagnostic accuracy, offer diagnostic tips and guidance, and improve clinical decision-making in real-world scenarios. By showcasing the tangible benefits of ChatGPT through these case studies, the presentation aims to highlight the potential of AI-assisted diagnosis in revolutionizing radiology practice.

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## Abstract Archives of the RSNA, 2023

INEE-2

### Anatomy of an Ontology

All Day Room: Learning Center

David J. Vining, MD (*Presenter*) Royalties, Bracco Group;CEO, VisionSR, Inc;Stockholder, VisionSR, Inc

#### TEACHING POINTS

1. Understand the distinction between a taxonomy and an ontology.2. Comprehend the need for ontologies in medical reporting and electronic records to support interoperability.3. Survey the strengths and weaknesses of existing medical ontologies applicable to radiology reporting.4. Learn about an effort to create an ontology that has evolved from the concept of the now antiquated American College of Radiology's Index of Radiological Diagnoses.

#### TABLE OF CONTENTS/OUTLINE

1. Define what is a taxonomy and what is an ontology. 1a. Illustrate the concepts of CUI, AUI, TUI, and SUI.2. Demonstrate why an ontology is important for use in radiology reporting. 2a. Illustrate how an ontology is essential for natural language processing and the creation of mineable, structured data.3. Provide an overview of the major medical ontologies applicable to radiology reporting, including SNOMED, RadLex, ICD-10, FMA, MedDRA, and others. 3a. Show where there are deficiencies in the major ontologies, including knowledge gaps pertinent to diagnostic radiology reporting.4. Review the original concept of the American College of Radiology's Index of Radiological Diagnoses and how it was used to create teaching files before the existence of desktop computers.5. Illustrate how a new ontology is being constructed inspired by the Index of Radiological Diagnoses but in a more pragmatic fashion to accommodate interactive multimedia reporting. 5a. Show cross-mappings between this new ontology and existing ontologies. 5b. Demonstrate the importance of incorporating synoptic phrase for use in radiology reporting.

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## Abstract Archives of the RSNA, 2023

INEE-20

### Using a Workflow Engine to Improve Data Retrieval and Curation in Multi-modal Research Studies

All Day Room: Learning Center

Ali Ganjizadeh, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Introduction to workflow concepts and their importance in research studies  
2. Overview of the technologies used in the retrieval system: MongoDB, FastAPI, Camunda and NextJS  
3. Understanding the retrieval system architecture  
3a. A modular data retrieval browser-based program to collect multiple data types from multiple data sources  
3b. Setting up a browser-based user interface to create and execute tasks for each subject to retrieve its data from servers  
4. Handling errors and failures in retrieving data using the workflow engine  
5. Additional steps in the workflow system, such as de-identification and data storage  
6. Conclusion and impact of the workflow system on research studies

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
1a. Overview of workflow systems  
1b. Importance of workflow-based systems in research studies  
2. Technologies Used  
2a. MongoDB  
2b. FastAPI  
2c. NextJS  
2d. Tailwind CSS  
2e. Camunda  
3. Workflow System Architecture  
3a. Overview of the system architecture  
3b. Explanation of the workflow engine  
4. Modular Data Retrieval Program  
4a. Setting up the program to collect multiple data types from multiple sources  
4b. Creating tasks for each subject to retrieve data  
5. Browser-Based User Interface  
5a. Designing a user interface to execute tasks for data retrieval  
5b. Graphical user interface for selecting patients to include in the study  
6. Handling Errors and Failures  
6a. How the workflow engine handles errors and failures in data retrieval  
7. Conclusion and Impact  
7a. Significance of the workflow system in research studies  
7b. Lessons learned from the development and implementation of the system

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## Abstract Archives of the RSNA, 2023

INEE-21

### Use of Chat GPT in Radiology Research

All Day Room: Learning Center

Andrew R. Benza, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Highlight unique and generalizable prompts to leverage large language models in research.- Discuss the art of prompt engineering and key phrases to improve outputs.- Demonstrate the variety of functionalities of ChatGPT and Bing AI Search and how it pertains to research.-Discuss the future of research with AI as a supplemental tool.

#### TABLE OF CONTENTS/OUTLINE

1. History of AI.2. New AI systems and their functionalities.3. Prompt engineering and key phrases to leverage ChatGPT.4. Illustrate how ChatGPT can be used throughout the entire research process for example during the following stages: a. Formulate the idea b. Write an IRB proposal c. Design a research study d. Analyze data e. Interpret results f. Prepare publication 5. The future of AI and what it means for research/education.

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## Abstract Archives of the RSNA, 2023

INEE-22

### **Beyond Writing and Reporting: Opportunities and Challenges of GPT-based Models in Radiology**

All Day Room: Learning Center

Jose G. Maluf, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To learn definitions and basic concepts of generative AI, natural language processing (NLP) and large language models (LLM) applied to healthcare; - To understand the potential impact of generative pre-trained transformer (GPT)-based models in the radiology practice; - To be familiar with some potential applications of GPT-based models in radiology, including image manipulation, report generation, educational support, clinical decision support, and data analysis; - To emphasize the challenges and limitations before implementation of these models in clinical practice, with focus on ethical and regulatory issues.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: AI in healthcare Generative AI, NLP and LLM: Definitions and Basic Concepts Applications in Radiology Image manipulation and improving Medical writing and reporting Clinical decision support Health insurance and advocacy issues Education Other emerging applications Limitations and Challenges Hallucinations and other common mistakes Privacy, security and other risks on clinical implementation Ethical issues: Transparency, bias and discrimination Regulation Future perspectives: what is next? Take home messages

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## Abstract Archives of the RSNA, 2023

INEE-23

### Artificial Intelligence: Missed steps and a double edge sword

All Day Room: Learning Center

Anisa A. Chowdhary, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Radiologists should be vigilant and careful as AI can certainly make incorrect diagnosis or miss the diagnosis in certain case scenarios.
- Radiologists should use AI as a secondary adjunct. AI can underperform in specific subset of patients where a radiologist approach is crucial to avoid any diagnostic error.
- AI will continue to serve as a secondary adjunct rather than an alternative to a radiologist.
- AI can certainly help improve work flow and patient care by looking at flagged cases to do a quick triage of which cases to dictate first.

#### TABLE OF CONTENTS/OUTLINE

- Introduction
- Overview
- Missed diagnosis and missed cases by Artificial intelligence
- Teaching points

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## Abstract Archives of the RSNA, 2023

INEE-24

### How Federated Learning Improves Pancreatic Segmentation Using Three Distributed Training

All Day Room: Learning Center

Chen Shen (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To learn Federated Learning, a method for learning from several remote datasets without centralized processing. 2. To learn a new robust aggregation method for Federated Learning. 3. To learn the effectiveness of using Federated Learning for pancreatic segmentation.

#### TABLE OF CONTENTS/OUTLINE

Why Federated Learning is useful in healthcare applications? - Distinct from natural images, collecting data from various resources may lead to multiple technical, legal, and privacy issues. - Can produce a model with features from several dispersed sources without requiring the training data to be centralized. Demonstrate the pancreatic segmentation process using Federated Learning. - How does Federated Learning work? - How does the server use FedAvg, a standard aggregation method, to aggregate models from multiple clients? - Introduce a dynamic weight aggregation method to aggregate the model updates properly. A comparison of the pancreatic segmentation performance. - Introduce the datasets and the segmentation models. - Compares the performance of Federated Learning over standalone training on three pancreas datasets. - Compares the effectiveness of dynamic weight aggregation with the original FedAvg algorithm. 1. Qualitative evaluation results. 2. Quantitative segmentation accuracy to show the Federated Learning and our proposed aggregation method improve the segmentation performance on pancreas.

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## Abstract Archives of the RSNA, 2023

INEE-25

### Achieving Trustworthy Artificial Intelligence in Clinical Applications: A Comprehensive Review of Key Concepts and Solutions in Medical Imaging

All Day Room: Learning Center

Pouria Rouzrokh, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In this exhibit, radiologists will learn to: 1) Understand why predictive power doesn't ensure AI models' clinical trustworthiness; 2) name and describe methods to explain AI models, quantify their uncertainty, and detect outlier data for their predictions; 3) analyze the clinical trustworthiness of AI models introduced in scientific studies or commercial products.

#### TABLE OF CONTENTS/OUTLINE

Problem Statement: Is predictive power (e.g., accuracy) all we need?; A review of scenarios where AI fails in clinical deployment. The Triangle of Trustworthiness: Model explainability; Uncertainty quantification; Out-of-distribution detection. Model Explainability: Can we explain the black box of AI models?; A review of interpretation maps (e.g., saliency maps, occlusion sensitivity, integrated maps, etc.) and their use cases; A review of SHAP values and their use cases; Limitations of model explainability. Uncertainty Quantification (UQ): What is vs. what is not model uncertainty?; Where do we expect AI to be uncertain?; UQ methods (Bayesian methods, evidential deep learning methods, posthoc calibration methods); Pros and cons of UQ Methods. Outlier Detection: Out-of-distribution vs. out-of-domain data: what's the difference?; How can outlier data harm your model?; Potential sources of outlier data (covariate drift, dataset drift, concept drift); a review of outlier detection methods (threshold-based, classifier-based, generative AI-based, distance-based, Nearest-neighbor-based); Pros and cons of outlier detection methods. How to shift gears toward trustworthy AI in radiology? Recommendations for AI developers, scientific journals/reviewers, and end-user organizations/radiologists.

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## Abstract Archives of the RSNA, 2023

INEE-26

### From Pixels to Diagnosis: Unleashing the Power of Generative AI in Radiology

All Day Room: Learning Center

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Understand basic concepts of image-based neural networks in radiology. Understand how generative AI models architecture and how they are built and trained on radiological images. Most notable applications of Generative AI in radiology. Impact of Generative AI on radiology practice.

#### TABLE OF CONTENTS/OUTLINE

1- Understand basic concepts of deep learning and image-based neural networks. a) What is deep learning? b) How neural networks train and Backpropagation c) The significance of convolutional neural networks d) Dissection of a basic convolutional neural network architecture  
2- Understand how generative AI models architecture and how they are built and trained on radiological images. a) generator models architectures b) How are generative models trained to create radiology images? c) Emphasis on CycleGan models d) What are diffusion models and their potential in imaging?  
3- Provide examples of current and possible applications of generative AI in abdominal radiology a) Synthesizing CT images from MRI b) Image segmentation c) Image reconstruction from image space  
4- Impact of Generative AI on radiology practice with different applications of generative models in abdominal imaging ( image synthesis from noise, CT synthesis from MRI, image reconstruction, segmentation)

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## Abstract Archives of the RSNA, 2023

INEE-27

### 3D Printing in Pectus Excavatum Surgical Planning

All Day Room: Learning Center

Mikel Garcia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Pectus excavatum is the most common deformity of the chest wall, characterized by a concave depression of the sternum.- While diagnosis can often be made without imaging, chest radiographs and CT scans can be useful in cases where the diagnosis is uncertain or to assess the severity of the deformity. Haller's index is commonly used in this evaluation. - The Nuss procedure is a minimally invasive technique used to treat pectus excavatum. It involves inserting a metal bar behind the sternum to correct the deformity, with the bar typically being shaped during the operation based on the patient's chest.- By utilizing 3D printing of the patient's chest CT, the bar can be shaped prior to the surgery, which can help decrease the duration of the operation.

#### TABLE OF CONTENTS/OUTLINE

- Imaging of pectus excavatum- Nuss procedure- 3D reconstruction and segmentation- 3D printing- Presurgical planning using a 3D printed model

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-28

### Promoting Equitable AI in Radiology: Harnessing Open Source Tools for Bias and Fairness Estimation

All Day Room: Learning Center

Henrique M. Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Identifying and addressing biases in AI radiology applications is crucial for promoting equitable healthcare and accurate patient outcomes. 2. Open-source tools such as AI Fairness 360, Fairlearn, What-If Tool, and Scikit offer tailored techniques for bias estimation and fairness assessment in radiology. 3. Implementing bias mitigation strategies in AI radiology applications can help reduce disparities in diagnoses and treatment recommendations. 4. Collaborative efforts within the radiology and AI research community are essential for developing robust, up-to-date tools and methodologies. 5. Integrating multiple tools enables comprehensive evaluations across diverse radiological scenarios and patient demographics.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction - Importance of assessing bias and fairness in AI radiology applications  
A. Equitable patient outcomes  
B. Open source tools for evaluation  
II. Variety of Open Source Tools  
A. Comprehensive fairness evaluation  
B. Identification of potential biases  
III. Available Packages for Bias Estimation  
Scikit-fairness/scikit-lego  
IBM Fairness 360  
Aequitas  
Google What-if tool  
PyMetrics  
audit-ai  
Microsoft Fairlearn  
IV. Comparison and integration of tools  
IV. Assessing Fairness Across Multiple Dimensions  
A. Demographic attributes  
B. Clinical attributes  
C. Mitigating disparities in AI radiology systems  
V. Collaboration and Regular Updates  
A. Engaging with the research community  
B. Addressing evolving fairness challenges  
C. Ensuring up-to-date tools and methodologies  
VI. Conclusion - The critical role of open source tools for bias and fairness estimation in radiology AI

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-29

### Effective Program Management for an Artificial Intelligence Team: Optimizing Performance and Productivity

All Day Room: Learning Center

Holly Meyer, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Provide insight on how to effectively build, recruit and manage multidisciplinary teams whose collective goal is to deliver AI solutions to the radiology practice. 2. Share lessons learned from the challenges encountered when trying to optimize an AI program management structure.

#### TABLE OF CONTENTS/OUTLINE

1. Purpose a. Provide requirements for creating an effective program management structure that optimizes team performance and productivity. 2. Building a Radiology AI Team a. Master FTE Plan b. Job Descriptions c. Roles and Responsibilities d. Org Chart e. Governance f. Recruitment g. Training Education 3. Program/Project Management a. Organization b. Methodology i. Hybrid c. Electronic Tools i. Monday.com ii. Azure Dev Ops iii. Microsoft Teams iv. OneNote v. SharePoint d. Quality Management System (QMS) Compliance e. Meeting Structure f. Communication 4. Lessons Learned a. Challenges b. Successes 5. Conclusion a. Building and managing a multidisciplinary team of individuals whose goal is to deliver AI solutions to the radiology practice in a safe and efficient manner requires careful consideration to the overall program management structure and associated tool sets. PDF Upload \*See attached ppt

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-3

### **Generative AI (Gen AI) Based Electronic Cleansing: Unlocking the Potential of Photon-counting CT Colonography**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Rie Tachibana, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Electronic cleansing (EC) plays a crucial role in enhancing the sensitivity of polyp detection during virtual endoscopic fly-through reading in CT colonography (CTC) by subtracting orally tagged residual materials from the images. This exhibit aims to (1) provide insights into recent advances in generative AI (GenAI) based EC for CTC; (2) explore the benefits and potential applications of photon-counting CTC; and (3) present clinical outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: Review the history and recent developments in GenAI-based EC for CTC, including the emergence of photon-counting CT technology. 2. How GenAI-based EC works: (2.1) Explain the basic ideas of GenAI; (2.2) Discuss how self-supervised GenAI-based EC differs from traditional EC; (2.3) Explain diffusion-based EC. 3. Photon-counting CT colonography: (3.1) Provide overview of photon-counting CT; (3.2) Discuss advantages and potential applications in CTC; (3.3) Explain Gen AI-based EC for photon-counting CTC. 4. Case studies: (4.1) Compare the image quality and outcomes of various GenAI-based EC techniques in clinical conventional and photon-counting CTC cases; (4.2) Review potential diagnostic challenges.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-30

### Take the Right Path: Overview of Artificial Intelligence Guidelines

All Day Room: Learning Center

Carlos Felipe D. Reyna, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Present the different kinds of guidelines. Describe guidelines for development, application and implementation, and evaluation of Artificial Intelligence (AI), created to direct and conduct research in a standardized way, avoiding process errors. To evaluate which of these guidelines is more useful for a specific interest.

#### TABLE OF CONTENTS/OUTLINE

Describe and compare such guides in terms of: purpose and format. Which contexts they fit using flowcharts and schematic images.

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## Abstract Archives of the RSNA, 2023

INEE-31

### **Federated Learning - Game Changing AI Concept to Train AI without Sending Patient Data Out from Hospitals**

All Day Room: Learning Center

Yuqiao Yang, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) To understand the concept of federated learning to address data security and privacy concerns. (2) To learn the application and advantages of federated learning for liver tumor segmentation in hepatic CT. (3) To study the process of the development and performance of federated learning with a patch-wise massive-training artificial neural network (MTANN) model for liver tumor segmentation.

#### **TABLE OF CONTENTS/OUTLINE**

A. Introduction to Federated Learning - Challenges in acquiring extensive training datasets for a deep learning model from multiple hospitals - Role of federated learning in collaborative learning without sharing data - Issues of federated learning: 1) small local training data, 2) high computational demands, and 3) heavy network loads B. Federated Learning for Tumor Segmentation in Medical Imaging - Overview of federated learning models and their applications to tumor segmentation in medical imaging - Federated learning coupled with MTANN models for addressing the above three issues of the current federated learning C. Clinical Relevance and Performance of Federated Learning for Tumor Segmentation - Ensuring data privacy while achieving accurate tumor segmentation - Performance of federated learning for tumor segmentation - Comparisons with the current-state-of-the art model and "gold-standard" centralized training model

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## Abstract Archives of the RSNA, 2023

INEE-32

### Use of Generative AI for Non-interpretative Tasks in Radiology

All Day Room: Learning Center

Vinit Baliyan, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To provide an overview of the current state-of-the-art in generative artificial intelligence (AI) and its applications for non-interpretative tasks in radiology. 2. To showcase examples of how generative AI is being used in radiology today. 3. To highlight the challenges associated with using generative AI in radiology. 4. To touch upon the potential future developments in the field of generative AI and their potential impact on radiology.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to Generative AI Key concepts and applications 2. Specific ways in which generative AI can be used used in for non-interpretative tasks in radiology, including: a. Reporting; checking grammar and syntax, generating summary, making reports more readable for non-specialists/patients b. Communication of important findings c. Managing work scheduled. Writing emails 3. Real-world examples of how generative AI has been used to enhance the accuracy and speed of radiological diagnoses 4. Challenges associated with using generative AI in radiology, including Data privacy and security concerns, Ethical considerations, The need for human oversight 5. Potential future developments in the field of generative AI and their potential impact on radiology Conclusion: Overall, the exhibit aims to educate and inform visitors about the latest advances in generative AI and its potential applications in radiology. By providing real-world examples and highlighting the challenges associated with using generative AI in radiology, the exhibit offers an opportunity for visitors to learn about cutting-edge technology that could help improve the efficiency of radiologists, ultimately benefiting patients and medical professionals alike.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-33

### **R Programming Language Basics for Radiologists**

All Day Room: Learning Center

Srinivas Kolla, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Learn how to install R 2. Know how to import and process data 3. Run common statistical tests 4. Explore and understand large datasets better

#### **TABLE OF CONTENTS/OUTLINE**

The R programming language serves as an invaluable resource for managing and analyzing large datasets effectively and efficiently. As a free and open-source software, R presents a cost-effective solution for performing common statistical tests, crafting visualizations, and even implementing machine learning algorithms. Exhibit Outline: Software installation: -Installing the R programming language -Setting up an Integrated Development Environment (IDE) -Installing essential packages Data import and processing: -File handling and manipulation -Data cleaning and preprocessing -Data transformation and aggregation Common statistical tests in radiology: Sample code and examples for: - Descriptive statistics -T-test -Analysis of Variance (ANOVA) -Pearson's correlation coefficient -Spearman's rank correlation coefficient -Chi-square test -Logistic regression and more. Large dataset analysis: -Data visualization techniques - Exploratory data analysis (EDA) -Machine learning and predictive modeling -Text mining and natural language processing (NLP)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-34

### Leveraging Medical Image Annotation with Practical Annotation Quality Check Tools

All Day Room: Learning Center

Henrique M. Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Prepare the data for an artificial intelligence (AI) models often involves intensive annotation work to ensure accurate ground truth. However, radiologists who participate in AI projects may lack practical training in annotation, leading to doubts that increase the variability of annotations. To address this, we developed an automated tool that evaluates bounding box and segmentation annotations and provides feedback to the annotator. The tool uses .json files for bounding box annotations and NifTY files for segmentation annotations, both exported from 3D Slicer. Python scripts compare the locations and categories of findings in the bounding box annotations, as well as the distance and similarity of binary masks in the segmentation annotations with those generated by experts. Results are presented in an HTML report. In a pilot study, we used 5 chest radiographs and 2 head CT scans from publicly available datasets (Montgomery and CQ-500) previously annotated by experts. The availability of reports in an introductory AI course for medical radiologists allowed instructors to monitor participants' progress and identify areas for further emphasis.

#### TABLE OF CONTENTS/OUTLINE

Our workflow resulted improved the overall quality of instruction, enhancing the professionalism of the annotations. Annotation tools can increase student engagement and productivity, with teacher supervision facilitating consensus-building and optimizing the laborious task of annotation. Our solution can be applied to various 2D and 3D images studied by radiologists. User-friendly applications that facilitate the teaching of high-quality image annotation are crucial for fostering the development and validation of novel AI models.

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## Abstract Archives of the RSNA, 2023

INEE-35

### Automatic Detection of Contrast Enhancement in T1-weighted Brain MRI Images Using Artificial Intelligence

All Day Room: Learning Center

Victor G. Martins, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: . Development and validation of a tool for post-contrast enhancement detection in T1-weighted MRI images.. Implementation of this tool in the clinical routine of the radiology and diagnostic imaging service of Clinical Hospital of Ribeirao Preto.

#### TABLE OF CONTENTS/OUTLINE

The use of magnetic resonance imaging (MRI) in medical practice is extensive and encompasses the diagnosis of multiple conditions such as neoplasms, infections, inflammatory diseases, among others. In these contexts, the analysis of post-contrast enhancement is essential. The detection and quantification of enhancement in T1-weighted cerebral MRI images is a challenging task due to the complexity of the images and the variability in the appearance of contrast enhancement. Artificial intelligence (AI) techniques have the potential to improve the efficiency and accuracy of this process, but the development and evaluation of AI-based approaches for this purpose is a laborious task.

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## Abstract Archives of the RSNA, 2023

INEE-36

### **A Practical Primer on the Radiomics Quality Score: How to Interpret the Results of Radiomics Studies**

All Day Room: Learning Center

Mohammad Mirza-aghazadeh-Attari, MD, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Radiomics quality scores are used to assess the quality of radiomics studies and are based on a set of criteria related to study design, image acquisition, segmentation, feature extraction, and statistical analysis. The purpose of a radiomics quality score is to provide a standardized method for evaluating the quality of radiomics studies and to aid in the interpretation and comparison of study results. Interpreting a radiomics quality score involves understanding the specific criteria used to evaluate the study and the scoring system employed. Typically, a higher score indicates a higher quality study that is more likely to produce reliable and reproducible results. It is important to note that a radiomics quality score is just one factor to consider when evaluating the results of a radiomics study. Other factors such as sample size, patient demographics, and clinical relevance of the results should also be taken into account. Ultimately, the interpretation of radiomics study results should be made in the context of the specific clinical question being addressed and in consultation with a radiologist or other medical expert. Here we present a step by step approach to understanding and applying the RQS.

#### **TABLE OF CONTENTS/OUTLINE**

1- Radiomics Quality Score: A short introduction on its History 2- Methodologic considerations covered in RQS: - 2.1 Extraction of features -2.2 Development of predictive models and classifiers - 2.3 Performance evaluation of models - 2.4 Utility considerations 3- Reporting RQS results 4-Applications of RQS in clinical practice and research 5-Prospectives to enhancing RQS: RQS V2 6- useful tools

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## Abstract Archives of the RSNA, 2023

INEE-37

### **From Models to Masks, Barriers to Roadblocks, Posters to Presentations: Experience in Forming Cross Institutional Collaborations for Artificial Intelligence Research**

All Day Room: Learning Center

Nader A. Refai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review of key collaborations necessary for AI related research.2. Review of potential roadblocks and barriers during project creation and execution.3. Infrastructure considerations needed for a successful project.

#### **TABLE OF CONTENTS/OUTLINE**

-Review of key collaborations which facilitate AI research--Domain Experts---Subspecialty radiologist involvement---Trainee involvement (resident/medical student)--AI Expertise---Programmers, data scientists--IT support--Graduate Students-  
Potential Roadblocks and Barriers--IRB and Data use agreements--DICOM de-identification at scale--De-identified DICOM storage--Image transfer between institutions--EHR data extraction at scale-Infrastructure considerations needed for a successful project.--Image or Data labeling---Example of open-source solutions for DICOM labeling/masking--GPU processing for model creation and testing--Project Management-Conclusion/Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

INEE-38

### Imaging Feature as a Function: A Novel Radiomics Framework

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Nicolo Gennaro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiomic features exhibit functional correlation with tumor size. Large datasets of pre-treatment scans of liver metastasis can uncover the functional association between tumor size and heterogeneity, providing potential insights into tumor growth and treatment. Harmonization allows to remove scanner-associated effects while preserving cancer-specific functional dependence. Texture features show functional size-dependence that allow to generate delta-radiomics data by utilizing post-treatment imaging data only.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Size measurement is a critical task for radiology and represents the pillar of response assessment to antitumor therapies. Size-dependence of radiomic features: We illustrate why radiomics features are affected by tumor size and how radiomic features might not be comparable even within ROIs of the same tumor but manually delineated by different operators. Harmonization in radiomics: The importance of feature harmonization to remove scanner-related biases and preserve size-dependence. Response Assessment: How size-dependence of texture features can be exploited to obtain delta-radiomics without baseline imaging.

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## Abstract Archives of the RSNA, 2023

INEE-39

### **The Comprehensive Open Federated Ecosystem (COFE): Enabling Impactful Healthcare Studies**

All Day Room: Learning Center

Sarthak Pati, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

There is a growing body of literature offering evidence of the potential impact that artificial intelligence (AI) methods can have on healthcare. To ensure robustness evaluate generalizability of AI methods, ample diverse multi-site patient datasets are desired. However, there are various factors that hinder access to such data in the current paradigm of multi-site collaborations, which include the tedious bureaucratic processes, data ownership concerns, legal considerations reflected in patient privacy regulations. To tackle these issues, we introduce the community-driven Comprehensive Open Federated Ecosystem (COFE), which includes multiple open-source software tools to make distributed healthcare AI more accessible by leveraging zero/low code principles to get models to learn across data silos using Federated Learning (FL), to evaluate their performance on diverse datasets that they were not used to train with using Federated Evaluation (FE). The goals of the exhibit are to: broaden the understanding of the general community regarding FL FE, showcase how a user can leverage FL to train a model across various sites, present results of the first real-world federation across 71 collaborating sites, focusing on brain tumors, discuss privacy data protection concerns how COFE hopes to solve it, showcase how a user can leverage FE to generate generalizable statistics for AI methods.

#### **TABLE OF CONTENTS/OUTLINE**

This exhibit will present a community-driven open-source ecosystem to train evaluate AI models across multiple clinical sites in a data-private paradigm. Specific principles to protect data privacy will be described, along with common pitfalls to avoid when performing FL-based studies.

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## Abstract Archives of the RSNA, 2023

INEE-4

### **Data Curation in Minutes not Days: Efficient Large Scale Dataset Preparation for Machine Learning Applications in Kaapana**

All Day Room: Learning Center

Stefan Denner (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In the era of rapidly growing medical imaging datasets and federated learning, efficient management and processing of medical images is crucial. Current medical image viewers, however, lack the capability for large-scale dataset curation. To address this, we introduce a data curation tool integrated into the Kaapana open-source framework, designed to streamline organization, management, and processing of extensive medical imaging datasets. Radiologists can easily filter for metadata, annotate and structure datasets, visualize dataset distributions, and quickly inspect individual studies. State-of-the-art machine learning algorithms, such as body part regression, nnUNet, and TotalSegmentator, can be applied to automatically annotate studies based on algorithm outcomes, which can accelerate the curation workflow by allowing filtering for specific organs, bone structures and body parts. This tool fosters collaboration between multidisciplinary teams, with machine learning researchers creating algorithms to support radiologists, who in turn annotate and curate the data. In conclusion, the proposed tool offers an intuitive interface for radiologists to efficiently curate datasets for use in machine learning algorithms.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Data Curation Tool 2.1. Features 2.2. Metadata Annotation 2.3. Structuring Visualization 3. ML Algorithm Integrations 4. Conclusion Future Directions

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## Abstract Archives of the RSNA, 2023

INEE-40

### Beyond the Hype: The Power of GANs in Restoring MRI Texture

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Kensuke Umehara, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Generative adversarial networks (GANs) are one of the deep learning-based image generation models that have been widely used in medical imaging research, such as modality conversion and data augmentation. However, their application in diagnostic imaging is still met with resistance due to the perception that "GANs easily generate fake images." On the other hand, it is not widely known that with proper model selection and training, GANs can be a useful tool for generating high-quality images from low-quality ones. The teaching points of this exhibit are to 1) provide an overview of GANs using supervised learning, 2) showcase the application of one of the representative supervised GANs, super-resolution GAN, to MRI images, achieving high-quality imaging while enabling short-time imaging, and 3) demonstrate the high-accuracy restoration of the texture of MRI images by applying super-resolution GAN.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Super-resolution GAN for Accelerating MRI 3. Radiomics Analysis 4. Clinical Showcases

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## Abstract Archives of the RSNA, 2023

INEE-41

### Accelerating Machine Learning for Medical Imaging by Integrating AIM and AI Federated Learning into Clinical Workflow

All Day Room: Learning Center

Pattanasak Mongkolwat, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The incorporation of Annotation and Image Markup (AIM) and AI Federated Learning (FL) framework into an imaging workflow can expedite the creation of deep neural network models without compromising the confidentiality and sharing of imaging data. Furthermore, this integration can standardize the creation of annotations for supervised or semi-supervised deep learning approaches in annotated images. 2. Integrating an AIM image annotation tool into clinical workflows can speed up the process of creating annotated images based on an AIM template. The user wants to make simple and constrained annotations. The annotation results can be stored as an AIM XML document, JSON object, or DICOM SR PS3.21 object. Combining the AIM information with corresponding image can facilitate the development and training of multimodal deep learning models. 3. The proposed software tools in this framework simplify the setup and usage of FL and enable the creation of standardized annotations, allowing radiologists and AI researchers to focus on data quality and deep learning model development.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of AIM, AI Federated Learning, and Multimodal Deep Learning 2. Imaging Workflow Architecture and Tools: modified ePAD, Fuji Synapse (example integration), DICOM anonymizer, Mini-PACS, AIM database, AI image inference, cohort creator, image and AIM staging location, Cohort worklist, DICOM reader, AIM transform, FL Web Admin Management, web-based AIM template builder. 3. Framework and Software Tool Requirements 4. Installation and Configuration Guide for Participating Institutions 5. Preparing Your DL Model and Data for AI Training 6. Live and Video Demonstration of the Installed Environments

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## Abstract Archives of the RSNA, 2023

INEE-42

### AI-assisted Decision Making for Prostate Cancer Diagnosis

All Day Room: Learning Center

Chacha Chen, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The interpretation of prostate multiparametric MRI is challenging. Up to 30% of clinically significant cancers (PCa) are missed even by expert, and there is large inter-reader variation. Artificial intelligence (AI) shows promise in diagnosing PCa using MR images. To leverage the power of AI, it is crucial to determine if AI can assist radiologists in the diagnostic process and if radiology trainees can learn from AI-generated insights. We trained a state-of-the-art AI model (nnUnet) on a large-scale MRI dataset for PCa diagnosis. We have developed a web-based system for interactive and learning resources, incorporating the AI. This system assists radiologists in PCa diagnosis by providing AI-generated predictions (lesion maps). With this information at their disposal, radiologists make their own predictions and annotations using our web application. We will compare the diagnostic performance of human-only, AI-only, and human+AI. We will also examine the interaction between radiologists and AI to inform better teaching processes. Ultimately, we hope the tool will improve radiologists diagnostic performance and patient outcomes by leveraging the power of AI.

#### TABLE OF CONTENTS/OUTLINE

Preliminary teaching results on simple AI assisted reader tasks. An AI model (nnUnet) trained on PI-CAI dataset: mpMRI images - T2W, DWI/ADC, DCE for human-only reader performance (we random sampled 80 cases for testing purposes). AI-assisted decision making: AI predicted lesion maps. Annotation tool: radiologists annotate prostate cancer with AI assistance at their disposal. Assessment: the performance of human-only, AI-only, and human+AI will be analyzed to generate insights to improve the task performance and teaching.

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## Abstract Archives of the RSNA, 2023

INEE-43

### Harnessing AI for Improved Workflow in Radiology: Beyond Image Analysis

All Day Room: Learning Center

Kevin Pierre (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

AI can be employed in numerous aspects of the radiology exam's electronic roundtrip, extending beyond image interpretation. This technology holds the potential to increase efficiency, reduce unnecessary scans, improve image quality and patient safety, and expedite the interpretation process. AI assisted reporting has tremendous potential to enhance practice and efficiency. By leveraging AI in these areas, healthcare professionals can save time and resources while enhancing the overall quality of patient care.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction  
2) AI Applications Prior to Image Acquisition • Scan Ordering Optimization • Pre-exam Screening • Protocoling • Scheduling  
3) AI Applications During Image Acquisition • Patient Positioning • Contrast and Radiation Dosimetry • Scan Time Reduction • Image Reconstruction and Postprocessing  
4) AI Applications Following Image Acquisition • Worklist Prioritization • Urgent Finding Notification • Hanging Protocol Optimization • Assisted Reporting  
a) Next generation reporting  
b) AI-generated preliminary reporting  
5) Other Applications • Resident Education • Quality Assurance and Patient Safety • Billing and Compliance  
6) Conclusion

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## Abstract Archives of the RSNA, 2023

INEE-44

### Designing and Implementing a DICOM Collector for Analytics, Quality Improvement, and Regulatory Compliance

All Day Room: Learning Center

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Understand the magnitude of DICOM data and architecture necessary to handle such large volumes, 2) Describe the utility that can be derived from DICOM data through additional applications, 3) Understand the pitfalls of naively scraping data without expert input

#### TABLE OF CONTENTS/OUTLINE

1) What are you collecting and why?, 2) How much data are we talking about?, 3) what kind of architecture do you need?, 4) You collected it, now what do you do with it? (applications), 5) Why is a team necessary for what database - seems like a summer project for a graduate computer science student?, 6) Does use justify the effort expended?

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## Abstract Archives of the RSNA, 2023

INEE-45

### NCI Imaging Data Commons: Towards Transparency and Reproducibility in Imaging AI

All Day Room: Learning Center

Andriy Fedorov, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

NCI Imaging Data Commons (IDC) is a cloud-based repository of publicly available cancer imaging data co-located with analysis and exploration tools and resources. IDC, part of the NCI Cancer Research Data Commons (CRDC), provides secure access to a large, comprehensive, and expanding collection of cancer research data. IDC uses a combination of commercially available (Google Cloud Platform (GCP), Amazon Web Services (AWS)) and open source components. The IDC portal (<https://imaging.datacommons.cancer.gov>) and SQL interface enable exploration and visualization of data and cohort building. As of Spring 2023, IDC hosts over 40 TB of radiology and digital pathology image data encoded using the DICOM standard, and available in both GCP and AWS. While the IDC is intended for cloud-based data processing, data can be freely downloaded for on-premise analysis. Cloud-based workflows enable reproducible analysis and results. We will present the scope and status of IDC (e.g., new datasets and features), learning resources (e.g., interactive notebooks with reproducible AI workflows applied to the data within IDC), use cases (including those demonstrating large scale time- and cost-efficient analysis workflows) and plans for future development, along with live interactive demonstrations.

#### TABLE OF CONTENTS/OUTLINE

Overview of CRDC and IDC; Data curation and the role of The Cancer Imaging Archive; Portal; Viewer; Organization of data; Integration of tools; Use case development; Documentation and user support resources; Large scale computing using CRDC Cloud Resources; IDC cloud credit program; Status update and plans for future development.

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## Abstract Archives of the RSNA, 2023

INEE-46

### Image-to-text and Text-to-image Models: A Primer for Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

An Ni Wu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review key concepts of neural network models connecting text and images;2. Discuss potential applications of image-to-text and text-to-image models in medical imaging;3. Illustrate key components involved in zero-shot prediction models;4. Understand the overall design and architectures of text-to-image models;5. Discuss future directions applicable in radiology.

#### TABLE OF CONTENTS/OUTLINE

1. Trend: groundbreaking emergence of neural network models connecting text and images.2. Relevance for radiology: a discipline connecting text reports with medical images.3. Illustration of key components involved in zero-shot prediction models: text vectorization, image vectorization, vector-space, attribute predictions, image attribute mapping, text classifier, and zero-shot prediction.4. Illustration of recent models connecting image to text (i.e., CLIP) and text to images (i.e., DALL-E, Stable Diffusion, Imagen).5. Architecture of CLIP and key messages: convolutional neural networks for text and image encoding, dataset classifier creation, zero-shot prediction model, transfer learning, natural language supervision, generalization, efficiency, flexibility, and limitations.6. Applications of text-to-image models in radiology: image classification, automated caption generation, synthetic image generation.7. Future directions: new applications in radiology and technical innovations.

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## Abstract Archives of the RSNA, 2023

INEE-47

### Rapid Clinical Deployment of AI Applications for Radiology Using Mercure - An Open Source DICOM Orchestration Platform

All Day Room: Learning Center

#### Awards

##### Cum Laude

James O'Callaghan, PhD, MEng (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this presentation is to inform the audience of available open-source software that can be used to rapidly integrate Radiology Artificial Intelligence (AI) applications into their clinical infrastructure. We will outline the need for software tools to address practical challenges in translating medical imaging research techniques into real world settings. This will be followed by a description of DICOM orchestrators and how they can help to bridge this gap by handling interactions and requirements of clinical environments. Mercure - an open-source and freely available DICOM orchestrator, will be used to demonstrate how attendees can easily integrate AI applications into their clinical workflow using an intuitive web-based user interface. MONAI (Medical Open Network for Artificial Intelligence) is a popular open-source framework for medical imaging AI. In the concluding section, we will give guidance on how MONAI can be used with Mercure to deploy AI applications for Radiology in a rapid and standardized manner.

#### TABLE OF CONTENTS/OUTLINE

1. The increasing demand for Artificial Intelligence in Radiology 2. Challenges in clinical translation of AI 3. Integration of AI applications into clinical environments using Mercure 4. Standardization and rapid deployment of AI applications

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## Abstract Archives of the RSNA, 2023

INEE-48

### AI Adoption in Clinical Practice: A Practical Guide for the Practicing Radiologist

All Day Room: Learning Center

Kevin Pierre (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- There is an increasing number of commercial AI algorithms. However, the actual value and useability of these algorithms requires more than evaluation of diagnostic performance metrics alone.
- We will review and provide practical suggestions for radiologists to use when evaluating AI software for their clinical practice.
- We will discuss important practical barriers that should be considered in order to properly assess useability and seamless integration into radiological practice.
- We will discuss pitfalls and opportunities for the use of AI to enhance clinical practice, including efficiency.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction
2. Discuss basic diagnostic metrics, relevance, and why diagnostic performance alone will not ensure impactful adoption
3. Importance of seamless workflow integration and avoiding pitfalls
  - a. Time to image processing and transfer to viewer
  - b. Pitfalls for algorithms requiring expert-viewer interactions
  - c. AI data transfer and reporting module
4. Importance of seamless workflow integration: Opportunities
  - a. Review increasing number of report augmentation and semi-automated reporting tools providing opportunities for reporting efficiency
  - b. Future areas of efficiency improvement
5. Algorithm testing and deployment challenges and opportunities
6. Non-interpretive AI applications
7. Conclusions

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## Abstract Archives of the RSNA, 2023

INEE-49

### Prompting Language Models 101: A Primer for Radiologists

All Day Room: Learning Center

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Large language model (LLMs) inception was four years ago; however, the advent of ChatGPT provides a unique user experience, showcasing the power of LLMs. Although the chat interface is exceedingly helpful, some nuances exist in creating a correctly structured prompt for a better answer, with less back and forth. This exhibit will cover three main points: 1. Introduction to Language Models 2. The Importance of Prompting 3. Popular Prompting Strategies

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to Language Models: This section covers large language model basics. What makes them a significant breakthrough in the natural language processing domain? We will focus on some of the applications of LLMs in radiology, specifically in report structuring. 2. The Importance of Prompting: The chat interface of LLMs, like ChatGPT, can cover many personal use cases. On the contrary, this interface may not be helpful for automated information extraction. Additionally, using open source LLMs (as an alternative to ChatGPT, which requires sending data outside of the institution), requires proper prompting to guide the LLM to output the desired results with only one question asked. 3. Popular Prompting Strategies: This section will cover three main prompting strategies: (a) zero-shot prompting, (b) few-shot prompting, (c) chain-of-thought prompting. We use the example of abstracting cervical vertebral fractures from radiology reports. We will provide examples of the model's output based on each prompt to give a better understanding of the importance of prompt engineering.

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## Abstract Archives of the RSNA, 2023

INEE-50

### Further Possibilities of Deep Learning in the Ultrasound Field

All Day Room: Learning Center

Gakuto Hirano (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In recent years, deep learning technology has become a necessity in the medical field. These technologies have been widely used in mammography, CT, and MRI in clinical applications. In the ultrasound field, a wide range of techniques using deep learning, such as noise reduction and automated detection, have been reported. However, it is clear that deep learning is still in its developing stage compared to other modalities. Why is this? The purpose of this exhibition is to describe the current situation, challenges, and future possibilities of deep learning applications in the ultrasound field. As an example of research using deep learning, we will go into deep learning in the ultrasound field from our research on carotid plaque region extraction and composition differentiation using ultrasound images. The major teaching points of this exhibit are: 1. Introduction of research on deep learning in the ultrasound field 2. Current situation and challenges of deep learning in the ultrasound field 3. Future possibilities with deep learning

#### TABLE OF CONTENTS/OUTLINE

1. Current situation of AI application to the ultrasound field -Noise Reduction -Segmentation -Classification 2. Introduction of our study 3. Potential AI applications in the ultrasound field

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## Abstract Archives of the RSNA, 2023

INEE-51

### **How Nationwide Medical Image Database and AI-based Image and Finding-text Analysis Work for Nation-wide Disease Spread Surveillance: Three years of experience on CT Image-based COVID-19 Monitoring**

All Day Room: Learning Center

Kensaku Mori, PhD (*Presenter*) Research Grant, Cybernet Systems Co, Ltd;Intellectual Property, Cybernet Systems Co, Ltd;Research Grant, J Morita Corporation;Intellectual Property, J Morita Corporation;Developer, J Morita Corporation

#### **TEACHING POINTS**

- To understand how nation-wide medical image database works for nationwide disease surveillance using AI-based medical image and finding-text analysis- To understand how national medical image database collects medical images from participating hospitals- To understand how AI analyzes national medical image database on a cloud computing platform- To understand what kind of data are stored on national medical image database- To understand how COVID-19 infection spread monitoring are performed on national medical image database

#### **TABLE OF CONTENTS/OUTLINE**

National medical image database- National Institute of Informatics, Japan, hosts the National Medical Image Database (NII-MID).- Participating hospitals automate daily image transfers to NII-MID.- AI-image and findings-text analyses are performed on incoming medical images.- Daily analysis utilizes AI-based methods.COVID-19 surveillance using CT images- AI -based (Convolutional Neural Network) analysis of CT images following RSNA COVID-19 CT scan classification guideline for images sent to NII-MID.- Automated data selection of CT images for analysis from NII-MID, using findings-texts.- COVID-19-related word analysis from findings-texts.- Calculation of daily COVID-19 suspicious image rates from data transfers.- Three years of experience monitoring COVID-19 cases through NII-MID.- Demonstrating the relationship between COVID-19 suspicious CT image rates and the daily number of COVID-19 related deaths.Future outlook- Expanding the functionality of NII-MID as a nationwide disease monitoring tool.- Broadening the scope of AI-based analysis targets.- Preparing for the prediction of the next unknown pandemic.

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## Abstract Archives of the RSNA, 2023

INEE-52

### Advanced and Versatile AI System for 3D Medical Image Super-resolution

All Day Room: Learning Center

Tong Zheng (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Gain an understanding of the concept of super-resolution (SR) and the differences between SR in RGB color images and medical images. 2. Identify the main challenges involved in performing SR on medical images. 3. Learn about a specialized AI system designed to overcome these challenges in medical image SR. 4. Explore the exceptional performance of our SR AI on two medical image datasets and its potential in aiding radiologists' diagnoses.

#### TABLE OF CONTENTS/OUTLINE

1. AI-based super-resolution (SR): fundamental concepts -SR is a technique that enhances the resolution of an image. -In medical imaging, SR can help radiologists observe precise anatomical structures in low-resolution (LR) images. 2. Challenges of medical image SR -AI for RGB image SR is typically trained using LR-high-resolution (HR) image pairs. - It is difficult to use AI for medical images' SR: LR and HR medical images are often acquired from different devices or scanning conditions. 3. Our specialized AI for medical image SR -We use a real-time registration network to minimize coordinate differences between LR and HR images. -We use a pre-trained generative model to minimize differences in intensity and scanning devices. 4. Two original medical image datasets to validate our SR AI -Dataset-A: micro CT (HR) - clinical CT (LR) dataset. LR-HR images differ in intensity, coordinate, and scanning device. -Dataset-B: Brain MRI dataset. LR-HR images differ in coordinate. 5. Radiologists' diagnostic process is aided by our SR AI -Our AI successfully performed SR on both medical image datasets, making it easier for radiologists to observe precise anatomical structures and make diagnosis. -Statistical analysis showed that our AI outperformed other recent AIs.

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## Abstract Archives of the RSNA, 2023

INEE-53

### Preparing for the (Un)Expected: Preventing Ransomware Attacks Before They Happen

All Day Room: Learning Center

John Gaede (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cyberattacks continue to be one of the toughest problems and biggest threats to have hit the healthcare industry in recent years. When hackers gain entry into a hospital's computer network, not only are the hospital operations, financials and data in jeopardy, but there is a direct threat to patient care and safety. As reported by SOPHOS, 34% of hospitals were hit by ransomware in the last year alone. With many hospitals expanding their digital landscape to include cloud computing, telemedicine and remote work, the vulnerability of being a target of an attack remains a risk. Sky Lakes Medical Center fell victim to a ransomware attack in October 2020. In this session, the director of information systems will discuss how his team was able to successfully recover 650 servers and 150 applications in just four weeks' time. He will share best practices of lessons learned and outline the necessary infrastructure and technology systems to have in place so other organizations can prevent disaster before it happens and ultimately help to reduce the number of ransomware attacks in healthcare.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Ransomware numbers within healthcare 3. Top vulnerabilities within healthcare organizations 4. Necessary informatics, infrastructure, and technologies to have in place 5. Key priorities and step by step on how to recover if it does happen to you 6. Conclusion

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

INEE-54

### **Collaborative Development of a PACS-Integrated Quality Control Dashboard : A Single Institutional Experience**

All Day Room: Learning Center

Vijaya K. Kosaraju, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) Designing and implementing a Technologist Quality assessment (Tech QA) dashboard that is integrated with PACS (2) Determine the appropriate QA metrics over a period of time to set up the baseline and target areas for improvement (3) Design a way to deploy the right interventions and measure the resulting response (4) Analyze the intervention response to measure improvement over baseline as a way to improve patient care and radiologist satisfaction.

#### **TABLE OF CONTENTS/OUTLINE**

(1) Introduction to Tech QA (2) How we did it over time (3) Developing the current PACS integrated QA system (4) Challenges associated with implementation and deployment a) Challenges in the backend b) Challenges to educate radiologists and technologists c) Make an efficient path for review of the QAs d) Design a closed feedback loop for efficient processing (5) Initial results of the Tech QA process (6) Interventions deployed as a result of baseline metrics (7) Analyzing the results of the interventions (8) Conclusion (9) Future goals

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## Abstract Archives of the RSNA, 2023

INEE-55

### Programmatically Generating Radiology Report Fields to Facilitate Structured Reporting Utilizing RadElements.org

All Day Room: Learning Center

Andrew A. Gomella, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-A significant barrier to adoption of structured reporting and use of standardized data elements is the need for each element/concept to be manually created within individual institution's production reporting software-The ability to programmatically create complex report fields and templates helps reduce the barrier to entry-With a relatively short python script the entirety of the RSNA/ACR RadElement.org common data element library can be converted to Powerscribe macros, which can be dragged-and-dropped into reports or batch loaded into the dictation system for department wide use

#### TABLE OF CONTENTS/OUTLINE

1. Motivation for creating a programmatic interface for generating radiology report fields and reports
2. Reverse engineering the structure of a standard radiology report file (from Powerscribe)
3. Approach to generating the report fields and templates in python utilizing XML (Extensible Markup Language) and raw text functions
4. Generating autotext snippets for use in reports from RSNA's radelement.org
5. Demo of drag and drop functionality adding rad elements or rad element sets to a report template

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## Abstract Archives of the RSNA, 2023

INEE-56

### How Graph Neural Network Works for Automated Nomenclature of Abdominal Blood Vessels

All Day Room: Learning Center

Kensaku Mori, PhD (*Presenter*) Research Grant, Cybernet Systems Co, Ltd;Intellectual Property, Cybernet Systems Co, Ltd;Research Grant, J Morita Corporation;Intellectual Property, J Morita Corporation;Developer, J Morita Corporation

#### TEACHING POINTS

- To understand what is graph convolutional network (GCN)- To understand how GCN is applied for vasculature nomenclature- To understand automated nomenclature performance by GCN- To understand anatomical annotation for 3D blood vessel regions by GCN-based automated nomenclature

#### TABLE OF CONTENTS/OUTLINE

Introduction- The importance of automated vasculature nomenclature as a key function in future CAD systems.- Enhancing CT image reading workflow with automated vasculature nomenclature.- Overview of abdominal vasculature systems and their anatomical names.Spectral based graph convolution and graph convolutional network- Review of the theoretical aspects of Graph Convolutional Networks (GCN).-Review of spectral-based graph convolution operations in GCN and their computer implementation.How to apply GCN for automated nomenclature of abdominal blood vessels- Extracting blood vessel tree structures from CT images.- Feature extraction from tree structure.- GCN training methodology.- Automated nomenclature using GCN.Experiments- Configuration of training data.- Annotation of training data.- Evaluating nomenclature performance.- Automated annotation of 3D-rendered blood vessels based on automated nomenclature.- Performance changes for different convolutional areas.Discussion- Limitations of GNN-based automated nomenclature for blood vessels.- Enhancing radiological and surgical readings of CT images with automated nomenclature.- The effectiveness of automated nomenclature in constructing symbolic logic-based CAD systems.

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## Abstract Archives of the RSNA, 2023

INEE-6

### Designing a Radiomics study: Hurdles and Pitfalls

All Day Room: Learning Center

Adarsh Ghosh, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Radiomic studies are complex, requiring a unique trial design, data preparation, informatics tools, and infrastructure.2. Radiomic studies are often designed to be hypothesis-generating rather than to answer a hypothesis. This difference in study design requires researchers to identify key comparative data such as patient outcome or histologic diagnosis before the study begins.3. Because radiomics is still a nascent field of imaging research, there are unique challenges and potential pitfalls at every step of the research process.

#### TABLE OF CONTENTS/OUTLINE

Radiomics 101 Tools needed to perform a radiomics study Steps of a radiomics study Asking the right questions: -- Is there clinical value? -- Finding the right comparative measure Data curation: the curse and blessing of electronic medical records Imaging data: -- Not all data is created equally: Data Preparation -- Managing multi-institutional data Image segmentation: - - So many circles, so much time -- Managing multiple series Feature extraction: IBSI and open source -- Pyradiomics and more Data modelling: Feature selection and dimensional reduction Data analysis and validation: Finding signal in the noise Common errors in study design and strategies to avoid them: -- Overfitting -- Data leakage -- Data peeking Significance does not equal importance

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## Abstract Archives of the RSNA, 2023

INEE-7

### Fight for Fairness in AI for Medical Imaging

All Day Room: Learning Center

Po-Chih Kuo, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To highlight the critical importance of fairness in AI for medical imaging, emphasizing the negative impacts of biased algorithms on patient outcomes. 2. To provide an overview of various evaluation metrics that can be used to assess fairness in AI models, including equality of opportunity and demographic parity, with a particular focus on their application in medical imaging. 3. To introduce debiasing methods such as pre-processing techniques and adversarial training, and discuss their effectiveness in addressing bias in AI models for medical imaging. 4. To encourage ongoing discussion and action to promote fairness and equity in healthcare AI and identify future challenges in this rapidly evolving field.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
1.1. Importance of fairness and bias in AI for medical imaging  
1.2. Brief review of previous studies addressing fairness issues  
2. Definitions of fairness and bias  
2.1. Explanation of fairness and bias  
2.2. Types of bias  
3. Methods to mitigate bias  
3.1. Pre-processing techniques (e.g., data cleaning, re-sampling, feature selection)  
3.2. In-processing techniques (e.g., pruning, contrastive learning, adversarial training)  
3.3. Post-processing techniques (e.g., calibration)  
4. Evaluation metrics for fairness  
4.1. Explanation of evaluation metrics used to assess fairness: demographic parity, equalized odds, and equality of opportunity  
4.2. Advantages and limitations of each metric  
5. Challenges  
5.1. Lack of diversity and representation in healthcare data  
5.2. Technical limitations of current debiasing methods  
5.3. Action to promote fairness and equity in AI for healthcare

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## Abstract Archives of the RSNA, 2023

INEE-8

### Approaches to Writing and Implementing Custom Software as a Trainee at a Large Academic Health Center

All Day Room: Learning Center

Andrew A. Gomella, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Coding is an increasingly popular and important skill, with more non-career programmers picking up coding skills.- Recently released large language models have decreased the entry barrier for coding by demonstrating the possibility of generating complex software from natural language prompts.- Writing, implementing, and testing code in a health system presents unique barriers and challenges, but it is possible even as a trainee.- Significant variation in practice/hospital IT infrastructure, security policies, and the suite of radiology/EHR combinations unfortunately limits cross-institutional development of software.- The software approach, including whether to use a specific language, how to distribute to colleagues, and attention to IT security, depends on the specific problem at hand and can range from surprisingly trivial to prohibitively complex.

#### TABLE OF CONTENTS/OUTLINE

- Motivation- A general approach to tackling software ideas, from feasibility to production- Is there an API(Application Programming Interface)? and what can be done if there isn't?- Institutional variation in IT and software suites, and why it matters- Security considerations- Low code solutions: Example of a program that can be completely run within our hospital infrastructure without any installation or 'writing' code.- Scripting solutions: Example of AutoHotKey scripts including a few line solutions, to dynamically modify open radiology report text.- Python: Swiss army knife, with limitless possibilities and vast online community- Browser plugins: Example of a Chrome plugin used to add features to intranet web pages.- PACS and EHR plugins

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## Abstract Archives of the RSNA, 2023

INEE-9

### Maximizing Generative AI's Potential in Radiology: Fine-Tuning and Prompt Engineering

All Day Room: Learning Center

Theodore T. Kim, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- ChatGPT and other generative AI tools have the potential to play significant roles in education, research and clinical practice for diagnostic radiology- One way to maximize their use and potential is by focusing on improving the quality of its output through the processes of fine-tuning and prompt engineering- Fine-tuning is the process of training a pre-trained model on a smaller, task-specific datasets to improve its performance on that task. For example, training a model with specific terminology and recommendations associated with updated Fleischner criteria to guide management of pulmonary nodules on a model already trained on a larger dataset of radiologic imaging- Prompt engineering focuses on designing and refining input queries to obtain the most accurate and relevant desired output. These methods can include using radiology-specific terminology, providing necessary medical context, crafting precise prompts with specific constraints, and using iterative processes to identify and develop the most effective prompt structures.

#### TABLE OF CONTENTS/OUTLINE

1. Principles of Fine Tuning  
2. Commonly used Algorithms for Fine Tuning  
3. Fine Tuning in ChatGPT  
4. Principles of Prompt Engineering  
5. Prompt Engineering in ChatGPT

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## Abstract Archives of the RSNA, 2023

IREE

### Interventional Radiology Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **IREE-1 Pre-operative Osseous Tumor Embolization: A Review of Presentation, Benefits, and Technical Details**

##### Awards

##### Certificate of Merit

Ashini A. Patel, MBA, BS (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

1. Preoperative tumor embolization is a safe and effective adjunctive to tumor resection that has benefits including decreased estimated blood loss, and less complications. 2. There are only few contraindications to pre-operative embolizations, and most patients that undergo the procedure will benefit for later tumor resection.3. Importance of tumor feeding arteries.4. It is valuable to consider all patients with suspected hypervascular osseous for preoperative tumor angiography and embolization.

##### TABLE OF CONTENTS/OUTLINE

1. A review on osseous tumors, their typical management and how preoperative embolization can improve outcomes.2. Selection of patients that would benefit from this procedure before tumor resection.3. Review of example cases outlining the technical details of the embolization procedure, to include devices used and the importance of tumor feeding arteries.4. Analyze the efficacy and safety of pre-operative embolization and its value in decreased estimated blood loss and transfusion need, and complications. Compare this data to surgical resection without embolization.

#### **IREE-10 To Sclerose or Decompress? Comparing BRTO and TIPS for Gastric Variceal Management**

Anish Narayanan, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

Objectives\* Understand gastric variceal (GV) anatomy\* Identify indications and contraindications for BRTO and TIPS\* List conventional and alternative procedure steps\* Recognize common and rare intra- and post-procedural complications

##### TABLE OF CONTENTS/OUTLINE

Outline:1. Introduction (epidemiology, mortality)2. Anatomy:\* Location (GOV and IGV classification)\* Afferent/efferent anatomy (Kiyosue classification)\* Uphill/downhill drainage patterns3. Indications:\* Variceal bleeding (active or prophylaxis)\* BRTO: HCC, refractory HE, preserving liver function\* TIPS: Portal HTN with  $\geq 12$  mmHg4. Contraindications:\* BRTO: Portal/splenic vein thrombosis, refractory ascites, uncontrolled EV, absent gastroduodenal shunt, severe portal HTN\* TIPS: HE, Child-Pugh C, CHF, pulmonary HTN, cystic liver disease5. Procedural Steps:\* BRTO (including both conventional approaches as well as modified approaches, including CARTO and PARTO)\* TIPS (including CO<sub>2</sub> venography, portography, various vascular approaches, and embolization)6. Complications:BRTO:\* Intra-procedural: sclerosant extravasation, balloon rupture, premature balloon deflation\* Post-procedural: ARF, hemolysis, cardiogenic shock, pulmonary edema, DIC, PE, portal/splenic/renal vein thrombosis, adrenal infarctTIPS:\* Intra-procedural: Liver capsule/parenchyma/biliary injury, PV rupture, arrhythmias\* Post-procedural: HE, hepatic failure, TIPS migration/dysfunction, infection

#### **IREE-11 Microwave Ablation of the Liver Lesions in Critical Locations: Are there No-No Zones**

Merve Ozen, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1. Thermal ablation is the mainstay of treatment for small hepatic tumors (<2 cm). Thermal ablation may not be preferred in these patients if the tumors are in high-risk locations, however. These high-risk locations include, but are not limited to, tumors adjacent to the main portal vein, the inferior vena cava, the gall bladder, the diaphragm, and the heart. 2. By discussing the literature and showing cases of successful microwave ablation of tumors in high-risk locations, we show that MWA can be a safe and effective.

## TABLE OF CONTENTS/OUTLINE

1. The major differences between radiofrequency ablation and microwave ablation as it pertains to the management of malignancy. 2. Cases of microwave ablation of tumors in high-risk locations and a discussion of the current literature on the safety and efficacy of such procedures. 3. The cases display the ablation of tumors adjacent to the main portal vein, the inferior vena cava, the gall bladder, the diaphragm, and the heart. 4. Technical maneuvers will be described to increase safety and efficacy for the difficult lesions.

### **IREE-12 Ablation vs Free Life. Colorectal Cancer with Lung Metastases: Evaluation of Local Recurrence and Chemotherapy-free Interval in Patients Treated with Ablative Therapy**

Pedro L. Lino, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To discuss percutaneous ablation and its role as a safe and effective treatment option for colorectal cancer lung metastases, and the benefits of its minimally invasive nature. To determine patient selection characteristics, preprocedural planning, and tactics involved in a safe and successful outcome, particularly in challenging cases. To examine the impact of ablation (RFA and MWA) on overall survival and chemotherapy-free interval in patients with lung metastases from colorectal cancer.

## TABLE OF CONTENTS/OUTLINE

1. Introduction and epidemiology 2. Procedure applied anatomy 3. RFA treatment techniques a. Patient positioning; b. Tactical pneumothorax; c. Leverage; d. Hydrodissection. 4. Acute complications 5. Evaluation of disease progression

### **IREE-13 Thermal Protection: Heightened Safety for Minimally Invasive Percutaneous Thermal Ablation of Musculoskeletal Tumors**

Anderanik Tomasian, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Over the past two decades, minimally invasive percutaneous image-guided thermal ablations have been progressively incorporated in the management paradigm of patients with musculoskeletal tumors and endorsed by the National Comprehensive Cancer Network and American College of Radiology. The high clinical success rates and durability of therapeutic effects of such interventions to achieve local tumor control, pain palliation, and cure have been documented in the recent literature. Therefore, safety of musculoskeletal thermal ablations is critical and must be ensured by radiologists in care of patients with bone tumors for improved patient outcomes. To enhance safety and minimize undesired thermal injury to surrounding vital tissues as a result of non-target ablation, several thermal protection strategies have been successfully implemented in clinical practice.

## TABLE OF CONTENTS/OUTLINE

- General considerations
- Neuroanatomic considerations
- Tissues at risk (Spinal cord, spinal and peripheral nerves, torso organs, articular cartilage, subchondral bone plate/physis, skin)
- Thermal protection techniques (Indications and Choice of technique)
- Passive thermal protection (Patient Biofeedback and Clinical Assessment, Temperature Monitoring strategies, Neurophysiological Monitoring with somatosensory and motor-evoked potentials, Electrostimulation)
- Active thermal protection (Thermal Insulation strategies, Thermal Modification techniques)
- Thermal Injuries/Complications and their management

### **IREE-14 The Rise of Robotics in Interventional Radiology**

Shen Ning (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- The use of robotics in interventional radiology is an emerging trend following medical technology and engineering developments in recent years.
- Robotic-assisted interventional radiology is beginning to play a key role in cardiac and neurovascular interventions and expanding rapidly.
- Endovascular robotic systems can help facilitate precise and stable catheter navigation while reducing radiation exposure during procedures.

## TABLE OF CONTENTS/OUTLINE

1. Overview of the history and timeline of robotics in interventional radiology. 2. Introduction and summary of robotic systems and their advantages and disadvantages. 3. Key studies demonstrating the role of robotics for endovascular interventions. 4.

Telerobotics in interventional radiology and its roles and limitations.5. Future prospects for robotic-assisted interventional radiology.

### **IREE-15 How to Perform a Correct Access for Minimally Invasive Lumbar Spine Procedures**

Natalia Parra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Fluoroscopy guided interventions in lumbar spine involve a variety of minimally invasive procedures for improving pain management. Three of the main approaches typically used to get access to the targeted structure are transforaminal, interlaminar and transpedicular. The aim of the proposed exhibit is to provide radiology residents and fellows with a quick guide to better understand the basics of these techniques and thus be able to perform a safer and more effective access. At the outset, the exhibit will list the different types of procedures enabled by the abovementioned approaches. Following, it will provide a pictorial review of the anatomical keys in preprocedural imaging studies. Finally, the exhibit will explain how to perform the approaches step-by-step, from the positioning of the angiograph and the anatomical references to the needle insertion, and will conclude by describing how to check its correct positioning.

#### **TABLE OF CONTENTS/OUTLINE**

1. Types of procedures and related approaches. 2. Imaging studies: what to look at and how to do it.3. Angiograph positioning and anatomical references.4. How to perform and correct the approaches in real time.5. How to check the positioning of the needle.

### **IREE-16 Percutaneous Cryoablation: A Comprehensive Review of Whole-body Application**

Luis E. Garza-Barrera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Percutaneous cryoablation is a minimally invasive procedure that is safe and effective in treating various solid benign and malignant lesions throughout the human body.2) Imaging and tissue diagnosis is necessary before ablation to ensure that cryoablation is the most appropriate modality of treatment.3) Percutaneous cryoablation can be performed with ultrasound, fluoroscopy, computed tomography, or magnetic resonance imaging guidance. Knowing the risks and benefits of each modality is important for choosing the best modality for individual patient lesions.4) Cryoshock is a feared clinical syndrome after cryoablation for which early diagnosis and management is crucial.5) Abscopal effect is a unique effect of cryoablation based on immune-mediated post-ablation antigen presentation.

#### **TABLE OF CONTENTS/OUTLINE**

1) Mechanism of action and physics of cryoablation leading to induction of cellular apoptosis and the understanding of ablation artifacts.2) Indications and contraindications, diagnostic workup, and imaging diagnosis for lesions amenable to cryoablation.3) Procedural protocols for the management of lung/kidney solid tumors, metastasis, bone and soft tissue solid/cystic lesions, nerve pain, and vascular malformations.4) Adverse effects of cryoablation including cryoshock and the mitigation of these effects.5) Abscopal effect and future directions for the use of cryoablation to prevent lesion recurrence and treat metastatic disease.

### **IREE-17 The Need for Virtual Fluoroscopic Imaging in Bronchial Artery Embolization: The Best for Radiation Exposure Dose Reduction**

Yoshihiro Tanaka, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In this study, we investigated the relationship between supporting images of a new concept and exposure reduction in bronchial artery embolization <BAE>. This is research on exposure reduction aimed at shortening the procedure time by creating a support image similar to the IR image using CT volume data, in contrast to the existing exposure protection and exposure reduction mechanisms of IR equipment.

#### **TABLE OF CONTENTS/OUTLINE**

A virtual fluoroscopic image<VFI> is a Ray-summation image that is similar to a fluoroscopic image, and blood vessel running and the lesioned part are superimposed and displayed(Fig.1). Thereby it possible to use information intuitively alongside fluoroscopic images, and to avoid unnecessary mapping imaging for bronchial artery identification and time waste due to blind catheterization under fluoroscopy, aiming at rapid vascular selection and hemostasis(Fig.2,3). Also, a workstation can be easily installed and implemented, and the CT volume data obtained in advance is used so that there is no need to purchase new and expensive IR equipment.As a result, the number of angiographies required for dissection can be minimized, which not only reduces the amount of contrast agent and exposure, but also reduces complications by shortening the procedure time(Table1,2).

### **IREE-18 2022 Barcelona Clinic Liver Cancer Update for the Interventional Radiologist**

BS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- 1) Understand the updates to the 2022 Barcelona Clinic Liver Cancer (BCLC) guidelines for managing patients with hepatocellular carcinoma (HCC)
- 2) Review supporting evidence for transarterial chemoembolization (TACE) and percutaneous ablation
- 3) Highlight recent evidence surrounding transarterial radioembolization (TARE) that warranted its inclusion in the new guidelines
- 4) Discuss the new systemic agents included in the 2022 BCLC guidelines and their supporting evidence

### TABLE OF CONTENTS/OUTLINE

- 1) Introduction, including epidemiology of HCC and interventional radiology (IR) management options in the previous BCLC guidelines
- 2) BCLC framework for classifying HCC
- 3) Review of existing literature on TACE and percutaneous ablation for patients with HCC
- 4) Overview of updates in the 2022 BCLC guidelines for IRs: Sub-division of Intermediate Stage (Stage B) patients, extending the existing liver transplant criterion to include more patients and include systemic options for other patients at this stage
- 5) Overview of updates in the 2022 BCLC guidelines for IRs: Inclusion of TARE for the first time in the guidelines, with a review of new, high impact studies leading to the inclusion of TARE
- 6) Overview of updates in the 2022 BCLC guidelines for IRs: New systemic agents for patients with advanced stage disease, including a review of high impact studies leading to the addition of the new systemic agents in the guidelines
- 7) Discussion of combination therapies for HCC such as TACE + systemic therapy, TARE + systemic therapy, TACE + percutaneous ablation, and percutaneous ablation combined with adjuvant systemic therapy
- 8) Conclusion and summary

## IREE-19 Imaging and Interventional Management of Lymphatic System Disorders

Eric Castane, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Review the lymphatic system disorders.
2. Describe the radiologic management of the lymphatic system disorders.

### TABLE OF CONTENTS/OUTLINE

1. Material and Methods / Background Lymphatic.
2. Anatomy and Physiology.
3. Disorders of the Lymphatic System.
  - 3.1. Classification.
  - 3.2. Diagnosis.
4. Imaging of the Lymphatic System.
  - 4.1. Ultrasound.
  - 4.2. Magnetic Resonance.
  - 4.3. Nodal Lymphangiography.
  - 4.4. Imaging in Lymphatic Disorders.
5. Interventional Management of Lymphatic Disorders.
  - 5.1. Chylothorax.
  - 5.2. Chyle Ascites.
  - 5.3. Peripheral Lymphatic Leak.
  - 5.4. Lymphatic Plastic Bronchitis.
6. Post Procedure
  - 6.1. Complications.
  - 6.2. Post Procedure Imaging.
7. Conclusions.

## IREE-2 Shoot Your Shot: Techniques and Pitfalls of Pelvic Collection Drainage

Kateryna Burlak, MBBS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Most pelvic collections can be drained safely and effectively through a percutaneous image-guided approach. Collections in locations that are difficult to access pose a unique challenge and invite consideration of alternative approaches. We aim to discuss the techniques and pitfalls of these approaches, to encourage drainage of collections initially considered difficult or inaccessible and to raise awareness about potential complications. Teaching points of this exhibit include the following:

- 1 - To review the methods and anatomy of potential approaches involved in drainage of pelvic collections (including transperineal, transgluteal, transrectal and transvaginal approaches)
- 2 - To demonstrate general techniques used (Trocar vs Seldinger techniques)
- 3 - To discuss potential complications which can occur in drainage of pelvic collections and how to avoid them

### TABLE OF CONTENTS/OUTLINE

1. Methods and anatomy of potential approaches: Lateral abdominal wall, Anterior abdominal wall, Transgluteal, Transperineal, Transrectal, Transvaginal
2. General techniques used
3. Examples of potential pitfalls and complications
4. Summary and teaching points

## IREE-20 Next Step for Colorectal Liver Metastasis Ablation: Computed Tomography During Hepatic Arteriography Guidance in Percutaneous Thermal Ablation

### Awards

#### Certificate of Merit

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- 1) This study aims to show the feasibility and accuracy of using computed tomography during hepatic arteriography (CTHA) as a percutaneous ablation guidance tool for colorectal liver metastasis (CLM) patients.
- 2) CTHA is performed via a transarterial catheter inserted into the hepatic artery for arterial assessment. It involves dual-phase contrast medium

acquisition with specific rates and acquisition delays during a breath hold on expiration. 3) CTHA improves CLM visibility due to high contrast resolution and absence of portal venous system contrast-media deposition. CLMs appear hypoattenuating with a necrotic center and ill-defined enhancing rim visible on the arterial phase. 4) In contrast to its high sensitivity, CTHA specificity for detecting small tumors is often limited by the presence of pseudolesions. Moreover, limitations include potential complications related to sheath and catheter placement, physician's costs and time, and arterial anatomy variants. 5) CTHA enables precise oncologic intervention planning, combined therapies, and intraprocedural treatment response monitoring. Further research is needed to fully evaluate its clinical utility for guiding CLM ablation.

#### **TABLE OF CONTENTS/OUTLINE**

1) 'Let's Put a Ring on It' - CLM imaging presentation on CTHA; 2) Setting the Target - Image-guiding techniques in percutaneous liver tumor ablation and CTHA protocol; 3) Tips or tricks - Pseudolesions or CLMs? 4) Thinking Outside the Box - Future Perspectives

### **IREE-21 Minimally Invasive Thoracic Tumor Treatment and Palliation**

Anna S. McKenney, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Percutaneous ablation is an established safe treatment for primary and metastatic lung tumors. Adjunct intra-procedural maneuvers, such as creation of artificial pleural effusions or pneumothoraces, can permit treatment of tumors adjacent to critical structures. Emerging approaches such as arterial chemoembolization are altering the landscape of intervention for thoracic malignancies. Minimally invasive procedures such as percutaneous tumor localization, thoracic tumor embolization, and image-guided brachytherapy seed implantation can enable multidisciplinary treatment. Palliative interventions, ranging from embolization to shunt implantation, can provide palliation for thoracic oncology patients.

#### **TABLE OF CONTENTS/OUTLINE**

Tumor treatment Percutaneous ablation Radiofrequency ablation Cryoablation Microwave ablation Technical considerations during ablation Chemoembolization of lung tumors Interdisciplinary procedures Tumor localization prior to surgical resection Preoperative embolization of central thoracic tumors Image guided brachytherapy seed implantation Palliation Glue embolization of bronchopleural fistulas Bronchial artery embolization for hemoptysis Recurrent pleural effusion management Tunneled indwelling pleural catheters Denver pleurovenous shunt

### **IREE-22 The Effects of Artificial Intelligence and ChatGPT on Interventional Radiology**

Mahmoud Odeh (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

\*Artificial intelligence (AI) learns from data, and processes it to perform tasks requiring human intelligence\*AI can help create customized treatment plans for patients\*Fluoroscopy systems with AI reduce radiation exposure to make procedures safer\*Pre-operative and intraoperative images integrated by AI, provide more accurate guidance for image-guided procedures\*AI can create virtual angiography, which can be used for education and planning purposes\*ChatGPT can assist radiologists in creating educational and research materials more efficiently

#### **TABLE OF CONTENTS/OUTLINE**

Artificial intelligence (AI) refers to computational models that use algorithms to process data, learn from it using the output to perform tasks traditionally associated with human intelligence. AI models utilize patient diagnostic images and clinical findings to anticipate procedural outcomes. This enables interventional radiologists to customize treatment plans for each patient beforehand. AI has enabled fluoroscopy systems to substantially decrease radiation exposure to patients and staff. This is evidenced by a significant reduction in median dose area product from 5,708 mGy·cm<sup>2</sup> to 2,178 mGy·cm<sup>2</sup> (P < 0.001). AI can integrate pre-operative 3D with intraoperative 2D images, improving guidance for biopsies and image-guided procedures. This added augmented-reality element enhances the accuracy and safety of interventional procedures. AI employs preoperative imaging to create virtual angiography, which acts as an educational and real-time planning aid for both trainees and seasoned interventionalists. With the advent of chatGPT radiologists can harness AI to aid in the composition of educational and research material.

### **IREE-23 Intercostal Neurolysis: A Primer**

Omar Al-Daoud, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review relevant anatomy of the intercostal nerves. Describe indications for neurolysis. Describe risks of intercostal neurolysis. Highlight tips and tricks for risk mitigation.

## TABLE OF CONTENTS/OUTLINE

Goals and Objectives, Case Presentation, Intercostal Nerve Anatomy, Indications for Intercostal Nerve Block and Neurolysis, Risks of Intercostal Neurolysis, Mitigating Risks, Nerve Block Cocktail, Additional Case Presentations, Learning Points

### IREE-24 Gastrointestinal Tract Tumors: Imaging and Interventional Management of Bleeding

Forrest B. Linch, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Learn mesenteric angiographic anatomy with special attention to anatomical variations and the blood supply to specific portions of the GI tract, which may affect treatment approach. 2. Learn common primary and metastatic etiologies of gastrointestinal tract bleeding requiring intravascular intervention. 3. Understand diagnostic imaging findings and interventional radiologic techniques for managing gastrointestinal tract bleeding

## TABLE OF CONTENTS/OUTLINE

1. Mesenteric angiography: A) Standard technique and anatomy, B) Normal variant anatomy, C) Blood supply to specific portions of the GI tract; 2. Angiography of gastrointestinal tract malignancies: A) Common pathologies by location, B) Angiographic finding of tumors; 3. Diagnostic imaging of gastrointestinal tract malignancies: A) Modality selection (CT, MRI, NM), B) Expected findings and treatment implications; 4. Intravascular management of bleeding gastrointestinal tract malignancies: A) Indications, contraindications, B) Pre-procedure planning - i) Clinical evaluation, ii) Role of cross-sectional imaging and endoscopy, iii) Anatomic/vascular considerations (arterial supply, collaterals, variants), C) Technique - i) Particle versus coil embolization, ii) Coil embolization for protection of non-target structures, D) Outcomes and complications;

### IREE-25 Advancing Frontiers in Lung Malignancy Treatment: Unraveling the Potential of Interventional Radiology in the Ablation of Lung Malignancies

Izzet Altun, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Interventional radiology has evolved as a promising modality for the ablation of lung malignancies. Various techniques such as Radiofrequency Ablation (RFA), Microwave Ablation (MWA), and Cryoablation are extensively utilized, each with unique benefits and limitations. The choice of technique is determined by factors such as lesion size, location, and patient condition. These image-guided percutaneous ablation techniques are particularly advantageous for patients unsuitable for surgery or stereotactic radiation therapy. Future directions point towards refining these techniques, improving patient selection criteria, and integrating these modalities with novel systemic and loco-regional therapies for comprehensive patient care.

## TABLE OF CONTENTS/OUTLINE

The report provides an overview of image guided ablation of lung malignancies. The goal is to present mechanism, advantages, and limitations of RFA, MWA, cryoablation and other less common techniques such as laser ablation. Discussion on patient selection, pre and post-procedural evaluation for lung ablation will be presented. Outline: 1- Introduction to IR in lung ablation, highlighting the scope of RFA, MWA, and cryoablation. 2- Detailed exploration of ablative techniques, focusing on mechanisms, optimal application, and potential drawbacks. 3- Examination of patient selection criteria, pre and post-procedural evaluation, and contraindications. 4- Analysis of the anesthesia management, CT protocols, and periprocedural considerations for lung ablation. 5- Discussion on the current state of research and future directions, emphasizing the potential for improved techniques and integrative treatment approaches. 6- Conclusion

### IREE-26 Creating Transvenous Intrahepatic Portosystemic Shunts (TIPS) with the Aid of Ultrasound (US): Tips for US

#### Awards

##### Certificate of Merit

Andrew Ni (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Learning Objectives Review standard steps for conventional TIPS creation. Provide steps and tips for using intracardiac echography (ICE) catheters and transabdominal ultrasound for aiding in TIPS creation. Discuss advantages and disadvantages of the various equipment used for TIPS creation and when to consider each.

## TABLE OF CONTENTS/OUTLINE

Content/Outline Introduction Review steps for performing TIPS creation using fluoroscopic guidance Review cross sectional imaging to aid in procedure planning Demonstrate indirect portography and limitations. Demonstrate each of the key steps for creating a TIPS. Review ICE catheter setup Jugular vs Femoral approach Tips for orienting user to key anatomy and needle directing Tips to improve efficiency Review Transabdominal US set up Tips for orienting user to key anatomy and

needle directing Tips to improve efficiency Discuss advantages and disadvantages each approach Unique cases best managed by each guidance modality Prevention of complications by each guidance modality Cost accessibility of each guidance modality While TIPS procedures are most commonly done using conventional fluoroscopy guidance, ultrasound may be used in conjunction with benefit. This presentation reviews guidance modalities for TIPS creation focusing on key imaging and circumstances favorable and unfavorable to each guidance modality.

### **IREE-27 The ABCs of CT-guided Lung Biopsy: Tips and Tricks for Optimal Outcomes**

Miriana E. Mariussi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to: • Review the indications for the percutaneous CT-Guided lung biopsy • Comprehend the pre-procedural imaging analysis and planning • Assess the principles of the percutaneous biopsy techniques and co-axial techniques • Knowledge the common complications after the procedures and their management • Highlight the recommendations to avoid pneumothorax and other complications • Recognize common CT image findings observed in the post-procedural follow-up

#### **TABLE OF CONTENTS/OUTLINE**

Percutaneous biopsy of lung lesions is increasing due to the rise of cancer incidence and the growing need for molecular and immunohistologic analyses. The size of the lesion, the size of the biopsy needle and the chosen technique have a direct impact on the success of the procedure. A case based pictorial essay allows for a comprehensive assessment of: • Indications and patient selection for percutaneous CT-Guided lung biopsy • Establishing a concise pre-procedural imaging analysis and planning • Percutaneous technique and co-axial techniques • Needle positioning, trajectory and lesion sampling • Recognizing expected complications after the procedure • Strategies and tips for achieving a successful outcome • Reducing the risk of pneumothorax and other complications • Highlighting important post-procedural management steps • Understanding biopsy results and follow up

### **IREE-28 CT Guided Trans-osseous Biopsy, a Road Less Traveled: A review of Indications, Technical Aspects and Literature Summary**

Omar Rendon SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

CT guided transosseous biopsy is an alternative technique for lesions blocked by vital structures or apparently directly inaccessible. Coaxial technique is essential in transosseous biopsy, as it allows taking various samples through a secure access diminishing the number of skin punctures and risks of tumor seeding. The success of these procedures depends on the knowledge of regional anatomy, a correct planning and experience of the operator.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Usually when performing an image guided percutaneous biopsy, the access is selected using the shortest path, avoiding vessels, nerves, or organs. Sometimes, this is not possible and more aggressive procedures, such as surgery, are required. A transosseous access can be used as an alternative approach to tackle this setback and sample deep and challenging targets. Furthermore, CT guided transosseous biopsies can be performed in order to reduce complication risks. Approaches: -Trans-sternal: lesions in anterior mediastinum. -Trans-rib: for pleural-based lung lesions or immediately deep to a rib -Trans-scapular: for apical lung lesions abutting superior margin of major fissure. -Trans-vertebral: for lesions anterior to the vertebral body, aorticaval lymph nodes. -Trans-iliac, pubic or sacral for internal iliac lymph nodes, other deep pelvic nodes in patients with pelvic malignancy or presacral lesions. Technical considerations. Complications. Take home messages

### **IREE-29 Multiple Cavitory Lung Lesions on CT: Biopsy Approach, Accuracy and Safety**

Juan Wang (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the different biopsy approaches available for multiple cavitory lung lesions on CT, including transthoracic needle biopsy, bronchoscopy, and surgical biopsy, and their relative advantages and disadvantages.
2. Learn how to assess the accuracy of biopsy results, including sensitivity, specificity, and positive predictive value.
3. Become familiar with the potential complications associated with each biopsy approach, such as pneumothorax, bleeding, and infection, and how to manage them.
4. Appreciate the role of image guidance in improving the accuracy and safety of biopsy procedures for multiple cavitory lung lesions on CT.
5. Understand the importance of multidisciplinary collaboration among radiologists, pulmonologists, and thoracic surgeons in developing a biopsy strategy.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: This section will provide an overview of multiple cavitory lung lesions and the importance of accurate diagnosis and treatment.
2. Biopsy approaches: This section will discuss the different biopsy approaches for multiple cavitory



lung lesions, including CT-guided biopsy, bronchoscopy, and surgical biopsy.3. Accuracy of biopsy: This section will focus on the accuracy of biopsy for multiple cavitary lung lesions. It will discuss factors that can affect the accuracy of biopsy, such as lesion size, location, and underlying pathology.4. Safety of biopsy: This section will review the safety of biopsy for multiple cavitary lung lesions. It will discuss potential complications associated with each biopsy approach, such as bleeding, pneumothorax, and infection.5. Conclusion: This section will summarize the key takeaways from the education exhibit.

### **IREE-3 Sticky Situations: Expanding the Role of Glue in Trauma**

Shriya Veluri (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Discuss the properties of liquid embolic (glue); Characterize ideal uses for glue in traumatic injuries; Use cases to review diagnostic trauma CT findings, angiographic correlates and post glue embolization appearances; Review potential complications and pitfalls of glue embolization.

#### **TABLE OF CONTENTS/OUTLINE**

Outline: Introduction; Review of traumatic injuries and ideal cases for liquid embolics; Properties of glue (N-butyl cyanoacrylate), how to prepare, mixtures and delivery techniques; CT findings before and after glue embolization and how to differentiate from evolving injuries; Case presentations: Pseudoaneurysms (Spleen, Liver, Renal, Pelvis, Extremity), Active Extravasation (Spleen, Liver, Pelvis), and Traumatic AV Fistulas; Complications of glue embolization (non-target embolization, portal vein embolization, pulmonary emboli, skin injury) and how to prevent them. Conclusion: Glue is a versatile embolic which can be safely deployed in traumatic intervention. As glue becomes more frequently used, an understanding of expected post embolization changes is necessary to minimize erroneous reporting.

### **IREE-30 Thoracic Vent for Management of Pneumothorax: Review of Technique and Comparison to Conventional Thoracostomy**

Latika Baranga, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Incidence of pneumothorax in patients undergoing transthoracic needle biopsy reported varying from 9-54%. Current treatment options include observation/conservative, simple aspiration, thoracostomy tube placement, ambulatory management with Thoracic vent placement or thoracostomy tube with or without Heimlich valve. Here we describe Thoracic vent device as an alternative to chest tube for iatrogenic pneumothorax. It is a simple one-piece device made of polyurethane catheter connected to a plastic chamber containing a one-way valve and comes with an adhesive tape to secure it. It does not require suture or additional securing devices nor additional tubing or bag/container attachments enabling early mobilization and outpatient monitoring. It's simple design without attachment makes it easier and safer to manage as an outpatient compared to thoracostomy with or without a Heimlich valve.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief introduction discussing epidemiology, and treatment options for management of pneumothorax including technique such as thoracostomy tube with Heimlich valve and Thoracic vent. 2. Description of Thoracic vent device components, mechanism of action, placement technique. 3. and 4. Case describing steps of CT guided Thoracic vent placement, and follow up imaging. Appearance of the device on chest radiograph is demonstrated to assist in recognition of the device by diagnostic radiologist. 5. Comparison of Thoracic vent with conventional thoracostomy with and without Heimlich valve.

### **IREE-31 Look Before You Leap: Anatomical and Technical Considerations of Image-guided C2 Dorsal Root Ganglion Ablation and C1-C2 Lateral Joint Injections**

Bahram Mohajer, MD, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

i. Discuss the cervicogenic headache as the primary indication of Image-guided C2 dorsal root ganglion (DRG) ablation and C1-C2 lateral joint injections. ii. Review the general anatomy of C2 DRG and C1-C2 lateral articulation and notable anatomical structures. iii. Illustrate CT-guided C2 DRG ablation technique and considerations. iv. Illustrate Computed Tomography and Fluoroscopic-guided C1-C2 lateral articulation injection techniques and considerations.

#### **TABLE OF CONTENTS/OUTLINE**

i. Cervicogenic headache (1. Presentation 2. Prevalence and efficacy of intra-articular injections). 3. General anatomy of the C2 DRG and C1-C2 lateral articulation. 4. Degenerative arthritis of C1-C2 lateral articulation presentation on STIR MRI (a) and CT (b). ii. Important anatomical proximities of C2 DRG and lateral atlanto-axial joints (1. Vertebral artery 2. Thecal sac 3. C2 ventral ramus). iii. CT-guided C2 DRG ablation procedure, technique, and considerations (1. Patient positioning, 2. Trajectory selection, 3. Needle insertion, contrast administration, and ablation). iv. CT-guided intra-articular injection, technique, and considerations (1. Patient positioning, 2. Trajectory selection, 3. Needle insertion, contrast administration, and

injection). v. Fluoroscopy-guided procedure, technique, and considerations (1. Trajectory selection, 2. Needle insertion, contrast administration, and injection).

### **IREE-32 Utility Of Spectral CT During Percutaneous Thermal Ablation**

Ahmad Parvinian, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to demonstrate the utility of spectral CT for interventional ablation procedures. Recently, an interventional suite was developed which combined a dual-layer detector spectral CT scanner on rails with an image guided-therapy system (Spectral Angio CT, Philips Healthcare). In this exhibit, case examples will highlight use cases for spectral CT in procedure planning, probe placement, iceball visualization, and post-ablation assessment. Teaching points include: (1) technical background on spectral CT, (2) clinical background on minimally invasive ablations, and (3) overcoming interventional challenges with spectral CT.

#### **TABLE OF CONTENTS/OUTLINE**

1. Title page: Utility Of Spectral CT During Percutaneous Thermal Ablation. 2. Teaching points: Technical background, clinical background, and overcoming interventional challenges. 3. Interventional ablations clinical background: Procedure planning, probe placement, treatment monitoring, and post-ablation assessment. 4. Background on spectral CT for interventions: Dual-layer spectral detector technology, visualization modes for spectral imaging, and spectral CT on rails for interventions. 5. Case examples: (A.) Procedure planning with low MonoE for lesion visualization. (B.) Probe placement with high MonoE to reduce needle artifact. (C.) Treatment monitoring with z-effective and low MonoE. (D.) Bone ablations with bone removal. (E.) Post-ablation assessment with low MonoE to reduce contrast dose. 6. Conclusions

### **IREE-33 Transperineal Ultrasound-Guided Prostate Biopsy: Why and How**

Izabel O. Karam, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: Review different prostatic biopsies approaches, emphasizing the transperineal technique and its peculiarities. Illustrate with cases different applications of the technique (systematic biopsy, cognitive guidance and MR imaging fusion). Identifying the radiological features of common postprocedural complications

#### **TABLE OF CONTENTS/OUTLINE**

Prostate cancer: epidemiology and imaging findings; Indications and patient selection for prostate biopsy; Different biopsy approaches and its characteristics; Technique steps; Illustrative cases of different applications of the transperineal prostate biopsy technique; Understanding and managing common complications post-procedure; Recognizing common image findings observed after the procedure; Interpreting biopsy outcomes and ensuring proper follow-up.

### **IREE-34 "Too Hot to Handle?" Non-worrisome Extrahepatic Localization of 99mTc MAA and Yttrium-90 During Planning and Radioembolization Procedures**

Merve Ozen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. In the work-up of patients for Y-90 radioembolization of hepatic tumors, it is often revealed that 99mTc-macroaggregated albumin (MAA) has accumulated in extrahepatic organs and blood vessels. While substantial Y-90 localization in some extrahepatic sites, such as the lungs, is an absolute contraindication for treatment, other sites do not have strict guidelines. 2. We show the safe, complication-free administration of Y-90 to five patients with off-target uptake in each the following locations: a persistent falciform artery, the gall bladder, a portal vein tumor thrombus, a perihepatic lymph node, and the spleen. 3. The literature is consistent with the conclusion that uptake of Y-90 in the falciform artery, the gall bladder, and a tumor thromboses is generally safe and should not be an absolute contraindication to therapy. It has yet to be elucidated whether this is the case for uptake in the spleen and lymph nodes. 4. Off-target Y-90 uptake in the spleen may actually be beneficial and help treat/prevent post-radioembolization hypersplenism and thrombocytopenia.

#### **TABLE OF CONTENTS/OUTLINE**

1. Cases of safe and successful Y-90 therapy to patients with extrahepatic uptake in the extrahepatic following locations. 2. Along with each case, the current literature regarding the safety of treatment of patients with these off-target uptakes is discussed.

### **IREE-35 Contrast Enhanced CT Lymphangiography For Various Lymphatic Disorders**

#### **Awards**

**Certificate of Merit**



Yura Ahn, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Despite the physiologic and clinical significance of the lymphatic system, lymphatic imaging remains difficult and in the developmental stages. In recent years, MR lymphangiography has enabled the depiction of lymphatic structure, but its widespread use is limited by its inherent limitations: high cost, limited accessibility, contraindications to MR, inability to position change, and inability of bedside needle insertion in MR suite is still obstacles. CT, which is not restricted by these constraints, may be a solution for more accessible lymphatic imaging. We have utilized contrast enhanced CT lymphangiography for characterization of various thoracoabdominal lymphatic diseases and pre-interventional planning. Herein, we introduce our practice of CT lymphangiography.1. Learn the protocol and technical aspect of contrast-enhanced CT lymphangiography2. Describe normal lymphatics anatomy with contrast-enhanced CT lymphangiography3. Learn the characteristics of various thoracoabdominal lymphatic diseases with CT lymphangiography

### TABLE OF CONTENTS/OUTLINE

1. Protocol1) Procedure: Inguinal LN cannulation under US guidance2) CT technique for imaging the central lymphatics2. Technical aspect of CT lymphangiography1) Acquisition time and CT dose2) Comparison with MR lymphangiography3. Normal anatomy of the central lymphatics4. Various lymphatic disorders1) Iatrogenic thoracic duct injury with chylothorax2) Lymphatic anomaly

### IREE-36 Artificial Intelligence in Interventional Radiology: A Primer for Residents

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Artificial Intelligence (AI) has already demonstrated an ability to significantly improve efficiency in diagnostic radiology. There are however, unique challenges which need to be addressed to completely realise the potential of AI in Interventional Radiology (IR). Apart from key issues including data storage, lack of interoperability and non-standard practices, there are significant concerns about legal accountability and potential risks in interventions that prevent AI from being used independently or clinically without the oversight of an expert radiologist. Research and innovation involving AI in IR is limited to few higher centres, thus preventing adequate exposure of AI to Interventional Radiology residents, compared to their Diagnostic Radiology (DR) counterparts. Our Educational Exhibit aims to introduce IR residents and fellows to the vast possibilities of incorporating AI into their regular clinical practice (ranging from decision support and triaging of patients to prognostication and outcome prediction) and also introduce them to various open-source software and modules which can assist them in their day-to-day IR practice.

### TABLE OF CONTENTS/OUTLINE

1. Introduction 1A. AI in Medical Imaging 1B. Types of Data in DR and IR 2. Unique Challenges in IR 3. Opportunities of AI Implementation 3A. Pre-Procedural Support 3B. Peri-Procedural Support 3C. Post-Procedural Support 4. Established AI algorithms in Interventions 5. Open-Source software and modules 6. Opportunities for AI innovation in IR 7. Can AI Replace Us? 8. The way ahead for an AI-assisted Interventional Radiology practice

### IREE-37 Portosystemic Shunts: A Comprehensive Review

#### Awards

#### Cum Laude

John A. Walker, MD, PhD (*Presenter*) Speaker, Shionogi & Co, Ltd; Consultant, Shionogi & Co, Ltd

### TEACHING POINTS

1. To review the development of the portal system and teach normal and variant anatomy.2. To become familiar with cross sectional and angiographic appearances of both common and uncommon portosystemic shunts.3. To understand the clinical relevance of portosystemic shunts form congenital to acquired.4. To demonstrate minimally invasive treatment options for portosystemic shunts.

### TABLE OF CONTENTS/OUTLINE

1. Review the development of normal portal venous anatomy and subsequently congenital variant anatomy. In addition, understand shared territories with systemic veins that may allow shunts to form 2. Use cross sectional and angiographic images to teach the anatomy of portosystemic shunts to include congenital intra-hepatic and extrahepatic (Abernethy) shunts, as well as common acquired gastroesophageal, splenorenal, paraumbilical shunts and less common acquired mesenteric to retroperitoneal territories and consider surgically altered sites allowing for unique shunts 3. Discuss clinical implications of untreated portosystemic shunt and 4. Explore indications and techniques for treating shunts by type and location, to include discussion on expected sequelae of treating and potential complications.

### IREE-38 Training of Interventional Radiology Procedures Using Virtual Reality: Current Status and Potential Metaverse

Honda, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The COVID-19 pandemic made it difficult to train learners on procedures that involve direct patient contact, such as interventional radiology (IR). For this reason, we developed training materials for learners on endovascular procedures of the abdominal pelvis in IR using virtual reality (VR). Advantages of VR-based IR education include the ability to conduct training at any time, repeated training exercises, no invasiveness to the patients, and no risk of infection to both the patient and the learner. Even after the pandemic, to further develop the good points of VR education, many educators are attempting to apply metaverse to the education of their specialty. Although metaverse education is considered useful in IR education, it is not widely used at present. This educational exhibit will provide a brief overview of simulators available for purchase, benefits of metaverse education, and our VR-based training software, and discuss its advantages, current issues, and future prospects.

### TABLE OF CONTENTS/OUTLINE

1. Features of the currently commercially available VR simulators of endovascular procedures. 2. Benefits of metaverse education. 3. What is needed to spread metaverse education. a. Three components: hardware, software, and contents, b. High-speed networks, c. Computing technologies: edge computing, and cloud computing, d. Modeling and rendering technologies: Unity or Blender, e. Interaction technologies: Sensors, or real-time tracking, f. Authentication technologies: blockchain, g. Wearable device: head-mounted displays or smart glasses, h. Concerning the learner: learning logging, and analysis. 4. Review of reports on the cases of metaverse education. 5. Future challenges and our approach.

### IREE-39 **Interventional Radiology Role in Treating Primary Pancreatic Cancer: Current Treatments and Future Prospects**

Fereshteh Khorshidi, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Review primary pancreatic cancer epidemiology, current therapies and prognosis- Review interventional radiology role in diagnosis of pancreatic cancer and palliative care- Review percutaneous and transarterial image-guided treatment options for unresectable primary pancreatic cancer offered by interventional radiology.- Importance of having a multidisciplinary approach and individually tailored treatment plan.

### TABLE OF CONTENTS/OUTLINE

Primary pancreatic cancer- Prevalence- Significance- Clinical stages- Survival rate- Current therapies for resectable tumors Minimally invasive treatments of unresectable pancreatic cancer, their advantages, effectiveness and complications Treatments- Transarterial therapies o Regional intra-arterial chemotherapy with double-balloon catheter (RenovoCath)• Mechanism of action• Safety and efficacy• Ongoing Trials- Percutaneous ablative therapies: o Non-thermal ablation: Irreversible electroporation• Mechanism of action• Safety and efficacy• Ongoing Trials Synergetic effect of ablative therapies and immunotherapy; a future prospective Cases?. A few cases of ablation?

### IREE-4 **Superior Vena Cava Syndrome Imaging and Management**

Ben Rybin, DO (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Review central venous anatomy and highlight potential collateral pathways. 2. Review the historical and current superior vena cava (SVC) syndrome etiologies. 3. Review the pathophysiology of SVC syndrome. 4. Present SVC syndrome classification systems. 5. Discuss SVC syndrome treatment and management. 6. Detail indications, benefits, and complications of endovascular treatment of SVC syndrome.

### TABLE OF CONTENTS/OUTLINE

I. History and evolution of SVC syndrome etiologies. II. Central venous anatomy. III. Pathophysiology and symptoms of SVC syndrome. IV. SVC syndrome classification systems. V. SVC syndrome treatment algorithm. VI. Endovascular therapy cases. VII. Endovascular therapy techniques. VIII. SVC syndrome endovascular complications. IX. Projected future of SVC syndrome therapy.

### IREE-40 **Thermoprotective Techniques in Musculoskeletal Ablation**

Ahmad Parvinian, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The purpose of this exhibit is to provide a case-based review of thermoprotective techniques used during percutaneous thermal ablation of musculoskeletal tumors. The exhibit will demonstrate the basic principles of musculoskeletal ablations performed using ultrasound, CT, fluoroscopic, and MRI guidance, depict the various active and passive thermoprotective

techniques that are critical to safe and effective ablation, and provide a framework for recognizing and addressing complications. Teaching points include: (1) clinical background and principles of musculoskeletal ablation, (2) active thermoprotective techniques, (3) passive thermoprotective techniques, (4) complication management.

#### **TABLE OF CONTENTS/OUTLINE**

1. Title page  
2. Teaching points  
3. Musculoskeletal ablation background  
4. Preprocedural Considerations  
5. Passive thermoprotection- Ablation zone monitoring- Temperature monitoring- Neurophysiologic monitoring  
6. Active thermoprotection- Hydrodisplacement- Pneumodisplacement- Balloon interposition- Probe traction- Internal warming- External warming  
7. Complication recognition and management  
8. Conclusions

#### **IREE-41 Thyroid Nodule Fine Needle Aspiration: What the Pathologist Wants You to Know**

Berali Del Espiritu Santo Padilla, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Fine needle aspiration (FNA) is an optimal diagnostic tool for thyroid nodules because it is cost-effective, safe, and accurate.
- The Bethesda guidelines for thyroid FNA consider that the unsatisfactory rate on cytopathology is of about 10% , however different studies have shown that the unsatisfactory rate can range from 0.4% up to 40%.
- Some of the reasons why FNA results may be inaccurate include:
  1. Sampling error: the sample may not accurately represent the entire nodule.
  2. Inadequate sample size: the sample taken during FNA may be too small to yield accurate results.
  3. Technical error: The accuracy of FNA results can be affected by technical errors, such as improper handling or processing of the tissue sample.
  4. Nodule size: multiple studies have shown that the diagnostic accuracy of FNA is limited in large thyroid nodules.
- The technique of the specimen collection and evaluation and the preparation of the slide can play a decisive role in the diagnostic accuracy therefore it's important for the radiologist to recognize the correct technique.
- The "classic" technique uses three slides and generates two slides for interpretation. A slide to be deposited in fixative, a slide to be air dried , and a spreader slide.
- The two-slide technique has been called the "butterfly" or "book-end" technique. It has the advantage of simplicity and better reproducibility. It produces a relatively uniform and rounded imprint of FNA material for evaluation on two mirror image slides.

#### **TABLE OF CONTENTS/OUTLINE**

1. Patient selection  
2. Equipment needed for thyroid biopsy  
3. Patient preparation  
4. Needle based sample collection techniques  
5. Sample preparation  
6. Pathologist recommendations in order to reduce inconclusive results

#### **IREE-42 Nutcracker Syndrome: Diagnosis and the Role of Minimally Invasive Interventions**

Alina Hasanain, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Nutcracker phenomenon is an anatomic condition characterized by extrinsic compression of the left renal vein, causing entrapment, and subsequent diminished outflow to the inferior vena cava.  
2. Nutcracker syndrome refers to Nutcracker phenomenon with clinically apparent sequelae, which include hematuria, abdominal pain, and gonadal varices among a variety of other symptoms, the severity of which can depend on the severity of the anatomic findings.  
3. The role of interventions, especially minimally invasive interventions such as endovascular treatment, has become more prominent in the treatment of severe Nutcracker syndrome. This exhibit will outline diagnostic methods and management options for Nutcracker syndrome with a focus on endovascular approaches.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the pathophysiology of Nutcracker syndrome with anatomic causes and variations  
2. Discuss diagnostic methods doppler ultrasound, CT, MRI and angiography, venography and intravascular ultrasound.

- a. Imaging criteria and classification
- b. Examples of cases from a single institution

  
3. Discuss management options including conservative management and surgical options with an emphasis on endovascular approaches (stenting, coil embolization of varices).

- a. Advantages over open or laparoscopic interventions
- b. Complications and pitfalls
- c. Future directions

#### **IREE-43 Managing Hemoptysis from Diagnosis to the Angio Suite: A How-to Guide for the Radiologist**

Pierluca Minelli, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Hemoptysis is the airway bleeding, ranging from blood-tinged mucus to gross hemorrhage: when massive -almost defined as a >300mL/24h bleeding- it is a life-threatening and challenging condition. Angiography with embolization is the front-line therapy for emergent cases of hemoptysis. The aim of this study is to give a concise guide to the diagnostic and interventional management of hemoptysis in the angiography suite.

## TABLE OF CONTENTS/OUTLINE

Hemoptysis generally arises from the bronchial arteries (BAs, ~90%) and encompasses infectious, inflammatory and malignant causes, being tuberculosis the most common worldwide. After airway securing, underlying conditions and laterality must be assessed: CT angiogram -eventually along with bronchoscopy- is a useful tool to review and report origin (orthotopic/ectopic), course and morphology of BAs or to identify nonbronchial systemic/pulmonary bleeding source. On conventional bronchial arteriograms, selective catheterization of BAs origins is mandatory, while the anterior spinal artery and its medullary branches must be identified in order to avoid iatrogenic transverse myelitis or paralysis, the major complications. Hypertrophied vessels, parenchymal hyperemia, blushing or pseudoaneurysm suggest bleed source. For BAs, embolic particles (350-700microm) are usually preferred, while coils and plugs preclude reintervention if hemoptysis recurs and are thus limited to bronchial aneurysms and pulmonary arteries embolization. Recurrence rates range from 10 to 58% and increase over time and in certain diseases (e.g. cystic fibrosis).

### **IREE-44    Abernethy Malformations: Making Sense of Congenital Portosystemic Shunts**

#### **Awards**

#### **Certificate of Merit**

Hannah El-Sabrou (Presenter) Nothing to Disclose

#### **TEACHING POINTS**

Abernethy malformation, or congenital portosystemic shunt, is a rare abnormality of the portal venous system. The portal vein either fails to form or forms abnormally, resulting in an anomalous shunt that diverts blood from the portal vein to the systemic circulation without passing through the liver. The clinical manifestations of Abernethy malformation can vary depending on the severity and location of the shunt, and may include encephalopathy, portal hypertension, and liver failure. Abernethy malformation can be detected via ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI). Patients with Abernethy malformation are at risk for liver lesions, thus particular attention must be paid to the liver parenchyma. The orientation and size of the shunt can be confirmed via catheter-directed angiography and balloon occlusion. Treatment options for Abernethy malformation include interventional or surgical shunt closure, liver transplantation, or conservative medical management of symptoms. The choice of treatment depends on the severity of the malformation and the patient's clinical condition.

## TABLE OF CONTENTS/OUTLINE

(1) Introduction: Overview of Abernethy malformation(2) Clinical presentation: Signs and symptoms(3) Imaging: Detection, associated findings, characterization, and confirmation(4) Treatment: To close or not to close?

### **IREE-46    Vasculitis: Clinical Evaluation, Imaging, and Treatment**

Kausthubh Hegde, MBBS (Presenter) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the definition and types of Vasculitis. 2. Discuss the signs, symptoms, and clinical evaluation of the most common types of Vasculitis. 3. Diagnosis with an emphasis on the role of imaging in diagnosing Vasculitis. 4. Case-based examples of IR treatment options and follow-up care.

## TABLE OF CONTENTS/OUTLINE

1. Vasculitis: definition and pathophysiology of the disease. 2. Classification of vasculitis - Lie classification of vasculitis (1994) - 2012 revised International Chapel Hill Consensus Conference nomenclature of vasculitides 3. Review of the signs and symptoms of different types of vasculitis. 4. Role of diagnostic imaging modalities in the evaluation of vasculitis (with case-based examples). 5. Indications and contraindications for endovascular treatment of vasculitis (with case-based examples). 6. Complications and follow-up care after IR procedures.

### **IREE-47    Embolization of Extracranial Arteriovenous Malformations: Strategies of Interventional Approaches According to the Yakes Classification**

#### **Awards**

#### **Magna Cum Laude**

Marin Halut, MD (Presenter) Nothing to Disclose

#### **TEACHING POINTS**

Learn imaging findings associated with arteriovenous malformations (AVM) and present the Yakes classificationPresent briefly the main genetic mutations associated pathways and potential drug therapiesUnderstand interventional management of AVM according to the Yakes classificationDiscuss embolization strategies according to the Yakes classification and AVM territoryDiscuss outcomes, follow-up and complicationsPropose a therapeutic algorithm based on the Yakes classification, clinical staging and genotyping

## TABLE OF CONTENTS/OUTLINE

Overview and classification of AVM according to the Yakes classification  
Clinical and imaging evaluation before procedure  
Presentation of the Shobinger classification and discussion of the relative roles of Doppler ultrasound, CT, MRI, DSA  
Embolization techniques  
Presentation of liquid and mechanical embolizing agents and their use according to the approach (endovascular transarterial approach, direct puncture, retrograde venous approach). The safe use of ethanol and bleomycin will be also discussed  
Treatment techniques according to AVM territory and Yakes classification  
Discuss specific considerations for head and neck, limbs, thoracic, abdominal and pelvic AVMs  
Yakes Type I (transarterial, transvenous, coils, plug)  
Yakes Type II (transarterial, direct puncture, retrograde venous, liquid agent)  
Yakes IIIa (transvenous, coils, plug ± liquid agents)  
Yakes IIIb (transarterial, direct puncture, retrograde venous, liquid agent, coils)  
Yakes IV (direct puncture ethanol, interstitial infiltration bleomycin)  
Follow-up and outcomes evaluation  
Clinical and imaging criteria to assess therapeutic response  
Conclusion  
Therapeutic algorithm proposed

## IREE-48 Fluid Solutions for Complex Cases: A Comprehensive Guide to Sclerosant and Liquid Embolic Agents for Radiologists

### Awards

#### Cum Laude

Keith Ameyaw, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Liquid embolic and sclerosant agents are vital tools in interventional procedures capable of achieving targeted vessel occlusion, space occupation or tissue fibrosis.  
2. Understanding the mechanism of action of these agents is essential for optimal use, procedural technique, and informing operator preference.  
3. Different agents have unique advantages and complications. Selecting the appropriate agent is critical for optimizing patient outcomes.  
4. Radiologists must be intimately familiar with the unique post-procedural imaging characteristics of liquid embolics/sclerosants. These imaging findings play a crucial role in assessing both the success of the procedure and informing follow-up care.

## TABLE OF CONTENTS/OUTLINE

1. Mechanism of action of sclerosant and liquid embolic agents.  
2. Indications for use in several disease entities, including: intracranial and extracranial vascular malformations, lymphatic malformations, tumors, cysts, benign prostatic hyperplasia, venous insufficiency, arterial hemorrhage, portal hypertensive variceal hemorrhage, aortic graft endoleak, lymphatic leak/chylothorax, lymphoceles, post-operative seroma, and gonadal vein embolization.  
3. Technique and procedural considerations.  
4. Advantages and associated complications of different agents.  
5. Imaging findings with descriptions of associated artifacts necessary for appropriately assessing procedural success and informing follow-up care.

## IREE-49 Benefits of Hybrid CT/Angiography Utilization for Microsphere Trans-arterial Radioembolization with Yttrium-90

Elliot T. Varney, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Hybrid angiography/CT (Angio-CT) employs both traditional CT imaging with concurrent fluoroscopic angiography in the same procedure room. Although introduced prior to cone-beam CT, Angio-CT has been under-utilized due to cost and availability. The resurgence of Angio-CT has proven to be a very useful tool in interventional oncology; however, its application in microsphere trans-arterial radioembolization is not well documented through the literature. Angio-CT shows unique advantages in the image resolution regardless of patient preparation, catheter directed contrast imaging in the planned treatment field to precisely calculate more accurate dosimetry in routine and multifocal lesions, to more accurately characterize lesions and any potential changes in lesions with higher sensitivity and specificity, and to more accurately detect anatomic variants and/or accessory tumor feeding vessels. Lastly, early data suggests Angio-CT systems utilization could improve survival in patients with HCC when performing trans-arterial therapy, likely due to more accurate and precise pre-treatment and intraprocedural imaging.

## TABLE OF CONTENTS/OUTLINE

1. What is Angio/CT?  
2. Practical points and precision of dosimetry with Angio/CT  
3. Unique Advantages in image quality and predicting success  
4. Optimal Utility of Each Modality  
5. The Unknowns and the Research Potential  
6. Case Examples  
a. Improved detection and characterization  
b. Anatomic variants potentially unnoticed with cone-beam  
c. Improving dosimetry accuracy  
7. Quantifiable benefit in outcome?

## IREE-5 Advances in Percutaneous Jejunostomy: Novel Techniques and Their Clinical Implications

Kimberly D. Coffman, MD, MPH (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Percutaneous radiologic jejunostomy (PRJ) is a minimally invasive procedure for patients requiring enteral feeding and access for biliary interventions, especially in patients who have altered anatomy, such as after gastric resection, gastric bypass surgery, Whipple procedure, or liver transplant. After reviewing this exhibit learners should be able to: 1. Recognize common indications for PRJ 2. Understand novel techniques to aid in successful PRJ access 3. Recognize and address complications related to PRJ

## TABLE OF CONTENTS/OUTLINE

This exhibit will: 1. Review imaging and anatomical considerations for jejunal access 2. Discuss common indications, contraindications and patient selection for PRJ 3. Introduce procedural advancements in PRJ through a case-based approach- Traditional techniques in PRJ- Modified coaxial technique for T fastener deployment through a sheath- Utilizing cone beam CT to ensure proper T fastener placement- Using an orogastric magnetic balloon and ultrasound guidance to assist in complicated cases where traditional methods fail 4. Address pitfalls and potential complications of PRJ  
Summary Clinical Implications: As the number of liver transplants, cholecystectomies and gastric surgeries increase every year, there may be more demand for jejunal access to manage potential complications of these procedures. PRJ can allow for enteral nutrition and access for repeated biliary interventions.

## IREE-50 A Review of Superior Vena Cava Interventions

Jorge E. Lopera, MD (*Presenter*) Shareholder, Tecnostent SA; Consultant, Merit Medical Systems, Inc; Research Grant, AngioDynamics, Inc

## TEACHING POINTS

To review the clinical presentation and treatment options for SVC syndrome. To understand the role of different endovascular techniques to treat stenoses, occlusions and thrombosis of the SVC. To illustrate the challenges when treating SVC stenoses in patients with existing central lines. To discuss the different recanalization techniques to treat complex chronic occlusions of the SVC. To review the different complications with SVC interventions and how to treat them .

## TABLE OF CONTENTS/OUTLINE

1. Clinical presentations and imaging of central venous and SVC stenoses and occlusions. 2. Review of treatment options in malignant SVC syndrome. 3. Treatment options in SVC syndrome - special situations: a. SVC syndrome with existing ports and dialysis lines. b. SVC syndrome with thrombus c. Endovascular stenting : single or kissing stents. Covered or bare stents. d. Recanalization techniques for complex chronic occlusions. 4. Complications .

## IREE-51 Percutaneously Induced Neuroregeneration for Treatment of Chronic Neuropathic Pain

### Awards

### Certificate of Merit

Maxwell Cooper, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1) Review the pathophysiology of neuropathic pain and the Sunderland classification of nerve injury. 2) Explain how percutaneous cryoneurolysis can induce regeneration of damaged peripheral nerves causing chronic pain. 3) Demonstrate the ability of percutaneous cryoneurolysis to provide long term relief and neuroregeneration for the treatment of chronic neuropathic pain. 4) Discuss current indications and potential new applications of cryoneurolysis.

## TABLE OF CONTENTS/OUTLINE

1) Incidence and causes of neuropathic pain. 2) Pathophysiology of nerve injury and chronic peripheral nerve pain. 3) Mechanism of cryoneurolysis and neuroregeneration. 4) Current indications and patient selection. 5) Techniques for cryoneurolysis, including approaches and duration/temperature of ablation. 6) Post-procedure follow-up and outcomes. 7) Case examples of cryoneurolysis for pain relief and neuroregeneration. 8) The pre-operative use of cryoneurolysis to reduce pain caused by other interventions including ablation, embolization, and post-mastectomy pain. 9) Exploring new applications of cryoneurolysis.

## IREE-52 Super Selective Radioembolization for Hepatocellular Carcinoma: Radiation Segmentectomy and Beyond

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Radioembolization has emerged as an effective treatment option for hepatocellular carcinoma that cannot be surgically removed. The procedure involves the preferential deposition of radioactive microspheres into the hypervascular tumor through a siphoning effect, typically achieved by injecting the microspheres at the lobar artery level. However, to improve



tumor response and minimize potential complications, superselective radioembolization is recommended. The purpose of this exhibit is : (1) To review the rationale behind radiation segmentectomy. (2) To learn when superselective radioembolization is necessary, (3) to offer technical tips for performing superselective radioembolization.

#### **TABLE OF CONTENTS/OUTLINE**

1) Radiation segmentectomy : rationale and evidence 2) Dosimetry : Practical guide for dosimetry of superselective radioembolization 3) When superselective radioembolization is needed A. small single tumor : radiation segmentectomy B. Large single tumor saddling on both lobes C. Small remnant liver D. Hepatic artery branching at acute angle E. Extrahepatic collateral artery supplying the tumor 4) Technical consideration of superselective radioembolization A. Protection of distal normal liver by using balloon microcatheter and detachable coil B. Combination treatment of lobar and segmental artery C. Combination treatment of 1st and 2nd week dosing of glass microsphere 5) Follow-up imaging after superselective radioembolization A. Early loss of arterial enhancement of the tumor B. Focal radiation necrosis mimicking new hypovascular tumor

#### **IREE-53 TESLA: The Future in Treatment for Malignant Perihilar Obstruction**

Michelle de Bloeme-Hus, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In malignant bile duct obstructions the most common treatment in the Netherlands is endoscopic drainage (ERCP) with placing plastic tubes, combined with biliary drainage. Cholangitis due to ERCP occurs often, in 40-60% of the patients, probably caused by colonization of bowel bacteria and infection of undrained segments. Patients often need multiple re-interventions. The 90days mortality after diagnosis is 35%. In the TESLA trial the hypothesis is that primary percutaneous stenting, without placing a biliary drain and without stenting the ampulla of Vater, provides less infectious complications and less reinterventions compared to endoscopic drainage. Ensuring a decrease in morbidity and mortality and improving the quality of life.

#### **TABLE OF CONTENTS/OUTLINE**

Compare primary percutaneous stenting above the ampulla versus endoscopic drainage for palliative treatment of malignant hilar biliary obstruction in the TESLA study. Primary providing a lower complication rate and furthermore lowering the absolute and relative bilirubin levels, decreasing the number of reinterventions and providing a better quality of life. This abstract provides an overview of the TESLA trial, an education of the interventional procedure and materials and provides the first promising data retrieved from the TESLA trial.

#### **IREE-54 Advancing Interventional Procedures With Mixed Reality**

Jonathan Collier (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Introduction: The presentation focuses on Microsoft's HoloLens2 for visualization on an angiography biplane system. The HoloLens2 device is a mixed reality device that uses depth, light, and infrared cameras to track its environment and anchor multiple virtual displays to view ultrasound and fluoroscopy in real-time during image-guided interventions. Teaching Points: • Overview of the HoloLens2 device and its functionalities as they relate to interventional procedures • Demonstrate improvements in customization, decrease visual field discrepancies, and reduce ergonomic challenges associated with the current angiography systems • Evaluation of the image quality, latency, customization capabilities, and overall user experience • Demonstrate functionality like voice, gaze, and gesture controls in the live angiography environment • Case examples of the HoloLens2 integration in image-guided interventions on secondary personnel and primary phantom work

#### **TABLE OF CONTENTS/OUTLINE**

Outline: The presentation will cover the various teaching points related to HoloLens2 integration into an angiography suite. Attendees will learn how the device facilitates the clinician seeing what they want and where they want. The presentation will conclude with a summary of the promising role the HoloLens2 provides in advancing the clinician experience in interventional radiology and answer the question of why integrating this emerging technology will be beneficial in the clinical environment.

#### **IREE-55 Percutaneous Cryoneurolysis for Complex Pain: Indications, Technique, and Expectations**

Tarik Babar, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the epidemiology of complex pain syndromes and current need for analgesic adjuncts in pain management 2. Discuss the mechanisms of how percutaneous cryoneurolysis affects pain 3. Review the uses and techniques of various procedures including intercostal, ilioinguinal, intercostobrachial, and pudendal nerve cryoneurolysis 4. Demonstrate successful approaches to complex pain including pathologies involving the rib, hip, arm, and groin 5. Discuss common complications after percutaneous cryoneurolysis, including their diagnosis and management

## TABLE OF CONTENTS/OUTLINE

1. Introduction, including epidemiology of complex pain syndromes  
2. Mechanism and physiology behind cryoneurolysis effect on pain  
3. Indication, technique, and successful case of intercostal nerve cryoneurolysis  
4. Indication, technique, and successful case of ilioinguinal nerve cryoneurolysis  
5. Indication, technique, and successful case of intercostobrachial nerve cryoneurolysis  
6. Indication, technique, and successful case of pudendal nerve cryoneurolysis  
7. Recognition and management of common complications  
8. Conclusion and summary

### **IREE-56 Ectopic Varices: Anatomic and Hemodynamic Features and Endovascular Techniques**

Yoshitaka Tamura (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Ectopic varices arise in the hepatopetal or hepatofugal collateral vessels outside the gastro-esophageal region account for up to 5% of variceal bleeding. Various endovascular techniques can be effectively applied based upon their anatomic and hemodynamic features. Duodenal varices (DVs) are the most common type and arise in either hepatopetal collaterals or hepatofugal collaterals. DVs with hepatopetal collaterals are treated by portal vein (PV) stenting and those with hepatofugal collateral are treated by antegrade and/or retrograde obliteration techniques with or without TIPS. Rectal varices (RVs) are common complication in portal hypertension and arise in hepatofugal collaterals from the superior rectal vein to the bilateral internal iliac veins. Antegrade obliteration is often required to eradication of RVs because of their complicated drainage system. TIPS is effective to prevent recurrent bleeding. (Peri)stomal varices (SVs) can develop after ileostomy. SVs are supplied by the ileal veins and drains into the epigastric veins. They are often associated with portal hypertension but also with local hemodynamic abnormality. SVs with refractory bleeding have been treated by direct puncture embolization, antegrade obliteration and TIPS. Choledochal (-jejunal) varices arise in hepatopetal collaterals with extrahepatic PV occlusion often associated with choledocojejunostomy. They are treated by PV stenting with additional endovascular techniques.

## TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline 1. Basics of ectopic varices and various endovascular techniques 2. Duodenal varices 3. Rectal varices 4. Stomal varices 5. Choledochal (-jejunal) varices 6. Miscellaneous/ infrequent varices

### **IREE-57 Thermoablation of Pulmonary Metastasis: A Standard for a Secure Approach**

#### **Awards**

#### **Certificate of Merit**

Barbara d. Nunes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To illustrate noble structures in the pulmonary ablation areas under risk, which should be minded during the procedure.- To discuss patient selection, positioning, rationale of safe routes for the probe, and safety maneuvers in order to avoid and protect the above structures.- To assess the criterias of an adequate ablation zone and its expected course.- To illustrate the most important complications involved in the thermoablation of pulmonary metastasis.

## TABLE OF CONTENTS/OUTLINE

- Anatomy- Thermoablation mechanics- Patient positioning rationale and safe routes on pulmonary nodules ablation- Protective maneuvers- Defining an adequate ablation zone- Expected course of an adequate ablation zone- Most important acute complications

### **IREE-58 Buffalo Lung: A Human Complication after Lung Biopsy**

Nicole Law, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Buffalo lung is a rare occurrence of bilateral pneumothoracies due to an abnormal physical communication between the two pleural spaces.  
2. Iatrogenic buffalo lung can occur following intrathoracic procedures such as median sternotomy, laparoscopic surgery and heart-lung transplantation, putting these patients at higher risk for bilateral pneumothoracies during a lung biopsy procedure.  
3. Presentation of buffalo chest can be worse than that of unilateral pneumothorax, including severe and sudden onset of dyspnea and pleuritic chest pain, tachycardia, hypotension, and even cardiac arrest or death.  
4. Quick action should be taken in these patients to place bilateral chest tubes in order to re-expand the collapsed lungs. For this reason, it is important for IR physicians to be aware of the risk of buffalo lung in lung biopsy patients.

## TABLE OF CONTENTS/OUTLINE

Introduction. Patient case example. Picture examples. Discussion of buffalo lung and its' presentations. Patient risk factors. Treatment and case outcome.

**IREE-59** Taylor K. Loon, MD (*Presenter*) Nothing to Disclose



## **Anatomic Variants of the Hepatic Arteries and Technical Considerations for Y90 Radioembolization**

## **TEACHING POINTS**

1) Review

hepatic arterial variants that a radiologist should be able to recognize using the MICHEL classification. 2) Identify and familiarize the most common hepatic arterial variants encountered in pre-treatment mapping for Yttrium-90 radioembolization based on imaging findings. 3) Highlight the possible complications of Y90 microsphere diffusion into replaced right and left hepatic arteries and technical considerations when encountering variants.

### **TABLE OF CONTENTS/OUTLINE**

1) Review standard hepatic artery anatomy and the relevant imaging findings trainees should know to quickly evaluate using CT and digital subtraction angiography. 2) Introduce the MICHEL classification and subclassify based on right, left and common hepatic arterial origins. Present digitally drawn visual diagrams demonstrating each MICHEL classification. 3) Present cases from our institution depicting hepatic arterial anatomic variants using CT angiography and 3D-rendered images (MICHEL Classification, II, III and IV, which have a prevalence of 12.5%, 7.5% and 1% respectively). 4) Using cases from our institution, review relevant imaging findings on digital subtraction angiography for identifying hepatic arterial variants during pre-procedure mapping for Y90 chemoembolization. 5) Discuss possible branches of replaced/accessory left and right hepatic arteries and impact of diffusion of Y90 spheres. 6) Discuss technical considerations when encountering hepatic arterial variants including; injection rate for mapping DSA, prophylactic embolization of branches, and microcatheter tip position.

## **IREE-6 Purchasing Decisions for an Interventional CT Program**

Jonathan L. Troville, PhD (*Presenter*) Research support, Canon Medical Systems Corporation

### **TEACHING POINTS**

(1) Interventional CT fluoroscopy is becoming widely used and scanner features that meet both diagnostic and interventional needs are becoming increasingly complex. In this paper, the most important scanner features are discussed and ranked for both diagnostic and interventional purposes. (2) Vendors provide different offerings for the features, so hypothetical comparisons for three vendors are included to facilitate explaining various tradeoffs in purchasing decisions.

### **TABLE OF CONTENTS/OUTLINE**

This education exhibit provides a complete overview of CT scanner features which are necessary, desired, or useful for meeting both diagnostic and interventional purposes. The viewer will become familiar with the nuances of each feature and leave more comfortable with purchasing decisions in an increasingly complex market.

## **IREE-60 Vascular Interventions in Angiosarcoma with Pulmonary Hemorrhage**

Denes Szekeres, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The aim of this exhibit is to identify the role of the radiologist in diagnosis and management of vascular tumors. We begin with a review the epidemiology and presentation of angiosarcoma, a rare and diverse subset of malignant soft tissue sarcoma that is often insidious. We discuss the broad range of imaging findings for a variety of common sites of primary and secondary angiosarcoma through a review of SEER data and prior studies. We tie together the educational points with a case report of a cardiac angiosarcoma, including a review of the multidisciplinary approach to diagnostic workup and oncologic management. We end with a description of endovascular interventions (coil embolization) in treating pulmonary hemorrhage, a common complication of metastatic disease.

### **TABLE OF CONTENTS/OUTLINE**

1. Statistics and clinical pearls of angiosarcoma  
2. Review of multimodality imaging findings  
3. Case presentation of primary cardiac angiosarcoma  
4. Technique for coil embolization of pulmonary arterial hemorrhage  
5. Summary of educational points

## **IREE-61 Oops, We Did It Again: A Review of CT- and US-Guided Thoracic Interventional Procedure Complications**

Valeria Richart Sierra, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To review the potential complications of CT- and US-guided thoracic interventional procedures. To analyze the causes and risk factors of these complications and discuss how they could be prevented. To explain the different treatment options for these complications.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction- Lung biopsy and lung abscess drainage indications - Pleural biopsy indications- Thoracocentesis and pleural drainage indications - Techniques: CT- and US guided- Procedure: patient preparation, materials, technical considerations  
2.

Complications 2.1. Pneumothorax - Risk factors - Treatment 2.2. Lung Hemorrhage- Risk factors - Treatment 2.3. Subcutaneous Hematoma- Causes - Treatment 2.4. Seeding 2.5. Gas embolism- Clinical manifestations, causes - Treatment 2.6. Hemothorax- Causes - Treatment 2.7. Non-diagnostic biopsy- Risk factors - FNA vs CNB - Methods to increase biopsy performance 2.8. Non-productive pleural drainage- Causes- Treatment 3. Prevention of complications 4. Summary 5. Conclusion

## **IREE-62 Intra-procedural Ablation Margin Confirmation for Thermal Ablation of Liver Tumors Using Open Source Software**

Iwan Paolucci, PhD (*Presenter*) Stockholder, Intuitive Surgical, Inc ; Stockholder, SOPHiA GENETICS

### **TEACHING POINTS**

1) Dedicated software for confirmation of ablation margins is commercially available but expensive and often unavailable to in health care centers and research laboratories with limited budgets - even in developed nations. This abstract presents a workflow for ablation confirmation using free and open source software. 2) The minimum ablation margin (MAM) after thermal ablation of liver tumors is the most important predictor of local tumor progression. 3) Detecting an insufficient minimum ablation margin during the procedure allows for immediate re-ablation during the same treatment session. 4) Intra-operative images acquired using controlled breathing (e.g. apnea, high frequency jet ventilation) yield the most accurate results as they involve minimal tissue deformation.

### **TABLE OF CONTENTS/OUTLINE**

1) Software requirements 2) Loading and organizing the data 3) Registering the pre- and post-ablation CT images 4) Segmentation of the tumor and ablation zone 5) Calculation and visualization of the minimum ablation margin

## **IREE-63 The Role of Cone Beam Computed Tomography in Embolization of a Technically Challenging Distal Pulmonary Artery Mycotic Aneurysm**

Achintya Patel, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Cone-Beam Computed Tomography (CBCT) has many potential applications for both diagnostic and interventional radiology. The use of CBCT, as exemplified by the following case, allowed for the expeditious identification and treatment of a distal pulmonary artery mycotic aneurysm. This exhibit will enable participants to directly compare the differences in appearance between traditional CT and CBCT of the same entity and to display how CBCT data can be fused to live fluoroscopy to hasten the time to intervention.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction of the case example a. 42-year-old female with a complex medical history most notable for recent endocarditis treated with antibiotics and mitral valve replacement who presented with hemoptysis. 2. Description of traditional CTA findings a. CTA Chest demonstrated a distal, fourth-order pulmonary artery mycotic aneurysm. Axial images and coronal reformat provided. 3. Description of the CBCT findings a. Redemonstration of the aneurysm, comparing appearance to that of the CTA 4. Tutorial of fusing CBCT with live fluoroscopic images using guidance software, specifically using GE EMBO ASSIST ® as an example a. Images of the 3D reconstruction of the CBCT data b. Discussion of how guidance software is applied to the fluoroscopic images 5. Conclusion of case a. Successful, expeditious coil embolization of a difficult-to-access distal pulmonary artery mycotic aneurysm 6. Discussion of additional applications of this technique to other entities

## **IREE-64 Overview of Diagnosis and Treatment of Large or Medium-sized Vessel Vasculitis**

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Vasculitis is a group of disorders characterized by inflammation of the walls of blood vessels, and they are classified based on the diameter of the predominantly affected vessels. The clinical manifestations of vasculitis can be non-specific and may overlap with other disorders. Imaging techniques allow for direct evaluation of the arteries in large or medium-sized vessel vasculitis, and various interventional procedures may be used in these cases. However, the vessels involved in small vessel vasculitis are smaller than the current imaging resolution, meaning that only end organ changes secondary to the involvement of small vessels can be examined. This review presents the most important imaging modalities and typical findings in large and medium-sized vasculitis. The purpose of this exhibit is : (1) To list the vascularitis according to the vessel size affected. (2) To review the clinical and radiological manifestation of various vascularitis. (3) To learn the indication and technical tips for interventional procedures for vascularitis.

### **TABLE OF CONTENTS/OUTLINE**

1) List of vascularitis A: large vessels (eg, giant cell arteritis, Takayasu arteritis), B: medium-sized vessels (eg, polyarteritis nodosa, Kawasaki disease, primary granulomatous central nervous system vasculitis), C : small vessels (eg, Wegener granulomatosis, Churg-Strauss syndrome, microscopic polyangiitis, Henoch-Schönlein syndrome, systemic lupus

erythematosus, rheumatoid vasculitis, Behçet syndrome). 2) Clinical manifestation and diagnostic criteria 3) Imaging modality and angiographic appearance 4) Treatment options : medical vs interventional 5) interventional procedures and their indication

## **IREE-65 Intra-arterial Treatment for Hepatocellular Carcinomas: How to Manage Shunting from the Artery**

### **Awards**

#### **Certificate of Merit**

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

In the treatment of hepatocellular carcinomas, intra-arterial therapy such as chemoembolization and radioembolization is commonly used. However, operators may encounter shunts from the artery (such as arterioportal, arteriovenous, and arteriopulmonary shunts) that can hinder effective treatment. These shunts can be caused by various factors such as tumor invasion, previous percutaneous procedures, chronic inflammation, or congenital acquisition. If not properly occluded, embolic material can pass through the shunt and cause non-target embolization or serious complications. This exhibit aims to achieve three goals: (1) Review the radiologic appearance of arterioportal, arteriovenous, and arteriopulmonary shunts; (2) Learn how to manage these shunts with proper embolic materials; and (3) List the possible complications and their management.

### **TABLE OF CONTENTS/OUTLINE**

1) List of shunts Arteriportal shunt (hepatic artery - portal vein), Arteriovenous shunt (hepatic artery - hepatic vein), Arteriopulmonary shunt (hepatic artery - pulmonary artery/vein), 2) Imaging findings on CT/MR and angiography according to the cause (tumorous vs non-tumorous condition) 3) Embolization strategy and materials for shunts 4) Complications related with non-target embolization and their management

## **IREE-66 Nonsurgical Management of Renal Masses**

Laura Jorgenson (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Learn the nonsurgical approaches to treat renal masses, including ablation, embolization, and SBRT, the indications for treatment and intraprocedural tips and tricks to optimize response. Understand post ablation, embolization and SBRT changes in the renal tumor and how to avoid pitfalls in interpretation. How to evaluate for tumor recurrence post treatment and avoid pitfalls in assessment. Understand common complications following ablation, embolization, and SBRT.

### **TABLE OF CONTENTS/OUTLINE**

1. Ablation, embolization, and SBRT technique Discuss evolution of nonsurgical management of renal tumors as a viable treatment option. Discuss indications and fundamentals of ablation, embolization, and SBRT: Patient selection Tumor types Treatment planning Procedural insights to avoid complications Role of spectral CT during ablation 2. Post ablation SBRT and embolization changes in renal tumors and assessment of tumor response Response of renal masses to nonsurgical management Typical features on imaging (CT/MRI) which depict normal evolution of typical changes on imaging - acute, subacute and chronic changes Tips on how to avoid pitfalls in interpretation 3. Potential Complications and related imaging features in each modality Intraprocedural complications Immediate post-procedural complications Delayed complications

## **IREE-67 Radioembolization of Hepatocellular Carcinoma with Extrahepatic Collateral Blood Supply: Anatomic and Technical Considerations**

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The utilization of radioembolization as a treatment method for hepatocellular carcinoma (HCC) has significantly increased in recent years. Typically, HCC derives its blood supply from the hepatic artery; however, it can also obtain a parasitic blood supply from extrahepatic collateral arteries (EHC). While chemoembolization has been carried out through EHC without significant complications, there is limited experience with radioembolization via EHC. The aim of this exhibit is threefold: (1) to examine the critical anatomy of EHC utilizing cone-beam CT, (2) To review when we suspect the presence of EHC supplying HCC, (3) To learn how to do safe radioembolization through EHC.

### **TABLE OF CONTENTS/OUTLINE**

1) List of treated EHC, 2) Vascular anatomy of EHC by using cone-beam CT and safe point of each EHC, 3) Suggestive findings of EHC on CT/MR and cone-beam CT, 4) Special considerations for radioembolization through EHC: dosimetry, embolization of pulmonary shunt, protection of normal vessel, and redistribution by proximal embolization.

## **IREE-68 Reducing the Learning Curve: The Use of an Ex Vivo Model for Teaching Double J Ureteral Stent Insertion and Retrograde Exchange**

Marina Borrego, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Discuss the benefits of simulation-based training for procedure competence. To describe our experience with a new training model for learning double J ureteral stent (DJS) insertion and retrograde exchange.

### **TABLE OF CONTENTS/OUTLINE**

Introduction. Urinary tract obstruction and how the performance of DJS can provide relief. The current master-apprentice model and the importance of procedure competence for trainees before practicing on patients. Benefits of simulation-based training and the current models available. Illustration of a developed ex vivo model for simulating a DJS procedure. Conclusion: Percutaneous access into the renal collecting system is a crucial step when performing DJS. This developed model allows for training on this technical skill as well as the remaining steps in a realistic and safe environment.

## **IREE-69 Diagnostic and Interventional Radiology for Budd-Chiari: An Update on BCS Classification and IVUS**

Anne Sailer, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Budd-Chiari syndrome (BCS) is the occlusion of one or more veins of the liver due to various disorders that result in sinusoidal congestion, portal hypertension, fibrosis, cirrhosis, and nodular regeneration. 2. The new BCS classifications can provide more appropriate treatment options; accurately determining the type of obstructor, number of blocked vessels, and length of the obstruction and categorizing the patients according to the updated BCS classification can improve the success of the patient's therapeutic treatment plan.

### **TABLE OF CONTENTS/OUTLINE**

1. Review pathophysiology of Budd Chiari and the BCS classifications. 2. Briefly review potential mimics of Budd Chiari (i.e. other cause of sinusoidal or post hepatic obstruction). 2. Discuss general concepts of assessing the liver Doppler US, CTA, MRA, venography, and intravascular ultrasound (IVUS) with emphasis on technique, protocol, and image optimization for diagnosing Budd Chiari. a. Describe differentiating imaging features of various BCS presentations depending on the location of the occlusion. b. Review complications associated with BCS. c. Briefly demonstrate pitfalls of BCS. 4. Discuss management options with interventional radiology procedures (venoplasty and stenting, local pharmacologic and mechanical thrombolysis, transjugular intrahepatic portosystemic shunt (TIPS) placement), and potential complications.

## **IREE-7 Prophylactic Intervention for Placenta Accreta Spectrum**

Bo-Syuan Huang, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Placenta accreta spectrum (PAS) is an abnormal placentation with invasion of myometrium or extrauterine structures and can be associated with maternal morbidity and mortality. Not only the prenatal diagnosis but also the management are important to reach a better outcome. To date, pre-operative prophylactic balloon occlusion is developing with balloon placement in various sites including internal iliac arteries, common iliac arteries, uterine arteries and abdominal aorta. The purpose of this exhibit is: 1) to review the MRI features of PAS. 2) to review different treatment options including procedural risk, benefit and outcome. 3) to demonstrate techniques of balloon occlusion of internal iliac arteries. 4) to enhance the value of MRI image for preprocedural guidance or predictive indicator.

### **TABLE OF CONTENTS/OUTLINE**

1) Introduction of placenta accreta spectrum (PAS) 2) MRI diagnosis of PAS. 3) Management for abnormal placentation a. traditional approach b. prophylactic balloon occlusion in various anatomic regions c. outcome for each treatment 4) Case demonstration: balloon occlusion of internal iliac arteries. 5) Additional MRI role for interventional radiologist

## **IREE-70 Image-guided Percutaneous Cryoablation for Lung Malignancies: Giving the Tumor a Cold Send-off**

Angel F. Castillo Fortuno, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To describe the physical and therapeutical mechanisms of image-guided percutaneous lung cryoablation (L-CYOA).
- To discuss the clinical and imaging features and the diagnostic and therapeutical algorithms of patients with lung malignancies amenable to treatment L-CYOA, including a proposed systematic pre-procedural evaluation protocol.
- To explain the

technique, intraprocedural considerations, imaging findings, and most common complications related to L-CYOA. • To describe the short-, mid-, and long-term follow-up imaging findings, clinical outcomes, and prospects of L-CYOA in the treatment of lung malignancies.

#### **TABLE OF CONTENTS/OUTLINE**

1.- Introduction 1.1- Background 1.2 - Surgery, SBRT or lung ablation? 1.3.- Heat vs. cold ablation techniques: Why CYOA? 1.4.- CYOA: Basic principles 2.- Indications 2.1.- Non-small cell lung carcinoma (NSCLC). 2.2.- Oligometastatic lung disease (OLD). 3.- Assessment before L-CYOA 3.1.- Patient selection. 3.2.- Preprocedural evaluation and preparation. 3.3.- Proposal of a systematic protocol. 4.- L-CYOA procedure 4.1.- Technical considerations: CYOA equipment and CT protocol. 4.2.- Technique. 4.3.- Intraprocedural clinical and imaging evaluation. 4.4.- Immediate clinical and imaging findings. 4.5.- Complications. 5.- Post-L-CYOA follow-up 5.1.- Clinical and imaging follow-up scheme. 5.2.- Short-, mid-, and long-term follow-up imaging and clinical findings. 6.- Clinical outcomes 6.1.- Stage I NSCLC. 6.2.- Alternatives indications in NSCLC. 6.3.- OLD. 6.4.- Immunotherapy synergy. 7.- Summarize 8.- Conclusion

#### **IREE-71 Superior Vena Cava Interventions**

##### **Awards**

##### **Cum Laude**

Irene Dixe de Oliveira Santo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the causes, anatomic considerations, presentation, and grading of superior vena cava syndrome (SVCS); Describe the main treatment options for SVCS with a special focus upon the endovascular therapies (ET), including angioplasty, stenting and catheter-based thrombus removal; Provide a brief case-based overview of ET, including stent selection; Review the main complications of ET.

#### **TABLE OF CONTENTS/OUTLINE**

Causes of superior vena cava syndrome (SVCS); Review of the main anatomic considerations, including patterns of obstruction and collateral pathways; Clinical presentation and grading system of SVCS; Diagnostic approach for SVCS; Main treatment options including chemotherapy with or without RT, surgical bypass or ET, including angioplasty, stenting and catheter-based thrombus removal, with pros and cons of each modality; Selected cases from our institution to illustrate several ET options; Venous Stents: types, descriptions, benefits and drawbacks; Complications of ET: hematoma, local infection, pericardial tamponade, SVC rupture, stent migration, in-stent restenosis, pulmonary edema, major bleeding, pulmonary embolism, and cardiac injury.

#### **IREE-72 Combined Y90 Radioembolization and Immunotherapy for the Treatment of Hepatocellular Carcinoma: Is it Effective or Harmful Due to Adverse Effects**

Johnny Yang, BS, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the mechanism of immunotherapy and Yttrium-90 radioembolization for the treatment of hepatocellular carcinoma (HCC). Explore the risks, benefits, and safety of combined immunotherapy and radioembolization treatment. Review outcomes of real-life cases of combined therapy.

#### **TABLE OF CONTENTS/OUTLINE**

Understanding the Hepatocellular carcinoma (HCC) immune microenvironment is important for developing effective immunotherapies. Suppression of the cytotoxic immune response - including CD8+ T lymphocytes, Natural Killer (NK) cells, and their associated cytokines - is associated with HCC progression. New drugs targeting immune checkpoint inhibitors, such as nivolumab, pembrolizumab, and atezolizumab have revolutionized the treatment of HCC. The latest research is exploring combination therapy with multiple immunotherapy agents and/or locoregional therapies such as surgical resection, ablation, or embolization. We reviewed stand alone widely used radioembolization with yttrium-90 (Y-90) therapy versus the safety of combining radioembolization with the PD-1 inhibitor nivolumab in HCC. Several Studies looked at the safety of the combination therapy by examining adverse events and overall survival. Results have shown that the combination therapy was well-tolerated, with no major adverse events reported. The most common side effects were fatigue, nausea, and abdominal pain. The median overall survival for the patients was 17 months, which is similar to prior studies. Some studies showed similar survival between these two therapies. Personalized selection based on age, burden of disease and other favorable criteria are important on which patient will benefit from single or combined therapy.

#### **IREE-73 Understanding the Complex Mechanisms of Complications in IR**

Jorge E. Lopera, MD (*Presenter*) Shareholder, Tecnostent SA; Consultant, Merit Medical Systems, Inc; Research Grant, AngioDynamics, Inc

## TEACHING POINTS

- To review how complications affect our performance in IR
- To understand the most common mechanism of IR complications
- To learn how to prevent and deal with complications
- To illustrate healthy and unhealthy ways to deal with complications

## TABLE OF CONTENTS/OUTLINE

Introduction : Error or complication ? Most common cause of complications : Judgmental errors : incorrect strategy of treatment is chosen.(1) overly heroic procedures(2) failure to intervene when the situation demands. Technical errors : poor technique , poor selection of devices .Normative or moral errors: irresponsible or unethical behavior. IR specific complications: Choosing the wrong materials .Not knowing your patient's history well. Poor communication. Rushing through cases. Poor technique .Bad luck? . Simple steps to prevent complications Coping with complications : What to do next . Healthy and unhealthy ways to deal with complications Economic and social cost of complications Conclusions

### **IREE-74 Considerations for the Nonconventional Transjugular Intrahepatic Portosystemic Shunt (TIPS) Creation in Cancer Patients: Alternative Techniques and When to Use Them**

Kevin Agahi (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Review the indications and potential interfering factors to performing a TIPS procedure in cancer patients.2. Present the standard technique for performing a TIPS; modifications that can be made; and when to use them to circumvent difficulties of the pre-, intra-, and post-operative process in cancer patients with altered post-surgical anatomy and acute or chronic splenoportal venous thrombosis.

## TABLE OF CONTENTS/OUTLINE

The transjugular intrahepatic portosystemic shunt (TIPS) is widely used in relieving pressure in the portal venous system (~90% success rate) in patients with refractory variceal bleeding or ascites, often due to cirrhosis. The standard process involves catheter guidance from a hepatic vein to a target portal vein branch. Several factors in cancer patients can complicate this procedure. These patients routinely have altered post-surgical anatomy such as a partial hepatectomy. Additionally, an association with increased thrombophilia can cause portal vein thrombosis. Moreover, certain tumors can compress or invade into splenic or mesenteric veins and result in occlusions interfering with a TIPS creation. For such cases, modifications to recanalize or bypass the obstruction have been demonstrated. We review the literature and present alternative techniques for shunt creation in a nonconventional TIPS:1. The diagnostic presentation of patient factors that can interfere with a successful TIPS creation.2. Case-based discussion regarding modifications to the TIPS technique to circumvent complicating factors.

### **IREE-75 Local and Systemic Immune Cell Landscape after Transcatheter Arterial Embolotherapies for Hepatocellular Carcinoma**

#### **Awards**

#### **Certificate of Merit**

Hannah E. Kostan (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Review the magnitude and influence of post embolization hypoxic microenvironment on the local and systemic immune cell landscape in hepatocellular carcinoma (HCC)
- Illustrate preclinical and clinical data on T-cell and myeloid populations in post embolization and radioembolization in tumor microenvironment
- Describe the current status of systemic immune cell response after catheter-based therapies for HCC

## TABLE OF CONTENTS/OUTLINE

1.Introduction to catheter-based interventions for HCC and technical impact on post embolization hypoxia 2. Overview of the role of hypoxic stress and angiogenic factors induced by embolization on HCC cell survival 3. Characterize T-cell and myeloid cell local landscape after catheter-based interventions. 4. Discuss changes to splenic and plasma levels of inflammatory markers after HCC embolotherapies. 5. Demonstrate sustained immune responses after Y90 Radioembolization in Hepatocellular Carcinoma 6. Discuss future applications of embolization therapies in treating liver tumors.

### **IREE-76 Imaging Findings and Interventional Management in Benign and Malignant Biliary Disease**

Daniel Freedman, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Biliary disease consists of benign and malignant entities with a diverse spectrum of clinical presentation and imaging findings.2. Benign biliary disease includes choledochal cysts, hamartomas, autoimmune diseases, chronic pancreatitis, HIV



cholangiopathy, iatrogenic injury, gallstones, infection (cholangitis), and may develop after liver transplantation.<sup>3</sup> Malignant biliary disease includes primary biliary cancers (cholangiocarcinoma) and secondary tumor/metastatic disease, and causes severe illness secondary to local obstruction.<sup>4</sup> Multimodality imaging plays a critical role in guiding diagnosis and treatment options executed by interventional radiologists and advanced endoscopists including PTC, PTBD, ERCP, biliary stents, and surgery.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review of the clinical presentation and diagnostic imaging workup for benign and malignant biliary disease.<sup>2</sup> Multimodal imaging and procedural approach to the diagnosis, management, and treatment of benign and malignant biliary disease, including: a. Percutaneous transhepatic cholangiography and drain placement (PTC, PTBD)b. Endoscopic retrograde cholangiopancreatography (ERCP)c. Percutaneous transhepatic cholangioscopyd. Biliary stenting. Surgical intervention

#### **IREE-77 Deep Gluteal Syndrome: Anatomy, Imaging and CT-guided Treatment (Sciatic Nerve Neurolysis)**

Cristina Candelaria Linares Bello, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Remember the anatomy of the subgluteal space and the sciatic nerve.Explain the causes of deep gluteal syndrome and the different imaging findings.Explain the procedure of CT-guided treatment (sciatic neurolysis).

#### **TABLE OF CONTENTS/OUTLINE**

Deep gluteal syndrome is considered an underdiagnosed entity and defined as the compression or irritation of a non-discogenic origin of the sciatic nerve in the anatomical region of the subgluteal space. The typical symptoms are: dysesthesias and/or pain in the buttock and hip. There are many etiologies that can produce this syndrome: Specific musculoskeletal entrapments: fibrous, fibrovascular or vascular bands, piriformis syndrome, gemelli-obturator internus syndrome, phatology of the quadratus femoris muscle and the ischiofemoral space and insertional pathology of the hamstring muscles. Non-specific pathologies: iatrogenic, inflammatory, traumatic, infectious, gynecologic, vascular and tumors. For its diagnosis, physical examination and an adequate clinical history are of great importance. MR imaging is the procedure is the diagnosis procedure of choice. On the other hand, the CT-guided procedure to perform sciatic nerve neurolysis is both a diagnostic and therapeutic procedure and an alternative to surgical treatments.The deep gluteal syndrome is an underdiagnosed entity with multiple etiologies. The CT-guided sciatic nerve neurolysis is a safe procedure and an alternative to surgical treatments.

#### **IREE-78 Hidden Time Bombs: Image Features of Abdominal Visceral Pseudoaneurysms and Treatment**

Mario Dervishi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Describe the common locations of, and clinical presentation including the complications of abdominal visceral artery pseudoaneurysms.
- Review the key imaging features of abdominal pseudoaneurysms on different modalities.
- Discuss the non-surgical endovascular and percutaneous treatment approaches to abdominal pseudoaneurysms.

#### **TABLE OF CONTENTS/OUTLINE**

•Definition of pseudoaneurysms and location of visceral abdominal aneurysm such as-Splenic Artery Pseudoaneurysm-Hepatic Artery Pseudoaneurysm -Renal Artery Pseudoaneurysm -Pancreatic Artery Pseudoaneurysm-Mesenteric Artery Pseudoaneurysm•Clinical presentation of pseudoaneurysms• Imaging features of pseudoaneurysms - Findings on doppler and contrast enhanced ultrasound- Features on computed tomography (CT) angiogram- Vasculature characteristics and assessment of pseudoaneurysm features on conventional angiogram. • Indication of pseudoaneurysm treatment and non-surgical treatment options - Symptomatic versus non symptomatic pseudoaneurysm- Endovascular fluoroscopic guided pseudoaneurysm treatment.- Percutaneous CT guided treatment - Percutaneous US (doppler and or contrast enhanced) guided treatment.

#### **IREE-8 Minimally Invasive Thoracic Oncology Treatments: Comprehensive Review and Comparison of RFA, MWA, Cryoablation, and Chemoembolization Techniques**

Shakthi K. Ramasamy, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This educational exhibit aims to provide a comprehensive overview of minimally invasive thoracic oncology treatments, focusing on radiofrequency ablation (RFA), microwave ablation (MWA), cryoablation, and bronchial/pulmonary artery chemoembolization. RFA and MWA offer reduced morbidity and mortality, while preserving pulmonary function and allowing for repeatability. Cryoablation has shown promise in the treatment of early-stage lung cancer and advanced-stage palliative care, as well as in emerging applications such as ground-glass nodules. When lung metastases that are inoperable and unsuitable for ablation cease to respond to systemic chemotherapy, the prognosis becomes poor. Bronchial and pulmonary

artery chemoembolization provide alternative treatment options for patients with large, multifocal lung tumors and those experiencing hemoptysis. The exhibit will delve into the principles, applications, imaging guidance, and outcomes associated with each technique, as well as the comparative efficacy of these treatments.

#### **TABLE OF CONTENTS/OUTLINE**

I. RFA, MWA, Cryoablation and Bronchial and Pulmonary Artery Chemoembolization will be discussed under the following categories: A. Principles and techniques B. Imaging guidance C. Patient selection and indications D. Treatment outcomes and comparisons E. Potential complications and management strategies II. Comparing the Treatments A. RFA, MWA, Cryoablation, and Chemoembolization B. Factors influencing treatment selection C. Efficacy and safety of each technique III. Future Directions and Research A. Ongoing clinical trials and studies B. Potential applications in personalized medicine and targeted therapy

#### **IREE-80 Gonadal Vein Embolization for the Management of Varicocele, Infertility, and Pelvic Congestion: Patient Anatomy, Evaluation, and Technique for Successful Treatment**

Younes Atlassy (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Varicocele and PCS are similar disorders associated with vascular dysfunction. Varicocele occurs due to the pooling of venous blood while PCS is the result of vascular pressure buildup in the pelvic region. 2. Understanding the diagnostic and imaging workup for both conditions is imperative for radiologists and treatment teams to identify, grade, and treat both conditions. 3. Several interventions and treatments, including gonadal vein embolization, are available for patients with these conditions with varying success and complication rates. Information regarding the risks and benefits surrounding these interventions is paramount to ensuring the proper standard of care for each individual patient. 4. Interventional radiology percutaneous embolization has become a safe and effective minimally invasive option for varicocele and PCS treatment with high success rates and few complications.

#### **TABLE OF CONTENTS/OUTLINE**

1. Understanding the anatomy and pathophysiology of both PCS and varicocele including the anatomical variants and attributes that make gonadal vein embolization a more attractive treatment modality in certain cases. 2. A review of the clinical presentation, diagnostic imaging, workup, grading/classification systems, and the interventions for each one. 3. A look at the various treatment options and the risk-benefit analysis around each one. 4. An in-depth guide on IR-guided procedural protocol for the management of varicocele and PCS including how to address anatomical variants, contraindications, and expected post-procedural outcomes.

#### **IREE-81 Endovascular Interventions of the Mesenteric Vasculature Through Collaterals: A Technical Savior**

Gottipati P. Choudary, MD, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Vascular pathologies involving the arteries distal to stenosed or occluded main mesenteric arterial trunk is difficult to access. In these situations, one should be aware of arterial arcades and knowledge about these collateral pathways can bail the interventionalist out. We present four cases of endovascular interventions performed through the mesenteric collateral pathways.

#### **TABLE OF CONTENTS/OUTLINE**

Case 1. GLUE EMBOLIZATION OF SPLENIC ARTERY ANEURYSM (SAA) VIA HYPERTROPHIED RIGHT GASTRO-EPIPLOIC ARTERY (RGEA). 28-year/female - acute necrotizing pancreatitis with intraabdominal bleed. Status post proximal splenic artery embolization using coils. Embolization of the SAA was done via the hypertrophied RGEA. Case 2. SPLENIC PARENCHYMAL EMBOLIZATION (SPE) VIA INFERIOR PANCREATICO-DUODENAL (IPD) ARTERY - RIGHT GASTRIC ARTERY (RGA) COLLATERALS. 58-year/male - Post liver transplant and SA ligation. Refractory ascites due to persistent portal hypertension. Distal SA is reformed through collaterals from the RGEA (minor) and the IPD artery. Embolization was performed using PVA particles. Case 3. COIL EMBOLIZATION OF LEFT HEPATIC ARTERY (LHA) PSEUDOANEURYSM VIA THE IPD ARTERY. 32-year/male - Pseudoaneurysm arising from the LHA branch after removal of biliary catheter. Celiac artery stenosis was noted. Celiac axis reformed through IPD artery. A microcatheter was navigated across the hypertrophied collaterals and the pseudoaneurysm was coiled. Case 4. SPE VIA HYPERTROPHIED RGEA COLLATERALS. 42 years/male - Post liver transplant and SA ligation. Persistent hypersplenism and Splenomegaly. Splenic parenchymal embolization was done via the hypertrophied RGEA by injection of PVA particles

#### **IREE-82 From Classic to Quirky: A Journey through the "Aunt Minnie's" of Angiography**

Kara M. Fitzgerald, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

Provide radiology resident level review of classic, "Aunt Minnie" angiographic signs and findings. Briefly discuss pertinent management aspects of underlying pathology diagnosed on angiography. Review intravenous contrast agent selection, contrast injection rates and fluoroscopic projections as key technical components for optimizing image acquisition in angiography and venography.

## TABLE OF CONTENTS/OUTLINE

Introduction:- Considerations for contrast selection- Contrast injection rates in angiography and venography- Common fluoroscopic projections for image acquisition  
Abdominal Angiography- Aortic dissection with Floating Viscera Sign- Budd Chiari- Non-inflammatory, non-atherosclerotic arteriopathies- Fibromuscular Dysplasia- Segmental Arterial Mediolysis- Standing Wave- Polyarteritis Nodosa  
Peripheral Angiography- Sciatic artery- Dissection- Popliteal Artery Entrapment Syndrome- Hypothenar Hammer Syndrome- Arterial Thoracic Outlet Syndrome  
Pelvic Angiography- Uterine Arteriovenous Malformation- Postpartum hemorrhage- Trauma- Corona Mortis- Pruning, truncation, petechial hemorrhage and vasospasm- Cavernosal Blush  
Angiography of Collateral Pathways:- Arc of Buhler and Rioloan- Subclavian Steal- Aortic occlusion and Winslow's pathway  
Venography- Venous Thoracic Outlet Syndrome- Paget-Schroetter Syndrome- Deep Vein Thrombosis- Azygos Continuation of the Inferior Vena Cava

### **IREE-83 Mechanical Thrombectomy for the Treatment of Deep Vein Thrombosis: A Primer for Interventional Radiologists**

Abinaya Ramakrishnan (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Teaching Points: Review treatment strategies using percutaneous mechanical thrombectomy devices including its indications and current state of literature. Review data from a single institution's experience and discuss factors that impact post-procedure outcomes.

## TABLE OF CONTENTS/OUTLINE

Table of Contents/ Outlines: Background of management for acute deep vein thrombosis Discuss indications for percutaneous mechanical thrombectomy vs thrombolysis vs anticoagulation Discuss the diagnosis of May Thurner on incidence of recurrent DVT Discussion of major clinical trials of thrombectomy devices CLOUT Registry (Inari Medical) ATTRACT trial (Angiojet Rheolytic Thrombectomy System, Boston Scientific) Overview of current percutaneous mechanical thrombectomy devices on the market Data from a single-institution's experience with percutaneous mechanical thrombectomy Discuss findings from a single institution's retrospective analysis of thrombectomy procedures (n=82) Discuss specific factors that may influence post-procedure outcomes of re-thrombectomy, specifically sex, location of clot, chronicity of clot. Discuss intraprocedural characteristics that improve outcomes like placement of a stent and venoplasty. Review some of the contraindications for the use of percutaneous mechanical thrombectomy Highlight 2 successful cases with pre- and post-procedure imaging.

### **IREE-84 Straight to the Heart: State of the Art Thoracic Central Vein (Superior Vena Cava) Endovascular Recanalization, Thrombectomy and Stent Reconstruction**

Kara M. Fitzgerald, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review anatomy and embryology of mediastinum and central thoracic veins. Recognize common etiologies and classifications of thoracic central vein obstruction (TCVO) including lesions of the brachiocephalic veins and superior vena cava. Describe endovascular treatment of TCVO including access, recanalization, thrombectomy, stent reconstruction, and extra-anatomic bypass creation as well as intraprocedural adverse event management. Discuss comprehensive care from initial work-up to post-procedure management.

## TABLE OF CONTENTS/OUTLINE

Upper extremity and thoracic central vein anatomic review  
Common etiologies for TCVO  
Benign Malignant Patient evaluation  
Presentation, physical examination, and imaging evaluation  
Acute and chronic occlusive symptoms  
Patient centered care  
Technical aspects of procedure  
Sedation Access  
Venography  
Blunt and sharp recanalizations  
Thrombectomy and tissue sampling  
Stent selection and reconstruction  
Use of intravascular ultrasound (IVUS)  
Adverse event management  
Hemothorax and hemopericardium  
Stent migration  
Extra-anatomic bypass creation  
Post-procedure care and follow-up  
Antiplatelet and anticoagulation regimen  
Imaging surveillance  
Outcomes and patency  
Pediatric considerations

### **IREE-85 Extra Abdominal Desmoid Tumors and Image Guided Percutaneous Cryoablation**

Roberto Luigi Cazzato (*Presenter*) Proctor, Medtronic plc

## TEACHING POINTS

- Unique anatomy and pathophysiology of extra-abdominal desmoid tumors- Treatment planning including image and clinical evaluation- Procedural techniques of image guided percutaneous cryoablation- Adjunctive techniques including thermoprotection- Necessary clinical and imaging follow-up after treatment - Treatment guidelines for extra abdominal desmoids and the role of ablation

## TABLE OF CONTENTS/OUTLINE

- Sporadic vs familial desmoid tumors- Rationale for using cryoablation to treat extra-abdominal desmoid tumors- Selection criteria for proposing cryoablation of extra-abdominal desmoid tumors-Follow-up

## IREE-86 Minimally Invasive Treatment of Postoperative Pancreatic Fistula Using Interventional Radiology

### Awards

#### Certificate of Merit

Toshihiro Horii, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Although the incidence of surgical complications has gradually decreased with the advancement of minimally invasive surgical techniques and instruments, such as laparoscopic surgery and robot-assisted technology, postoperative pancreatic fistula remains a severe complication requiring prompt management. Percutaneous and endoscopic postoperative management has a lower mortality rate than surgical methods, and expectations for interventional radiology (IR) are increasing. Therefore, it is necessary to understand the etiology, diagnosis, and indications of postoperative pancreatic fistula and be familiar with appropriate IR intervention methods. Knowledge of technical tips in treatment is essential for successful procedures. The aims of this presentation are as follows: To explain the etiology, diagnosis, indications, and imaging features of postoperative pancreatic fistula. To discuss the treatment methods, management strategies, advancements, and complications in interventional radiology for postoperative pancreatic fistula, including techniques.

## TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Overview Etiology, Diagnostic Criteria, and Treatment Indications for Postoperative Pancreatic Fistula Management Strategies for Postoperative Pancreatic Fistula 3. Illustrated Case Studies Management of Pancreatic Fistula after Pancreaticoduodenectomy Management of pancreatic fistula after combined resection of the body and tail of the pancreas Management of Pancreatic Fistula after Gastric Surgery Complications and Difficult Cases 4. Conclusion

## IREE-9 Acute Massive Hematochezia Due to Colonic Varix: Antegrade Transsplenic Embolization of Abdominal Garland Vein

Gottipati P. Choudary, MD, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

In patients with cirrhosis of liver, acute variceal bleeding can be a fatal complication. Varices may develop anywhere in GIT, in cirrhotic patient. Ectopic varices, are not so common, accounting less than 5% of all variceal bleeding. Among these, colonic varices are very rare. Here, in this report, we emphasize the role of endovascular intervention in the management of acute massively bleeding colonic varix in a hemodynamically unstable cirrhotic patient.

## TABLE OF CONTENTS/OUTLINE

In patients with cirrhosis of liver, acute variceal bleeding can be a fatal complication. Colonic varices are very rare cause of lower gastrointestinal bleeding that can bleed spontaneously and result in massive haemorrhage in patients with liver cirrhosis and portal hypertension. Here we present a case of 50-year-Male, known case of non-alcoholic cirrhosis of liver with portal hypertension (for past 15 years) and type 2 diabetes mellitus, who presented with massive fresh bleeding per rectum. Despite early colonoscopy and glue injection of the colonic varix, patient continued to bleed. Triple phase CT scan of abdomen was done which showed large portosystemic shunt (mesocaval shunt) arising from superior mesenteric vein (SMV) traversing around the ascending colon and forming sub mucosal varices protruding into the colon lumen and joining the right renal vein and draining into the inferior vena cava (IVC) giving a garland appearance. He underwent successful transsplenic antegrade obliteration of the varix by coil embolization and glue injection. There are no clear-cut established management guidelines for such patients. Endovascular embolization could be an effective treatment option of colonic variceal bleeding.

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## Abstract Archives of the RSNA, 2023

IREE-1

### Pre-operative Osseous Tumor Embolization: A Review of Presentation, Benefits, and Technical Details

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ashini A. Patel, MBA, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Preoperative tumor embolization is a safe and effective adjunctive to tumor resection that has benefits including decreased estimated blood loss, and less complications. 2. There are only few contraindications to pre-operative embolizations, and most patients that undergo the procedure will benefit for later tumor resection.3. Importance of tumor feeding arteries.4. It is valuable to consider all patients with suspected hypervascular osseous for preoperative tumor angiography and embolization.

#### TABLE OF CONTENTS/OUTLINE

1. A review on osseous tumors, their typical management and how preoperative embolization can improve outcomes.2. Selection of patients that would benefit from this procedure before tumor resection.3. Review of example cases outlining the technical details of the embolization procedure, to include devices used and the importance of tumor feeding arteries.4. Analyze the efficacy and safety of pre-operative embolization and its value in decreased estimated blood loss and transfusion need, and complications. Compare this data to surgical resection without embolization.

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## Abstract Archives of the RSNA, 2023

IREE-10

### To Sclerose or Decompress? Comparing BRTO and TIPS for Gastric Variceal Management

All Day Room: Learning Center

Anish Narayanan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Objectives\* Understand gastric variceal (GV) anatomy\* Identify indications and contraindications for BRTO and TIPS\* List conventional and alternative procedure steps\* Recognize common and rare intra- and post-procedural complications

#### TABLE OF CONTENTS/OUTLINE

Outline:1. Introduction (epidemiology, mortality)2. Anatomy:\* Location (GOV and IGV classification)\* Afferent/efferent anatomy (Kiyosue classification)\* Uphill/downhill drainage patterns3. Indications:\* Variceal bleeding (active or prophylaxis)\* BRTO: HCC, refractory HE, preserving liver function\* TIPS: Portal HTN with  $\geq 12$  mmHg4. Contraindications:\* BRTO: Portal/splenic vein thrombosis, refractory ascites, uncontrolled EV, absent gastrorenal shunt, severe portal HTN\* TIPS: HE, Child-Pugh C, CHF, pulmonary HTN, cystic liver disease5. Procedural Steps:\* BRTO (including both conventional approaches as well as modified approaches, including CARTO and PARTO)\* TIPS (including CO2 venography, portography, various vascular approaches, and embolization)6. Complications:BRTO:\* Intra-procedural: sclerosant extravasation, balloon rupture, premature balloon deflation\* Post-procedural: ARF, hemolysis, cardiogenic shock, pulmonary edema, DIC, PE, portal/splenic/renal vein thrombosis, adrenal infarctTIPS:\* Intra-procedural: Liver capsule/parenchyma/biliary injury, PV rupture, arrhythmias\* Post-procedural: HE, hepatic failure, TIPS migration/dysfunction, infection

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## Abstract Archives of the RSNA, 2023

IREE-11

### **Microwave Ablation of the Liver Lesions in Critical Locations: Are there No-No Zones**

All Day Room: Learning Center

Merve Ozen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Thermal ablation is the mainstay of treatment for small hepatic tumors (<2 cm). Thermal ablation may not be preferred in these patients if the tumors are in high-risk locations, however. These high-risk locations include, but are not limited to, tumors adjacent to the main portal vein, the inferior vena cava, the gall bladder, the diaphragm, and the heart. 2. By discussing the literature and showing cases of successful microwave ablation of tumors in high-risk locations, we show that MWA can be a safe and effective.

#### **TABLE OF CONTENTS/OUTLINE**

1. The major differences between radiofrequency ablation and microwave ablation as it pertains to the management of malignancy. 2. Cases of microwave ablation of tumors in high-risk locations and a discussion of the current literature on the safety and efficacy of such procedures. 3. The cases display the ablation of tumors adjacent to the main portal vein, the inferior vena cava, the gall bladder, the diaphragm, and the heart. 4. Technical maneuvers will be described to increase safety and efficacy for the difficult lesions.

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## Abstract Archives of the RSNA, 2023

IREE-12

### **Ablation vs Free Life. Colorectal Cancer with Lung Metastases: Evaluation of Local Recurrence and Chemotherapy-free Interval in Patients Treated with Ablative Therapy**

All Day Room: Learning Center

Pedro L. Lino, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To discuss percutaneous ablation and its role as a safe and effective treatment option for colorectal cancer lung metastases, and the benefits of its minimally invasive nature. To determine patient selection characteristics, preprocedural planning, and tactics involved in a safe and successful outcome, particularly in challenging cases. To examine the impact of ablation (RFA and MWA) on overall survival and chemotherapy-free interval in patients with lung metastases from colorectal cancer.

#### **TABLE OF CONTENTS/OUTLINE**

1.Introduction and epidemiology 2.Procedure applied anatomy 3.RFA treatment techniques a.Patient positioning; b.Tactical pneumothorax; c.Leverage; d.Hydrodissection. 4.Acute complications 5.Evaluation of disease progression

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-13

### **Thermal Protection: Heightened Safety for Minimally Invasive Percutaneous Thermal Ablation of Musculoskeletal Tumors**

All Day Room: Learning Center

Anderanik Tomasian, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Over the past two decades, minimally invasive percutaneous image-guided thermal ablations have been progressively incorporated in the management paradigm of patients with musculoskeletal tumors and endorsed by the National Comprehensive Cancer Network and American College of Radiology. The high clinical success rates and durability of therapeutic effects of such interventions to achieve local tumor control, pain palliation, and cure have been documented in the recent literature. Therefore, safety of musculoskeletal thermal ablations is critical and must be ensured by radiologists in care of patients with bone tumors for improved patient outcomes. To enhance safety and minimize undesired thermal injury to surrounding vital tissues as a result of non-target ablation, several thermal protection strategies have been successfully implemented in clinical practice.

#### **TABLE OF CONTENTS/OUTLINE**

- General considerations
- Neuroanatomic considerations
- Tissues at risk (Spinal cord, spinal and peripheral nerves, torso organs, articular cartilage, subchondral bone plate/physis, skin)
- Thermal protection techniques (Indications and Choice of technique)
- Passive thermal protection (Patient Biofeedback and Clinical Assessment, Temperature Monitoring strategies, Neurophysiological Monitoring with somatosensory and motor-evoked potentials, Electrostimulation)
- Active thermal protection (Thermal Insulation strategies, Thermal Modification techniques)
- Thermal Injuries/Complications and their management

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## Abstract Archives of the RSNA, 2023

IREE-14

### The Rise of Robotics in Interventional Radiology

All Day Room: Learning Center

Shen Ning (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- The use of robotics in interventional radiology is an emerging trend following medical technology and engineering developments in recent years.
- Robotic-assisted interventional radiology is beginning to play a key role in cardiac and neurovascular interventions and expanding rapidly.
- Endovascular robotic systems can help facilitate precise and stable catheter navigation while reducing radiation exposure during procedures.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of the history and timeline of robotics in interventional radiology.
2. Introduction and summary of robotic systems and their advantages and disadvantages.
3. Key studies demonstrating the role of robotics for endovascular interventions.
4. Telerobotics in interventional radiology and its roles and limitations.
5. Future prospects for robotic-assisted interventional radiology.

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## Abstract Archives of the RSNA, 2023

IREE-15

### How to Perform a Correct Access for Minimally Invasive Lumbar Spine Procedures

All Day Room: Learning Center

Natalia Parra, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Fluoroscopy guided interventions in lumbar spine involve a variety of minimally invasive procedures for improving pain management. Three of the main approaches typically used to get access to the targeted structure are transforaminal, interlaminar and transpedicular. The aim of the proposed exhibit is to provide radiology residents and fellows with a quick guide to better understand the basics of these techniques and thus be able to perform a safer and more effective access. At the outset, the exhibit will list the different types of procedures enabled by the abovementioned approaches. Following, it will provide a pictorial review of the anatomical keys in preprocedural imaging studies. Finally, the exhibit will explain how to perform the approaches step-by-step, from the positioning of the angiograph and the anatomical references to the needle insertion, and will conclude by describing how to check its correct positioning.

#### TABLE OF CONTENTS/OUTLINE

1. Types of procedures and related approaches. 2. Imaging studies: what to look at and how to do it.3. Angiograph positioning and anatomical references.4. How to perform and correct the approaches in real time.5. How to check the positioning of the needle.

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## Abstract Archives of the RSNA, 2023

IREE-16

### **Percutaneous Cryoablation: A Comprehensive Review of Whole-body Application**

All Day Room: Learning Center

Luis E. Garza-Barrera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Percutaneous cryoablation is a minimally invasive procedure that is safe and effective in treating various solid benign and malignant lesions throughout the human body.2) Imaging and tissue diagnosis is necessary before ablation to ensure that cryoablation is the most appropriate modality of treatment.3) Percutaneous cryoablation can be performed with ultrasound, fluoroscopy, computed tomography, or magnetic resonance imaging guidance. Knowing the risks and benefits of each modality is important for choosing the best modality for individual patient lesions.4) Cryoshock is a feared clinical syndrome after cryoablation for which early diagnosis and management is crucial.5) Abscopal effect is a unique effect of cryoablation based on immune-mediated post-ablation antigen presentation.

#### **TABLE OF CONTENTS/OUTLINE**

1) Mechanism of action and physics of cryoablation leading to induction of cellular apoptosis and the understanding of ablation artifacts.2) Indications and contraindications, diagnostic workup, and imaging diagnosis for lesions amenable to cryoablation.3) Procedural protocols for the management of lung/kidney solid tumors, metastasis, bone and soft tissue solid/cystic lesions, nerve pain, and vascular malformations.4) Adverse effects of cryoablation including cryoshock and the mitigation of these effects.5) Abscopal effect and future directions for the use of cryoablation to prevent lesion recurrence and treat metastatic disease.

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## Abstract Archives of the RSNA, 2023

IREE-17

### **The Need for Virtual Fluoroscopic Imaging in Bronchial Artery Embolization: The Best for Radiation Exposure Dose Reduction**

All Day Room: Learning Center

Yoshihiro Tanaka, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In this study, we investigated the relationship between supporting images of a new concept and exposure reduction in bronchial artery embolization <BAE>. This is research on exposure reduction aimed at shortening the procedure time by creating a support image similar to the IR image using CT volume data, in contrast to the existing exposure protection and exposure reduction mechanisms of IR equipment.

#### **TABLE OF CONTENTS/OUTLINE**

A virtual fluoroscopic image <VFI> is a Ray-summation image that is similar to a fluoroscopic image, and blood vessel running and the lesioned part are superimposed and displayed (Fig.1). Thereby it possible to use information intuitively alongside fluoroscopic images, and to avoid unnecessary mapping imaging for bronchial artery identification and time waste due to blind catheterization under fluoroscopy, aiming at rapid vascular selection and hemostasis (Fig.2,3). Also, a workstation can be easily installed and implemented, and the CT volume data obtained in advance is used so that there is no need to purchase new and expensive IR equipment. As a result, the number of angiographies required for dissection can be minimized, which not only reduces the amount of contrast agent and exposure, but also reduces complications by shortening the procedure time (Table 1,2).

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## Abstract Archives of the RSNA, 2023

IREE-18

### 2022 Barcelona Clinic Liver Cancer Update for the Interventional Radiologist

All Day Room: Learning Center

Tarik Babar, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- 1) Understand the updates to the 2022 Barcelona Clinic Liver Cancer (BCLC) guidelines for managing patients with hepatocellular carcinoma (HCC)
- 2) Review supporting evidence for transarterial chemoembolization (TACE) and percutaneous ablation
- 3) Highlight recent evidence surrounding transarterial radioembolization (TARE) that warranted its inclusion in the new guidelines
- 4) Discuss the new systemic agents included in the 2022 BCLC guidelines and their supporting evidence

#### TABLE OF CONTENTS/OUTLINE

- 1) Introduction, including epidemiology of HCC and interventional radiology (IR) management options in the previous BCLC guidelines
- 2) BCLC framework for classifying HCC
- 3) Review of existing literature on TACE and percutaneous ablation for patients with HCC
- 4) Overview of updates in the 2022 BCLC guidelines for IRs: Sub-division of Intermediate Stage (Stage B) patients, extending the existing liver transplant criterion to include more patients and include systemic options for other patients at this stage
- 5) Overview of updates in the 2022 BCLC guidelines for IRs: Inclusion of TARE for the first time in the guidelines, with a review of new, high impact studies leading to the inclusion of TARE
- 6) Overview of updates in the 2022 BCLC guidelines for IRs: New systemic agents for patients with advanced stage disease, including a review of high impact studies leading to the addition of the new systemic agents in the guidelines
- 7) Discussion of combination therapies for HCC such as TACE + systemic therapy, TARE + systemic therapy, TACE + percutaneous ablation, and percutaneous ablation combined with adjuvant systemic therapy
- 8) Conclusion and summary

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## Abstract Archives of the RSNA, 2023

IREE-19

### Imaging and Interventional Management of Lymphatic System Disorders

All Day Room: Learning Center

Eric Castane, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the lymphatic system disorders. 2. Describe the radiologic management of the lymphatic system disorders.

#### TABLE OF CONTENTS/OUTLINE

1. Material and Methods / Background Lymphatic. 2. Anatomy and Physiology. 3. Disorders of the Lymphatic System. 3.1. Classification. 3.2. Diagnosis. 4. Imaging of the Lymphatic System. 4.1. Ultrasound. 4.2. Magnetic Resonance. 4.3. Nodal Lymphangiography. 4.4. Imaging in Lymphatic Disorders. 5. Interventional Management of Lymphatic Disorders. 5.1. Chylothorax. 5.2. Chyle Ascites. 5.3. Peripheral Lymphatic Leak. 5.4. Lymphatic Plastic Bronchitis. 6. Post Procedure 6.1. Complications. 6.2. Post Procedure Imaging. 7. Conclusions.

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## Abstract Archives of the RSNA, 2023

IREE-2

### Shoot Your Shot: Techniques and Pitfalls of Pelvic Collection Drainage

All Day Room: Learning Center

Kateryna Burlak, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Most pelvic collections can be drained safely and effectively through a percutaneous image-guided approach. Collections in locations that are difficult to access pose a unique challenge and invite consideration of alternative approaches. We aim to discuss the techniques and pitfalls of these approaches, to encourage drainage of collections initially considered difficult or inaccessible and to raise awareness about potential complications. Teaching points of this exhibit include the following: 1 - To review the methods and anatomy of potential approaches involved in drainage of pelvic collections (including transperineal, transgluteal, transrectal and transvaginal approaches) 2- To demonstrate general techniques used (Trocar vs Seldinger techniques) 3- To discuss potential complications which can occur in drainage of pelvic collections and how to avoid them

#### TABLE OF CONTENTS/OUTLINE

1. Methods and anatomy of potential approaches: Lateral abdominal wall, Anterior abdominal wall, Transgluteal, Transperineal, Transrectal, Transvaginal 2. General techniques used 3. Examples of potential pitfalls and complications 4. Summary and teaching points

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## Abstract Archives of the RSNA, 2023

IREE-20

### Next Step for Colorectal Liver Metastasis Ablation: Computed Tomography During Hepatic Arteriography Guidance in Percutaneous Thermal Ablation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) This study aims to show the feasibility and accuracy of using computed tomography during hepatic arteriography (CTHA) as a percutaneous ablation guidance tool for colorectal liver metastasis (CLM) patients. 2) CTHA is performed via a transarterial catheter inserted into the hepatic artery for arterial assessment. It involves dual-phase contrast medium acquisition with specific rates and acquisition delays during a breath hold on expiration. 3) CTHA improves CLM visibility due to high contrast resolution and absence of portal venous system contrast-media deposition. CLMs appear hypoattenuating with a necrotic center and ill-defined enhancing rim visible on the arterial phase. 4) In contrast to its high sensitivity, CTHA specificity for detecting small tumors is often limited by the presence of pseudolesions. Moreover, limitations include potential complications related to sheath and catheter placement, physician's costs and time, and arterial anatomy variants. 5) CTHA enables precise oncologic intervention planning, combined therapies, and intraprocedural treatment response monitoring. Further research is needed to fully evaluate its clinical utility for guiding CLM ablation.

#### TABLE OF CONTENTS/OUTLINE

1) 'Let's Put a Ring on It' - CLM imaging presentation on CTHA; 2) Setting the Target - Image-guiding techniques in percutaneous liver tumor ablation and CTHA protocol; 3) Tips or tricks - Pseudolesions or CLMs? 4) Thinking Outside the Box - Future Perspectives

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## Abstract Archives of the RSNA, 2023

IREE-21

### Minimally Invasive Thoracic Tumor Treatment and Palliation

All Day Room: Learning Center

Anna S. McKenney, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Percutaneous ablation is an established safe treatment for primary and metastatic lung tumors. Adjunct intra-procedural maneuvers, such as creation of artificial pleural effusions or pneumothoraces, can permit treatment of tumors adjacent to critical structures. Emerging approaches such as arterial chemoembolization are altering the landscape of intervention for thoracic malignancies. Minimally invasive procedures such as percutaneous tumor localization, thoracic tumor embolization, and image-guided brachytherapy seed implantation can enable multidisciplinary treatment. Palliative interventions, ranging from embolization to shunt implantation, can provide palliation for thoracic oncology patients.

#### TABLE OF CONTENTS/OUTLINE

Tumor treatment  
Percutaneous ablation  
Radiofrequency ablation  
Cryoablation  
Microwave ablation  
Technical considerations during ablation  
Chemoembolization of lung tumors  
Interdisciplinary procedures  
Tumor localization prior to surgical resection  
Preoperative embolization of central thoracic tumors  
Image guided brachytherapy seed implantation  
Palliation  
Glue embolization of bronchopleural fistulas  
Bronchial artery embolization for hemoptysis  
Recurrent pleural effusion management  
Tunneled indwelling pleural catheters  
Denver pleurovenous shunt

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## Abstract Archives of the RSNA, 2023

IREE-22

### The Effects of Artificial Intelligence and ChatGPT on Interventional Radiology

All Day Room: Learning Center

Mahmoud Odeh (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

\*Artificial intelligence (AI) learns from data, and processes it to perform tasks requiring human intelligence\*AI can help create customized treatment plans for patients\*Fluoroscopy systems with AI reduce radiation exposure to make procedures safer\*Pre-operative and intraoperative images integrated by AI, provide more accurate guidance for image-guided procedures\*AI can create virtual angiography, which can be used for education and planning purposes\*ChatGPT can assist radiologists in creating educational and research materials more efficiently

#### TABLE OF CONTENTS/OUTLINE

Artificial intelligence (AI) refers to computational models that use algorithms to process data, learn from it using the output to perform tasks traditionally associated with human intelligence. AI models utilize patient diagnostic images and clinical findings to anticipate procedural outcomes. This enables interventional radiologists to customize treatment plans for each patient beforehand. AI has enabled fluoroscopy systems to substantially decrease radiation exposure to patients and staff. This is evidenced by a significant reduction in median dose area product from 5,708 mGy·cm<sup>2</sup> to 2,178 mGy·cm<sup>2</sup> (P < 0.001). AI can integrate pre-operative 3D with intraoperative 2D images, improving guidance for biopsies and image-guided procedures. This added augmented-reality element enhances the accuracy and safety of interventional procedures. AI employs preoperative imaging to create virtual angiography, which acts as an educational and real-time planning aid for both trainees and seasoned interventionalists. With the advent of chatGPT radiologists can harness AI to aid in the composition of educational and research material.

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## Abstract Archives of the RSNA, 2023

IREE-23

### Intercostal Neurolysis: A Primer

All Day Room: Learning Center

Omar Al-Daoud, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review relevant anatomy of the intercostal nerves. Describe indications for neurolysis. Describe risks of intercostal neurolysis. Highlight tips and tricks for risk mitigation.

#### TABLE OF CONTENTS/OUTLINE

Goals and Objectives, Case Presentation, Intercostal Nerve Anatomy, Indications for Intercostal Nerve Block and Neurolysis, Risks of Intercostal Neurolysis, Mitigating Risks, Nerve Block Cocktail, Additional Case Presentations, Learning Points

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## Abstract Archives of the RSNA, 2023

IREE-24

### Gastrointestinal Tract Tumors: Imaging and Interventional Management of Bleeding

All Day Room: Learning Center

Forrest B. Linch, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Learn mesenteric angiographic anatomy with special attention to anatomical variations and the blood supply to specific portions of the GI tract, which may affect treatment approach. 2. Learn common primary and metastatic etiologies of gastrointestinal tract bleeding requiring intravascular intervention. 3. Understand diagnostic imaging findings and interventional radiologic techniques for managing gastrointestinal tract bleeding

#### TABLE OF CONTENTS/OUTLINE

1. Mesenteric angiography: A) Standard technique and anatomy, B) Normal variant anatomy, C) Blood supply to specific portions of the GI tract; 2. Angiography of gastrointestinal tract malignancies: A) Common pathologies by location, B) Angiographic finding of tumors; 3. Diagnostic imaging of gastrointestinal tract malignancies: A) Modality selection (CT, MRI, NM), B) Expected findings and treatment implications; 4. Intravascular management of bleeding gastrointestinal tract malignancies: A) Indications, contraindications, B) Pre-procedure planning - i) Clinical evaluation, ii) Role of cross-sectional imaging and endoscopy, iii) Anatomic/vascular considerations (arterial supply, collaterals, variants), C) Technique - i) Particle versus coil embolization, ii) Coil embolization for protection of non-target structures, D) Outcomes and complications;

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## Abstract Archives of the RSNA, 2023

IREE-25

### Advancing Frontiers in Lung Malignancy Treatment: Unraveling the Potential of Interventional Radiology in the Ablation of Lung Malignancies

All Day Room: Learning Center

Izzet Altun, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Interventional radiology has evolved as a promising modality for the ablation of lung malignancies. Various techniques such as Radiofrequency Ablation (RFA), Microwave Ablation (MWA), and Cryoablation are extensively utilized, each with unique benefits and limitations. The choice of technique is determined by factors such as lesion size, location, and patient condition. These image-guided percutaneous ablation techniques are particularly advantageous for patients unsuitable for surgery or stereotactic radiation therapy. Future directions point towards refining these techniques, improving patient selection criteria, and integrating these modalities with novel systemic and loco-regional therapies for comprehensive patient care.

#### TABLE OF CONTENTS/OUTLINE

The report provides an overview of image guided ablation of lung malignancies. The goal is to present mechanism, advantages, and limitations of RFA, MWA, cryoablation and other less common techniques such as laser ablation. Discussion on patient selection, pre and post-procedural evaluation for lung ablation will be presented. Outline: 1- Introduction to IR in lung ablation, highlighting the scope of RFA, MWA, and cryoablation. 2- Detailed exploration of ablative techniques, focusing on mechanisms, optimal application, and potential drawbacks. 3- Examination of patient selection criteria, pre and post-procedural evaluation, and contraindications. 4- Analysis of the anesthesia management, CT protocols, and periprocedural considerations for lung ablation. 5- Discussion on the current state of research and future directions, emphasizing the potential for improved techniques and integrative treatment approaches. 6- Conclusion

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## Abstract Archives of the RSNA, 2023

IREE-26

### Creating Transvenous Intrahepatic Portosystemic Shunts (TIPS) with the Aid of Ultrasound (US): Tips for US

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Andrew Ni (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Learning Objectives Review standard steps for conventional TIPS creation. Provide steps and tips for using intracardiac echography (ICE) catheters and transabdominal ultrasound for aiding in TIPS creation. Discuss advantages and disadvantages of the various equipment used for TIPS creation and when to consider each.

#### TABLE OF CONTENTS/OUTLINE

Content/Outline Introduction Review steps for performing TIPS creation using fluoroscopic guidance Review cross sectional imaging to aid in procedure planning Demonstrate indirect portography and limitations. Demonstrate each of the key steps for creating a TIPS. Review ICE catheter setup Jugular vs Femoral approach Tips for orienting user to key anatomy and needle directing Tips to improve efficiency Review Transabdominal US set up Tips for orienting user to key anatomy and needle directing Tips to improve efficiency Discuss advantages and disadvantages each approach Unique cases best managed by each guidance modality Prevention of complications by each guidance modality Cost accessibility of each guidance modality While TIPS procedures are most commonly done using conventional fluoroscopy guidance, ultrasound may be used in conjunction with benefit. This presentation reviews guidance modalities for TIPS creation focusing on key imaging and circumstances favorable and unfavorable to each guidance modality.

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## Abstract Archives of the RSNA, 2023

IREE-27

### The ABCs of CT-guided Lung Biopsy: Tips and Tricks for Optimal Outcomes

All Day Room: Learning Center

Miriana E. Mariussi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: • Review the indications for the percutaneous CT-Guided lung biopsy • Comprehend the pre-procedural imaging analysis and planning • Assess the principles of the percutaneous biopsy techniques and co-axial techniques • Knowledge the common complications after the procedures and their management • Highlight the recommendations to avoid pneumothorax and other complications • Recognize common CT image findings observed in the post-procedural follow-up

#### TABLE OF CONTENTS/OUTLINE

Percutaneous biopsy of lung lesions is increasing due to the rise of cancer incidence and the growing need for molecular and immunohistologic analyses. The size of the lesion, the size of the biopsy needle and the chosen technique have a direct impact on the success of the procedure. A case based pictorial essay allows for a comprehensive assessment of: • Indications and patient selection for percutaneous CT-Guided lung biopsy • Establishing a concise pre-procedural imaging analysis and planning • Percutaneous technique and co-axial techniques • Needle positioning, trajectory and lesion sampling • Recognizing expected complications after the procedure • Strategies and tips for achieving a successful outcome • Reducing the risk of pneumothorax and other complications • Highlighting important post-procedural management steps • Understanding biopsy results and follow up

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## Abstract Archives of the RSNA, 2023

IREE-28

### **CT Guided Trans-osseous Biopsy, a Road Less Traveled: A review of Indications, Technical Aspects and Literature Summary**

All Day Room: Learning Center

Omar Rendon SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

CT guided transosseous biopsy is an alternative technique for lesions blocked by vital structures or apparently directly inaccessible. Coaxial technique is essential in transosseous biopsy, as it allows taking various samples through a secure access diminishing the number of skin punctures and risks of tumor seeding. The success of these procedures depends on the knowledge of regional anatomy, a correct planning and experience of the operator.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Usually when performing an image guided percutaneous biopsy, the access is selected using the shortest path, avoiding vessels, nerves, or organs. Sometimes, this is not possible and more aggressive procedures, such as surgery, are required. A transosseous access can be used as an alternative approach to tackle this setback and sample deep and challenging targets. Furthermore, CT guided transosseous biopsies can be performed in order to reduce complication risks. Approaches: -Trans-sternal: lesions in anterior mediastinum. -Trans-rib: for pleural-based lung lesions or immediately deep to a rib -Trans-scapular: for apical lung lesions abutting superior margin of major fissure. -Trans-vertebral: for lesions anterior to the vertebral body, aortocaval lymph nodes. -Trans-iliac, pubic or sacral for internal iliac lymph nodes, other deep pelvic nodes in patients with pelvic malignancy or presacral lesions. Technical considerations. Complications. Take home messages

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-29

### Multiple Cavitory Lung Lesions on CT: Biopsy Approach, Accuracy and Safety

All Day Room: Learning Center

Juan Wang (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understand the different biopsy approaches available for multiple cavitory lung lesions on CT, including transthoracic needle biopsy, bronchoscopy, and surgical biopsy, and their relative advantages and disadvantages. 2. Learn how to assess the accuracy of biopsy results, including sensitivity, specificity, and positive predictive value. 3. Become familiar with the potential complications associated with each biopsy approach, such as pneumothorax, bleeding, and infection, and how to manage them. 4. Appreciate the role of image guidance in improving the accuracy and safety of biopsy procedures for multiple cavitory lung lesions on CT. 5. Understand the importance of multidisciplinary collaboration among radiologists, pulmonologists, and thoracic surgeons in developing a biopsy strategy.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: This section will provide an overview of multiple cavitory lung lesions and the importance of accurate diagnosis and treatment. 2. Biopsy approaches: This section will discuss the different biopsy approaches for multiple cavitory lung lesions, including CT-guided biopsy, bronchoscopy, and surgical biopsy. 3. Accuracy of biopsy: This section will focus on the accuracy of biopsy for multiple cavitory lung lesions. It will discuss factors that can affect the accuracy of biopsy, such as lesion size, location, and underlying pathology. 4. Safety of biopsy: This section will review the safety of biopsy for multiple cavitory lung lesions. It will discuss potential complications associated with each biopsy approach, such as bleeding, pneumothorax, and infection. 5. Conclusion: This section will summarize the key takeaways from the education exhibit.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

IREE-3

### Sticky Situations: Expanding the Role of Glue in Trauma

All Day Room: Learning Center

Shriya Veluri (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Discuss the properties of liquid embolic (glue); Characterize ideal uses for glue in traumatic injuries; Use cases to review diagnostic trauma CT findings, angiographic correlates and post glue embolization appearances; Review potential complications and pitfalls of glue embolization.

#### TABLE OF CONTENTS/OUTLINE

Outline: Introduction; Review of traumatic injuries and ideal cases for liquid embolics; Properties of glue (N-butyl cyanoacrylate), how to prepare, mixtures and delivery techniques; CT findings before and after glue embolization and how to differentiate from evolving injuries; Case presentations: Pseudoaneurysms (Spleen, Liver, Renal, Pelvis, Extremity), Active Extravasation (Spleen, Liver, Pelvis), and Traumatic AV Fistulas; Complications of glue embolization (non-target embolization, portal vein embolization, pulmonary emboli, skin injury) and how to prevent them. Conclusion: Glue is a versatile embolic which can be safely deployed in traumatic intervention. As glue becomes more frequently used, an understanding of expected post embolization changes is necessary to minimize erroneous reporting.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-30

### **Thoracic Vent for Management of Pneumothorax: Review of Technique and Comparison to Conventional Thoracostomy**

All Day Room: Learning Center

Latika Baranga, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Incidence of pneumothorax in patients undergoing transthoracic needle biopsy reported varying from 9-54%. Current treatment options include observation/conservative, simple aspiration, thoracostomy tube placement, ambulatory management with Thoracic vent placement or thoracostomy tube with or without Heimlich valve. Here we describe Thoracic vent device as an alternative to chest tube for iatrogenic pneumothorax. It is a simple one-piece device made of polyurethane catheter connected to a plastic chamber containing a one-way valve and comes with an adhesive tape to secure it. It does not require suture or additional securing devices nor additional tubing or bag/container attachments enabling early mobilization and outpatient monitoring. It's simple design without attachment makes it easier and safer to manage as an outpatient compared to thoracostomy with or without a Heimlich valve.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief introduction discussing epidemiology, and treatment options for management of pneumothorax including technique such as thoracostomy tube with Heimlich valve and Thoracic vent. 2. Description of Thoracic vent device components, mechanism of action, placement technique. 3. and 4. Case describing steps of CT guided Thoracic vent placement, and follow up imaging. Appearance of the device on chest radiograph is demonstrated to assist in recognition of the device by diagnostic radiologist. 5. Comparison of Thoracic vent with conventional thoracostomy with and without Heimlich valve.

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## Abstract Archives of the RSNA, 2023

IREE-31

### **Look Before You Leap: Anatomical and Technical Considerations of Image-guided C2 Dorsal Root Ganglion Ablation and C1-C2 Lateral Joint Injections**

All Day Room: Learning Center

Bahram Mohajer, MD, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

i. Discuss the cervicogenic headache as the primary indication of Image-guided C2 dorsal root ganglion (DRG) ablation and C1-C2 lateral joint injections. ii. Review the general anatomy of C2 DRG and C1-C2 lateral articulation and notable anatomical structures. iii. Illustrate CT-guided C2 DRG ablation technique and considerations. iv. Illustrate Computed Tomography and Fluoroscopic-guided C1-C2 lateral articulation injection techniques and considerations.

#### **TABLE OF CONTENTS/OUTLINE**

i. Cervicogenic headache (1. Presentation 2. Prevalence and efficacy of intra-articular injections). 3. General anatomy of the C2 DRG and C1-C2 lateral articulation. 4. Degenerative arthritis of C1-C2 lateral articulation presentation on STIR MRI (a) and CT (b). ii. Important anatomical proximities of C2 DRG and lateral atlanto-axial joints (1. Vertebral artery 2. Thecal sac 3. C2 ventral ramus). iii. CT-guided C2 DRG ablation procedure, technique, and considerations (1. Patient positioning, 2. Trajectory selection, 3. Needle insertion, contrast administration, and ablation). iv. CT-guided intra-articular injection, technique, and considerations (1. Patient positioning, 2. Trajectory selection, 3. Needle insertion, contrast administration, and injection). v. Fluoroscopy-guided procedure, technique, and considerations (1. Trajectory selection, 2. Needle insertion, contrast administration, and injection).

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## Abstract Archives of the RSNA, 2023

IREE-32

### Utility Of Spectral CT During Percutaneous Thermal Ablation

All Day Room: Learning Center

Ahmad Parvinian, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to demonstrate the utility of spectral CT for interventional ablation procedures. Recently, an interventional suite was developed which combined a dual-layer detector spectral CT scanner on rails with an image guided-therapy system (Spectral Angio CT, Philips Healthcare). In this exhibit, case examples will highlight use cases for spectral CT in procedure planning, probe placement, iceball visualization, and post-ablation assessment. Teaching points include: (1) technical background on spectral CT, (2) clinical background on minimally invasive ablations, and (3) overcoming interventional challenges with spectral CT.

#### TABLE OF CONTENTS/OUTLINE

1. Title page: Utility Of Spectral CT During Percutaneous Thermal Ablation. 2. Teaching points: Technical background, clinical background, and overcoming interventional challenges. 3. Interventional ablations clinical background: Procedure planning, probe placement, treatment monitoring, and post-ablation assessment. 4. Background on spectral CT for interventions: Dual-layer spectral detector technology, visualization modes for spectral imaging, and spectral CT on rails for interventions. 5. Case examples: (A.) Procedure planning with low MonoE for lesion visualization. (B.) Probe placement with high MonoE to reduce needle artifact. (C.) Treatment monitoring with z-effective and low MonoE. (D.) Bone ablations with bone removal. (E.) Post-ablation assessment with low MonoE to reduce contrast dose. 6. Conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-33

### **Transperineal Ultrasound-Guided Prostate Biopsy: Why and How**

All Day Room: Learning Center

Izabel O. Karam, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: Review different prostatic biopsies approaches, emphasizing the transperineal technique and its peculiarities. Illustrate with cases different applications of the technique (systematic biopsy, cognitive guidance and MR imaging fusion). Identifying the radiological features of common postprocedural complications

#### **TABLE OF CONTENTS/OUTLINE**

Prostate cancer: epidemiology and imaging findings; Indications and patient selection for prostate biopsy; Different biopsy approaches and its characteristics; Technique steps; Illustrative cases of different applications of the transperineal prostate biopsy technique; Understanding and managing common complications post-procedure; Recognizing common image findings observed after the procedure; Interpreting biopsy outcomes and ensuring proper follow-up.

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## Abstract Archives of the RSNA, 2023

IREE-34

### **“Too Hot to Handle?” Non-worrisome Extrahepatic Localization of 99mTc MAA and Yttrium-90 During Planning and Radioembolization Procedures**

All Day Room: Learning Center

Merve Ozen, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. In the work-up of patients for Y-90 radioembolization of hepatic tumors, it is often revealed that 99mTc-macroaggregated albumin (MAA) has accumulated in extrahepatic organs and blood vessels. While substantial Y-90 localization in some extrahepatic sites, such as the lungs, is an absolute contraindication for treatment, other sites do not have strict guidelines.2. We show the safe, complication-free administration of Y-90 to five patients with off-target uptake in each the following locations: a persistent falciform artery, the gall bladder, a portal vein tumor thrombus, a perihepatic lymph node, and the spleen.3. The literature is consistent with the conclusion that uptake of Y-90 in the falciform artery, the gall bladder, and a tumor thromboses is generally safe and should not be an absolute contraindication to therapy. It has yet to be elucidated whether this is the case for uptake in the spleen and lymph nodes.4. Off-target Y-90 uptake in the spleen may actually be beneficial and help treat/prevent post-radioembolization hypersplenism and thrombocytopenia.

#### **TABLE OF CONTENTS/OUTLINE**

1. Cases of safe and successful Y-90 therapy to patients with extrahepatic uptake in the extrahepatic following locations2. Along with each case, the current literature regarding the safety of treatment of patients with these off-target uptakes is discussed.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-35

### Contrast Enhanced CT Lymphangiography For Various Lymphatic Disorders

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Yura Ahn, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Despite the physiologic and clinical significance of the lymphatic system, lymphatic imaging remains difficult and in the developmental stages. In recent years, MR lymphangiography has enabled the depiction of lymphatic structure, but its widespread use is limited by its inherent limitations: high cost, limited accessibility, contraindications to MR, inability to position change, and inability of bedside needle insertion in MR suite is still obstacles. CT, which is not restricted by these constraints, may be a solution for more accessible lymphatic imaging. We have utilized contrast enhanced CT lymphangiography for characterization of various thoracoabdominal lymphatic diseases and pre-interventional planning. Herein, we introduce our practice of CT lymphangiography.1. Learn the protocol and technical aspect of contrast-enhanced CT lymphangiography2. Describe normal lymphatics anatomy with contrast-enhanced CT lymphangiography3. Learn the characteristics of various thoracoabdominal lymphatic diseases with CT lymphangiography

#### TABLE OF CONTENTS/OUTLINE

1. Protocol1) Procedure: Inguinal LN cannulation under US guidance2) CT technique for imaging the central lymphatics2. Technical aspect of CT lymphangiography1) Acquisition time and CT dose2) Comparison with MR lymphangiography3. Normal anatomy of the central lymphatics4. Various lymphatic disorders1) Iatrogenic thoracic duct injury with chylothorax2) Lymphatic anomaly

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## Abstract Archives of the RSNA, 2023

IREE-36

### Artificial Intelligence in Interventional Radiology: A Primer for Residents

All Day Room: Learning Center

Suvrankar Datta, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Artificial Intelligence (AI) has already demonstrated an ability to significantly improve efficiency in diagnostic radiology. There are however, unique challenges which need to be addressed to completely realise the potential of AI in Interventional Radiology (IR). Apart from key issues including data storage, lack of interoperability and non-standard practices, there are significant concerns about legal accountability and potential risks in interventions that prevent AI from being used independently or clinically without the oversight of an expert radiologist. Research and innovation involving AI in IR is limited to few higher centres, thus preventing adequate exposure of AI to Interventional Radiology residents, compared to their Diagnostic Radiology (DR) counterparts. Our Educational Exhibit aims to introduce IR residents and fellows to the vast possibilities of incorporating AI into their regular clinical practice (ranging from decision support and triaging of patients to prognostication and outcome prediction) and also introduce them to various open-source software and modules which can assist them in their day-to-day IR practice.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 1A. AI in Medical Imaging 1B. Types of Data in DR and IR 2. Unique Challenges in IR 3. Opportunities of AI Implementation 3A. Pre-Procedural Support 3B. Peri-Procedural Support 3C. Post-Procedural Support 4. Established AI algorithms in Interventions 5. Open-Source software and modules 6. Opportunities for AI innovation in IR 7. Can AI Replace Us? 8. The way ahead for an AI-assisted Interventional Radiology practice

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## Abstract Archives of the RSNA, 2023

IREE-37

### Portosystemic Shunts: A Comprehensive Review

All Day Room: Learning Center

#### Awards

##### Cum Laude

John A. Walker, MD, PhD (*Presenter*) Speaker, Shionogi & Co, Ltd; Consultant, Shionogi & Co, Ltd

#### TEACHING POINTS

1. To review the development of the portal system and teach normal and variant anatomy. 2. To become familiar with cross sectional and angiographic appearances of both common and uncommon portosystemic shunts. 3. To understand the clinical relevance of portosystemic shunts from congenital to acquired. 4. To demonstrate minimally invasive treatment options for portosystemic shunts.

#### TABLE OF CONTENTS/OUTLINE

1. Review the development of normal portal venous anatomy and subsequently congenital variant anatomy. In addition, understand shared territories with systemic veins that may allow shunts to form 2. Use cross sectional and angiographic images to teach the anatomy of portosystemic shunts to include congenital intra-hepatic and extrahepatic (Abernethy) shunts, as well as common acquired gastroesophageal, splenorenal, paraumbilical shunts and less common acquired mesenteric to retroperitoneal territories and consider surgically altered sites allowing for unique shunts 3. Discuss clinical implications of untreated portosystemic shunt and 4. Explore indications and techniques for treating shunts by type and location, to include discussion on expected sequelae of treating and potential complications.

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## Abstract Archives of the RSNA, 2023

IREE-38

### Training of Interventional Radiology Procedures Using Virtual Reality: Current Status and Potential Metaverse

All Day Room: Learning Center

Yukiko Honda, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The COVID-19 pandemic made it difficult to train learners on procedures that involve direct patient contact, such as interventional radiology (IR). For this reason, we developed training materials for learners on endovascular procedures of the abdominal pelvis in IR using virtual reality (VR). Advantages of VR-based IR education include the ability to conduct training at any time, repeated training exercises, no invasiveness to the patients, and no risk of infection to both the patient and the learner. Even after the pandemic, to further develop the good points of VR education, many educators are attempting to apply metaverse to the education of their specialty. Although metaverse education is considered useful in IR education, it is not widely used at present. This educational exhibit will provide a brief overview of simulators available for purchase, benefits of metaverse education, and our VR-based training software, and discuss its advantages, current issues, and future prospects.

#### TABLE OF CONTENTS/OUTLINE

1. Features of the currently commercially available VR simulators of endovascular procedures.
2. Benefits of metaverse education.
3. What is needed to spread metaverse education.
  - a. Three components: hardware, software, and contents,
  - b. High-speed networks,
  - c. Computing technologies: edge computing, and cloud computing,
  - d. Modeling and rendering technologies: Unity or Blender,
  - e. Interaction technologies: Sensors, or real-time tracking,
  - f. Authentication technologies: blockchain,
  - g. Wearable device: head-mounted displays or smart glasses,
  - h. Concerning the learner: learning logging, and analysis.
4. Review of reports on the cases of metaverse education.
5. Future challenges and our approach.

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## Abstract Archives of the RSNA, 2023

IREE-39

### Interventional Radiology Role in Treating Primary Pancreatic Cancer: Current Treatments and Future Prospects

All Day Room: Learning Center

Fereshteh Khorshidi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review primary pancreatic cancer epidemiology, current therapies and prognosis- Review interventional radiology role in diagnosis of pancreatic cancer and palliative care- Review percutaneous and transarterial image-guided treatment options for unresectable primary pancreatic cancer offered by interventional radiology.- Importance of having a multidisciplinary approach and individually tailored treatment plan.

#### TABLE OF CONTENTS/OUTLINE

Primary pancreatic cancer- Prevalence- Significance- Clinical stages- Survival rate- Current therapies for resectable tumors  
Minimally invasive treatments of unresectable pancreatic cancer, their advantages, effectiveness and complications  
Treatments- Transarterial therapies  
o Regional intra-arterial chemotherapy with double-balloon catheter (RenovoCath)  
• Mechanism of action  
• Safety and efficacy  
• Ongoing Trials  
- Percutaneous ablative therapies:  
o Non-thermal ablation: Irreversible electroporation  
• Mechanism of action  
• Safety and efficacy  
• Ongoing Trials  
Synergetic effect of ablative therapies and immunotherapy; a future prospective  
Cases?. A few cases of ablation?

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## Abstract Archives of the RSNA, 2023

IREE-4

### Superior Vena Cava Syndrome Imaging and Management

All Day Room: Learning Center

Ben Rybin, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review central venous anatomy and highlight potential collateral pathways. 2. Review the historical and current superior vena cava (SVC) syndrome etiologies. 3. Review the pathophysiology of SVC syndrome. 4. Present SVC syndrome classification systems. 5. Discuss SVC syndrome treatment and management. 6. Detail indications, benefits, and complications of endovascular treatment of SVC syndrome.

#### TABLE OF CONTENTS/OUTLINE

I. History and evolution of SVC syndrome etiologies. II. Central venous anatomy. III. Pathophysiology and symptoms of SVC syndrome. IV. SVC syndrome classification systems. V. SVC syndrome treatment algorithm. VI. Endovascular therapy cases. VII. Endovascular therapy techniques. VIII. SVC syndrome endovascular complications. IX. Projected future of SVC syndrome therapy.

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## Abstract Archives of the RSNA, 2023

IREE-40

### Thermoprotective Techniques in Musculoskeletal Ablation

All Day Room: Learning Center

Ahmad Parvinian, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to provide a case-based review of thermoprotective techniques used during percutaneous thermal ablation of musculoskeletal tumors. The exhibit will demonstrate the basic principles of musculoskeletal ablations performed using ultrasound, CT, fluoroscopic, and MRI guidance, depict the various active and passive thermoprotective techniques that are critical to safe and effective ablation, and provide a framework for recognizing and addressing complications. Teaching points include: (1) clinical background and principles of musculoskeletal ablation, (2) active thermoprotective techniques, (3) passive thermoprotective techniques, (4) complication management.

#### TABLE OF CONTENTS/OUTLINE

1. Title page
2. Teaching points
3. Musculoskeletal ablation background
4. Preprocedural Considerations
5. Passive thermoprotection- Ablation zone monitoring- Temperature monitoring- Neurophysiologic monitoring
6. Active thermoprotection- Hydrodisplacement- Pneumodisplacement- Balloon interposition- Probe traction- Internal warming- External warming
7. Complication recognition and management
8. Conclusions

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## Abstract Archives of the RSNA, 2023

IREE-41

### Thyroid Nodule Fine Needle Aspiration: What the Pathologist Wants You to Know

All Day Room: Learning Center

Berali Del Espiritu Santo Padilla, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Fine needle aspiration (FNA) is an optimal diagnostic tool for thyroid nodules because it is cost-effective, safe, and accurate.
- The Bethesda guidelines for thyroid FNA consider that the unsatisfactory rate on cytopathology is of about 10% , however different studies have shown that the unsatisfactory rate can range from 0.4% up to 40%.
- Some of the reasons why FNA results may be inaccurate include:
  1. Sampling error: the sample may not accurately represent the entire nodule.
  2. Inadequate sample size: the sample taken during FNA may be too small to yield accurate results.
  3. Technical error: The accuracy of FNA results can be affected by technical errors, such as improper handling or processing of the tissue sample.
  4. Nodule size: multiple studies have shown that the diagnostic accuracy of FNA is limited in large thyroid nodules.
- The technique of the specimen collection and evaluation and the preparation of the slide can play a decisive role in the diagnostic accuracy therefore it's important for the radiologist to recognize the correct technique.
- The "classic" technique uses three slides and generates two slides for interpretation. A slide to be deposited in fixative, a slide to be air dried , and a spreader slide.
- The two-slide technique has been called the "butterfly" or "book-end" technique. It has the advantage of simplicity and better reproducibility. It produces a relatively uniform and rounded imprint of FNA material for evaluation on two mirror image slides.

#### TABLE OF CONTENTS/OUTLINE

1. Patient selection
2. Equipment needed for thyroid biopsy
3. Patient preparation
4. Needle based sample collection techniques
5. Sample preparation
6. Pathologist recommendations in order to reduce inconclusive results

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-42

### **Nutcracker Syndrome: Diagnosis and the Role of Minimally Invasive Interventions**

All Day Room: Learning Center

Alina Hasanain, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Nutcracker phenomenon is an anatomic condition characterized by extrinsic compression of the left renal vein, causing entrapment, and subsequent diminished outflow to the inferior vena cava. 2. Nutcracker syndrome refers to Nutcracker phenomenon with clinically apparent sequelae, which include hematuria, abdominal pain, and gonadal varices among a variety of other symptoms, the severity of which can depend on the severity of the anatomic findings. 3. The role of interventions, especially minimally invasive interventions such as endovascular treatment, has become more prominent in the treatment of severe Nutcracker syndrome. This exhibit will outline diagnostic methods and management options for Nutcracker syndrome with a focus on endovascular approaches.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the pathophysiology of Nutcracker syndrome with anatomic causes and variations 2. Discuss diagnostic methods doppler ultrasound, CT, MRI and angiography, venography and intravascular ultrasound. a. Imaging criteria and classification b. Examples of cases from a single institution 3. Discuss management options including conservative management and surgical options with an emphasis on endovascular approaches (stenting, coil embolization of varices). a. Advantages over open or laparoscopic interventions b. Complications and pitfalls c. Future directions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-43

### Managing Hemoptysis from Diagnosis to the Angio Suite: A How-to Guide for the Radiologist

All Day Room: Learning Center

Pierluca Minelli, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Hemoptysis is the airway bleeding, ranging from blood-tinged mucus to gross hemorrhage: when massive -almost defined as a >300mL/24h bleeding- it is a life-threatening and challenging condition. Angiography with embolization is the front-line therapy for emergent cases of hemoptysis. The aim of this study is to give a concise guide to the diagnostic and interventional management of hemoptysis in the angiography suite.

#### TABLE OF CONTENTS/OUTLINE

Hemoptysis generally arises from the bronchial arteries (BAs, ~90%) and encompasses infectious, inflammatory and malignant causes, being tuberculosis the most common worldwide. After airway securing, underlying conditions and laterality must be assessed: CT angiogram -eventually along with bronchoscopy- is a useful tool to review and report origin (orthotopic/ectopic), course and morphology of BAs or to identify nonbronchial systemic/pulmonary bleeding source. On conventional bronchial arteriograms, selective catheterization of BAs origins is mandatory, while the anterior spinal artery and its medullary branches must be identified in order to avoid iatrogenic transverse myelitis or paralysis, the major complications. Hypertrophied vessels, parenchymal hyperemia, blushing or pseudoaneurysm suggest bleed source. For BAs, embolic particles (350-700microm) are usually preferred, while coils and plugs preclude reintervention if hemoptysis recurs and are thus limited to bronchial aneurysms and pulmonary arteries embolization. Recurrence rates range from 10 to 58% and increase over time and in certain diseases (e.g. cystic fibrosis).

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## Abstract Archives of the RSNA, 2023

IREE-44

### Abernethy Malformations: Making Sense of Congenital Portosystemic Shunts

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Hannah El-Sabrouh (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Abernethy malformation, or congenital portosystemic shunt, is a rare abnormality of the portal venous system. The portal vein either fails to form or forms abnormally, resulting in an anomalous shunt that diverts blood from the portal vein to the systemic circulation without passing through the liver. The clinical manifestations of Abernethy malformation can vary depending on the severity and location of the shunt, and may include encephalopathy, portal hypertension, and liver failure. Abernethy malformation can be detected via ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI). Patients with Abernethy malformation are at risk for liver lesions, thus particular attention must be paid to the liver parenchyma. The orientation and size of the shunt can be confirmed via catheter-directed angiography and balloon occlusion. Treatment options for Abernethy malformation include interventional or surgical shunt closure, liver transplantation, or conservative medical management of symptoms. The choice of treatment depends on the severity of the malformation and the patient's clinical condition.

#### TABLE OF CONTENTS/OUTLINE

(1) Introduction: Overview of Abernethy malformation(2) Clinical presentation: Signs and symptoms(3) Imaging: Detection, associated findings, characterization, and confirmation(4) Treatment: To close or not to close?

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## Abstract Archives of the RSNA, 2023

IREE-46

### **Vasculitis: Clinical Evaluation, Imaging, and Treatment**

All Day Room: Learning Center

Kausthubh Hegde, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the definition and types of Vasculitis. 2. Discuss the signs, symptoms, and clinical evaluation of the most common types of Vasculitis. 3. Diagnosis with an emphasis on the role of imaging in diagnosing Vasculitis. 4. Case-based examples of IR treatment options and follow-up care.

#### **TABLE OF CONTENTS/OUTLINE**

1. Vasculitis: definition and pathophysiology of the disease. 2. Classification of vasculitis - Lie classification of vasculitis (1994) - 2012 revised International Chapel Hill Consensus Conference nomenclature of vasculitides 3. Review of the signs and symptoms of different types of vasculitis. 4. Role of diagnostic imaging modalities in the evaluation of vasculitis (with case-based examples). 5. Indications and contraindications for endovascular treatment of vasculitis (with case-based examples). 6. Complications and follow-up care after IR procedures.

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## Abstract Archives of the RSNA, 2023

IREE-47

### **Embolization of Extracranial Arteriovenous Malformations: Strategies of Interventional Approaches According to the Yakes Classification**

All Day Room: Learning Center

#### **Awards**

##### **Magna Cum Laude**

Marin Halut, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Learn imaging findings associated with arteriovenous malformations (AVM) and present the Yakes classification  
Present briefly the main genetic mutations associated pathways and potential drug therapies  
Understand interventional management of AVM according to the Yakes classification  
Discuss embolization strategies according to the Yakes classification and AVM territory  
Discuss outcomes, follow-up and complications  
Propose a therapeutic algorithm based on the Yakes classification, clinical staging and genotyping

#### **TABLE OF CONTENTS/OUTLINE**

Overview and classification of AVM according to the Yakes classification  
Clinical and imaging evaluation before procedure  
Presentation of the Shobinger classification and discussion of the relative roles of Doppler ultrasound, CT, MRI, DSA  
Embolization techniques  
Presentation of liquid and mechanical embolizing agents and their use according to the approach (endovascular transarterial approach, direct puncture, retrograde venous approach). The safe use of ethanol and bleomycin will be also discussed  
Treatment techniques according to AVM territory and Yakes classification  
Discuss specific considerations for head and neck, limbs, thoracic, abdominal and pelvic AVMs  
Yakes Type I (transarterial, transvenous, coils, plug)  
Yakes Type II (transarterial, direct puncture, retrograde venous, liquid agent)  
Yakes IIIa (transvenous, coils, plug ± liquid agents)  
Yakes IIIb (transarterial, direct puncture, retrograde venous, liquid agent, coils)  
Yakes IV (direct puncture ethanol, interstitial infiltration bleomycin)  
Follow-up and outcomes evaluation  
Clinical and imaging criteria to assess therapeutic response  
Conclusion  
Therapeutic algorithm proposed

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## Abstract Archives of the RSNA, 2023

IREE-48

### Fluid Solutions for Complex Cases: A Comprehensive Guide to Sclerosant and Liquid Embolic Agents for Radiologists

All Day Room: Learning Center

#### Awards

##### Cum Laude

Keith Ameyaw, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Liquid embolic and sclerosant agents are vital tools in interventional procedures capable of achieving targeted vessel occlusion, space occupation or tissue fibrosis. 2. Understanding the mechanism of action of these agents is essential for optimal use, procedural technique, and informing operator preference. 3. Different agents have unique advantages and complications. Selecting the appropriate agent is critical for optimizing patient outcomes. 4. Radiologists must be intimately familiar with the unique post-procedural imaging characteristics of liquid embolics/sclerosants. These imaging findings play a crucial role in assessing both the success of the procedure and informing follow-up care.

#### TABLE OF CONTENTS/OUTLINE

1. Mechanism of action of sclerosant and liquid embolic agents. 2. Indications for use in several disease entities, including: intracranial and extracranial vascular malformations, lymphatic malformations, tumors, cysts, benign prostatic hyperplasia, venous insufficiency, arterial hemorrhage, portal hypertensive variceal hemorrhage, aortic graft endoleak, lymphatic leak/chylothorax, lymphoceles, post-operative seroma, and gonadal vein embolization. 3. Technique and procedural considerations. 4. Advantages and associated complications of different agents. 5. Imaging findings with descriptions of associated artifacts necessary for appropriately assessing procedural success and informing follow-up care.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-49

### Benefits of Hybrid CT/Angiography Utilization for Microsphere Trans-arterial Radioembolization with Yttrium-90

All Day Room: Learning Center

Elliot T. Varney, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Hybrid angiography/CT (Angio-CT) employs both traditional CT imaging with concurrent fluoroscopic angiography in the same procedure room. Although introduced prior to cone-beam CT, Angio-CT has been under-utilized due to cost and availability. The resurgence of Angio-CT has proven to be a very useful tool in interventional oncology; however, its application in microsphere trans-arterial radioembolization is not well documented through the literature. Angio-CT shows unique advantages in the image resolution regardless of patient preparation, catheter directed contrast imaging in the planned treatment field to precisely calculate more accurate dosimetry in routine and multifocal lesions, to more accurately characterize lesions and any potential changes in lesions with higher sensitivity and specificity, and to more accurately detect anatomic variants and/or accessory tumor feeding vessels. Lastly, early data suggests Angio-CT systems utilization could improve survival in patients with HCC when performing trans-arterial therapy, likely due to more accurate and precise pre-treatment and intraprocedural imaging.

#### TABLE OF CONTENTS/OUTLINE

1. What is Angio/CT?
2. Practical points and precision of dosimetry with Angio/CT
3. Unique Advantages in image quality and predicting success
4. Optimal Utility of Each Modality
5. The Unknowns and the Research Potential
6. Case Examples
  - a. Improved detection and characterization
  - b. Anatomic variants potentially unnoticed with cone-beam
  - c. Improving dosimetry accuracy
7. Quantifiable benefit in outcome?

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-5

### Advances in Percutaneous Jejunostomy: Novel Techniques and Their Clinical Implications

All Day Room: Learning Center

Kimberly D. Coffman, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Percutaneous radiologic jejunostomy (PRJ) is a minimally invasive procedure for patients requiring enteral feeding and access for biliary interventions, especially in patients who have altered anatomy, such as after gastric resection, gastric bypass surgery, Whipple procedure, or liver transplant. After reviewing this exhibit learners should be able to: 1. Recognize common indications for PRJ 2. Understand novel techniques to aid in successful PRJ access 3. Recognize and address complications related to PRJ

#### TABLE OF CONTENTS/OUTLINE

This exhibit will: 1. Review imaging and anatomical considerations for jejunal access 2. Discuss common indications, contraindications and patient selection for PRJ 3. Introduce procedural advancements in PRJ through a case-based approach- Traditional techniques in PRJ- Modified coaxial technique for T fastener deployment through a sheath- Utilizing cone beam CT to ensure proper T fastener placement- Using an orogastric magnetic balloon and ultrasound guidance to assist in complicated cases where traditional methods fail 4. Address pitfalls and potential complications of PRJ  
Summary Clinical Implications: As the number of liver transplants, cholecystectomies and gastric surgeries increase every year, there may be more demand for jejunal access to manage potential complications of these procedures. PRJ can allow for enteral nutrition and access for repeated biliary interventions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-50

### A Review of Superior Vena Cava Interventions

All Day Room: Learning Center

Jorge E. Lopera, MD (*Presenter*) Shareholder, Tecnostent SA; Consultant, Merit Medical Systems, Inc; Research Grant, AngioDynamics, Inc

#### TEACHING POINTS

To review the clinical presentation and treatment options for SVC syndrome. To understand the role of different endovascular techniques to treat stenoses, occlusions and thrombosis of the SVC. To illustrate the challenges when treating SVC stenoses in patients with existing central lines. To discuss the different recanalization techniques to treat complex chronic occlusions of the SVC. To review the different complications with SVC interventions and how to treat them .

#### TABLE OF CONTENTS/OUTLINE

1. Clinical presentations and imaging of central venous and SVC stenoses and occlusions. 2. Review of treatment options in malignant SVC syndrome. 3. Treatment options in SVC syndrome - special situations: a. SVC syndrome with existing ports and dialysis lines. b. SVC syndrome with thrombus c. Endovascular stenting : single or kissing stents. Covered or bare stents. d. Recanalization techniques for complex chronic occlusions. 4. Complications .

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-51

### Percutaneously Induced Neuroregeneration for Treatment of Chronic Neuropathic Pain

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Maxwell Cooper, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Review the pathophysiology of neuropathic pain and the Sunderland classification of nerve injury. 2) Explain how percutaneous cryoneurolysis can induce regeneration of damaged peripheral nerves causing chronic pain. 3) Demonstrate the ability of percutaneous cryoneurolysis to provide long term relief and neuroregeneration for the treatment of chronic neuropathic pain. 4) Discuss current indications and potential new applications of cryoneurolysis.

#### TABLE OF CONTENTS/OUTLINE

1) Incidence and causes of neuropathic pain. 2) Pathophysiology of nerve injury and chronic peripheral nerve pain. 3) Mechanism of cryoneurolysis and neuroregeneration. 4) Current indications and patient selection. 5) Techniques for cryoneurolysis, including approaches and duration/temperature of ablation. 6) Post-procedure follow-up and outcomes. 7) Case examples of cryoneurolysis for pain relief and neuroregeneration. 8) The pre-operative use of cryoneurolysis to reduce pain caused by other interventions including ablation, embolization, and post-mastectomy pain. 9) Exploring new applications of cryoneurolysis.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

IREE-52

### Super Selective Radioembolization for Hepatocellular Carcinoma: Radiation Segmentectomy and Beyond

All Day Room: Learning Center

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radioembolization has emerged as an effective treatment option for hepatocellular carcinoma that cannot be surgically removed. The procedure involves the preferential deposition of radioactive microspheres into the hypervascular tumor through a siphoning effect, typically achieved by injecting the microspheres at the lobar artery level. However, to improve tumor response and minimize potential complications, superselective radioembolization is recommended. The purpose of this exhibit is : (1) To review the rationale behind radiation segmentectomy. (2) To learn when superselective radioembolization is necessary, (3) to offer technical tips for performing superselective radioembolization.

#### TABLE OF CONTENTS/OUTLINE

1) Radiation segmentectomy : rationale and evidence 2) Dosimetry : Practical guide for dosimetry of superselective radioembolization 3) When superselective radioembolization is needed A. small single tumor : radiation segmentectomy B. Large single tumor saddling on both lobes C. Small remnant liver D. Hepatic artery branching at acute angle E. Extrahepatic collateral artery supplying the tumor 4) Technical consideration of superselective radioembolization A. Protection of distal normal liver by using balloon microcatheter and detachable coil B. Combination treatment of lobar and segmental artery C. Combination treatment of 1st and 2nd week dosing of glass microsphere 5) Follow-up imaging after superselective radioembolization A. Early loss of arterial enhancement of the tumor B. Focal radiation necrosis mimicking new hypovascular tumor

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## Abstract Archives of the RSNA, 2023

IREE-53

### **TESLA: The Future in Treatment for Malignant Perihilar Obstruction**

All Day Room: Learning Center

Michelle de Bloeme-Hus, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In malignant bile duct obstructions the most common treatment in the Netherlands is endoscopic drainage (ERCP) with placing plastic tubes, combined with biliary drainage. Cholangitis due to ERCP occurs often, in 40-60% of the patients, probably caused by colonization of bowel bacteria and infection of undrained segments. Patients often need multiple re-interventions. The 90days mortality after diagnosis is 35%. In the TESLA trial the hypothesis is that primary percutaneous stenting, without placing a biliary drain and without stenting the ampulla of Vater, provides less infectious complications and less reinterventions compared to endoscopic drainage. Ensuring a decrease in morbidity and mortality and improving the quality of life.

#### **TABLE OF CONTENTS/OUTLINE**

Compare primary percutaneous stenting above the ampulla versus endoscopic drainage for palliative treatment of malignant hilar biliary obstruction in the TESLA study. Primary providing a lower complication rate and furthermore lowering the absolute and relative bilirubin levels, decreasing the number of reinterventions and providing a better quality of life. This abstract provides an overview of the TESLA trial, an education of the interventional procedure and materials and provides the first promising data retrieved from the TESLA trial.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-54

### Advancing Interventional Procedures With Mixed Reality

All Day Room: Learning Center

Jonathan Collier (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Introduction: The presentation focuses on Microsoft's HoloLens2 for visualization on an angiography biplane system. The HoloLens2 device is a mixed reality device that uses depth, light, and infrared cameras to track its environment and anchor multiple virtual displays to view ultrasound and fluoroscopy in real-time during image-guided interventions. Teaching Points: • Overview of the HoloLens2 device and its functionalities as they relate to interventional procedures • Demonstrate improvements in customization, decrease visual field discrepancies, and reduce ergonomic challenges associated with the current angiography systems • Evaluation of the image quality, latency, customization capabilities, and overall user experience • Demonstrate functionality like voice, gaze, and gesture controls in the live angiography environment • Case examples of the HoloLens2 integration in image-guided interventions on secondary personnel and primary phantom work

#### TABLE OF CONTENTS/OUTLINE

Outline: The presentation will cover the various teaching points related to HoloLens2 integration into an angiography suite. Attendees will learn how the device facilitates the clinician seeing what they want and where they want. The presentation will conclude with a summary of the promising role the HoloLens2 provides in advancing the clinician experience in interventional radiology and answer the question of why integrating this emerging technology will be beneficial in the clinical environment.

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## Abstract Archives of the RSNA, 2023

IREE-55

### **Percutaneous Cryoneurolysis for Complex Pain: Indications, Technique, and Expectations**

All Day Room: Learning Center

Tarik Babar, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the epidemiology of complex pain syndromes and current need for analgesic adjuncts in pain management  
2. Discuss the mechanisms of how percutaneous cryoneurolysis affects pain  
3. Review the uses and techniques of various procedures including intercostal, ilioinguinal, intercostobrachial, and pudendal nerve cryoneurolysis  
4. Demonstrate successful approaches to complex pain including pathologies involving the rib, hip, arm, and groin  
5. Discuss common complications after percutaneous cryoneurolysis, including their diagnosis and management

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction, including epidemiology of complex pain syndromes  
2. Mechanism and physiology behind cryoneurolysis effect on pain  
3. Indication, technique, and successful case of intercostal nerve cryoneurolysis  
4. Indication, technique, and successful case of ilioinguinal nerve cryoneurolysis  
5. Indication, technique, and successful case of intercostobrachial nerve cryoneurolysis  
6. Indication, technique, and successful case of pudendal nerve cryoneurolysis  
7. Recognition and management of common complications  
8. Conclusion and summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-56

### Ectopic Varices: Anatomic and Hemodynamic Features and Endovascular Techniques

All Day Room: Learning Center

Yoshitaka Tamura (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ectopic varices arise in the hepatopetal or hepatofugal collateral vessels outside the gastro-esophageal region account for up to 5% of variceal bleeding. Various endovascular techniques can be effectively applied based upon their anatomic and hemodynamic features. Duodenal varices (DVs) are the most common type and arise in either hepatopetal collaterals or hepatofugal collaterals. DVs with hepatopetal collaterals are treated by portal vein (PV) stenting and those with hepatofugal collateral are treated by antegrade and/or retrograde obliteration techniques with or without TIPS. Rectal varices (RVs) are common complication in portal hypertension and arise in hepatofugal collaterals from the superior rectal vein to the bilateral internal iliac veins. Antegrade obliteration is often required to eradication of RVs because of their complicated drainage system. TIPS is effective to prevent recurrent bleeding. (Peri)stomal varices (SVs) can develop after ileostomy. SVs are supplied by the ileal veins and drains into the epigastric veins. They are often associated with portal hypertension but also with local hemodynamic abnormality. SVs with refractory bleeding have been treated by direct puncture embolization, antegrade obliteration and TIPS. Choledochal (-jejunal) varices arise in hepatopetal collaterals with extrahepatic PV occlusion often associated with choledocojejunostomy. They are treated by PV stenting with additional endovascular techniques.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline 1. Basics of ectopic varices and various endovascular techniques 2. Duodenal varices 3. Rectal varices 4. Stomal varices 5. Choledochal (-jejunal) varices 6. Miscellaneous/ infrequent varices

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## Abstract Archives of the RSNA, 2023

IREE-57

### Thermoablation of Pulmonary Metastasis: A Standard for a Secure Approach

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Barbara d. Nunes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To illustrate noble structures in the pulmonary ablation areas under risk, which should be minded during the procedure.- To discuss patient selection, positioning, rationale of safe routes for the probe, and safety maneuvers in order to avoid and protect the above structures.- To assess the criterias of an adequate ablation zone and its expected course.- To illustrate the most important complications involved in the thermoablation of pulmonary metastasis.

#### TABLE OF CONTENTS/OUTLINE

- Anatomy- Thermoablation mechanics- Patient positioning rationale and safe routes on pulmonary nodules ablation- Protective maneuvers- Defining an adequate ablation zone- Expected course of an adequate ablation zone- Most important acute complications

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## Abstract Archives of the RSNA, 2023

IREE-58

### **Buffalo Lung: A Human Complication after Lung Biopsy**

All Day Room: Learning Center

Nicole Law, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Buffalo lung is a rare occurrence of bilateral pneumothoracies due to an abnormal physical communication between the two pleural spaces. 2. Iatrogenic buffalo lung can occur following intrathoracic procedures such as median sternotomy, laparoscopic surgery and heart-lung transplantation, putting these patients at higher risk for bilateral pneumothoracies during a lung biopsy procedure. 3. Presentation of buffalo chest can be worse than that of unilateral pneumothorax, including severe and sudden onset of dyspnea and pleuritic chest pain, tachycardia, hypotension, and even cardiac arrest or death. 4. Quick action should be taken in these patients to place bilateral chest tubes in order to re-expand the collapsed lungs. For this reason, it is important for IR physicians to be aware of the risk of buffalo lung in lung biopsy patients.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction. Patient case example. Picture examples. Discussion of buffalo lung and its' presentations. Patient risk factors. Treatment and case outcome.

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## Abstract Archives of the RSNA, 2023

IREE-59

### Anatomic Variants of the Hepatic Arteries and Technical Considerations for Y90 Radioembolization

All Day Room: Learning Center

Taylor K. Loon, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Review hepatic arterial variants that a radiologist should be able to recognize using the MICHEL classification. 2) Identify and familiarize the most common hepatic arterial variants encountered in pre-treatment mapping for Yttrium-90 radioembolization based on imaging findings. 3) Highlight the possible complications of Y90 microsphere diffusion into replaced right and left hepatic arteries and technical considerations when encountering variants.

#### TABLE OF CONTENTS/OUTLINE

1) Review standard hepatic artery anatomy and the relevant imaging findings trainees should know to quickly evaluate using CT and digital subtraction angiography. 2) Introduce the MICHEL classification and subclassify based on right, left and common hepatic arterial origins. Present digitally drawn visual diagrams demonstrating each MICHEL classification. 3) Present cases from our institution depicting hepatic arterial anatomic variants using CT angiography and 3D-rendered images (MICHEL Classification, II, III and IV, which have a prevalence of 12.5%, 7.5% and 1% respectively). 4) Using cases from our institution, review relevant imaging findings on digital subtraction angiography for identifying hepatic arterial variants during pre-procedure mapping for Y90 chemoembolization. 5) Discuss possible branches of replaced/accessory left and right hepatic arteries and impact of diffusion of Y90 spheres. 6) Discuss technical considerations when encountering hepatic arterial variants including; injection rate for mapping DSA, prophylactic embolization of branches, and microcatheter tip position.

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## Abstract Archives of the RSNA, 2023

IREE-6

### Purchasing Decisions for an Interventional CT Program

All Day Room: Learning Center

Jonathan L. Troville, PhD (*Presenter*) Research support, Canon Medical Systems Corporation

#### TEACHING POINTS

(1) Interventional CT fluoroscopy is becoming widely used and scanner features that meet both diagnostic and interventional needs are becoming increasingly complex. In this paper, the most important scanner features are discussed and ranked for both diagnostic and interventional purposes. (2) Vendors provide different offerings for the features, so hypothetical comparisons for three vendors are included to facilitate explaining various tradeoffs in purchasing decisions.

#### TABLE OF CONTENTS/OUTLINE

This education exhibit provides a complete overview of CT scanner features which are necessary, desired, or useful for meeting both diagnostic and interventional purposes. The viewer will become familiar with the nuances of each feature and leave more comfortable with purchasing decisions in an increasingly complex market.

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## Abstract Archives of the RSNA, 2023

IREE-60

### Vascular Interventions in Angiosarcoma with Pulmonary Hemorrhage

All Day Room: Learning Center

Denes Szekeres, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this exhibit is to identify the role of the radiologist in diagnosis and management of vascular tumors. We begin with a review the epidemiology and presentation of angiosarcoma, a rare and diverse subset of malignant soft tissue sarcoma that is often insidious. We discuss the broad range of imaging findings for a variety of common sites of primary and secondary angiosarcoma through a review of SEER data and prior studies. We tie together the educational points with a case report of a cardiac angiosarcoma, including a review of the multidisciplinary approach to diagnostic workup and oncologic management. We end with a description of endovascular interventions (coil embolization) in treating pulmonary hemorrhage, a common complication of metastatic disease.

#### TABLE OF CONTENTS/OUTLINE

1. Statistics and clinical pearls of angiosarcoma
2. Review of multimodality imaging findings
3. Case presentation of primary cardiac angiosarcoma
4. Technique for coil embolization of pulmonary arterial hemorrhage
5. Summary of educational points

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## Abstract Archives of the RSNA, 2023

IREE-61

### **Oops, We Did It Again: A Review of CT- and US-Guided Thoracic Interventional Procedure Complications**

All Day Room: Learning Center

Valeria Richart Sierra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the potential complications of CT- and US-guided thoracic interventional procedures. To analyze the causes and risk factors of these complications and discuss how they could be prevented. To explain the different treatment options for these complications.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction- Lung biopsy and lung abscess drainage indications - Pleural biopsy indications- Thoracocentesis and pleural drainage indications - Techniques: CT- and US guided- Procedure: patient preparation, materials, technical considerations 2. Complications 2.1. Pneumothorax - Risk factors - Treatment 2.2. Lung Hemorrhage- Risk factors - Treatment 2.3. Subcutaneous Hematoma- Causes - Treatment 2.4. Seeding 2.5. Gas embolism- Clinical manifestations, causes - Treatment 2.6. Hemothorax- Causes - Treatment 2.7. Non-diagnostic biopsy- Risk factors - FNA vs CNB - Methods to increase biopsy performance 2.8. Non-productive pleural drainage- Causes- Treatment 3. Prevention of complications 4. Summary 5. Conclusion

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## Abstract Archives of the RSNA, 2023

IREE-62

### **Intra-procedural Ablation Margin Confirmation for Thermal Ablation of Liver Tumors Using Open Source Software**

All Day Room: Learning Center

Iwan Paolucci, PhD (*Presenter*) Stockholder, Intuitive Surgical, Inc ;Stockholder, SOPHiA GENETICS

#### **TEACHING POINTS**

1) Dedicated software for confirmation of ablation margins is commercially available but expensive and often unavailable to in health care centers and research laboratories with limited budgets - even in developed nations. This abstract presents a workflow for ablation confirmation using free and open source software.2) The minimum ablation margin (MAM) after thermal ablation of liver tumors is the most important predictor of local tumor progression.3) Detecting an insufficient minimum ablation margin during the procedure allows for immediate re-ablation during the same treatment session.4) Intra-operative images acquired using controlled breathing (e.g. apnea, high frequency jet ventilation) yield the most accurate results as they involve minimal tissue deformation.

#### **TABLE OF CONTENTS/OUTLINE**

1) Software requirements2) Loading and organizing the data3) Registering the pre- and post-ablation CT images4) Segmentation of the tumor and ablation zone5) Calculation and visualization of the minimum ablation margin

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## Abstract Archives of the RSNA, 2023

IREE-63

### **The Role of Cone Beam Computed Tomography in Embolization of a Technically Challenging Distal Pulmonary Artery Mycotic Aneurysm**

All Day Room: Learning Center

Achintya Patel, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Cone-Beam Computed Tomography (CBCT) has many potential applications for both diagnostic and interventional radiology. The use of CBCT, as exemplified by the following case, allowed for the expeditious identification and treatment of a distal pulmonary artery mycotic aneurysm. This exhibit will enable participants to directly compare the differences in appearance between traditional CT and CBCT of the same entity and to display how CBCT data can be fused to live fluoroscopy to hasten the time to intervention.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction of the case example a. 42-year-old female with a complex medical history most notable for recent endocarditis treated with antibiotics and mitral valve replacement who presented with hemoptysis.
2. Description of traditional CTA findings a. CTA Chest demonstrated a distal, fourth-order pulmonary artery mycotic aneurysm. Axial images and coronal reformat provided.
3. Description of the CBCT findings a. Redemonstration of the aneurysm, comparing appearance to that of the CTA
4. Tutorial of fusing CBCT with live fluoroscopic images using guidance software, specifically using GE EMBO ASSIST ® as an example a. Images of the 3D reconstruction of the CBCT data b. Discussion of how guidance software is applied to the fluoroscopic images
5. Conclusion of case a. Successful, expeditious coil embolization of a difficult-to-access distal pulmonary artery mycotic aneurysm
6. Discussion of additional applications of this technique to other entities

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## Abstract Archives of the RSNA, 2023

IREE-64

### Overview of Diagnosis and Treatment of Large or Medium-sized Vessel Vasculitis

All Day Room: Learning Center

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Vasculitis is a group of disorders characterized by inflammation of the walls of blood vessels, and they are classified based on the diameter of the predominantly affected vessels. The clinical manifestations of vasculitis can be non-specific and may overlap with other disorders. Imaging techniques allow for direct evaluation of the arteries in large or medium-sized vessel vasculitis, and various interventional procedures may be used in these cases. However, the vessels involved in small vessel vasculitis are smaller than the current imaging resolution, meaning that only end organ changes secondary to the involvement of small vessels can be examined. This review presents the most important imaging modalities and typical findings in large and medium-sized vasculitis. The purpose of this exhibit is : (1) To list the vascularitis according to the vessel size affected. (2) To review the clinical and radiological manifestation of various vascularitis. (3) To learn the indication and technical tips for interventional procedures for vascularitis.

#### TABLE OF CONTENTS/OUTLINE

1) List of vascularitis A: large vessels (eg, giant cell arteritis, Takayasu arteritis), B: medium-sized vessels (eg, polyarteritis nodosa, Kawasaki disease, primary granulomatous central nervous system vasculitis), C : small vessels (eg, Wegener granulomatosis, Churg-Strauss syndrome, microscopic polyangiitis, Henoch-Schönlein syndrome, systemic lupus erythematosus, rheumatoid vasculitis, Behçet syndrome). 2) Clinical manifestation and diagnostic criteria 3) Imaging modality and angiographic appearance 4) Treatment options : medical vs interventional 5) interventional procedures and their indication

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-65

### Intra-arterial Treatment for Hepatocellular Carcinomas: How to Manage Shunting from the Artery

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In the treatment of hepatocellular carcinomas, intra-arterial therapy such as chemoembolization and radioembolization is commonly used. However, operators may encounter shunts from the artery (such as arterioportal, arteriovenous, and arteriopulmonary shunts) that can hinder effective treatment. These shunts can be caused by various factors such as tumor invasion, previous percutaneous procedures, chronic inflammation, or congenital acquisition. If not properly occluded, embolic material can pass through the shunt and cause non-target embolization or serious complications. This exhibit aims to achieve three goals: (1) Review the radiologic appearance of arterioportal, arteriovenous, and arteriopulmonary shunts; (2) Learn how to manage these shunts with proper embolic materials; and (3) List the possible complications and their management.

#### TABLE OF CONTENTS/OUTLINE

1) List of shunts Arterioportal shunt (hepatic artery - portal vein), Arteriovenous shunt (hepatic artery - hepatic vein), Arteriopulmonary shunt (hepatic artery - pulmonary artery/vein), 2) Imaging findings on CT/MR and angiography according to the cause (tumorous vs non-tumorous condition) 3) Embolization strategy and materials for shunts 4) Complications related with non-target embolization and their management

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## Abstract Archives of the RSNA, 2023

IREE-66

### Nonsurgical Management of Renal Masses

All Day Room: Learning Center

Laura Jorgenson (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Learn the nonsurgical approaches to treat renal masses, including ablation, embolization, and SBRT, the indications for treatment and intraprocedural tips and tricks to optimize response. Understand post ablation, embolization and SBRT changes in the renal tumor and how to avoid pitfalls in interpretation. How to evaluate for tumor recurrence post treatment and avoid pitfalls in assessment. Understand common complications following ablation, embolization, and SBRT.

#### TABLE OF CONTENTS/OUTLINE

1. Ablation, embolization, and SBRT technique Discuss evolution of nonsurgical management of renal tumors as a viable treatment option. Discuss indications and fundamentals of ablation, embolization, and SBRT: Patient selection Tumor types Treatment planning Procedural insights to avoid complications Role of spectral CT during ablation 2. Post ablation SBRT and embolization changes in renal tumors and assessment of tumor response Response of renal masses to nonsurgical management Typical features on imaging (CT/MRI) which depict normal evolution of typical changes on imaging - acute, subacute and chronic changes Tips on how to avoid pitfalls in interpretation 3. Potential Complications and related imaging features in each modality Intraprocedural complications Immediate post-procedural complications Delayed complications

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## Abstract Archives of the RSNA, 2023

IREE-67

### **Radioembolization of Hepatocellular Carcinoma with Extrahepatic Collateral Blood Supply: Anatomic and Technical Considerations**

All Day Room: Learning Center

Hyo-Cheol Kim, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The utilization of radioembolization as a treatment method for hepatocellular carcinoma (HCC) has significantly increased in recent years. Typically, HCC derives its blood supply from the hepatic artery; however, it can also obtain a parasitic blood supply from extrahepatic collateral arteries (EHC). While chemoembolization has been carried out through EHC without significant complications, there is limited experience with radioembolization via EHC. The aim of this exhibit is threefold: (1) to examine the critical anatomy of EHC utilizing cone-beam CT, (2) To review when we suspect the presence of EHC supplying HCC, (3) To learn how to do safe radioembolization through EHC.

#### **TABLE OF CONTENTS/OUTLINE**

1) List of treated EHC, 2) Vascular anatomy of EHC by using cone-beam CT and safe point of each EHC, 3) Suggestive findings of EHC on CT/MR and cone-beam CT, 4) Special considerations for radioembolization through EHC: dosimetry, embolization of pulmonary shunt, protection of normal vessel, and redistribution by proximal embolization.

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## Abstract Archives of the RSNA, 2023

IREE-68

### **Reducing the Learning Curve: The Use of an Ex Vivo Model for Teaching Double J Ureteral Stent Insertion and Retrograde Exchange**

All Day Room: Learning Center

Marina Borrego, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Discuss the benefits of simulation-based training for procedure competence. To describe our experience with a new training model for learning double J ureteral stent (DJS) insertion and retrograde exchange.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction. Urinary tract obstruction and how the performance of DJS can provide relief. The current master-apprentice model and the importance of procedure competence for trainees before practicing on patients. Benefits of simulation-based training and the current models available. Illustration of a developed ex vivo model for simulating a DJS procedure. Conclusion: Percutaneous access into the renal collecting system is a crucial step when performing DJS. This developed model allows for training on this technical skill as well as the remaining steps in a realistic and safe environment.

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## Abstract Archives of the RSNA, 2023

IREE-69

### Diagnostic and Interventional Radiology for Budd-Chiari: An Update on BCS Classification and IVUS

All Day Room: Learning Center

Anne Sailer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Budd-Chiari syndrome (BCS) is the occlusion of one or more veins of the liver due to various disorders that result in sinusoidal congestion, portal hypertension, fibrosis, cirrhosis, and nodular regeneration. 2. The new BCS classifications can provide more appropriate treatment options; accurately determining the type of obstructor, number of blocked vessels, and length of the obstruction and categorizing the patients according to the updated BCS classification can improve the success of the patient's therapeutic treatment plan.

#### TABLE OF CONTENTS/OUTLINE

1. Review pathophysiology of Budd Chiari and the BCS classifications. 2. Briefly review potential mimics of Budd Chiari (i.e. other cause of sinusoidal or post hepatic obstruction). 2. Discuss general concepts of assessing the liver Doppler US, CTA, MRA, venography, and intravascular ultrasound (IVUS) with emphasis on technique, protocol, and image optimization for diagnosing Budd Chiari. a. Describe differentiating imaging features of various BCS presentations depending on the location of the occlusion. b. Review complications associated with BCS. c. Briefly demonstrate pitfalls of BCS. 4. Discuss management options with interventional radiology procedures (venoplasty and stenting, local pharmacologic and mechanical thrombolysis, transjugular intrahepatic portosystemic shunt (TIPS) placement), and potential complications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-7

### Prophylactic Intervention for Placenta Accreta Spectrum

All Day Room: Learning Center

Bo-Syuan Huang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Placenta accreta spectrum (PAS) is an abnormal placentation with invasion of myometrium or extrauterine structures and can be associated with maternal morbidity and mortality. Not only the prenatal diagnosis but also the management are important to reach a better outcome. To date, pre-operative prophylactic balloon occlusion is developing with balloon placement in varies sites including internal iliac arteries, common iliac arteries, uterine arteries and abdominal aorta. The purpose of this exhibit is: 1) to review the MRI features of PAS. 2) to review different treatment options including procedural risk, benefit and outcome. 3) to demonstrate techniques of balloon occlusion of internal iliac arteries. 4) to enhance the value of MRI image for preprocedural guidance or predictive indicator.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction of placenta accreta spectrum (PAS) 2) MRI diagnosis of PAS. 3) Management for abnormal placentation a. traditional approach b. prophylactic balloon occlusion in varies anatomic regions c. outcome for each treatment 4) Case demonstration: balloon occlusion of internal iliac arteries. 5) Additional MRI role for interventional radiologist

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-70

### Image-guided Percutaneous Cryoablation for Lung Malignancies: Giving the Tumor a Cold Send-off

All Day Room: Learning Center

Angel F. Castillo Fortuno, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To describe the physical and therapeutical mechanisms of image-guided percutaneous lung cryoablation (L-CYOA).
- To discuss the clinical and imaging features and the diagnostic and therapeutical algorithms of patients with lung malignancies amenable to treatment L-CYOA, including a proposed systematic pre-procedural evaluation protocol.
- To explain the technique, intraprocedural considerations, imaging findings, and most common complications related to L-CYOA.
- To describe the short-, mid-, and long-term follow-up imaging findings, clinical outcomes, and prospects of L-CYOA in the treatment of lung malignancies.

#### TABLE OF CONTENTS/OUTLINE

1.- Introduction 1.1- Background 1.2 - Surgery, SBRT or lung ablation? 1.3.- Heat vs. cold ablation techniques: Why CYOA? 1.4.- CYOA: Basic principles 2.- Indications 2.1.- Non-small cell lung carcinoma (NSCLC). 2.2.- Oligometastatic lung disease (OLD). 3.- Assessment before L-CYOA 3.1.- Patient selection. 3.2.- Preprocedural evaluation and preparation. 3.3.- Proposal of a systematic protocol. 4.- L-CYOA procedure 4.1.- Technical considerations: CYOA equipment and CT protocol. 4.2.- Technique. 4.3.- Intraprocedural clinical and imaging evaluation. 4.4.- Immediate clinical and imaging findings. 4.5.- Complications. 5.- Post-L-CYOA follow-up 5.1.- Clinical and imaging follow-up scheme. 5.2.- Short-, mid-, and long-term follow-up imaging and clinical findings. 6.- Clinical outcomes 6.1.- Stage I NSCLC. 6.2.- Alternatives indications in NSCLC. 6.3.- OLD. 6.4.- Immunotherapy synergy. 7.- Summarize 8.- Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-71

### Superior Vena Cava Interventions

All Day Room: Learning Center

#### Awards

##### Cum Laude

Irene Dixe de Oliveira Santo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the causes, anatomic considerations, presentation, and grading of superior vena cava syndrome (SVCS); Describe the main treatment options for SVCS with a special focus upon the endovascular therapies (ET), including angioplasty, stenting and catheter-based thrombus removal; Provide a brief case-based overview of ET, including stent selection; Review the main complications of ET.

#### TABLE OF CONTENTS/OUTLINE

Causes of superior vena cava syndrome (SVCS); Review of the main anatomic considerations, including patterns of obstruction and collateral pathways; Clinical presentation and grading system of SVCS; Diagnostic approach for SVCS; Main treatment options including chemotherapy with or without RT, surgical bypass or ET, including angioplasty, stenting and catheter-based thrombus removal, with pros and cons of each modality; Selected cases from our institution to illustrate several ET options; Venous Stents: types, descriptions, benefits and drawbacks; Complications of ET: hematoma, local infection, pericardial tamponade, SVC rupture, stent migration, in-stent restenosis, pulmonary edema, major bleeding, pulmonary embolism, and cardiac injury.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-72

### **Combined Y90 Radioembolization and Immunotherapy for the Treatment of Hepatocellular Carcinoma: Is it Effective or Harmful Due to Adverse Effects**

All Day Room: Learning Center

Johnny Yang, BS, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the mechanism of immunotherapy and Yttrium-90 radioembolization for the treatment of hepatocellular carcinoma (HCC). Explore the risks, benefits, and safety of combined immunotherapy and radioembolization treatment. Review outcomes of real-life cases of combined therapy.

#### **TABLE OF CONTENTS/OUTLINE**

Understanding the Hepatocellular carcinoma (HCC) immune microenvironment is important for developing effective immunotherapies. Suppression of the cytotoxic immune response - including CD8+ T lymphocytes, Natural Killer (NK) cells, and their associated cytokines - is associated with HCC progression. New drugs targeting immune checkpoint inhibitors, such as nivolumab, pembrolizumab, and atezolizumab have revolutionized the treatment of HCC. The latest research is exploring combination therapy with multiple immunotherapy agents and/or locoregional therapies such as surgical resection, ablation, or embolization. We reviewed stand alone widely used radioembolization with yttrium-90 (Y-90) therapy versus the safety of combining radioembolization with the PD-1 inhibitor nivolumab in HCC. Several Studies looked at the safety of the combination therapy by examining adverse events and overall survival. Results have shown that the combination therapy was well-tolerated, with no major adverse events reported. The most common side effects were fatigue, nausea, and abdominal pain. The median overall survival for the patients was 17 months, which is similar to prior studies. Some studies showed similar survival between these two therapies. Personalized selection based on age, burden of disease and other favorable criteria are important on which patient will benefit from single or combined therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-73

### Understanding the Complex Mechanisms of Complications in IR

All Day Room: Learning Center

Jorge E. Lopera, MD (*Presenter*) Shareholder, Tecnostent SA; Consultant, Merit Medical Systems, Inc; Research Grant, AngioDynamics, Inc

#### TEACHING POINTS

- To review how complications affect our performance in IR
- To understand the most common mechanism of IR complications
- To learn how to prevent and deal with complications
- To illustrate healthy and unhealthy ways to deal with complications

#### TABLE OF CONTENTS/OUTLINE

Introduction : Error or complication ? Most common cause of complications : Judgmental errors : incorrect strategy of treatment is chosen.(1) overly heroic procedures(2) failure to intervene when the situation demands. Technical errors : poor technique , poor selection of devices .Normative or moral errors: irresponsible or unethical behavior. IR specific complications: Choosing the wrong materials .Not knowing your patient's history well. Poor communication. Rushing through cases. Poor technique .Bad luck? . Simple steps to prevent complications Coping with complications : What to do next . Healthy and unhealthy ways to deal with complications Economic and social cost of complications Conclusions

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

IREE-74

### **Considerations for the Nonconventional Transjugular Intrahepatic Portosystemic Shunt (TIPS) Creation in Cancer Patients: Alternative Techniques and When to Use Them**

All Day Room: Learning Center

Kevin Agahi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the indications and potential interfering factors to performing a TIPS procedure in cancer patients. 2. Present the standard technique for performing a TIPS; modifications that can be made; and when to use them to circumvent difficulties of the pre-, intra-, and post-operative process in cancer patients with altered post-surgical anatomy and acute or chronic splenoportal venous thrombosis.

#### **TABLE OF CONTENTS/OUTLINE**

The transjugular intrahepatic portosystemic shunt (TIPS) is widely used in relieving pressure in the portal venous system (~90% success rate) in patients with refractory variceal bleeding or ascites, often due to cirrhosis. The standard process involves catheter guidance from a hepatic vein to a target portal vein branch. Several factors in cancer patients can complicate this procedure. These patients routinely have altered post-surgical anatomy such as a partial hepatectomy. Additionally, an association with increased thrombophilia can cause portal vein thrombosis. Moreover, certain tumors can compress or invade into splenic or mesenteric veins and result in occlusions interfering with a TIPS creation. For such cases, modifications to recanalize or bypass the obstruction have been demonstrated. We review the literature and present alternative techniques for shunt creation in a nonconventional TIPS: 1. The diagnostic presentation of patient factors that can interfere with a successful TIPS creation. 2. Case-based discussion regarding modifications to the TIPS technique to circumvent complicating factors.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-75

### Local and Systemic Immune Cell Landscape after Transcatheter Arterial Embolotherapies for Hepatocellular Carcinoma

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Hannah E. Kostan (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the magnitude and influence of post embolization hypoxic microenvironment on the local and systemic immune cell landscape in hepatocellular carcinoma (HCC)
- Illustrate preclinical and clinical data on T-cell and myeloid populations in post embolization and radioembolization in tumor microenvironment
- Describe the current status of systemic immune cell response after catheter-based therapies for HCC

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to catheter-based interventions for HCC and technical impact on post embolization hypoxia  
2. Overview of the role of hypoxic stress and angiogenic factors induced by embolization on HCC cell survival  
3. Characterize T-cell and myeloid cell local landscape after catheter-based interventions.  
4. Discuss changes to splenic and plasma levels of inflammatory markers after HCC embolotherapies.  
5. Demonstrate sustained immune responses after Y90 Radioembolization in Hepatocellular Carcinoma  
6. Discuss future applications of embolization therapies in treating liver tumors.

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## Abstract Archives of the RSNA, 2023

IREE-76

### Imaging Findings and Interventional Management in Benign and Malignant Biliary Disease

All Day Room: Learning Center

Daniel Freedman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Biliary disease consists of benign and malignant entities with a diverse spectrum of clinical presentation and imaging findings. 2. Benign biliary disease includes choledochal cysts, hamartomas, autoimmune diseases, chronic pancreatitis, HIV cholangiopathy, iatrogenic injury, gallstones, infection (cholangitis), and may develop after liver transplantation. 3. Malignant biliary disease includes primary biliary cancers (cholangiocarcinoma) and secondary tumor/metastatic disease, and causes severe illness secondary to local obstruction. 4. Multimodality imaging plays a critical role in guiding diagnosis and treatment options executed by interventional radiologists and advanced endoscopists including PTC, PTBD, ERCP, biliary stents, and surgery.

#### TABLE OF CONTENTS/OUTLINE

1. Review of the clinical presentation and diagnostic imaging workup for benign and malignant biliary disease. 2. Multimodal imaging and procedural approach to the diagnosis, management, and treatment of benign and malignant biliary disease, including: a. Percutaneous transhepatic cholangiography and drain placement (PTC, PTBD) b. Endoscopic retrograde cholangiopancreatography (ERCP) c. Percutaneous transhepatic cholangioscopy d. Biliary stenting e. Surgical intervention

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## Abstract Archives of the RSNA, 2023

IREE-77

### Deep Gluteal Syndrome: Anatomy, Imaging and CT-guided Treatment (Sciatic Nerve Neurolysis)

All Day Room: Learning Center

Cristina Candelaria Linares Bello, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Remember the anatomy of the subgluteal space and the sciatic nerve. Explain the causes of deep gluteal syndrome and the different imaging findings. Explain the procedure of CT-guided treatment (sciatic neurolysis).

#### TABLE OF CONTENTS/OUTLINE

Deep gluteal syndrome is considered an underdiagnosed entity and defined as the compression or irritation of a non-discogenic origin of the sciatic nerve in the anatomical region of the subgluteal space. The typical symptoms are: dysesthesias and/or pain in the buttock and hip. There are many etiologies that can produce this syndrome: Specific musculoskeletal entrapments: fibrous, fibrovascular or vascular bands, piriformis syndrome, gemelli-obturator internus syndrome, pathology of the quadratus femoris muscle and the ischiofemoral space and insertional pathology of the hamstring muscles. Non-specific pathologies: iatrogenic, inflammatory, traumatic, infectious, gynecologic, vascular and tumors. For its diagnosis, physical examination and an adequate clinical history are of great importance. MR imaging is the procedure of choice. On the other hand, the CT-guided procedure to perform sciatic nerve neurolysis is both a diagnostic and therapeutic procedure and an alternative to surgical treatments. The deep gluteal syndrome is an underdiagnosed entity with multiple etiologies. The CT-guided sciatic nerve neurolysis is a safe procedure and an alternative to surgical treatments.

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## Abstract Archives of the RSNA, 2023

IREE-78

### Hidden Time Bombs: Image Features of Abdominal Visceral Pseudoaneurysms and Treatment

All Day Room: Learning Center

Mario Dervishi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Describe the common locations of, and clinical presentation including the complications of abdominal visceral artery pseudoaneurysms.
- Review the key imaging features of abdominal pseudoaneurysms on different modalities.
- Discuss the non-surgical endovascular and percutaneous treatment approaches to abdominal pseudoaneurysms.

#### TABLE OF CONTENTS/OUTLINE

- Definition of pseudoaneurysms and location of visceral abdominal aneurysm such as-Splenic Artery Pseudoaneurysm- Hepatic Artery Pseudoaneurysm -Renal Artery Pseudoaneurysm -Pancreatic Artery Pseudoaneurysm-Mesenteric Artery Pseudoaneurysm
- Clinical presentation of pseudoaneurysms
- Imaging features of pseudoaneurysms - Findings on doppler and contrast enhanced ultrasound- Features on computed tomography (CT) angiogram- Vasculature characteristics and assessment of pseudoaneurysm features on conventional angiogram.
- Indication of pseudoaneurysm treatment and non-surgical treatment options - Symptomatic versus non symptomatic pseudoaneurysm- Endovascular fluoroscopic guided pseudoaneurysm treatment.- Percutaneous CT guided treatment - Percutaneous US (doppler and or contrast enhanced) guided treatment.

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## Abstract Archives of the RSNA, 2023

IREE-8

### Minimally Invasive Thoracic Oncology Treatments: Comprehensive Review and Comparison of RFA, MWA, Cryoablation, and Chemoembolization Techniques

All Day Room: Learning Center

Shakthi K. Ramasamy, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibit aims to provide a comprehensive overview of minimally invasive thoracic oncology treatments, focusing on radiofrequency ablation (RFA), microwave ablation (MWA), cryoablation, and bronchial/pulmonary artery chemoembolization. RFA and MWA offer reduced morbidity and mortality, while preserving pulmonary function and allowing for repeatability. Cryoablation has shown promise in the treatment of early-stage lung cancer and advanced-stage palliative care, as well as in emerging applications such as ground-glass nodules. When lung metastases that are inoperable and unsuitable for ablation cease to respond to systemic chemotherapy, the prognosis becomes poor. Bronchial and pulmonary artery chemoembolization provide alternative treatment options for patients with large, multifocal lung tumors and those experiencing hemoptysis. The exhibit will delve into the principles, applications, imaging guidance, and outcomes associated with each technique, as well as the comparative efficacy of these treatments.

#### TABLE OF CONTENTS/OUTLINE

I. RFA, MWA, Cryoablation and Bronchial and Pulmonary Artery Chemoembolization will be discussed under the following categories: A. Principles and techniques B. Imaging guidance C. Patient selection and indications D. Treatment outcomes and comparisons E. Potential complications and management strategies II. Comparing the Treatments A. RFA, MWA, Cryoablation, and Chemoembolization B. Factors influencing treatment selection C. Efficacy and safety of each technique III. Future Directions and Research A. Ongoing clinical trials and studies B. Potential applications in personalized medicine and targeted therapy

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## Abstract Archives of the RSNA, 2023

IREE-80

### **Gonadal Vein Embolization for the Management of Varicocele, Infertility, and Pelvic Congestion: Patient Anatomy, Evaluation, and Technique for Successful Treatment**

All Day Room: Learning Center

Younes Attlassy (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Varicocele and PCS are similar disorders associated with vascular dysfunction. Varicocele occurs due to the pooling of venous blood while PCS is the result of vascular pressure buildup in the pelvic region. 2. Understanding the diagnostic and imaging workup for both conditions is imperative for radiologists and treatment teams to identify, grade, and treat both conditions. 3. Several interventions and treatments, including gonadal vein embolization, are available for patients with these conditions with varying success and complication rates. Information regarding the risks and benefits surrounding these interventions is paramount to ensuring the proper standard of care for each individual patient. 4. Interventional radiology percutaneous embolization has become a safe and effective minimally invasive option for varicocele and PCS treatment with high success rates and few complications.

#### **TABLE OF CONTENTS/OUTLINE**

1. Understanding the anatomy and pathophysiology of both PCS and varicocele including the anatomical variants and attributes that make gonadal vein embolization a more attractive treatment modality in certain cases. 2. A review of the clinical presentation, diagnostic imaging, workup, grading/classification systems, and the interventions for each one. 3. A look at the various treatment options and the risk-benefit analysis around each one. 4. An in-depth guide on IR-guided procedural protocol for the management of varicocele and PCS including how to address anatomical variants, contraindications, and expected post-procedural outcomes.

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## Abstract Archives of the RSNA, 2023

IREE-81

### Endovascular Interventions of the Mesenteric Vasculature Through Collaterals: A Technical Savior

All Day Room: Learning Center

Gottipati P. Choudary, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Vascular pathologies involving the arteries distal to stenosed or occluded main mesenteric arterial trunk is difficult to access. In these situations, one should be aware of arterial arcades and knowledge about these collateral pathways can bail the interventionalist out. We present four cases of endovascular interventions performed through the mesenteric collateral pathways.

#### TABLE OF CONTENTS/OUTLINE

Case 1. GLUE EMBOLIZATION OF SPLENIC ARTERY ANEURYSM (SAA) VIA HYPERTROPHIED RIGHT GASTRO-EPIPLOIC ARTERY (RGEA). 28-year/female - acute necrotizing pancreatitis with intraabdominal bleed. Status post proximal splenic artery embolization using coils. Embolization of the SAA was done via the hypertrophied RGEA. Case 2. SPLENIC PARENCHYMAL EMBOLIZATION (SPE) VIA INFERIOR PANCREATICO-DUODENAL (IPD) ARTERY - RIGHT GASTRIC ARTERY (RGA) COLLATERALS. 58-year/male - Post liver transplant and SA ligation. Refractory ascites due to persistent portal hypertension. Distal SA is reformed through collaterals from the RGEA (minor) and the IPD artery. Embolization was performed using PVA particles. Case 3. COIL EMBOLIZATION OF LEFT HEPATIC ARTERY (LHA) PSEUDOANEURYSM VIA THE IPD ARTERY. 32-year/male - Pseudoaneurysm arising from the LHA branch after removal of biliary catheter. Celiac artery stenosis was noted. Celiac axis reformed through IPD artery. A microcatheter was navigated across the hypertrophied collaterals and the pseudoaneurysm was coiled. Case 4. SPE VIA HYPERTROPHIED RGEA COLLATERALS. 42 years/male - Post liver transplant and SA ligation. Persistent hypersplenism and Splenomegaly. Splenic parenchymal embolization was done via the hypertrophied RGEA by injection of PVA particles

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## Abstract Archives of the RSNA, 2023

IREE-82

### From Classic to Quirky: A Journey through the “Aunt Minnie's” of Angiography

All Day Room: Learning Center

Kara M. Fitzgerald, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Provide radiology resident level review of classic, “Aunt Minnie” angiographic signs and findings. Briefly discuss pertinent management aspects of underlying pathology diagnosed on angiography. Review intravenous contrast agent selection, contrast injection rates and fluoroscopic projections as key technical components for optimizing image acquisition in angiography and venography.

#### TABLE OF CONTENTS/OUTLINE

Introduction:- Considerations for contrast selection- Contrast injection rates in angiography and venography- Common fluoroscopic projections for image acquisition  
Abdominal Angiography- Aortic dissection with Floating Viscera Sign- Budd Chiari- Non-inflammatory, non-atherosclerotic arteriopathies- Fibromuscular Dysplasia- Segmental Arterial Mediolysis- Standing Wave- Polyarteritis Nodosa  
Peripheral Angiography- Sciatic artery- Dissection- Popliteal Artery Entrapment Syndrome- Hypothenar Hammer Syndrome- Arterial Thoracic Outlet Syndrome  
Pelvic Angiography- Uterine Arteriovenous Malformation- Postpartum hemorrhage- Trauma- Corona Mortis- Pruning, truncation, petechial hemorrhage and vasospasm- Cavernosal Blush  
Angiography of Collateral Pathways:- Arc of Buhler and Riolan- Subclavian Steal- Aortic occlusion and Winslow's pathway  
Venography- Venous Thoracic Outlet Syndrome- Paget-Schroetter Syndrome- Deep Vein Thrombosis- Azygos Continuation of the Inferior Vena Cava

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## Abstract Archives of the RSNA, 2023

IREE-83

### **Mechanical Thrombectomy for the Treatment of Deep Vein Thrombosis: A Primer for Interventional Radiologists**

All Day Room: Learning Center

Abinaya Ramakrishnan (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points: Review treatment strategies using percutaneous mechanical thrombectomy devices including its indications and current state of literature. Review data from a single institution's experience and discuss factors that impact post-procedure outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents/ Outlines: Background of management for acute deep vein thrombosis Discuss indications for percutaneous mechanical thrombectomy vs thrombolysis vs anticoagulation Discuss the diagnosis of May Thurner on incidence of recurrent DVT Discussion of major clinical trials of thrombectomy devices CLOUT Registry (Inari Medical) ATTRACT trial (Angiojet Rheolytic Thrombectomy System, Boston Scientific) Overview of current percutaneous mechanical thrombectomy devices on the market Data from a single-institution's experience with percutaneous mechanical thrombectomy Discuss findings from a single institution's retrospective analysis of thrombectomy procedures (n=82) Discuss specific factors that may influence post-procedure outcomes of re-thrombectomy, specifically sex, location of clot, chronicity of clot. Discuss intraprocedural characteristics that improve outcomes like placement of a stent and venoplasty. Review some of the contraindications for the use of percutaneous mechanical thrombectomy Highlight 2 successful cases with pre- and post-procedure imaging.

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## Abstract Archives of the RSNA, 2023

IREE-84

### **Straight to the Heart: State of the Art Thoracic Central Vein (Superior Vena Cava) Endovascular Recanalization, Thrombectomy and Stent Reconstruction**

All Day Room: Learning Center

Kara M. Fitzgerald, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review anatomy and embryology of mediastinum and central thoracic veins. Recognize common etiologies and classifications of thoracic central vein obstruction (TCVO) including lesions of the brachiocephalic veins and superior vena cava. Describe endovascular treatment of TCVO including access, recanalization, thrombectomy, stent reconstruction, and extra-anatomic bypass creation as well as intraprocedural adverse event management. Discuss comprehensive care from initial work-up to post-procedure management.

#### **TABLE OF CONTENTS/OUTLINE**

Upper extremity and thoracic central vein anatomic review  
Common etiologies for TCVO  
Benign Malignant Patient evaluation  
Presentation, physical examination, and imaging evaluation  
Acute and chronic occlusive symptoms  
Patient centered care  
Technical aspects of procedure  
Sedation Access  
Venography  
Blunt and sharp recanalizations  
Thrombectomy and tissue sampling  
Stent selection and reconstruction  
Use of intravascular ultrasound (IVUS)  
Adverse event management  
Hemothorax and hemopericardium  
Stent migration  
Extra-anatomic bypass creation  
Post-procedure care and follow-up  
Antiplatelet and anticoagulation regimen  
Imaging surveillance  
Outcomes and patency  
Pediatric considerations

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## Abstract Archives of the RSNA, 2023

IREE-85

### Extra Abdominal Desmoid Tumors and Image Guided Percutaneous Cryoablation

All Day Room: Learning Center

Roberto Luigi Cazzato (*Presenter*) Proctor, Medtronic plc

#### TEACHING POINTS

- Unique anatomy and pathophysiology of extra-abdominal desmoid tumors- Treatment planning including image and clinical evaluation- Procedural techniques of image guided percutaneous cryoablation- Adjunctive techniques including thermoprotection- Necessary clinical and imaging follow-up after treatment - Treatment guidelines for extra abdominal desmoids and the role of ablation

#### TABLE OF CONTENTS/OUTLINE

- Sporadic vs familial desmoid tumors- Rationale for using cryoablation to treat extra-abdominal desmoid tumors- Selection criteria for proposing cryoablation of extra-abdominal desmoid tumors-Follow-up

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

IREE-86

### Minimally Invasive Treatment of Postoperative Pancreatic Fistula Using Interventional Radiology

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Toshihiro Horii, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Although the incidence of surgical complications has gradually decreased with the advancement of minimally invasive surgical techniques and instruments, such as laparoscopic surgery and robot-assisted technology, postoperative pancreatic fistula remains a severe complication requiring prompt management. Percutaneous and endoscopic postoperative management has a lower mortality rate than surgical methods, and expectations for interventional radiology (IR) are increasing. Therefore, it is necessary to understand the etiology, diagnosis, and indications of postoperative pancreatic fistula and be familiar with appropriate IR intervention methods. Knowledge of technical tips in treatment is essential for successful procedures. The aims of this presentation are as follows: To explain the etiology, diagnosis, indications, and imaging features of postoperative pancreatic fistula. To discuss the treatment methods, management strategies, advancements, and complications in interventional radiology for postoperative pancreatic fistula, including techniques.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Overview Etiology, Diagnostic Criteria, and Treatment Indications for Postoperative Pancreatic Fistula Management Strategies for Postoperative Pancreatic Fistula 3. Illustrated Case Studies Management of Pancreatic Fistula after Pancreaticoduodenectomy Management of pancreatic fistula after combined resection of the body and tail of the pancreas Management of Pancreatic Fistula after Gastric Surgery Complications and Difficult Cases 4. Conclusion

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## Abstract Archives of the RSNA, 2023

IREE-9

### Acute Massive Hematochezia Due to Colonic Varix: Antegrade Transsplenic Embolization of Abdominal Garland Vein

All Day Room: Learning Center

Gottipati P. Choudary, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In patients with cirrhosis of liver, acute variceal bleeding can be a fatal complication. Varices may develop anywhere in GIT, in cirrhotic patient. Ectopic varices, are not so common, accounting less than 5% of all variceal bleeding. Among these, colonic varices are very rare. Here, in this report, we emphasize the role of endovascular intervention in the management of acute massively bleeding colonic varix in a hemodynamically unstable cirrhotic patient.

#### TABLE OF CONTENTS/OUTLINE

In patients with cirrhosis of liver, acute variceal bleeding can be a fatal complication. Colonic varices are very rare cause of lower gastrointestinal bleeding that can bleed spontaneously and result in massive haemorrhage in patients with liver cirrhosis and portal hypertension. Here we present a case of 50-year-Male, known case of non-alcoholic cirrhosis of liver with portal hypertension (for past 15 years) and type 2 diabetes mellitus, who presented with massive fresh bleeding per rectum. Despite early colonoscopy and glue injection of the colonic varix, patient continued to bleed. Triple phase CT scan of abdomen was done which showed large portosystemic shunt (mesocaval shunt) arising from superior mesenteric vein (SMV) traversing around the ascending colon and forming sub mucosal varices protruding into the colon lumen and joining the right renal vein and draining into the inferior vena cava (IVC) giving a garland appearance. He underwent successful transsplenic antegrade obliteration of the varix by coil embolization and glue injection. There are no clear-cut established management guidelines for such patients. Endovascular embolization could be an effective treatment option of colonic variceal bleeding.

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## Abstract Archives of the RSNA, 2023

MKEE

### Musculoskeletal Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **MKEE-1 Imaging-Guided Perineural Injections of the Lower Extremity from the Pelvis to the Foot**

Tanya L. Tivorsak, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Perineural injections can be performed under CT or ultrasound guidance for diagnostic and therapeutic purposes.2. Ultrasound guidance can be used for peripheral nerve injections as peripheral nerves can be localized well on ultrasound and with real-time guidance.3. CT guidance can be used for certain perineural injections such as in the pelvis that may be difficult to visualize under ultrasound.4. This exhibit will provide a guide for injecting certain nerves that are commonly requested at our institution.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction and indications for perineural injections - relieve nerve pain, pinpoint site of potential nerve injury prior to nerve surgery.2. Procedure preparation - pre-procedure imaging review (MR neurography), ultrasound transducers, needle size, and volume of injectant.3. Technique for injecting certain nerves from the pelvis to the foot including lateral femoral cutaneous, pudendal, genitofemoral, sciatic and piriformis muscle, saphenous (adductor canal), common peroneal, sural, superficial peroneal, and tibial nerves.4. Risks and complications.5. Overview of cryoneurolysis application and techniques.

#### **MKEE-10 Out of Shape: Musculoskeletal Manifestations of Sickle Cell Disease**

Leonardo Kazunori Tsuji, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the main aspects related to musculoskeletal findings of sickle cell disease, including etiology, pathophysiology, epidemiology, clinical classification. 2. To illustrate the main imaging findings and how to assess this condition in a multimodality approach, focusing on radiographs, CT and MRI studies, including new concepts and advanced sequences.

#### TABLE OF CONTENTS/OUTLINE

1. Review the main aspects related to musculoskeletal findings of sickle cell disease, including etiology, pathophysiology, epidemiology, clinical classification. 2. Clinical and imaging findings in a multimodality approach, focusing on radiographs, CT and MRI studies. 3. Musculoskeletal findings of sickle cell disease, as microcirculation or anemia related, and major complications (including septic arthritis and osteomyelitis). 4. Bring the most updated concepts of the disease and the imaging role, including advanced MRI sequences, involving diagnosis and patient care.

#### **MKEE-101 Rewriting the story back: Spondyloarthritis**

#### Awards

#### Cum Laude

Sara Siguenza-Gonzalez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Bone marrow edema (BME) is the key requirement for a "MRI positive of sacroiliitis" in the Assessment of Spondyloarthritis international Society (ASAS).The radiologist should be careful when applying the ASAS classification criteria, because BME could also be found in early mechanical and degenerative changes, which are much more common than inflammatory disorders.Knowing the type of BME pattern, other radiological features (bone erosion, ankylosis or the spine disease), as well as the clinical picture, increase radiologists diagnostic confidence and reduce overdiagnosis of inflammatory sacroiliitis.

## TABLE OF CONTENTS/OUTLINE

Anatomy and biomechanics of the Sacroiliac Joints (SIJs) and Spine. Including anatomical variants and pitfalls. Some clues to difference between mechanical issues and inflammatory disorders. Subchondral BME in the SIJs is a common finding in both entities, so radiologists should be careful when interpreting. Recognise principal features of spondyloarthritis in the main radiological techniques (Rx, TC, MRI and also with new techniques). Describe and illustrate general features and typical image findings in the spondyloarthritis: Ankylosing Spondylitis (AS), Psoriatic Arthritis (PsA), Reactive Arthritis (RA), enteropathy-associated arthritis and undifferentiated spondylitis. Common pitfalls and differential diagnosis with other diseases that affect the axial bone: infection, amiloidosis , tumors, DISH and traumatism.

### **MKEE-102 Deep Learning Imaging Reconstruction Based Virtual Non-calcium Image Can Improve the Bone Metastasis Detection Compared with Conventional CT, Hybrid IR Based Virtual Non-calcium Image**

Hiroataka Nakashima, MSc, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Deep learning imaging reconstruction (DLIR)-based virtual non-calcium (VNCa) images were created by two-material decomposition processing based on dual-energy acquisition using a fast kV switching method.2. Compared the diagnostic performance of DLIR-based VNCa images with conventional CT in 57 patients with clinically confirmed bone metastasis.3. Compared the diagnostic performance of DLIR-based VNCa images with hybrid IR-based VNCa images.4. DLIR-based VNCa images were superior to the diagnostic performance of conventional CT and Hybrid IR-based VNCa images.

## TABLE OF CONTENTS/OUTLINE

Bone metastasis is a possible disease of all carcinomas and reduces the quality of life of patients. Since CT can detect bone calcification sensitively, it is excellent in diagnosing bone metastasis with bone destruction, but bone metastasis without bone destruction is difficult to diagnose and has a problem that it is easy to overlook.Virtual non-calcium image (VNCa) is one of the material decomposition images created by dual energy CT, which is also a density image obtained by emphasizing the water component and removing the calcium component. While previous studies have reported that VNCa images are superior in detecting bone metastases, DLIR-based VNCa images offer better discrimination of metastatic lesions due to their noise reduction effect. In this exhibition, we compared the diagnostic performance of DLIR-based VNCa images with that of conventional CT and hybrid IR-based VNCa images. The results show that DLIR-based VNCa images have a higher discrimination ability than conventional images for bone metastasis.

### **MKEE-103 Osteoid Osteoma in Small Bones of Hands and Feet: 'Not' So Common with 'Not' So Small Challenges in RF Ablation**

Malini A. Lawande, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Osteoid osteomas are benign painful lesions usually seen in the long bones. Less commonly they may be seen in the small bones of hands and feet especially in the pediatric age group.2. They have typical imaging features on MRI and CT which are diagnostic.3. RF ablation is the recommended treatment for osteoid osteomas and are regularly done. However, the small size of the bones results in challenges that can be dealt with by using some modifications.

## TABLE OF CONTENTS/OUTLINE

Osteoid osteomas are common benign tumor found commonly in children and young adults. They classically present with night pain that is relieved by non steroidal anti-inflammatory drugs. They are usually cortical lesions and most commonly occur in the long bones, with proximal femur being the most common location. Less commonly they may be seen in the spine and small bones of the hands and feet. CT is excellent at diagnosing the lesion and shows small lucent nidus and surrounding reactive bone sclerosis. MRI may be confusing due to the disproportionate marrow edema and the poor delineation of nidus if it is very tiny. CT guided radiofrequency ablation is the current accepted standard treatment for osteoid osteomas. However in small bones, this may be challenging due to the very small size as well as proximity of neurovascular structures. We will discuss the imaging appearances of osteoid osteomas in small bones of hands and feet as well as highlight the challenges faced during RF ablation is some of these cases and some of the ways these can be overcome.

### **MKEE-104 Zero Echo Time Magnetic Resonance Imaging: Physics and Clinical Utility in Musculoskeletal System**

Takatoshi Aoki, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To recognize the clinical utilities of zero echo-time (ZTE) sequences in various disorders of the musculoskeletal system.2. To understand the imaging physics of ZTE sequence, practical limitations, and image reconstruction.3. To discuss how to incorporate ZTE sequence into the clinical workflow.



## TABLE OF CONTENTS/OUTLINE

Physics of ZTE imaging 1 Pulse sequence design 2 Image reconstruction 3 Parameter optimization Clinical utility of ZTE in musculoskeletal system 1 Inflammatory arthritis 2 Soft tissue calcification/ossification 3 Bone and soft tissue tumors and tumor-like lesions 4 Osteoarthritis and spondylitis 5 Trauma 6 Morphometric evaluation before surgery 7 Children and fetuses Summary ZTE MRI can be readily incorporated into the clinical workflow, and CT-like images generated by ZTE MRI would minimize the need for CT contemporaneously with MRI in various musculoskeletal disorders. We systematically review the imaging physics of these sequences, practical limitations, and image reconstruction, and then discuss the clinical utilities in the musculoskeletal system while presenting several imaging examples.

### **MKEE-105 Hamstring Sport Injuries: What, How, Why and Where**

#### **Awards**

#### **Certificate of Merit**

Agustin M. Marrero SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To know the anatomy, function, and biodynamic aspects of the hamstrings complex. To recognize the spectrum of tearing of hamstring muscles and tendons during sports practice analyzing their mechanism of injury. To evaluate the imaging methods in the different hamstrings lesions to describe the precise location and characteristics. To describe ultrasound and magnetic resonance signs of these tears, emphasizing the prognostic criteria for recovery, return to play, and re-injury.

## TABLE OF CONTENTS/OUTLINE

Most of muscle tears occur in the lower extremities and commonly in the hamstrings. The hamstrings complex consists of the semimembranosus (SM), semitendinosus (ST) and biceps femoris (BF) muscles. They originate from the ischial tuberosity. BF muscle has two portions, the long and short head and its distal insertion is at fibular head. ST and SM are medial, and their distal insertion is in the medial aspect of the leg. BF and ST are close to the sciatic nerve. Except for BF's short head, the hamstrings are primarily hip extensors and knee flexors. Hamstring injuries are grouped and classified, with typical tear sites that recur in sports practices during forceful stretching or high-speed running. Proximal injuries result in a large amount of time away from sports and a high risk of re-injury. Sprint tears are generally located on BF. Depending on its extent and location, we can estimate the evolution of injuries and the return to play. Finally, we will include insertional injuries in children.

### **MKEE-106 Acute Traumatic Craniocervical Injuries: What to Look for and Not to Miss**

Maria Carvajo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To describe acute traumatic craniocervical injuries and its classification based on a revision of cervical CTs performed in the emergency setting at 3rd level hospital. - To show key imaging features to identify stable and unstable injuries. - To present most common errors and missed craniocervical injuries as well as tips to avoid them.

## TABLE OF CONTENTS/OUTLINE

1. Anatomy and biomechanics of craniocervical junction and ligaments. 2. Key measurements and anatomy landmarks to assess alignment of craniocervical junction. 3. Craniocervical injuries classification. 3.1. Atlanto-occipital dissociation. 3.1.1. Traynelis classification. 3.2. Occipital condyle fractures. 3.2.1. Anderson-Montesano classification. 3.2.2. Alar ligament injuries. 3.2.3. Stable and unstable injuries. 3.3. Atlas fractures. 3.3.1. Gehweiler classification. 3.3.2. Transverse ligament injuries. Dickson classification. 3.3.3. Stable and unstable injuries. 3.4. Axis fractures. 3.4.1. Odontoid fractures. Anderson and D'Alonzo classification. 3.4.2. Hangman fractures. Effendi/Francis modified by Levine classification. 3.4.3. Non-odontoid non-hangman fractures (axis body fractures). 3.4.4. Teardrop fractures. 3.4.5. Stable and unstable injuries. 3.5. Atlantoaxial subluxation. 3.5.1. Atlantoaxial rotatory fixation. Fielding and Hawkins classification. 3.5.2. Stable and unstable injuries. 4. Pitfalls of craniocervical injuries at CT imaging. 5. Conclusions.

### **MKEE-107 Ultrasound Guide to Have at Your Fingertips: Wrist and Hand Evaluation**

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To emphasize the potential of ultrasound in the assessment of musculoskeletal structures. 2. To become familiar with the normal sonographic appearance of the wrist, hand and fingers. 3. To propose a systematic approach to perform a complete ultrasound of the wrist, hand and fingers. 4. To show the correlation of the ultrasound findings with MR images and anatomical drawings for a better understanding.

## TABLE OF CONTENTS/OUTLINE

Ultrasound is an imaging technique very useful in the assessment of musculoskeletal structures. However, for its correct interpretation, it is essential for the explorer to be familiar with the ultrasound appearance of normal anatomical structures, which can be difficult at the beginning. This work is intended to be an aid for anyone who wants to get started in musculoskeletal ultrasound of the wrist, hand and fingers. First of all, we will check the basic requirements to perform a proper musculoskeletal ultrasound. Then, we will systematically review the normal ultrasound anatomy of the different musculoskeletal structures of the wrist, hand and fingers, dividing them according to their dorsal or ventral location. We will also propose some tips and tricks, and we will highlight the importance of dynamic maneuvers. In order to make our work more visual, we will correlate the different ultrasound images with anatomical drawings and MR images, which will allow a better understanding.

### MKEE-108 MR Imaging of Traumatic Injury of the Fingers

#### Awards

#### Certificate of Merit

Roque Oca, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the anatomy of the fingers, focusing on the extensor and flexor complexes, as well as the passive stabilizers of their joints. 2. To detail the MRI protocol used for the study of traumatic pathology of the fingers. 3. To illustrate by means of representative cases the most frequent pathology of the fingers after blunt trauma. 4. To teach instability patterns, which may be useful when understanding and describing the MRI findings in these patients.

## TABLE OF CONTENTS/OUTLINE

Traumatic injuries of the fingers are one of the frequent reasons for musculoskeletal MRI evaluation. It is important to know the specific anatomy of the tendon structures and ligaments, as well as the most frequent injury patterns. Extensor finger complex, including central and lateral slips, as well as sagittal bands; flexor tendon, pulleys and articular structures (main and accessory collateral ligaments, and volar plate) play a capital role in finger biomechanics. Closed finger trauma frequently causes instability patterns (in coronal, sagittal or combined planes) that should be recognized and that facilitate the understanding of the lesion mechanism and its diagnosis. Thus favoring an adequate treatment and a prompt recovery. Injuries secondary to closed trauma of the fingers will be reviewed, with a detailed description of their semiology and the injured structures and their complications.

### MKEE-109 Read It Like a Pro: Tips And Tricks To Interpret Lumbar Spine MRI

Ana Cristina Delgado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the normal spine anatomy of lumbar spine 2. review lumbar spine MRI protocol 3. Analyze step by step the systematic of lecture of spine lumbar MRI, learn how to make a good MRI report, describe findings with standardized nomenclature. 4. Identify, review the most common findings in lumbar benign-malignant pathology.

## TABLE OF CONTENTS/OUTLINE

Description of general characteristics in lumbar spine a) Anatomy review b) MRI protocol sequences c) Systematic lecture of lumbar spine MRI, how to elaborate a good report. Review of MRI cases, common findings in lumbar spine pathology Pathologies included: a) Degenerative changes of intervertebral disc. b) Degenerative changes of vertebral body. c) Degenerative changes of facet joint. d) Malignant pathology. e) Others: infection, cystic lesions, trauma.

### MKEE-11 Exploring Osteochondral Lesions of the Talus: Imaging Evaluation and Treatment Options

Lucas K. Miyahara, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: 1. Review the talar dome anatomy, and pathophysiology of osteochondral lesions 2. Illustrate and discuss the patterns of osteochondral injuries and main surgical options with didactic cases. 3. Highlight the main information that radiologists should include in the report when analyzing an osteochondral lesion of the talus and their postoperative imaging.

## TABLE OF CONTENTS/OUTLINE

Osteochondral lesions of the talus are lesions of the articular cartilage of the talus and underlying subchondral bone. Trauma accounts for the majority of osteochondral lesions, with an osteochondral lesion occurring with over half of ankle sprains, especially if there is a fracture. Introduction: General review of talar dome anatomy, and pathophysiology of osteochondral lesions. Preoperative evaluation: Main information that should be included in the radiological report. Clinical relevance of the

findings. Staging: Didactic illustration about the historical classic staging systems. Postoperative evaluation: Main surgical techniques considerations. Main information that should be included in the radiological report. Bibliographical references.

## **MKEE-110 Under Pressure: Exploring Normal Anatomy and Entrapment Neuropathy of the Ulnar Nerve**

Matthew G. Tracey, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Describe the normal course and imaging appearance of the ulnar nerve with emphasis on the cubital tunnel and Guyon's Canal. 2. Describe the anatomical boundaries of both the cubital tunnel and Guyon's Canal. 3. Discuss ulnar neuropathy symptoms. 4. List common etiologies of ulnar nerve compression. 5. Discuss the MR appearances of ulnar nerve impingement in the cubital tunnel and Guyon's Canal. 6. Identify the normal motion of the ulnar nerve within the cubital fossa under ultrasound as well as the abnormal motion of the nerve in the setting of symptomatic anterior dislocation and snapping triceps syndrome.

### **TABLE OF CONTENTS/OUTLINE**

We review the normal course of the ulnar nerve with attention to sites of potential compression, namely the cubital tunnel and Guyon's Canal. We review the anatomical boundaries of the cubital tunnel and Guyon's canal on MR imaging. We examine the structures innervated by the ulnar nerve and the clinical signs/symptoms of ulnar neuropathy corresponding to the site of impingement. We list common etiologies of entrapment neuropathies. We review the normal MR appearance of the ulnar nerve and utilize MR cases to illustrate the abnormal appearance of impingement in the setting of cubital tunnel and Guyon's canal syndrome. We present dynamic ultrasound examples demonstrating both the typical movement of the ulnar nerve in the cubital fossa, as well as abnormal motion in the setting of dislocation and snapping triceps syndrome. We discuss common surgical treatments of ulnar nerve dislocation and review the expected MR appearance of ulnar nerve anterior transposition.

## **MKEE-111 Fight of Phyte Calcification & Ossification Around Spine**

Kengo Ikejima, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Understand the mechanism of perivertebral sclerotic changes2. Learn the imaging findings of representative perivertebral sclerotic changes along with specific cases3. Learn about complications associated with perivertebral sclerotic changes4. Learn key points for differentiating perivertebral sclerotic changes

### **TABLE OF CONTENTS/OUTLINE**

Spine anatomy, particularly joint structures and ligamentsPathophysiology of OsteophytesPathophysiology of SyndesmophytesPathophysiology of common calcium deposition diseases that occur in the perivertebral regionCases:- Spondylosis- Ossification of the posterior longitudinal ligament- Ossification of the ligamentum flavum- Calcium pyrophosphate dihydrate deposition disease- Calcific tendinitis of the longus colli muscle- Ankylosing Spondylitis- Psoriatic arthritis- Diffuse idiopathic skeletal hyperostosis (DISH)- SAPHO syndrome- Osteitis condensans illii- Dystrophic calcification- Intervertebral disc calcification

## **MKEE-112 Looking Beneath the Surface: Imaging of Bone Surface Lesions**

### **Awards**

#### **Certificate of Merit**

Utkarsh Parwal, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Define intracortical, subperiosteal, periosteal, and parosteal/juxtacortical locations along the bone surface2. Understand that multiple cell types within the bone surface give rise to bone-forming, cartilage-forming, and fibrous surface lesions.3. Generate a differential diagnosis for surface lesions spanning benign, malignant, infectious, and traumatic etiologies.

### **TABLE OF CONTENTS/OUTLINE**

1. Bone surface anatomy and terminologya. Define intracortical, subperiosteal, periosteal, and parosteal/juxtacortical locationsb. Illustrate the two layers of the periosteum: inner cambrial and outer fibrousc. Briefly discuss important cell types within the bone surface as the originators of bone-forming, cartilage-forming, and fibrous surface lesions.2. Case based review of multiple surface lesionsa. Bone forming: Osteoid osteoma, Surface osteosarcomas (OS) - periosteal OS, parosteal OS, high grade surface OSb. Cartilage forming: Osteochondroma, Periosteal chondroma, Bizarre parosteal osteochondromatous proliferation, Periosteal chondrosarcomac. Fibrous: Nonossifying fibroma, Juxtacortical desmoid tumor, Osteofibrous dysplasiad. Infectious: Cortical osteomyelitis, Subperiosteal abscesse. Traumatic: Stress reaction, Periostitis ossificans

## **MKEE-113 Can you See Me Now? A Case Based Quiz Of Shoulder Instability Lesions**

Ana Cristina Delgado, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Describe and recognize the different key clinical/imaging features that help diagnose each glenohumeral instability entity. 2. Identify through a series of MRI/ Arthrography MRI image based cases the different glenohumeral anterior, posterior instability lesions. 3. Describe the role of different imaging modalities in the diagnosis of glenohumeral instability, evaluate the MRI/ Arthrography MRI imaging findings that can help radiologists discriminate differential diagnosis. 4. Review static dynamic glenohumeral stabilizers.

### **TABLE OF CONTENTS/OUTLINE**

-Pathologies will be presented in a case based format with pertinent MRI/ Arthrography MRI images and a brief clinical history. -Diagnostic clue section divided in clinical facts ( general features, miscellaneous information) radiological facts ( key imaging findings, best image modality for further evaluation). -Review the concepts and important tips for image diagnosis. - Review anatomy of static dynamic glenohumeral stabilizers. -Pathologies included: a) Anterior instability: Classic Bankart, HAGL ( Humeral avulsion of glenohumeral ligament), GLAD ( Gleno labral articular disruption), Perthes, ALPSA ( Anterior Labroligamentous sleeve avulsion), Hillsachs. b) Posterior Instability: Reverse Bankart, POLPSA: Posterior labro capsular periosteal sleeve avulsion), Kim , Bennet, Reverse Hillsachs. c) Variants Pitfalls: Sublabral Recess, Sublabral foramen, Buford Complex.

## **MKEE-114 Elasticity Matters: Role of Shear Wave Elastography in Rheumatology**

Alejandra Micolich Vergara, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

General principles of shear wave elastography in musculoskeletal radiology. Potential applications in the assessment of rheumatologic diseases. Future directions and limitations.

### **TABLE OF CONTENTS/OUTLINE**

Elasticity is a fundamental characteristic closely related to the pathological state of tissues. Elastasonography is a diagnostic technique that assesses the biomechanical properties such as stiffness and elasticity of tissues by exposing them to a specific ultrasound beam. Shear Wave Elastasonography (SWE) is a non-invasive and objective method that determines the absolute stiffness value of various tissues. SWE has been validated in liver disease, thyroid, breast, prostate, skin and ocular pathologies and is being considered a promising tool in rheumatologic disorders. Greyscale and Power Doppler ultrasound as well as Magnetic Resonance Imaging (MRI) have been extensively studied as diagnostic techniques in rheumatologic pathologies and in 2021 the European League Against Rheumatism (EULAR) recommends elastasonography in the reporting of ultrasound studies in musculoskeletal disease. There has been advancements in recognizing the role of SWE in entities such as Primary Sjögren's Syndrome and Gout Arthritis, however, future prospects include exploring its utility in the early diagnosis and therapeutic response monitoring in Rheumatoid Arthritis, Systemic Lupus Erythematosus and Thumb Osteoarthritis. We will review the potential applications of SWE in different rheumatologic disorders using a case based approach.

## **MKEE-115 Not Normal: An Illustrated Guide to Potentially Symptomatic Musculoskeletal Anatomic Variants**

Matthew R. Skalski, DC (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Review commonly discovered anatomic variants on routine musculoskeletal imaging that may be symptomatic or become symptomatic.
- Recognize what imaging features suggest a given variant may be at risk of being symptomatic or require treatment, and what additional imaging may be required for a more definitive diagnosis.
- Discuss treatment options available for the management of pain associated with anatomic variants, including: activity modification, physical therapy, image-guided injection, and surgery.

### **TABLE OF CONTENTS/OUTLINE**

- Spinal variants o Upper cervical § Dens retroversion § Posterior arch agenesis § Short arch o Rib anomalies cervical ribs o Segmentation anomalies § Congenital block § Occipitalization § Hemivertebra § Butterfly o Oppenheimer ossicle o Lumbosacral transitional vertebra o Sacroiliac variants o Coccyx angulation o Posterior elements § Bastrup pseudoarthrosis § Hypoplastic facets § Facet tropism o Piriformis sciatic nerve o Other • Hip o Developmental dysplasia o Cam/pincer o Coxa profunda protrusio o AIIS morphology o Coxa vara valga • Wrist hand o Ulnar variance o Type 2 lunate o Coalition o Os styloideum • Shoulder o Acromion shape slope o subcoracoid o Coracoclavicular joint o glenoid dysplasia hypoplasia o Luschka tubercle o Os acromiale • Elbow o Anconeus epitrochlearis o Gantzer's muscle o Synovial fold o Os supratrochlear dorsale o • Knee o Patellofemoral anomalies § Patella type § Trochlear groove § Patella alta/baja § Bi/multipartite patella o

Aberrant popliteal and anterior tibial artery o Discoid meniscus o Plica • Foot ankle o Os trigonum syndrome o Painful os peroneum o Accessory muscles o Type II os naviculare o Coalition o Os intermetatarsium o Sesamoid anomalies

## **MKEE-116 Calcifications as Harbingers of Malignancy in Soft Tissue Tumors: A Case-Based Review**

### **Awards**

#### **Cum Laude**

Atefe Pooyan, MD, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Gain familiarity with the morphology of calcifications in soft tissues 2. Demonstrate that approaching soft tissue calcifications based on morphologic appearance, distribution, and tumor cell-type can yield clues when triaging lesions 3. Present scenarios in which soft tissue calcifications are helpful in assessing the malignancy or benignity of a lesion

#### **TABLE OF CONTENTS/OUTLINE**

Key Anatomic or Pathophysiologic Issues, Imaging Findings or Imaging Technique This case-based exhibit will review the morphology of soft tissue calcifications (e.g. stippled, chondroid, coarse, osseous, amorphous), with imaging correlation using multiple modalities (i.e. radiographs, CT, and MR), as demonstrated by various cases of benign and malignant pathophysiologic processes of calcification. Conclusion 1. Approaching soft tissue calcifications according to their descriptive morphology and location can yield clues into interpreting a lesion's malignant potential. 2. Calcifications are disproportionately represented by the most common high-grade soft tissue neoplasms, including synovial sarcoma, liposarcoma, and undifferentiated pleomorphic sarcoma, which comprise more than half of all soft tissue malignancies. 3. Malignant tumors can have a characteristic morphology of calcifications, such as stippled calcifications in synovial sarcoma and central osseous calcifications in extra-skeletal

## **MKEE-117 Posterior Ankle Pain: Pathologies Surrounding the Kager Fat Pad**

Leandro A. Mazza, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe the anatomy of the Kager fat pad (KFP) and its relationships with the rest of the structures of the posterior region of the ankle. To analyze the different pathologies responsible for posterior ankle pain and the degree of involvement of the KFP in each of them. To discuss the role of KFP in the symptomatology of these entities

#### **TABLE OF CONTENTS/OUTLINE**

KFP is a mass of adipose tissue that occupies the Kager triangle, located between the Achilles tendon, the flexor hallucis longus and the calcaneus. Although its content is predominantly fatty, it also contains nerves and small vessels. It presents multiple connections with the different anatomical structures that surround. Three regions that are closely related to the sides of this triangle have been described. The most firmly linked to the Achilles tendon being an important part of its entheses. The more mobile, wedge-shaped and closely related to the calcaneus moves passively and actively towards the retrocalcaneal bursa during plantarflexion. These relationships make the KFP a necessary participant, to a greater or lesser extent, in a large part of the different entities that present with posterior ankle pain. We will describe tendinopathies, os trigonum syndrome and other causes, with particular interest in the degree of involvement of the KFP.

## **MKEE-118 Don't Touch Lesions: How Can We Avoid the Misdiagnosis**

Janaina M. Moreira (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Don't touch lesions are incidental findings, that are divided into three categories: Post traumatic, normal variants, and lesions that are real but obviously benign. Radiography is the first method used for the identification, characterization, and classification of these type of lesions. However, some cases can be so challenging that computed tomography or magnetic resonance imaging are used to evaluate the lesion, therefore increasing the accuracy of the diagnosis. The purpose of this presentation is to review the imaging characteristics of typical skeletal "don't touch" lesions in the many imaging methods such as X-Ray, computed tomography (CT) and magnetic resonance imaging (MRI) therefore avoiding misdiagnosis and invasive procedures, which reduces the morbidity and costs in the health care system.

#### **TABLE OF CONTENTS/OUTLINE**

Case based didactic review of the radiological appearance of the "don't touch" lesions including clinical and epidemiological aspects of bone infarction, osteopoikilosis, intraosseous migration of tendinous calcification, myositis ossificans, aggressive vertebral hemangioma, among others, based on our service's digital archive.

## **MKEE-119 High-Resolution Ultrasound of the Nerves of the Foot and Ankle: A Landmark Approach to Scanning and Review of Common Pathologies**

**Cum Laude**

Lisa M. Billone, BSc (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

The purpose of this exhibit is to: 1. Review the anatomy of the nerves at the level of the foot and ankle, using a landmark approach with cadaveric correlation. 2. Highlight clinical signs and symptoms warranting a detailed ultrasound nerve assessment, relating them to specific nerves. 3. Review common sites and causes of nerve injury and entrapment at the foot and ankle and demonstrate associated abnormal direct and indirect sonographic findings using diagrams, images and video clips from case-examples.

**TABLE OF CONTENTS/OUTLINE**

1. OBJECTIVES 2. INTRODUCTION 3. ANATOMY, ULTRASOUND TECHNIQUE, PATHOLOGY WITH CASE EXAMPLES FOR THE: a) Tibial nerve and medial and lateral plantar branches b) Plantar digital nerves c) Sural nerve d) Saphenous nerve e) Deep peroneal nerve f) Superficial peroneal nerve 4. TAKE HOME POINTS

**MKEE-12 PET-MR Imaging Applications in Pediatric Musculoskeletal Tumors**

Jose Martel, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

? PET-RM imaging is emerging as a suitable technique for the assessment of pediatric malignancies, with specific applications in musculoskeletal tumors. ? Its utility includes primary tumor characterization, local / distant staging and post-treatment follow-up. ? Dose reduction of ionizing radiation and overall scanning time decrease are remarkable advantages. ? However, it has low sensibility for detection of pulmonary nodules. Chest CT remains essential in thoracic staging of pediatric musculoskeletal malignancies.

**TABLE OF CONTENTS/OUTLINE**

? Introduction: Integrated MRI and PET provide efficient staging of children and adolescents with malignant bone tumors by evaluating the primary tumor and the whole body in one session. ? Our protocol included a whole-body and a local tumor scan. ? Applications in pediatric musculoskeletal tumors: PET-MRI is useful in the study of osteosarcoma, Ewing sarcoma, bone lymphoma, Langerhans cell histiocytosis and bone and bone marrow metastases. We report our experience in the last ten years. ? Conclusions: the combination of functional PET imaging with the lack of non-ionizing radiation of MRI is ideal in a pediatric population.

**MKEE-120 Do Not Harm: Thermal Protection in Musculoskeletal Abdominal Wall Soft Tissue Tumors Cryoablation**

Albert Castillo Pinar, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

Teaching points: To review the main characteristics of thermoablation in musculoskeletal soft tissue tumors. To illustrate different techniques and indications of thermoprotection procedures. To show possible complications if the thermoprotection techniques are not performed correctly. Thermoablation of musculoskeletal tumors is a growing technique with good results; however, it can be limited by the location of the tumors. There are close anatomical relationships related to the tumor such as different intra-abdominal structures or the skin itself which can contraindicate the technique, make it difficult or lead to complications if the correct thermo-protection techniques are not applied. Radiologists must be familiar with the thermoprotective techniques in order to be able to choose the most appropriate in each case.

**TABLE OF CONTENTS/OUTLINE**

Table of contents/Outline Introduction. Classification and description of thermoprotective technique. Case series illustrating clinical situations and the application of thermoprotection techniques. Conclusion.

**MKEE-121 Non-infectious Spinal Diseases Mimicking Infection****Awards****Certificate of Merit**

Jungmin Lim, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

Infectious spinal disease may be suspected if inflammatory markers are increased in blood tests in patients with acute spinal pain and limited range of motion. These clinical findings can also be seen in spinal crystal deposition disease and intraspinal rupture of synovial cysts located in facet joints. In cases of acute inflammation in these two diseases, there is a risk of



unnecessary biopsies and antibiotic treatments because the clinical and imaging findings overlap with those of infectious spinal diseases. Recognizing the radiographic characteristics of these diseases and raising awareness of these findings will be helpful in accurate diagnosis and treatment. We present various cases of spinal crystal deposition disease (crowned dens syndrome, calcific tendinitis of longus colli, calcific tendinitis of levator scapulae, facet joint crystal arthropathy, and interspinous bursitis with crystal deposition) and intraspinal rupture of facet joint synovial cyst, and present their clinical and imaging findings. This aims to raise awareness of these diseases and facilitate accurate diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction  
Case 1: Calcified tendinitis of longus colli  
Case 2: Calcific tendinitis of levator scapulae  
Case 3: Crowned Dens syndrome  
Case 4: Crystal arthropathy of facet joint  
Case 5: Facet joint infection

### **MKEE-122 The Bubble Trouble: Differential Diagnosis of Cystic Bone Tumors and the Importance of Not Missing the Mark**

Leticia dos Reis Morimoto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. To review the main differential diagnosis of cystic bone lesions. 2. To expose the general evaluation of cystic bone tumors - what is necessary to report: review of the characteristics by image that must be reported and propose a structured report for bone tumors in a multimodality approach (CR, US, CT and MRI). 3. To review the main combined injuries and when to think about them. 4. To demonstrate through didactic illustrative cases the main complications that can be found due to cystic bone lesions. 5. To demonstrate currently available treatment modalities for those conditions.

#### **TABLE OF CONTENTS/OUTLINE**

1 - Radiological propaedeutics of cystic bone tumors. 2 - Radiograph, ultrasound (US) computed tomography (CT), and MRI findings in: 2.1 - Unicameral bone cyst 2.2 - Multicameral bone cyst 2.3 - Aneurysmal bone cyst 2.4 - Cystic fibrous dysplasia 2.5 - Vascular malformation (cystic angiomas) 2.6 - Telangiectasic osteosarcoma 2.7 - Other miscellaneous cystic tumors 3 - General evaluation of cystic bone tumors - what is necessary to report? - review of the main image characteristics. 4 - When to be suspicious of concomitant lesions and their primary associations. 5 - Propose a structured report for cystic bone tumors in a multimodality approach (CR, US, CT, and MRI). 6 - Complications related to cystic bone tumors. 7 - Therapies currently used in cystic bone tumors. 8 - Last updates and trendings of cystic bone tumors 9 - Summary and take-home message

### **MKEE-123 Knee-ding a Closer Look: MRI Evaluation of Cartilage Surgical Repair**

Leticia dos Reis Morimoto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. Revisit the anatomy and biomechanics of knee joint and focusing in cartilage 2. To demonstrate the MRI image findings in chondral lesions of the knee, with the main classifications 3. To illustrate the main operative techniques involved in knee cartilage surgery with radiology and surgery images correlation 4. Demonstrate through didactic illustrative cases the normal and pathological postoperative image findings, focusing on MRI

#### **TABLE OF CONTENTS/OUTLINE**

1 - Anatomy and biomechanics of knee joint and cartilage 2 - MRI findings in chondral lesions of the knee 3 - Modified Outerbridge classification (MRI and arthroscopy imaging) 4 - Noyes Classification (MRI and arthroscopy imaging) 5 - International Cartilage Repair Society (ICRS) classification (MRI and arthroscopy imaging) 6 - Surgery and radiologic images of: 6.1 - Marrow-Stimulating Procedures (microfracture) (surgery and radiologic images) 6.2 - Osteochondral Autograft Transplantation 6.3 - Osteochondral Allograft Transplantation 6.4 - Autologous Chondrocyte Implantation 7 - Normal postoperative findings after surgical repair of the knee cartilage 8 - Pathological postoperative findings after surgical repair of the knee cartilage

### **MKEE-124 Dual Energy CT in Spinal Disease: Application Review**

Li Neng (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Dual-energy CT (DECT) separately acquires high and low energy X-ray data to enable material characterization applications for substances that exhibit different energy-dependent x-ray absorption behavior. Based on conventional CT imaging, DECT significantly improves the detection ability of spinal lesions and adds more quantitative indicators. Virtual non-calcium (VNCa), virtual monochromatic imaging (VMI), and other parameters have unique advantages over traditional CT imaging in displaying bone marrow edema and tumor, detecting spinal urate crystal deposition, reducing spinal related metal artifacts, and intervertebral disc degeneration, showing a good clinical application prospect.

## TABLE OF CONTENTS/OUTLINE

Vertebral fracture, Bone Marrow Lesions and Mimics, Herniation of intervertebral disc, Gout, Artifact Suppression

### **MKEE-125 Myopathies: Radiologist's Essential Tips for Clinical, Pathological, and Imaging Findings**

Yumi Tai (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) To review inherited and acquired myopathies including clinical, pathological, and diagnostic imaging findings. 2) To discuss clinico-radiological key findings in the differential diagnosis of myopathies for radiologists.

## TABLE OF CONTENTS/OUTLINE

1) Imaging techniques and general imaging findings of muscle 2) Illustrated findings of the following myopathies: 1. Hereditary myopathies : Congenital myopathies (Nemaline myopathies, Central core disease, Congenital fiber type disproportion myopathy), Muscular dystrophies (Duchenne, Becker, Limb-girdle, Myotonic, Facioscapulohumeral, Emery-Dreifuss, Oculopharyngeal), Distal myopathies (GNE myopathy, Oculopharyngodistal myopathy), Metabolic myopathies (Mitochondrial disease, Lipid storage myopathies). 2 Acquired myopathies : Inflammatory myopathies (Dermatomyositis, Antisynthetase syndrome, Immune-mediated necrotizing myopathy, Inclusion body myositis, Eosinophilic myositis, Drug-induced (Immune checkpoint inhibitor (ICI)-related myositis), Associated with GVHD), Associated with systemic disease (Overlap myositis, Muscle Sarcoidosis) 3) Clinico-radiological key findings in the differential diagnosis

### **MKEE-126 Winging It: The Radiologist's Guide to the Scapula**

Wilfred R. Manzano, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

[1] Understanding the anatomy and bony landmarks of the scapula is important for identifying a range of pathologies, including fractures, tumors, and degenerative changes. [2] The scapula has a number of anatomic variants, particularly in the pediatric population, that may mimic trauma or other pathologies. [3] While radiographs can provide an initial assessment of the scapula, CT and MRI are useful imaging modalities to evaluate complex or subtle bony and adjacent soft tissue pathologies.

## TABLE OF CONTENTS/OUTLINE

[1] Overview [2] Normal anatomy: important radiological landmarks [3] Imaging technique: dedicated scapula radiographs and the importance of CT/MRI [4] Case-based review by pathology [5] Congenital/developmental variants: acromial ossification centers; os acromiale; Sprengel deformity; glenoid dysplasia [6] Traumatic processes: different fracture patterns (including of the scapular body, neck, glenoid, acromion, and coracoid process) and stress fractures [7] Degenerative/inflammatory processes: osteoarthritis; rheumatic conditions; elastofibroma dorsi; scapulothoracic bursitis [8] Infection and inflammation: osteomyelitis; septic arthritis [9] Neoplasm: benign and malignant [10] Hardware and related complications: curettage and graft; shoulder arthroplasty notching [11] Miscellaneous conditions: Looser's zones in osteomalacia [12] Conclusion

### **MKEE-127 Worth the Weight: Weight-bearing Cone-beam CT in Foot and Ankle Pathology**

Maryam Soltanolkotabi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Weight-bearing computed tomography (WBCT) has advantages over conventional CT and radiography, namely the ability to identify alignment issues and evaluate joint line congruencies. 2. WBCT can be used for the assessment of fracture healing, pre-operative planning, and evaluation of treatment efficacy. 3. WBCT offers technical and logistic advantages over conventional CT including decreased radiation dose, less technical training for use, and decreased space and energy demands. 4. WBCT enables reliable 3D measurements in a functionally relevant position (weight-bearing).

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Objectives/goals 3. What is weight-bearing CT and how does it work? 4. What are the advantages and disadvantages of WBCT? 5. What is the impact of WBCT on radiation dose, cost, and workflow? 6. What are the indications of WBCT? a. Fracture detection b. Alignment evaluation c. Pre-operative planning d. Evaluation of fracture healing e. Post-operative evaluation 7. How to measure in 3D? 8. What further developments are to be expected? 9. Summary/conclusion

### **MKEE-128 Percutaneous Bone Consolidation in Cancer Patients: Who and How**

Roberto Luigi Cazzato (*Presenter*) Proctor, Medtronic plc



## TEACHING POINTS

- To promote the indications of percutaneous bone and spine consolidation in multi disciplinary tumor boards- To present the interventional techniques applied to consolidate impending, pathological, and secondary bone insufficiency fractures in cancer patients- To propose an algorithm useful to select the best consolidative method based on the biomechanics of the affected bone

## TABLE OF CONTENTS/OUTLINE

- Indications- Techniques available based on biomechanics- Definition of the target fracture- Algorithm for bone consolidation

## MKEE-129 Spectrum of Common and Uncommon Multiple Bone Tumors: Imaging Findings with Pathologic Correlations

Yuan-Chang Chen (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Multifocality is common in metastasis, myeloma, histiocytosis, and vascular tumors, including the location of spine; occasional in fibrous dysplasia, osteofibrous dysplasia, adamantinoma, enchondroma, and osteochondroma; extremely rare in osteosarcoma and giant cell tumor. 2. Multiple bone tumors carry an increased risk of malignant transformation, especially in the enchondroma, osteochondroma, and giant cell tumor. 3. Non-ossifying fibroma are typically cortically based; osteofibrous dysplasia and osteofibrous dysplasia-like adamantinoma can be pure cortical lesions, or with medullary cavity involvement; the majority of the adamantinoma involve the cortex and complete medullary cavity; fibrous dysplasia and metastasis primarily involve the medullary cavity and occasional the cortex. 4. A stippled or ring-like pattern indicates cartilage calcification, cloud-like appearance indicates osteoid mineralization, and a ground-glass density indicates fiber matrix. 5. Age needs to be considered in solid tumors with non-specific imaging features. Metastasis, myeloma, lymphoma, and Erdheim-Chester disease are common in adults; whereas, multiple chondrogenic tumours, fibrous dysplasia, langerhans cell histiocytosis, and osteosarcoma are more frequent in young individuals.

## TABLE OF CONTENTS/OUTLINE

1. Enchondroma 2. Osteochondroma 3. Osteoma 4. Osteosarcoma 5. Haemangioma 6. Epithelioid haemangioendothelioma 7. Giant cell tumour 8. Non-ossifying fibroma 9. Simple bone cyst 10. Osteofibrous dysplasia 11. Adamantinoma 12. Fibrous dysplasia 13. Metastasis 14. Myeloma 15. Lymphoma 16. Langerhans cell histiocytosis 17. Erdheim-Chester disease 18. Rosai-Dorfman disease

## MKEE-13 Thermal Protection Techniques During Musculoskeletal Ablation

### Awards

#### Certificate of Merit

Arash Azhideh, MD, MPH (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Percutaneous thermal ablation of benign and malignant musculoskeletal tumors has expanded in scope and popularity in recent years. Although safe and efficacious, thermal ablation requires a thorough knowledge of the range of thermal protection techniques in order to limit the risk of thermal injury to adjacent nerves and other sensitive structures. In this educational exhibit, we briefly review the most commonly used musculoskeletal thermal ablation techniques, describe the spectrum of thermal protection techniques utilized during musculoskeletal thermal ablation, and discuss the mitigation techniques employed prophylactically or once nerve injury has occurred.

## TABLE OF CONTENTS/OUTLINE

1. Overview of Musculoskeletal Thermal Ablation Techniques a. Radiofrequency Ablation b. Cryoablation c. Microwave Ablation d. Other 2. Thermal Protection Techniques a. Active Thermoprotection Techniques i. Hydrodissection ii. Gas Dissection iii. Dissection with Other Agents iv. Physical displacement methods 1. Balloon interposition 2. Blunt needle displacement b. Passive Thermoprotection Techniques i. Biofeedback ii. Neurophysiologic intraoperative monitoring 1. Somatosensory evoked potentials 2. Motor evoked potentials 3. Electromyography iii. Temperature monitoring 3. Mitigation strategies to reduce thermal nerve injury

## MKEE-14 Post-treatment Changes in Bone and Soft Tissue Tumors: A Primer for Radiologists

Daniel S. Lobo, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To review the normal and pathologic findings following different therapeutic modalities in bone and soft tissue tumors: systemic treatment (chemotherapy, immunotherapy), radiotherapy and surgery.
- To illustrate complications and signs of tumor response to treatment, persistent or recurrent disease, as well as non-neoplastic complications.

## TABLE OF CONTENTS/OUTLINE

• Brief introduction: relevance and challenges associated with post-treatment musculoskeletal tumors cases in the daily practice of the radiologist. • Post-systemic treatment (chemotherapy and immunotherapy): Signs of treatment response; Signs of tumor progression; Systemic effect on the musculoskeletal system. • Post-radiotherapy changes: Signs of treatment response; Local progression; Actinic changes; Others (infection, radioinduced tumors). • Post-operative changes: Normal post-operative findings; Non-neoplastic complication; Signs of recidivant lesion. • Conclusion and key takeaways.

### **MKEE-15 Temporomandibular Joint: A Jaw-Some Multimodality Guide of TMJ Disorders**

Jerky N. Ebai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review anatomy of the Temporomandibular joint (TMJ) and its biomechanics. 2. Review clinical presentation of temporomandibular joint disorder (TMJD) 3. Discuss different causes of TMJD. 4. Multimodality overview of TMJD with emphasis on pertinent MRI findings. 5. Overview of management of TMJD.

## TABLE OF CONTENTS/OUTLINE

Background- Temporomandibular anatomy- Clinical presentation of TMJD Causes of TMJD- Biomechanical/Traumatic- Internal derangement (Disk Displacement with reduction and Disk displacement without reduction)- Fractures- Dislocation.- Inflammatory Arthritis (Rheumatoid Arthritis, Psoriatic Arthritis Juvenile and Inflammatory Arthritis)- Degenerative Arthritis- Crystal Arthropathy- Neoplastic/Variant (Synovial chondromatosis, Tenosynovial giant cell tumor, TMJ aplasia/hypoplasia and TMJ hyperplasia) Pertinent MRI Findings- Direct Signs (Abnormal disk morphology Abnormal disk displacement in closed-mouth position Abnormal disk movement in open-mouth position Osteoarthritic changes)- Indirect Signs (Joint Effusion and Rupture of retrodiscal layers) Management (Physical Therapy, Joint Injection, TMJ Arthroplasty, Disc Plication, Discectomy and Recontouring of the articular eminence)

### **MKEE-16 Augmented Bone Remodeling: An Emerging Concept in Bone Marrow MRI**

Bruno C. Vande Berg, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Normal bone remodeling, the lifelong process of bone removal and reconstruction, can not be seen at CT and MRI. 2. Bone remodeling can accelerate as a physiological response to many non destructive insults to bone such as a change in biomechanical load, or adjacent bone and soft tissue lesions. 3. Accelerated bone remodeling can be seen at MRI as a marrow area with a moderate increase in signal intensity on fat-saturated fluid-sensitive images with limited or no signal changes on fat-sensitive images. 4. Signal changes patterns in accelerated bone remodeling can be linear subcortical, patchy or diffuse. 5. Knowledge of these marrow patterns at MRI is important to increase our understanding of bone pathophysiology and avoid confusion with more destructive bone lesions.

## TABLE OF CONTENTS/OUTLINE

A/ Bone remodeling in normal and abnormal situations B/ The « regional acceleratory phenomenon » concept developed by H. Frost C/ MRI of accelerated bone remodeling Signal patterns Signal distribution D/ Correlations with pathological, radionuclide and radiological findings E/ Limitations and perspectives

### **MKEE-17 Uncovering Common Lesions in the Sternoclavicular Joint and Costal Cartilages: A Diagnostic Guide**

#### **Awards**

#### **Certificate of Merit**

Giancarlo Domingues, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this study is: • To provide a comprehensive review of the normal anatomy and imaging appearance of the sternoclavicular joint and costal cartilages. • To improve understanding and diagnostic accuracy of the pathologies by didactically categorizing them into five distinct groups: degenerative, inflammatory, metabolic, traumatic, and infection.

## TABLE OF CONTENTS/OUTLINE

The sternoclavicular joint is a critical structure that connects the axial skeleton and upper extremities and enables the movement of the upper limbs. This synovial joint can undergo degenerative alterations, with osteoarthritis being the most prevalent pathology. Additionally, degenerative calcifications in the costal cartilages are frequently observed. Inflammatory conditions, such as costochondritis, SAPHO syndrome, rheumatoid arthritis and spondyloarthritis also affect these structures. Differentiating between metabolic and inflammatory disorders often requires a detailed clinical history. Infections usually occur in immunosuppressed patients and spread hematogenously. Traumatic injuries are often misdiagnosed, leading to

persistent chronic pain. Although rare, posterior sternoclavicular dislocation is potentially dangerous as it can compress vital structures.

## **MKEE-18 Opportunistic Imaging in Musculoskeletal Radiology**

Vivek Kalia, MD, MPH (*Presenter*) Research Consultant, Hyalex Orthopaedics, Inc

### **TEACHING POINTS**

1. Opportunistic imaging is leveraging existing imaging data, commonly in the form of DICOM-format CT images, to extract potentially useful clinical information unrelated to the examination's original indication. 2. Opportunistic imaging, currently employed for a fairly narrow list of indications such as osteoporosis screening, is poised to enable large-scale population-based screening in the very near future. 3. At-scale deployment of opportunistic imaging creates opportunities and challenges in MSK radiology.

### **TABLE OF CONTENTS/OUTLINE**

1. Definition and technical requirements a. Artificial intelligence (AI)/machine learning (ML) algorithms 2. Areas of Current Use a. Osteoporosis screening to predict fractures i. Bone mineral density (BMD) assessment ii. Finite element analysis for bone strength assessment b. Body composition analysis to predict cardiometabolic risk and mortality i. Muscle mass (sarcopenia) and quality (fatty infiltration) ii. Visceral adiposity iii. Hepatic steatosis iv. Atherosclerotic calcifications 3. Opportunities / Areas of Potential Use in the Future a. Individual risk stratification and customization of therapy b. Large-scale population screening c. Integration into electronic health records 4. Ongoing Challenges Considerations a. Potentially important and/or confounding information will be revealed by opportunistic imaging b. Potential for overdiagnosis and patient anxiety c. Potential for increased costs of care to healthcare system and/or individual patient

## **MKEE-19 Scapulothoracic Disorders: Anatomy, Kinematics and Imaging Approach**

Marilia Da Cruz Fagundes, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The scapulothoracic is a functional joint and an important part of the shoulder kinematic chain, supporting the center of the humeral head correctly aligned with the glenoid fossa during arm elevation and increasing the range of motion and strength of the rotator cuff muscles. Scapulothoracic disorders usually result in abnormal contact between scapula and chest wall. Pathophysiology includes structural abnormalities (such as scapula anatomic variants and bone and soft tissue expansive lesions), scapular dyskinesia (caused by denervation injuries or imbalance in muscle strength) and microtrauma (associated with overuse). Rarely, the joint may experience acute trauma leading to scapulothoracic dissociation. Primary pathologies are more frequent in young athletes, especially in throwing sports. Due to its functional nature, the identification of disorders related to scapulothoracic joint can be a diagnostic challenge for radiologists. Radiography and Computed Tomography allows the assessment of bone anatomy and anomalies, while Magnetic Resonance Imaging provides information on soft tissue causes and consequences of these disorders. Finally, imaging plays an important role in guiding treatment, whether clinical, including physiotherapy and other conservative measures, or surgical if necessary.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction; 2. Anatomy and Kinematics; 3. Pathophysiology: a. Morphological causes; b. Functional causes; 4. Imaging Assessment; 5. Management.

## **MKEE-2 Beyond the Surface: The Power of Ultrasound in Diagnosing Epidermal Inclusion Cysts**

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To know the typical sonographic features of the epidermal inclusion cyst. - To describe the different complications of epidermal inclusion cysts and their characteristic sonographic findings. - To review other cysts and tumors that, given their location, are part of the differential diagnosis of the epidermal inclusion cyst, as well as the sonographic features that allow us to suspect them.

### **TABLE OF CONTENTS/OUTLINE**

Epidermal inclusion cysts are very frequent lesions, and their ultrasound evaluation is a daily request. As radiologists, we must be able to recognize their representative characteristics, as well as other atypical findings that should make us think of other lesions of the same location. Our work is organized as follows: 1. The epidermal inclusion cyst: brief review of its definition, etiopathogenesis, clinical presentation and histopathology. 2. Ultrasonographic features of the epidermal inclusion cyst: everything we should take into account. - Location/relation to the dermis. - Morphology. - Echostructure. - Relation with adjacent tissues. - Vascularization. - Elastography. 3. Ultrasonographic features of the different complications of the epidermal inclusion cyst, including: - Rupture. - Inflammation and infection. - Degeneration in giant cysts. 4. Differential diagnosis of the epidermal inclusion cyst: when to suspect other lesions? - Cystic lesions of adnexal origin. - True dermal and hair follicle sweat gland derived tumors. - Differential diagnosis of complicated inclusion cysts.

## **MKEE-20 The Weight of the Neck: Understanding Subaxial Cervical Spine Injuries**

Francis X. Cedeno Rodriguez (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Subaxial cervical spine injuries occur in the lower part of the neck (C3-C7) due to trauma and can range from mild to life-threatening. 2. Compression fractures are the most common, these fractures consist of a collapse of the vertebral body height due to trauma. Burst fractures involve posterior vertebral body wall fracture and can compromise the spinal canal. 3. Flexion and extension teardrop fractures present with typical corner fractures at typical locations. 4. Translation injuries are seen in high energy trauma mechanisms with severe flexion distraction and often associated with severe neurological sequelae. 5. Unilateral and bilateral facet dislocation result from rotational and/or flexion distraction injuries.

### **TABLE OF CONTENTS/OUTLINE**

I. Introduction  
A. Overview of Subaxial Cervical Spine Injuries  
B. Review of AO Spine Subaxial Cervical Spine Classification  
II. Radiologic Review of Types of Fractures  
A. Compression Fracture (CF)  
B. Burst Fracture (BF)  
C. Flexion Teardrop Fracture versus Linear Nondisplaced Anterior Inferior Corner Fracture  
D. Extension Teardrop Fracture (ETF)  
III. Rotation and Translation Injuries  
A. Facet Subluxation  
B. Facet Dislocation  
C. Vertebral Translation  
IV. Complications of Cervical Spine Injury  
A. Vascular Injury  
B. Spinal Cord and/or Exiting Nerve Injury  
C. Hematomas (Epidural / Prevertebral)  
D. Ligament Injury  
E. Disc Injury  
V. Conclusion  
VI. Self Assessment

## **MKEE-21 Flying High and Falling Hard: A Radiological Review of Ultimate Frisbee Injury Patterns**

Shaun H. Johnson, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Understand the game of ultimate frisbee  
Learn how injuries commonly occur in this sport  
Understand commonly reported injuries from previous literature  
Review imaging findings in these patients

### **TABLE OF CONTENTS/OUTLINE**

Introduction to ultimate frisbee  
Defining terminology and gameplay  
Discussion of rules  
Common maneuvers  
Prior reports of common injuries, epidemiology  
Literature review of common ultimate frisbee related injuries  
Fajardo Pulido et al 2020  
Demonstrated a high lifetime prevalence of injury with injury to the knee, thigh, ankle, and shoulder being most common  
Akinbola et al 2015  
Ultimate frisbee accounts for a high percentage of collegiate athlete injuries with similar trends to other sports  
Imaging review of patients with ultimate frisbee related injuries  
Discussion of diagnosis, mechanism injury, correlation with activity, and management strategies, from most common to least common  
Knee Ligament, meniscal, tendon pathologies  
Overuse injuries  
Foot/Ankle  
Ankle sprains  
Overuse injuries  
Shoulder  
Glenohumeral dislocation  
Acromioclavicular joint injuries  
Clavicular fractures  
Head  
Concussion  
Wrist  
Injuries related to fall on outstretched hand  
Chest  
Contusions  
Thigh  
Muscle strains  
Elbow  
Conclusion  
Discuss similarities and differences with various sports and known injury patterns such as soccer (football), American football, rugby.

## **MKEE-22 Did You Know that Your Slot-Scan Radiograph for Scoliosis can Artefactually Cause a Worsening Spinal Curvature? Plus Other Stories of Artifacts Associated with Digital Slot-Scanning Radiography**

Sean Schoeman (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Biplanar digital slot-scanning technology is a stereoradiography imaging (SRI) system that reduces radiation exposure for patients requiring serial imaging for chronic and progressive skeletal conditions (1). This has become preferred to standard x-ray additionally because of the ability to image full length spine and lower limbs for follow-up of children with scoliosis and leg-length discrepancy - images are interpreted by pediatric radiologists and orthopedic surgeons. Here we use our experience reviewing multiple images of patients at different time points to demonstrate distinct types of imaging artifact with this imaging modality. Reviewing physicians should be aware of such artifacts so as not to confuse artifacts with pathology which may lead to misdiagnosis or unnecessary management. The purpose of this educational abstract is to demonstrate common artifacts found at our institution. 1. Melhem E, Assi A, El Rachkidi R, Ghanem I. EOS(®) biplanar X-ray imaging: concept, developments, benefits, and limitations. *J Child Orthop.* 2016 Feb 16;10(1):1-14.

## TABLE OF CONTENTS/OUTLINE

1. Image acquisition technique for slot-scanning and resultant artifacts 2. Incorrect image centering artifact - causing change in Cobb angle and mimicking worsening scoliosis 3. Movement artifacts a. Wavy cardiac margin b. Wavy bones c. Wavy hardware 4. Edge enhancement artifacts a. Halo around hardware b. Pseudo-pneumomediastinum c. Lucency above diaphragm

### **MKEE-23 Improving Bone Tissue Characterization on MRI Using Gradient-echo: The Role of Simulated CT (sCT) Sequences**

Felipe P. Correa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

.Conventional MRI has limited ability to assess trabecular and cortical bone due to low proton density and markedly reduced T2 decay time..The FRACTURE sequence (Fast field echo Resembling A CT Using Restricted Echo-spacing) aims to improve the visualization of trabecular and cortical bone on MRI by simulating CT tissue contrast..In FRACTURE multiple echoes are acquired at a precise echo-spacing that corresponds to in-phase TEs. Following acquisition, the first post-processing step consists of a magnitude summation of all echoes. After summation, the images from the last echo are subtracted from the summated images to invert the grayscale and give bone a CT-like contrast..Simulated CT contrast sequences have great potential to assist in the diagnosis of inflammatory diseases, neoplasms, trauma, and normal variants. These sequences are useful for demonstrating bone fragmentation, resorption, and bone reaction, which facilitates the identification and understanding of deformities and complex bone remodeling..The great advantages of the FRACTURE sequence are the possibility of using gradient sequences available in all MRI devices and simple post-processing steps.

## TABLE OF CONTENTS/OUTLINE

.How sCT sequence acquisition and post-processing are performed..Role of the sCT sequence to evaluate the trabecular and cortical bone in routine examinations..Cases of clinical practice in which the sCT sequence turned out to be superior to conventional MRI for trabecular and cortical bone abnormalities.

### **MKEE-24 Shouldering the Load: Bridging the Gap of Rotator Cuff Tears with Patch Augmentation**

Sirui Jiang, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Anatomy of the rotator cuff 2. Common patterns of rotator cuff tears 3. Standard of practice for surgical repair 4. Emerging treatments in graft augmentation 5. Advanced imaging characteristics of graft-augmented versus conventional repairs

## TABLE OF CONTENTS/OUTLINE

1. Review of rotator cuff anatomy, 2. Clinical presentations of rotator cuff tears 3. Spectrum of rotator cuff disease 3a. Prevalence of tears and common tear patterns, 3a.i. Acute versus chronic tear presentations and diagnosis, 3a.ii. MRI findings and Goutallier classification, 3a.iii. Ellman classification of partial-thickness rotator cuff tears, 3a. iv. Massive rotator cuff tears, 4. Arthroscopic Repair Techniques, 4a. Single versus double row repair, 4b. MRI findings after conventional arthroscopic repair, 4b.i. Failure findings, 4b.ii. Assessment of repaired tendon quality (Sugaya Classification), 5. Patch augmentation, 5a. Indications for patch augmentation, 5b. Benefits and complications of patch augmentation, 5b.i. Reduction in retear rate and improvement in tendon thickness/quality, 5b.ii. Complications with xenografts, 5c. Types of patch augments, 5c.i. Collagen Scaffold (Regeneten), 5c.i.a. Clinical outcomes and MRI features of healed Regeneten patch, 5c.ii. Acellular dermal allograft (Dermis-on-demand), 5c.ii.a. Clinical outcomes and MRI features of healed Dermis-on-demand, 6. Future directions, 6a. Anticipated advancements, 6b. Biologic injections (PRP, stem cells) with concomitant patch augmentation

### **MKEE-26 Navigating the Lumbosacral Plexus: A Guide to Understanding its Normal Anatomy and Injuries.**

LEON PERIN (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this study is: 1. Review with didactic illustrations the anatomy of the lumbosacral plexus, including how to recognize it on MRI. 2. Demonstrate how various lumbosacral plex injuries manifest clinically and on imaging studies. 3. Present didactic cases of lumbosacral plexus injuries, highlighting the main findings that the radiologist should expect.

## TABLE OF CONTENTS/OUTLINE

- Introduction and review of lumbosacral brachial anatomy, with didactic illustration.
- Review normal anatomy without MRI, highlighting anatomical landmarks.
- Overview of the main lumbosacral plexus injuries, their clinical and epidemiological manifestations and their imaging findings.
- Demonstrate with challenging clinical cases traumatic and non-traumatic pathologies, such as inflammatory polyneuropathy, other neuropathies, and associated alterations such as piriformis syndrome.
- Present a case series of lumbosacral plexus injuries and what you should actively look for depending on the

clinical history. • Propose a diagnostic checklist for evaluating lumbosacral plexus injuries, simplifying the reading of these challenging exams. • Summary.

## **MKEE-27 Crystal Spine: Findings of Spinal Crystal Deposition Disease on CT and MRI**

Andrea S. Costacurta, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1- Crystal Deposition Disease must be considered in the differential of spinal pain. 2- Findings are often located outside the spinal canal, in the soft tissues, and can be overlooked. 3- MRI has a high sensitivity in detecting inflammation but poorly detects calcification. CT on the other hand has high sensitivity to calcification however the amount of associated inflammation is often underestimated. Awareness of the disease may help in the diagnosis.

### **TABLE OF CONTENTS/OUTLINE**

1. Definition and clinical aspects of Crystal Deposition Disease. 2. Classification. 3. Brief review of pathophysiology. 4. Description of the main imaging findings in the spine: longus colli tendinitis, crowned dens syndrome, aseptic spondylodiscitis, disc, ligament or dural calcifications, facet joint arthropathy. 5. Discussion of the differential diagnosis.

## **MKEE-28 Assessment of Sagittal Balance in Degenerative Spine Disease: Role of Imaging Modalities in Post-operative Follow-up**

### **Awards**

#### **Certificate of Merit**

Pedro H. Arruda, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The sagittal balance depends on the correlation of the spine, pelvis and lower limbs for proper body alignment, which is crucial for maintaining a healthy posture and optimal body functioning. The pelvis sets the foundation of this alignment through pelvic incidence, which is a fixed anatomical parameter that determines the amount of lumbar lordosis required to maintain a proper balance. An increase in spinal fusion for degenerative diseases has led to a rise in postoperative complications, such as sagittal imbalance. Spinal fusion can result in a reduction of the lumbar lordosis, thus shifting forward the body's center of gravity. The body tries to compensate by pelvis retroversion or knee flexion, leading to an altered gait pattern and pain. Increased stress on the discs and facet joints adjacent to the fused spine segment may also be depicted. Imaging modalities play a crucial role in alignment monitoring. X-rays provide an orthostatic two-dimensional image of the spine or lower limbs, while MRI and CT scans identify structural abnormalities that predispose to spine imbalance, as well as disc herniation, spinal stenosis or adjacent disc syndrome. EOS imaging is a recently specialized modality that provides an orthostatic full-body and low-dose tridimensional image. Therefore, it is important to know the concept of sagittal alignment of the spine, the main measures performed, and how to interpret and describe the normal and abnormal findings.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Sagittal imbalance and compensatory mechanisms 3. Sagittal Alignment assessment A- Care in image acquisition B- What measures to perform C- How to interpret and describe 4. Pre and postoperative spine balance analysis 5. Conclusion

## **MKEE-29 Back to the Future: Automatic Deep Learning Approaches to Opportunistically Assess Spine Health**

### **Awards**

#### **Certificate of Merit**

Abhinav Suri, BA, MPH (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Complications from spine diseases are highly prevalent across the world. For example, over 1.5 million individuals suffer from back pain due to vertebral fractures and millions more are afflicted with neurogenic back pain. One way to prevent these diseases from developing is to opportunistically assess imaging studies for overall spine health by trending changes in quantitative spine metrics. However, the process of making measurements necessary to diagnose such pathologies is time-consuming, resulting in high underreporting rates for some of the aforementioned conditions (as high as 85%). This exhibit will focus on explaining how deep learning algorithms can be used for detecting vertebral body and disc deformities, trending Cobb angle, assessing paraspinal muscle fat content, and quantifying spinal cord/foramen compression.

### **TABLE OF CONTENTS/OUTLINE**

At the end of this presentation the learner should have knowledge about the following: 1. Overview of the prevalence of vertebral fractures, disc herniation, spinal cord compression, scoliosis and current manual methods used to quantify severity



of these pathologies.2. How neural networks can be used for anatomic object detection across multiple modalities using novel visual transformer and deep convolutional neural networks.3. How keypoint detection networks can be used for automated quantitative vertebral deformity diagnoses.4. How segmentation networks can be used to extract vertebral bodies, intervertebral discs, paraspinal muscles, spinal canal/cord/foramina using 2D and 3D UNets and Swin3D transformer networks.5. A framework for how these measurements can be used for comprehensive spine health assessment in an opportunistic manner.

### **MKEE-3 Imaging of Meniscal Root Tears: A Practical Review**

Bruno E. Watabe, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to:•Review and illustrate the anatomy of the meniscal roots and their specific characteristics.•Illustrate and discuss patterns and classifications of injuries involving these structures, along with their clinical relevance.•Illustrate and discuss various surgical treatments, arthroscopic correlation, and postoperative imaging findings of meniscectomy and repair with suture techniques.

#### **TABLE OF CONTENTS/OUTLINE**

The meniscal roots and supporting structures anchor the menisci to the tibial plateau, resisting hoop stress and preventing radial displacement of the menisci and subsequent degeneration of the tibiofemoral compartment. Imaging helps determine the type and location of lesions, guiding treatment decisions. An accurate description of lesions and associated imaging findings helps orthopedic surgeons determine the best surgical technique and improve patient outcomes.• Anatomy: Illustration and imaging of the tibial plateau and sites of meniscal root fixation, highlighting their specific characteristics.• Pathological Conditions: Recognition of degenerative changes and various types of traumatic tears in the meniscal roots, along with commonly associated findings, can aid in treatment decisions and potentially delay the onset of secondary osteoarthritis due to meniscal lesions.• Surgical Treatment and Postoperative Imaging: Illustration of different surgical techniques, including partial meniscectomy and meniscus repair, along with their indications and contraindications. Arthroscopic correlation and postoperative images showing follow-up within a certain time interval and potential outcomes.

### **MKEE-30 Hip Instability Beyond Dislocation: An Overview of New Concepts and Current Radiological Approaches**

Julio B. Guimaraes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Hip instability is conceptually divided into traumatic and atraumatic causes, eventually leading to long-term complications, such as osteoarthritis. Hip dislocation and subluxation are well-established entities associated with high and low-energy trauma. Conversely, microinstability is a developing concept, mainly atraumatic, characterized by the inability to keep the femoral head centered within the acetabular fossa in extra physiological movements, which diagnosis involves detailed anamnesis and physical examination, as well as imaging approach. Bone markers for instability are classified into acetabular and femoral subgroups, which can be evaluated by radiographs and CT scans. Acetabular coverage and orientation are assessed to diagnose developmental hip dysplasia. In patients with borderline acetabular coverage, the concomitant evaluation of the Shenton line and femoral physeal scar orientation can determine microinstability diagnosis. The femoral head is assessed for bone morphology, CAM deformity, femoral torsion and neck-shaft angle. Connective tissue disorders are best depicted with MRI, related to capsular laxity, thinning or redundancy. Iatrogenic causes are related to capsular disruption due to intra-articular assessment during hip procedures. MRI can also reveal specific secondary chondral and labral lesions resulting from those structural abnormalities.

#### **TABLE OF CONTENTS/OUTLINE**

1. Definition; 2. Anatomy; 3. Pathophysiology: a. Traumatic: i. Dislocation and subluxation; b. Microinstability (atraumatic): i. Bone insufficiency; ii. Soft tissue insufficiency; iii. Post-surgical; 4. Imaging Assessment; 5. Management.

### **MKEE-31 Imaging Spectrum of Foot Infections: A Practical Guide to Radiologists**

Carlos Francisco Kallas Pereira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The differentiation between foot infection imaging patterns is a common challenge for radiologists. Imaging methods provide detailed anatomical information in the assessment of infections, thus helping clinicians to reach the most accurate diagnosis. CT scans play a key role in providing multi planar reconstructions for bone evaluations, whereas MRI is highly sensitive for detecting osteomyelitis in initial stages and can help particularly in looking for soft tissues' complications. In this evaluation it is also important to understand the particularities of each etiological agent. Bacteria is the most common cause of infection, frequently associated with synovitis and osteomyelitis. Tuberculosis can also be related to tenosynovitis and osteomyelitis, especially in immunocompromised patients. Fungal infections have been described to have the classic "dot in a circle" sign on T2 weighted images. It is also important to remember foreign bodies related infections, to avoid misdiagnosis. The diabetic foot is another condition that requires special attention by radiologists. Neuropathic arthropathy predisposes to a greater risk

of infection, mostly due to the loss of sensitivity, repetitive trauma and poor healing. Osteomyelitis and Charcot arthropathy frequently coexists, therefore, it is essential radiologists to understand the particular imaging features of these conditions and how they affect the foot compartments, to aid in diagnosis and proper management.

#### **TABLE OF CONTENTS/OUTLINE**

Background/epidemiologyAnatomy, vascularity and foot compartmentsEtiological agentsDiabetic footImaging techniquesDiagnostic approach: what to report?Differential diagnosisTake-home Points

### **MKEE-32 MRI and US Evaluation of the Carpal Tunnel and Guyon ´s Canal: Normal Anatomy, Pathological and Postoperative Findings**

Diego N. dos Santos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Report general information about the carpal tunnel and Guyon ´s canal.- Review the normal anatomy of these canals and their main anatomical variations.- Describe its pathological involvement and its imaging patterns and postoperative evaluation on ultrasonography (US) and magnetic resonance imaging (MRI), through clinical cases from our service.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction:- General information about the carpal tunnel and Guyon ´s canal.Normal anatomy of carpal tunnel and Guyon ´s canal.Clinical cases of pathological and postoperative findings and its imaging patterns on US and MRI:\* Carpal Tunnel:- Carpal tunnel syndrome- Anatomical variation of carpal bones with tunnel reduction- Accessory tendon of the superficial flexor muscle- Arthrosynovial cyst determining median nerve neuropathy- Calcium deposit in the carpal tunnel- Thrombosis of the ulnar tributary artery\* Guyon ´s canal:- Arthrosynovial cyst in Guyon's canal- Thrombosis of the ulnar artery\* Other structures:- Neuropathy of the palmar cutaneous branch of the median nerve\* Postoperative findings:- Postoperative changes from carpal tunnel decompression / median nerve injury- Postoperative median nerve neuroma\* Other cases

### **MKEE-33 Plain Film Evaluation of the Traumatic Knee: A Case-Based Primer**

Mariam S. Mostamandy, BS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The knee is a commonly injured joint in both children and adults. Plain film evaluation is often first line and familiarity with knee anatomy on plain films is critical for appropriate imaging evaluation. This exhibit reviews normal anatomy of the knee on plain films and illustrates the utility and limitations of plain films in evaluation of the knee joint in the setting of trauma. Utilizing a case-based approach, it reviews common and uncommon knee injuries, their mechanisms, and offers pearls and pitfalls to aid the radiologist in comprehensive radiographic assessment.

#### **TABLE OF CONTENTS/OUTLINE**

AnatomyIntercondylar FracturesTibial Plateau FracturesPatellar FracturesPatellar DislocationAvulsion InjuriesPhyseal InjuriesStress FracturesKnee Dislocation

### **MKEE-34 Avoiding the Iceberg and the Ring of Fire: Thermal Protection on Musculoskeletal Ablations**

Mario H. Carneiro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1 - Review and explain the methods that can be used to protect the tissues surrounding thermoablation areas. 2 - Discuss the monitoring methods and devices to evaluate sensitive structures near procedure sites. 3 - Didactic clinical cases with images of musculoskeletal ablations, each kind of protecting measures and potential complications.

#### **TABLE OF CONTENTS/OUTLINE**

1 - Types of musculoskeletal ablations; 2 - Radiofrequency; 3 - Cryoablation; 4 - Microwave; 5 - Interstitial laser; 6 - Complications; 7 - Safety measures on ablations; 8 - Preparation and monitoring; 9 - Thermal protection types; 10 - Hydrodissection; 11 - Pneumodissection; 12 - Mechanical manipulation; 13 - Skin temperature control.

### **MKEE-35 Anterior Glenohumeral Instability: Biomechanics, Preoperative and Postoperative Evaluations**

Renata V. Leao (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Traumatic dislocation of the shoulder leads to labral detachment and elongation of the capsular ligamentous restraints, as well as bone loss on the glenoid, humerus or both.-Characterization of the bone loss, with glenoid track, allows an accurate treatment choice.-Most common procedures: Labral repair, glenoid augmentation and humeral reconstruction.-Labral retear:



1. fluid insinuation between the labrum and the glenoid bone margin; 2. Fluid insinuation within the labrum; 3. Morphologic abnormality greater than expected; 4. Anchor detachment.-Latarjet: 1.Graft complications: non-union, dislocation, mispositioning; 2.Hardware complications: loosening, fracture, dislocation; 3.Others: glenohumeral arthritis, neurovascular injuries, subscapularis muscle injury.-Remplissage: indications and normal/abnormal postoperative findings.

#### **TABLE OF CONTENTS/OUTLINE**

1.Glenohumeral biomechanics and anterior instability2.Anterior glenohumeral dislocation and associated injuries3.Glenoid labrum tears4.Bone compression and bone loss - glenoid - humerus and bipolar bone loss5.Labral repair procedure: indications, normal and abnormal postoperative imaging6.Glenoid reconstruction techniques: indications, Latarjet/Bristow and others7.Normal and abnormal imaging findings in glenoid reconstruction techniques8.Humeral head reconstruction: indications, normal and abnormal findings9.Conclusion: the correct assessment of glenohumeral instability is important for the surgical decision. It is essential to know the expected imaging patterns of each surgical technique and the corresponding pathological findings to properly manage potential complications in patients.

### **MKEE-36 Giant Cell Tumor of Bone: Atypical Imaging Features, Treatment and Complications**

Adriano Silveira Moreira Novaes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. Briefly review of the most important features suggesting the diagnosis of the giant cell tumors (GCT) of bone. 2. Demonstrate the unusual locations of the GCT. 3. Review de atypical imaging findings of the GCT and complications in follow-up.

#### **TABLE OF CONTENTS/OUTLINE**

Giant cell tumor (GCT) of the bone is a generally benign tumor that has recently been reclassified as osteoclastic giant cell-rich tumors according to WHO 2020 classification.It is typically diagnosed through conventional radiographs that show a lytic lesion with a well-defined, non-sclerotic margin, eccentric location, extension to the subchondral bone, and centered in the metaepiphysis of mature long bones. Fluid-fluid levels are seen in 15% of cases, consistent with secondary formation of aneurysmal bone cyst. GCT commonly develops in long bones, particularly around the knee, but can occur in atypical locations with less characteristic radiographic features.Pediatric patients with open epiphyseal growth plates are infrequently affected. Lung metastases are rare, occurring in 1-6% of cases.Recurrence after curettage with cement placement is a possible complication, but this has become less common with the use of adjuvant therapies such as Denosumab.

### **MKEE-37 Congenital Hand Malformations: A Review in the Palm of Your Hand**

Karla Ortega Rivera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Congenital hand malformations can have a significant impact on hand function and aesthetics, and thus, management should be multidisciplinary and involve specialists in plastic surgery, orthopedics, radiology, and psychology.2. Radiographic imaging allows for visualization of bone structures, assessment of alignment, and morphology of the hand.3. Radiographic evaluation is a crucial tool in the assessment of congenital hand malformations. Radiographic findings can help determine the type and severity of the malformation, which can be useful in treatment planning.4. The aim is to provide a review of the most common congenital hand malformations, their radiographic findings, classifications, and therapeutic approaches, along with illustrative cases both pre- and post-surgery.

#### **TABLE OF CONTENTS/OUTLINE**

I. IntroductionII. EmbryologyIII. ClassificationIV. Specific types of congenital hand malformations and radiographic evaluationPolydactyly, syndactyly, camptodactyly, brachydactyly, clinodactyly, constriction ring syndromeV. Management of congenital hand malformationsVI. Cases

### **MKEE-38 The Muscle Fascia: From Anatomy to Pathological Findings**

Diego N. dos Santos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Report some concepts related to the muscle fascia, clarifying its definition.- Review the normal anatomy of the muscle fascia through illustrative schemes and correlation with imaging methods - magnetic resonance imaging (MRI) and ultrasonography (US).- Describe its pathological findings and its imaging patterns, through clinical cases gathered in our service.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction:- Definition and general information about the muscle fascia: fascia superficialis, deep peripheral fascia and deep intermuscular fasciaNormal anatomy of the muscle fascia and correlation with MRI and US.Clinical cases of pathological findings and its imaging patterns on US and MRI:\* Traumatic:- Morel-Lavallée lesion- Plantar fascia injury- Muscle hernia / Myo-aponeurotic injuries\* Inflammatory:- Post viral inflammatory fasciitis- Nodular fasciitis- Plantar fasciitis\* Infectious:-

Necrotizing and non-necrotizing cellulitis and fasciitis\* Autoimmune: - Eosinophilic fasciitis- Systemic lupus erythematosus- Polymyalgia rheumatica\* Neoplastic:- Superficial fibromatosis- Desmoid tumor / Hibernoma- Sarcoma\* Postoperative:- Assessment of muscle fascia after fasciotomy\* Other:- Compartment syndromes- Granulomatous disease\* Other cases

### **MKEE-39 The Resident's Thriller: A Pictorial Essay on Benign Bone Tumors**

Izabel O. Karam, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This essay aims to review the main benign bone tumors and its multimodality radiological features. Although many tumors' diagnoses are histopathological, radiologists and radiology residents must be able to identify several entities, especially those whose correct identification are imaging-made.

#### **TABLE OF CONTENTS/OUTLINE**

Bone cysts. Chondroblastoma. Chondromyxoid fibroma. Enchondroma. Eosinophilic granuloma. Fibrous dysplasia. Giant cell tumor. Intraosseous hemangioma. Lipoma of the bone. Non-ossifying fibroma. Osteochondroma. Osteoid osteoma.

### **MKEE-4 Glenohumeral Osteoarthritis: Overview, Imaging Approach and Preoperative Assessment**

Marco Aurelio Soato Ratti (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Glenohumeral osteoarthritis (GHOA) has a prevalence as high as 20% in the middle-age and elderly population, predominantly observed as the primary form (no specific risk factors). Conversely, secondary GHOA is associated with diverse causes, including rotator cuff tear, post-traumatic degeneration, gleno-humeral morphology (retroversion and glenoid dysplasia), shoulder instability, inflammatory arthropathies and microcrystal deposition. Imaging plays a pivotal role for GHOA diagnosis, investigation of underlying predisposing factors, evaluation of the extent of degeneration and of local complications. Since surgery can be considered in symptomatic patients with moderate to severe degenerative changes, unresponsive to conservative treatment, preoperative assessment by imaging is fundamental. A multimodality approach including radiographic images, computed tomography and magnetic resonance imaging helps the surgeon to choose the ideal technique for better outcomes. Pathologic glenoid version, bone loss and rotator cuff atrophy, as examples, have established association with poor clinical outcomes and hardware complications following arthroplasty. Thus, complete preoperative assessment of glenohumeral joint includes the following aspects: evaluation of bone stock, glenoid version, glenoid tilt, assessment of the rotator cuff with Goutallier classification and Walch classification.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction; 2. Epidemiology; 3. Definition and pathophysiology; 4. Etiology, a. Primary form (or non-specific risk factors), b. Secondary form (or specific risk factors); 5. Multimodality imaging evaluation; 6. Preoperative imaging assessment: what to report.

### **MKEE-40 CT Myelography and Blood Patches in Intracranial Hypotension: A Primer**

Mario H. Carneiro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1 - Review and explain the intracranial hypotension syndrome, its image manifestations, causes and treatments. 2 - Present didactic clinical cases with images of cerebrospinal fluid (CSF) leaks and fistulas. 3 - Discuss CT myelography technique and interpretation. 4- Show the treatment options for CSF leaks and fistulas. 5 - Demonstrate guided epidural blood patch treatment with real cases images.

#### **TABLE OF CONTENTS/OUTLINE**

1 - Intracranial hypotension syndrome; 2 - Etiologies; 3 - Diagnostic criteria; 4 - Most common image manifestations; 5 - Imaging methods for etiology investigation. 6 - Spine MRI; 7 - CT myelography; 8 - CSF leaks; 9 - CSF-venous fistulas; 10 - Conservative, interventional and surgical treatments. 11 - Epidural blood patch: how to.

### **MKEE-41 Distal Tibiofibular Syndesmosis: Stabilize Your Knowledge and Leave the Instability to the Injuries**

Izabel O. Karam, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: To review the anatomy and biomechanics of the distal tibiofibular syndesmosis; Discuss the role of each imaging method, including indications, advantages and disadvantages of each modality; To illustrate the main acute and chronic alterations in radiological and orthopedic practice, through didactic cases illustrating our institution through

a multimodality approach; Discuss surgical indications and the importance of the findings for the orthopaedic surgeon, according to the imaging methods.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy. Biomechanics. Indication for requesting imaging exams in general. Role of radiography, main views and how to evaluate. Role of ultrasonography. Role of CT in neutral. Role of CT with stress maneuvers. Role of Weight-bearing CT. Role of MRI. Surgical indications, importance of radiological findings, and radiological and surgical correlation. Summary and proposed evaluation and test request flowchart. Future perspectives.

### **MKEE-42 Capturing Psoriatic Arthritis on Film: A Comprehensive Guide to Radiographic Assessment**

Axel A. Torres Monarrez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Provide an overview of psoriatic arthritis.
- Emphasize the indications, limitations, and benefits of radiography in psoriatic arthritis.
- Compare different imaging techniques for psoriatic arthritis.
- Discuss the normal anatomy of the hand on plain film radiography.
- Emphasize the importance of a systematic approach to hand radiography.
- Become familiar with descriptive terms for common bone and soft tissue abnormalities seen in psoriatic arthritis.
- Provide case studies to illustrate the practical application of theoretical concepts.
- Analyze differential diagnostics, tips, and tricks.

#### **TABLE OF CONTENTS/OUTLINE**

Overview of psoriatic arthritis: definition, epidemiology, pathogenesis, and clinical manifestations. Radiography in psoriatic arthritis: indications, limitations, and benefits. Comparison of imaging techniques for psoriatic arthritis: radiography, ultrasound, and MRI. Normal anatomy and systematic approach to the hand on plain film radiography. X-rays and psoriatic arthritis: descriptive terms for common bone and soft tissue abnormalities. Case studies: practical application of theoretical concepts. Differential diagnostics: osteoarthritis, gout, and rheumatoid arthritis. Tips and tricks for improving radiology reports. Conclusions: What rheumatologists want to know?

### **MKEE-43 Bad to the Bone! Understanding and Applying Bone-RADS: A Standardized Scoring System for Bone Lesions**

Ellis D. Mejias Febres, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Review pathology of bone anatomy-Bone-RADS provides an algorithmic-type approach to assessing differential diagnosis of bone tumors -Each Bone-RADS score is determined by certain criteria that includes the clinical implications for each - Provision of case examples on conventional radiography and computed tomography (CT) to better understand Bone-RADS In this educational exhibit, we will review the standardized scoring system Bone-RADS, as well as provide radiologists and other health professionals with an understanding of Bone-RADS. the scoring system itself will be explained, supported by imaging from real cases. Finally, we will explain the implications every score has on the management of individual cases based on the Bone-RADS score assigned.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction-Review of bony anatomy Creation of Bone-RADS II. Overview of the criteria used in Bone-RADS III. Clinical implications/management of bone tumors based on Bone Rads-How Bone-RADS serves as a guide to assessing bone lesions. IV. Imaging examples-Case by case analysis of how Bone-RADS scores are determined. V. Conclusion-Recap of teaching points.

### **MKEE-44 Anterior Cruciate Ligament Reconstruction: Imaging Evaluation of the Techniques, Normal Appearance and Complications**

Andre Y. Aihara, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Anterior cruciate ligament (ACL) reconstruction aims to restore knee stability. The surgical techniques for ACL reconstruction include single and double bundle, while the most frequently used autografts are bone-patellar tendon-bone and hamstring tendons. CT is the gold standard for evaluating tunnel placement, while MRI is best for assessing graft continuity and soft tissue complications. MRI signal intensity of the graft changes over time, with low signal immediately after surgery, increased signal in the first year due to remodeling, and low signal at 18 months. The objectives of this exhibit are: 1. To review ACL reconstruction techniques 2. Discuss imaging findings of normal postoperative ACL 3. Illustrate post-operative complications according to the potential sources: graft, technical and hardware complications, and soft tissues.

#### **TABLE OF CONTENTS/OUTLINE**

ACL reconstruction Techniques Normal postoperative Imaging • Femoral and tibial tunnels: position and size • Signal intensity of the graft over time • Harvest sites • Radiographic findings • CT findings • MRI findings Complications • Graft Partial

tearComplete tearPorto-Knee Testing Device• Technical and hardware complicationsAnterior tibial tunnel with impingementAnterior femoral tunnelTunnel wideningHardware migrationHardware fracture• Soft tissuesArthrofibrosisInfectionAdventitious Bursitis

## **MKEE-45 Imaging Evaluation of the Patella as the Largest Sesamoid Bone**

Andre Rosenfeld, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The patella is the largest sesamoid bone in the human body, developing within the quadriceps tendon and becoming a part of the knee's extensor mechanism. Ossification centers can be associated with congenital disorders. Forceful contraction of the extensor mechanism can lead to chronic apophysitis or acute avulsion fractures. Although rare, tumors of the patella can occur, with the majority being benign. Additionally, crystal arthropathies such as gout and CPPD can affect the patella through the deposit of crystals in the tendons or cartilage. Certain diseases are associated with typical patellar morphologies. For example, multiple epiphyseal dysplasia is characterized by a double-layered patella, Cryopyrin-Associated periodic syndromes result in a disproportionately diffuse increase in size, and CPPD deposits cause a gear-like morphology. The purpose of this study is to Review the normal development and anatomy of the patella. Discuss and illustrate the imaging findings of pathologies of the patella, which can be didactically divided into congenital disorders, mechanical/trauma, tumors, and crystal arthropathies. For this purpose, radiographs, CT scans, and MR images will be used. Highlight the typical patellar morphologies associated with various diseases. Elucidate how to differentiate normal variants from pathological conditions.

### **TABLE OF CONTENTS/OUTLINE**

Normal development of the patella and anatomy Pathologies• Congenital: Bipartite, tripartite, double-layered patella, absence of the patella• Mechanical/trauma: Fracture, sleeve avulsion, Sinding-Larsen-Johansson• Tumors: benign and malign• Cryopyrin-Associated periodic syndromes• Crystal arthropathies: gout and CPPD

## **MKEE-46 3D Printing and Metaverse in Musculoskeletal Tumors - A New Assessment Tool**

Flavia M. Costa, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- 3D printing preoperative planning for the treatment of MSK tumors ( soft tissue and bone tumors).a. Segmentation. Virtual modeling. Build preparations. Quality assessment• Patient-specific devices - Personal surgical instruments ( PSIs);• Identify what sequences should be used for Preoperative planning in many oncological patients with computed tomography (CT) ( maximum slice thickness of 1 mm) and contrast-enhanced magnetic resonance (MR- 3 Tesla -Siemens) and multiplanar reconstruction;• Mixed Reality (MR) is a technology of real and virtual worlds to enhance visualizations, where physical and digital objects coexist and allow users to interact with both in real-time• Special considerations and Pitfalls.

### **TABLE OF CONTENTS/OUTLINE**

1) The value of the combination of 3D printing and metaverse in surgical planning procedures in soft tissue and bone tumors;2) These techniques promise improvements and outcomes for complex bone tumor resection2) Case discussion:• Osteosarcomas resection and prosthesis manufacture• Pleomorphic liposarcomas recidive assessment• Schwannomas• Condrossarcomas• Bone marrow metastasis3) To demonstrate many indirect effects of 3D printing on surgical procedures: • reduced surgery time;• to a reduced complication rate of wound infections and wound healing disorders and therefore enable earlier adjuvant therapy initiation 4) Common pitfalls 5) Conclusion Surgical planning using 3D printing and metaverse/ may result in negative tumor resection margins that reduce the risk of local recurrence and adversely affect patients' survival. Computer navigation and 3D-printed resection guides have been reported to be surgical accurate.

## **MKEE-47 What, Where, and Why - A Primer on Sonographic Evaluation of Traumatic Injuries to the Tendons of the Wrist and Hand**

Kevin Sweetwood, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Ultrasound of the tendons of the wrist and hand can provide a high spatial resolution evaluation of tendon pathology which is augmented by the ability to perform dynamic maneuvers that are unavailable with MRI studies.2. Knowledge of the sonographic appearance and anatomy of these tendons and their associated structures is essential in correctly identifying pathology, providing relevant information to the referring physicians to guide appropriate management, and avoiding pitfalls leading to misdiagnosis.3. Review of common injuries to the tendons of the wrist and hand focusing on relevant anatomy, sonographic findings, mechanisms of injury, and associated complications and classification schema that are significant for surgical planning.

### **TABLE OF CONTENTS/OUTLINE**

1. What - Different traumatic pathologies of the tendons with review of terminology, sonographic appearance, and image acquisition techniquesa. Partial versus complete tendon tears, tendon stump separation and retractionb. Pulley injuriesc.

Sagittal band injuries<sup>2</sup>. Where - Review of relevant anatomy, sonographic landmarks, and surgical classification<sup>a</sup>. Appearance and relationships of the flexor digitorum profundus tendon, flexor digitorum superficialis tendon slips, and pulleys<sup>b</sup>. Identification of flexor tendon zones utilizing landmarks<sup>c</sup>. Appearance and relationships of the extensor tendons and sagittal bands<sup>3</sup>. Why - Isolated tendon injury versus secondary post-traumatic injuries and significance of findings for surgical approach<sup>a</sup>. Distal radius fractures<sup>b</sup>. Hardware complications<sup>c</sup>. Surgical management

## **MKEE-49 Carpal Instability: Current Concepts and Diagnostic Approach**

Tomas A. Pascual, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To show the complex anatomy of the wrist ligaments and its assess in imaging studies. Describe the different types of carpal instability, its pathomechanism, clinical prognosis and treatment implications .Review the different stages of nondissociative carpal instability, integrating images into the pathological process and clinical stages.

### **TABLE OF CONTENTS/OUTLINE**

Carpal instability refers to a group of ligament injuries that are responsible for a considerable degree of wrist pain and dysfunction, interfering with sports and daily life activities. Scapholunate and lunotriquetral ligament injuries are the most frequent cause of carpal instability. Depending on the type of injury, these ligaments may be the harbinger of a relentless progression to abnormal joint mechanics, cartilage wear, and degenerative changes. Imaging methods play a crucial role in the diagnosis and staging of this type of injuries which, if not treated, can lead to wrist osteoarthritis

## **MKEE-5 Diagnostic Evaluation of Very Small Peripheral Nerves: When Ultrasonography Made the Difference**

### **Awards**

#### **Certificate of Merit**

Marcos Felipe D. Correa, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Describe the role of the high frequency ultrasound (US) in the assessment of very small peripheral nerves and its comparison with magnetic resonance imaging (MRI). Review the sonoanatomy and the topographic anatomy of the reported nerves and its correlation with MRI. Report selected clinical cases from our service, highlighting pathological involvement of very small peripheral nerves on US and its correlation with MRI, through illustrative images and videos.

### **TABLE OF CONTENTS/OUTLINE**

Introduction  
The role of the high frequency US in the assessment of the very small peripheral nerves  
Clinical cases of pathological involvement of very small peripheral nerves on US and its correlation with MRI:  
Palmar cutaneous neuropathy  
Posterior interosseous nerve syndrome  
Digital palmar proper nerve injury (stump neuroma neurotmesis)  
Lateral femoral cutaneous neuropathy (meralgia paresthetica)  
Postoperative radial nerve neuropathy  
Postoperative sural nerve (stump neuroma neurotmesis)

## **MKEE-50 An Ounce of Prevention is Worth a Pound of Cure**

Murilo Campos Silva, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is:  
A. Discuss the classic concepts of instability and the relatively new concepts of microinstability of the spine; B. Demonstrate the cascade of degenerative instability going through three stages: (1) temporary dysfunction, (2) unstable dysfunction and a (3) final phase of restabilization; C. Correlate the phases of spinal instability and radiological findings in a multimodality approach; D. To review the main therapeutic options in the context of chronic spinal pain, microinstability and instability.

### **TABLE OF CONTENTS/OUTLINE**

A. Spine anatomy and biomechanics of spinal pain; B. Classic spinal instability concepts and degenerative stages; C. Concepts of microinstability and imaging findings in a multimodality approach; D. Discussion of the therapy decision, including conservative treatment measures, surgical indications and modalities of intervention.

## **MKEE-51 MR Neurography of the Lumbosacral Plexus- Tips on Technique and Injury Patterns**

### **Awards**

#### **Certificate of Merit**

Jenifer Pitman, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Pelvic and lower extremity sensorimotor disturbances frequently present a diagnostic challenge for referring clinicians and radiologists. Complex anatomy of the lumbosacral plexus in addition to varied clinical presentations make it difficult to pinpoint the site of pathology accounting for patients' symptoms. MR Neurography is a useful modality for evaluation of the nerves in the lumbosacral plexus and can serve as an adjunct to conventional MRI lumbar spine.<sup>1-5</sup> Significant improvements in signal to noise ratio and spatial resolution, particularly with 3D isotropic sequences, and emerging techniques such as deep learning reconstruction facilitate improved nerve visualization. When performing MR neurography, it is important for the radiologist to understand the anatomy of the lumbosacral plexus and to be aware of technical considerations in the pelvis.

## TABLE OF CONTENTS/OUTLINE

Background Anatomy Overview; Technical Considerations; Protocol/Sequences: high field strength, heavily T2W FS images perpendicular to nerve, 2D/3D; Fat suppression: STIR, DIXON; Vascular suppression: DESS/MENSA; Motion reduction; Contrast- Gadolinium, Ferrumoxytol; Imaging around Metal; Deep learning reconstruction; Imaging features; Normal Injury Patterns; Case examples Iatrogenic, Traumatic

### **MKEE-52 Whole Body of MRI of Castration-Resistant Prostate Bone Metastasis: How and When**

Javier Hernandez Ganan (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To explain Whole-Body MRI protocol focusing on Dixon and Dwi sequences. 2. To discuss main indications. 3. To select target lesion to biopsy. Whole-body MRI is becoming increasingly important in patients diagnosed with disseminated prostate neoplasia, not only in clinical trials but also in daily practice. Specifically in patients with biochemical progression with bone disease, where more scenarios open up for adequate therapeutic guidance.

## TABLE OF CONTENTS/OUTLINE

Natural history of prostate cancer. WB MRI protocol: MET RADS. Role of Dixon and DWI sequences. Indications 1. Before starting a new treatment. 2. Follow-up. 3. Select viable lesion to perform percutaneous biopsy. Current developments 1. WB MRI at diagnosis in patients at high risk for prostate cancer: 'all in one' study. 2. PET MRI future indications.

### **MKEE-53 Hematopoietic Tumors of Bone - Growing Your Knowledge**

Bruno B. Cardoso, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Obtaining a differential diagnosis for hematopoietic bone tumors is often challenging due to their varied features. Hematopoietic bone tumors encompass a wide spectrum, including multiple myeloma, lymphoma, histiocytosis, Erdheim-Chester disease, and Rosai-Dorfman disease. In some cases, these pathologies can mimic osteomyelitis or bone metastasis, making an accurate diagnosis crucial prior to treatment. X-rays are often the initial imaging study used to evaluate hematopoietic bone tumors, but they have limited sensitivity and specificity in some cases. CT scans, which provide detailed images of the spine and pelvis, are particularly useful for evaluating bony structures while avoiding the effects of overlapping structures. On the other hand, MRI provides better soft tissue contrast, aiding in the differentiation of benign and malignant conditions. Overall, the DWI technique can provide information about tumor cellularity and aggressiveness, potentially improving the accuracy and efficiency of MRI and enhancing patient care.

## TABLE OF CONTENTS/OUTLINE

I. Introduction, II. Imaging Modalities, III. Multiple myeloma, IV. Lymphoma, V. Langerhans cell histiocytosis, VI. Erdheim-Chester disease, VII. Rosai-Dorfman disease, IX. Differential diagnosis, X. Conclusion.

### **MKEE-54 Measurement of Bone Mineral Density in CT: Current Status and Future Perspectives**

Youngjune Kim, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Screening bone mineral density at opportunistic CT is under active research to be adopted in daily practice. The major teaching points of this exhibit are 1) the history of measuring bone mineral density at CT, 2) the pros and cons of measuring bone mineral density at CT in comparison with DEXA, 3) technical considerations of measuring bone mineral density at CT, and 4) future perspectives of measuring bone mineral density at CT including deep learning technique.

## TABLE OF CONTENTS/OUTLINE

1. History of measuring bone mineral density using CT: QCT and opportunistic CT 2. Pros and cons of measuring bone mineral density at CT in comparison with DEXA 3. Technical considerations when measuring bone mineral density at CT 4. Future perspectives of measuring bone mineral density at CT: deep learning technique and finite element analysis 5. References



## **MKEE-55 Inside the Spinal Canal: A Journey Through Intraspinal Pathologies**

Alan F. Strapasson, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Lesions within the spinal canal can range from benign to highly malignant, with only 20% of these lesions being intramedullary. Other possible origins include nerves, meninges, and vessels. The main objective of this exhibit are: 1. Review the anatomy, imaging protocols, and main pathologies affecting the medullary canal of the lumbar spine or the thoracolumbar transition. 2. Create a diagnostic flowchart for main intraspinal lesions based on age and comorbidities. 3. Describe the main imaging characteristics used to narrow down differentials. 4. Provide an updated classification of intramedullary lesions according to the World Health Organization's 5th edition.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to lumbar spine anatomy, including transitional vertebra classification. 2. MRI protocols for the lumbar spine. 3. Diagnostic flowchart for lesions categorized by age and comorbidities. 4. Discussion of main imaging findings for various conditions such as Mixopapillary ependymoma, Intradural spinal lipoma, Schwannoma, Lipoma of the filum terminale, Plexiform neurofibroma, Metastases, Vertebral body hemangioma with epidural component, Chordoma, Dermoid cyst, and Epidermoid cyst, using illustrative cases. 5. Highlighting the main clinical and imaging aspects that differentiate lesions within the vertebral canal, to aid in prompt diagnosis and proper treatment. Overall, this exhibit provides a comprehensive overview of intraspinal lesions and their characteristics, contributing to accurate diagnosis and treatment planning.

## **MKEE-56 So, You Have a Trained AI Model, Now What? Step-by-step Guide to Deploying a Prototype Interface Using Open-source Python Tools to Test Newly Developed Internal MSK AI Tools**

Brendan M. Franz, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. A brief overview of the initial process of training, and validation of an AI model. 2. Overview of open-source tools in python which can be used to deploy a test of an AI solution. 3. Walkthrough of implementation of tools to create a platform to internally test custom AI tools.

### **TABLE OF CONTENTS/OUTLINE**

-A brief overview of the initial process of training, and validation of an AI model.--Expected output of a training/validation process during AI model creation.--Walkthrough of open-source tools to deploy a test of an AI solution--Anaconda / Python Flask--Flask--Streamlit-Walkthrough of implementation of a web-based interface to test internally create AI tools--Conda installation--Installation of Flask, Streamlit and other related dependencies--Creating a simple HTML website to take an MSK radiograph and predict the image projection using a custom model file--Using Streamlit to visualize imaging data, masks and output.--Review of the utility of open-source software in healthcare--Conclusion/Summary

## **MKEE-57 MR Arthrograms: Expecting the Unexpected**

Aishwarya Gulati, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

After reviewing this education exhibit, the reader will understand: 1. Technique of normal arthrograms discussing the major large and medium joints with brief overview of normal post direct arthrogram anatomy. 2. Pitfalls and imaging findings related to common errors or unexpected findings in MR arthrography of larger and medium joints with focus on shoulder and knee. 3. Genesis of common errors and general procedural techniques to avoid these.

### **TABLE OF CONTENTS/OUTLINE**

1. Basic technique of fluoroscopic guided direct MR arthrogram for major joints. 2. Overview of normal appearance of common joint spaces post direct arthrogram 3. Unexpected findings or errors related to: a. Contrast media preparation -Over dilution -Increased concentration b. Injection technique -Over distention and contrast extravasation -Extra-articular injection -Intra-articular gas -Extra-articular local anesthetic c. Soft tissue injury d. Unexpected findings related to -Enhancing lesions e.g. fracture, vascular malformation -Anatomic variants e. Scanning -Timing -Incorrect sequence

## **MKEE-58 Cervical and Lumbar Spinal Fusion and Arthroplasty Beyond the Basics: From Surgical Techniques to Postoperative Imaging**

### **Awards**

#### **Cum Laude**

Gabriel D. Miranda, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

I) Discuss the role of each imaging method in postoperative evaluation of patients who have undergone cervical/lumbar spinal fusion or total disc replacement/disc arthroplasty.II) Review the different techniques of cervical and lumbar spinal surgery (indications, advantages and limitations), and describe the various surgical instrumentations/devices used in spinal fusion and total disc replacement (TDR)/disc arthroplasty procedures.III) Discuss a basic primer/checklist for radiological evaluation after cervical and lumbar spinal fusion or total disc replacement/disc arthroplasty, to help identify normal and abnormal postoperative findings on the various imaging modalities.IV) List the main early and late postoperative complications.

## TABLE OF CONTENTS/OUTLINE

Introduction: The importance of imaging in the evaluation after cervical/lumbar spinal fusion or disc arthroplasty. The main uses of each imaging modalitiesSpinal instrumentation nomenclature: Spinal fusion instrumentation: screws, plates, rods, interbody cages, bone grafts. Disc arthroplasty devices: disc prosthesis and its various models.Surgery techniques: Cervical spine: anterior cervical corpectomy and fusion, anterior cervical discectomy and fusion, posterior laminoforaminotomy, cervical disc arthroplasty. Lumbar spine: anterior lumbar interbody fusion, oblique lumbar interbody fusion, lateral/extreme/direct lumbar interbody fusion, transforaminal lumbar interbody fusion, posterior lumbar interbody fusion, and lumbar disc arthroplasty.Checklist for radiological postoperative evaluation: Normal postoperative findings. Early and late postoperative complications.

## MKEE-59 Blossom with Artificial Intelligence: Hidden MSK Imaging Biomarkers for Cardiothoracic Diseases from Conventional Chest CT Examination

### Awards

#### Certificate of Merit

Elena Ghotbi, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

\*Definition and benefits:Opportunistic CT imaging means analyzing CT scans initially taken for other purposes but with potential to contribute to medical screening levels (primary, secondary, and tertiary screening), and identify incidental pathologies at zero additional costs or radiation exposure. \*Extraction of important musculoskeletal biomarkers is now feasible from conventional CT scans as predictors of cardiothoracic diseases, such as:-Bone density, osteoporosis and osteopenia, using phantomless measures of bone density-Thoracic spine degeneration, using modified Pfirrmann grading-Detailed pectoralis muscle composition measures loss (subcutaneous adipose tissue, intermuscular and perimuscular adipose tissue, extramyocellular lipids), sarcopenia, and prevention of adverse outcomes-Measures of costochondral and tracheal calcification as a marker for extraosseous calcium deposition \*Implementation of artificial intelligence (AI):AI algorithms hold promise for enhancing the precision and speed of the opportunistic CT imaging and can generate robust, reliable, and fast quantitative measurements that may not be readily apparent to the human eye.

## TABLE OF CONTENTS/OUTLINE

-Introduction-Methodology: Development of deep-learning algorithm -Clinical application: Current evidences for predictive values for various common cardiothoracic disease-Future directions: AI role for efficient implementation in routine clinical practice

## MKEE-6 All Grown Up: Pictorial Review of Premalignant Bone and Soft Tissue Lesions

### Awards

#### Certificate of Merit

Sepideh Abdi, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- There are several bones and soft tissue lesions that can undergo malignant transformation.
- It is important to understand the characteristic imaging appearance and pitfalls of these lesions.
- Radiologists should be familiar with the clinical and imaging management of these premalignant lesions to prevent misdiagnosis.

## TABLE OF CONTENTS/OUTLINE

Several bones and soft tissue lesions can undergo malignant transformation. This includes premalignant benign tumors and non-neoplastic conditions that injure bone and soft tissue. Both groups require an understanding of key clinical and imaging features to arrive at the correct diagnosis. Enlargement, new pain, or aggressive imaging features can raise suspicion for malignant transformation. This exhibit will discuss 3 main categories of premalignant musculoskeletal lesions:Benign tumors• Osteochondroma/multiple hereditary exostoses (MHE) ? chondrosarcoma• Enchondroma (Maffucci, Olliers) ? chondrosarcoma• Fibrous dysplasia? osteosarcoma• Giant cell tumor of bone? malignant giant cell tumorPrior bone injury (non-neoplastic)• Osteomyelitis ? squamous cell carcinoma, osteosarcoma. • Radiation ? osteosarcomas, soft tissue sarcomas• Bone infarct ? secondary osteosarcoma• Paget disease ? osteosarcomas, chondrosarcomas, or fibrosarcoma.Soft



tissue lesions • Burns/scars ? squamous cell carcinoma, basal cell carcinoma • Synovial Chondromatosis ? chondrosarcoma • Neurofibroma ? Malignant peripheral nerve sheath tumor • Atypical lipomatous tumor (ALT) ? dedifferentiated Liposarcoma

## **MKEE-60 Unraveling Wrist Radiographs: A Review of Traumatic Wrist Injuries Focusing on Radiographic Imaging**

Aishwarya Gulati, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

After reviewing this education exhibit, the reader will: 1. Understand how various views of the wrist are obtained and the indications of different special views. 2. Understand normal anatomy and imaging appearance of the wrist on radiographs. 3. Understand the imaging appearance and clinical context of common and uncommon traumatic carpal injuries and carpal joint disruptions.

### **TABLE OF CONTENTS/OUTLINE**

1. Wrist radiographs - indications of various views (including standard views and less common views such as carpal tunnel) and optimal patient positioning. 2. Normal wrist anatomy on standard radiographs. 3. Approach to interpretation 4. Relevant anatomy, mechanism of injury/ pathogenesis, imaging examples, brief review of clinical presentation and implications, and management of: a. Different carpal bone fractures b. Different types of carpal dislocations c. Carpo-metacarpal joint fracture-dislocations

## **MKEE-61 Microinstability and MRI: Unveiling the Invisible**

Natan P. Ribeiro, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Introduce microinstability as a disorder with subtle joint instability- Understand the significance of MRI in diagnosing microinstability- Explore the application of MRI in various joints affected by microinstability- Discuss advanced MRI techniques for accurate detection and staging of joint lesions- Review the evolving relationship between MRI and arthroscopy for microinstability diagnosis and treatment

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to Microinstability and MRI 2. The Role of MRI in the Diagnosis and Management of Joint Microinstability 3. Comprehensive Imaging Evaluation of Microinstability in Various Joints 4. Dynamic MRI for Detection of Functional Causes of Joint Instability 5. Quantitative MRI Techniques for Objective Evaluation of Cartilage Health 6. The Benefits of Functional MRI in Understanding Joint Microinstability 7. Advanced MRI Techniques for Accurate Detection and Staging of Joint Lesions 8. The Evolving Relationship Between MRI and Arthroscopy for Microinstability Diagnosis and Treatment 9. The Pivotal Role of Radiologists in Microinstability Diagnosis and Management 10. Imaging Findings in Anterior Shoulder Microinstability: An MRI-Based Approach 11. MRI Findings Suggestive of Knee Microinstability: A Comprehensive Review 12. Management of Microinstability in Different Joints: An Evidence-Based Approach 13. Role of MRI in Guiding Surgical Intervention for Joint Microinstability 14. Understanding the Pathophysiology and Anatomy of Joint Microinstability for Accurate MRI Interpretation 15. Advancements in MR Imaging Technology for Improved Detection and Characterization of Microinstability

## **MKEE-62 Lateral Meniscus Instability: Understanding Its Anatomy and Unraveling Posterior Attachment Lesions**

Carlos H. Longo, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The lateral meniscus is more mobile than the medial meniscus due to its less extensive attachments, and its posterior attachment anatomy has been less studied than the medial meniscus. The posterior root attachment and meniscotibial (coronary) ligaments serve as important static stabilizers, but it is the thin popliteomeniscal fascicles (PMF) that play an important role in the dynamic stabilization of the lateral meniscus during knee flexion. The anterior (Humphrey) and posterior (Wrisberg) meniscofemoral ligaments also contribute to stabilization. The absence of popliteomeniscal ligaments (congenital or traumatic origin) allows an anterior displacement of the posterior horn of the lateral meniscus during the flexion of the knee (hypermobile meniscus). It can cause symptoms, including pain, blockage and snapping ("snapping knee syndrome"). Peripheric tears of the posterior horn can be associated with buckle-handle tears and meniscal flap dislocation. Posterior root tear is less common in the lateral meniscus than the medial meniscus. The purpose of this study is to: - Review the normal anatomy of the posterior horn of the lateral meniscus and its attachments. - Discuss and illustrate cases of hypermobile meniscus associated with absence of the PMF on MRI. - Illustrate cases of posterior attachments tear on MRI

### **TABLE OF CONTENTS/OUTLINE**

Normal anatomy of the posterior attachments of the lateral meniscus and its normal appearance on MRI  
Hypermobile meniscus associated with tear of the PMF  
Buckle-handle tear  
Posterior root tear  
Meniscofemoral ligaments tear

## **MKEE-63 Geographic Superficial Soft Tissue Masses: A Guide for Ill-defined Masses**

Rachel Z. Bass, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Masses in the superficial soft tissues often have ill-defined borders, and are often benign. Framing the differential into dermal, lipomatous, fibrous, lymphatic and vascular categories may be helpful. 2. Skin thickening with ill-defined underlying edema without enhancement suggests lymphatic origin. This may be localized, and correspond to a pedunculated mass in the morbidly obese, known as a "pseudosarcoma". 3. Ill-defined mass with a fascial tail suggests fibromatosis, which may be desmoid type or superficial. Degree of hyperintensity of fluid weighted sequences corresponds to immature collagen and active tumor. 4. Diffuse fibromatosis is a unique form of neurofibroma that is uncommonly associated with NF-1, and presents with geographic skin thickening with ill-defined subcutaneous edema, nodularity and enhancement. 5. Superficial angiosarcoma will be a nodular, vascular tumor with enhancement and increased activity hot on PET. Often metastatic at presentation.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Lymphatic: Massive localized lymphedema, papillomatosis cutis lymphocystica, Proteus syndrome, cutaneous lymphoma 3. Vascular: Vascular malformation, angiosarcoma 4. Lipomatous: Fat necrosis, adiposis delorosa 5. Fibrous: Desmoid type fibromatosis, superficial fibromatosis, fibrosarcoma 5. Neurogenic: Diffuse neurofibroma 6. Dermal: Squamous cell carcinoma

## **MKEE-64 "Thinking On Your Feet" - A Step Forward on the Evaluation and Treatment of Morton Neuromas**

Mary Creedon, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Overview of Morton neuromas and relevant anatomy 2. Review of the sonographic evaluation of Morton neuromas including patient position, transducer position, and dynamic maneuvers 3. Review of the MRI protocol and findings related to Morton neuromas 4. Differential diagnoses and pitfalls 5. Treatment overview including ultrasound-guided procedure indications, required materials, and technique for steroid, anesthetic, and alcohol Morton neuroma injections

### **TABLE OF CONTENTS/OUTLINE**

Introduction and overview Pathophysiology and types of traumatic neuromas Nomenclature Epidemiology Clinical Findings Most common locations Ultrasound evaluation Transducer selection and settings Patient and transducer position (dorsal versus plantar imaging) Dynamic maneuvers Sonographic findings Differential diagnoses (including plantar plate tears and intermetatarsal bursitis) and ways to differentiate sonographically MRI evaluation MRI protocol and the use of intravenous gadolinium contrast Literature favoring prone vs supine patient position for MRI and US Differential diagnoses and pitfalls Treatment options Non-operative, non-invasive treatments Ultrasound-guided procedures: a. Indications, risks, and precautions, b. Required materials for steroid, anesthetic, and alcohol injections, c. Technique details Surgical excision Summary

## **MKEE-65 Post-operative Fluid Collections Following Lumbar Spine Surgery: Differential Diagnosis and Surgical Considerations**

Hoiwan Cheung, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Post-operative fluid collections represent a common imaging finding in patients who have undergone recent lumbar spine surgery. Radiologists must be familiar with different types of post-operative fluid collections that can occur following lumbar spine surgery and their salient imaging findings to guide patient management. 1) Recognize different types of lumbar spine surgical techniques including posterior spinal, transforaminal, anterior, extreme lateral, and oblique lateral interbody fusions 2) Review different types of lumbar spine post-operative fluid collections, including cerebrospinal fluid leak (CSF) and pseudomeningocele, lymphocele, bone morphogenetic protein (BMP)-related fluid collection, hematoma, abscess, and urinoma 3) Identify which types of surgical techniques are associated with different post-operative lumbar fluid collections 4) Review treatment considerations for different types of post-operative lumbar spine fluid collections

### **TABLE OF CONTENTS/OUTLINE**

Review anterior and posterior approach lumbar spine fusion techniques, relevant anatomy, and post-operative imaging appearance Anterior approach-Anterior lumbar interbody fusion (ALIF)-Oblique lateral interbody fusion (OLIF)-Extreme lateral lumbar interbody fusion (XLIF) Posterior approach-Posterior lumbar interbody fusion (PLIF)-Transforaminal lumbar interbody fusion (TLIF) Review the imaging appearance and management, of different types of post-operative fluid collections after lumbar spine fusion-Pseudomeningocele/CSF leak-Bone morphogenetic protein (BMP)-related fluid collections-Lymphocele-Hematoma-Abscess with discitis/osteomyelitis-Urinoma

## **MKEE-66 MRI Evaluation of Oblique Injuries: Introduction of the Deadrise Sign**

### **Awards**

#### **Certificate of Merit**

Nicholas M. Hanna, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Importance of oblique injuries in sports imaging Primary muscle involved and location of injuries Common MRI findings Basic MRI protocol and treatment algorithm

#### **TABLE OF CONTENTS/OUTLINE**

Epidemiology of oblique injuries - Target population - Mechanism of injury - Value of MRI Anatomy of the lateral abdominal wall - Muscle layers, fiber orientation, and important attachments - Normal variations in the lower "floating" ribs Single institution retrospective cohort of 29 unique injuries in 23 patients - Primary muscle involved - Surrounding injury - Location - Average length of injury Common MRI findings and pitfalls - Introduction of the "deadrise" imaging sign - Severity grading considerations Case examples - Low grade strain (muscle edema only; no macroscopic tear) - Tears at the lower rib insertions (deadrise sign) - Tears at the iliac attachment (less common) - Differential diagnosis MRI protocol considerations - Sequences, scanning time, and short and long-axis views of the rib/cartilage at the site of injury - Common MRI artifacts - Rib level identification Treatment algorithm - Collaboration with orthopedic surgery

## **MKEE-67 The Musculoskeletal Manifestations of Aging: What the Radiologist Needs to Know in Caring for Our Growing Elderly Population**

Catalina N. Flores, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Briefly discuss the multifactorial biochemical processes that contribute to normal aging of the musculoskeletal system. 2. Familiarize the radiologist with the normal radiologic manifestations seen in the musculoskeletal system that arise from aging. 3. Review the radiologic manifestations of the most common musculoskeletal pathologies that occur in the elderly population resulting from normal aging.

#### **TABLE OF CONTENTS/OUTLINE**

A. Brief review of the biochemical processes that contribute to normal aging in the context of musculoskeletal manifestations. B. Illustrate normal and pathologic radiologic manifestations of aging in the musculoskeletal system a) Changes in bone homeostasis i. Osteopenia/osteoporosis, Paget's disease ii. Insufficiency fractures iii. Fragility fractures b) Architectural changes in skeletal muscle composition i. Sarcopenia c) Architectural changes in articular cartilage composition i. Osteoarthritis d) Architectural changes in tendon composition decreased cellular response to injury i. Tendinopathy and tendon tears e) Metabolic derangement and predisposing co-morbidities seen in the elderly population i. Diffuse idiopathic skeletal hyperostosis ii. Crystal deposition disease f) Genomic instability from accumulated oxidative damage and decreased repair mechanisms i. Multiple myeloma ii. Metastatic disease

## **MKEE-68 Where is the Contrast? Patterns to Recognize and Pitfalls to Avoid for Successful MSK Arthrography**

Maxine E. Kresse, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Review of arthrograph techniques of the major joints to include range of normal appearances and demonstrate pathology with successful injection -Recognition of extra-articular injection, with cross-sectional correlates -How to avoid and correct for common pitfalls

#### **TABLE OF CONTENTS/OUTLINE**

-Brief introduction to fluoroscopy guided arthrograms of the major joints (including shoulder, elbow, wrist, hip, knee, and ankle) -For each of the major joints: a. Normal arthrograph appearance, including normal bursa/recess communications with the joint; b. Successful intra-articular injection with pathology diagnosed by the arthrograph fluoroscopy images (i.e. full thickness rotator cuff tear); c. Numerous examples of extra-articular injections, with cross sectional correlates on the location of the contrast; d. Tips to avoid common pitfalls and ways to adjust to achieve an intra-articular injection -Summarize pearls and pitfalls to aid in troubleshooting to avoid compromised cross-sectional exams

## **MKEE-69 "Untangling the Nerves" - Sonographic Findings of Upper Extremity Nerve Entrapments and Injuries with MRI Correlation**

Preethi Kesavan, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Benefits in the use of ultrasound with technique details  
2. Classification and sonographic imaging of peripheral nerve injuries with MRI correlation  
3. Ultrasound of nerve entrapment syndromes of the upper extremity with MRI correlation  
4. Ultrasound-guided peripheral nerve interventions

## TABLE OF CONTENTS/OUTLINE

Why ultrasound and how? Benefits and advantages in the use of ultrasound  
Technique details, including transducer selection and machine settings  
Dynamic imaging and the use of Doppler (including newer microvascular imaging techniques)  
Sonographic findings including normal reference cross-sectional measurements  
Types of peripheral nerve injuries  
Classification and types of peripheral nerve injuries  
Sonographic findings of normal versus abnormal peripheral nerves  
MRI correlative imaging  
Ultrasound imaging of upper extremity nerve entrapment syndromes  
Sites of entrapment, relevant anatomy, and associated pathophysiology  
Sonographic imaging findings with MRI correlation  
Secondary imaging findings including muscle denervation edema, atrophy, and myosteatosis  
Ultrasound-guided peripheral nerve interventions  
Indications, risks, precautions, and benefits of ultrasound. Required materials including what to inject (e.g., nonparticulate versus particulate corticosteroids)  
Ultrasound-guided diagnostic and therapeutic injections including hydrodissection and alcohol/ethanol neurolysis  
Ultrasound-guided cyst aspiration/decompression to relieve nerve compression  
Summary

## MKEE-7 Tibial Plateau Fractures: Common Classification Systems and Clinical Considerations

Rachel Z. Bass, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. The Schatzker classification of tibial plateau fractures is commonly used but lacks description for coronally oriented fractures. The three column approach highlights the importance of the posterior tibial plateau. 2. The Kfuri (modified Schatzker) classification system was introduced in 2018, and marries the Schatzker classification with anterior and posterior modifiers, and is accepted among orthopedic surgeons. 3. Involvement of the posterior column affects surgical approach and technique, and stabilization of the posterior medial column and tibial rim is critical for good functional outcome. 4. Preoperative CT provides critical information regarding fracture orientation, depression, and vascular injury. 5. Preoperative MRI following external fixation may provide critical information to the orthopedic surgeon regarding meniscus and ligamentous injury that will be addressed at the time of definitive internal fixation.

## TABLE OF CONTENTS/OUTLINE

1. Tibial Plateau Classification systems: AO/OTA, Schatzker, Three Column, Kfuri (Modified Schatzker)  
2. Surgical Approach and clinical importance: Buttress fixation, posterior column fixation, graft placement  
3. Soft tissue injury: Open fracture, vascular injury, meniscal tear, cruciate ligament tear, compartment syndrome  
4. Long term outcomes: Expected healing, postoperative osteoarthritis leading to arthroplasty.

## MKEE-70 Don't Miss a Step: Ligament Injury in Midtarsal Sprain

Christian Kestler, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review anatomy of the midtarsal (Chopart) joint complex  
Describe variant anatomy and common pitfalls  
Provide recommendations for best visualization of ligaments of midtarsal joint complex in MRI-scans  
Discuss trauma mechanisms of midtarsal sprain and deduce possible injury patterns  
Provide imaging examples of midtarsal sprains (MRI and X-ray)  
Discuss treatment

## TABLE OF CONTENTS/OUTLINE

Background:

- Epidemiology
- Role of imaging
- Ligament anatomy visualized by 3D-renderings and MRI-imaging examples (with common variant appearances):
  - Talocalcaneonavicular joint
  - Dorsal talonavicular ligament
  - Calcaneonavicular portion of bifurcate ligament
  - Spring ligament complex
  - Calcaneocuboid joint
  - Dorsal calcaneocuboid ligament
  - Calcaneocuboid portion of bifurcate ligament
  - Short and long plantar ligaments
- Pathomechanisms of midtarsal sprain:
  - Inversion-type trauma (most common): lateral and possible dorsal distraction with medial compression
  - Eversion-type trauma: medial distraction with lateral compression
- Imaging examples of midtarsal ligament injuries:
  - Ligament tear and sprain
  - Common findings accompanying ligament injuries
- Treatment

## MKEE-71 Keeping Cool: Thermoprotection Strategies for Musculoskeletal Ablations

Christopher Newman, BMBS, FRANZCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Basic principles of how to ablate targeted tissues and minimize damage to surrounding structures.  
-Review passive monitoring and active protection techniques during thermoablation.

## TABLE OF CONTENTS/OUTLINE

Percutaneous thermal ablation is being increasingly performed for oncologic treatment within bone and non-visceral soft tissue.-Certain risks are of interest during musculoskeletal ablation, namely skin and neurovascular bundle injury when compared to other deep organ ablations. Given this, concurrent multi-modal thermoprotective measures should be used to prevent non-target destruction of overlying skin and adjacent structures. Both active and passive protective measures are outlined in our presentation.-Passive techniques are utilised to monitor the patient and can include clinical monitoring and real-time intra-procedural imaging. Direct patient interaction and instruction, such as asking the patient to move intermittently or report altered sensation is a subjective method of clinical monitoring in order to detect neural injury. In contrast, intra-procedural imaging is more objective, whereby the radiologist can view the ablation zone in real-time, allowing confident treatment of the target lesion while avoiding non-target structures.-By comparison, active techniques are utilised to protect non-target structures and can be subdivided into temperature modulation and displacement techniques. Temperature modulation can be achieved with warmed/cooled saline gloves on the skin or subcutaneous fluid injection to dissipate temperature. Displacement of non-target adjacent structures is usually achieved with hydrodisplacement or pneumodisplacement.

### **MKEE-72 Dual Energy X-ray Absorptiometry (DXA): Principles and Tips in Classic and New Applications**

Rosa M. Lorente-Ramos, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To review the basics of dual energy x-ray absorptiometry (DXA)
- To discuss the use of DXA in the assessment of bone density, also reviewing the contribution of new developments such as trabecular bone score (TBS) in the diagnosis of osteoporosis.
- To analyze the evolving role of DXA in the evaluation of soft tissues especially for body composition such as quantification of fat and estimation of skeletal muscle mass in sarcopenia.
- To emphasize pitfalls, diagnostic difficulties, and provide clue points in order to improve performance in DXA exams.

## TABLE OF CONTENTS/OUTLINE

DXA is the 'gold-standard' in quantitative assessment of bone mineral density in the diagnosis of osteoporosis. The use of DXA has been also recommended in sarcopenia, to assess lean mass as an estimation of all non-fat/non-bone tissues, fat mass and bone mineral content. We review: 1. Basics and technique of DXA. DXA principle is based on attenuation coefficient of different tissues with low energy X-ray beams. 2. Uses of DXA. BMD study. Body composition and sarcopenia studies 3. BMD study. DXA performance. Causes of mistakes in different steps of DXA study: 3.1 Before the study: technologist training and competence, daily calibration, anthropometric data, regions to scan. 3.2 During the study: Patient positioning, Image acquisition: regions of interest. 4. Osteoporosis diagnosis. Image interpretation: Parameters. Adequate use of T-score and Z-score; Report. Detection of vertebral fractures or bone diseases (osteoarthritis, metastases, Paget's disease), soft tissue lesions, detection of artifacts-foreign bodies. New developments: TBS. 5. Body composition. Sarcopenia. DXA software analysis. Comparison with different techniques.

### **MKEE-73 A Radiological Overview of Elbow Arthroplasty: Practical Keys in the Assessment of Elbow Replacement**

Javier Azpeitia Arman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To know the different types of elbow replacement.
- To review the role of imaging techniques (plain radiograph, CT, MR, US, scintigraphy) in the evaluation of elbow replacements.
- To understand usefulness and limitations of plain radiographs and CT in the evaluation of elbow replacements, emphasizing useful parameters and illustrating image analysis and interpretation.
- To become familiar with normal and abnormal postoperative imaging findings and signs of complications

## TABLE OF CONTENTS/OUTLINE

We review imaging of elbow replacement, highlighting key concepts perceived as important variables by the surgeon and correlating images with clinical considerations and functional outcomes. We present: 1. A review of types of replacement. 2. Surgery. Aims. 3. Imaging. Plain radiographs: -Technique and views. Standard image acquisition: beam and anatomical landmarks -Parameters that should be evaluated: description of the components, alignment relative to normal anatomic alignment. 4. Imaging. CT: -Technique. -Parameters that should be evaluated. -Imaging of complications: Aseptic loosening, infections, ulnar nerve complications, instability, disassembly, dislocation, subluxation, intraoperative fractures, mechanical failure of prosthetic components, and ectopic bone formation 5. Role of MRI, US and scintigraphy. .

### **MKEE-74 Beyond the Surface: Exploring Extradigital Glomus Tumors - A Comprehensive Review of 64 Cases with Radiologic-Pathologic Correlation**

Gabriela Serra Del Carpio (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- In our study males outnumbered females with a male-female ratio of 2.1:1. - The mean age at the time of diagnosis was 55,8 years. - The tumors had a mean size of 1 cm and were located in the lower limbs in most cases (38/64).- In 17 cases (27%) a diagnostic imaging test was performed (US, MRI or both). - The radiological appearance of a glomus tumor on ultrasound was in most cases as a circumscribed hypoechoic oval nodule located in the subcutaneous layer and horizontally oriented. - Spectral Doppler can demonstrate both venous and arterial intralesional flow and in some cases a "Vascular stalk sign". - Images obtained by ultrasound are not specific but they play an important role in early diagnosis, give precise information on location, and provide guidance for excision of glomus tumors.

## TABLE OF CONTENTS/OUTLINE

IntroductionMaterials and Methods1.Results- Clinical findings - Radiological findings- Histological, cytological and immunohistochemical features- Differential diagnosis- Discussion2. Conclusions

### **MKEE-75 Weight-Bearing MRI: A New Technology for Changing the Approach to Pathology from Diagnosis to Therapy**

Joan C. Vilanova, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Learn the technical methodology to perform a weight bearing MRI (WB) for the different areas of the body/joints
- Show the proper analysis of the weight bearing examination to distinguish physiological changes from pathology on a clinical-radiological correlation
- Know the most common and appropriate indications for weight bearing MRI from the different areas/joints of the body

## TABLE OF CONTENTS/OUTLINE

- Introduction
- WB MRI equipment characteristics
- WB MRI technique of different areas/joints, procedure to perform the upright examination: craniovertebral junction (CVJ), spine, shoulder, knee, hip, ankle, foot, temporomandibular joint (TMJ); showing dynamic MRI evaluation
- WB postprocessing: quantification of the changes from non-WB to the WB examination
- Indications: CVJ: instability; Spine: instability, postural alignments changes, discopathy, lateral recess - foramen - central canal, postsurgical evaluation; Shoulder: instability, impingement; Knee: meniscal-ligamentous instability, patellar shift, Impingement; Hip: impingement, microinstability; Ankle: ligamentous instability, impingement, plantar fascia; Foot: metatarsalgia evaluation; TMJ: internal joint disorders
- Benefits and limitations
- Conclusions

### **MKEE-76 Radiologic Stranger Thing: Phosphaturic Mesenchymal Tumor (PMT) and Pitfalls**

Jacobo Porto Alvarez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-To describe and understand the physiopathology of PMT. -To learn about the most typical presentation of PMT. -To describe that the diagnosis is based on pathologic and biochemical analysis, but the imaging techniques are crucial in the tumor location for surgery treatment. -To alert about PMT and emphasise the radiologist's role in the management of PMT and when a radiologist can be crucial in raising the suspicion of PMT. -To describe some of the most common radiologic pitfalls.

## TABLE OF CONTENTS/OUTLINE

-Introduction: Actions of FGF-23, analytic changes and the bone implication. -Location and symptoms of PMT.-Diagnoses and treatment of PMT.-The radiologist's role in the management of PMT.-Pitfalls of PMT.

### **MKEE-77 Soft Tissue Tumours: Anatomic-Based Approach**

Imran Ladak, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review the 2020 World Health Organization (WHO) classification of soft tissue tumours. Understand the role of imaging in the diagnosis and management of soft tissue tumours Learn an approach to benign and malignant soft tissue tumours based on characteristic location and imaging appearance.

## TABLE OF CONTENTS/OUTLINE



Introduction Introduction to soft tissue tumours 2020 World Health Organization classification of soft tissue tumours Role of imaging in soft tissue tumours Soft tissue tumours by location and appearance Common/benign soft tissue tumours Lipoma Venous hemangioma Peripheral nerve sheath tumour Skin Dermatofibrosarcoma protuberans Chest Elastofibroma dorsi Solitary fibrous tumour of the pleura Arm Desmoid-type fibromatosis Nodular fasciitis Trunk Desmoid tumour Leiomyosarcoma Retroperitoneal liposarcoma Hand Fibrolipomatous hamartoma Giant cell tumour of tendon sheath Palmar fibromatosis Thigh Intramuscular myxoma Liposarcoma Undifferentiated pleomorphic sarcoma Leg/foot Synovial sarcoma Palmar fibromatosis

## **MKEE-78 Breaking Down Bone and Muscle: The Nitty-gritty of MSK Infections**

### **Awards**

#### **Certificate of Merit**

Alba Salgado Parente, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To revise the physiopathology and imaging findings of musculoskeletal infections (soft tissue, bone and joint, spine and periprosthetic infections) with different imaging modalities (conventional radiography, US, CT, MRI, PET)  
2. To discuss the differential entities that can mimic septic arthritis and osteomyelitis, focusing on pearls and potential pitfalls to make a correct diagnosis  
3. To develop a systematic approach for interpreting imaging findings of MSK infections, including evaluation of the extent and severity of infection and potential complications

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Imaging techniques in the evaluation of MSK infections: conventional radiography, ultrasound, CT, MRI and nuclear medicine techniques  
3. MSK infections: Pathophysiology and key concepts  
a. Soft tissue infections: Cellulitis, abscess/phlegmon, myositis/pyomyositis, superficial, deep and necrotizing fasciitis  
b. Bone and joint infections: Septic arthritis, septic bursitis, tenosynovitis, acute osteomyelitis, chronic osteomyelitis, Diabetic foot  
c. Spine infections: Spondylodiscitis, facet joint septic arthritis  
d. Periprosthetic infections: Technical considerations and imaging  
4. Pitfalls and mimics - How to avoid them: Is this septic arthritis?, Is this osteomyelitis?  
5. Systematic approach to MSK infections: What steps to follow  
6. Conclusions  
7. References

## **MKEE-79 Spotlight on Musculoskeletal Lymphoma: A Radiological Exploration of an Uncommon Entity**

### **Awards**

#### **Certificate of Merit**

Maxine E. Kresse, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Radiology plays a central role in the diagnosis of musculoskeletal lymphoma.  
2. Musculoskeletal lymphoma can present with different patterns.  
3. Lymphoma involving the muscle, skin, and bones can occur at nearly every age and may present with atypical features that can distinguish it from other entities.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction-Overview of musculoskeletal lymphoma-Importance of radiology in diagnosis  
2. Imaging modalities for musculoskeletal lymphoma, including Radiography, Ultrasound (US), Computed Tomography (CT), Positron Emission Tomography (PET), and Magnetic Resonance Imaging (MRI)  
3. Imaging features and patterns of musculoskeletal lymphoma-  
Osseous lymphoma: lytic pattern, sclerotic pattern, and "near normal" radiographic findings-  
Soft tissue lymphoma-  
Trans-spatial lymphoma  
4. Differential diagnosis-Other primary bone and soft tissue neoplasms-Metastatic lesions-Inflammatory and infectious conditions  
5. Conclusion: key takeaways from radiologic evaluation of musculoskeletal lymphoma

## **MKEE-8 Non-Tumoral Spine Bone Lesions: A Pictorial Review of Common and Uncommon Pathologies**

Andre Mannato, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The features of non-neoplastic bone lesions in the spine are often similar to those of malignant tumors, and a differential diagnosis is challenging to obtain in some cases. Non-tumoral bone lesions of the spine have a broad spectrum, including mechanical, infectious, inflammatory, vascular, and other causes. The clinical manifestations of ranging from back pain to neurological deficits mimicking myelopathy or radiculopathy. A careful and attentive imaging evaluation can help narrow differential diagnosis and potentially avoid unnecessary biopsy. Therefore, an accurate diagnosis is important prior to treatment. X-rays are often the first imaging study used to evaluate spinal tumors, but they have limited sensitivity and specificity for diagnosing benign tumors. CT scans provide detailed images of the spine and are particularly useful for evaluating the bony structures, such as in the case of vertebral hemangiomas. MRI, on the other hand, provides better soft tissue contrast and can help differentiate between benign and malignant tumors. Overall, the DWI and Dixon techniques offer several advantages in magnetic resonance imaging, including improved detection of diseases, improved visualization of

structures, can help distinguish between benign and malignant tumors and provide information about tumor cellularity and aggressiveness. These techniques have the potential to improve the accuracy and efficiency of MRI and enhance patient care.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction; II. Imaging Modalities; III. Mechanical Causes; IV. Infectious Lesions of the Spine; V. Inflammatory Causes; VI. Vascular; VII. Miscellaneous; IX. Conclusion.

#### **MKEE-80 Imaging Review of Knee Ligament Reconstructions Other Than the ACL**

##### **Awards**

##### **Cum Laude**

Thurl Hugh C. Cledera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Knee ligament injuries are common and operative techniques are continually evolving. Accurate clinical information along with imaging diagnosis aids in selection of the appropriate operative technique. While imaging features of anterior cruciate ligament (ACL) reconstruction are well-described in literature, data on indications, postoperative imaging findings and complications of reconstructions of other ligaments of the knee are limited. In this education exhibit, we discuss the imaging findings and complications of reconstructions of knee ligaments other than the ACL. The objectives of this education exhibit are: 1. Recognize normal radiographic and MR appearance of non-ACL ligament reconstructions 2. Understand the basic operative concepts and techniques for each type of reconstruction including indications and common grafts used 3. Recognize commonly encountered postoperative complications to aid in providing a precise and meaningful radiologic report

#### **TABLE OF CONTENTS/OUTLINE**

TECHNICAL CONSIDERATIONS • Conventional radiographs • Stress radiographs • Pre and postoperative MRI BASIC INDICATIONS AND NORMAL RADIOGRAPHS AND MRI OF THE FOLLOWING PROCEDURES Posterior cruciate ligament (PCL) reconstruction Posterolateral corner reconstruction • Laprade technique • Andrews technique • Lemaire technique Anterolateral knee reconstruction • Lateral extra-articular tenodesis (LET) • Anterolateral ligament (ALL) reconstruction Posteromedial corner reconstruction Medial patellofemoral ligament (MPFL) reconstruction Multiligament reconstruction COMPLICATIONS • Graft failure • Malpositioned graft • Femoral and/or tibial tunnel widening • Arthrofibrosis • Graft impingement

#### **MKEE-81 Radiographs and MRI of Tendon and Ligament Surgeries: A Resident's Primer**

Juvel Lee, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Radiodense hardware such as in metallic fixation and arthroplasties are easily evaluated on radiographs by both trainees and nontrainees alike. On the other hand, surgeries that utilize mostly radiolucent or nonmetallic components such as tendon transfer, ligament reconstruction and other soft tissue procedures may be more challenging to assess, especially by trainees. These procedures may manifest with nodular or tubular lucencies that may be mistaken for cysts, infection or tumors. In this education exhibit, we provide a concise review or "pocket guide" of normal and abnormal imaging appearance of commonly encountered soft tissue procedures to aid the radiology resident/trainee in appropriate assessment of non-radiodense operative hardware. The objectives of this education exhibit are: 1. Recognize normal radiographic appearance of commonly encountered non-radiodense operative hardware 2. Understand the basic operative concepts and indications of these soft tissue procedures 3. Recognize radiographic and basic MR appearance of complications of these soft tissue procedures

#### **TABLE OF CONTENTS/OUTLINE**

For each procedure, the following will be discussed: PROCEDURE: INDICATIONS: RADIOGRAPHS: MRI: COMPLICATIONS: SHOULDER Rotator cuff repair Biceps tenodesis Anterior stabilization ELBOW UCL reconstruction Distal biceps repair WRIST and HAND Volar oblique ligament reconstruction Thumb UCL reconstruction KNEE ACL reconstruction MPFL reconstruction Patellar tendon transfer ANKLE Tendon transfer procedures Lateral ligament reconstruction

#### **MKEE-82 Utilizing Dual Energy CT for Evaluating Gout: A Review of Imaging Artifacts and Pitfalls for Trainees to Avoid**

Kush Purohit, MD, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Discuss the basics of dual-energy CT (DECT) technology and its current clinical application in the detection of gout. Demonstrate typical imaging findings of gout on DECT. Review imaging artifacts commonly seen when utilizing DECT gout protocol, including those related to keratin, metallic objects, and image noise. Explore additional pitfalls for trainees to avoid including the physiologic deposition of monosodium urate in various tissues. Understand techniques to minimize DECT artifacts.



## TABLE OF CONTENTS/OUTLINE

Epidemiology and clinical presentation of gout, a crystal arthropathy caused by the deposition of monosodium urate (MSU) crystals  
Typical imaging findings of gout on radiography, conventional CT and MRI  
Physics of DECT and its clinical application for the evaluation of gout  
Reviewing artifacts causing misregistration of non-MSU crystals as gout: Keratin: Nailbed keratin and skin callous  
Metallic objects: Foreign bodies, CT table and orthopedic hardware including intervertebral disc spacer material  
Image noise: Quantum mottle causing image noise artifact with incorrectly-labeled submillimeter foci of MSU crystals  
Additional miscellaneous pitfalls for trainees to avoid: Limitations of DECT for evaluating chronic gout  
Physiologic deposition of MSU crystals in non-gout patients  
Troubleshooting and minimizing DECT artifacts  
Physiologic deposition of MSU crystals in non-gout patients  
Troubleshooting and minimizing DECT artifacts

### **MKEE-83 CUP - A Novel Comprehensive Classification System for Triangular Fibrocartilage Complex Lesions**

Jan P. Grunz, MD (*Presenter*) Research Consultant, Siemens AG

#### TEACHING POINTS

The classifications of Palmer (1989) and Atzei/Luchetti (2011) constitute the current standard to characterize lesions of the triangular fibrocartilage complex (TFCC). However, both systems have substantial drawbacks that limit clinical applicability. The Palmer classification does not discern between the foveal and styloid insertions of the radioulnar ligaments, which is essential for treatment, while differentiating between traumatic and degenerative lesions is often not feasible. In contrast, the Atzei classification focuses exclusively on the ulnar-sided periphery. Several less common lesion types are not included in either system. These limitations motivated us to develop a new comprehensive and clinically-oriented classification for lesions of the TFCC. In the proposed system, the acronym 'CUP' refers to central lesions (C) limited to the articular disc, ulnar lesions (U) affecting the insertions of the radioulnar ligaments, and peripheral lesions (P), which comprise injuries of the ulnocarpal meniscus and ligaments, the dorsal joint capsule, and the extensor carpi ulnaris tendon sheath. Each group is subdivided into three grades of severity with adequate treatment recommendations.

#### TABLE OF CONTENTS/OUTLINE

1. TFCC anatomy 1.1 Biomechanical properties 1.2 Vascularization 2. Imaging 2.1 MRI with and without intravenous contrast enhancement 2.2 CT and MR arthrography 3. Lesion types 3.1 Central lesions 3.2 Ulnar lesions 3.3 Peripheral lesions 3.4 Combinations with fractures and avulsion injuries 4. Therapy 4.1 Surgery versus conservative treatment 4.2 Overview of surgical procedures 5. Discussion

### **MKEE-84 There's Light at the End of the Carpal Tunnel - But is it a Good Thing**

Jan P. Grunz, MD (*Presenter*) Research Consultant, Siemens AG

#### TEACHING POINTS

Constituting the most common entrapment neuropathy by far, carpal tunnel syndrome (CTS) is caused by compression of the median nerve within a narrow passage on the palmar side of the wrist. The carpal tunnel is located beneath the transverse carpal ligament and extends from the scaphoid and trapezium to the hamate and pisiform bone. Containing the deep and superficial flexor tendons in addition to the median nerve, entrapment neuropathy can occur in case of mismatches between the tunnel's size and the volume of its contents. CTS patients typically report painful paresthesia of digits I-III with aggravation at night, when provoked by tapping the median nerve at the carpal tunnel entrance (Hoffmann-Tinel sign), and when flexing the wrist (Phalen test). Chronic CTS results in atrophy of the thenar muscles with limited opposition and abduction of the thumb. Among several causes, tenosynovialitis of the flexor tendons is the most frequent. While CTS is usually diagnosed in clinical and electrophysiological examinations, radiologists can provide valuable insights by performing cross-sectional measurements and qualitative assessment of the edematous nerve structure in ultrasound and MRI. Particularly if symptoms persist after carpal tunnel release surgery, both imaging methods are of great importance.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy of the carpal tunnel 2. Imaging techniques 2.1 Ultrasound 2.2 MRI with and without i.v. contrast enhancement 3. Pathophysiology of CTS 3.1 Tenosynovialitis 3.2 Congenital anatomical variants 3.2 Bony stenoses 3.4. Tumors 4. Postoperative imaging 5. Discussion

### **MKEE-85 The Many Faces of Heterotopic Ossification: Pathogenesis, Imaging Features and Differential Diagnosis**

#### Awards

#### Certificate of Merit

Ustun Aydingoz, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

• Three requisites stand out for heterotopic ossification (HO) formation: osteogenic precursor cells, multiple inducing factors and pertinent biochemical signaling pathways, a favorable microenvironment. • Recent evidence suggests that the initiation of HO particularly necessitates local hypoxia in the microenvironment. • Heterotopic ossification is a commonly encountered condition on imaging with characteristic—if not pathognomonic—findings involving musculoskeletal soft tissues such as muscles, ligaments, and tendons. • A host of differential diagnostic possibilities need to be considered when there is concern for heterotopic ossification.

## TABLE OF CONTENTS/OUTLINE

• Pathophysiologic background of HO. • Case examples of various manifestations of HO on imaging with pearls and pitfalls (e.g., myositis ossificans [traumatic, neurogenic], periostitis ossificans, arachnoiditis ossificans, panniculitis ossificans, Pellegrini-Stieda lesion [HO of the medial collateral ligament of the knee], HO of the posterior longitudinal ligament [OPLL] or nuchal ligament, Bennett lesion [HO of the posterior band of the inferior glenohumeral ligament], other enthesal ossifications [diffuse idiopathic skeletal hyperostosis], tendon ossifications [Achilles, hip abductors, rotator cuff], fibrodysplasia ossificans progressiva). • Differential diagnostic considerations for HO on imaging (e.g., calcific tendinitis, calcific periarthritis, dystrophic calcifications, extraskeletal bone tumors, synovial sarcoma, calcinosis cutis, calcinosis of chronic renal failure).

## MKEE-86 Spectrum of Calcaneal Tumors and Tumor-like Lesions: Imaging Findings with Pathological Correlations

Yuan-Chang Chen (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Lipomas can be distinguished from simple bone cysts based on central dystrophic calcification, particularly with fat necrosis and cyst formation. 2. An associated primary bone lesion should always be considered in older patients with aneurysmal bone cyst-like changes. The differential diagnosis can be narrowed down using a combination of imaging features (lesion components, location) and clinical information (age). 3. The age for some calcaneal tumors is different from tumors in other locations. This makes it difficult to differentiate between chondroblastomas, characterized by marginal sclerosis and calcifications, and giant cell tumors (GCTs). 4. The tumor matrix pattern should be emphasized. A stippled or ring-like pattern indicates cartilage calcification, cloud-like appearance indicates osteoid mineralization, and a ground-glass density indicates fiber matrix. 5. Age needs to be considered in solid tumors with non-specific imaging features. Enchondromas, chondrosarcomas, metastatic tumors, myelomas, lymphomas, and undifferentiated pleomorphic sarcomas are common in adults, whereas, GCTs, chondroblastomas, osteosarcomas, Ewing sarcomas, and Langerhans cell histiocytosis are more common in young individuals.

## TABLE OF CONTENTS/OUTLINE

1. Chondroblastoma 2. Chondromyxoid fibroma 3. Secondary peripheral atypical cartilaginous tumor 4. Chondrosarcoma 5. Osteoid osteoma 6. Osteosarcoma 7. Hemangioma 8. Epithelioid hemangioendothelioma 9. Aneurysmal bone cyst 10. Giant cell tumor 11. Simple bone cyst 12. Fibrous dysplasia 13. Lipoma 14. Undifferentiated pleomorphic sarcoma 15. Metastases 16. Myeloma 17. Primary lymphoma 18. Ewing sarcoma

## MKEE-87 Discordance Between Bone Mineral Density and Trabecular Bone Scores for the Lumbar Spine in the Setting of Intra-Abdominal Calcifications and Dense Surgical Materials

Yuchen Dong, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Spinal vertebrae contain the most metabolically active components, and they are therefore commonly the first site to manifest the osteoporotic process. Calcifications (i.e., fibroids, vascular calcifications, and degenerative joint disease) and dense surgical material (i.e., vertebroplasty, stents, embolization coils, and IVC filters) within the field of view falsely elevate bone mineral density (BMD) measurements. To mitigate such artifactual elevation of BMD measurements, the International Society of Clinical Densitometry (ISCD) has come up with guidelines for BMD reporting such as excluding affected vertebrae from analysis. Trabecular Bone Score (TBS), on the other hand, is a novel tool for assessing fracture risk by analyzing bone trabecular microarchitecture. Despite being adherent to ISCD guidelines, we have found in clinical practice that many patients with intra-abdominal calcifications and surgical material have normal lumbar spine BMD measurements but low TBS scores. These inconsistencies suggest that the utilization of DXA BMD measurements alone may under-predict fracture risk, especially in patients with calcifications or surgical material, and that TBS may be especially helpful as an adjunct to DXA in this patient population.

## TABLE OF CONTENTS/OUTLINE

1. Fundamentals of DXA. 2. Pathophysiology of osteoporosis. 3. Fundamentals of TBS. 4. Limitations of DXA in the setting of intra-abdominal calcifications and surgical material. 5. Case comparisons of DXA and TBS scores to demonstrate discordances. 6. Conclusion.

## **MKEE-88 Peripheral Arthropathies: Step by Step**

Raquel Acosta Hernandez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Introduction: Despite the development of CT and MRI, plain radiography stands as the irreplaceable test of first diagnostic approach in peripheral arthropathies. Following a complete diagnostic algorithm helps to emphasize the key points in the differential diagnosis between inflammatory versus osteoarthritis disease. Once joint space narrowing is evaluated, the presence of bone erosions (as a hallmark of joint inflammatory arthritis in ankylosing spondylitis, psoriatic arthritis, and reactive arthritis), osteophytes (typical of degenerative arthritis), and their distribution are basic pillars on guiding an accurate diagnosis. Teaching points Approach the radiographic algorithm evaluation of peripheral arthropathies based on classification into inflammatory or degenerative pattern: joint space narrowing (uniform and non-uniform), bone erosion and distribution pattern. Introduced a systematic reading of hands and feet plain radiographs following the ABCDs acronym: articular, bone, cartilage, distribution and soft tissue. Correlate typical plain radiographic of peripheral arthritis findings with CT and MRI studies.

### **TABLE OF CONTENTS/OUTLINE**

- Radiographic algorithm evaluation of peripheral arthropathies based on joint space narrowing and typical examples of articular erosions patterns.- Systematic ABCDs acronym reading: articular (deformity and destruction), bone (erosion, osteopenia, proliferative changes and distal affectation), cartilage, distribution and soft tissue (soft tissue swelling).

## **MKEE-89 Imaging Findings of Monoclonal Gammopathy of Clinical Significance**

Anika Dutta, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Monoclonal Gammopathy of Clinical Significance (MGCS) describes a constellation of diseases involving clonal B cells or plasma cells which produce monoclonal proteins and cause organ damage. MGCSs can be divided into groups based on which organ systems are most affected. Some of these entities have distinct imaging findings that suggest the diagnosis. By the end of this education exhibit, the viewer should be able to identify those findings and clinical symptoms that characterize them. Recognizing these findings may help lead to an expedited and accurate diagnosis.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction - what is MGCS? 2. MGCS definition and symptom classes 3. Detailed description of syndromes, for example:- POEMS syndrome (polyradiculoneuropathy, organomegaly, endocrinopathy, monoclonal plasma cell disorder, and skin changes): Description, Imaging findings with case example-AL Amyloid: Description, Imaging findings with examples 4. Conclusions 5. References

## **MKEE-9 Patellofemoral Dysfunction: A Practical Approach and New Radiological Insights**

Lucas D. Bettin, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Patellofemoral dysfunction occurs as a result of an imbalance in the dynamic relationship between the patella and the trochlea during knee flexion, secondary to anatomical or functional abnormalities. Classic risk factors are usually limited to local anatomy, such as trochlear dysplasia, patella alta, patellar tilt and increased TT-GT distance. Recently, new concepts on the functional evaluation of the lower limbs and their relationship with the pelvis have earned more attention, including muscle function. Imaging of the patellofemoral joint includes standard radiographs of the knee to evaluate bone morphology and patellofemoral relationship. MR imaging is important to also assess cartilage, capsule and ligaments. For preoperative planning, computed tomography can assess the knee in different degrees of flexion, besides providing multiplanar reconstructions. The evaluation of the entire mechanical axis of the lower limb is also of fundamental importance. Findings such as the anterior tilt of the pelvis, femoral or tibial torsion abnormalities, increased femorotibial rotation and deviations of the mechanical axis significantly modify the dynamics of the extensor mechanism. Clinical treatment and physiotherapy are typically the first-line approach, taking into account the particularities of the mechanical axis. Surgical intervention is indicated for recurrent dislocations. Therefore, anatomical and functional concepts of the patellofemoral joint and the entire lower limb are necessary to determine the optimal treatment.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction; 2. Anatomy biomechanics; 3. Dysfunction vs. instability; 4. Radiological approach; 5. Beyond Dejour; 6. Conclusion.

**MKEE-90 What's New and Not So New in Postoperative MRI of Rotator Cuff Tendon Repair: Conventional and New Surgical Techniques, Normal and Abnormal Postoperative Findings**

**Awards**  
**Certificate of Merit**

Yeongseo Yoo, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

1. To review conventional techniques for rotator cuff tendon (RCT) repair, including correlation with postoperative MRI findings
2. To introduce newer techniques of RCT repair with MRI correlation
3. To diagnose normal and abnormal postoperative MRI findings of RCT repair, including complications and RCT repair failures

**TABLE OF CONTENTS/OUTLINE**

I. Surgical techniques on postoperative MRI of RCT repair  
A. Conventional suture techniques (single, double row, transosseous equivalent suture bridge)  
B. Newer techniques- Augmentation, pectoralis major transfer, biceps transfer, Polyglycolic acid insertion, allograft patch graft (fascia lata, dermis), biceps splinting, Others (biceps tenotomy, deltoidoplasty)  
II. Normal postoperative MRI findings  
1. MR appearance of repaired SST tendon (SI, morphology changes, gap) - thinning, high SI (Sugaya type I, II -Sugaya classification)  
2. Significance of fluid collections: glenohumeral joint, subacromial-subdeltoid bursa, subcoracoid bursa  
3. Susceptibility artifacts (air, anchor, metal from burr)  
4. Suture anchor positions: absorbable vs. non-absorbable  
5. Rotator interval change: arthroscopy portal  
III. Abnormal postoperative MRI findings  
1. Thinning of repaired tendon (Sugaya type III)  
2. Focal defect/minor discontinuity of repaired tendon (Sugaya type IV)  
3. Major discontinuity/full thickness tear with retraction (Sugaya type V)  
4. Displacement of anchors  
5. Infection (arthritis, bursitis, soft tissue infection)  
6. Fracture

**MKEE-91 The Key Determinant of Purely Lytic Diaphyseal Lesion Visibility on Radiographs: Exclusively Trabecular Versus Concurrent Endosteal Cortical Involvement**

Ustun Aydingoz, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

- Location of a lytic lesion within a long bone (i.e., metaphyseal versus diaphyseal; trabecular versus cortical involvement) is a key determinant of the lesion's conspicuity on conventional radiographs.
- Due to the sparseness of trabeculae at diaphysis, lytic diaphyseal bone lesions without matrix mineralization are visible on radiographs only if they involve the endosteal cortex.
- The oft-repeated statement that "30%-50% of trabecular bone must be removed before radiolucency becomes visible on radiographs" can be misleading: A large diaphyseal trabecular lytic lesion involving 100% of the cancellous bone may not be visible on radiographs, if it is confined to the medullary space and does not also involve at least the endosteal surface of the cortex—constituting a major limitation for conventional radiography.
- This is true for lytic lesions of all Lodwick grades: Moth-eaten or permeative lytic bone lesions that involve the diaphysis are not be visible on radiographs at sites where they spare the cortex.
- Such lytic lesions that are obscure on conventional radiography are readily detected on MRI; when a primary bone tumor is suspected and radiographs are negative, MRI is appropriate.

**TABLE OF CONTENTS/OUTLINE**

- The modified Lodwick classification of lytic bone lesions on conventional radiographs.
- Radiographic-anatomic explanation of the crucial role the location plays in lytic lesion conspicuity on radiography at different sites (i.e., metaphyseal versus diaphyseal; trabecular versus trabecular plus cortical) on anatomic specimens.
- Case examples of lytic lesions that are obscure on conventional radiographs (due to their diaphyseal medullary space involvement) but are visible on CT or MRI.

**MKEE-92 Ultrasound of Acute Tendon Tears with Emphasis on Anatomic Landmarks**

Juvel Lee, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

Ultrasound of acute tendon tears with emphasis on anatomic landmarks  
Sonography has become an essential imaging tool in musculoskeletal imaging, with precision nearly equal to that of MRI for imaging tendon abnormalities. In emergency setting, the rarity of acute tendon tears compared to overuse tendon abnormalities may result in a challenging scan for trainees, sonographers, emergency and musculoskeletal radiologists. In this education exhibit, we present an approach to sonography of acute tendon tears that may be encountered in the emergency or radiology department. The objectives of this educational exhibit are:  
Brief review of scanning techniques of the various tendons  
Recognize the normal appearance of the outlined tendons with MRI correlation and emphasizing important anatomic landmarks  
Recognize imaging presentation of the various traumatic tendon tears

**TABLE OF CONTENTS/OUTLINE**

For each structure, the following will be discussed:  
1. US scanning technique  
2. US anatomy and landmarks with MRI correlate  
3. Pathology (strains, partial, complete tears)  
Pectoralis Distal biceps Triceps Quadriceps Hamstrings Achilles tendon

and related structures

### **MKEE-93 A 360-degree Imaging Tour of Sports Injuries in the Elbow**

Lauren Pringle, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review of anatomy of the elbow, with detail of the ulnar collateral ligament bundles and bands of the anterior bundle. 2. Phases of throwing mechanism are important in understanding forces applied to different structures of the elbow and how injuries then develop. 3. Pediatric throwers are susceptible to injuries also seen in adults but can experience additional injuries seen only during certain phases of development. 4. Medial elbow injuries are among the most common and well-known in athletes but specific injuries in the posterior elbow, lateral elbow, and anterior elbow are not infrequent and will be described. 5. Illustrative cases of these injuries demonstrate important imaging findings and diagnostic tools to improve detection for learners. 6. Treatment/surgical strategies and the surgeon's perspective will also be reviewed for some of these conditions.

#### **TABLE OF CONTENTS/OUTLINE**

1. Anatomy review 2. Throwing mechanism and stresses 3. Medial elbow injuries a. Ulnar collateral ligament b. Medial epicondylitis c. Medial epicondylar apophysitis d. Ulnar neuritis e. Posteromedial impingement syndrome 4. Posterior elbow injuries a. Olecranon stress fractures b. Triceps i. Tendon ii. Muscle c. Snapping triceps 5. Lateral elbow injuries a. Panner's disease b. Capitellum osteochondral lesion c. Tennis elbow d. Synovial fold 6. Anterior elbow injuries a. Biceps b. Brachialis

### **MKEE-94 Image-guided Symphyseal and Perisymphyseal Musculoskeletal Interventions: Indications, Challenges and Authors' Experience**

Juvel Lee, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Image-guided musculoskeletal interventions in and about the symphysis pubis can be technically challenging. The joint and surrounding region are small, resulting in limited ability to maneuver and an often cumbersome procedure. Important neurovascular and visceral structures are present nearby, including the dorsal vessels of the penis in males, pudendal nerve, branches of the ilioinguinal nerve and urinary bladder, necessitating judicious pre-procedure planning. Lastly, most procedures require inguinal or groin exposure thereby making careful draping of the pelvis of paramount importance. The main benefits of image guidance are improved precision of needle placement and simultaneous visualization of the needle and critical neurovascular structures that must be avoided during needle insertion. In this education exhibit, we provide an overview of symphyseal and perisymphyseal interventions including injections, aspirations, percutaneous tendon treatments and biopsies, their indications, risks, and complications, focusing on approaches, tips and tricks to a successful procedure.

#### **TABLE OF CONTENTS/OUTLINE**

Relevant anatomy of the symphysis and parasymphyseal spaces  
Pre-procedural considerations  
General technical considerations  
For each specific procedure, the following will be outlined: Purpose, patient position, equipment, technique, anatomic considerations (critical structures to avoid)  
Specific procedures: Fluoroscopy-guided diagnostic injection  
US and fluoroscopy-guided therapeutic injection  
US and fluoroscopy-guided joint and soft tissue aspiration  
Percutaneous tendon treatments  
US and CT-guided bone biopsies

### **MKEE-95 Solitary Bone Metastasis: Multimodality Imaging Approach and Ten Years Experience**

Fernando Rodado Aranguren, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To analyze the radiological presentation and spectrum of solitary bone metastasis (SBM) through the different techniques: plain x-ray, Computed Tomography (CT), Magnetic Resonance imaging and Positron Emission Tomography/CT (PET/CT). -To present our ten year experience in two centers.

#### **TABLE OF CONTENTS/OUTLINE**

Metastatic bone disease occurs frequently in malignant tumors, but isolated involvement is unusual and has been proposed as a favorable prognostic factor against multiple bone metastatic involvement. This study aims to analyze the radiological presentation of these unique metastasis. We reviewed all bone metastases diagnosed in the last 10 years in two centers and we included patients with SBM with histological confirmation and no visceral, brain or lymph node metastases (n= 79). The primary tumors, in order of frequency, were lung, breast, prostate and melanoma. In up to 36% of SBM, the primary tumor was unknown at the time of diagnosis. 86% of the lesions were located in the spine, pelvis or femur. The most frequent radiological and clinical presentation was osteolytic lesion without periosteal reaction (75%) causing pain (42%). 68% were treated, mostly with radiotherapy. The detection of these lesions depends on their size, so the methods of choice are MR or PET/CT, with good correlation for the evaluation of the associated soft tissue mass component. In the presence of a solitary bone lesion, metastasis should be included in the differential diagnosis along with primary bone tumors, especially osteolytic

lesions in patients older than 40 years with or without cancer disease history. Radiologists should be aware of the characteristics of suspicious malignant lesions that would require biopsy.

## **MKEE-96 Musculoskeletal Paraneoplastic Syndromes**

Derek T. Nhan, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Early recognition of a paraneoplastic syndrome allows for diagnosis of an occult malignancy, and earlier treatment. This review describes unique imaging findings and clinical associations of musculoskeletal paraneoplastic disorders.1. Oncogenic osteomalacia is associated with phosphaturic mesenchymal tumors (PMT), which produces FGF23, leading to decreased calcium/phosphate absorption, and consequently insufficiency fractures.2. Secondary hypertrophic osteoarthropathy, associated with non-small cell lung cancer, manifests with digital clubbing or joint effusions and symmetric long bone periostitis.3. Cancer-associated myositis, most commonly dermatomyositis, occurs within 3 years of the diagnosis of an underlying malignancy.4. Palmar fasciitis and polyarthritits presents with painful hand swelling and palmar skin thickening. It is associated with breast and female genitourinary malignancies.5. Remitting seronegative symmetric synovitis with pitting edema presents with nonerosive polyarthritits and is associated with hematopoietic and lung malignancies.6. Pancreatic panniculitits with polyarthritits, associated with pancreatic neoplasms, shows osteolytic lesions of the distal extremities with increased periarticular edema and synovitis on MRI.7. Sweet Syndrome, associated with acute myeloid leukemia, presents with fever and erythematous skin lesions.8. Eosinophilic fasciitis presents with fascial edema and enhancement, and is associated with hematologic malignancies.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction2. Musculoskeletal Paraneoplastic Syndromes including malignant associations, clinical manifestations, and imaging features.

## **MKEE-97 Principles, Anatomy and Imaging of Ankle and Foot Tendon Transfers**

### **Awards**

**Magna Cum Laude**

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The goals of any tendon transfer are to create a stable, functioning, and plantigrade foot. Tendon transfers were reported first in the literature as early as 1881; the first case was transfer of peroneal tendons to the Achilles in a young patient who had poliomyelitis. With the eradication of polio in developed countries, experience with a variety of tendon transfers has been lost. Aside from correction of foot deformities, tendon transfer can be performed for tendon dysfunction and tendinopathy and correction of lateral ankle instability. In this education exhibit, we discuss common foot and ankle tendon transfers highlighting principles, anatomy and imaging.

### **TABLE OF CONTENTS/OUTLINE**

Anatomy and biomechanics of ankle tendon transfers Principles of tendon transfers Types of ankle tendon transfers:1. For correction of foot deformity PTT transfer for adult acquired flatfoot deformity Extensor tendon transfer for equinovarus deformity Peroneus longus to peroneus brevis tendon transfer for Charcot-Marie-Tooth disease2. For reinforcement of a diseased tendon (tendinopathy or tendon tear)FHL transfer for Achilles tendon FHL transfer for peroneal tendons FDL transfer for tibialis posterior tendon 3. For correction of lateral ankle instability Lee procedure Evans procedure Chrisman Snook procedureAncillary osseous (i.e. calcaneal osteotomy) and soft tissue (i.e. Achilles tendon lengthening) procedures

## **MKEE-98 Cricket is Coming; Are You Ready to Image**

Malini A. Lawande, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1.Cricket is one of the fastest growing sports in the world, with popularity growth in non-traditional cricketing nations like the United States and continental Europe.2.Understanding player roles and biomechanics is key to understanding common injury patterns.

### **TABLE OF CONTENTS/OUTLINE**

From starting in south east England in the 1600s and traditionally played in the Commonwealth countries, played over 5 days with a rest day to the current 100 ball and 20 over three to four hour formats with night games, entertainment value, advertisement, immigration, universal online access and money spinning leagues have resulted in unprecedented growth in popularity of cricket across the world. In the United States alone, from 30,000 people watching/playing cricket in 2006, there are now more than 200,000 people playing cricket in over 6000 teams. The Indian premier league (IPL) is the most popular league, and had a value of \$10.9 billion in 2022. Specific player roles actions in cricket predispose them to different injury



patterns. This exhibit provides a comprehensive overview of common cricketing injuries based on player role actions. The three basic roles in cricket are batting, bowling and fielding, each with sub specializations. Fast/medium pace bowlers are most prone to injuries in the spine (pars/pedicle stress), elbow, ankle (instability, posterior impingement), abdominal wall (side strain) and groin (athletic pubalgia) due to the nature of bowling action. Batsmen and fielders are prone to hamstring and quadriceps strains due to sudden sprints. Acrobatic fielding attempts diving result in shoulder injuries. Contact injuries of the fingers like dislocations fractures are common in the wicketkeeper and fielders.

## **MKEE-99    Microinstability in the Musculoskeletal System: Biomechanical Concepts to Imaging Interpretation**

Aurea V. Mohana-Borges, MD, MSc (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To introduce joint biomechanics as a guide for imaging interpretation of microinstability, emphasizing its relationship with osseous and soft tissue (capsule, ligaments, and muscles) integrity and the role of imaging [Radiographs (Rx), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI)] in its diagnosis. This guide will highlight anatomic landmarks implicated in joint stability, their relevance in different types of synovial joints, and implications in joint biomechanics. It will compare and contrast normal anatomy with examples of commonly encountered pathologies associated with microinstability.

### **TABLE OF CONTENTS/OUTLINE**

Explanation of the concept of microinstability. Demonstration of types of movements in different synovial joints. Demonstration of normal anatomy of joint stabilizers with Rx, CT, and MRI. Examples of microinstability with corresponding commonly encountered pathologies in the osseous structure and soft tissues, with emphasis on the shoulder, hip, knee, and ankle joints.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-1

### Imaging-Guided Perineural Injections of the Lower Extremity from the Pelvis to the Foot

All Day Room: Learning Center

Tanya L. Tivorsak, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Perineural injections can be performed under CT or ultrasound guidance for diagnostic and therapeutic purposes.2. Ultrasound guidance can be used for peripheral nerve injections as peripheral nerves can be localized well on ultrasound and with real-time guidance.3. CT guidance can be used for certain perineural injections such as in the pelvis that may be difficult to visualize under ultrasound.4. This exhibit will provide a guide for injecting certain nerves that are commonly requested at our institution.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction and indications for perineural injections - relieve nerve pain, pinpoint site of potential nerve injury pain prior to nerve surgery.2. Procedure preparation - pre-procedure imaging review (MR neurography), ultrasound transducers, needle size, and volume of injectant.3. Technique for injecting certain nerves from the pelvis to the foot including lateral femoral cutaneous, pudendal, genitofemoral, sciatic and piriformis muscle, saphenous (adductor canal), common peroneal, sural, superficial peroneal, and tibial nerves.4. Risks and complications.5. Overview of cryoneurolysis application and techniques.

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## Abstract Archives of the RSNA, 2023

MKEE-10

### **Out of Shape: Musculoskeletal Manifestations of Sickle Cell Disease**

All Day Room: Learning Center

Leonardo Kazunori Tsuji, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the main aspects related to musculoskeletal findings of sickle cell disease, including etiology, pathophysiology, epidemiology, clinical classification. 2. To illustrate the main imaging findings and how to assess this condition in a multimodality approach, focusing on radiographs, CT and MRI studies, including new concepts and advanced sequences.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review the main aspects related to musculoskeletal findings of sickle cell disease, including etiology, pathophysiology, epidemiology, clinical classification. 2. Clinical and imaging findings in a multimodality approach, focusing on radiographs, CT and MRI studies. 3. Musculoskeletal findings of sickle cell disease, as microcirculation or anemia related, and major complications (including septic arthritis and osteomyelitis). 4. Bring the most updated concepts of the disease and the imaging role, including advanced MRI sequences, involving diagnosis and patient care.

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## Abstract Archives of the RSNA, 2023

MKEE-101

### Rewriting the story back: Spondyloarthritis

All Day Room: Learning Center

#### Awards

##### Cum Laude

Sara Siguenza-Gonzalez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Bone marrow edema (BME) is the key requirement for a "MRI positive of sacroiliitis" in the Assessment of Spondyloarthritis international Society (ASAS). The radiologist should be careful when applying the ASAS classification criteria, because BME could also be found in early mechanical and degenerative changes, which are much more common than inflammatory disorders. Knowing the type of BME pattern, other radiological features (bone erosion, ankylosis or the spine disease), as well as the clinical picture, increase radiologists diagnostic confidence and reduce overdiagnosis of inflammatory sacroiliitis.

#### TABLE OF CONTENTS/OUTLINE

Anatomy and biomechanics of the Sacroiliac Joints (SIJs) and Spine. Including anatomical variants and pitfalls. Some clues to difference between mechanical issues and inflammatory disorders. Subchondral BME in the SIJs is a common finding in both entities, so radiologists should be careful when interpreting. Recognise principal features of spondyloarthritis in the main radiological techniques (Rx, TC, MRI and also with new techniques). Describe and illustrate general features and typical image findings in the spondyloarthritis: Ankylosing Spondylitis (AS), Psoriatic Arthritis (PsA), Reactive Arthritis (RA), enteropathy-associated arthritis and undifferentiated spondylitis. Common pitfalls and differential diagnosis with other diseases that affect the axial bone: infection, amyloidosis, tumors, DISH and traumatism.

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## Abstract Archives of the RSNA, 2023

MKEE-102

### Deep Learning Imaging Reconstruction Based Virtual Non-calcium Image Can Improve the Bone Metastasis Detection Compared with Conventional CT, Hybrid IR Based Virtual Non-calcium Image

All Day Room: Learning Center

Hiroataka Nakashima, MSc, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Deep learning imaging reconstruction (DLIR)-based virtual non-calcium (VNCA) images were created by two-material decomposition processing based on dual-energy acquisition using a fast kV switching method. 2. Compared the diagnostic performance of DLIR-based VNCA images with conventional CT in 57 patients with clinically confirmed bone metastasis. 3. Compared the diagnostic performance of DLIR-based VNCA images with hybrid IR-based VNCA images. 4. DLIR-based VNCA images were superior to the diagnostic performance of conventional CT and Hybrid IR-based VNCA images.

#### TABLE OF CONTENTS/OUTLINE

Bone metastasis is a possible disease of all carcinomas and reduces the quality of life of patients. Since CT can detect bone calcification sensitively, it is excellent in diagnosing bone metastasis with bone destruction, but bone metastasis without bone destruction is difficult to diagnose and has a problem that it is easy to overlook. Virtual non-calcium image (VNCA) is one of the material decomposition images created by dual energy CT, which is also a density image obtained by emphasizing the water component and removing the calcium component. While previous studies have reported that VNCA images are superior in detecting bone metastases, DLIR-based VNCA images offer better discrimination of metastatic lesions due to their noise reduction effect. In this exhibition, we compared the diagnostic performance of DLIR-based VNCA images with that of conventional CT and hybrid IR-based VNCA images. The results show that DLIR-based VNCA images have a higher discrimination ability than conventional images for bone metastasis.

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## Abstract Archives of the RSNA, 2023

MKEE-103

### **Osteoid Osteoma in Small Bones of Hands and Feet: 'Not' So Common with 'Not' So Small Challenges in RF Ablation**

All Day Room: Learning Center

Malini A. Lawande, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Osteoid osteomas are benign painful lesions usually seen in the long bones. Less commonly they may be seen in the small bones of hands and feet especially in the pediatric age group. 2. They have typical imaging features on MRI and CT which are diagnostic. 3. RF ablation is the recommended treatment for osteoid osteomas and are regularly done. However, the small size of the bones results in challenges that can be dealt with by using some modifications.

#### **TABLE OF CONTENTS/OUTLINE**

Osteoid osteomas are common benign tumor found commonly in children and young adults. They classically present with night pain that is relieved by non steroidal anti-inflammatory drugs. They are usually cortical lesions and most commonly occur in the long bones, with proximal femur being the most common location. Less commonly they may be seen in the spine and small bones of the hands and feet. CT is excellent at diagnosing the lesion and shows small lucent nidus and surrounding reactive bone sclerosis. MRI may be confusing due to the disproportionate marrow edema and the poor delineation of nidus if it is very tiny. CT guided radiofrequency ablation is the current accepted standard treatment for osteoid osteomas. However in small bones, this may be challenging due to the very small size as well as proximity of neurovascular structures. We will discuss the imaging appearances of osteoid osteomas in small bones of hands and feet as well as highlight the challenges faced during RF ablation in some of these cases and some of the ways these can be overcome.

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## Abstract Archives of the RSNA, 2023

MKEE-104

### Zero Echo Time Magnetic Resonance Imaging: Physics and Clinical Utility in Musculoskeletal System

All Day Room: Learning Center

Takatoshi Aoki, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To recognize the clinical utilities of zero echo-time (ZTE) sequences in various disorders of the musculoskeletal system. 2. To understand the imaging physics of ZTE sequence, practical limitations, and image reconstruction. 3. To discuss how to incorporate ZTE sequence into the clinical workflow.

#### TABLE OF CONTENTS/OUTLINE

Physics of ZTE imaging 1 Pulse sequence design 2 Image reconstruction 3 Parameter optimization Clinical utility of ZTE in musculoskeletal system 1 Inflammatory arthritis 2 Soft tissue calcification/ossification 3 Bone and soft tissue tumors and tumor-like lesions 4 Osteoarthritis and spondylitis 5 Trauma 6 Morphometric evaluation before surgery 7 Children and fetuses Summary ZTE MRI can be readily incorporated into the clinical workflow, and CT-like images generated by ZTE MRI would minimize the need for CT contemporaneously with MRI in various musculoskeletal disorders. We systematically review the imaging physics of these sequences, practical limitations, and image reconstruction, and then discuss the clinical utilities in the musculoskeletal system while presenting several imaging examples.

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## Abstract Archives of the RSNA, 2023

MKEE-105

### Hamstring Sport Injuries: What, How, Why and Where

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Agustin M. Marrero SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To know the anatomy, function, and biodynamic aspects of the hamstrings complex. To recognize the spectrum of tearing of hamstring muscles and tendons during sports practice analyzing their mechanism of injury. To evaluate the imaging methods in the different hamstrings lesions to describe the precise location and characteristics. To describe ultrasound and magnetic resonance signs of these tears, emphasizing the prognostic criteria for recovery, return to play, and re-injury.

#### TABLE OF CONTENTS/OUTLINE

Most of muscle tears occur in the lower extremities and commonly in the hamstrings. The hamstrings complex consists of the semimembranosus (SM), semitendinosus (ST) and biceps femoris (BF) muscles. They originate from the ischial tuberosity. BF muscle has two portions, the long and short head and its distal insertion is at fibular head. ST and SM are medial, and their distal insertion is in the medial aspect of the leg. BF and ST are close to the sciatic nerve. Except for BF's short head, the hamstrings are primarily hip extensors and knee flexors. Hamstring injuries are grouped and classified, with typical tear sites that recur in sports practices during forceful stretching or high-speed running. Proximal injuries result in a large amount of time away from sports and a high risk of re-injury. Sprint tears are generally located on BF. Depending on its extent and location, we can estimate the evolution of injuries and the return to play. Finally, we will include insertional injuries in children.

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## Abstract Archives of the RSNA, 2023

MKEE-106

### Acute Traumatic Craniocervical Injuries: What to Look for and Not to Miss

All Day Room: Learning Center

Maria Carvajo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To describe acute traumatic craniocervical injuries and its classification based on a revision of cervical CTs performed in the emergency setting at 3rd level hospital. - To show key imaging features to identify stable and unstable injuries. - To present most common errors and missed craniocervical injuries as well as tips to avoid them.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy and biomechanics of craniocervical junction and ligaments. 2. Key measurements and anatomy landmarks to assess alignment of craniocervical junction. 3. Craniocervical injuries classification. 3.1. Atlanto-occipital dissociation. 3.1.1. Traynelis classification. 3.2. Occipital condyle fractures. 3.2.1. Anderson-Montesano classification. 3.2.2. Alar ligament injuries. 3.2.3. Stable and unstable injuries. 3.3. Atlas fractures. 3.3.1. Gehweiler classification. 3.3.2. Transverse ligament injuries. Dickson classification. 3.3.3. Stable and unstable injuries. 3.4. Axis fractures. 3.4.1. Odontoid fractures. Anderson and D'Alonzo classification. 3.4.2. Hangman fractures. Effendi/Francis modified by Levine classification. 3.4.3. Non-odontoid non-hangman fractures (axis body fractures). 3.4.4. Teardrop fractures. 3.4.5. Stable and unstable injuries. 3.5. Atlantoaxial subluxation. 3.5.1. Atlantoaxial rotatory fixation. Fielding and Hawkins classification. 3.5.2. Stable and unstable injuries. 4. Pitfalls of craniocervical injuries at CT imaging. 5. Conclusions.

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## Abstract Archives of the RSNA, 2023

MKEE-107

### Ultrasound Guide to Have at Your Fingertips: Wrist and Hand Evaluation

All Day Room: Learning Center

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To emphasize the potential of ultrasound in the assessment of musculoskeletal structures. 2. To become familiar with the normal sonographic appearance of the wrist, hand and fingers. 3. To propose a systematic approach to perform a complete ultrasound of the wrist, hand and fingers. 4. To show the correlation of the ultrasound findings with MR images and anatomical drawings for a better understanding.

#### TABLE OF CONTENTS/OUTLINE

Ultrasound is an imaging technique very useful in the assessment of musculoskeletal structures. However, for its correct interpretation, it is essential for the explorer to be familiar with the ultrasound appearance of normal anatomical structures, which can be difficult at the beginning. This work is intended to be an aid for anyone who wants to get started in musculoskeletal ultrasound of the wrist, hand and fingers. First of all, we will check the basic requirements to perform a proper musculoskeletal ultrasound. Then, we will systematically review the normal ultrasound anatomy of the different musculoskeletal structures of the wrist, hand and fingers, dividing them according to their dorsal or ventral location. We will also propose some tips and tricks, and we will highlight the importance of dynamic maneuvers. In order to make our work more visual, we will correlate the different ultrasound images with anatomical drawings and MR images, which will allow a better understanding.

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## Abstract Archives of the RSNA, 2023

MKEE-108

### MR Imaging of Traumatic Injury of the Fingers

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Roque Oca, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the anatomy of the fingers, focusing on the extensor and flexor complexes, as well as the passive stabilizers of their joints. 2. To detail the MRI protocol used for the study of traumatic pathology of the fingers. 3. To illustrate by means of representative cases the most frequent pathology of the fingers after blunt trauma. 4. To teach instability patterns, which may be useful when understanding and describing the MRI findings in these patients.

#### TABLE OF CONTENTS/OUTLINE

Traumatic injuries of the fingers are one of the frequent reasons for musculoskeletal MRI evaluation. It is important to know the specific anatomy of the tendon structures and ligaments, as well as the most frequent injury patterns. Extensor finger complex, including central and lateral slips, as well as sagittal bands; flexor tendon, pulleys and articular structures (main and accessory collateral ligaments, and volar plate) play a capital role in finger biomechanics. Closed finger trauma frequently causes instability patterns (in coronal, sagittal or combined planes) that should be recognized and that facilitate the understanding of the lesion mechanism and its diagnosis. Thus favoring an adequate treatment and a prompt recovery. Injuries secondary to closed trauma of the fingers will be reviewed, with a detailed description of their semiology and the injured structures and their complications.

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## Abstract Archives of the RSNA, 2023

MKEE-109

### Read It Like a Pro: Tips And Tricks To Interpret Lumbar Spine MRI

All Day Room: Learning Center

Ana Cristina Delgado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the normal spine anatomy of lumbar spine 2. review lumbar spine MRI protocol 3. Analyze step by step the systematic of lecture of spine lumbar MRI, learn how to make a good MRI report, describe findings with standardized nomenclature. 4. Identify, review the most common findings in lumbar benign-malignant pathology.

#### TABLE OF CONTENTS/OUTLINE

Description of general characteristics in lumbar spine a) Anatomy review b)MRI protocol sequences c)Systematic lecture of lumbar spine MRI,how to elaborate a good report.Review of MRI cases, common findings in lumbar spine pathology Pathologies included:a) Degenerative changes of intervertebral disc.b) Degenerative changes of vertebral body.c) Degenerative changes of facet joint. d) Malignant pathology. e) Others: infection, cystic lesions, trauma.

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## Abstract Archives of the RSNA, 2023

MKEE-11

### Exploring Osteochondral Lesions of the Talus: Imaging Evaluation and Treatment Options

All Day Room: Learning Center

Lucas K. Miyahara, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: 1. Review the talar dome anatomy, and pathophysiology of osteochondral lesions 2. Illustrate and discuss the patterns of osteochondral injuries and main surgical options with didactic cases. 3. Highlight the main information that radiologists should include in the report when analyzing an osteochondral lesion of the talus and their postoperative imaging.

#### TABLE OF CONTENTS/OUTLINE

Osteochondral lesions of the talus are lesions of the articular cartilage of the talus and underlying subchondral bone. Trauma accounts for the majority of osteochondral lesions, with an osteochondral lesion occurring with over half of ankle sprains, especially if there is a fracture. Introduction: General review of talar dome anatomy, and pathophysiology of osteochondral lesions. Preoperative evaluation: Main information that should be included in the radiological report. Clinical relevance of the findings. Staging: Didactic illustration about the historical classic staging systems. Postoperative evaluation: Main surgical techniques considerations. Main information that should be included in the radiological report. Bibliographical references.

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## Abstract Archives of the RSNA, 2023

MKEE-110

### **Under Pressure: Exploring Normal Anatomy and Entrapment Neuropathy of the Ulnar Nerve**

All Day Room: Learning Center

Matthew G. Tracey, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe the normal course and imaging appearance of the ulnar nerve with emphasis on the cubital tunnel and Guyon's Canal. 2. Describe the anatomical boundaries of both the cubital tunnel and Guyon's Canal. 3. Discuss ulnar neuropathy symptoms. 4. List common etiologies of ulnar nerve compression. 5. Discuss the MR appearances of ulnar nerve impingement in the cubital tunnel and Guyon's Canal. 6. Identify the normal motion of the ulnar nerve within the cubital fossa under ultrasound as well as the abnormal motion of the nerve in the setting of symptomatic anterior dislocation and snapping triceps syndrome.

#### **TABLE OF CONTENTS/OUTLINE**

We review the normal course of the ulnar nerve with attention to sites of potential compression, namely the cubital tunnel and Guyon's Canal. We review the anatomical boundaries of the cubital tunnel and Guyon's canal on MR imaging. We examine the structures innervated by the ulnar nerve and the clinical signs/symptoms of ulnar neuropathy corresponding to the site of impingement. We list common etiologies of entrapment neuropathies. We review the normal MR appearance of the ulnar nerve and utilize MR cases to illustrate the abnormal appearance of impingement in the setting of cubital tunnel and Guyon's canal syndrome. We present dynamic ultrasound examples demonstrating both the typical movement of the ulnar nerve in the cubital fossa, as well as abnormal motion in the setting of dislocation and snapping triceps syndrome. We discuss common surgical treatments of ulnar nerve dislocation and review the expected MR appearance of ulnar nerve anterior transposition.

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## Abstract Archives of the RSNA, 2023

MKEE-111

### Fight of Phyte Calcification & Ossification Around Spine

All Day Room: Learning Center

Kengo Ikejima, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Understand the mechanism of perivertebral sclerotic changes  
2. Learn the imaging findings of representative perivertebral sclerotic changes along with specific cases  
3. Learn about complications associated with perivertebral sclerotic changes  
4. Learn key points for differentiating perivertebral sclerotic changes

#### TABLE OF CONTENTS/OUTLINE

Spine anatomy, particularly joint structures and ligaments  
Pathophysiology of Osteophytes  
Pathophysiology of Syndesmophytes  
Pathophysiology of common calcium deposition diseases that occur in the perivertebral region  
Cases:-  
Spondylosis- Ossification of the posterior longitudinal ligament- Ossification of the ligamentum flavum- Calcium pyrophosphate dihydrate deposition disease- Calcific tendinitis of the longus colli muscle- Ankylosing Spondylitis- Psoriatic arthritis- Diffuse idiopathic skeletal hyperostosis (DISH)- SAPHO syndrome- Osteitis condensans ilii- Dystrophic calcification- Intervertebral disc calcification

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## Abstract Archives of the RSNA, 2023

MKEE-112

### Looking Beneath the Surface: Imaging of Bone Surface Lesions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Utkarsh Parwal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Define intracortical, subperiosteal, periosteal, and parosteal/juxtacortical locations along the bone surface. 2. Understand that multiple cell types within the bone surface give rise to bone-forming, cartilage-forming, and fibrous surface lesions. 3. Generate a differential diagnosis for surface lesions spanning benign, malignant, infectious, and traumatic etiologies.

#### TABLE OF CONTENTS/OUTLINE

1. Bone surface anatomy and terminology. a. Define intracortical, subperiosteal, periosteal, and parosteal/juxtacortical locations. b. Illustrate the two layers of the periosteum: inner cambial and outer fibrous. Briefly discuss important cell types within the bone surface as the originators of bone-forming, cartilage-forming, and fibrous surface lesions. 2. Case based review of multiple surface lesions. a. Bone forming: Osteoid osteoma, Surface osteosarcomas (OS) - periosteal OS, parosteal OS, high grade surface OS. b. Cartilage forming: Osteochondroma, Periosteal chondroma, Bizarre parosteal osteochondromatous proliferation, Periosteal chondrosarcoma. c. Fibrous: Nonossifying fibroma, Juxtacortical desmoid tumor, Osteofibrous dysplasia. d. Infectious: Cortical osteomyelitis, Subperiosteal abscess. e. Traumatic: Stress reaction, Periostitis ossificans

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## Abstract Archives of the RSNA, 2023

MKEE-113

### Can you See Me Now? A Case Based Quiz Of Shoulder Instability Lesions

All Day Room: Learning Center

Ana Cristina Delgado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe and recognize the different key clinical/imaging features that help diagnose each glenohumeral instability entity. 2. Identify through a series of MRI/ Arthrography MRI image based cases the different glenohumeral anterior, posterior instability lesions. 3. Describe the role of different imaging modalities in the diagnosis of glenohumeral instability, evaluate the MRI/ Arthrography MRI imaging findings that can help radiologists discriminate differential diagnosis. 4. Review static dynamic glenohumeral stabilizers.

#### TABLE OF CONTENTS/OUTLINE

-Pathologies will be presented in a case based format with pertinent MRI/ Arthrography MRI images and a brief clinical history. -Diagnostic clue section divided in clinical facts ( general features, miscellaneous information) radiological facts ( key imaging findings, best image modality for further evaluation). -Review the concepts and important tips for image diagnosis. - Review anatomy of static dynamic glenohumeral stabilizers. -Pathologies included: a) Anterior instability: Classic Bankart, HAGL ( Humeral avulsion of glenohumeral ligament), GLAD ( Gleno labral articular disruption), Perthes, ALPSA ( Anterior Labroligamentous sleeve avulsion), Hillsachs. b) Posterior Instability: Reverse Bankart, POLPSA: Posterior labro capsular periosteal sleeve avulsion), Kim , Bennet, Reverse Hillsachs. c) Variants Pitfalls: Sublabral Recess, Sublabral foramen, Buford Complex.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-114

### Elasticity Matters: Role of Shear Wave Elastography in Rheumatology

All Day Room: Learning Center

Alejandra Micolich Vergara, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

General principles of shear wave elastography in musculoskeletal radiology. Potential applications in the assessment of rheumatologic diseases. Future directions and limitations.

#### TABLE OF CONTENTS/OUTLINE

Elasticity is a fundamental characteristic closely related to the pathological state of tissues. Elastasonography is a diagnostic technique that assesses the biomechanical properties such as stiffness and elasticity of tissues by exposing them to a specific ultrasound beam. Shear Wave Elastasonography (SWE) is a non-invasive and objective method that determines the absolute stiffness value of various tissues. SWE has been validated in liver disease, thyroid, breast, prostate, skin and ocular pathologies and is being considered a promising tool in rheumatologic disorders. Greyscale and Power Doppler ultrasound as well as Magnetic Resonance Imaging (MRI) have been extensively studied as diagnostic techniques in rheumatologic pathologies and in 2021 the European League Against Rheumatism (EULAR) recommends elastasonography in the reporting of ultrasound studies in musculoskeletal disease. There has been advancements in recognizing the role of SWE in entities such as Primary Sjögren's Syndrome and Gout Arthritis, however, future prospects include exploring its utility in the early diagnosis and therapeutic response monitoring in Rheumatoid Arthritis, Systemic Lupus Erythematosus and Thumb Osteoarthritis. We will review the potential applications of SWE in different rheumatologic disorders using a case based approach.

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## Abstract Archives of the RSNA, 2023

MKEE-115

### Not Normal: An Illustrated Guide to Potentially Symptomatic Musculoskeletal Anatomic Variants

All Day Room: Learning Center

Matthew R. Skalski, DC (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review commonly discovered anatomic variants on routine musculoskeletal imaging that may be symptomatic or become symptomatic.
- Recognize what imaging features suggest a given variant may be at risk of being symptomatic or require treatment, and what additional imaging may be required for a more definitive diagnosis.
- Discuss treatment options available for the management of pain associated with anatomic variants, including: activity modification, physical therapy, image-guided injection, and surgery.

#### TABLE OF CONTENTS/OUTLINE

- Spinal variants o Upper cervical § Dens retroversion § Posterior arch agenesis § Short arch o Rib anomalies cervical ribs o Segmentation anomalies § Congenital block § Occipitalization § Hemivertebra § Butterfly o Oppenheimer ossicle o Lumbosacral transitional vertebra o Sacroiliac variants o Coccyx angulation o Posterior elements § Baastrup pseudoarthrosis § Hypoplastic facets § Facet tropism o Piriformis sciatic nerve o Other
- Hip o Developmental dysplasia o Cam/pincer o Coxa profunda protrusio o AIIS morphology o Coxa vara valga
- Wrist hand o Ulnar variance o Type 2 lunate o Coalition o Os styloideum
- Shoulder o Acromion shape slope o subcoracoid o Coracoclavicular joint o glenoid dysplasia hypoplasia o Luschka tubercle o Os acromiale
- Elbow o Anconeus epitrochlearis o Gantzer's muscle o Synovial fold o Os supratrochlear dorsale o
- Knee o Patellofemoral anomalies § Patella type § Trochlear groove § Patella alta/baja § Bi/multipartite patella o Aberrant popliteal and anterior tibial artery o Discoid meniscus o Plica
- Foot ankle o Os trigonum syndrome o Painful os peroneum o Accessory muscles o Type II os naviculare o Coalition o Os intermetatarsium o Sesamoid anomalies

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-116

### Calcifications as Harbingers of Malignancy in Soft Tissue Tumors: A Case-Based Review

All Day Room: Learning Center

#### Awards

##### Cum Laude

Atefe Pooyan, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Gain familiarity with the morphology of calcifications in soft tissues 2. Demonstrate that approaching soft tissue calcifications based on morphologic appearance, distribution, and tumor cell-type can yield clues when triaging lesions 3. Present scenarios in which soft tissue calcifications are helpful in assessing the malignancy or benignity of a lesion

#### TABLE OF CONTENTS/OUTLINE

Key Anatomic or Pathophysiologic Issues, Imaging Findings or Imaging Technique This case-based exhibit will review the morphology of soft tissue calcifications (e.g. stippled, chondroid, coarse, osseous, amorphous), with imaging correlation using multiple modalities (i.e. radiographs, CT, and MR), as demonstrated by various cases of benign and malignant pathophysiologic processes of calcification. Conclusion 1. Approaching soft tissue calcifications according to their descriptive morphology and location can yield clues into interpreting a lesion's malignant potential. 2. Calcifications are disproportionately represented by the most common high-grade soft tissue neoplasms, including synovial sarcoma, liposarcoma, and undifferentiated pleomorphic sarcoma, which comprise more than half of all soft tissue malignancies. 3. Malignant tumors can have a characteristic morphology of calcifications, such as stippled calcifications in synovial sarcoma and central osseous calcifications in extra-skeletal

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## Abstract Archives of the RSNA, 2023

MKEE-117

### Posterior Ankle Pain: Pathologies Surrounding the Kager Fat Pad

All Day Room: Learning Center

Leandro A. Mazza, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe the anatomy of the Kager fat pad (KFP) and its relationships with the rest of the structures of the posterior region of the ankle. To analyze the different pathologies responsible for posterior ankle pain and the degree of involvement of the KFP in each of them. To discuss the role of KFP in the symptomatology of these entities

#### TABLE OF CONTENTS/OUTLINE

KFP is a mass of adipose tissue that occupies the Kager triangle, located between the Achilles tendon, the flexor hallucis longus and the calcaneus. Although its content is predominantly fatty, it also contains nerves and small vessels. It presents multiple connections with the different anatomical structures that surround. Three regions that are closely related to the sides of this triangle have been described. The most firmly linked to the Achilles tendon being an important part of its entheses. The more mobile, wedge-shaped and closely related to the calcaneus moves passively and actively towards the retrocalcaneal bursa during plantarflexion. These relationships make the KFP a necessary participant, to a greater or lesser extent, in a large part of the different entities that present with posterior ankle pain. We will describe tendinopathies, os trigonum syndrome and other causes, with particular interest in the degree of involvement of the KFP.

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## Abstract Archives of the RSNA, 2023

MKEE-118

### Don't Touch Lesions: How Can We Avoid the Misdiagnosis

All Day Room: Learning Center

Janaina M. Moreira (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Don't touch lesions are incidental findings, that are divided into three categories: Post traumatic, normal variants, and lesions that are real but obviously benign. Radiography is the first method used for the identification, characterization, and classification of these type of lesions. However, some cases can be so challenging that computed tomography or magnetic resonance imaging are used to evaluate the lesion, therefore increasing the accuracy of the diagnosis. The purpose of this presentation is to review the imaging characteristics of typical skeletal "don't touch" lesions in the many imaging methods such as X-Ray, computed tomography (CT) and magnetic resonance imaging (MRI) therefore avoiding misdiagnosis and invasive procedures, which reduces the morbidity and costs in the health care system.

#### TABLE OF CONTENTS/OUTLINE

Case based didactic review of the radiological appearance of the "don't touch" lesions including clinical and epidemiological aspects of bone infarction, osteopoikilosis, intraosseous migration of tendinous calcification, myositis ossificans, aggressive vertebral hemangioma, among others, based on our service's digital archive.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-119

### High-Resolution Ultrasound of the Nerves of the Foot and Ankle: A Landmark Approach to Scanning and Review of Common Pathologies

All Day Room: Learning Center

#### Awards

##### Cum Laude

Lisa M. Billone, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: 1. Review the anatomy of the nerves at the level of the foot and ankle, using a landmark approach with cadaveric correlation. 2. Highlight clinical signs and symptoms warranting a detailed ultrasound nerve assessment, relating them to specific nerves. 3. Review common sites and causes of nerve injury and entrapment at the foot and ankle and demonstrate associated abnormal direct and indirect sonographic findings using diagrams, images and video clips from case-examples.

#### TABLE OF CONTENTS/OUTLINE

1. OBJECTIVES 2. INTRODUCTION 3. ANATOMY, ULTRASOUND TECHNIQUE, PATHOLOGY WITH CASE EXAMPLES FOR THE: a) Tibial nerve and medial and lateral plantar branches b) Plantar digital nerves c) Sural nerve d) Saphenous nerve e) Deep peroneal nerve f) Superficial peroneal nerve 4. TAKE HOME POINTS

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## Abstract Archives of the RSNA, 2023

MKEE-12

### **PET-MR Imaging Applications in Pediatric Musculoskeletal Tumors**

All Day Room: Learning Center

Jose Martel, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

? PET-MR imaging is emerging as a suitable technique for the assessment of pediatric malignancies, with specific applications in musculoskeletal tumors. ? Its utility includes primary tumor characterization, local / distant staging and post-treatment follow-up. ? Dose reduction of ionizing radiation and overall scanning time decrease are remarkable advantages. ? However, it has low sensibility for detection of pulmonary nodules. Chest CT remains essential in thoracic staging of pediatric musculoskeletal malignancies.

#### **TABLE OF CONTENTS/OUTLINE**

? Introduction: Integrated MRI and PET provide efficient staging of children and adolescents with malignant bone tumors by evaluating the primary tumor and the whole body in one session. ? Our protocol included a whole-body and a local tumor scan. ? Applications in pediatric musculoskeletal tumors: PET-MRI is useful in the study of osteosarcoma, Ewing sarcoma, bone lymphoma, Langerhans cell histiocytosis and bone and bone marrow metastases. We report our experience in the last ten years. ? Conclusions: the combination of functional PET imaging with the lack of non-ionizing radiation of MRI is ideal in a pediatric population.

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## Abstract Archives of the RSNA, 2023

MKEE-120

### **Do Not Harm: Thermal Protection in Musculoskeletal Abdominal Wall Soft Tissue Tumors Cryoablation**

All Day Room: Learning Center

Albert Castillo Pinar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching points: To review the main characteristics of thermoablation in musculoskeletal soft tissue tumors. To illustrate different techniques and indications of thermoprotection procedures. To show possible complications if the thermoprotection techniques are not performed correctly. Thermoablation of musculoskeletal tumors is a growing technique with good results; however, it can be limited by the location of the tumors. There are close anatomical relationships related to the tumor such as different intra-abdominal structures or the skin itself which can contraindicate the technique, make it difficult or lead to complications if the correct thermo-protection techniques are not applied. Radiologists must be familiar with the thermoprotective techniques in order to be able to choose the most appropriate in each case.

#### **TABLE OF CONTENTS/OUTLINE**

Table of contents/Outline Introduction. Classification and description of thermoprotective technique. Case series illustrating clinical situations and the application of thermoprotection techniques. Conclusion.

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## Abstract Archives of the RSNA, 2023

MKEE-121

### Non-infectious Spinal Diseases Mimicking Infection

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jungmin Lim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Infectious spinal disease may be suspected if inflammatory markers are increased in blood tests in patients with acute spinal pain and limited range of motion. These clinical findings can also be seen in spinal crystal deposition disease and intraspinal rupture of synovial cysts located in facet joints. In cases of acute inflammation in these two diseases, there is a risk of unnecessary biopsies and antibiotic treatments because the clinical and imaging findings overlap with those of infectious spinal diseases. Recognizing the radiographic characteristics of these diseases and raising awareness of these findings will be helpful in accurate diagnosis and treatment. We present various cases of spinal crystal deposition disease (crowned dens syndrome, calcific tendinitis of longus colli, calcific tendinitis of levator scapulae, facet joint crystal arthropathy, and interspinous bursitis with crystal deposition) and intraspinal rupture of facet joint synovial cyst, and present their clinical and imaging findings. This aims to raise awareness of these diseases and facilitate accurate diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Introduction  
Case 1: Calcified tendinitis of longus colli  
Case 2: Calcific tendinitis of levator scapulae  
Case 3: Crowned Dens syndrome  
Case 4: Crystal arthropathy of facet joint  
Case 5: Facet joint infection

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## Abstract Archives of the RSNA, 2023

MKEE-122

### **The Bubble Trouble: Differential Diagnosis of Cystic Bone Tumors and the Importance of Not Missing the Mark**

All Day Room: Learning Center

Leticia dos Reis Morimoto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. To review the main differential diagnosis of cystic bone lesions. 2. To expose the general evaluation of cystic bone tumors - what is necessary to report: review of the characteristics by image that must be reported and propose a structured report for bone tumors in a multimodality approach (CR, US, CT and MRI). 3. To review the main combined injuries and when to think about them. 4. To demonstrate through didactic illustrative cases the main complications that can be found due to cystic bone lesions. 5. To demonstrate currently available treatment modalities for those conditions.

#### **TABLE OF CONTENTS/OUTLINE**

1 - Radiological propaedeutics of cystic bone tumors. 2 - Radiograph, ultrasound (US) computed tomography (CT), and MRI findings in: 2.1 - Unicameral bone cyst 2.2 - Multicameral bone cyst 2.3 - Aneurysmal bone cyst 2.4 - Cystic fibrous dysplasia 2.5 - Vascular malformation (cystic angiomatosis) 2.6 - Telangiectasic osteosarcoma 2.7 - Other miscellaneous cystic tumors 3 - General evaluation of cystic bone tumors - what is necessary to report? - review of the main image characteristics. 4 - When to be suspicious of concomitant lesions and their primary associations. 5 - Propose a structured report for cystic bone tumors in a multimodality approach (CR, US, CT, and MRI). 6 - Complications related to cystic bone tumors. 7 - Therapies currently used in cystic bone tumors. 8 - Last updates and trendings of cystic bone tumors 9 - Summary and take-home message

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## Abstract Archives of the RSNA, 2023

MKEE-123

### **Knee-ding a Closer Look: MRI Evaluation of Cartilage Surgical Repair**

All Day Room: Learning Center

Leticia dos Reis Morimoto, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. Revisit the anatomy and biomechanics of knee joint and focusing in cartilage2. To demonstrate the MRI image findings in chondral lesions of the knee, with the main classifications 3. To illustrate the main operative techniques involved in knee cartilage surgery with radiology and surgery imagings correlation4. Demonstrate through didactic illustrative cases the normal and pathological postoperative image findings, focusing on MRI

#### **TABLE OF CONTENTS/OUTLINE**

1 - Anatomy and biomechanics of knee joint and cartilage2 - MRI findings in chondral lesions of the knee3 - Modified Outerbridge classification (MRI and arthroscopy imaging)4 - Noyes Classification (MRI and arthroscopy imaging)5 - International Cartilage Repair Society (ICRS) classification (MRI and arthroscopy imaging)6 - Surgery and radiologic imagings of:  
6.1 - Marrow-Stimulating Procedures (microfracture) (surgery and radiologic imagings)6.2 - Osteochondral Autograft Transplantation  
6.3 - Osteochondral Allograft Transplantation6.4 - Autologous Chondrocyte Implantation7 - Normal postoperative findings after surgical repair of the knee cartilage8 - Pathological postoperative findings after surgical repair of the knee cartilage

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## Abstract Archives of the RSNA, 2023

MKEE-124

### Dual Energy CT in Spinal Disease: Application Review

All Day Room: Learning Center

Li Neng (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Dual-energy CT (DECT) separately acquires high and low energy X-ray data to enable material characterization applications for substances that exhibit different energy-dependent x-ray absorption behavior. Based on conventional CT imaging, DECT significantly improves the detection ability of spinal lesions and adds more quantitative indicators. Virtual non-calcium (VNCa), virtual monochromatic imaging (VMI), and other parameters have unique advantages over traditional CT imaging in displaying bone marrow edema and tumor, detecting spinal urate crystal deposition, reducing spinal related metal artifacts, and intervertebral disc degeneration, showing a good clinical application prospect.

#### TABLE OF CONTENTS/OUTLINE

Vertebral fracture, Bone Marrow Lesions and Mimics, Herniation of intervertebral disc, Gout, Artifact Suppression

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## Abstract Archives of the RSNA, 2023

MKEE-125

### **Myopathies: Radiologist's Essential Tips for Clinical, Pathological, and Imaging Findings**

All Day Room: Learning Center

Yumi Tai (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) To review inherited and acquired myopathies including clinical, pathological, and diagnostic imaging findings. 2) To discuss clinico-radiological key findings in the differential diagnosis of myopathies for radiologists.

#### **TABLE OF CONTENTS/OUTLINE**

1) Imaging techniques and general imaging findings of muscle 2) Illustrated findings of the following myopathies:  
1. Hereditary myopathies : Congenital myopathies (Nemaline myopathies, Central core disease, Congenital fiber type disproportion myopathy), Muscular dystrophies (Duchenne, Becker, Limb-girdle, Myotonic, Facioscapulohumeral, Emery-Dreifuss, Oculopharyngeal), Distal myopathies (GNE myopathy, Oculopharyngodistal myopathy), Metabolic myopathies (Mitochondrial disease, Lipid storage myopathies). 2 Acquired myopathies : Inflammatory myopathies (Dermatomyositis, Antisynthetase syndrome, Immune-mediated necrotizing myopathy, Inclusion body myositis, Eosinophilic myositis, Drug-induced (Immune checkpoint inhibitor (ICI)-related myositis), Associated with GVHD), Associated with systemic disease (Overlap myositis, Muscle Sarcoidosis) 3 Clinico-radiological key findings in the differential diagnosis

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## Abstract Archives of the RSNA, 2023

MKEE-126

### Winging It: The Radiologist's Guide to the Scapula

All Day Room: Learning Center

Wilfred R. Manzano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

[1] Understanding the anatomy and bony landmarks of the scapula is important for identifying a range of pathologies, including fractures, tumors, and degenerative changes.[2] The scapula has a number of anatomic variants, particularly in the pediatric population, that may mimic trauma or other pathologies.[3] While radiographs can provide an initial assessment of the scapula, CT and MRI are useful imaging modalities to evaluate complex or subtle bony and adjacent soft tissue pathologies.

#### TABLE OF CONTENTS/OUTLINE

[1] Overview[2] Normal anatomy: important radiological landmarks[3] Imaging technique: dedicated scapula radiographs and the importance of CT/MRI[4] Cased-based review by pathology[5] Congenital/developmental variants: acromial ossification centers; os acromiale; Sprengel deformity; glenoid dysplasia[6] Traumatic processes: different fracture patterns (including of the scapular body, neck, glenoid, acromion, and coracoid process) and stress fractures[7] Degenerative/inflammatory processes: osteoarthritis; rheumatic conditions; elastofibroma dorsi; scapulothoracic bursitis[8] Infection and inflammation: osteomyelitis; septic arthritis[9] Neoplasm: benign and malignant[10] Hardware and related complications: curettage and graft; shoulder arthroplasty notching[11] Miscellaneous conditions: Looser's zones in osteomalacia[12] Conclusion

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## Abstract Archives of the RSNA, 2023

MKEE-127

### **Worth the Weight: Weight-bearing Cone-beam CT in Foot and Ankle Pathology**

All Day Room: Learning Center

Maryam Soltanolkotabi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Weight-bearing computed tomography (WBCT) has advantages over conventional CT and radiography, namely the ability to identify alignment issues and evaluate joint line congruencies. 2. WBCT can be used for the assessment of fracture healing, pre-operative planning, and evaluation of treatment efficacy. 3. WBCT offers technical and logistic advantages over conventional CT including decreased radiation dose, less technical training for use, and decreased space and energy demands. 4. WBCT enables reliable 3D measurements in a functionally relevant position (weight-bearing).

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Objectives/goals 3. What is weight-bearing CT and how does it work? 4. What are the advantages and disadvantages of WBCT? 5. What is the impact of WBCT on radiation dose, cost, and workflow? 6. What are the indications of WBCT? a. Fracture detection b. Alignment evaluation c. Pre-operative planning d. Evaluation of fracture healing e. Post-operative evaluation 7. How to measure in 3D? 8. What further developments are to be expected? 9. Summary/conclusion

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## Abstract Archives of the RSNA, 2023

MKEE-128

### **Percutaneous Bone Consolidation in Cancer Patients: Who and How**

All Day Room: Learning Center

Roberto Luigi Cazzato (*Presenter*) Proctor, Medtronic plc

#### **TEACHING POINTS**

- To promote the indications of percutaneous bone and spine consolidation in multi disciplinary tumor boards- To present the interventional techniques applied to consolidate impending, pathological, and secondary bone insufficiency fractures in cancer patients- To propose an algorithm useful to select the best consolidative method based on the biomechanics of the affected bone

#### **TABLE OF CONTENTS/OUTLINE**

- Indications- Techniques available based on biomechanics- Definition of the target fracture- Algorithm for bone consolidation

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## Abstract Archives of the RSNA, 2023

MKEE-129

### Spectrum of Common and Uncommon Multiple Bone Tumors: Imaging Findings with Pathologic Correlations

All Day Room: Learning Center

Yuan-Chang Chen (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Multifocality is common in metastasis, myeloma, histiocytosis, and vascular tumors, including the location of spine; occasional in fibrous dysplasia, osteofibrous dysplasia, adamantinoma, enchondroma, and osteochondroma; extremely rare in osteosarcoma and giant cell tumor. 2. Multiple bone tumors carry an increased risk of malignant transformation, especially in the enchondroma, osteochondroma, and giant cell tumor. 3. Non-ossifying fibroma are typically cortically based; osteofibrous dysplasia and osteofibrous dysplasia-like adamantinoma can be pure cortical lesions, or with medullary cavity involvement; the majority of the adamantinoma involve the cortex and complete medullary cavity; fibrous dysplasia and metastasis primarily involve the medullary cavity and occasional the cortex. 4. A stippled or ring-like pattern indicates cartilage calcification, cloud-like appearance indicates osteoid mineralization, and a ground-glass density indicates fiber matrix. 5. Age needs to be considered in solid tumors with non-specific imaging features. Metastasis, myeloma, lymphoma, and Erdheim-Chester disease are common in adults; whereas, multiple chondrogenic tumours, fibrous dysplasia, langerhans cell histiocytosis, and osteosarcoma are more frequent in young individuals.

#### TABLE OF CONTENTS/OUTLINE

1. Enchondroma 2. Osteochondroma 3. Osteoma 4. Osteosarcoma 5. Haemangioma 6. Epithelioid haemangioendothelioma 7. Giant cell tumour 8. Non-ossifying fibroma 9. Simple bone cyst 10. Osteofibrous dysplasia 11. Adamantinoma 12. Fibrous dysplasia 13. Metastasis 14. Myeloma 15. Lymphoma 16. Langerhans cell histiocytosis 17. Erdheim-Chester disease 18. Rosai-Dorfman disease

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## Abstract Archives of the RSNA, 2023

MKEE-13

### Thermal Protection Techniques During Musculoskeletal Ablation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Arash Azhideh, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Percutaneous thermal ablation of benign and malignant musculoskeletal tumors has expanded in scope and popularity in recent years. Although safe and efficacious, thermal ablation requires a thorough knowledge of the range of thermal protection techniques in order to limit the risk of thermal injury to adjacent nerves and other sensitive structures. In this educational exhibit, we briefly review the most commonly used musculoskeletal thermal ablation techniques, describe the spectrum of thermal protection techniques utilized during musculoskeletal thermal ablation, and discuss the mitigation techniques employed prophylactically or once nerve injury has occurred.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of Musculoskeletal Thermal Ablation Techniques a. Radiofrequency Ablation b. Cryoablation c. Microwave Ablation d. Other  
2. Thermal Protection Techniques a. Active Thermoprotection Techniques i. Hydrodissection ii. Gas Dissection iii. Dissection with Other Agents iv. Physical displacement methods 1. Balloon interposition 2. Blunt needle displacement b. Passive Thermoprotection Techniques i. Biofeedback ii. Neurophysiologic intraoperative monitoring 1. Somatosensory evoked potentials 2. Motor evoked potentials 3. Electromyography iii. Temperature monitoring 3. Mitigation strategies to reduce thermal nerve injury

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## Abstract Archives of the RSNA, 2023

MKEE-14

### Post-treatment Changes in Bone and Soft Tissue Tumors: A Primer for Radiologists

All Day Room: Learning Center

Daniel S. Lobo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To review the normal and pathologic findings following different therapeutic modalities in bone and soft tissue tumors: systemic treatment (chemotherapy, immunotherapy), radiotherapy and surgery.
- To illustrate complications and signs of tumor response to treatment, persistent or recurrent disease, as well as non-neoplastic complications.

#### TABLE OF CONTENTS/OUTLINE

- Brief introduction: relevance and challenges associated with post-treatment musculoskeletal tumors cases in the daily practice of the radiologist.
- Post-systemic treatment (chemotherapy and immunotherapy): Signs of treatment response; Signs of tumor progression; Systemic effect on the musculoskeletal system.
- Post-radiotherapy changes: Signs of treatment response; Local progression; Actinic changes; Others (infection, radioinduced tumors).
- Post-operative changes: Normal post-operative findings; Non-neoplastic complication; Signs of recidivant lesion.
- Conclusion and key takeaways.

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## Abstract Archives of the RSNA, 2023

MKEE-15

### Temporomandibular Joint: A Jaw-Some Multimodality Guide of TMJ Disorders

All Day Room: Learning Center

Jerky N. Ebai, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review anatomy of the Temporomandibular joint (TMJ) and its biomechanics. 2. Review clinical presentation of temporomandibular joint disorder (TMJD) 3. Discuss different causes of TMJD. 4. Multimodality overview of TMJD with emphasis on pertinent MRI findings. 5. Overview of management of TMJD.

#### TABLE OF CONTENTS/OUTLINE

Background- Temporomandibular anatomy- Clinical presentation of TMJD Causes of TMJD- Biomechanical/Traumatic- Internal derangement (Disk Displacement with reduction and Disk displacement without reduction)- Fractures- Dislocation.- Inflammatory Arthritis (Rheumatoid Arthritis, Psoriatic Arthritis Juvenile and Inflammatory Arthritis)- Degenerative Arthritis- Crystal Arthropathy- Neoplastic/Variant (Synovial chondromatosis, Tenosynovial giant cell tumor, TMJ aplasia/hypoplasia and TMJ hyperplasia) Pertinent MRI Findings- Direct Signs (Abnormal disk morphology Abnormal disk displacement in closed-mouth position Abnormal disk movement in open-mouth position Osteoarthritic changes)- Indirect Signs (Joint Effusion and Rupture of retrodiscal layers) Management (Physical Therapy, Joint Injection, TMJ Arthroplasty, Disc Plication, Discectomy and Recontouring of the articular eminence)

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## Abstract Archives of the RSNA, 2023

MKEE-16

### Augmented Bone Remodeling: An Emerging Concept in Bone Marrow MRI

All Day Room: Learning Center

Bruno C. Vande Berg, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Normal bone remodeling, the lifelong process of bone removal and reconstruction, can not be seen at CT and MRI. 2. Bone remodeling can accelerate as a physiological response to many non destructive insults to bone such as a change in biomechanical load, or adjacent bone and soft tissue lesions. 3. Accelerated bone remodeling can be seen at MRI as a marrow area with a moderate increase in signal intensity on fat-saturated fluid-sensitive images with limited or no signal changes on fat-sensitive images. 4. Signal changes patterns in accelerated bone remodeling can be linear subcortical, patchy or diffuse. 5. Knowledge of these marrow patterns at MRI is important to increase our understanding of bone pathophysiology and avoid confusion with more destructive bone lesions.

#### TABLE OF CONTENTS/OUTLINE

A/ Bone remodeling in normal and abnormal situations B/ The « regional acceleratory phenomenon » concept developed by H. Frost C/ MRI of accelerated bone remodeling Signal patterns Signal distribution D/ Correlations with pathological, radionuclide and radiological findings E/ Limitations and perspectives

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## Abstract Archives of the RSNA, 2023

MKEE-17

### Uncovering Common Lesions in the Sternoclavicular Joint and Costal Cartilages: A Diagnostic Guide

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Giancarlo Domingues, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this study is: • To provide a comprehensive review of the normal anatomy and imaging appearance of the sternoclavicular joint and costal cartilages. • To improve understanding and diagnostic accuracy of the pathologies by didactically categorizing them into five distinct groups: degenerative, inflammatory, metabolic, traumatic, and infection.

#### TABLE OF CONTENTS/OUTLINE

The sternoclavicular joint is a critical structure that connects the axial skeleton and upper extremities and enables the movement of the upper limbs. This synovial joint can undergo degenerative alterations, with osteoarthritis being the most prevalent pathology. Additionally, degenerative calcifications in the costal cartilages are frequently observed. Inflammatory conditions, such as costochondritis, SAPHO syndrome, rheumatoid arthritis and spondyloarthritis also affect these structures. Differentiating between metabolic and inflammatory disorders often requires a detailed clinical history. Infections usually occur in immunosuppressed patients and spread hematogenously. Traumatic injuries are often misdiagnosed, leading to persistent chronic pain. Although rare, posterior sternoclavicular dislocation is potentially dangerous as it can compress vital structures.

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## Abstract Archives of the RSNA, 2023

MKEE-18

### Opportunistic Imaging in Musculoskeletal Radiology

All Day Room: Learning Center

Vivek Kalia, MD, MPH (*Presenter*) Research Consultant, Hyalex Orthopaedics, Inc

#### TEACHING POINTS

1. Opportunistic imaging is leveraging existing imaging data, commonly in the form of DICOM-format CT images, to extract potentially useful clinical information unrelated to the examination's original indication. 2. Opportunistic imaging, currently employed for a fairly narrow list of indications such as osteoporosis screening, is poised to enable large-scale population-based screening in the very near future. 3. At-scale deployment of opportunistic imaging creates opportunities and challenges in MSK radiology.

#### TABLE OF CONTENTS/OUTLINE

1. Definition and technical requirements a. Artificial intelligence (AI)/machine learning (ML) algorithms 2. Areas of Current Use a. Osteoporosis screening to predict fractures i. Bone mineral density (BMD) assessment ii. Finite element analysis for bone strength assessment b. Body composition analysis to predict cardiometabolic risk and mortality i. Muscle mass (sarcopenia) and quality (fatty infiltration) ii. Visceral adiposity iii. Hepatic steatosis iv. Atherosclerotic calcifications 3. Opportunities / Areas of Potential Use in the Future a. Individual risk stratification and customization of therapy b. Large-scale population screening c. Integration into electronic health records 4. Ongoing Challenges Considerations a. Potentially important and/or confounding information will be revealed by opportunistic imaging b. Potential for overdiagnosis and patient anxiety c. Potential for increased costs of care to healthcare system and/or individual patient

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## Abstract Archives of the RSNA, 2023

MKEE-19

### Scapulothoracic Disorders: Anatomy, Kinematics and Imaging Approach

All Day Room: Learning Center

Marilia Da Cruz Fagundes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The scapulothoracic is a functional joint and an important part of the shoulder kinematic chain, supporting the center of the humeral head correctly aligned with the glenoid fossa during arm elevation and increasing the range of motion and strength of the rotator cuff muscles. Scapulothoracic disorders usually result in abnormal contact between scapula and chest wall. Pathophysiology includes structural abnormalities (such as scapula anatomic variants and bone and soft tissue expansive lesions), scapular dyskinesia (caused by denervation injuries or imbalance in muscle strength) and microtrauma (associated with overuse). Rarely, the joint may experience acute trauma leading to scapulothoracic dissociation. Primary pathologies are more frequent in young athletes, especially in throwing sports. Due to its functional nature, the identification of disorders related to scapulothoracic joint can be a diagnostic challenge for radiologists. Radiography and Computed Tomography allows the assessment of bone anatomy and anomalies, while Magnetic Resonance Imaging provides information on soft tissue causes and consequences of these disorders. Finally, imaging plays an important role in guiding treatment, whether clinical, including physiotherapy and other conservative measures, or surgical if necessary.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction; 2. Anatomy and Kinematics; 3. Pathophysiology: a. Morphological causes; b. Functional causes; 4. Imaging Assessment; 5. Management.

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## Abstract Archives of the RSNA, 2023

MKEE-2

### **Beyond the Surface: The Power of Ultrasound in Diagnosing Epidermal Inclusion Cysts**

All Day Room: Learning Center

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To know the typical sonographic features of the epidermal inclusion cyst. - To describe the different complications of epidermal inclusion cysts and their characteristic sonographic findings. - To review other cysts and tumors that, given their location, are part of the differential diagnosis of the epidermal inclusion cyst, as well as the sonographic features that allow us to suspect them.

#### **TABLE OF CONTENTS/OUTLINE**

Epidermal inclusion cysts are very frequent lesions, and their ultrasound evaluation is a daily request. As radiologists, we must be able to recognize their representative characteristics, as well as other atypical findings that should make us think of other lesions of the same location. Our work is organized as follows: 1. The epidermal inclusion cyst: brief review of its definition, etiopathogenesis, clinical presentation and histopathology. 2. Ultrasonographic features of the epidermal inclusion cyst: everything we should take into account. - Location/relation to the dermis. - Morphology. - Echostructure. - Relation with adjacent tissues. - Vascularization. - Elastography. 3. Ultrasonographic features of the different complications of the epidermal inclusion cyst, including: - Rupture. - Inflammation and infection. - Degeneration in giant cysts. 4. Differential diagnosis of the epidermal inclusion cyst: when to suspect other lesions? - Cystic lesions of adnexal origin. - True dermal and hair follicle sweat gland derived tumors. - Differential diagnosis of complicated inclusion cysts.

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## Abstract Archives of the RSNA, 2023

MKEE-20

### The Weight of the Neck: Understanding Subaxial Cervical Spine Injuries

All Day Room: Learning Center

Francis X. Cedeno Rodriguez (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Subaxial cervical spine injuries occur in the lower part of the neck (C3-C7) due to trauma and can range from mild to life-threatening. 2. Compression fractures are the most common, these fractures consist of a collapse of the vertebral body height due to trauma. Burst fractures involve posterior vertebral body wall fracture and can compromise the spinal canal. 3. Flexion and extension teardrop fractures present with typical corner fractures at typical locations. 4. Translation injuries are seen in high energy trauma mechanisms with severe flexion distraction and often associated with severe neurological sequelae. 5. Unilateral and bilateral facet dislocation result from rotational and/or flexion distraction injuries.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction  
A. Overview of Subaxial Cervical Spine Injuries  
B. Review of AO Spine Subaxial Cervical Spine Classification  
II. Radiologic Review of Types of Fractures  
A. Compression Fracture (CF)  
B. Burst Fracture (BF)  
C. Flexion Teardrop Fracture versus Linear Nondisplaced Anterior Inferior Corner Fracture  
D. Extension Teardrop Fracture (ETF)  
III. Rotation and Translation Injuries  
A. Facet Subluxation  
B. Facet Dislocation  
C. Vertebral Translation  
IV. Complications of Cervical Spine Injury  
A. Vascular Injury  
B. Spinal Cord and/or Exiting Nerve Injury  
C. Hematomas (Epidural / Prevertebral)  
D. Ligament Injury  
E. Disc Injury  
V. Conclusion  
VI. Self Assessment

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## Abstract Archives of the RSNA, 2023

MKEE-21

### **Flying High and Falling Hard: A Radiological Review of Ultimate Frisbee Injury Patterns**

All Day Room: Learning Center

Shaun H. Johnson, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Understand the game of ultimate frisbee Learn how injuries commonly occur in this sport Understand commonly reported injuries from previous literature Review imaging findings in these patients

#### **TABLE OF CONTENTS/OUTLINE**

Introduction to ultimate frisbee Defining terminology and gameplay Discussion of rules Common maneuvers Prior reports of common injuries, epidemiology Literature review of common ultimate frisbee related injuries Fajardo Pulido et al 2020 Demonstrated a high lifetime prevalence of injury with injury to the knee, thigh, ankle, and shoulder being most common Akinbola et al 2015 Ultimate frisbee accounts for a high percentage of collegiate athlete injuries with similar trends to other sports Imaging review of patients with ultimate frisbee related injuries Discussion of diagnosis, mechanism injury, correlation with activity, and management strategies, from most common to least common Knee Ligament, meniscal, tendon pathologies Overuse injuries Foot/Ankle Ankle sprains Overuse injuries Shoulder Glenohumeral dislocation Acromioclavicular joint injuries Clavicular fractures Head Concussion Wrist Injuries related to fall on outstretched hand Chest Contusions Thigh Muscle strains Elbow Conclusion Discuss similarities and differences with various sports and known injury patterns such as soccer (football), American football, rugby.

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## Abstract Archives of the RSNA, 2023

MKEE-22

### **Did You Know that Your Slot-Scan Radiograph for Scoliosis can Artefactually Cause a Worsening Spinal Curvature? Plus Other Stories of Artifacts Associated with Digital Slot-Scanning Radiography**

All Day Room: Learning Center

Sean Schoeman (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Biplanar digital slot-scanning technology is a stereoradiography imaging (SRI) system that reduces radiation exposure for patients requiring serial imaging for chronic and progressive skeletal conditions (1). This has become preferred to standard x-ray additionally because of the ability to image full length spine and lower limbs for follow-up of children with scoliosis and leg-length discrepancy - images are interpreted by pediatric radiologists and orthopedic surgeons. Here we use our experience reviewing multiple images of patients at different time points to demonstrate distinct types of imaging artifact with this imaging modality. Reviewing physicians should be aware of such artifacts so as not to confuse artifacts with pathology which may lead to misdiagnosis or unnecessary management. The purpose of this educational abstract is to demonstrate common artifacts found at our institution. 1. Melhem E, Assi A, El Rachkidi R, Ghanem I. EOS(®) biplanar X-ray imaging: concept, developments, benefits, and limitations. J Child Orthop. 2016 Feb 16;10(1):1-14.

#### **TABLE OF CONTENTS/OUTLINE**

1. Image acquisition technique for slot-scanning and resultant artifacts 2. Incorrect image centering artifact - causing change in Cobb angle and mimicking worsening scoliosis 3. Movement artifacts a. Wavy cardiac margin b. Wavy bones c. Wavy hardware 4. Edge enhancement artifacts a. Halo around hardware b. Pseudo-pneumomediastinum c. Lucency above diaphragm

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## Abstract Archives of the RSNA, 2023

MKEE-23

### Improving Bone Tissue Characterization on MRI Using Gradient-echo: The Role of Simulated CT (sCT) Sequences

All Day Room: Learning Center

Felipe P. Correa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

.Conventional MRI has limited ability to assess trabecular and cortical bone due to low proton density and markedly reduced T2 decay time..The FRACTURE sequence (Fast field echo Resembling A CT Using Restricted Echo-spacing) aims to improve the visualization of trabecular and cortical bone on MRI by simulating CT tissue contrast..In FRACTURE multiple echoes are acquired at a precise echo-spacing that corresponds to in-phase TEs. Following acquisition, the first post-processing step consists of a magnitude summation of all echoes. After summation, the images from the last echo are subtracted from the summated images to invert the grayscale and give bone a CT-like contrast..Simulated CT contrast sequences have great potential to assist in the diagnosis of inflammatory diseases, neoplasms, trauma, and normal variants. These sequences are useful for demonstrating bone fragmentation, resorption, and bone reaction, which facilitates the identification and understanding of deformities and complex bone remodeling..The great advantages of the FRACTURE sequence are the possibility of using gradient sequences available in all MRI devices and simple post-processing steps.

#### TABLE OF CONTENTS/OUTLINE

.How sCT sequence acquisition and post-processing are performed..Role of the sCT sequence to evaluate the trabecular and cortical bone in routine examinations..Cases of clinical practice in which the sCT sequence turned out to be superior to conventional MRI for trabecular and cortical bone abnormalities.

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## Abstract Archives of the RSNA, 2023

MKEE-24

### Shouldering the Load: Bridging the Gap of Rotator Cuff Tears with Patch Augmentation

All Day Room: Learning Center

Sirui Jiang, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Anatomy of the rotator cuff  
2. Common patterns of rotator cuff tears  
3. Standard of practice for surgical repair  
4. Emerging treatments in graft augmentation  
5. Advanced imaging characteristics of graft-augmented versus conventional repairs

#### TABLE OF CONTENTS/OUTLINE

1. Review of rotator cuff anatomy,  
2. Clinical presentations of rotator cuff tears  
3. Spectrum of rotator cuff disease  
3a. Prevalence of tears and common tear patterns,  
3a.i. Acute versus chronic tear presentations and diagnosis,  
3a.ii. MRI findings and Goutallier classification,  
3a.iii. Ellman classification of partial-thickness rotator cuff tears,  
3a. iv. Massive rotator cuff tears,  
4. Arthroscopic Repair Techniques,  
4a. Single versus double row repair,  
4b. MRI findings after conventional arthroscopic repair,  
4b.i. Failure findings,  
4b.ii. Assessment of repaired tendon quality (Sugaya Classification),  
5. Patch augmentation,  
5a. Indications for patch augmentation,  
5b. Benefits and complications of patch augmentation,  
5b.i. Reduction in retear rate and improvement in tendon thickness/quality,  
5b.ii. Complications with xenografts,  
5c. Types of patch augments,  
5c.i. Collagen Scaffold (Regeneten),  
5c.i.a. Clinical outcomes and MRI features of healed Regeneten patch,  
5c.ii. Acellular dermal allograft (Dermis-on-demand),  
5c.ii.a. Clinical outcomes and MRI features of healed Dermis-on-demand,  
6. Future directions,  
6a. Anticipated advancements,  
6b. Biologic injections (PRP, stem cells) with concomitant patch augmentation

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## Abstract Archives of the RSNA, 2023

MKEE-26

### **Navigating the Lumbosacral Plexus: A Guide to Understanding its Normal Anatomy and Injuries.**

All Day Room: Learning Center

LEON PERIN (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The aim of this study is: 1. Review with didactic illustrations the anatomy of the lumbosacral plexus, including how to recognize it on MRI. 2. Demonstrate how various lumbosacral plex injuries manifest clinically and on imaging studies. 3. Present didactic cases of lumbosacral plexus injuries, highlighting the main findings that the radiologist should expect.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction and review of lumbosacral brachial anatomy, with didactic illustration.
- Review normal anatomy without MRI, highlighting anatomical landmarks.
- Overview of the main lumbosacral plexus injuries, their clinical and epidemiological manifestations and their imaging findings.
- Demonstrate with challenging clinical cases traumatic and non-traumatic pathologies, such as inflammatory polyneuropathy, other neuropathies, and associated alterations such as piriformis syndrome.
- Present a case series of lumbosacral plexus injuries and what you should actively look for depending on the clinical history.
- Propose a diagnostic checklist for evaluating lumbosacral plexus injuries, simplifying the reading of these challenging exams.
- Summary.

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## Abstract Archives of the RSNA, 2023

MKEE-27

### Crystal Spine: Findings of Spinal Crystal Deposition Disease on CT and MRI

All Day Room: Learning Center

Andrea S. Costacurta, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Crystal Deposition Disease must be considered in the differential of spinal pain. 2- Findings are often located outside the spinal canal, in the soft tissues, and can be overlooked. 3- MRI has a high sensitivity in detecting inflammation but poorly detects calcification. CT on the other hand has high sensitivity to calcification however the amount of associated inflammation is often underestimated. Awareness of the disease may help in the diagnosis.

#### TABLE OF CONTENTS/OUTLINE

1. Definition and clinical aspects of Crystal Deposition Disease. 2. Classification. 3. Brief review of pathophysiology. 4. Description of the main imaging findings in the spine: longus colli tendinitis, crowned dens syndrome, aseptic spondylodiscitis, disc, ligament or dural calcifications, facet joint arthropathy. 5. Discussion of the differential diagnosis.

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## Abstract Archives of the RSNA, 2023

MKEE-28

### Assessment of Sagittal Balance in Degenerative Spine Disease: Role of Imaging Modalities in Post-operative Follow-up

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Pedro H. Arruda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The sagittal balance depends on the correlation of the spine, pelvis and lower limbs for proper body alignment, which is crucial for maintaining a healthy posture and optimal body functioning. The pelvis sets the foundation of this alignment through pelvic incidence, which is a fixed anatomical parameter that determines the amount of lumbar lordosis required to maintain a proper balance. An increase in spinal fusion for degenerative diseases has led to a rise in postoperative complications, such as sagittal imbalance. Spinal fusion can result in a reduction of the lumbar lordosis, thus shifting forward the body's center of gravity. The body tries to compensate by pelvis retroversion or knee flexion, leading to an altered gait pattern and pain. Increased stress on the discs and facet joints adjacent to the fused spine segment may also be depicted. Imaging modalities play a crucial role in alignment monitoring. X-rays provide an orthostatic two-dimensional image of the spine or lower limbs, while MRI and CT scans identify structural abnormalities that predispose to spine imbalance, as well as disc herniation, spinal stenosis or adjacent disc syndrome. EOS imaging is a recently specialized modality that provides an orthostatic full-body and low-dose tridimensional image. Therefore, it is important to know the concept of sagittal alignment of the spine, the main measures performed, and how to interpret and describe the normal and abnormal findings.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Sagittal imbalance and compensatory mechanisms 3. Sagittal Alignment assessment A- Care in image acquisition B- What measures to perform C- How to interpret and describe 4. Pre and postoperative spine balance analysis 5. Conclusion

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## Abstract Archives of the RSNA, 2023

MKEE-29

### Back to the Future: Automatic Deep Learning Approaches to Opportunistically Assess Spine Health

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Abhinav Suri, BA, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Complications from spine diseases are highly prevalent across the world. For example, over 1.5 million individuals suffer from back pain due to vertebral fractures and millions more are afflicted with neurogenic back pain. One way to prevent these diseases from developing is to opportunistically assess imaging studies for overall spine health by trending changes in quantitative spine metrics. However, the process of making measurements necessary to diagnose such pathologies is time-consuming, resulting in high underreporting rates for some of the aforementioned conditions (as high as 85%). This exhibit will focus on explaining how deep learning algorithms can be used for detecting vertebral body and disc deformities, trending Cobb angle, assessing paraspinal muscle fat content, and quantifying spinal cord/foramen compression.

#### TABLE OF CONTENTS/OUTLINE

At the end of this presentation the learner should have knowledge about the following:1. Overview of the prevalence of vertebral fractures, disc herniation, spinal cord compression, scoliosis and current manual methods used to quantify severity of these pathologies.2. How neural networks can be used for anatomic object detection across multiple modalities using novel visual transformer and deep convolutional neural networks.3. How keypoint detection networks can be used for automated quantitative vertebral deformity diagnoses.4. How segmentation networks can be used to extract vertebral bodies, intervertebral discs, paraspinal muscles, spinal canal/cord/foramina using 2D and 3D UNets and Swin3D transformer networks.5. A framework for how these measurements can be used for comprehensive spine health assessment in an opportunistic manner.

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## Abstract Archives of the RSNA, 2023

MKEE-3

### Imaging of Meniscal Root Tears: A Practical Review

All Day Room: Learning Center

Bruno E. Watabe, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to:•Review and illustrate the anatomy of the meniscal roots and their specific characteristics.•Illustrate and discuss patterns and classifications of injuries involving these structures, along with their clinical relevance.•Illustrate and discuss various surgical treatments, arthroscopic correlation, and postoperative imaging findings of meniscectomy and repair with suture techniques.

#### TABLE OF CONTENTS/OUTLINE

The meniscal roots and supporting structures anchor the menisci to the tibial plateau, resisting hoop stress and preventing radial displacement of the menisci and subsequent degeneration of the tibiofemoral compartment. Imaging helps determine the type and location of lesions, guiding treatment decisions. An accurate description of lesions and associated imaging findings helps orthopedic surgeons determine the best surgical technique and improve patient outcomes. • Anatomy: Illustration and imaging of the tibial plateau and sites of meniscal root fixation, highlighting their specific characteristics. • Pathological Conditions: Recognition of degenerative changes and various types of traumatic tears in the meniscal roots, along with commonly associated findings, can aid in treatment decisions and potentially delay the onset of secondary osteoarthritis due to meniscal lesions. • Surgical Treatment and Postoperative Imaging: Illustration of different surgical techniques, including partial meniscectomy and meniscus repair, along with their indications and contraindications. Arthroscopic correlation and postoperative images showing follow-up within a certain time interval and potential outcomes.

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## Abstract Archives of the RSNA, 2023

MKEE-30

### **Hip Instability Beyond Dislocation: An Overview of New Concepts and Current Radiological Approaches**

All Day Room: Learning Center

Julio B. Guimaraes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Hip instability is conceptually divided into traumatic and atraumatic causes, eventually leading to long-term complications, such as osteoarthritis. Hip dislocation and subluxation are well-established entities associated with high and low-energy trauma. Conversely, microinstability is a developing concept, mainly atraumatic, characterized by the inability to keep the femoral head centered within the acetabular fossa in extra physiological movements, which diagnosis involves detailed anamnesis and physical examination, as well as imaging approach. Bone markers for instability are classified into acetabular and femoral subgroups, which can be evaluated by radiographs and CT scans. Acetabular coverage and orientation are assessed to diagnose developmental hip dysplasia. In patients with borderline acetabular coverage, the concomitant evaluation of the Shenton line and femoral physeal scar orientation can determine microinstability diagnosis. The femoral head is assessed for bone morphology, CAM deformity, femoral torsion and neck-shaft angle. Connective tissue disorders are best depicted with MRI, related to capsular laxity, thinning or redundancy. Iatrogenic causes are related to capsular disruption due to intra-articular assessment during hip procedures. MRI can also reveal specific secondary chondral and labral lesions resulting from those structural abnormalities.

#### **TABLE OF CONTENTS/OUTLINE**

1. Definition; 2. Anatomy; 3. Pathophysiology: a. Traumatic: i. Dislocation and subluxation; b. Microinstability (atraumatic): i. Bone insufficiency; ii. Soft tissue insufficiency; iii. Post-surgical; 4. Imaging Assessment; 5. Management.

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## Abstract Archives of the RSNA, 2023

MKEE-31

### Imaging Spectrum of Foot Infections: A Practical Guide to Radiologists

All Day Room: Learning Center

Carlos Francisco Kallas Pereira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The differentiation between foot infection imaging patterns is a common challenge for radiologists. Imaging methods provide detailed anatomical information in the assessment of infections, thus helping clinicians to reach the most accurate diagnosis. CT scans play a key role in providing multi planar reconstructions for bone evaluations, whereas MRI is highly sensitive for detecting osteomyelitis in initial stages and can help particularly in looking for soft tissues' complications. In this evaluation it is also important to understand the particularities of each etiological agent. Bacteria is the most common cause of infection, frequently associated with synovitis and osteomyelitis. Tuberculosis can also be related to tenosynovitis and osteomyelitis, especially in immunocompromised patients. Fungal infections have been described to have the classic "dot in a circle" sign on T2 weighted images. It is also important to remember foreign bodies related infections, to avoid misdiagnosis. The diabetic foot is another condition that requires special attention by radiologists. Neuropathic arthropathy predisposes to a greater risk of infection, mostly due to the loss of sensitivity, repetitive trauma and poor healing. Osteomyelitis and Charcot arthropathy frequently coexists, therefore, it is essential radiologists to understand the particular imaging features of these conditions and how they affect the foot compartments, to aid in diagnosis and proper management.

#### TABLE OF CONTENTS/OUTLINE

Background/epidemiology  
Anatomy, vascularity and foot compartments  
Etiological agents  
Diabetic foot  
Imaging techniques  
Diagnostic approach: what to report?  
Differential diagnosis  
Take-home Points

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## Abstract Archives of the RSNA, 2023

MKEE-32

### **MRI and US Evaluation of the Carpal Tunnel and Guyon's Canal: Normal Anatomy, Pathological and Postoperative Findings**

All Day Room: Learning Center

Diego N. dos Santos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Report general information about the carpal tunnel and Guyon's canal.- Review the normal anatomy of these canals and their main anatomical variations.- Describe its pathological involvement and its imaging patterns and postoperative evaluation on ultrasonography (US) and magnetic resonance imaging (MRI), through clinical cases from our service.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction:- General information about the carpal tunnel and Guyon's canal.Normal anatomy of carpal tunnel and Guyon's canal.Clinical cases of pathological and postoperative findings and its imaging patterns on US and MRI:\* Carpal Tunnel:- Carpal tunnel syndrome- Anatomical variation of carpal bones with tunnel reduction- Accessory tendon of the superficial flexor muscle- Arthrosynovial cyst determining median nerve neuropathy- Calcium deposit in the carpal tunnel- Thrombosis of the ulnar tributary artery\* Guyon's canal:- Arthrosynovial cyst in Guyon's canal- Thrombosis of the ulnar artery\* Other structures:- Neuropathy of the palmar cutaneous branch of the median nerve\* Postoperative findings:- Postoperative changes from carpal tunnel decompression / median nerve injury- Postoperative median nerve neuroma\* Other cases

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## Abstract Archives of the RSNA, 2023

MKEE-33

### Plain Film Evaluation of the Traumatic Knee: A Case-Based Primer

All Day Room: Learning Center

Mariam S. Mostamandy, BS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The knee is a commonly injured joint in both children and adults. Plain film evaluation is often first line and familiarity with knee anatomy on plain films is critical for appropriate imaging evaluation. This exhibit reviews normal anatomy of the knee on plain films and illustrates the utility and limitations of plain films in evaluation of the knee joint in the setting of trauma. Utilizing a case-based approach, it reviews common and uncommon knee injuries, their mechanisms, and offers pearls and pitfalls to aid the radiologist in comprehensive radiographic assessment.

#### TABLE OF CONTENTS/OUTLINE

Anatomy Intercondylar Fractures Tibial Plateau Fractures Patellar Fractures Patellar Dislocation Avulsion Injuries Physeal Injuries Stress Fractures Knee Dislocation

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## Abstract Archives of the RSNA, 2023

MKEE-34

### Avoiding the Iceberg and the Ring of Fire: Thermal Protection on Musculoskeletal Ablations

All Day Room: Learning Center

Mario H. Carneiro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1 - Review and explain the methods that can be used to protect the tissues surrounding thermoablation areas. 2 - Discuss the monitoring methods and devices to evaluate sensitive structures near procedure sites. 3 - Didactic clinical cases with images of musculoskeletal ablations, each kind of protecting measures and potential complications.

#### TABLE OF CONTENTS/OUTLINE

1 - Types of musculoskeletal ablations; 2 - Radiofrequency; 3 - Cryoablation; 4 - Microwave; 5 - Interstitial laser; 6 - Complications; 7 - Safety measures on ablations; 8 - Preparation and monitoring; 9 - Thermal protection types; 10 - Hydrodissection; 11 - Pneumodissection; 12 - Mechanical manipulation; 13 - Skin temperature control.

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## Abstract Archives of the RSNA, 2023

MKEE-35

### Anterior Glenohumeral Instability: Biomechanics, Preoperative and Postoperative Evaluations

All Day Room: Learning Center

Renata V. Leao (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Traumatic dislocation of the shoulder leads to labral detachment and elongation of the capsular ligamentous restraints, as well as bone loss on the glenoid, humerus or both.-Characterization of the bone loss, with glenoid track, allows an accurate treatment choice.-Most common procedures: Labral repair, glenoid augmentation and humeral reconstruction.-Labral retear: 1.fluid insinuation between the labrum and the glenoid bone margin; 2. Fluid insinuation within the labrum; 3. Morphologic abnormality greater than expected; 4. Anchor detachment.-Latarjet: 1.Graft complications: non-union, dislocation, mispositioning; 2.Hardware complications: loosening, fracture, dislocation; 3.Others: glenohumeral arthritis, neurovascular injuries, subscapularis muscle injury.-Remplissage: indications and normal/abnormal postoperative findings.

#### TABLE OF CONTENTS/OUTLINE

1.Glenohumeral biomechanics and anterior instability2.Anterior glenohumeral dislocation and associated injuries3.Glenoid labrum tears4.Bone compression and bone loss - glenoid - humerus and bipolar bone loss5.Labral repair procedure: indications, normal and abnormal postoperative imaging6.Glenoid reconstruction techniques: indications, Latarjet/Bristow and others7.Normal and abnormal imaging findings in glenoid reconstruction techniques8.Humeral head reconstruction: indications, normal and abnormal findings9.Conclusion: the correct assessment of glenohumeral instability is important for the surgical decision. It is essential to know the expected imaging patterns of each surgical technique and the corresponding pathological findings to properly manage potential complications in patients.

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## Abstract Archives of the RSNA, 2023

MKEE-36

### Giant Cell Tumor of Bone: Atypical Imaging Features, Treatment and Complications

All Day Room: Learning Center

Adriano Silveira Moreira Novaes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is: 1. Briefly review of the most important features suggesting the diagnosis of the giant cell tumors (GCT) of bone. 2. Demonstrate the unusual locations of the GCT. 3. Review de atypical imaging findings of the GCT and complications in follow-up.

#### TABLE OF CONTENTS/OUTLINE

Giant cell tumor (GCT) of the bone is a generally benign tumor that has recently been reclassified as osteoclastic giant cell-rich tumors according to WHO 2020 classification. It is typically diagnosed through conventional radiographs that show a lytic lesion with a well-defined, non-sclerotic margin, eccentric location, extension to the subchondral bone, and centered in the metaepiphysis of mature long bones. Fluid-fluid levels are seen in 15% of cases, consistent with secondary formation of aneurysmal bone cyst. GCT commonly develops in long bones, particularly around the knee, but can occur in atypical locations with less characteristic radiographic features. Pediatric patients with open epiphyseal growth plates are infrequently affected. Lung metastases are rare, occurring in 1-6% of cases. Recurrence after curettage with cement placement is a possible complication, but this has become less common with the use of adjuvant therapies such as Denosumab.

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## Abstract Archives of the RSNA, 2023

MKEE-37

### **Congenital Hand Malformations: A Review in the Palm of Your Hand**

All Day Room: Learning Center

Karla Ortega Rivera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Congenital hand malformations can have a significant impact on hand function and aesthetics, and thus, management should be multidisciplinary and involve specialists in plastic surgery, orthopedics, radiology, and psychology.2. Radiographic imaging allows for visualization of bone structures, assessment of alignment, and morphology of the hand.3. Radiographic evaluation is a crucial tool in the assessment of congenital hand malformations. Radiographic findings can help determine the type and severity of the malformation, which can be useful in treatment planning.4. The aim is to provide a review of the most common congenital hand malformations, their radiographic findings, classifications, and therapeutic approaches, along with illustrative cases both pre- and post-surgery.

#### **TABLE OF CONTENTS/OUTLINE**

I. IntroductionII. EmbryologyIII. ClassificationIV. Specific types of congenital hand malformations and radiographic evaluationPolydactyly, syndactyly, camptodactyly, brachydactyly, clinodactyly, constriction ring syndromeV. Management of congenital hand malformationsVI. Cases

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## Abstract Archives of the RSNA, 2023

MKEE-38

### The Muscle Fascia: From Anatomy to Pathological Findings

All Day Room: Learning Center

Diego N. dos Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Report some concepts related to the muscle fascia, clarifying its definition.- Review the normal anatomy of the muscle fascia through illustrative schemes and correlation with imaging methods - magnetic resonance imaging (MRI) and ultrasonography (US).- Describe its pathological findings and its imaging patterns, through clinical cases gathered in our service.

#### TABLE OF CONTENTS/OUTLINE

Introduction:- Definition and general information about the muscle fascia: fascia superficialis, deep peripheral fascia and deep intermuscular fascia  
Normal anatomy of the muscle fascia and correlation with MRI and US.  
Clinical cases of pathological findings and its imaging patterns on US and MRI:  
\* Traumatic:- Morel-Lavallée lesion- Plantar fascia injury- Muscle hernia / Myo-aponeurotic injuries\* Inflammatory:- Post viral inflammatory fasciitis- Nodular fasciitis- Plantar fasciitis\* Infectious:- Necrotizing and non-necrotizing cellulitis and fasciitis\* Autoimmune: - Eosinophilic fasciitis- Systemic lupus erythematosus- Polymyalgia rheumatica\* Neoplastic:- Superficial fibromatosis- Desmoid tumor / Hibernoma- Sarcoma\* Postoperative:- Assessment of muscle fascia after fasciotomy\* Other:- Compartment syndromes- Granulomatous disease\* Other cases

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-39

### **The Resident's Thriller: A Pictorial Essay on Benign Bone Tumors**

All Day Room: Learning Center

Izabel O. Karam, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This essay aims to review the main benign bone tumors and its multimodality radiological features. Although many tumors' diagnoses are histopathological, radiologists and radiology residents must be able to identify several entities, especially those whose correct identification are imaging-made.

#### **TABLE OF CONTENTS/OUTLINE**

Bone cysts. Chondroblastoma. Chondromyxoid fibroma. Enchondroma. Eosinophilic granuloma. Fibrous dysplasia. Giant cell tumor. Intraosseous hemangioma. Lipoma of the bone. Non-ossifying fibroma. Osteochondroma. Osteoid osteoma.

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## Abstract Archives of the RSNA, 2023

MKEE-4

### Glenohumeral Osteoarthritis: Overview, Imaging Approach and Preoperative Assessment

All Day Room: Learning Center

Marco Aurelio Soato Ratti (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Glenohumeral osteoarthritis (GHOA) has a prevalence as high as 20% in the middle-age and elderly population, predominantly observed as the primary form (no specific risk factors). Conversely, secondary GHOA is associated with diverse causes, including rotator cuff tear, post-traumatic degeneration, gleno-humeral morphology (retroversion and glenoid dysplasia), shoulder instability, inflammatory arthropathies and microcrystal deposition. Imaging plays a pivotal role for GHOA diagnosis, investigation of underlying predisposing factors, evaluation of the extent of degeneration and of local complications. Since surgery can be considered in symptomatic patients with moderate to severe degenerative changes, unresponsive to conservative treatment, preoperative assessment by imaging is fundamental. A multimodality approach including radiographic images, computed tomography and magnetic resonance imaging helps the surgeon to choose the ideal technique for better outcomes. Pathologic glenoid version, bone loss and rotator cuff atrophy, as examples, have established association with poor clinical outcomes and hardware complications following arthroplasty. Thus, complete preoperative assessment of glenohumeral joint includes the following aspects: evaluation of bone stock, glenoid version, glenoid tilt, assessment of the rotator cuff with Goutallier classification and Walch classification.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction; 2. Epidemiology; 3. Definition and pathophysiology; 4. Etiology, a. Primary form (or non-specific risk factors), b. Secondary form (or specific risk factors); 5. Multimodality imaging evaluation; 6. Preoperative imaging assessment: what to report.

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## Abstract Archives of the RSNA, 2023

MKEE-40

### CT Myelography and Blood Patches in Intracranial Hypotension: A Primer

All Day Room: Learning Center

Mario H. Carneiro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1 - Review and explain the intracranial hypotension syndrome, its image manifestations, causes and treatments. 2 - Present didactic clinical cases with images of cerebrospinal fluid (CSF) leaks and fistulas. 3 - Discuss CT myelography technique and interpretation. 4- Show the treatment options for CSF leaks and fistulas. 5 - Demonstrate guided epidural blood patch treatment with real cases images.

#### TABLE OF CONTENTS/OUTLINE

1 - Intracranial hypotension syndrome; 2 - Etiologies; 3 - Diagnostic criteria; 4 - Most common image manifestations; 5 - Imaging methods for etiology investigation. 6 - Spine MRI; 7 - CT myelography; 8 - CSF leaks; 9 - CSF-venous fistulas; 10 - Conservative, interventional and surgical treatments. 11 - Epidural blood patch: how to.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-41

### **Distal Tibiofibular Syndesmosis: Stabilize Your Knowledge and Leave the Instability to the Injuries**

All Day Room: Learning Center

Izabel O. Karam, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: To review the anatomy and biomechanics of the distal tibiofibular syndesmosis; Discuss the role of each imaging method, including indications, advantages and disadvantages of each modality; To illustrate the main acute and chronic alterations in radiological and orthopedic practice, through didactic cases illustrating our institution through a multimodality approach; Discuss surgical indications and the importance of the findings for the orthopaedic surgeon, according to the imaging methods.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy. Biomechanics. Indication for requesting imaging exams in general. Role of radiography, main views and how to evaluate. Role of ultrasonography. Role of CT in neutral. Role of CT with stress maneuvers. Role of Weight-bearing CT. Role of MRI. Surgical indications, importance of radiological findings, and radiological and surgical correlation. Summary and proposed evaluation and test request flowchart. Future perspectives.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-42

### Capturing Psoriatic Arthritis on Film: A Comprehensive Guide to Radiographic Assessment

All Day Room: Learning Center

Axel A. Torres Monarrez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Provide an overview of psoriatic arthritis.
- Emphasize the indications, limitations, and benefits of radiography in psoriatic arthritis.
- Compare different imaging techniques for psoriatic arthritis.
- Discuss the normal anatomy of the hand on plain film radiography.
- Emphasize the importance of a systematic approach to hand radiography.
- Become familiar with descriptive terms for common bone and soft tissue abnormalities seen in psoriatic arthritis.
- Provide case studies to illustrate the practical application of theoretical concepts.
- Analyze differential diagnostics, tips, and tricks.

#### TABLE OF CONTENTS/OUTLINE

Overview of psoriatic arthritis: definition, epidemiology, pathogenesis, and clinical manifestations. Radiography in psoriatic arthritis: indications, limitations, and benefits. Comparison of imaging techniques for psoriatic arthritis: radiography, ultrasound, and MRI. Normal anatomy and systematic approach to the hand on plain film radiography. X-rays and psoriatic arthritis: descriptive terms for common bone and soft tissue abnormalities. Case studies: practical application of theoretical concepts. Differential diagnostics: osteoarthritis, gout, and rheumatoid arthritis. Tips and tricks for improving radiology reports. Conclusions: What rheumatologists want to know?

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

MKEE-43

### **Bad to the Bone! Understanding and Applying Bone-RADS: A Standardized Scoring System for Bone Lesions**

All Day Room: Learning Center

Ellis D. Mejias Febres, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Review pathology of bone anatomy-Bone-RADS provides an algorithmic-type approach to assessing differential diagnosis of bone tumors -Each Bone-RADS score is determined by certain criteria that includes the clinical implications for each - Provision of case examples on conventional radiography and computed tomography (CT) to better understand Bone-RADSIn this educational exhibit, we will review the standardized scoring system Bone-RADS, as well as provide radiologists and other health professionals with an understanding of Bone-RADS. the scoring system itself will be explained, supported by imaging from real cases. Finally, we will explain the implications every score has on the management of individual cases based on the Bone-RADS score assigned.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction-Review of bony anatomyCreation of Bone-RADSIIO. Overview of the criteria used in Bone-RADSIII. Clinical implications/management of bone tumors based on Bone Rads-How Bone-RADS serves as a guide to assessing bone lesions.IV. Imaging examples-Case by case analysis of how Bone-RADS scores are determined.V. Conclusion-Recap of teaching points.

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## Abstract Archives of the RSNA, 2023

MKEE-44

### Anterior Cruciate Ligament Reconstruction: Imaging Evaluation of the Techniques, Normal Appearance and Complications

All Day Room: Learning Center

Andre Y. Aihara, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Anterior cruciate ligament (ACL) reconstruction aims to restore knee stability. The surgical techniques for ACL reconstruction include single and double bundle, while the most frequently used autografts are bone-patellar tendon-bone and hamstring tendons. CT is the gold standard for evaluating tunnel placement, while MRI is best for assessing graft continuity and soft tissue complications. MRI signal intensity of the graft changes over time, with low signal immediately after surgery, increased signal in the first year due to remodeling, and low signal at 18 months. The objectives of this exhibit are: 1. To review ACL reconstruction techniques 2. Discuss imaging findings of normal postoperative ACL 3. Illustrate post-operative complications according to the potential sources: graft, technical and hardware complications, and soft tissues.

#### TABLE OF CONTENTS/OUTLINE

ACL reconstruction Techniques Normal postoperative Imaging • Femoral and tibial tunnels: position and size • Signal intensity of the graft over time • Harvest sites • Radiographic findings • CT findings • MRI findings Complications • Graft Partial tear Complete tear Porto-Knee Testing Device • Technical and hardware complications Anterior tibial tunnel with impingement Anterior femoral tunnel Tunnel widening Hardware migration Hardware fracture • Soft tissues Arthrofibrosis Infection Adventitious Bursitis

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## Abstract Archives of the RSNA, 2023

MKEE-45

### Imaging Evaluation of the Patella as the Largest Sesamoid Bone

All Day Room: Learning Center

Andre Rosenfeld, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The patella is the largest sesamoid bone in the human body, developing within the quadriceps tendon and becoming a part of the knee's extensor mechanism. Ossification centers can be associated with congenital disorders. Forceful contraction of the extensor mechanism can lead to chronic apophysitis or acute avulsion fractures. Although rare, tumors of the patella can occur, with the majority being benign. Additionally, crystal arthropathies such as gout and CPPD can affect the patella through the deposit of crystals in the tendons or cartilage. Certain diseases are associated with typical patellar morphologies. For example, multiple epiphyseal dysplasia is characterized by a double-layered patella, Cryopyrin-Associated periodic syndromes result in a disproportionately diffuse increase in size, and CPPD deposits cause a gear-like morphology. The purpose of this study is to review the normal development and anatomy of the patella. Discuss and illustrate the imaging findings of pathologies of the patella, which can be didactically divided into congenital disorders, mechanical/trauma, tumors, and crystal arthropathies. For this purpose, radiographs, CT scans, and MR images will be used. Highlight the typical patellar morphologies associated with various diseases. Elucidate how to differentiate normal variants from pathological conditions.

#### TABLE OF CONTENTS/OUTLINE

Normal development of the patella and anatomy Pathologies • Congenital: Bipartite, tripartite, double-layered patella, absence of the patella • Mechanical/trauma: Fracture, sleeve avulsion, Sinding-Larsen-Johansson • Tumors: benign and malign • Cryopyrin-Associated periodic syndromes • Crystal arthropathies: gout and CPPD

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## Abstract Archives of the RSNA, 2023

MKEE-46

### 3D Printing and Metaverse in Musculoskeletal Tumors - A New Assessment Tool

All Day Room: Learning Center

Flavia M. Costa, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- 3D printing preoperative planning for the treatment of MSK tumors ( soft tissue and bone tumors).a. Segmentation. Virtual modeling. Build preparations. Quality assessment
- Patient-specific devices - Personal surgical instruments ( PSIs);
- Identify what sequences should be used for Preoperative planning in many oncological patients with computed tomography (CT) ( maximum slice thickness of 1 mm) and contrast-enhanced magnetic resonance (MR- 3 Tesla -Siemens) and multiplanar reconstruction;
- Mixed Reality (MR) is a technology of real and virtual worlds to enhance visualizations, where physical and digital objects coexist and allow users to interact with both in real-time
- Special considerations and Pitfalls.

#### TABLE OF CONTENTS/OUTLINE

- 1) The value of the combination of 3D printing and metaverse in surgical planning procedures in soft tissue and bone tumors;
- 2) These techniques promise improvements and outcomes for complex bone tumor resection
- 2) Case discussion:
  - Osteosarcomas resection and prosthesis manufacture
  - Pleomorphic liposarcomas recidive assessment
  - Schwannomas
  - Condrossarcomas
  - Bone marrow metastasis
- 3) To demonstrate many indirect effects of 3D printing on surgical procedures:
  - reduced surgery time;
  - to a reduced complication rate of wound infections and wound healing disorders and therefore enable earlier adjuvant therapy initiation
- 4) Common pitfalls
- 5) Conclusion Surgical planning using 3D printing and metaverse/ may result in negative tumor resection margins that reduce the risk of local recurrence and adversely affect patients' survival. Computer navigation and 3D-printed resection guides have been reported to be surgical accurate.

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## Abstract Archives of the RSNA, 2023

MKEE-47

### **What, Where, and Why - A Primer on Sonographic Evaluation of Traumatic Injuries to the Tendons of the Wrist and Hand**

All Day Room: Learning Center

Kevin Sweetwood, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Ultrasound of the tendons of the wrist and hand can provide a high spatial resolution evaluation of tendon pathology which is augmented by the ability to perform dynamic maneuvers that are unavailable with MRI studies. 2. Knowledge of the sonographic appearance and anatomy of these tendons and their associated structures is essential in correctly identifying pathology, providing relevant information to the referring physicians to guide appropriate management, and avoiding pitfalls leading to misdiagnosis. 3. Review of common injuries to the tendons of the wrist and hand focusing on relevant anatomy, sonographic findings, mechanisms of injury, and associated complications and classification schema that are significant for surgical planning.

#### **TABLE OF CONTENTS/OUTLINE**

1. What - Different traumatic pathologies of the tendons with review of terminology, sonographic appearance, and image acquisition techniques. a. Partial versus complete tendon tears, tendon stump separation and retraction. b. Pulley injuries. c. Sagittal band injuries. 2. Where - Review of relevant anatomy, sonographic landmarks, and surgical classification. a. Appearance and relationships of the flexor digitorum profundus tendon, flexor digitorum superficialis tendon slips, and pulleys. b. Identification of flexor tendon zones utilizing landmarks. c. Appearance and relationships of the extensor tendons and sagittal bands. 3. Why - Isolated tendon injury versus secondary post-traumatic injuries and significance of findings for surgical approach. a. Distal radius fractures. b. Hardware complications. c. Surgical management

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## Abstract Archives of the RSNA, 2023

MKEE-49

### **Carpal Instability: Current Concepts and Diagnostic Approach**

All Day Room: Learning Center

Tomas A. Pascual, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To show the complex anatomy of the wrist ligaments and its assess in imaging studies. Describe the different types of carpal instability, its pathomechanism, clinical prognosis and treatment implications .Review the different stages of nondissociative carpal instability, integrating images into the pathological process and clinical stages.

#### **TABLE OF CONTENTS/OUTLINE**

Carpal instability refers to a group of ligament injuries that are responsible for a considerable degree of wrist pain and dysfunction, interfering with sports and daily life activities. Scapholunate and lunotriquetral ligament injuries are the most frequent cause of carpal instability. Depending on the type of injury, these ligaments may be the harbinger of a relentless progression to abnormal joint mechanics, cartilage wear, and degenerative changes. Imaging methods play a crucial role in the diagnosis and staging of this type of injuries which, if not treated, can lead to wrist osteoarthritis

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## Abstract Archives of the RSNA, 2023

MKEE-5

### Diagnostic Evaluation of Very Small Peripheral Nerves: When Ultrasonography Made the Difference

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Marcos Felipe D. Correa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the role of the high frequency ultrasound (US) in the assessment of very small peripheral nerves and its comparison with magnetic resonance imaging (MRI). Review the sonoanatomy and the topographic anatomy of the reported nerves and its correlation with MRI. Report selected clinical cases from our service, highlighting pathological involvement of very small peripheral nerves on US and its correlation with MRI, through illustrative images and videos.

#### TABLE OF CONTENTS/OUTLINE

Introduction  
The role of the high frequency US in the assessment of the very small peripheral nerves  
Clinical cases of pathological involvement of very small peripheral nerves on US and its correlation with MRI:  
Palmar cutaneous neuropathy  
Posterior interosseous nerve syndrome  
Digital palmar proper nerve injury (stump neuroma neurotmesis)  
Lateral femoral cutaneous neuropathy (meralgia paresthetica)  
Postoperative radial nerve neuropathy  
Postoperative sural nerve (stump neuroma neurotmesis)

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## Abstract Archives of the RSNA, 2023

MKEE-50

### **An Ounce of Prevention is Worth a Pound of Cure**

All Day Room: Learning Center

Murilo Campos Silva, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: A. Discuss the classic concepts of instability and the relatively new concepts of microinstability of the spine; B. Demonstrate the cascade of degenerative instability going through three stages: (1) temporary dysfunction, (2) unstable dysfunction and a (3) final phase of restabilization; C. Correlate the phases of spinal instability and radiological findings in a multimodality approach; D. To review the main therapeutic options in the context of chronic spinal pain, microinstability and instability.

#### **TABLE OF CONTENTS/OUTLINE**

A. Spine anatomy and biomechanics of spinal pain; B. Classic spinal instability concepts and degenerative stages; C. Concepts of microinstability and imaging findings in a multimodality approach; D. Discussion of the therapy decision, including conservative treatment measures, surgical indications and modalities of intervention.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

MKEE-51

### MR Neurography of the Lumbosacral Plexus- Tips on Technique and Injury Patterns

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jenifer Pitman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pelvic and lower extremity sensorimotor disturbances frequently present a diagnostic challenge for referring clinicians and radiologists. Complex anatomy of the lumbosacral plexus in addition to varied clinical presentations make it difficult to pinpoint the site of pathology accounting for patients' symptoms. MR Neurography is a useful modality for evaluation of the nerves in the lumbosacral plexus and can serve as an adjunct to conventional MRI lumbar spine.1-5 Significant improvements in signal to noise ratio and spatial resolution, particularly with 3D isotropic sequences, and emerging techniques such as deep learning reconstruction facilitate improved nerve visualization. When performing MR neurography, it is important for the radiologist to understand the anatomy of the lumbosacral plexus and to be aware of technical considerations in the pelvis.

#### TABLE OF CONTENTS/OUTLINE

Background Anatomy Overview; Technical Considerations; Protocol/Sequences: high field strength, heavily T2W FS images perpendicular to nerve, 2D/3D; Fat suppression: STIR, DIXON; Vascular suppression: DESS/MENSA; Motion reduction; Contrast- Gadolinium, Ferrumoxytol; Imaging around Metal; Deep learning reconstruction; Imaging features; Normal Injury Patterns; Case examples Iatrogenic, Traumatic

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-52

### Whole Body of MRI of Castration-Resistant Prostate Bone Metastasis: How and When

All Day Room: Learning Center

Javier Hernandez Ganan (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To explain Whole-Body MRI protocol focusing on Dixon and Dwi sequences. 2. To discuss main indications. 3. To select target lesion to biopsy. Whole-body MRI is becoming increasingly important in patients diagnosed with disseminated prostate neoplasia, not only in clinical trials but also in daily practice. Specifically in patients with biochemical progression with bone disease, where more scenarios open up for adequate therapeutic guidance.

#### TABLE OF CONTENTS/OUTLINE

Natural history of prostate cancer. WB MRI protocol: MET RADS. Role of Dixon and DWI sequences. Indications 1. Before starting a new treatment. 2. Follow-up. 3. Select viable lesion to perform percutaneous biopsy. Current developments 1. WB MRI at diagnosis in patients at high risk for prostate cancer: 'all in one' study. 2. PET MRI future indications.

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## Abstract Archives of the RSNA, 2023

MKEE-53

### Hematopoietic Tumors of Bone - Growing Your Knowledge

All Day Room: Learning Center

Bruno B. Cardoso, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Obtaining a differential diagnosis for hematopoietic bone tumors is often challenging due to their varied features. Hematopoietic bone tumors encompass a wide spectrum, including multiple myeloma, lymphoma, histiocytosis, Erdheim-Chester disease, and Rosai-Dorfman disease. In some cases, these pathologies can mimic osteomyelitis or bone metastasis, making an accurate diagnosis crucial prior to treatment. X-rays are often the initial imaging study used to evaluate hematopoietic bone tumors, but they have limited sensitivity and specificity in some cases. CT scans, which provide detailed images of the spine and pelvis, are particularly useful for evaluating bony structures while avoiding the effects of overlapping structures. On the other hand, MRI provides better soft tissue contrast, aiding in the differentiation of benign and malignant conditions. Overall, the DWI technique can provide information about tumor cellularity and aggressiveness, potentially improving the accuracy and efficiency of MRI and enhancing patient care.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction, II. Imaging Modalities, III. Multiple myeloma, IV. Lymphoma, V. Langerhans cell histiocytosis, VI. Erdheim-Chester disease, VII. Rosai-Dorfman disease, IX. Differential diagnosis, X. Conclusion.

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## Abstract Archives of the RSNA, 2023

MKEE-54

### Measurement of Bone Mineral Density in CT: Current Status and Future Perspectives

All Day Room: Learning Center

Youngjune Kim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Screening bone mineral density at opportunistic CT is under active research to be adopted in daily practice. The major teaching points of this exhibit are 1) the history of measuring bone mineral density at CT, 2) the pros and cons of measuring bone mineral density at CT in comparison with DEXA, 3) technical considerations of measuring bone mineral density at CT, and 4) future perspectives of measuring bone mineral density at CT including deep learning technique.

#### TABLE OF CONTENTS/OUTLINE

1. History of measuring bone mineral density using CT: QCT and opportunistic CT  
2. Pros and cons of measuring bone mineral density at CT in comparison with DEXA  
3. Technical considerations when measuring bone mineral density at CT  
4. Future perspectives of measuring bone mineral density at CT: deep learning technique and finite element analysis  
5. References

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## Abstract Archives of the RSNA, 2023

MKEE-55

### Inside the Spinal Canal: A Journey Through Intraspinal Pathologies

All Day Room: Learning Center

Alan F. Strapasson, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Lesions within the spinal canal can range from benign to highly malignant, with only 20% of these lesions being intramedullary. Other possible origins include nerves, meninges, and vessels. The main objective of this exhibit are: 1. Review the anatomy, imaging protocols, and main pathologies affecting the medullary canal of the lumbar spine or the thoracolumbar transition. 2. Create a diagnostic flowchart for main intraspinal lesions based on age and comorbidities. 3. Describe the main imaging characteristics used to narrow down differentials. 4. Provide an updated classification of intramedullary lesions according to the World Health Organization's 5th edition.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to lumbar spine anatomy, including transitional vertebra classification. 2. MRI protocols for the lumbar spine. 3. Diagnostic flowchart for lesions categorized by age and comorbidities. 4. Discussion of main imaging findings for various conditions such as Mixopapillary ependymoma, Intradural spinal lipoma, Schwannoma, Lipoma of the filum terminale, Plexiform neurofibroma, Metastases, Vertebral body hemangioma with epidural component, Chordoma, Dermoid cyst, and Epidermoid cyst, using illustrative cases. 5. Highlighting the main clinical and imaging aspects that differentiate lesions within the vertebral canal, to aid in prompt diagnosis and proper treatment. Overall, this exhibit provides a comprehensive overview of intraspinal lesions and their characteristics, contributing to accurate diagnosis and treatment planning.

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## Abstract Archives of the RSNA, 2023

MKEE-56

### **So, You Have a Trained AI Model, Now What? Step-by-step Guide to Deploying a Prototype Interface Using Open-source Python Tools to Test Newly Developed Internal MSK AI Tools**

All Day Room: Learning Center

Brendan M. Franz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. A brief overview of the initial process of training, and validation of an AI model. 2. Overview of open-source tools in python which can be used to deploy a test of an AI solution. 3. Walkthrough of implementation of tools to create a platform to internally test custom AI tools.

#### **TABLE OF CONTENTS/OUTLINE**

-A brief overview of the initial process of training, and validation of an AI model.--Expected output of a training/validation process during AI model creation.--Walkthrough of open-source tools to deploy a test of an AI solution--Anaconda / Python Flask--Flask--Streamlit-Walkthrough of implementation of a web-based interface to test internally create AI tools--Conda installation--Installation of Flask, Streamlit and other related dependencies--Creating a simple HTML website to take an MSK radiograph and predict the image projection using a custom model file--Using Streamlit to visualize imaging data, masks and output.--Review of the utility of open-source software in healthcare--Conclusion/Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-57

### MR Arthrograms: Expecting the Unexpected

All Day Room: Learning Center

Aishwarya Gulati, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

After reviewing this education exhibit, the reader will understand: 1. Technique of normal arthrograms discussing the major large and medium joints with brief overview of normal post direct arthrogram anatomy. 2. Pitfalls and imaging findings related to common errors or unexpected findings in MR arthrography of larger and medium joints with focus on shoulder and knee. 3. Genesis of common errors and general procedural techniques to avoid these.

#### TABLE OF CONTENTS/OUTLINE

1. Basic technique of fluoroscopic guided direct MR arthrogram for major joints. 2. Overview of normal appearance of common joint spaces post direct arthrogram 3. Unexpected findings or errors related to: a. Contrast media preparation -Over dilution -Increased concentration b. Injection technique -Over distention and contrast extravasation -Extra-articular injection -Intra-articular gas -Extra-articular local anesthetic c. Soft tissue injury d. Unexpected findings related to -Enhancing lesions e.g. fracture, vascular malformation -Anatomic variants e. Scanning -Timing -Incorrect sequence

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-58

### **Cervical and Lumbar Spinal Fusion and Arthroplasty Beyond the Basics: From Surgical Techniques to Postoperative Imaging**

All Day Room: Learning Center

#### **Awards**

##### **Cum Laude**

Gabriel D. Miranda, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

I) Discuss the role of each imaging method in postoperative evaluation of patients who have undergone cervical/lumbar spinal fusion or total disc replacement/disc arthroplasty.II) Review the different techniques of cervical and lumbar spinal surgery (indications, advantages and limitations), and describe the various surgical instrumentations/devices used in spinal fusion and total disc replacement (TDR)/disc arthroplasty procedures.III) Discuss a basic primer/checklist for radiological evaluation after cervical and lumbar spinal fusion or total disc replacement/disc arthroplasty, to help identify normal and abnormal postoperative findings on the various imaging modalities.IV) List the main early and late postoperative complications.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: The importance of imaging in the evaluation after cervical/lumbar spinal fusion or disc arthroplasty. The main uses of each imaging modalitiesSpinal instrumentation nomenclature: Spinal fusion instrumentation: screws, plates, rods, interbody cages, bone grafts. Disc arthroplasty devices: disc prosthesis and its various models.Surgery techniques: Cervical spine: anterior cervical corpectomy and fusion, anterior cervical discectomy and fusion, posterior laminoforaminotomy, cervical disc arthroplasty. Lumbar spine: anterior lumbar interbody fusion, oblique lumbar interbody fusion, lateral/extreme/direct lumbar interbody fusion, transforaminal lumbar interbody fusion, posterior lumbar interbody fusion, and lumbar disc arthroplasty.Checklist for radiological postoperative evaluation: Normal postoperative findings. Early and late postoperative complications.

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## Abstract Archives of the RSNA, 2023

MKEE-59

### **Blossom with Artificial Intelligence: Hidden MSK Imaging Biomarkers for Cardiothoracic Diseases from Conventional Chest CT Examination**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Elena Ghotbi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

\*Definition and benefits: Opportunistic CT imaging means analyzing CT scans initially taken for other purposes but with potential to contribute to medical screening levels (primary, secondary, and tertiary screening), and identify incidental pathologies at zero additional costs or radiation exposure. \*Extraction of important musculoskeletal biomarkers is now feasible from conventional CT scans as predictors of cardiothoracic diseases, such as: -Bone density, osteoporosis and osteopenia, using phantomless measures of bone density-Thoracic spine degeneration, using modified Pfirrmann grading- Detailed pectoralis muscle composition measures loss (subcutaneous adipose tissue, intermuscular and perimuscular adipose tissue, extramyocellular lipids), sarcopenia, and prevention of adverse outcomes-Measures of costochondral and tracheal calcification as a marker for extraosseous calcium deposition \*Implementation of artificial intelligence (AI): AI algorithms hold promise for enhancing the precision and speed of the opportunistic CT imaging and can generate robust, reliable, and fast quantitative measurements that may not be readily apparent to the human eye.

#### **TABLE OF CONTENTS/OUTLINE**

-Introduction-Methodology: Development of deep-learning algorithm -Clinical application: Current evidences for predictive values for various common cardiothoracic disease-Future directions: AI role for efficient implementation in routine clinical practice

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## Abstract Archives of the RSNA, 2023

MKEE-6

### All Grown Up: Pictorial Review of Premalignant Bone and Soft Tissue Lesions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Sepideh Abdi, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- There are several bones and soft tissue lesions that can undergo malignant transformation.
- It is important to understand the characteristic imaging appearance and pitfalls of these lesions.
- Radiologists should be familiar with the clinical and imaging management of these premalignant lesions to prevent misdiagnosis.

#### TABLE OF CONTENTS/OUTLINE

Several bones and soft tissue lesions can undergo malignant transformation. This includes premalignant benign tumors and non-neoplastic conditions that injure bone and soft tissue. Both groups require an understanding of key clinical and imaging features to arrive at the correct diagnosis. Enlargement, new pain, or aggressive imaging features can raise suspicion for malignant transformation. This exhibit will discuss 3 main categories of premalignant musculoskeletal lesions: Benign tumors • Osteochondroma/multiple hereditary exostoses (MHE) ? chondrosarcoma • Enchondroma (Maffucci, Olliers) ? chondrosarcoma • Fibrous dysplasia? osteosarcoma • Giant cell tumor of bone? malignant giant cell tumor Prior bone injury (non-neoplastic) • Osteomyelitis ? squamous cell carcinoma, osteosarcoma. • Radiation ? osteosarcomas, soft tissue sarcomas • Bone infarct ? secondary osteosarcoma • Paget disease ? osteosarcomas, chondrosarcomas, or fibrosarcoma. Soft tissue lesions • Burns/scars ? squamous cell carcinoma, basal cell carcinoma • Synovial Chondromatosis ? chondrosarcoma • Neurofibroma ? Malignant peripheral nerve sheath tumor • Atypical lipomatous tumor (ALT) ? dedifferentiated Liposarcoma

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-60

### **Unraveling Wrist Radiographs: A Review of Traumatic Wrist Injuries Focusing on Radiographic Imaging**

All Day Room: Learning Center

Aishwarya Gulati, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

After reviewing this education exhibit, the reader will: 1. Understand how various views of the wrist are obtained and the indications of different special views. 2. Understand normal anatomy and imaging appearance of the wrist on radiographs. 3. Understand the imaging appearance and clinical context of common and uncommon traumatic carpal injuries and carpal joint disruptions.

#### **TABLE OF CONTENTS/OUTLINE**

1. Wrist radiographs - indications of various views (including standard views and less common views such as carpal tunnel) and optimal patient positioning. 2. Normal wrist anatomy on standard radiographs. 3. Approach to interpretation 4. Relevant anatomy, mechanism of injury/ pathogenesis, imaging examples, brief review of clinical presentation and implications, and management of: a. Different carpal bone fractures b. Different types of carpal dislocations c. Carpo-metacarpal joint fracture-dislocations

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-61

### **Microinstability and MRI: Unveiling the Invisible**

All Day Room: Learning Center

Natan P. Ribeiro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Introduce microinstability as a disorder with subtle joint instability- Understand the significance of MRI in diagnosing microinstability- Explore the application of MRI in various joints affected by microinstability- Discuss advanced MRI techniques for accurate detection and staging of joint lesions- Review the evolving relationship between MRI and arthroscopy for microinstability diagnosis and treatment

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to Microinstability and MRI  
2. The Role of MRI in the Diagnosis and Management of Joint Microinstability  
3. Comprehensive Imaging Evaluation of Microinstability in Various Joints  
4. Dynamic MRI for Detection of Functional Causes of Joint Instability  
5. Quantitative MRI Techniques for Objective Evaluation of Cartilage Health  
6. The Benefits of Functional MRI in Understanding Joint Microinstability  
7. Advanced MRI Techniques for Accurate Detection and Staging of Joint Lesions  
8. The Evolving Relationship Between MRI and Arthroscopy for Microinstability Diagnosis and Treatment  
9. The Pivotal Role of Radiologists in Microinstability Diagnosis and Management  
10. Imaging Findings in Anterior Shoulder Microinstability: An MRI-Based Approach  
11. MRI Findings Suggestive of Knee Microinstability: A Comprehensive Review  
12. Management of Microinstability in Different Joints: An Evidence-Based Approach  
13. Role of MRI in Guiding Surgical Intervention for Joint Microinstability  
14. Understanding the Pathophysiology and Anatomy of Joint Microinstability for Accurate MRI Interpretation  
15. Advancements in MR Imaging Technology for Improved Detection and Characterization of Microinstability

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## Abstract Archives of the RSNA, 2023

MKEE-62

### Lateral Meniscus Instability: Understanding Its Anatomy and Unraveling Posterior Attachment Lesions

All Day Room: Learning Center

Carlos H. Longo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The lateral meniscus is more mobile than the medial meniscus due to its less extensive attachments, and its posterior attachment anatomy has been less studied than the medial meniscus. The posterior root attachment and meniscotibial (coronary) ligaments serve as important static stabilizers, but it is the thin popliteomeniscal fascicles (PMF) that play an important role in the dynamic stabilization of the lateral meniscus during knee flexion. The anterior (Humphrey) and posterior (Wrisberg) meniscofemoral ligaments also contribute to stabilization. The absence of popliteomeniscal ligaments (congenital or traumatic origin) allows an anterior displacement of the posterior horn of the lateral meniscus during the flexion of the knee (hypermobile meniscus). It can cause symptoms, including pain, blockage and snapping ("snapping knee syndrome"). Peripheric tears of the posterior horn can be associated with buckle-handle tears and meniscal flap dislocation. Posterior root tear is less common in the lateral meniscus than the medial meniscus. The purpose of this study is to:- Review the normal anatomy of the posterior horn of the lateral meniscus and its attachments.- Discuss and illustrate cases of hypermobile meniscus associated with absence of the PMF on MRI.- Illustrate cases of posterior attachments tear on MRI

#### TABLE OF CONTENTS/OUTLINE

Normal anatomy of the posterior attachments of the lateral meniscus and its normal appearance on MRI  
Hypermobile meniscus associated with tear of the PMF  
Buckle-handle tear  
Posterior root tear  
Meniscofemoral ligaments tear

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-63

### Geographic Superficial Soft Tissue Masses: A Guide for Ill-defined Masses

All Day Room: Learning Center

Rachel Z. Bass, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Masses in the superficial soft tissues often have ill-defined borders, and are often benign. Framing the differential into dermal, lipomatous, fibrous, lymphatic and vascular categories may be helpful. 2. Skin thickening with ill-defined underlying edema without enhancement suggests lymphatic origin. This may be localized, and correspond to a pedunculated mass in the morbidly obese, known as a "pseudosarcoma". 3. Ill-defined mass with a fascial tail suggests fibromatosis, which may be desmoid type or superficial. Degree of hyperintensity of fluid weighted sequences corresponds to immature collagen and active tumor. 4. Diffuse fibromatosis is a unique form of neurofibroma that is uncommonly associated with NF-1, and presents with geographic skin thickening with ill-defined subcutaneous edema, nodularity and enhancement. 5. Superficial angiosarcoma will be a nodular, vascular tumor with enhancement and increased activity hot on PET. Often metastatic at presentation.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Lymphatic: Massive localized lymphedema, papillomatosis cutis lymphocystica, Proteus syndrome, cutaneous lymphoma 3. Vascular: Vascular malformation, angiosarcoma 4. Lipomatous: Fat necrosis, adiposis delorosa 5. Fibrous: Desmoid type fibromatosis, superficial fibromatosis, fibrosarcoma 6. Neurogenic: Diffuse neurofibroma 6. Dermal: Squamous cell carcinoma

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-64

### "Thinking On Your Feet" - A Step Forward on the Evaluation and Treatment of Morton Neuromas

All Day Room: Learning Center

Mary Creedon, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Overview of Morton neuromas and relevant anatomy
2. Review of the sonographic evaluation of Morton neuromas including patient position, transducer position, and dynamic maneuvers
3. Review of the MRI protocol and findings related to Morton neuromas
4. Differential diagnoses and pitfalls
5. Treatment overview including ultrasound-guided procedure indications, required materials, and technique for steroid, anesthetic, and alcohol Morton neuroma injections

#### TABLE OF CONTENTS/OUTLINE

Introduction and overview  
Pathophysiology and types of traumatic neuromas  
Nomenclature  
Epidemiology  
Clinical Findings  
Most common locations  
Ultrasound evaluation  
Transducer selection and settings  
Patient and transducer position (dorsal versus plantar imaging)  
Dynamic maneuvers  
Sonographic findings  
Differential diagnoses (including plantar plate tears and intermetatarsal bursitis) and ways to differentiate sonographically  
MRI evaluation  
MRI protocol and the use of intravenous gadolinium contrast  
Literature favoring prone vs supine patient position for MRI and US  
Differential diagnoses and pitfalls  
Treatment options  
Non-operative, non-invasive treatments  
Ultrasound-guided procedures: a. Indications, risks, and precautions, b. Required materials for steroid, anesthetic, and alcohol injections, c. Technique details  
Surgical excision  
Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-65

### Post-operative Fluid Collections Following Lumbar Spine Surgery: Differential Diagnosis and Surgical Considerations

All Day Room: Learning Center

Hoiwan Cheung, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Post-operative fluid collections represent a common imaging finding in patients who have undergone recent lumbar spine surgery. Radiologists must be familiar with different types of post-operative fluid collections that can occur following lumbar spine surgery and their salient imaging findings to guide patient management.1) Recognize different types of lumbar spine surgical techniques including posterior spinal, transforaminal, anterior, extreme lateral, and oblique lateral interbody fusions2) Review different types of lumbar spine post-operative fluid collections, including cerebrospinal fluid leak (CSF) and pseudomeningocele, lymphocele, bone morphogenetic protein (BMP)-related fluid collection, hematoma, abscess, and urinoma3) Identify which types of surgical techniques are associated with different post-operative lumbar fluid collections4) Review treatment considerations for different types of post-operative lumbar spine fluid collections

#### TABLE OF CONTENTS/OUTLINE

Review anterior and posterior approach lumbar spine fusion techniques, relevant anatomy, and post-operative imaging appearance  
Anterior approach-Anterior lumbar interbody fusion (ALIF)-Oblique lateral interbody fusion (OLIF)-Extreme lateral lumbar interbody fusion (XLIF)  
Posterior approach-Posterior lumbar interbody fusion (PLIF)-Transforaminal lumbar interbody fusion (TLIF)  
Review the imaging appearance and management, of different types of post-operative fluid collections after lumbar spine fusion-Pseudomeningocele/CSF leak-Bone morphogenetic protein (BMP)-related fluid collections-Lymphocele-Hematoma-Abscess with discitis/osteomyelitis-Urinoma

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

MKEE-66

### MRI Evaluation of Oblique Injuries: Introduction of the Deadrise Sign

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Nicholas M. Hanna, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Importance of oblique injuries in sports imaging  
Primary muscle involved and location of injuries  
Common MRI findings  
Basic MRI protocol and treatment algorithm

#### TABLE OF CONTENTS/OUTLINE

Epidemiology of oblique injuries - Target population - Mechanism of injury - Value of MRI  
Anatomy of the lateral abdominal wall - Muscle layers, fiber orientation, and important attachments - Normal variations in the lower "floating" ribs  
Single institution retrospective cohort of 29 unique injuries in 23 patients - Primary muscle involved - Surrounding injury - Location - Average length of injury  
Common MRI findings and pitfalls - Introduction of the "deadrise" imaging sign - Severity grading considerations  
Case examples - Low grade strain (muscle edema only; no macroscopic tear) - Tears at the lower rib insertions (deadrise sign) - Tears at the iliac attachment (less common) - Differential diagnosis  
MRI protocol considerations - Sequences, scanning time, and short and long-axis views of the rib/cartilage at the site of injury - Common MRI artifacts - Rib level identification  
Treatment algorithm - Collaboration with orthopedic surgery

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-67

### **The Musculoskeletal Manifestations of Aging: What the Radiologist Needs to Know in Caring for Our Growing Elderly Population**

All Day Room: Learning Center

Catalina N. Flores, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Briefly discuss the multifactorial biochemical processes that contribute to normal aging of the musculoskeletal system. 2. Familiarize the radiologist with the normal radiologic manifestations seen in the musculoskeletal system that arise from aging. 3. Review the radiologic manifestations of the most common musculoskeletal pathologies that occur in the elderly population resulting from normal aging.

#### **TABLE OF CONTENTS/OUTLINE**

A. Brief review of the biochemical processes that contribute to normal aging in the context of musculoskeletal manifestations. B. Illustrate normal and pathologic radiologic manifestations of aging in the musculoskeletal system a) Changes in bone homeostasis i. Osteopenia/osteoporosis, Paget's disease ii. Insufficiency fractures iii. Fragility fractures b) Architectural changes in skeletal muscle composition i. Sarcopenia c) Architectural changes in articular cartilage composition i. Osteoarthritis d) Architectural changes in tendon composition decreased cellular response to injury i. Tendinopathy and tendon tears e) Metabolic derangement and predisposing co-morbidities seen in the elderly population i. Diffuse idiopathic skeletal hyperostosis ii. Crystal deposition disease f) Genomic instability from accumulated oxidative damage and decreased repair mechanisms i. Multiple myeloma ii. Metastatic disease

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-68

### Where is the Contrast? Patterns to Recognize and Pitfalls to Avoid for Successful MSK Arthrography

All Day Room: Learning Center

Maxine E. Kresse, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Review of arthrogram techniques of the major joints to include range of normal appearances and demonstrate pathology with successful injection-Recognition of extra-articular injection, with cross-sectional correlates-How to avoid and correct for common pitfalls

#### TABLE OF CONTENTS/OUTLINE

-Brief introduction to fluoroscopy guided arthrograms of the major joints (including shoulder, elbow, wrist, hip, knee, and ankle)-For each of the major joints: a. Normal arthrogram appearance, including normal bursa/recess communications with the joint; b. Successful intra-articular injection with pathology diagnosed by the arthrogram fluoroscopy images (i.e. full thickness rotator cuff tear); c. Numerous examples of extra-articular injections, with cross sectional correlates on the location of the contrast; d. Tips to avoid common pitfalls and ways to adjust to achieve an intra-articular injection-Summarize pearls and pitfalls to aid in troubleshooting to avoid compromised cross-sectional exams

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-69

### **"Untangling the Nerves" - Sonographic Findings of Upper Extremity Nerve Entrapments and Injuries with MRI Correlation**

All Day Room: Learning Center

Preethi Kesavan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Benefits in the use of ultrasound with technique details
2. Classification and sonographic imaging of peripheral nerve injuries with MRI correlation
3. Ultrasound of nerve entrapment syndromes of the upper extremity with MRI correlation
4. Ultrasound-guided peripheral nerve interventions

#### **TABLE OF CONTENTS/OUTLINE**

Why ultrasound and how? Benefits and advantages in the use of ultrasound  
Technique details, including transducer selection and machine settings  
Dynamic imaging and the use of Doppler (including newer microvascular imaging techniques)  
Sonographic findings including normal reference cross-sectional measurements  
Types of peripheral nerve injuries  
Classification and types of peripheral nerve injuries  
Sonographic findings of normal versus abnormal peripheral nerves  
MRI correlative imaging  
Ultrasound imaging of upper extremity nerve entrapment syndromes  
Sites of entrapment, relevant anatomy, and associated pathophysiology  
Sonographic imaging findings with MRI correlation  
Secondary imaging findings including muscle denervation edema, atrophy, and myosteatosis  
Ultrasound-guided peripheral nerve interventions  
Indications, risks, precautions, and benefits of ultrasound. Required materials including what to inject (e.g., nonparticulate versus particulate corticosteroids)  
Ultrasound-guided diagnostic and therapeutic injections including hydrodissection and alcohol/ethanol neurolysis  
Ultrasound-guided cyst aspiration/decompression to relieve nerve compression  
Summary

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## Abstract Archives of the RSNA, 2023

MKEE-7

### **Tibial Plateau Fractures: Common Classification Systems and Clinical Considerations**

All Day Room: Learning Center

Rachel Z. Bass, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. The Schatzker classification of tibial plateau fractures is commonly used but lacks description for coronally oriented fractures. The three column approach highlights the importance of the posterior tibial plateau. 2. The Kfuri (modified Schatzker) classification system was introduced in 2018, and marries the Schatzker classification with anterior and posterior modifiers, and is accepted among orthopedic surgeons. 3. Involvement of the posterior column affects surgical approach and technique, and stabilization of the posterior medial column and tibial rim is critical for good functional outcome. 4. Preoperative CT provides critical information regarding fracture orientation, depression, and vascular injury. 5. Preoperative MRI following external fixation may provide critical information to the orthopedic surgeon regarding meniscus and ligamentous injury that will be addressed at the time of definitive internal fixation.

#### **TABLE OF CONTENTS/OUTLINE**

1. Tibial Plateau Classification systems: AO/OTA, Schatzker, Three Column, Kfuri (Modified Schatzker) 2. Surgical Approach and clinical importance: Buttress fixation, posterior column fixation, graft placement 3. Soft tissue injury: Open fracture, vascular injury, meniscal tear, cruciate ligament tear, compartment syndrome 4. Long term outcomes: Expected healing, postoperative osteoarthritis leading to arthroplasty.

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## Abstract Archives of the RSNA, 2023

MKEE-70

### Don't Miss a Step: Ligament Injury in Midtarsal Sprain

All Day Room: Learning Center

Christian Kestler, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review anatomy of themidtarsal (Chopart) joint complexDescribe variant anatomy and common pitfallsProvide recommendations for best visualization of ligaments ofmidtarsal joint complex in MRI-scansDiscuss trauma mechanisms ofmidtarsal sprain and deduce possible injury patternsProvide imaging examples ofmidtarsal sprains (MRI and X-ray)Discuss treatment

#### TABLE OF CONTENTS/OUTLINE

Background: • Epidemiology• Role of imagingLigament anatomy visualized by 3D-renderings and MRI-imaging examples (with common variant appearances):Talocalcaneonavicular joint • Dorsal talonavicular ligament• Calcaneonavicular portion of bifurcate ligament• Spring ligament complexCalcaneocuboid joint• Dorsal calcaneocuboid ligament• Calcaneocuboid portion of bifurcate ligament• Short and long plantar ligamentsPathomechanisms ofmidtarsal sprain:• Inversion-type trauma (most common): lateral and possible dorsal distraction with medial compression• Eversion-type trauma: medial distraction with lateral compressionImaging examples ofmidtarsal ligament injuries:• Ligament tear and sprain• Common findings accompanying ligament injuriesTreatment

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## Abstract Archives of the RSNA, 2023

MKEE-71

### Keeping Cool: Thermoprotection Strategies for Musculoskeletal Ablations

All Day Room: Learning Center

Christopher Newman, BMBS, FRANZCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Basic principles of how to ablate targeted tissues and minimize damage to surrounding structures.-Review passive monitoring and active protection techniques during thermoablation.

#### TABLE OF CONTENTS/OUTLINE

Percutaneous thermal ablation is being increasingly performed for oncologic treatment within bone and non-visceral soft tissue.-Certain risks are of interest during musculoskeletal ablation, namely skin and neurovascular bundle injury when compared to other deep organ ablations. Given this, concurrent multi-modal thermoprotective measures should be used to prevent non-target destruction of overlying skin and adjacent structures. Both active and passive protective measures are outlined in our presentation.-Passive techniques are utilised to monitor the patient and can include clinical monitoring and real-time intra-procedural imaging. Direct patient interaction and instruction, such as asking the patient to move intermittently or report altered sensation is a subjective method of clinical monitoring in order to detect neural injury. In contrast, intra-procedural imaging is more objective, whereby the radiologist can view the ablation zone in real-time, allowing confident treatment of the target lesion while avoiding non-target structures.-By comparison, active techniques are utilised to protect non-target structures and can be subdivided into temperature modulation and displacement techniques. Temperature modulation can be achieved with warmed/cooled saline gloves on the skin or subcutaneous fluid injection to dissipate temperature. Displacement of non-target adjacent structures is usually achieved with hydrodisplacement or pneumodisplacement.

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## Abstract Archives of the RSNA, 2023

MKEE-72

### Dual Energy X-ray Absorptiometry (DXA): Principles and Tips in Classic and New Applications

All Day Room: Learning Center

Rosa M. Lorente-Ramos, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To review the basics of dual energy x-ray absorptiometry (DXA)
- To discuss the use of DXA in the assessment of bone density, also reviewing the contribution of new developments such as trabecular bone score (TBS) in the diagnosis of osteoporosis.
- To analyze the evolving role of DXA in the evaluation of soft tissues especially for body composition such as quantification of fat and estimation of skeletal muscle mass in sarcopenia.
- To emphasize pitfalls, diagnostic difficulties, and provide clue points in order to improve performance in DXA exams.

#### TABLE OF CONTENTS/OUTLINE

DXA is the 'gold-standard' in quantitative assessment of bone mineral density in the diagnosis of osteoporosis. The use of DXA has been also recommended in sarcopenia, to assess lean mass as an estimation of all non-fat/non-bone tissues, fat mass and bone mineral content. We review: 1. Basics and technique of DXA. DXA principle is based on attenuation coefficient of different tissues with low energy X-ray beams. 2. Uses of DXA. BMD study. Body composition and sarcopenia studies 3. BMD study. DXA performance. Causes of mistakes in different steps of DXA study: 3.1 Before the study: technologist training and competence, daily calibration, anthropometric data, regions to scan. 3.2 During the study: Patient positioning, Image acquisition: regions of interest. 4. Osteoporosis diagnosis. Image interpretation: Parameters. Adequate use of T-score and Z-score; Report. Detection of vertebral fractures or bone diseases (osteoarthritis, metastases, Paget's disease), soft tissue lesions, detection of artifacts-foreign bodies. New developments: TBS. 5. Body composition. Sarcopenia. DXA software analysis. Comparison with different techniques.

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## Abstract Archives of the RSNA, 2023

MKEE-73

### **A Radiological Overview of Elbow Arthroplasty: Practical Keys in the Assessment of Elbow Replacement**

All Day Room: Learning Center

Javier Azpeitia Arman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To know the different types of elbow replacement. -To review the role of imaging techniques (plain radiograph, CT, MR, US, scintigraphy) in the evaluation of elbow replacements. -To understand usefulness and limitations of plain radiographs and CT in the evaluation of elbow replacements, emphasizing useful parameters and illustrating image analysis and interpretation. -To become familiar with normal and abnormal postoperative imaging findings and signs of complications

#### **TABLE OF CONTENTS/OUTLINE**

We review imaging of elbow replacement, highlighting key concepts perceived as important variables by the surgeon and correlating images with clinical considerations and functional outcomes. We present: 1. A review of types of replacement. 2. Surgery. Aims. 3. Imaging. Plain radiographs: -Technique and views. Standard image acquisition: beam and anatomical landmarks -Parameters that should be evaluated: description of the components, alignment relative to normal anatomic alignment. 4. Imaging. CT: -Technique. -Parameters that should be evaluated. -Imaging of complications: Aseptic loosening, infections, ulnar nerve complications, instability, disassembly, dislocation, subluxation, intraoperative fractures, mechanical failure of prosthetic components, and ectopic bone formation 5. Role of MRI, US and scintigraphy. .

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## Abstract Archives of the RSNA, 2023

MKEE-74

### **Beyond the Surface: Exploring Extradigital Glomus Tumors - A Comprehensive Review of 64 Cases with Radiologic-Pathologic Correlation**

All Day Room: Learning Center

Gabriela Serra Del Carpio (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- In our study males outnumbered females with a male-female ratio of 2.1:1. - The mean age at the time of diagnosis was 55,8 years. - The tumors had a mean size of 1 cm and were located in the lower limbs in most cases (38/64).- In 17 cases (27%) a diagnostic imaging test was performed (US, MRI or both). - The radiological appearance of a glomus tumor on ultrasound was in most cases as a circumscribed hypoechoic oval nodule located in the subcutaneous layer and horizontally oriented. - Spectral Doppler can demonstrate both venous and arterial intralesional flow and in some cases a "Vascular stalk sign". - Images obtained by ultrasound are not specific but they play an important role in early diagnosis, give precise information on location, and provide guidance for excision of glomus tumors.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction  
Materials and Methods  
1. Results- Clinical findings - Radiological findings- Histological, cytological and immunohistochemical features- Differential diagnosis- Discussion  
2. Conclusions

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## Abstract Archives of the RSNA, 2023

MKEE-75

### Weight-Bearing MRI: A New Technology for Changing the Approach to Pathology from Diagnosis to Therapy

All Day Room: Learning Center

Joan C. Vilanova, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Learn the technical methodology to perform a weight bearing MRI (WB) for the different areas of the body/joints
- Show the proper analysis of the weight bearing examination to distinguish physiological changes from pathology on a clinical-radiological correlation
- Know the most common and appropriate indications for weight bearing MRI from the different areas/joints of the body

#### TABLE OF CONTENTS/OUTLINE

- Introduction
- WB MRI equipment characteristics
- WB MRI technique of different areas/joints, procedure to perform the upright examination: craniovertebral junction (CVJ), spine, shoulder, knee, hip, ankle, foot, temporomandibular joint (TMJ); showing dynamic MRI evaluation
- WB postprocessing: quantification of the changes from non-WB to the WB examination
- Indications: CVJ: instability; Spine: instability, postural alignments changes, discopathy, lateral recess - foramen - central canal, postsurgical evaluation; Shoulder: instability, impingement; Knee: meniscal-ligamentous instability, patellar shift, Impingement; Hip: impingement, microinstability; Ankle: ligamentous instability, impingement, plantar fascia; Foot: metatarsalgia evaluation; TMJ: internal joint disorders
- Benefits and limitations
- Conclusions

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## Abstract Archives of the RSNA, 2023

MKEE-76

### **Radiologic Stranger Thing: Phosphaturic Mesenchymal Tumor (PMT) and Pitfalls**

All Day Room: Learning Center

Jacobo Porto Alvarez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To describe and understand the physiopathology of PMT. -To learn about the most typical presentation of PMT. -To describe that the diagnosis is based on pathologic and biochemical analysis, but the imaging techniques are crucial in the tumor location for surgery treatment. -To alert about PMT and emphasise the radiologist's role in the management of PMT and when a radiologist can be crucial in raising the suspicion of PMT. -To describe some of the most common radiologic pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

-Introduction: Actions of FGF-23, analytic changes and the bone implication. -Location and symptoms of PMT.-Diagnoses and treatment of PMT.-The radiologist's role in the management of PMT.-Pitfalls of PMT.

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## Abstract Archives of the RSNA, 2023

MKEE-77

### Soft Tissue Tumours: Anatomic-Based Approach

All Day Room: Learning Center

Imran Ladak, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the 2020 World Health Organization (WHO) classification of soft tissue tumours. Understand the role of imaging in the diagnosis and management of soft tissue tumours Learn an approach to benign and malignant soft tissue tumours based on characteristic location and imaging appearance.

#### TABLE OF CONTENTS/OUTLINE

Introduction Introduction to soft tissue tumours 2020 World Health Organization classification of soft tissue tumours Role of imaging in soft tissue tumours Soft tissue tumours by location and appearance Common/benign soft tissue tumours Lipoma Venous hemangioma Peripheral nerve sheath tumour Skin Dermatofibrosarcoma protuberans Chest Elastofibroma dorsi Solitary fibrous tumour of the pleura Arm Desmoid-type fibromatosis Nodular fasciitis Trunk Desmoid tumour Leiomyosarcoma Retroperitoneal liposarcoma Hand Fibrolipomatous hamartoma Giant cell tumour of tendon sheath Palmar fibromatosis Thigh Intramuscular myxoma Liposarcoma Undifferentiated pleomorphic sarcoma Leg/foot Synovial sarcoma Palmar fibromatosis

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## Abstract Archives of the RSNA, 2023

MKEE-78

### Breaking Down Bone and Muscle: The Nitty-gritty of MSK Infections

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Alba Salgado Parente, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To revise the pathophysiology and imaging findings of musculoskeletal infections (soft tissue, bone and joint, spine and periprosthetic infections) with different imaging modalities (conventional radiography, US, CT, MRI, PET)2. To discuss the differential entities that can mimic septic arthritis and osteomyelitis, focusing on pearls and potential pitfalls to make a correct diagnosis3. To develop a systematic approach for interpreting imaging findings of MSK infections, including evaluation of the extent and severity of infection and potential complications

#### TABLE OF CONTENTS/OUTLINE

1. Introduction2. Imaging techniques in the evaluation of MSK infections: conventional radiography, ultrasound, CT, MRI and nuclear medicine techniques3. MSK infections: Pathophysiology and key conceptsa. Soft tissue infections: Cellulitis, abscess/phlegmon, myositis/pyomyositis, superficial, deep and necrotizing fasciitisb. Bone and joint infections: Septic arthritis, septic bursitis, tenosynovitis, acute osteomyelitis, chronic osteomyelitis, Diabetic footc. Spine infections: Spondylodiscitis, facet joint septic arthritisd. Periprosthetic infections: Technical considerations and imaging4. Pitfalls and mimics - How to avoid them: Is this septic arthritis?, Is this osteomyelitis?5. Systematic approach to MSK infections: What steps to follow6. Conclusions7. References

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## Abstract Archives of the RSNA, 2023

MKEE-79

### Spotlight on Musculoskeletal Lymphoma: A Radiological Exploration of an Uncommon Entity

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Maxine E. Kresse, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Radiology plays a central role in the diagnosis of musculoskeletal lymphoma.2. Musculoskeletal lymphoma can present with different patterns.3. Lymphoma involving the muscle, skin, and bones can occur at nearly every age and may present with atypical features that can distinguish it from other entities.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction-Overview of musculoskeletal lymphoma-Importance of radiology in diagnosis2. Imaging modalities for musculoskeletal lymphoma, including Radiography, Ultrasound (US), Computed Tomography (CT), Positron Emission Tomography (PET), and Magnetic Resonance Imaging (MRI)3. Imaging features and patterns of musculoskeletal lymphoma- Osseous lymphoma: lytic pattern, sclerotic pattern, and "near normal" radiographic findings-Soft tissue lymphoma-Trans-spatial lymphoma4. Differential diagnosis-Other primary bone and soft tissue neoplasms-Metastatic lesions-Inflammatory and infectious conditions5. Conclusion: key takeaways from radiologic evaluation of musculoskeletal lymphoma

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## Abstract Archives of the RSNA, 2023

MKEE-8

### Non-Tumoral Spine Bone Lesions: A Pictorial Review of Common and Uncommon Pathologies

All Day Room: Learning Center

Andre Mannato, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The features of non-neoplastic bone lesions in the spine are often similar to those of malignant tumors, and a differential diagnosis is challenging to obtain in some cases. Non-tumoral bone lesions of the spine have a broad spectrum, including mechanical, infectious, inflammatory, vascular, and other causes. The clinical manifestations of ranging from back pain to neurological deficits mimicking myelopathy or radiculopathy. A careful and attentive imaging evaluation can help narrow differential diagnosis and potentially avoid unnecessary biopsy. Therefore, an accurate diagnosis is important prior to treatment. X-rays are often the first imaging study used to evaluate spinal tumors, but they have limited sensitivity and specificity for diagnosing benign tumors. CT scans provide detailed images of the spine and are particularly useful for evaluating the bony structures, such as in the case of vertebral hemangiomas. MRI, on the other hand, provides better soft tissue contrast and can help differentiate between benign and malignant tumors. Overall, the DWI and Dixon techniques offer several advantages in magnetic resonance imaging, including improved detection of diseases, improved visualization of structures, can help distinguish between benign and malignant tumors and provide information about tumor cellularity and aggressiveness. These techniques have the potential to improve the accuracy and efficiency of MRI and enhance patient care.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction; II. Imaging Modalities; III. Mechanical Causes; IV. Infectious Lesions of the Spine; V. Inflammatory Causes; VI. Vascular; VII. Miscellaneous; IX. Conclusion.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

MKEE-80

### Imaging Review of Knee Ligament Reconstructions Other Than the ACL

All Day Room: Learning Center

#### Awards

##### Cum Laude

Thurl Hugh C. Cledera, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Knee ligament injuries are common and operative techniques are continually evolving. Accurate clinical information along with imaging diagnosis aids in selection of the appropriate operative technique. While imaging features of anterior cruciate ligament (ACL) reconstruction are well-described in literature, data on indications, postoperative imaging findings and complications of reconstructions of other ligaments of the knee are limited. In this education exhibit, we discuss the imaging findings and complications of reconstructions of knee ligaments other than the ACL. The objectives of this education exhibit are: 1. Recognize normal radiographic and MR appearing of non-ACL ligament reconstructions 2. Understand the basic operative concepts and techniques for each type of reconstruction including indications and common grafts used 3. Recognize commonly encountered postoperative complications to aid in providing a precise and meaningful radiologic report

#### TABLE OF CONTENTS/OUTLINE

TECHNICAL CONSIDERATIONS •Conventional radiographs •Stress radiographs•Pre and postoperative MRI BASIC INDICATIONS AND NORMAL RADIOGRAPHS AND MRI OF THE FOLLOWING PROCEDURES Posterior cruciate ligament (PCL) reconstruction Posterolateral corner reconstruction •Laprade technique •Andrews technique •Lemaire technique Anterolateral knee reconstruction •Lateral extra-articular tenodesis (LET) •Anterolateral ligament (ALL) reconstruction Posteromedial corner reconstruction Medial patellofemoral ligament (MPFL) reconstruction Multiligament reconstruction COMPLICATIONS •Graft failure •Malpositioned graft •Femoral and/or tibial tunnel widening •Arthrofibrosis •Graft impingement

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-81

### Radiographs and MRI of Tendon and Ligament Surgeries: A Resident's Primer

All Day Room: Learning Center

Juvel Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiodense hardware such as in metallic fixation and arthroplasties are easily evaluated on radiographs by both trainees and nontrainees alike. On the other hand, surgeries that utilize mostly radiolucent or nonmetallic components such as tendon transfer, ligament reconstruction and other soft tissue procedures may be more challenging to assess, especially by trainees. These procedures may manifest with nodular or tubular lucencies that may be mistaken for cysts, infection or tumors. In this education exhibit, we provide a concise review or "pocket guide" of normal and abnormal imaging appearance of commonly encountered soft tissue procedures to aid the radiology resident/trainee in appropriate assessment of non-radiodense operative hardware. The objectives of this education exhibit are: 1. Recognize normal radiographic appearance of commonly encountered non-radiodense operative hardware 2. Understand the basic operative concepts and indications of these soft tissue procedures 3. Recognize radiographic and basic MR appearance of complications of these soft tissue procedures

#### TABLE OF CONTENTS/OUTLINE

For each procedure, the following will be discussed: PROCEDURE: INDICATIONS: RADIOGRAPHS: MRI: COMPLICATIONS:  
SHOULDER Rotator cuff repair Biceps tenodesis Anterior stabilization ELBOW UCL reconstruction Distal biceps repair WRIST  
and HAND Volar oblique ligament reconstruction Thumb UCL reconstruction KNEE ACL reconstruction MPFL reconstruction  
Patellar tendon transfer ANKLE Tendon transfer procedures Lateral ligament reconstruction

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## Abstract Archives of the RSNA, 2023

MKEE-82

### **Utilizing Dual Energy CT for Evaluating Gout: A Review of Imaging Artifacts and Pitfalls for Trainees to Avoid**

All Day Room: Learning Center

Kush Purohit, MD, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Discuss the basics of dual-energy CT (DECT) technology and its current clinical application in the detection of gout. Demonstrate typical imaging findings of gout on DECT. Review imaging artifacts commonly seen when utilizing DECT gout protocol, including those related to keratin, metallic objects, and image noise. Explore additional pitfalls for trainees to avoid including the physiologic deposition of monosodium urate in various tissues. Understand techniques to minimize DECT artifacts.

#### **TABLE OF CONTENTS/OUTLINE**

Epidemiology and clinical presentation of gout, a crystal arthropathy caused by the deposition of monosodium urate (MSU) crystals  
Typical imaging findings of gout on radiography, conventional CT and MRI  
Physics of DECT and its clinical application for the evaluation of gout  
Reviewing artifacts causing misregistration of non-MSU crystals as gout:  
Keratin: Nailbed keratin and skin callous  
Metallic objects: Foreign bodies, CT table and orthopedic hardware including intervertebral disc spacer material  
Image noise: Quantum mottle causing image noise artifact with incorrectly-labeled submillimeter foci of MSU crystals  
Additional miscellaneous pitfalls for trainees to avoid: Limitations of DECT for evaluating chronic gout  
Physiologic deposition of MSU crystals in non-gout patients  
Troubleshooting and minimizing DECT artifacts  
Physiologic deposition of MSU crystals in non-gout patients  
Troubleshooting and minimizing DECT artifacts

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-83

### **CUP - A Novel Comprehensive Classification System for Triangular Fibrocartilage Complex Lesions**

All Day Room: Learning Center

Jan P. Grunz, MD (*Presenter*) Research Consultant, Siemens AG

#### **TEACHING POINTS**

The classifications of Palmer (1989) and Atzei/Luchetti (2011) constitute the current standard to characterize lesions of the triangular fibrocartilage complex (TFCC). However, both systems have substantial drawbacks that limit clinical applicability. The Palmer classification does not discern between the foveal and styloid insertions of the radioulnar ligaments, which is essential for treatment, while differentiating between traumatic and degenerative lesions is often not feasible. In contrast, the Atzei classification focuses exclusively on the ulnar-sided periphery. Several less common lesion types are not included in either system. These limitations motivated us to develop a new comprehensive and clinically-oriented classification for lesions of the TFCC. In the proposed system, the acronym 'CUP' refers to central lesions (C) limited to the articular disc, ulnar lesions (U) affecting the insertions of the radioulnar ligaments, and peripheral lesions (P), which comprise injuries of the ulnocarpal meniscus and ligaments, the dorsal joint capsule, and the extensor carpi ulnaris tendon sheath. Each group is subdivided into three grades of severity with adequate treatment recommendations.

#### **TABLE OF CONTENTS/OUTLINE**

1. TFCC anatomy 1.1 Biomechanical properties 1.2 Vascularization 2. Imaging 2.1 MRI with and without intravenous contrast enhancement 2.2 CT and MR arthrography 3. Lesion types 3.1 Central lesions 3.2 Ulnar lesions 3.3 Peripheral lesions 3.4 Combinations with fractures and avulsion injuries 4. Therapy 4.1 Surgery versus conservative treatment 4.2 Overview of surgical procedures 5. Discussion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-84

### There's Light at the End of the Carpal Tunnel - But is it a Good Thing

All Day Room: Learning Center

Jan P. Grunz, MD (*Presenter*) Research Consultant, Siemens AG

#### TEACHING POINTS

Constituting the most common entrapment neuropathy by far, carpal tunnel syndrome (CTS) is caused by compression of the median nerve within a narrow passage on the palmar side of the wrist. The carpal tunnel is located beneath the transverse carpal ligament and extends from the scaphoid and trapezium to the hamate and pisiform bone. Containing the deep and superficial flexor tendons in addition to the median nerve, entrapment neuropathy can occur in case of mismatches between the tunnel's size and the volume of its contents. CTS patients typically report painful paresthesia of digits I-III with aggravation at night, when provoked by tapping the median nerve at the carpal tunnel entrance (Hoffmann-Tinel sign), and when flexing the wrist (Phalen test). Chronic CTS results in atrophy of the thenar muscles with limited opposition and abduction of the thumb. Among several causes, tenosynovialitis of the flexor tendons is the most frequent. While CTS is usually diagnosed in clinical and electrophysiological examinations, radiologists can provide valuable insights by performing cross-sectional measurements and qualitative assessment of the edematous nerve structure in ultrasound and MRI. Particularly if symptoms persist after carpal tunnel release surgery, both imaging methods are of great importance.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy of the carpal tunnel 2. Imaging techniques 2.1 Ultrasound 2.2 MRI with and without i.v. contrast enhancement 3. Pathophysiology of CTS 3.1 Tenosynovialitis 3.2 Congenital anatomical variants 3.2 Bony stenoses 3.4. Tumors 4. Postoperative imaging 5. Discussion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-85

### The Many Faces of Heterotopic Ossification: Pathogenesis, Imaging Features and Differential Diagnosis

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ustun Aydingoz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Three requisites stand out for heterotopic ossification (HO) formation: osteogenic precursor cells, multiple inducing factors and pertinent biochemical signaling pathways, a favorable microenvironment.
- Recent evidence suggests that the initiation of HO particularly necessitates local hypoxia in the microenvironment.
- Heterotopic ossification is a commonly encountered condition on imaging with characteristic—if not pathognomonic—findings involving musculoskeletal soft tissues such as muscles, ligaments, and tendons.
- A host of differential diagnostic possibilities need to be considered when there is concern for heterotopic ossification.

#### TABLE OF CONTENTS/OUTLINE

- Pathophysiologic background of HO.
- Case examples of various manifestations of HO on imaging with pearls and pitfalls (e.g., myositis ossificans [traumatic, neurogenic], periostitis ossificans, arachnoiditis ossificans, panniculitis ossificans, Pellegrini-Stieda lesion [HO of the medial collateral ligament of the knee], HO of the posterior longitudinal ligament [OPLL] or nuchal ligament, Bennett lesion [HO of the posterior band of the inferior glenohumeral ligament], other enthesal ossifications [diffuse idiopathic skeletal hyperostosis], tendon ossifications [Achilles, hip abductors, rotator cuff], fibrodysplasia ossificans progressiva).
- Differential diagnostic considerations for HO on imaging (e.g., calcific tendinitis, calcific periarthritis, dystrophic calcifications, extraskeletal bone tumors, synovial sarcoma, calcinosis cutis, calcinosis of chronic renal failure).

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## Abstract Archives of the RSNA, 2023

MKEE-86

### Spectrum of Calcaneal Tumors and Tumor-like Lesions: Imaging Findings with Pathological Correlations

All Day Room: Learning Center

Yuan-Chang Chen (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Lipomas can be distinguished from simple bone cysts based on central dystrophic calcification, particularly with fat necrosis and cyst formation. 2. An associated primary bone lesion should always be considered in older patients with aneurysmal bone cyst-like changes. The differential diagnosis can be narrowed down using a combination of imaging features (lesion components, location) and clinical information (age). 3. The age for some calcaneal tumors is different from tumors in other locations. This makes it difficult to differentiate between chondroblastomas, characterized by marginal sclerosis and calcifications, and giant cell tumors (GCTs). 4. The tumor matrix pattern should be emphasized. A stippled or ring-like pattern indicates cartilage calcification, cloud-like appearance indicates osteoid mineralization, and a ground-glass density indicates fiber matrix. 5. Age needs to be considered in solid tumors with non-specific imaging features. Enchondromas, chondrosarcomas, metastatic tumors, myelomas, lymphomas, and undifferentiated pleomorphic sarcomas are common in adults, whereas, GCTs, chondroblastomas, osteosarcomas, Ewing sarcomas, and Langerhans cell histiocytosis are more common in young individuals.

#### TABLE OF CONTENTS/OUTLINE

1. Chondroblastoma 2. Chondromyxoid fibroma 3. Secondary peripheral atypical cartilaginous tumor 4. Chondrosarcoma 5. Osteoid osteoma 6. Osteosarcoma 7. Hemangioma 8. Epithelioid hemangioendothelioma 9. Aneurysmal bone cyst 10. Giant cell tumor 11. Simple bone cyst 12. Fibrous dysplasia 13. Lipoma 14. Undifferentiated pleomorphic sarcoma 15. Metastases 16. Myeloma 17. Primary lymphoma 18. Ewing sarcoma

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## Abstract Archives of the RSNA, 2023

MKEE-87

### **Discordance Between Bone Mineral Density and Trabecular Bone Scores for the Lumbar Spine in the Setting of Intra-Abdominal Calcifications and Dense Surgical Materials**

All Day Room: Learning Center

Yuchen Dong, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Spinal vertebrae contain the most metabolically active components, and they are therefore commonly the first site to manifest the osteoporotic process. Calcifications (i.e., fibroids, vascular calcifications, and degenerative joint disease) and dense surgical material (i.e., vertebroplasty, stents, embolization coils, and IVC filters) within the field of view falsely elevate bone mineral density (BMD) measurements. To mitigate such artifactual elevation of BMD measurements, the International Society of Clinical Densitometry (ISCD) has come up with guidelines for BMD reporting such as excluding affected vertebrae from analysis. Trabecular Bone Score (TBS), on the other hand, is a novel tool for assessing fracture risk by analyzing bone trabecular microarchitecture. Despite being adherent to ISCD guidelines, we have found in clinical practice that many patients with intra-abdominal calcifications and surgical material have normal lumbar spine BMD measurements but low TBS scores. These inconsistencies suggest that the utilization of DXA BMD measurements alone may under-predict fracture risk, especially in patients with calcifications or surgical material, and that TBS may be especially helpful as an adjunct to DXA in this patient population.

#### **TABLE OF CONTENTS/OUTLINE**

1. Fundamentals of DXA. 2. Pathophysiology of osteoporosis. 3. Fundamentals of TBS. 4. Limitations of DXA in the setting of intra-abdominal calcifications and surgical material. 5. Case comparisons of DXA and TBS scores to demonstrate discordances. 6. Conclusion.

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## Abstract Archives of the RSNA, 2023

MKEE-88

### Peripheral Arthropathies: Step by Step

All Day Room: Learning Center

Raquel Acosta Hernandez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Introduction: Despite the development of CT and MRI, plain radiography stands as the irreplaceable test of first diagnostic approach in peripheral arthropathies. Following a complete diagnostic algorithm helps to emphasize the key points in the differential diagnosis between inflammatory versus osteoarthritis disease. Once joint space narrowing is evaluated, the presence of bone erosions (as a hallmark of joint inflammatory arthritis in ankylosing spondylitis, psoriatic arthritis, and reactive arthritis), osteophytes (typical of degenerative arthritis), and their distribution are basic pillars on guiding an accurate diagnosis. Teaching points Approach the radiographic algorithm evaluation of peripheral arthropathies based on classification into inflammatory or degenerative pattern: joint space narrowing (uniform and non-uniform), bone erosion and distribution pattern. Introduced a systematic reading of hands and feet plain radiographs following the ABCDs acronym: articular, bone, cartilage, distribution and soft tissue. Correlate typical plain radiographic of peripheral arthritis findings with CT and MRI studies.

#### TABLE OF CONTENTS/OUTLINE

- Radiographic algorithm evaluation of peripheral arthropathies based on joint space narrowing and typical examples of articular erosions patterns.- Systematic ABCDs acronym reading: articular (deformity and destruction), bone (erosion, osteopenia, proliferative changes and distal affectation), cartilage, distribution and soft tissue (soft tissue swelling).

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## Abstract Archives of the RSNA, 2023

MKEE-89

### Imaging Findings of Monoclonal Gammopathy of Clinical Significance

All Day Room: Learning Center

Anika Dutta, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Monoclonal Gammopathy of Clinical Significance (MGCS) describes a constellation of diseases involving clonal B cells or plasma cells which produce monoclonal proteins and cause organ damage. MGCSs can be divided into groups based on which organ systems are most affected. Some of these entities have distinct imaging findings that suggest the diagnosis. By the end of this education exhibit, the viewer should be able to identify those findings and clinical symptoms that characterize them. Recognizing these findings may help lead to an expedited and accurate diagnosis.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction - what is MGCS?
2. MGCS definition and symptom classes
3. Detailed description of syndromes, for example:- POEMS syndrome (polyradiculoneuropathy, organomegaly, endocrinopathy, monoclonal plasma cell disorder, and skin changes): Description, Imaging findings with case example-AL Amyloid: Description, Imaging findings with examples
4. Conclusions
5. References

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## Abstract Archives of the RSNA, 2023

MKEE-9

### Patellofemoral Dysfunction: A Practical Approach and New Radiological Insights

All Day Room: Learning Center

Lucas D. Bettin, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Patellofemoral dysfunction occurs as a result of an imbalance in the dynamic relationship between the patella and the trochlea during knee flexion, secondary to anatomical or functional abnormalities. Classic risk factors are usually limited to local anatomy, such as trochlear dysplasia, patella alta, patellar tilt and increased TT-GT distance. Recently, new concepts on the functional evaluation of the lower limbs and their relationship with the pelvis have earned more attention, including muscle function. Imaging of the patellofemoral joint includes standard radiographs of the knee to evaluate bone morphology and patellofemoral relationship. MR imaging is important to also assess cartilage, capsule and ligaments. For preoperative planning, computed tomography can assess the knee in different degrees of flexion, besides providing multiplanar reconstructions. The evaluation of the entire mechanical axis of the lower limb is also of fundamental importance. Findings such as the anterior tilt of the pelvis, femoral or tibial torsion abnormalities, increased femorotibial rotation and deviations of the mechanical axis significantly modify the dynamics of the extensor mechanism. Clinical treatment and physiotherapy are typically the first-line approach, taking into account the particularities of the mechanical axis. Surgical intervention is indicated for recurrent dislocations. Therefore, anatomical and functional concepts of the patellofemoral joint and the entire lower limb are necessary to determine the optimal treatment.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction; 2. Anatomy biomechanics; 3. Dysfunction vs. instability; 4. Radiological approach; 5. Beyond Dejour; 6. Conclusion.

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## Abstract Archives of the RSNA, 2023

MKEE-90

### What's New and Not So New in Postoperative MRI of Rotator Cuff Tendon Repair: Conventional and New Surgical Techniques, Normal and Abnormal Postoperative Findings

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Yeongseo Yoo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review conventional techniques for rotator cuff tendon (RCT) repair, including correlation with postoperative MRI findings
2. To introduce newer techniques of RCT repair with MRI correlation
3. To diagnose normal and abnormal postoperative MRI findings of RCT repair, including complications and RCT repair failures

#### TABLE OF CONTENTS/OUTLINE

I. Surgical techniques on postoperative MRI of RCT repair  
A. Conventional suture techniques (single, double row, transosseous equivalent suture bridge)  
B. Newer techniques- Augmentation, pectoralis major transfer, biceps transfer, Polyglycolic acid insertion, allograft patch graft (fascia lata, dermis), biceps splinting, Others (biceps tenotomy, deltoidoplasty)  
II. Normal postoperative MRI findings  
1. MR appearance of repaired SST tendon (SI, morphology changes, gap) - thinning, high SI (Sugaya type I, II -Sugaya classification)  
2. Significance of fluid collections: glenohumeral joint, subacromial-subdeltoid bursa, subcoracoid bursa  
3. Susceptibility artifacts (air, anchor, metal from burr)  
4. Suture anchor positions: absorbable vs. non-absorbable  
5. Rotator interval change: arthroscopy portal  
III. Abnormal postoperative MRI findings  
1. Thinning of repaired tendon (Sugaya type III)  
2. Focal defect/minor discontinuity of repaired tendon (Sugaya type IV)  
3. Major discontinuity/full thickness tear with retraction (Sugaya type V)  
4. Displacement of anchors  
5. Infection (arthritis, bursitis, soft tissue infection)  
6. Fracture

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-91

### **The Key Determinant of Purely Lytic Diaphyseal Lesion Visibility on Radiographs: Exclusively Trabecular Versus Concurrent Endosteal Cortical Involvement**

All Day Room: Learning Center

Ustun Aydingoz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Location of a lytic lesion within a long bone (i.e., metaphyseal versus diaphyseal; trabecular versus cortical involvement) is a key determinant of the lesion's conspicuity on conventional radiographs.
- Due to the sparseness of trabeculae at diaphysis, lytic diaphyseal bone lesions without matrix mineralization are visible on radiographs only if they involve the endosteal cortex.
- The oft-repeated statement that "30%-50% of trabecular bone must be removed before radiolucency becomes visible on radiographs" can be misleading: A large diaphyseal trabecular lytic lesion involving 100% of the cancellous bone may not be visible on radiographs, if it is confined to the medullary space and does not also involve at least the endosteal surface of the cortex—constituting a major limitation for conventional radiography.
- This is true for lytic lesions of all Lodwick grades: Moth-eaten or permeative lytic bone lesions that involve the diaphysis are not be visible on radiographs at sites where they spare the cortex.
- Such lytic lesions that are obscure on conventional radiography are readily detected on MRI; when a primary bone tumor is suspected and radiographs are negative, MRI is appropriate.

#### **TABLE OF CONTENTS/OUTLINE**

- The modified Lodwick classification of lytic bone lesions on conventional radiographs.
- Radiographic-anatomic explanation of the crucial role the location plays in lytic lesion conspicuity on radiography at different sites (i.e., metaphyseal versus diaphyseal; trabecular versus trabecular plus cortical) on anatomic specimens.
- Case examples of lytic lesions that are obscure on conventional radiographs (due to their diaphyseal medullary space involvement) but are visible on CT or MRI.

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## Abstract Archives of the RSNA, 2023

MKEE-92

### Ultrasound of Acute Tendon Tears with Emphasis on Anatomic Landmarks

All Day Room: Learning Center

Juvel Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ultrasound of acute tendon tears with emphasis on anatomic landmarks Sonography has become an essential imaging tool in musculoskeletal imaging, with precision nearly equal to that of MRI for imaging tendon abnormalities. In emergency setting, the rarity of acute tendon tears compared to overuse tendon abnormalities may result in a challenging scan for trainees, sonographers, emergency and musculoskeletal radiologists. In this education exhibit, we present an approach to sonography of acute tendon tears that may be encountered in the emergency or radiology department. The objectives of this educational exhibit are: Brief review of scanning techniques of the various tendons Recognize the normal appearance of the outlined tendons with MRI correlation and emphasizing important anatomic landmarks Recognize imaging presentation of the various traumatic tendon tears

#### TABLE OF CONTENTS/OUTLINE

For each structure, the following will be discussed:1. US scanning technique2. US anatomy and landmarks with MRI correlate3. Pathology (sprains, partial, complete tears)Pectoralis Distal biceps Triceps Quadriceps Hamstrings Achilles tendon and related structures

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## Abstract Archives of the RSNA, 2023

MKEE-93

### A 360-degree Imaging Tour of Sports Injuries in the Elbow

All Day Room: Learning Center

Lauren Pringle, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review of anatomy of the elbow, with detail of the ulnar collateral ligament bundles and bands of the anterior bundle. 2. Phases of throwing mechanism are important in understanding forces applied to different structures of the elbow and how injuries then develop. 3. Pediatric throwers are susceptible to injuries also seen in adults but can experience additional injuries seen only during certain phases of development. 4. Medial elbow injuries are among the most common and well-known in athletes but specific injuries in the posterior elbow, lateral elbow, and anterior elbow are not infrequent and will be described. 5. Illustrative cases of these injuries demonstrate important imaging findings and diagnostic tools to improve detection for learners. 6. Treatment/surgical strategies and the surgeon's perspective will also be reviewed for some of these conditions.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy review 2. Throwing mechanism and stresses 3. Medial elbow injuries a. Ulnar collateral ligament b. Medial epicondylitis c. Medial epicondylar apophysitis d. Ulnar neuritis e. Posteromedial impingement syndrome 4. Posterior elbow injuries a. Olecranon stress fractures b. Triceps i. Tendon ii. Muscle c. Snapping triceps 5. Lateral elbow injuries a. Panner's disease b. Capitellum osteochondral lesion c. Tennis elbow d. Synovial fold 6. Anterior elbow injuries a. Biceps b. Brachialis

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## Abstract Archives of the RSNA, 2023

MKEE-94

### Image-guided Symphyseal and Perisymphyseal Musculoskeletal Interventions: Indications, Challenges and Authors' Experience

All Day Room: Learning Center

Juvel Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Image-guided musculoskeletal interventions in and about the symphysis pubis can be technically challenging. The joint and surrounding region are small, resulting in limited ability to maneuver and an often cumbersome procedure. Important neurovascular and visceral structures are present nearby, including the dorsal vessels of the penis in males, pudendal nerve, branches of the ilioinguinal nerve and urinary bladder, necessitating judicious pre-procedure planning. Lastly, most procedures require inguinal or groin exposure thereby making careful draping of the pelvis of paramount importance. The main benefits of image guidance are improved precision of needle placement and simultaneous visualization of the needle and critical neurovascular structures that must be avoided during needle insertion. In this education exhibit, we provide an overview of symphyseal and perisymphyseal interventions including injections, aspirations, percutaneous tendon treatments and biopsies, their indications, risks, and complications, focusing on approaches, tips and tricks to a successful procedure.

#### TABLE OF CONTENTS/OUTLINE

Relevant anatomy of the symphysis and parasymphyseal spaces  
Pre-procedural considerations  
General technical considerations  
For each specific procedure, the following will be outlined: Purpose, patient position, equipment, technique, anatomic considerations (critical structures to avoid)  
Specific procedures: Fluoroscopy-guided diagnostic injection  
US and fluoroscopy-guided therapeutic injection  
US and fluoroscopy-guided joint and soft tissue aspiration  
Percutaneous tendon treatments  
US and CT-guided bone biopsies

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## Abstract Archives of the RSNA, 2023

MKEE-95

### Solitary Bone Metastasis: Multimodality Imaging Approach and Ten Years Experience

All Day Room: Learning Center

Fernando Rodado Aranguren, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-To analyze the radiological presentation and spectrum of solitary bone metastasis (SBM) through the different techniques: plain x-ray, Computed Tomography (CT), Magnetic Resonance imaging and Positron Emission Tomography/CT (PET/CT).-To present our ten year experience in two centers.

#### TABLE OF CONTENTS/OUTLINE

Metastatic bone disease occurs frequently in malignant tumors, but isolated involvement is unusual and has been proposed as a favorable prognostic factor against multiple bone metastatic involvement. This study aims to analyze the radiological presentation of these unique metastasis. We reviewed all bone metastases diagnosed in the last 10 years in two centers and we included patients with SBM with histological confirmation and no visceral, brain or lymph node metastases (n= 79). The primary tumors, in order of frequency, were lung, breast, prostate and melanoma. In up to 36% of SBM, the primary tumor was unknown at the time of diagnosis. 86% of the lesions were located in the spine, pelvis or femur. The most frequent radiological and clinical presentation was osteolytic lesion without periosteal reaction (75%) causing pain (42%). 68% were treated, mostly with radiotherapy. The detection of these lesions depends on their size, so the methods of choice are MR or PET/CT, with good correlation for the evaluation of the associated soft tissue mass component. In the presence of a solitary bone lesion, metastasis should be included in the differential diagnosis along with primary bone tumors, especially osteolytic lesions in patients older than 40 years with or without cancer disease history. Radiologists should be aware of the characteristics of suspicious malignant lesions that would require biopsy.

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## Abstract Archives of the RSNA, 2023

MKEE-96

### Musculoskeletal Paraneoplastic Syndromes

All Day Room: Learning Center

Derek T. Nhan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Early recognition of a paraneoplastic syndrome allows for diagnosis of an occult malignancy, and earlier treatment. This review describes unique imaging findings and clinical associations of musculoskeletal paraneoplastic disorders.1. Oncogenic osteomalacia is associated with phosphaturic mesenchymal tumors (PMT), which produces FGF23, leading to decreased calcium/phosphate absorption, and consequently insufficiency fractures.2. Secondary hypertrophic osteoarthropathy, associated with non-small cell lung cancer, manifests with digital clubbing or joint effusions and symmetric long bone periostitis.3. Cancer-associated myositis, most commonly dermatomyositis, occurs within 3 years of the diagnosis of an underlying malignancy.4. Palmar fasciitis and polyarthrititis presents with painful hand swelling and palmar skin thickening. It is associated with breast and female genitourinary malignancies.5. Remitting seronegative symmetric synovitis with pitting edema presents with nonerosive polyarthrititis and is associated with hematopoietic and lung malignancies.6. Pancreatic panniculitis with polyarthrititis, associated with pancreatic neoplasms, shows osteolytic lesions of the distal extremities with increased periarticular edema and synovitis on MRI.7. Sweet Syndrome, associated with acute myeloid leukemia, presents with fever and erythematous skin lesions.8. Eosinophilic fasciitis presents with fascial edema and enhancement, and is associated with hematologic malignancies.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction2. Musculoskeletal Paraneoplastic Syndromes including malignant associations, clinical manifestations, and imaging features.

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## Abstract Archives of the RSNA, 2023

MKEE-97

### Principles, Anatomy and Imaging of Ankle and Foot Tendon Transfers

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Dyan V. Flores, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The goals of any tendon transfer are to create a stable, functioning, and plantigrade foot. Tendon transfers were reported first in the literature as early as 1881; the first case was transfer of peroneal tendons to the Achilles in a young patient who had poliomyelitis. With the eradication of polio in developed countries, experience with a variety of tendon transfers has been lost. Aside from correction of foot deformities, tendon transfer can be performed for tendon dysfunction and tendinopathy and correction of lateral ankle instability. In this education exhibit, we discuss common foot and ankle tendon transfers highlighting principles, anatomy and imaging.

#### TABLE OF CONTENTS/OUTLINE

Anatomy and biomechanics of ankle tendon transfers Principles of tendon transfers Types of ankle tendon transfers:1. For correction of foot deformity PTT transfer for adult acquired flatfoot deformity Extensor tendon transfer for equinovarus deformity Peroneus longus to peroneus brevis tendon transfer for Charcot-Marie-Tooth disease2. For reinforcement of a diseased tendon (tendinopathy or tendon tear)FHL transfer for Achilles tendon FHL transfer for peroneal tendons FDL transfer for tibialis posterior tendon 3. For correction of lateral ankle instability Lee procedure Evans procedure Chrisman Snook procedureAncillary osseous (i.e. calcaneal osteotomy) and soft tissue (i.e. Achilles tendon lengthening) procedures

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-98

### Cricket is Coming; Are You Ready to Image

All Day Room: Learning Center

Malini A. Lawande, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Cricket is one of the fastest growing sports in the world, with popularity growth in non-traditional cricketing nations like the United States and continental Europe. 2. Understanding player roles and biomechanics is key to understanding common injury patterns.

#### TABLE OF CONTENTS/OUTLINE

From starting in south east England in the 1600s and traditionally played in the Commonwealth countries, played over 5 days with a rest day to the current 100 ball and 20 over three to four hour formats with night games, entertainment value, advertisement, immigration, universal online access and money spinning leagues have resulted in unprecedented growth in popularity of cricket across the world. In the United States alone, from 30,000 people watching/playing cricket in 2006, there are now more than 200,000 people playing cricket in over 6000 teams. The Indian premier league (IPL) is the most popular league, and had a value of \$10.9 billion in 2022. Specific player roles actions in cricket predispose them to different injury patterns. This exhibit provides a comprehensive overview of common cricketing injuries based on player role actions. The three basic roles in cricket are batting, bowling and fielding, each with sub specializations. Fast/medium pace bowlers are most prone to injuries in the spine (pars/pedicle stress), elbow, ankle (instability, posterior impingement), abdominal wall (side strain) and groin (athletic pubalgia) due to the nature of bowling action. Batsmen and fielders are prone to hamstring and quadriceps strains due to sudden sprints. Acrobatic fielding attempts diving result in shoulder injuries. Contact injuries of the fingers like dislocations fractures are common in the wicketkeeper and fielders.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MKEE-99

### **Microinstability in the Musculoskeletal System: Biomechanical Concepts to Imaging Interpretation**

All Day Room: Learning Center

Aurea V. Mohana-Borges, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To introduce joint biomechanics as a guide for imaging interpretation of microinstability, emphasizing its relationship with osseous and soft tissue (capsule, ligaments, and muscles) integrity and the role of imaging [Radiographs (Rx), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI)] in its diagnosis. This guide will highlight anatomic landmarks implicated in joint stability, their relevance in different types of synovial joints, and implications in joint biomechanics. It will compare and contrast normal anatomy with examples of commonly encountered pathologies associated with microinstability.

#### **TABLE OF CONTENTS/OUTLINE**

Explanation of the concept of microinstability. Demonstration of types of movements in different synovial joints. Demonstration of normal anatomy of joint stabilizers with Rx, CT, and MRI. Examples of microinstability with corresponding commonly encountered pathologies in the osseous structure and soft tissues, with emphasis on the shoulder, hip, knee, and ankle joints.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE

### Multisystem Education Exhibits

All Day Room: Learning Center

#### Sub-Events

##### **MSEE-1 Rosai-Dorfman Disease- Multimodality Imaging**

Babina Gosangi, MD, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Rosai-Dorfman disease is a benign proliferative disease characterized by sinus-histiocytosis with massive lymphadenopathy. The mean age of presentation is 21-years with a male preponderance. It is a result of immune dysregulation following a viral infection. Lymphadenopathy is the key finding but extranodal involvement is also seen.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Examples of cases: a. Multistation lymphadenopathy b. Extranodal involvement • Nasal cavity- Pansinusitis • Orbital involvement- cranial nerve thickening • Intracranial lesions- Brain neoplasms, meningitis • Lung lesions- perilymphatic nodules, interstitial thickening, endobronchial nodules, pleural lesions • Renal masses • Mesenteric masses • Lytic lesions in the bone • Soft tissue lesions 3. Conclusion.

##### **MSEE-10 Another Great Pretender: Extragenital Endometriosis, A Pictorial Review**

Francisca Aliaga, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Extragenital endometriosis (EE) is a relatively infrequent occurrence with a broad spectrum of clinical and phenotypic presentations, posing significant diagnostic difficulties, particularly outside the pelvic region. Radiologists play a pivotal role in suspecting the presence of EE by identifying its characteristic imaging hallmarks even before the onset of clinical symptoms. As such, they can facilitate timely diagnosis and intervention for better patient outcomes. MRI is the imaging modality of choice for EE evaluation, owing to its high specificity and sensitivity in detecting EE-specific imaging signs.

#### **TABLE OF CONTENTS/OUTLINE**

a) Introduction: General characteristics of EE, demographics, and imaging features, mostly in CT and MRI. b) Description of the case series: The experience in extragenital endometriosis in two tertiary care centers. A retrospective review of last 5 years cases was performed. c) MRI protocol d) Extragenital endometriosis distribution: Pelvic non gynecological organs, gastrointestinal, genitourinary, musculoskeletal, thoracic, nervous system, miscellaneous) Conclusions: Endometriosis is a commonly underdiagnosed disease, and the diagnostic challenge is further enhanced by the non-specific clinical and phenotypic features of EE. When radiologists are aware to these complexities, they can be the first physician to suspect and propose this diagnosis, allowing timely intervention and improved patient outcomes. MRI is the backbone of EE diagnosis, thanks to its characteristics.

##### **MSEE-11 Didactic Cases of Oncologic Emergencies in Radiology**

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To be able to recognize the main urgent pathologies related to oncological diseases and treatments. To be able to distinguish the severity level of these conditions and properly guide the clinician regarding the causative agent. To raise awareness among radiologists about the significant prevalence of these complications in general medical care.

## TABLE OF CONTENTS/OUTLINE

1. Oncologic diagnosis in the emergency department (not previously known malignancy) 2. Tumor-related complications and emergencies a Superior vena cava b Intestinal obstruction c Obstructive hydrocephalus d Spinal cord compression e Hypercoagulability f Carcinoid syndrome 3. Complications arising from diagnostic procedures and classic treatments a Surgical (suture dehiscence) b Chemo-radiotherapy c Vasculitis d Fistula e Esophagitis/esophageal necrosis f Hemorrhagic complications g Post-radioembolization h Cholecystitis i Leukoencephalopathy due to chemotherapeutics 4. Post-hematopoietic stem cell transplantation (HSCT) a Pulmonary infections: febrile neutropenia (aspergillus may occur in all time segments) 0-30 days post-HSCT (fungal): Aspergillus 31-100 days post-HSCT (early): CMV and PJ >100 days post-HSCT (late): Bacterial and viral infections (common infections) b Sinusoidal obstructive syndrome and intestinal graft versus host disease c Neutropenic colitis (typhlitis) 5. Emergencies related with new therapies and targeted therapies a Immune-related adverse events and complications b Pancolitis due to TKI c Pancolitis secondary to immune-checkpoint inhibitors d Immune-mediated pancreatitis e Hyperprogesion f Cytokine release syndrome (CRS) and immune effector cell-associated neurotoxicity syndrome (ICANS)

## MSEE-12 ctDNA in the Reading Room: A Guide for Radiologists

### Awards

#### Certificate of Merit

Yu-Cherng C. Chang, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

? Review applications of circulating tumor DNA (ctDNA) in oncology? Summarize current clinical guidelines for use of ctDNA? Review role of ctDNA in everyday practice

## TABLE OF CONTENTS/OUTLINE

-Overview of circulating tumor DNA (ctDNA).? What is ctDNA? Lexicon and definitions (tumor microenvironment, liquid biopsy, ctDNA, cell free DNA)? Available techniques and most commonly used platforms for liquid biopsy and ctDNA? ctDNA as a biomarker-ctDNA current oncology guidelines include National Comprehensive Cancer Network, American Society of Clinical Oncology, European Society of Molecular Oncology.-ctDNA in cancer surveillance, prognosis, and treatment response for: ? Lung? Breast? Colorectal? Lung? Pancreas? Sarcomas (Detectable targetable mutations, imaging examples, and indications in clinical practice are presented for each tumor)-ctDNA Strengths for imaging interpretation, Limitations in cancer surveillance, prognosis, and treatment-Future Directions and Promising Future Applications? Non-invasive tissue characterization? ctDNA and radiomics? Personalized patient management and therapy selection

## MSEE-13 When Suspect Nonneoplastic Lymphadenopathy on PET/CT

Francisca Aliaga, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Morphological changes of lymph nodes or their metabolism are not enough to predict tumoral compromise. 2. The distribution pattern, relation with a primary tumor and its typical extension, inflammatory or posttreatment changes, and clinical conditions should be considered. 3. Different nonneoplastic pathologies characteristically manifest with lymph node enlargement and are frequently confused with malignancy, such as connective tissue diseases, infections, IgG4-related disease, granulomatous inflammation, non-clonal lymphoproliferative disorders, and others.

## TABLE OF CONTENTS/OUTLINE

1. Clues to suspect nonneoplastic lymphadenopathy: Morphological characteristics, distribution pattern, relation with the drainage pathways of a primary tumor or inflammatory process, and association with other findings. 2. Nonneoplastic diseases related to lymphadenopathies: a) Connective tissue diseases: lupus and rheumatoid arthritis; b) Infections: HIV, tuberculosis, toxoplasmosis, histoplasmosis, Epstein-Barr virus, and Bartonella; c) IgG4-related disease; d) Granulomatous inflammation: sarcoidosis, sarcoid-like reaction, and pneumoconiosis; e) Non-clonal lymphoproliferative disorders: Castleman disease and Amyloidosis; f) Kikuchi and Kimura disease; g) Posttreatment lymphadenopathies: immunotherapy, target therapy, surgical and radiation inflammatory changes; h) COVID-19 vaccine; i) Others: pulmonary edema, interstitial lung disease, emphysema, chronic liver disease, and reactive lymph nodes in young patients 3. Conclusions

## MSEE-14 Potential Pitfalls of Splitting Interpretation of Concurrent Chest and Abdominal CTs

Eyal Ron, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Simultaneously obtained chest and abdomen/pelvis CTs are sometimes read by separate subspecialized radiologists. This creates the potential for missed, incomplete, and conflicting diagnoses involving the scanned areas that overlap. 2. Chest findings can sometimes be more conspicuous on the "abdomen" CT and vice-versa. This can be due to differences in contrast timing and CT reconstruction technique. 3. Some processes require synthesizing findings from both the chest and abdomen CT for optimal radiology analysis.

## TABLE OF CONTENTS/OUTLINE

We provide example cases demonstrating how splitting radiology interpretations either did or potentially could have led to misdiagnoses of abdominal findings seen on chest CT and vice versa. Additionally, we provide guidelines to avoid these potential pitfalls. Examples include: 1. Missed pancreatic adenocarcinoma conspicuous only on the chest CT portion. 2. Pulmonary embolism poorly visualized on chest CT with contrast but more conspicuous on the arterial phase of the concurrently obtained abdominal CT. 3. Area of slow flow seen on chest CT misinterpreted as pulmonary embolism when a concurrently obtained abdominal shows these arteries are adequately opacified. The patient later developed an intra-abdominal bleed related to the anti-coagulation started for the false positive pulmonary embolism call. 4. Intrathoracic extent of a metastatic GIST tumor and reactive pericardial effusion, challenging to synthesize without strong collaboration between the chest and abdominal radiologists.

### **MSEE-15 Facial Mapping: High Frequency Ultrasound Step-by-step Approach in Facial Anatomical Evaluation for Aesthetics**

Luciana C. Zattar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Facial aesthetic procedures are increasingly being performed. Different aesthetic surgery techniques, injectable materials and technologies aimed at improving skin quality and restoring the redistributed volume of facial layers have been used against the multifactorial process of the facial aging. The correct evaluation and characterization of the facial layers is crucial for safe and effective rejuvenation procedures, specially the minimally invasive, since a wrong manipulation might yield an aesthetically undesirable result and lead to serious complications. In this context, the radiologists may be requested to recognize and evaluate the facial layers, compartments and their contents. To achieve accurate and timely detection and appropriate approach of each case, High frequency ultrasound (HFUS/24-33MHz) is the most effective method since it provides optimal anatomical information of the skin and allows facial layers differentiation as well as aesthetic anti-ageing procedures identification. This study aims to discuss and illustrate the radiologist's role in the evaluation of facial anatomy with HFUS, and purposes: (1) To describe the correct examination technique / HFUS advantages. (2) To illustrate the anatomy of the skin/facial layers. (3) To show a step-by-step approach of the most important facial structures. (4) To discuss the course of the main facial neurovascular structures and its variations. (5) To list and describe the anatomy of the Facial Danger Zones. (6) To highlight the importance of HFUS in pre and post-procedural evaluation.

#### **TABLE OF CONTENTS/OUTLINE**

1. INTRODUCTION. 2. FACIAL LAYERS. 3. VASCULAR MAPPING. 4. FRESH FROZEN SPECIMEN CORRELATION. 5. CONCLUSION

### **MSEE-16 State of the Heart: A Pictorial Review of Classic and Novel Cardiac Devices**

Nikhil Gupta, MD, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Outline the indication, function, and imaging of classic cardiac implant devices. Review commonly encountered complications of classic implanted cardiac devices. Understand the role of novel implanted cardiac devices and their appearance on plain film radiography and computed tomography.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to Classic Implanted Devices in the Chest Chest Ports, Heart Valve Prostheses, Pacemakers/Implanted Defibrillators, Coronary Artery Bypass Stents, Implantable Loop Recorder 2. Outline complications of Classic Implanted Devices 3. New Implanted Devices Left Atrial Appendage Closure Devices, Atrial Septal Occlusion Devices, Ventricular Support Devices, ECMO

### **MSEE-17 Imaging in Sexagenarians and Beyond: What Clinicians Want to Know and What Radiologists Need to Know**

Sirui Jiang, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. By 2030 approximately 20% of all Americans or about 70 million people will be 65 years or older. This population utilizes about 30% of our imaging resources yearly and is ever increasing. 2. How to incorporate the geriatric scoring systems to risk stratify and prioritize treatment in the reading room. 3. Review the common imaging findings in the geriatric population with special emphasis in the emergency/trauma and oncology settings using multimodality images. 4. Review imaging differences of pathology in a young versus an elderly patient.

#### **TABLE OF CONTENTS/OUTLINE**

Background History of geriatrics Importance of geriatric care and management Development of multiple geriatric scoring systems Succinctly synthesizing common geriatric imaging findings Common Scenarios of Geriatric Population in the Reading



RoomHead and Neck: subdural hematomas, cerebral atrophy, vascular calcificationsChest: rib fractures, emphysema, cardiovascular (coronary and valvular calcifications), lung/esophageal primary malignancies, acute/chronic lung infectionAbdomen: steatosis, chronic renal failure, chronic cystitis, pancreatic issues (malignancy/insufficiency), adrenal issues (insufficiency/hyperplasia/atrophy)Pelvis: prostate, diverticulitisMusculoskeletal: osteopenia, multiple myeloma, osteoarthritis, steroid associated changes, vertebral compression fracturesCollaborative Approach for Geriatric CareTemplates with these common findings to help create a concise reportMultidisciplinary approach with geriatric subspecialtiesIs it time for a geriatric radiology fellowship/subspecialty?

## **MSEE-18 SBRT and Isolated Metastases: A Primer for Radiologists**

Raelynn R. MacBeth, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Review the natural history of stereotactic radiation therapy (SBRT) and how it has progressed to treatment of intra-thoracic and intra-abdominal malignancies. 2. To review the different types of malignancies SBRT is used to treat and the potential toxicities associated with each. 3. To discuss the multimodality appearance and evaluation of tumor burden after SBRT. 4. To discuss the multimodality appearance of SBRT associated toxicities after treatment. 5. To discuss the multimodality appearance of recurrence patterns after SBRT.

### **TABLE OF CONTENTS/OUTLINE**

1. Define stereotactic body radiation therapy (SBRT) and how it differs from other modes of radiation therapy.2. Review the pathophysiology of radiation therapy-induced cellular damage. 3. Review the natural evolution of SBRT and how it has progressed to treatment of malignancies in the chest, abdomen, and pelvis. 4. Discuss the indications for utilizing SBRT in selected malignancies and their common associated toxicities. 5. Discuss the typical and atypical response patterns after SBRT and their multimodality appearance. 6. Discuss the typical and atypical toxicity profiles after SBRT and their multimodality appearance. 7. Examine the multimodality appearance of local recurrence patterns after SBRT. 8. Discuss distant recurrence patterns after SBRT and their multimodality appearance. 9. Discuss the financial toxicities associated with SBRT.

## **MSEE-19 Syphilis: The Re-emerging Great Mimicker - A Case-based Review from Head to Toe**

### **Awards**

#### **Magna Cum Laude**

Shintaro Kano, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Syphilis, a sexually transmitted disease caused by the spirochete bacterium *T. Pallidum*, is a multisystemic infection that can affect various organs. Recently, the number of syphilitic patients has been rapidly increasing worldwide. Clinical manifestations of syphilis are often inconspicuous and imaging examinations performed for other purposes may lead to potential overlook or misdiagnosis of syphilis, making it challenging for radiologists to diagnose it accurately. Therefore, it is crucial for radiologists to understand the imaging spectrums and differential diagnosis of syphilis to ensure accurate diagnosis and appropriate patient management.The purposes of this exhibit are (1) to review the imaging spectrums of syphilis through case-based studies for the improved ability to identify potential cases of syphilis and (2) to discuss approaches to distinguish syphilis from other diseases that can mimic it.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 1-1.Epidemiology 1-2.Clinical manifestation therapy 2. Case presentations: Body imaging 2-1.head and neck 2-2.chest 2-3.cardiovascular 2-4.abdomen urogenital 3.Case presentations: Neuroimaging 3-1.brain 3-2.spinal cord 4.Case presentations:Pediatric imaging 5. Summary

## **MSEE-2 Body MRI Approach Fundamentals: A Guide for Beginners**

Mark J. Hoegger, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Body MRI interpretation can be daunting for the inexperienced reader because 1) the relevance of key clinical parameters may be unknown, 2) the importance of certain sequences in diagnosis may be unclear, and 3) a routine search pattern may not be established. To aid those inexperienced in body MRI, this exhibit's purpose is to:- Discuss the general body MRI sequences and their uses.- Identify and explain key clinical factors for the most commonly encountered clinical questions that can be answered with body MRI.- Describe the sequences and their relevance for these common body MRI indications.The intent of this exhibit is not provide an exhaustive overview of body MRI, but to arm a trainee starting on service, or a radiologist in practice who has been called upon to read body MRI exams but may be inexperienced or out of practice, with the tools needed to be successful.

## TABLE OF CONTENTS/OUTLINE

- General body MRI sequences and their uses: T1-weighted imaging pre- and post-contrast, chemical shift imaging, T2-weighted imaging, and DWI.- Body MRI search pattern fundamentals: CT versus MR approach, flexibility in body MRI, lesion finding versus lesion characterization, and pitfalls.- Disease-specific clinical parameters and sequences for common indications: liver lesions and hepatocellular carcinoma (LI-RADS), rectal cancer, renal masses, prostate adenocarcinoma (PI-RADS), pancreatic cysts and solid masses, inflammatory bowel disease, biliary disease, and uterine and ovarian masses.

### **MSEE-20 Monitoring the Abdomen: How to Do It - Tumor Surveillance and Follow-up**

Melissa A. Persad, MBBS, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Different imaging modalities are used for follow-up Surveillance increases accuracy compared with clinical follow-up alone Detecting recurrence early allows potentially curative salvage therapy Protocols reflect tumor risk stratification. Guidelines outline imaging follow-up of abdominopelvic tumours Radiomics and liquid biopsies may augment surveillance protocols to identify patients at higher risk of relapse

## TABLE OF CONTENTS/OUTLINE

Imaging modality pearls and pitfalls for follow-up CT - role of MPR, MIP, dual-energy MRI - anatomical and functional sequences; merits and practicalities of whole-body MRI Nuclear Medicine - including novel radiotracers System based overview of abdominopelvic cancers, how and where to detect relapse Practical tips for spotting recurrence early and avoiding mimics Understanding routes of disease spread eg. in peritoneal disease Specific challenges of detecting skeletal disease recurrence Assessing lymph node recurrence - not just size Differentiating expected post treatment changes from recurrent disease Immunotherapy and pseudoprogression Guidelines for imaging surveillance post curative treatment Upper, lower, gynaecological and urological tumors Key similarities and differences in international guidelines for follow up of abdominopelvic cancers, why this matters clinically Role of clinical and laboratory markers to augment radiology Tumor markers Liquid biopsy - a new era in cancer surveillance? AI and radiomics in disease surveillance, hype or reality?

### **MSEE-21 Congenital and Acquired Causes, Mimickers and Treatment of Diaphragmatic Paralysis**

Achala Donuru, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Phrenic nerves originate from cervical nerves C3-C5. Injury of the phrenic nerve can occur by multiple mechanisms. Due to the long course of the left phrenic nerve in the thorax, left-side diaphragmatic weakness is more common compared to right side. One of the most frequent causes of unilateral diaphragmatic paralysis is iatrogenic. In bilateral diaphragmatic paralysis, one of the most common causes is a motor neuron disease. Most cases of DP are idiopathic (70%), other causes include congenital (birth trauma), tumors, infections, muscular disorders, and iatrogenic (medication induced, from nerve block, post-surgical). The main differentials to consider when an elevated hemidiaphragm is noted on a chest radiograph are diaphragmatic eventration, lobar collapse, subphrenic abscess and subdiaphragmatic mass.

## TABLE OF CONTENTS/OUTLINE

On a chest radiograph, the right dome of the diaphragm is higher in position when compared to the left dome. If the left dome of the diaphragm is elevated by more than 2 cm, DP should be suspected. Functional imaging with a sniff test is very useful in diagnosing DP, the affected side demonstrates a paradoxical upward movement. Performance of dynamic MR imaging for evaluation of diaphragmatic function has also been described. Most patients with unilateral DP are detected incidentally and do not require any specific management. Most patients with bilateral DP require permanent ventilator support. Selected patients with persistent respiratory failure can benefit from diaphragmatic plication or phrenic nerve pacing. It is important for the radiologists to recognize diaphragmatic paralysis and look for pathology along the course of the phrenic nerve.

### **MSEE-22 It's Not Always Cancer: A Pictorial Essay on Nonneoplastic Lymphadenopathies with Histopathologic Correlation**

Brenda N. Lahlou, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. List and compartmentalize the different causes of nonneoplastic lymphadenopathies. 2. Recognize typical radiological aspects of certain etiologies of lymphadenopathies. 3. Improve the approach of differential diagnosis of lymph node enlargement by correlating multimodality imaging and clinical findings. 4. Recognize the most common histopathological patterns found in lymph node enlargement caused by benign conditions.

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Overview of normal lymph node anatomy and its radiological and histological aspects 3. Subdivision of various pathologies that can encompass lymphadenopathy based on etiology 4. Localized lymphadenopathy a. Foreign-body related b. Idiopathic diseases c. Reactive conditions d. Infections 5. Generalized lymphadenopathy a. Autoimmune diseases b. Idiopathic diseases c. Reactive conditions d. Infections 6. A practical diagnostic approach in the presence of lymph node enlargement 7. Take home message

### MSEE-23 From Brain to Bones: A Radiological Saga Through Multisystemic Tuberos Sclerosis

Fernanda L. Limonge, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review radiological manifestations of Tuberos Sclerosis To illustrate the imaging findings of the most important features of Tuberos Sclerosis (ultrasound, MRI, CT) Discuss the radiologist's role on establishing clinical diagnosis

## TABLE OF CONTENTS/OUTLINE

Clinical criteria for Tuberos Sclerosis Diagnostic Radiological manifestations of Tuberos Sclerosis- Neurological features- Cardiological features- Thoracic features- Abdominal features- Musculoskeletal features

### MSEE-24 What on Earth is That: Newer Medical Devices on Chest Radiographs

Ashrith Kandula (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

There has been a constant influx of newer medical devices as technology veers towards more noninvasive methods of treating diseases. Plethora of new devices are seen on today's plain radiographs. Cardiovascular devices are further divided into- cardiac devices comprising of rhythm monitors such as Pacemakers, Implantable cardioverter defibrillators, Ventricular Assist Devices, Occlusion devices, Valve prosthesis- (Open heart and Trans catheter placement), Loop recorders. Vascular devices range from Central venous catheters, Swan Ganz catheter , remote pulmonary artery pressure monitoring devices, devices used for catheter directed thrombolysis, IABP, ECMO to many more. Non-Cardiovascular devices include- esophageal devices- LINX for reflux, nerve stimulators including Vagal, Trigeminal and Hypoglossal, phrenic nerve stimulators, diaphragmatic pacers.

## TABLE OF CONTENTS/OUTLINE

To review the newer medical devices seen on plain radiographs of the chest. Pictorial review of the optimal location, function and complications of the different devices. Organization: Introduction, classification, pictorial review of device along with in-vitro images, optimal location, function and evaluation of complications associated with the device. Entities discussed: Cardio Microelectromechanical device (CardioMEMS), Pulmonary Artery catheters for thrombolysis , Cordella Pulmonary Artery Pressure Monitor, Mitraclip, Transcatheter Mitral Valve Replacement (TMVR), Transcatheter Pulmonary Valve Replacement (TPVR), LINX - device for reflux management, Endoscopic clips from POEMS, Hypoglossal nerve stimulators, Diaphragmatic pacers.

### MSEE-25 Nail it: A Guide to Diagnosing Nail Disorders

Isabela Ribeiro (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ultrasonography serves as a valuable tool for assessing the nail unit, providing real-time evaluation of its components, which includes the periungual tissue's appearance and thickness, vascularization via color Doppler application, and possible involvement of underlying bone structures. It is crucial to understand not only the normal anatomy of the nail bed on ultrasonography but also the main points of some pathologies encountered in daily clinical and radiological practice. While nail tumors are rare anomalies, a detailed prior anatomical knowledge allows for their easy identification. In addition, it is important to highlight the ultrasonographic findings of other common conditions, such as retronychia, foreign bodies, and paronychia, in order to better define the appropriate course of action. Given its ability to diagnose, localize, and differentiate various nail disorders, it is not surprising that nail unit assessment through ultrasonography can significantly improve patient outcomes.

## TABLE OF CONTENTS/OUTLINE

Highlight the importance of ultrasonographic assessment for the nail unit. Review the advantages and limitations of high-frequency ultrasound for evaluating the nail compartment. Identify the ultrasonographic characteristics of common nail pathologies.

### MSEE-26 "To Cyst or Not to Cyst," Imaging Spectrum of Mucinous Neoplasms in the Abdomen and Pelvis

Nakrou, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The purpose of this exhibit is to: • Review imaging features of mucin-producing neoplasms in the abdomen and pelvis with attention to organ-specific involvement. • Discuss worrisome findings that favor malignant potentials over benign tumors. • Demonstrate imaging role in management including pre-surgical planning and imaging follow-ups. • Address misdiagnosis, pitfalls, and mimicking pathologies that may resemble mucinous neoplasms

### TABLE OF CONTENTS/OUTLINE

Present multi-modality imaging review of mucinous neoplasms involving the following organs Pancreas Intrahepatic and extrahepatic biliary tree GI tract (Esophagus, stomach, small bowel, colon, appendix and rectum) GU system (ovaries, epididymis, bladder, kidney, renal collecting system) Peritoneum and serosal involvement List syndromic association and predisposing systemic conditions

### MSEE-27 **Make Every Connection Matter: Multi-modality Imaging Features of Fistulas in the Chest, Abdomen and Pelvis**

Ayman H. Gaballah, MD, FRCR (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Review the definition, classifications, and types of fistulas 2. Discuss multi-modality imaging features of fistulas in the chest, abdomen, and pelvis 3. Point out the appropriate imaging workup and pitfalls according to the anatomic region 4. Illustrate the long-term complications of chronic and untreated fistulas 5. Highlight some of the management options

### TABLE OF CONTENTS/OUTLINE

1- Introduction 2- Etiology and types of fistulas a. Congenital: Congenital fistulae arise from remnants of embryonic ducts that persist (e.g., tracheoesophageal, vitello-intestinal, urachal, etc.) b. Acquired: Acquired fistulae are secondary to variety of causes. i. Traumatic ii. Iatrogenic iii. Inflammatory/infectious iv. Neoplastic v. Post-radiation therapy vi. Vascular vii. Miscellaneous c. Types according to fistula opening i. External opening (e.g., enterocutaneous fistula) ii. Internal opening (e.g., tracheoesophageal, recto-vesical, cholecysto-duodenal, perianal, arteriovenous fistula, etc.) 3- Multimodality imaging features of fistulas in different body parts from head to toe with related classifications as applicable 4- Complications of fistulas 5- Case presentation and imaging pitfalls 6- Management options

### MSEE-28 **You'll Float Too: A Guide of Ectopic Gas for the Radiology Resident**

Sofia Arizaga, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

after the exhibit the reader would be able: To describe the imaging features and differentiate normal air/gas in the different tissues and potential body spaces. To identify the origin and causes of ectopic gas. To analyze abnormal gas location in order to detect situations and diseases that involve high mortality rate.

### TABLE OF CONTENTS/OUTLINE

Introduction- Pathways of Ectopic Gas Distribution.- Imaging assessment of abnormal gas.- Etiopathogenesis of ectopic Gas: Iatrogenic, trauma, inflammatory/infectious, ischemic, neoplastic, others.- Recognize alarm signs.- Summary

### MSEE-29 **Alohomora: Opening the Mind and Demystifying Abdominal Tuberculosis Findings**

Kamila S. Albuquerque, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Brazil is one of the countries with the highest incidence of tuberculosis in the world, ranking among the top 22, according to the WHO. Abdominal tuberculosis is considered a great mimic of other abdominal diseases, and can affect the gastrointestinal tract (GIT), peritoneum, lymph nodes and other organs. It often represents a diagnostic challenge due to its nonspecific findings, which may result in diagnostic delay and the development of complications. Imaging tests play an important role in its diagnosis, with an impact on the morbidity and mortality of the disease. This study aims to carry out an inconographic review of the most common abdominal manifestations of the disease, atypical presentations and complications from the perspective of different types of imaging methods, which include tomography and magnetic resonance imaging and even CT / PET.

### TABLE OF CONTENTS/OUTLINE

In this educational exhibition, we address the different abdominal radiological manifestations related to tuberculosis bacillus infection, in addition to epidemiological and pathophysiological data, as well as some differential diagnoses and miscellaneous.

### **MSEE-3 Visualizing Beyond the Joints: Imaging the Extra-articular Manifestations of Rheumatoid Arthritis**

Marco Y. Tsuno (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To understand the prevalence and significance of extra-articular manifestations in rheumatoid arthritis.- To recognize the characteristic imaging features of common extra-articular manifestations in rheumatoid arthritis.- To recognize the role of imaging in monitoring disease progression and detecting new or worsening extra-articular manifestations in rheumatoid arthritis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Pathophysiology. 3. Diagnostic criteria. 4. Articular manifestations. 4.1. Imaging: articular manifestations (Temporomandibular Joint, Spine, Shoulder, Elbow, Wrist and Hand, Hip, Knee, Ankle and Foot). 5. Extra-articular manifestations. 5.1. Imaging: extra-articular manifestations (Central Nervous System, Pulmonary, Cardiovascular, Rheumatoid Nodules). 6. Conclusion. 7. Bibliographic references.

### **MSEE-30 Beyond Genetics: A Review of Current Renal Cancer Screening Guidelines for Hereditary Renal Cancer Syndromes**

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Hereditary renal cancer syndromes, including von Hippel-Lindau (VHL), Birt-Hogg-Dubé (BHD), Hereditary Leiomyomatosis and Renal Cell Carcinoma (HLRCC), Tuberous Sclerosis Complex (TSC), Succinate Dehydrogenase (SDH)-deficient renal cell carcinoma (RCC), and BRCA1-associated Protein-1 (BAP1) tumor predisposition syndrome, are associated with an increased risk of developing renal tumors. Early detection of renal cancer in individuals with hereditary renal cancer syndromes is of extreme importance as it facilitates timely intervention and improves the prognosis. Owing to differences in their extra-renal manifestations and age of onset, the screening guidelines for each hereditary renal cancer syndrome are unique. Here, we provide a summary of the current recommendations for screening of renal cancer in each of these hereditary renal cancer syndromes.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents/OutlineI. Introduction: (a) Hereditary renal cancer syndromes: Renal and extra-renal manifestations; (b) Importance of screeningII. Screening guidelines for hereditary renal cancer syndromesIII. CT/MRI images of patients with extra-renal manifestations undergoing renal cancer screening and eventually detecting renal tumor in each syndrome:(a) Von Hippel-Lindau syndrome (vHL); (b) Birt Hogg Dubé syndrome (BHD); (c) Hereditary Leiomyomatosis and Renal Cell Cancer syndrome; (d) Tuberous Sclerosis Complex; (e) Succinate Dehydrogenase-deficient RCC; (f) BAP1 tumor predisposition syndromeIV. Conclusion

### **MSEE-31 DWI vs 18-FDG PET/CT in Oncology: Which Technique for Which Clinical Scenario**

Antonio Luna, MD, PhD (*Presenter*) Speaker, General Electric Company

#### **TEACHING POINTS**

Learn how to introduce whole-body diffusion-weighted imaging (WB-DWI) for tumor assessment. Review the technological adjustments including parallel imaging, compressed sensing, and deep learning to optimize WB-DWI protocols. Learn how WB-DWI/MRI is a valid alternative to 18-FDG PET/CT for tumor staging and is particularly advantageous in the assessment of peritoneum, bone marrow, liver, and brain metastases. Analyze the complementary role in tumor detection and staging and therapy monitoring of both techniques, using a head-to-head comparison, defining the most adequate technique for common clinical scenarios in oncology and including their applications in special populations (i.e., pregnant, or pediatric patients). Establish the range of clinical applications of PET/MRI combining DWI and 18-FDG PET acquisitions in oncology.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction.2. Technical adjustments in WB-DWI 3. Tumor staging: 3a. WB-DWI vs 18-FDG PET-CT. 3b. N staging. 3c. M staging. 3d. Specific tumors: NSCLC, breast cancer, prostate cancer, malignant melanoma, colorectal cancer, lymphoma, multiple myeloma and others. 4. Therapy monitoring. 5. Prediction of treatment response. 6. Posttreatment surveillance. 8. Conclusions

### **MSEE-32 An Easy Approach to Cheson-Lungano Criteria: From Staging to Treatment Response Assessment**

Michael-Fernandez, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

-To know how to evaluate a lymphoma staging study and treatment response interpretation according to Cheson-Lungano criteria.- Learning how to manage complex situations where this criteria seems to be unclear and its limitations.- Discussing the differences between Cheson-Lungano criteria and other evaluation systems such as RECIST 1.1

### TABLE OF CONTENTS/OUTLINE

Standard criteria for radiological evaluation lymphoma response allowed to optimise the therapeutic management in a more accurate way in this type of patients. It is based on the selection of target and non-target disease in a first staging study, and the evaluation of their presence and change in size in follow-up studies, allowing a global assessment of treatment response. These criteria can be applied by radiologists by evaluating CT studies (Cheson criteria) or CT and PET together (Cheson-Lungano criteria). It should be noted that although these criteria may be similar to the RECIST 1.1 criteria for the evaluation of other solid tumours, there are important differences in their interpretation (number of target lesions, required diameters, percentage limits to consider response/progression...), as well as the specific assessment of splenic involvement (which is more infrequent in other solid tumours). This paper reviews the importance of a correct use of Cheson-Lungano criteria in: 1) performing an adequate staging study inform; 2) interpretate the treatment response in follo-up studies; 3) other special situations where this criteria is sometimes unclear and are discussed in this article.

### MSEE-33 POCUS: Radiology Vs Other Medical Professions Perspectives - Where Do We Stand

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Point-of-care ultrasonography (POCUS) refers to a focused ultrasound performed at the patient's bedside by a clinician who both performs the US and interprets the images. The protocols usually answer a specific question that helps guide treatment. Goals: Understand what is point of care US (POCUS), its benefits and applications. Discuss differences in US training pathways among the different specialties vs Radiology. Review current issues of US Quality assurance and reimbursement, image archiving and accountability. Understand areas of potential threats and conflicts, and explore potential areas for collaboration and growth.

### TABLE OF CONTENTS/OUTLINE

Define Point-of-care ultrasonography (POCUS) Review benefits and various applications of POCUS ( cardiovascular, ophthalmology, nervous system assessment, procedures ( line placement, nerve block, FAST) Discuss training pathways for POCUS, their strengths and limitations vs Radiology, review accreditation processs for POCUS vs Radiology. Discuss training in medical school Review available methods of US Quality assurance and reimbursement, provide examples of misinterpretation/misdiagnosis and role of Radiology in detailed evaluation of the POCUS findings. Discuss issues related to image archiving and accountability. Understand areas of potential threats and conflicts among Radiology and other fields of medicine utilizing POCUS. Explore potential areas for collaboration and growth.

### MSEE-34 Diffusion-weighted Imaging (DWI) in the Era of Abbreviated MRI: How to Make the Most Out it for Abdominal MRI Applications

Claudio A. Lagos, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Introduce and briefly review abbreviated-MRI concepts. 2. Discuss detectability of lesions through abdominal organs using DWI alone, and review evidence comparing it with other imaging modalities, with emphasis in most and least useful applications. 3. Review DWI utility for characterizing abdominal lesions based on patterns and its correlate with pathology and aggressiveness, with emphasis in liver - pancreas. 4. Review last evidence regarding ADC value as a biomarker and a quantitative parameter in oncology imaging, prognosis and treatment response. 5. Illustrate frequent artifact and how they lead to interpretation pitfalls.

### TABLE OF CONTENTS/OUTLINE

- Physics principles of diffusion- DWI image acquisition, ADC value and ADC map. Role of increasing b values in detectability.- Review abbreviated-MRI concept, goals and applicability.- Evidence based review of detectability of different lesions with emphasis in liver and pancreas.- Comparison of diagnostic yield with other techniques (ie. PET-CT, CECT) and other MR sequences, for different organs and frequent lesions, including peritoneal disease.- Practical approach in liver and pancreatic lesions for predicting histology / aggressiveness using a pattern based fashion.- Case based review of high performance situations: Liver mets, LIRADS evaluation, pancreatic nodules, extra - abdominal metastatic disease.- Case based review of low performance situations: Aggressiveness in renal nodules.- Role of quantitative DWI and its evidence, with emphasis in oncology.- Detectability and interpretation pitfalls, and how to avoid them.- Summary.- References.

### MSEE-35 From Head to Toe Non-Langerhans Cell Histiocytosis (Erdheim-Chester Disease): Understanding a Rare Pathology in the Era of Hybrid Imaging



Kimura Sandoval, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Understand the epidemiology and pathology behind Erdheim-Chester disease, as well as its clinical presentation- Learn the importance of 18F-FDG PET/CT in the diagnosis, detection of disease extent, and severity- Identify the radiological signs with which the disease can manifest- Case-based review of the main radiologic signs and features observed in this rare disease

### TABLE OF CONTENTS/OUTLINE

1. Epidemiology 2. Clinical presentation 3. Pathology 4. Radiographic features  
A) Central Nervous system: - Pituitary Gland - Posterior Fossa  
B) Orbits  
C) Thorax - Lung - Mediastinum  
D) Vasculature - Thoracic and abdominal aorta  
E) Kidneys and retroperitoneum  
F) Musculoskeletal system

### MSEE-36 Imaging in Erdheim Chester disease

#### Awards

#### Certificate of Merit

Yashant Aswani, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Discuss recent updates in classification and pathogenesis of Erdheim-Chester disease  
2. Describe role of imaging and clinical and radiologic findings of Erdheim-Chester disease  
3. Review new treatment options and therapeutic response evaluation

### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Epidemiology 3. Pathology 4. Pathogenesis 5. Newer classification systems (2016 WHO classification of lymphoid neoplasms and 2016 Working group of Histiocytic Society Classification) 6. Mixed histiocytosis: an overlap syndrome 7. Diagnosis 8. Role of Imaging 9. Manifestations of Erdheim-Chester disease 10. Skeletal involvement 11. Retroperitoneal disease 12. CNS involvement 13. Cutaneous disease 14. Pulmonary involvement 15. Cardiothoracic disease 16. Endocrine involvement 17. Orbital disease 18. Miscellaneous: Craniofacial bones and skull base 19. Miscellaneous: Hepatobiliary disease 20. Newer imaging findings 21. Association with non-histiocytic malignancies and autoimmune diseases 22. Markers of prognosis 23. Molecular targets for treatment 24. Treatment approach 25. Therapeutic response evaluation modified PERCIST criteria

### MSEE-37 Response Assessment in Solid Tumors Criteria: Similarities and Differences

Tagwa Idris, MBBS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To review the history and evolution of solid tumor response criteria; To compare similarities and differences across various response criteria; To describe RECIST, RECIST-related criteria adaptations, and immune-related criteria; To recognize the challenges of applying these criteria; To provide case-based scenarios and identify the response categories with particular emphasis on immune-related criteria.

### TABLE OF CONTENTS/OUTLINE

Timeline of Response Assessment in Solid Tumor; Terminology and rules for solid tumor response assessment; Similarities and differences across various response assessment criteria; Case-based scenarios to demonstrate assessment variations in response criteria/categories; Challenges in image metrics assessment using these different criteria; Summary and future directions; References.

### MSEE-38 Bugs that Suck (Your Blood): Imaging Manifestations of Vector-Borne Diseases

Francisco Calle, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Familiarize the radiologist with the range of pathogens transmitted by arthropod vectors and the diseases they cause.
- Discuss the epidemiology of these diseases, including areas of endemicity, types of arthropod vectors, transmission dynamics, and prior outbreaks.
- Discuss the clinical presentations and medical complications associated with vector-borne diseases.
- Describe the imaging features associated with infection on ultrasound, CT, and MRI.
- Provide a brief overview of management and treatment.

### TABLE OF CONTENTS/OUTLINE

Introduction to vector-borne diseases, including types of vectors and variety of pathogens, as well as epidemiology and major outbreaks. Role of imaging and imaging features in detecting infection and identifying complications: • Neurologic (e.g., viral

encephalitis, lyme encephalitis, cerebral malaria) • Chest/cardiac (e.g., Chagas dilated cardiomyopathy) • Gastrointestinal (e.g., yellow fever, malaria) • Urogenital (e.g., arbovirus-associated acute kidney injury, acute tubular necrosis, and renal failure) • Musculoskeletal: (e.g., cutaneous and mucocutaneous leishmaniasis, ectoparasites). Brief overview of management and treatment of vector-borne diseases and their complications

### **MSEE-39 Whole-Body MRI in Hereditary Tumor Syndromes: How We Do It**

Francesco Mungai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Whole-body MRI can be helpful for screening, detection, and follow-up of bone and soft tissue tumors in patients with hereditary tumor syndromes - Different tumor syndromes require appropriate MRI acquisition protocols to highlight the different pathological findings - Whole-body fluid and cartilage sensitives MRI sequences are necessary for patients with multiple hereditary exostoses (MHE) and enchondromatosis to reveal the cartilaginous portion of the tumors and the associated bursitis - Post-contrast imaging is critical in patients with familiar Paragangliomatosis to identify small mediastinal and retroperitoneal paragangliomas - Diffusion-weighted imaging is useful in patients with an increased risk of malignant tumors (for example, in Li-Fraumeni syndrome) or when a malignant degeneration of a benign lesion is suspected

#### **TABLE OF CONTENTS/OUTLINE**

- Imaging approach in hereditary tumor syndromes - Role of Whole-Body MRI for screening, detection, and follow-up of hereditary multisystem and multisite tumors - MR imaging acquisition protocol and evaluation in MHE, Enchondromatosis, and Maffucci syndrome - MR imaging acquisition and evaluation in familiar Paragangliomatosis - MR imaging acquisition and evaluation in Neurofibromatosis - MR imaging acquisition and evaluation in Li-Fraumeni syndrome - When to use Dw imaging - When to use post-contrast imaging

### **MSEE-4 Getting Started with PCCT: Lessons Learned**

Fides R. Schwartz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Photon-counting computed tomography (PCCT) uses energy-resolving detectors whereas conventional CT detectors integrate the entire x-ray signal. Decision trees for protocol selection and scan mode are different from EID and must be defined at scanner setup Technologists need to learn the use of a new interface Automatic monoenergetic reconstructions with PCCT need to be optimized by imaging protocol including display window levels Higher spatial resolution may increase image noise, but can be beneficial for many applications Detector based spectral information collected, creates the need to set up what reconstructions automatically get sent to PACS This project is geared toward helping new users in the RSNA imaging community in their decision-making processes when setting up a new clinical photon-counting CT. Patient case examples from the PCCTs installed at three major US institutions are shown to underline benefits of the new scanner system.

#### **TABLE OF CONTENTS/OUTLINE**

Overview of differences between PCCT and EID scanner systems New Terminology What do I need to set up Setting up your exam cards: scan modes, reconstruction kernels Reviewing the images: adjusting window level settings, sending thinner slices Comparison of PCCT and EID images from three major US institutions Abdominal imaging Pediatric imaging

### **MSEE-40 How Multiple Joint CT Scanning Would Benefit from Artificial Intelligence**

Mingjun Wang (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points: 1. Artificial intelligence (AI) diagnosis platforms are playing more and more important role in clinical imaging diagnosis. 2. Multi-part joint CT scanning can highly reduce the radiation dose and contrast injection volume, effectively reduce the scanning time to protect patients and improve diagnosis efficiency while remaining image quality. 3. Taking coronary and carotid-cerebral joint scanning as example, the diagnosis time and mouse click number using AI platform can be reduced to 80% - 90% and 20% - 60% comparing to manual diagnosis. There is more diagnosis time reduction for junior radiologists than senior radiologists. And the diagnosis accuracy is comparable between AI platform and senior manual diagnosis. 4. We assume AI platform can help make the whole-body CT diagnosis more efficient and reduce 70 - 90% diagnosis time with body auto-segmentation and auto-diagnosis. AI platform offers over-sensitive diagnosis results and radiologists only need to double check to screen out wrong results.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents/Outline: The purpose of this educational exhibit is to: 1. Review the current development and application of AI diagnosis platforms. Review the clinical benefit and outcome of multi-part joint CT scanning. 2. Demonstrate the role of AI platform for coronary and carotid-cerebral atherosclerosis diagnosis using one-step heart-brain CT angiography. 3. Illustrate the potential application value of AI platform for whole-body CT scanning using auto-segmentation and auto-diagnosis.



## **MSEE-41 Imaging-based Response Criteria in Oncologic Clinical Trials: What Radiologists Need to Know**

### **Awards**

#### **Certificate of Merit**

Guilherme M. Cunha, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Discuss the role of imaging for assessing treatment response as endpoint of oncologic clinical trials. 2) Summarize differences and similarities of treatment response assessment in clinical practice vs for clinical trials. 3) Review the most common imaging-based treatment response criteria used in oncologic clinical trials. 4) Provide guidance on tumor response interpretation and reporting. 5) Discuss future directions.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: a. Relevance of clinical trials for advances in medicine and patient care. b. Oncologic clinical trials: Definitions and practical points. c. The role of imaging in oncologic clinical trials. 2. Assessment of response during oncologic treatment: a. Differences to clinical practice. b. Standardization. c. Blind and independent review. d. Need for objective metrics and endpoints. 3. Imaging-based treatment response criteria: a. Rationale for different criteria. b. Target vs non-target lesions. c. Pictorial review of the most used response criteria. 4. Imaging-based treatment response assessment: a. Image analysis and interpretation. b. Reporting. 5. Future directions: a. Criteria updates. b. Technical Innovations.

## **MSEE-42 Evaluation of Hidradenitis Suppurativa Through Imaging Methods**

Carolina A. Almeida, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Hidradenitis suppurativa is a chronic inflammatory skin condition with lesions including deep-seated nodules and abscesses, draining tracts, and fibrotic scars. 2) The classification of the severity of hidradenitis suppurativa is done clinically using the Hurley scale. Correct severity classification allows for appropriate treatment. 3) Currently, high-frequency ultrasound has been used to map lesions and proposes a new classification: clinical-sonographic scoring system (SOS-HS). 4) Explain how lesions are classified using ultrasonography and the standardization of nomenclature. 5) Clarify doubts about magnetic resonance imaging protocols in the evaluation of hidradenitis suppurativa and when to use this method. 6) To present 3D reconstruction as a useful tool for the pre-surgical study of lesions. 7) Correlate clinical and ultrasound findings, magnetic resonance imaging and 3D reconstruction.

#### **TABLE OF CONTENTS/OUTLINE**

1) Overview of hidradenitis suppurativa. 2) Hurley classification. 3) Criteria for diagnosing hidradenitis suppurativa by ultrasonography. 4) Hidradenitis suppurativa 3T MRI protocol. 5) Cases exemplifying the importance of imaging exams in the clinical and surgical management of the disease.

## **MSEE-43 Beyond the Neonatal Intensive Care Unit: Imaging of Long-term Sequel of Prematurity**

Mika Shapira Rootman, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Radiologists should be aware of the potential for late imaging manifestations in patients with a remote history of prematurity, and carefully evaluate imaging studies to identify these complications. Late common CNS manifestations include white matter injury and post-hemorrhagic hydrocephalus. Both frequently co-exist and may have distinctive features on imaging. Advanced chest imaging techniques, including CT and MRI, can enhance the accurate diagnosis and monitoring of late lung complications of prematurity such as bronchopulmonary dysplasia. Late complications of necrotizing enterocolitis, such as strictures and short bowel syndrome, can be accurately identified and monitored using appropriate abdominal imaging techniques, which should be tailored specifically to the patient.

#### **TABLE OF CONTENTS/OUTLINE**

Outline I. Introduction Premature birth rates and associated health risks Role of imaging in the management of premature infants II. Late Imaging Features of Prematurity Brain abnormalities: periventricular leukomalacia, cerebral atrophy, post-hemorrhagic hydrocephalus, etc. Lung abnormalities: bronchopulmonary dysplasia. Gastrointestinal abnormalities: long term sequel of necrotizing enterocolitis Bone abnormalities: osteopenia, fractures, etc. Differentiating late imaging features from other conditions III. Clinical Case Studies and Outcomes VI. Conclusion Recap of key points Future directions for research and clinical practice.

## **MSEE-44 The Perirenal Space: Anatomy and Spectrum of Disease**

Mikel Elgezabal, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Anatomy of the perirenal space with boundaries, key landmarks and pathways for the spread of disease. 2. Complete revision of pathology that can arise in the perirenal space. Radiologic clues to approach the final diagnosis.

## TABLE OF CONTENTS/OUTLINE

1. Anatomy of the perirenal space: The Inverted Cone 1.1. Perirenal space anatomy with illustrations. 1.2. Key relations. 2. Pathology of the perirenal space 2.1. Masses/Pseudomasses: Pattern based diagnostic approach to perirenal masses and pseudomasses. Renal cell carcinoma. Lymphoma. Leukaemia. Sarcoma and liposarcoma. Myeloma. Lymphangioma. Angiomyolipoma. Extraadrenal myelolipoma. Pancreatic pseudocyst. GIST. 2.2. Collections/Fluid: Infectious: perirenal abscess, xantogranulomatous pyelonephritis, emphysematous pyelonephritis. Perirenal hematoma. Perirenal urinoma. 2.3. Inflammation/Systemic: Retroperitoneal fibrosis. IgG4-related-disease. Erdheim-Chester disease. Castleman disease. Rosai-Dorfman disease. 2.4. Others/Miscellaneous: Extramedullary hematopoiesis. Spilled lithiasis after nephrolithotripsy. Congested kidneys. 2.5. Summary. 3. Take home points

## MSEE-45 No Warming Your Way Out of This One: Multimodality Imaging of Helminthic Infections

Nadia Solomon, MD, MSc (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Familiarize the radiologist with the variety of helminths which infect humans. Discuss the epidemiology, clinical presentation, and medical complications/sequelae of helminthic infections in humans. Describe the imaging features associated with common and uncommon sequelae of helminthic infections across imaging modalities (ultrasound, CT, MRI). Provide an overview of management and treatment of helminthic infections.

## TABLE OF CONTENTS/OUTLINE

Classification of helminths, helminth lifecycles, and epidemiology. Potential complications of helminthic infection. Role of imaging and imaging features associated with helminthic infections, including: Neurologic (e.g., neurocysticercosis, ocular cysticercosis, ocular toxocariasis); Pulmonary (e.g., paragonimiasis); Cardiac (e.g., filariasis-associated tropical hyper-eosinophilia with Loeffler endocarditis and restrictive cardiomyopathy); Gastrointestinal (e.g., ascariasis, fascioliasis, cystic/alveolar/polycystic echinococcosis); Urogenital (e.g., genital schistosomiasis); Musculoskeletal: (e.g., onchocercomata, filarial elephantiasis, dirofilariasis). Management of helminthic infections and their sequelae.

## MSEE-46 Getting Under Your Skin: Multimodality Imaging of Protozoan Infections

Jannatun Sikder, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Familiarize the radiologist with the variety of protozoa which infect humans. Discuss the epidemiology, clinical presentation, and medical complications/sequelae of protozoan infections in humans. Describe the imaging features associated with common and uncommon sequelae of protozoan infections across imaging modalities (ultrasound, CT, MRI). Provide an overview of management and treatment of protozoan infections.

## TABLE OF CONTENTS/OUTLINE

Classification of protozoa. Epidemiology of protozoan infections. Role of imaging in diagnosing protozoan infections, including imaging features associated with protozoan infections and their complications: Neurologic (e.g., cerebral malaria, toxoplasmosis); Chest/Cardiac (e.g., pleuropulmonary amoebiasis, acute myopericarditis and chronic fibrosing cardiomyopathy from Chagas disease); Gastrointestinal (e.g., Chagasic megaesophagus and achalasia, amoebic dysentery and hepatic abscess, giardiasis, visceral leishmaniasis); Urogenital (e.g., trichomoniasis resulting in Fitz-Hugh-Curtis syndrome, ureteric dilatation from Chagas disease); Musculoskeletal: (e.g., Giardia synovitis, sarcocystis myositis). Management of protozoan infections and their sequelae.

## MSEE-47 The Beauty And The Botched: A Pictorial of Usual, Unusual, and Botched Cosmetic Procedures for the Unsuspecting Radiologist

Alexander Sasse, BA (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Familiarize the radiologist with the diversity of implant procedures performed, with particular focus on the sociocultural phenomenon that is cosmetic implant surgery (including historical context and evolution of the practice).
- Describe typical and atypical implant locations of implants, and their appearances on medical imaging studies.
- Describe potential complications of cosmetic implants and imaging findings associated with "botched" implant procedures.
- Discuss management of "botched" and otherwise complicated implants, where applicable.

## TABLE OF CONTENTS/OUTLINE

Discuss history of cosmetic implant procedures and diversity of current practices/implant placements. Discuss complications and appearance of “botched” implants. Discuss the role of imaging and imaging features in visualizing both appropriately placed and “botched” or otherwise complicated implants: • Head and Neck (e.g., chin implant) • Breast (e.g., saline and silicone implants) • Urogenital (e.g., scrotal and penile implants) • Extremities (e.g., muscle-simulating implants) • Soft tissue: (e.g., buttock implants). Discuss the management of botched cosmetic implants and other associated complications.

### MSEE-48 Alcohol-use Related Diseases and Disorders: Head to Toe Imaging Findings

#### Awards

#### Certificate of Merit

Mark J. Brown, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Alcohol is a significant contributor to the global burden of diseases. Understand the metabolism of alcohol, and effects of alcohol and its metabolites on various organs. Review imaging findings of alcohol-use related diseases and disorders head to toe.

## TABLE OF CONTENTS/OUTLINE

Metabolism of alcohol and factors affecting metabolism. Pathophysiology of alcohol induced damage to various organs. Imaging findings: Central nervous system: Wernicke-Korsakoff syndrome, hyperammonemic encephalopathy, subacute combined degeneration of the spinal cord, diffuse cerebral atrophy, osmotic demyelination syndrome, Marchiafava-Bignami disease. Cardiovascular system: Alcoholic cardiomyopathy. Lungs: Aspiration and bacterial pneumonia, acute respiratory distress syndrome. Gastrointestinal tract: Fatty liver, acute alcoholic hepatitis, acute and chronic alcoholic steatohepatitis, alcoholic cirrhosis, hepatocellular carcinoma, acute and chronic pancreatitis, GI dysbiosis, Boerhaave syndrome, alcoholic gastritis. Genitourinary tract: Renal stones, hypogonadism. Musculoskeletal system: Alcohol induced muscle disease, avascular necrosis of the femoral heads, osteoporosis, gout. Cancers of the head and neck, esophagus, breast, colon, and rectum. Fetus: Fetal alcohol syndrome

### MSEE-49 Extrapulmonary Tuberculosis: Imaging Findings Beyond the Chest

Irene Diaz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Extrapulmonary tuberculosis affects the lymph nodes most frequently, but it can affect any other organ of the body. The presence of necrotic lymph nodes and other organ-specific imaging features increases the diagnostic probability of extrapulmonary disease.

## TABLE OF CONTENTS/OUTLINE

Objectives To identify imaging features that are suggestive of extrapulmonary tuberculosis and its differential diagnosis. Findings Extrapulmonary tuberculosis can be challenging to diagnose as it can mimic many other diseases, so a biopsy is often required. An image-based quiz will lead the review of: Cases of central nervous system, head and neck, lymphatic, abdominal, genitourinary, and musculoskeletal tuberculosis; describing some key imaging features and including its main differential diagnosis. Conclusion Extrapulmonary tuberculosis remains a challenge to diagnose. It is essential to know its key imaging features for an early and successful diagnosis.

### MSEE-5 Demystifying Mucin in the Abdomen and Pelvis: Tissue Characterization and Spectrum of Disease

#### Awards

#### Certificate of Merit

Carolyn F. Dishuck, BS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Mucinous neoplasms are a diverse group of benign and malignant tumors arising from mucin-producing epithelial cells.
2. Mucinous neoplasms arise from a wide range of organs including the appendix, ovary, pancreas, colon, and rectum.
3. Mucin has a characteristic imaging appearance at each modality and differs from other types of tumors that have higher cellular density.
4. Pseudomyxoma peritonei is characterized by the spread of mucinous material throughout the peritoneal cavity and has specific imaging findings.
5. Diagnosis and treatment of mucinous tumors requires a multidisciplinary approach that includes imaging, surgery, and systemic therapies, including hyperthermic intraperitoneal chemotherapy in the case of pseudomyxoma peritonei.

## TABLE OF CONTENTS/OUTLINE

I. Introductiona. Overview of mucinous neoplasmsII. Imaging features of mucinous neoplasms with case examplesa. Mucinous cystic neoplasms of the pancreasb. Appendiceal mucinous neoplasmsc. Colon and rectal mucinous adenocarcinomad. Ovarian mucinous cystadenoma and cystadenocarcinomae. Miscellaneous (seminal vesicle, primary peritoneal)III. Pseudomyxoma peritoneia. Imaging featuresb. Treatment, including hyperthermic intraperitoneal chemotherapyIV. Conclusiona. Summary of key teaching points

### **MSEE-50 Technical Aspects in Imaging Patients Under Extracorporeal Membrane Oxygenation (ECMO) Support**

Fernando Diego Choque Chavez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review recommendations to perform optimal CT examinations in patients under extracorporeal membrane oxygenation (ECMO) support according to clinical suspicion and within possible clinical scenarios.- Illustrate examples of optimal and suboptimal examinations in this populations.- Describe the key technical aspects to obtain adequate images and avoid errors.

## TABLE OF CONTENTS/OUTLINE

1. Introduction and physiology during ECMO support 2. Optimizing the technique: protocol recommendations regarding access, contrast dose and rate injection 2.1. General considerations 2.2. Venovenous ECMO 2.3. Venoarterial ECMO 2.3.1. Central nervous system evaluation 2.3.2. Pulmonary embolism 2.3.3. Aorta evaluation 2.3.4. Abdomen and pelvis 3. Summary and conclusions

### **MSEE-51 I CT Dead People: Exploring the Application of Postmortem Imaging to Cause of Death Investigation in a Hospital Setting**

#### **Awards**

##### **Certificate of Merit**

Nadia Solomon, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Familiarize the radiologist with the growing field of forensic radiology, primarily as it pertains to postmortem imaging and cause-of-death investigation.
- Provide an introduction to postmortem computed tomography (CT), including its benefits and limitations.
- Describe the application of and experiences with postmortem CT at an academic teaching hospital.

## TABLE OF CONTENTS/OUTLINE

- Introduction to forensic radiology with focus on role in cause-of-death investigation.
- Benefits of postmortem CT as a supplement to autopsy.
- Common postmortem changes on imaging and how to mitigate them, where applicable.
- Application of and experience with postmortem CT at an academic teaching hospital, including: integration with the Autopsy Service; types of cases performed; imaging methods utilized; and correlation with autopsy.
- Case image integration throughout, as illustrative examples.

### **MSEE-52 Microvascular Imaging Ultrasound (MVI) in Children: Current Use and Potential Applications**

#### **Awards**

##### **Cum Laude**

Santiago Martinez-Correa, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To overview the current knowledge of MVI in children. 2. To illustrate MVI benefits in specific pediatric conditions. 3. To describe possible clinical applications of MVI in the future.

## TABLE OF CONTENTS/OUTLINE

- Disclosures. - Background Current use and advantages of advanced ultrasound techniques. - Microvascular Imaging Ultrasound 1. Technique description Advanced ultrasound technology that allows high-resolution visualization of slow-flow microvasculature by using clutter suppression algorithms. 2. Protocol Acoustic windows and settings adjustment. 3. Advantages and pitfalls: non-invasive tool, can be used at the bedside. Depends on the scan settings and operator. - Clinical use: 1. Brain Evaluation of vascularity in hypoxic-ischemic injury, hydrocephalus, and infections. 2. Thyroid Approach to vasculature architecture, and focal lesions. 3. Liver Characterization of focal lesions. 4. Spleen Use in assessing trauma, infarcts, focal lesions, and infections. 5. Kidney Evaluation of solid and cystic lesions. 6. Reproductive (Ovaries/Testes): Use in gonadal torsion, and infections. 7. Bowel Assessing small bowel infection and/or inflammation. 8. Lymph nodes Blood flow evaluation in benign and malignant nodes. 9. Skin Evaluation of infected subcutaneous nodules. - Potential future use: 1. MVI

as an ancillary method in assessing pediatric brain death. 2. Liver and renal post-transplant perfusion follow-up. 3. Diagnostic and prognostic tool during ECMO therapy. - Take Home Points.

### **MSEE-53 Immunotherapy-Related Adverse Events - A Review of the Breadth of Toxicities and Imaging Findings**

Nicholas DiSanti, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Blocking of immune checkpoints by immune checkpoint inhibitors (ICIs) can cause novel autoimmune disease or uncover subclinical autoimmune disease.- These toxicities are termed immune-related adverse events (irAEs) and can involve any organ.- IrAEs can be mistaken for disease progression or non-autoimmune processes.- Incidence of irAEs is 25% with anti-CTLA-4 inhibitors, 10% with anti-PD(L)-1 inhibitors, and 50% for combination therapy.- The lungs and colon are the most common organs affected radiologically, although cutaneous manifestations are the most common overall.- IrAEs are graded from 1 (asymptomatic) to 5 (death) and management options include continuing immunotherapy, holding immunotherapy and initiating corticosteroids, and discontinuing immunotherapy permanently.

#### **TABLE OF CONTENTS/OUTLINE**

- Pneumonitis: o Organizing pneumonia o Nonspecific interstitial pneumonia o Hypersensitivity pneumonitis o Bronchiolitis o Acute interstitial pneumonitis/ARDS o Radiation-recall pneumonitis- Sarcoid-like reaction- Enterocolitis- Pancreatitis- Hepatitis- Nephritis- Hypophysitis- Adrenalitis- Thyroiditis- Aortitis- Pericarditis- Serositis: o Pericardial effusion o Pleural effusion o Peritoneal effusion- Sinusoidal obstruction syndrome- Arthritis- Myositis- Polymyalgia rheumatica-like syndrome

### **MSEE-54 Phenotypic Diversity of Germinal Center-Derived Malignancies: Implications on Diagnosis and Management**

Steven S. Chua, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The germinal center (GC) is a unique and dynamic microenvironment within lymphoid follicles where selection, maturation and antibody production by activated B lymphocytes occur in response to infections. A multitude of unique malignancies arise within the GC that display characteristic histogenesis, genetic abnormalities, tumor pathways, molecular biology and varied clinical behavior. PET/CT is the mainstay for the diagnosis and staging of these tumors and is critical for the assessment of treatment response. Neoplastic B cells within different GC compartments and maturation stages give rise to follicular lymphoma, Burkitt's lymphoma and diffuse large B cell lymphoma that harbor distinctive genetic mutations. While the follicular T cell lymphoma and angioimmunoblastic T cell lymphoma originate from helper T cells, the follicular dendritic cell sarcomas evolve from the follicular dendritic cells of mesenchymal origin. We present salient imaging features of GC-derived malignancies and correlate with histopathology and tumor genetics. We discuss the implications of the diagnosis on tailored therapeutics and prognosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction, epidemiology, clinical features this group of germinal center-derived tumors. 2. Histopathology, clinical features, molecular biology of these tumors. 3. Multimodality cross-section delineation of imaging features with CT, MR and PET/CT. 4. Prognosis and management. \* Follicular lymphoma.\* Burkitt's lymphoma.\* Diffuse large B cell lymphoma.\* Angioimmunoblastic T-cell lymphoma.\* Follicular T cell lymphoma.\* Peripheral T cell lymphoma with Tfh phenotype.\* Follicular dendritic cell sarcomas.

### **MSEE-55 Diversity of Epstein-Barr Virus-associated Diseases**

#### **Awards**

#### **Cum Laude**

Moto Nakaya, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

•Summarize the clinical and radiological findings of Epstein-Barr virus (EBV)-associated diseases caused by various etiologies. •Describe radiological findings in EBV-associated neoplasms in contrast to those observed in uninfected conventional tumors. •Recognize important imaging points that lead to a definitive diagnosis in patients with suspected EBV-associated diseases.

#### **TABLE OF CONTENTS/OUTLINE**

I. What are EBV-associated diseases? •Pathomechanisms •The role of EBV in tumorigenesis and progression •Recommended workups II. Content Infection: infectious mononucleosis, human immunodeficiency virus co-infection Autoimmune: multiple sclerosis, systemic lupus erythematosus, rheumatoid arthritis, inflammatory bowel disease, type 1 diabetes mellitus, juvenile idiopathic arthritis, celiac disease Neoplasm: lymphomas (primary central nervous system lymphoma, natural killer/T-cell

lymphoma, diffuse large B-cell lymphoma, lymphomatoid granulomatosis, and post-transplantation lymphoproliferative disorder), solid tumor (gastric cancer, squamous cell carcinoma, EBV-associated smooth muscle tumor, leiomyosarcoma, breast cancer, hepatocellular carcinoma, and follicular dendritic cell sarcoma), others (EBV-associated inflammatory pseudotumor - like follicular/fibroblastic dendritic cell sarcoma) Medication-related EBV infection: methotrexate-related malignant lymphoma Miscellaneous: EBV-positive mucocutaneous ulcer III. Summary 1. The entities associated with EBV are diverse. 2. Clinical and radiological findings can be the diagnostic indicators of the etiology. 3. Appropriate workup is necessary for timely diagnosis and management.

## **MSEE-56 Beyond the Skeletal Survey: Multimodality Imaging Manifestations of Plasma Cell Dyscrasias**

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To review the wide spectrum of plasma cell dyscrasias, including common and rare subtypes, and their pathophysiology. 2. To present the multimodality imaging features seen in the spectrum of plasma cell dyscrasias to aid in accurate diagnosis and staging, as well as subsequent evaluation of post-therapeutic response.

### **TABLE OF CONTENTS/OUTLINE**

Plasma cell dyscrasias are a group of hematological disorders that arise from the abnormal proliferation of plasma cells, which are responsible for producing antibodies. These disorders include monoclonal gammopathy of undetermined significance (MGUS), Waldenström macroglobulinemia, multiple myeloma (MM) and its variants, including smoldering myeloma (SMM), plasma cell leukemia (PCL), solitary and extramedullary plasmacytoma, and amyloidosis. Recent advances in treatment with chemotherapy and immunotherapies have led to improved outcomes, with some patients achieving long-term remission. Early detection and diagnosis allow for appropriate initiation of surveillance and treatment, which will improve outcomes as well as preserve organ function. The imaging manifestations of plasma cell dyscrasias can provide crucial information for diagnosis, prognosis, and management of these diseases. This educational exhibit will (1) review the pathophysiology of plasma cell dyscrasias and the wide spectrum of subtypes, and (2) present the multimodality imaging features of the common and rare subtypes of plasma cell dyscrasias.

## **MSEE-57 Practical Imaging Approach to Unraveling the Causes of Non-neoplastic Lymphadenopathy**

Sota Masuoka, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Non-neoplastic lymphadenopathy may not have specific histopathologic features within the lymph node itself, but determining its underlying cause is still important. Radiologists play a critical role in identifying the cause of lymphadenopathy in three scenarios: (1) when infection or inflammation is clinically suspected, (2) during initial or follow-up imaging for malignancy, and (3) when abnormal lymph nodes are detected incidentally on imaging. Careful observation of the imaging characteristics and anatomical distribution of the abnormal lymph nodes, along with other ancillary imaging findings and clinical information, can help establish an accurate diagnosis of the etiology of the lymphadenopathy, leading to appropriate treatment and avoiding unnecessary further testing for the patient. This exhibit aims to: 1. Review the diverse underlying conditions that cause non-neoplastic lymphadenopathy and their characteristic imaging findings. 2. Discuss an imaging-based approach for diagnosing the underlying causes of non-neoplastic lymphadenopathy.

### **TABLE OF CONTENTS/OUTLINE**

1. Overview of non-neoplastic lymphadenopathy 2. Imaging approach for non-neoplastic lymphadenopathy: Focus on inferring the underlying cause- Based on the distribution of abnormal lymph nodes- Based on the imaging characteristics of abnormal lymph nodes 3. Case illustrations- (1) Clinically suspected inflammation or infection- (2) Initial/follow-up imaging for malignancies- (3) Incidental detection of abnormal lymph nodes on imaging 4. Summary

## **MSEE-58 Stroma-Derived Neoplasms and Tumor-Like Lesions of the Lymphoid Tissues: 2022 WHO Classification System Updates**

Steven S. Chua, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

A new category of mesenchymal neoplasms and tumor-like lesions that involve the lymphatic and reticuloendothelial system has been introduced in the 2022 WHO classification of hematolymphoid tumors. This diverse group of tumors include mesenchymal dendritic cell tumors like follicular dendritic cell sarcoma (FDCCS) and its inflammatory pseudotumor-like variant (EBV positive inflammatory FDCCS), Epstein-Barr virus associated smooth muscle tumor, vascular/vascular-stromal tumors and tumor-like lesions including littoral cell angioma (LCA), hemangioma, bacillary angiomatosis, hemangioendothelioma, angiosarcoma and sclerosing angiomatoid nodular transformation (SANT). These tumors vary in biological potential and prognosis from the indolent littoral cell angioma to the aggressive angiosarcoma. Correlating the salient imaging and histopathological features can facilitate proper identification and optimize treatment to improve morbidity and mortality of patients.



## TABLE OF CONTENTS/OUTLINE

1. To review the diverse histopathological spectrum of stroma-derived tumors of the lymphoid tissues. 2. To describe epidemiology, tumor genetics, molecular biology and cross-sectional imaging findings of diverse tumors and to correlate them to histopathological features. 3. To discuss the implications of the diagnosis on management and prognostication of these tumors. \* Follicular dendritic cell sarcoma. \* EBV positive inflammatory follicular dendritic cell sarcoma. \* Inflammatory pseudotumor. \* Epstein-Barr associated smooth muscle tumor. \* Littoral Cell Angioma. \* Bacillary angiomatosis. \* Hemangioendothelioma. \* Angiosarcoma. \* Sclerosing angiomatoid nodular transformation.

### **MSEE-59 Imaging Diagnostic Odyssey of Germ Cell Tumors: Illuminating the Path with Insights into Epigenetic Pathogenesis**

Toshitaka Ishiguro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Germ cell tumors (GCTs) are neoplasms derived from cells committed to the germ cell lineage, but exhibit diverse histologies, including embryonic and extraembryonic components. GCTs also arise at various sites throughout the body, from neonates to adults, making their imaging diagnosis challenging. However, recent progress in understanding the biology of GCTs has allowed them to be categorized into several types based on the latent developmental potential of their cells of origin with different epigenomic features, facilitating our understanding of their anatomical distribution, age of onset, male-to-female ratio, and possible histologies. This exhibit aims to explain this recent classification of GCT types and apply insights into epigenetic pathogenesis to the imaging diagnosis of GCTs, which will contribute to accurate diagnosis leading to better patient outcomes. The purposes of this exhibit are: 1. To explain the recent classification of GCT types based on epigenetic pathogenesis. 2. To review the imaging findings of each histology of GCTs. 3. To discuss the imaging diagnostic approach for GCTs combined with the knowledge of epigenetic pathogenesis.

## TABLE OF CONTENTS/OUTLINE

1. Minimal essentials of epigenetics for radiologists 2. Classification of GCT types based on epigenetic pathogenesis 3. Imaging findings of each histology of GCTs 4. Imaging diagnostic approach for each type of GCTs combined with the knowledge of epigenetic pathogenesis 5. Summary

### **MSEE-6 Multimodality Imaging of Large and Medium Vessel Vasculitis**

#### Awards

##### Certificate of Merit

Mitesh Naik, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To outline classification, clinical presentation, pathogenesis and management of large and medium vessel vasculitis
- To define the role of non-invasive imaging in diagnosis and response to therapy
- To describe the range of modalities used and their relative merits
- To review multimodality appearances of large and medium vessel vasculitis

## TABLE OF CONTENTS/OUTLINE

Background • Epidemiology, clinical presentation, pathogenesis and management • Classification of Large vessel vasculitis: Takayasu arteritis, giant cell arteritis of Medium vessel vasculitis: Polyarteritis nodosa, Kawasaki disease of Variable vessel vasculitis: Behçet syndrome of Secondary vasculitis Review of international guidance on utilization and interpretation of imaging • Diagnosis • Response assessment • Surveillance • Imaging parameters • Imaging criteria - e.g. PET vascular activity score (PETVAS) Multimodality appearances including pros and cons • Ultrasound • CT angiography • MR angiography and MR vessel wall imaging • 18F-fluorodeoxyglucose-PET/CT • Adjunctive modalities - e.g. renography Case examples with interpretive pearls and pitfalls; differential diagnoses; and complex scenarios

### **MSEE-60 Multimodality Imaging Features of Hepatoid Adenocarcinoma and its Mimics**

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the pathophysiology of hepatoid adenocarcinoma and the common sites involved, including the liver, stomach, pancreas, lung, and ovary. 2. To present, through case-based review, the multimodality imaging features of hepatoid adenocarcinoma, with differential clues to aid in diagnosis.

## TABLE OF CONTENTS/OUTLINE

Hepatoid adenocarcinoma (HAC) is a rare and aggressive type of cancer that has a histologic appearance similar to hepatocellular carcinoma (HCC) through metaplastic transformation to hepatocyte-like cells. HAC can involve various organs, including the liver, stomach, pancreas, lung, and ovary. Imaging features of HAC may overlap with other extrahepatic tumors,

including gastric adenocarcinoma, pancreatic adenocarcinoma, primary lung adenocarcinoma, ovarian adenocarcinoma, or lymphoma, making accurate diagnosis challenging. HAC can produce alpha-fetoprotein (AFP) like HCC, which may be useful in differentiating HAC from tumors in extrahepatic organs. However, given its rarity, unfamiliarity, non-specific clinical presentation, and overlapping imaging features, differentiation of HAC remains difficult and is often diagnosed at an advanced stage or with metastases. At this stage, prognosis of HAC is poor with a median survival of less than one year. Early detection and aggressive treatment, including surgical resection and systemic chemotherapy, are crucial for improving the prognosis of patients with HAC. This educational exhibit will (1) review the pathophysiology of HAC and the common sites of involvement, and (2) present the multimodality imaging features of HAC and differentiation from its imaging mimics.

### **MSEE-61 Multi-system Imaging Manifestations of Large Vessel Vasculitis**

Anne Sailer, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Large-vessel vasculitis (LVV) results in inflammation of the aorta and its major branches and is the most common primary vasculitis in adults. LVV comprises two distinct conditions, giant cell arteritis (GCA), and Takayasu arteritis. LVV can have substantial complications including luminal stenosis, arterial thrombosis and infarction of the corresponding organs and structures. Development of pseudoaneurysms and dissections, and rarely arterial ruptures are potentially serious complications in this patient population. 2. Doppler US is a first-line imaging modality utilized for the assessment of the peripheral arterial system, abdominal aorta, and its branches. Review of normal arterial wall anatomy and pathophysiology of waveforms on Doppler ultrasound, with multi-imaging correlation with particular focus on CTA and MRA.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review pathophysiology of Takayasu and giant cell arteritis and their multi-system potential complications. 2. Discuss general concepts of the assessment of the peripheral arterial system and aorta using Doppler US, CTA, and MRA with emphasis on technique, protocol, image optimization. 3. Demonstrate key multi-modality imaging features LVV. Review role of various imaging applications in diagnosis and surveillance of complications in this group of patients. 4. Discuss management options with interventional radiology procedures.

### **MSEE-62 COVID-associated Mucormycosis - Imaging Spectrum**

Nidhi Goyal, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the spectrum of imaging findings in patients with COVID-associated Mucormycosis. 2. To correlate imaging findings and the clinical-laboratory parameters in patients with COVID-associated Mucormycosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of Clinical profile of patients with COVID-associated Mucormycosis. 2. The spectrum of imaging findings in patients with COVID-associated Mucormycosis across different organ systems. 3. Correlation of imaging findings and clinical - laboratory parameters in patients with COVID-associated Mucormycosis. 4. Enlist the key imaging findings which helps in early diagnosis and allows prompt treatment in these patients.

### **MSEE-63 Role of Imaging in Endocrine Hypertension**

Azfar Siddiqui, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Assess the epidemiology, classification, and etiopathogenesis of the endocrine hypertension. 2. Review the role of imaging in localizing the pathology.

#### **TABLE OF CONTENTS/OUTLINE**

1. Epidemiology and etiopathogenesis of the endocrine hypertension. 2. Incidence and risk factors. 3. Classification and imaging findings: A. Primary Aldosteronism (Conn's syndrome): Adrenal adenoma, carcinoma, hyperplasia B. Pheochromocytoma C. Congenital adrenal hyperplasia D. Cushing syndrome E. Adrenal disorders F. ACTH secreting tumor: Pituitary adenoma (Cushing disease), Ectopic production - Small cell cancers of the lung thymus, carcinoid, Pancreatic NET, Ovarian steroid cell tumors G. Hyperthyroidism H. Hyperparathyroidism I. Acromegaly

### **MSEE-64 Spectrum of Imaging Appearances of Perivascular Epithelioid Cell Tumors (PEComas)**

#### **Awards**

#### **Certificate of Merit**

Lam H. Tu, DO (*Presenter*) Nothing to Disclose



## TEACHING POINTS

1. PEComas are very rare mesenchymal tumors of variable malignant potential characterized by smooth muscle and melanocytic differentiation, perivascular distribution and frequent infiltration of small to medium sized vessels. 2. Up to 60% of PEComas are associated with Tuberous Sclerosis Complex (TSC) and TSC and TFE3 gene mutations. Angiomyolipomas and lymphangioliomyomatosis are the most common PEComa subtypes seen with TSC. 3. PEComa - NOS most commonly arise in the retroperitoneum, uterus and kidneys. 4. Hypervascularity and vessel encasement are common imaging features of PEComas. Vascular invasion, size greater than 5 cm, necrosis and tumor thrombus suggest malignant subtypes. 5. Definitive treatment is surgical resection; massive blood loss may result if extent of vascular invasion is not recognized. TSC-related PEComas may be treated with mTOR inhibitors. The only FDA approved treatment for advanced/metastatic/inoperable PEComa is FYARRO™ (Sirolimus protein-bound particles for injectable suspension).

## TABLE OF CONTENTS/OUTLINE

Introduction - PEComa definition and etiology  
Background: epidemiology, genetics and classification  
Spectrum of Imaging  
Features of:- Various PEComa subtypes;- PEComas in most common locations - Common PEComa mimickers: leiomyosarcoma, GIST, RCC - Invasive/malignant PEComas (size, necrosis, tumor thrombus)- Common metastatic sites: lung, liver and peritoneum  
Treatment options

## MSEE-65 The 'New' 2022 World Health Organization (WHO) Classification of Lymphoid Neoplasms: A Primer for Radiologists

Diego J. Cebrian Chaustre, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Familiarize radiologists with new 2022 WHO classification of lymphoid neoplasms review major changes
- Discuss pathology, genetics, and imaging findings of tumor-like lesions select updated lymphomas pertinent to radiologists
- Familiarize the audience with clinically significant, and most important aspects of lymphoma imaging, including the role of CT PET-CT for staging response assessment.
- Review potential therapeutic management implications of the new classification system with special emphasis on novel therapies.

## TABLE OF CONTENTS/OUTLINE

Introduction 2022 WHO Classification Tumor-like lesions, new tumors changes in existing tumors B-cell lymphoid proliferations lymphomas IgG4-related disease, Castleman's disease, small lymphocytic, splenic B-cell, marginal zone, follicular, mantle cell, diffuse large B-cell, Burkitt, Immunosuppressed-associated lymphomas Hodgkin lymphoma. T-cell lymphoid proliferations lymphomas Kikuchi disease, primary cutaneous T-cell, intestinal T-cell, anaplastic large cell EBV-positive lymphomas Stromal-derived dendritic cell sarcoma, littoral cell angioma, splenic hamartoma SANT Imaging findings Role of Imaging in Staging Response Assessment-CT PET-CT: Lugano classification Deauville scoring system Management Novel therapies Conclusion The current WHO classification of lymphoid neoplasms added new tumors reorganized previous categories based on updated molecular/genetic findings that change management decisions. Select lymphomas demonstrate characteristic genetic/pathology imaging findings. Imaging with CT PET/CT plays a pivotal role in staging, response assessment testing the efficacy of novel drugs.

## MSEE-66 A Pictorial Review of Extrapulmonary Tuberculosis: From Head to Toe

Masatoshi Hotta, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Extrapulmonary tuberculosis (EPTB) is a form of tuberculosis that affects parts of the body other than the lungs and accounts for 10-20% of all TB infections. A diagnosis of EPTB is challenging and can mimic malignancy, often requiring a biopsy. Therefore, radiologists should be familiar with the imaging features of EPTB, even when there is no active pulmonary involvement. This exhibit aims to: 1) review the pathophysiology of EPTB, 2) present characteristic EPTB images of various organ systems, and 3) identify the key imaging findings of EPTB.

## TABLE OF CONTENTS/OUTLINE

1) Introduction; 2) Central Nervous System (tuberculous leptomeningitis, brain TB, spinal TB); 3) Head and Neck (tuberculous uveitis, pharyngeal TB, tuberculous otitis media); 4) Chest (esophageal TB, endobronchial TB, pericostal TB); 5) Abdomen (hepatic TB, splenic TB, adrenal TB, intestinal TB, peritoneal TB); 6) Genitourinary (renal TB, seminal vesicle TB, epididymis/testicular TB); 7) Musculoskeletal (tuberculous spondylitis, tuberculous arthritis, tuberculous osteomyelitis)

## MSEE-67 Multisystem Imaging Manifestations of Fibromuscular Dysplasia

### Awards

#### Certificate of Merit

Anne Sailer, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Fibromuscular dysplasia (FMD) is an idiopathic segmentary, non-inflammatory, non-atherosclerotic disease that can affect all layers of both small and medium-caliber arteries. Clinical manifestations are primarily dependent on the vessels affected by FMD, most frequently affecting the renal, carotid, and vertebral arteries.2. Complications of FMD can include severe stenosis, hypoperfusion, aneurysm, dissection, arterial occlusion, and subarachnoid hemorrhage in the brain.

## TABLE OF CONTENTS/OUTLINE

1. Review pathophysiology of FMD and its multi-system potential complications, and associated disorders.2. Discuss general concepts of the assessment of the peripheral arterial system and aorta using Doppler US, CTA, and with MRA, with emphasis on technique, protocol, and image optimization.3. Demonstrate key multi-modality imaging features FMD. Review role of various imaging applications in diagnosis and surveillance of FMD and its potential complications.4. Discuss management options with review of available interventional radiology procedures.5. Discuss the shared features and difference between FMD and polyarteritis nodosa, Takayasu, and other mimics.

## MSEE-68 Imaging Manifestations and Treatment of Renovascular Hypertension

Anne Sailer, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Renovascular hypertension is a type of secondary hypertension where high blood pressure develops secondary to renal artery disease.2. Doppler US is a first line imaging modality utilized for the assessment of the renal arterial system. CTA and MRA are useful confirmatory tests in equivocal or nondiagnostic ultrasonographic exams and can be preferred in specific clinical situations.

## TABLE OF CONTENTS/OUTLINE

1. Review pathophysiology of renovascular hypertension and its multisystem complications. Causes include atherosclerotic renal artery stenosis, fibromuscular dysplasia, renal artery dissection, renal infarction, Page kidney, polyarteritis nodosa, post EVAR RAS, etc.2. Discuss general concepts of the assessment of the renal arterial system and abdominal aorta using Doppler US: technique protocol, image optimization, and common pitfalls in diagnosis.3. Demonstrate key multimodality imaging features of renovascular hypertension. Review role of various imaging modalities in diagnosis and surveillance of complications in this group of patients.4. Discuss management options with emphasis on interventional radiology procedures.

## MSEE-69 US of the Neck Beyond the Thyroid: Parathyroids

Irene Dixe de Oliveira Santo, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Discuss the role of ultrasound in the evaluation of parathyroid gland pathologies;2. Discuss the advantages of ultrasound including the possibility of evaluation for concurrent nodular thyroid disease which may alter the surgical approach and treatment planning;3. Review the role and advantages of complementary imaging modalities in the diagnosis and management of parathyroid gland pathologies including SPECT with technetium-99m sestamibi, 4D computed tomography, and venous sampling

## TABLE OF CONTENTS/OUTLINE

1. Embryology, anatomy, and function of the parathyroid glands;2. Clinical manifestations of hyper- and hypoparathyroidism;3. Role of ultrasound in the assessment of the parathyroid glands: advantages, limitations, technical considerations;4. Ultrasound imaging of parathyroid pathologies: parathyroid adenoma(s) involving one or multiple parathyroid glands, parathyroid carcinoma, multiple endocrine neoplasia, Cowden's disease, parathyromatosis, ectopic or intrathyroidal parathyroid glands;5. Distinguish parathyroid gland pathologies from its mimics such as exophytic thyroid nodules, normal and abnormal lymph nodes, the esophagus, and the longus colli muscle;6. Role of additional imaging modalities: SPECT with Tc-99m sestamibi, 4D computed tomography, and venous sampling;7. Treatment options and clinical challenges

## MSEE-7 Review of MRI Defecography: Technique, Indication, Diagnosis and Limitations

Alice Schuch, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Pelvic floor disorders are commonly encountered in clinical practice and can significantly affect patient quality of life. MR defecography is a non-invasive exam that provides high spatial resolution, multiplanar capability, and superior soft tissue differentiation for assessing the pelvic floor compartments at rest and during defecation maneuvers. Abdominal radiologists should be able to recognize normal and abnormal anatomy, as well as the most common pelvic floor pathologies.

## TABLE OF CONTENTS/OUTLINE

MRI defecography is a non-invasive diagnostic technique used to evaluate the function of the pelvic floor compartments during rest, squeezing, valsalva and defecation, in patients with obstructed defecation, constipation, pelvic pain, incontinence and pelvic organ prolapse and others, providing a more accurate diagnosis of pelvic floor disorders that can guide treatment and surgical planning. Usual findings include cystocele, uterine prolapse, enteroceles, perineal descent, and rectal intussusception, and the association between these alterations. While MRI defecography is a valuable diagnostic tool for assessing pelvic floor disorders, it does have some limitations, such as cost, availability, interpretation variability, and patient discomfort. Abdominal radiologists should be able to recognize normal and abnormal anatomy, and evaluate the common pathologies that can affect the three pelvic floor compartments, especially those that may appear only through dynamic images of the pelvis.

### MSEE-70 **Bigger Butt Not Better: A Radiologist's Guide to the Lifecycle of Cosmetic Injectables**

#### Awards

#### Certificate of Merit

Nadia Solomon, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Familiarize the radiologist with the composition and use of cosmetic injectables, with a focus on illegal and unregulated substances and practices.
- Describe the appearances of injectables on imaging throughout the body, as well as potential complications and their associated imaging findings.
- Provide guidance to radiologists for how to report findings related to injectables and their complications to best guide surgical management.
- Describe how patients with injectables are surgically managed, including post-operative imaging findings and imaging of post-operative complications.

## TABLE OF CONTENTS/OUTLINE

- Introduction to cosmetic injectables, their composition (legal and illegal substances), and common and uncommon injection locations.
- Imaging appearance of injectables throughout the body and associated complications.
- Important features to report on (i.e., foreign material migration, intramuscular location).
- Approach to surgical management.
- Imaging of post-operative findings and common post-operative complications.

### MSEE-71 **Opportunistic Imaging in Musculoskeletal Radiology: The Data Scavengers**

Seyed Arash Mahdavi Anari, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Each radiologic examination contains robust additional data that can be leveraged for opportunistic screening of disease and risk assessment of future adverse clinical events.
2. With the radiology transition from volume-based to value-based practice the interest in opportunistic imaging is growing.
3. AI models enabling fully automated evaluation of biometric measures provide the opportunity of individualized patient risk assessment and pre-symptomatic diseases detection.
4. Opportunistic imaging in musculoskeletal radiology can be used in:
  - Detecting clinically important musculoskeletal findings (e.g., screening for osteoporosis).
  - Systematically discovering non-musculoskeletal findings in musculoskeletal studies (e.g., screening for abdominal aorta aneurysm in lumbosacral MRI).

## TABLE OF CONTENTS/OUTLINE

- Assess opportunistic imaging for detection of sarcopenia in cancer patients and its clinical relevance
- Review opportunistic screening for osteoporosis in abdominopelvic or thoracic CT examinations
- Review opportunistic screening for abdominal aorta aneurysm in lumbosacral MRI examinations
- Discuss the role of radiomic features extracted from imaging specially in oncology imaging as an opportunity to improve diagnosis and prognostication
- Explain the capacity of AI models to fully automate assessment of biometric measures for the use in musculoskeletal imaging

### MSEE-72 **Dual-Energy CT: Still Haven't Found What You Are Looking For**

Roberto Garcia Figueiras, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Dual-energy CT (DECT) imaging has broadened the potential of CT imaging by offering multiple postprocessing datasets which are achieved using discrete acquisitions at more than one energy level. DECT shows profound capabilities to improve diagnosis based on its superior material differentiation, but alsoThe aim of this exhibit is:-To review physical concepts of DECT, parameters influencing image quality, postprocessing methods, and daily routine workflow.-To describe the strengths and weaknesses of different DECT platforms.-To discuss advantages and limitations of DECT in different clinical scenarios.-To provide a comprehensive and practical overview of diagnostic pitfalls and possible artifacts that may be encountered at DECT.-To evaluate future perspectives for DECT imaging and photon-counting technology.

## TABLE OF CONTENTS/OUTLINE

-Basic concepts of DECT: atomic numbers, energy levels, and other physics concepts.-Strengths and weaknesses of different DECT platforms: "one does not fit all".-Understanding the puzzle of the different types of DECT images.-What you can and cannot expect from a DECT scan: opportunities and limitations (that you need to know) of DECT in daily practice.-Pitfalls and artifacts: how to avoid them?-Cutting-edge applications of DECT: iodine concentration and tumor response, advanced material characterization, electron-density maps in radiotherapy, etc.-Future directions: from dual-energy to photon-counting CT.-Conclusions

### MSEE-73 Multimodality Imaging of Sarcoidosis and Sarcoid-like Reaction

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the clinical findings, prognosis, management and imaging guidelines for sarcoidosis and associated complications.
- Describe the imaging appearance of sarcoidosis across multiple organ systems and modalities.
- Discuss the differential diagnoses for imaging findings of for sarcoidosis.
- Discuss radiology-pathology correlation as it applies to sarcoidosis.

## TABLE OF CONTENTS/OUTLINE

Sarcoidosis is a systemic disease but presents most commonly in the lungs. While up to 90% of patients will have an abnormal chest radiograph, less than 20% of patients will exhibit respiratory symptoms. Extrapulmonary manifestations are seen in up to 40% of patients with involvement of central nervous system, circulatory system, abdomen, musculoskeletal system, or skin. In this educational exhibit we describe the imaging appearance and differential diagnosis of the following pulmonary and extrapulmonary manifestations of sarcoidosis: • Pulmonary o Natural history stages of pulmonary sarcoidosis, imaging timeline o Chest radiograph findings and signs o Chest CT findings and signs o FDG and Gallium PET • Cardiac • Intra-abdominal o Hepatic o Splenic o Renal o Peritoneal • Neurosarcoidosis o Leptomeningeal Dural o Pituitary Endocrine o Cranial nerves o Spine: leptomeningeal, myelopathy • Musculoskeletal Cutaneous Sarcoidosis o Bone lesions o Arthropathy o Myopathy o Lofgren syndrome • Pitfalls o Immunotherapy-induced sarcoid-like reaction Finally, we discuss the relevant radiology-pathology relationships in the systemic manifestations of sarcoidosis with a rich complement of histologic images.

### MSEE-74 Nontraditional Uses of CT Contrast Agents

Rodrigo S. Loto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- This abstract discusses the basics of tomographic technique and anatomy, with a focus on the appropriate choice of imaging modality for the evaluation of the specific alterations- Assurance of a valid clinical indication for each contrast medium administration. - To compare positive versus neutral oral contrast material for detecting pathological thoracoabdominal conditions. - Recognize appropriate uses of CT in clinical practice.

## TABLE OF CONTENTS/OUTLINE

CT scanning is fast, painless, noninvasive, and accurate. The CT exam can now be more effectively tailored to the presumed diagnosis. Specifics related to oral and IV contrast protocols in terms of timing and volume regimens will be covered in detail in this presentation. Table of contents:1- CT pharyngography 2- CT esophagography 3- CT gastrography 4- CT enterography 5- CT fistulography 6- CT urography 7- CT cystography 8- CT angiography.To illustrate the spectrum of MDCT findings based on our series of CT studies performed between 2015 and 2022. Conclusions: -On-site radiologist supervision is essential? These exams are always radiologist-guided. -Optimal performance of CT requires knowledge of anatomy and pathophysiology, familiarity with the basic physics and techniques of CT, and knowledge of radiation safety. - Specifics related to oral and IV contrast protocols in terms of timing and volume regimens will be covered in detail in this presentation. - Radiologists must be familiar with the radiologic findings for both accurate diagnosis and, in many cases, guidance of management planning. - A practical case-based review.

### MSEE-75 Multimodality Imaging of Systemic and Localized Amyloidosis

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the etiologies, pathophysiology and clinical findings of systemic and localized amyloidosis
- Describe the imaging appearance of amyloidosis across multiple organ systems and imaging modalities
- Discuss the differential diagnoses for imaging findings of amyloidosis
- Discuss radiology-pathology correlation as it applies to amyloidosis

## TABLE OF CONTENTS/OUTLINE

Amyloidosis is a condition secondary to a range of pathologic processes resulting in deposition of abnormal protein in tissues (amyloid). Amyloid deposition may be due to neoplastic, infectious, inflammatory, and even congenital processes, leading to marked heterogeneity in clinical and imaging manifestations. In this exhibit, we will discuss the varying etiologies of systemic

amyloidosis including AL, AA,  $\beta$ 2- microglobulin, ATTR (transthyretin), and hereditary forms. We will also discuss the etiologies of localized amyloidosis including:  $\beta$ -amyloid (Alzheimer's), AANF (isolated atrial amyloid), and AIAPP (DM2). The focus of our work is the imaging appearance and differential diagnosis for the following organ-specific manifestations of amyloidosis with accompanying clinical images: 1. Pulmonary Amyloidosis o Nodular parenchymal o Diffuse parenchymal o Tracheobronchial laryngeal 2. Cardiac with specific MR and NM findings 3. Intra-abdominal o Hepatosplenic o Renal o Bowel o Bladder 4. Cerebral o Angiopathy o Alzheimer's disease 5. Musculoskeletal o Arthropathy o Myopathy o Carpal tunnel syndrome 6. Amyloidomas Soft Tissue Amyloid Finally, we will describe radiology-pathology relationships that influence imaging findings of amyloidosis.

## **MSEE-76 Characteristic Imaging Features and Screening/Surveillance Recommendations for Hereditary Syndromes**

Joy Li, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

I. Many heritable syndromes have characteristic imaging features. Recognizing common multi-system findings in heritable syndromes allows radiologists to make a unifying diagnosis and guide surveillance strategies. II. Heritable syndromes can have overlapping imaging features. a. Multiple endocrine neoplasia (MEN) type 1, tuberous sclerosis complex (TSC), neurofibromatosis (NF), and von Hippel Lindau (VHL) have characteristic findings in the central nervous system (CNS). b. Lynch, Gardner, and Peutz-Jegher (PJS) syndromes are characterized by gastrointestinal tract malignancies. c. Renal tumors can be seen in Birt-Hogg-Dubé (BHD), TSC, and VHL. d. Pheochromocytomas can be seen in NF type 1, VHL, and MEN type 2. III. While oncologic screening is a critical part of heritable syndrome monitoring, it is equally important to recognize acute pathologies that can result from heritable syndromes. a. CNS tumors can cause acute neurologic problems such as mass effect and obstructive hydrocephalus. b. Small bowel polyps in PJS can lead to intussusceptions and small bowel obstructions. c. Angiomyolipomas, seen in BHD and TSC, can bleed or rupture if large or rapidly growing. This is the second most common cause of morbidity in these patients.

### **TABLE OF CONTENTS/OUTLINE**

I. General concepts about hereditary syndromes II. Review of key imaging findings and screening recommendations for the following diagnoses: Lynch syndrome, Gardner syndrome, PJS, MEN, NF, TSC, BHD, VHL, hereditary breast and ovarian cancer syndrome III. Summary of key concepts

## **MSEE-8 Paraganglioma Imaging: Radiology and Nuclear Medicine**

Aurelie Choucair, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Describe the different hereditary forms of paragangliomas insisting on Succinate Dehydrogenase Mutations. Review the genetic associations predisposing to paragangliomas including Von Hippel- Lindau, Multiple Endocrine Neoplasia Type 2 NEM2, Neurofibromatosis Type 1 NF1 and Carney Triad. Define the secreting or non-secreting character. Provide a detailed overview of anatomical imaging (CT and MRI) features. Improve knowledge about the different Nuclear Medicine and functional imaging techniques, and the multiple radiopharmaceuticals available for Scintigraphy and PET/CT, according to paraganglioma site and mutational pattern. Analyse the different functional imaging modalities and review the strengths and weaknesses of each modality in detecting lesions depending on their location, secretory function and underlying genetic mutation. Prognosis of paragangliomas, frequent sites of metastasis and therapeutic options.

### **TABLE OF CONTENTS/OUTLINE**

Definition of Paraganglioma Epidemiology Succinate Dehydrogenase Mutations Genetic Association: - Von Hippel-Lindau- NEM2- NF1- Carney Triad Characteristics (secreting / non secreting), and clinical presentation Location:- Parasympathetic Paraganglioma: Carotid Body Tumor, Glomus Tympanicum, Jugulotympanicum, Jugulare, and Vagale- Sympathetic Paraganglioma: Adrenal: Pheochromocytoma Extra-adrenal Imaging of Paraganglioma Radiology CT Scan MRI Nuclear Medicine Scintigraphy PET Differential diagnosis Complications Prognosis and Treatment

## **MSEE-9 Eponyms in Radiology: The Controversies Worth Re-examining**

### **Awards**

#### **Certificate of Merit**

Madeleine Sertic, MBBCh (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Eponymous diseases are a long-standing tradition in Western medicine, however, there are numerous arguments against the practice. o Plain-language descriptive names are easier to understand for both patients and health care providers o Eponyms often only recognize individuals, when in reality discoveries are often collaborative o Bias toward recognizing Western, male and non-minority figures
- Eponyms may serve to honor figures that are controversial. o Affiliations with

totalitarian regimes o Documented views of intolerance based on race, disability, age, etc. o Professional scandals involving venality, fraud, etc. • Stigler’s Law of Eponymy states that no scientific eponym is named for its original discoverer.

## **TABLE OF CONTENTS/OUTLINE**

• Introduction o The concept of “controversy” o Holding historical figures to modern standards • Multi-system overview of controversial eponymous figures o Breast o Cardiothoracic o Emergency o Gastrointestinal and Genitourinary o Musculoskeletal o Neuroradiology o Nuclear Medicine o Pediatrics o Vascular/Interventional • Stigler’s Law of Eponymy • Conclusion

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## Abstract Archives of the RSNA, 2023

MSEE-1

### **Rosai-Dorfman Disease- Multimodality Imaging**

All Day Room: Learning Center

Babina Gosangi, MD, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Rosai-Dorfman disease is a benign proliferative disease characterized by sinus-histiocytosis with massive lymphadenopathy. The mean age of presentation is 21-years with a male preponderance. It is a result of immune dysregulation following a viral infection. Lymphadenopathy is the key finding but extranodal involvement is also seen.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Examples of cases: a. Multistation lymphadenopathy b. Extranodal involvement • Nasal cavity- Pansinusitis • Orbital involvement- cranial nerve thickening • Intracranial lesions- Brain neoplasms, meningitis • Lung lesions- perilymphatic nodules, interstitial thickening, endobronchial nodules, pleural lesions • Renal masses • Mesenteric masses • Lytic lesions in the bone • Soft tissue lesions 3. Conclusion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-10

### Another Great Pretender: Extragenital Endometriosis, A Pictorial Review

All Day Room: Learning Center

Francisca Aliaga, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Extragenital endometriosis (EE) is a relatively infrequent occurrence with a broad spectrum of clinical and phenotypic presentations, posing significant diagnostic difficulties, particularly outside the pelvic region. Radiologists play a pivotal role in suspecting the presence of EE by identifying its characteristic imaging hallmarks even before the onset of clinical symptoms. As such, they can facilitate timely diagnosis and intervention for better patient outcomes. MRI is the imaging modality of choice for EE evaluation, owing to its high specificity and sensitivity in detecting EE-specific imaging signs.

#### TABLE OF CONTENTS/OUTLINE

a) Introduction: General characteristics of EE, demographics, and imaging features, mostly in CT and MRI. b) Description of the case series: The experience in extragenital endometriosis in two tertiary care centers. A retrospective review of last 5 years cases was performed. c) MRI protocol d) Extragenital endometriosis distribution: Pelvic non gynecological organs, gastrointestinal, genitourinary, musculoskeletal, thoracic, nervous system, miscellaneous e) Conclusions: Endometriosis is a commonly underdiagnosed disease, and the diagnostic challenge is further enhanced by the non-specific clinical and phenotypic features of EE. When radiologists are aware to these complexities, they can be the first physician to suspect and propose this diagnosis, allowing timely intervention and improved patient outcomes. MRI is the backbone of EE diagnosis, thanks to its characteristics.

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## Abstract Archives of the RSNA, 2023

MSEE-11

### Didactic Cases of Oncologic Emergencies in Radiology

All Day Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To be able to recognize the main urgent pathologies related to oncological diseases and treatments. To be able to distinguish the severity level of these conditions and properly guide the clinician regarding the causative agent. To raise awareness among radiologists about the significant prevalence of these complications in general medical care.

#### TABLE OF CONTENTS/OUTLINE

1. Oncologic diagnosis in the emergency department (not previously known malignancy)  
2. Tumor-related complications and emergencies  
a Superior vena cava  
b Intestinal obstruction  
c Obstructive hydrocephalus  
d Spinal cord compression  
e Hypercoagulability  
f Carcinoid syndrome  
3. Complications arising from diagnostic procedures and classic treatments  
a Surgical (suture dehiscence)  
b Chemo-radiotherapy  
c Vasculitis  
d Fistula  
e Esophagitis/esophageal necrosis  
f Hemorrhagic complications  
g Post-radioembolization  
h cholecystitis  
i Leukoencephalopathy due to chemotherapeutics  
4. Post-hematopoietic stem cell transplantation (HSCT)  
a Pulmonary infections: febrile neutropenia (aspergillus may occur in all time segments)  
0-30 days post-HSCT (fungal): Aspergillus  
31-100 days post-HSCT (early): CMV and PJ  
>100 days post-HSCT (late): Bacterial and viral infections (common infections)  
b Sinusoidal obstructive syndrome and intestinal graft versus host disease  
c Neutropenic colitis (typhlitis)  
5. Emergencies related with new therapies and targeted therapies  
a Immune-related adverse events and complications  
b Pancolitis due to TKI  
c Pancolitis secondary to immune-checkpoint inhibitors  
d Immune-mediated pancreatitis  
e Hyperprogesion  
f Cytokine release syndrome (CRS) and immune effector cell-associated neurotoxicity syndrome (ICANS)

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## Abstract Archives of the RSNA, 2023

MSEE-12

### ctDNA in the Reading Room: A Guide for Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Yu-Cherng C. Chang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? Review applications of circulating tumor DNA (ctDNA) in oncology? Summarize current clinical guidelines for use of ctDNA? Review role of ctDNA in everyday practice

#### TABLE OF CONTENTS/OUTLINE

-Overview of circulating tumor DNA (ctDNA).? What is ctDNA? Lexicon and definitions (tumor microenvironment, liquid biopsy, ctDNA, cell free DNA)? Available techniques and most commonly used platforms for liquid biopsy and ctDNA? ctDNA as a biomarker-ctDNA current oncology guidelines include National Comprehensive Cancer Network, American Society of Clinical Oncology, European Society of Molecular Oncology.-ctDNA in cancer surveillance, prognosis, and treatment response for:? Lung? Breast? Colorectal? Lung? Pancreas? Sarcomas(Detectable targetable mutations, imaging examples, and indications in clinical practice are presented for each tumor)-ctDNA Strengths for imaging interpretation, Limitations in cancer surveillance, prognosis, and treatment-Future Directions and Promising Future Applications? Non-invasive tissue characterization? ctDNA and radiomics? Personalized patient management and therapy selection

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## Abstract Archives of the RSNA, 2023

MSEE-13

### When Suspect Nonneoplastic Lymphadenopathy on PET/CT

All Day Room: Learning Center

Francisca Aliaga, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Morphological changes of lymph nodes or their metabolism are not enough to predict tumoral compromise. 2. The distribution pattern, relation with a primary tumor and its typical extension, inflammatory or posttreatment changes, and clinical conditions should be considered. 3. Different nonneoplastic pathologies characteristically manifest with lymph node enlargement and are frequently confused with malignancy, such as connective tissue diseases, infections, IgG4-related disease, granulomatous inflammation, non-clonal lymphoproliferative disorders, and others.

#### TABLE OF CONTENTS/OUTLINE

1. Clues to suspect nonneoplastic lymphadenopathy: Morphological characteristics, distribution pattern, relation with the drainage pathways of a primary tumor or inflammatory process, and association with other findings. 2. Nonneoplastic diseases related to lymphadenopathies: a) Connective tissue diseases: lupus and rheumatoid arthritis; b) Infections: HIV, tuberculosis, toxoplasmosis, histoplasmosis, Epstein-Barr virus, and Bartonella; c) IgG4-related disease; d) Granulomatous inflammation: sarcoidosis, sarcoid-like reaction, and pneumoconiosis; e) Non-clonal lymphoproliferative disorders: Castleman disease and Amyloidosis; f) Kikuchi and Kimura disease; g) Posttreatment lymphadenopathies: immunotherapy, target therapy, surgical and radiation inflammatory changes; h) COVID-19 vaccine; i) Others: pulmonary edema, interstitial lung disease, emphysema, chronic liver disease, and reactive lymph nodes in young patients. 3. Conclusions

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## Abstract Archives of the RSNA, 2023

MSEE-14

### Potential Pitfalls of Splitting Interpretation of Concurrent Chest and Abdominal CTs

All Day Room: Learning Center

Eyal Ron, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Simultaneously obtained chest and abdomen/pelvis CTs are sometimes read by separate subspecialized radiologists. This creates the potential for missed, incomplete, and conflicting diagnoses involving the scanned areas that overlap. 2. Chest findings can sometimes be more conspicuous on the "abdomen" CT and vice-versa. This can be due to differences in contrast timing and CT reconstruction technique. 3. Some processes require synthesizing findings from both the chest and abdomen CT for optimal radiology analysis.

#### TABLE OF CONTENTS/OUTLINE

We provide example cases demonstrating how splitting radiology interpretations either did or potentially could have led to misdiagnoses of abdominal findings seen on chest CT and vice versa. Additionally, we provide guidelines to avoid these potential pitfalls. Examples include: 1. Missed pancreatic adenocarcinoma conspicuous only on the chest CT portion. 2. Pulmonary embolism poorly visualized on chest CT with contrast but more conspicuous on the arterial phase of the concurrently obtained abdominal CT. 3. Area of slow flow seen on chest CT misinterpreted as pulmonary embolism when a concurrently obtained abdominal shows these arteries are adequately opacified. The patient later developed an intra-abdominal bleed related to the anti-coagulation started for the false positive pulmonary embolism call. 4. Intrathoracic extent of a metastatic GIST tumor and reactive pericardial effusion, challenging to synthesize without strong collaboration between the chest and abdominal radiologists.

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## Abstract Archives of the RSNA, 2023

MSEE-15

### **Facial Mapping: High Frequency Ultrasound Step-by-step Approach in Facial Anatomical Evaluation for Aesthetics**

All Day Room: Learning Center

Luciana C. Zattar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Facial aesthetic procedures are increasingly being performed. Different aesthetic surgery techniques, injectable materials and technologies aimed at improving skin quality and restoring the redistributed volume of facial layers have been used against the multifactorial process of the facial aging. The correct evaluation and characterization of the facial layers is crucial for safe and effective rejuvenation procedures, specially the minimally invasive, since a wrong manipulation might yield an aesthetically undesirable result and lead to serious complications. In this context, the radiologists may be requested to recognize and evaluate the facial layers, compartments and their contents. To achieve accurate and timely detection and appropriate approach of each case, High frequency ultrasound (HFUS/24-33MHz) is the most effective method since it provides optimal anatomical information of the skin and allows facial layers differentiation as well as aesthetic anti-ageing procedures identification. This study aims to discuss and illustrate the radiologist's role in the evaluation of facial anatomy with HFUS, and purposes: (1)To describe the correct examination technique / HFUS advantages. (2)To illustrate the anatomy of the skin/facial layers. (3)To show a step-by-step approach of the most important facial structures. (4)To discuss the course of the main facial neurovascular structures and its variations.(5)To list and describe the anatomy of the Facial Danger Zones. (6)To highlight the importance of HFUS in pre and post-procedural evaluation.

#### **TABLE OF CONTENTS/OUTLINE**

1.INTRODUCTION. 2. FACIAL LAYERS. 3.VASCULAR MAPPING. 4. FRESH FROZEN SPECIMEN CORRELATION. 5.CONCLUSION

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## Abstract Archives of the RSNA, 2023

MSEE-16

### State of the Heart: A Pictorial Review of Classic and Novel Cardiac Devices

All Day Room: Learning Center

Nikhil Gupta, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Outline the indication, function, and imaging of classic cardiac implant devices. Review commonly encountered complications of classic implanted cardiac devices. Understand the role of novel implanted cardiac devices and their appearance on plain film radiography and computed tomography.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to Classic Implanted Devices in the Chest Chest Ports, Heart Valve Prostheses, Pacemakers/Implanted Defibrillators, Coronary Artery Bypass Stents, Implantable Loop Recorder
2. Outline complications of Classic Implanted Devices
3. New Implanted Devices Left Atrial Appendage Closure Devices, Atrial Septal Occlusion Devices, Ventricular Support Devices, ECMO

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## Abstract Archives of the RSNA, 2023

MSEE-17

### Imaging in Sexagenarians and Beyond: What Clinicians Want to Know and What Radiologists Need to Know

All Day Room: Learning Center

Sirui Jiang, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. By 2030 approximately 20% of all Americans or about 70 million people will be 65 years or older. This population utilizes about 30% of our imaging resources yearly and is ever increasing. 2. How to incorporate the geriatric scoring systems to risk stratify and prioritize treatment in the reading room. 3. Review the common imaging findings in the geriatric population with special emphasis in the emergency/trauma and oncology settings using multimodality images. 4. Review imaging differences of pathology in a young versus an elderly patient.

#### TABLE OF CONTENTS/OUTLINE

Background  
History of geriatrics  
Importance of geriatric care and management  
Development of multiple geriatric scoring systems  
Succinctly synthesizing common geriatric imaging findings  
Common Scenarios of Geriatric Population in the Reading Room  
Head and Neck: subdural hematomas, cerebral atrophy, vascular calcifications  
Chest: rib fractures, emphysema, cardiovascular (coronary and valvular calcifications), lung/esophageal primary malignancies, acute/chronic lung infection  
Abdomen: steatosis, chronic renal failure, chronic cystitis, pancreatic issues (malignancy/insufficiency), adrenal issues (insufficiency/hyperplasia/atrophy)  
Pelvis: prostate, diverticulitis  
Musculoskeletal: osteopenia, multiple myeloma, osteoarthritis, steroid associated changes, vertebral compression fractures  
Collaborative Approach for Geriatric Care  
Templates with these common findings to help create a concise report  
Multidisciplinary approach with geriatric subspecialties  
Is it time for a geriatric radiology fellowship/subspecialty?

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## Abstract Archives of the RSNA, 2023

MSEE-18

### **SBRT and Isolated Metastases: A Primer for Radiologists**

All Day Room: Learning Center

Raelynne R. MacBeth, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the natural history of stereotactic radiation therapy (SBRT) and how it has progressed to treatment of intra-thoracic and intra-abdominal malignancies. 2. To review the different types of malignancies SBRT is used to treat and the potential toxicities associated with each. 3. To discuss the multimodality appearance and evaluation of tumor burden after SBRT. 4. To discuss the multimodality appearance of SBRT associated toxicities after treatment. 5. To discuss the multimodality appearance of recurrence patterns after SBRT.

#### **TABLE OF CONTENTS/OUTLINE**

1. Define stereotactic body radiation therapy (SBRT) and how it differs from other modes of radiation therapy. 2. Review the pathophysiology of radiation therapy-induced cellular damage. 3. Review the natural evolution of SBRT and how it has progressed to treatment of malignancies in the chest, abdomen, and pelvis. 4. Discuss the indications for utilizing SBRT in selected malignancies and their common associated toxicities. 5. Discuss the typical and atypical response patterns after SBRT and their multimodality appearance. 6. Discuss the typical and atypical toxicity profiles after SBRT and their multimodality appearance. 7. Examine the multimodality appearance of local recurrence patterns after SBRT. 8. Discuss distant recurrence patterns after SBRT and their multimodality appearance. 9. Discuss the financial toxicities associated with SBRT.

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## Abstract Archives of the RSNA, 2023

MSEE-19

### Syphilis: The Re-emerging Great Mimicker - A Case-based Review from Head to Toe

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Shintaro Kano, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Syphilis, a sexually transmitted disease caused by the spirochete bacterium *T. Pallidum*, is a multisystemic infection that can affect various organs. Recently, the number of syphilitic patients has been rapidly increasing worldwide. Clinical manifestations of syphilis are often inconspicuous and imaging examinations performed for other purposes may lead to potential overlook or misdiagnosis of syphilis, making it challenging for radiologists to diagnose it accurately. Therefore, it is crucial for radiologists to understand the imaging spectrums and differential diagnosis of syphilis to ensure accurate diagnosis and appropriate patient management. The purposes of this exhibit are (1) to review the imaging spectrums of syphilis through case-based studies for the improved ability to identify potential cases of syphilis and (2) to discuss approaches to distinguish syphilis from other diseases that can mimic it.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 1-1.Epidemiology 1-2.Clinical manifestation therapy 2. Case presentations: Body imaging 2-1.head and neck 2-2.chest 2-3.cardiovascular 2-4.abdomen urogenital 3.Case presentations: Neuroimaging 3-1.brain 3-2.spinal cord 4.Case presentations:Pediatric imaging 5. Summary

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## Abstract Archives of the RSNA, 2023

MSEE-2

### Body MRI Approach Fundamentals: A Guide for Beginners

All Day Room: Learning Center

Mark J. Hoegger, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Body MRI interpretation can be daunting for the inexperienced reader because 1) the relevance of key clinical parameters may be unknown, 2) the importance of certain sequences in diagnosis may be unclear, and 3) a routine search pattern may not be established. To aid those inexperienced in body MRI, this exhibit's purpose is to:- Discuss the general body MRI sequences and their uses.- Identify and explain key clinical factors for the most commonly encountered clinical questions that can be answered with body MRI.- Describe the sequences and their relevance for these common body MRI indications. The intent of this exhibit is not provide an exhaustive overview of body MRI, but to arm a trainee starting on service, or a radiologist in practice who has been called upon to read body MRI exams but may be inexperienced or out of practice, with the tools needed to be successful.

#### TABLE OF CONTENTS/OUTLINE

- General body MRI sequences and their uses: T1-weighted imaging pre- and post-contrast, chemical shift imaging, T2-weighted imaging, and DWI.- Body MRI search pattern fundamentals: CT versus MR approach, flexibility in body MRI, lesion finding versus lesion characterization, and pitfalls.- Disease-specific clinical parameters and sequences for common indications: liver lesions and hepatocellular carcinoma (LI-RADS), rectal cancer, renal masses, prostate adenocarcinoma (PI-RADS), pancreatic cysts and solid masses, inflammatory bowel disease, biliary disease, and uterine and ovarian masses.

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## Abstract Archives of the RSNA, 2023

MSEE-20

### Monitoring the Abdomen: How to Do It - Tumor Surveillance and Follow-up

All Day Room: Learning Center

Melissa A. Persad, MBBS, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Different imaging modalities are used for follow-up Surveillance increases accuracy compared with clinical follow-up alone  
Detecting recurrence early allows potentially curative salvage therapy Protocols reflect tumor risk stratification. Guidelines outline imaging follow-up of abdominopelvic tumours Radiomics and liquid biopsies may augment surveillance protocols to identify patients at higher risk of relapse

#### TABLE OF CONTENTS/OUTLINE

Imaging modality pearls and pitfalls for follow-up CT - role of MPR, MIP, dual-energy MRI - anatomical and functional sequences; merits and practicalities of whole-body MRI Nuclear Medicine - including novel radiotracers System based overview of abdominopelvic cancers, how and where to detect relapse· Practical tips for spotting recurrence early and avoiding mimics Understanding routes of disease spread eg. in peritoneal disease Specific challenges of detecting skeletal disease recurrencAssessing lymph node recurrence - not just sizeDifferentiating expected post treatment changes from recurrent disease Immunotherapy and pseudoprogession Guidelines for imaging surveillance post curative treatment Upper, lower, gynaecological and urological tumors Key similarities and differences in international guidelines for follow up of abdominopelvic cancers, why this matters clinically Role of clinical and laboratory markers to augment radiology Tumor markers Liquid biopsy - a new era in cancer surveillance? AI and radiomics in disease surveillance, hype or reality?

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## Abstract Archives of the RSNA, 2023

MSEE-21

### **Congenital and Acquired Causes, Mimickers and Treatment of Diaphragmatic Paralysis**

All Day Room: Learning Center

Achala Donuru, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Phrenic nerves originate from cervical nerves C3-C5. Injury of the phrenic nerve can occur by multiple mechanisms. Due to the long course of the left phrenic nerve in the thorax, left-side diaphragmatic weakness is more common compared to right side. One of the most frequent causes of unilateral diaphragmatic paralysis is iatrogenic. In bilateral diaphragmatic paralysis, one of the most common causes is a motor neuron disease. Most cases of DP are idiopathic (70%), other causes include congenital (birth trauma), tumors, infections, muscular disorders, and iatrogenic (medication induced, from nerve block, post-surgical). The main differentials to consider when an elevated hemidiaphragm is noted on a chest radiograph are diaphragmatic eventration, lobar collapse, subphrenic abscess and subdiaphragmatic mass.

#### **TABLE OF CONTENTS/OUTLINE**

On a chest radiograph, the right dome of the diaphragm is higher in position when compared to the left dome. If the left dome of the diaphragm is elevated by more than 2 cm, DP should be suspected. Functional imaging with a sniff test is very useful in diagnosing DP, the affected side demonstrates a paradoxical upward movement. Performance of dynamic MR imaging for evaluation of diaphragmatic function has also been described. Most patients with unilateral DP are detected incidentally and do not require any specific management. Most patients with bilateral DP require permanent ventilator support. Selected patients with persistent respiratory failure can benefit from diaphragmatic plication or phrenic nerve pacing. It is important for the radiologists to recognize diaphragmatic paralysis and look for pathology along the course of the phrenic nerve.

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## Abstract Archives of the RSNA, 2023

MSEE-22

### **It's Not Always Cancer: A Pictorial Essay on Nonneoplastic Lymphadenopathies with Histopathologic Correlation**

All Day Room: Learning Center

Brenda N. Lahlou, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. List and compartmentalize the different causes of nonneoplastic lymphadenopathies. 2. Recognize typical radiological aspects of certain etiologies of lymphadenopathies. 3. Improve the approach of differential diagnosis of lymph node enlargement by correlating multimodality imaging and clinical findings. 4. Recognize the most common histopathological patterns found in lymph node enlargement caused by benign conditions.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Overview of normal lymph node anatomy and its radiological and histological aspects 3. Subdivision of various pathologies that can encompass lymphadenopathy based on etiology 4. Localized lymphadenopathy a. Foreign-body related b. Idiopathic diseases c. Reactive conditions d. Infections 5. Generalized lymphadenopathy a. Autoimmune diseases b. Idiopathic diseases c. Reactive conditions d. Infections 6. A practical diagnostic approach in the presence of lymph node enlargement 7. Take home message

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## Abstract Archives of the RSNA, 2023

MSEE-23

### **From Brain to Bones: A Radiological Saga Through Multisystemic Tuberous Sclerosis**

All Day Room: Learning Center

Fernanda L. Limonge, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review radiological manifestations of Tuberous Sclerosis  
To illustrate the imaging findings of the most important features of Tuberous Sclerosis (ultrasound, MRI, CT)  
Discuss the radiologist's role on establishing clinical diagnosis

#### **TABLE OF CONTENTS/OUTLINE**

Clinical criteria for Tuberous Sclerosis Diagnostic  
Radiological manifestations of Tuberous Sclerosis- Neurological features-  
Cardiological features- Thoracic features- Abdominal features- Musculoskeletal features

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## Abstract Archives of the RSNA, 2023

MSEE-24

### What on Earth is That: Newer Medical Devices on Chest Radiographs

All Day Room: Learning Center

Ashrith Kandula (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

There has been a constant influx of newer medical devices as technology veers towards more noninvasive methods of treating diseases. Plethora of new devices are seen on today's plain radiographs. Cardiovascular devices are further divided into- cardiac devices comprising of rhythm monitors such as Pacemakers, Implantable cardioverter defibrillators, Ventricular Assist Devices, Occlusion devices, Valve prosthesis- (Open heart and Trans catheter placement), Loop recorders. Vascular devices range from Central venous catheters, Swan Ganz catheter , remote pulmonary artery pressure monitoring devices, devices used for catheter directed thrombolysis, IABP, ECMO to many more. Non-Cardiovascular devices include- esophageal devices- LINX for reflux, nerve stimulators including Vagal, Trigeminal and Hypoglossal, phrenic nerve stimulators, diaphragmatic pacers.

#### TABLE OF CONTENTS/OUTLINE

To review the newer medical devices seen on plain radiographs of the chest. Pictorial review of the optimal location, function and complications of the different devices. Organization: Introduction, classification, pictorial review of device along with in-vitro images, optimal location, function and evaluation of complications associated with the device. Entities discussed: Cardio Microelectromechanical device (CardioMEMS), Pulmonary Artery catheters for thrombolysis , Cordella Pulmonary Artery Pressure Monitor, Mitraclip, Transcatheter Mitral Valve Replacement (TMVR), Transcatheter Pulmonary Valve Replacement (TPVR), LINX - device for reflux management, Endoscopic clips from POEMS, Hypoglossal nerve stimulators, Diaphragmatic pacers.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-25

### **Nail it: A Guide to Diagnosing Nail Disorders**

All Day Room: Learning Center

Isabela Ribeiro (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Ultrasonography serves as a valuable tool for assessing the nail unit, providing real-time evaluation of its components, which includes the periungual tissue's appearance and thickness, vascularization via color Doppler application, and possible involvement of underlying bone structures. It is crucial to understand not only the normal anatomy of the nail bed on ultrasonography but also the main points of some pathologies encountered in daily clinical and radiological practice. While nail tumors are rare anomalies, a detailed prior anatomical knowledge allows for their easy identification. In addition, it is important to highlight the ultrasonographic findings of other common conditions, such as retronychia, foreign bodies, and paronychia, in order to better define the appropriate course of action. Given its ability to diagnose, localize, and differentiate various nail disorders, it is not surprising that nail unit assessment through ultrasonography can significantly improve patient outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

Highlight the importance of ultrasonographic assessment for the nail unit. Review the advantages and limitations of high-frequency ultrasound for evaluating the nail compartment. Identify the ultrasonographic characteristics of common nail pathologies.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

MSEE-26

### **"To Cyst or Not to Cyst," Imaging Spectrum of Mucinous Neoplasms in the Abdomen and Pelvis**

All Day Room: Learning Center

Nabih Nakrou, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to: • Review imaging features of mucin-producing neoplasms in the abdomen and pelvis with attention to organ-specific involvement. • Discuss worrisome findings that favor malignant potentials over benign tumors. • Demonstrate imaging role in management including pre-surgical planning and imaging follow-ups. • Address misdiagnosis, pitfalls, and mimicking pathologies that may resemble mucinous neoplasms

#### **TABLE OF CONTENTS/OUTLINE**

Present multi-modality imaging review of mucinous neoplasms involving the following organs Pancreas Intrahepatic and extrahepatic biliary tree GI tract (Esophagus, stomach, small bowel, colon, appendix and rectum) GU system (ovaries, epididymis, bladder, kidney, renal collecting system) Peritoneum and serosal involvement List syndromic association and predisposing systemic conditions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-27

### **Make Every Connection Matter: Multi-modality Imaging Features of Fistulas in the Chest, Abdomen and Pelvis**

All Day Room: Learning Center

Ayman H. Gaballah, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the definition, classifications, and types of fistulas 2. Discuss multi-modality imaging features of fistulas in the chest, abdomen, and pelvis 3. Point out the appropriate imaging workup and pitfalls according to the anatomic region 4. Illustrate the long-term complications of chronic and untreated fistulas 5. Highlight some of the management options

#### **TABLE OF CONTENTS/OUTLINE**

1- Introduction 2- Etiology and types of fistulas a. Congenital: Congenital fistulae arise from remnants of embryonic ducts that persist (e.g., tracheoesophageal, vitello-intestinal, urachal, etc.) b. Acquired: Acquired fistulae are secondary to variety of causes. i. Traumatic ii. Iatrogenic iii. Inflammatory/infectious iv. Neoplastic v. Post-radiation therapy vi. Vascular vii. Miscellaneous c. Types according to fistula opening i. External opening (e.g., enterocutaneous fistula) ii. Internal opening (e.g., tracheoesophageal, recto-vesical, cholecysto-duodenal, perianal, arteriovenous fistula, etc.) 3- Multimodality imaging features of fistulas in different body parts from head to toe with related classifications as applicable 4- Complications of fistulas 5- Case presentation and imaging pitfalls 6- Management options

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## Abstract Archives of the RSNA, 2023

MSEE-28

### **You'll Float Too: A Guide of Ectopic Gas for the Radiology Resident**

All Day Room: Learning Center

Sofia Arizaga, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

after the exhibit the reader would be able: To describe the imaging features and differentiate normal air/gas in the different tissues and potential body spaces. To identify the origin and causes of ectopic gas. To analyze abnormal gas location in order to detect situations and diseases that involve high mortality rate.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction- Pathways of Ectopic Gas Distribution.- Imaging assessment of abnormal gas.- Etiopathogeneses of ectopic Gas: Iatrogenic, trauma, inflammatory/infectious, ischemic, neoplastic, others.- Recognize alarm signs.- Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-29

### **Alohomora: Opening the Mind and Demystifying Abdominal Tuberculosis Findings**

All Day Room: Learning Center

Kamila S. Albuquerque, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Brazil is one of the countries with the highest incidence of tuberculosis in the world, ranking among the top 22, according to the WHO. Abdominal tuberculosis is considered a great mimic of other abdominal diseases, and can affect the gastrointestinal tract (GIT), peritoneum, lymph nodes and other organs. It often represents a diagnostic challenge due to its nonspecific findings, which may result in diagnostic delay and the development of complications. Imaging tests play an important role in its diagnosis, with an impact on the morbidity and mortality of the disease. This study aims to carry out an inconographic review of the most common abdominal manifestations of the disease, atypical presentations and complications from the perspective of different types of imaging methods, which include tomography and magnetic resonance imaging and even CT / PET.

#### **TABLE OF CONTENTS/OUTLINE**

In this educational exhibition, we address the different abdominal radiological manifestations related to tuberculosis bacillus infection, in addition to epidemiological and pathophysiological data, as well as some differential diagnoses and miscellaneous.

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## Abstract Archives of the RSNA, 2023

MSEE-3

### Visualizing Beyond the Joints: Imaging the Extra-articular Manifestations of Rheumatoid Arthritis

All Day Room: Learning Center

Marco Y. Tsuno (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To understand the prevalence and significance of extra-articular manifestations in rheumatoid arthritis.- To recognize the characteristic imaging features of common extra-articular manifestations in rheumatoid arthritis.- To recognize the role of imaging in monitoring disease progression and detecting new or worsening extra-articular manifestations in rheumatoid arthritis.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Pathophysiology. 3. Diagnostic criteria. 4. Articular manifestations. 4.1. Imaging: articular manifestations (Temporomandibular Joint, Spine, Shoulder, Elbow, Wrist and Hand, Hip, Knee, Ankle and Foot). 5. Extra-articular manifestations. 5.1. Imaging: extra-articular manifestations (Central Nervous System, Pulmonary, Cardiovascular, Rheumatoid Nodules). 6. Conclusion. 7. Bibliographic references.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-30

### **Beyond Genetics: A Review of Current Renal Cancer Screening Guidelines for Hereditary Renal Cancer Syndromes**

All Day Room: Learning Center

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Hereditary renal cancer syndromes, including von Hippel-Lindau (VHL), Birt-Hogg-Dubé (BHD), Hereditary Leiomyomatosis and Renal Cell Carcinoma (HLRCC), Tuberous Sclerosis Complex (TSC), Succinate Dehydrogenase (SDH)-deficient renal cell carcinoma (RCC), and BRCA1-associated Protein-1 (BAP1) tumor predisposition syndrome, are associated with an increased risk of developing renal tumors. Early detection of renal cancer in individuals with hereditary renal cancer syndromes is of extreme importance as it facilitates timely intervention and improves the prognosis. Owing to differences in their extra-renal manifestations and age of onset, the screening guidelines for each hereditary renal cancer syndrome are unique. Here, we provide a summary of the current recommendations for screening of renal cancer in each of these hereditary renal cancer syndromes.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents/OutlineI. Introduction: (a) Hereditary renal cancer syndromes: Renal and extra-renal manifestations; (b) Importance of screeningII. Screening guidelines for hereditary renal cancer syndromesIII. CT/MRI images of patients with extra-renal manifestations undergoing renal cancer screening and eventually detecting renal tumor in each syndrome:(a) Von Hippel-Lindau syndrome (vHL); (b) Birt Hogg Dubé syndrome (BHD); (c) Hereditary Leiomyomatosis and Renal Cell Cancer syndrome; (d) Tuberous Sclerosis Complex; (e) Succinate Dehydrogenase-deficient RCC; (f) BAP1 tumor predisposition syndromeIV. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-31

### **DWI vs 18-FDG PET/CT in Oncology: Which Technique for Which Clinical Scenario**

All Day Room: Learning Center

Antonio Luna, MD, PhD (*Presenter*) Speaker, General Electric Company

#### **TEACHING POINTS**

Learn how to introduce whole-body diffusion-weighted imaging (WB-DWI) for tumor assessment. Review the technological adjustments including parallel imaging, compressed sensing, and deep learning to optimize WB-DWI protocols. Learn how WB-DWI/MRI is a valid alternative to 18-FDG PET/CT for tumor staging and is particularly advantageous in the assessment of peritoneum, bone marrow, liver, and brain metastases. Analyze the complementary role in tumor detection and staging and therapy monitoring of both techniques, using a head-to-head comparison, defining the most adequate technique for common clinical scenarios in oncology and including their applications in special populations (i.e., pregnant, or pediatric patients). Establish the range of clinical applications of PET/MRI combining DWI and 18-FDG PET acquisitions in oncology.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Technical adjustments in WB-DWI 3. Tumor staging: 3a. WB-DWI vs 18-FDG PET-CT. 3b. N staging. 3c. M staging. 3d. Specific tumors: NSCLC, breast cancer, prostate cancer, malignant melanoma, colorectal cancer, lymphoma, multiple myeloma and others. 4. Therapy monitoring. 5. Prediction of treatment response. 6. Posttreatment surveillance. 8. Conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-32

### An Easy Approach to Cheson-Lungano Criteria: From Staging to Treatment Response Assessment

All Day Room: Learning Center

Antonio Michael-Fernandez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-To know how to evaluate a lymphoma staging study and treatment response interpretation according to Cheson-Lungano criteria.- Learning how to manage complex situations where this criteria seems to be unclear and its limitations.- Discussing the differences between Cheson-Lungano criteria and other evaluation systems such as RECIST 1.1

#### TABLE OF CONTENTS/OUTLINE

Standard criteria for radiological evaluation lymphoma response allowed to optimise the therapeutic management in a more accurate way in this type of patients. It is based on the selection of target and non-target disease in a first staging study, and the evaluation of their presence and change in size in follow-up studies, allowing a global assessment of treatment response. These criteria can be applied by radiologists by evaluating CT studies (Cheson criteria) or CT and PET together (Cheson-Lungano criteria). It should be noted that although these criteria may be similar to the RECIST 1.1 criteria for the evaluation of other solid tumours, there are important differences in their interpretation (number of target lesions, required diameters, percentage limits to consider response/progression...), as well as the specific assessment of splenic involvement (which is more infrequent in other solid tumours). This paper reviews the importance of a correct use of Cheson-Lungano criteria in: 1) performing an adequate staging study inform; 2) interpretate the treatment response in follo-up studies; 3) other special situations where this criteria is sometimes unclear and are discussed in this article.

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## Abstract Archives of the RSNA, 2023

MSEE-33

### **POCUS: Radiology Vs Other Medical Professions Perspectives - Where Do We Stand**

All Day Room: Learning Center

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Point-of-care ultrasonography (POCUS) refers to a focused ultrasound performed at the patient's bedside by a clinician who both performs the US and interprets the images. The protocols usually answer a specific question that helps guide treatment. Goals: Understand what is point of care US (POCUS), its benefits and applications. Discuss differences in US training pathways among the different specialties vs Radiology. Review current issues of US Quality assurance and reimbursement, image archiving and accountability. Understand areas of potential threats and conflicts, and explore potential areas for collaboration and growth.

#### **TABLE OF CONTENTS/OUTLINE**

Define Point-of-care ultrasonography (POCUS) Review benefits and various applications of POCUS ( cardiovascular, ophthalmology, nervous system assessment, procedures ( line placement, nerve block, FAST) Discuss training pathways for POCUS, their strengths and limitations vs Radiology, review accreditation processes for POCUS vs Radiology. Discuss training in medical school Review available methods of US Quality assurance and reimbursement, provide examples of misinterpretation/misdiagnosis and role of Radiology in detailed evaluation of the POCUS findings. Discuss issues related to image archiving and accountability. Understand areas of potential threats and conflicts among Radiology and other fields of medicine utilizing POCUS. Explore potential areas for collaboration and growth.

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## Abstract Archives of the RSNA, 2023

MSEE-34

### **Diffusion-weighted Imaging (DWI) in the Era of Abbreviated MRI: How to Make the Most Out of it for Abdominal MRI Applications**

All Day Room: Learning Center

Claudio A. Lagos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Introduce and briefly review abbreviated-MRI concepts. 2. Discuss detectability of lesions through abdominal organs using DWI alone, and review evidence comparing it with other imaging modalities, with emphasis in most and least useful applications. 3. Review DWI utility for characterizing abdominal lesions based on patterns and its correlate with pathology and aggressiveness, with emphasis in liver - pancreas. 4. Review latest evidence regarding ADC value as a biomarker and a quantitative parameter in oncology imaging, prognosis and treatment response. 5. Illustrate frequent artifact and how they lead to interpretation pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

- Physics principles of diffusion- DWI image acquisition, ADC value and ADC map. Role of increasing b values in detectability.- Review abbreviated-MRI concept, goals and applicability.- Evidence based review of detectability of different lesions with emphasis in liver and pancreas.- Comparison of diagnostic yield with other techniques (ie. PET-CT, CECT) and other MR sequences, for different organs and frequent lesions, including peritoneal disease.- Practical approach in liver and pancreatic lesions for predicting histology / aggressiveness using a pattern based fashion.- Case based review of high performance situations: Liver mets, LIRADS evaluation, pancreatic nodules, extra - abdominal metastatic disease.- Case based review of low performance situations: Aggressiveness in renal nodules.- Role of quantitative DWI and its evidence, with emphasis in oncology.- Detectability and interpretation pitfalls, and how to avoid them.- Summary.- References.

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## Abstract Archives of the RSNA, 2023

MSEE-35

### **From Head to Toe Non-Langerhans Cell Histiocytosis (Erdheim-Chester Disease): Understanding a Rare Pathology in the Era of Hybrid Imaging**

All Day Room: Learning Center

Yumi Kimura Sandoval, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Understand the epidemiology and pathology behind Erdheim- Chester disease, as well as its clinical presentation- Learn the importance of 18F-FDG PET/CT in the diagnosis, detection of disease extent, and severity- Identify the radiological signs with which the disease can manifest- Case-based review of the main radiologic signs and features observed in this rare disease

#### **TABLE OF CONTENTS/OUTLINE**

1. Epidemiology 2. Clinical presentation 3. Pathology 4. Radiographic features  
A) Central Nervous system: - Pituitary Gland - Posterior Fossa  
B) Orbits  
C) Thorax - Lung - Mediastinum  
D) Vasculature - Thoracic and abdominal aorta  
E) Kidneys and retroperitoneum  
F) Musculoskeletal system

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## Abstract Archives of the RSNA, 2023

MSEE-36

### Imaging in Erdheim Chester disease

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Yashant Aswani, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Discuss recent updates in classification and pathogenesis of Erdheim-Chester disease  
2. Describe role of imaging and clinical and radiologic findings of Erdheim-Chester disease  
3. Review new treatment options and therapeutic response evaluation

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Epidemiology 3. Pathology 4. Pathogenesis 5. Newer classification systems (2016 WHO classification of lymphoid neoplasms and 2016 Working group of Histiocytic Society Classification) 6. Mixed histiocytosis: an overlap syndrome 7. Diagnosis 8. Role of Imaging 9. Manifestations of Erdheim-Chester disease 10. Skeletal involvement 11. Retroperitoneal disease 12. CNS involvement 13. Cutaneous disease 14. Pulmonary involvement 15. Cardiothoracic disease 16. Endocrine involvement 17. Orbital disease 18. Miscellaneous: Craniofacial bones and skull base 19. Miscellaneous: Hepatobiliary disease 20. Newer imaging findings 21. Association with non-histiocytic malignancies and autoimmune diseases 22. Markers of prognosis 23. Molecular targets for treatment 24. Treatment approach 25. Therapeutic response evaluation modified PERCIST criteria

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## Abstract Archives of the RSNA, 2023

MSEE-37

### Response Assessment in Solid Tumors Criteria: Similarities and Differences

All Day Room: Learning Center

Tagwa Idris, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review the history and evolution of solid tumor response criteria; To compare similarities and differences across various response criteria; To describe RECIST, RECIST-related criteria adaptations, and immune-related criteria; To recognize the challenges of applying these criteria; To provide case-based scenarios and identify the response categories with particular emphasis on immune-related criteria.

#### TABLE OF CONTENTS/OUTLINE

Timeline of Response Assessment in Solid Tumor; Terminology and rules for solid tumor response assessment; Similarities and differences across various response assessment criteria; Case-based scenarios to demonstrate assessment variations in response criteria/categories; Challenges in image metrics assessment using these different criteria; Summary and future directions; References.

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## Abstract Archives of the RSNA, 2023

MSEE-38

### **Bugs that Suck (Your Blood): Imaging Manifestations of Vector-Borne Diseases**

All Day Room: Learning Center

Francisco Calle, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Familiarize the radiologist with the range of pathogens transmitted by arthropod vectors and the diseases they cause.
- Discuss the epidemiology of these diseases, including areas of endemicity, types of arthropod vectors, transmission dynamics, and prior outbreaks.
- Discuss the clinical presentations and medical complications associated with vector-borne diseases.
- Describe the imaging features associated with infection on ultrasound, CT, and MRI.
- Provide a brief overview of management and treatment.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction to vector-borne diseases, including types of vectors and variety of pathogens, as well as epidemiology and major outbreaks. Role of imaging and imaging features in detecting infection and identifying complications: • Neurologic (e.g., viral encephalitis, lyme encephalitis, cerebral malaria) • Chest/cardiac (e.g., Chagas dilated cardiomyopathy) • Gastrointestinal (e.g., yellow fever, malaria) • Urogenital (e.g., arbovirus-associated acute kidney injury, acute tubular necrosis, and renal failure) • Musculoskeletal: (e.g., cutaneous and mucocutaneous leishmaniasis, ectoparasites). Brief overview of management and treatment of vector-borne diseases and their complications

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## Abstract Archives of the RSNA, 2023

MSEE-39

### Whole-Body MRI in Hereditary Tumor Syndromes: How We Do It

All Day Room: Learning Center

Francesco Mungai, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Whole-body MRI can be helpful for screening, detection, and follow-up of bone and soft tissue tumors in patients with hereditary tumor syndromes - Different tumor syndromes require appropriate MRI acquisition protocols to highlight the different pathological findings - Whole-body fluid and cartilage sensitive MRI sequences are necessary for patients with multiple hereditary exostoses (MHE) and enchondromatosis to reveal the cartilaginous portion of the tumors and the associated bursitis - Post-contrast imaging is critical in patients with familiar Paragangliomatosis to identify small mediastinal and retroperitoneal paragangliomas - Diffusion-weighted imaging is useful in patients with an increased risk of malignant tumors (for example, in Li-Fraumeni syndrome) or when a malignant degeneration of a benign lesion is suspected

#### TABLE OF CONTENTS/OUTLINE

- Imaging approach in hereditary tumor syndromes - Role of Whole-Body MRI for screening, detection, and follow-up of hereditary multisystem and multisite tumors - MR imaging acquisition protocol and evaluation in MHE, Enchondromatosis, and Maffucci syndrome - MR imaging acquisition and evaluation in familiar Paragangliomatosis - MR imaging acquisition and evaluation in Neurofibromatosis - MR imaging acquisition and evaluation in Li-Fraumeni syndrome - When to use Dw imaging - When to use post-contrast imaging

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## Abstract Archives of the RSNA, 2023

MSEE-4

### Getting Started with PCCT: Lessons Learned

All Day Room: Learning Center

Fides R. Schwartz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Photon-counting computed tomography (PCCT) uses energy-resolving detectors whereas conventional CT detectors integrate the entire x-ray signal. Decision trees for protocol selection and scan mode are different from EID and must be defined at scanner setup. Technologists need to learn the use of a new interface. Automatic monoenergetic reconstructions with PCCT need to be optimized by imaging protocol including display window levels. Higher spatial resolution may increase image noise, but can be beneficial for many applications. Detector based spectral information collected, creates the need to set up what reconstructions automatically get sent to PACS. This project is geared toward helping new users in the RSNA imaging community in their decision-making processes when setting up a new clinical photon-counting CT. Patient case examples from the PCCTs installed at three major US institutions are shown to underline benefits of the new scanner system.

#### TABLE OF CONTENTS/OUTLINE

Overview of differences between PCCT and EID scanner systems  
New Terminology  
What do I need to set up  
Setting up your exam cards: scan modes, reconstruction kernels  
Reviewing the images: adjusting window level settings, sending thinner slices  
Comparison of PCCT and EID images from three major US institutions  
Abdominal imaging  
Pediatric imaging

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## Abstract Archives of the RSNA, 2023

MSEE-40

### How Multiple Joint CT Scanning Would Benefit from Artificial Intelligence

All Day Room: Learning Center

Mingjun Wang (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: 1. Artificial intelligence (AI) diagnosis platforms are playing more and more important role in clinical imaging diagnosis. 2. Multi-part joint CT scanning can highly reduce the radiation dose and contrast injection volume, effectively reduce the scanning time to protect patients and improve diagnosis efficiency while remaining image quality. 3. Taking coronary and carotid-cerebral joint scanning as example, the diagnosis time and mouse click number using AI platform can be reduced to 80% - 90% and 20% - 60% comparing to manual diagnosis. There is more diagnosis time reduction for junior radiologists than senior radiologists. And the diagnosis accuracy is comparable between AI platform and senior manual diagnosis. 4. We assume AI platform can help make the whole-body CT diagnosis more efficient and reduce 70 - 90% diagnosis time with body auto-segmentation and auto-diagnosis. AI platform offers over-sensitive diagnosis results and radiologists only need to double check to screen out wrong results.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline: The purpose of this educational exhibit is to: 1. Review the current development and application of AI diagnosis platforms. Review the clinical benefit and outcome of multi-part joint CT scanning. 2. Demonstrate the role of AI platform for coronary and carotid-cerebral atherosclerosis diagnosis using one-step heart-brain CT angiography. 3. Illustrate the potential application value of AI platform for whole-body CT scanning using auto-segmentation and auto-diagnosis.

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## Abstract Archives of the RSNA, 2023

MSEE-41

### Imaging-based Response Criteria in Oncologic Clinical Trials: What Radiologists Need to Know

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Guilherme M. Cunha, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Discuss the role of imaging for assessing treatment response as endpoint of oncologic clinical trials. 2) Summarize differences and similarities of treatment response assessment in clinical practice vs for clinical trials. 3) Review the most common imaging-based treatment response criteria used in oncologic clinical trials. 4) Provide guidance on tumor response interpretation and reporting. 5) Discuss future directions.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: a. Relevance of clinical trials for advances in medicine and patient care. b. Oncologic clinical trials: Definitions and practical points. c. The role of imaging in oncologic clinical trials. 2. Assessment of response during oncologic treatment: a. Differences to clinical practice. b. Standardization. c. Blind and independent review. d. Need for objective metrics and endpoints. 3. Imaging-based treatment response criteria: a. Rationale for different criteria. b. Target vs non-target lesions. c. Pictorial review of the most used response criteria. 4. Imaging-based treatment response assessment: a. Image analysis and interpretation. b. Reporting. 5. Future directions: a. Criteria updates. b. Technical Innovations.

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## Abstract Archives of the RSNA, 2023

MSEE-42

### Evaluation of Hidradenitis Suppurativa Through Imaging Methods

All Day Room: Learning Center

Carolina A. Almeida, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Hidradenitis suppurativa is a chronic inflammatory skin condition with lesions including deep-seated nodules and abscesses, draining tracts, and fibrotic scars. 2) The classification of the severity of hidradenitis suppurativa is done clinically using the Hurley scale. Correct severity classification allows for appropriate treatment. 3) Currently, high-frequency ultrasound has been used to map lesions and proposes a new classification: clinical-sonographic scoring system (SOS-HS). 4) Explain how lesions are classified using ultrasonography and the standardization of nomenclature. 5) Clarify doubts about magnetic resonance imaging protocols in the evaluation of hidradenitis suppurativa and when to use this method. 6) To present 3D reconstruction as a useful tool for the pre-surgical study of lesions. 7) Correlate clinical and ultrasound findings, magnetic resonance imaging and 3D reconstruction.

#### TABLE OF CONTENTS/OUTLINE

1) Overview of hidradenitis suppurativa. 2) Hurley classification. 3) Criteria for diagnosing hidradenitis suppurativa by ultrasonography. 4) Hidradenitis suppurativa 3T MRI protocol. 5) Cases exemplifying the importance of imaging exams in the clinical and surgical management of the disease.

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## Abstract Archives of the RSNA, 2023

MSEE-43

### Beyond the Neonatal Intensive Care Unit: Imaging of Long-term Sequel of Prematurity

All Day Room: Learning Center

Mika Shapira Rootman, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiologists should be aware of the potential for late imaging manifestations in patients with a remote history of prematurity, and carefully evaluate imaging studies to identify these complications. Late common CNS manifestations include white matter injury and post-hemorrhagic hydrocephalus. Both frequently co-exist and may have distinctive features on imaging. Advanced chest imaging techniques, including CT and MRI, can enhance the accurate diagnosis and monitoring of late lung complications of prematurity such as bronchopulmonary dysplasia. Late complications of necrotizing enterocolitis, such as strictures and short bowel syndrome, can be accurately identified and monitored using appropriate abdominal imaging techniques, which should be tailored specifically to the patient.

#### TABLE OF CONTENTS/OUTLINE

Outline I. Introduction Premature birth rates and associated health risks Role of imaging in the management of premature infants II. Late Imaging Features of Prematurity Brain abnormalities: periventricular leukomalacia, cerebral atrophy, post-hemorrhagic hydrocephalus, etc. Lung abnormalities: bronchopulmonary dysplasia. Gastrointestinal abnormalities: long term sequel of necrotizing enterocolitis Bone abnormalities: osteopenia, fractures, etc. Differentiating late imaging features from other conditions III. Clinical Case Studies and Outcomes VI. Conclusion Recap of key points Future directions for research and clinical practice.

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## Abstract Archives of the RSNA, 2023

MSEE-44

### The Perirenal Space: Anatomy and Spectrum of Disease

All Day Room: Learning Center

Mikel Elgezabal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Anatomy of the perirenal space with boundaries, key landmarks and pathways for the spread of disease. 2. Complete revision of pathology that can arise in the perirenal space. Radiologic clues to approach the final diagnosis.

#### TABLE OF CONTENTS/OUTLINE

1. Anatomy of the perirenal space: The Inverted Cone 1.1. Perirenal space anatomy with illustrations. 1.2. Key relations. 2. Pathology of the perirenal space 2.1. Masses/Pseudomasses: Pattern based diagnostic approach to perirenal masses and pseudomasses. Renal cell carcinoma. Lymphoma. Leukaemia. Sarcoma and liposarcoma. Myeloma. Lymphangioma. Angiomyolipoma. Extraadrenal myelolipoma. Pancreatic pseudocyst. GIST. 2.2. Collections/Fluid: Infectious: perirenal abscess, xanthogranulomatous pyelonephritis, emphysematous pyelonephritis. Perirenal hematoma. Perirenal urinoma. 2.3. Inflammation/Systemic: Retroperitoneal fibrosis. IgG4-related-disease. Erdheim-Chester disease. Castleman disease. Rosai-Dorfman disease. 2.4. Others/Miscellaneous: Extramedullary hematopoiesis. Spilled lithiasis after nephrolithotripsy. Congested kidneys. 2.5. Summary. 3. Take home points

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## Abstract Archives of the RSNA, 2023

MSEE-45

### **No Worming Your Way Out of This One: Multimodality Imaging of Helminthic Infections**

All Day Room: Learning Center

Nadia Solomon, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Familiarize the radiologist with the variety of helminths which infect humans. Discuss the epidemiology, clinical presentation, and medical complications/sequelae of helminthic infections in humans. Describe the imaging features associated with common and uncommon sequelae of helminthic infections across imaging modalities (ultrasound, CT, MRI). Provide an overview of management and treatment of helminthic infections.

#### **TABLE OF CONTENTS/OUTLINE**

Classification of helminths, helminth lifecycles, and epidemiology. Potential complications of helminthic infection. Role of imaging and imaging features associated with helminthic infections, including: Neurologic (e.g., neurocysticercosis, ocular cysticercosis, ocular toxocariasis); Pulmonary (e.g., paragonimiasis); Cardiac (e.g., filariasis-associated tropical hyper-eosinophilia with Loeffler endocarditis and restrictive cardiomyopathy); Gastrointestinal (e.g., ascariasis, fascioliasis, cystic/alveolar/polycystic echinococcosis); Urogenital (e.g., genital schistosomiasis); Musculoskeletal: (e.g., onchocercomata, filarial elephantiasis, dirofilariasis). Management of helminthic infections and their sequelae.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-46

### Getting Under Your Skin: Multimodality Imaging of Protozoan Infections

All Day Room: Learning Center

Jannatun Sikder, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Familiarize the radiologist with the variety of protozoa which infect humans. Discuss the epidemiology, clinical presentation, and medical complications/sequelae of protozoan infections in humans. Describe the imaging features associated with common and uncommon sequelae of protozoan infections across imaging modalities (ultrasound, CT, MRI). Provide an overview of management and treatment of protozoan infections.

#### TABLE OF CONTENTS/OUTLINE

Classification of protozoa. Epidemiology of protozoan infections. Role of imaging in diagnosing protozoan infections, including imaging features associated with protozoan infections and their complications: Neurologic (e.g., cerebral malaria, toxoplasmosis); Chest/Cardiac (e.g., pleuropulmonary amoebiasis, acute myopericarditis and chronic fibrosing cardiomyopathy from Chagas disease); Gastrointestinal (e.g., Chagasic megaesophagus and achalasia, amoebic dysentery and hepatic abscess, giardiasis, visceral leishmaniasis); Urogenital (e.g., trichomoniasis resulting in Fitz-Hugh-Curtis syndrome, ureteric dilatation from Chagas disease); Musculoskeletal: (e.g., Giardia synovitis, sarcocystis myositis). Management of protozoan infections and their sequelae.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-47

### **The Beauty And The Botched: A Pictorial of Usual, Unusual, and Botched Cosmetic Procedures for the Unsuspecting Radiologist**

All Day Room: Learning Center

Alexander Sasse, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Familiarize the radiologist with the diversity of implant procedures performed, with particular focus on the sociocultural phenomenon that is cosmetic implant surgery (including historical context and evolution of the practice).
- Describe typical and atypical implant locations of implants, and their appearances on medical imaging studies.
- Describe potential complications of cosmetic implants and imaging findings associated with “botched” implant procedures.
- Discuss management of “botched” and otherwise complicated implants, where applicable.

#### **TABLE OF CONTENTS/OUTLINE**

Discuss history of cosmetic implant procedures and diversity of current practices/implant placements. Discuss complications and appearance of “botched” implants. Discuss the role of imaging and imaging features in visualizing both appropriately placed and “botched” or otherwise complicated implants: • Head and Neck (e.g., chin implant) • Breast (e.g., saline and silicone implants) • Urogenital (e.g., scrotal and penile implants) • Extremities (e.g., muscle-simulating implants) • Soft tissue: (e.g., buttock implants). Discuss the management of botched cosmetic implants and other associated complications.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

MSEE-48

### Alcohol-use Related Diseases and Disorders: Head to Toe Imaging Findings

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mark J. Brown, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Alcohol is a significant contributor to the global burden of diseases. Understand the metabolism of alcohol, and effects of alcohol and its metabolites on various organs. Review imaging findings of alcohol-use related diseases and disorders head to toe.

#### TABLE OF CONTENTS/OUTLINE

Metabolism of alcohol and factors affecting metabolism. Pathophysiology of alcohol induced damage to various organs. Imaging findings: Central nervous system: Wernicke-Korsakoff syndrome, hyperammonemic encephalopathy, subacute combined degeneration of the spinal cord, diffuse cerebral atrophy, osmotic demyelination syndrome, Marchiafava-Bignami disease. Cardiovascular system: Alcoholic cardiomyopathy. Lungs: Aspiration and bacterial pneumonia, acute respiratory distress syndrome. Gastrointestinal tract: Fatty liver, acute alcoholic hepatitis, acute and chronic alcoholic steatohepatitis, alcoholic cirrhosis, hepatocellular carcinoma, acute and chronic pancreatitis, GI dysbiosis, Boerhaave syndrome, alcoholic gastritis. Genitourinary tract: Renal stones, hypogonadism. Musculoskeletal system: Alcohol induced muscle disease, avascular necrosis of the femoral heads, osteoporosis, gout. Cancers of the head and neck, esophagus, breast, colon, and rectum. Fetus: Fetal alcohol syndrome

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-49

### Extrapulmonary Tuberculosis: Imaging Findings Beyond the Chest

All Day Room: Learning Center

Irene Diaz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Extrapulmonary tuberculosis affects the lymph nodes most frequently, but it can affect any other organ of the body. The presence of necrotic lymph nodes and other organ-specific imaging features increases the diagnostic probability of extrapulmonary disease.

#### TABLE OF CONTENTS/OUTLINE

**Objectives** To identify imaging features that are suggestive of extrapulmonary tuberculosis and its differential diagnosis.  
**Findings** Extrapulmonary tuberculosis can be challenging to diagnose as it can mimic many other diseases, so a biopsy is often required. An image-based quiz will lead the review of: Cases of central nervous system, head and neck, lymphatic, abdominal, genitourinary, and musculoskeletal tuberculosis; describing some key imaging features and including its main differential diagnosis.  
**Conclusion** Extrapulmonary tuberculosis remains a challenge to diagnose. It is essential to know its key imaging features for an early and successful diagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-5

### Demystifying Mucin in the Abdomen and Pelvis: Tissue Characterization and Spectrum of Disease

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Carolyn F. Dishuck, BS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Mucinous neoplasms are a diverse group of benign and malignant tumors arising from mucin-producing epithelial cells. 2. Mucinous neoplasms arise from a wide range of organs including the appendix, ovary, pancreas, colon, and rectum. 3. Mucin has a characteristic imaging appearance at each modality and differs from other types of tumors that have higher cellular density. 4. Pseudomyxoma peritonei is characterized by the spread of mucinous material throughout the peritoneal cavity and has specific imaging findings. 5. Diagnosis and treatment of mucinous tumors requires a multidisciplinary approach that includes imaging, surgery, and systemic therapies, including hyperthermic intraperitoneal chemotherapy in the case of pseudomyxoma peritonei.

#### TABLE OF CONTENTS/OUTLINE

I. Introductiona. Overview of mucinous neoplasmsII. Imaging features of mucinous neoplasms with case examplesa. Mucinous cystic neoplasms of the pancreasb. Appendiceal mucinous neoplasmsc. Colon and rectal mucinous adenocarcinomad. Ovarian mucinous cystadenoma and cystadenocarcinomae. Miscellaneous (seminal vesicle, primary peritoneal)III. Pseudomyxoma peritoneia. Imaging featuresb. Treatment, including hyperthermic intraperitoneal chemotherapyIV. Conclusiona. Summary of key teaching points

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-50

### Technical Aspects in Imaging Patients Under Extracorporeal Membrane Oxygenation (ECMO) Support

All Day Room: Learning Center

Fernando Diego Choque Chavez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review recommendations to perform optimal CT examinations in patients under extracorporeal membrane oxygenation (ECMO) support according to clinical suspicion and within possible clinical scenarios.- Illustrate examples of optimal and suboptimal examinations in this populations.- Describe the key technical aspects to obtain adequate images and avoid errors.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction and physiology during ECMO support 2. Optimizing the technique: protocol recommendations regarding access, contrast dose and rate injection 2.1. General considerations 2.2. Venovenous ECMO 2.3. Venoarterial ECMO 2.3.1. Central nervous system evaluation 2.3.2. Pulmonary embolism 2.3.3. Aorta evaluation 2.3.4. Abdomen and pelvis 3. Summary and conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-51

### **I CT Dead People: Exploring the Application of Postmortem Imaging to Cause of Death Investigation in a Hospital Setting**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Nadia Solomon, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Familiarize the radiologist with the growing field of forensic radiology, primarily as it pertains to postmortem imaging and cause-of-death investigation.
- Provide an introduction to postmortem computed tomography (CT), including its benefits and limitations.
- Describe the application of and experiences with postmortem CT at an academic teaching hospital.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction to forensic radiology with focus on role in cause-of-death investigation.
- Benefits of postmortem CT as a supplement to autopsy.
- Common postmortem changes on imaging and how to mitigate them, where applicable.
- Application of and experience with postmortem CT at an academic teaching hospital, including: integration with the Autopsy Service; types of cases performed; imaging methods utilized; and correlation with autopsy.
- Case image integration throughout, as illustrative examples.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-52

### Microvascular Imaging Ultrasound (MVI) in Children: Current Use and Potential Applications

All Day Room: Learning Center

#### Awards

##### Cum Laude

Santiago Martinez-Correa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To overview the current knowledge of MVI in children. 2. To illustrate MVI benefits in specific pediatric conditions. 3. To describe possible clinical applications of MVI in the future.

#### TABLE OF CONTENTS/OUTLINE

- Disclosures. - Background Current use and advantages of advanced ultrasound techniques. - Microvascular Imaging Ultrasound 1. Technique description Advanced ultrasound technology that allows high-resolution visualization of slow-flow microvasculature by using clutter suppression algorithms. 2. Protocol Acoustic windows and settings adjustment. 3. Advantages and pitfalls: non-invasive tool, can be used at the bedside. Depends on the scan settings and operator. - Clinical use: 1. Brain Evaluation of vascularity in hypoxic-ischemic injury, hydrocephalus, and infections. 2. Thyroid Approach to vasculature architecture, and focal lesions. 3. Liver Characterization of focal lesions. 4. Spleen Use in assessing trauma, infarcts, focal lesions, and infections. 5. Kidney Evaluation of solid and cystic lesions. 6. Reproductive (Ovaries/Testes): Use in gonadal torsion, and infections. 7. Bowel Assessing small bowel infection and/or inflammation. 8. Lymph nodes Blood flow evaluation in benign and malignant nodes. 9. Skin Evaluation of infected subcutaneous nodules. - Potential future use: 1. MVI as an ancillary method in assessing pediatric brain death. 2. Liver and renal post-transplant perfusion follow-up. 3. Diagnostic and prognostic tool during ECMO therapy. - Take Home Points.

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## Abstract Archives of the RSNA, 2023

MSEE-53

### Immunotherapy-Related Adverse Events - A Review of the Breadth of Toxicities and Imaging Findings

All Day Room: Learning Center

Nicholas DiSanti, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Blocking of immune checkpoints by immune checkpoint inhibitors (ICIs) can cause novel autoimmune disease or uncover subclinical autoimmune disease.- These toxicities are termed immune-related adverse events (irAEs) and can involve any organ.- IrAEs can be mistaken for disease progression or non-autoimmune processes.- Incidence of irAEs is 25% with anti-CTLA-4 inhibitors, 10% with anti-PD(L)-1 inhibitors, and 50% for combination therapy.- The lungs and colon are the most common organs affected radiologically, although cutaneous manifestations are the most common overall.- IrAEs are graded from 1 (asymptomatic) to 5 (death) and management options include continuing immunotherapy, holding immunotherapy and initiating corticosteroids, and discontinuing immunotherapy permanently.

#### TABLE OF CONTENTS/OUTLINE

- Pneumonitis: o Organizing pneumonia o Nonspecific interstitial pneumonia o Hypersensitivity pneumonitis o Bronchiolitis o Acute interstitial pneumonitis/ARDS o Radiation-recall pneumonitis- Sarcoid-like reaction- Enterocolitis- Pancreatitis- Hepatitis- Nephritis- Hypophysitis- Adrenalitis- Thyroiditis- Aortitis- Pericarditis- Serositis: o Pericardial effusion o Pleural effusion o Peritoneal effusion- Sinusoidal obstruction syndrome- Arthritis- Myositis- Polymyalgia rheumatica-like syndrome

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-54

### Phenotypic Diversity of Germinal Center-Derived Malignancies: Implications on Diagnosis and Management

All Day Room: Learning Center

Steven S. Chua, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The germinal center (GC) is a unique and dynamic microenvironment within lymphoid follicles where selection, maturation and antibody production by activated B lymphocytes occur in response to infections. A multitude of unique malignancies arise within the GC that display characteristic histogenesis, genetic abnormalities, tumor pathways, molecular biology and varied clinical behavior. PET/CT is the mainstay for the diagnosis and staging of these tumors and is critical for the assessment of treatment response. Neoplastic B cells within different GC compartments and maturation stages give rise to follicular lymphoma, Burkitt's lymphoma and diffuse large B cell lymphoma that harbor distinctive genetic mutations. While the follicular T cell lymphoma and angioimmunoblastic T cell lymphoma originate from helper T cells, the follicular dendritic cell sarcomas evolve from the follicular dendritic cells of mesenchymal origin. We present salient imaging features of GC-derived malignancies and correlate with histopathology and tumor genetics. We discuss the implications of the diagnosis on tailored therapeutics and prognosis.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction, epidemiology, clinical features this group of germinal center-derived tumors. 2. Histopathology, clinical features, molecular biology of these tumors. 3. Multimodality cross-section delineation of imaging features with CT, MR and PET/CT. 4. Prognosis and management. \* Follicular lymphoma.\* Burkitt's lymphoma.\* Diffuse large B cell lymphoma.\* Angioimmunoblastic T-cell lymphoma.\* Follicular T cell lymphoma.\* Peripheral T cell lymphoma with Tfh phenotype.\* Follicular dendritic cell sarcomas.

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## Abstract Archives of the RSNA, 2023

MSEE-55

### Diversity of Epstein-Barr Virus-associated Diseases

All Day Room: Learning Center

#### Awards

##### Cum Laude

Moto Nakaya, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Summarize the clinical and radiological findings of Epstein-Barr virus (EBV)-associated diseases caused by various etiologies.
- Describe radiological findings in EBV-associated neoplasms in contrast to those observed in uninfected conventional tumors.
- Recognize important imaging points that lead to a definitive diagnosis in patients with suspected EBV-associated diseases.

#### TABLE OF CONTENTS/OUTLINE

I. What are EBV-associated diseases?•Pathomechanisms•The role of EBV in tumorigenesis and progression•Recommended workups II. ContentInfection: infectious mononucleosis, human immunodeficiency virus co-infectionAutoimmune: multiple sclerosis, systemic lupus erythematosus, rheumatoid arthritis, inflammatory bowel disease, type 1 diabetes mellitus, juvenile idiopathic arthritis, celiac diseaseNeoplasm: lymphomas (primary central nervous system lymphoma, natural killer/T-cell lymphoma, diffuse large B-cell lymphoma, lymphomatoid granulomatosis, and post-transplantation lymphoproliferative disorder), solid tumor (gastric cancer, squamous cell carcinoma, EBV-associated smooth muscle tumor, leiomyosarcoma, breast cancer, hepatocellular carcinoma, and follicular dendritic cell sarcoma), others (EBV-associated inflammatory pseudotumor - like follicular/fibroblastic dendritic cell sarcoma)Medication-related EBV infection: methotrexate-related malignant lymphomaMiscellaneous: EBV-positive mucocutaneous ulcer III. Summary1. The entities associated with EBV are diverse.2. Clinical and radiological findings can be the diagnostic indicators of the etiology.3. Appropriate workup is necessary for timely diagnosis and management.

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## Abstract Archives of the RSNA, 2023

MSEE-56

### Beyond the Skeletal Survey: Multimodality Imaging Manifestations of Plasma Cell Dyscrasias

All Day Room: Learning Center

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the wide spectrum of plasma cell dyscrasias, including common and rare subtypes, and their pathophysiology. 2. To present the multimodality imaging features seen in the spectrum of plasma cell dyscrasias to aid in accurate diagnosis and staging, as well as subsequent evaluation of post-therapeutic response.

#### TABLE OF CONTENTS/OUTLINE

Plasma cell dyscrasias are a group of hematological disorders that arise from the abnormal proliferation of plasma cells, which are responsible for producing antibodies. These disorders include monoclonal gammopathy of undetermined significance (MGUS), Waldenström macroglobulinemia, multiple myeloma (MM) and its variants, including smoldering myeloma (SMM), plasma cell leukemia (PCL), solitary and extramedullary plasmacytoma, and amyloidosis. Recent advances in treatment with chemotherapy and immunotherapies have led to improved outcomes, with some patients achieving long-term remission. Early detection and diagnosis allow for appropriate initiation of surveillance and treatment, which will improve outcomes as well as preserve organ function. The imaging manifestations of plasma cell dyscrasias can provide crucial information for diagnosis, prognosis, and management of these diseases. This educational exhibit will (1) review the pathophysiology of plasma cell dyscrasias and the wide spectrum of subtypes, and (2) present the multimodality imaging features of the common and rare subtypes of plasma cell dyscrasias.

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## Abstract Archives of the RSNA, 2023

MSEE-57

### Practical Imaging Approach to Unraveling the Causes of Non-neoplastic Lymphadenopathy

All Day Room: Learning Center

Sota Masuoka, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Non-neoplastic lymphadenopathy may not have specific histopathologic features within the lymph node itself, but determining its underlying cause is still important. Radiologists play a critical role in identifying the cause of lymphadenopathy in three scenarios: (1) when infection or inflammation is clinically suspected, (2) during initial or follow-up imaging for malignancy, and (3) when abnormal lymph nodes are detected incidentally on imaging. Careful observation of the imaging characteristics and anatomical distribution of the abnormal lymph nodes, along with other ancillary imaging findings and clinical information, can help establish an accurate diagnosis of the etiology of the lymphadenopathy, leading to appropriate treatment and avoiding unnecessary further testing for the patient. This exhibit aims to: 1. Review the diverse underlying conditions that cause non-neoplastic lymphadenopathy and their characteristic imaging findings. 2. Discuss an imaging-based approach for diagnosing the underlying causes of non-neoplastic lymphadenopathy.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of non-neoplastic lymphadenopathy  
2. Imaging approach for non-neoplastic lymphadenopathy: Focus on inferring the underlying cause- Based on the distribution of abnormal lymph nodes- Based on the imaging characteristics of abnormal lymph nodes  
3. Case illustrations- (1) Clinically suspected inflammation or infection- (2) Initial/follow-up imaging for malignancies- (3) Incidental detection of abnormal lymph nodes on imaging  
4. Summary

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## Abstract Archives of the RSNA, 2023

MSEE-58

### Stroma-Derived Neoplasms and Tumor-Like Lesions of the Lymphoid Tissues: 2022 WHO Classification System Updates

All Day Room: Learning Center

Steven S. Chua, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

A new category of mesenchymal neoplasms and tumor-like lesions that involve the lymphatic and reticuloendothelial system has been introduced in the 2022 WHO classification of hematolymphoid tumors. This diverse group of tumors include mesenchymal dendritic cell tumors like follicular dendritic cell sarcoma (FDCS) and its inflammatory pseudotumor-like variant (EBV positive inflammatory FDCS), Epstein-Barr virus associated smooth muscle tumor, vascular/vascular-stromal tumors and tumor-like lesions including littoral cell angioma (LCA), hemangioma, bacillary angiomatosis, hemangioendothelioma, angiosarcoma and sclerosing angiomatoid nodular transformation (SANT). These tumors vary in biological potential and prognosis from the indolent littoral cell angioma to the aggressive angiosarcoma. Correlating the salient imaging and histopathological features can facilitate proper identification and optimize treatment to improve morbidity and mortality of patients.

#### TABLE OF CONTENTS/OUTLINE

1. To review the diverse histopathological spectrum of stroma-derived tumors of the lymphoid tissues. 2. To describe epidemiology, tumor genetics, molecular biology and cross-sectional imaging findings of diverse tumors and to correlate them to histopathological features. 3. To discuss the implications of the diagnosis on management and prognostication of these tumors. \* Follicular dendritic cell sarcoma. \* EBV positive inflammatory follicular dendritic cell sarcoma. \* Inflammatory pseudotumor. \* Epstein-Barr associated smooth muscle tumor. \* Littoral Cell Angioma. \* Bacillary angiomatosis. \* Hemangioendothelioma. \* Angiosarcoma. \* Sclerosing angiomatoid nodular transformation.

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## Abstract Archives of the RSNA, 2023

MSEE-59

### **Imaging Diagnostic Odyssey of Germ Cell Tumors: Illuminating the Path with Insights into Epigenetic Pathogenesis**

All Day Room: Learning Center

Toshitaka Ishiguro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Germ cell tumors (GCTs) are neoplasms derived from cells committed to the germ cell lineage, but exhibit diverse histologies, including embryonic and extraembryonic components. GCTs also arise at various sites throughout the body, from neonates to adults, making their imaging diagnosis challenging. However, recent progress in understanding the biology of GCTs has allowed them to be categorized into several types based on the latent developmental potential of their cells of origin with different epigenomic features, facilitating our understanding of their anatomical distribution, age of onset, male-to-female ratio, and possible histologies. This exhibit aims to explain this recent classification of GCT types and apply insights into epigenetic pathogenesis to the imaging diagnosis of GCTs, which will contribute to accurate diagnosis leading to better patient outcomes. The purposes of this exhibit are: 1. To explain the recent classification of GCT types based on epigenetic pathogenesis. 2. To review the imaging findings of each histology of GCTs. 3. To discuss the imaging diagnostic approach for GCTs combined with the knowledge of epigenetic pathogenesis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Minimal essentials of epigenetics for radiologists
2. Classification of GCT types based on epigenetic pathogenesis
3. Imaging findings of each histology of GCTs
4. Imaging diagnostic approach for each type of GCTs combined with the knowledge of epigenetic pathogenesis
5. Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-6

### Multimodality Imaging of Large and Medium Vessel Vasculitis

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mitesh Naik, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To outline classification, clinical presentation, pathogenesis and management of large and medium vessel vasculitis
- To define the role of non-invasive imaging in diagnosis and response to therapy
- To describe the range of modalities used and their relative merits
- To review multimodality appearances of large and medium vessel vasculitis

#### TABLE OF CONTENTS/OUTLINE

Background • Epidemiology, clinical presentation, pathogenesis and management • Classification of Large vessel vasculitis: Takayasu arteritis, giant cell arteritis of Medium vessel vasculitis: Polyarteritis nodosa, Kawasaki disease of Variable vessel vasculitis: Behçet syndrome of Secondary vasculitis Review of international guidance on utilization and interpretation of imaging • Diagnosis • Response assessment • Surveillance • Imaging parameters • Imaging criteria - e.g. PET vascular activity score (PETVAS) Multimodality appearances including pros and cons • Ultrasound • CT angiography • MR angiography and MR vessel wall imaging • 18F-fluorodeoxyglucose-PET/CT • Adjunctive modalities - e.g. renography Case examples with interpretive pearls and pitfalls; differential diagnoses; and complex scenarios

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## Abstract Archives of the RSNA, 2023

MSEE-60

### Multimodality Imaging Features of Hepatoid Adenocarcinoma and its Mimics

All Day Room: Learning Center

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the pathophysiology of hepatoid adenocarcinoma and the common sites involved, including the liver, stomach, pancreas, lung, and ovary. 2. To present, through case-based review, the multimodality imaging features of hepatoid adenocarcinoma, with differential clues to aid in diagnosis.

#### TABLE OF CONTENTS/OUTLINE

Hepatoid adenocarcinoma (HAC) is a rare and aggressive type of cancer that has a histologic appearance similar to hepatocellular carcinoma (HCC) through metaplastic transformation to hepatocyte-like cells. HAC can involve various organs, including the liver, stomach, pancreas, lung, and ovary. Imaging features of HAC may overlap with other extrahepatic tumors, including gastric adenocarcinoma, pancreatic adenocarcinoma, primary lung adenocarcinoma, ovarian adenocarcinoma, or lymphoma, making accurate diagnosis challenging. HAC can produce alpha-fetoprotein (AFP) like HCC, which may be useful in differentiating HAC from tumors in extrahepatic organs. However, given its rarity, unfamiliarity, non-specific clinical presentation, and overlapping imaging features, differentiation of HAC remains difficult and is often diagnosed at an advanced stage or with metastases. At this stage, prognosis of HAC is poor with a median survival of less than one year. Early detection and aggressive treatment, including surgical resection and systemic chemotherapy, are crucial for improving the prognosis of patients with HAC. This educational exhibit will (1) review the pathophysiology of HAC and the common sites of involvement, and (2) present the multimodality imaging features of HAC and differentiation from its imaging mimics.

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## Abstract Archives of the RSNA, 2023

MSEE-61

### Multi-system Imaging Manifestations of Large Vessel Vasculitis

All Day Room: Learning Center

Anne Sailer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Large-vessel vasculitis (LVV) results in inflammation of the aorta and its major branches and is the most common primary vasculitis in adults. LVV comprises two distinct conditions, giant cell arteritis (GCA), and Takayasu arteritis. LVV can have substantial complications including luminal stenosis, arterial thrombosis and infarction of the corresponding organs and structures. Development of pseudoaneurysms and dissections, and rarely arterial ruptures are potentially serious complications in this patient population.2. Doppler US is a first-line imaging modality utilized for the assessment of the peripheral arterial system, abdominal aorta, and its branches. Review of normal arterial wall anatomy and pathophysiology of waveforms on Doppler ultrasound, with multi-imaging correlation with particular focus on CTA and MRA.

#### TABLE OF CONTENTS/OUTLINE

1. Review pathophysiology of Takayasu and giant cell arteritis and their multi-system potential complications.2. Discuss general concepts of the assessment of the peripheral arterial system and aorta using Doppler US, CTA, and MRA with emphasis on technique, protocol, image optimization.3. Demonstrate key multi-modality imaging features LVV. Review role of various imaging applications in diagnosis and surveillance of complications in this group of patients.4. Discuss management options with interventional radiology procedures.

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## Abstract Archives of the RSNA, 2023

MSEE-62

### COVID-associated Mucormycosis - Imaging Spectrum

All Day Room: Learning Center

Nidhi Goyal, MD,FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the spectrum of imaging findings in patients with COVID-associated Mucormycosis. 2. To correlate imaging findings and the clinical-laboratory parameters in patients with COVID-associated Mucormycosis.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of Clinical profile of patients with COVID-associated Mucormycosis. 2. The spectrum of imaging findings in patients with COVID-associated Mucormycosis across different organ systems. 3. Correlation of imaging findings and clinical - laboratory parameters in patients with COVID-associated Mucormycosis. 4. Enlist the key imaging findings which helps in early diagnosis and allows prompt treatment in these patients.

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## Abstract Archives of the RSNA, 2023

MSEE-63

### Role of Imaging in Endocrine Hypertension

All Day Room: Learning Center

Azfar Siddiqui, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Assess the epidemiology, classification, and etiopathogenesis of the endocrine hypertension. 2. Review the role of imaging in localizing the pathology.

#### TABLE OF CONTENTS/OUTLINE

1. Epidemiology and etiopathogenesis of the endocrine hypertension. 2. Incidence and risk factors. 3. Classification and imaging findings: A. Primary Aldosteronism (Conn's syndrome): Adrenal adenoma, carcinoma, hyperplasia B. Pheochromocytoma C. Congenital adrenal hyperplasia D. Cushing syndrome i. Adrenal disorders ii. ACTH secreting tumor: Pituitary adenoma (Cushing disease), Ectopic production - Small cell cancers of the lung thymus, carcinoid, Pancreatic NET, Ovarian steroid cell tumors E. Hyperthyroidism F. Hyperparathyroidism G. Acromegaly

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## Abstract Archives of the RSNA, 2023

MSEE-64

### Spectrum of Imaging Appearances of Perivascular Epithelioid Cell Tumors (PEComas)

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Lam H. Tu, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. PEComas are very rare mesenchymal tumors of variable malignant potential characterized by smooth muscle and melanocytic differentiation, perivascular distribution and frequent infiltration of small to medium sized vessels. 2. Up to 60% of PEComas are associated with Tuberous Sclerosis Complex (TSC) and TSC and TFE3 gene mutations. Angiomyolipomas and lymphangiomyomatosis are the most common PEComa subtypes seen with TSC. 3. PEComa - NOS most commonly arise in the retroperitoneum, uterus and kidneys. 4. Hypervascularity and vessel encasement are common imaging features of PEComas. Vascular invasion, size greater than 5 cm, necrosis and tumor thrombus suggest malignant subtypes. 5. Definitive treatment is surgical resection; massive blood loss may result if extent of vascular invasion is not recognized. TSC-related PEComas may be treated with mTOR inhibitors. The only FDA approved treatment for advanced/metastatic/inoperable PEComa is FYARRO™ (Sirolimus protein-bound particles for injectable suspension).

#### TABLE OF CONTENTS/OUTLINE

Introduction - PEComa definition and etiology  
Background: epidemiology, genetics and classification  
Spectrum of Imaging  
Features of:- Various PEComa subtypes;- PEComas in most common locations - Common PEComa mimickers: leiomyosarcoma, GIST, RCC - Invasive/malignant PEComas (size, necrosis, tumor thrombus)- Common metastatic sites: lung, liver and peritoneum  
Treatment options

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-65

### The 'New' 2022 World Health Organization (WHO) Classification of Lymphoid Neoplasms: A Primer for Radiologists

All Day Room: Learning Center

Diego J. Cebrian Chaustre, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Familiarize radiologists with new 2022 WHO classification of lymphoid neoplasms review major changes
- Discuss pathology, genetics, and imaging findings of tumor-like lesions select updated lymphomas pertinent to radiologists
- Familiarize the audience with clinically significant, and most important aspects of lymphoma imaging, including the role of CT PET-CT for staging response assessment.
- Review potential therapeutic management implications of the new classification system with special emphasis on novel therapies.

#### TABLE OF CONTENTS/OUTLINE

Introduction 2022 WHO Classification Tumor-like lesions, new tumors changes in existing tumors B-cell lymphoid proliferations lymphomas IgG4-related disease, Castleman's disease, small lymphocytic, splenic B-cell, marginal zone, follicular, mantle cell, diffuse large B-cell, Burkitt, Immunosuppressed-associated lymphomas Hodgkin lymphoma. T-cell lymphoid proliferations lymphomas Kikuchi disease, primary cutaneous T-cell, intestinal T-cell, anaplastic large cell EBV-positive lymphomas Stromal-derived dendritic cell sarcoma, littoral cell angioma, splenic hamartoma SANT Imaging findings Role of Imaging in Staging Response Assessment-CT PET-CT: Lugano classification Deauville scoring system Management Novel therapies ConclusionThe current WHO classification of lymphoid neoplasms added new tumors reorganized previous categories based on updated molecular/genetic findings that change management decisions. Select lymphomas demonstrate characteristic genetic/pathology imaging findings. Imaging with CT PET/CT plays a pivotal role in staging, response assessment testing the efficacy of novel drugs.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-66

### A Pictorial Review of Extrapulmonary Tuberculosis: From Head to Toe

All Day Room: Learning Center

Masatoshi Hotta, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Extrapulmonary tuberculosis (EPTB) is a form of tuberculosis that affects parts of the body other than the lungs and accounts for 10-20% of all TB infections. A diagnosis of EPTB is challenging and can mimic malignancy, often requiring a biopsy. Therefore, radiologists should be familiar with the imaging features of EPTB, even when there is no active pulmonary involvement. This exhibit aims to: 1) review the pathophysiology of EPTB, 2) present characteristic EPTB images of various organ systems, and 3) identify the key imaging findings of EPTB.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction; 2) Central Nervous System (tuberculous leptomeningitis, brain TB, spinal TB); 3) Head and Neck (tuberculous uveitis, pharyngeal TB, tuberculous otitis media); 4) Chest (esophageal TB, endobronchial TB, pericostal TB); 5) Abdomen (hepatic TB, splenic TB, adrenal TB, intestinal TB, peritoneal TB); 6) Genitourinary (renal TB, seminal vesicle TB, epididymis/testicular TB); 7) Musculoskeletal (tuberculous spondylitis, tuberculous arthritis, tuberculous osteomyelitis)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-67

### Multisystem Imaging Manifestations of Fibromuscular Dysplasia

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Anne Sailer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Fibromuscular dysplasia (FMD) is an idiopathic segmentary, non-inflammatory, non-atherosclerotic disease that can affect all layers of both small and medium-caliber arteries. Clinical manifestations are primarily dependent on the vessels affected by FMD, most frequently affecting the renal, carotid, and vertebral arteries.2. Complications of FMD can include severe stenosis, hypoperfusion, aneurysm, dissection, arterial occlusion, and subarachnoid hemorrhage in the brain.

#### TABLE OF CONTENTS/OUTLINE

1. Review pathophysiology of FMD and its multi-system potential complications, and associated disorders.2. Discuss general concepts of the assessment of the peripheral arterial system and aorta using Doppler US, CTA, and with MRA, with emphasis on technique, protocol, and image optimization.3. Demonstrate key multi-modality imaging features FMD. Review role of various imaging applications in diagnosis and surveillance of FMD and its potential complications.4. Discuss management options with review of available interventional radiology procedures.5. Discuss the shared features and difference between FMD and polyarteritis nodosa, Takayasu, and other mimics.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-68

### Imaging Manifestations and Treatment of Renovascular Hypertension

All Day Room: Learning Center

Anne Sailer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Renovascular hypertension is a type of secondary hypertension where high blood pressure develops secondary to renal artery disease. 2. Doppler US is a first line imaging modality utilized for the assessment of the renal arterial system. CTA and MRA are useful confirmatory tests in equivocal or nondiagnostic ultrasonographic exams and can be preferred in specific clinical situations.

#### TABLE OF CONTENTS/OUTLINE

1. Review pathophysiology of renovascular hypertension and its multisystem complications. Causes include atherosclerotic renal artery stenosis, fibromuscular dysplasia, renal artery dissection, renal infarction, Page kidney, polyarteritis nodosa, post EVAR RAS, etc. 2. Discuss general concepts of the assessment of the renal arterial system and abdominal aorta using Doppler US: technique protocol, image optimization, and common pitfalls in diagnosis. 3. Demonstrate key multimodality imaging features of renovascular hypertension. Review role of various imaging modalities in diagnosis and surveillance of complications in this group of patients. 4. Discuss management options with emphasis on interventional radiology procedures.

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## Abstract Archives of the RSNA, 2023

MSEE-69

### US of the Neck Beyond the Thyroid: Parathyroids

All Day Room: Learning Center

Irene Dixe de Oliveira Santo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Discuss the role of ultrasound in the evaluation of parathyroid gland pathologies; 2. Discuss the advantages of ultrasound including the possibility of evaluation for concurrent nodular thyroid disease which may alter the surgical approach and treatment planning; 3. Review the role and advantages of complementary imaging modalities in the diagnosis and management of parathyroid gland pathologies including SPECT with technetium-99m sestamibi, 4D computed tomography, and venous sampling

#### TABLE OF CONTENTS/OUTLINE

1. Embryology, anatomy, and function of the parathyroid glands; 2. Clinical manifestations of hyper- and hypoparathyroidism; 3. Role of ultrasound in the assessment of the parathyroid glands: advantages, limitations, technical considerations; 4. Ultrasound imaging of parathyroid pathologies: parathyroid adenoma(s) involving one or multiple parathyroid glands, parathyroid carcinoma, multiple endocrine neoplasia, Cowden's disease, parathyromatosis, ectopic or intrathyroidal parathyroid glands; 5. Distinguish parathyroid gland pathologies from its mimics such as exophytic thyroid nodules, normal and abnormal lymph nodes, the esophagus, and the longus colli muscle; 6. Role of additional imaging modalities: SPECT with Tc-99m sestamibi, 4D computed tomography, and venous sampling; 7. Treatment options and clinical challenges

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## Abstract Archives of the RSNA, 2023

MSEE-7

### Review of MRI Defecography: Technique, Indication, Diagnosis and Limitations

All Day Room: Learning Center

Alice Schuch, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pelvic floor disorders are commonly encountered in clinical practice and can significantly affect patient quality of life. MR defecography is a non-invasive exam that provides high spatial resolution, multiplanar capability, and superior soft tissue differentiation for assessing the pelvic floor compartments at rest and during defecation maneuvers. Abdominal radiologists should be able to recognize normal and abnormal anatomy, as well as the most common pelvic floor pathologies.

#### TABLE OF CONTENTS/OUTLINE

MRI defecography is a non-invasive diagnostic technique used to evaluate the function of the pelvic floor compartments during rest, squeezing, valsalva and defecation, in patients with obstructed defecation, constipation, pelvic pain, incontinence and pelvic organ prolapse and others, providing a more accurate diagnosis of pelvic floor disorders that can guide treatment and surgical planning. Usual findings include cystocele, uterine prolapse, enteroceles, perineal descent, and rectal intussusception, and the association between these alterations. While MRI defecography is a valuable diagnostic tool for assessing pelvic floor disorders, it does have some limitations, such as cost, availability, interpretation variability, and patient discomfort. Abdominal radiologists should be able to recognize normal and abnormal anatomy, and evaluate the common pathologies that can affect the three pelvic floor compartments, especially those that may appear only through dynamic images of the pelvis.

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## Abstract Archives of the RSNA, 2023

MSEE-70

### **Bigger Butt Not Better: A Radiologist's Guide to the Lifecycle of Cosmetic Injectables**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Nadia Solomon, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Familiarize the radiologist with the composition and use of cosmetic injectables, with a focus on illegal and unregulated substances and practices.
- Describe the appearances of injectables on imaging throughout the body, as well as potential complications and their associated imaging findings.
- Provide guidance to radiologists for how to report findings related to injectables and their complications to best guide surgical management.
- Describe how patients with injectables are surgically managed, including post-operative imaging findings and imaging of post-operative complications.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction to cosmetic injectables, their composition (legal and illegal substances), and common and uncommon injection locations.
- Imaging appearance of injectables throughout the body and associated complications.
- Important features to report on (i.e., foreign material migration, intramuscular location).
- Approach to surgical management.
- Imaging of post-operative findings and common post-operative complications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

MSEE-71

### Opportunistic Imaging in Musculoskeletal Radiology: The Data Scavengers

All Day Room: Learning Center

Seyed Arash Mahdavi Anari, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Each radiologic examination contains robust additional data that can be leveraged for opportunistic screening of disease and risk assessment of future adverse clinical events. 2. With the radiology transition from volume-based to value-based practice the interest in opportunistic imaging is growing. 3. AI models enabling fully automated evaluation of biometric measures provide the opportunity of individualized patient risk assessment and pre-symptomatic diseases detection. 4. Opportunistic imaging in musculoskeletal radiology can be used in: ü Detecting clinically important musculoskeletal findings (e.g., screening for osteoporosis). ü Systematically discovering non-musculoskeletal findings in musculoskeletal studies (e.g., screening for abdominal aorta aneurysm in lumbosacral MRI).

#### TABLE OF CONTENTS/OUTLINE

- Assess opportunistic imaging for detection of sarcopenia in cancer patients and its clinical relevance
- Review opportunistic screening for osteoporosis in abdominopelvic or thoracic CT examinations
- Review opportunistic screening for abdominal aorta aneurysm in lumbosacral MRI examinations
- Discuss the role of radiomic features extracted from imaging specially in oncology imaging as an opportunity to improve diagnosis and prognostication
- Explain the capacity of AI models to fully automate assessment of biometric measures for the use in musculoskeletal imaging

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## Abstract Archives of the RSNA, 2023

MSEE-72

### Dual-Energy CT: Still Haven't Found What You Are Looking For

All Day Room: Learning Center

Roberto Garcia Figueiras, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Dual-energy CT (DECT) imaging has broadened the potential of CT imaging by offering multiple postprocessing datasets which are achieved using discrete acquisitions at more than one energy level. DECT shows profound capabilities to improve diagnosis based on its superior material differentiation, but alsoThe aim of this exhibit is:-To review physical concepts of DECT, parameters influencing image quality, postprocessing methods, and daily routine workflow.-To describe the strengths and weaknesses of different DECT platforms.-To discuss advantages and limitations of DECT in different clinical scenarios.-To provide a comprehensive and practical overview of diagnostic pitfalls and possible artifacts that may be encountered at DECT.-To evaluate future perspectives for DECT imaging and photon-counting technology.

#### TABLE OF CONTENTS/OUTLINE

-Basic concepts of DECT: atomic numbers, energy levels, and other physics concepts.-Strengths and weaknesses of different DECT platforms: "one does not fit all".-Understanding the puzzle of the different types of DECT images.-What you can and cannot expect from a DECT scan: opportunities and limitations (that you need to know) of DECT in daily practice.-Pitfalls and artifacts: how to avoid them?-Cutting-edge applications of DECT: iodine concentration and tumor response, advanced material characterization, electron-density maps in radiotherapy, etc.-Future directions: from dual-energy to photon-counting CT.-Conclusions

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## Abstract Archives of the RSNA, 2023

MSEE-73

### Multimodality Imaging of Sarcoidosis and Sarcoid-like Reaction

All Day Room: Learning Center

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the clinical findings, prognosis, management and imaging guidelines for sarcoidosis and associated complications.
- Describe the imaging appearance of sarcoidosis across multiple organ systems and modalities.
- Discuss the differential diagnoses for imaging findings of for sarcoidosis.
- Discuss radiology-pathology correlation as it applies to sarcoidosis.

#### TABLE OF CONTENTS/OUTLINE

Sarcoidosis is a systemic disease but presents most commonly in the lungs. While up to 90% of patients will have an abnormal chest radiograph, less than 20% of patients will exhibit respiratory symptoms. Extrapulmonary manifestations are seen in up to 40% of patients with involvement of central nervous system, circulatory system, abdomen, musculoskeletal system, or skin. In this educational exhibit we describe the imaging appearance and differential diagnosis of the following pulmonary and extrapulmonary manifestations of sarcoidosis:

- Pulmonary
  - o Natural history stages of pulmonary sarcoidosis, imaging timeline
  - o Chest radiograph findings and signs
  - o Chest CT findings and signs
  - o FDG and Gallium PET
- Cardiac
  - o Intra-abdominal
    - o Hepatic
    - o Splenic
    - o Renal
    - o Peritoneal
- Neurosarcoidosis
  - o Leptomeningeal
  - o Dural
  - o Pituitary
  - o Endocrine
  - o Cranial nerves
  - o Spine: leptomeningeal, myelopathy
- Musculoskeletal
  - o Cutaneous Sarcoidosis
  - o Bone lesions
  - o Arthropathy
  - o Myopathy
  - o Lofgren syndrome
- Pitfalls
  - o Immunotherapy-induced sarcoid-like reaction

Finally, we discuss the relevant radiology-pathology relationships in the systemic manifestations of sarcoidosis with a rich complement of histologic images.

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## Abstract Archives of the RSNA, 2023

MSEE-74

### Nontraditional Uses of CT Contrast Agents

All Day Room: Learning Center

Rodrigo S. Loto, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- This abstract discusses the basics of tomographic technique and anatomy, with a focus on the appropriate choice of imaging modality for the evaluation of the specific alterations-
- Assurance of a valid clinical indication for each contrast medium administration.
- To compare positive versus neutral oral contrast material for detecting pathological thoracoabdominal conditions.
- Recognize appropriate uses of CT in clinical practice.

#### TABLE OF CONTENTS/OUTLINE

CT scanning is fast, painless, noninvasive, and accurate. The CT exam can now be more effectively tailored to the presumed diagnosis. Specifics related to oral and IV contrast protocols in terms of timing and volume regimens will be covered in detail in this presentation. Table of contents: 1- CT pharyngography 2- CT esophagography 3- CT gastrography 4- CT enterography 5- CT fistulography 6- CT urography 7- CT cystography 8- CT angiography. To illustrate the spectrum of MDCT findings based on our series of CT studies performed between 2015 and 2022. Conclusions: -On-site radiologist supervision is essential? These exams are always radiologist-guided. -Optimal performance of CT requires knowledge of anatomy and pathophysiology, familiarity with the basic physics and techniques of CT, and knowledge of radiation safety. - Specifics related to oral and IV contrast protocols in terms of timing and volume regimens will be covered in detail in this presentation. - Radiologists must be familiar with the radiologic findings for both accurate diagnosis and, in many cases, guidance of management planning. - A practical case-based review.

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## Abstract Archives of the RSNA, 2023

MSEE-75

### Multimodality Imaging of Systemic and Localized Amyloidosis

All Day Room: Learning Center

Nitin Venugopal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the etiologies, pathophysiology and clinical findings of systemic and localized amyloidosis
- Describe the imaging appearance of amyloidosis across multiple organ systems and imaging modalities
- Discuss the differential diagnoses for imaging findings of amyloidosis
- Discuss radiology-pathology correlation as it applies to amyloidosis

#### TABLE OF CONTENTS/OUTLINE

Amyloidosis is a condition secondary to a range of pathologic processes resulting in deposition of abnormal protein in tissues (amyloid). Amyloid deposition may be due to neoplastic, infectious, inflammatory, and even congenital processes, leading to marked heterogeneity in clinical and imaging manifestations. In this exhibit, we will discuss the varying etiologies of systemic amyloidosis including AL, AA,  $\beta_2$ -microglobulin, ATTR (transthyretin), and hereditary forms. We will also discuss the etiologies of localized amyloidosis including:  $\beta$ -amyloid (Alzheimer's), AANF (isolated atrial amyloid), and AIAPP (DM2). The focus of our work is the imaging appearance and differential diagnosis for the following organ-specific manifestations of amyloidosis with accompanying clinical images: 1. Pulmonary Amyloidosis o Nodular parenchymal o Diffuse parenchymal o Tracheobronchial laryngeal 2. Cardiac with specific MR and NM findings 3. Intra-abdominal o Hepatosplenic o Renal o Bowel o Bladder 4. Cerebral o Angiopathy o Alzheimer's disease 5. Musculoskeletal o Arthropathy o Myopathy o Carpal tunnel syndrome 6. Amyloidomas Soft Tissue Amyloid Finally, we will describe radiology-pathology relationships that influence imaging findings of amyloidosis.

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## Abstract Archives of the RSNA, 2023

MSEE-76

### Characteristic Imaging Features and Screening/Surveillance Recommendations for Hereditary Syndromes

All Day Room: Learning Center

Joy Li, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

I. Many heritable syndromes have characteristic imaging features. Recognizing common multi-system findings in heritable syndromes allows radiologists to make a unifying diagnosis and guide surveillance strategies. II. Heritable syndromes can have overlapping imaging features. a. Multiple endocrine neoplasia (MEN) type 1, tuberous sclerosis complex (TSC), neurofibromatosis (NF), and von Hippel Lindau (VHL) have characteristic findings in the central nervous system (CNS). b. Lynch, Gardner, and Peutz-Jegher (PJS) syndromes are characterized by gastrointestinal tract malignancies. c. Renal tumors can be seen in Birt-Hogg-Dubé (BHD), TSC, and VHL. d. Pheochromocytomas can be seen in NF type 1, VHL, and MEN type 2. III. While oncologic screening is a critical part of heritable syndrome monitoring, it is equally important to recognize acute pathologies that can result from heritable syndromes. a. CNS tumors can cause acute neurologic problems such as mass effect and obstructive hydrocephalus. b. Small bowel polyps in PJS can lead to intussusceptions and small bowel obstructions. c. Angiomyolipomas, seen in BHD and TSC, can bleed or rupture if large or rapidly growing. This is the second most common cause of morbidity in these patients.

#### TABLE OF CONTENTS/OUTLINE

I. General concepts about hereditary syndromes II. Review of key imaging findings and screening recommendations for the following diagnoses: Lynch syndrome, Gardner syndrome, PJS, MEN, NF, TSC, BHD, VHL, hereditary breast and ovarian cancer syndrome III. Summary of key concepts

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## Abstract Archives of the RSNA, 2023

MSEE-8

### Paraganglioma Imaging: Radiology and Nuclear Medicine

All Day Room: Learning Center

Aurelie Choucair, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the different hereditary forms of paragangliomas insisting on Succinate Dehydrogenase Mutations. Review the genetic associations predisposing to paragangliomas including Von Hippel-Lindau, Multiple Endocrine Neoplasia Type 2 NEM2, Neurofibromatosis Type 1 NF1 and Carney Triad. Define the secreting or non-secreting character. Provide a detailed overview of anatomical imaging (CT and MRI) features. Improve knowledge about the different Nuclear Medicine and functional imaging techniques, and the multiple radiopharmaceuticals available for Scintigraphy and PET/CT, according to paraganglioma site and mutational pattern. Analyse the different functional imaging modalities and review the strengths and weaknesses of each modality in detecting lesions depending on their location, secretory function and underlying genetic mutation. Prognosis of paragangliomas, frequent sites of metastasis and therapeutic options.

#### TABLE OF CONTENTS/OUTLINE

Definition of Paraganglioma  
Epidemiology  
Succinate Dehydrogenase Mutations  
Genetic Association: - Von Hippel-Lindau- NEM2- NF1- Carney Triad  
Characteristics (secreting / non secreting), and clinical presentation  
Location:- Parasympathetic Paraganglioma: Carotid Body Tumor, Glomus Tympanicum, Jugulotympanicum, Jugulare, and Vagale- Sympathetic Paraganglioma: Adrenal: Pheochromocytoma Extra-adrenal  
Imaging of Paraganglioma Radiology CT Scan MRI Nuclear Medicine Scintigraphy PET Differential diagnosis  
Complications  
Prognosis and Treatment

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## Abstract Archives of the RSNA, 2023

MSEE-9

### Eponyms in Radiology: The Controversies Worth Re-examining

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Madeleine Sertic, MBBCh (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Eponymous diseases are a long-standing tradition in Western medicine, however, there are numerous arguments against the practice.
  - o Plain-language descriptive names are easier to understand for both patients and health care providers
  - o Eponyms often only recognize individuals, when in reality discoveries are often collaborative
  - o Bias toward recognizing Western, male and non-minority figures
- Eponyms may serve to honor figures that are controversial.
  - o Affiliations with totalitarian regimes
  - o Documented views of intolerance based on race, disability, age, etc.
  - o Professional scandals involving venality, fraud, etc.
- Stigler's Law of Eponymy states that no scientific eponym is named for its original discoverer.

#### TABLE OF CONTENTS/OUTLINE

- Introduction
  - o The concept of "controversy"
  - o Holding historical figures to modern standards
- Multi-system overview of controversial eponymous figures
  - o Breast
  - o Cardiothoracic
  - o Emergency
  - o Gastrointestinal and Genitourinary
  - o Musculoskeletal
  - o Neuroradiology
  - o Nuclear Medicine
  - o Pediatrics
  - o Vascular/Interventional
- Stigler's Law of Eponymy
- Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE

### Nuclear Medicine & Molecular Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **NMMIEE-1 What Radiologists Need to Know About Immune-related Adverse Events: Clinical Significance of FDG-PET/CT Diagnosis of Immune-related Adverse Events**

Mana Ishibashi (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Immune-related adverse events (irAE) are common in patients receiving immune checkpoint inhibitors. Frequency varies by molecular target of the agent in use, with irAE of any grade reported approximately 80-90%. Pneumonitis, hypothyroidism, arthralgias, and cutaneous reactions are most often seen with PD-1/PD-L1 inhibitors, and colitis and hypophysitis with CTLA-4 inhibitors. FDG-PET/CT is used to assess the malignancy; it is also able to detect tissue inflammation, one of the hallmarks of irAE. This unique ability sets FDG-PET/CT apart from CT and MRI and potentially enables the early identification and therapeutic intervention in patients with irAE prior to their developing clinical symptoms. Depending on the site, particularly in lymph nodes, an irAE-related uptake may mimic metastases or disease progression.

#### TABLE OF CONTENTS/OUTLINE

1. Basic information about immune checkpoint inhibitors  
2. The mechanism of autoimmune-reactions in patients receiving immune checkpoint inhibitors  
3. FDG-PET/CT findings of irAE  
4. Differential diagnosis of irAE and other pathologies

#### **NMMIEE-10 Imaging of Thyroid Cancer Post-thyroidectomy: Primer for Radiologists**

Wei Ming Chua, FRCR, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Differentiated thyroid cancer (DTC) arising from thyroid follicular epithelial cells, comprising > 90% of all thyroid cancers.  
2. After thyroidectomy, depending on post-operative risk stratification, the primary goal of radioactive iodine (RAI) can include remnant ablation, adjuvant therapy or treatment of known disease. A whole-body scan performed following administration of therapeutic RAI identifies the presence of iodine-avid thyroid tissue, both normal and malignant, allowing staging of the disease.  
3. Cervical ultrasound is recommended for surveillance of the thyroid bed and regional lymphadenopathy post-thyroidectomy.  
4. Serum Thyroglobulin (Tg) and anti-Tg antibodies are important in the follow-up of these patients; rising levels would warrant further evaluation with RAI imaging.  
5. 18F-FDG PET scanning should be considered in high-risk DTC with elevated serum Tg but negative RAI imaging. Alternatives would include CT imaging of the chest and if negative CT imaging of the abdomen.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of differentiated thyroid cancer  
2. Goals of treatment, including the role of radioactive iodine  
3. Basics of Thyroglobulin and anti-Thyroglobulin interpretation for monitoring for thyroid cancer recurrence/disease  
4. Common sites of disease recurrence and metastasis  
5. Role of US and other imaging modalities (RAI, CT, MRI, PET/CT) in the follow-up of thyroid cancer  
6. Spectrum of imaging appearances on the various modalities after primary treatment of thyroid cancer  
7. Important imaging pitfalls leading to diagnostic errors and misinterpretation

#### **NMMIEE-11 Imaging of Dementias using 18F-FDG PET: Unique and Overlapping Features**

Rita Maria Lahoud, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Establishing a specific diagnosis in cases of dementia may be challenging as symptoms and features often overlap. Characteristic metabolic patterns on 18F-FDG PET, in concert with clinical features, aid in reaching an accurate and timely

diagnosis. • Technical considerations and proper patient preparation are necessary to minimize confounders. • Alzheimer's dementia represents the most common neurodegenerative process encountered on PET/CT and manifests with regional hypometabolism of the posterior temporoparietal regions and cingulate gyrus, although there are variations and overlap with other neurodegenerative processes. • Reduced radiotracer uptake predominantly involves the frontal and anterior temporal lobes in frontotemporal dementia. • In Lewy body dementia, the occipital cortex is mainly affected with sparing of the posterior cingulate gyrus, "the cingulate island sign". • Asymmetric cortical involvement and decreased uptake in the basal ganglia and thalami are characteristic of corticobasal degeneration.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to Dementias a. Alzheimer's b. Frontotemporal c. Lewy Body d. Posterior Cerebral Atrophy e. Corticobasal Degeneration f. NMDA Encephalitis 2. 18F-FDG PET in the evaluation of dementias a. Rationale for use b. Normal brain metabolic patterns c. Patient preparation and technique 3. Metabolic pattern interpretation: a. Unique and overlapping imaging patterns b. Confounding factors

#### **NMMIEE-12 Hybrid Imaging in Infective Endocarditis**

Antonio R. Lopez, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Infective endocarditis (IE) is a serious infection of the heart valves caused by microorganisms, resulting in inflammation and potential complications such as heart failure, stroke, or sepsis. IE is typically diagnosed using the modified Duke criteria, which examines pathologic and clinical criteria; however, due to a variety in presentation and complicating patient factors, I remains a diagnostic challenge. Patients with prosthetic valves (PV) or intracardiac devices (ICD) are at a higher risk for IE, are more difficult to diagnose with IE, and have higher mortality than patients without these cardiac interventions. Combination of cardiac CT and FDG-PET/CT is currently being investigated for adjunct use in I diagnosis in this patient population, which preliminary data shows improve diagnostic accuracy. Here we examine the use of FDG-PET and cardiac CT in diagnosing I in patients with PV and ICD, including a discussion on common cardiac and non-cardiac manifestations of IE on imaging and an examination of its role in future diagnostic algorithms.

#### **TABLE OF CONTENTS/OUTLINE**

Describe current diagnostic methods for IE. Examine the use of Cardiac CT and PET/CT in I diagnosis for patients with PV and ICD, including key imaging features. Discuss the future incorporation of hybrid imaging in I diagnosis.

#### **NMMIEE-13 Theory into Action: A Step-by-Step Guide to Interpreting Scintigraphy Images for Sentinel Node Assessment**

Juan A. Tempra SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Review the basics of the sentinel node and its importance in the diagnosis and staging in cancer. -Describe the technique and methods of optimizing the procedure and the resulting images. -Illustrate different imaging patterns and their clinical significance. -Learn the limitations and pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

-Introduction. -Sentinel lymph node Scintigraphy: principles and technique. -Interpretation of sentinel lymph node mapping images. -Advantages and limitations. -Conclusions.

#### **NMMIEE-14 Findings of Primary and Secondary Breast Malignancies on Dotatate PET/CT**

#### **Awards**

#### **Certificate of Merit**

Lauren C. Hubbard, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review somatostatin receptor-based PET imaging and normal distribution. Positive radiotracer uptake in the breast on Dotatate PET can be seen with metastatic neuroendocrine tumors. Metastatic neuroendocrine tumors to the breast can result in corresponding mammogram findings indistinguishable from a primary breast malignancy. Primary breast malignancies can also demonstrate positive Dotatate PET uptake due to variable somatostatin receptor expression. Invasive lobular carcinoma can demonstrate low to absent abnormal uptake on FDG-PET/CT, but can demonstrate positive uptake on Dotatate-PET/CT.

#### **TABLE OF CONTENTS/OUTLINE**

a. Review of somatostatin receptor-based PET imaging and normal distribution. b. Case presentations of 5 cases of dotatate PET findings of primary and secondary breast malignancies i. A case of biopsy-proven incidentally discovered invasive ductal carcinoma on Dotatate-PET/CT for evaluation of metastatic neuroendocrine tumor. ii. A case of incidentally discovered

invasive lobular carcinoma on Dotatate-PET/CT for metastatic neuroendocrine tumor with comparison to FDG- and 18F-Fluoroestradiol-PET/CT. iii. A case of neuroendocrine tumor metastases to the bilateral breasts with corresponding mammographic findings. iv. A case of neuroendocrine tumor metastases to the left breast with additional systemic sites of metastatic disease. v. A case of bilateral dotatate PET avid breast lesions, histologically proven to be atypical carcinoid tumors of the breast. c. Conclusions/Future Directions

### **NMMIEE-15 PET-CT 18F-FES: Selecting Patients Who Will Benefit from Endocrine Therapy**

Victor M. Osaki, BMedSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Invasive lobular carcinoma (ILC), the second-most prevalent invasive breast cancer subtype comprising approximately 15% of breast cancers;
- ILC is nearly always (95%) estrogen receptor (ER) positive;
- The determination of ER expression by immunohistochemistry has several limitations;
- PET-CT with 18F-fluoroestradiol (PET-FES) has emerged as a diagnostic method that allows evaluating the ER expression status of breast cancer lesions in a non-invasive way;
- Patients with estrogen receptor positive breast cancer benefit from endocrine therapy by blocking these receptors on tumor cells, preventing tumor progression. Some patients, though, have immunohistochemistry showing positive receptors and PET-CT with 18F-FES with lesions not showing uptake. In these cases we suppose the estrogen receptors are non-functioning ones and, therefore, patient will not benefit from endocrine therapy.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction;
- Objective;
- Discussion;
- Clinical and epidemiologic aspects;
- Show cases that are functioning estrogen receptor positive and non-functioning estrogen receptor;
- Discuss endocrine therapy in non-functioning ER+ cancer;
- Take home messages;
- References.

### **NMMIEE-16 The Value of 18F-FDG-PET-CT in the Management of Head and Neck Tumors**

Salome Kukava, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To understand the role of 18F-FDG PET CT in the diagnosis, staging, treatment response assessment and radiotherapy treatment planning in head and neck tumors.

#### **TABLE OF CONTENTS/OUTLINE**

18F-FDG PET-CT is a widely used diagnostic tool in the evaluation of head and neck squamous cell cancers. It is at least as sensitive as MRI or CT in detecting the primary head and neck tumors, but there is no clear evidence of routine use in T staging, due to low spatial resolution and the presence of physiologic uptake on PET. The meta-analysis shows 18F-FDG PET-CT has high sensitivity (79%) and specificity (86%) for N staging, being superior to CT and MRI. For distant spread and second primary cancer detection, 18F-FDG PET-CT may be superior to whole body MRI, while both have high NPV. For the detection of synchronous primary tumor the pooled sensitivity and specificity is above 95%. The meta-analysis of 27 studies shows the high rate of detection of recurrence or residual tumor with 18F-FDG PET-CT (PPV-75 %, NPV-94%). Performed 12 months after therapy for detection of recurrence, the sensitivity and specificity has been reported as high as 100%. The recent response evaluation criteria-so called Hopkins criteria-has high NPV and is characterized by high inter-reader agreement. PET-CT based contouring during radiotherapy treatment planning is more accurate than CT based contouring in terms of gross tumor volume (GTV). Recent advances in hybrid imaging of head and neck tumors include the introduction of integrated PET MRI systems. Studies have shown the intratumoral heterogeneity of FDG uptake, as well as PET-derived volumetric parameters, such as MTV and TLG to be important prognostic factors for disease recurrence, progression and survival.

### **NMMIEE-17 PET-CT 18F-FES: The Use in Clinical Practice in One of the Largest Private Health Centers in Brazil**

Victor M. Osaki, BMedSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- PET-Fluoroestradiol (FES) is a type of Positron Emission Tomography (PET) imaging agent used to detect estrogen receptor-positive (ER+) breast cancer. FES is a synthetic form of estrogen that has been radiolabeled with a positron-emitting isotope, the fluorine-18;
- When 18F-FES is injected into the body, it binds to estrogen receptors on breast cancer cells, allowing PET imaging to detect the presence and location of these cancer cells;
- PET-FES imaging can provide valuable information to healthcare professionals about the extent of ER+ breast cancer, as well as guide treatment decisions;
- PET-FES has emerged as a diagnostic method that allows evaluating the ER expression status of breast cancer lesions in a non-invasive way;
- In addition to breast cancer, PET-FES imaging has also been used in research to investigate other estrogen-receptor positive cancers, such as ovarian and endometrial cancer.

## TABLE OF CONTENTS/OUTLINE

- Clinical and epidemiologic aspects;
- Show the possible applications of PET-CT with 18F-FES and show its applicability in clinical practice in our hospital.
- Take home messages;
- References.

## NMMIEE-18 Gallium-68 DOTATATE PET for the Imaging of Non-Gastrointestinal Neoplasm: A Review

Amar Shah, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Somatostatin-receptor analogue based imaging, including Gallium(Ga)-68 DOTATATE PET/CT, has long played a central role in the evaluation of gastroenteropancreatic neuroendocrine tumor. However, Ga-68 DOTATATE has a variety of clinical applications beyond this, both in oncologic pathologies. In this exhibit, we aim to review Ga-68 DOTATATE physiology and its use beyond gastroenteropancreatic neuroendocrine tumor. 1. Review physiology of Ga68-DOTATATE distribution and uptake. 2. Catalogue non-gastrointestinal uses, both oncologic and nononcologic, of Ga-68 DOTATATE based imaging. 3. Highlight pitfalls of Ga68-DOTATATE imaging.

## TABLE OF CONTENTS/OUTLINE

1. Review normal Ga-68 DOTATATE distribution and mechanism of uptake.
2. Non-gastrointestinal tumoral indications. a. Meningioma b. Medullary thyroid cancer c. Paraganglioma d. Phosphaturic mesenchymal tumor e. Pulmonary carcinoid
3. Pitfalls of Ga-68 DOTATATE PET/CT.

## NMMIEE-19 FDG PET/CT in Evaluation of Cardiac Device Infections: What an Imager Should Know

Wenhui Zhou, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

FDG PET/CT is increasingly utilized for the diagnosis and evaluation of cardiac device infections. The objective of this case-based educational exhibit is to 1) review established and emerging applications of FDG PET/CT in the diagnosis of cardiac device infections 2) review protocols and guidelines for integrating FDG PET/CT in the diagnosis of cardiac device infections 3) highlight interpretation criteria, pearls, and pitfalls of FDG PET/CT for cardiac device infections. Implementing this knowledge is important to avoid errors and provide accurate imaging interpretation for cardiac device infection.

## TABLE OF CONTENTS/OUTLINE

The most demonstrative cases of cardiac device infections noted on FDG PET/CT performed at our tertiary care academic institution for evaluation of cardiac device infections were selected to highlight the teaching points for this exhibit, including: 1) cardiac implantable electronic device (CIED) infection 2) left ventricular assist device (LVAD) infection 3) prosthetic valve endocarditis. We will summarize take-home points to facilitate transfer of knowledge.

## NMMIEE-2 Skeletal Muscle Uptake in FDG-PET: Physiology and Pathology, Pearls and Pitfalls

Jessica L. Dobson, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

18F-fluorodeoxyglucose (FDG)-PET is commonly used in oncology, and while key for staging may also reveal nonspecific findings related to any number of neoplastic, infectious, and inflammatory etiologies. Despite the ubiquity of FDG-PET, intense skeletal muscle uptake remains an uncommon and sometimes unexpected finding. Patterns of uptake are often similar between vastly different entities, and the interpreting physician must be familiar with these entities to provide a useful diagnosis or differential. This exhibit will review a series of local cases demonstrating skeletal muscle FDG uptake and discuss the clinical and imaging context leading to the diagnosis, with the goal of conveying an understanding of skeletal muscle uptake on FDG-PET and considerations to provide a relevant differential diagnosis and advise on appropriate next steps.

## TABLE OF CONTENTS/OUTLINE

1. Overview normal physiologic distribution of FDG;
2. Review the biochemical basis of physiologic and pathologic skeletal muscle FDG uptake;
3. Discuss the differential considerations for skeletal muscle uptake, including physiologic, inflammatory, infectious, and neoplastic etiologies, and possible mimics of skeletal muscle uptake on FDG-PET;
4. Analyze local cases of skeletal muscle uptake with emphasis on imaging patterns and clinical indicators guiding diagnosis.

## NMMIEE-21 PSMA PET/CT and Spectrum of Nonprostatic Disease

Qiubai Li (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Prostate-specific membrane antigen (PSMA) based radiopharmaceutical 18F-PSMA and 68Ga-PSMA for imaging of prostate cancer.
- PSMA PET/CT plays a key role in diagnosis, staging and evaluation of treatment response of prostate cancer
- PSMA

uptake on PET/CT can be divided into prostatic disease and nonprostatic disease. Comparison between cytoplasmic PSMA expression in nonprostatic disease and apical PSMA expression in prostate cancer can help to differentiate these conditions. • The purpose of this presentation is to introduce of spectrum of nonprostatic disease on PSMA PET/CT which may be interpreted as metastatic disease. • Recognizing the false positive imaging findings can help narrow the differential diagnosis and triage appropriate patient care

#### **TABLE OF CONTENTS/OUTLINE**

• PSMA uptake and CNS disease • PSMA uptake and PNS disease • PSMA uptake and lacrimal gland disease • PSMA uptake and thyroid disease • PSMA uptake and inflammatory/inflammatory disease • PSMA uptake and lung disease • PSMA uptake and liver disease • PSMA uptake and kidney disease • PSMA uptake and adrenal gland disease • PSMA uptake and bone disease • PSMA uptake and chronic lymphocytic leukemia

#### **NMMIEE-22 FDG PET: Not Just a One-trick Pony: Non-oncologic Uses of FDG PET Imaging**

Patrick Handwork, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to:- Understand the underlying physiologic mechanism of FDG PET and conventional clinical applications- Discuss non-oncologic pathologies that can be evaluated on FDG PET, including those which may mimic other neoplastic processes.- Examine the pros and cons of utilizing FDG PET versus conventional imaging modalities in non-oncologic applications.

#### **TABLE OF CONTENTS/OUTLINE**

Mechanism of Action of FDG PET  
Head and Neck applications- Seizures- Dementia/neurocognitive disease- Differentiating CNS lymphoma versus toxoplasmosis  
Chest and Cardiac applications- Sarcoidosis- Evaluating for hibernating myocardium- Cardiac/pericardiac infection myocarditis- Incidental infection/inflammation, including organizing pneumonia  
Abdominal- Infection in polycystic liver or kidney disease- Infection in mucinous peritoneal carcinomatosis- Autoimmune pancreatitis/ IgG4 related disease- Incidental infection/inflammation including: inflammatory bowel disease, hepatitis, pyelonephritis  
Vascular- Aortitis vasculitis- Inflammatory plaques- Incidental findings including: endoleak and deep vein thrombosis  
Musculoskeletal- Chronic recurrent multifocal osteomyelitis (CRMO) synovitis, acne, pustulosis, hyperostosis, and osteitis (SAPHO) syndrome- Non-post-operative spinal infections- Peripheral bone osteomyelitis- Septic arthritis  
Multisystem- Sarcoidosis, tuberculosis, granulomatous infections- Non-Langerhans cell histiocytosis- Fever of unknown origin neoplastic mimics- Sequelae of endocarditis- HIV/Covid reactive adenopathy reactive adenopathy

#### **NMMIEE-23 Why PET/MRI in Pediatric Oncology? A Pictorial Review of Advantages and Challenges**

##### **Awards**

**Cum Laude**

#### **TEACHING POINTS**

• PET/MRI has better soft tissue resolution and lower radiation dose than PET/CT. • PET/MRI is a one-stop-shop that may decrease the number of anesthesia events and patient visits to complete imaging work-up. • PET/MRI provides simultaneous anatomic and functional images, facilitating both initial staging and restaging of various oncologic conditions.

#### **TABLE OF CONTENTS/OUTLINE**

• Introduction of PET/MRI: an overview of technical aspects and protocol • Case-based approach of oncologic pediatric body PET/MRI: advantages and limitations:- Lymphoma: initial staging and follow up- Sarcoma: soft tissue and osseous sarcoma- Predisposing Conditions: malignant transformation in neurofibromatosis- Congenital hyperinsulinism: focal versus diffuse lesions • Case-based approach of PET/MRI in pediatric neuro-oncology: advantages and limitations- FDG-PET/MRI: is it a helpful tool?- Amino acid PET: in non-enhancing tumor and anti-angiogenic therapy • Current and future role of PET/MRI in theragnostic (diagnosis and therapy) in pediatric oncology • Conclusions

#### **NMMIEE-24 Bringing PET/MRI into Practice- Challenges and Considerations**

##### **Awards**

**Magna Cum Laude**

Naveen Rajamohan, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Developing a PET/MRI program involves planning for optimal physical layout and incorporation of unique safety considerations. 2) Truly simultaneous PET and MRI data acquisition in modern PET/MRI systems minimize the likelihood of image misregistration and provide more robust anatomic co-localization comparison to PET/CT. 3) Identification of appropriate oncologic and non-oncologic clinical indications, education of referring physicians, development of scheduling, protocoling and image interpretation workflows and dedicated order sets are imperative for successful implementation of a clinical PET/MRI program.



## TABLE OF CONTENTS/OUTLINE

Safety regulations • Facility guidelines and regulatory requirements • Challenges of working in the PET/MRI environment (governance, safety, technologist training, emergency responses, etc.) • Radiotracers in the PET/MRI environment. PET/MR hardware/data acquisition • Hardware components, data acquisition systems • Technical considerations including attenuation correction and image co-registration Indications, imaging findings, programmatic and workflow considerations • Billing challenges and CPT codes • Protocol development, order sets and education of referring physicians • Clinical workflow including protocoling, scheduling, and image interpretation models. Case-based review of oncologic and non-oncologic clinical indications appropriate for PET/MRI including classic imaging findings and pitfalls

### NMMIEE-25 Is There a Role for Radium-223 in the Era of 177Lu PSMA?

Flavia P. Lopes, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In cases of prostate bone metastasis, a destructive cycle of bone formation and resorption occurs, making it imperative for treatment to focus on the microenvironment through various mechanisms. This can be achieved through direct targeting of tumor cells, osteoblasts, osteoclasts, inflammatory cells, and bystander effects, which affect non-irradiated cells in the surrounding area by producing cytokines and growth factors. For patients who have previously received Radium-223, it is possible to administer 177LuPSMA and/or chemotherapy as subsequent treatments. Patients with a good medullary reserve who have shown a positive response to initial treatment may receive additional cycles of Radium-223, as it is well-tolerated with minimal toxicity and effectively controls bone progression. For patients with exclusively bone metastatic prostate cancer, Radium-223 may be initiated to control bone progression when first-line therapy fails to achieve optimal control of disease progression. Subsequently, in the treatment sequence, 177Lu-PSMA may be employed as an effective tool in the management of progressive disease involving bone and soft tissue metastases.

## TABLE OF CONTENTS/OUTLINE

Theranostics in Prostate Cancer: Current Treatment Options Radium-223: Indications and Contraindications Treatment Sequencing: Discussion of Primary Guidelines 177Lu-PSMA and Radium-223: Partners or Competitors?

### NMMIEE-26 DEXA - It's Not Just About the Numbers

Namir Asmar, MBBCHIR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

· To describe the classification, clinical presentation, pathogenesis and management of osteopenia and osteoporosis· To outline indications for performing dual-energy x-ray absorptiometry (DEXA)· To review technical aspects of DEXA· To interpret DEXA outputs including quality assurance and recognition of pitfalls

## TABLE OF CONTENTS/OUTLINE

Background· Epidemiology, clinical presentation, pathogenesis and management of osteopenia and osteoporosis· Classification of bone mineral density· Review of international guidance on DEXA - e.g. American Association of Clinical Endocrinologists consensus statement· Technical aspects of DEXA· Underlying scientific basis· Acquisition parameters· Regions of interest· Outputs including reference standards· Interpretation· Defining Z-scores and T-scores· Monitoring changes in bone mineral density· Fracture risk assessment tool - e.g. FRAX· Clinical application and relevance· Suggested reporting templates· Pearls and pitfalls· Case examples including less typical and challenging scenarios· Summary

### NMMIEE-27 Utility of FDG PET/CT in Pyrexia of Unknown Origin: A Pictorial Essay

Anand A. Zade, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

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## TABLE OF CONTENTS/OUTLINE

Pyrexia of unknown origin (PUO) is defined as fever higher than 38.3 °C/101°F, lasting more than 3 weeks and remaining undiagnosed after 1 week of thorough investigation. Identifying the cause of pyrexia of unknown origin is a clinical challenge. Early identification of source of PUO helps guide further diagnostic invasive procedures and initiation of prompt appropriate treatment. The current diagnostic approach includes initially first-line procedures such as general examination and various laboratory tests and basic imaging techniques followed by second-line tests like FDG PET/CT and tissue biopsies. Conventional imaging modalities can have limited sensitivity Understanding imaging patterns of FDG uptake in common and uncommon causes of PUO helps to accurately identify the potential source. Advantages of 18F-FDG PET/CT as first line modality : high sensitivity, whole body imaging can identify pathologic focus at clinically unsuspected sites, high negative predictive value, can identify the source of infection or inflammation before morphological changes on conventional anatomical imaging techniques, no hazardous manipulation of blood for labeling in WBC imaging, no need for complementary



bone or bone marrow scan, ability to perform quantitative analysis, cost-effective as first line modality. Images attached of Common and uncommon sites detected on FDG PET/CT in PUO: Fig1) infected aortic stent Fig 2) infected central venous catheters Fig 3) Tuberculous Osteomyelitis Fig 4) Renal Mucormycosis Fig 5) Acute Pyelonephritis in Transplant Kidney Fig 6) Tracheobronchitis

## **NMMIEE-28 How to Master Nuclear CSF Imaging: A Comprehensive Guide to Procedures and Interpretation**

### **Awards**

#### **Certificate of Merit**

Megan K. Mercer, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This presentation aims to educate the learner on: 1- Indications and imaging protocol of nuclear CSF imaging (Nuclear cisternography and shuntogram). 2- Patterns of normal and abnormal findings. 3- Complementary role of anatomic imaging (Xray, CT, MRI). 4- Pearls and pitfalls for performing the procedures and imaging interpretation.

#### **TABLE OF CONTENTS/OUTLINE**

1- Nuclear Cisternography: A. Review CSF physiology and the common indications for nuclear cisternography. B. Review Imaging protocol: Patient preparation, radiopharmaceutical, imaging timing, the role of pledgets in cases of CSF leak. C. Review normal and abnormal findings (normal pressure hydrocephalus, spontaneous hypotension, CSF leaks). D. Describe classic signs that are helpful for the interpretation. E. Discuss pitfalls for injection and interpretation and the importance of correlation with anatomic imaging. 2- Nuclear Shuntogram: A. Present a background on hydrocephalus, different types of CSF shunts, and their complications. B. Review multimodality imaging evaluation of shunts with a focus on nuclear shuntogram. C. Present an overview of the nuclear shuntogram procedure (shunt reservoir access, measuring opening pressure, types of radiopharmaceutical, radiopharmaceutical injection, and imaging protocol). D. Review interpretation checklist (opening pressure, T1/2 clearance, flow into the proximal and distal limbs, documentation of free dispersion). E. Present an algorithmic approach for differentiating normal and abnormal drainage patterns (proximal and distal obstruction, shunt over-drainage, CSF pseudocyst, gravity-dependent drainage). F. Review pitfalls of inappropriate injection and falsely elevated pressure.

## **NMMIEE-29 Hybrid DOTATATE PET/MRI Imaging of the Head and Neck**

Graham C. Keir, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. The superior soft tissue resolution of MRI improves lesion localization and helps to delineate fine anatomic detail. 2. DOTATATE-PET/MRI detects extent of disease and lesions not detected by MRI alone. 3. DOTATATE-PET may improve surveillance and radiation therapy planning. 4. DOTATATE-PET/MRI may detect more lesions than MRI alone, providing valuable genetic information in cases of multiple paragangliomas. 5. DOTATATE PET is useful for determining lesions that may respond to somatostatin analogue therapy.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of Somatostatin Receptor Imaging 2. PET/MRI Fusion Protocols 3. Meningiomas 4. Paragangliomas 5. Olfactor Neuroblastoma (Esthesioneuroblastoma) 6. Pituitary Lesions 7. Conclusion

## **NMMIEE-3 Neo-adjuvant Immune-checkpoint Inhibitors in Lung Cancer - Pearls and Pitfalls in Imaging**

Daria Kifjak, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Neo-adjuvant chemo-immunotherapy results in a high rate of pathologic complete remissions. 2) Residual tumor size and changes (eg., decrease) in tumor size do not necessarily correlate with histopathological response. 3) Metabolic examinations such as [18F]-FDG-PET/CT better assess treatment response compared to morphological changes. 4) Immune mediated increased lymphatic FDG uptake and/or increased lymph node size is called "nodal immune flare".

#### **TABLE OF CONTENTS/OUTLINE**

1) Pathological response patterns in patients with early-stage, non-small cell lung cancer (NSCLC) receiving neo-adjuvant chemo-immune checkpoint inhibitor therapy (ICIT): - Complete pathological response (cPR): no vital tumor cells, - Major pathological response (MPR): =10% vital tumor; 2) Radiological response patterns in patients with early-stage NSCLC receiving neo-adjuvant chemo-ICIT: - Radiological response may be consistent or inconsistent with pathological response, - Some patients with partial radiological response show a poor pathological response compared to others who show a cPR, - Nodal immune flare; 3) Current role of imaging in patients with early-stage, NSCLC receiving neo-adjuvant chemo-ICIT: - CT, - [18F]-FDG-PET/CT, - Limitation and pitfalls; 4) Limitations

## **NMMIEE-30 Nuclear Medicine Lymphoscintigraphy: Established and Emerging Applications with Technical Overview**

### **Awards**

#### **Certificate of Merit**

Saeed Elojeimy, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The goal of this presentation is to educate the learner on: 1- The clinical approach and role of nuclear scintigraphy in the assessment and management of patients with lymphedema. 2- The imaging protocol for performing nuclear scintigraphy. 3- The imaging patterns of normal and abnormal lymphoscintigraphy. 4- The potential limitations of nuclear medicine examinations for lymphedema assessment. 5- The complementary role of nuclear scintigraphy and MR lymphangiography. 6- The treatment options available for patients with lymphedema.

#### **TABLE OF CONTENTS/OUTLINE**

1- Introduction a. Review the epidemiology and pathophysiology of lymphedema. b. Review the clinical approach to the diagnosis of lymphedema, as well as the role of nuclear lymphoscintigraphy in evaluating these patients. 2- Review Lymphoscintigraphy protocols: a. Patient preparation, radiopharmaceutical, imaging timing, and areas of interest. 3- Review how to evaluate lymphoscintigraphy examinations. a. Provide examples of normal and abnormal lymphoscintigraphy studies (unilateral or bilateral, upper or lower extremity), lymphatic malformations, and lymphatic leak (recurrent chylous ascites or pleural effusions). b. Provide MR lymphangiography correlative features for lymphoscintigraphy to highlight the strengths, limitations, and complementary roles of both modalities. 4- Emerging applications, treatments, and future directions

## **NMMIEE-31 PET/MRI: Pictorial Review of Hepatobiliary and Pancreatic Applications**

Malak Itani, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

PET/MRI combines physiologic information with superior soft-tissue contrast resolution from MRI, improving assessment of the following hepatopancreaticobiliary diseases:(1) Biliary: assess disease severity, screen for cholangiocarcinoma, delineate local tumor extent and regional spread, and assess treatment response.(2) Hepatic metastases: detecting metastases and evaluating response to treatment.(3) Hepatocellular carcinoma: Y-90 PET/MRI dosimetry, extrahepatic metastases.(4) Pancreatic neoplasms: characterization and local staging, assessing spread to lymph nodes, metastatic disease in the liver, and assessing treatment response.(5) Liver transplant: detecting recurrent HCC, recurrent sclerosing cholangitis, and post-transplant lymphoproliferative disorder.

#### **TABLE OF CONTENTS/OUTLINE**

(1) Hepatobiliary PET/MRI techniques, clinical workflow, and reimbursement issues.(2) Applications:(A) Neoplastic evaluation: (i) Cholangiocarcinoma. (ii) Metastatic liver disease. (iii) Hepatocellular carcinoma. (iv) Pancreatic ductal adenocarcinoma. (v) Pancreatic neuroendocrine neoplasms.(B) Differentiating tumor from non-neoplastic processes:(i) Infectious: Cholangitis, hepatic abscesses. (ii) Inflammatory: Risk-stratifying benign versus malignant biliary strictures. (iii) Post-treatment: Perilesional hemorrhage/necrosis versus residual/recurrent tumor. (iv) Problem solving after locoregional therapy. (v) Follow-up of liver transplant.(3) Emerging tracers and advanced applications.

## **NMMIEE-32 Patterns of Response and Progression on Post-treatment SPECT/CT Scans in Patients Treated with Lu-177-PSMA**

Ridvan A. Demirci, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

With the wider availability of Lu-177-psma therapy, imaging of this population became more important. Post-treatment imaging with SPECT/CT is a helpful tool for response assessment by providing functional and anatomical imaging information. This educational exhibit aims to present certain response and progression patterns in post-treatment SPECT/CT scans.

#### **TABLE OF CONTENTS/OUTLINE**

Non-contrast enhanced CT portion of SPECT/CT needs to be closely reviewed for monitoring of low or no PSMA-expressing disease (defined as lesional uptake equal or less than liver), particularly in the liver, and temporal changes of the osseous disease on CT in relation to intensity of PSMA expression. In addition, patterns of response or progression could be used for clinical decision-making. Below, is the summary of patterns. 1. Response Patterns a. Rapid Response (Rapid decline in disease burden before 4 cycles of treatment) b. Slow Response (Continued response after 4 cycles of treatment) c. Stable Disease 2. Progression Patterns a. Primary Progression (Progression without initial response) i. Increased burden of preexisting disease (bone, soft tissue or both) ii. New lesions (PSMA avid, non or low PSMA avid either in bone or soft tissues) b. Secondary Progression (after initial response) i. Increased burden of preexisting disease (bone, soft tissue or

both) ii. New lesions (PSMA avid, non or low PSMA avid either in bone or soft tissues) 3. Mixed Pattern a. Non-uniform response pattern: While being responsive in certain sites/organs, showing progression in other sites/organs.

### **NMMIEE-33 Evolving role of PETCT in Systemic Vasculitis**

Vani Vijayakumar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Learn different Systemic Vasculitides Different PET CT Scoring systems Role of PET CT in Treatment response

#### **TABLE OF CONTENTS/OUTLINE**

Large vessel vasculitis (LVV) and medium-sized vessel vasculitis such as giant cell arteritis (GCA) and Takayasu arteritis (TAK) are three common autoimmune systemic Vasculitides. 18F-FDG PET visual and semiquantitative criteria has been proposed. A standardized 4-point visual grading scale (arterial to liver uptake) is recommended with grade 0, no uptake; grade 1, uptake lower than liver; grade 2, uptake similar to liver; and grade 3, uptake higher than liver. Grade 3 is considered positive for LVV, whereas grade 2 may be indicative of LVV. In addition, a quantitative composite score, based on the visual grading scale of several individual arterial segments (typically between 7 and 15 segments), known as PET vascular activity score (PETVAS). PETVAS provides an overall assessment of disease burden, with little interobserver variability, in evaluating treatment response. 18F-FDG uptake in cranial arteries are scored as 3-point visual grading (0-2), with grade 0 representing uptake not above the surrounding tissue, grade 1 uptake just above the surrounding tissue, and grade 2 uptake significantly above the surrounding tissue. In PMR, The PET CT Leuven score is the best validated one, with sensitivity of 89.6% and specificity of 93.3%. The Leuven score is the summed score of visual 18F-FDG uptake at the cervical and lumbar interspinous bursae, sternoclavicular joints, ischial tuberosities, greater trochanters, hips, and shoulders. 18F-FDG PET/CT plays a role in diagnostic and therapeutic monitoring of patients with vasculitides and PMR.

### **NMMIEE-34 Avoid False Positives with Quantitation and Tc 99m Pyrophosphate (Pyp) SPECT with CT Fusion in ATTR Cardiac Amyloidosis (ATTR- CA)**

Vani Vijayakumar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Update on the role of Pyp Imaging cardiac amyloidosis - How to improve Image interpretation with SPECT and CT fusion - Correlate with Anatomic imaging with CT And MRI - Quantitative SPECT Parameters SUV and advanced metrics

#### **TABLE OF CONTENTS/OUTLINE**

Transthyretin (ATTR) cardiac amyloidosis (CA) is a form of heart failure (HF) in the elderly representing approximately 13% to 18% with preserved ejection fraction (HFpEF). Until recently, ATTR-CA was very underdiagnosed. Due to advances in cardiac scintigraphy using the old Bone radiotracer Tc 99m Pyrophosphate single-photon emission computed tomography [SPECT], there is increased awareness to diagnose ATTR -CA. In addition there have been new ATTR stabilizing and silencing medications currently being available for use. Because of these rapid advances in diagnostic and therapeutic approaches, ATTR-CA, once known as a rare and progressive disorder, now can be accurately diagnosed and treated in the elderly with HFpEF. Whole heart SPECT/CT absolute quantification shows strong correlation with the visual Perugini score and high diagnostic performance with SUVmax cut-off of more than 6.1. Specificity of this approach can be increased to 99% by ruling out elevated monoclonal proteins. 99mTc-DPD and 99mTc-PYP, are the most common cardiac scintigraphy agents used for the diagnosis of ATTR- CA. Planar scintigraphy with SPECT can help with more detailed assessment of the myocardial radiotracer uptake. In addition, Fusion with cardiac CT or MRI improves the correct interpretation avoiding false positives due to blood pool activity. In addition Quantitative measures may help early diagnosis. Risk assessment and therapy response.

### **NMMIEE-35 Lymphoscintigraphy of Lymphedema**

Sara Babapour, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Definition and pathophysiology of lymphedema. 2. Progressive clinical signs in lymphedema and correlating imaging stages. 3. How different lymphoscintigraphic techniques (agents, planar imaging, and SPECT) can be helpful for defining lymphatic function. 4. How to plan treatment based on imaging. 5. Describe post-treatment findings in lymphoscintigraphy.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction to Lymphedema 1.Primary 2.Secondary 3.Treatment options for lymphedema Lymphoscintigraphy Technique 1.Tracer types 2.Imaging protocols 3.Equipment Lymphoscintigraphy signs 1.Normal 2.Early lymphedema 3.Severe lymphedema 4.Correlation with other imaging techniques and clinical measures Post-treatment Lymphoscintigraphy monitoring 1.Lymphovenous bypass 2.Fat debulking 3.Lymph node transplant Current Research and Innovations in Lymphoscintigraphy, Summary

### **NMMIEE-36 PET-CT Goes Large: Its Main Role in Large-vessel Vasculitis**

Collada, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. To review the leading role of PET-CT in large-vessel systemic vasculitis. 2. To describe our experience in a tertiary hospital during the last 5 years.

### TABLE OF CONTENTS/OUTLINE

PET-CT is the best imaging technique in large-vessel vasculitis. Metabolic findings may suggest the diagnosis of cranial and large vessel-giant cell arteritis (C-GCA and LV-GCA) or Takayasu arteritis (TAK), the latter often affecting carotid, renal and mesenteric branches. Sensitivity/specificity for them are around 80%. In addition, PET-CT may detect features of polymyalgia rheumatica (PMR) (by means of Leuven score); and helps differentiating perivascular or atherosclerotic inflammation from "true" vasculitis. Metabolic activity (assessed using Meller scale) and extent diminish with treatment response, although it remains challenging to differentiate remission from smoldering mild disease. From 2018 to 2023 we performed 5082 PET-CT, 41 positive for vasculitis in diagnostic or follow-up stage: 71% women, mean age 70; 63% were GCA, the rest of them TAK, aortitis and one Behçet's disease. PET-CT diagnosis was definitive in 61%, only half the cases of GCA needing confirmatory biopsy. MRI was also used. The majority of GCA associated PMR clinical diagnosis, though just 30% had PET-CT signs. During follow-up, 52% had significant response on PET-CT, most of them complete. However, 40% didn't have pre-treatment PET-CT available. In conclusion, regarding our experience and the literature published to date, we deduce that PET-CT stands out as the main technique to assess large-vessel vasculitis, allowing accurate diagnosis, assessment of comorbid disorders and follow-up.

### NMMIEE-37 Radiotheranostics for Prostate Cancer Management: a New and Evolving Standard of Care

Moozhan Nikpanah, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Radiotheranostics, which combines diagnostic and therapeutic capabilities, is changing the clinical management of prostate cancer. Radiopharmaceuticals, specifically prostate-specific membrane antigen (PSMA)-targeting tracers, play a vital role not only in initial diagnosis, staging, and detecting biochemical recurrence of prostate cancer, but also in targeted therapy. Cutting-edge imaging and therapeutic applications of radiotheranostics, such as <sup>177</sup>Lu-PSMA-617, are improving patient outcomes. Additionally, there are a number of clinical trials investigating the expanding use of PSMA-based radiopharmaceuticals and other targeted radionuclide therapies. The objective of this educational exhibit is to familiarize radiology and nuclear medicine physicians and trainees with the pivotal role of radiopharmaceuticals in the management of prostate cancer.

### TABLE OF CONTENTS/OUTLINE

1) Overview of prostate cancer (PCa). 2) Concise review of radiotracers used for initial diagnosis, staging, and biochemical recurrence of PCa, with a focus on PSMA ligands. 3) PSMA PET imaging for PCa: 3a) Application of PSMA PET for treatment guidance and management: implications and considerations. 3b) Pitfalls of PSMA PET imaging. 4) Radioligands and radiopharmaceuticals: advanced imaging and therapeutic applications: 4a) <sup>68</sup>Ga-PSMA-11. 4b) <sup>18</sup>F-DCFPyL (Piflufolastat F-18). 4c) <sup>177</sup>Lu-PSMA-617. 4c-i) Clinical applications and ongoing challenges. 4c-ii) Predictive biomarkers for assessing efficacy of <sup>177</sup>Lu-PSMA therapy. 4d) <sup>223</sup>Ra-Dichloride. 5) Conclusion and future directions.

### NMMIEE-38 Multimodality Imaging of Epstein-Barr Virus-Associated Diseases with Emphasis on PET/CT

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To review the spectrum of diseases associated with Epstein-Barr virus (EBV), including infectious mononucleosis, lymphoproliferative diseases, malignancies, and systemic autoimmune diseases. To present the multimodality imaging of the EBV-associated disease spectrum, with emphasis on F-18 FDG PET/CT in the initial staging and subsequent evaluation of therapeutic response.

### TABLE OF CONTENTS/OUTLINE

Epstein-Barr virus (EBV) is an oncogenic herpesvirus that infects over 90% of the population worldwide. Although usually asymptomatic, EBV is associated with a wide spectrum of lymphoproliferative diseases and malignancies, especially in patients with immunologic suppression or compromise. EBV has been implicated in the pathogenesis of a variety of diseases, including but not limited to infectious mononucleosis, Burkitt's lymphoma, Hodgkin's and non-Hodgkin's lymphoma, nasopharyngeal carcinoma, gastric carcinoma, post-transplant lymphoproliferative disorders (PTLD), smooth muscle tumors, and autoimmune diseases. While chemotherapy and immunotherapy are therapeutic considerations for many of these diseases, modulation of immunosuppression is considered the first-line management, when applicable, with a regression rate of up to 50%. PET/CT imaging is a critical tool for initial disease staging, assessment of treatment response, and monitoring for disease recurrence. This educational exhibit will (1) review the multimodality imaging features of EBV-associated spectrum of diseases such as infectious mononucleosis, lymphoproliferative diseases, malignancies, and autoimmune diseases and (2) emphasize the role of PET/CT in the detection and surveillance of EBV-associated diseases.

### **NMMIEE-39 Revealing the Hidden Mysteries of the Brain: A Guide to Brain Perfusion Single Photon Emission Computed Tomography (SPECT)**

Tomoki Imokawa, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Single Photon Emission Computed Tomography (SPECT) is one of the nuclear medicine imaging modalities to evaluate cerebral hemodynamics. Cerebral perfusion studies are important in the diagnosis of a variety of diseases. Sometimes, cerebral perfusion studies are the only diagnostic clue. This presentation introduces the use of SPECT in the diagnosis of epilepsy and dementia. We also present cases in which SPECT played a decisive role in the diagnosis of inflammatory diseases and tumors, as well as cases in which SPECT served as an objective indicator of psychiatric symptoms and treatment efficacy. The results of SPECT research have important implications in clinical practice, and the application of its findings to MR perfusion imaging is also expected.

#### **TABLE OF CONTENTS/OUTLINE**

1. Basics of SPECT 2. Epilepsy 3. Neurodegenerative Diseases 4. Cerebrovascular Diseases 5. Tumor 6. Inflammatory Diseases 7. Psychiatric Disorders 8. Others

### **NMMIEE-4 Feasibility of Performing SPECT/CT Imaging on a CZT Scanner to Monitor Lutetium-177-PSMA-617 Therapy**

Aaron Oraham, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Lutetium-177-PSMA-617 (Pluvicto) is a novel radioligand therapy for treatment of metastatic prostate cancer. Current time points for PSMA PET/CT include pre- and post- therapy imaging for patient selection and evaluation of treatment response, respectively. To date, there is no clinical imaging available to monitor the treatment progress during cycles of Pluvicto administration. Current Pluvicto treatment monitoring relies on non-imaging clinical tools, such as PSA levels. Sequential imaging (SPECT/CT) during treatment cycles provides imaging direction to monitor Pluvicto treatment targets and perform organ-based dosimetry. Technical challenges, image quality, and sensitivity of Lu SPECT/CT acquisition will be discussed with its implications in the future of image-guided personalized adaptive dosimetry and diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

F-18 PET/CT diagnostic scan for metastatic prostate cancer. Lutetium-177-PSMA-617 (Pluvicto) treatment of metastatic castration resistant prostate cancer. Use of Lu-177 SPECT/CT for sequential monitoring over Pluvicto treatment cycles. Acquisition of Lu SPECT/CT at 24 hours post cycle 1 of Pluvicto treatment. Evaluation of Pluvicto treatment target with SPECT/CT, avidity for metastatic and primary lesions, sparing of nonaffected essential organs. F-18 PET/CT and Lu SPECT/CT imaging qualitative concordance and discordance. Ongoing feasibility study to perform advanced quantification and dosimetry across treatment duration. Future possibility to tailor Pluvicto treatment and minimize patient risk across treatment cycles.

### **NMMIEE-40 Incremental Value of PET/CT in Identification of Infections Associated with Cardiac Devices**

Matthew Y. Koh, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The diagnosis and anatomic localization of cardiac device-related infections is a presently challenging and clinically relevant topic. Historically, transthoracic and transesophageal echocardiography has been the gold standard of cardiac imaging, however, they are limited in the evaluation of implantable cardiac devices and prostheses, particularly left ventricular assist devices and prosthetic valves. 18F-fluoro-2-deoxyglucose positron emission tomography with CT (FDG PET/CT) has gained increased attention in recent years for the diagnosis of cardiac infections in these select populations. In this educational exhibit, we intend to provide relevant background information on this topic, review the essential components of left ventricular devices and prosthetic valves, outline the current standards regarding cardiac device-related infections, and finally provide cases that demonstrate the utility of FDG PET/CT in imaging cardiac device-related infection in both initial diagnosis and follow-up.

## TABLE OF CONTENTS/OUTLINE

Introduction/Relevant background information. Review of essential components of left ventricular assist devices. Review of prosthetic cardiac valves. Current standards regarding imaging of cardiac device-related infections. Case collection of PET/CT in imaging cardiac device-related infections in initial diagnosis and follow-up. Conclusion/Final points.

### **NMMIEE-41 FDG PET/CT Imaging Pitfalls in Current Era of Immunotherapy: Watch Out for Sarcoid Like Reactions**

Vivek Batra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Recognize the imaging features of sarcoidosis, sarcoid like reaction post immunotherapy on FDG PET/CT. Distinguish between tumor progression vs sarcoid like reaction on FDG PET/CT.

## TABLE OF CONTENTS/OUTLINE

The imaging features of sarcoidosis are diverse and can be shown on a variety of imaging techniques. FDG avidity on PET/CT in patients with sarcoidosis is variable and can mimic malignancies (lymphoma, metastatic disease, post immunotherapy). Sarcoidosis typically demonstrates FDG avid supraclavicular, mediastinal, and bilateral hilar lymph nodes on PET/CT. Biopsy demonstrates non caseating granulomas. Immunologic toxicities in cancer patients are often referred to as immune-related adverse events (irAEs). Among various irAEs, sarcoid-like granulomatous lymphadenopathy occurs in 5% to 7% of patients, and typically presents as asymptomatic mediastinal/hilar lymphadenopathy, sometimes with accompanying multifocal pulmonary nodularity. Resolution or decrease in the original tumor burden on restaging PET/CT, and development of new FDG avid mediastinal/hilar lymphadenopathy in patients receiving immunotherapy indicates probable sarcoid like reaction. Recognition of this pattern of distribution is essential in interpreting the post treatment PET/CT. In equivocal cases, a biopsy or short interval PET scan may be necessary. Using a case based approach, we'll demonstrate PET/CT images of patients with sarcoidosis, evolution of sarcoid like reaction to various immunotherapeutic agents and sarcoid like distribution of metastatic disease.

### **NMMIEE-42 Boning Up on DXA in Adults: A Radiologist's Guide to Interpretation and Quality Control**

#### **Awards**

#### **Certificate of Merit**

Saeed Elojeimy, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1- List DXA indications. 2- Recognize appropriate and inappropriate acquisition techniques. 3- Review the pathologic conditions detectable on DXA. 4- Recognize pitfalls that can arise on DXA and how to troubleshoot.

## TABLE OF CONTENTS/OUTLINE

1- Introduction 2- DXA's role in assessing bone mineral density a. Imaging preparation and technique: Patient preparation, imaging technique (describe when to image spine, hip, and forearm and appropriate techniques for ROI placement) b. Interpretation (Comparative databases, T-score, Z-score) c. Review WHO criteria for diagnosing normal bone density, low bone mass, and osteoporosis d. Fracture Risk Assessment (Role of FRAX and Trabecular bone score) e. Pitfalls (improper positioning, artifacts, incidental findings) 3- DXA's emerging role in evaluating and tracking body lean mass and fat composition (review indications, technique, interpretation, available comparison databases, reporting) 4- Summary

### **NMMIEE-43 18F-FDG PET/CT Focus on Inflammatory-infectious Diseases. Beyond Tumor-related Processes**

Maria J. Baladron, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the applications and importance of non-oncologic 18F-FDG PET-CT in various infectious and inflammatory cases. Demonstrate the utility of 18F-FDG PET/CT in evaluating fever of unknown origin. Case-based review of common and uncommon inflammatory and infectious pathologies, including sarcoidosis, osteomyelitis, spondylodiscitis, and vasculitis, among others. Demonstrate the utility of 18F-FDG PET/CT in evaluating the extension of the disease and treatment response in some of these pathologies. Be aware that these pathologies sometimes are incidental findings in routine oncology follow up.

## TABLE OF CONTENTS/OUTLINE

A brief theoretical basis of PET-CT imaging and mechanism of 18F-FDG interaction with cells. Fever of unknown origin as a clinical entity that benefits from the sensitivity of FDG uptake. Metabolic findings before morphologic variations challenge conventional imaging. Different potential uses of 18F-FDG PET/CT in infectious and inflammatory cases; assessing active inflammation, disease extent, occult disease, treatment response and sometimes determining the most suitable biopsy



site. Display specific FDG18 uptake patterns in rare conditions like recurrent aseptic osteomyelitis. Illustrate cases of incidental inflammatory-infectious finding during oncologic patient evaluation.

## **NMMIEE-44 FDG PET/CT Imaging of Systemic Vasculitis: A Pictorial Review**

### **Awards**

#### **Certificate of Merit**

Masatoshi Hotta, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Vasculitis can be classified into primary or secondary types based on its etiology or by the size of the affected blood vessels according to the Chapel Hill Consensus Conference criteria. As any size of vessel in any organ may be affected, the imaging findings vary widely. The heterogeneous nature of vasculitis poses a diagnostic challenge. The aims of this review are to: 1) present FDG-PET/CT images of primary and secondary systemic vasculitis affecting vessels of various sizes, including large, medium, small, and variable-sized vessels, 2) describe the FDG-PET/CT features of each systemic vasculitis type and discuss non-vascular findings that can aid in the differential diagnosis, and 3) review the role of FDG-PET/CT in the management of systemic vasculitis.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction | 2. Primary vasculitis: a) Large-vessel vasculitis (Takayasu arteritis, giant cell arteritis); b) Medium-vessel vasculitis (polyarteritis nodosa); c) ANCA-associated small-vessel vasculitis (microscopic polyangiitis, granulomatosis with polyangiitis, eosinophilic granulomatosis with polyangiitis); d) Variable-vessel vasculitis (Behçet's disease, Cogan's syndrome). | 3. Secondary vasculitis: a) Vasculitis associated with systemic disease (IgG4-related disease, sarcoidosis, relapsing polychondritis, Erdheim-Chester disease); b) Vasculitis associated with probable etiology (drugs, infection)

## **NMMIEE-45 Transthyretin Cardiac Amyloidosis (ATTR-CM) and Alzheimer's Disease: Is There a Real Correlation or Age-related Specific to Certain Population**

Matin Goldooz, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

-Review the relationship between cerebral amyloidosis (Alzheimer disease) and Transthyretin cardiac amyloidosis (ATTR-CM).  
-Review the imaging technique and radiotracer used for cerebral and cardiac amyloidosis. -Illustrate cases with cardiac and cerebral amyloidosis who presented to our institution

### **TABLE OF CONTENTS/OUTLINE**

The term "cardiac dementia" (ATTR - CM) is referred to heart failure (HF) as a risk factor for Alzheimer disease (AD). It is thought that the correlation between these two entities is through perfusion defects, angiopathy, and inflammation. Some studies suggest that AD is a multiorgan, systemic disease that may contribute to diminished cardiovascular function. Moreover, recent studies have shown common molecular and pathological features in the brain and heart of the patients with AD, including intramyocardial deposits of A $\beta$ . Whether this amount of A $\beta$  deposit can play a role in compromised myocardial function in patients with AD is yet unknown. High A $\beta$  level in the brain is detected on PET imaging. Although the intramyocardial deposits of A $\beta$  are at a much lower concentration than those seen in the brain, cardiac PET imaging with C-PIB, 18F-florbetapir, and 18F-florbetaben can detect light chain and transthyretin amyloidosis and identify cardiac amyloidosis early in the course of the disease. In ATTR-CM, Tc PYP Cardiac SPECT CT improves the differentiation from blood pool and myocardial uptake and decreases false negatives. Alzheimer's disease and heart failure are two common age-related diseases that can coexist. However, whether there is a real correlation between the two is still a subject of debate and more large-scale population studies are being conducted to further investigate this.

## **NMMIEE-46 Preoperative and Postoperative 18F-Choline PET/CT Value in Patients with Primary Hyperparathyroidism**

### **Awards**

#### **Certificate of Merit**

Magali Hovsepian, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To learn about 18F-Choline (FCH) molecule and recognize its physiologic biodistribution, pathological uptake and potential pitfalls.- To understand the acquisition protocol and recognize the importance of early phase PET scan combined with iodine contrast-enhanced CT.- To review current recommendations for the use of FCH PET/CT in patients with primary hyperparathyroidism (PHPT) and related clinical conditions (eg. tertiary hyperparathyroidism, MEN syndromes).

## TABLE OF CONTENTS/OUTLINE

Choline is a chemical precursor for the synthesis of phospholipids that form the cell membrane. Parathyroid (PT) active tissue has a high uptake of FCH due to the upregulation of choline kinase. Hyperparathyroidism causes urinary, bone, neurologic, and gastrointestinal symptoms and complications. Most cases of PHPT are caused by a solitary PT adenoma. Surgery is the appropriate treatment, but the main reasons for surgical failure are ectopic glands and multiple active tissues. Precise preoperative location of PT tissue remains a difficult task with conventional imaging (99Tc-MIBI scan, CT, MRI) and it is more challenging in patients with previous neck surgery. FCH PET/CT has a high sensitivity for preoperative localization of PT adenomas and postoperative search of active PT tissue. FCH PET/CT is becoming a first-line imaging modality for preoperative and postoperative localization of active PT tissue in PHPT patients. Table of Contents- FCH physiologic uptake and normal biodistribution.- Imaging acquisition protocol. - Preoperative and postoperative localization of orthotopic and ectopic active PT tissue. - Recommendations for the use of FCH PET/CT in patients with PHPT. - Illustrative cases.

## NMMIEE-47 Brain Death: Review of Neuroimaging criteria, Techniques and Pitfalls

### Awards

#### Cum Laude

Priya O. Pathak, MBBS, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1) Overview of brain death imaging with a focus on the role of radionuclide perfusion scintigraphy for early and accurate determination of brain death. 2) Review brain death physiology, medical standards, clinical and imaging criteria, confounding variables and inconsistencies in the concept of brain death documentation. 3) Highlight the imaging indications, patient preparation, techniques/protocols, instrumentation, imaging artifacts and pitfalls.

## TABLE OF CONTENTS/OUTLINE

- Introduction: Review of brain death imaging to assist radiologists in performing, interpreting and appropriate reporting of the results for the confirmation of brain death. Outline
- Confirmatory examinations: Includes tests that show absence of brain electrical activity (EEG and somatosensory evoked potentials) and those that evaluate blood flow (radionuclide studies, multivessel angiography, CT/MR angiography).
- Methods of evaluating blood flow: Contrast enhanced angiography, Transcranial Doppler ultrasound, Radionuclide brain flow scintigraphy.
- Review of radionuclides-Tc-99m HMPAO-Tc-99m ECD-Tc-99m DTPA-Tc-99m Glucoheptonate-Tc-99m TcO<sub>4</sub>
- Pitfalls of radionuclide scintigraphy -False positive tracer activity due to infection, tumors, scalp hyperemia due to head trauma, CSF shunts, intracranial pressure transducer.-False negative results due to disruptions in the skull and scalp, as well as pressure on the portion of the scalp resting on a hard surface causing photopenic area on the flow study.

## NMMIEE-48 The Utility of Brain Perfusion Single Photon Emission Computed Tomography (SPECT) in the Assessment of Neurodegenerative Diseases

Tomoki Imokawa, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

SPECT, or Single Photon Emission Computed Tomography, is one of the nuclear medicine imaging modalities to evaluate cerebral hemodynamics. Cerebral perfusion studies contain much information useful for the diagnosis of various diseases, especially neurodegenerative diseases. This presentation will highlight the use of SPECT in the diagnosis of neurodegenerative diseases and other conditions that cause dementia, such as cerebrovascular disease and idiopathic normal pressure hydrocephalus. The findings of SPECT have important clinical implications, and the application of the knowledge to MR perfusion imaging is also expected.

## TABLE OF CONTENTS/OUTLINE

1. The Basics of SPECT 2. Alzheimer's Disease 3, Dementia with Lewy Bodies 4. Frontotemporal Dementia 5. Corticobasal Syndrome 6. Idiopathic Normal Pressure Hydrocephalus 7. Progressive Supranuclear Palsy 8. Multiple System Atrophy 9. Spinocerebellar Ataxia 10. Cerebrovascular Diseases 11. Creutzfeldt-Jakob Disease 12. Others

## NMMIEE-49 Advanced Cancer Imaging with Hyperpolarized<sup>13</sup>C-MRI: Techniques and Applications

Ying-Chieh Lai (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Hyperpolarized carbon-13 MRI (HP 13C-MRI) is a promising metabolic imaging for oncology that employs dynamic nuclear polarization to enhance the polarization of solid-state compounds labeled with carbon-13, increasing signal by up to 50,000-fold, and allowing the detection of the probe and its downstream metabolites using a clinical MRI scanner. 2. HP 13C-MRI using [1-<sup>13</sup>C]pyruvate enables non-invasive and rapid monitoring of the upregulated anaerobic glycolysis in cancer cells. MCT in the cellular membrane enables the uptake of [1-<sup>13</sup>C]pyruvate, which is then converted into [1-<sup>13</sup>C]lactate by LDH or into [1-<sup>13</sup>C]alanine by ALT or into 13C-bicarbonate by PDH. 3. Hyperpolarization is transient and relaxes back to thermal



equilibrium once leaving polarizer, providing an acquisition window of 2-3 minutes. MRI sequences are optimized to utilize the unrecoverable magnetization rapidly and efficiently. 4. Kinetic modeling involves developing a mathematical model that describes the rates at which probes are converted to products, while model-free metrics rely on metabolite ratios. 5. HP 13C-MRI has been applied to prostate cancer, renal cell carcinoma, brain tumors, and breast cancer, showing its potential to distinguish between benign and malignant tumors, determine tumor aggressiveness, monitor response to therapy, and predict patient outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction of HP 13C-MRI. 2. Technical aspects: (a) 13C labeled probes; (b) Probe preparation and pharmacy kit assembly; (c) Hyperpolarization, dissolution, and quality control; (d) Patient injection, imaging acquisition, and data analysis. 3. Clinical applications. 4. Conclusions.

#### **NMMIEE-5 Molecular Imaging of Dementia: A Case-Based Review**

Zhiyang A. Wei, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Introduction: Molecular imaging plays an increasingly important role in the early identification and monitoring of various forms of dementia, as well as in selecting appropriate patients for therapy in these disorders. In this educational exhibit, we aim to review the pathologic basis and salient imaging findings of the most common causes of dementia, drawing on case examples from our institution. Teaching points/ Learning objectives: 1. Understand the basic pathologic processes responsible for the most common neurodegenerative processes as well as their relative prevalence. 2. Learn the normal and abnormal uptake patterns in the brain on various nuclear medicine studies, including FDG PET, amyloid PET, and DaTScan. 3. Learn what further imaging workup would be recommended for indeterminate findings on FDG PET.

#### **TABLE OF CONTENTS/OUTLINE**

Outline: 1. Background of dementia a. Definition b. Review of different neurocognitive domains i. Perceptual-motor function ii. Language iii. Executive function iv. Learning and memory v. Complex attention vi. Social cognition c. Review of the most common causes of dementia and their pathologic basis d. Review of various proteinopathies 2. Review of findings of most common causes of dementia on FDG and amyloid PET as well as DaTScan with associated case examples i. Alzheimer's disease ii. Vascular dementia iii. Mixed dementia iv. Dementia with Lewy Bodies v. Frontotemporal dementia vi. Corticobasal degeneration vii. Creutzfeldt-Jakob disease 3. Imaging using F-18-DOPA in parkinsonism 4. Suggested further workup based on imaging findings 5. Review amyloid and Tau imaging tracers and briefly discuss other functional tracers useful in neurodegenerative diseases

#### **NMMIEE-50 Radiation Safety in Theragnostics: Educational Simulated Real-life Scenarios**

Kip E. Guja, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Theragnostics is a rapidly growing field in nuclear medicine in the era of personalized medicine. Knowledge of radiation safety issues in targeted radionuclide therapies (TRT) is vital for delivering safe and effective patient care, and for maintaining the safety of healthcare workers involved in patient care. The objective of this educational exhibit is to address fundamental issues in radiation safety related to TRT in an engaging way by presenting educational real-life scenarios which may be encountered in a theragnostics clinic.

#### **TABLE OF CONTENTS/OUTLINE**

Educational real-life scenarios to be discussed in this exhibit include: (1) Dose calibrator fails quality control testing, (2) Discrepancy >20% between assayed and prescribed dose, (3) Misadministration of the wrong therapeutic radiopharmaceutical, (4) Preparation of theragnostics treatment room and restroom, and (5) Patients with nephrostomy tubes referred for Lu-177 therapy, (6) Management of Lu-177 radionuclide spill, (7) Management of radioiodine spill (8) Precautions related to liquid I-131 therapy. The appropriate actions/response to each scenario will be summarized.

#### **NMMIEE-51 Prostate Cancer Theragnostics: Review and Early Insights**

Emmanuel Carrodeguas, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the general characteristics of prostate cancer 2. Explore current treatment options and algorithms for prostate cancer, focusing on the increasing role of PSMA theragnostics 3. Establish a framework for the evaluation and selection of patients who would benefit from PSMA RLT 4. Understand the factors behind successful PSMA RLT therapy; including protocols for treatment, side effects/contraindications and the role of imaging/laboratory monitoring during treatment 5. Identify current ongoing research and unanswered questions in the role of PSMA RLT

## TABLE OF CONTENTS/OUTLINE

I. Overview of prostate cancer. Epidemiology, diagnosis, and progressionb. Localized versus metastatic; Castration sensitive versus resistantII. Overview of current treatmenta. Medical and surgicali. Surgery and radiotherapyii. Androgen basediii. Chemotherapyb. Nuclear medicinei. Radium-223ii. 177Lu-PSMA-617III. Overview of 177Lu-PSMA-617a. Mechanism of actionb. Overview of trial results and evidenceIV. Treatment with 177Lu-PSMA-617a. Patient selectioni. Inclusion criteria and contraindicationsii. Choosing between Ra-223 and PSMA RLTb. Treatment protocolsV. Evaluation and monitoring of 177Lu-PSMA-617 treatment responsea. Adverse effects and managementb. SPECT monitoring between cyclesi. Range of responsesii. Imaging monitoring and adjusting therapyc. Criteria for cessation of therapyd. Case based review and examples.VI. Future directions and unanswered questionsa. Review of ongoing trials

## NMMIEE-52 Beyond the Glowing Hues: A Comprehensive Review of False Positive Cases on FDG PET/CT

Kota Yokoyama, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

FDG PET is one of the most widely used nuclear medicine examination in clinical use today, with high detection capability for malignant tumors and inflammatory diseases. On the other hand, its specificity for tumors is not high, making it difficult to distinguish between inflammation and tumors. In addition, with the recent rise in the price of therapeutic drugs, there are more opportunities to use it for treatment response assessment, and it is important to understand the changes that may be encountered after various types of treatment. This section will provide an overview of the physiologic accumulation of FDG PET/CT and the frequently encountered and somewhat rare false-positive cases (non-neoplastic lesions), presenting a wide range of cases from initial presentation to post-treatment.

## TABLE OF CONTENTS/OUTLINE

1. The basics of FDG PET/CT 2. Physiological uptake, Artifacts, reactive change, lipomatous hypertrophy, brown adipose3. Iatrogenic or post-treatment changes: radiation pneumonitis, radiation pulmonary fibrosis, radiation sialadenitis, radiation liver disease, postoperative PPFE, foreign body granuloma, thymic rebound, G-CSF reactive bone marrow, vaccine reactive accumulation, etc.4. Benign lesions: Pituitary adenoma, chronic thyroiditis, hypercellular bone marrow, desmoids, hypercellular bone marrow, etc.5. Inflammatory disease Sarcoidosis/sarcoid-like reaction, vasculitis, IgG4-related disease, Cattleman's disease, TAFRO syndrome, etc.6. Infectious diseases: Tuberculosis, mycosi fungoides, actinomycosis/nocardia, echinococcosis, etc.

## NMMIEE-54 Nuclear Medicine Imaging in Epilepsy: What the Radiologist Needs to Know

Aakanksha Sriwastwa, MD, MBBS (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Nuclear medicine imaging plays an essential role in the evaluation of medically refractory epilepsy patients. For these patients, surgery is effective provided there is a well-delineated epileptogenic focus. 2. Functional imaging methods—SPECT and PET—complement structural imaging, allowing accurate ictal focus localization even in the absence of a structural abnormality. 3. Comparison of ictal and interictal SPECT combined with MRI (SISCOM) increases the sensitivity for epileptogenic focus detection. 4. Interictal F-18 FDG PET helps to lateralize the epileptogenic focus, assess for other abnormalities, and guide further testing in pre-surgical planning. 5. Future endeavors include quantitative analysis improvements, neuroreceptor PET radiotracers, and multimodality imaging integration.

## TABLE OF CONTENTS/OUTLINE

1. Introduction of medically refractory epilepsy. 2. Overview of surgical options. 3. Description of the pre-surgical evaluation process, focusing on ictal and interictal SPECT and interictal FDG PET. 4. Presentation of radiopharmaceuticals and their characteristics. 5. Review of methodology, imaging protocols, and post-processing techniques. • Ictal and interictal SPECT • Interictal F-18 FDG PET 6. Illustration of SPECT and PET usage in ictal focus localization and pre-surgical guidance through a series of commonly encountered pathologies- temporal and extratemporal epilepsy, cortical dysplasia, arteriovenous malformations, encephalocele, tumors. 7. Review of emerging radiopharmaceutical imaging options.

## NMMIEE-55 PSMA Radiotheranostics in Prostate Cancer: Principles, Practice, and Future Prospects

Laszlo Szidonya, MD, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. 177Lu-PSMA is a safe and effective therapy in metastatic castration-resistant prostate cancer. 2. Eligibility for treatment is based on the uptake of lesions on PSMA PET. 3. The degree of uptake on PSMA and FDG PET offers predictive and prognostic information. 4. Post-therapy imaging is important to confirm tumor uptake of the therapeutic agent, monitor response, and identify progressing lesions.

## TABLE OF CONTENTS/OUTLINE

1. Introduction:a. Clinical overview of prostate cancer and treatment options.b. Concept of radiotheranostics.c. Data from the VISION and TheraP trials.2. Current practice:a. Eligibility for treatment.b. Therapy administration and dosing.c. Toxicity and side effects.3. Added value of imaging:a. Prognostic/predictive PET biomarkers:i. Qualitative parameters:1. Level of PSMA uptake relative to liver/spleen and salivary glands.ii. Quantitative parameters:1. Absolute uptake values (e.g. SUVmax).2. Total tumor burden.iii. PSMA/FDG concordance/discordance.b. Post-therapy imaging:i. SPECT quantification to predict response.ii. Detection of disease progression.4. Future directions:a. Timing, sequencing, and dose optimization.b. Potential role of personalized dosimetry.c. Alternative PSMA targeting molecules.d. PSMA therapy using alpha emitters.e. Combination therapy.

### **NMMIEE-56 Improving the Diagnostic Sensitivity of <sup>13</sup>N-Ammonia PET Imaging: Creating Age- and Gender-Matched Normal Databases for Myocardial Flow Reserve Measurements**

Takuji Nanno (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

<sup>13</sup>N-Ammonia myocardial perfusion PET imaging (ammonia PET), is a non-invasive, quantitative imaging method that enables the evaluation of myocardial blood flow (MBF) for detecting myocardial ischemia and assessing disease severity. Myocardial flow reserve (MFR) measurements, obtained by comparing stress and rest MBF ratios, provide important diagnostic and prognostic information for ischemic heart disease. However, clinical interpretation of MFR values depends on the normal population values, and the normal database (NDB) for MFR has not been sufficiently evaluated. Since MFR measurements vary, it is desirable to create age- and gender-matched NDBs for individuals under 70 years old as well as NDB for individuals over 70 years old. By comparing MFR values with the appropriate reference NDB, it is possible to evaluate the severity of ischemia in a more detailed and objective manner. This presentation aims to introduce the methods for creating age- and gender-matched NDBs and their usefulness in clinical cases, thereby improving the diagnostic sensitivity in ammonia PET.

## TABLE OF CONTENTS/OUTLINE

1. Age and Gender Differences in MFR in ammonia PET 2. Creation of age- and gender-matched NDBs for MFR using Syngo MBF software 3. Clinical case 1: Normal perfusion with normal coronary artery 4. Clinical case 2: Mild ischemia with significant stenosis in RCA and D1 5. Clinical case 3: Multi-vessel CAD

### **NMMIEE-57 Nuclear Medicine Lung Perfusion (Q) Imaging: SPECT/CT Indications and Interpretation Pearls and Pitfalls**

Brandon G. Brockbank, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Highlight the PISAPED interpretation criteria for perfusion-only lung scans 2. Understand indications for and utility of SPECT/CT in lung perfusion scans 3. Recognize common pearls and pitfalls in the interpretation of Q scans

## TABLE OF CONTENTS/OUTLINE

1. Perfusion-only lung imaginga. Historic use of V/Q scansb. COVID pandemic and perfusion-only scansc. 2022 Global contrast shortage crisis 2. Interpretation Criteriaa. PISAPED perfusion-only criteriab. PIOPED perfusion-only criteria 3. SPECT/CT Indicationsa. Non-wedge shaped perfusion defectsb. Heterogeneous radiotracer uptake and distribution 4. Case Examplesa. COVID pneumonia with and without pulmonary embolism (PE)b. Emphysema as a mimic of PEC. Bronchopneumonia with and without PED. CTEPH - missed on CTPA and better seen on Q scan. PE with pulmonary infarctf. Pleural effusion masking PE on planar imagesg. Pulmonary masses as a mimic of PEh. Fibrosis as a mimic of PE 5. Teaching Pointsa. Indications and utility of SPECT/CTb. Common pitfalls of interpretation

### **NMMIEE-58 COVID-19 Pandemic and Its Impact on Nuclear Medicine with Teaching Pearls**

Nick Balanda, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

COVID-19 is a multi-systemic viral disease also known as SARS-CoV-2 or severe acute respiratory syndrome coronavirus 2. Worldwide rapid emergence of the COVID-19 pandemic altered the practice of medicine including nuclear medicine. It is considered to be one of the most massive and chaotic challenges confronting global public health of our times. This educational exhibit aims to: 1. Summarize economic impact of COVID 19 in a tertiary care university teaching hospital. 2. Describe the adaptation to the pandemic by modification of various imaging protocols (for example Myocardial perfusion, V/Q scan, scheduling of PET CT after COVID-19 vaccination), highlighting the importance of CT portion of SPECT CT and PET CT, especially for lung findings. 3. Offer Teaching Pearls and a case-based multi-modality correlation of interesting COVID-19-related findings in nuclear medicine and PET CT imaging with a focus on the impact on patient management.

## TABLE OF CONTENTS/OUTLINE

We present 15 interesting COVID-19-related findings in nuclear medicine and PET CT imaging with a focus on the impact on patient management. These cases include incidental findings secondary to vaccination and COVID-19 infection as well as modified imaging protocols and highlight important considerations for radiologists interpreting images in the era of COVID-19.

### **NMMIEE-59 Role of 18F FDG PET CT in Patients with Lymphoma Treated with CAR-T Cell Therapy: Current Concepts**

Vanessa Murad, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Understand the principles and biological effects of CAR-T cell therapy. CAR-T cell therapy is a novel cancer treatment based on the genetic modification of the patient-derived T cells by adding synthetic functional chimeric antigen receptors (CARs), which permit the identification of specific tumor antigens. 18F -FDG PET/CT (=PET CT) is the imaging of choice for pre and post CAR-T cell therapy assessment, in patients with metabolically active lymphomas. 2) Recognize the role of PET CT in pre-therapy assessment. Highly metabolically active disease and high tumor burden at baseline PET CT, are predictors of unfavorable patients' outcomes and risk of therapy related toxicities. 3) Define the optimal timing of PET CT in therapy response assessment, as well as its impact on management (with demonstrative cases). PET CT 1-month after the infusion is the preferable timing for therapy response assessment, and may trigger a possible therapeutic intervention. A few cases of pseudo-progression after therapy have been described; however, all have been during the first few days after the infusion, with complete resolution at 1-month PET/CT. 4) Identify the main toxicities associated with CAR-T cell therapy and the role of PET CT in their evaluation.

## TABLE OF CONTENTS/OUTLINE

1) Introduction to CAR-T cell therapy, brief history and indications. 2) Role of PET CT in CAR-T cell therapy: 2.1) Pre-therapy considerations. 2.2) Post-therapy response assessment: timing, impact and imaging interpretation including pseudo-progression evaluation. Demonstrative cases. 2.3) Evaluation of toxicities during CAR-T cell therapy: Cytokine release syndrome, immune effector cell-associated neurotoxicity syndrome and infection.

### **NMMIEE-6 Acute Adverse Events in Theragnostics: Educational Simulated Real-life Scenarios**

Kip E. Guja, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Theragnostics is a rapidly growing field in nuclear medicine in the era of personalized medicine. Recognizing and appropriately managing acute adverse events associated with targeted radionuclide therapies (TRT) is vital for delivering safe and effective patient care. The objective of this educational exhibit is to highlight management of acute adverse associated with TRT in an engaging way by presenting simulated real-life scenarios which may be encountered in a theragnostics clinic.

## TABLE OF CONTENTS/OUTLINE

Educational simulated real-life scenarios to be discussed in this exhibit include: (1) Extravasation of 177-Lu radionuclide, (2) Management of potential complications associated with amino acid infusion during Lu-177 DOTATATE therapy, (3) Management of carcinoid crisis after Lu-177 DOTATATE therapy, and (4) Mitigation of flare reaction to TRT (5) Management of acute sialadenitis with Lu-177 PSMA-617 therapy. The appropriate actions/response to each scenario will be summarized.

### **NMMIEE-60 Pediatric PET/MRI: The How and Why**

#### **Awards**

#### **Certificate of Merit**

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

#### **TEACHING POINTS**

Since its introduction a decade ago, integrated PET/MRI has been established as a hybrid imaging modality that provides unique diagnostic information. A key application of PET/MRI is pediatric imaging for oncologic, neurologic, inflammatory, and metabolic conditions given its reduced radiation exposure and potential for reduction of administered radiotracer dose. Despite its successful clinical adoption, the availability of PET/MRI for pediatric patients is still limited to larger academic and clinical centers due to high complexity studies which require thorough patient preparation and exam planning, skilled image acquisition and careful image analysis and interpretation. These factors limit the accessibility of PET/MRI not only for imaging specialists in training, but also for experienced radiologists and nuclear medicine physicians. The purpose of this contribution is to provide guidance and the value of pediatric PET/MRI with clinical examples drawn from pediatric PET/MRI programs world-wide.

## TABLE OF CONTENTS/OUTLINE

1. Common clinical indications for PET/MRI in pediatric patients 2. Commonly used PET tracers for these indications 3. PET/MRI instrumentation 4. Patient preparation (patient information, dietary aspects, sedation, anesthesia) 5. Examination planning and protocol definition 6. Examination execution 7. Aspects of image processing 8. Interpretation and reporting 9. Pitfalls and troubleshooting

## NMMIEE-61 Role of FDG PET/CT in Therapeutic Decision Making in Lymphoma

Elena Anigati, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Therapeutic options for lymphoma include chemotherapy, monoclonal antibody therapy, radiation therapy, stem cell transplant and chimeric antigen receptor therapy (CAR-T). FDG PET/CT plays an integral part in therapeutic decision making. 2. Interim FDG PET/CT allows response-adapted treatment with either reduction in the number of chemotherapy cycles or early use of more aggressive treatment. 3. In patients receiving CAR-T, response assessment on FDG PET/CT should be guided by LYRIC response criteria. 4. Interpretation of interim and post treatment FDG PET/CT can be confounded by thymic hyperplasia, infection/inflammation, immune related adverse events, marrow stimulation by granulocyte colony-stimulating factor (G-CSF). 5. FDG PET/CT plays a role in evaluating disease relapse or transformation and provides guide to biopsy.

## TABLE OF CONTENTS/OUTLINE

1. NCCN treatment guidelines- illustrations of role of FDG PET/CT in therapeutic decision making. 2. Overview of CAR-T. 3. Illustrate staging by FDG PET/CT. 4. Illustrate Lugano and LYRIC treatment response criteria for interim and end of treatment FDG PET/CT. 5. Illustrate pitfalls in treatment response assessment- thymic hyperplasia, infection/inflammation, irAEs (immune related adverse events), marrow stimulation by G-CSF. 6. Illustrate role of PET/CT in identifying disease relapse or transformation

## NMMIEE-62 Functional Imaging of Liver and Spleen Using Tc 99m Sulphur Colloid. A Case Based Multi-modality Pictorial Review with Teaching Pearls

Nick Balanda, BSc (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Nuclear Medicine Tc-99m Sulphur colloid liver-spleen scan has declined over recent years, however, it is still very useful in certain specific scenarios where it can be virtually diagnostic or confirmatory. Our case-based educational exhibit aims to: 1. Evaluate functional abnormalities of the liver and spleen based on the location and amount of radiotracer uptake. 2. Review specific scenarios for evaluating intra-pancreatic, left hemi abdominal, mediastinal, and left lung masses by liver spleen scan as questioned on conventional anatomic imaging with multi-modality correlation. 3. Evaluate a few specific space-occupying hepatic and splenic masses with multi-modality correlation. 4. Importance of SPECT CT over planar imaging.

## TABLE OF CONTENTS/OUTLINE

Our case-based educational exhibit includes: Assessment for Hypersplenism in patients with thrombocytopenia, evaluating for cirrhosis, evaluating/confirming the presence of accessory/ectopic splenic tissue, evaluating specific intrapancreatic lesions, Hepatic cysts, hepatic hemangiomas, FNH, splenic infarcts, Budd-Chiari syndrome.

## NMMIEE-63 Pictorial Review of MRI Fused with Somatostatin Receptor PET Tracers in Meningiomas: Does the Integration of Molecular and Anatomic Imaging Impact Clinical Management

### Awards

#### Certificate of Merit

Julio C. Marin Concha, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Physiologic avidity of somatostatin receptor PET tracers is minimal in the brain parenchyma, providing an excellent tumor background ratio (TBR), unlike FDG PET. 2. Somatostatin receptor PET assists in targeting meningiomas in complex anatomic regions such as the skull base and identifying additional sites. 3. MRI fused somatostatin receptor PET allows for distinguishing enhancing scar tissue from meningiomas. 4. Somatostatin receptor PET impacts clinical and radiation therapy (RT) management leading to changes in the clinical approach and/or modifications in radiation treatment volumes. 5. Somatostatin receptor PET has potential in neurotheranostics to provide diagnostic imaging to guide molecular therapeutic radionuclides, such as <sup>177</sup>Lutetium-DOTATATE.

## TABLE OF CONTENTS/OUTLINE

1. General considerations: § Imaging evaluation of intracranial meningiomas in NM and anatomic modalities § Review the mechanism of Somatostatin Receptor Targeted PET Imaging 2. Integration of PET and imaging guided therapy: Radiotherapy

fundamentals.3. Cased-based approach of impact on patient's treatment decisions.4. Somatostatin receptor PET pitfalls: What you need to know?Summary: Our preliminary experience of MRI fused with somatostatin receptor PET has shown to enhance identification of disease extent compared to MRI only, especially in patients with prior treatments and extracranial components, impacting management decisions and providing information for potential radionuclide targeted therapy.

### **NMMIEE-64 Radiotheranostics in Prostate Cancer: Current Practice and Future Outlook**

Daniel Kwon, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Next generation radiotheranostics are effective in patients with prostate cancer, with studies supporting imaging- and treatment-based on the molecular determinants of patient's disease2. Prostate-specific membrane antigen (PSMA)-targeted radiotheranostics represent the frontier of this paradigm, with PSMA-targeted imaging showing superiority compared to conventional imaging for staging and monitoring patients during therapy3. <sup>177</sup>Lu-based PSMA-targeted and <sup>223</sup>Ra radioligand therapy are effective in metastatic prostate cancer, and multiple clinical trials are exploring further indications4. Dosimetry will personalize doses per patient to maximize therapeutic benefit while minimizing toxicity5. Other radioisotopes (e.g. <sup>225</sup>Ac, <sup>161</sup>Tb) and molecular targets (e.g. gastrin-releasing peptide receptor (GRPR)) are being explored for radiotheranostic applications in prostate cancer

#### **TABLE OF CONTENTS/OUTLINE**

- Overview of prostate cancer: current diagnosis and treatment
- Introduction to radiotheranostics: common theranostic radioisotopes and their selection
- PSMA-targeted imaging and radioligand therapy: recent trial data, indications, clinical pearls, image-guided monitoring, and case examples
- Radium-223: indications, clinical pearls, and case examples in bone metastases in prostate cancer
- Dosimetry: principles and applications for personalized radioligand therapy
- The Future: Ongoing PSMA-targeting radiotheranostic clinical trials, emerging theranostic radioisotopes and radiotheranostic agents (e.g. GRPR)
- Conclusions and Summary

### **NMMIEE-65 18F-FDG PET/CT: Least Useful to Most Important Imaging Modality for Evaluation of Prostate Cancer**

Lewen Stempler, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the roles and mechanism of PSMA and FDG PET/CT imaging in evaluating prostate cancer at different stages of the disease.2. When reading PSMA PET/CT scans, interpreters should always correlate with clinical history such as PSA level, disease stage, and prior treatments. If PSMA positive lesions are not in proportion to high PSA level or if lesions are only seen on CT without PSMA avidity, think of transformation of prostatic adenocarcinoma (CRPC-Adeno) to treatment-induced neuroendocrine prostate cancer (t-NEPC). Consider <sup>18</sup>F-FDG PET/CT for further evaluation. In some cases, <sup>68</sup>Ga-DOTATATE PET/CT may be helpful.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction2. Case examples3. Educational objectives4. Summary

### **NMMIEE-7 Perineural Tumoral Spread- A Search Pattern for PET Scan Readers**

Deepashri Basavalingu, MD,MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Perineural tumor spread is the macroscopic analogue of perineural tumor invasion. 2. F-18 FDG PET CT is often used in staging and response assessment in head and neck malignancies and has an important role in identification of perineural tumor spread.3. Familiarity with relevant cranial and peripheral nerve anatomy, pattern of perineural tumor spread and associated PET imaging appearance will lead to improved detection of this important prognosticating factor.4. FDG uptake resulting from postsurgical and postradiotherapy inflammation in addition to other infectious and inflammatory causes may lead to false positive cases mimicking perineural tumor spread.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background- what's in a name- perineural tumor spread versus perineural tumor invasion.2. Overview of relevant cranial nerve and peripheral nerve anatomy.3. Pathophysiology of perineural tumor invasion and perineural tumor spread.4. Tumor types, sites, and clinical presentation of perineural tumor spread.5. Case based review of PET patterns of perineural tumor spread in the head and neck.6. Other usual and unusual locations for perineural tumor spread on PET imaging.7. Search pattern for peritumoral spread for PET scan readers.8. Imaging differentials for consideration and false positives. 9. Prognosis and treatment considerations in patients with perineural tumor spread.

### **NMMIEE-8 Imaging Appearances of Large Vessel Vasculitis on 18F-FDG PET/CT: The Dark, the Bright, and the In-between**



Lahoud, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- 18F- FDG PET/CT can be used in the diagnostic evaluation of vasculitis, to determine the distribution of involvement, the activity status of the disease, and to assess treatment response.
- Where possible, CT angiography should be added to 18F- FDG PET/CT as it not only improves diagnostic accuracy but can identify frequent complications such as aneurysm formation or vascular dissection.
- PET vascular activity score (PETVAS) is a grading system that provides qualitative and quantitative assessment.
- Limitations include superficial cranial vessel involvement, extensive atherosclerosis, and persistent uptake in remission limiting the use of PET/CT for routine follow-up.
- Systemic rheumatologic conditions, including Erdheim Chester and IgG4 Related Disease can have secondary involvement of the large vessels, mimicking a large vessel vasculitis. It is important to recognize their distinguishing features and patterns of involvement on 18F- FDG PET/CT.

### TABLE OF CONTENTS/OUTLINE

1. Introduction to Large Vessel Vasculitis: a. GCA and PMR b. Takaysu's 2. Role of PET/CT in the Evaluation of LVV a. Disease activity b. Extent of involvement c. Biopsy Target d. Response Assessment 3. PET/CT protocol a. General patient preparation b. Impact of glucocorticoids c. Incubation time d. Contemporaneous CT angiogram 4. Common Imaging Appearances of LVV on PET/CT a. GCA pre and post therapy b. Takayasu's c. TIPIC variant of GCA 5. Differential Considerations a. Erdheim Chester b. IgG4 related disease 6. Diagnostic Accuracy of PET/CT

### NMMIEE-9 Epilepsy Beyond HARNESS-MRI Protocol through Hybrid PET-MRI and Advanced MRI Imaging

Piedad A. Acosta Mora, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- To learn the causes of drug-resistant epilepsy and structural alterations in neuroimaging.- To recognize the spectrum of MRI sequences optimized for epilepsy and to implement the use of HARNESS MRI protocol.- To review advanced neuroimaging techniques (functional, metabolic, post-processing.) and to explain the utility in the drug-resistant epilepsy - To evaluate the clinical impact of hybrid FDG -PETMRI in decision-making in drug-resistant epilepsy- To understand how hybrid imaging with PETMRI optimizes the subtle epileptogenic lesions detections and improves postsurgical seizure outcome.

### TABLE OF CONTENTS/OUTLINE

1.Introduction2.Classification of seizure types3.Causes of drug-resistant epilepsy 4.MRI sequences optimized for epilepsy - HARNESS MRI protocol5.Advanced neuroimaging techniques - BOLD- MRI functional - Texture analysis - Spectroscopy - Diffusion tensor imaging (DTI) and fiber tractography 6.Role of hybrid FDG-PETMRI in epilepsy - Indications - Preparation - Technique and recommendations for acquisition - Normal patterns of brain FDG uptake - Cortical analysis 7.Case-based learning 8.Conclusions

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## Abstract Archives of the RSNA, 2023

NMMIEE-1

### **What Radiologists Need to Know About Immune-related Adverse Events: Clinical Significance of FDG-PET/CT Diagnosis of Immune-related Adverse Events**

All Day Room: Learning Center

Mana Ishibashi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Immune-related adverse events (IrAE) are common in patients receiving immune checkpoint inhibitors. Frequency varies by molecular target of the agent in use, with irAE of any grade reported approximately 80-90%. Pneumonitis, hypothyroidism, arthralgias, and cutaneous reactions are most often seen with PD-1/PD-L1 inhibitors, and colitis and hypophysitis with CTLA-4 inhibitors. FDG-PET/CT is used to assess the malignancy; it is also able to detect tissue inflammation, one of the hallmarks of IrAE. This unique ability sets FDG-PET/CT apart from CT and MRI and potentially enables the early identification and therapeutic intervention in patients with IrAE prior to their developing clinical symptoms. Depending on the site, particularly in lymph nodes, an IrAE-related uptake may mimic metastases or disease progression.

#### **TABLE OF CONTENTS/OUTLINE**

1. Basic information about immune checkpoint inhibitors  
2. The mechanism of autoimmune-reactions in patients receiving immune checkpoint inhibitors  
3. FDG-PET/CT findings of irAE  
4. Differential diagnosis of irAE and other pathologies

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## Abstract Archives of the RSNA, 2023

NMMIEE-10

### Imaging of Thyroid Cancer Post-thyroidectomy: Primer for Radiologists

All Day Room: Learning Center

Wei Ming Chua, FRCR, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Differentiated thyroid cancer (DTC) arising from thyroid follicular epithelial cells, comprising > 90% of all thyroid cancers. 2. After thyroidectomy, depending on post-operative risk stratification, the primary goal of radioactive iodine (RAI) can include remnant ablation, adjuvant therapy or treatment of known disease. A whole-body scan performed following administration of therapeutic RAI identifies the presence of iodine-avid thyroid tissue, both normal and malignant, allowing staging of the disease. 3. Cervical ultrasound is recommended for surveillance of the thyroid bed and regional lymphadenopathy post-thyroidectomy. 4. Serum Thyroglobulin (Tg) and anti-Tg antibodies are important in the follow-up of these patients; rising levels would warrant further evaluation with RAI imaging. 5. 18FDG-PET scanning should be considered in high-risk DTC with elevated serum Tg but negative RAI imaging. Alternatives would include CT imaging of the chest and if negative CT imaging of the abdomen.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of differentiated thyroid cancer 2. Goals of treatment, including the role of radioactive iodine 3. Basics of Thyroglobulin and anti-Thyroglobulin interpretation for monitoring for thyroid cancer recurrence/disease 4. Common sites of disease recurrence and metastasis 5. Role of US and other imaging modalities (RAI, CT, MRI, PET/CT) in the follow-up of thyroid cancer 6. Spectrum of imaging appearances on the various modalities after primary treatment of thyroid cancer 7. Important imaging pitfalls leading to diagnostic errors and misinterpretation

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## Abstract Archives of the RSNA, 2023

NMMIEE-11

### Imaging of Dementias using 18F-FDG PET: Unique and Overlapping Features

All Day Room: Learning Center

Rita Maria Lahoud, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Establishing a specific diagnosis in cases of dementia may be challenging as symptoms and features often overlap. Characteristic metabolic patterns on 18F-FDG PET, in concert with clinical features, aid in reaching an accurate and timely diagnosis.
- Technical considerations and proper patient preparation are necessary to minimize confounders.
- Alzheimer's dementia represents the most common neurodegenerative process encountered on PET/CT and manifests with regional hypometabolism of the posterior temporoparietal regions and cingulate gyrus, although there are variations and overlap with other neurodegenerative processes.
- Reduced radiotracer uptake predominantly involves the frontal and anterior temporal lobes in frontotemporal dementia.
- In Lewy body dementia, the occipital cortex is mainly affected with sparing of the posterior cingulate gyrus, "the cingulate island sign".
- Asymmetric cortical involvement and decreased uptake in the basal ganglia and thalami are characteristic of corticobasal degeneration.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to Dementias a. Alzheimer's b. Frontotemporal c. Lewy Body d. Posterior Cerebral Atrophy e. Corticobasal Degeneration f. NMDA Encephalitis  
2. 18F-FDG PET in the evaluation of dementias a. Rationale for use b. Normal brain metabolic patterns c. Patient preparation and technique  
3. Metabolic pattern interpretation: a. Unique and overlapping imaging patterns b. Confounding factors

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## Abstract Archives of the RSNA, 2023

NMMIEE-12

### Hybrid Imaging in Infective Endocarditis

All Day Room: Learning Center

Antonio R. Lopez, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Infective endocarditis (IE) is a serious infection of the heart valves caused by microorganisms, resulting in inflammation and potential complications such as heart failure, stroke, or sepsis. IE is typically diagnosed using the modified Duke criteria, which examines pathologic and clinical criteria; however, due to a variety in presentation and complicating patient factors, I remains a diagnostic challenge. Patients with prosthetic valves (PV) or intracardiac devices (ICD) are at a higher risk for IE, are more difficult to diagnose with IE, and have higher mortality than patients without these cardiac interventions. Combination of cardiac CT and FDG-PET/CT is currently being investigated for adjunct use in I diagnosis in this patient population, which preliminary data shows improve diagnostic accuracy. Here we examine the use of FDG-PET and cardiac CT in diagnosing I in patients with PV and ICD, including a discussion on common cardiac and non-cardiac manifestations of IE on imaging and an examination of its role in future diagnostic algorithms.

#### TABLE OF CONTENTS/OUTLINE

Describe current diagnostic methods for IE. Examine the use of Cardiac CT and PET/CT in I diagnosis for patients with PV and ICD, including key imaging features. Discuss the future incorporation of hybrid imaging in I diagnosis.

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## Abstract Archives of the RSNA, 2023

NMMIEE-13

### **Theory into Action: A Step-by-Step Guide to Interpreting Scintigraphy Images for Sentinel Node Assessment**

All Day Room: Learning Center

Juan A. Tempra SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Review the basics of the sentinel node and its importance in the diagnosis and staging in cancer.-Describe the technique and methods of optimizing the procedure and the resulting images.-Illustrate different imaging patterns and their clinical significance.-Learn the limitations and pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

-Introduction.-Sentinel lymph node Scintigraphy: principles and technique.-Interpretation of sentinel lymph node mapping images.-Advantages and limitations.-Conclusions.

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## Abstract Archives of the RSNA, 2023

NMMIEE-14

### Findings of Primary and Secondary Breast Malignancies on Dotatate PET/CT

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Lauren C. Hubbard, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review somatostatin receptor-based PET imaging and normal distribution. Positive radiotracer uptake in the breast on Dotatate PET can be seen with metastatic neuroendocrine tumors. Metastatic neuroendocrine tumors to the breast can result in corresponding mammogram findings indistinguishable from a primary breast malignancy. Primary breast malignancies can also demonstrate positive Dotatate PET uptake due to variable somatostatin receptor expression. Invasive lobular carcinoma can demonstrate low to absent abnormal uptake on FDG-PET/CT, but can demonstrate positive uptake on Dotatate-PET/CT.

#### TABLE OF CONTENTS/OUTLINE

a. Review of somatostatin receptor-based PET imaging and normal distribution. b. Case presentations of 5 cases of dotatate PET findings of primary and secondary breast malignancies i. A case of biopsy-proven incidentally discovered invasive ductal carcinoma on Dotatate-PET/CT for evaluation of metastatic neuroendocrine tumor. ii. A case of incidentally discovered invasive lobular carcinoma on Dotatate-PET/CT for metastatic neuroendocrine tumor with comparison to FDG- and 18F-Fluoroestradiol-PET/CT. iii. A case of neuroendocrine tumor metastases to the bilateral breasts with corresponding mammographic findings. iv. A case of neuroendocrine tumor metastases to the left breast with additional systemic sites of metastatic disease. v. A case of bilateral dotatate PET avid breast lesions, histologically proven to be atypical carcinoid tumors of the breast. c. Conclusions/Future Directions

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## Abstract Archives of the RSNA, 2023

NMMIEE-15

### **PET-CT 18F-FES: Selecting Patients Who Will Benefit from Endocrine Therapy**

All Day Room: Learning Center

Victor M. Osaki, BMedSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Invasive lobular carcinoma (ILC), the second-most prevalent invasive breast cancer subtype comprising approximately 15% of breast cancers;
- ILC is nearly always (95%) estrogen receptor (ER) positive;
- The determination of ER expression by immunohistochemistry has several limitations;
- PET-CT with 18F-fluoroestradiol (PET-FES) has emerged as a diagnostic method that allows evaluating the ER expression status of breast cancer lesions in a non-invasive way;
- Patients with estrogen receptor positive breast cancer benefit from endocrine therapy by blocking these receptors on tumor cells, preventing tumor progression. Some patients, though, have immunohistochemistry showing positive receptors and PET-CT with 18F-FES with lesions not showing uptake. In these cases we suppose the estrogen receptors are non-functioning ones and, therefore, patient will not benefit from endocrine therapy.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction;
- Objective;
- Discussion;
- Clinical and epidemiologic aspects;
- Show cases that are functioning estrogen receptor positive and non-functioning estrogen receptor;
- Discuss endocrine therapy in non-functioning ER+ cancer;
- Take home messages;
- References.

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## Abstract Archives of the RSNA, 2023

NMMIEE-16

### The Value of 18F-FDG-PET-CT in the Management of Head and Neck Tumors

All Day Room: Learning Center

Salome Kukava, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To understand the role of 18F-FDG PET CT in the diagnosis, staging, treatment response assessment and radiotherapy treatment planning in head and neck tumors.

#### TABLE OF CONTENTS/OUTLINE

18F-FDG PET-CT is a widely used diagnostic tool in the evaluation of head and neck squamous cell cancers. It is at least as sensitive as MRI or CT in detecting the primary head and neck tumors, but there is no clear evidence of routine use in T staging, due to low spatial resolution and the presence of physiologic uptake on PET. The meta-analysis shows 18F-FDG PET-CT has high sensitivity (79%) and specificity (86%) for N staging, being superior to CT and MRI. For distant spread and second primary cancer detection, 18F-FDG PET-CT may be superior to whole body MRI, while both have high NPV. For the detection of synchronous primary tumor the pooled sensitivity and specificity is above 95%. The meta-analysis of 27 studies shows the high rate of detection of recurrence or residual tumor with 18F-FDG PET-CT (PPV-75 %, NPV-94%). Performed 12 months after therapy for detection of recurrence, the sensitivity and specificity has been reported as high as 100%. The recent response evaluation criteria-so called Hopkins criteria-has high NPV and is characterized by high inter-reader agreement. PET-CT based contouring during radiotherapy treatment planning is more accurate than CT based contouring in terms of gross tumor volume (GTV). Recent advances in hybrid imaging of head and neck tumors include the introduction of integrated PET MRI systems. Studies have shown the intratumoral heterogeneity of FDG uptake, as well as PET-derived volumetric parameters, such as MTV and TLG to be important prognostic factors for disease recurrence, progression and survival.

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## Abstract Archives of the RSNA, 2023

NMMIEE-17

### **PET-CT 18F-FES: The Use in Clinical Practice in One of the Largest Private Health Centers in Brazil**

All Day Room: Learning Center

Victor M. Osaki, BMedSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- PET-Fluorestradiol (FES) is a type of Positron Emission Tomography (PET) imaging agent used to detect estrogen receptor-positive (ER+) breast cancer. FES is a synthetic form of estrogen that has been radiolabeled with a positron-emitting isotope, the fluorine-18;
- When 18F-FES is injected into the body, it binds to estrogen receptors on breast cancer cells, allowing PET imaging to detect the presence and location of these cancer cells;
- PET-FES imaging can provide valuable information to healthcare professionals about the extent of ER+ breast cancer, as well as guide treatment decisions;
- PET-FES has emerged as a diagnostic method that allows evaluating the ER expression status of breast cancer lesions in a non-invasive way;
- In addition to breast cancer, PET-FES imaging has also been used in research to investigate other estrogen-receptor positive cancers, such as ovarian and endometrial cancer.

#### **TABLE OF CONTENTS/OUTLINE**

- Clinical and epidemiologic aspects;
- Show the possible applications of PET-CT with 18F-FES and show its applicability in clinical practice in our hospital.
- Take home messages;
- References.

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## Abstract Archives of the RSNA, 2023

NMMIEE-18

### Gallium-68 DOTATATE PET for the Imaging of Non-Gastrointestinal Neoplasm: A Review

All Day Room: Learning Center

Amar Shah, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Somatostatin-receptor analogue based imaging, including Gallium(Ga)-68 DOTATATE PET/CT, has long played a central role in the evaluation of gastroenteropancreatic neuroendocrine tumor. However, Ga-68 DOTATATE has a variety of clinical applications beyond this, both in oncologic pathologies. In this exhibit, we aim to review Ga-68 DOTATATE physiology and its use beyond gastroenteropancreatic neuroendocrine tumor. 1. Review physiology of Ga68-DOTATATE distribution and uptake. 2. Catalogue non-gastrointestinal uses, both oncologic and nononcologic, of Ga-68 DOTATATE based imaging. 3. Highlight pitfalls of Ga68-DOTATATE imaging.

#### TABLE OF CONTENTS/OUTLINE

1. Review normal Ga-68 DOTATATE distribution and mechanism of uptake. 2. Non-gastrointestinal tumoral indications. a. Meningioma b. Medullary thyroid cancer c. Paraganglioma d. Phosphaturic mesenchymal tumor e. Pulmonary carcinoid 3. Pitfalls of Ga-68 DOTATATE PET/CT.

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## Abstract Archives of the RSNA, 2023

NMMIEE-19

### **FDG PET/CT in Evaluation of Cardiac Device Infections: What an Imager Should Know**

All Day Room: Learning Center

Wenhui Zhou, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

FDG PET/CT is increasingly utilized for the diagnosis and evaluation of cardiac device infections. The objective of this case-based educational exhibit is to 1) review established and emerging applications of FDG PET/CT in the diagnosis of cardiac device infections 2) review protocols and guidelines for integrating FDG PET/CT in the diagnosis of cardiac device infections 3) highlight interpretation criteria, pearls, and pitfalls of FDG PET/CT for cardiac device infections. Implementing this knowledge is important to avoid errors and provide accurate imaging interpretation for cardiac device infection.

#### **TABLE OF CONTENTS/OUTLINE**

The most demonstrative cases of cardiac device infections noted on FDG PET/CT performed at our tertiary care academic institution for evaluation of cardiac device infections were selected to highlight the teaching points for this exhibit, including: 1) cardiac implantable electronic device (CIED) infection 2) left ventricular assist device (LVAD) infection 3) prosthetic valve endocarditis. We will summarize take-home points to facilitate transfer of knowledge.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE-2

### Skeletal Muscle Uptake in FDG-PET: Physiology and Pathology, Pearls and Pitfalls

All Day Room: Learning Center

Jessica L. Dobson, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

<sup>18</sup>F-fluorodeoxyglucose (FDG)-PET is commonly used in oncology, and while key for staging may also reveal nonspecific findings related to any number of neoplastic, infectious, and inflammatory etiologies. Despite the ubiquity of FDG-PET, intense skeletal muscle uptake remains an uncommon and sometimes unexpected finding. Patterns of uptake are often similar between vastly different entities, and the interpreting physician must be familiar with these entities to provide a useful diagnosis or differential. This exhibit will review a series of local cases demonstrating skeletal muscle FDG uptake and discuss the clinical and imaging context leading to the diagnosis, with the goal of conveying an understanding of skeletal muscle uptake on FDG-PET and considerations to provide a relevant differential diagnosis and advise on appropriate next steps.

#### TABLE OF CONTENTS/OUTLINE

1. Overview normal physiologic distribution of FDG; 2. Review the biochemical basis of physiologic and pathologic skeletal muscle FDG uptake; 3. Discuss the differential considerations for skeletal muscle uptake, including physiologic, inflammatory, infectious, and neoplastic etiologies, and possible mimics of skeletal muscle uptake on FDG-PET; 4. Analyze local cases of skeletal muscle uptake with emphasis on imaging patterns and clinical indicators guiding diagnosis.

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## Abstract Archives of the RSNA, 2023

NMMIEE-21

### PSMA PET/CT and Spectrum of Nonprostatic Disease

All Day Room: Learning Center

Qiubai Li (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Prostate-specific membrane antigen (PSMA) based radiopharmaceutical 18F-PSMA and 68Ga-PSMA for imaging of prostate cancer.
- PSMA PET/CT plays a key role in diagnosis, staging and evaluation of treatment response of prostate cancer
- PSMA uptake on PET/CT can be divided into prostatic disease and nonprostatic disease. Comparison between cytoplasmic PSMA expression in nonprostatic disease and apical PSMA expression in prostate cancer can help to differentiate these conditions.
- The purpose of this presentation is to introduce of spectrum of nonprostatic disease on PSMA PET/CT which may be interpreted as metastatic disease.
- Recognizing the false positive imaging findings can help narrow the differential diagnosis and triage appropriate patient care

#### TABLE OF CONTENTS/OUTLINE

- PSMA uptake and CNS disease
- PSMA uptake and PNS disease
- PSMA uptake and lacrimal gland disease
- PSMA uptake and thyroid disease
- PSMA uptake and inflammatory/inflammatory disease
- PSMA uptake and lung disease
- PSMA uptake and liver disease
- PSMA uptake and kidney disease
- PSMA uptake and adrenal gland disease
- PSMA uptake and bone disease
- PSMA uptake and chronic lymphocytic leukemia

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## Abstract Archives of the RSNA, 2023

NMMIEE-22

### **FDG PET: Not Just a One-trick Pony: Non-oncologic Uses of FDG PET Imaging**

All Day Room: Learning Center

Patrick Handwork, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to:- Understand the underlying physiologic mechanism of FDG PET and conventional clinical applications- Discuss non-oncologic pathologies that can be evaluated on FDG PET, including those which may mimic other neoplastic processes.- Examine the pros and cons of utilizing FDG PET versus conventional imaging modalities in non-oncologic applications.

#### **TABLE OF CONTENTS/OUTLINE**

Mechanism of Action of FDG PET  
Head and Neck applications- Seizures- Dementia/neurocognitive disease- Differentiating CNS lymphoma versus toxoplasmosis  
Chest and Cardiac applications- Sarcoidosis- Evaluating for hibernating myocardium- Cardiac/pericardiac infection myocarditis- Incidental infection/inflammation, including organizing pneumonia  
Abdominal- Infection in polycystic liver or kidney disease- Infection in mucinous peritoneal carcinomatosis- Autoimmune pancreatitis/ IgG4 related disease- Incidental infection/inflammation including: inflammatory bowel disease, hepatitis, pyelonephritis  
Vascular- Aortitis vasculitis- Inflammatory plaques- Incidental findings including: endoleak and deep vein thrombosis  
Musculoskeletal- Chronic recurrent multifocal osteomyelitis (CRMO) synovitis, acne, pustulosis, hyperostosis, and osteitis (SAPHO) syndrome- Non-post-operative spinal infections- Peripheral bone osteomyelitis- Septic arthritis  
Multisystem- Sarcoidosis, tuberculosis, granulomatous infections- Non-Langerhans cell histiocytosis- Fever of unknown origin neoplastic mimics- Sequelae of endocarditis- HIV/Covid reactive adenopathy reactive adenopathy

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## Abstract Archives of the RSNA, 2023

NMMIEE-23

### Why PET/MRI in Pediatric Oncology? A Pictorial Review of Advantages and Challenges

All Day Room: Learning Center

#### Awards

Cum Laude

#### TEACHING POINTS

- PET/MRI has better soft tissue resolution and lower radiation dose than PET/CT.
- PET/MRI is a one-stop-shop that may decrease the number of anesthesia events and patient visits to complete imaging work-up.
- PET/MRI provides simultaneous anatomic and functional images, facilitating both initial staging and restaging of various oncologic conditions.

#### TABLE OF CONTENTS/OUTLINE

- Introduction of PET/MRI: an overview of technical aspects and protocol
- Case-based approach of oncologic pediatric body PET/MRI: advantages and limitations:- Lymphoma: initial staging and follow up- Sarcoma: soft tissue and osseous sarcoma- Predisposing Conditions: malignant transformation in neurofibromatosis- Congenital hyperinsulinism: focal versus diffuse lesions
- Case-based approach of PET/MRI in pediatric neuro-oncology: advantages and limitations- FDG-PET/MRI: is it a helpful tool?- Amino acid PET: in non-enhancing tumor and anti-angiogenic therapy
- Current and future role of PET/MRI in theragnostic (diagnosis and therapy) in pediatric oncology
- Conclusions

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## Abstract Archives of the RSNA, 2023

NMMIEE-24

### Bringing PET/MRI into Practice- Challenges and Considerations

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Naveen Rajamohan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Developing a PET/MRI program involves planning for optimal physical layout and incorporation of unique safety considerations. 2) Truly simultaneous PET and MRI data acquisition in modern PET/MRI systems minimize the likelihood of image misregistration and provide more robust anatomic co-localization comparison to PET/CT. 3) Identification of appropriate oncologic and non-oncologic clinical indications, education of referring physicians, development of scheduling, protocoling and image interpretation workflows and dedicated order sets are imperative for successful implementation of a clinical PET/MRI program.

#### TABLE OF CONTENTS/OUTLINE

Safety regulations • Facility guidelines and regulatory requirements • Challenges of working in the PET/MRI environment (governance, safety, technologist training, emergency responses, etc.) • Radiotracers in the PET/MRI environment. PET/MR hardware/data acquisition • Hardware components, data acquisition systems • Technical considerations including attenuation correction and image co-registration Indications, imaging findings, programmatic and workflow considerations • Billing challenges and CPT codes • Protocol development, order sets and education of referring physicians • Clinical workflow including protocoling, scheduling, and image interpretation models. Case-based review of oncologic and non-oncologic clinical indications appropriate for PET/MRI including classic imaging findings and pitfalls

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE-25

### Is There a Role for Radium-223 in the Era of <sup>177</sup>Lu PSMA?

All Day Room: Learning Center

Flavia P. Lopes, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In cases of prostate bone metastasis, a destructive cycle of bone formation and resorption occurs, making it imperative for treatment to focus on the microenvironment through various mechanisms. This can be achieved through direct targeting of tumor cells, osteoblasts, osteoclasts, inflammatory cells, and bystander effects, which affect non-irradiated cells in the surrounding area by producing cytokines and growth factors. For patients who have previously received Radium-223, it is possible to administer <sup>177</sup>LuPSMA and/or chemotherapy as subsequent treatments. Patients with a good medullary reserve who have shown a positive response to initial treatment may receive additional cycles of Radium-223, as it is well-tolerated with minimal toxicity and effectively controls bone progression. For patients with exclusively bone metastatic prostate cancer, Radium-223 may be initiated to control bone progression when first-line therapy fails to achieve optimal control of disease progression. Subsequently, in the treatment sequence, <sup>177</sup>Lu-PSMA may be employed as an effective tool in the management of progressive disease involving bone and soft tissue metastases.

#### TABLE OF CONTENTS/OUTLINE

Theranostics in Prostate Cancer: Current Treatment Options Radium-223: Indications and Contraindications Treatment Sequencing: Discussion of Primary Guidelines <sup>177</sup>Lu-PSMA and Radium-223: Partners or Competitors?

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## Abstract Archives of the RSNA, 2023

NMMIEE-26

### **DEXA - It's Not Just About the Numbers**

All Day Room: Learning Center

Namir Asmar, MBBCHIR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

· To describe the classification, clinical presentation, pathogenesis and management of osteopenia and osteoporosis· To outline indications for performing dual-energy x-ray absorptiometry (DEXA)· To review technical aspects of DEXA· To interpret DEXA outputs including quality assurance and recognition of pitfalls

#### **TABLE OF CONTENTS/OUTLINE**

Background· Epidemiology, clinical presentation, pathogenesis and management of osteopenia and osteoporosis· Classification of bone mineral density· Review of international guidance on DEXA - e.g. American Association of Clinical Endocrinologists consensus statementTechnical aspects of DEXA· Underlying scientific basis· Acquisition parameters· Regions of interest· Outputs including reference standardsInterpretation· Defining Z-scores and T-scores· Monitoring changes in bone mineral density· Fracture risk assessment tool - e.g. FRAX· Clinical application and relevance· Suggested reporting templates· Pearls and pitfallsCase examples including less typical and challenging scenariosSummary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE-27

### Utility of FDG PET/CT in Pyrexia of Unknown Origin: A Pictorial Essay

All Day Room: Learning Center

Anand A. Zade, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

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#### TABLE OF CONTENTS/OUTLINE

Pyrexia of unknown origin (PUO) is defined as fever higher than 38.3 °C/101°F, lasting more than 3 weeks and remaining undiagnosed after 1 week of thorough investigation. Identifying the cause of pyrexia of unknown origin is a clinical challenge. Early identification of source of PUO helps guide further diagnostic invasive procedures and initiation of prompt appropriate treatment. The current diagnostic approach includes initially first-line procedures such as general examination and various laboratory tests and basic imaging techniques followed by second-line tests like FDG PET/CT and tissue biopsies. Conventional imaging modalities can have limited sensitivity Understanding imaging patterns of FDG uptake in common and uncommon causes of PUO helps to accurately identify the potential source. Advantages of 18F-FDG PET/CT as first line modality : high sensitivity, whole body imaging can identify pathologic focus at clinically unsuspected sites, high negative predictive value, can identify the source of infection or inflammation before morphological changes on conventional anatomical imaging techniques, no hazardous manipulation of blood for labeling in WBC imaging, no need for complementary bone or bone marrow scan, ability to perform quantitative analysis, cost-effective as first line modality. Images attached of Common and uncommon sites detected on FDG PET/CT in PUO: Fig1) infected aortic stent Fig 2) infected central venous catheters Fig 3) Tuberculous Osteomyelitis Fig 4) Renal Mucormycosis Fig 5) Acute Pyelonephritis in Transplant Kidney Fig 6) Tracheobronchitis

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## Abstract Archives of the RSNA, 2023

NMMIEE-28

### How to Master Nuclear CSF Imaging: A Comprehensive Guide to Procedures and Interpretation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Megan K. Mercer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This presentation aims to educate the learner on: 1- Indications and imaging protocol of nuclear CSF imaging (Nuclear cisternography and shuntogram). 2- Patterns of normal and abnormal findings. 3- Complementary role of anatomic imaging (Xray, CT, MRI). 4- Pearls and pitfalls for performing the procedures and imaging interpretation.

#### TABLE OF CONTENTS/OUTLINE

1- Nuclear Cisternography: A. Review CSF physiology and the common indications for nuclear cisternography. B. Review Imaging protocol: Patient preparation, radiopharmaceutical, imaging timing, the role of pledgets in cases of CSF leak. C. Review normal and abnormal findings (normal pressure hydrocephalus, spontaneous hypotension, CSF leaks). D. Describe classic signs that are helpful for the interpretation. E. Discuss pitfalls for injection and interpretation and the importance of correlation with anatomic imaging. 2- Nuclear Shuntogram: A. Present a background on hydrocephalus, different types of CSF shunts, and their complications. B. Review multimodality imaging evaluation of shunts with a focus on nuclear shuntogram. C. Present an overview of the nuclear shuntogram procedure (shunt reservoir access, measuring opening pressure, types of radiopharmaceutical, radiopharmaceutical injection, and imaging protocol). D. Review interpretation checklist (opening pressure, T1/2 clearance, flow into the proximal and distal limbs, documentation of free dispersion). E. Present an algorithmic approach for differentiating normal and abnormal drainage patterns (proximal and distal obstruction, shunt over-drainage, CSF pseudocyst, gravity-dependent drainage). F. Review pitfalls of inappropriate injection and falsely elevated pressure.

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## Abstract Archives of the RSNA, 2023

NMMIEE-29

### Hybrid DOTATATE PET/MRI Imaging of the Head and Neck

All Day Room: Learning Center

Graham C. Keir, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The superior soft tissue resolution of MRI improves lesion localization and helps to delineate fine anatomic detail.2. DOTATATE-PET/MRI detects extent of disease and lesions not detected by MRI alone.3. DOTATATE-PET may improve surveillance and radiation therapy planning.4. DOTATATE-PET/MRI may detect more lesions than MRI alone, providing valuable genetic information in cases of multiple paragangliomas.5. DOTATATE PET is useful for determining lesions that may respond to somatostatin analogue therapy.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of Somatostatin Receptor Imaging2. PET/MRI Fusion Protocols3. Meningiomas4. Paragangliomas5. Olfactor Neuroblastoma (Esthesioneuroblastoma)6. Pituitary Lesions7. Conclusion

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## Abstract Archives of the RSNA, 2023

NMMIEE-3

### Neo-adjuvant Immune-checkpoint Inhibitors in Lung Cancer - Pearls and Pitfalls in Imaging

All Day Room: Learning Center

Daria Kifjak, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Neo-adjuvant chemo-immunotherapy results in a high rate of pathologic complete remissions. 2) Residual tumor size and changes (eg., decrease) in tumor size do not necessarily correlate with histopathological response. 3) Metabolic examinations such as [18F]-FDG-PET/CT better assess treatment response compared to morphological changes. 4) Immune mediated increased lymphatic FDG uptake and/or increased lymph node size is called "nodal immune flare".

#### TABLE OF CONTENTS/OUTLINE

1) Pathological response patterns in patients with early-stage, non-small cell lung cancer (NSCLC) receiving neo-adjuvant chemo-immune checkpoint inhibitor therapy (ICIT): - Complete pathological response (cPR): no vital tumor cells, - Major pathological response (MPR): =10% vital tumor; 2) Radiological response patterns in patients with early-stage NSCLC receiving neo-adjuvant chemo-ICIT: - Radiological response may be consistent or inconsistent with pathological response, - Some patients with partial radiological response show a poor pathological response compared to others who show a cPR, - Nodal immune flare; 3) Current role of imaging in patients with early-stage, NSCLC receiving neo-adjuvant chemo-ICIT: - CT, - [18F]-FDG-PET/CT, - Limitation and pitfalls; 4) Limitations

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## Abstract Archives of the RSNA, 2023

NMMIEE-30

### **Nuclear Medicine Lymphoscintigraphy: Established and Emerging Applications with Technical Overview**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Saeed Elojeimy, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The goal of this presentation is to educate the learner on: 1- The clinical approach and role of nuclear scintigraphy in the assessment and management of patients with lymphedema. 2- The imaging protocol for performing nuclear scintigraphy. 3- The imaging patterns of normal and abnormal lymphoscintigraphy. 4- The potential limitations of nuclear medicine examinations for lymphedema assessment. 5- The complementary role of nuclear scintigraphy and MR lymphangiography. 6- The treatment options available for patients with lymphedema.

#### **TABLE OF CONTENTS/OUTLINE**

1- Introduction a. Review the epidemiology and pathophysiology of lymphedema. b. Review the clinical approach to the diagnosis of lymphedema, as well as the role of nuclear lymphoscintigraphy in evaluating these patients. 2- Review Lymphoscintigraphy protocols: a. Patient preparation, radiopharmaceutical, imaging timing, and areas of interest. 3- Review how to evaluate lymphoscintigraphy examinations. a. Provide examples of normal and abnormal lymphoscintigraphy studies (unilateral or bilateral, upper or lower extremity), lymphatic malformations, and lymphatic leak (recurrent chylous ascites or pleural effusions). b. Provide MR lymphangiography correlative features for lymphoscintigraphy to highlight the strengths, limitations, and complementary roles of both modalities. 4- Emerging applications, treatments, and future directions

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## Abstract Archives of the RSNA, 2023

NMMIEE-31

### **PET/MRI: Pictorial Review of Hepatobiliary and Pancreatic Applications**

All Day Room: Learning Center

Malak Itani, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

PET/MRI combines physiologic information with superior soft-tissue contrast resolution from MRI, improving assessment of the following hepatopancreaticobiliary diseases: (1) Biliary: assess disease severity, screen for cholangiocarcinoma, delineate local tumor extent and regional spread, and assess treatment response. (2) Hepatic metastases: detecting metastases and evaluating response to treatment. (3) Hepatocellular carcinoma: Y-90 PET/MRI dosimetry, extrahepatic metastases. (4) Pancreatic neoplasms: characterization and local staging, assessing spread to lymph nodes, metastatic disease in the liver, and assessing treatment response. (5) Liver transplant: detecting recurrent HCC, recurrent sclerosing cholangitis, and post-transplant lymphoproliferative disorder.

#### **TABLE OF CONTENTS/OUTLINE**

(1) Hepatobiliary PET/MRI techniques, clinical workflow, and reimbursement issues. (2) Applications: (A) Neoplastic evaluation: (i) Cholangiocarcinoma. (ii) Metastatic liver disease. (iii) Hepatocellular carcinoma. (iv) Pancreatic ductal adenocarcinoma. (v) Pancreatic neuroendocrine neoplasms. (B) Differentiating tumor from non-neoplastic processes: (i) Infectious: Cholangitis, hepatic abscesses. (ii) Inflammatory: Risk-stratifying benign versus malignant biliary strictures. (iii) Post-treatment: Perilesional hemorrhage/necrosis versus residual/recurrent tumor. (iv) Problem solving after locoregional therapy. (v) Follow-up of liver transplant. (3) Emerging tracers and advanced applications.

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## Abstract Archives of the RSNA, 2023

NMMIEE-32

### Patterns of Response and Progression on Post-treatment SPECT/CT Scans in Patients Treated with Lu-177-PSMA

All Day Room: Learning Center

Ridvan A. Demirci, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

With the wider availability of Lu-177-psma therapy, imaging of this population became more important. Post-treatment imaging with SPECT/CT is a helpful tool for response assessment by providing functional and anatomical imaging information. This educational exhibit aims to present certain response and progression patterns in post-treatment SPECT/CT scans.

#### TABLE OF CONTENTS/OUTLINE

Non-contrast enhanced CT portion of SPECT/CT needs to be closely reviewed for monitoring of low or no PSMA-expressing disease (defined as lesional uptake equal or less than liver), particularly in the liver, and temporal changes of the osseous disease on CT in relation to intensity of PSMA expression. In addition, patterns of response or progression could be used for clinical decision-making. Below, is the summary of patterns. 1. Response Patterns a. Rapid Response (Rapid decline in disease burden before 4 cycles of treatment) b. Slow Response (Continued response after 4 cycles of treatment) c. Stable Disease 2. Progression Patterns a. Primary Progression (Progression without initial response) i. Increased burden of preexisting disease (bone, soft tissue or both) ii. New lesions (PSMA avid, non or low PSMA avid either in bone or soft tissues) b. Secondary Progression (after initial response) i. Increased burden of preexisting disease (bone, soft tissue or both) ii. New lesions (PSMA avid, non or low PSMA avid either in bone or soft tissues) 3. Mixed Pattern a. Non-uniform response pattern: While being responsive in certain sites/organs, showing progression in other sites/organs.

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## Abstract Archives of the RSNA, 2023

NMMIEE-33

### Evolving role of PETCT in Systemic Vasculitis

All Day Room: Learning Center

Vani Vijayakumar, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Learn different Systemic Vasculitides Different PET CT Scoring systems Role of PET CT in Treatment response

#### TABLE OF CONTENTS/OUTLINE

Large vessel vasculitis (LVV) and medium-sized vessel vasculitis such as giant cell arteritis (GCA) and Takayasu arteritis (TAK) are three common autoimmune systemic Vasculitides. 18F-FDG PET visual and semiquantitative criteria has been proposed. A standardized 4-point visual grading scale (arterial to liver uptake) is recommended with grade 0, no uptake; grade 1, uptake lower than liver; grade 2, uptake similar to liver; and grade 3, uptake higher than liver. Grade 3 is considered positive for LVV, whereas grade 2 may be indicative of LVV . In addition, a quantitative composite score, based on the visual grading scale of several individual arterial segments (typically between 7 and 15 segments), known as PET vascular activity score (PETVAS). PETVAS provides an overall assessment of disease burden, with little interobserver variability, in evaluating treatment response. 18F-FDG uptake in cranial arteries are scored as 3-point visual grading (0-2), with grade 0 representing uptake not above the surrounding tissue, grade 1 uptake just above the surrounding tissue, and grade 2 uptake significantly above the surrounding tissue In PMR, The PET CT Leuven score is the best validated one, with sensitivity of 89.6% and specificity of 93.3%. The Leuven score is the summed score of visual 18F-FDG uptake at the cervical and lumbar interspinous bursae, sternoclavicular joints, ischial tuberosities, greater trochanters, hips, and shoulders. 18F-FDG PET/CT plays a role in diagnostic and therapeutic monitoring of patients with vasculitidis and PMR.

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## Abstract Archives of the RSNA, 2023

NMMIEE-34

### **Avoid False Positives with Quantitation and Tc 99m Pyrophosphate (Pyp) SPECT with CT Fusion in ATTR Cardiac Amyloidosis (ATTR- CA)**

All Day Room: Learning Center

Vani Vijayakumar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Update on the role of Pyp Imaging cardiac amyloidosis - How to improve Image interpretation with SPECT and CT fusion - Correlate with Anatomic imaging with CT And MRI - Quantitative SPECT Parameters SUV and advanced metrics

#### **TABLE OF CONTENTS/OUTLINE**

Transthyretin (ATTR) cardiac amyloidosis (CA) is a form of heart failure (HF) in the elderly representing approximately 13% to 18% with preserved ejection fraction (HFpEF). Until recently, ATTR-CA was very underdiagnosed. Due to advances in cardiac scintigraphy using the old Bone radiotracer Tc 99m Pyrophosphate single-photon emission computed tomography [SPECT], there is increased awareness to diagnose ATTR -CA. In addition there have been new ATTR stabilizing and silencing medications currently being available for use. Because of these rapid advances in diagnostic and therapeutic approaches, ATTR-CA, once known as a rare and progressive disorder, now can be accurately diagnosed and treated in the elderly with HFpEF. Whole heart SPECT/CT absolute quantification shows strong correlation with the visual Perugini score and high diagnostic performance with SUVmax cut-off of more than 6.1. Specificity of this approach can be increased to 99% by ruling out elevated monoclonal proteins. 99mTc-DPD and 99mTc-PYP, are the most common cardiac scintigraphy agents used for the diagnosis of ATTR- CA. Planar scintigraphy with SPECT can help with more detailed assessment of the myocardial radiotracer uptake. In addition, Fusion with cardiac CT or MRI improves the correct interpretation avoiding false positives due to blood pool activity. In addition Quantitative measures may help early diagnosis. Risk assessment and therapy response.

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## Abstract Archives of the RSNA, 2023

NMMIEE-35

### Lymphoscintigraphy of Lymphedema

All Day Room: Learning Center

Sara Babapour, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Definition and pathophysiology of lymphedema. 2. Progressive clinical signs in lymphedema and correlating imaging stages. 3. How different lymphoscintigraphic techniques (agents, planar imaging, and SPECT) can be helpful for defining lymphatic function. 4. How to plan treatment based on imaging. 5. Describe post-treatment findings in lymphoscintigraphy.

#### TABLE OF CONTENTS/OUTLINE

Introduction to Lymphedema 1.Primary 2.Secondary 3.Treatment options for lymphedema Lymphoscintigraphy Technique 1.Tracer types 2.Imaging protocols 3.Equipment Lymphoscintigraphy signs 1.Normal 2.Early lymphedema 3.Severe lymphedema 4.Correlation with other imaging techniques and clinical measures Post-treatment Lymphoscintigraphy monitoring 1.Lymphovenous bypass 2.Fat debulking 3.Lymph node transplant Current Research and Innovations in Lymphoscintigraphy, Summary

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## Abstract Archives of the RSNA, 2023

NMMIEE-36

### **PET-CT Goes Large: Its Main Role in Large-vessel Vasculitis**

All Day Room: Learning Center

Javier Collada, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the leading role of PET-CT in large-vessel systemic vasculitis. 2. To describe our experience in a tertiary hospital during the last 5 years.

#### **TABLE OF CONTENTS/OUTLINE**

PET-CT is the best imaging technique in large-vessel vasculitis. Metabolic findings may suggest the diagnosis of cranial and large vessel-giant cell arteritis (C-GCA and LV-GCA) or Takayasu arteritis (TAK), the latter often affecting carotid, renal and mesenteric branches. Sensitivity/specificity for them are around 80%. In addition, PET-CT may detect features of polymyalgia rheumatica (PMR) (by means of Leuven score); and helps differentiating perivascular or atherosclerotic inflammation from "true" vasculitis. Metabolic activity (assessed using Meller scale) and extent diminish with treatment response, although it remains challenging to differentiate remission from smoldering mild disease. From 2018 to 2023 we performed 5082 PET-CT, 41 positive for vasculitis in diagnostic or follow-up stage: 71% women, mean age 70; 63% were GCA, the rest of them TAK, aortitis and one Behçet's disease. PET-CT diagnosis was definitive in 61%, only half the cases of GCA needing confirmatory biopsy. MRI was also used. The majority of GCA associated PMR clinical diagnosis, though just 30% had PET-CT signs. During follow-up, 52% had significant response on PET-CT, most of them complete. However, 40% didn't have pre-treatment PET-CT available. In conclusion, regarding our experience and the literature published to date, we deduce that PET-CT stands out as the main technique to assess large-vessel vasculitis, allowing accurate diagnosis, assessment of comorbid disorders and follow-up.

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## Abstract Archives of the RSNA, 2023

NMMIEE-37

### Radiotheranostics for Prostate Cancer Management: a New and Evolving Standard of Care

All Day Room: Learning Center

Moozhan Nikpanah, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiotheranostics, which combines diagnostic and therapeutic capabilities, is changing the clinical management of prostate cancer. Radiopharmaceuticals, specifically prostate-specific membrane antigen (PSMA)-targeting tracers, play a vital role not only in initial diagnosis, staging, and detecting biochemical recurrence of prostate cancer, but also in targeted therapy. Cutting-edge imaging and therapeutic applications of radiotheranostics, such as <sup>177</sup>Lu-PSMA-617, are improving patient outcomes. Additionally, there are a number of clinical trials investigating the expanding use of PSMA-based radiopharmaceuticals and other targeted radionuclide therapies. The objective of this educational exhibit is to familiarize radiology and nuclear medicine physicians and trainees with the pivotal role of radiopharmaceuticals in the management of prostate cancer.

#### TABLE OF CONTENTS/OUTLINE

1) Overview of prostate cancer (PCa). 2) Concise review of radiotracers used for initial diagnosis, staging, and biochemical recurrence of PCa, with a focus on PSMA ligands. 3) PSMA PET imaging for PCa: 3a) Application of PSMA PET for treatment guidance and management: implications and considerations. 3b) Pitfalls of PSMA PET imaging. 4) Radioligands and radiopharmaceuticals: advanced imaging and therapeutic applications: 4a) <sup>68</sup>Ga-PSMA-11. 4b) <sup>18</sup>F-DCFPyL (Piflufolastat F-18). 4c) <sup>177</sup>Lu-PSMA-617. 4c-i) Clinical applications and ongoing challenges. 4c-ii) Predictive biomarkers for assessing efficacy of <sup>177</sup>Lu-PSMA therapy. 4d) <sup>223</sup>Ra- Dichloride. 5) Conclusion and future directions.

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## Abstract Archives of the RSNA, 2023

NMMIEE-38

### Multimodality Imaging of Epstein-Barr Virus-Associated Diseases with Emphasis on PET/CT

All Day Room: Learning Center

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review the spectrum of diseases associated with Epstein-Barr virus (EBV), including infectious mononucleosis, lymphoproliferative diseases, malignancies, and systemic autoimmune diseases. To present the multimodality imaging of the EBV-associated disease spectrum, with emphasis on F-18 FDG PET/CT in the initial staging and subsequent evaluation of therapeutic response.

#### TABLE OF CONTENTS/OUTLINE

Epstein-Barr virus (EBV) is an oncogenic herpesvirus that infects over 90% of the population worldwide. Although usually asymptomatic, EBV is associated with a wide spectrum of lymphoproliferative diseases and malignancies, especially in patients with immunologic suppression or compromise. EBV has been implicated in the pathogenesis of a variety of diseases, including but not limited to infectious mononucleosis, Burkitt's lymphoma, Hodgkin's and non-Hodgkin's lymphoma, nasopharyngeal carcinoma, gastric carcinoma, post-transplant lymphoproliferative disorders (PTLD), smooth muscle tumors, and autoimmune diseases. While chemotherapy and immunotherapy are therapeutic considerations for many of these diseases, modulation of immunosuppression is considered the first-line management, when applicable, with a regression rate of up to 50%. PET/CT imaging is a critical tool for initial disease staging, assessment of treatment response, and monitoring for disease recurrence. This educational exhibit will (1) review the multimodality imaging features of EBV-associated spectrum of diseases such as infectious mononucleosis, lymphoproliferative diseases, malignancies, and autoimmune diseases and (2) emphasize the role of PET/CT in the detection and surveillance of EBV-associated diseases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE-39

### Revealing the Hidden Mysteries of the Brain: A Guide to Brain Perfusion Single Photon Emission Computed Tomography (SPECT)

All Day Room: Learning Center

Tomoki Imokawa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Single Photon Emission Computed Tomography (SPECT) is one of the nuclear medicine imaging modalities to evaluate cerebral hemodynamics. Cerebral perfusion studies are important in the diagnosis of a variety of diseases. Sometimes, cerebral perfusion studies are the only diagnostic clue. This presentation introduces the use of SPECT in the diagnosis of epilepsy and dementia. We also present cases in which SPECT played a decisive role in the diagnosis of inflammatory diseases and tumors, as well as cases in which SPECT served as an objective indicator of psychiatric symptoms and treatment efficacy. The results of SPECT research have important implications in clinical practice, and the application of its findings to MR perfusion imaging is also expected.

#### TABLE OF CONTENTS/OUTLINE

1. Basics of SPECT 2. Epilepsy 3. Neurodegenerative Diseases 4. Cerebrovascular Diseases 5. Tumor 6. Inflammatory Diseases 7. Psychiatric Disorders 8. Others

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE-4

### Feasibility of Performing SPECT/CT Imaging on a CZT Scanner to Monitor Lutetium-177-PSMA-617 Therapy

All Day Room: Learning Center

Aaron Oraham, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Lutetium-177-PSMA-617 (Pluvicto) is a novel radioligand therapy for treatment of metastatic prostate cancer. Current time points for PSMA PET/CT include pre- and post- therapy imaging for patient selection and evaluation of treatment response, respectively. To date, there is no clinical imaging available to monitor the treatment progress during cycles of Pluvicto administration. Current Pluvicto treatment monitoring relies on non-imaging clinical tools, such as PSA levels. Sequential imaging (SPECT/CT) during treatment cycles provides imaging direction to monitor Pluvicto treatment targets and perform organ-based dosimetry. Technical challenges, image quality, and sensitivity of Lu SPECT/CT acquisition will be discussed with its implications in the future of image-guided personalized adaptive dosimetry and diagnosis.

#### TABLE OF CONTENTS/OUTLINE

F-18 PET/CT diagnostic scan for metastatic prostate cancer. Lutetium-177-PSMA-617 (Pluvicto) treatment of metastatic castration resistant prostate cancer. Use of Lu-177 SPECT/CT for sequential monitoring over Pluvicto treatment cycles. Acquisition of Lu SPECT/CT at 24 hours post cycle 1 of Pluvicto treatment. Evaluation of Pluvicto treatment target with SPECT/CT, avidity for metastatic and primary lesions, sparing of nonaffected essential organs. F-18 PET/CT and Lu SPECT/CT imaging qualitative concordance and discordance. Ongoing feasibility study to perform advanced quantification and dosimetry across treatment duration. Future possibility to tailor Pluvicto treatment and minimize patient risk across treatment cycles.

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## Abstract Archives of the RSNA, 2023

NMMIEE-40

### Incremental Value of PET/CT in Identification of Infections Associated with Cardiac Devices

All Day Room: Learning Center

Matthew Y. Koh, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The diagnosis and anatomic localization of cardiac device-related infections is a presently challenging and clinically relevant topic. Historically, transthoracic and transesophageal echocardiography has been the gold standard of cardiac imaging, however, they are limited in the evaluation of implantable cardiac devices and prostheses, particularly left ventricular assist devices and prosthetic valves. 18F-fluoro-2-deoxyglucose positron emission tomography with CT (FDG PET/CT) has gained increased attention in recent years for the diagnosis of cardiac infections in these select populations. In this educational exhibit, we intend to provide relevant background information on this topic, review the essential components of left ventricular devices and prosthetic valves, outline the current standards regarding cardiac device-related infections, and finally provide cases that demonstrate the utility of FDG PET/CT in imaging cardiac device-related infection in both initial diagnosis and follow-up.

#### TABLE OF CONTENTS/OUTLINE

Introduction/Relevant background information. Review of essential components of left ventricular assist devices. Review of prosthetic cardiac valves. Current standards regarding imaging of cardiac device-related infections. Case collection of PET/CT in imaging cardiac device-related infections in initial diagnosis and follow-up. Conclusion/Final points.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE-41

### FDG PET/CT Imaging Pitfalls in Current Era of Immunotherapy: Watch Out for Sarcoid Like Reactions

All Day Room: Learning Center

Vivek Batra, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recognize the imaging features of sarcoidosis, sarcoid like reaction post immunotherapy on FDG PET/CT. Distinguish between tumor progression vs sarcoid like reaction on FDG PET/CT.

#### TABLE OF CONTENTS/OUTLINE

The imaging features of sarcoidosis are diverse and can be shown on a variety of imaging techniques. FDG avidity on PET/CT in patients with sarcoidosis is variable and can mimic malignancies (lymphoma, metastatic disease, post immunotherapy). Sarcoidosis typically demonstrates FDG avid supraclavicular, mediastinal, and bilateral hilar lymph nodes on PET/CT. Biopsy demonstrates non caseating granulomas. Immunologic toxicities in cancer patients are often referred to as immune-related adverse events (irAEs). Among various irAEs, sarcoid-like granulomatous lymphadenopathy occurs in 5% to 7% of patients, and typically presents as asymptomatic mediastinal/hilar lymphadenopathy, sometimes with accompanying multifocal pulmonary nodularity. Resolution or decrease in the original tumor burden on restaging PET/CT, and development of new FDG avid mediastinal/hilar lymphadenopathy in patients receiving immunotherapy indicates probable sarcoid like reaction. Recognition of this pattern of distribution is essential in interpreting the post treatment PET/CT. In equivocal cases, a biopsy or short interval PET scan may be necessary. Using a case based approach, we'll demonstrate PET/CT images of patients with sarcoidosis, evolution of sarcoid like reaction to various immunotherapeutic agents and sarcoid like distribution of metastatic disease.

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## Abstract Archives of the RSNA, 2023

NMMIEE-42

### **Boning Up on DXA in Adults: A Radiologist's Guide to Interpretation and Quality Control**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Saeed Elojeimy, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1- List DXA indications. 2- Recognize appropriate and inappropriate acquisition techniques. 3- Review the pathologic conditions detectable on DXA. 4- Recognize pitfalls that can arise on DXA and how to troubleshoot.

#### **TABLE OF CONTENTS/OUTLINE**

1- Introduction 2- DXA's role in assessing bone mineral density a. Imaging preparation and technique: Patient preparation, imaging technique (describe when to image spine, hip, and forearm and appropriate techniques for ROI placement) b. Interpretation (Comparative databases, T-score, Z-score) c. Review WHO criteria for diagnosing normal bone density, low bone mass, and osteoporosis d. Fracture Risk Assessment (Role of FRAX and Trabecular bone score) e. Pitfalls (improper positioning, artifacts, incidental findings) 3- DXA's emerging role in evaluating and tracking body lean mass and fat composition (review indications, technique, interpretation, available comparison databases, reporting) 4- Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NMMIEE-43

### **18F-FDG PET/CT Focus on Inflammatory-infectious Diseases. Beyond Tumor-related Processes**

All Day Room: Learning Center

Maria J. Baladron, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the applications and importance of non-oncologic 18F-FDG PET-CT in various infectious and inflammatory cases. Demonstrate the utility of 18F-FDG PET/CT in evaluating fever of unknown origin. Case-based review of common and uncommon inflammatory and infectious pathologies, including sarcoidosis, osteomyelitis, spondylodiscitis, and vasculitis, among others. Demonstrate the utility of 18F-FDG PET/CT in evaluating the extension of the disease and treatment response in some of these pathologies. Be aware that these pathologies sometimes are incidental findings in routine oncology follow up.

#### **TABLE OF CONTENTS/OUTLINE**

A brief theoretical basis of PET-CT imaging and mechanism of 18F-FDG interaction with cells. Fever of unknown origin as a clinical entity that benefits from the sensitivity of FDG uptake. Metabolic findings before morphologic variations challenge conventional imaging. Different potential uses of 18F-FDG PET/CT in infectious and inflammatory cases; assessing active inflammation, disease extent, occult disease, treatment response and sometimes determining the most suitable biopsy site. Display specific FDG18 uptake patterns in rare conditions like recurrent aseptic osteomyelitis. Illustrate cases of incidental inflammatory-infectious finding during oncologic patient evaluation.

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## Abstract Archives of the RSNA, 2023

NMMIEE-44

### FDG PET/CT Imaging of Systemic Vasculitis: A Pictorial Review

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Masatoshi Hotta, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Vasculitis can be classified into primary or secondary types based on its etiology or by the size of the affected blood vessels according to the Chapel Hill Consensus Conference criteria. As any size of vessel in any organ may be affected, the imaging findings vary widely. The heterogeneous nature of vasculitis poses a diagnostic challenge. The aims of this review are to: 1) present FDG-PET/CT images of primary and secondary systemic vasculitis affecting vessels of various sizes, including large, medium, small, and variable-sized vessels, 2) describe the FDG-PET/CT features of each systemic vasculitis type and discuss non-vascular findings that can aid in the differential diagnosis, and 3) review the role of FDG-PET/CT in the management of systemic vasculitis.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction | 2. Primary vasculitis: a) Large-vessel vasculitis (Takayasu arteritis, giant cell arteritis); b) Medium-vessel vasculitis (polyarteritis nodosa); c) ANCA-associated small-vessel vasculitis (microscopic polyangiitis, granulomatosis with polyangiitis, eosinophilic granulomatosis with polyangiitis); d) Variable-vessel vasculitis (Behçet's disease, Cogan's syndrome). | 3. Secondary vasculitis: a) Vasculitis associated with systemic disease (IgG4-related disease, sarcoidosis, relapsing polychondritis, Erdheim-Chester disease); b) Vasculitis associated with probable etiology (drugs, infection)

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## Abstract Archives of the RSNA, 2023

NMMIEE-45

### **Transthyretin Cardiac Amyloidosis (ATTR-CM) and Alzheimer's Disease: Is There a Real Correlation or Age-related Specific to Certain Population**

All Day Room: Learning Center

Matin Goldooz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the relationship between cerebral amyloidosis (Alzheimer disease) and Transthyretin cardiac amyloidosis (ATTR-CM).
- Review the imaging technique and radiotracer used for cerebral and cardiac amyloidosis. -Illustrate cases with cardiac and cerebral amyloidosis who presented to our institution

#### **TABLE OF CONTENTS/OUTLINE**

The term "cardiac dementia" (ATTR - CM) is referred to heart failure (HF) as a risk factor for Alzheimer disease (AD). It is thought that the correlation between these two entities is through perfusion defects, angiopathy, and inflammation. Some studies suggest that AD is a multiorgan, systemic disease that may contribute to diminished cardiovascular function. Moreover, recent studies have shown common molecular and pathological features in the brain and heart of the patients with AD, including intramyocardial deposits of A $\beta$ . Whether this amount of A $\beta$  deposit can play a role in compromised myocardial function in patients with AD is yet unknown. High A $\beta$  level in the brain is detected on PET imaging. Although the intramyocardial deposits of A $\beta$  are at a much lower concentration than those seen in the brain, cardiac PET imaging with C-PIB, 18F-florbetapir, and 18F-florbetaben can detect light chain and transthyretin amyloidosis and identify cardiac amyloidosis early in the course of the disease. In ATTR-CM, Tc PYP Cardiac SPECT CT improves the differentiation from blood pool and myocardial uptake and decreases false negatives. Alzheimer's disease and heart failure are two common age-related diseases that can coexist. However, whether there is a real correlation between the two is still a subject of debate and more large-scale population studies are being conducted to further investigate this.

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## Abstract Archives of the RSNA, 2023

NMMIEE-46

### Preoperative and Postoperative 18F-Choline PET/CT Value in Patients with Primary Hyperparathyroidism

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Magali Hovsepian, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To learn about 18F-Choline (FCH) molecule and recognize its physiologic biodistribution, pathological uptake and potential pitfalls.- To understand the acquisition protocol and recognize the importance of early phase PET scan combined with iodine contrast-enhanced CT.- To review current recommendations for the use of FCH PET/CT in patients with primary hyperparathyroidism (PHPT) and related clinical conditions (eg. tertiary hyperparathyroidism, MEN syndromes).

#### TABLE OF CONTENTS/OUTLINE

Choline is a chemical precursor for the synthesis of phospholipids that form the cell membrane. Parathyroid (PT) active tissue has a high uptake of FCH due to the upregulation of choline kinase. Hyperparathyroidism causes urinary, bone, neurologic, and gastrointestinal symptoms and complications. Most cases of PHPT are caused by a solitary PT adenoma. Surgery is the appropriate treatment, but the main reasons for surgical failure are ectopic glands and multiple active tissues. Precise preoperative location of PT tissue remains a difficult task with conventional imaging (99Tc-MIBI scan, CT, MRI) and it is more challenging in patients with previous neck surgery. FCH PET/CT has a high sensitivity for preoperative localization of PT adenomas and postoperative search of active PT tissue. FCH PET/CT is becoming a first-line imaging modality for preoperative and postoperative localization of active PT tissue in PHPT patients. Table of Contents- FCH physiologic uptake and normal biodistribution.- Imaging acquisition protocol. - Preoperative and postoperative localization of orthotopic and ectopic active PT tissue. - Recommendations for the use of FCH PET/CT in patients with PHPT. - Illustrative cases.

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## Abstract Archives of the RSNA, 2023

NMMIEE-47

### Brain Death: Review of Neuroimaging criteria, Techniques and Pitfalls

All Day Room: Learning Center

#### Awards

##### Cum Laude

Priya O. Pathak, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Overview of brain death imaging with a focus on the role of radionuclide perfusion scintigraphy for early and accurate determination of brain death. 2) Review brain death physiology, medical standards, clinical and imaging criteria, confounding variables and inconsistencies in the concept of brain death documentation. 3) Highlight the imaging indications, patient preparation, techniques/protocols, instrumentation, imaging artifacts and pitfalls.

#### TABLE OF CONTENTS/OUTLINE

- Introduction: Review of brain death imaging to assist radiologists in performing, interpreting and appropriate reporting of the results for the confirmation of brain death. Outline
- Confirmatory examinations: Includes tests that show absence of brain electrical activity (EEG and somatosensory evoked potentials) and those that evaluate blood flow (radionuclide studies, multivessel angiography, CT/MR angiography).
- Methods of evaluating blood flow: Contrast enhanced angiography, Transcranial Doppler ultrasound, Radionuclide brain flow scintigraphy.
- Review of radionuclides-Tc-99m HMPAO-Tc-99m ECD-Tc-99 m DTPA-Tc-99 m Glucoheptonate-Tc-99 m TcO<sub>4</sub>
- Pitfalls of radionuclide scintigraphy -False positive tracer activity due to infection, tumors, scalp hyperemia due to head trauma, CSF shunts, intracranial pressure transducer.-False negative results due to disruptions in the skull and scalp, as well as pressure on the portion of the scalp resting on a hard surface causing photopenic area on the flow study.

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## Abstract Archives of the RSNA, 2023

NMMIEE-48

### **The Utility of Brain Perfusion Single Photon Emission Computed Tomography (SPECT) in the Assessment of Neurodegenerative Diseases**

All Day Room: Learning Center

Tomoki Imokawa, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

SPECT, or Single Photon Emission Computed Tomography, is one of the nuclear medicine imaging modalities to evaluate cerebral hemodynamics. Cerebral perfusion studies contain much information useful for the diagnosis of various diseases, especially neurodegenerative diseases. This presentation will highlight the use of SPECT in the diagnosis of neurodegenerative diseases and other conditions that cause dementia, such as cerebrovascular disease and idiopathic normal pressure hydrocephalus. The findings of SPECT have important clinical implications, and the application of the knowledge to MR perfusion imaging is also expected.

#### **TABLE OF CONTENTS/OUTLINE**

1. The Basics of SPECT 2. Alzheimer's Disease 3. Dementia with Lewy Bodies 4. Frontotemporal Dementia 5. Corticobasal Syndrome 6. Idiopathic Normal Pressure Hydrocephalus 7. Progressive Supranuclear Palsy 8. Multiple System Atrophy 9. Spinocerebellar Ataxia 10. Cerebrovascular Diseases 11. Creutzfeldt-Jakob Disease 12. Others

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## Abstract Archives of the RSNA, 2023

NMMIEE-49

### Advanced Cancer Imaging with Hyperpolarized<sup>13</sup>C-MRI: Techniques and Applications

All Day Room: Learning Center

Ying-Chieh Lai (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Hyperpolarized carbon-13 MRI (HP 13C-MRI) is a promising metabolic imaging for oncology that employs dynamic nuclear polarization to enhance the polarization of solid-state compounds labeled with carbon-13, increasing signal by up to 50,000-fold, and allowing the detection of the probe and its downstream metabolites using a clinical MRI scanner. 2. HP 13C-MRI using [1-13C]pyruvate enables non-invasive and rapid monitoring of the upregulated anaerobic glycolysis in cancer cells. MCT in the cellular membrane enables the uptake of [1-13C]pyruvate, which is then converted into [1-13C]lactate by LDH or into [1-13C]alanine by ALT or into 13C-bicarbonate by PDH. 3. Hyperpolarization is transient and relaxes back to thermal equilibrium once leaving polarizer, providing an acquisition window of 2-3 minutes. MRI sequences are optimized to utilize the unrecoverable magnetization rapidly and efficiently. 4. Kinetic modeling involves developing a mathematical model that describes the rates at which probes are converted to products, while model-free metrics rely on metabolite ratios. 5. HP 13C-MRI has been applied to prostate cancer, renal cell carcinoma, brain tumors, and breast cancer, showing its potential to distinguish between benign and malignant tumors, determine tumor aggressiveness, monitor response to therapy, and predict patient outcomes.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction of HP 13C-MRI. 2. Technical aspects: (a) 13C labeled probes; (b) Probe preparation and pharmacy kit assembly; (c) Hyperpolarization, dissolution, and quality control; (d) Patient injection, imaging acquisition, and data analysis. 3. Clinical applications. 4. Conclusions.

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## Abstract Archives of the RSNA, 2023

NMMIEE-5

### Molecular Imaging of Dementia: A Case-Based Review

All Day Room: Learning Center

Zhiyang A. Wei, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Introduction: Molecular imaging plays an increasingly important role in the early identification and monitoring of various forms of dementia, as well as in selecting appropriate patients for therapy in these disorders. In this educational exhibit, we aim to review the pathologic basis and salient imaging findings of the most common causes of dementia, drawing on case examples from our institution. Teaching points/ Learning objectives: 1. Understand the basic pathologic processes responsible for the most common neurodegenerative processes as well as their relative prevalence. 2. Learn the normal and abnormal uptake patterns in the brain on various nuclear medicine studies, including FDG PET, amyloid PET, and DaTScan. 3. Learn what further imaging workup would be recommended for indeterminate findings on FDG PET.

#### TABLE OF CONTENTS/OUTLINE

Outline: 1. Background of dementia a. Definition b. Review of different neurocognitive domains i. Perceptual-motor function ii. Language iii. Executive function iv. Learning and memory v. Complex attention vi. Social cognition c. Review of the most common causes of dementia and their pathologic basis d. Review of various proteinopathies 2. Review of findings of most common causes of dementia on FDG and amyloid PET as well as DaTScan with associated case examples i. Alzheimer's disease ii. Vascular dementia iii. Mixed dementia iv. Dementia with Lewy Bodies v. Frontotemporal dementia vi. Corticobasal degeneration vii. Creutzfeldt-Jakob disease 3. Imaging using F-18-DOPA in parkinsonism 4. Suggested further workup based on imaging findings 5. Review amyloid and Tau imaging tracers and briefly discuss other functional tracers useful in neurodegenerative diseases

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## Abstract Archives of the RSNA, 2023

NMMIEE-50

### **Radiation Safety in Theragnostics: Educational Simulated Real-life Scenarios**

All Day Room: Learning Center

Kip E. Guja, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Theragnostics is a rapidly growing field in nuclear medicine in the era of personalized medicine. Knowledge of radiation safety issues in targeted radionuclide therapies (TRT) is vital for delivering safe and effective patient care, and for maintaining the safety of healthcare workers involved in patient care. The objective of this educational exhibit is to address fundamental issues in radiation safety related to TRT in an engaging way by presenting educational real-life scenarios which may be encountered in a theragnostics clinic.

#### **TABLE OF CONTENTS/OUTLINE**

Educational real-life scenarios to be discussed in this exhibit include: (1) Dose calibrator fails quality control testing, (2) Discrepancy >20% between assayed and prescribed dose, (3) Misadministration of the wrong therapeutic radiopharmaceutical, (4) Preparation of theragnostics treatment room and restroom, and (5) Patients with nephrostomy tubes referred for Lu-177 therapy, (6) Management of Lu-177 radionuclide spill, (7) Management of radioiodine spill (8) Precautions related to liquid I-131 therapy. The appropriate actions/response to each scenario will be summarized.

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## Abstract Archives of the RSNA, 2023

NMMIEE-51

### Prostate Cancer Theragnostics: Review and Early Insights

All Day Room: Learning Center

Emmanuel Carrodeguas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the general characteristics of prostate cancer  
2. Explore current treatment options and algorithms for prostate cancer, focusing on the increasing role of PSMA theragnostics  
3. Establish a framework for the evaluation and selection of patients who would benefit from PSMA RLT  
4. Understand the factors behind successful PSMA RLT therapy; including protocols for treatment, side effects/contraindications and the role of imaging/laboratory monitoring during treatment  
5. Identify current ongoing research and unanswered questions in the role of PSMA RLT

#### TABLE OF CONTENTS/OUTLINE

I. Overview of prostate cancer  
a. Epidemiology, diagnosis, and progression  
b. Localized versus metastatic; Castration sensitive versus resistant  
II. Overview of current treatment  
a. Medical and surgical  
i. Surgery and radiotherapy  
ii. Androgen based  
iii. Chemotherapy  
b. Nuclear medicine  
i. Radium-223  
ii. <sup>177</sup>Lu-PSMA-617  
III. Overview of <sup>177</sup>Lu-PSMA-617  
a. Mechanism of action  
b. Overview of trial results and evidence  
IV. Treatment with <sup>177</sup>Lu-PSMA-617  
a. Patient selection  
i. Inclusion criteria and contraindications  
ii. Choosing between Ra-223 and PSMA RLT  
b. Treatment protocols  
V. Evaluation and monitoring of <sup>177</sup>Lu-PSMA-617 treatment response  
a. Adverse effects and management  
b. SPECT monitoring between cycles  
i. Range of responses  
ii. Imaging monitoring and adjusting therapy  
c. Criteria for cessation of therapy  
d. Case based review and examples  
VI. Future directions and unanswered questions  
a. Review of ongoing trials

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## Abstract Archives of the RSNA, 2023

NMMIEE-52

### **Beyond the Glowing Hues: A Comprehensive Review of False Positive Cases on FDG PET/CT**

All Day Room: Learning Center

Kota Yokoyama, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

FDG PET is one of the most widely used nuclear medicine examination in clinical use today, with high detection capability for malignant tumors and inflammatory diseases. On the other hand, its specificity for tumors is not high, making it difficult to distinguish between inflammation and tumors. In addition, with the recent rise in the price of therapeutic drugs, there are more opportunities to use it for treatment response assessment, and it is important to understand the changes that may be encountered after various types of treatment. This section will provide an overview of the physiologic accumulation of FDG PET/CT and the frequently encountered and somewhat rare false-positive cases (non-neoplastic lesions), presenting a wide range of cases from initial presentation to post-treatment.

#### **TABLE OF CONTENTS/OUTLINE**

1. The basics of FDG PET/CT 2. Physiological uptake, Artifacts, reactive change, lipomatous hypertrophy, brown adipose 3. Iatrogenic or post-treatment changes: radiation pneumonitis, radiation pulmonary fibrosis, radiation sialadenitis, radiation liver disease, postoperative PPFE, foreign body granuloma, thymic rebound, G-CSF reactive bone marrow, vaccine reactive accumulation, etc. 4. Benign lesions: Pituitary adenoma, chronic thyroiditis, hypercellular bone marrow, desmoids, hypercellular bone marrow, etc. 5. Inflammatory disease Sarcoidosis/sarcoid-like reaction, vasculitis, IgG4-related disease, Cattleman's disease, TAFRO syndrome, etc. 6. Infectious diseases: Tuberculosis, mycosi fungoides, actinomycosis/nocardia, echinococcosis, etc.

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## Abstract Archives of the RSNA, 2023

NMMIEE-54

### Nuclear Medicine Imaging in Epilepsy: What the Radiologist Needs to Know

All Day Room: Learning Center

Aakanksha Sriwastwa, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Nuclear medicine imaging plays an essential role in the evaluation of medically refractory epilepsy patients. For these patients, surgery is effective provided there is a well-delineated epileptogenic focus. 2. Functional imaging methods—SPECT and PET—complement structural imaging, allowing accurate ictal focus localization even in the absence of a structural abnormality. 3. Comparison of ictal and interictal SPECT combined with MRI (SISCOM) increases the sensitivity for epileptogenic focus detection. 4. Interictal F-18 FDG PET helps to lateralize the epileptogenic focus, assess for other abnormalities, and guide further testing in pre-surgical planning. 5. Future endeavors include quantitative analysis improvements, neuroreceptor PET radiotracers, and multimodality imaging integration.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction of medically refractory epilepsy. 2. Overview of surgical options. 3. Description of the pre-surgical evaluation process, focusing on ictal and interictal SPECT and interictal FDG PET. 4. Presentation of radiopharmaceuticals and their characteristics. 5. Review of methodology, imaging protocols, and post-processing techniques. • Ictal and interictal SPECT • Interictal F-18 FDG PET 6. Illustration of SPECT and PET usage in ictal focus localization and pre-surgical guidance through a series of commonly encountered pathologies- temporal and extratemporal epilepsy, cortical dysplasia, arteriovenous malformations, encephalocele, tumors. 7. Review of emerging radiopharmaceutical imaging options.

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## Abstract Archives of the RSNA, 2023

NMMIEE-55

### PSMA Radiotheranostics in Prostate Cancer: Principles, Practice, and Future Prospects

All Day Room: Learning Center

Laszlo Szidonya, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. <sup>177</sup>Lu-PSMA is a safe and effective therapy in metastatic castration-resistant prostate cancer. 2. Eligibility for treatment is based on the uptake of lesions on PSMA PET. 3. The degree of uptake on PSMA and FDG PET offers predictive and prognostic information. 4. Post-therapy imaging is important to confirm tumor uptake of the therapeutic agent, monitor response, and identify progressing lesions.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: a. Clinical overview of prostate cancer and treatment options. b. Concept of radiotheranostics. c. Data from the VISION and TheraP trials. 2. Current practice: a. Eligibility for treatment. b. Therapy administration and dosing. c. Toxicity and side effects. 3. Added value of imaging: a. Prognostic/predictive PET biomarkers: i. Qualitative parameters: 1. Level of PSMA uptake relative to liver/spleen and salivary glands. ii. Quantitative parameters: 1. Absolute uptake values (e.g. SUVmax). 2. Total tumor burden. iii. PSMA/FDG concordance/discordance. b. Post-therapy imaging: i. SPECT quantification to predict response. ii. Detection of disease progression. 4. Future directions: a. Timing, sequencing, and dose optimization. b. Potential role of personalized dosimetry. c. Alternative PSMA targeting molecules. d. PSMA therapy using alpha emitters. e. Combination therapy.

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## Abstract Archives of the RSNA, 2023

NMMIEE-56

### Improving the Diagnostic Sensitivity of $^{13}\text{N}$ -Ammonia PET Imaging: Creating Age- and Gender-Matched Normal Databases for Myocardial Flow Reserve Measurements

All Day Room: Learning Center

Takuji Nanno (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

$^{13}\text{N}$ -Ammonia myocardial perfusion PET imaging (ammonia PET), is a non-invasive, quantitative imaging method that enables the evaluation of myocardial blood flow (MBF) for detecting myocardial ischemia and assessing disease severity. Myocardial flow reserve (MFR) measurements, obtained by comparing stress and rest MBF ratios, provide important diagnostic and prognostic information for ischemic heart disease. However, clinical interpretation of MFR values depends on the normal population values, and the normal database (NDB) for MFR has not been sufficiently evaluated. Since MFR measurements vary, it is desirable to create age- and gender-matched NDBs for individuals under 70 years old as well as NDB for individuals over 70 years old. By comparing MFR values with the appropriate reference NDB, it is possible to evaluate the severity of ischemia in a more detailed and objective manner. This presentation aims to introduce the methods for creating age- and gender-matched NDBs and their usefulness in clinical cases, thereby improving the diagnostic sensitivity in ammonia PET.

#### TABLE OF CONTENTS/OUTLINE

1. Age and Gender Differences in MFR in ammonia PET 2. Creation of age- and gender-matched NDBs for MFR using Syngo MBF software 3. Clinical case 1: Normal perfusion with normal coronary artery 4. Clinical case 2: Mild ischemia with significant stenosis in RCA and D1 5. Clinical case 3: Multi-vessel CAD

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## Abstract Archives of the RSNA, 2023

NMMIEE-57

### **Nuclear Medicine Lung Perfusion (Q) Imaging: SPECT/CT Indications and Interpretation Pearls and Pitfalls**

All Day Room: Learning Center

Brandon G. Brockbank, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Highlight the PISAPED interpretation criteria for perfusion-only lung scans  
2. Understand indications for and utility of SPECT/CT in lung perfusion scans  
3. Recognize common pearls and pitfalls in the interpretation of Q scans

#### **TABLE OF CONTENTS/OUTLINE**

1. Perfusion-only lung imaging  
a. Historic use of V/Q scans  
b. COVID pandemic and perfusion-only scans  
c. 2022 Global contrast shortage crisis  
2. Interpretation Criteria  
a. PISAPED perfusion-only criteria  
b. PIOPED perfusion-only criteria  
3. SPECT/CT Indications  
a. Non-wedge shaped perfusion defects  
b. Heterogeneous radiotracer uptake and distribution  
4. Case Examples  
a. COVID pneumonia with and without pulmonary embolism (PE)  
b. Emphysema as a mimic of PE  
c. Bronchopneumonia with and without PE  
d. CTEPH - missed on CTPA and better seen on Q scan  
e. PE with pulmonary infarct  
f. Pleural effusion masking PE on planar images  
g. Pulmonary masses as a mimic of PE  
h. Fibrosis as a mimic of PE  
5. Teaching Points  
a. Indications and utility of SPECT/CT  
b. Common pitfalls of interpretation

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## Abstract Archives of the RSNA, 2023

NMMIEE-58

### COVID-19 Pandemic and Its Impact on Nuclear Medicine with Teaching Pearls

All Day Room: Learning Center

Nick Balanda, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

COVID-19 is a multi-systemic viral disease also known as SARS-CoV-2 or severe acute respiratory syndrome coronavirus 2. Worldwide rapid emergence of the COVID-19 pandemic altered the practice of medicine including nuclear medicine. It is considered to be one of the most massive and chaotic challenges confronting global public health of our times. This educational exhibit aims to: 1. Summarize economic impact of COVID 19 in a tertiary care university teaching hospital. 2. Describe the adaptation to the pandemic by modification of various imaging protocols (for example Myocardial perfusion, V/Q scan, scheduling of PET CT after COVID-19 vaccination), highlighting the importance of CT portion of SPECT CT and PET CT, especially for lung findings. 3. Offer Teaching Pearls and a case-based multi-modality correlation of interesting COVID-19-related findings in nuclear medicine and PET CT imaging with a focus on the impact on patient management.

#### TABLE OF CONTENTS/OUTLINE

We present 15 interesting COVID-19-related findings in nuclear medicine and PET CT imaging with a focus on the impact on patient management. These cases include incidental findings secondary to vaccination and COVID-19 infection as well as modified imaging protocols and highlight important considerations for radiologists interpreting images in the era of COVID-19.

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## Abstract Archives of the RSNA, 2023

NMMIEE-59

### Role of 18F FDG PET CT in Patients with Lymphoma Treated with CAR-T Cell Therapy: Current Concepts

All Day Room: Learning Center

Vanessa Murad, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Understand the principles and biological effects of CAR-T cell therapy. CAR-T cell therapy is a novel cancer treatment based on the genetic modification of the patient-derived T cells by adding synthetic functional chimeric antigen receptors (CARs), which permit the identification of specific tumor antigens. 18F -FDG PET/CT (=PET CT) is the imaging of choice for pre and post CAR-T cell therapy assessment, in patients with metabolically active lymphomas. 2) Recognize the role of PET CT in pre-therapy assessment. Highly metabolically active disease and high tumor burden at baseline PET CT, are predictors of unfavorable patients' outcomes and risk of therapy related toxicities. 3) Define the optimal timing of PET CT in therapy response assessment, as well as its impact on management (with demonstrative cases). PET CT 1-month after the infusion is the preferable timing for therapy response assessment, and may trigger a possible therapeutic intervention. A few cases of pseudo-progression after therapy have been described; however, all have been during the first few days after the infusion, with complete resolution at 1-month PET/CT. 4) Identify the main toxicities associated with CAR-T cell therapy and the role of PET CT in their evaluation.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction to CAR-T cell therapy, brief history and indications. 2) Role of PET CT in CAR-T cell therapy: 2.1) Pre-therapy considerations. 2.2) Post-therapy response assessment: timing, impact and imaging interpretation including pseudo-progression evaluation. Demonstrative cases. 2.3) Evaluation of toxicities during CAR-T cell therapy: Cytokine release syndrome, immune effector cell-associated neurotoxicity syndrome and infection.

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## Abstract Archives of the RSNA, 2023

NMMIEE-6

### Acute Adverse Events in Theragnostics: Educational Simulated Real-life Scenarios

All Day Room: Learning Center

Kip E. Guja, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Theragnostics is a rapidly growing field in nuclear medicine in the era of personalized medicine. Recognizing and appropriately managing acute adverse events associated with targeted radionuclide therapies (TRT) is vital for delivering safe and effective patient care. The objective of this educational exhibit is to highlight management of acute adverse associated with TRT in an engaging way by presenting simulated real-life scenarios which may be encountered in a theragnostics clinic.

#### TABLE OF CONTENTS/OUTLINE

Educational simulated real-life scenarios to be discussed in this exhibit include: (1) Extravasation of 177-Lu radionuclide, (2) Management of potential complications associated with amino acid infusion during Lu-177 DOTATATE therapy, (3) Management of carcinoid crisis after Lu-177 DOTATATE therapy, and (4) Mitigation of flare reaction to TRT (5) Management of acute sialadenitis with Lu-177 PSMA-617 therapy. The appropriate actions/response to each scenario will be summarized.

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## Abstract Archives of the RSNA, 2023

NMMIEE-60

### Pediatric PET/MRI: The How and Why

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Helen R. Nadel, MD, FRCPC (*Presenter*) Consultant, ICON plc;;

#### TEACHING POINTS

Since its introduction a decade ago, integrated PET/MRI has been established as a hybrid imaging modality that provides unique diagnostic information. A key application of PET/MRI is pediatric imaging for oncologic, neurologic, inflammatory, and metabolic conditions given its reduced radiation exposure and potential for reduction of administered radiotracer dose. Despite its successful clinical adoption, the availability of PET/MRI for pediatric patients is still limited to larger academic and clinical centers due to high complexity studies which require thorough patient preparation and exam planning, skilled image acquisition and careful image analysis and interpretation. These factors limit the accessibility of PET/MRI not only for imaging specialists in training, but also for experienced radiologists and nuclear medicine physicians. The purpose of this contribution is to provide guidance and the value of pediatric PET/MRI with clinical examples drawn from pediatric PET/MRI programs world-wide.

#### TABLE OF CONTENTS/OUTLINE

1. Common clinical indications for PET/MRI in pediatric patients 2. Commonly used PET tracers for these indications 3. PET/MRI instrumentation 4. Patient preparation (patient information, dietary aspects, sedation, anesthesia) 5. Examination planning and protocol definition 6. Examination execution 7. Aspects of image processing 8. Interpretation and reporting 9. Pitfalls and troubleshooting

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## Abstract Archives of the RSNA, 2023

NMMIEE-61

### Role of FDG PET/CT in Therapeutic Decision Making in Lymphoma

All Day Room: Learning Center

Elena Anigati, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Therapeutic options for lymphoma include chemotherapy, monoclonal antibody therapy, radiation therapy, stem cell transplant and chimeric antigen receptor therapy (CAR-T). FDG PET/CT plays an integral part in therapeutic decision making.
2. Interim FDG PET/CT allows response-adapted treatment with either reduction in the number of chemotherapy cycles or early use of more aggressive treatment.
3. In patients receiving CAR-T, response assessment on FDG PET/CT should be guided by LYRIC response criteria.
4. Interpretation of interim and post treatment FDG PET/CT can be confounded by thymic hyperplasia, infection/inflammation, immune related adverse events, marrow stimulation by granulocyte colony-stimulating factor (G-CSF).
5. FDG PET/CT plays a role in evaluating disease relapse or transformation and provides guide to biopsy.

#### TABLE OF CONTENTS/OUTLINE

1. NCCN treatment guidelines- illustrations of role of FDG PET/CT in therapeutic decision making.
2. Overview of CAR-T.
3. Illustrate staging by FDG PET/CT.
4. Illustrate Lugano and LYRIC treatment response criteria for interim and end of treatment FDG PET/CT.
5. Illustrate pitfalls in treatment response assessment- thymic hyperplasia, infection/inflammation, irAEs (immune related adverse events), marrow stimulation by G-CSF.
6. Illustrate role of PET/CT in identifying disease relapse or transformation

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## Abstract Archives of the RSNA, 2023

NMMIEE-62

### Functional Imaging of Liver and Spleen Using Tc 99m Sulphur Colloid. A Case Based Multi-modality Pictorial Review with Teaching Pearls

All Day Room: Learning Center

Nick Balanda, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Nuclear Medicine Tc-99m Sulphur colloid liver-spleen scan has declined over recent years, however, it is still very useful in certain specific scenarios where it can be virtually diagnostic or confirmatory. Our case-based educational exhibit aims to: 1. Evaluate functional abnormalities of the liver and spleen based on the location and amount of radiotracer uptake. 2. Review specific scenarios for evaluating intra-pancreatic, left hemi abdominal, mediastinal, and left lung masses by liver spleen scan as questioned on conventional anatomic imaging with multi-modality correlation. 3. Evaluate a few specific space-occupying hepatic and splenic masses with multi-modality correlation. 4. Importance of SPECT CT over planar imaging.

#### TABLE OF CONTENTS/OUTLINE

Our case-based educational exhibit includes: Assessment for Hypersplenism in patients with thrombocytopenia, evaluating for cirrhosis, evaluating/confirming the presence of accessory/ectopic splenic tissue, evaluating specific intrapancreatic lesions, Hepatic cysts, hepatic hemangiomas, FNH, splenic infarcts, Budd-Chiari syndrome.

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## Abstract Archives of the RSNA, 2023

NMMIEE-63

### **Pictorial Review of MRI Fused with Somatostatin Receptor PET Tracers in Meningiomas: Does the Integration of Molecular and Anatomic Imaging Impact Clinical Management**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Julio C. Marin Concha, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Physiologic avidity of somatostatin receptor PET tracers is minimal in the brain parenchyma, providing an excellent tumor background ratio (TBR), unlike FDG PET. 2. Somatostatin receptor PET assists in targeting meningiomas in complex anatomic regions such as the skull base and identifying additional sites. 3. MRI fused somatostatin receptor PET allows for distinguishing enhancing scar tissue from meningiomas. 4. Somatostatin receptor PET impacts clinical and radiation therapy (RT) management leading to changes in the clinical approach and/or modifications in radiation treatment volumes. 5. Somatostatin receptor PET has potential in neurotheranostics to provide diagnostic imaging to guide molecular therapeutic radionuclides, such as <sup>177</sup>Luthium-DOTATATE.

#### **TABLE OF CONTENTS/OUTLINE**

1. General considerations: § Imaging evaluation of intracranial meningiomas in NM and anatomic modalities § Review the mechanism of Somatostatin Receptor Targeted PET Imaging 2. Integration of PET and imaging guided therapy: Radiotherapy fundamentals. 3. Cased-based approach of impact on patient's treatment decisions. 4. Somatostatin receptor PET pitfalls: What you need to know? Summary: Our preliminary experience of MRI fused with somatostatin receptor PET has shown to enhance identification of disease extent compared to MRI only, especially in patients with prior treatments and extracranial components, impacting management decisions and providing information for potential radionuclide targeted therapy.

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## Abstract Archives of the RSNA, 2023

NMMIEE-64

### Radiotheranostics in Prostate Cancer: Current Practice and Future Outlook

All Day Room: Learning Center

Daniel Kwon, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Next generation radiotheranostics are effective in patients with prostate cancer, with studies supporting imaging- and treatment-based on the molecular determinants of patient's disease<sup>2</sup>. Prostate-specific membrane antigen (PSMA)-targeted radiotheranostics represent the frontier of this paradigm, with PSMA-targeted imaging showing superiority compared to conventional imaging for staging and monitoring patients during therapy<sup>3</sup>. <sup>177</sup>Lu-based PSMA-targeted and <sup>223</sup>Ra radioligand therapy are effective in metastatic prostate cancer, and multiple clinical trials are exploring further indications<sup>4</sup>. Dosimetry will personalize doses per patient to maximize therapeutic benefit while minimizing toxicity<sup>5</sup>. Other radioisotopes (e.g. <sup>225</sup>Ac, <sup>161</sup>Tb) and molecular targets (e.g. gastrin-releasing peptide receptor (GRPR)) are being explored for radiotheranostic applications in prostate cancer

#### TABLE OF CONTENTS/OUTLINE

- Overview of prostate cancer: current diagnosis and treatment
- Introduction to radiotheranostics: common theranostic radioisotopes and their selection
- PSMA-targeted imaging and radioligand therapy: recent trial data, indications, clinical pearls, image-guided monitoring, and case examples
- Radium-223: indications, clinical pearls, and case examples in bone metastases in prostate cancer
- Dosimetry: principles and applications for personalized radioligand therapy
- The Future: Ongoing PSMA-targeting radiotheranostic clinical trials, emerging theranostic radioisotopes and radiotheranostic agents (e.g. GRPR)
- Conclusions and Summary

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## Abstract Archives of the RSNA, 2023

NMMIEE-65

### **18F-FDG PET/CT: Least Useful to Most Important Imaging Modality for Evaluation of Prostate Cancer**

All Day Room: Learning Center

Lewen Stempler, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the roles and mechanism of PSMA and FDG PET/CT imaging in evaluating prostate cancer at different stages of the disease. 2. When reading PSMA PET/CT scans, interpreters should always correlate with clinical history such as PSA level, disease stage, and prior treatments. If PSMA positive lesions are not in proportion to high PSA level or if lesions are only seen on CT without PSMA avidity, think of transformation of prostatic adenocarcinoma (CRPC-Adeno) to treatment-induced neuroendocrine prostate cancer (t-NEPC). Consider 18F-FDG PET/CT for further evaluation. In some cases, 68Ga-DOTATATE PET/CT may be helpful.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Case examples 3. Educational objectives 4. Summary

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## Abstract Archives of the RSNA, 2023

NMMIEE-7

### Perineural Tumoral Spread- A Search Pattern for PET Scan Readers

All Day Room: Learning Center

Deepashri Basavalingu, MD,MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Perineural tumor spread is the macroscopic analogue of perineural tumor invasion. 2. F-18 FDG PET CT is often used in staging and response assessment in head and neck malignancies and has an important role in identification of perineural tumor spread.3. Familiarity with relevant cranial and peripheral nerve anatomy, pattern of perineural tumor spread and associated PET imaging appearance will lead to improved detection of this important prognosticating factor.4. FDG uptake resulting from postsurgical and postradiotherapy inflammation in addition to other infectious and inflammatory causes may lead to false positive cases mimicking perineural tumor spread.

#### TABLE OF CONTENTS/OUTLINE

1. Background- what's in a name- perineural tumor spread versus perineural tumor invasion.2. Overview of relevant cranial nerve and peripheral nerve anatomy.3. Pathophysiology of perineural tumor invasion and perineural tumor spread.4. Tumor types, sites, and clinical presentation of perineural tumor spread.5. Case based review of PET patterns of perineural tumor spread in the head and neck.6. Other usual and unusual locations for perineural tumor spread on PET imaging.7. Search pattern for peritumoral spread for PET scan readers.8. Imaging differentials for consideration and false positives. 9. Prognosis and treatment considerations in patients with perineural tumor spread.

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## Abstract Archives of the RSNA, 2023

NMMIEE-8

### Imaging Appearances of Large Vessel Vasculitis on 18F-FDG PET/CT: The Dark, the Bright, and the In-between

All Day Room: Learning Center

Rita Maria Lahoud, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- 18F- FDG PET/CT can be used in the diagnostic evaluation of vasculitis, to determine the distribution of involvement, the activity status of the disease, and to assess treatment response.
- Where possible, CT angiography should be added to 18F-FDG PET/CT as it not only improves diagnostic accuracy but can identify frequent complications such as aneurysm formation or vascular dissection.
- PET vascular activity score (PETVAS) is a grading system that provides qualitative and quantitative assessment.
- Limitations include superficial cranial vessel involvement, extensive atherosclerosis, and persistent uptake in remission limiting the use of PET/CT for routine follow-up.
- Systemic rheumatologic conditions, including Erdheim Chester and IgG4 Related Disease can have secondary involvement of the large vessels, mimicking a large vessel vasculitis. It is important to recognize their distinguishing features and patterns of involvement on 18F- FDG PET/CT.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to Large Vessel Vasculitis: a. GCA and PMR b. Takaysu's
2. Role of PET/CT in the Evaluation of LVV a. Disease activity b. Extent of involvement c. Biopsy Target d. Response Assessment
3. PET/CT protocol a. General patient preparation b. Impact of glucocorticoids c. Incubation time d. Contemporaneous CT angiogram
4. Common Imaging Appearances of LVV on PET/CT a. GCA pre and post therapy b. Takayasu's c. TIPIC variant of GCA
5. Differential Considerations a. Erdheim Chester b. IgG4 related disease
6. Diagnostic Accuracy of PET/CT

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## Abstract Archives of the RSNA, 2023

NMMIEE-9

### Epilepsy Beyond HARNESS-MRI Protocol through Hybrid PET-MRI and Advanced MRI Imaging

All Day Room: Learning Center

Piedad A. Acosta Mora, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To learn the causes of drug-resistant epilepsy and structural alterations in neuroimaging.- To recognize the spectrum of MRI sequences optimized for epilepsy and to implement the use of HARNESS MRI protocol.- To review advanced neuroimaging techniques (functional, metabolic, post-processing.) and to explain the utility in the drug-resistant epilepsy - To evaluate the clinical impact of hybrid FDG -PETMRI in decision-making in drug-resistant epilepsy- To understand how hybrid imaging with PETMRI optimizes the subtle epileptogenic lesions detections and improves postsurgical seizure outcome.

#### TABLE OF CONTENTS/OUTLINE

1.Introduction2.Classification of seizure types3.Causes of drug-resistant epilepsy 4.MRI sequences optimized for epilepsy - HARNESS MRI protocol5.Advanced neuroimaging techniques - BOLD- MRI functional - Texture analysis - Spectroscopy - Diffusion tensor imaging (DTI) and fiber tractography 6.Role of hybrid FDG-PETMRI in epilepsy - Indications - Preparation - Technique and recommendations for acquisition - Normal patterns of brain FDG uptake - Cortical analysis 7.Case-based learning 8.Conclusions

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## Abstract Archives of the RSNA, 2023

NPMEE

### Noninterpretive Skills (Beyond Imaging) Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **NPMEE-1 Every Little Bit Helps. How to Reduce Carbon Footprint with a Mobile MR. Experience from the Northwest of Spain.**

Mercedes Arias Gonzalez, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Mobile MRs are able to fill the service void in small to medium-sized hospital without in-house magnets. Delivering care closer to home avoids travel kilometers, highly contributing to an improved carbon footprint. Carbon footprint per MR scan can be even further reduced due to a higher utilization rate, as MR scanners cannot be turned off. Being conscious of radiology contribution to carbon footprint and greenhouse gas emissions can contribute to reduce them, as much as possible.

#### TABLE OF CONTENTS/OUTLINE

Evolution of needs and mobile MR implementation in the public healthcare system in Galicia (a region in the Northwest of Spain) since 2006. Evaluation of kilometers avoided by patients since 2006 and its effect in carbon footprint. Study of utilization rates of each mobile MR scan through the years. Easy explanation of useful concepts concerning carbon footprint and greenhouse gas emissions.

#### **NPMEE-10 Financial Fitness for the Radiology Resident**

Kevin Wu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiologists receive little formal instruction on basic concepts related to financial planning. Yet, certain financial decisions and strategies that are best employed during residency can yield as much as hundreds of thousands in savings over the course of a career. Therefore, early financial literacy is one of the most important aspects of career counseling that trainees can receive. Indeed, certain financial maneuvers are only possible during the training years. For those with an average loan burden, income driven repayment (IDR) can be worth >\$400,000 over the course of a career, and is a priority consideration. Other maneuvers, such as electing to contribute to a Roth 403b/401k (if available) rather than a pre-tax 403b/401k during residency, or performing a 403b/401k-to-IRA rollover followed Roth conversion after training, are expected to be worth \$84,000 by retirement. Even greater savings are likely with such maneuvers if marginal income tax rates increase in the future. These and other strategies require only hours to employ, and must not be missed for all who are eligible. In this light, we present an "order of priorities" regarding financial maneuvers that maximize yield with respect to ease of execution. Specifically, we discuss maneuvers such as student loan IDR, value-driven credit card rewards, 403b/401k to Roth IRA rollover, strategies around tax season, and early modifications of the retirement portfolio mix.

#### TABLE OF CONTENTS/OUTLINE

Philosophy/disclaimers, The financial waterfall, Student loan IDR, Credit card optimization, Expense ratios, Pretax purchasing, Roth vs. traditional and conversions, Income tax projections, Portfolio mix, Avoidance of taxation events, Tax season, Subtleties

#### **NPMEE-11 Radiology Dashboards: Applications in Addressing Healthcare Disparities in Image Utilization**

#### Awards

#### Cum Laude

Jay Patel (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Review the role of dashboards in radiology  
2. Examine how healthcare disparities (HCD) in radiology can affect morbidity and mortality  
3. Highlight specific applications of radiology dashboards in addressing HCDs in imaging utilization  
4. Discuss the limitations of radiology dashboards

## TABLE OF CONTENTS/OUTLINE

1. What is a Radiology Dashboard?  
a. Key Performance Indicators (KPIs)  
i. Patient tracking  
ii. Image utilization  
iii. Turnaround time  
iv. Resource allocation  
v. Quality assurance  
2. Overview of the literature on HCDs in image utilization (e.g. disparities in imaging utilization in the emergency department, disparities in utilization of low dose CT for lung cancer screening, etc.)  
3. Applications of radiology dashboards in addressing HCDs in image utilization  
a. Identifying risk factors for decreased imaging utilization stratified by type of study (e.g. screening mammogram, low dose CT for lung cancer screening) and patient setting (e.g. emergency department)  
i. Zip code of patient residence  
ii. Race and ethnicity  
iii. Age  
iv. Language preference  
b. Developing quality improvement initiatives  
i. Patient education  
ii. Language accessibility  
iii. Cultural competency training and diversification of work force  
iv. Community outreach (e.g. mammogram vans and patient education efforts)  
v. ACR Select  
c. Monitoring response  
i. Before and after studies  
ii. Non-Comparative studies  
iii. Time series  
4. Limitations of radiology dashboards  
5. Conclusions

## NPMEE-12 Out of the Darkness and into the Light: Redefining the Role of Radiology in Community Engagement

### Awards

#### Certificate of Merit

Somiah Almekey, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Provide a radiology-focused overview of foundational elements related to community engagement, community-based participatory research, reciprocal innovation, and community needs assessment and outreach
- Discuss evidence-based examples of how radiology staff/trainees play a crucial role in delivering equitable care
- Explore how community engagement can be leveraged as an effective method to restore purpose in our daily work and prevent burn-out
- Review practical examples of community engagement across various settings (ie. rural, urban, global health)
- Discuss steps to establish a centralized curriculum that defines the role of radiology in the community, and provides trainees with concrete examples of this work

## TABLE OF CONTENTS/OUTLINE

1. Interface between Radiology and the Community  
•Definition of Community Engagement, Community-Based Participatory Research, Reciprocal Innovation  
•Leveraging institutional resources and community needs assessments to guide outreach efforts  
c. Evidence-based community engagement startup toolkit for radiology  
2. Case-based review of ongoing outreach efforts in various settings  
•Cancer screening efforts  
•Resident-driven initiatives  
•Health equity efforts  
•Outreach interventions among veteran populations  
3. Potential pitfalls and opportunities for growth  
•Allocation of effort and time in alignment with community needs and departmental workload.  
•Tips on identifying opportunities to engage diverse communities  
4. Empowering the next generation  
•Establishing a "Community Engagement in Radiology" curriculum  
•Overview of required competency elements  
•Facilitators and barriers to dissemination of the curriculum

## NPMEE-13 Breaking Bad News: What the Radiologist Needs to Know

Natalia Orthmann, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1.To emphasize the importance of breaking bad news in appropriate ways.  
2.To present the existing and consolidated bad news protocols.  
3.To elaborate on how the protocols can be applied in the day-to-day practice of radiologists, especially breast radiologists.  
4.To assist in the training of radiologists in this time of breaking bad news.  
5.To illustrate the differences between the most frequent protocols for breaking the bad news

## TABLE OF CONTENTS/OUTLINE

1.Literature review focusing of consolidates bad news protocols.  
2.To illustrate and discuss how bad news protocols can make the moment less traumatic for physicians and patients.  
3.Discuss how to apply the protocols in the radiologist's routine.  
4.Examples cases of how bad news may occur in the radiologist's routine.  
5.Summary and conclusion.

## NPMEE-14 Green Teams - an AI Gore-ithm for Addressing Sustainability in Radiology

Katherine C. Frederick-Dyer, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

We explain the process of forming a sustainability committee in the Department of Radiology to identify and address the environmental footprint in our academic department.

## TABLE OF CONTENTS/OUTLINE

I. Introduction A. What is sustainability and how does addressing it reduce costs and improve human health B. What is design thinking and how do we use it to solve non-linear problems II. Baseline Survey A. Identify attitudes and interest in climate change B. Identify opportunities to reduce carbon footprint and build allies III. First meeting A. Forming the committee - approaches to inclusivity B. Guidance with local climate experts to guide discussion 1. Assess - What is the carbon footprint of the department? 2. Inspire - To what extent do concerns about climate change and support for climate mitigation affect employee morale and patient satisfaction? 3. Model - How do we share our successes to decarbonize our department to guide other departments? C. Design thinking session 1. Actively engage participants to brainstorm ideas using colorful sticky notes 2. Visually organize ideas into the Categories (IIIb) 3. Establish culture of inclusivity, collaboration, transparency, fun, and accountability D. Organize team into subgroups to address each Categories IV. Subsequent meetings A. Encourage teams to produce achievable deliverables each meeting B. Assess what expertise and resources are needed C. Delineate team member roles and responsibilities D. Define timeline and metrics for success V. Highlighting early wins and how this contributes to the bigger picture

## NPMEE-15 Forward Together: Collaboratively Integrating Radiology throughout a Medical School Curriculum

### Awards

#### Certificate of Merit

Matthew H. Lee, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Integrating radiology throughout a medical school curriculum mirrors the breadth, depth, and impact of radiology in the real world 2. Sustainable implementation of radiology throughout a curriculum is a product of thoughtful and strategic partnerships with medical school leadership across disciplines and central governance committees 3. Collaboratively working with colleagues across disciplines can expand the footprint and impact of radiology in medical school 4. Early consistent exposure to quality radiology education promotes recruitment into radiology and positively impacts learners pursuing other specialties 5. Effective student education transcends passive modes of learning through activities that promote increased learner engagement

## TABLE OF CONTENTS/OUTLINE

1. ForWard - 3-phase model integrating basic, clinical, and public health sciences, 10 integrated "threads" 2. Phase 1 - thematic blocks incorporating basic and clinical science and early clinical medicine - incorporating radiology into anatomy, patient-centered education cases 3. Phase 2 - clinical rotations integrating clinical care, basic sciences, and thread areas - case-based learning 4. Phase 3 - career exploration, intern preparation, "selectives" - novel radiology course development 5. Leadership - medical student directors, block leaders 6. Innovative educational content creation and delivery - embracing remote techniques, case-based learning, website development 7. Novel course development - Screening in Radiology, Financial Wellness 8. Faculty Recruitment - range of faculty, educational RVUs 9. Resident Recruitment - radiology interest group 10. Lessons learned - staff support for sustainable implementation

## NPMEE-16 #FOAMrad: A Personal Productivity Curriculum for Radiologists

Alice Shieh, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Simplify and adopt the "Getting Things Done" methodology for busy radiologists- Understand and incorporate the fundamentals of "Deep Work" for peak performance- Learn how to apply the science of habits based on best-selling book "Atomic Habits"- Demonstrate tried and tested productivity software applications to streamline repetitive tasks (for Mac users)- Review time-saving settings and approaches to combat e-mail overwhelm

## TABLE OF CONTENTS/OUTLINE

Getting Things Done framework ?- Delete it, Do it, Delegate it, Deposit it, Defer it ?Deep Work ?- 4 deep work philosophies: monastic, bimodal, rhythmic, journalistic?- 3 steps to rewire your brain: embrace boredom, quit social media, drain the shallows ?Atomic Habits ?- 4 laws of behavior change: cue, craving, response, rewards ?- Creating a new identity to develop new habits ?- Building better systems to achieve goals ?Tried and tested productivity software applications to streamline repetitive tasks on a Mac?- Alfred, SetApp, 1Password, Evernote, Notion, Ecamm, Endnote, Backblaze ?E-mail management ?- Understanding e-mail communication principles ?- Time-saving settings for Outlook and Gmail ?Multitasking and prioritization techniques ?- MoSCoW (Must, Should, Could, Would)

NPMEE-17 Elliot S. Breshears, MD (*Presenter*) Nothing to Disclose

utility of macropads in automating and simplifying repetitive nature of the radiologist's workflow-Learn how to easily assemble, program, and implement macropads into your own radiology practice-Discuss the time-saving features of macropads

-Review the

### TABLE OF CONTENTS/OUTLINE

Macropad device utility- Assign complex repetitive tasks to a single button click, improving efficiency- Ability to bypass IT restrictions and firewalls; eliminates need to install additional software on PACS workstationsResource selection process- Consolidating resources into 15 programmable keys- Implementing input from abdominal imaging faculty ?Assembly- Physical components: front and back plates, keycaps, switches, USB cables- Assembly process- Creating custom key stickers to promote intuitive access of selected resources ?Programming- Utilizing duckyScript and the duckyPad Configurator software- Navigating computing system compatibility issues ?Implementation and impact on radiology workflow- Reduction in mouse clicks needed to access resources- Plug and play with ability to use at different workstations ?Limitations- Cost- Time and effort associated with self-assembly, selecting and organizing incidentaloma guidelines- Minimal scripting required ? Future directions- Implementing Elgato stream deck into PACS stations with software installed after security clearance

## NPMEE-19 Journey to Parenthood in Radiology: Progress, Challenges, and Opportunities

Shinnhuey S. Chou, MD, MPH (*Presenter*) Institutional research support, General Electric Company

### TEACHING POINTS

1. Delayed childbearing impacts the reproductive outcomes among physicians.2. A better understanding of the options to achieve parenthood allows for comprehensive family planning, flexible practice management, and inclusive dialogues.3. Accurate knowledge of occupational radiation exposure to women physicians may help assuage unrealistic fear and build a stronger pipeline of future radiologists.

### TABLE OF CONTENTS/OUTLINE

- To highlight the importance of and obstacles to family planning and childbearing for physicians and physicians-in-training
- To review occupational radiation risks and safety precautions in the radiology work environments and specifically within each radiology subspecialties
- To raise awareness of the various options and processes involved in egg preservation, fertility treatment, surrogacy, adoption, and fostering
- To provide an overview of existing policies and guidelines for family and medical leave in the United States, including the American Board of Radiology updated policies and state and federal laws
- To discuss potential mechanisms to support medical students, radiology trainees, and radiologists on their journey to parenthood and those who are parents

## NPMEE-2 Small Nodule, Big Impact: Incidental Findings Module

Robert J. Lewis, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1) Studies have found that as radiographic imaging numbers continue to increase, so has the number of incidental findings. 2) Based on literature and guidelines including the ACR white papers and Fleischner Society recommendations, a new incidental/follow up tab was built into our electronic health record (EHR) to provide simple, fast and streamlined recommendations by radiologists for clinicians. 3) Additional measures are also built in to help achieve the proper patient follow up, such as dedicated nurse navigators to help track down incidental findings and assure proper follow up as well as inbox EHR messages to patients PCP upon discharge. 4)Future directions include expanding the followed-up incidental, education to both ordering providers and patients as well as research for continued evolution of incidental finding guidelines.

### TABLE OF CONTENTS/OUTLINE

1) Define the impact of incidental pulmonary findings by radiologists on patient care. 2) Discuss the implemented incidental findings tab within our health network and how it has changed patient care/outcomes. 3) Identify methods to expand this model to include more incidental findings and increase patient follow up. 4) Data collection and interruption for future incidental finding recommendations and guidelines.

## NPMEE-20 Artificial Intelligence for Pediatric Radiologists: A Gentle Introduction for the Non-enthusiast

Marcelo S. Takahashi, MD, PhD (*Presenter*) Speaker, Vertex Pharmaceuticals Incorporated

### TEACHING POINTS

This presentation is intended for pediatric radiologists with no/little AI experience. We will explain the basic concepts of AI applied to radiology and discuss practical example of usage of AI in pediatric radiology. Main points: 1)Core AI concepts and

1)Brief history of AI in radiology 2)Basic algorithm creation and operation 3)Applications of AI in radiology 4)Limitations of AI in radiology

#### **TABLE OF CONTENTS/OUTLINE**

1 - Disclaimer: • created for pediatric radiologists with no/very little experience in AI. • Essential concepts will be explained in straightforward manner and accessible language.2 - Introduction: • Core concepts: • What is artificial intelligence, narrow AI and broad AI • Machine Learning and Deep Learning. • Big Data, Data Science, Domain Knowledge3 - Brief history of AI in radiology: • The early years. • The CAD era • The Machine Learning and Deep Learning era.5 - Basic Lexicon: • Dataset, model, algorithm, training, testing, generalization, features, classification, segmentation, regression, clustering, prediction, label, supervised learning, unsupervised learning4 - "Classic Machine Learning" and Deep Learning: • How is a "classic ML" algorithm created? • DL algorithm creation • Main differences, advantages and disadvantages ("classic ML" vs DL).5 - Where is/can AI be applied in the pediatric radiologist's workflow (with practical examples) • Imaging criteria, scheduling, acquisition (MR acceleration, CT/XR dose reduction), image analysis (segmentation, classification, detection), reporting (NLP), precision medicine.6 - "Must know" AI limitations : • Algorithm creation vs algorithm implementation • Interpretation errors • Generalization errors7 - Take home message

#### **NPMEE-21 The Potential Applications of ChatGPT in the Field of Medical Imaging**

Kexin Wang (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This exhibit combines recent literature reviews to explore the application prospects of ChatGPT in the field of medical imaging, including its potential applications in medical service, teaching, and scientific research settings, possible ways to apply ChatGPT, and the attitudes of the academic community towards the application of ChatGPT in the field of medical imaging.

#### **TABLE OF CONTENTS/OUTLINE**

1. ChatGPT can be used in the processing of medical document texts such as medical records in the medical imaging workflow, to achieve the structuring and standardization of texts, promoting effective interaction between staff and patients.2. ChatGPT can also be used to train medical students and resident physicians in image diagnosis by improving teaching efficiency through interactive learning and teaching methods.3. ChatGPT can assist in the literature retrieval, data collection, statistical analysis, and article writing processes in scientific research. However, researchers should be aware of the risk of ChatGPT taking over as the main tool and control the research process to ensure the authenticity of the research.

#### **NPMEE-22 Ways to Improve Patient Satisfaction Analytics in the Modern Era of Radiology: Tips and Tricks from the Patient Satisfaction Officer**

Austin Williams, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Third party analytics evaluate care directly from patients in a simple, fast, and easy-to-use fashion. 2. The information obtained from analytics offers radiologists and their practices an opportunity to identify patient needs and priorities while recognizing weaknesses and opportunity for improvement.3. Modifications and implementation of new practices are often minor, requiring little to no infrastructure, cost, or time while having a positive impact on retention, referral, and most importantly patient satisfaction.

#### **TABLE OF CONTENTS/OUTLINE**

1. Define the patient experience as it relates to most commonly observed factors.2. Discuss the role that current-day technology has played in the implementation and innovation of healthcare analytics regarding both acquisition and interpretation.3. Recognize that personnel, speed, and ease of care are common subjects of both positive and negative patient experiences. 4. Identify methods to respond to feedback that increase patient satisfaction.

#### **NPMEE-23 Utilizing 3D Printing and Phantoms to Teach the Basic Principles and Pitfalls of Ultrasound**

Patricia A. Garcia (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Ultrasound (US) is an operator-dependent imaging technique; thus, teaching this skill is critical to radiology education. Ensuring adequate training is essential to patient safety and quality assurance in clinical practice. Those trained in US are keenly aware of the many pitfalls of US imaging. US physics and related artefacts are covered comprehensively in the Diagnostic Radiology curriculum; however, modern education emphasises alternate approaches to teaching, including hands-on practical sessions. US phantoms are used to teach biopsy techniques, but little literature exists on the use of phantoms to teach US basic principles. To simulate commonly encountered US limitations and artefacts, we created gelatin-based US phantoms with embedded objects made from 3D-printed moulds, allowing trainees to experience them in real-time. The embedded objects demonstrated concepts such as relative echogenicity, the importance of imaging an object in multiple

planes, mirror image artefact, increased acoustic through-transmission and shadowing. Representative scans of these phantoms will be presented to confirm their utility in demonstrating these concepts.

#### **TABLE OF CONTENTS/OUTLINE**

1. Challenges of teaching hands-on ultrasound skills 2. Technical aspects of phantom creation 3. Demonstration of basic principles 4. Demonstration of artefacts

#### **NPMEE-24 Scire Quod Sciendum: Knowledge at the Intersection of Suboptimal Photography and Radiography**

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Learning Objectives Using the author-shot photographs and curated suboptimal radiographs, this exhibit will help the audience: 1. Understand the causes and types of suboptimal chest radiographs. 2. Learn about the global frequency of suboptimality in the most frequent radiological procedure - chest radiographs. 3. Understand what errors in photography can teach about suboptimal radiography. 4. Understand how suboptimality in radiography influences the interpretation using photo-radio-graphic examples.

#### **TABLE OF CONTENTS/OUTLINE**

Content organization 1. What makes a chest radiograph suboptimal? 2. What are the parallels between suboptimal radiography and photography? 3. Use of common causes and examples of suboptimal photographs to educate about suboptimal chest radiographs. 4. Parallel examples of how suboptimal photography and radiography hide or distort key findings

#### **NPMEE-25 RadioGraphics Trainee Editorial Advisory Members Board (RG TEAM)**

Melina Hosseiny, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-The RadioGraphics Trainee Editorial Advisory Members Board (RG TEAM) was established in December 2020 to involve trainees in shaping the journal's content and direction. -The RG TEAM is a group of radiology trainees from around the world who play a crucial role in developing high-quality educational resources that are specifically tailored to trainees. RG TEAM initiatives include content curation, innovation of creative trainee resources, organization of trainee Top 10 reading lists, creation of trainee-focused editorials, Cases from the Cookie Jar (in-print and social media), and the new official Spanish version on social media (Casos Cooky). -Joining the RG TEAM offers multiple benefits to its members, such as mentorship, networking, career development, experience in academic writing and publishing, and exposure to global radiology education. -Trainees can obtain mentorship through the RG TEAM by collaborating directly with RadioGraphics editorial board members and radiology experts, and gain valuable skills including communication, writing, and critical thinking skills. This relationship extends beyond the one-year term and can last a lifetime. -RG TEAM has an annual call for new applications available in SPRING. Interested trainees can submit their curriculum vitae, statement of interest, and an idea for a trainee-focused RG TEAM initiative. Residents and fellows in diagnostic or interventional radiology, radiation oncology, and nuclear medicine, as well as medical students, are encouraged to join.

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction to RadioGraphics and RG TEAM 2) RG TEAM Initiatives 3) Benefits of Joining the RG TEAM and How to Get Involved 4) Conclusion

#### **NPMEE-26 Blueprint for Medical Student Exposure to Radiology through Research: GSW and MVC Projects**

Hanna K. Thompson (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Medical students can be given early exposure to radiology through research. Research projects can be initiated using pre-existing data sets like the Trauma Registry maintained at Level I trauma centers. Projects can give residents and medical students leadership opportunities. Projects can give medical students opportunities to present their work at local, regional, and national conferences.

#### **TABLE OF CONTENTS/OUTLINE**

Purpose: Few opportunities exist for medical students to gain exposure to radiology outside of seeking out electives during clinical years. Methods: IRB approval was obtained to access 10 years of GSW injury data. See Figures 1 and 2. Under trainee guidance, medical students reviewed radiology images and worked to grade injuries by the American Association for the Surgery of Trauma injury grading scales. Once injuries were scored, clinical questions were examined. As part of the expansion to MVC injuries, we are recruiting new students at M1 Orientation and collaborating with other specialties. Results: In year 1, 13 posters were presented at a local conference, Research!Louisville, and 6 at state, regional, and national

conferences. See Figures 3 and 4. Data presented at RSNA will include the number and listing of the projects presented at Research!Louisville in September 2023 (planning for 45 posters) and will also include 2 years of survey responses from medical student participants and leaders. Conclusion: Trauma registries provide a robust dataset that can be utilized to increase early exposure to radiology in medical school and facilitates collaborative projects between residents and medical students, that students can further expand on as their research experience grows. .

## **NPMEE-27 Radiology at the Crossroads: Navigating Patient Safety, Risk Management, and Clinical Ethics in Modern Imaging Practice**

Jay Starkey, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Comprehensive overview of medical ethics, patient safety, and risk management in radiology 2. Empowering radiologists and trainees to actively engage in quality improvement 3. Transcending specialties to create a positive impact on patient care

### **TABLE OF CONTENTS/OUTLINE**

1) Intro: Radiology, Patient Safety, Ethics2) Radiation Safety, Dose Reduction3) Informed Consent in Procedures4) Communicating Critical/Incidental Findings5) Radiology Research Ethics6) AI, Machine Learning: Safety, Ethics7) Justification/Appropriateness of Imaging8) Optimizing Imaging Protocols9) Pediatric Radiology Safety10) Radiology Workflow, Patient Safety11) Contrast Media Safety, Reactions12) Radiation Exposure in Pregnancy13) Safety/Quality Improvement Initiatives14) Reducing Reporting Errors15) Incident Reporting, Learning from Errors16) Patient-centered Care17) Confidentiality, Data Protection18) Teleradiology Ethics19) Credentialing, Privileging20) Sports Injuries Imaging Ethics21) Cultural Competence, Diversity22) Managing Incidental Findings23) Peer Review, Feedback24) Radiology Education Ethics25) Financial Considerations, Conflicts26) Interprofessional Collaboration27) End-of-Life Care Ethics28) Cognitive/Mental Health Issues29) Radiology in Global Health, Disaster30) Palliative Care Imaging Ethics31) Addressing Healthcare Disparities32) Shared Decision-making33) Public Health Emergencies Ethics34) Access to Radiology Services35) Conclusion, Future Directions

## **NPMEE-28 Myth Busters: Questioning Standard Radiology Practices for Value-added Care**

Jay Starkey, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

This exhibit aims to debunk common myths in radiology practices that are believed to provide value-added care but, in reality, lack sufficient scientific evidence to support their efficacy. By analyzing scientific data and exploring recent research, the article challenges widely accepted practices to promote a more evidence-based approach to radiology.

### **TABLE OF CONTENTS/OUTLINE**

I. Introduction, a. Value-added care definition, b. Importance of evidence-based practicesII. Radiology Myths, a. Myths 1-5, b. Myths 6-10III. AUC Reality, a. AUC role in debunking myths, b. AUC examplesIV. Barriers to AUC, a. Resistance to change, b. Financial incentives, c. Technology and trainingV. Overcoming Barriers, a. Education, b. Incentives for evidence-based practices, c. Technology upgradesVI. Measuring Radiology Value, a. Patient outcomes, b. Costs, c. EfficiencyVII. Strategies for Value-Added Care, a. Staying current on evidence-based practices, b. AUC for dispelling myths, c. CommunicationVIII. Conclusion, a. Summary of exhibitIX. References

## **NPMEE-29 From Detection to Action: A Journey Through Incidental Findings in Radiology**

Jay Starkey, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

This educational exhibit aims to provide a comprehensive understanding of incidental findings in radiology, addressing their various aspects including identification, communication, management, legal implications, and patient autonomy. The presentation highlights the importance of awareness and proper handling of incidental findings, balancing patient autonomy with ethical considerations and potential harms. It emphasizes the need for evidence-based management, structured reporting, and effective communication. The evolving role of technology, particularly AI, in detecting and managing incidental findings is also discussed.

### **TABLE OF CONTENTS/OUTLINE**

Introduction: Definition and variability among radiologists || Settings where incidental findings may ariseEducation: ACGME and ABR guidelinesPatient autonomy Access to images, understanding reports, imaging preferences, and referralsCommunication of incidental findings: Timing, disclosure, responsibilities, and documentationLegal implications: Civil and criminal lawsuits, protection for radiologistsManagement of incidental findings Evidence-based practices, second opinions, structured reporting, national/international variations, conflicts of interest, guidelines, and low-resource settingsHarms of incidental findings Costs, psychological impact, overcalling and undercalling incidentalsCommon incidental findings: ACR

white papers, unclear clinical significance, small focus of ischemia Conclusion Importance of awareness, research, guidelines, and technology in managing incidental findings.

### **NPMEE-3 International Observerships in Pediatric Radiology: Optimization and Potential Benefits**

Hermon Derbew, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

International clinical observership programs can facilitate highly effective academic collaboration, international brand building, information dissemination and recruitment. However, this type of program typically adds bureaucracy, logistics and faculty workload for the hosting institution—as well as many regulatory and financial barriers for interested individuals. Our institution's proactive approach to welcoming observers from diverse backgrounds minimizes the financial burden to applicants and allows collaboration to advance our academic mission. This exhibit explains the process and impact of the program with emphasis on specific steps taken towards improved workflow and increased throughput of observers.

#### **TABLE OF CONTENTS/OUTLINE**

1. Process, 2. Institutional benefits, 3. Impact

### **NPMEE-30 A Step-By-Step Approach to Establish and Enhance MRI Site Safety: A Primer for Radiologists**

Pradnya Y. Mhatre, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

MRI Site Safety is important for protection of patients, staff and public. Proactively thinking about MR Safety features while designing an MR suite is key in establishing robust MR safe environment. American College of Radiology has created MR Safety Manual which includes general principles of MR Safety. We describe various components of MR Site Safety that need to be implemented in a systematic manner to create a robust and sustainable program.

#### **TABLE OF CONTENTS/OUTLINE**

Initial step in establishing site safety is to identify MR Medical Director, MR Safety Officer and MR Safety Committee. We describe how to structure MRI zones, including placement of ferrous quarantine, safe storage, patient transfer, mechanical room, and control room. We also discuss marking of equipment with appropriate signage, use of ferromagnetic detection devices, operation of MR conditional devices in Zone IV and infection control. Specific considerations for cryogen safety, cryogen vent pathway and quench scenario are discussed. Important design details during construction and installation are included. Development of key site safety policies and procedures needed and will be discussed including quarterly and yearly site safety checklist and QC program. Lastly, we will discuss emergency plans for various emergencies like fire, water damage, quench, structural damage, establishment of code area, and preparation for emergency resuscitation, which are a key component of site safety.

### **NPMEE-31 Stay Calm and Don't Attract the Magnet: A Comprehensive Review of MRI Safety Precautions**

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Following completion of this presentation, the reader will be able to: (1) Identify the four zones of MRI facilities (2) Describe the direct effects of MRI on patients (e.g., noise, heat, neurostimulation) (3) Describe the indirect effects of MRI on patients (e.g., interactions with existing devices and equipment) (4) Define specific absorption rate (SAR) and specific energy dose (SED) and their applications to MRI examinations (5) Discuss specific MRI safety considerations for special patient populations (6) Discuss safety profiles of gadolinium-based contrast media

#### **TABLE OF CONTENTS/OUTLINE**

(1) Background: Physical setup and zones, Hardware and parts of MR apparatus (2) Auditory concerns (3) Heating effects (including burns) (4) Peripheral neural stimulation (5) Portable metallic objects and equipment (6) Medical device and hardware compatibility and interactions (7) Contrast agents (8) Personnel and staffing (9) Special populations: pediatric patients, pregnant patients, patients with altered states of consciousness, obese patients, prisoners and detainees

### **NPMEE-32 Common Errors in Neuroradiology**

Luke M. Wojdyla, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Diagnostic errors in neuroradiology are alarmingly common, with estimates ranging from 1-16% in clinical practice. It is well established that most diagnostic misses, including those which result in malpractice litigation, are due to errors in perception. Despite this, the miss rates of specific neuroradiologic diseases have historically been undefined. Recently, a growing number



of studies have quantified and categorized neuroradiologic errors across training levels and in a variety of practice schema, measuring the influence of radiologist experience, specific pathology, and other individual and systematic factors. In this exhibit, the most common diagnostic errors described in emerging neuroradiologic literature will be presented. Briefly, these include errors of cerebrovascular pathology, blind spots on CT head imaging, errors of cerebrovascular pathology, misses of head and neck pathology, and errors of skull-base pathology. Systemic factors affecting performance such as practice volumes, reading speeds, and fatigue will also be presented. Knowledge of these findings can provide insight into understanding why errors occur, and in turn, help develop robust strategies to prevent them. Radiologists should be aware of the common blind spots and missed pathologies in the variety of settings described in this exhibit.

#### **TABLE OF CONTENTS/OUTLINE**

Explore the impact of diagnostic error in neuroradiology. Summarize recent literature quantifying common neuroradiologic errors amongst residents, generalists, and neuroradiologists. Appreciate the risk factors and biases associated with error. Provide case examples of real errors encountered in one department. Discuss strategies to minimize error.

### **NPMEE-33 Microaggression or Cross-Cultural Competence?**

Peter Kalina, MD, MBA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The pursuit of cultural competence among an increasingly diverse and interconnected workforce is vital. It requires empathy and perspective taking. It behooves us to successfully distinguish the subtleties that exist between the negative connotation of microaggressions from the positive influence of cultural competence. Microaggressions are subtle indignities, slights or insults whose derogatory nature communicates prejudice, dismissal, denigration, hostility or negativity to a member of a marginalized group. They may appear indirect, casual, innocuous, and insignificant. They are often unconscious and unintentional, arising from underlying: prejudice, discrimination, oppression, or bias. Are microaggressions sometimes confused with a genuine desire to improve one's cross-cultural competence?

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction 2) Cross-Cultural Competence and Communication 3) Microaggressions 4) "Microaggressions are a real problem" 5) "Microaggressions are much ado about nothing" 6) Conclusions

### **NPMEE-34 RadLinks: Creating an Efficient Reference Webpage for Incidentaloma Management Guidelines and Template Generation**

Alice Shieh, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Conceptualize and design a webpage (RadLinks) to efficiently reference incidentaloma management guidelines- Discuss webpage design features that streamline incidentaloma management- Provide a seamless workflow so radiologists can provide incidentaloma management recommendations quickly with ease

#### **TABLE OF CONTENTS/OUTLINE**

Barriers to efficiency when managing incidentalomas?- Time consuming and repetitive efforts to look up information?- Lack of resource consolidation? Benefits of using the RadLinks page?- Minimalist, user-friendly design?- Thoughtfully consolidated resources ?- Pre-generated templates and text macros ?- Hosted on public domain, with lack of institutional barriers RadLinks user interface features ?- Expandable/collapsible navigation menu, ability to enlarge figures/charts in-screen, copy text to clipboard with one-click, mobile device compatibility ? Website hosting and building options and tools ?- Squarespace, Wix, WordPress ?- Flaticon ?- HTML/CSS tutorials Copyright issues ?- Obtaining permissions to display figures and graphs from published articles Future directions ?- Keeping content and guidelines up to date?- Expanding resources beyond incidentaloma management?- Reducing scrolling distance ?- Implementing user suggestions and feedback ?

### **NPMEE-35 Beauty Beyond a Few Slides Deep: How to Increase Radiology Lecture Engagement**

Julia Tran, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) Engaging lectures can hold the audience's attention, convey information more effectively, and make lessons more memorable. (2) Use graphic design resources (eg. AI art sites, design software, typography sites) to visually enhance your presentation. (3) Include activities that require active participation such as games, polls, and PACS simulators to increase engagement.

#### **TABLE OF CONTENTS/OUTLINE**

Didactics are an integral part of radiology education but creating engaging learning experiences can be challenging. Effective and interactive lectures improve learning outcomes by helping learners retain and apply new information. This educational exhibit will (1) introduce the concepts of graphic design and its role in creating impactful presentations. We will share various

graphic design software, AI tools, and web resources useful for creating visually appealing designs. We provide examples of how to format lecture slides to emphasize key learning points and findings. This exhibit also aims to (2) showcase various interactive tools and activities that increase audience engagement. PACS simulators, such as PACSBIN, combine imaging software with educational tools to create case-based quizzes and lesson plans. Gamifying cases into competitions, such as Taboo™ or Pictionary™, motivates learners to strive for mastery. By implementing these strategies, educators can create more effective and engaging learning experiences.

### **NPMEE-36 Sustainability, Climate Change and Radiology: Why We Should Care and What We Can Do**

#### **Awards**

##### **Certificate of Merit**

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

#### **TEACHING POINTS**

Producing, using, and powering medical imaging equipment to provide radiology services are estimated to contribute to 1% of total global greenhouse gas emissions. Achieving sustainability in radiology requires immediate and strategic action. Strategies should focus not only on mitigating radiology's impacts, but also building resiliency to the risks of climate change through adaptation, with action taken at individual, department, and industry levels. Opportunities to reduce radiology's carbon footprint include reducing emissions due to non-productive scanner time and minimizing the use of single-use products and overall waste. Reducing overall emissions in health care and radiology will also require partnerships with both industrial and clinical stakeholders.

#### **TABLE OF CONTENTS/OUTLINE**

The overarching goal of this exhibit is to review the intersection of sustainability, climate change and radiology with a focus on why we should care and steps we can take to reduce waste and greenhouse gas emissions. This will be achieved by: 1. Describing the human health impacts of climate change, with health equity considerations. 2. Discussing diagnostic and interventional radiology's contributions to greenhouse gas emissions and waste. 3. Reviewing sources and classification of emissions related to radiology. 4. Differentiating mitigation (reducing impacts) and adaptation (building resiliency) strategies related to radiology. 5. Exploring strategies to promote sustainable practices at individual, institutional, and industry levels.

### **NPMEE-37 Decolonizing Radiology: Addressing Historical Influences and Promoting Global Equity**

Pareena Sharma (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

It is well established there are worldwide disparities in access to radiology services as well as image guided procedures. While differences in access to care persist in the United States, there are profound disparities in access to care between high income countries (HIC) and low/middle -income countries (LMIC). Socioeconomic differences in patient populations, lack of equipment, career opportunities, and until recently lack of formal training programs have all contributed to differences in global access to radiology services. An additional well known contributing factor in differences to access to care are the historical effects of colonialism. While there have been increasing world-wide efforts to decrease the gaps in access to care and addressing the training gap in radiology, there has been little effort to address the history of colonialism in global health work in the context of radiology. This educational exhibit aims to provide context to the history of colonialism in global health and how this perspective is crucial to provide sustainable solutions for long term global radiology equity and culturally competent global health work.

#### **TABLE OF CONTENTS/OUTLINE**

1. History of Colonial Influence on Radiology 2. Consequences of Colonialism in Radiology 3. Current State of Global Radiology Outreach 4. Strategies for Decolonizing Radiology

### **NPMEE-38 Global Radiology: Building Equitable and Sustainable Partnerships with Low- and Middle-Income Countries (LMICs)**

Lydia A. Kwarteng, BS, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Global radiology partnerships can be leveraged to help address the shortage of radiology professionals in LMICs. Simultaneously, there are efforts to address the legacy of colonization on global health initiatives by highlighting the power asymmetry between High-Income Country (HIC) and LMIC partners. This exhibit reviews the critical need to help establish and scale-up radiology training programs in LMICs, highlights opportunities for reform in global health, and provides examples of best practices to foster equitable and sustainable global radiology partnerships with LMICs.



## TABLE OF CONTENTS/OUTLINE

Background- Shortage of radiology professionals in LMICs- Global radiology engagement in LMICs The Decolonize Global Health movement- Origins in global health- Goals and controversies Building equitable global radiology partnerships- Leadership and decision-making- Understanding sociocultural context- Equity in research, education, and capacity-building- Funding practices- Transparency and accountability Examples of successful partnerships in Africa- HIC-LMIC institutional collaborations in global cancer research, subspecialty training, and capacity-building (e.g. in neuroradiology, breast imaging, and interventional radiology).

### **NPMEE-39 Usefulness of Deep Learning for Improved Image Quality and Noise Reduction in Diffusion Weighted Imaging (DWI)**

Hirofumi Koike (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Deep learning (DL) has recently experienced explosive growth including many areas of medical research. Recent advances in DL-based image reconstruction in MRI have been reported to achieve improved image quality through noise reduction and super-resolution (SR), but there have been very few reports of its application to diffusion-weighted imaging (DWI). We have scanned various body regions with a DL-based DWI research application for clinical evaluation. These images are presented with clinical findings. In addition, underlying technical details and imaging parameter optimizations are presented. Although the visual impression varies depending on imaging regions or scan parameters, the following advantages in DL-based reconstruction are observed: noise reduction due to DL, reduced distortion due to higher acceleration factor, sharpness improvement due to SR and higher spatial resolution, and better visibility of background normal tissues due to shorter echo time.

## TABLE OF CONTENTS/OUTLINE

1. To present DWI images with deep learning-based image reconstruction and its findings in various body regions. 2. To understand the mechanism of deep learning-based image reconstruction. 3. To understand scan parameter optimization in DL DWI. 4. To know the clinical feasibility of DL DWI in patients with various diseases.

### **NPMEE-4 Waste Reduction in Radiology: Educational Case Series**

#### **Awards**

#### **Certificate of Merit**

Christine Yao, BA, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

In the U.S. the healthcare sector is estimated to contribute almost 10% of our nation's carbon emissions. As healthcare professionals, we are committed to improving the well-being of our patients, so we also must focus on decreasing our contribution to climate change. Radiology departments can target both direct and indirect emissions by decreasing energy usage within the workspace, reducing unnecessary imaging, and transitioning to green suppliers for the procurement and disposal of medical equipment. Studies have shown that there is a high rate of imaging overuse. Understanding the environmental impact associated with these practices can help to encourage appropriate usage. There are both external and internal factors that can drive a physician to order unnecessary or inappropriate imaging, including but not limited to defensive medicine, patient expectations, obliviousness to cost and risks, breaks in patient-provider communication, and inadequate knowledge.

## TABLE OF CONTENTS/OUTLINE

Introduction a. Health care impact on environment b. Radiology energy use c. Avenues for reduction Case examples a. Emissions by scan b. Contrast use Inappropriate imaging examples a. Contributions to inappropriate imaging b. Inpatient cases c. Outpatient cases Advocacy strategies

### **NPMEE-40 The Second Mountain - Climbing the Challenges of Mid-career Radiology**

Miltiadis Tembelis, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The mid-career phase for a radiologist, and many other professions, is a time burdened by career stagnation and high rates of burnout. To spite it being a particularly difficult time in the radiologist career, there is little dedicated mid-career support to help radiologists overcome their woes. The goal of this presentation is to highlight the difficulties faced by the mid-career radiologists as well as provide potential solutions to these problems. A focus on the mid-career female radiologist and their unique challenges will also be presented.

## TABLE OF CONTENTS/OUTLINE

This review will define the mid-career radiologist and provide an overview of the current radiology workforce. Problems such as burnout, career stagnation, alternative career pursuits, lack of mentorship, sponsorship and career development programs, and gender specific challenges of women will be discussed. Potential solutions to these problems will also be presented.

### **NPMEE-41 Subspecialty Breast Imaging Education in Tanzania: Clinical, Infrastructure and Logistical Paradigms for Best Practices in the Low- and- Middle Income (LMIC) Setting**

Toma S. Omofoye, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Given the global rise in breast cancer, radiology workforce shortages in sub-Saharan Africa are critical.
- The RSNA-led Global Learning Center (GLC) initiative in Tanzania for sub-specialty breast radiology training is presented as a paradigm for remote/in-person education.
- It is imperative to tailor interventions for the resource-limited LMIC environment.
- Presenting a scalable education program for best practices in the LMIC setting, with goals of improving interdisciplinary breast care through training, infrastructure, and optimization of local resources.
- An example of an transnational alliance to care for underserved populations.

## TABLE OF CONTENTS/OUTLINE

1. Introduction a. Radiology workforce in Africa b. Breast Cancer in Tanzania 2. Educational Paradigm a. Background/need i. Tanzania medical education, radiology and subspecialty education b. Trainees c. Curriculum i. Goals/objectives ii. Content iii. Learners iv. Faculty v. Resources and Methods ? Synchronous teaching ? Asynchronous teaching ? Observerships vi. Assessment vii. Governance viii. Continuous improvement 3. Breast Imaging Service a. LMIC modality specific goals b. Reporting c. Interprofessional collaborations 4. Infrastructure a. improving technology and support staff 5. Future directions

### **NPMEE-42 Radiologists for a Sustainable Future (R4SF): Bridging the Gap Between Radiology Practice and Environmental Responsibility**

Melina Hosseiny, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Radiologists for a sustainable future(R4SF) is an international community of radiologists and trainees, dedicated to promoting environmentally sustainable radiology practice and healthcare delivery.-R4SF advocates for policies that promote environmental sustainability in healthcare.At R4SF, radiologists/radiologists-in-training and leaders in the field unite to promote sustainable practices in radiology through education and awareness initiatives, the promotion of sustainable projects, and the establishment of a supportive network.-The R4SF has teams working together to advocate for sustainable radiology through education, policy, social media, and research. -Education team focuses on expanding the participation of medical students and residents in sustainable practices.-R4SF collaborated with members' ACR chapters to propose and pass a resolution on climate change and sustainability at the 2022 National ACR meeting. -R4SF team is a subgroup of the larger multispecialty Healthcare without Harm physician network and has support, mentorship, and sponsorship from great leaders in the radiology society.-Members of R4SF have delivered talks and shared our aims to the radiology community at various societies, including RSNA, ARRS, SABI, AUR, and others.

## TABLE OF CONTENTS/OUTLINE

1)Introduction to Radiologists for a Sustainable Future (R4SF)2)R4SF Initiatives 3)R4SF Goals and Collaborations4)Benefits of Joining the R4SF and How to Get Involved5)Future Direction

### **NPMEE-43 Let it Go, Let it Go: An Approach to Assessment and Reporting of Benign or Low-Risk Incidental Findings in the Chest**

#### Awards

#### Certificate of Merit

Erin N. Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiologists are expected to provide management recommendations for incidentally detected pulmonary nodules and thyroid nodules. While some are clinically impactful, a majority are benign and inconsequential. Fleischner, Thyroid White Paper and TIRADS consensus recommendations were developed to decrease inappropriate recommendations for further evaluation. In our quest to do no harm, radiologists can help decrease patient anxiety, time spent, medical expenses and potential risks associated with further characterization by using best practices for characterizing and reporting nodules which do not require further evaluation through clear, concise language. We will present examples of nodules inappropriately recommended for follow up and a step by step approach to assessment and reporting. ?

## TABLE OF CONTENTS/OUTLINE

Introduction? Commonly Mischaracterized Incidental Findings on Chest CT: ?- Pulmonary nodules? - Mucous plugging? Granulomas? - AVMs? - Thyroid Nodules? Risk statistics for nodules by size? Reporting considerations: ?- Morphologic descriptors (shape, density, distribution)? - Measurements - 3 plane review? - Concise, specific language; avoiding vague terms? - Comparison with prior imaging? Patient history? Letting it go: supporting data? Role of Structured Reporting? Pre-Populated Macros: Pros and Cons? Society Recommendations and Indications for Incorporation into Reports? Closed Loop Communication? Conclusion

## NPMEE-44 Best Practices for Medical Student Engagement in the Radiology Reading Room

### Awards

#### Certificate of Merit

Devyn C. Rigsby (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. There is no standardized approach to engaging medical students in the radiology reading room during radiology electives (1). 2. Without intentional incorporation of medical students into the reading room team, students may feel disinterested, excluded, or insufficiently challenged to learn. Negative experiences on radiology electives may dissuade students from pursuing radiology as a career. 3. This presentation shares best practices for radiology preceptors to foster a healthy learning environment, maximize educational opportunities, and increase medical student interest in radiology. 4. Best practices for engaging medical students in radiology courses can be divided into three parts: preparing for student arrival, starting a learning session, and facilitating case-based instruction. 5. These best practices are transferrable to any institution's in-person radiology curriculum for medical students. Reference 1. Darras KE, Spouge R, Kang H, et al. The challenge with clinical radiology electives. *Can Assoc Radiol J.* 2019;70(4):337-343.

## TABLE OF CONTENTS/OUTLINE

1. Problem statement 2. Common concerns about the reading room experience raised by students at our institution 3. Preparing for student arrival in the reading room a. Introductory information b. Identify near-peer mentor (resident or fellow) c. Student workspace 4. Starting a learning session a. Learning objectives b. Transfer of foundational knowledge c. Select cases for student to attempt independently 5. Facilitating learning through cases a. Student inclusion in all trainee readouts b. 1:1 student readouts on assigned cases c. Session wrap-up

## NPMEE-46 It Takes a Village: Multidisciplinary Breast Subspecialty Telementoring for Low- to Middle-Income Countries (LMICs)

Toma S. Omofoye, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Funded by an RSNA International education grant, a method for telementoring is described for breast radiologists, pathologists, oncologists, and surgeons where domestic/foreign, low/high resource, and within/outside subspecialty input is used to adapt best practices to available resources. Breast subspecialist shortages in African Low-Middle-Income Countries (LMICs) call for creative solutions. Many LMICs lack multidisciplinary communication (radiology-pathology or tumor board). While LMIC practitioners have varying levels of breast subspecialty training and resources, they have tailored creative solutions for optimizing resources to address advanced disease. The transnational collaboration (with 200 participants from 3 continents- Africa, North and South America) assists capacity building.

## TABLE OF CONTENTS/OUTLINE

We describe a model for multidisciplinary telementoring to provide paired subspecialty support for breast health practitioners in LMICs. 1. Introduction: LMIC breast cancer burden and subspecialty workforce gaps 2. Project Extension for Community Healthcare Outcomes (ECHO) ABCD model: a. Amplification of medical knowledge b. Best practices to improve outcomes c. Case based (clinically-relevant) learning d. Database: outcome monitoring 3. Program Formata. Case presentation b. Interprofessional and multidisciplinary input c. Complementary didactics 4. Case-based examples including: Rad-path concordance, quality, symptom, interesting or difficult cases, and rare disease management

## NPMEE-47 Supporting Women in Radiology: Implementing a Multi-institutional Coalition

Madiha Aseem, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Women are underrepresented in radiology. Even though men and women are about equally represented among medical school graduates, only 27% of applicants in radiology are women.<sup>1,2</sup> Furthermore, female radiology leaders make up an even smaller minority, consisting of only 13% of radiology leaders.<sup>3,4</sup> The purpose of this exhibit is to showcase how a women in radiology (WIR) group in a teaching institution can provide role models, mentorship, and promote a culture of diversity and inclusion. Furthermore, the introduction of WIR collaborations with other institutions can promote an

institution's inter-institutional alliances and provide career advancement opportunities for its trainees. Training institutes are in a unique position to bring about this change. Trainees who have cultivated gender equality values can have a positive impact on their future practices. Though it takes time and effort to foster a culture of diversity and inclusion, it is necessary to do so in order to create a gender inclusive workplace which will benefit not only radiology departments but also patients.

#### **TABLE OF CONTENTS/OUTLINE**

A) Mentorship: Implementation of "mentoring up" and "mentoring down". B) Promote career advancement opportunities and promotions: Organize discussion panels with panelists from both private practice and academics with a mix of early, mid, and advanced career radiologists. C) Collaborate with other institutions' WIR committees to create inter-institutional alliances focused on promoting the above. D) Overcome or mitigate bias by organizing upstander workshops as part of the training curriculum. E) Understand the unique needs of women in the field, including pregnancy, parental leave, and lactation.

#### **NPMEE-48 Benefits and Applications of ChatGPT for Radiology Trainees**

Wenqiao Wang (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To provide an overview of ChatGPT from a trainee perspective  
2. To highlight best practices for using ChatGPT  
3. To illustrate how ChatGPT can be used to create relevant radiology review content including practice questions  
4. To demonstrate the radiology virtual-advisor capability of ChatGPT  
5. To describe how medical students can use ChatGPT to develop a preparation plan for radiology rotations  
6. To provide an overview of the future of ChatGPT in radiology undergraduate medical education

#### **TABLE OF CONTENTS/OUTLINE**

- What is ChatGPT? - How are trainees using ChatGPT? - Applications of ChatGPT for radiology learning and best practices- Using ChatGPT to generate radiology practice questions - Using ChatGPT to prepare for radiology rotations- Using ChatGPT as a virtual radiology advisor- Using ChatGPT to assist during core clinical rotations - Using ChatGPT to assist with professional communication - Future of ChatGPT in radiology undergraduate medical education

#### **NPMEE-49 Promoting Health Equity Through Radiology: Practical Tips for Empowering the Next Generation of Trainees**

Pooja Agrawal, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Medical students and residents in radiology represent the next generation of trainees and have a vital role in fostering sustainable health equity efforts focused on eliminating health disparities in radiology. Three ways trainees can promote health equity in radiology are through research, community outreach, and education.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Review existing health disparities in radiology using findings from a published systematic review; discuss the importance of trainee involvement in eliminating disparities; describe practical ways how research, community outreach, and education can promote health equity  
Health equity research: Introduce tips to identify a mentor; discuss how to select a research topic by identifying gaps in existing research; review opportunities at national meetings to build research network  
Community outreach: Discuss how to leverage existing community needs assessment to identify emerging opportunities; develop initiatives to educate patients about the importance of screening as a trainee; provide examples of radiology-focused community efforts (mobile mammography/lung cancer screening, RAD-AID)  
Education in health equity: Participate in the creation of radiology health equity-focused learning materials; collaborate in establishing mentorship programs to promote diverse applicants in radiology; explore how current radiology pillars in quality safety, innovation, and AI can be used as catalysts to bridge existing disparities  
Conclusion: Discuss how long-lasting health equity necessitates an understanding of systemic obstacles and a commitment to staying informed on fields such as molecular imaging, social genomics, and AI algorithms

#### **NPMEE-5 Medicolegal Readout: A Malpractice Primer for Radiologists**

##### **Awards**

##### **Magna Cum Laude**

Luke M. Wojdyla, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The majority of radiologists will face litigation in their careers. In a 2021 survey, 71% of radiologists said they were sued which is similar to estimates in prior reports. Despite this, dedicated teaching of medicolegal issues is often lacking or incomplete in radiology training programs. Residents are seldom exposed to legal issues that can arise when caring for patients, and attendings themselves may feel unqualified in leading medicolegal discussions. Concerningly, residents may transition to independent practice with an incomplete understanding of the legal environment applicable to their practice. This

exhibit will provide background for the legal frameworks relevant to modern radiology practice. A brief historical summary of key court decisions will be presented alongside a discussion of malpractice and radiologic errors. Challenging case scenarios will address nonroutine communication, reporting missed findings on comparison imaging, addressing technical limitations, and admitting mistakes, among others. At the end of the presentation, the reader should understand the legal basis for common radiologic practices, identify challenging situations with increased medicolegal risk, and implement practical strategies to mitigate risk of litigation.

#### **TABLE OF CONTENTS/OUTLINE**

Recognize the magnitude of malpractice within radiology. Understand how fundamental radiology practices have arisen directly from court rulings. Describe the most common causes for malpractice. Identify examples of frequently encountered medicolegal hazards and controversies. Case-based imaging examples will be used to discuss challenging medicolegal issues encountered in radiology.

#### **NPMEE-50 Integration of Clinical Context into Medical School Gross Anatomy Based on CT Imaging of the Students' Dissection Cadavers**

Peter J. Haar, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Incorporating imaging in medical school gross anatomy courses can provide medical students with early, positive learning experiences with radiology. The teaching points of this exhibit include the following: first, to describe methods to incorporate CT imaging of the students' dissection cadavers into a novel exercise in which dissection cadavers are regarded as medical students' "first patients;" second, to outline roles for radiology attendings and residents in interactive cadaver CT workshops; and third, to explore the potential benefits of the experience in medical education and radiology residency training.

#### **TABLE OF CONTENTS/OUTLINE**

1.) Anatomy Rounds: an exercise for medical students to synthesize clinically relevant cadaver observations. 2.) Methods and resources to acquire and distribute cadaver CT images to medical students. 3.) Involving radiology residents in generating radiology findings on full-body cadaver CT image sets. 4.) Strategies to enhance the learning experience of interactive workshops based on the dissection cadaver CT images. 5.) Potential benefits of interactive radiology experiences early in medical school education. 6.) Feedback from medical students and radiology residents on the value of the learning experience.

#### **NPMEE-51 Designing Interactive Team-Based Learning Experiences with Cadaver CT Images in Medical School Gross Anatomy**

Peter J. Haar, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Curricula involving CT images of medical school gross anatomy cadavers can provide students with a rewarding educational experience early in medical school. Teaching points of this exhibit include the following: first, to describe the challenges and benefits of teaching simple CT image analysis to enhance and complement gross anatomy instruction; second, to outline a strategy for developing interactive team-based learning modules and assessments; and third, to examine potential pitfalls and solutions in teaching the curriculum.

#### **TABLE OF CONTENTS/OUTLINE**

1.) Teaching gross anatomy and cross-sectional anatomy in parallel. 2.) User-friendly image interaction and teaching foundational concepts of CT imaging. 3.) Designing learning experiences with the intellectual rewards of correctly making real imaging diagnoses. 4.) Interactive group-learning assignments, and assessment of learning. 5.) Advantages and disadvantages of the interactive cadaver CT-based curriculum. 6.) Feedback and student response to the curriculum.

#### **NPMEE-6 A National Plan for the Renewal of Imaging in the EU: A Regional Perspective**

Cristina Enjamio, PhD, MEng (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

With this publication it is intended to disseminate a National Investment Plan and how it was managed and developed from a regional point of view. The main objective of this Plan is to increase overall survival and the quality of life of people through the diagnosis of diseases in early stages, which allow rapid therapeutic intervention. The plan pays special attention to the pathologies with the greatest impact on the present and future of a National Public Health Service (SNS), such as chronic diseases, oncological diseases, rare diseases and neurological diseases. All this, consolidating equity in access to high technology and improving the quality of care and the safety of patients and professionals. This poster describes the objectives, method and results of a national plan that involves the acquisition of 847 state-of-the-art equipment for the SNS in order to: Reduce the obsolescence of high-tech equipment, guaranteeing the renewal of 100% of equipment that is 12 years old or older in accordance with scientific recommendations. Raise the average density rate of high-tech equipment per 100,000 inhabitants by at least 15%, in order to improve equity in access throughout the national territory, bring the service

closer to patients and position the SNS, progressively, in the European average. As a consequence of the application of the Plan in our region, 76 new pieces of equipment are being installed (63 renewals and 13 extensions) and the total amount of the investment is € 67,204,159.

## **TABLE OF CONTENTS/OUTLINE**

TABLE OF CONTENTS Context and introduction Objectives of the Plan Methodology Results Discussion and conclusions

## **NPMEE-9 Using Process Mapping to Identify Targeted Interventions to Reduce Imaging Disparities**

Natasha M. McFarlane, BA (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Process mapping is a quality improvement tool used to depict flow of healthcare processes.
- Components of the imaging process are addressed in order to reduce imaging disparities.
- Pre-imaging interventions include reviewing imaging guidelines, providing culturally dexterous patient educational materials, community outreach, and improving imaging access.
- Imaging interventions include high quality interpretation services, patient-centered communication strategies, and maximizing patient comfort.
- Post-imaging interventions include structured collection of patient feedback and culturally-responsive patient navigation services to ensure adequate follow-up.

## **TABLE OF CONTENTS/OUTLINE**

1) Process Mapping Definition  
a) Published Process Maps  
b) Apply Health Equity Lens to Published Imaging Process Maps  
2) Pre-Imaging  
a) Review Imaging Guidelines Using Health Equity Lens  
i) Cancer Screening (breast, lung, colorectal)  
b) Clinical Decision Support to Reduce Variability in Decision-Making  
c) Patient and Provider Education  
d) Maximizing Patient Access  
i) Evidence-Based Strategies  
3) Imaging  
a) Culturally Dexterous Communication Strategies  
i) Definition  
ii) Standardized Communication Strategies to Improve Patient Communication for Diverse Patient Populations  
(1) Review Evidence-Based Strategies  
iii) Stigmatizing Language in Medicine  
(1) Definition  
(2) Application of Stigmatizing Language in Radiology  
1. Physician-patient encounter  
2. Radiology Reports  
3. Electronic health records  
(3) Vulnerable groups  
1. Patients of color  
2. Obese population  
3. LGBTQ community  
4) Post-Imaging  
a) Collection of Patient Feedback  
b) Patient-Navigation Services  
i) Review Evidence-Based Strategies

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## Abstract Archives of the RSNA, 2023

NPMEE-1

### **Every Little Bit Helps. How to Reduce Carbon Footprint with a Mobile MR. Experience from the Northwest of Spain.**

All Day Room: Learning Center

Mercedes Arias Gonzalez, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Mobile MRs are able to fill the service void in small to medium-sized hospital without in-house magnets. Delivering care closer to home avoids travel kilometers, highly contributing to an improved carbon footprint. Carbon footprint per MR scan can be even further reduced due to a higher utilization rate, as MR scanners cannot be turned off. Being conscious of radiology contribution to carbon footprint and greenhouse gas emissions can contribute to reduce them, as much as possible.

#### **TABLE OF CONTENTS/OUTLINE**

Evolution of needs and mobile MR implementation in the public healthcare system in Galicia (a region in the Northwest of Spain) since 2006. Evaluation of kilometers avoided by patients since 2006 and its effect in carbon footprint. Study of utilization rates of each mobile MR scan through the years. Easy explanation of useful concepts concerning carbon footprint and greenhouse gas emissions.

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## Abstract Archives of the RSNA, 2023

NPMEE-10

### Financial Fitness for the Radiology Resident

All Day Room: Learning Center

Kevin Wu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiologists receive little formal instruction on basic concepts related to financial planning. Yet, certain financial decisions and strategies that are best employed during residency can yield as much as hundreds of thousands in savings over the course of a career. Therefore, early financial literacy is one of the most important aspects of career counseling that trainees can receive. Indeed, certain financial maneuvers are only possible during the training years. For those with an average loan burden, income driven repayment (IDR) can be worth >\$400,000 over the course of a career, and is a priority consideration. Other maneuvers, such as electing to contribute to a Roth 403b/401k (if available) rather than a pre-tax 403b/401k during residency, or performing a 403b/401k-to-IRA rollover followed Roth conversion after training, are expected to be worth \$84,000 by retirement. Even greater savings are likely with such maneuvers if marginal income tax rates increase in the future. These and other strategies require only hours to employ, and must not be missed for all who are eligible. In this light, we present an "order of priorities" regarding financial maneuvers that maximize yield with respect to ease of execution. Specifically, we discuss maneuvers such as student loan IDR, value-driven credit card rewards, 403b/401k to Roth IRA rollover, strategies around tax season, and early modifications of the retirement portfolio mix.

#### TABLE OF CONTENTS/OUTLINE

Philosophy/disclaimers, The financial waterfall, Student loan IDR, Credit card optimization, Expense ratios, Pretax purchasing, Roth vs. traditional and conversions, Income tax projections, Portfolio mix, Avoidance of taxation events, Tax season, Subtleties

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## Abstract Archives of the RSNA, 2023

NPMEE-11

### Radiology Dashboards: Applications in Addressing Healthcare Disparities in Image Utilization

All Day Room: Learning Center

#### Awards

##### Cum Laude

Jay Patel (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the role of dashboards in radiology  
2. Examine how healthcare disparities (HCD) in radiology can affect morbidity and mortality  
3. Highlight specific applications of radiology dashboards in addressing HCDs in imaging utilization  
4. Discuss the limitations of radiology dashboards

#### TABLE OF CONTENTS/OUTLINE

1. What is a Radiology Dashboard?  
a. Key Performance Indicators (KPIs)  
i. Patient tracking  
ii. Image utilization  
iii. Turnaround time  
iv. Resource allocation  
v. Quality assurance  
2. Overview of the literature on HCDs in image utilization (e.g. disparities in imaging utilization in the emergency department, disparities in utilization of low dose CT for lung cancer screening, etc.)  
3. Applications of radiology dashboards in addressing HCDs in image utilization  
a. Identifying risk factors for decreased imaging utilization stratified by type of study (e.g. screening mammogram, low dose CT for lung cancer screening) and patient setting (e.g. emergency department)  
i. Zip code of patient residence  
ii. Race and ethnicity  
iii. Age  
iv. Language preference  
b. Developing quality improvement initiatives  
i. Patient education  
ii. Language accessibility  
iii. Cultural competency training and diversification of work force  
iv. Community outreach (e.g. mammogram vans and patient education efforts)  
v. ACR Select  
c. Monitoring response  
i. Before and after studies  
ii. Non-Comparative studies  
iii. Time series  
4. Limitations of radiology dashboards  
5. Conclusions

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## Abstract Archives of the RSNA, 2023

NPMEE-12

### Out of the Darkness and into the Light: Redefining the Role of Radiology in Community Engagement

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Somiah Almeky, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Provide a radiology-focused overview of foundational elements related to community engagement, community-based participatory research, reciprocal innovation, and community needs assessment and outreach
- Discuss evidence-based examples of how radiology staff/trainees play a crucial role in delivering equitable care
- Explore how community engagement can be leveraged as an effective method to restore purpose in our daily work and prevent burn-out
- Review practical examples of community engagement across various settings (ie. rural, urban, global health)
- Discuss steps to establish a centralized curriculum that defines the role of radiology in the community, and provides trainees with concrete examples of this work

#### TABLE OF CONTENTS/OUTLINE

1. Interface between Radiology and the Community
  - Definition of Community Engagement, Community-Based Participatory Research, Reciprocal Innovation
  - Leveraging institutional resources and community needs assessments to guide outreach efforts
  - c. Evidence-based community engagement startup toolkit for radiology
2. Case-based review of ongoing outreach efforts in various settings
  - Cancer screening efforts
  - Resident-driven initiatives
  - Health equity efforts
  - Outreach interventions among veteran populations
3. Potential pitfalls and opportunities for growth
  - Allocation of effort and time in alignment with community needs and departmental workload.
  - Tips on identifying opportunities to engage diverse communities
4. Empowering the next generation
  - Establishing a "Community Engagement in Radiology" curriculum
  - Overview of required competency elements
  - Facilitators and barriers to dissemination of the curriculum

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## Abstract Archives of the RSNA, 2023

NPMEE-13

### Breaking Bad News: What the Radiologist Needs to Know

All Day Room: Learning Center

Natalia Orthmann, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1.To emphasize the importance of breaking bad news in appropriate ways.2.To present the existing and consolidated bad news protocols.3.To elaborate on how the protocols can be applied in the day-to-day practice of radiologists, especially breast radiologists.4.To assist in the training of radiologists in this time of breaking bad news.5.To illustrate the differences between the most frequent protocols for breaking the bad news

#### TABLE OF CONTENTS/OUTLINE

1.Literature review focusing of consolidates bad news protocols.2.To illustrate and discuss how bad news protocols can make the moment less traumatic for physicians and patients.3.Discuss how to apply the protocols in the radiologist's routine.4.Examples cases of how bad news may occur in the radiologist's routine.5.Summary and conclusion.

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## Abstract Archives of the RSNA, 2023

NPMEE-14

### Green Teams - an AI Gore-ithm for Addressing Sustainability in Radiology

All Day Room: Learning Center

Katherine C. Frederick-Dyer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

We explain the process of forming a sustainability committee in the Department of Radiology to identify and address the environmental footprint in our academic department.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction A. What is sustainability and how does addressing it reduce costs and improve human health B. What is design thinking and how do we use it to solve non-linear problems II. Baseline Survey A. Identify attitudes and interest in climate change B. Identify opportunities to reduce carbon footprint and build allies III. First meeting A. Forming the committee - approaches to inclusivity B. Guidance with local climate experts to guide discussion 1. Assess - What is the carbon footprint of the department? 2. Inspire - To what extent do concerns about climate change and support for climate mitigation affect employee morale and patient satisfaction? 3. Model - How do we share our successes to decarbonize our department to guide other departments? C. Design thinking session 1. Actively engage participants to brainstorm ideas using colorful sticky notes 2. Visually organize ideas into the Categories (IIIb) 3. Establish culture of inclusivity, collaboration, transparency, fun, and accountability D. Organize team into subgroups to address each CategoriesIV. Subsequent meetings A. Encourage teams to produce achievable deliverables each meeting B. Assess what expertise and resources are needed C. Delineate team member roles and responsibilities D. Define timeline and metrics for success V. Highlighting early wins and how this contributes to the bigger picture

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## Abstract Archives of the RSNA, 2023

NPMEE-15

### Forward Together: Collaboratively Integrating Radiology throughout a Medical School Curriculum

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Matthew H. Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Integrating radiology throughout a medical school curriculum mirrors the breadth, depth, and impact of radiology in the real world  
2. Sustainable implementation of radiology throughout a curriculum is a product of thoughtful and strategic partnerships with medical school leadership across disciplines and central governance committees  
3. Collaboratively working with colleagues across disciplines can expand the footprint and impact of radiology in medical school  
4. Early consistent exposure to quality radiology education promotes recruitment into radiology and positively impacts learners pursuing other specialties  
5. Effective student education transcends passive modes of learning through activities that promote increased learner engagement

#### TABLE OF CONTENTS/OUTLINE

1. ForWard - 3-phase model integrating basic, clinical, and public health sciences, 10 integrated "threads"  
2. Phase 1 - thematic blocks incorporating basic and clinical science and early clinical medicine - incorporating radiology into anatomy, patient-centered education cases  
3. Phase 2 - clinical rotations integrating clinical care, basic sciences, and thread areas - case-based learning  
4. Phase 3 - career exploration, intern preparation, "selectives" - novel radiology course development  
5. Leadership - medical student directors, block leaders  
6. Innovative educational content creation and delivery - embracing remote techniques, case-based learning, website development  
7. Novel course development - Screening in Radiology, Financial Wellness  
8. Faculty Recruitment - range of faculty, educational RVUs  
9. Resident Recruitment - radiology interest group  
10. Lessons learned - staff support for sustainable implementation

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## Abstract Archives of the RSNA, 2023

NPMEE-16

### #FOAMrad: A Personal Productivity Curriculum for Radiologists

All Day Room: Learning Center

Alice Shieh, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Simplify and adopt the "Getting Things Done" methodology for busy radiologists- Understand and incorporate the fundamentals of "Deep Work" for peak performance- Learn how to apply the science of habits based on best-selling book "Atomic Habits"- Demonstrate tried and tested productivity software applications to streamline repetitive tasks (for Mac users)- Review time-saving settings and approaches to combat e-mail overwhelm

#### TABLE OF CONTENTS/OUTLINE

Getting Things Done framework ?- Delete it, Do it, Delegate it, Deposit it, Defer it ?Deep Work ?- 4 deep work philosophies: monastic, bimodal, rhythmic, journalistic?- 3 steps to rewire your brain: embrace boredom, quit social media, drain the shallows ?Atomic Habits ?- 4 laws of behavior change: cue, craving, response, rewards ?- Creating a new identity to develop new habits ?- Building better systems to achieve goals?Tried and tested productivity software applications to streamline repetitive tasks on a Mac?- Alfred, SetApp, 1Password, Evernote, Notion, Ecam, Endnote, Backblaze ?E-mail management ?  
- Understanding e-mail communication principles ?- Time-saving settings for Outlook and Gmail ?Multitasking and prioritization techniques ?- MoSCoW (Must, Should, Could, Would)

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## Abstract Archives of the RSNA, 2023

NPMEE-17

### Radiology Management at Your Fingertips: Incorporating Macropads Into the Radiology Workflow

All Day Room: Learning Center

Elliot S. Breshears, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Review the utility of macropads in automating and simplifying repetitive nature of the radiologist's workflow-Learn how to easily assemble, program, and implement macropads into your own radiology practice-Discuss the time-saving features of macropads

#### TABLE OF CONTENTS/OUTLINE

Macropad device utility- Assign complex repetitive tasks to a single button click, improving efficiency- Ability to bypass IT restrictions and firewalls; eliminates need to install additional software on PACS workstationsResource selection process- Consolidating resources into 15 programmable keys- Implementing input from abdominal imaging faculty ?Assembly- Physical components: front and back plates, keycaps, switches, USB cables- Assembly process- Creating custom key stickers to promote intuitive access of selected resources ?Programming- Utilizing duckyScript and the duckyPad Configurator software- Navigating computing system compatibility issues ?Implementation and impact on radiology workflow- Reduction in mouse clicks needed to access resources- Plug and play with ability to use at different workstations ?Limitations- Cost- Time and effort associated with self-assembly, selecting and organizing incidentaloma guidelines- Minimal scripting required ? Future directions- Implementing Elgato stream deck into PACS stations with software installed after security clearance

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## Abstract Archives of the RSNA, 2023

NPMEE-19

### **Journey to Parenthood in Radiology: Progress, Challenges, and Opportunities**

All Day Room: Learning Center

Shinnhuey S. Chou, MD, MPH (*Presenter*) Institutional research support, General Electric Company

#### **TEACHING POINTS**

1. Delayed childbearing impacts the reproductive outcomes among physicians.2. A better understanding of the options to achieve parenthood allows for comprehensive family planning, flexible practice management, and inclusive dialogues.3. Accurate knowledge of occupational radiation exposure to women physicians may help assuage unrealistic fear and build a stronger pipeline of future radiologists.

#### **TABLE OF CONTENTS/OUTLINE**

- To highlight the importance of and obstacles to family planning and childbearing for physicians and physicians-in-training
- To review occupational radiation risks and safety precautions in the radiology work environments and specifically within each radiology subspecialties
- To raise awareness of the various options and processes involved in egg preservation, fertility treatment, surrogacy, adoption, and fostering
- To provide an overview of existing policies and guidelines for family and medical leave in the Unites States, including the American Board of Radiology updated policies and state and federal laws
- To discuss potential mechanisms to support medical students, radiology trainees, and radiologists on their journey to parenthood and those who are parents

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

NPMEE-2

### Small Nodule, Big Impact: Incidental Findings Module

All Day Room: Learning Center

Robert J. Lewis, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Studies have found that as radiographic imaging numbers continue to increase, so has the number of incidental findings. 2) Based on literature and guidelines including the ACR white papers and Fleischner Society recommendations, a new incidental/follow up tab was built into our electronic health record (EHR) to provide simple, fast and streamlined recommendations by radiologists for clinicians. 3) Additional measures are also built in to help achieve the proper patient follow up, such as dedicated nurse navigators to help track down incidental findings and assure proper follow up as well as inbox EHR messages to patients PCP upon discharge. 4) Future directions include expanding the followed-up incidental, education to both ordering providers and patients as well as research for continued evolution of incidental finding guidelines.

#### TABLE OF CONTENTS/OUTLINE

1) Define the impact of incidental pulmonary findings by radiologists on patient care. 2) Discuss the implemented incidental findings tab within our health network and how it has changed patient care/outcomes. 3) Identify methods to expand this model to include more incidental findings and increase patient follow up. 4) Data collection and interruption for future incidental finding recommendations and guidelines.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-20

### Artificial Intelligence for Pediatric Radiologists: A Gentle Introduction for the Non-enthusiast

All Day Room: Learning Center

Marcelo S. Takahashi, MD, PhD (*Presenter*) Speaker, Vertex Pharmaceuticals Incorporated

#### TEACHING POINTS

This presentation is intended for pediatric radiologists with no/little AI experience. We will explain the basic concepts of AI applied to radiology and discuss practical example of usage of AI in pediatric radiology. Main points: 1)Core AI concepts and lexicon 2)Brief history of AI in radiology 3)Basic algorithm creation and operation 4)Applications of AI in radiology 5)Limitations of AI in radiology

#### TABLE OF CONTENTS/OUTLINE

1 - Disclaimer: • created for pediatric radiologists with no/very little experience in AI. • Essential concepts will be explained in straightforward manner and accessible language.2 - Introduction: • Core concepts: • What is artificial intelligence, narrow AI and broad AI • Machine Learning and Deep Learning. • Big Data, Data Science, Domain Knowledge3 - Brief history of AI in radiology: • The early years. • The CAD era • The Machine Learning and Deep Learning era.5 - Basic Lexicon: • Dataset, model, algorithm, training, testing, generalization, features, classification, segmentation, regression, clustering, prediction, label, supervised learning, unsupervised learning4 - "Classic Machine Learning" and Deep Learning: • How is a "classic ML" algorithm created? • DL algorithm creation • Main differences, advantages and disadvantages ("classic ML" vs DL).5 - Where is/can AI be applied in the pediatric radiologist's workflow (with practical examples) • Imaging criteria, scheduling, acquisition (MR acceleration, CT/XR dose reduction), image analysis (segmentation, classification, detection), reporting (NLP), precision medicine.6 - "Must know" AI limitations : • Algorithm creation vs algorithm implementation • Interpretation errors • Generalization errors7 - Take home message

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-21

### The Potential Applications of ChatGPT in the Field of Medical Imaging

All Day Room: Learning Center

Kexin Wang (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This exhibit combines recent literature reviews to explore the application prospects of ChatGPT in the field of medical imaging, including its potential applications in medical service, teaching, and scientific research settings, possible ways to apply ChatGPT, and the attitudes of the academic community towards the application of ChatGPT in the field of medical imaging.

#### TABLE OF CONTENTS/OUTLINE

1. ChatGPT can be used in the processing of medical document texts such as medical records in the medical imaging workflow, to achieve the structuring and standardization of texts, promoting effective interaction between staff and patients.
2. ChatGPT can also be used to train medical students and resident physicians in image diagnosis by improving teaching efficiency through interactive learning and teaching methods.
3. ChatGPT can assist in the literature retrieval, data collection, statistical analysis, and article writing processes in scientific research. However, researchers should be aware of the risk of ChatGPT taking over as the main tool and control the research process to ensure the authenticity of the research.

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## Abstract Archives of the RSNA, 2023

NPMEE-22

### Ways to Improve Patient Satisfaction Analytics in the Modern Era of Radiology: Tips and Tricks from the Patient Satisfaction Officer

All Day Room: Learning Center

Austin Williams, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Third party analytics evaluate care directly from patients in a simple, fast, and easy-to-use fashion. 2. The information obtained from analytics offers radiologists and their practices an opportunity to identify patient needs and priorities while recognizing weaknesses and opportunity for improvement. 3. Modifications and implementation of new practices are often minor, requiring little to no infrastructure, cost, or time while having a positive impact on retention, referral, and most importantly patient satisfaction.

#### TABLE OF CONTENTS/OUTLINE

1. Define the patient experience as it relates to most commonly observed factors. 2. Discuss the role that current-day technology has played in the implementation and innovation of healthcare analytics regarding both acquisition and interpretation. 3. Recognize that personnel, speed, and ease of care are common subjects of both positive and negative patient experiences. 4. Identify methods to respond to feedback that increase patient satisfaction.

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## Abstract Archives of the RSNA, 2023

NPMEE-23

### Utilizing 3D Printing and Phantoms to Teach the Basic Principles and Pitfalls of Ultrasound

All Day Room: Learning Center

Patricia A. Garcia (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ultrasound (US) is an operator-dependent imaging technique; thus, teaching this skill is critical to radiology education. Ensuring adequate training is essential to patient safety and quality assurance in clinical practice. Those trained in US are keenly aware of the many pitfalls of US imaging. US physics and related artefacts are covered comprehensively in the Diagnostic Radiology curriculum; however, modern education emphasises alternate approaches to teaching, including hands-on practical sessions. US phantoms are used to teach biopsy techniques, but little literature exists on the use of phantoms to teach US basic principles. To simulate commonly encountered US limitations and artefacts, we created gelatin-based US phantoms with embedded objects made from 3D-printed moulds, allowing trainees to experience them in real-time. The embedded objects demonstrated concepts such as relative echogenicity, the importance of imaging an object in multiple planes, mirror image artefact, increased acoustic through-transmission and shadowing. Representative scans of these phantoms will be presented to confirm their utility in demonstrating these concepts.

#### TABLE OF CONTENTS/OUTLINE

1. Challenges of teaching hands-on ultrasound skills 2. Technical aspects of phantom creation 3. Demonstration of basic principles 4. Demonstration of artefacts

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-24

### Scire Quod Sciendum: Knowledge at the Intersection of Suboptimal Photography and Radiography

All Day Room: Learning Center

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Learning Objectives Using the author-shot photographs and curated suboptimal radiographs, this exhibit will help the audience:

1. Understand the causes and types of suboptimal chest radiographs.
2. Learn about the global frequency of suboptimality in the most frequent radiological procedure - chest radiographs.
3. Understand what errors in photography can teach about suboptimal radiography.
4. Understand how suboptimality in radiography influences the interpretation using photo-radio-graphic examples.

#### TABLE OF CONTENTS/OUTLINE

Content organization

1. What makes a chest radiograph suboptimal?
2. What are the parallels between suboptimal radiography and photography?
3. Use of common causes and examples of suboptimal photographs to educate about suboptimal chest radiographs.
4. Parallel examples of how suboptimal photography and radiography hide or distort key findings

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## Abstract Archives of the RSNA, 2023

NPMEE-25

### RadioGraphics Trainee Editorial Advisory Members Board (RG TEAM)

All Day Room: Learning Center

Melina Hosseiny, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-The RadioGraphics Trainee Editorial Advisory Members Board (RG TEAM) was established in December 2020 to involve trainees in shaping the journal's content and direction. -The RG TEAM is a group of radiology trainees from around the world who play a crucial role in developing high-quality educational resources that are specifically tailored to trainees. RG TEAM initiatives include content curation, innovation of creative trainee resources, organization of trainee Top 10 reading lists, creation of trainee-focused editorials, Cases from the Cookie Jar (in-print and social media), and the new official Spanish version on social media (Casos Cooky). -Joining the RG TEAM offers multiple benefits to its members, such as mentorship, networking, career development, experience in academic writing and publishing, and exposure to global radiology education. -Trainees can obtain mentorship through the RG TEAM by collaborating directly with RadioGraphics editorial board members and radiology experts, and gain valuable skills including communication, writing, and critical thinking skills. This relationship extends beyond the one-year term and can last a lifetime. -RG TEAM has an annual call for new applications available in SPRING. Interested trainees can submit their curriculum vitae, statement of interest, and an idea for a trainee-focused RG TEAM initiative. Residents and fellows in diagnostic or interventional radiology, radiation oncology, and nuclear medicine, as well as medical students, are encouraged to join.

#### TABLE OF CONTENTS/OUTLINE

1)Introduction to RadioGraphics and RG TEAM2)RG TEAM Initiatives3)Benefits of Joining the RG TEAM and How to Get Involved4)Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-26

### Blueprint for Medical Student Exposure to Radiology through Research: GSW and MVC Projects

All Day Room: Learning Center

Hanna K. Thompson (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Medical students can be given early exposure to radiology through research. Research projects can be initiated using pre-existing data sets like the Trauma Registry maintained at Level I trauma centers. Projects can give residents and medical students leadership opportunities. Projects can give medical students opportunities to present their work at local, regional, and national conferences.

#### TABLE OF CONTENTS/OUTLINE

Purpose: Few opportunities exist for medical students to gain exposure to radiology outside of seeking out electives during clinical years. Methods: IRB approval was obtained to access 10 years of GSW injury data. See Figures 1 and 2. Under trainee guidance, medical students reviewed radiology images and worked to grade injuries by the American Association for the Surgery of Trauma injury grading scales. Once injuries were scored, clinical questions were examined. As part of the expansion to MVC injuries, we are recruiting new students at M1 Orientation and collaborating with other specialties. Results: In year 1, 13 posters were presented at a local conference, Research!Louisville, and 6 at state, regional, and national conferences. See Figures 3 and 4. Data presented at RSNA will include the number and listing of the projects presented at Research!Louisville in September 2023 (planning for 45 posters) and will also include 2 years of survey responses from medical student participants and leaders. Conclusion: Trauma registries provide a robust dataset that can be utilized to increase early exposure to radiology in medical school and facilitates collaborative projects between residents and medical students, that students can further expand on as their research experience grows. .

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## Abstract Archives of the RSNA, 2023

NPMEE-27

### **Radiology at the Crossroads: Navigating Patient Safety, Risk Management, and Clinical Ethics in Modern Imaging Practice**

All Day Room: Learning Center

Jay Starkey, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Comprehensive overview of medical ethics, patient safety, and risk management in radiology 2. Empowering radiologists and trainees to actively engage in quality improvement 3. Transcending specialties to create a positive impact on patient care

#### **TABLE OF CONTENTS/OUTLINE**

1) Intro: Radiology, Patient Safety, Ethics2) Radiation Safety, Dose Reduction3) Informed Consent in Procedures4) Communicating Critical/Incidental Findings5) Radiology Research Ethics6) AI, Machine Learning: Safety, Ethics7) Justification/Appropriateness of Imaging8) Optimizing Imaging Protocols9) Pediatric Radiology Safety10) Radiology Workflow, Patient Safety11) Contrast Media Safety, Reactions12) Radiation Exposure in Pregnancy13) Safety/Quality Improvement Initiatives14) Reducing Reporting Errors15) Incident Reporting, Learning from Errors16) Patient-centered Care17) Confidentiality, Data Protection18) Teleradiology Ethics19) Credentialing, Privileging20) Sports Injuries Imaging Ethics21) Cultural Competence, Diversity22) Managing Incidental Findings23) Peer Review, Feedback24) Radiology Education Ethics25) Financial Considerations, Conflicts26) Interprofessional Collaboration27) End-of-Life Care Ethics28) Cognitive/Mental Health Issues29) Radiology in Global Health, Disaster30) Palliative Care Imaging Ethics31) Addressing Healthcare Disparities32) Shared Decision-making33) Public Health Emergencies Ethics34) Access to Radiology Services35) Conclusion, Future Directions

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## Abstract Archives of the RSNA, 2023

NPMEE-28

### Myth Busters: Questioning Standard Radiology Practices for Value-added Care

All Day Room: Learning Center

Jay Starkey, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This exhibit aims to debunk common myths in radiology practices that are believed to provide value-added care but, in reality, lack sufficient scientific evidence to support their efficacy. By analyzing scientific data and exploring recent research, the article challenges widely accepted practices to promote a more evidence-based approach to radiology.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction, a. Value-added care definition, b. Importance of evidence-based practices  
II. Radiology Myths, a. Myths 1-5, b. Myths 6-10  
III. AUC Reality, a. AUC role in debunking myths, b. AUC examples  
IV. Barriers to AUC, a. Resistance to change, b. Financial incentives, c. Technology and training  
V. Overcoming Barriers, a. Education, b. Incentives for evidence-based practices, c. Technology upgrades  
VI. Measuring Radiology Value, a. Patient outcomes, b. Costs, c. Efficiency  
VII. Strategies for Value-Added Care, a. Staying current on evidence-based practices, b. AUC for dispelling myths, c. Communication  
VIII. Conclusion, a. Summary of exhibit  
IX. References

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## Abstract Archives of the RSNA, 2023

NPMEE-29

### From Detection to Action: A Journey Through Incidental Findings in Radiology

All Day Room: Learning Center

Jay Starkey, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibit aims to provide a comprehensive understanding of incidental findings in radiology, addressing their various aspects including identification, communication, management, legal implications, and patient autonomy. The presentation highlights the importance of awareness and proper handling of incidental findings, balancing patient autonomy with ethical considerations and potential harms. It emphasizes the need for evidence-based management, structured reporting, and effective communication. The evolving role of technology, particularly AI, in detecting and managing incidental findings is also discussed.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Definition and variability among radiologists || Settings where incidental findings may arise  
Education: ACGME and ABR guidelines  
Patient autonomy Access to images, understanding reports, imaging preferences, and referrals  
Communication of incidental findings: Timing, disclosure, responsibilities, and documentation  
Legal implications: Civil and criminal lawsuits, protection for radiologists  
Management of incidental findings Evidence-based practices, second opinions, structured reporting, national/international variations, conflicts of interest, guidelines, and low-resource settings  
Harms of incidental findings Costs, psychological impact, overcalling and undercalling incidentals  
Common incidental findings: ACR white papers, unclear clinical significance, small focus of ischemia  
Conclusion Importance of awareness, research, guidelines, and technology in managing incidental findings.

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## Abstract Archives of the RSNA, 2023

NPMEE-3

### International Observerships in Pediatric Radiology: Optimization and Potential Benefits

All Day Room: Learning Center

Hermon Derbew, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

International clinical observership programs can facilitate highly effective academic collaboration, international brand building, information dissemination and recruitment. However, this type of program typically adds bureaucracy, logistics and faculty workload for the hosting institution—as well as many regulatory and financial barriers for interested individuals. Our institution's proactive approach to welcoming observers from diverse backgrounds minimizes the financial burden to applicants and allows collaboration to advance our academic mission. This exhibit explains the process and impact of the program with emphasis on specific steps taken towards improved workflow and increased throughput of observers.

#### TABLE OF CONTENTS/OUTLINE

1. Process, 2. Institutional benefits, 3. Impact

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## Abstract Archives of the RSNA, 2023

NPMEE-30

### A Step-By-Step Approach to Establish and Enhance MRI Site Safety: A Primer for Radiologists

All Day Room: Learning Center

Pradnya Y. Mhatre, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

MRI Site Safety is important for protection of patients, staff and public. Proactively thinking about MR Safety features while designing an MR suite is key in establishing robust MR safe environment. American College of Radiology has created MR Safety Manual which includes general principles of MR Safety. We describe various components of MR Site Safety that need to be implemented in a systematic manner to create a robust and sustainable program.

#### TABLE OF CONTENTS/OUTLINE

Initial step in establishing site safety is to identify MR Medical Director , MR Safety Officer and MR Safety Committee. We describe how to structure MRI zones, including placement of ferrous quarantine, safe storage, patient transfer, mechanical room, and control room. We also discuss marking of equipment with appropriate signage, use of ferromagnetic detection devices, operation of MR conditional devices in Zone IV and infection control. Specific considerations for cryogen safety, cryogen vent pathway and quench scenario are discussed. Important design details during construction and installation are included. Development of key site safety policies and procedures needed and will be discussed including quarterly and yearly site safety checklist and QC program. Lastly, we will discuss emergency plans for various emergencies like fire, water damage, quench, structural damage, establishment of code area, and preparation for emergency resuscitation, which are a key component of site safety.

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## Abstract Archives of the RSNA, 2023

NPMEE-31

### **Stay Calm and Don't Attract the Magnet: A Comprehensive Review of MRI Safety Precautions**

All Day Room: Learning Center

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Following completion of this presentation, the reader will be able to: (1) Identify the four zones of MRI facilities (2) Describe the direct effects of MRI on patients (e.g., noise, heat, neurostimulation) (3) Describe the indirect effects of MRI on patients (e.g., interactions with existing devices and equipment) (4) Define specific absorption rate (SAR) and specific energy dose (SED) and their applications to MRI examinations (5) Discuss specific MRI safety considerations for special patient populations (6) Discuss safety profiles of gadolinium-based contrast media

#### **TABLE OF CONTENTS/OUTLINE**

(1) Background: Physical setup and zones, Hardware and parts of MR apparatus (2) Auditory concerns (3) Heating effects (including burns) (4) Peripheral neural stimulation (5) Portable metallic objects and equipment (6) Medical device and hardware compatibility and interactions (7) Contrast agents (8) Personnel and staffing (9) Special populations: pediatric patients, pregnant patients, patients with altered states of consciousness, obese patients, prisoners and detainees

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## Abstract Archives of the RSNA, 2023

NPMEE-32

### Common Errors in Neuroradiology

All Day Room: Learning Center

Luke M. Wojdyla, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Diagnostic errors in neuroradiology are alarmingly common, with estimates ranging from 1-16% in clinical practice. It is well established that most diagnostic misses, including those which result in malpractice litigation, are due to errors in perception. Despite this, the miss rates of specific neuroradiologic diseases have historically been undefined. Recently, a growing number of studies have quantified and categorized neuroradiologic errors across training levels and in a variety of practice schema, measuring the influence of radiologist experience, specific pathology, and other individual and systematic factors. In this exhibit, the most common diagnostic errors described in emerging neuroradiologic literature will be presented. Briefly, these include errors of cerebrovascular pathology, blind spots on CT head imaging, errors of cerebrovascular pathology, misses of head and neck pathology, and errors of skull-base pathology. Systemic factors affecting performance such as practice volumes, reading speeds, and fatigue will also be presented. Knowledge of these findings can provide insight into understanding why errors occur, and in turn, help develop robust strategies to prevent them. Radiologists should be aware of the common blind spots and missed pathologies in the variety of settings described in this exhibit.

#### TABLE OF CONTENTS/OUTLINE

Explore the impact of diagnostic error in neuroradiology. Summarize recent literature quantifying common neuroradiologic errors amongst residents, generalists, and neuroradiologists. Appreciate the risk factors and biases associated with error. Provide case examples of real errors encountered in one department. Discuss strategies to minimize error.

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## Abstract Archives of the RSNA, 2023

NPMEE-33

### Microaggression or Cross-Cultural Competence?

All Day Room: Learning Center

Peter Kalina, MD, MBA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The pursuit of cultural competence among an increasingly diverse and interconnected workforce is vital. It requires empathy and perspective taking. It behooves us to successfully distinguish the subtleties that exist between the negative connotation of microaggressions from the positive influence of cultural competence. Microaggressions are subtle indignities, slights or insults whose derogatory nature communicates prejudice, dismissal, denigration, hostility or negativity to a member of a marginalized group. They may appear indirect, casual, innocuous, and insignificant. They are often unconscious and unintentional, arising from underlying: prejudice, discrimination, oppression, or bias. Are microaggressions sometimes confused with a genuine desire to improve one's cross-cultural competence?

#### TABLE OF CONTENTS/OUTLINE

1) Introduction 2) Cross-Cultural Competence and Communication 3) Microaggressions 4) "Microaggressions are a real problem" 5) "Microaggressions are much ado about nothing" 6) Conclusions

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## Abstract Archives of the RSNA, 2023

NPMEE-34

### **RadLinks: Creating an Efficient Reference Webpage for Incidentaloma Management Guidelines and Template Generation**

All Day Room: Learning Center

Alice Shieh, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Conceptualize and design a webpage (RadLinks) to efficiently reference incidentaloma management guidelines- Discuss webpage design features that streamline incidentaloma management- Provide a seamless workflow so radiologists can provide incidentaloma management recommendations quickly with ease

#### **TABLE OF CONTENTS/OUTLINE**

Barriers to efficiency when managing incidentalomas?- Time consuming and repetitive efforts to look up information?- Lack of resource consolidation?Benefits of using the RadLinks page?- Minimalist, user-friendly design?- Thoughtfully consolidated resources ?- Pre-generated templates and text macros ?- Hosted on public domain, with lack of institutional barriersRadLinks user interface features ?- Expandable/collapsible navigation menu, ability to enlarge figures/charts in-screen, copy text to clipboard with one-click, mobile device compatibility ?Website hosting and building options and tools ?- Squarespace, Wix, WordPress ?- Flatiron ?- HTML/CSS tutorialsCopyright issues ?- Obtaining permissions to display figures and graphs from published articlesFuture directions ?- Keeping content and guidelines up to date?- Expanding resources beyond incidentaloma management?- Reducing scrolling distance ?- Implementing user suggestions and feedback ?

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## Abstract Archives of the RSNA, 2023

NPMEE-35

### Beauty Beyond a Few Slides Deep: How to Increase Radiology Lecture Engagement

All Day Room: Learning Center

Julia Tran, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) Engaging lectures can hold the audience's attention, convey information more effectively, and make lessons more memorable. (2) Use graphic design resources (eg. AI art sites, design software, typography sites) to visually enhance your presentation. (3) Include activities that require active participation such as games, polls, and PACS simulators to increase engagement.

#### TABLE OF CONTENTS/OUTLINE

Didactics are an integral part of radiology education but creating engaging learning experiences can be challenging. Effective and interactive lectures improve learning outcomes by helping learners retain and apply new information. This educational exhibit will (1) introduce the concepts of graphic design and its role in creating impactful presentations. We will share various graphic design software, AI tools, and web resources useful for creating visually appealing designs. We provide examples of how to format lecture slides to emphasize key learning points and findings. This exhibit also aims to (2) showcase various interactive tools and activities that increase audience engagement. PACS simulators, such as PACSBIN, combine imaging software with educational tools to create case-based quizzes and lesson plans. Gamifying cases into competitions, such as Taboo<sup>TM</sup> or Pictionary<sup>TM</sup>, motivates learners to strive for mastery. By implementing these strategies, educators can create more effective and engaging learning experiences.

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## Abstract Archives of the RSNA, 2023

NPMEE-36

### Sustainability, Climate Change and Radiology: Why We Should Care and What We Can Do

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Kate Hanneman, MD, MPH (*Presenter*) Speaker, Groupe Sanofi; Speaker, Amicus Therapeutics, Inc

#### TEACHING POINTS

Producing, using, and powering medical imaging equipment to provide radiology services are estimated to contribute to 1% of total global greenhouse gas emissions. Achieving sustainability in radiology requires immediate and strategic action. Strategies should focus not only on mitigating radiology's impacts, but also building resiliency to the risks of climate change through adaptation, with action taken at individual, department, and industry levels. Opportunities to reduce radiology's carbon footprint include reducing emissions due to non-productive scanner time and minimizing the use of single-use products and overall waste. Reducing overall emissions in health care and radiology will also require partnerships with both industrial and clinical stakeholders.

#### TABLE OF CONTENTS/OUTLINE

The overarching goal of this exhibit is to review the intersection of sustainability, climate change and radiology with a focus on why we should care and steps we can take to reduce waste and greenhouse gas emissions. This will be achieved by: 1. Describing the human health impacts of climate change, with health equity considerations. 2. Discussing diagnostic and interventional radiology's contributions to greenhouse gas emissions and waste. 3. Reviewing sources and classification of emissions related to radiology. 4. Differentiating mitigation (reducing impacts) and adaption (building resiliency) strategies related to radiology. 5. Exploring strategies to promote sustainable practices at individual, institutional, and industry levels.

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## Abstract Archives of the RSNA, 2023

NPMEE-37

### **Decolonizing Radiology: Addressing Historical Influences and Promoting Global Equity**

All Day Room: Learning Center

Pareena Sharma (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

It is well established there are worldwide disparities in access to radiology services as well as image guided procedures. While differences in access to care persist in the United States, there are profound disparities in access to care between high income countries (HIC) and low/middle -income countries (LMIC). Socioeconomic differences in patient populations, lack of equipment, career opportunities, and until recently lack of formal training programs have all contributed to differences in global access to radiology services. An additional well known contributing factor in differences to access to care are the historical effects of colonialism. While there have been increasing world-wide efforts to decrease the gaps in access to care and addressing the training gap in radiology, there has been little effort to address the history of colonialism in global health work in the context of radiology. This educational exhibit aims to provide context to the history of colonialism in global health and how this perspective is crucial to provide sustainable solutions for long term global radiology equity and culturally competent global health work.

#### **TABLE OF CONTENTS/OUTLINE**

1. History of Colonial Influence on Radiology 2. Consequences of Colonialism in Radiology 3. Current State of Global Radiology Outreach 4. Strategies for Decolonizing Radiology

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## Abstract Archives of the RSNA, 2023

NPMEE-38

### **Global Radiology: Building Equitable and Sustainable Partnerships with Low- and Middle-Income Countries (LMICs)**

All Day Room: Learning Center

Lydia A. Kwarteng, BS, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Global radiology partnerships can be leveraged to help address the shortage of radiology professionals in LMICs. Simultaneously, there are efforts to address the legacy of colonization on global health initiatives by highlighting the power asymmetry between High-Income Country (HIC) and LMIC partners. This exhibit reviews the critical need to help establish and scale-up radiology training programs in LMICs, highlights opportunities for reform in global health, and provides examples of best practices to foster equitable and sustainable global radiology partnerships with LMICs.

#### **TABLE OF CONTENTS/OUTLINE**

Background- Shortage of radiology professionals in LMICs- Global radiology engagement in LMICs The Decolonize Global Health movement- Origins in global health- Goals and controversies Building equitable global radiology partnerships- Leadership and decision-making- Understanding sociocultural context- Equity in research, education, and capacity-building- Funding practices- Transparency and accountability Examples of successful partnerships in Africa- HIC-LMIC institutional collaborations in global cancer research, subspecialty training, and capacity-building (e.g. in neuroradiology, breast imaging, and interventional radiology).

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## Abstract Archives of the RSNA, 2023

NPMEE-39

### Usefulness of Deep Learning for Improved Image Quality and Noise Reduction in Diffusion Weighted Imaging (DWI)

All Day Room: Learning Center

Hirofumi Koike (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Deep learning (DL) has recently experienced explosive growth including many areas of medical research. Recent advances in DL-based image reconstruction in MRI have been reported to achieve improved image quality through noise reduction and super-resolution (SR), but there have been very few reports of its application to diffusion-weighted imaging (DWI). We have scanned various body regions with a DL-based DWI research application for clinical evaluation. These images are presented with clinical findings. In addition, underlying technical details and imaging parameter optimizations are presented. Although the visual impression varies depending on imaging regions or scan parameters, the following advantages in DL-based reconstruction are observed: noise reduction due to DL, reduced distortion due to higher acceleration factor, sharpness improvement due to SR and higher spatial resolution, and better visibility of background normal tissues due to shorter echo time.

#### TABLE OF CONTENTS/OUTLINE

1. To present DWI images with deep learning-based image reconstruction and its findings in various body regions.
2. To understand the mechanism of deep learning-based image reconstruction.
3. To understand scan parameter optimization in DL DWI.
4. To know the clinical feasibility of DL DWI in patients with various diseases.

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## Abstract Archives of the RSNA, 2023

NPMEE-4

### Waste Reduction in Radiology: Educational Case Series

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Christine Yao, BA, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In the U.S. the healthcare sector is estimated to contribute almost 10% of our nation's carbon emissions. As healthcare professionals, we are committed to improving the well-being of our patients, so we also must focus on decreasing our contribution to climate change. Radiology departments can target both direct and indirect emissions by decreasing energy usage within the workspace, reducing unnecessary imaging, and transitioning to green suppliers for the procurement and disposal of medical equipment. Studies have shown that there is a high rate of imaging overuse. Understanding the environmental impact associated with these practices can help to encourage appropriate usage. There are both external and internal factors that can drive a physician to order unnecessary or inappropriate imaging, including but not limited to defensive medicine, patient expectations, obliviousness to cost and risks, breaks in patient-provider communication, and inadequate knowledge.

#### TABLE OF CONTENTS/OUTLINE

Introduction a. Health care impact on environment b. Radiology energy use c. Avenues for reduction  
Case examples a. Emissions by scan b. Contrast use  
Inappropriate imaging examples a. Contributions to inappropriate imaging b. Inpatient cases c. Outpatient cases  
Advocacy strategies

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-40

### **The Second Mountain - Climbing the Challenges of Mid-career Radiology**

All Day Room: Learning Center

Miltiadis Tembelis, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The mid-career phase for a radiologist, and many other professions, is a time burdened by career stagnation and high rates of burnout. To spite it being a particularly difficult time in the radiologist career, there is little dedicated mid-career support to help radiologists overcome their woes. The goal of this presentation is to highlight the difficulties faced by the mid-career radiologists as well as provide potential solutions to these problems. A focus on the mid-career female radiologist and their unique challenges will also be presented.

#### **TABLE OF CONTENTS/OUTLINE**

This review will define the mid-career radiologist and provide an overview of the current radiology workforce. Problems such as burnout, career stagnation, alternative career pursuits, lack of mentorship, sponsorship and career development programs, and gender specific challenges of women will be discussed. Potential solutions to these problems will also be presented.

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## Abstract Archives of the RSNA, 2023

NPMEE-41

### **Subspecialty Breast Imaging Education in Tanzania: Clinical, Infrastructure and Logistical Paradigms for Best Practices in the Low- and- Middle Income (LMIC) Setting**

All Day Room: Learning Center

Toma S. Omofoye, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Given the global rise in breast cancer, radiology workforce shortages in sub-Saharan Africa are critical.
- The RSNA-led Global Learning Center (GLC) initiative in Tanzania for sub-specialty breast radiology training is presented as a paradigm for remote/in-person education.
- It is imperative to tailor interventions for the resource-limited LMIC environment.
- Presenting a scalable education program for best practices in the LMIC setting, with goals of improving interdisciplinary breast care through training, infrastructure, and optimization of local resources.
- An example of an transnational alliance to care for underserved populations.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction
  - a. Radiology workforce in Africa
  - b. Breast Cancer in Tanzania
2. Educational Paradigm
  - a. Background/need i. Tanzania medical education, radiology and subspecialty education
  - b. Trainees
  - c. Curriculum
    - i. Goals/objectives
    - ii. Content
    - iii. Learners
    - iv. Faculty
    - v. Resources and Methods ? Synchronous teaching ? Asynchronous teaching ? Observerships
    - vi. Assessment
    - vii. Governance
    - viii. Continuous improvement
3. Breast Imaging Service
  - a. LMIC modality specific goals
  - b. Reporting
  - c. Interprofessional collaborations
4. Infrastructure
  - a. improving technology and support staff
5. Future directions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-42

### **Radiologists for a Sustainable Future (R4SF): Bridging the Gap Between Radiology Practice and Environmental Responsibility**

All Day Room: Learning Center

Melina Hosseiny, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-Radiologists for a sustainable future(R4SF) is an international community of radiologists and trainees, dedicated to promoting environmentally sustainable radiology practice and healthcare delivery.-R4SF advocates for policies that promote environmental sustainability in healthcare.At R4SF, radiologists/radiologists-in-training and leaders in the field unite to promote sustainable practices in radiology through education and awareness initiatives, the promotion of sustainable projects, and the establishment of a supportive network.-The R4SF has teams working together to advocate for sustainable radiology through education, policy, social media, and research. -Education team focuses on expanding the participation of medical students and residents in sustainable practices.-R4SF collaborated with members' ACR chapters to propose and pass a resolution on climate change and sustainability at the 2022 National ACR meeting. -R4SF team is a subgroup of the larger multispecialty Healthcare without Harm physician network and has support, mentorship, and sponsorship from great leaders in the radiology society.-Members of R4SF have delivered talks and shared our aims to the radiology community at various societies, including RSNA, ARRS, SABI, AUR, and others.

#### **TABLE OF CONTENTS/OUTLINE**

1)Introduction to Radiologists for a Sustainable Future (R4SF)2)R4SF Initiatives 3)R4SF Goals and Collaborations4)Benefits of Joining the R4SF and How to Get Involved5)Future Direction

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-43

### Let it Go, Let it Go: An Approach to Assessment and Reporting of Benign or Low-Risk Incidental Findings in the Chest

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Erin N. Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiologists are expected to provide management recommendations for incidentally detected pulmonary nodules and thyroid nodules. While some are clinically impactful, a majority are benign and inconsequential. Fleischner, Thyroid White Paper and TIRADS consensus recommendations were developed to decrease inappropriate recommendations for further evaluation. In our quest to do no harm, radiologists can help decrease patient anxiety, time spent, medical expenses and potential risks associated with further characterization by using best practices for characterizing and reporting nodules which do not require further evaluation through clear, concise language. We will present examples of nodules inappropriately recommended for follow up and a step by step approach to assessment and reporting.

#### TABLE OF CONTENTS/OUTLINE

Introduction  
Commonly Mischaracterized Incidental Findings on Chest CT:  
- Pulmonary nodules  
- Mucous plugging  
- Granulomas  
- AVMs  
- Thyroid Nodules  
Risk statistics for nodules by size  
Reporting considerations:  
- Morphologic descriptors (shape, density, distribution)  
- Measurements - 3 plane review  
- Concise, specific language; avoiding vague terms  
- Comparison with prior imaging  
- Patient history  
Letting it go: supporting data  
Role of Structured Reporting  
Pre-Populated Macros: Pros and Cons  
Society Recommendations and Indications for Incorporation into Reports  
Closed Loop Communication  
Conclusion

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## Abstract Archives of the RSNA, 2023

NPMEE-44

### Best Practices for Medical Student Engagement in the Radiology Reading Room

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Devyn C. Rigsby (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. There is no standardized approach to engaging medical students in the radiology reading room during radiology electives (1).2. Without intentional incorporation of medical students into the reading room team, students may feel disinterested, excluded, or insufficiently challenged to learn. Negative experiences on radiology electives may dissuade students from pursuing radiology as a career.3. This presentation shares best practices for radiology preceptors to foster a healthy learning environment, maximize educational opportunities, and increase medical student interest in radiology.4. Best practices for engaging medical students in radiology courses can be divided into three parts: preparing for student arrival, starting a learning session, and facilitating case-based instruction.5. These best practices are transferrable to any institution's in-person radiology curriculum for medical students.Reference 1. Darras KE, Spouge R, Kang H, et al. The challenge with clinical radiology electives. *Can Assoc Radiol J.* 2019;70(4):337-343.

#### TABLE OF CONTENTS/OUTLINE

1. Problem statement2. Common concerns about the reading room experience raised by students at our institution3. Preparing for student arrival in the reading room a. Introductory information b. Identify near-peer mentor (resident or fellow) c. Student workspace4. Starting a learning session a. Learning objectives b. Transfer of foundational knowledge c. Select cases for student to attempt independently5. Facilitating learning through cases a. Student inclusion in all trainee readouts b. 1:1 student readouts on assigned cases c. Session wrap-up

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NPMEE-46

### **It Takes a Village: Multidisciplinary Breast Subspecialty Telementoring for Low- to- Middle-Income-Countries (LMICs)**

All Day Room: Learning Center

Toma S. Omofoye, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Funded by an RSNA International education grant, a method for telementoring is described for breast radiologists, pathologists, oncologists, and surgeons where domestic/foreign, low/high resource, and within/outside subspecialty input is used to adapt best practices to available resources. Breast subspecialist shortages in African Low-Middle-Income Countries (LMICs) call for creative solutions. Many LMICs lack multidisciplinary communication (radiology-pathology or tumor board). While LMIC practitioners have varying levels of breast subspecialty training and resources, they have tailored creative solutions for optimizing resources to address advanced disease. The transnational collaboration (with 200 participants from 3 continents- Africa, North and South America) assists capacity building.

#### **TABLE OF CONTENTS/OUTLINE**

We describe a model for multidisciplinary telementoring to provide paired subspecialty support for breast health practitioners in LMICs. 1. Introduction: LMIC breast cancer burden and subspecialty workforce gaps 2. Project Extension for Community Healthcare Outcomes (ECHO) ABCD model: a. Amplification of medical knowledge b. Best practices to improve outcomes c. Case based (clinically-relevant) learning d. Database: outcome monitoring 3. Program Formata. Case presentation b. Interprofessional and multidisciplinary input c. Complementary didactics 4. Case-based examples including: Rad-path concordance, quality, symptom, interesting or difficult cases, and rare disease management

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## Abstract Archives of the RSNA, 2023

NPMEE-47

### Supporting Women in Radiology: Implementing a Multi-institutional Coalition

All Day Room: Learning Center

Madiha Aseem, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Women are underrepresented in radiology. Even though men and women are about equally represented among medical school graduates, only 27% of applicants in radiology are women.<sup>1,2</sup> Furthermore, female radiology leaders make up an even smaller minority, consisting of only 13% of radiology leaders.<sup>3,4</sup> The purpose of this exhibit is to showcase how a women in radiology (WIR) group in a teaching institution can provide role models, mentorship, and promote a culture of diversity and inclusion. Furthermore, the introduction of WIR collaborations with other institutions can promote an institution's inter-institutional alliances and provide career advancement opportunities for its trainees. Training institutes are in a unique position to bring about this change. Trainees who have cultivated gender equality values can have a positive impact on their future practices. Though it takes time and effort to foster a culture of diversity and inclusion, it is necessary to do so in order to create a gender inclusive workplace which will benefit not only radiology departments but also patients.

#### TABLE OF CONTENTS/OUTLINE

A) Mentorship: Implementation of "mentoring up" and "mentoring down". B) Promote career advancement opportunities and promotions: Organize discussion panels with panelists from both private practice and academics with a mix of early, mid, and advanced career radiologists. C) Collaborate with other institutions' WIR committees to create inter-institutional alliances focused on promoting the above. D) Overcome or mitigate bias by organizing upstander workshops as part of the training curriculum. E) Understand the unique needs of women in the field, including pregnancy, parental leave, and lactation.

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## Abstract Archives of the RSNA, 2023

NPMEE-48

### Benefits and Applications of ChatGPT for Radiology Trainees

All Day Room: Learning Center

Wenqiao Wang (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To provide an overview of ChatGPT from a trainee perspective  
2. To highlight best practices for using ChatGPT  
3. To illustrate how ChatGPT can be used to create relevant radiology review content including practice questions  
4. To demonstrate the radiology virtual-advisor capability of ChatGPT  
5. To describe how medical students can use ChatGPT to develop a preparation plan for radiology rotations  
6. To provide an overview of the future of ChatGPT in radiology undergraduate medical education

#### TABLE OF CONTENTS/OUTLINE

- What is ChatGPT? - How are trainees using ChatGPT? - Applications of ChatGPT for radiology learning and best practices-  
Using ChatGPT to generate radiology practice questions - Using ChatGPT to prepare for radiology rotations- Using ChatGPT as a virtual radiology advisor- Using ChatGPT to assist during core clinical rotations - Using ChatGPT to assist with professional communication - Future of ChatGPT in radiology undergraduate medical education

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## Abstract Archives of the RSNA, 2023

NPMEE-49

### Promoting Health Equity Through Radiology: Practical Tips for Empowering the Next Generation of Trainees

All Day Room: Learning Center

Pooja Agrawal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Medical students and residents in radiology represent the next generation of trainees and have a vital role in fostering sustainable health equity efforts focused on eliminating health disparities in radiology. Three ways trainees can promote health equity in radiology are through research, community outreach, and education.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Review existing health disparities in radiology using findings from a published systematic review; discuss the importance of trainee involvement in eliminating disparities; describe practical ways how research, community outreach, and education can promote health equity  
Health equity research: Introduce tips to identify a mentor; discuss how to select a research topic by identifying gaps in existing research; review opportunities at national meetings to build research network  
Community outreach: Discuss how to leverage existing community needs assessment to identify emerging opportunities; develop initiatives to educate patients about the importance of screening as a trainee; provide examples of radiology-focused community efforts (mobile mammography/lung cancer screening, RAD-AID)  
Education in health equity: Participate in the creation of radiology health equity-focused learning materials; collaborate in establishing mentorship programs to promote diverse applicants in radiology; explore how current radiology pillars in quality safety, innovation, and AI can be used as catalysts to bridge existing disparities  
Conclusion: Discuss how long-lasting health equity necessitates an understanding of systemic obstacles and a commitment to staying informed on fields such as molecular imaging, social genomics, and AI algorithms

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## Abstract Archives of the RSNA, 2023

NPMEE-5

### Medicolegal Readout: A Malpractice Primer for Radiologists

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Luke M. Wojdyla, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The majority of radiologists will face litigation in their careers. In a 2021 survey, 71% of radiologists said they were sued which is similar to estimates in prior reports. Despite this, dedicated teaching of medicolegal issues is often lacking or incomplete in radiology training programs. Residents are seldom exposed to legal issues that can arise when caring for patients, and attendings themselves may feel unqualified in leading medicolegal discussions. Concerningly, residents may transition to independent practice with an incomplete understanding of the legal environment applicable to their practice. This exhibit will provide background for the legal frameworks relevant to modern radiology practice. A brief historical summary of key court decisions will be presented alongside a discussion of malpractice and radiologic errors. Challenging case scenarios will address nonroutine communication, reporting missed findings on comparison imaging, addressing technical limitations, and admitting mistakes, among others. At the end of the presentation, the reader should understand the legal basis for common radiologic practices, identify challenging situations with increased medicolegal risk, and implement practical strategies to mitigate risk of litigation.

#### TABLE OF CONTENTS/OUTLINE

Recognize the magnitude of malpractice within radiology. Understand how fundamental radiology practices have arisen directly from court rulings. Describe the most common causes for malpractice. Identify examples of frequently encountered medicolegal hazards and controversies. Case-based imaging examples will be used to discuss challenging medicolegal issues encountered in radiology.

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## Abstract Archives of the RSNA, 2023

NPMEE-50

### **Integration of Clinical Context into Medical School Gross Anatomy Based on CT Imaging of the Students' Dissection Cadavers**

All Day Room: Learning Center

Peter J. Haar, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Incorporating imaging in medical school gross anatomy courses can provide medical students with early, positive learning experiences with radiology. The teaching points of this exhibit include the following: first, to describe methods to incorporate CT imaging of the students' dissection cadavers into a novel exercise in which dissection cadavers are regarded as medical students' "first patients;" second, to outline roles for radiology attendings and residents in interactive cadaver CT workshops; and third, to explore the potential benefits of the experience in medical education and radiology residency training.

#### **TABLE OF CONTENTS/OUTLINE**

1.) Anatomy Rounds: an exercise for medical students to synthesize clinically relevant cadaver observations. 2.) Methods and resources to acquire and distribute cadaver CT images to medical students. 3.) Involving radiology residents in generating radiology findings on full-body cadaver CT image sets. 4.) Strategies to enhance the learning experience of interactive workshops based on the dissection cadaver CT images. 5.) Potential benefits of interactive radiology experiences early in medical school education. 6.) Feedback from medical students and radiology residents on the value of the learning experience.

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## Abstract Archives of the RSNA, 2023

NPMEE-51

### **Designing Interactive Team-Based Learning Experiences with Cadaver CT Images in Medical School Gross Anatomy**

All Day Room: Learning Center

Peter J. Haar, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Curricula involving CT images of medical school gross anatomy cadavers can provide students with a rewarding educational experience early in medical school. Teaching points of this exhibit include the following: first, to describe the challenges and benefits of teaching simple CT image analysis to enhance and complement gross anatomy instruction; second, to outline a strategy for developing interactive team-based learning modules and assessments; and third, to examine potential pitfalls and solutions in teaching the curriculum.

#### **TABLE OF CONTENTS/OUTLINE**

1.) Teaching gross anatomy and cross-sectional anatomy in parallel. 2.) User-friendly image interaction and teaching foundational concepts of CT imaging. 3.) Designing learning experiences with the intellectual rewards of correctly making real imaging diagnoses. 4.) Interactive group-learning assignments, and assessment of learning. 5.) Advantages and disadvantages of the interactive cadaver CT-based curriculum. 6.) Feedback and student response to the curriculum.

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## Abstract Archives of the RSNA, 2023

NPMEE-6

### A National Plan for the Renewal of Imaging in the EU: A Regional Perspective

All Day Room: Learning Center

Cristina Enjamio, PhD, MEng (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

With this publication it is intended to disseminate a National Investment Plan and how it was managed and developed from a regional point of view. The main objective of this Plan is to increase overall survival and the quality of life of people through the diagnosis of diseases in early stages, which allow rapid therapeutic intervention. The plan pays special attention to the pathologies with the greatest impact on the present and future of a National Public Health Service (SNS), such as chronic diseases, oncological diseases, rare diseases and neurological diseases. All this, consolidating equity in access to high technology and improving the quality of care and the safety of patients and professionals. This poster describes the objectives, method and results of a national plan that involves the acquisition of 847 state-of-the-art equipment for the SNS in order to: Reduce the obsolescence of high-tech equipment, guaranteeing the renewal of 100% of equipment that is 12 years old or older in accordance with scientific recommendations. Raise the average density rate of high-tech equipment per 100,000 inhabitants by at least 15%, in order to improve equity in access throughout the national territory, bring the service closer to patients and position the SNS, progressively, in the European average. As a consequence of the application of the Plan in our region, 76 new pieces of equipment are being installed (63 renewals and 13 extensions) and the total amount of the investment is € 67,204,159.

#### TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS Context and introduction Objectives of the Plan Methodology Results Discussion and conclusions

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## Abstract Archives of the RSNA, 2023

NPMEE-9

### Using Process Mapping to Identify Targeted Interventions to Reduce Imaging Disparities

All Day Room: Learning Center

Natasha M. McFarlane, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Process mapping is a quality improvement tool used to depict flow of healthcare processes.
- Components of the imaging process are addressed in order to reduce imaging disparities.
- Pre-imaging interventions include reviewing imaging guidelines, providing culturally dexterous patient educational materials, community outreach, and improving imaging access.
- Imaging interventions include high quality interpretation services, patient-centered communication strategies, and maximizing patient comfort.
- Post-imaging interventions include structured collection of patient feedback and culturally-responsive patient navigation services to ensure adequate follow-up.

#### TABLE OF CONTENTS/OUTLINE

1) Process Mapping Definition  
a) Published Process Maps  
b) Apply Health Equity Lens to Published Imaging Process Maps  
2) Pre-Imaging  
a) Review Imaging Guidelines Using Health Equity Lens  
i) Cancer Screening (breast, lung, colorectal)  
b) Clinical Decision Support to Reduce Variability in Decision-Making  
c) Patient and Provider Education  
d) Maximizing Patient Access  
i) Evidence-Based Strategies  
3) Imaging  
a) Culturally Dexterous Communication Strategies  
i) Definition  
ii) Standardized Communication Strategies to Improve Patient Communication for Diverse Patient Populations  
(1) Review Evidence-Based Strategies  
iii) Stigmatizing Language in Medicine  
(1) Definition  
(2) Application of Stigmatizing Language in Radiology  
1. Physician-patient encounter  
2. Radiology Reports  
3. Electronic health records  
(3) Vulnerable groups  
1. Patients of color  
2. Obese population  
3. LGBTQ community  
4) Post-Imaging  
a) Collection of Patient Feedback  
b) Patient-Navigation Services  
i) Review Evidence-Based Strategies

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## Abstract Archives of the RSNA, 2023

NREE

### Neuroradiology Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **NREE-1 Variants and Anomalies of Intracranial Cerebral Arteries and Considerations for Neuroendovascular Procedures**

##### Awards

##### Certificate of Merit

Ana Maria Rodriguez Martinez, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

- To describe the embryology of the intracranial cerebral arteries in order to explain the origin of its anatomical variants and anomalies.- To review all the variants and anomalies of intracranial cerebral arteries giving examples from cases from our institution.- To revise the associated pathology and the implications for endovascular procedures.

##### TABLE OF CONTENTS/OUTLINE

1. Introduction2. Embryology3. Intracranial Internal Carotid Artery 3.1. Variants. Tortuosity. 3.2. Anomalies 3.2.1. Aberrant carotid artery 3.2.2. Persistent estapedial artery 3.3. Ophthalmic artery4. Persistent carotid-basilar communications4.1. Trigeminal artery 4.2. Hypoglossal artery 4.3. Proatlantal intersegmental artery5. Anterior cerebral artery (ACA) 5.1. Variants 5.1.1. The anterior communicating artery 5.2. Anomalies 5.2.1. Infraoptic origin and persistent olfactory primitive artery 5.2.2. Accessory, multiple and aberrant ACA 5.2.3. Bihemispheric and azygos ACA6. Middle cerebral artery (MCA) 6.1. Variants 6.2. Anomalies 6.2.1. Accessory, fenestrated and duplicated MCA7. The posterior arterial circulation 7.1. Variants 7.1.1. Fetal origin 7.1.2. AICA-PICA 7.2. Anomalies 7.2.1. Basilar fenestration

#### **NREE-10 'Incidental' Intracranial Arterial Anatomical Variants: Implications for Diagnosis, Pathology and Treatment**

Charlotte Y. Chung, MD, PhD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

Variability in intracranial arterial anatomy is well recognized to be the rule, not the exception. For example, the Circle of Willis is incomplete in 75-80% of brain CT/MR angiography. While anatomic variations may be clinically inconsequential in the normal patient, accurate delineation of the involved anatomy may be critical in the setting of pathology. This exhibit employs a systematic vessel-based approach to illustrate common intracranial arterial variants and their potential clinical implications through case-based discussions.Educational objectives of this exhibit are:- Outline intracranial arterial development and resultant spectrum of anatomic variations- Illustrate common 'incidental' variant configurations of the intracranial arteries on multimodal (CTA, MRA, and DSA) neuroimaging.- Highlight implications of anatomical variants in diagnosis, pathology, and treatment of cerebrovascular diseases

##### TABLE OF CONTENTS/OUTLINE

I. Case-based review of anatomical variants in the distal ICAII. Case-based review of anatomical variants in the Circle of WillisIII. Case-based illustration of the continuum of variant MCA and ACA cortical branching patternIV. Case-based review of anatomical variants in the vertebrobasilar circulationV. Variants in vessel morphology and caliber mimicking pathology

#### **NREE-100 Frontier Technology in Non-Invasive Vascular Imaging; Arterial Spin Labeling-Based Non-Contrast MR Digital Subtraction Angiography on Cerebral Diseases**

##### Awards

##### Cum Laude

Miho Gomyo (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. To learn the basic principles of arterial spin labeling-based non-contrast MR digital subtraction angiography (ASL-MRDSA) that can obtain dynamic information of cerebral arteries without using a Gd-based contrast agent. 2. To learn various scanning methods of ASL-MRDSA. 3. To learn clinical applications of ASL-MRDSA to evaluate cerebral lesions. 4. To know some novel techniques of ASL-MRDSA. 5. To review pitfalls and limitations of ASL-MRDSA.

### TABLE OF CONTENTS/OUTLINE

1. Basic principles of ASL-MRDSA 2. Various scanning methods of ASL-MRDSA and their characteristics; 2D-methods, 3D-methods, and ultra-short TE methods 3. Novel techniques of ASL-MRDSA 4. Clinical applications of ASL-MRDSA to evaluate the following diseases; • intracranial arterial stenosis/occlusion • moyamoya disease • arteriovenous malformation (AVM) • carotid-cavernous fistula (CCF) • dural arteriovenous fistula (dAVF) • extracranial to intracranial (EC-IC) bypass • hypervascular tumors (skull tumor, hemangioblastoma, paraganglioma, and so on) • post-operative study of cerebral aneurysms (clipping, coil embolization) 5. Pitfalls and limitations

### NREE-101 Patterns of Abnormal Magnetic Susceptibility in the Brain

Kendal L. Weger (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1) Susceptibility weighted imaging (SWI) is an MRI sequence that uses phase and magnitude information to characterize substances that distort the local magnetic field, allowing for identification of hemosiderin, calcification, and iron deposition. 2) Depending on the pathology, abnormal magnetic susceptibility may appear as a single or multiple lesions and can present with varying morphology. 3) SWI lesion locations correlate with the disease mechanism. Understanding physiologic and pathologic reasons for localization is key to formulating the differential diagnosis and diagnosis 4) SWI is instrumental in characterization of vascular abnormalities, masses, and causes of microhemorrhage. 5) SWI is often able to detect changes earlier in a disease process than other sequences.

### TABLE OF CONTENTS/OUTLINE

Pathology organized by susceptibility patterns: -Single lesion: - Location specific - Basal ganglia: neurodegenerative diseases, hypertensive hemorrhages, toxic/metabolic entities - Midline: desmoid - Sulcal: siderosis - Single vascular: thrombosis of cerebral vein or DVA, calcified embolus in Circle of Willis artery - Linear susceptibility along margins of cerebral mass: pyogenic abscess - Multiple lesions: - Location specific - Grey-white matter junction: hemorrhagic metastases, grade 1 DAI - Lobar: CAA - Diffuse vascular: ferumoxytol - Corpus callosum: grade 2 DAI - Brainstem: grade 3 DAI, kernohan phenomenon -Non-location specific - Diffuse axonal injury - Fat emboli - Microhemorrhage of acute illness, post-cardiac surgery

### NREE-102 Head On: Facing Central Nervous System Lymphoma

MARCELO DOS SANTOS BANDEIRA FILHO (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The purpose of this exhibit is- To explore the proper terminology and classification of lymphomas based on updates of the fifth edition of the WHO Classification of Tumors of the Central Nervous System (CNS).- List the main clinical and epidemiological characteristics and risk factors associated with the appearance of CNS lymphomas.- To show through a pictorial review the classic imaging findings of various lymphomas of the CNS.- Show atypical cases of lymphomas and develop adequate reasoning for the radiologist to face unusual findings.

### TABLE OF CONTENTS/OUTLINE

Powerpoint Layout Introduction: 1. Overview of clinical, epidemiological and risk factors. 2. Neuroradiology: 2.1 Terminology of SNC lymphomas. 5th edition of the WHO 2.2 Classification of Tumors: SNC lymphomas. CNS Lymphomas: Primary diffuse large B-cell lymphoma of the CNS. Immunodeficiency-associated CNS lymphoma Lymphomatoid granulomatosis Intravascular large B-cell lymphoma Miscellaneous rare lymphomas in the CNS: MALT lymphoma of the dura Other low-grade B-cell lymphomas of the CNS Anaplastic large cell lymphoma (ALK+/ALK-) T-cell and NK/T-cell lymphomas

### NREE-103 Photon Counting Detector Lateral Decubitus CT Myelography: A Developing Technique for Detection of Cerebrospinal Fluid - Venous Fistulas

Nikkole Weber, ARRT (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Discuss protocol development and optimization of Photon Counting Detector (PCD) CT Myelography (CTM) 2. Describe features of PCD technology that improve detection of cerebrospinal fluid- venous fistulas (CVFs): spectral, spatial and fast 4D serial acquisitions 3. Demonstrate examples of CVFs found on PCD CTM

## TABLE OF CONTENTS/OUTLINE

1. Review current imaging modalities for myelography 2. PCD CTM protocol development a. Performed in right and left lateral decubitus Trendelenburg positions b. Lumbar spine localizers c. Spinal needle placement intrathecally d. Bolus tracking to monitor contrast flow within the thecal sac e. Serial paired acquisitions, with multi-energy (ME) and high-resolution (HR)/ME scan modes 3. Unique technologic advantages of PCD that aide in detection of subtle CVF a. Higher spatial resolution i. Spinal anatomy of interest very small ii. HRME (0.2mm), ME (0.4mm) scan mode reconstructions b. Improved radiation dose efficiency compared to energy integrating detector CT scanners—reduced electronic noise, optimal photon weighting, smaller detector pixel size, and removal of septae. Resultant images with thinner slices and sharper kernels can be generated without increasing noise c. Spectral reconstructions to improve contrast enhancement and iodine contrast to noise ratio (CNR) i. Increased iodine CNR due to more optimal energy weighting of PCDs (more weight towards low-energy photons) ii. Subtle CVFs can be very faint. Virtual monoenergetic images (VMI) at low keV (40) increases the conspicuity of iodine d. Fast 4D acquisition: 3D volume + a series of acquisitions at different time points. e. Metal artifact reduction vs high keV VMI reconstructions tested 4. CVF example patient images

## **NREE-104 MR Bone Imaging: Value of Application to Cervical and Intracranial Vessel Wall Imaging**

Kazuhiro Tsuchiya, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. To learn basic concepts and technical aspects of bone imaging like CT by MR imaging. 2. To know basic concepts of vessel wall imaging (VWI) by MR bone imaging with improved visualization between vessel walls and vessel lumen. 3. To know what benefits MR bone imaging offers over conventional cervical and intracranial VWI techniques and some pitfalls.

## TABLE OF CONTENTS/OUTLINE

1. Basic issues of MR bone imaging including currently employed scanning sequences and postprocessing methods. 2. MR bone imaging-based VWI: how to improve image quality. 3. MR bone imaging-based VWI: how does it work in the diagnosis of vessel wall abnormalities? 4. Presentation of clinical cases with discussion of implications. Cases will cover carotid calcified plaques, intracranial main trunk plaques, aneurysms, vasculitis, moyamoya disease, and so on. 5. Additional discussion including current limitations and future directions of this technique.

## **NREE-105 Posterior Fossa Ependymomas: Newly Defined Molecular and Genetic Subtypes with Characteristic Imaging Features**

Shan McBurney-Lin, MD, MBA (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Posterior fossa (PF) ependymomas have been newly classified into two distinct subtypes, PFA and PFB, based on molecular and genetic features by the World Health Organization in 2021. 2. Each subtype has unique epidemiologic, biologic, prognostic, clinical, and imaging features. 3. Imaging plays an important role in differentiating the two subtypes of PF ependymomas and in distinguishing PFA and PFB subtypes from other PF tumors, which benefits surgical planning and tumor recurrence surveillance. 4. Upon completion of review of this exhibit, readers will be able to recognize the distinct molecular, genetic, and clinical features of PF ependymomas and become familiar with the characteristic imaging features of each subtype for improved early imaging diagnostic capability.

## TABLE OF CONTENTS/OUTLINE

1. Overview of PFA and PFB ependymal tumor subtypes, including epidemiology, prognosis and molecular/epigenetic alteration 2. Characteristic imaging features of PFA and PFB tumor subtypes 3. Radiologic differences between PFA/PFB subtypes and similar entities within the radiologic differential diagnosis a. Medulloblastoma b. Atypical teratoid rhabdoid tumor c. Pilocytic astrocytoma 4. Summary and quiz a. Summary of key radiologic findings of PFA/PFB subtypes b. Quiz to review new knowledge via example cases

## **NREE-106 SWI Brush Sign of Cerebral Parenchymal Veins in CNS Diseases and Conditions**

Seiya Kishi (*Presenter*) Nothing to Disclose

### TEACHING POINTS

SWI brush sign (BS) represents prominent intracerebral veins in various diseases including ischemic stroke, moyamoya disease, cerebral venous thrombosis (CVT) and Sturge-Weber syndrome (SWS). We aimed to 1) learn anatomy of intracerebral veins 2) understand mechanisms of SWI BS in each disease 3) learn clinical significance related to this sign.

## TABLE OF CONTENTS/OUTLINE

1. What is SWI BS; SWI allows visualization of intracerebral veins (in white matter and occasionally in cortex). BS represents findings of prominent intracerebral veins in some diseases and conditions. 2. Diseases that cause the SWI BS; SWI BS is caused by ischemic stroke, moyamoya disease, CVT, and SWS. It may disappear over time with or without treatments. 3.



Mechanisms of brush sign; Increased deoxyhemoglobin in venous blood (BOLD effect) in ischemic stroke and moyamoya disease Congestion, and partially BOLD effect in CVT and SWS.4. Clinical significance related to SWI BS; indicates severe hemodynamic impairment in ischemic stroke correlates with severity in moyamoya disease and with increased intracranial venous pressure in CVT suggests the diagnosis of cortical vein thrombosis when found in affected cortex may contribute to better clinical outcomes in SWS.

### **NREE-107 How to Improve in Intraoperative Image Quality in Transcranial MR-guided Focused Ultrasound Surgery**

Hiroki Hori, PhD, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The objective of this exhibition is to provide a method for enhancing of intraoperative image quality in transcranial MR-guided focused ultrasound surgery (TcMRgFUS). TcMRgFUS possesses the distinct advantage of allowing expeditious assessment of therapeutic efficacy post each sonication and intraoperative magnetic resonance (MR) imaging for visualization of the lesion. In circumstances which denotes a lack of desired therapeutic effects and the lesion misses the planned target, subsequent ablation targets can be delicately re-aligned based on the intraoperative image. Thus, the acquisition of high-quality intraoperative images, which can accurately confirm the lesion, is imperative. The accuracy of this re-alignment is contingent upon the quality of the intraoperative image. Unfortunately, the current intraoperative image quality obtained from a 3.0T MRI system, is deficient in precisely identifying the lesion. In view of this limitation, we have been developed and substantiated a method for ameliorating the quality of intraoperative images.

#### **TABLE OF CONTENTS/OUTLINE**

1. TcMRgFUS procedure a. Overview of TcMRgFUS b. Intraoperative T2-weighted image using 3.0T MRI2. Method for improving intraoperative image quality a. Calculating manual transmitter gainb. Acquiring high-quality intraoperative T2-weighted image3. Effectiveness of enhancing intraoperative image quality a. Clinical images resultsb. Contrast between the lesion and thalamus

### **NREE-108 Primary Angiitis of the Central Nervous System (PACNS): Imaging Features and Differential Diagnosis**

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

-To provide a detailed review of the literature of PACNS.-To review the different imaging features of PANCS.-To know the most frequent mimickers of PACNS.

#### **TABLE OF CONTENTS/OUTLINE**

PACNS is a rare inflammatory vasculopathy (affecting the medium and small vessels) in brain and spinal cord that is frequently difficult to diagnose. The neurological manifestations vary, but they typically include chronic headache, encephalopathy, focal weakness, or stroke. Brain biopsy is the gold standard and only definitive test for PACNS, but has limited sensitivity, is invasive, and is associated with high rates of morbidity. Lumbar puncture is also performed, but has limited specificity for diagnosis. Catheter angiography is the imaging reference standard and is frequently employed, even though it has limited sensitivity and specificity. Neuroimaging is critical in the diagnosis of PACNS. PACNS may present with diffuse or multi-focal white matter abnormalities, hemorrhagic stroke, single or multi-territorial ischemic infarcts, micro-hemorrhages, and pseudotumoral lesions. Vessel wall MRI increases diagnostic accuracy by showing concentric mural thickening and contrast enhancement in brain arteries affected by vasculitis.Reversible cerebral vasoconstriction syndrome, atherosclerosis, Moyamoya disease, CLIPPERS, primary CNS diffuse lymphoma, and secondary cerebral vasculitis are the most common differential diagnoses.In this review, we will illustrate and describe the radiological appearance and differential diagnosis of primary angiitis of the central nervous system (PACNS), and imaging's role in diagnosis.

### **NREE-109 The T2-FLAIR Mismatch Sign in Oncologic Neuroradiology: Imaging Criteria, Current Uses, and Histo-Molecular Correlates**

#### **Awards**

#### **Certificate of Merit**

Samir A. Dagher, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Detecting the "classic" T2-FLAIR Mismatch sign (T2FMM) requires a strict application of the T2 and FLAIR criteria in adult patients with suspected CNS gliomas. The "classic" T2FMM exhibits near-perfect specificity yet variably low sensitivity for the diagnosis of astrocytoma, IDH-mutant in adults.2. A less stringent application of the strict criteria allows for the detection of the "partial" T2FMM. Studies suggest it may reliably exclude the diagnosis of glioblastoma, IDH-wildtype while compromising the near-perfect specificity of the "classic" sign.3. Differences in MRI acquisition parameters may affect the visibility of the T2FMM.4. The T2FMM has also been reported in pediatric-type CNS tumors, namely dysembryoplastic neuroepithelial tumors

and H3K27-altered diffuse midline gliomas<sup>5</sup>. Although limited data suggests significantly larger intercellular spaces, including microcysts, and upregulation of the mTOR pathway in mismatched compared to non-mismatched tumors, this has not yet translated into prognostic implications.<sup>6</sup> Mismatched tumors have significantly higher apparent diffusion coefficient, and lower relative cerebral blood volume on diffusion- and perfusion-weighted imaging, respectively, compared to non-mismatched tumors.

#### **TABLE OF CONTENTS/OUTLINE**

1. Adult-type diffuse gliomas in the 2021 WHO classification of CNS tumors<sup>2</sup>. The “classic” T2FMM: imaging criteria, clinical uses and pitfalls<sup>3</sup>. The “partial” T2FMM: imaging criteria and clinical uses<sup>4</sup>. The T2FMM in pediatric-type tumors<sup>5</sup>. Clinical and histo-molecular correlates<sup>6</sup>. Diffusion- and perfusion-weighted imaging correlates

#### **NREE-11 Cerebral Small Vessel Disease: Small Size, Big Problems**

Eduardo Freire, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the imaging patterns of cerebral small vessel disease (SVD). Review the classification and subgroups of SVD. Correlate clinical findings and complaints with imaging patterns. Review the subtypes of SVD and their own diagnostic criteria. Review the Boston criteria 2.0 for cerebral amyloid angiopathy (CAA). Review the new markers of Boston criteria 2.0. Discuss the role of the radiologist in the diagnosis of SVD.

#### **TABLE OF CONTENTS/OUTLINE**

Cerebral Small Vessel Disease (SVD) is a high prevalence disease, and a common cause of stroke and dementia. Although SVD can be asymptomatic at the beginning, some imaging findings may suggest its diagnosis. The study “Standards for Reporting Vascular change on neuroimaging (STRIVE)” shows SVD imaging patterns on brain magnetic resonance (MR) that allows considering it as a differential diagnosis. SVD comprises a group of diseases that affect capillaries, arterioles, small veins and venules, and small perforating arteries. Didactically, we can classify SVD according to its pathological and genetic characteristics into sporadic and hereditary (genetically determined). Sporadic subtypes are the most common and represent the two main etiologies of SVD: hypertensive and related to cerebral amyloid angiopathy. Brain MR imaging findings are usually similar for all etiologies. To assist the radiologist, STRIVE compiled imaging findings that represent SVD’s indirect signs.

#### **NREE-110 It's Not All About the Shine: Spotting MS MRI Biomarkers**

Nicole Lambrakos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Briefly describe the multiple sclerosis biomarkers and which techniques have the highest sensitivity and specificity.<sup>2</sup>. Discuss the importance of spotting imaging multiple sclerosis biomarkers and their pathology correlation.<sup>3</sup>. Expose the role of MR in identifying the main multiple sclerosis biomarkers.<sup>4</sup>. Looking for multiple sclerosis biomarkers in doubtful lesions to favor demyelinating etiology.

#### **TABLE OF CONTENTS/OUTLINE**

1. Main multiple sclerosis biomarkers identifiable via MR.<sup>2</sup>. Pathophysiology: correlation of imaging and pathology of multiple sclerosis biomarkers.<sup>3</sup>. Differential diagnosis: using MR biomarkers to help favor demyelinating etiology.

#### **NREE-111 Pituitary Insufficiency in Children: Spectrum of MR Imaging Findings**

Benjamin Pinsky, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Hypo-functioning pituitary tissue may appear normal on MRI. 2. Congenital anomalies of hypothalamic-pituitary axis (HPA) often present with pituitary insufficiency in children and are frequently associated with additional CNS anomalies. 3. Normally developed but hypo-functioning pituitary tissue may demonstrate subtle imaging abnormalities such as small size or decreased enhancement. 4. Common infiltrative lesions resulting in pituitary insufficiency in children include germ cell tumors and histiocytosis. 5. Pituitary insufficiency can be seen as a long-term side effect of radiation treatment for pediatric posterior fossa tumors.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background a. Normal embryologic development of the HPA b. Characteristics of normal HPA on MR imaging, including quantitative assessment of pituitary gland enhancement c. Brief clinical overview of hypopituitarism in children 2. Case-based review highlighting the spectrum of abnormalities seen in 85 children with pituitary insufficiency seen at a tertiary care children's hospital over a 5-year period. a. Normal pituitary gland b. Subtle imaging abnormalities in otherwise well-formed HPA c. Congenital abnormalities affecting HPA i. Associated CNS anomalies d. Mass Lesions involving HPA i. Neoplasms ii. Non-neoplastic e. Post-radiation pituitary insufficiency

## **NREE-112 Highways to the Danger Zone: Craniofacial to Cerebrovascular Anastomoses**

### **Awards**

#### **Certificate of Merit**

Benjamin Pinsky, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) The etiology of vascular collateralization includes congenital and pathologic connections. 2) Cerebral angiography is the gold standard for identifying extra- to intra-cranial collateralization. 3) Familiarity with the functional vascular territory schema for extra- to intra-cranial collaterals can help dictate appropriate and safe treatment.

### **TABLE OF CONTENTS/OUTLINE**

1) Background a) Review of extra- to intra- cranial anastomosis. i) Developed in the setting of large artery occlusion, vascular agenesis, or high flow shunting due to "sump effect". ii) Small non-visualized collaterals can open in response to acutely increased intra-arterial pressure (e.g., embolization, superselective injection). iii) Anastomotic channels often follow cranial nerves. b) Review of normal cerebrovascular anatomy c) Extra- to intra- cranial anastomotic classification scheme i) Orbital ii) Petrocavernous-Clival iii) Cervical iv) Dural-Pial 2) Interactive case-based review of anastomotic channels organized by functional vascular territories a) Non-invasive imaging b) Cerebral angiography c) Interactive 3D-reconstruction 3) Implications for endovascular therapy a) Complications (e.g., stroke, cranial nerve palsy) b) Common angiographic markers to avoid injury (e.g., choroidal blush) c) Methods to avoid non-target embolization (e.g., balloon occlusion) 4) Summary

## **NREE-114 Posterior Cranial Fossa Tumors: Tips and Tricks for Diagnosis**

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Review the anatomy of the posterior cranial fossa (PCF). - Establish a proper differential diagnosis based on patient age and imaging findings. - Highlight the specific radiological features of the most common posterior cranial fossa tumors (PCFT).

### **TABLE OF CONTENTS/OUTLINE**

The PCF is the infratentorial compartment of the cranial vault that houses the cerebellum, brainstem and fourth ventricle. Tumors that settle in this location have serious implications not only because of their potential malignancy but also because they can cause brainstem compression, herniation and hydrocephalus, among other complications. Tumor location and patient demographics, as well as imaging findings on CT or MR must be considered in order to establish a proper differential diagnosis. While cerebellar metastases are the most common PCFT in adults, medulloblastoma is the most common in children. Specific radiologic features have been described to differentiate PCFT, allowing the radiologist to make an accurate diagnosis. In addition, neuroimaging is also useful in surgical planning for these tumors. In this work we review the most common PCFT in patients of all ages, through cases studied in our center highlighting the key radiologic findings that enable us to make a correct diagnosis.

## **NREE-115 Autoimmune Encephalitis: When Your Immune System Attacks Your Brain and MRI is Your Detective**

### **Awards**

#### **Magna Cum Laude**

Fernando Diego Choque Chavez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Review the pathophysiology and classification of autoimmune encephalitis. 2. Describe and illustrate characteristic MRI findings related to autoimmune encephalitis 3. Discuss the role of neuroradiology in the diagnostic work-up.

### **TABLE OF CONTENTS/OUTLINE**

1. Teaching points 2. Introduction 3. Pathophysiology and classification 4. Clinical presentation and radiological findings 4.1 Autoimmune encephalitis with intracellular antigens (group I) 4.2. Autoimmune encephalitis with cell-surface directed antigens (group II) 5. Differential diagnosis 6. Summary and conclusions 7. Bibliography

**NREE-116** Sonoko Oshima, MD, PhD (*Presenter*) Nothing to Disclose

Knowledge

on neural connections in movement disorders is crucial to understand mechanisms of clinical manifestations, diagnose the diseases, and maximize benefits and minimize side effects of therapies. The aim of this presentation is to improve radiologists' role in diagnosing and treating Parkinson's disease (PD) and essential tremor (ET) by 1) overviewing neural connections between cortex and deep gray matter and 2) discussing neuromodulation therapies for movement disorders including deep brain stimulation (DBS) and MR-guided focused ultrasound (MRgFUS) from the perspective of neural connections and neuroimaging.

**TABLE OF CONTENTS/OUTLINE**

1) Neural connections related to Parkinson's disease and essential tremor - Histological findings - Imaging findings 2) Neuromodulation therapies: deep brain stimulation (DBS) and MR-guided focused ultrasound (MRgFUS) - Neurophysiological mechanisms - Treatment targets: subthalamic nucleus (STN), globus pallidus interna (GPi), ventral intermediate nucleus (Vim) of the thalamus - Localization of targets by imaging technique: indirect and direct targeting - Post-operative imaging

**NREE-117 Unraveling Dementia Imaging: Challenging Common Misconceptions and Exploring Emerging Conditions**

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

(1) Radiologists are generally unfamiliar with clinical and imaging features of common neurodegenerative diseases and wary of suggesting it in their reports. (2) AD, FTL, PPA and DLB often present with classic, unambiguous appearances on CT, MRI and FDG PET. (3) PCA and CBDS have typical clinical and imaging presentations but are syndromes with multiple potential underlying causes. (4) As the US population ages and lifespans increase, mixed dementia and recently described, more indolent forms of neurodegenerative disease become more prevalent. (5) Newly recognized neurodegenerative diseases (CARTS, LATE and PART) share clinical and imaging features, and may mimic Alzheimer's disease.

**TABLE OF CONTENTS/OUTLINE**

(1) Neurodegenerative disease in everyday radiology (2) Classic clinical, MRI and FDG PET presentations of neurodegenerative diseases: Alzheimer's Disease, Frontotemporal Lobar Degeneration, Primary Progressive Aphasia, Dementia with Lewy Bodies, Vascular cognitive impairment (3) Challenges to neurodegenerative imaging workup: "Normal aging?", Specificity limits of MRI, FDG or Amyloid PET, Mixed dementia is common, Dementia with Lewy bodies (Mimic of both PD and AD, Current imaging limitations, Frequent comorbidity with AD), Confusion in radiology re: clinical-radiology syndromes (Specific diagnosis vs differential for underlying pathology, CBDS [corticobasal degeneration syndrome], PCA [posterior cortical atrophy], PPA [primary progressive aphasia], (4) Newly recognized indolent forms of neurodegeneration: Mimics of AD in patients > 75 years (CARTS, PART, LATE), Are there specific MRI and PET findings?

**NREE-118 Quick Diagnosis and Treatment - A Novel AIS Treatment Strategy using Hybrid Emergency Room System**

Naoyuki Inagaki, RT (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

•A quick diagnosis is important to determine treatment indications for patients who have AIS. •HERS (Hybrid-Emergency Room System) is an all-in-one concept for an Emergency Room. HERS is useful in critical trauma treatment strategies as computed tomography, interventional radiology and surgery are available in one environment. •It is reported that using HERS for AIS, shortened the time to reperfusion. •With my study, we have setup an AIS protocol that allows a Time Based Strategy and Tissue Based Strategy using HERS.

**TABLE OF CONTENTS/OUTLINE**

•We established an AIS treatment strategy (one stop management) using HERS (Angio-CT suite). •HERS can go from diagnostic imaging to treatment without transferring the patient from department to department. •A one-stop stroke protocol with simultaneous CT perfusion and whole body CTA can determine treatment indications, optimize treatment planning, and ensure safety. •This novel protocol is useful for identifying occluded vessels, assessing brain function, and confirming access routes. • Using our approach, a quick diagnosis and quick treatment were possible in cases of acute aortic dissection, aortic aneurysm rupture, carotid artery stenosis, carotid artery dissection in patients suspected with AIS. •A one-stop stroke protocol using HERS can be confirmed to shorten the door-to-image and treatment time and increase the re-canalization rate.

**NREE-119 Don't Hold Your Breath: Reproducible Hypercapnic Stimuli for Cerebrovascular Reactivity Mapping with RespirAct**

Diana V. Vera, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Review the fundamental physiology of hypercapnia and its association with cerebrovascular reactivity (CVR).2. Explain the mechanisms and advantages of hypercapnic stimuli as generated by the RespirAct instrument as compared to conventional breath-hold techniques for BOLD fMRI-based CVR mapping.3. Showcase representative examples of patients with cerebrovascular disease and CVR maps produced by RespirAct and BOLD fMRI.

## TABLE OF CONTENTS/OUTLINE

I. Hypercapnia and its association with cerebrovascular reactivity (CVR)a. Fundamentals of CVRb. Importance of measuring CVRII. Design of the RespirAct device for the production of controlled hypercapniaa. Current established practiceb. The RespirAct device descriptionIII. Comparison of RespirAct and conventional breath-hold methods of CVR mapping with BOLD fMRIa. A brief review of the origin of the BOLD signalb. RespirAct advantages over conventional breath-hold techniqueIV. Representative examples of CVR measurements with RespirAct in the context of a. Cerebrovascular steno-occlusive diseasesb. Arteriovenous malformationsc. Brain tumorsV. Summary/Conclusion

## **NREE-12 Spinal Vascular Malformations: A Systematic Angioarchitecture and Pathophysiology-Based Approach to Classification and Diagnosis**

Charlotte Y. Chung, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Spinal vascular malformation refers to a spectrum of lesions with abnormal connection between (or morphology of) spinal arteries and veins, all of which differ in angioarchitecture, pathophysiology, and clinical sequelae. Advances in angiographic and non-invasive imaging techniques have improved spinal vasculature visualization, enabling identification of distinctive morphologic and hemodynamic features. This exhibit introduces a comprehensive classification system based on these imaging features to aid diagnosis of well recognized as well as rare/recently identified spinal vascular lesions.The educational objectives of this exhibit are:- Review normal spinal vascular anatomy.- Discuss multimodal imaging techniques for evaluating spinal vascular malformations.- Differentiate spinal vascular malformations based on location, angioarchitecture, pathophysiology, and symptomology.- Illustrate radiographic appearance of spinal vascular malformations including arteriovenous fistulas and malformations, and non-shunting lesions such as aneurysms.

## TABLE OF CONTENTS/OUTLINE

I. Annotated diagrams of normal spinal arterial and venous anatomyII. Imaging techniques for spinal vascular malformation evaluationIII. Systematic classification of spinal vascular malformationsIV. Radiographic features of various spinal vascular malformationsV. Radiographic mimics

## **NREE-120 Uncovering the Hidden Dangers: Addressing Diagnostic Errors in Brain Emergency Neuroradiology**

Maria Lucia Brun, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To explain the importance of accurate and timely diagnosis in brain emergency neuroradiology. - To describe the different types of diagnostic errors in brain emergency neuroradiology. - To identify the potential causes of diagnostic errors and to develop effective strategies for error prevention and mitigation in emergency neuroradiology. - Case-based series examples to highlight different error types and the factors that led to the errors.

## TABLE OF CONTENTS/OUTLINE

1. Introduction2. Background3. Types of errors:- Cognitive errors: biases or heuristics that influence the radiologist's thinking or decision-making (Framing, Anchoring, Alliterative, Satisfaction of search, Availability, Attribution).- Communication errors: Breakdown in communication.- Perception/perceptual errors: Misinterpretation or misperception.- Technical errors: Limitations in the imaging equipment or technique used. - Organizational errors: Factors outside of the radiologist's control (workload, staffing issues, etc)4. Consequences of errors- Delayed/missed diagnoses- Incorrect/unnecessary treatments - Patient harm- Legal and financial consequences5. Strategies for error prevention and mitigation in emergency neuroradiology- Valuable tools to reduce errors in the imaging evaluation of brain emergencies- Showcase the particular strategies used at our departments.6. Case series examples- Provide case examples to further illustrate and explain the statements mentioned above.- Highlight the factors that led to the errors and how they could have been prevented or mitigated in that particular case.7. Conclusion

## **NREE-121 A Game-Changing Approach to Non-Invasive Vascular Imaging: Ultra High-Resolution CT with Novel Deep Learning Reconstruction**

Yuta Shimizu (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To learn the basic principles of ultra high-resolution CT (UHRCT).2. To learn the basic principles of the novel reconstruction technology "deep learning reconstruction (DLR)".3. To know the differences in image quality between DLR and conventional reconstruction methods on brain CTA using UHRCT.4. Clinical applications of brain CTA with DLR using UHRCT and comparison with digital subtraction angiography (DSA).5. To know the pitfalls of CTA with DLR and DSA on cerebral diseases.6. To present the outlook of brain CTA with DLR using UHRCT in the near future.

## TABLE OF CONTENTS/OUTLINE

1. Basic principles of UHRCT2. Basic principles of the novel imaging reconstruction method "DLR"3. The image quality of DLR and conventional reconstruction methods on brain CTA using UHRCT4. Clinical applications of brain CTA with DLR using UHRCT and DSA to evaluate the following diseasesintracranial aneurysmsmoyamoya diseasearteriovenous malformations (AVMs)dural arteriovenous fistulas (dAVFs)giant cell arteritistumors (skull tumor, meningioma, schwannoma, glioma, and so on)5. Pitfalls of CTA and DSA6. The future outlook of brain CTA with DLR using UHRCT

## **NREE-122 Erdheim-Chester Disease Beyond MSK: Do You Know What to Look for in Brain MRI?**

Marta Barrios Lopez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To explain and illustrate the main neuroradiological findings in Erdheim-Chester Disease (ECD), an uncommon type of systemic histiocytosis with almost constant bone involvement. 2. To learn the prognostic implications of certain neuroradiological findings. 3. Much of the literature on this subject focuses on its musculoskeletal findings. However, neuroradiological manifestations are an important source of morbidity and mortality in these patients.

## TABLE OF CONTENTS/OUTLINE

1. Introduction: 1.1. Main systemic manifestations of ECD: establishing a context. 1.2. The BRAF mutation and its (neuro)imaging implications. 2. Neuroradiological findings: 2.1. Introduction: Classification and frequency of neurological manifestations. MRI protocol. 2.2. Intra-axial involvement. Typically infratentorial. 2.3. Hypothalamic-pituitary manifestations. Several patterns. 2.4. Meningeal involvement: Different patterns. Masses often present a diagnostic challenge. 2.5. Orbital involvement. Do not forget the orbits in your systematic search. 3. Conclusions 4. References

## **NREE-123 Neurocysticercosis: Findings from a Challenge Disease in the Third World**

Lua P. Carvalho, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purposes of this exhibit are: review and illustrate the imaging findings of neurocysticercosis, the differential diagnoses, and their correlation with pathological images. Describe through illustrative presentations the benefits of the multimodality imaging approach to the diagnosis of neurocysticercosis. Present challenging cases, such as pseudotumoral lesions. Establish the imaging red flags and how they can help the radiologist reach the correct diagnosis.

## TABLE OF CONTENTS/OUTLINE

Neurocysticercosis stages and parasite life cycle. Imaging patterns on MR and CT. Susceptibility weighted imaging (SWI) role on calcified lesions. Diffusion-weighted imaging (DWI) showing the scolex. Spectroscopy as a valuable tool for differential diagnosis. 3D CISS sequence applicability for subarachnoid lesions. Vessel wall imaging sequence showing vasculitis with or without infarction. Pseudotumoral lesions. Differential diagnoses based on a pictorial review using representative cases from a Tertiary University Hospital database. A practical approach for better diagnostic accuracy and avoiding pitfalls. Final remarks.

## **NREE-124 Evaluation of Head and Spinal CT Angiography with Photon-counting Detector CT: How Close to the Angiographic and Operative Findings**

### Awards

#### Certificate of Merit

Fumiyo Higaki (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is: 1) To review imaging of head and spinal CT angiography with photon-counting detector CT 2) To correlate with angiography and intraoperative findings.

## TABLE OF CONTENTS/OUTLINE

Recently, Photon-counting detector (PCD-CT) has been developed and enabling high-resolution imaging at a lower radiation dose. PCD-CT employs a photon-counting detector that can measure the number of incident X-ray photons and their energy.



The newly released PCD-CT (NAEOTOM Alpha, Siemens Healthineers, Forchheim, Germany) has been in clinical use at our institution since December 2022. The PCD-CT offers several advantages over current state-of-the-art energy-integrating detector CT (EID-CT). The PCD-CT does not require septa to create a detector channel but does EID-CT. Therefore, it can be seen that downsizing the anode to achieve higher resolution does not affect the dose efficiency of the PCD-CT. The purpose of our exhibit is to present head and spinal cord CT angiographic images acquired with PCD-CT and corresponding images acquired angiographically and intraoperatively to clarify the delineation potential of PCD-CT. In spinal arterio-venous fistula (AVF), feeder, shunted pouch, and drainer are depicted in CTA. In spinal tumor of hemangioblastoma, tumor drainer is recognized in CTA. We would like to provide insight into how close the PCD-CTA findings are to the angiographic and intraoperative findings.

## **NREE-125 MRI Analysis of Causes and Consequences of Acute Epileptic Seizures from Temporal Lobe Origin**

Silvana I. Sarria Estrada I, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

MRI is useful to diagnose the cause and functional changes associated with acute seizures or status epilepticus (SE) from temporal lobe origin. Several MRI abnormalities on diffusion/perfusion-weighted, T2-weighted and contrast-enhanced T1-weighted sequences, observed after acute seizures in chronic conditions, even distant from the temporal lobe, are relevant to detect changes in the evolution. The identification of inflammatory component on MRI after a new onset temporal lobe seizure impacts the prognosis of infectious or autoimmune encephalitis, stroke or malignant tumours. Acute MRI findings in new onset seizures or SE are often subtle or unspecific. Timing of serial follow-up MRIs must be protocolized. Increase of amygdalar enlargements, hippocampal atrophy or autoimmune epilepsies can be detected using time defined follow-up MRI studies. In conclusion, a standardized MRI protocol for acute seizures and SE that analyses structure and function of the temporal lobe can lead to an early diagnosis of severe and chronic disorders. The time intervals between serial follow-up MRIs are relevant to avoid further consequences.

### **TABLE OF CONTENTS/OUTLINE**

1 Temporal lobe seizures are often associated with ictal MRI abnormalities. 2 Acute MRI can diagnose acute seizures or status epilepticus. 3 Some MRI features, even distant from chronic lesions, may suggest change in evolution. 4 Early MRI features in new onset seizures can lead to the diagnosis of chronic conditions. 5 Time-defined serial MR scans are needed in cases of subtle or unspecific MRI features.

## **NREE-126 The Haunted Core in Acute Ischemic Stroke**

Liv Jorunn Hollesli, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Perfusion-based imaging used in the evaluation of tissue viability is crucial in the management of patients with acute ischemic stroke (AIS), especially in extended time windows. Currently used imaging techniques in AIS cannot accurately differentiate between salvageable and non-salvageable tissue. There is no widespread gold standard definition of ischemic core. Different findings highlighting current challenges and solutions in AIS imaging will be presented through clinical cases.

### **TABLE OF CONTENTS/OUTLINE**

Perfusion-based CT and MR imaging techniques are used for detection of AIS and evaluation of tissue viability. At present, common available imaging techniques fail to accurately differentiate between salvageable and non-salvageable ischemic tissue. Additionally, a widespread gold standard definition of the ischemic core is lacking. Through clinical cases, image findings highlighting challenges and solutions in the evaluation of tissue viability will be discussed, like limited sensitivity to detect early ischemic changes on non-contrast enhanced CT (NCCT), variation in outcome after successful recanalization, potential reversibility of DWI-lesions, false negative initial DWI, overestimation of ischemic core on perfusion computed tomography and variation in penumbra and core volume calculations. Considering the important role of imaging in the management of patients with AIS, it is crucial with profound knowledge about advantages and limitations of penumbra and core evaluation. The teaching points will be extensively illustrated through clinical imaging examples.

## **NREE-128 Understanding Perisylvian Cortical Anatomy: Tips and Tricks**

Sally J. Choi, MD, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Perisylvian area serves as a crossroad for important cortical structures with principal functions for example Broca's area is located along the anterior and ascending rami of the Sylvian fissure (M sign) o Wernicke area is classically located along the inferior aspect of the posterior ramus of the Sylvian fissure
- Important structures form this area are o Frontal operculum o Parietal operculum o Temporal operculum o Insula
- Knowing these structures is beneficial for a radiologist in describing the anatomical component of a lesion to better understand the physiologic symptoms corresponding to the lesion location with surgical and prognostic importance.

## TABLE OF CONTENTS/OUTLINE

- Briefly discuss the sylvian fissure anatomy• Discuss the different cortical structures from the perisylvian area such as frontal, parietal and temporal operculum and insula. • Discuss the MRI anatomy of these structures utilizing some tips and tricks to understand the anatomy such as- M shaped appearance of the inferior frontal gyrus along the anterior and ascending rami of the sylvian fissure• Discuss the role of these cortical structures in the principal functions of the body. • Discuss the role of relevance of Functional MRI in these areas

### **NREE-129 The Cortico-Limbo-Thalamo-Cortical Circuits: An Update to the Papez Circuit of the Limbic System**

Parnian Shobeiri, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? The Papez circuit is a circuit believed to control memory and emotion, composed of the cingulate cortex, entorhinal cortex, parahippocampal gyrus, hippocampus, hypothalamus, and thalamus. ? In recent years, multiple additional limbic fiber connectivity has been revealed using diffusion-weighted imaging (DWI) techniques. Some of these fiber tracts include the amygdalofugal tract (AFT), amygdalothalamic tract (ATT), stria terminalis (ST), dorsal thalamo-hypothalamic tract (DTH), cerebello-hypothalamic tracts, and the parieto-occipito-hypothalamic tract (POHT) ? This presentation aims to summarize the anatomy of the limbic system, outline previous updates to the circuit, and elaborate on the anatomical connectivity of the limbic circuits based on recent DWI as an update to the original Papez circuit.

#### TABLE OF CONTENTS/OUTLINE

? The original Papez circuit and updates over time ? The Yakovlev model/circuit ? The MacLean's model ? Overview of high spatial resolution diffusion weighted imaging ? Review of previously established Papez circuit (See Figures 1 5 for specific tracts) ? Detailed fiber tract anatomy ? Updates to previously known limbic circuits: the role of additional fibers in creating multiple neuronal loops and circuits

### **NREE-13 Mapping the Way: A Road Map for Diagnosing, Treatment and Follow Up of Brain Metastases**

Julia M. Brunelli, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibition aims to provide a comprehensive overview of the imaging evaluation of patients with suspected brain metastases, emphasizing the prevalence and potential diagnostic challenges associated with these neoplasms. It will highlight specific imaging patterns, differential diagnoses, and potential pitfalls in imaging interpretation. The exhibition will also discuss the clinical and imaging features that suggest the etiology of primary tumors, including a pictorial essay of specific patterns. Additionally, it will review radiological criteria for diagnosing radionecrosis, pseudoprogression, and disease progression in brain metastases patients and emphasize the importance of advanced imaging techniques. Case studies will be used to illustrate radiological challenges and diagnostic considerations in the treatment and follow-up of these patients.

#### TABLE OF CONTENTS/OUTLINE

1. Imaging Evaluation of Patients with Suspected Brain Metastases• Overview of intracranial metastases as the most common adult intracranial neoplasms and their imaging evaluation • Imaging patterns and differential diagnoses• Mimickers and pitfalls in imaging interpretation2. Etiology of the Primary Tumor • Clinical and imaging features suggestive of the primary tumor • Pictorial essay of brain metastases with specific patterns3. Treatment and Follow-up• Radiological criteria for diagnosing radionecrosis, pseudoprogression, and disease progression• Case studies illustrating radiological challenges in distinguishing these conditions

### **NREE-130 CNS Imaging of the Immunocompromised - An Opportunistic Review for the Radiologist**

Luis G. Colon Flores, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Review the main imaging findings of the different opportunistic infections. 2) Review and recognize the different HIV/AIDS associated CNS conditions. 3) Discuss the imaging findings of immunodeficiency-associated primary CNS lymphomas.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction 2) Opportunistic infections (Bacterial, viral, fungal and parasitic) 3) HIVS/AIDS CNS associated conditions 4) Immunodeficiency-associated primary CNS lymphoma 5) Conclusion



## **NREE-131 The Ultimate Imaging Companion to Vascular Complications in Cancer Patients: A Comprehensive Review for Radiologists**

### **Awards**

#### **Certificate of Merit**

Jessica T. De Oliveira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Vascular complications are a significant cause of morbidity and mortality in cancer patients, with increasing incidence due to improved survival and evolving treatments. Oncologic patients are more prone to vascular complication such as hypercoagulability state, reduction in mobility and aggressive treatments as brain radiation. These complications may occur at disease presentation or be secondary to treatment. Our aim is to review the main imaging findings of vascular complications in a didactic way. We believe this approach may facilitate diagnostic suspicion.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Review main intracranial vascular complications in oncology patients, with an emphasis on the pathophysiological mechanisms involved. To display a flowchart dividing these complications according to treatment status and treatments applied. To discuss for each vascular complication the risk factors, clinical presentation, main imaging findings and relevant treatments. The discussion will be enriched with illustrative cases, including: Complications before treatment: Hypercoagulability (Trousseau syndrome, cerebral venous thrombosis). Vascular compression/ obstruction by the tumor or Vascular compression/ obstruction due to brain herniation. Intravascular tumor dissemination (oncotic aneurysm and intravascular lymphoma). Complications during treatment: Post-operative ischemia Late complications after treatment: Aneurysm after radiotherapy, SMART, Radiation induced cavernous malformations. To highlight the most relevant clinical and imaging aspects of these vascular complications, essential for prompt diagnosis and treatment.

## **NREE-132 Skull Drip: Algorithmic Multimodality Imaging Approach**

Pokhraj P. Suthar, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Briefly discuss various causes and sites of skull base CSF leak. To learn the diagnostic imaging findings of various modalities including high resolution NECT, CT cisternogram, MRI and radiotracer studies, in identifying the cause and localizing the exact site of skull base CSF leaks. To learn the algorithmic imaging approach and how it is helpful for surgical planning in cases of skull base CSF leak. To diagnose recurrent leaks in post-surgical repair of primary CSF leak

#### **TABLE OF CONTENTS/OUTLINE**

Cerebrospinal fluid (CSF) leaks are extracranial leaks of CSF via an osteodural defect in the skull base into the tympanomastoid cavity, paranasal sinus, or rarely in the skull base neck space. There are various etiologies for the same, including accidental trauma, congenital malformation, spontaneous leaks in idiopathic intracranial hypertension and iatrogenic. Accurate localization of the site of the leak and identification of the underlying cause is necessary for surgical planning to avoid associated complications and prevent recurrence. In this educational exhibit, we outline the various interesting cases of skull base defects, their multimodality algorithmic imaging diagnosis approach (CT, MRI, CT/MR/Nuclear medicine radionuclide cisternography), correlation of imaging diagnosed skull base defect with surgical outcome, and imaging diagnosis of recurrent CSF leaks.

## **NREE-133 The Ternary Plot Analysis of Time-sensitive Diffusion Imaging in CNS Pathologies**

Toshiaki Taoka, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### **TEACHING POINTS**

Time-sensitive diffusion imaging provides potentially valuable information on tissue characteristics, with the oscillating gradient spin-echo (OGSE) method enabling short diffusion times compared to the conventional pulsed-field gradient spin-echo (PGSE) method. Comparing the signal on OGSE and PGSE can provide information on tissue compartmentalization. However, comparing different images can make interpretation challenging, and organizing pixel information is necessary. The ternary plot method presents the relationship between diffusivity, compartmentalization, and water content for a single pixel, simplifying the presentation of tissue characteristics obtained from OGSE, PGSE, and  $b=0$  images. This educational exhibit demonstrates the tissue characteristics of various central nervous system pathologies provided by time-sensitive diffusion imaging using the triangulation method of the ternary plot. The ternary plot method has further applications, including the color coding of the pixels according to the tissue characteristics.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of time dependence of diffusion MRI
2. Methods for displaying time-dependent diffusion-related coefficients
3. Distribution of the time-dependent diffusion-related coefficients on ternary plot
4. Further application of ternary plot method

## **NREE-134 A Review of Imaging Findings in Neurogenic Ptosis**

### **Awards**

#### **Certificate of Merit**

Yiseul Son, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To understand the anatomy of the neural pathways that innervate the upper eyelid retractor muscles (e.g. oculosympathetic pathway and oculomotor nerve pathway). To describe the normal cross-sectional anatomy of the neural pathways causing neurogenic ptosis. To illustrate the imaging findings of various lesions causing neurogenic ptosis according to a course-based approach.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction and general overview of ptosis / Anatomic review and imaging-based normal cross-sectional anatomy of the neural pathways innervating the upper eyelid retractor muscles (oculosympathetic and oculomotor pathway) / A variety of pathologic conditions causing neurogenic ptosis according to a course-based approach 1. Oculomotor nerve palsy (oculomotor nerve pathway) - Intra-axial segment - Cisternal segment - Cavernous segment - Orbital segment 2. Horner's syndrome (oculosympathetic pathway) - Central neuron - Preganglionic neuron - Postganglionic neuron 3. Neuromuscular junction disorders / Summary and conclusion

## **NREE-135 Epilepsy Surgery: Nuts and Bolts for Radiologists**

### **Awards**

#### **Certificate of Merit**

Jack Yang (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

A broad range of surgical procedures are available for medically refractory epilepsy from open parenchymal resections to more recent minimally-invasive ablative therapies. In this exhibit, we outline the scope and techniques of these surgical procedures, role of neuroimaging, expected post surgical imaging findings and associated complications. We describe neuroimaging role in subdural or depth electrode placement, an invasive diagnostic surgical procedure for more precise localization of epileptogenic focus. We briefly outline the MRI safety issues in imaging patients with neuromodulation devices.

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents: I. Epilepsy surgery: Evolution II. Types of surgical procedures: Scope and Techniques A. Surgery for localization of epileptogenic focus: a. Invasive procedure - Subdural grid and strip placement. b. Minimally-invasive procedure - Stereo-EEG B. Surgery for refractory epilepsy a. Invasive procedures: Resection - 1. Hemispherectomy 2. Lobar resection 3. Lesionectomy. Disconnection - 1. Conventional corpus callosotomy 2. Multiple subpial resections. b. Minimally- or less-invasive procedures: Ablative therapies - 1. Laser Interstitial thermal therapy (LITT) 2. MR guided focused US 3. Gamma knife. Neuromodulation procedures - 1. Vagal nerve stimulation (VNS) 2. Deep brain stimulation (DBS) 3. Responsive neurostimulation (RNS) III. MRI safety issues in imaging epilepsy patients with implants and electrodes

## **NREE-136 Exploring the FDA Pharmacovigilance Database to Assess the Importance of Symptoms Associated with Gadolinium Exposure (SAGE)**

Eric Lancelot, PharmD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Analysis of FDA pharmacovigilance database to determine safety of gadolinium based contrast media.

#### **TABLE OF CONTENTS/OUTLINE**

**Objective** The aim of this study was to assess the tendency of adverse events representing "symptoms associated with gadolinium exposure" (SAGE) among the bulk of safety experiences reported to health authorities. **Materials and Methods** SAGE symptoms were searched by preferred terms (PTs) in different system organ class (SOC) categories in the FDA Adverse Event Reporting System (FAERS) database over a 5-year period ranging from 2014 to 2019. The numbers of SAGE symptoms per PT, and cumulatively per SOC, were recorded and their weights in the overall spectrum of AEs were determined for 3 linear and 3 macrocyclic GBCAs. **Results:** The analysis of FAERS data revealed a significantly higher SAGE weight for linear GBCAs, namely gadodiamide (23.27%), gadopentetate dimeglumine (22.12%) and gadobenate dimeglumine (19.27%), than for the macrocyclic GBCAs, namely gadoteridol (8.45%), gadobutrol (4.53%) and gadoterate meglumine (3.82%). The SOCs "musculoskeletal and connective tissue disorders", "nervous system disorders", "general disorders and administration site conditions" and "psychiatric disorders" were consistent with this ranking. Moreover, SAGE weights displayed a steady growth of about 5% per year for the linear GBCAs and 1% per year for the macrocyclic agents. **Conclusion** This study showed that SAGE symptoms may be more prevalent with linear than macrocyclic GBCAs, and that SAGE reporting tends to rise

significantly more in patients exposed to linear agents. These differences might be explained by the differences in kinetic stability between the GBCAs.

### **NREE-138 The Radiologist's Guide to Lumbar Spine Pain Procedures: Indications, Techniques and Complications**

Rajul Gupta, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Less than 3 percent of the 4 million annual pain procedures are performed by radiologists, despite having the unique ability to correlate imaging findings with clinical features for targeted pain interventions. This exhibit is aimed at educating the radiologists regarding indications, planning, techniques and challenges of common lumbar pain procedures, with emphasis on 'how to' perform transforaminal and interlaminar epidural spinal injections (ESI). Other technically demanding pain procedures including dorsal transforaminal S1 ESI, synovial cyst rupture and blood patches will be discussed, along with tips and tricks for performing challenging interventions in postoperative, scoliotic and degenerative spine.

#### **TABLE OF CONTENTS/OUTLINE**

1. Relevant Lumbar Spine anatomy and fluoroscopic positioning 2. Clinico-radiologic correlation- Clinical examination, patient counselling, selecting the right procedure. 3. Procedure and tray setup 4. Transforaminal ESI- 'how to' approach the target, pre and post contrast injection views. • Supra-neural TFESI • Infra-neural TFESI 5. Interlaminar ESI- • Optimal needle positioning in multiplanar imaging • Recognizing suboptimal needle location 6. Dorsal S1 ESI- recognizing landmarks and optimal views for needle positioning. 7. Other pain relief procedures • Synovial cyst rupture- Direct (IL/TF) and Indirect Techniques • Epidural blood patch 8. Challenging cases and difficult myelograms • Scoliotic and degenerative spine • Postoperative spine 9. Pearls and pitfalls- complications and how to prevent them.

### **NREE-139 From Genes to Emergencies: An Innovative Approach to Imaging Assessment, Genetic Aspects, and Emergency Room Evaluation in CADASIL**

Ana Luiza Basilio Franca (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This educational exhibit aims to provide a comprehensive understanding of cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) disease, including: To illustrate the imaging highlights of the cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL). To exhibit the genetic cascade involved in the disease. To explain the imaging approach to the disease within the context of acute stroke in the emergency. To illustrate the differential diagnosis, including cerebral autosomal recessive arteriopathy with subcortical infarcts and leukoencephalopathy (CARASIL) and white matter diseases.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction and revision of CADASIL's epidemiology, clinical presentation, and etiology. 2. MRI highlights in CADASIL. 3. Genetic considerations associated with CADASIL. 4. Differential diagnosis, including CARASIL and other white matter diseases. 5. Imaging assessment in the emergency room. 6. Take-home messages.

### **NREE-14 An Imaging Review of Autoimmune Encephalitis: An Often-Overlooked Diagnosis**

Miriam Fernandez-Gomez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To understand the many signs, symptoms, and types of autoimmune encephalitis. - To Review the main antibodies that have been identified, their patterns of CNS involvement, and their typical anatomical distributions due to the relative concentration of target proteins. - To Highlight the characteristic MRI findings associated with autoimmune encephalitis, with specific emphasis on the role of neuroimaging in the diagnostic work-up. - Finally, to describe a case report of anti-LGI1 autoimmune encephalitis associated with SARS-CoV-2 (COVID-19).

#### **TABLE OF CONTENTS/OUTLINE**

TABLE OF CONTENTS  
I. Introduction  
Introduce the topic of autoimmune encephalitis  
II. Understanding Autoimmune Encephalitis  
Define autoimmune encephalitis  
Discuss the symptoms of autoimmune encephalitis  
Explain the pathophysiology of autoimmune encephalitis  
Describe the different types of autoimmune encephalitis  
III. MR Imaging Findings Associated with Autoimmune Encephalitis  
Discuss the characteristic MRI findings associated with autoimmune encephalitis  
Emphasize the role of neuroimaging in the diagnostic work-up  
IV. Autoimmune Encephalitis in SARS-CoV-2 Infection (COVID-19): Illustrative Case  
Describe a case report of anti-LGI1 autoimmune encephalitis associated with SARS-CoV-2 (COVID-19)  
V. Conclusion  
Summarize the key points of the paper  
Discuss the importance of recognizing and diagnosing autoimmune encephalitis

### **NREE-140 Predictors of Intracerebral Hemorrhage Expansion on CT**

Ahmed (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Review classification of intracranial hemorrhages and define hemorrhage expansion  
 2. Importance of identifying intracranial hemorrhage expansion  
 3. Describe findings on imaging that can predict hemorrhage expansion  
 Intracerebral hemorrhage (ICH) results in 10-20% of all strokes and leaves 60-80% of survivors functionally dependent. Identifying early hematoma expansion (HE), defined as growth >12.5 mL or volume >33%, is crucial for modifying its potential impact. Three accepted HE indicators in non-contrast computed tomography include baseline hematoma volume as measured by the ABC/2 method. Secondly, irregularly hemorrhage shape indicating multiple leaking blood vessels. Radiologically, the satellite sign and island sign are imaging correlates that indicate irregular hemorrhage shape. Lastly, the imaging density heterogeneity of the hematoma can represent active bleeding. Three signs that represent heterogeneity of the hematoma include the swirl, black hole, and blend sign.

### TABLE OF CONTENTS/OUTLINE

1. Classification of intracranial hemorrhage  
 a. Intra-axial hemorrhage  
 b. Extra-axial hemorrhage  
 2. Defining hematoma expansion (HE)  
 3. Importance of identifying intracerebral hemorrhage expansion  
 a. Relative incidence  
 b. Prognostic indicator  
 4. Clinical aspects that increase risk of hematoma expansion  
 a. Systolic BP and onset to CT time  
 b. Prior anticoagulant therapy  
 c. hyperglycemia  
 5. Radiological signs of hemorrhage expansion  
 a. Hematoma shape/volume/location  
 b. Perihematomal edema  
 c. Hematocrit levels  
 d. Spot sign  
 e. Satellite sign, Island sign, Swirl sign, Blend sign and Black hole sign

### **NREE-141 Beyond the Blind Spots: A Comprehensive Approach to Reducing Diagnostic Errors in Neuroradiology in the Emergency Room for Enhanced Patient Safety**

Heber Colares Costa, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To exhibit a timely and accurate diagnosis of neurological conditions like stroke, brain tumors, and traumatic brain injury, providing effective treatment. To show misdiagnosis or diagnosis delays due to errors in imaging evaluation that can seriously harm the patient, including permanent neurological deficits or death. To prevent unnecessary interventions or treatments, inhibiting inaccurate interpretation of imaging studies and unnecessary surgeries, medications, or other medicines that can harm the patient physically and financially. To avoid significant medicolegal consequences.

### TABLE OF CONTENTS/OUTLINE

1. Revision of epidemiology, pathology, and demographics of neuroradiologic emergencies. 2. Imaging evaluation of the emergency room's crucial and prevalent neuroradiologic diseases. 3. Potential imaging pitfalls in neuroradiologic emergencies and how to avoid them. 4. Potential causes of imaging medical errors, including night periods, fatigue and exhaustion of radiologists, a large volume of examinations, and short evaluation times. 5. The consequences of errors in neuroradiological imaging evaluation in the emergency room, including delays in stroke recanalization therapy, misdiagnoses of intracranial hemorrhages, dural venous sinus thrombosis, and inadequate treatment for these conditions. 6. Highlights on medicolegal issues and reputational damage for healthcare providers and hospitals. 7. How to ensure that hospitals and healthcare providers can reduce the risk of misdiagnosis, unnecessary interventions, and legal consequences, ultimately leading to better patient outcomes. 8. Take-home messages.

### **NREE-142 The Uncharted Territory of Neurodegeneration: Keeping Pace with the Latest Advances in Imaging Diagnosis and Novel Therapies for Degenerative Diseases**

Ana Luiza Basilio Franca (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Brain neurodegenerative diseases are a group of disorders characterized by progressive damage and loss of neurons in the brain. These diseases include Alzheimer's disease, Parkinson's disease, Huntington's disease, and amyotrophic lateral sclerosis (ALS), among others. Recent advances in imaging diagnosis and novel therapies have shown promising results in improving the diagnosis and treatment of these conditions. The study aims to: To explain the imaging features, genetic cascade, and neuropathology involved in neurodegenerative diseases. To exhibit that advanced imaging techniques have significantly improved the diagnosis of brain neurodegenerative diseases. To explain the imaging approach to the diseases, differential diagnosis, and current therapeutics.

### TABLE OF CONTENTS/OUTLINE

1. Revision of epidemiology, clinical presentation, and etiology of neurodegenerative diseases. 2. Genetical considerations. 3. The role of magnetic resonance imaging (MRI) and functional MRI (fMRI) in identifying structural changes in the brain associated with neurodegeneration. 4. Positron emission tomography (PET) in assessing amyloid plaques and tau protein in the brain, characteristic features of Alzheimer's disease. 5. Novel therapies for neurodegenerative brain diseases, including immunotherapy, gene therapy, stem cell therapy, neuroprotection with drugs, and deep brain stimulation. 6. Differential diagnosis. 7. Take-home messages.

## **NREE-143 Exploring the Depths of Pediatric Posterior Fossa Tumors: Integrating Molecular Analysis and Magnetic Resonance Imaging for Unprecedented Diagnosis and Prognosis**

Laura C. Magalhaes, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To illustrate the imaging diversity of these tumors, including a range of histological subtypes, including medulloblastoma, ependymoma, and pilocytic astrocytoma, among others. To demonstrate the importance of pediatric posterior fossa CNS tumors molecular analysis, providing an accurate diagnosis, risk stratification, and personalized treatment. To identify the specific genetic alterations and biomarkers for managing these tumors.

### **TABLE OF CONTENTS/OUTLINE**

1. Revision of epidemiology, pathology, and pediatric posterior fossa CNS tumor demographics. 2. Imaging features in pediatric posterior fossa CNS tumors, including pilocytic astrocytoma, ependymoma, medulloblastoma, other embryonal tumors, Rosette-forming glioneuronal tumor, diffuse midline gliomas, tectal gliomas including diffuse low-grade MAPK pathway-altered. 3. Most recent updates on pediatric posterior fossa CNS tumors molecular alterations, including WNT, SHH, and non-WNT/non-SHH medulloblastomas, BRAF mutations in pilocytic astrocytoma, EZHIP in group A ependymomas, MAPK pathway-altered in diffuse low-grade tectal gliomas. 4. Imaging strategies to depict the correct diagnosis based on the genetic profile. 5. Flowchart of the changes and last updates based on the neoplastic molecular profile. 6. Take-home messages.

## **NREE-144 From Conception to Cancer: Exploring the Molecular Signatures of Embryonal Tumors for Precision Medicine**

Laura C. Magalhaes, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Recent advances in molecular biology have led to a better understanding of the types and subtypes of these tumors based on the 2021 World Health Organization of central nervous system tumors. The study aims to: To illustrate that the molecular analysis of Central Nervous System (CNS) embryonal tumors is critical for accurate diagnosis, risk stratification, and targeted therapy. To show that molecular analysis can help identify specific genetic alterations and biomarkers that can provide valuable information for managing these tumors.

### **TABLE OF CONTENTS/OUTLINE**

1. Revision of epidemiology, pathology, and demographics of CNS embryonal tumors. 2. Imaging features in CNS embryonal tumors. 3. Most recent updates on CNS embryonal tumors molecular alterations, including WNT-activated medulloblastoma, sonic hedgehog (SHH) activated, and non-WNT/non-SHH medulloblastomas. 4. Recent advances in molecular biology have led to identifying specific genetic alterations and biomarkers in non-medulloblastoma embryonal tumors, including teratoid/rhabdoid tumors (AT/RTs), embryonal tumors with multilayered rosettes (ETMRs), CNS Neuroblastoma, FOXR2-Activated, CNS Tumor with BCOR Internal Tandem Duplication, Cribriform Neuroepithelial Tumor. 5. Specific genetic mutations, amplifications, or deletions associated with tumor progression, recurrence, and response to therapy, including C19MC, DCER 1, FOXR2, BCOR-ITD, SMARCB1, SMARCB4, AT/RT (TYR), AT/RT (SHH), AT/RT (MYC). 6. Imaging strategies to depict the correct diagnosis based on the genetic profile. 7. Flowchart of the changes and last updates based on the neoplastic molecular profile. 8. Take-home messages.

## **NREE-145 Neurogenetics and Imaging of Motor Neuron Disease**

Maxwell Wright, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1.To discuss the classification and pathogenesis of motor neuron disease (MND). 2.To highlight the neurogenetics, imaging findings, and diagnostic pearls for the specific diagnosis of various upper and lower MNDs.

### **TABLE OF CONTENTS/OUTLINE**

We retrospectively reviewed 113 patients from our PACS system with clinical and Imaging findings correlating with motor neuron disease (MND). All the patients underwent routine MRIs of the brain and spine. Almost 100% of these patients had CSF examinations, while genetic studies were available in 49% of the patients. All studies were read by two neuroradiologists. Imaging findings were correlated with the clinical examination, CSF, and biochemical results, which were further correlated with the genetic studies when available. For easy understanding, this exhibit is classified under the following categories: 1. Upper MND: Primary lateral sclerosis (PLS), Hereditary Spastic Paraparesis (HSP), Pseudobulbar Palsy 2. Lower MND: a) Chronic onset: Inherited- Spinal Muscular Atrophy (SMA), Progressive Muscular Atrophy (PMA), Distal hereditary motor neuropathy; Acquired- Upper limb dominance (Flail Arm, Hirayama, Segmental MND) Lower limb dominance (PMA, Monomelic Amyotrophy) b) Acute onset: Guillain Barre Syndrome, Polio; and 3. Combination of UMN and LMN: Amyotrophic lateral sclerosis (ALS). Conclusion: 1. Neurogenetics and neuroimaging complement each other in clinching the specific diagnosis of MND. 2. We discuss the neurogenetics, pathogenesis, and imaging appearance of the MND in this exhibit.

### **NREE-146 Imaging Spectrum of Cystic Spinal Lesions**

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To illustrate the compartmental spinal anatomy.
- To discuss the key imaging findings of cystic spinal lesions and their mimics.
- To demonstrate the utility of multimodality imaging in the differential diagnosis of cystic spinal lesions.

#### **TABLE OF CONTENTS/OUTLINE**

A wide variety of benign and malignant cystic lesions can involve the different compartments of the spine. Although an exact diagnosis may be challenging, different imaging characteristics are used in order to narrow the differential diagnosis and/or establish the exact diagnosis. In addition, spinal cysts can be divided into: intramedullary, intradural extramedullary, or extradural, depending on their location, which is only useful in planning treatment. Magnetic resonance imaging (MRI) is the imaging method of choice to identify and characterize spinal cysts, and ultrasound (US) is often used as the initial imaging modality in pediatric patients. Instead, CT is helpful for evaluating cystic lesions of the vertebral column. In this exhibit, we will review the multimodal imaging features of the most common cystic spinal lesions based on their etiology, including neoplastic, congenital, degenerative, infectious, post-traumatic, and postsurgical disorders. We will also review the main differential diagnoses that should be considered.

### **NREE-147 Pediatric Neurometabolic Diseases: A Pictorial Review of How the Radiologist can Approach Hypomyelinating and Dysmyelinating Disorders**

Thomaz R. Mostardeiro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1: Pediatric Neurological metabolic diseases are a group of disorders affecting the brain, mostly related with a specific enzyme deficiency. 2: These disorders traditionally affect the white matter but can also affect the gray matter (both cortex and basal ganglia). 3: Pattern of white matter disease is one of the most helpful clues in the characterizing these conditions on imaging. 4: Pathologically, these disorders can be classified as hypomyelinating (with mild signal changes, with T2 hyperintensity and T1 hypo to isointensity) or other white matter diseases (pronounced T2 hyperintensity and T1 hypointensity) 5: Hypomyelinating disorders can be differentiated based on peripheral neural compromise or not. 5: Other white matter diseases (dysmyelinating) can be characterized based on the pattern of white matter disease (confluent vs multifocal). 6: Confluent white matter disease has an extensive differential, and it is critical to depict where changes are visualized (diffuse, frontal, parieto-occipital, posterior fossa, periventricular or subcortical).

#### **TABLE OF CONTENTS/OUTLINE**

1: Hypomyelinating disorders (T1 hypointensity and T2 hyperintensity). 1.1: Without typical PNS involvement: Pelizaeus Merzbacher Disease- 1.2: With typical PNS involvement: Cockayne disease 2: Other white matter diseases (mild T1 hypo or isointensity and T2 mild hyperintensity). 2.1: Confluent. 2.1.1: Frontal: Infantile Neuroaxonal Dystrophy. 2.1.2: Parieto-occipital: X-Linked adrenoleukodystrophy. 2.1.3: Posterior Fossa: Leigh syndrome. 2.1.4: Periventricular: Krabbe Disease. 2.1.5: Subcortical: Kearns Sayre Syndrome. 2.2: Multifocal: Hydroxy glutaric Aciduria.

### **NREE-148 Imaging Approach and Review of Arteriovenous Orbital Fistulae**

Daniela Jaramillo Arias, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Reinforce the knowledge and correct identification of the vascular structures involved in the orbital-venous arterial fistula. List the imaging findings through contrasted tomography and contrasted MRI, to identify the main aspects to highlight in the diagnosis of orbital arteriovenous fistula. Complications of orbital arteriovenous fistula Management and prognosis of patients with orbital arteriovenous fistula



## TABLE OF CONTENTS/OUTLINE

Definition, Diagnosis and image findings, Clinical findings, Treatment Arteriovenous orbital fistulae is a rare condition that occurs when an abnormal connection forms between an artery and a vein within the orbit; This causes blood to flow directly from the arterial system to the venous system, bypassing the capillary network. As a result, there is a high-pressure gradient in the venous system, leading to congestion and dilation of the veins. Arteriovenous orbital fistulae can be congenital or acquired. The most common cause of acquired arteriovenous orbital fistulae is trauma, such as a blunt or penetrating injury. Symptoms of arteriovenous orbital fistulae include bulging of the eye, proptosis, diplopia, visual disturbance, and in severe cases, loss of vision or even blindness. Diagnosis of arteriovenous orbital fistulae involves a thorough medical history and physical examination, including imaging studies such as ANGIO CT or enhanced MRI. Treatment options depend on the severity of the condition and may include observation, embolization or surgical removal of the abnormal vessels.

## NREE-149 Intradural Spinal Lesions: A Review of Common and Rare Pathologies

Sultan H. Yahya, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Review normal spinal anatomy and compartments- Approach to intradural spinal pathologies, and distinguishing intra and extramedullary pathologies- Review common and rare intra-medullary neoplasms, including ependymomas, subependymomas, astrocytomas, metastasis, hemangioblastomas and spinal involvement in diffuse leptomeningeal glioneuronal tumors. - Discuss medullary neoplastic mimics, including demyelinating/inflammatory abnormalities, infarctions, and arteriovenous malformations. - Review common and rare extramedullary neoplasms including meningiomas, schwannomas, metastasis, angioliipomas, mature cystic teratomas, paragangliomas, dermoids/epidermoid/lipomas and neuroenteric cysts.

## TABLE OF CONTENTS/OUTLINE

- Spinal compartmental anatomy- Approach to intradural pathologies- Intramedullary abnormalities: tumors, differentials of medullary signal abnormalities and neoplastic mimics- Extramedullary lesions: common / rare tumoral entities and cystic lesions

## NREE-15 Cortically-Based Brain Tumors: Who is Who

Irene Diaz, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Cortically-based brain tumors have some features in common. They usually clinically manifest as epilepsy refractory to anti-epileptic drugs and most frequently affect children and young adults. We can also talk about long-term epilepsy-associated tumors (LEAT), and they are usually low-grade tumors. Radiologically, they may be difficult to differentiate, but there are some imaging diagnostic clues that will help us find the correct diagnosis.

## TABLE OF CONTENTS/OUTLINE

An image-based quiz will lead the review of different cases of cortically-based brain tumors, with its differential diagnostic clues at imaging. Most of our patients were young adults and clinically presented with focal epilepsy. We are mainly showing low-grade tumors, such as dysembryoplastic neuroepithelial tumor (DNET), ganglioglioma, pleomorphic xanthoastrocytoma, oligodendroglioma, multinodular and vacuolating neuronal tumor (MVNT) or polymorphous low-grade neuroepithelial tumor of the young (PLNTY).

## NREE-150 Cerebellar Ataxia: Differential Diagnosis Based on Common Imaging Patterns

Paulo S. Ferreira (*Presenter*) Nothing to Disclose

### TEACHING POINTS

- Ataxia is a physical finding characterized by impaired coordination of voluntary muscle movement, resulting in disequilibrium, vertigo and gait ataxia. - Ataxia can be caused by either impaired vestibular input to the cerebellum or by cerebellum dysfunction itself. - Brain MRI, the imaging modality of choice, has a key role in differentiating the many causes of ataxia. - Ataxia may present with different cerebellum findings: normal, hypoplastic and atrophic morphology. - Regarding clinical findings, ataxia may be further classified as acute / subacute or chronic; traumatic; autoimmune; paraneoplastic or genetic. - Combining imaging and clinical features, differential diagnosis is made.

## TABLE OF CONTENTS/OUTLINE

- Defining ataxia. - Clinical findings that are relevant for the diagnosis based on MRI. - Differentiating normal vs hypoplastic vs atrophic cerebellum.- Further exemplifying findings in atrophic cerebellum that lead towards specific diagnosis (e.g.: superficial syderosis, basal ganglia abnormalities, white matter abnormalities). - Further exemplifying findings in hypoplastic cerebellum that lead towards specific diagnosis (e.g.: unilateral hypoplasia, posterior fossa malformations, hemorrhage). - Flowchart to the approach of cerebellar ataxia.

## **NREE-151 Interstitial Fluidopathy: A Concept for Understanding CNS Diseases with Impaired Interstitial Fluid Dynamics**

Toshiaki Taoka, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

### **TEACHING POINTS**

This educational presentation proposes a new concept called "Central Nervous System (CNS) Interstitial Fluidopathy," which encompasses diseases whose pathologies are associated with abnormal interstitial fluid dynamics. The glymphatic system hypothesis proposes that cerebrospinal fluid and interstitial fluid in the brain constitute a mass transport system, including waste clearance. Impairment of these functions results in protein leakage into the interstitium and impaired efflux of waste products, leading to the accumulation of waste products, tissue dysfunction, and conditions such as neuroinflammation. The term "CNS interstitial fluidopathy" describes diseases or conditions in which abnormalities in interstitial fluid dynamics are one of the significant factors in the pathological process. Various diseases, including Alzheimer's disease, Parkinson's disease, traumatic brain injury, multiple sclerosis, and small vessel diseases, develop due to abnormalities in the interstitial fluid dynamics. By categorizing these diseases as CNS interstitial fluidopathies, we can improve our understanding of their disease mechanisms, develop potential imaging methods, clinical methods, and common treatment methods or drugs. The dynamics of interstitial fluid are critical for understanding CNS diseases or disorders, and the proposed concept may promote advancements in disease treatment or prevention.

### **TABLE OF CONTENTS/OUTLINE**

1. An overview of the dynamics of cerebrospinal fluid and interstitial fluid in the CNS.2. The waste clearance system in the CNS.3. Pathologies associated with abnormal interstitial fluid dynamics.4. A summary of the concept of interstitial fluidopathy.

## **NREE-152 A Night in the ER: Diagnostic Errors in Emergency Neuroradiology**

### **Awards**

#### **Certificate of Merit**

George K. Vilanilam, MBBS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Introduction: Diagnostic errors in emergency neuroradiology are a major contributor to unnecessary healthcare costs and have been implicated in preventable deaths in the US. Errors are broadly categorized into perceptive and interpretive errors. The most common erroneous studies are CT head (32%), CT cervical spine (18%), and CTA head and neck (24%).Specific teaching points1) Defining and understanding common sources of diagnostic errors in emergency neuroradiology.2) Providing examples of common cognitive biases and perceptual errors.3) Discussing methods to mitigate diagnostic errors in emergency neuroradiology.

### **TABLE OF CONTENTS/OUTLINE**

Common cognitive biases/interpretive errors1) Truncation of the search and analytical thought processes (premature closure, satisfaction of search, and satisfaction of report).2) Affirming initial diagnosis (anchoring bias and attribution bias).3) Recency (availability and non-availability bias).4) Outcome-related bias (regret bias/defensive reporting, outcome bias).5) Biases stemming from clinical parameters (framing bias, attribution bias).6) Retrospective biases (hindsight bias, self-serving bias).Perceptual errors1) Related to viewing technique (inappropriate windowing and fogging phenomenon). 2) Related to the finding itself (edge of film, first or last slice, bilateral or diffuse findings, subtle or poorly conspicuous).Recommendations to reduce diagnostic and reporting errors

## **NREE-16 Nervous System MR Elastography: Current Update**

### **Awards**

#### **Cum Laude**

Safa Hoodeshenas, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) How MR elastography of the nervous system is performed; From the generation of the shear waves to obtain qualitative and quantitative parameters2) What MRE can tell us about neural tissue biomechanical properties in physiologic and pathologic conditions



## TABLE OF CONTENTS/OUTLINE

1) Principles of MR elastography technique in the nervous system 2) Qualitative and quantitative obtained parameters 3) Role of artificial intelligence in MRE 4) Slip interface imaging 5) MRE in neurodegenerative disease (Alzheimer's disease, Frontotemporal dementia, Lewy body dementia, Normal pressure hydrocephalus) 6) MRE in characterizing and treatment planning of intracranial tumors (tumor subtype and grade, consistency, adhesion to surrounding tissue) 7) MRE in traumatic brain injury 8) MRE in neuroinflammatory disorders 9) Functional MRE 10) Pediatric nervous system MRE

### **NREE-17 I Only See White Spots: Understanding the Clinical and Radiological Features of CNS Demyelination**

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe the most typical imaging characteristics of secondary demyelinating processes. To know the basic notions in relation with epidemiology, clinical presentation, pathology, possibility of spinal cord involvement and differential diagnosis. To be able to assist the diagnosis of each etiological group in order to provide better and faster management, taking into account the severity of the findings and prediction of outcome.

## TABLE OF CONTENTS/OUTLINE

1. Autoimmune a. Multiple sclerosis b. Baló (example of tumefactive autoimmune lesions) c. Devic (optic neuromyelitis) 2. Infectious a. HIV encephalopathy b. PML (progressive multifocal leukoencephalopathy) c. Subacute sclerosing encephalomyelitis 3. Vasculature a. Binswanger (subcortical arteriolesclerotic encephalopathy) b. CADASIL (Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy) c. Post-anoxic d. PRES (posterior reversible encephalopathy) 4. Toxic-metabolic a. Osmotic demyelination b. Toxic leukoencephalopathy c. CLOCC (cytotoxic lesions of the corpus callosum) 5. Traumatic a. Diffuse axonal injury

### **NREE-18 Facets of a "Heavy Brain": Exploring Patterns of Iron Metabolism Disturbances**

#### Awards

#### Certificate of Merit

Mayne S. Brandao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Iron accumulation in the brain is common in several neurodegenerative disorders and normal aging. It likely contributes to the pathophysiology of neurodegenerative changes in these conditions by inducing oxidative stress, inflammation, and cell death. The patterns of iron deposits in the central nervous system vary between different conditions, both at the macroscopic and microscopic level. The role of iron in the pathogenesis and response to iron chelation therapy varies between individual disorders.

## TABLE OF CONTENTS/OUTLINE

This review summarizes the whole brain, cellular, and subcellular patterns of iron accumulation in neurodegenerative diseases of genetic and sporadic origin, and also other associations as neuroinfections. We also provide an update on mechanisms, biomarkers, and effects of brain iron accumulation in these disorders, focusing on recent publications. This pictorial review will also show how we can systematize the role of iron in brain and provide a practical guide to identify the main pathologies.

### **NREE-19 Don't Take the Long Way: A Diagnostic Shortcut to Longitudinally Extensive Myelopathies**

Nicole Lambrakos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Outline and describe the types of myelopathies (mechanical and non-mechanical). 2. Explain the pathology and imaging findings of myelopathies. 3. Build a decision making diagnostic flowchart, pointing out the imaging characteristics of myelopathies.

## TABLE OF CONTENTS/OUTLINE

1. Brief review of spinal cord anatomy, tracts and function. 2. Definition of myelopathy and longitudinally extensive spinal cord lesions and their subtypes (mechanical and non-mechanical). 3. Pathology of spondylotic myelopathy. 4. Clinical and imaging findings. 5. Most specific imaging findings. 6. Decision making diagnostic flowchart of myelopathies based on their imaging characteristics.

### **NREE-2 Variants and Anomalies of Extracranial Cerebral Arteries and Considerations for Neuroendovascular Procedures**

## **Awards**

### **Certificate of Merit**

Ana Maria Rodriguez Martinez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To describe the embryology of the aortic arch in order to explain the origin of its anatomical variants and anomalies.- To review the variants and anomalies of extracranial cerebral arteries giving examples from cases from our institution.- To revise some of the pathology associated with extracranial vascular variants and anomalies and the implications for endovascular procedures.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Embryology. 3. Aortic arch3.1. Variants 3.1.1. Bovine arch 3.1.2. Elongation and tortuosity 3.2. Anomalies 3.2.1 Right-sided aortic arch 3.2.2. Right aberrant subclavian artery and bicarotid trunk 3.2.3. Double aortic arch4. Cervical Internal carotid artery4.1. Variants 4.1.1. Elongation and tortuosity4.2. Anomalies 4.2.1. Internal carotid artery agenesis 4.2.2. Main branches anomalous origins5. Cervical vertebral artery5.1. Variants5.2. Anomalies 5.2.1. Anomalous origin of the vertebral artery

### **NREE-20 Beyond the Basic: Advanced MRI Techniques in Neuroimaging**

Marina C. Da Cruz (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Advanced magnetic resonance imaging (MRI) techniques allow expanding the range of diagnostic tools with the potential to assess functional parameters in neuroimaging, complementary to traditional sequences, that can and should be used by radiologists to aid in the differential diagnosis. The purposes of this submission are: - To review advanced MRI techniques in neuroimaging, such as spectroscopy, perfusion weighted imaging, tractography, nigrosome and neuromelanine avaliation and vessel wall study; - To expose the main indications of each method; - To discuss possible imaging features in some groups of pathologies;

### **TABLE OF CONTENTS/OUTLINE**

1. Review technique and indications of spectroscopy;2. Technique and indications of perfusion weighted imaging;3. Discuss technique, indications and basic interpretation of tractography;4. Assessment of nigrosome and neuromelanine;5. Discuss technique, indications and basic interpretation of vessel wall study;

### **NREE-21 Progressive Multifocal Leukoencephalopathy (PML): A Thorough Overview from Traditional to Contemporary Findings, Including Inflammatory Subtype, IRIS, Drug-associated, and Asymptomatic Cases**

## **Awards**

### **Magna Cum Laude**

Koichiro Mori (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1: Discuss PML imaging findings from classical observations to the latest insights. Explain the progression of lesions, taking into account the pathological findings. 2: Contrast-enhanced PML lesions are extremely important in clinical management, and discussing their significance in imaging findings is essential. 3: Address the key points of imaging findings for recently discussed drug-related PML and asymptomatic PML.

### **TABLE OF CONTENTS/OUTLINE**

1: About progressive multifocal leukoencephalopathy (PML) 1-1: Classification of JCV diseases of the Brainl 2: PML progresses through the following 3 steps, reflecting pathological findings 2-1: First step: "Initiation" as a small demyelinating lesion 2-2: Second step: "Expansion" and "Extension" of demyelinating lesions 2-3: Third step: "Fusion" of demyelinating lesions, resulting in axonal destructionl 3: Interpretation of contrast enhancement in PML lesionsl 4: New MRI findings related to PML 4-1: low signal intensity on T2\*WI and SWI in U-fibers and deep gray matter adjacent to the lesions 4-2: hyperintense cortical sign (HCS) on T1WI 5: Drug-associated PML 5-1: natalizumab-associated PML 5-2: punctate lesions

### **NREE-22 Neurological Emergencies in Oncologic Patients: Understanding the Importance of Early Imaging Evaluation**

THARYN Goncalves FRANCO DE GODOY (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Neurological emergencies are common and life-threatening conditions, particularly in oncologic patients who are at higher risk due to factors, including immunosuppression, coagulopathy, and treatments such as chemotherapy and radiation therapy. Due to their compromised status, early diagnosis can be challenging, and imaging exams are often required for proper evaluation. Radiologists, especially those working in cancer centers, must be familiar with these emergencies to ensure prompt treatment and reduce morbidity and mortality. Our aim is to review the neurologic emergencies to oncologic patients dividing them into pre and post-treatment, including early and late complications. To increment the discussion, risk factors, clinical presentation, imaging findings and treatment will be in illustrative cases.

## TABLE OF CONTENTS/OUTLINE

Introduction: review neurologic emergencies to oncologic patients. To divide the emergencies in two groups: related to cancer itself or its treatment (early and late complications), through a visual flowchart. To discuss, for each condition risk factors, clinical presentation, imaging findings and treatment. Following conditions: Pre-treatment: intracranial hypertension, vasogenic edema, herniations, spinal cord compression, paraneoplastic syndromes, ischemic and hemorrhagic stroke, venous sinus thrombosis. Post-treatment: radiation-induced vasogenic edema and leukoencephalopathy, infections, hemorrhages, radiation necrosis, SMART syndrome, radiation vasculopathy, encephalopathy, PRES, opportunistic infections. To highlight the particular aspects to oncologic patients, discussing the clinical and imaging for early diagnosis and treatment.

### **NREE-23 Beyond the Lumen: Unraveling the Vessel Wall Technique**

Maria Laura Piassa, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- A method that is here to stay, the vessel wall study, aims to evaluate the vascular wall and characterize the pathologies that compromise it, whether inflammatory, dissection, or atheromatous plaques.- It is a study that requires a high spatial resolution, with homogeneous signal suppression of the intravascular lumen, 2D or 3D multiplanar acquisitions, allowing several acquisitions.- In the evaluation of atherosclerotic diseases, VW-MRI demonstrates parietal thickening that eccentrically involves the circumference of the arterial wall, showing different characteristics on T1 and T2 sequences, depending on its internal content. Active/unstable plaques present a thin fibrous cap, large lipid core, presence of hemorrhage, contrast uptake and vascular remodeling.- Other differential diagnoses of intracranial luminal stenosis would be dissection, vasculitis (primary or secondary), reversible vasoconstriction and Moya-moya. VW-MRI is also used in the evaluation of aneurysms.- Pitfalls are points that deserve full attention, highlighting low flow, in which incomplete suppression can mimic wall thickening and vasa vasorum, mimicking vasculitis.

## TABLE OF CONTENTS/OUTLINE

- Raise the importance of the VW-RM, including its techniques and applications.- Access atherosclerotic disease and its differential diagnoses more precisely, stratifying individual risks, with potential influence on treatment decisions.

### **NREE-24 Help When You're Feeling Low: Intracranial Hypotension and Algorithms for Diagnosis**

Rahim Ismail, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Familiarize radiologists with the pathology and pathophysiology of spinal CSF leaks resulting in spontaneous intracranial hypotension (SIH).2. Localization of the culprit spinal CSF leak in SIH patients can be difficult. At our institution we use a combination of brain and spinal MRI to guide the type of myelographic imaging and patient positioning for the myelogram to help localize the CSF leak.3. Role of dynamic CT myelogram (DCM) and digital subtraction myelogram (DSM) in patients demonstrating a spinal longitudinally extensive collection (SLEC) on spinal MRI4. Role of lateral decubitus DSM in patients with SLEC negative MRI in evaluating for a CSF venous fistula (CVF) or distal tears of the nerve root sleeve.5. Role of DSM for precise localization in patients with suspected fast flow CSF leaks, such as dural tears from sharp osteophytes .6. Role of DCM in patients with suspected CSF leaks from proximal nerve root sleeve tears/perineural cysts.7. Describe our institutional protocols for performing DCM and DSM including tips for optimizing timing and provocative assessments.

## TABLE OF CONTENTS/OUTLINE

The following illustrative examples will be shown:1. Pathology: Different etiologies of spinal CSF leaks will be shown including:a. Microspurs b. perineural cysts c. CSF venous fistula (CVF) d. distal dural tears.2. We will describe our institutional algorithm for the work up of these complex subsets of patients.

### **NREE-25 Connecting the Dots: A Step-by-Step Guide of Brain Myelination**

#### **Awards**

#### **Certificate of Merit**

Afonso P. Santos, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purposes of this exhibit are: To review the normal appearance of myelination on imaging studies To define a step-by-step analysis algorithm to facilitate the assessment of myelination To display a compendium of cases involving myelination disorders

## TABLE OF CONTENTS/OUTLINE

Myelin is a vital component of the nervous system, serving as an insulator for neurons and found in both the central and peripheral nervous systems. It not only insulates but also speeds up action potentials by 10-100 times that of an unmyelinated axon. Moreover, it regulates ion composition and fluid volume around the axon, which is crucial for maintaining its health and integrity. MRI is the best noninvasive way to assess myelin and myelination in the pediatric brain. Mature myelin usually appears hyperintense to the gray matter cortex on T1 and hypointense to the gray matter cortex on T2. The process of myelination starts during fetal development with the cranial nerves, which are essential for our survival, and continues throughout life. As myelination progresses, it generally follows a pattern of development from bottom to top (caudocranial), back to front (posterior to anterior), and central to peripheral (deep to superficial). In conclusion, myelin is a vital component of the nervous system and plays a critical role in proper functioning. Understanding the process of myelination and the appearance of mature myelin on imaging is essential for the evaluation of many neurological conditions.

## NREE-26 Nigrosome 1: Anatomy, Variants and Pathologies

Danielly V. Santos SR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is to help the readers to determine the presence or absence of an abnormality in the N1 and establish diagnostic reasoning in cases of parkinsonism. The objectives of this electronic exhibit are: - to revisit the anatomical definition of the N1 region using schematic illustrations and imaging MRI; - to illustrate the anatomical variants of the N1; - to exhibit parkinsonism diagnostic algorithm; - provide imaging findings of various patients who presented with parkinsonism.

## TABLE OF CONTENTS/OUTLINE

Parkinson's disease is a clinically heterogeneous chronic progressive neurodegenerative disease with loss of dopaminergic neurons in Nigrosome 1 (N1). Nigrosomes are small clusters of dopaminergic cells within the substantia nigra. Five nigrosomes have been described with the largest labeled as N1, located in the posterior third of the substantia nigra. The N1 is the key structure in the midbrain that is very important in movement disorders, particularly those associated with parkinsonism. Interpreting the N1 sign can be difficult because it can take many forms but the high-resolution data and clear characterization of the N1 appearance help to make that decision easier.

## NREE-27 Stroke of Luck: Imaging of Hyperacute Stroke and Selecting Patients Effectively

Bernardo C. Teixeira, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

? Stroke management was revolutionized recently by the proven benefit of intervention with a larger time window on selected patients ? Time is brain: CT perfusion helps identifying salvageable brain tissue ? Radiologists play a crucial role on helping the multidisciplinary team select patients who will benefit from intervention based on imaging criteria ? Perfusion studies should be routinely assessed to avoid misinterpretation and excluding patients from therapy

## TABLE OF CONTENTS/OUTLINE

Introduction Over the past few years, after publication of the results of the DEFUSE 3, EXTEND and DAWN trials, stroke management has been revolutionized. These studies proved the benefit from intervention with a larger time window based on certain perfusion imaging criteria. This educational exhibit's goal is to review the role of conventional and advanced imaging on hyperacute stroke, ending with a proposed interpretation algorithm for selecting patients effectively. Current treatment options and inclusion criteria Imaging of hyperacute stroke ? Acquisition protocols ? CT ? MR ? Perfusion CT/MR ? ASPECTS ? AI (Rapid, Brainomix) ? Assessing study's quality ? Pitfalls ? Proposed interpretation algorithm

## NREE-28 Headache, Dizziness, and Leaks. May the Balance be with You. A Pictorial Review of Intracranial Hypo and Hypertension

Fernanda N. Avalos, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Cerebrospinal fluid (CSF) homeostasis is essential to maintain normal intracranial pressure. Even a small imbalance in CSF production, absorption, or flow can lead to altered intracranial pressure. Imaging in increased intracranial pressure (ICP): Although there are no specific imaging findings of idiopathic intracranial hypertension, enlarged arachnoid outpouchings such as an empty sella, enlarged Meckel's cave, or signs in the optic nerve such as vertical tortuosity or flattening of the posterior sclera should raise suspicion, as these signs have been identified in 23-80% of patients. ICP may be due to

secondary causes such as disturbances in CSF production and absorption or obstructive hydrocephalus that can result from lesions such as intracranial masses. Imaging in intracranial hypotension: the major radiological features can be summarized with the acronym SPACE (Sagging of the brain, Pituitary enlargement, Angles, Collections, and Enhancement of the pachymeninges). Dural membrane leaks contribute to the majority of causes of intracranial hypotension. Therefore, understanding the imaging methods and findings can guide definitive treatment and improve patient outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

1. Understand the physiological mechanism of CSF in the central nervous system. 2. Describe the common symptoms of intracranial hypo- and hypertension, and recall clinical findings during neurological examination. 3. Radiological findings of intracranial hypertension with differential diagnosis. 4. Radiological and clinical evolution of a patient with intracranial hypotension, from the first study with unspecified headache, through spinal leak diagnosis, to control after treatment

#### **NREE-29 Meningiomas - Do You Know Their Presentations: Brief Pictorial Review of Intracranial Meningiomas Presentations and Their Radiological Findings. Our Image Experience**

Mario J. Zelaya Villafranco, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Remember the definition of meningiomas and its most relevant epidemiological data. Review the current classification of intracranial meningiomas according to the World Health Organization (WHO) and their different imaging characteristics. Overhaul a brief pictorial review with exemplified cases of typical and atypical meningiomas from our institute.

#### **TABLE OF CONTENTS/OUTLINE**

Meningiomas are the most common nonglial primary tumors of the Central Nervous System and the most common extraaxial neoplasms. They may originate in unexpected locations such as the orbit, paranasal sinus, or ventricles or be entirely intraosseous (within the calvaria). The radiologist must be aware of their less frequent and uncharacteristic the imaging features in order to suggest the right diagnoses in cases that are atypical. The present educational exhibit intends to make a brief pictorial review of the main presentations of intracranial meningiomas, their current classification and imaging characteristics, and exemplify them with cases of patients from our institute.

#### **NREE-3 Don't be Afraid of Neuroimaging Epilepsy: A Case-based Review of a Myriad of Etiologies and Findings**

ANA P. MACHADO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Epilepsy is seen as a clinical manifestation due to excessive or synchronous abnormal neuronal activity in the brain, defined as recurrent, unprovoked seizures. The prevalence is high, and patients have an increased risk of premature death, injuries, psychosocial dysfunction, and reduced quality of life. The etiologies encompass multiple causes. Neuroimaging studies (particularly magnetic resonance imaging) are essential in evaluating epilepsy, mainly in cases refractory to pharmacotherapy, once the location of the epileptogenic focus is a turning point in a successful neurosurgery approach. The purpose of this exhibit is to present, through illustrative cases, a practical approach to imaging findings within multiple epilepsy etiologies.

#### **TABLE OF CONTENTS/OUTLINE**

Education Exhibit Presentation ? Introduction. ? Clinical and epidemiological aspects. ? A case-based review of original cases from the neuroradiology department of a tertiary hospital showing imaging features of a range of etiological substrates of epilepsy (from the common ones to the rarest), always through the perspective and purpose of a practical approach. Key and ancillary imaging features will be highlighted in each case. ? Take-home messages ? References.

#### **NREE-30 Maxillo-mandibular Lesions: Gnawing Through the Differentials**

Gilleen A. Cortes, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To provide an overview and differential diagnosis for maxillo-mandibular lesions encountered during imaging of the head and neck. 2. To present the multimodal radiologic features with case-based review of maxillo-mandibular lesions. 3. To highlight the approach of maxillo-mandibular lesions including diagnosis and management.

#### **TABLE OF CONTENTS/OUTLINE**

Maxillo-mandibular lesions are commonly encountered and usually incidental during head and neck imaging. There is a broad spectrum of lesions, which may be of odontogenic and non-odontogenic origin and can be further classified by cystic, solid, infectious/inflammatory, benign, and malignant processes. Patient characteristics and location of the lesion may be helpful; however, without pathognomonic imaging features, tissue sampling is frequently required. Several key cases presented at our institution will be reviewed such as: periapical cyst, dentigerous cyst, odontogenic keratocyst, non-odontogenic

developmental cystic lesions, aneurysmal bone cyst, ameloblastoma, fibrous dysplasia, osteosclerosis, condensing osteitis, cementoblastoma, ossifying fibroma, osteomyelitis, odontogenic carcinoma, invasive squamous cell carcinoma, and osteoradionecrosis. Accurate diagnosis is essential to prevent further complications, as otherwise treatable lesions with destructive potential may be missed.

### **NREE-31 Looking Back: Everything You Need to Know on Infratentorial Malformations**

Taisa M. Guarilha, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is:- To review normal anatomy of the posterior fossa- To explain in a simplified way normal embryology and the modifications that result in these malformations- To demonstrate how infratentorial malformations can present themselves- Exemplify with cases- Present a flow chart

#### **TABLE OF CONTENTS/OUTLINE**

1. Normal anatomy  
2. Embryology: - Normal- Malformations  
3. Cases:  
3.a. Cystic malformations: Dandy-Walker continuum  
Blake Pouch Cyst  
Mega Cisterna Magna  
Arachnoid cyst  
3.b. Non-cystic malformations:-- Predominant cerebellar involvement:- Rhombencephalosynapsis- Macrocerebellum- Microcerebellum- Cerebellar Hypoplasia - bilateral, unilateral - Cortical cerebellar malformation- Cobblestone-- Predominant brainstem involvement:- Pontine tegmental cap dysplasia- Horizontal gaze palsy with progressive scoliosis- Möbius Syndrome-- Predominant cerebellar and brainstem involvement:- Molar tooth malformations - including Joubert Syndrome- Pontocerebellar hypoplasia- Walker-Walburg- Lhermitte-Duclos syndrome - Craniocervical junction: Chiari spectrum  
3.c. Others- Masiner-Santino Syndrome- Quadrigeminal cistern lipoma  
4. Flowchart  
5. Take home messages

### **NREE-32 No More Conflict: Imaging of Neurovascular Compression Syndromes, Related Anatomy and Surgical Approach**

#### **Awards**

#### **Certificate of Merit**

Bernardo C. Teixeira, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Neurovascular compression (or conflict) is one of the causes that must be considered in patients presenting with cranial nerve related symptoms. MR imaging is key to rule out differential diagnosis. Knowing the involved anatomy is fundamental to identify possible sites of compression. Communication with the surgeon plays a major role and the reports must include necessary information to surgical planning.

#### **TABLE OF CONTENTS/OUTLINE**

Neurovascular conflict syndromes (NVCS) consist of symptoms related to compression of the V, VII, VIII or XII cranial nerves by vascular structures, usually at the transition zone near the nerve root entry zone. When indicated microsurgical decompression can be done. Trigeminal Nerve NVCS of the V CN usually presents as trigeminal neuralgia and is caused by compression at its REZ at the level of the pons by an elongated superior cerebellar or anterior inferior cerebellar arteries. Facial and Vestibulocochlear Nerves Facial hemispasm (VII CN) / vertigo and tinnitus (VIII CN) may come from compression at the inferior pons level by the AICA. Glossopharyngeal Nerve IX CN compression at its REZ on the upper medulla by the PICA may cause glossopharyngeal neuralgia.

### **NREE-33 Emergency Neuroradiology Misses: Case Examples and Lessons Learned**

Tran Anh Vu, BSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Diagnostic errors are the 3rd leading cause of death in the United States. In diagnostic radiology, the rate of errors increases significantly in the emergency setting, this is particularly critical in neuroradiology, where misinterpretation or misidentification may significantly delay treatment and adversely impact patient outcome. In this educational exhibit, readers will be able to: Recognize the two types of thought processing in human decision making, Recognize common diagnostic errors and underlying cognitive biases in image interpretation, See examples of real life missed/misinterpreted cases in emergency neuroradiology and Understand different approaches to reduce diagnostic errors.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background of diagnostic errors in radiology (statistics and common misses in emergency neuroradiology). 2. Type 1 and Type 2 Processing in Clinical Decision Making (heuristic vs analytical approaches). 3. Different Types of Errors During Image Interpretation (cognitive/interpretive biases, perceptual errors). 4. Sample cases to illustrate different types of misses in emergency neuroradiology (perceptual errors - blind spot; cognitive error/lack of knowledge; perceptive error - satisfaction of search; inadequate history). 5. How do we reduce diagnostic errors (strategies from the literature and our institution will be



provided such as non-random peer review, double reading, interdisciplinary rounds and tumor boards, reducing interruptions, computer-aided decision making support system)

### **NREE-34    Infarcts, Malformations, and Tumors.. Oh My! A Review of Vascular Pathology In and Around the Spinal Cord**

#### **Awards**

#### **Cum Laude**

Jennifer L. McCarty, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review spinal vascular anatomy with original diagrams. 2. To review International Society for the Study of Vascular Anomalies (ISSVA) and other classification systems. 3. To discuss the clinical presentation and etiologies. 4. To demonstrate common imaging findings.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Infarcts 3. Malformations 4. Tumors 5. Conclusion

### **NREE-35    Teratomas of the Brain, Head and Neck, and Spine: Imaging Appearances**

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Illustrate the different imaging appearances of teratomas in the brain, head and neck, and spine.
- Discuss their locations and associated complications.
- Understand the usefulness of CT and MRI in the diagnosis and characterization of teratomas.

#### **TABLE OF CONTENTS/OUTLINE**

Intracranial and spine teratomas, as well as those in the head and neck, are rare tumors that originate from all three embryonic germ layers (ectoderm, mesoderm, endoderm). They can be classified depending on their differentiation as mature, immature, and teratoma with malignant transformation. Clinical manifestations vary according to location and size. Intracranial teratomas are usually located in the midline, generally in the pineal and suprasellar regions, and represent more than two-thirds of brain tumors diagnosed before birth. In the spine, teratomas can occur at any level and compartment (extradural, intradural, or intramedullary). Characteristically, all show distinct components with fat, calcification, and soft-tissue attenuation on CT. Predominantly cystic teratomas also occur. MRI offers better characterization of these tumors and detection of their complications. In this exhibit, we will discuss typical and unusual appearances of teratomas on CT and MRI approaching them by location: • Intracranial: congenital, midline, and off-midline location • Head and Neck • Spine: intramedullary, intradural extramedullary, and extradural/sacroccygeal

### **NREE-36    Radiographic Findings in Hypoxic-Ischemic Brain Injury and the Role of Imaging in Brain Death Determination**

Min Tae Kim, MD, BSC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to 1. Discuss patterns of hypoxic-ischemic brain injury in pediatric and adult patients 2. Review the utility of imaging in prognostication 3. Review brain death determination using clinical criteria and imaging support 4. Present select cases from our institution

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Patterns of hypoxic-ischemic brain injury in neonates- Normal MRI appearance of the neonatal brain- Patterns of mild, moderate, and severe injury 3. Patterns of hypoxic-ischemic brain injury in infants, young children, and adults- Commonly involved regions of the brain - cortex, deep gray matter, perirolandic cortex, watershed distribution, white matter, cerebellum- Review of radiographic findings on CT- Review of radiographic findings on MR 4. How imaging can assist in determining prognosis 5. Radiographic imaging in the brain death examination- CT angiography- Digital subtraction angiography (DSA) - gold standard- Nuclear medicine 6. Select cases from our institution

### **NREE-37    Don't Get Trapped: Diagnostic Errors in Emergency Neuroradiology**

Julia M. Brunelli, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Diagnostic errors in neuroradiology in the emergency department can have serious consequences for patients. The prevalence of errors in diagnostic radiology is around 3-5%. Factors such as less time to prepare the report and discuss the case with peers, the patient's clinical condition evolving rapidly, and dependence on the radiological report to take immediate actions

according to the imaging findings can all contribute to errors. In this educational presentation, we will review a series of cases to address a series of etiologies that are present in a neurological emergency room and provide tips to improve accuracy and patient outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction• Overview of diagnostic errors• Renfrew Classification (revised by Kim and Mansfield in 2014)2. Case based review• Etiologies that are present in the emergency• Learning with the case: tips about that etiology3. Do it yourself• Cases as a diagnostic challenge for the audience

#### **NREE-38 A to Z of Motor Neuron Diseases**

Amit B. Desai, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review neuroanatomy of the motor system2. Discuss common upper and lower motor neuron diseases3. Provide a multi-disciplinary and radiologic pattern based approach to diagnosis of motor neuron diseases

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction2. Neuroanatomy Review3. Classification of Upper and Lower Motor Neuron Diseases. Imaging features, pathophysiology, genetics, clinical symptoms, and management will be reviewed.A. Upper Motor Neuron Involvement Only: i. Primary Lateral Sclerosisii. Hereditary Spastic Paraplegiaiii. Spinal AVM/AVFiv. Radiation MyelitisB. Lower Motor Neuron Involvement Only: i. Progressive Muscular Atrophyii. Flail Arm/Leg Syndromeiii. Post-Polio Syndromeiv. AIDPv. CIDPvi. Motor Neuron Lymphoproliferative DisordersC. Upper and Lower Motor Neuron Involvement: i. Amyotrophic Lateral Sclerosis (ALS)ii. ALS Plus Syndrome, Progressive Bulbar Atrophyiii. Bulbar-onset ALSD. Diseases affecting the Muscle/Neuromuscular Junction: i. Myasthenia Gravisii. Lambert Eatoniii. Inclusion Body Myositis4. Simplified Diagnostic Approach Based Upon Clinical Symptomatology and Radiologic Imaging Pattern5. Conclusion

#### **NREE-39 Novel WHO Intra-axial Tumoral Entities: Beyond Gliomas**

Sultan H. Yahya, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the evolution of CNS tumor classification- Concepts in the WHO 2021 classification of tumors - What's new?- Pertinent Radiomics and Molecular Classification of tumors- Recognize imaging features of relatively Novel CNS tumoral entities- Diffuse Pediatric high grade glioma- High Grade astrocytoma with piloid features (HGAP)- Astroblastoma- Multinodular and Vacuolating neuronal tumor (MVNT)- Multiloculated and Vacuolating Posterior Fossa lesions of Unknown Significance (MV-PLUS)- Diffuse Leptomeningeal Glioneuronal Tumor (DLMGT) - Calcifying Pseudoneoplasm of the Neuroaxis (CAPNON)- Polymorphous Low Grade Neuroepithelial tumor of the Young (PLNTY).

#### **TABLE OF CONTENTS/OUTLINE**

Review of CNS tumor classification and Novel concepts in the WHO 2021 classificationCased- based review of new CNS tumoral entities: - Diffuse Pediatric high grade glioma- High Grade astrocytoma with piloid features (HGAP)- Astroblastoma- Multinodular and Vacuolating neuronal tumor (MVNT)- Multiloculated and Vacuolating Posterior Fossa lesions of Unknown Significance (MV-PLUS)- Diffuse Leptomeningeal Glioneuronal Tumor (DLMGT) - Calcifying Pseudoneoplasm of the Neuroaxis (CAPNON)- Polymorphous Low Grade Neuroepithelial tumor of the Young (PLNTY).

#### **NREE-4 Radiological Approach to Toxic-metabolic Encephalopathies**

Valeria Andrea G. Schonstedt, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To propose a systematic radiologic approach in the evaluation of toxic-metabolic diseases.

#### **TABLE OF CONTENTS/OUTLINE**

1) When to suspect toxic-metabolic disease in a patient with acute encephalopathy 2) Important differential diagnosis that should be ruled out 3) To establish a topographic approach to suggest an etiologic diagnosis 4) To be aware of rare asymmetric presentations

#### **NREE-40 Radiopharmaceutical Therapy for Fibromyalgia: A Promising Treatment Option**

Sriram S. Paravastu, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Despite the availability of several pharmacological and non-pharmacological therapies, the management of fibromyalgia remains challenging.2. Preliminary studies have shown promising results in PET imaging of fibromyalgia.3.



Radiopharmaceutical therapy involves the administration of radiopharmaceutical agents that selectively accumulate in specific tissues or organs and may be the next step in treatment of fibromyalgia.

#### **TABLE OF CONTENTS/OUTLINE**

1. Current challenges in the management of fibromyalgia  
2. Radiopharmaceutical therapy for fibromyalgia  
a. Current radiotracers under investigation  
3. Preliminary studies on molecular imaging of fibromyalgia  
a. Radiolabeled Substance-P monoclonal antibody  
b. Radiolabeled small molecules  
4. Future directions and challenges  
a. Theranostics in fibromyalgia and other chronic pain syndromes  
b. Establishment of objective clinical markers of fibromyalgia

#### **NREE-41 Neurovascular Devices and Related Complications: A Case-based Approach**

Victor M. De Carvalho, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to: 1. Showcase the mainly used neurovascular devices, highlighting the preferred imaging modalities and what to avoid in the postoperative evaluation of each device. 2. Review the most relevant complications assessed by imaging related to each neurovascular device : what to look for?

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction with a brief and illustrative review of the main neurovascular devices used in clinical practice and the modalities of choice for assessment of each device.
- Provide a guide on what to look for when assessing neurovascular devices with the most commonly associated complications.
- Provide didactic cases to illustrate the most important complications related to each neurovascular device and consolidate the acquired knowledge.
- Conclusions.
- Bibliographical references.

#### **NREE-42 Impact of Deep Learning-Based Reconstruction on Neuro MR Imaging: Image Noise Reduction and Super Spatial Resolution**

Hiroyuki Uetani (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To understand the principle of deep learning-based reconstruction (DLR) for reducing image noise and enhancing spatial resolution of neuro MRI. 2. To illustrate the applications of DLR with/without compressed sensing (CS) and parallel imaging and super spatial resolution-DLR (SR-DLR) for neuro MRI, and discuss the strengths of these techniques. 3. To discuss the pitfalls and limitations of DLR with/without CS and parallel imaging and SR-DLR techniques.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: 1) What is DLR with/without CS and parallel imaging, and SR-DLR techniques? 2) The advantages and disadvantages of DLR with/without CS and parallel imaging, and SR-DLR techniques. Clinical application of DLR with/without CS and parallel imaging and SR-DLR in neuro MR imaging: 1) DLR: High signal-to-noise ratio (SNR) images without long acquisition times A) High-resolution 3D T2 weighted imaging (HR-3D T2WI) B) MR angiography 1) Combination of DLR and CS/parallel imaging: High SNR images in a short acquisition time without sacrificing spatial resolution A) 2D-T2WI on the sellar region or spine B) MR angiography C) High-resolution 3D-T2WI 2) SR-DLR: High SNR images with super spatial resolution without long acquisition times A) 2D-T2WI on the hippocampus B) MR angiography C) Double inversion recovery (DIR) imaging D) Contrast-enhanced 3D T1WI E) Bone imaging Pitfalls and limitations of DLR with/without CS and parallel imaging, and SR-DLR in neuro MR imaging.

#### **NREE-43 NODDI vs Traditional dMRI Metrics: Revealing Microstructure Without a Microscope**

Janova Anbarasi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Importance of dMRI as a non-invasive medical imaging modality for investigating the white matter integrity in the brain. Different traditional scalar metrics currently used for characterising the diffusion of water molecules - FA, MD, RD and AD and discussing their pitfalls. Introduction to new advanced metrics like NODDI (neurite orientation dispersion and density imaging) for neuroscience clinical research. Clinical relevance of scalar metrics

#### **TABLE OF CONTENTS/OUTLINE**

Introduction to dMRI Traditional dMRI metrics to reveal microscopic details of tissue architecture (FA, AD, RD, MD) Pitfalls of traditional metrics NODDI- introduction and applications in clinical research (TBI and Epilepsy)

#### **NREE-44 Practical Guide for Young Radiologists: Basic Sequences in Neuroradiology**

Taisa V. Santos, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Describe the aspects and physical parameters of basic magnetic resonance imaging sequences of the brain. Identify the main evaluation structures and tissue signal patterns in each sequence. Correlate brain diseases with signal changes.

## TABLE OF CONTENTS/OUTLINE

Different Magnetic Resonance (MRI) imaging sequences are used together for brain evaluation. Knowledge of the physical aspects and signal patterns of basic MR sequences are essential for elucidation of neurological pathologies. Variables such as the number of radiofrequency (RF) pulses, angle, period between excitations (repetition time - TR) and period between excitation to echo (echo time - TE) determine the different signals between tissues on T1, T2 and image density proton weights. Some tissues and contents show different signals in each sequence. In the T1 sequence, fat, lesions with high protein content, some stages of hemoglobin degradation and melanin have high signal. In this sequence, it is important to analyze bone structures, brain parenchyma, flow-void, pineal and pituitary glands. In the T2/FLAIR sequence, most lesions have high signal, is a good sequence to see white lesions. In T2\*/SWI, blood, calcium, air have low signal. Some neoplastic, infectious, and ischemic changes show diffusion restriction on the DWI sequence and characteristic postcontrast enhancement. The correlation of signal patterns from different tissues in the evaluation of basic sequences helps in the recognition of patterns of normality and pathological alterations, being an important knowledge for young radiologists to begin to understand the findings of magnetic resonance imaging of the brain.

### NREE-45 The Art of Arteritis: Imaging Primary CNS Vasculitis

Eleanor Taylor, MSc, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. A practical approach to the investigation of PCSNV, covering the diagnostic criteria, presentation, and laboratory tests, but with a primary focus on imaging. 2. A structured discussion of the radiological manifestations of PCNSV. 3. An awareness of the common mimics and their differentiating clinical and radiological features. 4. Insight into the role of imaging in the process of diagnosis and treatment from a multidisciplinary perspective.

## TABLE OF CONTENTS/OUTLINE

Primary central nervous system (CNS) vasculitis (PCNSV) is an extremely rare diagnosis but a common clinical concern. The presentation is non-specific; it typically manifests in middle-aged patients with subacute headache, altered cognition, and variable additional neurological features. Cerebrospinal fluid analysis can be normal in up to one third of cases. The radiological phenotype is protean, with no pathognomonic findings and innumerable mimics. Luminal vascular imaging has variable sensitivity and poor specificity. Assessment can be augmented by the use of vessel wall imaging, but this is not a panacea. Definitive diagnosis requires biopsy, not always an attractive prospect, but the risks need to be weighed against those of the disease and its treatment, both of which are considerable. To meet this formidable challenge, we will outline a practical approach to the investigation of suspected PCSNV, review the imaging findings, and explore the common mimics and their differentiating features. This will be illustrated with a series of cases compiled from a neurosciences centre in London.

### NREE-46 The Hidden Dangers of Hypothalamic and Hypophyseal Lesions: Not Everything is Neoplastic

Taisa V. Santos, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Review the normal anatomy and embryology of hypothalamic-pituitary axis using schematic illustrations and imaging MRI. Identify the main imaging features to guide differential diagnosis in non-neoplastic hypothalamic-pituitary involvement. To display a compendium of cases of non-neoplastic hypothalamic-pituitary axis.

## TABLE OF CONTENTS/OUTLINE

The hypothalamic-pituitary axis is responsible to regulate many other endocrine glands through its hormone, and the pituitary being known as the master gland, is divided into two distinct parts: the anterior pituitary (adenohypophysis) and the posterior pituitary (neurohypophysis), differ in embryologic origin and function. There are several diseases that can affect the function and morphology of the hypothalamic-pituitary axis. It is susceptible to involvement by a variety of processes, including congenital, infectious or inflammatory, neoplastic or toxic-metabolic diseases. Imaging plays a key role in determining the most probable diagnosis and the Magnetic resonance (MR) imaging is the modality of choice for evaluating the anatomy and pathologic conditions of the hypothalamic-pituitary axis, helping to distinguish neoplastic and non-neoplastic lesions. The MRI differential diagnosis depends on anatomic recognition and characterization of associated imaging findings such as volumetric changes, stalk thickening, cystic appearance, intensity of signal in T1 and T2-weighted imaging. Therefore, we propose a systematic approach to address non-neoplastic pituitary changes based on the most important imaging patterns.

### NREE-47 Uncovering Coverage: Best Cases on Meningeal Pathology

Raissa Marjory Zonta Moreti, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To review normal meningeal embryology and anatomy. To understand normal behavior of brain meninges. To discuss best MR imaging protocol to evaluate meningeal diseases. To create systematic approach to evaluation of imaging patterns of most relevant meningeal pathology.

## TABLE OF CONTENTS/OUTLINE

Introduction Normal embryology Anatomy Physiological behavior of meninges Imaging protocol MR imaging patterns Anatomic - leptomeningeal, pachymeningeal. Morphologic - mass-like, nodular, smooth. Meningeal pathology Infection Pyogenic Viral Fungal Parasite Tumors Benign Malignant - primary and secondary Granulomatosis Sarcoidosis Tuberculosis Wegener disease Langerhans Cell Disease Non Langerhans Cell Disease Inflammatory Diseases IgG4 related Pseudotumor Miscellaneous Iatrogenic Traumatic

## **NREE-48 Everything About CNS Infections: A Pictorial Review. Tips and Tricks for General Radiologists**

David Castanedo SR, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To highlight the diagnostic pearls to recognize properly CNS infections. - To showcase the differential diagnosis of the main CNS infections. - To point out the importance of the state of the immune system when analyzing these studies. - To provide an extensive pictorial review with the most typical findings of both common and uncommon infections, from bacteria, to viruses, and also fungi and parasites.

## TABLE OF CONTENTS/OUTLINE

1. Bacterial meningitis. 1.1. Typical imaging features. 1.2. Complications: acute hydrocephalus, extra-axial collections, cranial nerve involvement, arterial and venous strokes, ventriculitis. 2. Brain abscesses and cerebritis. 2.1. Ring enhancing lesions differential diagnosis. 3. Herpes encephalitis. 4. Rhombencephalitis. 5. Acute cerebellitis. 6. Encephalitis with bithalamic lesions. 7. Neurosyphilis. 8. Neurocysticercosis. 9. Hydatidosis. 10. Toxoplasmosis. 11. Cryptococcal meningitis. 12. Progressive multifocal leukoencephalopathy. 13. HIV encephalopathy. 14. Nocardia. 15. Aspergillosis. 16. Mucormycosis. 17. Neuroborreliosis. 18. Rickettsial infections. 19. COVID-19. 20. Creutzfeldt-Jakob.

## **NREE-49 Cranial Surgical Approaches: What the Radiologist Needs to Know**

### Awards

### Cum Laude

Taisa V. Santos, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To correlate the topography of brain lesions with surgical approaches through illustrations and imaging tests. Assist in the identification of surgical accesses through imaging exams. Establish anatomical relationships and correlate with the surgical approaches crania.

## TABLE OF CONTENTS/OUTLINE

In addition to the pre-surgical evaluation for neurosurgeries, the imaging study is extremely important in identifying postoperative findings. Post-surgical changes include repercussions on the brain parenchyma, soft tissues and recognition of the cranial approaches used. The evolution of the location of the pathology helps in the interpretation of the surgical approach. Some topographies favor the use of specific accesses to allow manipulation of certain structures. Access to the skull base, brainstem, supratentorial and intraventricular are well established in the literature and the correct description in the medical report is part of the post-surgical evaluation. Therefore, we proposed to correlate surgical procedures with the location of encephalic pathologies. The demonstration of these aspects is facilitated through schematic illustrations that make it possible to associate these findings with the topography of the lesion in the surgical approach.

## **NREE-5 Old but Gold: A Primer of Spine Radiography**

Bianca Bianco, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The spine is made up of a complex anatomy and its evaluation could be challenging sometimes. It is a curved structure composed of bony vertebrae that are connected through cartilaginous intervertebral discs. It ensures proper posture, spinal cord protection, communication with the brain, body mobility and sensation through the complex interplay between the bones, ligaments and muscle structures. The radiography is the first method for its evaluation. Although this a simple imaging method, the correct analysis is very important for the clinical management of the patient. A well-performed radiography, with an appropriate position and adequate beam increases the accuracy of the diagnosis, besides the low-cost

exam and high availability in the health care system. The purpose of this presentation is to review the normal anatomy of the cervical, thoracic and lumbar spine, to provide a didactic approach about the main characteristics of the evaluation, and to guide young physicians through the analysis of spine radiography.

#### **TABLE OF CONTENTS/OUTLINE**

Didactic review of how to evaluate the spine radiography, including the aspects of the technique, anatomy of the cervical, thoracic and lumbar spine as well as the most common pathologies, based on our service's digital archive.

#### **NREE-50 Encephalitis and Encephalopathy: Differential Diagnosis of Infectious and Autoimmune Diseases Based on Imaging Patterns and Topography**

Beatriz D. Prado, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: To review and discuss the differential diagnosis and brain MRI imaging patterns of infectious and autoimmune diseases by brain topography. Discuss and illustrate through illustrative cases different imaging patterns and emphasize the key findings that may lead to a specific diagnoses.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Describe the most common brain MRI imaging features of encephalitis and encephalopathy, including images that illustrate each feature, such as swelling, inflammation, bleeding, among others. Discuss the differential diagnosis of encephalitis and encephalopathy on brain MRI, divided by topography: -Cortical: Anti-NMDAR encephalitis, Herpes simplex encephalitis, Progressive Multifocal Leukoencephalopathy -White matter: Multiple Sclerosis, Susac Syndrome, FLAMES -Basal ganglia and/or thalamus: Auto-immune striatal encephalitis, FLAMES, acute necrotizing encephalitis, Neurocysticercosis -Cerebellum: Paraneoplastic cerebellar degeneration with anti-TR, Paraneoplastic cerebellar degeneration with anti-GAD, Aseptic meningitis with systemic lupus erythematosus, Acute disseminated encephalomyelitis -Brainstem: Progressive Multifocal Leukoencephalopathy, enterovirus rhomboencephalitis, Listeria rhomboencephalitis, NMSOD Key findings and diagnostic tips Diagnostic Approach Final remarks

#### **NREE-51 Motor Neuron Diseases: Diagnostic Approach, Imaging Findings, and Mimics**

Tatiana Iutaka, BDS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This panel aims to: Study the diagnostic approach and clinical indications of imaging in motor neuron disease (MND); Review the MRI acquisition protocols, including advanced MRI techniques; Explain and demonstrate through illustrative cases different imaging patterns of MND; Discuss the main MND mimics and their imaging findings

#### **TABLE OF CONTENTS/OUTLINE**

Review of the definition and clinical syndrome of MND Review the clinical indications of imaging in MND Review the main imaging techniques used for the evaluation of MND Standard MRI acquisition protocol MRI signs that might support the diagnosis directly: T2WI, FLAIR, and magnetization transfer hyperintensities in the corticospinal tract (CST) in the brain or sometimes in the spinal cord Atrophy of the precentral gyrus The 'motor dark line' in T2WI and susceptibility sequences The bright tongue sign Illustrative cases of motor neuron diseases: Amyotrophic lateral sclerosis (ALS) Bulbar ALS Primary lateral sclerosis Mills syndrome Imaging findings of the main MND mimics, divided by clinical feature (e.g.: upper motor neuron (UMN) onset, purely UMN, bulbar onset): Ischemia (e.g., stroke) Mass (e.g., tumor, vascular malformation) Radiculopathies (cervical, lumbosacral) Demyelinating disease (e.g., multiple sclerosis) Advanced imaging and respective findings: DWI: Lower mean fractional anisotropy in the CST Volumetric or morphometric analyses of T1WI 3D MRI: Volume changes mainly in classical motor areas Proton (1H) magnetic resonance spectroscopy (MRS): NAA decline over time in the motor cortex Functional MRI: Altered cortical activity in patients with ALS PET and SPECT: Hypometabolism and hypoperfusion are most prominent in the motor cortex

#### **NREE-52 The Fascinating Limbic System: Anatomy, Pathology and Involvement Patterns**

Lucas S. Souza, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: - Review and illustrate the imaging anatomy of the limbic system, correlating with the main imaging methods, emphasizing the potential of each in identifying the structures. - To describe the main imaging patterns of lesions involving the limbic system, including dementia and psychiatric disorders, inflammatory and infectious diseases, temporal lobe epilepsy, neoplasms, Wernicke's encephalopathy, ischemic events, among others, highlighting key points for approaching the diagnosis differential. - Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

## TABLE OF CONTENTS/OUTLINE

- Anatomy of the limbic system, emphasizing the functional aspects.- Imaging patterns of diseases that affect the limbic system.- Differential diagnosis based on a pictorial review using representative cases from our institutional database: - Neoplasms - Infection and inflammation- Dementia and neuropsychiatric disorders- Ischemia and Infarction - Metabolic diseases - Developmental malformations- Diagnostic Algorithm- Final remarks

### **NREE-53 Imaging the Sick Neonate: Neurosonogram in Hypoxic Ischemic Injury**

Anjuna Reghunath, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Hypoxic-ischemic injury (HII) of the neonatal brain and resulting encephalopathy sequel remains a significant cause of morbidity and mortality in the neonatal population. 2. Ultrasound of skull (neurosonogram) is a powerful and effective screening tool in the evaluation of sick neonates with clinical hypoxia as it determines the pattern, timing, and extent of injury in HII and differentiates it from other conditions with similar clinical picture. 3. The pattern of injury on brain imaging has crucial implications in therapies and predicted neurodevelopmental outcomes. 4. Major role of neurosonogram is identifying the diagnosis, directing appropriate therapy, monitoring evolution of disease, predicting outcomes and detecting complications of therapy. 5. Addition of Doppler and shear wave elastography (SWE) in determining the difference in brain stiffness in neonates with birth asphyxia can increase the specificity of grey-scale ultrasound.

## TABLE OF CONTENTS/OUTLINE

1. Normal neurosonogram appearance and technique in neonates. 2. Pathogenesis, grading and evolution of HII in term and preterm neonates with less profound and severe injury. 3. Patterns of HII in term and preterm neonates with illustration. 4. Role of ultrasound Doppler and SWE in evaluation of HII. 5. Ultrasound illustration of few clinical mimics of HII. 6. Uses and limitations of neurosonography.

### **NREE-54 Errors in the Neuroradiological Emergency: An Escape Room Experience**

Nathalia C. Santos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

TEACHING POINTS The purposes of this exhibit are:- Discuss and illustrate clinical cases of the neuroradiological emergency in a quiz and gamification format, simulating an Escape Room experience.- Highlight the imaging points and red flags to make right diagnoses in the context of emergency. - Describe the most common possible errors in neuroradiological emergency, highlighting tips and challenges in the cases presented.

## TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS: - Neuroradiological emergency cases in an escape room dynamic:- The most emblematic cases in the context of neuroradiological emergency- Types of errors that can occur while the radiologist is analyzing a case- Series of cases that leads to escape and to finish the call and escape the room- Clinical cases - Quiz format- Ischemic stroke - Early and late signs of stroke- Main trials and treatment windows- Hemorrhagic lesions- Trauma - Fracture and anatomic pitfalls - Pseudofractures in a child skull - Hematic collections- Brain herniations- Headache- Arterial dissection- Metabolic disorders in the emergency- Most common intoxications- Key tips and challenges from the cases demonstrated- Escaping the room: conclusions and lessons learned

### **NREE-55 Temporal Lobe Tumors: A Pattern-based Imaging Approach**

Afonso P. Santos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the anatomy of the temporal lobe; 2. Group the main primary central nervous system (CNS) tumors that affect the temporal lobe according to imaging characteristics; 3. Synthesize the main imaging features of each tumor that help in the differential diagnosis on flashcards for quick reference; 4. Show some differential diagnoses that can be confused with temporal lobe tumors

## TABLE OF CONTENTS/OUTLINE

Temporal lobe disorders are associated with several conditions, including seizures, dementia, and memory impairment, followed by a spectrum of behavioral disorders. It is noteworthy that about 10% of temporal lobe epilepsies are caused by focal temporal lesions. In this context, this work has as main objectives: In this sense, most primary CNS tumors can potentially occur in the temporal lobe, but entities with a predilection for being diagnosed in this location include: ganglioglioma (40%), DNET (20%), diffuse low-grade astrocytoma (20%) and others (20%). Some of these lesions may present specific imaging characteristics, which allow narrowing the differential diagnosis. Didactically, these lesions can be grouped based on imaging features into solid-cystic, bullous, or solid. Besides any primary CNS tumor can arise from temporal lobe, this location has specific clinical symptoms, and some tumors has a particular predilection for the temporal lobe. The

radiologist has a special role to recognize and narrow the differential diagnosis that will guide the treatment or follow up on each case.

## **NREE-56 Embryonal Tumors - Correlations Between Imaging Findings and Molecular Subtypes**

Larissa Freitas, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purposes of this exhibit are: • To present the essential embryonal malignancies of the Central Nervous System. • To review the WHO CNS5 classification, considering the new modifications in nomenclature and distribution of embryonal tumors. • To make a parallel between radiophenotypic imaging and genomic features. • To present the essential imaging features correlated to tumor's genetic pattern. • To highlight the importance of recognizing the imaging pattern of embryonal tumors to therapeutics and prognosis.

### **TABLE OF CONTENTS/OUTLINE**

• Introduction - Essential embryonal malignancies of the Central Nervous System. - Review the WHO CNS5 classification making a parallel between radiophenotypic imaging and genomic features. • Medulloblastoma - Medulloblastoma WNT-activated - Medulloblastoma SHH-activated - Medulloblastoma, non-WNT / non-SHH - Group 3 - Group 4 - Other embryonal tumors - Atypical teratoid rhabdoid tumor - Embryonal tumor with multilayered rosettes - CNS Neuroblastoma, FOXR2-activated

## **NREE-57 A Pocket Guide of the Main Side Effects, from Common to Rare, of Radiation Therapy in the Brain**

Marta Calvo-Imirizaldu, MD (*Presenter*) Research Grant, Siemens AG

### **TEACHING POINTS**

- To review the different techniques of brain radiation therapy available for primary or metastatic tumors, that radiologists need to know. Basic pathophysiology. Novel approaches and indications.- To recognize the main radiation-related findings on brain studies, from common to unexpected, and its differential diagnosis. Focus on radiation necrosis, radiation induced tumors, and mimics of vascular diseases (SMART syndrome, vasculitis, PRES).

### **TABLE OF CONTENTS/OUTLINE**

1. Background and basics pathophysiology of radiation therapy.i. Clinical relevance statement ii. Basic pathophysiology iii. Risk factors. Benefits and risks iv. Radiation therapy techniques: conventional radiation therapy (external beam radiation therapy), stereotactic radiosurgery, proton therapy. v. Dosimetry2. MRI features and pictorial review of the main radiation-related findings on brain imaging, with differential diagnosis:- Common: a. Atrophy b. Leukoencephalopathy c. Microhemorrhages/cavernomas d. Hypoperfusion e. Mastoiditis- Less common: a. Pseudoprogression b. Radionecrosis c. Intratumoral bleeding d. Radiation-induced vasculitis- Rare: a. Radiation-induced tumors (most commonly meningioma) b. SMART syndrome: stroke-like migraine attack after radiation therapy c. PRES3. Reporting tips4. Conclusion

## **NREE-58 Radiological Evaluation of the Spectrum of Pathologies Involving Medullary Veins in Neonates and Young Children**

Esther Martin Ramirez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To describe the anatomy and the venous drainage pathways of the intracranial venous system, with emphasis on medullary veins.To review the main pathologies that can cause medullary veins injury in newborns and young children.To explain the pathophysiology of diseases associated with medullary veins injury and their characteristic radiological findings, especially based on magnetic resonance imaging (MRI).To review the guideline-recommended MRI technique for medullary veins evaluation.

### **TABLE OF CONTENTS/OUTLINE**

There are two types of medullary veins: superficial veins (SMV) and deep veins (DMV). SMV drain the subcortical white matter centrifugally into pial veins, whereas DMV drain the deep white and grey matter centripetally into subependymal veins, with a characteristic distribution consisting of a radial pattern with four convergence zones in frontal horns and trigons, and a parallel pattern in bodies and inferior horns of lateral ventricles. The unique disposition of medullary veins allows us to detect their involvement in different pathologies through different imaging techniques, especially on MRI with susceptibility-weighted imaging sequences.The aim of this educational exhibit is to review the most frequent pathologies related to medullary veins seen in neonates and young children, including vascular anomalies, thrombosis, hemorrhage and infectious encephalitis, among others.

## **NREE-59 Fungus on the Mind: There's Much Room for Improvement**



Girija Agarwal, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. An overview of the epidemiology, pathophysiology and clinical features of fungal CNS infections. 2. A structured review of the imaging features of various fungal CNS infections and their complications. 3. An approach to the differentiation of fungal CNS infections from other common infectious and non-infectious mimics, with a focus on clinico-radiologic correlation.

#### **TABLE OF CONTENTS/OUTLINE**

Fungal infections of the central nervous system (CNS) typically occur in immunocompromised patients and can be caused by yeasts (e.g. Cryptococcus), molds (e.g. Aspergillus), and dimorphic fungi (e.g. Coccidioides). The prognosis is influenced by the specific organism and patient factors but is frequently poor with mortality generally exceeding >50%. The imaging features, whilst often non-specific with a broad differential in a majority of cases, can also be distinctive and sometimes organism specific. Pathophysiological knowledge of varying fungal infections aids understanding the pathognomonic features to aid in narrowing the differential. Querying fungal etiology, even if the findings are less specific, at an early-stage aids directed laboratory testing and empirical treatment. Prolonged iatrogenic immunosuppression is on the rise, with increasing organ transplantation and cancer incidence. Old foes like HIV remain common. Radiologists are therefore increasingly likely to encounter fungal CNS infections sporadically and must be familiar with the imaging manifestations to aid early diagnosis and improve clinical outcomes.

#### **NREE-6     **Neuroradiologic Complications of Immunotherapy in the Treatment of Cancer****

John A. Arrington, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

• As immune modulation in the treatment of cancer is becoming more common, its complications become more prevalent and the radiologist should be aware of these to aid rapid diagnosis and appropriate therapy. Unlike conventional chemotherapy which typically will cause immune suppression, immune modulation therapy generates an increase in systemic immune response and therefore a different spectrum of complications. This exhibit will explain the nomenclature, mechanism of action, and imaging features of more common complications of immunotherapy in the treatment of neoplasm.

#### **TABLE OF CONTENTS/OUTLINE**

• Mechanism of action of Immune Checkpoint Inhibitor (ICI) therapy • Mechanism of action of Chimeric Antigen Receptor T Cell (CAR-T) therapy • Recognizing ICI nomenclature (\*mab) is helpful to know to determine if a patient's therapeutic regimen includes ICI • Neuroimaging examples • Hypophysitis • Pseudoprogression • Myositis • Acute Idiopathic Demyelinating Polyneuropathy (AIDP). • Acute myelitis (CAR-T) • Thyoiditis • CAR-T related infarction

#### **NREE-60     **Diffuse High-Grade Gliomas - New Concepts****

Bruna B. Carvalho (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: • To present the current classification of central nervous system tumors and genetic biomarker roles. • To define pediatric-type and adult-type diffuse high-grade gliomas and their molecular pathways. • To present the essential imaging features correlated to the tumor's genetic pattern. • To correlate radiophenotypic imaging and genomic features with prognosis and determination of treatment approaches.

#### **TABLE OF CONTENTS/OUTLINE**

• Adult-type diffuse high-grade gliomas - Glioblastoma, IDH wildtype - Astrocytoma, IDH-mutant, grade 4 - Astrocytoma, IDHm, CDKN2A/B homozygous deletion, grade 4 • Pediatric-type diffuse high-grade gliomas - Diffuse midline glioma, H3 K27-altered - Diffuse hemispheric glioma, H3 G34-mutant

#### **NREE-61     **Anoxic Brain Injury Patterns. What Can't I miss? Reviewing Patterns and Differential Diagnosis of Anoxic Brain Injury in Newborns, Children and Adults****

Bernardo P. Pillar Quadros (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: - Review and illustrate the imaging findings of the main anoxic brain injuries patterns, classified according to age: newborns, children and adults. - Describe the main imaging patterns of the anoxic brain injuries, including brainstem lesion, thalamic lesion, periventricular leukomalacia, ventrolateral thalamic lesion, posterior putamen lesion, perirolandic cortex lesion, cortical laminar necrosis, delayed post-hypoxic leukoencephalopathy, HACE, diffuse edema, some intoxication hypoxia patterns and some differential diagnosis, highlighting key points to differential diagnosis approach. - Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

## TABLE OF CONTENTS/OUTLINE

- Imaging patterns of main anoxic brain injuries in newborns, children and adults. - Preterm newborn patterns lesions - Term newborn patterns lesions - Children/ adults patterns lesions - Intoxication hypoxia patterns lesions - Differential diagnosis based on a pictorial review using representative cases from our institutional database - Hypoglycemia - Creutzfeldt-Jakob disease - Uremic Encephalopathy - Metabolic disorders - Diagnostic Algorithm- Final Remarks

### **NREE-62 Cerebrovascular Reserve Imaging Evaluation: How Much of a Challenge Can it Be**

#### **Awards**

#### **Certificate of Merit**

Bernardo C. Teixeira, MD,PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Cerebrovascular reserve imaging with arterial spin labeling (ASL) and acetazolamide challenge is a non-invasive MRI-based technique that evaluates cerebrovascular reactivity. ASL measures cerebral blood flow by magnetically labeling arterial blood water protons, allowing for quantification of regional cerebral blood flow (CBF) without exogenous contrast agents. Acetazolamide (a vasodilator) challenge can be used to estimate cerebrovascular reserve (CVR). ASL with acetazolamide challenge is useful for assessing CVR in neurological conditions such as cerebrovascular disease and neurodegenerative disease.

## TABLE OF CONTENTS/OUTLINE

I. Introduction II. Arterial Spin Labeling III. Acetazolamide Challenge IV. Cerebrovascular Reserve Imaging with ASL and Acetazolamide Challenge Protocol, applications and analysis. V. Clinical Utility in Various Neurological Disorders VI. Conclusion

### **NREE-63 Brainstorming the Brainstem: A Pictorial Review of Challenging Diagnosis**

Rafael Oliveira (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The goals of this paper are: - Brief anatomy review of the brainstem - Summarize uncommon diseases of the brainstem - Review imaging presentations of brainstem diseases - Differentiate common and uncommon patterns of known diseases affecting the brainstem

## TABLE OF CONTENTS/OUTLINE

Powerpoint layout  
1 Midbrain: 1.1 Parkinson 1.2 Wernicke-Korsakoff Syndrome 1.3 Wilson's Disease  
2 Pons: 2.1 Chronic lymphocytic inflammation with pontine perivascular enhancement responsive to steroids (CLIPPERS) 2.2 Osmotic Myelinolysis 2.3 Autosomal recessive spastic ataxia of Charlevoix-Saguenay (ARSACS)  
3 Medulla: 3.1 Friedreich Ataxia 3.2 Neuromyelitis optica spectrum disorder (NMOSD) 3.3 Dural Arteriovenous Fistula 3.4 Adult Onset Alexander Disease (AOAD) 3.5 Leukoencephalopathy with brainstem and spinal cord involvement and lactate elevation (LBSL)  
4 Miscellany: 4.1 Neuro-Behçet 4.2 Enterovirus Rombencephalitis 4.3 Myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD) 4.4 Adrenoleukodystrophy

### **NREE-64 Glioneuronal and Neuronal Tumors: What Can Molecular Pathways Teach Us**

Giovanna S. Calfi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- List the essential information on various glioneuronal and neuronal tumors according to the 5th Edition of the WHO Classification of Tumors of the Central Nervous System. - Identify the main imaging features and molecular pathway involved in these brain tumors. - Highlight the importance of recognizing those patterns to help neuroradiologists narrow their diagnostic hypotheses, thus saving time and resources.

## TABLE OF CONTENTS/OUTLINE

- Introduction: Brief review of the inclusion of glioneuronal and neuronal tumors in the 5th edition of the 2021 WHO Classification of Tumors of the Central Nervous System; Presentation of the main common characteristics of glioneuronal and neuronal tumors; Illustration of the MAPK pathway - The radiological, epidemiological and clinical characteristics correlated based on the most known genetic mutations of each tumor, namely: Dysembryoplastic neuroepithelial tumor (DNET); Multinodular and vacuolating neuronal tumor (MVNT); Central neurocytoma; Extraventricular neurocytoma; Ganglioglioma; Rosette-forming glioneuronal tumor; Dysplastic cerebellar gangliocytoma (Lhermitte-Duclos disease); Diffuse leptomeningeal glioneuronal tumor; Desmoplastic infantile astrocytoma; Papillary glioneuronal tumor; Gangliocytoma; Myxoid glioneuronal tumor

### **NREE-65 Practical Guide to Fetal Craniospinal MRI: Essentials for General Neuroradiologists and Trainees**



**Certificate of Merit**

Elliot T. Varney, MD, PhD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

After review of this exhibit, the radiologist should: Be able to recognize the normal fetal anatomy of the craniospinal axis. Be familiar with common indications for fetal MRI and protocol for fetal Neuroimaging. Recognize and diagnose a broad range of pathologies that can be assessed with fetal MRI.

**TABLE OF CONTENTS/OUTLINE**

Fetal ultrasound is the primary diagnostic tool used for fetal imaging, but there are limitations to imaging the fetal brain, face and neck, and spinal canal. Fetal MRI is often performed to characterize ultrasound findings and provide better prognostic information for obstetric patients. Common indications for fetal craniospinal MRI include ventriculomegaly, midline anomalies, posterior fossa malformations, fetal intracranial mass, encephaloceles, cleft lip and palate, spinal malformations, and in utero disruptive events. With increased demand for these exams for pre- and post-natal health, more general neuroradiologists will be needed for interpretation. This comprehensive review has the potential to improve patient access to fetal craniospinal MRI by increasing general neuroradiologist's and trainee's comfort with interpretation of these exams. We will review imaging protocols, normal fetal anatomy, common indications, case examples, and postnatal MRI correlates. Case examples will include the Pierre Robin sequence, congenital epulis, Dandy Walker variants, open and closed dysraphism, intrauterine fetal demise with intracranial hemorrhage, oro-facial-digital syndrome, and multiple midline abnormalities including alobar holoprosencephaly with synophthalmia.

**NREE-66 The Hidden Face of Gliomas: Decoding the Pathophysiology and Infiltrative Patterns of Gliomas**

Marta Calvo-Imirizaldu, MD (*Presenter*) Research Grant, Siemens AG

**TEACHING POINTS**

- To review the current knowledge of the pathophysiology of gliomas and the challenges of their study and management.- To outline different imaging presentations of gliomas and the role of MRI in the presurgical workup of these tumors. Pearls on imaging biomarkers available and potential diagnostic pitfalls.

**TABLE OF CONTENTS/OUTLINE**

1. Background. Pathophysiological aspects of glioma  
2. Imaging protocol recommended for brain tumors  
3. Pictorial review of the main different infiltrative patterns of gliomas, from isolated hyperintense signal on T2-FLAIR to ring-enhancing necrotic gliomas:  
a. Non-contrast enhancing gliomas  
b. Gliomatosis pattern of gliomas  
c. Non-enhancing with contrast enhancing components gliomas  
d. Homogeneous enhancing gliomas  
e. "Ring enhancing" with necrosis gliomas  
f. Cystic gliomas  
g. Butterfly gliomas  
h. Multifocal gliomas  
With the following information applying for each: clinical issues and pearls on the updated 2021 World Health Organization classification, imaging biomarkers available and potential diagnostic pitfalls.  
4. Reporting tips  
5. Conclusion

**NREE-67 Myelination and Inborn Errors of Metabolism: Learning That Goes Hand in Hand**

Lucas S. Souza, MD (*Presenter*) Nothing to Disclose

**TEACHING POINTS**

The purposes of this exhibit are:  
- Review and illustrate the classic patterns of myelination, emphasizing the main findings for age delimitation, as well as signs of developmental delay.  
- To describe the main imaging patterns of Inborn Errors of Metabolism, including hypomyelination and demyelination, exemplifying cases of Pelizaeus disease, Alexander disease, Canavan disease, Krabbe disease, Metachromatic leukodystrophy, among others, highlighting key points for approaching the differential diagnosis.  
- Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

**TABLE OF CONTENTS/OUTLINE**

- Imaging patterns of white matter myelination, emphasizing the key findings.  
- Neuroimaging of Inborn Errors of Metabolism.  
- Differential diagnosis based on a pictorial review using representative cases from our institutional database:  
- Organelle-based approach  
- Imaging pattern approach: white matter predominance versus gray matter predominance; diffuse white matter involvement (vanishing white matter disease), involvement of the basal ganglia (PKAN, MELAS), periventricular predominance (metachromatic leukodystrophy and Krabbe disease), subcortical predominance (L2-hydroxyglutaric aciduria), among other patterns.  
- Diagnostic Algorithm  
- Final remarks

**NREE-68 Neurovascular Potpourri: Disentangling the Differentials**

Eugene Shin, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Vascular pathology may be the primary reason for, or an incidental finding on contrast enhanced exams. The goal of this presentation is to provide a broad overview of the range of neurovascular findings one may encounter, from benign congenital variations to neoplasms.

## TABLE OF CONTENTS/OUTLINE

Neurovascular topics covered include the following: 1. Congenital/anatomic variants, including aortic arch and major branches, Circle of Willis and persistent carotid-vertebrobasilar anastomoses, arterial fenestration, and junctional dilatation of the basilar artery tip. 2. Review International Society for the Study of Vascular Anomalies characterization of vascular anomalies, primarily discerning vascular malformations from tumors with case examples. Tips will be provided to help discern vascular lesions from similar appearing processes in the head and neck region. 3. Examine other vascular disorders including moyamoya disease, fibromuscular dysplasia (including carotid intimal variant), reversible cerebral vasoconstriction syndrome, and amyloid angiopathy.

## NREE-69 'To Bleed or Not to Bleed'- The DVA Conundrum

### Awards

#### Certificate of Merit

Sabha Ahmed, MBBS, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- Delineate the angioanatomy of developmental venous anomalies.
- Classify the various mechanisms that render DVAs symptomatic.
- The following are illustrated with sample cases:
  - "Flow related" pathomechanisms.
  - decreased outflow; collector vein thrombosis and DVA thrombosis.
  - Increased inflow in the form of arterialisation of DVA.
  - DVAs associated with cavernomas
  - DVAs with no overt neuroparenchymal signal changes but with resistant epilepsy with metabolic abnormality on PET.
  - DVAs associated with grey matter abnormalities.
  - DVAs in tandem with high grade gliomas.

## TABLE OF CONTENTS/OUTLINE

- Angioanatomy of developmental venous anomalies
- Classification of the various pathomechanisms of symptomatic DVAs
- The following are illustrated with sample cases:
  - "Flow related" pathomechanisms (as would be illustrated in our case series)
    - decreased outflow; collector vein thrombosis and DVA thrombosis.
    - Collector vein stenosis culminating in outflow restricted DVAs.
    - Increased inflow in the form of arterialisation of DVA.
    - DVAs associated with cavernomas
    - DVAs with no overt neuroparenchymal signal changes but with resistant epilepsy with metabolic abnormality on PET.
    - DVAs associated with grey matter abnormalities.
    - DVAs in tandem with high grade gliomas.
  - Overview of the treatment strategies both endovascular and conservative in the management of these vascular lesions.

## NREE-70 Easy Come, Easy Go - Transient Brain Findings

Samya S. Alves, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Despite the notability of sequelae left by neurological diseases, many conditions may present as transient abnormalities. Toxic-metabolic encephalopathies comprise one of the groups which classically presents in such manner and is part of the radiologists' daily practice - most of them having a pattern of symmetrical restricted diffusion. Other entities, like some vasculopathies and genetic determined diseases - although instinctively associated with permanent brain damage - might also portray themselves as temporary imaging alterations. In these cases, the follow-up would be critical in determining the diagnosis as it is in differentiating a post-ictal change (typically reversible) from an autoimmune encephalitis (more enduring). - Present a didactic manner for sorting of transient findings and reversible conditions by pathophysiology. - Illustrate transient imaging features in a case-based review.

## TABLE OF CONTENTS/OUTLINE

Suggestion for sorting of reversible imaging findings and conditions

- o Toxic-metabolic: exogenous intoxications (medication, recreational drugs), endogenous intoxications, cytotoxic lesions of corpus callosum (CLOC)
- o Vascular: PRESS, vasoconstriction syndromes, hemiplegic migraine, transient global amnesia, focal cerebral arteriopathy of childhood
- o Genetic determined: phenylketonuria, urea cycle disorders, mitochondrial encephalopathy with lactic acidosis (MELAS)
- o Neoplastic: some brain tumors may exhibit temporary post contrast enhancement or cystic changes without meaning tumor progression (e.g., pilocytic astrocytoma)
- o Miscellaneous: stroke-like migraine attacks after radiation therapy, benign external hydrocephalus, torcular pseudomass

## NREE-71 Post-operative Spine Imaging: Evolution of Percutaneous and Surgical Devices

Bernardo C. Teixeira, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

? Percutaneous devices, such as pedicle screws and vertebral augmentation, are often used in minimally invasive procedures and have lower complication rates. ? Post-operative imaging is essential to assess the success of spine surgery, detect complications, and guide further treatment. ? Radiologists should be familiar with the different surgical approaches and devices used in spinal surgery to accurately describe the post-operative imaging findings and identify any complications that may arise.

## TABLE OF CONTENTS/OUTLINE

Arthrosis Degenerative changes in the lumbar spine are a common source of back pain and disability, affecting millions of people around the world. A great part is discogenic. Degenerative disc changes can take several forms, including disc herniation, spinal stenosis, and osteoarthritis, all of which can cause nerve compression and pain. Surgical approaches ? Anterior lumbar interbody fusion (ALIF) ? Lateral lumbar interbody fusion (LLIF) ? Transforaminal lumbar interbody fusion (TLIF) ? Posterior lumbar interbody fusion (PLIF) Common devices used for arthrodesis How do surgeons decide which approach option? Some challenging cases

## NREE-72 From A to V: Arterial and Venous Intracranial Anatomy, Variants and Malformations

Eduardo D. Valadares, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Describe the anatomy of arterial and venous intracranial systems Exhibit the normal appearance and common variations of the arterial and venous intracranial systems Summarize the most common and some rare congenital and acquired intracranial vascular malformations

## TABLE OF CONTENTS/OUTLINE

Anatomy of Intracranial Arteries and Veins Normal CT and MRI Appearance Common Arterial Variations Fenestrations and Duplications Internal Carotid Arteries Variants Anterior Cerebral Artery Variants Middle Cerebral Artery Variants Posterior cerebral Artery Variants Persistent Carotid-Basilar Artery Anastomoses Common Venous Variations Hypoplastic Venous Sinus Absent Venous Sinus Arachnoid Granulations Pure Arterial Malformations Anterior Cerebral Artery Dolichoectasia Associated with Cortical Dysplasia CVM with Arteriovenous Shunting Arteriovenous Malformation Cerebral Proliferative Angiopathy Dural AV Fistula Carotid-Cavernous Fistula Vein of Galen Aneurysmal Malformation CVM without Arteriovenous Shunting Developmental Venous Anomaly Sinus Pericranii Cerebral Cavernous Malformation Capillary Telangiectasia Vascular Neurocutaneous Syndromes Sturge-Weber Syndrome PHACE Syndrome Wyburn-Mason Syndrome

## NREE-73 A Radiologist Guide to Evaluating White Matter Lesions in Pediatric Patients

Roberto Bastos, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purposes of this exhibit are:- Review and illustrate the classic imaging patterns of white matter lesions in pediatric patients, with a step-by-step approach.- To describe the main imaging patterns of white matter lesions, including hypomyelination and demyelination diseases, highlighting key points for approaching the differential diagnosis.- Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

## TABLE OF CONTENTS/OUTLINE

Imaging patterns of white matter lesions in pediatric patients Differential diagnosis of pediatric conditions that may course with white matter lesions, discussing the main recognizable image patterns:- Terminal myelination- Periventricular leukomalacia- Hypoxic ischemic encephalopathy- Posterior reversible encephalopathy syndrome (PRES)- Hypoglycemic encephalopathy- Adrenoleukodystrophy- Kearns Sayre syndrome- L-2-hydroxyglutaric aciduria- Methotrexate-related leukoencephalopathy- Focal cortical dysplasia- Multiple sclerosis- Acute disseminated encephalomyelitis (ADEM)- Vascular malformation- Ischemic stroke- Hemorrhagic stroke- Perivascular spaces- Other conditions including aggressive and non-aggressive neoplasms, infection of CNS, phakomatosis, autoimmune and neurodegenerative disorders Limitations and tips for the correct diagnosis Practical Diagnostic Algorithm Final remarks

## NREE-74 CNS Tumor on Drugs - Nuts and Bolts of Neuro-oncology Agents for the Radiologist in the Age of Personalized Medicine

Ilkyu D. Oh, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To introduce both common and newly emerging targeted neuro-oncology agents, typical imaging response patterns, and the imaging manifestation of associated toxicities. To highlight targeted agents with actionable molecular markers in primary brain tumors and brain metastasis, focusing on their mechanism of action in oncogenesis. To recognize atypical imaging response

patterns and describe the crucial role of radiologists in providing crucial input for the management of CNS neoplasms in the age of personalized medicine.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduce commonly used traditional chemotherapy agents as well as emerging targeted chemotherapy with their mechanism of actions• Traditional alkylating agents, including Wafer• Anti-metabolites• Targeted chemotherapy i. ALK ii. HER2 iii. EGFR iv. VEGF v. PD-1 vi. CTLA-4 vii. mTOR viii. BRAF ix. MEK x. HIF xi. CAR T-cell therapy xii. IDH inhibitor• Combination therapy• Experimental drugs2. Usual imaging findings of favorable treatment response and/or disease progression.3. Unique atypical response patterns of different neuro-oncology agents and their clinical implications in cancer management.4. Important chemotherapy-related adverse events and corresponding imaging presentation.5. Illustration of imaging manifestations of newly emerging therapies in the era of personalized medicine.

#### **NREE-76 ECASS Radiological Classification of Hemorrhagic Transformation of Infarcted Brain Tissue: Don't Miss the Blood**

Valentina Munera Orozco, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Define the characteristics of hemorrhagic transformation of infarcted brain tissue, recognize the pitfalls and mimics of this entity and reproduce the new classification system: ECCAS II. Recall the different possible etiologies and clinical factors for developing this hemorrhagic complication.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction The hemorrhagic transformation of the infarcted brain tissue is a frequent complication of acute stroke, because of the extravasation of blood across a disrupted blood brain barrier. There are many risk factors and contributors for this disruption. By the ECASS classification system, the types of hemorrhage can be divided in two: hemorrhagic infarction (HI) and parenchymal hematoma (PH). The recognition and classification of this entity is important because the PH2 is found to be a significant predictor of neurological deterioration with higher mortality rates. Teaching points Illustrate the characteristics of an intracranial hemorrhage, specifically the hemorrhagic transformation of infarcted brain tissue. Employ the ECASS classification for hemorrhagic transformation of infarcted brain tissue. Recognize the patterns and learn how to report the different types of hemorrhagic transformation. Distinguish the pitfalls that can mimic a hemorrhagic transformation of infarcted brain tissue. Describe the possible etiologies and clinical factors for developing an intracranial hemorrhagic transformation of infarcted brain tissue.

#### **NREE-77 Vein of Galen Aneurysmal Malformations: A Resident's Approach**

Sameer P. Chandra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- What is a Vein of Galen aneurysmal malformations (VGAM), and how does it appear in a CT and MRI scan. - Highlight the differences between Mural and choroidal Vein of Galen aneurysmal malformations (VGAM). - Exemplify the natural evolution of VGAMs, when treated vs left untreated.

#### **TABLE OF CONTENTS/OUTLINE**

Vein of Galen aneurysmal malformations (VGAM) are characterized by an embryonic choroidal arteriovenous malformation supplied by the choroidal arteries (ACA, AChOA, PChOA). The venous drainage in VGAMs is towards the median prosencephalic vein. VGAMs are formed between 6th and 11th weeks of embryological development, and corresponds to 30-50% of all vascular malformations in infants. VGAMs can be subdivided into two types Choroidal and Mural. Choroidal VGAMs are characterized by multiple feeders including thalamoperforating, choroidal and pericallosal arteries are located in the subarachnoid space in the choroidal fissure. Choroidal VGAMs converge on a fistula at the anterior aspect of the median prosencephalic vein (MPV); Tend to present earlier (neonates) with more severe shunts. Choroidal VGAMs result in high output cardiac failure because of multiple high flow fistulas with less outflow restriction. Mural VGAMs are characterized by fistulae in the subarachnoid space in the wall of the median prosencephalic vein; supply may be unilateral or bilateral. They are associated with absence or stenosis of Dural sinuses and stenosis at the level of the jugular foramen. Present later (infants) and with hydrocephalus. Mural VGAMs presents with fewer fistulas with high outflow restriction.

#### **NREE-78 Review of a HIV-associated Pathology in the Central Nervous System (CNS) & Head and Neck**

Ahmed F. Abdelhalim, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review clinical presentation and imaging manifestations of HIV-associated CNS and head neck pathology, including infectious, inflammatory and neoplastic etiologies2. To discuss differential diagnoses and management considerations3. To present select cases from our institution that highlight these imaging features

## TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Infectious etiologies: presentation, imaging features, differential diagnosis  
a. Virali. HIV encephalopathy  
ii. Progressive multifocal leukoencephalopathy  
iii. Cytomegalovirus  
iv. AIDS encephalopathy and atrophy  
v. Fungali. Cryptococcus  
c. Bacteriali. Tuberculosis  
ii. Neurosyphilis  
d. Parasitici. Toxoplasmosis  
3. Immune reconstitution inflammatory syndrome (IRIS)  
4. CNS Lymphoma  
5. Select head and neck case review: HIV myelopathy, Kaposi sarcoma, lymphadenopathy, lymphoepithelial parotid cysts

### **NREE-79 Anatomy and Congenital Variations of the Sella Turcica, Suprasellar Cistern and Hypothalamus**

Alex C. Dias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the normal embryology and anatomy of the pituitary gland, the suprasellar cistern and the hypothalamus. Summarize the imaging characteristics of the sellar region on CT and MRI. Provide tools to identify anomalies in the sellar region; discuss differential diagnosis and common pitfalls.

## TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Anatomy and embryology review- sella turcica and hypophysis- parasellar region, suprasellar region and hypothalamus  
3. Clinical-radiological correlation of congenital sellar variations  
4. Case-based review of congenital variations and pathology: - osseous - intrasellar - suprasellar - justasellar  
5. Take-home points

### **NREE-81 Beware of the Railway Crossing, Neuralgia Awaits You. A Resident's Guide to Neurovascular Conflict**

Andres B. Haro Laverde, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Not all vascular conflicts may lead to a clinical condition; therefore, the topographical finding must correlate with the symptoms.  
2. Peripheral nerves have critical segments, where they run without a myelin sheath; this is called the transition zone.  
3. The correct imaging protocol can lead to the diagnosis; nevertheless, the best pulse sequences are prone to artifacts, and it is important to identify them.  
4. Infectious, neoplastic, or inflammatory causes may overlap; therefore, be aware of differentials.

## TABLE OF CONTENTS/OUTLINE

1. Anatomical review of the cranial nerves with a hub in the most common trapped roots  
2. Physiopathology of vascular palsy and the common clinical findings.  
3. Types of cranial nerve vascular conflicts and pitfalls.

### **NREE-82 A Comprehensive Guide of Neurovascular Imaging: Discovering Pearls and Overcoming Pitfalls**

Niels Vinicius Padua Carvalho, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this exhibition is to:

- Thoroughly review the technical aspects of neurovascular imaging (arterial and venous angiography and magnetic resonance angiography) and vessel wall imaging.
- Illustrate the role of these imaging methods, overall CT and MRI, highlighting advantages and disadvantages of each modality.
- Unify the most important methods in a single article/presentation.
- Summarize the pearls of these methods for diagnosis purpose and how to overcome the main pitfalls.

## TABLE OF CONTENTS/OUTLINE

- INTRODUCTION  
o Importance of neurovascular imaging through the time and where we stand today
- IMAGING TECHNIQUE  
o Neurovascular imaging techniques, including:  
§ Protocol: when to choose each method  
§ Sequences: which sequences are preferred for each modality  
§ Imaging acquisition: the physical aspects and time of acquisition
- INTERACTIVE CASE-BASED DIDACTICS  
o Sample cases to illustrate and consolidate the main pearls and pitfalls of neurovascular imaging, separated by imaging method and type of errors
- FUTURE DIRECTIONS AND TAKE HOME MESSAGES  
o Where do we need improvement?  
o What is on the horizon for neurovascular imaging?

### **NREE-83 INTRA-ARTERIAL CHEMOTHERAPY FOR RETINOBLASTOMA: ANATOMICAL & HEMODYNAMIC CHALLENGES**

Matteo Zanoni (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- In the hope of salvaging eyes with retinoblastoma (RB) from enucleation, intra-arterial chemotherapy(IAC) has been proposed in 2008.- The main goal of IAC is to deliver a high dose of drugs directly to the tumor while avoiding the side effects and risks of systemic chemotherapy.- In the ideal scenario, an adequate blush is visualized from the internal carotid artery, ophthalmic artery origin is favorable for catheterization and no prominent cutaneous branches from the ophthalmic artery are seen.- IAC is not always as straightforward as expected and some challenges may be seen.- The first scenario is a difficult and unstable catheterization of the OA, in spite of its visualization by selective angiography, usually due to a too angulated origin of the OA.- The second scenario occurs when OA is not visible from ICA injection or the blush is not visible and contrast medium flows back into the ICA when catheterization of the OA is properly achieved. One anastomosis with the external carotid artery could be in place providing alternative pathways for the orbital supply and drug administration.- Distribution volume of the drug, which correlates to effectiveness of the IAC, could increase because of cutaneous branches originating from OA, thus increasing local side effects.

## TABLE OF CONTENTS/OUTLINE

- Intra-arterial chemotherapy for retinoblastoma- IAC technique and ideal scenario- Anatomical challenges and solutions- Hemodynamic challenges and solutions- Distribution volume understanding

### **NREE-84 Pictorial Review of the Applications of Dynamic Susceptibility Contrast (DSC) MRI Perfusion in the Characterization of Meningiomas**

Theodore Wang (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Background review on the key characteristics of meningiomas and basics of dynamic susceptibility contrast (DSC) MRI perfusion. 2. Literature and pictorial review of the applications of DSC perfusion in the evaluation of meningioma characteristics, including grade, histologic subtypes, consistency, and vascularity. 3. Future applications of DSC in the evaluation of meningiomas.

## TABLE OF CONTENTS/OUTLINE

1. Background on meningiomas and DSC MRI perfusion: (a) Brief background on meningiomas, including differences in grade, histologic subtype, consistency, and vascularity. (b) Background on the clinical importance of these different characteristics and current imaging evaluation. (c) Review of the current literature on the application of DSC for meningioma evaluation. 2. Applications of DSC perfusion in meningioma evaluation: (a) Pictorial review of applications of DSC perfusion in meningioma evaluation. (i) Review the differences in perfusion between histologic subtypes of meningiomas, including the correlation of higher perfusion values with higher grade tumors and surrounding brain parenchyma. (ii) Discuss the role of DSC in predicting vascularity and consistency of meningiomas. 3. Discussion of future directions of DSC for meningioma evaluation.

### **NREE-86 Arteriovenous Malformations: Practical Application of Spetzler Martin Classification**

Ingrid G. Larreynaga Portillo, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Brain arteriovenous malformations are a type of intracranial high flow vascular malformation composed of enlarged feeding arteries, a nidus of vessels closely associated with the brain parenchyma through which arteriovenous shunting occurs, and draining veins. These malformations are characterized by a nidus forming the transition between the feeding artery and draining vein. If this transition is made directly, then it is considered an arteriovenous fistula, which is a separate type of cerebral vascular anomaly.

## TABLE OF CONTENTS/OUTLINE

Definition Clinical findings Location Incidence Associated anomalies Classification Cases

### **NREE-87 Advances in NOWinBRAIN 3D Neuroimage Large Repository: Cortical and Cranial Openings and Neurologic Disorders**

Wieslaw L. Nowinski, DSc, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The exhibit: 1) Demonstrates a novel image display and exploration method using sequences of cortical and cranial openings; 2) Enables skull-brain correlation via cranial openings exposing the underlying parcellated and labeled brain (divided into lobes, gyri, and sulci) and intracranial arteries and venous system; 3) Facilitates brain-intracranial arteries correlation by opening 64 gyri and 6 lobules exposing the white matter and the arteries usually hidden deep in the sulci; 4) Provides a correspondence between brain damage (lesion) and the resulting disorder for vascular, cranial nerve and regional anatomy-related synthesized lesions, each lesion labeled with a disorder, signs, symptoms, and/or syndromes; 5) Presents a wide



spectrum of over 8,600 3D neuroimages systematically organized, named and grouped into over 630 folders; 6) Is a valuable resource for medical students and residents as well as educators to prepare presentations.

#### **TABLE OF CONTENTS/OUTLINE**

The NOWinBRAIN repository contains 12 galleries (G1-G12) with 3D neuroimages derived from 3D brain atlases constructed from multiple 3/7 T MR and CT scans of a living brain. Galleries G1-G6 with 5000+ images were earlier presented at RSNA. For RSNA 2023 this repository is extended, enhanced, and two new galleries are created with cortical and cranial openings (G8) and 3D simulated neurologic disorders with outcomes (G11). The NOWinBRAIN repository is web-based and publically available at [www.nowinbrain.org](http://www.nowinbrain.org)

### **NREE-88 Brain Bubbles: Updates on Intracranial Cystic Lesions**

#### **Awards**

##### **Certificate of Merit**

Azza Reda, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To describe the intra- and extra-axial cystic lesions based on the anatomical location.
- To highlight the recently described and updated cystic lesions.
- To provide an algorithmic approach describing incidental lesions elucidating the differential diagnosis with an aim to recognize do not touch lesions, aid in appropriate management, and prevent inadvertent surgical intervention.

#### **TABLE OF CONTENTS/OUTLINE**

Updated approach to diagnose neoplastic and neoplastic intracranial cystic lesions

A. Intra-axial: supra and infratentorial parenchymal lesions.

B. Extra-axial: supra and infratentorial; and each divided, into midline, off midline, and intraventricular lesions.

Intra-axial cystic lesions

- Non neoplastic lesions: Enlarged perivascular spaces (Glymphatic system and tumefactive type), Neuroglial cyst, porencephalic cyst, and ependymal cyst.
- Infectious cysts: Cryptococcosis, Neurocysticercosis, and abscess.
- Neoplastic lesions: MVNT and MVNT plus, DNET, ganglioglioma, metastasis, glioblastoma and oligodendroglioma, pilocytic astrocytoma, haemangioblastoma, medulloblastoma, pleomorphic xanthoastrocytoma, and rarely ependymoma.

Extra-axial cystic lesions

- Non neoplastic lesions: Pineal cyst, Rathke's cleft cyst, normal, arachnoid cyst, dermoid, epidermoid cyst, choroid plexus cyst and fissure, colloid cyst, Neurocysticercosis and neuroenteric cyst.
- Neoplastic lesions: craniopharyngioma, schwannoma, ependymoma and pituitary apoplexy. Significant emphasis would be on the atypical cystic brain metastatic lesions and don't touch lesions.

### **NREE-89 MR Case-based Review of Cavernous Sinus Lesions**

Eva E. Romo (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the anatomy of the cavernous sinuses and normal appearance on MR  
To make a case-based illustration of the MR imaging features on the main cavernous sinus lesions

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy of the cavernous sinus  
MR protocol for suspected cavernous sinus pathology  
Case-based MR imaging findings of main cavernous sinus lesions

Neoplastic

Case 1: Pituitary adenoma

Case 2: Meningioma

Case 3: Giant hemangioma

Case 4: Lymphoma

Case 5: Chordoma

Case 6: Metastatic lesion of skin carcinoma

Inflammatory

Case 7: Tolosa-Hunt syndrome

Vascular

Case 8: Cavernous ICAs aneurysms

Case 9: ICA occlusion

### **NREE-9 Caught in the Web: Imaging Techniques in Identifying Ischemic Stroke Due to Carotid Web**

#### **Awards**

##### **Certificate of Merit**

Ana Luiza Basilio Franca (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The carotid web is a rare vascular anomaly that can lead to ischemic stroke. Its diagnosis and management can be challenging due to its limited pathophysiology and presentation understanding. However, advanced diagnostic imaging techniques have greatly enhanced the identification and management of the carotid web. This educational exhibit highlights the importance of early detection, accurate diagnosis, and interdisciplinary approach to carotid web management: To illustrate carotid web radiologic highlights. To explain the complications involved with the finding. To explain the imaging assessment.

## TABLE OF CONTENTS/OUTLINE

1. Definition of carotid web and revision of epidemiology, clinical presentation, and etiology, including prevalence and incidence of the carotid web, common clinical presentations, and etiological factors contributing to carotid web. 2. CT angiography highlights. 3. Underlying factors contributing to carotid web development, including early detection and management importance. 4. Differential diagnosis of carotid web and the importance of accurate diagnosis for appropriate management. 5. Potential complications associated with carotid web and the importance of identifying and managing complications promptly. 6. Clinical perspective: current management strategies for carotid web and the importance of an interdisciplinary approach to the patient. 7. Take-home messages.

### **NREE-90 Big Vents: Causes of Hydrocephalus**

#### **Awards**

#### **Certificate of Merit**

Daniel R. Wayer, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Classification and terminology of hydrocephalus continue to be sources of confusion and debate in the literature. This exhibit provides an overview of the ventricular system and hydrocephalus classification scheme, covering typical pathologies and their imaging findings to enable the reader to approach hydrocephalus confidently. Normal ventricular anatomy consists of four interconnected choroid plexus-lined cavities and two canals. Anatomic variants can mimic hydrocephalus. Hydrocephalus is a disorder of flow, formation, or resorption of cerebrospinal fluid (CSF). Hydrocephalus classification is based on obstruction site and includes high pressure, normal pressure (NPH), and low-pressure subtypes. Intraventricular obstructive hydrocephalus (IVOH) inhibits CSF outflow due to obstruction at or before the 4th ventricle. Extraventricular obstructive hydrocephalus (EVOH) is due to obstruction anywhere from the 4th ventricular outlet foramina to the arachnoid granulations. Overproduction hydrocephalus is frequently caused by choroid plexus papilloma. NPH is diagnosed via a combination of history, neurological examination, and specific imaging findings. Syndrome of Inappropriately Low-Pressure Acute Hydrocephalus (SILPAH) is a rare and unrecognized condition with imaging findings mirroring severe obstructive hydrocephalus.

## TABLE OF CONTENTS/OUTLINE

Ventricular Anatomy CSF Production and Circulation Models Normal Variants Hydrocephalus Classification High Pressure subtypes IVOH EVOH Overproduction NPH SILPAH Summary

### **NREE-91 CNS Imaging Correlates of an FDA Cleared Diagnostic Meningitis/Encephalitis Panel**

#### **Awards**

#### **Certificate of Merit**

Norbert G. Campeau, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Diagnosis of CNS infections from cerebrospinal fluid collected by lumbar puncture is increasingly performed using comprehensive diagnostic panels. 2. This exhibit serves as a useful imaging reference atlas for the 14 microbial entities of meningitis/encephalitis included on an FDA cleared diagnostic panel which includes 6 bacteria, 7 viruses, and 1 yeast. 3. Knowledge of the imaging findings for these entities is clinically useful to monitor the extent of CSF involvement in known positive cases, or to suggest CSF testing in suspected cases undergoing CNS imaging. 4. The relative merits of CT, MRI and cranial ultrasound imaging modalities and contrast use will be discussed.

## TABLE OF CONTENTS/OUTLINE

A. The 14 microbial entities included on the diagnostic panel are: - 6 bacteria (Haemophilus Influenza, Streptococcus pneumoniae, Neisseria meningitidis, Escherichia coli K1, Streptococcus agalactiae, Listeria monocytogenes) - 7 viruses (Enterovirus, Cytomegalovirus, Herpes Simplex 1, Herpes Simplex 2, Human Herpesvirus 6, Human parechovirus, and Varicella zoster) - 1 yeast (Cryptococcus neoformans/C. gattii) B. The CNS imaging findings for each of the above microbial entities will be presented, including a brief synopsis of the epidemiology and clinical presentation. C. Summary Table of Imaging Findings.

### **NREE-92 Portable Ultralow Field(0.064 Tesla)MRI for Neuroimaging**

Saurabh Jindal, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Bedside magnetic resonance imaging (MRI) performed by an MRI or non-MRI-trained technologist in the presence of clinical staff/family. 2. Clinical utility in neurointensive care units and unstable patients who cannot be transferred to the MRI suite. 3. Standard sequences to diagnose common neurological emergencies, such as stroke, hypoxic-ischemic injury, and



empyema. 4. Infarct or Artifact?: When in doubt on the low signal-to-noise ratio (SNR) diffusion-weighted images (DWI), evidence of edema on T2W/FLAIR images can aid in the diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to portable MRI scanner 2. Clinical cases 3. Teaching points 4. References 5. Acknowledgments

### **NREE-93 Radiologist's Guide to Image-guided Spinal Steroid Injections: Anatomy, Procedural Technique, and Potential Pitfalls**

Jeffrey Ling, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review pertinent spinal anatomy with emphasis on key radiographic landmarks for epidural needle access. Discuss the utility and indications for spinal steroid injections in the setting of neck or back pain. Provide a brief overview of image guided approaches that can be utilized for spinal steroid injections. Understand potential procedural pitfalls and complications.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Epidemiology of painful spine conditions and associated imaging findings. Relevant anatomy of the lumbar and cervical spine. Indications and contraindications of image-guided steroid injections. Choice of corticosteroid and/or local anesthetics. Potential procedural risks and complications. Procedure approach and technique Preprocedural planning: evaluate degenerative disease at the target level, assess epidural target and adjacent structures, anticipate distance to target and optimal needle length; CT versus fluoroscopy technique. Interlaminar epidural steroid injections. Transforaminal epidural steroid injections: supraneural approach, infraneural approach. Complications Common: temporary local discomfort during needle placement; inadvertent dural puncture (CSF leak). Rare, serious: contrast reaction; hemorrhage, epidural hematoma; spinal cord infarct (intravascular injection). Discussion Evaluation of post-procedural improvement in pain. CT versus fluoroscopy. Review of tips and tricks for technical procedural success. Alternative options for pain relief.

### **NREE-94 The Big Picture: A Radiologist's Guide to Unlocking the Intricacies of Pediatric Neurometabolic Diseases**

Mika Shapira Rootman, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Brain MRI is the primary imaging modality for assessing neurometabolic disease in children. 2. MR spectroscopy should be considered as a supplemental imaging tool when neurometabolic disease is suspected. 3. Symmetric signal abnormalities involving white matter, basal ganglia, thalami, brainstem, and cerebellum can be major clues on imaging for neurometabolic disease. 4. Narrowing down the differential diagnosis requires further assessment of anatomic distribution, temporal progression, and additional imaging findings such as cysts and calcifications. 5. Age at presentation, particularly neonatal onset, is an important factor to consider when diagnosing devastating metabolic diseases in newborns.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Brief overview of the importance of radiological assessment in pediatric neurometabolic disease Imaging Modalities for Neurometabolic Disease Highlighting brain MRI as the primary imaging modality Discussing the added value of MR spectroscopy Clues on Imaging for Neurometabolic Disease Describing specific patterns and findings on imaging, such as symmetric signal abnormalities involving white matter, basal ganglia, thalami, brainstem, and cerebellum Emphasizing the importance of pattern recognition in identifying potential neurometabolic disease Narrowing Down the Differential Diagnosis Discussing the role of further assessment, including anatomic distribution, temporal progression, and additional imaging findings such as cysts and calcifications Highlighting the significance of age at presentation, particularly neonatal onset Conclusion Summarizing the key take-home messages for radiologists in imaging pediatric neurometabolic disease

### **NREE-95 Multimodality Imaging of Cerebral Vasospasm**

#### **Awards**

#### **Certificate of Merit**

Mikel Elgezabal, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To highlight key concepts such as symptomatic vasospasm, radiographic vasospasm and delayed cerebral ischemia, that will help the reader understand cerebral vasospasm and its consequences. 2. To describe different diagnostic methods for detection of cerebral vasospasm, each with their advantages and disadvantages, providing illustrative examples. 3. To propose a practical diagnostic-therapeutic approach of severe SAH and vasospasm.

## TABLE OF CONTENTS/OUTLINE

1. Cerebral vasospasm: key concepts 1.1. Definitions: SAH, radiographic vasospasm, symptomatic vasospasm, delayed cerebral ischemia (DCI). 1.2. Etiology: SAH. Risk factors, diagnostic protocol, prognosis. 2. Diagnosis of cerebral vasospasm 2.1. Clinical signs and symptoms and other monitoring tools. 2.2. Transcranial Doppler ultrasound. 2.3. CT (NECT, CT perfusion, CTA) 2.4. DSA 2.5. Diagnostic management - proposed algorithm 3. Treatment: the fight against DCI 3.1. Medical treatment. 3.2. Angiographic/Interventional treatment and its complications. 4. Take home points

### **NREE-96 A Trip Through Gyriiform Enhancement**

Adria Roset Altadill, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Gyriiform enhancement is mainly secondary to vascular and infectious causes. - Gyriiform enhancement should be discerned at imaging from leptomeningeal enhancement.- Distinction between the different etiologies of gyriiform enhancement has to be made based on clinical history, brain distribution and ancillary radiologic findings.

## TABLE OF CONTENTS/OUTLINE

Gyriiform enhancement, also called gyral or cortical enhancement, is an uncommon brain pattern that refers to contrast deposition on the superficial grey matter of the cerebral cortex. The main causes of this enhancement pattern are vascular and infectious. Vascular causes can be related to arterial or venous infarctions, seizures, migraine syndromes, posterior reversible encephalopathy syndrome (PRES) and subarachnoid hemorrhage. Infectious processes include mainly herpes encephalitis, cerebritis and meningitis. Finally, gyral enhancement may also rarely occur in neoplastic diseases or cases of neurotoxicity. Cortical enhancement can be detected by contrast-enhanced head CT or brain MRI, although the latter is much more sensitive due to its higher contrast resolution. It is important to differentiate cortical enhancement from leptomeningeal enhancement, which can demonstrate a similar "serpentine" morphology but affects the subarachnoid space and the pia matter instead. In order to narrow the differential diagnosis between the spectrum of causes of cortical enhancement, a focus should be placed on clinical history, distribution of the gyral enhancement and ancillary radiologic findings.

### **NREE-97 Cerebrovascular Disease in Young Adults: A Case-Based Review**

Huijuan Wang, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Cerebrovascular disease (CVD) can result from blood vessel narrowing, rupture, or a hypercoagulable state, which may present on imaging as vascular stenosis, hemorrhage, or occlusion, respectively. As an emerging public health issue with debilitating effects on young adults, recognizing the similarities and differences between young adults and elderly patients for the etiologies and prevalence of various types of CVD is imperative for optimal patient outcomes.

## TABLE OF CONTENTS/OUTLINE

1. Review the common etiologies and prevalence of cerebrovascular disease (CVD) in young adults and how this compares to elderly patients. 2. Categorize the differential diagnosis based on the general imaging appearance of vascular stenosis, hemorrhage, and occlusion in conjunction with the location of the abnormality. 3. Practice the diagnostic approach previously reviewed with multiple vignette-style young adult CVD cases with questions accompanying each case focused on differential diagnosis, prognosis, and management. 4. Discuss clinical presentation, key imaging findings, differential diagnosis, and management of each presented case.

### **NREE-98 Imaging of Deep Brain Stimulation Systems**

Alexandre Boutet, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) Deep brain stimulation (DBS) surgery, which is the most common functional neurosurgery treatment, is increasingly being performed worldwide. (2) Its therapeutic effect hinges upon accurate and precise targeting of the intended brain structure—maximizing therapeutic benefits while minimizing spillover onto neighbouring structures that may produce adverse effects. (3) Knowledge of the anatomical relationships of the most common targets including the subthalamic nucleus and pallidum is essential for accurate reporting. (4) Postoperative imaging of DBS patients is subject to strict MRI safety guidelines to prevent heating at the electrode tips, which is the main risk. Knowledge of the factors influencing safety such as specific absorption rate (SAR) is crucial to provide these patients with optimal MRI when it is required. (5) Interpretation of DBS postoperative imaging requires knowledge of the expected appearances and the complications. (6) Functional neurosurgery is a rapidly evolving field with considerable scope for the role of radiologists to grow beyond their current contributions.

## TABLE OF CONTENTS/OUTLINE

(1) Brief background of functional neurosurgery focusing on DBS. (2) Anatomical relationships of the most common targets. (3) Framework on how to safely acquire MRI in postoperative DBS patients. (4) Expected and complicated postoperative

imaging appearances of DBS. (5) Future directions and opportunities for radiologists.

## **NREE-99 MRI Characteristics of Chemotherapy Related Central Neurotoxicity: A Pictorial Review**

Rugaiyah F. Alkhatib, MBBS, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Due to the increasing incidence of cancer and advancements in cancer treatment, the prevalence of chemotherapy-related neurotoxicity has also seen an increasing trend. Chemotherapy-related neurotoxicity is a well-recognized complication in oncologic patients, with a wide range of patients, from 19% to more than 85% receiving chemotherapeutic agents experiencing symptoms of neurotoxicity. This may present with a wide range of neurological manifestations, which can pose diagnostic challenges, particularly, in distinguishing it from tumor progression and paraneoplastic syndrome. Therefore, imaging plays a crucial role in the management of these patients. MRI can reveal various imaging patterns of chemotherapy-induced neurotoxicity, including acute-subacute leukoencephalopathy with reversible DWI pattern, commonly observed with methotrexate use, as well as acute cerebellar syndrome and reversible acute cerebellar toxicity patterns, which is most often induced by high-dose cytarabine. Other imaging patterns include posterior reversible encephalopathy syndrome, neurovascular complications pattern, progressive multifocal leukoencephalopathy pattern and spinal cord toxicity. In this pictorial review, we will highlight the MRI characteristics and patterns related to chemotherapy-induced neurotoxicity, as well as provide case-based examples to better illustrate these features.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Types of chemotherapeutic agents and mechanism of action  
3. Characteristics MRI features of chemotherapy-induced central neurotoxicity  
4. Conclusion

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## Abstract Archives of the RSNA, 2023

NREE-1

### **Variants and Anomalies of Intracranial Cerebral Arteries and Considerations for Neuroendovascular Procedures**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Ana Maria Rodriguez Martinez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To describe the embryology of the intracranial cerebral arteries in order to explain the origin of its anatomical variants and anomalies.- To review all the variants and anomalies of intracranial cerebral arteries giving examples from cases from our institution.- To revise the associated pathology and the implications for endovascular procedures.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Embryology  
3. Intracranial Internal Carotid Artery  
3.1. Variants. Tortuosity.  
3.2. Anomalies  
3.2.1. Aberrant carotid artery  
3.2.2. Persistent estapedial artery  
3.3. Ophthalmic artery  
4. Persistent carotid-basilar communications  
4.1. Trigeminal artery  
4.2. Hypoglossal artery  
4.3. Proatlantal intersegmental artery  
5. Anterior cerebral artery (ACA)  
5.1. Variants  
5.1.1. The anterior communicating artery  
5.2. Anomalies  
5.2.1. Infraoptic origin and persistent olfactory primitive artery  
5.2.2. Accessory, multiple and aberrant ACA  
5.2.3. Bihemispheric and azygos ACA  
6. Middle cerebral artery (MCA)  
6.1. Variants  
6.2. Anomalies  
6.2.1. Accessory, fenestrated and duplicated MCA  
7. The posterior arterial circulation  
7.1. Variants  
7.1.1. Fetal origin  
7.1.2. AICA-PICA  
7.2. Anomalies  
7.2.1. Basilar fenestration

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## Abstract Archives of the RSNA, 2023

NREE-10

### 'Incidental' Intracranial Arterial Anatomical Variants: Implications for Diagnosis, Pathology and Treatment

All Day Room: Learning Center

Charlotte Y. Chung, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Variability in intracranial arterial anatomy is well recognized to be the rule, not the exception. For example, the Circle of Willis is incomplete in 75-80% of brain CT/MR angiography. While anatomic variations may be clinically inconsequential in the normal patient, accurate delineation of the involved anatomy may be critical in the setting of pathology. This exhibit employs a systematic vessel-based approach to illustrate common intracranial arterial variants and their potential clinical implications through case-based discussions. Educational objectives of this exhibit are:- Outline intracranial arterial development and resultant spectrum of anatomic variations- Illustrate common 'incidental' variant configurations of the intracranial arteries on multimodal (CTA, MRA, and DSA) neuroimaging.- Highlight implications of anatomical variants in diagnosis, pathology, and treatment of cerebrovascular diseases

#### TABLE OF CONTENTS/OUTLINE

I. Case-based review of anatomical variants in the distal ICAII. Case-based review of anatomical variants in the Circle of WillisIII. Case-based illustration of the continuum of variant MCA and ACA cortical branching patternIV. Case-based review of anatomical variants in the vertebrobasilar circulationV. Variants in vessel morphology and caliber mimicking pathology

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## Abstract Archives of the RSNA, 2023

NREE-100

### Frontier Technology in Non-Invasive Vascular Imaging; Arterial Spin Labeling-Based Non-Contrast MR Digital Subtraction Angiography on Cerebral Diseases

All Day Room: Learning Center

#### Awards

##### Cum Laude

Miho Gomyo (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To learn the basic principles of arterial spin labeling-based non-contrast MR digital subtraction angiography (ASL-MRDSA) that can obtain dynamic information of cerebral arteries without using a Gd-based contrast agent. 2. To learn various scanning methods of ASL-MRDSA. 3. To learn clinical applications of ASL-MRDSA to evaluate cerebral lesions. 4. To know some novel techniques of ASL-MRDSA. 5. To review pitfalls and limitations of ASL-MRDSA.

#### TABLE OF CONTENTS/OUTLINE

1. Basic principles of ASL-MRDSA 2. Various scanning methods of ASL-MRDSA and their characteristics; 2D-methods, 3D-methods, and ultra-short TE methods 3. Novel techniques of ASL-MRDSA 4. Clinical applications of ASL-MRDSA to evaluate the following diseases; • intracranial arterial stenosis/occlusion • moyamoya disease • arteriovenous malformation (AVM) • carotid-cavernous fistula (CCF) • dural arteriovenous fistula (dAVF) • extracranial to intracranial (EC-IC) bypass • hypervascular tumors (skull tumor, hemangioblastoma, paraganglioma, and so on) • post-operative study of cerebral aneurysms (clipping, coil embolization) 5. Pitfalls and limitations

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## Abstract Archives of the RSNA, 2023

NREE-101

### Patterns of Abnormal Magnetic Susceptibility in the Brain

All Day Room: Learning Center

Kendal L. Weger (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Susceptibility weighted imaging (SWI) is an MRI sequence that uses phase and magnitude information to characterize substances that distort the local magnetic field, allowing for identification of hemosiderin, calcification, and iron deposition. 2) Depending on the pathology, abnormal magnetic susceptibility may appear as a single or multiple lesions and can present with varying morphology. 3) SWI lesion locations correlate with the disease mechanism. Understanding physiologic and pathologic reasons for localization is key to formulating the differential diagnosis and diagnosis 4) SWI is instrumental in characterization of vascular abnormalities, masses, and causes of microhemorrhage. 5) SWI is often able to detect changes earlier in a disease process than other sequences.

#### TABLE OF CONTENTS/OUTLINE

Pathology organized by susceptibility patterns: -Single lesion: - Location specific - Basal ganglia: neurodegenerative diseases, hypertensive hemorrhages, toxic/metabolic entities - Midline: desmoid - Sulcal: siderosis - Single vascular: thrombosis of cerebral vein or DVA, calcified embolus in Circle of Willis artery - Linear susceptibility along margins of cerebral mass: pyogenic abscess - Multiple lesions: - Location specific - Grey-white matter junction: hemorrhagic metastases, grade 1 DAI - Lobar: CAA - Diffuse vascular: ferumoxytol - Corpus callosum: grade 2 DAI - Brainstem: grade 3 DAI, kernohan phenomenon -Non-location specific - Diffuse axonal injury - Fat emboli - Microhemorrhage of acute illness, post-cardiac surgery

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## Abstract Archives of the RSNA, 2023

NREE-102

### Head On: Facing Central Nervous System Lymphoma

All Day Room: Learning Center

MARCELO DOS SANTOS BANDEIRA FILHO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is- To explore the proper terminology and classification of lymphomas based on updates of the fifth edition of the WHO Classification of Tumors of the Central Nervous System (CNS).- List the main clinical and epidemiological characteristics and risk factors associated with the appearance of CNS lymphomas.- To show through a pictorial review the classic imaging findings of various lymphomas of the CNS.- Show atypical cases of lymphomas and develop adequate reasoning for the radiologist to face unusual findings.

#### TABLE OF CONTENTS/OUTLINE

Powerpoint Layout  
Introduction: 1. Overview of clinical, epidemiological and risk factors. 2. Neuroradiology: 2.1 Terminology of SNC lymphomas. 5th edition of the WHO 2.2 Classification of Tumors: SNC lymphomas. CNS Lymphomas: Primary diffuse large B-cell lymphoma of the CNS. Immunodeficiency-associated CNS lymphoma Lymphomatoid granulomatosis Intravascular large B-cell lymphoma Miscellaneous rare lymphomas in the CNS: MALT lymphoma of the dura Other low-grade B-cell lymphomas of the CNS Anaplastic large cell lymphoma (ALK+/ALK-) T-cell and NK/T-cell lymphomas

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## Abstract Archives of the RSNA, 2023

NREE-103

### Photon Counting Detector Lateral Decubitus CT Myelography: A Developing Technique for Detection of Cerebrospinal Fluid - Venous Fistulas

All Day Room: Learning Center

Nikkole Weber, ARRT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Discuss protocol development and optimization of Photon Counting Detector (PCD) CT Myelography (CTM) 2. Describe features of PCD technology that improve detection of cerebrospinal fluid- venous fistulas (CVFs): spectral, spatial and fast 4D serial acquisitions 3. Demonstrate examples of CVFs found on PCD CTM

#### TABLE OF CONTENTS/OUTLINE

1. Review current imaging modalities for myelography 2. PCD CTM protocol development a. Performed in right and left lateral decubitus Trendelenburg positions b. Lumbar spine localizers c. Spinal needle placement intrathecally d. Bolus tracking to monitor contrast flow within the thecal sac e. Serial paired acquisitions, with multi-energy (ME) and high-resolution (HR)/ME scan modes 3. Unique technologic advantages of PCD that aide in detection of subtle CVF a. Higher spatial resolution i. Spinal anatomy of interest very small ii. HRME (0.2mm), ME (0.4mm) scan mode reconstructions b. Improved radiation dose efficiency compared to energy integrating detector CT scanners—reduced electronic noise, optimal photon weighting, smaller detector pixel size, and removal of septae. Resultant images with thinner slices and sharper kernels can be generated without increasing noise c. Spectral reconstructions to improve contrast enhancement and iodine contrast to noise ratio (CNR) i. Increased iodine CNR due to more optimal energy weighting of PCDs (more weight towards low-energy photons) ii. Subtle CVFs can be very faint. Virtual monoenergetic images (VMI) at low keV (40) increases the conspicuity of iodine d. Fast 4D acquisition: 3D volume + a series of acquisitions at different time points. e. Metal artifact reduction vs high keV VMI reconstructions tested 4. CVF example patient images

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## Abstract Archives of the RSNA, 2023

NREE-104

### **MR Bone Imaging: Value of Application to Cervical and Intracranial Vessel Wall Imaging**

All Day Room: Learning Center

Kazuhiro Tsuchiya, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To learn basic concepts and technical aspects of bone imaging like CT by MR imaging.2. To know basic concepts of vessel wall imaging (VWI) by MR bone imaging with improved visualization between vessel walls and vessel lumen.3. To know what benefits MR bone imaging offers over conventional cervical and intracranial VWI techniques and some pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

1. Basic issues of MR bone imaging including currently employed scanning sequences and postprocessing methods.2. MR bone imaging-based VWI: how to improve image quality.3. MR bone imaging-based VWI: how does it work in the diagnosis of vessel wall abnormalities?4. Presentation of clinical cases with discussion of implications. Cases will cover carotid calcified plaques, intracranial main trunk plaques, aneurysms, vasculitis, moyamoya disease, and so on.5. Additional discussion including current limitations and future directions of this technique.

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## Abstract Archives of the RSNA, 2023

NREE-105

### Posterior Fossa Ependymomas: Newly Defined Molecular and Genetic Subtypes with Characteristic Imaging Features

All Day Room: Learning Center

Shan McBurney-Lin, MD, MBA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Posterior fossa (PF) ependymomas have been newly classified into two distinct subtypes, PFA and PFB, based on molecular and genetic features by the World Health Organization in 2021.2. Each subtype has unique epidemiologic, biologic, prognostic, clinical, and imaging features.3. Imaging plays an important role in differentiating the two subtypes of PF ependymomas and in distinguishing PFA and PFB subtypes from other PF tumors, which benefits surgical planning and tumor recurrence surveillance.4. Upon completion of review of this exhibit, readers will be able to recognize the distinct molecular, genetic, and clinical features of PF ependymomas and become familiar with the characteristic imaging features of each subtype for improved early imaging diagnostic capability.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of PFA and PFB ependymal tumor subtypes, including epidemiology, prognosis and molecular/epigenetic alteration2. Characteristic imaging features of PFA and PFB tumor subtypes3. Radiologic differences between PFA/PFB subtypes and similar entities within the radiologic differential diagnosisa. Medulloblastoma b. Atypical teratoid rhabdoid tumor c. Pilocytic astrocytoma4. Summary and quiza. Summary of key radiologic findings of PFA/PFB subtypes b. Quiz to review new knowledge via example cases

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## Abstract Archives of the RSNA, 2023

NREE-106

### SWI Brush Sign of Cerebral Parenchymal Veins in CNS Diseases and Conditions

All Day Room: Learning Center

Seiya Kishi (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

SWI brush sign (BS) represents prominent intracerebral veins in various diseases including ischemic stroke, moyamoya disease, cerebral venous thrombosis (CVT) and Sturge-Weber syndrome (SWS). We aimed to 1) learn anatomy of intracerebral veins 2) understand mechanisms of SWI BS in each disease 3) learn clinical significance related to this sign.

#### TABLE OF CONTENTS/OUTLINE

1. What is SWI BS; SWI allows visualization of intracerebral veins (in white matter and occasionally in cortex). BS represents findings of prominent intracerebral veins in some diseases and conditions.
2. Diseases that cause the SWI BS; SWI BS is caused by ischemic stroke, moyamoya disease, CVT, and SWS. It may disappear over time with or without treatments.
3. Mechanisms of brush sign; Increased deoxyhemoglobin in venous blood (BOLD effect) in ischemic stroke and moyamoya disease Congestion, and partially BOLD effect in CVT and SWS.
4. Clinical significance related to SWI BS; indicates severe hemodynamic impairment in ischemic stroke correlates with severity in moyamoya disease and with increased intracranial venous pressure in CVT suggests the diagnosis of cortical vein thrombosis when found in affected cortex may contribute to better clinical outcomes in SWS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-107

### How to Improve in Intraoperative Image Quality in Transcranial MR-guided Focused Ultrasound Surgery

All Day Room: Learning Center

Hiroki Hori, PhD, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The objective of this exhibition is to provide a method for enhancing of intraoperative image quality in transcranial MR-guided focused ultrasound surgery (TcMRgFUS). TcMRgFUS possesses the distinct advantage of allowing expeditious assessment of therapeutic efficacy post each sonication and intraoperative magnetic resonance (MR) imaging for visualization of the lesion. In circumstances which denotes a lack of desired therapeutic effects and the lesion misses the planned target, subsequent ablation targets can be delicately re-aligned based on the intraoperative image. Thus, the acquisition of high-quality intraoperative images, which can accurately confirm the lesion, is imperative. The accuracy of this re-alignment is contingent upon the quality of the intraoperative image. Unfortunately, the current intraoperative image quality obtained from a 3.0T MRI system, is deficient in precisely identifying the lesion. In view of this limitation, we have been developed and substantiated a method for ameliorating the quality of intraoperative images.

#### TABLE OF CONTENTS/OUTLINE

1. TcMRgFUS procedure a. Overview of TcMRgFUS b. Intraoperative T2-weighted image using 3.0T MRI2. Method for improving intraoperative image quality a. Calculating manual transmitter gainb. Acquiring high-quality intraoperative T2-weighted image3. Effectiveness of enhancing intraoperative image quality a. Clinical images resultsb. Contrast between the lesion and thalamus

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-108

### Primary Angiitis of the Central Nervous System (PACNS): Imaging Features and Differential Diagnosis

All Day Room: Learning Center

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-To provide a detailed review of the literature of PACNS.-To review the different imaging features of PANCS.-To know the most frequent mimickers of PACNS.

#### TABLE OF CONTENTS/OUTLINE

PACNS is a rare inflammatory vasculopathy (affecting the medium and small vessels) in brain and spinal cord that is frequently difficult to diagnose. The neurological manifestations vary, but they typically include chronic headache, encephalopathy, focal weakness, or stroke. Brain biopsy is the gold standard and only definitive test for PACNS, but has limited sensitivity, is invasive, and is associated with high rates of morbidity. Lumbar puncture is also performed, but has limited specificity for diagnosis. Catheter angiography is the imaging reference standard and is frequently employed, even though it has limited sensitivity and specificity. Neuroimaging is critical in the diagnosis of PACNS. PACNS may present with diffuse or multi-focal white matter abnormalities, hemorrhagic stroke, single or multi-territorial ischemic infarcts, micro-hemorrhages, and pseudotumoral lesions. Vessel wall MRI increases diagnostic accuracy by showing concentric mural thickening and contrast enhancement in brain arteries affected by vasculitis. Reversible cerebral vasoconstriction syndrome, atherosclerosis, Moyamoya disease, CLIPPERS, primary CNS diffuse lymphoma, and secondary cerebral vasculitis are the most common differential diagnoses. In this review, we will illustrate and describe the radiological appearance and differential diagnosis of primary angiitis of the central nervous system (PACNS), and imaging's role in diagnosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-109

### **The T2-FLAIR Mismatch Sign in Oncologic Neuroradiology: Imaging Criteria, Current Uses, and Histo-Molecular Correlates**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Samir A. Dagher, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Detecting the "classic" T2-FLAIR Mismatch sign (T2FMM) requires a strict application of the T2 and FLAIR criteria in adult patients with suspected CNS gliomas. The "classic" T2FMM exhibits near-perfect specificity yet variably low sensitivity for the diagnosis of astrocytoma, IDH-mutant in adults. 2. A less stringent application of the strict criteria allows for the detection of the "partial" T2FMM. Studies suggest it may reliably exclude the diagnosis of glioblastoma, IDH-wildtype while compromising the near-perfect specificity of the "classic" sign. 3. Differences in MRI acquisition parameters may affect the visibility of the T2FMM. 4. The T2FMM has also been reported in pediatric-type CNS tumors, namely dysembryoplastic neuroepithelial tumors and H3K27-altered diffuse midline gliomas. 5. Although limited data suggests significantly larger intercellular spaces, including microcysts, and upregulation of the mTOR pathway in mismatched compared to non-mismatched tumors, this has not yet translated into prognostic implications. 6. Mismatched tumors have significantly higher apparent diffusion coefficient, and lower relative cerebral blood volume on diffusion- and perfusion-weighted imaging, respectively, compared to non-mismatched tumors.

#### **TABLE OF CONTENTS/OUTLINE**

1. Adult-type diffuse gliomas in the 2021 WHO classification of CNS tumors 2. The "classic" T2FMM: imaging criteria, clinical uses and pitfalls 3. The "partial" T2FMM: imaging criteria and clinical uses 4. The T2FMM in pediatric-type tumors 5. Clinical and histo-molecular correlates 6. Diffusion- and perfusion-weighted imaging correlates

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## Abstract Archives of the RSNA, 2023

NREE-11

### Cerebral Small Vessel Disease: Small Size, Big Problems

All Day Room: Learning Center

Eduardo Freire, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the imaging patterns of cerebral small vessel disease (SVD). Review the classification and subgroups of SVD. Correlate clinical findings and complaints with imaging patterns. Review the subtypes of SVD and their own diagnostic criteria. Review the Boston criteria 2.0 for cerebral amyloid angiopathy (CAA). Review the new markers of Boston criteria 2.0. Discuss the role of the radiologist in the diagnosis of SVD.

#### TABLE OF CONTENTS/OUTLINE

Cerebral Small Vessel Disease (SVD) is a high prevalence disease, and a common cause of stroke and dementia. Although SVD can be asymptomatic at the beginning, some imaging findings may suggest its diagnosis. The study "Standards for Reporting Vascular change on neuroimaging (STRIVE)" shows SVD imaging patterns on brain magnetic resonance (MR) that allows considering it as a differential diagnosis. SVD comprises a group of diseases that affect capillaries, arterioles, small veins and venules, and small perforating arteries. Didactically, we can classify SVD according to its pathological and genetic characteristics into sporadic and hereditary (genetically determined). Sporadic subtypes are the most common and represent the two main etiologies of SVD: hypertensive and related to cerebral amyloid angiopathy. Brain MR imaging findings are usually similar for all etiologies. To assist the radiologist, STRIVE compiled imaging findings that represent SVD's indirect signs.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

NREE-110

### **It's Not All About the Shine: Spotting MS MRI Biomarkers**

All Day Room: Learning Center

Nicole Lambrakos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Briefly describe the multiple sclerosis biomarkers and which techniques have the highest sensitivity and specificity.2. Discuss the importance of spotting imaging multiple sclerosis biomarkers and their pathology correlation.3. Expose the role of MR in identifying the main multiple sclerosis biomarkers.4. Looking for multiple sclerosis biomarkers in doubtful lesions to favor demyelinating etiology.

#### **TABLE OF CONTENTS/OUTLINE**

1. Main multiple sclerosis biomarkers identifiable via MR.2. Pathophysiology: correlation of imaging and pathology of multiple sclerosis biomarkers.3. Differential diagnosis: using MR biomarkes to help favor demyelinating etiology.

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## Abstract Archives of the RSNA, 2023

NREE-111

### Pituitary Insufficiency in Children: Spectrum of MR Imaging Findings

All Day Room: Learning Center

Benjamin Pinsky, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Hypo-functioning pituitary tissue may appear normal on MRI. 2. Congenital anomalies of hypothalamic-pituitary axis (HPA) often present with pituitary insufficiency in children and are frequently associated with additional CNS anomalies. 3. Normally developed but hypo-functioning pituitary tissue may demonstrate subtle imaging abnormalities such as small size or decreased enhancement. 4. Common infiltrative lesions resulting in pituitary insufficiency in children include germ cell tumors and histiocytosis. 5. Pituitary insufficiency can be seen as a long-term side effect of radiation treatment for pediatric posterior fossa tumors.

#### TABLE OF CONTENTS/OUTLINE

1. Background a. Normal embryologic development of the HPA b. Characteristics of normal HPA on MR imaging, including quantitative assessment of pituitary gland enhancement c. Brief clinical overview of hypopituitarism in children 2. Case-based review highlighting the spectrum of abnormalities seen in 85 children with pituitary insufficiency seen at a tertiary care children's hospital over a 5-year period. a. Normal pituitary gland b. Subtle imaging abnormalities in otherwise well-formed HPA c. Congenital abnormalities affecting HPA i. Associated CNS anomalies d. Mass Lesions involving HPA i. Neoplasms ii. Non-neoplastic e. Post-radiation pituitary insufficiency

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## Abstract Archives of the RSNA, 2023

NREE-112

### Highways to the Danger Zone: Craniofacial to Cerebrovascular Anastomoses

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Benjamin Pinsky, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) The etiology of vascular collateralization includes congenital and pathologic connections. 2) Cerebral angiography is the gold standard for identifying extra- to intra-cranial collateralization. 3) Familiarity with the functional vascular territory schema for extra- to intra-cranial collaterals can help dictate appropriate and safe treatment.

#### TABLE OF CONTENTS/OUTLINE

1) Background a) Review of extra- to intra- cranial anastomosis. i) Developed in the setting of large artery occlusion, vascular agenesis, or high flow shunting due to "sump effect". ii) Small non-visualized collaterals can open in response to acutely increased intra-arterial pressure (e.g., embolization, superselective injection). iii) Anastomotic channels often follow cranial nerves. b) Review of normal cerebrovascular anatomy c) Extra- to intra- cranial anastomotic classification scheme i) Orbital ii) Petrocavernous-Clival iii) Cervical iv) Dural-Pial 2) Interactive case-based review of anastomotic channels organized by functional vascular territories a) Non-invasive imaging b) Cerebral angiography c) Interactive 3D-reconstruction 3) Implications for endovascular therapy a) Complications (e.g., stroke, cranial nerve palsy) b) Common angiographic markers to avoid injury (e.g., choroidal blush) c) Methods to avoid non-target embolization (e.g., balloon occlusion) 4) Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-114

### Posterior Cranial Fossa Tumors: Tips and Tricks for Diagnosis

All Day Room: Learning Center

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the anatomy of the posterior cranial fossa (PCF). - Establish a proper differential diagnosis based on patient age and imaging findings. - Highlight the specific radiological features of the most common posterior cranial fossa tumors (PCFT).

#### TABLE OF CONTENTS/OUTLINE

The PCF is the infratentorial compartment of the cranial vault that houses the cerebellum, brainstem and fourth ventricle. Tumors that settle in this location have serious implications not only because of their potential malignancy but also because they can cause brainstem compression, herniation and hydrocephalus, among other complications. Tumor location and patient demographics, as well as imaging findings on CT or MR must be considered in order to establish a proper differential diagnosis. While cerebellar metastases are the most common PCFT in adults, medulloblastoma is the most common in children. Specific radiologic features have been described to differentiate PCFT, allowing the radiologist to make an accurate diagnosis. In addition, neuroimaging is also useful in surgical planning for these tumors. In this work we review the most common PCFT in patients of all ages, through cases studied in our center highlighting the key radiologic findings that enable us to make a correct diagnosis.

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## Abstract Archives of the RSNA, 2023

NREE-115

### **Autoimmune Encephalitis: When Your Immune System Attacks Your Brain and MRI is Your Detective**

All Day Room: Learning Center

#### **Awards**

##### **Magna Cum Laude**

Fernando Diego Choque Chavez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the pathophysiology and classification of autoimmune encephalitis. 2. Describe and illustrate characteristic MRI findings related to autoimmune encephalitis 3. Discuss the role of neuroradiology in the diagnostic work-up.

#### **TABLE OF CONTENTS/OUTLINE**

1. Teaching points 2. Introduction 3. Pathophysiology and classification 4. Clinical presentation and radiological findings 4.1 Autoimmune encephalitis with intracellular antigens (group I) 4.2. Autoimmune encephalitis with cell-surface directed antigens (group II) 5. Differential diagnosis 6. Summary and conclusions 7. Bibliography

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## Abstract Archives of the RSNA, 2023

NREE-116

### Insights into Neural Connections: Neuroimaging and Neuromodulation in Parkinson's Disease and Essential Tremor

All Day Room: Learning Center

Sonoko Oshima, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Knowledge on neural connections in movement disorders is crucial to understand mechanisms of clinical manifestations, diagnose the diseases, and maximize benefits and minimize side effects of therapies. The aim of this presentation is to improve radiologists' role in diagnosing and treating Parkinson's disease (PD) and essential tremor (ET) by 1) overviewing neural connections between cortex and deep gray matter and 2) discussing neuromodulation therapies for movement disorders including deep brain stimulation (DBS) and MR-guided focused ultrasound (MRgFUS) from the perspective of neural connections and neuroimaging.

#### TABLE OF CONTENTS/OUTLINE

1) Neural connections related to Parkinson's disease and essential tremor - Histological findings - Imaging findings 2) Neuromodulation therapies: deep brain stimulation (DBS) and MR-guided focused ultrasound (MRgFUS) - Neurophysiological mechanisms - Treatment targets: subthalamic nucleus (STN), globus pallidus interna (GPi), ventral intermediate nucleus (Vim) of the thalamus - Localization of targets by imaging technique: indirect and direct targeting - Post-operative imaging

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## Abstract Archives of the RSNA, 2023

NREE-117

### Unraveling Dementia Imaging: Challenging Common Misconceptions and Exploring Emerging Conditions

All Day Room: Learning Center

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) Radiologists are generally unfamiliar with clinical and imaging features of common neurodegenerative diseases and wary of suggesting it in their reports. (2) AD, FTLN, PPA and DLB often present with classic, unambiguous appearances on CT, MRI and FDG PET. (3) PCA and CBDS have typical clinical and imaging presentations but are syndromes with multiple potential underlying causes. (4) As the US population ages and lifespans increase, mixed dementia and recently described, more indolent forms of neurodegenerative disease become more prevalent. (5) Newly recognized neurodegenerative diseases (CARTS, LATE and PART) share clinical and imaging features, and may mimic Alzheimer's disease.

#### TABLE OF CONTENTS/OUTLINE

(1) Neurodegenerative disease in everyday radiology (2) Classic clinical, MRI and FDG PET presentations of neurodegenerative diseases: Alzheimer's Disease, Frontotemporal Lobar Degeneration, Primary Progressive Aphasia, Dementia with Lewy Bodies, Vascular cognitive impairment (3) Challenges to neurodegenerative imaging workup: "Normal aging?", Specificity limits of MRI, FDG or Amyloid PET, Mixed dementia is common, Dementia with Lewy bodies (Mimic of both PD and AD, Current imaging limitations, Frequent comorbidity with AD), Confusion in radiology re: clinical-radiology syndromes (Specific diagnosis vs differential for underlying pathology, CBDS [corticobasal degeneration syndrome], PCA [posterior cortical atrophy], PPA [primary progressive aphasia], (4) Newly recognized indolent forms of neurodegeneration: Mimics of AD in patients > 75 years (CARTS, PART, LATE), Are there specific MRI and PET findings?

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## Abstract Archives of the RSNA, 2023

NREE-118

### Quick Diagnosis and Treatment - A Novel AIS Treatment Strategy using Hybrid Emergency Room System

All Day Room: Learning Center

Naoyuki Inagaki, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

•A quick diagnosis is important to determine treatment indications for patients who have AIS. •HERS (Hybrid-Emergency Room System) is an all-in-one concept for an Emergency Room. HERS is useful in critical trauma treatment strategies as computed tomography, interventional radiology and surgery are available in one environment. •It is reported that using HERS for AIS, shortened the time to reperfusion. •With my study, we have setup an AIS protocol that allows a Time Based Strategy and Tissue Based Strategy using HERS.

#### TABLE OF CONTENTS/OUTLINE

•We established an AIS treatment strategy (one stop management) using HERS (Angio-CT suite). •HERS can go from diagnostic imaging to treatment without transferring the patient from department to department. •A one-stop stroke protocol with simultaneous CT perfusion and whole body CTA can determine treatment indications, optimize treatment planning, and ensure safety. •This novel protocol is useful for identifying occluded vessels, assessing brain function, and confirming access routes. • Using our approach, a quick diagnosis and quick treatment were possible in cases of acute aortic dissection, aortic aneurysm rupture, carotid artery stenosis, carotid artery dissection in patients suspected with AIS. •A one-stop stroke protocol using HERS can be confirmed to shorten the door-to-image and treatment time and increase the re-canalization rate.

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## Abstract Archives of the RSNA, 2023

NREE-119

### **Don't Hold Your Breath: Reproducible Hypercapnic Stimuli for Cerebrovascular Reactivity Mapping with RespirAct**

All Day Room: Learning Center

Diana V. Vera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the fundamental physiology of hypercapnia and its association with cerebrovascular reactivity (CVR).2. Explain the mechanisms and advantages of hypercapnic stimuli as generated by the RespirAct instrument as compared to conventional breath-hold techniques for BOLD fMRI-based CVR mapping.3. Showcase representative examples of patients with cerebrovascular disease and CVR maps produced by RespirAct and BOLD fMRI.

#### **TABLE OF CONTENTS/OUTLINE**

I. Hypercapnia and its association with cerebrovascular reactivity (CVR)a. Fundamentals of CVRb. Importance of measuring CVRII. Design of the RespirAct device for the production of controlled hypercapniaa. Current established practiceb. The RespirAct device descriptionIII. Comparison of RespirAct and conventional breath-hold methods of CVR mapping with BOLD fMRIa. A brief review of the origin of the BOLD signalb. RespirAct advantages over conventional breath-hold techniqueIV. Representative examples of CVR measurements with RespirAct in the context of a. Cerebrovascular steno-occlusive diseasesb. Arteriovenous malformationsc. Brain tumorsV. Summary/Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-12

### **Spinal Vascular Malformations: A Systematic Angioarchitecture and Pathophysiology-Based Approach to Classification and Diagnosis**

All Day Room: Learning Center

Charlotte Y. Chung, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Spinal vascular malformation refers to a spectrum of lesions with abnormal connection between (or morphology of) spinal arteries and veins, all of which differ in angioarchitecture, pathophysiology, and clinical sequelae. Advances in angiographic and non-invasive imaging techniques have improved spinal vasculature visualization, enabling identification of distinctive morphologic and hemodynamic features. This exhibit introduces a comprehensive classification system based on these imaging features to aid diagnosis of well recognized as well as rare/recently identified spinal vascular lesions. The educational objectives of this exhibit are:- Review normal spinal vascular anatomy.- Discuss multimodal imaging techniques for evaluating spinal vascular malformations.- Differentiate spinal vascular malformations based on location, angioarchitecture, pathophysiology, and symptomology.- Illustrate radiographic appearance of spinal vascular malformations including arteriovenous fistulas and malformations, and non-shunting lesions such as aneurysms.

#### **TABLE OF CONTENTS/OUTLINE**

I. Annotated diagrams of normal spinal arterial and venous anatomy  
II. Imaging techniques for spinal vascular malformation evaluation  
III. Systematic classification of spinal vascular malformations  
IV. Radiographic features of various spinal vascular malformations  
V. Radiographic mimics

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## Abstract Archives of the RSNA, 2023

NREE-120

### Uncovering the Hidden Dangers: Addressing Diagnostic Errors in Brain Emergency Neuroradiology

All Day Room: Learning Center

Maria Lucia Brun, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To explain the importance of accurate and timely diagnosis in brain emergency neuroradiology. - To describe the different types of diagnostic errors in brain emergency neuroradiology. - To identify the potential causes of diagnostic errors and to develop effective strategies for error prevention and mitigation in emergency neuroradiology. - Case-based series examples to highlight different error types and the factors that led to the errors.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Background  
3. Types of errors:- Cognitive errors: biases or heuristics that influence the radiologist's thinking or decision-making (Framing, Anchoring, Alliterative, Satisfaction of search, Availability, Attribution).- Communication errors: Breakdown in communication.- Perception/perceptual errors: Misinterpretation or misperception.- Technical errors: Limitations in the imaging equipment or technique used. - Organizational errors: Factors outside of the radiologist's control (workload, staffing issues, etc)  
4. Consequences of errors- Delayed/missed diagnoses- Incorrect/unnecessary treatments - Patient harm- Legal and financial consequences  
5. Strategies for error prevention and mitigation in emergency neuroradiology- Valuable tools to reduce errors in the imaging evaluation of brain emergencies- Showcase the particular strategies used at our departments.  
6. Case series examples- Provide case examples to further illustrate and explain the statements mentioned above.- Highlight the factors that led to the errors and how they could have been prevented or mitigated in that particular case.  
7. Conclusion

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## Abstract Archives of the RSNA, 2023

NREE-121

### **A Game-Changing Approach to Non-Invasive Vascular Imaging: Ultra High-Resolution CT with Novel Deep Learning Reconstruction**

All Day Room: Learning Center

Yuta Shimizu (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To learn the basic principles of ultra high-resolution CT (UHRCT).2. To learn the basic principles of the novel reconstruction technology "deep learning reconstruction (DLR)".3. To know the differences in image quality between DLR and conventional reconstruction methods on brain CTA using UHRCT.4. Clinical applications of brain CTA with DLR using UHRCT and comparison with digital subtraction angiography (DSA).5. To know the pitfalls of CTA with DLR and DSA on cerebral diseases.6. To present the outlook of brain CTA with DLR using UHRCT in the near future.

#### **TABLE OF CONTENTS/OUTLINE**

1. Basic principles of UHRCT2. Basic principles of the novel imaging reconstruction method "DLR"3. The image quality of DLR and conventional reconstruction methods on brain CTA using UHRCT4. Clinical applications of brain CTA with DLR using UHRCT and DSA to evaluate the following diseasesintracranial aneurysmsmoyamoya diseasearteriovenous malformations (AVMs)dural arteriovenous fistulas (dAVFs)giant cell arteritistumors (skull tumor, meningioma, schwannoma, glioma, and so on)5. Pitfalls of CTA and DSA6. The future outlook of brain CTA with DLR using UHRCT

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## Abstract Archives of the RSNA, 2023

NREE-122

### **Erdheim-Chester Disease Beyond MSK: Do You Know What to Look for in Brain MRI?**

All Day Room: Learning Center

Marta Barrios Lopez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To explain and illustrate the main neuroradiological findings in Erdheim-Chester Disease (ECD), an uncommon type of systemic histiocytosis with almost constant bone involvement. 2. To learn the prognostic implications of certain neuroradiological findings. 3. Much of the literature on this subject focuses on its musculoskeletal findings. However, neuroradiological manifestations are an important source of morbidity and mortality in these patients.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: 1.1. Main systemic manifestations of ECD: establishing a context. 1.2. The BRAF mutation and its (neuro)imaging implications. 2. Neuroradiological findings: 2.1. Introduction: Classification and frequency of neurological manifestations. MRI protocol. 2.2. Intra-axial involvement. Typically infratentorial. 2.3. Hypothalamic-pituitary manifestations. Several patterns. 2.4. Meningeal involvement: Different patterns. Masses often present a diagnostic challenge. 2.5. Orbital involvement. Do not forget the orbits in your systematic search. 3. Conclusions 4. References

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## Abstract Archives of the RSNA, 2023

NREE-123

### **Neurocysticercosis: Findings from a Challenge Disease in the Third World**

All Day Room: Learning Center

Lua P. Carvalho, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: review and illustrate the imaging findings of neurocysticercosis, the differential diagnoses, and their correlation with pathological images. Describe through illustrative presentations the benefits of the multimodality imaging approach to the diagnosis of neurocysticercosis. Present challenging cases, such as pseudotumoral lesions. Establish the imaging red flags and how they can help the radiologist reach the correct diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

Neurocysticercosis stages and parasite life cycle. Imaging patterns on MR and CT. Susceptibility weighted imaging (SWI) role on calcified lesions. Diffusion-weighted imaging (DWI) showing the scolex. Spectroscopy as a valuable tool for differential diagnosis. 3D CISS sequence applicability for subarachnoid lesions. Vessel wall imaging sequence showing vasculitis with or without infarction. Pseudotumoral lesions. Differential diagnoses based on a pictorial review using representative cases from a Tertiary University Hospital database. A practical approach for better diagnostic accuracy and avoiding pitfalls. Final remarks.

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## Abstract Archives of the RSNA, 2023

NREE-124

### Evaluation of Head and Spinal CT Angiography with Photon-counting Detector CT: How Close to the Angiographic and Operative Findings

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Fumiyo Higaki (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is: 1) To review imaging of head and spinal CT angiography with photon-counting detector CT 2) To correlate with angiography and intraoperative findings.

#### TABLE OF CONTENTS/OUTLINE

Recently, Photon-counting detector (PCD-CT) has been developed and enabling high-resolution imaging at a lower radiation dose. PCD-CT employs a photon-counting detector that can measure the number of incident X-ray photons and their energy. The newly released PCD-CT (NAEOTOM Alpha, Siemens Healthineers, Forchheim, Germany) has been in clinical use at our institution since December 2022. The PCD-CT offers several advantages over current state-of-the-art energy-integrating detector CT (EID-CT). The PCD-CT does not require septa to create a detector channel but does EID-CT. Therefore, it can be seen that downsizing the anode to achieve higher resolution does not affect the dose efficiency of the PCD-CT. The purpose of our exhibit is to present head and spinal cord CT angiographic images acquired with PCD-CT and corresponding images acquired angiographically and intraoperatively to clarify the delineation potential of PCD-CT. In spinal arterio-venous fistula (AVF), feeder, shunted pouch, and drainer are depicted in CTA. In spinal tumor of hemangioblastoma, tumor drainer is recognized in CTA. We would like to provide insight into how close the PCD-CTA findings are to the angiographic and intraoperative findings.

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## Abstract Archives of the RSNA, 2023

NREE-125

### **MRI Analysis of Causes and Consequences of Acute Epileptic Seizures from Temporal Lobe Origin**

All Day Room: Learning Center

Silvana I. Sarria Estrada I, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

MRI is useful to diagnose the cause and functional changes associated with acute seizures or status epilepticus (SE) from temporal lobe origin. Several MRI abnormalities on diffusion/perfusion-weighted, T2-weighted and contrast-enhanced T1-weighted sequences, observed after acute seizures in chronic conditions, even distant from the temporal lobe, are relevant to detect changes in the evolution. The identification of inflammatory component on MRI after a new onset temporal lobe seizure impacts the prognosis of infectious or autoimmune encephalitis, stroke or malignant tumours. Acute MRI findings in new onset seizures or SE are often subtle or unspecific. Timing of serial follow-up MRIs must be protocolized. Increase of amygdalar enlargements, hippocampal atrophy or autoimmune epilepsies can be detected using time defined follow-up MRI studies. In conclusion, a standardized MRI protocol for acute seizures and SE that analyses structure and function of the temporal lobe can lead to an early diagnosis of severe and chronic disorders. The time intervals between serial follow-up MRIs are relevant to avoid further consequences.

#### **TABLE OF CONTENTS/OUTLINE**

1 Temporal lobe seizures are often associate with ictal MRI abnormalities. 2 Acute MRI can diagnose acute seizures or status epilepticus. 3 Some MRI features, even distant from chronic lesions, may suggest change in evolution. 4 Early MRI features in new onset seizures can lead to the diagnostic of chronic conditions. 5 Time-defined serial MR scans are needed in cases of subtle or unspecific MRI features.

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## Abstract Archives of the RSNA, 2023

NREE-126

### The Haunted Core in Acute Ischemic Stroke

All Day Room: Learning Center

Liv Jorunn Hollesli, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Perfusion-based imaging used in the evaluation of tissue viability is crucial in the management of patients with acute ischemic stroke (AIS), especially in extended time windows. Currently used imaging techniques in AIS cannot accurately differentiate between salvageable and non-salvageable tissue. There is no widespread gold standard definition of ischemic core. Different findings highlighting current challenges and solutions in AIS imaging will be presented through clinical cases.

#### TABLE OF CONTENTS/OUTLINE

Perfusion-based CT and MR imaging techniques are used for detection of AIS and evaluation of tissue viability. At present, common available imaging techniques fail to accurately differentiate between salvageable and non-salvageable ischemic tissue. Additionally, a widespread gold standard definition of the ischemic core is lacking. Through clinical cases, image findings highlighting challenges and solutions in the evaluation of tissue viability will be discussed, like limited sensitivity to detect early ischemic changes on non-contrast enhanced CT (NCCT), variation in outcome after successful recanalization, potential reversibility of DWI-lesions, false negative initial DWI, overestimation of ischemic core on perfusion computed tomography and variation in penumbra and core volume calculations. Considering the important role of imaging in the management of patients with AIS, it is crucial with profound knowledge about advantages and limitations of penumbra and core evaluation. The teaching points will be extensively illustrated through clinical imaging examples.

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## Abstract Archives of the RSNA, 2023

NREE-128

### Understanding Perisylvian Cortical Anatomy: Tips and Tricks

All Day Room: Learning Center

Sally J. Choi, MD, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Perisylvian area serves as a crossroad for important cortical structures with principal functions for example Broca's area is located along the anterior and ascending rami of the Sylvian fissure (M sign) o Wernicke area is classically located along the inferior aspect of the posterior ramus of the Sylvian fissure
- Important structures form this area areo Frontal operculum o Parietal operculum o Temporal operculum o Insula
- Knowing these structures is beneficial for a radiologist in describing the anatomical component of a lesion to better understand the physiologic symptoms corresponding to the lesion location with surgical and prognostic importance.

#### TABLE OF CONTENTS/OUTLINE

- Briefly discuss the Sylvian fissure anatomy
- Discuss the different cortical structures form the perisylvian area such as frontal, parietal and temporal operculum and insula.
- Discuss the MRI anatomy of these structures utilizing some tips and tricks to understand the anatomy such as- M shaped appearance of the inferior frontal gyrus along the anterior and ascending rami of the Sylvian fissure
- Discuss the role of these cortical structures in the principal functions of the body.
- Discuss the role of relevance of Functional MRI in these areas

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-129

### **The Cortico-Limbo-Thalamo-Cortical Circuits: An Update to the Papez Circuit of the Limbic System**

All Day Room: Learning Center

Parnian Shobeiri, MD, MPH (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

? The Papez circuit is a circuit believed to control memory and emotion, composed of the cingulate cortex, entorhinal cortex, parahippocampal gyrus, hippocampus, hypothalamus, and thalamus. ? In recent years, multiple additional limbic fiber connectivity has been revealed using diffusion-weighted imaging (DWI) techniques. Some of these fiber tracts include the amygdalofugal tract (AFT), amygdalothalamic tract (ATT), stria terminalis (ST), dorsal thalamo-hypothalamic tract (DTH), cerebello-hypothalamic tracts, and the parieto-occipito-hypothalamic tract (POHT) ? This presentation aims to summarize the anatomy of the limbic system, outline previous updates to the circuit, and elaborate on the anatomical connectivity of the limbic circuits based on recent DWI as an update to the original Papez circuit.

#### **TABLE OF CONTENTS/OUTLINE**

? The original Papez circuit and updates over time ? The Yakovlev model/circuit ? The MacLean's model ? Overview of high spatial resolution diffusion weighted imaging ? Review of previously established Papez circuit (See Figures 1 5 for specific tracts) ? Detailed fiber tract anatomy ? Updates to previously known limbic circuits: the role of additional fibers in creating multiple neuronal loops and circuits

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## Abstract Archives of the RSNA, 2023

NREE-13

### Mapping the Way: A Road Map for Diagnosing, Treatment and Follow Up of Brain Metastases

All Day Room: Learning Center

Julia M. Brunelli, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibition aims to provide a comprehensive overview of the imaging evaluation of patients with suspected brain metastases, emphasizing the prevalence and potential diagnostic challenges associated with these neoplasms. It will highlight specific imaging patterns, differential diagnoses, and potential pitfalls in imaging interpretation. The exhibition will also discuss the clinical and imaging features that suggest the etiology of primary tumors, including a pictorial essay of specific patterns. Additionally, it will review radiological criteria for diagnosing radionecrosis, pseudoprogression, and disease progression in brain metastases patients and emphasize the importance of advanced imaging techniques. Case studies will be used to illustrate radiological challenges and diagnostic considerations in the treatment and follow-up of these patients.

#### TABLE OF CONTENTS/OUTLINE

1. Imaging Evaluation of Patients with Suspected Brain Metastases • Overview of intracranial metastases as the most common adult intracranial neoplasms and their imaging evaluation • Imaging patterns and differential diagnoses • Mimickers and pitfalls in imaging interpretation  
2. Etiology of the Primary Tumor • Clinical and imaging features suggestive of the primary tumor • Pictorial essay of brain metastases with specific patterns  
3. Treatment and Follow-up • Radiological criteria for diagnosing radionecrosis, pseudoprogression, and disease progression • Case studies illustrating radiological challenges in distinguishing these conditions

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## Abstract Archives of the RSNA, 2023

NREE-130

### **CNS Imaging of the Immunocompromised - An Opportunistic Review for the Radiologist**

All Day Room: Learning Center

Luis G. Colon Flores, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Review the main imaging findings of the different opportunistic infections. 2) Review and recognize the different HIV/AIDS associated CNS conditions. 3) Discuss the imaging findings of immunodeficiency-associated primary CNS lymphomas.

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction 2) Opportunistic infections (Bacterial, viral, fungal and parasitic) 3) HIVS/AIDS CNS associated conditions 4) Immunodeficiency-associated primary CNS lymphoma 5) Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-131

### The Ultimate Imaging Companion to Vascular Complications in Cancer Patients: A Comprehensive Review for Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jessica T. De Oliveira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Vascular complications are a significant cause of morbidity and mortality in cancer patients, with increasing incidence due to improved survival and evolving treatments. Oncologic patients are more prone to vascular complication such as hypercoagulability state, reduction in mobility and aggressive treatments as brain radiation. These complications may occur at disease presentation or be secondary to treatment. Our aim is to review the main imaging findings of vascular complications in a didactic way. We believe this approach may facilitate diagnostic suspicion.

#### TABLE OF CONTENTS/OUTLINE

Introduction: Review main intracranial vascular complications in oncology patients, with an emphasis on the pathophysiological mechanisms involved. To display a flowchart dividing these complications according to treatment status and treatments applied. To discuss for each vascular complication the risk factors, clinical presentation, main imaging findings and relevant treatments. The discussion will be enriched with illustrative cases, including: Complications before treatment: Hypercoagulability (Trousseau syndrome, cerebral venous thrombosis). Vascular compression/ obstruction by the tumor or Vascular compression/ obstruction due to brain herniation. Intravascular tumor dissemination (oncotic aneurysm and intravascular lymphoma). Complications during treatment: Post-operative ischemia Late complications after treatment: Aneurysm after radiotherapy, SMART, Radiation induced cavernous malformations. To highlight the most relevant clinical and imaging aspects of these vascular complications, essential for prompt diagnosis and treatment.

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## Abstract Archives of the RSNA, 2023

NREE-132

### **Skull Drip: Algorithmic Multimodality Imaging Approach**

All Day Room: Learning Center

Pokhraj P. Suthar, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Briefly discuss various causes and sites of skull base CSF leak. To learn the diagnostic imaging findings of various modalities including high resolution NECT, CT cisternogram, MRI and radiotracer studies, in identifying the cause and localizing the exact site of skull base CSF leaks. To learn the algorithmic imaging approach and how it is helpful for surgical planning in cases of skull base CSF leak. To diagnose recurrent leaks in post-surgical repair of primary CSF leak

#### **TABLE OF CONTENTS/OUTLINE**

Cerebrospinal fluid (CSF) leaks are extracranial leaks of CSF via an osteodural defect in the skull base into the tympanomastoid cavity, paranasal sinus, or rarely in the skull base neck space. There are various etiologies for the same, including accidental trauma, congenital malformation, spontaneous leaks in idiopathic intracranial hypertension and iatrogenic. Accurate localization of the site of the leak and identification of the underlying cause is necessary for surgical planning to avoid associated complications and prevent recurrence. In this educational exhibit, we outline the various interesting cases of skull base defects, their multimodality algorithmic imaging diagnosis approach (CT, MRI, CT/MR/Nuclear medicine radionuclide cisternography), correlation of imaging diagnosed skull base defect with surgical outcome, and imaging diagnosis of recurrent CSF leaks.

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## Abstract Archives of the RSNA, 2023

NREE-133

### The Ternary Plot Analysis of Time-sensitive Diffusion Imaging in CNS Pathologies

All Day Room: Learning Center

Toshiaki Taoka, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### TEACHING POINTS

Time-sensitive diffusion imaging provides potentially valuable information on tissue characteristics, with the oscillating gradient spin-echo (OGSE) method enabling short diffusion times compared to the conventional pulsed-field gradient spin-echo (PGSE) method. Comparing the signal on OGSE and PGSE can provide information on tissue compartmentalization. However, comparing different images can make interpretation challenging, and organizing pixel information is necessary. The ternary plot method presents the relationship between diffusivity, compartmentalization, and water content for a single pixel, simplifying the presentation of tissue characteristics obtained from OGSE, PGSE, and  $b=0$  images. This educational exhibit demonstrates the tissue characteristics of various central nervous system pathologies provided by time-sensitive diffusion imaging using the triangulation method of the ternary plot. The ternary plot method has further applications, including the color coding of the pixels according to the tissue characteristics.

#### TABLE OF CONTENTS/OUTLINE

1. Overview of time dependence of diffusion MRI2. Methods for displaying time-dependent diffusion-related coefficients.3. Distribution of the time-dependent diffusion-related coefficients on ternary plot4. Further application of ternary plot method

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## Abstract Archives of the RSNA, 2023

NREE-134

### A Review of Imaging Findings in Neurogenic Ptosis

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Yiseul Son, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To understand the anatomy of the neural pathways that innervate the upper eyelid retractor muscles (e.g. oculosympathetic pathway and oculomotor nerve pathway). To describe the normal cross-sectional anatomy of the neural pathways causing neurogenic ptosis. To illustrate the imaging findings of various lesions causing neurogenic ptosis according to a course-based approach.

#### TABLE OF CONTENTS/OUTLINE

Introduction and general overview of ptosis / Anatomic review and imaging-based normal cross-sectional anatomy of the neural pathways innervating the upper eyelid retractor muscles (oculosympathetic and oculomotor pathway) / A variety of pathologic conditions causing neurogenic ptosis according to a course-based approach 1. Oculomotor nerve palsy (oculomotor nerve pathway) - Intra-axial segment - Cisternal segment - Cavernous segment - Orbital segment 2. Horner's syndrome (oculosympathetic pathway) - Central neuron - Preganglionic neuron - Postganglionic neuron 3. Neuromuscular junction disorders / Summary and conclusion

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## Abstract Archives of the RSNA, 2023

NREE-135

### Epilepsy Surgery: Nuts and Bolts for Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jack Yang (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

A broad range of surgical procedures are available for medically refractory epilepsy from open parenchymal resections to more recent minimally-invasive ablative therapies. In this exhibit, we outline the scope and techniques of these surgical procedures, role of neuroimaging, expected post surgical imaging findings and associated complications. We describe neuroimaging role in subdural or depth electrode placement, an invasive diagnostic surgical procedure for more precise localization of epileptogenic focus. We briefly outline the MRI safety issues in imaging patients with neuromodulation devices.

#### TABLE OF CONTENTS/OUTLINE

Table of Contents: I. Epilepsy surgery: Evolution II. Types of surgical procedures: Scope and Techniques A. Surgery for localization of epileptogenic focus: a. Invasive procedure - Subdural grid and strip placement. b. Minimally-invasive procedure - Stereo-EEG B. Surgery for refractory epilepsy a. Invasive procedures: Resection - 1. Hemispherectomy 2. Lobar resection 3. Lesionectomy. Disconnection - 1. Conventional corpus callosotomy 2. Multiple subpial resections. b. Minimally- or less-invasive procedures: Ablative therapies - 1. Laser Interstitial thermal therapy (LITT) 2. MR guided focused US 3. Gamma knife. Neuromodulation procedures - 1. Vagal nerve stimulation (VNS) 2. Deep brain stimulation (DBS) 3. Responsive neurostimulation (RNS) III. MRI safety issues in imaging epilepsy patients with implants and electrodes

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## Abstract Archives of the RSNA, 2023

NREE-136

### Exploring the FDA Pharmacovigilance Database to Assess the Importance of Symptoms Associated with Gadolinium Exposure (SAGE)

All Day Room: Learning Center

Eric Lancelot, PharmD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Analysis of FDA pharmacovigilance database to determine safety of gadolinium based contrast media.

#### TABLE OF CONTENTS/OUTLINE

**Objective** The aim of this study was to assess the tendency of adverse events representing “symptoms associated with gadolinium exposure” (SAGE) among the bulk of safety experiences reported to health authorities. **Materials and Methods** SAGE symptoms were searched by preferred terms (PTs) in different system organ class (SOC) categories in the FDA Adverse Event Reporting System (FAERS) database over a 5-year period ranging from 2014 to 2019. The numbers of SAGE symptoms per PT, and cumulatively per SOC, were recorded and their weights in the overall spectrum of AEs were determined for 3 linear and 3 macrocyclic GBCAs. **Results:** The analysis of FAERS data revealed a significantly higher SAGE weight for linear GBCAs, namely gadodiamide (23.27%), gadopentetate dimeglumine (22.12%) and gadobenate dimeglumine (19.27%), than for the macrocyclic GBCAs, namely gadoteridol (8.45%), gadobutrol (4.53%) and gadoterate meglumine (3.82%). The SOCs “musculoskeletal and connective tissue disorders”, “nervous system disorders”, “general disorders and administration site conditions” and “psychiatric disorders” were consistent with this ranking. Moreover, SAGE weights displayed a steady growth of about 5% per year for the linear GBCAs and 1% per year for the macrocyclic agents. **Conclusion** This study showed that SAGE symptoms may be more prevalent with linear than macrocyclic GBCAs, and that SAGE reporting tends to rise significantly more in patients exposed to linear agents. These differences might be explained by the differences in kinetic stability between the GBCAs.

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## Abstract Archives of the RSNA, 2023

NREE-138

### **The Radiologist's Guide to Lumbar Spine Pain Procedures: Indications, Techniques and Complications**

All Day Room: Learning Center

Rajul Gupta, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Less than 3 percent of the 4 million annual pain procedures are performed by radiologists, despite having the unique ability to correlate imaging findings with clinical features for targeted pain interventions. This exhibit is aimed at educating the radiologists regarding indications, planning, techniques and challenges of common lumbar pain procedures, with emphasis on 'how to' perform transforaminal and interlaminar epidural spinal injections (ESI). Other technically demanding pain procedures including dorsal transforaminal S1 ESI, synovial cyst rupture and blood patches will be discussed, along with tips and tricks for performing challenging interventions in postoperative, scoliotic and degenerative spine.

#### **TABLE OF CONTENTS/OUTLINE**

1. Relevant Lumbar Spine anatomy and fluoroscopic positioning 2. Clinico-radiologic correlation- Clinical examination, patient counselling, selecting the right procedure. 3. Procedure and tray setup 4. Transforaminal ESI- 'how to' approach the target, pre and post contrast injection views. • Supra-neural TFESI • Infra-neural TFESI 5. Interlaminar ESI- • Optimal needle positioning in multiplanar imaging • Recognizing suboptimal needle location 6. Dorsal S1 ESI- recognizing landmarks and optimal views for needle positioning. 7. Other pain relief procedures • Synovial cyst rupture- Direct (IL/TF) and Indirect Techniques • Epidural blood patch 8. Challenging cases and difficult myelograms • Scoliotic and degenerative spine • Postoperative spine 9. Pearls and pitfalls- complications and how to prevent them.

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## Abstract Archives of the RSNA, 2023

NREE-139

### **From Genes to Emergencies: An Innovative Approach to Imaging Assessment, Genetic Aspects, and Emergency Room Evaluation in CADASIL**

All Day Room: Learning Center

Ana Luiza Basilio Franca (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This educational exhibit aims to provide a comprehensive understanding of cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) disease, including: To illustrate the imaging highlights of the cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL). To exhibit the genetic cascade involved in the disease. To explain the imaging approach to the disease within the context of acute stroke in the emergency. To illustrate the differential diagnosis, including cerebral autosomal recessive arteriopathy with subcortical infarcts and leukoencephalopathy (CARASIL) and white matter diseases.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction and revision of CADASIL's epidemiology, clinical presentation, and etiology. 2. MRI highlights in CADASIL. 3. Genetic considerations associated with CADASIL. 4. Differential diagnosis, including CARASIL and other white matter diseases. 5. Imaging assessment in the emergency room. 6. Take-home messages.

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## Abstract Archives of the RSNA, 2023

NREE-14

### An Imaging Review of Autoimmune Encephalitis: An Often-Overlooked Diagnosis

All Day Room: Learning Center

Miriam Fernandez-Gomez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To understand the many signs, symptoms, and types of autoimmune encephalitis. - To Review the main antibodies that have been identified, their patterns of CNS involvement, and their typical anatomical distributions due to the relative concentration of target proteins. - To Highlight the characteristic MRI findings associated with autoimmune encephalitis, with specific emphasis on the role of neuroimaging in the diagnostic work-up. - Finally, to describe a case report of anti-LGI1 autoimmune encephalitis associated with SARS-CoV-2 (COVID-19).

#### TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS  
I. Introduction  
Introduce the topic of autoimmune encephalitis  
II. Understanding Autoimmune Encephalitis  
Define autoimmune encephalitis  
Discuss the symptoms of autoimmune encephalitis  
Explain the pathophysiology of autoimmune encephalitis  
Describe the different types of autoimmune encephalitis  
III. MR Imaging Findings Associated with Autoimmune Encephalitis  
Discuss the characteristic MRI findings associated with autoimmune encephalitis  
Emphasize the role of neuroimaging in the diagnostic work-up  
IV. Autoimmune Encephalitis in SARS-CoV-2 Infection (COVID-19): Illustrative Case  
Describe a case report of anti-LGI1 autoimmune encephalitis associated with SARS-CoV-2 (COVID-19)  
V. Conclusion  
Summarize the key points of the paper  
Discuss the importance of recognizing and diagnosing autoimmune encephalitis

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## Abstract Archives of the RSNA, 2023

NREE-140

### Predictors of Intracerebral Hemorrhage Expansion on CT

All Day Room: Learning Center

Rayan Ahmed (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review classification of intracranial hemorrhages and define hemorrhage expansion  
2. Importance of identifying intracranial hemorrhage expansion  
3. Describe findings on imaging that can predict hemorrhage expansion  
Intracerebral hemorrhage (ICH) results in 10-20% of all strokes and leaves 60-80% of survivors functionally dependent. Identifying early hematoma expansion (HE), defined as growth >12.5 mL or volume >33%, is crucial for modifying its potential impact. Three accepted HE indicators in non-contrast computed tomography include baseline hematoma volume as measured by the ABC/2 method. Secondly, irregularly hemorrhage shape indicating multiple leaking blood vessels. Radiologically, the satellite sign and island sign are imaging correlates that indicate irregular hemorrhage shape. Lastly, the imaging density heterogeneity of the hematoma can represent active bleeding. Three signs that represent heterogeneity of the hematoma include the swirl, black hole, and blend sign.

#### TABLE OF CONTENTS/OUTLINE

1. Classification of intracranial hemorrhagea. Intra-axial hemorrhageb. Extra-axial hemorrhage  
2. Defining hematoma expansion (HE)  
3. Importance of identifying intracerebral hemorrhage expansion.a. Relative incidenceb. Prognostic indicator  
4. Clinical aspects that increase risk of hematoma expansiona. Systolic BP and onset to CT timeb. Prior anticoagulant therapyc. hyperglycemia  
5. Radiological signs of hemorrhage expansiona. Hematoma shape/volume/locationb. Perihematomal edemac. Hematocrit levelsd. Spot signe. Satellite sign, Island sign, Swirl sign, Blend sign and Black hole sign

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## Abstract Archives of the RSNA, 2023

NREE-141

### **Beyond the Blind Spots: A Comprehensive Approach to Reducing Diagnostic Errors in Neuroradiology in the Emergency Room for Enhanced Patient Safety**

All Day Room: Learning Center

Heber Colares Costa, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To exhibit a timely and accurate diagnosis of neurological conditions like stroke, brain tumors, and traumatic brain injury, providing effective treatment. To show misdiagnosis or diagnosis delays due to errors in imaging evaluation that can seriously harm the patient, including permanent neurological deficits or death. To prevent unnecessary interventions or treatments, inhibiting inaccurate interpretation of imaging studies and unnecessary surgeries, medications, or other medicines that can harm the patient physically and financially. To avoid significant medicolegal consequences.

#### **TABLE OF CONTENTS/OUTLINE**

1. Revision of epidemiology, pathology, and demographics of neuroradiologic emergencies. 2. Imaging evaluation of the emergency room's crucial and prevalent neuroradiologic diseases. 3. Potential imaging pitfalls in neuroradiologic emergencies and how to avoid them. 4. Potential causes of imaging medical errors, including night periods, fatigue and exhaustion of radiologists, a large volume of examinations, and short evaluation times. 5. The consequences of errors in neuroradiological imaging evaluation in the emergency room, including delays in stroke recanalization therapy, misdiagnoses of intracranial hemorrhages, dural venous sinus thrombosis, and inadequate treatment for these conditions. 6. Highlights on medicolegal issues and reputational damage for healthcare providers and hospitals. 7. How to ensure that hospitals and healthcare providers can reduce the risk of misdiagnosis, unnecessary interventions, and legal consequences, ultimately leading to better patient outcomes. 8. Take-home messages.

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## Abstract Archives of the RSNA, 2023

NREE-142

### **The Uncharted Territory of Neurodegeneration: Keeping Pace with the Latest Advances in Imaging Diagnosis and Novel Therapies for Degenerative Diseases**

All Day Room: Learning Center

Ana Luiza Basilio Franca (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Brain neurodegenerative diseases are a group of disorders characterized by progressive damage and loss of neurons in the brain. These diseases include Alzheimer's disease, Parkinson's disease, Huntington's disease, and amyotrophic lateral sclerosis (ALS), among others. Recent advances in imaging diagnosis and novel therapies have shown promising results in improving the diagnosis and treatment of these conditions. The study aims to: To explain the imaging features, genetic cascade, and physiopathology involved in neurodegenerative diseases. To exhibit that advanced imaging techniques have significantly improved the diagnosis of brain neurodegenerative diseases. To explain the imaging approach to the diseases, differential diagnosis, and current therapeutics.

#### **TABLE OF CONTENTS/OUTLINE**

1. Revision of epidemiology, clinical presentation, and etiology of neurodegenerative diseases. 2. Genetical considerations. 3. The role of magnetic resonance imaging (MRI) and functional MRI (fMRI) in identifying structural changes in the brain associated with neurodegeneration. 4. Positron emission tomography (PET) in assessing amyloid plaques and tau protein in the brain, characteristic features of Alzheimer's disease. 5. Novel therapies for neurodegenerative brain diseases, including immunotherapy, gene therapy, stem cell therapy, neuroprotection with drugs, and deep brain stimulation. 6. Differential diagnosis. 7. Take-home messages.

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## Abstract Archives of the RSNA, 2023

NREE-143

### Exploring the Depths of Pediatric Posterior Fossa Tumors: Integrating Molecular Analysis and Magnetic Resonance Imaging for Unprecedented Diagnosis and Prognosis

All Day Room: Learning Center

Laura C. Magalhaes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To illustrate the imaging diversity of these tumors, including a range of histological subtypes, including medulloblastoma, ependymoma, and pilocytic astrocytoma, among others. To demonstrate the importance of pediatric posterior fossa CNS tumors molecular analysis, providing an accurate diagnosis, risk stratification, and personalized treatment. To identify the specific genetic alterations and biomarkers for managing these tumors.

#### TABLE OF CONTENTS/OUTLINE

1. Revision of epidemiology, pathology, and pediatric posterior fossa CNS tumor demographics. 2. Imaging features in pediatric posterior fossa CNS tumors, including pilocytic astrocytoma, ependymoma, medulloblastoma, other embryonal tumors, Rosette-forming glioneuronal tumor, diffuse midline gliomas, tectal gliomas including diffuse low-grade MAPK pathway-altered. 3. Most recent updates on pediatric posterior fossa CNS tumors molecular alterations, including WNT, SHH, and non-WNT/non-SHH medulloblastomas, BRAF mutations in pilocytic astrocytoma, EZHIP in group A ependymomas, MAPK pathway-altered in diffuse low-grade tectal gliomas. 4. Imaging strategies to depict the correct diagnosis based on the genetic profile. 5. Flowchart of the changes and last updates based on the neoplastic molecular profile. 6. Take-home messages.

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## Abstract Archives of the RSNA, 2023

NREE-144

### From Conception to Cancer: Exploring the Molecular Signatures of Embryonal Tumors for Precision Medicine

All Day Room: Learning Center

Laura C. Magalhaes, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Recent advances in molecular biology have led to a better understanding of the types and subtypes of these tumors based on the 2021 World Health Organization of central nervous system tumors. The study aims to: To illustrate that the molecular analysis of Central Nervous System (CNS) embryonal tumors is critical for accurate diagnosis, risk stratification, and targeted therapy. To show that molecular analysis can help identify specific genetic alterations and biomarkers that can provide valuable information for managing these tumors.

#### TABLE OF CONTENTS/OUTLINE

1. Revision of epidemiology, pathology, and demographics of CNS embryonal tumors. 2. Imaging features in CNS embryonal tumors. 3. Most recent updates on CNS embryonal tumors molecular alterations, including WNT-activated medulloblastoma, sonic hedgehog (SHH) activated, and non-WNT/non-SHH medulloblastomas. 4. Recent advances in molecular biology have led to identifying specific genetic alterations and biomarkers in non-medulloblastoma embryonal tumors, including teratoid/rhabdoid tumors (AT/RTs), embryonal tumors with multilayered rosettes (ETMRs), CNS Neuroblastoma, FOXR2-Activated, CNS Tumor with BCOR Internal Tandem Duplication, Cribriform Neuroepithelial Tumor. 5. Specific genetic mutations, amplifications, or deletions associated with tumor progression, recurrence, and response to therapy, including C19MC, DCER 1, FOXR2, BCOR-ITD, SMARCB1, SMARCB4, AT/RT (TYR), AT/RT (SHH), AT/RT (MYC). 6. Imaging strategies to depict the correct diagnosis based on the genetic profile. 7. Flowchart of the changes and last updates based on the neoplastic molecular profile. 8. Take-home messages.

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## Abstract Archives of the RSNA, 2023

NREE-145

### Neurogenetics and Imaging of Motor Neuron Disease

All Day Room: Learning Center

Maxwell Wright, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To discuss the classification and pathogenesis of motor neuron disease (MND). 2. To highlight the neurogenetics, imaging findings, and diagnostic pearls for the specific diagnosis of various upper and lower MNDs.

#### TABLE OF CONTENTS/OUTLINE

We retrospectively reviewed 113 patients from our PACS system with clinical and Imaging findings correlating with motor neuron disease (MND). All the patients underwent routine MRIs of the brain and spine. Almost 100% of these patients had CSF examinations, while genetic studies were available in 49% of the patients. All studies were read by two neuroradiologists. Imaging findings were correlated with the clinical examination, CSF, and biochemical results, which were further correlated with the genetic studies when available. For easy understanding, this exhibit is classified under the following categories: 1. Upper MND: Primary lateral sclerosis (PLS), Hereditary Spastic Paraparesis (HSP), Pseudobulbar Palsy 2. Lower MND: a) Chronic onset: Inherited- Spinal Muscular Atrophy (SMA), Progressive Muscular Atrophy (PMA), Distal hereditary motor neuropathy; Acquired- Upper limb dominance (Flail Arm, Hirayama, Segmental MND) Lower limb dominance (PMA, Monomelic Amyotrophy) b) Acute onset: Guillain Barre Syndrome, Polio; and 3. Combination of UMN and LMN: Amyotrophic lateral sclerosis (ALS). Conclusion: 1. Neurogenetics and neuroimaging complement each other in clinching the specific diagnosis of MND. 2. We discuss the neurogenetics, pathogenesis, and imaging appearance of the MND in this exhibit.

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## Abstract Archives of the RSNA, 2023

NREE-146

### Imaging Spectrum of Cystic Spinal Lesions

All Day Room: Learning Center

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To illustrate the compartmental spinal anatomy.
- To discuss the key imaging findings of cystic spinal lesions and their mimics.
- To demonstrate the utility of multimodality imaging in the differential diagnosis of cystic spinal lesions.

#### TABLE OF CONTENTS/OUTLINE

A wide variety of benign and malignant cystic lesions can involve the different compartments of the spine. Although an exact diagnosis may be challenging, different imaging characteristics are used in order to narrow the differential diagnosis and/or establish the exact diagnosis. In addition, spinal cysts can be divided into: intramedullary, intradural extramedullary, or extradural, depending on their location, which is only useful in planning treatment. Magnetic resonance imaging (MRI) is the imaging method of choice to identify and characterize spinal cysts, and ultrasound (US) is often used as the initial imaging modality in pediatric patients. Instead, CT is helpful for evaluating cystic lesions of the vertebral column. In this exhibit, we will review the multimodal imaging features of the most common cystic spinal lesions based on their etiology, including neoplastic, congenital, degenerative, infectious, post-traumatic, and postsurgical disorders. We will also review the main differential diagnoses that should be considered.

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## Abstract Archives of the RSNA, 2023

NREE-147

### **Pediatric Neurometabolic Diseases: A Pictorial Review of How the Radiologist can Approach Hypomyelinating and Dysmyelinating Disorders**

All Day Room: Learning Center

Thomaz R. Mostardeiro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1: Pediatric Neurological metabolic diseases are a group of disorders affecting the brain, mostly related with a specific enzyme deficiency. 2: These disorders traditionally affect the white matter but can also affect the gray matter (both cortex and basal ganglia). 3: Pattern of white matter disease is one of the most helpful clues in the characterizing these conditions on imaging. 4: Pathologically, these disorders can be classified as hypomyelinating (with mild signal changes, with T2 hyperintensity and T1 hypo to isointensity) or other white matter diseases (pronounced T2 hyperintensity and T1 hypointensity) 5: Hypomyelinating disorders can be differentiated based on peripheral neural compromise or not. 5: Other white matter diseases (dysmyelinating) can be characterized based on the pattern of white matter disease (confluent vs multifocal). 6: Confluent white matter disease has an extensive differential, and it is critical to depict where changes are visualized (diffuse, frontal, parieto-occipital, posterior fossa, periventricular or subcortical).

#### **TABLE OF CONTENTS/OUTLINE**

1: Hypomyelinating disorders (T1 hypointensity and T2 hyperintensity). 1.1: Without typical PNS involvement: Pelizaeus Merzbacher Disease- 1.2: With typical PNS involvement: Cockayne disease2: Other white matter diseases (mild T1 hypo or isointensity and T2 mild hyperintensity). 2.1: Confluent. 2.1.1: Frontal: Infantile Neuroaxonal Dystrophy. 2.1.2: Parieto-occipital: X-Linked adrenoleukodystrophy. 2.1.3: Posterior Fossa: Leigh syndrome. 2.1.4: Periventricular: Krabbe Disease. 2.1.5: Subcortical: Kearns Sayre Syndrome. 2.2: Multifocal: Hydroxy glutaric Aciduria.

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## Abstract Archives of the RSNA, 2023

NREE-148

### Imaging Approach and Review of Arteriovenous Orbital Fistulae

All Day Room: Learning Center

Daniela Jaramillo Arias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Reinforce the knowledge and correct identification of the vascular structures involved in the orbital-venous arterial fistula. List the imaging findings through contrasted tomography and contrasted MRI, to identify the main aspects to highlight in the diagnosis of orbital arteriovenous fistula. Complications of orbital arteriovenous fistula. Management and prognosis of patients with orbital arteriovenous fistula.

#### TABLE OF CONTENTS/OUTLINE

Definition, Diagnosis and image findings, Clinical findings, Treatment. Arteriovenous orbital fistulae is a rare condition that occurs when an abnormal connection forms between an artery and a vein within the orbit; This causes blood to flow directly from the arterial system to the venous system, bypassing the capillary network. As a result, there is a high-pressure gradient in the venous system, leading to congestion and dilation of the veins. Arteriovenous orbital fistulae can be congenital or acquired. The most common cause of acquired arteriovenous orbital fistulae is trauma, such as a blunt or penetrating injury. Symptoms of arteriovenous orbital fistulae include bulging of the eye, proptosis, diplopia, visual disturbance, and in severe cases, loss of vision or even blindness. Diagnosis of arteriovenous orbital fistulae involves a thorough medical history and physical examination, including imaging studies such as ANGIO CT or enhanced MRI. Treatment options depend on the severity of the condition and may include observation, embolization or surgical removal of the abnormal vessels.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-149

### **Intradural Spinal Lesions: A Review of Common and Rare Pathologies**

All Day Room: Learning Center

Sultan H. Yahya, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review normal spinal anatomy and compartments- Approach to intradural spinal pathologies, and distinguishing intra and extramedullary pathologies- Review common and rare intra-medullary neoplasms, including ependymomas, subependymomas, astrocytomas, metastasis, hemangioblastomas and spinal involvement in diffuse leptomeningeal glioneuronal tumors. - Discuss medullary neoplastic mimics, including demyelinating/inflammatory abnormalities, infarctions, and arteriovenous malformations. - Review common and rare extramedullary neoplasms including meningiomas, schwannomas, metastasis, angioliomas, mature cystic teratomas, paragangliomas, dermoids/epidermoid/lipomas and neuroenteric cysts.

#### **TABLE OF CONTENTS/OUTLINE**

- Spinal compartmental anatomy- Approach to intradural pathologies- Intramedullary abnormalities: tumors, differentials of medullary signal abnormalities and neoplastic mimics- Extramedullary lesions: common / rare tumoral entities and cystic lesions

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

NREE-15

### Cortically-Based Brain Tumors: Who is Who

All Day Room: Learning Center

Irene Diaz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cortically-based brain tumors have some features in common. They usually clinically manifest as epilepsy refractory to anti-epileptic drugs and most frequently affect children and young adults. We can also talk about long-term epilepsy-associated tumors (LEAT), and they are usually low-grade tumors. Radiologically, they may be difficult to differentiate, but there are some imaging diagnostic clues that will help us find the correct diagnosis.

#### TABLE OF CONTENTS/OUTLINE

An image-based quiz will lead the review of different cases of cortically-based brain tumors, with its differential diagnostic clues at imaging. Most of our patients were young adults and clinically presented with focal epilepsy. We are mainly showing low-grade tumors, such as dysembryoplastic neuroepithelial tumor (DNET), ganglioglioma, pleomorphic xanthoastrocytoma, oligodendroglioma, multinodular and vacuolating neuronal tumor (MVNT) or polymorphous low-grade neuroepithelial tumor of the young (PLNTY).

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-150

### Cerebellar Ataxia: Differential Diagnosis Based on Common Imaging Patterns

All Day Room: Learning Center

Paulo S. Ferreira (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Ataxia is a physical finding characterized by impaired coordination of voluntary muscle movement, resulting in disequilibrium, vertigo and gait ataxia. - Ataxia can be caused by either impaired vestibular input to the cerebellum or by cerebellum dysfunction itself. - Brain MRI, the imaging modality of choice, has a key role in differentiating the many causes of ataxia. - Ataxia may present with different cerebellum findings: normal, hypoplastic and atrophic morphology. - Regarding clinical findings, ataxia may be further classified as acute / subacute or chronic; traumatic; autoimmune; paraneoplastic or genetic. - Combining imaging and clinical features, differential diagnosis is made.

#### TABLE OF CONTENTS/OUTLINE

- Defining ataxia. - Clinical findings that are relevant for the diagnosis based on MRI. - Differentiating normal vs hypoplastic vs atrophic cerebellum.- Further exemplifying findings in atrophic cerebellum that lead towards specific diagnosis (e.g.: superficial siderosis, basal ganglia abnormalities, white matter abnormalities). - Further exemplifying findings in hypoplastic cerebellum that lead towards specific diagnosis (e.g.: unilateral hypoplasia, posterior fossa malformations, hemorrhage). - Flowchart to the approach of cerebellar ataxia.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-151

### **Interstitial Fluidopathy: A Concept for Understanding CNS Diseases with Impaired Interstitial Fluid Dynamics**

All Day Room: Learning Center

Toshiaki Taoka, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### **TEACHING POINTS**

This educational presentation proposes a new concept called "Central Nervous System (CNS) Interstitial Fluidopathy," which encompasses diseases whose pathologies are associated with abnormal interstitial fluid dynamics. The glymphatic system hypothesis proposes that cerebrospinal fluid and interstitial fluid in the brain constitute a mass transport system, including waste clearance. Impairment of these functions results in protein leakage into the interstitium and impaired efflux of waste products, leading to the accumulation of waste products, tissue dysfunction, and conditions such as neuroinflammation. The term "CNS interstitial fluidopathy" describes diseases or conditions in which abnormalities in interstitial fluid dynamics are one of the significant factors in the pathological process. Various diseases, including Alzheimer's disease, Parkinson's disease, traumatic brain injury, multiple sclerosis, and small vessel diseases, develop due to abnormalities in the interstitial fluid dynamics. By categorizing these diseases as CNS interstitial fluidopathies, we can improve our understanding of their disease mechanisms, develop potential imaging methods, clinical methods, and common treatment methods or drugs. The dynamics of interstitial fluid are critical for understanding CNS diseases or disorders, and the proposed concept may promote advancements in disease treatment or prevention.

#### **TABLE OF CONTENTS/OUTLINE**

1. An overview of the dynamics of cerebrospinal fluid and interstitial fluid in the CNS.
2. The waste clearance system in the CNS.
3. Pathologies associated with abnormal interstitial fluid dynamics.
4. A summary of the concept of interstitial fluidopathy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-152

### A Night in the ER: Diagnostic Errors in Emergency Neuroradiology

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

George K. Vilanilam, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Introduction: Diagnostic errors in emergency neuroradiology are a major contributor to unnecessary healthcare costs and have been implicated in preventable deaths in the US. Errors are broadly categorized into perceptive and interpretive errors. The most common erroneous studies are CT head (32%), CT cervical spine (18%), and CTA head and neck (24%). Specific teaching points: 1) Defining and understanding common sources of diagnostic errors in emergency neuroradiology. 2) Providing examples of common cognitive biases and perceptual errors. 3) Discussing methods to mitigate diagnostic errors in emergency neuroradiology.

#### TABLE OF CONTENTS/OUTLINE

Common cognitive biases/interpretive errors: 1) Truncation of the search and analytical thought processes (premature closure, satisfaction of search, and satisfaction of report). 2) Affirming initial diagnosis (anchoring bias and attribution bias). 3) Recency (availability and non-availability bias). 4) Outcome-related bias (regret bias/defensive reporting, outcome bias). 5) Biases stemming from clinical parameters (framing bias, attribution bias). 6) Retrospective biases (hindsight bias, self-serving bias). Perceptual errors: 1) Related to viewing technique (inappropriate windowing and fogging phenomenon). 2) Related to the finding itself (edge of film, first or last slice, bilateral or diffuse findings, subtle or poorly conspicuous). Recommendations to reduce diagnostic and reporting errors

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-16

### Nervous System MR Elastography: Current Update

All Day Room: Learning Center

#### Awards

##### Cum Laude

Safa Hoodeshenas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) How MR elastography of the nervous system is performed; From the generation of the shear waves to obtain qualitative and quantitative parameters  
2) What MRE can tell us about neural tissue biomechanical properties in physiologic and pathologic conditions

#### TABLE OF CONTENTS/OUTLINE

1) Principles of MR elastography technique in the nervous system  
2) Qualitative and quantitative obtained parameters  
3) Role of artificial intelligence in MRE  
4) Slip interface imaging  
5) MRE in neurodegenerative disease (Alzheimer's disease, Frontotemporal dementia, Lewy body dementia, Normal pressure hydrocephalus)  
6) MRE in characterizing and treatment planning of intracranial tumors (tumor subtype and grade, consistency, adhesion to surrounding tissue)  
7) MRE in traumatic brain injury  
8) MRE in neuroinflammatory disorders  
9) Functional MRE  
10) Pediatric nervous system MRE

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-17

### **I Only See White Spots: Understanding the Clinical and Radiological Features of CNS Demyelination**

All Day Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe the most typical imaging characteristics of secondary demyelinating processes. To know the basic notions in relation with epidemiology, clinical presentation, pathology, possibility of spinal cord involvement and differential diagnosis. To be able to assist the diagnosis of each etiological group in order to provide better and faster management, taking into account the severity of the findings and prediction of outcome.

#### **TABLE OF CONTENTS/OUTLINE**

1. Autoimmune a. Multiple sclerosisb. Baló (example of tumefactive autoimmune lesions)c. Devic (optic neuromyelitis)2. Infectiousa. HIV encephalopathyb. PML (progressive multifocal leukoencephalopathy)c. Subacute sclerosing encephalomyelitis3. Vasculara. Binswanger (subcortical arterioesclerotic encephalopathy)b. CADASIL (Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy)c. Post-anoxicd. PRES (posterior reversible encephalopathy)4. Toxic-metabolica. Osmotic demyelinationb. Toxic leukoencephalopathyc. CLOCC (cytotoxic lesions of the corpus callosum)5. Traumatica. Diffuse axonal injury

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-18

### Facets of a "Heavy Brain": Exploring Patterns of Iron Metabolism Disturbances

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mayne S. Brandao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Iron accumulation in the brain is common in several neurodegenerative disorders and normal aging. It likely contributes to the pathophysiology of neurodegenerative changes in these conditions by inducing oxidative stress, inflammation, and cell death. The patterns of iron deposits in the central nervous system vary between different conditions, both at the macroscopic and microscopic level. The role of iron in the pathogenesis and response to iron chelation therapy varies between individual disorders.

#### TABLE OF CONTENTS/OUTLINE

This review summarizes the whole brain, cellular, and subcellular patterns of iron accumulation in neurodegenerative diseases of genetic and sporadic origin, and also other associations as an neuroinfections. We also provide an update on mechanisms, biomarkers, and effects of brain iron accumulation in these disorders, focusing on recent publications. This pictorial review will also show how we can systematize the role of iron in brain and provide a practical guide to identify the main pathologies.

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## Abstract Archives of the RSNA, 2023

NREE-19

### **Don't Take the Long Way: A Diagnostic Shortcut to Longitudinally Extensive Myelopathies**

All Day Room: Learning Center

Nicole Lambrakos, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Outline and describe the types of myelopathies (mechanical and non-mechanical).2. Explain the pathology and imaging findings of myelopathies.3. Build a decision making diagnostic flowchart, pointing out the imaging characteristics of myelopathies.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief review of spinal cord anatomy, tracts and function.2. Definition of myelopathy and longitudinally extensive spinal cord lesions and their subtypes (mechanical and non-mechanical).3. Pathology of spondylotic myelopathy.4. Clinical and imaging findings.6. Most specific imaging findings.5. Decision making diagnostic flowchart of myelopathies based on their imaging characteristics.

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## Abstract Archives of the RSNA, 2023

NREE-2

### Variants and Anomalies of Extracranial Cerebral Arteries and Considerations for Neuroendovascular Procedures

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ana Maria Rodriguez Martinez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To describe the embryology of the aortic arch in order to explain the origin of its anatomical variants and anomalies.- To review the variants and anomalies of extracranial cerebral arteries giving examples from cases from our institution.- To revise some of the pathology associated with extracranial vascular variants and anomalies and the implications for endovascular procedures.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Embryology. 3. Aortic arch3.1. Variants 3.1.1. Bovine arch 3.1.2. Elongation and tortuosity 3.2. Anomalies 3.2.1 Right-sided aortic arch 3.2.2. Right aberrant subclavian artery and bicarotid trunk 3.2.3. Double aortic arch4. Cervical Internal carotid artery4.1. Variants 4.1.1. Elongation and tortuosity4.2. Anomalies 4.2.1. Internal carotid artery agenesis 4.2.2. Main branches anomalous origins5. Cervical vertebral artery5.1. Variants5.2. Anomalies 5.2.1. Anomalous origin of the vertebral artery

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## Abstract Archives of the RSNA, 2023

NREE-20

### **Beyond the Basic: Advanced MRI Techniques in Neuroimaging**

All Day Room: Learning Center

Marina C. Da Cruz (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Advanced magnetic resonance imaging (MRI) techniques allow expanding the range of diagnostic tools with the potential to assess functional parameters in neuroimaging, complementary to traditional sequences, that can and should be used by radiologists to aid in the differential diagnosis. The purposes of this submission are: - To review advanced MRI techniques in neuroimaging, such as spectroscopy, perfusion weighted imaging, tractography, nigrosome and neuromelanine avaiation and vessel wall study; - To expose the main indications of each method; - To discuss possible imaging features in some groups of pathologies;

#### **TABLE OF CONTENTS/OUTLINE**

1. Review technique and indications of spectroscopy;2. Technique and indications of perfusion weighted imaging;3. Discuss technique, indications and basic interpretation of tractography;4. Assessment of nigrosome and neuromelanine;5. Discuss technique, indications and basic interpretation of vessel wall study;

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## Abstract Archives of the RSNA, 2023

NREE-21

### **Progressive Multifocal Leukoencephalopathy (PML): A Thorough Overview from Traditional to Contemporary Findings, Including Inflammatory Subtype, IRIS, Drug-associated, and Asymptomatic Cases**

All Day Room: Learning Center

#### **Awards**

##### **Magna Cum Laude**

Koichiro Mori (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1: Discuss PML imaging findings from classical observations to the latest insights. Explain the progression of lesions, taking into account the pathological findings. 2: Contrast-enhanced PML lesions are extremely important in clinical management, and discussing their significance in imaging findings is essential. 3: Address the key points of imaging findings for recently discussed drug-related PML and asymptomatic PML.

#### **TABLE OF CONTENTS/OUTLINE**

1: About progressive multifocal leukoencephalopathy (PML) 1-1: Classification of JCV diseases of the Brainl 2: PML progresses through the following 3 steps, reflecting pathological findings 2-1: First step: "Initiation" as a small demyelinating lesion 2-2: Second step: "Expansion" and "Extension" of demyelinating lesions 2-3: Third step: "Fusion" of demyelinating lesions, resulting in axonal destructionl 3: Interpretation of contrast enhancement in PML lesionsl 4: New MRI findings related to PML 4-1: low signal intensity on T2\*WI and SWI in U-fibers and deep gray matter adjacent to the lesions 4-2: hyperintense cortical sign (HCS) on T1WI l 5: Drug-associated PML 5-1: natalizumab-associated PML 5-2: punctate lesions

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## Abstract Archives of the RSNA, 2023

NREE-22

### Neurological Emergencies in Oncologic Patients: Understanding the Importance of Early Imaging Evaluation

All Day Room: Learning Center

THARYN Goncalves FRANCO DE GODOY (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Neurological emergencies are common and life-threatening conditions, particularly in oncologic patients who are at higher risk due to factors, including immunosuppression, coagulopathy, and treatments such as chemotherapy and radiation therapy. Due to their compromised status, early diagnosis can be challenging, and imaging exams are often required for proper evaluation. Radiologists, especially those working in cancer centers, must be familiar with these emergencies to ensure prompt treatment and reduce morbidity and mortality. Our aim is to review the neurologic emergencies to oncologic patients dividing them into pre and post-treatment, including early and late complications. To increment the discussion, risk factors, clinical presentation, imaging findings and treatment will be in illustrative cases.

#### TABLE OF CONTENTS/OUTLINE

Introduction: review neurologic emergencies to oncologic patients. To divide the emergencies in two groups: related to cancer itself or its treatment (early and late complications), through a visual flowchart. To discuss, for each condition risk factors, clinical presentation, imaging findings and treatment. Following conditions: Pre-treatment: intracranial hypertension, vasogenic edema, herniations, spinal cord compression, paraneoplastic syndromes, ischemic and hemorrhagic stroke, venous sinus thrombosis. Post-treatment: radiation-induced vasogenic edema and leukoencephalopathy, infections, hemorrhages, radiation necrosis, SMART syndrome, radiation vasculopathy, encephalopathy, PRES, opportunistic infections. To highlight the particular aspects to oncologic patients, discussing the clinical and imaging for early diagnosis and treatment.

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## Abstract Archives of the RSNA, 2023

NREE-23

### Beyond the Lumen: Unraveling the Vessel Wall Technique

All Day Room: Learning Center

Maria Laura Piassa, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- A method that is here to stay, the vessel wall study, aims to evaluate the vascular wall and characterize the pathologies that compromise it, whether inflammatory, dissection, or atheromatous plaques.- It is a study that requires a high spatial resolution, with homogeneous signal suppression of the intravascular lumen, 2D or 3D multiplanar acquisitions, allowing several acquisitions.- In the evaluation of atherosclerotic diseases, VW-MRI demonstrates parietal thickening that eccentrically involves the circumference of the arterial wall, showing different characteristics on T1 and T2 sequences, depending on its internal content. Active/unstable plaques present a thin fibrous cap, large lipid core, presence of hemorrhage, contrast uptake and vascular remodeling.- Other differential diagnoses of intracranial luminal stenosis would be dissection, vasculitis (primary or secondary), reversible vasoconstriction and Moya-moya. VW-MRI is also used in the evaluation of aneurysms.- Pitfalls are points that deserve full attention, highlighting low flow, in which incomplete suppression can mimic wall thickening and vasa vasorum, mimicking vasculitis.

#### TABLE OF CONTENTS/OUTLINE

- Raise the importance of the VW-RM, including its techniques and applications.- Assess atherosclerotic disease and its differential diagnoses more precisely, stratifying individual risks, with potential influence on treatment decisions.

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## Abstract Archives of the RSNA, 2023

NREE-24

### Help When You're Feeling Low: Intracranial Hypotension and Algorithms for Diagnosis

All Day Room: Learning Center

Rahim Ismail, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Familiarize radiologists with the pathology and pathophysiology of spinal CSF leaks resulting in spontaneous intracranial hypotension (SIH).2. Localization of the culprit spinal CSF leak in SIH patients can be difficult. At our institution we use a combination of brain and spinal MRI to guide the type of myelographic imaging and patient positioning for the myelogram to help localize the CSF leak.3. Role of dynamic CT myelogram (DCM) and digital subtraction myelogram (DSM) in patients demonstrating a spinal longitudinally extensive collection (SLEC) on spinal MRI4. Role of lateral decubitus DSM in patients with SLEC negative MRI in evaluating for a CSF venous fistula (CVF) or distal tears of the nerve root sleeve.5. Role of DSM for precise localization in patients with suspected fast flow CSF leaks, such as dural tears from sharp osteophytes .6. Role of DCM in patients with suspected CSF leaks from proximal nerve root sleeve tears/perineural cysts.7. Describe our institutional protocols for performing DCM and DSM including tips for optimizing timing and provocative assessments.

#### TABLE OF CONTENTS/OUTLINE

The following illustrative examples will be shown:1. Pathology: Different etiologies of spinal CSF leaks will be shown including:a. Microspurs b. perineural cysts c. CSF venous fistula (CVF) d. distal dural tears.2. We will describe our institutional algorithm for the work up of these complex subsets of patients.

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## Abstract Archives of the RSNA, 2023

NREE-25

### Connecting the Dots: A Step-by-Step Guide of Brain Myelination

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Afonso P. Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: To review the normal appearance of myelination on imaging studies To define a step-by-step analysis algorithm to facilitate the assessment of myelination To display a compendium of cases involving myelination disorders

#### TABLE OF CONTENTS/OUTLINE

Myelin is a vital component of the nervous system, serving as an insulator for neurons and found in both the central and peripheral nervous systems. It not only insulates but also speeds up action potentials by 10-100 times that of an unmyelinated axon. Moreover, it regulates ion composition and fluid volume around the axon, which is crucial for maintaining its health and integrity. MRI is the best noninvasive way to assess myelin and myelination in the pediatric brain. Mature myelin usually appears hyperintense to the gray matter cortex on T1 and hypointense to the gray matter cortex on T2. The process of myelination starts during fetal development with the cranial nerves, which are essential for our survival, and continues throughout life. As myelination progresses, it generally follows a pattern of development from bottom to top (caudocranial), back to front (posterior to anterior), and central to peripheral (deep to superficial). In conclusion, myelin is a vital component of the nervous system and plays a critical role in proper functioning. Understanding the process of myelination and the appearance of mature myelin on imaging is essential for the evaluation of many neurological conditions.

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## Abstract Archives of the RSNA, 2023

NREE-26

### **Nigrosome 1: Anatomy, Variants and Pathologies**

All Day Room: Learning Center

Danielly V. Santos SR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to help the readers to determine the presence or absence of an abnormality in the N1 and establish diagnostic reasoning in cases of parkinsonism. The objectives of this electronic exhibit are: - to revisit the anatomical definition of the N1 region using schematic illustrations and imaging MRI; - to illustrate the anatomical variants of the N1; - to exhibit parkinsonism diagnostic algorithm; - provide imaging findings of various patients who presented with parkinsonism.

#### **TABLE OF CONTENTS/OUTLINE**

Parkinson's disease is a clinically heterogeneous chronic progressive neurodegenerative disease with loss of dopaminergic neurons in Nigrosome 1 (N1). Nigrosomes are small clusters of dopaminergic cells within the substance nigra. Five nigrosomes have been described with the largest labeled as N1, located in the posterior third of the substantia nigra. The N1 is the key structure in the midbrain that is very important in movement disorders, particularly those associated with parkinsonism. Interpreting the N1 sign can be difficult because it can take many forms but the high-resolution data and clear characterization of the N1 appearance help to make that decision easier.

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## Abstract Archives of the RSNA, 2023

NREE-27

### Stroke of Luck: Imaging of Hyperacute Stroke and Selecting Patients Effectively

All Day Room: Learning Center

Bernardo C. Teixeira, MD,PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? Stroke management was revolutionized recently by the proven benefit of intervention with a larger time window on selected patients ? Time is brain: CT perfusion helps identifying salvageable brain tissue ? Radiologists play a crucial role on helping the multidisciplinary team select patients who will benefit from intervention based on imaging criteria ? Perfusion studies should be routinely assessed to avoid misinterpretation and excluding patients from therapy

#### TABLE OF CONTENTS/OUTLINE

Introduction Over the past few years, after publication of the results of the DEFUSE 3, EXTEND and DAWN trials, stroke management has been revolutionized. These studies proved the benefit from intervention with a larger time window based on certain perfusion imaging criteria. This educational exhibit's goal is to review the role of conventional and advanced imaging on hyperacute stroke, ending with a proposed interpretation algorithm for selecting patients effectively. Current treatment options and inclusion criteria Imaging of hyperacute stroke ? Acquisition protocols ? CT ? MR ? Perfusion CT/MR ? ASPECTS ? AI (Rapid, Brainomix) ? Assessing study's quality ? Pitfalls ? Proposed interpretation algorithm

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## Abstract Archives of the RSNA, 2023

NREE-28

### Headache, Dizziness, and Leaks. May the Balance be with You. A Pictorial Review of Intracranial Hypo and Hypertension

All Day Room: Learning Center

Fernanda N. Avalos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cerebrospinal fluid (CSF) homeostasis is essential to maintain normal intracranial pressure. Even a small imbalance in CSF production, absorption, or flow can lead to altered intracranial pressure. Imaging in increased intracranial pressure (ICP): Although there are no specific imaging findings of idiopathic intracranial hypertension, enlarged arachnoid outpouchings such as an empty sella, enlarged Meckel's cave, or signs in the optic nerve such as vertical tortuosity or flattening of the posterior sclera should raise suspicion, as these signs have been identified in 23-80% of patients. ICP may be due to secondary causes such as disturbances in CSF production and absorption or obstructive hydrocephalus that can result from lesions such as intracranial masses. Imaging in intracranial hypotension: the major radiological features can be summarized with the acronym SPACE (Sagging of the brain, Pituitary enlargement, Angles, Collections, and Enhancement of the pachymeninges). Dural membrane leaks contribute to the majority of causes of intracranial hypotension. Therefore, understanding the imaging methods and findings can guide definitive treatment and improve patient outcomes.

#### TABLE OF CONTENTS/OUTLINE

1. Understand the physiological mechanism of CSF in the central nervous system.
2. Describe the common symptoms of intracranial hypo- and hypertension, and recall clinical findings during neurological examination.
3. Radiological findings of intracranial hypertension with differential diagnosis.
4. Radiological and clinical evolution of a patient with intracranial hypotension, from the first study with unspecified headache, through spinal leak diagnosis, to control after treatment

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-29

### **Meningiomas - Do You Know Their Presentations: Brief Pictorial Review of Intracranial Meningiomas Presentations and Their Radiological Findings. Our Image Experience**

All Day Room: Learning Center

Mario J. Zelaya Villafranco, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Remember the definition of meningiomas and its most relevant epidemiological data. Review the current classification of intracranial meningiomas according to the World Health Organization (WHO) and their different imaging characteristics. Overhaul a brief pictorial review with exemplified cases of typical and atypical meningiomas from our institute.

#### **TABLE OF CONTENTS/OUTLINE**

Meningiomas are the most common nonglial primary tumors of the Central Nervous System and the most common extraaxial neoplasms. They may originate in unexpected locations such as the orbit, paranasal sinus, or ventricles or be entirely intraosseous (within the calvaria). The radiologist must be aware of their less frequent and uncharacteristic the imaging features in order to suggest the right diagnoses in cases that are atypical. The present educational exhibit intends to make a brief pictorial review of the main presentations of intracranial meningiomas, their current classification and imaging characteristics, and exemplify them with cases of patients from our institute.

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## Abstract Archives of the RSNA, 2023

NREE-3

### **Don't be Afraid of Neuroimaging Epilepsy: A Case-based Review of a Myriad of Etiologies and Findings**

All Day Room: Learning Center

ANA P. MACHADO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Epilepsy is seen as a clinical manifestation due to excessive or synchronous abnormal neuronal activity in the brain, defined as recurrent, unprovoked seizures. The prevalence is high, and patients have an increased risk of premature death, injuries, psychosocial dysfunction, and reduced quality of life. The etiologies encompass multiple causes. Neuroimaging studies (particularly magnetic resonance imaging) are essential in evaluating epilepsy, mainly in cases refractory to pharmacotherapy, once the location of the epileptogenic focus is a turning point in a successful neurosurgery approach. The purpose of this exhibit is to present, through illustrative cases, a practical approach to imaging findings within multiple epilepsy etiologies.

#### **TABLE OF CONTENTS/OUTLINE**

Education Exhibit Presentation ? Introduction. ? Clinical and epidemiological aspects. ? A case-based review of original cases from the neuroradiology department of a tertiary hospital showing imaging features of a range of etiological substrates of epilepsy (from the common ones to the rarest), always through the perspective and purpose of a practical approach. Key and ancillary imaging features will be highlighted in each case. ? Take-home messages ? References.

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## Abstract Archives of the RSNA, 2023

NREE-30

### Maxillo-mandibular Lesions: Gnawing Through the Differentials

All Day Room: Learning Center

Gillean A. Cortes, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To provide an overview and differential diagnosis for maxillo-mandibular lesions encountered during imaging of the head and neck. 2. To present the multimodal radiologic features with case-based review of maxillo-mandibular lesions. 3. To highlight the approach of maxillo-mandibular lesions including diagnosis and management.

#### TABLE OF CONTENTS/OUTLINE

Maxillo-mandibular lesions are commonly encountered and usually incidental during head and neck imaging. There is a broad spectrum of lesions, which may be of odontogenic and non-odontogenic origin and can be further classified by cystic, solid, infectious/inflammatory, benign, and malignant processes. Patient characteristics and location of the lesion may be helpful; however, without pathognomonic imaging features, tissue sampling is frequently required. Several key cases presented at our institution will be reviewed such as: periapical cyst, dentigerous cyst, odontogenic keratocyst, non-odontogenic developmental cystic lesions, aneurysmal bone cyst, ameloblastoma, fibrous dysplasia, osteosclerosis, condensing osteitis, cementoblastoma, ossifying fibroma, osteomyelitis, odontogenic carcinoma, invasive squamous cell carcinoma, and osteoradionecrosis. Accurate diagnosis is essential to prevent further complications, as otherwise treatable lesions with destructive potential may be missed.

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## Abstract Archives of the RSNA, 2023

NREE-31

### Looking Back: Everything You Need to Know on Infratentorial Malformations

All Day Room: Learning Center

Taisa M. Guarilha, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is:- To review normal anatomy of the posterior fossa- To explain in a simplified way normal embryology and the modifications that result in these malformations- To demonstrate how infratentorial malformations can present themselves- Exemplify with cases- Present a flow chart

#### TABLE OF CONTENTS/OUTLINE

1. Normal anatomy  
2. Embryology: - Normal- Malformations  
3. Cases:  
3.a. Cystic malformations: Dandy-Walker continuum  
Blake Pouch Cyst  
Mega Cisterna Magna  
Arachnoid cyst  
3.b. Non-cystic malformations:  
-- Predominant cerebellar involvement:- Rhombencephalosynapsis- Macrocerbellum- Microcerbellum- Cerebellar Hypoplasia - bilateral, unilateral - Cortical cerebellar malformation- Cobblestone  
-- Predominant brainstem involvement:- Pontine tegmental cap dysplasia- Horizontal gaze palsy with progressive scoliosis- Möbius Syndrome  
-- Predominant cerebellar and brainstem involvement:- Molar tooth malformations - including Joubert Syndrome- Pontocerebellar hypoplasia- Walker-Walburg- Lhermitte-Duclos syndrome - Craniocervical junction: Chiari spectrum  
3.c. Others- Masiner-Santino Syndrome- Quadrigeminal cistern lipoma  
4. Flowchart  
5. Take home messages

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## Abstract Archives of the RSNA, 2023

NREE-32

### No More Conflict: Imaging of Neurovascular Compression Syndromes, Related Anatomy and Surgical Approach

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Bernardo C. Teixeira, MD,PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Neurovascular compression (or conflict) is one of the causes that must be considered in patients presenting with cranial nerve related symptoms. MR imaging is key to rule out differential diagnosis. Knowing the involved anatomy is fundamental to identify possible sites of compression. Communication with the surgeon plays a major role and the reports must include necessary information to surgical planning.

#### TABLE OF CONTENTS/OUTLINE

Neurovascular conflict syndromes (NVCS) consist of symptoms related to compression of the V, VII, VIII or XII cranial nerves by vascular structures, usually at the transition zone near the nerve root entry zone. When indicated microsurgical decompression can be done. Trigeminal Nerve NVCS of the V CN usually presents as trigeminal neuralgia and is caused by compression at its REZ at the level of the pons by an elongated superior cerebellar or anterior inferior cerebellar arteries. Facial and Vestibulocochlear Nerves Facial hemispasm (VII CN) / vertigo and tinnitus (VIII CN) may come from compression at the inferior pons level by the AICA. Glossopharyngeal Nerve IX CN compression at its REZ on the upper medulla by the PICA may cause glossopharyngeal neuralgia.

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## Abstract Archives of the RSNA, 2023

NREE-33

### Emergency Neuroradiology Misses: Case Examples and Lessons Learned

All Day Room: Learning Center

Tran Anh Vu, BSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Diagnostic errors are the 3rd leading cause of death in the United States. In diagnostic radiology, the rate of errors increases significantly in the emergency setting, this is particularly critical in neuroradiology, where misinterpretation or misidentification may significantly delay treatment and adversely impact patient outcome. In this educational exhibit, readers will be able to: Recognize the two types of thought processing in human decision making, Recognize common diagnostic errors and underlying cognitive biases in image interpretation, See examples of real life missed/misinterpreted cases in emergency neuroradiology and Understand different approaches to reduce diagnostic errors.

#### TABLE OF CONTENTS/OUTLINE

1. Background of diagnostic errors in radiology (statistics and common misses in emergency neuroradiology). 2. Type 1 and Type 2 Processing in Clinical Decision Making (heuristic vs analytical approaches). 3. Different Types of Errors During Image Interpretation (cognitive/interpretive biases, perceptual errors). 4. Sample cases to illustrate different types of misses in emergency neuroradiology (perceptual errors - blind spot; cognitive error/lack of knowledge; perceptive error - satisfaction of search; inadequate history). 5. How do we reduce diagnostic errors (strategies from the literature and our institution will be provided such as non-random peer review, double reading, interdisciplinary rounds and tumor boards, reducing interruptions, computer-aided decision making support system)

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

NREE-34

### **Infarcts, Malformations, and Tumors.. Oh My! A Review of Vascular Pathology In and Around the Spinal Cord**

All Day Room: Learning Center

#### **Awards**

##### **Cum Laude**

Jennifer L. McCarty, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review spinal vascular anatomy with original diagrams. 2. To review International Society for the Study of Vascular Anomalies (ISSVA) and other classification systems. 3. To discuss the clinical presentation and etiologies. 4. To demonstrate common imaging findings.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Infarcts 3. Malformations 4. Tumors 5. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-35

### Teratomas of the Brain, Head and Neck, and Spine: Imaging Appearances

All Day Room: Learning Center

Willem G. Calderon Miranda I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Illustrate the different imaging appearances of teratomas in the brain, head and neck, and spine.
- Discuss their locations and associated complications.
- Understand the usefulness of CT and MRI in the diagnosis and characterization of teratomas.

#### TABLE OF CONTENTS/OUTLINE

Intracranial and spine teratomas, as well as those in the head and neck, are rare tumors that originate from all three embryonic germ layers (ectoderm, mesoderm, endoderm). They can be classified depending on their differentiation as mature, immature, and teratoma with malignant transformation. Clinical manifestations vary according to location and size. Intracranial teratomas are usually located in the midline, generally in the pineal and suprasellar regions, and represent more than two-thirds of brain tumors diagnosed before birth. In the spine, teratomas can occur at any level and compartment (extradural, intradural, or intramedullary). Characteristically, all show distinct components with fat, calcification, and soft-tissue attenuation on CT. Predominantly cystic teratomas also occur. MRI offers better characterization of these tumors and detection of their complications. In this exhibit, we will discuss typical and unusual appearances of teratomas on CT and MRI approaching them by location:

- Intracranial: congenital, midline, and off-midline location
- Head and Neck
- Spine: intramedullary, intradural extramedullary, and extradural/sacroccygeal

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-36

### **Radiographic Findings in Hypoxic-Ischemic Brain Injury and the Role of Imaging in Brain Death Determination**

All Day Room: Learning Center

Min Tae Kim, MD,BSC (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is to 1. Discuss patterns of hypoxic-ischemic brain injury in pediatric and adult patients 2. Review the utility of imaging in prognostication 3. Review brain death determination using clinical criteria and imaging support 4. Present select cases from our institution

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Patterns of hypoxic-ischemic brain injury in neonates- Normal MRI appearance of the neonatal brain- Patterns of mild, moderate, and severe injury 3. Patterns of hypoxic-ischemic brain injury in infants, young children, and adults- Commonly involved regions of the brain - cortex, deep gray matter, perirolandic cortex, watershed distribution, white matter, cerebellum- Review of radiographic findings on CT- Review of radiographic findings on MR 4. How imaging can assist in determining prognosis 5. Radiographic imaging in the brain death examination- CT angiography- Digital subtraction angiography (DSA) - gold standard- Nuclear medicine 6. Select cases from our institution

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## Abstract Archives of the RSNA, 2023

NREE-37

### **Don't Get Trapped: Diagnostic Errors in Emergency Neuroradiology**

All Day Room: Learning Center

Julia M. Brunelli, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Diagnostic errors in neuroradiology in the emergency department can have serious consequences for patients. The prevalence of errors in diagnostic radiology is around 3-5%. Factors such as less time to prepare the report and discuss the case with peers, the patient's clinical condition evolving rapidly, and dependence on the radiological report to take immediate actions according to the imaging findings can all contribute to errors. In this educational presentation, we will review a series of cases to address a series of etiologies that are present in a neurological emergency room and provide tips to improve accuracy and patient outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction• Overview of diagnostic errors• Renfrew Classification (revised by Kim and Mansfield in 2014)2. Case based review• Etiologies that are present in the emergency• Learning with the case: tips about that etiology3. Do it yourself• Cases as a diagnostic challenge for the audience

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## Abstract Archives of the RSNA, 2023

NREE-38

### A to Z of Motor Neuron Diseases

All Day Room: Learning Center

Amit B. Desai, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review neuroanatomy of the motor system  
2. Discuss common upper and lower motor neuron diseases  
3. Provide a multi-disciplinary and radiologic pattern based approach to diagnosis of motor neuron diseases

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Neuroanatomy Review  
3. Classification of Upper and Lower Motor Neuron Diseases. Imaging features, pathophysiology, genetics, clinical symptoms, and management will be reviewed.  
A. Upper Motor Neuron Involvement Only: i. Primary Lateral Sclerosis ii. Hereditary Spastic Paraplegia iii. Spinal AVM/AVF iv. Radiation Myelitis  
B. Lower Motor Neuron Involvement Only: i. Progressive Muscular Atrophy ii. Flail Arm/Leg Syndrome iii. Post-Polio Syndrome iv. AIDP v. CIDP vi. Motor Neuron Lymphoproliferative Disorders  
C. Upper and Lower Motor Neuron Involvement: i. Amyotrophic Lateral Sclerosis (ALS) ii. ALS Plus Syndrome, Progressive Bulbar Atrophy iii. Bulbar-onset ALS  
D. Diseases affecting the Muscle/Neuromuscular Junction: i. Myasthenia Gravis ii. Lambert Eaton iii. Inclusion Body Myositis  
4. Simplified Diagnostic Approach Based Upon Clinical Symptomatology and Radiologic Imaging Pattern  
5. Conclusion

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## Abstract Archives of the RSNA, 2023

NREE-39

### Novel WHO Intra-axial Tumoral Entities: Beyond Gliomas

All Day Room: Learning Center

Sultan H. Yahya, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the evolution of CNS tumor classification- Concepts in the WHO 2021 classification of tumors - What's new?- Pertinent Radiomics and Molecular Classification of tumors- Recognize imaging features of relatively Novel CNS tumoral entities- Diffuse Pediatric high grade glioma- High Grade astocytoma with piloid features (HGAP)- Astroblastoma- Multinodular and Vacuolating neuronal tumor (MVNT)- Multiloculated and Vacuolating Posterior Fossa lesions of Unknown Significance (MV-PLUS)- Diffuse Leptomeningeal Glioneuronal Tumor (DLMGT) - Calcifying Pseudoneoplasm of the Neuroaxis (CAPNON)- Polymorphous Low Grade Neuroepithelial tumor of the Young (PLNTY).

#### TABLE OF CONTENTS/OUTLINE

Review of CNS tumor classification and Novel concepts in the WHO 2021 classification  
Cased- based review of new CNS tumoral entities: - Diffuse Pediatric high grade glioma- High Grade astocytoma with piloid features (HGAP)- Astroblastoma- Multinodular and Vacuolating neuronal tumor (MVNT)- Multiloculated and Vacuolating Posterior Fossa lesions of Unknown Significance (MV-PLUS)- Diffuse Leptomeningeal Glioneuronal Tumor (DLMGT) - Calcifying Pseudoneoplasm of the Neuroaxis (CAPNON)- Polymorphous Low Grade Neuroepithelial tumor of the Young (PLNTY).

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## Abstract Archives of the RSNA, 2023

NREE-4

### **Radiological Approach to Toxic-metabolic Encephalopathies**

All Day Room: Learning Center

Valeria Andrea G. Schonstedt, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To propose a systematic radiologic approach in the evaluation of toxic-metabolic diseases.

#### **TABLE OF CONTENTS/OUTLINE**

1) When to suspect toxic-metabolic disease in a patient with acute encephalopathy 2) Important differential diagnosis that should be ruled out 3) To establish a topographic approach to suggest an etiologic diagnosis 4) To be aware of rare asymmetric presentations

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## Abstract Archives of the RSNA, 2023

NREE-40

### Radiopharmaceutical Therapy for Fibromyalgia: A Promising Treatment Option

All Day Room: Learning Center

Sriram S. Paravastu, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Despite the availability of several pharmacological and non-pharmacological therapies, the management of fibromyalgia remains challenging. 2. Preliminary studies have shown promising results in PET imaging of fibromyalgia. 3. Radiopharmaceutical therapy involves the administration of radiopharmaceutical agents that selectively accumulate in specific tissues or organs and may be the next step in treatment of fibromyalgia.

#### TABLE OF CONTENTS/OUTLINE

1. Current challenges in the management of fibromyalgia 2. Radiopharmaceutical therapy for fibromyalgia a. Current radiotracers under investigation 3. Preliminary studies on molecular imaging of fibromyalgia a. Radiolabeled Substance-P monoclonal antibody b. Radiolabeled small molecules 4. Future directions and challenges a. Theranostics in fibromyalgia and other chronic pain syndromes b. Establishment of objective clinical markers of fibromyalgia

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## Abstract Archives of the RSNA, 2023

NREE-41

### Neurovascular Devices and Related Complications: A Case-based Approach

All Day Room: Learning Center

Victor M. De Carvalho, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to: 1. Showcase the mainly used neurovascular devices, highlighting the preferred imaging modalities and what to avoid in the postoperative evaluation of each device. 2. Review the most relevant complications assessed by imaging related to each neurovascular device : what to look for?

#### TABLE OF CONTENTS/OUTLINE

- Introduction with a brief and illustrative review of the main neurovascular devices used in clinical practice and the modalities of choice for assessment of each device.
- Provide a guide on what to look for when assessing neurovascular devices with the most commonly associated complications.
- Provide didactic cases to illustrate the most important complications related to each neurovascular device and consolidate the acquired knowledge.
- Conclusions.
- Bibliographical references.

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## Abstract Archives of the RSNA, 2023

NREE-42

### Impact of Deep Learning-Based Reconstruction on Neuro MR Imaging: Image Noise Reduction and Super Spatial Resolution

All Day Room: Learning Center

Hiroyuki Uetani (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To understand the principle of deep learning-based reconstruction (DLR) for reducing image noise and enhancing spatial resolution of neuro MRI. 2. To illustrate the applications of DLR with/without compressed sensing (CS) and parallel imaging and super spatial resolution-DLR (SR-DLR) for neuro MRI, and discuss the strengths of this techniques. 3. To discuss the pitfalls and limitations of DLR with/without CS and parallel imaging and SR-DLR techniques.

#### TABLE OF CONTENTS/OUTLINE

Introduction: 1) What is DLR with/without CS and parallel imaging, and SR-DLR techniques? 2) The advantages and disadvantages of DLR with/without CS and parallel imaging, and SR-DLR techniques. Clinical application of DLR with/without CS and parallel imaging and SR-DLR in neuro MR imaging: 1) DLR: High signal-to-noise ratio (SNR) images without long acquisition times A) High-resolution 3D T2 weighted imaging (HR-3D T2WI) B) MR angiography 1) Combination of DLR and CS/parallel imaging: High SNR images in a short acquisition time without sacrificing spatial resolution A) 2D-T2WI on the sellar region or spine B) MR angiography C) High-resolution 3D-T2WI 2) SR-DLR: High SNR images with super spatial resolution without long acquisition times A) 2D-T2WI on the hippocampus B) MR angiography C) Double inversion recovery (DIR) imaging D) Contrast-enhanced 3D T1WI E) Bone imaging Pitfalls and limitations of DLR with/without CS and parallel imaging, and SR-DLR in neuro MR imaging.

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## Abstract Archives of the RSNA, 2023

NREE-43

### **NODDI vs Traditional dMRI Metrics: Revealing Microstructure Without a Microscope**

All Day Room: Learning Center

Janova Anbarasi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Importance of dMRI as a non-invasive medical imaging modality for investigating the white matter integrity in the brain. Different traditional scalar metrics currently used for characterising the diffusion of water molecules - FA, MD, RD and AD and discussing their pitfalls. Introduction to new advanced metrics like NODDI (neurite orientation dispersion and density imaging) for neuroscience clinical research. Clinical relevance of scalar metrics

#### **TABLE OF CONTENTS/OUTLINE**

Introduction to dMRI Traditional dMRI metrics to reveal microscopic details of tissue architecture (FA, AD, RD, MD) Pitfalls of traditional metrics NODDI- introduction and applications in clinical research (TBI and Epilepsy)

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-44

### Practical Guide for Young Radiologists: Basic Sequences in Neuroradiology

All Day Room: Learning Center

Taisa V. Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the aspects and physical parameters of basic magnetic resonance imaging sequences of the brain. Identify the main evaluation structures and tissue signal patterns in each sequence. Correlate brain diseases with signal changes.

#### TABLE OF CONTENTS/OUTLINE

Different Magnetic Resonance (MRI) imaging sequences are used together for brain evaluation. Knowledge of the physical aspects and signal patterns of basic MR sequences are essential for elucidation of neurological pathologies. Variables such as the number of radiofrequency (RF) pulses, angle, period between excitations (repetition time - TR) and period between excitation to echo (echo time - TE) determine the different signals between tissues on T1, T2 and image density proton weights. Some tissues and contents show different signals in each sequence. In the T1 sequence, fat, lesions with high protein content, some stages of hemoglobin degradation and melanin have high signal. In this sequence, it is important to analyze bone structures, brain parenchyma, flow-void, pineal and pituitary glands. In the T2/FLAIR sequence, most lesions have high signal, is a good sequence to see white lesions. In T2\*/SWI, blood, calcium, air have low signal. Some neoplastic, infectious, and ischemic changes show diffusion restriction on the DWI sequence and characteristic postcontrast enhancement. The correlation of signal patterns from different tissues in the evaluation of basic sequences helps in the recognition of patterns of normality and pathological alterations, being an important knowledge for young radiologists to begin to understand the findings of magnetic resonance imaging of the brain.

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## Abstract Archives of the RSNA, 2023

NREE-45

### The Art of Arteritis: Imaging Primary CNS Vasculitis

All Day Room: Learning Center

Eleanor Taylor, MSc, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. A practical approach to the investigation of PCSNV, covering the diagnostic criteria, presentation, and laboratory tests, but with a primary focus on imaging. 2. A structured discussion of the radiological manifestations of PCNSV. 3. An awareness of the common mimics and their differentiating clinical and radiological features. 4. Insight into the role of imaging in the process of diagnosis and treatment from a multidisciplinary perspective.

#### TABLE OF CONTENTS/OUTLINE

Primary central nervous system (CNS) vasculitis (PCNSV) is an extremely rare diagnosis but a common clinical concern. The presentation is non-specific; it typically manifests in middle-aged patients with subacute headache, altered cognition, and variable additional neurological features. Cerebrospinal fluid analysis can be normal in up to one third of cases. The radiological phenotype is protean, with no pathognomonic findings and innumerable mimics. Luminal vascular imaging has variable sensitivity and poor specificity. Assessment can be augmented by the use of vessel wall imaging, but this is not a panacea. Definitive diagnosis requires biopsy, not always an attractive prospect, but the risks need to be weighed against those of the disease and its treatment, both of which are considerable. To meet this formidable challenge, we will outline a practical approach to the investigation of suspected PCSNV, review the imaging findings, and explore the common mimics and their differentiating features. This will be illustrated with a series of cases compiled from a neurosciences centre in London.

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## Abstract Archives of the RSNA, 2023

NREE-46

### The Hidden Dangers of Hypothalamic and Hypophyseal Lesions: Not Everything is Neoplastic

All Day Room: Learning Center

Taisa V. Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the normal anatomy and embryology of hypothalamic-pituitary axis using schematic illustrations and imaging MRI. Identify the main imaging features to guide differential diagnosis in non-neoplastic hypothalamic-pituitary involvement. To display a compendium of cases of non-neoplastic hypothalamic-pituitary axis.

#### TABLE OF CONTENTS/OUTLINE

The hypothalamic-pituitary axis is responsible to regulate many other endocrine glands through its hormone, and the pituitary being known as the master gland, is divided into two distinct parts: the anterior pituitary (adenohypophysis) and the posterior pituitary (neurohypophysis), differ in embryologic origin and function. There are several diseases that can affect the function and morphology of the hypothalamic-pituitary axis. It is susceptible to involvement by a variety of processes, including congenital, infectious or inflammatory, neoplastic or toxic-metabolic diseases. Imaging plays a key role in determining the most probable diagnosis and Magnetic resonance (MR) imaging is the modality of choice for evaluating the anatomy and pathologic conditions of the hypothalamic-pituitary axis, helping to distinguish neoplastic and non-neoplastic lesions. The MRI differential diagnosis depends on anatomic recognition and characterization of associated imaging findings such as volumetric changes, stalk thickening, cystic appearance, intensity of signal in T1 and T2-weighted imaging. Therefore, we propose a systematic approach to address non-neoplastic pituitary changes based on the most important imaging patterns.

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## Abstract Archives of the RSNA, 2023

NREE-47

### Uncovering Coverage: Best Cases on Meningeal Pathology

All Day Room: Learning Center

Raissa Marjory Zonta Moreti, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review normal meningeal embryology and anatomy. To understand normal behavior of brain meninges. To discuss best MR imaging protocol to evaluate meningeal diseases. To create systematic approach to evaluation of imaging patterns of most relevant meningeal pathology.

#### TABLE OF CONTENTS/OUTLINE

Introduction Normal embryology Anatomy Physiological behavior of meninges Imaging protocol MR imaging patterns Anatomic - leptomeningeal, pachymeningeal. Morphologic - mass-like, nodular, smooth. Meningeal pathology Infection Pyogenic Viral Fungal Parasite Tumors Benign Malignant - primary and secondary Granulomatosis Sarcoidosis Tuberculosis Wegener disease Langerhans Cell Disease Non Langerhans Cell Disease Inflammatory Diseases IgG4 related Pseudotumor Miscellaneous Iatrogenic Traumatic

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## Abstract Archives of the RSNA, 2023

NREE-48

### Everything About CNS Infections: A Pictorial Review. Tips and Tricks for General Radiologists

All Day Room: Learning Center

David Castanedo SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To highlight the diagnostic pearls to recognize properly CNS infections. - To showcase the differential diagnosis of the main CNS infections.- To point out the importance of the state of the immune system when analyzing these studies. - To provide an extensive pictorial review with the most typical findings of both common and uncommon infections, from bacteria, to viruses, and also fungi and parasites.

#### TABLE OF CONTENTS/OUTLINE

1. Bacterial meningitis. 1.1. Typical imaging features. 1.2. Complications: acute hydrocephalus, extra-axial collections, cranial nerve involvement, arterial and venous strokes, ventriculitis. 2. Brain abscesses and cerebritis. 2.1. Ring enhancing lesions differential diagnosis. 3. Herpes encephalitis. 4. Rhombencephalitis. 5. Acute cerebellitis. 6. Encephalitis with bithalamic lesions. 7. Neurosyphilis. 8. Neurocysticercosis. 9. Hydatidosis. 10. Toxoplasmosis.11. Cryptococcal meningitis. 12. Progressive multifocal leukoencephalopathy. 13. HIV encephalopathy. 14. Nocardia. 15. Aspergillosis. 16. Mucormycosis. 17. Neuroborreliosis. 18. Rickettsial infections. 19. COVID-19. 20. Creutzfeldt-Jakob.

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## Abstract Archives of the RSNA, 2023

NREE-49

### Cranial Surgical Approaches: What the Radiologist Needs to Know

All Day Room: Learning Center

#### Awards

##### Cum Laude

Taisa V. Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To correlate the topography of brain lesions with surgical approaches through illustrations and imaging tests. Assist in the identification of surgical accesses through imaging exams. Establish anatomical relationships and correlate with the surgical approaches crania.

#### TABLE OF CONTENTS/OUTLINE

In addition to the pre-surgical evaluation for neurosurgeries, the imaging study is extremely important in identifying postoperative findings. Post-surgical changes include repercussions on the brain parenchyma, soft tissues and recognition of the cranial approaches used. The evolution of the location of the pathology helps in the interpretation of the surgical approach. Some topographies favor the use of specific accesses to allow manipulation of certain structures. Access to the skull base, brainstem, supratentorial and intraventricular are well established in the literature and the correct description in the medical report is part of the post-surgical evaluation. Therefore, we proposed to correlate surgical procedures with the location of encephalic pathologies. The demonstration of these aspects is facilitated through schematic illustrations that make it possible to associate these findings with the topography of the lesion in the surgical approach.

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## Abstract Archives of the RSNA, 2023

NREE-5

### Old but Gold: A Primer of Spine Radiography

All Day Room: Learning Center

Bianca Bianco, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The spine is made up of a complex anatomy and its evaluation could be challenging sometimes. It is a curved structure composed of bony vertebrae that are connected through cartilaginous intervertebral discs. It ensures proper posture, spinal cord protection, communication with the brain, body mobility and sensation through the complex interplay between the bones, ligaments and muscle structures. The radiography is the first method for its evaluation. Although this a simple imaging method, the correct analysis is very important for the clinical management of the patient. A well-performed radiography, with an appropriate position and adequate beam increases the accuracy of the diagnosis, besides the low-cost exam and high availability in the health care system. The purpose of this presentation is to review the normal anatomy of the cervical, thoracic and lumbar spine, to provide a didactic approach about the main characteristics of the evaluation, and to guide young physicians through the analysis of spine radiography.

#### TABLE OF CONTENTS/OUTLINE

Didactic review of how to evaluate the spine radiography, including the aspects of the technique, anatomy of the cervical, thoracic and lumbar spine as well as the most common pathologies, based on our service 's digital archive.

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## Abstract Archives of the RSNA, 2023

NREE-50

### **Encephalitis and Encephalopathy: Differential Diagnosis of Infectious and Autoimmune Diseases Based on Imaging Patterns and Topography**

All Day Room: Learning Center

Beatriz D. Prado, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: To review and discuss the differential diagnosis and brain MRI imaging patterns of infectious and autoimmune diseases by brain topography. Discuss and illustrate through illustrative cases different imaging patterns and emphasize the key findings that may lead to a specific diagnoses.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Describe the most common brain MRI imaging features of encephalitis and encephalopathy, including images that illustrate each feature, such as swelling, inflammation, bleeding, among others. Discuss the differential diagnosis of encephalitis and encephalopathy on brain MRI, divided by topography: -Cortical: Anti-NMDAR encephalitis, Herpes simplex encephalitis, Progressive Multifocal Leukoencephalopathy -White matter: Multiple Sclerosis, Susac Syndrome, FLAMES -Basal ganglia and/or thalamus: Auto-immune striatal encephalitis, FLAMES, acute necrotizing encephalitis, Neurocysticercosis -Cerebellum: Paraneoplastic cerebellar degeneration with anti-TR, Paraneoplastic cerebellar degeneration with anti-GAD, Aseptic meningitis with systemic lupus erythematosus, Acute disseminated encephalomyelitis -Brainstem: Progressive Multifocal Leukoencephalopathy, enterovirus rhomboencephalitis, Listeria rhomboencephalitis, NMSOD Key findings and diagnostic tips Diagnostic Approach Final remarks

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## Abstract Archives of the RSNA, 2023

NREE-51

### Motor Neuron Diseases: Diagnostic Approach, Imaging Findings, and Mimics

All Day Room: Learning Center

Tatiana Iutaka, BDS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This panel aims to: Study the diagnostic approach and clinical indications of imaging in motor neuron disease (MND); Review the MRI acquisition protocols, including advanced MRI techniques; Explain and demonstrate through illustrative cases different imaging patterns of MND; Discuss the main MND mimics and their imaging findings

#### TABLE OF CONTENTS/OUTLINE

Review of the definition and clinical syndrome of MND  
Review the clinical indications of imaging in MND  
Review the main imaging techniques used for the evaluation of MND  
Standard MRI acquisition protocol  
MRI signs that might support the diagnosis directly: T2WI, FLAIR, and magnetization transfer hyperintensities in the corticospinal tract (CST) in the brain or sometimes in the spinal cord  
Atrophy of the precentral gyrus  
The 'motor dark line' in T2WI and susceptibility sequences  
The bright tongue sign  
Illustrative cases of motor neuron diseases: Amyotrophic lateral sclerosis (ALS) Bulbar ALS Primary lateral sclerosis Mills syndrome  
Imaging findings of the main MND mimics, divided by clinical feature (e.g.: upper motor neuron (UMN) onset, purely UMN, bulbar onset): Ischemia (e.g., stroke) Mass (e.g., tumor, vascular malformation) Radiculopathies (cervical, lumbosacral) Demyelinating disease (e.g., multiple sclerosis)  
Advanced imaging and respective findings: DWI: Lower mean fractional anisotropy in the CST  
Volumetric or morphometric analyses of T1WI 3D MRI: Volume changes mainly in classical motor areas  
Proton (1H) magnetic resonance spectroscopy (MRS): NAA decline over time in the motor cortex  
Functional MRI: Altered cortical activity in patients with ALS  
PET and SPECT: Hypometabolism and hypoperfusion are most prominent in the motor cortex

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## Abstract Archives of the RSNA, 2023

NREE-52

### **The Fascinating Limbic System: Anatomy, Pathology and Involvement Patterns**

All Day Room: Learning Center

Lucas S. Souza, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are:- Review and illustrate the imaging anatomy of the limbic system, correlating with the main imaging methods, emphasizing the potential of each in identifying the structures.- To describe the main imaging patterns of lesions involving the limbic system, including dementia and psychiatric disorders, inflammatory and infectious diseases, temporal lobe epilepsy, neoplasms, Wernicke's encephalopathy, ischemic events, among others, highlighting key points for approaching the diagnosis differential.- Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

#### **TABLE OF CONTENTS/OUTLINE**

- Anatomy of the limbic system, emphasizing the functional aspects.- Imaging patterns of diseases that affect the limbic system.- Differential diagnosis based on a pictorial review using representative cases from our institutional database: - Neoplasms - Infection and inflammation- Dementia and neuropsychiatric disorders- Ischemia and Infarction - Metabolic diseases - Developmental malformations- Diagnostic Algorithm- Final remarks

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## Abstract Archives of the RSNA, 2023

NREE-53

### Imaging the Sick Neonate: Neurosonogram in Hypoxic Ischemic Injury

All Day Room: Learning Center

Anjuna Reghunath, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Hypoxic-ischemic injury (HII) of the neonatal brain and resulting encephalopathy sequel remains a significant cause of morbidity and mortality in the neonatal population. 2. Ultrasound of skull (neurosonogram) is a powerful and effective screening tool in the evaluation of sick neonates with clinical hypoxia as it determines the pattern, timing, and extent of injury in HII and differentiates it from other conditions with similar clinical picture. 3. The pattern of injury on brain imaging has crucial implications in therapies and predicted neurodevelopmental outcomes. 4. Major role of neurosonogram is identifying the diagnosis, directing appropriate therapy, monitoring evolution of disease, predicting outcomes and detecting complications of therapy. 5. Addition of Doppler and shear wave elastography (SWE) in determining the difference in brain stiffness in neonates with birth asphyxia can increase the specificity of grey-scale ultrasound.

#### TABLE OF CONTENTS/OUTLINE

1. Normal neurosonogram appearance and technique in neonates. 2. Pathogenesis, grading and evolution of HII in term and preterm neonates with less profound and severe injury. 3. Patterns of HII in term and preterm neonates with illustration. 4. Role of ultrasound Doppler and SWE in evaluation of HII. 5. Ultrasound illustration of few clinical mimics of HII. 6. Uses and limitations of neurosonography.

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## Abstract Archives of the RSNA, 2023

NREE-54

### Errors in the Neuroradiological Emergency: An Escape Room Experience

All Day Room: Learning Center

Nathalia C. Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

TEACHING POINTS The purposes of this exhibit are:- Discuss and illustrate clinical cases of the neuroradiological emergency in a quiz and gamification format, simulating an Escape Room experience.- Highlight the imaging points and red flags to make right diagnoses in the context of emergency. - Describe the most common possible errors in neuroradiological emergency, highlighting tips and challenges in the cases presented.

#### TABLE OF CONTENTS/OUTLINE

TABLE OF CONTENTS: - Neuroradiological emergency cases in an escape room dynamic:- The most emblematic cases in the context of neuroradiological emergency- Types of errors that can occur while the radiologist is analyzing a case- Series of cases that leads to escape and to finish the call and escape the room- Clinical cases - Quiz format- Ischemic stroke - Early and late signs of stroke- Main trials and treatment windows- Hemorrhagic lesions- Trauma - Fracture and anatomic pitfalls - Pseudofractures in a child skull - Hematic collections- Brain herniations- Headache- Arterial dissection- Metabolic disorders in the emergency- Most common intoxications- Key tips and challenges from the cases demonstrated- Escaping the room: conclusions and lessons learned

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-55

### Temporal Lobe Tumors: A Pattern-based Imaging Approach

All Day Room: Learning Center

Afonso P. Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the anatomy of the temporal lobe; 2. Group the main primary central nervous system (CNS) tumors that affect the temporal lobe according to imaging characteristics; 3. Synthesize the main imaging features of each tumor that help in the differential diagnosis on flashcards for quick reference; 4. Show some differential diagnoses that can be confused with temporal lobe tumors

#### TABLE OF CONTENTS/OUTLINE

Temporal lobe disorders are associated with several conditions, including seizures, dementia, and memory impairment, followed by a spectrum of behavioral disorders. It is noteworthy that about 10% of temporal lobe epilepsies are caused by focal temporal lesions. In this context, this work has as main objectives: In this sense, most primary CNS tumors can potentially occur in the temporal lobe, but entities with a predilection for being diagnosed in this location include: ganglioglioma (40%), DNET (20%), diffuse low-grade astrocytoma (20%) and others (20%). Some of these lesions may present specific imaging characteristics, which allow narrowing the differential diagnosis. Didactically, these lesions can be grouped based on imaging features into solid-cystic, bullous, or solid. Besides any primary CNS tumor can arise from temporal lobe, this location has specific clinical symptoms, and some tumors has a particular predilection for the temporal lobe. The radiologist has a special rule to recognize and narrow the differential diagnosis that will guide the treatment or follow up on each case.

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## Abstract Archives of the RSNA, 2023

NREE-56

### Embryonal Tumors - Correlations Between Imaging Findings and Molecular Subtypes

All Day Room: Learning Center

Larissa Freitas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: • To present the essential embryonal malignancies of the Central Nervous System. • To review the WHO CNS5 classification, considering the new modifications in nomenclature and distribution of embryonal tumors. • To make a parallel between radiophenotypic imaging and genomic features. • To present the essential imaging features correlated to tumor's genetic pattern. • To highlight the importance of recognizing the imaging pattern of embryonal tumors to therapeutics and prognosis.

#### TABLE OF CONTENTS/OUTLINE

- Introduction - Essential embryonal malignancies of the Central Nervous System. - Review the WHO CNS5 classification making a parallel between radiophenotypic imaging and genomic features.
- Medulloblastoma - Medulloblastoma WNT-activated - Medulloblastoma SHH-activated - Medulloblastoma, non-WNT / non-SHH - Group 3 - Group 4 - Other embryonal tumors
- Atypical teratoid rhabdoid tumor - Embryonal tumor with multilayered rosettes - CNS Neuroblastoma, FOXR2-activated

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## Abstract Archives of the RSNA, 2023

NREE-57

### **A Pocket Guide of the Main Side Effects, from Common to Rare, of Radiation Therapy in the Brain**

All Day Room: Learning Center

Marta Calvo-Imirizaldu, MD (*Presenter*) Research Grant, Siemens AG

#### **TEACHING POINTS**

- To review the different techniques of brain radiation therapy available for primary or metastatic tumors, that radiologists need to know. Basic pathophysiology. Novel approaches and indications.- To recognize the main radiation-related findings on brain studies, from common to unexpected, and its differential diagnosis. Focus on radiation necrosis, radiation induced tumors, and mimics of vascular diseases (SMART syndrome, vasculitis, PRES).

#### **TABLE OF CONTENTS/OUTLINE**

1. Background and basics pathophysiology of radiation therapy.i. Clinical relevance statement ii. Basic pathophysiology iii. Risk factors. Benefits and risks iv. Radiation therapy techniques: conventional radiation therapy (external beam radiation therapy), stereotactic radiosurgery, proton therapy. v. Dosimetry2. MRI features and pictorial review of the main radiation-related findings on brain imaging, with differential diagnosis:- Common: a. Atrophy b. Leukoencephalopathy c. Microhemorrhages/cavernomas d. Hypoperfusion e. Mastoiditis- Less common: a. Pseudoprogession b. Radionecrosis c. Intratumoral bleeding d. Radiation-induced vasculitis- Rare: a. Radiation-induced tumors (most comonly meningioma) b. SMART syndrome: stroke-like migraine attack after radiation therapyc. PRES3. Reporting tips4. Conclusion

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## Abstract Archives of the RSNA, 2023

NREE-58

### **Radiological Evaluation of the Spectrum of Pathologies Involving Medullary Veins in Neonates and Young Children**

All Day Room: Learning Center

Esther Martin Ramirez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe the anatomy and the venous drainage pathways of the intracranial venous system, with emphasis on medullary veins. To review the main pathologies that can cause medullary veins injury in newborns and young children. To explain the pathophysiology of diseases associated with medullary veins injury and their characteristic radiological findings, especially based on magnetic resonance imaging (MRI). To review the guideline-recommended MRI technique for medullary veins evaluation.

#### **TABLE OF CONTENTS/OUTLINE**

There are two types of medullary veins: superficial veins (SMV) and deep veins (DMV). SMV drain the subcortical white matter centrifugally into pial veins, whereas DMV drain the deep white and grey matter centripetally into subependymal veins, with a characteristic distribution consisting of a radial pattern with four convergence zones in frontal horns and trigons, and a parallel pattern in bodies and inferior horns of lateral ventricles. The unique disposition of medullary veins allows us to detect their involvement in different pathologies through different imaging techniques, especially on MRI with susceptibility-weighted imaging sequences. The aim of this educational exhibit is to review the most frequent pathologies related to medullary veins seen in neonates and young children, including vascular anomalies, thrombosis, hemorrhage and infectious encephalitis, among others.

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## Abstract Archives of the RSNA, 2023

NREE-59

### Fungus on the Mind: There's Much Room for Improvement

All Day Room: Learning Center

Girija Agarwal, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. An overview of the epidemiology, pathophysiology and clinical features of fungal CNS infections. 2. A structured review of the imaging features of various fungal CNS infections and their complications. 3. An approach to the differentiation of fungal CNS infections from other common infectious and non-infectious mimics, with a focus on clinico-radiologic correlation.

#### TABLE OF CONTENTS/OUTLINE

Fungal infections of the central nervous system (CNS) typically occur in immunocompromised patients and can be caused by yeasts (e.g. *Cryptococcus*), molds (e.g. *Aspergillus*), and dimorphic fungi (e.g. *Coccidioides*). The prognosis is influenced by the specific organism and patient factors but is frequently poor with mortality generally exceeding >50%. The imaging features, whilst often non-specific with a broad differential in a majority of cases, can also be distinctive and sometimes organism specific. Pathophysiological knowledge of varying fungal infections aids understanding the pathognomonic features to aid in narrowing the differential. Querying fungal etiology, even if the findings are less specific, at an early-stage aids directed laboratory testing and empirical treatment. Prolonged iatrogenic immunosuppression is on the rise, with increasing organ transplantation and cancer incidence. Old foes like HIV remain common. Radiologists are therefore increasingly likely to encounter fungal CNS infections sporadically and must be familiar with the imaging manifestations to aid early diagnosis and improve clinical outcomes.

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## Abstract Archives of the RSNA, 2023

NREE-6

### Neuroradiologic Complications of Immunotherapy in the Treatment of Cancer

All Day Room: Learning Center

John A. Arrington, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

• As immune modulation in the treatment of cancer is becoming more common, its complications become more prevalent and the radiologist should be aware of these to aid rapid diagnosis and appropriate therapy. Unlike conventional chemotherapy which typically will cause immune suppression, immune modulation therapy generates an increase in systemic immune response and therefore a different spectrum of complications. This exhibit will explain the nomenclature, mechanism of action, and imaging features of more common complications of immunotherapy in the treatment of neoplasm.

#### TABLE OF CONTENTS/OUTLINE

• Mechanism of action of Immune Checkpoint Inhibiter (ICI) therapy • Mechanism of action of Chimeric Antigen Receptor T Cell (CAR-T) therapy • Recognizing ICI nomenclature (\*mab) is helpful to know to determine if a patient's therapeutic regimen includes ICI • Neuroimaging examples • Hypophysitis • Pseudoprogression • Myositis • Acute Idiopathic Demyelinating Polyneuropathy (AIDP). • Acute myelitis (CAR-T) • Thyoiditis • CAR-T related infarction

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## Abstract Archives of the RSNA, 2023

NREE-60

### Diffuse High-Grade Gliomas - New Concepts

All Day Room: Learning Center

Bruna B. Carvalho (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: • To present the current classification of central nervous system tumors and genetic biomarker roles. • To define pediatric-type and adult-type diffuse high-grade gliomas and their molecular pathways. • To present the essential imaging features correlated to the tumor's genetic pattern. • To correlate radiophenotypic imaging and genomic features with prognosis and determination of treatment approaches.

#### TABLE OF CONTENTS/OUTLINE

- Adult-type diffuse high-grade gliomas - Glioblastoma, IDH wildtype - Astrocytoma, IDH-mutant, grade 4 - Astrocytoma, IDHm, CDKN2A/B homozygous deletion, grade 4
- Pediatric-type diffuse high-grade gliomas - Diffuse midline glioma, H3 K27-altered - Diffuse hemispheric glioma, H3 G34-mutant

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## Abstract Archives of the RSNA, 2023

NREE-61

### **Anoxic Brain Injury Patterns. What Can't I miss? Reviewing Patterns and Differential Diagnosis of Anoxic Brain Injury in Newborns, Children and Adults**

All Day Room: Learning Center

Bernnardo P. Pillar Quadros (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: - Review and illustrate the imaging findings of the main anoxic brain injuries patterns, classified according to age: newborns, children and adults. - Describe the main imaging patterns of the anoxic brain injuries, including brainstem lesion, thalamic lesion, periventricular leukomalacia, ventrolateral thalamic lesion, posterior putamen lesion, perirolandic cortex lesion, cortical laminar necrosis, delayed post-hypoxic leukoencephalopathy, HACE, diffuse edema, some intoxication hypoxia patterns and some differential diagnosis, highlighting key points to differential diagnosis approach. - Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

#### **TABLE OF CONTENTS/OUTLINE**

- Imaging patterns of main anoxic brain injuries in newborns, children and adults. - Preterm newborn patterns lesions - Term newborn patterns lesions - Children/ adults patterns lesions - Intoxication hypoxia patterns lesions - Differential diagnosis based on a pictorial review using representative cases from our institutional database - Hypoglycemia - Creutzfeldt-Jakob disease - Uremic Encephalopathy - Metabolic disorders - Diagnostic Algorithm- Final Remarks

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-62

### Cerebrovascular Reserve Imaging Evaluation: How Much of a Challenge Can it Be

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Bernardo C. Teixeira, MD,PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cerebrovascular reserve imaging with arterial spin labeling (ASL) and acetazolamide challenge is a non-invasive MRI-based technique that evaluates cerebrovascular reactivity. ASL measures cerebral blood flow by magnetically labeling arterial blood water protons, allowing for quantification of regional cerebral blood flow (CBF) without exogenous contrast agents. Acetazolamide (a vasodilator) challenge can be used to estimate cerebrovascular reserve (CVR). ASL with acetazolamide challenge is useful for assessing CVR in neurological conditions such as cerebrovascular disease and neurodegenerative disease.

#### TABLE OF CONTENTS/OUTLINE

I. Introduction II. Arterial Spin Labeling III. Acetazolamide Challenge IV. Cerebrovascular Reserve Imaging with ASL and Acetazolamide Challenge Protocol, applications and analysis. V. Clinical Utility in Various Neurological Disorders VI. Conclusion

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## Abstract Archives of the RSNA, 2023

NREE-63

### Brainstorming the Brainstem: A Pictorial Review of Challenging Diagnosis

All Day Room: Learning Center

Rafael Oliveira (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The goals of this paper are: - Brief anatomy review of the brainstem - Summarize uncommon diseases of the brainstem - Review imaging presentations of brainstem diseases - Differentiate common and uncommon patterns of known diseases affecting the brainstem

#### TABLE OF CONTENTS/OUTLINE

Powerpoint layout  
1 Midbrain: 1.1 Parkinson 1.2 Wernicke-Korsakoff Syndrome 1.3 Wilson's Disease  
2 Pons: 2.1 Chronic lymphocytic inflammation with pontine perivascular enhancement responsive to steroids (CLIPPERS) 2.2 Osmotic Myelinolysis 2.3 Autosomal recessive spastic ataxia of Charlevoix-Saguenay (ARSACS)  
3 Medulla: 3.1 Friedreich Ataxia 3.2 Neuromyelitis optica spectrum disorder (NMOSD) 3.3 Dural Arteriovenous Fistula 3.4 Adult Onset Alexander Disease (AOAD) 3.5 Leukoencephalopathy with brainstem and spinal cord involvement and lactate elevation (LBSL)  
4 Miscellany: 4.1 Neuro-Behçet 4.2 Enterovirus Rhombencephalitis 4.3 Myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD) 4.4 Adrenoleukodystrophy

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## Abstract Archives of the RSNA, 2023

NREE-64

### **Glioneuronal and Neuronal Tumors: What Can Molecular Pathways Teach Us**

All Day Room: Learning Center

Giovanna S. Calfi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- List the essential information on various glioneuronal and neuronal tumors according to the 5th Edition of the WHO Classification of Tumors of the Central Nervous System. - Identify the main imaging features and molecular pathway involved in these brain tumors. - Highlight the importance of recognizing those patterns to help neuroradiologists narrow their diagnostic hypotheses, thus saving time and resources.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction: Brief review of the inclusion of glioneuronal and neuronal tumors in the 5th edition of the 2021 WHO Classification of Tumors of the Central Nervous System; Presentation of the main common characteristics of glioneuronal and neuronal tumors; Illustration of the MAPK pathway - The radiological, epidemiological and clinical characteristics correlated based on the most known genetic mutations of each tumor, namely: Dysembryoplastic neuroepithelial tumor (DNET); Multinodular and vacuolating neuronal tumor (MVNT); Central neurocytoma; Extraventricular neurocytoma; Ganglioglioma; Rosette-forming glioneuronal tumor; Dysplastic cerebellar gangliocytoma (Lhermitte-Duclos disease); Diffuse leptomeningeal glioneuronal tumor; Desmoplastic infantile astrocytoma; Papillary glioneuronal tumor; Gangliocytoma; Myxoid glioneuronal tumor

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## Abstract Archives of the RSNA, 2023

NREE-65

### Practical Guide to Fetal Craniospinal MRI: Essentials for General Neuroradiologists and Trainees

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Elliot T. Varney, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

After review of this exhibit, the radiologist should: Be able to recognize the normal fetal anatomy of the craniospinal axis. Be familiar with common indications for fetal MRI and protocol for fetal Neuroimaging. Recognize and diagnose a broad range of pathologies that can be assessed with fetal MRI.

#### TABLE OF CONTENTS/OUTLINE

Fetal ultrasound is the primary diagnostic tool used for fetal imaging, but there are limitations to imaging the fetal brain, face and neck, and spinal canal. Fetal MRI is often performed to characterize ultrasound findings and provide better prognostic information for obstetric patients. Common indications for fetal craniospinal MRI include ventriculomegaly, midline anomalies, posterior fossa malformations, fetal intracranial mass, encephaloceles, cleft lip and palate, spinal malformations, and in utero disruptive events. With increased demand for these exams for pre- and post-natal health, more general neuroradiologists will be needed for interpretation. This comprehensive review has the potential to improve patient access to fetal craniospinal MRI by increasing general neuroradiologist's and trainee's comfort with interpretation of these exams. We will review imaging protocols, normal fetal anatomy, common indications, case examples, and postnatal MRI correlates. Case examples will include the Pierre Robin sequence, congenital epulis, Dandy Walker variants, open and closed dysraphism, intrauterine fetal demise with intracranial hemorrhage, oro-facial-digital syndrome, and multiple midline abnormalities including alobar holoprosencephaly with synophthalmia.

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## Abstract Archives of the RSNA, 2023

NREE-66

### **The Hidden Face of Gliomas: Decoding the Pathophysiology and Infiltrative Patterns of Gliomas**

All Day Room: Learning Center

Marta Calvo-Imirizaldu, MD (*Presenter*) Research Grant, Siemens AG

#### **TEACHING POINTS**

- To review the current knowledge of the pathophysiology of gliomas and the challenges of their study and management.- To outline different imaging presentations of gliomas and the role of MRI in the presurgical workup of these tumors. Pearls on imaging biomarkers available and potential diagnostic pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background. Pathophysiological aspects of glioma  
2. Imaging protocol recommended for brain tumors  
3. Pictorial review of the main different infiltrative patterns of gliomas, from isolated hyperintense signal on T2-FLAIR to ring-enhancing necrotic gliomas:  
a. Non-contrast enhancing gliomas  
b. Gliomatosis pattern of gliomas  
c. Non-enhancing with contrast enhancing components gliomas  
d. Homogeneous enhancing gliomas  
e. "Ring enhancing" with necrosis gliomas  
f. Cystic gliomas  
g. Butterfly gliomas  
h. Multifocal gliomas  
With the following information applying for each: clinical issues and pearls on the updated 2021 World Health Organization classification, imaging biomarkers available and potential diagnostic pitfalls.  
4. Reporting tips  
5. Conclusion

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## Abstract Archives of the RSNA, 2023

NREE-67

### Myelination and Inborn Errors of Metabolism: Learning That Goes Hand in Hand

All Day Room: Learning Center

Lucas S. Souza, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are:- Review and illustrate the classic patterns of myelination, emphasizing the main findings for age delimitation, as well as signs of developmental delay.- To describe the main imaging patterns of Inborn Errors of Metabolism, including hypomyelination and demyelination, exemplifying cases of Pelizaeus disease, Alexander disease, Canavan disease, Krabbe disease, Metachromatic leukodystrophy, among others, highlighting key points for approaching the differential diagnosis.- Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

#### TABLE OF CONTENTS/OUTLINE

- Imaging patterns of white matter myelination, emphasizing the key findings.- Neuroimaging of Inborn Errors of Metabolism.- Differential diagnosis based on a pictorial review using representative cases from our institutional database:- Organelle-based approach- Imaging pattern approach: white matter predominance versus gray matter predominance; diffuse white matter involvement (vanishing white matter disease), involvement of the basal ganglia (PKAN, MELAS), periventricular predominance (metachromatic leukodystrophy and Krabbe disease), subcortical predominance (L2-hydroxyglutaric aciduria), among other patterns.- Diagnostic Algorithm- Final remarks

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## Abstract Archives of the RSNA, 2023

NREE-68

### Neurovascular Potpourri: Disentangling the Differentials

All Day Room: Learning Center

Eugene Shin, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Vascular pathology may be the primary reason for, or an incidental finding on contrast enhanced exams. The goal of this presentation is to provide a broad overview of the range of neurovascular findings one may encounter, from benign congenital variations to neoplasms.

#### TABLE OF CONTENTS/OUTLINE

Neurovascular topics covered include the following: 1. Congenital/anatomic variants, including aortic arch and major branches, Circle of Willis and persistent carotid-vertebrobasilar anastomoses, arterial fenestration, and junctional dilatation of the basilar artery tip. 2. Review International Society for the Study of Vascular Anomalies characterization of vascular anomalies, primarily discerning vascular malformations from tumors with case examples. Tips will be provided to help discern vascular lesions from similar appearing processes in the head and neck region. 3. Examine other vascular disorders including moyamoya disease, fibromuscular dysplasia (including carotid intimal variant), reversible cerebral vasoconstriction syndrome, and amyloid angiopathy.

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## Abstract Archives of the RSNA, 2023

NREE-69

### 'To Bleed or Not to Bleed'- The DVA Conundrum

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Sabha Ahmed, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Delineate the angioanatomy of developmental venous anomalies.
- Classify the various mechanisms that render DVAs symptomatic.
- The following are illustrated with sample cases:
  - "Flow related" pathomechanisms.
  - decreased outflow; collector vein thrombosis and DVA thrombosis.
  - Increased inflow in the form of arterialisation of DVA .
  - DVAs associated with cavernomas
  - DVAs with no overt neuroparenchymal signal changes but with resistant epilepsy with metabolic abnormality on PET.
  - DVAs associated with grey matter abnormalities.
  - DVAs in tandem with high grade gliomas.

#### TABLE OF CONTENTS/OUTLINE

- Angioanatomy of developmental venous anomalies
- Classification of the various pathomechanisms of symptomatic DVAs
- The following are illustrated with sample cases:
  - "Flow related" pathomechanisms (as would be illustrated in our case series)
  - decreased outflow; collector vein thrombosis and DVA thrombosis.
  - Collector vein stenosis culminating in outflow restricted DVAs.
  - Increased inflow in the form of arterialisation of DVA .
  - DVAs associated with cavernomas
  - DVAs with no overt neuroparenchymal signal changes but with resistant epilepsy with metabolic abnormality on PET.
  - DVAs associated with grey matter abnormalities.
  - DVAs in tandem with high grade gliomas.
  - Overview of the treatment strategies both endovascular and conservative in the management of these vascular lesions.

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## Abstract Archives of the RSNA, 2023

NREE-70

### Easy Come, Easy Go - Transient Brain Findings

All Day Room: Learning Center

Samya S. Alves, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Despite the notability of sequelae left by neurological diseases, many conditions may present as transient abnormalities. Toxic-metabolic encephalopathies comprise one of the groups which classically presents in such manner and is part of the radiologists' daily practice - most of them having a pattern of symmetrical restricted diffusion. Other entities, like some vasculopathies and genetic determined diseases - although instinctively associated with permanent brain damage - might also portray themselves as temporary imaging alterations. In these cases, the follow-up would be critical in determining the diagnosis as it is in differentiating a post-ictal change (typically reversible) from an autoimmune encephalitis (more enduring).- Present a didactic manner for sorting of transient findings and reversible conditions by pathophysiology.- Illustrate transient imaging features in a case-based review.

#### TABLE OF CONTENTS/OUTLINE

Suggestion for sorting of reversible imaging findings and conditions

- Toxic-metabolic: exogenous intoxications (medication, recreational drugs), endogenous intoxications , cytotoxic lesions of corpus callosum (CLOC)
- Vascular: PRESS, vasoconstriction syndromes, hemiplegic migraine, transient global amnesia, focal cerebral arteriopathy of childhood
- Genetic determined: phenylketonuria, urea cycle disorders, mitochondrial encephalopathy with lactic acidosis (MELAS).
- Neoplastic: some brain tumors may exhibit temporary post contrast enhancement or cystic changes without meaning tumor progression (e.g., pilocytic astrocytoma).
- Miscellaneous: stroke-like migraine attacks after radiation therapy, benign external hydrocephalus, torcular pseudomass

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## Abstract Archives of the RSNA, 2023

NREE-71

### Post-operative Spine Imaging: Evolution of Percutaneous and Surgical Devices

All Day Room: Learning Center

Bernardo C. Teixeira, MD,PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? Percutaneous devices, such as pedicle screws and vertebral augmentation, are often used in minimally invasive procedures and have lower complication rates. ? Post-operative imaging is essential to assess the success of spine surgery, detect complications, and guide further treatment. ? Radiologists should be familiar with the different surgical approaches and devices used in spinal surgery to accurately describe the post-operative imaging findings and identify any complications that may arise.

#### TABLE OF CONTENTS/OUTLINE

Arthrosis Degenerative changes in the lumbar spine are a common source of back pain and disability, affecting millions of people around the world. A great part is discogenic. Degenerative disc changes can take several forms, including disc herniation, spinal stenosis, and osteoarthritis, all of which can cause nerve compression and pain. Surgical approaches ? Anterior lumbar interbody fusion (ALIF) ? Lateral lumbar interbody fusion (LLIF) ? Transforaminal lumbar interbody fusion (TLIF) ? Posterior lumbar interbody fusion (PLIF) Common devices used for arthrodesis How do surgeons decide which approach option? Some challenging cases

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## Abstract Archives of the RSNA, 2023

NREE-72

### From A to V: Arterial and Venous Intracranial Anatomy, Variants and Malformations

All Day Room: Learning Center

Eduardo D. Valadares, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe the anatomy of arterial and venous intracranial systems  
Exhibit the normal appearance and common variations of the arterial and venous intracranial systems  
Summarize the most common and some rare congenital and acquired intracranial vascular malformations

#### TABLE OF CONTENTS/OUTLINE

Anatomy of Intracranial Arteries and Veins  
Normal CT and MRI Appearance  
Common Arterial Variations  
Fenestrations and Duplications  
Internal Carotid Arteries Variants  
Anterior Cerebral Artery Variants  
Middle Cerebral Artery Variants  
Posterior cerebral Artery Variants  
Persistent Carotid-Basilar Artery Anastomoses  
Common Venous Variations  
Hypoplastic Venous Sinus  
Absent Venous Sinus  
Arachnoid Granulations  
Pure Arterial Malformations  
Anterior Cerebral Artery Dolichoectasia  
Associated with Cortical Dysplasia  
CVM with Arteriovenous Shunting  
Arteriovenous Malformation  
Cerebral Proliferative Angiopathy  
Dural AV Fistula  
Carotid-Cavernous Fistula  
Vein of Galen Aneurysmal Malformation  
CVM without Arteriovenous Shunting  
Developmental Venous Anomaly  
Sinus Pericranii  
Cerebral Cavernous Malformation  
Capillary Telangiectasia  
Vascular Neurocutaneous Syndromes  
Sturge-Weber Syndrome  
PHACE Syndrome  
Wyburn-Mason Syndrome

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## Abstract Archives of the RSNA, 2023

NREE-73

### A Radiologist Guide to Evaluating White Matter Lesions in Pediatric Patients

All Day Room: Learning Center

Roberto Bastos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are:- Review and illustrate the classic imaging patterns of white matter lesions in pediatric patients, with a step-by-step approach.- To describe the main imaging patterns of white matter lesions, including hypomyelination and demyelination diseases, highlighting key points for approaching the differential diagnosis.- Determine an algorithm for the systematic evaluation of differential diagnosis, emphasizing the main clinical features and imaging red flags.

#### TABLE OF CONTENTS/OUTLINE

Imaging patterns of white matter lesions in pediatric patients  
Differential diagnosis of pediatric conditions that may course with white matter lesions, discussing the main recognizable image patterns:- Terminal myelination- Periventricular leukomalacia- Hypoxic ischemic encephalopathy- Posterior reversible encephalopathy syndrome (PRES)- Hypoglycemic encephalopathy- Adrenoleukodystrophy- Kearns Sayre syndrome- L-2-hydroxyglutaric aciduria- Methotrexate-related leukoencephalopathy- Focal cortical dysplasia- Multiple sclerosis- Acute disseminated encephalomyelitis (ADEM)- Vascular malformation- Ischemic stroke- Hemorrhagic stroke- Perivascular spaces- Other conditions including aggressive and non-aggressive neoplasms, infection of CNS, phakomatosis, autoimmune and neurodegenerative disorders  
Limitations and tips for the correct diagnosis  
Practical Diagnostic Algorithm  
Final remarks

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## Abstract Archives of the RSNA, 2023

NREE-74

### **CNS Tumor on Drugs - Nuts and Bolts of Neuro-oncology Agents for the Radiologist in the Age of Personalized Medicine**

All Day Room: Learning Center

Ilkyu D. Oh, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To introduce both common and newly emerging targeted neuro-oncology agents, typical imaging response patterns, and the imaging manifestation of associated toxicities. To highlight targeted agents with actionable molecular markers in primary brain tumors and brain metastasis, focusing on their mechanism of action in oncogenesis. To recognize atypical imaging response patterns and describe the crucial role of radiologists in providing crucial input for the management of CNS neoplasms in the age of personalized medicine.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduce commonly used traditional chemotherapy agents as well as emerging targeted chemotherapy with their mechanism of actions• Traditional alkylating agents, including Wafer• Anti-metabolites• Targeted chemotherapy i. ALK ii. HER2 iii. EGFR iv. VEGF v. PD-1 vi. CTLA-4 vii. mTOR viii. BRAF ix. MEK x. HIF xi. CAR T-cell therapy xii. IDH inhibitor• Combination therapy• Experimental drugs2. Usual imaging findings of favorable treatment response and/or disease progression.3. Unique atypical response patterns of different neuro-oncology agents and their clinical implications in cancer management.4. Important chemotherapy-related adverse events and corresponding imaging presentation.5. Illustration of imaging manifestations of newly emerging therapies in the era of personalized medicine.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-76

### **ECASS Radiological Classification of Hemorrhagic Transformation of Infarcted Brain Tissue: Don't Miss the Blood**

All Day Room: Learning Center

Valentina Munera Orozco, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Define the characteristics of hemorrhagic transformation of infarcted brain tissue, recognize the pitfalls and mimics of this entity and reproduce the new classification system: ECCAS II. Recall the different possible etiologies and clinical factors for developing this hemorrhagic complication.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction The hemorrhagic transformation of the infarcted brain tissue is a frequent complication of acute stroke, because of the extravasation of blood across a disrupted blood brain barrier. There are many risk factors and contributors for this disruption. By the ECASS classification system, the types of hemorrhage can be divided in two: hemorrhagic infarction (HI) and parenchymal hematoma (PH). The recognition and classification of this entity is important because the PH2 is found to be a significant predictor of neurological deterioration with higher mortality rates. Teaching points Illustrate the characteristics of an intracranial hemorrhage, specifically the hemorrhagic transformation of infarcted brain tissue. Employ the ECASS classification for hemorrhagic transformation of infarcted brain tissue. Recognize the patterns and learn how to report the different types of hemorrhagic transformation. Distinguish the pitfalls that can mimic a hemorrhagic transformation of infarcted brain tissue. Describe the possible etiologies and clinical factors for developing an intracranial hemorrhagic transformation of infarcted brain tissue.

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## Abstract Archives of the RSNA, 2023

NREE-77

### **Vein of Galen Aneurysmal Malformations: A Resident's Approach**

All Day Room: Learning Center

Sameer P. Chandra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- What is a Vein of Galen aneurysmal malformations (VGAM), and how does it appear in a CT and MRI scan. - Highlight the differences between Mural and choroidal Vein of Galen aneurysmal malformations (VGAM). - Exemplify the natural evolution of VGAMs, when treated vs left untreated.

#### **TABLE OF CONTENTS/OUTLINE**

Vein of Galen aneurysmal malformations (VGAM) are characterized by an embryonic choroidal arteriovenous malformation supplied by the choroidal arteries (ACA, AChoA, PChoA). The venous drainage in VGAMs is towards the median prosencephalic vein. VGAMs are formed between 6th and 11th weeks of embryological development, and corresponds to 30-50% of all vascular malformations in infants. VGAMs can be subdivided into two types Choroidal and Mural. Choroidal VGAMs are characterized by multiple feeders including thalamoperforating, choroidal and pericallosal arteries are located in the subarachnoid space in the choroidal fissure. Choroidal VGAMs converge on a fistula at the anterior aspect of the median prosencephalic vein (MPV); Tend to present earlier (neonates) with more severe shunts. Choroidal VGAMs result in high output cardiac failure because of multiple high flow fistulas with less outflow restriction. Mural VGAMs are characterized by fistulae in the subarachnoid space in the wall of the median prosencephalic vein; supply may be unilateral or bilateral. They are associated with absence or stenosis of Dural sinuses and stenosis at the level of the jugular foramen. Present later (infants) and with hydrocephalus. Mural VGAMs presents with fewer fistulas with high outflow restriction.

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## Abstract Archives of the RSNA, 2023

NREE-78

### Review of a HIV-associated Pathology in the Central Nervous System (CNS) & Head and Neck

All Day Room: Learning Center

Ahmed F. Abdelhalim, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review clinical presentation and imaging manifestations of HIV-associated CNS and head neck pathology, including infectious, inflammatory and neoplastic etiologies  
2. To discuss differential diagnoses and management considerations  
3. To present select cases from our institution that highlight these imaging features

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Infectious etiologies: presentation, imaging features, differential diagnosis  
a. Virali. HIV encephalopathy  
ii. Progressive multifocal leukoencephalopathy  
iii. Cytomegalovirus  
iv. AIDS encephalopathy and atrophy  
v. Fungali. Cryptococcus  
c. Bacteriali. Tuberculosis  
ii. Neurosyphilis  
d. Parasitici. Toxoplasmosis  
3. Immune reconstitution inflammatory syndrome (IRIS)  
4. CNS Lymphoma  
5. Select head and neck case review: HIV myelopathy, Kaposi sarcoma, lymphadenopathy, lymphoepithelial parotid cysts

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-79

### **Anatomy and Congenital Variations of the Sella Turcica, Suprasellar Cistern and Hypothalamus**

All Day Room: Learning Center

Alex C. Dias, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the normal embryology and anatomy of the pituitary gland, the suprasellar cistern and the hypothalamus. Summarize the imaging characteristics of the sellar region on CT and MRI. Provide tools to identify anomalies in the sellar region; discuss differential diagnosis and common pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Anatomy and embryology review- sella turcica and hypophysis- parasellar region, suprasellar region and hypothalamus  
3. Clinical-radiological correlation of congenital sellar variations  
4. Case-based review of congenital variations and pathology: - osseous - intrasellar - suprasellar - justasellar  
5. Take-home points

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

NREE-81

### **Beware of the Railway Crossing, Neuralgia Awaits You. A Resident's Guide to Neurovascular Conflict**

All Day Room: Learning Center

Andres B. Haro Laverde, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Not all vascular conflicts may lead to a clinical condition; therefore, the topographical finding must correlate with the symptoms. 2. Peripheral nerves have critical segments, where they run without a myelin sheath; this is called the transition zone. 3. The correct imaging protocol can lead to the diagnosis; nevertheless, the best pulse sequences are prone to artifacts, and it is important to identify them. 4. Infectious, neoplastic, or inflammatory causes may overlap; therefore, be aware of differentials.

#### **TABLE OF CONTENTS/OUTLINE**

1. Anatomical review of the cranial nerves with a hub in the most common trapped roots 2. Physiopathology of vascular palsy and the common clinical findings. 3. Types of cranial nerve vascular conflicts and pitfalls.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-82

### **A Comprehensive Guide of Neurovascular Imaging: Discovering Pearls and Overcoming Pitfalls**

All Day Room: Learning Center

Niels Vinicius Padua Carvalho, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The aim of this exhibition is to:

- Thoroughly review the technical aspects of neurovascular imaging (arterial and venous angiotomography and magnetic resonance angiography) and vessel wall imaging.
- Illustrate the role of these imaging methods, overall CT and MRI, highlighting advantages and disadvantages of each modality.
- Unify the most important methods in a single article/presentation.
- Summarize the pearls of these methods for diagnosis purpose and how to overcome the main pitfalls.

#### **TABLE OF CONTENTS/OUTLINE**

- **INTRODUCTION**o Importance of neurovascular imaging through the time and where we stand today
- **IMAGING TECHNIQUE**o Neurovascular imaging techniques, including:
  - § Protocol: when to choose each method
  - § Sequences: which sequences are preferred for each modality
  - § Imaging acquisition: the physical aspects and time of acquisition.
- **INTERACTIVE CASE-BASED DIDACTICS**o Sample cases to illustrate and consolidate the main pearls and pitfalls of neurovascular imaging, separated by imaging method and type of errors
- **FUTURE DIRECTIONS AND TAKE HOME MESSAGES**o Where do we need improvement?
  - o What is on the horizon for neurovascular imaging?

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## Abstract Archives of the RSNA, 2023

NREE-83

### **INTRA-ARTERIAL CHEMOTHERAPY FOR RETINOBLASTOMA: ANATOMICAL & HEMODYNAMIC CHALLENGES**

All Day Room: Learning Center

Matteo Zanoni (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- In the hope of salvaging eyes with retinoblastoma (RB) from enucleation, intra-arterial chemotherapy (IAC) has been proposed in 2008.- The main goal of IAC is to deliver a high dose of drugs directly to the tumor while avoiding the side effects and risks of systemic chemotherapy.- In the ideal scenario, an adequate blush is visualized from the internal carotid artery, ophthalmic artery origin is favorable for catheterization and no prominent cutaneous branches from the ophthalmic artery are seen.- IAC is not always as straightforward as expected and some challenges may be seen.- The first scenario is a difficult and unstable catheterization of the OA, in spite of its visualization by selective angiography, usually due to a too angulated origin of the OA.- The second scenario occurs when OA is not visible from ICA injection or the blush is not visible and contrast medium flows back into the ICA when catheterization of the OA is properly achieved. One anastomosis with the external carotid artery could be in place providing alternative pathways for the orbital supply and drug administration.- Distribution volume of the drug, which correlates to effectiveness of the IAC, could increase because of cutaneous branches originating from OA, thus increasing local side effects.

#### **TABLE OF CONTENTS/OUTLINE**

- Intra-arterial chemotherapy for retinoblastoma- IAC technique and ideal scenario- Anatomical challenges and solutions- Hemodynamic challenges and solutions- Distribution volume understanding

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-84

### **Pictorial Review of the Applications of Dynamic Susceptibility Contrast (DSC) MRI Perfusion in the Characterization of Meningiomas**

All Day Room: Learning Center

Theodore Wang (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Background review on the key characteristics of meningiomas and basics of dynamic susceptibility contrast (DSC) MRI perfusion. 2. Literature and pictorial review of the applications of DSC perfusion in the evaluation of meningioma characteristics, including grade, histologic subtypes, consistency, and vascularity. 3. Future applications of DSC in the evaluation of meningiomas.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background on meningiomas and DSC MRI perfusion: (a) Brief background on meningiomas, including differences in grade, histologic subtype, consistency, and vascularity. (b) Background on the clinical importance of these different characteristics and current imaging evaluation. (c) Review of the current literature on the application of DSC for meningioma evaluation. 2. Applications of DSC perfusion in meningioma evaluation: (a) Pictorial review of applications of DSC perfusion in meningioma evaluation. (i) Review the differences in perfusion between histologic subtypes of meningiomas, including the correlation of higher perfusion values with higher grade tumors and surrounding brain parenchyma. (ii) Discuss the role of DSC in predicting vascularity and consistency of meningiomas. 3. Discussion of future directions of DSC for meningioma evaluation.

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## Abstract Archives of the RSNA, 2023

NREE-86

### Arteriovenous Malformations: Practical Application of Spetzler Martin Classification

All Day Room: Learning Center

Ingrid G. Larreynaga Portillo, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Brain arteriovenous malformations are a type of intracranial high flow vascular malformation composed of enlarged feeding arteries, a nidus of vessels closely associated with the brain parenchyma through which arteriovenous shunting occurs, and draining veins. These malformations are characterized by a nidus forming the transition between the feeding artery and draining vein. If this transition is made directly, then it is considered an arteriovenous fistula, which is a separate type of cerebral vascular anomaly.

#### TABLE OF CONTENTS/OUTLINE

DefinitionClinical findingsLocationIncidenceAssociated anomaliesClassificationCases

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## Abstract Archives of the RSNA, 2023

NREE-87

### Advances in NOWinBRAIN 3D Neuroimage Large Repository: Cortical and Cranial Openings and Neurologic Disorders

All Day Room: Learning Center

Wieslaw L. Nowinski, DSc, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The exhibit: 1) Demonstrates a novel image display and exploration method using sequences of cortical and cranial openings; 2) Enables skull-brain correlation via cranial openings exposing the underlying parcellated and labeled brain (divided into lobes, gyri, and sulci) and intracranial arteries and venous system; 3) Facilitates brain-intracranial arteries correlation by opening 64 gyri and 6 lobules exposing the white matter and the arteries usually hidden deep in the sulci; 4) Provides a correspondence between brain damage (lesion) and the resulting disorder for vascular, cranial nerve and regional anatomy-related synthesized lesions, each lesion labeled with a disorder, signs, symptoms, and/or syndromes; 5) Presents a wide spectrum of over 8,600 3D neuroimages systematically organized, named and grouped into over 630 folders; 6) Is a valuable resource for medical students and residents as well as educators to prepare presentations.

#### TABLE OF CONTENTS/OUTLINE

The NOWinBRAIN repository contains 12 galleries (G1-G12) with 3D neuroimages derived from 3D brain atlases constructed from multiple 3/7 T MR and CT scans of a living brain. Galleries G1-G6 with 5000+ images were earlier presented at RSNA. For RSNA 2023 this repository is extended, enhanced, and two new galleries are created with cortical and cranial openings (G8) and 3D simulated neurologic disorders with outcomes (G11). The NOWinBRAIN repository is web-based and publically available at [www.nowinbrain.org](http://www.nowinbrain.org)

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## Abstract Archives of the RSNA, 2023

NREE-88

### Brain Bubbles: Updates on Intracranial Cystic Lesions

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Azza Reda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To describe the intra-and extra-axial cystic lesions based on the anatomical location.
- To highlight the recently described and updated cystic lesions.
- To provide an algorithmic approach describing incidental lesions elucidating the differential diagnosis with an aim to recognize do not touch lesions, aid in appropriate management, and prevent inadvertent surgical intervention.

#### TABLE OF CONTENTS/OUTLINE

Updated approach to diagnose neoplastic and neoplastic intracranial cystic lesions A. Intra-axial: supra and infratentorial parenchymal lesions. B. Extra-axial: supra and infratentorial; and each divided, into midline, off midline, and intraventricular lesions. Intra-axial cystic lesions • Non neoplastic lesions: Enlarged perivascular spaces (Glymphatic system and tumefactive type), Neuroglial cyst, porencephalic cyst, and ependymal cyst. • Infectious cysts: Cryptococcosis, Neurocysticercosis, and abscess. • Neoplastic lesions: MVNT and MVNT plus, DNET, ganglioglioma, metastasis, glioblastoma and oligodendroglioma, pilocytic astrocytoma, haemangioblastoma, medulloblastoma, pleomorphic xanthoastrocytoma, and rarely ependymoma. Extra-axial cystic lesions • Non neoplastic lesions: Pineal cyst, Rathke's cleft cyst, normal, arachnoid cyst, dermoid, epidermoid cyst, choroid plexus cyst and fissure, colloid cyst, Neurocysticercosis and neuroenteric cyst. • Neoplastic lesions: craniopharyngioma, schwannoma, ependymoma and pituitary apoplexy. Significant emphasis would be on the atypical cystic brain metastatic lesions and don't touch lesions.

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## Abstract Archives of the RSNA, 2023

NREE-89

### MR Case-based Review of Cavernous Sinus Lesions

All Day Room: Learning Center

Eva E. Romo (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To review the anatomy of the cavernous sinuses and normal appearance on MR  
To make a case-based illustration of the MR imaging features on the main cavernous sinus lesions

#### TABLE OF CONTENTS/OUTLINE

Anatomy of the cavernous sinus  
MR protocol for suspected cavernous sinus pathology  
Case-based MR imaging findings of main cavernous sinus lesions  
Neoplastic  
Case 1: Pituitary adenoma  
Case 2: Meningioma  
Case 3: Giant hemangioma  
Case 4: Lymphoma  
Case 5: Chordoma  
Case 6: Metastatic lesion of skin carcinoma  
Inflammatory  
Case 7: Tolosa-Hunt syndrome  
Vascular  
Case 8: Cavernous ICAs aneurysms  
Case 9: ICA occlusion

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## Abstract Archives of the RSNA, 2023

NREE-9

### Caught in the Web: Imaging Techniques in Identifying Ischemic Stroke Due to Carotid Web

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ana Luiza Basilio Franca (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The carotid web is a rare vascular anomaly that can lead to ischemic stroke. Its diagnosis and management can be challenging due to its limited pathophysiology and presentation understanding. However, advanced diagnostic imaging techniques have greatly enhanced the identification and management of the carotid web. This educational exhibit highlights the importance of early detection, accurate diagnosis, and interdisciplinary approach to carotid web management: To illustrate carotid web radiologic highlights. To explain the complications involved with the finding. To explain the imaging assessment.

#### TABLE OF CONTENTS/OUTLINE

1. Definition of carotid web and revision of epidemiology, clinical presentation, and etiology, including prevalence and incidence of the carotid web, common clinical presentations, and etiological factors contributing to carotid web.
2. CT angiography highlights.
3. Underlying factors contributing to carotid web development, including early detection and management importance.
4. Differential diagnosis of carotid web and the importance of accurate diagnosis for appropriate management.
5. Potential complications associated with carotid web and the importance of identifying and managing complications promptly.
6. Clinical perspective: current management strategies for carotid web and the importance of an interdisciplinary approach to the patient.
7. Take-home messages.

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## Abstract Archives of the RSNA, 2023

NREE-90

### Big Vents: Causes of Hydrocephalus

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Daniel R. Wayer, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Classification and terminology of hydrocephalus continue to be sources of confusion and debate in the literature. This exhibit provides an overview of the ventricular system and hydrocephalus classification scheme, covering typical pathologies and their imaging findings to enable the reader to approach hydrocephalus confidently. Normal ventricular anatomy consists of four interconnected choroid plexus-lined cavities and two canals. Anatomic variants can mimic hydrocephalus. Hydrocephalus is a disorder of flow, formation, or resorption of cerebrospinal fluid (CSF). Hydrocephalus classification is based on obstruction site and includes high pressure, normal pressure (NPH), and low-pressure subtypes. Intraventricular obstructive hydrocephalus (IVOH) inhibits CSF outflow due to obstruction at or before the 4th ventricle. Extraventricular obstructive hydrocephalus (EVOH) is due to obstruction anywhere from the 4th ventricular outlet foramina to the arachnoid granulations. Overproduction hydrocephalus is frequently caused by choroid plexus papilloma. NPH is diagnosed via a combination of history, neurological examination, and specific imaging findings. Syndrome of Inappropriately Low-Pressure Acute Hydrocephalus (SILPAH) is a rare and unrecognized condition with imaging findings mirroring severe obstructive hydrocephalus.

#### TABLE OF CONTENTS/OUTLINE

Ventricular Anatomy CSF Production and Circulation Models Normal Variants Hydrocephalus Classification High Pressure subtypes IVOH EVOH Overproduction NPH SILPAH Summary

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## Abstract Archives of the RSNA, 2023

NREE-91

### CNS Imaging Correlates of an FDA Cleared Diagnostic Meningitis/Encephalitis Panel

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Norbert G. Campeau, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Diagnosis of CNS infections from cerebrospinal fluid collected by lumbar puncture is increasingly performed using comprehensive diagnostic panels. 2. This exhibit serves as a useful imaging reference atlas for the 14 microbial entities of meningitis/encephalitis included on an FDA cleared diagnostic panel which includes 6 bacteria, 7 viruses, and 1 yeast. 3. Knowledge of the imaging findings for these entities is clinically useful to monitor the extent of CSF involvement in known positive cases, or to suggest CSF testing in suspected cases undergoing CNS imaging. 4. The relative merits of CT, MRI and cranial ultrasound imaging modalities and contrast use will be discussed.

#### TABLE OF CONTENTS/OUTLINE

A. The 14 microbial entities included on the diagnostic panel are: - 6 bacteria (*Haemophilus Influenza*, *Streptococcus pneumoniae*, *Neisseria meningitidis*, *Escherichia coli* K1, *Streptococcus agalactiae*, *Listeria monocytogenes*) - 7 viruses (*Enterovirus*, *Cytomegalovirus*, *Herpes Simplex 1*, *Herpes Simplex 2*, *Human Herpesvirus 6*, *Human parechovirus*, and *Varicella zoster*) - 1 yeast (*Cryptococcus neoformans/C. gattii*) B. The CNS imaging findings for each of the above microbial entities will be presented, including a brief synopsis of the epidemiology and clinical presentation. C. Summary Table of Imaging Findings.

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## Abstract Archives of the RSNA, 2023

NREE-92

### Portable Ultralow Field(0.064 Tesla)MRI for Neuroimaging

All Day Room: Learning Center

Saurabh Jindal, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Bedside magnetic resonance imaging (MRI) performed by an MRI or non-MRI-trained technologist in the presence of clinical staff/family. 2. Clinical utility in neurointensive care units and unstable patients who cannot be transferred to the MRI suite. 3. Standard sequences to diagnose common neurological emergencies, such as stroke, hypoxic-ischemic injury, and empyema. 4. Infarct or Artifact?: When in doubt on the low signal-to-noise ratio (SNR) diffusion-weighted images (DWI), evidence of edema on T2W/FLAIR images can aid in the diagnosis.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to portable MRI scanner 2. Clinical cases 3. Teaching points 4. References 5. Acknowledgments

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## Abstract Archives of the RSNA, 2023

NREE-93

### **Radiologist's Guide to Image-guided Spinal Steroid Injections: Anatomy, Procedural Technique, and Potential Pitfalls**

All Day Room: Learning Center

Jeffrey Ling, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review pertinent spinal anatomy with emphasis on key radiographic landmarks for epidural needle access. Discuss the utility and indications for spinal steroid injections in the setting of neck or back pain. Provide a brief overview of image guided approaches that can be utilized for spinal steroid injections. Understand potential procedural pitfalls and complications.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Epidemiology of painful spine conditions and associated imaging findings. Relevant anatomy of the lumbar and cervical spine. Indications Indications and contraindications of image-guided steroid injections. Choice of corticosteroid and/or local anesthetics. Potential procedural risks and complications. Procedure approach and technique Preprocedural planning: evaluate degenerative disease at the target level, assess epidural target and adjacent structures, anticipate distance to target and optimal needle length; CT versus fluoroscopy technique. Interlaminar epidural steroid injections. Transforaminal epidural steroid injections: supraneural approach, infraneural approach. Complications Common: temporary local discomfort during needle placement; inadvertent dural puncture (CSF leak). Rare, serious: contrast reaction; hemorrhage, epidural hematoma; spinal cord infarct (intravascular injection). Discussion Evaluation of post-procedural improvement in pain. CT versus fluoroscopy. Review of tips and tricks for technical procedural success. Alternative options for pain relief.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-94

### **The Big Picture: A Radiologist's Guide to Unlocking the Intricacies of Pediatric Neurometabolic Diseases**

All Day Room: Learning Center

Mika Shapira Rootman, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Brain MRI is the primary imaging modality for assessing neurometabolic disease in children. 2. MR spectroscopy should be considered as a supplemental imaging tool when neurometabolic disease is suspected. 3. Symmetric signal abnormalities involving white matter, basal ganglia, thalami, brainstem, and cerebellum can be major clues on imaging for neurometabolic disease. 4. Narrowing down the differential diagnosis requires further assessment of anatomic distribution, temporal progression, and additional imaging findings such as cysts and calcifications. 5. Age at presentation, particularly neonatal onset, is an important factor to consider when diagnosing devastating metabolic diseases in newborns.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Brief overview of the importance of radiological assessment in pediatric neurometabolic disease  
Imaging Modalities for Neurometabolic Disease Highlighting brain MRI as the primary imaging modality  
Discussing the added value of MR spectroscopy  
Clues on Imaging for Neurometabolic Disease Describing specific patterns and findings on imaging, such as symmetric signal abnormalities involving white matter, basal ganglia, thalami, brainstem, and cerebellum  
Emphasizing the importance of pattern recognition in identifying potential neurometabolic disease  
Narrowing Down the Differential Diagnosis Discussing the role of further assessment, including anatomic distribution, temporal progression, and additional imaging findings such as cysts and calcifications  
Highlighting the significance of age at presentation, particularly neonatal onset  
Conclusion Summarizing the key take-home messages for radiologists in imaging pediatric neurometabolic disease

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-95

### Multimodality Imaging of Cerebral Vasospasm

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mikel Elgezabal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To highlight key concepts such as symptomatic vasospasm, radiographic vasospasm and delayed cerebral ischemia, that will help the reader understand cerebral vasospasm and its consequences. 2. To describe different diagnostic methods for detection of cerebral vasospasm, each with their advantages and disadvantages, providing illustrative examples. 3. To propose a practical diagnostic-therapeutic approach of severe SAH and vasospasm.

#### TABLE OF CONTENTS/OUTLINE

1. Cerebral vasospasm: key concepts 1.1. Definitions: SAH, radiographic vasospasm, symptomatic vasospasm, delayed cerebral ischemia (DCI). 1.2. Etiology: SAH. Risk factors, diagnostic protocol, prognosis. 2. Diagnosis of cerebral vasospasm 2.1. Clinical signs and symptoms and other monitoring tools. 2.2. Transcranial Doppler ultrasound. 2.3. CT (NECT, CT perfusion, CTA) 2.4. DSA 2.5. Diagnostic management - proposed algorithm 3. Treatment: the fight against DCI 3.1. Medical treatment. 3.2. Angiographic/Interventional treatment and its complications. 4. Take home points

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

NREE-96

### A Trip Through Gyriform Enhancement

All Day Room: Learning Center

Adria Roset Altadill, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Gyriform enhancement is mainly secondary to vascular and infectious causes. - Gyriform enhancement should be discerned at imaging from leptomeningeal enhancement.- Distinction between the different etiologies of gyriform enhancement has to be made based on clinical history, brain distribution and ancillary radiologic findings.

#### TABLE OF CONTENTS/OUTLINE

Gyriform enhancement, also called gyral or cortical enhancement, is an uncommon brain pattern that refers to contrast deposition on the superficial grey matter of the cerebral cortex. The main causes of this enhancement pattern are vascular and infectious. Vascular causes can be related to arterial or venous infarctions, seizures, migraine syndromes, posterior reversible encephalopathy syndrome (PRES) and subarachnoid hemorrhage. Infectious processes include mainly herpes encephalitis, cerebritis and meningitis. Finally, gyral enhancement may also rarely occur in neoplastic diseases or cases of neurotoxicity. Cortical enhancement can be detected by contrast-enhanced head CT or brain MRI, although the latter is much more sensitive due to its higher contrast resolution. It is important to differentiate cortical enhancement from leptomeningeal enhancement, which can demonstrate a similar "serpentine" morphology but affects the subarachnoid space and the pia matter instead. In order to narrow the differential diagnosis between the spectrum of causes of cortical enhancement, a focus should be placed on clinical history, distribution of the gyral enhancement and ancillary radiologic findings.

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## Abstract Archives of the RSNA, 2023

NREE-97

### Cerebrovascular Disease in Young Adults: A Case-Based Review

All Day Room: Learning Center

Huijuan Wang, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cerebrovascular disease (CVD) can result from blood vessel narrowing, rupture, or a hypercoagulable state, which may present on imaging as vascular stenosis, hemorrhage, or occlusion, respectively. As an emerging public health issue with debilitating effects on young adults, recognizing the similarities and differences between young adults and elderly patients for the etiologies and prevalence of various types of CVD is imperative for optimal patient outcomes.

#### TABLE OF CONTENTS/OUTLINE

1. Review the common etiologies and prevalence of cerebrovascular disease (CVD) in young adults and how this compares to elderly patients.
2. Categorize the differential diagnosis based on the general imaging appearance of vascular stenosis, hemorrhage, and occlusion in conjunction with the location of the abnormality.
3. Practice the diagnostic approach previously reviewed with multiple vignette-style young adult CVD cases with questions accompanying each case focused on differential diagnosis, prognosis, and management.
4. Discuss clinical presentation, key imaging findings, differential diagnosis, and management of each presented case.

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## Abstract Archives of the RSNA, 2023

NREE-98

### Imaging of Deep Brain Stimulation Systems

All Day Room: Learning Center

Alexandre Boutet, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) Deep brain stimulation (DBS) surgery, which is the most common functional neurosurgery treatment, is increasingly being performed worldwide. (2) Its therapeutic effect hinges upon accurate and precise targeting of the intended brain structure—maximizing therapeutic benefits while minimizing spillover onto neighbouring structures that may produce adverse effects. (3) Knowledge of the anatomical relationships of the most common targets including the subthalamic nucleus and pallidum is essential for accurate reporting. (4) Postoperative imaging of DBS patients is subject to strict MRI safety guidelines to prevent heating at the electrode tips, which is the main risk. Knowledge of the factors influencing safety such as specific absorption rate (SAR) is crucial to provide these patients with optimal MRI when it is required. (5) Interpretation of DBS postoperative imaging requires knowledge of the expected appearances and the complications. (6) Functional neurosurgery is a rapidly evolving field with considerable scope for the role of radiologists to grow beyond their current contributions.

#### TABLE OF CONTENTS/OUTLINE

(1) Brief background of functional neurosurgery focusing on DBS. (2) Anatomical relationships of the most common targets. (3) Framework on how to safely acquire MRI in postoperative DBS patients. (4) Expected and complicated postoperative imaging appearances of DBS. (5) Future directions and opportunities for radiologists.

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## Abstract Archives of the RSNA, 2023

NREE-99

### **MRI Characteristics of Chemotherapy Related Central Neurotoxicity: A Pictorial Review**

All Day Room: Learning Center

Rugaiyah F. Alkhatib, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Due to the increasing incidence of cancer and advancements in cancer treatment, the prevalence of chemotherapy-related neurotoxicity has also seen an increasing trend. Chemotherapy-related neurotoxicity is a well-recognized complication in oncologic patients, with a wide range of patients, from 19% to more than 85% receiving chemotherapeutic agents experiencing symptoms of neurotoxicity. This may present with a wide range of neurological manifestations, which can pose diagnostic challenges, particularly, in distinguishing it from tumor progression and paraneoplastic syndrome. Therefore, imaging plays a crucial role in the management of these patients. MRI can reveal various imaging patterns of chemotherapy-induced neurotoxicity, including acute-subacute leukoencephalopathy with reversible DWI pattern, commonly observed with methotrexate use, as well as acute cerebellar syndrome and reversible acute cerebellar toxicity patterns, which is most often induced by high-dose cytarabine. Other imaging patterns include posterior reversible encephalopathy syndrome, neurovascular complications pattern, progressive multifocal leukoencephalopathy pattern and spinal cord toxicity. In this pictorial review, we will highlight the MRI characteristics and patterns related to chemotherapy-induced neurotoxicity, as well as provide case-based examples to better illustrate these features.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction  
2. Types of chemotherapeutic agents and mechanism of action  
3. Characteristics MRI features of chemotherapy-induced central neurotoxicity  
4. Conclusion

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## Abstract Archives of the RSNA, 2023

OBEE

### OB/Gynecology Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **OBEE-1 Isthmocele: A Simplified Guide**

Isabela C. Ferracini, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Isthmocele may be present in 24-69% of women evaluated with transvaginal ultrasound and may be the cause of several clinical dysfunctions: dysmenorrhea, abnormal uterine bleeding, obstetric complications and perhaps even subfertility. When found in an ultrasound examination, there are several criteria to be considered. Accurate reporting of the description and measurement of this area in ultrasound examinations becomes important not only for research, but also for the clinical approach and planning of surgical treatment and to standardize the language in the documentation of the examination and the performance of reports. The objective of this work is to carry out a didactic review of how to examine an isthmocele in non-pregnant women, based on the first European consensus.

#### **TABLE OF CONTENTS/OUTLINE**

A literature review was carried out and cases of ultrasound, magnetic resonance imaging and hysterospingography obtained from the digital archive of our institution. We approach a didactic review of the imaging aspects and how to measure them adequately, including teaching points and additional cases.

#### **OBEE-10 Diaphragmatic Endometriosis: A Breathtaking Challenge**

Nathalie C. Burger, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) This study aims to demonstrate MR's feasibility and accuracy in detecting diaphragmatic endometriosis, which can cause long-standing disability and pain, negatively impacting quality of life. 2) Symptomatic diaphragmatic endometriosis is part of thoracic endometriosis syndrome, usually diagnosed later than pelvic endometriosis. The symptoms include chest pain, shortness of breath and coughing, worsening during menses, and associated with pneumothorax and phrenic nerve irradiation. 3) Endometrial cells follow peritoneal circulation through the right paracolic gutter towards the right subdiaphragmatic area, where they can aggregate and form nodules, favored by a preferred stagnation site in the posterior portion of the right side of the diaphragm. 4) MR allows high-sensitivity diagnosis of diaphragmatic endometriosis, offering better characterization of hemorrhagic lesions on fat-suppressed T1-weighted sequences and requiring no radiation exposure. 5) Diaphragmatic lesions present hyperintense nodules on fat-suppressed weighted sequences. Herniation is less frequent and can result from repeated proliferation, bleeding, and necrosis of endometriotic lesions leading to fenestrations and partial or complete diaphragmatic rupture.

#### **TABLE OF CONTENTS/OUTLINE**

1) Know What You're Dealing With: Anatomy and main symptoms 2) Active Search: MRI Protocol 3) Behold the visual representation of diaphragmatic lesions on magnetic resonance 4) What information should the gynecologist look for in the report? 5) Pearls and pitfalls in the differential diagnosis.

#### **OBEE-11 Unfolding Endometriosis Clinical Cases Controls: What to Look For**

Alice Cristina C. Brandao Salomao, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Endometriosis is a chronic disease that impacts women from adolescence to menopause. Treatment options can vary from hormonal suppression to radical surgery and should be individualized and personalized. This educational exhibit presentation

aims to: Discuss the clinical management of endometriosis including the different drugs available; Discuss the imaging methods available for hormonal treatment controls; Discuss imaging findings of endometriosis clinical controls.

#### **TABLE OF CONTENTS/OUTLINE**

To discuss the available drugs used in the clinical management of endometriosis, including its mechanisms of action and therapeutic efficacy, such as: Combined oral contraceptives; Selective estrogen receptors modulators; Hormonal intrauterine device (IUD); Progestins; Selective progesterone; GnRH agonists; Oral GnRH antagonists; Aromatase inhibitors; Review clinical cases undergoing medical treatment and the correlation between clinical response and imaging findings in different sites such as: Retrocervical disease; Deep endometriosis with myometrial infiltration; Endometriomas; Intestinal lesions; Diafragmatic lesions; To discuss genetic and immunological aspects that can interfere with clinical response.

### **OBEE-12 Uterine Sarcomas: Update on Pathologic and Imaging Findings**

#### **Awards**

#### **Certificate of Merit**

Ana Claudia V. Uski SR, MD,MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Demonstrate the imaging features that favor the diagnosis of uterine sarcomas and the particularities of each subtype; review staging and the role of imaging in monitoring response and suspected recurrence. Recognize their mimickers.

#### **TABLE OF CONTENTS/OUTLINE**

Gynecologic sarcomas are rare tumors and usually have an unfavorable prognosis. Magnetic resonance imaging (MRI) is the best method for characterization of these tumors, initial staging and treatment planning. MRI shows features that can be used to try to differentiate between subtypes of uterine sarcomas. Combined DWI and DCE techniques allow more accurate assessment of the degree of myometrial and cervical invasion and characterization of potential metastatic sites. Although several findings increase the suspicion of malignancy in gynecologic tumors (including irregular contouring, intratumoral necrosis/hemorrhage, and low ADC values), some particular features may suggest the diagnosis of sarcoma, such as macroscopic lymphovascular invasion in cases of endometrial stromal sarcomas, the "bag of worms" aspect of low-grade endometrial stromal sarcoma, and the "lattice-like" appearance of adenosarcomas that result from the mixed composition of solid and cystic multiseptate components. Their diagnosis remains a challenge in the radiologist's practice.

### **OBEE-13 Imaging in Pregnancy: Safe and Sound With Contrast-Enhanced US**

Stephanie A. Nguyen, MD, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) Contrast-enhanced US (CEUS) is safe in pregnancy (2) Microbubble contrast agents do not cross the placental barrier (3) CEUS in pregnancy is an effective alternate to CT and MRI when enhanced imaging is required (4) A major indication is in the determination of malignancy when masses anywhere in the abdomen or pelvis are found in a pregnant patient (5) Ability of CEUS to differentiate benign from malignant processes allows prompt diagnosis and management with significant implications on maternal and fetal outcomes (6) CEUS is capable of evaluating more than one organ in any patient

#### **TABLE OF CONTENTS/OUTLINE**

(1) Review of the safety record of CEUS in pregnancy (2) CEUS technique in the pregnant patient (3) Case examples (3a) Malignant lesions (3b) Benign diseases (3c) Assessment of acute pain in pregnancy

### **OBEE-14 Beyond the Scar: A Comprehensive Guide to Postoperative Endometrioses Imaging**

Sofia B. Maksoud, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Endometriosis affects approximately 176 million women worldwide, with a prevalence of one in ten women during the reproductive period. Treatment can be clinical or surgical. The main surgical indications include clinical failure, lesions in the appendix, small bowel lesions, intrinsic ureter involvement and rectosigmoid (greater than 50% of the circumference). The goals of surgery include radical removal of all lesions and the restoration of normal pelvic anatomy. Postoperative evaluation is the new challenge of imaging studies, as the number of radical surgeries to treat endometriosis has increased enormously. Radiologists must be familiar with the common imaging findings, possible complications and the differentiation between residual disease and fibrotic scar.

#### **TABLE OF CONTENTS/OUTLINE**

- Review the common post-surgical findings following surgery for deep endometriosis.- Differentiate residual / recurrence disease and fibrotic scar. - Illustrate didactical cases with pre and post-surgical imaging.- Be familiar with possible

complications after surgery.

## **OBEE-15 What Not to Miss in Obstetric Ultrasounds - Multifetal Pregnancies: Chorionicity and Amnionity**

Laura Santiago Caobi (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Review the embryologic division in multifetal pregnancies and its significance for prenatal care. - Discuss the criteria for the classification of twin pregnancies using ultrasounds. - Provide case examples for classic imaging for each type of multifetal pregnancy. - Use an algorithm to assist in ultrasound monitoring and surveillance of multifetal pregnancies.

### **TABLE OF CONTENTS/OUTLINE**

Multifetal pregnancies pose a significant risk for adverse outcomes compared to singleton pregnancies. Early and accurate diagnosis requires a comprehensive understanding of chorionicity and amnionity. Ultrasound evaluation of placental number, interposed membranes, fetal genders, amniotic fluid volume, and presence of lambda sign are key for successful assessment of chorionicity and amnionity. The use of an algorithm for ultrasound monitoring and surveillance of multifetal pregnancies can aid facilitate early interventions that will benefit the health of both, mother and fetus. Outline: (1) Introduction Objectives, (2) Multifetal Pregnancies, (3) Division Timing, (4) Classic Imaging Findings for Each Type of Multifetal Pregnancy, (5) Ultrasound Criteria for Diagnosis of Type of Multifetal Pregnancy, (6) Comparison of Fetal and Infant Mortality Rates, (7) Algorithm for Ultrasound Monitoring and Surveillance, (8) Case Examples, (9) Conclusion

## **OBEE-16 Don't Forget the Bowel: Imaging Techniques, Associations and Treatment Implications of Bowel Endometriosis**

### **Awards**

#### **Cum Laude**

Haatal D. Macer, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. As the GI tract is the most common extragenital organ involved with endometriosis, imagers need to actively look for bowel involvement. Therefore, our exhibit will highlight the associations of bowel endometriosis leading imagers to actively look for bowel implants. 2. Practical tips on Ultrasound and MRI technique of bowel endometriosis imaging and how to improve lesion detection. 3. Discussion of detailed assessment of large and small bowel involvement with implications on management, especially related to pain and fertility, will be highlighted.

### **TABLE OF CONTENTS/OUTLINE**

1. Background of GI tract endometriosis. 2. Associations: Incidence and prevalence with ovarian endometriomas; deep pelvic endometriosis especially with posterior compartment (rectovaginal and uterosacral ligament) involvement. 3. Ultrasound Technique: Bowel preparation; transvaginal technique for delineating normal anatomy and pathology; tips on separating bowel layers on ultrasound enabling detection of depth of muscle invasion. 4. MR Enterography: bowel preparation; role of antispasmodics; MR protocol favoring detection of appendiceal, ileocecal junction, small bowel and rectosigmoid deep endometriosis. 5. Detailed anatomic reporting of small and large bowel disease that have implications on management, particularly related to pain and fertility.

## **OBEE-17 Unmasking Atypical Adenomyosis: Imaging Spectrum with Laparoscopic and Pathologic Correlation**

Alice Cristina C. Brandao Salomao, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Adenomyosis is a prevalent gynecologic condition defined by the presence of endometrial glands and stroma within the myometrium. 2. It remains poorly understood with severe implications on fertility and quality of life. 3. Although there is no agreement on the imaging classification of adenomyosis, the typical features are more discussed and widely known. 4. MUSA statement consensus is an important available tool to recognize and describe the typical forms of adenomyosis on ultrasound. 5. Atypical presentations of adenomyosis are less discussed, remaining a diagnostic challenge. 6. This presentation aims to review imaging findings of atypical adenomyosis, highlighting their potential differential diagnosis, as well as their impact on clinical management and patients outcome.

### **TABLE OF CONTENTS/OUTLINE**

- Overview of adenomyosis. - Review imaging-based adenomyosis classification. - Ultrasound and MRI imaging findings of atypical adenomyosis, including: Solid adenomyoma; Cystic adenomyoma; Submucosal adenomyoma; Subserosal adenomyoma; Accessory cavitated uterine mass; Polypoid adenomyoma; Adenomatoid tumor. - Differential diagnosis, such

as: Adenosarcoma; Cystic / hemorrhagic degeneration of leiomyoma; Cellular degeneration of leiomyoma; Isthmocele; Unicornuate uterus. - Present clinical cases with laparoscopic and pathological correlation. -Summary of key concepts.

## **OBEE-18 Exploring the Pelvic Floor through MRI - A Comprehensive Trainee's Handbook**

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) This review highlights the benefits and recent updates in defecography, a radiological examination used to evaluate patients with defecatory and pelvic floor dysfunction. This functional anatomical condition affects support structures and is more common in women over 50 years old. 2) MR defecography evaluates multicompartamental dysfunction, etiologies of defecation dysfunction, and postoperative complications and recurrence, providing both anatomical and functional information while allowing simultaneous assessment of the anal sphincters. 3) Most patients present changes in more than one compartment, and the reoperation rate after initial pelvic floor surgery is high. Understanding changes in various compartments can contribute to reducing the need for reapproaches. 4) Examples of pathologies found in defecography include cystocele, urethral hypermobility, uterine and vaginal prolapse, background hernias, and intussusception. This review discusses the implications of these findings for clinical practice.

### **TABLE OF CONTENTS/OUTLINE**

1) 1) General Aspects: A Little Bit of Everything; 2) Essential MR Protocol - What you need to remember; 3) Assessing the dynamic study on MR; 4) MR images evaluation - Is defecating three times really necessary?

## **OBEE-19 Adeno-My-Goodness: Comprehensive Review of Adenomyosis**

Paulo H. Miro, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Adenomyosis is a prevalent condition which may cause symptoms (such as abnormal uterine bleeding and pain), and affect pregnancy outcomes. Ectopic endometrial glandular tissue within the uterine myometrium with associated smooth muscle hypertrophy may have a variety of appearances across the imaging modalities. Imaging findings may be further confounded by hemorrhage or development of myometrial cysts, and changes under the hormonal influence (particularly during pregnancy). Cases may arise when adenomyosis mimics uterine malignancy, and uncommonly, malignancy may arise from the glandular tissue within adenomyosis. This exhibit is a comprehensive review of adenomyosis across multiple imaging modalities with pathologic and graphical correlation.

### **TABLE OF CONTENTS/OUTLINE**

Relevant uterine anatomy1. Classic Imaging Findings of AdenomyosisA) Ultrasound "Adeno"• Echogenic striations/buds• Myometrial cysts "Myosis"• Myometrial thickening (focal or diffuse)• Globular uterus• Thickened inner myometrium• "Venetian blinds" shadowingB) MRI "Adeno"• T2 hyperintense foci and myometrial cysts• T1 hypointense foci "Myosis"• T2 hypointense junctional zone thickening• Myometrial thickening (focal or diffuse)C) CTD) Hysterosalpingogram2. Atypical findings of adenomyosisA) Cystic/hemorrhagicB) Pedunculated3. Adenomyosis in pregnancy4. Clearing up the confusion between focal adenomyosis and adenomyoma (the mixed Mullerian tumor)5. Malignancy arising within adenomyosis

## **OBEE-2 Postpartum Woman in the ER? A Surviving Guide for the On-Call Radiologist**

Marta Barrios Lopez, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To learn what are the main puerperal obstetric complications and their imaging findings. 2. To understand the importance of clinical correlation in the diagnosis of many of these conditions: some can only be diagnosed in the proper clinical setting and a high suspicion is essential. 3. To review the anatomy landmarks necessary to locate certain types of hematomas.

### **TABLE OF CONTENTS/OUTLINE**

1. Normal imaging findings during the puerperium: Vaginal delivery. 2. Normal imaging findings during the puerperium: Cesarean delivery. 3. Surgical technique for Cesarean section and potential complications at each step. 4. Thromboembolic conditions: 4.1. Ovarian vein thrombosis/ thrombophlebitis and their complications. 5. Infectious complications 5.1. Postpartum endometritis. 6. Hemorrhagic complications 6.1. Lower genital tract injury: supra and infralevator hematomas. 6.2. Abnormal placentation: placenta accreta, increta, percreta. 7. Cesarean-related complications 7.1. Wound cellulitis/ abscess 7.2. Uterine dehiscence 7.3. Bladder flap hematoma 7.4. Subfascial hematoma 7.5. Rectus sheath hematoma 7.6. Urinary tract injury

## **OBEE-20 Imaging of Functional Ovarian Tumors and Tumor Like Conditions with Pathological Correlation**

### **Awards Certificate of Merit**

Niloofer Karbasian, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Describe the ovarian histology and the hormone axes. 2. Discuss clinical features of hormone excess as secondary signs of hormone producing tumors and tumor like conditions. 3. Explain different categories of functional ovarian tumors and tumor like conditions. 4. Illustrate multimodality imaging characteristics of different tumors.

### **TABLE OF CONTENTS/OUTLINE**

1. Ovarian histological anatomy a. Including role of different cell types within the ovary 2. Hypothalamus-Pituitary-Ovary axis a. Introduce sex hormones and their role b. Flowchart demonstrating the hormone pathways 3. Clinical features of hormonal excess. a. Excess androgen and symptoms b. Excess estrogen and symptoms 4. Subtypes of functional ovarian tumors. a. Sex cord-stromal b. Surface epithelial c. Stroma d. Tumor-like lesions and conditions 5. Approach to diagnosing functional ovarian tumors a. Multidisciplinary approach i. Role of imaging. ii. Hormonal analysis in follow up. iii. Tissue sample often needed for diagnosis. b. Imaging direct and indirect signs of hormonal excess. i. Contribution of different modalities: US, MRI, CT. ii. Features of malignancy. iii. Radiologic examples of different functional tumors. c. Pathology correlation 6. Treatment options a. Conservative b. Surgical c. Prognosis

## **OBEE-21 Decoding the Pandora's Box With Fetal MRI: A Comprehensive Pictorial Review of Fetal Abdominal Abnormalities**

Taruna Yadav, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To study indications, advantages and limitations of fetal MRI for antenatal assessment of various abdominal anomalies. 2. To define a standard MRI protocol for assessment of fetal abdominal anomalies. 3. Using a case-based approach, to learn about myriad of common and rare fetal abdominal anomalies including gastrointestinal (bowel atresias, meconium peritonitis), genitourinary (posterior urethral valve, urethral atresia, pelviureteric junction obstruction, cystic renal dysplasia, fetal pyelectasis, ectopic kidney, syndromic associations like Meckel Gruber and Joubert syndrome), ventral wall defects (gastroschisis, omphalocele, limb body wall defects, pentalogy of Cantrell, bladder exstrophy, amniotic band syndrome), pelvic disorders including presacral masses (sacroccygeal teratoma, anterior meningocele) with syndromic associations and follow up (wherever available). 4. To develop an imaging approach to complex fetal abdominal anomalies including ventral abdominal wall defects.

### **TABLE OF CONTENTS/OUTLINE**

1. Role of MRI for assessment of fetal abdomen: indications, advantages and limitations 2. Fetal MR protocol to assess various abdominal anomalies 3. Fetal Abdominal Anomalies (A Case Based Approach): 3A. Gastrointestinal anomalies 3B. Genitourinary anomalies 3C. Ventral wall defects: spectrum of anomalies and simplified imaging approach 3D. Pelvic disorders: presacral masses 3E. Syndromic associations 3F. Miscellaneous 4. Conclusion

## **OBEE-22 Magnetic Resonance Imaging in Obstetric Patients: How Can We Help?**

Sarah d. E Vasconcelos, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

? Brief review of indications and protocols of obstetric magnetic resonance imaging (MRI)? Illustrate the characteristics of image in cases of normal anatomy obstetric patients, when appropriate? Review most common pathologies in obstetric cases? Highlight the impact of imaging in the management

### **TABLE OF CONTENTS/OUTLINE**

? MRI indications and protocols? MRI obstetric normal anatomy, when appropriate? MRI aspects of obstetrics patients: pathologies and complications:? Placenta accreta? Different locations of ectopic pregnancies? Heterotopic pregnancy? Angular pregnancy? Uterine perforation? Per vaginal bleeding in pregnancy? Miscarriage / Retained products of conception? Uterine arteriovenous malformation? Gestational trophoblastic disease? Applications in fetal pathologies or malformations (for example: fetus with cervical mass, congenital diaphragmatic hernia, congenital pulmonary airway malformation and fetal urinary tract anomalies)

## **OBEE-23 Placenta 101: A Pictorial Review of Normal and Pathological Findings by US and MRI**

Carlos S. Tapia SR, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

To normal thickness of the placenta is 2 to 4 cm, and it must be measured where the umbilical cord is inserted. Placental grading maturity (Grannum classification) is divided into 4 grades by ultrasound and it is based on the extent of calcifications. To differentiate a retroplacental hematoma from a uterine contraction, it is recommended to wait a few minutes for the contraction to disappear. An easy Doppler finding for the differentiation of hematomas from other placental masses is the absence of internal blood flow. Currently, when the placental edge is less than 20 mm away from the internal cervical orifice (ICO) is a low-lying placenta, and when the placenta covers partially or completely the ICO, it is called placenta previa.

## TABLE OF CONTENTS/OUTLINE

History. Embryology. Normal appearance and grades of maturation. Variations in placental morphology. Placental hematoma. Placenta previa. Placental accretism. Placental tumors. Teaching points. Conclusion. Bibliography.

## OBEE-24 FOMO, No More - A Comprehensive Guide for Identifying Head to Toe Fetal Anomalies

Rishika Gupta (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To highlight the importance of level I scan and develop an algorithmic approach to diagnose structural anomalies at the earliest. To diagnose progressive anomalies on subsequent scans and devise a trimester based checklist to avoid missing abnormalities. To assess the maternal risk factors in conjunction with fetal parameters to be able to assess growth of the fetus as well as restriction. To know the importance of color doppler in all the scans and how it affects further management. Scanning beyond fetus- to diagnose various placental, uterine and adnexal abnormalities for effective management. An obstetric ultrasound plays a pivotal role in each stage of pregnancy in providing a non-invasive diagnostic method, yielding immediate, extensive and accurate results for evaluating the fetus as well as the health of the mother. Protocol based screening reduces the "fear of missing out" an abnormality.

## TABLE OF CONTENTS/OUTLINE

1. First Trimester Scan A) Early First Trimester: • Ectopic pregnancy • Twin or higher order pregnancy with correct labelling • Adnexal abnormality B) Late First Trimester: Detectable 9 • Anencephaly • Holoprosencephaly • Encephalocele • Omphalocele • Gastroschisis • Iniencephaly • Limb abnormality • Megacystis • Major cardiac defects • First trimester markers for chromosomal abnormalities • Abnormal UAD 2. Second Trimester Scan • Detectable 9 • Cardiac defect • Situs abnormalities • Spinal abnormalities • Placental abnormalities 3. Fetal Echocardiography 4. Third Trimester Scan • Evolving cardiac abnormalities • Placental abnormalities • Abnormal Doppler

## OBEE-25 Patterns of Ovarian Cancer Recurrence on MDCT: Early Imaging Features

Sharad Maheshwari, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Review of Ovarian ca 2. Review the pattern of recurrence in ovarian ca 3. Review Application of clinical laboratory findings with Imaging 4. Understand the role of imaging, how it can potentially accelerate time to treatment.

## TABLE OF CONTENTS/OUTLINE

1. General overview of ovarian ca a. Epidemiology recurrence rates b. Pathogenesis how tumour spreads c. Clinical presentation Tumour markers d. quick review of treatment options 2. Multimodality imaging appearance a. Why cross sectional Imaging b. Benefits of MDCT c. Role of MRI PET c. Scanning protocol d. Recurrence sites appearance on Imaging: - Peritoneum - Mesentery - Nodes - Periheptic and fissural spread - The muscle planes - Urinary bladder surface - Serosal deposits on the bowel surface - Miscellaneous sites e. Review protocol: Region wise f. Examples of early recurrence that would have been missed on routine imaging

## OBEE-26 See What's Inside: A Look at Pelvic Devices

Flavia M. Starling, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The female pelvis has a complex anatomy; thus, it requires deep study and its image can be challenging. Besides the anatomy knowledge, radiologists need to keep up with the daily devices and techniques, used by doctors and by the patients. It is important to be prepared to face unknown figures like foreign bodies, and also to recognize these devices in the pelvis, such as contraceptive methods (vaginal ring and intrauterine devices), tampons, menstrual cups, vaginal pessaries, catheters and slings. Questionnaires are often vague when referring to these devices and most women forget to mention actively whether they have or are using any of them. This study has the objective of reviewing common devices placed in the pelvis, especially in gynecology, urogynecology and its possible complications, helping radiologists to interpret these images. An understanding of the radiological appearance of some of these devices in the many imaging methods such as X-ray, ultrasound, CT and MRI is useful to avoid misinterpreting them, as well as obtaining a diagnosis more quickly and accurately.

## TABLE OF CONTENTS/OUTLINE

For this education exhibit, we obtained clinical and epidemiological information in literature and selected images of cases that show different findings of women's vaginal and uterine devices, including normal aspects or complications.

### OBEE-27 This Is Rare, but It Happens: Atypical Presentation of Teratomas

TATIANA A. GONCALVES (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teratomas are germ cell tumors composed of multiple tissues derived from two or three germ layers. Mature teratomas are the most common benign ovarian neoplasms. They are easily diagnosed on imaging studies because of their characteristic intratumoral fat and calcification components. However, a minor percentage of teratomas have no visible fat on imaging studies. Malignancy is an uncommon presentation, which may be suspected in the presence of an enhancing, irregularly marginated solid component. Gliomatosis peritonei (GP) is another unusual form, that it is characterized by the implantation of mature glial tissue in the peritoneum or omentum. Mature teratomas have also an high complication rate compared with other ovarian tumors, however, there is a low rate of spontaneous rupture. The purpose of this presentation is to discuss the various atypical imaging features of teratoma that can be particularly misleading for radiologists.

## TABLE OF CONTENTS/OUTLINE

Index 1. Introduction 2. Mature teratoma 3. Mature teratoma simulating malignant lesion 4. Gliomatosis peritonei 5. Immature teratoma 6. Ruptured teratoma 7. Pre sacral teratoma 8. Pre sacral myelolipoma and dermoid 9. Retrorectal dermoid 10. Cul-de-sac dermoid 11. Currarino syndrom

### OBEE-28 Adenomyosis: MRI for Diagnosis and Problem-Solving

Lauren F. Alexander, MD (*Presenter*) Spouse, Stockholder, Abbott Laboratories;Spouse, Stockholder, AbbVie Inc;Spouse, Stockholder, General Electric Company;Spouse, Stockholder, Myriad Genetics, Inc

#### TEACHING POINTS

Uterine adenomyosis develops from the abnormal proliferation of heterotopic endometrial glands and stroma in the myometrium. Recognizing the characteristic magnetic resonance imaging (MRI) findings is essential for accurate diagnosis and appropriate patient management, as clinical symptoms such as dysmenorrhea, menorrhagia and pelvic pain overlap with other gynecologic diagnoses. After reviewing this exhibit on adenomyosis, the learner will be able to -- Discuss how to optimize MRI sequences to evaluate for adenomyosis. -- Identify typical and atypical MRI findings of adenomyosis. -- Distinguish other diagnoses which can mimic or have overlapping findings with adenomyosis. -- Describe treatment options for patients with adenomyosis.

## TABLE OF CONTENTS/OUTLINE

(1) Background: Pathophysiology of adenomyosis, Clinical findings, Role of imaging for diagnosis and management. (2) MRI protocol: Key sequences, Tips for optimization. (3) Imaging features on MRI: Normal anatomy, Typical adenomyosis findings, Atypical findings (Polypoid, External adenomyosis, Cystic adenomyosis without with hemorrhage, Pregnancy related changes, Endometrial ablation changes). (4) Differential diagnosis mimics: Deep infiltrating endometriosis, Leiomyoma, Neoplasms (endometrial cancer, Mullerian adenosarcoma), Accessory and cavitated uterine mass, Pitfalls/Mimics (Uterine contraction, pseudo-thickening of junctional zone). (5) Treatment options: Medical, Procedural (ablation, excision, hysterectomy).

### OBEE-29 What Not to Miss in Obstetric Ultrasounds - Fetal Skeletal System Evaluation

Oswaldo A. Guevara Tirado, BS, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the essential components of an ultrasound based fetal skeletal assessment. Discuss common sources of error when evaluating the fetal skeletal system using ultrasound. Analyze case examples of classic images with normal findings that are frequently misinterpreted. Follow a systematic approach to avoid missing significant skeletal defects.

## TABLE OF CONTENTS/OUTLINE

Obstetric ultrasounds play a crucial role in the accurate identification of fetal skeletal abnormalities, allowing physicians to optimize management in order to improve both fetal and maternal outcomes. Fetal skeletal abnormalities can manifest early during embryonic life. Therefore, proper evaluation and identification of developmental anomalies requires a profound understanding of normal fetal development and knowledge about ultrasound imaging techniques. Moreover, it is important to take into consideration the various sources of error that exist when performing a fetal skeletal assessment. Ultrasound is the primary imaging modality used to assess fetal well-being by providing a non-invasive method to precisely identify fetal skeletal abnormalities, amongst other irregularities, and intervene in a timely manner. 1. Introduction Objectives 2. How to Approach the Fetal Skeletal System 3. Skeletal Assessment: Ultrasound Findings 3a. Long Bones 3b. Hands Feet 3c. Fetal

Head 3d. Fetal Thorax 3e. Fetal Movement 4. Femur Length Measurement Sources of Error 5. Review of cases in quiz format 6. Conclusion

### **OBEE-30 Incidental Findings of Pelvic Endometriosis in Routine Transvaginal Ultrasound: A Pictorial Essay**

Alexandre M. Minoda, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The aim of this exhibit is: • To conduct a review and illustrate through ultrasound images the female pelvic compartments. • To describe and disseminate the main ultrasound findings suggestive of deep infiltrating endometriosis (DIE) and ovarian endometriomas on transvaginal ultrasounds performed as part of a routine gynecological evaluation. • To demonstrate how the unique capabilities of ultrasound can help in the diagnosis and management of patients.

#### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION / BACKGROUND • Epidemiology, clinical symptoms and classifications of endometriosis ROUTINE TRANSVAGINAL ULTRASOUND AND TRANSVAGINAL ULTRASOUND AFTER BOWEL PREPARATION • International Deep Endometriosis Analysis (IDEA) group consensus PELVIC COMPARTMENTS • Anatomy and normal findings in routine transvaginal ultrasound INCIDENTAL FINDINGS OF PELVIC ENDOMETRIOSIS IN ROUTINE TRANSVAGINAL ULTRASOUND • Anterior compartment • Middle compartment • Posterior compartment • Other findings that may optimize the diagnosis of endometriosis on routine transvaginal ultrasound

### **OBEE-31 How Far Can We Go With Computed Tomography in the Diagnosis of Endometriosis: Correlation With MRI and US**

Gabriel Faria Medeiros (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Recognize the most common CT findings associated with endometriosis and how to describe them 2. Discuss and highlight the role of CT in aiding endometriosis management, by suggesting the diagnosis and prompting MRI recommendation, accelerating diagnosis and improving patient outcomes. 3. Illustrate cases where CT and MRI were both used in the diagnosis of endometriosis, with emphasis on how the correlation between the two modalities aided in the diagnosis. 4. Identify post-treatment changes and potential pitfalls

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: Epidemiology, pathophysiology and clinical aspects of endometriosis Currently available treatment options 2. Role of different imaging techniques in diagnosis and assessment of disease extension (benefits and limitations) Hysterosalpingography Transvaginal ultrasound (with bowel preparation) CT MRI Videolaparoscopy 3. CT findings of endometriosis, with MRI correlation - Case-by-case discussion 4. Post-operative changes and confounding factors Salpingo-oophorectomy Hysterectomy Rectosigmoidectomy Post-radiation therapy Adhesions Inflammatory pelvic disease 5. Summary and take-home messages

### **OBEE-32 Smooth Seas Never Made Skilled Sailors: Navigating the Challenges That Arise After Cervical Cancer Treatments**

Antonella Pierina Ruiz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the different radiotherapy modalities and the clinical indications in cervical cancer treatment. To identify the most frequent early and late complications of radiotherapy. To demonstrate that high doses of radiotherapy are associated with a greater risk of complications. To provide key points and radiologic tools in order to differentiate post-actinic changes from residual or recurrent disease.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Epidemiology and clinical importance -FIGO staging review in cervical cancer -The role of radiotherapy treating cervical cancer. Early and late complications in the uterus, ovaries, intestines, bones, and bladder. Case based approach with radiologic correlation. Imaging findings with histologic and colonoscopy correlation. Conclusion.

### **OBEE-33 Imaging Uterus After Endometrial Ablation**

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Endometrial ablation is a minimally invasive surgical procedure available for the management of patients with abnormal uterine bleeding. Post endometrial ablation expected imaging findings and post procedural complications have a characteristic pattern on imaging and if not readily recognized by the radiologists may lead to misinterpretation and unnecessary follow up imaging and inadequate management. Teaching points The goal of this study is to familiarize radiologists with imaging findings of uterus after endometrial ablation therapy. This will serve to enhance recognition of normal imaging findings and life threatening conditions and help radiologists create a focused differential diagnosis for various complications after the procedure.

## TABLE OF CONTENTS/OUTLINE

A. Review pathophysiology of dysfunctional uterine bleeding. B. Review of treatment options in management of DUB with emphasis on endometrial ablation. C. Discuss imaging options available for the assessment of uterus after ablation: US, CT, MRI and their strengths and weaknesses. D. Review key imaging features of the post endometrial ablation. 1. Expected post-op changes (early: intracavitary air, intrauterine /cervical hematoma, uterus edema; late: endometrial cavity contracture, endometrial thinning) 2. Complications (immediate: infectious (endometritis, myometritis, salpingitis); cornual hematomata, hematosalpinx; chronic: synechia, infertility from post-ablation tubal sterilization syndrome, ectopic pregnancy, abnormal placentation, endometriosis, malignancy (adenocarcinoma of the uterus) E. Management of the presented post-ablation complications will be reviewed.

## OBEE-34 Dedicated MR Imaging for Endometriosis: What You Can't Miss in Your Report

Patricia P. Cardia, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

MR imaging is an important tool for diagnosis of deep pelvic endometriosis. Understanding and recognizing the MRI manifestations of this disease may be challenging. In this presentation, we will summarize the most important points to include in our reports considering a region-based reading and reporting system

## TABLE OF CONTENTS/OUTLINE

Anterior compartment: -Differentiating bladder endometriosis from peritoneal endometriosis: bladder endometriosis is diagnosed when the muscular layer of the bladder is involved. If a bladder lesion is identified, informing the location, distance from vesical trigone and distal ureters are mandatory. Middle compartment: Characterization of endometriomas and differentiation with hemorrhagic ovarian cysts- it is a daily point of attention. -Malignant transformation of ovarian endometriosis: it should be considered if vascular solid tissue is identified with Diffusion imaging and Dynamic post contrast sequences. -Endometriotic tissue infiltrating the uterus: including this information and its differential diagnosis is relevant for treatment planning. Posterior compartment: -Differentiating deep rectal endometriosis from superficial endometriosis: characterization of penetration from endometriotic tissue into muscular layer of rectal wall will be definitive. Location of the lesion (intraperitoneal or extraperitoneal) will also impact in treatment options. -Superficial endometriosis: this is a challenge in diagnostic imaging. Small deposits of glandular tissue are missed frequently. An indirect sign to look for is the peritoneal pocket sign, defined as a peritoneal defect that collects fluid, frequently identified in posterior cul de sac.

## OBEE-35 Current Concepts in Imaging of Uterine Adenomyosis: What Radiologists Should Know

Alexandre M. Minoda, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The aim of this exhibit is: • To discuss the pathophysiology of adenomyosis and how it relates to imaging findings. • To describe the various US and MR imaging manifestations of adenomyosis. • To discuss the classifications of adenomyosis based on US and MR imaging findings. • To provide the diagnostic clues that allow differentiation of adenomyosis from its mimics.

## TABLE OF CONTENTS/OUTLINE

INTRODUCTION • Historical background, epidemiology, physiopathology, clinical features and phenotypes of adenomyosis THE UTERINE JUNCTIONAL ZONE • Normal zonal anatomy, physiologic variations and alterations in adenomyosis IMAGING FINDINGS IN ADENOMYOSIS • Direct and indirect sonographic signs of adenomyosis • Direct and indirect MRI signs of adenomyosis CLASSIFICATIONS OF ADENOMYOSIS AND PHENOTYPES IN IMAGING • Atypical presentations DIFFERENTIAL DIAGNOSIS AND PITFALLS IN DIAGNOSIS OF ADENOMYOSIS

## OBEE-36 Practical Approach to Ovarian Masses - The ABC's

Antonio Michael-Fernandez, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

- To know how to properly identify ovaries and its organ dependency when facing pelvic lesions. - Going over the most common and specific characteristics and radiological features of the different ovarian lesions

## TABLE OF CONTENTS/OUTLINE

The differential diagnosis of ovarian lesions is broad and complex. It is not only a diagnostic challenge due to the existence of multiple tumour lineages, but also to the proper differentiation of their ovarian dependence, which is often unclear. First of all, it is important to properly identify the ovaries by knowing pelvic anatomy, their location and their vascular relations. In the same way, when facing pelvic lesions of possible ovarian origin, there are some radiological signs that can help us to better determine their organ dependence (such as the "phantom organ" or the "beak sign"). Once we have confirmed that the dependence is ovarian, it is important to know the different possible lesions that may exist, and their most common radiological characteristics, both in CT and (mostly) in MRI. According to their T1, T2 signal, and internal component (solid, cystic or mixed), we propose a simple diagnostic algorithm that helps to approximate the diagnosis, based on the most frequent radiological characteristics of ovarian tumours.

### OBEE-37 First Things First! First Trimester Obstetric Ultrasound From the Basics to the Pearls

Niels Vinicius Padua Carvalho, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this exhibition is to:

- Review the recommendations for screening and diagnostic ultrasound in pregnant women during the first trimester of pregnancy.
- Demonstrate how the obstetric ultrasound should be documented in this context.
- Discuss how to use ultrasound for risk assessment of common forms of aneuploidies, malformations and gestational diseases/complications, in a practical approach.
- Highlight the pearls and pitfalls in that evaluation.

## TABLE OF CONTENTS/OUTLINE

- INTRODUCTION
  - o Purpose of a first trimester ultrasound
  - o Standard equipment and protocols
  - o Documentation requirements
- GUIDELINE FOR EXAMINATION
  - o Demonstrate by case-based images the minimum requirements for a 11-14 weeks gestation examination, including:
    - § Assessment of viability
    - § Confirmation of intrauterine pregnancy and uterine integrity
    - § Fetal biometry
    - § Fetal anatomy
    - § Risk assessment for common forms of aneuploidy
- SCREENING
  - o Describe the pretest counseling, biomarkers and ultrasound-based assessment for aneuploidies, malformations and gestational diseases
- SUMMARY AND SYSTEMATIC APPROACH
- TAKE HOME MESSAGES

### OBEE-38 A Multimodality Review of Gynecologic Medical Devices in the Pelvis

Kaitlin M. Zaki-Metias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Given the frequency with which gynecologic pelvic devices are encountered on imaging, understanding the imaging characteristics and appropriate positioning on various modalities is important for radiologists to recognize. Positioning and integrity of all pelvic devices should be evaluated on all studies when visualized. Radiologists should be able to confidently communicate pertinent findings of pelvic device malposition to referring clinicians.

## TABLE OF CONTENTS/OUTLINE

Understand the importance and clinical implications of gynecologic medical devices in the pelvis, including intrauterine contraceptive devices (IUCD), pessaries, contraceptive vaginal rings, tubal occlusion and ligation devices, brachytherapy seeds, and menstrual products. Describe the normal appearance and appropriate positioning of gynecologic medical devices in the pelvis and be familiar with their appearance on various imaging modalities. Describe the strengths and pitfalls of various imaging modalities in the assessment of medical pelvic devices.

### OBEE-39 Pelvic Venous Congestion Syndrome: The Forgotten Culprit of Chronic Pelvic Pain

Lena Deb, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To raise awareness of pelvic venous congestion syndrome as an underdiagnosed etiology for chronic pelvic pain.
2. Review the clinical and multimodality (CT, MR and Angiography) imaging work-up of diagnosing pelvic venous congestion syndrome.
3. Discuss various differential diagnoses such as Nutcracker Syndrome, May-Thurner Syndrome, and arteriovenous malformation and understand the importance of an accurate diagnosis as there are different treatment methods for each entity.

## TABLE OF CONTENTS/OUTLINE

1. Pelvic Venous Congestion Syndrome (PVCS) - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging (CT, MRA, Angiography) - Treatment/Prognosis
2. Differential Diagnoses
  - a) Nutcracker Syndrome - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis
  - b) May-Thurner Syndrome - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis
  - c) Arteriovenous Malformation (AVM) - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis
  - d) Inferior vena cava (IVC)

thrombosis - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis3. Summary Chart

#### **OBEE-4 First-Trimester US and Current Methods of Genetic Screening**

Ami Gokli, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Describe first trimester ultrasound findings including normal, abnormal and indeterminate with imaging correlates, as well as criteria diagnostic for failed pregnancy and pitfalls. Discuss the current methods of genetic screening including carrier testing and all maternal blood tests in conjunction with fetal ultrasound Review current methods of diagnostic testing in conjunction with fetal ultrasound including common complications, sensitivity/specificity, false neg/pos, how often these occur and why Review clinical management of the most common diseases and necessary details to include in radiology reports that guide management

##### **TABLE OF CONTENTS/OUTLINE**

Overview of first trimester US and screening tests -what can be detected in the first trimester, limitations of sonography in the first trimester, and safety issues First trimester ultrasound imaging findings (pictorial review) of detailed fetal anatomic survey including normal anatomy, standard views Most common methods of genetic screening and diagnostic testing in conjunction with US Examples of common pathology encountered with sonographic imaging correlation and management discussion Case examples with explanations including: Early hydrops Anencephaly, Body stalk anomaly, Ectopic cordis, omphalocele, gastroschisis, Megacystis Carrier testing, when and why 10-13 week blood test with nuchal translucency and intracranial translucency ultrasound Integrated screening/sequential screening Cell-free DNA screening clinical indications for advanced imaging such as fetal MRI clinical management guidance and reporting future directions for improving diagnostic capabilities

#### **OBEE-40 MR Imaging of Gynecologic Emergencies in the Pregnant Patient: An Overview of Clinical Indications, Proper Sequence Choice and Not to Miss Emergencies**

Riya Goyal, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Describe the clinical indications for MR imaging in pregnancy based upon the risks of fetal harm with ionizing radiation and recommendations from organizations including the American College of Radiology (ACR) and American College of Obstetricians and Gynecologists (ACOG). Outline the sequences included in the protocol for an MRI abdomen/pelvis of a pregnant female with examples of the features best evaluated on each sequence. Review the imaging features of gynecologic emergencies including ovarian torsion, ectopic pregnancy, placenta accreta spectrum and acute uterine rupture based on an understanding of the associated pathophysiology. Understand pertinent positive and negative information that should be conveyed to the primary team and characteristics that may portend prognosis.

##### **TABLE OF CONTENTS/OUTLINE**

Background discussing the difficulty of diagnosing pathology in pregnancy and crucial role of the radiologist. Clinical indications for MR in pregnancy - outline the ACR and ACOG recommendations and reason to avoid gadolinium contrast. Discussion of the risk of fetal harm with ionizing radiation including the difference between stochastic and deterministic effects, absorbed dose of different radiology exams and impact on fetus based on gestational age. List of the sequences included in a typical MR abdomen/pelvis protocol followed by slides with pictures demonstrating the pertinent features evaluated in each sequence. Examples of gynecologic emergencies seen in pregnancy with slides specifically focused on ovarian torsion, ectopic pregnancy (ruptured tubal ectopic, abdominal ectopic and interstitial ectopic), placenta accreta spectrum, and acute uterine rupture.

#### **OBEE-41 First Trimester Ultrasound Screening**

Shannon M. Navarro, MD, MPH (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

-The importance of the nuchal translucency exam and significance of a widened nuchal translucency -Quality standards - Correlation with blood work for first trimester screen-significance of the ossification of the nasal bone

##### **TABLE OF CONTENTS/OUTLINE**

A. What is the nuchal translucency? Pictorial review of a normal nuchal translucency B. Pitfalls! the amnion before fusion with the chorion, quality standards for appropriate neck flexion/extension, how the ultrasound should be performed C. Abnormal nuchal translucencies: the movement from screening to diagnostic exams. A pictorial review of abnormal nuchal translucency screening exams with correlation from diagnostic tests. D. Pictorial review of normal nasal bone ossification E. Pictorial review of abnormal nasal bone ossification.



## **OBEE-42 Pitfalls in Ovarian Imaging: Limits of the ORAD's System**

Balkis El Khouni, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The first step in characterizing a pelvic mass using the ORAD'S system is to determine its ovarian origin. The second step is to avoid misdiagnosing infections and inflammatory conditions. The third step is to identify features of peritoneal carcinomatosis. Finally, the adnexal lesions are analyzed according to the ORADS criteria. Although this system is standardized and clear, care must be taken to avoid the many pitfalls that can occur at each stage of the reasoning.

### **TABLE OF CONTENTS/OUTLINE**

We will report our experience on the pitfalls of the ORAD's system from a series of 3000 MRI's obtained over the past 5 years in a large tertiary institution by : - Presenting a variety of extra-ovarian lesions that mimic ovarian lesions such as exophytic myometrial masses, lymphocele, lymph node and other tumors arising from other structures of the pelvis. - Presenting confusing infections and inflammatory conditions such as complicated endometriosis or actinomycesis - Discussing and illustrating lesions that mimic peritoneal carcinomatosis, such as Demons-Meigs syndrome and functionally hyper-stimulated ovaries - Discussing and illustrating some benign ovarian tumors that mimic malignancy, such as cellular fibromas, sclerosing stromal tumors and necrotic, infected or distorted lesions. - Discussing and illustrating some malignant lesions that mimic benignity, such as calcified tumors (low-grade serous ovarian carcinoma) and serous cystadenofibromas associated with a borderline component.

## **OBEE-43 Serous Tumors in the Female Pelvis: Comprehensive Review of Diagnostic and Therapeutic Strategy**

Mayumi Takeuchi, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Serous tumors are common female pelvic neoplasm presenting a variety of clinical and imaging manifestations. Recently, there has been a paradigm shift that most extrauterine pelvic high-grade serous carcinomas (HGSC) are metastases of STIC. While HGSC is the majority of serous carcinomas, but also low-grade serous carcinoma (LGSC) developing through serous borderline tumor (SBT) may occur. This exhibit provides an overview of diagnostic and treatment strategies including Hereditary Breast and Ovarian Cancer (HBOC) managements. 2. 3D-DCE-MRI and reduced FOV/computed DWI are useful in detecting early-stage HGSC, or small mural nodules of LGSC. Characteristic imaging findings such as black sponge in adenofibroma, papillary architecture with internal branching in SBT, dense calcification in psammocarcinoma, and CT pattern classifications for genomic subtypes estimation of advanced HGSC, and differentiation of invasive/non-invasive peritoneal implants of SBT are demonstrated.

### **TABLE OF CONTENTS/OUTLINE**

Benign: Surface epithelial inclusion /Cystadenoma /Adenofibroma SBT: Exophytic /intra-cystic papillary growth; Micropapillary subtype /Adenofibromatous SBT; Peritoneal implants /LN involvement; Fertility-preserving treatment options LGSC Psammoma body /Psammocarcinoma; HGSC arising from LGSC/SBTHGSC STIC /Tubal /Peritoneal cancers; Advanced MR techniques: SWS, MRS, CEST; Therapeutic strategies for HBOC (BRCA1/2): Risk-reducing surgery /Molecularly targeted drug; Radiomics/Radiogenomics

## **OBEE-44 Pelvic Perspectives: Unveiling the Imaging Findings and Complications of Female Pelvic Devices**

Cailin O'Connell (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Review normal imaging findings of the female pelvis, including CT, US, and MRI. 2. Review normal and abnormal placement of intrauterine devices (IUDs) and required imaging studies for emergent cases, as in perforation. 3. Review indications for pessary placement and imaging findings for pelvic organ prolapse (POP) and describe their appearance on imaging. 4. Review normal imaging appearance of catheter placement in female patients and discuss potential complications that are visible on imaging. 5. Discuss imaging findings for menstrual devices, including tampons and menstrual cups.

### **TABLE OF CONTENTS/OUTLINE**

1. Review of normal pelvic anatomy and imaging: CT, MRI, Ultrasound  
2. Contraceptive devices: Types of IUDs (Copper, hormonal), Intrauterine contraception (NuvaRing), CT, KUB, MRI and safety note, Ultrasound, Malpositioned IUDs  
3. Pelvic organ prolapse (POP) and pessaries: Anatomy of POP and imaging before treatment, Pessary types (ring, cube, Gellhorn), CT, MRI, Complications of pessaries (migration, fistulization, forgotten pessary)  
4. Catheter placement in female patients: Indications for catheter placement and review of normal placement, CT, MRI, Misplaced catheters and complications (vaginal placement, bladder perforation from traumatic insertion)  
5. Menstrual Products: Imaging findings of tampons, menstrual cups, CT, MRI  
6. Quick cases with multiple choice questions: Malpositioned IUD, Pessary on CT of patient with POP, Vaginal placement of catheter

## **OBEE-45 Achy Breaky Baby Heart: Guide to Understanding Normal Fetal Cardiac Views**

### **Awards**

#### **Certificate of Merit**

Venus Barlas, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) Fetal cardiac assessment is a key component of the fetal anatomic survey. An understanding of the different cardiac views is crucial to accurate image interpretation during a level 1 fetal anatomic survey.  
2) Use of 5 standard scan planes and systematic assessment of the fetal cardiovascular system is the initial step in screening for congenital heart disease.  
3) Features at risk for congenital heart disease should be further examined using a detailed echocardiogram, which includes 5 additional views.

### **TABLE OF CONTENTS/OUTLINE**

A. Overview of basic cardiac exam components  
B. Standardized scan planes, including a graphic schema, US anatomy, CT correlate of the same view, and significance/associated pathologies:  
1) Transabdominal (determining fetal situs and cardiac axis)  
2) 4 chamber view  
3) Left ventricular outflow tract  
4) Right ventricular outflow tract  
5) 3 vessel and 3 vessel trachea  
C. Fetal echocardiography planes, including a graphic schema, US anatomy, CT correlate of the same view, and significance/associated pathologies:  
6) Bicaval  
7) Long axis view of the aortic arch  
8) Long axis view of the ductal arch  
9) Low short axis view of the ventricles  
10) High short axis view of the great arteries  
D. Pictorial review of common congenital heart diseases detected on fetal cardiac views with key diagnostic findings

## **OBEE-46 Endometrioma - Beyond the Basics: Examining the Nuances and Variations of This Condition**

Soumyadeep Ghosh, MBBS, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) To apprise radiologists of the imaging features of endometrioma/endometriotic cysts. 2) Case-based illustrations of the atypical locations to watch out for in the appropriate clinical context. 3) To illustrate the imaging predictors of malignancy in endometriotic cysts. 4) To outline the common pitfalls encountered on various imaging techniques. 5) To highlight the implications of endometriomas on fertility. 6) To emphasize the importance of pain management techniques in patients with endometriotic cysts.

### **TABLE OF CONTENTS/OUTLINE**

1) Background 2) Typical/ovarian endometrioma - Introduction - Classic ultrasound findings - Classic MRI findings 3) Atypical locations - a) Peritoneal Endometrioma b) Perihepatic Endometrioma 4) Imaging predictors of malignancy - Locations - Pathology - Imaging - Pitfalls on Imaging 5) Decidualized endometrioma - What is Decidualization? - Ultrasound appearance - MR imaging 6) Complications 7) Associations - Deep infiltrative endometriosis - Extra gynecological organ involvement 8) Implications on fertility 9) Implications on pain management

## **OBEE-47 Don't Miss - Understand: Solving Pitfalls in the Diagnosis of Endometriosis and Adenomyosis**

Karina d. Giassi, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Endometriosis and adenomyosis are prevalent diseases among reproductive age women with a negative impact on their quality of life and reproductive outcomes. Their imaging manifestations may be challenging due to a wide imaging spectrum of both diseases, leading to incorrect interpretations even by experienced radiologists. This presentation aims to demonstrate common imaging pitfalls of endometriosis and adenomyosis, with a comprehensive and instructive problem-solving guide.

### **TABLE OF CONTENTS/OUTLINE**

1) Overview of endometriosis and adenomyosis, emphasizing the imaging diagnosis: ultrasound and magnetic resonance.  
2) Imaging pitfalls in the diagnosis of endometriosis, including:  
Posterior compartment: Folds in the sigmoid colon; Vessels in the parametrium and paracolpos; Diverticulitis; Pericolic lymph nodes;  
Middle compartment: Adenomyosis; Fallopian tubes; Functional ovarian cysts; Pelvic Varices;  
Anterior compartment: Leiomyomas; Fibrocontractile changes; Folds in the bladder



wall;3) Imaging pitfalls in the diagnosis of adenomyosis, such as:Myometrial contractions;Physiologic thickening of the junctional zone in the menstrual phase;Deep endometriosis with myometrial infiltration;Leiomyomas with cystic or red degeneration;Unicornuate uterus with functional non-communicating uterine remnant4) A didactic guide for problem-solving pitfalls.

### **OBEE-48 Magnetic Resonance Imaging (MRI) of Mayer-Rokitansky- Kuster-Hauser Syndrome, Herlyn-Werner-Wunderlich Syndrome and Related Complex Mullerian Duct Anomalies With Special Emphasis on Surgical Reconstruction & Management;- What the Radiologist Should Know to Guide the Reconstruction Surgeon**

Aruna S. Pallewatte, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Explain Embryology of Mullerian Duct Anomalies (MDA) and Mayer-Rokitansky-Kuster-Hauser Syndrome(MRKHS) and Herlyn-Wener-Wunderlich Syndrome(HWWS) 2) ASRM Classification of MDA with demography 3) Case based introduction to MRKHS, HWWS other complex MDA, associations with Renal, ovarian, spine anomalies 4) Clinico-social aspects of MDA, effect on menarche, fertility pregnancy 5) MRI protocols, Imaging features of MRKHS,HWWS and MDA with sample cases 6) Document MRI findings and dimensions specially for reconstructive surgeon. Detailed analysis of structures - Cervix,Vagina,Plica palmatae,uterine/vaginal septa, uterine buds and extent of uterovaginal aplasia 7) MRI evaluation of Neovagina, other vaginoplasties follow up their complications (with example cases)

#### **TABLE OF CONTENTS/OUTLINE**

1) Developmental Embryology of MDA genetics 2) Classification of MDA(classes 1-VII) with cases 3) Case based description of MRKHS (type 1II), HWWS and MDA with MRI imaging features imaging pearls, coexistent extragenital genital anomalies, fibroids, endometriosis etc influencing surgical management prognosis 4) Clinical presentations, amenorrhea, subfertility pregnancy complications with sample cases 5) Targeted MRI reporting of MRKHS, HWWS, MDA associated extragenital anomalies. Specific points/dimensions useful for reconstruction, implants, surgery and for assisted reproduction. Describe uterine buds, triangular cord sign etc 6. Introduction to neovagina, vaginoplasty, uterine transplant and other surgical options with MRI features 7. Case based review of MRI of post reconstruction and post treatment follow up their complications (stenosis, fistulae, infections, hernia etc)

### **OBEE-49 Pelvic Endometriosis: Lexicon on Magnetic Resonance Imaging (MRI)**

Claudia Hurtado (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The most common sites of involvement are the vesicouterine space (in the anterior compartment) and the uterosacral ligaments (in the posterior compartment). The "T2 black dot sign" is a specific sign of endometriosis. Malignant transformation should be suspected when a nodule enhances, nodule more than 3 cm, growth or loss of T2 shading.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction- Objectives- Teaching points- MRI protocol- Gross anatomy- Morphological subtypes- Endometriomas- Structured Report- Conclusions

### **OBEE-5 MRI of Müllerian Duct Anomalies Based on the New ASRM Classification**

Marianna Konidari, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Müllerian duct anomalies (MDAs) consist of a wide spectrum of congenital malformations of the uterus, cervix, fallopian tubes and upper 2/3 of the vagina and are the result of abnormal development, fusion or resorption of the Müllerian ducts.
- The new 2021 American Society of Reproductive Medicine-ASRM (previously, American Fertility Society-AFS) MDAs classification (MAC2021) expands the 1988 classification to include cervical and vaginal anomalies; it classifies MDAs into nine categories using standardized descriptive terminology.
- Imaging is crucial in the diagnostic workup of individuals with suspected MDAs, particularly adolescents with primary amenorrhea and adults with infertility, since identification of these anomalies and their complications allows tailored clinical management.
- MRI is the modality of choice for detailed pelvic anatomy evaluation, accurate MDA classification and preoperative planning.

#### **TABLE OF CONTENTS/OUTLINE**

- Embryology overview and imaging anatomy of internal female genitalia
- MDAs: how do they develop and what are the clinical implications
- ASRM Müllerian anomalies classification 2021: overview and differences with the AFS 1988 classification
- Imaging evaluation: rationale behind imaging of congenital uterovaginal anomalies, available techniques and the role of MRI
- Case-based discussion on MRI appearances, clinical presentation and treatment management of MDAs, according to the new ASRM classification
- Diagnostic algorithm for imaging approach of MDAs

## **OBEE-50 Endometriosis Revisited: Current Concept of Pathophysiology, Diagnosis, and Therapeutic Strategy**

Mayumi Takeuchi, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Endometriosis, which significantly impairs women's QOL with chronic pain and reduced fertility, is a benign, common, but controversial disease due to its enigmatic etiopathogenesis and biologic behavior. Recent studies suggest multiple genetic, and environmental factors: endocrinic, inflammatory, immunological, and angiogenetic may affect its onset and development. Genomic analysis revealed the presence of cancer-associated gene mutations, which may reflect the neoplastic aspect of endometriosis. The management has changed dramatically with the development of fertility-preserving, minimally invasive therapies. 2. The appropriate examinations with advanced MR techniques (3D-T2WI, reduced FOV DWI, computed DWI, SWI, DCE-MRI, cine MRI), and careful imaging interpretation are considered useful in evaluating endometriosis and associated lesions, which may be effective for therapeutic strategy with improved patient's outcome.

### **TABLE OF CONTENTS/OUTLINE**

Imaging manifestations of endometrioma (shading sign; T2 dark spot; hemosiderin deposition on SWI), deep endometriosis, adenomyosis, less common site and rare site endometriosis, endometriosis-associated tumor-like lesions (polypoid endometriosis; decidualized endometriosis), and malignant transformation, with pathophysiologic conditions, clinical classification, optimal treatment options and clinical outcomes.

## **OBEE-51 Pearls and Pitfalls of First-Trimester US Screening and Prenatal Testing: A Pictorial Review**

### **Awards**

#### **Certificate of Merit**

Cynthia De la Garza Ramos, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. First trimester ultrasound (US) is key in establishing pregnancy viability, number, and location. 2. Early intrauterine pregnancy (IUP) sonographic milestones, including appearance of a gestational sac, yolk sac, embryo, and cardiac activity, follow a consistent timeline. 3. Prenatal genetic testing and sonographic fetal structural assessment serve as initial screening tools for chromosomal disorders and facilitate detection of patients who may benefit from subsequent amniocentesis, chorionic villous sampling, or fetal intervention. 4. Beta human chorionic gonadotropin ( $\beta$ -hCG) in combination with pelvic US can be used to evaluate early pregnancy complications, but threshold  $\beta$ -hCG values should not be used as a sole decision-making tool.

### **TABLE OF CONTENTS/OUTLINE**

1. Review the indications for first trimester US. 2. Recognize the normal appearance of an IUP and identify the sonographic milestones of the first trimester. 3. Illustrate the components of a first trimester fetal anatomy scan. 4. Describe the current prenatal genetic screening recommendations for chromosomal defects and their relationship with US fetal anatomy, including nuchal translucency (NT) measurement. 5. Understand the role of  $\beta$ -hCG and its correlation with US findings in the evaluation of early pregnancy complications. 6. Review the Society of Radiologists in Ultrasound (SRU) consensus statement for diagnosing a nonviable pregnancy in the first trimester. 7. Identify US findings that may be associated with poor pregnancy outcomes and require follow-up. 8. Case Examples.

## **OBEE-52 Nothing Complex about Ovarian Lesions: Expert Guidance from the O-RADS US Committee**

### **Awards**

#### **Certificate of Merit**

Catherine R. Phillips, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Based on validation studies feedback, the Ovarian-Adnexal Reporting and Data System (O-RADS) US has been updated to address clinical application challenges, improve system specificity, harmonize with other consensus statements and O-RADS MRI. 2. New lexicon terms include bilocular for cystic lesions shadowing for smooth solid lesions, features which favor benignity and may improve specificity by down-scoring lesions. 3. Features of classic benign lesions were further refined to capture their typical appearance and also aim to improve specificity. 4. Updated surveillance and growth parameters optimize management better align with existing consensus statements. 5. Emerging data suggests O-RADS US 3 lesions are at the lower end of the risk of malignancy range (1-<10%); management recommendations have thus been updated to allow short-term US follow-up.

## TABLE OF CONTENTS/OUTLINE

1. Clarification of updated O-RADS US v2022 governing concepts on applicability criteria, definitions/technique, and rules for system use with diagrammatic depictions illustrative examples. 2. Image rich example cases featuring new lexicon descriptors with an explanation of how their presence alters risk score assessment and management options. 3. Algorithmic approach to assessment and diagnosis using O-RADS US v2022 lexicon terms demonstrating ease use for daily clinical practice.

### OBEE-53 Unusual Presentations of Common Female Pelvic Lesions

May A. Shaaban (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Uterine leiomyomas, uterine adenomyosis, ovarian mature cystic teratomas and endometriomas represent the most common pathologies in everyday practice. They have characteristic imaging features that allow confident diagnosis. Occasionally these common lesions present with atypical features which makes it more challenging. Teaching points: Describe the classic imaging features of Uterine leiomyomas, uterine adenomyosis, ovarian mature cystic teratomas and endometriomas Describe unusual imaging features of variant or complicated lesions Provide differential possibilities based on the imaging features

## TABLE OF CONTENTS/OUTLINE

Atypical leiomyomas: I. Degenerated and variant leiomyomas: 1. Cellular leiomyoma 2. Cystic degeneration 3. Myxoid degeneration 4. Red degeneration 5. Lipoleiomyoma II. Infected leiomyoma III. Torsion of leiomyoma IV. Prolapsed leiomyoma Atypical adenomyosis/adenomyomas: Focal adenomyosis (adenomyoma) Cystic adenomyosis Adenomyosis in pregnancy Exophytic adenomyoma Atypical endometriomas: Mural nodules and decidualization Malignant transformation Rupture Atypical presentations of dermoid cysts: Rupture Malignant transformation

### OBEE-54 Medical Devices of the Female Pelvis: Multimodality Patterns, Pitfalls, and Pearls

Mariam S. Mostamandy, BS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Medical devices in the female pelvis are less frequently encountered than those in the chest or abdomen. Nevertheless, radiologist familiarity with these devices is critical for appropriate imaging evaluation. This exhibit reviews normal and abnormal radiologic presentations of medical devices commonly found in the female pelvis on multiple imaging modalities as well as examples of complications that may arise from device placement. Finally, we will present radiologic examples of device mimics that could lead to pitfalls in imaging evaluation.

## TABLE OF CONTENTS/OUTLINE

Pessaries Pessary Mimic: Menstrual cup Pessary Mimic: NuvaRing Pessary Mimic: Tampon Intrauterine devices (IUDs) Essure devices Tubal ligation clips Embolization coils Ureteral stents Foley catheter Rectal tube

### OBEE-55 Don't Be Fooled by Uterine Masses: How MRI Can Help You Spot Atypical and Malignant Impostors Among Leiomyomas

Valeria Richart Sierra, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the specific MRI features of usual leiomyomas. Explain the known and emerging MRI features of atypical leiomyomas and describe how to differentiate them. Describe MRI characteristics of uterine sarcomas and compare them with those of leiomyomas. Develop a systematic image-based approach to recognize these entities.

## TABLE OF CONTENTS/OUTLINE

1. Introduction- Uterine anatomy - Clinical relevance - Definitions 2. MRI protocol 3. Usual leiomyomas - MR typical findings - Other RM signs: flow void sign, bridging vascular sign, high signal intensity rim on T2 4. Atypical leiomyomas: MR findings correlation with Histology 4.1. Atypical location- Subserosal - Submucosal 4.2. Degenerated leiomyomas- Hyaline degeneration - Mixoid degeneration - Red degeneration - Cystic degeneration 4.3. Histologic subtypes- Cellular leiomyoma - Lipoleiomyoma - STUMP 5. Uterine sarcomas: MR findings correlation with Histology 5.1. Uterine leiomyosarcoma 5.2. Endometrial stromal sarcoma 6. Differential Diagnosis 7. Conclusion

### OBEE-56 3D Ultrasound - Troubleshooting in Gynaecological Imaging

#### Awards Certificate of Merit

Sanchita Gupta, MBBS, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The purpose of this exhibit is to -1) Provide information about system requirements and scanning techniques to obtain a standard 3D dataset, rendering and image reconstruction.2) Explore newer techniques and software in 3D USG for improving diagnosis.3) Know common clinical scenarios where 3D provides additional information over simple 2D USG.

## TABLE OF CONTENTS/OUTLINE

1) 2D vs 3D ultrasound2) System requirements for 3D dataset acquisition3) Rendering and multiplanar reconstructions4) Transvaginal 3D USG - Importance of the coronal plane5) Newer techniques and software in 3D USG:- Walk thru mode - Virtual Hysteroscopy- 3D USG with Saline infusion sonography (SIS)- Translabial 3D USG- 3D Power Doppler- Endometrial volume calculation using VOCAL (Virtual Organ Computer-Aided Analysis)- Sono AVC (Automated volume calculation)6) Common clinical scenarios where 3D imaging can help provide a diagnosis- Evaluation of the external and internal uterine contour1) Congenital uterine anomalies2) Subserosal and pedunculated fibroids deforming external contour3) Submucosal fibroids deforming internal contour- Pathologies of the endometrial cavity1) Identifying intrauterine adhesions2) Locating polyps and Retained products of conception3) Placement of Intra-uterine contraceptive devices- Assessment of endo-myometrial junction in adenomyosis and carcinoma endometrium

## OBEE-57 How to Handle Hydrops

### Awards

#### Magna Cum Laude

April M. Griffith, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1: Hydrops fetalis is defined as the presence of fluid in two spaces -skin, pericardium, pleural space, peritoneal cavity.2: The prognosis is generally poor due to lack of treatment options.3: Fetal tachycardia and fetal anemia are treatable causes. Middle cerebral artery (MCA) Doppler is a non-invasive method to screen for fetal anemia which can be treated by intrauterine transfusion.4: Fetal intervention may be lifesaving - shunt placement in large cysts in a lung mass, laser ablation for twin twin transfusion syndrome, radiofrequency ablation for twin reversed arterial perfusion sequence.5: For some tumors (e.g., sacrococcygeal teratoma) elective preterm delivery with immediate resection is preferable to expectant management. The decision to deliver in such cases is based on multiple factors including the combined cardiac output calculated by echocardiography. 6: Some causes of hydrops can recur. Correct diagnosis of the cause is essential for management of current and future pregnancies.

## TABLE OF CONTENTS/OUTLINE

1: Pitfalls in diagnosis of abnormal fluid locations. 2: Immune vs Non immune hydrops: Antibody screening, MCA Doppler velocimetry. 3: Cardiac - rhythm disturbance more likely than structural defects. 4: Genetic - Aneuploidy, syndromic. 5: Infection - Serology, growth restriction, hepatosplenomegaly, intracranial and abdominal calcifications. 6: High output states - Vascular malformation, vascular tumor, chorangioma. 7: Mechanical compression - Large lung mass, mediastinal mass. 8: Multiple gestations - Twin twin transfusion, monochorionic twin demise, twin reversed arterial perfusion. 9: Metabolic - Lysosomal storage disorders, gestational alloimmune liver disease.

## OBEE-58 A Headache Free Approach to Hydrocephalus

April M. Griffith, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1: The prognosis for fetal ventriculomegaly depends on the underlying etiology thus a systematic approach is recommended. 2: Scan technique is critical to ensure correct measurements for grading (mild, moderate, severe) and tracking for progression over time. 3: Accurate diagnosis is essential for pregnancy management and delivery planning. 4: Some conditions with ventriculomegaly can recur in future pregnancies (e.g., autosomal recessive Walker Warburg syndrome). 5: Fetal MRI plays an essential role in characterizing the underlying pathology. 6: Isolated mild ventriculomegaly is a diagnosis of exclusion, generally associated with good intellectual outcome. It may be unilateral (usually left), in males.

## TABLE OF CONTENTS/OUTLINE

A: Technique to measure ventricles - US and MRIB: Evaluate the posterior fossa: Exclude Chiari malformation, Dandy Walker syndrome, aqueductal stenosis, rhombencephalosynapsisC: Systematic assessment of the supratentorial brain: Midline: Is the falx present, is the cavum septi pellucidi normal? Cortical mantle: Gyral and sulcal development, thickness, symmetry, defects? Ventricles: Shape, lining, contents? D: Is there a mass? E: Is there a vascular malformation? F: Are there cystic areas?G: Perform a detailed anatomy scan to look for signs of syndromes, infection, aneuploidy, growth restriction and complications of monochorionic twinning.

## OBEE-59 Medical Devices in Female Genital System: What Radiologists Need to Know

Jian Guan, MD, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To review the classification and function of medical devices in female genital system (uterus, vagina and adnexa).2. To realize the normal, abnormal and special imaging findings of medical devices in female genital system.3. To introduce complications related to medical devices in female genital system (including imaging appearance, diagnosis and differential diagnosis).4. To learn assistance in imaging diagnosis of medical devices in female genital system.

## TABLE OF CONTENTS/OUTLINE

1. Classifications of medical devices in female genital system (1) Medical devices of the uterus (IUDs, uterine suspension mesh, etc.); (2) Medical devices of the vagina (pessary, vaginal occluder, vaginal tamponade, etc.); (3) Medical devices of the ovary and adnexa (tubal ligation clips, ovarian suspension clips, etc.).2. Medical devices of the uterus (1) Function and normal imaging appearance; (2) Abnormal imaging appearance and related complications; (3) Assistance in imaging diagnosis.3. Medical devices of the vagina (1) Function and normal imaging appearance; (2) Abnormal imaging appearance and related complications; (3) Assistance in imaging diagnosis.4. Medical devices of the ovary and adnexa (1) Function and normal imaging appearance; (2) Differential diagnosis of post-ovarian suspension findings (e.g. ovarian maldescent, supernumerary ovary); (3) Abnormal imaging appearance and related complications; (4) Assistance in imaging diagnosis.

## OBEE-6 Role of Fetal MRI in Antenatal Assessment of Central Nervous System Anomalies: What a Radiologist Should Know

Smily Sharma, MD, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To study the role of fetal MRI for antenatal assessment of various central nervous system anomalies including indications, added advantage over obstetric ultrasound as well as certain limitations. 2. To define a fetal MRI protocol for central nervous system assessment. 3. To learn about normal appearances of sulcation and gyration of brain at various periods of gestation and beware of MR pitfalls in fetal CNS imaging. 4. Using state of the art cases, to learn about myriad of CNS anomalies that can be detected in fetus, their syndromic and non-syndromic associations and their antenatal or postnatal follow up (wherever available).

## TABLE OF CONTENTS/OUTLINE

1. Introduction to fetal MR for antenatal central nervous system anomalies: Indications, advantages/ disadvantages and comparison with obstetric ultrasound 2. MR protocol to assess various central nervous system anomalies in fetus 3. MRI appearances of fetal brain at different periods of gestation (Pearls and Pitfalls) 4. Various CNS anomalies on fetal MRI with postnatal follow up wherever available: 4A. Fetal Ventriculomegaly 4B. Malformations of cortical development and midline brain anomalies 4C. Corpus Callosal Agenesis/ Dysgenesis and associations 4D. Posterior Fossa Malformations 4E. Neural Tube defects and Spinal Dysraphism 4F. Vascular anomalies 4G. Syndromic associations 4H. Miscellaneous CNS Disorders including ischemic insults, germinal matrix and intraventricular hemorrhage in fetus 5. Conclusion

## OBEE-60 Once in a Lifetime Gynecological Cases: Seen One, Seen Them All

Ana Villanueva, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To illustrate and review unusual gynecological cases, some of them with classic appearance as well as common gynecological cases with rare presentation.2. Role of radiologist in evaluation of challenging gynecological cases.

## TABLE OF CONTENTS/OUTLINE

1. BackgroundHow do abdominal radiologists like to report gynecological cases? And what about general radiologists?Many colleagues say that they find themselves in trouble when reporting these cases. And why is that? Probably it is a combination of lack of knowledge or experience; not familiar reporting different techniques TV US, CT and MRI; etc.We as radiologist look for entities that we know. If we do not know about a disease, we will not think about it and therefore we will not reach a correct diagnosis.However, there are certain entities that even they are challenging because they are uncommon, they have a classic appearance (for example malignant adenoma of the cervix). Once you see one case, you will not forget. Also, common gynecological diseases can present in a very unusual way (for example ileal and appendiceal endometriosis without pelvic endometriotic findings).2. Identification of characteristic imaging features• Different imaging techniques will be shown: Transvaginal US, CT, MRI• To propose key points to accurately reach the diagnosis• Algorithm of differential diagnosis based on imaging features along with relevant clinical and analytical information3. Understand the clinical and treatment implications of diseases with characteristic radiologic appearance4. Radiologic- pathologic correlation will be shown for most of the cases5. Conclusion6. References

## OBEE-61 First Trimester Ultrasound (FTUS): Screening Techniques

Saubhagya Srivastava, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Increased nuchal translucency (NT) remains an internationally recognized indication for invasive testing (amniocentesis or CVS). By the end of this educational exhibit, the reader/listener would be able to: 1. Understand the various screening policies for chromosomal abnormalities utilized in the first trimester (Combined screening vs Contingent screening policies). 2. Learn about the importance and technique of measuring NT in the first trimester. 3. Learn about new ultrasound markers utilized in first-trimester screening. 4. Identify important fetal structural abnormalities and their significance system-wise. 5. Algorithmically co-relate first-trimester ultrasound findings to the next steps in the screening process.

## TABLE OF CONTENTS/OUTLINE

1. Introduction to FTUS 2. Combined screening vs Contingent screening for chromosomal abnormalities 3. Nuchal translucency (NT) i. Significance and efficiency ii. The technique of measuring NT 4. New FTUS markers i. Nasal bone ii. Tricuspid flow iii. Ductus Venosus flow 5. Cell-free DNA (cfDNA) i. The utility of cfDNA in relation to FTUS- When to use and when NOT to use? ii. Advantages and limitations of cfDNA compared to FTUS. 6. Fetal structural abnormalities NOT to miss in FTUS i. CNS abnormalities ii. GI and GU abnormalities iii. Skeletal abnormalities iv. Cardiac abnormalities 7. Summary

## OBEE-62 The Hidden Enemy: A Visual Journey Through Ovarian Tumor Imaging

Sofia B. Maksoud, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Ovarian tumors are classified according to their origin: epithelial cell tumors, germ cell tumors, sex cord-stromal tumors and metastatic tumors. Among them, epithelial tumors are the most common, with a higher prevalence between 60 and 70 years of age. Imaging exams have the capability to predict the risk of malignancy: mural nodules, papillary projections, solid components, thickened walls and septa (greater than 3.0 mm) with associated vascularization are some aspects that suggest malignancy, while of fat components suggests benignity. Pelvic ultrasound is commonly the first exam to be performed due to its high availability and low cost. However, for adequate characterization of the ovarian mass, additional tests such as magnetic resonance imaging may be requested, with the aim of helping to distinguish between benign and malignant tumors and, mainly, in staging and surgical planning. The results of radiological examinations associated with the clinical features, family history and laboratory tests allow the diagnosis of ovarian lesions. A thorough evaluation provides part of data that may be associated with the histology of these tumors. This information plays a fundamental role in choosing the appropriate therapy.

## TABLE OF CONTENTS/OUTLINE

To demonstrate cases of malignant and benign ovarian tumors and to review their presentations in different imaging modalities, including pelvic ultrasonography and magnetic resonance imaging, correlating with anatomopathological results and surgical specimens.

## OBEE-63 Placenta Accreta Spectrum and the Emergence of MRI

Leslie W. Nelson, DO (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Placenta Accreta Spectrum (PAS) refers to abnormal placental adherence and/or invasion into the uterine wall due to a defective decidualization process. Difficult placental separation can cause life threatening peripartum hemorrhage if not diagnosed prenatally. 2. The prevalence of PAS has increased 10-fold over the last 4 decades and has been linked to increased rate of cesarean deliveries. 3. Ultrasound is the first line modality for placenta imaging, however, MRI is an emerging modality that provides superior soft tissue contrast and is vital for surgical planning in Placenta percreta. 4. In 2020, SAR and ESUR published a joint consensus statement to standardize MRI acquisition, interpretation and reporting of PAS. 5. This educational exhibit will help the learner understand and identify the described MRI signs associated with PAS and their pathophysiologic subcategories.

## TABLE OF CONTENTS/OUTLINE

1. Introduction of PAS 2. Compare and contrast use of ultrasound versus MRI 3. Normal MRI appearance of the placenta 4. Review of the MRI features described by SAR and ESUR joint consensus statement 5. Review the three pathophysiological oriented classifications (gross morphologic signs, interface signs and tissue architecture signs) 6. Review pathology proven cases (accreta, increta and percreta)

## OBEE-64 CT Imaging of the IUD: Expected Findings, Unexpected Findings, and Complications

Grace G. Zhu, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

After viewing this exhibit, the reader will be able to: 1. Understand the approach in evaluating the CT appearance of an intrauterine device and recognize a normally positioned intrauterine device. 2. Recognize the CT imaging appearance of wide



spectrum of complications involving the intrauterine device.

#### **TABLE OF CONTENTS/OUTLINE**

Outline:1. Introductiona. Types of IUDsb. Approach to evaluating IUDs on CTc. Normal Imaging appearance of an appropriately positioned IUD2. Complicated IUDsa. Malpositioned IUDi. Low lying IUDii. Intracervical IUDiii. Rotated IUD/UpSide Down IUDb. Embedded IUDc. Extrauterine IUDd. Fragmented IUDe. Pregnancy and IUDi. Ectopic pregnancyii. Intrauterine pregnancyf. Miscellaneousi. Actinomycoses and IUDsii. Fibroids and IUDSiii. Mullerian abnormalities and IUDs

### **OBEE-65 To Treat, or Not to Treat, That is the Question: Multimodality Approach to Secondary Post Pregnancy Hemorrhage**

#### **Awards**

#### **Certificate of Merit**

Alyssa K. Kirsch, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Secondary post pregnancy hemorrhage occurs 24 hours to 12 weeks following delivery. Etiologies include retained products of conception (RPOC), subinvolution of the placental site (SIPS), arteriovenous malformation/arteriovenous fistula (AVM/AVF) spectrum.- Ultrasound is often a first line imaging modality in the identification of causes of secondary post pregnancy hemorrhage. However, CT and MRI may also be used in the imaging work up. Recognizing key features of each etiology is essential to timely diagnosis and clinical management.- Certain pathology may mimic causes of secondary post pregnancy hemorrhage such as endometritis and gestational trophoblastic disease.

#### **TABLE OF CONTENTS/OUTLINE**

- Explanation of causes, pathophysiology, and management of secondary post pregnancy hemorrhage including RPOC, SIPS, and AVM/AVF- Case-based, multimodality imaging review of secondary post pregnancy hemorrhage including US, CT, and MRI with discussion of management options- Imaging review of mimics of retained products of conception including endometritis and gestational trophoblastic disease- Proposed algorithmic approach to management of secondary post pregnancy hemorrhage based on imaging findings and how to differentiate from mimickers

### **OBEE-66 Malignant Transformation of Endometriosis and Its Mimics**

Cesar Resino Sanchez, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review the types of malignant transformation of endometriosis, taking into account the typical and atypical locations. 2. To recognize the usefulness of magnetic resonance imaging (MRI) in the early diagnosis of malignant transformation of endometriosis. 3. To describe forms of presentation of endometriosis that can simulate malignant transformation.

#### **TABLE OF CONTENTS/OUTLINE**

Definition, types and typical and atypical locations of endometriosis. Pathological mechanisms of malignant transformation: genomic alterations, oxidative stress, inflammation, and hormonal influences. Types of ovarian tumors in endometriosis (endometrioid adenocarcinoma and clear cell carcinoma as the most frequent). Optimal protocol and MRI findings suggestive of malignancy: appearance of enhancing intramural nodules, enlargement of the endometrioma and disappearance of shading sign on T2-weighted images. Imaging findings in cancers arising from extraovarian endometriosis. Malignancy simulators: decidualization during pregnancy, polypoid endometriosis, extraovarian endometriosis mimicking peritoneal carcinomatosis, etc.

### **OBEE-67 Hysterosalpingography: What's Current and What's Next**

Erica D. Cruz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Hysterosalpingography is an exam with consolidated use in medical practice, with well-established indications and contraindications in the literature. The main indications for the exam are: human reproduction (infertility), preoperative uterine fibroids, repeat abortions and reversal of tubal ligation. Although new technologies and imaging methods have been developed in the past years, it currently persists as the method of choice and gold standard for evaluating the thickening of the mucous pleats of the fallopian tube. The objective of this study is to provide a didact review of hysterosalpingography, from the examination technique to its main findings, since the images acquired's quality depends on the correct preparation and technique. We also provide a comparative study of hysterosalpingography with other emerging imaging methods, such as magnetic resonance hysterosalpingography (HSG-MRI) and hysterosonosalpingography, with future perspectives related to these methods.

## TABLE OF CONTENTS/OUTLINE

Case-based review of hysterosalpingography exams, including the technique, most common findings and pitfalls, with a literature review, teaching points, and references. We also provide correlation with other imaging methods, such as ultrasonography and magnetic resonance imaging (MRI).

### **OBEE-68 Highlighting the Updates in Mid-Trimester Fetal Ultrasound Scan According to the Updated International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) Practice Guideline**

Ilkay S. Idilman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The mid-trimester ultrasound scan is performed for anatomic evaluation of the fetus and is accepted as a part of routine prenatal care by many countries. The International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) published a guideline for the performance of the routine mid-trimester fetal ultrasound scan in 2011 and updated the guideline in 2022. According to these guidelines, a routine mid-trimester fetal ultrasound examination should include an evaluation of the cardiac activity; fetal number (and chorionicity and amnionicity in cases of multiple pregnancy); gestational age/fetal size; basic fetal anatomy; placental appearance and location. In the updated ISUOG guideline, amniotic fluid volume assessment and measurement of cervical length for prediction and prevention of preterm birth are also recommended. Pregnancies in which the umbilical cord inserts into the amniotic membranes (velamentous cord insertion) or at the edge of the placenta (marginal cord insertion) should be reported. Suggested minimum (and optional) requirements for the fetal anatomic survey were also updated and will be discussed in the exhibition. Technical challenges to obtaining these standard images will also be discussed.

## TABLE OF CONTENTS/OUTLINE

The suggested basic mid-trimester fetal anatomic survey according to ISUOG is updated in 2022. Knowledge of minimum and optional requirements according to the current guideline is important for the appropriate evaluation of the fetus. This exhibit aims to highlight the updates as well as remaining unchanged requirements with ultrasound images.

### **OBEE-69 Postmenopausal Endometriosis: Clinical Insights and Imaging Considerations**

#### Awards

##### Certificate of Merit

Lekui Xiao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Postmenopausal endometriosis is estimated to affect around 2-4% of women and is more commonly seen in patients undergoing hormone replacement therapy.
- There is no current guidelines for management of postmenopausal women with endometriosis.
- Transvaginal ultrasound and magnetic resonance imaging are the primary imaging modalities for assessing extent of endometriosis.
- Imaging findings will demonstrate a predominance of the fibrotic component associated with anatomical distortion.

## TABLE OF CONTENTS/OUTLINE

- To review the clinical presentation of endometriosis in the postmenopausal population
- To understand how hormonal status affects the pathogenesis of endometriosis, including both exogenous and endogenous sources
- To use a case-based approach to illustrate the sonographic and MRI findings of endometriosis in patients undergoing hormonal replacement therapy, as well as in those who are not undergoing hormonal treatment. Laparoscopic correlation will be included, when available.
- To describe the risk of malignant transformation for specific lesions such as endometriomas and deep invasive lesions, while using cases to demonstrate imaging features of neoplasm.
- To explore proposed non-invasive screening imaging methods.

### **OBEE-7 Hysterosalpingography and Infertility: Beyond Tube Obstruction**

Leticia Cardoso Ern, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The causes of infertility can be genetic or acquired. When anatomically compartmentalized, it is possible to determine some groups of causes: uterine, tubal, ovarian, and central (pituitary and hypothalamic). Hysterosalpingography (HSG) is a contrast-enhanced examination of the female genital tract that uses serial radiographs to assess uterine and tubal anatomy. It is known to be the first-line test for assessing tubal obstruction, as it can determine the local anatomy in a relatively simple and inexpensive way. There are several other findings that HSG can offer and suggest diagnoses of other causes of infertility, such as endometriosis, adenomyosis, Müllerian duct malformations, and uterine synechiae. By the end of this study, the reader will be able to define the importance of fluoroscopy in the investigation of infertility, understand the methodology of HSG and identify its causes based on imaging findings.



## TABLE OF CONTENTS/OUTLINE

Define the role of imaging exams in the investigation of infertility; Determine the methodology of HSG and its usefulness; Explain the causes of infertility and illustrate their compatible findings in HSG through image examples.

### **OBEE-70 From the Pathology Lab to the Radiology Suite: Navigating Neuroendocrine Tumors of the Female Reproductive System**

#### **Awards**

#### **Certificate of Merit**

Mayara R. Dos Santos Cruz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To present a rare subtype of gynecological tumor, the Neuroendocrine gynecological tumors (NEG). To review clinical-pathological features of NEG, highlighting the pathologic differences between NEG and non-NEG cancers. To expose the aggressive clinical behavior of NEG tumors by evolutive imaging examples and well-documented cases, with emphasis on the radiological role for staging and follow-up. To become aware of the different prognostic data between NEG and non-NEG tumors with a brief overview on the suggested treatment.

## TABLE OF CONTENTS/OUTLINE

Neuroendocrine gynecological tumors can dramatically affect the cervix, ovary, endometrium, vagina, and vulva. As extremely rare tumors, studies on NEG are scarce and most are based on case reports. Although the imaging features are non-specific for diagnosis, imaging is quintessential in staging, treatment response assessment, and surveillance. To demonstrate with clinical cases, imaging exams, and temporal evolution the regional and advanced involvement of NEG. Review in a didactical way the disease-related pathology, and its differentials, based on illustrations, pathology / immunohistochemistry analysis. Case-based discussion and review of the essential information for the radiological report, that will imply the follow-up and treatment of the patient. Discuss the clinical prognosis associated with the disease, and demonstrate briefly the limitations related to the therapies available.

### **OBEE-71 Many Faces of Uterine Fibroids: Imaging Findings of Degenerations, Differential Diagnoses, and Complications**

Shintaro Ichikawa, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Uterine fibroids are benign tumors composed of smooth muscle and are the most common tumors in gynecology. Because uterine fibroids tend to produce different symptoms depending on their site of origin, accurate assessment of the site and size of the fibroids using diagnostic imaging is required. Although typical uterine fibroids are easy to diagnose using imaging, there are a variety of degenerations, and it is important to know the characteristics of each.

## TABLE OF CONTENTS/OUTLINE

The following typical and degenerated uterine fibroids are discussed along with their key imaging findings: 1. Typical fibroids (intramural, subserosal, submucosal, and cervical) 2. Hyaline degeneration 3. Hydropic degeneration 4. Myxoid degeneration 5. Fatty degeneration 6. Red degeneration The following differential diagnoses and complications are discussed, along with their key imaging findings: 1. Uterine lipoleiomyoma 2. Hypercellular uterine fibroid 3. Uterine leiomyosarcoma 4. Focal adenomyosis 5. Low-grade endometrial stromal sarcoma 6. Submucosal uterine fibroid prolapse into the vagina (vaginal delivery) 7. Uterine intravenous leiomyomatosis 8. Peritoneal leiomyomatosis following uterine fibroid morcellation 9. Rupture of fibroid 10. Torsion of subserosal fibroid 11. Infection of fibroid

### **OBEE-72 Comprehensive Imaging of Pelvic Medical Devices: Beyond IUDs**

Lidiamara Van Der Zwaag, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Recognize the usual appearance of the main pelvic devices in different imaging methods (Radiographic, Ultrasound, CT and MRI): Vaginal tampon Menstrual cup Contraceptive devices (IUDs, Female sterilization device, Vaginal ring) Therapeutic devices (Pessaries, Brachytherapy applicator, etc) Post-surgical devices (Suture artifacts, catheters, etc) How to assess the proper placement of the most common pelvic devices and what points and measurements should be included in the report Recognize the main complications related to Intrauterine contraceptive devices (IUDs) displacement

## TABLE OF CONTENTS/OUTLINE

INTRODUCTION Main pelvic devices and their radiographic features How to assess correct placement of pelvic devices and practical points COMPLICATIONS RELATED TO INTRAUTERINE CONTRACEPTIVE DEVICES DISPLACEMENT. Case based Review of: - Displacement- Embedment- Complete perforation

## **OBEE-73 Piecing Together the Puzzles: Imaging Diagnostic Approach to Genetic Diseases Affecting the Female Reproductive Organs and Beyond**

### **Awards Cum Laude**

Tsukasa Saida, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The genetic links to various tumors have become more apparent, and it is crucial for radiologists to understand them in order to make an accurate diagnosis and establish an appropriate testing strategy. This exhibit will describe the genetic diseases associated with neoplastic lesions in gynecology, including the specific characteristics of each tumor and lesions that occur in other regions of the same disease. The teaching points of this exhibit are: 1. Description of the inheritance pattern and characteristics of each genetic disease 2. Presentation of key imaging findings that contribute to the diagnosis of various genetic diseases

### **TABLE OF CONTENTS/OUTLINE**

A. Inheritance pattern  
B. Characteristics of the genetic disease  
C. Imaging features of gynecologic tumors associated with genetic diseases  
D. Imaging features of lesions that occur in other regions of the body

## **OBEE-74 Hystero-Salpingography in Current Clinical Practice - Old Flames, Die Hard!**

Nitin P. Ghonge, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. To review the clinical status of Hysterosalpingography [HSG] in infertility work-up in the current era of cross-sectional imaging. 2. To revisit the nuances of HSG procedure and image interpretation for better understanding of uterine, tubo-ovarian and peritoneal lesions in these patients. 3. To understand the spectrum of findings on the initial HSG study and impact on the subsequent infertility work-up.

### **TABLE OF CONTENTS/OUTLINE**

1. Status of HSG in current clinical practice as an initial first-line investigation for infertility work-up. 2. Procedural nuances in HSG and the image interpretation skills play an important role in diagnostic accuracy of HSG in patients with infertility and the overall utility. 3. Implications of slow continuous injection of contrast with acquisition of standard set of images: early filling phase, late distended phase, peritoneal spillage phase and post-cannula removal phase. 4. Review of basic principles in Radiation hygiene as applicable to HSG. 5. Image interpretation includes evaluation of endometrial cavity in terms of shape, distension and the mucosal surface. Tubal and peritoneal evaluation is not restricted to contrast spillage alone. Apart from tubal patency, evaluation of tubal mucosa is an important component of tubal evaluation. Apart from the tubal opacification and luminal caliber, the course of fallopian tubes should also be carefully evaluated as it provides vital clues about the status of peri-tubal peritoneum and peritubal adhesions.

## **OBEE-75 Hereditary and Non-Hereditary Syndromes with Gynecologic Manifestations: What the Radiologist Needs to Know**

Ekta Maheshwari, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. A number of key hereditary and non-hereditary syndromes are associated with gynecologic manifestations. 2. Awareness of these syndromes and their associations is integral to optimal patient management, facilitating recommendations for ancillary imaging and follow up.

### **TABLE OF CONTENTS/OUTLINE**

**Hereditary Cancer Predisposition Syndromes** Some examples of hereditary cancer predisposition syndromes include Lynch syndrome (mismatch repair genes), Cowden Syndrome (PTEN), hereditary breast and ovarian cancer syndrome (BRCA1/BRCA2), Peutz-Jeghers syndrome (STK 11) and hereditary leiomyomatosis and renal cell cancer syndrome (FH). These syndromes can predispose individuals to distinct uterine and ovarian neoplasms.  
**Congenital Syndromes with Benign associations**• Gynecologic manifestations observed in multiple congenital and acquired syndromes can also be associated with benign entities• Congenital malformation of the reproductive tract can be seen in Mayer-Rokitansky-Küster-Hauser syndrome. Familial clustering of these cases suggests a genetic basis of inheritance.  
**Acquired Syndromes** Acquired syndromes with gynecologic manifestations include-• Meig's syndrome • Ovarian hyperstimulation syndrome • Ovarian remnant syndrome • Fitz-Hugh-Curtis syndrome • Growing teratoma syndrome  
**AIMS**• Summarize and illustrate imaging findings observed for key hereditary and non-hereditary syndromes associated with gynecologic manifestations, including features of malignancy and those features overlapping and mimicking malignancy. • Describe the clinical implications, most current imaging recommendations and screening and surveillance guidelines for these syndromes.

## **OBEE-8 Quantification in Fetal MRI: Why, When, and How**

Haithuy N. Nguyen, MD (*Presenter*) Research Grant, Siemens AG

### **TEACHING POINTS**

1. Recognize the fetal abnormalities that require a radiologist to use the measuring tool. 2. Understand the impact of measurements on prognostication and/or family counseling. 3. How to correctly perform the measurements and compare to previously published normative values or thresholds.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Why, when, how to measure lung volumes - Congenital diaphragmatic hernia (CDH), congenital lung malformation, giant omphalocele, anhydramnios, skeletal dysplasia, and cervical teratoma. 3. Why, when, how to measure tracheoesophageal displacement index and tumor volume to fetal weight ratio for cervical and sacrococcygeal teratomas, respectively. 4. Why, when, how to measure liver volumes - CDH. 5. Future work - lung signal ratios, estimating CDH defect size, open neural tube myelomeningocele sac size, and amniotic fluid maximum vertical pocket.

## **OBEE-9 Imaging Cervical Cancer: Beyond Diagnosis**

### **Awards**

#### **Certificate of Merit**

Melissa J. McGettigan, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Abdominal imaging plays an essential role in the contemporary management of cervical cancer. MRI is a key imaging modality due to excellent tissue contrast resolution, enabling superior accuracy for tumor size, parametrial and pelvic sidewall invasion and evaluation of nodal metastases, all of which are key prognostic factors for cervical cancer. <sup>18</sup>F-FDG-PETCT is essential in the assessment of advanced stage disease to evaluate for distant metastasis and can also aid in the detection of involved locoregional lymph nodes. Imaging also plays an integral role in brachytherapy treatment planning and execution. Ultrasound, MRI, CT and, on occasionally radiography, are used for guidance of brachytherapy applicator placement and to confirm appropriate implant positioning prior to the delivery of therapeutic radiation. Imaging is integral in the post-treatment surveillance to detect treatment-related complications and identify recurrent disease.

### **TABLE OF CONTENTS/OUTLINE**

Review the current FIGO staging system of cervical cancer and illustrate the role of imaging as it relates to stage determination and stage-specific treatment options. Demonstrate the role of imaging for brachytherapy treatment planning and execution, including structured reporting recommendations for brachytherapy implant assessment. Illustrate expected post-therapy imaging findings and the role for MRI, PETCT and CT. Show imaging findings of common and uncommon post-therapy complications. Illustrate cases of recurrence vs. expected benign post treatment changes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-1

### Isthmocele: A Simplified Guide

All Day Room: Learning Center

Isabela C. Ferracini, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Isthmocele may be present in 24-69% of women evaluated with transvaginal ultrasound and may be the cause of several clinical dysfunctions: dysmenorrhea, abnormal uterine bleeding, obstetric complications and perhaps even subfertility. When found in an ultrasound examination, there are several criteria to be considered. Accurate reporting of the description and measurement of this area in ultrasound examinations becomes important not only for research, but also for the clinical approach and planning of surgical treatment and to standardize the language in the documentation of the examination and the performance of reports. The objective of this work is to carry out a didactic review of how to examine an isthmocele in non-pregnant women, based on the first European consensus.

#### TABLE OF CONTENTS/OUTLINE

A literature review was carried out and cases of ultrasound, magnetic resonance imaging and hysterospingography obtained from the digital archive of our institution. We approach a didact review of the imaging aspects and how to measure them adequately, including teaching points and additional cases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-10

### Diaphragmatic Endometriosis: A Breathtaking Challenge

All Day Room: Learning Center

Nathalie C. Burger, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) This study aims to demonstrate MR's feasibility and accuracy in detecting diaphragmatic endometriosis, which can cause long-standing disability and pain, negatively impacting quality of life. 2) Symptomatic diaphragmatic endometriosis is part of thoracic endometriosis syndrome, usually diagnosed later than pelvic endometriosis. The symptoms include chest pain, shortness of breath and coughing, worsening during menses, and associated with pneumothorax and phrenic nerve irradiation. 3) Endometrial cells follow peritoneal circulation through the right paracolic gutter towards the right subdiaphragmatic area, where they can aggregate and form nodules, favored by a preferred stagnation site in the posterior portion of the right side of the diaphragm. 4) MR allows high-sensitivity diagnosis of diaphragmatic endometriosis, offering better characterization of hemorrhagic lesions on fat-suppressed T1-weighted sequences and requiring no radiation exposure. 5) Diaphragmatic lesions present hyperintense nodules on fat-suppressed weighted sequences. Herniation is less frequent and can result from repeated proliferation, bleeding, and necrosis of endometriotic lesions leading to fenestrations and partial or complete diaphragmatic rupture.

#### TABLE OF CONTENTS/OUTLINE

1) Know What You're Dealing With: Anatomy and main symptoms 2) Active Search: MRI Protocol 3) Behold the visual representation of diaphragmatic lesions on magnetic resonance 4) What information should the gynecologist look for in the report? 5) Pearls and pitfalls in the differential diagnosis.

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## Abstract Archives of the RSNA, 2023

OBEE-11

### Unfolding Endometriosis Clinical Cases Controls: What to Look For

All Day Room: Learning Center

Alice Cristina C. Brandao Salomao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Endometriosis is a chronic disease that impacts women from adolescence to menopause. Treatment options can vary from hormonal suppression to radical surgery and should be individualized and personalized. This educational exhibit presentation aims to: ? Discuss the clinical management of endometriosis including the different drugs available; ? Discuss the imaging methods available for hormonal treatment controls; ? Discuss imaging findings of endometriosis clinical controls.

#### TABLE OF CONTENTS/OUTLINE

? To discuss the available drugs used in the clinical management of endometriosis, including its mechanisms of action and therapeutic efficacy, such as: ? Combined oral contraceptives; ? Selective estrogen receptors modulators; ? Hormonal intrauterine device (IUD); ? Progestins; ? Selective progesterone; ? GnRH agonists; ? Oral GnRH antagonists; ? Aromatase inhibitors; ? Review clinical cases undergoing medical treatment and the correlation between clinical response and imaging findings in different sites such as: ? Retrocervical disease; ? Deep endometriosis with myometrial infiltration; ? Endometriomas; ? Intestinal lesions; ? Diafragmatic lesions; ? To discuss genetic and immunological aspects that can interfere with clinical response.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-12

### Uterine Sarcomas: Update on Pathologic and Imaging Findings

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Ana Claudia V. Uski SR, MD,MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Demonstrate the imaging features that favor the diagnosis of uterine sarcomas and the particularities of each subtype; review staging and the role of imaging in monitoring response and suspected recurrence. Recognize their mimickers.

#### TABLE OF CONTENTS/OUTLINE

Gynecologic sarcomas are rare tumors and usually have an unfavorable prognosis. Magnetic resonance imaging (MRI) is the best method for characterization of these tumors, initial staging and treatment planning. MRI shows features that can be used to try to differentiate between subtypes of uterine sarcomas. Combined DWI and DCE techniques allow more accurate assessment of the degree of myometrial and cervical invasion and characterization of potential metastatic sites. Although several findings increase the suspicion of malignancy in gynecologic tumors (including irregular contouring, intratumoral necrosis/hemorrhage, and low ADC values), some particular features may suggest the diagnosis of sarcoma, such as macroscopic lymphovascular invasion in cases of endometrial stromal sarcomas, the "bag of worms" aspect of low-grade endometrial stromal sarcoma, and the "lattice-like" appearance of adenosarcomas that result from the mixed composition of solid and cystic multiseptate components. Their diagnosis remains a challenge in the radiologist's practice.

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## Abstract Archives of the RSNA, 2023

OBEE-13

### Imaging in Pregnancy: Safe and Sound With Contrast-Enhanced US

All Day Room: Learning Center

Stephanie A. Nguyen, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) Contrast-enhanced US (CEUS) is safe in pregnancy (2) Microbubble contrast agents do not cross the placental barrier (3) CEUS in pregnancy is an effective alternate to CT and MRI when enhanced imaging is required (4) A major indication is in the determination of malignancy when masses anywhere in the abdomen or pelvis are found in a pregnant patient (5) Ability of CEUS to differentiate benign from malignant processes allows prompt diagnosis and management with significant implications on maternal and fetal outcomes (6) CEUS is capable of evaluating more than one organ in any patient

#### TABLE OF CONTENTS/OUTLINE

(1) Review of the safety record of CEUS in pregnancy (2) CEUS technique in the pregnant patient (3) Case examples (3a) Malignant lesions (3b) Benign diseases (3c) Assessment of acute pain in pregnancy

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

OBEE-14

### Beyond the Scar: A Comprehensive Guide to Postoperative Endometrioses Imaging

All Day Room: Learning Center

Sofia B. Maksoud, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Endometriosis affects approximately 176 million women worldwide, with a prevalence of one in ten women during the reproductive period. Treatment can be clinical or surgical. The main surgical indications include clinical failure, lesions in the appendix, small bowel lesions, intrinsic ureter involvement and rectosigmoid (greater than 50% of the circumference). The goals of surgery include radical removal of all lesions and the restoration of normal pelvic anatomy. Postoperative evaluation is the new challenge of imaging studies, as the number of radical surgeries to treat endometriosis has increased enormously. Radiologists must be familiar with the common imaging findings, possible complications and the differentiation between residual disease and fibrotic scar.

#### TABLE OF CONTENTS/OUTLINE

- Review the common post-surgical findings following surgery for deep endometriosis.- Differentiate residual / recurrence disease and fibrotic scar. - Illustrate didactical cases with pre and post-surgical imaging.- Be familiar with possible complications after surgery.

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## Abstract Archives of the RSNA, 2023

OBEE-15

### What Not to Miss in Obstetric Ultrasounds - Multifetal Pregnancies: Chorionicity and Amnionicity

All Day Room: Learning Center

Laura Santiago Caobi (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the embryologic division in multifetal pregnancies and its significance for prenatal care. - Discuss the criteria for the classification of twin pregnancies using ultrasounds. - Provide case examples for classic imaging for each type of multifetal pregnancy. - Use an algorithm to assist in ultrasound monitoring and surveillance of multifetal pregnancies.

#### TABLE OF CONTENTS/OUTLINE

Multifetal pregnancies pose a significant risk for adverse outcomes compared to singleton pregnancies. Early and accurate diagnosis requires a comprehensive understanding of chorionicity and amnionicity. Ultrasound evaluation of placental number, interposed membranes, fetal genders, amniotic fluid volume, and presence of lambda sign are key for successful assessment of chorionicity and amnionicity. The use of an algorithm for ultrasound monitoring and surveillance of multifetal pregnancies can aid facilitate early interventions that will benefit the health of both, mother and fetus. Outline: (1) Introduction Objectives, (2) Multifetal Pregnancies, (3) Division Timing, (4) Classic Imaging Findings for Each Type of Multifetal Pregnancy, (5) Ultrasound Criteria for Diagnosis of Type of Multifetal Pregnancy, (6) Comparison of Fetal and Infant Mortality Rates, (7) Algorithm for Ultrasound Monitoring and Surveillance, (8) Case Examples, (9) Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-16

### **Don't Forget the Bowel: Imaging Techniques, Associations and Treatment Implications of Bowel Endometriosis**

All Day Room: Learning Center

#### **Awards**

##### **Cum Laude**

Haatal D. Macer, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. As the GI tract is the most common extragenital organ involved with endometriosis, imagers need to actively look for bowel involvement. Therefore, our exhibit will highlight the associations of bowel endometriosis leading imagers to actively look for bowel implants. 2. Practical tips on Ultrasound and MRI technique of bowel endometriosis imaging and how to improve lesion detection. 3. Discussion of detailed assessment of large and small bowel involvement with implications on management, especially related to pain and fertility, will be highlighted.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background of GI tract endometriosis. 2. Associations: Incidence and prevalence with ovarian endometriomas; deep pelvic endometriosis especially with posterior compartment (rectovaginal and uterosacral ligament) involvement. 3. Ultrasound Technique: Bowel preparation; transvaginal technique for delineating normal anatomy and pathology; tips on separating bowel layers on ultrasound enabling detection of depth of muscle invasion. 4. MR Enterography: bowel preparation; role of antispasmodics; MR protocol favoring detection of appendiceal, ileocecal junction, small bowel and rectosigmoid deep endometriosis. 5. Detailed anatomic reporting of small and large bowel disease that have implications on management, particularly related to pain and fertility.

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## Abstract Archives of the RSNA, 2023

OBEE-17

### Unmasking Atypical Adenomyosis: Imaging Spectrum with Laparoscopic and Pathologic Correlation

All Day Room: Learning Center

Alice Cristina C. Brandao Salomao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Adenomyosis is a prevalent gynecologic condition defined by the presence of endometrial glands and stroma within the myometrium. 2. It remains poorly understood with severe implications on fertility and quality of life. 3. Although there is no agreement on the imaging classification of adenomyosis, the typical features are more discussed and widely known. 4. MUSA statement consensus is an important available tool to recognize and describe the typical forms of adenomyosis on ultrasound. 5. Atypical presentations of adenomyosis are less discussed, remaining a diagnostic challenge. 6. This presentation aims to review imaging findings of atypical adenomyosis, highlighting their potential differential diagnosis, as well as their impact on clinical management and patients outcome.

#### TABLE OF CONTENTS/OUTLINE

- Overview of adenomyosis. - Review imaging-based adenomyosis classification. - Ultrasound and MRI imaging findings of atypical adenomyosis, including: Solid adenomyoma; Cystic adenomyoma; Submucosal adenomyoma; Subserosal adenomyoma; Accessory cavitated uterine mass; Polypoid adenomyoma; Adenomatoid tumor. - Differential diagnosis, such as: Adenosarcoma; Cystic / hemorrhagic degeneration of leiomyoma; Cellular degeneration of leiomyoma; Isthmocele; Unicornuate uterus. - Present clinical cases with laparoscopic and pathological correlation. -Summary of key concepts.

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## Abstract Archives of the RSNA, 2023

OBEE-18

### Exploring the Pelvic Floor through MRI - A Comprehensive Trainee's Handbook

All Day Room: Learning Center

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) This review highlights the benefits and recent updates in defecography, a radiological examination used to evaluate patients with defecatory and pelvic floor dysfunction. This functional anatomical condition affects support structures and is more common in women over 50 years old. 2) MR defecography evaluates multicompartamental dysfunction, etiologies of defecation dysfunction, and postoperative complications and recurrence, providing both anatomical and functional information while allowing simultaneous assessment of the anal sphincters. 3) Most patients present changes in more than one compartment, and the reoperation rate after initial pelvic floor surgery is high. Understanding changes in various compartments can contribute to reducing the need for reapproaches. 4) Examples of pathologies found in defecography include cystocele, urethral hypermobility, uterine and vaginal prolapse, background hernias, and intussusception. This review discusses the implications of these findings for clinical practice.

#### TABLE OF CONTENTS/OUTLINE

1) 1) General Aspects: A Little Bit of Everything; 2) Essential MR Protocol - What you need to remember; 3) Assessing the dynamic study on MR; 4) MR images evaluation - Is defecating three times really necessary?

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## Abstract Archives of the RSNA, 2023

OBEE-19

### Adeno-My-Goodness: Comprehensive Review of Adenomyosis

All Day Room: Learning Center

Paulo H. Miro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Adenomyosis is a prevalent condition which may cause symptoms (such as abnormal uterine bleeding and pain), and affect pregnancy outcomes. Ectopic endometrial glandular tissue within the uterine myometrium with associated smooth muscle hypertrophy may have a variety of appearances across the imaging modalities. Imaging findings may be further confounded by hemorrhage or development of myometrial cysts, and changes under the hormonal influence (particularly during pregnancy). Cases may arise when adenomyosis mimics uterine malignancy, and uncommonly, malignancy may arise from the glandular tissue within adenomyosis. This exhibit is a comprehensive review of adenomyosis across multiple imaging modalities with pathologic and graphical correlation.

#### TABLE OF CONTENTS/OUTLINE

Relevant uterine anatomy  
1. Classic Imaging Findings of Adenomyosis  
A) Ultrasound "Adeno"  
• Echogenic striations/buds  
• Myometrial cysts "Myosis"  
• Myometrial thickening (focal or diffuse)  
• Globular uterus  
• Thickened inner myometrium  
• "Venetian blinds" shadowing  
B) MRI "Adeno"  
• T2 hyperintense foci and myometrial cysts  
• T1 hypointense foci "Myosis"  
• T2 hypointense junctional zone thickening  
• Myometrial thickening (focal or diffuse)  
C) CTD) Hysterosalpingogram  
2. Atypical findings of adenomyosis  
A) Cystic/hemorrhagic  
B) Pedunculated  
3. Adenomyosis in pregnancy  
4. Clearing up the confusion between focal adenomyosis and adenomyoma (the mixed Mullerian tumor)  
5. Malignancy arising within adenomyosis

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## Abstract Archives of the RSNA, 2023

OBEE-2

### Postpartum Woman in the ER? A Surviving Guide for the On-Call Radiologist

All Day Room: Learning Center

Marta Barrios Lopez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To learn what are the main puerperal obstetric complications and their imaging findings. 2. To understand the importance of clinical correlation in the diagnosis of many of these conditions: some can only be diagnosed in the proper clinical setting and a high suspicion is essential. 3. To review the anatomy landmarks necessary to locate certain types of hematomas.

#### TABLE OF CONTENTS/OUTLINE

1. Normal imaging findings during the puerperium: Vaginal delivery. 2. Normal imaging findings during the puerperium: Cesarean delivery. 3. Surgical technique for Cesarean section and potential complications at each step. 4. Thromboembolic conditions: 4.1. Ovarian vein thrombosis/ thrombophlebitis and their complications. 5. Infectious complications 5.1. Postpartum endometritis. 6. Hemorrhagic complications 6.1. Lower genital tract injury: supra and infralevator hematomas. 6.2. Abnormal placentation: placenta accreta, increta, percreta. 7. Cesarean-related complications 7.1. Wound cellulitis/ abscess 7.2. Uterine dehiscence 7.3. Bladder flap hematoma 7.4. Subfascial hematoma 7.5. Rectus sheath hematoma 7.6. Urinary tract injury

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## Abstract Archives of the RSNA, 2023

OBEE-20

### Imaging of Functional Ovarian Tumors and Tumor Like Conditions with Pathological Correlation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Niloofer Karbasian, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the ovarian histology and the hormone axes. 2. Discuss clinical features of hormone excess as secondary signs of hormone producing tumors and tumor like conditions. 3. Explain different categories of functional ovarian tumors and tumor like conditions. 4. Illustrate multimodality imaging characteristics of different tumors.

#### TABLE OF CONTENTS/OUTLINE

1. Ovarian histological anatomy a. Including role of different cell types within the ovary 2. Hypothalamus-Pituitary-Ovary axis a. Introduce sex hormones and their role b. Flowchart demonstrating the hormone pathways 3. Clinical features of hormonal excess. a. Excess androgen and symptoms b. Excess estrogen and symptoms 4. Subtypes of functional ovarian tumors. a. Sex cord-stromal b. Surface epithelial c. Stroma d. Tumor-like lesions and conditions 5. Approach to diagnosing functional ovarian tumors a. Multidisciplinary approach i. Role of imaging. ii. Hormonal analysis in follow up. iii. Tissue sample often needed for diagnosis. b. Imaging direct and indirect signs of hormonal excess. i. Contribution of different modalities: US, MRI, CT. ii. Features of malignancy. iii. Radiologic examples of different functional tumors. c. Pathology correlation 6. Treatment options a. Conservative b. Surgical c. Prognosis

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## Abstract Archives of the RSNA, 2023

OBEE-21

### **Decoding the Pandora's Box With Fetal MRI: A Comprehensive Pictorial Review of Fetal Abdominal Abnormalities**

All Day Room: Learning Center

Taruna Yadav, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To study indications, advantages and limitations of fetal MRI for antenatal assessment of various abdominal anomalies. 2. To define a standard MRI protocol for assessment of fetal abdominal anomalies. 3. Using a case-based approach, to learn about myriad of common and rare fetal abdominal anomalies including gastrointestinal (bowel atresias, meconium peritonitis), genitourinary (posterior urethral valve, urethral atresia, pelviureteric junction obstruction, cystic renal dysplasia, fetal pyelectasis, ectopic kidney, syndromic associations like Meckel Gruber and Joubert syndrome), ventral wall defects (gastroschisis, omphalocele, limb body wall defects, pentalogy of Cantrell, bladder exstrophy, amniotic band syndrome), pelvic disorders including presacral masses (sacroccygeal teratoma, anterior meningocele) with syndromic associations and follow up (wherever available). 4. To develop an imaging approach to complex fetal abdominal anomalies including ventral abdominal wall defects.

#### **TABLE OF CONTENTS/OUTLINE**

1. Role of MRI for assessment of fetal abdomen: indications, advantages and limitations 2. Fetal MR protocol to assess various abdominal anomalies 3. Fetal Abdominal Anomalies (A Case Based Approach): 3A. Gastrointestinal anomalies 3B. Genitourinary anomalies 3C. Ventral wall defects: spectrum of anomalies and simplified imaging approach 3D. Pelvic disorders: presacral masses 3E. Syndromic associations 3F. Miscellaneous 4. Conclusion

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## Abstract Archives of the RSNA, 2023

OBEE-22

### Magnetic Resonance Imaging in Obstetric Patients: How Can We Help?

All Day Room: Learning Center

Sarah d. E Vasconcelos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? Brief review of indications and protocols of obstetric magnetic resonance imaging (MRI)? Illustrate the characteristics of image in cases of normal anatomy obstetric patients, when appropriate? Review most common pathologies in obstetric cases? Highlight the impact of imaging in the management

#### TABLE OF CONTENTS/OUTLINE

? MRI indications and protocols? MRI obstetric normal anatomy, when appropriate? MRI aspects of obstetrics patients: pathologies and complications: ? Placenta accreta? Different locations of ectopic pregnancies? Heterotopic pregnancy? Angular pregnancy? Uterine perforation? Per vaginal bleeding in pregnancy? Miscarriage / Retained products of conception? Uterine arteriovenous malformation? Gestational trophoblastic disease? Applications in fetal pathologies or malformations (for example: fetus with cervical mass, congenital diaphragmatic hernia, congenital pulmonary airway malformation and fetal urinary tract anomalies)

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## Abstract Archives of the RSNA, 2023

OBEE-23

### Placenta 101: A Pictorial Review of Normal and Pathological Findings by US and MRI

All Day Room: Learning Center

Carlos S. Tapia SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To normal thickness of the placenta is 2 to 4 cm, and it must be measured where the umbilical cord is inserted. Placental grading maturity (Grannum classification) is divided into 4 grades by ultrasound and it is based on the extent of calcifications. To differentiate a retroplacental hematoma from a uterine contraction, it is recommended to wait a few minutes for the contraction to disappear. An easy Doppler finding for the differentiation of hematomas from other placental masses is the absence of internal blood flow. Currently, when the placental edge is less than 20 mm away from the internal cervical orifice (ICO) is a low-lying placenta, and when the placenta covers partially or completely the ICO, it is called placenta previa.

#### TABLE OF CONTENTS/OUTLINE

History. Embryology. Normal appearance and grades of maturation. Variations in placental morphology. Placental hematoma. Placenta previa. Placental accretion. Placental tumors. Teaching points. Conclusion. Bibliography.

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## Abstract Archives of the RSNA, 2023

OBEE-24

### **FOMO, No More - A Comprehensive Guide for Identifying Head to Toe Fetal Anomalies**

All Day Room: Learning Center

Rishika Gupta (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To highlight the importance of level I scan and develop an algorithmic approach to diagnose structural anomalies at the earliest. To diagnose progressive anomalies on subsequent scans and devise a trimester based checklist to avoid missing abnormalities. To assess the maternal risk factors in conjunction with fetal parameters to be able to assess growth of the fetus as well as restriction. To know the importance of color doppler in all the scans and how it affects further management. Scanning beyond fetus- to diagnose various placental, uterine and adnexal abnormalities for effective management. An obstetric ultrasound plays a pivotal role in each stage of pregnancy in providing a non-invasive diagnostic method, yielding immediate, extensive and accurate results for evaluating the fetus as well as the health of the mother. Protocol based screening reduces the "fear of missing out" an abnormality.

#### **TABLE OF CONTENTS/OUTLINE**

1. First Trimester Scan A) Early First Trimester: • Ectopic pregnancy • Twin or higher order pregnancy with correct labelling • Adnexal abnormality B) Late First Trimester: Detectable 9 • Anencephaly • Holoprosencephaly • Encephalocele • Omphalocele • Gastroschisis • Iniencephaly • Limb abnormality • Megacystis • Major cardiac defects • First trimester markers for chromosomal abnormalities • Abnormal UAD 2. Second Trimester Scan • Detectable 9 • Cardiac defect • Situs abnormalities • Spinal abnormalities • Placental abnormalities 3. Fetal Echocardiography 4. Third Trimester Scan • Evolving cardiac abnormalities • Placental abnormalities • Abnormal Doppler

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## Abstract Archives of the RSNA, 2023

OBEE-25

### Patterns of Ovarian Cancer Recurrence on MDCT: Early Imaging Features

All Day Room: Learning Center

Sharad Maheshwari, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. 1. Review of Ovarian ca 2. 2. Review the pattern of recurrence in ovarian ca 3. 3. Review Application of clinical laboratory findings with Imaging 4. 4. Understand the role of imaging, how it can potentially accelerate time to treatment.

#### TABLE OF CONTENTS/OUTLINE

1. 1. General overview of ovarian ca a. Epidemiology recurrence rates b. Pathogenesis how tumour spreads c. Clinical presentation Tumour markers d. quick review of treatment options 2. 2. Multimodality imaging appearance a. Why cross sectional Imaging b. Benefits of MDCT c. Role of MRI PET c. Scanning protocol d. Recurrence sites appearance on Imaging: - Peritoneum - Mesentery - Nodes - Periheptic and fissural spread - The muscle planes - Urinary bladder surface - Serosal deposits on the bowel surface - Miscellaneous sites e. Review protocol: Region wise f. Examples of early recurrence that would have been missed on routine imaging

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## Abstract Archives of the RSNA, 2023

OBEE-26

### See What's Inside: A Look at Pelvic Devices

All Day Room: Learning Center

Flavia M. Starling, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The female pelvis has a complex anatomy; thus, it requires deep study and its image can be challenging. Besides the anatomy knowledge, radiologists need to keep up with the daily devices and techniques, used by doctors and by the patients. It is important to be prepared to face unknown figures like foreign bodies, and also to recognize these devices in the pelvis, such as contraceptive methods (vaginal ring and intrauterine devices), tampons, menstrual cups, vaginal pessaries, catheters and slings. Questionnaires are often vague when referring to these devices and most women forget to mention actively whether they have or are using any of them. This study has the objective of reviewing common devices placed in the pelvis, especially in gynecology, urogynecology and its possible complications, helping radiologists to interpret these images. An understanding of the radiological appearance of some of these devices in the many imaging methods such as X-ray, ultrasound, CT and MRI is useful to avoid misinterpreting them, as well as obtaining a diagnosis more quickly and accurately.

#### TABLE OF CONTENTS/OUTLINE

For this education exhibit, we obtained clinical and epidemiological information in literature and selected images of cases that show different findings of women's vaginal and uterine devices, including normal aspects or complications.

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## Abstract Archives of the RSNA, 2023

OBEE-27

### **This Is Rare, but It Happens: Atypical Presentation of Teratomas**

All Day Room: Learning Center

TATIANA A. GONCALVES (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teratomas are germ cell tumors composed of multiple tissues derived from two or three germ layers. Mature teratomas are the most common benign ovarian neoplasms. They are easily diagnosed on imaging studies because of their characteristic intratumoral fat and calcification components. However, a minor percentage of teratomas have no visible fat on imaging studies. Malignancy is an uncommon presentation, which may be suspected in the presence of an enhancing, irregularly marginated solid component. Gliomatosis peritonei (GP) is another unusual form, that it is characterized by the implantation of mature glial tissue in the peritoneum or omentum. Mature teratomas have also an high complication rate compared with other ovarian tumors, however, there is a low rate of spontaneous rupture. The purpose of this presentation is to discuss the various atypical imaging features of teratoma that can be particularly misleading for radiologists.

#### **TABLE OF CONTENTS/OUTLINE**

Index 1. Introduction 2. Mature teratoma 3. Mature teratoma simulating malignant lesion 4. Gliomatosis peritonei 5. Immature teratoma 6. Ruptured teratoma 7. Pre sacral teratoma 8. Pre sacral myelolipoma and dermoid 9. Retrorectal dermoid 10. Cul-de-sac dermoid 11. Currarino syndrom

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## Abstract Archives of the RSNA, 2023

OBEE-28

### Adenomyosis: MRI for Diagnosis and Problem-Solving

All Day Room: Learning Center

Lauren F. Alexander, MD (*Presenter*) Spouse, Stockholder, Abbott Laboratories; Spouse, Stockholder, AbbVie Inc; Spouse, Stockholder, General Electric Company; Spouse, Stockholder, Myriad Genetics, Inc

#### TEACHING POINTS

Uterine adenomyosis develops from the abnormal proliferation of heterotopic endometrial glands and stroma in the myometrium. Recognizing the characteristic magnetic resonance imaging (MRI) findings is essential for accurate diagnosis and appropriate patient management, as clinical symptoms such as dysmenorrhea, menorrhagia and pelvic pain overlap with other gynecologic diagnoses. After reviewing this exhibit on adenomyosis, the learner will be able to -- Discuss how to optimize MRI sequences to evaluate for adenomyosis. -- Identify typical and atypical MRI findings of adenomyosis. -- Distinguish other diagnoses which can mimic or have overlapping findings with adenomyosis. -- Describe treatment options for patients with adenomyosis.

#### TABLE OF CONTENTS/OUTLINE

(1) Background: Pathophysiology of adenomyosis, Clinical findings, Role of imaging for diagnosis and management. (2) MRI protocol: Key sequences, Tips for optimization. (3) Imaging features on MRI: Normal anatomy, Typical adenomyosis findings, Atypical findings (Polypoid, External adenomyosis, Cystic adenomyosis without with hemorrhage, Pregnancy related changes, Endometrial ablation changes). (4) Differential diagnosis mimics: Deep infiltrating endometriosis, Leiomyoma, Neoplasms (endometrial cancer, Mullerian adenosarcoma), Accessory and cavitated uterine mass, Pitfalls/Mimics (Uterine contraction, pseudo-thickening of junctional zone). (5) Treatment options: Medical, Procedural (ablation, excision, hysterectomy).

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## Abstract Archives of the RSNA, 2023

OBEE-29

### What Not to Miss in Obstetric Ultrasounds - Fetal Skeletal System Evaluation

All Day Room: Learning Center

Oswaldo A. Guevara Tirado, BS, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the essential components of an ultrasound based fetal skeletal assessment. Discuss common sources of error when evaluating the fetal skeletal system using ultrasound. Analyze case examples of classic images with normal findings that are frequently misinterpreted. Follow a systematic approach to avoid missing significant skeletal defects.

#### TABLE OF CONTENTS/OUTLINE

Obstetric ultrasounds play a crucial role in the accurate identification of fetal skeletal abnormalities, allowing physicians to optimize management in order to improve both fetal and maternal outcomes. Fetal skeletal abnormalities can manifest early during embryonic life. Therefore, proper evaluation and identification of developmental anomalies requires a profound understanding of normal fetal development and knowledge about ultrasound imaging techniques. Moreover, it is important to take into consideration the various sources of error that exist when performing a fetal skeletal assessment. Ultrasound is the primary imaging modality used to assess fetal well-being by providing a non-invasive method to precisely identify fetal skeletal abnormalities, amongst other irregularities, and intervene in a timely manner.1. Introduction Objectives 2. How to Approach the Fetal Skeletal System 3. Skeletal Assessment: Ultrasound Findings 3a. Long Bones 3b. Hands Feet 3c. Fetal Head 3d. Fetal Thorax 3e. Fetal Movement 4. Femur Length Measurement Sources of Error 5. Review of cases in quiz format 6. Conclusion

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## Abstract Archives of the RSNA, 2023

OBEE-30

### Incidental Findings of Pelvic Endometriosis in Routine Transvaginal Ultrasound: A Pictorial Essay

All Day Room: Learning Center

Alexandre M. Minoda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this exhibit is:• To conduct a review and illustrate through ultrasound images the female pelvic compartments.• To describe and disseminate the main ultrasound findings suggestive of deep infiltrating endometriosis (DIE) and ovarian endometriomas on transvaginal ultrasounds performed as part of a routine gynecological evaluation.• To demonstrate how the unique capabilities of ultrasound can help in the diagnosis and management of patients.

#### TABLE OF CONTENTS/OUTLINE

INTRODUCTION / BACKGROUND• Epidemiology, clinical symptoms and classifications of endometriosisROUTINE TRANSVAGINAL ULTRASOUND AND TRANSVAGINAL ULTRASOUND AFTER BOWEL PREPARATION• International Deep Endometriosis Analysis (IDEA) group consensusPELVIC COMPARTMENTS• Anatomy and normal findings in routine transvaginal ultrasoundINCIDENTAL FINDINGS OF PELVIC ENDOMETRIOSIS IN ROUTINE TRANSVAGINAL ULTRASOUND• Anterior compartment• Middle compartment• Posterior compartment• Other findings that may optimize the diagnosis of endometriosis on routine transvaginal ultrasound

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## Abstract Archives of the RSNA, 2023

OBEE-31

### How Far Can We Go With Computed Tomography in the Diagnosis of Endometriosis: Correlation With MRI and US

All Day Room: Learning Center

Gabriel Faria Medeiros (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Recognize the most common CT findings associated with endometriosis and how to describe them 2. Discuss and highlight the role of CT in aiding endometriosis management, by suggesting the diagnosis and prompting MRI recommendation, accelerating diagnosis and improving patient outcomes. 3. Illustrate cases where CT and MRI were both used in the diagnosis of endometriosis, with emphasis on how the correlation between the two modalities aided in the diagnosis. 4. Identify post-treatment changes and potential pitfalls

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: Epidemiology, pathophysiology and clinical aspects of endometriosis Currently available treatment options 2. Role of different imaging techniques in diagnosis and assessment of disease extension (benefits and limitations) Hysterosalpingography Transvaginal ultrasound (with bowel preparation) CT MRI Videolaparoscopy 3. CT findings of endometriosis, with MRI correlation - Case-by-case discussion 4. Post-operative changes and confounding factors Salpingo-oophorectomy Hysterectomy Rectosigmoidectomy Post-radiation therapy Adhesions Inflammatory pelvic disease 5. Summary and take-home messages

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## Abstract Archives of the RSNA, 2023

OBEE-32

### **Smooth Seas Never Made Skilled Sailors: Navigating the Challenges That Arise After Cervical Cancer Treatments**

All Day Room: Learning Center

Antonella Pierina Ruiz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To review the different radiotherapy modalities and the clinical indications in cervical cancer treatment. To identify the most frequent early and late complications of radiotherapy. To demonstrate that high doses of radiotherapy are associated with a greater risk of complications. To provide key points and radiologic tools in order to differentiate post-actinic changes from residual or recurrent disease.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Epidemiology and clinical importance -FIGO staging review in cervical cancer -The role of radiotherapy treating cervical cancer. Early and late complications in the uterus, ovaries, intestines, bones, and bladder. Case based approach with radiologic correlation. Imaging findings with histologic and colonoscopy correlation. Conclusion.

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## Abstract Archives of the RSNA, 2023

OBEE-33

### Imaging Uterus After Endometrial Ablation

All Day Room: Learning Center

Margarita V. Revzin, MD, MS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Endometrial ablation is a minimally invasive surgical procedures available for the management of patients with abnormal uterine bleeding. Post endometrial ablation expected imaging findings and post procedural complications have a characteristic pattern on imaging and if not readily recognized by the radiologists may lead to misinterpretation and unnecessary follow up imaging and inadequate management. Teaching points The goal of this study is to familiarize radiologists with imaging findings of uterus after endometrial ablation therapy. This will serve to enhance recognition of normal imaging findings and life threatening conditions and help radiologists create a focused differential diagnosis for various complications after the procedure.

#### TABLE OF CONTENTS/OUTLINE

A. Review pathophysiology of dysfunctional uterine bleeding. B. Review of treatment options in management of DUB with emphasis on endometrial ablation C. Discuss imaging options available for the assessment of uterus after ablation: US, CT, MRI and their strengths and weaknesses D. Review key imaging features of the post endometrial ablation 1. Expected post-op changes (early: intracavitary air, intrauterine /cervical hematoma, uterus edema; late: endometrial cavity contracture, endometrial thinning) 2. Complications (immediate: infectious (endometritis, myometritis, salpingitis); cornual hematometra, hematosalpinx; chronic: synechia, infertility from post-ablation tubal sterilization syndrome, ectopic pregnancy, abnormal placentation, endometriosis, malignancy (adenocarcinoma of the uterus) E. Management of the presented post-ablation complications will be reviewed.

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## Abstract Archives of the RSNA, 2023

OBEE-34

### Dedicated MR Imaging for Endometriosis: What You Can't Miss in Your Report

All Day Room: Learning Center

Patricia P. Cardia, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

MR imaging is an important tool for diagnosis of deep pelvic endometriosis. Understanding and recognizing the MRI manifestations of this disease may be challenging. In this presentation, we will summarize the most important points to include in our reports considering a region-based reading and reporting system

#### TABLE OF CONTENTS/OUTLINE

Anterior compartment: -Differentiating bladder endometriosis from peritoneal endometriosis: bladder endometriosis is diagnosed when the muscular layer of the bladder is involved. If a bladder lesion is identified, informing the location, distance from vesical trigone and distal ureters are mandatory. Middle compartment: Characterization of endometriomas and differentiation with hemorrhagic ovarian cysts- it is a daily point of attention. -Malignant transformation of ovarian endometriosis: it should be considered if vascular solid tissue is identified with Diffusion imaging and Dynamic post contrast sequences.-Endometriotic tissue infiltrating the uterus: including this information and its differential diagnosis is relevant for treatment planning. Posterior compartment: -Differentiating deep rectal endometriosis from superficial endometriosis: characterization of penetration from endometriotic tissue into muscular layer of rectal wall will be definitive. Location of the lesion (intraperitoneal or extraperitoneal) will also impact in treatment options. -Superficial endometriosis: this is a challenge in diagnostic imaging. Small deposits of glandular tissue are missed frequently. An indirect sign to look for is the peritoneal pocket sign, defined as a peritoneal defect that collects fluid, frequently identified in posterior cul de sac.

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## Abstract Archives of the RSNA, 2023

OBEE-35

### Current Concepts in Imaging of Uterine Adenomyosis: What Radiologists Should Know

All Day Room: Learning Center

Alexandre M. Minoda, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this exhibit is:• To discuss the pathophysiology of adenomyosis and how it relates to imaging findings. • To describe the various US and MR imaging manifestations of adenomyosis. • To discuss the classifications of adenomyosis based on US and MR imaging findings. • To provide the diagnostic clues that allow differentiation of adenomyosis from its mimics.

#### TABLE OF CONTENTS/OUTLINE

INTRODUCTION• Historical background, epidemiology, physiopathology, clinical features and phenotypes of adenomyosis  
THE UTERINE JUNCTIONAL ZONE• Normal zonal anatomy, physiologic variations and alterations in adenomyosis  
IMAGING FINDINGS IN ADENOMYOSIS• Direct and indirect sonographic signs of adenomyosis• Direct and indirect MRI signs of adenomyosis  
CLASSIFICATIONS OF ADENOMYOSIS AND PHENOTYPES IN IMAGING• Atypical presentations  
DIFFERENTIAL DIAGNOSIS AND PITFALLS IN DIAGNOSIS OF ADENOMYOSIS

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## Abstract Archives of the RSNA, 2023

OBEE-36

### Practical Approach to Ovarian Masses - The ABC's

All Day Room: Learning Center

Antonio Michael-Fernandez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To know how to properly identify ovaries and its organ dependency when facing pelvic lesions.- Going over the most common and specific characteristics and radiological features of the different ovarian lesions

#### TABLE OF CONTENTS/OUTLINE

The differential diagnosis of ovarian lesions is broad and complex. It is not only a diagnostic challenge due to the existence of multiple tumour lineages, but also to the proper differentiation of their ovarian dependence, which is often unclear. First of all, it is important to properly identify the ovaries by knowing pelvic anatomy, their location and their vascular relations. In the same way, when facing pelvic lesions of possible ovarian origin, there are some radiological signs that can help us to better determine their organ dependence (such as the "phantom organ" or the "beak sign"). Once we have confirmed that the dependence is ovarian, it is important to know the different possible lesions that may exist, and their most common radiological characteristics, both in CT and (mostly) in MRI. According to their T1, T2 signal, and internal component (solid, cystic or mixed), we propose a simple diagnostic algorithm that helps to approximate the diagnosis, based on the most frequent radiological characteristics of ovarian tumours.

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## Abstract Archives of the RSNA, 2023

OBEE-37

### First Things First! First Trimester Obstetric Ultrasound From the Basics to the Pearls

All Day Room: Learning Center

Niels Vinicius Padua Carvalho, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The aim of this exhibition is to:

- Review the recommendations for screening and diagnostic ultrasound in pregnant women during the first trimester of pregnancy.
- Demonstrate how the obstetric ultrasound should be documented in this context.
- Discuss how to use ultrasound for risk assessment of common forms of aneuploidies, malformations and gestational diseases/complications, in a practical approach.
- Highlight the pearls and pitfalls in that evaluation.

#### TABLE OF CONTENTS/OUTLINE

- **INTRODUCTION**o Purpose of a first trimester ultrasoundo Standard equipment and protocolo Documentation requirements
- **GUIDELINE FOR EXAMINATION**o Demonstrate by case-based images the minimum requirements for a 11-14 weeks gestation examination, including:
  - § Assessment of viability
  - § Confirmation of intrauterine pregnancy and uterine integrity
  - § Fetal biometry
  - § Fetal anatomy
  - § Risk assessment for common forms of aneuploidy
- **SCREENINGS**o Describe the pretest counseling, biomarkers and ultrasound-based assessment for aneuploidies, malformations and gestational diseases
- **SUMMARY AND SYSTEMATIC APPROACH**
- **TAKE HOME MESSAGES**

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## Abstract Archives of the RSNA, 2023

OBEE-38

### A Multimodality Review of Gynecologic Medical Devices in the Pelvis

All Day Room: Learning Center

Kaitlin M. Zaki-Metias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Given the frequency with which gynecologic pelvic devices are encountered on imaging, understanding the imaging characteristics and appropriate positioning on various modalities is important for radiologists to recognize. Positioning and integrity of all pelvic devices should be evaluated on all studies when visualized. Radiologists should be able to confidently communicate pertinent findings of pelvic device malposition to referring clinicians.

#### TABLE OF CONTENTS/OUTLINE

Understand the importance and clinical implications of gynecologic medical devices in the pelvis, including intrauterine contraceptive devices (IUCD), pessaries, contraceptive vaginal rings, tubal occlusion and ligation devices, brachytherapy seeds, and menstrual products. Describe the normal appearance and appropriate positioning of gynecologic medical devices in the pelvis and be familiar with their appearance on various imaging modalities. Describe the strengths and pitfalls of various imaging modalities in the assessment of medical pelvic devices.

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## Abstract Archives of the RSNA, 2023

OBEE-39

### **Pelvic Venous Congestion Syndrome: The Forgotten Culprit of Chronic Pelvic Pain**

All Day Room: Learning Center

Lena Deb, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To raise awareness of pelvic venous congestion syndrome as an underdiagnosed etiology for chronic pelvic pain. 2. Review the clinical and multimodality (CT, MR and Angiography) imaging work-up of diagnosing pelvic venous congestion syndrome. 3. Discuss various differential diagnoses such as Nutcracker Syndrome, May-Thurner Syndrome, and arteriovenous malformation and understand the importance of an accurate diagnosis as there are different treatment methods for each entity.

#### **TABLE OF CONTENTS/OUTLINE**

1. Pelvic Venous Congestion Syndrome (PVCS) - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging (CT, MRA, Angiography) - Treatment/Prognosis  
2. Differential Diagnoses  
a) Nutcracker Syndrome - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis  
b) May-Thurner Syndrome - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis  
c) Arteriovenous Malformation (AVM) - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis  
d) Inferior vena cava (IVC) thrombosis - Clinical Presentation - Epidemiology - Pathogenesis - Multimodality Imaging - Treatment/Prognosis  
3. Summary Chart

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## Abstract Archives of the RSNA, 2023

OBEE-4

### First-Trimester US and Current Methods of Genetic Screening

All Day Room: Learning Center

Ami Gokli, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe first trimester ultrasound findings including normal, abnormal and indeterminate with imaging correlates, as well as criteria diagnostic for failed pregnancy and pitfalls. Discuss the current methods of genetic screening including carrier testing and all maternal blood tests in conjunction with fetal ultrasound Review current methods of diagnostic testing in conjunction with fetal ultrasound including common complications, sensitivity/specificity, false neg/pos, how often these occur and why Review clinical management of the most common diseases and necessary details to include in radiology reports that guide management

#### TABLE OF CONTENTS/OUTLINE

Overview of first trimester US and screening tests -what can be detected in the first trimester, limitations of sonography in the first trimester, and safety issues First trimester ultrasound imaging findings (pictorial review) of detailed fetal anatomic survey including normal anatomy, standard views Most common methods of genetic screening and diagnostic testing in conjunction with US Examples of common pathology encountered with sonographic imaging correlation and management discussion Case examples with explanations including: Early hydrops Anencephaly, Body stalk anomaly, Ectopic cordis, omphalocele, gastroschisis, Megacystis Carrier testing, when and why 10-13 week blood test with nuchal translucency and intracranial translucency ultrasound Integrated screening/sequential screening Cell-free DNA screening clinical indications for advanced imaging such as fetal MRI clinical management guidance and reporting future directions for improving diagnostic capabilities

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## Abstract Archives of the RSNA, 2023

OBEE-40

### **MR Imaging of Gynecologic Emergencies in the Pregnant Patient: An Overview of Clinical Indications, Proper Sequence Choice and Not to Miss Emergencies**

All Day Room: Learning Center

Riya Goyal, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Describe the clinical indications for MR imaging in pregnancy based upon the risks of fetal harm with ionizing radiation and recommendations from organizations including the American College of Radiology (ACR) and American College of Obstetricians and Gynecologists (ACOG). Outline the sequences included in the protocol for an MRI abdomen/pelvis of a pregnant female with examples of the features best evaluated on each sequence. Review the imaging features of gynecologic emergencies including ovarian torsion, ectopic pregnancy, placenta accreta spectrum and acute uterine rupture based on an understanding of the associated pathophysiology. Understand pertinent positive and negative information that should be conveyed to the primary team and characteristics that may portend prognosis.

#### **TABLE OF CONTENTS/OUTLINE**

Background discussing the difficulty of diagnosing pathology in pregnancy and crucial role of the radiologist. Clinical indications for MR in pregnancy - outline the ACR and ACOG recommendations and reason to avoid gadolinium contrast. Discussion of the risk of fetal harm with ionizing radiation including the difference between stochastic and deterministic effects, absorbed dose of different radiology exams and impact on fetus based on gestational age. List of the sequences included in a typical MR abdomen/pelvis protocol followed by slides with pictures demonstrating the pertinent features evaluated in each sequence. Examples of gynecologic emergencies seen in pregnancy with slides specifically focused on ovarian torsion, ectopic pregnancy (ruptured tubal ectopic, abdominal ectopic and interstitial ectopic), placenta accreta spectrum, and acute uterine rupture.

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## Abstract Archives of the RSNA, 2023

OBEE-41

### First Trimester Ultrasound Screening

All Day Room: Learning Center

Shannon M. Navarro, MD, MPH (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-The importance of the nuchal translucency exam and significance of a widened nuchal translucency -Quality standards - Correlation with blood work for first trimester screen-significance of the ossification of the nasal bone

#### TABLE OF CONTENTS/OUTLINE

A. What is the nuchal translucency? Pictorial review of a normal nuchal translucency  
B. Pitfalls! the amnion before fusion with the chorion, quality standards for appropriate neck flexion/extension, how the ultrasound should be performed  
C. Abnormal nuchal translucencies: the movement from screening to diagnostic exams. A pictorial review of abnormal nuchal translucency screening exams with correlation from diagnostic tests.  
D. Pictorial review of normal nasal bone ossification  
E. Pictorial review of abnormal nasal bone ossification.

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## Abstract Archives of the RSNA, 2023

OBEE-42

### Pitfalls in Ovarian Imaging: Limits of the ORAD's System

All Day Room: Learning Center

Balkis El Khouni, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The first step in characterizing a pelvic mass using the ORAD'S system is to determine its ovarian origin. The second step is to avoid misdiagnosing infections and inflammatory conditions. The third step is to identify features of peritoneal carcinomatosis. Finally, the adnexal lesions are analyzed according to the ORADS criteria. Although this system is standardized and clear, care must be taken to avoid the many pitfalls that can occur at each stage of the reasoning.

#### TABLE OF CONTENTS/OUTLINE

We will report our experience on the pitfalls of the ORAD's system from a series of 3000 MRI's obtained over the past 5 years in a large tertiary institution by : - Presenting a variety of extra-ovarian lesions that mimic ovarian lesions such as exophytic myometrial masses, lymphocele, lymph node and other tumors arising from other structures of the pelvis. - Presenting confusing infections and inflammatory conditions such as complicated endometriosis or actinomycosis - Discussing and illustrating lesions that mimic peritoneal carcinomatosis, such as Demons-Meigs syndrome and functionally hyper-stimulated ovaries - Discussing and illustrating some benign ovarian tumors that mimic malignancy, such as cellular fibromas, sclerosing stromal tumors and necrotic, infected or distorted lesions. - Discussing and illustrating some malignant lesions that mimic benignity, such as calcified tumors (low-grade serous ovarian carcinoma) and serous cystadenofibromas associated with a borderline component.

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## Abstract Archives of the RSNA, 2023

OBEE-43

### Serous Tumors in the Female Pelvis: Comprehensive Review of Diagnostic and Therapeutic Strategy

All Day Room: Learning Center

Mayumi Takeuchi, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Serous tumors are common female pelvic neoplasm presenting a variety of clinical and imaging manifestations. Recently, there has been a paradigm shift that most extrauterine pelvic high-grade serous carcinomas (HGSC) are metastases of STIC. While HGSC is the majority of serous carcinomas, but also low-grade serous carcinoma (LGSC) developing through serous borderline tumor (SBT) may be occur. This exhibit provides an overview of diagnostic and treatment strategies including Hereditary Breast and Ovarian Cancer (HBOC) managements. 2. 3D-DCE-MRI and reduced FOV/computed DWI are useful in detecting early-stage HGSC, or small mural nodules of LGSC. Characteristic imaging findings such as black sponge in adenofibroma, papillary architecture with internal branching in SBT, dense calcification in psammocarcinoma, and CT pattern classifications for genomic subtypes estimation of advanced HGSC, and differentiation of invasive/non-invasive peritoneal implants of SBT are demonstrated.

#### TABLE OF CONTENTS/OUTLINE

Benign: Surface epithelial inclusion /Cystadenoma /Adenofibroma  
SBT: Exophytic /intra-cystic papillary growth; Micropapillary subtype /Adenofibromatous SBT; Peritoneal implants /LN involvement; Fertility-preserving treatment options  
LGSC  
Psammoma body /Psammocarcinoma; HGSC arising from LGSC/SBTHGSC  
STIC /Tubal /Peritoneal cancers; Advanced MR techniques: SWS, MRS, CEST; Therapeutic strategies for HBOC (BRCA1/2): Risk-reducing surgery /Molecularly targeted drug; Radiomics/Radiogenomics

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## Abstract Archives of the RSNA, 2023

OBEE-44

### **Pelvic Perspectives: Unveiling the Imaging Findings and Complications of Female Pelvic Devices**

All Day Room: Learning Center

Cailin O'Connell (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review normal imaging findings of the female pelvis, including CT, US, and MRI. 2. Review normal and abnormal placement of intrauterine devices (IUDs) and required imaging studies for emergent cases, as in perforation. 3. Review indications for pessary placement and imaging findings for pelvic organ prolapse (POP) and describe their appearance on imaging. 4. Review normal imaging appearance of catheter placement in female patients and discuss potential complications that are visible on imaging. 5. Discuss imaging findings for menstrual devices, including tampons and menstrual cups.

#### **TABLE OF CONTENTS/OUTLINE**

1. Review of normal pelvic anatomy and imaging: CT, MRI, Ultrasound  
2. Contraceptive devices: Types of IUDs (Copper, hormonal), Intrauterine contraception (NuvaRing), CT, KUB, MRI and safety note, Ultrasound, Malpositioned IUDs  
3. Pelvic organ prolapse (POP) and pessaries: Anatomy of POP and imaging before treatment, Pessary types (ring, cube, Gellhorn), CT, MRI, Complications of pessaries (migration, fistulization, forgotten pessary)  
4. Catheter placement in female patients: Indications for catheter placement and review of normal placement, CT, MRI, Misplaced catheters and complications (vaginal placement, bladder perforation from traumatic insertion)  
5. Menstrual Products: Imaging findings of tampons, menstrual cups, CT, MRI  
6. Quick cases with multiple choice questions: Malpositioned IUD, Pessary on CT of patient with POP, Vaginal placement of catheter

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## Abstract Archives of the RSNA, 2023

OBEE-45

### Achy Breaky Baby Heart: Guide to Understanding Normal Fetal Cardiac Views

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Venus Barlas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Fetal cardiac assessment is a key component of the fetal anatomic survey. An understanding of the different cardiac views is crucial to accurate image interpretation during a level 1 fetal anatomic survey. 2) Use of 5 standard scan planes and systematic assessment of the fetal cardiovascular system is the initial step in screening for congenital heart disease. 3) Features at risk for congenital heart disease should be further examined using a detailed echocardiogram, which includes 5 additional views.

#### TABLE OF CONTENTS/OUTLINE

A. Overview of basic cardiac exam components  
B. Standardized scan planes, including a graphic schema, US anatomy, CT correlate of the same view, and significance/associated pathologies:  
1) Transabdominal (determining fetal situs and cardiac axis)  
2) 4 chamber view  
3) Left ventricular outflow tract  
4) Right ventricular outflow tract  
5) 3 vessel and 3 vessel trachea  
C. Fetal echocardiography planes, including a graphic schema, US anatomy, CT correlate of the same view, and significance/associated pathologies:  
6) Bicaval  
7) Long axis view of the aortic arch  
8) Long axis view of the ductal arch  
9) Low short axis view of the ventricles  
10) High short axis view of the great arteries  
D. Pictorial review of common congenital heart diseases detected on fetal cardiac views with key diagnostic findings

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## Abstract Archives of the RSNA, 2023

OBEE-46

### **Endometrioma - Beyond the Basics: Examining the Nuances and Variations of This Condition**

All Day Room: Learning Center

Soumyadeep Ghosh, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) To apprise radiologists of the imaging features of endometrioma/endometriotic cysts. 2) Case-based illustrations of the atypical locations to watch out for in the appropriate clinical context. 3) To illustrate the imaging predictors of malignancy in endometriotic cysts. 4) To outline the common pitfalls encountered on various imaging techniques. 5) To highlight the implications of endometriomas on fertility. 6) To emphasize the important of pain management techniques in patients with endometriotic cysts.

#### **TABLE OF CONTENTS/OUTLINE**

1) Background 2) Typical/ovarian endometrioma - Introduction - Classic ultrasound findings - Classic MRI findings 3) Atypical locations - a) Peritoneal Endometrioma b) Perihepatic Endometrioma 4) Imaging predictors of malignancy - Locations - Pathology - Imaging - Pitfalls on Imaging 5) Decidualized endometrioma - What is Decidualization? - Ultrasound appearance - MR imaging 6) Complications 7) Associations - Deep infiltrative endometriosis - Extra gynecological organ involvement 8) Implications on fertility 9) Implications on pain management

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## Abstract Archives of the RSNA, 2023

OBEE-47

### **Don't Miss - Understand: Solving Pitfalls in the Diagnosis of Endometriosis and Adenomyosis**

All Day Room: Learning Center

Karina d. Giassi, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Endometriosis and adenomyosis are prevalent diseases among reproductive age women with a negative impact on their quality of life and reproductive outcomes. Their imaging manifestations may be challenging due to a wide imaging spectrum of both diseases, leading to incorrect interpretations even by experienced radiologists. This presentation aims to demonstrate common imaging pitfalls of endometriosis and adenomyosis, with a comprehensive and instructive problem-solving guide.

#### **TABLE OF CONTENTS/OUTLINE**

1) Overview of endometriosis and adenomyosis, emphasizing the imaging diagnosis: ultrasound and magnetic resonance. 2) Imaging pitfalls in the diagnosis of endometriosis, including: Posterior compartment: Folds in the sigmoid colon; Vessels in the parametrium and paracolpos; Diverticulitis; Pericolic lymph nodes; Middle compartment: Adenomyosis; Fallopian tubes; Functional ovarian cysts; Pelvic Varices; Anterior compartment: Leiomyomas; Fibrocicatricial changes; Folds in the bladder wall; 3) Imaging pitfalls in the diagnosis of adenomyosis, such as: Myometrial contractions; Physiologic thickening of the junctional zone in the menstrual phase; Deep endometriosis with myometrial infiltration; Leiomyomas with cystic or red degeneration; Unicornuate uterus with functional non-communicating uterine remnant 4) A didactic guide for problem-solving pitfalls.

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## Abstract Archives of the RSNA, 2023

OBEE-48

### **Magnetic Resonance Imaging (MRI) of Mayer-Rokitansky- Kuster-Hauser Syndrome, Herlyn-Werner-Wunderlich Syndrome and Related Complex Mullerian Duct Anomalies With Special Emphasis on Surgical Reconstruction & Management;- What the Radiologist Should Know to Guide the Reconstruction Surgeon**

All Day Room: Learning Center

Aruna S. Pallewatte, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Explain Embryology of Mullerian Duct Anomalies (MDA) and Mayer-Rokitansky-Kuster-Hauser Syndrome(MRKHS) and Herlyn-Wener-Wunderlich Syndrome(HWWS) 2) ASRM Classification of MDA with demography 3) Case based introduction to MRKHS, HWWS other complex MDA, associations with Renal, ovarian, spine anomalies 4) Clinico-social aspects of MDA, effect on menarche, fertility pregnancy 5) MRI protocols, Imaging features of MRKHS,HWWS and MDA with sample cases 6) Document MRI findings and dimensions specially for reconstructive surgeon. Detailed analysis of structures - Cervix,Vagina,Plica palmatae,uterine/vaginal septa, uterine buds and extent of uterovaginal aplasia 7) MRI evaluation of Neovagina, other vaginoplasties follow up their complications (with example cases)

#### **TABLE OF CONTENTS/OUTLINE**

1) Developmental Embryology of MDA genetics 2) Classification of MDA(classes 1-VII) with cases 3) Case based description of MRKHS (type 1II), HWWS and MDA with MRI imaging features imaging pearls, coexistent extragenital genital anomalies, fibroids, endometriosis etc influencing surgical management prognosis 4) Clinical presentations, amenorrhea, subfertility pregnancy complications with sample cases 5) Targeted MRI reporting of MRKHS, HWWS, MDA associated extragenital anomalies. Specific points/dimensions useful for reconstruction, implants, surgery and for assisted reproduction. Describe uterine buds, triangular cord sign etc 6. Introduction to neovagina, vaginoplasty, uterine transplant and other surgical options with MRI features 7. Case based review of MRI of post reconstruction and post treatment follow up their complications (stenosis, fistulae, infections, hernia etc)

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## Abstract Archives of the RSNA, 2023

OBEE-49

### **Pelvic Endometriosis: Lexicon on Magnetic Resonance Imaging (MRI)**

All Day Room: Learning Center

Claudia Hurtado (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The most common sites of involvement are the vesicouterine space (in the anterior compartment) and the uterosacral ligaments (in the posterior compartment). The "T2 black dot sign" is a specific sign of endometriosis. Malignant transformation should be suspected when a nodule enhances, nodule more than 3 cm, growth or loss of T2 shading.

#### **TABLE OF CONTENTS/OUTLINE**

- Introduction- Objectives- Teaching points- MRI protocol- Gross anatomy- Morphological subtypes- Endometriomas- Structured Report- Conclusions

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-5

### MRI of Müllerian Duct Anomalies Based on the New ASRM Classification

All Day Room: Learning Center

Marianna Konidari, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Müllerian duct anomalies (MDAs) consist of a wide spectrum of congenital malformations of the uterus, cervix, fallopian tubes and upper 2/3 of the vagina and are the result of abnormal development, fusion or resorption of the Müllerian ducts.
- The new 2021 American Society of Reproductive Medicine-ASRM (previously, American Fertility Society-AFS) MDAs classification (MAC2021) expands the 1988 classification to include cervical and vaginal anomalies; it classifies MDAs into nine categories using standardized descriptive terminology.
- Imaging is crucial in the diagnostic workup of individuals with suspected MDAs, particularly adolescents with primary amenorrhea and adults with infertility, since identification of these anomalies and their complications allows tailored clinical management.
- MRI is the modality of choice for detailed pelvic anatomy evaluation, accurate MDA classification and preoperative planning.

#### TABLE OF CONTENTS/OUTLINE

- Embryology overview and imaging anatomy of internal female genitalia
- MDAs: how do they develop and what are the clinical implications
- ASRM Müllerian anomalies classification 2021: overview and differences with the AFS 1988 classification
- Imaging evaluation: rationale behind imaging of congenital uterovaginal anomalies, available techniques and the role of MRI
- Case-based discussion on MRI appearances, clinical presentation and treatment management of MDAs, according to the new ASRM classification
- Diagnostic algorithm for imaging approach of MDAs

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-50

### Endometriosis Revisited: Current Concept of Pathophysiology, Diagnosis, and Therapeutic Strategy

All Day Room: Learning Center

Mayumi Takeuchi, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Endometriosis, which significantly impairs women's QOL with chronic pain and reduced fertility, is a benign, common, but controversial disease due to its enigmatic etiopathogenesis and biologic behavior. Recent studies suggest multiple genetic, and environmental factors: endocrinic, inflammatory, immunological, and angiogenetic may affect its onset and development. Genomic analysis revealed the presence of cancer-associated gene mutations, which may reflect the neoplastic aspect of endometriosis. The management has changed dramatically with the development of fertility-preserving, minimally invasive therapies. 2. The appropriate examinations with advanced MR techniques (3D-T2WI, reduced FOV DWI, computed DWI, SWI, DCE-MRI, cine MRI), and careful imaging interpretation are considered useful in evaluating endometriosis and associated lesions, which may be effective for therapeutic strategy with improved patient's outcome.

#### TABLE OF CONTENTS/OUTLINE

Imaging manifestations of endometrioma (shading sign; T2 dark spot; hemosiderin deposition on SWI), deep endometriosis, adenomyosis, less common site and rare site endometriosis, endometriosis-associated tumor-like lesions (polypoid endometriosis; decidualized endometriosis), and malignant transformation, with pathophysiologic conditions, clinical classification, optimal treatment options and clinical outcomes.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

OBEE-51

### Pearls and Pitfalls of First-Trimester US Screening and Prenatal Testing: A Pictorial Review

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Cynthia De la Garza Ramos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. First trimester ultrasound (US) is key in establishing pregnancy viability, number, and location. 2. Early intrauterine pregnancy (IUP) sonographic milestones, including appearance of a gestational sac, yolk sac, embryo, and cardiac activity, follow a consistent timeline. 3. Prenatal genetic testing and sonographic fetal structural assessment serve as initial screening tools for chromosomal disorders and facilitate detection of patients who may benefit from subsequent amniocentesis, chorionic villous sampling, or fetal intervention. 4. Beta human chorionic gonadotropin ( $\beta$ -hCG) in combination with pelvic US can be used to evaluate early pregnancy complications, but threshold  $\beta$ -hCG values should not be used as a sole decision-making tool.

#### TABLE OF CONTENTS/OUTLINE

1. Review the indications for first trimester US. 2. Recognize the normal appearance of an IUP and identify the sonographic milestones of the first trimester. 3. Illustrate the components of a first trimester fetal anatomy scan. 4. Describe the current prenatal genetic screening recommendations for chromosomal defects and their relationship with US fetal anatomy, including nuchal translucency (NT) measurement. 5. Understand the role of  $\beta$ -hCG and its correlation with US findings in the evaluation of early pregnancy complications. 6. Review the Society of Radiologists in Ultrasound (SRU) consensus statement for diagnosing a nonviable pregnancy in the first trimester. 7. Identify US findings that may be associated with poor pregnancy outcomes and require follow-up. 8. Case Examples.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-52

### Nothing Complex about Ovarian Lesions: Expert Guidance from the O-RADS US Committee

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Catherine R. Phillips, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Based on validation studies feedback, the Ovarian-Adnexal Reporting and Data System (O-RADS) US has been updated to address clinical application challenges, improve system specificity, harmonize with other consensus statements and O-RADS MRI. 2. New lexicon terms include bilocular for cystic lesions shadowing for smooth solid lesions, features which favor benignity and may improve specificity by down-scoring lesions. 3. Features of classic benign lesions were further refined to capture their typical appearance and also aim to improve specificity. 4. Updated surveillance and growth parameters optimize management better align with existing consensus statements. 5. Emerging data suggests O-RADS US 3 lesions are at the lower end of the risk of malignancy range (1-<10%); management recommendations have thus been updated to allow short-term US follow-up.

#### TABLE OF CONTENTS/OUTLINE

1. Clarification of updated O-RADS US v2022 governing concepts on applicability criteria, definitions/technique, and rules for system use with diagrammatic depictions illustrative examples. 2. Image rich example cases featuring new lexicon descriptors with an explanation of how their presence alters risk score assessment and management options. 3. Algorithmic approach to assessment and diagnosis using O-RADS US v2022 lexicon terms demonstrating ease use for daily clinical practice.

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## Abstract Archives of the RSNA, 2023

OBEE-53

### Unusual Presentations of Common Female Pelvic Lesions

All Day Room: Learning Center

May A. Shaaban (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Uterine leiomyomas, uterine adenomyosis, ovarian mature cystic teratomas and endometriomas represent the most common pathologies in everyday practice. They have characteristic imaging features that allow confident diagnosis. Occasionally these common lesions present with atypical features which makes it more challenging. Teaching points: Describe the classic imaging features of Uterine leiomyomas, uterine adenomyosis, ovarian mature cystic teratomas and endometriomas Describe unusual imaging features of variant or complicated lesions Provide differential possibilities based on the imaging features

#### TABLE OF CONTENTS/OUTLINE

Atypical leiomyomas: I. Degenerated and variant leiomyomas: 1. Cellular leiomyoma 2. Cystic degeneration 3. Myxoid degeneration 4. Red degeneration 5. Lipoleiomyoma II. Infected leiomyoma III. Torsion of leiomyoma IV. Prolapsed leiomyoma Atypical adenomyosis/adenomyomas: Focal adenomyosis (adenomyoma) Cystic adenomyosis Adenomyosis in pregnancy Exophytic adenomyoma Atypical endometriomas: Mural nodules and decidualization Malignant transformation Rupture Atypical presentations of dermoid cysts: Rupture Malignant transformation

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-54

### Medical Devices of the Female Pelvis: Multimodality Patterns, Pitfalls, and Pearls

All Day Room: Learning Center

Mariam S. Mostamandy, BS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Medical devices in the female pelvis are less frequently encountered than those in the chest or abdomen. Nevertheless, radiologist familiarity with these devices is critical for appropriate imaging evaluation. This exhibit reviews normal and abnormal radiologic presentations of medical devices commonly found in the female pelvis on multiple imaging modalities as well as examples of complications that may arise from device placement. Finally, we will present radiologic examples of device mimics that could lead to pitfalls in imaging evaluation.

#### TABLE OF CONTENTS/OUTLINE

Pessaries Pessary Mimic: Menstrual cup Pessary Mimic: NuvaRing Pessary Mimic: Tampon Intrauterine devices (IUDs) Essure devices Tubal ligation clips Embolization coils Ureteral stents Foley catheter Rectal tube

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-55

### **Don't Be Fooled by Uterine Masses: How MRI Can Help You Spot Atypical and Malignant Impostors Among Leiomyomas**

All Day Room: Learning Center

Valeria Richart Sierra, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the specific MRI features of usual leiomyomas. Explain the known and emerging MRI features of atypical leiomyomas and describe how to differentiate them. Describe MRI characteristics of uterine sarcomas and compare them with those of leiomyomas. Develop a systematic image-based approach to recognize these entities.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction- Uterine anatomy - Clinical relevance - Definitions  
2. MRI protocol  
3. Usual leiomyomas - MR typical findings - Other RM signs: flow void sign, bridging vascular sign, high signal intensity rim on T2  
4. Atypical leiomyomas: MR findings correlation with Histology  
4.1. Atypical location- Subserosal - Submucosal  
4.2. Degenerated leiomyomas- Hyaline degeneration - Mixoid degeneration - Red degeneration - Cystic degeneration  
4.3. Histologic subtypes- Cellular leiomyoma - Lipoleiomyoma - STUMP  
5. Uterine sarcomas: MR findings correlation with Histology  
5.1. Uterine leiomyosarcoma  
5.2. Endometrial stromal sarcoma  
6. Differential Diagnosis  
7. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-56

### 3D Ultrasound - Troubleshooting in Gynaecological Imaging

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Sanchita Gupta, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is to -1) Provide information about system requirements and scanning techniques to obtain a standard 3D dataset, rendering and image reconstruction.2) Explore newer techniques and software in 3D USG for improving diagnosis.3) Know common clinical scenarios where 3D provides additional information over simple 2D USG.

#### TABLE OF CONTENTS/OUTLINE

1) 2D vs 3D ultrasound2) System requirements for 3D dataset acquisition3) Rendering and multiplanar reconstructions4) Transvaginal 3D USG - Importance of the coronal plane5) Newer techniques and software in 3D USG:- Walk thru mode - Virtual Hysteroscopy- 3D USG with Saline infusion sonography (SIS)- Translabial 3D USG- 3D Power Doppler- Endometrial volume calculation using VOCAL (Virtual Organ Computer-Aided Analysis)- Sono AVC (Automated volume calculation)6) Common clinical scenarios where 3D imaging can help provide a diagnosis- Evaluation of the external and internal uterine contour1) Congenital uterine anomalies2) Subserosal and pedunculated fibroids deforming external contour3) Submucosal fibroids deforming internal contour- Pathologies of the endometrial cavity1) Identifying intrauterine adhesions2) Locating polyps and Retained products of conception3) Placement of Intra-uterine contraceptive devices- Assessment of endo-myometrial junction in adenomyosis and carcinoma endometrium

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-57

### How to Handle Hydrops

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

April M. Griffith, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1: Hydrops fetalis is defined as the presence of fluid in two spaces -skin, pericardium, pleural space, peritoneal cavity.2: The prognosis is generally poor due to lack of treatment options.3: Fetal tachycardia and fetal anemia are treatable causes. Middle cerebral artery (MCA) Doppler is a non-invasive method to screen for fetal anemia which can be treated by intrauterine transfusion.4: Fetal intervention may be lifesaving - shunt placement in large cysts in a lung mass, laser ablation for twin twin transfusion syndrome, radiofrequency ablation for twin reversed arterial perfusion sequence.5: For some tumors (e.g., sacrococcygeal teratoma) elective preterm delivery with immediate resection is preferable to expectant management. The decision to deliver in such cases is based on multiple factors including the combined cardiac output calculated by echocardiography. 6: Some causes of hydrops can recur. Correct diagnosis of the cause is essential for management of current and future pregnancies.

#### TABLE OF CONTENTS/OUTLINE

1: Pitfalls in diagnosis of abnormal fluid locations. 2: Immune vs Non immune hydrops: Antibody screening, MCA Doppler velocimetry. 3: Cardiac - rhythm disturbance more likely than structural defects. 4: Genetic - Aneuploidy, syndromic. 5: Infection - Serology, growth restriction, hepatosplenomegaly, intracranial and abdominal calcifications. 6: High output states - Vascular malformation, vascular tumor, chorangioma. 7: Mechanical compression - Large lung mass, mediastinal mass. 8: Multiple gestations - Twin twin transfusion, monochorionic twin demise, twin reversed arterial perfusion. 9: Metabolic - Lysosomal storage disorders, gestational alloimmune liver disease.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-58

### A Headache Free Approach to Hydrocephalus

All Day Room: Learning Center

April M. Griffith, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1: The prognosis for fetal ventriculomegaly depends on the underlying etiology thus a systematic approach is recommended. 2: Scan technique is critical to ensure correct measurements for grading (mild, moderate, severe) and tracking for progression over time. 3: Accurate diagnosis is essential for pregnancy management and delivery planning. 4: Some conditions with ventriculomegaly can recur in future pregnancies (e.g., autosomal recessive Walker Warburg syndrome). 5: Fetal MRI plays an essential role in characterizing the underlying pathology. 6: Isolated mild ventriculomegaly is a diagnosis of exclusion, generally associated with good intellectual outcome. It may be unilateral (usually left), in males.

#### TABLE OF CONTENTS/OUTLINE

A: Technique to measure ventricles - US and MRIB: Evaluate the posterior fossa: Exclude Chiari malformation, Dandy Walker syndrome, aqueductal stenosis, rhombencephalosynapsisC: Systematic assessment of the supratentorial brain: Midline: Is the falx present, is the cavum septi pellucidi normal? Cortical mantle: Gyral and sulcal development, thickness, symmetry, defects? Ventricles: Shape, lining, contents? D: Is there a mass? E: Is there a vascular malformation? F: Are there cystic areas?G: Perform a detailed anatomy scan to look for signs of syndromes, infection, aneuploidy, growth restriction and complications of monozygotic twinning.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

OBEE-59

### Medical Devices in Female Genital System: What Radiologists Need to Know

All Day Room: Learning Center

Jian Guan, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the classification and function of medical devices in female genital system (uterus, vagina and adnexa).2. To realize the normal, abnormal and special imaging findings of medical devices in female genital system.3. To introduce complications related to medical devices in female genital system (including imaging appearance, diagnosis and differential diagnosis).4. To learn assistance in imaging diagnosis of medical devices in female genital system.

#### TABLE OF CONTENTS/OUTLINE

1. Classifications of medical devices in female genital system (1) Medical devices of the uterus (IUDs, uterine suspension mesh, etc.); (2) Medical devices of the vagina (pessary, vaginal occluder, vaginal tamponade, etc.); (3) Medical devices of the ovary and adnexa (tubal ligation clips, ovarian suspension clips, etc.).2. Medical devices of the uterus (1) Function and normal imaging appearance; (2) Abnormal imaging appearance and related complications; (3) Assistance in imaging diagnosis.3. Medical devices of the vagina (1) Function and normal imaging appearance; (2) Abnormal imaging appearance and related complications; (3) Assistance in imaging diagnosis.4. Medical devices of the ovary and adnexa (1) Function and normal imaging appearance; (2) Differential diagnosis of post-ovarian suspension findings (e.g. ovarian maldescent, supernumerary ovary); (3) Abnormal imaging appearance and related complications; (4) Assistance in imaging diagnosis.

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## Abstract Archives of the RSNA, 2023

OBEE-6

### Role of Fetal MRI in Antenatal Assessment of Central Nervous System Anomalies: What a Radiologist Should Know

All Day Room: Learning Center

Smily Sharma, MD, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To study the role of fetal MRI for antenatal assessment of various central nervous system anomalies including indications, added advantage over obstetric ultrasound as well as certain limitations. 2. To define a fetal MRI protocol for central nervous system assessment. 3. To learn about normal appearances of sulcation and gyration of brain at various periods of gestation and beware of MR pitfalls in fetal CNS imaging. 4. Using state of the art cases, to learn about myriad of CNS anomalies that can be detected in fetus, their syndromic and non-syndromic associations and their antenatal or postnatal follow up (wherever available).

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to fetal MR for antenatal central nervous system anomalies: Indications, advantages/ disadvantages and comparison with obstetric ultrasound 2. MR protocol to assess various central nervous system anomalies in fetus 3. MRI appearances of fetal brain at different periods of gestation (Pearls and Pitfalls) 4. Various CNS anomalies on fetal MRI with postnatal follow up wherever available: 4A. Fetal Ventriculomegaly 4B. Malformations of cortical development and midline brain anomalies 4C. Corpus Callosal Agenesis/ Dysgenesis and associations 4D. Posterior Fossa Malformations 4E. Neural Tube defects and Spinal Dysraphism 4F. Vascular anomalies 4G. Syndromic associations 4H. Miscellaneous CNS Disorders including ischemic insults, germinal matrix and intraventricular hemorrhage in fetus 5. Conclusion

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## Abstract Archives of the RSNA, 2023

OBEE-60

### Once in a Lifetime Gynecological Cases: Seen One, Seen Them All

All Day Room: Learning Center

Ana Villanueva, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To illustrate and review unusual gynecological cases, some of them with classic appearance as well as common gynecological cases with rare presentation. 2. Role of radiologist in evaluation of challenging gynecological cases.

#### TABLE OF CONTENTS/OUTLINE

1. Background How do abdominal radiologists like to report gynecological cases? And what about general radiologists? Many colleagues say that they find themselves in trouble when reporting these cases. And why is that? Probably it is a combination of lack of knowledge or experience; not familiar reporting different techniques TV US, CT and MRI; etc. We as radiologist look for entities that we know. If we do not know about a disease, we will not think about it and therefore we will not reach a correct diagnosis. However, there are certain entities that even they are challenging because they are uncommon, they have a classic appearance (for example malignant adenoma of the cervix). Once you see one case, you will not forget. Also, common gynecological diseases can present in a very unusual way (for example ileal and appendiceal endometriosis without pelvic endometriotic findings). 2. Identification of characteristic imaging features • Different imaging techniques will be shown: Transvaginal US, CT, MRI • To propose key points to accurately reach the diagnosis • Algorithm of differential diagnosis based on imaging features along with relevant clinical and analytical information 3. Understand the clinical and treatment implications of diseases with characteristic radiologic appearance 4. Radiologic- pathologic correlation will be shown for most of the cases 5. Conclusion 6. References

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## Abstract Archives of the RSNA, 2023

OBEE-61

### First Trimester Ultrasound (FTUS): Screening Techniques

All Day Room: Learning Center

Saubhagya Srivastava, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Increased nuchal translucency (NT) remains an internationally recognized indication for invasive testing (amniocentesis or CVS). By the end of this educational exhibit, the reader/listener would be able to: 1. Understand the various screening policies for chromosomal abnormalities utilized in the first trimester (Combined screening vs Contingent screening policies). 2. Learn about the importance and technique of measuring NT in the first trimester. 3. Learn about new ultrasound markers utilized in first-trimester screening. 4. Identify important fetal structural abnormalities and their significance system-wise. 5. Algorithmically co-relate first-trimester ultrasound findings to the next steps in the screening process.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to FTUS  
2. Combined screening vs Contingent screening for chromosomal abnormalities  
3. Nuchal translucency (NT)  
i. Significance and efficiency  
ii. The technique of measuring NT  
4. New FTUS markers  
i. Nasal bone  
ii. Tricuspid flow  
iii. Ductus Venosus flow  
5. Cell-free DNA (cfDNA)  
i. The utility of cfDNA in relation to FTUS- When to use and when NOT to use?  
ii. Advantages and limitations of cfDNA compared to FTUS  
6. Fetal structural abnormalities NOT to miss in FTUS  
i. CNS abnormalities  
ii. GI and GU abnormalities  
iii. Skeletal abnormalities  
iv. Cardiac abnormalities  
7. Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-62

### The Hidden Enemy: A Visual Journey Through Ovarian Tumor Imaging

All Day Room: Learning Center

Sofia B. Maksoud, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Ovarian tumors are classified according to their origin: epithelial cell tumors, germ cell tumors, sex cord-stromal tumors and metastatic tumors. Among them, epithelial tumors are the most common, with a higher prevalence between 60 and 70 years of age. Imaging exams have the capability to predict the risk of malignancy: mural nodules, papillary projections, solid components, thickened walls and septa (greater than 3.0 mm) with associated vascularization are some aspects that suggest malignancy, while of fat components suggests benignity. Pelvic ultrasound is commonly the first exam to be performed due to its high availability and low cost. However, for adequate characterization of the ovarian mass, additional tests such as magnetic resonance imaging may be requested, with the aim of helping to distinguish between benign and malignant tumors and, mainly, in staging and surgical planning. The results of radiological examinations associated with the clinical features, family history and laboratory tests allow the diagnosis of ovarian lesions. A thorough evaluation provides part of data that may be associated with the histology of these tumors. This information plays a fundamental role in choosing the appropriate therapy.

#### TABLE OF CONTENTS/OUTLINE

To demonstrate cases of malignant and benign ovarian tumors and to review their presentations in different imaging modalities, including pelvic ultrasonography and magnetic resonance imaging, correlating with anatomopathological results and surgical specimens.

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## Abstract Archives of the RSNA, 2023

OBEE-63

### Placenta Accreta Spectrum and the Emergence of MRI

All Day Room: Learning Center

Leslie W. Nelson, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Placenta Accreta Spectrum (PAS) refers to abnormal placental adherence and/or invasion into the uterine wall due to a defective decidualization process. Difficult placental separation can cause life threatening peripartum hemorrhage if not diagnosed prenatally. 2. The prevalence of PAS has increased 10-fold over the last 4 decades and has been linked to increased rate of cesarean deliveries. 3. Ultrasound is the first line modality for placenta imaging, however, MRI is an emerging modality that provides superior soft tissue contrast and is vital for surgical planning in Placenta percreta. 4. In 2020, SAR and ESUR published a joint consensus statement to standardize MRI acquisition, interpretation and reporting of PAS. 5. This educational exhibit will help the learner understand and identify the described MRI signs associated with PAS and their pathophysiologic subcategories.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction of PAS 2. Compare and contrast use of ultrasound versus MRI 3. Normal MRI appearance of the placenta 4. Review of the MRI features described by SAR and ESUR joint consensus statement 5. Review the three pathophysiological oriented classifications (gross morphologic signs, interface signs and tissue architecture signs) 6. Review pathology proven cases (accreta, increta and percreta)

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## Abstract Archives of the RSNA, 2023

OBEE-64

### CT Imaging of the IUD: Expected Findings, Unexpected Findings, and Complications

All Day Room: Learning Center

Grace G. Zhu, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

After viewing this exhibit, the reader will be able to: 1. Understand the approach in evaluating the CT appearance of an intrauterine device and recognize a normally positioned intrauterine device. 2. Recognize the CT imaging appearance of wide spectrum of complications involving the intrauterine device.

#### TABLE OF CONTENTS/OUTLINE

Outline: 1. Introductiona. Types of IUDsb. Approach to evaluating IUDs on CTc. Normal Imaging appearance of an appropriately positioned IUD2. Complicated IUDsa. Malpositioned IUDi. Low lying IUDii. Intracervical IUDiii. Rotated IUD/Upside Down IUDb. Embedded IUDc. Extrauterine IUDd. Fragmented IUDe. Pregnancy and IUDi. Ectopic pregnancyii. Intrauterine pregnancyf. Miscellaneousi. Actinomycoses and IUDsii. Fibroids and IUDSiii. Mullerian abnormalities and IUDs

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## Abstract Archives of the RSNA, 2023

OBEE-65

### To Treat, or Not to Treat, That is the Question: Multimodality Approach to Secondary Post Pregnancy Hemorrhage

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Alyssa K. Kirsch, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Secondary post pregnancy hemorrhage occurs 24 hours to 12 weeks following delivery. Etiologies include retained products of conception (RPOC), subinvolution of the placental site (SIPS), arteriovenous malformation/arteriovenous fistula (AVM/AVF) spectrum.- Ultrasound is often a first line imaging modality in the identification of causes of secondary post pregnancy hemorrhage. However, CT and MRI may also be used in the imaging work up. Recognizing key features of each etiology is essential to timely diagnosis and clinical management.- Certain pathology may mimic causes of secondary post pregnancy hemorrhage such as endometritis and gestational trophoblastic disease.

#### TABLE OF CONTENTS/OUTLINE

- Explanation of causes, pathophysiology, and management of secondary post pregnancy hemorrhage including RPOC, SIPS, and AVM/AVF- Case-based, multimodality imaging review of secondary post pregnancy hemorrhage including US, CT, and MRI with discussion of management options- Imaging review of mimics of retained products of conception including endometritis and gestational trophoblastic disease- Proposed algorithmic approach to management of secondary post pregnancy hemorrhage based on imaging findings and how to differentiate from mimickers

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## Abstract Archives of the RSNA, 2023

OBEE-66

### Malignant Transformation of Endometriosis and Its Mimics

All Day Room: Learning Center

Cesar Resino Sanchez, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the types of malignant transformation of endometriosis, taking into account the typical and atypical locations. 2. To recognize the usefulness of magnetic resonance imaging (MRI) in the early diagnosis of malignant transformation of endometriosis. 3. To describe forms of presentation of endometriosis that can simulate malignant transformation.

#### TABLE OF CONTENTS/OUTLINE

Definition, types and typical and atypical locations of endometriosis. Pathological mechanisms of malignant transformation: genomic alterations, oxidative stress, inflammation, and hormonal influences. Types of ovarian tumors in endometriosis (endometrioid adenocarcinoma and clear cell carcinoma as the most frequent). Optimal protocol and MRI findings suggestive of malignancy: appearance of enhancing intramural nodules, enlargement of the endometrioma and disappearance of shading sign on T2-weighted images. Imaging findings in cancers arising from extraovarian endometriosis. Malignancy simulators: decidualization during pregnancy, polypoid endometriosis, extraovarian endometriosis mimicking peritoneal carcinomatosis, etc.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-67

### Hysterosalpingography: What's Current and What's Next

All Day Room: Learning Center

Erica D. Cruz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Hysterosalpingography is an exam with consolidated use in medical practice, with well-established indications and contraindications in the literature. The main indications for the exam are: human reproduction (infertility), preoperative uterine fibroids, repeat abortions and reversal of tubal ligation. Although new technologies and imaging methods have been developed in the past years, it currently persists as the method of choice and gold standard for evaluating the thickening of the mucous pleats of the fallopian tube. The objective of this study is to provide a didact review of hysterosalpingography, from the examination technique to its main findings, since the images acquired's quality depends on the correct preparation and technique. We also provide a comparative study of hysterosalpingography with other emerging imaging methods, such as magnetic resonance hysterosalpingography (HSG-MRI) and hysterosonosalpingography, with future perspectives related to these methods.

#### TABLE OF CONTENTS/OUTLINE

Case-based review of hysterosalpingography exams, including the technique, most common findings and pitfalls, with a literature review, teaching points, and references. We also provide correlation with other imaging methods, such as ultrasonography and magnetic resonance imaging (MRI).

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## Abstract Archives of the RSNA, 2023

OBEE-68

### Highlighting the Updates in Mid-Trimester Fetal Ultrasound Scan According to the Updated International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) Practice Guideline

All Day Room: Learning Center

Ilkay S. Idilman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The mid-trimester ultrasound scan is performed for anatomic evaluation of the fetus and is accepted as a part of routine prenatal care by many countries. The International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) published a guideline for the performance of the routine mid-trimester fetal ultrasound scan in 2011 and updated the guideline in 2022. According to these guidelines, a routine mid-trimester fetal ultrasound examination should include an evaluation of the cardiac activity; fetal number (and chorionicity and amnionicity in cases of multiple pregnancy); gestational age/fetal size; basic fetal anatomy; placental appearance and location. In the updated ISUOG guideline, amniotic fluid volume assessment and measurement of cervical length for prediction and prevention of preterm birth are also recommended. Pregnancies in which the umbilical cord inserts into the amniotic membranes (velamentous cord insertion) or at the edge of the placenta (marginal cord insertion) should be reported. Suggested minimum (and optional) requirements for the fetal anatomic survey were also updated and will be discussed in the exhibition. Technical challenges to obtaining these standard images will also be discussed.

#### TABLE OF CONTENTS/OUTLINE

The suggested basic mid-trimester fetal anatomic survey according to ISUOG is updated in 2022. Knowledge of minimum and optional requirements according to the current guideline is important for the appropriate evaluation of the fetus. This exhibit aims to highlight the updates as well as remaining unchanged requirements with ultrasound images.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-69

### Postmenopausal Endometriosis: Clinical Insights and Imaging Considerations

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Lekui Xiao, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Postmenopausal endometriosis is estimated to affect around 2-4% of women and is more commonly seen in patients undergoing hormone replacement therapy.
- There is no current guidelines for management of postmenopausal women with endometriosis.
- Transvaginal ultrasound and magnetic resonance imaging are the primary imaging modalities for assessing extent of endometriosis.
- Imaging findings will demonstrate a predominance of the fibrotic component associated with anatomical distortion.

#### TABLE OF CONTENTS/OUTLINE

- To review the clinical presentation of endometriosis in the postmenopausal population
- To understand how hormonal status affects the pathogenesis of endometriosis, including both exogenous and endogenous sources
- To use a case-based approach to illustrate the sonographic and MRI findings of endometriosis in patients undergoing hormonal replacement therapy, as well as in those who are not undergoing hormonal treatment. Laparoscopic correlation will be included, when available.
- To describe the risk of malignant transformation for specific lesions such as endometriomas and deep invasive lesions, while using cases to demonstrate imaging features of neoplasm.
- To explore proposed non-invasive screening imaging methods.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-7

### Hysterosalpingography and Infertility: Beyond Tube Obstruction

All Day Room: Learning Center

Leticia Cardoso Ern, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The causes of infertility can be genetic or acquired. When anatomically compartmentalized, it is possible to determine some groups of causes: uterine, tubal, ovarian, and central (pituitary and hypothalamic). Hysterosalpingography (HSG) is a contrast-enhanced examination of the female genital tract that uses serial radiographs to assess uterine and tubal anatomy. It is known to be the first-line test for assessing tubal obstruction, as it can determine the local anatomy in a relatively simple and inexpensive way. There are several other findings that HSG can offer and suggest diagnoses of other causes of infertility, such as endometriosis, adenomyosis, Müllerian duct malformations, and uterine synechiae. By the end of this study, the reader will be able to define the importance of fluoroscopy in the investigation of infertility, understand the methodology of HSG and identify its causes based on imaging findings.

#### TABLE OF CONTENTS/OUTLINE

Define the role of imaging exams in the investigation of infertility; Determine the methodology of HSG and its usefulness; Explain the causes of infertility and illustrate their compatible findings in HSG through image examples.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-70

### From the Pathology Lab to the Radiology Suite: Navigating Neuroendocrine Tumors of the Female Reproductive System

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mayara R. Dos Santos Cruz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To present a rare subtype of gynecological tumor, the Neuroendocrine gynecological tumors (NEG). To review clinical-pathological features of NEG, highlighting the pathologic differences between NEG and non-NEG cancers. To expose the aggressive clinical behavior of NEG tumors by evolutive imaging examples and well-documented cases, with emphasis on the radiological role for staging and follow-up. To become aware of the different prognostic data between NEG and non-NEG tumors with a brief overview on the suggested treatment.

#### TABLE OF CONTENTS/OUTLINE

Neuroendocrine gynecological tumors can dramatically affect the cervix, ovary, endometrium, vagina, and vulva. As extremely rare tumors, studies on NEG are scarce and most are based on case reports. Although the imaging features are non-specific for diagnosis, imaging is quintessential in staging, treatment response assessment, and surveillance. To demonstrate with clinical cases, imaging exams, and temporal evolution the regional and advanced involvement of NEG. Review in a didactical way the disease-related pathology, and its differentials, based on illustrations, pathology / immunohistochemistry analysis. Case-based discussion and review of the essential information for the radiological report, that will imply the follow-up and treatment of the patient. Discuss the clinical prognosis associated with the disease, and demonstrate briefly the limitations related to the therapies available.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-71

### Many Faces of Uterine Fibroids: Imaging Findings of Degenerations, Differential Diagnoses, and Complications

All Day Room: Learning Center

Shintaro Ichikawa, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Uterine fibroids are benign tumors composed of smooth muscle and are the most common tumors in gynecology. Because uterine fibroids tend to produce different symptoms depending on their site of origin, accurate assessment of the site and size of the fibroids using diagnostic imaging is required. Although typical uterine fibroids are easy to diagnose using imaging, there are a variety of degenerations, and it is important to know the characteristics of each.

#### TABLE OF CONTENTS/OUTLINE

The following typical and degenerated uterine fibroids are discussed along with their key imaging findings: 1. Typical fibroids (intramural, subserosal, submucosal, and cervical) 2. Hyaline degeneration 3. Hydropic degeneration 4. Myxoid degeneration 5. Fatty degeneration 6. Red degeneration The following differential diagnoses and complications are discussed, along with their key imaging findings: 1. Uterine lipoleiomyoma 2. Hypercellular uterine fibroid 3. Uterine leiomyosarcoma 4. Focal adenomyosis 5. Low-grade endometrial stromal sarcoma 6. Submucosal uterine fibroid prolapse into the vagina (vaginal delivery) 7. Uterine intravenous leiomyomatosis 8. Peritoneal leiomyomatosis following uterine fibroid morcellation 9. Rupture of fibroid 10. Torsion of subserosal fibroid 11. Infection of fibroid

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## Abstract Archives of the RSNA, 2023

OBEE-72

### **Comprehensive Imaging of Pelvic Medical Devices: Beyond IUDs**

All Day Room: Learning Center

Lidiamara Van Der Zwaag, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Recognize the usual appearance of the main pelvic devices in different imaging methods (Radiographic, Ultrasound, CT and MRI):  
Vaginal tampon  
Menstrual cup  
Contraceptive devices (IUDs, Female sterilization device, Vaginal ring)  
Therapeutic devices (Pessaries, Brachytherapy applicator, etc)  
Post-surgical devices (Suture artifacts, catheters, etc)  
How to assess the proper placement of the most common pelvic devices and what points and measurements should be included in the report  
Recognize the main complications related to Intrauterine contraceptive devices (IUDs) displacement

#### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION  
Main pelvic devices and their radiographic features  
How to assess correct placement of pelvic devices and practical points  
COMPLICATIONS RELATED TO INTRAUTERINE CONTRACEPTIVE DEVICES DISPLACEMENT.  
Case based Review of:  
- Displacement- Embedment- Complete perforation

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## Abstract Archives of the RSNA, 2023

OBEE-73

### **Piecing Together the Puzzles: Imaging Diagnostic Approach to Genetic Diseases Affecting the Female Reproductive Organs and Beyond**

All Day Room: Learning Center

#### **Awards**

##### **Cum Laude**

Tsukasa Saida, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The genetic links to various tumors have become more apparent, and it is crucial for radiologists to understand them in order to make an accurate diagnosis and establish an appropriate testing strategy. This exhibit will describe the genetic diseases associated with neoplastic lesions in gynecology, including the specific characteristics of each tumor and lesions that occur in other regions of the same disease. The teaching points of this exhibit are: 1. Description of the inheritance pattern and characteristics of each genetic disease 2. Presentation of key imaging findings that contribute to the diagnosis of various genetic diseases

#### **TABLE OF CONTENTS/OUTLINE**

A. Inheritance pattern B. Characteristics of the genetic disease C. Imaging features of gynecologic tumors associated with genetic diseases D. Imaging features of lesions that occur in other regions of the body

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-74

### Hystero-Salpingography in Current Clinical Practice - Old Flames, Die Hard!

All Day Room: Learning Center

Nitin P. Ghonge, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review the clinical status of Hysterosalpingography[HSG] in infertility work-up in the current era of cross-sectional imaging. 2. To revisit the nuances of HSG procedure and image interpretation for better understanding of uterine, tubo-ovarian and peritoneal lesions in these patients. 3. To understand the spectrum of findings on the initial HSG study and impact on the subsequent infertility work-up.

#### TABLE OF CONTENTS/OUTLINE

1. Status of HSG in current clinical practice as an initial first-line investigation for infertility work-up. 2. Procedural nuances in HSG and the image interpretation skills play an important role in diagnostic accuracy of HSG in patients with infertility and the overall utility. 3. Implications of slow continuous injection of contrast with acquisition of standard set of images: early filling phase, late distended phase, peritoneal spillage phase and post-cannula removal phase. 4. Review of basic principles in Radiation hygiene as applicable to HSG. . 5. Image interpretation includes evaluation of endometrial cavity in terms of shape, distension and the mucosal surface. Tubal and peritoneal evaluation is not restricted to contrast spillage alone. Apart from tubal patency, evaluation of tubal mucosa is an important component of tubal evaluation. Apart from the tubal opacification and luminal caliber, the course of fallopian tubes should also be carefully evaluated as it provides vital clues about the status of peri-tubal peritoneum and peritubal adhesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

OBEE-75

### Hereditary and Non-Hereditary Syndromes with Gynecologic Manifestations: What the Radiologist Needs to Know

All Day Room: Learning Center

Ekta Maheshwari, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. A number of key hereditary and non-hereditary syndromes are associated with gynecologic manifestations. 2. Awareness of these syndromes and their associations is integral to optimal patient management, facilitating recommendations for ancillary imaging and follow up.

#### TABLE OF CONTENTS/OUTLINE

**Hereditary Cancer Predisposition Syndromes** Some examples of hereditary cancer predisposition syndromes include Lynch syndrome (mismatch repair genes), Cowden Syndrome (PTEN), hereditary breast and ovarian cancer syndrome (BRCA1/BRCA2), Peutz-Jeghers syndrome (STK 11) and hereditary leiomyomatosis and renal cell cancer syndrome (FH). These syndromes can predispose individuals to distinct uterine and ovarian neoplasms. **Congenital Syndromes with Benign associations** • Gynecologic manifestations observed in multiple congenital and acquired syndromes can also be associated with benign entities • Congenital malformation of the reproductive tract can be seen in Mayer-Rokitansky-Küster-Hauser syndrome. Familial clustering of these cases suggests a genetic basis of inheritance. **Acquired Syndromes** Acquired syndromes with gynecologic manifestations include • Meig's syndrome • Ovarian hyperstimulation syndrome • Ovarian remnant syndrome • Fitz-Hugh-Curtis syndrome • Growing teratoma syndrome **AIMS** • Summarize and illustrate imaging findings observed for key hereditary and non-hereditary syndromes associated with gynecologic manifestations, including features of malignancy and those features overlapping and mimicking malignancy. • Describe the clinical implications, most current imaging recommendations and screening and surveillance guidelines for these syndromes.

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## Abstract Archives of the RSNA, 2023

OBEE-8

### Quantification in Fetal MRI: Why, When, and How

All Day Room: Learning Center

Haithuy N. Nguyen, MD (*Presenter*) Research Grant, Siemens AG

#### TEACHING POINTS

1. Recognize the fetal abnormalities that require a radiologist to use the measuring tool. 2. Understand the impact of measurements on prognostication and/or family counseling. 3. How to correctly perform the measurements and compare to previously published normative values or thresholds.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Why, when, how to measure lung volumes - Congenital diaphragmatic hernia (CDH), congenital lung malformation, giant omphalocele, anhydramnios, skeletal dysplasia, and cervical teratoma. 3. Why, when, how to measure tracheoesophageal displacement index and tumor volume to fetal weight ratio for cervical and sacrococcygeal teratomas, respectively. 4. Why, when, how to measure liver volumes - CDH. 5. Future work - lung signal ratios, estimating CDH defect size, open neural tube myelomeningocele sac size, and amniotic fluid maximum vertical pocket.

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## Abstract Archives of the RSNA, 2023

OBEE-9

### Imaging Cervical Cancer: Beyond Diagnosis

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Melissa J. McGettigan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Abdominal imaging plays an essential role in the contemporary management of cervical cancer. MRI is a key imaging modality due to excellent tissue contrast resolution, enabling superior accuracy for tumor size, parametrial and pelvic sidewall invasion and evaluation of nodal metastases, all of which are key prognostic factors for cervical cancer. 18F-FDG-PETCT is essential in the assessment of advanced stage disease to evaluate for distant metastasis and can also aid in the detection of involved locoregional lymph nodes. Imaging also plays an integral role in brachytherapy treatment planning and execution. Ultrasound, MRI, CT and, on occasionally radiography, are used for guidance of brachytherapy applicator placement and to confirm appropriate implant positioning prior to the delivery of therapeutic radiation. Imaging is integral in the post-treatment surveillance to detect treatment-related complications and identify recurrent disease.

#### TABLE OF CONTENTS/OUTLINE

Review the current FIGO staging system of cervical cancer and illustrate the role of imaging as it relates to stage determination and stage-specific treatment options. Demonstrate the role of imaging for brachytherapy treatment planning and execution, including structured reporting recommendations for brachytherapy implant assessment. Illustrate expected post-therapy imaging findings and the role for MRI, PETCT and CT. Show imaging findings of common and uncommon post-therapy complications. Illustrate cases of recurrence vs. expected benign post treatment changes.

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## Abstract Archives of the RSNA, 2023

PDEE

### Pediatric Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

##### **PDEE-1 Ear Anatomy and Anomalies in Fetal MRI**

Matheus Dorigatti Soldatelli, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Describe ear anatomy and anomalies using in-vivo MRI in fetuses between 16 and 41 weeks of gestational age (GA). Additional 3D skin-surface reconstructions and postnatal or post-mortem imaging were performed in selected cases.

#### **TABLE OF CONTENTS/OUTLINE**

- Illustrate the ease of visualization of the pinna, external auditory meatus, cochlea, modiolus, vestibule, and semicircular canals at different GAs.- Demonstrate ear malformations in syndromic and non-syndromic patients and the associated extra-labyrinthine anomalies, such as facial and extremity abnormalities, that aid in phenotype-genotype correlation.

##### **PDEE-11 Synapses and Signals: Nuclear Medicine Applications in Neurology and Endocrinology**

Valentina Ferrer Valencia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Nuclear medicine imaging can provide valuable diagnostic and therapeutic information in the evaluation of central nervous system and thyroid diseases, but appropriate dose optimization and imaging protocols are essential to minimize the potential risks associated with radiation exposure. 2. Epilepsy evaluation can benefit from various nuclear medicine imaging techniques such as CSF flow studies, CNS radionuclide angiography, and SISCOM, which can provide valuable information about brain function and blood flow. 3. 18F-FDG PET is a useful tool for evaluating epilepsy, as it can provide information on brain metabolism and can help identify the location of seizure foci. 4. Pediatric thyroid diseases, such as hyperthyroidism, nodular thyroid disease, thyroid cancer, Graves Disease, and subacute thyroiditis, can be evaluated using a range of nuclear medicine imaging techniques, including thyroid uptake and scan, 123I whole-body scan, and 99mTc-MIBI imaging. 5. Nuclear medicine imaging can play a crucial role in the diagnosis and management of thyroid cancer, including the use of radioiodine therapy to target and destroy cancerous thyroid cells.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction 1.PET 2.Image acquisition 3.Radiation dose Epilepsy 1.Epilepsy Evaluation 2.Tracers for Targeted Epilepsy PET Imaging 3.CSF Flow Studies 4.CNS Radionuclide Angiography 5.SISCOM 6.18F-FDG PET Pediatric Thyroid Disease 1.Hyperthyroidism 2.Nodular thyroid disease 3.Thyroid Cancer 4.Graves Disease 5.Subacute Thyroiditis Conclusions

##### **PDEE-12 Cortical Development Evaluation on Fetal Brain MRI Between 22 and 28 weeks: A Practical Guideline**

Mariana Cerdeira Machado, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To demonstrate the correct protocols for the adequate acquisition of the necessary sequences for the analysis of the cortical development; - To illustrate the morphological aspects of the principal sulci and gyri of the fetal brain between 22 and 28 weeks in a fetal MRI; - To learn the timing of the appearance of each new sulci between 22 and 28 weeks in a fetal MRI; - To recognize the early signs of cortical development abnormalities.

## TABLE OF CONTENTS/OUTLINE

The purpose of this work is to illustrate the morphological aspects of the principal sulci and gyri and their time of appearance in the fetal brain between 22 and 28 weeks in a fetal MRI. For this, we will briefly discuss cortical development (neuronal proliferation, migration, and organization) and explore anatomic landmarks and their normal morphology throughout this period. Furthermore, we will demonstrate how to adequately perform an MRI exam and use it to evaluate the fetal brain cortex. Finally, we shall explore the early signs of cortex developmental abnormalities and the importance of a prompt diagnosis on the outcomes and prognoses.

### **PDEE-13 Abdominopelvic Emergencies in Pediatric Oncology Patients: A Pictorial Review**

Sara Garcia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Pediatric cancer patients are at increased risk for life-threatening emergencies that can affect all organs and systems. Such emergencies may be directly related to the disease at its debut or during its evolution or be secondary to the treatment administered.- Abdominal emergencies are frequent in these patients, and the imaging technique of choice for their study is ultrasound. Plain abdominal radiography, CT and MRI are usually used as complementary studies in case of specific suspicions or for better characterization.- Among the pathology affecting the intestinal loops at the debut intestinal obstruction stands out, especially intussusception, which is very typical in the pediatric population. Typhlitis or neutropenic colitis usually occurs as a complication of QT treatment in patients with ALL.- Among the hepato-biliary emergencies secondary to treatment, hepatotoxicity and sinusoidal obstruction syndrome are the most frequent, the latter presenting typical characteristics on Doppler study.- Acute pancreatitis is a possible complication of chemotherapy with L-asparaginase.- Hemorrhagic cystitis occurs as a complication treatment with cyclophosphamide in patients with HSCT. The bladder is the most affected organ.- Testicular neoplasms do not increase the risk of torsion but can present at onset as acute scrotal syndrome.

## TABLE OF CONTENTS/OUTLINE

1. General classification of emergencies in pediatric oncology patients. Classification of abdominal emergencies, both those that occur at the onset of the disease and those that are secondary to oncological treatment.2. Description of the main clinical features and imaging findings of abdominal emergencies in these patients.

### **PDEE-14 Mind the Gaps: Avoiding Fracture Pitfalls in Pediatric Musculoskeletal Radiology**

Lucas R. Medeiros (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. To review normal pediatric musculoskeletal imaging findings that can mimic fractures in a multimodality approach 2. To discuss hard-to-identify and pediatric-specific fractures 3. To assess the differential diagnosis of pediatric pathological conditions 4. To analyze treatment-related findings that can simulate pathologies

## TABLE OF CONTENTS/OUTLINE

1. Salter-Harris fractures 2. Green-stick fractures 3. Plastic deformation fractures 4. Torus fractures 5. Non-accidental injury fractures 6. Ossification centers mimicking fractures 7. Secondary fracture findings 8. Metabolic and genetic conditions (e.g. rickets, osteogenesis imperfecta) 9. Skeletal dysplasias 10. Obstetric injury 11. Anatomical variations

### **PDEE-15 Temporosquamous Suture: An Updated View of the Importance of this Finding in Craniosynostosis**

Yuree M. Herenio SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The squamous suture is the main object of our work. While the phenotypic appearances and sequelae of synostosis of the major cranial vault sutures are well documented, little is reported concerning synostosis of the squamous suture. Involvement of this suture can be individual or associated with other sutures, both in syndromic cases and in primary craniosynostosis. This work has the objective to demonstrate the importance of the temporosquamous suture, which has been undervalued over the years in literature. Recent studies and their surgical correlations show different types of cranial deformity, depending on the location of partial or complete closure of this suture. Deformities include scaphocephaly, plagiocephaly or brachycephaly. Our work shows different types of closure evaluated in our department. We also consider fundamental the use of the Maximum Intensity Projection protocol (MIP) to demonstrate the real shape of the sutures and to investigate craniolacunias, which constitutes a relevant finding in the surgical decision, as it may represent signs of intracranial hypertension.

## TABLE OF CONTENTS/OUTLINE

The work shows a literature review about the squamous suture, showing part of the cases of CT with Maximum Intensity Projection protocol (MIP) and volume rendering 3D reconstruction of different types of closure, evaluated in our department.

## **PDEE-16 Epiphanyes about Epiphyses: Distinguishing Epiphyseal Mass Lesions in Children**

### **Awards**

#### **Cum Laude**

Eric L. Tung, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Epiphyses have unique histology and play an important role in osseous development. The differential diagnosis for epiphyseal mass lesions in children is one that radiologists interpreting pediatric imaging should be familiar with. Overlapping imaging findings of epiphyseal tumors and other focal lesions on radiography and magnetic resonance imaging can hinder the ability of radiologists to establish specific diagnoses by imaging alone. However, knowledge of characteristic imaging features for each lesion can improve the accuracy and specificity of radiologists' interpretations. By the end of this exhibit, learners should be able to provide a differential diagnosis for pediatric epiphyseal mass lesions, recognize the unique imaging features of each diagnosis, and apply a framework for MRI evaluation of epiphyseal lesions to unknown cases.

### **TABLE OF CONTENTS/OUTLINE**

1. Background: Epiphyseal development, structure, equivalents; 2. Differential diagnosis for epiphyseal tumors and other focal lesions in children; 3. Review of characteristic imaging findings for each diagnosis; 4. Framework for MRI interpretation to help narrow differential diagnosis; 5. Unknown cases to reinforce learning objectives

## **PDEE-17 Pediatric Metabolic Bone Disorders - A Comprehensive Review**

Archana Malik, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Illustrate the common and uncommon metabolic bone disorders in children. Identify imaging features that can help differentiate the various metabolic disorders.

### **TABLE OF CONTENTS/OUTLINE**

Metabolic bone disease in children includes hereditary and acquired conditions of varying etiologies. The purpose of this educational exhibit is to describe the characteristic imaging findings of metabolic bone disorders to include endocrine and nutritional deficiencies. Entities such as rickets, scurvy/ hypovitaminosis C, osteogenesis imperfecta, hyperparathyroidism, renal osteodystrophy, celiac disease, inflammatory bowel disease, hypophosphatasia, osteopetrosis, sickle cell anemia, Gaucher's, heavy metal poisoning, and bone disease secondary to medication such as prolonged steroid treatment will be discussed. Early recognition and treatment of potential risk factors is important to avoid significant clinical consequences.

## **PDEE-18 Pediatric Skull Lesions**

Preeti S. Prasad, MBBS, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- To discuss the common pathologies affecting the pediatric skull.
- To discuss imaging appearance of various skull lesions seen in children.
- To develop a systematic approach to diagnosing skull lesions.

### **TABLE OF CONTENTS/OUTLINE**

Goals and objectives -Background information -Common and uncommon skull lesions in children -Imaging spectrum of pediatric skull lesions -Indications for further imaging -Summary. Pediatric skull lesions can be congenital, traumatic, vascular, inflammatory, infectious, or malignant. These lesions can be clinically palpable or incidentally detected on imaging. The incidentally detected lesions include parietal foramina, sinus pericranii, and venous lakes. The palpable abnormalities can be present at birth, such as cephalohematoma, birth trauma, meningocele/encephalocele, venous malformation, and dermoid/epidermoid cysts. Thalassemia, intraosseous hemangioma, osteoma, lipoma, Langerhans Cell Histiocytosis (LCH), Fibrous dysplasia, Neuroblastoma metastases, Ewing's sarcoma usually present later in life. Most of these lesions are visible on skull radiographs. Further evaluation is performed by ultrasound, computed tomography (CT), and Magnetic Resonance Imaging (MRI). Cephalohematoma and Parietal foramina are identified on ultrasound and radiographs respectively. Dermoid /Epidermoid cysts are commonly seen in the midline, frontal and temporal regions. LCH is usually seen as a beveled edge skull lesion. Fibrous dysplasia presents as expansile lesions with a ground glass matrix seen on CT. Our exhibit will discuss various skull lesions seen in the pediatric age group, their imaging appearance, and a systematic approach to the correct diagnosis.

## **PDEE-19 Focused Thoracic Ultrasonography for the Elucidation of Radiolucent Areas in Pediatric Patient's Chest X-ray: Approach Based on Cases**



Moura Fe (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The main objectives of this exhibit are to: 1- Review the importance of thoracic ultrasonography in critical pediatric care and its potential benefits in reducing radiation exposure in neonates and infants. 2- Discuss various conditions that present as lucent lesions on chest X-rays and review sonographic findings of these conditions. 3- Emphasize the use of Focused Thoracic Ultrasound as a reliable tool in critical pediatric care and expand the use of bedside thoracic ultrasound helping physical examination.

### TABLE OF CONTENTS/OUTLINE

Introduction; Review of the use of thoracic ultrasonography; Case-based review of conditions that present as lucent lesions, with a challenging chest x-ray at the beginning of each case, followed by sonographic findings; Conditions included: Diaphragmatic hernia (Morgagni's and Bochdalek's hernia); Pneumothorax; Pneumomediastinum; Necrotizing pneumonia; Pulmonary cavitation/pneumatocele; Poland syndrome; Subcutaneous emphysema; Congenital deficiency of surfactant production; Congenital pulmonary airway malformation (CPAM)

### PDEE-2 Imaging Review of the Pediatric Spine: Do Abnormalities Always Indicate Disease?

Ana Carolina D. Augusto, MD, MSc (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The purpose of this study is: • To review the development of the spine, focusing on the formation and malformations of vertebrae. • To illustrate and discuss the normal appearance, anatomical variations, and common pathologies involving the spine during skeletal growth.

### TABLE OF CONTENTS/OUTLINE

- Embryology: The vertebral column and spinal cord develop in a precise, sequential manner during gestation. Any deviation from this normal process can cause structural variations in the spine and spinal cord.
- Congenital and acquired deformities of the vertebral bodies: defects related to fusion, formation, and segmentation of the vertebral bodies may lead to congenital scoliosis and could be linked with spinal dysraphisms, skeletal, cardiac, genitourinary, and gastrointestinal anomalies. Acquired deformities of the vertebral bodies can be caused by different factors, including trauma, infection, malignancies, systemic diseases, among others.
- Bone marrow: bone marrow conversion from red to yellow marrow follows a well-established pattern during childhood. Understanding the normal signal intensity changes on MRI is crucial to detect deviations that may represent disease.
- Normal developmental events, pitfalls, and common abnormalities during skeletal maturation: recognizing these developmental events and common abnormalities can assist in image interpretation, guiding treatment and management decisions.

### PDEE-20 Osteogenesis Imperfecta: A Pictorial Review

Adriano Silveira Moreira Novaes, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Osteogenesis imperfecta (OI) is a genetic disease characterized by increased bone fragility, low bone mass and other connective tissue manifestations. The most common cause of OI is mutations in one of the two genes encoding collagen type 1, which is a major component of bone and other connective tissues. OI can present with a wide range of symptoms, and there are now seven recognized types of the disorder. The radiologist must be prepared to recognize the image patterns, determining a correct diagnosis, which facilitates the early and adequate treatment of the patient. Excluding differential diagnoses, such as non-accidental injury, is of fundamental importance. The purpose of the present study is to exhibit imaging findings of types I, III, IV, V and VI of OI; to demonstrate how to differentiate the types based on imaging findings; to demonstrate how to differentiate OI from non-accidental injuries.

### TABLE OF CONTENTS/OUTLINE

Introduction. Epidemiology and clinical finds. Main findings of type I, II, III, IV, V and VI. How to differentiate the types based on imaging findings. Excluding differential diagnoses, such as non-accidental injury, is of fundamental importance. Conclusion/Take home message.

### PDEE-21 Pediatric Renovascular Hypertension A-Z: Diagnostic Work-up, Imaging, Interventions, and Troubleshooting

Anthony T. Chong, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Renovascular hypertension (RVH) is caused by an upregulation of the renin-angiotensin-aldosterone system due to flow-limiting renovascular disease (RVD). In pediatric patients, the differential includes fibromuscular dysplasia, neurofibromatosis,

vasculitis, abnormal arterial supply and trauma.2. Although ultrasound is the initial imaging modality for diagnosing RVD, it is limited in evaluation of segmental branches. Angiography is the gold standard for diagnosis.3. Interventional radiology can offer a variety of interventions for RVD, including angioplasty and embolization. Surgical interventions can be offered in angioplasty-refractory stenosis.4. A multidisciplinary care team consisting of nephrologists, diagnostic and interventional radiologists, and transplant and vascular surgeons is necessary for the global care of young patients with RVH.

#### **TABLE OF CONTENTS/OUTLINE**

1. Differential diagnosis, diagnostic work-up and medical management for pediatric RVH2. Multi-modality approach to the imaging diagnosis for pediatric RVD including: renal artery Doppler ultrasound, contrast-enhanced ultrasound, computed tomography angiography, magnetic resonance angiography, and catheter angiography3. Endovascular renal artery interventions and technique for RVH management4. Indications for surgical intervention5. Surveillance and follow-up; troubleshooting for persistent hypertension

#### **PDEE-22 Radiogenomics of PIK3CA Related Disorders: A New Era**

Jada Hislop, BA (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Vascular anomalies are traditionally classified based on clinical characteristics, imaging and pathology. Diagnosis is challenging due to overlapping phenotype and inconsistent naming conventions. With the rapid development of new technologies in oncology, radiogenomics has emerged as a science which is beginning to change our understanding and treatment of vascular anomalies as well. Advances aid in clarifying etiology and elucidate previously unknown pathomechanisms. Through sequencing of tissue samples, postzygotic somatic variants have been discovered for several vascular anomalies with and without overgrowth as is the case with PIK3CA. PIK3CA driven vascular anomalies may now be treated with mTOR inhibitors and newly approved PIK3CA inhibitors. This exhibit will be a case-based approach to review recent advances in diagnosis including imaging finds, genetic testing, and review management of these disorders. Review the clinical spectrum of disorders associated with pathogenic variants in PIK3CA gene - from isolated vascular malformations to recognizable disorders. Highlight the manifestations of some PIK3CA-related disorders presenting with overgrowth (PROS). Review MRI imaging findings and pathology in patients with confirmed variants in PIK3CA. Discuss the evolving nature of genetic testing in somatic disorders and suitable tissue samples for testing. Briefly discuss therapeutic options including new medical managements

#### **TABLE OF CONTENTS/OUTLINE**

Introduction to PROSPIK3CA Genetic Pathway  
Selected examples and isolated vascular anomalies and overgrowth disorders  
Diagnostic approaches with imaging  
Diagnostic approaches with genetic  
Therapeutic approaches  
Conclusion

#### **PDEE-23 The Top 10 Most Feared Diagnostic Errors by Radiology Trainees in Pediatric Neuroradiology Emergencies: Practical Tips and Tricks for Early Detection and Prevention**

#### **Awards**

#### **Certificate of Merit**

Agustin M. Cardenas, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Recognize the key imaging findings of the "top 10" Pediatric Neuroradiology Emergencies considered most challenging by Radiology trainees.2. Identify the most feared potential errors and pitfalls made by Radiology trainees when interpreting these type of cases.3. Learn potential contributing factors to developing these errors.4. Provide practical tips and tricks to help prevent these potential errors. Provide specific strategies to apply them, in order to improve diagnostic confidence of Radiology trainees in clinical practice.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction  
II. Top 10 challenging Pediatric Neuroradiology cases during call  
1. Detection of early cerebral edema. 2. Detection of dural sinus thrombosis in noncontrast head CT. 3. Retropharyngeal edema vs early abscess.4. Detection of early shunt failure. 5. Craniocervical junction fracture vs normal developing ossification center.6. Calvarial fracture vs suture. 7. Branchial cleft cyst vs retropharyngeal abscess. 8. Time estimation of heterogeneous subdural collections. 9. Porencephalic cyst vs ventriculomegaly 10. Detection of early orbital cellulitis.  
III. Take home points  
IV. References

#### **PDEE-24 The Role of Imaging in Radiotherapy Planning: An Illustrated Review of Common Pediatric Tumors Treated with Radiotherapy**

Susan C. Gowdy, FRCPC, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review some of the more common paediatric tumours treated with radiotherapy. Understand the role of imaging in the decision-making process regarding type of radiation therapy and mode of delivery. Consider how different imaging modalities

may be incorporated into planning a radiation therapy field. Evaluate the potential role of imaging surveillance following radiotherapy.

#### **TABLE OF CONTENTS/OUTLINE**

Successful management of pediatric malignancies requires a multidisciplinary team approach. This educational exhibit aims to highlight the importance of close collaboration between radiologists, nuclear medicine physicians and radiation oncologists when assessing tumours of childhood which can be treated with radiotherapy. Using case examples of a medulloblastoma, Hodgkin's lymphoma and neuroblastoma, we will present imaging to review radiological features at diagnosis, relevant staging systems and response criteria that are important considerations for radiation oncologists planning radiotherapy treatment. The role of the different imaging modalities including various MRI sequences will be illustrated as the process of planning a radiation therapy field is discussed. Potential treatment complications including current literature regarding the role of imaging in surveillance will be reviewed.

#### **PDEE-25 MRI Findings in Hypovitaminosis C: Separating Scurvy from the Crowd**

Sean J. Sun, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Symmetric metaphyseal edema involving the lower extremities is an uncommon finding. Causes include metabolic disorders, multifocal infection, autoimmune disorders, inherited diseases, and malignancy. Recognizing that bilateral lower extremity metaphyseal edema is a consistent finding in hypovitaminosis C can lead to early diagnosis and avoidance of further unnecessary testing and procedures. 2. Differential diagnoses for symmetric metaphyseal edema include focal periphyseal edema zones, chronic noninfectious osteitis, malignancy, osteomyelitis, and sickle cell disease. 3. Although subperiosteal hemorrhage can be seen with other etiologies such as bone infarct from sickle cell disease it can be a specific finding in hypovitaminosis C. 4. Since the diagnosis of hypovitaminosis C may not be initially considered, recognition of the imaging findings is important for early diagnosis. This allows for timely treatment and avoidance of further testing. 5. Scurvy has several clinical and laboratory findings that overlap with more common pathologies. a. Clinical: (Early) Gingival hyperplasia, joint swelling and bruising. (Late) Fever, jaundice, hemolysis, spontaneous bleeding and neuropathy. b. Laboratory: Mild leukocytosis. Elevated ESR and CRP.

#### **TABLE OF CONTENTS/OUTLINE**

1. Case series of 4 patients with hypovitaminosis C. a. History b. Clinical presentation c. Laboratory values d. Imaging 2. Review of the differential diagnosis of symmetric metaphyseal edema a. Imaging features that can be specific for hypovitaminosis C. b. Imaging findings suggestive of an alternative diagnosis. c. Nonspecific clinical findings of hypovitaminosis C.

#### **PDEE-26 Pediatric Rhabdomyosarcoma: Imaging Evaluation from Diagnosis to Treatment Monitoring**

Dana Alkhulaifat, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Rhabdomyosarcomas (RMS) are the most common type of soft tissue sarcomas in children. Risk factors include cancer predisposition syndromes such as Li-Fraumeni, Noonan and Beckwith-Wiedemann.
- Prognosis depends on several factors including location of the tumor, size, histopathology, genetics and imaging findings.
- The most optimal imaging modality for measuring local tumor involvement is cross sectional imaging by CT or MRI.
- For regional lymph node and metastatic assessment, whole-body fluorodeoxyglucose (FDG) PET/CT or PET/MRI in combination with chest CT is recommended.
- Treatment is multimodal and consists of multi-agent chemotherapy, along with surgical resection and radiotherapy of the primary tumor.
- MRI is the recommended modality for monitoring chemotherapy response for primary tumor, while FDG PET/CT or PET/MRI in combination with chest CT is recommended for lymph nodal and metastatic disease.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief overview of pediatric rhabdomyosarcomas: epidemiology, risk factors and clinical presentation. 2. Initial tumor assessment: a. Primary tumor b. Regional lymph nodes c. Metastatic lesions 3. Stratification of severity a. Tumor location b. Histological subtype c. Cytogenetic information d. Imaging staging (CT, MRI and PET) 4. Treatment regimens and response monitoring a. Imaging modalities b. Frequency of monitoring c. Definitions of remission or progression.

#### **PDEE-27 Central Nervous System Involvement in Mucopolysaccharidoses: Understanding Pathophysiology and Radiological Findings**

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To understand the basic pathophysiology that directly or indirectly affects the central nervous system, including bone instability. To be able to recognize the main radiological findings of the different subtypes of this disease. To inform about new imaging diagnostic strategies such as spectroscopy.

## TABLE OF CONTENTS/OUTLINE

1. Introduction: Definition and general characteristics  
2. Clinical presentation in the central nervous system. I: Alpha-L-iduronidase - Hurler (I H): mental retardation, dysostosis -Scheie (I S): normal intelligence - Hurler-Scheie (I H-S): Intermediate between both above II: Iduronate sulphatase -Hunter: dysostosis III: Profound mental deterioration -Sanfilippo A: Heparan sulphamidase -Sanfilippo B: N-acetyl-glucosaminidase -Sanfilippo C: Acetyl-CoA: alpha-glucosaminide acetyltransferase -Sanfilippo D: N-acetylglucosamine 6-sulphatase IV: Galactose-6-sulphate sulphatase, Beta-galactosidase: Dysostosis, motor dysfunction -Morquio A -Morquio B VI: N-acetylgalactosamine-4-sulphatase -Maroteaux-Lamy: dysostosis, kyphosis VII: Beta-glucuronidase -Sly: dysostosis  
3. Diagnostic methods. Imaging findings and protocols.  
4. Treatment options for mucopolysaccharidoses.  
5. Future directions in imaging of mucopolysaccharidoses -Spectroscopy: diagnosis and future applications  
7. Case series

### **PDEE-28 Easy-peasy! Simplifying the Myelination Progress in Term Newborn**

Marcella N. Brandao, MD, MEd (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review the normal myelination process in term newborn, as well as its progression. Tips for standardizing the evaluation of the myelination process. Guide step by step the myelination milestones, the main differential diagnoses and the disturbances in the myelination process that must be recognized.

## TABLE OF CONTENTS/OUTLINE

Infant brain magnetic resonance imaging (MRI) interpretation presents unique challenges due to different appearances depending on age. This occurs through the myelination process which, despite starting in utero, has acceleration and predictability between individuals in the first postnatal year, with a predetermined scheme of chronological and topographical sequences, serving as an important normal brain maturation marker on MRI. Myelination occurs by a gradual myelin sheath dehydration, at the same time that lipids and proteins are deposited. This process is dynamic and the molecular interactions of water with lipids and myelin membrane proteins are modified and affect the relaxation time in the T1W and T2W sequences. T1W weighted images are most useful up to 8 months old with the myelinated white matter showing hypersignal, and T2W weighted images are useful in the later stages of myelination, showing hyposignal in the face of reduced myelin water content. Although predictable, the evaluation of myelination on MRI is still a challenge for many radiologists, so the authors structure a step-by-step guide with the myelination milestones, the main differential diagnoses and the disturbances in the myelination process that must be recognized.

### **PDEE-29 Anatomic Approach to Non-Traumatic Lesions of the Pediatric Visual Pathway**

Vivek B. Pai, MBBS, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Most of the visual pathway is inaccessible for histopathology; radiology is the only diagnostic modality available. Hence accuracy is of utmost importance for adequate management and optimal outcome  
2. Having an anatomic approach will help narrow differentials.

## TABLE OF CONTENTS/OUTLINE

A. Discussion on the anatomy of the visual pathway. B. Pictorial essay on lesions affecting the visual pathway with discussion on etiopathogenesis and presentation. Lesions are divided according to the anatomic location:  
1. Retina: Retinal Detachment, Retinal hemorrhage, Panophthalmitis, Medulloepithelioma, Retinoma, Retinoblastoma.  
2. Optic disc: Papilledema and IIH, Optic Drusen, Coloboma, CHARGE syndrome, Morning Glory syndrome  
3. Optic nerve: Anophthalmia-related aplasia, hypoplasia, demyelinating disorders, mitochondrial disorders, visual pathway gliomas  
4. Optic chiasm: Septo-optic dysplasia, Krabbe disease, Opto-Chiasmatic tuberculosis, hypothalamic-chiasmatic glioma.  
5. Occipital lobes: Adrenoleukodystrophy, hypoxic-ischemic encephalopathy, hypoglycemic encephalopathy, PCA territory infarction, Posterior Reversible Encephalopathy Syndrome, occipital cephalocele, focal cortical dysplasia

### **PDEE-3 US Evaluation of the Pediatric Hand Trauma: From One Through Five**

Emilio Inarejos Clemente, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

After reviewing this exhibit, the learner should be able to:  
1. Recognize the normal US appearance of the pediatric hand.  
2. Describe the use of high-resolution US, Doppler US and microvascular imaging for the evaluation of trauma-related conditions of the hand in children.  
3. Review the most common traumatic conditions affecting the hand in children.  
4. Discuss the US findings of the most frequent traumatic entities occurring in hand and wrist.

## TABLE OF CONTENTS/OUTLINE

1. Introduction.2. Transducers and technical US parameters to optimize the examination of the hand.3. Normal US appearance of the pediatric hand, including tendons, ligaments, vessels, and nerves.4. Authors will focus on five compartments (from one through five):4.1. Ligaments4.2. Tendons4.3. Vessels4.4. Nerves4.5. Bone5. Ligament injuries: Collateral ligaments (Stener lesion), pulley lesions, volar plate lesions.6. Tendon injuries: Superficial and profundus flexor tendon lacerations and transections, extensor tendon injuries, impingements, tenosynovitis.7. Vessels: Venous/arterial thrombosis, post-traumatic pseudoaneurysm8. Nerves: Laceration and transection, post-traumatic neuroma9. Bone: Fractures, callus formation with secondary impingement10. Foreign bodies characterization and removal with US guidance11. Injuries will be correlated with anatomical draws, as well as with MRI images.12. Summary

## PDEE-30 Diagnostic Error in Pediatric Neuroradiology

### Awards

#### Certificate of Merit

Buffy F. Dekmar, MD, MEd (*Presenter*) Nothing to Disclose

### TEACHING POINTS

(1) Medical error has significant impacts on patient outcomes and society as a whole. (2) Error in diagnostic radiology can be organized in terms of types of thinking. (3) Metacognition, self-awareness, and understanding of specific strategies related to types of error can help radiologists reduce error. (4) Case-specific teaching to reduce error in pediatric emergency neuroradiology.

## TABLE OF CONTENTS/OUTLINE

For each error type there will be: A pediatric neuroimaging case, a definition of error type, lessons learned, and known strategies to prevent this error. (1) Perceptive Error; (2) Cognitive Error: a) Anchoring bias, b) Confirmation bias, c) Availability bias, d) Satisfaction of report, e) Framing bias, f) Attribution bias, g) Satisfaction of search, h) Premature closure, i) Inattentive bias, k) Hindsight bias; (3) Communication Error; (4) Process Error

## PDEE-32 Polymorphous Low Grade Neuroepithelial Tumor of the Young: An Institutional Case Series with Radiological and Pathological Correlation

Thomas P. Reith, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Polymorphous low grade neuroepithelial tumor of the young (PLNTY) is a rare, epileptogenic brain tumor that was recently described as a distinct entity in the 2021 World Health Organization classification of CNS tumors. Teaching points include: 1) PLNTY usually occurs in children and adolescents, although is occasionally diagnosed in adults. Clinically, patients often present with refractory seizures. 2) Histological characteristics of PLNTY include an infiltrative growth pattern, intense CD34 expression, cellular components resembling oligodendroglioma, and calcifications. 3) Imaging characteristics of PLNTY include T1 hypo/iso-intensity, T2 hyperintensity, GRE blooming artifact, non- (or slight) enhancement on contrast imaging, cystic components, and internal calcifications. Morphologically, PLNTY is often well-circumscribed and located in the temporal lobe. 4) At a molecular level, PLNTY is characterized by the presence of either a BRAF V600E mutation or chromosomal translocations involving FGFR2 and FGFR3. Both genetic alterations activate the MAP kinase pathway. 5) Imaging differential diagnoses include other low grade cortically based tumors such as oligodendroglioma (usually found in adults), dysembryoplastic neuroepithelial tumor (DNET), ganglioglioma, pleomorphic xanthoastrocytoma, and pilocytic astrocytoma. 6) Surgical resection is usually curative of seizures.

## TABLE OF CONTENTS/OUTLINE

-Introduction, PLNTY's place in the WHO 2021 Classification of CNS tumors -Imaging characteristics of PLNTY -Histological characteristics of PLNTY -Discussion of pathophysiology and molecular subtypes -Imaging comparisons of differential diagnoses

## PDEE-33 Inside the Womb: A Fascinating Look at Congenital Kidney Pathology through Fetal MRI

Lizbet Perez-Marrero (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1) Fetal MRI has emerged as a valuable and high-resolution imaging modality for the comprehensive assessment of fetal renal anomalies.2) By utilizing a systematic review approach, radiologists can effectively characterize the fetal kidneys, providing a comprehensive understanding of the extent and severity of the anomalies.3) Incorporating functional kidney assessments and measuring total lung volume during fetal MRI can enhance the overall evaluation of the fetus, providing a better understanding of the patient's condition and enabling more informed parental counseling.

## TABLE OF CONTENTS/OUTLINE

When evaluating the kidneys, the following topics should be assessed, as combined alterations may be found associated with different pathologies:- position: situs solitus versus ectopia.- morphology: duplex, horseshoe.- size: duplex, autosomal recessive polycystic kidney disease (ARPKD)/ autosomal dominant polycystic kidney disease (ADPKD).- focal lesions: cysts, tumors.- excretory system: posterior urethral valves.- renal function: hypofunctioning - related systems: amniotic fluid, assessment of lung volume (hypoplasia cutoff value?), uterus/annexa.

## PDEE-34 Neonatal Liver Imaging: Techniques, Normal Variations and Common Pathologies

### Awards

#### Certificate of Merit

Govind B. Chavhan, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Neonatal liver has some unique aspects in terms of imaging and imaging appearances as compared to older children. Choosing and tailoring of imaging for each indication in neonate is therefore important for optimal care with minimal invasiveness. Common indications for imaging include incidental focal lesions, neonatal liver failure, cholestasis and sepsis. Imaging is important component of work up in neonatal liver failure helping to narrow differentials. It may help to salvage liver and potential transplant by timely diagnosis of conditions such as neonatal hemochromatosis.

## TABLE OF CONTENTS/OUTLINE

Introduction (overview of neonatal liver pathology, incidence, etc.; role of imaging) Imaging modalities- (discussion of specific roles, pros/cons, with relevant summary tables) What changes and what is normal at birth? (discussion of normal imaging appearance of structures related to neonatal liver) Indications for imaging (Incidental lesions, liver failure/dysfunction, cholestasis, sepsis, etc) Common pathologies (work up and role of imaging in the work up) - Congenital calcifications (causes, natural course, imaging) - Line related complications (hematoma, abscess) - Infections (TORCH, herpes, bacterial) - Neoplastic lesions (common lesions- hemangioma/HB/mesenchymal hamartoma /mets) - Vascular abnormalities (thrombosis, portosystemic shunts, AVMs, Heterotaxy) - Neonatal liver failure- causes, workup and role of imaging (NH, HLH, metabolic diseases, infection, cholestatic diseases)Summary

## PDEE-35 Pediatric Neck Cystic Lesions

Juan F. Velez, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Cystic lesions are common findings in pediatric patients. Imaging plays a crucial role guiding the diagnosis and depicting the anatomical extent of the lesion. Multimodality imaging narrows the differential diagnosis by demonstrating the lesion's components. Age groups and anatomic location in the neck are also diagnostic clues. It is important to recognize potential complications, especially infections.

## TABLE OF CONTENTS/OUTLINE

o Congenital and Developmental Disorders § Thyroglossal duct cyst § Branchial cleft anomalies § Dermoid/Epidermoid cyst § Thymopharyngeal duct cyst o Vascular § Lymphatic malformations § Venous malformations § Cervical hemangioma § Pseudoaneurysms § Internal jugular phlebectasia o Infectious § Suppurative lymphadenitis § Tuberculous lymphadenitis § Abscess o Neoplastic § Schwannoma § Warthin tumor § Congenital cervical teratoma § Cervical lymph node metastases o Miscellaneous § Ranula § Thyroid colloid cyst § Laryngeal cyst

## PDEE-36 Imaging of DDH: An Update on Diagnostic, Follow-up and Post-operative Findings

Murilo Campos Silva, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The purpose of this exhibit is:To review the anatomy of the infant hip. To discuss the incidence, risk factors and pathophysiology of Developmental Dysplasia of the Hip. To review the clinical and imaging diagnostic criteria for DDH. To discuss the role of each imaging method in the context of DDH. To demonstrate the importance of early diagnosis and proper treatment of DDH with successful cases and adequate treatment, as well as late diagnosis and its complications.

## TABLE OF CONTENTS/OUTLINE

Theoretical introduction containing epidemiology, risk factors and pathophysiology. Anatomy of the infant hip, including bone structures and the most relevant anatomic landmarks in DDH's diagnosis and follow-up. Images of clinical cases demonstrating some of the long-term complications, with emphasis on the importance of early diagnosis and proper treatment to avoid them. Brief discussion and illustration of the main current treatments as well as imaging follow-up evaluation with expected and unfavorable outcomes. Latest updates on diagnosis and treatment of DDH.



## **PDEE-37 Imaging Appearance of Common and Less Common Fetal Masses from Head to Toe**

### **Awards**

#### **Magna Cum Laude**

Elizabeth J. Snyder, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) Masses detected prenatally range from congenital malformations to tumors; knowledge of the imaging appearance of common and uncommon fetal masses is important for appropriate pregnancy management, delivery planning and immediate postnatal management-2) Both US and fetal MRI play important and complementary roles in the evaluation of fetal masses.3) Using an anatomic approach to fetal masses, the differential diagnosis can be narrowed, allowing for more accurate prenatal counseling and management.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: a. Epidemiology of fetal masses, b. Overview of categories of fetal masses: congenital malformations, benign tumors, malignant tumors2. Imaging approach to fetal masses: a. Prenatal ultrasound, including 3-D ultrasound b. Role of fetal MRI3. Anatomic approach to the prenatal diagnosis of fetal masses: a. Head neck: teratoma, lymphatic malformations, etc. b. Chest: congenital lung lesions, mediastinal teratoma, congenital myofibroblastic tumor, cardiac rhabdomyoma, etc. c. Abdomen/pelvis: hepatic congenital hemangiomas, neuroblastoma, congenital mesoblastic nephroma, sacrococcygeal teratoma, ovarian cyst, etc. d. Extremities: infantile fibrosarcoma, etc.4. Conclusion

## **PDEE-38 Detection of Aspirated Food in Pediatric Airway using Computed Tomography (CT)**

Joseph R. Swicklik, RT, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

•Explain clinical significance challenges detecting aspirated food in pediatric airway.•Describe challenges solutions for CT imaging.•Explain method for optimal imaging of radiopaque food matter.•Illustrate benefits of CT in detecting aspirated food particles in clinical applications.

### **TABLE OF CONTENTS/OUTLINE**

1. Foreign body aspiration in pediatric airways a. Common issue in pediatric patients b. The most common type of foreign bodies aspirated is food c. Challenges with plain film radiography in visualizing food due to low contrast 2. How computed tomography can be used to achieve improved visualization of aspirated food particles in the pediatric airway a. CT offers thin slice axial images without superimposition of anatomy b. Multiplanar reformats offer views from multiple angles to better detect food stuck in the airway 3. Challenges of CT imaging and solutions a. CT has a longer exposure time which increases the chance of motion b. Flash scanning to reduce scan time c. Determining the best scanning factors to best visualize radio-translucent food 4. Phantom studies a. Food items commonly aspired in peds seen in the ED b. Tubes representing realistic sizes of airways in children c. Tubes filled with food items placed inside anthropomorphic chest phantoms representing pediatric patients of different ages d. Optimal scanning, reconstruction, and display techniques to visualize food items e. CT number look-up table of commonly aspirated foods 5. Clinical examples and applications a. Gummy bear detected in airway b. Thoracic c. Pediatrics d. Adults at high risk for aspiration

## **PDEE-39 Spectrum of Pediatric Distal Bowel Pathology Imaging from Prenatal Period to Adolescence**

### **Awards**

#### **Cum Laude**

Hajer Jarraya (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. The differential diagnosis of neonatal colonic obstruction includes Hirschsprung's disease, colonic atresia, congenital segmental dilation of the colon, NEC, anorectal malformation, and meconium plug syndrome. 2. The differential diagnosis of colonic obstruction in infants and children includes incarcerated intestinal hernia, sigmoid, cecal and transverse volvulus, intussusception, and rectal obstruction related to abdominopelvic masses or cysts. 3. The differential diagnosis of colonic wall thickening in older children includes infectious colitis, typhlitis, inflammatory (Crohn's or ulcerative colitis), vasculitis, ischemia, and neoplasm. 4. The differential diagnosis of colonic pathology can be classified based on age at presentation and primary imaging features (wall thickening, dilation/obstruction, transition point).

### **TABLE OF CONTENTS/OUTLINE**

1.Epidemiology and classification of colonic pathology, 2.Imaging Findings A) Colonic pathology in the prenatal period B) Colonic obstruction in neonates, infants, children and adolescents C) Colonic wall thickening: infectious, inflammatory and neoplastic 3.Differential diagnosis 4.Algorithm of differential diagnosis based on age and primary imaging features

## **PDEE-4 Lymphoscintigraphy: A Pictorial Review with Focus on Pediatric Patients**

### **Awards**

#### **Certificate of Merit**

Valentina Ferrer Valencia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Classification of lymphedema and lymphatic dysplasias via illustrative mixed-modality case-examples 2. Sentinel node mapping in pediatric patients 3. Important pitfalls of the technical and interpretive aspects of lymphoscintigraphy

#### **TABLE OF CONTENTS/OUTLINE**

Introduction: Lymphoscintigraphy is a minimally invasive imaging technique that uses radiolabeled colloidal particles to evaluate lymphatic function Technique: 1. Radiopharmaceuticals 2. Administered activity/radiation dose 3. Imaging Protocols Indications for Lymphoscintigraphy: 1. Primary Lymphedema including Lymphatic Dysplasia 2. Secondary Lymphedema 3. Chylous Leaks 4. Sentinel Lymph Node Mapping Imaging Findings with Illustrative Case Discussions: 1. Lymphedema 2. Absent Visualization of Regional Lymph Nodes 3. Delayed or Asymmetric lymphatic Transit 4. Collateral Lymphatic Channels 5. Dermal Backflow 6. Chylous Effusion or Ascites 7. Sentinel Lymph Node Visualization Pitfalls Summary: Lymphoscintigraphy plays a unique role in evaluation disorders of lymphatic development, acquired lymphatic disorders, and assessment of chylous fluid collections. Familiarity with normal patterns of lymphatic transit, abnormal lymphatic transit, and common pitfalls are crucial for radiologists performing and interpreting these examinations.

## **PDEE-40 Imaging of Congenital Hearing Loss: A Practical Approach**

Rafael Maffei Loureiro, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review important anatomic landmarks in the pediatric temporal bone. 2. To discuss the imaging technique and protocols for the evaluation of congenital hearing loss. 3. To present a practical guide to facilitate comprehension of radiologic findings and the role of imaging in the evaluation of congenital hearing loss.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Principles of the basic workout investigation- Screening for hearing loss in newborns- Functional evaluation: quick review of audiometric studies for radiologists Temporal Bone Anatomy Classification of congenital hearing loss- by severity: slight, mild, moderate, severe and profound- by type: conductive, sensorineural, mixed- by causes: genetic (syndromic and non-syndromic); environmental; congenital lesions and malformations Imaging studies: CT and MRI of the temporal bone- imaging protocol and special considerations for congenital hearing loss evaluation Instructive cases by causes and main imaging features A step-by-step guide to diagnose congenital malformations Principles of imaging evaluation for guiding treatment Take home messages

## **PDEE-41 Systematic Approach to Congenital Brain Tumor**

Felipe Scortegagna SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are to:- Describe through illustrative cases the classification and imaging patterns of neonatal brain and spine tumors.- Correlate imaging with molecular and genetic alterations.- Present comprehensive imaging protocols.- Highlight important differential diagnoses to consider.

#### **TABLE OF CONTENTS/OUTLINE**

- Definition of congenital tumors.- Classification of congenital CNS tumors- Based on location, age and updated WHO Classification 2021.- Overview of common predisposing genetic syndromes.- Recommended fetal and neonatal imaging protocols.- Typical imaging features of each tumor type.- Teratoma Astrocytic tumors.- Neuronal and mixed neuronal-glioma tumors.- Choroid plexus papilloma.- Embryonal tumor Craniopharyngioma.- Ependymoma.- Important tumor mimics to consider.- Hemorrhage.- Vascular malformations.- Infections.- Hamartomas.- Cortical malformations.- Treatment challenges and developments.- Diagnostic algorithm.- Final remarks.

## **PDEE-42 Bridging the Gap Between the Symptoms to Radiology Beyond the Anatomy of Temporal Bones in Pediatrics and Young Adults**

Nahyun Jo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The ear is a highly specialized organ in a tightly packed space. Trainees are used to the classification of temporal bone pathology with respect to their anatomical locations; inner, middle, and outer ear. Although anatomical search patterns allow



a thorough evaluation of complex ear structures, understanding symptomatologic categorization not only aids in an active search for differential diagnosis but also broadens the understanding of the pathophysiology and management.

#### **TABLE OF CONTENTS/OUTLINE**

The introduction is a basic review of temporal bone anatomy and commonly used modality. The second section, "Bridging the gap," discusses a quick guide to understanding relevant clinical information, such as audiometry or otoscopy. In the third section, "Symptoms to radiology," each ear pathology is categorized by each clinical scenario. For each symptom and appropriate pathology, key points to report or "what surgeons want to know" are detailed. The symptoms are divided into otalgia, hearing loss, tinnitus, and otorrhea. Otolgia is subdivided into the acute and chronic onset of symptoms. Hearing loss is subdivided into conductive hearing loss and sensory hearing loss. Both conductive and sensory hearing loss has congenital, infectious/inflammatory, tumor, trauma, and miscellaneous etiologies. Tinnitus has vascular, tumor, and various etiologies. Otorrhea may occur with otalgia due to infection, but CSF otorrhea is discussed separately as it can be the sole reason for the exam without other overlapping symptoms.

#### **PDEE-43 Palpable Head and Neck Lumps in Pediatrics: Tips and Tricks in Ultrasound**

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To illustrate the ultrasound appearance of the most frequent pediatric head and neck palpable lumps, acknowledge the imaging hallmarks of each condition, and correlate with other imaging tools. To Highlight the warning signs on ultrasound, recognize when additional testing is necessary and discuss subsequent management.

#### **TABLE OF CONTENTS/OUTLINE**

The presence of palpable lumps of the head and neck is a frequent complaint in children, including a broad spectrum of infectious, tumoral conditions, embryologic remnants, and vascular malformations, with the large majority proven benign. The radiologist must recognize the warning signs that allow early management of those with potential malignancy or those leading to space compromise over vascular and respiratory structures, including onset during the neonatal period, firm consistency, rapid growth, or location underneath the fascia. Ultrasound has arisen as the first-line imaging modality for initial evaluation. It represents a fast and safe technique, which can provide essential information for the characterization of the lesion, acting as a guide in diagnostic and therapeutic procedures. This ultrasound approach guides subsequent decision-making, including follow-up, complementary testing, or treatment through interventional drainage or surgical excision. Further investigation with cross-sectional imaging is warranted if the characteristics of the mass are beyond the scope of ultrasound or if malignancy is suspected. We provide a pictorial review of illustrative cases from our institution to help identify the key imaging findings and emphasize the role of ultrasound in the diagnosis and interventional treatment of pediatric lumps.

#### **PDEE-44 Atlas of Secondary Ossification Centers, Physeal Variations, and Cortical "Buckles" in the Pediatric Skeleton: Radiographic and MRI Correlation of Normal and Abnormal Findings.**

Jade Iwasaka-Neder, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Systematically illustrate the variable radiographic appearances of secondary ossification centers and physes at different stages of skeletal development
- Compare and contrast MRI appearances of normal versus abnormal growth centers to highlight their differences and improve their diagnosis
- Elucidate normal and abnormal areas of cortical buckling in children
- Illustrative examples of pathologic mimickers

#### **TABLE OF CONTENTS/OUTLINE**

o Secondary ossification centers on radiography and MRI: imaging characteristics, expected time of appearance, and locational differences.

- Sternum (Manubrium; Sternebrae; Xiphisternum; Unfused sternbrae sternal foramen)
- Scapula (Coracoid centers; Acromion centers)
- Upper limb (Greater humeral tuberosity; Lesser humeral tuberosity; Elbow mnemonics: CRITOE and CRITOL; Carpal bones)
- Pelvis (Iliac spines; Ischial tuberosity; Acetabular rim)
- Lower limb (Distal femoral condyles; Tibial tubercle; Medial and lateral malleoli; Patella; Calcaneus)

o Cortical buckles and nutrient canals. Do they belong here? (Tibia; Fibula; Femur; Clavicle; Tarsal bones; Metacarpals and phalanges; Metatarsals)

o Physeal variations (Distal fibula; Distal tibia; Proximal humerus; Distal radius; Distal ulna; Different types of normal physes)

o Normal versus Fracture (Case review)

#### **PDEE-45 Childhood Constipation: How Imaging Evaluation Can Help**

#### **Awards**

#### **Certificate of Merit**

Livia Alves (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Constipation in the pediatric population is a prevalent diagnosis worldwide. Frequent imaging examinations are required to investigate the diagnosis, and generally to differentiate the functional etiology and its degrees from an organic cause. Therefore, the radiologist must know the particularities of each imaging method, know how to indicate the ideal exam in the face of clinical suspicion, and interpret the most diverse findings to arrive at the final diagnosis. This presentation aims to: (1) point out the main imaging tests that can be used in the diagnosis of constipation in pediatric patients, detail their characteristics and help in choosing the method in the face of clinical suspicion. (2) review the imaging findings in cases of functional and organic constipation, highlighting the main related pathologies: Hirschsprung's disease, visceral myopathy and chronic intestinal pseudo-obstruction. (3) debate the imaging findings of the most frequent complications.

## TABLE OF CONTENTS/OUTLINE

Imaging methods used in the diagnosis of constipation, its characteristics, and main indications in the face of clinical suspicion include abdominal radiography, barium enema and colonic transit, computed tomography, magnetic resonance imaging and ultrasound. Case-based review of the functional and organic etiology of constipation (Hirschsprung's disease, visceral myopathy, chronic intestinal pseudo-obstruction, intra-abdominal tumor and VACTERL association). Case-based review of complications (fecaloma, stercoral colitis, and perforation) and associated diseases (voiding dysfunction).

### **PDEE-46 The PRETEXT Staging System for Primary Liver Tumors in the Pediatric Population. A Cases-based Pictorial Review**

#### **Awards**

#### **Certificate of Merit**

Mariano Lorea (*Presenter*) Nothing to Disclose

## TEACHING POINTS

The PRE-Treatment EXTent of tumor (PRETEXT) system aims to standardize imaging evaluation and risk stratification of hepatoblastoma and hepatocellular carcinoma before implementation of any treatment. PRETEXT grades provide valuable information regarding prognosis and overall survival. Liver is divided into four sections: left lateral (LL), left medial (LM), right anterior (RA) and right posterior (RP). Liver tumors are separated in four groups (I-IV) based on the number of contiguous tumor-free liver sections. Higher groups are related to worst outcomes.

## TABLE OF CONTENTS/OUTLINE

Introduction What means PRETEXT? Prognosis implications Liver segmentation How to divide the liver? From Couinaud's segmentation to PRETEXT segments. PRETEXT groups Groups I to IV. Cases-based pictorial review. Imaging clues to precise PRETEXT group assignment. Additional PRETEXT criteria. Hepatic venous involvement (V and P) Extrahepatic disease (E) Multifocality (F) Tumor rupture (R) Caudate lobe involvement (C) Lymph nodes (N) and distant metastasis (M)

### **PDEE-47 Pediatric Primary Intracranial Sarcoma with Features of DICER1 Mutation: A Challenging Diagnosis**

Jossue V. Espinoza SR, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

TEACHING POINTS Pediatric primary intracranial sarcomas have an aggressive clinical course. The incidence of pediatric primary intracranial sarcoma with features of DICER1 mutation has been increasing. Imaging features of pediatric primary intracranial sarcomas with features of DICER1 mutation are not well documented. MRI and CT imaging play a crucial role in establishing a diagnosis. MRI plays a crucial role in follow up during treatment and evaluation for residual disease after surgery. Since there are several differential diagnoses, radio-pathologic correlation of these tumors is essential to confirm the diagnosis.

## TABLE OF CONTENTS/OUTLINE

The goals of this exhibit are to: Provide a pictorial review of the diverse imaging appearances of pediatric primary intracranial sarcoma with features of DICER1 mutation and differential diagnoses. Discuss specific imaging and pathological characteristics of pediatric primary intracranial sarcoma with features of DICER1 mutation and differential diagnoses. Familiarize the audience with the imaging of pediatric primary intracranial sarcoma with features of DICER1 mutation and emphasize the importance of radio-pathologic correlation. These entities include: • Pediatric Primary intracranial sarcomas with features of DICER1 mutation. • Potential pitfalls and differential diagnoses of these tumors including other mesenchymal non-meningothelial tumors of the central nervous system, cavernous malformation (cavernous angioma or cavernoma) and high-grade brain tumors in pediatric patients.

### **PDEE-48 The Lung and Winding Road - A Pictorial Essay on Cystic Lung Diseases in Pediatric Radiology**

Victor D. Nishimura, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

PNEUMATOCELE is a transient round and variable sized cyst, adjacent to consolidation or ground glass opacities. INTERSTITIAL LUNG EMPHYSEMA cystic or linear radiolucencies in the interstitium radiating from the hilum can be seen. CONGENITAL LUNG HYPERINFLATION increased lung volume and transparency can be seen. NEURENTERIC CYST is a fluid attenuating paravertebral lesion. BRONCHOGENIC CYST well circumscribed spherical or ovoid masses of variable attenuation can be seen. PULMONARY SEQUESTRATION multiple cystic lesions and anomalous artery nutrition can be seen. CYSTIC LYMPHANGIECTASY can be associated with syndromes, also congenital cardiac anomalies. CONGENITAL PULMONARY AIRWAY MALFORMATION usually presents as a solitary well defined thin walled cyst or multiple cysts of varying sizes. Multiple irregular shaped cysts are characteristic of LANGERHANS CELL HISTIOCYTOSIS. LYMPHANGIOLEIOMYOMATOSIS characterized by diffuse thin walled cysts surrounded by normal lung without regional sparing, accompanied by small centrilobular nodules.

## TABLE OF CONTENTS/OUTLINE

ACQUIRED PNEUMATOCELE INTERSTITIAL LUNG EMPHYSEMA CONGENITAL CONGENITAL LUNG HYPERINFLATION NEURENTERIC CYST BRONCHOGENIC CYST PULMONARY SEQUESTRATION CYSTIC LYMPHANGIECTASY CONGENITAL PULMONARY AIRWAY MALFORMATION NEOPLASTIC LANGERHANS CELL HISTIOCYTOSIS LYMPHANGIOLEIOMYOMATOSIS

### PDEE-49 Neonatal Subpial Hemorrhage: A Closer Look

Eman E. Marie, MD, MSc (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1- Understand the anatomy and physiology of the subpial space. 2- Describe causes of subpial hemorrhage in neonates. 3- Discuss the clinical presentation and the indications of imaging. 4- Identify the different imaging modalities used to identify and evaluate the subpial hemorrhage. 5- Discuss and exemplify the imaging features of subpial hemorrhage. 6- Classify the different types of subpial hemorrhage, comorbid conditions, and prognosis.

## TABLE OF CONTENTS/OUTLINE

1- Embryology and early development of brain meninges with a focus on the pia mater. 2- Anatomy (gross and microscopic) and physiology of the subpial space. 3- Incidence and potential risk factors linked to subpial hemorrhage in neonates. 4- Imaging of neonatal subpial hemorrhage: US, CT and MRI findings, standard protocols and special considerations during neonatal brain imaging 5- Diagnostic accuracy of each imaging modality and factors that may affect the accuracy of interpretation. 6- Pitfalls and differential diagnosis of subpial hemorrhage. 7- What the referring physician needs to know: diagnosis and extent of abnormalities. 8- Proposed imaging-based prognostication. 9- Neonatal subpial hemorrhage and abusive head trauma. 10- Management strategies of neonatal subpial hemorrhage and the role of imaging follow up. 11- Recent research and future directions on neonatal subpial hemorrhage.

### PDEE-50 Growing Pains: Navigating Pediatric Metabolic Bone Disorder

Ami Gokli, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

-Discuss with illustrative examples the anatomy and physiology of normal bone growth in the pediatric population- Review common pediatric metabolic bone diseases including the pathophysiology and characteristic imaging features associated with these diseases using a multimodality approach- Describe clinical management, necessary details to include in radiologic reports, and the importance of radiologists role in these diseases

## TABLE OF CONTENTS/OUTLINE

Overview:-Anatomy and physiology of pediatric bone growth/turnover including Identifying regions in the bone growth process particularly susceptible to disease Etiology:-Hereditary-Acquired (Nutritional deficiencies, Drug Treatments, etc) Pathology:-Diseases that can be discussed including discussion of pathophysiology with an image rich, multimodality approach; identify pathognomonic radiographic findings/tools that can aid in diagnosis Primary/Secondary osteoporosis, Osteogenesis imperfecta, Rickets, Skeletal dysplasias (Achondroplasia, cleidocranial dysplasia, achondroplasia), Albright hereditary osteodystrophy, (pseudohypoparathyroidism)/renal osteodystrophy, Fibrous dysplasia/McCune Albright syndrome, Juvenile Paget disease, Sclerosing bone disorders (osteoporosis, pyknodysostosis, osteopoikilosis, osteopathy striata, melorheostosis), Hypophosphatasia- Describe necessary details to include in radiologic reports Treatment/management:- Peds metabolic bone disorders require an extensive Team (endocrine, ortho, medical genetics, PM+R, physical/occupational therapy, pediatric radiology, nursing), detailed description of what is involved and the central role radiologists play Conclusion

### PDEE-51 Imaging Findings and Management Strategies to Liver Masses in Children with Underlying Predispositions: A Review from the ACR Pediatric LI-RADS Working Group

## Awards

Certificate of Merit

Amy B. Kolbe, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Review the imaging approach and differential diagnosis for liver masses in children with underlying genetic syndromes, congenital abnormalities, vascular abnormalities, and other conditions that predispose to liver lesions. 2. Illustrate the characteristic imaging findings of benign and malignant liver tumors in children with predisposing conditions. 3. Discuss the screening guidelines and management approach to liver masses encountered in the predisposed child.

### TABLE OF CONTENTS/OUTLINE

Spectrum of pediatric liver tumors and pseudotumors in: 1. Genetic syndromes: Beckwith Wiedemann syndrome, familial adenomatous polyposis, progressive familial intrahepatic cholestasis, tuberous sclerosis, cystic fibrosis, glycogen storage disease, tyrosinemia, Wilson disease, hereditary hemochromatosis 2. Congenital abnormalities: Biliary atresia, Alagille syndrome, Abernethy malformation 3. Miscellaneous: Metabolic syndrome, Fontan associated liver disease, Budd Chiari syndrome For each entity we will discuss the underlying pathogenesis of liver disease, types of liver masses described with the entity, characteristic imaging findings of each liver mass, surveillance strategies, and key findings that warrant further intervention

### PDEE-52 Fetal Magnetic Resonance Imaging Findings in Conjoined Twin Pregnancies

Julie E. Walcutt, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

The learner will understand how to differentiate the various conjoined twin variants by their fetal MRI appearance. The learner will understand which features of conjoined twin shared anatomy predict survival and the potential for separation and how fetal MRI can be used in this assessment. The learner will review fetal MRI examples of additional congenital anomalies within the context of conjoined twinning.

### TABLE OF CONTENTS/OUTLINE

Conjoined twins are a rare complication of monozygotic twinning. Fetal MRI can provide a detailed evaluation of these twins' shared anatomy and identify additional congenital anomalies, thereby allowing the fetal care team to anticipate the potential for survival and separation in these complex twin pairs. This exhibit will review the fetal MRI appearance of the different morphological variants of conjoined twins, including several unusual cases of minimally conjoined twins. Emphasis will be placed on those anatomical features most important for determining conjoined twin prognosis and potential for separation. Fetal MRI cases demonstrating additional important congenital anomalies within the context of conjoined twinning will be presented as part of a comprehensive fetal assessment.

### PDEE-53 Sonographic Evaluation of the Umbilical Region in Children

#### Awards

#### Cum Laude

Lizbet Perez-Marrero (*Presenter*) Nothing to Disclose

### TEACHING POINTS

o To describe the normal sonographic appearance of the umbilicus and the midline structures of the anterior abdominal wall. To recognize ultrasound findings of the most common lesions of the umbilicus, including anomalies of the embryonic remnants.

### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Ultrasound protocol of the umbilical region and anterior abdominal wall. 3. Normal anatomy of the umbilicus and midline anterior abdominal wall 4. Umbilical lesions a. Umbilical granuloma b. Omphalitis b. Epidermal cyst c. Cutaneous ciliated cyst d. Tumors (hemangioma) e. Keloid f. Polyp g. Cutaneous umbilicus h. Umbilical hernia i. Paraumbilical hernia j. Epigastric hernia 5. Embryonal anomalies a. Umbilical vessels i. Omphaloarteritis ii. Omphalophlebitis iii. Thrombosis of umbilical vein varix b. Urachus: i. Urachal cyst ii. Infected urachal cyst iii. Urachal diverticulum iv. Urachal sinus v. Urachal fistula c. Omphalomesenteric duct i. Vitelline cyst ii. Persistent vitelline vessel iii. Meckel diverticulum iv. Omphalomesenteric fistula v. Omphalomesenteric fibrotic cord 6. Conclusions

### PDEE-54 Malignant Rhabdoids and Related Pediatric Tumors: A Multimodality Imaging Review and Pathologic Correlation

Apeksha Chaturvedi, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Malignant rhabdoid tumors of childhood include malignant rhabdoid tumor of kidney (MRTK), extrarenal malignant rhabdoid (eMRT) and atypical rhabdoid-teratoid tumors (AT/RT); tumors are highly aggressive, carry a dismal prognosis and

may develop in utero 2. "Rhabdoid" morphology on histology- large polygonal cells with eosinophilic cytoplasm, vesicular nuclei and central prominent nucleolus 3. Underlying SMARCB1 mutations, a gene encoding a core subunit of the SWI/SNF chromatin-remodeling complex 4. Imaging appearances overlap with those of other entities, with certain imaging features aiding distinction; eg. cerebellopontine angle involvement and intratumoral hemorrhage favor AT/RT over medulloblastoma 5. Rhabdoid tumor predisposition syndrome (RTPS) is characterized by proband with rhabdoid tumor and/or family history of rhabdoid tumors and/or multiple SMARCB1- and/or SMARCB1 A4 deficient tumors (synchronous or metachronous) and a heterozygous germline variant in SMARCB1 or SMARCB1 A4; imaging surveillance guidelines have been proposed

#### **TABLE OF CONTENTS/OUTLINE**

1. Spectrum of malignant rhabdoid and related SMARCB1 deficient neoplasms of childhood 2. Updated WHO classification (2021) for malignant rhabdoids and related pediatric tumors 3. Underlying SMARCB1 deficiency and mechanisms by which it drives rhabdoid tumor growth 4. Multimodality imaging manifestations of malignant rhabdoid tumors, with emphasis on PET-CT and PET-MR 5. Role of ultrasound and whole-body MRI in surveillance in patients with RTPS 6. Pathologic correlation

#### **PDEE-55 A Trainee's Guide to Neonatal Abdominal Radiographs**

Isabelle D. Gauthier, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Abdominal radiographs are an important tool to diagnose and screen acute intra-abdominal pathologies in the neonatal population. 2. The widespread availability and portable nature of radiographs make it ideal for the bedside evaluation of unstable neonates. 3. Knowledge of pathologies and their appearance on abdominal radiographs are crucial for timely and accurate diagnoses of life-threatening conditions and to guide further imaging and management.

#### **TABLE OF CONTENTS/OUTLINE**

1. Technique and views to obtain neonatal abdominal radiographs: Assessment of quality, tips for mobile exams, and use of shielding (ie. gonadal shielding and update on recommendations). 2. Review of lines and tubes on abdominal radiographs in neonates (ie. Umbilical artery and vein catheters, PICC, NG tube and port location). 3. Review of normal findings (ie. Expected gas pattern based on hours of life). 4. Do-not-miss findings: Pneumoperitoneum, pneumatosis, portovenous gas, bowel obstruction, pneumomediastinum/pneumothorax in the lung bases. 5. Review of acute pathologies and findings on abdominal radiographs (abnormal patterns): Necrotizing enterocolitis, congenital causes of bowel obstructions (upper/lower) (ie. Malrotation/volvulus, duodenal/jejunal atresia, Hirschsprung's disease, imperforate anus), gasless abdomen

#### **PDEE-56 From Head to Tail: Exploring Applications of Pediatric Neurological Ultrasound**

Isabelle D. Gauthier, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Ultrasound for neurological pathologies is a useful adjunct to conventional imaging (CT/MRI) as a screening and diagnostic tool in pediatric patients due to its universal availability and low cost. 2. Lack of ionizing radiation and IV contrast, and incomplete pediatric bone ossification and unfused fontanelle make ultrasound an excellent modality for evaluation of neurological pathologies in young patients. 3. Optimal ultrasound technique and understanding of the relevant pathophysiology of pediatric neurological conditions that can be assessed with ultrasound can significantly improve timely access to screening, diagnosis and patient care.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brain ultrasound: Indication (ie. Premature screen, cooling therapy), Technique, Normal structures, variants and measurements (ie. ventricular index), Vascular assessment, Pathologies (ie. germinal matrix bleed, periventricular leukomalacia). 2. Transcranial doppler ultrasound: Indications (ie. Sick cell disease), Technique, Vessel anatomy, Normal measurements, Abnormal findings and clinical significance. 3. Cranial sutures ultrasound: Indications (ie. Abnormal skull shape), Technique, Cranial suture anatomy, Normal findings (ie. fontanelles, suture closure), Craniosynostosis and clinical significance. 4. Spine ultrasound: Indication (ie. sacral dimple, suspected spinal dysraphism), Technique, Normal findings and anatomy, Pathologies (ie. low conus, thickened filum, myelomeningocele, intraspinal collections, masses).

#### **PDEE-57 US Evaluation with CT/MRI Correlation of Neonatal and Infantile Brain Tumors and Other Intracranial Masses**

#### **Awards**

#### **Certificate of Merit**

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

While some neonatal brain tumors are suspected on antenatal US imaging, most are diagnosed postnatally. Head US may be the first imaging modality for work-up of an intracranial mass which can present with non-specific clinical features. Most cases will require further imaging work-up, usually with MRI. Recognition of the US features of the most common neonatal and

infantile intracranial masses and their complications can aid in appropriate and timely subspecialty referral. Objectives: 1. Discuss the US features of the most common neonatal and infantile intracranial masses. 2. Describe the correlation between antenatal US and fetal MRI and postnatal US and CT/MRI in the imaging work-up of these masses. 3. Explain the use of US to identify any associated complications which require urgent neurosurgical assessment.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Pseudomass 2a. Intraventricular hemorrhage 3. Non-neoplastic masses 3a. Arachnoid cyst 3b. Choroid fissure cyst 3c. Hypothalamic hamartoma 4. Supratentorial neoplasms 4a. Teratoma 4b. Low-grade glioma 4c. High-grade glioma 4d. Embryonal tumor with multilayered rosettes 4e. Choroid plexus tumors 4f. Osteochondrolipoma 5. Posterior fossa neoplasms 5a. Atypical teratoid/rhabdoid tumor 5b. High-grade glioma 6. Conclusion

#### **PDEE-58 US Evaluation with Fetal MRI and CT/MRI Correlation of Pediatric Congenital and Inherited Brain Anomalies**

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. While many congenital and inherited brain anomalies are suspected from antenatal US and fetal MRI, postnatal head US may be the first imaging modality in the work-up of these heterogeneous anomalies 2. Most cases will require further imaging work-up with CT and/or MRI 3. Recognition of the US features of the most common of these lesions is important in order to direct appropriate additional imaging and timely subspecialty referral Objectives 1. Discuss the US features of the most common pediatric congenital and inherited brain anomalies 2. Describe the correlation between antenatal US and fetal MRI and postnatal US and CT/MRI 3. Explain the use of US to narrow the differential diagnosis and direct appropriate additional imaging work-up and management

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Midline anomalies a. Agenesis of corpus callosum (ACC) b. Dysgenesis of corpus callosum variants i. Asymmetric ventriculomegaly, interhemispheric cyst and dysgenesis of corpus callosum (AVID) ii. Dysgenesis of corpus callosum with pericallosal lipoma c. Septo-optic dysplasia 3. Malformations of cortical development a. Periventricular nodular heterotopia b. Lissencephaly c. Hemimegalencephaly d. Tuberous sclerosis 4. Metabolic a. Ornithine transcarbamylase (OTC) deficiency 5. Brainstem and posterior fossa anomalies a. Diencephalic mesencephalic junction dysplasia b. Dandy-Walker malformation c. Joubert syndrome and related disorders (JSRD) d. Chiari 2 malformation secondary to myelomeningocele e. Arachnoid cyst f. Mega cisterna magna 6. Vascular anomalies a. COL4A1 mutation b. Vein of Galen malformation 7. Conclusion

#### **PDEE-59 Differential Diagnosis of Hyperechoic Lesions on Neonatal Head US**

##### **Awards**

##### **Certificate of Merit**

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. There are normal areas of increased echogenicity on neonatal head US which should not be mistaken for pathology, including choroid, midline vermis, hyperechoic caudate heads, periventricular white matter "halo", and white matter tracts including the corticospinal tracts 2. The differential diagnosis of hyperechoic lesions depends on their location 3. Many lesions can be confidently diagnosed and follow on US, while others require further imaging work-up to narrow the differential diagnosis and assist in ongoing management

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Normal areas of increased echogenicity a. Choroid b. Midline vermis c. Hyperechoic caudate heads d. Mineralizing vasculopathy e. Periventricular white matter "halo" f. Transmantle speckled increased echogenicity g. Corticospinal tracts 3. Caudothalamic groove a. Grade 1 germinal matrix hemorrhage b. Grades 2 and 3 germinal matrix hemorrhage 4. Periventricular/deep white matter a. Periventricular hemorrhagic infarction b. White matter injury c. Deep medullary venous thrombosis d. Infection e.g. Citrobacter koseri e. ECMO-related hemorrhage f. Water-shed infarct g. Punctate foci of white matter injury 5. Diffuse white matter a. Arterial infarction b. Hypoxic-ischemic encephalopathy 6. Deep gray matter a. Central cerebral venous sinus thrombosis 7. Peripheral parenchyma a. Peripheral cerebral venous sinus thrombosis b. Vein of Labbé hemorrhagic venous infarction 8. Cerebellum a. Cerebellar hemorrhage 9. Extraaxial a. Subdural hemorrhage b. Extradural hemorrhage c. Subpial hemorrhage 10. Conclusion

#### **PDEE-6 Pictorial Review of Pediatric Neuroimmune Disease**

Alejandra Aguado, MD, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

Neuroimmune diseases are a group of inflammatory disorders with varying pathogenic mechanisms, including autoantibodies against self-targets, cell-mediated, infection-triggered, paraneoplastic, and genetically determined diseases. This group continues to expand with the discovery of new clinicopathologic entities. Radiologists should be familiar with these diseases and able to make a differential diagnosis, as early diagnosis and appropriate treatment with immunotherapy can modify disease course in some cases. Additionally, different diseases within this group can present with varied evolution and prognosis. The main teaching points of this exhibit include: 1. Review of the most frequent entities within each group 2. Description of key imaging features that aid in differential diagnosis among different entities.

## TABLE OF CONTENTS/OUTLINE

This exhibit presents a range of disease pathologies encountered in clinical practice, including: 1. Demyelinating diseases: a) Acute disseminated encephalomyelitis (ADEM) b) Pediatric multiple sclerosis (MS) c) Neuromyelitis optica spectrum disorders (NMOSDs) d) Anti-MOG associated disease 2. Anti-NMDAR encephalitis, including one triggered by herpes simplex virus encephalitis 3. Lupus erythematosus 4. Rasmussen encephalitis 5. Hemophagocytic lymphohistiocytosis.

## PDEE-60 Navigating the Fine Line of Pediatric Lines: A Primer on Pediatric Intravascular Catheters

Narendra S. Shet, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. To review various reasons and approaches for vascular access in pediatric patients. 2. To discuss the role of the radiologist in assessment of pediatric vascular access. 3. To review optimal and suboptimal line placement in pediatric patients in a variety of clinical scenarios, including neonates and patients with congenital heart disease.

## TABLE OF CONTENTS/OUTLINE

1. Overview of vascular access in pediatric patients - reasons for short and long term access and means of guidance (non-guided versus image-guided), and role of radiologist (for diagnostic radiologist, assessing adequacy of line position, and for interventional radiologist, line placement using means of image guidance). 2. Central lines in pediatric patients, including PICC, Non-PICC (IJ/Femoral), and long-term Access including hemodialysis catheters/tunneled central venous lines, as well as ports. 3. Neonatal specific catheters, including umbilical arterial and venous catheters. 4. Cardiac catheters, such as intra-cardiac catheters, ECMO cannulae, and ventricular assist devices. 5. Where relevant, photographs of support devices, either in vivo or ex vivo, will be included in figures to allow for comparison to radiographic appearance.

## PDEE-61 Imaging Evaluation of Pediatric Cystic Neck Masses

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Pediatric neck masses are a common indication for imaging referral and US is often the first imaging modality in their work-up. 2. Following detection of a cystic neck mass on US, the radiologist must determine whether the lesion has a characteristic US appearance and requires no further imaging work-up or whether further imaging work-up is required. 3. Appropriate use of CT/MRI can aid in narrowing the differential diagnosis and assist in surgical planning. Objectives: 1. List the sonographic features of pediatric cystic neck masses which have a characteristic sonographic appearance and require no further imaging work-up 2. Recognize those lesions which require additional imaging work-up 3. Discuss the appropriate use of CT/MRI to aid in narrowing the differential diagnosis

## TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Congenital anomalies a. First branchial cleft anomalies b. Second branchial cleft anomalies c. Pyriform fossa sinus tract (PFST) lesions d. Dermoid cyst e. Lymphatic malformation f. Thyroglossal duct cyst 3. Inflammatory a. Ranula 4. Infectious a. Suppurative pyogenic lymphadenitis b. Non-tuberculous mycobacterial cervical lymphadenitis (MAIC) c. Retropharyngeal abscess 5. Neoplastic a. Teratoma 6. Conclusion

## PDEE-62 Twist and Turns: Comprehensive Radiological Review of Intestinal Malrotation and Midgut Volvulus

Ayat A. Yousef, MBBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Describe the imaging findings of intestinal malrotation and midgut volvulus in upper gastrointestinal (UGI) studies. 2. Discuss the utility of ultrasound (US) in intestinal malrotation and midgut volvulus. 3. Highlight the imaging pearls and pitfalls in cases of intestinal malrotation and midgut volvulus. 4. Illustrate different clinical presentations of malrotation and midgut volvulus through a variety of clinical cases.

## TABLE OF CONTENTS/OUTLINE

1. Introduction: Describe the normal orientation and fetal development of the intestine. Highlight the importance of early detection and management of intestinal malrotation. 2. Pathophysiology of intestinal malrotation and midgut volvulus: Discuss the mechanism of midgut volvulus in intestinal malrotation along with clinical presentation and complications. 3. Upper GI studies: Review the standard views in UGI studies with emphasis on imaging landmarks to insure proper position and quality. Discuss the imaging pearls and pitfalls in diagnosing intestinal malrotation/midgut volvulus in UGI studies. 4. Other radiological modalities: Role of other imaging modalities in intestinal malrotation/midgut volvulus as a problem solver in challenging cases including US, computed tomography (CT) and lower GI studies. 5. Atypical cases of midgut volvulus: Examples of atypical cases of midgut volvulus including recurrent and chronic presentations. Use different cases as a teaching key points in diagnosis and management of midgut volvulus. 6. Conclusion: Summary of the radiological approach in intestinal malrotation and midgut volvulus.

### **PDEE-63 Intestinal Ultrasound in Pediatric Inflammatory Bowel Disease: What Radiology Residents Should Know**

Paola Aguirre Camino, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Become familiar with the correct performance of pediatric bowel ultrasound scan. 2) Propose a standardized ultrasound report. 3) Recognize the ultrasound appearance of the normal and pathological bowel pattern. 4) Learn the typical sonographic findings, evaluate the activity and assess the presence of possible complications in Inflammatory Bowel Disease.

## TABLE OF CONTENTS/OUTLINE

Crohn's disease and ulcerative colitis are chronic inflammatory bowel diseases frequently diagnosed in childhood, being imaging methods fundamental in the diagnostic approach, severity assessment, treatment monitoring and in the suspicion of complications. Due to the need to frequently evaluate these children, intestinal ultrasound becomes especially important compared to colonoscopy and MRI, as it is a non-invasive technique, easy for the child to accept, accessible and repeatable; however, as it is an operator-dependent examination, it requires certain experience and should be performed systematically using the appropriate technique. Intestinal ultrasound is a useful modality for intestinal bowel disease imaging and a valuable screening tool in the preliminary diagnostic workup of pediatric patients with suspected Inflammatory Bowel Disease. It assesses the presence of thickening of the intestinal wall as an indicator of inflammation, as well as the location and extent of the disease. It also allows evaluating the activity by quantifying the hyperemia of the intestinal wall using color Doppler, being a useful tool in the follow-up and control of the response to the treatment.

### **PDEE-64 Slipped Capital Femoral Epiphysis: Emphasis on Early Recognition and Potential Pitfalls**

#### **Awards**

##### **Certificate of Merit**

Daniel G. Rosenbaum, MD (*Presenter*) Consultant, Ipsen SA

#### **TEACHING POINTS**

\* Slipped capital femoral epiphysis (SCFE) is the most common hip disorder in adolescence, however the diagnosis is often delayed or missed due to vague clinical presentation, subtle radiographic findings, and technical variability.\* Early detection of SCFE hinges on close scrutiny of physeal morphology with particular attention to the epiphyseal tubercle, an important stabilizer of the physis in children.\* An AP and frog-lateral view of the pelvis including both hips is the mainstay of radiographic assessment of SCFE, and failure to diagnose SCFE is often a product of improper technique.\* Cross-sectional imaging is not routinely performed in SCFE patients, but can be helpful to identify radiographically occult early slips, assess femoral head perfusion, and better understand anatomy for surgical planning purposes.

## TABLE OF CONTENTS/OUTLINE

\* Learning objectives\* Background including rationale for focus on SCFE, definition and epidemiology, pathophysiology and histology, and clinical findings and classification\* Early physeal changes in SCFE, introduction of the epiphyseal tubercle and rotational microinstability, and illustration of the peritubercle lucency on radiographs\* Later radiographic findings and severity grading on frontal and frog-lateral radiographs\* Technical pitfalls on radiography with emphasis on the importance of imaging both hips on all views\* Role of cross-sectional imaging including MRI for early slips, prognostic relevance of femoral head perfusion, and use of CT or Zero-TE MRI to assess callus preoperatively

### **PDEE-65 Imaging Approach to Pediatric Neurometabolic Imaging**

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe the most commonly used classification systems for pediatric neurometabolic diseases 2. Discuss the clinical features and imaging patterns which aid in narrowing the differential diagnosis in the work-up of pediatric neurometabolic



diseases. Illustrate the MR features of the most common pediatric neurometabolic diseases, including the MR spectra suggestive of specific disorders

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Classification systems a. Organelle dysfunction i. Mitochondrial disorders ii. Lysosomal storage disorders iii. Peroxisomal biosynthesis disorders b. Laboratory markers i. Lactate ii. Ammonia iii. Inborn errors of metabolism c. Presentation i. Neonatal metabolic encephalopathy ii. Head size d. Imaging pattern i. Deep gray matter involvement - striatum, globus pallidus, hyperdense thalami ii. White matter involvement - subcortical U-fibres, central white matter, anterior vs posterior iii. Hypomyelination disorders iv. MR spectroscopy suggestive of specific diseases v. Enhancement pattern 3. 16 "must know" imaging patterns suggestive of a specific neurometabolic disease: a. Maple syrup urine disease b. Canavan disease c. Alexander disease d. X-linked adrenoleucodystrophy e. Metachromatic leucodystrophy f. Pelizaeus-Merzbacher disease g. Mitochondrial encephalopathy with lactic acidosis and stroke-like episodes h. Non-ketotic hyperglycinemia i. Zellweger syndrome j. Mucopolysaccharidosis k. Leigh syndrome l. Panthothenate kinase-associated neurodegeneration m. Creatine kinase deficiency n. Megaloencephalic leucodystrophy with subcortical cysts o. Vigabatrin-related changes p. Methotrexate-related changes 4. Future directions 5. Conclusion

#### **PDEE-66 Newborn Skeletal Radiographs: A Practical Guide**

Marcelo S. Takahashi, MD, PhD (*Presenter*) Speaker, Vertex Pharmaceuticals Incorporated

#### **TEACHING POINTS**

Neonatal skeletal abnormalities are rare occurrences in pediatric practice with a wide variety of causes and often overlapping radiographic features. The main teaching points of this exhibit are: 1) Illustrate the expected normal plain film appearance of the neonatal bone, including and what the most common pitfalls, regarding both normal development as well as technical imaging aspects. 2) Explain specific diseases radiographic findings with key clinical and epidemiological considerations 3) Illustrate the different imaging patterns with differential diagnosis checklist and explanation for each one

#### **TABLE OF CONTENTS/OUTLINE**

& 5; & 5; Normal newborn particularities and pitfalls& 5; Normal Anatomy& 5; Physiologic Neonatal Periostitis& 5; & 5; Trauma:& 5; Delivery related fractures& 5; Non accidental trauma& 5; & 5; Diffuse bone disease:& 5; Rickets& 5; Metabolic Bone Disease of Prematurity& 5; Caffey Disease& 5; Osteopetrosis& 5; & 5; Congenital abnormalities and malformations& 5; Amniotic band syndrome& 5; Hemimelia& 5; Proximal Femoral Focal Deficiencies& 5; Spine malformations& 5; Chondrodysplasia punctata& 5; Developmental Dysplasia of the Hip& 5; & 5; Infections:& 5; Congenital Syphilis& 5; Neonatal osteomyelitis

#### **PDEE-67 Entering a New Dimension: Novel Use of Transabdominal 3D Ultrasound in Pediatric Gynecology**

Jeffrey J. Tutman, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

3D transvaginal pelvic ultrasound is a well-established imaging technique in the adult population for gynecologic applications. However, transvaginal ultrasound is not commonly utilized in the pediatric population. There are only sparse reports in the literature on the use of 3D transabdominal pelvic ultrasound in the pediatric population for gynecologic applications. In this educational exhibit, we will share our experience with 3D transabdominal pelvic ultrasound in the pediatric population, particularly for the evaluation of Mullerian duct anomalies and IUD positioning. We will begin with a review of scan technique and post-processing. Instructions for creation of a simple homemade ultrasound phantom for practicing these techniques will also be reviewed. We will then share several illustrative cases where 3D ultrasound provided useful information beyond standard 2D imaging in the assessment of Mullerian duct anomalies and IUD positioning. The challenges and limitations to this technique will also be discussed.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Review of scan technique and post-processing 3. Homemade ultrasound phantom: instructions and utility 4. Example cases of Mullerian duct anomalies 5. Example cases of IUD positioning

#### **PDEE-68 Ultra Low Dose Fetal CT: A Simple Way to Understand the Various Exposure Doses to the Fetus**

Rumi Imai (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

(1) When skeletal dysplasia is suspected by fetal ultrasound, it is often difficult to make an accurate prenatal diagnosis using ultrasound alone.(2) In such case, fetal skeletal CT is recommended because it has diagnostic power comparable to postnatal bone survey, but the only drawback is fetal radiation exposure. For this reason, we have devised Ultra low dose fetal CT (ULDFCT) from the viewpoint of ALARA.(3) On the other hand, estimating fetal radiation dose involves complex calculations, and methods that are easily understood by pediatric radiologists and CT technicians are needed. (4) This exhibition

introduces a method to insufflate the exposure dose of the fetus and maternal body by simple calculation using the CT dose index (CTDI), which is available immediately before and after scanning.

#### **TABLE OF CONTENTS/OUTLINE**

A. Data acquisition (n=36); Patients with ULDFCT throughout of 2014 to 2021. CTDIvol : mean 0.48mGy, DLP : mean 18.62mGy.cm. These are the lowest exposure doses in fetal CT scans in the literature search. B. Estimation of various exposure doses of the fetus  
Fetal dose: mean; 0.36mGy. Fetal dose = CTDIvol x 0.8 mGy  
Organ dose of uterus; mean 0.58mGy. Organ dose of uterus = CTDIvol x 1.2; SSDE; mean: 0.57mGy, SSDE= = CTDIvol x 1.18  
Effective dose (ED) of maternal body; 0.39mSv. ED = CTDIvol x 0.81

#### **PDEE-69 Neonatal Chest X-ray: How to Spot Abnormal Gas Patterns and Potential Pitfalls**

Marta Sanmartin Lopez, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the main projections and technical guidelines of neonatal chest radiography. 2. Review the systematic analysis of chest X-rays performed in neonates. 3. Emphasize some normal findings that differ from X-rays performed in older children and adults. 4. Analyze the typical radiological signs of pneumothorax, pneumomediastinum, pneumopericardium and pneumoperitoneum, and provide some practical examples that may help to differentiate pathology from potential pitfalls and mimics.

#### **TABLE OF CONTENTS/OUTLINE**

1. Analysis of neonatal chest X-ray a) Radiographic technique b) Systematic interpretation of neonatal chest X-ray. 2. Abnormal gas patterns a) Pneumothorax b) Pneumomediastinum c) Pneumopericardium d) Pneumoperitoneum

#### **PDEE-7 Going with the Flow: Implementing a 4D Flow MRI Program at a Children's Hospital**

Aparna Sodhi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Four-dimensional flow MRI (4D flow) is a three dimensional spatial and velocity encoded phase contrast sequence that has emerged as a versatile imaging technique for qualitative as well as quantitative characterization of cardiovascular flow. The benefits of 4D flow include an easily prescribed volumetric acquisition with the ability to retrospectively quantify flow in any plane, in the acquired field of view. In the past, long scan times and complex post-processing workflows hindered 4D flow adoption into routine clinical practice for cardiovascular velocity and flow assessment, but improvements in image acquisition and processing have enabled standard clinical workflows. Additionally, there are unique in-vivo flow investigative parameters that provide newer insights into understanding cardiovascular physiology and pathophysiology. Our purpose is to: 1. Explain the utility of 4D flow. 2. Describe 4D flow acquisition parameters designed for imaging children with various congenital or acquired cardiovascular diseases. 3. Demonstrate a streamlined clinical 4D flow post-processing workflow. 4. Discuss research 4D flow applications.

#### **TABLE OF CONTENTS/OUTLINE**

1. General overview of 4D flow and key applications in the pediatric setting 2. Advantages of 4D flow over 2D phase contrast imaging 3. Image acquisition and post-processing using clinical cases (i) 9-years-old male with Fontan (ii) 19-years-old female with Bicuspid Aortic Valve 4. Research utility of 4D flow and future directions

#### **PDEE-70 Acute Upper Airway Obstruction in the Pediatric Population: What's Behind the Stridor**

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Review the anatomic features of the pediatric airway. - Establish a systematic approach to radiographic evaluation. - Identify the key radiographic findings of common causes of acute upper airway obstruction through cases studied in our center.

#### **TABLE OF CONTENTS/OUTLINE**

Acute upper airway obstruction is more common in the pediatric population due to its various anatomical and physiological peculiarities. Several causes of airway obstruction have been described, such as foreign body obstruction, infection, neoplasm, congenital or vascular entities. Since the clinical presentation is often nonspecific and the evaluation of pediatric patients in the emergency setting is complicated, imaging techniques play a critical role in achieving an accurate diagnosis. The aim of this review is to evaluate the specific radiologic features that can be found in the different imaging modalities, with special emphasis on plain radiography, which is often sufficient to reach a correct diagnosis. As acute airway obstruction can be a life-threatening condition, it is essential that the radiologist recognizes the key imaging findings in order to ensure prompt management.

## **PDEE-71 What Every Radiologist Should Know About Cranial Ultrasound: A Systematic Approach and Common Pathologies**

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

- Define the technical procedure of standard cranial ultrasound (CUS) and review the normal anatomic structures of the brain.
- Identify the spectrum of pathologies seen in clinical practice. - Highlight some tips and tricks for diagnosis.

### **TABLE OF CONTENTS/OUTLINE**

CUS is an extremely valuable tool for evaluating the brain in the first year of life and has become an essential part of routine pediatric radiology practice. It is an accessible, portable, inexpensive, and safe technique that can be used as often as needed. Because of its great advantages, it is imperative for the radiologist to know how to perform CUS and correctly interpret the findings. This review attempts to establish the clinical indications, define a systematic technique to adequately visualize and document all relevant intracranial structures, and highlight the most common pathologies seen in neonates, including - Hypoxic-ischemic encephalopathy in preterm infants (germinal matrix hemorrhage, cerebellar hemorrhage, and periventricular leukomalacia) - Hypoxic-ischemic encephalopathy in term patients - Cerebrovascular disease - Trauma-associated hematomas - Macrocephaly However, the usefulness of CUS is still highly dependent on the skill, knowledge and experience of the observer.

## **PDEE-73 Congenital Anomalies of the Posterior Fossa - An Imaging Travelogue**

Shivaprakash B. Hiremath, DMRD, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

This educational exhibit aims to: 1. Review the embryology and cross-sectional imaging anatomy of the posterior fossa. 2. Describe typical congenital malformations based on predominant cerebellar involvement, cerebellar and brainstem involvement, and predominant brainstem involvement.

### **TABLE OF CONTENTS/OUTLINE**

- Describe the embryology and anatomical assessment of the posterior fossa along with diffusion tensor imaging.
- Depict the imaging findings in malformations predominantly affecting the cerebellum including cerebellar hypoplasia, hyperplasia and dysplasia (Chudley-mccullough syndrome, and Poretti-Bolthausen syndrome).
- Highlight the malformations affecting the cerebellum and brainstem such as alpha dystroglycanopathies, tubulinopathy, molar tooth malformations, and pontocerebellar hypoplasia.
- Illustrate the malformations predominantly affecting the brainstem such as pontine tegmental cap dysplasia, horizontal gaze palsy with progressive scoliosis, and diencephalic-mesencephalic junction dysplasia along with malformations with no known genetic cause such as Rhombencephalosynapsis, PHACE syndrome, and oculocerebrocutaneous syndrome.

## **PDEE-74 Imaging in Pediatric Neuroinflammatory Disorders and Mimics**

Shivaprakash B. Hiremath, DMRD, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

This educational exhibit aims to: 1. Review the basic concepts of neuroinflammatory disorders in childhood 2. Describe the imaging manifestations of Myelin Oligodendrocyte Glycoprotein antibody-associated disease (MOGAD) in different age groups 3. Illustrate both common and uncommon findings in Neuromyelitis Optica Spectrum Disorder (NMOSD) and Multiple Sclerosis in the pediatric age range 4. Illustrate mimics of these entities based on imaging phenotypes encompassing pathologies that target the optic nerves, deep grey nuclei, white matter, and spinal cord.

### **TABLE OF CONTENTS/OUTLINE**

- Review the pathophysiological basis of pediatric neuroinflammatory diseases.
- Illustrate the common and uncommon imaging manifestations in myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD) including acute disseminated encephalomyelitis (ADEM)-like phenotype, encephalitis-like phenotype, and leukodystrophy like phenotype.
- Depict common and uncommon findings in AQP4-associated neuromyelitis optica spectrum disorder (NMOSD), and Multiple Sclerosis (MS) including tumefactive demyelinating lesions.
- Provide localization related illustrations of mimics of demyelinating diseases including infectious, inflammatory, and metabolic disorders along with tumors that mimic demyelinating diseases.

## **PDEE-75 Mastering Neck Ultrasound in Pediatric Patients**

Mikel Elgezabal, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Neck anatomy from the ultrasound perspective: key structures and sonographic landmarks. 2. Ultrasound protocol focusing on children's peculiarities. 3. Clinical and US findings of common and not-so-common pediatric neck entities. 4. Radiologic approach to a neck lump in a child.

## TABLE OF CONTENTS/OUTLINE

1. US technique for the pediatric neck 1.1. Technical recommendations 1.2. Anatomy: spaces of the head and neck and landmarks from the US perspective. 1.3. Basic US protocol and further tricks to get to more unusual locations (palatine tonsils, vocal cords). 2. Pathology of the pediatric neck 2.1. Lymph nodes: Anatomy, node levels. Pathology: reactive, suppurative, malignant. Tips: malignant vs. benign. 2.2. Thyroid: dysgenesias, nodes, thyroiditis. 2.3. Vascular anomalies: tumors, malformations and subtypes. 2.4. Salivary glands: parotitis, submaxillitis, ranula of the sublingual gland. 2.5. Cysts: thyroglossal duct, branchial cleft, dermoid, epidermoid. 2.6. Fibromatosis colli. 2.7. Cervical thymus. 2.8. Soft tissue tumours: sarcoma, schwannoma, neuroblastoma. 2.9. Pilomatricoma. 3. Summary: approach to a neck lump in a child. 4. Take home points

## PDEE-76 Keeping it Straight: A Guide to Pediatric Renal Neoplasms

Hassan A. Aboughalia, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Ultrasound is the first-line imaging modality for suspected abdominal masses, followed by contrast-enhanced CT or MRI renal mass protocol. 2. When a renal tumor is suspected, the patient's age, imaging characteristics, distribution of metastases, and co-morbid conditions are the most important factors to consider. 3. Synchronous ipsilateral and contralateral renal lesions, metastatic disease, lymphadenopathy, invasion of the renal vein/IVC, and signs of tumor rupture are essential features to be evaluated. 4. Suprarenal pathologies can mimic a renal tumor such as neuroblastoma.

## TABLE OF CONTENTS/OUTLINE

1. Imaging approach to a patient with a suspected renal tumor, emphasizing optimal imaging techniques 2. Solid renal neoplasms, including mesoblastic nephroma, nephrogenic rests, Wilms tumor, rhabdoid tumor, clear cell sarcoma, angiomyolipoma, renal cell carcinoma, lymphoma, and metastases. 3. Cystic renal neoplasms, including cystic nephroma, cystic partially differentiated neuroblastoma, and cystic Wilms tumor. 4. Mimics of renal neoplasms, including hypertrophied column of Bertin, focal pyelonephritis and abscess, infarct, granulomatous diseases, suprarenal pathologies, and cystic renal diseases. 5. Diagram slide of pediatric renal neoplasms underscoring key factors differentiating these entities.

## PDEE-77 Craniovertebral Junction Instability, Fixation and Stenosis in Children

Stephen B. Little, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Radiographs of the cervical spine are often inadequate or falsely reassuring in children with torticollis. A high-risk mechanism of injury or high clinical suspicion should prompt further evaluation with CT or MRI. 2. Early recognition and treatment of atlantoaxial rotatory fixation (AARF) is essential to limit morbidity. 3. AARF may be neither purely atlantoaxial, merely rotatory, nor completely fixed. 4. Significant lateral inclination of C1, facet deformity, new bone and multi-ligament insufficiency are associated with irreducible AARF. 5. An increased atlantodental interval (ADI) is a poor indicator of symptomatic atlantoaxial instability in children with trisomy 21. Furthermore, a normal ADI does not exclude craniovertebral junction instability. 6. Symptomatic CVJ instability in children with trisomy 21 is more frequent in those with associated osseous anomalies, particularly os odontoideum. 7. Osseous anomalies in children with CVJ instability include assimilation of the atlas, split atlas, odontoid hypoplasia or aplasia, os odontoideum, and Klippel-Feil syndrome. 8. A variety of skeletal dysplasias are associated with CVJ instability or stenosis. 9. Narrow C2 pedicles increase the risk of vertebral artery groove violation with pedicle screw placement, possibly producing devastating neurovascular consequences.

## TABLE OF CONTENTS/OUTLINE

1. Osseous and ligamentous anatomy 2. Key morphometry 3. Rotatory dynamics 4. Atlantoaxial rotatory fixation 5. Trisomy 21 and CVJ instability 6. Osseous anomalies and CVJ instability 7. Skeletal dysplasias 8. Surgical considerations

## PDEE-78 Pediatric Dural Arteriovenous Fistulas: An Unusual Connection

Sophia Z. Liu, BS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Dural arteriovenous fistulas (DAVFs) are vascular abnormalities in which a meningeal artery drains directly into a meningeal vein or dural venous sinus. DAVFs are rare in children, accounting for around 10% of all intracranial shunts in the pediatric population. The transverse-sigmoid, superior sagittal sinus, and torcular herophili are commonly involved fistula sites in pediatric DAVFs. Pediatric DAVFs can be classified into three types: dural sinus malformations, infantile/juvenile-type dural

shunts, or adult-type dural shunts. Younger children with DAVFs tend to present with cardiopulmonary symptoms (congestive heart failure and/or respiratory distress), while older children present with neurological symptoms (headaches, intracranial hemorrhage, focal deficits). The primary treatment for DAVFs is endovascular embolization, commonly with microcoils or liquid adhesives. Challenges in the endovascular treatment of DAVFs include high-flow fistulas, tortuous intracranial feeding arteries, and small femoral artery access sites.

#### **TABLE OF CONTENTS/OUTLINE**

- Review neurovascular anatomy relevant to dural arteriovenous fistulas (DAVFs).- Recognize DAVFs in the pediatric population using a case-based approach.- Review the multimodal imaging appearance of pediatric DAVFs.- Understand the treatment of pediatric DAVFs and the application of neurovascular interventional techniques.- Discuss the complications and challenges in the treatment of pediatric DAVFs.

#### **PDEE-79 Pediatric Coronary Artery Anomalies**

Maria Navallas, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Recognize the anatomic variations of coronary origin and course. 2. Understand the high risk imaging features in anomalous aortic origin of the coronary arteries. 3. Discuss acquired and post surgical anomalies of the coronary arteries.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction 2. Cardiac CT technique 2.1. Type of scanner 2.2. Patient preparation 2.3. Electrocardiogram gating 2.4. Contrast administration 3. Classification of congenital coronary artery anomalies 3.1. Anomalies of origin/course- High take-off- Single coronary artery- ALCAPA/ASCAPA- Origin of coronary artery or branch from opposite or noncoronary sinus and anomalous course: Retroaortic, interarterial, prepulmonic, septal (subpulmonic) 3.2. Anomalies of intrinsic coronary anatomy: Myocardial bridging 3.3. Anomalies of coronary termination: Coronary artery fistula 4. High risk imaging features and risk of sudden death 5. Acquired coronary artery abnormalities: 5.1. Kawasaki disease 5.2. Multisystem inflammatory syndrome in children associated with COVID-19 5.3. Postsurgical anomalies 6. Conclusion

#### **PDEE-80 Transcranial Doppler Ultrasound in Children with Sickle Cell Disease: All What You Have to Know**

Joseph Abi Ghanem (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1- Sickle cell disease (SCD) has an incidence of 4/10000 births. It is characterized by a chronic proinflammatory state, prothrombotic state and increased aggregation of red blood cells (RBC). Children with the SCD HbSS and HbSBthal0 phenotypes have a 200-fold increased risk of stroke compared to healthy children. 2- Radiologists play a major role in treatment decision plan as Transcranial Doppler ultrasound (TCD) is the only radiologic test of choice to detect SCD children at higher risk for stroke. 3- The stroke prevention trial in sickle cell anemia (STOP) and The Silent Cerebral Infarct Transfusion (SIT) multicentric trial are pivotal studies demonstrating the benefit of chronic transfusion program based on screening with TCD velocities to prevent symptomatic and silent ischemia in SCD children between 2 and 16 years. 4-The tracings on the TCD reflect, the size of the artery, type of flow and flow velocities related to rheologic and hemodynamic factors.

#### **TABLE OF CONTENTS/OUTLINE**

1- Introduction of the STOP and SIT trials. 2- Indications and recommendations on when and how to perform TCD. 3- How to interpret Doppler tracing on TCD. 4- Case based presentation of threshold velocities for a conditional and an abnormal TCD. 5- Quantitative ultrasound for RBC aggregation estimation as potential new test to decrease the number needed to treat and avoid unnecessary transfusion.

#### **PDEE-81 Dermatologic Ultrasound in Children: Benign and Pseudo-Tumoral Lesions**

#### **Awards**

#### **Certificate of Merit**

Luis O. Tierradentro-Garcia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- 1. To overview the current applications of dermatologic ultrasound in children. - 2. To illustrate the utility of ultrasound to differentiate benign and pseudo-tumoral dermatologic lesions in children. - 3. To describe the role of conventional and advanced ultrasound as a complementary tool to CT and MRI in making diagnoses and assisting in surgical planning.

## TABLE OF CONTENTS/OUTLINE

1. Background: Skin lesions in children are common, most lesions are benign. Clinical findings can be non-specific. 2. Technical aspects: - Image acquisition is non-invasive and harmless. - Frequency > 15 MHz. - Protocol: grayscale, Color Doppler, Pulsed-wave Doppler, microvascular flow imaging. - Normal sonographic appearance of the skin layers. 3. Pseudo-tumoral lesions 3.1 Cystic lesions - Epidermal inclusion cyst. - Trichilemmal cyst. - Dermoid cyst. - Cutaneous bronchogenic cyst. 3.3 Pilomatricoma 3.4 Dermatofibroma 3.5 Neurofibroma 3.6 Lipoma 4. Inflammatory lesions 4.1 Warts 4.2 Foreign body 4.3 Morphea 4.4 Insect bite 4.5 Kerion celsi 4.6 Juvenile xanthogranuloma 4.7 Congenital aplasia cutis 4.8 Annular granuloma 4.9 Keloid 5. Differential diagnosis 6. Take Home points

### **PDEE-82 Pediatric Magnetic Resonance Neurography: Technical Considerations, Indications, and Findings**

Frederik Abel (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Review technical considerations and imaging challenges of pediatric patients referred for magnetic resonance (MR) neurography. 2) Discuss the most common indications and anatomic regions referred for MR Neurography. 3) Illustrate typical imaging findings, their clinical correlation, and management strategies.

## TABLE OF CONTENTS/OUTLINE

1) Technical aspects of MR Neurography (3.0 T, conformable phased-array coils) and unique challenges of the pediatric population (e.g. SNR limitations due to small body habitus and size of peripheral nerves, sedation, motion artifact, flexion contracture (developmental or posttraumatic)). 2) Demographics and characteristics of a pediatric database at a tertiary orthopedic referral center 3) Imaging examples of both traumatic (e.g. median nerve entrapment following elbow fracture, drop foot post knee dislocation) and atraumatic (Charcot-Marie-Tooth, neurofibromatosis, limb hemihypoplasia) peripheral neuropathies and their clinical management 4) Strengths and weaknesses of MR Neurography for assessing pediatric patients, role of ultrasound, and discussion of future directions in this field

### **PDEE-83 Acute Pediatric Elbow Trauma - Adding the Orthopedist's Perspective to Imaging Interpretation**

Vivek Batra, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Knowledge of the specific developmental sequence of pediatric elbow apophyses is key to accurate interpretation of pediatric elbow trauma. 2. Knowledge of pitfalls is important, e.g., normal developmental irregularity of the apophyses can be mistaken for trauma. 3. In younger children, assessment of apophyseal avulsion/displacement on radiographs may be difficult due to incomplete ossification; MR may be necessary for more complete evaluation. 4. Chondroepiphyseal separation/transphyseal fracture of the distal humerus is a rare manifestation of mechanical birth related trauma of the newborn and may be difficult to diagnose on radiographs. Ultrasound and MRI may aid in further assessment. 5. Optimal orthopedic management of pediatric patients with elbow trauma is hinged on accurate imaging interpretation. Radiology reports should include entity-specific information that will benefit patient management. For example, a radial neck fracture is a sentinel fracture, often accompanied by additional fractures. Post reduction of elbow dislocation, the developing medial epicondyle can be entrapped in joint. A nursemaid's elbow may not manifest any imaging abnormalities.

## TABLE OF CONTENTS/OUTLINE

1. Embryology and normal developmental anatomy of the elbow. 2. Radiographic views used for elbow trauma and technique of acquisition. 3. Role of MRI and CT acquisition parameters. 4. Imaging manifestations of pediatric elbow trauma. 5. Entity-specific additional information to be included in radiology reports that aid in orthopedic management. 6. Complications and mimics of acute elbow trauma. 7. Imaging spectrum of chronic overuse injuries of the developing elbow.

### **PDEE-84 Masqueraders of Clarity - Tumor Mimics in Pediatric Oncology**

Manisha Jana, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pitfalls in oncologic imaging are inflammatory, infective and vascular disorders which mimic tumors. Post-treatment changes and complications must be differentiated from residual or recurrent disease. Problem-solving tools include a multimodality approach, functional imaging and serial follow-up.

## TABLE OF CONTENTS/OUTLINE

Non-neoplastic entities that mimic tumors lead to diagnostic confusion and delay appropriate therapy. In a patient with focal neurologic deficit or seizures, the cause may be demyelination, sarcoidosis or infections such as fungal, parasitic, tuberculosis and neurocysticercosis. Bone tumors are commonly mistaken in the setting of osteomyelitis, bone cysts, fracture, scurvy and



osteogenesis imperfecta. Clinical context and plain radiographs must be correlated with MRI. Intrapulmonary nodes or granuloma mimic lung metastases. Abscesses, focal steatosis, cysts and arteriportal shunting are tumor mimics in the liver. Infarcts, cysts and perfusion abnormalities mimic tumors in the spleen, while adrenal hemorrhage can be mistaken for an adrenal mass. A hypertrophied column of Bertin, sludge and stones in the renal collecting system can mimic a renal mass - CEUS can help in the distinction. In a known cancer patient, radiotherapy-induced organ injury, post-chemotherapy infections, bone marrow changes and thymic rebound hyperplasia are common. Diffusion-weighted imaging and dynamic contrast-enhanced MRI can help in problem-solving.

## **PDEE-85 Don't Ovary-act: A Sonographic Approach to Benign Pediatric Ovarian Pathology**

Fatemeh Hadian, MBChB, FRCR (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. A multi-follicular appearance is normal in neonates and teenagers and can be seen in prepubertal children. 2. Doppler flow may still be present in a twisted ovary and should not preclude making a diagnosis of torsion. 3. Benign ovarian lesions include ovarian cysts, para-ovarian cysts, mature cystic teratomas, cystadenomas and benign sex cord stromal tumors. 4. Diagnosing polycystic ovaries in adolescent females is challenging, but at-risk females can be identified for assessment at reproductive maturity. 5. Clinical history is crucial in differentiating between ovarian lesions with similar sonographic characteristics.

### **TABLE OF CONTENTS/OUTLINE**

Introduction - Normal ovaries, ovarian development, ovum development  
Acute ovarian pathology - ovarian torsion, antenatal ovarian torsion, canal of Nuck hernia, tubo-ovarian abscess  
Benign ovarian lesions  
Ovarian cysts - neonatal cysts, physiological and functional cysts, para-ovarian cysts  
Benign cystic tumors - mature cystic teratoma, cystadenoma  
Other benign ovarian tumors - benign subtypes of sex cord stromal tumors, gonadoblastoma  
Key points in differentiating benign vs malignant ovarian lesions  
Special considerations in adolescents - polycystic ovaries, endometriosis  
Role of O-RADS in children  
Conclusion

## **PDEE-86 Imaging Approach for Pediatric Thyroid Diseases**

Yuko Tsujioka, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Pediatric thyroid diseases have unique problems not seen in adult diseases. For example, congenital hypothyroidism is a common disorder that is usually detected on neonatal screening, but if missed, it causes serious intellectual disabilities. Juvenile thyroid dysfunction often manifest with non-specific symptoms (e.g., personality changes, declined school performance, weight fluctuation, decreased growth velocity), and may be fraught with diagnostic errors. Diagnostic imaging can be used to determine the underlying etiologies of endocrine thyroid diseases and provide supplementary information for thyroid hormone replacement therapy and antithyroid medication as well as to aid in the diagnosis of focal thyroid diseases, i.e., severity and extent of thyroid tumors and inflammatory diseases. In this educational exhibit, learners understand 1) the etiology, clinical features, and imaging findings in common pediatric thyroid diseases, 2) their unique features, and 3) how to use imaging modalities in the diagnostic approach for the diverse group of the disorders.

### **TABLE OF CONTENTS/OUTLINE**

Introduction - Thyroid development - Modalities of thyroid imaging - Congenital thyroid diseases including congenital hypothyroidism (thyroid dysgenesis, thyroid dysmorphogenesis, transient hypothyroidism, congenital central hypothyroidism) and congenital hyperthyroidism - Acquired thyroid diseases including autoimmune thyroiditis, non-autoimmune thyroiditis, secondary thyroid dysfunction, acquired central hypo- and hyperthyroidism, and tumor and tumor like lesions

## **PDEE-87 Skeletal Disorders Due to Abnormal Aggrecan Biosynthesis**

Yuko Tsujioka, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

We review the imaging findings of disorders associated with abnormal biosynthesis of aggrecan, a major proteoglycan of cartilage. Proteoglycans are widely distributed in the extracellular matrix, and impaired aggrecan synthesis interferes with normal bone and joint development and causes disorders with abnormal bone and joint. With development of massively parallel sequencing technology and increased understanding of proteoglycan biology, disorders once considered separate entities have been lumped together as a group of disorders called "aggrecanopathies." All aggrecanopathies are autosomal recessive disorders with 25% of recurrence risk, and the accurate diagnosis is crucial for genetic counseling. Aggrecanopathies manifest with growth failure and multiple joint abnormalities that often lead to a misdiagnosis of joint hypermobility/contracture syndromes, such as arthrogyrosis and Larsen's syndrome. However, radiological examination allows the differential diagnosis. The skeletal hallmarks of aggrecanopathies include stunted tubular bones due to impaired endochondral ossification and an abnormal "pattern formation" due to maldevelopment of embryonic cartilage templates, such as distal humeral bifurcation, double-layered patella, monkey wrench-like proximal femora, hyperphalangy, and accelerated carpal ossification.

## TABLE OF CONTENTS/OUTLINE

Introduction - Aggrecan synthesis process and related genes - Sulfation disorders (DTDST related, and others) - UDP-sugar deficiency (CANT1-related Desbuquios syndrome and others) - Linkeopathies

### **PDEE-88 High Negative Appendectomy Rates in Under-18-year-old Patients - A 10-year Review with Radiologic-Pathologic Correlation: And Then There Were None**

Juan Carlos Monte Gonzalez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Radiologist-performed ultrasound (R-US) is a reliable diagnostic technique for acute appendicitis in under-18-year-old (U18) patients. - In inconclusive R-US studies (9% in this sample), positive second-look techniques were CT (55,6%), R-US (33,3%) and MRI (11,1%). - Discordance with pathology findings/negative appendectomy rate (NAR) was 6%, lower than other series.

## TABLE OF CONTENTS/OUTLINE

One of our institution's pediatric surgeons suspected high NAR due to R-US low accuracy. This motivated a review of every appendectomy (610) in U18 patients, since the inauguration of our hospital (2012-2022). For this abstract, we sampled 100 patients that underwent appendectomy. We classified the cases by:- Age: 6-17 years-old (mean: 11,27 yo).- Gender: 41% female, 59% male.- Symptoms: 99% right lower quadrant pain, 63% nausea/vomiting, 18% temperature >37.3°C/99.1°F, 13% diarrhea, 12% hyporexia/anorexia.- Clinical signs: 67% Blumberg, 22% Psoas.- Laboratory values: 83% Leukocytosis >10,000, 68% leukocyte left shift (>75% PMNs), 67% CRP > 0.5.- Alvarado Score: 2-10 points (mean: 7,2).- R-US results: 90% positive, 1% negative, 9% inconclusive.- Second-look positive technique for inconclusive cases: 55,6% CT, 33,3% R-US, 11,1% MRI.- Appendix diameter: 5-20 mm (mean: 8,5 mm).- Surgical findings: 62% phlegmonous/suppurative, 17% phlegmonogangrenous/gangrenous.- Surgical technique: 53% open, 47% laparoscopic.- Pathology findings: 83% phlegmonous, 11% gangrenous, 5% reactive follicular lymphoid hyperplasia, 1% normal.- Discordance with pathology findings/NAR: 6%.- Evolution: 93% favorable, 4% complicated (1% dehiscence, 3% post-operative collections that resolved with antibiotics), 3% N/A.

### **PDEE-89 The Many Faces of Pediatric Langerhans Cell Histiocytosis: A Pictorial Review**

Maria F. Dien Esquivel, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Recognizing the typical imaging findings on different modalities of this rare disease is key to an early diagnosis and to guide management.2. MR imaging is the modality of choice to evaluate central nervous system involvement.3. FDG PET/CT plays a crucial role in the diagnosis, staging, surveillance and assessment of response to treatment of patients with LCH.

## TABLE OF CONTENTS/OUTLINE

-Epidemiology-Classification-Etiopathogenesis and molecular findings-Pathology-Clinical Presentation-Treatment-Imaging Modalities• Radiography (skeletal survey)• Computed Tomography• Magnetic Resonance Imaging• Bone scintigraphy• PET/CT -Imaging Features by system• Central Nervous System• Axial and appendicular skeleton (bone marrow)• Chest• Abdomen• Nodal involvement• Other sites: Skin-Role of imaging• At diagnosis/initial staging• To assess response to treatment• During surveillance/follow up

### **PDEE-90 Intravascular Catheters in Pediatrics: Methods, Imaging and Complications**

Larisa Gorenstein, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Intravascular catheter insertion in the pediatric population can be challenging, especially in infants. 2. The radiologist must be familiar with the imaging appearance of intravascular catheters, and recognize catheter malposition as well as other complications. In selected cases, a linogram may be diagnostic.3. Pediatric patients may experience unique complications such as thrombosis of the portal vein associated with umbilical vein catheterization.4. In some complications, such as malposition, it may be possible to perform an 'over-the-wire exchange.' However, in other cases, the only option may be to insert a new catheter.

## TABLE OF CONTENTS/OUTLINE

1. Important anatomy highlights.2. Types of catheters.3. Insertion methods and pitfalls.4. Intravascular catheters on pediatric imaging: pearls and pitfalls.5. Neonatal lines-special considerations.6. Cases.7. Diagnosis and management of complications.

### **PDEE-91 Little Bellies, Big Impact: Blunt Abdominal Trauma in Pediatric Patients**



## **Awards**

### **Certificate of Merit**

Fabiana Gual, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purposes of this exhibit are: To emphasize that trauma is a leading cause of death in the pediatric population, with abdominal injuries being a common and often unrecognized cause; To discuss the factors contributing to the higher risk of abdominal injuries in children, such as thinner abdominal wall and reduced adipose tissue; To highlight the importance of using the appropriate imaging test (including radiography, ultrasonography, contrast-enhanced CT and eventually magnetic resonance) based on the severity of the trauma and the stability of the patient; To provide examples of cases of low- and high-energy blunt abdominal trauma to demonstrate the utility of these imaging tests in diagnosing injuries to specific organs, such as the pancreas, liver, spleen, and kidneys; To acknowledge the challenges in evaluating children with blunt abdominal injury, especially pre-verbal children, and the need for diagnostic imaging to guide management decisions.

### **TABLE OF CONTENTS/OUTLINE**

A flowchart illustrating the use of diagnostic imaging in low- and high-energy blunt abdominal trauma in children. A table listing the "packages of injuries" that can be identified based on force vectors when the pancreas, liver, spleen, and kidney are injured. Illustrated teaching cases of patients who were treated at the pediatric emergency department of a quaternary hospital and underwent imaging tests. The cases involve low- and high-energy blunt abdominal trauma resulting in pancreatic, hepatic, splenic and renal injuries. The Pediatric Organ Injury Scale was used to classify the severity of these injuries.

### **PDEE-92 Multimodality Imaging Review of Inherited Collagen Disorders**

Daniel F. Morgan, DO (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Describe the epidemiology and pathophysiology of inherited collagen disorders in children. 2. Identify typical and atypical features of inherited collagen disorders. 3. Provide a comprehensive review of the key imaging findings for each disorder using a multi-system and multi-modality approach. 4. Discuss complications of disease and treatment options.

### **TABLE OF CONTENTS/OUTLINE**

I. General Introduction to Inherited Collagen Disorders  
II. Conditions  
A. Epidemiology  
B. Diagnostic Imaging Findings and Complications  
a. Osteogenesis Imperfecta: Wormian bones, multiple fractures, osteoporosis, in-utero manifestations, zebra stripe sign  
b. Ehlers-Danlos joint dislocations, fractures, hemarthrosis, sigmoid colon rupture, splenic artery aneurysm  
c. Stickler Syndrome facial deformities, articular manifestations  
d. Epidermolysis Bullosa cutaneous blisters and erosions with transformation to squamous cell carcinoma, pseudosyndactyly with mitten hand/sock toe deformities, esophageal stricture, pyloric atresia, osteomyelitis  
e. Alport Syndrome end-stage renal disease manifestations, esophageal leiomyomatosis  
C. Treatment  
III. Conclusion

### **PDEE-93 Fetal MRI to Detect Congenital Anomalies of the Kidney and Urinary Tract**

Chihiro Tani, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

As congenital anomalies of the kidney and urinary tract (CAKUT) account for 40% of childhood end-stage renal failure, an early diagnosis and appropriate treatment are important. Fetal ultrasonography and MRI help to diagnose some of the diseases included in CAKUT. Fetal MRI is important for postnatal treatment and follow-up. We discuss the development of the renal and urinary system in fetuses and present fetal MRI findings of major diseases in CAKUT.

### **TABLE OF CONTENTS/OUTLINE**

(1) The development of the renal and urinary system during the fetal period ; kidney, ureter, bladder, urethra  
(2) Fetal MRI findings of major diseases in CAKUT  
a. Renal anomalies ; multicystic dysplastic kidney, autosomal recessive polycystic kidney disease, horseshoe kidney, pelvic kidney, etc. Renal pelvis, calyx, and ureter anomalies ; ureteropelvic junction obstruction, megaureter, etc. Bladder and urethral anomalies ; bladder exstrophy, posterior urethral valves, etc.  
Outline  
CAKUT accounts for childhood end-stage renal failure. Therefore, an early diagnosis and appropriate treatment are important. As some of the diseases included in CAKUT can be diagnosed prenatally, radiologists must be cognizant of fetal MRI findings of major diseases in CAKUT.

### **PDEE-94 It's all about location! A Practical Compartment-Based Approach to Diagnosing Pediatric Head and Neck Masses**

Begum Ergin, MD, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Provide a practical compartment-based approach to create the best differential diagnosis of pediatric neck masses.2. Review the anatomy and content of each compartment3. Review relevant clinical and specific imaging findings of common and rare pediatric neck lesions based on a compartmentalized approach.

## TABLE OF CONTENTS/OUTLINE

A. BackgroundHow to diagnose a pediatric neck mass?Why should we prefer a compartment-based approach for diagnosing pediatric neck masses?B. Head and neck compartments and compartment-based pediatric head and neck masses • Superficial Fascia• Parapharyngeal Space• Pharyngeal Mucosal Space• Submandibular space• Sublingual Space• Masticator Space• Buccal Space• Parotid Space• Carotid Space• Retropharyngeal Space• Perivertebral Space• Posterior Cervical Space• Visceral Space • Transspatial-multispatial• MiscellaneousSummary1. Evaluation of pediatric head and neck masses can be challenging due to their embryologic origin, complex anatomy, and various affecting pathologies.2. Using a practical compartment-based approach with careful consideration of the clinical details and specific imaging findings will enable the best differential diagnosis.

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## Abstract Archives of the RSNA, 2023

PDEE-1

### Ear Anatomy and Anomalies in Fetal MRI

All Day Room: Learning Center

Matheus Dorigatti Soldatelli, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Describe ear anatomy and anomalies using in-vivo MRI in fetuses between 16 and 41 weeks of gestational age (GA). Additional 3D skin-surface reconstructions and postnatal or post-mortem imaging were performed in selected cases.

#### TABLE OF CONTENTS/OUTLINE

- Illustrate the ease of visualization of the pinna, external auditory meatus, cochlea, modiolus, vestibule, and semicircular canals at different GAs.- Demonstrate ear malformations in syndromic and non-syndromic patients and the associated extra-labyrinthine anomalies, such as facial and extremity abnormalities, that aid in phenotype-genotype correlation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-11

### Synapses and Signals: Nuclear Medicine Applications in Neurology and Endocrinology

All Day Room: Learning Center

Valentina Ferrer Valencia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Nuclear medicine imaging can provide valuable diagnostic and therapeutic information in the evaluation of central nervous system and thyroid diseases, but appropriate dose optimization and imaging protocols are essential to minimize the potential risks associated with radiation exposure. 2. Epilepsy evaluation can benefit from various nuclear medicine imaging techniques such as CSF flow studies, CNS radionuclide angiography, and SISCOM, which can provide valuable information about brain function and blood flow. 3. 18F-FDG PET is a useful tool for evaluating epilepsy, as it can provide information on brain metabolism and can help identify the location of seizure foci. 4. Pediatric thyroid diseases, such as hyperthyroidism, nodular thyroid disease, thyroid cancer, Graves Disease, and subacute thyroiditis, can be evaluated using a range of nuclear medicine imaging techniques, including thyroid uptake and scan, 123I whole-body scan, and 99mTc-MIBI imaging. 5. Nuclear medicine imaging can play a crucial role in the diagnosis and management of thyroid cancer, including the use of radioiodine therapy to target and destroy cancerous thyroid cells.

#### TABLE OF CONTENTS/OUTLINE

Introduction 1.PET 2.Image acquisition 3.Radiation dose Epilepsy 1.Epilepsy Evaluation 2.Tracers for Targeted Epilepsy PET Imaging 3.CSF Flow Studies 4.CNS Radionuclide Angiography 5.SISCOM 6.18F-FDG PET Pediatric Thyroid Disease 1.Hyperthyroidism 2.Nodular thyroid disease 3.Thyroid Cancer 4.Graves Disease 5.Subacute Thyroiditis Conclusions

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## Abstract Archives of the RSNA, 2023

PDEE-12

### Cortical Development Evaluation on Fetal Brain MRI Between 22 and 28 weeks: A Practical Guideline

All Day Room: Learning Center

Mariana Cerdeira Machado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To demonstrate the correct protocols for the adequate acquisition of the necessary sequences for the analysis of the cortical development; - To illustrate the morphological aspects of the principal sulci and gyri of the fetal brain between 22 and 28 weeks in a fetal MRI; - To learn the timing of the appearance of each new sulci between 22 and 28 weeks in a fetal MRI; - To recognize the early signs of cortical development abnormalities.

#### TABLE OF CONTENTS/OUTLINE

The purpose of this work is to illustrate the morphological aspects of the principal sulci and gyri and their time of appearance in the fetal brain between 22 and 28 weeks in a fetal MRI. For this, we will briefly discuss cortical development (neuronal proliferation, migration, and organization) and explore anatomic landmarks and their normal morphology throughout this period. Furthermore, we will demonstrate how to adequately perform an MRI exam and use it to evaluate the fetal brain cortex. Finally, we shall explore the early signs of cortex developmental abnormalities and the importance of a prompt diagnosis on the outcomes and prognoses.

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## Abstract Archives of the RSNA, 2023

PDEE-13

### Abdominopelvic Emergencies in Pediatric Oncology Patients: A Pictorial Review

All Day Room: Learning Center

Sara Garcia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Pediatric cancer patients are at increased risk for life-threatening emergencies that can affect all organs and systems. Such emergencies may be directly related to the disease at its debut or during its evolution or be secondary to the treatment administered.- Abdominal emergencies are frequent in these patients, and the imaging technique of choice for their study is ultrasound. Plain abdominal radiography, CT and MRI are usually used as complementary studies in case of specific suspicions or for better characterization.- Among the pathology affecting the intestinal loops at the debut intestinal obstruction stands out, especially intussusception, which is very typical in the pediatric population. Typhlitis or neutropenic colitis usually occurs as a complication of QT treatment in patients with ALL.- Among the hepato-biliary emergencies secondary to treatment, hepatotoxicity and sinusoidal obstruction syndrome are the most frequent, the latter presenting typical characteristics on Doppler study.- Acute pancreatitis is a possible complication of chemotherapy with L-asparaginase.- Hemorrhagic cystitis occurs as a complication treatment with cyclophosphamide in patients with HSCT. The bladder is the most affected organ.- Testicular neoplasms do not increase the risk of torsion but can present at onset as acute scrotal syndrome.

#### TABLE OF CONTENTS/OUTLINE

1. General classification of emergencies in pediatric oncology patients. Classification of abdominal emergencies, both those that occur at the onset of the disease and those that are secondary to oncological treatment.2. Description of the main clinical features and imaging findings of abdominal emergencies in these patients.

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## Abstract Archives of the RSNA, 2023

PDEE-14

### **Mind the Gaps: Avoiding Fracture Pitfalls in Pediatric Musculoskeletal Radiology**

All Day Room: Learning Center

Lucas R. Medeiros (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1. To review normal pediatric musculoskeletal imaging findings that can mimic fractures in a multimodality approach 2. To discuss hard-to-identify and pediatric-specific fractures 3. To assess the differential diagnosis of pediatric pathological conditions 4. To analyze treatment-related findings that can simulate pathologies

#### **TABLE OF CONTENTS/OUTLINE**

1. Salter-Harris fractures 2. Green-stick fractures 3. Plastic deformation fractures 4. Torus fractures 5. Non-accidental injury fractures 6. Ossification centers mimicking fractures 7. Secondary fracture findings 8. Metabolic and genetic conditions (e.g. rickets, osteogenesis imperfecta) 9. Skeletal dysplasias 10. Obstetric injury 11. Anatomical variations

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## Abstract Archives of the RSNA, 2023

PDEE-15

### Temporosquamous Suture: An Updated View of the Importance of this Finding in Craniosynostosis

All Day Room: Learning Center

Yuree M. Herenio SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The squamous suture is the main object of our work. While the phenotypic appearances and sequelae of synostosis of the major cranial vault sutures are well documented, little is reported concerning synostosis of the squamous suture. Involvement of this suture can be individual or associated with other sutures, both in syndromic cases and in primary craniosynostosis. This work has the objective to demonstrate the importance of the temporosquamous suture, which has been undervalued over the years in literature. Recent studies and their surgical correlations show different types of cranial deformity, depending on the location of partial or complete closure of this suture. Deformities include scaphocephaly, plagiocephaly or brachycephaly. Our work shows different types of closure evaluated in our department. We also consider fundamental the use of the Maximum Intensity Projection protocol (MIP) to demonstrate the real shape of the sutures and to investigate craniolacunia, which constitutes a relevant finding in the surgical decision, as it may represent signs of intracranial hypertension.

#### TABLE OF CONTENTS/OUTLINE

The work shows a literature review about the squamous suture, showing part of the cases of CT with Maximum Intensity Projection protocol (MIP) and volume rendering 3D reconstruction of different types of closure, evaluated in our department.

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## Abstract Archives of the RSNA, 2023

PDEE-16

### Epiphanies about Epiphyses: Distinguishing Epiphyseal Mass Lesions in Children

All Day Room: Learning Center

#### Awards

##### Cum Laude

Eric L. Tung, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Epiphyses have unique histology and play an important role in osseous development. The differential diagnosis for epiphyseal mass lesions in children is one that radiologists interpreting pediatric imaging should be familiar with. Overlapping imaging findings of epiphyseal tumors and other focal lesions on radiography and magnetic resonance imaging can hinder the ability of radiologists to establish specific diagnoses by imaging alone. However, knowledge of characteristic imaging features for each lesion can improve the accuracy and specificity of radiologists' interpretations. By the end of this exhibit, learners should be able to provide a differential diagnosis for pediatric epiphyseal mass lesions, recognize the unique imaging features of each diagnosis, and apply a framework for MRI evaluation of epiphyseal lesions to unknown cases.

#### TABLE OF CONTENTS/OUTLINE

1. Background: Epiphyseal development, structure, equivalents; 2. Differential diagnosis for epiphyseal tumors and other focal lesions in children; 3. Review of characteristic imaging findings for each diagnosis; 4. Framework for MRI interpretation to help narrow differential diagnosis; 5. Unknown cases to reinforce learning objectives

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## Abstract Archives of the RSNA, 2023

PDEE-17

### **Pediatric Metabolic Bone Disorders - A Comprehensive Review**

All Day Room: Learning Center

Archana Malik, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Illustrate the common and uncommon metabolic bone disorders in children. Identify imaging features that can help differentiate the various metabolic disorders.

#### **TABLE OF CONTENTS/OUTLINE**

Metabolic bone disease in children includes hereditary and acquired conditions of varying etiologies. The purpose of this educational exhibit is to describe the characteristic imaging findings of metabolic bone disorders to include endocrine and nutritional deficiencies. Entities such as rickets, scurvy/ hypovitaminosis C, osteogenesis imperfecta, hyperparathyroidism, renal osteodystrophy, celiac disease, inflammatory bowel disease, hypophosphatasia, osteopetrosis, sickle cell anemia, Gaucher's, heavy metal poisoning, and bone disease secondary to medication such as prolonged steroid treatment will be discussed. Early recognition and treatment of potential risk factors is important to avoid significant clinical consequences.

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## Abstract Archives of the RSNA, 2023

PDEE-18

### Pediatric Skull Lesions

All Day Room: Learning Center

Preeti S. Prasad, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To discuss the common pathologies affecting the pediatric skull.
- To discuss imaging appearance of various skull lesions seen in children.
- To develop a systematic approach to diagnosing skull lesions.

#### TABLE OF CONTENTS/OUTLINE

Goals and objectives -Background information -Common and uncommon skull lesions in children -Imaging spectrum of pediatric skull lesions -Indications for further imaging -Summary. Pediatric skull lesions can be congenital, traumatic, vascular, inflammatory, infectious, or malignant. These lesions can be clinically palpable or incidentally detected on imaging. The incidentally detected lesions include parietal foramina, sinus pericranii, and venous lakes. The palpable abnormalities can be present at birth, such as cephalohematoma, birth trauma, meningocele/encephalocele, venous malformation, and dermoid/epidermoid cysts. Thalassemia, intraosseous hemangioma, osteoma, lipoma, Langerhans Cell Histiocytosis (LCH), Fibrous dysplasia, Neuroblastoma metastases, Ewing's sarcoma usually present later in life. Most of these lesions are visible on skull radiographs. Further evaluation is performed by ultrasound, computed tomography (CT), and Magnetic Resonance Imaging (MRI). Cephalohematoma and Parietal foramina are identified on ultrasound and radiographs respectively. Dermoid /Epidermoid cysts are commonly seen in the midline, frontal and temporal regions. LCH is usually seen as a beveled edge skull lesion. Fibrous dysplasia presents as expansile lesions with a ground glass matrix seen on CT. Our exhibit will discuss various skull lesions seen in the pediatric age group, their imaging appearance, and a systematic approach to the correct diagnosis.

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## Abstract Archives of the RSNA, 2023

PDEE-19

### **Focused Thoracic Ultrasonography for the Elucidation of Radiolucent Areas in Pediatric Patient's Chest X-ray: Approach Based on Cases**

All Day Room: Learning Center

Taila S. Moura Fe (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The main objectives of this exhibit are to: 1- Review the importance of thoracic ultrasonography in critical pediatric care and its potential benefits in reducing radiation exposure in neonates and infants. 2- Discuss various conditions that present as lucent lesions on chest X-rays and review sonographic findings of these conditions. 3- Emphasize the use of Focused Thoracic Ultrasound as a reliable tool in critical pediatric care and expand the use of bedside thoracic ultrasound helping physical examination.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction; Review of the use of thoracic ultrasonography; Case-based review of conditions that present as lucent lesions, with a challenging chest x-ray at the beginning of each case, followed by sonographic findings; Conditions included: Diaphragmatic hernia (Morgagni's and Bochdalek's hernia); Pneumothorax; Pneumomediastinum; Necrotizing pneumonia; Pulmonary cavitation/pneumatocele; Poland syndrome; Subcutaneous emphysema; Congenital deficiency of surfactant production; Congenital pulmonary airway malformation (CPAM)

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## Abstract Archives of the RSNA, 2023

PDEE-2

### Imaging Review of the Pediatric Spine: Do Abnormalities Always Indicate Disease?

All Day Room: Learning Center

Ana Carolina D. Augusto, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this study is: • To review the development of the spine, focusing on the formation and malformations of vertebrae. • To illustrate and discuss the normal appearance, anatomical variations, and common pathologies involving the spine during skeletal growth.

#### TABLE OF CONTENTS/OUTLINE

- Embryology: The vertebral column and spinal cord develop in a precise, sequential manner during gestation. Any deviation from this normal process can cause structural variations in the spine and spinal cord.
- Congenital and acquired deformities of the vertebral bodies: defects related to fusion, formation, and segmentation of the vertebral bodies may lead to congenital scoliosis and could be linked with spinal dysraphisms, skeletal, cardiac, genitourinary, and gastrointestinal anomalies. Acquired deformities of the vertebral bodies can be caused by different factors, including trauma, infection, malignancies, systemic diseases, among others.
- Bone marrow: bone marrow conversion from red to yellow marrow follows a well-established pattern during childhood. Understanding the normal signal intensity changes on MRI is crucial to detect deviations that may represent disease.
- Normal developmental events, pitfalls, and common abnormalities during skeletal maturation: recognizing these developmental events and common abnormalities can assist in image interpretation, guiding treatment and management decisions.

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## Abstract Archives of the RSNA, 2023

PDEE-20

### **Osteogenesis Imperfecta: A Pictorial Review**

All Day Room: Learning Center

Adriano Silveira Moreira Novaes, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Osteogenesis imperfecta (OI) is a genetic disease characterized by increased bone fragility, low bone mass and other connective tissue manifestations. The most common cause of OI is mutations in one of the two genes encoding collagen type 1, which is a major component of bone and other connective tissues. OI can present with a wide range of symptoms, and there are now seven recognized types of the disorder. The radiologist must be prepared to recognize the image patterns, determining a correct diagnosis, which facilitates the early and adequate treatment of the patient. Excluding differential diagnoses, such as non-accidental injury, is of fundamental importance. The purpose of the present study is to exhibit imaging findings of types I, III, IV, V and VI of OI; to demonstrate how to differentiate the types based on imaging findings; to demonstrate how to differentiate OI from non-accidental injuries.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction. Epidemiology and clinical finds. Main findings of type I, II, III, IV, V and VI. How to differentiate the types based on imaging findings. Excluding differential diagnoses, such as non-accidental injury, is of fundamental importance. Conclusion/Take home message.

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## Abstract Archives of the RSNA, 2023

PDEE-21

### **Pediatric Renovascular Hypertension A-Z: Diagnostic Work-up, Imaging, Interventions, and Troubleshooting**

All Day Room: Learning Center

Anthony T. Chong, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Renovascular hypertension (RVH) is caused by an upregulation of the renin-angiotensin-aldosterone system due to flow-limiting renovascular disease (RVD). In pediatric patients, the differential includes fibromuscular dysplasia, neurofibromatosis, vasculitis, abnormal arterial supply and trauma.2. Although ultrasound is the initial imaging modality for diagnosing RVD, it is limited in evaluation of segmental branches. Angiography is the gold standard for diagnosis.3. Interventional radiology can offer a variety of interventions for RVD, including angioplasty and embolization. Surgical interventions can be offered in angioplasty-refractory stenosis.4. A multidisciplinary care team consisting of nephrologists, diagnostic and interventional radiologists, and transplant and vascular surgeons is necessary for the global care of young patients with RVH.

#### **TABLE OF CONTENTS/OUTLINE**

1. Differential diagnosis, diagnostic work-up and medical management for pediatric RVH2. Multi-modality approach to the imaging diagnosis for pediatric RVD including: renal artery Doppler ultrasound, contrast-enhanced ultrasound, computed tomography angiography, magnetic resonance angiography, and catheter angiography3. Endovascular renal artery interventions and technique for RVH management4. Indications for surgical intervention5. Surveillance and follow-up; troubleshooting for persistent hypertension

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## Abstract Archives of the RSNA, 2023

PDEE-22

### Radiogenomics of PIK3CA Related Disorders: A New Era

All Day Room: Learning Center

Jada Hislop, BA (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Vascular anomalies are traditionally classified based on clinical characteristics, imaging and pathology. Diagnosis is challenging due to overlapping phenotype and inconsistent naming conventions. With the rapid development of new technologies in oncology, radiogenomics has emerged as a science which is beginning to change our understanding and treatment of vascular anomalies as well. Advances aid in clarifying etiology and elucidate previously unknown pathomechanisms. Through sequencing of tissue samples, postzygotic somatic variants have been discovered for several vascular anomalies with and without overgrowth as is the case with PIK3CA. PIK3CA driven vascular anomalies may now be treated with mTOR inhibitors and newly approved PIK3CA inhibitors. This exhibit will be a case-based approach to review recent advances in diagnosis including imaging finds, genetic testing, and review management of these disorders. Review the clinical spectrum of disorders associated with pathogenic variants in PIK3CA gene - from isolated vascular malformations to recognizable disorders. Highlight the manifestations of some PIK3CA-related disorders presenting with overgrowth (PROS). Review MRI imaging findings and pathology in patients with confirmed variants in PIK3CA. Discuss the evolving nature of genetic testing in somatic disorders and suitable tissue samples for testing. Briefly discuss therapeutic options including new medical managements

#### TABLE OF CONTENTS/OUTLINE

Introduction to PROSPIK3CA Genetic Pathway  
Selected examples and isolated vascular anomalies and overgrowth disorders  
Diagnostic approaches with imaging  
Diagnostic approaches with genetic  
Therapeutic approaches  
Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-23

### **The Top 10 Most Feared Diagnostic Errors by Radiology Trainees in Pediatric Neuroradiology Emergencies: Practical Tips and Tricks for Early Detection and Prevention**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Agustin M. Cardenas, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Recognize the key imaging findings of the "top 10" Pediatric Neuroradiology Emergencies considered most challenging by Radiology trainees. 2. Identify the most feared potential errors and pitfalls made by Radiology trainees when interpreting these type of cases. 3. Learn potential contributing factors to developing these errors. 4. Provide practical tips and tricks to help prevent these potential errors. Provide specific strategies to apply them, in order to improve diagnostic confidence of Radiology trainees in clinical practice.

#### **TABLE OF CONTENTS/OUTLINE**

I. Introduction II. Top 10 challenging Pediatric Neuroradiology cases during call 1. Detection of early cerebral edema. 2. Detection of dural sinus thrombosis in noncontrast head CT. 3. Retropharyngeal edema vs early abscess. 4. Detection of early shunt failure. 5. Craniocervical junction fracture vs normal developing ossification center. 6. Calvarial fracture vs suture. 7. Branchial cleft cyst vs retropharyngeal abscess. 8. Time estimation of heterogeneous subdural collections. 9. Porencephalic cyst vs ventriculomegaly 10. Detection of early orbital cellulitis. III. Take home points IV. References

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## Abstract Archives of the RSNA, 2023

PDEE-24

### **The Role of Imaging in Radiotherapy Planning: An Illustrated Review of Common Pediatric Tumors Treated with Radiotherapy**

All Day Room: Learning Center

Susan C. Gowdy, FRCPC, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Review some of the more common paediatric tumours treated with radiotherapy. Understand the role of imaging in the decision-making process regarding type of radiation therapy and mode of delivery. Consider how different imaging modalities may be incorporated into planning a radiation therapy field. Evaluate the potential role of imaging surveillance following radiotherapy.

#### **TABLE OF CONTENTS/OUTLINE**

Successful management of pediatric malignancies requires a multidisciplinary team approach. This educational exhibit aims to highlight the importance of close collaboration between radiologists, nuclear medicine physicians and radiation oncologists when assessing tumours of childhood which can be treated with radiotherapy. Using case examples of a medulloblastoma, Hodgkin's lymphoma and neuroblastoma, we will present imaging to review radiological features at diagnosis, relevant staging systems and response criteria that are important considerations for radiation oncologists planning radiotherapy treatment. The role of the different imaging modalities including various MRI sequences will be illustrated as the process of planning a radiation therapy field is discussed. Potential treatment complications including current literature regarding the role of imaging in surveillance will be reviewed.

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## Abstract Archives of the RSNA, 2023

PDEE-25

### MRI Findings in Hypovitaminosis C: Separating Scurvy from the Crowd

All Day Room: Learning Center

Sean J. Sun, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Symmetric metaphyseal edema involving the lower extremities is an uncommon finding. Causes include metabolic disorders, multifocal infection, autoimmune disorders, inherited diseases, and malignancy. Recognizing that bilateral lower extremity metaphyseal edema is a consistent finding in hypovitaminosis C can lead to early diagnosis and avoidance of further unnecessary testing and procedures. 2. Differential diagnoses for symmetric metaphyseal edema include focal periphyseal edema zones, chronic noninfectious osteitis, malignancy, osteomyelitis, and sickle cell disease. 3. Although subperiosteal hemorrhage can be seen with other etiologies such as bone infarct from sickle cell disease it can be a specific finding in hypovitaminosis C. 4. Since the diagnosis of hypovitaminosis C may not be initially considered, recognition of the imaging findings is important for early diagnosis. This allows for timely treatment and avoidance of further testing. 5. Scurvy has several clinical and laboratory findings that overlap with more common pathologies. a. Clinical: (Early) Gingival hyperplasia, joint swelling and bruising. (Late) Fever, jaundice, hemolysis, spontaneous bleeding and neuropathy. b. Laboratory: Mild leukocytosis. Elevated ESR and CRP.

#### TABLE OF CONTENTS/OUTLINE

1. Case series of 4 patients with hypovitaminosis C. a. History b. Clinical presentation c. Laboratory values d. Imaging 2. Review of the differential diagnosis of symmetric metaphyseal edema. a. Imaging features that can be specific for hypovitaminosis C. b. Imaging findings suggestive of an alternative diagnosis. c. Nonspecific clinical findings of hypovitaminosis C.

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## Abstract Archives of the RSNA, 2023

PDEE-26

### **Pediatric Rhabdomyosarcoma: Imaging Evaluation from Diagnosis to Treatment Monitoring**

All Day Room: Learning Center

Dana Alkhulaifat, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Rhabdomyosarcomas (RMS) are the most common type of soft tissue sarcomas in children. Risk factors include cancer predisposition syndromes such as Li- Fraumeni, Noonan and Beckwith-Wiedemann.
- Prognosis depends on several factors including location of the tumor, size, histopathology, genetics and imaging findings.
- The most optimal imaging modality for measuring local tumor involvement is cross sectional imaging by CT or MRI.
- For regional lymph node and metastatic assessment, whole-body fluorodeoxyglucose (FDG) PET/CT or PET/MRI in combination with chest CT is recommended.
- Treatment is multimodal and consists of multi-agent chemotherapy, along with surgical resection and radiotherapy of the primary tumor.
- MRI is the recommended modality for monitoring chemotherapy response for primary tumor, while FDG PET/CT or PET/MRI in combination with chest CT is recommended for lymph nodal and metastatic disease.

#### **TABLE OF CONTENTS/OUTLINE**

1. Brief overview of pediatric rhabdomyosarcomas: epidemiology, risk factors and clinical presentation.
2. Initial tumor assessment:
  - a. Primary tumor
  - b. Regional lymph nodes
  - c. Metastatic lesions
3. Stratification of severity
  - a. Tumor location
  - b. Histological subtype
  - c. Cytogenetic information
  - d. Imaging staging (CT, MRI and PET)
4. Treatment regimens and response monitoring
  - a. Imaging modalities
  - b. Frequency of monitoring
  - c. Definitions of remission or progression.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-27

### Central Nervous System Involvement in Mucopolysaccharidoses: Understanding Pathophysiology and Radiological Findings

All Day Room: Learning Center

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To understand the basic pathophysiology that directly or indirectly affects the central nervous system, including bone instability. To be able to recognize the main radiological findings of the different subtypes of this disease. To inform about new imaging diagnostic strategies such as spectroscopy.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: Definition and general characteristics  
2. Clinical presentation in the central nervous system. I: Alpha-L-iduronidase - Hurler (I H): mental retardation, dysostosis - Scheie (I S): normal intelligence - Hurler-Scheie (I H-S): Intermediate between both above  
II: Iduronate sulphatase - Hunter: dysostosis  
III: Profound mental deterioration - Sanfilippo A: Heparan sulphamidase - Sanfilippo B: N-acetyl-glucosaminidase - Sanfilippo C: Acetyl-CoA: alpha-glucosaminide acetyltransferase - Sanfilippo D: N-acetylglucosamine 6-sulphatase  
IV: Galactose-6-sulphate sulphatase, Beta-galactosidase: Dysostosis, motor dysfunction - Morquio A - Morquio B  
VI: N-acetylgalactosamine-4-sulphatase - Maroteaux-Lamy: dysostosis, kyphosis  
VII: Beta-glucuronidase - Sly: dysostosis  
3. Diagnostic methods. Imaging findings and protocols.  
4. Treatment options for mucopolysaccharidoses.  
5. Future directions in imaging of mucopolysaccharidoses - Spectroscopy: diagnosis and future applications  
7. Case series

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-28

### Easy-peasy! Simplifying the Myelination Progress in Term Newborn

All Day Room: Learning Center

Marcella N. Brandao, MD, MEd (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review the normal myelination process in term newborn, as well as its progression. Tips for standardizing the evaluation of the myelination process. Guide step by step the myelination milestones, the main differential diagnoses and the disturbances in the myelination process that must be recognized.

#### TABLE OF CONTENTS/OUTLINE

Infant brain magnetic resonance imaging (MRI) interpretation presents unique challenges due to different appearances depending on age. This occurs through the myelination process which, despite starting in utero, has acceleration and predictability between individuals in the first postnatal year, with a predetermined scheme of chronological and topographical sequences, serving as an important normal brain maturation marker on MRI. Myelination occurs by a gradual myelin sheath dehydration, at the same time that lipids and proteins are deposited. This process is dynamic and the molecular interactions of water with lipids and myelin membrane proteins are modified and affect the relaxation time in the T1W and T2W sequences. T1W weighted images are most useful up to 8 months old with the myelinated white matter showing hypersignal, and T2W weighted images are useful in the later stages of myelination, showing hyposignal in the face of reduced myelin water content. Although predictable, the evaluation of myelination on MRI is still a challenge for many radiologists, so the authors structure a step-by-step guide with the myelination milestones, the main differential diagnoses and the disturbances in the myelination process that must be recognized.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-29

### Anatomic Approach to Non-Traumatic Lesions of the Pediatric Visual Pathway

All Day Room: Learning Center

Vivek B. Pai, MBBS, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Most of the visual pathway is inaccessible for histopathology; radiology is the only diagnostic modality available. Hence accuracy is of utmost importance for adequate management and optimal outcome 2. Having an anatomic approach will help narrow differentials.

#### TABLE OF CONTENTS/OUTLINE

A. Discussion on the anatomy of the visual pathway. B. Pictorial essay on lesions affecting the visual pathway with discussion on etiopathogenesis and presentation. Lesions are divided according to the anatomic location: 1. Retina: Retinal Detachment, Retinal hemorrhage, Panophthalmitis, Medulloepithelioma, Retinoma, Retinoblastoma. 2. Optic disc: Papilledema and IIH, Optic Drusen, Coloboma, CHARGE syndrome, Morning Glory syndrome. 3. Optic nerve: Anophthalmia-related aplasia, hypoplasia, demyelinating disorders, mitochondrial disorders, visual pathway gliomas. 4. Optic chiasm: Septo-optic dysplasia, Krabbe disease, Opto-Chiasmatic tuberculosis, hypothalamic-chiasmatic glioma. 5. Occipital lobes: Adrenoleukodystrophy, hypoxic-ischemic encephalopathy, hypoglycemic encephalopathy, PCA territory infarction, Posterior Reversible Encephalopathy Syndrome, occipital cephalocele, focal cortical dysplasia

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## Abstract Archives of the RSNA, 2023

PDEE-3

### US Evaluation of the Pediatric Hand Trauma: From One Through Five

All Day Room: Learning Center

Emilio Inarejos Clemente, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

After reviewing this exhibit, the learner should be able to: 1. Recognize the normal US appearance of the pediatric hand. 2. Describe the use of high-resolution US, Doppler US and microvascular imaging for the evaluation of trauma-related conditions of the hand in children. 3. Review the most common traumatic conditions affecting the hand in children. 4. Discuss the US findings of the most frequent traumatic entities occurring in hand and wrist.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Transducers and technical US parameters to optimize the examination of the hand. 3. Normal US appearance of the pediatric hand, including tendons, ligaments, vessels, and nerves. 4. Authors will focus on five compartments (from one through five): 4.1. Ligaments 4.2. Tendons 4.3. Vessels 4.4. Nerves 4.5. Bone 5. Ligament injuries: Collateral ligaments (Stener lesion), pulley lesions, volar plate lesions. 6. Tendon injuries: Superficial and profundus flexor tendon lacerations and transections, extensor tendon injuries, impingements, tenosynovitis. 7. Vessels: Venous/arterial thrombosis, post-traumatic pseudoaneurysm. 8. Nerves: Laceration and transection, post-traumatic neuroma. 9. Bone: Fractures, callus formation with secondary impingement. 10. Foreign bodies characterization and removal with US guidance. 11. Injuries will be correlated with anatomical draws, as well as with MRI images. 12. Summary

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## Abstract Archives of the RSNA, 2023

PDEE-30

### Diagnostic Error in Pediatric Neuroradiology

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Buffy F. Dekmar, MD, MEd (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) Medical error has significant impacts on patient outcomes and society as a whole. (2) Error in diagnostic radiology can be organized in terms of types of thinking. (3) Metacognition, self-awareness, and understanding of specific strategies related to types of error can help radiologists reduce error. (4) Case-specific teaching to reduce error in pediatric emergency neuroradiology.

#### TABLE OF CONTENTS/OUTLINE

For each error type there will be: A pediatric neuroimaging case, a definition of error type, lessons learned, and known strategies to prevent this error. (1) Perceptive Error; (2) Cognitive Error: a) Anchoring bias, b) Confirmation bias, c) Availability bias, d) Satisfaction of report, e) Framing bias, f) Attribution bias, g) Satisfaction of search, h) Premature closure, i) Inattentional bias, k) Hindsight bias; (3) Communication Error; (4) Process Error

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-32

### **Polymorphous Low Grade Neuroepithelial Tumor of the Young: An Institutional Case Series with Radiological and Pathological Correlation**

All Day Room: Learning Center

Thomas P. Reith, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Polymorphous low grade neuroepithelial tumor of the young (PLNTY) is a rare, epileptogenic brain tumor that was recently described as a distinct entity in the 2021 World Health Organization classification of CNS tumors. Teaching points include: 1) PLNTY usually occurs in children and adolescents, although is occasionally diagnosed in adults. Clinically, patients often present with refractory seizures. 2) Histological characteristics of PLNTY include an infiltrative growth pattern, intense CD34 expression, cellular components resembling oligodendroglioma, and calcifications. 3) Imaging characteristics of PLNTY include T1 hypo/iso-intensity, T2 hyperintensity, GRE blooming artifact, non- (or slight) enhancement on contrast imaging, cystic components, and internal calcifications. Morphologically, PLNTY is often well-circumscribed and located in the temporal lobe. 4) At a molecular level, PLNTY is characterized by the presence of either a BRAF V600E mutation or chromosomal translocations involving FGFR2 and FGFR3. Both genetic alterations activate the MAP kinase pathway. 5) Imaging differential diagnoses include other low grade cortically based tumors such as oligodendroglioma (usually found in adults), dysembryoplastic neuroepithelial tumor (DNET), ganglioglioma, pleomorphic xanthoastrocytoma, and pilocytic astrocytoma. 6) Surgical resection is usually curative of seizures.

#### **TABLE OF CONTENTS/OUTLINE**

-Introduction, PLNTY's place in the WHO 2021 Classification of CNS tumors -Imaging characteristics of PLNTY -Histological characteristics of PLNTY -Discussion of pathophysiology and molecular subtypes -Imaging comparisons of differential diagnoses

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-33

### Inside the Womb: A Fascinating Look at Congenital Kidney Pathology through Fetal MRI

All Day Room: Learning Center

Lizbet Perez-Marrero (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Fetal MRI has emerged as a valuable and high-resolution imaging modality for the comprehensive assessment of fetal renal anomalies.2) By utilizing a systematic review approach, radiologists can effectively characterize the fetal kidneys, providing a comprehensive understanding of the extent and severity of the anomalies.3) Incorporating functional kidney assessments and measuring total lung volume during fetal MRI can enhance the overall evaluation of the fetus, providing a better understanding of the patient's condition and enabling more informed parental counseling.

#### TABLE OF CONTENTS/OUTLINE

When evaluating the kidneys, the following topics should be assessed, as combined alterations may be found associated with different pathologies:- position: situs solitus versus ectopia.- morphology: duplex, horseshoe.- size: duplex, autosomal recessive polycystic kidney disease (ARPKD)/ autosomal dominant polycystic kidney disease (ADPKD).- focal lesions: cysts, tumors.- excretory system: posterior urethral valves.- renal function: hypofunctioning - related systems: amniotic fluid, assessment of lung volume (hypoplasia cutoff value?), uterus/annexa.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-34

### Neonatal Liver Imaging: Techniques, Normal Variations and Common Pathologies

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Govind B. Chavhan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Neonatal liver has some unique aspects in terms of imaging and imaging appearances as compared to older children. Choosing and tailoring of imaging for each indication in neonate is therefore important for optimal care with minimal invasiveness. Common indications for imaging include incidental focal lesions, neonatal liver failure, cholestasis and sepsis. Imaging is important component of work up in neonatal liver failure helping to narrow differentials. It may help to salvage liver and potential transplant by timely diagnosis of conditions such as neonatal hemochromatosis.

#### TABLE OF CONTENTS/OUTLINE

Introduction (overview of neonatal liver pathology, incidence, etc.; role of imaging) Imaging modalities- (discussion of specific roles, pros/cons, with relevant summary tables) What changes and what is normal at birth? (discussion of normal imaging appearance of structures related to neonatal liver) Indications for imaging (Incidental lesions, liver failure/dysfunction, cholestasis, sepsis, etc) Common pathologies (work up and role of imaging in the work up) - Congenital calcifications (causes, natural course, imaging) - Line related complications (hematoma, abscess) - Infections (TORCH, herpes, bacterial) - Neoplastic lesions (common lesions- hemangioma/HB/mesenchymal hamartoma /mets) - Vascular abnormalities (thrombosis, portosystemic shunts, AVMs, Heterotaxy) - Neonatal liver failure- causes, workup and role of imaging (NH, HLH, metabolic diseases, infection, cholestatic diseases)Summary

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-35

### Pediatric Neck Cystic Lesions

All Day Room: Learning Center

Juan F. Velez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cystic lesions are common findings in pediatric patients. Imaging plays a crucial role guiding the diagnosis and depicting the anatomical extent of the lesion. Multimodality imaging narrows the differential diagnosis by demonstrating the lesion's components. Age groups and anatomic location in the neck are also diagnostic clues. It is important to recognize potential complications, especially infections.

#### TABLE OF CONTENTS/OUTLINE

o Congenital and Developmental Disorders § Thyroglossal duct cyst § Branchial cleft anomalies § Dermoid/Epidermoid cyst § Thymopharyngeal duct cyst o Vascular § Lymphatic malformations § Venous malformations § Cervical hemangioma § Pseudoaneurysms § Internal jugular phlebectasia o Infectious § Suppurative lymphadenitis § Tuberculous lymphadenitis § Abscess o Neoplastic § Schwannoma § Warthin tumor § Congenital cervical teratoma § Cervical lymph node metastases o Miscellaneous § Ranula § Thyroid colloid cyst § Laryngeal cyst

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-36

### Imaging of DDh: An Update on Diagnostic, Follow-up and Post-operative Findings

All Day Room: Learning Center

Murilo Campos Silva, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is: To review the anatomy of the infant hip. To discuss the incidence, risk factors and pathophysiology of Developmental Dysplasia of the Hip. To review the clinical and imaging diagnostic criteria for DDH. To discuss the role of each imaging method in the context of DDH. To demonstrate the importance of early diagnosis and proper treatment of DDH with successful cases and adequate treatment, as well as late diagnosis and its complications.

#### TABLE OF CONTENTS/OUTLINE

Theoretical introduction containing epidemiology, risk factors and pathophysiology. Anatomy of the infant hip, including bone structures and the most relevant anatomic landmarks in DDH's diagnosis and follow-up. Images of clinical cases demonstrating some of the long-term complications, with emphasis on the importance of early diagnosis and proper treatment to avoid them. Brief discussion and illustration of the main current treatments as well as imaging follow-up evaluation with expected and unfavorable outcomes. Latest updates on diagnosis and treatment of DDH.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-37

### Imaging Appearance of Common and Less Common Fetal Masses from Head to Toe

All Day Room: Learning Center

#### Awards

##### Magna Cum Laude

Elizabeth J. Snyder, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) Masses detected prenatally range from congenital malformations to tumors; knowledge of the imaging appearance of common and uncommon fetal masses is important for appropriate pregnancy management, delivery planning and immediate postnatal management-2) Both US and fetal MRI play important and complementary roles in the evaluation of fetal masses.3) Using an anatomic approach to fetal masses, the differential diagnosis can be narrowed, allowing for more accurate prenatal counseling and management.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction: a. Epidemiology of fetal masses, b. Overview of categories of fetal masses: congenital malformations, benign tumors, malignant tumors2. Imaging approach to fetal masses: a. Prenatal ultrasound, including 3-D ultrasound b. Role of fetal MRI3. Anatomic approach to the prenatal diagnosis of fetal masses: a. Head neck: teratoma, lymphatic malformations, etc. b. Chest: congenital lung lesions, mediastinal teratoma, congenital myofibroblastic tumor, cardiac rhabdomyoma, etc. c. Abdomen/pelvis: hepatic congenital hemangiomas, neuroblastoma, congenital mesoblastic nephroma, sacrococcygeal teratoma, ovarian cyst, etc. d. Extremities: infantile fibrosarcoma, etc.4. Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-38

### Detection of Aspirated Food in Pediatric Airway using Computed Tomography (CT)

All Day Room: Learning Center

Joseph R. Swicklik, RT, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Explain clinical significance challenges detecting aspirated food in pediatric airway.
- Describe challenges solutions for CT imaging.
- Explain method for optimal imaging of radiopaque food matter.
- Illustrate benefits of CT in detecting aspirated food particles in clinical applications.

#### TABLE OF CONTENTS/OUTLINE

1. Foreign body aspiration in pediatric airways
  - a. Common issue in pediatric patients
  - b. The most common type of foreign bodies aspirated is food
  - c. Challenges with plain film radiography in visualizing food due to low contrast
2. How computed tomography can be used to achieve improved visualization of aspirated food particles in the pediatric airway
  - a. CT offers thin slice axial images without superimposition of anatomy
  - b. Multiplanar reformats offer views from multiple angles to better detect food stuck in the airway
3. Challenges of CT imaging and solutions
  - a. CT has a longer exposure time which increases the chance of motion
  - b. Flash scanning to reduce scan time
  - c. Determining the best scanning factors to best visualize radio-translucent food
4. Phantom studies
  - a. Food items commonly aspired in peds seen in the ED
  - b. Tubes representing realistic sizes of airways in children
  - c. Tubes filled with food items placed inside anthropomorphic chest phantoms representing pediatric patients of different ages
  - d. Optimal scanning, reconstruction, and display techniques to visualize food items
  - e. CT number look-up table of commonly aspirated foods
5. Clinical examples and applications
  - a. Gummy bear detected in airway
  - b. Thoracic
  - c. Pediatrics
  - d. Adults at high risk for aspiration

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## Abstract Archives of the RSNA, 2023

PDEE-39

### Spectrum of Pediatric Distal Bowel Pathology Imaging from Prenatal Period to Adolescence

All Day Room: Learning Center

#### Awards

##### Cum Laude

Hajer Jarraya (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. The differential diagnosis of neonatal colonic obstruction includes Hirschsprung's disease, colonic atresia, congenital segmental dilation of the colon, NEC, anorectal malformation, and meconium plug syndrome. 2. The differential diagnosis of colonic obstruction in infants and children includes incarcerated intestinal hernia, sigmoid, cecal and transverse volvulus, intussusception, and rectal obstruction related to abdominopelvic masses or cysts. 3. The differential diagnosis of colonic wall thickening in older children includes infectious colitis, typhlitis, inflammatory (Crohn's or ulcerative colitis), vasculitis, ischemia, and neoplasm. 4. The differential diagnosis of colonic pathology can be classified based on age at presentation and primary imaging features (wall thickening, dilation/obstruction, transition point).

#### TABLE OF CONTENTS/OUTLINE

1.Epidemiology and classification of colonic pathology, 2.Imaging Findings A) Colonic pathology in the prenatal period B) Colonic obstruction in neonates, infants, children and adolescents C) Colonic wall thickening: infectious, inflammatory and neoplastic 3.Differential diagnosis 4.Algorithm of differential diagnosis based on age and primary imaging features

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## Abstract Archives of the RSNA, 2023

PDEE-4

### Lymphoscintigraphy: A Pictorial Review with Focus on Pediatric Patients

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Valentina Ferrer Valencia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Classification of lymphedema and lymphatic dysplasias via illustrative mixed-modality case-examples 2. Sentinel node mapping in pediatric patients 3. Important pitfalls of the technical and interpretive aspects of lymphoscintigraphy

#### TABLE OF CONTENTS/OUTLINE

Introduction: Lymphoscintigraphy is a minimally invasive imaging technique that uses radiolabeled colloidal particles to evaluate lymphatic function  
Technique: 1. Radiopharmaceuticals 2. Administered activity/radiation dose 3. Imaging Protocols  
Indications for Lymphoscintigraphy: 1. Primary Lymphedema including Lymphatic Dysplasia 2. Secondary Lymphedema 3. Chylous Leaks 4. Sentinel Lymph Node Mapping  
Imaging Findings with Illustrative Case Discussions: 1. Lymphedema 2. Absent Visualization of Regional Lymph Nodes 3. Delayed or Asymmetric Lymphatic Transit 4. Collateral Lymphatic Channels 5. Dermal Backflow 6. Chylous Effusion or Ascites 7. Sentinel Lymph Node Visualization Pitfalls  
Summary: Lymphoscintigraphy plays a unique role in evaluation disorders of lymphatic development, acquired lymphatic disorders, and assessment of chylous fluid collections. Familiarity with normal patterns of lymphatic transit, abnormal lymphatic transit, and common pitfalls are crucial for radiologists performing and interpreting these examinations.

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## Abstract Archives of the RSNA, 2023

PDEE-40

### Imaging of Congenital Hearing Loss: A Practical Approach

All Day Room: Learning Center

Rafael Maffei Loureiro, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To review important anatomic landmarks in the pediatric temporal bone. 2. To discuss the imaging technique and protocols for the evaluation of congenital hearing loss. 3. To present a practical guide to facilitate comprehension of radiologic findings and the role of imaging in the evaluation of congenital hearing loss.

#### TABLE OF CONTENTS/OUTLINE

Introduction  
Principles of the basic workout investigation- Screening for hearing loss in newborns- Functional evaluation: quick review of audiometric studies for radiologists  
Temporal Bone Anatomy  
Classification of congenital hearing loss- by severity: slight, mild, moderate, severe and profound- by type: conductive, sensorineural, mixed- by causes: genetic (syndromic and non-syndromic); environmental; congenital lesions and malformations  
Imaging studies: CT and MRI of the temporal bone- imaging protocol and special considerations for congenital hearing loss evaluation  
Instructive cases by causes and main imaging features  
A step-by-step guide to diagnose congenital malformations  
Principles of imaging evaluation for guiding treatment  
Take home messages

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## Abstract Archives of the RSNA, 2023

PDEE-41

### Systematic Approach to Congenital Brain Tumor

All Day Room: Learning Center

Felipe Scortegagna SR, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are to:- Describe through illustrative cases the classification and imaging patterns of neonatal brain and spine tumors.- Correlate imaging with molecular and genetic alterations.- Present comprehensive imaging protocols.- Highlight important differential diagnoses to consider.

#### TABLE OF CONTENTS/OUTLINE

- Definition of congenital tumors.- Classification of congenital CNS tumors- Based on location, age and updated WHO Classification 2021.- Overview of common predisposing genetic syndromes.- Recommended fetal and neonatal imaging protocols.- Typical imaging features of each tumor type.- Teratoma Astrocytic tumors.- Neuronal and mixed neuronal-glial tumors.- Choroid plexus papilloma.- Embryonal tumorso Craniopharyngioma.- Ependymoma.- Important tumor mimics to consider.- Hemorrhage.- Vascular malformations.- Infections.- Hamartomas.- Cortical malformations.- Treatment challenges and developments.- Diagnostic algorithm.- Final remarks.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-42

### **Bridging the Gap Between the Symptoms to Radiology Beyond the Anatomy of Temporal Bones in Pediatrics and Young Adults**

All Day Room: Learning Center

Nahyun Jo, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The ear is a highly specialized organ in a tightly packed space. Trainees are used to the classification of temporal bone pathology with respect to their anatomical locations; inner, middle, and outer ear. Although anatomical search patterns allow a thorough evaluation of complex ear structures, understanding symptomatologic categorization not only aids in an active search for differential diagnosis but also broadens the understanding of the pathophysiology and management.

#### **TABLE OF CONTENTS/OUTLINE**

The introduction is a basic review of temporal bone anatomy and commonly used modality. The second section, "Bridging the gap," discusses a quick guide to understanding relevant clinical information, such as audiometry or otoscopy. In the third section, "Symptoms to radiology," each ear pathology is categorized by each clinical scenario. For each symptom and appropriate pathology, key points to report or "what surgeons want to know" are detailed. The symptoms are divided into otalgia, hearing loss, tinnitus, and otorrhea. Otorrhea is subdivided into the acute and chronic onset of symptoms. Hearing loss is subdivided into conductive hearing loss and sensory hearing loss. Both conductive and sensory hearing loss has congenital, infectious/inflammatory, tumor, trauma, and miscellaneous etiologies. Tinnitus has vascular, tumor, and various etiologies. Otorrhea may occur with otalgia due to infection, but CSF otorrhea is discussed separately as it can be the sole reason for the exam without other overlapping symptoms.

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## Abstract Archives of the RSNA, 2023

PDEE-43

### Palpable Head and Neck Lumps in Pediatrics: Tips and Tricks in Ultrasound

All Day Room: Learning Center

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To illustrate the ultrasound appearance of the most frequent pediatric head and neck palpable lumps, acknowledge the imaging hallmarks of each condition, and correlate with other imaging tools. To Highlight the warning signs on ultrasound, recognize when additional testing is necessary and discuss subsequent management.

#### TABLE OF CONTENTS/OUTLINE

The presence of palpable lumps of the head and neck is a frequent complaint in children, including a broad spectrum of infectious, tumoral conditions, embryologic remnants, and vascular malformations, with the large majority proven benign. The radiologist must recognize the warning signs that allow early management of those with potential malignancy or those leading to space compromise over vascular and respiratory structures, including onset during the neonatal period, firm consistency, rapid growth, or location underneath the fascia. Ultrasound has arisen as the first-line imaging modality for initial evaluation. It represents a fast and safe technique, which can provide essential information for the characterization of the lesion, acting as a guide in diagnostic and therapeutic procedures. This ultrasound approach guides subsequent decision-making, including follow-up, complementary testing, or treatment through interventional drainage or surgical excision. Further investigation with cross-sectional imaging is warranted if the characteristics of the mass are beyond the scope of ultrasound or if malignancy is suspected. We provide a pictorial review of illustrative cases from our institution to help identify the key imaging findings and emphasize the role of ultrasound in the diagnosis and interventional treatment of pediatric lumps.

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## Abstract Archives of the RSNA, 2023

PDEE-44

### **Atlas of Secondary Ossification Centers, Physeal Variations, and Cortical “Buckles” in the Pediatric Skeleton: Radiographic and MRI Correlation of Normal and Abnormal Findings.**

All Day Room: Learning Center

Jade Iwasaka-Neder, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Systematically illustrate the variable radiographic appearances of secondary ossification centers and physes at different stages of skeletal development
- Compare and contrast MRI appearances of normal versus abnormal growth centers to highlight their differences and improve their diagnosis
- Elucidate normal and abnormal areas of cortical buckling in children
- Illustrative examples of pathologic mimickers

#### **TABLE OF CONTENTS/OUTLINE**

o Secondary ossification centers on radiography and MRI: imaging characteristics, expected time of appearance, and locational differences.

- Sternum (Manubrium; Sternebrae; Xiphisternum; Unfused sternebrae sternal foramen)
- Scapula (Coracoid centers; Acromion centers)
- Upper limb (Greater humeral tuberosity; Lesser humeral tuberosity; Elbow mnemonics: CRITOE and CRITOL; Carpal bones)
- Pelvis (Iliac spines; Ischial tuberosity; Acetabular rim)
- Lower limb (Distal femoral condyles; Tibial tubercle; Medial and lateral malleoli; Patella; Calcaneus)

o Cortical buckles and nutrient canals. Do they belong here? (Tibia; Fibula; Femur; Clavicle; Tarsal bones; Metacarpals and phalanges; Metatarsals)

o Physeal variations (Distal fibula; Distal tibia; Proximal humerus; Distal radius; Distal ulna; Different types of normal physes)

o Normal versus Fracture (Case review)

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## Abstract Archives of the RSNA, 2023

PDEE-45

### Childhood Constipation: How Imaging Evaluation Can Help

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Livia Alves (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Constipation in the pediatric population is a prevalent diagnosis worldwide. Frequent imaging examinations are required to investigate the diagnosis, and generally to differentiate the functional etiology and its degrees from an organic cause. Therefore, the radiologist must know the particularities of each imaging method, know how to indicate the ideal exam in the face of clinical suspicion, and interpret the most diverse findings to arrive at the final diagnosis. This presentation aims to:(1) point out the main imaging tests that can be used in the diagnosis of constipation in pediatric patients, detail their characteristics and help in choosing the method in the face of clinical suspicion.(2) review the imaging findings in cases of functional and organic constipation, highlighting the main related pathologies: Hirschsprung's disease, visceral myopathy and chronic intestinal pseudo-obstruction.(3) debate the imaging findings of the most frequent complications.

#### TABLE OF CONTENTS/OUTLINE

Imaging methods used in the diagnosis of constipation, its characteristics, and main indications in the face of clinical suspicion include abdominal radiography, barium enema and colonic transit, computed tomography, magnetic resonance imaging and ultrasound. Case-based review of the functional and organic etiology of constipation (Hirschsprung's disease, visceral myopathy, chronic intestinal pseudo-obstruction, intra-abdominal tumor and VACTERL association). Case-based review of complications (fecaloma, stercoral colitis, and perforation) and associated diseases (voiding dysfunction).

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## Abstract Archives of the RSNA, 2023

PDEE-46

### **The PRETEXT Staging System for Primary Liver Tumors in the Pediatric Population. A Cases-based Pictorial Review**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Mariano Lorea (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The PRE-Treatment EXTent of tumor (PRETEXT) system aims to standardize imaging evaluation and risk stratification of hepatoblastoma and hepatocellular carcinoma before implementation of any treatment. PRETEXT grades provide valuable information regarding prognosis and overall survival. Liver is divided into four sections: left lateral (LL), left medial (LM), right anterior (RA) and right posterior (RP). Liver tumors are separated in four groups (I-IV) based on the number of contiguous tumor-free liver sections. Higher groups are related to worst outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction  
What means PRETEXT?  
Prognosis implications  
Liver segmentation  
How to divide the liver? From Coudinaud's segmentation to PRETEXT segments.  
PRETEXT groups  
Groups I to IV. Cases-based pictorial review. Imaging clues to precise PRETEXT group assignment.  
Additional PRETEXT criteria.  
Hepatic venous involvement (V and P)  
Extrahepatic disease (E)  
Multifocality (F)  
Tumor rupture (R)  
Caudate lobe involvement (C)  
Lymph nodes (N) and distant metastasis (M)

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## Abstract Archives of the RSNA, 2023

PDEE-47

### **Pediatric Primary Intracranial Sarcoma with Features of DICER1 Mutation: A Challenging Diagnosis**

All Day Room: Learning Center

Jossue V. Espinoza SR, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

TEACHING POINTS Pediatric primary intracranial sarcomas have an aggressive clinical course. The incidence of pediatric primary intracranial sarcoma with features of DICER1 mutation has been increasing. Imaging features of pediatric primary intracranial sarcomas with features of DICER1 mutation are not well documented. MRI and CT imaging play a crucial role in establishing a diagnosis. MRI plays a crucial role in follow up during treatment and evaluation for residual disease after surgery. Since there are several differential diagnoses, radio-pathologic correlation of these tumors is essential to confirm the diagnosis.

#### **TABLE OF CONTENTS/OUTLINE**

The goals of this exhibit are to: Provide a pictorial review of the diverse imaging appearances of pediatric primary intracranial sarcoma with features of DICER1 mutation and differential diagnoses. Discuss specific imaging and pathological characteristics of pediatric primary intracranial sarcoma with features of DICER1 mutation and differential diagnoses. Familiarize the audience with the imaging of pediatric primary intracranial sarcoma with features of DICER1 mutation and emphasize the importance of radio-pathologic correlation. These entities include: • Pediatric Primary intracranial sarcomas with features of DICER1 mutation. • Potential pitfalls and differential diagnoses of these tumors including other mesenchymal non-meningothelial tumors of the central nervous system, cavernous malformation (cavernous angioma or cavernoma) and high-grade brain tumors in pediatric patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-48

### The Lung and Winding Road - A Pictorial Essay on Cystic Lung Diseases in Pediatric Radiology

All Day Room: Learning Center

Victor D. Nishimura, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

PNEUMATOCELE is a transient round and variable sized cyst, adjacent to consolidation or ground glass opacities. INTERSTITIAL LUNG EMPHYSEMA cystic or linear radiolucencies in the interstitium radiating from the hilum can be seen. CONGENITAL LUNG HYPERINFLATION increased lung volume and transparency can be seen. NEURENTERIC CYST is a fluid attenuating paravertebral lesion. BRONCHOGENIC CYST well circumscribed spherical or ovoid masses of variable attenuation can be seen. PULMONARY SEQUESTRATION multiple cystic lesions and anomalous artery nutrition can be seen. CYSTIC LYMPHANGIECTASY can be associated with syndromes, also congenital cardiac anomalies. CONGENITAL PULMONARY AIRWAY MALFORMATION usually presents as a solitary well defined thin walled cyst or multiple cysts of varying sizes. Multiple irregular shaped cysts are characteristic of LANGERHANS CELL HISTIOCYTOSIS. LYMPHANGIOLEIOMYOMATOSIS characterized by diffuse thin walled cysts surrounded by normal lung without regional sparing, accompanied by small centrilobular nodules.

#### TABLE OF CONTENTS/OUTLINE

ACQUIRED PNEUMATOCELE INTERSTITIAL LUNG EMPHYSEMA CONGENITAL CONGENITAL LUNG HYPERINFLATION NEURENTERIC CYST BRONCHOGENIC CYST PULMONARY SEQUESTRATION CYSTIC LYMPHANGIECTASY CONGENITAL PULMONARY AIRWAY MALFORMATION NEOPLASTIC LANGERHANS CELL HISTIOCYTOSIS LYMPHANGIOLEIOMYOMATOSIS

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-49

### Neonatal Subpial Hemorrhage: A Closer Look

All Day Room: Learning Center

Eman E. Marie, MD, MSc (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Understand the anatomy and physiology of the subpial space. 2- Describe causes of subpial hemorrhage in neonates. 3- Discuss the clinical presentation and the indications of imaging. 4- Identify the different imaging modalities used to identify and evaluate the subpial hemorrhage. 5- Discuss and exemplify the imaging features of subpial hemorrhage. 6- Classify the different types of subpial hemorrhage, comorbid conditions, and prognosis.

#### TABLE OF CONTENTS/OUTLINE

1- Embryology and early development of brain meninges with a focus on the pia mater. 2- Anatomy (gross and microscopic) and physiology of the subpial space. 3- Incidence and potential risk factors linked to subpial hemorrhage in neonates. 4- Imaging of neonatal subpial hemorrhage: US, CT and MRI findings, standard protocols and special considerations during neonatal brain imaging 5- Diagnostic accuracy of each imaging modality and factors that may affect the accuracy of interpretation. 6- Pitfalls and differential diagnosis of subpial hemorrhage. 7- What the referring physician needs to know: diagnosis and extent of abnormalities. 8- Proposed imaging-based prognostication. 9- Neonatal subpial hemorrhage and abusive head trauma. 10- Management strategies of neonatal subpial hemorrhage and the role of imaging follow up. 11- Recent research and future directions on neonatal subpial hemorrhage.

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## Abstract Archives of the RSNA, 2023

PDEE-50

### Growing Pains: Navigating Pediatric Metabolic Bone Disorder

All Day Room: Learning Center

Ami Gokli, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-Discuss with illustrative examples the anatomy and physiology of normal bone growth in the pediatric population- Review common pediatric metabolic bone diseases including the pathophysiology and characteristic imaging features associated with these diseases using a multimodality approach- Describe clinical management, necessary details to include in radiologic reports, and the importance of radiologists role in these diseases

#### TABLE OF CONTENTS/OUTLINE

Overview:-Anatomy and physiology of pediatric bone growth/turnover including Identifying regions in the bone growth process particularly susceptible to disease  
Etiology:-Hereditary-Acquired (Nutritional deficiencies, Drug Treatments, etc)  
Pathology:-Diseases that can be discussed including discussion of pathophysiology with an image rich, multimodality approach; identify pathognomonic radiographic findings/tools that can aid in diagnosis  
Primary/Secondary osteoporosis, Osteogenesis imperfecta, Rickets, Skeletal dysplasias (Achondroplasia, cleidocranial dysplasia, achondroplasia), Albright hereditary osteodystrophy, (pseudohypoparathyroidism)/renal osteodystrophy, Fibrous dysplasia/McCune Albright syndrome, Juvenile Paget disease, Sclerosing bone disorders (osteoporosis, pyknodysostosis, osteopoikilosis, osteopathy striata, melorheostosis), Hypophosphatasia- Describe necessary details to include in radiologic reports  
Treatment/management:- Peds metabolic bone disorders require an extensive Team (endocrine, ortho, medical genetics, PM+R, physical/occupational therapy, pediatric radiology, nursing), detailed description of what is involved and the central role radiologists play  
Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-51

### **Imaging Findings and Management Strategies to Liver Masses in Children with Underlying Predispositions: A Review from the ACR Pediatric LI-RADS Working Group**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Amy B. Kolbe, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Review the imaging approach and differential diagnosis for liver masses in children with underlying genetic syndromes, congenital abnormalities, vascular abnormalities, and other conditions that predispose to liver lesions. 2. Illustrate the characteristic imaging findings of benign and malignant liver tumors in children with predisposing conditions. 3. Discuss the screening guidelines and management approach to liver masses encountered in the predisposed child.

#### **TABLE OF CONTENTS/OUTLINE**

Spectrum of pediatric liver tumors and pseudotumors in: 1. Genetic syndromes: Beckwith Wiedemann syndrome, familial adenomatous polyposis, progressive familial intrahepatic cholestasis, tuberous sclerosis, cystic fibrosis, glycogen storage disease, tyrosinemia, Wilson disease, hereditary hemochromatosis 2. Congenital abnormalities: Biliary atresia, Alagille syndrome, Abernethy malformation 3. Miscellaneous: Metabolic syndrome, Fontan associated liver disease, Budd Chiari syndrome For each entity we will discuss the underlying pathogenesis of liver disease, types of liver masses described with the entity, characteristic imaging findings of each liver mass, surveillance strategies, and key findings that warrant further intervention

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-52

### Fetal Magnetic Resonance Imaging Findings in Conjoined Twin Pregnancies

All Day Room: Learning Center

Julie E. Walcutt, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The learner will understand how to differentiate the various conjoined twin variants by their fetal MRI appearance. The learner will understand which features of conjoined twin shared anatomy predict survival and the potential for separation and how fetal MRI can be used in this assessment. The learner will review fetal MRI examples of additional congenital anomalies within the context of conjoined twinning.

#### TABLE OF CONTENTS/OUTLINE

Conjoined twins are a rare complication of monozygotic twinning. Fetal MRI can provide a detailed evaluation of these twins' shared anatomy and identify additional congenital anomalies, thereby allowing the fetal care team to anticipate the potential for survival and separation in these complex twin pairs. This exhibit will review the fetal MRI appearance of the different morphological variants of conjoined twins, including several unusual cases of minimally conjoined twins. Emphasis will be placed on those anatomical features most important for determining conjoined twin prognosis and potential for separation. Fetal MRI cases demonstrating additional important congenital anomalies within the context of conjoined twinning will be presented as part of a comprehensive fetal assessment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-53

### Sonographic Evaluation of the Umbilical Region in Children

All Day Room: Learning Center

#### Awards

##### Cum Laude

Lizbet Perez-Marrero (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

o To describe the normal sonographic appearance of the umbilicus and the midline structures of the anterior abdominal wall.  
To recognize ultrasound findings of the most common lesions of the umbilicus, including anomalies of the embryonic remnants.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Ultrasound protocol of the umbilical region and anterior abdominal wall. 3. Normal anatomy of the umbilicus and midline anterior abdominal wall 4. Umbilical lesions a. Umbilical granuloma b. Omphalitis b. Epidermal cyst c. Cutaneous ciliated cyst d. Tumors (hemangioma) e. Keloid f. Polyp g. Cutaneous umbilicus h. Umbilical hernia i. Paraumbilical hernia j. Epigastric hernia 5. Embryonal anomalies a. Umbilical vessels i. Omphaloarteritis ii. Omphalophlebitis iii. Thrombosis of umbilical vein varix b. Urachus: i. Urachal cyst ii. Infected urachal cyst iii. Urachal diverticulum iv. Urachal sinus v. Urachal fistula c. Omphalomesenteric duct i. Vitelline cyst ii. Persistent vitelline vessel iii. Meckel diverticulum iv. Omphalomesenteric fistula v. Omphalomesenteric fibrotic cord 6. Conclusions

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

PDEE-54

### **Malignant Rhabdoids and Related Pediatric Tumors: A Multimodality Imaging Review and Pathologic Correlation**

All Day Room: Learning Center

Apeksha Chaturvedi, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Malignant rhabdoid tumors of childhood include malignant rhabdoid tumor of kidney (MRTK), extrarenal malignant rhabdoid (eMRT) and atypical rhabdoid-teratoid tumors (AT/RT); tumors are highly aggressive, carry a dismal prognosis and may develop in utero 2. "Rhabdoid" morphology on histology- large polygonal cells with eosinophilic cytoplasm, vesicular nuclei and central prominent nucleolus 3. Underlying SMARCB1 mutations, a gene encoding a core subunit of the SWI/SNF chromatin-remodeling complex 4. Imaging appearances overlap with those of other entities, with certain imaging features aiding distinction; eg. cerebellopontine angle involvement and intratumoral hemorrhage favor AT/RT over medulloblastoma 5. Rhabdoid tumor predisposition syndrome (RTPS) is characterized by proband with rhabdoid tumor and/or family history of rhabdoid tumors and/or multiple SMARCB1- and/or SMARCA4 deficient tumors (synchronous or metachronous) and a heterozygous germline variant in SMARCB1 or SMARCA4; imaging surveillance guidelines have been proposed

#### **TABLE OF CONTENTS/OUTLINE**

1. Spectrum of malignant rhabdoid and related SMARCB1 deficient neoplasms of childhood 2. Updated WHO classification (2021) for malignant rhabdoids and related pediatric tumors 3. Underlying SMARCB1 deficiency and mechanisms by which it drives rhabdoid tumor growth 4. Multimodality imaging manifestations of malignant rhabdoid tumors, with emphasis on PET-CT and PET-MR 5. Role of ultrasound and whole-body MRI in surveillance in patients with RTPS 6. Pathologic correlation

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## Abstract Archives of the RSNA, 2023

PDEE-55

### A Trainee's Guide to Neonatal Abdominal Radiographs

All Day Room: Learning Center

Isabelle D. Gauthier, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Abdominal radiographs are an important tool to diagnose and screen acute intra-abdominal pathologies in the neonatal population. 2. The widespread availability and portable nature of radiographs make it ideal for the bedside evaluation of unstable neonates. 3. Knowledge of pathologies and their appearance on abdominal radiographs are crucial for timely and accurate diagnoses of life-threatening conditions and to guide further imaging and management.

#### TABLE OF CONTENTS/OUTLINE

1. Technique and views to obtain neonatal abdominal radiographs: Assessment of quality, tips for mobile exams, and use of shielding (ie. gonadal shielding and update on recommendations). 2. Review of lines and tubes on abdominal radiographs in neonates (ie. Umbilical artery and vein catheters, PICC, NG tube and port location). 3. Review of normal findings (ie. Expected gas pattern based on hours of life). 4. Do-not-miss findings: Pneumoperitoneum, pneumatosis, portovenous gas, bowel obstruction, pneumomediastinum/pneumothorax in the lung bases. 5. Review of acute pathologies and findings on abdominal radiographs (abnormal patterns): Necrotizing enterocolitis, congenital causes of bowel obstructions (upper/lower) (ie. Malrotation/volvulus, duodenal/jejunal atresia, Hirschsprung's disease, imperforate anus), gasless abdomen

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## Abstract Archives of the RSNA, 2023

PDEE-56

### From Head to Tail: Exploring Applications of Pediatric Neurological Ultrasound

All Day Room: Learning Center

Isabelle D. Gauthier, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Ultrasound for neurological pathologies is a useful adjunct to conventional imaging (CT/MRI) as a screening and diagnostic tool in pediatric patients due to its universal availability and low cost. 2. Lack of ionizing radiation and IV contrast, and incomplete pediatric bone ossification and unfused fontanelle make ultrasound an excellent modality for evaluation of neurological pathologies in young patients. 3. Optimal ultrasound technique and understanding of the relevant pathophysiology of pediatric neurological conditions that can be assessed with ultrasound can significantly improve timely access to screening, diagnosis and patient care.

#### TABLE OF CONTENTS/OUTLINE

1. Brain ultrasound: Indication (ie. Premature screen, cooling therapy), Technique, Normal structures, variants and measurements (ie. ventricular index), Vascular assessment, Pathologies (ie germinal matrix bleed, periventricular leukomalacia). 2. Transcranial doppler ultrasound: Indications (ie. Sickle cell disease), Technique, Vessel anatomy, Normal measurements, Abnormal findings and clinical significance. 3. Cranial sutures ultrasound: Indications (ie. Abnormal skull shape), Technique, Cranial suture anatomy, Normal findings (ie. fontanelles, suture closure), Craniosynostosis and clinical significance. 4. Spine ultrasound: Indication (ie. sacral dimple, suspected spinal dysraphism), Technique, Normal findings and anatomy, Pathologies (ie. low conus, thickened filum, myelomeningocele, intraspinal collections, masses).

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## Abstract Archives of the RSNA, 2023

PDEE-57

### US Evaluation with CT/MRI Correlation of Neonatal and Infantile Brain Tumors and Other Intracranial Masses

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

While some neonatal brain tumors are suspected on antenatal US imaging, most are diagnosed postnatally. Head US may be the first imaging modality for work-up of an intracranial mass which can present with non-specific clinical features. Most cases will require further imaging work-up, usually with MRI. Recognition of the US features of the most common neonatal and infantile intracranial masses and their complications can aid in appropriate and timely subspecialty referral. Objectives: 1. Discuss the US features of the most common neonatal and infantile intracranial masses. 2. Describe the correlation between antenatal US and fetal MRI and postnatal US and CT/MRI in the imaging work-up of these masses. 3. Explain the use of US to identify any associated complications which require urgent neurosurgical assessment.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Pseudomass 2a. Intraventricular hemorrhage 3. Non-neoplastic masses 3a. Arachnoid cyst 3b. Choroid fissure cyst 3c. Hypothalamic hamartoma 4. Supratentorial neoplasms 4a. Teratoma 4b. Low-grade glioma 4c. High-grade glioma 4d. Embryonal tumor with multilayered rosettes 4e. Choroid plexus tumors 4f. Osteochondrolipoma 5. Posterior fossa neoplasms 5a. Atypical teratoid/rhabdoid tumor 5b. High-grade glioma 6. Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-58

### US Evaluation with Fetal MRI and CT/MRI Correlation of Pediatric Congenital and Inherited Brain Anomalies

All Day Room: Learning Center

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. While many congenital and inherited brain anomalies are suspected from antenatal US and fetal MRI, postnatal head US may be the first imaging modality in the work-up of these heterogeneous anomalies 2. Most cases will require further imaging work-up with CT and/or MRI 3. Recognition of the US features of the most common of these lesions is important in order to direct appropriate additional imaging and timely subspecialty referral Objectives 1. Discuss the US features of the most common pediatric congenital and inherited brain anomalies 2. Describe the correlation between antenatal US and fetal MRI and postnatal US and CT/MRI 3. Explain the use of US to narrow the differential diagnosis and direct appropriate additional imaging work-up and management

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Midline anomalies a. Agenesis of corpus callosum (ACC) b. Dysgenesis of corpus callosum variants i. Asymmetric ventriculomegaly, interhemispheric cyst and dysgenesis of corpus callosum (AVID) ii. Dysgenesis of corpus callosum with pericallosal lipoma c. Septo-optic dysplasia 3. Malformations of cortical development a. Periventricular nodular heterotopia b. Lissencephaly c. Hemimegalencephaly d. Tuberous sclerosis 4. Metabolic a. Ornithine transcarbamylase (OTC) deficiency 5. Brainstem and posterior fossa anomalies a. Diencephalic mesencephalic junction dysplasia b. Dandy-Walker malformation c. Joubert syndrome and related disorders (JSRD) d. Chiari 2 malformation secondary to myelomeningocele e. Arachnoid cyst f. Mega cisterna magna 6. Vascular anomalies a. COL4A1 mutation b. Vein of Galen malformation 7. Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-59

### Differential Diagnosis of Hyperechoic Lesions on Neonatal Head US

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. There are normal areas of increased echogenicity on neonatal head US which should not be mistaken for pathology, including choroid, midline vermis, hyperechoic caudate heads, periventricular white matter "halo", and white matter tracts including the corticospinal tracts 2. The differential diagnosis of hyperechoic lesions depends on their location 3. Many lesions can be confidently diagnosed and follow on US, while others require further imaging work-up to narrow the differential diagnosis and assist in ongoing management

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Normal areas of increased echogenicity a. Choroid b. Midline vermis c. Hyperechoic caudate heads d. Mineralizing vasculopathy e. Periventricular white matter "halo" f. Transmantle speckled increased echogenicity g. Corticospinal tracts 3. Caudothalamic groove a. Grade 1 germinal matrix hemorrhage b. Grades 2 and 3 germinal matrix hemorrhage 4. Periventricular/deep white matter a. Periventricular hemorrhagic infarction b. White matter injury c. Deep medullary venous thrombosis d. Infection e.g. Citrobacter koseri e. ECMO-related hemorrhage f. Water-shed infarct g. Punctate foci of white matter injury 5. Diffuse white matter a. Arterial infarction b. Hypoxic-ischemic encephalopathy 6. Deep gray matter a. Central cerebral venous sinus thrombosis 7. Peripheral parenchyma a. Peripheral cerebral venous sinus thrombosis b. Vein of Labbé hemorrhagic venous infarction 8. Cerebellum a. Cerebellar hemorrhage 9. Extraaxial a. Subdural hemorrhage b. Extradural hemorrhage c. Subpial hemorrhage 10. Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-6

### Pictorial Review of Pediatric Neuroimmune Disease

All Day Room: Learning Center

Alejandra Aguado, MD, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Neuroimmune diseases are a group of inflammatory disorders with varying pathogenic mechanisms, including autoantibodies against self-targets, cell-mediated, infection-triggered, paraneoplastic, and genetically determined diseases. This group continues to expand with the discovery of new clinicopathologic entities. Radiologists should be familiar with these diseases and able to make a differential diagnosis, as early diagnosis and appropriate treatment with immunotherapy can modify disease course in some cases. Additionally, different diseases within this group can present with varied evolution and prognosis. The main teaching points of this exhibit include: 1. Review of the most frequent entities within each group 2. Description of key imaging features that aid in differential diagnosis among different entities.

#### TABLE OF CONTENTS/OUTLINE

This exhibit presents a range of disease pathologies encountered in clinical practice, including: 1. Demyelinating diseases: a) Acute disseminated encephalomyelitis (ADEM) b) Pediatric multiple sclerosis (MS) c) Neuromyelitis optica spectrum disorders (NMOSDs) d) Anti-MOG associated disease 2. AntiNMDAR encephalitis, including one triggered by herpes simplex virus encephalitis 3. Lupus erythematosus 4. Rasmussen encephalitis 5. Hemophagocytic lymphohistiocytosis.

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## Abstract Archives of the RSNA, 2023

PDEE-60

### **Navigating the Fine Line of Pediatric Lines: A Primer on Pediatric Intravascular Catheters**

All Day Room: Learning Center

Narendra S. Shet, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To review various reasons and approaches for vascular access in pediatric patients. 2. To discuss the role of the radiologist in assessment of pediatric vascular access. 3. To review optimal and suboptimal line placement in pediatric patients in a variety of clinical scenarios, including neonates and patients with congenital heart disease.

#### **TABLE OF CONTENTS/OUTLINE**

1. Overview of vascular access in pediatric patients - reasons for short and long term access and means of guidance (non-guided versus image-guided), and role of radiologist (for diagnostic radiologist, assessing adequacy of line position, and for interventional radiologist, line placement using means of image guidance). 2. Central lines in pediatric patients, including PICC, Non-PICC (IJ/Femoral), and long-term Access including hemodialysis catheters/tunneled central venous lines, as well as ports. 3. Neonatal specific catheters, including umbilical arterial and venous catheters. 4. Cardiac catheters, such as intra-cardiac catheters, ECMO cannulae, and ventricular assist devices. 5. Where relevant, photographs of support devices, either in vivo or ex vivo, will be included in figures to allow for comparison to radiographic appearance.

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## Abstract Archives of the RSNA, 2023

PDEE-61

### Imaging Evaluation of Pediatric Cystic Neck Masses

All Day Room: Learning Center

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Pediatric neck masses are a common indication for imaging referral and US is often the first imaging modality in their work-up. 2. Following detection of a cystic neck mass on US, the radiologist must determine whether the lesion has a characteristic US appearance and requires no further imaging work-up or whether further imaging work-up is required. 3. Appropriate use of CT/MRI can aid in narrowing the differential diagnosis and assist in surgical planning. Objectives: 1. List the sonographic features of pediatric cystic neck masses which have a characteristic sonographic appearance and require no further imaging work-up 2. Recognize those lesions which require additional imaging work-up 3. Discuss the appropriate use of CT/MRI to aid in narrowing the differential diagnosis

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Congenital anomalies a. First branchial cleft anomalies b. Second branchial cleft anomalies c. Pyriform fossa sinus tract (PFST) lesions d. Dermoid cyst e. Lymphatic malformation f. Thyroglossal duct cyst 3. Inflammatory a. Ranula 4. Infectious a. Suppurative pyogenic lymphadenitis b. Non-tuberculous mycobacterial cervical lymphadenitis (MAIC) c. Retropharyngeal abscess 5. Neoplastic a. Teratoma 6. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-62

### **Twist and Turns: Comprehensive Radiological Review of Intestinal Malrotation and Midgut Volvulus**

All Day Room: Learning Center

Ayat A. Yousef, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Describe the imaging findings of intestinal malrotation and midgut volvulus in upper gastrointestinal (UGI) studies. 2. Discuss the utility of ultrasound (US) in intestinal malrotation and midgut volvulus. 3. Highlight the imaging pearls and pitfalls in cases of intestinal malrotation and midgut volvulus. 4. Illustrate different clinical presentations of malrotation and midgut volvulus through a variety of clinical cases.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction: Describe the normal orientation and fetal development of the intestine. Highlight the importance of early detection and management of intestinal malrotation. 2. Pathophysiology of intestinal malrotation and midgut volvulus: Discuss the mechanism of midgut volvulus in intestinal malrotation along with clinical presentation and complications. 3. Upper GI studies: Review the standard views in UGI studies with emphasis on imaging landmarks to insure proper position and quality. Discuss the imaging pearls and pitfalls in diagnosing intestinal malrotation/midgut volvulus in UGI studies. 4. Other radiological modalities: Role of other imaging modalities in intestinal malrotation/midgut volvulus as a problem solver in challenging cases including US, computed tomography (CT) and lower GI studies. 5. Atypical cases of midgut volvulus: Examples of atypical cases of midgut volvulus including recurrent and chronic presentations. Use different cases as a teaching key points in diagnosis and management of midgut volvulus. 6. Conclusion: Summary of the radiological approach in intestinal malrotation and midgut volvulus.

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## Abstract Archives of the RSNA, 2023

PDEE-63

### **Intestinal Ultrasound in Pediatric Inflammatory Bowel Disease: What Radiology Residents Should Know**

All Day Room: Learning Center

Paola Aguirre Camino, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Become familiar with the correct performance of pediatric bowel ultrasound scan. 2) Propose a standardized ultrasound report. 3) Recognize the ultrasound appearance of the normal and pathological bowel pattern. 4) Learn the typical sonographic findings, evaluate the activity and assess the presence of possible complications in Inflammatory Bowel Disease.

#### **TABLE OF CONTENTS/OUTLINE**

Crohn's disease and ulcerative colitis are chronic inflammatory bowel diseases frequently diagnosed in childhood, being imaging methods fundamental in the diagnostic approach, severity assessment, treatment monitoring and in the suspicion of complications. Due to the need to frequently evaluate these children, intestinal ultrasound becomes especially important compared to colonoscopy and MRI, as it is a non-invasive technique, easy for the child to accept, accessible and repeatable; however, as it is an operator-dependent examination, it requires certain experience and should be performed systematically using the appropriate technique. Intestinal ultrasound is a useful modality for intestinal bowel disease imaging and a valuable screening tool in the preliminary diagnostic workup of pediatric patients with suspected Inflammatory Bowel Disease. It assesses the presence of thickening of the intestinal wall as an indicator of inflammation, as well as the location and extent of the disease. It also allows evaluating the activity by quantifying the hyperemia of the intestinal wall using color Doppler, being a useful tool in the follow-up and control of the response to the treatment.

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## Abstract Archives of the RSNA, 2023

PDEE-64

### Slipped Capital Femoral Epiphysis: Emphasis on Early Recognition and Potential Pitfalls

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Daniel G. Rosenbaum, MD (*Presenter*) Consultant, Ipsen SA

#### TEACHING POINTS

\* Slipped capital femoral epiphysis (SCFE) is the most common hip disorder in adolescence, however the diagnosis is often delayed or missed due to vague clinical presentation, subtle radiographic findings, and technical variability.\* Early detection of SCFE hinges on close scrutiny of physeal morphology with particular attention to the epiphyseal tubercle, an important stabilizer of the physis in children.\* An AP and frog-lateral view of the pelvis including both hips is the mainstay of radiographic assessment of SCFE, and failure to diagnose SCFE is often a product of improper technique.\* Cross-sectional imaging is not routinely performed in SCFE patients, but can be helpful to identify radiographically occult early slips, assess femoral head perfusion, and better understand anatomy for surgical planning purposes.

#### TABLE OF CONTENTS/OUTLINE

\* Learning objectives\* Background including rationale for focus on SCFE, definition and epidemiology, pathophysiology and histology, and clinical findings and classification\* Early physeal changes in SCFE, introduction of the epiphyseal tubercle and rotational microinstability, and illustration of the peritubercle lucency on radiographs\* Later radiographic findings and severity grading on frontal and frog-lateral radiographs\* Technical pitfalls on radiography with emphasis on the importance of imaging both hips on all views\* Role of cross-sectional imaging including MRI for early slips, prognostic relevance of femoral head perfusion, and use of CT or Zero-TE MRI to assess callus preoperatively

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## Abstract Archives of the RSNA, 2023

PDEE-65

### Imaging Approach to Pediatric Neurometabolic Imaging

All Day Room: Learning Center

Samantha K. Gerrie, MBChB, FRANZCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the most commonly used classification systems for pediatric neurometabolic diseases 2. Discuss the clinical features and imaging patterns which aid in narrowing the differential diagnosis in the work-up of pediatric neurometabolic diseases 3. Illustrate the MR features of the most common pediatric neurometabolic diseases, including the MR spectra suggestive of specific disorders

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Classification systems a. Organelle dysfunction i. Mitochondrial disorders ii. Lysosomal storage disorders iii. Peroxisomal biosynthesis disorders b. Laboratory markers i. Lactate ii. Ammonia iii. Inborn errors of metabolism c. Presentation i. Neonatal metabolic encephalopathy ii. Head size d. Imaging pattern i. Deep gray matter involvement - striatum, globus pallidus, hyperdense thalami ii. White matter involvement - subcortical U-fibres, central white matter, anterior vs posterior iii. Hypomyelination disorders iv. MR spectroscopy suggestive of specific diseases v. Enhancement pattern 3. 16 "must know" imaging patterns suggestive of a specific neurometabolic disease: a. Maple syrup urine disease b. Canavan disease c. Alexander disease d. X-linked adrenoleucodystrophy e. Metachromatic leucodystrophy f. Pelizaeus-Merzbacher disease g. Mitochondrial encephalopathy with lactic acidosis and stroke-like episodes h. Non-ketotic hyperglycinemia i. Zellweger syndrome j. Mucopolysaccharidosis k. Leigh syndrome l. Panthothenate kinase-associated neurodegeneration m. Creatine kinase deficiency n. Megaloencephalic leucodystrophy with subcortical cysts o. Vigabatrin-related changes p. Methotrexate-related changes 4. Future directions 5. Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-66

### Newborn Skeletal Radiographs: A Practical Guide

All Day Room: Learning Center

Marcelo S. Takahashi, MD, PhD (*Presenter*) Speaker, Vertex Pharmaceuticals Incorporated

#### TEACHING POINTS

Neonatal skeletal abnormalities are rare occurrences in pediatric practice with a wide variety of causes and often overlapping radiographic features. The main teaching points of this exhibit are: 1) Illustrate the expected normal plain film appearance of the neonatal bone, including and what the most common pitfalls, regarding both normal development as well as technical imaging aspects. 2) Explain specific diseases radiographic findings with key clinical and epidemiological considerations 3) Illustrate the different imaging patterns with differential diagnosis checklist and explanation for each one

#### TABLE OF CONTENTS/OUTLINE

& 5; & 5; Normal newborn particularities and pitfalls& 5; Normal Anatomy& 5; Physiologic Neonatal Periostitis& 5; & 5; Trauma:& 5; Delivery related fractures& 5; Non accidental trauma& 5; & 5; Diffuse bone disease:& 5; Rickets& 5; Metabolic Bone Disease of Prematurity& 5; Caffey Disease& 5; Osteopetrosis& 5; & 5; Congenital abnormalities and malformations& 5; Amniotic band syndrome& 5; Hemimelia& 5; Proximal Femoral Focal Deficiencies& 5; Spine malformations& 5; Chondrodysplasia punctata& 5; Developmental Dysplasia of the Hip& 5; & 5; Infections:& 5; Congenital Syphilis& 5; Neonatal osteomyelitis

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## Abstract Archives of the RSNA, 2023

PDEE-67

### Entering a New Dimension: Novel Use of Transabdominal 3D Ultrasound in Pediatric Gynecology

All Day Room: Learning Center

Jeffrey J. Tutman, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

3D transvaginal pelvic ultrasound is a well-established imaging technique in the adult population for gynecologic applications. However, transvaginal ultrasound is not commonly utilized in the pediatric population. There are only sparse reports in the literature on the use of 3D transabdominal pelvic ultrasound in the pediatric population for gynecologic applications. In this educational exhibit, we will share our experience with 3D transabdominal pelvic ultrasound in the pediatric population, particularly for the evaluation of Mullerian duct anomalies and IUD positioning. We will begin with a review of scan technique and post-processing. Instructions for creation of a simple homemade ultrasound phantom for practicing these techniques will also be reviewed. We will then share several illustrative cases where 3D ultrasound provided useful information beyond standard 2D imaging in the assessment of Mullerian duct anomalies and IUD positioning. The challenges and limitations to this technique will also be discussed.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction
2. Review of scan technique and post-processing
3. Homemade ultrasound phantom: instructions and utility
4. Example cases of Mullerian duct anomalies
5. Example cases of IUD positioning

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## Abstract Archives of the RSNA, 2023

PDEE-68

### Ultra Low Dose Fetal CT: A Simple Way to Understand the Various Exposure Doses to the Fetus

All Day Room: Learning Center

Rumi Imai (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

(1) When skeletal dysplasia is suspected by fetal ultrasound, it is often difficult to make an accurate prenatal diagnosis using ultrasound alone. (2) In such case, fetal skeletal CT is recommended because it has diagnostic power comparable to postnatal bone survey, but the only drawback is fetal radiation exposure. For this reason, we have devised Ultra low dose fetal CT (ULDFCT) from the viewpoint of ALARA. (3) On the other hand, estimating fetal radiation dose involves complex calculations, and methods that are easily understood by pediatric radiologists and CT technicians are needed. (4) This exhibition introduces a method to insuflate the exposure dose of the fetus and maternal body by simple calculation using the CT dose index (CTDI), which is available immediately before and after scanning.

#### TABLE OF CONTENTS/OUTLINE

A. Data acquisition (n=36); Patients with ULDFCT throughout of 2014 to 2021. CTDIvol : mean 0.48mGy, DLP : mean 18.62mGy.cm. These are the lowest exposure doses in fetal CT scans in the literature search. B. Estimation of various exposure doses of the fetus  
Fetal dose: mean; 0.36mGy. Fetal dose = CTDIvol x 0.8 mGy  
Organ dose of uterus; mean 0.58mGy. Organ dose of uterus = CTDIvol x 1.2; SSDE; mean: 0.57mGy, SSDE = CTDIvol x 1.18  
Effective dose (ED) of maternal body; 0.39mSv. ED = CTDIvol x 0.81

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## Abstract Archives of the RSNA, 2023

PDEE-69

### Neonatal Chest X-ray: How to Spot Abnormal Gas Patterns and Potential Pitfalls

All Day Room: Learning Center

Marta Sanmartin Lopez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the main projections and technical guidelines of neonatal chest radiography.2. Review the systematic analysis of chest X-rays performed in neonates.3. Emphasize some normal findings that differ from X-rays performed in older children and adults.4. Analyze the typical radiological signs of pneumothorax, pneumomediastinum, pneumopericardium and pneumoperitoneum, and provide some practical examples that may help to differentiate pathology from potential pitfalls and mimics.

#### TABLE OF CONTENTS/OUTLINE

1. Analysis of neonatal chest X-ray a) Radiographic technique b) Systematic interpretation of neonatal chest X-ray.2. Abnormal gas patterns a) Pneumothorax b) Pneumomediastinum c) Pneumopericardium d) Pneumoperitoneum

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## Abstract Archives of the RSNA, 2023

PDEE-7

### Going with the Flow: Implementing a 4D Flow MRI Program at a Children's Hospital

All Day Room: Learning Center

Aparna Sodhi (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Four-dimensional flow MRI (4D flow) is a three dimensional spatial and velocity encoded phase contrast sequence that has emerged as a versatile imaging technique for qualitative as well as quantitative characterization of cardiovascular flow. The benefits of 4D flow include an easily prescribed volumetric acquisition with the ability to retrospectively quantify flow in any plane, in the acquired field of view. In the past, long scan times and complex post-processing workflows hindered 4D flow adoption into routine clinical practice for cardiovascular velocity and flow assessment, but improvements in image acquisition and processing have enabled standard clinical workflows. Additionally, there are unique in-vivo flow investigative parameters that provide newer insights into understanding cardiovascular physiology and pathophysiology. Our purpose is to: 1. Explain the utility of 4D flow. 2. Describe 4D flow acquisition parameters designed for imaging children with various congenital or acquired cardiovascular diseases. 3. Demonstrate a streamlined clinical 4D flow post-processing workflow. 4. Discuss research 4D flow applications.

#### TABLE OF CONTENTS/OUTLINE

1. General overview of 4D flow and key applications in the pediatric setting 2. Advantages of 4D flow over 2D phase contrast imaging 3. Image acquisition and post-processing using clinical cases (i) 9-years-old male with Fontan (ii) 19-years-old female with Bicuspid Aortic Valve 4. Research utility of 4D flow and future directions

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## Abstract Archives of the RSNA, 2023

PDEE-70

### Acute Upper Airway Obstruction in the Pediatric Population: What's Behind the Stridor

All Day Room: Learning Center

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Review the anatomic features of the pediatric airway. - Establish a systematic approach to radiographic evaluation. - Identify the key radiographic findings of common causes of acute upper airway obstruction through cases studied in our center.

#### TABLE OF CONTENTS/OUTLINE

Acute upper airway obstruction is more common in the pediatric population due to its various anatomical and physiological peculiarities. Several causes of airway obstruction have been described, such as foreign body obstruction, infection, neoplasm, congenital or vascular entities. Since the clinical presentation is often nonspecific and the evaluation of pediatric patients in the emergency setting is complicated, imaging techniques play a critical role in achieving an accurate diagnosis. The aim of this review is to evaluate the specific radiologic features that can be found in the different imaging modalities, with special emphasis on plain radiography, which is often sufficient to reach a correct diagnosis. As acute airway obstruction can be a life-threatening condition, it is essential that the radiologist recognizes the key imaging findings in order to ensure prompt management.

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## Abstract Archives of the RSNA, 2023

PDEE-71

### What Every Radiologist Should Know About Cranial Ultrasound: A Systematic Approach and Common Pathologies

All Day Room: Learning Center

Nahia Lizarraga Oroz, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Define the technical procedure of standard cranial ultrasound (CUS) and review the normal anatomic structures of the brain.
- Identify the spectrum of pathologies seen in clinical practice. - Highlight some tips and tricks for diagnosis.

#### TABLE OF CONTENTS/OUTLINE

CUS is an extremely valuable tool for evaluating the brain in the first year of life and has become an essential part of routine pediatric radiology practice. It is an accessible, portable, inexpensive, and safe technique that can be used as often as needed. Because of its great advantages, it is imperative for the radiologist to know how to perform CUS and correctly interpret the findings. This review attempts to establish the clinical indications, define a systematic technique to adequately visualize and document all relevant intracranial structures, and highlight the most common pathologies seen in neonates, including - Hypoxic-ischemic encephalopathy in preterm infants (germinal matrix hemorrhage, cerebellar hemorrhage, and periventricular leukomalacia) - Hypoxic-ischemic encephalopathy in term patients - Cerebrovascular disease - Trauma-associated hematomas - Macrocephaly However, the usefulness of CUS is still highly dependent on the skill, knowledge and experience of the observer.

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## Abstract Archives of the RSNA, 2023

PDEE-73

### **Congenital Anomalies of the Posterior Fossa - An Imaging Travelogue**

All Day Room: Learning Center

Shivaprakash B. Hiremath, DMRD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

This educational exhibit aims to: 1. Review the embryology and cross-sectional imaging anatomy of the posterior fossa. 2. Describe typical congenital malformations based on predominant cerebellar involvement, cerebellar and brainstem involvement, and predominant brainstem involvement.

#### **TABLE OF CONTENTS/OUTLINE**

- Describe the embryology and anatomical assessment of the posterior fossa along with diffusion tensor imaging.
- Depict the imaging findings in malformations predominantly affecting the cerebellum including cerebellar hypoplasia, hyperplasia and dysplasia (Chudley-mccullough syndrome, and Poretti-Bolthausen syndrome).
- Highlight the malformations affecting the cerebellum and brainstem such as alpha dystroglycanopathies, tubulinopathy, molar tooth malformations, and pontocerebellar hypoplasia.
- Illustrate the malformations predominantly affecting the brainstem such as pontine tegmental cap dysplasia, horizontal gaze palsy with progressive scoliosis, and diencephalic-mesencephalic junction dysplasia along with malformations with no known genetic cause such as Rhombencephalosynapsis, PHACE syndrome, and oculocerebrocutaneous syndrome.

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## Abstract Archives of the RSNA, 2023

PDEE-74

### Imaging in Pediatric Neuroinflammatory Disorders and Mimics

All Day Room: Learning Center

Shivaprakash B. Hiremath, DMRD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

This educational exhibit aims to: 1. Review the basic concepts of neuroinflammatory disorders in childhood 2. Describe the imaging manifestations of Myelin Oligodendrocyte Glycoprotein antibody-associated disease (MOGAD) in different age groups 3. Illustrate both common and uncommon findings in Neuromyelitis Optica Spectrum Disorder (NMOSD) and Multiple Sclerosis in the pediatric age range 4. Illustrate mimics of these entities based on imaging phenotypes encompassing pathologies that target the optic nerves, deep grey nuclei, white matter, and spinal cord.

#### TABLE OF CONTENTS/OUTLINE

- Review the pathophysiological basis of pediatric neuroinflammatory diseases.
- Illustrate the common and uncommon imaging manifestations in myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD) including acute disseminated encephalomyelitis (ADEM)-like phenotype, encephalitis-like phenotype, and leukodystrophy like phenotype.
- Depict common and uncommon findings in AQP4-associated neuromyelitis optica spectrum disorder (NMOSD), and Multiple Sclerosis (MS) including tumefactive demyelinating lesions.
- Provide localization related illustrations of mimics of demyelinating diseases including infectious, inflammatory, and metabolic disorders along with tumors that mimic demyelinating diseases.

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## Abstract Archives of the RSNA, 2023

PDEE-75

### Mastering Neck Ultrasound in Pediatric Patients

All Day Room: Learning Center

Mikel Elgezabal, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Neck anatomy from the ultrasound perspective: key structures and sonographic landmarks. 2. Ultrasound protocol focusing on children's peculiarities. 3. Clinical and US findings of common and not-so-common pediatric neck entities. 4. Radiologic approach to a neck lump in a child.

#### TABLE OF CONTENTS/OUTLINE

1. US technique for the pediatric neck 1.1. Technical recommendations 1.2. Anatomy: spaces of the head and neck and landmarks from the US perspective. 1.3. Basic US protocol and further tricks to get to more unusual locations (palatine tonsils, vocal cords). 2. Pathology of the pediatric neck 2.1. Lymph nodes: Anatomy, node levels. Pathology: reactive, suppurative, malignant. Tips: malignant vs. benign. 2.2. Thyroid: dysgenesias, nodes, thyroiditis. 2.3. Vascular anomalies: tumors, malformations and subtypes. 2.4. Salivary glands: parotitis, submaxillitis, ranula of the sublingual gland. 2.5. Cysts: thyroglossal duct, branchial cleft, dermoid, epidermoid. 2.6. Fibromatosis colli. 2.7. Cervical thymus. 2.8. Soft tissue tumours: sarcoma, schwannoma, neuroblastoma. 2.9. Pilomatricoma. 3. Summary: approach to a neck lump in a child. 4. Take home points

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## Abstract Archives of the RSNA, 2023

PDEE-76

### Keeping it Straight: A Guide to Pediatric Renal Neoplasms

All Day Room: Learning Center

Hassan A. Aboughalia, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Ultrasound is the first-line imaging modality for suspected abdominal masses, followed by contrast-enhanced CT or MRI renal mass protocol. 2. When a renal tumor is suspected, the patient's age, imaging characteristics, distribution of metastases, and co-morbid conditions are the most important factors to consider. 3. Synchronous ipsilateral and contralateral renal lesions, metastatic disease, lymphadenopathy, invasion of the renal vein/IVC, and signs of tumor rupture are essential features to be evaluated. 4. Suprarenal pathologies can mimic a renal tumor such as neuroblastoma.

#### TABLE OF CONTENTS/OUTLINE

1. Imaging approach to a patient with a suspected renal tumor, emphasizing optimal imaging techniques 2. Solid renal neoplasms, including mesoblastic nephroma, nephrogenic rests, Wilms tumor, rhabdoid tumor, clear cell sarcoma, angiomyolipoma, renal cell carcinoma, lymphoma, and metastases. 3. Cystic renal neoplasms, including cystic nephroma, cystic partially differentiated nephroblastoma, and cystic Wilms tumor. 4. Mimics of renal neoplasms, including hypertrophied column of Bertin, focal pyelonephritis and abscess, infarct, granulomatous diseases, suprarenal pathologies, and cystic renal diseases. 5. Diagram slide of pediatric renal neoplasms underscoring key factors differentiating these entities.

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## Abstract Archives of the RSNA, 2023

PDEE-77

### Craniovertebral Junction Instability, Fixation and Stenosis in Children

All Day Room: Learning Center

Stephen B. Little, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Radiographs of the cervical spine are often inadequate or falsely reassuring in children with torticollis. A high-risk mechanism of injury or high clinical suspicion should prompt further evaluation with CT or MRI. 2. Early recognition and treatment of atlantoaxial rotatory fixation (AARF) is essential to limit morbidity. 3. AARF may be neither purely atlantoaxial, merely rotatory, nor completely fixed. 4. Significant lateral inclination of C1, facet deformity, new bone and multi-ligament insufficiency are associated with irreducible AARF. 5. An increased atlantodental interval (ADI) is a poor indicator of symptomatic atlantoaxial instability in children with trisomy 21. Furthermore, a normal ADI does not exclude craniovertebral junction instability. 6. Symptomatic CVJ instability in children with trisomy 21 is more frequent in those with associated osseous anomalies, particularly os odontoideum. 7. Osseous anomalies in children with CVJ instability include assimilation of the atlas, split atlas, odontoid hypoplasia or aplasia, os odontoideum, and Klippel-Feil syndrome. 8. A variety of skeletal dysplasias are associated with CVJ instability or stenosis. 9. Narrow C2 pedicles increase the risk of vertebral artery groove violation with pedicle screw placement, possibly producing devastating neurovascular consequences.

#### TABLE OF CONTENTS/OUTLINE

1. Osseous and ligamentous anatomy 2. Key morphometry 3. Rotatory dynamics 4. Atlantoaxial rotatory fixation 5. Trisomy 21 and CVJ instability 6. Osseous anomalies and CVJ instability 7. Skeletal dysplasias 8. Surgical considerations

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## Abstract Archives of the RSNA, 2023

PDEE-78

### **Pediatric Dural Arteriovenous Fistulas: An Unusual Connection**

All Day Room: Learning Center

Sophia Z. Liu, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Dural arteriovenous fistulas (DAVFs) are vascular abnormalities in which a meningeal artery drains directly into a meningeal vein or dural venous sinus. DAVFs are rare in children, accounting for around 10% of all intracranial shunts in the pediatric population. The transverse-sigmoid, superior sagittal sinus, and torcular herophili are commonly involved fistula sites in pediatric DAVFs. Pediatric DAVFs can be classified into three types: dural sinus malformations, infantile/juvenile-type dural shunts, or adult-type dural shunts. Younger children with DAVFs tend to present with cardiopulmonary symptoms (congestive heart failure and/or respiratory distress), while older children present with neurological symptoms (headaches, intracranial hemorrhage, focal deficits). The primary treatment for DAVFs is endovascular embolization, commonly with microcoils or liquid adhesives. Challenges in the endovascular treatment of DAVFs include high-flow fistulas, tortuous intracranial feeding arteries, and small femoral artery access sites.

#### **TABLE OF CONTENTS/OUTLINE**

- Review neurovascular anatomy relevant to dural arteriovenous fistulas (DAVFs).
- Recognize DAVFs in the pediatric population using a case-based approach.
- Review the multimodal imaging appearance of pediatric DAVFs.
- Understand the treatment of pediatric DAVFs and the application of neurovascular interventional techniques.
- Discuss the complications and challenges in the treatment of pediatric DAVFs.

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## Abstract Archives of the RSNA, 2023

PDEE-79

### Pediatric Coronary Artery Anomalies

All Day Room: Learning Center

Maria Navallas, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Recognize the anatomic variations of coronary origin and course. 2. Understand the high risk imaging features in anomalous aortic origin of the coronary arteries. 3. Discuss acquired and post surgical anomalies of the coronary arteries.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction  
2. Cardiac CT technique  
2.1. Type of scanner  
2.2. Patient preparation  
2.3. Electrocardiogram gating  
2.4. Contrast administration  
3. Classification of congenital coronary artery anomalies  
3.1. Anomalies of origin/course- High take-off- Single coronary artery- ALCAPA/ASCAPA- Origin of coronary artery or branch from opposite or noncoronary sinus and anomalous course: Retroaortic, interarterial, prepulmonic, septal (subpulmonic)  
3.2. Anomalies of intrinsic coronary anatomy: Myocardial bridging  
3.3. Anomalies of coronary termination: Coronary artery fistula  
4. High risk imaging features and risk of sudden death  
5. Acquired coronary artery abnormalities:  
5.1. Kawasaki disease  
5.2. Multisystem inflammatory syndrome in children associated with COVID-19  
5.3. Postsurgical anomalies  
6. Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-80

### Transcranial Doppler Ultrasound in Children with SickleCell Disease: All What You Have to Know

All Day Room: Learning Center

Joseph Abi Ghanem (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1- Sickle cell disease (SCD) has an incidence of 4/10000 births. It is characterized by a chronic proinflammatory state, prothrombotic state and increased aggregation of red blood cells (RBC). Children with the SCD HbSS and HbSBthal0 phenotypes have a 200-fold increased risk of stroke compared to healthy children. 2- Radiologists play a major role in treatment decision plan as Transcranial Doppler ultrasound (TCD) is the only radiologic test of choice to detect SCD children at higher risk for stroke. 3- The stroke prevention trial in sickle cell anemia (STOP) and The Silent Cerebral Infarct Transfusion (SIT) multicentric trial are pivotal studies demonstrating the benefit of chronic transfusion program based on screening with TCD velocities to prevent symptomatic and silent ischemia in SCD children between 2 and 16 years. 4-The tracings on the TCD reflect, the size of the artery, type of flow and flow velocities related to rheologic and hemodynamic factors.

#### TABLE OF CONTENTS/OUTLINE

1- Introduction of the STOP and SIT trials. 2- Indications and recommendations on when and how to perform TCD. 3- How to interpret Doppler tracing on TCD. 4- Case based presentation of threshold velocities for a conditional and an abnormal TCD. 5- Quantitative ultrasound for RBC aggregation estimation as potential new test to decrease the number needed to treat and avoid unnecessary transfusion.

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## Abstract Archives of the RSNA, 2023

PDEE-81

### **Dermatologic Ultrasound in Children: Benign and Pseudo-Tumoral Lesions**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Luis O. Tierradentro-Garcia, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- 1. To overview the current applications of dermatologic ultrasound in children. - 2. To illustrate the utility of ultrasound to differentiate benign and pseudo-tumoral dermatologic lesions in children. - 3. To describe the role of conventional and advanced ultrasound as a complementary tool to CT and MRI in making diagnoses and assisting in surgical planning.

#### **TABLE OF CONTENTS/OUTLINE**

1. Background: Skin lesions in children are common, most lesions are benign. Clinical findings can be non-specific. 2. Technical aspects: - Image acquisition is non-invasive and harmless. - Frequency > 15 MHz. - Protocol: grayscale, Color Doppler, Pulsed-wave Doppler, microvascular flow imaging. - Normal sonographic appearance of the skin layers. 3. Pseudo-tumoral lesions 3.1 Cystic lesions - Epidermal inclusion cyst. - Trichilemmal cyst. - Dermoid cyst. - Cutaneous bronchogenic cyst. 3.3 Pilomatricoma 3.4 Dermatofibroma 3.5 Neurofibroma 3.6 Lipoma 4. Inflammatory lesions 4.1 Warts 4.2 Foreign body 4.3 Morphea 4.4 Insect bite 4.5 Kerion celsi 4.6 Juvenile xanthogranuloma 4.7 Congenital aplasia cutis 4.8 Annular granuloma 4.9 Keloid 5. Differential diagnosis 6. Take Home points

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## Abstract Archives of the RSNA, 2023

PDEE-82

### **Pediatric Magnetic Resonance Neurography: Technical Considerations, Indications, and Findings**

All Day Room: Learning Center

Frederik Abel (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) Review technical considerations and imaging challenges of pediatric patients referred for magnetic resonance (MR) neurography. 2) Discuss the most common indications and anatomic regions referred for MR Neurography. 3) Illustrate typical imaging findings, their clinical correlation, and management strategies.

#### **TABLE OF CONTENTS/OUTLINE**

1) Technical aspects of MR Neurography (3.0 T, conformable phased-array coils) and unique challenges of the pediatric population (e.g. SNR limitations due to small body habitus and size of peripheral nerves, sedation, motion artifact, flexion contracture (developmental or posttraumatic)). 2) Demographics and characteristics of a pediatric database at a tertiary orthopedic referral center 3) Imaging examples of both traumatic (e.g. median nerve entrapment following elbow fracture, drop foot post knee dislocation) and atraumatic (Charcot-Marie-Tooth, neurofibromatosis, limb hemihypoplasia) peripheral neuropathies and their clinical management 4) Strengths and weaknesses of MR Neurography for assessing pediatric patients, role of ultrasound, and discussion of future directions in this field

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## Abstract Archives of the RSNA, 2023

PDEE-83

### Acute Pediatric Elbow Trauma - Adding the Orthopedist's Perspective to Imaging Interpretation

All Day Room: Learning Center

Vivek Batra, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Knowledge of the specific developmental sequence of pediatric elbow apophyses is key to accurate interpretation of pediatric elbow trauma. 2. Knowledge of pitfalls is important, e.g., normal developmental irregularity of the apophyses can be mistaken for trauma. 3. In younger children, assessment of apophyseal avulsion/displacement on radiographs may be difficult due to incomplete ossification; MR may be necessary for more complete evaluation. 4. Chondroepiphyseal separation/transphyseal fracture of the distal humerus is a rare manifestation of mechanical birth related trauma of the newborn and may be difficult to diagnose on radiographs. Ultrasound and MRI may aid in further assessment. 5. Optimal orthopedic management of pediatric patients with elbow trauma is hinged on accurate imaging interpretation. Radiology reports should include entity-specific information that will benefit patient management. For example, a radial neck fracture is a sentinel fracture, often accompanied by additional fractures. Post reduction of elbow dislocation, the developing medial epicondyle can be entrapped in joint. A nursemaid's elbow may not manifest any imaging abnormalities.

#### TABLE OF CONTENTS/OUTLINE

1. Embryology and normal developmental anatomy of the elbow. 2. Radiographic views used for elbow trauma and technique of acquisition. 3. Role of MRI and CT acquisition parameters. 4. Imaging manifestations of pediatric elbow trauma. 5. Entity-specific additional information to be included in radiology reports that aid in orthopedic management. 6. Complications and mimics of acute elbow trauma. 7. Imaging spectrum of chronic overuse injuries of the developing elbow.

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## Abstract Archives of the RSNA, 2023

PDEE-84

### Masqueraders of Clarity - Tumor Mimics in Pediatric Oncology

All Day Room: Learning Center

Manisha Jana, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pitfalls in oncologic imaging are inflammatory, infective and vascular disorders which mimic tumors. Post-treatment changes and complications must be differentiated from residual or recurrent disease. Problem-solving tools include a multimodality approach, functional imaging and serial follow-up.

#### TABLE OF CONTENTS/OUTLINE

Non-neoplastic entities that mimic tumors lead to diagnostic confusion and delay appropriate therapy. In a patient with focal neurologic deficit or seizures, the cause may be demyelination, sarcoidosis or infections such as fungal, parasitic, tuberculosis and neurocysticercosis. Bone tumors are commonly mistaken in the setting of osteomyelitis, bone cysts, fracture, scurvy and osteogenesis imperfecta. Clinical context and plain radiographs must be correlated with MRI. Intrapulmonary nodes or granuloma mimic lung metastases. Abscesses, focal steatosis, cysts and arterioportal shunting are tumor mimics in the liver. Infarcts, cysts and perfusion abnormalities mimic tumors in the spleen, while adrenal hemorrhage can be mistaken for an adrenal mass. A hypertrophied column of Bertin, sludge and stones in the renal collecting system can mimic a renal mass - CEUS can help in the distinction. In a known cancer patient, radiotherapy-induced organ injury, post-chemotherapy infections, bone marrow changes and thymic rebound hyperplasia are common. Diffusion-weighted imaging and dynamic contrast-enhanced MRI can help in problem-solving.

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## Abstract Archives of the RSNA, 2023

PDEE-85

### Don't Ovary-act: A Sonographic Approach to Benign Pediatric Ovarian Pathology

All Day Room: Learning Center

Fatemeh Hadian, MBChB, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. A multi-follicular appearance is normal in neonates and teenagers and can be seen in prepubertal children. 2. Doppler flow may still be present in a twisted ovary and should not preclude making a diagnosis of torsion. 3. Benign ovarian lesions include ovarian cysts, para-ovarian cysts, mature cystic teratomas, cystadenomas and benign sex cord stromal tumors. 4. Diagnosing polycystic ovaries in adolescent females is challenging, but at-risk females can be identified for assessment at reproductive maturity. 5. Clinical history is crucial in differentiating between ovarian lesions with similar sonographic characteristics.

#### TABLE OF CONTENTS/OUTLINE

Introduction - Normal ovaries, ovarian development, ovum development  
Acute ovarian pathology - ovarian torsion, antenatal ovarian torsion, canal of Nuck hernia, tubo-ovarian abscess  
Benign ovarian lesions  
Ovarian cysts - neonatal cysts, physiological and functional cysts, para-ovarian cysts  
Benign cystic tumors - mature cystic teratoma, cystadenoma  
Other benign ovarian tumors - benign subtypes of sex cord stromal tumors, gonadoblastoma  
Key points in differentiating benign vs malignant ovarian lesions  
Special considerations in adolescents - polycystic ovaries, endometriosis  
Role of O-RADS in children  
Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-86

### Imaging Approach for Pediatric Thyroid Diseases

All Day Room: Learning Center

Yuko Tsujioka, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Pediatric thyroid diseases have unique problems not seen in adult diseases. For example, congenital hypothyroidism is a common disorder that is usually detected on neonatal screening, but if missed, it causes serious intellectual disabilities. Juvenile thyroid dysfunction often manifest with non-specific symptoms (e.g., personality changes, declined school performance, weight fluctuation, decreased growth velocity), and may be fraught with diagnostic errors. Diagnostic imaging can be used to determine the underlying etiologies of endocrine thyroid diseases and provide supplementary information for thyroid hormone replacement therapy and antithyroid medication as well as to aid in the diagnosis of focal thyroid diseases, i.e., severity and extent of thyroid tumors and inflammatory diseases. In this educational exhibit, learners understand 1) the etiology, clinical features, and imaging findings in common pediatric thyroid diseases, 2) their unique features, and 3) how to use imaging modalities in the diagnostic approach for the diverse group of the disorders.

#### TABLE OF CONTENTS/OUTLINE

Introduction - Thyroid development - Modalities of thyroid imaging - Congenital thyroid diseases including congenital hypothyroidism (thyroid dysgenesis, thyroid dysmorphogenesis, transient hypothyroidism, congenital central hypothyroidism) and congenital hyperthyroidism - Acquired thyroid diseases including autoimmune thyroiditis, non-autoimmune thyroiditis, secondary thyroid dysfunction, acquired central hypo- and hyperthyroidism, and tumor and tumor like lesions

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## Abstract Archives of the RSNA, 2023

PDEE-87

### Skeletal Disorders Due to Abnormal Aggrecan Biosynthesis

All Day Room: Learning Center

Yuko Tsujioka, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

We review the imaging findings of disorders associated with abnormal biosynthesis of aggrecan, a major proteoglycan of cartilage. Proteoglycans are widely distributed in the extracellular matrix, and impaired aggrecan synthesis interferes with normal bone and joint development and causes disorders with abnormal bone and joint. With development of massively parallel sequencing technology and increased understanding of proteoglycan biology, disorders once considered separate entities have been lumped together as a group of disorders called "aggrecanopathies.". All aggrecanopathies are autosomal recessive disorders with 25% of recurrence risk, and the accurate diagnosis is crucial for genetic counseling. Aggrecanopathies manifest with growth failure and multiple joint abnormalities that often lead to a misdiagnosis of joint hypermobility/contracture syndromes, such as arthrogyrosis and Larsen's syndrome. However, radiological examination allows the differential diagnosis. The skeletal hallmarks of aggrecanopathies include stunted tubular bones due to impaired endochondral ossification and an abnormal "pattern formation" due to maldevelopment of embryonic cartilage templates, such as distal humeral bifurcation, double-layered patella, monkey wrench-like proximal femora, hyperphalangy, and accelerated carpal ossification.

#### TABLE OF CONTENTS/OUTLINE

Introduction - Aggrecan synthesis process and related genes - Sulfation disorders (DTDST related, and others) - UDP-sugar deficiency (CANT1-related Desbuquios syndrome and others) - Linkeopathies

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-88

### High Negative Appendectomy Rates in Under-18-year-old Patients - A 10-year Review with Radiologic-Pathologic Correlation: And Then There Were None

All Day Room: Learning Center

Juan Carlos Monte Gonzalez, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Radiologist-performed ultrasound (R-US) is a reliable diagnostic technique for acute appendicitis in under-18-year-old (U18) patients. - In inconclusive R-US studies (9% in this sample), positive second-look techniques were CT (55,6%), R-US (33,3%) and MRI (11,1%). - Discordance with pathology findings/negative appendectomy rate (NAR) was 6%, lower than other series.

#### TABLE OF CONTENTS/OUTLINE

One of our institution's pediatric surgeons suspected high NAR due to R-US low accuracy. This motivated a review of every appendectomy (610) in U18 patients, since the inauguration of our hospital (2012-2022). For this abstract, we sampled 100 patients that underwent appendectomy. We classified the cases by:- Age: 6-17 years-old (mean: 11,27 yo).- Gender: 41% female, 59% male.- Symptoms: 99% right lower quadrant pain, 63% nausea/vomiting, 18% temperature >37.3°C/99.1°F, 13% diarrhea, 12% hyporexia/anorexia.- Clinical signs: 67% Blumberg, 22% Psoas.- Laboratory values: 83% Leukocytosis >10,000, 68% leukocyte left shift (>75% PMNs), 67% CRP > 0.5.- Alvarado Score: 2-10 points (mean: 7,2).- R-US results: 90% positive, 1% negative, 9% inconclusive.- Second-look positive technique for inconclusive cases: 55,6% CT, 33,3% R-US, 11,1% MRI.- Appendix diameter: 5-20 mm (mean: 8,5 mm).- Surgical findings: 62% phlegmonous/suppurative, 17% phlegmonogangrenous/gangrenous.- Surgical technique: 53% open, 47% laparoscopic.- Pathology findings: 83% phlegmonous, 11% gangrenous, 5% reactive follicular lymphoid hyperplasia, 1% normal.- Discordance with pathology findings/NAR: 6%.- Evolution: 93% favorable, 4% complicated (1% dehiscence, 3% post-operative collections that resolved with antibiotics), 3% N/A.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-89

### The Many Faces of Pediatric Langerhans Cell Histiocytosis: A Pictorial Review

All Day Room: Learning Center

Maria F. Dien Esquivel, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Recognizing the typical imaging findings on different modalities of this rare disease is key to an early diagnosis and to guide management. 2. MR imaging is the modality of choice to evaluate central nervous system involvement. 3. FDG PET/CT plays a crucial role in the diagnosis, staging, surveillance and assessment of response to treatment of patients with LCH.

#### TABLE OF CONTENTS/OUTLINE

-Epidemiology-Classification-Etiopathogenesis and molecular findings-Pathology-Clinical Presentation-Treatment-Imaging Modalities• Radiography (skeletal survey)• Computed Tomography• Magnetic Resonance Imaging• Bone scintigraphy• PET/CT  
-Imaging Features by system• Central Nervous System• Axial and appendicular skeleton (bone marrow)• Chest• Abdomen• Nodal involvement• Other sites: Skin-Role of imaging• At diagnosis/initial staging• To assess response to treatment• During surveillance/follow up

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-90

### **Intravascular Catheters in Pediatrics: Methods, Imaging and Complications**

All Day Room: Learning Center

Larisa Gorenstein, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Intravascular catheter insertion in the pediatric population can be challenging, especially in infants. 2. The radiologist must be familiar with the imaging appearance of intravascular catheters, and recognize catheter malposition as well as other complications. In selected cases, a linogram may be diagnostic.3. Pediatric patients may experience unique complications such as thrombosis of the portal vein associated with umbilical vein catheterization.4. In some complications, such as malposition, it may be possible to perform an 'over-the-wire exchange.' However, in other cases, the only option may be to insert a new catheter.

#### **TABLE OF CONTENTS/OUTLINE**

1. Important anatomy highlights.2. Types of catheters.3. Insertion methods and pitfalls.4. Intravascular catheters on pediatric imaging: pearls and pitfalls.5. Neonatal lines-special considerations.6. Cases.7. Diagnosis and management of complications.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PDEE-91

### Little Bellies, Big Impact: Blunt Abdominal Trauma in Pediatric Patients

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Fabiana Gual, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: To emphasize that trauma is a leading cause of death in the pediatric population, with abdominal injuries being a common and often unrecognized cause; To discuss the factors contributing to the higher risk of abdominal injuries in children, such as thinner abdominal wall and reduced adipose tissue; To highlight the importance of using the appropriate imaging test (including radiography, ultrasonography, contrast-enhanced CT and eventually magnetic resonance) based on the severity of the trauma and the stability of the patient; To provide examples of cases of low- and high-energy blunt abdominal trauma to demonstrate the utility of these imaging tests in diagnosing injuries to specific organs, such as the pancreas, liver, spleen, and kidneys; To acknowledge the challenges in evaluating children with blunt abdominal injury, especially pre-verbal children, and the need for diagnostic imaging to guide management decisions.

#### TABLE OF CONTENTS/OUTLINE

A flowchart illustrating the use of diagnostic imaging in low- and high-energy blunt abdominal trauma in children. A table listing the "packages of injuries" that can be identified based on force vectors when the pancreas, liver, spleen, and kidney are injured. Illustrated teaching cases of patients who were treated at the pediatric emergency department of a quaternary hospital and underwent imaging tests. The cases involve low- and high-energy blunt abdominal trauma resulting in pancreatic, hepatic, splenic and renal injuries. The Pediatric Organ Injury Scale was used to classify the severity of these injuries.

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## Abstract Archives of the RSNA, 2023

PDEE-92

### Multimodality Imaging Review of Inherited Collagen Disorders

All Day Room: Learning Center

Daniel F. Morgan, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Describe the epidemiology and pathophysiology of inherited collagen disorders in children. 2. Identify typical and atypical features of inherited collagen disorders. 3. Provide a comprehensive review of the key imaging findings for each disorder using a multi-system and multi-modality approach. 4. Discuss complications of disease and treatment options.

#### TABLE OF CONTENTS/OUTLINE

I. General Introduction to Inherited Collagen Disorders  
II. Conditions  
A. Epidemiology  
B. Diagnostic Imaging Findings and Complications  
a. Osteogenesis Imperfecta: Wormian bones, multiple fractures, osteoporosis, in-utero manifestations, zebra stripe sign  
b. Ehlers-Danlos joint dislocations, fractures, hemarthrosis, sigmoid colon rupture, splenic artery aneurysm  
c. Stickler Syndrome facial deformities, articular manifestations  
d. Epidermolysis Bullosa cutaneous blisters and erosions with transformation to squamous cell carcinoma, pseudosyndactyly with mitten hand/sock toe deformities, esophageal stricture, pyloric atresia, osteomyelitis  
e. Alport Syndrome end-stage renal disease manifestations, esophageal leiomyomatosis  
C. Treatment  
III. Conclusion

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## Abstract Archives of the RSNA, 2023

PDEE-93

### Fetal MRI to Detect Congenital Anomalies of the Kidney and Urinary Tract

All Day Room: Learning Center

Chihiro Tani, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

As congenital anomalies of the kidney and urinary tract (CAKUT) account for 40% of childhood end-stage renal failure, an early diagnosis and appropriate treatment are important. Fetal ultrasonography and MRI help to diagnose some of the diseases included in CAKUT. Fetal MRI is important for postnatal treatment and follow-up. We discuss the development of the renal and urinary system in fetuses and present fetal MRI findings of major diseases in CAKUT.

#### TABLE OF CONTENTS/OUTLINE

(1) The development of the renal and urinary system during the fetal period ; kidney, ureter, bladder, urethra(2) Fetal MRI findings of major diseases in CAKUTa. Renal anomalies ; multicystic dysplastic kidney, autosomal recessive polycystic kidney disease, horseshoe kidney, pelvic kidney, etcb. Renal pelvis, calyx, and ureter anomalies ; ureteropelvic junction obstruction, megaureter, etc. Bladder and urethral anomalies ; bladder exstrophy, posterior urethral valves, etc.OutlineCAKUT accounts for childhood end-stage renal failure. Therefore, an early diagnosis and appropriate treatment are important. As some of the diseases included in CAKUT can be diagnosed prenatally, radiologists must be cognizant of fetal MRI findings of major diseases in CAKUT.

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## Abstract Archives of the RSNA, 2023

PDEE-94

### **It's all about location! A Practical Compartment-Based Approach to Diagnosing Pediatric Head and Neck Masses**

All Day Room: Learning Center

Begum Ergin, MD, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Provide a practical compartment-based approach to create the best differential diagnosis of pediatric neck masses.2. Review the anatomy and content of each compartment3. Review relevant clinical and specific imaging findings of common and rare pediatric neck lesions based on a compartmentalized approach.

#### **TABLE OF CONTENTS/OUTLINE**

A. BackgroundHow to diagnose a pediatric neck mass?Why should we prefer a compartment-based approach for diagnosing pediatric neck masses?B. Head and neck compartments and compartment-based pediatric head and neck masses • Superficial Fascia• Parapharyngeal Space• Pharyngeal Mucosal Space• Submandibular space• Sublingual Space• Masticator Space• Buccal Space• Parotid Space• Carotid Space• Retropharyngeal Space• Perivertebral Space• Posterior Cervical Space• Visceral Space • Transspatial-multispatial• MiscellaneousSummary1. Evaluation of pediatric head and neck masses can be challenging due to their embryologic origin, complex anatomy, and various affecting pathologies.2. Using a practical compartment-based approach with careful consideration of the clinical details and specific imaging findings will enable the best differential diagnosis.

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## Abstract Archives of the RSNA, 2023

PHEE

### Physics Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **PHEE-1 CT Dose Evaluation by Monte Carlo Simulation: Challenges for Personalized Dosimetry**

Kosuke Matsubara, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The teaching points of this exhibit include the following: (1) Monte Carlo simulation is an effective tool for achieving personalized dosimetry in CT. (2) To improve the accuracy of radiation dose calculation on Monte Carlo simulation, the optimization of the patient or phantom model, energy spectrum, bow-tie filter model, patient support model, number of projections, and tube current modulation method are essential. (3) Radiation dose calculation in dual-energy CT is also feasible by modifying the calculation code of single-energy CT.

#### **TABLE OF CONTENTS/OUTLINE**

1. Monte Carlo simulation for radiation dose calculation: a) Principles, b) Monte Carlo simulation code, and c) Advantages and disadvantages of Monte Carlo simulation. 2. Optimization of Monte Carlo simulation in CT: a) Patient or phantom model, b) Energy spectrum, c) Bow-tie filter model, d) Patient support model, e) Number of projections, and f) Tube current modulation. 3. Monte Carlo simulation in dual-energy CT: a) Dual-source system and b) Rapid kV switching system. 4. Summary.

#### **PHEE-10 How Can We Establish Direct Radiation Dose Measurement During CT Examinations?**

Hiroaki Hayashi, PhD (*Presenter*) Research collaboration, Meditec Japan Co., Ltd; Research collaboration, JOB Corporation

#### **TEACHING POINTS**

<<1>> Because the surface dose distribution fluctuates approximately twice during helical scanning CT, it is difficult to estimate proper radiation exposure dose when using a small number of dosimeters. <<2>> By estimating the X-ray incident direction from the standard deviation (SD) distribution of the X-ray (CT) image and fitting the predetermined dose function to the measured point dose, it is possible to evaluate the surface dose distribution regardless of both the incident angle of X-rays and heterogeneity of the subject.

#### **TABLE OF CONTENTS/OUTLINE**

<<1>> The surface dose distribution fluctuates due to the influence of the incident direction of X-rays during helical scanning CT. The information concerning the incident direction of the X-ray can be analyzed from the SD distribution of the X-ray image. <<2>> The proposed algorithm for analyzing doses combines the dose distribution and the SD distribution of the X-ray image. <<3>> A phantom study was conducted using the latest X-ray CT equipment. <<4>> It was demonstrated that consistent mean values could be calculated regardless of the incident direction of X-rays. <<5>> We proved that the measurement data using only one dosimeter showed the same results as the data when using many dosimeters. From this experiment it was determined that our method using only one dosimeter can be applied to actual clinical examinations.

#### **PHEE-11 Artificial Intelligence and MRI Artifacts: A Pictorial Review of MR Artifacts and AI Techniques for Reduction**

Joseph Carbone, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Teaching Points: 1. To provide a pictorial review of MRI artifacts and their specific causes as it relates to MR physics, with imaging correlates illustrating their significance in hindering radiologists' interpretation of images. 2. To describe emerging artificial intelligence and deep learning architecture as it pertains to the minimization of artifacts and image augmentation. 3.

To illustrate how radiologists may benefit in interpretive ability from MRI artifact reduction and image enhancement, and describe future aims pertaining to image augmentation.

#### **TABLE OF CONTENTS/OUTLINE**

MRI artifacts result from an array of factors and are troublesome for radiologists as they may mimic or obscure structures of interest or disease conditions. Artificial intelligence and deep learning have emerged as a post-processing tool to augment radiologist's interpretation of MRI by eliminating or diminishing various artifacts, increasing signal to noise (SNR), and enhancing image resolution. It is important for radiologists to be familiar with MRI artifacts and emerging methods of negating these artifacts with deep learning and artificial intelligence. This abstract will serve as a pictorial review of varying MRI artifacts, as well as an update on the various methods that deep learning and artificial intelligence can be used as a post-processing tool to negate various MRI artifacts and augment radiologist's ability to interpret MRI images.

#### **PHEE-12 What is Trustworthy AI and How It Contributes in Diagnosis**

Masahiro Oda, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of our exhibit are:1. To confirm difficulty of using AIs that have black box nature in diagnosis assistance2. To learn what is trustworthy AI that unboxes black box AI3. To learn explainable AI that clarifies the reason of decision4. To learn uncertainty in AI that clarifies cases where AI is difficult to decide

#### **TABLE OF CONTENTS/OUTLINE**

AI in diagnosis assistance - Provide decision assistance information- How AI decides is difficult to understand for radiologistsTrustworthy AI - What is trustable AI for radiologists- Clarification including the reason of decision by AI and what AI doesn't know is necessary- Important research fields in trustworthy AI: Explainable AI, Uncertainty in AIExplainable AI - What is Explainable AI- Outcome explanation: provide explanations for AI outcomes- Model explanation: provide interpretable model that approximates black box model- Model inspection: understand model from its inputs and outcomes- Transparent box design: make parts of black box model interpretableUncertainty in AI - What is Uncertainty in AI- Aleatoric uncertainty (data uncertainty): uncertainty in AI decision caused by noise or variance in data- Epistemic uncertainty (model uncertainty): uncertainty in AI decision caused by variance in model parameter determinationTrustworthy AI in diagnosis assistance - Provide reasons of decisions made by AI- Provide a degree of confidence in AI decision

#### **PHEE-13 Contrast Enhancement at CT: Principles and Clinical Applications**

Toru Higaki, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Contrast enhancement is important in CT examinations to evaluate the vessel morphology and the blood supply in tissues. The enhancement degree of iodine contrast media changes with the injection volume and speed. We describe the properties and pharmacokinetics of contrast agents, the theory of contrast enhancement, present optimized contrast administration methods, and discuss side-effects of contrast media.

#### **TABLE OF CONTENTS/OUTLINE**

1. Pharmacokinetics of iodine contrast media (PDF-p.1)2. Basics of the contrast enhancement protocol for CT- Effect of the injection volume (PDF-p.2)- Effect of the injection duration/speed (PDF-p.3)- Effect of the patient body weight (PDF-p.4)3. Optimization of contrast protocols- Target organ-based optimization- Body weight-based optimization- Optimization by other body indexes- Low-kV scan / Dual-energy scan (PDF-p.5)4. Side-effects of contrast media

#### **PHEE-14 Spreading a Culture of MR Safety Outside of the Academic Practice: Regional Practices and other Departments**

Avery Scripture, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- With the development and growth of "Health Systems", and the use of MR units outside of radiology departments, a culture of MR safety must be fostered and maintained at all sites.
- Academic medical centers typically image patients with the greatest level of risk related to MR safety, including untested and off-label implants.
- Partnering between the Academic Medical Center with Regional Radiology Practices and other off-site MR users helps to establish a uniform culture of safety while maintaining effective clinical operations.
- MR safety has a significant role in creating or eliminating MR access disparities, especially in rural areas.
- Other non-imaging modalities that utilize magnetic fields, such as transcranial magnetic stimulation, can also benefit from collaboration with the MR safety committee.

#### **TABLE OF CONTENTS/OUTLINE**

What is a Culture of MR Safety and how was it established Growth of the MRI fleet from acquisitions of practices and expanding use of technology Regional radiology growth MR-Linac and Intra-op MR units Culture change is difficult - how to do

it effectively? Finding partners - benefit of local MDRD Shared expertise - such as one MRSO for all sites Engage all relevant personnel at early stages, to plant the seed of MR Safety Establishing local MR Safety Committees Practices vary, so can help meet specific needs Improves relevance to specific Clinical Operations and maintains efficiency Importance of Quality Assurance Recording at the time of the incident Emphasize non-punitive culture Record "near misses" Review by MR Safety Committee Role of MR safety in imaging access and equity

## **PHEE-15 Alleviating MR Artifacts Induced by Programmable Shunt for Hydrocephalus Patients**

Kuan Zhang, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) The primary treatment for idiopathic normal pressure hydrocephalus (iNPH) is surgical insertion of a shunt system, such as the Certas Plus valve (VP shunt), to drain the excess cerebrospinal fluid. 2) MRI is typically used for diagnosis and postoperative monitoring of patients with iNPH. However, susceptibility artifacts may arise due to the metal component in the shunt. 3) Although 3T MRI could provide higher imaging quality than 1.5T, post-shunt imaging with iNPH is usually conducted at 1.5T, due to the recognition that metal artifacts are generally more prominent at higher field strength. 4) Our experience with patient and phantom scans indicates that shunt-induced artifacts demonstrated similar metal artifacts on 3T and 1.5T for some routine clinical imaging sequences, including MPRAGE, DWI, and GRE, due to differences in acquisition parameters between field strengths. Nevertheless, T2 FSE and T2 FLAIR show larger artifacts at 3T, compared to 1.5T. 5) To further improve the quality of post-shunt MRI with the programmable shunt at 3T, techniques that could be helpful in reducing metal artifacts were shown. 6) The effect of metal presence was demonstrated with advanced technologies such as parallel imaging and deep learning algorithm. 7) With imaging protocol optimization, 3T programmable shunt imaging was feasible and could achieve comparable or superior image quality than 1.5T.

### **TABLE OF CONTENTS/OUTLINE**

1) Introduction 2) Routine clinical post-shunt imaging sequences at 1.5T vs 3T. 3) Commonly used strategies to alleviate shunt-induced artifacts. 4) Advanced techniques related to shunt-induced artifacts. 5) Conclusion

## **PHEE-16 Will General Radiography Become More Valuable When Exploiting the Performance of a Photon Counting Detector?**

Daiki Kobayashi, BS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Quantitative diagnosis can be established using Energy Resolving Photon Counting Detectors (ERPCD). 2. Because a functional image can be generated via several calculation processes, the quality of a functional image degrades. High-quality images can be obtained by optimizing the imaging parameters. 3. Image blurring interferes with quantitative analysis. Therefore, we should devise a novel blurring correction method instead of using the conventional Unsharp Masking method.

### **TABLE OF CONTENTS/OUTLINE**

1. Impact of developing ERPCD. When obtaining functional images using ERPCD, quantitative diagnosis can be performed. The ERPCD system can also generate conventional qualitative diagnosis which can be performed using a traditional Energy Integrating Detector (EID). 2. An in-house program is available to simulate the actual X-ray imaging process in an imaging detector. In the program, X-ray attenuation, detector response, and statistics are taken into consideration. 3. When optimizing the settings of an ERPCD system, we found that a high kV system can generate a higher-quality functional image. 4. Image blurring should be corrected to analyze the object edge of functional images. 5. If ERPCD is used for general radiography, we can extract more information from X-ray images. For example, in the diagnosis of the fractures, we can obtain not only the visual information about the broken bones but also BMD information. ERPCD makes it possible to perform the screening test for osteoporosis.

## **PHEE-17 DXA Quality Control Review**

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Understand the types and reasons for different QC tests, 2. Appraise suggested quality control tests based on key limits and elements, 3. Implement a DXA quality control program

### **TABLE OF CONTENTS/OUTLINE**

1. Why Establish a DXA QC Program?, 2. Least Significant Change, 3. Elements of a Good QC test, 4. Types of DXA QC Tests, 4a. Cross-calibration of Machines, 5. Example QC Program, 6. Recommendations from National and International Societies

## **PHEE-18 A Comprehensive Review of Ultrasound-guided Vascular Access for Residents, Fellows, and Medical Students**

Atlee Witt (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1) To detail different ultrasound techniques for vascular access 2) To explore the indications, contraindications, and potential complications of ultrasound-guided vascular access 3) To examine the utility of ultrasound-guided access for arterial, systemic venous, portomesenteric venous, and AV fistula procedures

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction: a) Indications for US vascular access (i. difficult or high-risk IV access ii. delivery of medications, fluids, or blood iii. diagnostic and interventional procedures) b) Relative contraindications (i. time limitations in emergent situations ii. ultrasound resolution with increasing depth iii. subcutaneous emphysema iv. volume depletion v. infection at the site of access) 2) Procedure: a) Equipment (i. ultrasound machine with high-frequency capable probe, ii. supplies for vascular access [1. IV starting kit, sterile gel, IV flushes, sterile probe cover]) b) Pre-procedure (i. consent ii. site identification and preparation) c) Technique (i. static approach ii. real-time approach [1. longitudinal approach 2. transverse or short-access approach]) d) Post-procedure (i. infection prevention) e) Complications (i. vessel puncture ii. malpositioning iii. injury to surrounding structures iv. infection) 3) Access sites: a) Artery (i. radial, brachial, femoral, and dorsalis pedis arteries) b) Systemic vein (i. internal jugular vein ii. subclavian vein iii. femoral vein) c) Portomesenteric vein (i. access to portal vein system ii. portography and portal pressure iii. embolization) d) AV fistula or graft

#### **PHEE-19 Would You Like to Ride the Wave Called CT Images? As a Novel Frequency Analysis Tool**

Yoichiro Ota, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The spatial resolution CT images is expressed by a wave so-called Modulation Transfer Function. It is difficult to associate clinical CT images with MTFs, which is confusing to interpret. This can be explained by using the proposed method Band-limited CT images. This study will lecture on the contribution of high-frequency components to the image and the interpretation of MTFs intersections.

#### **TABLE OF CONTENTS/OUTLINE**

The process of Band limited image is based on Fast Fourier Transformation and frequency band limitation of CT images. Each band-limited CT image can contribute to characterizing how much information is in a signal of original CT images. The inclusion of high-frequency components results in high CT value and high resolution. Even if MTFs have an intersection, The band-limited image shows the difference in the amount of information that images have. We can associate clinical CT images MTFs and interpret the feature of CT images from physical point of view.

#### **PHEE-2 3D Fast Spin Echo MRI with Variable Refocusing Flip Angles: Principles, Techniques, and Applications**

#### **Awards**

#### **Certificate of Merit**

Zhongwei Zhang, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

3D FSE MRI with variable refocusing flip angles provides high-quality images with good contrast in various clinical applications. Its speed and versatility have made it a workhorse in MRI. The purposes of this Education Exhibit are 1. Overview of 3D FSE MRI acquisition schemes and the rationale of the variable flip angle strategies. 2. Explain the constant low flip angle refocusing and Pseudo Steady State (PSS) Principle, the transitions between pseudo steady states (TRAPS) principle, Mugler's Relaxation-specific Method, and Busse's General method for refocusing flip angle modulation. 3. Discuss the common-used RF excitation techniques such as non-selective/slab-selective RF excitation, inner volume RF excitation, etc. 4. k-space view ordering. 5. Review the RF modules used for magnetization preparation and contrast optimization. 6. T1-preparation (inversion recovery), T2-preparation, magnetization transfer contrast, fat suppression, diffusion weighting, flow suppression or enhancement, etc. are discussed in detail. Clinical protocols along with representative images are given for each magnetization preparation approach. 7. Review acceleration techniques including GRAPPA, CAIPIRINHA, and compressed sensing (CS) MRI.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction; 2. The Constant Low Flip Angle Refocusing and PSS Principle; 3. The TRAPS principle; 4. Mugler's Relaxation-specific method; 5. Busse's General Method; 6. RF excitation techniques; 7. K-space view ordering; 8. Magnetization preparation and contrast optimization; 9. T1-preparation; 10. T2-preparation; 11. MTC; 12. Fat suppression; 13. Diffusion weighting; 14. Flow suppression and enhancement; 15. Acceleration techniques.

#### **PHEE-20 Photon-Counting Detector CT in Comparison to Energy-Integrating Detector CT: Optimization and Implementation of a Non-contrast Enhanced Chest Protocol for All Patient Sizes**

Danielle Vialle, MSc (*Presenter*) Nothing to Disclose

### TEACHING POINTS

o To demonstrate how to measure the diagnostic image quality (IQ) of a photon-counting detector (PCD) CT protocol  
o To learn how to assess and evaluate IQ of a PCD-CT protocol compared to energy-integrating detector (EID) CT  
o To provide tips and learn how to adjust the imaging protocol for a specific task and patient size

### TABLE OF CONTENTS/OUTLINE

With the introduction of PCD-CT in clinical practice, question rises how the IQ relates to the IQ of EID-CT scanners, and what the possibilities are for further dose reduction and/or image quality improvements. This exhibit provides you with knowledge on how IQ could be determined and evaluated by objective and subjective measures.

- o What is image quality and how can it be evaluated?
- Objective IQ quantified by noise, contrast, resolution and combined into the detectability index (d')
- Subjective IQ assessed by radiologists with 5-point Likert Scale
- o Effect on IQ and dose (phantom study examples)
- Determination of your site reference standard
- Determination of differences in scan and reconstruction parameters between scanners (EID-CT and PCD-CT)
- Influence of scan and reconstruction parameters
- Effect of differences in patient size
- Effect of dose adjustment
- o Guidelines on protocol adaptation
- How to find the right balance between IQ and dose
- Tips and tricks in adaptation of current EID- and PCD-CT protocols
- Tips for utilizing the full potential of a PCD-CT

## PHEE-21 Radiation Protection Essentials for Interventional Radiology Workers

Koichi Chida, PhD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

-To understand the present status of medical interventional radiology (IVR) occupational radiation protection/shielding.-To understand the advantages/disadvantages of various radiation-shielding equipment.-To understand current protection/reduction methods and identify methods to improve these methods.-To understand the necessity of combining various reduction methods (tools) to reduce occupational radiation—shielding is only one such component.-To understand that the methods used to reduce the patient radiation dose are the same as the methods employed to reduce staff doses.

### TABLE OF CONTENTS/OUTLINE

Advantages/disadvantages of various shielding devices. There is no perfect device! Relationship between the patient radiation dose and medical worker exposure. Physician-received scattered radiation during IVR was strongly correlated with the patient dose. Therefore, reduction of the patient dose will decrease the staff dose. Outline The regulation dose limit is seldom exceeded when protection is appropriate. However, radiation injuries such as cataracts have recently been reported in physicians and staff who perform IVR. There is no perfect shield. Combinations of shields are required. Radiology workers must be appropriately educated in terms of reducing the radiation exposure among both patients and staff; such workers must understand the various methods used to estimate occupational exposure. Decreasing the patient dose reduces occupational exposure. Although shielding is critical, it is only one component of radiation protection. Patient dose optimization means that the patient never receives a higher dose than is necessary, which also reduces the dose received by the staff.

## PHEE-22 Fluoroscopy: An Overview and Refresher for Radiologists

### Awards

#### Certificate of Merit

Jay Starkey, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

Note to reviewer: this submission is in response to the call of Dr. Christine Cooky Menias for a Physics educational exhibit on Fluoroscopy.

1. Provide an introduction to fluoroscopy and its history.
2. Describe the major components of a fluoroscopy system.
3. Explore principles and techniques, with a focus on image quality and radiation dose.
4. Discuss clinical applications across multiple subspecialties in diagnostic and interventional radiology.
5. Identify similarities and differences between projection radiography and fluoroscopy

### TABLE OF CONTENTS/OUTLINE

1. Introduction to Fluoroscopy and Historya. Invention, early uses, evolution, current state of the art2. Major Components of a Fluoroscopy Systema. Imaging chain from x-ray tube to control consoleb. Image intensifier and flat panel detector systems3. Principles and Techniquesa. Continuous vs. pulsed fluoroscopyb. Automatic brightness controlc. Last-image holdd. Factors influencing image quality and radiation dose4. Clinical Applications Across Subspecialtiesa. Pediatric radiology, body imaging, neuroradiology, musculoskeletal radiology, thoracic radiologyb. Interventional radiology5. Comparing Projection Radiography and Fluoroscopya. Nomenclatureb. Image formation and technologyc. Location and mobility differencesd. Target, filter, and grid similarities and differencese. Continuous exposure vs. pulsatile exposuref. Radiation dose and exposure considerations6. Radiation Protection in Fluoroscopya. Stochastic and deterministic effectsb. Radiation safety for patientsc. Radiation safety for personnel



## **PHEE-23 Automated Evaluation of Radiograph Accuracy Using Deep Learning With Explainable Artificial Intelligence**

Haruyuki Watanabe, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

In radiography, it is vital to maintain precise positioning to guarantee consistent image reproducibility. However, the decision to retake a radiograph is the responsibility of the supervising radiological technologists, whose evaluation methods are subjective. With the development of artificial intelligence (AI), deep learning is effectively used to guarantee the accuracy of radiographs. The focus of this study is to develop a deep learning-based automated quantitative evaluation method for radiography. It can guarantee the quality of radiographs and provide useful information for retaking radiography. Furthermore, explainable AI was utilized to determine the typical sources of information that AI relies on when making decisions. Analyzing data from the explainable AI could facilitate enhancements to the network's architecture. The major teaching points of this exhibit are to: 1. Evaluate automatically the radiograph accuracy. 2. Understand how to classify schemes using deep learning. 3. Clarify the typical sources of information that AI relies on when making decisions using explainable AI.

### **TABLE OF CONTENTS/OUTLINE**

To provide automated quantitative evaluation of radiograph accuracy using deep learning with explainable artificial intelligence and to discuss clinical usefulness toward an accurate diagnosis in radiography. To reduce variability in individual assessments and achieve a quantitative index. Ultimately, the aim is to reveal the network structure using explainable AI in order to construct an appropriate network.

## **PHEE-24 Don't Get Burned: Hot Topics in MRI Safety**

### **Awards**

#### **Certificate of Merit**

Jay Starkey, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Note to reviewer: this submission is in response to the call of Dr. Christine Cooky Menias for a Physics educational exhibit on MRI Safety. This educational exhibit provides a comprehensive overview of MRI safety for radiologists. It covers foundational principles, safety zones, personnel and patient screening, handling of special cases, and emergency procedures. The importance of continuous learning and adherence to guidelines by regulatory bodies is emphasized. Case studies and scenarios supplement the understanding of topics and foster application of knowledge.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction• Safety Ethics in MRI• Importance of MRI Safety2. Understanding the MRI Environment• Safety Zones• MRI Zone Protections3. Staff and Patient Considerations• Personnel Screening• Patient Screening• Special Case: Inability to Obtain Consent4. MRI Hazards• Radiofrequency (RF)-Induced Heating• Metallic Foreign Bodies• Medical Implants• Quenching in MRI5. Safety Guidelines and Emergency Procedures• MRI Safety Guidelines and Standards• Emergency Procedures in MRI6. Case Studies and Scenarios• Case Studies: Stents, Pacemakers, Pregnant Patient, Unconscious Patient• Safety Scenarios and Answers7. Special Topics in MRI Safety• High Field Strength Magnets• MRI and Pregnancy

## **PHEE-25 Super-resolution Deep Learning Reconstruction of MR Imaging: Technical Features and Clinical Impact on Abdominal and Pelvic MR Imaging**

Atsushi Nakamoto, MD, PhD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Deep learning reconstruction (DLR) has recently been introduced by several vendors to improve MR image quality by reducing image noise. Super-resolution deep learning reconstruction (SR-DLR) is a newly developed MR image reconstruction method that not only reduces image noise but also improves spatial resolution. SR-DLR is expected to provide even higher image quality and improved diagnostic performance compared to DLR. The aims of this exhibit are: 1. To illustrate the technical features of SR-DLR, 2. To discuss the image quality of MR imaging using SR-DLR, and 3. To discuss the clinical impact on MR studies in the diagnosis of abdominal and pelvic disease.

### **TABLE OF CONTENTS/OUTLINE**



1. Overview 2. Principle of SR-DLR 3. Sequences applicable to SR-DLR: fast spin echo T2WI, single-shot fast spin echo T2WI, DWI, steady-state free precession (SSFP), 3D T1-weighted gradient-echo with or without contrast enhancement, etc. 4. Effective reduction of image noise with SR-DLR 5. Improved spatial resolution with SR-DLR 6. Differences in image quality and spatial resolution from the conventional image reconstruction technique and DLR 7. Clinical impact on the diagnosis of abdominal diseases (liver, biliary tract, and pancreas) 8. Clinical impact on the diagnosis of pelvic diseases (uterus, ovaries, prostate, bladder, and rectum) 9. Summary

## **PHEE-26 Optimal Acquisition and Reconstruction Techniques of Coronary CT Angiography: Current Status and Trends Over the Past Decade**

### **Awards**

#### **Cum Laude**

Rika Fukui (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) To introduce recent technological developments in coronary CT angiography (CCTA); 2) To describe optimal acquisition and reconstruction techniques in CCTA based on these developments; 3) To illustrate clinical utilities of these techniques in CCTA by presenting various clinical data and images.

### **TABLE OF CONTENTS/OUTLINE**

1) Recent technological developments in CCTA (a) Hardware: high-output/fast-rotating x-ray tube, high-definition/ultra-high-resolution CT (HD/UHRCT), area-detector CT (ADCT), dual-source CT (DSCT), dual-energy CT (DECT); (b) Software: automatic selection of optimal acquisition parameters/cardiac phase (Auto gating/Smart phase), motion correction algorithm (MCA), iterative/deep learning reconstruction (IR/DLR). 2) Optimal acquisition and reconstruction techniques in CCTA (a) HD/UHRCT, DECT vs. coronary artery calcification/stent; (b) Fast-rotating x-ray tube, DSCT, Smart phase, MCA: motion artifact reduction; (c) ADCT: misalignment (banding/stair-step) artifact reduction; (d) Low kV acquisition by high-output x-ray tube, Auto gating, IR/DLR: radiation dose reduction; (e) Low kV acquisition by high-output x-ray tube, DECT vs. poor contrast; (f) Auto gating, Smart phase, MCA: workflow improvement; (g) DECT: detailed coronary plaque assessment. 3) Clinical utilities of these techniques in CCTA (a) Better image quality/interpretability/diagnostic accuracy/workflow; (b) Lower radiation/contrast media dose.

## **PHEE-27 Low kV or Low keV, That Is the Question: What the Radiologist and Radiology Technologist Need to Know in Contrast-Enhanced Body CT With Current and Novel Technologies**

Haruhiko Machida, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1) To introduce basic principles and clinical usefulness of single-energy CT (SECT) at low tube voltage (kV)/virtual monochromatic imaging (VMI) at low energy (keV) by dual-energy CT (DECT) in contrast-enhanced body CT; 2) To illustrate factors affecting image quality (IQ) of SECT at low kV/VMI at low keV and current and novel technologies for improving the IQ; 3) To demonstrate strategies to determine the optimal imaging option.

### **TABLE OF CONTENTS/OUTLINE**

1) Basic principles clinical usefulness of SECT at low kV/VMI at low keV (a) Basic principles: SECT/DECT/VMI; (b) Clinical usefulness: improved contrast enhancement/reduced iodine load/reduced radiation dose (for SECT)/reduced beam-hardening (BH) metallic artifact (for DECT)/flexible keV selection (for DECT)/improved material decomposition (MD) various DECT-specific imaging/analysis options (for DECT). 2) Factors affecting IQ of SECT at low kV/VMI at low keV technologies for improving the IQ (a) IQ factors: CT value/image noise/contrast-noise ratio/spatial resolution/BH metallic artifact; (b) Current novel technologies: high output x-ray tube/kV mA synchronized switching/highly efficient detector/iterative deep-learning reconstruction/metallic artifact reduction software. 3) Strategies to determine the optimal imaging option (a) Better spatial resolution for SECT; (b) Better image contrast/less BH metallic artifact/better MD for DECT.

## **PHEE-28 Development of 3D Performance Phantom in UHR-CT (Evaluation of MPR, MIP, VR and VE images)**

Katsumi Tsujioka, RT (*Presenter*) Researcher, Canon Medical Systems Corporation

### **TEACHING POINTS**

We report on the new phantom to evaluate the 3D performance. Its name is "Spiral Micro Holes Phantom". This phantom is made of an acrylic cylinder with 40mm diameter. We used two types of phantoms. Phantom A has holes with diameter of 0.5mm and phantom B has holes with diameter of 0.3mm. CT scans were performed with the long axis of phantom placed parallel to the X-Y plane of the CT system. For the experiment, we used a conventional CT system and an ultra-high-resolution CT (UHR-CT) system. The multi planar reconstruction (MPR), maximum intensity projection (MIP), volume rendering (VR), and virtual endoscopy (VE) were performed on the obtained volume data, and the displaying of the holes in each direction was studied. In the MIP image, since the air layer of the acrylic pillar is detected, the comparison between the

X-Y plane to the Z axis was performed accurately. VR, VE and curved MPR were able to be evaluated continuously from the X - Y plane to the Z axis. In clinical image diagnosis, MPR, MIP, VR and VE are performed for each case. Evaluation by Spiral Micro Holes Phantom is also useful for explaining the characteristics of each display method to the radiologist.

#### **TABLE OF CONTENTS/OUTLINE**

(1) What is 3D performance (2) Development of Spiral Micro Holes Phantom (3) Development of evaluation method (MPR, MIP, VR and VE images) (4) Experiment using phantom (Positioning and scan) (5) Conclusion and clinical use (For example, CT colonography and CT angiography)

### **PHEE-29 “Will That X-Ray Harm My Unborn Child?” - A Meta-Analysis of Fetal Health Effects Indicates Very Low Risk to Fetus Following Occupational Exposure of Pregnant Interventional Physicians**

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

For our interventional physicians with proper radiation safety practices, fetal radiation dose is predicted to be <4 mGy per term. Compared with known risk of childhood disorders, the predicted risk of cancer following fetal occupational radiation exposure is very low.

#### **TABLE OF CONTENTS/OUTLINE**

Concern of radiation-induced fetal health effects deters women from entering interventional practices. If proper radiation safety practices are applied, radiation dose to the fetus is expected to be <4mGy per term for physician performing interventional fluoroscopy procedures. In this work we compared predicted risk of early childhood cancer from in-utero fetal radiation exposure to risks associated with maternal BMI, age, and hormonal therapy. We performed random effect meta-analysis of 15 studies (1970-2020) investigating early childhood cancer following in-utero exposure from 0.3 to 1000 mGy. The natural incidence of early childhood cancer is ~0.3%. Linear no-threshold model fit to the meta-analysis predicted cancer HR of 1.01 (incremental risk 0.003%) for fetal dose 4 mGy. The natural incidence of childhood disorder is 1.3%. Maternal BMI of =30kg/m<sup>2</sup>, age >35yrs, or hormonal therapy were associated with HR in the range 1.14-1.40 [95% CI 0.99-1.75]. The predicted risk of childhood cancer following fetal occupational radiation exposure is very low compared with other fetal risks.

### **PHEE-3 ChatGPT in Medical Physics: What You Need to Know**

Jie Zhang, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Learn the basics of ChatGPT and its potential applications in medical physics 2. Identify the types of questions ChatGPT can answer, such as those related to radiation safety, imaging protocols, and quality assurance 3. Understand how to integrate ChatGPT with existing systems, such as quality assurance programs, to improve efficiency and accuracy 4. Discuss the limitations of ChatGPT and ethical considerations 5. Recognize the importance of training and validating ChatGPT, including the need to continually update its knowledge base and monitor its performance over time

#### **TABLE OF CONTENTS/OUTLINE**

Since its introduction in November 2022, ChatGPT has become a topic of discussion across various fields, including medicine. A literature search using the keyword ChatGPT on PubMed yielded 340 results as of April 30, 2023, with 335 published in the first four months of 2023. As this number continues to grow, medical physicists may be curious about the potential applications of ChatGPT in their field. This education provides a comprehensive review of ChatGPT and its potential applications in medical physics, along with other relevant considerations. The content is organized as follows: 1. An overview of ChatGPT and its potential applications in Medical Physics 2. Types of questions ChatGPT can answer, including radiation safety, imaging protocols, and quality assurance 3. Integration of ChatGPT with existing systems to improve efficiency and accuracy 4. Limitations of ChatGPT and ethical considerations 5. Continued training and validation of ChatGPT to maintain accuracy and relevance over time.

### **PHEE-30 How Should We Set Tube Voltage for Pediatric Cardiac CT Examination Using Photon-Counting CT?: A Phantom Study**

Junya Nakamura, BS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) We explain the proper tube voltage setting during a pediatric cardiac CT based on the image quality analysis and exposure dose evaluation. 2) The photon-counting CT scanner can always derive the virtual monoenergetic image (VMI) and high contrast can be obtained by applying lower energy VMI. In addition, using energy integrated image (T3D) at low tube voltage can also create high contrast image. 3) The operator should take into consideration not only exposure dose inside the scanning range but also that outside the range.

## TABLE OF CONTENTS/OUTLINE

1) Explanation of VMI and T3D image obtained by photon counting CT. When the high tube voltage is used, image contrast can be adjusted based on the reconstruction energy of VMI. On the other hand, low tube voltage has been historically applied to pediatric cardiac CT scans. 2) Comparison of image quality of low and high tube voltages. When the same CTDIvol was set for each tube voltage, the image quality was similar trend. 3) A key issue in selecting the tube voltage. The scattered X-rays increase when using high tube voltage, therefore the dose outside the scanning region needs to be considered. 4) Experimental results of dose measurement. When the low tube voltage was adopted, the dose outside the scanning region was reduced. 5) What the operator should know how to determine tube voltage for pediatric cardiac CT.

### **PHEE-4 What You Should Know About CT NCLSC Radiomics: Uncertainties in Data Preparation, Feature Extraction, Feature and Model Selection, and Outcomes**

Gary Ge, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Provide overview of radiomics workflow and key components related to inconsistent outcomes 2. Examine data types appropriate for inclusion in effective model training, e.g., high-order, low-order, clinical 3. Learn key aspects of cohort selection for robust models 4. Provide overview of common feature selection methods and predictive models used in literature and their use in different clinical endpoints, e.g., classification and prognosis 5. Understand uncertainty of feature selection methods and predictive models during implementation 6. Provide relative performance of aforementioned teaching points based on actual study outcomes

## TABLE OF CONTENTS/OUTLINE

In radiomics, key components include but are not limited to data quality, feature extraction, feature and model selection, and training/validation. Based on our recent review of more than 160 published papers there is a current emphasis on data quality and feature reproducibility, however, feature and model selection are not yet well defined. In this education exhibit, we provide a review of feature and model selection methods and their effects on outcomes as well as findings from our systemic evaluation of radiomic feature selection and predictive models. The content is organized as follows: 1. Describe the radiomics workflow in clinical studies 2. Overview commonly used feature selection methods and predictive methods 3. Show feature selection method and predictive model selection for different end-points 4. Familiarize sources of uncertainty from feature selection and predictive models in study design

### **PHEE-5 The Echo Chamber: Unraveling the Mysteries of Spin Echo and Gradient Echo MRI Pulse Sequences**

Jay Starkey, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

MRI sequences and their clinical utility can be difficult to keep track of, particularly for radiology residents and trainees. Understanding the underlying properties of MRI sequences and their image contrast is critical for proper diagnosis. Additionally, understanding the differences between various spin echo and gradient echo sequences is critical for the evaluation of images and for future optimization and design. Once learned, the clinical applications of these techniques are critical for training of radiology and medical physics residents.

## TABLE OF CONTENTS/OUTLINE

1. Basic Pulse Sequence Tenetsa. Review of MRI signal and T1, T2 and T2\* relaxation times.b. Review of basic pulse sequence block including TE and TR2. Review of Basic Spin Echo and Gradient Echo Sequences a. Basic pulse sequence block for spin and gradient echo sequencesb. Comparison of spin echo to fast spin echo sequences and effects on image qualityc. Comparison between bSSFP and RF spoiled sequences and their tradeoffsd. Introduction of inversion prepared sequences (STIR, FLAIR)3. Clinical Applications of FSE, bSSFP, and RF spoiled sequencesa. Clinical examples of FSE sequences- T1 weighted FSE of osteosarcoma- T2 weighted FSE of oligodendrogliomab. Clinical examples of gradient echo sequences- bSSFP of multicystic mass in heart- bSSFP in abdomen and B0 artifacts- FLASH imaging in the abdomen- FLASH T2w imaging in the brain, including gliomas- Susceptibility T2\* imaging of brainc. Clinical examples of inversion prepared sequences- STIR imaging of spine- FLAIR imaging of multiple sclerosis

### **PHEE-6 Impact of Reconstruction Field of View, Matrix Size, and Kernel on Spatial Resolution of Photon Counting CT**

#### **Awards**

#### **Certificate of Merit**

Zhongxing Zhou, PhD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Limited by pixel size (determined by reconstruction FOV and matrix size), the visual spatial resolution on clinical images is often below that allowed by the acquisition geometry and reconstruction kernel. 2. Use of an ultra-sharp kernel without considering the combined effect of pixel size, noise, visual and system spatial resolution may lead to suboptimal image quality. 3. For a given CT acquisition and reconstruction kernel, there is a threshold pixel size, above which the visual spatial resolution will be sacrificed. 4. Dramatically increased image noise associated with small pixel size and high-resolution reconstruction kernels may be controlled using deep-learning-based noise reduction methods.

## TABLE OF CONTENTS/OUTLINE

1. Describe difference between system limit spatial resolution and visual spatial resolution on images: 1). System limit spatial resolution is determined by the CT acquisition geometry and reconstruction kernel. It is often measured and quantified using pre-sampling modulation transfer function. 2). Visual spatial resolution is affected by pixel size in addition to the system limit spatial resolution. 2. Explain how pixel size (determined by reconstruction FOV and matrix size) and reconstruction kernel affect the visual spatial resolution in images and provide a guide on how to determine reconstruction kernel and pixel size. 3. Demonstrate the combined effect of pixel size, matrix size, reconstruction FOV and kernel using clinical image examples. 4. Demonstrate benefit of deep-learning-based noise reduction to improve visual spatial resolution.

## PHEE-7 The Physics and Clinical Considerations of Radionuclide Therapy

Daniel Braga, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Review the physical properties of different modes of radionuclide decay and their relevant clinical applications. 2. Discussion production of radioisotopes and radiopharmaceuticals, and the radiation biophysics that result in tumor cell death and DNA damage. 3. Discuss the physical properties of various radioisotopes used in therapy, as well as emerging clinical applications, and clinical considerations. 4. Describe the management considerations regarding dose limiting properties and off-target biological effects associated with radionuclide therapies. 5. Review patient and general public safety considerations for radiation emitted by patients after discharge.

## TABLE OF CONTENTS/OUTLINE

1. Physics - Types of radionuclide decay and Linear Energy Transfer- Review of radioisotope production 2. Biological Effects- Principles of radiotherapy- Ionizing radiation effects (Direct and Indirect Effects)- Implications for treatment 3. Dosimetry - how to perform and clinical importance 4. Review current and future Radioisotopes and Radiopharmaceuticals- Production, logistics, clinical administration/dosing 5. Radiation Safety- Spillage considerations- Precursors to patient discharge, dosage to general public

## PHEE-8 I Want You To Improve My Abdominal MRI Quality

Martin Horwarth, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1 - In an interactive form of a quiz, be able to identify magnetic resonance (MR) artifacts on abdominal studies and how to avoid them if needed. 2 - Be able to recognize unwanted MR artifacts or imaging errors, especially the ones that can lead to erroneous reports. 3 - Understand the sources of these imaging artifacts. 4 - Improve radiologists' and technicians' knowledge of MR physics regarding abdominal imaging with practical cases.

## TABLE OF CONTENTS/OUTLINE

1 - Introduction on MR physics, imaging errors and what are some imaging artifacts that we do need. 2 - A series of interactive cases with questions. The first question on how to identify the imaging error. 3 - The answer is followed by an explanation about the physics of the error and why they occur. 4 - Divide these artifacts and imaging errors into the ones we can change and the ones we can not. 5 - Those avoidable artifacts are followed by another question on how to do so. 6 - Explanation on how to avoid or minimize artifacts. 7 - Summary and take home notes.

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## Abstract Archives of the RSNA, 2023

PHEE-1

### CT Dose Evaluation by Monte Carlo Simulation: Challenges for Personalized Dosimetry

All Day Room: Learning Center

Kosuke Matsubara, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The teaching points of this exhibit include the following: (1) Monte Carlo simulation is an effective tool for achieving personalized dosimetry in CT. (2) To improve the accuracy of radiation dose calculation on Monte Carlo simulation, the optimization of the patient or phantom model, energy spectrum, bow-tie filter model, patient support model, number of projections, and tube current modulation method are essential. (3) Radiation dose calculation in dual-energy CT is also feasible by modifying the calculation code of single-energy CT.

#### TABLE OF CONTENTS/OUTLINE

1. Monte Carlo simulation for radiation dose calculation: a) Principles, b) Monte Carlo simulation code, and c) Advantages and disadvantages of Monte Carlo simulation. 2. Optimization of Monte Carlo simulation in CT: a) Patient or phantom model, b) Energy spectrum, c) Bow-tie filter model, d) Patient support model, e) Number of projections, and f) Tube current modulation. 3. Monte Carlo simulation in dual-energy CT: a) Dual-source system and b) Rapid kV switching system. 4. Summary.

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## Abstract Archives of the RSNA, 2023

PHEE-10

### How Can We Establish Direct Radiation Dose Measurement During CT Examinations?

All Day Room: Learning Center

Hiroaki Hayashi, PhD (*Presenter*) Research collaboration, Meditec Japan Co., Ltd; Research collaboration, JOB Corporation

#### TEACHING POINTS

<<1>> Because the surface dose distribution fluctuates approximately twice during helical scanning CT, it is difficult to estimate proper radiation exposure dose when using a small number of dosimeters.<<2>> By estimating the X-ray incident direction from the standard deviation (SD) distribution of the X-ray (CT) image and fitting the predetermined dose function to the measured point dose, it is possible to evaluate the surface dose distribution regardless of both the incident angle of X-rays and heterogeneity of the subject.

#### TABLE OF CONTENTS/OUTLINE

<<1>> The surface dose distribution fluctuates due to the influence of the incident direction of X-rays during helical scanning CT. The information concerning the incident direction of the X-ray can be analyzed from the SD distribution of the X-ray image.<<2>> The proposed algorithm for analyzing doses combines the dose distribution and the SD distribution of the X-ray image.<<3>> A phantom study was conducted using the latest X-ray CT equipment.<<4>> It was demonstrated that consistent mean values could be calculated regardless of the incident direction of X-rays.<<5>> We proved that the measurement data using only one dosimeter showed the same results as the data when using many dosimeters. From this experiment it was determined that our method using only one dosimeter can be applied to actual clinical examinations.

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## Abstract Archives of the RSNA, 2023

PHEE-11

### Artificial Intelligence and MRI Artifacts: A Pictorial Review of MR Artifacts and AI Techniques for Reduction

All Day Room: Learning Center

Joseph Carbone, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Teaching Points: 1. To provide a pictorial review of MRI artifacts and their specific causes as it relates to MR physics, with imaging correlates illustrating their significance in hindering radiologists' interpretation of images. 2. To describe emerging artificial intelligence and deep learning architecture as it pertains to the minimization of artifacts and image augmentation. 3. To illustrate how radiologists may benefit in interpretive ability from MRI artifact reduction and image enhancement, and describe future aims pertaining to image augmentation.

#### TABLE OF CONTENTS/OUTLINE

MRI artifacts result from an array of factors and are troublesome for radiologists as they may mimic or obscure structures of interest or disease conditions. Artificial intelligence and deep learning have emerged as a post-processing tool to augment radiologist's interpretation of MRI by eliminating or diminishing various artifacts, increasing signal to noise (SNR), and enhancing image resolution. It is important for radiologists to be familiar with MRI artifacts and emerging methods of negating these artifacts with deep learning and artificial intelligence. This abstract will serve as a pictorial review of varying MRI artifacts, as well as an update on the various methods that deep learning and artificial intelligence can be used as a post-processing tool to negate various MRI artifacts and augment radiologist's ability to interpret MRI images.

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## Abstract Archives of the RSNA, 2023

PHEE-12

### What is Trustworthy AI and How It Contributes in Diagnosis

All Day Room: Learning Center

Masahiro Oda, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of our exhibit are: 1. To confirm difficulty of using AIs that have black box nature in diagnosis assistance 2. To learn what is trustworthy AI that unboxes black box AI 3. To learn explainable AI that clarifies the reason of decision 4. To learn uncertainty in AI that clarifies cases where AI is difficult to decide

#### TABLE OF CONTENTS/OUTLINE

AI in diagnosis assistance - Provide decision assistance information- How AI decides is difficult to understand for radiologists  
Trustworthy AI - What is trustable AI for radiologists- Clarification including the reason of decision by AI and what AI doesn't know is necessary- Important research fields in trustworthy AI: Explainable AI, Uncertainty in AI  
Explainable AI - What is Explainable AI- Outcome explanation: provide explanations for AI outcomes- Model explanation: provide interpretable model that approximates black box model- Model inspection: understand model from its inputs and outcomes- Transparent box design: make parts of black box model interpretable  
Uncertainty in AI - What is Uncertainty in AI- Aleatoric uncertainty (data uncertainty): uncertainty in AI decision caused by noise or variance in data- Epistemic uncertainty (model uncertainty): uncertainty in AI decision caused by variance in model parameter determination  
Trustworthy AI in diagnosis assistance - Provide reasons of decisions made by AI- Provide a degree of confidence in AI decision

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## Abstract Archives of the RSNA, 2023

PHEE-13

### Contrast Enhancement at CT: Principles and Clinical Applications

All Day Room: Learning Center

Toru Higaki, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Contrast enhancement is important in CT examinations to evaluate the vessel morphology and the blood supply in tissues. The enhancement degree of iodine contrast media changes with the injection volume and speed. We describe the properties and pharmacokinetics of contrast agents, the theory of contrast enhancement, present optimized contrast administration methods, and discuss side-effects of contrast media.

#### TABLE OF CONTENTS/OUTLINE

1. Pharmacokinetics of iodine contrast media (PDF-p.1)2. Basics of the contrast enhancement protocol for CT- Effect of the injection volume (PDF-p.2)- Effect of the injection duration/speed (PDF-p.3)- Effect of the patient body weight (PDF-p.4)3. Optimization of contrast protocols- Target organ-based optimization- Body weight-based optimization- Optimization by other body indexes- Low-kV scan / Dual-energy scan (PDF-p.5)4. Side-effects of contrast media

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## Abstract Archives of the RSNA, 2023

PHEE-14

### Spreading a Culture of MR Safety Outside of the Academic Practice: Regional Practices and other Departments

All Day Room: Learning Center

Avery Scripture, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- With the development and growth of “Health Systems”, and the use of MR units outside of radiology departments, a culture of MR safety must be fostered and maintained at all sites.
- Academic medical centers typically image patients with the greatest level of risk related to MR safety, including untested and off-label implants.
- Partnering between the Academic Medical Center with Regional Radiology Practices and other off-site MR users helps to establish a uniform culture of safety while maintaining effective clinical operations.
- MR safety has a significant role in creating or eliminating MR access disparities, especially in rural areas.
- Other non-imaging modalities that utilize magnetic fields, such as transcranial magnetic stimulation, can also benefit from collaboration with the MR safety committee.

#### TABLE OF CONTENTS/OUTLINE

What is a Culture of MR Safety and how was it established Growth of the MRI fleet from acquisitions of practices and expanding use of technology Regional radiology growth MR-Linac and Intra-op MR units Culture change is difficult - how to do it effectively? Finding partners - benefit of local MDRD Shared expertise - such as one MRSO for all sites Engage all relevant personnel at early stages, to plant the seed of MR Safety Establishing local MR Safety Committees Practices vary, so can help meet specific needs Improves relevance to specific Clinical Operations and maintains efficiency Importance of Quality Assurance Recording at the time of the incident Emphasize non-punitive culture Record “near misses” Review by MR Safety Committee Role of MR safety in imaging access and equity

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## Abstract Archives of the RSNA, 2023

PHEE-15

### Alleviating MR Artifacts Induced by Programmable Shunt for Hydrocephalus Patients

All Day Room: Learning Center

Kuan Zhang, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) The primary treatment for idiopathic normal pressure hydrocephalus (iNPH) is surgical insertion of a shunt system, such as the Certas Plus valve (VP shunt), to drain the excess cerebrospinal fluid. 2) MRI is typically used for diagnosis and postoperative monitoring of patients with iNPH. However, susceptibility artifacts may arise due to the metal component in the shunt. 3) Although 3T MRI could provide higher imaging quality than 1.5T, post-shunt imaging with iNPH is usually conducted at 1.5T, due to the recognition that metal artifacts are generally more prominent at higher field strength. 4) Our experience with patient and phantom scans indicates that shunt-induced artifacts demonstrated similar metal artifacts on 3T and 1.5T for some routine clinical imaging sequences, including MPRAGE, DWI, and GRE, due to differences in acquisition parameters between field strengths. Nevertheless, T2 FSE and T2 FLAIR show larger artifacts at 3T, compared to 1.5T. 5) To further improve the quality of post-shunt MRI with the programmable shunt at 3T, techniques that could be helpful in reducing metal artifacts were shown. 6) The effect of metal presence was demonstrated with advanced technologies such as parallel imaging and deep learning algorithm. 7) With imaging protocol optimization, 3T programmable shunt imaging was feasible and could achieve comparable or superior image quality than 1.5T.

#### TABLE OF CONTENTS/OUTLINE

1) Introduction 2) Routine clinical post-shunt imaging sequences at 1.5T vs 3T. 3) Commonly used strategies to alleviate shunt-induced artifacts. 4) Advanced techniques related to shunt-induced artifacts. 5) Conclusion

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## Abstract Archives of the RSNA, 2023

PHEE-16

### Will General Radiography Become More Valuable When Exploiting the Performance of a Photon Counting Detector?

All Day Room: Learning Center

Daiki Kobayashi, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Quantitative diagnosis can be established using Energy Resolving Photon Counting Detectors (ERPCD).2. Because a functional image can be generated via several calculation processes, the quality of a functional image degrades. High-quality images can be obtained by optimizing the imaging parameters.3. Image blurring interferes with quantitative analysis. Therefore, we should devise a novel blurring correction method instead of using the conventional Unsharp Masking method.

#### TABLE OF CONTENTS/OUTLINE

1. Impact of developing ERPCD. When obtaining functional images using ERPCD, quantitative diagnosis can be performed. The ERPCD system can also generate conventional qualitative diagnosis which can be performed using a traditional Energy Integrating Detector (EID).2. An in-house program is available to simulate the actual X-ray imaging process in an imaging detector. In the program, X-ray attenuation, detector response, and statistics are taken into consideration.3. When optimizing the settings of an ERPCD system, we found that a high kV system can generate a higher-quality functional image.4. Image blurring should be corrected to analyze the object edge of functional images.5. If ERPCD is used for general radiography, we can extract more information from X-ray images. For example, in the diagnosis of the fractures, we can obtain not only the visual information about the broken bones but also BMD information. ERPCD makes it possible to perform the screening test for osteoporosis.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-17

### **DXA Quality Control Review**

All Day Room: Learning Center

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. Understand the types and reasons for different QC tests, 2. Appraise suggested quality control tests based on key limits and elements, 3. Implement a DXA quality control program

#### **TABLE OF CONTENTS/OUTLINE**

1. Why Establish a DXA QC Program?, 2. Least Significant Change, 3. Elements of a Good QC test, 4. Types of DXA QC Tests, 4a. Cross-calibration of Machines, 5. Example QC Program, 6. Recommendations from National and International Societies

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-18

### **A Comprehensive Review of Ultrasound-guided Vascular Access for Residents, Fellows, and Medical Students**

All Day Room: Learning Center

Atlee Witt (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purpose of this exhibit is: 1) To detail different ultrasound techniques for vascular access 2) To explore the indications, contraindications, and potential complications of ultrasound-guided vascular access 3) To examine the utility of ultrasound-guided access for arterial, systemic venous, portomesenteric venous, and AV fistula procedures

#### **TABLE OF CONTENTS/OUTLINE**

1) Introduction: a) Indications for US vascular access (i. difficult or high-risk IV access ii. delivery of medications, fluids, or blood iii. diagnostic and interventional procedures) b) Relative contraindications (i. time limitations in emergent situations ii. ultrasound resolution with increasing depth iii. subcutaneous emphysema iv. volume depletion v. infection at the site of access) 2) Procedure: a) Equipment (i. ultrasound machine with high-frequency capable probe, ii. supplies for vascular access [1. IV starting kit, sterile gel, IV flushes, sterile probe cover]) b) Pre-procedure (i. consent ii. site identification and preparation) c) Technique (i. static approach ii. real-time approach [1. longitudinal approach 2. transverse or short-access approach]) d) Post-procedure (i. infection prevention) e) Complications (i. vessel puncture ii. malpositioning iii. injury to surrounding structures iv. infection) 3) Access sites: a) Artery (i. radial, brachial, femoral, and dorsalis pedis arteries) b) Systemic vein (i. internal jugular vein ii. subclavian vein iii. femoral vein) c) Portomesenteric vein (i. access to portal vein system ii. portography and portal pressure iii. embolization) d) AV fistula or graft

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-19

### Would You Like to Ride the Wave Called CT Images? As a Novel Frequency Analysis Tool

All Day Room: Learning Center

Yoichiro Ota, RT (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The spatial resolution CT images is expressed by a wave so-called Modulation Transfer Function. It is difficult to associate clinical CT images with MTFs, which is confusing to interpret. This can be explained by using the proposed method Band-limited CT images. This study will lecture on the contribution of high-frequency components to the image and the interpretation of MTFs intersections.

#### TABLE OF CONTENTS/OUTLINE

The process of Band limited image is based on Fast Fourier Transformation and frequency band limitation of CT images. Each band-limited CT image can contribute to characterizing how much information is in a signal of original CT images. The inclusion of high-frequency components results in high CT value and high resolution. Even if MTFs have an intersection, The band-limited image shows the difference in the amount of information that images have. We can associate clinical CT images MTFs and interpret the feature of CT images from physical point of view.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-2

### **3D Fast Spin Echo MRI with Variable Refocusing Flip Angles: Principles, Techniques, and Applications**

All Day Room: Learning Center

#### **Awards**

##### **Certificate of Merit**

Zhongwei Zhang, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

3D FSE MRI with variable refocusing flip angles provides high-quality images with good contrast in various clinical applications. Its speed and versatility have made it a workhorse in MRI. The purposes of this Education Exhibit are 1. Overview of 3D FSE MRI acquisition schemes and the rationale of the variable flip angle strategies. 2. Explain the constant low flip angle refocusing and Pseudo Steady State (PSS) Principle, the transitions between pseudo steady states (TRAPS) principle, Mugler's Relaxation-specific Method, and Busse's General method for refocusing flip angle modulation. 3. Discuss the common-used RF excitation techniques such as non-selective/slab-selective RF excitation, inner volume RF excitation, etc. 4. k-space view ordering. 5. Review the RF modules used for magnetization preparation and contrast optimization. 6. T1-preparation (inversion recovery), T2-preparation, magnetization transfer contrast, fat suppression, diffusion weighting, flow suppression or enhancement, etc. are discussed in detail. Clinical protocols along with representative images are given for each magnetization preparation approach. 7. Review acceleration techniques including GRAPPA, CAIPIRINHA, and compressed sensing (CS) MRI.

#### **TABLE OF CONTENTS/OUTLINE**

1. Introduction; 2. The Constant Low Flip Angle Refocusing and PSS Principle; 3. The TRAPS principle; 4. Mugler's Relaxation-specific method; 5. Busse's General Method; 6. RF excitation techniques; 7. K-space view ordering; 8. Magnetization preparation and contrast optimization; 9. T1-preparation; 10. T2-preparation; 11. MTC; 12. Fat suppression; 13. Diffusion weighting; 14. Flow suppression and enhancement; 15. Acceleration techniques.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

PHEE-20

### **Photon-Counting Detector CT in Comparison to Energy-Integrating Detector CT: Optimization and Implementation of a Non-contrast Enhanced Chest Protocol for All Patient Sizes**

All Day Room: Learning Center

Danielle Vialle, MSc (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

o To demonstrate how to measure the diagnostic image quality (IQ) of a photon-counting detector (PCD) CT protocol  
o To learn how to assess and evaluate IQ of a PCD-CT protocol compared to energy-integrating detector (EID) CT  
o To provide tips and learn how to adjust the imaging protocol for a specific task and patient size

#### **TABLE OF CONTENTS/OUTLINE**

With the introduction of PCD-CT in clinical practice, question rises how the IQ relates to the IQ of EID-CT scanners, and what the possibilities are for further dose reduction and/or image quality improvements. This exhibit provides you with knowledge on how IQ could be determined and evaluated by objective and subjective measures.

- o What is image quality and how can it be evaluated?
- Objective IQ quantified by noise, contrast, resolution and combined into the detectability index ( $d'$ )
- Subjective IQ assessed by radiologists with 5-point Likert Scale
- o Effect on IQ and dose (phantom study examples)
- Determination of your site reference standard
- Determination of differences in scan and reconstruction parameters between scanners (EID-CT and PCD-CT)
- Influence of scan and reconstruction parameters
- Effect of differences in patient size
- Effect of dose adjustment
- o Guidelines on protocol adaptation
- How to find the right balance between IQ and dose
- Tips and tricks in adaptation of current EID- and PCD-CT protocols
- Tips for utilizing the full potential of a PCD-CT

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-21

### Radiation Protection Essentials for Interventional Radiology Workers

All Day Room: Learning Center

Koichi Chida, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

-To understand the present status of medical interventional radiology (IVR) occupational radiation protection/shielding.-To understand the advantages/disadvantages of various radiation-shielding equipment.-To understand current protection/reduction methods and identify methods to improve these methods.-To understand the necessity of combining various reduction methods (tools) to reduce occupational radiation—shielding is only one such component.-To understand that the methods used to reduce the patient radiation dose are the same as the methods employed to reduce staff doses.

#### TABLE OF CONTENTS/OUTLINE

Advantages/disadvantages of various shielding devices. There is no perfect device! Relationship between the patient radiation dose and medical worker exposure. Physician-received scattered radiation during IVR was strongly correlated with the patient dose. Therefore, reduction of the patient dose will decrease the staff dose. Outline The regulation dose limit is seldom exceeded when protection is appropriate. However, radiation injuries such as cataracts have recently been reported in physicians and staff who perform IVR. There is no perfect shield. Combinations of shields are required. Radiology workers must be appropriately educated in terms of reducing the radiation exposure among both patients and staff; such workers must understand the various methods used to estimate occupational exposure. Decreasing the patient dose reduces occupational exposure. Although shielding is critical, it is only one component of radiation protection. Patient dose optimization means that the patient never receives a higher dose than is necessary, which also reduces the dose received by the staff.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-22

### Fluoroscopy: An Overview and Refresher for Radiologists

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jay Starkey, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Note to reviewer: this submission is in response to the call of Dr. Christine Cooky Menias for a Physics educational exhibit on Fluoroscopy.1. Provide an introduction to fluoroscopy and its history.2. Describe the major components of a fluoroscopy system.3. Explore principles and techniques, with a focus on image quality and radiation dose.4. Discuss clinical applications across multiple subspecialties in diagnostic and interventional radiology.5. Identify similarities and differences between projection radiography and fluoroscopy

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to Fluoroscopy and Historya. Invention, early uses, evolution, current state of the art2. Major Components of a Fluoroscopy Systema. Imaging chain from x-ray tube to control consoleb. Image intensifier and flat panel detector systems3. Principles and Techniquesa. Continuous vs. pulsed fluoroscopyb. Automatic brightness controlc. Last-image holdd. Factors influencing image quality and radiation dose4. Clinical Applications Across Subspecialtiesa. Pediatric radiology, body imaging, neuroradiology, musculoskeletal radiology, thoracic radiologyb. Interventional radiology5. Comparing Projection Radiography and Fluoroscopya. Nomenclatureb. Image formation and technologyc. Location and mobility differencesd. Target, filter, and grid similarities and differencese. Continuous exposure vs. pulsatile exposuref. Radiation dose and exposure considerations6. Radiation Protection in Fluoroscopya. Stochastic and deterministic effectsb. Radiation safety for patientsc. Radiation safety for personnel

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-23

### Automated Evaluation of Radiograph Accuracy Using Deep Learning With Explainable Artificial Intelligence

All Day Room: Learning Center

Haruyuki Watanabe, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In radiography, it is vital to maintain precise positioning to guarantee consistent image reproducibility. However, the decision to retake a radiograph is the responsibility of the supervising radiological technologists, whose evaluation methods are subjective. With the development of artificial intelligence (AI), deep learning is effectively used to guarantee the accuracy of radiographs. The focus of this study is to develop a deep learning-based automated quantitative evaluation method for radiography. It can guarantee the quality of radiographs and provide useful information for retaking radiography. Furthermore, explainable AI was utilized to determine the typical sources of information that AI relies on when making decisions. Analyzing data from the explainable AI could facilitate enhancements to the network's architecture. The major teaching points of this exhibit are to: 1. Evaluate automatically the radiograph accuracy. 2. Understand how to classify schemes using deep learning. 3. Clarify the typical sources of information that AI relies on when making decisions using explainable AI.

#### TABLE OF CONTENTS/OUTLINE

To provide automated quantitative evaluation of radiograph accuracy using deep learning with explainable artificial intelligence and to discuss clinical usefulness toward an accurate diagnosis in radiography. To reduce variability in individual assessments and achieve a quantitative index. Ultimately, the aim is to reveal the network structure using explainable AI in order to construct an appropriate network.

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## Abstract Archives of the RSNA, 2023

PHEE-24

### Don't Get Burned: Hot Topics in MRI Safety

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Jay Starkey, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Note to reviewer: this submission is in response to the call of Dr. Christine Cooky Menias for a Physics educational exhibit on MRI Safety. This educational exhibit provides a comprehensive overview of MRI safety for radiologists. It covers foundational principles, safety zones, personnel and patient screening, handling of special cases, and emergency procedures. The importance of continuous learning and adherence to guidelines by regulatory bodies is emphasized. Case studies and scenarios supplement the understanding of topics and foster application of knowledge.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction • Safety Ethics in MRI • Importance of MRI Safety  
2. Understanding the MRI Environment • Safety Zones • MRI Zone Protections  
3. Staff and Patient Considerations • Personnel Screening • Patient Screening • Special Case: Inability to Obtain Consent  
4. MRI Hazards • Radiofrequency (RF)-Induced Heating • Metallic Foreign Bodies • Medical Implants • Quenching in MRI  
5. Safety Guidelines and Emergency Procedures • MRI Safety Guidelines and Standards • Emergency Procedures in MRI  
6. Case Studies and Scenarios • Case Studies: Stents, Pacemakers, Pregnant Patient, Unconscious Patient • Safety Scenarios and Answers  
7. Special Topics in MRI Safety • High Field Strength Magnets • MRI and Pregnancy

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## Abstract Archives of the RSNA, 2023

PHEE-25

### Super-resolution Deep Learning Reconstruction of MR Imaging: Technical Features and Clinical Impact on Abdominal and Pelvic MR Imaging

All Day Room: Learning Center

Atsushi Nakamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Deep learning reconstruction (DLR) has recently been introduced by several vendors to improve MR image quality by reducing image noise. Super-resolution deep learning reconstruction (SR-DLR) is a newly developed MR image reconstruction method that not only reduces image noise but also improves spatial resolution. SR-DLR is expected to provide even higher image quality and improved diagnostic performance compared to DLR. The aims of this exhibit are: 1. To illustrate the technical features of SR-DLR, 2. To discuss the image quality of MR imaging using SR-DLR, and 3. To discuss the clinical impact on MR studies in the diagnosis of abdominal and pelvic disease.

#### TABLE OF CONTENTS/OUTLINE

1. Overview 2. Principle of SR-DLR 3. Sequences applicable to SR-DLR: fast spin echo T2WI, single-shot fast spin echo T2WI, DWI, steady-state free precession (SSFP), 3D T1-weighted gradient-echo with or without contrast enhancement, etc. 4. Effective reduction of image noise with SR-DLR 5. Improved spatial resolution with SR-DLR 6. Differences in image quality and spatial resolution from the conventional image reconstruction technique and DLR 7. Clinical impact on the diagnosis of abdominal diseases (liver, biliary tract, and pancreas) 8. Clinical impact on the diagnosis of pelvic diseases (uterus, ovaries, prostate, bladder, and rectum) 9. Summary

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## Abstract Archives of the RSNA, 2023

PHEE-26

### Optimal Acquisition and Reconstruction Techniques of Coronary CT Angiography: Current Status and Trends Over the Past Decade

All Day Room: Learning Center

#### Awards

##### Cum Laude

Rika Fukui (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) To introduce recent technological developments in coronary CT angiography (CCTA); 2) To describe optimal acquisition and reconstruction techniques in CCTA based on these developments; 3) To illustrate clinical utilities of these techniques in CCTA by presenting various clinical data and images.

#### TABLE OF CONTENTS/OUTLINE

1) Recent technological developments in CCTA (a) Hardware: high-output/fast-rotating x-ray tube, high-definition/ultra-high-resolution CT (HD/UHRCT), area-detector CT (ADCT), dual-source CT (DSCT), dual-energy CT (DECT); (b) Software: automatic selection of optimal acquisition parameters/cardiac phase (Auto gating/Smart phase), motion correction algorithm (MCA), iterative/deep learning reconstruction (IR/DLR). 2) Optimal acquisition and reconstruction techniques in CCTA (a) HD/UHRCT, DECT vs. coronary artery calcification/stent; (b) Fast-rotating x-ray tube, DSCT, Smart phase, MCA: motion artifact reduction; (c) ADCT: misalignment (banding/stair-step) artifact reduction; (d) Low kV acquisition by high-output x-ray tube, Auto gating, IR/DLR: radiation dose reduction; (e) Low kV acquisition by high-output x-ray tube, DECT vs. poor contrast; (f) Auto gating, Smart phase, MCA: workflow improvement; (g) DECT: detailed coronary plaque assessment. 3) Clinical utilities of these techniques in CCTA (a) Better image quality/interpretability/diagnostic accuracy/workflow; (b) Lower radiation/contrast media dose.

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## Abstract Archives of the RSNA, 2023

PHEE-27

### **Low kV or Low keV, That Is the Question: What the Radiologist and Radiology Technologist Need to Know in Contrast-Enhanced Body CT With Current and Novel Technologies**

All Day Room: Learning Center

Haruhiko Machida, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) To introduce basic principles and clinical usefulness of single-energy CT (SECT) at low tube voltage (kV)/virtual monochromatic imaging (VMI) at low energy (keV) by dual-energy CT (DECT) in contrast-enhanced body CT; 2) To illustrate factors affecting image quality (IQ) of SECT at low kV/VMI at low keV and current and novel technologies for improving the IQ; 3) To demonstrate strategies to determine the optimal imaging option.

#### **TABLE OF CONTENTS/OUTLINE**

1) Basic principles clinical usefulness of SECT at low kV/VMI at low keV (a) Basic principles: SECT/DECT/VMI; (b) Clinical usefulness: improved contrast enhancement/reduced iodine load/reduced radiation dose (for SECT)/reduced beam-hardening (BH) metallic artifact (for DECT)/flexible keV selection (for DECT)/improved material decomposition (MD) various DECT-specific imaging/analysis options (for DECT).2) Factors affecting IQ of SECT at low kV/VMI at low keV technologies for improving the IQ (a) IQ factors: CT value/image noise/contrast-noise ratio/spatial resolution/BH metallic artifact; (b) Current novel technologies: high output x-ray tube/kV mA synchronized switching/highly efficient detector/iterative deep-learning reconstruction/metallic artifact reduction software.3) Strategies to determine the optimal imaging option (a) Better spatial resolution for SECT; (b) Better image contrast/less BH metallic artifact/better MD for DECT.

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## Abstract Archives of the RSNA, 2023

PHEE-28

### Development of 3D Performance Phantom in UHR-CT (Evaluation of MPR, MIP, VR and VE images)

All Day Room: Learning Center

Katsumi Tsujioka, RT (*Presenter*) Researcher, Canon Medical Systems Corporation

#### TEACHING POINTS

We report on the new phantom to evaluate the 3D performance. Its name is "Spiral Micro Holes Phantom". This phantom is made of an acrylic cylinder with 40mm diameter. We used two types of phantoms. Phantom A has holes with diameter of 0.5mm and phantom B has holes with diameter of 0.3mm. CT scans were performed with the long axis of phantom placed parallel to the X-Y plane of the CT system. For the experiment, we used a conventional CT system and an ultra-high-resolution CT (UHR-CT) system. The multi planar reconstruction (MPR), maximum intensity projection (MIP), volume rendering (VR), and virtual endoscopy (VE) were performed on the obtained volume data, and the displaying of the holes in each direction was studied. In the MIP image, since the air layer of the acrylic pillar is detected, the comparison between the X-Y plane to the Z axis was performed accurately. VR, VE and curved MPR were able to be evaluated continuously from the X - Y plane to the Z axis. In clinical image diagnosis, MPR, MIP, VR and VE are performed for each case. Evaluation by Spiral Micro Holes Phantom is also useful for explaining the characteristics of each display method to the radiologist.

#### TABLE OF CONTENTS/OUTLINE

(1) What is 3D performance (2) Development of Spiral Micro Holes Phantom (3) Development of evaluation method (MPR, MIP, VR and VE images) (4) Experiment using phantom (Positioning and scan) (5) Conclusion and clinical use (For example, CT colonography and CT angiography)

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## Abstract Archives of the RSNA, 2023

PHEE-29

### **“Will That X-Ray Harm My Unborn Child?” - A Meta-Analysis of Fetal Health Effects Indicates Very Low Risk to Fetus Following Occupational Exposure of Pregnant Interventional Physicians**

All Day Room: Learning Center

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

For our interventional physicians with proper radiation safety practices, fetal radiation dose is predicted to be <4 mGy per term. Compared with known risk of childhood disorders, the predicted risk of cancer following fetal occupational radiation exposure is very low.

#### **TABLE OF CONTENTS/OUTLINE**

Concern of radiation-induced fetal health effects deters women from entering interventional practices. If proper radiation safety practices are applied, radiation dose to the fetus is expected to be <4mGy per term for physician performing interventional fluoroscopy procedures. In this work we compared predicted risk of early childhood cancer from in-utero fetal radiation exposure to risks associated with maternal BMI, age, and hormonal therapy. We performed random effect meta-analysis of 15 studies (1970-2020) investigating early childhood cancer following in-utero exposure from 0.3 to 1000 mGy. The natural incidence of early childhood cancer is ~0.3%. Linear no-threshold model fit to the meta-analysis predicted cancer HR of 1.01 (incremental risk 0.003%) for fetal dose 4 mGy. The natural incidence of childhood disorder is 1.3%. Maternal BMI of =30kg/m<sup>2</sup>, age >35yrs, or hormonal therapy were associated with HR in the range 1.14-1.40 [95% CI 0.99-1.75]. The predicted risk of childhood cancer following fetal occupational radiation exposure is very low compared with other fetal risks.

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## Abstract Archives of the RSNA, 2023

PHEE-3

### ChatGPT in Medical Physics: What You Need to Know

All Day Room: Learning Center

Jie Zhang, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Learn the basics of ChatGPT and its potential applications in medical physics 2. Identify the types of questions ChatGPT can answer, such as those related to radiation safety, imaging protocols, and quality assurance 3. Understand how to integrate ChatGPT with existing systems, such as quality assurance programs, to improve efficiency and accuracy 4. Discuss the limitations of ChatGPT and ethical considerations 5. Recognize the importance of training and validating ChatGPT, including the need to continually update its knowledge base and monitor its performance over time

#### TABLE OF CONTENTS/OUTLINE

Since its introduction in November 2022, ChatGPT has become a topic of discussion across various fields, including medicine. A literature search using the keyword ChatGPT on PubMed yielded 340 results as of April 30, 2023, with 335 published in the first four months of 2023. As this number continues to grow, medical physicists may be curious about the potential applications of ChatGPT in their field. This education provides a comprehensive review of ChatGPT and its potential applications in medical physics, along with other relevant considerations. The content is organized as follows: 1. An overview of ChatGPT and its potential applications in Medical Physics 2. Types of questions ChatGPT can answer, including radiation safety, imaging protocols, and quality assurance 3. Integration of ChatGPT with existing systems to improve efficiency and accuracy 4. Limitations of ChatGPT and ethical considerations 5. Continued training and validation of ChatGPT to maintain accuracy and relevance over time.

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## Abstract Archives of the RSNA, 2023

PHEE-30

### How Should We Set Tube Voltage for Pediatric Cardiac CT Examination Using Photon-Counting CT?: A Phantom Study

All Day Room: Learning Center

Junya Nakamura, BS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) We explain the proper tube voltage setting during a pediatric cardiac CT based on the image quality analysis and exposure dose evaluation. 2) The photon-counting CT scanner can always derive the virtual monoenergetic image (VMI) and high contrast can be obtained by applying lower energy VMI. In addition, using energy integrated image (T3D) at low tube voltage can also create high contrast image. 3) The operator should take into consideration not only exposure dose inside the scanning range but also that outside the range.

#### TABLE OF CONTENTS/OUTLINE

1) Explanation of VMI and T3D image obtained by photon counting CT. When the high tube voltage is used, image contrast can be adjusted based on the reconstruction energy of VMI. On the other hand, low tube voltage has been historically applied to pediatric cardiac CT scans. 2) Comparison of image quality of low and high tube voltages. When the same CTDIvol was set for each tube voltage, the image quality was similar trend. 3) A key issue in selecting the tube voltage. The scattered X-rays increase when using high tube voltage, therefore the dose outside the scanning region needs to be considered. 4) Experimental results of dose measurement. When the low tube voltage was adopted, the dose outside the scanning region was reduced. 5) What the operator should know how to determine tube voltage for pediatric cardiac CT.

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## Abstract Archives of the RSNA, 2023

PHEE-4

### What You Should Know About CT NCLSC Radiomics: Uncertainties in Data Preparation, Feature Extraction, Feature and Model Selection, and Outcomes

All Day Room: Learning Center

Gary Ge, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Provide overview of radiomics workflow and key components related to inconsistent outcomes 2. Examine data types appropriate for inclusion in effective model training, e.g., high-order, low-order, clinical 3. Learn key aspects of cohort selection for robust models 4. Provide overview of common feature selection methods and predictive models used in literature and their use in different clinical endpoints, e.g., classification and prognosis 5. Understand uncertainty of feature selection methods and predictive models during implementation 6. Provide relative performance of aforementioned teaching points based on actual study outcomes

#### TABLE OF CONTENTS/OUTLINE

In radiomics, key components include but are not limited to data quality, feature extraction, feature and model selection, and training/validation. Based on our recent review of more than 160 published papers there is a current emphasis on data quality and feature reproducibility, however, feature and model selection are not yet well defined. In this education exhibit, we provide a review of feature and model selection methods and their effects on outcomes as well as findings from our systemic evaluation of radiomic feature selection and predictive models. The content is organized as follows: 1. Describe the radiomics workflow in clinical studies 2. Overview commonly used feature selection methods and predictive methods 3. Show feature selection method and predictive model selection for different end-points 4. Familiarize sources of uncertainty from feature selection and predictive models in study design

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## Abstract Archives of the RSNA, 2023

PHEE-5

### The Echo Chamber: Unraveling the Mysteries of Spin Echo and Gradient Echo MRI Pulse Sequences

All Day Room: Learning Center

Jay Starkey, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

MRI sequences and their clinical utility can be difficult to keep track of, particularly for radiology residents and trainees. Understanding the underlying properties of MRI sequences and their image contrast is critical for proper diagnosis. Additionally, understanding the differences between various spin echo and gradient echo sequences is critical for the evaluation of images and for future optimization and design. Once learned, the clinical applications of these techniques are critical for training of radiology and medical physics residents.

#### TABLE OF CONTENTS/OUTLINE

1. Basic Pulse Sequence Tenets  
a. Review of MRI signal and T1, T2 and T2\* relaxation times.  
b. Review of basic pulse sequence block including TE and TR  
2. Review of Basic Spin Echo and Gradient Echo Sequences  
a. Basic pulse sequence block for spin and gradient echo sequences  
b. Comparison of spin echo to fast spin echo sequences and effects on image quality  
c. Comparison between bSSFP and RF spoiled sequences and their tradeoffs  
d. Introduction of inversion prepared sequences (STIR, FLAIR)  
3. Clinical Applications of FSE, bSSFP, and RF spoiled sequences  
a. Clinical examples of FSE sequences- T1 weighted FSE of osteosarcoma- T2 weighted FSE of oligodendroglioma  
b. Clinical examples of gradient echo sequences- bSSFP of multicystic mass in heart- bSSFP in abdomen and B0 artifacts- FLASH imaging in the abdomen- FLASH T2w imaging in the brain, including gliomas- Susceptibility T2\* imaging of brain  
c. Clinical examples of inversion prepared sequences- STIR imaging of spine- FLAIR imaging of multiple sclerosis

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## Abstract Archives of the RSNA, 2023

PHEE-6

### Impact of Reconstruction Field of View, Matrix Size, and Kernel on Spatial Resolution of Photon Counting CT

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Zhongxing Zhou, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Limited by pixel size (determined by reconstruction FOV and matrix size), the visual spatial resolution on clinical images is often below that allowed by the acquisition geometry and reconstruction kernel. 2. Use of an ultra-sharp kernel without considering the combined effect of pixel size, noise, visual and system spatial resolution may lead to suboptimal image quality. 3. For a given CT acquisition and reconstruction kernel, there is a threshold pixel size, above which the visual spatial resolution will be sacrificed. 4. Dramatically increased image noise associated with small pixel size and high-resolution reconstruction kernels may be controlled using deep-learning-based noise reduction methods.

#### TABLE OF CONTENTS/OUTLINE

1. Describe difference between system limit spatial resolution and visual spatial resolution on images: 1). System limit spatial resolution is determined by the CT acquisition geometry and reconstruction kernel. It is often measured and quantified using pre-sampling modulation transfer function. 2). Visual spatial resolution is affected by pixel size in addition to the system limit spatial resolution. 2. Explain how pixel size (determined by reconstruction FOV and matrix size) and reconstruction kernel affect the visual spatial resolution in images and provide a guide on how to determine reconstruction kernel and pixel size. 3. Demonstrate the combined effect of pixel size, matrix size, reconstruction FOV and kernel using clinical image examples. 4. Demonstrate benefit of deep-learning-based noise reduction to improve visual spatial resolution.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

PHEE-7

### The Physics and Clinical Considerations of Radionuclide Therapy

All Day Room: Learning Center

Daniel Braga, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Review the physical properties of different modes of radionuclide decay and their relevant clinical applications. 2. Discussion production of radioisotopes and radiopharmaceuticals, and the radiation biophysics that result in tumor cell death and DNA damage. 3. Discuss the physical properties of various radioisotopes used in therapy, as well as emerging clinical applications, and clinical considerations. 4. Describe the management considerations regarding dose limiting properties and off-target biological effects associated with radionuclide therapies. 5. Review patient and general public safety considerations for radiation emitted by patients after discharge.

#### TABLE OF CONTENTS/OUTLINE

1. Physics - Types of radionuclide decay and Linear Energy Transfer- Review of radioisotope production 2. Biological Effects- Principles of radiotherapy- Ionizing radiation effects (Direct and Indirect Effects)- Implications for treatment 3. Dosimetry - how to perform and clinical importance 4. Review current and future Radioisotopes and Radiopharmaceuticals- Production, logistics, clinical administration/dosing 5. Radiation Safety- Spillage considerations- Precursors to patient discharge, dosage to general public

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

PHEE-8

### I Want You To Improve My Abdominal MRI Quality

All Day Room: Learning Center

Martin Horwarth, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1 - In an interactive form of a quiz, be able to identify magnetic resonance (MR) artifacts on abdominal studies and how to avoid them if needed.2 - Be able to recognize unwanted MR artifacts or imaging errors, especially the ones that can lead to erroneous reports.3 - Understand the sources of these imaging artifacts.4 - Improve radiologists' and technicians' knowledge of MR physics regarding abdominal imaging with practical cases.

#### TABLE OF CONTENTS/OUTLINE

1 - Introduction on MR physics, imaging errors and what are some imaging artifacts that we do need.2 - A series of interactive cases with questions. The first question on how to identify the imaging error.3 - The answer is followed by an explanation about the physics of the error and why they occur.4 - Divide these artifacts and imaging errors into the ones we can change and the ones we can not.5 - Those avoidable artifacts are followed by another question on how to do so.6 - Explanation on how to avoid or minimize artifacts.7 - Summary and take home notes.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

ROEE

### Radiation Oncology Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **ROEE-1 Artificial Intelligence for Detecting Interstitial Lung Disease in Radiation Therapy**

Sonja Kandel, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

1. Every patient planned for Radiation Therapy (SBRT) must have a CT available for treatment field contouring. 2. The presence of Interstitial Lung Disease (ILD) can be detected on these CTs 3. Reviewing CTs performed for treatment planning is labour-intensive and may cause delays in treatment planning 4. The presence of ILD puts patients at a significantly higher risk of radiation pneumonitis (increased lung toxicity) 5. The use of an automated ILD detection algorithm improves workflow and helps detect patients with high-risk for radiation pneumonitis

##### TABLE OF CONTENTS/OUTLINE

1. Training the AI was performed on 4393 historical patient CTs performed for treatment planning (ethics board approval was obtained, the requirement for consent was waived). In this cohort, 1366 patient CTs showed the presence of interstitial lung disease. 2. Validation in 537 patients. 3. Prospective testing: After go-live, 111 patients have been screened by the AI so far, 15 patients have been flagged by the AI for suspected lung changes indicative for ILD 4. Automated e-mail notification to the treating radiation oncologist under an ongoing quality improvement ethics framework 5. Two patients were caught by the AI with ILD previously unknown to the radiation oncologist 6. Conclusion: An AI-based screening tool for ILD in planning CTs for SBRT may help detect patients with unknown ILD who would otherwise undergo treatment with an increased risk of radiation pneumonitis

#### **ROEE-2 More than Skin Deep: Imaging of Dermatologic Disease in the Head and Neck**

Cameron J. Overfield, MD (*Presenter*) Nothing to Disclose

##### TEACHING POINTS

1. Radiologist should be aware of the current trends and guidelines for cutaneous malignancies. After reviewing this presentation, the audience will understand the basics of the different treatment modalities and the major decision pathways available to patients and clinicians. 2. The skin is the largest organ of the human body and present on every radiologic exam. The audience learn how to report pertinent findings, both positive and negative, to the referring clinician as well as recommend the appropriate imaging modality to properly stage a cutaneous malignancy. 3. The audience will be presented with gross images and comparison radiologic exams of both primary and recurrent cutaneous malignancies. The Radiologist should be able to distinguish normal post-treatment changes from findings would prompt further investigation.

##### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Teaching Points and Target Audience 3. Decision-points for Surgical, Systemic, and Radiation therapies a. Surgical techniques b. Systemic therapies (immuno- and chemotherapy) c. Radiation therapy 4. The Role of Imaging for Cutaneous Malignancies a. When should imaging be considered? b. What is the modality of choice? c. What are the goals of imaging? d. How does imaging guide management or treatment options? 5. What the Dermatologist wants to know a. Checklist of pertinent positive and negative findings b. Lesion extent, size, perineural invasion, osseous spread, dermal spread, and metastatic nodal disease 6. Follow-up after treatment a. When to image for recurrence? b. What are the major risk factors for recurrence? (Perineural spread on initial histopathology) 7. Conclusion 8. References

#### **ROEE-3 Protect Your Heart and Lungs - Usefulness of Left Side Breast Radiotherapy Using Deep Inspiration Breath Hold Technique**

Tadashi Shimamoto (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Radiation therapy for postoperative breast cancer significantly reduces intra breast recurrence and improves survival. However, adverse events in normal tissues such as the heart and lungs due to left side breast radiotherapy is a problem. The use of deep inspiration breath hold for left side breast radiotherapy can significantly reduce cardiac and pulmonary doses compared with free breathing treatment.

## TABLE OF CONTENTS/OUTLINE

Radiation therapy for postoperative breast cancer has been shown to significantly reduce breast recurrence and improve survival. However, adverse events such as pericarditis, myocardial infarction, ischemic heart disease, and pneumonia are problems with left side breast radiotherapy. Left side breast radiation therapy should strive to minimize the dose delivered to the heart and lungs. Deep inspiration breath hold irradiation is a method to reduce the exposure dose to the heart and lungs. The treatment plans were compared from deep inspiration breath hold and free breathing CT images of 36 patients who underwent left side breast radiotherapy. Deep inspiration breath hold radiotherapy performed better than free breathing in most categories. It is useful to use deep inspiration breath hold technique for radiotherapy after left breast cancer surgery. When performing radiation therapy after surgery for left side breast cancer, it is important to obtain CT images of both deep inspiration breath hold and free breathing to create a treatment plan and compare the results.

## ROEE-4 Imaging Features of Anal Carcinoma after Chemoradiation

### Awards

#### Certificate of Merit

Kyungmin Kim, BMBS (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Anal cancer is a rare type of cancer primarily treated with chemoradiation. Surgical resection can be considered for residual or recurrent anal canal tumors in suitable patients after chemoradiation. Early salvage surgery is associated with better outcomes. Clinical examination after chemoradiation is often limited by canal stenosis and pain. Therefore, radiological surveillance with pelvic MR and PET-CT plays a fundamental role in assessment of both local treatment response and presence of distant metastasis. Imaging features post-treatment include: Resolution of tumor; Stereotypical patterns of fibrosis; Tumor necrosis/post-treatment inflammation; and Viable tumor residuum or recurrence. It can be challenging to differentiate post-treatment changes from tumor residuum or recurrence. It is important to recognize and differentiate imaging features of incomplete response/recurrence from other post-treatment changes, such that early and timely salvage surgery can be offered to patients.

## TABLE OF CONTENTS/OUTLINE

1. Introduction
2. Treatment options for anal cancer
  - 2.1 Chemoradiation therapy
  - 2.2 Surgery
3. Methods of monitoring treatment response
  - 3.1 Clinical examination
  - 3.2 Contrast enhanced CT
  - 3.3 Pelvic MR
    - 3.3.1 Recommended sequences
    - 3.4 PET-CT
  4. Imaging appearance of anal cancer after chemoradiation
    - 4.1 Complete resolution
    - 4.2 Fibrosis
    - 4.3 Residual disease
    - 4.4 Frank progression
    - 4.5 Pearls and pitfalls
      - 4.5.1 Tram-track sign
      - 4.5.2 Pseudotumor
      - 4.5.3 Post-treatment mucositis
      - 4.5.4 MR correlation with PET-CT
    5. Summary

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## Abstract Archives of the RSNA, 2023

ROEE-1

### Artificial Intelligence for Detecting Interstitial Lung Disease in Radiation Therapy

All Day Room: Learning Center

Sonja Kandel, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Every patient planned for Radiation Therapy (SBRT) must have a CT available for treatment field contouring. 2. The presence of Interstitial Lung Disease (ILD) can be detected on these CTs 3. Reviewing CTs performed for treatment planning is labour-intensive and may cause delays in treatment planning 4. The presence of ILD puts patients at a significantly higher risk of radiation pneumonitis (increased lung toxicity) 5. The use of an automated ILD detection algorithm improves workflow and helps detect patients with high-risk for radiation pneumonitis

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Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

ROEE-2

### More than Skin Deep: Imaging of Dermatologic Disease in the Head and Neck

All Day Room: Learning Center

Cameron J. Overfield, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Radiologist should be aware of the current trends and guidelines for cutaneous malignancies. After reviewing this presentation, the audience will understand the basics of the different treatment modalities and the major decision pathways available to patients and clinicians. 2. The skin is the largest organ of the human body and present on every radiologic exam. The audience learn how to report pertinent findings, both positive and negative, to the referring clinician as well as recommend the appropriate imaging modality to properly stage a cutaneous malignancy. 3. The audience will be presented with gross images and comparison radiologic exams of both primary and recurrent cutaneous malignancies. The Radiologist should be able to distinguish normal post-treatment changes from findings would prompt further investigation.

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## Abstract Archives of the RSNA, 2023

ROEE-3

### Protect Your Heart and Lungs - Usefulness of Left Side Breast Radiotherapy Using Deep Inspiration Breath Hold Technique

All Day Room: Learning Center

Tadashi Shimamoto (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Radiation therapy for postoperative breast cancer significantly reduces intra breast recurrence and improves survival. However, adverse events in normal tissues such as the heart and lungs due to left side breast radiotherapy is a problem. The use of deep inspiration breath hold for left side breast radiotherapy can significantly reduce cardiac and pulmonary doses compared with free breathing treatment.

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Radiation therapy for postoperative breast cancer has been shown to significantly reduce breast recurrence and improve survival. However, adverse events such as pericarditis, myocardial infarction, ischemic heart disease, and pneumonia are problems with left side breast radiotherapy. Left side breast radiation therapy should strive to minimize the dose delivered to the heart and lungs. Deep inspiration breath hold irradiation is a method to reduce the exposure dose to the heart and lungs. The treatment plans were compared from deep inspiration breath hold and free breathing CT images of 36 patients who underwent left side breast radiotherapy. Deep inspiration breath hold radiotherapy performed better than free breathing in most categories. It is useful to use deep inspiration breath hold technique for radiotherapy after left breast cancer surgery. When performing radiation therapy after surgery for left side breast cancer, it is important to obtain CT images of both deep inspiration breath hold and free breathing to create a treatment plan and compare the results.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

ROEE-4

### Imaging Features of Anal Carcinoma after Chemoradiation

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Kyungmin Kim, BMBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Anal cancer is a rare type of cancer primarily treated with chemoradiation. Surgical resection can be considered for residual or recurrent anal canal tumors in suitable patients after chemoradiation. Early salvage surgery is associated with better outcomes. Clinical examination after chemoradiation is often limited by canal stenosis and pain. Therefore, radiological surveillance with pelvic MR and PET-CT plays a fundamental role in assessment of both local treatment response and presence of distant metastasis. Imaging features post-treatment include: Resolution of tumor; Stereotypical patterns of fibrosis; Tumor necrosis/post-treatment inflammation; and Viable tumor residuum or recurrence. It can be challenging to differentiate post-treatment changes from tumor residuum or recurrence. It is important to recognize and differentiate imaging features of incomplete response/recurrence from other post-treatment changes, such that early and timely salvage surgery can be offered to patients.

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4.1 Complete resolution  
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4.4 Frank progression  
4.5 Pearls and pitfalls  
4.5.1 Tram-track sign  
4.5.2 Pseudotumor  
4.5.3 Post-treatment mucositis  
4.5.4 MR correlation with PET-CT  
5. Summary

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## Abstract Archives of the RSNA, 2023

VAEE

### Vascular Imaging Education Exhibits

All Day Room: Learning Center

#### Sub-Events

#### **VAEE-1 Hepatic Vascular Pathology: A Journey From the Hilum to the Cava**

Ignacio De Garcillan, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Review hepatic vascular anatomy. Revise most common anatomic variants. Understand most frequent pathology.

##### **TABLE OF CONTENTS/OUTLINE**

The liver has a double vascular supply through the portal vein and the hepatic artery. The drainage takes place into the hepatic veins and inferior vena cava. In this poster, pathology that can affect these vascular structures will be reviewed and illustrated with different cases from our hospital. The portal vein and its branches are involved in the main hepatic vascular pathologies. Portal vein thrombosis is one of the most common vascular complications. It can be acute or chronic and produced by bland, tumoral or infected thrombus (thrombophlebitis). Thrombosis can lead to cavernomatous transformation, portal hypertension and portosystemic collateral channels. Understanding hepatic artery anatomy and its variants is mandatory especially in presurgical studies. Pathology is less frequent and it is mainly surgery related. The most frequent anomaly involving the hepatic veins is thrombosis leading to Budd-Chiari syndrome and passive hepatic congestion due to cardiac disease. Within the hepatic sinusoid's pathology, it is important to be familiar with the sinusoidal obstruction syndrome. Connections can develop between vascular structures, leading to arterioportal, arteriovenous and portosystemic shunts. Radiologists must be familiar with all of these in order to make a correct diagnosis and guide appropriate treatment.

#### **VAEE-10 A to Z of Whole-Body Vasculitis Imaging: A Comprehensive Review for Radiologists**

Seyed Arash Mahdavi Anari, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

Familiarize radiologists with classification of vasculitis. Review the most common arteries involved in different vasculitis. Provide ideal CT, MR, PET, and US imaging protocols for assessment of vasculitis. Review complications of vasculitis and non-vascular findings in vasculitis cases.

##### **TABLE OF CONTENTS/OUTLINE**

Vasculitis: definition and classification. Overview of different types of vasculitis with their associated immune markers. An algorithmic approach to diagnosis of vasculitis using combination of imaging and non-imaging data. Imaging protocols for vascular imaging: MRI, CT, PET, and US. Pros and cons of each imaging modality for assessment of vasculitis. Pictorial review of expected vascular findings in vasculitis cases. Review of non-vascular findings in vasculitis cases. Pitfalls in vascular imaging related to diagnosis and assessment of response to treatment of vasculitis.

#### **VAEE-11 Let the Waveform Lead the Way: What There Is to Know About Vertebral Arteries Doppler Ultrasound**

Sofia Arizaga, MD (*Presenter*) Nothing to Disclose

##### **TEACHING POINTS**

after the exhibit the reader would be able- To review the normal anatomy regarding vertebral arteries. To identify normal and abnormal vertebral arteries waveform which may provide useful clues regarding pathology in the subclavian, carotid, brachiocephalic, and intracranial arteries. To recognize the most common vertebral arteries pathology using Color Doppler-ultrasonography.



## TABLE OF CONTENTS/OUTLINE

Introduction. Normal vertebral arteries anatomy. Ultrasound: Technical requirements and examination techniques. Morphological assessment (B-mode), Color Doppler and spectral normal vertebral arteries waveform. Color Doppler and spectral abnormal vertebral arteries waveform. Subclavian Steal Syndrome: definitions, etiology, clinical presentation and Pre-steal and Steal Waveform. Vertebral arteries stenosis and occlusion: Definitions, Etiology, and Clinical Presentation. Differential diagnosis of changes in vertebral artery waveforms. Illustrative cases- Summary

### **VAEE-12 Vascular Malformation: From Classification to Characterization**

Geetika Mittal, MBBS (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Vascular malformations and tumors are a heterogeneous group of lesions that may affect the arterial, capillary, venous or lymphatic system or any combination thereof. They encompass a bewildering range of lesions, syndromes, and masses ranging from the relatively common to the rare. The classification available for these lesions is complex and involves various histopathological aspects. Creating a classification system primarily based on different radiological modalities is beneficial. Understanding differentiating features between low flow and high flow vascular malformations is essential as they have different treatment protocols. Understanding differentiating features between arterial, venous and lymphatic malformations helps to understand the different components in a mixed vascular malformation. In case of histopathological dilemma, radiological features play a major role. Knowing different locations, imaging features and progression with age of hemangioma helps to understand their etiology and natural history.

## TABLE OF CONTENTS/OUTLINE

Imaging features of vascular malformations on ultrasound, color Doppler, CT angiography, MRI. Characterization of vascular malformations. Algorithmic approach to classify vascular malformations. Various syndromes associated with vascular malformations.

### **VAEE-13 Hands Up! This Is An... Upper Extremities CT Angiography**

Vanessa Hernandez Olivera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Explain an overview of current imaging guidelines for upper extremities CT angiography. Pictorial review of the most frequent pathologies and atypical cases and their diagnosis in our medical center.

## TABLE OF CONTENTS/OUTLINE

Introduction Review current imaging guidelines for upper extremities CT angiography. Anatomy and anatomical variations of the upper extremities arteries. CT angiography protocols in different clinical scenarios. Upper extremities arterial diseases: • In situ thrombosis. • Aneurysm or pseudoaneurysm. • Vasculitides. • AVF complications. • Trauma. • Post procedure complications. • Thoracic outlet syndrome. Conclusions

### **VAEE-14 Too Soon to Enhance: Pearls and Pitfalls of Early Venous Enhancement**

Iza C. Vieira, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- Revisit through cases and recall the characteristics of the main pathological and physiological causes of early venous enhancement.- Demonstrate protocols and techniques for optimizing venous studies (CTA/CTV and MRA), allowing differentiation of the various conditions associated with early venous enhancement.

## TABLE OF CONTENTS/OUTLINE

- Pictorial review of the main physiological causes of early venous enhancement (commonly associated with rapid venous return), including the territories of the jugular veins, venous sinus, renal veins, inferior vena cava and hepatic veins.- Demonstration of the main methods of venous phase acquisition and discussion of techniques and methods. Show examples of techniques that can facilitate specific diagnosis, such as injection of contrast through alternative venous access (e.g. podalic vein). - Demonstrate that in the same venous territory, early enhancement can represent either a pathological or physiological finding depending on the evaluation of the other venous territories and associated pathologies, including territories of left gonadal vein and left iliac vein.- Display selected cases of uncommon causes of early venous enhancement: portosystemic shunt, cecal angiodysplasia, congenital and acquired arteriovenous fistula.- Summary of teaching points.

### **VAEE-15 Inflammatory and Infectious Conditions of the Aorta: A Review of Concepts and Imaging Findings**

Vitor D. Bichuette, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

? To review concepts involving epidemiology, clinical presentation and imaging findings of inflammatory and infectious conditions of the aorta. ? To identify the main imaging features of diseases that affect the aorta and its branches. ? To differentiate pathological and treatment-related imaging patterns of aortic disease. ? To discuss how radiologists can help in the management of aortitis.

## TABLE OF CONTENTS/OUTLINE

- Introduction - General concepts o The use of different images modalities to assess the aorta. • Aortitis classification: o Involvement of the branches of the aorta in the main diseases. o Definition, clinical presentation and imaging features of diseases involving the aorta. • Case-Based Review: o Sample cases explaining and demonstrating image findings of aortitis and how imaging modalities can be used before and after the treatment. This section will present illustrative cases of: § Takayasu arteritis § Giant cell arteritis § Granulomatosis with polyangiitis § Polyarteritis nodosa § IgG4-related disease § Idiopathic aortitis § Siphilitic aortitis § Staphylococcus aureus aortitis § Mycobacterium tuberculosis aortitis § COVID-19 aortitis • Future Directions: new perspectives in the assessment of the aorta. • Conclusion and key takeaways.

## VAEE-16 Multimodality Imaging in Large Vessel Vasculitides

### Awards

#### Certificate of Merit

Sahar Alizada (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Large Vessel Vasculitides (LVV) encompass a range of pathologies classified as non-infectious/inflammatory (primary and secondary vasculitides) and infectious vasculitides. • Various imaging modalities are available for diagnosis, including Ultrasound, CTA, MA, and FDG-PET/CT, each with its own advantages and disadvantages. • Each modality has specific imaging features that aid in the diagnosis of vasculitis, such as the halo sign in ultrasound or circumferential thickening and vessel wall enhancement on CTA or MA, which are consistent with inflammatory vasculitis. Conversely, crescentic-shaped thickening with adjacent fat stranding are features of infectious vasculitis. Moderate to intense circumferential FDG uptake along the vessel wall on FDG-PET/CT indicates active vasculitis. Recent publications suggest that FDG uptake in the temporal or maxillary arteries has similar sensitivity/specificity in diagnosing LV (GA). • This educational exhibit proposes an algorithm for patients suspected of having either inflammatory large vessel vasculitis or infectious vasculitis. For inflammatory vasculitis, ultrasound should be the first-line imaging modality.

## TABLE OF CONTENTS/OUTLINE

- LVV classifications. • Available imaging modalities that can be utilized in LVV. • Key imaging features • Proposed algorithm for patients with LVV

## VAEE-17 Doppler High Frequency Ultrasound in Vascular Complications: What Radiologists Should Know Before, During or After Injectable Procedures

### Awards

#### Cum Laude

Luciana C. Zattar, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Facial injections with different dermal fillers have become increasingly common. The explosion in the use of these injectable materials has brought a concomitant rise in the incidence of complications. Vascular compromise is the most concerning complication of all, caused either by intravascular injection (arterial or venous), external compression (mostly of the veins), thrombosis or embolization. As a result, blood flow may be interrupted in the occluded facial arteries, leading to ischemia, necrosis or ulcerations. Fortunately, Doppler high frequency ultrasound (DHFUS) is valuable to avoid, to diagnose and to treat vascular complications in most clinical scenarios. However, the clinicians should be alerted that many factors will affect the sensitivity of this examination. And, in this context, the radiologists may be requested to recognize and evaluate patients before, during or after injectable procedures, for safe and effective injections. This study aims: (1) To review and clarify the facial vascular anatomy and major variations. (2) To describe the correct examination technique: basic probe positions. (3) To teach how to recognize different dermal fillers substances and signs of vascular occlusion. (4) To list different possible imaging findings of vascular occlusion (new pattern based on angiosome with fresh-frozen specimen correlation). (5) To describe guided procedures to avoid or treat complications.

## TABLE OF CONTENTS/OUTLINE

1. INTRODUCTION. 2. VASCULAR FACIAL ANATOMY. 3. IMAGING TECHNIQUE. 4. DERMAL FILLERS DESCRIPTION. 5. DHFUS FINDINGS IN VASCULAR OCCLUSIONS: a new finding. 6. GUIDED PROCEDURES. 7. CONCLUSION.

## VAEE-18 Collateral Networks in Superior Vena Cava Obstruction

Sarmiento Santos, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To illustrate with schematic figures and cases the patterns of collateral venous pathways depending on the level of superior vena cava (SVC) obstruction (above or below the junction of the azygos arch). To discuss the technical aspects related to vena cava imaging To describe the mechanisms and illustrate with cases the different etiologies of SVC obstruction. To discuss the treatment options, the role of imaging to plan therapy, as well as post-therapeutic findings.

### TABLE OF CONTENTS/OUTLINE

SCV obstruction is a relatively common entity in the everyday practice of different radiology subspecialties, including head and neck, thoracic, abdominal, vascular and interventional radiologists. Hence, to schematize in an easy way the collateral venous pathways developed secondary to caval obstruction is of wide interest to facilitate diagnosis and treatment. We herein describe the collateral pathways resulting from SCV obstruction and correlate the opacification of those collaterals to the site of contrast injection in CT and MR angiography exams. Graphic representations of the sites of obstruction and respective formed collaterals are depicted, as well as the azygos / hemiazygos system participation to the collateral venous return. The normal anatomy and anatomical variations which might play a role in the collateral system development are detailed. The main causes of obstruction are discussed: extrinsic compressions, tumoral invasion, thrombosis and traumatic injury.

### VAEE-2 Spontaneous Abdominal Wall Hemorrhage: A Practical Diagnostic Guide to Aid the Interventional Radiologist

Claudia Campos Bas (*Presenter*) Nothing to Disclose

### TEACHING POINTS

To describe the diagnostic process using Angio-CT of spontaneous soft tissue haemorrhage ( SSTH) in the abdominal wall and the key findings to guide interventional treatment.To share practical advice on identifying the probable bleeding artery in angio-TC using vascular territory mapping and correlating with arteriography.

### TABLE OF CONTENTS/OUTLINE

SSTH in the abdominal wall characterizes by sudden extravasation of blood into a muscle group without an underlying medical condition. Whilst most cases remain confined, some may become extensive and life-threatening. In such situations, radiological management may be both diagnostic and interventional.Angio-TC is the gold standard for the detection of haemorrhage, allowing a fast and non-invasive diagnosis. Moreover, it enables us to differentiate between arterial and venous bleeding and to approximate the most probable bleeding artery, serving as a road map for targeted angiography and embolization. We retrospectively reviewed 28 patients (aged 59-88) admitted to our angiography suite due to acute anemia in the setting of active arterial abdominal wall bleeding described on triphasic CT. We determined the presence of active arterial bleeding and identifies the responsible vascular pedicle when possible. In all other cases, we inferred the most probable bleeding vessel based on location of contrast extravasation, known as " arterial mapping". We compared our results with the subsequent arteriography. Angio-TC is essential in the setting of SSTH as it enables to determine the presence and origin of bleeding. Differentiating arterial from venous bleeding and identifying the potentially damaged vessel is of paramount to manage these patients.

### VAEE-20 Chronic Mesenteric Ischemia: Mesenteric Artery Duplex Sonography and the Utility of Postprandial Imaging

Kaitlin M. Zaki-Metias, MD (*Presenter*) Nothing to Disclose

### TEACHING POINTS

1. Duplex sonography performed in the fasting state serves as a good initial screening tool for chronic mesenteric ischemia.
2. There is a wide range and lack of consensus of established cut-offs for peak systolic velocity criteria suggestive of hemodynamically significant mesenteric arterial stenosis in the literature.
3. The evidence supporting the utility of postprandial assessment of the mesenteric arteries is inconclusive.
4. Failure of peak systolic velocity to increase 20-30% between fasting and postprandial states may indicate hemodynamically significant stenosis.
5. Given the lack of clarity surrounding postprandial duplex sonography of the mesenteric arteries, inclusion of postprandial assessment in the imaging protocol may lead to confusion.

### TABLE OF CONTENTS/OUTLINE

1. Introduction
2. Epidemiology and clinical presentation of chronic mesenteric ischemia
3. Pathophysiology of chronic mesenteric ischemia
4. Duplex sonography of the mesenteric arteries: common protocols and pitfalls
5. Postprandial imaging of the mesenteric arteries and associated challenges
6. ACR appropriateness criteria for imaging of mesenteric ischemia
7. Case-based review of mesenteric artery duplex sonography including normal cases, abnormal cases, and cases mistakenly interpreted as abnormal
8. Management of chronic mesenteric ischemia
9. Conclusion

### VAEE-21 The Forgotten Vessels: Imaging of the Inferior Mesenteric Vasculature

## **Awards**

### **Certificate of Merit**

Anup S. Shetty, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The inferior mesenteric artery (IMA) and vein (IMV) supply and drain the distal colon and rectum, but can be neglected as part of a standard search pattern. This exhibit will: 1) Familiarize the reader with the embryology, anatomy, and physiology of the inferior mesenteric vessels 2) Discuss modalities used to image the IMA/IMV 3) Illustrate a broad spectrum of diseases affecting the IMA/IMV through a series of illustrative cases

### **TABLE OF CONTENTS/OUTLINE**

Outline- Embryology, Anatomy (and variants), and Physiology- Imaging Modalities (CT, US, MR, angiography)\* IMA abnormalities - acute thromboembolic disease - chronic occlusion (AAA, Leriche) and collateral pathways - dissection, aneurysm, pseudoaneurysm, and arteriovenous fistula - vasculitis - hemorrhage - tumor invasion\* IMV abnormalities - thrombosis - septic thrombophlebitis - intravenous gas in the setting of pneumatosis - tumor invasion - rectal varices in portal hypertension - mass effect from sigmoid volvulus leading to rectal edema\* diagnostic clues- displacement from internal hernia - lymphadenopathy from rectal cancer - flow artifact at portosplenic confluence

### **VAEE-22 CT Angiography of the Upper Extremity: Purpose, Protocols, Problems, and Pathology**

Alexander M. Satei, MBBS (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. CT angiography is a key diagnostic imaging tool to evaluate for upper extremity arterial pathology. 2. Understanding the vascular anatomy of the upper extremity, including variant anatomy, is critical for interpretation of CT angiography of the upper extremity. 3. Benefits of CT angiography include rapid noninvasive image acquisition, lower cost and radiation exposure than digital subtraction angiography, and simultaneous evaluation of the adjacent osseous structures and soft tissues. 4. Limitations of CT angiography include patient positioning for optimal imaging, contrast bolus timing, increased cost and radiation exposure relative to sonographic evaluation, and artifact relating to arterial calcification, implanted hardware, or metallic foreign bodies. 5. CT angiography of the upper extremity is ideal for evaluation of traumatic arterial injury, vasculitides, congenital vascular anomalies, arteriovenous fistulae for hemodialysis, and pre- and post-operative evaluation relating to vascular and surgical intervention.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction. 2. Vascular anatomy of the upper extremity. 3. Review of important variant vascular anomalies of the upper extremity. 4. Indications for CTA of the upper extremity. 5. Benefits and limitations of CTA of the upper extremity. 6. Extended case-based review of CTA upper extremity including subclavian steal syndrome, active post-traumatic extravasation, arteriovenous fistulae, pseudoaneurysm and aneurysm, mycotic aneurysm, dissection, transection, hematoma, fibromuscular dysplasia, and thoracic outlet syndrome, among others. 7. Conclusion.

### **VAEE-23 Hearts on Fire: Imaging the Coronary Arteries in Systemic Vasculitis**

Sean Johnson (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Overview of systemic vasculitis, highlighting entities which can involve the coronary arteries. Review the incidence and prevalence of coronary artery vasculitis. Demonstrate coronary artery manifestation of systemic vasculitis with case-based reviews. Discuss various diagnostic modalities and protocols used to identify and characterize coronary artery vasculitis.

### **TABLE OF CONTENTS/OUTLINE**

1. Incidence and prevalence of coronary artery vasculitides. 2. Review forms of systemic vasculitis, coronary artery manifestations and pathophysiology, including: Takayasu arteritis, Kawasaki disease, microscopic polyangiitis, Erdheim-Chester disease, IgG4-related vasculitis and polyarteritis nodosa. 3. Case-based review of coronary artery vasculitides, including both acute and chronic manifestations. 4. Brief discussion of non-coronary thoracic aortic disease in systemic vasculitis. 5. An approach evaluating the coronary arteries for involvement in systemic vasculitis, including review of imaging selection and protocols.

### **VAEE-24 Advanced Multimodal MRA Techniques for Cerebrovascular Disease: A Comprehensive Guide**

Toshiya Akatsu (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Cerebrovascular disorder treatment has evolved, now employing a range of advanced devices. While time-of-flight MR angiography (TOF-MRA) can suffer from image degradation, innovative multimodal MRA techniques such as phase contrast

(PC), ultrashort echo time (UTE), and 4D offer improved image quality. Embracing these cutting-edge imaging methods is crucial in managing cerebrovascular disorders. Our presentation aims to: 1. Provide a comprehensive overview of cerebrovascular diseases. 2. Highlight the technical details of state-of-the-art multimodal MRA imaging techniques. 3. Showcase the clinical applications of multimodal MRA imaging in diagnosis, treatment, and postoperative care for cerebrovascular diseases.

#### **TABLE OF CONTENTS/OUTLINE**

1. Exploring the significance and recent advancements in multimodal MRA imaging for cerebrovascular diseases. 2. Diving deep into the technical aspects of various MRA sequences, including TOF, PC, UTE, and 4D. 3. Unveiling the latest clinical applications of multimodal MRA imaging for cerebrovascular conditions, such as intracranial aneurysms, arteriovenous malformation (AVM), dural arteriovenous fistula (dAVF), and moyamoya disease, through real-life case studies.

#### **VAEE-25 US of Lower Extremity Deep Vein Thrombosis: A Review**

Nicholas C. Roberts, DO (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

· Describe SRU Multidisciplinary 2018 Consensus protocol for complete duplex ultrasound (CDUS) of lower extremity· Differentiate acute thrombosis, chronic post thrombotic change· Discuss implications of slow flow· Describe normal and abnormal spectral Doppler and how it can be used to infer more central thrombosis· Describe pitfalls related to anatomy, gray scale and color Doppler

#### **TABLE OF CONTENTS/OUTLINE**

Table of Contents/Outline1. Ultrasound Protocols a. SRU consensus for complete duplex ultrasound (CDUS) b. Alternative (limited protocols) i. Appropriate situations ii. Follow up c. Example of imaging and labeling for CDUS2. Acute DVT a. Gray scale b. Types: Occlusive, Non-occlusive, Mobile c. Appearance over time d. "Acute on chronic" and indeterminate acuity e. Phlegmasia cerula dolans3. Post thrombotic change a. Diminutive size of veins b. Wall thickening c. Synechiae d. Calcification e. Collaterals and deep reflux f. Neovascularization /arterialization4. Other Issues a. Central DVT implied by abnormal spectral Doppler b. Slow Flow i. Normal ii. Progression to DVT c. Isolated calf thrombus d. Increased venous pulsatility e. Positive DVT with ipsilateral renal transplant5. Follow up US, alternative imaging and treatment recommendations based on US appearance and extent of thrombus6. Pitfalls a. Related to frequency of transducers b. Anatomic variations c. Poor color Doppler settings

#### **VAEE-26 A Novel Approach to Deforming Device for Optimal Frozen Elephant Trunk Technique via Patient Specific 3D Printed Model**

Koichi Osuda, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Frozen elephant trunk implantation for thoracic aortic aneurysms is recognized as a less invasive surgical technique. However, because intraoperative fluoroscopy is not available, device insertion must be done with blind operation. To avoid complications, we developed a novel approach for deforming device in advance and simulating surgical procedures via life size 3D model.

#### **TABLE OF CONTENTS/OUTLINE**

Datasets for printing were converted, using CT data which has submillimeter spatial resolution. Patient specific life size 3D printed models were faithfully reproduced luminal surface of thoracic aorta. 3D printed model enables surgeon to assess physiological morphology including stenosis or spiculated atheroma, practically, though it is impossible to see that intraoperatively. Furthermore, this method allowed surgeon to simulate surgical procedures, considering precise device size in advance. 3D printed model is clinically available and promising for facilitating the operation strategy optimization, and assistant for frozen elephant trunk technique safely. There will be contributions to clinical practice for preoperative accurate assessment and simulation.

#### **VAEE-27 Nonatherosclerotic Conditions of Peripheral Arteries**

Taila S. Moura Fe (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: Make a didactic review of the nonatherosclerotic conditions of peripheral arteries, including the following conditions: Aneurysm, Pseudoaneurysm, Dissection, Vascular prosthesis and grafts, Embolism, Arteriovenous fistula, Arterial adventitial cystic disease, Locked-in arterial syndrome. To illustrate these conditions based on cases from our ultrasonography team. Correlate sonography findings with different image methods.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction including the nonatherosclerotic conditions of peripheral arteries, including the following conditions: Aneurysm, Pseudoaneurysm, Dissection, Vascular prosthesis and graft, Embolism Arteriovenous fistula, Arterial adventitial cystic disease,

Locked-in arterial syndrome. Describe the main information of each condition. Illustrated teaching cases from our ultrasonography team, each condition. Correlate the ultrasound findings with other image methods.

### **VAEE-28 Development of a Double Bolus Tracking Method for Individualized CT Angiography Scan Timing**

Yoshiya Ohashi (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To perform surgical procedures safely, understanding the anatomical variations of the veins in preoperative computed tomography (CT) angiography is critical. The scan timing of the venous phase is generally performed via fixed scan delay, but the contrast effect is often inadequate owing to individual differences in the peak timing of the veins. We have developed the double bolus tracking (DBT) method, which effectively utilizes low-dose monitoring in preoperative CT angiography to individualize the timing of the venous and the arterial phases. The advantage of the DBT method is that the CT angiography enhances the contrast effect in complex anatomical regions such as the portal venous system. Consequently, it might improve the surgical outcomes and patients' quality of life.

#### **TABLE OF CONTENTS/OUTLINE**

A) An overview of the DBT method B) Scanning techniques used for low dose monitoring C) Differences in contrast effects between the fixed scan delay and the DBT methods D) Clinical applications of preoperative vascular mapping E) Advantages of using the DBT method in complex anatomical regions such as the portal venous system F) Limitations and future directions of the DBT method G) Conclusions and clinical relevance of using DBT in preoperative screening methods for colon cancer surgery

### **VAEE-29 The Anatomy of Danger: Exploring Hemodynamic Perils in Type B Aortic Dissection**

#### **Awards**

#### **Certificate of Merit**

Hyun Jung Koo, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

- To explore the debated issues regarding the relationship between the number of entries and aneurysm progression in patients with type B aortic dissection (AD)- To simulate in-vitro dissection model for assessing the relationship between the flow and entries in the dissection- To demonstrate the utility of 4D flow magnetic resonance imaging (MRI) and computational fluid dynamics (CFD) for assessing hemodynamic flow in patients with type B AD - To suggest potential applications of CT and 4D flow MRI in personalized treatment planning for aortic dissection, such as selecting the optimal timing for surgical intervention based on hemodynamic parameters and individual patient factors.

#### **TABLE OF CONTENTS/OUTLINE**

1. CT features - Predictors of high-risk adverse outcome in patients with type B AD2. Controversies - Entry and re-entries - Hemodynamic flow and thrombosis in false lumen3. Assessment of Hemodynamics 1) In-vitro Fluid Dynamics Study- Aorta modeling method - In-vitro 4D flow2) In-vivo 4D flow MRI Study- Wall shear stress, flow displacement, and flow velocity - The role in predicting aortic dissection progression3) CT-based CFD Analysis- In-vivo patient study- In-vitro model matching

### **VAEE-3 Abdominal Aortic Aneurysm: Pre and Post Operative Evaluation**

Matheus Marcelino Dias, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

The purposes of this exhibit are: Make a multimodality-based didactic review of the main topics of infradiaphragmatic aneurysm at pre and post operative evaluation. Make a practice guide on how to perform an evaluation with all the necessary variables for follow-up or surgical planning using different imaging methods. Propose a didactic categorization of these topics: Ultrasound evaluation of Abdominal aortic aneurysm. Postoperative Endovascular Ultrasound Evaluation. Postoperative complications d. Ultrasound with microbubbles contrast. Correlate those findings with other exams. Adequate evaluation and early recognition of post operative complications of endovascular repair of aneurysms. Illustrate those conditions based on cases from our radiology group.

#### **TABLE OF CONTENTS/OUTLINE**

We will discuss the principles of the abdominal aortic aneurysm at pre and post operative evaluation and focus on their imaging features using a multimodality approach in this exhibit. Ultrasound evaluation of infradiaphragmatic aneurysm. Postoperative Endovascular Ultrasound Evaluation. Postoperative complications. Ultrasound with microbubbles contrast.

### **VAEE-30 Why is CT Useful in the Diagnosis of Klippel-Trenaunay-Weber Syndrome?**



Noda (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is: 1. Klippel-Trenaunay-Weber syndrome (KTWS) is a rare and intractable disorder characterized by unilateral hypertrophy associated with one or more mixed vascular malformations of the extremities. 2. The main imaging modalities used at KTWS are US, MRI, angiography and CT. 3. CT images can clearly depict the vascular malformations of KTWS. 4. In addition, volume measurement and histogram analysis of the extremity by CT imaging can be used to help diagnose KTWS and guide treatment.

### **TABLE OF CONTENTS/OUTLINE**

Major headings: 1. Describe KTWS. 2. How to create a CT Venography. 3. Usefulness of volume rendering (VR) images by CT.- About VR images of superficial veins.- About VR images of deep veins. 4. Volumetric measurements with CT imaging of the lower extremities are useful in the diagnosis of KTWS.- The volume of the affected and healthy side can be measured reliably and easily. 5. Histogram analysis with CT images of the lower extremity is useful in the treatment strategy for KTWS.- Histogram analysis can determine the components within the analysis area from the CT number.- In the present case, the enlargement of the lower extremities was determined to be due to an increase in the fat component (CT number indicates a negative value), not edema (CT number indicates near zero).

## **VAEE-31 Vascular Malformations and the Mimickers: A Spectrum of Imaging Features**

### **Awards**

#### **Certificate of Merit**

Mayu Uka (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

The purpose of this exhibit is: 1) To review contrast-enhanced MRI and other imaging features of vascular malformations and vascular tumors compared to imaging features of other similar diseases and 2) to discuss the differential diagnosis of vascular malformations and vascular tumors with other lesion types.

### **TABLE OF CONTENTS/OUTLINE**

The cause of most vascular tumors and vascular malformations of the body surface and soft tissue is unknown. Hemangiomas, which are benign vascular tumors, and vascular malformations are often referred to idiomatically as "hemangiomas," but the International Society for the Study of Vascular Anomalies (ISSVA) classifies them as separate diseases. Vascular malformations, which include venous malformations, arteriovenous malformations, lymphatic malformations, capillary malformations, and combined types, whose clinical and imaging findings sometimes resemble not only vascular tumors but also other neoplastic and non-neoplastic lesions. In this presentation, we will present common vascular malformations, vascular tumors, and other rare conditions, and review the imaging features and pathological findings of "mimickers," which sometimes have imaging similarities to vascular malformations and are difficult to diagnose.

## **VAEE-32 Aortitis and Large Vessel Arteritis: Diagnosis, Follow-up, Treatment and Mimics**

Miltiadis Tembelis, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Aortitis and large vessel arteritis encompass both infections and noninfectious causes of vascular wall inflammation. These pathologies often produce non-specific clinical presentations and inflammatory markers, complicating the diagnosis. Correlation with demographics, key clinical features and recognition of typical imaging features and distribution can allow radiologist to assist in the diagnosis. Diagnosis is not the only difficult aspect of these pathologies though, as recommendations for appropriate follow-up and the definitions of remission in the literature are heterogeneous.

### **TABLE OF CONTENTS/OUTLINE**

This review will demonstrate different imaging features of infectious and noninfectious large vessel arteritis and aortitis across different modalities to help radiologists clue in on the diagnosis. Common complications and post-interventional appearances will also be exemplified. In addition, treatments and post-treatment follow-up will be addressed.

## **VAEE-33 Which Vascular Variations Are Important to Colorectal Surgeons for Right Colon Surgery?**

Minho Lee, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

In right colic surgery, the choice of surgical methods, such as right hemicolectomy, transverse colectomy, or extended right colectomy, depends on the location of the colon cancer. However, vascular variations can occasionally necessitate a change in the planned surgical approach, preventing the originally intended reduced surgery and leading to an extended right

colectomy instead. The diverse and frequent vascular anatomy variations in the right colon, if not identified preoperatively, can contribute to increased morbidity and mortality rates. Unexpected arterial variations can prolong surgical time, while venous variations can result in bleeding complications. To assess the impact of vascular variations on surgical methods, we will review approximately 380 CT angiographies and determine the type and incidence of right colic and middle colic arterial and venous variations. We will also identify vascular ligation points according to the type of surgery. Additionally, common mistakes and prevention strategies when inexperienced radiologists evaluate CT angiographies will be discussed. Readers will understand that preoperative CT angiographic evaluations can help shorten surgical time, minimize unexpected bleeding risks, and ultimately improve surgical outcomes.

#### **TABLE OF CONTENTS/OUTLINE**

1. Arterial and venous anatomy of the right colon. 2. Various types of right colon surgery and corresponding vascular ligation points for each procedure. 3. Important measurements of right and middle colic arteries relevant to right colon surgery. 4. Incidence and representative cases of vascular variations. 5. Pitfalls in interpretation and associated cases.

#### **VAEE-34 Clinical Applications of MR Angiography Based on Arterial Spin Labeling to Cerebrovascular Disorders**

Osamu Togao, MD, PhD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1) To explain the basic principles of 3D or 4D arterial spin labeling (ASL)-based MR angiography (MRA) 2) To discuss the advantages of ASL-based MRA over other imaging techniques 3) To review clinical applications of ASL-based MRA for various cerebrovascular diseases

#### **TABLE OF CONTENTS/OUTLINE**

1) Basic principles of ASL-based MRA •Labeling schemes, Pulsed ASL; Pseudo-Continuous ASL (PCASL); Superselective PCASL; Acceleration-selective ASL (AccASL) •3D or 4D imaging acquisition techniques 2) Advantages of ASL-based MRA over time-of-flight MRA or digital subtraction angiography •Readily available •No need for contrast media •No radiation exposure •Short acquisition time •Non-invasive •Cost effective •Time-resolved information •Selective vascular visualization •Easy follow-up after treatment •Easily applicable to children 3) Specific techniques for ASL-based MRA •3D-MRA using PCASL - Silent MRA •4D-MRA using pulsed ASL - Contrast inherent inflow enhanced multi-phase angiography (CINEMA) •4D-MRA using PCASL - 4D-MRA based on PCASL with CENTRA-Keyhole and view-sharing (4D-PACK) •Vessel-selective 4D-MRA using superselective PCASL (4D-S-PACK) • AccASL MRA 4) Clinical applications •Intracranial steno-occlusive arterial diseases (e.g. Moyamoya disease) •Brain arteriovenous malformation • Intracranial dural arteriovenous fistula •Assessment of extra-intracranial bypass arteries 5) Limitations of each ASL-based MRA technique

#### **VAEE-35 Clinical Applications and Implementation of Photon Counting Detector CT in Vascular Imaging**

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

1. To discuss the advantages of photon-counting detector (PCD) CT in vascular imaging 2. To review the modes, kernels, and protocols of PCD CT in vascular imaging 3. To illustrate the clinical applications of PCD CT in vascular imaging

#### **TABLE OF CONTENTS/OUTLINE**

1. PCD CT TECHNOLOGIES- Single source, Dual-source 2. BENEFITS OF PCD-CT-Ultra-high spatial resolution; Multi energy (ME)/spectral imaging; K-edge imaging; High vascular signal; Low electronic noise artifacts; Lower radiation and contrast doses; 3. TECHNICAL ASPECTS RELEVANT TO VASCULAR IMAGING- Modes Ultra-high resolution, ME, HR-ME, Flash-ME, gated/ungated; Kernels, denoising; Collimation; Images- Single energy like (T3D), VMI, iodine, VNC, virtual non calcium, spectral post-processing; Radiation doses, CARE keV; 4. VASCULAR APPLICATIONS OF PCD CT WITH CASE EXAMPLES- Ultra-high resolution- Improved visualization of small vessels (Flaps, eg. DIEP, fibular perforators; Artery of Adamkiewicz; distal arteries of hand, feet, head), calcified plaques, small stents; High iodine CNR - Low dose of iodinated contrast, salvage of suboptimal-enhanced studies; Decreased artifacts- Calcium blooming, beam hardening, metal; ME calcium separation- Improved lumen visualization; ME bone subtraction- Rapid and accurate; ME lesion characterization-hematoma vs active bleed vs calcification; Vascular perfusion- Lung, myocardium, extremities; Multi-contrast and novel contrast media- e.g. iodine and gadolinium; Advanced material separation- Calcium; Radiation dose reduction- VNC images in multiphasic studies, lower noise profile; 5. LIMITATIONS, PITFALLS-Increased data - storage and transfer issues; Noise in high resolution mode

#### **VAEE-36 Review of CTA Findings in Patients With Circulatory Assisted Devices**

#### **Awards**

#### **Certificate of Merit**

Dennis Adaaquah, MD (*Presenter*) Nothing to Disclose



## TEACHING POINTS

Present CT imaging findings and clinical presentations of complications associated with circulatory assisted devices. Review entities that may present as pitfalls in CT imaging of circulatory assisted devices.

## TABLE OF CONTENTS/OUTLINE

This educational exhibit will present pictorial review of multiple CT findings of complications associated with circulatory assisted devices to increase Radiologists awareness. Highlight challenges associated with CT imaging of circulatory assisted devices and also provide tips to overcome the challenges.

### **VAEE-37 CT Angiography's Role in Virtual Surgical Planning for Craniomaxillofacial Reconstruction with Scapular Free Flap**

Kendal L. Weger (*Presenter*) Nothing to Disclose

## TEACHING POINTS

1. Virtual surgical planning plays an important role in craniomaxillofacial (CMF) reconstruction with scapular free flap. 2. Scapular free flaps are preferred over fibular or deep circumflex artery free flaps for CMF reconstruction when there is variant anatomy, significant atherosclerosis, or prior utilization of lower extremity vessels. 3. Preoperative virtual surgical planning (VSP) has numerous advantages over traditional intraoperative decision making including shortened operative times, improved patient matched custom implant design, improved patient specific oncologic margins and anatomic understanding, and decreased rate of nonunion and flap related complications. 4. Virtual surgical planning and 3D printing sterilizable guides at the point of care requires a centralized manufacturing ecosystem and collaboration between surgeons, radiologists, engineers, and support staff. 5. CT angiography is an important first step in the pre-surgical planning for scapular free flap harvesting because of common variant anatomy and localization of perforating branches.

## TABLE OF CONTENTS/OUTLINE

- Scapular free flap advantages over fibular and deep circumflex artery flaps. - CT angiography's role in virtual surgical planning. - Optimal imaging acquisition to achieve optimal radiologic planning. - Role of 3D modeling and medical device design in virtual surgical planning.

### **VAEE-4 Segmental Arterial Mediolytic: A Visual Journey Through Its Imaging Findings**

Camila P. Reifegerste, MD (*Presenter*) Nothing to Disclose

## TEACHING POINTS

Segmental arterial mediolysis (SAM) is a nonatherosclerotic and noninflammatory arteriopathy, unknown to many radiologists. It can lead to severe complications, which have a high mortality rate, thus it is important for us to be aware of this disease. SAM is characterized by lysis of the medial arterial layer, normally compromising visceral and renal arteries, coursing with dissections, aneurysms and even arterial rupture. The imaging findings on computed tomography angiography (CTA) of SAM can be very similar to others vasculitides, such as polyarteritis nodosa and granulomatosis with polyangiitis, but most vasculitides can be diagnosed based on clinical, laboratory and imaging findings, while SAM's diagnosis is based majorly on imaging findings and exclusion of other vasculitides. The aim of this presentation is to show some cases of segmental arterial mediolysis from our institution, its complications and some differential diagnosis, for the purpose of making radiologists more familiar with this pathology.

## TABLE OF CONTENTS/OUTLINE

Brief literature review of segmental arterial mediolysis; didactic cases of SMA from the digital archive of our hospital's radiology department, to show SAM typical findings, complications and differential diagnosis on multiple imaging modalities, including computed tomography angiography (CTA), magnetic resonance angiography (MRA), Doppler ultrasound and arterial angiography

### **VAEE-5 The Aortic Isthmus from A to Z**

Juliana G. Da Trindade (*Presenter*) Nothing to Disclose

## TEACHING POINTS

To describe the embryology of the aortic isthmus, and its developmental stages. To demonstrate with cases the peculiar anatomical variations of this segment. To exemplify with cases the congenital malformations and pathological states.

## TABLE OF CONTENTS/OUTLINE

The aortic isthmus is a small aortic segment located between the left subclavian artery and the ductus arteriosus. This segment undergoes singular changes to allow flow adjustments necessary for the blood circulation from intra to extra-uterine life. The process of closure of the ductus arteriosus after birth normally results in a fibrous band called ligamentum arteriosus. However, different factors as prematurity, genetics, prenatal infections, concomitance of congenital heart diseases, the

extension of the ductal tissue to the aortic wall may lead to either persistence of the ductus arteriosus or to variable patterns of ductal involution (aortic knobs or ampullas, aortic-coarctation, etc). The presence of fibrotic tissue within the aortic wall and flow disturbances due to focal ectasia may additionally predispose to aneurysm formation, ulcerations and dissection during adulthood. Therefore, the aortic isthmus is an extremely complex region covering several anatomical variations and a wide spectrum of pathologies that may affect all age groups in a congenital or acquired form. Our goals are to review the isthmic developmental changes along intra to extra-uterine life, and to discuss the imaging findings of different anatomical variations and pathological states of this intricate aortic segment.

## **VAEE-6 Abdominal Vascular Compression Syndromes: What the Radiologist Needs to Know (and Let the Surgeons Know)**

Daniel L. Cardoso, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

Recognize the key structures of the abdominal vasculature and its anatomical relations. Understand the causes of Abdominal Vascular Compression Syndromes (AVCS) and related clinical features. Comprehend computed tomography angiography (CTA) imaging patterns of AVCS. Recognize the complications associated to AVCS and its imaging patterns. Understand AVCS treatment methods and criteria.

### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION: Anatomy of the abdominal vasculature and its relation to other structures. Definition of AVCS. Epidemiology of the most common causes of AVCS. Signs and symptoms. associated to the Median Arcuate Ligament Syndrome (MALS), Superior Mesenteric Artery Syndrome (SMAS), Nutcracker Syndrome (NCS), and May-Thurner Syndrome (MTS). DIAGNOSING, AND IDENTIFYING POST TREATMENT IMAGING PATTERNS - MALS, SMAS, NCS, and MTS: Imaging findings. Complications, and its imaging patterns. Treatment methods, and what to evaluate

## **VAEE-7 Pelvic Congestion Syndrome. CT Angiography and Doppler Ultrasound Findings**

Carlos Capunay, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

To be aware of pelvic congestion syndrome as a cause of female chronic pelvic pain. To recognize the anatomic variants and pathologic conditions that can cause the pelvic congestion syndrome To illustrate the spectrum of CT and Doppler US findings in these patients. To emphasize the most representative imaging features on this clinical syndrome.

### **TABLE OF CONTENTS/OUTLINE**

Anatomy of the normal female pelvic venous plexus. Pathogenesis of the pelvic congestion syndrome. Description of the Doppler US technique. Description of the CTA scan protocol: technical parameters and IV contrast administration CT image analysis and post-processing algorithms in the different clinical setting. Sample cases of compression syndromes (including superior mesenteric artery compression of the left renal vein, and compression of the left common iliac vein by the right common iliac artery). Summary.

## **VAEE-8 The Use of Ferumoxytol for High-Resolution Vascular Imaging and Troubleshooting for Solid Organ Transplantation**

Amar Shah, MD (*Presenter*) Nothing to Disclose

### **TEACHING POINTS**

1. Ferumoxytol, a novel MR contrast agent in off-label use, is safe for patients with renal dysfunction. 2. Due to its prolonged intravascular half-life and lack of parenchymal extravasation, high-resolution vascular imaging, including distal intraparenchymal branches, is feasible. 3. Ferumoxytol MRA can identify clinically actionable vascular complications of solid organ transplant several weeks to months before ultrasound or traditional MRA. 4. 3D reconstructions facilitate procedural planning and may obviate unnecessary intervention in select patients.

### **TABLE OF CONTENTS/OUTLINE**

1. Introduction to ferumoxytol as a contrast agent: imaging characteristics, protocol details, and safety/administration. 2. Advantages and utility in comparison to GBCA. a. High-resolution vascular imaging without background parenchymal enhancement. b. Curved planar MIP reformats. c. Virtual angiography (Time-Resolved contrast-enhanced MRA) d. Coadministration with GBCA. e. Repeat imaging up to 72 hours. 3. Catalogue of example cases with preceding equivocal or normal ultrasound and/or GBCA MRA (highlighting above techniques). a. Transplant renal artery stenosis (TRAS) b. Transplant renal vein thrombosis (TRVT) with capsular neovascularization (CV) c. TRVT with CV d. TRAS and transplant pancreas artery stenosis (TPAS). e. Transplant pancreas vein thrombosis. f. Transplant pancreas intraparenchymal AVF. g. Transplant hepatic artery stenosis. h. Transplant hepatic vein thrombosis.

**VAEE-9** Veeraiah Koppula, MD (*Presenter*) Nothing to Disclose

## **Imaging of Primary Malignancies of Inferior VenaCava and its Involvement in Secondary Abdominal Malignancies**

### **TEACHING POINTS**

After

reviewing this educational exhibit, the learner will be able to:• Learn the key imaging features of primary malignancies of Inferior Vena cava• Identify the clinical scenarios in which abdominal malignancies can extrinsically or intrinsically involve the IVC• Review the normal anatomy of IVC and its tributaries

### **TABLE OF CONTENTS/OUTLINE**

• Introduction• Normal anatomy and variants of IVC• Clinical and radiological features and management of primary leiomyosarcoma and angiosarcoma of Inferior Vena cava.• Case based discussion of abdominal malignancies involving IVC• Relevance of IVC involvement in staging of malignancies and undertaking oncological surgeries• Conclusion  
Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-1

### Hepatic Vascular Pathology: A Journey From the Hilum to the Cava

All Day Room: Learning Center

Ignacio De Garcillan, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Review hepatic vascular anatomy. Revise most common anatomic variants. Understand most frequent pathology.

#### TABLE OF CONTENTS/OUTLINE

The liver has a double vascular supply through the portal vein and the hepatic artery. The drainage takes place into the hepatic veins and inferior vena cava. In this poster, pathology that can affect these vascular structures will be reviewed and illustrated with different cases from our hospital. The portal vein and its branches are involved in the main hepatic vascular pathologies. Portal vein thrombosis is one of the most common vascular complications. It can be acute or chronic and produced by bland, tumoral or infected thrombus (thrombophlebitis). Thrombosis can lead to cavernomatous transformation, portal hypertension and portosystemic collateral channels. Understanding hepatic artery anatomy and its variants is mandatory especially in presurgical studies. Pathology is less frequent and it is mainly surgery related. The most frequent anomaly involving the hepatic veins is thrombosis leading to Budd-Chiari syndrome and passive hepatic congestion due to cardiac disease. Within the hepatic sinusoid's pathology, it is important to be familiar with the sinusoidal obstruction syndrome. Connections can develop between vascular structures, leading to arterioportal, arteriovenous and portosystemic shunts. Radiologists must be familiar with all of these in order to make a correct diagnosis and guide appropriate treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-10

### **A to Z of Whole-Body Vasculitis Imaging: A Comprehensive Review for Radiologists**

All Day Room: Learning Center

Seyed Arash Mahdavi Anari, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Familiarize radiologists with classification of vasculitis. Review the most common arteries involved in different vasculitis. Provide ideal CT, MR, PET, and US imaging protocols for assessment of vasculitis. Review complications of vasculitis and non-vascular findings in vasculitis cases.

#### **TABLE OF CONTENTS/OUTLINE**

Vasculitis: definition and classification. Overview of different types of vasculitis with their associated immune markers. An algorithmic approach to diagnosis of vasculitis using combination of imaging and non-imaging data. Imaging protocols for vascular imaging: MRI, CT, PET, and US. Pros and cons of each imaging modality for assessment of vasculitis. Pictorial review of expected vascular findings in vasculitis cases. Review of non-vascular findings in vasculitis cases. Pitfalls in vascular imaging related to diagnosis and assessment of response to treatment of vasculitis.

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## Abstract Archives of the RSNA, 2023

VAEE-11

### Let the Waveform Lead the Way: What There Is to Know About Vertebral Arteries Doppler Ultrasound

All Day Room: Learning Center

Sofia Arizaga, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

after the exhibit the reader would be able- To review the normal anatomy regarding vertebral arteries. To identify normal and abnormal vertebral arteries waveform which may provide useful clues regarding pathology in the subclavian, carotid, brachiocephalic, and intracranial arteries. To recognize the most common vertebral arteries pathology using Color Doppler-ultrasonography.

#### TABLE OF CONTENTS/OUTLINE

Introduction. Normal vertebral arteries anatomy. Ultrasound: Technical requirements and examination techniques. Morphological assessment (B-mode), Color Doppler and spectral normal vertebral arteries waveform. Color Doppler and spectral abnormal vertebral arteries waveform. Subclavian Steal Syndrome: definitions, etiology, clinical presentation and Pre-steal and Steal Waveform. Vertebral arteries stenosis and occlusion: Definitions, Etiology, and Clinical Presentation. Differential diagnosis of changes in vertebral artery waveforms. Illustrative cases- Summary

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## Abstract Archives of the RSNA, 2023

VAEE-12

### Vascular Malformation: From Classification to Characterization

All Day Room: Learning Center

Geetika Mittal, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Vascular malformations and tumors are a heterogeneous group of lesions that may affect the arterial, capillary, venous or lymphatic system or any combination thereof. They encompass a bewildering range of lesions, syndromes, and masses ranging from the relatively common to the rare. The classification available for these lesions is complex and involves various histopathological aspects. Creating a classification system primarily based on different radiological modalities is beneficial. Understanding differentiating features between low flow and high flow vascular malformations is essential as they have different treatment protocols. Understanding differentiating features between arterial, venous and lymphatic malformations helps to understand the different components in a mixed vascular malformation. In case of histopathological dilemma, radiological features play a major role. Knowing different locations, imaging features and progression with age of hemangioma helps to understand their etiology and natural history.

#### TABLE OF CONTENTS/OUTLINE

Imaging features of vascular malformations on ultrasound, color Doppler, CT angiography, MRI. Characterization of vascular malformations. Algorithmic approach to classify vascular malformations. Various syndromes associated with vascular malformations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-13

### **Hands Up! This Is An... Upper Extremities CT Angiography**

All Day Room: Learning Center

Vanessa Hernandez Olivera, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Explain an overview of current imaging guidelines for upper extremities CT angiography. Pictorial review of the most frequent pathologies and atypical cases and their diagnosis in our medical center.

#### **TABLE OF CONTENTS/OUTLINE**

Introduction Review current imaging guidelines for upper extremities CT angiography. Anatomy and anatomical variations of the upper extremities arteries. CT angiography protocols in different clinical scenarios. Upper extremities arterial diseases: • In situ thrombosis. • Aneurysm or pseudoaneurysm. • Vasculitis. • AVF complications. • Trauma. • Post procedure complications. • Thoracic outlet syndrome. Conclusions

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

VAEE-14

### Too Soon to Enhance: Pearls and Pitfalls of Early Venous Enhancement

All Day Room: Learning Center

Iza C. Vieira, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Revisit through cases and recall the characteristics of the main pathological and physiological causes of early venous enhancement.- Demonstrate protocols and techniques for optimizing venous studies (CTA/CTV and MRA), allowing differentiation of the various conditions associated with early venous enhancement.

#### TABLE OF CONTENTS/OUTLINE

- Pictorial review of the main physiological causes of early venous enhancement (commonly associated with rapid venous return), including the territories of the jugular veins, venous sinus, renal veins, inferior vena cava and hepatic veins.- Demonstration of the main methods of venous phase acquisition and discussion of techniques and methods. Show examples of techniques that can facilitate specific diagnosis, such as injection of contrast through alternative venous access (e.g. podalic vein). - Demonstrate that in the same venous territory, early enhancement can represent either a pathological or physiological finding depending on the evaluation of the other venous territories and associated pathologies, including territories of left gonadal vein and left iliac vein.- Display selected cases of uncommon causes of early venous enhancement: portosystemic shunt, cecal angiodysplasia, congenital and acquired arteriovenous fistula.- Summary of teaching points.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-15

### Inflammatory and Infectious Conditions of the Aorta: A Review of Concepts and Imaging Findings

All Day Room: Learning Center

Vitor D. Bichuette, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

? To review concepts involving epidemiology, clinical presentation and imaging findings of inflammatory and infectious conditions of the aorta. ? To identify the main imaging features of diseases that affect the aorta and its branches. ? To differentiate pathological and treatment-related imaging patterns of aortic disease. ? To discuss how radiologists can help in the management of aortitis.

#### TABLE OF CONTENTS/OUTLINE

- Introduction - General concepts
  - o The use of different images modalities to assess the aorta.
- Aortitis classification:
  - o Involvement of the branches of the aorta in the main diseases.
  - o Definition, clinical presentation and imaging features of diseases involving the aorta.
- Case-Based Review:
  - o Sample cases explaining and demonstrating image findings of aortitis and how imaging modalities can be used before and after the treatment. This section will present illustrative cases of:
    - § Takayasu arteritis
    - § Giant cell arteritis
    - § Granulomatosis with polyangiitis
    - § Polyarteritis nodosa
    - § IgG4-related disease
    - § Idiopathic aortitis
    - § Siphilitic aortitis
    - § Staphylococcus aureus aortitis
    - § Mycobacterium tuberculosis aortitis
    - § COVID-19 aortitis
- Future Directions: new perspectives in the assessment of the aorta.
- Conclusion and key takeaways.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-16

### Multimodality Imaging in Large Vessel Vasculitides

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Sahar Alizada (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Large Vessel Vasculitides (LVV) encompass a range of pathologies classified as non-infectious/inflammatory (primary and secondary vasculitides) and infectious vasculitides. • Various imaging modalities are available for diagnosis, including Ultrasound, CTA, MA, and FDG-PET/CT, each with its own advantages and disadvantages. • Each modality has specific imaging features that aid in the diagnosis of vasculitis, such as the halo sign in ultrasound or circumferential thickening and vessel wall enhancement on CTA or MA, which are consistent with inflammatory vasculitis. Conversely, crescentic-shaped thickening with adjacent fat stranding are features of infectious vasculitis. Moderate to intense circumferential FDG uptake along the vessel wall on FDG-PET/CT indicates active vasculitis. Recent publications suggest that FDG uptake in the temporal or maxillary arteries has similar sensitivity/specificity in diagnosing LV (GA). • This educational exhibit proposes an algorithm for patients suspected of having either inflammatory large vessel vasculitis or infectious vasculitis. For inflammatory vasculitis, ultrasound should be the first-line imaging modality.

#### TABLE OF CONTENTS/OUTLINE

- LVV classifications.
- Available imaging modalities that can be utilized in LVV.
- Key imaging features
- Proposed algorithm for patients with LVV

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-17

### **Doppler High Frequency Ultrasound in Vascular Complications: What Radiologists Should Know Before, During or After Injectable Procedures**

All Day Room: Learning Center

#### **Awards**

##### **Cum Laude**

Luciana C. Zattar, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Facial injections with different dermal fillers have become increasingly common. The explosion in the use of these injectable materials has brought a concomitant rise in the incidence of complications. Vascular compromise is the most concerning complication of all, caused either by intravascular injection (arterial or venous), external compression (mostly of the veins), thrombosis or embolization. As a result, blood flow may be interrupted in the occluded facial arteries, leading to ischemia, necrosis or ulcerations. Fortunately, Doppler high frequency ultrasound (DHFUS) is valuable to avoid, to diagnose and to treat vascular complications in most clinical scenarios. However, the clinicians should be alerted that many factors will affect the sensitivity of this examination. And, in this context, the radiologists may be requested to recognize and evaluate patients before, during or after injectable procedures, for safe and effective injections. This study aims:(1)To review and clarify the facial vascular anatomy and major variations.(2)To describe the correct examination technique: basic probe positions.(3)To teach how to recognize different dermal fillers substances and signs of vascular occlusion.(4)To list different possible imaging findings of vascular occlusion (new pattern based on angiosome with fresh-frozen specimen correlation).(5)To describe guided procedures to avoid or treat complications.

#### **TABLE OF CONTENTS/OUTLINE**

1.INTRODUCTION. 2. VASCULAR FACIAL ANATOMY. 3.IMAGING TECHNIQUE. 4.DERMAL FILLERS DESCRIPTION. 5.DHFUS FINDINGS IN VASCULAR OCCLUSIONS: a new finding. 6.GUIDED PROCEDURES. 7.CONCLUSION.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-18

### Collateral Networks in Superior Vena Cava Obstruction

All Day Room: Learning Center

Joao C. Sarmiento Santos, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To illustrate with schematic figures and cases the patterns of collateral venous pathways depending on the level of superior vena cava (SVC) obstruction (above or below the junction of the azygos arch). To discuss the technical aspects related to vena cava imaging To describe the mechanisms and illustrate with cases the different etiologies of SVC obstruction. To discuss the treatment options, the role of imaging to plan therapy, as well as post-therapeutic findings.

#### TABLE OF CONTENTS/OUTLINE

SCV obstruction is a relatively common entity in the everyday practice of different radiology subspecialties, including head and neck, thoracic, abdominal, vascular and interventional radiologists. Hence, to schematize in an easy way the collateral venous pathways developed secondary to caval obstruction is of wide interest to facilitate diagnosis and treatment. We herein describe the collateral pathways resulting from SCV obstruction and correlate the opacification of those collaterals to the site of contrast injection in CT and MR angiography exams. Graphic representations of the sites of obstruction and respective formed collaterals are depicted, as well as the azygos / hemiazygos system participation to the collateral venous return. The normal anatomy and anatomical variations which might play a role in the collateral system development are detailed. The main causes of obstruction are discussed: extrinsic compressions, tumoral invasion, thrombosis and traumatic injury.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-2

### **Spontaneous Abdominal Wall Hemorrhage: A Practical Diagnostic Guide to Aid the Interventional Radiologist**

All Day Room: Learning Center

Claudia Campos Bas (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To describe the diagnostic process using Angio-CT of spontaneous soft tissue haemorrhage ( SSTH) in the abdominal wall and the key findings to guide interventional treatment.To share practical advice on identifying the probable bleeding artery in angio-TC using vascular territory mapping and correlating with arteriography.

#### **TABLE OF CONTENTS/OUTLINE**

SSTH in the abdominal wall characterizes by sudden extravasation of blood into a muscle group without an underlying medical condition. Whilst most cases remain confined, some may become extensive and life-threatening. In such situations, radiological management may be both diagnostic and interventional.Angio-TC is the gold standard for the detection of haemorrhage, allowing a fast and non-invasive diagnosis. Moreover, it enables us to differentiate between arterial and venous bleeding and to approximate the most probable bleeding artery, serving as a road map for targeted angiography and embolization. We retrospectively reviewed 28 patients (aged 59-88) admitted to our angiography suite due to acute anemia in the setting of active arterial abdominal wall bleeding described on triphasic CT. We determined the presence of active arterial bleeding and identifies the responsible vascular pedicle when possible. In all other cases, we inferred the most probable bleeding vessel based on location of contrast extravasation, known as " arterial mapping". We compared our results with the subsequent arteriography. Angio-TC is essential in the setting of SSTH as it enables to determine the presence and origin of bleeding. Differentiating arterial from venous bleeding and identifying the potentially damaged vessel is of paramount to manage these patients.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-20

### Chronic Mesenteric Ischemia: Mesenteric Artery Duplex Sonography and the Utility of Postprandial Imaging

All Day Room: Learning Center

Kaitlin M. Zaki-Metias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Duplex sonography performed in the fasting state serves as a good initial screening tool for chronic mesenteric ischemia. 2. There is a wide range and lack of consensus of established cut-offs for peak systolic velocity criteria suggestive of hemodynamically significant mesenteric arterial stenosis in the literature. 3. The evidence supporting the utility of postprandial assessment of the mesenteric arteries is inconclusive. 4. Failure of peak systolic velocity to increase 20-30% between fasting and postprandial states may indicate hemodynamically significant stenosis. 5. Given the lack of clarity surrounding postprandial duplex sonography of the mesenteric arteries, inclusion of postprandial assessment in the imaging protocol may lead to confusion.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction 2. Epidemiology and clinical presentation of chronic mesenteric ischemia 3. Pathophysiology of chronic mesenteric ischemia 4. Duplex sonography of the mesenteric arteries: common protocols and pitfalls 5. Postprandial imaging of the mesenteric arteries and associated challenges 6. ACR appropriateness criteria for imaging of mesenteric ischemia 7. Case-based review of mesenteric artery duplex sonography including normal cases, abnormal cases, and cases mistakenly interpreted as abnormal 8. Management of chronic mesenteric ischemia 9. Conclusion

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-21

### The Forgotten Vessels: Imaging of the Inferior Mesenteric Vasculature

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Anup S. Shetty, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The inferior mesenteric artery (IMA) and vein (IMV) supply and drain the distal colon and rectum, but can be neglected as part of a standard search pattern. This exhibit will: 1) Familiarize the reader with the embryology, anatomy, and physiology of the inferior mesenteric vessels 2) Discuss modalities used to image the IMA/IMV 3) Illustrate a broad spectrum of diseases affecting the IMA/IMV through a series of illustrative cases

#### TABLE OF CONTENTS/OUTLINE

Outline- Embryology, Anatomy (and variants), and Physiology- Imaging Modalities (CT, US, MR, angiography)\* IMA abnormalities - acute thromboembolic disease - chronic occlusion (AAA, Leriche) and collateral pathways - dissection, aneurysm, pseudoaneurysm, and arteriovenous fistula - vasculitis - hemorrhage - tumor invasion\* IMV abnormalities - thrombosis - septic thrombophlebitis - intravenous gas in the setting of pneumatosis - tumor invasion - rectal varices in portal hypertension - mass effect from sigmoid volvulus leading to rectal edema\* diagnostic clues- displacement from internal hernia - lymphadenopathy from rectal cancer - flow artifact at portosplenic confluence

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

VAEE-22

### CT Angiography of the Upper Extremity: Purpose, Protocols, Problems, and Pathology

All Day Room: Learning Center

Alexander M. Satei, MBBS (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. CT angiography is a key diagnostic imaging tool to evaluate for upper extremity arterial pathology. 2. Understanding the vascular anatomy of the upper extremity, including variant anatomy, is critical for interpretation of CT angiography of the upper extremity. 3. Benefits of CT angiography include rapid noninvasive image acquisition, lower cost and radiation exposure than digital subtraction angiography, and simultaneous evaluation of the adjacent osseous structures and soft tissues. 4. Limitations of CT angiography include patient positioning for optimal imaging, contrast bolus timing, increased cost and radiation exposure relative to sonographic evaluation, and artifact relating to arterial calcification, implanted hardware, or metallic foreign bodies. 5. CT angiography of the upper extremity is ideal for evaluation of traumatic arterial injury, vasculitides, congenital vascular anomalies, arteriovenous fistulae for hemodialysis, and pre- and post-operative evaluation relating to vascular and surgical intervention.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction. 2. Vascular anatomy of the upper extremity. 3. Review of important variant vascular anomalies of the upper extremity. 4. Indications for CTA of the upper extremity. 5. Benefits and limitations of CTA of the upper extremity. 6. Extended case-based review of CTA upper extremity including subclavian steal syndrome, active post-traumatic extravasation, arteriovenous fistulae, pseudoaneurysm and aneurysm, mycotic aneurysm, dissection, transection, hematoma, fibromuscular dysplasia, and thoracic outlet syndrome, among others. 7. Conclusion.

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## Abstract Archives of the RSNA, 2023

VAEE-23

### Hearts on Fire: Imaging the Coronary Arteries in Systemic Vasculitis

All Day Room: Learning Center

Sean Johnson (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Overview of systemic vasculitis, highlighting entities which can involve the coronary arteries. Review the incidence and prevalence of coronary artery vasculitis. Demonstrate coronary artery manifestation of systemic vasculitis with case-based reviews. Discuss various diagnostic modalities and protocols used to identify and characterize coronary artery vasculitis.

#### TABLE OF CONTENTS/OUTLINE

1. Incidence and prevalence of coronary artery vasculitides. 2. Review forms of systemic vasculitis, coronary artery manifestations and pathophysiology, including: Takayasu arteritis, Kawasaki disease, microscopic polyangiitis, Erdheim-Chester disease, IgG4-related vasculitis and polyarteritis nodosa. 3. Case-based review of coronary artery vasculitides, including both acute and chronic manifestations. 4. Brief discussion of non-coronary thoracic aortic disease in systemic vasculitis. 5. An approach evaluating the coronary arteries for involvement in systemic vasculitis, including review of imaging selection and protocols.

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## Abstract Archives of the RSNA, 2023

VAEE-24

### Advanced Multimodal MRA Techniques for Cerebrovascular Disease: A Comprehensive Guide

All Day Room: Learning Center

Toshiya Akatsu (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Cerebrovascular disorder treatment has evolved, now employing a range of advanced devices. While time-of-flight MR angiography (TOF-MRA) can suffer from image degradation, innovative multimodal MRA techniques such as phase contrast (PC), ultrashort echo time (UTE), and 4D offer improved image quality. Embracing these cutting-edge imaging methods is crucial in managing cerebrovascular disorders. Our presentation aims to:

1. Provide a comprehensive overview of cerebrovascular diseases.
2. Highlight the technical details of state-of-the-art multimodal MRA imaging techniques.
3. Showcase the clinical applications of multimodal MRA imaging in diagnosis, treatment, and postoperative care for cerebrovascular diseases.

#### TABLE OF CONTENTS/OUTLINE

1. Exploring the significance and recent advancements in multimodal MRA imaging for cerebrovascular diseases.
2. Diving deep into the technical aspects of various MRA sequences, including TOF, PC, UTE, and 4D.
3. Unveiling the latest clinical applications of multimodal MRA imaging for cerebrovascular conditions, such as intracranial aneurysms, arteriovenous malformation (AVM), dural arteriovenous fistula (dAVF), and moyamoya disease, through real-life case studies.

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## Abstract Archives of the RSNA, 2023

VAEE-25

### US of Lower Extremity Deep Vein Thrombosis: A Review

All Day Room: Learning Center

Nicholas C. Roberts, DO (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- Describe SRU Multidisciplinary 2018 Consensus protocol for complete duplex ultrasound (CDUS) of lower extremity· Differentiate acute thrombosis, chronic post thrombotic change· Discuss implications of slow flow· Describe normal and abnormal spectral Doppler and how it can be used to infer more central thrombosis· Describe pitfalls related to anatomy, gray scale and color Doppler

#### TABLE OF CONTENTS/OUTLINE

Table of Contents/Outline1. Ultrasound Protocols a. SRU consensus for complete duplex ultrasound (CDUS) b. Alternative (limited protocols) i. Appropriate situations ii. Follow up c. Example of imaging and labeling for CDUS2. Acute DVT a. Gray scale b. Types: Occlusive, Non-occlusive, Mobile c. Appearance over time d. "Acute on chronic" and indeterminate acuity e. Phlegmasia cerula dolans3. Post thrombotic change a. Diminutive size of veins b. Wall thickening c. Synechiae d. Calcification e. Collaterals and deep reflux f. Neovascularization /arterialization4. Other Issues a. Central DVT implied by abnormal spectral Doppler b. Slow Flow i. Normal ii. Progression to DVT c. Isolated calf thrombus d. Increased venous pulsatility e. Positive DVT with ipsilateral renal transplant5. Follow up US, alternative imaging and treatment recommendations based on US appearance and extent of thrombus6. Pitfalls a. Related to frequency of transducers b. Anatomic variations c. Poor color Doppler settings

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-26

### **A Novel Approach to Deforming Device for Optimal Frozen Elephant Trunk Technique via Patient Specific 3D Printed Model**

All Day Room: Learning Center

Koichi Osuda, RT (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Frozen elephant trunk implantation for thoracic aortic aneurysms is recognized as a less invasive surgical technique. However, because intraoperative fluoroscopy is not available, device insertion must be done with blind operation. To avoid complications, we developed a novel approach for deforming device in advance and simulating surgical procedures via life size 3D model.

#### **TABLE OF CONTENTS/OUTLINE**

Datasets for printing were converted, using CT data which has submillimeter spatial resolution. Patient specific life size 3D printed models were faithfully reproduced luminal surface of thoracic aorta. 3D printed model enables surgeon to assess physiological morphology including stenosis or spiculated atheroma, practically, though it is impossible to see that intraoperatively. Furthermore, this method allowed surgeon to simulate surgical procedures, considering precise device size in advance. 3D printed model is clinically available and promising for facilitating the operation strategy optimization, and assistant for frozen elephant trunk technique safely. There will be contributions to clinical practice for preoperative accurate assessment and simulation.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-27

### Nonatherosclerotic Conditions of Peripheral Arteries

All Day Room: Learning Center

Taila S. Moura Fe (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: Make a didactic review of the nonatherosclerotic conditions of peripheral arteries, including the following conditions: Aneurysm, Pseudoaneurysm, Dissection, Vascular prosthesis and grafts, Embolism, Arteriovenous fistula, Arterial adventitial cystic disease, Locked-in arterial syndrome. To illustrate these conditions based on cases from our ultrasonography team. Correlate sonography findings with different image methods.

#### TABLE OF CONTENTS/OUTLINE

Introduction including the nonatherosclerotic conditions of peripheral arteries, including the following conditions: Aneurysm, Pseudoaneurysm, Dissection, Vascular prosthesis and graft, Embolism, Arteriovenous fistula, Arterial adventitial cystic disease, Locked-in arterial syndrome. Describe the main information of each condition. Illustrated teaching cases from our ultrasonography team, each condition. Correlate the ultrasound findings with other image methods.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-28

### Development of a Double Bolus Tracking Method for Individualized CT Angiography Scan Timing

All Day Room: Learning Center

Yoshiya Ohashi (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To perform surgical procedures safely, understanding the anatomical variations of the veins in preoperative computed tomography (CT) angiography is critical. The scan timing of the venous phase is generally performed via fixed scan delay, but the contrast effect is often inadequate owing to individual differences in the peak timing of the veins. We have developed the double bolus tracking (DBT) method, which effectively utilizes low-dose monitoring in preoperative CT angiography to individualize the timing of the venous and the arterial phases. The advantage of the DBT method is that the CT angiography enhances the contrast effect in complex anatomical regions such as the portal venous system. Consequently, it might improve the surgical outcomes and patients' quality of life.

#### TABLE OF CONTENTS/OUTLINE

A) An overview of the DBT method B) Scanning techniques used for low dose monitoring C) Differences in contrast effects between the fixed scan delay and the DBT methods D) Clinical applications of preoperative vascular mapping E) Advantages of using the DBT method in complex anatomical regions such as the portal venous system F) Limitations and future directions of the DBT method G) Conclusions and clinical relevance of using DBT in preoperative screening methods for colon cancer surgery

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-29

### The Anatomy of Danger: Exploring Hemodynamic Perils in Type B Aortic Dissection

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Hyun Jung Koo, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

- To explore the debated issues regarding the relationship between the number of entries and aneurysm progression in patients with type B aortic dissection (AD)- To simulate in-vitro dissection model for assessing the relationship between the flow and entries in the dissection- To demonstrate the utility of 4D flow magnetic resonance imaging (MRI) and computational fluid dynamics (CFD) for assessing hemodynamic flow in patients with type B AD - To suggest potential applications of CT and 4D flow MRI in personalized treatment planning for aortic dissection, such as selecting the optimal timing for surgical intervention based on hemodynamic parameters and individual patient factors.

#### TABLE OF CONTENTS/OUTLINE

1. CT features - Predictors of high-risk adverse outcome in patients with type B AD2. Controversies - Entry and re-entries - Hemodynamic flow and thrombosis in false lumen3. Assessment of Hemodynamics 1) In-vitro Fluid Dynamics Study- Aorta modeling method - In-vitro 4D flow2) In-vivo 4D flow MRI Study- Wall shear stress, flow displacement, and flow velocity - The role in predicting aortic dissection progression3) CT-based CFD Analysis- In-vivo patient study- In-vitro model matching

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

VAEE-3

### Abdominal Aortic Aneurysm: Pre and Post Operative Evaluation

All Day Room: Learning Center

Matheus Marcelino Dias, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purposes of this exhibit are: Make a multimodality-based didactic review of the main topics of infradiaphragmatic aneurysm at pre and post operative evaluation. Make a practice guide on how to perform an evaluation with all the necessary variables for follow-up or surgical planning using different imaging methods. Propose a didactic categorization of these topics: Ultrasound evaluation of Abdominal aortic aneurysm. Postoperative Endovascular Ultrasound Evaluation. Postoperative complications d. Ultrasound with microbubbles contrast. Correlate those findings with other exams. Adequate evaluation and early recognition of post operative complications of endovascular repair of aneurysms. Illustrate those conditions based on cases from our radiology group.

#### TABLE OF CONTENTS/OUTLINE

We will discuss the principles of the abdominal aortic aneurysm at pre and post operative evaluation and focus on their imaging features using a multimodality approach in this exhibit. Ultrasound evaluation of infradiaphragmatic aneurysm. Postoperative Endovascular Ultrasound Evaluation. Postoperative complications. Ultrasound with microbubbles contrast.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-30

### Why is CT Useful in the Diagnosis of Klippel-Trenaunay-Weber Syndrome?

All Day Room: Learning Center

Takaharu Noda (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is:1. Klippel-Trenaunay-Weber syndrome (KTWS) is a rare and intractable disorder characterized by unilateral hypertrophy associated with one or more mixed vascular malformations of the extremities.2. The main imaging modalities used at KTWS are US, MRI, angiography and CT.3. CT images can clearly depict the vascular malformations of KTWS.4. In addition, volume measurement and histogram analysis of the extremity by CT imaging can be used to help diagnose KTWS and guide treatment.

#### TABLE OF CONTENTS/OUTLINE

Major headings:1. Describe KTWS.2. How to create a CT Venography.3. Usefulness of volume rendering (VR) images by CT.- About VR images of superficial veins.- About VR images of deep veins.4. Volumetric measurements with CT imaging of the lower extremities are useful in the diagnosis of KTWS.- The volume of the affected and healthy side can be measured reliably and easily.5. Histogram analysis with CT images of the lower extremity is useful in the treatment strategy for KTWS.- Histogram analysis can determine the components within the analysis area from the CT number.- In the present case, the enlargement of the lower extremities was determined to be due to an increase in the fat component (CT number indicates a negative value), not edema (CT number indicates near zero).

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## Abstract Archives of the RSNA, 2023

VAEE-31

### Vascular Malformations and the Mimickers: A Spectrum of Imaging Features

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Mayu Uka (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

The purpose of this exhibit is: 1) To review contrast-enhanced MRI and other imaging features of vascular malformations and vascular tumors compared to imaging features of other similar diseases and 2) to discuss the differential diagnosis of vascular malformations and vascular tumors with other lesion types.

#### TABLE OF CONTENTS/OUTLINE

The cause of most vascular tumors and vascular malformations of the body surface and soft tissue is unknown. Hemangiomas, which are benign vascular tumors, and vascular malformations are often referred to idiomatically as "hemangiomas," but the International Society for the Study of Vascular Anomalies (ISSVA) classifies them as separate diseases. Vascular malformations, which include venous malformations, arteriovenous malformations, lymphatic malformations, capillary malformations, and combined types, whose clinical and imaging findings sometimes resemble not only vascular tumors but also other neoplastic and non-neoplastic lesions. In this presentation, we will present common vascular malformations, vascular tumors, and other rare conditions, and review the imaging features and pathological findings of "mimickers," which sometimes have imaging similarities to vascular malformations and are difficult to diagnose.

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## Abstract Archives of the RSNA, 2023

VAEE-32

### **Aortitis and Large Vessel Arteritis: Diagnosis, Follow-up, Treatment and Mimics**

All Day Room: Learning Center

Miltiadis Tembelis, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Aortitis and large vessel arteritis encompass both infectious and noninfectious causes of vascular wall inflammation. These pathologies often produce non-specific clinical presentations and inflammatory markers, complicating the diagnosis. Correlation with demographics, key clinical features and recognition of typical imaging features and distribution can allow radiologist to assist in the diagnosis. Diagnosis is not the only difficult aspect of these pathologies though, as recommendations for appropriate follow-up and the definitions of remission in the literature are heterogeneous.

#### **TABLE OF CONTENTS/OUTLINE**

This review will demonstrate different imaging features of infectious and noninfectious large vessel arteritis and aortitis across different modalities to help radiologists clue in on the diagnosis. Common complications and post-interventional appearances will also be exemplified. In addition, treatments and post-treatment follow-up will be addressed.

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## Abstract Archives of the RSNA, 2023

VAEE-33

### Which Vascular Variations Are Important to Colorectal Surgeons for Right Colon Surgery?

All Day Room: Learning Center

Minho Lee, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

In right colic surgery, the choice of surgical methods, such as right hemicolectomy, transverse colectomy, or extended right colectomy, depends on the location of the colon cancer. However, vascular variations can occasionally necessitate a change in the planned surgical approach, preventing the originally intended reduced surgery and leading to an extended right colectomy instead. The diverse and frequent vascular anatomy variations in the right colon, if not identified preoperatively, can contribute to increased morbidity and mortality rates. Unexpected arterial variations can prolong surgical time, while venous variations can result in bleeding complications. To assess the impact of vascular variations on surgical methods, we will review approximately 380 CT angiographies and determine the type and incidence of right colic and middle colic arterial and venous variations. We will also identify vascular ligation points according to the type of surgery. Additionally, common mistakes and prevention strategies when inexperienced radiologists evaluate CT angiographies will be discussed. Readers will understand that preoperative CT angiographic evaluations can help shorten surgical time, minimize unexpected bleeding risks, and ultimately improve surgical outcomes.

#### TABLE OF CONTENTS/OUTLINE

1. Arterial and venous anatomy of the right colon. 2. Various types of right colon surgery and corresponding vascular ligation points for each procedure. 3. Important measurements of right and middle colic arteries relevant to right colon surgery. 4. Incidence and representative cases of vascular variations. 5. Pitfalls in interpretation and associated cases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-34

### Clinical Applications of MR Angiography Based on Arterial Spin Labeling to Cerebrovascular Disorders

All Day Room: Learning Center

Osamu Togao, MD, PhD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1) To explain the basic principles of 3D or 4D arterial spin labeling (ASL)-based MR angiography (MRA) 2) To discuss the advantages of ASL-based MRA over other imaging techniques 3) To review clinical applications of ASL-based MRA for various cerebrovascular diseases

#### TABLE OF CONTENTS/OUTLINE

1) Basic principles of ASL-based MRA •Labeling schemes, Pulsed ASL; Pseudo-Continuous ASL (PCASL); Superselective PCASL; Acceleration-selective ASL (AccASL) •3D or 4D imaging acquisition techniques2) Advantages of ASL-based MRA over time-of-flight MRA or digital subtraction angiography •Readily available •No need for contrast media •No radiation exposure •Short acquisition time •Non-invasive •Cost effective •Time-resolved information •Selective vascular visualization •Easy follow-up after treatment •Easily applicable to children3) Specific techniques for ASL-based MRA •3D-MRA using PCASL - Silent MRA •4D-MRA using pulsed ASL -Contrast inherent inflow enhanced multi-phase angiography (CINEMA) •4D-MRA using PCASL -4D-MRA based on PCASL with CENTRA-Keyhole and view-sharing (4D-PACK) •Vessel-selective 4D-MRA using superselective PCASL (4D-S-PACK) • AccASL MRA 4) Clinical applications •Intracranial steno-occlusive arterial diseases (e.g. Moyamoya disease) •Brain arteriovenous malformation • Intracranial dural arteriovenous fistula •Assessment of extra-intracranial bypass arteries 5) Limitations of each ASL-based MRA technique

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-35

### Clinical Applications and Implementation of Photon Counting Detector CT in Vascular Imaging

All Day Room: Learning Center

Prabhakar Rajiah, MD, FRCR (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. To discuss the advantages of photon-counting detector (PCD) CT in vascular imaging 2. To review the modes, kernels, and protocols of PCD CT in vascular imaging 3. To illustrate the clinical applications of PCD CT in vascular imaging

#### TABLE OF CONTENTS/OUTLINE

1. PCD CT TECHNOLOGIES- Single source, Dual-source 2. BENEFITS OF PCD-CT-Ultra-high spatial resolution;Multi energy (ME)/spectral imaging;K-edge imaging ;High vascular signal;Low electronic noise artifacts;Lower radiation and contrast doses; 3. TECHNICAL ASPECTS RELEVANT TO VASCULAR IMAGING-Modes Ultra-high resolution, ME, HR-ME, Flash-ME, gated/ungated;Kernels, denoising;Collimation;Images- Single energy like (T3D), VMI, iodine, VNC, virtual non calcium, spectral post-processing;Radiation doses, CARE keV;4. VASCULAR APPLICATIONS OF PCD CT WITH CASE EXAMPLES-Ultra-high resolution- Improved visualization of small vessels (Flaps ,eg. DIEP, fibular perforators; Artery of Adamkiewicz; distal arteries of hand, feet, head), calcified plaques, small stents;High iodine CNR - Low dose of iodinated contrast, salvage of suboptimal-enhanced studies;Decreased artifacts- Calcium blooming, beam hardening, metal;ME calcium separation- Improved lumen visualization;ME bone subtraction- Rapid and accurate;ME lesion characterization-hematoma vs active bleed vs calcification;Vascular perfusion- Lung, myocardium, extremities;Multi-contrast and novel contrast media- e.g. iodine and gadolinium;Advanced material separation- Calcium;Radiation dose reduction- VNC images in multiphasic studies, lower noise profile; 5. LIMITATIONS, PITFALLS-Increased data - storage and transfer issues; Noise in high resolution mode

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## Abstract Archives of the RSNA, 2023

VAEE-36

### Review of CTA Findings in Patients With Circulatory Assisted Devices

All Day Room: Learning Center

#### Awards

##### Certificate of Merit

Dennis Adaaquah, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Present CT imaging findings and clinical presentations of complications associated with circulatory assisted devices. Review entities that may present as pitfalls in CT imaging of circulatory assisted devices.

#### TABLE OF CONTENTS/OUTLINE

This educational exhibit will present pictorial review of multiple CT findings of complications associated with circulatory assisted devices to increase Radiologists awareness. Highlight challenges associated with CT imaging of circulatory assisted devices and also provide tips to overcome the challenges.

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## Abstract Archives of the RSNA, 2023

VAEE-37

### CT Angiography's Role in Virtual Surgical Planning for Craniomaxillofacial Reconstruction with Scapular Free Flap

All Day Room: Learning Center

Kendal L. Weger (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Virtual surgical planning plays an important role in craniomaxillofacial (CMF) reconstruction with scapular free flap. 2. Scapular free flaps are preferred over fibular or deep circumflex artery free flaps for CMF reconstruction when there is variant anatomy, significant atherosclerosis, or prior utilization of lower extremity vessels. 3. Preoperative virtual surgical planning (VSP) has numerous advantages over traditional intraoperative decision making including shortened operative times, improved patient matched custom implant design, improved patient specific oncologic margins and anatomic understanding, and decreased rate of nonunion and flap related complications. 4. Virtual surgical planning and 3D printing sterilizable guides at the point of care requires a centralized manufacturing ecosystem and collaboration between surgeons, radiologists, engineers, and support staff. 5. CT angiography is an important first step in the pre-surgical planning for scapular free flap harvesting because of common variant anatomy and localization of perforating branches.

#### TABLE OF CONTENTS/OUTLINE

- Scapular free flap advantages over fibular and deep circumflex artery flaps. - CT angiography's role in virtual surgical planning. - Optimal imaging acquisition to achieve optimal radiologic planning. - Role of 3D modeling and medical device design in virtual surgical planning.

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## Abstract Archives of the RSNA, 2023

VAEE-4

### Segmental Arterial Mediolyis: A Visual Journey Through Its Imaging Findings

All Day Room: Learning Center

Camila P. Reifegerste, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

Segmental arterial mediolysis (SAM) is a nonatherosclerotic and noninflammatory arteriopathy, unknown to many radiologists. It can lead to severe complications, which have a high mortality rate, thus it is important for us to be aware of this disease. SAM is characterized by lysis of the medial arterial layer, normally compromising visceral and renal arteries, coursing with dissections, aneurysms and even arterial rupture. The imaging findings on computed tomography angiography (CTA) of SAM can be very similar to others vasculitides, such as polyarteritis nodosa and granulomatosis with polyangiitis, but most vasculitides can be diagnosed based on clinical, laboratory and imaging findings, while SAM's diagnosis is based majorly on imaging findings and exclusion of other vasculitides. The aim of this presentation is to show some cases of segmental arterial mediolysis from our institution, its complications and some differential diagnosis, for the purpose of making radiologists more familiar with this pathology.

#### TABLE OF CONTENTS/OUTLINE

Brief literature review of segmental arterial mediolysis; didactic cases of SMA from the digital archive of our hospital's radiology department, to show SAM typical findings, complications and differential diagnosis on multiple imaging modalities, including computed tomography angiography (CTA), magnetic resonance angiography (MRA), Doppler ultrasound and arterial angiography

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

VAEE-5

### The Aortic Isthmus from A to Z

All Day Room: Learning Center

Juliana G. Da Trindade (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

To describe the embryology of the aortic isthmus, and its developmental stages. To demonstrate with cases the peculiar anatomical variations of this segment. To exemplify with cases the congenital malformations and pathological states.

#### TABLE OF CONTENTS/OUTLINE

The aortic isthmus is a small aortic segment located between the left subclavian artery and the ductus arteriosus. This segment undergoes singular changes to allow flow adjustments necessary for the blood circulation from intra to extra-uterine life. The process of closure of the ductus arteriosus after birth normally results in a fibrous band called ligamentum arteriosus. However, different factors as prematurity, genetics, prenatal infections, concomitance of congenital heart diseases, the extension of the ductal tissue to the aortic wall may lead to either persistence of the ductus arteriosus or to variable patterns of ductal involution (aortic knobs or ampullas, aortic-coarctation, etc). The presence of fibrotic tissue within the aortic wall and flow disturbances due to focal ectasia may additionally predispose to aneurysm formation, ulcerations and dissection during adulthood. Therefore, the aortic isthmus is an extremely complex region covering several anatomical variations and a wide spectrum of pathologies that may affect all age groups in a congenital or acquired form. Our goals are to review the isthmic developmental changes along intra to extra-uterine life, and to discuss the imaging findings of different anatomical variations and pathological states of this intricate aortic segment.

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## Abstract Archives of the RSNA, 2023

VAEE-6

### **Abdominal Vascular Compression Syndromes: What the Radiologist Needs to Know (and Let the Surgeons Know)**

All Day Room: Learning Center

Daniel L. Cardoso, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

Recognize the key structures of the abdominal vasculature and its anatomical relations. Understand the causes of Abdominal Vascular Compression Syndromes (AVCS) and related clinical features. Comprehend computed tomography angiography (CTA) imaging patterns of AVCS. Recognize the complications associated to AVCS and its imaging patterns. Understand AVCS treatment methods and criteria.

#### **TABLE OF CONTENTS/OUTLINE**

INTRODUCTION: Anatomy of the abdominal vasculature and its relation to other structures. Definition of AVCS. Epidemiology of the most common causes of AVCS. Signs and symptoms. associated to the Median Arcuate Ligament Syndrome (MALS), Superior Mesenteric Artery Syndrome (SMAS), Nutcracker Syndrome (NCS), and May-Thurner Syndrome (MTS).

DIAGNOSING, AND IDENTIFYING POST TREATMENT IMAGING PATTERNS - MALS, SMAS, NCS, and MTS: Imaging findings. Complications, and its imaging patterns. Treatment methods, and what to evaluate

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## Abstract Archives of the RSNA, 2023

VAEE-7

### **Pelvic Congestion Syndrome. CT Angiography and Doppler Ultrasound Findings**

All Day Room: Learning Center

Carlos Capunay, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

To be aware of pelvic congestion syndrome as a cause of female chronic pelvic pain. To recognize the anatomic variants and pathologic conditions that can cause the pelvic congestion syndrome To illustrate the spectrum of CT and Doppler US findings in these patients. To emphasize the most representative imaging features on this clinical syndrome.

#### **TABLE OF CONTENTS/OUTLINE**

Anatomy of the normal female pelvic venous plexus. Pathogenesis of the pelvic congestion syndrome. Description of the Doppler US technique. Description of the CTA scan protocol: technical parameters and IV contrast administration CT image analysis and post-processing algorithms in the different clinical setting. Sample cases of compression syndromes (including superior mesenteric artery compression of the left renal vein, and compression of the left common iliac vein by the right common iliac artery). Summary.

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## Abstract Archives of the RSNA, 2023

VAEE-8

### The Use of Ferumoxytol for High-Resolution Vascular Imaging and Troubleshooting for Solid Organ Transplantation

All Day Room: Learning Center

Amar Shah, MD (*Presenter*) Nothing to Disclose

#### TEACHING POINTS

1. Ferumoxytol, a novel MR contrast agent in off-label use, is safe for patients with renal dysfunction. 2. Due to its prolonged intravascular half-life and lack of parenchymal extravasation, high-resolution vascular imaging, including distal intraparenchymal branches, is feasible. 3. Ferumoxytol MRA can identify clinically actionable vascular complications of solid organ transplant several weeks to months before ultrasound or traditional MRA. 4. 3D reconstructions facilitate procedural planning and may obviate unnecessary intervention in select patients.

#### TABLE OF CONTENTS/OUTLINE

1. Introduction to ferumoxytol as a contrast agent: imaging characteristics, protocol details, and safety/administration. 2. Advantages and utility in comparison to GBCA. a. High-resolution vascular imaging without background parenchymal enhancement. b. Curved planar MIP reformats. c. Virtual angiography (Time-Resolved contrast-enhanced MRA) d. Coadministration with GBCA. e. Repeat imaging up to 72 hours. 3. Catalogue of example cases with preceding equivocal or normal ultrasound and/or GBCA MRA (highlighting above techniques). a. Transplant renal artery stenosis (TRAS) b. Transplant renal vein thrombosis (TRVT) with capsular neovascularization (CV) c. TRVT with CV d. TRAS and transplant pancreas artery stenosis (TPAS). e. Transplant pancreas vein thrombosis. f. Transplant pancreas intraparenchymal AVF. g. Transplant hepatic artery stenosis. h. Transplant hepatic vein thrombosis.

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## Abstract Archives of the RSNA, 2023

VAEE-9

### **Imaging of Primary Malignancies of Inferior VenaCava and its Involvement in Secondary Abdominal Malignancies**

All Day Room: Learning Center

Veeraiah Koppula, MD (*Presenter*) Nothing to Disclose

#### **TEACHING POINTS**

After reviewing this educational exhibit, the learner will be able to:• Learn the key imaging features of primary malignancies of Inferior Vena cava• Identify the clinical scenarios in which abdominal malignancies can extrinsically or intrinsically involve the IVC• Review the normal anatomy of IVC and its tributaries

#### **TABLE OF CONTENTS/OUTLINE**

• Introduction• Normal anatomy and variants of IVC• Clinical and radiological features and management of primary leiomyosarcoma and angiosarcoma of Inferior Vena cava. • Case based discussion of abdominal malignancies involving IVC• Relevance of IVC involvement in staging of malignancies and undertaking oncological surgeries• Conclusion

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## Abstract Archives of the RSNA, 2023

M2-SPBR

### Breast Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPBR-1 Stand-alone Performance of Artificial Intelligence-based Computer-assisted Diagnosis in Screening Automated Breast Ultrasound**

Haejung Kim, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the stand-alone performance of artificial intelligence-based computer-assisted diagnosis (AI-CAD) in screening automated breast ultrasound (ABUS) interpretation and find the factors associated with false-negative and false-positive results.

##### **METHODS AND MATERIALS**

The ABUS source data of 435 women in a single institution were retrospectively analyzed using AI-CAD system (LUCAS). Three volume data of antero-posterior, medial, and lateral scanning were obtained for each breast. Of total 435 women, 97 were breast cancer patients with screening detected single malignant lesion between October 2019 and June 2020, and 338 were women who underwent screening ABUS between May 2019 and June 2019 and showed negative final diagnosis. We reviewed the results of AI-CAD system in detecting malignant lesion on ABUS and analyzed the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Also the associated factors with false-negative and false-positive results were analyzed.

##### **RESULTS**

The sensitivity, specificity, PPV, and NPV of AI-CAD in ABUS interpretation were 0.75 (73 of 97; 95% confidence interval, 0.65 to 0.83), 0.58 (195 of 338; 95% CI, 0.52 to 0.63), 0.34 (73 of 216; 95% CI, 0.30 to 0.37), and 0.89 (195 of 219; 95% CI, 0.85 to 0.92), respectively. The average number of CAD-detected lesion was 1.2 per study (1.8 in patients with cancer, and 1.0 in patients without cancer). True positive lesions were detected in 1.81 of 3 volumes of breast, while false positive lesions were detected in 1.30 of 3 volumes (1.5 in benign lesions and 1.1 in pseudo-lesions). False-negative results in breast cancer were more frequent for isoechoic mass ( $p < 0.001$ ) and mass without echogenic rind ( $p = 0.043$ ). Among 143 patients with false-positive results, 49 (34.3%) had pseudo-lesions. False-positive results were more frequent for dense breasts on mammography ( $p < 0.001$ ), however, the background echotexture of ABUS was not associated with false positive results or pseudo-lesions.

##### **CONCLUSION**

AI system showed NPV of 89% for negative interpretation of ABUS. However, radiologists should carefully recheck the results of AI-CAD system to reduce false-positive results and recall rate.

##### **CLINICAL RELEVANCE/APPLICATION**

By providing information on the stand-alone performance of AI-CAD in screening ABUS interpretation, it helps to correctly understand the advantages and disadvantages of AI-CAD system and apply them to clinical practice.

#### **M2-SPBR-2 A Novel Triage Model for Screening Mammograms Based on a Density AI and a Cancer Detection AI**

Serena Pacile, PhD (*Presenter*) Employee, Therapixel SA

##### **PURPOSE**

To estimate the effectiveness of a triage model for breast cancer screening examinations based on two AI systems: one for breast density assessment and one for cancer detection.



## METHODS AND MATERIALS

For this retrospective simulation study, a dataset of 2,981 tomosynthesis screening examinations was collected. The dataset included 696 biopsy-proven cancer cases and 2,285 negative screens (verified by a negative follow-up). For each collected screen, the interpretation made by the primary reader was also collected. A two-steps triage model was set up based on two AI systems: one estimating the breast composition, and one detecting and characterizing regions suspicious for malignancy (hereafter referred to as AI-density and AI-detection). The first step was based on density: examinations whose density was assessed as C or D by AI-density were considered as requiring human interpretation. Examinations whose density was assessed as A or B were further processed by AI-detection: those with an AI-detection score lower than a given threshold were considered negative and not worth of reader interpretation, otherwise they were considered as requiring human interpretation. The proposed triage model is based on the French breast screening context where patients with high density breasts systematically undergo both mammography and ultrasound, and autonomous offloading of examinations by AI is mainly applicable to low density breasts. We examined the effect on recall rate and workload reduction keeping constant the cancer detection rate. We used inverse probability weighting to compensate for distribution differences between the used dataset and a typical screening population.

## RESULTS

AI-density assessed 611 exams (20.5%) as density A, 1,024 (34.35%) exams as density B, 967 exams (32.44%) as density C and 379 exams (12.71%) as density D. Based on AI-detection scores of examinations assigned with densities A and B, 26.43% of women were considered negative without significantly affecting the cancer detection rate (which remained constant around 5/1000 - 95% CI 4.6/1000 to 5.7/1000). The recall rate decreased from 10.02% (8.74% - 11.29%) to 8.2% (7.07% - 9.32%).

## CONCLUSION

Results have shown that the proposed two-step triage strategy could safely select patients to be removed from radiologists' workload without affecting the cancer detection rate. A prospective study that applies this model has been set up in France and is supposed to start including patients on January 2024.

## CLINICAL RELEVANCE/APPLICATION

Using two AI systems (one for density and one for cancer detection) to triage mammograms could potentially reduce radiologist workload at constant cancer detection rate, and decrease the rate of women recalled back for further examinations.

## M2-SPBR-3 Automated Assessment of Breast Positioning and Image Quality Using Artificial Intelligence for Digital Breast Tomosynthesis (DBT) with Two-Dimensional Synthetic Mammography and Full-Field Digital Mammography (FFDM)

Ying Guo (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to evaluate the accuracy of an artificial intelligence based tool for automated assessment of breast positioning and image quality in DBT, using synthetically reconstructed projection images.

## METHODS AND MATERIALS

A total of 150 mammography examinations were enrolled in this study. Subjects underwent screening mammography including DBT with 2D-SM and FFDM. The AI-assisted automated assessment tool evaluated the quality of breast positioning in each image set. Nine image quality criteria evaluating the appearance of the nipple, breast rotation, pectoral muscle, inframammary fold, pectoral nipple line, shoulder overlap shadow, abdominal skin, contralateral breast and foreign body were used for craniocaudal and mediolateral-oblique views. Image quality of cases were also evaluated with the standards of Mammography Quality Standards Act (MQSA) as grade "adequate" or "inadequate". The performance of the AI system was evaluated using accuracy, sensitivity, and specificity. The inter-rater agreement and comparison of their findings with those reported by the AI system was calculated using Cohen's kappa coefficient.

## RESULTS

The AI algorithm demonstrated high accuracy in distinguishing between adequate and inadequate images, with an overall accuracy of 93%, sensitivity of 94% and specificity of 92% for FFDM and an accuracy of 92%, sensitivity of 95 and specificity of 91% for DBT with 2D-SM. In terms of breast positioning, the AUC of poor imaging quality prediction by AI system according to incomplete gland, incomplete pectoralis muscle, over or insufficient exposure was (0.903 vs 0.937 vs 0.982). Overall accuracy of AI system were 0.958 for FFDM and 0.932 for DBT with 2D-SM. Inter-observer agreement for image quality assessment was found to be 0.82 (95% confidence interval [CI]: 0.77-0.87), indicating substantial agreement between radiologists and AI system using 2D-SM images. The kappa coefficients for breast positioning assessment were also calculated and found to be moderate to substantial, with values ranging from 0.57 to 0.83 (95% CI: 0.48-0.67 and 0.78-0.88, respectively).

## CONCLUSION

The results showed a high degree of agreement between the automated and manual assessments, also indicating the performance of the AI tool in assessing breast positioning and image quality in DBT using 2D-SM images was comparable with that in FFDM.

## CLINICAL RELEVANCE/APPLICATION

The study demonstrated the potential of this AI assisted system to improve the efficiency, accuracy, and reliability in DBT screening.

## M2-SPBR-4 TopoTxR: A Topology-based Framework for Breast Parenchyma Characterization on DCE-MRI

Prateek Prasanna, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

In order to comprehensively analyze the biology of breast cancer, it is necessary to examine the surrounding breast parenchyma. Automated characterization of breast parenchyma using DCE-MRI is challenging due to the intricacy of the parenchymal tissue structures. Existing quantitative techniques, when combined with deep learning, are unable to accurately represent the complex structures, such as fibroglandular tissue. The fibroglandular tissue may undergo malignant transformation. To better evaluate the subtle structures of the breast, we propose a novel approach, TopoTxR, that incorporates topological features extracted from persistence diagrams as auxiliary information. This enables the convolutional neural network (CNN) to directly focus on the biologically-relevant topological structures.

### METHODS AND MATERIALS

We train and validate TopoTxR to predict pathological complete response (pCR) using ISPY-1 post-contrast DCE-MRI data. Our study involves 161 patients, with 47 achieving pCR and 114 not. To enhance the performance of the 3D CNN, we integrated a mask-guided attention module that leverages a prepared topology-related mask. This mask approximates the curvilinear tissue-like structures enclosed by tissues and glands in their proximity. While inputting the raw DCE-MRI as the input of the CNN backbone, we applied the topological structure mask to guide the generation of the attention map in the latent space. TopoTxR takes advantage of the noise-free topological structures while retaining other biologically relevant information of the original data. Finally, we employed a classifier to the attention-filtered features for pCR prediction, followed by a custom loss function combined mask guided loss and refined the classification loss to address the sample imbalance problem.

### RESULTS

TopoTxR utilizes the topological mask as supplementary input combined with the original image and incorporating Focal Loss. It improves pCR prediction significantly compared to previous methods and it also surpasses the state-of-the-art, Densenet-KD, by 3% in accuracy. Our ablation studies show the effectiveness of mask-guided attention modules and Focal Loss, respectively.

## CONCLUSION

Our novel method leverages pre-computed topological biomarkers to enhance the performance of 3D CNN in pCR prediction. This model reasonably integrates both topology and full image information to obtain and evaluate high biological related features.

## CLINICAL RELEVANCE/APPLICATION

Predicting treatment response enables physicians to plan and determine the most effective treatment strategy for their patients prior to disease progression (i.e. immediate surgical intervention in cases where neoadjuvant chemotherapy is predicted to fail).

## M2-SPBR-5 Cloud-Based Machine Learning Platform for the Detection and Localization of Breast Cancer on DCE-MR Scans

Gavin Jones (*Presenter*) Nothing to Disclose

### PURPOSE

Breast cancer is the most common cancer diagnosed in US women and is second to lung cancer as a cause of death in women. Machine learning (ML) can play a role in aiding breast radiologists with the detection and localization of tumors on MRI. The aim of this project was to create an ML algorithm using cloud-based software capable of accurately identifying breast cancer on DCE-MRI. The trained algorithm may be used as a radiologist adjunct in the early identification of lesions.

### METHODS AND MATERIALS

Breast cancer MR images were obtained from a publicly available dataset of 922 radiologist-annotated and biopsy-confirmed breast cancer. The provided annotations denoted a 3D bounding box of each tumor. Using these coordinates, multiple 2D

slices of the tumor were selected to augment the total number of tumor-containing images to 1267 training and 396 test images. Tumor images were further processed to exploit contrast enhancement data by compiling pre-contrast tumor slices with their corresponding early and late post-contrast slices into a single RGB image. Cloud-based ML software was then used to train the algorithm on the processed 1267 pre-annotated MR images. Following training, the algorithm's accuracy and precision were assessed using the remaining 396 test images. Tumor subgroup analyses were also performed to assess detection performance on classifiers such as ductal and lobular histology and molecular features such as luminal A/B, HER2+/-, ER +/-, PR+/-, and triple-negative carcinomas.

## RESULTS

The trained ML model had 94.3% recall and 89.8% precision when the probability and overlap thresholds were set to 95% and 30% respectively. When tested on the 396 non-annotated validation images, the model localized breast cancer tumors with a recall of 88.6% and an average precision of 86.5% with a confidence interval of 0.95 and an F1 score of 0.89. For the subgroup analyses, HER2 enriched molecular subtype (n=20) had the highest overall average precision (95.5%), recall (95.5%), and F1 (0.95). The lowest-performing subgroup was lobular carcinoma (n=31) with average precision (88.8%), recall (84.4%), and F1 (0.90).

## CONCLUSION

Our study has shown that ML techniques trained on a large set of annotated MR images can produce a highly accurate breast cancer detection and identification tool. The performance of tumor classifiers varies depending on tumor type, receptor status, and molecular subtype.

## CLINICAL RELEVANCE/APPLICATION

An ML tool that can accurately detect and localize breast cancer tumors can improve care by providing women with diagnoses and thus treatment options more quickly. In the future, this ML model can be made accessible within an online tool that will quickly review breast MR slices and determine if there is breast cancer and localize tumors.

## M2-SPBR-6 Artificial Intelligence-Supported Additional Review of Screening Mammography Improves Radiologist Cancer Detection Rate

Matthew McCabe, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Studies estimate that for every 5 cancers detected by screening mammography, there is 1 false negative. A common method of reducing the false negative rate is "double-reading," where two readers interpret mammograms. However, double-reading is costly, and single-reading is standard practice in the USA. The purpose of this study was to explore the utility of an Artificial Intelligence (AI) supported additional review process (AIAR) where AI identifies the most suspicious exams for selective additional review. The goal is to realize the benefit of decreased false negatives through double-reading while minimizing additional workload.

## METHODS AND MATERIALS

A total of 522,078 digital breast tomosynthesis screening mammograms from March 2021 to August 2022 underwent AIAR at 5 practices in the US. The dataset contained 2,739 screen-caught cancers. In the AIAR process, screening mammograms were assessed using a custom AI algorithm. Exams considered suspicious by the AI algorithm that were not recalled by the interpreting radiologist (i.e. given a BIRADS 1 or 2) were flagged for review by an experienced radiologist. The reviewer could consult with the interpreting radiologist if they thought a recall was warranted, who could decide whether to revise to a BIRADS 0 and recall the patient. Performance metrics, including recall rate (RR), cancer detection rate (CDR), and positive predictive value 1 (PPV1) were computed for 98 individual interpreting radiologists.

## RESULTS

A total of 19,560 exams were flagged by AIAR, and 201 additional cancers were detected. Thus, with AIAR only 4% of exams required an additional review, while yielding an 8% increase in cancer detection. AIAR increased CDR across practices (range 5-21%), while minimally impacting RR (range 1-3%). PPV1 also increased at every practice (range 3-16%), indicating AIAR finds more cancers for each recall. Radiologists with lower pre-AIAR CDRs improved more compared to those with high pre-AIAR CDR (e.g., CDR increase of 0.55 vs 0.35 for radiologists with pre-AIAR CDR of 2-4 vs 4-6). Finally, AIAR could be further improved to identify up to 243 more cancers by standardizing the consult rate to ~5 consults per 100 reviews which would maximize the positive predictive value of consults at ~35 cancers per 100 consults.

## CONCLUSION

AIAR increases cancers detected, while minimizing the additional workload required to identify and recall at-risk patients in a large real-world dataset.

## CLINICAL RELEVANCE/APPLICATION

AIAR is a practical means to improve cancer detection in the real-world, and therefore reduce false negatives without incurring substantial additional costs.

## **M2-SPBR-7 Sonographic Prediction of Breast Cancer Patients Non-Responding to Neoadjuvant Chemotherapy at Baseline: Comparison of Standard B-mode and a Deep-Learning Model**

Panagiotis Kapetas, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To evaluate whether pre-therapeutic breast ultrasound (US) can serve in the prediction of breast cancer (BC) patients non-responding to neoadjuvant chemotherapy (NAC) and to compare two different models.

### **METHODS AND MATERIALS**

This retrospective, IRB-approved study included 245 patients with histologically confirmed invasive BC who underwent NAC. The dataset was divided into a training (165 cases) and a validation set (80 cases). A representative B-mode US image of each tumor from the pre-treatment examination was selected. 2 experienced breast fellows independently evaluated the lesions using standard BI-RADS descriptors. Logistic regression was used to identify independent predictors of response to NAC in the training set and create a model. Additionally, a Resnet18-based neural network with Dropout layers to decrease the amount of overfitting was trained to predict the treatment outcome. The performance of both models was evaluated on the validation set using descriptive statistics. Postoperative histology was the standard of reference for treatment response: absence (pathological complete response- pCR) or presence of residual invasive tumor in the breast or axillary lymph nodes.

### **RESULTS**

145 patients (59.2%) did not achieve a pCR. From the BI-RADS descriptors, oval or round shape, microlobulated or spiculated margin and the presence of calcifications or edema proved to be independent predictors of pCR. A model using these showed an accuracy, sensitivity, specificity, positive and negative predictive value of respectively 65%, 82%, 41%, 67% and 61% for the prediction of non-responders to NAC. Compared to that, the DL-based model achieved an accuracy, sensitivity, specificity, positive and negative predictive value of 72%, 83%, 55%, 74% and 69%.

### **CONCLUSION**

Breast US can accurately predict lack of response to NAC for BC patients prior to its initiation. A DL model using images from the baseline US examination demonstrates an increased diagnostic performance as compared to standard B-mode BI-RADS descriptors.

### **CLINICAL RELEVANCE/APPLICATION**

Pre-therapeutic breast ultrasound offers accurate information, which may aid in the management of breast cancer patients, planned to undergo neoadjuvant chemotherapy.

## **M2-SPBR-8 Prediction of Pathologic Response to Neoadjuvant Chemotherapy in Patients with Breast Cancer Based on Artificial Intelligence Techniques**

Ahmed Sharafeldeen, MSc, BSc (*Presenter*) Nothing to Disclose

### **PURPOSE**

The aim is to develop a computer aided diagnosis (CAD) system to accurately predict the response of neoadjuvant chemotherapy on breast cancer patients based on magnetic resonance imaging (MRI). The system aims to predict three possible responses, which are complete response (indicating the complete disappearance of the lesion), partial response (in which the tumor partially disappeared), or no response (suggesting that the tumor did not respond to chemotherapy).

### **METHODS AND MATERIALS**

The proposed system is composed of four distinct stages. The first stage involves manual delineation of the breast tumor by an experienced radiologist. Secondly, four distinct features are extracted from the manually segmented tumor, namely functional imaging markers, apparent diffusion coefficient (ADC), computed from diffusion-weighted imaging (DWI) using baseline scans and b-500, b-1000, and b-1500 scans, along with texture features, grey level co-occurrence matrix (GLCM) and grey level run length matrix (GLRLM), extracted from T1-weighted, T2-weighted, and STIR models. Thirdly, these features are statistically represented using percentiles, which helps to capture the salient aspects of the data distribution while minimizing the impact of outliers. Finally, the features are combined together and then fed into a gradient boosting classifier.

### **RESULTS**

To evaluate the effectiveness of the proposed system, a dataset of 110 breast cancer patients was used, with 28 patients showing complete response, 53 with partial response, and 29 with no response. The system's performance is assessed using k=15 cross-validation approach. The findings demonstrated that the proposed system outperforms the accuracy of classifying each feature individually as well as other statistical machine learning classifiers, achieving an impressive accuracy of 85.5 a specificity of 73.5 a sensitivity of 98.5. The results clearly indicate that integrating functional imaging markers and texture markers using majority voting approach significantly enhances the diagnostic system's performance.

## CONCLUSION

The proposed CAD system accurately predicts the response of neoadjuvant chemotherapy on breast cancer patients by utilizing various markers related to the pathology. The system's performance is further improved by integrating functional imaging markers and texture markers in a non-invasive manner.

## CLINICAL RELEVANCE/APPLICATION

The motivation behind this objective is to reduce the risk of exposure to neoadjuvant chemotherapy, which can be painful and dangerous. By assessing the response of the impact of chemotherapy exposure, physicians can determine whether chemotherapy is necessary or if the patient should undergo surgery directly.

## M2-SPBR-9 Analyzing the Collinearity of Race and Breast Tissue Density in Misclassification of Abnormality in Screening Mammograms

Linglin Zhang (*Presenter*) Nothing to Disclose

## PURPOSE

Deep learning techniques have been developed to assist the assessment of potential breast cancer in screening mammograms. Research has shown gaps in model performance within subgroups of some demographic and imaging features in classifying abnormality in mammograms presenting region of interests (ROIs); However, the collinearity between such features is unknown. The purpose of this study was to investigate the collinearity of those demographic and imaging characteristics in association with the performance of deep learning model in classifying abnormality in screening mammograms.

## METHODS AND MATERIALS

We applied a modified ResNet152V2 convolutional neural network structure trained on 39,054 and tested on 13,390 mammogram patches from (REDACTED) dataset. Positive patches are the ROIs annotated by the original interpreting radiologists on BI-RADS 0 images; Negative patches were randomly selected from regions in BI-RADS 0 images avoiding ROIs, and regions in BI-RADS 1 and BI-RADS 2 images. The classification result of test set patches was aggregated to their source images, while only images containing all correctly classified patches were considered as successful prediction. Image-level classification results on 5,723 test images containing ROIs were analyzed by logistic regression models for the association with race and tissue densities, separately and together. Variance inflation factor (VIF) was calculated for race and tissue density.

## RESULTS

VIF between race and density is 1.000005, showing features are moderately, nearly not correlated. Experiment 1 combined three race groups and four densities into 12 subgroups, no significant correlation with image misclassification was found. Experiment 2 had three models built in White, Black and Other races populations separately, we found that only in Black population, BI-RADS densities C ( $p=0.026$ ) and D ( $p=0.012$ ) have significantly higher chance to be misclassified.

## CONCLUSION

The study reveals there is no collinearity issue with race and tissue density in the dataset and deep learning structure that were used.

## CLINICAL RELEVANCE/APPLICATION

This can be used as a guide for future model development.

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## Abstract Archives of the RSNA, 2023

M2-SPCA

### Cardiac Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPCA-3 Preliminary Investigation of the Right Ventricular Scalloping Index as a Novel CMR-derived Marker for Diagnosing Arrhythmogenic Right Ventricular Cardiomyopathy**

Ko Ying Huang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The cardiac magnetic resonance (CMR) evaluation of right ventricular (RV) morphologic abnormalities in patients with arrhythmogenic right ventricular cardiomyopathy (ARVC) is subjective. Here we aimed to develop a novel index, the right ventricular scalloping index (RVSI), to standardize the measurement of RV free wall scalloping and aid in the imaging diagnosis.

#### **METHODS AND MATERIALS**

We retrospectively included 15 patients with definite ARVC and 45 age- and sex-matched patients with idiopathic right ventricular outflow tract ventricular arrhythmia (RVOT-VA) as controls. The RVSI was measured from cine images on four-chamber view to evaluate its ability to distinguish between ARVC and RVOT-VA patients.

#### **RESULTS**

The RVSI was significantly higher in the ARVC than RVOT-VA group ( $1.57 \pm 0.22$  vs.  $1.27 \pm 0.07$ ,  $p < 0.001$ ). The RVSI demonstrated high intra- and interobserver reliability (intraclass correlation coefficient, 0.94 and 0.93, respectively). A cut-off value of RVSI = 1.38 provided high sensitivity of 86.7% and high specificity of 95.6%. Moderate linear correlations were found between RVSI and RVEF ( $r = -0.42$ ,  $p < 0.001$ ) as well as between RVSI and RVEDVI ( $r = 0.5$ ,  $p < 0.001$ ). The subgroup analysis revealed a moderate linear correlation between RVSI and RVEDVI ( $r = 0.67$ ,  $p = 0.006$ ) in the ARVC subgroup. In a multivariable analysis, a family history of ARVC or sudden cardiac death (odds ratio, 98.14; 95% confidence interval, 2.34-4116.35;  $p = 0.016$ ) and an RVSI = 1.38 (odds ratio, 145.24; 95% confidence interval, 9.90-2131.10;  $p < 0.001$ ) remained predictive of definite ARVC.

#### **CONCLUSION**

RVSI is a quantitative method with good performance for distinguishing ARVC and RVOT-VA patients.

#### **CLINICAL RELEVANCE/APPLICATION**

ARVC is among the major differential diagnoses to be considered in patients with an initial impression of RVOT-VA, image survey with CMR before ablation is recommended to provide a comprehensive assessment of RV morphology, and RVSI is easy and intuitive to measure.

#### **M2-SPCA-4 Regional Variation of Left Ventricular Myocardial T2 Mapping Values and Diagnostic Performance for Active Cardiac Sarcoidosis**

Jordan H. Chamberlin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Myocardial tissue characterization with T2 mapping has been shown to aid in diagnosis of cardiac sarcoidosis, but the regional variation and diagnostic performance has not been well evaluated.

#### **METHODS AND MATERIALS**

2503 patients undergoing 1.5T cardiac MRI from 2017-2022 were queried. 326 patients with biopsy proven extracardiac sarcoidosis were enrolled in this retrospective cohort analysis, of which 110 were found to have complete T2 mapping series.



The left ventricle was manually delineated into the 16 corresponding anatomic segments and 7 regions (Basal, mid, apical, anterior, inferior, septal, and lateral) according to the American Heart Association segmentation guidelines. Active cardiac sarcoidosis (aCS) was defined using the 2017 Japanese Circulation Society criteria within 30 days of imaging. Optimal thresholds were calculated using a balanced resampling bootstrapping technique. The optimal thresholds were rounded to the nearest integer for ease of clinical use. Mann-Whitney U Tests were used for comparing continuous distributions.

## RESULTS

37 (33.6%) patients (mean age 57 years, 65.9% males, 63.4% Black) were found to meet aCS criteria. T2 values across all myocardial regions were found to be significantly higher for patients meeting criteria for aCS ( $P < 0.05$ ). Median regional T2 values in patients with aCS ranged from 48.6 ms (septal) to 50.8 ms (apical) and median regional T2 values in patients without aCS ranged from 47.0 ms (lateral) to 49.5 ms (apical). Utilizing optimized thresholds ( $>50$ ms), the septal myocardium was most specific for active disease (specificity = 0.923). The single region most sensitive for active disease involvement was the inferior segments (sensitivity = 0.630). Using a 50 ms positive threshold for each region, the positive predictive value (PPV) increased proportionally with the addition of each positive region (PPV 1 region  $> 50$ ms, = 0.42, PPV 5 regions = 0.65, PPV 6 regions = 0.88, PPV 7 regions = 1.00). Correspondingly, using a  $< 47$  ms negative threshold, the negative predictive value for ruling out aCS was highest for three segments  $< 47$  ms (NPV = 0.82).

## CONCLUSION

T2 mapping values vary significantly across the left ventricular myocardium. The best threshold for active disease was found to be  $> 50$  ms, and the best threshold for ruling out active disease was  $< 47$  ms. Elevated regional T2 mapping (especially in the septal and inferior segments) is highly specific for active disease and shows a proportional relationship of myocardial involvement with diagnostic performance.

## CLINICAL RELEVANCE/APPLICATION

T2 mapping, with attention to regional variation, can help identify patients with active cardiac sarcoidosis.

## M2-SPCA-5 Cardiac Magnetic Resonance Feature-tracking Assessment of Whole-heart Myocardial Mechanics: Prognostic Value for Early Outcomes in Non-ischemic Dilated Cardiomyopathy

Gryte Galnaitiene, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the prognostic value of whole-heart myocardial strain parameters derived from feature tracking (FT) on cardiac magnetic resonance imaging (CMRI) for early outcomes in patients with nonischemic dilated cardiomyopathy (NIDCM).

## METHODS AND MATERIALS

This was a single-center prospective study involving 97 patients (mean age  $49.5 \pm 10.1$  years; 69.1% males) with NIDCM. We identified the baseline CMRI-derived whole-heart myocardial mechanical parameters: global longitudinal and circumferential strains of the left ventricle (LVGLS and LVGCS, respectively), global longitudinal strain of the right ventricle (RVGLS), peak longitudinal strain of the left atrium (LA strain) and right atrium (RA strain). The volumes of both ventricles and areas of both atria were also assessed. We evaluated the prognostic impact of the mechanical parameters for early outcomes that were: cardiac death, heart transplantation and hospitalization for worsening heart failure (HF) at 1 year after diagnosis of NIDCM. Logistic regression analysis was used to assess the potential predictors of these early outcomes.

## RESULTS

The patients were divided into two groups according to the presence of early outcomes. The groups did not differ in mean age and males ( $p > 0.05$ ). The early outcomes were established in 32 patients (3 heart transplantations, 9 cardiac death, and 30 hospitalizations for HF worsening). All patients' left ventricular ejection fraction (LVEF) was severely reduced (mean LVEF  $28.9 \pm 8.9\%$ ) and more decreased in the group with early adverse outcomes ( $23.7 \pm 10.1\%$  vs  $32.9 \pm 10.6\%$ ,  $p < 0.001$ ). Both ventricles and atria were more dilated in the group with early adverse outcomes ( $p < 0.05$ ). Patients without early outcomes had higher LVGLS and RVGLS values ( $-8.2 \pm 4.1$  vs  $-11.7 \pm 4.6$  and  $-12.7 \pm 5.3$  vs  $-16.8 \pm 6.5$ , respectively,  $p < 0.05$ ). The similar tendency was noticed in LA strain and RA strain parameters ( $8.4 \pm 5.0$  vs  $14.6 \pm 4.3$  and  $11.5 \pm 6.9$  vs  $17.1 \pm 8.0$ , respectively,  $p < 0.05$ ). Logistic regression analysis showed that LVGLS was an independent predictor of early adverse outcomes in patients with NIDCM after 1 year ( $p = 0.001$ ).

## CONCLUSION

LVGLS derived from FT on CMRI can be a significant independent predictor of early adverse outcomes in patients with NIDCM.

## CLINICAL RELEVANCE/APPLICATION

The mechanics of all parts of the heart in patients with NIDCM were evaluated. It was revealed that LVGLS has an additive prognostic value to predict early adverse outcomes in patients with severely reduced LVEF and NIDCM.

## M2-SPCA-6 Evaluation of Myocardial Histological Properties by Pharmacokinetic Analysis Using Golden-angle Radial Sparse Parallel Imaging-volumetric Interpolated Breath-hold Examination

Nothing to Disclose

**PURPOSE**

Golden-angle radial sparse parallel imaging-volumetric interpolated breath-hold examination (GRASP-VIBE) is a sequence used for dynamic contrast-enhance (DCE) MRI that is robust to motion and enables to evaluate of tissue dynamic contrast analysis. This study examined the feasibility of myocardial perfusion imaging under free-breathing conditions using the GRASP-VIBE method and the possibility of assessing myocardial properties using pharmacokinetic analysis.

**METHODS AND MATERIALS**

Prior to cardiac contrast-enhanced MRI, written informed consent was obtained from all 60 subjects enrolled in the study. Perfusion imaging was performed using GRASP-VIBE for 100 seconds following bolus injection of contrast agent. 3D-image reconstruction was performed with a temporal resolution of 3.0 seconds with liver gate, a breath correction technique using liver tracking. The reconstructed images were visually evaluated for streak and cardiac motion artifacts using a 5-point scale, and the image set with the best visual quality was chosen for pharmacokinetic analysis. The analysis was conducted using a workstation (Syngo Tissue 4D) and involved placing a region of interest (ROI) in the septum of the left ventricular myocardium and calculating the volume transfer constant (Ktrans) using curve fitting with the Tofts model. The myocardial properties were evaluated by pharmacokinetic analysis for the three groups of hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy (DCM), and normal subjects, as diagnosed from clinical information. ROC analysis determined cutoff values for differentiation of these diseases using Ktrans, and sensitivity and specificity were calculated.

**RESULTS**

Among the participants, 7 were diagnosed as normal, 14 as HCM, and 8 as DCM. The Ktrans was significantly lower in the HCM (0.606,  $p=0.0104$ ) and DCM (0.694,  $p=0.0188$ ) groups compared to the normal group (1.299). The area under the curve (AUC) for differentiating HCM from normal myocardium was 0.964, and the sensitivity and specificity were 0.857 and 1.00, respectively, when a cutoff value of 0.816 was used. The AUC for differentiating DCM from normal myocardium was 0.939, and the sensitivity and specificity were 0.875 and 1.00, respectively, when a cutoff value of 0.834 was used.

**CONCLUSION**

GRASP-VIBE is a promising tool for evaluating myocardial perfusion and has the potential to become a new myocardial histological characterization index using pharmacokinetic analysis.

**CLINICAL RELEVANCE/APPLICATION**

GRASP-VIBE can acquire myocardial perfusion images without motion artifacts under free breathing without ECG synchronization. Ktrans might be a new biomarker for assessing myocardial properties.

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## Abstract Archives of the RSNA, 2023

M2-SPCH

### Chest Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPCH-1 Low-field MRI to Visualize Interstitial Lung Disease Yields High Conformity with CT in Assessing Fibrosis Extent**

Nadine Bayerl (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to assess the feasibility of lung imaging using a 0.55 T MRI for visualization of interstitial lung disease (ILD) compared to high-resolution CT (HRCT) as the current standard of reference.

#### **METHODS AND MATERIALS**

This ongoing prospective clinical trial complied with the Declaration of Helsinki and enrolled 25 consecutive patients so far (mean age  $63 \pm 13$  years; male  $n=15$ ; female  $n=10$ ). Inclusion criteria were confirmed ILD on HRCT and the absence of MRI contraindications. Underlying primary diseases were systemic sclerosis ( $n=16$ ), anti-synthetase syndrome ( $n=3$ ), rheumatoid arthritis ( $n=2$ ), mixed collagenases ( $n=1$ ), systemic lupus erythematosus ( $n=1$ ) and idiopathic pulmonary fibrosis ( $n=2$ ). All patients gave informed written consent. Within the maximum of 30 days, patients underwent conventional HRCT and lung MRI on a 0.55 T scanner. In the latter, two-dimensional turbo-spin-echo (TSE) proton density-weighted sequences (TE/TR=35/2000 milliseconds) with BLADE (periodically rotated overlapping parallel lines with enhanced reconstruction) readout,  $1.25 \times 1.25$  mm<sup>2</sup> in plane-resolution,  $304 \times 304$  matrix and 6 mm slice thickness were acquired in transversal plane for visualization of pulmonary findings. Evaluating the visualization of ILD was performed at five defined levels of the lung by assessing the overall extent of ILD, ground-glass opacity (GGO) and reticulation. Wilcoxon signed-rank tests were performed to evaluate the differences between the paired groups. Significance was assumed for  $p < 0.05$ . Statistical analysis was carried out using GraphPad Prism 9 for macOS, Version 9.4.1 (458).

#### **RESULTS**

Low-field MRI of the lung allowed an assessment of the overall extent of pulmonary fibrosis comparable to CT (MRI, median=10 %, interquartile range IQR=5-40%; CT, median=15%, IQR=5-40%) with no significant differences between the two modalities. In MRI the extent of reticulation was slightly underestimated compared to CT (MRI, median=5%, IQR=5-18%; CT, median=10%, IQR=5-20%), and the extent of GGO was overestimated (MRI, median=5%, IQR=0-20%; CT, median=5%, IQR=0-10%), both reaching significance ( $p < 0.01$ ). The main limitation of this still ongoing study is the small sample size. Our observations will be substantiated in further studies.

#### **CONCLUSION**

Our study indicates that low-field MRI of the lung provides a reliable visualization of overall extent of ILD and could be useful for monitoring in follow-up examinations as a radiation-free alternative to HRCT.

#### **CLINICAL RELEVANCE/APPLICATION**

Patients undergo CT scans up to once a year to monitor the extent of ILD, resulting in repeated radiation exposure. Low-field MRI has the potential to be a promising radiation-free alternative to CT for follow-up.

#### **M2-SPCH-2 Idiopathic and Infection-triggered Acute Exacerbation of Idiopathic Inflammatory Myopathies-associated Interstitial Lung Disease: Clinical, Radiological Features and Prognosis**

Jingping Zhang (*Presenter*) Nothing to Disclose

## PURPOSE

Acute exacerbation (AE) of idiopathic inflammatory myopathies-associated interstitial lung disease (IIM-ILD) is a life-threatening event. According to the newly proposed diagnostic criteria for the AE of rheumatic disease-associated interstitial lung disease (RD-ILD), infection is regarded as one of the triggers of AE, and AE could be categorised as idiopathic (I-AE) or infection-triggered (iT-AE). In the present study, we aimed to investigate the differences in the clinical, radiological features and prognosis between I-AE and iT-AE of IIM-ILD patients.

## METHODS AND MATERIALS

We retrospectively analysed 69 patients with AE-IIM-ILD (I-AE (34), iT-AE (35)) in our hospital consecutively between January 2014 and December 2020. Infection was identified as confirmation of bacteria, virus, or fungus in samples obtained from the respiratory tract. The outcome was 1-year all-cause mortality.

## RESULTS

I-AE patients showed higher haemoglobin and PaO<sub>2</sub>/FiO<sub>2</sub> ratio than iT-AE patients ( $P < 0.05$ ), and lower pulse, body temperature, white blood cell (WBC) count, neutrophil percentage (NEU), lower C-reactive protein, erythrocyte sedimentation rate, lactate dehydrogenase, hydroxybutyrate dehydrogenase levels, and lower extent of ground-glass opacities (GGO) on HRCT than iT-AE patients ( $P < 0.05$ ). Multiple logistic regression analysis showed that the combination of NEU and the extent of GGO could help discriminate I-AE from iT-AE patients; the area under the receiver operating characteristic (ROC) curves (AUC) was 0.812 (95%CI 0.711-0.913, Sensitivity 0.714, Specificity 0.735, Accuracy 0.725). There is a significant difference in 1-year all-cause mortality between I-AE and iT-AE patients (mortality: I-AE 17.9%, iT-AE 54.3%; log-rank test,  $P = 0.0023$ ).

## CONCLUSION

Infection-triggered AE-IIM-ILD suffered a poorer prognosis than the idiopathic AE-IIM-ILD. The combination of NEU and the extent of GGO on HRCT could help differentiate between the two groups.

## CLINICAL RELEVANCE/APPLICATION

Distinguishing infection-triggered AE from idiopathic AE of IIM-ILD is essential in clinical practice for providing appropriate treatment. NEU combined with GGO extent on HRCT could help differentiate idiopathic AE from infection-triggered AE of IIM-ILD. Infection-triggered AE-IIM-ILD suffered a poorer prognosis than the idiopathic AE-IIM-ILD.

## M2-SPCH-3 Role and Accuracy of MRI in Connective Tissue Disease Related Interstitial Lung Disease

Surabhi Vyas, MD, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

To determine diagnostic accuracy of MRI with respect to HRCT in connective tissue disease related interstitial lung disease CTD-ILD.

## METHODS AND MATERIALS

Prospective single-center diagnostic study with sample size of 31 patients of CTD-ILD. Patients underwent HRCT chest and MRI chest on a 1.5 T scanner. PFT and 6-minute-walk-test were done. Warrick-scores and extent-scores were calculated for HRCT and MRI. Warrick score is sum of morphology-score extent-score. Morphology score is sum of scores given for presence/absence of various CT findings with maximum score of 5 for subpleural cyst and minimum score of 1 for ground-glass-opacity, 0 for absence. Extent-score is calculated for each morphology based on number of bronchopulmonary-segments involved, 1 for less than 3, 2 for 4 to 6 and 3 for more than 6 segments. Each MRI sequence was scored independently and combined-MRI-score was also calculated.

## RESULTS

MRI showed agreement with HRCT for extent of subpleural-line (50%;  $p=0.0015$ ), honeycombing (46.67%;  $p=0.0004$ ), subpleural-cysts (60%;  $p<0.0001$ ) and ground-glass-opacities (50%;  $p=0.003$ ). Best sequences to look for subpleural-line, honeycombing, subpleural-cyst and ground-glass-opacities were STIR (46.67%;  $p=0.0194$ ), 4-minute postcontrast sequence (61.11%;  $p=0.0290$ ), BTFE (50%;  $p=0.0003$ ). Among combined-scores calculated excluding postcontrast sequences, only 1/31 cases had different score than combined-score derived from all 10 sequences (including postcontrast sequences). Ground-glass-opacities were overestimated by MRI (higher scores in 13; lower scores in 2). Combined-MRI-score showed significant correlation with FEV<sub>1</sub>( $r=0.3484$ ;  $p=0.05$ ), FEV<sub>1</sub>/FVC( $r=0.4086$ ;  $p=0.02$ ), MEF50( $r=0.4203$ ;  $p=0.03$ ) post-walk test fatigue score( $0.4639$ ;  $p=0.01$ ).

## CONCLUSION

MRI shows moderate, statistically significant, agreement with HRCT and clinical-parameters in morphological and global assessment of ILD extent in CTD patients. Abbreviated MRI protocol for ILD assessment would be T2, STIR, BTFE in axial planes as these sequences show closest correlation with the CT-scores. Post-contrast sequences didn't contribute significantly

to global-score. With evolving MRI technology, shorter scan times and longer lifespan of patients, MRI becomes an attractive radiation-free option for serial follow-up of such patients.

#### **CLINICAL RELEVANCE/APPLICATION**

MRI has the potential to provide a radiation free imaging alternative to CT in follow up of ILD.

### **M2-SPCH-5 An Explainable Artificial Intelligence to Detect Histopathological UIP Pattern from HRCT Images and Validation of its Ability**

Ryoko Egashira, MD, PhD (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH; Speakers Bureau, AstraZeneca PLC; Speakers Bureau, Shionogi & Co, Ltd; Speakers Bureau, KYORIN Holdings, Inc; Speakers Bureau, DAIICHI SANKYO Group; Speakers Bureau, Bayer AG; Speakers Bureau, Otsuka Holdings Co, Ltd;

#### **PURPOSE**

To create an explainable artificial intelligence that can predict histopathological UIP pattern from HRCT images by machine learning and to validate its ability

#### **METHODS AND MATERIALS**

233 cases of interstitial lung diseases (ILDs) of mixed etiologies with volumetric CT images were retrospectively identified for this study from an archive with pathologically proven ILDs. The cases were divided into CT-training set for CT-imaging features (n=74), pathology-training set for UIP/non-UIP labels (n=61, UIP: non-UIP=34:27), and a test set (n=98, UIP: non-UIP=60:38). CT-training set cases were selected to include a variety of morphologic patterns and etiologic backgrounds. A custom machine learning model was trained to CT-imaging features. CT-feature extractors for 2D patches from volumetric CT images were created using self-supervised learning. The CT patches with similar features were clustered based on the output features and then pulmonologists/radiologist integrated the radiologically synonymous clusters. Using the integrated clusters as labeled data, deep-learning models to classify the CT findings were created by transfer-learning. A UIP/non-UIP classifier model to classify the cases into UIP or non-UIP by distribution of CT findings in each lung zone using Random Forest. The model was validated using leave-one-out cross validation. Unaware of the labels, two board-certified radiologists classified the test-set cases into UIP/non-UIP pattern according to modified Fleischner's UIP criteria. The validation and test set results were presented as an average of UIP/non-UIP classifier output. The performance of the model was compared with the radiologists' performance.

#### **RESULTS**

The accuracy and area under curve (AUC) of the model in validation were 71.47%, 0.785, respectively. In the test set, the accuracy, AUC, sensitivity, specificity and F1 score of the model were 78.67%, 0.843, 84.16%, 70%, and 82.88%. The radiologists' accuracy, sensitivity and specificity were 74.49%, 58.3% and 92% in reader A, 68.37%, 48.3% and 92.1% in reader B, respectively.

#### **CONCLUSION**

The model's performance in predicting pathological UIP pattern in various ILDs was 78.67% in accuracy and 82.88% in F1 score, which was better than the radiologists' performance using modified UIP criteria. While radiologists' performance was excellent in specificity.

#### **CLINICAL RELEVANCE/APPLICATION**

The detection of histopathological UIP pattern is a key to the prediction of progressive pulmonary fibrosis. There are currently no diagnostic HRCT criteria for UIP pattern other than IPF, this predictive model may be useful.

### **M2-SPCH-6 Effect of Contrast Enhancement on Diagnosis of Interstitial Lung Abnormalities in Automatic Quantitative CT Measurement**

Jaeyeon Choi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the effect of contrast enhancement on the diagnosis of interstitial lung abnormalities (ILA) in automatic quantitative CT measurement

#### **METHODS AND MATERIALS**

Patients who underwent preoperative chest CT for lung cancer between April 2017 and December 2020 were retrospectively included. Each examination consisted of a pair of nonenhanced and contrast-enhanced CT scans, and images were analyzed using a commercially available deep learning-based automated quantification software for ILA. According to quantified results based on the definition by the Fleischner Society, patients were divided into normal and ILA groups. The agreement for the diagnosis of ILA was estimated with kappa values. Reproducibility and measurement variability were also estimated using the intra-class correlation coefficient (ICC) and Bland-Altman method.

## RESULTS

Of the 1199 included patients (mean age, 62.2 years  $\pm$  10.9 [SD]; 595 females), ILA was identified in 46 (3.8%) and 76 (6.3%) on pre- and post-contrast images, respectively. Pre-contrast and post-contrast CT scans showed substantial agreement (weighted Kappa: 0.67) in the diagnosis of ILA. Of the 46 patients diagnosed with ILA on pre-contrast scans, 42 were also diagnosed with ILA on post-contrast scans. Post-contrast images showed a greater extent of total ILA than pre-contrast images (mean percentage, 0.99%  $\pm$  2.2 vs 0.63%  $\pm$  1.6,  $p < 0.0001$ ). Pre- and post-contrast images showed excellent reproducibility for fibrotic ILA (ICC = 0.96), but only fair reproducibility for non-fibrotic ILA (ICC = 0.74). Measurement variability was wider in nonfibrotic ILA than in fibrotic ILA (95% limits of agreement, nonfibrotic: [-2.3, 3.0] vs. fibrotic: [-0.1, 0.1]).

## CONCLUSION

Contrast enhancement influenced the quantification of ILA with a tendency to overestimate, especially for nonfibrotic ILA.

## CLINICAL RELEVANCE/APPLICATION

Automatic quantitative assessment for ILA on contrast-enhanced CT images may lead to overdiagnosis of ILA; thus care should be taken in the diagnosis of ILA and subsequent visual assessment may be needed.

## M2-SPCH-7 Quantitative CT-based Regional Lung Function and PFT at Baseline Predict One-Year Change of DLCO in Idiopathic Pulmonary Fibrosis

Wonchul Chung (*Presenter*) Nothing to Disclose

### PURPOSE

While carbon monoxide lung diffusing capacity (DLCO) test is an important functional measure for idiopathic pulmonary fibrosis (IPF), it is also difficult for patients to conduct. We aimed to predict future DLCO using regional lung function variables computed from quantitative CT (QCT) and baseline pulmonary function test (PFT) variables, via machine learning.

### METHODS AND MATERIALS

Full inspiratory and full expiratory CTs, demographics, and PFT measurements (spirometry and DLCO) at baseline and DLCO at 1-year follow-up visits were prospectively collected of 45 IPF patients (age=71 $\pm$ 5, M:F=39:6) at 5 institutions in South Korea (under IRB approval and with subject consent, using a common dose-reduced QCT protocol). 113 multiscale lung structural and functional features were derived from QCT analysis, using VIDA Vision (Coralville, IA) and in-house software. QCT, demographics, and PFT features significantly correlated with percent predicted DLCO (DLCO%pred) after one year ( $p < 0.05$ , Pearson's correlation) were then used to predict DLCO%pred after one year using XGBoost machine learning algorithm. Model performance was evaluated by R<sup>2</sup> and mean absolute error (MAE).

### RESULTS

QCT variables had significant correlations with DLCO. Baseline percent predicted DLCO ( $r=0.76$ ;  $p < 0.001$ ), percent predicted forced expiratory volume in the first second (FEV1%pred) ( $r=0.65$ ;  $p < 0.001$ ) and forced vital capacity (FVC%pred) ( $r=0.64$ ;  $p < 0.001$ ), Among QCT variables, regional ventilation index (RRAVC) at whole lobe and Right lower lobe (RLL) ( $r=-0.35$ ,  $-0.13$ ;  $p=0.03$ ,  $0.04$ ), high attenuation area percent (HAA%) at whole lung, left upper lobe (LUL) and left lower lobe (LLL) ( $r=-0.45$ ,  $-0.40$ ,  $-0.39$ ;  $p=0.04$ ,  $0.02$ ,  $0.03$ ) also contributed in predicting future DLCO score. Normalized tracheal wall thickness (WT\*trachea) was also negatively associated with future DLCO ( $r=-0.3$ ;  $p < 0.03$ ). XGBoost model's performance in R-squared (R<sup>2</sup>) and mean absolute error (MAE) were 0.73 and 9.01, implying 73% of the total variation and predictions off by 9.01 units from the actual values. Results suggest association of left lung RRAVC, HAA% and tracheal wall thickening with smaller future DLCO in IPF.

### CONCLUSION

QCT based regional lung structure-function and PFT features can predict DLCO after 1 year via machine learning.

### CLINICAL RELEVANCE/APPLICATION

Predicting DLCO after 1 year via machine learning provide pathophysiological interpretation of regional changes in lung structure and function in IPF.

## M2-SPCH-8 Severe Asthma Patient Treatment Response Evaluation Using Visual and Quantitative Analysis of Chest CT

Miji Lee, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Visual and quantitative analysis on chest CT for bronchiectasis (BE) score and mucus impaction (MI) extent in patients with severe asthma investigate the correlation with the patient's treatment response.

## **METHODS AND MATERIALS**

The 34 asthma patients (mean age; 55.1±12.8 years, male;female=40%;60%) who had undergone initial and 1 year follow up inspiration/expiration CT after treatment. Experienced thoracic radiologists independently determined the change of BE score and MI extent. Using Aview software (Coreline Soft), quantitative air-trapping and airway were analyzed at the initial and 10months follow up CT scan. Clinical parameters considered in patient have FEV1 and FEV1/FVC, sputum and blood eosinophils. For statistical analysis, intraclass correlation coefficient and correlation analysis were used.

## **RESULTS**

In the intraclass correlation coefficient between the two readers, the bronchiectasis(BE) score showed a reliability of 78% and the mucus impaction showed a reliability of 89%. Table 1 shows the greater the BE score and MI extent, the closer the pattern of obstructive lung disease is derived from both readers. MI extent was positive correlated with eosinophils. In the quantitative analysis, FEV1 and FEV1/FVC showed a positive correlation in the normal lung area, but a negative correlation in the case of functional air-trapping with and without emphysema. Quantitatively, when the counted branch segment increases, the PFT result shows a positive correlation, and the Pi10 and wall area measurements show a negative correlation. According to table 2, changes in BE score and MI extent showed a relatively significant correlation with changes in clinical parameters. Only Pi10 showed a negative correlation with PFT, and quantitative normal lung and functional air-trapping changes did not show any correlation.

## **CONCLUSION**

In patient with asthma, changes in MI extent with treatment have clinical significance rather than the severity of BE score itself. Visual changes in MI extent after treatment of asthma on CT and quantitatively decreased Pi10 correlated with changes in PFT and eosinophilia.

## **CLINICAL RELEVANCE/APPLICATION**

Through quantitative analysis of airway and visual analysis of mucoid impaction extent, post-treatment response can be evaluated in patients with severe asthma.

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## Abstract Archives of the RSNA, 2023

M2-SPER

### Emergency Radiology Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPER-1 Classification of Acute Superior Mesenteric Artery Occlusion on CT using a 3D Machine Learning Model**

Robert J. Harris, PhD (*Presenter*) Scientist, Virtual Radiologic Corporation

#### **PURPOSE**

Acute superior mesenteric artery (SMA) occlusion is a life-threatening condition that requires immediate diagnosis and treatment. Although our group has previously developed a machine learning 2D model to identify SMA occlusion by analyzing each CT slice individually, it is sometimes not possible to identify an occlusion on a single CT slice. We hypothesized that we could train a machine learning 3D model to identify SMA occlusion on CT with full volumetric context.

#### **METHODS AND MATERIALS**

Natural language processing (NLP) of radiology CT reports was used retrospectively to identify studies containing SMA occlusion. An axial image series from each of these studies was annotated by a Board Certified radiologist by segmenting the region of occlusion using an in-house brush tool. These segmentations were converted into 3D bounding boxes; 615 annotated volumes were used as positives, and 618 CT volumes with no SMA occlusion were used as negatives in the training dataset. A RetinaNet 3D model using the Medical Open Network for AI (MONAI) framework was implemented for training. The model was applied to a test dataset consisting of 20 negative studies and 59 studies positive for SMA occlusion. The positive studies were cases where the pathology had been missed by the initial reading radiologist (quality assurance cases). Prior to running the RetinaNet 3D model, a separate CT anatomy classification model was run on each series and only slices with abdominal anatomy were kept, to reduce the total image volume inferred by the RetinaNet 3D model. The highest probability from bounding boxes generated by the RetinaNet 3D model was taken as the overall model result for a study.

#### **RESULTS**

The highest validation accuracy during training was 0.678, at which point the final model was saved. The model achieved an AUC of 0.837 on the test dataset. At a threshold of 0.88, sensitivity was 63.6% with a specificity of 100%, suggesting that over half of missed SMA occlusion cases at our practice would have been caught had this model been in place.

#### **CONCLUSION**

An artificial intelligence model was trained to identify SMA occlusion on CT imaging. To our knowledge, this is the first use of a machine learning 3D model to identify SMA occlusion on CT images. This model is currently undergoing iterative retraining with false positives and false negatives from prospective data and will be continually updated in preparation for live clinical deployment.

#### **CLINICAL RELEVANCE/APPLICATION**

SMA occlusions on CT must be timely diagnosed to improve patient outcome and are sometimes missed by radiologists. A 3D model to identify these cases for both worklist prioritization and quality assurance would be highly relevant to improving patient care.

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## Abstract Archives of the RSNA, 2023

M2-SPGI

### Gastrointestinal Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPGI-1 A Preliminary Study on the Value of Multi-frequency MR Elastography in Auxiliary Evaluating the Efficacy of Neoadjuvant Chemoradiotherapy for Locally Advanced Rectal Cancer**

Xiao Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the value of multi-frequency magnetic resonance elastography (m-MRE) in auxiliary evaluating the efficacy of neoadjuvant chemoradiotherapy (nCRT) for patients with locally advanced rectal cancer (LACR).

#### **METHODS AND MATERIALS**

From Nov. 2021 to Dec. 2022, 81 patients with rectal cancer were prospectively recruited and after screening by exclusion criteria, 64 patients who underwent radical resection after nCRT were finally enrolled. All patients underwent MRI and rectal elastography examination within 1 week before surgery. Maps of shear-wave speed  $c$  ( $c$ -map) and phase angle of the shear modulus  $f$  ( $f$ -map) were generated and then measured  $c$  and  $f$  values for tumor or rectum wall. According to the collected pathologic ypTN stages and tumor regression grades (TRG), patients were divided into Group1: ypT0-1 (Good response, GR) and ypT2-4 (Poor response, PR) groups, Group2: ypN0 and ypN1-2 groups and Group3: pCR (TRG0) and Non-pCR (TRG1-3) groups. To analyze whether the differences of m-MRE parameters ( $c$ ,  $f$ ,  $c+f$ ) among different groups were statistically significant, and drew ROC curve to analyze the diagnostic efficiency. Compared with T2WI+DWI, to explore whether m-MRE ( $c+f$ ) can show better diagnostic efficacy in distinguishing different groups and to further analyze whether the combination of T2WI+DWI and m-MRE ( $c+f$ ) can achieve higher diagnostic efficacy. To explore whether the combination of T2WI+DWI and m-MRE ( $c+f$ ) could improve the diagnostic accuracy and consistency than that of T2WI+DWI, with pathological results as gold standard.

#### **RESULTS**

Significant differences of  $c$  and  $f$  values were observed in Group 1 and Group 3 ( $P < 0.05$ ), but not in Group 2. m-MRE ( $c$ ,  $f$  and  $c+f$ ) showed good diagnostic efficacy both in Group 1 with AUC values 0.810, 0.736 and 0.853, and Group 3 with AUC values 0.810, 0.736 and 0.853 (all  $P < 0.05$ ). m-MRE ( $c+f$ ) had significantly higher AUC values ( $P < 0.05$ ) than T2WI+DWI in Group 1 and Group 3. Furthermore, the combination of T2WI+DWI and m-MRE ( $c+f$ ) can get higher AUC values ( $P < 0.05$ ) than T2WI+DWI in Group 1 and Group 3 as well. Besides, it could also improve the diagnostic accuracy and consistency than that of T2WI+DWI, with pathological results as gold standard.

#### **CONCLUSION**

m-MRE has a potential auxiliary value in evaluating the efficacy of nCRT for LARC patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Reliable preoperative methods to accurately evaluate tumor regression and identify patients with pCR are significant to LARC patients, which can promote making personalized clinical treatment plans.

#### **M2-SPGI-2 Predicting the Risk of Postoperative Distant Metastasis in Patients with Locally Advanced Rectal Cancer: Using MRI-based Delta-imaging Methods**

Yu Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To predict the risk of postoperative distant metastases in patients with locally advanced rectal cancer by using delta-imaging features extracted from MRI before and after nCRT.



## METHODS AND MATERIALS

A total of 213 patients with locally advanced rectal cancer were retrospectively enrolled in Yunnan Cancer Hospital from January 2016 to June 2019. All patients underwent surgical treatment after nCRT and underwent MRI examination before and after nCRT. All patients were followed up for at least 3 years after surgery, except those with postoperative endpoint events. They were randomly divided into training group and verification group (training group n=149, verification group n=64) in a ratio of 7:3, which were used for feature selection and verification respectively. Tumor lesions were delineated layer by layer on T2-weighted imaging (T2-weighted imaging) before and after nCRT, and 3D-slicer software was used for feature extraction. Delta-image omics features are defined as the difference in image omics features before and after nCRT. Using The least absolute shrinkage and selection operator algorithm (LASSO) for feature reduction and extraction, three delta-image omics models were constructed. It includes the Delta-Imagomics model and the combined Delta-imagomics model based on the absolute and relative variation of imagomics features before and after nCRT. Receiver operating characteristic curve (ROC) was used to evaluate the predictive value of the model for DM.

## RESULTS

A total of 213 patients with LARC were included in this study (42% female and 58% male), with an average age of  $58.50 \pm 12.37$  years and a median follow-up time of 39.8 months. A total of 36 patients (16.9%) developed DM after surgery. 1382 features were extracted from each lesion before and after nCRT. After feature reduction and screening, 7 key features were included in the delta-imaging model based on absolute and relative changes of imaging features before and after nCRT in the training set. In the training set, the area under ROC curve of the absolute and relative variation Delta-Imaging model and the combined Delta-imaging model were 0.77, 0.74 and 0.82, respectively, and the AUC of the corresponding test set were 0.73, 0.70 and 0.84, respectively.

## CONCLUSION

The combined prediction model based on delta-imaging features of MRI is helpful to predict the risk of distant metastasis after local advanced rectal cancer surgery, and is better than the pure delta-imaging model of absolute and relative changes.

## CLINICAL RELEVANCE/APPLICATION

To predict the risk of postoperative distant metastases in patients with locally advanced rectal cancer .

## M2-SPGI-3 Machine Learning-based Response Assessment in Patients with Rectal Cancer After Neoadjuvant CCRT: Radiomics Analysis for the Assessment of Tumor Regression Grade Using T2-weighted MR Exam

Yongdae Lee, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We investigated the machine learning model-based radiomics analysis for the assessment of tumor regression grade using T2-weighted MR images in patients with rectal cancer after neoadjuvant chemotherapy-radiation therapy (CRT).

## METHODS AND MATERIALS

A total of 100 patients with rectal cancer who underwent magnetic resonance (MR) imaging at baseline and after CRT between January 2010 to May 2021 were included. The median age was 64 (31-89) and male was 66% (66/100). All MR scans were acquired with two different 3T scanners (Achieva 3.0T MR system, Philips Healthcare; MAGNETOM Vida, Siemens Healthineers) and included the oblique axial T2-weighted images acquired perpendicular to the long axis of the tumor. Region of interest (ROI) for each cancer lesion was drawn and extracted by a radiologist and 116 radiomics-feature was analyzed using MEDIP software (MEDICAL IP, Seoul, Republic of Korea, medicalip.com/Medip). Treatment responses were evaluated by the radiologist using MR tumor regression grade (mrTRG). Responses were classified into two groups ('good' versus 'poor'); mrTRG 1, 2, and 3 were categorized as 'good', and mrTRG 4 and 5 were categorized as 'poor'. We implemented the 3-principle component analysis (PCA)-ensemble model to predict the response group. Model performance was evaluated by calculating the area under a receiver operating curve (AUROC) for each feature-set, and selected combination of the feature sets.

## RESULTS

Texture-feature based sets and selected combinations were compared with qualitative mrTRG assessment to identify the significant feature sets in predicting the treatment responses. With the volume feature set (3D), the mean volume change was calculated, and overall 38.55% of volume has decreased. In comparison between the two groups, good response group showed lower baseline tumor volume and larger volume loss at post-CRT MR (50.32%) while poor response group showed larger baseline tumor volume and lesser volume loss at post-CRT MR(29.54%). Of all texture-feature sets and selected combinations of the feature sets, volume feature set (3D) combined with histogram-based contrast feature set (1st order) achieved the largest AUC of 0.79 for differentiating good and poor response.

## CONCLUSION

Machine learning based radiomics analysis using T2-weighted MR imaging demonstrated feasible diagnostic ability for the response assessment in patients with post CRT rectal cancer. This radiomics analysis enables quantification of tumor volume



and texture change.

#### **CLINICAL RELEVANCE/APPLICATION**

Machine learning based radiomics analysis represents quantitative assessment of treatment response in post-CRT rectal cancer, and can be a useful assistant for treatment response assessment.

### **M2-SPGI-5 Personalized Weight-Based Dosing of Iodinated Contrast Material: Dose Savings and Effect on Image Quality in Abdominal Computed Tomography (CT)**

Christina Shehata, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Fixed dosing of iodinated contrast material (CM) (i.e., using the same amount of contrast for all patients or based on weight buckets) is a standard practice among many institutions for abdominal CT. This study aims to investigate effects of personalized weight-based dosing (1.14 mL/kg) of CM on saving of contrast and on image quality of abdominal CT.

#### **METHODS AND MATERIALS**

376 patients who underwent abdominal CT at a large urban academic medical center were included in this study. Each patient had at least two CT of abdomen performed within a one-year interval, with one study using a fixed dose of iodine contrast and the other implementing weight-based dosing. Studies were matched by imaging protocol, peak kilovoltage (kVp), and phase of enhancement. The amount of administered contrast for each study was collected. Attenuation of various organs and structures including portal vein, aorta, inferior vena cava, hepatic veins, liver, and spleen was measured. In addition, noise, contrast-to-noise ratio, and subjective image quality were calculated. Values were compared using paired and unpaired t-test. Sub-analysis based on patients' BMI was also performed.

#### **RESULTS**

In the fixed-dose protocol, the mean iodine dose was 35 g, compared to 26.2 g and 32.6 g in the weight-based protocol in patients with normal/low weight (BMI = 25) and those with high weight (BMI > 25), respectively. The weight-based protocol also resulted in an average cost reduction of 16.3% with average savings of \$72.58. There were no differences in noise between the two protocols. In patients with high weight, except for the aorta, there were no significant differences in enhancement at the selected ROI between the two contrast protocols. Patients with a normal or low weight with weight-based contrast dosing had lower enhancement ( $p < 0.001$ ), with mean difference in degree of enhancement ranging 7.4-28.1 HU depending on the organ/structure, compared to the studies with a fixed dosing.

#### **CONCLUSION**

The results of this study demonstrate that a personalized weight-based CM dosing strategy can result in significant saving of contrast. The saving is more pronounced in patients with lower BMI. In patients with higher BMI, the enhancement of abdominal organs was non-inferior to fixed-dosing CTs. Despite the lower degree of enhancement of structure in low-BMI group, as expected with the lower amount of administered iodine, the difference in degree of enhancement was small with no significant effect on subjective perceived image quality.

#### **CLINICAL RELEVANCE/APPLICATION**

These data support that a weight-based contrast protocol can maintain image quality (especially in larger patients) while improving patient safety and reducing healthcare costs.

### **M2-SPGI-7 Effect of the Body Water and the Body Composition, Calculated by Bioelectrical Impedance Analysis on Contrast-enhanced Dynamic Computed Tomography Images of the Liver**

Takanori Masuda, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To improve its diagnosis on contrast-enhanced dynamic CT (CE-DCT) scans, contrast injection protocol must yield stable arterial contrast enhancement. To investigate how the body-water distribution and the body composition, calculated by bioelectrical impedance analysis (BIA), affect aortic and hepatic enhancement on CE-DCT scans.

#### **METHODS AND MATERIALS**

This retrospective study was approved by our institutional review board; informed patient consent was waived. Between January 2019 and May 2020, 236 patients with liver cirrhosis underwent CE-DCT before BIA. The CT number (in Hounsfield units, HU) of the abdominal aorta at the celiac artery level on unenhanced scans and during the hepatic arterial phase (HAP) scans was recorded. And, the mean CT number of the hepatic parenchyma of both hepatic lobes at the celiac artery level on unenhanced and portal venous phase (PVP) scans was recorded. We calculated changes in the iodine dose per contrast enhancement (mgI/HU) (IDCE) to evaluate the effect of the patient age and of various constituents of the body composition by performing BIA.

## RESULTS

The IDCE of the abdominal aorta during HAP was  $121.5 \pm 32.1$  mgI/HU; it was  $698.7 \pm 211.1$  mgI/HU in the hepatic parenchyma during the PVP. Among the parameters used in our BIA, the total body weight (TBW) was the most important factor affecting the IDCE of the liver abdominal aorta on CE-DCT scans acquired during the HAP ( $r = 0.83$ ). The TBW and the skeletal muscle index most strongly affected the IDCE of the hepatic parenchyma on CE-DCT scans obtained during the PVP ( $r = 0.69$ ).

## CONCLUSION

The TBW had the strongest effect on contrast enhancement. The skeletal muscle index exhibited the strongest correlation with hepatic parenchymal contrast enhancement during the PVP.

## CLINICAL RELEVANCE/APPLICATION

We found that many body parameters included in BIA affect IDCE on CE-DCT images. Most exhibited a more than moderate correlation with IDCE of vessels and the hepatic parenchyma. It may be a useful index for machine learning to obtain a stable contrast enhancement on CE-DCT.

## M2-SPGI-8 Effect of the CT Values for Abdominal Aorta and Liver Parenchyma During Contrast Enhancement Dynamic CT with or without the Splenomegaly

Hiroyuki Ikenaga, BS (*Presenter*) Nothing to Disclose

## PURPOSE

To compare CT (computed tomography) values for abdominal aorta and liver parenchyma during dynamic contrast-enhanced (CE) CT in cirrhotic patients with and without splenomegaly.

## METHODS AND MATERIALS

We considered 258 patients (83 males and 46 females for the splenomegaly group, and 83 males and 46 females for the control group) for this study. We measured CT values in the abdominal aorta and hepatic parenchyma during the hepatic arterial (HAP) and portal venous (PVP) phases. The aortic CE at HAP and the hepatic parenchymal CE at PVP were compared between the two groups. For depiction ability, we also calculated the optimal CE rates ( $>280$  HU in the abdominal aorta and  $>50$  HU in the hepatic parenchyma) for each group.

## RESULTS

The median and range of the CE for all patients with abdominal aorta and liver parenchyma were 273.0 HU (110.9-477.3 HU) and 54.0 HU (19.9-78.6 HU), respectively, in the Splenomegaly (SM) group and 298.9 HU (158.6-494.0 HU) and 54.0 HU (16.5-78.5 HU), respectively, in the non-SM group. In the SM group, the CE for abdominal aorta decreased during the aortic phase for a dynamic CE CT ( $p < 0.05$ ). For the depiction ability, there were significant differences in the rates of optimal CE between both the groups ( $p < 0.05$ ).

## CONCLUSION

The diagnostic ability and CE for abdominal aorta during the aortic phase exhibited a significant decrease during dynamic CE CT in SM patients.

## CLINICAL RELEVANCE/APPLICATION

It is necessary to change the injection rates and contrast materials volume during CE CT depending on the presence or absence of SM.

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## Abstract Archives of the RSNA, 2023

M2-SPGU

### Genitourinary Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPGU-1 Fidelity of Iodine and HU Values in a Renal Phantom using a Novel edge-on-irradiated Si-based Photon-Counting Detector CT**

Fides R. Schwartz, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the accuracy of a new edge-on-irradiate silicon-based photon-counting detector CT (Deep Si-PCCT) prototype for quantification of iodine concentration and stability of HU values in moderately and strongly enhancing kidney parenchyma.

##### **METHODS AND MATERIALS**

A phantom that simulates moderately and strongly enhancing kidney parenchyma (at 180 and 240 HU) inside a small patient (23 cm diameter) was scanned using a novel, Deep Si-PCCT prototype. The simulated kidney parenchyma contains an internal dense water-equivalent rod at 60 HU and a rod of 2.2 mg/mL iodine concentration to simulate a proteinaceous, non-enhancing and a mildly enhancing cystic renal lesion. The rods were positioned in the kidney parenchyma in two separate setups, so each rod was imaged within both levels of kidney enhancement. The accuracy and stability of the iodine quantification and HU values were evaluated with repeated ROI measurements of the same size across consecutive slices along the length of the simulated kidney parenchyma and the internal rods. Images were reconstructed with prototype soft tissue kernel at 2.5mm slice thickness without additional denoising.

##### **RESULTS**

The Deep Si-PCCT accurately quantified the iodine concentration in the small rod at  $2.1 \pm 0.02$  and  $2.1 \pm 0.04$  mg/mL (Setup 1 and 2, respectively), and the quantification was stable across the length of the internal rod, with both setups. The water equivalent rod was also quantified correctly, showing iodine concentrations within the standard deviation and HU values of  $58 \pm 0.5$  HU and  $60 \pm 0.9$ . The HU values of moderately and strongly enhancing renal parenchyma were stable across the length of the rod and correlated with the know ground-truth values. The figure also shows images of the first patient with cystic renal lesions scanned on the new Deep Si-PCCT at 120 kVp with 400 mAs and 1 second rotation (axial scan), reconstructed with a standard soft tissue kernel.

##### **CONCLUSION**

The Deep Si-based PCCT is a promising tool for accurate and stable quantification of iodine concentration and measurement of HU values in cystic lesions within moderately and strongly enhancing kidney parenchyma. It has the potential to improve the diagnosis and management of cystic renal lesions.

##### **CLINICAL RELEVANCE/APPLICATION**

The novel Deep Si-based photon-counting detector CT provides, accurate iodine quantification and HU values in kidney parenchyma and cystic lesions, which is crucial for the classification and management of cystic renal lesions.

#### **M2-SPGU-2 Renal Cyst Pseudoenhancement: Impact of Virtual Monochromatic and Ultra-high-resolution Imaging with Photon-counting Detector CT**

Atsushi Nakamoto, MD, PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To investigate whether virtual monochromatic and ultra-high-resolution imaging with photon-counting detector CT (PCD-CD) can overcome renal cyst pseudoenhancement.

## **METHODS AND MATERIALS**

This retrospective study included 104 renal cysts in 31 patients (20 men and 11 women, age range, 42 to 91 years; mean age, 71.6 years) who underwent abdominal dynamic contrast-enhanced CT with PCD-CT. Cysts less than 3 mm in diameter and greater than 20 mm in diameter were excluded. Unenhanced and portal venous phase images were reconstructed with 512 and 1024 matrices with slice thicknesses of 0.2, 0.4, 1, and 2 mm, respectively. The 0.2-mm-thick images were reconstructed using polychromatic imaging (T3D) because virtual monochromatic imaging is not applicable to the 0.2-mm-thick images. For the other slice thicknesses, 70 keV virtual monochromatic images were reconstructed. In addition, 512-matrix, 1-mm-thick virtual monochromatic images were reconstructed at 50, 60, 80, and 90 keV. CT values were measured by placing regions of interest on the renal cysts and the attenuation increase from unenhanced to portal venous phase was calculated. The attenuation increases in each image were compared and the frequency of pseudoenhancement (an increase of 10 HU or more) was evaluated.

## **RESULTS**

There was no significant difference in attenuation increase between the 512 and 1024 matrix images at any slice thickness ( $P > .05$ ). The attenuation increases were significantly higher for the 0.2-mm-thick T3D images and the 2-mm-thick 70 keV images compared to the 0.4-mm and 1-mm-thick 70 keV images ( $P < .001$ ). The attenuation increase was lower at higher keVs, with significant differences among all keVs ( $P < .001$ ). The frequency of pseudoenhancement was lowest for 90 keV images (13/104, 12.5%), followed by 80 keV images and 0.4-mm-thick 70 keV images (18/104, 17.3%). When only cysts with 10 mm or larger in diameter were included, virtual monochromatic images at 70 keV or higher showed no pseudoenhancement.

## **CONCLUSION**

Virtual monochromatic images with PCD-CT can overcome renal cyst enhancement. Thinner slice thicknesses were useful in reducing pseudoenhancement, although 0.2-mm-thick images had a higher frequency of pseudoenhancement due to their polychromatic nature.

## **CLINICAL RELEVANCE/APPLICATION**

Virtual monochromatic imaging at 70 keV or higher using photon-counting detector CT shows no pseudoenhancement in renal cysts of 10 mm or larger in diameter and is expected to improve the diagnostic performance of renal masses.

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## Abstract Archives of the RSNA, 2023

M2-SPHN

### Head & Neck Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPHN-1 The Prevalence of Malleus-tympanum Synostosis on Ultra-high-resolution CT: A Preliminary Study**

Ning Xu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the prevalence of malleus-tympanum synostosis (MTS) in different individuals via 0.1 mm ultra -high-resolution CT (U-HRCT).

#### **METHODS AND MATERIALS**

This retrospective study evaluated U-HRCT scans with 0.1 mm thickness of 1587 ears from 1122 subjects from October 2020 to March 2022. MTS presented as a bony connection between the malleus and tympanic wall. MTS was detected in subjects with normal ears, subjects with different types of hearing loss (HL), and subjects with various causes of conductive HL. The prevalence of MTS was calculated and statistically compared between subjects with normal ears and with different types of HL, as well as between subjects with various causes of conductive HL. The correlation between MTS and age or gender was calculated using the Mann-Whitney U test.

#### **RESULTS**

The prevalence of MTS was 2.8% (16/577), 3.4% (12/352), 7.2% (27/374), and 13.7% (39/284) in subjects with normal, mixed HL, sensorineural HL, and conductive HL ears, respectively. MTS was more common in subjects with HL than in subjects with normal ears ( $p < 0.001$ ), and significant differences were shown between mixed and sensorineural HL groups ( $p_{m-s} = 0.023$ ), between mixed and conductive HL groups ( $p_{m-c} < 0.001$ ), and between sensorineural and conductive HL groups ( $p_{s-c} = 0.006$ ). The prevalence of MTS was 83.9% (52/62), 34.8% (23/66), 12.6% (61/483), 7.5% (8/107), and 6.9% (7/102) in subjects with conductive HL with tympanosclerosis, definite middle ear malformations, otitis media, otosclerosis, and middle ear cholesteatoma, respectively. Besides, MTS was found in 18.8% (6/32) of subjects with unexplained conductive HL, 3 of whom were confirmed as having malleus fixation by surgery. No correlation was shown between MTS and age ( $p = 0.41$ ) or gender ( $p = 0.70$ ) in subjects with normal ears.

#### **CONCLUSION**

MTS is a new sign that can be clearly visualized on an ultra-high-resolution CT with 0.1 mm thickness. The prevalence of MTS was 2.8% and 7.7% in subjects with normal ears and with HL, respectively. It may be asymptomatic, or may be associated with conductive HL.

#### **CLINICAL RELEVANCE/APPLICATION**

Malleus-tympanum synostosis (MTS) is a new sign that can be clearly visualized on an ultra-high-resolution CT with 0.1 mm thickness. It is not uncommon and may be asymptomatic or may be associated with conductive HL by resulting in malleus fixation. Moreover, MTS may be the cause of some "idiopathic" conductive HL. Otolologists can use their understanding of MTS to develop new treatment strategies and improve hearing outcomes.

#### **M2-SPHN-2 Comparative Study of the Sensitivity of Ultra-high-resolution CT and High-resolution CT in the Diagnosis of Isolated Fenestral Otosclerosis**

Ning Xu, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the sensitivity of ultra-high-resolution computed tomography (U-HRCT) and high-resolution computed tomography (HRCT) in the diagnosis of isolated fenestral otosclerosis (IFO).

## **METHODS AND MATERIALS**

Eighty-five patients (85 ears) with both clinical and intraoperative diagnosis of IFO were prospectively included between October 2020 and November 2022. Only U-HRCT (0.1mm thickness) was performed for 20 ears, only HRCT (0.67mm thickness) was performed for 45 ears, and both U-HRCT and HRCT were performed for 20 ears. General radiologists and neuroradiologists who were blinded to the clinical and surgical conditions evaluated the images. The sensitivity of U-HRCT and HRCT to detect IFO by the two groups of radiologists were compared.

## **RESULTS**

The diagnostic sensitivity of U-HRCT was 100% (40/40 ears) for neuroradiologists and 87.5% (35/40 ears) for general radiologists, which was significantly higher than that of HRCT (89.2% [58/65 ears] for neuroradiologists; 41.5% [27/65 ears] for general radiologists) ( $P=0.042$  and  $P=0.000$ , respectively). When evaluated with HRCT, the sensitivity of general radiologists was significantly lower compared to neuroradiologists ( $P=0.000$ ), while no difference was shown when general radiologists switched to U-HRCT ( $P=0.152$ ). Among the 20 ears that underwent both examinations, 5 ears with <1 mm lesion involving the fissula ante fenestram were shown on U-HRCT, while the sensitivity of HRCT was 40% (2/5 ears) for neuroradiologists, which was significantly lower than that for neuroradiologists to diagnose lesions >1 mm (93.3%, 14/15 ears,  $P=0.032$ ).

## **CONCLUSION**

U-HRCT is more sensitive than HRCT in the diagnosis of IFO, and has a significant advantage in the detection of < 1mm lesions.

## **CLINICAL RELEVANCE/APPLICATION**

U-HRCT has a high spatial resolution scale, which can significantly improve the delineation of IFO lesions and improve the ability of general radiologists to detect this disease. It has the potential to be used for screening of patients with suspected otosclerosis.

## **M2-SPHN-3 Feasibility of the mDIXON Method for Estimation the Parotid Gland Fat Fraction in Sjögren's Syndrome**

Changwei Ding (*Presenter*) Nothing to Disclose

## **PURPOSE**

SS characterized by irreversible varying degrees of fat deposition, the objective of this study is to explore the feasibility of estimating fat fraction (FF) in parotid glands with Sjogren's syndrome using the mDIXON method.

## **METHODS AND MATERIALS**

Conventional MRI and mDIXON-Quant were performed on 62 parotid glands (case group) in 31 SS patients and 62 parotid glands (control group) in 31 healthy volunteers with age and mean body mass index matching. The FF values of the two groups were compared, and the changes of FF values with different degrees of fat deposition were analyzed.

## **RESULTS**

The FF value of parotid gland in the case group was significantly higher than that in the control group ( $35.7 \pm 15.7$ ,  $28.3 \pm 16.1$ , respectively,  $P=0.008$ ). The FF value in the case group increased gradually from no significant fat deposition in the early stage ( $32.1 \pm 4.8$ ) to significant fat substitution ( $73.0 \pm 4.9$ ).

## **CONCLUSION**

The FF values obtained by the mDIXON method are a new method that can quantitatively assess the extent of SS parotid gland lesions.

## **CLINICAL RELEVANCE/APPLICATION**

mDIXON provides a simple and easy clinical method for quantitative assessment of the extent of SS parotid gland lesions.

## **M2-SPHN-5 Characterization of Intratumoral Heterogeneity by using Diffusion-relaxation Correlation Spectrum Imaging (DR-CSI) in HNSCC**

Yingwei Wu, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To determine the feasibility of diffusion-relaxation correlation spectrum imaging (DR-CSI) in the characterization of microstructural tissue compartments in HNSCC.

## METHODS AND MATERIALS

Patients suspected with HNSCC who underwent 3-T MRI and surgical resection were prospectively studied. DR-CSI was applied and imaged for primary HNSCC and metastatic lymph nodes in vivo and were co-registered pathological slides. The DR-CSI spectral signal components volume ( $V_A$ ,  $V_B$ ,  $V_C$ ) was identified in accordance with the pathological findings and compared between benign and malignant primary tumors or lymph nodes. A linear model assessed the correlations between ( $V_A$ ,  $V_B$ ,  $V_C$ ) and each component observed in pathological findings. Strength of correlations was evaluated by using Spearman correlation coefficients.

## RESULTS

Totally 32 subjects (mean age, 45 years  $\pm$  5.6) were evaluated in this study; Basically, three pathological components including epithelial, stroma and vascular areas were accordantly matched with DR-CSI spectral signal components (spectral peaks). Different DR-CSI pattern was observed between HNSCC and benign lesions or metastatic and benign lymph nodes. HNSCC exhibited increased  $V_A$  (HNSCC vs benign,  $0.41 \pm 0.06$  vs  $0.29 \pm 0.06$ ;  $P < 0.01$ ), decreased  $V_C$  ( $0.13 \pm 0.08$  vs  $0.27 \pm 0.09$ ,  $P < 0.01$ ). High malignancy suggested higher  $V_A$  (low- vs high malignancy  $0.36 \pm 0.11$  vs  $0.57 \pm 0.13$ ;  $P < 0.05$ ). In addition, metastatic lymph nodes presented decreased  $V_C$  (metastatic vs benign,  $0.14 \pm 0.08$  vs  $0.19 \pm 0.18$ ;  $P = 0.04$ ).and increased  $V_B$  (metastatic vs benign,  $0.21 \pm 0.08$  vs  $0.14 \pm 0.18$ ;  $P = 0.051$ ).

## CONCLUSION

Diffusion-relaxation correlation spectrum imaging is feasible to determine the intra-tumoral heterogeneity of HNSCC. The signal components correlate with pathological compartments. Quantitative  $V_A$ ,  $V_B$  and  $V_C$  can be applied to determine malignancy and cervical metastasis.

## CLINICAL RELEVANCE/APPLICATION

Microstructural MRI has the potential to improve diagnosis and characterization intra-tumoral heterogeneity. DR-CSI has been approved to quantitatively determine various components within the tumor, which is a promising approach for identify intra-tumoral heterogeneity.

## M2-SPHN-7 Improving Metal Artifact Reduction Methods in Dual-Energy CT for Head and Neck CT Examinations: A Clinical Assessment

Liu Xing (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the effectiveness of iterative metal artifact reduction (iMAR) technique in reducing dental metallic artifacts during head and neck CT examinations.

## METHODS AND MATERIALS

Thirty patients with dental prosthesis implants were prospectively collected. Siemens single-source dual-energy CT(SOMATOM Definition Edge CT) was used for examination and the original data were reconstructed respectively in iMAR group (Group A) and conventional iterative reconstruction group (Group B). The CT and SD values of the high density artifacts, low density artifacts, the surrounding soft tissue areas and the same layer of contralateral artifact-free affected areas in the two groups of images were measured respectively. The difference between the two groups was compared by paired t-test. Two senior radiologists used the 5-component table(1~5 points, non-assessable ~ excellent) method to score the metal artifacts removal ability of the two groups. Mann-Whitney U test was used to compare the subjective scores and the consistency of the scores was analyzed by Kappa test.

## RESULTS

There was no significant difference in CT values at the opposite side of the same layer without artifacts ( $P > 0.05$ ). The CT values in Group A were significantly reduced in the high density artifact area ( $p < 0.05$ ), while significantly increased in the low density artifact area ( $p < 0.05$ ), and were closer to the CT values in the corresponding anatomical areas at the opposite side of the same layer. In terms of image noise, the SD values in each measurement area of Group A's images were lower than those of Group B and were significantly lower in high density areas and low density areas ( $p < 0.05$ ). In terms of subjective score, the results of the two groups of image evaluation were excellent and consistent (Kappa=0.945,  $p < 0.05$ ). The subjective score of Group A was significantly higher than that of the control group, and the subjective score was increased by 2.1 (Group A:  $4.23 \pm 0.32$ , Group B:  $2.11 \pm 0.51$ ;  $P < 0.05$ ).

## CONCLUSION

The iMAR technique can significantly reduce metal artifacts around dental implants, correct CT values of surrounding tissues, help to accurately observe tissue structures around implants, improve image quality, and has great clinical application value.

## CLINICAL RELEVANCE/APPLICATION

Compared with conventional iterative reconstruction, it is preferable to use the iMAR technique in head and neck CT examinations as it allows better image quality and helps to accurately observe tissue structures around implants.  
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## Abstract Archives of the RSNA, 2023

M2-SPIN

### Imaging Informatics Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### M2-SPIN-1 Image Perturbation Analysis to Study the Effect of Motion on CT Radiomic Metrics

Hesam Setayesh (*Presenter*) Nothing to Disclose

##### PURPOSE

To investigate the robustness of radiomic metrics in simulated clinically observed ranges of organ motion using an anthropomorphic liver CT phantom with 3D-printed texture inserts.

##### METHODS AND MATERIALS

18 Volumetric CT images of the anthropomorphic liver radiomics phantom with 7 texture inserts were obtained under different imaging conditions varying slice thickness (0.625mm, 1.25mm and 2.5mm), dose (13,86 mGy standard, 40 % dose reduction, and 60 % dose reduction), tube voltage (100 kVp and 120 kVp) and reconstruction algorithms (deep learning image reconstruction algorithm and a hybrid iterative reconstruction algorithm ASiR-V50% one at a time). A circular region of interest (ROI) was manually contoured within a centrally placed texture insert of the phantom. 91 radiomic metrics belonging to 6 different texture families were extracted from the ROI using opensource Pyradiomics software. Subsequently, the same 91 radiomics metrics were extracted using the same ROI co-registered on motion perturbed versions of the original CT images. Specifically, 6 motion conditions: rotation by 5 degrees, rotation by 15 degrees, translation by 2 pixels to the right, translation by 3 pixels to the right, rotation 15 degrees plus translation 2 pixels, and rotation 15 degrees plus translation by 3 pixels were considered. Intraclass correlation (ICC) 2-way-mixed with absolute agreement was used to evaluate radiomics robustness under different imaging and motion conditions.

##### RESULTS

In all imaging conditions, translation by 2 or 3 pixels led to the highest number of radiomic metrics with ICC > 0.8 (indicating high robustness). As opposed to translations, rotation of 15 degrees compared to rotation by 5 degrees showed a significant reduction in robust radiomic metrics, under all imaging conditions ( $p < 0.0001$ ). Rotation followed by translation showed an increase in the number of robust metrics compared to rotation alone, possibly due to the overlap between the modified and the original ROI owing to small movements. Also, despite changes in imaging conditions, the trends in robustness were comparable across the different motion conditions.

##### CONCLUSION

Translation motion amplitudes  $\leq 3$  times the spatial resolution of the image retained the robustness of radiomic metrics on the CT images of anthropomorphic liver phantom. Different radiomic families showed different associations to the simulated motions. However, across different imaging conditions, the trends in robustness were comparable across the different motion conditions.

##### CLINICAL RELEVANCE/APPLICATION

In a clinical situation, understanding the effect of motion and suppressing its effects may support the development of a robust quantitative approach such as radiomics.

#### M2-SPIN-2 Deep Learning is a Promising Tool for Fully Automatic Malignant Lesions Identification and Segmentation in Whole-body [<sup>68</sup>Ga]Ga-PSMA PET/CT Scans

Joana Castanheira, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This work aims to assess the feasibility and robustness of deep learning-based fully automatic malignant lesion detection and segmentation on whole-body [68Ga]Ga-PSMA PET/CT scans.

## METHODS AND MATERIALS

A dataset of 122 whole-body [68Ga]Ga-PSMA-11 PET/CT scans from patients with prostate cancer was used as the training set. These scans were acquired on a Philips Gemini TF16 PET/CT scanner. Two nuclear medicine physicians labeled all lesions suspected of malignancy. Then, a self-adaptive Bayesian classifier was used for semiautomatic lesion segmentation [1]. All segmentations were reviewed and manually rectified if necessary. This set (scans and segmentations) was used to train a fully automatic lesion detection and segmentation 3D U-Net, using the nnU-Net framework [2]. The CT scans were used as a second channel to feed the network. For testing, an independent set containing 39 whole-body [68Ga]Ga-PSMA-11 PET/CT scans from prostate cancer patients was randomly selected from our archives. All these scans were performed on a Philips Vereos Digital PET/CT scanner. The gold standard malignant lesions identification and segmentation of the test set were generated as indicated for the training set. The Dice similarity coefficient was used to measure the voxelwise agreement/overlap between the gold standard segmentations and the ones obtained with the trained network.

## RESULTS

From the 39 test scans included, 32 scans were identified by the physicians as having malignant lesions, and 7 without. The trained network correctly identified all 32 scans with malignant lesions (sensitivity of 100%). From the 7 scans without malignant lesions, the trained network correctly identified 6 (specificity of 86%). Regarding the quality of the segmentation on the 32 scans, the median Dice coefficient was 0.73 (interquartile range [IQR] 0.53-0.82), the sensitivity was 72% (IQR 0.41-0.86), and the predictive positive value was 90% (IQR 0.72-0.99).

## CONCLUSION

The solution herein described and implemented using deep learning achieved very good results, despite the additional difficulty of segmenting scans acquired on a scanner significantly different from the one used to obtain the train scans. Therefore, fully automatic lesion detection and segmentation on [68Ga]Ga-PSMA-11 PET/CT scans using deep learning may be used to help routine clinical work, especially during disease staging and to assess response to therapy. References [1] Constantino et al. J Digit Imaging 2023; [2] Isensee et al. Nature Methods 2021.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-based fully automatic malignant lesions detection and segmentation on [68Ga]Ga-PSMA PET/CT scans is feasible and appears sufficiently robust to be used as an auxiliary tool in the clinics.

## M2-SPIN-3 The CadAIver: Reproducibility Assessment and Novel Normalization Algorithm of Radiomics Features of Vertebral Bone from Different CT Scanners and Protocols

Riccardo Levi (*Presenter*) Nothing to Disclose

## PURPOSE

1. To quantify the effects of different dose protocols, reconstruction algorithms, fields of view and CT scanners on Radiomics features of the lumbar vertebrae in a cadaveric trunk. 2. To develop a novel normalization algorithm to harmonize Radiomics analyses.

## METHODS AND MATERIALS

We performed a total of 96 CT acquisitions of a cadaveric trunk (80-year old male) on 3 different CT scanners from 2 different vendors, using different kV (80 to 140, with 20 kV steps) and mA (250 to 400, with 50 mA steps). Each acquisition was performed using 2 fields of view (500 and 320 mm) and 2 reconstruction kernels (standard and bone). We also performed a Test-Retest protocol on a single scanner to assess repeatability of features. The lumbar vertebrae were segmented using a convolutional neural network (CNN) with nnU-Net structure and Radiomics features were extracted using pyradiomics library. Intra- and Inter-scanner analyses were assessed using either Analysis of Variance Repeated Measurements (parametric test) or Friedman's Test (non-parametric test) and each radiomics feature was tested using a generalized linear model (GLM) to assess the effects of all the above-mentioned CT acquisition parameters. Moreover, the proposed GLM model was successively employed to standardize radiomics features across different acquisitions, and was compared to the Combat algorithm, using a 10-folds cross-validation (CV) evaluating the R2.

## RESULTS

Variation of KV showed the highest feature modification in intra- and inter-scanner analyses, with the First Order features showing the highest variability (up to 94.4% on Scanner 1). Little or no effect was evident upon mA variation. 100% of shape features on all scanners were found significantly dependent on FOV, and 83% of GLSZM were statistically different between reconstruction kernels. The proposed GLM normalization algorithm obtained a mean R2 across CV higher than 0.90 in 21 Radiomics features (19.6%), whereas Combat normalization algorithm obtained an high R2 value in 1 Radiomics feature

(0.90%). Moreover, GLM algorithm was statistically superior in 39 Radiomics features in respect to Combat (which was superior in 16 Radiomics features) in terms of R2.

## **CONCLUSION**

To our knowledge, this study is the first attempt in describing the effects of CT acquisition parameters on Radiomics features in lumbar vertebrae from cadaveric donor. Current and Voltage affect the Radiomics features in different ways. The developed GLM model was superior to Combat in normalizing radiomics features across all the different CT acquisitions.

## **CLINICAL RELEVANCE/APPLICATION**

CT radiomics features are to be normalized before multi-scanner studies. The complete dataset and GLM normalization model will be publicly available to foster research in Radiomics.

## **M2-SPIN-4 Independent Evaluation of the Winning Kits19 Model for Kidney Tumor Segmentation on a Large External Patient Cohort**

Alex G. Raman, MS (*Presenter*) Nothing to Disclose

### **PURPOSE**

The fully automatic segmentation of kidney tumors on Computed Tomography (CT) can enable significant advantages in clinical practice including increased accuracy of diagnosis and prognostication of patient outcomes. The Kits19 challenge in 2019 set a baseline for kidney tumor segmentation, with the highest scoring model, nnUNet, receiving a Dice score of 0.85. Herein we seek to evaluate this model on an independent dataset of 694 segmented kidney tumors.

### **METHODS AND MATERIALS**

The nnUNet model trained on 210 Kits19 cases was evaluated on a separate institution-specific dataset of 694 total segmented kidney tumor cases, acquired from a diverse range of partner sites. A separate nnUNet model was trained on 555 of the institutional cases and evaluated on both 139 held out cases from the same institution as well as the 210 Kits19 cases. Unfortunately, the KiTS19 90 test cases were not available to evaluate the model trained on institutional data.

### **RESULTS**

The nnUNet model trained on the 210 KiTS19 cases received a Dice score of 0.64 when evaluated on the institution specific dataset of 555 cases. The nnUNet trained on the 210 KiTS19 cases also received a Dice score of 0.66 on a held-out test set of 139 institutional cases. In addition, an nnUNet model was trained on these 555 institutional cases and received a Dice score of 0.72 when evaluated on the held-out test set of 139 cases from the same institution. The nnUNet model trained on 555 institutional cases received a Dice score of 0.55 when evaluated on the 210 KiTS19 training cases.

### **CONCLUSION**

That the KiTS19 nnUNet model performed significantly worse (0.21 and 0.19 Dice score drops) on the institutional dataset was unexpected, but bears significant implications. Likewise, that the institutional nnUNet model performed significantly worse on the KiTS19 dataset (0.17 Dice score drop) despite being trained on a larger pool of data, reinforces a similar concept. Both models tended to do better on independent data derived from their own respective datasets. This highlights the importance of creating large medical machine learning datasets that incorporate data from a broad range of sources that can capture the data heterogeneity present in distinct patient populations and allow for the creation of generalizable machine learning models.

### **CLINICAL RELEVANCE/APPLICATION**

These results also highlight the value of federated learning in a healthcare setting, which can allow for the incorporation of diverse datasets into model training, while maintaining the privacy of patient and institutional health data. Furthermore, these results raise the question of what the true state-of-the-art Dice score is for kidney tumor segmentation and demonstrate the importance of independent model evaluation prior to potential clinical deployment.

## **M2-SPIN-5 Evaluating the Segment Anything Model for MRI Organ Segmentation Using a Simulated Interactive Setup**

Yan Zhuang, PhD, MS (*Presenter*) Nothing to Disclose

### **PURPOSE**

To evaluate the multi-organ segmentation capabilities of the recently released Segment Anything Model (SAM) as an interactive semi-automated annotation tool for organ segmentation in magnetic resonance (MR) images.

### **METHODS AND MATERIALS**

This retrospective study used the publicly available multi-organ MRI dataset, AMOS22, which contains 60 MRI volumes from multiple institutions. The 15 target organs are: liver, spleen, right kidney, left kidney, gallbladder, esophagus, stomach, aorta, inferior vena cava, pancreas, right adrenal gland, left adrenal gland, duodenum, bladder, and prostate/uterus. We extracted

2D slices from each 3D MRI volume and resized images to 512 by 512 pixels, resulting in a total number of 3609 2D images. We evaluated the SAM in a simulated interactive annotation setup. The initial prompt given to SAM was the ground truth bounding box (bbox) with added random jitter. SAM then outputs an initial segmentation mask. In subsequent iterations, SAM takes point-based prompts, as well as all previous prompts and the current segmentation mask, to generate the next refined segmentation mask. This procedure was repeated for 10 iterations to produce the final segmentation. The magnitude of random jitter for the initial bbox is a scaling factor that's uniformly drawn between [0.5,2] for our experiment. The magnitude of random jitter for subsequent point prompts is a translation  $0.2 \cdot R_{\max}$  pixels, where  $R_{\max}$  is the shortest distance between the center and the boundary of a false positive/negative region. The segmentation results of target 15 organs were evaluated against the ground truth masks using the Dice similarity coefficient (DSC) on 2D slices.

## RESULTS

The mean $\pm$ std DSC for 15 organs after the initial bounding box prompt was  $0.777 \pm 0.049$ . The final mean $\pm$ std DSC after 10 iterative steps was  $0.901 \pm 0.056$ . The best three organs were the right kidney ( $0.954 \pm 0.034$ ), left kidney ( $0.951 \pm 0.028$ ), and spleen ( $0.949 \pm 0.051$ ). The worst three organs were right adrenal gland ( $0.807 \pm 0.113$ ), prostate/uterus ( $0.819 \pm 0.246$ ), and duodenum ( $0.825 \pm 0.156$ ). The mean DSCs increased monotonically with the number of prompts, implying better segmentation results.

## CONCLUSION

Experimental results demonstrated that after 10 iterations, the SAM model was able to provide reasonable segmentation results for most of the organs in the MR images.

## CLINICAL RELEVANCE/APPLICATION

The SAM model can potentially reduce radiologists' annotation burden for segmenting MR images to just a few mouse clicks.

## M2-SPIN-6 An Automated Quantification Algorithm for Evaluating Total Metabolic Tumor Volume in Patients with FDG-avid Lymphoma using a Deep-learning Model

Lale Kostakoglu, MD, MPH (*Presenter*) Research Consultant, F. Hoffmann-La Roche Ltd

## PURPOSE

Total metabolic tumor volume (TMTV) holds promise as a method for quantifying tumor burden in patients with 18F-fluorodeoxyglucose (FDG)-avid lymphoma, but methodological limitations mean that it is rarely used in clinical practice. We developed a deep-learning (DL) model for automatic lesion segmentation and TMTV quantification from FDG-positron emission tomography/computed tomography (FDG-PET/CT) scans. We aimed to evaluate the model and identify factors influencing its performance in patients with diffuse large B-cell lymphoma (DLBCL) or follicular lymphoma (FL).

## METHODS AND MATERIALS

The DL algorithm (aTMTV) was trained using retrospective trial data from 836 adults with DLBCL. Model testing was performed using an independent retrospective data set including baseline and post-treatment scans from 166 adults with DLBCL and 201 adults with advanced FL collected from two large phase 3 multicenter trials. FDG-PET/CT scans were assessed by expert readers using semiautomated software (mTMTV) and by aTMTV. Pearson's correlation coefficient ( $r$ ) was used to evaluate aTMTV performance versus mTMTV. Bias was assessed using the slope and intercept from a weighted Deming regression. Lesion detection performance was assessed by sensitivity (the proportion of mTMTV-detected lesions identified by aTMTV) and positive predictive value (PPV; the proportion of aTMTV-detected lesions identified by mTMTV).

## RESULTS

aTMTV quantification highly correlated with mTMTV in the test set ( $n = 367$ ;  $r$ , 0.96 [95% confidence interval (CI): 0.95, 0.96]) for DLBCL and FL. Only moderate bias was detected between aTMTV and mTMTV (slope, 1.06 [95% CI: 1.02, 1.09]; intercept, -0.27 [95% CI: -0.52, -0.03]; mean difference between methods, 0.10 [standard deviation: 1.15]). Agreement between aTMTV and mTMTV was consistent among patients with different demographics and clinical characteristics, and across scans from different PET/CT scanner manufacturers. Overall mean sensitivity and PPV for lesion detection were both  $> 0.8$ . Performance was lower for lesions  $\leq 10$  mL (mean sensitivity, 0.67; mean PPV, 0.72) than for lesions  $> 10$  mL (mean sensitivity and PPV  $> 0.95$ ).

## CONCLUSION

The model demonstrated good performance and acceptable bias for TMTV measurement in patients with DLBCL or FL. Good generalizability was observed across patient subpopulations and PET/CT scanner manufacturers. Reduced algorithm performance for small lesions ( $\leq 10$  mL) may be the result of higher variability among readers in the determination of small lesions.

## CLINICAL RELEVANCE/APPLICATION

With further optimization and validation, this model may provide a novel automated approach for lesion segmentation and TMTV quantification to inform the management of patients with FDG-avid lymphoma.

## Abstract Archives of the RSNA, 2023

M2-SPIR

### Interventional Radiology Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPIR-2 Unilateral Lung Disease Model Developed using Interventional Radiology Technique**

Hiroshi Kodama, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Standard mouse model of pulmonary fibrosis model has been made by administration of Bleomycin intratracheally or intraperitoneally. The problem of this traditional methods is high mortality rate of more than 50% after Bleomycin administration. Our hypothesis was that unilateral lung disease model established using interventional radiology technique can overcome this limitation, and the feasibility and usefulness of unilateral lung disease was assessed.

##### **METHODS AND MATERIALS**

After 6-week-old C57BL/6 mice were anesthetized, a 1.7Fr. microcatheter was advanced into trachea using otoscope. Then, 1.0mg/kg of Bleomycin was injected into bilateral lung at trachea (n=13) or unilateral lung (n=14) after advancing the microcatheter to left main bronchus under fluoroscopy. Technical success, %decrease of body weight and survival at day 28 were evaluated. Body weight change and survival were compared between bilateral and unilateral lung disease groups using Mann-Whitney test and log-rank test. Lungs were extracted and evaluated on HE or Masson Trichrome stained specimens.

##### **RESULTS**

In all mice, bleomycin was successfully injected in bilateral or unilateral lung: Technical success rate was 100%. Body weights decreased 75.7%±14.0% in bilateral lung disease group, and it was significantly improved to 94.1%±11.4% in unilateral lung disease group (p=0.03). Overall survival rate at day 28 was 30.8% and 85.7% in bilateral and unilateral lung disease model, respectively. Survival was significantly better in unilateral lung disease model(p=0.01). On histological evaluation, it is confirmed that collagen deposition was only seen in bleomycin injected lung in unilateral lung disease model.

##### **CONCLUSION**

Establishing both healthy lung and disease lung in the same individual model using interventional radiology technique was feasible and make it possible to achieve less body weight loss and more favorable survival.

##### **CLINICAL RELEVANCE/APPLICATION**

Interventional radiology technique helps developing new animal model. Unilateral lung disease mouse model may be useful to analyze the treatment effect to both diseased and normal lung in the same individual.

#### **M2-SPIR-3 Fully Automated Dynamic Frame Rate Adjustment in Digital Subtraction Angiography**

Brendan Crabb, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Digital subtraction angiography (DSA) is a commonly used method for visualizing vasculature throughout the human body. Unfortunately, patient motion can generate artifacts, limiting the diagnostic quality of the images. When motion artifacts are present, image quality can be effectively improved by utilizing higher acquisition frame rates. However, this approach increases radiation dose to both the patient and provider. Moreover, frame rate adjustments are currently performed manually and frequently overlooked. There is a critical need to automatically optimize acquisition frame rates to maximize image quality and limit unnecessary radiation. We aim to develop a fully automated method to adjust frame rates on a series-to-series basis in response to motion artifacts.

## **METHODS AND MATERIALS**

DSAs of the cerebral, hepatic, and splenic vasculature were retrospectively collected (n=88 patients, 217 series; frame rate range 1-7 frames per second). The degree of motion artifacts in each DSA was visually scored using a five-grade Likert scale. In addition, image histograms were calculated for each DSA, and the relationship between the standard deviation of pixel intensities and the artifact rating was investigated. A Pearson correlation coefficient with a two-sided p-value was used to quantify the relationship, and the processing time required to analyze each DSA image was recorded.

## **RESULTS**

The degree of motion artifacts was strongly associated with the standard deviation of pixel intensities in the image histogram ( $r = 0.78$ ,  $p < 1 \times 10^{-5}$ ). The average processing time required to calculate this metric for a DSA image was 0.008 seconds on a middle-entry PC (Intel Core i5 processor, 8GB RAM).

## **CONCLUSION**

The standard deviation of pixel intensities in DSA is significantly associated with the degree of motion artifacts and can be calculated in less than 0.01 seconds. This relationship can be utilized to adjust acquisition frame rates for DSA in a quantifiable, automated, real-time approach.

## **CLINICAL RELEVANCE/APPLICATION**

Increasing DSA acquisition frame rates is an effective method to improve image quality when motion artifacts are present, but it also increases the radiation dose. In this study, we present a concept to perform fully automated, real-time frame rate optimizations on a series-to-series basis. This approach will improve image quality when patient motion is present while limiting radiation exposure when high frame rates are unnecessary.

## **M2-SPIR-4 Impact of a Selective Lens Dose Reduction Protocol in 3D Rotational Angiography on Eye Lens Radiation Exposure in Cerebral Angiography: A Randomized Controlled Trial**

Jong-Tae Yoon, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

There is limited research on the radiation exposure to the eye lens during cerebral angiography. A recent study has reported that a simple adjustment of table height during three-dimensional rotational angiography (3D-RA) can significantly reduce the radiation dose to the lens. This study aims to investigate the radiation dose to the eye lens during cerebral angiography and evaluate the effectiveness of a lens dose reduction protocol for 3D-RA in reducing overall lens dose exposure.

## **METHODS AND MATERIALS**

A randomized, controlled clinical trial was conducted at a tertiary hospital, with patients undergoing diagnostic cerebral angiography for unruptured intracranial aneurysms. The lens dose reduction protocol in 3D-RA involved raising the table to position the patient's eye lens away from the rotation axis. The radiation dose at the eye lens was estimated by measuring the entrance surface air kerma with photoluminescent glass dosimeter (PLD). The lens doses of 3D-RA and overall examination were analyzed and compared between the two groups. Image quality of the 3D-RA was assessed using quantitative and qualitative methods.

## **RESULTS**

A total of 20 participants (mean age, 58 years  $\pm$  9.4 [SD]; 12 men [60%]) were enrolled and randomly assigned to either the conventional group or the lens dose group. The lens dose in 3D-RA was significantly lower in the lens dose group compared to the conventional group (median of 1.1 mGy vs 4.5 mGy,  $P < .001$ ). The total dose was significantly lower in the lens dose reduction group (median of 7.5 mGy vs 10.2 mGy,  $P = .003$ ). In the conventional group, 3D-RA accounted for 46% of the total lens dose, while in the lens dose group, its proportion decreased to 16%. No significant differences were observed in the image quality between the groups.

## **CONCLUSION**

The study demonstrated that the lens dose reduction protocol showed significant reduction in the lens dose of the 3D-RA as well as entire cerebral angiography, without compromising image quality.

## **CLINICAL RELEVANCE/APPLICATION**

Radiation exposure during neurointerventional procedures is one of the significant issues to consider clinically as lenses have a high radiation sensitivity, and frequent radiation exposure can increase the risk of developing cataracts. Therefore, managing radiation exposure is crucial, and the use of techniques to reduce radiation doses in lenses, as presented in this study, can potentially decrease the likelihood of cataract formation in patients.

## **M2-SPIR-5 Immunologic Stem Markers of Poorly-differentiated Hepatocellular Carcinoma: Potential Targets for Locoregional NK-cell Based Immunotherapy**



Jason Chiang, MD, PhD (*Presenter*) Consultant, Intuitive Surgical, Inc; Equipment support, Johnson & Johnson

## **PURPOSE**

Poorly differentiated hepatocellular carcinoma (HCC) is hypothesized to contain immunologic markers of cancer stem cells that elevate the risk for recurrence or progression after locoregional therapy. Natural killer (NK) cells are uniquely able to target cancer stem cells via the innate immune pathway. The goal of this study was to identify cancer stem cell immunologic markers of poorly- vs well-differentiated hepatocellular carcinomas that would make them susceptible to NK-cell based therapy. HCC cell lines of poor- and well-differentiated HCCs were then incubated with naïve and activated NK cells to validate their cytotoxicity profile.

## **METHODS AND MATERIALS**

Two HCC tumor cell lines of different grades of differentiation (SNU-423: poorly differentiated; HepG2: well-differentiated) were used to determine immunologic stem cell phenotype and susceptibility to NK cell-mediated cytotoxicity. Flow cytometry was used to evaluate for surface receptor expression of MHC-I, CD-54, CD-44, and PDL-1 after staining with PE-conjugated antibodies. Isotype control antibodies were used to determine non-specific bindings. Freshly isolated NK cells and IL-2 activated NK cells prior to using 4-hr 51Cr release assay.

## **RESULTS**

The poorly differentiated HCC (SNU-423) had significantly higher expression percentage of CD44 ( $P < 0.0001$ ) and much lower expression percentage of MHC-I ( $p = 0.028$ ) and CD-54 ( $P = 0.01$ ), compared to the well-differentiated HCC (HepG2). There was no difference in PDL-1 levels ( $p = 0.70$ ) between the two cell lines. Naïve NK cells and activated NK cells both demonstrated significantly higher targeted killing of the poorly differentiated HCC when compared to the well-differentiated HCC (untreated NK in Snu-423 vs HepG2,  $p = 0.013$ , IL2-treated NK in Snu-423 vs HepG2,  $p < 0.001$ ). Morphologically, poorly differentiated HCCs exhibited smaller size and proliferated faster when compared to well differentiated HCCs.

## **CONCLUSION**

Poorly-differentiated HCCs demonstrated significantly decreased expression of stem cell markers MHC-I, CD-54, and and higher expression of CD-44 when compared to well-differentiated HCC. Poorly-differentiated HCCs were subsequently validated to be more susceptible to NK cell therapy. Additional studies in in-vivo HCC models are required to confirm stem profile of poorly differentiated HCCs and their utility as a biomarker for successful NK cell targeting.

## **CLINICAL RELEVANCE/APPLICATION**

NK-cell based therapy can potentially be used to augment conventional locoregional therapy options for early- to intermediate-stage HCC. Advances in NK cell activation and expansion will lend itself well to transarterial directed delivery of immunotherapy.

## **M2-SPIR-6 Evaluating the Potential of ChatGPT's Competency in Interventional Radiology**

Hossam A. Zaki, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

This project investigates ChatGPT's proficiency in Interventional Radiology by evaluating its clinical decision making and performance on a standardized exam.

## **METHODS AND MATERIALS**

We utilized ChatGPT, an LLM by Open AI trained on general data, as well as GlassAI, an LLM by Glass Health trained on medical text. Using the American College of Radiology (ACR) Appropriateness Criteria's patient presentations and criteria, we prompted ChatGPT to rank the 3 best interventional procedures, devices, or venous access areas. GlassAI was prompted to provide the best interventional procedures only. Each output was scored out of 3, where 3 is "usually appropriate", 2 is "may be appropriate", 1 is "usually not appropriate", and 0 is not listed. Partial scores were given for non-specific answers. We also used a Self-Assessment Module for Vascular and Interventional Radiology from the ACR published in 2011 to feed non-image based multiple choice questions into ChatGPT. A 1 was given for a correct answer, while a 0 was given for an incorrect answer. Clinical scenarios and exam questions were passed into each LLM twice, to account for stochasticity. The score for the board exam questions were averaged across both runs. Statistical significance was determined using a two-sided student's T-test.

## **RESULTS**

ChatGPT achieved a score of 2.38, 2.32, and 3.00 in selecting interventional procedures, devices, and venous access sites, respectively. GlassAI achieved a score of 3.00 in selecting interventional procedures. The difference between the two scores was found to be statistically significant ( $p < 0.05$ ). The average score for the exam was 74.2%.

## **CONCLUSION**

This study has demonstrated the potential of LLMs as a valuable tool for IR contexts. Compared to the ACR Appropriateness Criteria, LLMs perform well selecting an interventional procedure when prompted with a specific clinical scenario. GlassAI, a

medical-specific model, performed better than ChatGPT, a general model. ChatGPT performed well in predicting interventional devices and venous access sites. ChatGPT performed well on the simulated IR exam.

#### **CLINICAL RELEVANCE/APPLICATION**

Throughout the study, LLMs consistently exhibited a strong ability to comprehend complex medical scenarios and provide accurate, relevant predictions in interventional radiology areas. Moreover, the use of ChatGPT in a test setting demonstrated its proficiency in answering a wide range of questions. By integrating the model into the decision-making process, we can enhance the efficacy of diagnostic and therapeutic interventions while reducing the cognitive burden on clinicians.

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## Abstract Archives of the RSNA, 2023

M2-SPMK

### Musculoskeletal Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPMK-1 Thumb Distal Phalangeal Pseudolesion: Imaging Findings and Associations of an Underappreciated Normal Variant that May Mimic Osteolytic Pathology**

Andrew G. Helming, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In daily practice, we often observe a thumb distal phalangeal lucency on routine radiographs which may prompt cross-sectional imaging for further work-up. We hypothesize this represents a "pseudolesion" similar to those at the proximal humerus, radial tuberosity and femoral neck. To our knowledge, this finding has not been described in peer-reviewed literature. We aim to: 1) Describe imaging features of the thumb distal phalangeal pseudolesion (DPPL), 2) record incidence and frequency across age groups, and 3) evaluate associations with underlying diseases.

#### **METHODS AND MATERIALS**

IRB approved, retrospective review of 450 radiographic exams from 7/1/2021-7/1/2022. Patients divided into 3 age groups: 0-17, mean 12; 18-65, mean 42; 66+, mean 74.5. Each group of 150 cases had 50 hand, wrist, digit exams. Demographics obtained from electronic medical records and cases reviewed on PACS for: DPPL (Likert scale- 0, not present; 1, possible; 2, definite), view-specific conspicuity, location (distal/proximal, radial/ulnar, palmar/dorsal), size, laterality, osteopenia, osteoarthritis (OA) (modified Kellgren-Lawrence), inflammatory arthropathy, periarticular mineralization, and indication.

#### **RESULTS**

450 patients, 51% female and 49% male, 51% left and 49% right, DPPL present in 23%. Frequency of DPPL varied with age as follows: 68 (45%) seen in >65, 34 (23%) in 18-65, and 3 (2%) in those <18. DPPL located at proximal palmar aspect of thumb distal phalanx in 100%, 97% at ulnar aspect, 3% radial. 2% of patients had inflammatory arthropathy, 21% osteopenia, and 2% peri-articular mineralization. Positive correlations between DPPL presence and patient age, osteopenia, and presence of osteoarthritis, ( $p < 0.001$ ); severity of OA was not correlated. DPPL was not associated with gender or inflammatory arthropathy, and dubiously associated with periarticular mineralization. DPPL frequently seen on frontal and oblique views, infrequently on lateral views. Average size 6.4 x 4.5 mm (CC x TV). DPPL more common on hand and digit radiographs.

#### **CONCLUSION**

DPPL is common in patients older than 65 and consistently identified at the proximal, palmar-ulnar aspect of the thumb distal phalanx at wrist, hand, and finger/thumb radiography. DPPL is significantly associated with aging, increasing osteopenia, and osteoarthritis, and is unusual in the pediatric population. Anatomically, DPPL may be attributed to radial and ulnar sided basal tubercles bordering a palmar fossa/concavity which is less discrete prior to skeletal maturation.

#### **CLINICAL RELEVANCE/APPLICATION**

Increasing radiologist awareness of DPPL as a normal variant at the thumb distal phalanx may decrease overcalls of osteolytic bone disease, eliminating unnecessary work-up and alleviating patient anxiety.

#### **M2-SPMK-2 Peripheral Tear of the TFCC: Diagnostic Accuracy of MR Imaging of the Wrist and Diagnostic Performance of the Primary and Secondary Signs**

Youngjun Hur, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of the study was to assess the diagnostic performance value of MRI findings in patients with type 1b triangular fibrocartilage complex (TFCC) tear of the wrist.

## **METHODS AND MATERIALS**

In this study, a retrospective enrollment of 78 patients was conducted to examine the diagnostic performance of preoperative MRI examinations in patients with type 1b TFCC tear. Of the enrolled patients, 39 were confirmed to have type 1b TFCC tear through arthroscopy and underwent MRI examination within 180 days before surgery. As the control group, 39 patients were randomly selected from 1157 patients who underwent MRI examination for wrist pain during the same period. Both groups underwent a review of 19 MRI findings by two independent observers, and the correlation between each diagnostic finding and type 1b TFCC tear was assessed using a Chi-square test. The 19 MRI findings comprise 8 primary signs of abnormalities in the distal or proximal lamina, alongside 11 secondary signs suggestive of abnormalities in the surrounding structures.

## **RESULTS**

The type 1b TFCC tear group exhibited a significantly greater incidence of 7 primary MRI signs, comprising fiber discontinuity, signal alteration, and retraction of both proximal and distal lamina, as well as scarring of the distal lamina, compared to the control group (all  $p < 0.05$ ). Remarkably, the presence of fiber discontinuity and signal alteration of the distal lamina were higher in the type 1b TFCC tear group (74.3% vs. 38.5%,  $p = 0.003$ , and 87.2% vs. 43.6%,  $p < 0.001$ , respectively), as detected by both observers. In contrast, none of the 11 secondary MRI signs were statistically significant.

## **CONCLUSION**

MRI assessment of fiber discontinuity and signal alteration in the distal lamina through MRI examination may provide predictive markers for type 1b TFCC tear. These findings highlight the potential value of MRI as a diagnostic tool for this particular condition.

## **CLINICAL RELEVANCE/APPLICATION**

This study holds the potential to identify the diagnostic accuracy of wrist MR imaging, as well as the diagnostic performance of both primary and secondary signs related to type 1b TFCC tear.

## **M2-SPMK-3 Wrist Instability after Sectioning the Different Components of the Scafolunate Ligament and DCSS using a Cadaveric Model and Evaluated by 4DCT**

Badr Sellami, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To study the effect of sectioning the different components of the SL (scafolunate) ligament-DCSS (dorsal scafolunate septum) in a cadaveric model and assessing dynamic effects with 4DCT.

## **METHODS AND MATERIALS**

Five fresh frozen cadaveric specimens were imaged with 4DCT while placed in a custom-made wooden frame before and after introduction of different SL-DCSS lesions. The lesions were created arthroscopically and consisted of VSL (ventral), DSL (dorsal), VSL+DSL, VSL+DSL+partial DCSS, and VSL+DSL+complete DCSS. With CT, dynamic acquisitions were obtained in flexion, extension (F-E), and radial and ulnar (R-U) deviation. Relevant bony structures were semi-automatically segmented. Based on this X; Y; Z graphs were created to analyze the movement of the bones.

## **RESULTS**

With VSL sectioning, no SL diastasis occurred. Dorsal tilt increased with VSL sectioning. With DSL sectioning SL diastasis was seen but only in flexion-extension, and not in ulnar-radial deviation. With sectioning of multiple components SL diastasis was observed in all motions. With VSL, DSL, VSL+ DSL tilting in F-E was not concordant with tilting in R-U deviation. When the DCSS was completely sectioned tilting increased significantly in all motions and SL diastasis was most pronounced.

## **CONCLUSION**

1. SL diastasis does not occur with VSL lesions, however with DSL lesions it can also not be shown on R-U deviation 2. Except for the most severe injury of all structures (SL+ DCSS) the motion in R-U deviation is not concordant with F-E as would be expected. We believe that the extrinsic ligaments restrain the expected motion. 3. The more components are injured the more SL diastasis and tilting increases. 4. The DCSS plays a very important stabilizing role, and SL instability is most severe when it is injured.

## **CLINICAL RELEVANCE/APPLICATION**

Patterns of abnormal scafolunate motion after section of different components can be analyzed on 4D CT, and could predict the underlying injuries. The DCSS (dorsal scafolunate septum) plays an important stabilizing role.

## **M2-SPMK-4 Clinical Importance of the Retinacula, Subsheat, Ligament Attachments and Dynamics of the ECU. An US-MRI Study with Anatomical and Histologic Correlation**

Michel O. De Maeseneer, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To perform an US-MR\_anatomical-histological correlation of the extensor carpi ulnaris retinaculae, subsheath, and their attachments to the TFC and carpal ligaments. To review MR and US imaging in 7 patients with abnormal subsheath and ulnar sided TFC tears.

## **METHODS AND MATERIALS**

Five cadaver specimens (fresh frozen, Thiel, embalmed) were dissected and sectioned at the level of the ECU. US was performed prior to dissection at 4 levels (cubital groove, styloid process, subsheath, carpal insertion). In the 2 dissected specimens (one nl TFC, one major TFC tear) dynamic clips during pro-supination were obtained. US imaging was obtained in consensus by 2 experienced MSK radiologists with a 24 Mhz ultrasound probe. Seven cases of abnormal ECU subsheath on MRI and US from 3 institutions were retrospectively reviewed.

## **RESULTS**

At the cubital level the ECU is only covered by a thin superficial retinaculum, there is no tight bony or ligament attachment and mobility in pro-supination is very significant. The subsheath starts at the styloid process level, where it connects to the styloid insertion of the TFC. The subsheath is actually a sling of ligamentous bands in continuity with other tendons and extrinsic carpal ligaments (band of Barfred, radiolunotriquetral, intercarpal ligament) Dynamic studies showed a sudden click in pro-supination in the specimens with a major TFC tear, in contrast to the specimens with a normal TFC. All studied cases with abnormal subsheath showed ulnar sided TFC tears.

## **CONCLUSION**

The ECU retinacula and subsheath are complex, and have not been correctly described in previous anatomical and imaging work. This area is best evaluated on 24 Mhz US as are dynamics of the ECU tendon in pro-supination. There is no subsheath nor tight attachment of the ECU at the cubital level, but tight connections to the extrinsic carpal ligaments distally. In the clinical patients, major abnormality of the subsheath on MR or snapping dislocation of the ECU on US, was associated with ulnar sided TFC tears.

## **CLINICAL RELEVANCE/APPLICATION**

Understanding the anatomy of the subsheath as described in this work is a requisite to correctly interpret US and MR imaging of this area. Our findings also shed light on the clinical concept of 'ECU dislocation-abnormal ECU motion' Although only limited clinical cases were studied, our findings suggest that subsheath abnormalities and 'abnormal ECU motion' are associated with ulnar sided TFC tears.

## **M2-SPMK-5 Open Access AI Tools in Clinical Support Roles - An Example of Shoulder Implant Recognition**

Wolfram A. Bosbach, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Uptake of novel artificial intelligence methods into clinical tools is slowed down by multiple factors. One is the lack of access to computing facilities. In this study, we test today's open access resources for performing a musculoskeletal 4-class labeling task.

## **METHODS AND MATERIALS**

The tools we chose are Google-Chrome as browser, Google-Drive as online repository, Google-Colab as running environment. The model was implemented in Python, specifically Google-TensorFlow. The code was run on a deliberately unbalanced dataset with X-ray images containing implants from four different shoulder implant manufacturers. We applied a fine tuning on the Google-EfficientNet, the dataset was enlarged for training by data augmentation.

## **RESULTS**

We show that today's available open access resources are suitable for the intended task. Google-EfficientNet can be trained to perform the class labeling. Accuracy and avoidance of overfitting are improved by the data augmentation.

## **CONCLUSION**

We will make the designed tool available as open access tool on github. Remaining issues today are the data safety and data privacy. Future tools will need to address those if sensitive data is supposed to be processed.

## **CLINICAL RELEVANCE/APPLICATION**

Identification of unknown implants is only one of the many clinical applications. The relevance of our work is to demonstrate a pilot that uses remotely open access tools for AI work. In the future, support tools could be designed to assist a radiologist in his daily clinical routine.

## **M2-SPMK-6 Wavelet Decomposition Synthetic Imaging in Metal Artifact Reduction MRI (Magnetic Resonance Imaging) in Patients With Long Bone Tumor Prosthesis**

Jiwoo Park, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To identify the optimal metal artifact reduction sequences (MARS) and to explore solutions to overcome the limitation of existing MARS by using wavelet decomposition.

### **METHODS AND MATERIALS**

We assessed a total of 1348 cases of thigh MRI from patients aged  $\geq 18$  years who underwent 3.0T MRI (Philips Healthcare, Best, the Netherlands) at our institution from January 2016 to April 2022. The inclusion criteria were as follows: (1) Bone resection and tumor prosthesis insertion for tumor involvement of the femur (2) MARS were applied to post-operative follow-up MRI; STIR Metal Artifact Reduction for Orthopedic Implants (O-MAR), mDixon O-MAR, STIR O-MAR XD (3) MARS included the coronal T2FS sequence, which allows for viewing the major axis of a long bone tumor prosthesis in a single image and is deemed the most useful for lesion detection (4) Sufficient image quality for assessment. A total of 61 cases (STIR O-MAR: 15 cases, mDixon O-MAR 17 cases, STIR O-MAR XD 29 cases) with MR images were included in the final analysis. To assess the metal related signal changes that can affect the diagnostic performance, MR images were assessed by the following parameters: the distinction of anatomic structures and image quality. (1) For the distinction of anatomic structures, (1.1) bony cortex on the outer layer of the long bone with the tumor prosthesis could be well observed (1.2) the range of the muscles showing artifacts in the anterior compartment of thigh muscles surrounding the femur, (2) Regarding image quality, (2.1) center signal void area and (2.2) total artifact area including geometric image distortion, spatial blurring and image noise. The scores for the four parameters assessed for each MARS were summed up (4-20 points). The scores of three sequences were evaluated using the one-way ANOVA and post hoc Tukey Honestly Significant Difference (HSD) test. Wavelet decomposition was applied to O-MAR XD images: a total of 101 conventional sequence-MARS pairs.

### **RESULTS**

There were no significant difference in OMAR sequence and mDixon O-MAR sequence ( $P=0.378$ ). However, in subsequent images, wavelet decomposition reduced artifacts caused by blurring, a drawback of OMAR-XD, and there were significantly improved image quality and decreased metal artifact reductions in area ( $P<0.001$ ).

### **CONCLUSION**

OMAR or mDIXON OMAR appeared to be more useful than OMAR-XD for assessing 3.0T MRI images of long bone tumor prostheses. Application of the Wavelet decomposition synthetic imaging would aid diagnosis than OMAR-XD in patients with long bone tumor prosthesis.

### **CLINICAL RELEVANCE/APPLICATION**

Efforts to reduce metal artifacts in MRI have been ongoing, but assessing postoperative magnetic resonance imaging (MRI) of patients with a long bone tumor prosthesis is still challenging.

## **M2-SPMK-7 Development of a Fitted Ultrasound Standoff Pad Device**

Mario Russo, MEng (*Presenter*) Nothing to Disclose

### **PURPOSE**

Ultrasound (US) examinations are ubiquitous diagnostic assessments, reaching nearly 350 scans per 1,000 person-years in the United States. However, US examinations of superficial structures near curved bony prominences, such as the ankle or wrist, can be challenging, often requiring the use of a standoff pad. Unfortunately, a standard standoff pad can be challenging to use due to its bulky size and instability. This is further exacerbated when dynamic maneuvers or procedures are necessary. To address this issue, we have developed initial prototypes of a custom standoff pad adaptor, the FreePad. This exploratory study aims to compare the FreePad to the standard standoff pad and no pad in selected patients undergoing musculoskeletal ultrasound.

### **METHODS AND MATERIALS**

We used an operator-centered iterative design approach to create the FreePad. The Form 3 3D-printer was utilized throughout this process to create and test consecutive prototypes. This study was granted IRB approval and utilized patient informed consent. Included were 12 patients who presented to the outpatient radiology clinic for musculoskeletal ultrasound with a focus on superficial structures near anatomic areas of bony eminences (elbow, wrist, hand, ankle and foot). Each patient was examined under three conditions: 1) using US gel with no standoff pad, 2) with a standard standoff pad, and 3) with the FreePad. Each condition was evaluated for: a) duration of examination in seconds and, on a scale of 1 to 5, b) ease of use, c) quality of images, d) patient comfort, and e) diagnostic confidence. Three staff radiologists assessed the diagnostic confidence independently. The criteria results were evaluated using paired sample t-tests.

## RESULTS

The FreePad was easier to use than both US gel and the standoff pad ( $p=0.03$ ,  $p=0.002$ ). While statistically better than US gel across all other conditions, the FreePad compared to a standoff pad trended towards requiring shorter duration (138 vs 169 sec,  $p=0.09$ ), producing higher quality images (4.5 vs 3.9,  $p=0.08$ ), greater diagnostic confidence (4.4 vs 3.8,  $p=0.08$ ), and increased patient comfort (4.8 vs 4.3,  $p=0.06$ ).

## CONCLUSION

Use of the FreePad allows for easier scanning of superficial anatomic regions associated with bony eminences. Utilizing a fitted standoff pad device can improve the diagnostic confidence and quality of US images, while significantly enhancing the ease of clinician imaging.

## CLINICAL RELEVANCE/APPLICATION

The significantly improved ease of imaging using the FreePad is of everyday benefit to MSK radiologists' diagnostic practice and holds even greater promise for improving US-guided procedures in challenging anatomy.

## M2-SPMK-8 The Laundry Dilemma: Long or Short Programme to Get Off Calcium Spots

David Macia-Suarez, PhD, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Long-term comparison of two follow up approaches in performing Ultrasound-guided Percutaneous Irrigation of Calcific Tendinopathy (US-PICT) in the shoulder.

## METHODS AND MATERIALS

A Cross-sectional study of the evolution of patients undergoing an US-PICT was performed in 2 hospitals, through a Shoulder Pain and Disability Index (SPADI) questionnaire and a clinical survey 5 years after the intervention. The two approaches to assess were: Hospital 1: follow-up by the radiology service a month and a half after the intervention, assessing the need to perform a new US-PICT in case both symptoms and calcification persisted. Hospital 2: the patient was discharged after the intervention, being able to return to the consultation at his own request. In both cases, the same US-PICT (single needle lavage) technique was performed. All patients were informed of their participation in the study and gave their approval through an informed consent document. Authorization was requested and obtained from the regional bioethics committee. At 5 years of the intervention the two approaches were compared using the SPADI questionnaire, a clinical survey and a physical and an US exploration. The SPADI questionnaire consisted of 5 items that assessed pain and 8 items for mobility. The survey consisted of 11 questions that assessed: pain, overall state, mobility and medications compared to before US-PICT. A total of 93 patients were analyzed. 34 from Hospital 1 and 58 from Hospital 2. Statistical analyses were performed using R Statistical Software (v.4.12; Rcore Team 2021), which include a descriptive analysis of the data. Welch test was used in SPADI score means. The Chi-Squared or Fisher test were performed in survey questions.

## RESULTS

SPADI Score was statistically significant different in the two centers (Hospital 1:  $2.26 \pm 2.18$ ; Hospital 2:  $4.41 \pm 3.01$ ;  $p$ -value  $< 0.001$ ). However, the number of US-PICT was not associated with SPADI Score. Statistically significant differences were found between hospitals in the following aspects of the clinical survey: pain ( $p$ -value = 0.007); mobility compared to healthy ( $p$ -value = 0.001); overall state ( $p$ -value = 0.008). No statistically significant differences were found between the two centers about sex, age, mobility assessment and US features.

## CONCLUSION

It seems that closer follow-up of patients (Hospital 1 approach) has better objective (SPADI Score) and subjective (clinical survey) long-term outcomes.

## CLINICAL RELEVANCE/APPLICATION

Performing a close and long follow up of patients after US-PICT allows a better outcome and, therefore, a better clinical state.

## M2-SPMK-9 MRI-guided Retrograde Drilling for Osteochondritis Dissecans of the Talus in Pediatric Patients

Jyri E. Jarvinen (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to evaluate the feasibility, effectivity, and safety of MRI-guided percutaneous retrograde drilling in the treatment of osteochondritis dissecans of the talus (OCDT) in pediatric population.

## **METHODS AND MATERIALS**

The retrospective study (2010 - 2019) had 27 consecutive pediatric patients (mean age 13 years) with 30 stable, symptomatic OCDT which were unresponsive to conservative treatment. The OCDT were treated using MRI-guided retrograde drilling. They were graded pre- and post-operatively on a validated 5-grade scale (I - V) based on MRI. The procedure's effectivity was assessed by radiological improvement of the OCDT, and by postprocedural questionnaire that was aimed to evaluate pain (Visual Analogue Scale (VAS) 0 - 10) and performance (scale 0 - 10). Also, an evaluation of procedure-associated symptom alleviation was elicited.

## **RESULTS**

The mean follow-up time was 6.1 (2.4 - 11.4) years. MRI-guided drilling was technically successful in all the cases. No major complications occurred. All the patients were discharged from hospital on the day as the procedure was performed. Mean time interval for follow-up imaging was 4.8 (1 - 12) months. All the OCDT represented grade II - III in pre-operative assessment, and they all remained stable during follow-up. The OCDT grade improved after drilling ( $p = 0.039$ ). Three of grade III OCDT improved to grade I, five of grade III OCDT improved to grade II, and one of grade II OCDT progressed to grade III. The rest of the OCDT remained unchanged. Increased ossification was observed in 39% of the OCDT. The symptoms were significantly alleviated or completely disappeared in 63% of the cases. Preoperative mean VAS and performance was 6.3 (SD 2.0) and 5.2 (SD 2.4), respectively. Both pain (mean change in VAS -3.8, SD 2.6) and performance (mean change 2.6, SD 3.1) were improved significantly ( $p < 0.001$  and  $P = 0.001$ , respectively). Orally administered anti-inflammatory drugs and paracetamol provided satisfactory postprocedural pain relief for 96.7% of the patients.

## **CONCLUSION**

MRI-guided retrograde drilling of stable OCDT is a feasible, effective, and safe treatment method for pediatric patients.

## **CLINICAL RELEVANCE/APPLICATION**

MRI-guided retrograde drilling of OCDT provides minimally invasive treatment option for patients who are unresponsive to conservative treatment. It is less invasive compared to surgery and is suitable for outpatient care. Additionally, lack of ionizing radiation makes it considerable treatment choice for pediatric patients.

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## Abstract Archives of the RSNA, 2023

M2-SPMS

### Multisystem Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

### M2-SPMS-1 STIR Features of Primary Lower Extremity Lymphedema: A Retrospective Analysis of 228 Patients

MENGKE LIU (*Presenter*) Nothing to Disclose

#### PURPOSE

The staging of primary lower extremity lymphedema (LEL) is difficult and vital in clinical work. So we investigated the STIR manifestations of primary lower extremity lymphedema (LEL) in different clinical stages.

#### METHODS AND MATERIALS

A retrospective analysis of 228 patients of primary LEL was conducted, all of which underwent MRI examination using a short-time inversion recovery (STIR) sequence. The affected limb MRI manifestation was observed, and patients were divided into stages I, II, and III based on the 2020 International Society of Lymphology (ISL) clinical staging standards. Two radiologists assessed the following characteristics on STIR: the extent of edema, the frequency of MRI manifestations, including dermal thickening (dermal thickness > 2mm), and the morphology of edema in subcutaneous (grid, honeycomb, parallel-lines, banded, crescent, and lymphatic lake). Parallel-lines were thin, 1-2 mm wide, and parallel to the superficial fascia, not forming a network. Grid signs were multiple intertwined lines, up to 3mm wide, with the largest meridian parallel to the superficial fascia and a width-to-length ratio of less than 2/3. Honeycomb signs represented a further thickening of the grid in more than two directions, with a wall thickness greater than 3mm and a width-to-length ratio greater than 2/3. Band sign is an accumulation of fluid on the fascial surface with a strip-like structure observed at the axial level. Crescent sign is a subfascial accumulation observed at the axial level. Lymphatic lake is a large, structureless area of edema located in the subcutaneous soft tissue.

#### RESULTS

The extent of edema was positively correlated with clinical stage, both longitudinally and transversely. When comparing stages, the incidence of dermal thickening in stages II and III were significantly higher than that in stage I. The incidence of parallel-lines in stage I was significantly higher than that in stages II and III. The incidence of grid in stages I and II was significantly higher than that in stage III. The incidence of honeycomb in stages II and III was significantly higher than that in stage I. The incidence of banded sign in stages I and II was significantly higher than that in stage III. The incidence of lymphatic lake and crescent in stage III was significantly higher than that in stages I and II ( $P < 0.05$ ).

#### CONCLUSION

STIR manifestations of primary LEL in different stages have certain characteristics, Parallel line sign is a characteristic sign of stage I, and crescentic sign and lymphatic lake are characteristic signs of stage III. MRI can be an effective auxiliary tool for evaluating the severity of primary LEL.

#### CLINICAL RELEVANCE/APPLICATION

STIR can sensitively diagnose lymphedema and assist in clinical staging.

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## Abstract Archives of the RSNA, 2023

M2-SPNMMI

### Nuclear Medicine & Molecular Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPNMMI-1 Virtual Myocardial PET Generated from SPECT-to-PET Translation Model Corrects False High Resting Score in SPECT Due to Photon Attenuation**

Masateru Kawakubo, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Myocardial single photon emission computed tomography (SPECT) is used worldwide for the diagnosis of myocardial ischemia. However, myocardial SPECT with an Anger-type gamma camera has specific artifacts, such as the effect of deep attenuation in the left ventricular inferior wall, that hinder accurate diagnosis. On the other hand, ammonia positron emission tomography (PET) has excellent detector sensitivity and its high-resolution images are considered the gold standard for ischemia diagnosis. We developed an algorithm to generate the virtual PET (vPET) from myocardial SPECT by deep learning network of SPECT-to-PET dataset of the same patient. This research investigates improvement in visual ischemia scoring accuracy of virtual myocardial PET generated by SPECT-to-PET translation (SPT) model.

#### **METHODS AND MATERIALS**

Fifty-four datasets of N-13 ammonia PET and Tc-99m-methoxyisobutylisonitrile SPECT at stress and resting state were retrospectively analyzed. These myocardial base to apical short-axis image dataset from same patient-to-patient were randomly divided into 34 cases of training datasets (2525 images) and 20 cases of test datasets (1762 images). Summed rest scores (SRS) and summed stress score (SSS) derived from vPET with the SPT model, SPECT, and PET in 20 test cases were blindly and independently assessed and compared among them.

#### **RESULTS**

SRS of vPET was not differ from those of PET ( $P > 0.999$ ), but those of SPECT was significantly over-estimated than PET ( $P = 0.002$ ) (vPET vs. SPECT vs. PET =  $0.8 \pm 2.0$  vs.  $1.8 \pm 1.5$  vs.  $0.5 \pm 0.4$ ). There were no differences of SSS among vPET, SPECT, and PET (vPET vs. SPECT vs. PET =  $1.5 \pm 2.2$  vs.  $3.4 \pm 3.0$  vs.  $4.1 \pm 5.6$ ).

#### **CONCLUSION**

Our proposed virtual PET imaging with SPT deep learning model potentially improves visual score based myocardial ischemia diagnosis in SPECT imaging without additional radioisotope injection and the high-cost novel imaging modality. This is the reasonable approach utilizing deep learning because myocardial ischemia diagnosis with standalone SPECT is used worldwide.

#### **CLINICAL RELEVANCE/APPLICATION**

Virtual PET for correcting attenuation artifact in SPECT is applicable as a low-cost and practical clinical tool which provides powerful auxiliary information for myocardial ischemia diagnosis.

#### **M2-SPNMMI-2 Coronary Artery Bypass Grafting Transiently Improves Myocardial Strain and Myocardial Flow Reserve: An Ammonia PET Study**

Atsushi Yamamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Coronary artery bypass grafting (CABG) is associated with better survival and lower rates of major cardiovascular events in the short and long terms. The patency of bypass grafts has been confirmed using coronary CT angiography; however, the effects of CABG on myocardial strain and microcirculatory functions have not been elucidated. We have made it possible to evaluate left ventricular myocardial strain (LVMS), adapting a feature-tracking technique to electrocardiography-gated high-resolution  $^{13}\text{N}$ -ammonia positron emission tomography ( $^{13}\text{N}$ -PET). The aim of this study was to evaluate the change of LVMS and myocardial flow reserve (MFR) measured by  $^{13}\text{N}$ -PET before and after CABG.



## **METHODS AND MATERIALS**

Between March 2015 and December 2022, 946 consecutive patients were performed resting and stressed NH<sub>3</sub>-PET because of known or suspected IHD. Patients who underwent NH<sub>3</sub>-PET before and after CABG (mean interval, 6 months) were enrolled. Patients with a transplanted heart, congenital heart disease, adenosine ineffectiveness, or poor imaging were excluded. LVMS was assessed by a feature-tracking technique on the NH<sub>3</sub>-PET cine images of horizontal long-axis slices, and the LVMS ratio (LVMSR) was defined as LVMS at stress divided by that at rest. MFR was calculated using a two-compartment model of the time concentration curve for the first two minutes after ammonia injection. LVMSR and MFR before and after CABG were compared by paired t-test. 11 patients who underwent NH<sub>3</sub>-PET before and after percutaneous coronary intervention (PCI) were analyzed as a comparison group.

## **RESULTS**

16 patients who underwent CABG were retrospectively analyzed. LVMSR in the CABG group showed significant improvement with invasive treatment ( $0.99 \pm 0.13$  vs.  $1.15 \pm 0.21$ ,  $p=0.0013$ ). Global MFR increased significantly from baseline to post CABG ( $1.49 \pm 0.42$  vs.  $1.91 \pm 0.51$ ,  $p<0.0001$ ). On the other hand, there was no significant difference in LVMSR before and after PCI ( $1.01 \pm 0.14$  vs.  $1.00 \pm 0.11$ ,  $p=0.87$ ). No significant improvements in global MFR ( $1.83 \pm 0.65$  vs.  $2.12 \pm 0.77$ ,  $p=0.16$ ) were observed in the PCI group.

## **CONCLUSION**

CABG transiently improves myocardial strain and MFR significantly. The effect is more pronounced than PCI.

## **CLINICAL RELEVANCE/APPLICATION**

This method can reproducibly assess local function before and after revascularization. Furthermore, it has the advantage of detecting ischemia-related wall motion abnormalities, whereas previously only ischemia was evaluated.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPNPM

### Noninterpretive Skills (Beyond Imaging) Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### M2-SPNPM- Radiology Practice Size Distribution Pre- and Post-COVID-19 Pandemic

2

Kyle Tegtmeyer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Prior investigations by Rosenkrantz et. al in 2019 have demonstrated a trend of consolidation of radiology groups in the mid-2010s. However, little is known about changes in radiology practice group size and numbers spanning the COVID-19 pandemic. This study seeks to investigate consolidation trends within radiology practice groups before and after the COVID-19 pandemic.

#### METHODS AND MATERIALS

Data on radiologists and their associated practice affiliations were obtained for 2017 and early 2023 from the Physician Compare national database provided by the Centers for Medicare and Medicaid Services. Calculations of unique radiology practice groups and number of unique associated national provider identifier (NPI) numbers associated with each radiology group were performed using R 4.2.2.

#### RESULTS

The number of unique radiologists nationally increased between 2017 and 2023 from 32060 to 34080. Between 2017 and 2023, the number of radiology practices decreased from 3909 to 3455 unique practice entities. The median number of radiologists per practice remained 6 between 2017 and 2023, but the mean practice size increased from 13.9 to 19.0 unique radiologists, indicating a growing skew towards larger groups. The top 10 groups by size increased from including 2411 unique radiologists in 2017 to 3554 unique radiologists in 2023. The top 10 groups by size in 2023 include 3 groups not previously within the top 100 groups by size; the top ranked group by size in 2023 ranked 39th in size in 2017. The number of unique NPI-Practice group pairs has increased from 54,274 in 2017 to 65,664 in 2023; the average radiologist increased billing from under an average of 1.69 to 1.93 distinct practice entities from 2017 to 2023. Analysis by group size demonstrates relative growth in number of radiology practices with >25 radiologists, with a 119% relative increase in number of groups with 100+ radiologists. Geographic analysis demonstrates a relative increase of proportion of groups located within the western census region of approximately 10%, with relative decreases in the remaining regions.

#### CONCLUSION

Consolidation of radiology practice groups has continued through the COVID-19 pandemic from 2017 to 2023, with fewer unique practices and higher average number of radiologists per practice. The greatest growth is seen among practices with 100+ radiologists, highlighting the high degree of consolidation in recent years among the largest groups in the US. At least some of this consolidation appears to be due to greater number of distinct practice entities under which radiologists are billing.

#### CLINICAL RELEVANCE/APPLICATION

Increasing consolidation of radiology practices was seen between 2017 and early 2023, with the largest growth seen in practices with 100 or more radiologists.

#### M2-SPNPM- Reducing Energy Consumption in MRI using Shorter Scan Protocols, Optimized Magnet Cooling Patterns and Deep Learning Sequences: How Low Can We Go

3

Saif Afat, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study aimed to investigate energy consumption in MRI scanners and identify strategies for improving energy efficiency in radiology departments and practices. We focused on musculoskeletal MRI and assessed the potential savings achievable through optimizing protocols, incorporating deep learning (DL) accelerated acquisitions, and optimizing the cooling system.

## **METHODS AND MATERIALS**

Energy consumption measurements were performed on three MRI scanners (1.5T Aera, 1.5T Sola, 3T Skyra) in practices in Munich, Germany, between December 2022 and March 2023. Two levels of energy reduction measures, eco protocols and DL accelerated sequences, were implemented and compared to baseline. Analysis was conducted in R and Python to evaluate the average, median, and standard deviations of sequence scan times and energy consumption.

## **RESULTS**

Our findings showed significant energy savings by optimizing protocol settings alone, with knee imaging achieving a 21% energy consumption reduction and 22% time reduction. Implementing DL technologies led to a 37% energy consumption reduction and a 46% time reduction compared to baseline. Optimizing the magnet cooling strategy resulted in a 23.2% reduction during off-cycles.

## **CONCLUSION**

Implementing energy-saving strategies, including eco protocols, DL accelerated sequences, and optimized magnet cooling, can significantly reduce energy consumption in MRI scanners without compromising image quality or operational efficiency. Radiology departments and practices should consider adopting these strategies to improve energy efficiency and reduce costs.

## **CLINICAL RELEVANCE/APPLICATION**

Reducing energy consumption in MRI scanners has environmental, financial, and operational implications for radiology departments and practices. Implementing energy-saving strategies can help address the growing demand for medical devices while reducing energy costs and greenhouse gas emissions.

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## Abstract Archives of the RSNA, 2023

M2-SPNR

### Neuroradiology Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPNR-1 Multiscale Principal Gradient Alterations in Subcortical-Cortical Connectome as Potential Biomarkers for Memory Impairments in Major Depressive Disorder**

Qian Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Major depressive disorder (MDD) is associated with functional abnormalities in subcortical networks, which contribute to clinical symptoms and cognitive impairments. This study introduces a new approach, functional gradient mapping, to identify hierarchical organization in subcortical connectivity patterns and evaluate their relationship with cognitive features.

#### **METHODS AND MATERIALS**

Resting-state fMRI studies were conducted on 145 never-treated first-episode MDD patients and 145 healthy controls (HCs). The voxel-wise gradient distributions of the subcortical-cortical connectome were mapped, and group-averaged gradient values were compared across all subcortical voxels, three main systems (limbic, thalamic, and basal ganglia), structural subregions, and functional subregions related to specific cortical functional networks. The study also assessed the association between significant gradient alterations and neuropsychological functioning.

#### **RESULTS**

The principal gradient values were organized along a gradual anterior-posterior axis across subcortical structures in MDD patients, which varied across different subcortical systems and subregions relative to HCs. At the system level, principal gradient values were lower in the thalamic and limbic systems but higher in the basal ganglia (BG) striatal system in the MDD group. Within subcortical functional subfields, MDD patients had lower gradient values in all limbic subregions and higher gradient values in thalamic subregions projecting to the frontoparietal network but lower values in other thalamic-subregions. Higher gradient values were observed in BG subregions projecting to FPN and visual networks, but lower gradient values were observed in BG regions projecting to sensorimotor, default mode (DMN), and ventral attention network (VAN). Notably, altered principal gradient values of the thalamic system and the subregion projecting to DMN were positively associated with episodic memory test performance in MDD patients, while the BG region projecting to VAN was negatively linked.

#### **CONCLUSION**

Multiscale principal gradient alterations of the subcortical-cortical connectome reflected hierarchical disorganization underlying functional segregation in MDD. The interactive associations of thalamic and BG gradient alterations were implicated in subcortical functional connectivity disturbance and episodic memory impairments in MDD patients, revealing an internally differentiated and clinically relevant pattern of subcortical gradient dysfunction in MDD.

#### **CLINICAL RELEVANCE/APPLICATION**

These findings enhanced our understanding of MDD-related hierarchical pathology and presented potential intervention biomarkers for memory improvements in MDD.

#### **M2-SPNR-10 Volume Reduction in Hippocampal Subregions is Associated with Cognitive Impairment in Patients with Cerebral Small Vessel Disease**

Na Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cerebral small vessel disease (CSVD) is a chronic disease that can lead to mental and psychiatric impairment. As a key brain region for memory and learning, the volume change in the hippocampus may play an important role in cognitive impairment in patients with CSVD, but the specific mechanism is still unknown. The purpose of this article is to compare the volume

changes in hippocampal subregions in patients with severe CSVD (CSVD-S), patients with mild CSVD (CSVD-M) and healthy controls (HCs) to investigate the influencing factors of cognitive differences in patients with CSVD.

## **METHODS AND MATERIALS**

Sixty-seven CSVD-S patients, 150 CSVD-M patients and 98 healthy controls underwent magnetic resonance imaging (MRI) and cognitive tests. FreeSurfer was used to automatically segment the hippocampus from high-resolution MRI and extract the volume data of 19 subregions. One-way analysis of variance was used to compare the volume differences in hippocampal subregions among the three groups, and the correlation between regions of interest (ROIs) and cognitive test results in the CSVD groups was analyzed. In addition, stepwise regression analysis was performed to correlate the ROIs with multiple risk factors in the CSVD groups.

## **RESULTS**

We found significant differences in the volumes of the presubiculum-body, head of granule cell and molecular layer of the dentate gyrus (GC-ML-DG-head), fimbria and hippocampus amygdala transition area (HATA) among the three groups ( $p < 0.003$ , Bonferroni correction), and the volumes of the CSVD-S group were significantly smaller than those of the HC group ( $p < 0.003$ ). Bivariate correlation analysis showed that these four subregions were correlated with the Stroop color-word test (SCWT), and the GC-ML-DG-head and fimbria were also correlated with the Montreal cognitive assessment (MoCA) ( $p < 0.013$ ) in the CSVD groups. Influencing factors of the four subregions included age, gender, smoking, hyperlipidemia and hypertension. Mediation analysis showed that the average volume of the 4 ROIs partially mediated the relationship between drinking and SCWT scores.

## **CONCLUSION**

The volume reduction of some hippocampal subregions can aggravate cognitive impairment in patients with CSVD, and the decreased volume of hippocampal subregions was associated with age, gender, smoking, hyperlipidemia and hypertension. The volume of 4 ROIs mediates cognitive function in CSVD patients with drinking.

## **CLINICAL RELEVANCE/APPLICATION**

Maintaining good living habits and paying more attention to blood pressure and blood lipids can help to reduce the cognitive impairment caused by CSVD.

## **M2-SPNR-11 Regional High Iron Deposition on Brain Quantitative Susceptibility Mapping Correlates with Decreased Cognitive Function in End Stage Renal Disease**

Yuan Li (*Presenter*) Nothing to Disclose

## **PURPOSE**

The end-stage renal disease (ESRD) patients usually have increased brain iron depositions. This study aimed to quantitatively evaluate the brain iron deposition in patients with ESRD by threshold method of quantitative susceptibility mapping (QSM), and to analyze the correlation between the iron deposition and cognitive function.

## **METHODS AND MATERIALS**

Thirty-four ESRD patients and 45 healthy controls (HCs) were prospectively recruited. All subjects were scanned using a 3T MRI to acquire strategically acquired gradient echo (STAGE) sequence. The mean magnetic sensitivity values (MSV) and volume (MSVM, VM) and high iron region (MSVH, VH) of bilateral caudate nucleus (CN), putamen (PUT), globus pallidus (GP), substantia nigra (SN), red nucleus (RN) and dentate nucleus (DN) in both groups were measured manually (Figure 1). All QSM data was compared between groups using analysis of covariance. Neuropsychological examination results were compared between the two groups by two-sample t tests or Mann-Whitney U tests. Partial correlation analysis was used to assess correlations between the MSVH, VH/VM data and cognitive test scores in the ESRD group, with gender, age and education level as covariates. Multiple comparisons of all statistical values were corrected by false discovery rate (FDR). A statistically significant P-value was set at 0.05.

## **RESULTS**

Compared with HCs, the MSVM of bilateral PUT, DN and right RN were decreased (Table 1), the VM of all gray matter nuclei were decreased, and the MSVH and VH/VM of bilateral CN, PUT, DN and right SN were increased in ESRD patients ( $P < 0.05$ , FDR corrected)(Figure 2). Patients with ESRD had lower MoCA and DSST scores but higher TMT-A, TMT-B, HAMA, HAMD and BDI-II scores (Table 2). The partial correlation analysis showed that the MSVH of the bilateral RN was negatively correlated with orientation scores (left:  $P = 0.002$ ,  $r = -0.568$ ; right:  $P < 0.001$ ,  $r = -0.651$ )(Figure 3).

## **CONCLUSION**

The iron deposition of gray matter nuclei increased as well as volume decreased in ESRD patients. The MSV in high iron areas can better assess the distribution of iron and is related to the cognitive dysfunction.

## CLINICAL RELEVANCE/APPLICATION

Previous studies were based on the mean MSV of gray matter nuclei in ESRD patients, but since the distribution of iron is uneven, we further divided the gray matter nuclei into high iron area according to the threshold, which can sensitively reflect the abnormal distribution of brain iron and cognitive impairment.

### M2-SPNR-12 Cerebral Blood Flow Changes in Patients with End Stage Renal Disease: A Study Based on Pseudo-continuous Arterial Spin Labeling

Yuan Li (*Presenter*) Nothing to Disclose

#### PURPOSE

Patients with end-stage renal disease (ESRD) lead to cerebral hemodynamic instability. This study aimed to quantitatively evaluate the cerebral blood flow (CBF) alteration in patients with ESRD and to analyze the correlation between the CBF with cognitive and clinical indicators.

#### METHODS AND MATERIALS

Thirty-five ESRD patients and 46 healthy controls (HCs) were prospectively recruited. All subjects were scanned using a 3T MRI to acquire pseudo-continuous arterial spin labeling (pCASL) sequence. The relative values of cerebral blood flow (rCBF) of the whole brain was measured using SPM8. All CBF data was compared between groups using analysis of covariance. Neuropsychological examination scores and laboratory indexes were compared between the two groups by two-sample t tests or Mann-Whitney U tests. Partial correlation analysis was used to assess correlations between the CBF data, cognitive test scores and blood biochemical test in the ESRD group, with gender, age and education level as covariates. A statistically significant P-value was set at 0.05.

#### RESULTS

Compared with the HCs, the ESRD group exhibited lower rCBF in the bilateral thalamus and putamen (Figure 1, Table 1)( $P < 0.05$ , FDR corrected). There were significant differences in the levels of RBC, HB, Cre, eGFR, UA and HCY between the two groups (all  $P < 0.05$ ). Patients with ESRD had lower MoCA and DSST scores but higher TMT-A, HAMA, HAMD and BDI-II scores (Table 3). The partial correlation analysis showed that the rCBF of the bilateral thalamus were positively correlated with HCY (left:  $P = 0.010$ ,  $r = 0.449$ ; right:  $P = 0.005$ ,  $r = 0.486$ ), the rCBF of the left putamen was negatively correlated with the MoCA scores ( $P = 0.010$ ,  $r = -0.447$ ), the rCBF of the right thalamus was negatively correlated with the orientation scores ( $P = 0.016$ ,  $r = -0.421$ ), the rCBF of the left putamen was negatively correlated with the delayed recall scores ( $P = 0.002$ ,  $r = -0.528$ ), and the right putamen was negatively correlated with the attention scores ( $P = 0.047$ ,  $r = -0.353$ )(Figure 2).

#### CONCLUSION

The cerebral blood flow in bilateral putamen and thalamus decreased in patients with ESRD, which correlated with HCY level and neurocognitive scores.

## CLINICAL RELEVANCE/APPLICATION

Patients with ESRD have cerebral hemodynamic imbalances and may suffer from a range of complications. So we used arterial-spin labeling MR imaging to non-invasively and quantitatively evaluate cerebral blood flow changes in patients with ESRD, and analysis the correlation between these changes and cognitive impairment.

### M2-SPNR-13 Visceral Abdominal Adipose Tissue and Insulin Resistance Respectively Influence Alzheimer's Disease Amyloid Pathology and Neurodegeneration in Midlife

Mahsa Dolatshahi, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

Obesity and adiposity at midlife, evidenced by high body mass index (BMI), are increasingly understood as risk factors for Alzheimer's disease (AD). Importantly, visceral fat is known to be associated with insulin resistance and a proinflammatory state, the mechanisms involved in AD pathology. Herein, we aimed to assess the association between brain MRI volumes as well as amyloid and tau uptake with obesity, insulin resistance, and abdominal adipose tissue in the cognitively normal midlife population.

#### METHODS AND MATERIALS

A total of 34 middle-aged (age:  $51.27 \pm 6.12$  years, BMI:  $32.28 \pm 6.39$  kg/m<sup>2</sup>), cognitively normal participants, underwent bloodwork, brain, and abdominal MRI, as well as amyloid and tau PET scan. Homeostatic Model Assessment for Insulin Resistance (HOMAIR)  $> 1.9$  was used as a measure of insulin resistance. Visceral and subcutaneous adipose tissue (VAT, SAT) were semi-automatically segmented using VOXel Analysis Suite (Voxa). FreeSurfer 7.1.1 was used for the automatic segmentation of cortical and subcortical brain regions using a probabilistic atlas. Dynamic amyloid imaging was performed with a bolus injection of  $\sim 15$  mCi of [11C]PiB, followed by a 60-min scan. A single intravenous bolus of between 7.2-10.8 mCi

of AV-1451 was administered. Data from the 30-60 minute, and 80-100 minute post-injection window for PiB and AV-1451 were used for the analysis, respectively. The association of brain volumes and PiB and AV-1451 standardized uptake value ratios (SUVRs) within the default mode network areas with BMI and VAT/SAT ratio were assessed using linear regression models.

## RESULTS

We observed lower right entorhinal white matter volumes in obese participants with insulin resistance compared to metabolically normal non-obese group ( $p=0.004$ ), without any significant difference in PiB or AV-1451 SUVRs. Regression models with sex, age and education as covariates showed a significant positive association between VAT/SAT ratio and left precuneus white matter PiB SUVRs ( $R^2=0.31$ ,  $p=0.005$ ), but no significant associations with AV-1451 SUVRs.

## CONCLUSION

In our midlife obese sample with insulin resistance, there was lower right entorhinal white matter volume, which is involved in relaying information to the hippocampus. We also demonstrated higher early amyloid pathology in AD-signature areas such as the precuneus in mid-life persons with high VAT/SAT ratio, a marker of visceral obesity.

## CLINICAL RELEVANCE/APPLICATION

These findings prompt designing interventions targeted at reducing abdominal visceral fat, obesity, and insulin resistance in midlife to prevent against Alzheimer disease pathology and neurodegeneration.

## M2-SPNR-14 Utility of Quantifying the Glymphatic System Activity using Diffusion Tensor Image Analysis Along the Perivascular Space (DTI-ALPS) in Mild Cognitive Impairment (MCI), Compared to the Cerebrospinal Fluid (CSF) Biomarker

Hiroto Takahashi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Identifying early Alzheimer's disease (AD) would offer better disease management. The cerebrospinal fluid (CSF) biomarker is sensitive to neurodegeneration in dementia. Dysfunction of the glymphatic system has been revealed to be associated with various diseases including AD. We evaluated the activity of the glymphatic system in mild cognitive impairment (MCI) with a diffusion-based technique called diffusion tensor image analysis along the perivascular space (DTI-ALPS) to explore the imaging biomarker for assessing early dementia, while comparing the CSF biomarker level.

## METHODS AND MATERIALS

Sixty-two patients with MCI underwent both CSF measurement and diffusion magnetic resonance imaging at 3T. No hyperintensities in the periventricular white matter were observed in all subjects on T2-weighted images. Based on the CSF p-tau/A $\beta$ 42 ratio value, 33 patients with AD pathology (AD group) were discriminated from 29 patients with non-AD pathology (non-AD group). Diffusivities in the X, Y and Z axes were obtained in the lateral ventricle body plane of all subjects. We assessed the diffusivity along the perivascular spaces, as well as projection fibers and association fibers, respectively in order to acquire the DTI-ALPS index of each hemisphere. The significance of intergroup difference in the DTI-ALPS index was tested using Mann-Whitney's U test. The performance of the DTI-ALPS index to discriminate the groups was assessed using receiver operating characteristic (ROC) analysis. Correlations between the DTI-ALPS index and each CSF amyloid B (A $\beta$ ) 42, phosphorylated tau (p-tau) and total tau (t-tau) value were assessed in all subjects using Pearson's correlation analysis.

## RESULTS

The DTI-ALPS indices of both hemispheres were higher in the AD group than those of the non-AD group (Right: 1.72/1.59 for AD group/non-AD group; P value was 0.056; Left: 1.61/1.44 for AD group/non-AD group; P value was 0.002, indicating significant intergroup difference). The respective areas under the ROC curve of the DTI-ALPS index of the right/left hemispheres were 0.64/0.73. The DTI-ALPS indices of both hemispheres showed significant correlation with each p-tau value ( $r$ : 0.26/0.28 for right/left) and t-tau value ( $r$ : 0.28/0.31 for right/left), whereas no significant correlation with the CSF A $\beta$  42 value was identified, in all subjects.

## CONCLUSION

Impairment of the glymphatic system was more observed in non-AD pathology than in AD pathology in MCI. The DTI-ALPS index might be useful for discriminating early AD from other dementias as well as for measuring neurodegeneration in MCI.

## CLINICAL RELEVANCE/APPLICATION

Quantifying the activity of the glymphatic system may be a useful biomarker for diagnosing early AD as well as for measuring neurodegeneration in early dementia.

## M2-SPNR-3 Evaluate Depression in Parkinson's Disease with a Multi-Flip-Angle and Multi-Echo Gradient Echo Sequence (Multiplex) MRI



He Sui, MD,MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Previous multimodal MRI has proven to be a useful imaging approach for both clinical diagnosis and research investigating, however, studies of Parkinson's disease (PD) have focused primarily on motor-related basal ganglia structures and little research has been done on clinical scale indicators. In this experiment, we used multiparametric MRI to detect changes related to non-motor symptoms (NMS) in patients with PD.

## **METHODS AND MATERIALS**

We included 37 patients with PD diagnosed by two neurologists from August to December 2021 in our hospital in this retrospective study. Hamilton Depression Scale (HAMD) were used to assess the PD patients. 3D TIWI and Multi-Flip-Angle and Multi-Echo Gradient Echo Sequence (Multiplex) MRI techniques such as T2\*-w, T1-w, PD-mapping and quantitative susceptibility mapping (QSM) were performed using a 3T MR scanner. The regions of interest of the whole brain were depicted according to automatic brain segmentation based on deep learning. The Spearman's rank correlation coefficient was used to analyze the relationship between volume, relaxation value of each brain subregion and NMS related assessment scales

## **RESULTS**

Among parkinsonian subjects, we found that left paracentral, precuneus on both sides, and right superior temporal gyrus in MTP-QSM, right frontal pole and left lateral occipital gyrus on MTP-T2\* mapping showed correlations with HAMD. Volume of the left superior frontal gyrus, middle frontal gyrus on both sides, left frontal pole, insula on both sides, right middle cingulate gyrus, right entorhinal cortex, right superior temporal gyrus, right middle temporal gyrus and optic chiasm showed negative correlations with HAMD on 3D TIWI images. The indicators in MTP-T1 mapping and PD mapping do not have a clear correlation with HAMD.

## **CONCLUSION**

There is a certain degree of correlation between Multiplex MRI and some clinical evaluation indicators related to depression of PD, we suggest the fusion of quantitative multiparametric neuroimaging measures as an effective strategy that could generally cope with early diagnosis of PD.

## **CLINICAL RELEVANCE/APPLICATION**

Quantitative multiparametric neuroimaging measures may serve as an effective strategy for non-invasively characterizing the Parkinson's disease.

## **M2-SPNR-4 The Impact of Amyloid & Cerebral Small Vascular Disease on Glymphatic Function: A Study Based on Alzheimer's Disease Continuum Participants**

Hui Hong, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Glymphatic dysfunction is a crucial pathway for dementia. Alzheimer's Disease (AD) pathologies co-existing with cerebral small vessel disease (CSVD) is the most common pathogenesis for dementia. We hypothesize that AD pathologies and CSVD could be associated with glymphatic dysfunction, contributing to cognitive impairment.

## **METHODS AND MATERIALS**

Participants completed with amyloid PET, diffusion tensor imaging (DTI) and T2FLAIR sequences were included from the Alzheimer's Disease Neuroimaging Initiative (ADNI). White matter hyperintensities (WMH) as the most common CSVD marker was evaluated from T2FLAIR images and represented the burden of CSVD, amyloid PET was used to assess A $\beta$  aggregation in the brain, and DTI-ALPS calculated from DTI reflected glymphatic function. We used correlation analysis to investigate the relationship between WMH burden/A $\beta$  aggregation and DTI-ALPS and the correlations of DTI-ALPS with cognitive domains. Next, mediation analysis was carried out to explore the mediating effects of DTI-ALPS between WMH burden/ A $\beta$  aggregation and cognitive domains.

## **RESULTS**

One hundred and thirty-three participants along the AD continuum were included, consisting of 40 CN-, 48 CN+, 26 MCI+, and 19 AD + participants. We found both WMH burden ( $r = -0.432$ ,  $p < 0.001$ ) and whole brain A $\beta$  aggregation ( $r = -0.268$ ,  $p = 0.003$ ) were independently negatively associated with DTI-ALPS. There were no interaction effects of A $\beta$  aggregation and WMH burden on DTI-ALPS ( $\beta = 0.109$ ,  $p = 0.260$ ). DTI-ALPS was positively associated with memory ( $r = 0.470$ ,  $p < 0.001$ ), executive function ( $r = 0.356$ ,  $p < 0.001$ ), visual-spatial function ( $r = 0.241$ ,  $p < 0.040$ ), and language performance ( $r = 0.391$ ,  $p = 0.007$ ). In the mediation analysis, we found that DTI-ALPS mediated the relationship of WMH burden/A $\beta$  with memory, executive and language performance.



## CONCLUSION

Our study provided evidence that both AD pathology (A $\beta$ ) and CSVD were associated with glymphatic dysfunction, which is further related to cognitive impairment.

## CLINICAL RELEVANCE/APPLICATION

Our results may provide a theoretical basis for glymphatic function intervention for treating AD.

## M2-SPNR-5 Discordant Hippocampal Atrophy and Cerebral Hypometabolism in Alzheimer's Disease Subjects with Confirmed $\beta$ -amyloid Positivity

Gavin Yuan, BA (*Presenter*) Nothing to Disclose

### PURPOSE

Hippocampal atrophy on MRI and cerebral hypometabolism on FDG-PET are both widely used biomarkers of Alzheimer's disease (AD). Clinically, hippocampal volumes and FDG-avidity are assessed in comparison to age-matched reference groups, but accuracy of such methods have largely been tested in cohorts without biomarker-confirmed AD. Here, we examined the accuracy of MRI and FDG-PET in amyloid-positive AD, at the single-subject level, and factors that could be associated with structural-metabolic discordance.

### METHODS AND MATERIALS

We included 108 subjects with AD (age 74.5 $\pm$  8.2 years, 59:49 males: females) from the Alzheimer's Disease Neuroimaging Initiative (ADNI), with a positive 18F-florbetapir amyloid PET scan, who underwent FDG-PET and volumetric MRI. 179 amyloid-negative, normal controls (age 75.1 $\pm$  6.9 years, 97:82 males:females) served as the age-matched reference group. Bilateral hippocampal volumes were segmented using *FreeSurfer v7.1.1*, averaged, and normalized by intracranial volume. The same *FreeSurfer* regions were applied to the coregistered FDG-PET and normalized by the pons. A threshold of 1.5 standard deviations below the reference group defined biomarker abnormality (e.g. presence of hippocampal atrophy or cerebral hypometabolism). Two-by-two contingency tables were used to assess concordance/discordance between hippocampal atrophy and hypometabolism. Statistical analyses were performed in STATA 16, and group differences were assessed using the Kruskal-Wallis or Fisher's Exact Tests.

### RESULTS

Hippocampal atrophy correctly classified 40/108 (37%) subjects as AD, whereas precuneus cerebral hypometabolism correctly classified 51/108 (47%) subjects. Structural-metabolic discordance was seen in 47/108 (44%) subjects. Individuals with higher Fazekas scores were less likely to have hippocampal atrophy (OR 0.56,  $p=0.015$ ) or cerebral hypometabolism (OR 0.62,  $p=0.04$ ). Older individuals were less likely to have cerebral hypometabolism (OR 0.93,  $p=0.007$ ). Some subjects without a typical pattern of temporoparietal hypometabolism had significantly decreased FDG avidity in the caudate (5/108) and thalamus (3/108).

## CONCLUSION

Cerebral hypometabolism on FDG-PET and hippocampal atrophy on MRI each detected less than half of the amyloid-confirmed AD subjects. Discordance was high, suggesting that other factors, including age and microvascular disease, could affect the sensitivity of these biomarkers. Notably, the caudate and thalamus were atypical areas of hypometabolism that warrant further investigation.

## CLINICAL RELEVANCE/APPLICATION

Knowing the limitations of clinically used quantitative AD biomarkers is important for appropriate management.

## M2-SPNR-6 Defining the Relationship Between Mesial Temporal Atrophy and CSF Biomarkers in Amnesic Mild Cognitive Impairment

Allison K. Sullivan, MD, MPH (*Presenter*) Nothing to Disclose

### PURPOSE

The NIA-AA research framework introduced a classification scheme to define and stage the pathologic processes leading to Alzheimer's disease (AD) using three groups of biomarkers: biomarkers of  $\beta$ -amyloid deposition, neurofibrillary tangles deposition, and neurodegeneration. Our aim was to evaluate the differences in mesial temporal atrophy rate among amnesic mild cognitive impairment (MCI) patients with normal CSF biomarkers, CSF biomarkers indicating abnormal  $\beta$ -amyloid deposition (A+), and abnormal CSF biomarkers without  $\beta$ -amyloid deposition.

### METHODS AND MATERIALS

We retrospectively identified 401 elderly patients from the Alzheimer's Disease Neuroimaging Initiative cohort, 243 with a diagnosis of amnesic MCI and 158 cognitively unimpaired (CU). MCI patients were classified into three groups: normal biomarkers ( $n = 46$ ), Alzheimer's continuum (A+,  $n = 144$ ), and non-AD pathologic change (all other biomarker profiles,  $n =$

53). Hippocampal (HV) and entorhinal cortex (ERCV) volumes were calculated from brain MRI obtained during the first and second year of study participation. We then evaluated group differences over time using mixed model Analysis of Covariance procedures. Results were considered statistically significant when  $p < 0.05$ .

## RESULTS

HV and ERCV atrophy rates differed among groups of subjects when controlling for age (HV:  $F = 20.45$ ,  $p < 0.001$ ; ERCV:  $F = 11.86$ ,  $p < 0.001$ ). HV atrophy rate was greatest in the MCI A+ group than all other groups. Worse ERCV atrophy rates were observed in the MCI A+ group than CU elderly individuals and MCI subjects with non-AD pathologic change.

## CONCLUSION

Mesial temporal atrophy rate is worse in MCI subjects with abnormal  $\beta$ -amyloid deposition (A+) than other MCI individuals.

## CLINICAL RELEVANCE/APPLICATION

Understanding structural brain differences among patients with different biomarker profiles will enhance the design of clinical trials targeting MCI subjects, especially when MRI markers of neurodegeneration are employed as endpoint.

## M2-SPNR-7 PET-based A $\beta$ Quantification and Volumetric Comparisons in A $\beta$ -classified Patients

Priya Santhanam, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to identify associations between PET-based quantification of amyloid- $\beta$  (A $\beta$ ) and MR brain volumetrics in patients with or without radiological presence of A $\beta$  plaques.

## METHODS AND MATERIALS

Patients ( $n=164$ ; mean age=75.1 years) who were clinically identified as having mild cognitive impairment (MCI) and/or Alzheimer's dementia underwent 3T MRI anatomical imaging and PET CT imaging using A $\beta$  binding tracers Amyvid or Vizamyl. Neuroradiologist interpretation of PET-imaging allowed patients to be classified as positive ( $n=89$ ; A $\beta$ +) or negative ( $n=75$ ; A $\beta$ -) for A $\beta$  presence. NeuroQuant (v3.0) was used to obtain normalized percentile volumes in regions of interest for this patient population (based on previous findings), which were then compared between A $\beta$ + and A $\beta$ - groups. Quantified A $\beta$  tracer in these same regions acquired through newly-available PETQuant (3.0.2) software was also compared between groups. Finally, the statistical association between volumetrics and PET A $\beta$  quantities within regions was assessed via regression modeling.

## RESULTS

PET-based A $\beta$  quantities were significantly higher in A $\beta$ + patients for bilateral amygdala ( $p < 0.001$ ), entorhinal cortex ( $p < 0.001$ ), hippocampus (left:  $p = 0.001$ , right:  $p = 0.002$ ), and parahippocampal regions ( $p < 0.001$ ) as compared to A $\beta$ - patients. Additionally, normalized percentile volumes were significantly lower in the A $\beta$ + group for bilateral amygdala (left:  $p = 0.001$ , right:  $p = 0.005$ ), left hippocampus ( $p = 0.009$ ), and bilateral parahippocampus (left:  $p = 0.003$ , right:  $p = 0.033$ ). A regression model further identified significant associations between A $\beta$  quantity and volumetric percentile in the left entorhinal cortex ( $p = 0.005$ ), bilateral hippocampus (left:  $p = 0.009$ , right:  $p = 0.038$ ), and right parahippocampus ( $p = 0.046$ ).

## CONCLUSION

Decreased volumes and increased A $\beta$  quantities in limbic regions were observed in patients with clinical A $\beta$  positivity. In combination, NeuroQuant and PETQuant metrics provide a useful supplement to radiological examination in patients with MCI or Alzheimer's dementia. Further analysis is needed to determine any predictive value for patient classification and outcomes.

## CLINICAL RELEVANCE/APPLICATION

A $\beta$  classification in patients with MCI or Alzheimer's dementia can be further informed by quantified metrics of volume and A $\beta$  tracer quantities in limbic regions.

## M2-SPNR-8 The Study of Total Load of Imaging Combined with Cognition on Cerebral Small Vessel Disease in High Altitude Areas

Hai Hua Bao (*Presenter*) Nothing to Disclose

## PURPOSE

Cerebral small vessel disease (CSVD) is the most common cerebrovascular disease that can result in disability and cognitive decline in older adults. Owing to the unique environmental conditions, research on cerebral small vessel disease in high altitude areas is limited. The purpose of this study was to investigate whether altitude can affect cognitive function in patients with CSVD, and to evaluate the correlation between total imaging load and cognitive scores.

## METHODS AND MATERIALS

A total of 56 patients with CSVD who were admitted to the Department of Neurology of the Affiliated Hospital of Qinghai University were included in the study, according to the altitude, it is divided into middle altitude group (1500-2500 meters, n=30) and high altitude group (2500-4500 meters, n=26). Use Prisma 3.0 T magnetic resonance to perform head T1WI, T2WI, T2Flair, DWI, SWI and MRA scans, evaluate CSVD imaging markers and calculate the total load (0-4 points, the severity of the disease is proportional to the score). After the scan, the Cambridge Automated Neuropsychological Test Battery (CANTAB) was used to evaluate the cognitive abilities of all patients, including motor screening task (MOT), reaction time (RTI), rapid visual information processing (RVP), paired association learning (PAL), delayed matching to sample (DMS), spatial working memory (SWM), psychomotor speed, sustained attention, memory ability, and executive function were assessed separately. Data analysis was performed using SPSS 25.0 software.

## RESULTS

When the total load score was 0 or 1, The high altitude group performed poorly in the DMS test( $P=0.019$ ) and the RIT test( $P=0.024$ ); When the score was 2, there was statistically significant difference between the two groups in DMS ( $P=0.004$ ); when the score was 3 or 4, there was no statistical difference in the test results between the two groups ( $P>0.05$ ). The CSVD total load score was positively correlated with DMSMLAD, DMSMLS, and MOTML ( $r=0.614, 0.727, 0.448$ , all  $P<0.05$ )

## CONCLUSION

With the increase in altitude, the memory ability and psychomotor speed of CSVD patients decreased more significantly. In addition, with the aggravation of CSVD, memory ability and psychomotor speed will also decrease.

## CLINICAL RELEVANCE/APPLICATION

Cognitive function decline is more serious in patients with cerebral small vessel disease at high altitude, and it is very important to strengthen early diagnosis and clinical intervention for patients in high altitude areas.

## M2-SPNR-9 Brain Cortical Complexity and Subcortical Morphometrics in T2D with Microvascular Complication

Linqing Fu (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the relationship between the change of cerebral gray matter volume and cognitive function in type 2 diabetes patients with microvascular complication (T2D-C), and to analyze how the change of cerebral gray matter volume and cognitive function are causal links through mediators.

## METHODS AND MATERIALS

39 normal controls, 39 type 2 diabetes patients without microvascular complication (T2D), and 39 T2D-C patients were recruited for 3D T1weighted imaging (3D T1WI) scanning and neuropsychological scale testing. Voxel-based morphology (VBM) was used to analyze and compare the differences in gray matter volume and neuropsychological scale among the three groups, then the mean gray matter volume of different brain regions between groups was used for partial correlation analysis with the scores of cognitive assessment scales such as Montreal cognitive assessment (MoCA) and biochemical indicators such as HbA1c.

## RESULTS

With  $p<0.05$  as the test level of statistical difference, the brain regions with the statistical difference in gray matter volume among the three groups were located in the calcarine, thalamus, left putamen, and left precentral gyrus. Compared with T2D group, the volume of gray matter in the thalamus and left putamen in T2D-C group decreased. Partial correlation analysis showed that the thalamic gray matter volume and left putamen in T2D-C patients were negatively correlated with fasting blood glucose, positively correlated with HOMA2-%B, and negatively correlated with TMT-A score. Mediation analysis found that the direct effect of fasting blood glucose on TMT-A was not significant, but the indirect effect was significant, that is, the gray matter volume of the left putamen played a complete intermediary role in the relationship between fasting blood glucose and TMT-A.

## CONCLUSION

In T2D-C patients, there are extensive areas of reduced gray matter, and the change in gray matter volume is related to cognitive decline.

## CLINICAL RELEVANCE/APPLICATION

Early detection of cognitive impairment in T2D patients and targeted intervention can delay the progression of cognitive decline.

## Abstract Archives of the RSNA, 2023

M2-SPPD

### Pediatric Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPPD-1 Diffusion and Perfusion Properties of Fetal Brain and Placenta in Fetuses Affected by Intrauterine Growth Restriction (IUGR): A Preliminary IVIM MRI Study**

Roberta Ninkova, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the potential use of Intravoxel Incoherent Motion (IVIM) imaging in the study of microperfusion and microstructural characteristics of fetal brain and placenta in Intrauterine Growth Restriction (IUGR) fetuses, comparing IVIM parameters with those of a healthy control group.

#### **METHODS AND MATERIALS**

112 pregnancies (30 IUGR; 82 normal) were enrolled. MR examinations were performed at 1.5 T, using a DWI sequence with 10 different b-values (0,10,30,50,75,100,200,400,700,1000 s/mm<sup>2</sup>). For each fetus, specific ROIs were manually placed on fetal and maternal sides of each placenta, and for fetal brain on the following areas: centrum semi-ovale (CSO), frontal and occipital white matter (FWM, OWM), basal ganglia (BG), thalamus (TH), cerebellar hemisphere (CH) and pons. Differences of mean values of perfusion fraction (f), diffusion coefficient (D), and pseudo-diffusion coefficient (D\*) and their correlation with Gestational Age (GA) and Birth Weight (BW) were investigated in both IUGR and control group.

#### **RESULTS**

We found that in the fetal side of placenta, f allowed to discriminate SGA (Small for Gestational Age) from real FGR (Fetal Growth Restriction) ( $p=0.03$ ), with FGR showing lower values. SGA showed intermediate perfusion pattern in terms of f compared to FGR and healthy controls. A significant positive correlation was found between f and BW in fetal side of IUGR group. Concerning the fetal brain, we found higher D values in supratentorial WM areas compared with the other regions (TH, BG, pons, CH), in both normal and IUGR groups. In particular, higher D values in OWM and pons in IUGR fetuses compared to healthy group. A significant negative correlation between D and GA was found for almost all brain areas in the healthy group and conversely not in the IUGR group.

#### **CONCLUSION**

Complex interactions between placental and fetal environments ensure normal fetal growth. Impairment of the fetoplacental unit may lead to Intrauterine Growth Restriction (IUGR), which is associated with perinatal morbidity and mortality, and long-term complications, like neurodevelopmental delay. In order to this, the development of new non-invasive examinations, such as fetal MRI, may be helpful in detecting fetal abnormalities and understanding their pathogenesis. Specifically, the IVIM model, may be a novel technique to detect microstructural and microperfusion abnormalities of the placenta and fetal brain that occur in IUGR fetuses.

#### **CLINICAL RELEVANCE/APPLICATION**

Preliminary results show that IVIM parameters may be potential in vivo biomarkers of IUGR severity, improving prenatal and postnatal diagnosis and management of IUGR fetuses.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-SPPH

### Physics Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-SPPH-1 Reliability of CT Numbers on Energy Integrating and Deep Silicon Photon Counting Detector CT with Patient Mispositioning**

Aria M. Salyapongse, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In this study we compared the CT number of six clinically relevant materials on an energy-integrating detector (EID) and deep silicon photon-counting (PCD) CT as an effect of mispositioning for different patient sizes.

#### **METHODS AND MATERIALS**

We performed three sets of dose-matched scans on a patient size-mimicking phantom with five different water-equivalent diameters (WED) (Mercury Phantom, Gammex). The acquisition modes were: (1) 120 kV single-energy (SE) EID CT, (2) 80/140 kV rapid kV-switching dual-energy (DE) EID CT, and (3) 120 kV deep silicon PCD CT at four positions in the bore: (1) isocenter (0 cm), (2) up 4 cm, (3) up 8 cm, (4) and up 12 cm. Average CT number was calculated for air, water, polystyrene, iodine 10 mg/mL, bone, and polyethylene in (1) 120 kV polychromatic EID, (2) 70 keV monochromatic EID, and (3) 70 keV monochromatic deep silicon PCD images. Trends in CT number with WED for each position were assessed by plotting CT numbers against WED. Slopes were compared using t-tests with multiple comparison adjustment to assess whether trends in CT number with WED were decreased for deep silicon PCD CT relative to EID CT. CT number accuracy was assessed by calculating ideal material CT numbers using the U.S. National Institute of Standards and Technology (NIST) XCOM database toolkit.

#### **RESULTS**

For air, water, iodine, and bone materials, deep silicon PCD CT had the smallest magnitude slope of CT number over WED for all tested positions. Deep silicon PCD CT slopes are flatter compared with SE EID CT and reached statistical significance for iodine ( $p < .001$ ), and bone ( $p < .001$ ) for all positions, and for air ( $p = .008$ ) and water ( $p = .01$ ) at three positions. Deep silicon PCD CT slopes were flatter compared with DE EID CT and reached statistical significance for air ( $p = .005$ ), water ( $p = .04$ ), and bone ( $p < .001$ ) for all positions, and for iodine ( $p = .04$ ) at three positions. The accuracy of deep silicon PCD CT was higher than either SE or DE EID CT for all materials at all positions except for polystyrene at 12 cm, based on relative root mean square error.

#### **CONCLUSION**

WED contributes more to CT number change than mispositioning. The change in CT number over WED was smallest for deep silicon PCD CT for air, water, and bone at all tested positions. The CT number accuracy was also closest to the ideal CT number on deep silicon PCD CT for all materials at all positions except polystyrene at 12 cm, compared with SE and DE EID CT.

#### **CLINICAL RELEVANCE/APPLICATION**

Accurate and stable CT numbers are important for clinical diagnoses, and use of deep silicon PCD CT provides more stable and accurate CT number over patient size and mispositioning compared with SE and DE EID CT.

#### **M2-SPPH-10 Dual-Energy CT-based Low Energy Virtual Monoenergetic Imaging of the Lower Extremity Runoff in Patients with Diabetes Mellitus: Impact on Image Quality, Vascular Contrast and Diagnostic Accessibility**

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

## PURPOSE

To evaluate the impact of low energy virtual monoenergetic imaging (VMI)+ dual-energy CT reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of lower extremity arteries in patients with diabetes mellitus.

## METHODS AND MATERIALS

Dual-energy CT angiography scans of lower extremities in patients suffering from diabetes who had undergone clinically indicated dual-energy CT examinations between January 2018 and January 2023 were retrospectively analyzed. Images were reconstructed with standard linear blending (F\_0.5) and low keV VMI+ series were generated from 40 to 100 keV, in an interval of 15 keV. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). A total of five CT number measurements per vessel were performed in the superficial and deep femoral artery, the popliteal artery, proximal anterior and posterior tibial artery as well as the fibular artery. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of lower extremity arteries.

## RESULTS

Our final study cohort consisted of 154 patients (82 males). Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU,  $1180.41 \pm 45.09$ ; SNR,  $29.91 \pm 0.99$ ; CNR,  $28.60 \pm 1.03$ ) followed by 55 keV VMI+ reconstructions; all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard F\_0.5 images (HU,  $251.32 \pm 7.13$ ; SNR:  $13.22 \pm 0.44$ ; CNR:  $10.57 \pm 0.39$ ) ( $p < .0001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 and 70 keV VMI+ series with a significant difference compared to standard F\_0.5 images regarding image quality, vascular contrast and diagnostic assessability of lower extremity arteries ( $p < .0001$ ).

## CONCLUSION

Low keV VMI+ reconstructions at a level of 40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of lower extremity arteries in patients with diabetes mellitus compared with standard CT series.

## CLINICAL RELEVANCE/APPLICATION

In patients with diabetes mellitus undergoing dual-energy CT scans of lower extremity arteries, low keV VMI+ CT reconstructions at a level of 40-55 keV should be routinely reconstructed in clinical routine to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

## M2-SPPH-11 Combining K-edge Filtration and Dual-layer CT for Improved Spectral Performance in Pediatric Diagnostics

Olivia F. Sandvold, BS (*Presenter*) Nothing to Disclose

## PURPOSE

In pediatric spectral CT, accurate quantitative performance with low radiation doses is imperative. Our study demonstrates the effectiveness of using a combination of a K-edge filter and dual-layer spectral detector to increase the quantification sensitivity of iodine and calcium in pediatric patients.

## METHODS AND MATERIALS

A polychromatic simulation based on a clinical dual-layer spectral CT (Spectral CT 7500, Philips Healthcare) was used to generate incident spectra at tube voltages of 100 and 120 kVp with radiation exposure of 33 mAs. An optimal K-edge filter material and thickness (holmium 0.15 mm) was selected from other potential filters using the Cramer-Rao lower bound of noise in the iodine domain for a single pencil-beam x-ray projection at the central detector. To model the combination of the K-edge filter and dual-layer CT, the input spectra were filtered and linearly scaled to match the patient dose of the non-filtered cases. The spectra were then applied to noiseless photoelectric and Compton scatter basis projections of three pediatric phantoms containing tissue equivalent inserts (iodine 0.5 mg/mL, iodine 2.0 mg/mL, blood, calcium 50 mg/mL). The phantoms ranged in diameter from 10 to 20 cm. Using fan beam geometry, Poisson noise was added, a material decomposition look-up table approach was used, and filtered back projection reconstruction was performed to generate photo/scatter basis images with realistic noise. To estimate spectral sensitivity, noise was measured for each insert in the photoelectric image, and a corresponding noise ratio relative to K-edge filtered simulations was calculated to compare filtered and non-filtered simulations.

## RESULTS

At 100 kVp and across all three phantom sizes, the holmium filter and dual-layer CT combination compared to the non-filtered simulation averaged 11% and 10% improvement in photoelectric noise in iodine 0.5 mg/mL and iodine 2.0 mg/mL inserts, respectively. Average filtered noise improvement at 120 kVp was 3% and 5% for the same rods. For the calcium



insert, the maximum relative noise improvement was 17% in the 20 cm phantom at 100 kVp. To match non-filtered patient dose, tube exposure was 93 and 85 mAs for 100 and 120 kVp scans.

## **CONCLUSION**

Combined holmium K-edge filtration with dual-layer CT increased iodine and calcium sensitivity in pediatric scans at 100 and 120 kVp with radiation exposures within tube capability. This could lead to increased iodine and calcium quantification accuracy and reduced additional non-contrast scans for pediatric patients.

## **CLINICAL RELEVANCE/APPLICATION**

The combination of K-edge filtration with dual-layer CT may enhance iodine and calcium quantification accuracy and reduce need for additional non-contrast scans in pediatric diagnostic imaging.

## **M2-SPPH-12 A Comparative Study of Extracellular Volume Fraction Measured by Spectral CT Between Liver and Pancreas in Patients with Hypertension**

Xiaoming Huang (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate the correlation between extracellular volume fraction of liver and pancreas measured by spectral CT iodine maps and hypertension-related indicators and to compare their diagnostic value.

## **METHODS AND MATERIALS**

166 patients who underwent abdominal spectral CT enhancement scanning were included. They were divided into a normal blood pressure group and a hypertension group according to whether they had hypertension. Then, the hypertension group was further divided into three subgroups according to the systolic and diastolic blood pressure levels. The fECV was calculated by measuring the iodine density (ID) of the liver and abdominal aorta from the iodine maps in equilibrium phase as follows:  $fECV = ID_{\text{hepatic or pancreatic}} \times (100 - Hct) / ID_{\text{Abdominal aorta}}$ . One-Way ANOVA analysis was used to compare fECV values among groups. Spearman correlation analysis was used to analyze the correlation between fECV and blood pressure-related indicators, i.e., systolic blood pressure, diastolic blood pressure, pulse pressure. Multiple linear stepwise regression equations were established to obtain the quantitative relationship between fECV and blood pressure-related indicators. ROC curves were used to evaluate the diagnostic performance of hepatic and pancreatic fECV for hypertension.

## **RESULTS**

The hepatic fECV ( $36.42 \pm 5.20$ ) and pancreatic fECV ( $36.64 \pm 5.46$ ) of patients with hypertension were significantly higher than those patients with normal blood pressure ( $30.17 \pm 4.12$ ,  $33.45 \pm 3.41$ ) and increased with the enhancement of hypertension level. The fECV of liver and pancreas were positively correlated with SBP ( $r=0.57$ ,  $0.42$ ) and DBP ( $r=0.33$ ,  $0.32$ ). Multiple linear regression analysis showed that SBP entered the equation finally ( $\beta=0.105$ , constant= $18.520$ ;  $\beta=0.119$ , constant= $17.528$ ). The AUC for diagnosing hypertension through hepatic fECV was  $0.830$  (SEN 61.50%, SPE 88.00%, cut-off value 34.16%) and the AUC for diagnosing hypertension through pancreatic fECV was  $0.663$  (SEN 53.00%, SPE 94.70%, cut-off value 37.93%). Comparing the two AUCs, the accuracy of hepatic fECV was higher than that of pancreatic fECV and the difference was statistically significant ( $P < 0.05$ ).

## **CONCLUSION**

The fECV of liver and pancreas measured by spectral CT iodine maps was related to hypertension-related indicators. SBP was an independent risk factor for elevating both hepatic and pancreatic fECV. The hepatic fECV was more helpful for diagnosing hypertension.

## **CLINICAL RELEVANCE/APPLICATION**

The fECV obtained by dual energy spectral examination is a convenient biomarker to assess the liver and pancreas chronic injury. The fECV derived from spectral CT iodine maps had clinical application values for studying the chronic damage of abdominal organs caused by hypertension.

## **M2-SPPH-2 Imaging Parameters Affecting Stone Detection using Virtual Unenhanced Images at Excretory Phase in Contrast-enhanced Dual-energy CT Urography**

Jianying Li, PhD (*Presenter*) Employee, General Electric Company

## **PURPOSE**

To investigate the imaging parameters influencing urinary stone detection rate with virtual unenhanced (VUE) images obtained at the excretory phase (EP) in contrast-enhanced dual-energy CT urography (DECTU).

## **METHODS AND MATERIALS**

150 urinary stone patients (mean age:  $47.51 \pm 14.42$  years; males vs females: 101 vs 49) who required triphasic DECTU were analyzed. The true unenhanced (TUE) and VUE images at EP (VUE(EP)) were obtained. Per stone detection rates on the

above images were recorded. Stone location, size and CT number on the TUE images were recorded and used in univariate and multivariate logistic regression analyses to investigate imaging factors influencing urinary stone detection rate on VUE(EP) images. In addition, five contrast agents were included in the regression analyses. Thresholds for detecting urinary stone on VUE(EP) images were determined using receiver operating characteristics (ROC) analysis.

## **RESULTS**

Three hundred and four stones were detected on TUE images; 217 stones were identified on VUE(EP) images (detection rate, 71.4%). Size (Univariate Multivariate:  $p < 0.001$ ) and CT number (Univariate Multivariate:  $p < 0.001$ ) of the stones were both important factors affecting the detection of stone on the VUE(EP) images (Tab.1). The stone detection rate in the urinary tract was significantly higher than that in the kidney (Univariate Multivariate:  $p < 0.01$ ) (Tab.1 and Fig. 1). However, different contrast agents did not affect the detection rate ( $p = 0.547$ ). The area under ROC curve (AUC) of using size and CT number for detecting stone on the VUE(EP) images was only 0.80 and 0.80, respectively with thresholds for stones with size larger than 3.3 mm and CT number greater than 615 HU being detected. After adding the stone location, the AUC of the three parameters can reach up to 0.88 (Tab.2 and Fig. 2).

## **CONCLUSION**

VUE images at EP in DECTU has a relatively low detection rate for urinary stones. Stone location, size and CT number have significant impact on the stone detection rate using VUE(EP) images.

## **CLINICAL RELEVANCE/APPLICATION**

VUE images at EP in DECTU are not suitable for detection of urinary stones. Stone location, size and CT number may have an impact on the stone detection rate.

## **M2-SPPH-3 Mobile Photon-counting Detector CT with MD Plus for Neuroimaging of Patients in Intensive Care Unit**

Junyoung Park (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study is to evaluate our developed multi-material decomposition method (MD Plus) with mobile PCD-CT for neuroimaging of patients at ICU, and prove the characterization and differentiation of materials between contrast agent and hemorrhage in high-density lesions.

## **METHODS AND MATERIALS**

For neuroimaging of patients at ICU, the MD Plus was developed and optimized. All CT scans were performed with the FDA 510(k) cleared mobile PCD-CT (OmniTom Elite). For verification of the accuracy of our MD plus algorithm with the mobile PCD-CT, the experiments were conducted using a multi-energy phantom with various exposure conditions and locations of contrast agent. To prove the material characterization of neuroimaging of patients at ICU, our MD plus algorithm was applied to the patients who underwent mobile PCD-CT. The ability of differentiation between iodine and hemorrhage was evaluated.

## **RESULTS**

The results of multi-energy phantom with different exposure showed that there is no critical artifacts on material decomposition maps with various exposure settings. The measured iodine concentrations of each exposure setting were compared to the ground truth. The linear relationships were observed the measured and true iodine concentrations and the coefficient of determinations ( $R^2$ ) for 5, 10, 15, 20 mA were 0.994, 0.995, 0.996, 0.998 respectively. The results of different contrast demonstrated that the material maps were comparable and the difference ratio was 3.644%. The results of neuro-images of patients at ICU demonstrate the key benefits of our MD plus algorithm with mobile PCD-CT: the regions of intracerebral hemorrhage are clearly visible in material decomposition map. Also, the consistent and repeatable ability to show iodine concentration in material map regardless of different patients was proved.

## **CONCLUSION**

Our quantitative results of multi-energy phantom verified the accuracy of our MD plus algorithm. In addition, the qualitative results regarding clinical cases of patient at ICU demonstrate that our MD plus algorithm with mobile PCD-CT can separate the contrast agent from the blood accurately. The differentiation of iodine and hemorrhage or acute ischemic stroke can be used in high density lesions after intra-arterial recanalization.

## **CLINICAL RELEVANCE/APPLICATION**

The accurate results of MD plus algorithm with mobile PCD-CT can lead to simplified clinical imaging protocols and improved workflow for neuroimaging of critical patients with the risks associated with transportation and life-threatening illness.

## **M2-SPPH-4 Self-Supervised Deep Learning Methods for Photon Counting CT (PCCT) Denoising without Clean References**

Sen Wang, PhD (*Presenter*) Research support, General Electric Company



## PURPOSE

To evaluate the performance of self-supervised methods for PCCT image denoising from routine scans, without repeat scans or clean images. These methods include: Noise2Noise (N2N), Noisier2Noise (Nr2N), and Noise2Void (N2V).

## METHODS AND MATERIALS

For clinical images, clean references are difficult to obtain, as noise is always present. Typically, synthetic low-dose images and full-dose images are used as training input and reference, namely Noise2Full-dose (N2Fd), where the inherent noise correlation degrades the result. Alternatively, several self-supervised learning methods have been proposed. N2N is supposed to be equivalent to Noise2Clean (N2C; trained with clean references). For PCCT scans, binomial selection can be used to create the noise independent pairs required in N2N; Nr2N leverages N2Fd which contains residual noise proportional to the synthetic low-dose noise. Thus, it is possible to cancel the residual noise with careful post-processing. To evaluate their performances, we converted clinical images from the KiTS21 Challenge to water and Ca density maps and simulated PCCT scans using a 120 kVp spectrum and a realistic energy response. For simplicity, the total counts were used to create a grayscale image. The dataset was split into train (211) / validation (30) / test (59) cases (5 slices from each case). A basic U-Net was trained for 90 epochs, minimizing L2 loss. Dose was split evenly using binomial selection for N2N. N2V was also included in our comparison.

## RESULTS

All methods reduced the original RMSE of the test set from 27.70 HU. Average RMSE in the test set was 12.37 HU for N2N, which was equivalent to that of N2C (12.38 HU). N2Fd, which violates the independence criterion, had suboptimal results (17.82 HU). Nr2N improved the performance of N2Fd to 13.30 HU. N2V (24.37 HU) had the worst performance since CT images violate its requirement of spatially uncorrelated noise. While Nr2N performed well, we found that the performance relies heavily on the convergence of N2Fd. With a limited amount of training data, the convergence of N2Fd might be incomplete, leading to suboptimal results for Nr2N.

## CONCLUSION

Among the representative self-supervised learning methods, N2N yields the best performance, approaching that of N2C while only requiring routine scans. Nr2N can effectively improve the performance of N2Fd with proper training and post-processing, but is slightly inferior to N2N. Future work will investigate the applicability of N2N to real data, as well as more sophisticated networks and loss functions.

## CLINICAL RELEVANCE/APPLICATION

We evaluated representative self-supervised learning methods for PCCT image denoising that can use routine scans to train a denoising network without a clean (noiseless) reference.

## M2-SPPH-5 Feasibility and Accuracy in Calcium Quantification of the Turbo Flash Mode on a Clinical Photon Counting Detector CT System: A Phantom Study

Shan Shui Zhou (*Presenter*) Nothing to Disclose

## PURPOSE

The high-pitch scan mode on a first-generation clinical dual-source photon counting detector (PCD) CT system can be used for energy analysis, which is helpful for calcium quantification. However, its performance has not been validated because the high-pitch scan could not obtain the energy spectrum information by the energy-integrating detector dual-source CT. The purpose of this study is to evaluate the feasibility and accuracy of calcium quantification in the high-pitch scan on PCD-CT.

## METHODS AND MATERIALS

A Gammex<sup>TM</sup> multi-energy CT phantom with three calcium inserts (50, 100, and 300 mg/ml), with and without the elliptical outer layer, was evaluated using a high-pitch (3.2) and regular (0.8) spiral modes on a PCD-CT. Each scan setting was repeated three times with two tube voltages (120 and 140 kVp) and 4 radiation doses (1, 3, 5, and 10 mGy). Calcium maps were generated by adjusting the specific calcium ratio in post-processing and the mean calcium attenuation (CaCT) across three consecutive slices were recorded. Linear regression and Pearson correlation coefficient was implemented for accessing the correlation between CaCT in all scan settings and calcium concentration. The root-mean-squared-error (RSME) was calculated and compared between the high-pitch and regular spiral scans.

## RESULTS

For all scan settings, the extremely strong correlations between CaCT and calcium concentration were proven by the statistically significant linear regressions (all R-square  $>$ ; 0.99,  $p$   $<$ ; 0.05) and Pearson correlation coefficients (all  $r$   $>$ ; 0.99). The conversion slope ranged from 0.310 to 0.354 mg/mL/HU for the high-pitch scans and from 0.315 to 0.361 mg/mL/HU for the regular spiral scans. The largest RMSE was witnessed in the high-pitch scans of the large phantom at 140 kVp and 1 mGy. The median [interquartile range] RMSE demonstrated similar calcium quantification abilities between the high-pitch and the regular spiral scans (1.25 [0.81; 2.75] versus 0.90 [0.68; 1.50] mg/mL,  $p = 0.152$ ).

## CONCLUSION

The high-pitch scan mode with full spectral information offers feasible and accurate calcium quantification using the dual-source PCD-CT.

## CLINICAL RELEVANCE/APPLICATION

Accurate calcium quantification by high-pitch scans on PCD-CT even under ultra-low doses could be promising for bone density screening.

## M2-SPPH-6 Decomposition of CT Contrast Agents: Single or Multiple Photon Counting CT Scans? Single or Dual Source PCCT?

Marc Kachelriess, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

With the beginning of the photon counting CT (PCCT) era, claims are being made that scanning two contrast agents simultaneously is beneficial in terms of dose. Our aim is to quantify the supposed benefit or the possible harm.

### METHODS AND MATERIALS

PCCT inherently records spectral information. Moreover, the only clinically approved PCCT system, the Naeotom Alpha, is a dual source CT (DSCT): both x-ray tubes can operate at different kV and can utilize different patient-specific prefilters (PSPs), e.g. tin. With PCCT it becomes possible to distinguish more than two materials. Potential applications focus on using two contrast agents, e.g. X=iodine and Y=hafnium. The simultaneous application of two such agents is claimed to be advantageous, e.g. in a way such that the arterial phase of an abdominal acquisition shows X and the venous phase is enhanced by Y. Is this strategy, WXY, with W being the soft tissue, better than two scans W+WX or WX+WY, assuming no patient motion in-between? Or would even three scans, e.g. W+WX+WXY be optimal? To find out, we conducted a study simulating various patient sizes, tube voltages from 70 to 150 kV, four different PSP thicknesses, and all possible bin settings of a photon counting detector to assess the dose-normalized signal-to-noise-ratio (SNRD) of the resulting virtual non-contrast images, and the contrast agent maps of X and Y. No additional noise reduction strategies were applied in order to obtain a fair comparison. Dose penalty (DP) factors are given by the squared ratio of the SNRD values.

### RESULTS

With just one agent, X=Iodine, doing WX (single source PCCT) instead of W+WX (two scans) yields  $DP=2.6$ . Doing WX+WX (DSCT) instead of W+WX yields  $DP=1.6$ . With two agents, X=Iodine, Y=Gadolinium, WXY comes with  $DP=1.5$  when compared to WX+WY and with  $DP=2.0$  when compared to W+WXY. Surprisingly, WXY+WXY, which can be realized by a DSCT scan, is only slightly ( $DP=1.25$ ) outperformed by W+WXY, which requires two separate scans. By far the best performance is obtained by W+WX+WY and by W+WY+WXY ( $DP=3.2$  if doing WXY instead), which, however, require three scans.

## CONCLUSION

For the task of providing contrast agent maps, simultaneous contrast agents always come with a penalty in the order of 1.5 to 3.2 which means that the 1.5- to 3.2-fold patient dose is necessary. If motion between two non-simultaneous scans could be perfectly corrected for, patient dose and thus patient risk could be drastically reduced. In particular, if an unenhanced scan (W) is performed in addition to the enhanced scan(s).

## CLINICAL RELEVANCE/APPLICATION

As long as no motion-compensation between scans can be performed, the currently proposed scan strategies are unavoidable. Once motion can be compensated for, scans should be separated into different contrast enhancement schemes.

## M2-SPPH-8 The Accuracy of Monoenergetic Attenuation at High-pitch Scans using A Dual-source Photon-counting Detector CT: A Phantom Study

Le Qin (*Presenter*) Nothing to Disclose

### PURPOSE

High-pitch scans performed on a dual-source photon-counting detector CT (PCD-CT) enable reconstructions of virtual monoenergetic imaging at different keV levels. However, the accuracy of monoenergetic attenuation at high-pitch acquisition remains unknown. Thus, the purpose of this study is to evaluate the monoenergetic accuracy of iodine inserts between the regular spiral scan and the high-pitch scan on a first-generation clinical dual-source PCD-CT.

### METHODS AND MATERIALS

The Gammex<sup>TM</sup> multi-energy CT phantom containing iodine inserts of 2, 5, 10 and 15 mg/mL was scanned on a dual-source PCD-CT, with and without the elliptical outer layer. Two pitch levels (3.2 and 0.8), two tube voltages (120 and 140 kVp) and 4 radiation doses (1, 3, 5 and 10 mGy) were alternated, and each scan setting was repeated three times. The image noise in the background and monoenergetic accuracy of the iodine inserts were evaluated at 40, 70, 100 and 140 keV. The median

attenuation errors and absolute attenuation bias were further assessed with linear regression to explore the impact of phantom setup and scan parameters.

## RESULTS

The background noise increased with lower keV level and radiation doses. The noise levels between high-pitch and regular spiral scans were evidently different for the large phantom at 40 and 70 keV, especially when radiation dose decreased. In the small phantom, the median attenuation errors at 1, 3, 5 and 10 mGy were 5.5 (1.8; 10.5) [median, (25th percentile; 75th percentile)], 5.9 (1.3; 10.6), 6.0 (2.1; 10.1) and 5.7 (2.6; 13.6) HU, respectively. Similarly, the errors were 3.3 (-2.5; 13.9), 4.1 (-1.6; 11.7), 4.1 (-1.0; 11.2) and 4.6 (-1.0; 12.9) HU in the large phantom. At the worst-case scenario, the attenuation bias exceeded 10 HU in 14.6% (7 of 48 measurements for 4 inserts, 4 keV levels and 3 scan repeats) and 29.2% (14 of 48) for the small and large phantom setups, respectively. The linear regression revealed comparable monoenergetic accuracy between high-pitch and regular spiral scans ( $p = 0.332$ ). Compared to the 70 keV, images at 40 keV and 140 keV were associated with statistically significant (6.6 HU and 1.6 HU, both  $p < 0.001$ ) higher attenuation bias.

## CONCLUSION

The high-pitch scans exhibited similar monoenergetic accuracy with the regular spiral scans, although the attenuations at 40 keV and 140 keV still required careful interpretation.

## CLINICAL RELEVANCE/APPLICATION

The monoenergetic images with high-pitch scans enabled by the dual-source PCD-CT provide accurate attenuation and could be quantitatively used in conditions requiring fast acquisition such as pulmonary embolism, chest pain triad and ruptured cerebral aneurysm.

## M2-SPPH-9 Comparison of Iodine Quantification between High-pitch and Regular Spiral Scans using a Dual-source Photon-counting Detector CT: A Phantom Study

Peng Liu (*Presenter*) Nothing to Disclose

## PURPOSE

With the advent of the dual source photon-counting detector CT (PCD-CT), material decomposition at high pitch could become a clinical reality and potentially exhibit unprecedented diagnostic value. However, its accuracy has not been validated so far. Thus, the purpose of this study is to investigate the accuracy of iodine quantification in a phantom setup and compare the performance between high-pitch and regular spiral scans based on the first-generation clinical PCD-CT.

## METHODS AND MATERIALS

Four inserts with known iodine concentrations (2, 5, 10 and 15 mg/mL) were placed in the removable head section of a Gammex<sup>TM</sup> multi-energy CT phantom. The phantom, with and without the elliptical outer layer, was scanned using high-pitch (3.2) and regular (0.8) spiral modes on a dual-source PCD-CT. Two tube voltages (120 and 140 kVp) and 4 radiation doses (1, 3, 5 and 10 mGy) were also alternated, and each scan setting was repeated three times. The mean iodine measurements across three consecutive slices were recorded, and the association between the percentage absolute bias (PAB, normalized to the actual reference) and all scan factors was explored using a linear regression analysis.

## RESULTS

A total of 96 acquisitions were performed with both phantom setups and all variations of scan parameters. In the small phantom, the PAB ranged from 1.8% to 5.9% and 1.5% to 3.2% for high-pitch and regular spiral acquisitions, respectively, across different radiation doses and tube voltages. The bias appeared more pronounced in the large phantom (4.4% to 8.5% for high-pitch and 2.5% to 6.8% for regular spiral). The linear regression analysis revealed that scan modes, tube voltages and radiation doses were all statistically irrelevant ( $P > 0.05$ ) to the iodine measurement bias. Compared to the phantom with the outer layer, the small phantom was significantly associated ( $p < 0.001$ ) with 7.2% fewer PAB.

## CONCLUSION

Iodine density can be accurately and reliably quantified with the high-pitch scan mode, whose ability of material decomposition was only recently brought by the advent of the dual-source PCD-CT.

## CLINICAL RELEVANCE/APPLICATION

High-pitch scans on PCD-CT ensures accurate iodine quantification even in low radiation doses, thus enabling clinical applications which require fast acquisition such as in pediatrics, pulmonary embolism and acute ischemic stroke.

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## Abstract Archives of the RSNA, 2023

M2-SPVA

### Vascular Imaging Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

### M2-SPVA-2 Assessment of Diagnostic Efficacy of Photon Counting CT Virtual Mono-Energetic Imaging for Abdominal Aortic and Pelvic Vascular Imaging in Patients Prior to Transcatheter Aortic Valve Replacement (TAVR)

Leona Alizadeh, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our study aim was to evaluate the diagnostic efficacy of photon counting CT (PCCT) virtual mono-energetic (VMI)+ imaging for low-keV abdominal and pelvic vascular imaging and TAVR planning.

#### METHODS AND MATERIALS

A total of 125 patients (69 male/ 56 female) underwent PCCT imaging pre-TAVR for assessment of the abdominal aorta and pelvic vessels for transfemoral access planning. Virtual mono-energetic images (40 - 120 keV) were generated in 15 keV steps from the spectral post-processing datasets (SPP). For assessment of quantitative image quality, SNR and CNR were calculated from measurements in the infrarenal aorta, common iliac artery, internal iliac artery, external iliac artery, and common femoral artery. Qualitative IQ, diagnostic significance, and vascular contrast were evaluated in a blinded manner by four experienced radiologists, using a 5-point Likert scale with clinically relevant criteria.

#### RESULTS

The highest mean SNR and CNR values of the VMI+ series were found in 40 keV reconstructions (SNR  $32.5 \pm 9.5$  CNR  $33.3 \pm 9.8$ ), followed by the measurements in the 55 keV VMI+ (SNR  $25.0 \pm 8.0$  CNR  $26.3 \pm 7.8$ ) ( $p < 0.001$ ). SNR and CNR of 40 keV and 55 keV were significantly higher than all other keV levels including standard 120 kV (SNR  $10.7 \pm 3.0$ ; CNR  $26.2 \pm 9.5$ ) ( $p < 0.001$ ). Accordingly, mean HU-values of 40 keV VMI+ reconstructions were significantly higher at  $1401 \pm 18$ , followed by  $748 \pm 14$  for 55 keV reconstructions ( $p < 0.001$ ). The IQ rating using the Likert scale was higher for the virtual mono-energetic images at 55 keV compared to 40 keV ( $4.6 \pm 1.6$  vs.  $3.9 \pm 1.8$ ) ( $p < 0.001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images series regarding image quality, vascular contrast and diagnostic assessability for the femoral access planning ( $p < .0001$ ).

#### CONCLUSION

Our findings suggest that PCCT virtual mono-energetic imaging provides higher SNR and CNR values and better IQ than conventional CT imaging for the abdominal aorta and pelvic vessels at 40 keV. However, for qualitative image quality, 55 keV may be preferred.

#### CLINICAL RELEVANCE/APPLICATION

Choice of the right VMI+ reconstruction, allows for use of the diagnostic quality reserve for potential reduction in contrast agent and radiation dose. Further, low-keV VMI+ PCCT reconstructions with enhanced diagnostic quality for TAVR procedure planning may improve patient safety.

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## Abstract Archives of the RSNA, 2023

M5A-SPBR

### Breast Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPBR- Added Value of Contrast-enhanced Digital Mammography (CEDM) in BI-RADS 3 Lesions** 1

Christofis Charalambous, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our study is to evaluate if our cancer detection rate in our institution for BI-RADS 3 lesions was less than 2%, and to assess if our detection rate could be improved by using contrast-enhanced digital mammography (CEDM).

#### **METHODS AND MATERIALS**

A total of 473 BI-RADS 3 patients depicted on screening mammogram from 2018 to 2020 were collected from our files. All the patients consented to undergo CEDM and biopsy at their next hospital visit. Contrast enhancement intensity categorized as follows: a) Type -1: negative enhancement, b) Type 0: no enhancement c) Type 1: moderate enhancement, d) Type 2: intense enhancement and/or e) Type BE: background enhancement. Pathology results confirmed 473 lesions in total.

#### **RESULTS**

18 (3,81%) out of the 473 lesions were diagnosed as malignant. The mean age of the patients was 56,22 years. On the contrary, 455 (96,89%) lesions were benign. The mean age of these patients was 51,04. Using CEDM's technique data a total of 5 (1,95%) out of 256 lesions with Type -1 and Type 0 enhancement were diagnosed as malignant and 251 (98,05%) were benign. Additionally, a total of 13 (5,99%) out of 217 lesions with any type of enhancement were proved as malignant and 204 (94,01%) were proved as benign. Negative or no enhancement of a BI-RADS 3 lesion at CEM technique shows 1,95% possibility to be malignant, which is 1,86% better than digital mammography alone.

#### **CONCLUSION**

Our study confirms CEDM's added value in BI-RADS 3 lesions evaluation, regarding the positive impact on more accurate staging in the first categorization.

#### **CLINICAL RELEVANCE/APPLICATION**

The use of CEDM on a BI-RADS 3 lesions could potentially predict more accurately benign entities, based on their type of enhancement, and thus play a key role as first line mammography.

#### **M5A-SPBR- Diagnostic Accuracy of Thoracic Photon-counting Computed Tomography for Locoregional Staging of Breast Cancer: A Prospective Trial** 2

Jakob Neubauer, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study was to demonstrate the feasibility of complementary locoregional staging of breast cancer in thoracic photon-counting CT (PC-CT) and determine diagnostic performance compared to digital mammography (DM) with MRI as the reference standard.

#### **METHODS AND MATERIALS**

This prospective clinical cohort study included patients with newly diagnosed breast cancer and indication for CT staging of the thorax over a period of 12 months. Patients underwent contrast-enhanced thoracic PC-CT (NAEOTOM Alpha, Siemens Healthineers) and breast MRI in prone position. PC-CT and DM were rated by two independent radiologists regarding the diameter of the largest mass, infiltration of cutis/pectoral muscle/ thoracic wall, number of masses, adjacent DCIS, tumor conspicuity, and diagnostic confidence in a blinded fashion. Reference standard was generated from a consensus reading of

MRI by an independent adjudication committee including all histopathological/clinical data. Statistical analysis comprised calculation of Cohen's kappa, Spearman's rho, and pooled measures of diagnostic accuracy.

## RESULTS

Among 32 enrolled female subjects (mean age 59 [SD 13.0]) diagnostic accuracy for T-classification (TNM8thEd.) was higher for PC-CT compared to DM (0.94 vs. 0.50;  $p < 0.01$ ) and the number of detected tumor masses were more strongly correlated with the reference standard compared to DM (0.72 vs. 0.50;  $p < 0.01$ ). Furthermore, sensitivity and specificity for DCIS were higher in PC-CT compared to DM (0.83 and 0.99 vs. 0.25 and 0.80;  $p < 0.04$ ). Average kappa values for inter-reader reliability were higher for PC-CT than DM (mean 0.88 vs. 0.54, respectively;  $p = 0.01$ ).

## CONCLUSION

Locoregional breast cancer staging using contrast-enhanced thoracic PC-CT outperformed digital mammography, with significant improvements in diagnostic accuracy for T-classification, number, and pattern of tumor masses.

## CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced thoracic PC-CT might help provide a more accurate locoregional staging for breast cancer compared to digital mammography.

## M5A-SPBR- Contrast Enhanced Mammography: Results after 10 Years of Breast Cancer Screening 3

Nisim Rahman, BA (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the efficacy of contrast-enhanced mammography (CEM) in detecting breast cancer over a ten-year period in women with intermediate breast cancer risk or dense breasts.

## METHODS AND MATERIALS

We conducted a retrospective analysis of all CEM examinations performed for screening purposes at our institution between 2012 and 2023. Demographic data, breast density scores, background enhancement, and BI-RADS scores were extracted using rule-based natural language processing (NLP) techniques. Biopsies performed following CEM examinations and their respective pathology results were also identified. Positive CEM results were defined as BI-RADS 3-5 or 0, while negative results were BI-RADS 1-2. BI-RADS scores of CEM and low-energy images (equivalent to 2D-mammography) were compared with biopsy results and imaging follow-up.

## RESULTS

A total of 5424 CEM screening examinations were performed between the years 2012 and 2023 in 3484 women. The mean age was 54 years, and 18.2% of women (633/3484) had family history of breast cancer. Dense breasts (BI-RADS density score C-D) were observed in 88.3% (3076/3484) of the women, and 34.2% (1193/3484) had background parenchymal enhancement at CEM. A total of 367 biopsies were performed following CEM examinations, and 42 were malignant. CEM detected all cancer cases: sensitivity 100% (42/42), specificity 79.2% (4297/5424), PPV 3.6% (42/1169), NPV 100% (4297/4297). Eight interval cancers were identified during the first-year of follow-up. Of them six with a BI-RADS 0 score at CEM and supplemental MRI recommendation, and two with BI-RADS 3 scores at CEM and six months follow-up. CEM increased the cancer detection rate beyond 2D mammography, with an incremental cancer detection rate of 4/1000 screens.

## CONCLUSION

CEM increased breast cancer detection rate compared to 2D mammography in women with dense breasts and intermediate breast cancer risk.

## CLINICAL RELEVANCE/APPLICATION

This ten-year screening cohort supports the implementation of CEM for breast cancer screening in specific populations, including women with intermediate breast cancer risk and dense breasts.

## M5A-SPBR- Seeing through Contrast: A Dosimetric Comparison of CEM-guided Biopsy and Other 4 Mammography-guided Procedures

Rodrigo Alcantara, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to evaluate the average glandular dose (AGD) of contrast-enhanced mammography (CEM) guidance in comparison with other mammography-guided techniques, including digital stereotactic breast biopsy (SBB) and digital breast tomosynthesis (DBT) guidance. Additionally, we investigate the relationship between AGD and compressed breast thickness (CBT) and estimate the percentage dose due to low-energy (LE) and high-energy (HE) images for routine and interventional CEM.



## METHODS AND MATERIALS

We performed a retrospective analysis of 163 anonymized mammography-guided interventions, comprising 43 contrast-enhanced mammography (CEM)-guided interventions, all conducted using the same upright mammography unit. Our assessment focused on the overall average glandular dose (AGD) per image acquisition and modality, as well as its dependence on breast thickness. Additionally, we evaluated the AGD differences between low-energy (LE) and high-energy (HE) acquisitions for both CEM approaches.

## RESULTS

Our study found that the AGD for a single CEM-guided biopsy acquisition (1.48 mGy) was similar to SBB (1.49 mGy) and a single DBT scout (1.55 mGy). The AGD increased with increasing breast thickness for all modalities, with a lower slope for CEM guidance compared to other modalities. Both SBB and CEM require a similar number of images per procedure, while DBT-guided biopsy requires fewer images and offers a lower AGD range. The AGD from a CEM was similar to SBB, even inferior for higher CBT. AGD proportions between LE and HE images are relatively similar for routine and single CEM-guided biopsy image acquisition, with overall dose increase predominantly attributed to LE images across all breast thicknesses.

## CONCLUSION

Our findings indicate that the radiation dose from CEM guidance during mammography-guided biopsies is within the range commonly achieved for conventional SBB and lower than the values obtained for standard SBB at higher compressed breast thickness. CEM guidance presents great potential to improve the visibility of suspected findings, suggesting it can be a valuable tool for breast interventionism, not only for RC-only findings but also for other indications where increased visibility is required.

## CLINICAL RELEVANCE/APPLICATION

This study provides important dosimetric information on the safety of CEM-guided biopsy, showing that it is a comparable and effective tool for breast interventionism, with similar radiation dose to other established procedures. Our results highlight the potential benefits of CEM-guidance in improving the visibility of suspected findings and increasing diagnostic accuracy in breast imaging.

## M5A-SPBR- Uncovering the Unseen: The Potential of CEM for Invasive Lobular Carcinoma Detection

5

Rodrigo Alcantara, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Invasive lobular carcinoma (ILC) can be challenging to detect due to its slow-growing nature and subtle appearance. The aim of this study was to determine the lesion conspicuity using contrast-enhanced mammography (CEM) and compare the diagnostic performance of CEM and MRI. We also assessed the correlation of the overall lesion size on imaging with the final histopathological report.

## METHODS AND MATERIALS

We retrospectively selected 94 patients with a histopathological diagnosis of ILC who had undergone preoperative CEM between January 2018 and June 2022 at the Hospital del Mar in Barcelona. We collected data on CEM indication, breast density, background parenchymal enhancement (BPE), multicentricity/multifocality, lesion location, lesion findings on low energy (LE) and recombined (RC) images, lesion conspicuity, and lesion size in LE (mm). We also performed a comparative analysis between CEM and MRI for the 59 cases that had both modalities, and verified the agreement between the measurement of lesions in CEM and the sizes in MRI and the final histologic report.

## RESULTS

CEM sensitivity in detecting ILC was 98%, and the lesion conspicuity was high in most cases. CEM was not inferior to MRI for ILC evaluation or tumor size assessment, with a positive correlation between CEM and MRI, CEM and histopathology, and MRI and histopathology. The difference between the mean lesion size for CEM and MRI compared to the mean lesion size reported by histopathology was not statically significant.

## CONCLUSION

Despite ongoing debate about ILC's perceived weaker enhancement on CEM compared to invasive ductal carcinoma, our results showed that CEM can be a valuable alternative to MRI for ILC evaluation, providing a safe, immediately available, and rapid assessment of tumor extent.

## CLINICAL RELEVANCE/APPLICATION

CEM can be a useful alternative to MRI for the preoperative assessment of patients with ILC. It can also help detect potentially larger tumor sizes than initially expected and aid in making appropriate targeting decisions.

## M5A-SPBR- Interobserver Agreement between Breast Imagers using the First Version of the BI-RADS CEM Lexicon

6

Santonocito, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study was to assess the interobserver agreement of the CEM lexicon, which has been introduced as a supplement to the 5th edition of the BI-RADS mammography lexicon.

## METHODS AND MATERIALS

IRB-approved single center retrospective study. Three breast imaging fellows reviewed 295 lesions in 246 routine clinical breast CEM according to the fifth edition of the BI-RADS lexicon for Mammography and to the first version of the BI-RADS lexicon for CEM. Readers were blinded to patient outcomes, and evaluated breast and lesion features on low energy images (ACR breast density, type of findings, associated architectural distortion), lesion features in recombined images (enhancement findings, lesion conspicuity, mass shape, mass margin, mass internal pattern of enhancement, non-mass distribution, non-mass internal pattern of enhancement, enhancing asymmetry) and also provided a final BI-RADS assessment for both images (MG BI-RADS and CEM BI-RADS assessment). Interobserver agreement was calculated for each evaluated feature using kappa ( $\kappa$ ) statistics.

## RESULTS

Interobserver agreement for ACR breast density was substantial ( $\kappa = 0.622$ ). Interobserver agreement was moderate to substantial for breast density and findings assessment on both low-energy and recombined images, especially for type of findings ( $\kappa = 0.644$ ) and for enhancement findings ( $\kappa = 0.700$ ). Regarding mass enhancement, there was moderate agreement for shape ( $\kappa = 0.571$ ) and substantial agreement for margins ( $\kappa = 0.603$ ) and internal enhancement ( $\kappa = 0.648$ ). For non-mass enhancement, there was moderate agreement on distribution ( $\kappa = 0.445$ ) and internal enhancement ( $\kappa = 0.518$ ). However, agreement was only fair for asymmetric enhancement's descriptors (homogeneous vs heterogeneous,  $\kappa = 0.313$ ) and MG and CEM BI-RADS assessment ( $\kappa = 0.379$  and  $\kappa = 0.375$ , respectively).

## CONCLUSION

Moderate and substantial interobserver agreement were demonstrated for breast density and findings assessment on both low-energy and recombined images. There was moderate to substantial agreement on most CEM BI-RADS lesion morphology descriptors, while the agreement was only fair for the descriptors of an enhancing asymmetry.

## CLINICAL RELEVANCE/APPLICATION

Most of CEM-BIRADS lexicon features allow for an overall high inter-reader agreement, with a lower agreement regarding the descriptors of an enhancing asymmetry and overall BI-RADS assessment.

## M5A-SPBR- Can Contrast-enhanced Mammography (CEM) Categorize More Accurate B3 Lesions and Reduce Unnecessary Surgical Excisions?

Christofis Charalambous, MD (*Presenter*) Nothing to Disclose

## PURPOSE

a) To evaluate the upgrade rates of B3 lesions to malignancy b) To assess if we can get any benefit using CEM to avoid unnecessary open surgical excisions (OSE).

## METHODS AND MATERIALS

This is a retrospective analysis of CEM examinations that performed in our institution from 2012-2015. The analysis included a total of 1092 CEM examinations. Contrast enhancement intensity was categorized in four categories as follows: a) "-1": negative enhancement, b) "0": no enhancement c) "1": enhancement and d) "BPE": background parenchymal enhancement. In addition to the CEM procedures, 776 core needle biopsies (CNB) were performed. The analysis found that 68 patients returned 71 B3 lesions at the pathology result. As a result, an open surgical excision (OSE) was then performed.

## RESULTS

Out of the 71 B3 lesions, 16 (22.54%) were atypical ductal hyperplasia (ADH), 2 (2.82%) were flat epithelial atypia (FEA), 14 (19.72%) were lobular neoplasia (LN), 1 (1.41%) was phyllodes tumor (PT), 33 (46.48%) were papillary lesions (PL) and 5 (7.04%) were radial scars (RS). Using CEM's results these lesions were categorized as follows: 59 (83.1%) lesions had any type of enhancement either "1" or "BPE" and 12 (16.9%) of the lesions had "0" enhancement. None of the lesions had "-1" enhancement. After OSE, 18 (25.35%) lesions upgraded their histological result to a malignancy from which 6 (33.33%) were first categorized as ADH, 1 (1.85%) as FEA, 7 (38.88%) as LN, 1 (1.85%) as PT and 3 (16.66%) as PL. None of the radial scars upgraded their histological result. From these 18 lesions, 17 (94.44%) had any type of enhancement and 1 (5.56%) had no enhancement on CEM.

## CONCLUSION

The findings of this study support the added value of contrast-enhanced mammography (CEM) in the evaluation of B3 lesions, as it can help to categorize these lesions more accurately. Notably, the absence of enhancement in a B3 lesion on CEM has a



high negative predictive value, suggesting that it could be a useful tool for reducing the need for open surgical excisions.

#### **CLINICAL RELEVANCE/APPLICATION**

In our institution, the use of CEM could potentially result in a 16.9% reduction in OSE

### **M5A-SPBR- Pectoralis Muscle Invasion by Breast Cancer: Can Digital Breast Tomosynthesis Combined with Contrast-enhanced Mammography Improve Diagnostic Confidence**

Olena O. Weaver, MD (*Presenter*) Research Grant, General Electric Company

#### **PURPOSE**

Pectoralis muscle invasion (PMI) by breast cancer (BC) cannot be confidently diagnosed by mammography. Breast MRI is more effective but has limitations. We evaluated a combination of contrast-enhanced mammography (CEM) and digital breast tomosynthesis (DBT) under the same compression for diagnostic accuracy and reader confidence in predicting PMI.

#### **METHODS AND MATERIALS**

Prepectoral cancers (defined as masses adjacent to pectoral muscle with no intervening fat plane) were retrospectively identified in patients with DBT/CEM for BC staging at a single institution. 5 radiologists independently reviewed CEM (low energy (LE) and recombined (RC)) and DBT images of the involved breast in craniocaudal (CC) and mediolateral oblique (MLO) projections, then MRI when available, evaluated predefined radiologic signs of PMI for each image, and graded their diagnostic confidence (Table 1). The ground truth was PMI on surgical pathology (SP). For patients with unavailable SP, or in those post neoadjuvant chemotherapy (NAC) with therapy response and no PMI on SP, radiologists' consensus on muscle and/or fascia enhancement on pre-NAC MRI was used as the ground truth. Measures of diagnostic accuracy, mean radiologist confidence and radiologist agreement for each image type/modality were calculated per radiologic sign, per view and per case.

#### **RESULTS**

Of 145 patients, 9 had prepectoral masses. PMI was present in 3 and absent in 6 cases, with the ground truth based on SP in 3 and on MRI in 6 cases. The range of accuracies for LE was 0.29-0.62 for CC and 0.56-0.67 for MLO. The accuracy of RC was 0.62 for CC and 0.78 for MLO. For CC views the accuracies of LE, RC, and DBT were 0.5, 0.5-0.62, and 0.29-0.5, respectively, with an overall CC DBT/CEM accuracy of 0.62. For MLO views the accuracies of LE, RC, and DBT were 0.67, 0.56-0.78, and 0.67, respectively, with an overall MLO DBT/CEM accuracy of 0.56. Breast MRI had higher per-case diagnostic accuracy than DBT/CEM (1 vs 0.78) with muscle enhancement as the most accurate MRI sign (1.0), followed by fascia enhancement (0.86). On a scale of 1-3, mean radiologist confidence per case was 1.9 for DBT/CEM (1.8-2.3 for LE, 1.6 -2.2 for RC, and 2.1 -2.4 for DBT) with poor agreement (-0.14); vs 2.7 for MRI with moderate to substantial agreement (0.56-0.6).

#### **CONCLUSION**

MRI is superior to DBT/CEM in accuracy and radiologist agreement for PMI. RC images improve the accuracy of non-enhanced images but have the lowest radiologist confidence among all modalities. DBT has lowest accuracy but highest confidence. Absence of SP on treatment-naïve BC and use of MRI as a surrogate limits this study.

#### **CLINICAL RELEVANCE/APPLICATION**

Although RC images marginally improve the accuracy of DBT/CEM for PMI, breast MRI remains the modality of choice for evaluation of prepectoral BC.

### **M5A-SPBR- Can the ROI of Enhancement Predict the Histopathology of a Lesion on CESM**

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Tamara D. Suaris, MBBS, FRCR (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Contrast-enhanced spectral mammography (CESM) is a rapidly emerging technique for the accurate staging of breast cancer. Can the enhancement levels in CESM be used to predict histology of a lesion?

#### **METHODS AND MATERIALS**

A retrospective analysis of patients undergoing CESM at St Bartholomew's Hospital, between November 2020 and November 2021, was performed. All lesions confirmed by imaging guided histopathology and had CESM enhancement characteristics analysed. The degree of contrast was quantitatively assessed by measuring the region of interest (ROI) difference between the enhancing lesion and background as a ratio, on both craniocaudal (CC) and mediolateral (ML) views. Statistical analysis was performed to determine whether the percentage signal difference between enhancing lesions and background (%RS) correlated to histopathological results. The %RS calculated for the 3 histological results were compared: invasive and non-invasive cancers and benign lesions.

## RESULTS

138 lesions were detected, consisting of 73 (52.9%) invasive cancers, 32 (23.2%) non-invasive cancers, and 32 (23.9%) benign lesions. Analysis of enhancement indices showed the following mean % RS: Invasive cancers (ML 1.64%, CC 1.51%), Non-invasive cancers (ML 0.98%, CC 1.02%), Benign lesions (ML 0.75%, CC 0.68%). The enhancement intensity of invasive cancers was significantly higher than that of non-invasive and benign lesions (in both views  $p < 0.01$ ). After the Bonferroni correction, the distribution of %RS in invasive and non-invasive cancers was statistically significant ( $p < 0.01$ , 95%CI -0.01 to 0.003). Similarly for the invasive lesions and benign lesions ( $p < 0.01$ , 95%CI 0.005 to 0.001), while the difference between non-invasive cancer and benign lesions was non statistically significant ( $p = 0.21$ , 95%CI -0.001 to 0.006).

## CONCLUSION

There is a correlation between the degree of lesion enhancement in CESM among invasive cancers, non-invasive cancers, and benign lesions. Invasive cancers had the stronger enhancement. There is difference in the enhancement between invasive cancer and non-invasive cancers as well as invasive cancers and benign lesions. There is no difference between the non-invasive cancers and benign lesions.

## CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of enhancement levels in CESM is a feasible in the pre-operative assessment of women with breast cancer and can be used to predict histology of a lesion.

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## Abstract Archives of the RSNA, 2023

M5A-SPCA

### Cardiac Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPCA- Improving Dynamic Evaluation of Myocardial Gadolinium Concentration using Elastic Registration for T1 Mapping with Pharmacokinetics Modeling**

Yasutoshi Ohta, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Developing a T1 mapping-based pharmacokinetic method to evaluate myocardial gadolinium concentration over time, and enhancing accuracy by optimizing elastic deformation registration

#### **METHODS AND MATERIALS**

Thirty-five subjects (66 yrs, IQR 65,76) referred for CMR examination were included in this study. In addition to routine examinations, including cine and LGE, Native T1 and dynamic T1 maps (2, 5, 9, and 15 min after contrast administration) were obtained using the MOLLI sequence. T1 maps were obtained at the base, mid, and apex of the left ventricle, and concentration maps without registration were calculated for each imaging time from the native T1map and the post-contrast T1map. Similarly, the concentration maps with elastic registration (ER) for the native T1 maps were calculated from the post-contrast maps as well. The time after contrast administration was calculated for each image in seconds from DICOM tags. Estimated myocardial concentration maps (mM/l) at each imaging time were generated from the parameters obtained from pharmacokinetic analysis using a two-compartment model for each time series concentration map with and without ER. The model fitting accuracy was evaluated by comparing the residuals with and without ER. Myocardium was extracted from each map, the measured myocardial concentration (MC) and the estimated concentration (EC) at the same post-contrast time of MC, and the mean difference ( $\Delta_{mean}$ ) and standard deviation ( $\Delta_{SD}$ ) between the MC and EC were measured. Gadolinium concentration of the blood pool was also evaluated for residuals with and without ER.

#### **RESULTS**

Analyzable dynamic T1 maps were obtained from all subjects. The fitting residuals in the myocardial contrast medium density analysis improved significantly from 0.746 to 0.822 by applying ER ( $p < 0.001$ ). The fitting residuals for the blood pool improved significantly from 0.848 to 0.875 by applying ER ( $p < 0.001$ ). The  $\Delta_{mean}$  with ER was significantly smaller than without ER: 2min; 0.031 vs. 0.026, 5min; -0.026 vs. -0.022, 9min; -0.025 vs. -0.022, 15min; 0.024 vs. 0.019, (without ER vs. with ER, respectively). The  $\Delta_{SD}$  was significantly reduced with ER compared to without ER at all imaging times (all; 0.05 vs. 0.03, 2min; 0.05 vs. 0.03, 5min; 0.06 vs. 0.04, 9min; 0.06 vs. 0.04 15min; 0.04 vs. 0.02mM/l) (all,  $p < 0.05$ ).

#### **CONCLUSION**

Employing elastic deformation registration in dynamic T1 mapping enhanced the accuracy of estimated concentrations derived from myocardial contrast medium pharmacokinetic analysis.

#### **CLINICAL RELEVANCE/APPLICATION**

The pharmacokinetic approach enables the creation of myocardial gadolinium concentration maps at any given time and the analysis of longitudinal properties such as contrast agent washout in myocardial tissues.

#### **M5A-SPCA- Comparison of Myocardial Lesions by Pharmacokinetic Modeling Concentration Maps Over Time and General One-point LGE**

Yasutoshi Ohta, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the feasibility of detecting myocardial lesions earlier than with conventional LGE timing, as well as to assess the temporal characteristics of these changes, utilizing gadolinium density maps generated from a pharmacokinetic model

## METHODS AND MATERIALS

Thirty-five subjects (66 yrs, IQR 65,76) referred for CMR examination were included in this study. In addition to routine examinations, including cine and 10 minutes LGE, native T1 and dynamic T1 maps (2, 5, 9, and 15 min after contrast administration) were obtained using the modified Look-Locker inversion recovery sequence. Pharmacokinetic analysis of myocardial and blood pool gadolinium concentrations was performed using a two-compartment model, and predicted concentration maps (mmol/l) at 5, 7, 10, 15, 20, 25, and 30 minutes after contrast were generated from calculated parameters. In cases with positive LGE, the gadolinium concentration of the LGE lesion and remote myocardium, extracellular volume fraction ECV (ECVles, ECVremo) was calculated at each time point. The contrast ratio between the lesion and the remote myocardium was measured on the density map and LGE images. Changes in these indices at each time point were compared.

## RESULTS

Hyperenhancement was observed in 20 cases in the LGE image. Lesions were detected at the same sites as LGE in all-time concentration maps. Gadolinium concentrations in the LGE area at each time were 0.48, 0.46, 0.41, 0.34, 0.27, 0.22, and 0.19, showing significant changes, respectively. Contrast concentration in remote myocardium was 0.29, 0.27, 0.24, 0.20, 0.16, 0.13, and 0.11, with significant changes each time. Contrast ratios were 0.25, 0.25, 0.26, 0.35, 0.34, 0.33, and 0.32, with significantly higher values after 15 minutes. The contrast ratio of LGE was 0.61. ECVles increased slightly over time to 43%, 45%, 46%, 47%, 47%, 48%, and 50%, but not significantly. ECVremo was 26%, 27%, 27%, 27%, 28%, 29%, and 29%, with no significant difference.

## CONCLUSION

Though the gadolinium density map was inferior to LGE in contrast, lesions were detected at the same sites as LGE after 5 min. Lesion ECV could also be measured without significant change after 5-30 min.

## CLINICAL RELEVANCE/APPLICATION

The evaluation with density maps can detect lesions as early as LGE after contrast and may allow evaluation of myocardial characteristics using contrast agent kinetic changes in the lesion.

## **M5A-SPCA- Evaluation of Myocardial Mass Index Effect on Myocardial Function and Adverse Events in Hypertrophic Cardiomyopathic Patients with Normal Left Ventricular Ejection Fraction and Minimal Fibrosis, by Cardiac MRI Strain Analysis: A Prospective Study**

Hamid Chalian, MD (*Presenter*) Nothing to Disclose

## PURPOSE

HCM patients are at risk of developing adverse cardiac events, so an effective risk stratification tool is desirable, strain value measurements by cardiac MRI are reproducible and can show subclinical myocardial deformity, which makes them a potential imaging marker to predict patient's outcome. We evaluated the pattern myocardial strain changes based on myocardial mass index by cardiac MRI in a group of HCM patients with normal left ventricular ejection fraction (LVEF) and low fibrosis.

## METHODS AND MATERIALS

We evaluated cardiac magnetic resonance (CMR) and clinical data of 70 cases, including 50 HCM (62% male) and 20 healthy (50% male) subjects. HCM cases inclusion criteria were; normal LVEF with a late gadolinium enhancement (LGE) percentage < 10%, exclusion criteria were history of hypertension, valvular heart disease, infiltrative cardiac disorders, ischemic heart disease and renal impairment with estimated glomerular filtration rate (eGFR) less than 30 mL/min. follow-up time is set to be 3 years, adverse events are defined as sudden cardiac death, aborted cardiopulmonary resuscitation (CPR), hospitalization because of heart failure or serious arrhythmic events. We clarified between-group differences by ANOVA and post hoc tests. Also Univariate, multivariate Cox regression and Kaplan-Meier analyses revealed the strain pattern differences between patient with favorable and unfavorable prognosis. P value < 0.05 was considered significant.

## RESULTS

LV global longitudinal, circumferential, and radial strains (GLS, GCS, and GRS) as well as LV myocardial mass index, were different between the control group and HCM cases (P value < 0.05). Even in HCM patients with normal myocardial mass index strain values were significantly lower than control group. A progressive decline in LVGLS, and LVGCS values were noted along with myocardial mass index increase. LVGLS, LVGCS, and LGE percentage predicted adverse events, and LVGCS was the most potent predictor of adverse events.

## CONCLUSION

Increase in Myocardial mass index, independently cause myocardial contraction abnormalities evident by LV strains impairment despite normal EF and minimal myocardial scar index. CMR parameters, especially CMR feature tracking strain values, could predict adverse events in our study population.

## CLINICAL RELEVANCE/APPLICATION

HCM can result in adverse cardiac events, but many patients are living an uneventful life, thus a screening method in HCM could optimize preventive approaches, strain measurement by CMR are potential imaging markers in this regard.

### **M5A-SPCA- Differentiating Cardiac Amyloidosis from Hypertrophic Cardiomyopathy using Myocardial Atrial Strains Derived from Cardiac MRI**

Kentaro Ohara (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cardiac amyloidosis (CA) is a curable disease for which early diagnosis and treatment are vital. T1 mapping or late gadolinium enhancement (LGE) is a reliable method to differentiate amyloidosis from hypertrophic cardiomyopathy (HCM). However, there are several limitations to its usage, such as additional image acquisition, differences in T1 values due to equipment and facility, and the need for contrast materials for LGE. Recently, myocardial atrial and ventricular strains derived from magnetic resonance imaging (MRI) were developed to assess myocardial dysfunction in each chamber. This study aimed to evaluate the feasibility of using cardiac atrial or ventricular myocardial strains derived from MRI to differentiate CA from HCM.

#### **METHODS AND MATERIALS**

A total of 27 patients with CA and 76 patients with HCM underwent cardiac MRI; of these, 27 were identified with matched left ventricular ejection fraction (LVEF). The left ventricular strain (LVS), left atrial strain (LAS), right ventricular strain (RVS), and right atrial strain (RAS) were calculated from 4-chamber cine MRI images using a dedicated workstation. The diagnostic performance of CA for HCM was compared using receiver operating characteristic analysis.

#### **RESULTS**

LAS (CA:9.7%, HCM: 15%), RVS (CA:13.1%, HCM: 16%), and RAS (CA:10.4%, HCM: 20%) were significantly lower in the CA group than in the HCM group ( $P < 0.05$ ), whereas LVS showed no significant difference between the two groups (CA, 11%; HCM, 12.4%) ( $P=0.21$ ). The areas under the curves were LVS, 0.60; LAS, 0.74; RVS, 0.68; and RAS, 0.82. The RAS and LAS showed significantly higher diagnostic performance than the LVS ( $P < 0.05$ ).

#### **CONCLUSION**

Myocardial atrial strain derived from MRI can differentiate CA from HCM with high diagnostic performance. Moreover, it reflects the pathophysiological differences between the two.

## CLINICAL RELEVANCE/APPLICATION

The myocardial atrial strain derived from MRI does not require additional image acquisition or contrast administration. This simple and convenient method could be used to diagnose cardiac amyloidosis.

### **M5A-SPCA- Multimodal Imaging using FDG PET/MR and Adenosine Stress NH3 PET was Used to Study Patients with Hypertrophic Cardiomyopathy**

Eun-Jung Kong, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Previous studies of FDG PET in HCM are lacking, but this modality can explain the inflammatory process that precedes myocardial fibrosis. The aim of the study was to compare regional inflammation by FDG uptake, fibrosis by LGE MRI, and microvascular dysfunction by adenosine stress NH3 PET in patients with HCM.

#### **METHODS AND MATERIALS**

Between Jan 2016 and Apr 2018, a total of 25 patients were included in the retrospective study. FDG PET and MRI were simultaneously acquired using an integrated PET/MR scanner, and patients were prepared with a low carbohydrate diet to suppress physiologic myocardial uptake. FDG PET and LGE were analyzed using a 17-segment model, and myocardial flow was analyzed using commercial software (4DM) and compared with FDG PET and LGE.

#### **RESULTS**

Four patients were excluded due to improper physiologic myocardial suppression ( $n=1$ ) or combined ischemic heart disease ( $n=3$ ), leaving 21 patients (16 males, age  $59 \pm 15$  years) in the final analysis. All 21 patients showed abnormal FDG uptake ( $6.8 \pm 3.7$  segments) and 20 patients showed LGE ( $5.7 \pm 3.1$  segments). Mean stress myocardial blood flow was  $1.89 \pm 0.59$  mL/min/g. FDG uptake and LGE were observed in hypertrophic myocardium and, in some patients, in non-hypertrophic myocardium. Hypertrophic myocardium showed decreased stress myocardial flow compared with non-hypertrophic myocardium. Increased FDG uptake was related to LGE ( $\rho=0.805$ ,  $p<0.001$ ). Of the total 357 segments analyzed, 83.8% showed matched results (102 segments were both positive and 197 segments were both negative). Increased FDG uptake was also related to decreased stress flow ( $\rho=-0.512$ ,  $p=0.043$ ).

## CONCLUSION

The study found that evaluation of HCM with FDG PET/MR and stress NH3 PET was useful in evaluating inflammatory changes, fibrosis, and ischemic severity, to explain pathophysiology and to understand disease status. The study also newly found that FDG PET has a correlation with LGE and ischemia, which are known as poor prognostic factors

## CLINICAL RELEVANCE/APPLICATION

The study also newly found that FDG PET has a correlation with LGE and ischemia, which are known as poor prognostic factors

## M5A-SPCA- Imaging Features in Female Patients with Wild-type Transthyretin Amyloidosis 7 Cardiomyopathy

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Wild-type transthyretin amyloid cardiomyopathy (ATTRwt-CM) is significantly male-dominated, but there are also female patients. However, sex-related differences in ATTRwt-CM remain unclear. This study aimed to assess imaging features in female patients with ATTRwt-CM.

## METHODS AND MATERIALS

We retrospectively analyzed 106 consecutive patients who were diagnosed with ATTRwt-CM and evaluated sex-related differences in the imaging features including cardiac MRI and 99mTc-labeled pyrophosphate scintigraphy (99mTc-PYP).

## RESULTS

Twelve patients (11.3%) were female. These female patients were significantly older at diagnosis ( $75.3 \pm 6.3$  years vs.  $80.6 \pm 4.4$  years;  $p < 0.01$ ). Cardiac MRI-measured left ventricular end-systolic volume was significantly lower ( $44.3 \pm 23.8$  ml vs.  $31.1 \pm 29.3$  ml;  $p < 0.05$ ) and the ejection fraction was significantly higher ( $51.6 \pm 14.1$  % vs.  $62.0 \pm 21.0$  %;  $p < 0.05$ ) in female patients. There was no significant gender difference in left ventricular mass ( $138.4 \pm 48.7$  g vs.  $115.0 \pm 75.7$  g;  $p = 0.26$ ). In T1 mapping, there was no significant difference in native T1 ( $1420.3 \pm 54.0$  ms vs.  $1427.3 \pm 77.5$  ms;  $p = 0.76$ ), but extracellular volume fraction (ECV) was significantly lower ( $56.6 \pm 13.3$  % vs.  $49.4 \pm 15.7$  %;  $p < 0.05$ ) in female patients. No significant difference in myocardial T2 value ( $51.0 \pm 4.5$  ms vs.  $51.0 \pm 3.0$  ms;  $p = 0.97$ ). The mean heart-to-contralateral ratio obtained using 99mTc-PYP was significantly lower in female patients ( $1.95 \pm 0.39$  vs.  $1.63 \pm 0.24$ ;  $p < 0.01$ ).

## CONCLUSION

Female patients with ATTRwt-CM were predominantly older and had preserved left ventricular ejection fraction, weaker cardiac uptake of the 99mTc-PYP, and lower ECV value compared with male patients. These imaging features may contribute to the underdiagnosis of ATTRwt-CM in female patients.

## CLINICAL RELEVANCE/APPLICATION

Female patients with ATTRwt-CM have different imaging features than the male counterparts, and we need to recognize these imaging features to avoid underdiagnosing it.

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## Abstract Archives of the RSNA, 2023

M5A-SPCH

### Chest Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPCH- Multimodal Classification Model for Gram-Positive and Gram-Negative Bacterial Pneumonia<sup>1</sup> using Imaging and Clinical Features: Improving Antibiotic Treatment Decisions**

Ru Wen (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to develop and validate a classification model that combines imaging features and clinical characteristics to accurately identify patients with Gram-positive and Gram-negative bacterial pneumonia, assisting clinical physicians in empirical antibiotic treatment.

#### **METHODS AND MATERIALS**

The study included patients with bacterial pneumonia who sought medical care at a tertiary hospital in China between 2010 and 2020. The patients were randomly divided into a training set and a validation set in an 8:2 ratio. The ResNet-18 model was used as the base model, and 512 features were extracted from the maximum lesion layer as deep features. Spearman correlation and mutual information were employed for dimensionality reduction, and the XGBoost model was utilized to construct the imaging model. The GBM model served as the classifier for establishing the clinical model. A logistic regression algorithm was employed to construct an imaging-clinical fusion model based on the individual scores of the imaging model and the clinical model. The classification performance of the clinical model, imaging model, and fusion model was compared using the DeLong test.

#### **RESULTS**

This study included data from 2423 patients with bacterial pneumonia. Among them, 563 cases were Gram-positive bacterial pneumonia, and 1860 cases were Gram-negative bacterial pneumonia. The imaging model and clinical model had AUCs of 0.719 and 0.827, respectively, in the test set. The fusion model achieved an AUC of 0.884 (95% CI: 0.868-0.898), sensitivity of 0.772, specificity of 0.822, and accuracy of 0.808 in the test set. The DeLong test results demonstrated that the performance of the fusion model was slightly higher than that of the individual imaging or clinical models ( $P < 0.05$ ). Nomogram results of the fusion model showed that clinical scores had the highest weight, and the fusion model exhibited good consistency between predicted probability and expected probability. Decision curve analysis (DCA) confirmed that the fusion model performed well in classifying bacterial pneumonia across most threshold probabilities.

#### **CONCLUSION**

In this study, we integrated multimodal data including imaging, laboratory tests, and clinical signs to classify gram-positive and gram-negative bacterial pneumonia. Our research demonstrates that the fusion of multiple modalities enhances the classification performance of the model.

#### **CLINICAL RELEVANCE/APPLICATION**

The fusion model we have developed enables accurate classification of bacterial pneumonia in patients based on CT images, laboratory tests, and clinical signs. It holds significant clinical value in avoiding unnecessary antibiotic usage and provides timely information for guiding clinical decisions and improving patient prognosis.

#### **M5A-SPCH- Differentiating Imaging Features of Post Lobectomy Right Middle Lobe Torsion<sup>2</sup>**

Farah Tamizuddin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To identify differences in imaging features between patients with confirmed right middle lobe (RML) torsion compared to those with suspected RML torsion who did not have torsion.



## METHODS AND MATERIALS

This retrospective study entailed a search of radiology reports from April 1, 2014 to April 15, 2021, yielding 52 patients with suspected torsion on imaging but ultimately no lobar torsion and 4 with confirmed torsion. This cohort was supplemented by 2 cases identified prior to the search period for a total of 6 confirmed RML torsion cases. Four thoracic radiologists including an adjudicator evaluated chest radiographs (CXRs) and computed tomography (CT) exams for multiple imaging signs and features. A resident measured the angle between the RML bronchus and bronchus intermedius on coronal reformats of any CTs performed to exclude or confirm torsion for these patients. Fisher exact and Mann-Whitney tests were used to identify any significant differences in imaging features ( $P < .05$ ).

## RESULTS

A reversed halo sign was more frequently seen in patients with confirmed torsion ( $P = .001$ ) compared to non-torsion patients (83.3% vs. 0% for 3 readers, including the adjudicator). Torsion patients had a higher percentage of ground-glass opacity (GGO) in the affected lobe compared to non-torsion patients (21.7% vs 13.9% for the adjudicator,  $P = .031$ ). The CT Coronal Bronchial Angle between RML bronchus and bronchus intermedius was larger ( $P = .035$ ) in torsion than non-torsion cases ( $121.3^\circ$  vs  $98.3^\circ$ ). A convex fissure towards the adjacent lobe on CT was more frequent in torsion patients (100% vs 27.3% for the adjudicator,  $P = .009$ ) and increased lobe volume on CT ( $P = .001$ ) occurred more often in confirmed torsion.

## CONCLUSION

A reversed halo sign, greater proportion of GGO in the affected lobe, larger CT Coronal Bronchial Angle, fissural convexity, and larger lobe volume on CT may aid in early recognition of the rare yet highly significant diagnosis of lobar torsion.

## CLINICAL RELEVANCE/APPLICATION

This paper is clinically relevant because RML torsion is a potentially life-threatening diagnosis and awareness of imaging signs and features associated with this diagnosis can aid radiologists in suggesting RML torsion earlier and more accurately, thus expediting patient care and optimizing patient outcomes.

## M5A-SPCH- Frogspawn Sign: Special CT Features for the Diagnosis of Pulmonary Lymphatic Reflux Diseases

Qi Hao (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study was to evaluate the value and the morphologic characteristics of the so-called "frogspawn sign" on high-resolution CT as the special CT feature for the diagnosis of pulmonary lymphedema and lymphatic dilatation caused by pulmonary lymphatic reflux diseases (PLRD). This sign has not been reported in the literature by our knowledge.

## METHODS AND MATERIALS

We collected 580 patients with clinical and operative proven PLRD in the study, of which 86 cases had frogspawn sign on HRCT and MSCT lymphography. The imaging features of frogspawn sign were retrospectively reviewed by two chest radiologists who reached decisions by consensus. All patients were followed up for HRCT within 3-6 months.

## RESULTS

The frogspawn sign was seen in 86 (15%) of 580 patients with PLRD, which consisted of diffuse inhomogeneous ground-glass opacity (GGO) with superimposed multiple discontinuous small nodules. The diffuse GGO showed bilateral asymmetrical (100%) and peripheral subpleural or peribronchovascular (14/86, 16%) distribution with predominance in the right middle or lower lung zone. The multiple small nodules appeared round-like or tree-in-bud (22/86, 26%) with 3-6mm in size, central or intrapleural distribution and no continuity or fusion between nodules and nodule-pleura. The spatial distance between the nodules is about 2-4mm. A dynamic changes of this sign was showed in all patients with obvious improvement (32/86, 37%) and aggravation (54/86, 64%) on the follow-up CT.

## CONCLUSION

The frogspawn sign strongly favors a diagnosis of pulmonary lymphedema and lymphatic dilatation caused by PLRD. This sign is very important for judging the degree of lymphedema and the clinical stage.

## CLINICAL RELEVANCE/APPLICATION

Pulmonary lymphatic reflux abnormalities are rare disorders characterized by developmental malformation of the bronchial-mediastinal lymph trunk and/or thoracic duct outlet anomaly. The frogspawn sign consisted of diffuse inhomogeneous ground-glass opacity (GGO) with superimposed multiple discontinuous small nodules and strongly favors a diagnosis of pulmonary lymphedema and lymphatic dilatation caused by PLRD.

## M5A-SPCH- Exploring the Biological Significance of a Robust Radiomic Biomarker of Tumor Heterogeneity in Advanced Non-small Cell Lung Cancer Patients Treated with First-line Immunotherapy



Chen, BS, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Tumor PD-L1 expression, the accepted predictive biomarker for pembrolizumab (PEMBRO) immunotherapy, is imperfect. We hypothesize that radiomic features, essentially high-throughput descriptors of tumor heterogeneity, can characterize molecular and histopathological tumor subtypes in vivo, and enable precision therapy selection.

## **METHODS AND MATERIALS**

After IRB approval, a single-center retrospective analysis of pre-treatment CT for stage 4 NSCLC patients (n=342) treated with 1st-line PEMBRO-based therapy Region of interest (ROI) segmentation was performed with ITK-SNAP. Feature extraction on ROIs was performed with the CaPTk toolkit. OPNested Combat mitigated radiomic feature heterogeneity due to differences in contrast enhancement, kernel resolution, and voxel spacing. Clinical variable categories, age, sex, race, ECOG, BMI, smoking status, and tumor histology, were protected during harmonization to prevent removal. Principal component (PC) analysis reduced harmonized feature dimensionality; the first PC was taken as a radiomic signature for histological subtypes (adenocarcinoma, squamous cell, other) and tumor differentiation, using a linear support vector machine (SVM) classifier. For a subset (n=234), a radiomic signature characterized tumor differentiation subtypes (well, moderate, poor). The statistical significance of the radiomic signature's Spearman correlation coefficient (c) for genomic mutational expression categories (negative, positive, unknown) of NSCLC relevant-genes (EGFR, BRAF, ALK, ROS, MET, HER2) and tumor expression of PDL1 was also assessed.

## **RESULTS**

The radiomic signature performed patient classification of histological subtype with an accuracy of 81.5% (AUC-0.59), and of tumor differentiation subtypes with an accuracy of 82.3% (AUC-0.62). Statistically significant correlations ( $p < 0.05$ ) were found between the radiomic signature and the following genomic mutational expression categories: ALK (c: 0.88), EGFR (c: 0.87) and ROS (c: 0.62).

## **CONCLUSION**

The radiomic signature was shown to have correlations with genes relevant to NSCLC tumor progression and was able to identify tumor subtypes based on their molecular and histopathological characteristics, indicating its biological significance. Our future work involves building a multi-omic predictor (combining radiomic, genomic and clinical information) of progression-free survival to study patient response to PEMBRO-based therapy.

## **CLINICAL RELEVANCE/APPLICATION**

The radiomic signature correlated significantly with NSCLC-related genes and identified tumor sub-types based on molecular and histological characteristics. These results help us better understand the biological meaning of radiomic descriptors.

## **M5A-SPCH- Lung Cancer Risk Using Never Smokers' Chest X-Rays: Validation of a Deep Learning-based Model**

Anika Walia (*Presenter*) Nothing to Disclose

## **PURPOSE**

Lung cancer is the most common cause of cancer death. In the United States, 10-20% of lung cancers occur in "never-smokers" - those who never smoked cigarettes or smoked fewer than 100 cigarettes in their lifetime. Centers for Medicare and Medicaid Services (CMS) lung cancer screening criteria do not recommend screening never-smokers; however, never-smokers often present with more advanced lung cancer than those who smoke. In this study, we tested whether a deep learning model CXR-Lung-Risk could identify never-smokers at high risk for lung cancer using chest x-rays (CXRs) from the electronic medical record.

## **METHODS AND MATERIALS**

The CXR-Lung-Risk model was developed using 147,497 CXRs of 40,643 asymptomatic smokers and never-smokers from the Prostate, Lung, Colorectal, and Ovarian (PLCO) cancer screening trial to predict lung-related mortality risk based on a single CXR image as input. In this study, we externally validated the model in a separate cohort of never-smokers having routine outpatient CXR from 2013-2014. The primary outcome was 6-year incident lung cancer, identified using International Classification of Disease (ICD) codes. Continuous CXR-Lung-Risk scores were converted to low, moderate, and high-risk groups based on externally derived risk thresholds.

## **RESULTS**

Of 24,333 patients (mean age  $63.4 \pm 8.21$  years; 44.3% male; 18,880 (80.5%) White, 1,789 (7.6%) Black, 789 (3.7%) Hispanic) included in the study, 32% (7774/24,333) were deemed high risk by CXR-Lung-Risk. 2.5% of the total cohort (616/24,333) developed lung cancer over 6 years of follow-up. CXR-Lung-Risk groups had a graded association with lung cancer risk, with 1.4% (37/2663) in the low-risk group (CXR-Lung-Risk  $< 45$ ), 2.2% (306/13896) in the moderate-risk group ( $45 < \text{CXR-Lung-Risk} < 55$ ), and 3.5% (273/7774) in the high-risk group (CXR-Lung-Risk  $> 55$ ). After adjusting for age, sex, race,

previous lower respiratory tract infection, and prevalent COPD, there was still a 2.1 (95% CI [1.4,3.1];  $p < 0.001$ ) times greater risk of developing lung cancer in the high-risk group compared to low risk.

## **CONCLUSION**

Using routine CXRs from the EMR, CXR-Lung-Risk identified never-smokers at high risk of lung cancer, a group in which lung cancer rates are increasing.

## **CLINICAL RELEVANCE/APPLICATION**

CXR-Lung-Risk identified never-smokers at high risk of lung cancer, well above the  $>1.3\%$  6-year risk threshold where lung cancer screening CT is recommended by National Comprehensive Cancer Network guidelines.

## **M5A-SPCH- Feasibility of Extracellular Volume Fraction Measurement Derived from the Equilibrium Phase Dual-energy CT for Predicting Pathological Grades of Lung Cancer**

Hiroaki Nagano, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To assess the diagnostic feasibility of extracellular volume (ECV) fraction measurement using the equilibrium phase dual-energy CT (DECT) for predicting the pathological grade of lung cancer.

### **METHODS AND MATERIALS**

This study included 110 patients with lung cancer who underwent preoperative DECT examination and surgical resection. These patients were divided into a low-grade group (G1 and G2) and a high-grade group (G3 and G4) based on their histopathological differentiation. Iodine concentration (IC) and effective atomic number ( $Z_{\text{eff}}$ ) were measured using the equilibrium phases DECT, and ECV fraction was calculated based on IC of the lung cancer and the aorta. DECT parameters and ECV fraction were compared between the pathological grade groups using the Mann-Whitney U test. Receiver-operating characteristic (ROC) curve analysis was performed to evaluate the ability of IC,  $Z_{\text{eff}}$  and ECV fraction to diagnose a high-grade pathological group of lung cancer.

### **RESULTS**

IC and  $Z_{\text{eff}}$  during the equilibrium phase and ECV fraction were significantly higher in the low-grade group than in the high-grade group (2.27mg/mL vs. 1.85mg/mL,  $p = 0.006$ ; 8.46 vs. 8.29,  $p = 0.012$ ; 45.2% vs. 35.0%,  $p < 0.001$ ; respectively). The area under the ROC curve values of IC and  $Z_{\text{eff}}$  during the equilibrium phase and of ECV fraction to differentiate high-grade cancers from low-grade cancers were 0.688 (optimal cutoff, 1.80mg/mL; sensitivity, 60.9%; specificity, 73.6%), 0.672 (optimal cutoff, 8.43; sensitivity, 78.3%; specificity, 51.7%) and 0.750 (optimal cutoff, 30.9%; sensitivity, 47.8%; specificity, 94.3%), respectively.

### **CONCLUSION**

IC,  $Z_{\text{eff}}$  and ECV fraction measurement using DECT can help predict the pathological grade of lung cancers. ECV fraction showed the best diagnostic performance.

### **CLINICAL RELEVANCE/APPLICATION**

ECV fraction derived from the equilibrium phase dual-energy CT provides useful information to predict the pathological grades of lung cancers.

## **M5A-SPCH- Impact of Duration of Diagnostic Workup on Prognosis for Early Lung Cancer: Validation using the NLST and IASLC Databases**

Rowena Yip, PhD, MPH (*Presenter*) Nothing to Disclose

### **PURPOSE**

Impact on prognosis of early stage lung cancer due to time delay for follow-up has been quantified in our previous publication using the I-ELCAP database. Here, our goal is to validate our published findings using two independent databases, the National Lung Screening Trial (NLST) and the International Association for the Study of Lung Cancer (IASLC).

### **METHODS AND MATERIALS**

Using data collected from the CT arm of the NLST randomized trial (2002-2009) and the IASLC Lung Cancer Staging Project (1999-2010), we determined the size specific 5-year lung cancer (LC)-specific and overall survival rates as surrogates for cure rates. We estimated the change in LC diameter after delays of 90-, 180-, and 365-days using three representative LC volume doubling times (VDTs) of 60(fast), 120(moderate), and 240(slow). We then estimated the decrease in the lung cancer (LC) cure rate resulting from time between CT scans to assess for growth during the diagnostic workup.

## RESULTS

Using the NLST data for a regression model of the 5-year LC survival rates on LC diameter, the estimated LC cure rate of a 4.0 mm LC with fast (60-day) VDT is 97.4%(95% CI: 97.1%-97.8%) initially, but it would decrease to 96.4%(95% CI: 95.9%-96.8%), 94.9%(95% CI: 94.2%-95.6%) and 89.6%(95% CI: 88.2%-89.6%) after delays of 90, 180, and 365 days, respectively. A 20.0 mm LC with the same VDTs has an initial lower LC cure rate of 87.2%(95% CI: 85.5%-88.9%) initially, and decreases more rapidly to 81.9%(95% CI: 79.4%-84.3%), 74.4%(95%CI:70.9%-77.9%) and 47.8%(95% CI: 40.7%-54.8%) after the same delays of 90, 180, and 365 days. Using the IASLC data for a regression model of the 5-year overall survival rates on LC diameter shows a similar trend.

## CONCLUSION

Although the average tumor size was larger in these two databases, the average change in LC cure rate per unit increase in tumor size was comparable to our previous results. These findings support our earlier research indicating that the interval between scans required to evaluate the growth of lung nodules has a significant impact on prognosis, particularly for fast-growing and larger cancers. To determine the effectiveness of various management protocols, it is essential to quantify the degree of change in prognosis results caused by this delay.

## CLINICAL RELEVANCE/APPLICATION

Timely follow-up is crucial for management of lung nodules. Our study shows that delays in CT scans have a significant impact on prognosis, emphasizing the need to quantify this effect for better management protocols.

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## Abstract Archives of the RSNA, 2023

M5A-SPER

### Emergency Radiology Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPER- Multicentre Randomised Controlled Trial to Assess the Impact of Online Training on the Diagnostic Performance of Emergency Department Clinicians in Interpreting CT Head Images: The Simulation Training for Emergency Department Imaging 2 (STEDI2) Trial**

Alex Novak (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Delays in reporting of CT scans can impair patient flow in the Emergency Department (ED). Artificial Intelligence led applications are being evaluated to enable ED physicians to interpret CT Head scans, but their baseline interpretation capability is currently unknown. Here we present preliminary results for a trial to measure the accuracy of ED clinicians in interpreting CT head images, determine the impact of an online training simulation, and estimate potential impacts of clinician-led CT head interpretation on patient flow within the Emergency Department

#### **METHODS AND MATERIALS**

A multicentre NIHR Portfolio randomised controlled trial (CPMS: 52221, Clinicaltrials.gov: NCT05427838, ISRCTN: 41484, REC reference: 22/HRA/0743) was undertaken across 6 UK hospitals. Emergency medicine clinicians undertook a blinded baseline online assessment of accuracy in interpreting a dataset of 50 CT Head scans. After completing the baseline assessment, participants were offered an online training package on CT head interpretation, then repeated the assessment and recorded interpretation of up to 30 prospective clinical cases with further assessments repeated at 3 and 6 months. Training and assessment were delivered using the online platform [www.raiqc.com](http://www.raiqc.com). The primary outcome was measured changes in reporting accuracy/sensitivity/specificity as calculated in a pooled analysis. Subgroup analyses included diagnostic performance stratified by clinical role, level of seniority, pathological finding. For prospective clinical interpretations times participant and radiology reporting were recorded and compared.

#### **RESULTS**

From April 2022 until September 2023 206 participants undertook the study. Overall, there was a significant increase in participants' sensitivity (73.3% to 83%) and specificity (65.8% to 89.1%) in detecting the presence of an acute abnormality on the online assessment scans, with a similar increase seen across all pathology subgroups. Overall diagnostic performance for acute abnormality detection remained elevated compared to baseline at six months post training (sensitivity 80.6%, specificity 79.1%).

#### **CONCLUSION**

Online training can be used to significantly improve ED clinicians' ability to interpret CT Head scans.

#### **CLINICAL RELEVANCE/APPLICATION**

Our results demonstrate that dedicated online training can significantly improve the image interpretation accuracy of ED clinicians. Provision of a web-based self-directed simulation-based learning platform is a scalable way of delivering this training to departments with a high staff turnover. Further detailed analysis is ongoing and will provide a detailed basis for comparison with other forthcoming interventions such as AI-assisted image interpretation of CT head scans.

#### **M5A-SPER- Inter-modality Data Augmentation and Multi-view Reconstructions from CT to Radiography for the Detection of C-Spine Fractures**

Duncan Ferguson, MD,BSC (*Presenter*) Nothing to Disclose

## **PURPOSE**

Cervical spine fractures are a significant cause of morbidity and mortality worldwide. While ACR appropriateness criteria recommend the use of CT over X-ray, access to imaging can be limited in rural areas. The difference in sensitivity between CT and XR has been shown to be 100% and 63% respectively. Delayed diagnosis of C-spine fractures may lead to adverse outcomes. The goal of this project is to develop a model that can be used in areas where there are significant barriers to acquiring CT C-spines. Our objectives are as follows: To develop a method of reconstructing radiographs from CT To train a convolutional neural network using the reconstructed radiographs to detect C-spine fractures, using single and multiple views To assess the use of reconstructed radiographs as a method of data augmentation To test the model on real radiographs on a model trained on reconstructions.

## **METHODS AND MATERIALS**

233 non-contrast CT C-spine studies with fracture labels were collected from a publicly available dataset. The dataset was divided into a training/validation (183) and test set (50). Sagittal, coronal, and oblique Average Intensity Projections (AvIPs) were created at a window width and level of 950/400. The EfficientNet V2-S model with pretrained weights was used as the initial model. A single channel model was trained and tested using sagittal AvIPs. Next, oblique AvIPs were added to the training set and the model re-trained. A multichannel model was trained and tested using sagittal and coronal AvIPs. A training and validation set was created using 5-fold cross validation for training of all models. 188 C-spine radiographs with fracture labels from a publicly available dataset were also used to test the two single channel models. The AUROC was plotted and Youden index used to determine the best threshold for prediction. Accuracy, specificity, and sensitivity were calculated for each model.

## **RESULTS**

There is improved AUROC with oblique data augmentation using both AvIPs (from 0.60 to 0.65) and true radiographs (0.77 to 0.79) as the test set. Sens/Spec of 0.78/0.70 on true radiographs using the augmented model. The multichannel model performed better than the single channel augmented model (AUROC 0.73)

## **CONCLUSION**

Inter-modality augmentation is possible to create a fair C-spine fracture model using 233 CTs. Multichannel model training can be used to optimize radiograph protocols to detect pathology.

## **CLINICAL RELEVANCE/APPLICATION**

With improvement, an application in rural communities may result in expedited fracture detection. As well, an inter-modality data augmentation technique would assure preservation of labelling and be a valuable tool to enhance datasets.

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## Abstract Archives of the RSNA, 2023

M5A-SPGI

### Gastrointestinal Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPGI- Evaluation of Contrast Enhanced Photon Counting Computed Tomography Performed in the Inpatient Setting**

Benjamin G. Steyer, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Prior work demonstrating the benefits of photon-counting computed tomography (PCCT) has been performed in controlled research or selective outpatient settings. Given high capital costs of this technology, many scanners will serve general purpose, including application in inpatient settings. Here, we evaluate the performance of a clinical PCCT scanner employed in routine inpatient enhanced abdomen and pelvis imaging and directly compare image quality, image contrast and radiation dose to that of a prior state of the art dual energy CT (DECT) scanner.

#### **METHODS AND MATERIALS**

In this institutional review board-approved retrospective study, we identified patients ( $n = 35$ ) who had undergone a routine contrast enhanced CT of the abdomen and pelvis on a clinical PCCT scanner (NAEOTOM Alpha, Siemens Healthineers) and who had also undergone a DECT (SOMATOM Force, Siemens Healthineers) within twelve months. The following patient and scan characteristics were recorded: BMI, radiation dose (CTDI<sub>vol</sub>) and contrast volume. For quantitative comparison, we calculated contrast to noise ratio (CNR) and signal to noise ratio (SNR) for organ parenchyma as well as the great vessels for both PCCT and DECT exams.

#### **RESULTS**

Average BMI of patients undergoing contrast enhanced PCCT was 25.9 (range: 17.1 to 54.7). Average time between contrast enhanced PCCT and DECT was 42 days (range: 4 to 204 days). We observed a 9% decrease in scan dose (CTDI<sub>vol</sub>) in PCCT compared to DECT, 8.7 versus 9.8 mGy respectively ( $p=0.03$ ). Despite reduced dose, calculated CNR and SNR were significantly increased on PCCT versus DECT across all evaluated anatomic structures with the exception of liver, where no significant difference in SNR was observed.

#### **CONCLUSION**

Our real-world comparison of inpatient contrast enhanced abdomen and pelvis studies on PCCT and DECT indicates decreased radiation exposure (CTDI<sub>vol</sub>) can be achieved on clinical PCCT with increased quantitative metrics of image quality (CNR and SNR). Future planned analysis will focus on rigorous comparison of qualitative and quantitative metrics of image quality utilizing direct comparison of spectral data from both PCCT and DECT.

#### **CLINICAL RELEVANCE/APPLICATION**

In routine inpatient application, PCCT can provide quantitatively improved image quality compared to DECT at a reduced radiation dose.

#### **M5A-SPGI- Low Dose Whole-liver CT Perfusion in Evaluating Residual Viable Tumor Tissue of Hepatocellular Carcinoma after Transcatheter Arterial Chemoembolization**

Liqin Zhao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the value of low dose whole liver CT perfusion (CTP) in evaluating the hemodynamics of residual viable tumor tissue of hepatocellular carcinoma (HCC) treated with transcatheter arterial chemoembolization (TACE).

## METHODS AND MATERIALS

HCC patients treated with TACE were prospectively collected. All patients underwent low dose whole liver perfusion CT examination 4-6 weeks after TACE. Thirty HCC cases with residual tumor viable tissue were selected. The hepatic arterial fraction (HAF, %), capillary surface permeability (PS, ml/min/100g), blood volume (BV, ml/100g) and time to peak (TTP, s) of necrotic tissue (T1), residual viable tumor tissue (T2) and background liver tissue (T3) were obtained using liver tumor perfusion software. Univariate Wilcoxon signed rank was used for the comparison of the above parameters between T2 and T1, T3 groups.

## RESULTS

35 HCC lesions with residual viable tumor tissue were found. The HAF, PS and BV of T2 were higher than those of T1 and T3 ( $P < 0.05$ ); there was no significant difference in TTP between T2 and T1 and T3 ( $P > 0.05$ ).

## CONCLUSION

Low dose whole liver perfusion CT could reflect the hemodynamics of residual viable tumor tissue of HCC treated with TACE.

## CLINICAL RELEVANCE/APPLICATION

It could provide valuable information for the selection of further treatment protocol for HCC patients.

## M5A-SPGI- DECT and MRI Indicators for Assessing Iron Overload and the Effectiveness of Iron Overload Therapy in Patients with Primary and Secondary Hemochromatosis

Anna M. Titova, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Evaluation of MRI, CT parameters after chelation and hemoexfusion therapy in patients with iron overload, identification of the prognostic value of CT indicators in the assessment of moderate and severe iron overload.

## METHODS AND MATERIALS

The design of the study is prospective. The study included the liver scans of 43 patients with hereditary hemochromatosis (HH), secondary transfusion-dependent hemochromatosis (TDH) receiving regular hemotransfusions, iron chelators. We evaluated age, frequency of hemotransfusions, chelating drug used. CT was performed on a Dual Energy computer CT scanner Siemens Somatom Definition 128. 27 patients (62.8%) reached repeated CT. MRI was performed on a Siemens Magnetom Espree high-field scanner with a magnetic field induction of 1.5 T.

## RESULTS

The median age was 34 y.o. [33.00; 53.50] for HH and 52 y.o. [36.00; 62.00] for TDH. After therapy in the general group, T2\* values increased by 26%, LIC decreased by 21.2%, DED (dual energy difference)HU 140 and 80 mean by 17.6%, DER (dual energy ratio) HU 140 and 80 mean by 3%, DEI (dual energy index) HU 140 and 80 mean by 92.8%, 80 max by 3%, DEDHU 140 and 80 max by 19%, DERHU 140 and 80 max by 2.5% after therapy. In patients with HH, liver T2\* increased by 4.6 times, LIC decreased by 5.5 times, DEDHU 140 and 80 mean by 35.1%, DERHU 140 and 80 mean by 7.8%, DEIHU 140 and 80 mean by 93.6%, DEDHU 140 and 80 max by 29.3%, DEIHU 140 and 80 max by 21.6%. In patients with TDH, LIC decreased by 18.9%, DEIHU 140 and 80 mean by 92.2%. A value of 80 mean=85.5, 140 mean=71.5, M0.3 mean=76, DEIHU 140 and 80 mean=0.007996 and DEDHU 140 and 80 mean=18.5 predict the probability of severe iron overload.

## CONCLUSION

In patients after chelation therapy and hemoexfusion therapy, MRI and CT indicators decrease. The values of CT 80 mean $\geq$ 85.5, 140 mean $\geq$ 71.5, M0.3 mean $\geq$ 76, DEIHU 140 and 80 mean $\geq$ 0.007996, DEDHU 140 and 80 mean $\geq$ 18.5 can predict LIC values of more than 11 mg/g.

## CLINICAL RELEVANCE/APPLICATION

The threshold of hepatic iron overload which can be diagnosed by measuring CT parameters, mainly with dual-energy scanning, was determined.

## M5A-SPGI- Shear Wave Elastography and Attenuation Imaging for the Prediction of Risk of Events in Patients with NAFLD

Yudai Fujiwara (*Presenter*) Nothing to Disclose

## PURPOSE

Common causes of mortality in non-alcoholic fatty liver disease (NAFLD) are cardiovascular events (CVEs), extrahepatic malignancies, and liver-related events (LREs). We aimed to determine the value of fibrosis and steatosis as determined by non-invasive ultrasound-based biomarkers for the prediction of the major events in patients with NAFLD.



## METHODS AND MATERIALS

During a period 2016-2020, we accumulated a prospective cohort of 279 patients with NAFLD, who underwent shear wave elastography (SWE) together with ultrasound-guided attenuation parameter (UGAP) and liver biopsy within a day, and followed them until December 2022. SWE and UGAP were determined by LOGIQ E9 (GE Healthcare) with a C1-6-D convex probe. The cutoff values of liver stiffness measurements (LSM) by SWE and attenuation coefficient (AC) by UGAP for advanced liver fibrosis stage (F=2) and mild steatosis grade (S=1) were determined by the area under the curve analysis. According to the values, we classified patients into group A (low LSM and low AC), group B (low LSM and high AC), group C (high LSM and high AC), and group D (high LSM and low AC). Cumulative incidence ratio (CIR) of CVE, extrahepatic malignancy or LRE was calculated by Kaplan-Meier analysis and compare among the groups by log-rank test.

## RESULTS

1) The median LSM values for each stage of liver fibrosis were 6.13 kPa in F0, 6.81 kPa in F1, 8.47 kPa in F3, and 10.23 kPa in F4 ( $p < 0.001$ ). The median AC values for each grade of steatosis were 0.42 dB/cm/MHz in S0, 0.55 dB/cm/MHz in S1, 0.68 dB/cm/MHz in S2, and 0.72 dB/cm/MHz in S3, ( $p < 0.001$ ). 2) 36 patients experienced one or more events during the observation period with a median of 4.1 years. Diabetes mellitus and AC were found to be independently associated with CIR of CVE (8.76%/5 years among all patients). Similarly, LSM was found to be associated with CIR of LRE (5.01%/5 years). 3) CIR of CVE, extrahepatic malignancy or LRE in groups A, B, C, and D was calculated to be 0.0%, 12.8%, 28.5%, and 46.7%, the values of which were significantly different among the groups ( $p < 0.05$ ).

## CONCLUSION

A combination of ultrasound-based biomarkers LSM and AC determined by 2D SWE and UGAP may be a help for identifying NAFLD patients at a high risk of subsequent life-threatening events.

## CLINICAL RELEVANCE/APPLICATION

Our prospective cohort study suggested that a combination of SWE and UGAP non-invasively assesses tissue characteristics of NAFLD and contributes to prediction of subsequent major life-threatening events.

## M5A-SPGI- 6 Multiparametric Quantitative Ultrasound: Assessment of High-risk Steatohepatitis in Patients with Metabolic Dysfunction-associated Fatty Liver Disease

Hong Ding, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Metabolic dysfunction-associated fatty liver disease (MAFLD) affects almost 25% of the adult population worldwide. Early diagnosis and intervention for high-risk steatohepatitis in liver steatosis can prevent disease progression and improve prognosis. Non-invasive detection and quantification are important for the timely management and prevention of the progression of liver steatosis. This study aimed to investigate the clinical value of the predictive model of multiparametric quantitative ultrasound for the non-invasive assessment of high-risk steatohepatitis.

## METHODS AND MATERIALS

The shear wave elastography (SWE), shear wave dispersion (SWD) and attenuation imaging (ATI) examinations were performed on 194 patients with metabolic dysfunction-associated fatty liver disease (MAFLD) who would undergo liver biopsy in Huashan Hospital, Fudan University from June 2021 to September 2022. Based on pathological SAF scoring system, high-risk steatohepatitis is defined as steatohepatitis with greater and clinically significant fibrosis, and a total activity score =4 of steatosis, hepatocyte ballooning and hepatic lobular inflammation. The binary logistic regression was used to identify factors influencing high-risk steatohepatitis. The predictive models were established by using R language. The diagnostic performance for high-risk steatohepatitis was assessed by using the area under curve (AUC), and AUCs were compared by using the Delong test.

## RESULTS

There were 46 cases of high-risk steatohepatitis. Quantitative ultrasound parameters of elastic modulus, dispersion slope and attenuation coefficient, and blood markers including alanine aminotransferase (ALT), aspartate aminotransferase (AST) and high-density lipoprotein cholesterol (HDL-C) were the factors influencing high-risk steatohepatitis (all  $P < 0.05$ ). The AUCs of elastic modulus, dispersion slope, attenuation coefficient, multiparametric ultrasound model, blood markers model and ultrasound combined with blood markers model for diagnosing high-risk steatohepatitis were 0.764, 0.758, 0.634, 0.786, 0.745 and 0.802, respectively. Delong test showed the ultrasound combined with blood markers model had significantly better predictive properties than blood markers model and attenuation coefficient ( $P = 0.017$ ,  $P < 0.001$ , respectively).

## CONCLUSION

The combination of multiparametric quantitative ultrasound is useful for the non-invasive diagnosis of high-risk steatohepatitis with positive clinical value.



## CLINICAL RELEVANCE/APPLICATION

This multiparametric quantitative ultrasound is useful for the non-invasive diagnosis of high-risk steatohepatitis.

## M5A-SPGI- Contrast Enhanced CT Based Radiomics for Predicting Postoperative Re-bleeding in Cirrhotic Patients

Xin Yang (*Presenter*) Nothing to Disclose

### PURPOSE

To investigate the feasibility of contrast enhanced CT-based radiomics in predicting postoperative esophagogastric variceal re-bleeding (EGVR) after laparoscopic splenectomy and azygoportal disconnection (LSD) in liver cirrhosis patients with portal hypertension.

### METHODS AND MATERIALS

Preoperative contrast-enhanced CT examinations of 182 patients receiving LSD were enrolled. Patients were divided into with and without EGVR groups basing one year follow-up. 145 patients were enrolled randomly into training and validation cohorts in the ratio of 7:3, respectively. 37 patients were used in independent testing group. All radiomic features were extracted from CT images of the portal venous phase. Regions of interest (ROIs) were delineated on liver and spleen at the hilum level, respectively. The liver volumes of interest (VOI) and spleen VOI were automatically extracted. The least absolute shrinkage and selection operator (LASSO) regression was used to obtain optimal features from combined ROIs, as well as combined VOIs features, and incorporated into a logistic regression classifier to construct a model. The EGVR predictive performance of radiomics models was evaluated by the area under receiver-operating characteristic curve (AUC).

### RESULTS

The constructed radiomics models showed good predictive efficacy and outperformed the clinical characteristics models. The best performance of radiomics model was the logistic regression model constructed by 8 features extracted from the ROIs of liver combining with spleen, with AUC of 0.931 and 0.914 for the training and validation group, respectively. An AUC of 0.858 in the independent testing group was obtained.

### CONCLUSION

Contrast enhanced CT-based radiomics model can predict the risk of EGVR after LSD in patient with cirrhotic portal hypertension.

## CLINICAL RELEVANCE/APPLICATION

The rate of esophagogastric vein bleeding in patients with cirrhotic portal hypertension is about 30%, with a 20% increase in mortality after six weeks. A 1 year prospectively study showed that the incidence of EGVR in patients after LSD is 13.4%, which is a lethal complication. Therefore, it is necessary to find a convenient way to predict EGVR, and our study provided a non-invasive way for the prediction of re-bleeding after LSD.

## M5A-SPGI- Non-invasive Liver Fibrosis Assessment with CT-based Iodine-uptake Parameters and Hepatosplenic Volumetric Indices

Kenichiro Yoshida (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the diagnostic performance of iodine uptake parameters and hepatosplenic volumetric indices measured from multiphase hepatic CT to predict liver fibrosis severity in patients who underwent liver resection.

### METHODS AND MATERIALS

Ninety-one patients with pathologically proven liver fibrosis who underwent multiphase hepatic CT during the portal-venous phase (PVP) and 3-min delayed phase (DP) were included. The hepatic extracellular volume fraction (ECV) was calculated as  $([1 - \text{hematocrit}] \times [\text{hepatic iodine uptake during DP}/\text{aortic iodine uptake during DP}] \times 100)$ . The iodine washout rate (IWR) was calculated as  $([\text{hepatic iodine uptake during PVP} - \text{hepatic iodine uptake during DP}]/\text{hepatic iodine uptake during PVP} \times 100)$ . The liver volume (LV) and spleen volume (SV) normalized to body surface area (LV/BSA and SV/BSA, respectively) were quantified on PVP images using a deep learning algorithm. The correlations between the imaging parameters and the pathologic liver fibrosis stages were assessed using Spearman's correlation coefficient. The areas under the receiver operating characteristic curves (AUCs) to predict liver fibrosis severity were calculated for each imaging parameter. Multivariable logistic regression analysis was performed to identify independent predictors for hepatic cirrhosis, and combined diagnostic performance was assessed.

### RESULTS

Patients with F2-4 (n = 37), F3-4 (n = 16), and F4 (n = 13) showed higher ECV, lower IWR, and higher SV/BSA than those with F0-1 (n=54), F0-2 (n=75), and F0-3 (n=78), respectively (all p<0.05). The highest correlation with fibrosis stages was

attained in IWR ( $r=-0.593$ ), followed by SV/BSA ( $r=0.383$ ), ECV ( $r=0.381$ ), and LV/BSA ( $r=0.062$ ). The AUC ranges of ECV, IWR, LV/BSA, and SV/BSA for predicting liver fibrosis severity were 0.667-0.717, 0.843-0.882, 0.507-0.560, and 0.685-0.819, respectively. IWR and SV/BSA were independent predictors of cirrhosis, with combined AUCs of 0.881.

#### **CONCLUSION**

IWR and SV/BSA can allow better prediction of liver fibrosis severity compared with ECV and LV/BSA in multiphase hepatic CT.

#### **CLINICAL RELEVANCE/APPLICATION**

IWR and SV/BSA may be served as a non-invasive imaging biomarker for predicting liver fibrosis severity on routine multiphase CT.

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## Abstract Archives of the RSNA, 2023

M5A-SPGU

### Genitourinary Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPGU- Feasibility Study of Bone Mineral Metabolism in Chronic Kidney Disease Based on Dual-energy CT** 1

Wei Huang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the accuracy of dual-energy CT (DECT) in assessing bone mineral metabolism in patients with chronic kidney disease (CKD) .

#### **METHODS AND MATERIALS**

The abdominal dual-energy CT images of 53 patients with CKD were retrospectively analyzed, and the images of T12-L4 vertebral bodies were analyzed by decalcification virtual plain scan technology. The images were processed and analyzed using the virtual non-contrast (VNC) software in the Dual-Energy tab of the Syngo Via CT post-processing workstation. The T12 - L4 vertebral body was measured on the median coronal image, the ROI was manually outlined along the outer edge of the vertebral body, and various measurements automatically given by the software were recorded: CT value of calcium (Contrast media, CM), mixed energy image (Mixing ratio of 0.6) CT value (Regular CT value, rCT), calcium concentration (Calcium density, CaD) and fat content percentage (Fat fraction, FF). Pearson correlation analysis was applied to explore the relation between clinical laboratory testing indicators and these parameters.

#### **RESULTS**

The contrast media, rCT, CaD in the hemodialysis patients were significantly lower than those in early stage CKD (  $p < 0.01$ ). The CM, rCT and CaD values of vertebral body were negatively correlated with Ca ( $r = 0.486, 0.389, 0.598$ , respectively, all  $p < 0.01$ ), There was no correlation between FF and Ca.

#### **CONCLUSION**

Dual-energy CT VNCA technique may constitute a valid alternative method for quantifying the mineral content and marrow fat composition of bone in the diagnostic assessments of bone mineral metabolism in chronic kidney disease.

#### **CLINICAL RELEVANCE/APPLICATION**

Using abdominal dual-energy CT images may additionally evaluate bone abnormalities early in CKD patients.

#### **M5A-SPGU- Development of a Radiomics Model for CT-based Clear Cell Likelihood Score in Small Solid Renal Masses** 2

Taekmin Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop an explainable CT radiomics-based model for diagnosing clear cell renal cell carcinoma (ccRCC) among small (= 4 cm) solid renal masses.

#### **METHODS AND MATERIALS**

This retrospective study included 159 patients (50 women; median age 58 years [IQR 50-65 years]) with pathologically confirmed renal solid masses (= 4 cm). Two radiologists independently evaluated mass-to-cortex ratio and heterogeneity score (on a 5-point Likert scale) in corticomedullary phases, and evaluated a five-tiered CT score for diagnosing ccRCC. Interpretable radiomics model was constructed using the CT radiomics features which were associated with mass-to-cortex

ratio (first-order statistics of the mass and renal cortex) and heterogeneity score (first-order statistics and texture features of the mass). Diagnostic performance of diagnosing ccRCC were compared between five-tiered CT score and radiomics model.

## RESULTS

The masses comprised 52.8% of ccRCC (84/159) and 47.2% (75/159) of other histologic diagnoses. The mass-to-cortex ratio and heterogeneity score were significantly higher in ccRCC than in other diagnoses ( $0.87 \pm 0.18$  vs.  $0.58 \pm 0.21$  and  $4.1 \pm 0.9$  vs.  $2.5 \pm 1.1$ , respectively,  $P < 0.001$  for both). CT score = 4 achieved an AUC of 0.851 with sensitivity, specificity, and PPV of 72.6%, 80%, and 80.2%, respectively. The radiomics-based mass-to-cortex ratio and radiomics-based heterogeneity score obtained intraclass correlation coefficient of 0.89 (95% CI 0.85-0.92) and 0.82 (95% CI 0.76-0.86) compared with the original values, respectively. Diagnostic performance of radiomics model for identifying ccRCC obtained AUC of 0.913, which was superior to that of CT score (difference between areas 0.06,  $P = 0.02$ )

## CONCLUSION

The CT-based radiomics algorithm, which was constructed using the features correlated with two key parameters, showed good performance of diagnosing ccRCC in small renal masses.

## CLINICAL RELEVANCE/APPLICATION

CT-based clear cell likelihood score (cCLS) could provide lower cost and greater accessibility for patients, but validation for diagnostic performance and inter-reader agreement are needed. We developed a CT radiomics model for identifying ccRCC, which has a potential to easily apply in clinical practice.

## M5A-SPGU- Succinate Dehydrogenase-deficient Renal Cell Carcinoma: Characterization of Imaging Features for Precision Diagnosis

Aditi Chaurasia, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

Succinate dehydrogenase-deficient RCC is a rare, newly defined distinct renal cancer subtype under WHO tumor classification, confirmed by immunohistochemistry showing loss of staining of SDHB in tumors. Our aim is to investigate the imaging findings of SDHB-deficient renal tumors to facilitate accurate tumor characterization.

## METHODS AND MATERIALS

The study included 20 SDH-deficient tumors from 16 patients with pathogenic variations in SDHB gene. Cross-sectional and PET imaging scans from this cohort was retrospectively evaluated by two radiologists and one nuclear medicine specialist. Clinical findings such as demographics, family history, extra-renal findings and metastases were recorded. Tumor imaging characteristics on CT and MRI included were laterality, size, homogeneity, morphology, margins, internal content, T1 and T2 signal intensity, enhancement features, and restricted diffusion.

## RESULTS

A total of 16 patients (median age 31 years, IQR 19-41, 8 men) were identified with 68.8% of patients having a known family history of SDHB mutation. 81.3% of lesions were solitary and majority were solid (86.7% on CT, 87.5% on MRI) with well-defined margins in >62.5% of lesions, without evidence of internal fat, calcifications, and vascular invasion. On MRI, 87.5% of lesions had T2 intensity equal or more than cortex but less than CSF, and 100% of lesions demonstrated restricted diffusion. 100% of lesions showed enhancement with degree greater than 75% for most lesions on CT and MRI. On PET, all renal masses showed radiotracer uptake (mean SUVmax 31.9, mean SUVmean 7.1). 43.8% of patients demonstrated extra-renal manifestations and 43.8% distant metastasis.

## CONCLUSION

SDHB-associated RCC is predominantly noted in young patients with no gender predilection. On imaging, SDH-deficient RCC are frequently unilateral, solitary, and solid with well-defined margins demonstrating avid enhancement with variability in enhancement pattern and showing restricted diffusion.

## CLINICAL RELEVANCE/APPLICATION

The present article is a pilot study to characterize the findings of newly defined SDH-deficient RCC in patients having germline variation in SDHB gene on morphological and PET imaging to aid in early and accurate tumor identification.

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## Abstract Archives of the RSNA, 2023

M5A-SPHN

### Head & Neck Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPHN- Intravoxel Incoherent Motion Diffusion-weighted Imaging in Nasopharyngeal Cancer: Comparison between Turbo Spin-echo and Echo-planar Imaging Techniques**

Yuan Liu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the qualitative and quantitative indicators between turbo spin-echo(TSE)-IVIM and echo-planar imaging(EPI)-IVIM in patients with nasopharyngeal cancer.

#### **METHODS AND MATERIALS**

Thirty patients with nasopharyngeal carcinoma underwent a pre-treatment staging MRI examination (Ingenia 3.0T , Philips Healthcare, the Netherlands). The IVIM images were evaluated subjectively and objectively for anatomical structures (nasopharyngeal lesions, turbinate, spinal cord and temporal pole). Subjective evaluation indicators(five-point scale for susceptibility artifacts, geometric distortion, lesion conspicuity and overall image quality) were compared with Wilcoxon signed rank test. Quantitative indicators were compared with paired t-test of signal-to-noise ratio(SNR), contrast-to-noise ratio (CNR), ADC and IVIM-derived parameters. Bland-Altman and coefficient of variance(CV) was performed to analyse reproducibility and robustness between ADC and IVIM-derived parameters of TSE-IVIM and EPI-IVIM.

#### **RESULTS**

TSE-IVIM performed significantly better than EPI-IVIM of the qualitative indicators in nasopharyngeal lesions, turbinate and temporal pole( all  $p < 0.001$ ), while no significant difference in spinal cord(table 1). SNR and CNR of TSE-IVIM were significantly lower than EPI-IVIM in spinal cord and temporal lobe, while no significant difference in the nasopharyngeal lesions and turbinate(table2). f values of TSE-IVIM showed significant lower than EPI-IVIM in the nasopharyngeal lesions, and ADC and  $D^*$  values of TSE-IVIM showed significant higher than EPI-IVIM in spinal cord (table3). CV of TSE-IVIM mainly showed lower percentage than EPI-IVIM. Bland-Altman analysis showed wide limits of agreement(LoA) in the nasopharyngeal lesions and turbinate(table4,figure1).

#### **CONCLUSION**

For better image subjective scores and no significant lower SNR and CNR, TSE-IVIM performed better image quality and more stable quantitative indicators in the nasopharyngeal lesions and turbinate area, which were more noticeable for magnetic sensitivity artifacts. For the different f values and wide LoAs between two sequences in the nasopharyngeal lesions , we recommended to use TSE-IVIM on follow-up of patients with nasopharyngeal lesions.

#### **CLINICAL RELEVANCE/APPLICATION**

TSE-IVIM provide better image quality and greatly reduce the susceptibility artifacts and geometric distortion in nasopharynx. TSE-IVIM benefit the accuracy and stability for IVIM-derived parameters. We recommend to use TSE-IVIM on follow-up for nasopharyngeal lesions.

#### **M5A-SPHN- Feasibility of Using Multi-frequency Magnetic Resonance Elastography for Evaluating the Parotid Glands In Healthy Volunteers**

Man Ting Tian, MMed (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the feasibility of using multifrequency magnetic resonance elastography (MRE) for evaluating the parotid glands in healthy volunteers.

## METHODS AND MATERIALS

Six healthy volunteers were divided into two groups. Three volunteers had a passive driver placed on the occiput during scanning (occiput group), while the other three had a passive driver placed on the right face (right face group). Both groups underwent multifrequency MRE(60, 90, 120, and 150 Hz) of parotid gland at 3 Tesla. The image quality of the MRE waveforms, elastograms was evaluated.

## RESULTS

In the occiput group, the shear wave propagation from the occiput region to the parotid gland was distant, resulting in significant attenuation and interference. The image quality was higher at 60 Hz, but lower at 90 Hz and 120 Hz. Volunteers could not tolerate the scan at 150 Hz and the scan was terminated. In the right face group, the attenuation and interference of the shear wave propagation were smaller. The image quality was high at all frequencies (60, 90, 120, and 150 Hz). However, because the arrival time of the shear wave in the bilateral parotid gland was different, this group was more suitable for observing the right parotid gland.

## CONCLUSION

The appropriate frequency for the occiput group to evaluate the parotid gland was 60 Hz, while the appropriate frequencies for the right face group were 60 Hz, 90 Hz, 120 Hz, and 150 Hz.

## CLINICAL RELEVANCE/APPLICATION

Multifrequency MRE can be applied to healthy parotid glands, and may be further applied to the study of parotid gland tumors and diffuse lesions such as Sjogren's syndrome in the future.

## M5A-SPHN- Validation of a Fluorescent MET-Targeting Probe for Assisting Biopsy in OPMDs

3

Jingbo Wang, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The objective of this study is to investigate the use of a topically applied mesenchymal-epithelial transition factor (MET) targeting probe, cMBP-ICG, in conjunction with near-infrared targeted fluorescent imaging (NIRFI) to improve the accuracy of biopsy site selection for oral potentially malignant disorders (OPMDs). This approach aims to reduce the rate of missed detection of intermediate-high grade dysplasia (IHD) and oral squamous cell carcinoma (OSCC).

## METHODS AND MATERIALS

The acute toxicological properties of cMBP-ICG were evaluated in mice. The progression of OPMDs to OSCC was simulated in mice treated with 4-NQO and monitored using MRI and NIRFI. Tongue tissue was evaluated for pathological characteristics and MET expression. The detection rate of IHD was compared between NIRFI-assisted and standard biopsy in mice. An exploratory clinical trial involving six subjects with OPMDs evaluated the consistency between NIRFI-assisted and physician-selected biopsy sites using Cohen's kappa statistic.

## RESULTS

No significant differences were observed in CBC and blood biochemical test results before and after administration of cMBP-ICG. Low-grade dysplasia was present in 62 cases and IHD was present in 34 cases. Carcinoma in situ was present in 21 cases and invasive carcinoma was present in 5 cases. The average signal-to-background ratio and mean fluorescence intensity of neoplasia with higher malignancy than IHD were  $6.3 \pm 2.7$  and  $17.4 \pm 8.9$  arbitrary units, respectively. The mean values of MET-positive area for the four pathological types were  $31.0 \pm 11.9\%$ ,  $57.8 \pm 18.9\%$ ,  $70.4 \pm 13.8\%$ , and  $85.5 \pm 8.4\%$ , respectively. NIRFI-assisted biopsy had a missed detection rate and a detection rate of IHD of  $0.0085 \pm 0.04$  and  $0.66 \pm 0.27$ , respectively, while standard biopsy had a missed detection rate and a detection rate of IHD of  $0.36 \pm 0.2$  and  $0.39 \pm 0.25$ , respectively. There was a statistically significant difference between the two groups ( $P < 0.01$ ). In contrast, there was no statistically significant difference between the two groups in the missed detection rate and detection rate of carcinoma. The OR value related to group assignment was less than 1 for the missed detection rate of IHD and greater than 1 for all detection rates. For the six enrolled patients, NIRFI-assisted biopsy was performed at all sites consistent with experienced clinicians, with a kappa value of 0.39 and a P-value of 0.19.

## CONCLUSION

Compared to standard biopsy, the use of cMBP-ICG in conjunction with NIRFI may improve the detection of IHD.

## CLINICAL RELEVANCE/APPLICATION

The NIRF probe cMBP-ICG and NIRF imaging system may provide a non-invasive method for biopsy sampling assistance, potentially changing the clinical protocol for OPMDs, and improving the early diagnosis rate of OSCC.

## M5A-SPHN- Development and Validation of Deep Learning Based Automated Detection of Cervical Lymphadenopathy in Patients With Lymphoma for Treatment Response Assessment: A Bi-institutional Feasibility Study

4

(Presenter) Nothing to Disclose

## PURPOSE

To train and evaluate a deep learning (DL) model for the accurate detection and segmentation of abnormal cervical lymph nodes (LN) on head and neck contrast-enhanced CT scans in patients diagnosed with lymphoma and evaluate the clinical utility of the DL model in response assessment.

## METHODS AND MATERIALS

This retrospective study included patients who underwent CT for abnormal cervical LN and lymphoma assessment between January 2021 and July 2022. Patients were grouped into the development (n=76), internal test 1 (n=27), internal test 2 (n=87), and external test (n=26) cohorts. A 3D SegResNet model was used to train the CT images. The volume change rates of cervical LN across longitudinal CT scans were compared among patients with different treatment outcomes (Stable, response, and progression). Dice similarity coefficient (DSC) and Bland-Altman plot were used to assess the model's segmentation performance and reliability, respectively.

## RESULTS

No significant differences in baseline clinical characteristics were found across cohorts (age, P=0.55; sex, P=0.13; diagnoses, P=0.06). The mean DSC was  $0.39 \pm 0.2$  with a precision and recall of 60.9% and 57.0%, respectively. Most LN volumes were within the limits of agreement on the Bland-Altman plot. The volume change rates among the three groups differed significantly (progression (n=74), 342.2%; response (n=8), -79.2%; stable (n=5), -8.1%; all P<0.01).

## CONCLUSION

Our proposed DL segmentation model is reliable for quantifying the cervical LN burden on CT in patients with heterogeneous lymphoma. Longitudinal changes in cervical LN volume, as predicted by the DL model, are useful for treatment response assessment.

## CLINICAL RELEVANCE/APPLICATION

DL-based auto segmentation model could effectively detect and quantify cervical LN burden in patients with lymphoma across longitudinal CT scans, which could ultimately improve guidance for treatment response assessment.

## M5A-SPHN- Deep Learning Based Multi-Modal Segmentation of Oropharyngeal Squamous Cell Carcinoma on CT and MRI Using Self-Configuring nnU-Net

DONGJUN LEE, MD (Presenter) Nothing to Disclose

## PURPOSE

To evaluate deep learning-based segmentation models for oropharyngeal squamous cell carcinoma (OPSCC) using CT and MRI with nnU-Net.

## METHODS AND MATERIALS

This retrospective study included 91 patients with OPSCC. The patients were grouped into development (n=56), test 1 (n=13), and test 2 (n=22) cohorts. In development cohort, OPSCC was manually segmented on CT, MR, and co-registered CT-MR, which served as ground truth. The multimodal and multichannel input images were then trained using a self-configuring nnU-Net framework. For evaluation metrics, dice similarity coefficient (DSC; 1=perfect and 0=no overlap) and mean Hausdorff distance (HD; near 0=good) were calculated for two test cohorts. Pearson's correlation and Bland-Altman analyses were performed between ground truth and prediction volumes. Kruskal-Wallis tests were performed to compare DSC and HD of the three models.

## RESULTS

All three models achieved robust segmentation performances with DSC of  $0.64 \pm 0.33$  (CT),  $0.67 \pm 0.27$  (MR), and  $0.65 \pm 0.29$  (CT-MR) in test cohort 1 and  $0.57 \pm 0.31$  (CT),  $0.77 \pm 0.08$  (MR), and  $0.73 \pm 0.18$  (CT-MR) in test cohort 2. No significant differences were found in DSC among the models. HD of CT-MR ( $1.57 \pm 1.06$  mm) and MR models ( $1.36 \pm 0.61$  mm) were significantly lower than that of CT model ( $3.48 \pm 5.0$  mm) (P=0.037 and P=0.014, respectively). The correlation coefficients between ground truth and prediction volumes for CT, MR, and CT-MR models were 0.88, 0.93, and 0.9, respectively.

## CONCLUSION

The self-configuring nnU-Net framework yielded a reliable and accurate segmentation of OPSCC on CT and MRI. The multimodal CT-MR model showed promising results for the simultaneous segmentation on CT and MRI.

## CLINICAL RELEVANCE/APPLICATION

The multimodal segmentation models trained with the nnU-Net framework provided reliable and accurate segmentations of OPSCC on both CT and MR, which can be applied to facilitate clinical staging, radiation therapy planning, and treatment



response assessment.

## **M5A-SPHN- Structure-Preserving Image Quality Improvement of Cone Beam CT Using Deep Learning** **6**

Won-Jin Yi, PhD, MS (*Presenter*) Nothing to Disclose

### **PURPOSE**

The purpose of this study is to increase the image quality and HU accuracy of CBCTs while preserving anatomical structures. We applied contrastive learning-based GAN for unpaired image translation to the quality improvement of CBCT images.

### **METHODS AND MATERIALS**

We generate CT-like images from CBCT images using a patchwise contrastive learning-based GAN model. Our model is trained on unpaired CT and CBCT datasets of 30 patients with the novel combination of loss, composed of semantic relation consistency loss, spatially correlative loss, and reconstruction loss. We used a customized feature extractor pretrained on our training dataset to calculate the spatially correlative loss. We evaluate the quality of the images generated by our model in terms of Fréchet inception distance (FID), peak signal-to-noise ratio (PSNR), mean absolute error (MAE), and root mean square error (RMSE). Additionally, the structure preservation performance is assessed by the structure score. Furthermore, we performed the ablation study by progressively adding components of the loss to analyze the impact of the various components on the performance.

### **RESULTS**

The generated CT-like images by our model are significantly superior to those generated by various baseline models in terms of FID, PSNR, MAE, RMSE, and structure score. The spatially correlative loss and the reconstruction loss in our model provided the complementary benefits of preserving the anatomical structures of the input CBCT images and improving the image quality to be similar to CT images.

### **CONCLUSION**

The generated CT-like images by our model were significantly superior to those generated by various baseline models in terms of FID, PSNR, MAE, RMSE, and structure score. We demonstrate that our model provides complementary benefits of preserving the anatomy of the input CBCT images and improving the image quality to be similar to those of CT images.

### **CLINICAL RELEVANCE/APPLICATION**

Cone-beam CT (CBCT) is widely used in dental clinics but exhibits limitations in assessing soft tissue pathology because of its lack of contrast resolution and low Hounsfield Units (HU) quantification accuracy. The proposed method considerably enhanced CBCT's quality and HU accuracy while preserving the anatomical structure. We demonstrated that our framework enables detailed visualization of soft tissues and accurate quantification of HU in CBCT. This work could allow for accurate quantification of HU, suggesting the possibility of using CBCT in more clinical situations.

## **M5A-SPHN- Quantitative Pharmacokinetic Parameter $K^{trans}$ Map Assists in Regional Segmentation of** **7** **Nasopharyngeal Carcinoma in Dynamic Contrast-enhanced Magnetic Resonance Imaging (DCE-MRI)**

Zhou Liu, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Accurate segmentation of nasopharyngeal carcinoma (NPC) lesion areas from dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) facilitates subsequent diagnostic and prognostic workups. Traditionally, anatomical DCE-MRI-based NPC segmentation using deep learning has achieved fair results but still needs further improvement. Hence, we investigate the incremental benefit of incorporating pharmacokinetic parameter maps into anatomical DCE-MR image segmentation tasks by taking advantage of the hemodynamic contrast between NPC and surrounding tissue.

### **METHODS AND MATERIALS**

In this paper, a pharmacokinetic parameter  $K^{trans}$  map of NPC is used as prior information and combined with anatomical DCE-MRI data to improve the performance of segmentation models. A novel model, multi-input branch residual U-Net (MBRU-Net), which extracts features from both anatomical DCE-MR images and  $K^{trans}$  maps and fuses them to improve the segmentation performance, is introduced. The effectiveness of the multibranch network is validated by comparing MBRU-Net with deep residual U-Net (ResU-Net) with DCE-MRI +  $K^{trans}$  data. Additionally, different models (U-Net, segmentation network (SegNet), recurrent residual U-Net (R2U-Net), and ResU-Net) are trained with DCE-MRI and DCE-MRI +  $K^{trans}$  data separately and compared to validate the effectiveness of multimodal data using the Dice coefficient (Dice).

### **RESULTS**

Our proposed MBRU-Net achieves the best Dice in this study ( $67.39 \pm 15.79\%$ ), higher than ResU-Net's Dice ( $65.57 \pm 17.52$ ) based on DCE-MRI and  $K^{trans}$  data. U-Net, SegNet, R2U-Net, and ResU-Net achieve better results in terms of segmenting



tumor regions with DCE-MRI + Ktrans data than those of the corresponding models with DCE-MRI data alone, where U-Net has the best performance (DCE-MRI + Ktrans: DCE-MRI =  $66.31 \pm 17.80\%$ :  $61.10 \pm 24.14\%$ ).

### **CONCLUSION**

It is beneficial to add a pharmacokinetic parametric ( $K^{\text{trans}}$ ) map as prior information to the conventional anatomical MRI-based segmentation task, and multibranch network structures perform better than single-branch network structures in terms of NPC segmentation.

### **CLINICAL RELEVANCE/APPLICATION**

I Ktrans map as a priori information is beneficial for the segmentation of NPC on DCE-MRI, which might facilitate diagnostic and prognostic workup.

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## Abstract Archives of the RSNA, 2023

M5A-SPIN

### Imaging Informatics Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPIN- Comparison of Human and AI-based Medical and Non-medical Segmentation Algorithms** 1

Matthias F. Froelich, MD (*Presenter*) Consultant, Smart Reporting GmbH; Consultant, Guerbet SA

#### **PURPOSE**

To evaluate the comparative performance of human and AI-based segmentation, especially in the context of novel algorithms, not trained exclusively on (sectional) imaging data.

#### **METHODS AND MATERIALS**

A challenging CT slice with suboptimal contrast was selected. Manual segmentation was performed by a radiologist using 3D-Slicer. Automated segmentation algorithms (Total Segmentator fast/standard mode, Segment Anything in four settings) were run on the image. No further adjustment of the segmentation was performed. A total of 7 radiologists (3-11 yrs experience), evaluated the segmentations in blinded approach.

#### **RESULTS**

Human segmentation took 18:23 min, compared to AI-based approaches which took a maximum of 1:12 min. 5 radiologists (62.5%) identified the human segmentation correctly, which was rated best (> 50% very or somewhat closely correct segmentation). For the AI-based approaches, the Total Segmentator Standard Mode was ranked best (at least moderately closely 100%). The results are summarised in the figure attached.

#### **CONCLUSION**

AI-based segmentation is significantly faster than human segmentation. In challenging cases with suboptimal contrast, models trained on imaging data exclusively may still be superior to other models.

#### **CLINICAL RELEVANCE/APPLICATION**

Segmentation is a task that should be performed automatically by AI.

#### **M5A-SPIN- Comparative Analysis of Spectral Characteristics of Monoenergetic CT Reconstructions for** 3 **Different Kidney Stone Types Scanned on Photon-Counting-CT**

Alexander Hertel, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study is to investigate the potential of using the radiomics profile of different monoenergetic reconstructions of photon-counting CT (PCCT) scans to differentiate various types of kidney stones. The study seeks to explore the relationship between radiomics features and the underlying composition of kidney stones, with the ultimate goal of developing a more accurate and non-invasive approach to diagnose and classify kidney stones. The learning objective of this study is to contribute to the development of a more personalized and precise approach to the diagnosis and treatment of kidney stone disease. The learning objective of this study is to contribute to the development of a more personalized and precise approach to the diagnosis and treatment of kidney stone disease.

#### **METHODS AND MATERIALS**

Photon-counting CT (PCCT) is a novel imaging technology that has shown great promise in Radiomics analysis, e.g. due to its high feature stability. In this study, we scanned 150 different types of kidney stones, including Xanthine, Brushite, Carbonateapatite, Cystine, and others, using a PCCT. Monoenergetic reconstructions of the scans were created using the Syngo Via software (version VB60A\_HF02) from Siemens in 30 keV steps from 40 to 190 keV. The stones were semi-

automatically segmented using the MITK-Workbench software (v2022.10), and radiomics features were then extracted using a Docker container based on Pyradiomics (Version 3.0.1). Statistical analyses, including cluster analyses and the creation of box plots, were performed using R-Statistics (Version 2023.03.0+386) to explore the potential of radiomics for differentiating between different types of kidney stones.

## RESULTS

In the study it could be shown that especially in the monoenergetic reconstructions with low keV values (40 and 70keV) a differentiation of the different kidney stone types, among other things on the basis of the average HU values, is possible, since these differed significantly depending on the kidney stone type. In contrast, no significant differences were found for the higher keV values.

## CONCLUSION

Radiomics evaluations of monoenergetic reconstructions with low keV values (40 and 70keV) of photon counting CT scans can help differentiate and characterize renal stones noninvasively, potentially optimizing therapy.

## CLINICAL RELEVANCE/APPLICATION

Non-invasive differentiation of kidney stones to potentially optimize therapy.

## M5A-SPIN- 4 Dual-Energy CT-derived Imaging Features: Diagnostic and Prognostic Value of Radiomics Features and Iodine Maps in Patients with Mediastinal Masses

Vitali Koch, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the diagnostic and prognostic value of radiomics features and dual-source dual-energy CT (DECT) based material decomposition in patients with benign and malignant mediastinal masses.

## METHODS AND MATERIALS

This retrospective study included 90 patients (38 males, mean age  $61 \pm 12$  years) with pathologically confirmed mediastinal masses who underwent contrast-enhanced DECT between 10/2014 and 04/2023. All patients were evaluated by two experienced readers regarding conventional radiomics features, as well as DECT-based texture features including attenuation (HU), iodine density (mg/ml), and fat fraction (%). Data comparisons were performed using analysis of variance (ANOVA) and chi-square statistic tests. Cox regression tests and receiver operating characteristic curve analysis were used to predict outcomes and discriminate between benign and malignant mediastinal masses.

## RESULTS

Of the 90 mediastinal masses, 28 (31%) were lymphomas, 6 (7%) were mediastinal tumors, and 9 (10%) were thymic carcinomas. Values differed significantly between benign and malignant mediastinal masses regarding DECT-based texture features ( $p < 0.04$ ) and 30 radiomics features ( $p < 0.03$ ). The area under the curve to differentiate between benign and malignant formations was 0.980 (95% CI, 0.893-1.000;  $p < 0.001$ ) for the combination of DECT imaging parameters and radiomics features, yielding a sensitivity of 100% and specificity of 91%. During a follow-up of 60 months (IQR, 52-60 months), the multiparametric approach including radiomics features, DECT parameters, and clinical parameters showed good prognostic power to predict all-cause mortality (c-index = 0.896 [95% CI, 0.802-0.970],  $p = 0.001$ ).

## CONCLUSION

A multiparametric approach including conventional radiomics features and DECT-based texture features facilitates accurate, non-invasive discrimination between benign and malignant mediastinal masses with high sensitivity and specificity.

## CLINICAL RELEVANCE/APPLICATION

Early detection of malignant masses is of utmost importance to avoid delays in treatment initiation. Combining radiomics features, DECT-derived imaging parameters, and clinical parameters through computational assessment of texture features has the potential to identify masses with an increased risk of malignancy.

## M5A-SPIN- 5 HASKE: A Low-Resource PACS Platform for Improving Diagnostic Imaging Access in Sub-Saharan Africa

Udunna Anazodo, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The delivery of diagnostic imaging in low-and-middle income countries (LMICs) is challenged by high costs of infrastructure acquisition and shortage of experts, particularly in Sub-Saharan Africa (SSA). One of the main issues accentuating this challenge is the availability of picture archiving and communication systems (PACS) for distribution, archiving and managing of images due to poor availability of quality internet service, high cost of computing infrastructure for hosting and distributing PACS and lack of skilled administrators to effectively maintain the system. Poor access to PACS contributes to poor diagnostic

outcomes as the few available radiologists who serve a large population over a vast geographical area, are unable to access images for proper diagnosis. To improve PACS access in resource limited settings, we propose a redistributable PACS platform, HASKE (light in Hausa) accessible to radiologists, physicians, and patients based open-source tools, designed for use in low bandwidth environments and for ease of management.

## **METHODS AND MATERIALS**

HASKE is designed (Figure 1) to provide a low-resource solution for rapid access to images with standard features for 1) onsite and cloud/remote archiving system, 2) integrated zero footprint DICOM viewer, 3) a straightforward DICOM query interface, 4) mobile phone accessibility, and 5) low maintenance requirements for easy management by non-IT health personnel.

## **RESULTS**

The pilot open-source PACS tool is currently in use at three imaging facilities in Nigeria will be scaled up to provide a Health Level 7 (HL7) vendor-neutral PACS platform to ensure ease of integration, especially given the nature of medical device procurement in SSA (third party vs. original equipment manufacturers [OEMs]).

## **CONCLUSION**

The HASKE PACS platform represents a significant step towards improving access to diagnostic imaging in SSA and other resource-limited settings. The platform is designed to overcome prevailing challenges from lost images either through non availability of storage systems or poorly interpreted due to the lack of accessibility to the radiologist. HASKE is designed to help clinicians with limited resources to distribute images better and readily read and share imaging findings to transform disease management in SSA. By utilizing open-source tools, the platform is scalable and affordable, making it accessible to radiologists, physicians, and patients, alike.

## **CLINICAL RELEVANCE/APPLICATION**

While HASKE address the immediate need for diagnostic image data management, it ultimately will enable health equity and inclusion of resource limited settings in imaging data science and artificial intelligence (AI) solutions, where AI is has the greatest potential to improve local health outcomes.

## **M5A-SPIN- A Platform for Automatically Extracting Imaging Biomarkers from Ischemic and Hemorrhagic Stroke Patients**

Rajat Dhar, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Imaging biomarkers of primary and secondary injury provide critical insights into disease progression and prognosis. Quantifying lesions (infarct or hemorrhage) and associated edema volume can be time-consuming and impractical in large multi-institutional cohorts. We present a cloud-based image repository and computational platform that can archive, analyze, and output multi-dimensional imaging biomarkers from brain CTs of ischemic and hemorrhagic stroke patients.

## **METHODS AND MATERIALS**

The Stroke NeuroImaging Phenotype Repository (SNIPR), based on the XNAT platform, has archived serial imaging from large stroke cohorts from multiple institutions. It allows the implementation of image analysis pipelines wrapped in Docker containers. In this study, we deployed containerized pipelines to analyze lesion and edema volume from both ischemic and hemorrhagic (ICH) stroke cohorts. Scans within each imaging session are first classified (using metadata and a deep learning-based classifier), allowing selection of 'axial brain CT' scans which can be processed (incl. DICOM to NIFTI conversion, brain extraction, and normalization), followed by (U-net-based) segmentation of infarct and hemorrhage lesions as well as peri-hematoma edema (in ICH) and displacement of CSF (for both ischemic stroke and ICH). The ratio of hemispheric CSF volumes was calculated in both groups. Net water uptake (NWU) is calculated in the infarct group as the relative density of infarct vs. Mirrored regions. Resulting segmentation masks are stored, while the biomarker results are stored as CSV files and presented as novel data types that can be viewed on a session, subject, or project level. A superimposed view of the lesion and edema/CSF masks over the NCCT image and a summary of the measurements are also held in a PDF.

## **RESULTS**

The analysis pipelines were implemented on 2649 CT sessions (ischemia:442 and ICH:2207) from three research centers. Axial brain scans could be found in the majority (74%) of sessions. Pipelines were completed in 1407 (71%), with biomarker extraction, including infarct/hemorrhage volumes, CSF ratio, and NWU. The platform can analyze around 1000 images in a week.

## **CONCLUSION**

The study presents a cloud-based image archive and analysis pipeline to calculate biomarkers in axial brain CT. It allows multi-centric collaboration and analyses of thousands of images at a time that would facilitate ongoing stroke research worldwide. The platform will be extended to include more image analysis pipelines useful for stroke research.

## CLINICAL RELEVANCE/APPLICATION

This platform can assist in quantifying infarction, hemorrhage, and edema in large volumes of serial brain CT scans of ischemic and hemorrhagic stroke patients, facilitating stroke research.

## M5A-SPIN- Complex Convolutional Neural Networks for Denoising Accelerated Submillimeter Magnetic Susceptibility Brain MRI

Bryan Quah, MSc (*Presenter*) Nothing to Disclose

### PURPOSE

Magnetic susceptibility-based imaging using submillimeter isotropic 3D echo-planar imaging (3D-EPI) enables the detection of biomarkers for neurological disorders, such as the central vein sign and paramagnetic rim lesions in multiple sclerosis. Recent developments combining 3D-EPI acquisition with CAIPIRINHA undersampling, have shown to significantly reduce scan times. However, this comes at the cost of a reduced signal-to-noise ratio (SNR) which we address here using a complex denoising deep learning method.

### METHODS AND MATERIALS

3T brain MRI scans from 52 adults scanned at three imaging sites were used. T2\*-weighted magnitude and phase images were acquired at 650  $\mu\text{m}$  isotropic using 3D-EPI without parallel imaging (Acquisition Time, AT:  $\sim 6$  minutes), and with parallel imaging using CAIPIRINHA at different acceleration factors: R=2, (AT:  $\sim 4$  minutes), R=3 (AT:  $\sim 3$  minutes) and R=4 (AT:  $\sim 2$  minutes). The subjects were divided into 2 datasets: a training set (N=41) for the network to learn the denoising task and a testing set (N=11) to evaluate the model performance. The training set consists of data acquired without CAIPIRINHA while the testing set consists of data acquired with CAIPIRINHA at the 3 acceleration factors. We developed a 2-dimensional convolutional neural network to denoise the complex valued data created from the magnitude and phase 3D-EPI images. Our developed network extends the convolution and rectified linear unit operations to the complex domain. Peak signal-to-noise ratio (PSNR) and structural similarity index measure (SSIM) were calculated before and after denoising.

### RESULTS

Upon visual inspection, the denoised magnitude and phase images displayed improved image quality while the visibility of brain features and disease-related biomarkers were preserved. The average PSNR values measured across the cohort were increased after denoising at all acceleration factors (+29% for R=2; +34% for R=3; +41% for R=4). Meanwhile, the SSIM values measured remained high for all acceleration factors (mean  $\pm$  SD: 0.959  $\pm$  0.014 for R=2; 0.951  $\pm$  0.021 for R=3; 0.942  $\pm$  0.023 for R=4).

### CONCLUSION

We developed a complex denoising deep learning approach to efficiently improve the image quality of accelerated submillimeter magnetic susceptibility brain MRI scans. Even at high acceleration factors (R $\geq$ 3), our method was able to restore the significant loss in SNR while maintaining structural details.

## CLINICAL RELEVANCE/APPLICATION

Our study demonstrates the feasibility of efficiently denoising accelerated magnetic susceptibility brain MRI with complex convolutional neural networks. Our proposed method opens the door for ultra-fast submillimeter SWI and QSM imaging in the clinical setting.

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## Abstract Archives of the RSNA, 2023

M5A-SPIR

### Interventional Radiology Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPIR- 1 Prediction of Response to Treatment and Outcome of Trans-arterial Chemoembolization in Patients with Hepatocellular Carcinoma Using Artificial Intelligence: A Systematic Review Study**

Pedram Keshavarz, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study reviews the efficacy of different AI models for prediction of hepatocellular carcinoma treatment response to transarterial chemoembolization (TACE) including the overall survival (OS).

#### **METHODS AND MATERIALS**

This systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines. We conducted a literature search in online databases, including Scopus, Medline (PubMed), Web of Science, Embase, and Google Scholar. The random-effect models were utilized to calculate pool sensitivity, specificity, predictive values, summary receiver operator characteristic (ROC), and area under curve (AUC) based on the "Standards for Reporting Diagnostic accuracy studies" (STARD) guidelines.

#### **RESULTS**

The systematic review cohort included 21 studies with 4,489 patients. The AI algorithm AUC for predicting HCC response to TACE ranged from 0.32-0.97. Radiomics and non-radiomics feature based models had similar pooled AUCs of 0.76 (95%CI: 0.73-0.79) and 0.75 (95%CI: 0.70-0.80), respectively. Compared to the most widely utilized machined learning methods relying on logistic regression, other AI-based methods such as convolutional neural networks (CNN) and support vector machine (SVM) had AUCs of 0.93 (95%CI 0.84-1.00) and 0.79 (95%CI, 0.77-0.81) respectively. Of all predictive feature models, models combing both CT or MR images with clinical features had higher AUCs of 0.78 (CT+clinical, 95%CI 0.74-0.83) and 0.81 (MR+clinical 95%CI 0.78-0.84) respectively, relative to models based on clinical features alone, AUC 0.67 (95%CI 0.53-0.80).

#### **CONCLUSION**

AI models showed acceptable performance in prediction of treatment response to TACE and post-TACE OS. CNN method utilizing a combination of cross-sectional images findings and clinical characteristics had superior performance compared to sole clinical features.

#### **CLINICAL RELEVANCE/APPLICATION**

The prediction of post-TACE, HCC treatment response by AI methods was feasible and significant in all studies. Contributing medical data is vital in improving predictions' confidence and stability, while it can significantly enhance accuracy and reduce the burden on the healthcare systems for investigating all the clinical and radiological features to determine the potential TACE responders. Comprehensive studies are required to introduce a highly accurate and reliable AI prediction model and reduce heterogeneity between outcomes.

#### **M5A-SPIR- 2 Predicting Survival of Lung Ablation Patients using Deep Learning-Based Automatic Segmentation and Radiomics Analysis**

Hossam A. Zaki, BS (*Presenter*) Nothing to Disclose

## PURPOSE

To identify radiomic features predictive of survival following image-guided thermal ablation (IGTA) of lung tumors segmented using a deep learning approach.

## METHODS AND MATERIALS

This HIPAA-compliant study was performed with a waiver for informed consent following institutional review board approval. Between January 1, 2004 and July 14, 2022, adult patients who underwent IGTA for primary and metastatic lung tumors were retrospectively identified. Using pre-procedure CT imaging data, lung zones were automatically segmented using a pre-trained U-Net, which was trained on a large dataset that covers significant visual variability and includes tumors in the segmentation. Following this, we used a U-shaped encoder-decoder transformer architecture (UNETR) to segment lung tumors. The model was trained on lung CT scans with tumor annotations. We then applied the pre-trained model to patients who underwent IGTA. Radiomic features were extracted from the lung segmentations. We utilized features related to the shape of the segmentation, including surface area, volume, and diameter. These radiomic features were then used to predict days-to-death of the patients using a Cox proportional hazards model. Death records were extracted from the electronic medical record and/or obituary data.

## RESULTS

154 consecutive patients were evaluated (median age, 74.6 years; 46.4% Male). Of these patients, 119 experienced the mortality event, with a mean time to death of 3.6 years (minimum 0.6 years; maximum 14.2 years) following the initial IGTA procedure. Median tumor size was 1.8 cm (minimum 0.6 cm; maximum 5.2 cm), and 138 patients (90%) had primary lung cancer. The initial lung tumor segmentation using UNETR achieved a DICE score of .72, indicating a 72% overlap of the predicted segmentation and the ground-truth. The survivability prediction task using radiomic features achieved a c-index of .69, showing a 69% chance the model will correctly predict which subject has a longer survival time out of a random pair. The most predictive features were flatness and diameter along the row, with a c-index of .57 and .55, respectively. Flatness indicates the elongation of the tumor, while diameter indicates the length in a certain axis, both of which relate to tumor growth patterns.

## CONCLUSION

Radiomic feature analysis of lung tumors following segmentation by transformer-based UNET may predict long-term survival following image-guided thermal ablation of pulmonary malignancies.

## CLINICAL RELEVANCE/APPLICATION

The incorporation of a survival prediction model based on radiomics features extracted from pre-procedure CT imaging by a deep learning algorithm may allow interventional radiologists to modify treatment approaches to optimize outcomes for patients.

## M5A-SPIR- 3 Assessing ChatGPT's Proficiency in Generating Differential Diagnoses Based on Transcribed Vascular and Interventional Radiology Findings

Kenneth N. Huynh, DO (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of specific vascular and interventional radiology (VIR) cases.

## METHODS AND MATERIALS

A sample of 20 cases specific to VIR imaging were evaluated. Cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

## RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 85.0% compared to 85.0% ( $p = 0.5$ ) and 30.0% compared to 15.0% ( $p = 0.13$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 60.0% compared to 56.7% ( $p = 0.42$ ). ChatGPT3.5 and ChatGPT4 hallucinated 48.3% versus 13.4% ( $p < 0.00001$ ) of the references provided and generated 1 false statement versus 0 false statements, respectively.



## CONCLUSION

The two generations of ChatGPT were able to generate a differential diagnosis for prompts containing descriptive radiological findings. The accuracy of top 1 diagnoses matched the expert literature from which the cases originated with reasonable accuracy, with no statistically significant improvement between the 3.5 to the 4<sup>th</sup> generation algorithm. However, responses from both algorithms matched the top 3 diagnoses from the expert literature a minority of the time. The well-known hallucination effect was encountered more commonly in the generation of citations than the generation of factual statements, which improved with the newest algorithm.

## CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) have a large potential to impact clinical and educational medicine. Knowledge of the accuracy and erroneous possibilities of these algorithms will provide a better understanding of the limitations of these new tools.

### **M5A-SPIR- 4 Identification of Inferior Vena Cava (IVC) Filters on CT, X-ray and MRI Radiological Reports with a Natural Language Processing (NLP) Based Tool for Management of Clinical Follow Up**

Yifan Wang, MD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Many patients with IVC filters don't get proper follow up and their filters are not removed even when it is not further needed. Many of the patients who are lost to follow up are undergoing other imaging studies in their lifetime with the presence of an IVC filter gets documented in radiological reports. NLP can assist in discovering those patients with IVC filters and help clinicians in monitoring and clinical follow up. The study aims to measure the effectiveness of an NLP solution in discovering IVC filters in radiological reports and explore the role of AI in improving follow up of patients with IVC filters.

## METHODS AND MATERIALS

Radiological reports of CT, X-ray, and MRI studies from a large academic health system generated between 7/1/2021 and 7/31/2021 were selected for analysis. Follow-up was reviewed up to 20 months after the initial report dates. Radiological reports were analyzed for the presence of mention of an IVC filter using an NLP solution. The NLP positive cases were reviewed to measure: the positive agreement rate of the solution in identifying patients with inferior vena cava (IVC) filter using radiological reports, the number of cases identified that were eligible for IVC removal, the number of cases identified that were eligible for IVC removal and not currently scheduled and the number of IVC removal procedures that resulted from the solution case identification.

## RESULTS

NLP solution classified 225 reports as positive for the presence of an IVC filter. The positive agreement rate was 99.56% (224/225). On secondary review by 4 clinicians, 164 unique cases were identified. 51.2% (84/164) filters were not placed by IR, and 20.1% (33/164) filters were non-retrievable type. 4.3% (7/164) identified cases had IVC filter related major complications. In 20 months follow up 57.3% (94/164) of the identified cases were eligible for removal at time of the scan, however only 12.8% (12/94) of the filters removed and 87.2% (82/94) of the cases had not been followed or scheduled. Particularly, 45 filters had been present for at least 5 years and 30 out of these 45 filters were eligible for removal.

## CONCLUSION

The NLP based solution accurately identified patients with IVC filters using the radiological reports. A significant number of the patients that had IVC filters did not have clinical follow up or their filters removed despite eligibility.

## CLINICAL RELEVANCE/APPLICATION

This is the first report to evaluate the efficacy of IVC filter detection using the commercial product AIDOC. Using radiological reports, NLP has the potential to greatly enhance follow-up management for patients with IVC filters, not only at their home institutions but also for those whose filters were discovered incidentally.

### **M5A-SPIR- 5 Generative Learned Models for Synthesis of Realistic Soft-Tissue Deformable Motion with Controllable Magnitude in Interventional Cone Beam CT**

Alejandro Sisniega, PhD (*Presenter*) Research Grant, Siemens AG; Research Grant, Micro-X Ltd; Research Grant, Izotropic Corporation

## PURPOSE

Cone-beam CT (CBCT) is a ubiquitous tool for guidance in interventional radiology, yet susceptible to motion artifacts from a combination of quasi-periodic motion and aperiodic, local, motion. Deep autofocus showed potential for compensation of deformable motion but requires large and diverse datasets of motion-corrupted CBCT, paired with the source motion, for training. Reliable simulation of complex motion remains an open challenge. This work reports a generative model for simulation of realistic deformable motion with controllable magnitude, via observation of unpaired, motion-corrupted data.



## METHODS AND MATERIALS

The generative model receives a motion-free volume as baseline anatomy, and a random perturbation, to synthesize a random, anatomy-aware 4-dimensional motion field. The model implements a variation of the CycleGAN architecture, with spatial transformers coupling the anatomical context to the spatiotemporal motion field. A customized GAN loss was designed to learn an amplitude control code (ACC) yielding controllable motion magnitude, and it was trained in an unsupervised fashion using solely motion-corrupted CBCT volumes. The model was exercised in a proof-of-concept study with (N=144) simulated CBCT including known motion, providing a controlled validation scenario before extension to clinical data. A test set with 594 motion fields was synthesized (9 anatomies, 6 random perturbations, and 11 amplitude control codes).

## RESULTS

Synthetic motion fields showed magnitude in line with the training set with median amplitude of 26 mm vs 32 mm in training (15 mm vs 17 mm IQR). The spatial distributions of synthetic motion agreed with underlying anatomy, with soft-tissue regions showing large motion distortion with a preference towards anterior parts of the anatomy (median 26 mm) and rigid regions around the spine remaining stationary (median 3.6 mm), in agreement with trends in training data. Variation of the ACC resulted in nearly linear increase in motion amplitude in soft-tissue regions with no significant variation of the spatial distribution. Variation of the random perturbation code resulted in different spatial allocation of motion but no change in magnitude for equivalent control codes.

## CONCLUSION

Random synthetic motion with anatomically realistic spatial distribution, amplitude, and direction was achieved with a learned generative model via observation of motion-corrupted CBCT. The proof-of-concept study opens the way to application of the model in clinical scenarios.

## CLINICAL RELEVANCE/APPLICATION

This work presents an unsupervised motion synthesis model able to generate anatomically-realistic motion vector fields, enabling the generation of large training datasets for development of deep autofocus methods.

## M5A-SPiR- Evaluating Artificial Intelligence for the Diagnosis of Acute PE

6

Yifan Wang, MD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Pulmonary embolism (PE) is a severe medical condition, with a high mortality rate if left untreated. A pulmonary embolism response team (PERT) is a multidisciplinary group of providers that provide consultation and care to patients with PE. Artificial Intelligence (AI) has the potential to improve the care provided by a PERT team by notifying members of the team immediately about suspected cases and enabling appropriate therapies to occur in a timely fashion by assisting with the rapid coordination of care amongst a PERT. This study aims to evaluate cases identified by an AI solution across a health system. The health system studied is composed of a main campus (hub) that is capable of performing all current PE therapies and multiple other hospitals (spokes) within the system that can provide limited therapies for PE. This study assesses if AI can correctly identify PE cases of a significant risk stratification and those that may benefit from transfer from a spoke hospital to the hub hospital for additional care.

## METHODS AND MATERIALS

A retrospective cohort of patients at 3 spoke hospitals undergoing computed tomography pulmonary angiography (CTPA) between 01/2019 -12/2020 was analyzed using an AI solution. A positive finding was defined as the AI solution detecting moderate to large central PE thrombi and a right ventricle to left ventricle (RV/LV) ratio greater than 1.3. CT parameters were obtained from radiological interpretation and data on clinical PERT activation and interventions at each site were obtained by chart review. Metrics measured included the European Society of Cardiology (ESC) PE risk stratification score, PERT consultation, transfer of patients from a spoke-to-hub, and treatment strategy. The findings were compared to historical averages from the hub/main campus.

## RESULTS

A total of 43 cases from 3,787 CTPA scans were identified by the algorithm, of which 92.5% (37/40) were intermediate-high or high-risk PE based on the ESC risk stratification. Comparing spoke hospitals to the hub hospital, 55% (22/40) vs 100% (133/133) of the identified cases had a PERT consultation and 22% (9/40) versus 70% (93/133) of identified cases received an advanced therapy (catheter or surgical therapies, systemic thrombolytics or mechanical support). Only 5% (2/40) of the identified cases resulted in a spoke-to-hub transfer.

## CONCLUSION

The use of AI may help optimize the coordination and care of PERT patients by correctly identifying intermediate and high-risk PE cases, those that may require a PERT consultation, and identifying patients who may benefit from transfer to a hub hospital for advanced therapies.

## **CLINICAL RELEVANCE/APPLICATION**

AI may have the ability to assist in detection of acute PE and coordination of care amongst clinicians across a health system.  
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## Abstract Archives of the RSNA, 2023

M5A-SPMK

### Musculoskeletal Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPMK- Quantitative Study of Bone Marrow Edema Due to Acute Fractures with Dual-energy Spectral CT Imaging** **1**

Yanan Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the utility of material density and CT attenuation value measurements in dual-energy spectral imaging for differentiating bone marrow edema due to acute bone fractures from the normal bone marrow.

#### **METHODS AND MATERIALS**

24 patients who presented with acute fractures from November 2017 to March 2018 underwent dual-energy spectral CT imaging on a 16cm wide-detector CT scanner. The virtual monochromatic images and water-calcium material decomposition (MD) images were reconstructed. The monochromatic CT images with color-coded water-calcium MD image overlay were reviewed by two radiologists to identify bone fractures and the associated bone marrow edema. The CT attenuations and water(calcium) concentrations were measured from the CT images and water(calcium) MD images, respectively for bone marrow edema and normal bone marrow. Receiver operator characteristic (ROC) curve analysis was used to determine the diagnostic accuracies of these measurements.

#### **RESULTS**

The water(calcium) concentrations ( $1040.28 \pm 33.55 \text{ mg/cm}^3$ ) in the areas with bone marrow edema were significantly higher than in the normal bone marrow ( $1011.11 \pm 45.83 \text{ mg/cm}^3$ ) ( $p < 0.001$ ). The CT attenuation values in the 70keV images were  $210.18 \pm 108.63 \text{ HU}$  and  $133.44 \pm 134.06 \text{ HU}$  in the areas with bone marrow edema and with normal bone marrow, respectively ( $p < 0.001$ ). The Area under the curve (AUC) for ROC analysis using the water(calcium) concentration was 0.771, significantly higher than the value of 0.719 using the CT attenuation measurement ( $p < 0.05$ ).

#### **CONCLUSION**

The measurement parameters, especially the water(calcium) concentration measurement in bone marrow obtained in the dual-energy spectral CT imaging, have high accuracy in differentiating bone marrow edema from normal bone marrow.

#### **CLINICAL RELEVANCE/APPLICATION**

Dual-energy spectral CT imaging provided a novel and accurate method to quantitatively evaluate the bone marrow edema due to acute bone fractures.

#### **M5A-SPMK- The Use of Monochromatic CT Images Overlaid with Water-calcium Material Decomposition Images in Dual-energy Spectral Imaging for Identifying Bone Marrow Edema Due to Acute Bone** **2**

Yanan Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the utility of identifying bone marrow edema due to acute bone fractures using the monochromatic CT images overlaid with color-coded water-calcium material decomposition (MD) images in dual-energy spectral imaging.

#### **METHODS AND MATERIALS**

24 patients who presented with acute bone fractures underwent dual-energy spectral imaging on a 16cm wide-detector CT scanner from November 2017 to March 2018. The virtual monochromatic images and water-calcium MD image pairs were

reconstructed. The monochromatic CT images overlaid with color-coded water-calcium images were reviewed by two radiologists, and the fractures and associated bone marrow edema were identified. The CT attenuations and water(calcium) concentrations of the areas with bone marrow edema and with normal bone marrow were measured from the CT images and water(calcium) MD images, respectively. These values were compared with paired t-test. Kappa values were calculated between the two readers on the identification of the areas with and without bone marrow edema.

## RESULTS

There was bone marrow edema associated with every bone fracture and the overlay images had higher confidence and clarity to identify the areas of edema than the CT images alone. The Kappa value was 0.878 between the two readers on the identification of the areas with and without bone marrow edema on color-coded water-calcium images. The water(calcium) concentrations ( $1040.28 \pm 33.55 \text{ mg/cm}^3$ ) in the areas with bone marrow edema were significantly higher than in the normal bone marrow area ( $1011.11 \pm 45.83 \text{ mg/cm}^3$ ) ( $p < 0.001$ ). The CT attenuation values in the 70keV images were  $210.18 \pm 108.63 \text{ HU}$  and  $133.44 \pm 134.06 \text{ HU}$  in the areas with and without bone marrow edema, also had a significant difference between the two areas ( $p < 0.001$ ).

## CONCLUSION

The monochromatic CT images overlaid with color-coded water-calcium images in dual-energy spectral CT imaging on a 16cm wide-detector CT is sensitive and quantitative to identify the bone marrow edema due to acute bone fracture.

## CLINICAL RELEVANCE/APPLICATION

The monochromatic CT images overlaid with water-calcium images in spectral CT can provide an alternative to MRI for detecting the bone marrow edema due to acute bone fractures.

## M5A-SPMK- Evaluation of Radiosynoviorthesis as a Palliative Treatment in Advanced Arthropathies

3

Marta Gallego Verdejo, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Radiosynoviorthesis consists of intra-articular injection of radionuclides to achieve a local therapeutic action in patients with chronic or resistant arthropathies in whom other treatments have failed. This study aims to demonstrate the effectiveness of radiosynoviorthesis in treating chronic synovitis at three levels: clinical, functional, and radiological. Additionally, it will study the safety of the technique.

## METHODS AND MATERIALS

It is a descriptive and retrospective study with a multidisciplinary approach (radiology, radiophysics and nuclear medicine). The current sample consists of 15 patients referred for treatment with radiosynoviorthesis from various hospitals between 2019 and 2022. However, we expect to expand to 30 patients in the coming months, when the controls will be carried out. Each patient is evaluated before and after treatment using a pain visual analog scale (VAS) from 0 (no pain) to 10 (maximum pain) and a functionality scale depending on the treated articulation. Immediately after the puncture, scintigraphy is performed to assess the adequate distribution of the radionuclide in the joint. Also, an ultrasound control is performed before and approximately 3 months after radiosynoviorthesis.

## RESULTS

In preliminary results, the mean VAS score lessened from 7.07 before radiosynoviorthesis to 3.47. Similarly, they show an upgrade in the functional scale from 41.47 % to 70.06 % (values expressed as a percentage of the maximum score for each test). In addition, some patients have exhibited an improvement in synovial hyperemia in the ultrasound control, with a reduction in effusion and synovial thickening. Furthermore, it has been confirmed that it is a safe technique, with a low incidence of complications in the treatments performed.

## CONCLUSION

Radiosynoviorthesis (RSO) is a good treatment for patients with chronic or resistant pathology of the synovial membrane in whom the first lines of treatment have not been effective. It brings improvements at the clinical and functional levels, with a reduction in ultrasound synovitis signs in some patients. It also has a low complication rate, which makes it an effective and safe alternative in the treatment of chronic arthropathies.

## CLINICAL RELEVANCE/APPLICATION

It is a safe procedure that can bring clinical and functional improvement to patients with limiting arthropathies that can substantially improve their quality of life.

## M5A-SPMK- Optimizing US-guided Lavage for Rotator Cuff Calcific Tendinitis: The Effect of Corticosteroids Injection Pre vs. Post-procedure

4

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to determine whether the pre or post-procedure injection of corticosteroids during US-guided lavage of rotator cuff calcific tendinitis affects the outcome.

## METHODS AND MATERIALS

At our institution, 124 patients with calcific tendinitis of the rotator cuff were treated with US-guided lavage between 2020 and 2021. In 71 patients, a corticosteroid was injected into the subacromial bursa following the lavage (corticosteroid-after group). The remaining 53 patients (corticosteroid-before group) received the injection before undergoing the procedure. Characteristics of calcification were recorded in terms of number, size, location and type according to Gartner and Hayer's classification. Other variables assessed were calcium extracted, number of adverse events and follow-up. Data were analysed using SPSS 25.0 software, and a p-value < 0.05 was considered statistically significant.

## RESULTS

Both groups showed no significant differences regarding sex ( $p = 0.612$ ) or age ( $p = 0.883$ ). The only reported adverse effect was vasovagal syncope in 7 patients (13.2%) in the corticosteroid-before group and 11 patients (15.5%) in the corticosteroid-after group ( $p = 0.721$ ). The percentage of patients in which a significant amount of calcium was extracted was similar in both groups (54.7% vs 54.9%;  $p = 0.981$ ). The type of calcification was the only factor that showed a statistical association with this outcome (68.5% for type 1 and 2 calcifications; 20% for type 3 calcifications;  $p < 0.01$ ). Finally, the number of patients who required further intervention during follow-up was 23 (43.4%) in the corticosteroid-before group and 41 (57.7%) in the corticosteroid-after group ( $p = 0.943$ ).

## CONCLUSION

Administration timing of corticosteroid injection before or after calcium deposit removal does not impact treatment outcomes or incidence of adverse effects. Both approaches are equally effective, (however, US guidance should always be recommended to ensure accurate placement and prevent potential complications).

## CLINICAL RELEVANCE/APPLICATION

The order in which this procedure is performed has been arbitrary, with no comprehensive study conducted on the optimal approach. Our study suggests that patients exhibit similar tolerance levels regardless of the treatment sequence.

## M5A-SPMK- Intra-articular Injections of the Foot: An Evaluation of Physician Ordering Practices of Ketorolac and Kenalog

Justin Choi, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Intra-articular steroid injections are widely utilized to provide therapeutic relief and diagnostic evaluation of foot pain. Nonsteroidal anti-inflammatory injectants may offer a safer profile and have been shown to provide similar levels of pain relief as steroids. This study sought to evaluate physician preferences for injection agents for intra-articular foot injections.

## METHODS AND MATERIALS

An IRB-approved retrospective review was performed using radiology data mining system (Nuance mPower) to identify patients who received intra-articular foot injections from 2011-2023 at a single academic institution. Study participants were eligible if they received an image-guided foot injection and divided into two cohorts: 1) injection with Kenalog and 2) injection with ketorolac. Demographics, BMI, diagnosis, site, agent, pre and post pain scores, treatment history, and ordering provider were recorded. The Visual Analogue Scale was used to collect the pain score. The difference between the pre and post pain scores determined the delta pain score. The Mann-Whitney U test was used to compare the delta pain score between the cohorts. Categorical variables were compared using Pearson's chi-square test.

## RESULTS

Forty one of the 182 injections were with ketorolac. Eighty four percent of the patients were female and the average age was 65.5 years-old. Fifty percent of patients had a BMI =30. Osteoarthritis was the most common diagnosis for Kenalog and ketorolac injections (95% and 51%, respectively,  $p < 0.01$ ) while the tarsometatarsal joints were the most common sites for both cohorts (82% and 37%, respectively,  $p < 0.01$ ). Out of the four ordering providers identified, Provider 1 ordered ketorolac for 85% of the injections and Provider 2 ordered Kenalog for 91% of the injections ( $p < 0.01$ ). Sixty seven percent of patients who received a kenalog injection and 3% of patients who had ketorolac injections required serial injections ( $p < 0.01$ ). Twenty one percent of cohort 1 and 34% of cohort 2 underwent surgery after injections ( $p = 0.26$ ). The mean delta scores reported for the Kenalog cohort and ketorolac cohort were -4 and -1, respectively ( $p < 0.01$ ).

## CONCLUSION

There was a clear preference in the type of agent ordered by each provider without a significant difference in post-injection surgical treatment rates. In recent years, there was an increase in usage of ketorolac and for a wider range of injection sites

and diagnoses compared to Kenalog. Future studies could quantitate efficacy of intra-articular injections for foot pain by injectant.

#### **CLINICAL RELEVANCE/APPLICATION**

Ketorolac is a low-cost option for diagnostic and therapeutic intra-articular injections of the foot that offers a safety profile comparable to steroids, without significant differences in outcomes.

#### **M5A-SPMK- Quantitative DWI Assessment of Changes in Graft Maturity at 6 and 12 Months after Anterior Cruciate Ligament Reconstruction and Correlation with Clinical Scores**

Feiyuan Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To quantify the status of graft remodeling using DWI functional MRI at 6 and 12 months after anterior cruciate ligament reconstruction (ACLR) and its correlation with the corresponding clinical function score.

#### **METHODS AND MATERIALS**

Forty-four patients who underwent ACLR between August 2020 and October 2021 and fifteen volunteers were recruited prospectively. Patients underwent 3.0T conventional MRI and DWI scans in 6 and 12 months after ACLR to measure ADC values of the intra-articular segment graft and its three segments (proximal, middle, and distal). IKDC, Lysholm scores were performed at each time point. Differences between 6 and 12 months postoperatively in ADC changes were compared using the Wilcoxon test. Correlation between ADC values of the intra-articular segment of the graft and clinical scores (IKDC, Lysholm score) in 6 and 12 months was analyzed using the Pearson correlation coefficient.

#### **RESULTS**

ADC values for the overall intra-articular segment of the ACL graft and its three parts (proximal, middle, and distal) decreased significantly from 6 to 12 months ( $P < 0.05$ ). There was no significant correlation between the ADC values of the grafts and the clinical scores (IKDC, Lysholm scores) at 6 and 12 months postoperatively. The ADC values of the distal segment of the intra-articular segment of the graft were higher than those of the middle and proximal segments at 6 months postoperatively ( $P < 0.05$ ), while the ADC values of the three segments in 12 months were similar.

#### **CONCLUSION**

The graft continued to mature from 6 months to 12 months after ACLR. The ADC values measured by the graft decreased but were not consistent with clinical function scores, suggesting that DWI and ADC are a finer reflection of changes in graft maturity than clinical scores.

#### **CLINICAL RELEVANCE/APPLICATION**

DWI can indicate the change of graft maturity and guide the recovery time of ACLR patients after surgery.

#### **M5A-SPMK- Metal Suppression Using a New Generation Low-Field MRI; In Vitro Assessment in a Pig Knee Model**

Johanna Luitjens, MD (*Presenter*) Consultant, Smart Reporting

#### **PURPOSE**

To evaluate the artifact size reduction using a metal artifact correction (SEMAC) sequence at 0.55T and 3T in porcine knee specimens with metal hardware compared to standard sequences. This study aims to assess the feasibility of metal suppression on a novel 0.55T system, to optimize the pulse sequence parameters and to compare them with imaging at 3T as standard of reference.

#### **METHODS AND MATERIALS**

Steel and titanium screws with 2.2mm diameter were implanted in 12 porcine knee specimens before imaging at 0.55T (Siemens Free.Max) and 3T (Siemens Vida) MRI using turbo spin echo (TSE), view angle tilting (VAT factor 50 and 100), and combined VAT and SEMAC (VAT100+SEMAC) in proton-density (PD) and T2 short TI inversion recovery (STIR) TSE pulse sequences. Sizes of metal artifacts were measured, and the visualization of the bone and cartilage, cruciate ligaments, joint effusion, and growth plate close to the metal artifact as well as the overall image quality, were assessed using a 5-point Likert scale. Wilcoxon-signed-rank tests were performed to determine the differences in image quality between 0.55T and 3T MRI.

#### **RESULTS**

The size of the metal artifacts for titanium was smaller in normal PD ( $p=0.002$ ), PD VAT100 ( $p=0.019$ ), PD VAT100+SEMAC ( $p=0.01$ ), and T2 STIR VAT50 ( $p=0.04$ ) at 0.55T MRI compared to 3T MRI. For stainless steel screws, almost all sequences showed smaller artifact sizes using 0.55T compared to 3T MRI ( $p<0.001$  for PD, PDVAT50/100, PD VAT100+SEMAC, T2 STIR VAT50/100, T2 STIR VAT100+SEMAC), only in T2 STIR no difference could be found. Close to stainless steel screws, the visualization of the growth plate and the bone was significantly better at 0.55T MRI in all sequences ( $p<0.001$ ). Results from

PD with VAT100 and PD VAT100+SEMAC showed better visualization of growth plates close to the titanium screws at 0.55T MR compared to 3T MRI. For all other sequences, the visualization of the growth plates did not differ close to titanium screws between both systems. PD VAT100+SEMAC, PDVAT100, and standard T2 STIR FSE sequences showed better image quality at 0.55T compared to 3T MRI. For all other sequences (PD, PDVAT50, T2 STIR 50/100, TS VAT100+SEMAC), the image quality did not differ between field strengths.

#### **CONCLUSION**

Our results show that imaging of metal hardware using a novel 0.55T MRI system, in particular, if combined with SEMAC techniques, especially by using factor VAT50, is superior compared to 3T MRI. The visualization of anatomical structures at 0.55T MRI is not inferior compared to 3T MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

New generation low-field MRI at 0.55T reduces metal artifacts in musculoskeletal imaging, leading to improved visualization of potential hardware complications and thus enhancing patient care.

#### **M5A-SPMK- Impact of Weight Loss on Knee Joint Synovitis over 48 months and Mediation by Local Subcutaneous Fat: Data from the Osteoarthritis Initiative**

Maximilian T. Loeffler, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Synovitis and joint effusion are characteristics of the inflammatory phenotype of osteoarthritis (OA). Weight gain promoted the development of synovitis in a previous study. The purpose of this study was to investigate the effect of weight loss on synovitis progression and to assess whether subcutaneous fat (SCF) around the knee mediates the relationship between weight loss and synovitis progression.

#### **METHODS AND MATERIALS**

We included 234 overweight and obese participants (BMI  $\geq 25$  kg/m<sup>2</sup>) from the Osteoarthritis Initiative (OAI) with  $>10\%$  weight loss (n=117) or stable overweight ( $<\pm 3\%$  change, n=117) over 48 months matched for age and sex. Effusion-synovitis and Hoffa-synovitis using the MRI Osteoarthritis Knee Score (MOAKS) as well as SCF were assessed in unenhanced MRI studies at baseline and 48 months. Average joint-adjacent SCF (ajSCF) was calculated as the arithmetic mean of medial, lateral, and anterior SCF measurements. Odds-ratios (ORs) for synovitis progression over 48 months (=1 score increase) were calculated in logistic regression models adjusting for age, sex, baseline BMI, Physical Activity Scale for the Elderly (PASE), and baseline SCF measurements. Mediation of the effect of weight loss on synovitis progression by a pathway through local SCF change was assessed.

#### **RESULTS**

The odds for effusion-synovitis progression decreased with weight loss and ajSCF decrease (OR=0.61 and 0.56 per standard deviation [SD] decrease, 95%-confidence interval [CI] 0.44-0.83 and 0.40-0.79, p=0.002 and 0.001, respectively). In contrast, the odds for Hoffa-synovitis progression increased with weight loss and ajSCF decrease (OR=1.47 and 1.48 per SD decrease, CI 1.05-2.04 and 1.02-2.13, p=0.024 and 0.038, respectively). Decrease in ajSCF mediated 39% of the effect of weight loss on effusion-synovitis progression.

#### **CONCLUSION**

Effusion-synovitis progression was slowed by weight loss and decrease in local subcutaneous fat. Hoffa-synovitis characterized by fluid in the infrapatellar fat pad increased at the same time, suggesting a decreasing fat pad rather than active synovitis. Decrease in local subcutaneous fat partially mediated the systemic effect of weight loss on synovitis progression.

#### **CLINICAL RELEVANCE/APPLICATION**

Local subcutaneous fat around the knee that can be easily measured in unenhanced MRI influences the progression of effusion-synovitis. Signal alterations in Hoffa's fat pad are non-specific for synovitis and should be interpreted with caution, particularly, in patients with weight loss.

#### **M5A-SPMK- Outcomes and Surgical Revision of Meniscus Allograft Transplant**

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Timothy McIntyre (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate factors influencing outcomes of meniscal allograft transplant as measured by both patient reported outcomes and complications requiring surgical revision of the meniscus.



## **METHODS AND MATERIALS**

Patients undergoing meniscal allograft transplant between 2002 and 2022 at one institution were reviewed. Patient reported outcomes were measured as symptom and function scores via written survey during clinic visits and surgical revision of the meniscus following transplant was recorded. Surgical revision of the transplanted meniscus included meniscectomy, revision transplant, and joint arthroplasty. Univariate and multivariate analyses were performed to evaluate the effect of various prognostic factors on these two outcome measures.

## **RESULTS**

81 patients were evaluated (median age 25 years, interquartile range 18-34, 44 patients were men). Patients showed a mean improvement in symptom score post-transplant of  $1.26 \pm 1.84$  ( $p < 0.001$ ). Patients without associated non-meniscal knee injuries showed a symptom improvement of  $2.26 \pm 1.66$  compared to  $0.83 \pm 1.87$  for those with these injuries ( $p = 0.006$ ). Interval time from meniscectomy to transplant was shown to have a spearman correlation coefficient of  $-0.293$  (95% CI  $-0.500$  to  $-0.051$ ,  $p = 0.017$ ) for symptom score improvement and  $-0.247$  (95% CI  $-0.462$  to  $-0.002$ ,  $p = 0.047$ ) for function score improvement. On multivariate analysis, age  $< 25$  years at the time of meniscectomy was found to be associated with increased need for post-transplant revision surgery (OR 0.18, 95% CI 0.03 - 0.96,  $p = 0.045$ ), as was post-transplant reinjury (OR 10.39, 95% CI 2.52 - 42.92,  $p = 0.001$ ).

## **CONCLUSION**

Meniscal transplant provides symptomatic improvement for patients, which may be limited by the presence of concomitant non-meniscal injuries and increased time between meniscectomy and transplant. Age  $< 25$  years and reinjury are associated with increased likelihood of revision surgery following transplant, likely due to initial traumatic injury or traumatic reinjury.

## **CLINICAL RELEVANCE/APPLICATION**

Meniscal allograft transplant is an increasingly used option for treating meniscal injury to preserve long term function of the knee. Previous studies have varied in choice of outcome measure, failure criteria, and sample size.

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## Abstract Archives of the RSNA, 2023

M5A-SPMS

### Multisystem Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPMS- Quantitative Assessment of Activity in Idiopathic Inflammatory Myopathy by Magnetic Resonance Image Compilation (MAGiC)**

Zhaorong Tian, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The study explored the feasibility of using Magnetic resonance image compilation (MAGIC) parameters to quantitatively evaluate changes of thigh muscles in idiopathic inflammatory myopathy (IIM), in order to provide a quantitative index for the evaluation of thigh muscle inflammatory activity in IIM. And to investigate the correlation between thigh muscle T1,T2 values and serum creatinine kinase (CK).

#### **METHODS AND MATERIALS**

Seventy patients with IIM proven by diagnostic criteria were enrolled in the study along with 30 healthy control subjects. According to clinical findings according to the International Myositis Assessment and Clinical Studies Group (IMACS), the 70 patients were divided into an active group (41 cases) and an inactive group (29 cases). All subjects were scanned using a SIGNATM Architect 3.0T MRI scanner by T1WI, FS-T2WI and MAGIC sequence of the thigh muscle. Two radiologists with 10 years of experience in musculoskeletal system diagnosis measured the T1, T2 values of active group, the inactive group, and the healthy control group thigh muscles on the Magic axial image. The T1,T2 values of thigh muscles in the active, inactive, and healthy groups were compared using one-way analysis of variance (ANOVA). Receiver operating characteristic (ROC) curves were used to analyze the diagnostic efficacy of T1,T2 values for activity of idiopathic inflammatory myopathy. A Spearman correlation coefficient model was used to correlate the mean T1,T2 values of thigh muscle with CK.  $P < 0.05$  was considered statistically significant.

#### **RESULTS**

The T1 values ( $516.11 \pm 82.42$ )ms in the active group of IIM were lower than those in the inactive group ( $794.24 \pm 84.38$ )ms, lower than those in the healthy control group ( $1184.73 \pm 178.23$ )ms, ( $T = -10.693$ ,  $p < 0.001$ ); T2 values of active groups in IIM ( $93.84 \pm 17.15$ )ms, were higher than inactive groups ( $65.07 \pm 9.7$ )ms, higher than those in the healthy control group ( $45.24 \pm 6.7$ )ms, ( $T = -10.013$ ,  $p < 0.001$ ). The areas under the ROC curves (AUCs) of T1,T2 values between the active and inactive groups of IIM,  $0.921$  (95%CI,  $0.846-0.967$ ),  $0.963$  (95%CI,  $0.912-0.993$ ), respectively. The T1,T2 values of thigh muscles in the IIM were positively correlated with CK, and the correlation coefficients ( $r$ ) were  $0.946$ ,  $0.969$  (all  $p < 0.001$ ), respectively.

#### **CONCLUSION**

MAGIC parameters can be used to quantitatively assess the activity of IIM, but also be used to demonstrate severity of damaged muscles in IIM, and T2 values can serve as a potential biomarker of disease activity. MAGIC provided imaging bases for the clinical diagnosis of IIM.

#### **CLINICAL RELEVANCE/APPLICATION**

MAGIC parameters can be used to quantitatively assess the activity and severity of damaged muscles of IIM, provided imaging bases for the clinical diagnosis of IIM.

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## Abstract Archives of the RSNA, 2023

M5A-SPNMMI

### Nuclear Medicine & Molecular Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPNMMI-1 Association Between Severity of Heart Failure<Myocardial Amyloid Deposition on <sup>99m</sup>Tc pyrophosphate Scintigraph<Echocardiography in Patients with Familial Amyloid Polyneuropathy**

Hiroshi Kanaya (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We investigated the relationship between heart failure severity and myocardial amyloid deposition in patients with familial amyloid polyneuropathy (FAP) using <sup>99m</sup>Tc-pyrophosphate (PYP) scintigraphy and echocardiography.

#### **METHODS AND MATERIALS**

Subjects were 71 cases diagnosed with FAP by histopathological diagnosis and genetic testing. Ejection fraction (EF), brain natriuretic peptide (BNP), and cardiac troponin T (TnT) were used as indexes of severity of heart failure. Echocardiography and PYP scintigraphy were performed within 3 months of the blood test. In PYP scintigraphy, the heart to contralateral (H/CL) ratio was calculated in planar image. Pearson's correlation coefficient was calculated for the relationship between the index of the severity of heart failure and the H/CL ratio, also echocardiogram index such as interventricular septum thickness in diastole (IVSTd), posterior wall thickness in diastole (PLVWd) and the ratio of mitral velocity to early diastolic velocity of the mitral annulus (E/e').

#### **RESULTS**

IVSTd, E/e' and H/CL ratio had significant correlation with EF ( $r=-0.36$ ,  $p<0.01$ ,  $r=-0.34$ ,  $p=0.01$ ,  $r=-0.31$ ,  $p=0.01$ , respectively). IVSTd, PLVWd, E/e' and H/CL ratio showed significant correlation with BNP ( $r=0.47$ ;  $p<0.01$ ,  $r=0.52$ ;  $p<0.01$ ,  $r=0.43$ ;  $p=0.01$ ,  $r=0.39$ ;  $p<0.01$ , respectively). IVSTd and PLVWd had significant correlation with TnT ( $r=-0.3$ ;  $p=0.02$ ,  $r=-0.46$ ;  $p<0.01$ , respectively). In addition, in patients with H/CL ratio  $> 1.3$ , H/CL ratio was not significantly correlated with any heart failure index.

#### **CONCLUSION**

Echocardiographic indices, especially IVSTd, may serve as indices of heart failure, whereas H/CL ratio may not.

#### **CLINICAL RELEVANCE/APPLICATION**

H/CL ratio on PYP scintigraphy is a useful index for the diagnosis of ATTR-CM, but it may not serve as indices of heart failure.

#### **M5A-SPNMMI-2 Diagnostic Potential of TID Ratio in <sup>13</sup>N-Ammonia PET Imaging: Differentiating INOCA from Multivessel CAD**

Midori Fukuyama, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Adenosine stress <sup>13</sup>N-Ammonia PET (Ammonia PET) is a valuable tool for evaluating both myocardial blood flow reserve (MFR) and cardiac function. It is especially useful for diagnosing multivessel coronary artery disease (Multivessel CAD) by measuring MFR. Ischemia with non-obstructive coronary artery disease (INOCA), one of the chronic coronary syndromes, is increasingly recognized as a risk factor for adverse cardiovascular mortality and outcomes. It is difficult to distinguish between INOCA and Multivessel CAD based on MFR alone because MFR is similarly reduced to less than 2.0 in both. Transient ischemic dilatation (TID) ratio is a useful marker of adverse outcomes on myocardial perfusion imaging in severe and extensive CAD. The usefulness of TID during Ammonia PET in INOCA patients has not been reported. We aimed to evaluate the diagnostic potential of TID ratio and other markers in differentiating INOCA from Multivessel CAD using Ammonia PET.

## **METHODS AND MATERIALS**

A retrospective analysis was conducted on 86 patients (47 males, 39 females; median age 73) who underwent rest/ adenosine stress-gated Ammonia PET for known or suspected CAD. Using a commercial-used software program, dynamic scanning measured myocardial blood flow (MBF) and MFR. Patients with global MFR>2.0 and no evaluation of epicardial coronary artery within three months before or after Ammonia PET were excluded. Seven INOCA patients and 21 Multivessel CAD patients with more than 50% stenosis were included in the final analysis. TID and LV functions were compared between INOCA and Multivessel CAD.

## **RESULTS**

No significant differences were detected in rest MBF and MFR between INOCA and Multivessel CAD (1.16 vs. 0.99, 1.52 vs. 1.70, respectively). Although the left ventricular ejection fraction (LVEF) of both INOCA and Multivessel CAD groups were within the normal range, there was a significant difference in rest/ adenosine stress LVEF (78 vs. 65;  $p = 0.008$ , 75 vs. 61;  $p = 0.015$ ). TID was significantly greater in INOCA than in Multivessel CAD (1.29 vs. 1.11;  $p = 0.026$ ). Based on the ROC analysis for identifying INOCA, a TID threshold of 1.22 could predict INOCA (AUC=0.69, sensitivity 95%, specificity 57%, accuracy 85%).

## **CONCLUSION**

The TID ratio obtained from adenosine stress Ammonia PET was significantly higher in INOCA patients than in Multivessel CAD patients. Patients with global MFR less than 2.0, TID ratio could be a valuable tool to distinguish INOCA from Multivessel CAD.

## **CLINICAL RELEVANCE/APPLICATION**

Transient ischemic dilatation (TID) in rest/ adenosine stress-gated  $^{13}\text{N}$ -Ammonia PET was more significantly observed in Ischemia with non-obstructive coronary artery disease (INOCA) than in Multivessel CAD. TID ratio can assist in distinguishing INOCA from Multivessel CAD.

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## Abstract Archives of the RSNA, 2023

M5A-SPNPM

### Noninterpretive Skills (Beyond Imaging) Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPNPM-1 Flipping Education Right Side Up: A Multiyear Assessment of Flipped Classroom Teaching Versus Traditional Didactic Teaching at Two Academic Institutions**

Michelle Ho, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Traditional radiology education consisting of didactic lectures and workstation readout is associated with poor retention of knowledge. Flipped classroom teaching may be more efficient and effective. At our institution (A), flipped classroom teaching has been used consistently for PGY2 residents on one rotation (FR). While on this rotation, residents are assigned daily teaching topics with pre-recorded lectures followed by in-person discussion of related clinical cases. This forces residents to integrate learned concepts and allows faculty to assess areas of weakness. The purpose of this study is to assess the effectiveness of flipped classroom teaching by comparing resident performance on RadExam for FR compared to other core rotations at Institution A, and to resident performance at another similar institution (B), where flipped classroom is not used.

#### **METHODS AND MATERIALS**

RadExam scores from 5 different PGY2 level core rotations (body imaging, emergency, musculoskeletal, neuro, and thoracic) were collected at both institutions from 7/1/2018 to 4/30/2020. At Institution A, the flipped classroom teaching model has been used consistently for one of the above core rotations (FR). The other rotations are referred to as traditional rotations (TR) 1 through 4. The rotation names are anonymized for privacy per data use requirement. Exam scores at institution A were compared using one-way ANOVA. Exam scores between institutions A and B were compared using factorial ANOVA. Survey scores for residents' perception of educational value and efficient use of time for above rotations at institution A were also compared.

#### **RESULTS**

There was significant difference in resident exam scores between rotations at institution A ( $p=0.005$ ) but no difference between the two institutions ( $p=0.7$ ). Residents at institution A performed better on FR than other rotations except for TR4 (Table and Figure). The perceived educational value of FR was higher compared to TR (4.96 vs 4.85,  $p=0.017$ ). No difference was observed in perception of efficient use of time between FR and TR (4.79 vs 4.66,  $p=0.11$ ).

#### **CONCLUSION**

Flipped classroom teaching is at least as effective as traditional teaching model and it is associated with better resident performance on standardized exams at one institution. It is also associated with higher perceived educational value.

#### **CLINICAL RELEVANCE/APPLICATION**

Flipped classroom teaching may increase efficiency in teaching while minimizing interruptions in clinical work, and may improve overall competency of radiology residents and their morale.

#### **M5A-SPNPM-2 Multicriteria Decision Analysis Comparing Gadolinium Based Contrast Agents for Use in Contrast Enhanced Magnetic Resonance Imaging: A Novel Tool in Benefit Risk Assessment**

Robert J. McDonald, MD, PhD (*Presenter*) Consultant, General Electric Company; Research Grant, General Electric Company; Consultant, Bracco Group

#### **PURPOSE**

To compare the benefit-risk balance of all currently available FDA-approved GBCAs using a multicriteria decision analysis (MCDA) model to determine if certain agents provide more favorable benefit-risk balance than others in clinical use.

## METHODS AND MATERIALS

An expert panel developed a MCDA model based on two benefits (relaxivity @ 1.5T and pharmacokinetics) and six safety effects (NSF cases, retained Gd in CNS tissues, and rates of physiologic reactions and mild, moderate, and severe hypersensitivity reactions). After scoring, weighted averages of preference scores for the eight criteria were used to give overall preference values for each GBCA in the MCDA model. The usability of the model was tested using 13 diverse clinical scenarios, 5 of which are detailed below.

## RESULTS

For routine adult patients, and those requiring mitigation of hypersensitivity reactions, preference values were driven by hypersensitivity and physiologic reaction rates: gadodiamide=95, gadopentetate=82, gadobutrol=68, gadoterate=48, gadobenate=34, gadoteridol=4. For patients requiring repeated GBCA doses over a longer timeframe in the detection of subtle/nascent disease preference values were driven by mitigation of Gd tissue retention and relaxivity: gadobenate=73, gadobutrol=55, gadoterate=38, gadodiamide=31, gadoteridol=30, gadopentetate=24. For patients with severely compromised renal function, preference values were driven by mitigation of NSF risk: gadobenate=82, gadoterate=82, gadobutrol=76, gadoteridol=70, gadodiamide=25, gadopentetate=21. For patients requiring hepatobiliary imaging, preference values were driven by pharmacokinetics and relaxivity: gadoxetate=66, gadobenate=44, gadodiamide=35, gadobutrol=29, gadopentetate=29, gadoterate=21, gadoteridol=6.

## CONCLUSION

The benefit-risk profiles for all FDA-approved GBCAs were found to be comparable and all had favorable benefit-risk ratios in many common clinical scenarios. However, depending on patient-centered characteristics and clinical needs, the relative ranking of these benefit-risk ratios varied. MCDA results provide insights in the identification of clinical scenarios/situations where use of specific GBCAs is warranted due to greater clinical benefits or diminished risks of undesirable effects. These results demonstrate the complexity and multimodal mechanisms underlying the clinical decision making necessary in diagnostic imaging.

## CLINICAL RELEVANCE/APPLICATION

Decision analysis models are commonly used by regulatory agencies to compare benefits and risks of similar prescribed agents. MCDA models are helpful in making patient-centered decisions about GBCA use and can optimize clinical decision making and health care delivery in radiology.

## M5A- SPNPM-3 Impact Analysis of Primary and Secondary Research in Radiology Journals

Mohamed K. Ibrahim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Primary and secondary studies are considered the two major research categories. In this study, we examined the scientific and social media impact of primary and secondary publication types in papers published radiological journals during 2010-2020

## METHODS AND MATERIALS

PubMed publication type tags were used to filter original articles and systematic review and meta-analysis (SR/MA) articles. Clarivate Web of Science was utilized to obtain a list of all radiology journals from the category "Radiology, Nuclear Medicine and Imaging" in Science Citation Index Expanded (SCIE). Automated approach was developed for programmatic extraction of bibliometric and Altmetric yearly citations of each included article using Dimensions API and Altmetric API with Python. Statistical analysis was performed to compare the citation rates between primary and secondary research articles.

## RESULTS

A total of 96,684 published articles from 2010 to 2020 were identified and their meta-data collected. The mean 2-year citation count following publication year was 5.8 for primary research and 10.2 for SR/MA articles ( $p < 0.001$ ). Between 2010 and 2020, the mean number of citations per SR/MA article was 51.3 compared to 30.5 per primary research article ( $p < 0.001$ ). Mean Altmetric score was 8.2 in SR/MA compared to 3.7 for primary research articles ( $p < 0.001$ ).

## CONCLUSION

Secondary research studies have been increasing in impact in both academia and social media compared to primary research. Our results highlight the importance and impact of systematic reviews and meta-analysis articles as a scientifically influential study type in radiology.

## CLINICAL RELEVANCE/APPLICATION

The study focuses on the impact and influence of different types of research publications in radiology, and highlights the increasing importance of systematic reviews and meta-analyses as influential types of research publications. The findings suggest that prioritizing secondary research studies in future research agendas may be valuable. The study also demonstrates the potential of bibliometric and Altmetric analysis in evaluating the impact of scientific research publications,

which can provide valuable insights into the impact of research on both academia and the wider public. Overall, this study has implications for researchers, clinicians, and policymakers in radiology and can inform the development of research strategies and priorities in this area.

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## Abstract Archives of the RSNA, 2023

M5A-SPNR

### Neuroradiology Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPNR- Dynamic Functional Connectivity Alterations Associated with Cognitive Impairment in Patients with Type 2 Diabetes** 1

Linqing Fu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to explore the change characteristics and differences of dynamic functional connectivity in type 2 diabetes patients with and without mild cognitive impairment by use of resting state functional magnetic resonance imaging (rs-fMRI).

#### **METHODS AND MATERIALS**

The research consisted of 45 healthy controls (HC) and 102 patients with T2 diabetes (T2). The patients with T2 diabetes were split into two groups based on the presence or absence of mild cognitive impairment, named T2-NC group (n=62) and T2-MCI group (n=40) separately. Thirty-nine components were selected by group independent component analysis (ICA) to construct 7 functional networks. Based on the sliding window method and k-means clustering, changes in dynamic functional connectivity between groups were analyzed and characteristic parameters were compared, while the correlations between characteristic parameters and cognitive performance were evaluated.

#### **RESULTS**

The whole cohort showed four kinds of dFC states: strong local connection state (state 1), extensive interconnection state (state 2), sparse connection state (state 3), and strong connection state (state 4). Compared with the control group, fractional time and mean dwell time of state 2 increased in T2 group, fractional time and mean dwell time decreased in state 4 in T2 group, the number of transitions between state 2 and state 4 reduced in T2 group. The changed dFC characteristics were significantly correlated with cognitive ability. When the statistical efficiency is 0.8 and there are 88 samples in each group, significant differences between T2-NC group and T2-MCI group can be observed.

#### **CONCLUSION**

Our findings indicated that the differences in dFC, which were associated with brain functional impairment due to T2D.

#### **CLINICAL RELEVANCE/APPLICATION**

The differences in dFC might be potential biomarkers for predicting the clinical progression, evaluating the cognitive impairment, and further understanding the pathophysiology of T2D.

#### **M5A-SPNR- The Alterations of Glymphatic System Function and Choroid Plexus and Their Correlation with Clinical Features in Relapsing Remitting Multiple Sclerosis Patients** 11

Kong Lina (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the difference in glymphatic system function between relapsing-remitting multiple sclerosis (RRMS) patients versus healthy controls (HCs), and examine the relationship between diffusion along perivascular space (DTI-ALPS) index and choroid plexus (CP) volume or clinical features in RRMS.

#### **METHODS AND MATERIALS**

The ALPS index, the volume of CP in lateral ventricle and the cortical lesions were derived from magnetic resonance imaging (MRI) in 92 RRMS patients and 40 HCs, 23 of 92 RRMS patients were followed up for an average of 6 months to examine the

changes in ALPS index and CP volumes.

## RESULTS

RRMS patients had lower ALPS-index and higher volume ratio of CP than HCs. Lower ALPS-index was significantly related to higher ratio of CP volume and cortical lesion volume, and longer disease duration. Higher ratio of CP volume was related to higher cortical lesion volume, and lower MoCA scores in MS. But the ALPS index and CP volume didn't have statistical changes after 6 months of follow-up in 23 patients.

## CONCLUSION

Our findings demonstrated that the impaired glymphatic system function is involved in the inflammatory processing in MS patients and might help us better understand the pathological mechanism of MS.

## CLINICAL RELEVANCE/APPLICATION

The DTI-ALPS index may have unique significance for monitoring MS inflammatory reaction.

## M5A-SPNR- The Diagnostic Value of Dynamic Contrast-enhanced MRI $K^{trans}$ in Diagnosing Neuropsychiatric Systemic Lupus Erythematosus 12

Satoru Ide, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Neuropsychiatric systemic lupus erythematosus (NPSLE) is a severe complication of SLE that affects nervous system. Brain MRI findings in SLE often show vascular lesions, but approximately 40% of NPSLE patients have normal MRI findings, which makes diagnosis challenging. The blood-brain barrier (BBB) is crucial for brain microenvironment integrity. However, microvascular disease and neuroinflammatory states can compromise the BBB in NPSLE. Dynamic contrast-enhanced (DCE)-MRI is a promising technique to evaluate BBB permeability, using  $K^{trans}$  as a flow parameter to measure the volume-transfer constant from intravascular to extravascular extracellular space. An increase in  $K^{trans}$  indicates compromised BBB integrity. The purpose of this study is to determine whether the  $K^{trans}$  value is useful for differentiating NPSLE from non-NPSLE.

## METHODS AND MATERIALS

Forty-seven NPSLE and 55 non-NPSLE patients were recruited. Based on the 1999 ACR classifications, NPSLE patients were classified 43 central nervous system lupus (11 diffuse and 32 focal manifestations) and 4 peripheral nervous system (PNS) lupus. DCE-MRI was performed, and the  $K^{trans}$  map was obtained for all patients. Regions of interest (ROIs) were set in the cerebral cortex, reflecting small vessel disease, as it is a pathological finding of SLE. Manual ROIs were placed on the frontal, temporal, and occipital cortex with reference to T1-weighted images (Figure 1). Subsequently, the  $K^{trans}$  value was measured, and the average of three points value was used for group comparison using Welch's t-test. ROC analysis was performed to analyze the diagnostic accuracy of the  $K^{trans}$  map. All statistics were performed with BellCurve for Excel (Social Survey Research Information Co., Ltd.).

## RESULTS

The mean value of  $K^{trans}$  (/min) was significantly larger for NPSLE than for non-NPSLE ( $0.88 \pm 0.56$  vs.  $0.26 \pm 0.46$ ,  $p < 0.001$ ) (Figure 2 and 3). The mean value of  $K^{trans}$  was  $1.10 \pm 0.41$  for diffuse manifestation,  $0.86 \pm 0.59$  for focal manifestation,  $0.42 \pm 0.43$  for PNS lupus, respectively. The mean value of  $K^{trans}$  of diffuse manifestation of NPSLE was larger than that of focal manifestation, although there were no significant differences between them due to the small sample size. The ROC analysis showed good diagnostic performance (AUC: 0.832, optimal cut-off points: 0.11 (/min), sensitivity: 71%, specificity: 89%).

## CONCLUSION

Our study found that  $K^{trans}$  value from DCE-MRI can differentiate between NPSLE and non-NPSLE, and suggests that BBB disruption may contribute to NP syndrome development in NPSLE.

## CLINICAL RELEVANCE/APPLICATION

The  $K^{trans}$  value derived from DCE-MRI can accurately differentiate between NPSLE and non-NPSLE, indicating that this technique may serve as a new biomarker for SLE.

## M5A-SPNR- Spinal Cord and Brain Atrophy Patterns in NMOSD and MS are Nonrandom and Clinically Relevant 13

Tiantian Hua (*Presenter*) Nothing to Disclose

## PURPOSE

Silent progressive spinal cord and brain atrophies are common findings in neuromyelitis optica spectrum disorder (NMOSD) and multiple sclerosis (MS), but harbor distinct patterns across brain areas leading to inter- and intra-disease heterogeneity,



accounting for different physical disability and cognitive decline.

## **METHODS AND MATERIALS**

This cohort study used data retrospectively collected from eight neurological centers. Totally, 209 patients with NMOSD, 304 patients with relapsing-remitting MS (RRMS), and 1160 healthy controls (HC) were studied. Non-negative matrix factorization (NMF) was used to determine the atrophy patterns of these two diseases, respectively. Then, the weightings across atrophy patterns were obtained for each individual using a linear regression model by regarding the individual atrophy profile as dependent variables and the NMF-derived atrophy patterns as independent variables. Next, we associated the individual weighting across each atrophy pattern with cognitive profiles scores and expanded disability status scale (EDSS) scores to explore the contribution of each atrophy pattern to the disease manifestations. An additional longitudinal cohort were conducted to validate the stability and progression of these NMF-derived atrophy patterns.

## **RESULTS**

Three atrophy patterns were observed in NMOSD: (1) Spinal Cord-Deep Grey Matter (SC-DGM) pattern associated with decreased Brief Visuospatial Memory Test (BVRT), and higher EDSS scores; (2) Frontal-Temporal pattern associated with decreased Mini-Mental State Examination (MMSE) and California Verbal Learning Test (CVLT) scores; and (3) Cerebellum-Brainstem pattern associated with decreased EDSS progression scores. Three atrophy patterns were observed in RRMS: (1) DGM pattern associated with decreased Symbol Digit Modalities Test (SDMT), Paced Auditory Serial Addition Test (PASAT), MMSE, Montreal Cognitive Assessment (MoCA), CVLT and BVRT, and higher EDSS scores; (2) Frontal-Temporal pattern associated with decreased MoCA scores; and (3) Occipital pattern associated with decreased EDSS progression scores. Additionally, the longitudinal cohort validate the stability of atrophy patterns, and formed trajectories of atrophy progression in NMOSD and RRMS.

## **CONCLUSION**

These findings suggested spinal and brain atrophy patterns in NMOSD and RRMS occurred largely in a non-random manner and developed (at least partly) according to distinct anatomical patterns. Additionally, these offered categorical perspectives that may facilitate clinical trials of stratifying participants.

## **CLINICAL RELEVANCE/APPLICATION**

Atrophy patterns showed stronger associations with cognitive impairment, physical disability, and progression.

## **M5A-SPNR- Advanced Imaging in First Episode Psychosis: A Systematic Review**

3

Riyad Hanafi (*Presenter*) Nothing to Disclose

## **PURPOSE**

In addition to ruling out numerous neurological conditions that may have psychiatric manifestations, advanced imaging techniques play a role in identifying imaging biomarkers of psychiatric disorders, selecting patients for optimal treatment, and tracking treatment effects. We performed a systematic review of the literature to determine how advanced imaging in FEP can allow for increasing diagnostic specificity and predicting disease's evolution.

## **METHODS AND MATERIALS**

PubMed searches were conducted on December 9, 2022, using combinations of the following predetermined search terms: "first episode psychosis" and "advanced imaging" or "functional MRI", or "resting state MRI" or "spectroscopy" or "ASL" or "DTI" or "diffusion imaging", with filters Clinical Trial, Meta-Analysis and Randomized Controlled Trial.

## **RESULTS**

To date, brain imaging studies have shown grey matter deficits, ventricular enlargement and reduced overall brain volume in FEP. Morphology is commonly assessed using T1-weighted volumetric MRI with automated computerized methods. Patients presenting a FEP show a thinning of certain cortical regions notably involved in emotional processing and higher executive functions. Functional MRI (fMRI) is based on the BOLD (Blood Oxygen Level Dependent) contrast, which uses the paramagnetic properties of deoxygenated hemoglobin, during task-activation or resting-state paradigms. Neuronal activity is associated with changes in oxygen consumption and thus in deoxyhemoglobin concentration. Correlations between BOLD signal time series of distant brain regions reflect their functional interactions, allowing for the identification of different functional resting state networks (RSNs).

## **CONCLUSION**

In the routine management of a FEP, brain imaging is mainly used to rule out other conditions. In this indication, structural brain MRI is considered the standard examination. In the near future, advanced sequences, particularly functional imaging studies, may allow improved diagnostic specificity, and play a predictive role, in line with the increasing development of personalized medicine.

## CLINICAL RELEVANCE/APPLICATION

Early treatment of first-episode psychosis (FEP) is one of the major factors that impacts long-term prognosis. Better understanding of FEP pathophysiology, proper patient selection for optimal treatment, and adequate prognostication of disease evolution are real challenges for current research. Besides ruling out some neurological conditions that may have psychiatric manifestations, advanced imaging techniques allow for identifying imaging biomarkers of psychiatric disorders.

### **M5A-SPNR- MRI Volumetric of Limbic System in Burnout Syndrome and Vigilant Attention in a Population with Nocturnal Shifts**

Christian A. Torres Ramirez, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine association between changes in the sleep pattern, burnout syndrome, vigilant attention deficit with structural alterations of the limbic system.

#### **METHODS AND MATERIALS**

39 Volunteer subjects with night shifts underwent a non-contrast brain MRI using a T1 MPRAGE sequence. Brain images were automatically segmented using the VolBrain software. The Maslach Burnout Inventory Index and the test Psychomotor Vigilante Test (PVT) were used to assess the vigilant attention deficit in all patients. The correlation between the volumetric findings with clinical scales were evaluated using Spearman's test. Non-parametric univariate analysis was performed using the Mann-Whitney U test between the volumetric data and burnout syndrome.

#### **RESULTS**

In subjects with burnout syndrome the hippocampal volume was significantly greater than subjects without burnout syndrome ( $p < 0.01$ ). The response time of the PVT test was lower in the subjects with greater volume of the amygdala ( $r = 0.40$ ,  $p = 0.025$ ). Regarding the precision of the test, an inverse correlation was found between the percentage of failed responses with the volume of the hippocampus ( $r = 0.39$ ,  $p = 0.02$ ) and the volume of the amygdala ( $r = 0.49$ ,  $p < 0.01$ ).

#### **CONCLUSION**

Burnout syndrome is associated with a decrease in the volume of the hippocampus. Vigilant attention deficit is associated with changes in the volume of the hippocampus and amygdala.

## CLINICAL RELEVANCE/APPLICATION

The clinical relevance of this work is to use artificial intelligence tools to define brain structural changes on MRI associated with burnout syndrome and vigilance attention that are complementary to clinical evaluation and in the future can will have utility as severity criteria or predictors of complications.

### **M5A-SPNR- A Multimodal Imaging Study of Adult-onset Neuronal Intranuclear Inclusion Disease**

Rui Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In this study, we propose to apply diffusion kurtosis imaging (DKI) to study the microstructural changes in patients with Neuronal intranuclear inclusion disease (NIID) and the relationship with cognitive dysfunction. We also analyze the changes in brain functional connections, hoping to provide a new imaging perspective on the neuropathological mechanism and early diagnosis of this disease.

#### **METHODS AND MATERIALS**

Our study retrospectively included 12 patients diagnosed with NIID in the Department of Neurology at \*, as well as 20 healthy control subjects matched for age, gender, and education level during the same period. Neuro-psychological assessments, DKI, and RS-fMRI data were collected in our study. Mean kurtosis (MK), axial kurtosis (AK), radial kurtosis (RK), fractional anisotropy (FA), and mean diffusivity (MD) parameters were obtained, and statistical analysis was performed on each DKI parameter of the subjects. We also analyzed the correlation between the DKI parameter values and neuro-psychological scores in brain regions which show significant differences between NIID patients and healthy controls. Finally, based on the ALL 116 template and independent component analysis, we explored changes in brain network functional connectivity in NIID patients.

#### **RESULTS**

Compared with healthy controls, NIID patients have lower MK and RK values in the thalamus, hippocampus, and left caudate in the gray matter, as well as lower AK values in the thalamus, insula, and left calcarine. In the white matter, FA is reduced in the superior frontal gyrus, corona radiata, corpus callosum splenium, inferior frontal gyrus, and temporal gyrus. While MD is increased in the white matter around the ventricles (FWE-corrected,  $p < 0.05$ ). In NIID patients, there is a positive correlation between the AK value of the left caudate and MoCA results ( $r = 0.770$ ,  $P = 0.015$ ), and a negative correlation between the MD

value of the white matter around the ventricles and MoCA results ( $r=-0.678$ ,  $P=0.045$ ). Additionally, functional connections in multiple brain regions of NIID patients are weakened (NBS correction,  $P_{edge}<0.05$ ,  $P_{cluster}<0.05$ , 1000 permutations), with decreased functional connections in the precuneus, angular and frontal\_mid regions of the default mode network (uncorrected,  $P<0.001$ ,  $cluster>5$ ).

#### **CONCLUSION**

NIID patients show changes in the microstructure and functional connections of multiple brain regions. These changes might contribute to the pathological physiology of NIID and serve as potential indicators for monitoring the severity and progression of NIID, which has potential clinical value for early diagnosis.

#### **CLINICAL RELEVANCE/APPLICATION**

We hope to provide a new imaging perspective on the neuropathological mechanism and early diagnosis of this disease.

#### **M5A-SPNR- Brain Mechanisms Underlying Emotional Response in Social Pain. Football as a Proxy to Study Fanatism: An fMRI Study**

6

Francisco Zamorano, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In this study, we aimed to explore the brain mechanisms underlying positive and negative social stimuli in football fanatics during positive and negative social scenarios and deepen the neural substrate of football-related emotional responses as a proxy of fanaticism.

#### **METHODS AND MATERIALS**

Forty-three healthy male volunteers who support Chilean football teams were recruited for this fMRI study. Participants were divided into two groups, 22 supporters of the Colo-Colo team and 21 supporters of the Universidad de Chile team. All participants were presented with a compilation of football matches containing 63 goals, and their brain activity was registered in a Siemens 3T SKYRA, during the visual stimulation of score annotations to rivals and from rivals. We also apply a football supporters' fanaticism scale (FSFS) in order to determine the fanaticism level for each participant.

#### **RESULTS**

The results demonstrate that the brain activity was different when the goals come or go to the most emblematic rival, which we termed the "emotional delta." In the winning scenarios, subcortical activation was observed, specifically in the ventral striatum, caudate, and lentiform nucleus. These areas are important for the reward dopaminergic circuit, inducing pleasure sensations. The mentalizing network was activated for the losing scenario. This mentalizing network strategy could be involved to mitigate the adverse result's pain. Simultaneously, a deactivation was observed at the dACC, which connects the limbic system with the frontal association regions that command normative behavior, decreasing cognitive control and increasing the probability to fall into disruptive or violent behavior. Both, mentalizing network and dACC correlate with FSFS, negatively and positively respectively.

#### **CONCLUSION**

Football is an excellent social affiliation model, promoting inclusivity, teamwork, community spirit, social change, and personal achievement. Still, the gregarious component could be the reason behind acts of violence and vandalism. Our study provides new inputs for future research on different fanaticism expressions, which is crucial for promoting a more equitable and inclusive society.

#### **CLINICAL RELEVANCE/APPLICATION**

Social affiliation is a crucial requirement for complex social phenomena. Fanaticism is extreme or excessive devotion or enthusiasm towards a particular cause, belief, or opinion. It often involves blind and unquestioning loyalty to a particular ideology or leader, and a refusal to consider other perspectives or opinions. Fanaticism can lead to intolerance, aggression, and even violence toward those who do not share the same beliefs or views. In this sense, our study proposes a new model for studying complex behaviors like fanaticism.

#### **M5A-SPNR- Comparison of fMRI Language Laterality With and Without Sedation in Pediatric Epilepsy**

7

Elmira Hassanzadeh, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Functional MRI is an essential component of presurgical language mapping. In clinical settings, young children may be sedated for the MRI with the functional stimuli presented passively. Research has found that sedation changes language activation in healthy adults and children. However, there is limited research comparing sedated and unsedated functional MRI in pediatric epilepsy patients. We compared language activation patterns in children with epilepsy who received sedation for functional MRI to the ones who did not.

## METHODS AND MATERIALS

We retrospectively identified the patients with focal epilepsy who underwent presurgical functional MRI including Auditory Descriptive Decision Task at our institution from 2014-2022. Patients were divided into sedated and awake groups, based on their sedation status during functional MRI. Auditory Descriptive Decision Task stimuli were presented passively to the sedated group per clinical protocol. We extracted language activation maps contrasted against a control task (reverse speech) in the Frontal and Temporal language regions and calculated separate language laterality indexes for each region. We considered positive laterality indexes as left dominant, negative laterality indexes as right dominant, and absolute laterality indexes less than 0.2 as bilateral. We defined 2 language patterns: typical (i.e., primarily left-sided) and atypical (Fig 1). Typical pattern required at least one left dominant region (either frontal or temporal) and no right dominant region. We then compared the language patterns between the sedated and awake groups.

## RESULTS

Seventy patients met the inclusion criteria, 25 sedated, and 45 awake (Fig 2). Using the Auditory Descriptive Decision Task paradigm, when adjusted for age, handedness, gender, and laterality of lesion in a weighted logistic regression model, the odds of the atypical pattern were 13.2 times higher in the sedated group compared to the awake group (CI: 2.55-68.41, p-value <0.01).

## CONCLUSION

Sedation may alter language activation patterns in pediatric epilepsy patients. Language patterns on sedated functional MRI with passive tasks may not represent language networks during wakefulness, sedation may differentially suppress some networks, or require a different task or method of analysis to capture the awake language network.

## CLINICAL RELEVANCE/APPLICATION

Given the critical surgical implication of these findings, additional studies are needed to better understand how sedation impacts the functional MRI blood oxygenation level-dependent signal. Consistent with current practice, sedated functional MRI should be interpreted with greater caution and requires additional validation as well as research on post-surgical language outcomes.

## M5A-SPNR- The Individual Functional Connectome in Pediatric Epilepsy Patients - Does it Add to 8 Presurgical fMRI Brain Mapping

Radheshyam Stepponat, MD, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

Speech is a complex brain function underlying an extended functional and structural neural network. fMRI as part of presurgical evaluation allows the investigation of language lateralization and organization. Nevertheless, conventional fMRI maps just represent a small aspect of the language network. In children, language networks may differ substantially from their general linear model (GLM) -based activation maps as generated by task-based fMRI post-processing. In this study, functional connectivity analysis (FCA) of task-based language fMRI data was compared to the general linear model-based analysis in children undergoing presurgical evaluation for drug resistant epilepsy.

## METHODS AND MATERIALS

9 patients (5 male, 4 female) between 8 and 16 years with lesional (n=6) and mr-negative epilepsy (n=3), underwent presurgical language evaluation by fMRI. All patients were right-handed. An echo planar imaging (EPI) sequence was used to acquire high temporal resolution (TR=1s) functional images at 3 Tesla. Two task-based fMRI paradigms (verb generation and sentence comprehension) were presented. The CONN-toolbox was used for preprocessing of anatomical and functional data and for creating individual functional connectomes. One experienced pediatric neuroradiologist was blinded to the patients history and reviewed conventionally processed as well as connectome language fMRI data and qualitatively described the activation patterns.

## RESULTS

Based on GLM-based analysis, 8 out of 9 patients were determined as left-hemispheric language dominant. One patient had a right-hemispheric language dominance in terms of atypical language representation. In the presurgical fMRI activation analysis 3 out of 9 patients showed contralateral activations in the frontal and temporal lobe. In the FCA in 7 out of 9 patients were found significant connectivities to contralateral frontal and temporal lobes at p-uncorrected <0.05. The FCA also demonstrated significant connectivities (p-uncorrected <0.05) to other cortical brain areas in frontal and temporal lobe in all patients, which were not detected in the activation pattern analysis.

## CONCLUSION

In this study it was shown that functional connectomes deliver more information about the language network. In the FCA a more extended bilateral functional network was found in most patients as compared to presurgical created activation patterns.

## CLINICAL RELEVANCE/APPLICATION

In order to further understand brain plasticity especially in the presence of brain pathologies, the visualization of functional brain networks and its implementation in clinical setting is essential. Further studies have to show how the information from the FCA can be interpreted in prediction of postoperative speech changes.

## M5A-SPNR- Causal Association Between Body Mass Index and Neuroimaging Features in Adults 9

Han Lv, MD (*Presenter*) Nothing to Disclose

### PURPOSE

High body mass index (BMI) is associated with negative brain health; however, its causal association remains unclear. This study evaluated the effect of high BMI on neuroimaging features in different age groups and to validated the causal relationship.

### METHODS AND MATERIALS

This real-world study has been performed based on the KaiLuan Study, a multicenter, long-term follow-up, community-based longitudinal cohort in the adult population since 2006. We modeled the trajectories of BMI during follow-up to evaluate cumulative exposure. Multimodality neuroimaging data have been collected by 3.0T MRI since 2020, which were available for volumetric measurements of the brain structure, white matter hyperintensity (WMH), and skeletonized white matter tract at the voxel-wise level. We performed two-sample Mendelian randomization analysis using genetic data from 681,275 individuals to analyze the causal relationship between BMI and neuroimaging features.

### RESULTS

In the real-world study, clinical and neuroimaging data were obtained from 1,074 adults (aged 25-83 years). High BMI was found to be associated with a wide range of negative brain health. For adults <45 years, differences in cerebral parenchyma volume between those with BMI > 26.2 kg/m<sup>2</sup> and those with normal BMI corresponded to 12.0 years (95% CI, 3.0 to 20.0) of brain aging. Volumetric results corresponded to -17.9ml (95% CI, -29.8 to -4.5). Differences in WMH were statistically significant for participants >60 years, with 6.0ml (95% CI, 1.5 to 10.5) increased volume. Genetic analysis of 681,275 individuals further indicated causal relationships among high BMI, decreased volume of the cerebral parenchyma and gray matter, and increased fractional anisotropy in projection fibers, further supporting the causal effect of BMI on brain aging and health.

### CONCLUSION

BMI is causally associated with decreased brain volume and disrupted microstructural integrity in projection fibers. Brain aging is prominent in young adults with high BMI.

## CLINICAL RELEVANCE/APPLICATION

Controlling BMI has been suggested throughout life, especially for young adults, for protecting brain health.

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## Abstract Archives of the RSNA, 2023

M5A-SPOB

### OB/Gynecology Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPOB- Proposed New MRI Scoring System of Rectosigmoid Endometriosis: Concise Qualitative Assessment with Pathologic Correlation to Guide Operative Planning** 1

Hiroaki Takahashi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Rectosigmoid endometriosis (RSE) manifests as a broad-spectrum of MRI findings ranging from serosal surface disease to deep bowel involvement, a spectrum which impacts the surgical strategy. We propose a new MRI scoring system for RSE that is beneficial in operative planning based on pathologic depth of invasion as it pertains to MRI.

#### **METHODS AND MATERIALS**

Patients with RSE treated by rectosigmoid surgery from May 2018 to June 2022 were retrieved. Types of surgery were classified into (1) partial thickness resection, (2) discoid resection, and (3) segmental resection, including low anterior resection and sigmoidectomy. Depth of bowel involvement was extracted from pathology reports. Each pre-treatment MRI was scored based on the mutual agreement of two abdominal radiologists. MRI score was defined as follows: (1) score 0: no evidence of RSE, (2) score 1: minimal tethering involving the serosal surface of the rectosigmoid colon, (3) score 2: indeterminate thickening and/or soft tissue involving the rectosigmoid colon without mushroom cap or submucosal involvement, and (4) score 3: definite mushroom cap sign or definite MRI evidence of submucosal involvement. The contingency of surgical strategy and pathological results between different MRI scores (MRI score 2 versus score 3) was assessed by Fisher's exact test with Freeman-Halton extension.  $P < 0.05$  was considered statically significant.

#### **RESULTS**

Among 89 enrolled patients (median age: 37 [22-57] year old), 3, 10, 34, and 42 patients had MRI score 0, 1, 2, and 3, respectively. All patients with MRI score 0 and 1 underwent partial thickness shaving. When comparing MRI score 2 to MRI score 3, there was a significant difference in patients requiring partial thickness shaving (53% [18/34] vs 7% [3/42]), discoid resection (18% [6/34] vs 7% [3/42]), and segmental resection (29% [10/34] vs 86% [36/42]) ( $p < 0.001$ ). The depth of bowel involvement was extracted from pathology reports in 13 patients with MRI score 2, and 33 patients with MRI score 3. A higher proportion of patients demonstrated greater depth of invasion with MRI score of 3 compared to MRI score of 2 with higher rates of submucosal invasion (52% [17/33] vs 15% [2/13]) and lower rates of muscularis propria invasion (48% [16/33] vs 62% [8/13]), serosal invasion (0% vs 8% [1/13]), and no invasion (0% vs 15% [2/13]) ( $p = 0.001$ ).

#### **CONCLUSION**

Our MRI scoring system for RSE has good correlation with the pathological spectrum of bowel invasion and is helpful in operative planning.

#### **CLINICAL RELEVANCE/APPLICATION**

Our MRI scoring system for rectosigmoid endometriosis is a concise and qualitative scale based on suspected depth of bowel wall invasion and correlates with pathology to best guide operative planning.

#### **M5A-SPOB- Contrast-enhanced 3D T1-weighted Image with Compressed Sensing and Fast 3D Wheel Technique on Women's Pelvic MRI: Utility for Improving Quality and Acquisition Time as Compared with Conventional Contrast-enhanced 3D T1-weighted Image** 2

Takahiro Ueda, MD, PhD (*Presenter*) Nothing to Disclose



## PURPOSE

To determine the utility of contrast enhanced 3D T1-weighted image with compressed sensing (CS) and wheel encoding order technique (Fast 3D wheel: Fast 3Dw) which is one of the technics for k-space based acceleration technique for improving image quality and acquisition time on women's pelvic MRI as compared with conventional parallel imaging (PI).

## METHODS AND MATERIALS

24 consecutive female patients with various pelvic diseases underwent contrasted-enhanced 3D T1-weighted image with PI, CS and Fast 3Dw, randomly. Then, all acquisition times were recorded in each patient. For quantitative assessment, SNR of muscle and CR between myometrium and muscle were determined on uterine corpus and cervical level by ROI measurements. For qualitative assessment, two board certified radiologists assessed overall image quality (OIQ), artifact and diagnostic confidence level (DCL) by 5-point scales. Then, each final score was determined as consensus of two readers. To compare the capability for acquisition time reduction, mean acquisition time was compared among all data sets by Tukey's HSD test. To determine quantitative image quality improvement, SNRs and CRs were compared among all methods by Tukey's HSD test. On qualitative image quality evaluations, inter-observer agreement on each data set was assessed by  $\chi^2$  statistics followed by  $\chi^2$  test. Finally, three indexes among all methods by Wilcoxon signed-rank test.

## RESULTS

Mean acquisition time of CS and Fast 3Dw (CS:  $156.6 \pm 4.8$  sec, Fast 3Dw:  $153.9 \pm 2.7$  sec) were significantly shorter than that of PI (PI:  $313.0 \pm 9.7$  sec,  $p < 0.001$ ). SNR of Fast 3Dw ( $19.3 \pm 0.9$ ) at uterine corpus level were significantly higher than that of PI ( $12.0 \pm 4.2$ ,  $p < 0.05$ ) and CS ( $15.0 \pm 1.4$ ,  $p < 0.05$ ). SNR of Fast 3Dw ( $20.4 \pm 5.5$ ) at uterine cervical level were significantly higher than that of PI ( $15.4 \pm 6.3$ ,  $p < 0.05$ ). There was no significant difference of CR among three methods ( $p > 0.05$ ). All inter-observer agreements were determined as 'moderate' or 'excellent' ( $0.57 < \kappa < 0.83$ ,  $p < 0.0001$ ). OIQs of CS and Fast 3Dw (CS: median 4, IQR 3-4; Fast 3Dw: median 5, IQR 4-5) were significantly higher than that of PI (median 4, IQR 3-4.75,  $p < 0.05$ ). Artifacts of CS and Fast 3Dw (CS: median 2, IQR 2-3; Fast 3Dw: median 1, IQR 1-2) were significantly lower than that of PI (median 2, IQR 1.25-3,  $p < 0.05$ ). There was no significant difference of DCL among three methods ( $p > 0.05$ ).

## CONCLUSION

CS and Fast 3Dw are considered as useful for image quality improvement with reducing acquisition time on women's pelvic MRI, when compared with conventional PI.

## CLINICAL RELEVANCE/APPLICATION

CS and Fast 3Dw are considered as useful for image quality improvement with reducing acquisition time on women's pelvic MRI, when compared with conventional PI.

## M5A-SPOB- Pain-free Survival after Percutaneous Image-guided Cryoablation of Extra Peritoneal Endometriosis

Milan Najdawi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To retrospectively evaluate the pain-free survival of percutaneous image-guided cryoablation of symptomatic extraperitoneal endometriosis (EE).

## METHODS AND MATERIALS

From 2017 to 2022, cryoablation of EE was performed in a single institution for 42 consecutive patients (median age: 37 years [interquartile range: 33 - 39.5]) on a total of 47 lesions. Patient and procedural characteristics were reviewed retrospectively. Tolerance and outcomes in terms of pain and patient's satisfaction were evaluated.

## RESULTS

The mean procedure and hospitalization lengths were 73 minutes [48-94] and 1 day [1-1], respectively; including 67% outpatients. The median follow-up was 13.5 months [1.1-37.7] after cryoablation. The median pain-free survival rates were 93.75% [95% CI, 77.25-98.4] at 6 month, and 82.72% [58.8-93.45] after 12 month, respectively. Pain decreased from a median of 8/10 [7-9] on the visual analogue scale to 0/10 [0-1] at the last follow-up ( $P < 0.0001$ ). The median Patient Global Impression of Change score recorded at last follow-up was 1/7 [1 - 2]. Efficacy rate of cryoablation to avoid secondary surgery was 92.8% (39/42) per patient and 93.6% (44/47) per nodule treated. Four patients (9.5%, 4/42) had adverse event in the days following the procedure, one patient (2%) had a severe adverse event.

## CONCLUSION

Percutaneous cryoablation is safe and effective to significantly reduce pain and obtain local control of extraperitoneal endometriosis.

## **CLINICAL RELEVANCE/APPLICATION**

Cryoablation provides a minimally invasive alternative to surgery that can achieve local control of the endometriosis and significantly reduce pain. This is important because endometriosis can cause significant pain and can be difficult to treat, often requiring surgery or long-term medical management.

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## Abstract Archives of the RSNA, 2023

M5A-SPPD

### Pediatric Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### M5A-SPPD- CT Angiography for Acute Pediatric Gastrointestinal Hemorrhage: A Search for Best Practices 1

Clinton Veselis, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Gastrointestinal bleeding (GIB) in children can be a life-threatening emergency. CT angiogram (CTA) is typically the first-line imaging modality to identify a source and direct further management. When evaluating pediatric patients with GIB; however, no guidelines exist to our knowledge for optimal patient selection and scanning protocols. This project sought to better delineate the best protocols for evaluating GIB in the pediatric patients.

#### METHODS AND MATERIALS

Our work meets criteria for quality improvement and did not constitute human subjects research. We retrospectively reviewed CTA exams performed for GIB at a tertiary care pediatric hospital from 1/23/2018 - 9/6/2022. Exams reported as non-diagnostic were excluded. Patient age and sex were recorded. Number of phases, positive studies, follow-up imaging modality and findings, intervention, and final diagnoses were identified. Phase of CTA with the clearest evidence of GIB was determined in consensus by two pediatric radiologists. Data were evaluated using descriptive statistics.

#### RESULTS

88 CTAs were performed for GIB evaluation in 89 patients [60 males (67%), median age 11.9 years (range 9 months to 28 years)] over the evaluation period. Of 88 exams, 24 (27%) were single-phase, 41 (47%) were dual-phase, 18 (20%) were triple-phase, and 5 (6%) included a fourth phase, 35 (40%) were dual energy, and 2 (2%) were nondiagnostic. Active GIB was identified on 18 exams (20%) with all being most conspicuous during the arterial phase. Further imaging occurred 46 times and included repeat CTA (n=5), Meckel's scan (n=14), tagged red blood cell scan (n=12), and angiography (n=15). 3 patients underwent repeat CTA after an initial negative study; 3 patients were found to be bleeding at subsequent angiography. 8 patients (9%) underwent embolization and 8 (9%) went to surgery. In total 20 (23%) occurrences of GIB were diagnosed in this cohort. Etiologies included vascular malformation, enteroenteric anastomoses, pseudoaneurysm, and a Meckel's diverticulum.

#### CONCLUSION

Among the varied CTA protocols, a majority (77%) of GIB cases were identified in the arterial phase. In this small sample size, bleeding was identified by CTA only in 19% of patients but there was a false negative rate of 18.75%. Further investigation of patient characteristics and a larger cohort may help better define which patients are more likely to have positive findings on imaging.

#### CLINICAL RELEVANCE/APPLICATION

Our data helps to further the clinical data available with regard to the optimal protocoling and patient selection for CT angiography to evaluate for acute gastrointestinal hemorrhage in pediatric patients.

#### M5A-SPPD- The Feasibility of Portal Vein Flow Quantitation in Pediatric Patients using 4D MRI 2

Parmede Vakil, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility of time-resolved flow-sensitive four-dimensional (4D) Flow MRI for the quantification of portal venous hemodynamics in a clinical pediatric population.

## **METHODS AND MATERIALS**

We retrospectively identified patients who received 4D Flow MRI using a 3T scanner at our institution in the past 1 year. Flow was quantified using Arterys Web-based flow analysis software in three pre-defined anatomic regions in the proximal, mid, and distal portal vein. Maximum velocities and flow volumes were tabulated. Inter-observer variability was assessed using Bland-Altman and regression techniques.

## **RESULTS**

15 patients (7 male, mean age 9.6 years, range [2, 17]) received 4D Flow MRI as part of the clinical work up of their underlying gastroenterological disease. Portal venous flow averaged 479 mL/min range [180, 1130] across all study participants. On average, portal flow increased from the proximal (453 mL/min) to the mid (480 mL/min) and distal (505 mL/min) portions. Flow rate correlated moderately with age ( $r = 0.5381$ ,  $p = 0.04$ ). Interobserver agreement was excellent with Bland-Altman analysis showing a mean inter-observer difference of 30 mL/min, a 7% difference, which was not significant on 1-tail t-test ( $p = 0.1$ ) or regression analysis ( $r^2 = 0$ ,  $p = 0.87$ ).

## **CONCLUSION**

4D Flow MRI assessment of portal venous flow is feasible in a pediatric population with excellent inter-observer agreement and flow measurements that are in line with literature values provided in quantitative portal flow studies in adults. More studies are required to further characterize the clinical utility of this modality.

## **CLINICAL RELEVANCE/APPLICATION**

4D Flow MRI has the capability of providing both anatomic and functional assessment of portal flow and has been validated against US and 2D Flow MRI in adults; however its feasibility in a pediatric population has not been explored.

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## Abstract Archives of the RSNA, 2023

M5A-SPPH

### Physics Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPPH- Carotid Artery Assessment in Dual-Source Photon-Counting CT: Impact of Low Energy Virtual Monoenergetic Imaging on Image Quality, Vascular Contrast and Diagnostic Accessibility** 1

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

#### **PURPOSE**

Preliminary dual-energy CT studies have shown that low energy virtual monoenergetic imaging (VMI)+ reconstructions can provide superior image quality compared to standard 120 kV CTA series. The purpose of this study is to evaluate the impact of low energy VMI+ reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of the carotid artery in patients undergoing photon-counting CTA examinations.

#### **METHODS AND MATERIALS**

A total of 122 patients (67 male) who had undergone dual-source photon-counting CTA scans of the carotid artery were retrospectively analyzed in this study. Standard 120 kV CT images and low keV VMI+ series from 40 to 100 keV with an interval of 15 keV were reconstructed. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). CT number measurements were performed in the common, external and internal carotid artery. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of the carotid artery.

#### **RESULTS**

Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU,  $1362 \pm 12$ ; CNR,  $33 \pm 8$ ; SNR,  $34 \pm 9$ ) followed by 55 keV VMI+ reconstructions (HU,  $737 \pm 9$ ; CNR,  $24 \pm 7$ ; SNR,  $26 \pm 7$ ); all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard 120 kV CT series (HU,  $154 \pm 7$ ; CNR,  $16 \pm 4$ ; SNR,  $24 \pm 6$ ) ( $p < .0001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images series regarding image quality, vascular contrast and diagnostic assessability of the carotid artery ( $p < .0001$ ).

#### **CONCLUSION**

Low keV VMI+reconstructions at a level of 40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of the carotid artery compared with standard CT series in photon-counting CTA.

#### **CLINICAL RELEVANCE/APPLICATION**

In patients undergoing photon-counting CTA scans of the carotid artery, low keV VMI+ reconstructions at a level of 40-55 keV should be routinely reconstructed to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

#### **M5A-SPPH- Assessment of Low-dose Chest CT Protocols Prior to Implementation of Lung Cancer Screening Program** 10

Elena Tonkopi, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate low-dose CT (LDCT) chest protocols prior to implementing a pilot lung cancer screening (LCS) program in the Canadian province of Nova Scotia.

## METHODS AND MATERIALS

Data were collected from five scanners of a university hospital. Each sample included 20 examinations conducted on average-sized adult patients chosen by image measurement of anterior-posterior (AP) thickness. All scanners were from the same manufacturer installed in 2011-2022. Dose modulation options and iterative reconstruction algorithms were implemented on all machines, and two were dual source (DS) scanners. The volume CT dose index (CTDIvol) and dose-length product (DLP) were collected in each study. The size-specific dose estimate (SSDE) was calculated using the conversion factor for each patient's AP diameter, and the effective dose (ED) was estimated using an anatomy-specific conversion factor for the chest. For quantitative analysis of image quality, CT numbers and image noise in Hounsfield Units (HU) were measured in three regions of interest: tracheal bifurcation, peripheral lung parenchyma, and subcutaneous fat. Signal-to-noise ratio (SNR) values were calculated for each region. Descriptive statistics determined the mean, standard deviation, and median values of obtained data. Protocol differences were determined using a single-factor ANOVA test, with a p-value less than 0.05 denoting statistical significance. The correlation between dose and SNR values was assessed using the Pearson correlation coefficient.

## RESULTS

The survey included 100 patients with an overall median AP thickness of 25.0 cm demonstrating no significant difference between patient size in each sample ( $p=0.52$ ). Median values of CTDIvol, DLP, and ED ranged from 2.0 to 4.7 mGy, 72.0 to 164 mGy·cm, and 1.0 to 2.3 mSv respectively. The SSDE varied from 2.5 to 5.8 mGy. Differences between the means of the dose distributions from each scanner were statistically significant with higher doses resulting from both DS scanners. A very weak correlation was found between dose and SNR values with the Pearson correlation coefficients of 0.24, -0.09, and -0.15 for trachea, lung, and fat respectively.

## CONCLUSION

Our study demonstrated up to a 2.3-fold difference in dose resulting from the LDCT examination. Only three of five scanners using this protocol comply with screening requirements. Due to iterative reconstruction, quantitative image quality had a very weak correlation with dose suggesting potential for protocol optimization without degradation of image quality.

## CLINICAL RELEVANCE/APPLICATION

Canada currently has no organized LCS, however, some provinces are implementing pilot studies. It is crucial to assess the radiation dose and image quality of LDCT protocols before using them for screening

## M5A-SPPH- Comparison of Photon-Counting-Detector CT and Energy-Integrated-Detector CT for 11 Evaluating Performance Using Tasks Involving Cerebral Small Vessels

Kazuya Ohashi, PhD, RT (*Presenter*) Nothing to Disclose

## PURPOSE

Detectability index ( $d'$ ) and task transfer function (TTF) are used for evaluating image quality of CT systems. TTF is generally measured using a 30 mm diameter cylindrical phantom. However, it has been reported that this task is not ideal for assessing small vessels, such as those with 1 mm diameter. In this study, we measured TTF using an iodine wire phantom to simulate CT angiography of the cerebral vasculature, and calculated  $d'$  to compare the results of a photon-counting CT system (PCD-CT) and an energy-integrating detector CT system (EID-CT).

## METHODS AND MATERIALS

We used a cylindrical water phantom with a diameter of 210 mm to simulate X-ray absorption in an adult head. A wire phantom with a 1-mm diameter, 100-mm length was placed in the water phantom as an object for in-plane TTF measurement. Custom-made iodine wire phantoms, 1 mm in diameter, manufactured by Kyoto Kagaku (Kyoto, Japan), and made of the same material equivalent to diluted iodine with a concentration of 12 mg/ml to simulate the anterior choroidal artery. We evaluated the image quality of small blood vessels in polyenergetic imaging and spectral imaging using this phantom. All images were acquired at 120 kVp and dual energy mode using a PCD-CT (NAEOTOM Alpha, Siemens Healthineers, Erlangen, Germany) and a second generation dual source EID-CT (SOMATOM Definition Flash, Siemens Healthineers, Erlangen, Germany). Virtual monoenergetic images (40 keV at spectral imaging) and polyenergetic image were generated, and noise and contrast-dependent spatial resolution were assessed with noise power spectral (NPS) and TTF, respectively. We also computed the detectability index ( $d'$ ) of simulated small vessels.

## RESULTS

The NPS at 120 kVp was only slightly different between PCD-CT and EID-CT. At 40 keV, PCD-CT had 29 % less noise. The 50 % TTF was 9 % higher for PCD-CT at 120 kVp and 18 % higher at 40 keV. The  $d'$  of PCD-CT was 63 % higher at 120 kVp and 84 % higher at 40 keV.

## CONCLUSION

The phantom used in this study accurately simulates the adult head with contrasted small vessels, enabling the evaluation of both spectral and polyenergetic images. Our measurements using iodine wire phantoms demonstrated the high performance of PCD-CT in cerebral CT angiography.

## CLINICAL RELEVANCE/APPLICATION

Our proposed method for measuring d' would be effective for clarifying the image quality of cerebral CT angiography.

### **M5A-SPPH- Clinical Usefulness of the Latest 256-detector CT Scanner with 3D Anti-scatter System and Multi-material Artifact Reduction Algorithm to Reduce Pseudoenhancement of Renal Cysts in Abdominal Contrast-enhanced CT**

Shingo Harashima (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The latest 256-detector CT scanner (Revolution CT, GE) has been clinically introduced with a focally aligned detector layout and 3D collimator to use 2D grids to reject scatter in the z-direction and angular plates in the third dimension to reduce scatter as well as multi-material artifact reduction (MMAR) algorithm to reduce heel effect and beam-hardening errors in reconstructed images. We assessed clinical usefulness of Revolution CT with the anti-scatter system and MMAR algorithm to reduce pseudoenhancement of renal cysts in abdominal contrast-enhanced CT (CECT).

#### **METHODS AND MATERIALS**

We included 64 simple renal cysts from 30 patients (16 men; mean age,  $68 \pm 10$  years; mean body mass index [BMI],  $24.9 \pm 4.5$  kg/m<sup>2</sup>) who underwent both the noncontrast CT (NCCT) and CECT at 120 kV with Revolution CT and 76 simple renal cysts from other 30 patients (18 men; mean age,  $65 \pm 12$  years; mean BMI,  $23.2 \pm 3.4$  kg/m<sup>2</sup>) with simple renal cysts who underwent both the NCCT and CECT at 120 kV with a conventional CT scanner (Discovery CT, GE). Each patient underwent helical acquisition of both the NCCT and CECT with iodine load of 600 mgI/kg during the nephrographic phase using our routine parameters including noise index of 10-11 HU (mean CT DIvol:  $6.8 \pm 3.1$  mGy for Revolution CT;  $12.3 \pm 3.0$  mGy, Discovery CT). We reconstructed axial images of slice thickness of 1.25 mm; measured the maximum diameter of the largest cyst on the CECT; and identically placed a region of interest within the cyst to measure the mean CT value on both the NCCT and CECT in each patient. Each renal cyst was classified into one of the following three groups based on the maximum diameter: group A, < 10 mm; group B, = 10 mm to < 20 mm; group C, = 20 mm. Degree of pseudoenhancement of each renal cyst was defined as difference of the mean CT value between CECT and NCCT. Unpaired t test was used to compare the degree of pseudoenhancement between Revolution CT and Discovery CT in the groups A-C.

#### **RESULTS**

The degree of pseudoenhancement was significantly smaller with Revolution CT than with Discovery CT in the group A ( $0.78 \pm 1.66$  HU [n = 22] vs.  $15.96 \pm 5.95$  HU [n = 28]), the group B ( $1.34 \pm 2.39$  HU [n = 22] vs.  $13.38 \pm 6.47$  HU [n = 26]), and the group C ( $0.39 \pm 1.12$  HU [n = 19] vs.  $6.62 \pm 4.05$  HU [n = 23]) (P < 0.001 for all), as shown in Table. Revolution CT better reduced pseudoenhancement of smaller renal cysts.

#### **CONCLUSION**

Revolution CT with the anti-scatter system and MMAR algorithm is clinically advantageous for significantly reducing pseudoenhancement of renal cysts in abdominal CECT over a conventional CT scanner.

## CLINICAL RELEVANCE/APPLICATION

Revolution CT with 3D anti-scatter system and MMAR algorithm is clinically useful to reduce pseudoenhancement of renal cysts and thus improve differentiation between renal cysts and solid masses in abdominal CECT.

### **M5A-SPPH- Phantom Study on Radiomic Features in Ultra-High-Resolution CT Imaging: Matrix Size, Radiation Dose, and Reconstruction Algorithms**

Tomoki Maebayashi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

With the advent of ultra-high-resolution (UHR) CT and photon-counting CT systems, 1024-matrix imaging has achieved clinical viability. These images display enhanced spatial resolution compared to conventional 512-matrix images. However, the impact of matrix size, radiation dose, and reconstruction algorithm on radiomic quantification remains unclear. This phantom study aimed to elucidate the effects of imaging parameters on CT radiomic feature quantification.

#### **METHODS AND MATERIALS**

3D-printed cylindrical plastic phantom (19 mm diameter) designed for radiomic analysis was fabricated. The phantom contained an array of cavities filled with varying contrast agent concentrations, generating spatial variation in CT values (6 distinct types). These cylindrical phantoms were integrated into a 30x20 cm CT evaluation phantom (Kyoto Kagaku) and imaged using an UHR scanner (Aquilion Precision; Canon). Radiomic analysis was conducted in two dimensions by placing 2.0 cm<sup>2</sup> circular ROI for each of the six phantoms, evaluating 118 features classified as first-order (n=19), shape (n=24), and texture (n=75). Two comparative analyses were performed: a) super-high-resolution (SHR) mode (0.25 mm thickness, 1024 matrix) versus normal-resolution (NR) mode (0.5 mm thickness, 512 matrix) images, utilizing hybrid iterative reconstruction;

b) SHR mode images with three tube currents (150 mA, 290 mA, 580 mA) and three reconstruction algorithms (deep learning, hybrid iterative, filtered back projection). A linear mixed-effects model assessed imaging parameter effects on features. A P-value less than 0.05 divided by 118 for Bonferroni correction was considered significant.

## RESULTS

In 13 (11.0%) of the 118 features, significant disparities arose between measurements from imaging matrices (1024 versus 512 matrix). Neighborhood Gray-Tone Difference Matrix (NGTDM; 20.0%) was primarily affected, followed by Gray-Level Dependence Matrix (GLDM; 14.3%). Examining 1024 matrix images, 35 features (29.7%) exhibited dose-induced measurement alterations. First-order features (73.7%) were most frequently significantly affected, followed by NGTDM (40.0%). No substantial differences were observed in feature measurements related to reconstruction algorithms.

## CONCLUSION

Significant discrepancies in feature measurements can be discerned when utilizing UHR CT. Approximately 30% of feature measurements using UHR CT images were notably influenced by dose but not by the reconstruction algorithm.

## CLINICAL RELEVANCE/APPLICATION

Radiomic features derived from CT images using a 1024 matrix deviate from those originating from conventional CT, with measurements dependent on radiation dose while remaining largely unaffected by the reconstruction algorithm.

## M5A-SPPH- Dual-Source Photon-Counting CTA of the Thorax: Impact of Low Energy Virtual Monoenergetic Imaging on Image Quality, Vascular Contrast and Diagnostic Accessibility

2

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

## PURPOSE

Preliminary dual-energy CT studies have shown that low energy virtual monoenergetic imaging (VMI)+ reconstructions can provide superior image quality compared to standard 120 kV CTA series. The purpose of this study is to evaluate the impact of low energy VMI+ reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of thoracic arteries in patients undergoing photon-counting CTA examinations.

## METHODS AND MATERIALS

A total of 120 patients (66 male) who had undergone dual-source photon-counting CTA scans of the thorax were retrospectively analyzed in this study. Standard 120 kV CT images and low keV VMI+ series from 40 to 100 keV with an interval of 15 keV were reconstructed. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). CT number measurements were performed in the ascending and descending aorta, the aortic arch, the common carotid artery, the subclavian artery and the coronaries. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of thoracic arteries.

## RESULTS

Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU, 1205 ± 11; CNR, 29 ± 7; SNR, 30 ± 9) followed by 55 keV VMI+ reconstructions (HU, 679 ± 8; CNR, 23 ± 6; SNR, 24 ± 7); all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard 120 kV CT series (HU, 169 ± 7; CNR, 19 ± 5; SNR, 27 ± 7) (p<.0001). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images regarding image quality, vascular contrast and diagnostic assessability of thoracic arteries (p<.0001).

## CONCLUSION

Low keV VMI+reconstructions at a level of40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of the thoracic arteries compared with standard CT series in photon-counting CTA.

## CLINICAL RELEVANCE/APPLICATION

In patients undergoing photon-counting CTA scans of the thorax, low keV VMI+ reconstructions at a level of 40-55 keV should be routinely reconstructed to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

## M5A-SPPH- Usage of DECT Features and Radiomics for Management of Renal Lesions in Patients with Von Hippel-Lindau

4

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

Von Hippel-Lindau syndrome (VHL) is a rare genetic condition that increases the risk of cancer, particularly clear cell renal cell carcinoma (ccRCC). Patients with VHL mutation are usually placed under active surveillance until the tumor reaches a size of



3cm, after which surgery is advised. This study aims to investigate the potential use of dual-energy CT (DECT) and radiomics in predicting time to 3cm in patients with VHL, providing a more accurate and efficient method of monitoring ccRCC lesions.

## **METHODS AND MATERIALS**

This IRB-approved study comprised 71 adult patients (mean age,  $44 \pm 13$  years, 39 males) with histologically proven ccRCCs in patients with VHL germline mutation who underwent contrast-enhanced DECT of the abdomen during their active surveillance period. A total of 134 lesions which were measured  $>1\text{cm}$  and  $<2.5\text{ cm}$  on their baseline DECT studies and had a follow-up study reaching 3cm included in our study. We classified the lesions based on their size on baseline images into small (1-1.5cm), medium (1.5-2cm), and large (2-2.5cm). Within each group, we calculated the median time taken for lesions to reach 3cm, enabling us to classify each lesion as either slow-growing or fast-growing. Deidentified low and high kV series of the venous phase of baseline images were imported and processed on the DECT tumor analysis prototype. We semiautomatically segmented all renal lesions to extract DECT and radiomic features. Using a region of interest on the renal cortex, we normalized the iodine concentrations. Data were analyzed with multiple logistic regression and receiver operator characteristic area under the curve (AUC) as the output.

## **RESULTS**

In each group, there was no difference in the maximum diameter, volume, and whole area of the lesions growing to 3cm slowly or fast ( $p>0.3$ ). Normalized iodine concentration was significantly higher in lesions that reached 3cm slower than the others ( $p<0.001$ ). Although the necrotic volume of the lesions was higher in those that reached 3cm faster, but it was not statistically significant. With multiple logistic regression, the combination of iodine concentration and normalized iodine concentration was the best subset in predicting lesions reaching 3cm fast (AUC: 0.72, 95% CI: 0.71-0.74). Radiomics were not able to predict time to 3cm based on baseline DECT studies.

## **CONCLUSION**

Quantitative iodine parameters of renal lesions derived from the venous phase of DECT studies show potential in predicting the growth of ccRCC lesions and guiding clinical decision-making in patients with VHL.

## **CLINICAL RELEVANCE/APPLICATION**

Predicting ccRCC lesion growth in patients with VHL improves care quality, prioritizes monitoring for rapidly growing lesions, and helps minimize unnecessary radiation exposure for slower-growing ones.

## **M5A-SPPH- Evaluation of an Experimental Tantalum Oxide Contrast Material for Material Separation 5 from Iodine and Gadolinium using DECT and PCCT**

Yuxin Sun, BS,MSc (*Presenter*) Stockholder, Nextrast, Inc

## **PURPOSE**

To evaluate material separation of an experimental tantalum oxide nanoparticle contrast agent (TaCZ) from iodine and gadolinium, using clinical DECT and a prototype deep silicon PCCT scanner.

## **METHODS AND MATERIALS**

Vials of the following concentrations of contrast agents: 2.5, 5.0, 10.0 mg iodine/mL (Ultravist, Bayer); 1.2, 1.9, 2.4, 5.8 mg Gd/mL (Multihance, Bracco); 2.0, 2.5, 4.0, 5.0, 6.0, 8.0, 10.0, 12.0 mg Ta/mL (TaCZ, RPI) were scanned in a water-equivalent CT phantom (MECT Phantom, Gammex) on a clinical fast-kV switching DECT scanner (Revolution CT, GE) and a prototype deep silicon PCCT. Paired iodine and water material decomposition (MD) images were generated for both scanners. Also, PCCT bin images were generated (bin A, 44-52 keV; bin B, 52-60 keV; and bin C, 60-80 keV). ROIs were drawn on 10 slices per vial for all image reconstructions to measure average CT attenuation, iodine and water signals. Slopes of iodine versus material concentration graphs were compared for MD images, and higher to lower bin CT number ratios were compared in the bin images.

## **RESULTS**

The mean attenuation of 5.0 mg/mL iodine and Ta, and Gd (5.8 mg/mL) at 120 kVp was 129, 130, and 175 HU for DECT, and 119, 130, and 229 HU at 70 keV for PCCT, respectively. Slopes of iodine signal versus elemental concentration for DECT and PCCT are 1.06 and 0.93 for iodine; 0.79 and 0.05 for Gd; and 0.10 and -0.04 for Ta, respectively. For MD iodine maps, a larger slope difference is seen for iodine vs. Ta than for iodine vs. Gd, suggesting better spectral separation of iodine from Ta by DECT and possibly PCCT. At DECT, separation of Ta from Gd appears modest (slope  $\gamma = 0.68$ ) but poor for PCCT ( $\gamma = 0.08$ ) because both materials are correctly classified as non-iodine by 2-MD. However, in PCCT bin images, Gd signal (K-edge 50.2 keV) is optimized between bins A B with an attenuation ratio of  $\sim 1.38$  between those bins, while Ta signal (K-edge 67.4 keV) is optimized between bins B C with a ratio of  $\sim 1.26$ . Attenuation ratios of other materials, including iodine and water are all = 1.0 for these same bin pairs, indicating promising bin-based material separation of Ta and Gd from iodine and other materials.

## CONCLUSION

Tantalum provides intense enhancement on par with iodine at 120 kVp. Iodine signal is more readily separated from that of Ta than Gd by DECT material decomposition images, and is slightly more readily separated from that of Ta than Gd by PCCT. When using PCCT bin (non-MD) images, both Gd and Ta signals are readily differentiated from that of iodine, from each other, and from other materials.

## CLINICAL RELEVANCE/APPLICATION

Experimental TaCZ contrast gives a strong "color" signal that should be readily separated from iodine signal by both DECT and PCCT, and from Gd for PCCT, and may enable future multi-color contrast discrimination.

## M5A-SPPH- Revisiting Noise Variance-mAs Dependence in Photon Counting Detector CT 6

Linying Zhan, BSc (*Presenter*) Nothing to Disclose

### PURPOSE

CT noise variance has long been known to be inversely proportional to tube current-time product (mAs), which is essential in clinical CT protocol optimization. With the introduction of photon counting detector CT (PCD-CT), there is an opportunity to provide low-dose CT imaging with high spatial resolution for various clinical tasks. However, the unique technical aspects of PCD-CT, such as pulse pileup and charge-sharing effects, require a new functional dependence on mAs for noise variance.

### METHODS AND MATERIALS

With the introduction of photon counting detectors (PCDs) in CT imaging, the finite deadtime of the detectors causes the statistical distribution of raw counts to deviate from the ideal Poisson distribution, becoming deadtime-dependent. In this study, a modified Poisson distribution of photon counts for non-paralyzable PCDs was used to derive the post-log sinogram projection data variance. To connect the noise variance of a CT image with the variance of the sinogram data, a cascaded systems analysis was introduced. Additionally, for PCD-CTs with pile-up corrections, a similar analysis was conducted to derive the functional dependence of noise variance on both mAs and deadtime  $t$ . The analytical  $s^2(mA, t)$  models were validated by comparing them with simulation results and experimental data obtained from a CdTe-based PCD-CT system.

### RESULTS

In PCD-CTs without pile-up corrections, the traditional noise variance of the CT image on mAs is modified by an additional multiplication factor of  $1/(1 + \beta mA t)$  with a numerical constant  $\beta$ . On the other hand, for PCD-CTs with pile-up corrections, the classical noise variance of CT image on mAs is modified by an additional additive factor  $\gamma t$ , where  $\gamma$  is another numerical constant. Compared with simulated PCD-CT noise data with and without pileup corrections, the mean percent errors of the theoretical models are 0.53% (95% limits of agreement: [-8.45%, 9.50%]) and 0.44% (95% limits of agreement: [-8.17%, 9.04%]) respectively. Compared with experimental PCD-CT noise data, the mean percent error of the theoretical model is 0.04% (95% limits of agreement: [-1.30%, 1.38%]).

## CONCLUSION

In the non-paralyzable counting mode of PCD-CTs, such as those in the existing clinical systems, the dependence of CT image noise on mAs is modified as follows: 1) without pile-up correction,  $\sigma^2$  is altered by a multiplicative factor, and 2) with pulse pile-up correction,  $\sigma^2$  is altered by an additive factor.

## CLINICAL RELEVANCE/APPLICATION

The novel noise variance-mAs relationships allow one to predict the CT noise variance at different mA levels accurately and provide the needed scientific foundation for clinical protocol optimization of PCD-CT.

## M5A-SPPH- Optimization and Feasibility of Breast Cancer Imaging with Photon-counting CT: A Phantom 7 Study

Richard W. Ahn, MD, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

Contrast enhancement is the most sensitive feature of breast malignancy and forms the basis of cancer detection with either breast MRI or contrast-enhanced mammography. Compared to conventional energy-integrating CT, photon-counting CT (PCCT) offers improved spatial resolution, superior iodine conspicuity, and material differentiation capabilities. The purpose of this study was to evaluate the performance of PCCT for breast cancer imaging using an anthropomorphic phantom.

### METHODS AND MATERIALS

A spectral mammography phantom (Sun Nuclear) containing 2 sets of simulated lesions with 0.2, 0.5, 1.0, 2.0 mg/mL iodine was placed on top of an anthropomorphic chest phantom (QRM GmbH, 35 cm X 25 cm). Additional iodine rods (Sun Nuclear) with matched iodine concentrations were placed in the center of the chest phantom. The phantom was imaged on a clinical



PCCT scanner (NAEOTOM Alpha, Siemens) using a chest protocol in both standard (144X0.4 mm) and ultra-high resolution (UHR: 120X0.2 mm) modes. Images were reconstructed using a quantitative kernel (Qr40) with quantum iterative reconstruction algorithm at a strength of 3 (QIR-3) with two field of views (FOVs): a large FOV of 420 mm X 420 mm containing both mammography phantom and chest phantom, and a small FOV of 224 mm X 224 mm only containing the mammography phantom. All reconstructions were performed with two matrix sizes of 512 and 1024. Threshold-low images (T3D), virtual monoenergetic images (VMIs) at 50, 60, and 70 keV, and iodine maps were generated. Circular ROI were drawn within the breast lesions and iodine rods. Normalized root mean square error (nRMSE) in CT number was calculated for ROI in the lesions compared to the reference iodine rods. Contrast to noise ratio (CNR) and linearity were measured. Circularity of the breast lesions was measured using a local threshold model and MATLAB.

## RESULTS

CNR was highest at 50 keV for all iodine concentrations and ranged from 8.2 at 2 mg/mL iodine to 1.0 at 0.2 mg/mL. The nRMSE was similar for all configurations and ranged from 0.5-0.7 HU. CT number linearity was excellent for all configurations ( $R^2=1$ ). Circularity of lesions was highest for the large FOV with standard or UHR mode and a 512 matrix size.

## CONCLUSION

Standard collimation with large FOV and 512 matrix size was optimal for nRMSE, CNR, and circularity measurements. 50 keV VMIs were optimal for breast lesion evaluation due to increased lesion conspicuity and shape fidelity. These phantom results will guide further protocol development to optimize clinical breast imaging on PCCT.

## CLINICAL RELEVANCE/APPLICATION

PCCT has the potential for improved breast cancer locoregional staging due to greater iodine conspicuity in spectrally derived images and improved resolution compared to prior generations of CT scanners.

## M5A-SPPH- Simultaneous Iodine and Bismuth Dual-contrast CT Enterography with Clinical Photon-counting CT: A Feasibility Phantom Study using Low-concentration Samples

Afrouz Ataei, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate whether low-concentration iodine and bismuth samples can be visually differentiated and accurately quantified using clinical dual-source photon-counting CT (PCCT).

## METHODS AND MATERIALS

Four bismuth-barium solutions (0.7, 1.3, 2.5, and 5.1 mg Bi/mL) were prepared by mixing over-the-counter Pepto-Bismol (10.1 mg Bi/mL, Procter Gamble) with a low-density barium sulfate oral suspension (0.1% w/v, NeuLumEX™, E-Z-EM Canada Inc). The 0.7 mg Bi/mL solution corresponded to 30 mL (one dose) of Pepto-Bismol mixed with 500 mL (one bottle) of oral barium suspension. The four bismuth solutions and three iodine rods (1, 2, and 5 mg I/mL, Sun Nuclear) were inserted into three different multi-energy CT phantoms (20, 33, and 40-cm lateral dimension, Sun Nuclear). Each phantom-sample configuration was scanned on a PCCT system (NAEOTOM Alpha, Siemens) at three kV settings (120 kV: [20, 65 keV]; 140 kV: [20, 70 keV]; Sn140 kV: [20, 80 keV], Sn = 0.6-mm tin filter). Radiation dose levels (CTDIvol) were 3, 8, and 12 mGy, respectively. A custom 3-material decomposition method (iodine/bismuth/water) was used to generate iodine, bismuth, and water maps from the PCCT low- and high-energy bin reconstructed images (Qr44, QIR-3, 2.0/1.0 mm slice thickness/increment) for each data acquisition. Volume conservation was incorporated as a physical constraint for the 3-material decomposition method. The mean bismuth and iodine mass concentrations (mg/mL  $\pm$  standard deviation) were measured by placing a circular ROI of  $\sim 2.2$ -cm<sup>2</sup> on each sample. Linear regression analysis was performed to evaluate the correlation between nominal and measured mg/mL values on the iodine and bismuth maps. The root-mean-square-error (RMSE) for iodine, bismuth, and their combination was computed to assess overall quantification accuracy and was compared across all three kV settings and three phantom sizes.

## RESULTS

All iodine and bismuth samples, including those with the lowest concentrations, were clearly differentiated at all kV settings and phantom sizes. The 140 kV setting (with no additional filter) was found to be the optimal kV across the small, medium, and large phantom sizes, with combined RMSE values of 1.45, 1.91, and 2.00 mg/mL, respectively. Both the iodine and bismuth measured mg/mL values were highly linearly correlated with the nominal mg/mL values ( $R^2>0.99$ ) at the optimal 140 kV setting.

## CONCLUSION

Iodine and bismuth dual-contrast imaging at low-concentration levels can be accurately performed on a clinical PCCT at routine clinical radiation dose levels.

## CLINICAL RELEVANCE/APPLICATION

Simultaneous imaging and visual segmentation of iodine-enhanced small bowel wall and bismuth containing small bowel lumen may allow for improved diagnosis in CT enterography imaging.

## **M5A-SPPH- Single-energy Low-kV in Energy-integrating Detector CT Versus Low-keV Virtual Monoenergetic Images in Photon-counting Detector CT for Iodine Imaging**

Hiroki Kawashima, PhD (*Presenter*) Kyoto Kagaku, Research collaboration

### **PURPOSE**

To investigate the performance for iodine imaging of low-keV virtual monoenergetic images (VMIs) in photon-counting detector CT (PCD-CT), compared with those of single energy low-kV images in energy-integrating detector CT (EID-CT), using a Fourier-based assessment.

### **METHODS AND MATERIALS**

A water-bath phantom with a diameter of 300 mm, which contains two rod-shaped phantoms made of diluted iodine (2 and 12 mg/ml), was scanned using a clinical PCD-CT (SIEMENS, NAEOTOM Alpha) and an EID-CT (SIEMENS, SOMATOM Force) at 15 mGy. A low-kV image was obtained with a tube voltage of 90 kV in EID-CT (EID 90 kV). VMIs at 40 and 64 keV were reconstructed from the scan data obtained with a tube voltage of 120 kV in PCD-CT. The energy level of 40 keV is the lowest keV setting, and 64 keV was the energy level that exhibited the closest CT number to that of EID 90 kV. In PCD-CT, a low energy threshold image with a tube voltage of 90 kV (PCD 90 kV) was also obtained for comparison. The iodine contrast (C) and the task transfer function (TTF) were measured with the rod images; the noise power spectrum (NPS) was measured in the water-only region. The system performance function, including the iodine contrast factor (SPFc2) was defined as  $[C^2 \cdot TTF^2(f)]/NPS(f)$ .

### **RESULTS**

The SPFc2 of VMI 40 keV was notably higher than that of EID 90 kV as the spatial frequency increased. The ratios of SPFc2 of VMI 40 keV to EID 90 kV were approximately 1.50 and 2.81 at 0.1 and 0.5 mm<sup>-1</sup>, respectively. The SPFc2 of VMI 64 keV was comparable to or somewhat lower than that of EID 90 kV. In comparison between the same tube voltage, PCD images were superior to EID images, which was consistent with the theoretical advantages of PCD. The ratios of SPFc2 of PCD 90 kV to EID 90 kV were approximately 1.28 and 1.58 at 0.1 and 0.5 mm<sup>-1</sup>, respectively.

### **CONCLUSION**

VMI 40 keV in PCD-CT had a higher performance for iodine imaging than the low tube voltage techniques (EID 90 kV and PCD 90 kV), whereas the performance degradation might be unavoidable when the iodine contrast equalized (EID 90 kV versus VMI 64 keV).

### **CLINICAL RELEVANCE/APPLICATION**

This study quantitatively demonstrates that PCD-CT has the potential to provide better image quality than EID-CT in a contrast-enhanced CT scan.

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## Abstract Archives of the RSNA, 2023

M5A-SPRO

### Radiation Oncology Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPRO- CT Patterns and Clinical Outcomes of Radiation Pneumonitis in Non-small Cell Lung Cancer 1 Patients**

Hee Kang, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the CT findings of radiation pneumonitis (RP) in non-small cell lung cancer (NSCLC) patients and their relationship with clinical outcomes.

#### **METHODS AND MATERIALS**

We assessed CT findings and clinical information of 58 patients with NSCLC who underwent radiotherapy as curative treatment. The CT findings were evaluated for the presence and distribution of the parenchymal abnormalities, which were then classified into three patterns: localized pneumonia (LP), cryptogenic organizing pneumonia (COP), and acute interstitial pneumonia (AIP). Radiation technique, gross tumor volume (GTV), radiation (RT) dose, mean lung dose (MLD), and volume of normal lung receiving 20Gy (V20) were also evaluated. Clinical outcome was evaluated on the basis of Common Terminology Criteria for Adverse Events (CTCAE) grade, corticosteroid treatment, admission, and death. Correlations between imaging findings and clinical outcomes were analyzed.

#### **RESULTS**

Of the total 58 patients, 47 developed RP. Out of 47 patients, 26(55.3%) had symptoms of grade 2 or less, and 2(4.7%) had symptoms of grade 3 or more. RP related death occurred in 11(19.0%) patients. All patients received radiotherapy using the intensity-modulated radiation therapy technique. The mean, median, and range of the radiation-related factors in all patients are as follows; GTV (134.0, 111.5, 6.9-466.4), RT dose (6010.3, 6600.0, 200.0-7000.0), MLD (1437.6, 1465.9, 364.8-2267.5), V20 (24.9, 25.2, 1.1-443.8). The CT findings of RP were ground-glass opacity with reticulation in 46 (97.8%), consolidation in 40 (85.1%), air-bronchogram in 41 (87.2%), traction bronchiectasis in 28 (59.6%), pleural effusion in 19 (40.4%) and necrosis or cavity formation in 4 (8.5%). The most common pattern of RP was LP (n=20, 42.6%) followed by AIP (n=19, 40.4%) and COP (n=8, 17.0%). GTV, MLD and V20 were significantly different between LP, COP, and AIP patterns ( $p<0.05$ ). The presence of underlying pulmonary fibrosis, AIP pattern and CT extent were higher in the patients with higher CTCAE grade than in patients with lower CTCAE grade ( $p<0.05$ ). RT dose, AIP pattern, CT extent were significantly associated with RP-related death ( $p<0.05$ ).

#### **CONCLUSION**

RP could be classified into LP, COP and AIP in NSCLC patients and GTV, MLD and V20 were significantly different in each pattern. The underlying pulmonary fibrosis, AIP pattern and high extent of RP were associated with poor clinical outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

In NSCLC patients undergoing radiotherapy, RP pattern could be classified into LP, COP and AIP, and GTV, MLD and V20 were significantly different in each pattern. Patients with underlying pulmonary fibrosis or those planned for high RT should be closely followed up to improve patient outcomes.

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## Abstract Archives of the RSNA, 2023

M5A-SPVA

### Vascular Imaging Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **M5A-SPVA- High Resolution MRI Based Radiomics for the Assessment of NIILs after CEA of Patients with Carotid Plaques** 1

Sihan Chen (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to assess the occurrence of fresh ipsilateral ischemic lesions in patients with carotid plaques following carotid endarterectomy.

#### **METHODS AND MATERIALS**

We retrospectively collected 115 patients from Renmin Hospital of Wuhan University, all of whom presented with at least 70% carotid luminal stenosis as determined by ultrasound angiography or computerized tomography. Prior to undergoing carotid endarterectomy (CEA), all patients underwent high resolution magnetic resonance imaging (hrMRI) using a 3.0T MR750 system (GE Healthcare, USA) equipped with an 8-channel carotid coil (GE Healthcare, USA). The hrMRI protocol consisted of 2D T1WI FSE, PDWI FSE, and 2D T2WI FSE. The hrMRI images were manually segmented using ITK-SNAP, and radiomics features were extracted using pyradiomics. The occurrence of NIILs was confirmed by DWI following CEA. The patients were randomly divided into training and test groups, and a non-invasive model was built using Lasso and multi-variable logistic regression analysis to predict NIILs.

#### **RESULTS**

Of the total number of patients, 75 were found to have new ipsilateral ischemic lesions (NIILs) following CEA, while 40 did not exhibit any such lesions. Initially, a total of 1175 radiomic features were extracted from T1-weighted images, which were subsequently reduced in dimension to construct a radiomics model to predict NIILs. The area under the curve (AUC) for the radiomics model was 0.864 (95% confidence interval (CI), 0.781-0.947) in the training group and 0.795 (95% CI, 0.646-0.945) in the testing group (Fig. a and b). A clinical model was also built using variables such as sex, age, LDL, HDL, LHR, hypertension, diabetes, IPH (predicted by MRI), and LRNC (predicted by MRI). IPH (OR=42.01) and LRNC (OR=5.11) were incorporated into the clinical model, and a multivariable logistic regression model was constructed by combining radscore, LRNC, and IPH. The model was visualized using a nomogram (Fig. c). The AUC for the combined model was 0.949 (95% CI, 0.906-0.991) in the training group and 0.837 (95% CI, 0.692-0.982) in the testing group. Calibration showed good fitting of the nomogram in both the training and testing groups (Fig. d and e). The nomogram demonstrated the best clinical benefit in the training and testing groups (Fig. f and g).

#### **CONCLUSION**

The findings of this study illustrate that the occurrence of NIILs in patients with carotid plaques after CEA can be predicted non-invasively using a radiomics model and a combined model.

#### **CLINICAL RELEVANCE/APPLICATION**

Compared to traditional hrMRI, the combined model, which incorporates radiomics and clinical variables, not only predicts the occurrence of NIILs but also enables personalized treatment for patients.

#### **M5A-SPVA- Imaging of the Aorta in Dual-Source Photon-Counting CT: Impact of Low Energy Virtual Monoenergetic Imaging on Image Quality, Vascular Contrast and Diagnostic Assessability** 2

Christian Booz, MD (*Presenter*) Speaker, Siemens AG

## **PURPOSE**

Preliminary dual-energy CT studies have shown that low energy virtual monoenergetic imaging (VMI)+ reconstructions can provide superior image quality compared to standard 120 kV CTA series. The purpose of this study is to evaluate the impact of low energy VMI+ reconstructions on quantitative and qualitative image quality, vascular contrast and diagnostic assessability of the aorta in patients undergoing photon-counting CTA examinations.

## **METHODS AND MATERIALS**

A total of 125 patients (69 male) who had undergone dual-source photon-counting CTA scans of the aorta were retrospectively analyzed in this study. Standard 120 kV CT images and low keV VMI+ series from 40 to 100 keV with an interval of 15 keV were reconstructed. Quantitative analyses included evaluation of vascular CT numbers, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). CT number measurements were performed in the ascending aorta, the aortic arch, the thoracic and infrarenal descending aorta. Qualitative analyses were performed by three board-certified radiologists independently using five-point scales to evaluate image quality, vascular contrast and diagnostic assessability of the aorta.

## **RESULTS**

Mean attenuation, CNR and SNR values were highest in 40 keV VMI+ reconstructions (HU, 1312  $\pm$  13; CNR, 32  $\pm$  8; SNR, 34  $\pm$  10) followed by 55 keV VMI+ reconstructions (HU, 731  $\pm$  9; CNR, 24  $\pm$  6; SNR, 27  $\pm$  9); all three mean values at these keV levels were significantly higher compared with the remaining VMI+ series and standard 120 kV CT series (HU, 160  $\pm$  8; CNR, 18  $\pm$  5; SNR, 26  $\pm$  6) ( $p < .0001$ ). The qualitative analysis showed highest rating scores for 55 keV VMI+ reconstructions followed by 40 keV and 70 keV VMI+ series with a significant difference compared to standard 120 kV CT images series regarding image quality, vascular contrast and diagnostic assessability of the aorta ( $p < .0001$ ).

## **CONCLUSION**

Low keV VMI+ reconstructions at a level of 40-55 keV significantly improve image quality, vascular contrast and the diagnostic assessability of the aorta compared with standard CT series in photon-counting CTA.

## **CLINICAL RELEVANCE/APPLICATION**

In patients undergoing photon-counting CTA scans of the aorta, low keV VMI+ reconstructions at a level of 40-55 keV should be routinely reconstructed to improve image quality and the diagnostic assessability and to potentially reduce radiation dose and the needed amount of intravenous contrast material in scan protocols in order to protect kidney function.

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## Abstract Archives of the RSNA, 2023

M5B-SPBR

### Breast Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPBR- Is Presence of Enhancement on Contrast-enhanced Mammography (CEM) A Diagnostic Biomarker to Determine the Presence of Malignancy in Suspicious Mammographic Calcifications**

Leyla Zeitouni, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Aim: Calcifications are a regular finding on screening mammograms and considered a potential early sign of breast cancer. However, the majority of calcifications are benign and stereotactic biopsies could be avoided in a large proportion of cases. We assessed whether the presence of a corresponding enhancement on CEM is diagnostic for the presence of malignancy in mammographic calcifications.

#### **METHODS AND MATERIALS**

Eligible for this retrospective, IRB-approved, single-center study were women recalled due to mammographic BI-RADS 4 calcifications and who received CEM as part of their diagnostic workup between 2020 and 2022 at our institution. CEM protocols followed international recommendations. Two blinded breast fellows (R1, R2) assessed the presence of enhancement corresponding to calcifications on CEM. Reference standard for findings was stereotactic 9G vacuum-assisted breast biopsy or follow up of at least 24 months. For lesions of uncertain malignant potential, surgery was considered. Proportions were compared using the chi-square test.

#### **RESULTS**

69 women with mammographic calcifications (mean age, range) were included. 17 out of 69 cases (25%) were malignant (13 cases were intraductal and 4 were invasive ductal cancers). In the malignant cases, an enhancement was found in 12/17 (71%, R1) and 15/17 (88%, R2) cases. Seven of 52 (13%) [PB1] benign lesions presented enhancement detected by both readers. The higher enhancement rate in malignant compared to benign calcifications was statistically significant ( $p < 0.001$ , respectively). Non enhancing malignant cases were DCIS cases of varying grades. Enhancing benign cases were intraductal papilloma, adenosis and fibrocystic changes with intraductal epithelial proliferation.

#### **CONCLUSION**

Enhancement in CEM is diagnostic for the presence of malignancy in mammographic calcifications. The risk of false negative in the absence of enhancement ranged between 1-3 of 10 malignant cases. Benign calcifications can sometimes show enhancement on CEM.

#### **CLINICAL RELEVANCE/APPLICATION**

CEM identifies pathological enhancement associated with malignant calcification in the majority of the cases, but a significant amount of DCIS may not show enhancement.

#### **M5B-SPBR- Performance of Node-RADS Scoring System for a Standardized Assessment of Regional Lymph Nodes in Breast Cancer Patients**

Roberto Maroncelli, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Current cross-sectional imaging modalities exhibit heterogeneous diagnostic performances for the detection of a lymph node invasion (LNI) in breast cancer (BC) patients. Recently, the Node-RADS score was introduced to provide a standardized comprehensive evaluation of LNI, based on a five-item Likert scale accounting for both size and configuration criteria. In the

current study, we hypothesized that the Node-RADS score accurately predicts the LNI and tested its diagnostic performance. The secondary objective focuses on assessing the applicability and feasibility of the score among readers.

## **METHODS AND MATERIALS**

We retrospectively reviewed BC patients treated with mastectomy or QUART and lymph node dissection, from January 2020 to January 2023. Patients receiving preoperative systemic chemotherapy were excluded, therefore we included only patients undergoing lymphadenectomy after sentinel node positivity, who refused neoadjuvant therapy (NT) by self-determination and patients who had contraindications to NT. A logistic regression analysis tested the correlation between the Node-RADS score and LNI both at patient and lymph-node level. The ROC curves and the AUC depicted the overall diagnostic performance. In addition, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for different cut-off values (>1, >2, >3, >4).

## **RESULTS**

Overall, data from 100 patients were collected. Node-RADS assigned on CT scans and CE-MRI images, was found to independently predict the LNI after an adjusted multivariable regression analysis, both at the patient (OR 3.36, 95%CI 1.68-9.40,  $p=0.004$ ) and lymph node (OR 5.18, 95%CI 3.39-8.64,  $p<0.001$ ) levels. Node-RADS exhibited an AUC of 0.85 and 0.90 at the patient and lymph node levels, respectively. With increasing Node-RADS cut-off values, the specificity and PPV increased from 50.0 to 95.3% and from 50.3 to 80.0%, respectively. Conversely, the sensitivity and NPV decreased from 100 to 40.0% and from 100 to 75.3%, respectively. Excellent inter-reader agreement was found in the classification of LN according to the Node-RADS MRI score.

## **CONCLUSION**

The current study lays the foundation for the introduction of Node-RADS for the regional lymph-node evaluation in BC patients. Interestingly, the Node-RADS score exhibited a moderate-to-high overall accuracy for the identification of LNI, with the possibility of setting different cut-off values according to specific scenarios.

## **CLINICAL RELEVANCE/APPLICATION**

Node-RADS has only been validated in prostate and bladder cancer, showing promising results. No previous reports have investigated its role in BC; we want to address this gap. Higher Node-RADS score could be associated with an increased risk of LNI.

## **M5B-SPBR- Multi-national Validation of A Clinical Image-based AI-risk Model for Individualizing Breast Cancer Screening**

Mikael Eriksson, PhD (*Presenter*) iCAD, Inc

## **PURPOSE**

To investigate the predictive performance of a clinically used image-derived AI-based breast cancer risk model in multiple European screening populations.

## **METHODS AND MATERIALS**

Four European mammographic screening populations in three countries screened between 2009-2020 for women aged 45-69 was used to perform a nested case-control study. In total, 739 women with incident breast cancers were included together with 7,812 controls matched to cases on year of study-entry. Mammographic features (density, microcalcifications, masses, left-right breast asymmetries of these features) for risk assessment were extracted using AI from full-field digital mammograms. Breast cancer occurrence was assessed after two years of follow-up. Absolute risks of breast cancer were predicted using the risk model from negative mammograms at study-entry. Adjusted Area Under the receiver operating characteristic Curves (aAUC) estimated discriminatory performance and, adjusted risk-ratios estimated the stratification performance of women at high/general risk per the clinical guidelines.

## **RESULTS**

The overall aAUC of the AI risk model was 0.72 (95%CI 0.70-0.75), range 0.71 (95%CI 0.67-0.75) to 0.74 (95%CI 0.69-0.78) for breast cancers developed in four screening populations. In the 4.6% of women classified at high risk using the NICE guidelines thresholds, cancers were more likely diagnosed after 2 years follow-up, risk-ratio (RR) 6.7 (95%CI 5.6-8.0), compared with the 71% of women classified at general risk by the model. Similar risk-ratios were observed across tertiles of mammographic density. In the high-risk group, 22% of the 2-year future cancers were diagnosed, and 29% of stage 2 and higher cancers,  $p<0.01$ .

## **CONCLUSION**

The AI risk model showed generalizable discriminatory performances across European populations and, captured ~30% of clinically relevant stage 2 and higher breast cancers in ~5% of high-risk women who were sent home with a negative mammogram. Similar results were seen in fatty and dense breasts. An image-derived AI model is feasible for personalized screening to improve screening outcomes.



## CLINICAL RELEVANCE/APPLICATION

Image-derived AI risk models for breast cancer have shown high discriminatory performances compared with clinical risk models based on family history and lifestyle factors. However, little is known about their generalizability across different screening settings and clinical feasibility.

### M5B-SPBR- The Tyrer-Cuzick Risk Model: Is it Effective for All Races?

5

Siya Patil, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the predictive value of the Tyrer-Cuzick Version 8 (TC8) Risk Model in a diverse group of patients in an urban medical center. TC scores predict a patient's 10 year and lifetime risk of developing breast cancer.

#### METHODS AND MATERIALS

A retrospective review of breast imaging patients from multiple clinics within a university hospital system from January 1, 2018-November 1, 2022 was conducted. We collected each patient's most recent lifetime TC8 score, self-reported race and ethnicity (Hispanic/Latina), and cancer status. We excluded patients who did not report race or did not have TC8 scores. The final cohort contained 74,181 total patients. Analyses to explore differences in TC8 scores by race and ethnicity were first conducted on the entire sample, and then on 700 patients with breast cancer. Patients not reporting race or ethnicity were excluded from those analyses. Data was analyzed using two sample unpaired, unequal variance t-tests and  $p < 0.05$ .

#### RESULTS

In the total sample ( $n=74,181$ ), mean TC8 risk scores were statistically different between all racial groups and the White reference group. The largest differences were between White and Black (2.4 points,  $p < 0.0001$ , CI 2.23-2.57) and White and "Other" (2.9 points,  $p < 0.0001$ , CI 2.74-3.06). For the breast cancer cohort ( $n=700$ ), Black patients had a mean TC8 score 2.4 points lower than White patients ( $p=0.02$ , CI 0.32-4.4). There was no statistical difference between mean TC8 scores for White vs. Asian or White vs. "Other". Ethnicity did not have a significant impact on TC8 score relationships. For the total group there was a statistical difference between Non-Hispanic (NH)-White and NH-Black (2.7 points,  $p < 0.0001$ , CI 2.53-2.87), consistent with the previous race findings. The Hispanic (H)-Black score was statistically higher than H-White score, however the difference was less than one point. For the breast cancer cohort NH-White had a mean TC8 score 2.2 points greater than NH-Black ( $p=0.045$ , CI 0.41-4.3), and there was no statistical difference between H-White and H-Black scores.

#### CONCLUSION

TC8 scores in Black patients were consistently lower suggesting that TC8 may underestimate Black patients' lifetime breast cancer risk.

## CLINICAL RELEVANCE/APPLICATION

The TC8 score is an important tool for predicting breast cancer risk. Currently insurance companies only reimburse MRI screening for patients with TC lifetime risk score  $>20$ . It is possible that some of our patients' risk was underestimated. Specifically, in our cohort 468 Black patients had scores between 17-19 narrowly missing the cutoff. If the 2.2-2.7 point difference was considered those patients may have been advised to pursue MRI screening. We hope our results encourage future research on the appropriateness of TC8 cutoffs for Black patients.

### M5B-SPBR- Development and Application of a Feature Based Explainable AI Method (XAI) for Trustworthy Breast Cancer Risk Prediction using the Mirai Model

6

Yao-Kuan Wang, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The Mirai model (Yala, MIT) is a publicly available deep learning (DL) model predicting 1- to 5-year breast cancer risk from digital mammograms. The model prediction relies on features extracted by an encoder that utilizes a convolutional neural network. We hypothesized that understanding the individual features in terms of their receptive fields offers a route to explainable AI (XAI). The purpose of this study was to retrieve and quantify the features captured in the final layer of the encoder for the short-term risk prediction.

#### METHODS AND MATERIALS

The Mirai encoder detects 512 receptive fields in each mammogram and computes one DL feature value for each field. In this study, features were indexed by the order of encoder outputs. Corresponding receptive fields were matched with the annotations in the individual images. Two datasets were used to evaluate localization and discriminatory power of these features for the present lesions: the Cyprus dataset (100 mammograms) with micro-calcification cases and BI-RADS scores, and the CSAW-S dataset (338 mammograms), which is a case collection of malignant masses. Precision scores between the receptive fields and the locations of masses and calcifications were used to identify lesion-specific features with the highest scores. The area under the receiver operating characteristic curve (AUC) for the discriminative power of BI-RADS scores was



calculated for the feature values with the highest calcification precision. Other annotated regions studied included the nipple, skin, thick vessels, and axillary lymph nodes.

## RESULTS

A precision score of 0.81 was found between feature (F) 145 and calcification clusters, while the annotated mass regions had a precision score of 0.80 for F 397. The discriminative ability of the calcification-related feature values for the BI-RADS scores resulted in AUCs of 0.91 and 0.88 for distinguishing suspicious (BI-RADS 4,5) cases from normal (BI-RADS 1,2) and benign (BI-RADS 2) cases, respectively. Other potentially relevant regions had the following feature indexes and precision scores: nipple (F 5, 0.31), skin (F 114, 0.60), thick vessels (F 171, 0.21), and axillary lymph nodes (F 166, 0.26).

## CONCLUSION

This study provides evidence that risk prediction features in the Mirai model focus on early detection of breast lesions in mammograms, despite not being trained with pixel-wise annotation. The findings provide essential insight into the functionality of short-term breast cancer risk prediction models.

## CLINICAL RELEVANCE/APPLICATION

It is possible to extract the main features at the core of a short-term breast cancer risk prediction AI algorithm. Increasing AI trustworthiness should encourage the inclusion of this AI algorithm in the clinical decision-making process.

## M5B-SPBR- Mammographic Density Changes after Neoadjuvant Chemotherapy in Triple-negative Breast Cancer: Association with Treatment and Survival Outcome

7

Yelim Choi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the associations between mammographic density changes after neoadjuvant chemotherapy (NAC) and treatment and survival outcomes in triple-negative breast cancer (TNBC).

## METHODS AND MATERIALS

This single center retrospective study evaluated a total of 306 women with TNBC who underwent NAC followed by surgery between 2010 and 2019. Baseline density and density changes after completion of NAC were evaluated both qualitatively and quantitatively. Qualitative breast density (a-d) was evaluated based on the BI-RADS. Quantitative breast density (%) was evaluated using an open-source software (LIBRA) and mediolateral oblique/craniocaudal mammograms of the contralateral breast. Multivariable logistic regression analysis was used to evaluate the association between breast density and pathologic complete response (pCR) according to the menopausal status. Cox proportional hazard regression analysis was used to evaluate the association between breast density and development of (a) contralateral breast cancer and (b) locoregional recurrence and/or distant metastasis.

## RESULTS

Among 306 women, 93 (30%) achieved pCR, and 71 (23%) had contralateral breast density reduction 10% or greater after NAC. For only premenopausal women (n=177), the contralateral breast density reduction 10% or greater was independently associated with pCR (odds ratio, 2.5; P value=.03). On a median follow-up of 54 months, 10 (3%) women developed contralateral breast cancers, and 68 (22%) women developed locoregional recurrences and/or distant metastases. The contralateral breast density reduction 10% or greater was not associated with the development of contralateral breast cancer (Hazard ratio [HR], 1.3; P value =.78) nor the development of locoregional recurrence and/or distant metastasis (HR, 1.1; P value =.79). Family history of breast cancer was independently associated with the development of contralateral breast cancer (HR, 6.2; P value =.005). The presence of lymphovascular invasion (HR, 2.1; P value=.02), invasive cancer 2cm or greater (HR, 3.9; P value <.001), and lymph node metastasis on the surgical specimen (HR, 2.7; P value =.004) were independently associated with the development of locoregional recurrence and/or distant metastasis. Baseline density was not associated with the treatment and survival outcomes.

## CONCLUSION

For premenopausal women, contralateral breast density reduction 10% or greater after NAC was independently associated with pCR, although it was not translated to improved outcomes.

## CLINICAL RELEVANCE/APPLICATION

The contralateral breast density reduction 10% or greater after NAC was associated with achievement of pCR in premenopausal women, however, the density reduction was not translated to improved outcomes.

## M5B-SPBR- Volumetric Parenchymal Pattern Radiomic Analysis in Digital Breast Tomosynthesis for Breast Cancer Risk Estimation

8

Alex A. Nguyen, BS, MS (*Presenter*) Nothing to Disclose

## PURPOSE

We evaluate the performance of volumetric parenchymal pattern analysis from digital breast tomosynthesis (DBT) versus digital mammography (DM), accounting for conventional risk factors and breast density for breast cancer risk estimation. The rationale is that 3D parenchymal texture analysis with radiomic features may provide information beyond 2D breast density.

## METHODS AND MATERIALS

We performed a retrospective case-control study in women with concurrent DM and DBT screening (Selenia Dimensions, Hologic Inc.) at our institution from 3/2011-12/2014. Cases were diagnosed with breast cancer within 1-year of screening; controls were confirmed negative or benign at 1-year follow-up, matched on race (Black, White, other/unknown) and age (5-year bins). After exclusions for imaging artifacts, craniocaudal (CC) and mediolateral oblique (MLO) views for 187 cases and 737 controls, in six image formats were assessed: 1) raw DM; 2) processed DM; 3) raw DBT central projection; 4) processed DBT central projection; 5) DBT central reconstructed slice; and 6) 3D DBT reconstructed stack. For cases, we analyzed the breast contralateral to cancer diagnosis and the same breast in matched controls. We extracted 487 radiomic features using a lattice-based approach with the Cancer Imaging Phenomics Toolkit, averaging features for each breast over CC and MLO views. We examined 3 lattice window sizes (6.4, 12.8, and 25.6 mm) and 23 image resampling resolutions (0.075 - 2mm). We performed principal component analysis on the resulting 487 features for each combination of window size and resampled resolution and built conditional logistic regression models to assess the association of the first seven principal components with breast cancer, with models adjusting for age, BMI, and Breast Imaging Reporting and Data System (BI-RADS) density. We calculated the model C-statistic at all window sizes and resolutions (i.e., total of 2304 experimental conditions).

## RESULTS

Radiomic features from 3D reconstructed DBT scans had on average higher C-statistics across all experimental conditions. A model using only age, BMI, and BI-RADS density had a C-statistic of 0.61. Models using radiomic features plus age, BMI, and BI-RADS density had mean C-statistic of 0.68 (IQR 0.68, 0.69) for reconstructed DBT scans; for all other image types, the mean C-statistic ranged from 0.64 to 0.66.

## CONCLUSION

3D volumetric breast parenchymal patterns from DBT may improve breast cancer risk estimation beyond markers derived from 2D DM and conventional breast density metrics alone.

## CLINICAL RELEVANCE/APPLICATION

Fully-automated, 3D parenchymal pattern radiomic analysis is feasible in DBT, and our preliminary evaluation suggests that it may improve breast cancer risk assessment beyond 2D DM measures.

## M5B-SPBR- Mammographic Density Assessment: Radiologists, Artificial Intelligence-based Computer-assisted Diagnosis, and Automated Volumetric Measurement

Su Min Cho, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate breast density assessment using BI-RADS (Breast Imaging Reporting and Data System) breast density category across readers with different levels of experience, artificial intelligence-based computer-assisted diagnosis (AI-CAD) and automated volumetric density measurement program (Volpara®).

## METHODS AND MATERIALS

A total of 1,015 screening mammography were retrospectively reviewed (56 ± 10 years). Density assessment according to BI-RADS category was performed by four readers with two different levels of experience; experts and general radiologists. Agreements between visually assessed BI-RADS category, AI-CAD (Lunit INSIGHT MMG) and Volpara® were evaluated using weighted kappa statistics.

## RESULTS

Inter-reader agreement between expert and general radiologist was substantial ( $k = 0.65$ ) with a matched rate of 72.8%. The agreement was substantial between the expert or general radiologist and Volpara® ( $k = 0.64 - 0.67$ ) with a matched rate of 72.0% but moderate between expert or general radiologist and AI-CAD ( $k = 0.45 - 0.58$ ) with a matched rate of 56.7 - 67.0%. The agreement between Volpara® and AI-CAD was moderate ( $k = 0.53$ ) with a matched rate of 60.8%.

## CONCLUSION

Density assessment by AI-CAD showed moderate agreement with those of radiologists, while Volpara® showed substantial agreement with radiologists.

## CLINICAL RELEVANCE/APPLICATION

Volpara® presented better agreement with radiologists than AI-CAD with a better matched rate.  
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## Abstract Archives of the RSNA, 2023

M5B-SPCA

### Cardiac Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPCA- Can Cardiac CT Alternate Cardiac MRI for Myocardial ECV Quantification in Cardiac Amyloidosis?** 1

Hidetaka Hayashi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Myocardial extracellular volume (ECV) on CT, a possible alternative to cardiac MRI, has significant practical clinical advantages. However, the consistency between ECVs quantified via CT and MRI in cardiac amyloidosis (CA) has not been fully investigated. Therefore, the current study investigated the application of CT-ECV in CA with MRI-ECV as the reference standard.

#### **METHODS AND MATERIALS**

We retrospectively evaluated 31 patients with CA who underwent cardiac CT and MRI. Pearson correlation analysis was performed to investigate correlations between CT-ECV and MRI-ECV at each segment. In addition, correlations between ECV and clinical parameters were assessed.

#### **RESULTS**

There were no significant differences in terms of the mean global ECVs between CT and MRI ( $51.3\% \pm 10.2\%$  vs  $50.0\% \pm 10.5\%$ ). CT-ECV was strongly correlated with MRI-ECV at the septal ( $r=0.88$ ), lateral ( $r=0.80$ ), and global ( $r=0.87$ ) segments. A strong correlation was also observed at the anterior ( $r=0.77$ ) and inferior ( $r=0.79$ ) segments. In both CT and MRI, the ECV had a weak to strong correlation with high-sensitivity cardiac troponin T level, moderate correlation with global longitudinal strain, and inverse correlation with left ventricular ejection fraction. The septal ECV and global ECV had a slightly higher correlation with the clinical parameters.

#### **CONCLUSION**

Cardiac CT can quantify myocardial ECV and yields results comparable with those obtained using MRI in patients with CA. A significant correlation was also observed between CT-ECV and clinical parameters.

#### **CLINICAL RELEVANCE/APPLICATION**

CT-ECV can be used as an imaging biomarker and alternative to MRI-ECV in patients with CA.

#### **M5B-SPCA- Clinical Utility of 'Faded Edge Sign' on the Post-contrast T1 Mapping for Diagnosis of Cardiac Amyloidosis** 2

Eun Ju Chun, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the frequency and potential clinical utility of the 'faded edge sign' on the post-contrast T1 mapping to identify cardiac amyloidosis (CA) among patients with left ventricular hypertrophy (LVH).

#### **METHODS AND MATERIALS**

We retrospectively enrolled 222 patients with pathologically confirmed LVH (56 CA, 116 hypertrophic cardiomyopathies [HCM], 50 hypertensive heart disease[HHD]) who underwent cardiac MR. The 'faded edge sign' was defined as the boundary between the myocardium and the left ventricular (LV) cavity was unclear and the LV myocardium/cavity signal intensity ratio was between 0.8 and 1.2 on the post-contrast T1 mapping. In diagnosing CA among patients with LVH, we compared the

diagnostic accuracy of additional faded edge sign compared to the characteristic late gadolinium enhancement (LGE) pattern (global subendocardial enhancement), native T1 values, and extracellular volume (ECV).

## RESULTS

The faded edge sign was noted in 40 of 56 patients with CA (71.4%) and 5 of 116 patients with HCM (4.3%) and none of the HHD patients. Mean native T1 value and ECV was the highest in CA, followed by HCM and HHD (1442±81msec vs. 1320±58 msec vs. 1230±32 msec for native T1 value; 41±7% vs. 29±7% vs. 23±2% for ECV;  $p < 0.05$ ). The sensitivity and specificity of faded edge sign for CA was 71.4% and 97.0%, respectively. For the diagnosis of CA, the diagnostic accuracy of the added faded edge sign for the combination of LGE, ECV, and native T1 (AUC 0.931) was higher than that of the combination of LGE+ECV+native T1 (AUC 0.920) or LGE alone (AUC 0.866).

## CONCLUSION

The 'faded edge sign' on the post-contrast T1 mapping is a simple observation method that is helpful in increasing the ability for diagnosis of CA.

## CLINICAL RELEVANCE/APPLICATION

In addition to LGE, native T1 and ECV, post-contrast T1 mapping was also helpful for the diagnosis of CA.

## M5B-SPCA- Prediction of Early Death from Anthracycline-induced Cardiotoxicity using CMR Parameters: An Animal Study

Nayoung Kim (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to compare cardiac magnetic resonance (CMR) parameters between the early death and survival groups of anthracycline-induced cardiotoxicity rat models, and to identify factors that could predict early death.

## METHODS AND MATERIALS

We generated 38 Sprague-Dawley cardiotoxicity rat models by injecting doxorubicin (1.0 mg/kg) twice weekly for 12 weeks. We conducted CMR biweekly until 12 weeks, including pre-contrast and post-contrast T1 mapping using a saturation recovery Look-Locker sequence and T2 mapping using a spin echo sequence using a 9.4 T Bruker scanner. Biventricular function, left ventricle (LV) mass, native T1, T2, and ECV (extracellular volume fraction) were measured. The CMR parameters and blood troponin I (TnI) were compared between the early death and survival groups using linear mixed regression analysis.

## RESULTS

Among 38 rats, seven were excluded because of poor image quality or because they died before CMR at two weeks. Seventeen rats died before 12 weeks, so they were assigned to the early death group: 2 rats surviving for 2 weeks, 2 rats for 4 weeks, 3 rats for 6 weeks, and 3 rats for 8 weeks. Fourteen rats survived until the maximum treating period of 12 weeks and were assigned to the survival group. During the treatment, native T1, T2, and ECV increased, and LVEF (left ventricular ejection fraction) decreased in each group. When the two groups were compared, native T1 showed a significant difference at 8th week, with the early death group showing a higher value than survival group (1364.1ms ± 75.6 vs. 1235.7ms ± 60.2,  $P = .01$ ). The ECV exhibited significant differences from 6th week (21.7% ± 2.4 in early death group vs. 18.5% ± 2.2 in the survival group,  $P = .046$ ) through 8th week (24.5% ± 2.5 vs. 20.5% ± 2.3 in survival group;  $P = .022$ ), with the early death group exhibiting significantly higher values. T2 and LVEF showed no significant differences between groups throughout all weeks. TnI levels significantly differed at 8th week (7.5µg/mL vs. 0.02µg/mL,  $P = .002$ ). In the survival group, ECV increased significantly between 4 and 6 weeks ( $P = .044$ ), and LVEF decreased significantly between 8 and 12 weeks ( $P = .001$ ). However, native T1 did not show significant week-by-week differences within the survival group. Within the early death group, LVEF decreased significantly between 2 and 4 weeks ( $P = .04$ ), and native T1 and ECV showed a significant increase between 4 and 6 weeks earlier than the survival group ( $P = .007$  and  $.001$ , respectively).

## CONCLUSION

We have observed the differences in changing patterns in native T1, ECV, T2, and LVEF over the treatment time between the survival and early death groups.

## CLINICAL RELEVANCE/APPLICATION

Quantitative measurement of native T1 and ECV with CMR may facilitate the prediction of anthracycline-induced cardiotoxicity.

## M5B-SPCA- Diagnostic Yield of Cardiac MRI in Patients with Clinically Suspected Myocarditis after COVID-19 Vaccination

Norain Talib (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate cardiac MRI findings in patients with suspected myocarditis following COVID-19 vaccination in relation to clinical presentation and timing of imaging.

## METHODS AND MATERIALS

Consecutive adult patients who underwent clinically indicated cardiac MRI for evaluation of suspected myocarditis following mRNA-based COVID-19 vaccination at a single center between June 2021-December 2022 were retrospectively evaluated using the revised 2018 Lake Louise Criteria (LLC). Patients were classified into groups based on presence/absence of T1 criteria (late gadolinium enhancement and/or high T1 map values) and T2 criteria (regional T2-hyperintensity and/or high T2 map values). Clinical information including vaccine history and presenting symptoms were extracted from the health record.

## RESULTS

89 patients were included, 64% male with mean age  $34 \pm 13$  years; all had received at least one dose of a COVID vaccine (mRNA-1273 in 38% and BNT162b2 in 62%) with median interval between the last dose vaccine dose and cardiac symptoms (chest pain, palpitations or shortness of breath) of 5 days (IQR 1-9). The median interval between last COVID-19 vaccine dose and MRI was 92 days (IQR 31-157). At least one T1 or T2 abnormality on MRI consistent with myocarditis was identified in 42 patients (47%); 25 (28%) met both T1 and T2 criteria on MRI (definite myocarditis); 17 (19%) met T1 criteria but not T2 criteria (possible myocarditis); and 47 (53%) did not meet either T1 or T2 criteria (no myocarditis). None of the patients met T2 criteria but not T1 criteria. The three groups did not differ in age ( $p=0.10$ ), sex ( $p=0.29$ ), vaccine type ( $p=0.24$ ), or left ventricular ejection fraction ( $p=0.53$ ). The interval between last vaccine dose and cardiac MRI was significantly shorter in patients who met both T1 and T2 criteria (28 days, IQR 8-69) compared to those meeting T1 criteria only (110 days, IQR 66-255,  $p<0.001$ ) and those not meeting either T1 or T2 criteria (120 days, IQR 80-252,  $p<0.001$ ). However, the interval between last vaccine dose and MRI did not differ between those meeting T1 criteria only and those not meeting either T1 or T2 criteria ( $p>0.99$ ).

## CONCLUSION

In a cohort of patients with symptoms concerning for acute myocarditis following COVID-19 vaccination who underwent clinically indicated cardiac MRI, 28% met criteria for definite myocarditis (T1 and T2 abnormal) and 19% met criteria for possible myocarditis (only T1 abnormal). Identification of myocardial edema on cardiac MRI was highly dependent on the timing of imaging after vaccination.

## CLINICAL RELEVANCE/APPLICATION

Cardiac MRI should be performed as soon as possible after symptom onset in patients with suspected acute myocarditis as the likelihood of detecting myocardial edema drops substantially after a few weeks.

## M5B-SPCA- Diagnostic Accuracy of Cardiac MRI Versus Nuclear Imaging for Cardiac Amyloidosis: A Systematic Review and Meta-Analysis

6

James Roberts, MD, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

There is no consensus regarding the relative diagnostic performance of cardiac MRI and nuclear imaging in cardiac amyloidosis. The purpose of this study was to perform a systematic review and meta-analysis to compare the diagnostic accuracy of cardiac MRI and cardiac nuclear imaging for cardiac amyloidosis.

## METHODS AND MATERIALS

MEDLINE, Ovid Epub, CENTRAL, EMBASE, EMCARE, and Scopus were searched from inception until September 2022. Inclusion criteria included studies that evaluated the diagnostic accuracy of cardiac MRI or cardiac nuclear imaging studies for cardiac amyloidosis in adults. Abstracts and case reports were excluded. Data were independently extracted by two investigators. Summary accuracy metrics were obtained using bivariate random-effects meta-analysis. Meta-regression was used to assess the impact of different covariates. Risk of bias was assessed using the Quality Assessment Tool for Diagnostic Accuracy Studies-2 tool. The study protocol was registered a priori in the International Prospective Register of Systematic Reviews (PROSPERO CRD42022352480).

## RESULTS

Our search strategy yielded 7322 studies. We screened 2785 studies after excluding duplicates and reviewed the full text of 272 studies. Thirty-nine studies were included (3836 patients, 2331 with cardiac amyloid); 18 studies evaluated cardiac MRI (1553 patients, 968 with cardiac amyloidosis) and 24 evaluated cardiac nuclear imaging (2372 patients, 1401 with cardiac amyloidosis). Only 3 evaluated both MRI and nuclear imaging in the same patients. Overall, combined  $^{99m}\text{Tc}$ -scintigraphy bone tracers (including  $^{99m}\text{Tc}$ -DPD,  $^{99m}\text{Tc}$ -PYP, and  $^{99m}\text{Tc}$ -HMDP) had higher specificity than LGE on cardiac MRI (96% vs. 85%,  $p<0.001$ ), with no difference in sensitivity (95% vs. 91%,  $p=0.88$ ). When the analysis was restricted to studies with endomyocardial biopsy as the reference standard, there was no difference in specificity between modalities (96% vs. 90%,  $p=0.56$ ). Covariate analysis demonstrated that sensitivity and specificity for nuclear imaging did not differ significantly by

quantitative vs. qualitative evaluation. Thirty-seven studies were at risk of bias. There were insufficient studies to pool data on the diagnostic performance of T1 mapping, ECV and PET.

#### **CONCLUSION**

Nuclear imaging Tc99m bone tracers have higher specificity for cardiac amyloidosis than LGE on cardiac MRI, but similar sensitivity. Limitations including risk of bias and few studies with direct comparison necessitate additional study.

#### **CLINICAL RELEVANCE/APPLICATION**

Nuclear imaging Tc99m bone tracers are only specific for transthyretin amyloid while MRI detects all types including light chain. Additional studies are needed to determine the relative diagnostic performance in amyloid subtypes.

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## Abstract Archives of the RSNA, 2023

M5B-SPCH

### Chest Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPCH- Modeling Risk of Progression to Lung-RADS 4 from a Benign Lung Cancer Screening CT using Imaging and Clinical Data** 1

Gunvant R. Chaudhari, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

For patients with benign low-dose chest CTs (LDCTs) with Lung-RADS score = 2, the screening interval is set to one year. To optimize screening intervals, we aim to build a deep learning system to predict risk progression in two years from full volume CT and clinical features.

#### **METHODS AND MATERIALS**

In this retrospective modeling study, full-volume LDCTs and baseline surveys from the National Lung Screening Trial (NLST) dataset (n=26,722 patients) were accessed to use as training data. A proprietary AI-based system augmented with solid-component segmentations was used to calculate the Lung-RADS 1.1 score for each scan. Baseline LDCTs with Lung-RADS = 2 were selected. For the clinical and demographics data, backward stepwise selection based on p-values was conducted to select the four most predictive features. Then, statistical and deep learning models were trained to predict progression to Lung-RADS 4 in two years. Models were compared based on the AUC-ROC score. To test generalizability, institutional lung screening LDCT and clinical data was collected (n=583 patients). A subset of baseline screenings with corresponding studies in 2 years +/- 4 months were selected. The NLST trained models were evaluated on institutional data.

#### **RESULTS**

From the NLST dataset, a subset 15,942 baseline LDCT screenings were found to have Lung-RADS = 2, with 1,637 progressing to Lung-RADS 4 (10.3%). Benign Lung-RADS score institutional studies totaled 50 studies, with 7 (14%) progressing to Lung-RADS 4 in two years. After backward stepwise selection on all input features, those that were significantly associated with Lung-RADS 4 progression were average nodule size, largest nodule size, number of nodules, and emphysema diagnosis. Models for predicting progression to Lung-RADS 4 based only on clinical and imaging features had a maximal AUC of 0.667 and 0.750 on the NLST and UCSF holdout data, respectively. Convolutional neural network-based models trained on full volume CTs had an AUC of 0.627 and 0.555 on the NLST and UCSF data, and combined models with clinical features and full-volume CT had a maximal AUC of 0.704 and 0.724.

#### **CONCLUSION**

This study shows that AI based models can predict future progression to Lung-RADS 4 from clinical features and full-volume CT scan. The full-volume CT based models have limited generalizability to institutional data, likely due to differences in acquisition dates and qualities.

#### **CLINICAL RELEVANCE/APPLICATION**

Modeling clinical and baseline imaging features that contribute to Lung-RADS 4 progression from a benign baseline LDCT may allow for optimized screening frequency for low-risk patients.

#### **M5B-SPCH- AI Assisted Lung Cancer Screening: A Retrospective Multinational Study in the US and Japan** 2

Atilla P. Kiraly, PhD (*Presenter*) Former Employee, Siemens AG; Employee, Alphabet Inc

#### **PURPOSE**

To evaluate the impact of an Artificial Intelligence (AI) assistant for lung cancer screening (LCS) on multinational clinical workflows.



## METHODS AND MATERIALS

We iteratively developed an AI interface via six user experience reader studies. We then conducted two retrospective randomized multi-reader multi-case studies where 627 (141 cancer positive) cases were each read twice (once with and once without AI assistance) by experienced thoracic radiologists (6 US-based or 6 Japan-based), resulting in a total of 7,524 interpretations. Positive cases were defined as imaging studies within two years before a lung cancer diagnosis. Cases without any subsequent cancer diagnosis for at least two years after the imaging study were defined as negative, and enriched for a spectrum of diverse nodules. The studies measured the readers' level of suspicion (LoS, on a 0-100 scale), country-specific screening system scoring categories, and management recommendations. Evaluation metrics included the area under the receiver operating characteristic curve (AUC) for LoS and sensitivity and specificity for recall recommendations.

## RESULTS

With AI assistance, the radiologists' AUC increased 2.3% (70% to 72%,  $p=0.022$ ) for the US study and 2.3% (93% to 96%,  $p=0.179$ ) for the Japan study. Scoring system specificity for positive screens increased 5.5% (57% to 63%,  $p<0.001$ ) for the US and 6.7% (23% to 30%,  $p<0.001$ ) for the Japan study. No significant drop in sensitivity occurred. Specificity increased 5.8% ( $p<0.001$ ) and 5.4% ( $p<0.001$ ) in the US-based and Japan-based studies for any actionable recommendations, respectively.

## CONCLUSION

We demonstrate a rigorous randomized study of an AI assistant into real-world-like clinical workflows. Our PACS-integrated AI interface demonstrated improved LCS specificity in both US and Japan-based reader studies, meriting further study in additional international screening environments.

## CLINICAL RELEVANCE/APPLICATION

We developed a general lung cancer screening AI interface and retrospectively tested it with experienced radiologists on more difficult screening cases under both US-based and Japan-based reading protocols.

## M5B-SPCH- Multi-modality Artificial Intelligence Model Based on CT and Haematoxylin and Erosin (H&E)-stained Slides Images to Predict PD-L1 Status in NSCLC

Dingpin Huang, MEd (*Presenter*) Nothing to Disclose

## PURPOSE

Programmed death-ligand 1(PD-L1)expression status is the most important biomarker that has been approved in immunotherapy for lung cancer. However, the gold standard of PD-L1 evaluation based on manual assessment by pathologists, which is influenced by the professional knowledge and experience. The aim of this study is to develop and validate a multi-modality artificial intelligence (AI) model to predict the PD-L1 expression status of lung cancer based on eligible computed tomography (CT) images and haematoxylin and eosin (HE)-stained slides.

## METHODS AND MATERIALS

We retrospectively analyzed a PD-L1 expression dataset from 227 consecutive eligible lung cancer patients, including chest CT images and whole slide images (WSI) of haematoxylin and eosin(HE)-stained specimen during the corresponding period. The multi-modality AI model integrates CT radiomics and pathological deep learning based on multi-instance learning. The datasets were divided into training, validation, and testing group in a 4:1:1 ratio ( $n=151,38,38$ , respectively). Finally, a separate lung cancer immunotherapy cohort ( $n=47$ ) was used to evaluate the prognostic value of the multi-modality fusion model.

## RESULTS

The proportion of PD-L1 positive in patients was 55.1%( $n=125$ ). The area under the curve (AUC) of fusion model to predict PD-L1 expression status was 0.922, 0.745 and 0.685 in the training, validation and testing group, respectively. The fusion model shows significantly better performance than the single-modality model (AUC=0.781, 0.695, 0.518 for CT radiomics model and AUC=0.93, 0.697, 0.594 for pathological deep learning model in training, validation, testing group, respectively; all  $p<0.05$ ). Additionally, for the survival cohort, the progression-free survival (PFS) was significantly longer in PD-L1 positive patients predicted by the multi-modality AI model than the negative patients (mean PFS 280 days vs 185 days,  $p<0.05$ ).

## CONCLUSION

The multi-modality AI model based on CT and haematoxylin and eosin (H&E)-stained slides images can predict the PD-L1 expression status of lung cancer effectively.

## CLINICAL RELEVANCE/APPLICATION

Our AI model can assess the PD-L1 expression status of NSCLC automatically, which can avoid subjective bias in manual evaluation and provide more precise assistance for clinical treatment decisions.

#### **M5B-SPCH- 4 Comparison of Radiologists' Reports and AI for Detecting Ectasia and Aneurysms of the Thoracic Aorta on LDCT for Lung Cancer Screening: A Multicenter, Multivendor Study of 430 Patients**

Lina Karout, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

We assessed the frequency of inconsistent reporting of thoracic aorta ectasia and aneurysm on unenhanced, low-dose CT for lung cancer screening (LCS) and compared the performance of radiologists' reports with an AI algorithm (AIRC, AI Rad Companion, Siemens) for measuring aortic dimensions.

##### **METHODS AND MATERIALS**

Our IRB-approved and HIPAA-compliant retrospective study included 420 patients (mean age 66±7 years; females: males 157:263) who underwent LCS-LDCT on 10 single and dual-source MDCT scanners at one of the three community and quaternary hospitals. The patients were identified from a commercial radiology report data mining software (mPower, Nuance) with the keywords of "thoracic aorta" "aneurysm" and "ectasia." The negative LDCT-LCS represented consecutive cases over the same period and scanners. We recorded the presence of thoracic aneurysm or ectasia as well as when available the thoracic aorta dimensions from the radiology reports. Separately, thin-section DICOM images (1-1.25mm) were deidentified, exported, and processed with the AIRC to obtain maximum diameter of ascending and descending thoracic aorta. To establish the standard of reference (SOR), a thoracic radiologist independently measured short-axis dimensions of the ascending and descending thoracic aorta. Descriptive statistics and receiver operating characteristics area under the curve were estimated (ROC AUC) with 95% confidence interval.

##### **RESULTS**

Per SOR, 25/420 patients (5.9%) had ascending thoracic aorta aneurysm ( $\geq 45$  mm), 78/420 (18.6%) had aortic ectasia ( $\geq 40 < 45$  mm), and 18/420 (4.3%) had descending thoracic aorta aneurysm ( $\geq 35$  mm). The respective AUC, sensitivity and specificity of radiology reports were 0.86 (95% CI: 0.75-0.97), 72% and 100% for ascending thoracic aorta aneurysm; 0.66 (95% CI: 0.59-0.74), 35% and 97% for aortic ectasia; and 0.50 (95% CI: 0.36-0.63), 0% and 99% for descending thoracic aneurysm. The corresponding ROC AUCs, sensitivity and specificity for the AI algorithm were 0.99 (95% CI 0.99-1.00), 100% and 99% for ascending thoracic aorta aneurysm; 0.86 (95% CI: 0.81-.091), 82% and 90% for aortic ectasia; and 0.93 (95% CI: 0.87-0.99), 94% and 91% for descending thoracic aneurysm. There was no difference in the performance of AI across different patients' gender, age groups, as well as scanners and hospitals ( $p > 0.1$ ).

##### **CONCLUSION**

The generalizable AI can improve radiology reporting of ascending and descending thoracic aorta aneurysms on LDCT for lung cancer screening.

##### **CLINICAL RELEVANCE/APPLICATION**

Radiologists' reports on thoracic aorta ectasia and aneurysm are inconsistent on LDCT; AI can help improve and automate aortic dimensions and help improve reporting accuracy.

#### **M5B-SPCH- 5 Clinical and Imaging Factors Associated with Growth of Subsolid Pulmonary Nodule on CT**

Masha Bondarenko (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Growth of part solid nodules are predictive of the nodule becoming cancerous along the adenocarcinoma spectrum. We aimed to investigate the clinical significant features that are predictive for growth of part-solid nodules (PSNs) identified by a commercial algorithm and verified by natural language processing (NLP) of radiology reports.

##### **METHODS AND MATERIALS**

A retrospective study was conducted on patients who underwent chest CT scans between 2015 and 2019 at a single institution. CT scan radiology reports were extracted from mPower to select for patients with subsolid nodules. A commercial algorithm was used on the final dataset to identify nodules with a solid component larger than 6 mm and a non-solid component. The radiology reports were processed using NLP to verify whether the PSNs were growing or not. Clinical and imaging features including age, gender, nodule location, shape, length, margin, lobulation, and pleural traction were evaluated for their predictive value for PSN growth using univariate and multivariate logistic regression analyses.

##### **RESULTS**

A total of 901 PSNs were included in this study, with 148 of those being growing PSNs. On univariate analysis, lobulated margin ( $p < 0.01$ ), age ( $p < 0.01$ ), and middle lobe ( $p = 0.6$ ) were significantly associated with growing PSNs at a significance level of 0.1. On multivariate analysis, middle lobe (Odds Ratio (OR) [95% Confidence Interval (CI)] = 0.27 [0.12-0.99],

$p=0.02$ ), age (OR=1.10 [0.98-1.02],  $p<0.001$ ), and lobulated margin (OR=1.53 [2.77-6.50],  $p<0.001$ ) were significant predictors of growing PSNs.

## **CONCLUSION**

In patients with PSNs identified by a commercial algorithm and verified by NLP of radiology reports, higher age, no presence in the right middle lobes, and lobulated margin were independent predictors for fast-growing PSNs. These findings could help identify patients who are at high risk of PSN growth and guide appropriate management decisions. The combination of a commercial algorithm and NLP of radiology reports may be a useful tool for identifying PSNs and monitoring their growth.

## **CLINICAL RELEVANCE/APPLICATION**

By identifying adenocarcinoma spectrum nodules at risk for further growth, clinicians can more precisely identify, monitor, and potentially treat high-risk nodules.

## **M5B-SPCH- Satellite Modularity as Indicator of Benign Versus Malignant Etiology of Lung Nodules in a 6 Histoplasmosis-endemic Region**

Ryan Staudte, MD, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate if presence of satellite nodularity can distinguish between benign and malignant lung nodules in histoplasmosis-endemic regions. Additionally, to evaluate any other factors that can add confidence in distinguishing between benign and malignant etiology.

## **METHODS AND MATERIALS**

An IRB-approved retrospective review was performed of all CT and CTA chest exams from November 2015-2020 containing the phrase "satellite nodule" in the report. Short- and long-axis measurements of both the primary lung nodule and largest satellite nodule were recorded. Data was collected on patient demographics, history of cancer, margins, cavitation, calcification, change in size over time, presence of adjacent bronchovascular bundle nodularity, and tissue diagnosis. Predictive capabilities for demographic and clinical variables were analyzed with logistic regression models to produce odds ratio and area under ROC curve values.

## **RESULTS**

346 chest CTs were identified, of which 111 were excluded based on primary nodule size outside the range of 0.6 to 3.0 cm ( $n = 46$ ), undecided final pathology ( $n=12$ ), or insufficient follow-up for diagnosis ( $n=53$ ). Benign primary nodule pathology was found in 201 of 235 patients (86%). Bronchovascular bundle nodularity demonstrated the highest odds of benignity (OR 18.4,  $p.01$ ) followed by presence of calcification (OR 10.6,  $plt;.01$ ) as single variables. Spiculated margins (OR 0.06,  $plt;.01$ ) and history of metastatic disease or newly diagnosed cancer (OR 0.15,  $plt;.01$ ) were most associated with malignant diagnosis. Bronchovascular nodularity alone demonstrated poor ability to predict the odds of benignity (AUC 0.66,  $plt;.01$ ) but was increased when combined with margin characteristics (AUC 0.82,  $plt;.01$ ) or patient age (AUC 0.80,  $plt;.01$ ). The multivariable combination of margin characteristics and age demonstrated the largest ability to predict the odds of benignity (AUC 0.84,  $plt;.01$ ).

## **CONCLUSION**

Approximately 86% of lung nodules with satellite nodules had benign pathology. Spiculated margins followed by clinical history of either new cancer or known metastatic disease were most associated with malignant diagnosis. Bronchovascular bundle nodularity was most associated with benign etiology, more strongly than presence of calcification. Bronchovascular nodularity combined with smooth primary nodule margins or younger patient age, was an excellent predictor of benign diagnosis, possibly permitting less rigorous follow up imaging or further work up.

## **CLINICAL RELEVANCE/APPLICATION**

The ability to predict benign etiology of a lung nodule based on the presence of satellite nodularity and bronchovascular bundle nodularity in histoplasmosis endemic regions can direct future follow up recommendations.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-SPER

### Emergency Radiology Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPER- The Diagnostic Ability of Postmortem CT for the Cause of Natural Death from Out-of-hospital Cardiac Arrest** 1

Yu Nakaki (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Postmortem CT (PMCT) can help to identify the cause of death. Its diagnostic ability has been reported, however, its findings depend on the corpse and the methodology applied. PMCT cannot diagnose cardiac disease, e.g. myocardial infarction, lethal arrhythmia, and pulmonary thromboembolism, consequently its ability to determine the cause of natural death, especially from out-of-hospital cardiac arrest (OHCA) may be lower than expected. To reveal the current issue of PMCT, we investigated the ability of PMCT to identify the cause of natural death from OHCA.

#### **METHODS AND MATERIALS**

Between January 2018 and December 2022, we enrolled 306 patients with OHCA who were taken to our hospital and performed non-contrast PMCT. Excluded were 94 patients with unnatural death and 6 patients younger than 18 years. Included were 206 patients (121 males, 85 females; median age 79 years, range 18-104 years) who died a natural death from OHCA. The median interval from death to PMCT was 2.5 hours (range 1 - 28 hours). All were scanned on a 16-row multi-detector CT scanner. The scan parameters were 120 kVp and automated exposure control; the preset noise was 11 Hounsfield units. All images were consensually interpreted by two board-certified radiologists and categorized into diagnostic (PMCT alone was sufficient to determine the cause of death), suggestive (the cause of death was suggested but additional information was needed), and non-diagnostic (the cause of death could not be determined on PMCT images).

#### **RESULTS**

Of 206 PMCT images, 46 (22.3%) were diagnostic, 16 (7.8%) were suggestive, and 144 (69.9%) were non-diagnostic. Aortic dissection (n=15), aortic aneurysm rupture (n=12), cardiac rupture (n=8), subarachnoid hemorrhage (n=6), cerebral hemorrhage (n=4) and visceral aneurysm rupture (n=1) were diagnosable. In the suggestive group were malignant tumors (n=7), gastrointestinal bleeding/occlusion/perforation (n=7), and 2 other causes.

#### **CONCLUSION**

As PMCT images were diagnostic or suggestive in only 62 of 206 cases (30.1%) of natural death from OHCA, the diagnostic ability of PMCT must be improved.

#### **CLINICAL RELEVANCE/APPLICATION**

The low diagnostic ability of PMCT for identifying the cause of natural death from OHCA may require the development of contrast-enhanced- and dual-energy PMCT.

#### **M5B-SPER- T1 and T2 Signal Appearance of Intracranial Hemorrhage in Post-mortem Magnetic Resonance Imaging** 2

Wolf-Dieter Zech, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In forensic medicine, age estimation of intracranial hemorrhage can be crucial. Post-mortem MRI (PMMR) can be used as an alternative to autopsy in certain case constellations. In clinical MRI, age estimation of intracranial hemorrhage is based on differing signal behaviors of T1 and T2 over time as hemoglobin passes through different forms before red cell lysis and breakdown into ferritin and hemosiderin. In PMMR, post-mortem phenomena such as putrefaction, autolysis, temperature decrease, and biochemical degradation processes can influence MR signal appearance, particularly at longer post-mortem

intervals. So far, it is unknown, if intracranial hemorrhage of different ages appears with the same T1 and T2 signals known in the living and if post-mortem interval alters signal appearance. Therefore, the purpose of this study was to investigate the PMMR T1 and T2 signal behavior of intracranial hemorrhage of different age stages at different post-mortem intervals and to compare it to the known signal behavior in the living.

## **METHODS AND MATERIALS**

N=200 forensic cases (110 male, 90 female, mean age 54 years) with intracranial hemorrhage due to traumatic injury or natural causes were investigated. Post-mortem interval (time from death to imaging) ranged from 12 h to 21 days. 3 Tesla T1 and T2 weighted unenhanced PMMR of the head was conducted before the autopsy. Age estimation of intracranial hemorrhage (hyperacute: < 12 h, acute: 12-48 h, early subacute: 2-7 d, late subacute: 8 d - 1 month, and chronic: > 1 month) was performed based on autopsy and histology findings as well as medical records. Two observers blinded for autopsy results and medical records evaluated the T1 and T2 signal appearance of intracranial hemorrhage in PMMR. Hemorrhage signal appearances were assigned to the corresponding age estimations. PMMR results were compared to known clinical MRI signal behavior in living patients.

## **RESULTS**

The following PMMR T1 and T2 signal appearances were observed for different age stages of intracranial hemorrhage: hyperacute: T1 isointense, T2 hyperintense; acute: T1 isointense to hypointense, T2 hypointense; early subacute: T1 hyperintense, T2 hypointense; late subacute: T1 hyperintense, T2 hyperintense; chronic: T1 hypointense, T2 hypointense. The observed signal appearance did not differ from the known signal appearance of living persons. Longer post-mortem intervals of up to 21 days did not significantly alter signal appearance.

## **CONCLUSION**

In a post-mortem interval of up to 3 weeks, PMMR T1 and T2 signal behavior of intracranial hemorrhage of different age stages are the same as in the living.

## **CLINICAL RELEVANCE/APPLICATION**

T1 and T2 post-mortem MRI of the head can be used as an alternative to autopsy for age estimation of intracranial hemorrhage.

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## Abstract Archives of the RSNA, 2023

M5B-SPGI

### Gastrointestinal Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPGI- Gd-EOB-DTPA MRI-based Severity Classification and Prognosis in Fontan-Associated Liver Disease** 1

Atsushi Yamamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Fontan procedure for congenital single ventricle improves prognosis in childhood but is not a curative treatment. The prognosis in the long-term period after Fontan procedure is extremely poor compared to other congenital heart diseases. This is due to liver injury caused by elevated central venous pressure, which is a feature of the Fontan circulation, and is now attracting attention as Fontan-associated liver disease (FALD). FALD frequently progresses to cirrhosis and develops hepatocellular carcinoma (HCC) despite the young age of the patient. Gd-EOB-DTPA MRI is an effective tool for detecting HCC, but the features of FALD have not been studied. We propose an Gd-EOB-DTPA MRI-based severity classification of FALD and its association with prognosis, including the development of HCC.

#### **METHODS AND MATERIALS**

Data of Gd-EOB-DTPA MRI for 44 patients (mean age, 25 years; female, 22) after Fontan procedure between January 2010 to April 2023 was retrospectively analyzed. The hepatocyte phase image at 15 minutes after Gd-EOB-DTPA injection was scored semi-qualitatively using the following four points. 1) The extent of low-signal reticular shadows extending from the subhepatic capsule with "reverse lobulation": 0, 1 or 2 points. 2) Liver marginal irregularity: 0 or 1 point. 3) Decreased liver-spleen signal ratio: 0 or 1 point. 4) Atrophy of entire liver: 0 or 1 point. Based on the summed scores, patients were classified as Grade-1 (0 or 1 point), 2 (2 points), 3 (3 points), or 4 (4 points or higher). The endpoint was a composite outcome consisting of HCC, intractable ascites, and heart failure (HF) hospitalization. The event-free survival was analyzed by Kaplan-Meier and log-rank test.

#### **RESULTS**

There were 11 Grade-1 patients, 18 Grade-2 patients, 8 Grade-3 patients, 7 Grade-4 patients. During a mean follow-up period of 60 months, the composite outcome occurred in 11 patients (6 cases of HCC, 3 cases of intractable ascites, and 2 cases of HF hospitalization). Nine of the 11 patients (82%) were in Grade-3 and 4 groups. Kaplan-Meier analysis revealed that patients with Grade-3 and 4 had significantly poorer prognosis than those with Grade-1 and 2 ( $p < 0.0001$ ).

#### **CONCLUSION**

Gd-EOB-DTPA MRI could classify the severity and predict prognosis of patients with FALD.

#### **CLINICAL RELEVANCE/APPLICATION**

This method is not as invasive as liver biopsy and has no sampling errors. It is suitable for surveillance of FALD in young subjects.

#### **M5B-SPGI- Staging Liver Fibrosis in Volunteers and Patients with Nonalcoholic Fatty Liver Disease with Intrinsic Shear Strain Measurement by 4D Phase-contrast MRI** 2

Amirhosein Baradaran Najjar, MSc, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic performance of intrinsic shear strain induced by pressure pulse and cardiac motion, measured by phase-contrast MRI, for the detection and staging of liver fibrosis in volunteers and patients with nonalcoholic fatty liver disease using liver biopsy as the reference standard.

## METHODS AND MATERIALS

This prospective cross-sectional study was institutional review board approved. The study included volunteers and patients with nonalcoholic fatty liver disease undergoing 3T MRI with a quantitative 4D phase contrast sequence with retrospective cardiac gating. The 3D displacement field during eight phases of the cardiac cycle were measured. Automated motion processing and masking techniques were used to extract the hepatic octahedral shear strain (OSS). The reference standard was fibrosis staging by liver biopsy. One-way ANOVA and receiver operating characteristic analyses were performed for normal categorized and dichotomized groups based on hepatic fibrosis stages, including F0 versus = F1, = F1 versus = F2, = F2 versus = F3, and = F3 versus F4. The area under the receiver operating characteristic curve (AUC) was reported for each dichotomization of fibrosis stages.

## RESULTS

The study included 11 volunteers and 24 patients. Mean values of OSS decreased with higher fibrosis stage, with a mean of  $0.15 \pm 0.08$  (standard deviation) for F0,  $0.12 \pm 0.01$  for F1,  $0.07 \pm 0.01$  for F2,  $0.07 \pm 0.02$  for F3, and  $0.05 \pm 0.03$  for F4. The cardiac-induced strain measurements demonstrated high accuracy in discriminating NASH patients, with  $p < 0.01$  and F score 8.35 from one-way ANOVA and the area under ROC curves (AUC) of 0.87 for F0 vs. = F1, 0.96 for = F1 vs. = F2, 0.90 for = F2 vs. = F3, and 0.90 for = F3 vs. F4.

## CONCLUSION

The study demonstrated a significant decrease in the liver's OSS with increasing fibrosis stage.

## CLINICAL RELEVANCE/APPLICATION

The study found that intrinsic shear strain measured by, standard phase-contrast MRI, without the use of any external actuation, has the potential to be a noninvasive diagnostic tool for detection and staging liver fibrosis.

## M5B-SPGI- Depiction of Lymphatic Pathway in Fontan Circulation Using Gd-EOB-DTPA Magnetic Resonance Lymphangiography

Michinobu Nagao, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Although postoperative mortality rates in congenital single ventricle patients after the Fontan procedure have dramatically improved, the long-term mortality rates have remained high compared to those in patients with other types of congenital heart disease. In the Fontan circulation, congestive liver and lymphatic congestion caused by elevated central venous pressure become permanent, resulting in cirrhosis, refractory ascites, and protein-losing enteropathy. These complications are considered poor prognostic factors as Fontan-associated liver disease (FALD). Gadolinium ethoxybenzyl diethylenetriamine pentaacetic acid (Gd-EOB-DTPA) MRI is expected to detect hepatocellular carcinoma (HCC) that develops in FALD. We attempt to depict abnormal lymphatic pathway in FALD using Gd-EOB-DTPA MRI and propose a classification of their severity.

## METHODS AND MATERIALS

Fifty-two patients (mean age, 25 years) after Fontan procedure who underwent Gd-EOB-DTPA MRI for evaluation of the FALD were enrolled. MR lymphangiography was scanned using three-dimensional heavily T2-weighted imaging with a 3-tesla scanner 10 minutes after Gd-EOB-DTPA administration. This sequence takes advantage of the T2 shortening effect of Gd-EOB-DTPA to suppress the bile duct and vessel's signals, thereby enhancing the lymphatic pathway. Based on the extent of lymphatic tract involvement in the abdomen, patients were classified into the following three categories; Grade 0: no lymphatic pathway, Grade 1: the presence of lymphatic pathway mainly around the bile duct and liver surface, Grade 2: lymphatic pathway extended from the spine to the inferior vena cava periphery. Refractory ascites, protein-losing enteropathy, development of HCC, and hospitalization for heart failure were used as composite outcomes and contrasted with lymphangiographic findings.

## RESULTS

In MR lymphangiography, 20 patients were Grade 0, 17 were Grade 1, and 15 were Grade 2. 16 patients had composite outcomes, including 10 with HCC, 4 with refractory ascites, and 2 with heart failure hospitalization. Grade 0 patients had no events (0/20), whereas Grade 1 and Grade 2 patients had the adverse events in 53% (9/17) and 47% (7/15) of patients, respectively.

## CONCLUSION

A novel technique, MR lymphangiography with Gd-EOB-DTPA, demonstrates the localization and extent of the abnormal lymphatic pathways in Fontan circulation. The lymphangiographic grade is associated with the adverse events in FALD.

## CLINICAL RELEVANCE/APPLICATION



This MR lymphangiography can be added as one of Gd-EOB-DTPA contrast protocol and does not extend the overall examination time.

## **M5B-SPGI- 4 A Rules-Based Algorithm for Extracting Structured Clinical Data from Liver CT Free-Text Radiology Reports**

Saif Zaman, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

A large proportion of patients throughout the world have undiagnosed liver disease. Given the abundance of data found in radiology reports, they represent an untapped source to study patients with liver disease. Oftentimes it may be arduous to manually sift through patient-level data. As such, validated methods to study these patients and associated radiology reports are needed. Here we present a rules-based algorithm that determines the presence or absence of liver pathologies from unstructured radiology reports for CT liver scans.

### **METHODS AND MATERIALS**

Three common diagnosis of liver pathologies were selected for this study, namely focal liver lesions, steatosis and cirrhosis. A data dictionary was created to identify phrases that describe these diagnoses in a radiology report. Data mining and dictionary generation was done by a gastroenterologist treating these liver conditions for more than 20 years at the James A Haley VA Hospital. A random subset of liver CT reports (n = 100) of patients with a liver-related complaint were extracted and split into training and testing sets (65 and 35 patients, respectively). Ground truth values for the presence or absence of three liver pathologies were manually annotated, specifically for focal liver lesions, cirrhosis, and steatosis. A rules-based algorithm was leveraged using the two phase sentence analysis for radiology label extraction (SARLE) method: (1) remove phrases and handle negations and (2) link remaining terms to liver pathologies. The algorithm's performance was assessed using accuracy, sensitivity, and specificity.

### **RESULTS**

On the test set, the algorithm had an average accuracy across all 3 pathologies of 99.25% (95% CI: 98.76% to 99.65%), sensitivity of 84.21% (68.75% to 93.98%), and specificity of 99.68% (95% CI: 99.25% to 99.89%). Across the 100 patients, the reports of 90 patients were perfectly extracted for all 3 attributes.

### **CONCLUSION**

We demonstrate high performance of a rules-based algorithm to extract tabular data information from free text reports of liver CT scans. Our tool performed well in identifying patients with focal liver lesions, steatosis, and cirrhosis, as benchmarked by an expert gastroenterologist.

### **CLINICAL RELEVANCE/APPLICATION**

This tool may be useful in developing new machine learning approaches to predict outcomes in liver and other abdominal conditions. Additionally this method may serve as a first step towards identifying the natural language used in radiology reports for future machine learning implementations.

## **M5B-SPGI- 5 Staging of Liver Fibrosis Assessed by Quantification of Hepatic Extracellular Volume Obtained by Dual-energy CT Would be Easier-to-Access than Previous**

Kumi Ozaki, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To assess the validity of 3-min equilibrium-phase CT images compared to 5-min equilibrium-phase images in the quantification of hepatic extracellular volume fraction (ECV) obtained by dual-energy CT.

### **METHODS AND MATERIALS**

A total of 80 patients (45 men and 35 women, mean age, 69.3 + 10.4 years) who underwent both 3- and 5-min equilibrium-phase CT images to assess the focal liver lesions, that were suspected of hepatic hemangioma or intrahepatic cholangiocarcinoma between January 2020 and July 2022. The iodine densities of the hepatic parenchyma and aorta were measured and ECV was calculated. Comparisons of value of ECV of each phase, and the relation with fibrosis-4 index (Fib4) and albumin-bilirubin (ALBI) grade were then statistically analyzed.

### **RESULTS**

There was no significant difference in value of ECV of 3- and 5-min equilibrium-phase CT images ( $p = 0.056$ ). ECV of 3- and 5-min showed a strong or moderate correlation with ALBI grade (Spearman's  $\rho$ ; 0.763, 0.724, respectively). The correlation with Fib4 was similar to each ECV (Spearman's  $\rho$ ; 0.537, 0.571, respectively).



## CONCLUSION

ECV value and the correlation with ALBI grade and Fib4 were not significantly different, and ECV of 3-min equilibrium-phase CT images is clinically acceptable.

## CLINICAL RELEVANCE/APPLICATION

Validity of ECV of 3-min equilibrium-phase CT image can facilitate the prevalence of staging of liver fibrosis assessed by ECV because it can be obtained within routine dynamic contrast examination.

## M5B-SPGI- Establishing the Evaluation Model for Liver Cirrhosis Based on CT Radiomics Characteristics of Different Liver Segments 6

Liqin Zhao, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the performance of evaluating liver cirrhosis by radiomics characteristics of different liver segments in contrast-enhanced CT portal vein phase images.

### METHODS AND MATERIALS

154 cases with clinically confirmed liver cirrhosis were included in the study group and 150 cases with normal liver findings in the control group. All patients underwent enhanced liver CT on a GE discovery CT 750 HD. The portal phase CT images were selected for analysis, and two radiologists used a commercial radiomics software (Shukun Radiomics V94) to outline different liver segments on the slice of portal vein left branch into four regions of interest (ROI): S1, S2/3, S4 and S7/8; Intraclass correlation coefficient was calculated to test the inter-group consistency. Patients were randomly divided into training set and testing set at a ratio of 7:3, the radiomics characteristics (first-order features, shape features and texture features) of each ROI were extracted. After dimensionality reduction, the radiomics features with the most predictive performance were selected to establish the evaluation model of liver cirrhosis. The area under curve (AUC) was used to evaluate the performance of the model.

### RESULTS

The two radiologists had good consistency ( $ICC > 0.75$ ). Five, 6, 6 and 6 radiomics features were used for modeling of liver segment S1, S2/3, and S4 and S7/8, respectively. The AUC, accuracy, sensitivity and specificity were 0.948, 0.931, 0.955 and 0.908 in the training set; and 0.928, 0.896, 0.912 and 0.879 in the testing set, respectively for S1; 0.958, 0.924, 0.955 and 0.892 in the training set; and 0.957, 0.881, 0.912 and 0.848 in the testing set, respectively for S2. 0.974, 0.924, 0.940 and 0.908 in the training set; and 0.964, 0.910, 0.941 and 0.879 in the testing set, respectively for S4, and 0.948, 0.908, 0.909 and 0.908 in the training set; and 0.955, 0.910, 0.941 and 0.879 in the testing set, respectively for S7/8

## CONCLUSION

Good evaluation models of liver cirrhosis may be established using different liver segments, and the model established in the left medial segment gives the highest AUC.

## CLINICAL RELEVANCE/APPLICATION

Good evaluation models of liver cirrhosis may be established using different liver segments, and the model established in the left medial segment gives the highest AUC.

## M5B-SPGI- Prediction of Lymph Node Metastasis of Progressive Gastric Adenocarcinoma Nodes with a Short-Axis Diameter of $\geq 6$ mm 7

Yang You (*Presenter*) Nothing to Disclose

### PURPOSE

To explore the value of the features of lymph nodes (LN) with a short-axis diameter = 6 mm in prediction of lymph node metastasis (LNM) in advanced gastric adenocarcinoma (GAC) based on dual-energy CT (DECT) radiomics.

### METHODS AND MATERIALS

Data of patients with GAC who underwent radical gastrectomy and LN dissection were retrospectively analyzed. To ensure the correspondence between imaging and pathology, metastatic LNs were only selected from pN3 patients, nonmetastatic LNs were selected from pN0 patients, and the short-axis diameters of the enrolled LNs were all =6 mm. The traditional features of LNs were recorded, including short-axis diameter, long-axis diameter, long-to-short axis ratio, position, shape, density, edge and the degree of enhancement, and univariate and multivariate logistic regression analyses were used to establish a clinical model. Radiomics features at the maximum level of LNs were extracted in venous phase equivalent 120 kV linear fusion images and iodine maps. Intraclass correlation coefficients and the Boruta algorithm were used to screen significant features, and random forest was used to build a radiomics model. The traditional features with statistical significance in univariate analysis and radiomics scores (Rad-score) were included in multivariate logistic regression analysis to construct a

combined model. ROC curve and DeLong test were used to evaluate and compare the diagnostic performance of the models. DCA was used to evaluate the clinical benefits of the models.

## RESULTS

This study included 114 metastatic LNs from 45 pN3 patients and 65 nonmetastatic LNs from 28 pN0 patients. The samples were divided into a training set (n=125) and a validation set (n=54) at a ratio of 7:3. Long-axis diameter and LN shape were independent predictors of LNM and were used to establish the clinical model. 27 screened radiomics features were used to build the radiomics model. LN shape and Rad-score were independent predictors of LNM and were used to construct the combined model. Both the radiomics model (AUC of 0.986 and 0.984) and the combined model (AUC of 0.970 and 0.977) outperformed the clinical model (AUC of 0.772 and 0.820) in predicting LNM in both the training and validation sets. DCA showed superior clinical benefits from the radiomics and combined models.

## CONCLUSION

The models based on LNs DECT radiomics features, or combined traditional features have high diagnostic performance in determining the nature of each LN with a short-axis diameter of  $\geq 6$  mm in advanced GAC.

## CLINICAL RELEVANCE/APPLICATION

The models have important clinical value in the preoperative judgment of N staging, individualized treatment plans and prognosis of patients.

## M5B-SPGI- The Spectral Parameters Measured by Fast kVp Switching Dual-Energy CT: The Association with Ki-67 Expression in Hepatocellular Carcinoma

Caiyun Li, BMedSc, BS (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the correlation between spectral parameters obtained from contrast-enhanced spectral CT scanning and Ki-67 expression in hepatocellular carcinoma (HCC).

## METHODS AND MATERIALS

91 HCC patients with hepatitis complicated underwent both pathological examination and two-phase contrast-enhanced CT scanning with spectral imaging mode were included in this study. Then water- and fat-based material decomposition images as well as virtual monochromatic images acquired at energies ranging from 100 to 140 keV were reconstructed. Region of interest (ROI) was placed on the lesion, and water and fat density ( $D_{water}$ ,  $D_{fat}$ ), CT values at monochromatic energy images (HU<sub>100-140keV</sub>), as well as effective atomic number were measured. The effective atomic number for lesions was normalized by those for aorta to derive normalized atomic number ( $N_{eff-Z}$ ). Ki-67 expression level was determined by Ki-67 positivity rate according to immunohistochemistry analysis. Pearson coefficient was used to analyze the correlation between spectral parameters and Ki-67 positivity.

## RESULTS

The  $N_{eff-Z}$ , HU<sub>100-140keV</sub>, water and fat density were positively and fairly correlated with the Ki-67 expression, and correlation coefficient  $r$  (P value), were 0.324 (P = 0.002), 0.252-0.358 (P = 0.016-0.001), 0.415 (P <0.001) and 0.293 (P = 0.005), respectively. Particularly,  $D_{water}$  showed strongest correlation with Ki-67 expression. Additionally, the correlation between CT value and Ki-67 was enhanced gradually with the increase of monochromatic energy (100keV to 140keV).

## CONCLUSION

Conclusion: The  $N_{eff-Z}$ , HU<sub>100-140keV</sub>, water and fat density obtained from spectral scanning on dual-energy CT exhibited positive and fair correlation with Ki-67 expression.

## CLINICAL RELEVANCE/APPLICATION

Ki-67 was a significant marker for HCC prognosis and clinical decision, however current method to evaluate Ki-67 always needs surgery, which is detrimental for assessing patients who lost surgery chance. Spectral scanning on Dual energy CT provides a new noninvasive method and various parameters to evaluate Ki-67 (indicative of proliferative activity) expression in HCC, which is valuable for clinical diagnosis and treatment.

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## Abstract Archives of the RSNA, 2023

M5B-SPGU

### Genitourinary Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPGU- The Additional Value of Pseudocapsule for Clear Cell Likelihood Score v2.0 in Predicting Small Renal Masses: A Multicenter Retrospective Study** 1

Yuwei Hao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to explore the additional value of pseudocapsule for clear cell likelihood score v2.0 (ccLS v2.0) in diagnosing small renal masses (SRM) and develop a modified clear cell likelihood score (m-cCLS) for predicting malignancy.

#### **METHODS AND MATERIALS**

In this study, clinical data and MR images of patients with pathologically confirmed solid SRM were retrospectively collected from three academic medical centers between January 1, 2019 and December 31, 2021. All patients were divided into a training group (n = 235), an internal validation group (n = 60), and an external validation group (n = 57). Two junior radiologists independently evaluated whether SRM had pseudocapsule, other MRI features and the ccLS scores according to ccLS v2.0, respectively. Disagreements were resolved by two senior radiologists who reached an agreement. The risk prediction value of pseudocapsules and the ccLS scores in ccRCC and malignant tumors were analyzed using the logistic regression model. M-cCLS was established and calibration curves were drawn to evaluate the consistency of m-cCLS predictions with pathological findings. The diagnostic performance of m-cCLS and ccLS v2.0 was evaluated by drawing ROC and the percentage of ccRCC and malignant tumors in each score was compared using ccLS v2.0 and m-cCLS. The net reclassification index (NRI) and integrated discrimination improvement (IDI) were calculated.

#### **RESULTS**

352 patients (248 males, 104 females; mean age, 54±12 years) with 358 renal masses were identified. The evaluation results of SRM revealed that pseudocapsule had the additional value for ccLS v2.0 evaluation of ccRCC and malignant tumors ( $P < 0.001$ ). M-cCLS showed a good interobserver agreement in predicting ccRCC and malignant tumors ( $P > 0.05$ ). The diagnostic performance of m-cCLS for ccRCC was comparable to ccLS v2.0 ( $P > 0.05$ ). Compared with ccLS v2.0, the AUC of m-cCLS for diagnosing malignant tumors increased from 0.772 (95%CI: 0.714-0.824), 0.801 (95%CI: 0.680-0.892) and 0.645 (95%CI: 0.507-0.767) to 0.848 (95%CI: 0.796-0.891), 0.887 (95%CI: 0.781-0.953) and 0.716 (95%CI: 0.581-0.827) among three groups, respectively. M-cCLS could achieve the prediction of benign and malignant tumors (the percentage of malignant tumors in m-cCLS 1-5 scores was 19.5%, 31.5%, 72.5%, 91.1%, and 100.0%, respectively). Among three groups, the NRI and IDI of m-cCLS were higher than those of ccLS v2.0.

#### **CONCLUSION**

Pseudocapsule had the additional value for ccLS v2.0 in the diagnosis of SRM. M-cCLS has great diagnostic performance and improvement for ccRCC and malignant tumors and could predict benign and malignant tumors of SRM.

#### **CLINICAL RELEVANCE/APPLICATION**

M-cCLS may prove to be a valuable tool for the future non-invasive evaluation of renal tumors.

#### **M5B-SPGU- CT-based Potential Predictor for CKD-free Survival after Partial Nephrectomy in Patients with Small RCC** 2

Seong Min Ahn, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate prognostic utility of 3D remaining functional parenchyma (RFP) extracting post-operative kidney CT in predicting chronic kidney disease (CKD)-free survival after partial nephrectomy (PN) in patients with small RCC.

## **METHODS AND MATERIALS**

A retrospective analysis was carried out of 331 patients who underwent PN for clear cell RCC (less than 5cm) between September 2006 and September 2020. In order to construct a predictive model for CKD-free survival probability after PN, multivariable Cox regression analysis was carried out adding 3D volume of RFP extracting from the post-operative kidney CT to clinical parameters proven to have an impact on postoperative renal function such as eGFR, age, or perioperative variables.

## **RESULTS**

The median age was 53 years, median tumor size was 3.4 cm. A total of 18 patients (5.4%) developed new-onset CKD at a median follow up of 35 months. The CKD-free survival rates at 1, 3, 5 and 7 year were 97.5%, 97.2%, 96.1% and 94.5%, respectively. On univariable Cox regression analysis, age (hazard ratio 1.097, P = 0.0001), Charlson Comorbidity Index (hazard ratio 1.728, P = 0.0001), hypertension (hazard ratio 4.792, P = 0.0017) and Furhmann\_grade (hazard ratio 2.828, P = 0.0086) were independent predictors for new-onset CKD. The C-index for CKD-free survival prediction with clinical parameters along was 0.8358. The addition of 3D RFP improved the C-index to 0.8525 (p =0.0405).

## **CONCLUSION**

Addition of 3D RFP values to standard clinical factors improves CKD-free survival prediction after PN in patients with small RCC. Using this model, RFP could be a reliable method for preoperative prediction of prognosis in PN.

## **CLINICAL RELEVANCE/APPLICATION**

The revised prediction model adding 3D imaging parameters might have an important role in partial nephrectomy decision-making and follow-up plan after surgery in patient with RCC.

## **M5B-SPGU- Automatic Segmentation of Renal Tumors: A Novel Visualization Approach**

3

Sophie Bachanek, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To establish an automatic segmentation algorithm and visualisation method for solid renal tumors that utilizes CT-studies acquired in clinical practice and multireader input.

## **METHODS AND MATERIALS**

Renal tumor patients diagnosed 2018-2021 were retrospectively assessed. Inclusion criteria were CT-imaging of renal tumors in corticomedullary or nephrogenic contrast media (CM/NG) phase. Patients with cystic or infiltrative renal tumors and age <18 years were excluded. Manual segmentation of the tumors was performed on all axial CT slices and used for training of a convolutional neural network (UNET). In an independent validation dataset, the accuracy of the UNETs predictions of renal tumor contours was compared to manual segmentations (quantified by DICE score).

## **RESULTS**

n=394/n=350 patients in CM/NG phases were included (median age 66 years; 35% female; median tumor diameter 5.4cm). CT-studies from >20 radiological imaging centers were included with different imaging protocols and slice thickness. The UNET was trained on n=316 CM/ n=294 NG contrast phase patients (n=7019 / n=6859 CT images). In the independent validation dataset (n=78 / n=56 patients with 1713 / 1298 CT images), the UNET achieved a DICE score of 0.88 and 0.90 for the corticomedullary and nephrogenic CM phase, respectively. The UNET predictions were visualized using a tile-based approach with color-coding and contour-lines that could be overlaid on CT-images to depict varying levels of prediction confidence.

## **CONCLUSION**

A UNET yields a robust automatic delineation of renal tumors on CT-images acquired in clinical routine, irrespective of the contrast media phase. Color-coding and contour-lines can be overlaid on original CT-images to provide visual feedback of UNET segmentations and confidence levels.

## **CLINICAL RELEVANCE/APPLICATION**

Automatic renal tumor segmentation using UNETs robustly performs on heterogeneous clinical CT data. Color-coding provides an explainable approach to model predictions and might improve acceptance in clinical practice.

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## Abstract Archives of the RSNA, 2023

M5B-SPHN

### Head & Neck Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPHN- Evaluation and Survival Prediction for A Novel Fully Automatic System for Lymph Node Segmentation and Counting in Nasopharyngeal Carcinoma Using Multimodal MRI**

Hui Xie (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The accurate segmentation and counting of lymph nodes (LNs) is essential for the structured reporting and prognostic diagnosis of nasopharyngeal carcinoma. As such, developing a fully automatic system for accurate LNs segmentation and counting in nasopharyngeal carcinoma patients is of great clinical significance for the accurate prognostic analysis of this disease

#### **METHODS AND MATERIALS**

First, we proposed a multimodal LNs segmentation model based on T1-weighted, contrast-enhanced T1-weighted, and T2-weighted MRI images, which named NPCnet. We then developed a fully automatic algorithm for LNs counting and combined it with the segmentation model to create a comprehensive system called the Fully Automatic Lymph Node Counting System (AMLNC). The accuracy and practical value of our system were evaluated by comparing its performance metrics (Interclass Correlation Coefficient (ICC) and Bland-Altman plot) with those of detailed MRI assessment (gold standard) and automatic counting using manual delineation (MDAC). Finally, we analyzed the relationship between the LNs count and the prognostic outcomes of the patients, such as Overall Survival (OS), Progression-free Survival (PFS), and Distant Metastasis-free Survival (DMFS)

#### **RESULTS**

we retrospectively analyzed the data of 995 patients and divided them into training and validation datasets at a ratio of 7:3 for constructing the segmentation model. The mean DICE similarity coefficient in the validation set of 298 cases was 0.771. We selected 20 cases randomly for manual repeat delineation, and there was no statistically significant difference in the mean DICE between automatic segmentation and manual delineation (0.785 vs 0.806,  $p = 0.068$ ). The median (IQR) LNs counts for the gold standard, AMLNC, and MDAC were 3 (2-4.074), 4 (2-4.581), and 4 (2-5.513), respectively. The ICC showed that the AMLNC had good repeatability (0.778 (Gold vs AMLNC), 0.638 (Gold vs MDAC), and 0.739 (AMLNC vs MDAC)). Furthermore, we selected 40 cases randomly for manual reading repeatedly, and the ICC still showed that the AMLNC system had good repeatability (0.805 (Gold vs AMLNC), 0.663 (Gold vs manual MDAC), and 0.672 (Gold vs Gold repeatedly)). The Bland-Altman plot displayed good agreement between the AMLNC and the gold standard. We divided all patients into low (1-4 positive LNs), moderate (5-9), and high (>9) risk groups, and the K-M plots showed a great discriminating ability for OS, PFS, and DMFS using AMLNC

#### **CONCLUSION**

The AMLNC System in this study demonstrates good repeatability and reliability in its results and clinical survival prediction ability

#### **CLINICAL RELEVANCE/APPLICATION**

The AMLNC System can be directly used for structured reporting and survival prognosis analysis of nasopharyngeal carcinoma

#### **M5B-SPHN- MRI Radiomics Approach with Deep Transfer Learning for Distinguishing Sinonasal Malignancies: A Preliminary Study Based on Different Machine Learning Algorithms**

Naier Lin, MS (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the diagnostic performance of MRI hand-crafted (HC) radiomics features combined with deep transfer learning (DTL) features in distinguishing between sinonasal squamous cell carcinoma (SCC), adenoid cystic carcinoma (ACC) and non-Hodgkin's lymphoma (NHL) .

## METHODS AND MATERIALS

This retrospective analysis consisted of 50 patients with sinonasal SCC, 42 patients with NHL and 40 patients with ACC. Patients were allocated to training and testing cohorts randomly at a ratio of 8:2. HC radiomics features and DTL features were extracted from T2-weighted image (T2WI), apparent diffusion coefficient (ADC) and contrast-enhanced T1-weighted image (CE-T1WI). A ResNet50 convolutional neural network (CNN) pretrained model was used for DTL features extracting. The least absolute shrinkage and selection operator (LASSO) regression was applied for feature selection and radiomic signature (radscore) construction. The classification performance for detection of sinonasal SCC, ACC and NHL was compared between seven machine learning (ML) algorithms.

## RESULTS

The radscore included 24 HC radiomics features and 8 DTL features. Algorithm of SVM showed the best performance with the highest accuracy (92.6%) in the testing cohort. ROC analysis indicated that the macro-average AUC and micro-average AUC values of SVM were 0.98 and 0.99. AUCs for diagnosis of ACC, NHL, SCC were 0.99, 0.97 and 1.00, respectively. Besides, KNN and XGBoost algorithms also provided better results with both the macro-average and micro-average AUC values > 0.90.

## CONCLUSION

Three-MRI sequence-based HC radiomics features and DTL features combined with SVM model improved differentiation between sinonasal SCC, NHL and ACC.

## CLINICAL RELEVANCE/APPLICATION

The tumor biological behaviors and therapeutic schedules of SCC, ACC and NHL are different. As a noninvasive and convenient method, the MRI radiomics approach with deep transfer learning represented an opportunity to advance precise prediction for the type of sinonasal malignancies preoperatively and assist in making appropriate treatment and improving the prognosis.

## M5B-SPHN- Radiomics Analysis for the Prediction of Locoregional Recurrence of Locally Advanced Oropharyngeal Cancer and Hypopharyngeal Cancer

Te-Chang Wu, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

By radiomic analysis of the postcontrast CT images, this study aimed to predict locoregional recurrence (LR) of locally advanced oropharyngeal cancer (OPC) and hypopharyngeal cancer (HPC), that carry high LR rate >50% and poor overall survival rate <50%.

## METHODS AND MATERIALS

From two independent cohorts, this retrospective study enrolled 194 patients with stage III-IV OPC or HPC according to the 7th edition of the American Joint Committee on Cancer. These patients were randomly split into a training cohort with 153 cases (80%) and a testing cohort with 39 cases (20%). Only the primary tumor mass was segmented manually for the radiomic analysis. Radiomic features were extracted using PyRadiomics, and then the support vector machine (SVM) was used to build the radiomic model with a 5-fold cross-validation process in the training dataset. For each case, a radiomics score was generated to indicate the probability of LR.

## RESULTS

Within a follow-up period of 2 years, there were 94 patients with LR assigned in the progression group and 98 patients without LR assigned in the stable group. There was no significant difference in clinical TNM staging, treatment strategies, and common risk factors between these two groups. For the training dataset, the radiomics model to predict LR showed 83.7% accuracy and 0.832 (95% CI: 0.72, 0.87) area under the ROC curve (AUC). For the test dataset, the accuracy and AUC slightly declined to 79.5% and 0.770 (95% CI: 0.64, 0.80), respectively. The sensitivity/specificity of the training and test dataset for LR prediction were 77.6%/ 89.6%, and 66.7%/ 90.5%, respectively.

## CONCLUSION

The proposed image-based radiomic approach could provide a reliable prediction model of LR in locally advanced OPC and HPC with high accuracy and specificity. Early identification of those prone to post-treatment recurrence would be helpful for appropriate adjustments to treatment strategies and posttreatment surveillance.



## CLINICAL RELEVANCE/APPLICATION

For locally advanced oropharyngeal and hypopharyngeal cancers with high recurrence rates and poor prognoses, we demonstrated that an image-based radiomic model might potentially identify those prone to post-treatment recurrence with high accuracy and high specificity. Pending the future validation in a large cohort, it is expected to provide an opportunity to make appropriate adjustments to the treatment choices (concurrent chemoradiation therapy vs. surgery with adjuvant treatment), post-treatment imaging interval (6 weeks vs. 12 weeks), chemoradiotherapy treatment protocols, and the patient's rehabilitation plan, psychological support, and social care resource allocation.

### **M5B-SPHN- Assessment of a Commercially Available Artificial Intelligence Algorithm for Risk Stratification of Thyroid Nodules: Diagnostic Performance at a Tertiary Academic Center**

5

Jeffrey R. Ashton, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the diagnostic performance of a commercially available, artificial intelligence-based software platform for risk stratification of thyroid nodules on ultrasound (US). This tool was recently FDA approved and no external validation studies have been published to date evaluating its clinical performance.

#### **METHODS AND MATERIALS**

This retrospective study included all thyroid US examinations containing thyroid nodules over a 1-year period at a large academic medical center. Nodules were included if they had a ground truth diagnosis by: a) surgical pathology, b) fine needle aspiration, or c) three-year follow up US showing stability. The cohort included 650 nodules from 348 patients. An FDA-approved, AI-based software tool (Koios DS Thyroid, Koios Medical) was applied to the images for each nodule. The Koios algorithm generates two primary outputs: 1) ACR TI-RADS nodule descriptors with TI-RADS score and follow up recommendation, and 2) an optional AI adaptor score which can adjust the risk assessment and recommendation based on the overall AI analysis of the images. Four different groups were compared: 1) AI software with AI adaptor enabled, 2) AI software without the AI adaptor, 3) clinical radiology reports (using ACR TI-RADS), and 4) radiology reports combined with AI adaptor score. Diagnostic performance of the final recommendations (FNA or no FNA) was determined based on the ground truth, and comparison between the four groups was made using sensitivity, specificity, and AUROC analysis.

#### **RESULTS**

Diagnostic performance of the AI algorithm with the AI adaptor tool enabled was similar to the performance of the clinical radiologists (AUC 0.70 for both). The algorithm + adaptor had improved specificity compared to radiologists (0.63 vs 0.43) but decreased sensitivity (0.69 vs 0.81). Without the AI adaptor enabled, performance of the algorithm was slightly worse (AUC 0.65), while the best performance was seen when the radiology interpretation was combined with the AI adaptor (AUC 0.76). When combined with the AI adaptor, radiologist specificity improved from 0.43 to 0.53, resulting in 17% fewer FNA recommendations, with unchanged sensitivity (0.81).

#### **CONCLUSION**

The Koios DS algorithm demonstrated standalone performance similar to that of radiologists, though with lower sensitivity and higher specificity. Performance was best when radiologist interpretations were combined with the AI adaptor component, which led to improved specificity and a reduction in unnecessary FNA recommendations.

## CLINICAL RELEVANCE/APPLICATION

AI software can improve thyroid US diagnostic performance and reduce unnecessary procedures. Workflow may also be improved through automated generation of TI-RADS scores, though performance is highest with human input.

### **M5B-SPHN- FaBoA: Computed Tomography-based Facial Bone Fracture Analysis Solution**

7

Hyun-Soo Choi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Facial bone fractures must be diagnosed and treated as early as possible to avoid complications and sequelae. Computed Tomography (CT) images are essential for accurate diagnosis and treatment planning, but analyzing these images is time-consuming and requires specialized expertise. While many classification and object detection studies have been conducted to address these issues, their limitations have hindered their widespread clinical use. The ability of classification-based studies to pinpoint the exact location of fractures is limited, while object detection-based research is challenging due to the ambiguity of the shape of a fracture. To address these challenges, we propose a deep learning-based facial bone fracture diagnosis system named FaBoA.

#### **METHODS AND MATERIALS**

FaBoA was trained on a dataset of 6,294 CT scans with facial bone fractures acquired from January 2009 to March 2020. Experienced expertise manually annotated facial fractures with bounding boxes on all the datasets. Our deep learning model

was evaluated on an additional 346 CT scans. We used deep learning-based object detection for the initial detection and class activation-based weakly-supervised segmentation for pixel-wise fine-grained localization.

## **RESULTS**

FaBoA achieved sensitivity and specificity were 100% and 84.2%, respectively, for nasal bone fractures. The sensitivity and specificity of all types of facial bone fractures were 81.3% and 70.5%, respectively. Furthermore, FaBoA can visualize fine-grained 3D fractures using the localization technique.

## **CONCLUSION**

FaBoA is a reliable and accurate CT-based facial bone fracture analysis solution that has the potential to assist radiologists in the diagnosis and treatment of facial bone fractures, leading to better patient outcomes. The combination of object detection and class-activation-based localization enables FaBoA to accurately detect and classify bone fractures with high sensitivity and specificity. In addition, FaBoA includes not only the diagnosis model but also a user-friendly interface that allows doctors to interact with the solution and access the analysis results easily. FaBoA can also be integrated into radiology workflows to enhance efficiency and reduce interpretation variability. The dataset used in this study, which spans over a decade of CT scans with facial bone fractures, provides a representative sample of real-world clinical cases and enhances the generalizability of the FaBoA model.

## **CLINICAL RELEVANCE/APPLICATION**

FaBoA's AI engine and user-friendly interface have the potential to assist in diagnosis, treatment planning, postoperative assessment, and monitoring of facial bone fractures, leading to better patient outcomes and workflow efficiency.

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## Abstract Archives of the RSNA, 2023

M5B-SPIN

### Imaging Informatics Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPIN- Scaling Temporal and Volumetric Datasets for Tumor Localization Without Per-Pixel Annotations** 1

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To examine whether AI trained using simple annotation strategies can achieve comparable or superior performance to that trained using per-pixel annotations in the context of computer-aided tumor detection.

#### **METHODS AND MATERIALS**

Two large-scale datasets were retrospectively collected for this study: SUN-SEG consists of 1,106 colonoscopy video clips for polyp detection, in which 49,136 frames are with polyps and 158,690 frames are without polyps. The video clips were split into training (507), validation (126), and test (473) sets. JHH contains 2,426 subjects collected and annotated at Johns Hopkins University for pancreatic tumor detection, where each subject was scanned by contrast-enhanced CT. We randomly split CT scans into training (1,683), validation (420), and test (323) sets. Tumors in both datasets were annotated on a per-pixel basis. We develop a new annotation strategy, simplifying the tumor annotation process to drag and drop (DragDrop). Furthermore, we designed a watershed-based weakly supervised learning method to leverage the DragDrop annotations and accommodate the high-dimensional temporal and volumetric data. Finally, we assessed Sensitivity, Specificity, Precision, and F1-score for tumor detection at both lesion and patient levels.

#### **RESULTS**

Given a certain annotation budget, our proposed DragDrop strategy improves the sensitivity, specificity, precision, and F1-score at the lesion-level for polyp detection when compared to per-pixel annotation, with improvements from 68% to 71%, 58% to 67%, 43% to 51%, and 54% to 59%, respectively. The patient-level results improve from 75% to 80%, 69% to 79%, 54% to 64%, and 62% to 66%, respectively. For pancreatic tumor detection, the results improve from 61% to 71%, 33% to 42%, 42% to 57%, and 52% to 61%, respectively. The patient-level results improve from 76% to 88%, 70% to 64%, 75% to 74%, and 61% to 73%, respectively. More importantly, for minority patients aged between 75 to 80 and 80 to 85, who only account for 7% and 3% of the JHH test set, our DragDrop improves lesion-level precision from 42% to 61%, and 45% to 60% and improves lesion-level F1-score from 55% to 72% and 59% to 75%.

#### **CONCLUSION**

Our proposed strategy reduced 87% and 99% annotation efforts for polyp and pancreatic tumor detection, respectively, and achieved a significantly better tumor detection rate than per-pixel annotations given an annotation budget.

#### **CLINICAL RELEVANCE/APPLICATION**

Simpler annotations demonstrate their advantages in scaling up datasets for tumor localization in comparison with per-pixel annotations. This not only improves accuracy and generalizability but also allows for better representation of underrepresented groups and identifying rare diseases that may be more prevalent in specific populations.

#### **M5B-SPIN- Early Prediction of Motor Abnormalities in Very Preterm Infants Using MRI Radiomic Data** 2 **with a Collaborative Self-Supervised Transformer Model**

Junqi Wang, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop a collaborative self-supervised learning (Co-SSL) deep learning model for predicting motor abnormalities in preterm infants using MRI radiomic data without large-scale annotated images.

## METHODS AND MATERIALS

Very preterm infants (gestational age =32 weeks) were enrolled in our institute, and axial T2-weighted MR images were collected on a 3T Philips Ingenia scanner. We processed T2 images using the Developing Human Connectome Project pipeline into 87 regions of interest (ROIs) and the PyRadiomics pipeline to extract 100 radiomic features for each ROI, resulting in a large radiomic feature map (87×100) for each subject. We assessed the motor abnormalities using Bayley III Motor score and dichotomized the infants into low-risk (score>85) vs. high-risk (score=85) groups. We developed a Co-SSL Transformer model for motor abnormalities prediction. Typical self-supervised learning (SSL) defines a pretext task to pretrain a model without using labels, then fine-tunes the model for the downstream real task. In contrast, our Co-SSL strategy uses two collaborative pretext tasks to jointly pretrain the model. Specifically, we first conducted data augmentation on N original subjects by randomly masking radiomic features of ROIs from radiomic feature maps, generating M augmented subjects. We defined two collaborative pretext tasks 1) Reconstruction- to reconstruct the masked radiomic features using the observable ones for all M subjects, and 2) Discrimination- to cluster M augmented subjects into N groups according to N original subjects. Using these two collaborative tasks, we pretrained a Transformer neural network to learn latent features without human labeling, and then fine-tuned this model for our motor abnormality prediction. Performance was assessed by 5-fold cross-validation.

## RESULTS

A total of 362 subjects were included in this study, out of which only 318 have Bayley III motor scores at 2 years corrected age. Our Co-SSL Transformer achieved a mean (standard deviation [SD]) accuracy of 76.3 (5.1)% and AUC of 0.73 (0.05), outperforming the supervised Transformer [accuracy = 66.6 (5.3)%, AUC=0.64 (0.05)], SimCLR [accuracy=67.3 (5.2)%, AUC=0.65 (0.07)], and Invariant [accuracy=68.3 (4.4)%, AUC=0.67 (0.08)].

## CONCLUSION

We showed that the proposed model outperformed peer self-supervised ones for early risk stratification of developing motor abnormalities assessed at 2 years corrected age.

## CLINICAL RELEVANCE/APPLICATION

Very preterm term infants are especially at increased risk of developing motor abnormalities compared to infants who were term born. Our AI strategy enables the early diagnosis of motor abnormalities using brain MRI radiomics without large-scale annotated datasets.

## M5B-SPIN- 3 Quantum Kernel Methods Can Improve Binary Classification of COVID-19 Pneumonia on Chest Radiographs

John D. Mayfield, MD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Chest radiography has continued to serve as the workhorse of initial screening and surveillance of patients diagnosed with COVID-19, however, the nonspecific and variable patterns of pneumonia limited diagnostic accuracy as a predictor of disease. Increasingly complex and robust datasets such as COVIDx CXR3 provide enriched training environments for machine learning (ML) models to help clarify diagnosis. However, the stochastic nature of the disease may benefit from emerging technologies that combine ML with quantum computing (QC), known as Quantum machine learning (QML). Here, we evaluate a Quantum Projected Kernel (QPK) method and compare its performance against classical ML methods.

## METHODS AND MATERIALS

8,000 chest radiographs were randomly selected from the COVIDx-CXR3 database and split 80:20 training:validation set as well as a hold-out testing set of 400 cases. The images underwent dimensionality reduction using UMAP and were encoded into a 11-qubit circuit. Google Cirq's Density Matrix simulator was utilized with realistic noise simulation that is based upon Google's Rainbow quantum processor. Kernel density matrices were optimized in a complex Hilbert space to provide greater separation between classes and then subsequently projected into spatial coordinate space. This processed data was then passed through a linear dense classifier layer where accuracy, f1-score, precision, recall, and sensitivity/specificity were calculated for cross-validation and hold-out testing sets.

## RESULTS

The model demonstrated an accuracy of 94% [95% CI: 87-95%] with an AUC of 0.94 [95% CI: 82-95%] and f1-score of 0.92. Performance on the holdout testing set yielded 84% accuracy, AUC of 0.83, with an f1-score of 0.84, precision of 81%, recall of 86%, and sensitivity and specificity of 87% and 81%, respectively.

## CONCLUSION

QPK methods demonstrated promising performance on a diverse database that generalized well to a hold-out testing set. However, further optimization and evaluations are required to assess its performance.

## CLINICAL RELEVANCE/APPLICATION

QML can provide a quantum advantage to the data to potentially improve robustness compared to classical architectures alone. Given the improved accessibility to cloud-based quantum machines, such approaches may increase productivity and reliability of classification strategies, easing the reliance on larger, more complex models.

### **M5B-SPIN- Joint Self-supervised and Supervised Contrastive Learning for Multimodal Brain MRI at Term: Towards Predicting Motor Impairments in Infants Born Preterm**

Zhiyuan Li, BS,MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop a joint self-supervised and supervised contrastive learning model using multimodal brain MRI at term-equivalent age to predict later motor impairments in infants born preterm.

#### METHODS AND MATERIALS

Data acquisition and pre-processing. This IRB approved study involves a multisite cohort of 297 preterm infants born before 33 weeks gestational age. T2-weighted structural MRI (sMRI), diffusion tensor imaging (DTI), resting-state functional MRI (fMRI), and clinical non-imaging data were collected for each subject. We preprocessed each subject using the Developing Human Connectome Project (dHCP) pipeline to segment the whole brain image into 87 regions of interest (ROIs) for the first three modalities. We further extracted radiomic features, structural connectome, and functional connectome from sMRI, DTI, and fMRI, respectively. Individual subjects underwent motor ability assessment using the Bayley-III Motor subtest at 2 years corrected age. We categorized infants into two groups based on their Motor score (range 40-160): high risk of (scores  $\leq 85$ ) or low risk of motor impairments (scores  $> 85$ ). Joint self-supervised and supervised contrastive learning. Our proposed model is shown in Figure 1. We first designed 5 feature extractors to extract feature embeddings from structural connectome, functional connectome, radiomic features, sMRI images, and clinical non-imaging features, respectively. Next, we pretrained all feature extractors by two pretext contrastive learning tasks, in which the first task was to learn the cross-modality-complementary features by clustering the feature types of an individual patient, and the second task was to learn cross-subject-similarity features by clustering the patient with the same class label. Finally, we fine-tuned the pre-trained network to solve the real task (i.e., risk stratification of motor impairments) in a supervised manner. We evaluated our model using 10-fold cross-validation.

#### RESULTS

Our model achieved an AUC of 0.73, outperforming the Siamese network (AUC=0.65) and Triplet network (AUC=0.68) models. In addition, our model also achieved better prediction performance than the single-modality models, such as the models using DTI (AUC=0.71) or fMRI (AUC=0.70).

#### CONCLUSION

We proposed a novel joint self-supervised and supervised contrastive learning model to predict later motor impairments in very preterm infants using multimodal MRI data. The results showed that our proposed model outperformed peer and single modality models, demonstrating the effectiveness of the designed approach.

## CLINICAL RELEVANCE/APPLICATION

The proposed model can facilitate deep learning-based applications for multimodal MRI data.

### **M5B-SPIN- Towards Patient Consumable Radiology Reports - Improving Content Signal-to-Noise Ratio (SNR) While Converting Medical Jargon to Plain English via GPT-4**

Ghulam Rasool, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

With the increasing complexity of imaging modalities and the trend toward higher-level structured reporting, radiology reports have become equally as complex and lengthier by default; becoming nearly incomprehensible to the average person (patient). Additionally, there are ongoing efforts to produce patient-consumable radiology reporting. However, we believe that improving radiologist report structure and content is a necessary first step to having consistently structured reports for clinician ease of reading. More concise reports with predictable fields in anatomically oriented top-down logical order more effectively convey meaning. We listed and further removed well-known unnecessary words (noise) common in radiologist reports that do not help convey meaning resulting in an easier-to-read objective report (signal). This was followed by prompting the resultant higher Signal-to-Noise Ratio (SNR) phrases to read in plain English.

#### METHODS AND MATERIALS

We first prompted GPT 4.0 (Generative Pretraining Transformer) to common radiologist phraseology that consistently slashed report length in half while maintaining content. Removed commonly used unnecessary words including: there is, of the, within the, visualized, measures, approximately, the patient, at this time. Second, we prompted GPT to convert the higher

SNR report text to active voice plain English understanding defined by established doctrine, e.g., SEC (Security and Exchange Commission Rule).

## RESULTS

Report content SNR was doubled (total words cut in half) following the removal of unnecessary words while maintaining meaning for physicians in a more inviting/easier-to-read structured format. Following prompting for improved SNR to read in plain English, the report content was explained in a manner for general public understanding. Example GPT input (37 words): "Nonobstructive renal calculus within the left kidney collecting system measuring approximately 0.4 to 0.5 cm in cross-sectional diameter. This renal calculus was present on prior CT, though it has enlarged compared to the previous study". Example GPT output (17 words): "Enlarged non-obstructive kidney stone in left collecting system measuring 0.4-0.5 cm, previously seen on CT." GPT plain English: This report shows that there is a small stone in your left kidney that is not causing a blockage. The stone is growing and has gotten a bit bigger since your last scan.

## CONCLUSION

We show that GPT-4 can significantly increase the SNR of the radiology report for both physicians and for patients.

## CLINICAL RELEVANCE/APPLICATION

Improving report content SNR leveraging GPT helps referring physicians radiologists report readability further converting to plain English completes radiology's service to our patients.

## M5B-SPIN- Quantifying the Technical Challenges and DICOM Metadata Variability in Stroke Machine Learning Data Curation

6

Peter Kamel, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Data curation is a challenging and often rate-limiting task in machine learning algorithm development. This is compounded by heterogeneity of DICOM metadata labeling and storage conventions, which often makes data curation require extensive preprocessing and manual cleaning. The purpose of this study was to quantify the variability in DICOM metadata labeling conventions and analyze the largest factors limiting data curation for the use case of machine learning on stroke CTs and MRIs.

## METHODS AND MATERIALS

We evaluated data curation on a set of stroke MRI-CT pairs consisting of DWI sequences from MRI and associated dual energy CT head with 120 kV and 190 keV virtual monochromatic images. From an initial list of 946 patients, we used DICOM queries to find the studies of interest, identify the b1000 DWI images and thick resolution axial 120 kV and 190 keV images, download the images from the PACS, anonymize them, and convert them to NIFTI file format for machine learning. During each step of the process, errors and limitations of data curation were recorded, characterized, and quantified.

## RESULTS

In the 946 MRI examinations we found 1,122 unique Series Descriptions, of which over 20 were used to identify the DWI sequence, due to varying labeling and storage conventions (Figure 1a). Multiple methods of encoding were used to store the DWI sequence b-value, requiring multiple iterations and regular expression matching to extract the necessary MRI images. Of the initial 946 MRI examination, 24 (2.5%) were missing the appropriate series or unretrievable from the PACS, 2 (0.2%) contained improper or absent b-value encoding, and 32 (3.4%) contained slice increment, geometric, or orientation inconsistencies that prevented image conversion to NIFTI. Similar challenges were encountered with head CT preprocessing and download which contained 18 unique Series Descriptions for the thick-slice axial images. The final yield of MRI-CT pairs that would be useful for our use case was 815, reflecting an approximately 13.8% data loss from the initial list (Figure 1b).

## CONCLUSION

Technical challenges in DICOM metadata variability pose a significant limitation to machine learning dataset curation. Even with extensive manual correcting, a loss of 10-15% can be expected from an initial list to a curated dataset due to technical factors, which do not include scan or clinical limitations on examinations. Such limitations in dataset curation should be considered at the outset of any machine learning project and accounted for during study design.

## CLINICAL RELEVANCE/APPLICATION

Machine learning data curation poses significant technical challenges, which need to be accounted for when estimating the yield of an initial data set.

## M5B-SPIN- M<sub>r</sub>

7

Muhammad Irfan Khan (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study is to introduce two approaches that leverage multi-armed bandit algorithms to select the most appropriate participants for each round of training in Federated Learning (FL) for brain tumor segmentation. FL is a machine learning approach that enables collaborative training of a model without sharing data. Developing accurate and reliable machine learning models for brain tumor segmentation in federated settings is crucial, and collaborator selection plays a significant role in achieving this goal. However, choosing the most appropriate collaborators for each round of training in Federated Learning (FL) is a challenge. Hence, Reinforcement Learning (RL) algorithms have potential to tackle this challenge.

## **METHODS AND MATERIALS**

We use RL to evaluate the estimated performance of each collaborator and select the most promising candidates for collaboration. We employ a markov decision process for reward-based selection of collaborators. We measure the estimated performance of each collaborator and the overall performance of the model. Segmentation accuracy and convergence scores are the evaluation metrics used to assess model performances in the OpenFL platform.

## **RESULTS**

The two proposed approaches (epsilon-greedy and upper confidence bound) effectively select the most promising collaborators for each round of training in FL for brain tumor segmentation. The results show that our approach induces participation of the best candidates leading to better segmentation results. The selected collaborators based on the RL approach showed a higher estimated performance than random selection or the batch-wise collaborator selection. Results indicate a positive correlation between selecting the most appropriate collaborators and the overall performance of the model.

## **CONCLUSION**

The proposed multi-armed bandit algorithms effectively select the most promising collaborators for each round of training in FL for brain tumor segmentation. The reward-based selection process encourages the participation of the best candidates, leading to better segmentation results and a generalizable model.

## **CLINICAL RELEVANCE/APPLICATION**

Accurate and reliable machine learning models are essential in clinical settings for early diagnosis and treatment planning. However, after GDPR and HIPAA laws, data privacy concerns limit data sharing, making federated learning a viable approach. This study can lead to better diagnosis and treatment planning for brain tumor patients.  
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## Abstract Archives of the RSNA, 2023

M5B-SPIR

### Interventional Radiology Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPIR- Prophylactic Internal Iliac Artery Balloon Occlusion in Placenta Accreta Spectrum: Evaluating Efficacy, Risks, and Clinical Implications**

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Rui Wang, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to assess the efficacy and risks of prophylactic internal iliac artery balloon occlusion (IIABO) in managing placenta accreta spectrum (PAS) disorders and to discuss the clinical implications of this technique.

#### **METHODS AND MATERIALS**

We conducted a retrospective analysis of 623 confirmed PAS cases, including placenta accreta, increta, and percreta, between December 2013 and December 2022. Patients were divided into two groups based on whether they received prophylactic IIABO (Balloon Group, n=310) or not (No Balloon Group, n=313). The diagnosis of PAS was based on ultrasonography and verified by MRI when needed. Clinical management, surgical outcomes, complications, and hospitalization-related outcomes were compared between the groups using independent sample t-test, Mann-Whitney U test, or Fisher's exact test, as appropriate.

#### **RESULTS**

Among 623 confirmed PAS cases, patients were divided into Balloon (n=310) and No Balloon (n=313) groups. The Balloon Group had lower intraoperative bleeding and transfusion, with a significant difference in placenta percreta cases ( $P=0.03$ ), and shorter operation duration for placenta percreta ( $P=0.02$ ). No significant differences were observed in demographics, placenta removal, hysterectomy, or obstetric complications between the groups. Balloon Group had higher rates of arterial injury, thrombosis, and lower extremity ischemia (without statistical differences), as well as higher hospitalization costs ( $P=0.01$ ). Balloon blocking time significantly increased from PA to PI and then to PP ( $P=0.03$ ).

#### **CONCLUSION**

Prophylactic IIABO can be beneficial in reducing intraoperative bleeding and operation duration in selected PAS cases, particularly placenta percreta. However, the increased vascular complications and costs must be weighed carefully. Further studies should focus on optimizing patient selection and minimizing complications.

#### **CLINICAL RELEVANCE/APPLICATION**

This study sheds light on the potential benefits and risks of prophylactic internal iliac artery balloon occlusion (IIABO) in managing placenta accreta spectrum (PAS) disorders. While IIABO may be advantageous in specific cases, such as placenta percreta, clinicians must carefully evaluate the associated risks and costs. Future research should focus on refining patient selection and mitigating complications to improve the safety and effectiveness of IIABO in clinical practice.

#### **M5B-SPIR- Time-driven Activity-based Cost Analysis of Uterine Artery embolization**

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Nicole H. Kim, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Time-driven activity-based costing (TDABC) is the most accurate costing methodology in healthcare. The aim of this study was to increase cost transparency and uncover potential areas for savings in outpatient uterine artery embolization (UAE) for using TDABC methodology.

## **METHODS AND MATERIALS**

We retrospectively reviewed 109 patients who underwent outpatient UAE for fibroids or adenomyosis at a large urban tertiary academic center between January 2020 and December 2022. A process map defined the steps of UAE during a procedure day. Utilization times were captured from electronic health record timestamps and staff interviews using validated techniques. Capacity cost rates were estimated using a combination of institutional data, regional surveys, and manufacturer proxy prices. Costs were calculated using TDABC methodology for personnel, equipment, and consumables. Consumables were further sub-categorized into standard items, vascular devices (eg, needles, sheaths, catheters, wires), embolic agents (trisacryl gelatin particles and/or gelfoam), medications, and other (eg, contrast, closure devices).

## **RESULTS**

The mean total cost of UAE was \$4,529 (SD=\$936), the greatest contributor of which was consumables (66%; \$2980 [\$799]), followed by personnel (30%; \$1372 [\$265]) and equipment (4%; \$177 [\$42]). Within consumables, embolic agents accounted for the greatest proportion of costs, accounting for 42% (\$1268 [\$771]), followed by vascular devices (33%; \$980 [\$151]). The cost of embolic agents was highly variable, largely driven by the number of vials (range 1-19) of trisacryl gelatin particles used.

## **CONCLUSION**

Consumables accounted for the majority of the total cost of UAE, largely driven by the cost of embolic agents and vascular devices. It is unlikely that improved efficiency in room or personnel time will lead to cost-savings for UAE.

## **CLINICAL RELEVANCE/APPLICATION**

Understanding true procedural costs and addressing the high cost of consumable equipment in interventional radiology remains an important obstacle in improving the cost-effectiveness of IR procedures.

## **M5B-SPIR- The Cost of an Interventional Radiology Fellow: Time-driven Activity-based Cost Analysis of 4 Uterine Artery Embolization for Symptomatic Uterine Fibroids**

Nicole H. Kim, BA (*Presenter*) Nothing to Disclose

## **PURPOSE**

Academic teaching hospitals garner many benefits for undertaking the training of residents and fellows; however, the cost of trainees in the context of clinical care is not well-captured. The aim of this study was to investigate differences in utilization time and total costs between attending alone and attending/fellow cases in patients receiving outpatient uterine artery embolization (UAE) for symptomatic uterine fibroids using time-driven activity-based costing (TDABC) methodology.

## **METHODS AND MATERIALS**

We retrospectively reviewed 109 patients who underwent outpatient UAE for fibroids or adenomyosis at a large urban tertiary academic center between January 2020 and December 2022. Using a process map to capture all steps of a single procedure, we gathered utilization times, including pre-procedure care, room time, intra-procedure time, and post-procedure care, from electronic health record timestamps and staff interviews. Capacity cost rates were estimated using validated techniques. Costs were calculated using TDABC methodology for personnel, equipment, and consumables. We analyzed differences in time utilization and costs between procedures performed by an IR attending only (AO) versus an IR attending and IR fellow (AF) using two-sample t-tests, additionally stratifying by time period (July-December vs January-June) to account for trainee experience.

## **RESULTS**

Of 109 total cases, 23 (21%) were performed by an attending alone. AO cases had significantly shorter room times (AO vs AF: 141 vs 156 min,  $p=.042$ ) and intra-procedure times (94 vs 110 min,  $p=.009$ ); there were no differences in pre- or post-procedure care times. The mean total cost of AO cases was 12% (\$539) cheaper than AF cases (\$4,103 vs 4,642;  $p=.003$ ). In both AO and AF cases, the greatest contributor of total costs were consumables (70% and 65%, respectively), followed by personnel (27% and 30%). Intra-procedure times were significantly lower for AO cases during July-December (88 vs 114 min,  $p=.024$ ) but not during January-June (99 vs 106 min,  $p=.48$ ).

## **CONCLUSION**

The presence of an IR fellow is associated with significantly longer room and intra-procedure times, as well as higher total costs in outpatient UAE. These differences are likely attributable to trainee inexperience during the first half of the fellowship year.

## **CLINICAL RELEVANCE/APPLICATION**

Cost of procedures varies depending on practice setting, as well as the presence and experience of a clinical trainee. Understanding true costs is important in determining cost-effectiveness of interventional radiology procedures in different environments.



## **M5B-SPIR- The Evolving Role of IR in the Management of Cholecystitis**

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Tarik Babar, BS (*Presenter*) Nothing to Disclose

### **PURPOSE**

(Please review this as an educational exhibit if possible- sorry for the inconvenience!)Teaching Points1. Introduce various innovative interventional radiology (IR) management options for cholecystitis and its complications that impact clinical outcomes2. Review the success of traditional interventions of cholecystitis by IR3. Present a successful example of a standardized multidisciplinary approach for the management of cholecystostomy drains4. Demonstrate successful approaches of management of cholecystitis and its complications through the use of novel IR techniques5. Review high-impact studies regarding IR management of cholecystitis including new, innovative interventions

### **METHODS AND MATERIALS**

Table of Contents1. Introduction, including epidemiology of cholecystitis and current traditional surgical management options2. Traditional role of IR in the management of non-operative cholecystitis3. Review of existing high-impact studies regarding success of percutaneous cholecystostomy drains4. Indication, technique, and complications of percutaneous cholecystostomy drain5. Standardized management of percutaneous cholecystostomy drains used at our center6. Novel roles for IR in management of cholecystitis7. Indication, technique, and successful cases of percutaneous stone extraction, electrohydraulic lithotripsy (EHL), and laser lithotripsy8. Indication, technique, and successful case of gallbladder cryoablation for chronic cholecystitis9. Review of a high-impact studies regarding novel IR techniques: percutaneous cystic duct interventions for non-operative cholecystitis and percutaneous stone extraction10. Conclusion and summary

### **RESULTS**

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### **CONCLUSION**

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## **M5B-SPIR- Bacterial Community Analysis of Pyogenic Liver Abscess With or Without Gas Formation by 16S rDNA Sequencing**

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Yawen Guo (*Presenter*) Nothing to Disclose

### **PURPOSE**

Gas formation is an important feature of pyogenic liver abscess (PLA). The potential relationship between gas formation bacterial composition in PLA remains unclear. The present study attempts to compare bacterial composition between gas-forming PLA (GFPLA) non-gas-forming PLA (non-GFPLA) to identify factors associated with gas formation in PLA .

### **METHODS AND MATERIALS**

Clinical data from 331 patients with PLA was collected retrospectively, 16S rDNA sequencing was performed to analyze the bacterial composition of pus samples from 60 consecutive PLA patients. Patients were divided into GFPLA non-GFPLA groups according to the presence or absence of gas on computed tomography (CT). Univariate multivariate logistic analyses were used to identify factors associated with gas formation in PLA.

### **RESULTS**

Rates of extrahepatic migratory infection (EMI), intensive care unit (ICU) admission mortality were significantly higher in the GFPLA group. 16S rDNA sequencing showed no differences in bacterial community richness diversity between the two groups. Linear discriminant analysis effect size (LEfSe) revealed a higher abundance of *Enterococcus faecium* *Enterobacter cloacae* in the GFPLA group. However, the presence of *Enterococcus faecium* *Enterobacter cloacae* was not associated with the gas formation on multivariate regression analysis. Only the history of digestive system cancer was independently associated with gas formation in PLA .

### **CONCLUSION**

No relationship was observed between gas formation & bacterial composition in PLA; only the history of digestive system cancer was independently associated with PLA gas formation.

### **CLINICAL RELEVANCE/APPLICATION**

An increased understanding of the mechanisms underlying PLA gas formation may provide new insights into the clinical phenomenon that patients with gas-forming pyogenic liver abscess (GFPLA) tend to have more severe symptoms increased mortality compared to patients with non-gas-forming PLA (non-GFPLA).



## Abstract Archives of the RSNA, 2023

M5B-SPMK

### Musculoskeletal Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### M5B-SPMK- A Preliminary Study of MRI T2 Mapping Imaging of Knee Cartilage in Type 2 Diabetic 1

Fengzi Yao (*Presenter*) Nothing to Disclose

#### PURPOSE

To preliminarily explore the effect of type 2 diabetes mellitus (T2DM) on articular cartilage of knee osteoarthritis (OA) based on MRI T2 mapping sequence.

#### METHODS AND MATERIALS

A total of 52 participants were recruited for MRI T2 mapping sequences. The subjects were divided into experimental group and control group. The experimental group was classified as group A of type 2 diabetic osteoarthritis (T2DM OA), with 32 patients and a total of 61 knees; and the control group was classified as group B of non-diabetic osteoarthritis (NDM OA), with 20 persons and a total of 34 knees. Group A was divided into severe group (Ax1) and mild group (Ax2) according to whether there were diabetes-related complications and basal insulin therapy. According to the course of the disease, = 10 years are classified as Ay1 and > 10 years are classified as Ay2 group. Each subject's cartilage was divided into four regions of interest according to the medial and medial femoral condyle and the medial and medial tibial condyle. The cartilage T2 value for each region of interest is defined as the average of the optimal cartilage display level and the most significant lesion level for each region of interest. The optimal cartilage display layer is selected at the middle level of the articular cartilage on this side; and the most significant lesion area level is selected, from the most serious grade of cartilage lesions. The cartilage T2 value of each region of interest is measured twice and averaged calculated.

#### RESULTS

(1) Compared with the NDM OA group, the T2 value of cartilage in the T2DM OA group was generally increased in the early cartilage grading group. (2) The T2 values of knee cartilage in the severe diabetes group were generally greater than those in the mild group, and the T2 values in the medial femoral condyle and the medial tibial condyle were statistically different ( $p < 0.05$ ). (3) When graded according to the course of the disease, the T2 value of cartilage in the Ay2 group was greater than that in the Ay1 group, and the T2 value of the medial tibial condyle cartilage was statistically different ( $p < 0.05$ ).

#### CONCLUSION

The sequence of MRI T2 mapping is able to help assess knee OA by detecting the T2 value of the knee cartilage. Type 2 diabetes has an impact on knee cartilage degeneration, and the course of diabetes and the condition of blood glucose control are correlated with the degree of knee cartilage degeneration.

#### CLINICAL RELEVANCE/APPLICATION

T2 mapping sequence was used to evaluate the quantitative effect of type 2 diabetes on articular cartilage of knee OA, and to provide evidence for early clinical intervention of T2DM OA.

#### M5B-SPMK- DISH: The Role of Peripheral Involvement 2

Ana Berasategui Criado, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Diffuse idiopathic skeletal hyperostosis (DISH) predominantly affects the axial skeleton. However, it can also affect peripheral joints, even prior to spinal involvement. In this study we aim to assess the frequency, distribution and precocity of lower limb joint involvement in these patients.

## METHODS AND MATERIALS

We reviewed chest CT scans of 200 patients, from January 1, 2023 to April 31, 2023, dividing them into two groups: first group of 100 patients aged between 50 and 70 years, and second group of 100 patients older than 70 years. We selected patients with DISH following the criteria of Arlet and Mazière. We then reviewed all previous imaging tests (simple x-Ray, CT and MRI) of the lower extremities stored in our PACS for findings characteristic of DISH and their time of onset.

## RESULTS

We detected 19 DISH patients in the first group (18 men and 1 woman) and 34 in the second (26 men and 8 women). Knee involvement is frequent. Thus, of the 19 patients in the first group, 30% had previous imaging of this joint, and 66% of the cases showed involvement. Of the 34 patients with DISH in the second group, 38% had previous images of the knee, and 53% of them were affected by their disease. In addition, knee involvement was present prior to axial skeletal involvement in 42% of the cases, all of them male. In all patients with knee involvement, the extensor apparatus involvement was in the form of "gull wings".

## CONCLUSION

The involvement of the joints of the lower limb joints in DISH disease is frequent and with typical characteristics that allow the diagnosis to be suspected in the absence of imaging studies of the axial skeleton. In a not negligible percentage of cases, peripheral involvement precedes axial involvement, especially in males. Earlier involvement of the axial skeleton is associated with a higher percentage of peripheral joint involvement.

## CLINICAL RELEVANCE/APPLICATION

We should familiarize ourselves with the characteristics of peripheral involvement in DISH that may even precede spinal disease, as early diagnosis is important for treatment and suspicion of complications.

## M5B-SPMK- Opportunistic CT-derived Analysis of Fat and Muscle Tissue Composition Predicts Mortality in Patients with Cardiogenic Shock

Babak Salam (*Presenter*) Nothing to Disclose

## PURPOSE

Estimation of prognosis in patients presenting with cardiogenic shock (CS) is important to guide clinical decision making. Patients with CS frequently undergo computed tomography (CT) on admission. Aim of this study was to investigate the predictive value of opportunistic CT-derived body composition analysis in CS patients.

## METHODS AND MATERIALS

Amount and density of fat and muscle tissue were quantified from single-slice CT images at the level of the intervertebral disc space L3/L4 in 152 patients with CS. Multivariable Cox regression and Kaplan-Meier survival analyses were performed to determine the predictive value of opportunistically CT-derived parameters of body composition and compare them with established clinical parameters for risk stratification. The primary endpoint was defined as 30-day mortality.

## RESULTS

Within the 30-day follow-up, 90/152 (59.2 %) patients died. On univariable analyses, patient age and lactate as clinical prognosticators, as well as skeletal muscle (SM) area, visceral adipose tissue (VAT) area, area of fat tissue in muscle, and inter-muscle fat fraction as imaging biomarkers, were associated with 30-day mortality. On multivariable analyses, lactate (HR 1.10 (CI:1.04-1.17);  $p=0.002$ ) and patient age (HR 1.04 (CI:1.01-1.07),  $p=0.017$ ), as well as visceral adipose tissue (VAT) area (HR 1.004 (CI:1.002-1.007);  $p=0.001$ ) and skeletal muscle (SM) area (HR 0.987 (CI:0.975-0.999);  $p=0.043$ ) remained as independent predictors of 30-day mortality. Kaplan-Meier survival analyses showed significantly increased 30-day mortality in patients with higher VAT area ( $p=0.015$ ) and lower SM area ( $p=0.035$ ).

## CONCLUSION

CT-derived VAT and SM area are independent predictors of dismal outcomes in CS-patients and have the potential to become a new imaging biomarker, which is available from clinical CT.

## CLINICAL RELEVANCE/APPLICATION

In this study we propose the use of VAT area and SM area, representing objective measures of patient clinical status, as promising imaging biomarkers for the outcome of patients with CS. The potentially outstanding value of VAT area and SM area is underscored by the fact that, unlike most CS risk scores, they can be rapidly and easily determined using available diagnostic imaging.

## M5B-SPMK- The Association Between Change of Muscle Quality and Mortality in Patients with Septic Shock

Jiyeon Ha, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the prognostic significance of myosteatosi s in septic shock patients undergoing protocolized bundle therapy in the emergency department.

## METHODS AND MATERIALS

We conducted a retrospective single center study based on prospectively collected registry of septic shock in adult patients between May 2016 and May 2020. Patients who conducted computed tomography (CT) scan on ED visit day and have prior CT more than 180 days ago were enrolled in this study. Myosteatosi s was defined as sum of low attenuation muscle (LAMA) which represents low quality muscles with fatty infiltration and intermuscular adipose tissue (IMAT) based on CT density of muscle area. Myosteatosi s area difference was calculated between the ED visit day and the prior visit day. An example of body composition measurement is shown in Figure 1. Multivariate logistic regression model was used to evaluate odds ratios (ORs) and 95% confidence intervals (CIs) for 28-day mortality.

## RESULTS

Of the 569 enrolled patients, the 28-day survival rate was 40.7% and myosteatosi s area was increased in ED visit day compared with the prior visit day in both non-survival and survival group. But the area was more increased in non-survival group (11.5 cm<sup>2</sup> vs. 22.2 cm<sup>2</sup>,  $p < 0.01$ ). Normal attenuation muscle area was more decreased (-20.0 cm<sup>2</sup> vs. -27.6 cm<sup>2</sup>,  $p < 0.01$ ) and LAMA was more increased (10.9 cm<sup>2</sup> vs. 18.8 cm<sup>2</sup>,  $p < 0.01$ ) in non-survival group. The multivariate analysis showed that the decreased SFA and increased myosteatosi s area were independent risk factor for 28-day mortality of septic shock.

## CONCLUSION

Myosteatosi s area which implies the low quality muscle area was increased in non-survival group of septic shock. Our results revealed the trend of myosteatosi s could be better indicator of septic shock prognosis compared with the single measurement of body composition.

## CLINICAL RELEVANCE/APPLICATION

The results of the study suggest that monitoring the trend of myosteatosi s could offer valuable insights into the prognosis of septic shock and guide clinical decision-making to enhance patient management.

## M5B-SPMK- Utilization of AI-aided Osteosarcopenia Measurement on Opportunistic Abdominal CT Scans<sup>6</sup> to Evaluate the Impact of Gastrectomy on Bone Mineral Density

Hyunseung Lee, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Osteosarcopenia is the co-existence of osteoporosis and sarcopenia, which is closely related with survival outcome in patients with major diseases and elderly patients. In patients treated with gastrectomy, osteoporosis and sarcopenia commonly occurred, but not evaluated routinely in clinical practice. Thus, we applied AI-aided osteosarcopenia measurement methods in opportunistic abdominal CT scans for evaluation of bone mineral density and skeletal muscle area (SMA) in patients treated with gastrectomy.

## METHODS AND MATERIALS

In fifty two gastric cancer patients (mean age,  $56.2 \pm 11.3$  years) treated with curative gastrectomy, preoperative and 1-year postoperative abdominal CT scans were analyzed for the SMA and BMD. Deep-learning AI techniques were applied to automatically select the L3 vertebrae level, measure the SMA, and place ROI for trabecular attenuation value. Nutritional risk index (NRI) was also calculated based on laboratory results.

## RESULTS

Between preoperative CT and postoperative CT, all patients showed a decrease in the SMA ( $123 \pm 30$  cm<sup>2</sup> vs.  $113 \pm 28$  cm<sup>2</sup>,  $p=0.08$ ) and the trabecular attenuation values ( $137 \pm 31$  HU vs.  $125 \pm 25$  HU,  $p=0.03$ ). The NRI ( $100 \pm 8$  vs.  $92 \pm 12$ ,  $p<0.001$ ), body weight ( $63 \pm 10$  kg vs.  $57 \pm 9$ ,  $p=0.002$ ) and BMI ( $23 \pm 3$  vs.  $21 \pm 3$ ,  $p=0.001$ ) were also decreased. During the 5-year follow-up record, two patients were identified to show osteoporotic vertebral compression fractures. Both patients showed both osteoporosis and sarcopenia.

## CONCLUSION

We found that the significant loss of bone mineral density and skeletal muscle mass occurred in patients treated with gastrectomy through AI-aided measurement techniques on opportunistic CT scans.

## CLINICAL RELEVANCE/APPLICATION

AI-aided measurement of bone mineral density and skeletal muscle area simultaneously is greatly helpful to evaluate osteoporosis and sarcopenia in clinical practice using opportunistic CT scans.

## **M5B-SPMK- Revolutionizing Bariatric Surgery Outcomes: A Radiomics-Based Model to Unveil the Prognostic Power of Preoperative Skeletal Muscle Analysis on Abdominal CT for Metabolic Syndrome Remission**

Yoon Jung Lee (*Presenter*) Nothing to Disclose

### **PURPOSE**

To develop and assess the performance of a CT radiomics-based machine learning predictive model to determine if preoperative skeletal muscle characteristics can predict the remission of metabolic syndrome following bariatric surgery.

### **METHODS AND MATERIALS**

Our study population included 79 morbidly obese patients who underwent bariatric surgery and had abdominal and pelvic CT scans preoperatively and one year postoperatively between January 2019 and October 2020. An experienced musculoskeletal radiologist with eight years of experience, unaware of the patients' clinical information, manually outlined regions of interest encompassing the total abdominal muscle area (including psoas, paraspinal, quadratus lumborum, rectus abdominis, transverse abdominis, and internal and external obliques) on every slice throughout the entire extent of the third lumbar vertebra (L3). We extracted radiomics features from preoperative CT images of skeletal muscle and developed a framework for optimal feature selection. To develop our predictive models, we randomly split the complete dataset into 70% for model development and 30% for model validation. To enhance predictive performance, we employed normalization, standardization, and a random search with 5 repeated 5-fold cross-validation for optimization. We utilized three popular algorithms: logistic regression (LR), random forest (RF), and support vector machine (SVM).

### **RESULTS**

Feature selection based on absolute correlation (COR) resulted in 43 features with Least Absolute Shrinkage and Selection Operator (LASSO), 35 with Elastic-Net (EN) and 10 with Random Forest (RF). In the cross-validation method, the logistic regression (LR) model achieved the best performance using the COR and RF combination, with train area under the curve (AUC) of 0.774 and test AUC of 0.800. The RF model attained train AUC of 1.000 and test AUC of 0.675 with the COR and RF combination. The SVM model secured train AUC of 0.819 and test AUC of 0.783 using the VIF and RF combination.

### **CONCLUSION**

In conclusion, our study demonstrates that the CT radiomics-based machine learning predictive models effectively utilize preoperative skeletal muscle analysis to predict the remission of metabolic syndrome after bariatric surgery. Among the models examined, the logistic regression model with the COR and RF combination yielded the best performance.

### **CLINICAL RELEVANCE/APPLICATION**

This study highlights the potential of radiomics and machine learning approaches in personalized preoperative evaluation and prediction of post-bariatric surgery outcomes, ultimately contributing to the advancement of precision medicine in obesity treatment.

## **M5B-SPMK- Deep Learning to Quantify Altered Muscle Status and its Association with Survival in Lung Cancer Screening Eligible Individuals**

Johannes Beat B. Kessler, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Skeletal muscle (SM) has been described as an important prognostic factor in patients with cancer or cardiovascular disease. However, its prognostic value in asymptomatic screening eligible individuals at increased risk is not routinely determined on performed CT scans due to limited resources. Thus, we used a 3D deep learning model for fully automatic quantification of SM on routine chest CT and explored its association with survival in heavy smokers participating in a lung cancer screening trial.

### **METHODS AND MATERIALS**

A 3D deep learning model was used to estimate SM volume (SMVol) and SM attenuation (SMHU), a known measure of muscle quality, on non-contrast enhanced lung screening chest CTs of 26,144 participants of the National Lung Screening Trial at baseline and on the 1-year follow-up scan (n=52,228). The primary outcome was all-cause mortality. Secondary outcomes were lung cancer and cardiovascular mortality. The association between SMVol and SMHU and outcomes was assessed via multivariable Cox proportional hazards regression at baseline. In addition, the association between muscle wasting (decrease in SMVol or SMHU [ $\geq 20\%$ ]) between the baseline and 1-year follow-up scan and mortality was determined.

## RESULTS

A total of 1,839 (7%) deaths occurred over a median follow-up of 6.5 years among the 26,144 participants (age 61.4±5.0 years; 40.9% female). At baseline, multivariable Cox regression revealed an independent association between SMVol SMHU and all-cause mortality after adjustment for age, sex, BMI, race, pack years, smoking status, prevalent diabetes or hypertension, prior myocardial infarction, prior stroke (SMVol: HR: 0.43, 95% CI [0.21-0.88]; p=0.02; SMHU: HR: 0.62, 95% CI [0.57-0.67]; p<0.001). Individuals with a decrease in SMVol or SMHU >20% within one year had a significantly worse survival than those with stable SM measures (HR adjusted for the same risk factors. SMVol: HR 2.10, 95% CI [1.91-2.31], p<0.001; SMHU: HR 1.78, 95% CI [1.62-1.95], p<0.001). Similar results were obtained for the prediction of lung cancer and cardiovascular mortality.

## CONCLUSION

Altered muscle status is an independent predictor of survival in a high-risk population of heavy smokers participating in a lung cancer screening trial. Deep learning allows for opportunistic assessment of this currently unused but prognostically relevant information with the potential to guide decision-making and improve personalized prevention.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-based opportunistic screening of altered muscle status can identify individuals at increased risk of mortality beyond traditional risk factors in a screening setting. Implementation of such methods may provide a solution to inform risk assessment and improve patient management.

## M5B-SPMK- Ability of Radiofrequency Echographic Multi Spectrometry to Identify Bone Fragility in Subjects with Osteogenesis Imperfecta

Carla Caffarelli, MEd, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Osteogenesis imperfecta (OI) is a heterogeneous group of heritable bone disease characterized by bone fragility, reduced bone mineral density (BMD), joint laxity, easy bruising, and variable short stature. This study aimed to evaluate the usefulness of the new Radiofrequency Echographic Multi Spectrometry (REMS) technique in the assessment of bone status in subjects with OI.

## METHODS AND MATERIALS

In a cohort of 35 subjects (39.5 ± 21.2 years) with OI and in 30 healthy controls we measured BMD at the lumbar spine (LS-BMD), at femoral neck (FN-BMD) and total hip (TH-BMD) using a dual-energy X-ray absorptiometry device; TBS was calculated using TBS iNsite software. Moreover, REMS scans were also carried out at the same axial sites. Moreover, in OI subjects the presence of prior fractures was reported.

## RESULTS

A total of 85.7% of patients presented with a fracture history. The most common fracture sites were extremity long bones (femur, tibia-fibula and radius-ulna) (70.0%) and at vertebral site (54.3%). BMD evaluated by DXA and REMS technique at all measurement sites were all significantly (p<0.01) lower in subjects suffering from OI than in controls. Dividing OI patients on the bases of Sillence classification, no differences between the BMD-LS values carried out with the DXA technique between OI type I group and OI Type III and IV group. On the contrary, the OI Type III and IV group presented significantly lower values of both TBS and BMD-LS by REMS with respect to patients OI type I (p<0.05) [figure 1]. TBS value presented significant correlations with both BMD-LS by DXA and BMD-LS by REMS technique, however, the better correlation was observed between TBS values and BMD-LS by REMS.

## CONCLUSION

This preliminary study has shown that REMS appears to be an accurate non-ionizing technology able to assess the bone status in subjects with OI. The attractiveness of the use of REMS for bone measurements in OI patients lies in its lack of ionizing radiation, its ease of use and the portability. In fact, the REMS device can be used directly on patient's bed, and this could represent an excellent method for assessing the bone status even in OI subjects with a recent fracture.

## CLINICAL RELEVANCE/APPLICATION

This is the first study that has evaluated the usefulness of REMS technology in adult patients with osteogenesis imperfecta. • Finding of a significant correlation between REMS and TBS • REMS could become an important tool able to assess the risk of fragility fractures so helping to overcome the limitations of DXA.

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## Abstract Archives of the RSNA, 2023

M5B-SPMS

### Multisystem Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPMS- Detection and Characterization of Urinary Stone Using Virtual Non-contrast Images Derived from Two Dual-energy CT Scanners: A Phantom Study** 1

Yannan Cheng, BS,BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the feasibility of virtual non-contrast images derived from dual-energy CT (DECT) for urinary stone detection and measurement at different iodine solutions and radiation doses

#### **METHODS AND MATERIALS**

Twenty-four urinary calcified stones (average size: 1.7-5.8mm) were placed in a custom-made cylindrical phantom filled with water and iodine contrast mixture at different degrees of concentration (0, 7, 13, 22, 30 and 57 mg/mL; CT attenuation value: 0, 200, 350, 600, 800 and 1500HU at 120kVp). Thirty-six scans with three radiation doses (CTDIvol) of 5, 10 and 15mGy at the above six iodine concentrations were performed with rapid tube voltage switching DECT (rsDECT) and dual-layer detector-based CT (dIDECT). True non-contrast images (TNC) and virtual non-contrast images (VNC) were reconstructed. Detection rate and measurement of urinary stones were assessed by two radiologists and statistically compared. Stone detection confidence was also assessed using 4-point grading scale (4: detectable; 3: iodine contrast agents and stones are distinguishable; 2: iodine contrast agents and stones are indistinguishable; 1: not detectable). Stones were considered detected only when the score was greater than 2 points. Size (length and width) and CT attenuation value were performed on the coronal image showing the maximal stone diameter.

#### **RESULTS**

Most stones were detected on both TNC and VNC images at different iodine concentrations (rsDECT: 91.7%-100%; dIDECT: 95.8%-100%) with detection confidence greater than 2 except VNC1500HU images (rsDECT: 8.3%-20.8%; dIDECT: 33.3%-45.8%) (Tab.1, Fig. 1). There was no statistically significant difference in stone detection rates among different radiation doses. Stone size and attenuation value on VNC images at different iodine concentrations were significantly lower than those of TNC images except the stone width on rsDECT (Tab.2 and 3). As the radiation dose increased, the measurement difference decreased on the VNC images from rsDECT, while not found on the dIDECT (Fig.2).

#### **CONCLUSION**

VNC images from the two dual-energy CT enabled reliable detection for urinary stone at moderate iodine concentrations (<30mg/mL) with less dependent on radiation dose. Stone size and CT value measurements were underestimated on VNC images.

#### **CLINICAL RELEVANCE/APPLICATION**

VNC images at different iodine concentrations and radiation doses are feasible to detect and measure urinary stones except higher iodine concentration. It should be noted that stone size and CT value measurements on VNC images were underestimated.

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## Abstract Archives of the RSNA, 2023

M5B-SPNMMI

### Nuclear Medicine & Molecular Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPNMMI-1** **Deep Learning Reconstruction Enables High SNR at Low Counts in SiPM-based PET/CT Imaging**

YUYA SHIRAKAWA, BSc (*Presenter*) Research funded, Nihon Medi-Physics Co, Ltd

#### **PURPOSE**

AiCE-i (Advanced intelligent Clear-IQ Engine-integrated) is an image reconstruction technique designed using deep learning for the Cartesion Prime SiPM-based PET/CT device from Canon. AiCE-i is a denoising reconstruction technique that effectively reduces noise without compromising contrast, leading to stable, high signal-to-noise ratio (SNR) images even with fewer counts contributing to image generation. In this study, we evaluated the relationship between counts and PET image SNR using clinical images with both the conventional method and the new deep learning reconstruction technique.

#### **METHODS AND MATERIALS**

We analyzed the relationship between liver SNR and counts (True+Scatter) in clinical images of 54 patients who underwent 18F-FDG PET/CT imaging using a SiPM-based PET/CT scanner, Cartesion Prime. The average weight of the patients was  $62.5 \pm 12.5$  kg. All cases underwent at least 4 hours of fasting before PET/CT, and after injection of  $233.3 \pm 51.1$  MBq of 18F-FDG, patients were instructed to rest quietly for 60 minutes. The injected dose per body weight was  $3.6 \pm 0.3$  MBq/kg. Data acquisition started  $60 \pm 7$  minutes after administration, and list-mode acquisition was performed for 5 minutes/bed at the position that included the liver the most (27 cm/bed), followed by 30sec/bed reconstruction from 30 to 300 seconds. The 3D-OSEM method with subset 12, iteration 3, time-of-flight (+), PSF correction (+), and reconstruction using Clear Adaptive Low-Noise Method (CaLM) and AiCE-i were performed. The obtained data were divided into two groups: CaLM and AiCE-i, and statistical analysis was performed using the Kruskal-Wallis test. In the case of significant differences in the multiple comparisons test (Dunn-Bonferroni) for three or more samples, the test was performed. P-values less than 0.05 were considered statistically significant in all analyses.

#### **RESULTS**

To achieve liver SNR of 10 or higher, which is recommended by the Japanese Society of Nuclear Medicine, a data acquisition time of 120 seconds using CaLM and 30 seconds using AiCE-i was required. In addition, with CaLM, liver SNR increased with increasing counts from 30 to 300 seconds (5.5-16.4,  $r_s=0.98$ ), whereas with AiCE-i, approximately constant liver SNR was obtained from 30 to 300 seconds, which did not correlate with counts (13-16,  $r_s=0.005$ ).

#### **CONCLUSION**

Using the deep learning reconstruction technique AiCE-i in SiPM-based PET/CT enables stable high liver SNR even with lower counts contributing to image generation, compared to conventional methods.

#### **CLINICAL RELEVANCE/APPLICATION**

Deep learning reconstruction in SiPM-based PET/CT improves spatial resolution and contrast, allowing high SNR images at low counts, reducing patient burden and radiation exposure.

#### **M5B-SPNMMI-2** **Tolerability of Lutetium-177-PSMA-617 in Men with Prostate Cancer and Baseline Cytopenia**

Ahmad Abdelrazek (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Results from the VISION trial (NCT03511664) led to the approval of lutetium-177 ( $^{177}\text{Lu}$ )-PSMA-617 for the treatment of metastatic castration-resistant prostate cancer (mCRPC). This trial excluded patients with baseline cytopenias, thus safety in

this frequently encountered patient population is unknown. We aimed to use real-world data to describe the tolerability of radioligand therapy in those with poorer bone marrow reserve.

## **METHODS AND MATERIALS**

We retrospectively reviewed the records of all patients, who received a first dose of 177Lu-PSMA-617 at Mayo Clinic in the interval of April 26, 2022, to December 1, 2022. Patients were categorized as having poor marrow reserve on the basis of pre-treatment hematologic parameters, including: (1) an anemia cohort with hemoglobin (Hg) less than 9 g/dL, (2) a thrombocytopenia cohort with platelets (Plt) less than  $100 \times 10^9/L$ , (3) a leukopenia cohort with white blood cell count (WBC) less than  $2.5 \times 10^9/L$ , and (4) a multiple cytopenia cohort. These were exclusionary parameters from the VISION trial. Longitudinal laboratory data and clinical outcomes were collected and analyzed using descriptive statistics.

## **RESULTS**

At data cutoff, 273 patients had received one or more doses of 177Lu, including 33 (12%) with at least one baseline cytopenia prior to their first cycle of treatment. In total, there were 25 (76%) patients with anemia, 4 (12%) with thrombocytopenia, 2 (6%) with leukopenia, and 2 (6%) with multiple cytopenias at baseline. The median number of cycles received thus far is 4, including 21 (64%) who are still receiving therapy and 12 (36%) who have permanently discontinued treatment. Median longitudinal changes in blood counts for the anemia cohort are presented in Table 1. Reasons for treatment discontinuation include: toxicity (n=5), disease progression (n=4), or death (n=8). Among the 9 patients who stopped 177Lu for toxicity or disease progression, 5 subsequently also died. Dose reductions or treatment delays for worsening myelosuppression were utilized in 8 (24%) and 8 (24%) patients, respectively. Transfusions of packed red blood cells or platelets were required for 26 (78%) patients. A total of 16 (48%) received care in the emergency department or were hospitalized.

## **CONCLUSION**

Treatment discontinuation for toxicity was rare among men with mCRPC and baseline cytopenias, while receiving 177Lu; however, these patients have an overall poor prognosis.

## **CLINICAL RELEVANCE/APPLICATION**

Patients with initial cytopenia have been excluded originally from the Vision trial and in our study, we found that this group of patients can safely receive 177-PSMA Lutetium.

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## Abstract Archives of the RSNA, 2023

M5B-SPNPM

### Noninterpretive Skills (Beyond Imaging) Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPNPM-1 Determining the Utility of Augmented Reality Coupled with Diagnostic Medical Sonography: A Potential Workflow Improvement**

Kevin D. Evans, PhD, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To systematically investigate the advantages and challenges related to the workflow implementation of augmented reality (AR) technology, specifically using the Microsoft HoloLens version 2 (HL2) (MediView LLC), paired with a portable ultrasound (US) equipment system.

#### **METHODS AND MATERIALS**

After obtaining IRB approval, multiple data collection methods were employed to assess the utility of AR for US applications. A diverse sample of US users, ranging in experience levels, were invited to participate in a video training session, a hands-on demonstration, and remote instruction while wearing the HL2, connected to a portable US system. The duration of participants' tasks was recorded, both with and without the AR platform. Participants' postures and positions were evaluated using the Rapid Upper Limb Assessment (RULA)<sup>1</sup>, which assesses ergonomic risk factors linked to body positioning and muscle usage. Subjects also completed the System Usability Scale (SUS) (IBM, Armonk, New York), a reliable tool for measuring usability consisting of a 10-item questionnaire. Lastly, participants were invited to share qualitative feedback regarding the AR system evaluation.

#### **RESULTS**

A total of 12 US users provided data during their individual sessions, with and without AR. The time spent on simulated work, both with and without the products, remained consistent, as a group. The RULA scores for the group indicated a lower (better) upper extremity sub-score and a statistically significant lower neck sub-score ( $p < 0.05$ ) when using AR. This suggests a reduced risk of repetitive stress injury when using AR compared to a traditional US examination. Post-test data revealed positive SUS scores, reflecting favorably on both the product and the education and training provided. Participants consistently expressed interest in having access to additional post-processing ultrasound equipment system controls while using the HL2 (i.e., overall gain, power, etc.). Qualitative exit interviews highlighted participants' enthusiasm for incorporating AR systems into their respective clinical workflow.

#### **CONCLUSION**

Although larger studies are necessary to validate these initial findings, this cohort identified numerous opportunities for integrating the AR platforms such as the HL2 and portable ultrasound systems. Preliminary evidence suggests that AR usage may offer occupational health benefits when the workflow includes providing ultrasound guidance.

#### **CLINICAL RELEVANCE/APPLICATION**

Implementation of AR systems for US, have the potential to decrease repetitive stress injuries related to ergonomics in the workplace thereby increasing the productivity and longevity of clinical staff.

#### **M5B-SPNPM-2 Online Search Trends Correlation with Imaging Volumes for Screening Mammography and Low-Dose Chest CT: A Multicenter Retrospective Five Year Study of 800,000 Examinations**

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Public awareness of disease and screening programs increases participation in cancer prevention programs. We assessed the correlation between the online search trends and the volume of clinical requests and scheduling for breast and lung cancer

screening with mammography and low-dose CT (LDCT) in multicenter settings of a predominantly urban population.

## **METHODS AND MATERIALS**

We first obtained the search interest for the terms "lung cancer" and "lung cancer screening," "breast cancer," and "breast cancer screening" from Google Trends data for the entire United States in the last five years (1st Jan 2018 to 31st Dec 2022). Google trends data are displayed as a linear graph on a scale of 0 to 100, where 100 is the peak popularity, and 0 means insufficient data. The weekly trend data were exported to Microsoft Excel. Next, we queried our radiology report search and analytic engine (Nuance mPower) to obtain data on physician orders for mammography and LDCT examinations per week over the same five years. We then performed a Pearson correlation between the weekly Google trends data and the ordered and performed mammography and LDCT.

## **RESULTS**

Over the 260-week study duration, 779,366 mammograms and 43,035 LDCT were performed across the 17 sites. There was a significant correlation between the Google trends for "breast cancer screening" and "lung cancer screening" with the corresponding volume of the ordered ( $r=0.48-0.55$ ) and performed ( $r=0.43-0.55$ ) mammograms and LDCT exams. Upon omission of word "screening," the Google trends for "lung cancer" and "breast cancer" had a much weaker correlation with the volumes of ordered ( $r= -0.07-0.37$ ) and performed ( $r= -0.06-0.23$ ) mammograms and LDCT examinations. Google search spikes during cancer awareness weeks had a stronger correlation with imaging volume surges in breast cancer than for lung cancer.

## **CONCLUSION**

Increased interest in "screening" for breast and lung cancer, as reflected in Google trends data, correlates with an increase in the utilization of screening mammography and LDCT.

## **CLINICAL RELEVANCE/APPLICATION**

Concerted and sustained online efforts aimed at screening awareness can help enhance the utilization of screening exams and help reduce mortality associated with lung and breast cancer.

## **M5B-SPNPM-3 Formal Wellness Training of Academic Radiology Leaders Improves Work-Life Conflict**

Jay R. Parikh, MD, FRCPC (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate the effect of formal leadership training of academic radiology leaders within an academic center on their own burnout and professional fulfillment.

## **METHODS AND MATERIALS**

The study cohort were academic radiology leaders within one of the largest academic organizations of academic radiologists within the United States. All academic radiology leaders within the organization were electronically mailed a weblink to a confidential IRB-approved survey in April 2021. The survey included validated questions from the Stanford Professional Fulfillment Index (PFI), values alignment, teamwork, overload, and work family conflict. Academic leaders were invited in May 2021 to participate in instructor-led formal training on leading wellness focusing on 5 core leadership skills - emotional intelligence, self-care, resilience support, demonstrating care, and managing burnout. An identical follow-up survey was electronically mailed 6 months after initial training in November 2021.

## **RESULTS**

The overall response rate of academic radiology leaders was 59 % (19/32). For both measures, there was acceptable internal consistency (Cronbach's  $\alpha = 0.63$  for work exhaustion and  $\alpha = 0.90$  for fulfillment). There was statistically significant improvement in work family conflict (3.32 vs 2.86;  $p=0.04$ ). No statistically significant differences were identified for fulfillment, work exhaustion, alignment, work overload and teamwork scores after training.

## **CONCLUSION**

Formal instruction in leading wellness improved work-life conflict for academic radiology leaders. There was no significant change in burnout, fulfillment nor organizational alignment of the leaders.

## **CLINICAL RELEVANCE/APPLICATION**

Formal instruction in leading wellness raised awareness and improved work-life conflict in academic radiology leaders.

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## Abstract Archives of the RSNA, 2023

M5B-SPNR

### Neuroradiology Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPNR- Advanced MRI Techniques in the Diagnosis of Amyotrophic Lateral Sclerosis (ALS): Morphometry, DTI, ASL Perfusion and BOLD Connectivity** 10

Jose Manuel Hidalgo Gomez De Travededo, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Amyotrophic lateral sclerosis (ALS) is a chronic and progressive neurodegenerative disease characterized by damage to the upper and lower motor neuron, whose diagnosis is currently based on clinical criteria. This study aims to analyze structural and functional MRI parameters in ALS patients to define imaging biomarkers.

#### **METHODS AND MATERIALS**

An observational cross-sectional study was conducted with a sample of 71 subjects; 34 patients diagnosed with ALS according to El Escorial criteria and 37 age and gender-matched healthy subjects. All participants underwent a basal 3T-MRI including 3D T1WI morphometric sequences, Susceptibility Weighted Imaging (SWI), Diffusion Tensor Imaging (DTI), perfusion Arterial Spin Labeling (ASL) and functional MRI (BOLD), as well as a neuropsychological evaluation. Patients underwent a second MRI and neuropsychological assessment six months later. Post-processing analysis was performed using FreeSurfer, MRTrix, TBSS, BASIL and CONN toolbox software.

#### **RESULTS**

Morphometric analysis demonstrated greater cortical atrophy in ALS patients, highlighting rolandic regions with left predominance, bilateral amygdala and cerebellum. An association between atrophy and some clinical phenotypes, including cognitive impairment, was found. Greater iron deposition in the rolandic cortex of the patients was quantified by SWI. DTI analysis identified widespread white matter damage in ALS patients, with decreased fractional anisotropy and increased mean diffusivity, in anterior temporal lobe and left frontal lobe. Asymmetric left predominantly disruption of the proximal corticospinal tract (CST), left superior longitudinal fasciculus and frontal aslant tract damage were also notified. Functional connectivity showed foci of motor network impairment in superior and middle frontal gyri and left fusiform gyrus. At six-month reassessment, patients showed an asymmetric progression of the atrophy in rolandic cortex, predominantly right, and cingulate gyrus; further disruption of white matter tracts in frontal and temporal lobes, corpus callosum and CST; and small areas of increased connectivity in motor network and DMN.

#### **CONCLUSION**

Advanced MRI techniques permit the identification of structural and functional damage in the brain of ALS patients and demonstrate progression of the atrophy over time. Involvement of motor and extra-motor areas was objectified, supporting the relationship between this condition and the group of frontotemporal dementias.

#### **CLINICAL RELEVANCE/APPLICATION**

ALS is a rare and fatal disease whose diagnosis, based on clinical parameters, is often delayed. Imaging biomarkers through advanced MRI techniques could improve diagnostic accuracy and positively impact healthcare practice.

#### **M5B-SPNR- Prediction of Conversion to Parkinson's Disease in Individuals with Prodromal Symptoms** 11 **through a Machine Learning Model using MRI**

Na-Young Shin, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Prodromal Parkinson's disease (PD) is the phase during which progressive neurodegenerative pathology is initiated, but motor features necessary for the diagnosis of PD are not yet manifested. Such preclinical nature of prodromal PD leads to the notion

that prodromal PD could be considered as being somewhere in between healthy and PD. In this study, we tested the notion by classifying individuals with prodromal PD into those close to healthy and PD respectively and checking plausibility of such distinction.

## **METHODS AND MATERIALS**

From the Parkinson's Progression Markers Initiative (<https://www.ppmi-info.org/>), 75 healthy individuals (59.9±11.3 years, 26 women), 132 individuals with PD (60.7±9.2 years, 44 women), and 66 individuals with prodromal PD (62.3±7.6 years, 31 women) for whom structural and diffusion-weighted MRI data were available at the baseline were included. A machine learning model for distinguishing healthy and PD was constructed using the random forests method based on brain structural features in terms of cortical thickness in 62 grey matter regions and fractional anisotropy in 48 white matter regions. The constructed model was externally tested for additional individuals (83 healthy individuals and 130 individuals with PD). Individuals with prodromal PD were divided into healthy-like and PD-like ones by making predictions with the model, while development of PD at follow-ups was assessed for them.

## **RESULTS**

For individuals with prodromal PD, motor symptoms as assessed with the Unified Parkinson's Disease Rating Scale Part III was significantly lower than individual with PD. In classifying healthy and PD, the machine learning model showed adequately high performance in cross-validation (accuracy = 91.3%) and external validation (accuracy = 93.8% for healthy individuals and 86.7% for individuals with PD). When the model was applied to individuals with prodromal PD, 40 were classified as PD-like ones while the other 26 were classified as healthy-like ones. Of 26 individuals with prodromal PD who were classified as PD-like ones, 8 (30.8%) converted to PD, while none of those who were classified as healthy-like ones were found to develop PD later ( $p = 0.018$  in Fisher's exact test).

## **CONCLUSION**

The externally validated machine learning model for classifying healthy and PD could be used to distinguish healthy-like and PD-like ones among individuals with prodromal PD. Occurrence of all PD converters in PD-like ones suggests that individuals with prodromal PD could be differently positioned on the course of PD development according to their individual risks.

## **CLINICAL RELEVANCE/APPLICATION**

Distinguishing PD-like ones from healthy-like ones among individuals with prodromal PD may help to assess the risk of developing PD.

## **M5B-SPNR- Quantitative Parameter Mapping of Brain Structure and Components in Parkinson's Disease and Progressive Supranuclear Palsy**

Yuki Matsumoto, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Our aim was to simultaneously evaluate changes in brain structure and components, depending on the level of dopamine receptor cells, in Parkinson's disease (PD) and progressive supranuclear palsy (PSP) using the quantitative parameter mapping (QPM) technique. Additionally, we investigated whether there were differences in the quantitative values of proton density, T1, T2\*, and quantitative susceptibility mapping (QSM) between PD and PSP patients.

## **METHODS AND MATERIALS**

A total of 44 patients with PD and PSP Richardson syndrome (PSP-RS), all of whom provided informed consent, underwent a 3T MRI brain scan (FUJIFILM Healthcare Corporation) and ioflupane [123I] SPECT (DaTscan, SIEMENS Healthcare). In this study, the quantitative values of proton density, T1, T2\*, and QSM images were generated. Additionally a synthetic T1-weighted (T1w) image was computed from the T1 map. FreeSurfer was used to estimate the brain volume, cortical thickness, and local gyrification index (LGI) in each region from the synthetic T1w data of these patients. Furthermore, regions of the left and right substantia nigra and red nucleus were determined by drawing a region of interest (ROI) for each patient. The parcellated results were then compared to the average specific binding ratio (SBR) adjusted by age, or the asymmetry index (AI) in the striatum using Pearson correlation coefficients ( $r$ ). Subsequently, the mean proton density, T1, T2\*, and QSM values of each brain region were measured using the parcellated results so as to investigate the relationship between the average SBR and the mean quantitative values. Finally, the standardized mean difference (SMD) was calculated. For SMD calculations, patients with a SBR<4.5 were included to determine differences between PD and PSP patients.

## **RESULTS**

We observed significant positive or negative correlations between the average SBR, cortical thickness, segmented volume, and mean quantitative values (refer to figure). Notably, the right amygdala exhibited the strongest correlation ( $r=0.54$ ), with a volume decrease observed depending on the average SBR. Our results were consistent with previous findings in cases when the correlation was strong.

## CONCLUSION

Our findings suggested that QPM can simultaneously evaluate changes in brain structure and components related to dopamine receptor cell levels. Moreover, QPM may prove to be a valuable tool for differentiating between PD from PSP in future research.

## CLINICAL RELEVANCE/APPLICATION

QPM has the ability to simultaneously detect changes in brain structure and components based on dopamine receptor cell levels, all within a short scan time. This makes it a valuable tool that may have clinical applications.

## M5B-SPNR- Cortical and Subcortical Morphological Alterations in Parkinson's Disease Patients with Depression 13

Mingrui Qu (*Presenter*) Nothing to Disclose

### PURPOSE

We aimed to explore the alteration pattern of cortical thickness and subcortical volume in Parkinson's disease (PD) with depression and their correlation with the severity of the depressive symptom.

### METHODS AND MATERIALS

PD patients with depression (PDD) (n=42), PD patients without depression (PDND) (n=26) and healthy controls (HC) (n=33) were studied. All subjects underwent a 3D-T1 sequence. FreeSurfer was used to derive measures of cortical thickness and deep grey matter nuclei volume. The FreeSurfer's QDEC was used for cortical thickness analysis and correlation analysis. Multiple comparisons were corrected with Monte Carlo Simulations set at  $P < 0.05$ . ANOVA was applied to compare the subcortical grey matter nuclei volume differences. Age, gender and education were included as covariates.

### RESULTS

The demographic and clinical data are summarized in Table 1. PDD group showed decreased cortical thickness compared to HC in the bilateral superior frontal gyrus, left middle temporal gyrus, right superior temporal gyrus, right insula, and right bankssts. A lower cortical thickness was observed in PDND group compared to HC in the left superior frontal gyrus, right rostral anterior cingulate and right superior temporal gyrus. PDD group only showed decreased cortical thickness in the right superior temporal gyrus compared to PDND group (Figure 1, Table 2). Cortical thinning correlated with higher HAMD scores in the middle temporal gyrus (Figure 2). In subcortical nuclei, PDD group showed significantly reduced volumes in bilateral hippocampus ( $p < 0.001$ ), bilateral amygdala ( $p = 0.008$ ), left thalamus ( $p < 0.001$ ) and right nucleus accumbens ( $p < 0.001$ ) compared to HC. PDD group showed significantly reduced volumes in left thalamus ( $p = 0.008$ ) and right nucleus accumbens ( $p = 0.001$ ) compared to PDND group. However, the volume of bilateral caudate and putamen ( $p < 0.01$ ) increased significantly compared with HC in the two PD groups (Figure 3).

## CONCLUSION

Depression has an impact on subcortical nuclei volume and cortical thickness in PD patients. Alterations were found in the frontotemporal regions, thalamus, nucleus accumbens and limbic brain region. Interestingly, this study indicated the volumes of bilateral putamen and caudate increased in the PD group; the effect may be due to a compensatory response to impaired cerebral function in early PD.

## CLINICAL RELEVANCE/APPLICATION

We explored the alteration pattern of cortical thickness and subcortical nuclei volumes in PDD. Our study implies the distinct effects of the frontotemporal regions, thalamus, nucleus accumbens and limbic brain region on emotional regulation in PD patients. Our results may guide the discovery of neuroimaging markers and underlying mechanisms related to emotional disorders in PD.

## M5B-SPNR- Advanced MRI Neuroimaging Biomarkers in Alzheimer's Disease and Their Association with Liquid Biopsy 14

Jose Manuel Hidalgo Gomez De Travededo, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Alzheimer's disease (AD) is the most frequent cause of age-related dementia, but it is only suspected when clinical cognitive decline appears and, by then, neural damage is already irreversible. The aim of this study is to define MRI biomarkers to improve diagnostic accuracy and to investigate their relationship with the recently described technique of liquid biopsy (LB).

### METHODS AND MATERIALS

An observational cross-sectional study was conducted with a sample of 150 subjects; 59 patients diagnosed with "dementia due to probable AD" according to NIA-AA criteria and 91 age- and gender-matched healthy subjects. Both groups were drawn from the cohort of a previous neuroepigenetic investigation (iBEAS) carried out in our institution. Participants underwent a 3T

MRI including T1WI morphometric sequences, diffusion tensor imaging (DTI) and Arterial Spin Labeling (ASL) perfusion assessment. Post-processing analysis was performed using FreeSurfer, TBSS and BASIL software. iBEAS group had previously identified in LB a series of differentially methylated genes in patients with AD that were proposed as potential biomarkers. In the current project, its association with the alterations detected in MRI was investigated.

## **RESULTS**

Morphometric analysis showed a marked cortical atrophy in AD patients, highlighting gray matter loss in medial temporal lobe and thalamus. In addition, certain relationships were demonstrated between clinical and epidemiological variables such as age, sex, time of evolution and score on the Mini Mental State Evaluation and atrophy. DTI revealed damage in corpus callosum and fornix, fronto-parieto-temporal deep white matter and parahippocampal gyri. ASL showed hypoperfusion in dorsolateral prefrontal cortex, inferior parietal and temporal lobe and posterior cingulate/precuneus. In the analysis of the results of the liquid biopsy, patients with differentially methylated ISR-2 and TREM-2 genes presented foci of cortical atrophy in the left frontal, right temporal, and bilateral parietal lobes; and in the lower region of the left cerebellar hemisphere respectively. DTI analysis showed greater disruption of white matter tracts in patients with differentially methylated APOE E4, IRS-2 and TREM-2.

## **CONCLUSION**

Advanced MRI permits the identification of structural and perfusion brain damage in AD. The association between differential methylation of some genes studied by LB and the pattern of brain atrophy could open the door to the development of new biomarkers of the disease.

## **CLINICAL RELEVANCE/APPLICATION**

AD is a frequent condition whose current diagnosis is mainly clinical and in most cases delayed. Advanced MRI biomarkers and liquid biopsy could improve diagnostic accuracy and positively impact healthcare practice.

## **M5B-SPNR- The Accero-Rex-Stent - A Giant Stent For Giant Aneurysms**

3

Hermann Kraehling, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Until now, the treatment of giant fusiform aneurysms of the posterior circulation has been a disease that is difficult or impossible to treat, mostly due to the lack of availability of a large-format stent. In this multicentre study, we report on the world's first five clinical deployments of the Accero-Rex-Stents (Acandis) for the treatment of fusiform giant aneurysms.

### **METHODS AND MATERIALS**

The Accero-Rex-Stents are self-expanding, braided, fully radiopaque Nitinol stents. They are available in three different sizes (diameter 7 - 10 mm, length 30 - 60 mm) and intended for implantation in vessels with diameters of 5.5 - 10 mm. The stents were implanted in aneurysm of the posterior circulation.

### **RESULTS**

Five patients with large fusiform aneurysms of the posterior circulation were treated endovascularly using the Accero-Rex-Stents. There were no major technical complications peri- and post-intervention and the implanted stents showed proper contrast perfusion in all follow-up examinations. A significant remodelling and reduction in the size of the stent-covered aneurysms was already seen in the short-term post-interventional course, no major clinical complications occurred.

### **CONCLUSION**

The Accero-Rex-Stents were used safely in five patients for the treatment of fusiform aneurysms of the posterior circulation without any technical complications. The treatment options of giant fusiform aneurysms are extended by the Accero-Rex-Stents.

### **CLINICAL RELEVANCE/APPLICATION**

The treatment options of giant fusiform aneurysms are extended by the Accero-Rex-Stents.

## **M5B-SPNR- A Systematic Search and Analysis of Diagnostic Reference Levels (DRLs) in Interventional Neuroradiology (INR)**

5

Marvin Grech (*Presenter*) Nothing to Disclose

### **PURPOSE**

The purpose of this study was to identify whether DRLs for diagnostic and interventional neuroradiology have been previously published and whether any guidelines specify optimal or maximum safe doses for various INR procedures. DRLs are crucial in standardizing practice and may potentially reduce radiation doses during such interventions. In general, INR procedures tend to be associated with high radiation doses both to the patient and operators.



## METHODS AND MATERIALS

An extensive electronic search of the literature was performed using 3 different databases, namely Scopus, Web of Science, and PubMed, without language restrictions. Four main keywords were identified for this search as follows: Dose Area Product (DAP), Fluoroscopy Time (FT), Cumulative Air Kerma (CAK) and Diagnostic Reference Levels (DRLs). The keywords and various synonyms were integrated using the Boolean operators "OR" and "AND". A reference management software was used to import the search results from the 3 databases and the results were scanned for duplicates. Strict inclusion and exclusion criteria were developed, and the abstracts were scanned to check whether the studies met the inclusion criteria. All exclusion and inclusion decisions were documented via the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA).

## RESULTS

The included studies were categorised into 4 main groups: - namely 'Cerebral Angiography', 'Aneurysm Coiling', 'Stroke (Thrombectomy)' and 'AVM/AVF Embolization'. The 3rd Quartile Values for DAP, Air Kerma, Fluoroscopy Time and Image Frames from each of the included studies recorded and tabulated for the 4 categories. Analysis of these values were then performed and screened for significant differences. The authors also sought to identify potential reasons for such discrepancies within the included studies.

## CONCLUSION

To date, few studies have published data regarding DRLs in INR procedures. Guidelines are necessary both for quality control and to reduce procedural radiation doses to "as low as reasonably achievable" as per the "ALARA" principle. This analysis has gathered all the available literature on the matter and may help in future development of standard acceptable doses in INR.

## CLINICAL RELEVANCE/APPLICATION

Identification and analysis of DRLs in INR procedures is essential for subsequent development of recommended radiation doses. Adherence to such recommendations may reduce radiation exposure to "as low as reasonably achievable".

## M5B-SPNR- Selective Aberrant Alterations in Structural-functional Coupling of Large-scale Brain Networks with Progressive Supranuclear Palsy

Junyu Qu, BMedSc (*Presenter*) Nothing to Disclose

## PURPOSE

We combined functional and structural connectivity to investigate both global and modular-specific topology changes in the brain following progressive supranuclear palsy (PSP). We also hypothesized that the disruption of connections may lead to structural-functional (S-F) connectivity alterations.

## METHODS AND MATERIALS

In our study, 51 PSP and 101 healthy control (HC) subjects were enrolled. These participants underwent 3D-T1WI, rs-fMRI, DTI and neuropsychological assessment. Furthermore, two weighted adjacency matrices, representing the structural and functional connectome, were created using the same cortical parcellation. S-F coupling was determined to use the Spearman rank correlation. Then, the intramodular and intermodular connectivity strengths were computed and the graph-theoretic method was used to calculate network topology metric. Finally, we make correlations between clinical scales and S-F coupling.

## RESULTS

For structural connectivity network (SCN), compared with HCs, the intramodular structural connectome of PSP in subcortical cortex (SC) decreased significantly. The intermodular SCN between SC and the sensorimotor network (SMN) decreased, while the connections between SC and limbic network increased (FDR  $q < 0.001$ ). The characteristic path length ( $L_p$ ) was significantly increased. At the nodal level, these alterations were in SMN, dorsal attention network (DAN), ventral attention network (VAN), frontoparietal network, default mode network (DMN) and SC. For functional connectivity network (FCN), the intramodular functional connectome of PSP in DMN decreased significantly. As the intermodular FCN, DAN-DMN, DAN-SMN, DAN-VAN and DAN-VN decreased (FDR  $q < 0.001$ ). At the global level, the normalized clustering coefficient (?), small worldness ( $s$ ) and  $L_p$  were significantly increased and normalized characteristic path length (?) was decreased. Both PSP and HC groups showed significant correlations in regional S-F connectivity ( $P < 0.05$ ). Besides, we compared regional S-F coupling between PSP and HC by two-sample T-test. We found that PSP increased significantly in visual network (VN), VAN and DMN. Finally, there is no association between S-F coupling and clinical variables.

## CONCLUSION

The S-F coupling features in PSP are aberrant. These results could contribute to better comprehending the relationships between structural and functional underlying the motor impairments in PSP.

## CLINICAL RELEVANCE/APPLICATION

Our study discovered increased S-F coupling in PSP, which would indicate the additional breakdown of coherence between brain function and structural connections after brain damage. These findings suggest that functional reorganization occurs along indirect anatomical pathways in PSP.

### **M5B-SPNR- 8 Development and Validation of a Deep Learning-based Automatic Brainstem Segmentation and Multi-class Classification Algorithm for Parkinsonian Syndromes using 3D T1-Weighted Images**

Seongken Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a deep learning-based automatic brainstem segmentation and multi-class classification algorithm for parkinsonian syndromes.

#### METHODS AND MATERIALS

The model was developed using 3D T1-weighted brain MR images from subjects that were either cognitively normal or had progressive supranuclear palsy, multiple system atrophy of the cerebellar variant, or Parkinson's disease. We used 2D U-NET for architecture and a multi-view ensemble strategy. The final output was inferred using ensembled probabilities. To assess our segmentation performance using Dice similarity coefficient (DSC), we compared segmentation masks with manual labels in both training and external datasets. We evaluated classification performance based on the regional volumetric measurements obtained from segmentation. The multi-class performance was evaluated using five-fold cross-validation. Three classification models based on support vector machine (SVM), random forest, and XGBoost were trained. We adopted the area under the receiver operating characteristic curve (AUROC) as a representative value of classification performance.

#### RESULTS

In total, 300, 513, 82 eligible patients were recruited as training, internal, and external dataset, respectively. Our model achieved DSC scores of 0.969 and 0.996 in the training and external datasets, respectively, when compared to the manually labeled ground truth masks for the brainstem region. The multi-class classification algorithm using SVM showed higher differentiation performance than the two other approaches. The AUROCs for SVM were  $0.937 \pm 0.022$  ( $\pm$  standard deviation) and 0.914 for internal and external validation, respectively.

#### CONCLUSION

We developed and validated a deep learning model using 3D T1-weighted brain MR images which may allow for fast and accurate differentiation of parkinsonian syndromes.

## CLINICAL RELEVANCE/APPLICATION

Considering the widespread availability of T1-weighted brain MRI, this automated brainstem segmentation algorithm might be a promising and widely applicable method for the differentiation of parkinsonian syndromes in the clinical practice.

### **M5B-SPNR- 9 Alterations in T1, Proton Density and T2\* Properties of Deep Brain Nuclei in Parkinson's Disease Patients Measured by Synthetic MRI**

Jinghan Zhao (*Presenter*) Nothing to Disclose

#### PURPOSE

Combined application of T1, proton density and T2\* map for the differential diagnosis of Parkinson disease (PD) from health controls with the Strategically Acquired Gradient Echo (STAGE) technique.

#### METHODS AND MATERIALS

41 PD patients and 38 volunteers as the control group were prospectively enrolled. Brain MRI examinations, including STAGE, were performed at 3T (Ingenia CX, Philips Healthcare, the Netherlands). T1, proton density and T2\* maps were obtained after post-processing. The nuclei included in this study were caudate nucleus (CN), putamen (PUT), globus pallidus (GP), thalamus (THU), red nucleus (RN), black nucleus (SN) and dentate nucleus (DN). The regions of interest (ROIs) to cover these structures were manually drawn on T1, proton density and T2\* maps by two researchers using SPIN (Signal Processing in NMR, SpinTech, Inc., Bingham Farms, MI, United States), and the mean value within each ROI was measured and recorded. Statistical analysis was performed using SPSS20.0 software, and the normal distribution was tested in each group. Data in accordance with normal distribution were expressed as means  $\pm$  standard deviation, while the others expressed by median (upper and lower quartiles). Independent sample t-test or Mann-Whitney U test (not in accordance with normal distribution) were used to compare the mean values of T1, proton density and T2\* between PD and control group in both hemispheres, and the differences between the left and right were tested by independent sample t-test or Mann-Whitney U test. A P-value  $<0.05$  was considered statistically significant.



## RESULTS

Compared to the control group, the T1 values of the CN, GP, RN and the proton density values of the CN, PUT, THU, RN were significantly reduced in the PD group, while the T1 values of the DN was increased. ( $P < 0.05$ ) (Table 4-5, Figure 1-2). Meanwhile the T2\* value of the SN was significantly reduced and the THU was increased in PD patients. ( $P < 0.05$ ) (Table 6, Figure 3). In control group, the T1 values of the right THU and DN and the proton density value of the right DN were significantly lower than when compared to their counterparts in the left. There was no difference in the T1 proton density and T2\* values between the affected side and the healthy side in the PD group. ( $P < 0.05$ ) (Table 1-3, 7-9)

## CONCLUSION

In summary, we found the alterations of T1, proton density and T2\* values may reflect the microstructural changes of deep brain nuclei.

## CLINICAL RELEVANCE/APPLICATION

Combined application of T1, proton density and T2\* map for the differential diagnosis of Parkinson disease (PD) from health controls is potentially promising and valuable methods in clinical application.

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## Abstract Archives of the RSNA, 2023

M5B-SPOB

### OB/Gynecology Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPOB- Automatic Detection and Segmentation of Ovarian Epithelial Tumor using a Multitask Model** **1** in CT Images

Jing Ren, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

It is of great importance to identify the location and boundary of the ovarian tumors on medical images. The study aimed to develop and validate a multitask model utilizing the 3D nnU-Net framework in multicentric datasets, which can simultaneously complete the tasks of ovarian tumor detection and segmentation.

#### **METHODS AND MATERIALS**

Multiphase contrast-enhanced CT images from 748 patients who were histologically diagnosed with ovarian epithelial tumors between January 2016 and September 2022 were obtained from two medical centers. The internal dataset from center A consisted of a training set (n=405) and a testing set (n=135), and the external dataset contained 208 patients from center B. The manual annotations of the primary ovarian tumors by two professional radiologists were served as the ground truth of the datasets. The multitask model utilizing the 3D nnU-Net framework was trained for 500 epochs with a loss function that combined binary cross entropy loss and Dice loss. The training procedure involved the 5-fold cross-validation method, and the ensemble prediction was utilized. The segmentation performance was evaluated using the Dice similarity coefficients (DSCs), 95% Hausdorff distance (HD95), and Average Surface Distance (ASD). To evaluate the detection performance of the model, the recall and precision metrics were calculated.

#### **RESULTS**

The proposed multitask model exhibited good segmentation performance both in the internal and external testing sets, with average DSCs of 91.2% and 85.1%, respectively. The HD95 and ASD of the model were  $17.79 \pm 35.24$  and  $2.86 \pm 7.27$  in the internal testing set, and  $20.99 \pm 31.41$  and  $4.73 \pm 11.73$  in the external testing set. For the task of ovarian tumor detection, the model showed good performance (recall = 95.3% and precision = 72.9%) in the internal dataset, and promising result (recall = 88.7% and precision = 63.4%) in the external dataset.

#### **CONCLUSION**

The proposed multitask model shows promising in the automatic detection and segmentation of ovarian epithelial tumors.

#### **CLINICAL RELEVANCE/APPLICATION**

Our proposed multitask model can automatically and accurately complete the tasks of ovarian tumor detection and segmentation, thus avoiding time-consuming and labor-intensive manual operations.

#### **M5B-SPOB- Don't Forget about the Teens! Does Adenomyosis Also Affect Young Girls** **2**

Ana Luiza G. Di Mango, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the difference in prevalence and pattern of adenomyosis between adolescents and reproductive-age adults patients.

#### **METHODS AND MATERIALS**

In a retrospective study, we evaluated the findings of dedicated pelvic magnetic resonance imaging (MRI) with a medical request of endometriosis/pelvic pain in 192 female patients, of which 96 were adolescents (aged between 11-19 years) and

others 96 were reproductive-age adults. Two radiologists independently evaluated the exams. Adenomyosis was defined as the ectopic presence of endometrium as a punctuate high-intensity T2-weighted signal in the junctional zone (JZ) seen in MRI.

## **RESULTS**

The prevalence of adenomyosis in adolescents patients was 8.3% (n=8) and in adult patients was 23% (n=22). Superficial adenomyosis was the most prevalent pattern in adolescent patients, with seven cases (87.5%), while only one case (12.5%) had deep adenomyosis with uterine cavity distortion. In adult patients, the most prevalent pattern of adenomyosis involvement was also superficial (n=11, 50%), followed by deep adenomyosis with uterine cavity distortion (n=8, 36.4%) and deep involvement without cavity distortion (n=3, 13.6%).

## **CONCLUSION**

Adenomyosis, like in adults patients, is one of the manifestations of endometriosis in adolescents patients, with a difference in prevalence of 14.7% in our study. The most common pattern of involvement in both groups was superficial.

## **CLINICAL RELEVANCE/APPLICATION**

The presence of pelvic pain and/or hypermenorrhea in adolescents patients should raise the suspicion of endometriosis, which despite being more common in adult patients, also affects the first group. Early suspicion and diagnosis of adenomyosis can reduce long-term morbidity.

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## Abstract Archives of the RSNA, 2023

M5B-SPPD

### Pediatric Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPPD- Clinical Value of Virtual Unenhanced CT Images for Children with Hepatic Tumors: CT Measurement and Lesion Detection** 1

Wei Weian (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To access the feasibility of multi-material decomposition based virtual unenhanced images (VUE) replacing true non-contrast (TNC) images in the CT follow-up of children with hepatic tumor

#### **METHODS AND MATERIALS**

This study retrospectively collected 24 children with hepatic tumor who received conventional non-contrast CT scan and sequent dual phase contrast-enhanced spectral CT scans. VUEs were generated at artery phase [VUE(A)] and portal vein phase [VUE(PV)]. Regions of interest were placed on liver parenchyma and tumor site, CT values were measured. The consistency of CT measurement on two-group images were accessed by Pearson analysis and Bland-Altman method. The detection rate of liver tumor lesions was also evaluated with pathologic examination and CT follow-up as standard reference.

#### **RESULTS**

The 24 children contained 10 with hepatoblastoma, 6 with hemangioma, 5 with focal nodular hyperplasia, 2 with hepatic metastases from neuroblastoma and 1 with lymphomatosis. Including 12 showing hypovascular and 12 cases showing hypervascular. The CT<sub>liver</sub> among three-group images shown no statistical difference (both  $P > 0.05$ ), while CT<sub>tumor</sub> were higher in VUEs than TNC ( $P < 0.05$ ). The CT<sub>liver</sub> and CT<sub>tumor</sub> between VUE(A) and VUE(PV) images exhibited strong positive correlation ( $r_{liver} = 0.878$ ,  $r_{tumor} = 0.972$ ,  $p < 0.001$ ). The CT<sub>liver</sub> showed strong correlations between TNC and VUEs [ $r_{VUE(A)} = 0.787$ ,  $r_{VUE(PV)} = 0.802$ ,  $p < 0.001$ ]. For CT<sub>tumor</sub>, VUE(PV) showed moderate correlation [ $r_{VUE(PV)} = 0.497$ ,  $p = 0.014$ ] while VUE(A) showed no correlation ( $r_{VUE(A)} = 0.394$ ,  $p = 0.057$ ) with TNC, however for hypervascular tumors the CT<sub>tumor</sub> had strong correlation between VUE(A) and TNC ( $r = 0.749$ ,  $p = 0.005$ ). Bland-Altman analysis displayed that the VUE(A) had 6 cases and VUE(PV) had 7 cases where the CT<sub>tumor</sub> bias to TNC larger than 10 HU, therein most had hypervascular lesions. For lesion detection, there were total of 111 lesions, TNC, VUE(A) and VUE(PV) had detection rates of 68.47%, 57.66% and 83.78%, respectively.

#### **CONCLUSION**

For CT follow-up of children with hepatic tumor, VUE(PV) could replace TNC, VUE(PV) had good correlation with TNC in CT<sub>liver</sub> and CT<sub>tumor</sub>, and VUE(PV) improved tumor lesion display and internal structure announcement.

#### **CLINICAL RELEVANCE/APPLICATION**

Patients with hepatic tumors need long-term CT follow-up, but children are sensitive to X-ray exposure, excessive radiation may affect growth and development. The CT values measured on the VUE(PV) generated from the enhanced spectral CT data are correlated with that on TNC, and VUE(PV) can improve the lesion detection, so VUE(PV) could replace TNC and reduce the radiation dose of one unenhanced CT scan in the follow-up of children with hepatic tumors.

#### **M5B-SPPD- A Comparative Analysis of Clinical and MRI Characteristics of Atypical Teratoid Rhabdoid Tumors and Medulloblastomas of the Posterior Fossa in Pediatric Patients** 2

Hsinwei Wu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Atypical teratoid rhabdoid tumor (AT/RT) typically presents at a younger age and had a poorer prognosis compared to medulloblastoma. Notwithstanding, these two neoplasms share a considerable degree of neuroimaging overlap and are nearly indistinguishable on MRI. The aim of our study was to discriminate between AT/RT and medulloblastoma through retrospective analysis of their clinical and MRI features, with the ultimate goal of improving treatment strategies and prognostic assessment.

## METHODS AND MATERIALS

Between 2005 and 2022, a total of 16 patients with histopathologically confirmed AT/RT and 58 patients diagnosed with medulloblastoma were retrospectively enrolled from our institution. We evaluated their clinical data and MRI findings, including lesion signals, intratumoral morphologies, and peritumoral/distal involvement.

## RESULTS

The age of children diagnosed with AT/RT was younger than that of children with medulloblastoma ( $2.8 \pm 4.9$  [0-17] vs.  $6.6 \pm 4.0$  [0-18],  $P < .001$ ), and the overall survival rate was lower (21.4% vs. 66.7%,  $P = .005$ ). With regards to lesion signals on MRI, AT/RT exhibited a lower ADCmin (cutoff value =  $544.7 \times 10^{-6}$  mm<sup>2</sup>/s, area under the curve [AUC]=0.845,  $P < .001$ ), a lower ADC ratio (cutoff value = .705, AUC=0.860,  $P < .001$ ), and a higher DWI ratio (cutoff value = 1.595, AUC=0.802,  $P < .001$ ) than medulloblastoma. In respect to the intratumoral morphologies, the manifestation of the "tumor central vein sign" was found to be predominantly limited to medulloblastoma while being absent in cases of AT/RT (24/58 [41.4%] vs 1/16 [6.3%],  $P = .008$ ). For the peritumoral invasion detected on T2WI, AT/RT demonstrated a greater propensity for invasion of the brainstem ( $P < .001$ ) and middle cerebellar peduncle ( $P < .001$ ) compared to medulloblastoma.

## CONCLUSION

MRI findings that include a lower ADC value, greater peritumoral invasion, and the absence of a "tumor central vein sign" have shown promise in distinguishing AT/RT from medulloblastoma. These discernible MRI features, coupled with the comparatively younger age of AT/RT patients, may account for the inferior prognoses observed in this patient population.

## CLINICAL RELEVANCE/APPLICATION

AT/RT can be distinguished from medulloblastoma based on specific MRI findings, such as a lower ADC value, greater peritumoral invasion, and the absence of the "tumor central vein sign." A combination of these MRI features and the patient's age can improve the accuracy of a pretreatment diagnosis of AT/RT versus medulloblastoma. This improved diagnostic accuracy can help guide treatment strategies and aid in prognostic assessment.

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## Abstract Archives of the RSNA, 2023

M5B-SPPH

### Physics Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPPH- CT Number Reliability on Energy Integrating and Deep Silicon Photon Counting Detector CT 10 with Patient Size**

Aria M. Salyapongse, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In this study we compared the CT number of six clinically relevant materials on an energy-integrating detector (EID) and a prototype deep silicon photon-counting detector (PCD) CT as an effect of patient size.

#### **METHODS AND MATERIALS**

We performed three sets of dose-matched scans on a patient size-mimicking phantom (Mercury Phantom, Gammex), (1) 120 kV single-energy (SE) EID CT, (2) 80/140 kV rapid kV-switching dual-energy (DE) EID CT, and (3) 120 kV deep silicon PCD CT. Average CT number was calculated for air, water, polystyrene, iodine 10 mg/mL, bone, and polyethylene in (1) 120 kV polychromatic EID, (2) 70 keV monochromatic EID, and (3) 70 keV monochromatic deep silicon PCD image volumes. Trends in CT number with patient size were assessed by plotting CT numbers against phantom water equivalent diameter (WED). Slopes were compared using t-tests with multiple comparison adjustment to assess whether trends in CT number with WED were decreased for deep silicon PCD CT relative to EID CT. CT number accuracy was assessed by calculating ideal material CT numbers using the U.S. National Institute of Standards and Technology (NIST) XCOM database toolkit.

#### **RESULTS**

For all tested materials, deep silicon PCD CT had the smallest magnitude slope of CT number over WED. Deep silicon PCD CT slopes compared with SE EID CT and DE EID CT reached statistical significance for air ( $p = .03$ ,  $p = .007$ ), water ( $p = .02$ ,  $p = .03$ ), iodine 10 mg/mL ( $p < .001$ ,  $p = .04$ ), and bone ( $p < .001$ ,  $p < .001$ ). The accuracy of deep silicon PCD CT was higher than either SE or DE EID CT for all materials based on relative root mean square error. All materials except air had negative slopes for CT number with WED. The slopes for iodine and bone were smallest for deep silicon PCD CT, then DE EID CT, followed by SE EID CT: 20.3, 34.7, 81.5 HU/cm for iodine and 46.9, 113.1, and 186.6 HU/cm for bone, respectively.

#### **CONCLUSION**

The change in CT number over WED was smallest for deep silicon PCD CT for air, water, iodine 10 mg/mL, and bone. The CT number accuracy was closest to the ideal CT number on deep silicon PCD CT for all materials compared with SE and DE EID CT.

#### **CLINICAL RELEVANCE/APPLICATION**

Myriad characterizations in clinical radiology rely on accurate and stable CT numbers, use of deep silicon PCD CT could provide more consistent and accurate CT number over patient size and therefore better classification of tissue in clinical radiology.

#### **M5B-SPPH- Assessing the Efficacy of Multiple Additive Processing in Contrast Enhancement Boost CT 11 Technique for the Diagnosis of Hypervascular Hepatocellular Carcinoma**

Shinji Yabe, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

For accurate diagnosis of hepatocellular carcinoma (HCC) in contrast-enhanced CT (CE-CT), providing better tumor-to-liver contrast is desirable. Recently, it has been demonstrated that a post-processing technique (CE-boost; Canon Medical Systems) can enhance the degree of contrast in CE-CT and facilitate HCC detection. In this technique, an iodine image can be obtained by subtracting the precontrast from the contrast phase image and is added to the contrast phase image with a non-

rigid registration and denoising procedure. Despite the potential for further contrast enhancement via an additional additive process, the efficacy of this process remains unexplored. This study aimed to investigate the usefulness of the CE-boost technique with multiple additive processing for the evaluation of hypervascular HCC.

## **METHODS AND MATERIALS**

This retrospective study included 21 patients (age,  $74 \pm 8$  years; 13 men) with 31 hypervascular HCCs who underwent multiphasic CE-CT. In this study, the late arterial phase (LAP) and portal venous phase (PVP) images were used to evaluate hypervascular HCCs. In the LAP, three types of CE-boost images were created by one to three times additive processing (LAP A1, LAP A2, and LAP A3, respectively). Similarly, three types of CE-boost images were created in the PVP (PVP A1, PVP A2, and PVP A3). Tumor-to-liver contrast-to-noise ratios (CNRs) were calculated in the LAP and PVP and were compared among CE-CT and CE-boost images using the Wilcoxon signed-rank test with Bonferroni correction. Also, the presence or absence of artifacts caused by the CE-boost technique was evaluated using a 3-point scale (1= non-diagnostic, 2= slight artifact, and 3= almost no artifact).

## **RESULTS**

The mean size of lesions was  $18.8 \pm 15.5$  mm (range, 8-93 mm). The tumor-to-liver CNR was significantly higher in CE-boost (LAP A3) images ( $7.0 \pm 3.9$ ) than in LAP ( $2.9 \pm 1.9$ ), CE-boost (LAP A1) ( $4.3 \pm 2.5$ ), and CE-boost (LAP A2) images ( $5.8 \pm 3.9$ ) ( $P < 0.01$  for all). On the other hand, there were no significant differences in tumor-to-liver CNR among CE-CT and CE-boost images in the PVP ( $P > 0.99$  for all). Artifacts due to the CE-boost technique were not noticeable in all CE-boost images and were rated 3.

## **CONCLUSION**

The CE-boost technique with multiple additive processing can increase the conspicuity of arterial phase hyperenhancement of hypervascular HCC by improving the tumor-to-liver CNR. In contrast, improvements in tumor-to-liver CNR were not observed in the PVP for washout assessment of hypervascular HCC.

## **CLINICAL RELEVANCE/APPLICATION**

CE-boost with multiple additive processing can improve the degree of contrast effect of CE-CT effectively. This technique is especially beneficial in the detection of focal liver lesions that show arterial phase hyperenhancement.

## **M5B-SPPH- Low-dose Cerebral Perfusion CT Reconstruction Based on Voxel-level TAC Correction (VTC)** **12**

Zixiang Chen (*Presenter*) Nothing to Disclose

## **PURPOSE**

To propose a low-dose cerebral perfusion CT (PCT) image reconstruction method and promote the application of PCT imaging in clinical cerebrovascular diseases (CVD) diagnosis.

## **METHODS AND MATERIALS**

A regularized least-squares method with high interpretability based on voxel-level time-attenuation curve (TAC) correction (VTC) is proposed in this study for low-dose PCT image reconstruction. The theory of third-order Hermite interpolation (THI) is applied to voxel-level TAC correction during dynamic images reconstruction. Clinical PCT imaging data is involved for the evaluation of the proposed VTC method, with peak signal-to-noise ratio (PSNR) and structural similarity (SSIM) being the quantitative indexes for imaging performance measurements. Based on the reconstructed PCT images, hemodynamic maps, including cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transition time (MTT), are calculated to validate its ability to restore hemodynamic parameters.

## **RESULTS**

Indicated by the PSNR and SSIM values of the low-dose PCT images reconstructed by different methods, the proposed VTC method for low-dose PCT imaging has better performance than several state-of-the-art dynamic CT imaging methods, including the PICCS, ndiNLM, PIDT and NL-T-RPCA methods. Meanwhile, VTC provides the most accurate hemodynamic maps (CBF, CBV and MTT) among all the compared methods.

## **CONCLUSION**

The proposed VTC method is capable to reconstruct PCT image with satisfactory image quality under a low-dose PCT scan protocol.

## **CLINICAL RELEVANCE/APPLICATION**

The VTC method remarkably reduced the necessary radiational dose for PCT scan. This meaningful for promoting the application of PCT technique in the clinical diagnosis of CVD.

## **M5B-SPPH- Photo-realistic Virtual Endoscopy Images for CT Colonography** **13**

Kuuya Shiuchi (*Presenter*) Nothing to Disclose

## PURPOSE

Algorithms introducing photo-realism to the volume rendering (VR) have been investigated since early 2010s; as a result, some applications for photo-realistic VR (PRVR) have been clinically available. However, there are no applications for photo-realistic virtual endoscopy (PRVE) used for the CT colonography (CTC). An image-based deep-learning technique was proposed for CTC; however, CT-number information is ignored in it and it focused on a different reality. The purpose of this study was to investigate methodologies to achieve the PRVE for CTC and compare images between PRVE and a conventional VE.

## METHODS AND MATERIALS

To achieve photo-realistic rendering in VE, the rendering calculation of PRVR was modified to suit to a typical viewing field of VE. Unlike the conventional VR for CT, the photo-realistic rendering reflects the CT-number gradient with small fractions in the shading. Thus, the PRVE improves spatial resolution and is less sensitive to the image noise similarly to PRVR. Exploiting this feature, we reconstructed CT images with a high-resolution kernel to improve shape reproducibility of lesions. For the conventional VE (VEc), a standard kernel for abdomen was used. The following parameters were not altered from routine ones: a slice thickness of 1.0 mm, a table position increment of 0.5 mm, and a CT dose index of  $\sim 3.8$  mGy. The averaged rendering time per frame (RT) was measured for consecutive 100 renderings. One radiologist visually evaluated the superiority of PRVE over VEc using a five-point scale (1: worse, 2: somewhat worse, 3: equal, 4: somewhat better, 5: better) for image sharpness, artifact, lesion conspicuity, and gross morphology of ten clinical cases.

## RESULTS

The RTs of PRVE and VEc were 0.032 and 0.015 s, respectively. The average scores of visual comparisons for image sharpness, artifact, lesion conspicuity, and gross morphology were 5.0, 3.8, 4.1, and 5.0, respectively. The lesions were rendered more clearly with PRVE than with VEc, thanks to the photo-reality enhanced by the high-resolution kernel. Since the CT-number is reflected in the shading more in PRVE than in VEc, residual stools with tagging were able to be easily recognized in the PRVE images.

## CONCLUSION

The PRVE for CTC exhibited high-quality VE images with better visual evaluations compared to the conventional VE. The PRVE would be effective visualization method for CTC.

## CLINICAL RELEVANCE/APPLICATION

The PRVE can render lesions in CTC more clearly compared to the VEc. Moreover, it was effective in the fecal tagging because the CT number is more reflected in the PRVE rendering than in VEc rendering.

## M5B-SPPH- Advancing Optimization Strategies for Oncological Abdominal CT Scanning: The i-Violin EU 2 Project Approach Applied to Photon Counting CT

Gizem Yegin, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

To propose CT optimization curves to improve oncological imaging of chest-abdomen CT as worked out in the i-violin EU4Health supported multicenter project for CT Guideline development.

## METHODS AND MATERIALS

An anthropomorphic abdominal phantom with an extension ring (PTW, Germany) and a length of 17cm was scanned on a Siemens Naeotom Alpha photon-counting CT scanner (Siemens-healthineers, Germany). The phantom contains an in-house designed cylindrical insert placed in the center of it. The first half of the insert contains a collection of low-contrast spheres with sizes of 4, 6, and 8mm diameter (15 of each size) while the second half was background only to provide signal-free segments. CT acquisitions were performed with a large range of scanning parameters and reconstruction settings: tube voltage, CTDI, bowtie filter, reconstruction kernel, iterative reconstruction strength, field of view, matrix size, and slice thickness. An anthropomorphic channelized Hotelling model observer was used to predict the human detectability of the spherical targets. From the percentages of correctly detected spheres of the 3 diameters, the threshold diameter (Dtr) at 62.5% correct was determined via logistic regression (GraphPad Prism, USA), and the 95% CI were estimated via bootstrapping. Optimization curves were realized with all Dtr values for specific parameters, each obtained from all scans with these parameter values.

## RESULTS

The results of most CT scan parameter combinations were as expected. As an example, a doubled CTDI value corresponds to a significantly lower Dtr ( $p < 0.001$ ). The results allow to compare the relative impact of the CTDI to other parameters. The switch to a smaller field of view, different slice thickness, bowtie filter, and iterative reconstruction strength did not lead to a significantly different low-contrast image quality ( $p > 0.07$ ). The change to 1024x1024 matrix size from 512x512 gave a significant performance increase ( $p = 0.001$ ). Interestingly, despite the use of the same CTDI, for the phantom with an extension ring, the 120 kVp scan outperformed the 90 kVp scan, while this effect was inverted without the ring.



## CONCLUSION

From this systematic task-based comparison focused on soft tissue performance, it becomes possible to assess the effects of various parameters quantitatively. When completed with reference levels typically used by multiple centers, this approach may facilitate the development of practical guidelines to optimize CT scan protocols.

## CLINICAL RELEVANCE/APPLICATION

Quantitative and graphical representations of the Dtr values for the different conditions provide a fast approach to measures and parameter settings that would lead to improved soft tissue detection thresholds in abdominal oncological CT.

### **M5B-SPPH- Evaluation of Low-contrast Detectability of Abdominal Protocols in Clinical Photon-counting CT**

Jessica D. Flores, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

Accurate and clear representation of anatomy is essential in the assessment of pathology in clinical computed tomography (CT). With the introduction of photon-counting CT (PCCT) and more advanced iterative reconstruction (IR) algorithms into clinical practice, there is potential to improve low-contrast detectability in clinical CT protocols. Therefore, this work aimed to assess IR image quality to optimize low-contrast detectability and reduce radiation dose in a clinical abdominal CT protocol.

#### METHODS AND MATERIALS

Data were acquired on a clinical PCCT scanner, Siemens NAEOTOM Alpha. Low contrast detectability was investigated in the CTP 515 low contrast module of the Catphan 600 phantom, which was surrounded by a fat ring to simulate an abdomen and resulted in a water equivalent diameter of 298-mm. Supra-slice contrast rods with a nominal 1.0 % contrast and diameters of 4, 6 and 9 mm were used. A factory abdominal protocol was adjusted to acquire virtual monoenergetic images (VMI) with four tube voltages and two quantum IR (QIR) strengths. VMI were produced at the mean energy of the applied spectrum. The noise power spectrum and task transfer function of each scan protocol was quantified; and detectability index and accuracy for each protocol was also determined using model (in-house non-prewhitening matched filter, NPW) and human observers (in-house 4-alternative forced choice, 4-AFC, scoring with standard deviation, SD), respectively.

#### RESULTS

Preliminary studies with a NPW model observer show that lower doses can be achieved without sacrificing low-contrast detectability of various target sizes when QIR strength is increased in clinical abdominal protocols. For a 6-mm 1% contrast target, detectability may be matched, regardless of tube potential setting, between a protocol using a CTDIvol of 10 mGy and QIR 2; and another protocol using CTDIvol of 5 mGy and QIR 4. Additionally, 4-AFC human observer studies confirm that detectability is relatively unchanged with different tube potential settings when VMI energy levels are selected to match the mean energy of the applied spectrum. For a 6-mm 1% contrast target imaged with a CTDIvol of 10 mGy and QIR 4, tube potential settings of 70, 90, 120, and 140 kVp yielded 4-AFC detective accuracy scores of  $68.3 \pm 2.6\%$ ,  $65.1 \pm 2.7\%$ ,  $63.7 \pm 2.7\%$  and  $60.6 \pm 2.7\%$ , respectively.

## CONCLUSION

Lower doses can be achieved without sacrificing diagnostic capability and low-contrast detectability in clinical PCCT abdominal protocols when QIR strength is increased and appropriate VMI energies are selected.

## CLINICAL RELEVANCE/APPLICATION

Comparing various settings in clinical abdominal protocols, this work investigates avenues for optimizing low-contrast detectability in PCCT while also reducing radiation doses.

### **M5B-SPPH- Contrast-enhancement Boost Technique on Abdominal-enhanced CT Improves Image Quality of Adamkiewicz Artery**

Huiqing Zhou (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the contrast-enhancement boost (CE-Boost) technique on improvement of the image quality of adamkiewicz artery.

#### METHODS AND MATERIALS

109 patients who underwent abdominal-enhanced CT in Aquilion ONE Genesis were retrospectively collected. Images of arterial phase were postprocessed with CE-Boost technique. The arterial phase images (group A) and CE-Boost images (group B) were transferred to vitrea workstation to evaluate the objective and subjective image quality. The CT value and image noise (SD) of descending aorta and erector spinae muscle were measured, and signal-to-noise ratio (SNR) and

contrast-to-noise ratio (CNR) were calculated. Subjective image quality was analyzed by using a five-point scale to score image quality of adamkiewicz artery.

## RESULTS

The CT value, SNR, CNR of descending aorta in group A and group B were  $406.2 \pm 104.9$  HU,  $46.1 \pm 13.9$ ,  $46.8 \pm 18.7$  and  $588.9 \pm 157.2$  HU,  $104.6 \pm 48.4$ ,  $120.6 \pm 52.2$ , respectively (all  $P < 0.01$ ). In group A, adamkiewicz artery were observed in 82 patients and observation rate was 75.2% (82/109). In group B, adamkiewicz artery were observed in 97 patients and observation rate was 88.9% (97/109). The image scores of group A (82 cases) and group B (97 cases) were 2 (1.5, 3) and 3 (2, 4), respectively ( $P < 0.01$ ).

## CONCLUSION

CE-Boost technique can improve the image quality of adamkiewicz artery.

## CLINICAL RELEVANCE/APPLICATION

CE-Boost technology can improve the visualization of adamkiewicz artery, which is beneficial for understanding spinal cord blood supply and improving the therapeutic effect of diseases of the thoracic aorta and abdominal aorta.

## M5B-SPPH- Comparison of Imaging Methods for Ultra-high-resolution CT to Delineate Very Small Vessels: Low Tube Voltage Imaging vs. Small Focal Spot Imaging

Kazuki Ishikawa (*Presenter*) General Electric Company

## PURPOSE

Imaging techniques with high contrast and spatial resolution are necessary to delineate such as Adamkiewicz. Low-tube-voltage imaging is effective in achieving high contrast, and small-focus imaging is effective in achieving high spatial resolution. Low-tube-voltage imaging requires the use of a large tube current, whereas small-focus imaging is limited by the tube current, which makes it difficult to achieve both low-tube-voltage and small-focus imaging. This study aimed to clarify whether low-tube-voltage imaging or small-focus imaging is superior for delineating blood vessels smaller than 1 mm.

## METHODS AND MATERIALS

In this study, we used an ultra-high-resolution CT (Aquilion Precision, Canon, Japan) to scan simulated vessel phantoms (DSA2, Kyoto Kagaku, Japan) with diameters of 1, 0.75, 0.5, and 0.25 mm as well as deep learning reconstruction. The imaging conditions were 80 kVp, large focus (0.8 mm  $\times$  1.3 mm) and CTDIvol 16.4 mGy for low-tube-voltage imaging and 120 kVp, small focus (0.4 mm  $\times$  0.5 mm) and CTDIvol 16 mGy and 29.6 mGy for small-focus imaging. The simulated vessel phantom was filled with a diluted contrast medium to achieve a contrast of approximately 500 HU (high contrast) and 300 HU (low contrast) against the background at 120 kVp. The peak CT values of the simulated vessels and SD of the background were measured for image evaluation, and the signal-to-noise ratio (SNR) was calculated.

## RESULTS

The SNR of the 1 mm simulated vessel with high contrast dilution contrast media was  $27.75 \pm 0.43$  at low kVp;  $17.74 \pm 0.35$  at small focus 16 mGy;  $22.78 \pm 0.29$  at 29.6 mGy; and  $19.96 \pm 0.45$ ,  $13.16 \pm 0.36$ , and  $22.83 \pm 0.43$  at 0.75 mm, respectively. The values were  $9.07 \pm 0.27$ ,  $7.78 \pm 0.15$  and  $10.75 \pm 0.32$  for 0.5 mm and  $5.52 \pm 0.12$ ,  $6.16 \pm 0.14$ , and  $6.96 \pm 0.13$  for 0.25 mm, respectively. The SNRs of 1 mm simulated vessels with low-contrast diluent were  $19.18 \pm 0.41$  for low kVp;  $12.82 \pm 0.28$  for small focus 16 mGy;  $16.21 \pm 0.27$  for 29.6 mGy; and  $13.3 \pm 0.31$ ,  $8.9 \pm 0.19$ , and  $12.45 \pm 0.26$  for 0.75 mm, respectively. The values were  $7.66 \pm 0.28$ ,  $6.8 \pm 0.23$ , and  $8.41 \pm 0.27$  for 0.5 mm and  $5.52 \pm 0.12$ ,  $6.16 \pm 0.14$ , and  $6.96 \pm 0.13$  for 0.25 mm, respectively.

## CONCLUSION

In microvascular imaging, low-tube-voltage imaging is effective when a sufficient contrast cannot be obtained, whereas small-focus imaging is effective when a large imaging dose is required.

## CLINICAL RELEVANCE/APPLICATION

In ultra-high-resolution CT, if the patient is large, rapid injection of a high-density contrast agent and small-focus imaging at 120 kVp can be used to ensure depiction of very small vessels, although the dose will increase. If the patient is small, Low-tube-voltage imaging can be used to ensure the depiction of very small vessels without increased invasiveness of rapid injection of high-density contrast medium.

## M5B-SPPH- Radiology Professional Preferences for CT Radiation Dose and Image Quality Monitoring

Njood Alsaihati, BS, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Existing radiation dose monitoring systems (RDMSs) primarily focus on radiation dose. The purpose of this work was to assess how image quality metrics can be incorporated into these systems taking into consideration the preference of different

radiology professionals.

## **METHODS AND MATERIALS**

A new RDMS was designed to incorporate image quality assessment alongside radiation dose for clinical performance monitoring in CT. The study investigated how such data should be visualized for effective utilization by radiology professionals. To achieve this, a set of key questions was formulated and answered using various charts, illustrating trends, variations, outliers, comparisons, and inconsistencies in radiation dose and image quality data as oriented by the question. Fifteen such charts were then systematically evaluated by 12 experienced radiology professionals of four radiologists, four technologists/radiographers, and four medical physicists, with a combined professional experience of over 130 years. A Likert scale (very useful = 10, useful = 8, moderately useful = 6, slightly useful = 4, and not useful = 0) was used to assess the usefulness of the charts. To provide additional insights on potential improvements, free-text fields were also enabled. The data were analyzed in terms of average score and deviation per group as well as their individual insights.

## **RESULTS**

The system interface overall received an overall average score of 7.8 out of 10.0. Among the 15 charts, the one comparing scanner radiation output with literature and regulatory standards (i.e., diagnostic reference level and achievable dose across patient body habitus), showed the highest variation in scores among professional subgroups. In contrast, the chart representing scanners workload received similar scores across the subgroups. Specific visualizations resonated differently with each professional group, leading to 58 unique suggestions to better inform performance monitoring.

## **CONCLUSION**

The study highlighted the importance of including image quality in performance monitoring, regardless of the professional subgroups' preferences. However, we found strong differences across radiology professionals as to what they wish to see visualized.

## **CLINICAL RELEVANCE/APPLICATION**

A comprehensive monitoring system that integrates radiation dose with image quality assessment should be tailored to different radiology professionals' roles and responsibilities for best clinical practice in radiology.

## **M5B-SPPH- Impact of X-Ray Tube on Image Quality and Conspicuity of Pancreatic Ductal Adenocarcinoma in Pancreatic Protocol Dual-Energy CT**

Tetsuro Kaga, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To compare the image quality and conspicuity of pancreatic ductal adenocarcinoma (PDAC) in dual-energy pancreatic protocol CT between two x-ray tubes mounted in Revolution CT Apex.

## **METHODS AND MATERIALS**

Between January 2019 and March 2022, 80 patients underwent dual-energy pancreatic protocol CT using either Performix HDw (old x-ray tube; Group A, n = 41) or Quantix 160 (new x-ray tube; Group B, n = 39) mounted in Revolution CT Apex, respectively. All data were reconstructed at 70- and 40-keV and with medium-strength level of deep-learning image reconstruction. The two groups were compared in terms of CT dose-index volume (CTDIvol), CT numbers of the abdominal aorta, pancreas and PDAC, background noise, and qualitative scores for image noise, overall image quality, and conspicuity of PDAC.

## **RESULTS**

The CTDIvol was lower in Group B than in Group A (9.2 mGy vs. 7.9 mGy;  $P < .001$ ). The median CT numbers of all anatomical structures at 70- and 40-keV were comparable between two groups ( $P = .06-.78$ ). The background noise at 70- (14 HU vs. 12 HU;  $P = .046$ ) and 40-keV (30 HU vs. 26 HU;  $P < .001$ ) were lower in Group B than in Group A. Qualitative scores for image noise and overall image quality at 70- and 40-keV and conspicuity of PDAC at 40-keV were higher in Group B than in Group A ( $P < .001-.045$ ).

## **CONCLUSION**

In dual-energy pancreatic protocol CT, Revolution CT Apex with Quantix 160 improved qualitative image quality and reduced radiation dose.

## **CLINICAL RELEVANCE/APPLICATION**

Even when using the same Revolution CT Apex, the latest x-ray tube of Quantix 160 has clinical impact on the image quality and conspicuity of PDAC.

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## Abstract Archives of the RSNA, 2023

M5B-SPRO

### Radiation Oncology Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPRO- Prediction of EGFR Mutations in Non-small Cell Lung Cancer Based on Hybrid Radiomics** **1**

Seonhwa Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to predict EGFR gene mutations in non-small cell lung cancer patients based on deep learning and radiomics using CT and clinical characteristics.

#### **METHODS AND MATERIALS**

A total of 1,917 patients with non-small cell lung cancer were selected as the final study population, who underwent contrast-enhanced CT scans and EGFR gene testing before treatment. Clinical characteristics included gender, family history, height, and weight. The region of interest was segmented from CT images to extract radiomics features and obtain tumor images. The tumor images were used as input data for a CNN model to extract 512 image features, and combined with radiomics features and clinical data to predict EGFR gene mutations. The generalization performance of the model was evaluated using external institutional data.

#### **RESULTS**

AUROC was used as the performance evaluation metric. The model using tumor images and radiomics features as input data showed an AUROC of 0.67. The model using tumor images, radiomics features, and clinical data showed an AUROC of 0.72.

#### **CONCLUSION**

This study provides a convenient and non-invasive method for predicting EGFR gene mutations. EGFR gene mutations play a very important role as one of the factors that increase the risk of recurrence in non-small cell lung cancer patients, and can also be used to determine treatment strategies. Therefore, further research is needed to improve the accuracy of the model and address issues related to data collection in the future.

#### **CLINICAL RELEVANCE/APPLICATION**

EGFR gene mutation is the most commonly observed gene mutation in non-small cell lung cancer patients. EGFR is a signal transduction protein that regulates cell growth and division. When the DNA sequence inside the gene is mutated, the signal transduction pathway works abnormally, causing cancer cells to rapidly proliferate or form tumors. Existing gene mutation tests can only observe a part of the tumor, not the entire tumor, and thus cannot determine the heterogeneity of the entire tumor. In addition, there are technical difficulties and high costs associated with conventional methods, so a non-invasive and convenient test method must be developed to overcome these limitations.

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## Abstract Archives of the RSNA, 2023

M5B-SPVA

### Vascular Imaging Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-SPVA- Benefit of Photon-counting CT for Lower Extremity CTA Compared to Conventional Energy-integrating Detector CT**

Safa Hoodeshenas, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the impact of photon-counting detector (PCD) CT on radiologist confidence and visualization of below-knee arteries at lower extremity CT angiography (CTA) compared to conventional energy-integrating detector (EID) CT.

#### **METHODS AND MATERIALS**

Patients who underwent clinically-indicated lower extremity CTA performed on a commercial PCD CT system (NAETOM Alpha, Siemens), as well as a prior or subsequent lower extremity CTA performed with EID CT were included. PCD-CTA included 0.6 mm slices with sharp kernel (Bv68), whereas EID CTA included 2 mm slices using routine kernel (Bv44), per clinical protocols. Two radiologists independently reviewed the anonymized and randomized CTA exams in separate reading sessions, with each patient's images appearing once per reading session. Readers estimated maximum stenosis grade for each of 7 below-knee arterial segments (popliteal to dorsalis pedis and plantar arteries), noting confidence in stenosis grading (0-100%). Visualization of small vessels was evaluated by counting the number of fibular perforators and grading visualization of fibular perforators, dorsalis pedis and plantar arteries on a 5-point Likert scale (1=worst, 5=best). Image quality metrics (i.e., sharpness, enhancement, and overall image quality) were assessed per patient.

#### **RESULTS**

25 patients (mean age  $68 \pm 10$  years; M: F=18: 7) underwent CTA runoff using PCD-CT (mean contrast volume:  $120 \pm 14$  cc) and EID-CT (mean contrast volume:  $114 \pm 16$  cc). For both readers, confidence in stenosis grading was significantly higher in PCD-CT for all evaluated arterial segments (e.g., popliteal artery  $92.9 \pm 6$  vs.  $77.3 \pm 14.7$ ;  $p < 0.001$ ; dorsalis pedis artery  $90.6 \pm 6.4$  vs.  $67 \pm 19.5$ ;  $p < 0.001$ ). The number of visualized fibular perforators was significantly higher with PCD-CT ( $8.1 \pm 3$  vs.  $5.4 \pm 2$ ;  $p < 0.001$ ). Visualization of small vessels was rated significantly higher with PCD-CT for all the evaluated small vessels (e.g., plantar arteries:  $4.5 \pm 0.8$  vs.  $3.1 \pm 0.8$ ,  $p < 0.001$ ; fibular perforators,  $p < 0.001$ ; dorsalis pedis,  $p < 0.001$ ). PCD-CT had significantly greater arterial sharpness ( $4.7 \pm 0.5$  vs.  $2.7 \pm 0.9$ ;  $p < 0.001$ ), arterial enhancement ( $4.3 \pm 0.6$  vs.  $3.4 \pm 0.7$ ;  $P < 0.001$ ), and overall image quality ( $4.6 \pm 0.6$  vs.  $3.3 \pm 0.8$ ;  $P < 0.001$ ).

#### **CONCLUSION**

Lower extremity CTA runoff with PCD-CT and 0.6 mm slices resulted in significantly increased reader confidence in small vessel stenosis grading, a higher number and improved visualization of small arteries, and greater arterial sharpness and enhancement.

#### **CLINICAL RELEVANCE/APPLICATION**

Thin-slice PCD-CT improved visualization of small calcified below-the-knee vessels, with greater reader confidence and higher number of visualized small vessels.

#### **M5B-SPVA- Short Segment Linear "Flaps" of the Abdominal Aorta are Not Dissections: Discovery of their Origin via Retrospective Imaging Review**

Amar Shah, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Linear filling defects of the abdominal aorta are often referred to as focal aortic dissection or flaps in radiology reports, triggering concern amongst clinicians for acute aortic syndrome. However, these "flaps" are highly unlikely to represent true

intimomedial dissection flaps given their short segment and often incidental discovery. This retrospective study aims to determine the etiology of linear filling defects of the abdominal aorta utilizing prior contrast-enhanced (CE) imaging.

## **METHODS AND MATERIALS**

An IRB-approved, HIPAA compliant retrospective study was performed. Abdomen/pelvis CT reports finalized Jan 2021 through Dec 2022 from two sites of an academic medical center were queried for the terms "focal dissection," "dissection flap," "linear filling defect," and "linear flap". Duplicate patients were removed. Exclusions based on reports were vessel other than abdominal aorta, thoracoabdominal dissection, no prior CE imaging, and less than 6 months between exams. On imaging review, cases with no change in appearance between exams were excluded. Cases were excluded if medical record review indicated femoral catheter access between imaging exam dates. Imaging review of more recent exam included presence of flap, flap calcification, and qualitative assessment of aortic caliber at the level of flap. Prior exam assessment included evaluation of aortic caliber and aortic findings at the location of subsequent flap.

## **RESULTS**

Report query yielded 865 reports and 702 unique patients. After initial exclusion, the imaging of 70 patients was reviewed, of which 40 were excluded for lack of change in imaging appearance of the linear filling defect. 10 patients were excluded for femoral access, yielding a final population of 20 patients. There was a median of 70 months between imaging exams (range 14-230). All aortas were atherosclerotic and 75% (n=15) were ectatic or aneurysmal at the level of flap; on the older exam only 5 aortas were ectatic or aneurysmal. Of 20 cases, mural thrombus or partially ulcerated mural thrombus was present at the flap site in 17, thrombosed PAU in 1, and no corresponding findings in 2.

## **CONCLUSION**

Short segment linear filling defects within the abdominal aorta correspond to sites of prior mural thrombus. Mural thrombus has ulcerated or resorbed, leaving behind the luminal surface of the thrombus. Therefore, short segmental filling defects within the abdominal aorta should not be referred to as a dissection flap but rather a remnant of ulcerated and resorbed mural thrombus.

## **CLINICAL RELEVANCE/APPLICATION**

Linear filling defects of the abdominal aorta are often reported as focal dissections, but this incorrectly describes their pathophysiology. These filling defects are the remnant surface of ulcerated/resorbed mural thrombus.

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## Abstract Archives of the RSNA, 2023

R2-SPBR

### Breast Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPBR-2 Multiparametric MRI Assessment of Primary Tumor for Predicting Axillary Tumor Burden in Women with Invasive Breast Cancer**

Jin You Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess whether multiparametric MRI features of a primary tumor are associated with axillary lymph node tumor burden in women with invasive breast cancer.

#### **METHODS AND MATERIALS**

This retrospective study evaluated women with invasive breast cancer who underwent 3-T multiparametric breast MRI including diffusion-weighted imaging (DWI) between 2019 and 2020. Two radiologists independently evaluated peritumoral edema and intratumoral necrosis on T2-weighted imaging (T2WI) and measured the mean, minimum, and maximum apparent diffusion coefficient (ADC) values by manually placing regions of interest within the breast tumors. Quantitative kinetic features of breast cancer assessed with computer-aided diagnosis (CAD) and clinical-pathologic characteristics were analyzed. Uni- and multivariable logistic regression was performed to identify predictors of axillary lymph node metastasis or high axillary nodal burden (= 3 positive nodes).

#### **RESULTS**

A total of 242 women (mean age, 54.4 years; age range, 29-86 years) were evaluated. Eighty-three (34.3%) had axillary lymph node metastasis and 39 (16.1%) had high axillary nodal burden by surgical pathologic analysis. On multivariate analysis, predictors of axillary lymph node metastasis were peritumoral edema (Odds ratio [OR]: 4.54; 95% confidence interval [CI]: 2.32, 8.87;  $P < .001$ ), maximum ADC value ( $= 1.207 \times 10^{-3} \text{mm}^2/\text{s}$ ) (OR: 2.60; 95% CI: 1.33, 5.10;  $P = .005$ ), lymphovascular invasion (OR: 5.20; 95% CI: 2.61, 10.35;  $P < .001$ ), and larger tumor size ( $> 2 \text{cm}$ ) (OR: 3.17; 95% CI: 1.59, 6.29;  $P < .001$ ). Predictors of high axillary nodal burden were peritumoral edema (OR: 7.39; 95% CI: 2.72, 20.02;  $P = .001$ ), maximum ADC value ( $= 1.045 \times 10^{-3} \text{mm}^2/\text{s}$ ) (OR: 9.74; 95% CI: 3.26, 29.07;  $P < .001$ ), lymphovascular invasion (OR: 8.38; 95% CI: 2.95, 23.75;  $P = .001$ ), and larger tumor size ( $> 2 \text{cm}$ ) (OR: 6.08; 95% CI: 1.77, 20.91;  $P = .004$ ). CAD-derived kinetic features of breast cancer did not associate with axillary nodal status. In the subgroup analysis of 192 early-stage breast cancer patients, peritumoral edema (OR: 17.12; 95% CI: 2.02, 144.90;  $P = .009$ ) and lymphovascular invasion (OR: 4.65; 95% CI: 1.01, 21.51;  $P = .049$ ) maintained significance for predicting high axillary nodal burden.

#### **CONCLUSION**

Peritumoral edema on T2WI and maximum ADC value of breast cancer on DWI could be helpful for predicting axillary lymph node tumor burden in women with invasive breast cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

Multiparametric MRI assessment of primary tumor using T2WI and DWI might have predictive value for assessing axillary tumor burden in women with invasive breast cancer.

#### **R2-SPBR-3 A Radiomic-Clinical Model of Contrast-Enhanced Mammography for Biopsy Outcome Prediction on BI-RADS 4A/4B Patients**

Chang Liu, BS (*Presenter*) Nothing to Disclose



## PURPOSE

In the US over 1 million biopsies are performed annually, with 9.6% diagnostic exams given BI-RADS =4A, most of which are rated as BI-RADS 4A/B. Contrast enhanced mammography (CEM) may improve lesion classification. BI-RADS 4A and 4B patients are particularly challenging for biopsy outcome prediction. The goal of the study is to build machine learning quantitative analysis of CEM to improve breast biopsy outcome prediction.

## METHODS AND MATERIALS

With HIPAA-compliance and IRB-approval, 292 patients (aged 30-86) with 332 included BI-RADS =4A lesions (78 cancers (49 IDC, 14 ILC, 15 DCIS) and 254 benign) underwent pre-biopsy CEM. An experienced radiologist produced Initial BI-RADS based on mammography, tomosynthesis and/or ultrasound, and then CEM-adjusted BI-RADS after CEM interpretation. Logistic regression models for outcome prediction were built using radiomic features of segmented lesions in CEM and four CEM-assessed qualitative clinical descriptors (enhancement, strength of enhancement, kinetics, and background parenchymal enhancement). The area under the receiver operating characteristic curve (AUC) measured model performance. PPV conditioned at 100% sensitivity assessed performance on BI-RADS 4A/B lesions.

## RESULTS

AUC for radiomics was 0.87, clinical descriptors 0.89, and combination 0.92. PPV3 for clinical BI-RADS 4A lesions is 6.9% and model 17.6%. PPV3 of CEM BI-RADS 4A is 5.1% and model 9.1%. PPV3 of clinical BI-RADS 4B is 15.3% and model 25.0%. PPV3 of CEM BI-RADS 4B is 35.9% and model 45.7%. Compared to the radiologist, the model increased 153% (or 63%) and 78% (or 30%) of the PPV for initial clinical BI-RADS 4A (or 4B) patients and CEM-adjusted 4A (or 4B) patients.

## CONCLUSION

Machine learning models of tumor radiomics and clinical descriptors of CEM can substantially increase biopsy outcome prediction accuracy, particularly for the 4A and 4B patients. For 4B patients, the collaboration of radiologists (producing CEM BI-RADS) and our model can largely reduce false positives with a PPV of 45.7%.

## CLINICAL RELEVANCE/APPLICATION

Machine learning analysis and radiologists' clinical assessment of CEM can improve biopsy outcome prediction and their collaboration can gain the highest benefits for the 4A/4B patients.

## R2-SPBR-4 Kinetic Features on DCE-MRI Rather than Glycolytic Phenotype on <sup>18</sup>F-FDG PET/CT Predict Recurrence Free Survival in Patients with ER-positive/HER2-negative Early Breast Cancer

Jiyoung Yoon, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Estrogen receptor (ER)-positive/human epidermal growth factor receptor 2 (HER2)-negative subtype of breast cancer is known to show low F-18 fluorodeoxyglucose ([<sup>18</sup>F]FDG) uptake on positron emission tomography/computed tomography (PET/CT). The purpose of this study was to evaluate prognostic value of preoperative dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) compared to [<sup>18</sup>F]FDG PET/CT in patients with ER-positive/HER2-negative early breast cancer.

## METHODS AND MATERIALS

We analyzed data from 145 consecutive women with breast cancer who underwent [<sup>18</sup>F]FDG PET/CT for initial staging and subsequent surgery between 2008 and 2015. Among them, a total of 118 patients had preoperative DCE-MRI. The clinicopathological variables, computer-aided diagnosis (CAD)-generated kinetic features, apparent diffusion coefficient, and maximum standardized uptake value (SUVmax) were assessed for the risks of recurrence. Hazard ratios (HRs) were estimated from Cox proportional hazards regressions. Recurrence free survival (RFS) curves were estimated using the Kaplan-Meier method and differences in each risk layer were assessed using the log-rank test.

## RESULTS

During the follow up (82.25±22.91 months), 16 (11.0%) patients experienced recurrence. Peak enhancement (PE) >210% (HR 10.70; 95% CI: 1.36-84.51; p=0.025), Ki-67 >6% (HR 5.06; 95% CI: 1.15-22.27; p=0.032) and SUVmax >6.75 (HR 4.50; 95% CI: 1.64-12.39; p=0.004) were significant factors for RFS on the univariate analysis. On the multivariate analysis, PE >210% (HR 9.23; 95% CI: 1.16-73.29; p=0.036) was the only significant prognostic factor. On the Kaplan-Meier survival analysis, patients with tumors showing PE >210% at preoperative MRI had a significantly poorer 5-year RFS compared to those with PE =210% (83.7% and 98.1%, respectively, p=0.010).

## CONCLUSION

In patients with early-stage ER-positive/HER2-negative breast cancer, high PE at preoperative DCE-MRI was more effective than [<sup>18</sup>F]FDG uptake on PET/CT for predicting RFS.



## CLINICAL RELEVANCE/APPLICATION

CAD-generated kinetic information that can be obtained automatically from preoperative breast MRI in routine clinical practice could help stratify which early-stage ER-positive HER2-negative breast cancer to treated with adjuvant chemotherapy.

### **R2-SPBR-5 An Innovative Technique using Discrete Multi-Wavelength Near Infra-Red Spectroscopy Diffuse Optical Imaging to Differentiate Breast Lesions in Fast Scans: A Feasibility Study**

Min Jung Kim, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the potential role of newly developed diffuse optical spectroscopic imaging (DOSI) device using discrete multi-wavelength near-infrared spectrum (DMW-NIRS) in fast scans to differentiate breast lesions.

#### METHODS AND MATERIALS

The protocol for DOSI using DMW-NIRS in fast scans was approved by the Institutional Review Boards of Severance Hospital; all participants provided informed consent. A total of 62 consecutive women (range, 29-80 years; mean, 49.9 years) with 62 breast lesions (37 malignant, 25 benign) that were biopsied under US guidance were included. A handheld probe consisting of 5 pairs of light-emitting diodes and photodiodes was used, with the lesion location marked according to conventional US findings. Light absorption and scattering were measured with 8 NIR wavelengths. Lesion to normal ratios (L/Ns) of quantitative chromophores (HbO<sub>2</sub>, HHb, THc, StO<sub>2</sub>, Water, Lipid, and TOI) that were calculated in comparison to the contralateral normal breast tissue were assessed. L/Ns of chromophores were compared between the malignancy and benign. Diagnostic performance was calculated for each L/N of chromophores. Subgroup analysis was performed for Breast Imaging Reporting And Data System (BI-RADS) category 4A lesions.

#### RESULTS

All L/Ns of chromophores showed significant differences between malignant and benign groups (all  $p < 0.05$ ). Area under receiver operating characteristic curve (AUROC)s of L/Ns of chromophores ranged 0.710-0.901 (all  $p < 0.05$ ), with TOIL/N showing the highest AUROC (0.901; 95% CI: 0.825-0.976). Accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of TOIL/N were 83.9%, 86.5%, 80.0%, 86.5%, and 80.0%, respectively. In subgroup analysis for BI-RADS category 4A lesions, all L/Ns of chromophores, except for Lipid, showed significant differences between malignant and benign groups ( $p < 0.05$ ). AUROCs of L/Ns of chromophores ranged 0.710-0.902 (all  $p$  except for Lipid  $< 0.05$ ), and TOIL/N showed the highest AUROC (0.902; 95% CI: 0.788-1.000). Accuracy, sensitivity, specificity, PPV, and NPV of TOIL/N were 90.6%, 100.0%, 82.4%, 83.3%, and 100.0%, respectively.

#### CONCLUSION

L/Ns of chromophores measured by the newly developed DOSI using DMW-NIRS in fast scans showed promise as an adjunct to BI-RADS categorization for distinguishing breast cancers from benign lesions. This new technique also demonstrated similar performance even in subgroup that included only low suspicious lesions.

## CLINICAL RELEVANCE/APPLICATION

New DOSI technique using DMW-NIRS could be a quick, safe, and noninvasive supplemental method to increase diagnostic accuracy. However, it is essential to validate our results with larger patient cohort.

### **R2-SPBR-6 Comparison of Radiomics-Based Machine-Learning Classifiers for Pretreatment Prediction of Pathologic Complete Response to Neoadjuvant Therapy in Breast Cancer**

Xue Li (*Presenter*) Nothing to Disclose

#### PURPOSE

In recent years, machine learning (ML) classifiers have gradually been used to establish high-performance predictive models for pathological complete response (pCR) in breast cancer after neoadjuvant therapy (NAT). However, few studies have compared the effectiveness of different ML classifiers. This study investigated the ability of radiomics models based on pre- and post-contrast first-phase T1 weighted images (T1WI) to predict breast cancer pCR after NAT and compared the performance of different ML classifiers.

#### METHODS AND MATERIALS

In this retrospective study, 300 patients from the Duke-Breast-Cancer-MRI dataset who underwent neoadjuvant therapy (NAT) were included, including pCR (n=76) and non-pCR (n=224) cases. These patients were randomly divided into training and validation groups at a ratio of 8:2. Radiomics features were extracted from pre- and post-contrast first-phase T1WI images of each patient. The radiomics model was built using features selected through the Spearman correlation analysis and the LASSO algorithm after normalization. SVM, RF, extraTrees, DT, KNN, XGBoost, LightGBM were used as classifiers. ROC curves were used to assess the predictive performance of the radiomics models.

## RESULTS

Out of the seven classifiers used, the LightGBM classifier performed best in predicting breast cancer pCR, with an AUC of 0.813 in the validation group (95% CI: 0.697-0.928, accuracy 78.3%, sensitivity 46.7%, specificity 100.0%). During subgroup analysis, RF achieved the highest AUC in pCR prediction in luminal breast cancers (0.859, 95% CI: 0.710-1.000, accuracy 85.9%, sensitivity 68.8%, and specificity 83.3%), and DT yielded the highest AUC in pCR prediction in triple negative (TN) breast cancers (0.909, 95% CI: 0.790-1.000, accuracy 88.2%, specificity 81.8%, accuracy 100%).

## CONCLUSION

Overall, the LightGBM-based radiomics model demonstrated superior performance in predicting breast cancer pCR, while RF and DT displayed promising results in predicting pCR for luminal and TN breast cancers, respectively, during subgroup analysis.

## CLINICAL RELEVANCE/APPLICATION

pCR after neoadjuvant therapy (NAT) in breast cancer strongly correlates with overall survival. Over the past few years, the value of radiomics in predicting pCR in breast cancer has attracted significant attention, and machine learning algorithms have become a research hotspot. It is widely acknowledged that high-performance machine learning algorithms are essential for establishing radiomics models. Therefore, in our study, we extracted radiomics features based on pre- and first post-contrast T1WI and used seven machine learning classifiers to build prediction models, respectively, and compared their prediction performance.

## R2-SPBR-7 Evaluating Mammography Positioning Quality on Digital Screening Mammograms in Large Urban Health Systems - Same as Film?

Laurie R. Margolies, MD (*Presenter*) Stock options, Nuevozen Corporation Medical Advisory Board, Screenpoint Medical

## PURPOSE

Mammography positioning quality (MPQ) is critical to detection of breast cancer. Approximately 90% of poor-quality screening mammography images are due to poor positioning. The most common errors on film screen mammography (FSM) reported in the medical literature are inadequate pectoralis major muscle, sagging and poor visualization of posterior tissue. Understanding how positioning errors present themselves on digital mammograms can help tailor quality improvement initiatives. The purpose of this study was to examine MPQ, as defined by American College of Radiology (ACR) criteria, of digital screening mammograms at two US health systems.

## METHODS AND MATERIALS

Data from two US health systems was collected as part of an international multi-center mammography positioning quality research collaboration (MAMMO.IQ Study). MPQ errors, including exaggeration, portion cut off, posterior tissue missing, nipple not in profile, too high on image receptor (IR), inadequate pectoralis length, sagging, and posterior nipple line (PNL) length difference, were evaluated using artificial intelligence MPQ algorithms applied to screening mammograms acquired between December 2019 and April 2021; associated proportions and rankings of the positioning errors were computed. A total of 221,427 and 318,929 digital mammography images were processed from two health systems. The study was approved by research ethics at the participating sites.

## RESULTS

175,591 and 290,503 MPQ errors were identified respectively at the centers. The rank order of the eight MPQ errors was nearly identical for the two centers (Wilcoxon Rank Sum Test,  $p=0.645$ ). The three most common MPQ errors, PNL on CC view not within 1 cm of that on MLO view, inadequate pectoralis major muscle, and excessive exaggeration on CC view, accounted for 66% and 72.0% of all MPQ errors at the centers respectively; only inadequate pectoralis major muscle is amongst the reported most common errors on FSM. The two least common errors, breast positioned too high on IR and sagging, accounted for 10.4% and 7.0% of all MPQ errors at the centers respectively.

## CONCLUSION

MPQ errors on digital mammograms were similarly distributed at the centers, but did not align with the pre-digital era reported findings on film screen mammograms.

## CLINICAL RELEVANCE/APPLICATION

Knowledge of common MPQ errors can inform technologist teaching efforts. MPQ errors may be affected by equipment used. MPQ assessments may be more reliable by AI than by humans.

## R2-SPBR-8 Using Artificial Intelligence to Triage Screening Mammograms after Breast-conserving Therapy

Jeaneun Park (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study aims to evaluate the clinical usefulness of artificial intelligence (AI) for triaging of screening mammograms after Breast-conserving therapy (BCT).

## **METHODS AND MATERIALS**

The consecutive mammograms from January to May 2021, conducted in patients who underwent BCT were included. Mammograms were analyzed by dividing into ipsilateral and contralateral breast. Triage was performed in the following three methods. One method was to classify exams as no recall (BI-RADS C1, C2) and recall (C0, C3, C4 or C5) based on the original report by expert radiologists. The commercially available AI for mammography was used for the others. If AI did not detect any abnormality, it was assigned as a no recall, and otherwise as a recall (Standalone AI-triage). For cases classified as recall by AI, one radiologist classified them as recall or no recall in consideration of mammography findings (Decision referral AI-triage). We analyzed cancer detection rate (CDR), recall rate and sensitivity for each method.

## **RESULTS**

A total of 1190 patients (mean age 56.6 years) were included in the study, with 1221 cases of the ipsilateral and 1135 cases of contralateral breast. In ipsilateral breast, the CDR, recall rate and sensitivity of the original report were 6.5/1000, 3.4%, and 80%. Standalone AI-triage was able to reduce the workload by 77%, while maintaining the same level of CDR and sensitivity. Decision referral AI-triage lowered the recall rate to 2.8%. The CDR, recall rate and sensitivity of the original report were 1.7/1000, 1.9%, and 66.7% in contralateral breast. About 90% of workload could be reduced in standalone AI-triage. In decision referral AI-triage, the CDR, recall rate and sensitivity for were 2.5/1000, 2.0% and 100%.

## **CONCLUSION**

AI-based triage can contribute to reducing the radiologist's workload without harming sensitivity in the screening mammograms of BCT patients. However, sufficient experience of radiologists is essential to interpret false-positive results, especially in ipsilateral breast after BCT.

## **CLINICAL RELEVANCE/APPLICATION**

The population undergoing screening after surgery is accumulating, as the number of breast cancer patients increases worldwide. Also, the personal history of breast cancer itself is a sustained long-term risk for future breast cancer. This study investigated the clinical usefulness of AI-based triage to maintain quality even in the screening of patients who underwent BCT, while reducing the radiologist's workload.

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## Abstract Archives of the RSNA, 2023

R2-SPCA

### Cardiac Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPCA-1 Impact of Diabetes Mellitus on Left Ventricular Deformation in Restrictive Cardiomyopathy Patients Assessed by Cardiac Magnetic Resonance Imaging**

Yue Gao, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Diabetes mellitus (DM) is considered a major risk factor for cardiovascular events and increases the risk of worse long-term outcomes in patients with restrictive cardiomyopathy (RCM). We aimed to investigate the impact of comorbid DM on LV deformation in RCM individuals.

#### **METHODS AND MATERIALS**

Seventy-four RCM patients without DM [RCM (DM-)], 33 with DM [RCM (DM+)], and 75 age- and sex-matched controls who underwent CMR scanning were included. We exclude patients with congenital heart disease and heart failure secondary to other cardiomyopathies or diseases. LV geometry, function, and LV global strains, including peak strain in the radial, circumferential, and longitudinal directions were measured. We evaluated the type of LGE in each RCM patient, which was divided into no-LGE (type 1), local LGE (type 2), and diffuse LGE (type 3). The determinants of reduced LV myocardial strain for all RCM patients were assessed using multivariable linear regression analyses.

#### **RESULTS**

Compared with normal controls, both RCM (DM-) and RCM (DM+) patients exhibited increased LV end-diastolic and end-systolic volume index and decreased LV ejection fraction. LV global strains progressively declined from the normal controls to two RCM groups. RCM subgroup analysis showed that LV global longitudinal PS was worse in RCM (DM+) group than in RCM (DM-) group ( $p = 0.014$ ). DM was an independent determinant of reduced LV global longitudinal PS in patients with RCM ( $\beta = -0.208$ ,  $p = 0.018$ ). The LGE type was independently associated with a decreased global longitudinal PS ( $\beta = 0.411$ ,  $p < 0.01$ ) in RCM patients.

#### **CONCLUSION**

DM has an additive deleterious effect on LV function and deformation in RCM patients. The LGE type and DM were found to be associated with reduced LV global longitudinal strain.

#### **CLINICAL RELEVANCE/APPLICATION**

Diabetes mellitus can aggravate the left ventricular global strain damage in patients with restrictive cardiomyopathy without heart failure, so the control of diabetes mellitus should be strengthened

#### **R2-SPCA-2 Could Coronary Artery Calcium Score be a Reliable Predictor of Coronary Artery Stenosis in Women?**

Yuval Liberman, MD, MMedSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Coronary Artery Calcium Score (CACS) has been widely used to predict coronary artery disease (CAD) risk in both men and women. However, due to physiological differences between these two groups, more studies are needed to assess CACS thresholds for suspected CAD in women. This study aims to evaluate the predictability of CACS for determining CAD with  $\geq 50\%$  stenosis in women and to explore the impact of age and CACS threshold selection on its predictive performance.

## METHODS AND MATERIALS

The study was approved by the hospital IRB. We reviewed all female patients who underwent CCTA for coronary artery disease (CAD) assessment (including CACS) between 01/01/2006 - 12/31/22 in tertiary medical center. CACS was assessed according to Agatston score. SCAS was identified qualitatively on CCTA as  $\geq 50\%$  stenosis using multiplanar curved reconstructions. Correlation between CACS and SCAS was assessed with Pearson correlation. Various CACS cutoff values were used to check the sensitivity and specificity of CACS as predictor for SCAS. Age information was used for multivariate analysis of the accuracy of CACS in predicting SCAS.

## RESULTS

1378 consecutive female patients ( $62.4 \pm 11.7$  y.o average, min 21, max 93) were included. Average CACS was 194.1 (min 0, max 4130). 381 of the patients had SCAS (27%). Continuous CACS demonstrated a correlation of 0.501 with SCAS. CACS threshold of 100 provided sensitivity of 68.9% and specificity of 88.8%. Increasing the threshold to 400 and 1000 resulted in higher sensitivity (87.3% and 94.8%, respectively) but lower specificity (81.3% and 76.3%, respectively). Optimal performance was achieved with a CACS threshold of 77, providing a sensitivity of 65.5% and specificity of 90.1%. Taking into consideration age and pre/post menopausal age did not statistically improve the results

## CONCLUSION

Our study demonstrates the potential of CACS as a non-invasive tool for predicting  $\geq 50\%$  coronary stenosis in women. Optimal performance is achieved with a CACS threshold of 77. Further research is needed to identify additional factors that can enhance the predictability of CACS for stenosis in women.

## CLINICAL RELEVANCE/APPLICATION

Utilizing CACS in women more accurately.

### **R2-SPCA-3 Coronary Artery Calcium Score (CACS) vs. CAD-RADS Predictability of Positive Cardiac Catheterization in Pre-Solid Organ Transplant Patients: A Comparative Analysis**

Yuval Liberman, MD, MMedSc (*Presenter*) Nothing to Disclose

## PURPOSE

The accurate prediction of significant coronary artery stenosis (SCAS) is crucial in the pre-solid organ transplant evaluation process. This study aims to compare the predictability of Coronary Artery Calcium Score (CACS) and CCTA in determining the presence of SCAS ( $\geq 50\%$ ) in pre-solid organ transplant patients, as detected by cardiac catheterization (Cath).

## METHODS AND MATERIALS

This study was IRB approved. All pre-solid organ transplant patients who underwent CCTA for coronary artery disease (CAD) assessment (including CACS) and were sent to Cath between 01/01/2018 - 12/31/22 were reviewed. CACS was assessed according to Agatston score. SCAS was identified as  $\geq 50\%$  stenosis on CCTA. Similarly, Cath was identified as positive if there was a finding of  $\geq 50\%$  stenosis. Correlation between CACS and Cath was assessed, as well as between CCTA and Cath. CCTA and Various CACS cutoff values were used to create predictors for a positive Cath, which were checked for their sensitivity and specificity.

## RESULTS

We analyzed data from 72 pre-solid organ transplant patients who underwent CCTA, CACS, and cardiac catheterization (57 males and 15 females). These patients had an average CACS of 709 (min 0, max 7675) and average CCTA of 2.2. The patients had an average age of  $58.2 \pm 9.8$  (min 37, max 71). Our results showed that CACS had a correlation of 0.35 with positive Cath, while CCTA demonstrated a correlation of 0.31. Using CCTA as a binary predictor of positive Cath resulted in a sensitivity of 46% and specificity of 100%. In contrast, CACS yielded a maximum sensitivity of 83.3% (specificity of 68.3%, threshold 2920) and a maximum specificity of 83.3% (sensitivity of 42%, threshold 45).

## CONCLUSION

The findings suggest that CACS is a better screening tool for eliminating patients without significant stenosis due to its higher specificity, whereas CCTA serves as a better diagnostic tool due to its higher sensitivity. However, it should be noted that both tools demonstrated only moderate correlations with positive catheterization findings, indicating the need for further research to optimize their performance in this patient population.

## CLINICAL RELEVANCE/APPLICATION

how predictive is calcium score in comparison to ccta of stenosis identified in cath (the gold standard)

### **R2-SPCA-4 Improving Spatial Resolution at Coronary CT Angiography on Photon-counting Detector CT: A Structured Phantom Study**

Zhou Yu, PhD (*Presenter*) Employee, Canon Medical Systems Corporation

## PURPOSE

The photon-counting detector CT (PCD-CT) features a semiconductor detector. Due to electrical noise cancellation, its high-density detector element yields high-resolution- and low-noise images. We developed a photon-counting detector CT scanner whose detector is made of CdZnTe. Here we evaluate the spatial resolution of PCD-CT using a structured phantom that simulates coronary CT angiographs (CCTA).

## METHODS AND MATERIALS

Our structured phantom for CCTA (Fig.1) uses a 3D printer (KEYENCE Agilista-3200). The vessels were filled with iodine contrast medium diluted to 20 mgI/ml; one simulated coronary artery harbored 70% of one simulated stenotic lesion, another a stent graft (Medtronic, BeStent, 3.0 mm × 15 mm). We scanned the phantom on a prototype PCD-CT scanner (Canon Medical Systems) in high-resolution mode. The detector element density was approximately three times that of a conventional CT system. The slice thickness was about 0.2 mm, the tube voltage was 120 kV, and the tube current was 250 mA. For comparison, a conventional energy integrating detector CT (EID-CT; Aquilion ONE GENESIS, Canon Medical Systems) was used; the structured phantom was scanned with a scan protocol that resulted in similar radiation exposure. All images were reconstructed with hybrid iterative reconstruction. To evaluate the image quality of the phantom we measured the noise power spectrum (NPS) as a metric of the noise characteristics and the task-based modulation transfer function (MTF) as a metric of the spatial resolution.

## RESULTS

The radiation doses (CTDIvol) were approximately 9.5 mGy. The image noise on PCD-CT scans was almost twice as high as on EID-CT scans (SD: 26.8 v.s. 13.8 HU, Fig. 2 left); the spatial resolution was higher with PCD-CT (10%MTF: 1.05 v.s. 0.75 cy/mm, Fig. 2 right) than EID-CT. Comparison of the images shown in Figs. 3 and 4 confirmed the high spatial resolution on PCD-CT images.

## CONCLUSION

The high-resolution mode on our PCD-CT scanner yields images of fine structures. It is suitable for examining fine structures because it significantly improves spatial resolution, its cost is increased noise.

## CLINICAL RELEVANCE/APPLICATION

The high-resolution mode of PCD-CT may facilitate a more precise stenosis evaluation and the assessment of the patency of coronary stent grafts at CCTA.

## R2-SPCA-6 Deep Learning Image Reconstruction Algorithm and Second-generation Motion Correction Algorithm Improve Dosage Saving and Diagnostic Performance of Coronary CT Angiography with Patients after Percutaneous Coronary

Wenjie Wu (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the image quality and diagnostic value of low-dose coronary CT angiography (CCTA) with deep learning image reconstruction algorithm (DLIR) and second-generation motion correction algorithm (SSF2) compared with conventional-dose CCTA with high-definition (HD) mode assisted by adaptive statistical iterative reconstruction Veo algorithm (ASIR-V) and first-generation motion correction algorithm (SSF) in coronary in-stent restenosis (ISR).

## METHODS AND MATERIALS

A total of 105 patients after Percutaneous coronary intervention (PCI) who received CCTA and invasive coronary angiography (ICA) were prospectively collected and randomly divided into two groups: 60 patients in 100kVp low-dose group (LD group) reconstructed with high-grade DLIR (DLIR-H) and second-generation motion correction algorithm (SSF2), and 45 patients in 120kVp conventional-dose group reconstructed with high-definition mode (HD group) assisted by ASIR-V 50% and first-generation motion correction algorithm (SSF1). Radiation dose and contrast media dose, objective image quality including CT value, image noise (SD), signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) for vessels, as well as subjective image quality parameters with Likert 5-level scoring method were assessed. Moreover, based on the ICA results, we compared the diagnostic performance of these two groups at patient level and stent level.

## RESULTS

With 58.2% radiation dose reduction and 22.5% contrast media reduction, 100kVp LD group assisted with DLIR and SSF2 could achieved even better objective and subjective image quality scores than the 120kVp HD group assisted with HD mode assisted with ASIR-V 50% and SSF. To be specific, SD in AO, LM, LAD, LCX and RCA in LD group was significantly lower than those in HD group (all  $p < 0.05$ ). SNR and CNR in all vessels in LD group were significantly higher than those in HD group (all  $P < 0.001$ ). The subjective image quality scores of the LD group were better than those of the HD group (all  $P < 0.001$ ). The sensitivity, specificity and accuracy of LD group and HD group for diagnosing coronary ISR were 100.0%, 92.1%, 94.2% and 100.0%, 77.9% and 83.8%, respectively, and the number of false positive cases in the DLIR group decreased by 19.2%.

## **CONCLUSION**

Compared with conventional-dose CCTA with HD mode assisted by ASIR-V and SSF1, 58.2% dose reduction and 22.5% contrast media reduction CCTA with DLIR and SSF2 could further improve the image quality and diagnostic performance in coronary ISR.

## **CLINICAL RELEVANCE/APPLICATION**

It can effectively reduce the radiation dose while improving the quality of CCTA images, and has a high diagnostic efficiency for ISR, which has good clinical application value.

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## Abstract Archives of the RSNA, 2023

R2-SPCH

### Chest Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPCH-1 AI-based Diagnosis of Incidental Pulmonary Embolism (PE) on Contrast-enhanced CT Images: A Multi-center Study**

Roshan Fahimi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Unsuspected, incidental PE on routine, contrast-enhanced chest CT can be overlooked and missed. We performed a standalone, multicenter, external validation study of an AI algorithm for detecting incidental PE on routine contrast-enhanced chest CT.

#### **METHODS AND MATERIALS**

Our IRB approved study included 432 patients from four hospitals (two quaternary and two community hospitals) with a mean age of  $56 \pm 12$  years and a female-to-male ratio of 248:184. We used a radiology reports database search engine (Nuance mPower) to identify routine contrast-enhanced CT examinations with and without incidental PE. CT images with section thickness  $<1.5$  mm were deidentified and exported from Visage PACS. All CT exams were processed with an AI algorithm (Cina, Compose, Avicenna Inc.) for triage (CE and FDA cleared) and detection of incidental PE on routine contrast enhanced chest CT. We assessed the model performance the area under the curve (AUC) of the receiver operating characteristic (ROC) curve and calculated sensitivity and specificity with SPSS (IBM).

#### **RESULTS**

The AI algorithm had an overall AUC of 0.86 (95%CI 0.94-0.78) and accuracy of 0.88 for diagnosing incidental PE on routine chest CT. When stratified by sex, the AUC was 0.83 (95%CI 0.95-0.71) for females and 0.92 (95%CI 0.99-0.83) for males. There were no significant inter-institutional variations in model performance across the four sites ( $p>0.1$ ). When stratified by age, the AUC was 0.85 (95%CI 0.98-0.72) for patients  $\leq 60$  years and 0.89 (95%CI 0.98-0.80) for  $> 60$  years, with specificities of 0.91 and 0.93 and sensitivities of 0.80 and 0.87. There were no significant differences among scanners from two main vendors in terms of model AUC, sensitivity, and specificity (GE: 0.85 [95%CI 0.70-0.99], 0.75, 0.96; Siemens: 0.88 [95%CI 0.78-0.98], 0.85, 0.92) ( $p>0.1$ ).

#### **CONCLUSION**

The assessed AI algorithm was generalizable across different imaging sites, patients gender, age, and scanner vendors for detection of incidental PE on routine contrast-enhanced chest CT.

#### **CLINICAL RELEVANCE/APPLICATION**

The assessed AI algorithm can help detect incidental PE on routine contrast-enhanced chest CT examination.

#### **R2-SPCH-2 Three-dimensional Growth Mapping in Subacute Type B Aortic Dissection Predicts Long-term Outcomes**

Prabhvir S. Marway, BA, MBBChir (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Aneurysmal degeneration of the false lumen (FL) is a common complication of Type B aortic dissection (TBAD) often requiring surgical repair. Prophylactic endovascular repair (TEVAR) can prevent FL aneurysm, but early identification of high-risk patients is challenging. Subacute FL growth may predict late adverse events (LAE) but detecting small changes (1-3 mm) is hampered by measurement error. Vascular deformation mapping (VDM) is an emerging CT analysis technique that provides highly accurate 3D maps of aortic growth using routine clinical CTs. We hypothesized that early identification of FL growth by VDM within 3 months post-TBAD can more accurately identify patients at risk of LAE versus standard CT measurements.



## METHODS AND MATERIALS

We performed a retrospective study (2005-2018) of adult patients with acute, uncomplicated TBAD, with high-quality CT angiograms (CTA) pre-discharge and at 1-3 months post-discharge. Exclusions included: Prior repair of the descending aorta; poor FL enhancement OR complete FL thrombosis. VDM analysis used a multi-step deformable image registration process after semi-automated segmentation. Quantitative growth data from the descending thoracic aorta was extracted from VDM, and 90th percentile radial values were used for analysis. Standard CT measures were collected by expert raters: maximal diameter; proximal tear size; tear distance from the left subclavian artery (LSC). LAE were defined as aneurysmal growth of the dissected aorta >55mm, rupture, and surgical repair of TBAD.

## RESULTS

Among the 33 patients analyzed, 22 (66%) had LAE. There was no significant difference in follow-up period ( $6.3 \pm 2.7$  vs.  $6.3 \pm 4.0$  years,  $p = 0.99$ ), or time between scans ( $45 \pm 17$  vs.  $46 \pm 29$  days,  $p = 0.88$ ). Based on clinically reported measurements (chart review), there were no significant predictors of LAE by anatomic metrics: maximal diameter ( $42.8 \pm 7.4$  vs.  $39.4 \pm 6.2$ mm,  $p = 0.20$ ), change in maximal TBAD diameter by clinical measurements between scans ( $3.3 \pm 4.2$  vs.  $2.2 \pm 5.3$ mm,  $p = 0.54$ ), and LSC to proximal tear distance ( $51.8 \pm 62.9$  vs.  $41.6 \pm 76.8$ mm,  $p = 0.70$ ). However, VDM identified higher growth in the LAE group compared to the no AE group ( $3.7 \pm 2.8$ mm vs  $1.0 \pm 0.8$ mm,  $p = 0.006$ ). Most (68%) patients in the LAE group had a maximum baseline diameter of = 40mm, compared to 45% in the no AE group ( $p = 0.20$ ).

## CONCLUSION

3D growth mapping (VDM) using routine CTA images can detect subacute FL growth that is largely missed by clinical CT diameter measurements. Small growth (>2 mm) 1-3 months post-TBAD can identify patients at high risk of late adverse events.

## CLINICAL RELEVANCE/APPLICATION

Even small aortic growth (>2 mm) can be mapped over a short CT interval using an image analysis technique called VDM, identifying TBAD patients at high risk of late adverse events.

## R2-SPCH-4 Real-world Performance of an AI-based Algorithm for Pulmonary Embolism Detection at Several Emergency Departments

Sarah Quenet, MD (*Presenter*) Employee, Avicenna.ai

## PURPOSE

The integration of artificial intelligence (AI) in clinical routine allows accurate diagnosis and may ultimately improve patients' outcome of life-threatening conditions such as pulmonary embolism (PE). However, the accuracy needs to be constantly evaluated. This study aims to analyze the real-world performance of an FDA-cleared and CE-marked AI-based software designed to detect PE on chest computed tomography angiograms (CTAs) at a large emergency teleradiology network.

## METHODS AND MATERIALS

CTAs from patients admitted to several emergency departments (ED) from June 2022 to March 2023 and received by a teleradiology company (Telediag, Lyon, France) for clinical interpretation were retrospectively analyzed. CINA-PE v1.0.3 (Avicenna.AI, La Ciotat, France), an AI-powered algorithm designed to flag acute suspected PEs up to the segmental level, was already integrated into the clinical workflow. Only the scans automatically processed by the device were included in the study. A board-certified senior thoracic radiologist, not blinded to any clinical information, randomly reviewed 5% of the CTAs and their radiological reports, as part of the company's quality control program. The AI-device results were compared to the expert's interpretation, defined as the ground truth. The sensitivity, specificity, PPV and NPV were calculated. Furthermore, the potential causes of false positives (FP) and false negatives (FN) were analyzed.

## RESULTS

A total of 295 scans (mean age:  $66.9$  yo  $\pm 18.5$  [SD]; 47.1% male) from 58 ED were reviewed. Among the 34 exams identified as positive for PE by the expert, the device correctly identified 29, yielding a sensitivity of 85.3% [95% CI: 68.9% - 95.1%]. Similarly, 250 out of 261 were correctly identified as negative for PE (specificity of 95.8% [95% CI: 92.6% - 97.9%]). The PPV and NPV were 72.5% and 98.1%, respectively. All the missed PEs (5 FN) were located at the segmental level. The 11 FP had confounding conditions such as bronchiolitis ( $n=3$ ), pulmonary edema ( $n=1$ ), lymphadenopathy ( $n=1$ ), fibrosis ( $n=1$ ), vena cava artifacts ( $n=1$ ), overlapping pulmonary vein and artery ( $n=1$ ), pleuritis ( $n=1$ ) and unknown ( $n=2$ ). In addition, the dataset included 2 PEs at the subsegmental level that were considered as negative cases because the algorithm is not intended to detect them.

## CONCLUSION

The AI-based algorithm, tested on real-world data from several ED, demonstrated high accuracy for PE detection. These results suggest that the integration of AI into daily practice may help optimize the clinical workflow providing a faster and accurate diagnosis.

## CLINICAL RELEVANCE/APPLICATION

This study provides insight into the high performance of an AI-based algorithm in real clinical routine, tested on heterogeneous data from several clinical sites.

### R2-SPCH-5 Unenhanced MR Angiography and V/Q Scan for the Detection of Pulmonary Embolism: Systematic Review and Meta-analysis

Stephan Altmayer, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Our purpose was to conduct an updated meta-analysis to compare the diagnostic performance of unenhanced magnetic resonance angiography (MRA) and ventilation/perfusion (V/Q) scintigraphy in the diagnosis of acute pulmonary embolism (PE).

#### METHODS AND MATERIALS

Systematic searches of PubMed, Embase, Scopus, BVS, Web of Science, and Cochrane databases were conducted through April 2023. The inclusion criteria of our study required the evaluation of the performance of unenhanced MRA and V/Q scintigraphy for the detection of acute pulmonary embolism using computed tomography pulmonary angiography (CTPA) as the reference standard. We excluded studies in which CTPA was performed more than 30 days after the MRA or V/Q scan.

#### RESULTS

A total of 1695 studies were identified through systematic searches, with seven studies meeting inclusion criteria. The results showed that unenhanced MRA had a pooled sensitivity of 0.87 (95% CI 0.82 - 0.91) and specificity of 0.96 (95% CI 0.93 - 0.98), with no statistically significant heterogeneity. The pooled summary receiver operating characteristic (SROC) curve for unenhanced MRA yielded an AUC of 0.92 (95% CI 0.85 - 0.96). On the other hand, V/Q scanning had a pooled sensitivity of 0.81 (95% CI 0.76 - 0.85) and specificity of 0.84 (95% CI 0.74 - 0.91), with statistically significant heterogeneity for both sensitivity and specificity. The selected studies were assessed using the revised QUADAS-2 tool, and all studies were considered to have a relatively low risk of bias.

#### CONCLUSION

Unenhanced MRA has a comparable if not superior diagnostic accuracy compared to V/Q perfusion scan for the detection of pulmonary embolism.

## CLINICAL RELEVANCE/APPLICATION

Unenhanced MRA for at least similar if not superior diagnostic performance compared to V/Q scan without the need for contrast agents, exposure to radiation, and contraindication in patients with known lung parenchymal abnormality.

### R2-SPCH-6 CT-defined Low-skeletal Muscle Mass and Muscle Density are Related with Mortality in Acute Pulmonary Embolism: A Multicenter Analysis

Hans-jonas Meyer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Computed tomography (CT) defined muscle mass can be used as a surrogate parameter for sarcopenia. The present study used thoracic CT to assess pectoralis muscle area and density as an imaging biomarker for prognosis of 30-day mortality in patients with acute pulmonary embolism (PE)

#### METHODS AND MATERIALS

The clinical database was retrospectively screened for patients with thoracic CT in 3 centers. Pectoralis musculature was measured on axial slices of the thoracic CT at the level of T4 of contrast enhanced pulmonary angiography CT. Skeletal muscle area (SMA), skeletal muscle index (SMI), muscle density and gauge were calculated.

#### RESULTS

Overall, 981 patients (440 female, 44.9%) with a mean age of  $63.5 \pm 15.9$  years were included into the study and 144 patients (14.6%) died within the 30-days period. Every pectoral muscle value was higher in survivors compared to non-survivors (exemplarily for SMI  $9.9 \pm 3.5$  cm<sup>2</sup>/m<sup>2</sup> versus  $7.8 \pm 2.6$  cm<sup>2</sup>/m<sup>2</sup>,  $p < 0.001$ ). Moreover, 91 patients were defined as hemodynamically instable (9.3%). Comparable, every pectoral muscle parameter was higher in patients with hemodynamically stable course compared to instable course. Different muscle variables are related to 30-day mortality: SMA, OR = 0.94 (95%CI= (0.92; 0.96),  $p < 0.001$ ); SMI, OR = 0.78 (95%CI= (0.72; 0.84),  $p < 0.001$ ); muscle density, OR = 0.96 (95%CI = (0.94; 0.97),  $p < 0.001$ ); muscle gauge OR = 0.96 (95%CI = (0.94; 0.99),  $p < 0.001$ ). SMI and muscle density were independently associated with 30-days mortality: SMI, OR = 0.81 (95%CI = (0.75; 0.88),  $p < 0.001$ ); muscle density: OR = 0.96 (95%CI= (0.95; 0.98),  $p < 0.001$ ).

## CONCLUSION

Parameters of the pectoralis musculature are associated with 30-day mortality in patients with acute PE. These findings should lead to an independent validation study and ultimately to the inclusion into clinical routine as a prognostic factor.

## CLINICAL RELEVANCE/APPLICATION

Pectoralis muscle is a potential important imaging biomarker, which can be easily quantified in clinical routine. There was an association with 30-day mortality in patients with acute PE.

## **R2-SPCH-7 Improved Quantification and Prognostication of Lung Disease on CT in Pulmonary Hypertension by Combining the Strengths of Deep Learning and Radiologists: A Retrospective Multicentre Study with External Validation**

Krit Dwivedi, BMBS, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

Gold standard for Computed Tomography (CT) lung disease quantification is visual assessment by specialist radiologists. Due to overlapping characteristics, distinguishing between Idiopathic Pulmonary Arterial Hypertension (IPAH) and PH associated with Lung Disease (PH-LD) is challenging in patients with 'mild' lung disease. A new IPAH lung disease sub-phenotype has been recently identified. Accurate diagnosis is vital, as therapeutic agents are only indicated in IPAH. CT imaging is routinely performed, but its prognostic impact is not well understood. This retrospective multicentre study deploys an artificial intelligence (AI) model to quantify the prognostic value of CT lung parenchymal patterns in a combined approach with radiological reporting.

### METHODS AND MATERIALS

521 consecutive IPAH and PH-CLD patients with incident CT imaging between 2001-19 were included from the ASPIRE registry. A DenseNet121 and nnU-net AI model with AUC 0.94 on external testing quantified the percentage of normal lung, ground glass, ground glass with reticulation (GGR), emphysema, honeycombing and fibrosis. Fibrosis severity was scored by sub-specialist radiologists. Multivariate cox regression adjusting for age, sex, WHO function class, pulmonary vascular resistance (PVR) and diffusing capacity of carbon monoxide (DLCO) was performed. Findings were externally validated in 246 patients.

### RESULTS

AI quantified fibrosis was a significant predictor independent of age, sex, WHO FC, PVR and DLCO in the internal (HR 1.01 per one percentage point,  $p=0.043$ ) and external (HR 1.03,  $p=0.006$ ) cohorts. In sub-group of patients scored by radiologists as having 'no' fibrosis, AI identified minor (1%) fibrosis, which was of prognostic (HR 1.03,  $p=0.004$ ) significance. Adding AI quantified fibrosis to a predictive model of radiologically scored disease and patient demographics significantly improved its predictive strength (c-index 0.763 vs 0.742,  $p=0.038$ ).

## CONCLUSION

AI quantified parenchymal patterns are prognostic markers for survival, independent of age, sex, WHO function class, disease severity (PVR) and DLCO. This is the largest AI study in this domain and first with external validation (246 patients, 33 centres, 37 scanners). AI is sensitive to minor lung disease, and when used in combination with radiological reporting, provides additional predictive value. These findings have implications for phenotyping, radiological reporting, and therapeutic decisions.

## CLINICAL RELEVANCE/APPLICATION

This study demonstrates the strength of combining radiological reporting and automated quantitative AI models together to improve patient outcomes. This approach will aid in identifying PH phenotypes and identify new phenotypes based on lung disease severity.

## **R2-SPCH-8 Artificial Intelligence Algorithms for Incidental Pulmonary Embolism Detection: A Systematic Review and Meta-analysis**

Mohamad Nawras (*Presenter*) Nothing to Disclose

### PURPOSE

In patients with suspected pulmonary embolism (PE) who undergo chest CT angiogram (CTA), the efficacy of artificial intelligence (AI) algorithms for PE detection has been well established. However, less is known about the use of AI algorithms for detection of incidental PE on imaging ordered for reasons other than suspected PE. The purpose of this study is to evaluate the use of AI algorithms for detection of incidental PE.

## **METHODS AND MATERIALS**

We performed a comprehensive literature search using PubMed, Embase, and Web of Science databases from inception to 2/25/2023, for all studies that assess an AI algorithm for detection of incidental PE. Pooled sensitivity, specificity, and the corresponding 95% CI were calculated using the random effect model. Heterogeneity was assessed using the Higgins I<sup>2</sup> index.

## **RESULTS**

A total of four studies, including 19,440 CT scans were included in the analysis. The pooled sensitivity of the artificial intelligence algorithms for the detection of incidental PE was 0.839 (95% CI:0.637-0.939, I<sup>2</sup>: 88.23%) and the pooled specificity was 0.999 (95% CI: 0.996-1.000, I<sup>2</sup>: 82.51%).

## **CONCLUSION**

Our meta-analysis demonstrated that AI algorithms can detect incidental PEs on CT scans with good sensitivity and excellent specificity. Such algorithms can potentially be used as screening tools or second readers for detection of PEs on non-CTA imaging. Further large-scale studies are necessary to validate our findings.

## **CLINICAL RELEVANCE/APPLICATION**

More hospitals are now implementing artificial intelligence and deep learning algorithms to their imaging protocols. It is important to present the overall usefulness of such algorithms as we have done in this study.

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## Abstract Archives of the RSNA, 2023

R2-SPER

### Emergency Radiology Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### R2-SPER-1 Dual-Energy CT for Suspected Scaphoid Fractures: Evaluation of a Clinical Implementation

Felix C. Muller, MD (*Presenter*) Employee, Siemens AG

#### PURPOSE

In December 2020 we changed the workup of patients with radiographically occult but clinically suspected scaphoid fractures from MRI to dual-energy CT (DECT) using virtual non-calcium images (VNCa). Previous studies have shown similar diagnostic accuracy for MRI and DECT, but we still wanted to investigate if this would lead to overlooked injuries. We also tested a previously proposed threshold level for detection of traumatic bone marrow edema on VNCa images.

#### METHODS AND MATERIALS

Patients were eligible for inclusion if they had received a DECT scan of the wrist with a clinical suspicion of a scaphoid fracture after a radiograph during the first 6 month of implementation. We excluded patients with known scaphoid or other fractures. All patients were scanned on a second or third generation dual-source CT scanner with a tube voltage combination of 80 kV / 140kV or 80kV / 150kV with use of tin filtration. VNCa images were available to the reading on-call radiologists. Definite or possible radius or scaphoid fractures as noted in the radiological report were recorded. We then audited the electronic health record and PACS for any follow up visit or radiological imaging of the wrist for a period of 12 months after the trauma for identification of scaphoid fractures, other fractures or soft tissue injury. Patient with scaphoid or radius fractures were selected for quantitative image analysis compared to patients without as a control group. Areas in the VNCa image above -40HU were color-coded for the automatic detection of fracture associated bone marrow edema.

#### RESULTS

Of 322 identified patients 87 were excluded. Of the 235 included patients (214 adults, 21 Children) 8.5% (20/235) had a scaphoid, 17% (40/235) a radius, and 19.1% (45/235) other fractures. We found no patients with overlooked scaphoid fractures during the follow-up period. Three patients presented with a new wrist trauma and were diagnosed with an avulsion from the scaphoid, a radius fracture and a scapholunate dissociation. Two patients were diagnosed with ulnar collateral ligament injury on clinical follow-up examination. VNCa cutoff of -40HU had a sensitivity and specificity of 100% (95% CI 83%-100%) and 96% (95% CI 79%-100%) for radius fracture and 100% (95% CI 59%-100%) and 92% (95% CI 78%-98%) for scaphoid fracture detection.

#### CONCLUSION

We find no evidence that a DECT based scaphoid fracture workup leads to overlooked scaphoid fracture. VNCa values above -40HU were highly sensitive and specific for the detection of fracture associated bone marrow edema.

#### CLINICAL RELEVANCE/APPLICATION

Implementation of DECT based scaphoid fracture detection is safe and quantitative assessment of virtual non-calcium images can assist radiologists in the detection of radiographically occult fractures.

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## Abstract Archives of the RSNA, 2023

R2-SPGI

### Gastrointestinal Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPGI-1 Comparison of Split Bolus Dual Energy CT and Multiphase Dual Energy CT in Assessing Vascular Invasion in Patients with Biliary Malignancies: A Randomized Study**

Kondaveeti N. Eswar, MBBS, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare image quality, definition of vascular invasion and radiation dose of split bolus dual energy CT (DECT) with multiphase DECT in biliary malignancies.

#### **METHODS AND MATERIALS**

This prospective single centre approved study included 88 patients of gallbladder cancer and hilar cholangiocarcinoma randomized into two groups and scanned on rapid-switching DECT scanner. Patients in group 1 (n=43, mean age: 54.6 years, 12 men) were scanned with multiphase protocol (MPP; arterial, venous, delayed phases in DECT) and those in group 2 (n=45, mean age: 52.6 years, 20 men) with split bolus protocol (SBP; split-bolus, delayed phases in DECT). For both groups, virtual monoenergetic images (VMI) were generated at 50 and 70 keV. Mean attenuation, contrast to noise ratio (CNR) and signal to noise ratio (SNR) of tumor, liver and hepatic vessels were assessed in each phase and VMI and were compared between the two groups along with dose length product and volumetric CT dose index. Two readers independently assessed subjective image quality and vascular invasion (5 point Likert scale) in each phase (MPP and SBP) and inter-reader agreement was compared within groups. Mann Whitney U-test and kappa statistics were used for comparison and  $p < .05$  was considered significant.

#### **RESULTS**

Arterial phase of group 1 had significantly higher attenuation, CNR and SNR of arteries compared to SBP (for both 50 and 70 keV) of group 2 ( $p < .001$ ). However, venous phase of group 1 had significantly poorer attenuation, CNR and SNR for arteries compared to SBP (both VMI) ( $p < .001$ ). Quantitative parameters for veins and tumor between venous phase (group 1) and SBP (group 2) were comparable. Good-to-strong inter-reader agreement ( $k = 0.45$  to  $0.75$ ) for image quality for both protocols was observed. For hepatic arterial invasion, SBP had significantly higher inter-reader agreement ( $k = 0.71$ ) compared to arterial phase of MPP ( $p < .001$ ). For arterial invasion, 32% and 24% of images of group 1 could not be assessed by reader 1 and 2 respectively, compared to 8% and 6%, respectively in group 2 ( $p < .001$ ). Venous invasion was comparable between the two readers. 50 and 70 KeV VMI were comparable for staging of vascular invasion for both readers. MPP had 37% higher radiation dose than SBP ( $p < .001$ ).

#### **CONCLUSION**

Image quality of SBP is non-inferior to MPP for biliary malignancies. However, SBP showed significantly better inter-observer agreement for arterial invasion indicating better assessment of vascular involvement with significantly lower radiation dose.

#### **CLINICAL RELEVANCE/APPLICATION**

Biliary malignancies are better defined in venous phase in which arteries are indistinct, making arterial invasion assessment tough. SBP overcomes this by clearly depicting arteries and tumor in same phase for confident assessment.

#### **R2-SPGI-3 Sarcopenia During Neoadjuvant Chemotherapy and its Effect on Survival in Gastroesophageal Adenocarcinomas**

Clarissa Hosse (*Presenter*) Nothing to Disclose

## PURPOSE

Gastroesophageal adenocarcinomas are one of the most prevalent types of cancer worldwide and their incidence has been increasing over the last few decades. Despite advances in treatment, the survival rate remains low, with less than 30% of patients surviving beyond five years. Patients suffer from dysphagia, weight loss and often present with sarcopenia, a progressive muscle loss associated with both age and cancer. Sarcopenia has been gaining attention as a prognostic factor in cancer, mainly focusing on surgical patients. Its prognostic power for patients who receive multimodal treatment, however, remains unclear. This study aimed to investigate the effect of changes in muscle mass on patients with gastroesophageal adenocarcinomas who received neoadjuvant chemotherapy before surgical resection. The study focused on overall survival (OS), disease-free survival (DFS), and length of stay (LOS) after curative resection as the endpoints.

## METHODS AND MATERIALS

We collected retrospective data from 146 patients treated between 2010 and 2020. We used a fully automatic "AI body composition analysis software" to measure the lumbar skeletal muscle index (LSMI) on CT scans taken before and after neoadjuvant chemotherapy to evaluate sarcopenia. We defined sarcopenia as LSMI < 38.5 cm<sup>2</sup>/m<sup>2</sup> (female) and < 52.4 cm<sup>2</sup>/m<sup>2</sup> (male). The primary outcome was OS, and the secondary outcomes were DFS and LOS after curative resection. We conducted Kaplan-Meier analyses for survival and tested with Log-Rank.

## RESULTS

The median OS was 82.13 months (95% CI [64.22 - 10.05]), with 32 recorded deaths (21.9%). The median skeletal muscle loss during neoadjuvant chemotherapy was 2.79%. Although any loss of skeletal muscle during neoadjuvant chemotherapy indicated worse OS, it did not reach statistical significance ( $p = 0.068$ ). LSMI-loss significantly correlated with worse DFS ( $p = 0.028$ ) with a mean of 77.06 months (95% CI [63.03 - 91.09]) without and 47.40 months (95% CI [37.92 - 56.89]) with loss of skeletal muscle mass. It also correlated with LOS ( $p = 0.026$ ) with a median of 12 days (95% CI [11.19 - 12.81]) without and 14 days (95% CI [12.86 - 15.14]) with loss of skeletal muscle mass.

## CONCLUSION

Patients with gastroesophageal adenocarcinomas undergoing neoadjuvant chemotherapy before surgery are at risk of skeletal muscle loss associated with adverse outcomes. While further studies are needed, loss of skeletal muscle mass during treatment, rather than sarcopenia at any timepoint, has the potential to become a prognostic marker and target for interventions.

## CLINICAL RELEVANCE/APPLICATION

Using AI body composition analysis techniques to find individual prognostic markers for patients with cancer

## R2-SPGI-7 Evaluation of Programmed Cell Death Ligand 1 Expression in Gastric Cancer by Enhanced CT Parameters

Min Xu (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to explore the correlation between enhanced CT imaging features and programmed cell death ligand-1(PD-L1) expression status in gastric cancer and to evaluate the predictive value of imaging parameters for immunotherapy biomarkers.

## METHODS AND MATERIALS

Patients with gastric adenocarcinoma who underwent abdominal CT three stage enhanced scan and PD-L1 immunohistochemical testing before treatment were retrospectively examined. All diagnoses were confirmed by pathology. According to the expression status of PD-L1, they were divided into positive group(CPS $\geq$ 5) and negative group(CPS<5). Baseline CT imaging features were collected. CT value were collected in the unenhanced(U), arterial(A), venous(V), and delayed(D)phases to further calculate the arterial attenuation and venous attenuation with arterial enhancement fraction(AEF). Diagnostic performances of the different variables were evaluated using receiver operating characteristic(ROC) curve.

## RESULTS

A total of 67patients with gastric adenocarcinoma were included in the study. On abdominal enhancement CT images, the probability of maximum lymph node short diameter>1cm and peak of lesion enhancement occurring in the arterial phase were statistically significant between the two group( $p<0.05$ ); Moreover, the AEF was significantly higher in the positive group than in the negative group( $p<0.05$ ). And the ROC curve analysis showed that the AEF exhibited a high evaluation efficacy [AUC: 0.724(95%CI: 0.602~0.826)]. The combined model had the best diagnostic efficacy[AUC: 0.786(95%CI: 0.669~0.877), sensitivity: 58.33%; specificity: 88.37%].



## CONCLUSION

There is a correlation between CT imaging features and PD-L1 expression status in gastric cancer, and AEF may help to assess high PD-L1 expression and help to select patients suitable for immunotherapy.

## CLINICAL RELEVANCE/APPLICATION

To explore the value of CT imaging features in evaluating biomarkers for immunotherapy of gastric.

## R2-SPGI-8 MRI-traceable Nanoparticles for Integrin Targeted Liver Fibrosis Detection

Qihui Hu JR, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To timely detection and intervention of liver fibrosis are crucial for preventing the progression of the liver disease, we designed an integrin  $\beta_3$  targeted nano-platform (cRGD-PLGA/IONP) based on iron oxide nanoparticles (IONPs) for the detection and grading of liver fibrosis.

## METHODS AND MATERIALS

Preparation of cRGD-PLGA/IONP. The PLGA microcapsules were prepared by the double emulsion process, where superparamagnetic IONPs were introduced into the reaction. cRGD-PLGA/IONP were subsequently characterized by a series of methods. Animal models. C57BL/6 mice received an intraperitoneal injection of 20% CCl<sub>4</sub> (1  $\mu$ g/g) twice weekly for 0, 3, 7, or 11 weeks. MRI protocol. C57BL/6 mice were imaged on a 3.0 T MRI system with animal coils. MR imaging (Discovery 750w, GE Healthcare) was performed at different time points after cRGD-PLGA/IONP, IONP and PBS i.v. injection. Scanning with T2WI and T2 mapping sequences. The T2 and R2 values in various areas of the mice livers at different time points after cRGD-PLGA/IOFA administration were measured and calculated to assess the contrast enhancement.

## RESULTS

Liver fibrosis induction. Immunofluorescence and Sirius staining confirmed the increased protein expression of integrin  $\beta_3$  subunit in aHSCs and the fibrogenic marker  $\alpha$ -SMA with the time of CCl<sub>4</sub> administration, which indicates the animal model was established successfully (Figure 1). cRGD-PLGA/IONP for MRI detection of liver fibrosis. cRGD-PLGA/IONP group demonstrated a contrast enhancement in R2 to 33.9 s<sup>-1</sup> ( $\Delta$ R2 ~ 4.7 s<sup>-1</sup>, an approximate 16.2% increase in the liver area) in the early-stage fibrotic liver (Ishak 1). Compared with the control group (Ishak 0), the significantly increased signal ( $\Delta$ R2) of mice (Ishak 3 and Ishak 5) injected with cRGD-PLGA/IONP were 12.4 (42.5%) and 37.4 (127.9%), and the R2 values were nearly 1.4 and 2.3 times than that of the control group, respectively. (Figure 2a, b). The Fe concentration in mice liver of cRGD-PLGA/IONP group was measured by the inductively coupled plasma-mass spectroscopy. Figure 2c showed that the levels of Fe content in the mice liver were basically consistent with the changes in MRI liver signal values. In contrast, the IONP group did not result in significant signal enhancement at different time points. These results illustrated that cRGD-PLGA/IONP was a highly efficient MRI agent for liver fibrosis diagnosis.

## CONCLUSION

In conclusion, cRGD-PLGA/IONP could perform MRI visualization detection and grading.

## CLINICAL RELEVANCE/APPLICATION

Liver fibrosis is the critical stage in developing chronic liver disease (CLD), from simple and reversible injury to irreversible cirrhosis. A novel contrast agent-enhanced MRI detection is a potential new method for diagnosing liver fibrosis.

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## Abstract Archives of the RSNA, 2023

R2-SPGU

### Genitourinary Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### R2-SPGU-1 Development and Validation of a Predictive Model Based on Clinical and mpMRI Findings to Reduce Additional Systematic Prostate Biopsy

Xueqing Cheng (*Presenter*) Nothing to Disclose

#### PURPOSE

To develop and validate a predictive model based on clinical features and multiparametric magnetic resonance imaging (mpMRI) to reduce unnecessary systematic biopsies (SB) in biopsy-naïve patients with suspected prostate cancer (PCa).

#### METHODS AND MATERIALS

274 patients who underwent combined cognitive MRI-targeted biopsy (MRTB) with SB were retrospectively enrolled, and temporally be split into development (n = 201) and validation cohorts (n = 73). Multivariable logistic regression analyses were used to determine independent predictors of clinically significant PCa (csPCa) on cognitive MRTB, and the clinical, MRI and combined models were established respectively. Area under the receiver operating characteristic curve (AUC), calibration plots and decision curve analyses were assessed.

#### RESULTS

Prostate imaging data and reporting system (PI-RADS) score, index lesion (IL) on the peripheral zone, age and prostate specific antigen density (PSAD) were independently predictors and included in the combined model. The combined model achieved the best discrimination (AUC: 0.88) as compared to both MRI model incorporated by PI-RADS score, IL level and zone (AUC: 0.86), and clinical model incorporated by age and PSAD (AUC: 0.70). The combined model also showed good calibration and enabled great net benefit on internal and external validation. Applying the combined model as a reference for performing MRTB alone with a cutoff of 60% would reduce 43.8% of additional SB, whilst missing 2.9% csPCa.

#### CONCLUSION

The combined model based on clinical and mpMRI findings improved csPCa prediction and might be useful in making a decision about which patient could safely avoid unnecessary SB in addition to MRTB in biopsy-naïve patients.

#### CLINICAL RELEVANCE/APPLICATION

- Age, PSAD, PI-RADS score and index lesion on the peripheral zone were independently predictors of detecting csPCa by cognitive MRTB.
- The combined model that incorporated clinical and mpMRI findings achieved best discrimination in predicting csPCa, with satisfactory calibration and net benefit in biopsy naïve patients.
- Using the combined model with a cutoff of 60% as an indication of performing MRTB alone would reduce 43.8% of unnecessary SBs, whilst missing 2.9% csPCa.

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## Abstract Archives of the RSNA, 2023

R2-SPHN

### Head & Neck Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### R2-SPHN-2 The Effects of Improved Position on Image Quality of CT Scanning of Thyroid

Shuting Liao, MMedSc (*Presenter*) Nothing to Disclose

##### PURPOSE

In this study, we explore the effect of the Improved Swimmer's position on computed tomography (CT) image quality of thyroid, on the radiation dose to patients and the detection rate of thyroid micronodules on CT, using GE Revolution Energy Spectrum CT.

##### METHODS AND MATERIALS

Thyroid examinations with spectral CT were compared for Traditional position group (TDN); Swimmer's position group (SWIM) and Improved Swimmer's position group (I-SWIM). We used subjective grades and objective SNRs and CNRs indicators to assess image quality. Potential confounders, such as Body Mass Index (BMI) and the effective diameter of the neck, were assessed. Patients' radiation exposure was measured by the volume CT dose index (CTDIvol), dose-length product (DLP), and the effective dose of the neck (EDN) and thyroid (EDT). We also evaluate the micronodules detection rate on CT images.

##### RESULTS

Subjective and objective evaluation of thyroid CT image quality were significantly improved in the I-SWIM group compared with SWIM group and TDN group ( $p < 0.001$ ). Although there was no statistically significant difference ( $p = 0.109$ ) in BMI, effective neck diameter and radiation dose received between the groups ( $P > 0.05$ ), there was no significant increase in radiation exposure in the modified swimming position group. There was a significant promotion in micronodules detection of thyroid in the I-SWIM group versus SWIM group and TDN group ( $p < 0.001$ ).

##### CONCLUSION

Based on spectral CT, I-SWIM position improved the image quality of thyroid CT without increasing the radiation exposure of the patients, and increased the detection rate of thyroid micronodules on CT.

##### CLINICAL RELEVANCE/APPLICATION

Based on spectral CT, I-SWIM position improved the image quality of thyroid CT without increasing the radiation exposure of the patients, and increased the detection rate of thyroid micronodules on CT.

#### R2-SPHN-3 Medium-Term Study Results of Ultrasound-Guided Radiofrequency Ablation for Thyroid Follicular Neoplasm with Low SUV in PET/CT

An-Ni Lin, MD (*Presenter*) Nothing to Disclose

##### PURPOSE

To evaluate the long-term results of radiofrequency ablation (RFA) of thyroid nodule with cytology of follicular neoplasm with low standard uptake value (SUV) in a positron emission tomography (PET/CT) study.

##### METHODS AND MATERIALS

From January 2018 to January 2021, 40 patients were diagnosed with follicular neoplasm. All patients received ultrasound, fine needle aspiration (FNA) or core needle biopsy (CNB) prior to the treatment. A PET/CT scan was performed in 33 patients prior to treatment. Under local anesthesia, RFA was performed with the use of an RF generator and an 18-gauge internally cooled electrode. Volume changes in nodules on follow-up ultrasonography (US), changes in symptomatic and cosmetic

scores, and complications arising during or after RFA were evaluated. Six to twelve months after RFA, all patients received FNA to reevaluate the neoplasm status.

## RESULTS

Significant volume reductions during follow-up between values prior to RFA and 6 months after RFA ( $7.31 \pm 12.83 \text{ cm}^3$ ,  $p < 0.001$ ) were demonstrated. The respective mean volume reduction ratios at the 6-month and final follow-up were 71.5% and 81.45%. The mean follow-up time was  $2.38 \pm 0.9$  years. One patient presented with vocal cord palsy and another patient presented with ptosis, both of whom recovered after RFA. No post-procedural hypothyroidism occurred in the RFA patients. Pre-RFA thyroglobulin level was significantly positively correlated with the SUVmax value of PET/CT ( $p = 0.001$ ).

## CONCLUSION

RFA is a safe and effective treatment for patients with low-risk follicular neoplasm (SUVmax value  $\leq 5$ ) in long-term follow-up. It is a viable alternative treatment for patients not suitable or willing to undergo surgery.

## CLINICAL RELEVANCE/APPLICATION

RFA is a safe and effective treatment option for patients with thyroid follicular neoplasm, specifically those with low SUVmax on PET/CT studies. This treatment can provide significant volume reductions in the nodule and improve symptomatic and cosmetic scores. Additionally, RFA may be a viable alternative to surgery for patients who are not suitable or willing to undergo surgery. Clinicians could consider using RFA as a treatment option in patients with low-risk follicular neoplasm, as it has been demonstrated to have minimal complications and no post-procedural hypothyroidism. Furthermore, clinicians could consider performing PET/CT studies in patients with thyroid nodules to assess their SUVmax value, as it can be a useful predictor of the malignancy rate of thyroid nodule.

## R2-SPHN-5 Development and Validation of Radiomics Model Based on Ultrasound Images to Predict Malignancy in Bethesda Category III and IV Thyroid Nodules

Xiaoxian Li (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to predict malignancy in thyroid nodules with initial fine-needle aspiration (FNA) results of Bethesda category III and IV using a machine learning algorithm.

## METHODS AND MATERIALS

A total of 266 thyroid nodules ( $\geq 1 \text{ cm}$ ) were included from January 2017 to May 2022 retrospectively. The initial FNA results were Bethesda category III or IV and subsequent pathological diagnoses were obtained. All subjects were divided into a training set and a test set randomly at a ratio of 7:3. One senior and one junior radiologist independently and blindly reviewed the images of the test set and evaluate the nodule features based on the American College of Radiology (ACR) Thyroid Imaging Reporting and Data System (TI-RADS). For each nodule, two grayscale ultrasonography images including one transverse and one longitudinal were selected and segmented. Then radiomics features were extracted and selected using a machine learning algorithm to develop a radiomics model. Univariate and multivariate logistic regression analyses were used to select clinical independent predictors which were used to develop the clinical-radiomics combined model. The receiver operating characteristic (ROC) curves of the radiomics model and combined model were plotted. The AUCs were calculated and compared using DeLong's test.

## RESULTS

Among the final set, 226 cases were Bethesda III nodules with a malignant rate of 39.4%; 40 cases were Bethesda IV nodules with a malignant rate of 50.0%. The variables included in the clinical-radiomics combined model were nodule size, suspected cervical lymph node metastasis and radiomics probability. In both the training and test sets, the AUC of the combined model was higher than that of the radiomics model (training, 0.823 vs 0.751,  $P = 0.003$ ; test, 0.800 vs 0.749,  $P = 0.040$ ). In the test set, the AUC of the combined model was significantly higher than that of the junior radiologist (0.800 vs 0.658,  $P = 0.029$ ) and no significant difference compared to senior radiologist (0.800 vs 0.760,  $P = 0.550$ ). Moreover, the specificity of the combined model (66.7%) was higher than that of the junior radiologist (44.4%) and senior radiologist (62.2%). There was no significant difference between the AUC of the radiomics model and two radiologists ( $P > 0.05$ ).

## CONCLUSION

The radiomics model and clinical-radiomics combined model based on grayscale ultrasound images can effectively predict malignancy in Bethesda category III and IV thyroid nodules. The diagnostic performance of the combined model is comparable to that of the senior radiologist and better than that of the junior radiologist.

## CLINICAL RELEVANCE/APPLICATION

Machine learning algorithm may help in more accurate identification of malignancy in Bethesda category III and IV thyroid nodules for further evaluation.

R2-SPHN-6 Jonahi S. Serrano Heredia (*Presenter*) Nothing to Disclose

# "Unlocking the Secrets of F-18-FDG PET/CT Thyroid Incidentalomas". A Comprehensive Analysis of Ultrasound and Pathology in a Leading Mexico City Hospital

## PURPOSE

Study the prevalence

of focal and diffuse thyroid incidentalomas detected by 18-FDG PET/CT. Investigate the relation between SUVmax, ultrasound features, and histopathology to estimate the risk of malignancy in these patients. Estimate a cut-off point of SUVmax to suspect malignancy.

## METHODS AND MATERIALS

We retrospectively reviewed the reports of 3958 patients in whom 18-FDG-PET/CT scans were performed. Studies in which the presence of thyroid incidentaloma were analyzed. SUVmax and Total lesion glycolysis (3D slicer) values were obtained prospectively. Ultrasound was also prospectively reviewed if available, Fine Needle Aspiration (FNA) and histopathology data were collected. Statistical analysis was made with SPSS 25.

## RESULTS

The prevalence of thyroid incidentaloma in FDG-PET/CT was 3.2% (130 patients), 98 (2.53%) had focal uptake, and 32 (0.82%) diffuse uptake. 43 patients with focal uptake underwent further workup. The prevalence of focal uptakes was higher in women than in men (33.7% vs 66.3 %, OR 1.54, CI 95% 1.0132 - 2.3644). Nodules were classified as benign (N=14) and malignant (N=14) by pathology. The median SUVmax of focal uptakes was 4.50 (1.66-56.24). Malignant lesions had higher SUVmax than Benign (8.25 vs 4.49,  $p=.049$ ). In ultrasound analysis ( $n=43$ ), nodules with the following features had higher SUVmax and malignancy rates: Hypoechoic ( $p=.004$ , SUVmax: 7.28.), taller-than-wide ( $p=.003$ , SUVmax: 8.84), lobulated or irregular margins ( $p=.000008$ , SUVmax: 8.84), punctate echogenic foci ( $p=.039$ , SUVmax: 10.23) and presence of adenopathy ( $p=.037$ , SUVmax: 12.16). A significant difference in SUVmax values among ATA classification was found ( $H=19.27$ ,  $df=4$ ,  $p=.0007$ ). Benign nodules had lower SUVmax values (2.46, 1.86-3.05), while high suspicion nodules had higher SUVmax values (11.62, 4.46-56.24). A cut-off value of 4.880 g/ml SUVmax was used to determine malignancy with a sensitivity of 81% and specificity of 77%.

## CONCLUSION

Higher SUVmax in PET/CT were consistent with ultrasound features of suspicion and the rate of malignancy. SUVmax values are significantly different among nodules classified according to the ATA guidelines, with benign and low suspicion nodules having lower SUVmax values and high suspicion nodules having higher SUVmax values. A cut-off value of 4.880 g/ml has good sensitivity, and specificity (81% and 77%, respectively). This suggests that SUVmax may be a useful metric for distinguishing between benign and malignant lesions in PET-CT imaging.

## CLINICAL RELEVANCE/APPLICATION

Up to 3% of PET-CT scans showed a thyroid incidentaloma. It is important to determine which nodules are more likely to be malignant. This study shows SUVmax has a good correlation with ultrasound and pathology for determining malignancy.

## R2-SPHN-7 Preoperative Localization of Previously Occult Parathyroid Adenomas using Dynamic, Contrast Enhanced Parathyroid MR Imaging

Jacob Musiol, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Common techniques for preoperative localization of parathyroid adenomas include nuclear medicine parathyroid sestamibi scans with or without SPECT or SPECT-CT, ultrasound, and 4D parathyroid CT with differing levels of success. While not widely utilized, dynamic contrast enhanced parathyroid MRI has also been previously shown to demonstrate parathyroid adenomas with increased sensitivity and specificity when compared to dynamic parathyroid CT. Our interest in dynamic parathyroid MRI began when a patient presented with clinical hyperparathyroidism but occult prior imaging. We tailored a protocol on our clinical use 3 Tesla Siemens magnet using previously published parameters. We subsequently scanned six patients for evaluation of parathyroid adenoma.

## METHODS AND MATERIALS

Our patient selection included six patients imaged over 18 months with biochemical hyperparathyroidism and elevated serum parathyroid hormone values, but negative prior imaging. Using a clinical Siemens 3T magnet, we performed T1 axial, T2 axial, T2 fat saturated coronal, T1 coronal, T1 axial VIBE pre contrast, and T1 axial VIBE post contrast dynamic sequences. After the administration of gadolinium-based contrast, 11 axial dynamic contrast series were obtained at 11.5 second intervals for a total imaging sequence time of 2 minutes 7 seconds. Additional T1 VIBE post contrast subtraction images were created. All images were submitted to the AGFA PACS, and clinical interpretation was performed by a board certified neuroradiologist.

## RESULTS

We utilized our protocol to image six patients, all with positive findings on MRI. The lesions identified as positive demonstrated T2 hyperintensity and intense arterial enhancement within the first 30 seconds of contrast injection, followed

by delayed washout. The patients were taken to surgery with accurate surgical localization. All six had pathology-proven parathyroid adenomas. The smallest lesion measured 6 mm and the largest lesion measured 14 mm.

#### **CONCLUSION**

While not widely utilized, dynamic parathyroid MR imaging is a helpful resource for localizing parathyroid adenomas with high sensitivity and specificity. While other modalities such as nuclear medicine parathyroid sestamibi scans or 4D parathyroid CT are more widely available, implementing this dynamic post contrast technique in clinical practice can assist surgeons in preoperative localization, as well as decrease the incidence of exploratory surgery of the neck.

#### **CLINICAL RELEVANCE/APPLICATION**

Dynamic parathyroid MRI can be readily and easily integrated into routine outpatient imaging protocols for evaluation of parathyroid adenoma. Utilization can improve preoperative surgical localization and improve patient outcomes.

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## Abstract Archives of the RSNA, 2023

R2-SPIN

### Imaging Informatics Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPIN-1 Prediction on Lateral Cephalograms of Post Orthognathic Surgery using Graph Convolutional Neural Network and Diffusion Model**

JiHeon Jeong (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To generate lateral cephalogram of post orthognathic surgery based on pre-operation lateral cephalogram using a graph convolutional neural net (GCN) and a diffusion model

#### **METHODS AND MATERIALS**

Among a dataset from nine university hospitals with different types of cephalography machines and radiation exposure protocols, 800 pairs of pre- (T0) and post- (T1) surgery with 12-bit deep grayscale images were selected and registered based on the sella and nasion points. And the dataset was divided into a training set of 700 pairs and a test set of 100 pairs. Landmarks were measured on each image at 41 points using a pre-trained model with an average error of  $0.80 \pm 0.79$  mm. First, a model was trained to predict the movement predictions of each landmark in T1 image by embedding the T0 image and its landmarks using CNN and graph GCN, respectively. To generate T1 images, we used various prompts, including the movement of landmarks based on surgical planning. To ensure more realistic and detailed generation quality using various prompts, an autoencoder using not only a labeled dataset of T0 and T1 but also an unlabeled cephalogram dataset was trained. A diffusion model for image generation in the encoding space was trained with various prompts as conditioning factors. Specifically, T0, and T0's landmarks, and movement predictions were used as prompts.

#### **RESULTS**

The distances between the landmark points on the images generated by the diffusion model and the T1 images were measured for 100 test images, both with and without various prompts. The diffusion model without prompts had an average error of approximately  $2.33\text{mm} \pm 6.16\text{mm}$  across 30 landmark points, while the diffusion model with prompts had an average error of  $1.76\text{mm} \pm 1.45\text{mm}$ , which was statistically significant based on paired t-test results ( $p < 0.001$ ).

#### **CONCLUSION**

A diffusion model was trained to generate T1 cephalogram based on T0 images of orthognathic surgery using graph CNN and diffusion model, which lead to better prediction of post-operational cephalogram.

#### **CLINICAL RELEVANCE/APPLICATION**

This generative model could be used to predict surgical result based on surgery planning and pre-operative cephalogram with landmarks. Therefore, based on this, among various surgical planning options of orthognathic surgery, better outcome could be selected.

#### **R2-SPIN-2 Artificial Intelligence (AI) Software for Automated Fracture Detection in Emergency Department: 2-month Experience**

Francesco Pucciarelli, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Computer-aided detection tools are routinely used in clinical practice. In recent years, artificial intelligence (AI) is playing an increasing role in medical imaging, aiming at speeding up the workflow and improving human diagnostic performances. The purpose of this study is to evaluate the reliability of an AI software trained to detect fractures on radiographs and to compare its accuracy to radiologists.

## METHODS AND MATERIALS

This retrospective study included radiographs of patients admitted for trauma to the emergency department of our hospital from May 19 2022 to July 19 2022. Radiographs of each patient were analyzed for the presence of fracture by both radiologists and AI software. For discordant cases a radiologist with 25 years of experience in emergency radiology was considered the ground truth and, when available, CT. Statistical analysis was performed with a dedicated software and accuracy of both radiologist and AI software was collected.

## RESULTS

Final population consisted of 981 patients, comprising 1360 anatomical districts and 3367 X-ray projections. Concordance between radiologists and AI software was 88.8% (871/981) and discordance was 11.2% (110/981). In discordant cases false positive (FP) were 30 for radiologists vs 76 for AI software; true negative (TN) were 76 vs 30, respectively; true positive (TP) were 3 vs 1 respectively; false negative (FN) were 1 vs 3 respectively. Accuracy was 0.96 for radiologists and 0.91 for AI software (sensitivity 0.99 vs 0.99 and specificity 0.96 vs 0.91 respectively). Positive predictive value (PPV) was 0.92 for radiologist vs 0.81 for AI software; negative predictive value (NPV) was equal (0.99). FP for AI software were mainly due to image artifacts, external devices, and immature bone in pediatric patients.

## CONCLUSION

Radiologists and AI software showed the same sensitivity on fracture detection with a slightly higher specificity for radiologists. NPV was equal. We can conclude that the use of AI software has shown good reliability in ruling out fractures on radiographs.

## CLINICAL RELEVANCE/APPLICATION

This AI software could be applied to clinical routine to improve the radiologist's confidence in ruling out fractures in the emergency department.

## R2-SPIN-3 Using Deep Learning to Augment Radiologist Interpretation of Brain MRIs for Alzheimer's Disease

Vijaya B. Kolachalama (*Presenter*) Nothing to Disclose

## PURPOSE

Modern machine learning approaches are being developed to assist radiologists in evaluating MRIs for Alzheimer's disease (AD) detection. We sought to determine if a deep learning model can augment neuroradiologist evaluations of MRIs for AD assessment.

## METHODS AND MATERIALS

We developed a multimodal deep learning framework for dementia assessment that combines MRIs and non-imaging data including demographics, past medical history, neuropsychological testing, and functional assessments [1]. The model was trained on 4,822 participants from the National Alzheimer's Coordinating Center dataset. A subset of cases clinically diagnosed with dementia (n=50) was evaluated by seven neuroradiologists who were asked to differentiate between persons with AD and those with non-Alzheimer's dementia (nADD) using MRI scans and demographic information. We evaluated the model performance against the radiologist assessments and constructed a consensus opinion from the expert ratings and model predictions. [1] Qiu et. al., Nat Commun. 2022 Jun 20;13(1):3404. doi: 10.1038/s41467-022-31037-5

## RESULTS

Our results showed that combining the radiologist assessments with predictions from our model yielded greater accuracy, sensitivity, specificity, and Matthews correlation coefficient (MCC) in differentiating persons with AD from those with nADD than the assessments made by the neuroradiologists alone. The consensus methods used in this study resulted in an improvement in accuracy from 58% to 64%, in sensitivity from 58% to 64%, in specificity from 60% to 72% , and an increase in the MCC from 0.16 to 0.28.

## CONCLUSION

Incorporating machine learning model assessments into the consensus radiologist interpretation improved the reliability of AD diagnosis based on brain MRIs, age, and gender.

## CLINICAL RELEVANCE/APPLICATION

AI-augmented radiologist assessment can improve the diagnostic accuracy of AD diagnosis, leading to more precise and timely treatment, potentially improving patient outcomes.

## R2-SPIN-4 Joint Generative and Mixture Data Augmentation for Metastatic Focal Liver Lesion Classification in Abdominal CT Images

Hansang Lee, PhD (*Presenter*) Nothing to Disclose



## PURPOSE

Generative data augmentation (DA) using generative adversarial network (GAN) has been successful in improving the learning efficiency of medical image analysis tasks where training data is limited. However, it is prone to mode collapse, where the GAN generates a limited variety of patterns due to inadequate learning of the training data pattern. To overcome this limitation, we propose a novel data augmentation approach that combines generative DA with MixUp-based mixture DA to diversify the pattern of synthetic data. We evaluate the effectiveness of this approach on the classification of metastatic focal liver lesions (FLLs) in abdominal CT images.

## METHODS AND MATERIALS

Our dataset consists of CT scans from 502 colorectal cancer patients, including 1,290 FLL images with 676 cysts, 130 hemangiomas, and 484 metastases. First, we generated synthetic images by training a StyleGAN model on real training images. We then created new training images by performing MixUp-based linear combinations between synthetic and real training images. The VGG-16 network is then trained using these training images to classify FLLs. To validate the effectiveness of our approach, we compared the accuracy, sensitivity, and specificity of classification results, and analyzed the t-SNE feature distribution to determine whether our approach mitigates mode collapse in generative DA.

## RESULTS

Generative DA achieved a marginal improvement over the affine DA-based baseline, with 73.2% accuracy compared to 72.3%. Our proposed method achieved 80.8% accuracy and demonstrated a significant enhancement in the sensitivity of cyst and metastasis. In the t-SNE feature distribution, synthetic images generated by generative DA were concentrated around specific locations due to mode collapse, while training images of our method were distributed across the entire class. This outcome confirms that our method can mitigate mode collapse by diversifying the pattern of synthetic images.

## CONCLUSION

We proposed a novel DA method that combines generative DA with mixture DA to address mode collapse, a major limitation in generative DA. We confirmed that our method diversifies the pattern of synthetic images created by generative DA, mitigating the mode collapse phenomenon and enhancing classification performance in the classification of FLLs in CT images. (This work was supported by the National Research Foundation of Korea Grant funded by the Korea government (No. RS-2023-00207947))

## CLINICAL RELEVANCE/APPLICATION

Our approach can be applied to a wide range of medical image analysis tasks in which training data is scarce or mode collapse arises during generative DA.

## R2-SPIN-5 Development of Accurate Automated Organ Segmentation in Pediatric CT Scans: Impacts of Model Pretraining

Panagiotis Korfiatis, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To develop a deep learning-based segmentation model for pediatric patients with CT imaging.

## METHODS AND MATERIALS

This study utilized two publicly available datasets: a pediatric dataset with imaging of 359 patients ranging from 5 days to 16 years old, with varying imaging parameters, and a dataset of adult patients consisting of 1204 scans, with annotations of 104 structures. The pediatric dataset comprised 29 organs. In this study we focused on 20 organs. The nnUNet model was trained utilizing the following approach: First, a model was trained using the adult dataset. Then, the weights of the adult model were used to initialize the weights of the pediatric model. The training/validation dataset was comprised of 325 scans, while 34 patients were used for testing. The default nnUNet augmentations were applied in this model excluding mirroring. Finally, the ensemble of the five models from the 5-fold training process was obtained as the final model (Figure 1, supplement).

## RESULTS

Training the model with weight initialization led to performance improvements especially in smaller structures (Figure 1, supplement). The performance of the pretrained nnUNet ranges from 0.57 to 0.97 with the performance of the model being better in larger structures. Smaller structures like the adrenal glands and more complex anatomical structures like the small intestine benefit when pretrained models are utilized.

## CONCLUSION

Leveraging pretrained models to facilitate model training for populations where large datasets that are not widely available can further improve segmentation performance. More advanced training techniques like self-supervised training or data-centric training should also be investigated.



## CLINICAL RELEVANCE/APPLICATION

Image segmentation is the fundamental step in many downstream clinical applications such as quantification and treatment planning, and less attention has been given to solving this problem in pediatric populations.

## R2-SPIN-6 Detection of Progression to Clinically Significant Prostate Cancer Using End-to-End Deep Learning in Sequential MRI

Christian Roest, MSc (*Presenter*) Grant, Siemens AG

### PURPOSE

Reading sequential prostate MRI is a difficult task for radiologists. Deep learning (DL) may help detect progression. We explored end-to-end deep learning to compare two sequential MRI scans in detecting progression to clinically significant prostate cancer.

### METHODS AND MATERIALS

This retrospective study included 714 patients with at least two consecutive biparametric MRI scans of the prostate between 2014 and 2021 (875 follow-up scans). We recorded all PIRADS reported prostate cancer lesions. PI-RADS=3 lesions received MRI-targeted biopsy, and lesions with histopathological grade of ISUP=2 were considered clinically significant (csPCa). All patients were negative for csPCa at the first MRI. Three separate end-to-end DL segmentation approaches were subsequently tested to detect csPCa: 1) a single, current MRI model; 2) a sequential model comparing prior and current MRI 3) model 2 extended with clinical parameters (PSA, PSA density, age, prostate volume). Maximum detected per lesion likelihood in the heatmap was considered the patient-level likelihood for csPCa progression. Receiver-operating characteristic (ROC) curve analysis was used to compare the three DL models at patient level. Lesion level performance was evaluated using free-ROC (FROC) analysis by comparing the area-under-the-FROC-curve (AUFROC) between 0.1 and 2.5 false-positives per patient. Explainable AI was used to create saliency maps, ranking the importance assigned by the model to information in the sequential MRI input. Differences in AUROC and AUFROC were evaluated using DeLong's and bootstrap tests, respectively.

### RESULTS

The sequential model outperformed the single-scan baseline at lesion-level (AUFROC: 1.45 [1.29–1.61] vs 1.56 [CI 1.40–1.72],  $p < 0.05$ ) and patient-level (AUROC: 72.9% [CI 68.7–77.2%] vs 75.7% [CI 71.6–79.9%],  $p = 0.008$ ). Including differential clinical parameters further improved patient-level performance to 76.1% AUROC (CI 71.6–80.6%). Saliency maps showed significantly higher importance for temporal high b-value sequences, compared to T2W and ADC ( $p < 0.0001$ ).

### CONCLUSION

Our proposed end-to-end deep learning model can accurately detect progression to csPCa using sequential MRI.

## CLINICAL RELEVANCE/APPLICATION

Active surveillance is crucial in prostate MRI, and an accurate artificial intelligence tool for detecting progression to clinically significant disease may help to prevent unnecessary biopsies.

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## Abstract Archives of the RSNA, 2023

R2-SPIR

### Interventional Radiology Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPIR-2 GNMT and MMP12 Expression Determines Transarterial Chemoembolization in Hepatocellular Carcinoma**

Tianhao Cong (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Transarterial chemoembolization (TACE) is a first-line treatment for patients with intermediate hepatocellular carcinoma (HCC). It is crucial to accurately identify patients who are effective for TACE and explore their related mechanisms. Our purpose is to determine the key molecular characteristics and related pathways that affect TACE efficacy.

##### **METHODS AND MATERIALS**

Based on microarray datasets and high-throughput sequencing dataset, a TACE-effectiveness model was constructed using logistic regression. Based on external data validation, its accuracy was verified by Kaplan-Meier survival analysis, Principal Component Analysis (PCA), and immunohistochemistry was used to verify the expression level of signature genes. Kyoto Encyclopedia of Genes and Genomes (KEGG) analysis and Cibersort x were used to investigate related mechanisms.

##### **RESULTS**

Three independent cohorts were used, among which GSE104580 was randomly divided into a training set and a validation set at a ratio of 6:4. TACE-effectiveness model was constructed including GNMT and MMP12 through the training set. Our model can effectively distinguish TACE efficient and inefficient patients in the validation set and GSE14520. The OS and DFS of TACE efficient patients were significantly higher than those of TACE inefficient patients. Immunohistochemistry results showed that GNMT was highly expressed in TACE efficient patients, while MMP12 was lowly expressed in TACE efficient patients ( $p < 0.05$ ). MMP12 and GNMT may determine the TACE effectiveness by affecting the metabolic pathway and HIF-1 $\alpha$  signaling pathway.

##### **CONCLUSION**

Our research provides a model that can accurately evaluate the effectiveness of TACE, and MMP12 and GNMT may determine the TACE effectiveness by affecting the metabolic pathway and HIF-1 $\alpha$  signaling pathway.

##### **CLINICAL RELEVANCE/APPLICATION**

Our study provides a basis for individualized accurate medical care for patients with HCC, and provides a novel idea and direction for exploring the mechanism of TACE.

#### **R2-SPIR-4 Efficacy, Mechanism & Safety of Melatonin-loaded on Thermosensitive Nanogels for Rabbit VX2 Tumor Embolization: A Novel Design**

Lei Chen (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To explore the efficacy, mechanism and safety of melatonin loaded on p(N-isopropyl-acrylamide-co-butyl methylacrylate) (PIB-M) in the treatment of rabbit VX2 tumors.

##### **METHODS AND MATERIALS**

In this study, PIB-M was used for tumor embolism. Two types of human hepatoma cell lines (HepG2 and LM3 cells) were used to explore the mechanism by which melatonin prevents the growth and metastasis of cancer cells in vitro. High-performance

liquid chromatography was used for pharmacokinetic analysis. A VX2 rabbit tumor model was used to evaluate the efficacy, mechanism and safety of PIB-M in vivo.

## RESULTS

We found that under hypoxic condition, melatonin could inhibit tumor cell proliferation and migration by targeting hypoxia inducible factor-1 $\alpha$  (HIF-1 $\alpha$ ) and vascular endothelial growth factor A (VEGF-A) in vitro. The results of pharmacokinetics in vivo showed that a high concentration of melatonin in the PIB-M group could be maintained in tumor tissue for 72 hours after embolization. In vivo, PIB-M inhibited tumor growth and metastasis in rabbit VX2 tumors by targeting related angiogenic proteins and vascular permeability proteins. The liver and kidney functions were most damaged on the first day but recovered to normal on the seventh day after embolization in the PIB-M group.

## CONCLUSION

PIB-M can effectively inhibit the growth and metastasis of tumor after treatment, and it is safe. This novel method may open avenues for reduced tumor growth and metastasis after embolism, which may be used for treatment for other solid tumors and clinical translation.

## CLINICAL RELEVANCE/APPLICATION

The conclusion of this study may provide a theoretical basis for the use of melatonin in interventional therapy for liver cancer.

## R2-SPIR-5 Impact of Acute Kidney Injury After Radiofrequency Ablation for Patients with T1a Renal Cell Carcinoma

Hang Jun Cho, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To investigate the association between acute kidney injury (AKI) and renal function 1 year after RFA, and whether this relationship is affected by the duration of AKI.

### METHODS AND MATERIALS

We analyzed the data of 393 patients treated by RFA for a single T1aN0M0 renal cell carcinoma. Three outcomes of interest have been defined as follows: (1) recovery of at least 90% of baseline function 1 year after RFA, (2) percentage change of 1-year renal function compared with baseline function, and (3) chronic kidney disease upstaging. AKI was defined according to the RIFLE criteria. The association between AKI and each endpoint of interest was investigated using a regression model after adjusting for common predictors of renal function.

### RESULTS

Total 58 patients (14%) experienced AKI after RFA. The rate of patients recovering 90% of baseline function was lower in the AKI group (20% vs. 51%), while the proportion of patients who had CKD upstaging was significantly higher (40% vs 19%;  $P < 0.0001$ ). At multivariable analysis, AKI was associated with worse renal function 1 year after RFA, regardless of the outcome of interest (all  $p < 0.0001$ ). Longer AKI increases the risk of functional deterioration, especially after the 3rd day of injury. The risk of CKD upstaging for an average patient who had 1-3 versus = 4th day of AKI was 26% (95% CI: 20-32%) versus 67% (95% CI: 45-68%; absolute risk increase of 11%; 95% CI: 7-22%).

### CONCLUSION

AKI negatively affects long-term functional recovery after RFA.

### CLINICAL RELEVANCE/APPLICATION

Monitoring of renal function after RFA for RCC is important for patient management. Through this study, it can be helpful for patient management by identifying the correlation between AKI and changes in renal function after RFA for RCC.

## R2-SPIR-6 Impact of Clinical Evident Portal Hypertension on Hepatocellular Carcinoma with Transarterial Chemoembolization (CHANCE-CHESS 2301): A Multicenter Cohort Study

Zhicheng Jin, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the impact of clinically evident portal hypertension (CEPH) on the prognosis of hepatocellular carcinoma (HCC) patients treated with transarterial chemoembolization (TACE).

### METHODS AND MATERIALS

A total of 1614 consecutive HCC patients treated with TACE were retrospectively collected from 10 tertiary centers between June 2006 and December 2019. CEPH was defined when at least one following factor was present: 1) esophageal/gastric varices on upper endoscopy or CT imaging, 2) ascites requiring diuretic treatment, 3) splenomegaly (largest diameter on CT

>12 cm) with a low platelet count (<100,000/mm<sup>3</sup>). Overall survival (OS) as the study endpoint was analyzed by Kaplan-Meier and Cox regression. Propensity score matching analysis was used to match patients for predetermined prognostic factors. During the following up, portal hypertension-related adverse events were described.

## **RESULTS**

Among 1614 patients, 504 (31.2%) were affected by CEPH. Most patients were male (1339, 83.0%) with predominantly etiology of HBV (1167, 72.3%). Before matching, the median OS in CEPH group was 24.5 months (95% confidence interval [CI]: 21.7-28.8) versus 27.3 months (95%CI: 24.9-31.4) (adjusted hazard ratio [HR], 1.22, p = 0.011). After matching, 413 pairs were included. The median OS was also significantly lower in CEPH group (23.4 months [95%CI: 21.6-28.8] vs. 31.7 months [95%CI: 28.0-39.3]; adjusted HR, 1.24, p = 0.022). Subgroup analysis showed that CEPH group had a trend that persisted on lower OS compared to non-CEPH group. Patients with =2 CEPH factors had a significantly worse prognosis than patients with 0 or 1 CEPH factor (p < 0.001). Among them, 25.2%, 5.8%, and 5% of patients developed ascites progression/occurrence, hepatic encephalopathy, and esophageal/gastric variceal bleeding, respectively.

## **CONCLUSION**

The presence of CEPH, especially  $\geq 2$  CEPH risk factors, was significantly associated with poor outcomes and should be taken into consideration when managing HCC patients who underwent TACE.

## **CLINICAL RELEVANCE/APPLICATION**

The large-sample, real-world study highlights the importance of portal hypertension management by identifying morbidity rate and prognostic impact on clinical decision-making and trial design in HCC patients treated with TACE.

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## Abstract Archives of the RSNA, 2023

R2-SPMK

### Musculoskeletal Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPMK-1 Assessing the Efficacy of Radiofrequency Ablation and Kyphoplasty for Alleviating Painful Spine Metastases: A Study Using VAS Pain Scale**

Chloe Issa, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the efficacy of pain improvement of radiofrequency ablation (RFA) in conjunction with kyphoplasty in treatment of patients with painful metastatic neoplastic disease to the spine.

#### **METHODS AND MATERIALS**

Between 3/2019 and 8/2022, a total of 59 kyphoplasty/RFA procedures were performed. The median age of the cohort was 65 years old (range, 41-86) with male-to-female ratio of 0.97. The primary neoplastic disease was as follows: multiple myeloma (n=17, 28.8%), breast cancer (n=15, 25.4%), lung cancer (n=7, 11.9%), prostate cancer (n= 6, 10.2%), lymphoma and colorectal cancer (each n= 3, 5.1%), urothelial carcinoma (n= 2, 3.4%), thyroid cancer, pancreas adenocarcinoma, renal cell carcinoma, and metastatic adenoid cystic carcinoma (each n=1, 3.3%). Pain relief was evaluated by the visual analogue scale (VAS) score before and within 3-months after the procedure. The highest documented VAS pre- and post-procedure was recorded. A P value < 0.05 was considered statistically significant.

#### **RESULTS**

Technical success was achieved in all patients. The median follow-up was 15 days (IQR, 14-52.5) after the procedure. The median VAS score decreased from 10 (IQR, 8-10) to 2 (IQR, 2-3) within 3 months after procedure (p < 0.001). There were no major complications.

#### **CONCLUSION**

RFA in conjunction with kyphoplasty is safe and provides meaningful clinical improvement in VAS pain scores when measured within 3 months of the procedure.

#### **CLINICAL RELEVANCE/APPLICATION**

MSK Interventional Radiology - Palliative Spine Intervention

#### **R2-SPMK-3 Preoperative Imaging Features of Bone Cement Leakage After Percutaneous Vertebroplasty in Kummell's Disease**

Hui Hao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the preoperative imaging features of bone cement leakage after percutaneous vertebroplasty for Kummell's disease.

#### **METHODS AND MATERIALS**

The clinical, imaging, treatment and follow-up data of patients with Kummell's disease vertebral compression fracture and percutaneous bone cement filled vertebroplasty from January 2016 to January 2022 were analyzed retrospectively. According to whether there was bone cement leakage in postoperative follow-up, they were divided into two groups. The continuous variable data were compared by independent sample t-test or Mann-Whitney U nonparametric rank sum test, and the classified variable data were compared by chi square or Fisher exact chi square; Finally, binary logistic regression was used to explore the independent risk factors of bone cement leakage.

## RESULTS

A total of 67 cases were included (mean age  $69.63 \pm 9.11$  years, 13 males and 54 females). The injured vertebrae of Kummell's disease were mainly in the thoracolumbar (T5, T6, T7 and T10 were all 1, T8:3, T11:8, T12:19, L1:16, L2:12, L3:1 and L4:4). 38 cases (57%) of bone cement leakage occurred within one month after follow-up, including 24 cases (63%) of intervertebral disc leakage, 11 cases (29%) of soft tissue leakage, 1 case (2.6%) of intravascular leakage, 1 case of intraspinal leakage and 1 case (2.6%) of mixed leakage. The following signs were statistically different between the leakage group and the non leakage group: the degree of X-ray vertebral compression ( $\chi^2=6.278, P=0.043$ ), CT Intravertebral Vacuum Clefts ( $\chi^2=4.899, P=0.025$ ), vertebral cortical discontinuity ( $\chi^2=4.540, P=0.030$ ). Binary logistic regression showed that CT Intravertebral Vacuum Clefts was an independent predictor of bone cement leakage (Odds ratio, OR=3.069, P=0.029).

## CONCLUSION

The Intravertebral Vacuum Clefts is related to the leakage of bone cement after percutaneous vertebroplasty, which can be used to guide the choice of treatment before operation.

## CLINICAL RELEVANCE/APPLICATION

The Intravertebral Vacuum Clefts is related to the leakage of bone cement after percutaneous vertebroplasty, which can be used to guide the choice of treatment before operation. The Intravertebral Vacuum Clefts is the preoperative imaging features of bone cement leakage after percutaneous vertebroplasty for Kummell's disease.

## R2-SPMK-4 Trabecular Bone Score as an Assessment Tool to Identify the Risk of Vertebral Fractures in SAPHO Syndrome

Zaizhu Zhang, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To investigate the clinical utility of TBS evaluation for vertebral fracture (VF) risk assessment in SAPHO patients compared with BMD assessment.

### METHODS AND MATERIALS

Seventy SAPHO patients [mean age 50.1 (10.7) years, 81% women] were enrolled in this cross-sectional study. TBS and BMD were assessed using dual-energy X-ray absorptiometry. VF of spine were evaluated using whole-spine CT. We compared BMD and TBS results regarding to the presence/absence of VF.

### RESULTS

Patients with VF had significantly lower BMD, T-score and Z-score of lumbar spine (LS) and TBS values and more frequently presented median-high fracture risk in TBS and abnormal BMD at the three evaluated sites than without. Univariate logistic regression analyses identified lower TBS value ( $<1.23$ ), abnormal BMD of the LS, femoral neck (FN) and total hip (TH) were associated with VF [odds ratio (95% CI): 22.9 (6.1, 85.7), 7.6 (2.4, 23.5), 7.6 (2.4, 23.5), and 10.1 (3.0, 33.8), respectively]. For predicting VF in SAPHO patients. TBS showed the greatest AUC in the ROC curve, with a value of 0.920 compared with 0.777, 0.690 and 0.652 for LS, FN and TH BMD, respectively.

### CONCLUSION

TBS has a better discriminatory value than BMD for prediction of VF in SAPHO patients.

### CLINICAL RELEVANCE/APPLICATION

TBS may, therefore, be a useful clinical tool to identify the risk of VF in SAPHO patients.

## R2-SPMK-5 Deep Learning Reconstructed T2-weighted Dixon Imaging of the Spine: Impact on Acquisition Time and Image Quality

Zeynep Berkarda, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To assess the image quality and impact on acquisition time of a novel deep learning based T2 Dixon sequence (T2DL) of the spine.

### METHODS AND MATERIALS

This prospective, single center study included  $n=44$  consecutive patients with a clinical indication for lumbar MRI at our university radiology department between September 2022 and March 2023. MRI examinations were performed on 1.5-T and 3-T scanners using dedicated spine coils (MAGNETOM Aera and Vida; Siemens Healthcare, Erlangen, Germany). The MR study protocol consisted of our standard clinical protocol, including a T2 standard Dixon sequence (T2std) and the additional T2DL. T2DL acquisition used a conventional sampling pattern with a higher parallel acceleration factor. The individual contrasts

acquired for Dixon water-fat separation were then reconstructed using a dedicated research application. After reconstruction of the contrast images from k-space data, a conventional water-fat separation was performed to provide derived water images. Two readers with 6 and 4 years of experience in interpreting MSK imaging, respectively, analyzed the images in a randomized fashion. Overall image quality (OIQ), banding artifacts, artifacts, sharpness, noise, and diagnostic confidence were analyzed using a 5-point Likert scale (from 1 = non-diagnostic to 5 = excellent image quality).

## RESULTS

Forty-four patients (median age 61.5 years, [IQR: 35.3,67.5], male sex: 39%) were prospectively included. 31 examinations were performed on 1.5-T and 13 examinations on 3-T-scanners. A sequence was successfully acquired in all patients. The total acquisition time of T2DL was 93 seconds at 1.5-T and 86 seconds at 3-T, compared to 235 seconds, and 257 seconds, respectively for T2std (reduction of acquisition time: 60.4% at 1.5-T, and 66.5% at 3-T;  $p < 0.01$ ). OIQ was rated equal for both sequences (mean T2DL  $4.66 \pm 0.61$ , and T2std  $4.61 \pm 0.72$ ;  $p = 0.59$ ). T2DL showed reduced noise levels compared to T2std ( $4.93 \pm 0.26$  versus  $3.84 \pm 0.37$ ;  $p < 0.01$ ). In addition, sharpness was rated to be higher in T2DL ( $4.84 \pm 0.37$  versus  $3.95 \pm 0.53$ ;  $p = 0.01$ ). Although T2DL displayed significantly more banding artifacts ( $4.25 \pm 0.92$  versus  $4.91 \pm 0.29$ ;  $p < 0.01$ ), no impact on readers diagnostic confidence between sequences was noted (T2std:  $4.7 \pm 0.63$ , and T2DL:  $4.8 \pm 0.48$ ;  $p = 0.61$ ). Inter-reader agreement ranged from fair (? for noise: 0.3) to substantial (? for OIQ: 0.8).

## CONCLUSION

T2<sub>DL</sub> is feasible with image quality comparable to the reference standard while substantially reducing the acquisition time.

## CLINICAL RELEVANCE/APPLICATION

T2DL may replace standard imaging, while significantly reducing time and cost in MRI of the spine. Further interchangeability analyses seem reasonable to assess the diagnostic performance of the new sequence.

## R2-SPMK-6 Diagnostic Delay in Patients with Osteoid Osteoma

Florian T. Gassert, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To assess the diagnostic delay in patients with osteoid osteoma and to analyze influencing factors.

### METHODS AND MATERIALS

All patients treated for osteoid osteoma at our tertiary referral center between December 1997 and February 2021 were retrospectively identified ( $n=302$ ). The diagnosis was verified by an expert panel of radiologists and orthopedic surgeons. Exclusion criteria were post-interventional recurrence, missing data on symptom onset, and if no pretherapeutic CT images were available. Clinical parameters were retrieved from the local clinical information system. CT and MR images were assessed by a senior specialist in musculoskeletal radiology.

### RESULTS

After all exclusions, we studied 162 patients (mean age,  $24 \pm 11$  years, 115 men). The average diagnostic delay was  $419 \pm 485$  days (median: 275 days; range: 21 - 4503 days). Gender, patient age, presence of nocturnal pain, positive Aspirin test, extent of bone sclerosis, and location of the tumor within bone and relative to joints did not influence diagnostic delay ( $p > .05$ ). It was, however, positively correlated with nidus size ( $r = 0.26$ ;  $p < .001$ ), and shorter with affection of long tubular bones compared to all other sites ( $p=.04$ ). If osteoid osteoma was included in the initial differential diagnoses, diagnostic delay was also shorter ( $p = .007$ ).

### CONCLUSION

The diagnostic delay in patients with osteoid osteoma is independent from demographics, clinical parameters and most imaging parameters.

### CLINICAL RELEVANCE/APPLICATION

A long average delay of more than one year suggests low awareness of the disease among physicians. Patients with unclear imaging findings should thus be referred to a specialized musculoskeletal center or an expert in the field should be consulted timely.

## R2-SPMK-7 Differentiation of Bone Metastases from Benign Red Marrow Depositions: Concerns of Conventional MR Imaging

Jisu Lim, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To differentiate bone metastases (BMs) from benign red marrow depositions (BRMs) by qualitative and quantitative analyses of T1-weighted imaging (T1w) and fat-suppressed T2-weighted imaging (T2 FS) and to compare the diagnostic performance of normal muscle and normal bone marrow as internal standards on T2 FS in differentiating BMs and BRMs



## METHODS AND MATERIALS

Seventy-five lesions, including 38 BMs and 37 BRMs, were assessed with T1w and T2 FS. Two radiologists independently evaluated MR images by qualitative (signal intensity [SI] of lesions compared to that of normal muscle [NM] or normal bone marrow [NBM]) and quantitative (parameters of the ROIs in the lesions, including T1 ratio [ratio of T1 SI of lesion to that of NM], T2FMu ratio [ratio of T2 FS SI of lesion to that of NM], and T2FMa ratio [ratio of T2 FS SI of lesion to that of NBM]) analyses. Qualitative and quantitative characteristics of BMs and BRMs were compared. To evaluate the diagnostic utilities of quantitative parameters, ROC curves were analyzed.

## RESULTS

Hyperintensity relative to NM or NBM on T2 FS was more frequent in BMs than in BRMs (100% vs 59.5%~78.4%, respectively;  $p=0.001$ ) but also was present in more than half of BRMs. All quantitative parameters showed a significant difference between BMs and BRMs (T1 ratio, 1.075 vs. 1.227 [ $p=0.002$ ]; T2FMu ratio, 2.094 vs. 1.282 [ $p<0.001$ ]; T2FMa ratio, 3.232 vs. 1.810 [ $p<0.001$ ]). The ROC AUCs of T2FMu and T2FMa ratios were clinically useful (0.781 and 0.841, respectively) and didn't demonstrate statistically significant differences.

## CONCLUSION

The quantitative analysis of T2 FS can be useful in differentiating BMs from BRMs, regardless of whether the reference was NM or NBM.

## CLINICAL RELEVANCE/APPLICATION

Quantitative analysis of conventional T2 FS without additional scanning could be used to differentiate bone metastases from benign red marrow depositions, regardless of whether the comparison reference was normal muscle or normal bone marrow.

## R2-SPMK-8 Can Material Density Imaging Improve Detection of Healthy-appearing Bone Metastases at Contrast-enhanced Dual-energy CT?

Hitoshi Takeuchi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Because CT is an imaging modality of choice for oncologic assessment but not sufficiently sensitive to detect bone metastases, sensitive detection of bone metastases by material density imaging is expected at body contrast-enhanced dual-energy CT (ceDECT). We assessed usefulness of water/hydroxyapatite (W/H-DI) and iodine/water density imaging (I/W-DI) to improve detection of healthy-appearing bone metastases at body ceDECT.

## METHODS AND MATERIALS

From September 2022 through March 2023, two experienced radiologists by consensus included 41 bone metastases that appeared healthy without definite sclerotic/lytic changes or mass formation on virtual monochromatic imaging (VMI) at 70 keV but were diagnosed by MRI, bone scintigraphy/SPECT, and/or FDG-PET/CT from four patients who underwent body ceDECT during the venous phase using a 256-detector DECT scanner (Revolution CT, GE). We reconstructed VMI at 70 keV, W/H-DI, and I/W-DI of slice thickness of 1.25 mm with a deep-learning reconstruction algorithm (TrueFidelity, GE) to place regions of interest within each healthy-appearing bone metastasis and its corresponding non-metastatic area with anatomical symmetry (for a vertebral metastasis, a non-metastatic area in only a little more cranial/caudal vertebra) as reference to measure mean CT value, W/H density, and I/W density, respectively. Paired t test was used to compare the mean CT value, W/H density, and I/W density between the healthy-appearing bone metastases and the reference areas. Receiver operating characteristic (ROC) analysis was adopted to assess diagnostic performance of these parameters to detect healthy-appearing bone metastases.

## RESULTS

W/H density was significantly higher ( $985.3 \pm 10.9$  mg/mL vs.  $962.9 \pm 10.6$  mg/mL;  $P < 0.001$ ) and I/W density was significantly lower in the metastases than in the reference areas ( $3.4 \pm 1.4$  mg/mL vs.  $3.8 \pm 1.3$  mg/mL;  $P < 0.001$ ), whereas CT value at 70 keV was comparable ( $151.3 \pm 62.8$  HU vs.  $149.1 \pm 60.7$  HU;  $P = 0.429$ ). Area under the ROC curve improved from CT value at 70 keV (0.513) to I/W density (0.595) to W/H density (0.951).

## CONCLUSION

Material density imaging, particularly W/H-DI, can improve detection of healthy-appearing bone metastases at body ceDECT.

## CLINICAL RELEVANCE/APPLICATION

As a comprehensive oncologic study, ceDECT with improved detectability of bone metastases by W/H-DI can reduce radiation exposure and/or medical cost and improve patient management by omitting unnecessary further examinations.



## Abstract Archives of the RSNA, 2023

R2-SPNMMI

### Nuclear Medicine & Molecular Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPNMMI-1 Functional Imaging Metrics in Patients with Metastatic Paraganglioma/pheochromocytoma Treated with Lu-177-dotatate: A Single-center Experience**

Ridvan A. Demirci, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Paragangliomas and pheochromocytomas are rare neuroendocrine tumors for which there is no standard of care for patients that develop metastatic disease. Radioligand therapy in neuroendocrine tumors shows promising results in disease control with minimal adverse events. This study describes our observations of changes in functional imaging metrics relative to time to progression (TTP) with Lu-177-dotatate treatment in patients with metastatic paraganglioma/pheochromocytoma (mPara/Pheo).

#### **METHODS AND MATERIALS**

Of nine patients with mPara/Pheo treated with four cycles of Lu-177-dotatate, eight patients had both pre-and post-treatment dotatate PET and were included in the image analysis. Total tumor volume (mL, TV) was determined by thresholding all tumor sites with uptake above blood pool activity measured from the left ventricle. SUVmean of the TV and ratio of SUVmean TV to liver (SUVmean T:L ratio) were also measured, and changes between these parameters on pre and post imaging were calculated. Progression was defined as presence of new lesions on post-treatment dotatate PET or by RECIST in those with RECIST measurable disease. TTP was calculated from the date of the 1st cycle.

#### **RESULTS**

Median age in the cohort was 52 [range 33 to 83], 4 female, with 0 - 1 lines of prior therapy. Median TTP for all patients was 19 [range 4 to 26]. Patients were then divided into two groups, those with progressive disease (N=2, PD) and those with stable disease or partial response (N=6, SD), on initial re-staging scans after the 4th cycle. Median values of TTP were 5 months [range 4 to 6] and 20.5 months [range 13 to 26], respectively. In the two patients in the PD group, TV increased by 103% and 235% from the pre-treatment scan and SUVmean T:L ratio decreased by 8% and 35%. Median change in TV in the SD group was -7.5% [range -43% to +25%]. Two had increased TV, and the remaining four had decreased TV in their post-treatment scans compared to pre-treatment scans. Median SUVmean T:L ratio change was -14.5% [range -52% to +53%].

#### **CONCLUSION**

Functional imaging metrics, particularly tumor volume, may have predictive power for clinical outcomes in metastatic paraganglioma/pheochromocytoma. Further studies with a larger patient population and correlation with other clinical and biochemical parameters are needed to confirm these results.

#### **CLINICAL RELEVANCE/APPLICATION**

Functional imaging metrics may serve as an independent biomarker of response in patients with metastatic paraganglioma/pheochromocytoma.

#### **R2-SPNMMI-2 The Usefulness of FDG-PET Indexes Including Heterogeneity Parameters in the Prediction of Initial Chemo-radiotherapeutic Effect in Oropharyngeal Cancer**

Shigeki Nagamachi, PhD, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

FDG-PET parameters were useful for prediction for the treatment response in various tumors. However, few reports have been analyzed regarding predictivity of FDG-PET indexes particularly heterogeneity indexes for the initial treatment response to chemoradiotherapy in oropharyngeal cancers. The study was done to analyze the predictive capability of various FDG-PET

indexes, including heterogeneity parameters such as Entropy, Kurtosis and Skewness for the initial treatment response to chemoradiotherapy.

## **METHODS AND MATERIALS**

Sixty-six patients with oropharyngeal cancer were analyzed. Forty patients showed CMR after the initial chemo-radiotherapy. Average age was 63.4, the gender ratio was male 51 and female 15. The case number of each stage were 12 in stage II, 39 in stage III and 15 in stage IV respectively. After the initial therapy, complete remission (CMR) was 48 and partial remission (PMR) was 18 cases based on PERCIST criteria using FDG-PET. The group comparison was done between CMR and PMR group regarding SUVmax, SUVpeak, metabolic tumor volume (MTV) and total lesion glycolysis (TLG). In addition, the values of heterogeneity indexes such as Entropy, Kurtosis and Skewness were also compared. Then under the best cut-off level, the value of positive predictive values (PPV) for CMR were compared among these parameters.

## **RESULTS**

Both MTV and TLG values showed significantly lower values in CMR group compared with those in PMR group (9.1 vs. 18.7ml, and 71.9 vs. 157.5g). Other parameters did not show any statistical significance. In the cases with lower TLG (<70g) at baseline, the rate of CMR cases was 100%. Similarly, the cases with lower MTV(<10ml) at base line showed CMR response in 90%. The value of PPV (%) in CMR to the chemo-radiotherapy under the best cut-off values were 100% in TLG, 90% in MTV, 85.7% in SUVmax, 80% in SUVpeak, 69.2% in Entropy, 76.9% in Kurtosis, and 63.6% in Skewness.

## **CONCLUSION**

In the prediction of therapeutic response for oropharyngeal cancer, both TLG and MTV were excellent parameters. Among, heterogeneity indexes, Kurtosis seemed to be promising parameter for predicting chemo-radio therapeutic response.

## **CLINICAL RELEVANCE/APPLICATION**

In the prediction of chemoradiotherapy for oropharyngeal cancer, the heterogenetic index in particular kurtosis preferably checked in addition to TLG and MTV.

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## Abstract Archives of the RSNA, 2023

R2-SPNPM

### Noninterpretive Skills (Beyond Imaging) Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### R2-SPNPM- Prevalence and Impact of Workplace Sexual Harassment Among Medical Sonographers in the United States<sup>1</sup>

Sue Y. Yi, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the prevalence and impact of workplace sexual harassment experienced by sonographers in the USA with a national survey including both quantitative and qualitative data.

#### METHODS AND MATERIALS

A survey was adapted from multiple existing well validated instruments and distributed anonymously to a convenience sample of medical sonographers via email contacts and sonographer-specific social media pages. Survey data were analyzed to determine respondent demographics, the prevalence of sexual harassment in the last two years, the type and severity of harassment experienced, demographics of perpetrators, personal and institutional responses to such experiences, and the impact of sexual harassment on sonographer physical and mental health and job satisfaction.

#### RESULTS

220 sonographers (82.7% female) participated in the survey. The majority (45%) were aged between 18 and 34 years, and 81% identified as white. The majority (87%) reported experiencing at least one incident of harassment within the last two years. Female respondents experienced higher harassment rates (76%) compared to male respondents (50%,  $p=0.02$ ). The most common forms of harassment were verbal, including suggestive or sexist jokes (69%) and offensive sexist remarks (61%). Perpetrators were predominantly male (78%) and most commonly patients (89%) or their friends/family members (46%). The majority of respondents either ignored the harassing behavior (70%) or treated it like a joke (50%), with only a minority (12%) officially reporting incidents. Of those who reported, 44% were unsatisfied with their institution's response. Among respondents, 34% reported negative impacts of workplace sexual harassment, such as anxiety, depression, sleep loss, or adverse workplace consequences.

#### CONCLUSION

Sexual harassment experienced by sonographers in the workplace is commonplace, and often leads to negative health and career outcomes. Female sonographers are significantly more likely to experience harassment compared to male sonographers, and in a profession where 90% of sonographers are female, it is critical to find systemic methods to prevent harassment behavior and support victims of sexual harassment in the workplace.

#### CLINICAL RELEVANCE/APPLICATION

Sexual harassment is prevalent among sonographers, harming their physical and mental health. Strong institutional policies are critical to curb harassment and lessen its impact.

#### R2-SPNPM- The Shift From Hospital Based Imaging To The Office Setting: A Medicare Analysis from 2013 to 2020<sup>2</sup>

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate trends in productivity for diagnostic radiologists serving the Medicare population, by practice setting.

## METHODS AND MATERIALS

All imaging interpretation claims from 2013 to 2020 were extracted from the CMS POSPUF Database for Medicare Part B, a national social insurance program providing health insurance for outpatient services for Americans over 65 yrs and disabled. Claims data were merged with CMS data files to determine the year specific total professional component (wRVU) value for each procedure. These values were aggregated for each individual radiologist and stratified by "Place of Service." "Place of service" has two possible values: "Facility" includes hospital affiliated sites, emergency room, or ambulatory surgery center, while "Non-facility" includes private offices and urgent care facilities. Market share of services was defined as the proportion of wRVUs from a given setting divided by wRVUs performed in both settings. Claims were assigned to a US Census region.

## RESULTS

In 2013, there were 52,179,386 total imaging wRVUs, 63,276,990 (+21.3%) in 2019, and 53,907,670 (-14.8%) in 2020. Facility (hospital) settings accounted for 42,607,520 wRVUs in 2013, 48,578,010 (+14.0%) in 2019, and 40,957,510 (-15.7%) in 2020. Facility market was 81.7% in 2013, 76.8% in 2019, and 76.0% in 2020. Non-facility (office) services accounted for 9,571,866 wRVUs in 2013, 14,698,980 in 2019 (+53.6%), and 12,950,160 (-11.9%). Non-facility market share was 18.3% in 2013, 23.2% in 2019, and 24.0% in 2020. By US region, 2020 total outpatient imaging wRVUs and CAGRs were: South 4,928,295 (+28.1% from 2013), Northeast 3,228,274 (+44.2%), West 2,791,136 (+31.9%), and Midwest 2,002,454 (+46.1%). 2020 wRVU market share of non-facility services by US region was: Northeast 30.5% (+8.7% from 2013), West 29.1% (+3.4%), South 23.6% (+5.5%), and Midwest 15.5% (+4.5%).

## CONCLUSION

In the Medicare population, the rate of growth of office based imaging wRVUs outpaced growth of hospital settings by 39.4% from 2013 to 2020. Office market share grew by 5.7% nationally, and by 3.4% - 8.7% across US regions. These findings document a shift toward office settings, which are often less subject to peer review, validation, or regulation than are hospital settings. This shift follows several legislative, regulatory and payer efforts to steer patients toward lower cost settings. Further research is advised to ensure appropriate imaging utilization and consistent high quality patient care is provided in non-facility settings.

## CLINICAL RELEVANCE/APPLICATION

Outpatient imaging services for the US Medicare population have shifted from hospital based to office settings, which are often less expensive, yet also less regulated.

## R2-SPNPM- The ACR Learning Network Mammography Positioning Improvement Collaborative: 3 Facilitating Local Performance Improvement through Shared Learning

Sarah M. Pittman, MD, FRCPC (*Presenter*) Nothing to Disclose

## PURPOSE

To establish and maintain consistent excellent performance in mammography positioning at multiple sites simultaneously by utilizing a structured quality improvement (QI) program within a learning network framework that enables participating sites to develop and implement locally-successful strategies while sharing with and learning from other sites.

## METHODS AND MATERIALS

The Mammography Positioning Improvement Collaborative is led by a physician leader and administrative leader, supported by learning facilitators and an advisory committee comprised of national experts and thought leaders. Sites enter the collaborative by first participating in a structured QI training and project execution program. Sites were selected on the basis of strength of local leadership support, intra-organizational relationships, access to data and analytic support, and experience with QI initiatives. During the QI program, participating sites went through a process of organizing their teams, developing goals, gathering data, evaluating their current state, understanding root causes of problems, and developing and testing solutions. A common process map and an image quality scoring system were established. The impact of the interventions implemented at each site was assessed by tracking the percentage of screening mammograms meeting overall passing criteria over time.

## RESULTS

Six organizations were selected to participate in the first cohort of the collaborative, beginning with participation in the QI program. Run charts from the six sites show that interventions developed and implemented at each site during the program resulted in improvement in the percentage of screening mammograms meeting overall passing criteria, with five of six sites meeting or exceeding the target mean performance of 85% by the end of the QI program. Anticipated variability in progress is observed between sites.

## CONCLUSION

Using a structured QI program within a learning network framework, five of six sites participating in the first cohort of the Mammography Positioning Improvement Collaborative increased the percentage of screening mammograms meeting overall passing criteria from a collaborative mean of 59% to greater than 85%.

## **CLINICAL RELEVANCE/APPLICATION**

Suboptimal mammography positioning can lead to undetected breast cancer on mammograms. A structured QI program within a learning network framework can facilitate improvement in mammography positioning at multiple sites simultaneously.

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## Abstract Archives of the RSNA, 2023

R2-SPNR

### Neuroradiology Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPNR-1 White Matter Lesion Asymmetry: An Indicator of Amyloid PET Positivity in Mild Cognitive Impairment Patients**

Hye Weon Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Assessing amyloid-positivity in mild cognitive impairment (MCI) patients is crucial as it may indicate a higher risk of developing dementia. This study aims to investigate whether the asymmetry of white matter lesions (WML) on T2-fluid attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI), assessed through artificial intelligence (AI) based hyperintensity segmentation, could potentially serve as an indicator for amyloid positron emission tomography (PET) positivity in patients with MCI.

#### **METHODS AND MATERIALS**

In this retrospective cohort study, MCI patients who visited a clinical site in South Korea were enrolled. The participants underwent a comprehensive evaluation, including clinical and neuropsychological assessments, brain MRI, and [18F]-Flutemetamol amyloid PET. Our study utilized in-house AI based software for segmenting and separating WML into left and right hemispheres. Using the processed segmentation, we measured individual WML differences through volumetric assessment.

#### **RESULTS**

A total of 122 subjects were enrolled in the study, with 53 in the amyloid-negative group and 69 in the amyloid-positive group based on amyloid-PET positivity. The two groups were comparable, with no significant differences in age ( $p=0.189$ ), sex ( $p=0.057$ ), education years ( $p=0.411$ ), and MMSE scores ( $p=0.861$ ). However, the amyloid-positive group showed a significantly higher frequency of having an  $\epsilon 4$  allele of APOE genotype ( $p=0.033$ ) and Clinical Dementia Rating scale ( $p=0.024$ ). The average WML volume differences between hemispheres were significant in the amyloid-negative group ( $p=0.02$ ) but not in the amyloid-positive group ( $p=0.2$ ). Both groups had a larger WML volume in the right hemisphere, which did not differ significantly between the groups.

#### **CONCLUSION**

Our study results indicate that it is crucial to evaluate the asymmetry of WML rather than the total hyperintensity lesion load in MCI patients, especially in those without amyloid pathology. Therefore, WML asymmetry could be a potential indicator of amyloid positivity in MCI patients.

#### **CLINICAL RELEVANCE/APPLICATION**

The WML asymmetry could be utilized as an indicator for amyloid PET positivity in MCI patients.

#### **R2-SPNR-10 Impact of an AI Software on the Diagnostic Performance of Radiologists for the Detection of Cerebral Aneurysms on Time of Flight MR-Angiography**

Nils C. Lehnen, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the impact of an AI based software trained to detect cerebral aneurysms on Time-of-Flight MR-Angiographies on the diagnostic performance and reading times of multiple readers with different amounts of experience in diagnostic neuroimaging.

## METHODS AND MATERIALS

A dataset of 186 MRI studies was evaluated by the different readers for the presence and localization of cerebral aneurysms. First, the reading was done with the support of an AI based software. After a washout period of six weeks, the reading was repeated without the support of the AI software. To document the findings and to measure the reading times, a standardized report was used. The results were compared to the consensus reading of two neuroradiological specialists as a reference standard and sensitivity on patient level and lesion level, specificity on patient level, and false positives per case were calculated.

## RESULTS

According to the reference standard, there were 54 aneurysms present in the dataset. Six readers took part in the reading with no experience (three medical students), two years experience (resident in neuroradiology), six years experience (fellow neurointerventional radiologist) and twelve years experience (neuroradiology specialist), respectively. Sensitivities on lesion level ranged from 66.7% - 87.0% with AI and 57.7% - 87.0% without AI, sensitivities on patient level ranged from 63.4% - 81.8% with AI and 52.3% - 75.0% without AI. Specificities ranged from 93.7% - 97.2% with AI and 89.4% - 98.6% without AI. False positive findings per case ranged from 0.03 - 0.12 with AI and 0.02 - 0.17 without AI. The differences in diagnostic performance did not reach the level of statistical significance. 4 out of 6 readers showed significantly shorter reading times with the use of AI, while the remaining two readers showed a significant increase in reading times.

## CONCLUSION

In our retrospective study, we found equivocal results for the diagnostic performance of six different readers for the detection of cerebral aneurysms with and without the use of an AI software. Although we found a tendency towards a better diagnostic performance, these differences were not statistically significant. The majority of readers showed a significant decrease of reading times, but the radiologist and one medical student showed a significant increase of reading times.

## CLINICAL RELEVANCE/APPLICATION

AI softwares for the detection of pathologies in neuroimaging are increasingly used in the clinical routine. There is a chance that the use of the softwares may improve readers' performances, but radiologists must be aware that with the use of additional softwares, there is a risk of slowing down established workflows without a significant increase in diagnostic performance.

## R2-SPNR- 11 **Sensitivity and Specificity of Ischemia Detection on Brain MRIs using a Commercially Available Deep Learning Algorithm in Patients with Suspected Stroke from a Non-comprehensive Stroke Center**

Christian Hedeager Krag, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Several deep learning artificial intelligence (AI) products exist to detect intracerebral pathology in magnetic resonance imaging (MRI). We set out to estimate the ability of a commercially available CE-approved AI product to detect acute brain ischemia on MRI, compared to an experienced Neuroradiologist.

## METHODS AND MATERIALS

We retrospectively included patients from January 2020 based on the following criteria: Age = 18 years, brain MRI due to suspicion of stroke, with onset of symptoms within four weeks prior to the scan. The Neuroradiologist reinterpreted the MRI scans and subclassified ischemic lesions, serving as the reference test. Scans were excluded if artifacts hampered interpretation, or if sequences were missing. The patients were scanned by one of four different MRI models from the same vendor. The first 3/4 of the patients were included consecutively and the remaining patients were included in an enriched manner to increase the size of subgroups of less frequent ischemic lesions. The index test was a CE-approved AI product.

## RESULTS

The final analysis cohort comprised 995 patients (mean age 69 years, 53% female). A case-based analysis for detecting acute or subacute ischemic lesions showed a sensitivity of 89% (95% CI: 85%-91%) and specificity of 90% (95% CI: 87%-92%). In the consecutive cohort only, consisting of 767 patients, we found a sensitivity of 86% (95% CI: 80-90%) and a specificity of 90% (95% CI: 87-92%). The consecutive and enriched cohorts did not differ significantly in sensitivity, nor was there a significant difference in sensitivity or specificity based on sex or age. However, specificity was significantly reduced in cases with DWI artifacts as opposed to those without (77% vs. 91%,  $p < 0.01$ ). Sensitivity increased significantly with lesion size, for fragmented lesions, and for lesions with signs of hemorrhagic transformation. Furthermore, sensitivity varied with the radiological age of the ischemic lesions. For lesions located in multiple anatomical subgroups, sensitivity was 97% (95%CI 94%-99%), while it was 82% (95%CI 77%-87%) for lesions located within one anatomical subgroup, which was significantly different ( $p < 0.001$ ).

## CONCLUSION

The AI product exhibits high sensitivity and specificity in detecting acute ischemic lesions on MRI compared to an experienced Neuroradiologist at our non-comprehensive stroke center. However, upon clinical application of this AI tool, awareness of the reduced sensitivity for detecting smaller ischemic lesions is required.

## CLINICAL RELEVANCE/APPLICATION

Validating AI products that analyze brain scans is essential before clinical application as they can impact patient diagnostics. AI models often decrease accuracy in clinical settings, highlighting the need for validation studies.

### R2-SPNR-12 **Diagnostic Performance of ChatGPT from Patient History and Imaging Findings in Neuroradiology**

Daisuke Horiuchi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the diagnostic performance and utility of Generative Pre-trained Transformer (GPT)-4 based ChatGPT in neuroradiology.

#### METHODS AND MATERIALS

We collected 80 consecutive "Case of the Week" cases in the American Journal of Neuroradiology between October 2021 and April 2023. ChatGPT was provided with patient history and imaging findings for each case and asked to provide a diagnosis. The generated diagnoses were compared with the ground truth to evaluate ChatGPT's diagnostic accuracy rate. Each case was categorized by anatomical location (brain, spine, and head neck). Brain cases were further divided into two groups: the central nervous system (CNS) tumor group and the non-CNS tumor group. The Fisher's exact tests were conducted to compare the diagnostic accuracy rates among the three anatomical locations, as well as between the CNS tumor and the non-CNS tumor groups.

#### RESULTS

ChatGPT's overall diagnostic accuracy rate was 43% (34/80). When categorized by anatomical location, the diagnostic accuracy rates were 40% (24/60) in brain cases, 60% (6/10) in spine cases, and 40% (4/10) in head neck cases. There was no significant difference in the diagnostic accuracy rates among the three anatomical locations ( $p = 0.56$ ). When comparing the CNS tumor and non-CNS tumor groups, the diagnostic accuracy rates were 8% (1/13) in the CNS tumor group, and 49% (23/47) in the non-CNS tumor group. The diagnostic accuracy rate was significantly lower for the CNS tumor group compared to the non-CNS tumor groups ( $p < 0.01$ ).

## CONCLUSION

This study demonstrates the potential of ChatGPT's diagnostic performance and utility in neuroradiology. ChatGPT can be used without considering anatomical locations in neuroradiology. ChatGPT's diagnostic accuracy may vary depending on the etiology of the diseases, and its diagnostic accuracy is significantly lower in CNS tumors compared to other diseases. Radiologists should understand the potential advantages and limitations of ChatGPT as a diagnostic tool and decision support system.

## CLINICAL RELEVANCE/APPLICATION

The integration of ChatGPT into neuroradiology practice has the potential to revolutionize the field, improve diagnostic accuracy, and ultimately improve patient outcomes.

### R2-SPNR-13 **Improved Differentiation of Cavernous Malformation and Acute Intraparenchymal Hemorrhage on CT using AI Algorithm**

Hwangseon Ju (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of this study was to evaluate the utility of an artificial intelligence (AI) algorithm in differentiating between cavernous malformation (CM) and acute intraparenchymal hemorrhage (AIH) on brain computed tomography (CT) images, as the differentiation between these two conditions can be challenging on brain CT and may lead to unnecessary additional studies in clinical practice.

#### METHODS AND MATERIALS

A retrospective, multi-reader, randomized study was conducted to validate the performance of the AI algorithm (SK Inc. CC Medical Insight + Brain Hemorrhage), a commercial software product, in differentiating AIH from CM on brain CT images. CT images of CM and AIH smaller than 3 cm were collected from the electronic database search. The diagnostic performance of the AI algorithm for differentiating CM and AIH was evaluated using the area under the receiver operating characteristics curve (AUC). Six blinded reviewers, including two neuroradiologists, two radiology residents, and two emergency department



physicians, evaluated CT images from 288 patients (CM, n = 173; AIH, n = 115) with and without AI assistance, and the diagnostic performance was compared.

## RESULTS

The overall AUCs for AI standalone performance in the dataset were 0.93 and 0.92 for slice-wise and patient-wise analyses, respectively. The best diagnostic performance was achieved with a cut-off level of 97.75 % and 97.95 %, sensitivity of 97.1 % and 94.2 %, and specificity of 73.0 % and 73.0 % in slice-wise and patient-wise analyses, respectively. Brain CT interpretation by the reviewers with AI assistance resulted in significantly higher diagnostic accuracy than that without AI assistance (86.92 % vs. 79.86 %,  $p < 0.0001$ ). Radiology residents and emergency department physicians showed significant improvement in the diagnostic accuracy for brain CT interpretation with AI assistance compared to that without AI assistance (84.21 % vs 75.35 %, 80.73 % vs. 72.57 %; respectively, all  $p < 0.05$ ). Neuroradiologists showed a trend of higher diagnostic accuracy with AI assistance in the brain CT interpretation, but with no statistically significant difference (95.83 % vs. 91.67 %).

## CONCLUSION

The use of AI algorithm can enhance the differentiation of AIH from CM in brain CT interpretation for non-experts in neuroradiology.

## CLINICAL RELEVANCE/APPLICATION

The AI algorithm can aid in the proper diagnosis and management of patients who present with a hyperdense lesion on brain CT in clinical practice.

## R2-SPNR-14 Battle of the Brains: Exploring the Accuracy of Artificial Intelligence in Detecting Brain Bleeds on CT Scans

Victor Tang, MBBS, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

Artificial intelligence (AI) has the potential to improve the accuracy and speed of diagnosis of acute intracranial haemorrhage (ICH) which can enhance daily radiology practice and reduce diagnostic errors. As the number of commercial AI algorithms increase, radiology departments are met with a choice of which companies to partner with. This study aimed to compare the performance of two different AI algorithms in detection of ICH on CT scans.

## METHODS AND MATERIALS

All technically adequate non-contrast CT brain studies collected over one month were second-read independently by a neuroradiologist to establish a ground truth for the presence of ICH. Two AI algorithms (1 and 2) were then utilized to review these CT studies and assess them for the presence of ICH. The outputs of the AI algorithms were then compared to the ground truth in order to evaluate their diagnostic accuracy and to compare their performance. Repeat CT brains performed on the same patient were included within the study.

## RESULTS

A total of 1241 brain CT scans were performed within the study period, with 1058 scans marked as negative and 183 scans marked as positive for ICH (14% incidence) by the neuroradiologist. The sensitivity and specificity for Algorithm 1 was 86.3% and 97.2%, respectively. Stratifying by location (emergency [ED], inpatient [IP], outpatient [OP]), the sensitivity was 82.6% (ED), 91.1% (IP), 53.8% (OP), the specificity was 97.1% (ED), 97.3% (IP), 91.7% (OP). The sensitivity and specificity for Algorithm 2 was 88.5% and 96.7%, respectively. Stratifying by location, the sensitivity was 87.0% (ED), 91.1% (IP), 69.2% (OP), the specificity was 96.7% (All), 97.2% (ED), 96.0% (IP), 94.4% (OP). Statistical analysis of the data was conducted using a McNemar test. No statistically significant differences between the two algorithms were found at a significance level of 0.05; all cases P-value: 0.913, ED P-value: 1, IP P-value: 0.458, OP P-value: 0.453

## CONCLUSION

Both algorithms demonstrate high diagnostic accuracy with no significant difference. The drop in OP sensitivity could be due to the low sample size (power = .80). AI 2 did provide a differential output for ICH subtypes, however this was not evaluated in this study. Nonetheless, other features of the AI, such as detection of pathologies other than ICH, user interface and cost, will carry more weight in determining which AI solutions to integrate into the departmental workflow.

## CLINICAL RELEVANCE/APPLICATION

The growing number of commercial AI algorithms presents radiology departments with an opportunity of selecting a partnering company, in order to enhance daily practice and reduce diagnostic errors.

## R2-SPNR-2 Automatic Brain MRI Segmentation Quality Control for More Reliable Study Outcomes

Kiril Vadimovic Klein, BSc, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

Large-scale (>10,000) retrospective observational studies of quantitative regional brain volume assessment from magnetic resonance imaging (MRI) require automated segmentations (SEG). Segmentation errors on standard clinical data are frequent and hamper results. We seek to mitigate this with automated reliability quantification.

## METHODS AND MATERIALS

All 35,818 consecutive 3D T1 brain MRI scans acquired for clinical purposes on 24,261 patients in 11 hospitals in the Capital Region of Denmark during 2019 and 2020 were harvested after regulatory waiving of consent. All MRIs were processed and segmented in anatomical brain regions using FAST-AID Brain [DOI:10.48550/arXiv.2208.14360]. A random subset of 4,887 MRIs was manually categorized by a neurologist as with no, minor, and major SEG failure. We fine-tuned a pre-trained 3D residual convolutional neural network (3DResNet) [DOI:10.1038/s41467-019-13163-9] on 3,910 brain MRIs excluding minor SEG failure to predict the SEG failure probability. We compared various scan exclusion (SE) methods, including no SE, manual SE based on major SEG failure (MM1), and manual SE based on any SEG failure (MM2). To examine the automatic approach, we excluded equally many scans with the highest predicted SEG failure probability matching MM1 and MM2, resulting in AM1 and AM2, respectively. We assessed male-female separation using Cohen's d (CD) across age groups for intracranial volume (ICV), hippocampus, cerebellum, and ventricles and computed the minimum sample size per group (MSS) to obtain a power of 0.8 with an alpha of 0.05.

## RESULTS

On the test set containing no and major SEG failures, we achieved a ROC-AUC of 0.98 and a PR-AUC of 0.99, with a specificity of 0.93 and an accuracy of 0.94 at the 95% sensitivity level. For ICV, both manual and automatic SE methods showed similar separation, with a higher CD for most age groups compared to no SE. Both approaches resulted in a larger average CD for all examined brain regions. The required MSS was significantly reduced, up to five times, compared to no SE.

## CONCLUSION

Employing a machine learning-based approach for predicting SEG failure probability effectively improves the power of retrospective clinical studies focusing on quantitative regional brain volume assessment. The automatic SE method led to a larger average CD for all examined brain regions and substantially reduced the required MSS, ultimately contributing to more reliable conclusions and improved power in retrospective observational studies.

## CLINICAL RELEVANCE/APPLICATION

Accurate and reliable quantitative regional brain volumes from MRI are critical for large-scale retrospective observational studies of neurological disorders. We automate quality assurance to increase power and insight.

## R2-SPNR-3 Advancing the Use of IA in Clinical Practice: Preliminary Outcomes of a Retrospective Clinical Validation Analysis of an AI Volumetric Segmentation Model

Rafael Maffei Loureiro, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The use of Artificial Intelligence (AI) in radiology presents a potential remedy to the escalating volume of medical exams and the insufficient number of specialists. Nonetheless, most AI applications in radiology have not undergone rigorous clinical validation trials. Such validation is essential to reveal any unforeseen downstream implications of implementing AI models in clinical practice, including sociodemographical factors that could affect the model's performance. Additionally, most volumetric brain segmentation tools were originally designed for Magnetic Resonance Imaging (MRI), which is more expensive, time-consuming, and limited in availability compared to Computed Tomography (CT). To tackle such challenges, we evaluated the reliability and accuracy of an AI model in the volumetric segmentation of the intracranial region and lateral ventricles task, using a retrospective dataset comprised of real-world head CT exams stored in our institution's PACS.

## METHODS AND MATERIALS

The model is based on an efficient, lightweight U-Net architecture and performs concurrent segmentation in head 3D images of brain and lateral ventricles. For model development, 559 real-world CT images from neonates to adults were used and included typical and atypical cases besides different scanner models, and acquisition settings. For retrospective clinical validation, 167 anonymized exams from February 2021 were chosen. Intracranial and ventricular ground-truth (GT) binary masks were generated using simpleITK and 3D Slicer, respectively and were approved by board-certified neuroradiologists with at least 6 years of experience. Both generation and validation of GT masks were done remotely by using a 3D Slicer Docker web application and a dashboard based on Trame framework. Project approved by the institutional Ethics Committee.

## RESULTS

Comparison between GT and AI model's masks showed positive results with a mean Hausdorff distance metric and a mean Jaccard similarity index of 10,11 and 0,97, for the intracranial masks, and 13,20 and 0,65 for the ventricle masks, respectively. Intracranial volumes were more homogenous than the ventricles volumes.

## CONCLUSION

The proposed model demonstrated favorable outcomes by using a pipeline that does not require software installation or data download. Future efforts will focus on advancing the model to a prospective stage by conducting external clinical validation using multicentric real-world data.

## CLINICAL RELEVANCE/APPLICATION

The model can accurately and efficiently segment CT exams, according to clinical retrospective results. In the future, it might help diagnose patients with greater precision and effectiveness, especially in resource-limited settings.

## R2-SPNR-4 An Experimental Study of Newborn Pigs Based on MRI Histological Analysis: Pathological Control for Predicting Brain Edema Gradation in HIE

Hefan Li (*Presenter*) Nothing to Disclose

## PURPOSE

Hypoxic-ischemic encephalopathy is one of the causes of death and severe disability in clinical children. Cerebral edema is the main pathological change affecting the clinical prognosis of HIE. Because the pathology of HIE cannot be obtained, clinical experience is commonly used to determine. Noninvasive and rapid prediction of the degree of cerebral edema is essential for clinical decision-making. To solve the clinical problem, we performed pathological studies by simulating clinical children through HIE animals. According to the pathological changes of brain tissue, the MRI images were divided into mild edema group and severe edema group, so that the microscopic pathological changes corresponded to the abnormal signals of macroscopic images. Then the microscopic pathological changes were associated with the omics model, and finally the omics model with pathological validation was realized to predict the HIE brain edema grade.

## METHODS AND MATERIALS

The HIE model was established by sealing both common carotid arteries and hypoxia in 54 newborn Yorkshire breeding pigs. T2WI and DWI scans were performed at 1 h, 3 h, 6 h, 9 h, 12 h, 16 h, 22 h, and 24 h. At the end of scanning at each time point, a group of neonatal pigs were taken for pathological examination of brain tissue. It provides a biological basis for omics research and explores the biological significance of image-omics. Each sequence manually delineated ROI in the region of interest to extract omics features, and three methods of dimensionality reduction screening features were used to establish the model. The combination of sequences and classifiers with better efficacy was assessed with ROC curves, K-Fold cross-validation, etc.

## RESULTS

Based on the sequence DWI, T2WI, ADC and their combination, the classifiers with better model efficacy were LR, LR, KNN and SVM, and the AUCs were 0.89, 0.86, 0.80 and 0.84, respectively. LR model has the best performance among different classifiers. In the combined sequence and classifier power: the LR classifier training set AUC was 0.88; the validation set AUC was 0.89. Logistic regression classifiers based on DWI images had the best predictive model diagnostic efficacy. Gray level dependent matrix class features and homogeneity class features were found to have more important potential for differentiating brain edema.

## CONCLUSION

1. The logistic regression model based on DWI sequences was effective in identifying HIE brain edema in neonatal pigs. 2. The gray-scale dependent matrix and homogeneity correlation features have the potential to be used as imaging biomarkers to reflect the degree of HIE edema.

## CLINICAL RELEVANCE/APPLICATION

To provide a non-invasive histological prediction model with pathobiological significance for children with clinical HIE.

## R2-SPNR-5 Deep Learning-based CT to MRI Image Synthesis with Contrastive Loss

Seungyu Kim (*Presenter*) Nothing to Disclose

## PURPOSE

Magnetic Resonance Imaging (MRI) is an essential imaging modality in clinical radiology. However, conventional Positron Emission Tomography (PET) quantitative analysis requires MR images, and it is challenging to utilize PET images alone. Recently, deep learning-based generative models have been widely applied in the medical field, yet attempts to synthesize MRI images from CT scans, which possess higher resolution, are scarce. Moreover, as PET-CT devices are more commonly used than PET-MRI, patients often require multiple scans, leading to increased time and cost. In this study, we introduce a deep learning model utilizing contrastive loss to obtain MRI images from CT scans and demonstrate the feasibility of replacing conventional MRI with synthesized MRI for PET quantitative analysis with <sup>18</sup>F-Fluorbetaben (FBB) PET imaging.

## **METHODS AND MATERIALS**

We used data from 150 patients with brain CT and T1 MRI scans. Among them, 114 were used for training and the remaining 36 for validation. The CT and MRI scans were co-registered using SPM12 and subsequently used for image translation training. We employed a 2D-based Generative Adversarial Network (GAN) model, utilizing four models: pix2pix, cycle-GAN, Dual Contrastive Learning GAN (DCLGAN) and Contrastive Unpaired Translation (CUT) . We extracted slices from CT scans, trained the deep learning models to synthesize MRI slices from 256x256 CT slices, and combined the synthesized slices to generate MRI images.

## **RESULTS**

We assessed the performance using the Peak Signal-to-Noise Ratio (PSNR), Root Mean Square Error (RMSE), and Structural Similarity Index Measure (SSIM). DCLGAN showed the best performance with a PSNR of 24.13, RMSE of 0.1038, and SSIM of 0.8590. Qualitative evaluation also revealed that DCLGAN accurately predicted structures like basal ganglia and cerebellum, challenging to discern in CT scans. Moreover, we retrospectively compared SUVR evaluation using original MRI and synthesized MRI from 142 patients' FBB-PET scans, obtaining an Intraclass Correlation Coefficient (ICC) of 0.9561, indicating a strong correlation between them.

## **CONCLUSION**

Our deep learning model demonstrates the ability to generate high-quality MRI images from CT scans, capturing intricate structures that are difficult to identify in CT images. This research highlights the potential of our approach as a valuable tool when MRI is inaccessible, ensuring continued advancements in medical imaging analysis.

## **CLINICAL RELEVANCE/APPLICATION**

Our deep learning model generates high-quality MRI images from CT scans, providing a time- and cost-effective alternative for clinical quantitative analysis, such as SUVR, when MRI is inaccessible.

## **R2-SPNR-7 Improved Multimodal Diagnosis of Alzheimer's Disease through MRI and PET Image Fusion**

Zeyu Chang (*Presenter*) Nothing to Disclose

## **PURPOSE**

Alzheimer's Disease (AD) is a degenerative neurological disorder commonly seen in the ageing population and there is currently no universally accepted automatic diagnostic technique. Previous studies have shown that multimodal analysis can be of great benefit in the diagnosis of AD. In this work, we present two novel multimodal diagnostic models for early detection of AD that utilize fused images from Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET): the 2D dynamic image analysis model and the 3D image analysis model. These models have the potential to improve diagnostic accuracy and facilitate early detection of AD, allowing for timely interventions and better patient outcomes.

## **METHODS AND MATERIALS**

Our study utilized a dataset of 394 paired MRI and PET scans from the Alzheimer's Disease Neuroimaging Initiative (ADNI), which included 120 AD, 154 MCI, and 120 Normal Control (NC) scans. We performed multimodal fusion of paired images to create 3D images containing structural and functional information about the brain. We trained two deep learning models for AD diagnosis: a traditional 3D ResNet-18 model and a novel 2D dynamic image analysis model.

## **RESULTS**

Based on our experiments, we found that both models performed similarly well in more challenging tasks such as differentiating between AD and MCI (85.75% for the 2D model vs 85.66% for the 3D model) and distinguishing between AD, MCI, and NC (86.88% for the 2D model vs 86.20% for the 3D model). However, the 3D image analysis model showed higher accuracy in relatively simpler tasks such as distinguishing between AD and NC (96.11% for the 3D model vs 99.44% for the 2D model) and between MCI and NC (93.47% for the 3D model vs 98.80% for the 2D model).

## **CONCLUSION**

In this study, we have developed two advanced multimodal diagnostic models that offer efficient and accurate early Computer Aided Diagnosis (CAD) of AD and have experimentally demonstrated their effectiveness. Our models outperform existing multimodal diagnostic models using PET images and MRI images as input, in terms of decision-based fusion and image fusion. The proposed models have the potential to assist in early detection and diagnosis of AD, ultimately improving patient outcomes.

## **CLINICAL RELEVANCE/APPLICATION**

Our models have significant clinical relevance as they can aid in the early detection and diagnosis of AD, leading to improved patient outcomes. Although the 2D and 3D models perform similarly in some tasks, we recommend the 2D model due to its faster processing time. Our automated approaches have the potential to enhance healthcare professionals' performance and save costs.

## **R2-SPNR-8 Improved Neurovascular Imaging using Advanced Intelligent Clear-IQ Engine (AiCE)**

Mario Abello Mercado (*Presenter*) Nothing to Disclose

### **PURPOSE**

To evaluate the effects of deep-learning image reconstruction on image quality and diagnostic confidence of ultra-high-resolution computed tomography (UHRCT).

### **METHODS AND MATERIALS**

In this single-center study, 100 consecutive patients with acute neurological symptoms underwent CT imaging including cranial computed tomography (CCT) and computed tomography angiography (CTA) using an ultra-high resolution CT scanner. CTA images were reconstructed with normal resolution mode (NR-CTA, matrix 512 x 512, slice thickness 0.5 mm) and ultra-high resolution mode (UHR-CTA, matrix 1024 x 1024, slice thickness 0.25 mm) using iterative reconstruction. Additionally, a deep-learning reconstruction algorithm (advanced intelligent clear-IQ engine, AiCE); specifically trained for ultra-high resolution CT-angiography of the brain was utilized to generate a further UHR-CTA datasets (DL-UHR-CTA, matrix 1024 x 1024, slice thickness 0.25 mm). Image quality for all three reconstructions was evaluated visually by two blinded radiologists using a 4-point Likert-scale. Therefore, general (overall image quality, contrast in general, artifacts, diagnostic confidence and image noise) and vessel specific (assessability of proximal, intermediate and subcortical vessels as well as perforators) criteria were assessed. The quantitative features including slope, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), noise, entropy and co-occurrence matrix (COOC) were examined and compared using an in-house tool.

### **RESULTS**

Qualitative analysis revealed highest scores for DL-UHR-CTA, followed by UHR-CTA and NR-CTA, whereas DL-UHR-CTA yielded excellent results for all qualitative parameters and was significantly superior to UHR-CTA and NR-CTA (all  $p < 0.001$ ). The quantitative analysis was in line with the qualitative findings with significantly superior results for DL-UHR-CTA (slope:  $p < .01$ , SNR/CNR:  $p = 0.004$ , entropy  $p < .01$ , COOC:  $p < .01$ ).

### **CONCLUSION**

Deep-Learning image reconstruction significantly improves image quality of ultra-high resolution neurovascular CT-angiography allowing for higher diagnostic confidence, potentially improving the detection of subtle but oftentimes-significant pathologies.

### **CLINICAL RELEVANCE/APPLICATION**

Deep-learning image reconstruction improves the quality of UHR-CTA images, leading to higher diagnostic confidence and potentially aiding in the detection of subtle but clinically significant pathologies.

## **R2-SPNR-9 Prediction Model of Vascular Cognitive Impairment Based on MRI White Matter Hyperintensities Radiomics Features in the Elderly Patients with CSVD**

Wei Wang (*Presenter*) Nothing to Disclose

### **PURPOSE**

To establish a prediction model of vascular cognitive impairment (VCI) based on white matter hyperintensities (WMH) radiomics feature, in order to guide people at risk of VCI to carry out early intervention and delay the occurrence of VCI or dementia.

### **METHODS AND MATERIALS**

MRI data of 57 patients with VCI and 169 patients with no cognitive impairment (NCI) were retrospectively analyzed. Patients were randomly divided into training set ( $n = 159$ ) and test set ( $n = 67$ ) in a ratio of 7:3. The images were standardized and WMHs were segmented automatically by using the lesion prediction algorithm in the SPM software package. Two radiologists determined whether there was any error, and if there was any error, ITK-SNAP software was imported for manual delineation. Then features were extracted from the segmented WMHs to select the best image morphological features to build the model. Clinical data and conventional MRI signs were incorporated into the study to build a clinical model, and then the radiomics model was combined with clinical model. The receiver operating characteristic (ROC) curve was plotted and the decision curve analysis (DCA) was performed to evaluate the diagnostic efficacy and clinical application value of each model.

### **RESULTS**

8 radiomics features were extracted from WMH, and the WMH radiomics model, clinical model and combined model were established respectively. The area under the ROC curve (AUC) of the training sets of the three models were as follows: WMH radiomics model was 0.74 (95%CI: 0.66-0.83), clinical model was 0.88 (95%CI: 0.81-0.94), combined model was 0.90 (95%CI: 0.84-0.96), The AUC in the test set was 0.75 (95%CI: 0.62-0.87), 0.81 (95%CI: 0.68-0.95) and 0.85 (95%CI: 0.74-0.96), respectively. The combined model has better diagnostic efficacy and a higher clinical net return as assessed by DCA.

## **CONCLUSION**

The diagnostic efficacy of WMH radiomics combined with clinical model was better than that of WMH radiomics or clinical model. It could provide more sensitive and reliable markers for the early prediction and diagnosis of VCI.

## **CLINICAL RELEVANCE/APPLICATION**

The model combined WMH radiomics and clinical data had potential clinical application and could provide more sensitive and reliable markers for the early prediction and diagnosis of VCI.

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## Abstract Archives of the RSNA, 2023

R2-SPPD

### Pediatric Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPPD-1 Absorbed Doses in Ovaries During Pediatric Hip Radiography: To Stop Routine Gonadal Shielding and Move Forward**

Kosuke Matsubara, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The National Council on Radiation Protection and Measurements (NCRP) stated that discontinuing routine use of gonad shield is based on our best scientific understanding. To provide data that contributes to our scientific understanding, we evaluated the difference in ovarian dose between the presence and absence of gonad shield and the difference in ovarian dose depending on the shield size and the depth of the positions of the ovaries.

#### **METHODS AND MATERIALS**

Twenty-five sensitivity-corrected fluorescent glass dosimeters were placed on the cross section at the level of the femoral head of a 1-year-old pediatric phantom to measure absorbed doses with and without a 2-mm-thick lead gonad shield. They were arranged within a depth of 3-9 cm from the body surface and 0-3 cm to the left and right of the body midline. The imaging conditions were as follows: a tube voltage of 50 kV, tube current-time product of 6.3 mAs, a field size of 7×10 cm, and the source-to-image receptor distance of 100 cm. The ovaries were assumed to be 6 cm depth from the body surface and 1.5 cm to the left and right of the body midline. In the Monte Carlo simulation, a voxel phantom was built from CT images of the 1-year-old pediatric phantom, and the absorbed doses in the ovaries were calculated when changing the area covered by the shield to large, medium, and small and when changing the depth of the ovaries to 3-9 cm.

#### **RESULTS**

Although the gonad shield blocks almost 100% of the primary X-rays, significant values of absorbed doses were observed in the area covered by the shield. There was a tendency for the dose reduction rate to decrease from 75.5-81.6% to 52.8-66.7% at positions covered by the shield with increasing depth from the body surface from 3 to 9 cm. The dose reduction rate ranged from 2.3% to 23.1% at positions not covered by the shield. The average dose reduction rates obtained from measurements and simulations at the assumed positions of the ovaries were 66.2% for measurements and 72.7% for simulations. In the simulation, the dose reduction rate was 80.0-80.1% when the ovaries were completely covered by the shield (large size), but it was 72.4-73.1% and 53.6-55.3% when the ovaries were partially uncovered (medium size) and completely uncovered (small size), respectively.

#### **CONCLUSION**

When using a gonadal shield, ovarian dose is affected by how deep the ovaries are located from the body surface and whether the locations of ovaries are covered by the shield. Ovarian doses were far below the thresholds for temporary and permanent infertility even without shielding.

#### **CLINICAL RELEVANCE/APPLICATION**

This study reveals that gonadal shielding does not eliminate a significant number of scattered X-rays produced in the unshielded irradiated areas, supporting the abolition of gonadal shielding in medical practice.

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## Abstract Archives of the RSNA, 2023

R2-SPPH

### Physics Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### R2-SPPH-1 Skin Dose Estimation Reduces Need for Patient Follow-up

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

##### PURPOSE

Determine how reference point air kerma and estimated skin dose are related. Further, determine how use of estimated skin dose could impact patient follow-up.

##### METHODS AND MATERIALS

Reference point air kerma ( $K_{air}$ ) and other demographic information was recorded from 629 patients (669 cases) with  $K_{air}$  above 2Gy. An in-house skin dose ( $D_{skin}$ ) estimation system (DIT Platform) was applied to each case. Dose differences between  $K_{air}$  and  $D_{skin}$  were recorded and summary statistics calculated. Trends against demographics were investigated. Percentage of cases brought below accepted dose thresholds related to skin damage and patient follow-up were determined.

##### RESULTS

Median  $D_{skin}$  estimates were 39.6% lower than  $K_{air}$  [24.9% 25th percentile, 51.1% 75th percentile]. Least squares linear trendline set  $D_{skin}$  as 63.2% of  $K_{air}$  with a  $R^2$  of 0.9. No trend was seen between patient weight and any dose metric. Similarly, difference between  $D_{skin}$  and  $K_{air}$  were not dependent on patient weight. 82.6% of  $K_{air}$  cases between 2 and 3 Gy fell below the erythema limit (2Gy). 40.7% of  $K_{air}$  cases between 3-4 Gy cases, 17.1% of  $K_{air}$  cases between 4-5Gy cases, and 5.6% of  $K_{air}$  cases between 5-6 Gy cases had  $D_{skin} < 2$  Gy. 91.7% of  $K_{air}$  cases between 5-6 Gy cases fell below 5 Gy which is a patient follow-up threshold suggested by several professional societies.

##### CONCLUSION

$K_{air}$  substantially overestimates  $D_{skin}$  in clinical cases. The estimates reduced the number of patients needing follow-up due to possible tissue reactions. When discussing possible skin reactions with patients and physicians the improved estimate reduced the need to discuss more severe skin reactions.

##### CLINICAL RELEVANCE/APPLICATION

The use of skin dose estimation software can decrease the need for patient follow-up and reduce the kinds of possible skin reactions that need to be discussed with patients and referring physicians.

#### R2-SPPH-11 Image Quality Assessment of Deep Learning Image Reconstruction Combined with Low Radiation Dose in Abdominal CT: A Phantom Study

Jiewen Chen (*Presenter*) Nothing to Disclose

##### PURPOSE

To compare the image quality of deep learning image reconstruction (DLIR) at low and ultra-low dose with filtered back projection (FBP) at clinical dose in abdominal CT.

##### METHODS AND MATERIALS

Ten consecutive scans of Catphan 500/600 phantom were performed on Revolution Apex CT using a clinical dose (20.7mGy), low dose (12.29 mGy), ultra-low dose (6.19 mGy). The acquired images were reconstructed with FBP in the clinical dose group, and reconstructed with medium, high strength DLIR algorithms (DLIR-M, DLIR-H) in the ultra-low dose and low-dose groups. The noise (SD), contrast noise ratio (CNR), low density insert diameter, spatial resolution line pair, noise power spectrum (NPS) and task transfer function (TTF) were measured. Image quality was assessed independently by two



radiologists using a 5-point scale. One-way analysis of variance and K-W test were used for statistics. Kappa test was to assess consistency.

## RESULTS

The values of SD and CNR of DLIR-H images in low-dose and ultra-low dose groups were better than FBP images in the clinical dose group (all  $P < 0.01$ ). Low density inserts diameter and the number of spatial resolution line pair of DLIR-H images in the low-dose group were equivalent to those of FBP images ( $P > 0.05$ ) in the clinical dose group. Compared to the FBP images of the clinical dose group, the image texture of DLIR-M and DLIR-H in the low-dose group and ultra-low dose group were almost unchanged, and the NPS noise of the DLIR-H group in the low-dose group was the lowest (FPB of the clinical dose group:  $f_{peak} = 0.28 \pm 0.01 \text{ mm}^{-1}$ ,  $f_{ave} = 0.32 \text{ mm}^{-1}$ ,  $NPS_{noise} = 4.44 \pm 0.05 \text{ HU}$ ; DLIR(M,H) of the low-dose group:  $f_{peak} = 0.28 \pm 0.01 \text{ mm}^{-1}$ ,  $f_{ave} = 0.29 \text{ mm}^{-1}$ ,  $NPS_{noise} = 3.88 \pm 0.04 \text{ HU}$ ; DLIR(M,H) of the ultra-low dose group:  $f_{peak} = 0.27 \text{ mm}^{-1}$ ,  $f_{ave} = 0.29 \text{ mm}^{-1}$ ,  $NPS_{noise} = 5 \text{ HU}$ ); The TTF10% of low contrast target in low-dose and ultra-low dose groups were higher than that of FBP the clinical dose group, while TTF50% were lower in both groups. The subjective score of image quality of DLIR in the ultra-low dose and low-dose groups were not statistically different from that of FBP images in the clinical group ( $P > 0.05$ ). The subjective scores of the two doctors showed good consistency (Kappa = 0.72).

## CONCLUSION

The DLIR algorithm hardly impacts the image texture, especially the contrast and spatial resolution of the low-dose group are comparable or even better than those of the clinical dose FBP image, and the potential reduction of radiation dose can reach 40%~70%, which provides theoretical basis and scanning parameter selection for clinical abdominal CT imaging.

## CLINICAL RELEVANCE/APPLICATION

Low-dose DLIR can reduce radiation dose and provide theoretical basis and scan parameter selection for clinical abdominal CT imaging.

## R2-SPPH-12 Improving Head CT Image Quality under Low-Dose Scanning Conditions using Deep Learning Image Reconstruction Algorithms

Chunyu C. Chen (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the potential of deep learning image reconstruction (DLIR) algorithm for improving image quality under low dose scanning conditions

## METHODS AND MATERIALS

22 inpatients requiring cranial CT reexamination who underwent routine low-dose brain CT scan (120kV200mA) were recruited. All images were reconstructed using filtered backprojection (FBP), ASIR-V at 50% strength (50%ASIR-V), DLIR at low, medium, and high level (DLIR-L, DLIR-M, DLIR-H). The CT values and noise (SD, standard deviation of CT values) of the gray matter (GM) and white matter (WM) at the basal ganglia and centrum semiovale levels were measured at different algorithm groups. The signal-to-noise ratio (SNR) of GM and WM, contrast-to-noise ratio (CNR) between GM and WM, and artifact index (AI) at posterior fossa were calculated. Two radiologists individually performed subjective evaluation of image noise, lesion clarity, overall image quality, and image artifacts using 1-5 scoring system. The consistency between two radiologists was analyzed. The objective and subjective measurements were compared at four algorithm groups.

## RESULTS

There were no significant differences in the CT values among the different algorithm groups (all  $p > 0.05$ ). In the DLIR groups, as the level of DLIR increased, the SD of GM and WM in the basal ganglia and centrum semiovale, as well as AI, gradually decreased, and while the SNR and CNR gradually increased, compared to FBP and 50% ASIR-V. There were significant statistical differences among the five algorithm groups, with the best performance observed in DLIR-H. (FBP vs DLIR-H, in basal ganglia, SDGM:  $9.45 \pm 2.41$ ,  $3.56 \pm 0.90$ ; SNRGM:  $4.42 \pm 1.27$ ,  $11.47 \pm 2.79$ ; CNR:  $1.23 \pm 0.51$ ,  $2.89 \pm 1.12$ ; AI:  $9.79 \pm 3.69$ ,  $7.22 \pm 2.30$ ; all  $p < 0.01$ ). The subjective evaluation scores in terms of image noise, overall image quality clarity of the lesion, and image artifacts gradually in DLIR (M, H) were higher compare with FBP and 50%ASIR-V, with a significant statistical difference among five algorithm groups (Radiologist1, FBP vs DLIR-H, image noise:  $2.09 \pm 0.53$ ,  $4.14 \pm 0.35$ ; over image quality:  $2.18 \pm 0.40$ ,  $4.00 \pm 0.00$ ; clarity of the lesion:  $2.55 \pm 0.67$ ,  $4.00 \pm 0.31$ ; Image artifacts:  $2.18 \pm 0.59$ ,  $4.05 \pm 0.49$ ; all  $p < 0.01$ ). Two radiologists showed a good consistency (ICC: 0.48-0.75,  $p < 0.01$ ).

## CONCLUSION

Under low-dose scanning conditions, compared with FBP and 50% ASIR-V, the deep learning optimization scheme has better performance in reducing image noise and artifacts, and subjectively evaluates DLIR-M and DLIR-H as the best post-processing image quality.

## CLINICAL RELEVANCE/APPLICATION

Compared with FBP and 50% ASIR-V, deep learning image reconstruction algorithms can better improve the quality of head CT images.

## R2-SPPH-2 Impact of Model Shape on Peak Skin Dose Estimates

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

To determine the impact of patient model shape on peak skin dose calculation

### METHODS AND MATERIALS

100 different human models randomly selected from the Civilian American and European Surface Anthropometry Resource dataset were used as input to a previously validated peak skin dose estimation system. Models were scaled to be the same approximate height as the default stylized phantom. Other Patient dimensions were scaled accordingly. The original phantom had craniocaudal, mediolateral, and anteroposterior dimensions of 173 cm, 39 cm, and 20 cm. The scaled patient models had dimensions of 173 cm,  $89 \pm 7.6$  cm, and  $34.5 \pm 3.4$  cm, respectively. Two positions were chosen for the phantoms: 1) patient models most posterior point aligned with default model's most posterior point and 2) patient model center of mass aligned with default model's center of mass. Beam data from 111 scans with reference point air kerma greater than 2 Gy ( $3.3 \text{ Gy} \pm 2 \text{ Gy}$ ) were applied to each patient model. Summary statistics and skin dose maps were calculated.

### RESULTS

When the posterior of the patient models was aligned with the default model the peak skin dose was  $16\% \pm 0.3\%$  larger than using the default model. When the patient model center of mass was aligned with the default model center of mass the peak skin dose was  $19\% \pm 0.3\%$  larger than the default model.

### CONCLUSION

Patient model substantially impacts final peak skin dose estimates. future work is will refine the existing meshes to better represent a realistic patient on the table.

## CLINICAL RELEVANCE/APPLICATION

Dose estimation software should implement an array of patient models to better approximate the patient on the table to improve peak skin dose estimation.

## R2-SPPH-3 Fetal Organ Dose Estimates from the Exposure of Pregnant Women in Fluoroscopy Procedures

Seth Streitmatter, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

To assess the dependence of fetal organ dose on gestational age (GA), beam size and angulation in common fluoroscopy procedures and interventions a pregnant patient may undergo.

### METHODS AND MATERIALS

Hybrid computational phantoms of pregnant woman at four GAs (10w, 20w, 30w, 38w) were used to assess fetal organ doses by simulating common beam quality (70 kVp, 6.83 mm Al), field size (19 x 19 cm) and projections (LAO 25 CAU 25, LAO 25 CRA 25) used in interventional cardiac procedures. The beam geometry data created for the adult female phantom using NCIRF (National Cancer Institute dosimetry system for Radiography and Fluoroscopy), was translated for dose calculations in MCNP6, a general-purpose Monte Carlo code, and fetal organ doses were assessed.

### RESULTS

The major organs that the ICRP has assigned tissue weighting factors to were assessed. As the GA increases and the fetus gets closer to the treatment field, the brain (and other fetal organs that are inferior with respect to the mother's thorax) doses decreases (up to 0.39x), while organs that are superior or distributed throughout the fetus (e.g., bone, skin) show increased dose (up to 4.25x). More dramatically, dose increases as the beam becomes more caudally angulated and the fetus is closer to the beam or partially in it; all fetal organ doses were significantly higher for the LAO 25 CAU 25 scenario (up to 5.19x). Bone shows the largest relative increase in dose for GA 10w - 38w in both scenarios. Figure 1 illustrates the dependence of the doses on GA and beam angulation, normalized to organ dose to dose area product (DAP), mGy/mGy·cm<sup>2</sup>.

### CONCLUSION

For fluoroscopy cases, specifically cardiac/thoracic interventions, differences in GA and beam angulation can have a dramatic effect on fetal organ doses. Using the methods described here provides a higher level of accuracy for fetal organ dose

estimates and the interplay between different potential exposure scenarios for pregnant patients than using the older, simple geometric phantoms and the uterus as a surrogate for fetal dose.

#### **CLINICAL RELEVANCE/APPLICATION**

Examinations that involve an unpredictable duration of fluoroscopy have "substantial risk" potential. The capability to compute more accurate fetal organ doses can provide the patient with more relevant fetal risk assessment.

### **R2-SPPH-4 Evaluation of Different Peak Skin Dose Calculators Using an OSL Dosimeter Array in a Hybrid CT/Angiography Suite**

Megan Glassell, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Fluoroscopically-guided interventional (FGI) procedures can result in high skin doses, potentially in the range where effects such as erythema could occur. Thus, it may be necessary to accurately determine the peak skin dose (PSD) so physicians can predict possible effects and inform the patient. The accuracy of three PSD calculators was evaluated using direct entrance skin dose measurements from optically stimulated luminescent dosimeters (OSLDs).

#### **METHODS AND MATERIALS**

An array of 286 OSLDs was used to measure entrance skin dose on patients (n=12) undergoing FGI procedures. A previously validated method was used to separate the OSLD dose into CT and fluoroscopy skin dose for patients who were scanned with CT during their procedure. The OSLD with the highest fluoroscopy skin dose was used as the measured PSD. Additionally, an in-house PSD calculator was used to determine the PSD based on information from each patient's RDSR and room-specific correction factors. The PSD values reported from an independent commercial dose tracking software were recorded for each patient. The PSD values from a vendor/system-specific dose tracking software were recorded for each patient.

#### **RESULTS**

The measured fluoroscopy PSD ranged from 189 mGy to 8,095 mGy for the 12 patients. The results show good agreement between the measured PSD and the PSD from the in-house PSD calculator. The mean percent error was -2% with mean absolute percent error of 10%. There was no statistical difference between the two PSD values ( $p = 0.445$ ). The independent commercial dose tracking software had a mean percent error of -16% with a mean absolute percent error of 21%. There was no statistical difference between the two PSD values ( $p = 0.054$ ). The vendor/system-specific dose tracking software showed the worst agreement between the measured PSD and displayed PSD. The mean percent error was -37% with a mean absolute percent error of 37%. There is a statistically significant difference between the measured PSD and the displayed PSD ( $p = 0.005$ ).

#### **CONCLUSION**

The in-house PSD calculator that considers parameters from each patient exam and used room-specific correction factors had the best agreement with the measured PSD. The in-house PSD can provide physicians with a relatively more accurate PSD compared to the commercial and vendor dose tracking software.

#### **CLINICAL RELEVANCE/APPLICATION**

Providing interventional radiologists with an accurate PSD estimation can help them better predict possible skin effects and potentially reduce effects by modifying exam parameters.

### **R2-SPPH-5 The Feasibility of High-Pitch Spectral CT Monochromatic Imaging in Combination with ASIR-V Technology: A Phantom Study**

Nana Ai (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To analyse the influence of high-pitch spectral CT monochromatic imaging in combination with pro-adaptive statistical iterative reconstruction-V(ASIR-V) technology on image quality and radiation dose.

#### **METHODS AND MATERIALS**

A chest phantom was scanned on a revolution energy spectrum CT scanner separately using 0.5s rotation time, 0.992 helical pitch and 0.5s rotation time, 1.531 helical pitch. 70KeV monochromatic images were separately reconstructed at slice thickness of 5mm, meanwhile, the 40% pro-ASIR-V was applied to 70 keV high-pitch monochromatic image. Images of lung window and mediastinal window were separately reconstructed by standard algorithm and sharp algorithm. A total of three sets of images were obtained: routine-pitch/0%ASIR-V group, high-pitch/0%ASIR-V group and high-pitch/40%ASIR-V group. The CT dose index volume (CTDIvol), dose-length product (DLP) and effective dose (ED) were recorded. Standard deviation (SD) of pulmonary parenchyma, soft tissues of chest wall and heart were measured. Subjective image quality of lung window and mediastinal window were assessed by two radiologists in a double blinded and randomized manner using five-point scale (from 5=good image quality, almost no artifacts, clear anatomic details, easy to distinguish to 1=poor image

quality, obvious artifacts, indistinct anatomic details, unable to distinguish). The differences between groups for MSD, radiation dose and mean subjective score were done with one-way ANOVA. The interobserver variation between two radiologists were assessed by the kappa statistic.  $P < 0.05$  was considered statistically significant.

## RESULTS

There was moderate agreement between the two radiologists in rating of subjective image quality ( $K=0.571$ ). Results indicated that the image quality of high-pitch spectral CT monochromatic imaging in combination with 40% pro-ASIR-V were better than routine-pitch or high-pitch in combination with 0% ASIR-V. Effective doses of the routine-pitch group and high-pitch group were 6.84 mSv and 5.31 mSv. The radiation dose reduction for high-pitch group was 22.37% in comparison with routine-pitch group.

## CONCLUSION

The use of high-pitch spectral CT monochromatic imaging in combination with pro-ASIR-V resulted in wonderful diagnostic images with lower radiation dose.

## CLINICAL RELEVANCE/APPLICATION

High-pitch spectral CT monochromatic imaging in combination with ASIR-V may acquire high image quality and low radiation dose.

## R2-SPPH-6 The Impact of Different Noise Index (NI) on Image Quality of "Three-low" Chest CTA

Yang C. Chenxiao (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the effect of low tube voltage, low contrast agent dosage and low contrast agent flow rate combined with different NI on the image quality of chest CTA.

## METHODS AND MATERIALS

This study was randomly divided into two groups: group A ( $n=20$ ) and group B ( $n=20$ ). Patients in group A were performed prospective "three-low" chest CTA with following parameters: 100 kVp, contrast volume 45 ml, contrast flow rate 3.0 ml/s, and NI = 12, 14, 16, 18 for subgroup A1, A2, A3 and A4. Group B was control group with routine scanning parameters: 120 kVp, contrast volume 60 ml, contrast flow rate 4.0 ml/s, NI = 10. The other scanning sets were same. CT values and SD of the ascending aorta, aortic arch, descending aorta and the same layer of chest wall fat were measured. Then the CNR were calculated. The effective dose ( $ED = DLP * 0.014$ ) were also recorded. The subjective image quality of five groups were scored independently by two senior radiologists according to the 5-point system (Five points is the highest and one point is the lowest). More than three points meet the diagnostic criteria.

## RESULTS

The CT values of experimental group A1, A2, A3, A4 and control group B were  $346.1 \pm 22.1$ ,  $340.7 \pm 13.9$ ,  $344.0 \pm 14.8$ ,  $342.7 \pm 11.8$  and  $406.5 \pm 8.1$  HU, respectively. There were statistical significance between groups A and B ( $P < 0.05$ ) and no statistical significance between group A ( $P > 0.05$ ). The CNR of experimental group A1, A2, A3, A4 and control group B were  $12.9 \pm 2.5$ ,  $15.3 \pm 2.8$ ,  $17.9 \pm 4.1$ ,  $20.0 \pm 2.9$  and  $9.99 \pm 0.99$ , respectively. There was statistical significance between groups ( $P < 0.05$ ). The CNR of experimental group A1, A2, A3, A4 and control group B were  $42.2 \pm 8.3$ ,  $36.1 \pm 5.9$ ,  $32.3 \pm 3.5$ ,  $24.9 \pm 2.8$  and  $53.3 \pm 6.2$ , respectively. There was statistical significance between groups ( $F = 69.6$ ,  $P < 0.05$ ). The effective dose (ED) were  $2.5 \pm 0.24$ ,  $1.41 \pm 0.26$ ,  $1.15 \pm 0.4$ ,  $0.93 \pm 0.08$  and  $5.0 \pm 0.32$ , respectively. The effective dose of each group was statistically significant ( $F = 1076$ ,  $P < 0.01$ ). In subjective statistics, the image scores of experimental group A1, A2, A3, A4 and control group B were  $5.0 \pm 0$ ,  $4.98 \pm 0.14$ ,  $4.17 \pm 0.38$ ,  $3.61 \pm 0.49$  and  $2.63 \pm 0.49$ , respectively. The result from two senior radiologists were high consistency ( $\kappa = 0.65$ ). Only the subjective score of B4 did not meet the diagnostic requirements, and the lowest radiation dose of B3 group was about 77% lower than that of the control group.

## CONCLUSION

Three low combined with high NI index can reduce the risk of contrast injection and the radiation dose of patients at the same time.

## CLINICAL RELEVANCE/APPLICATION

To reduce the risk of contrast injection and the radiation dose of patients

## R2-SPPH-7 A Study Related to the Optimal Phase Selection of Virtual Scanning of Spectral Enhanced CT Instead of Conventional Scanning

Qi Hao (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the optimal phase selection of virtual non-contrast (VNC) technique instead of conventional true non-contrast (TNC) for spectral enhanced CT scanning.

## METHODS AND MATERIALS

Fifty-seven patients with energy-spectrum-enhanced CT scans of the abdomen were collected, 23 males and 24 females with a mean age of  $55 \pm 12$  years. A spectral CT (Revolution, GE Healthcare, USA) scanner was used, with conventional (non-energy spectral) scanning mode for conventional scanning and gemstone spectral imaging (GSI) abdominal scanning mode for enhanced scanning. The CT scan used spectral mode. The CT values and SD values of the water were measured, and the signal-to-noise ratio (SNR) was calculated. The virtual scanning images were obtained by virtual non-contrast (VNC) technique, and the CT values and SD values of the liver in each phase, and the signal-to-noise ratio (SNR) was calculated. All statistical tests were performed using SPSS version 26.0, and one-way ANOVA was used to compare the differences between CT values, signal-to-noise ratio (SNR), and CT Dose Index (CTDI) of the liver after virtual scanning of the three phases of the spectral enhanced scanning images. For all tests, the level of statistical significance was set at  $P < 0.05$ .

## RESULTS

The SD and SNR of the liver after virtual scanning processing of the three phases of the spectral enhanced scanning were statistically significant ( $P < 0.05$ ) compared with those of the conventional scanning. The differences were statistically significant ( $P < 0.05$ ) when comparing the SD values and SNR of the liver between the virtual scanning of the three phases of spectral enhanced scanning. There were significant differences ( $P < 0.05$ ) in the SD values and SNR of the liver between the virtual scanning of the arterial phase and the virtual scanning of the venous and delayed phases, and there were no significant differences ( $P > 0.05$ ) in the SD values and SNR of the liver of the virtual scanning of the venous and delayed phases.

## CONCLUSION

The image quality of spectral CT virtual scanning was higher than conventional true scanning, the lowest CT Dose Index (CTDI) was in the delayed phase, while the virtual scanning image quality in the delayed phase was better than the virtual scanning image quality in the arterial phase, and there are no difference significantly between the image quality in the portal phase and delayed phase.

## CLINICAL RELEVANCE/APPLICATION

Spectral CT abdominal enhancement virtual scanning allows for the selection of delayed-period virtual scanning images instead of true scanning, this can reduce the number of scans, decrease radiation dose, and improve image quality.

## R2-SPPH-8 Silver (Ag) X-ray Spectrum Modulation Filter vs. Copper (Cu) X-ray Spectrum Modulation Filter: Capability of Low-Dose CT for Lung Cancer Screening at *In Vitro* and *In Vivo* Studies

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

## PURPOSE

To compare the capability of low-dose CT for lung cancer screening between newly developed silver (Ag) and traditionally applied copper (Cu) x-ray beam spectral modulation filters at in vitro and in vivo studies.

## METHODS AND MATERIALS

A chest CT phantom including simulated ground-glass and part-solid nodules was scanned with a 320-detector row CT with Ag and Cu filters at 0.6, 1.6 and 2.5 mGys and reconstructed with hybrid-type iterative reconstruction (IR) method at in vitro study. Then, 95 patients who underwent low-dose CT lung cancer screening with Ag and Cu filters at same radiation dose level (i.e. 1.6mGy) as well as standard-dose CT examination within 3 months were retrospectively included to in vivo study. At in vivo study, the same reconstruction method was applied. At in vitro study, SNR at each nodule were determined by region of interest (ROI) measurements at all protocols. At each simulated nodule, the probability of nodule was assessed with 5-point visual score by two board-certified chest radiologists. All final scores were determined as consensus of two readers. At in vivo study, SNR of normal lung parenchyma was also determined by ROI measurement at each low-dose CT. Then, the probability of nodule equal to or more than 4 mm in long-axis diameter was also assessed with 5-point scale by same board-certified chest radiologists. Student's t-test was performed to compare SNR of CT data between Ag and Cu filters at in vitro and in vivo studies. At in vitro study, ROC analyses were performed to compare nodule detection capability between Ag and Cu filters on each radiation dose data. At in vivo study, JAFROC analysis was performed to compare nodule detection capability between Ag and Cu filters. Finally, averaged sensitivity (SE) and false-positive/case (FP/case) were compared by McNemar's test and Wilcoxon's signed rank test.

## RESULTS

At in vitro studies, SNR and AUC of Ag filter were significantly higher than those of Cu filter at each radiation dose ( $p < 0.05$ ). At in vivo study, SNR of Ag filter was significantly higher than that of Cu filter ( $p < 0.05$ ). There were no significant differences

of averaged figure of merit (FOM) and FP/case of between Ag (FOM=0.92, FP/case=0.24/case) and Cu (FOM=0.91,  $p>0.05$ ; FP/case=0.24/case,  $p>0.05$ ) filters. However, averaged sensitivity of low-dose CT with Ag filter (SE=0.88) was significantly higher than that with Cu filter (SE=0.79,  $p<0.001$ ).

#### **CONCLUSION**

Ag filter can significantly improve image quality and nodule detection capability than Cu filter on low-dose CT screening at *in vitro* and *in vivo* studies.

#### **CLINICAL RELEVANCE/APPLICATION**

Ag filter can significantly improve image quality and nodule detection capability than Cu filter on low-dose CT screening at *in vitro* and *in vivo* studies.

### **R2-SPPH-9 Effects of Different Tube Voltages and Different Levels of Hybrid Iterative Reconstruction on the Detection and Characterization of Pulmonary Nodules in Ultra-low-dose Chest CT**

Yue Yao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the effects of different tube voltages combined with adaptive statistical iterative reconstruction (ASIR-V) algorithms on the detection and characterization of pulmonary nodules by an artificial intelligence software in ultra-low dose chest CT

#### **METHODS AND MATERIALS**

An anthropomorphic thorax phantom containing 12 spherical simulated nodules served as the reference standard (Diameter: 12, 10, 8, 5 mm; CT value: -800, -630, 100 HU) was scanned at different dose levels with combinations of kVp and tube current: Group A (70kV/30mA:0.11mSv, 100kV/10mA:0.10mSv), Group B (70kV/100mA:0.34mSv, 100kV/30mA:0.32mSv), and Group C (70kV/150mA:0.53, 100kV/50mA:0.51mSv). Scans were repeated 5 times. Four different weights of ASIR-V (0%=FBP, 30%, 50%, 70%) were used to generate images. All images were automatically analyzed using a commercially available artificial intelligence software (Intelligent 4D Imaging System for Chest CT 5.5, YITU Healthcare) and long diameter, short diameter, location and nature of each nodule, and CT and SD values of muscle under each group of conditions were obtained. The detection rate (DR), deformation coefficient (DC) and size measurement deviation percentage (SP) of pulmonary nodules were calculated and compared between groups. The image quality and noise of each group were compared.

#### **RESULTS**

Under the same ASIR-V weight, the image noise of 70kV was in general lower than that of 100kV group; and noise gradually decreased with the increase of reconstruction weight. Under the same dose level, there was no significant difference in DR of nodules between different kV ( $p>0.05$ ); and DR values in the 70kV group were slightly higher than 100kV at 50%ASIR-V and 70%ASIR-V in Group A, 50%ASIR-V in Group B and 70%ASIR-V in Group C. Higher percentages ASIR-V and 100kV in general had better (lower) DC and SP.

#### **CONCLUSION**

Detection rates were similar between 70kV and 100kV scans. 70kV had better noise performance under the same ASIR-V percentage, while 100kV and higher ASIR-V percentages were better in preserving the forms of nodules.

#### **CLINICAL RELEVANCE/APPLICATION**

Under ultra-low radiation dose chest CT, High weight IR is better to balance between nodule detection rate and shape deformation.

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## Abstract Archives of the RSNA, 2023

R2-SPRO

### Radiation Oncology Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### R2-SPRO-1 Auto-contouring of Brain Metastases for Stereotactic Radiosurgery

Ho-Hsin Chang, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Brain metastases (BMs) are a common complication of cancer and the most common type of brain tumor. Stereotactic radiosurgery (SRS) is a well-established treatment option which allows for the delivery of highly focused radiation allowing for improved sparing of healthy brain tissue when compared to whole-brain radiotherapy leading to better cognitive outcomes after treatment. Highly focused treatments such as SRS require very precise BMs identification and definition. In this study, we train and evaluate the nnUNet's ability to automatically identify and contour BMs for use in radiotherapy planning and treatment assessment.

#### METHODS AND MATERIALS

Post-contrast T1-weighted (T1w+C) MR scans and planning records from 784 SRS patients previously treated at our institution using Gamma Knife SRS were used in this study. Physician-drawn BMs contours were extracted for each patient treatment. T1w+C scans were acquired on the same day of treatment using Philips Ingenia 1.5T scanner using an axial 3D fast spin echo sequence using 1mm slice spacing and  $0.449 \times 0.449 - 1 \times 1$  pixel spacing. This dataset was split into training ( $n=759$ ) and final testing ( $n=25$ ) cohorts. We then trained the nnUNet (Isensee, F., et al. Nature methods, 2021) on 2 NVIDIA TITAN RTX 24GB GPU using 5-fold cross validation with 1000 epochs in each fold. The nnUNet is a self-configuring model that has demonstrated high performance in various automatic contouring tasks. Auto-contouring performance was evaluated using Dice similarity coefficient (DSC) and voxel-wise precision and recall.

#### RESULTS

The 25 test cases had 78 BMs defined by the treating physician at the time of treatment (average volume of  $9.91 \pm 15.28$  cm<sup>3</sup>). 75.6% (59/78) of BMs (average volume of  $8.89 \pm 12.07$  cm<sup>3</sup>) were detected by the trained model resulting in an average DSC of  $0.84 (\pm 0.11)$ , and voxel-wise precision and recall of 0.87 and 0.85, respectively. The nnUNet did not detect 19 physician-defined BMs (24.4%) (average volume  $1.82 \pm 5.74$  cm<sup>3</sup>) and identified 43 BMs which were not defined at the time of treatment (average volume  $0.98 \pm 3.22$  cm<sup>3</sup>).

#### CONCLUSION

Overall, the trained model shows promise in automatically detecting and contouring BMs. However, the current approach is less accurate in identifying smaller BM volumes. Further work is needed to improve automatic identification and contouring performance for these smaller lesions.

#### CLINICAL RELEVANCE/APPLICATION

Accurate detection and definition of brain metastasis volumes through automated solutions could help standardization of delivered treatments across radiation oncology practices. Furthermore, automation of this process could improve treatment assessment on post-treatment imaging.

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## Abstract Archives of the RSNA, 2023

R2-SPVA

### Vascular Imaging Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-SPVA-1 Evaluation and Comparison of CT Angiography Image Quality Acquired with Single-Energy Metal Artifact Reduction Algorithm and Deep Learning Reconstruction in Patients after Endovascular Aortic Repair**

Zhiman Lai (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess and compare the image quality of hybrid iterative reconstruction (HIR), deep learning reconstruction (DLR), combination of HIR and single-energy metal artifact reduction (SEMAR) algorithm (HIR+SEMAR), and combination of DLR and SEMAR algorithm (DLR+SEMAR) for computed tomography angiography (CTA) examinations in patients after abdominal aortic (AA) endovascular aortic repair (EVAR).

#### **METHODS AND MATERIALS**

CTA images of 27 patients (mean age  $\pm$  standard deviation,  $68.7 \pm 8.8$  years, 23 male) were reconstructed using HIR, DLR, HIR+SEMAR, and DLR+SEMAR. CT attenuation, image noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR) were measured in muscle, liver, AA distant to stents (region 1 of interest, ROI 1), AA near stents and artifacts (ROI 2), AA near stents but not artifacts (ROI 3), mural thrombus with artifacts, and mural thrombus without artifacts. Data were expressed as median (interquartile distribution) for non-normally distributed data. The subjective visual scores (1 for worst -5 for best) of images were obtained for the following: overall image quality and visibility of surrounding organs, vessels outside the scaffold, and stent thrombosis. These parameters were compared among above four methods.

#### **RESULTS**

HIR+SEMAR or DLR+SEMAR provided higher Hounsfield unit (HU) values in images with artifacts, while there is no statistically significant attenuation in images without artifacts among four methods. The image noise in HU of images with artifacts was significantly lower in HIR+SEMAR or DLR+SEMAR than in HIR and DLR ( $p < 0.001$ ), while the image noise in HU of images without artifacts was significantly lower in the DLR or DLR+SEMAR group than in the HIR and HIR+SEMAR groups ( $p < 0.0001$ ). For images with stents, SNR and CNR were significantly higher in the HIR+SEMAR [6.110 (4.5, 7.9)] or DLR+SEMAR [6.010 (4.7, 10.5)] group than in the HIR [3.080 (1.9, 4.0)] and DLR [2.860 (1.8, 4.6)] groups (SNR of ROI 2, respectively,  $p < 0.001$ ). But the SNR of liver and muscle were significantly higher in the DLR or DLR+SEMAR group than in the HIR and HIR+SEMAR groups ( $p < 0.0001$ ). The subjective visual scores in the DLR+SEMAR were the highest compared those in the images reconstructed with HIR, DLR and HIR+SEMAR ( $p < 0.0001$ ).

#### **CONCLUSION**

Compared to HIR, DLR, and HIR+SEMAR, DLR+SEMAR provides superior image quality in terms of quantitative and qualitative parameters, not only markedly reducing metal artifacts but also improving reliably attenuation of soft tissues.

#### **CLINICAL RELEVANCE/APPLICATION**

The combination of DLR and SEMAR algorithm technique significantly improving CTA image quality not only in the images with metal artifacts but also in those without metal artifacts in patients after EVAR, beneficial for postoperative surveillance.

#### **R2-SPVA-2 Ultra-High-Resolution Photon-Counting Detector CT Angiography of the Lower Limbs**

Dirk Graafen, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Peripheral arterial disease frequently affects the lower limbs, and heavy calcifications may reduce the accuracy of CT-angiography. Photon-counting detector (PCD) CT offers improved image quality for CT angiography, recently demonstrated for



coronary artery evaluation. However, no previous study investigated the potential of PCD-CT angiography for the assessment of the lower limbs. Therefore, the aim of this study was to identify the optimal reconstruction parameters for ultra-high-resolution (UHR) PCD-CT angiography of the lower limbs in a phantom and patient study.

## **METHODS AND MATERIALS**

Silicone pipes with five different inner diameters (1 to 5 mm) were filled with different iodine concentrations (0, 4.63, 9.25, 18.5, and 37.0 mg I/cm<sup>3</sup>) and scanned in a water container using six different radiation doses (CTDI = 1, 2, 3, 4, 10, and 30 mGy). Virtual monoenergetic images at 55 keV were reconstructed with 0.4 mm isotropic resolution using the quantitative kernels with all ten available sharpness levels (Qr36 to Qr76) combined with the three highest levels of Quantum iterative reconstruction (QIR-2 to QIR-4). Noise levels and sharpness (maximal slope values at the pipe walls) were determined for all reconstructions. Additionally, clinical CT angiographies of 20 patients were reconstructed with a normal (Qr-44), sharp (Qr-60), and ultra-sharp (Qr-72) kernel at QIR2-4. Three raters performed a qualitative analysis of these images with a 5-point Likert scale assessing noise, delineation of plaques and vessel walls, and overall image quality.

## **RESULTS**

Increase kernel sharpness led to higher image noise, e.g., for 4 mGy CTDI and QIR-2, noise level was 11 HU for Qr36, 45 HU for Qr60, and 141 HU for Qr76. Maximum slope values increase relevantly until a sharpness level of 60, while higher sharpness levels only yield small additional improvements. QIR clearly decreases noise with higher levels without reducing the maximum slope. Qualitative analysis of the clinical images confirmed these findings. Worse noise scores were given for higher sharpness levels, while no improvement in the delineation of plaques and vessel walls was found between the sharp and ultra-sharp kernel. The sharp kernel (Qr-60) with the highest QIR level (QIR-4) yielded the best overall quality.

## **CONCLUSION**

Reconstruction kernels with optimized sharpness level in combination with the highest QIR level yield the best image quality for UHR-PCD-CT angiography of the lower limbs, which is Qr60 for 0.4 mm isotropic voxels with edge lengths of 0.4 mm.

## **CLINICAL RELEVANCE/APPLICATION**

Using UHR-PCD-CT angiography with optimized reconstruction parameters might improve diagnostic accuracy and confidence in peripheral artery disease of the lower limbs.

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## Abstract Archives of the RSNA, 2023

R5A-SPBR

### Breast Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPBR- Optimizing Double Reading in Screening Mammography through Pairing Strategies Explored 1 by Modelled Radiologists' Assessments**

Jessie Gommers, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiologists' performance characteristics vary, yet the pairing of radiologists for the double reading of screening mammography is done randomly or out of convenience. No attempts have been made to prospectively optimise the pairing of radiologists for improved screening performance. We aim to investigate whether the optimal set of pairs of radiologists can be achieved by using modelled radiologist performance characteristics for pairing.

#### **METHODS AND MATERIALS**

Our retrospective study was performed with datasets from breast cancer screening programs in Sweden (2008-2015), England (2012-2014), and Norway (2004-2018). Logistic regression models with reader and case effects, for positive and negative screening examinations separately, were used to model radiologists' screening assessments. Screening programs with different pairing strategies, including the pairing of readers with 1) opposite or 2) similar true-positive rates (TPR) and/or false-positive rates (FPR), were simulated. Group performances of the different pairing strategies were compared against those of the random pairing strategies, with positive assessments defined by either reader flagging a case as abnormal. Bootstrap resampling (n=1,000) was used to obtain 95% confidence intervals.

#### **RESULTS**

The final study sample consisted of 3,191,955 screening examinations, 936,621 from Sweden, 435,281 from England, and 1,820,053 from Norway. The logistic-regression models adequately predicted individual (Pearson correlations > 0.95) reader performance. Within the simulations, pairing similar readers reduced what they were similar in and pairing opposite readers increased what they were opposite in. The pairing strategies involving readers with similar FPR resulted in significantly lower FPR outcomes (Sweden: 4.50%, England: 5.51%, Norway: 8.03%), compared to the random pairing strategies (Sweden: 4.74%, England: 5.76%, Norway: 8.30%), while the TPR did not change significantly. All other pairing strategies performed equally or worse than random pairing.

#### **CONCLUSION**

There was no pairing strategy that increased TPR and at the same time decreased FPR. However, according to our pairing rule, pairing readers with similar FPR performance characteristics may result in a reduced FPR with no significant reduction in TPR. Pairing readers with similar FPR characteristics may be helpful to reduce the number of examinations sent to consensus or arbitration. Additional studies are needed to explore the effect of consensus and arbitration.

#### **CLINICAL RELEVANCE/APPLICATION**

Pairing readers with similar FPR might result in reduced FPR while not significantly reducing TPR, potentially reducing workload. Future studies are needed to explore what happens after consensus/arbitration.

#### **R5A-SPBR- Comparison of Contrast-Enhanced Spectral Mammography and Digital Mammography in 2 Detecting Breast Cancer: A Systematic Review and Meta-Analysis**

Mostafa A. Shehata, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate and compare the diagnostic accuracy of digital mammography (DM) and contrast-enhanced spectral mammography (CESM) in breast cancer detection, through a systematic review and meta-analysis.

## METHODS AND MATERIALS

A comprehensive literature search was conducted using PubMed, Web of Science, Scopus, and Google Scholar up to February 15, 2023. Bivariate modeling was employed to obtain pooled diagnostic accuracy metrics (sensitivity, specificity, DOR, PPV, and NPV) of CESH and DM. Summary ROC curves were used for comparison.

## RESULTS

The systematic review incorporated twenty-four studies based on our eligibility criteria. However, we excluded four studies from the meta-analysis due to incomplete contingency tables. The meta-analysis ultimately included twenty studies, consisting of 3830 breast lesions. Among these, 17 studies focused on diagnostic purposes, two were dedicated to screening and one study aimed at preoperative assessment. For breast cancer detection, CESH demonstrated significantly higher sensitivity (0.948, 95% CI: 0.917-0.968) and better specificity (0.732, 95% CI: 0.626-0.816) than DM (sensitivity: 0.815, 95% CI: 0.731-0.877; specificity: 0.576, 95% CI: 0.415-0.723). The diagnostic odds ratio for CESH (50.4, 95% CI: 35.5-69.5) was notably superior to DM (6.12, 95% CI: 3.4-10.2).

## CONCLUSION

CESH exhibits superior diagnostic performance compared to DM in breast cancer detection. Clinicians should consider CESH as an alternative or complementary imaging modality to DM.

## CLINICAL RELEVANCE/APPLICATION

CESH offers improved diagnostic accuracy in breast cancer diagnosis of patients retrieved from screening, making it a valuable alternative or complement to DM in specific clinical situations, including dense breast tissue and inconclusive imaging cases, while considering its drawbacks.

## R5A-SPBR- Optimizing Lesion Detection in Digital Breast Tomosynthesis: A Phantom Study Investigating 5 Angular Range Across Varied Breast Density and Thickness

Hee Jeong Kim, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To determine the optimal angular range (AR) for digital breast tomosynthesis (DBT) systems that provides the highest detectability of breast lesions across various breast densities and thicknesses.

## METHODS AND MATERIALS

The Modular DBT phantom (Model 165SI; Gammex Inc, WI, USA) composed of tissue-equivalent adipose and glandular modules and a module embedded with test objects of speckles, masses, and fibers was used to generate ten modular combinations simulating different breast thicknesses and densities, as well as different lesion locations. A prototype DBT system (KERI, Gyeonggi-do, Korea) with a W/AI target/filter combination operating at ARs of  $\pm 7.5^\circ$  ( $AR\pm 7.5^\circ$ ),  $12.5^\circ$  ( $AR\pm 12.5^\circ$ ),  $\pm 19^\circ$  ( $AR\pm 19^\circ$ ), and  $\pm 25^\circ$  ( $AR\pm 25^\circ$ ) was used to acquire 11 low-dose projection images of each combination. Image datasets were acquired three times under the same conditions. Three blinded radiologists independently assessed lesion detectability on the reconstructed images according to the 2018 ACR Digital Mammography Quality Control Manual. Their scores were averaged and compared using linear mixed models with combination and reader as random intercepts.

## RESULTS

The  $AR\pm 12.5^\circ$  provided the highest overall lesion detectability across all breast combinations. Speckles were best detected with  $AR\pm 7.5^\circ$  or  $AR\pm 12.5^\circ$  in all breast combinations, with no significant difference between them. However, speckle detectability was significantly lower when using the  $AR\pm 19^\circ$  or  $AR\pm 25^\circ$  ( $P = .014$  for thin fatty,  $0.026$  for thick fatty, and  $< .001$  for dense breasts). The optimal AR for mass detection was  $AR\pm 19^\circ$  for thin breasts and  $AR\pm 25^\circ$  for thick breasts. Specifically, for thin fatty breasts,  $AR\pm 19^\circ$  significantly outperformed the other ranges ( $P = .042$ ), while for thick dense breasts,  $AR\pm 25^\circ$  significantly outperformed the others ( $P = .025$ ). Although the optimal AR for fiber detectability varied among the breast combinations,  $AR\pm 25^\circ$  provided the lowest detectability among the four ARs in all combinations ( $P = .013$  for thin fatty,  $.026$  for thin dense and thick fatty,  $.004$  for thick dense breasts).

## CONCLUSION

The optimal AR for overall lesion detectability was the  $AR\pm 12.5^\circ$  in all breast densities and thicknesses. However, for speckle and mass detection, narrower and wider ARs may be necessary, respectively.

## CLINICAL RELEVANCE/APPLICATION

While current DBT systems generally employ a single AR, using various ARs may enhance the lesion detectability for patients with different breast densities and thicknesses, as well as different lesion types of interest.

## R5A-SPBR- Diagnosis of Lesions Presenting as Architectural Distortion on DBT: Malignancy Rate Related 6 to Accompanied Features, Ultrasound Findings, and BI-RADS Density

Jiejie Zhou, PhD, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Accurate diagnosis of architectural distortion (AD) on DBT is challenging, and usually ultrasound (US) is performed to provide additional information. This study aims to: (1) compare the diagnosis in cases associated with nodular density and microcalcifications; (2) compare the diagnosis in cases with and without corresponding suspicious findings on US; (3) evaluate the malignancy rate in cases with different BI-RADS density backgrounds.

## **METHODS AND MATERIALS**

A total of 471 cases were included, 265 malignant and 206 benign, which were all pathologically confirmed. The DBT images were reviewed to identify the suspicious areas showing architectural distortion, and to determine whether the lesion was accompanied by nodular density or microcalcifications. The US reports were reviewed to determine whether there were suspicious findings corresponding to the detected AD. The malignancy rate in each DBT BI-RADS category, with or without accompanied nodule density, microcalcifications, US findings, and in different density backgrounds were analyzed.

## **RESULTS**

Malignant rate in DBT BI-RADS 5, 4C, 4B, 4A, and 2-3 groups were 100%, 86%, 57%, 37%, and 19%, respectively (Table 1). For cases accompanied by nodular density, microcalcifications, and without any features, the malignancy rate was 91%, 69% and 38%, respectively. Of 471 cases, 315 showed the corresponding abnormality on US, and the malignancy rate was 72%. In 156 cases without corresponding US findings, the malignancy rate was much lower at 24% ( $P < 0.00001$ , Table 2). The malignancy rate in patients who had BI-RADS density category A+B was significantly higher (48/64, 75%) than in those who had category C+D (217/407, 53%,  $p=0.0011$ ). When using DBT BI-RADS =4A as the cutoff, 252/265 (95%) malignancies were correctly diagnosed by DBT, and 13 cases were misdiagnosed; but 9 of them could be correctly diagnosed by the supplement US. In the benign group, 54/206 (26%) were correctly diagnosed as DBT BI-RADS 2 or 3. When US was considered, 35 false positive lesions showed US BI-RADS 2-3 and they might be spared of biopsy.

## **CONCLUSION**

AD lesions on DBT accompanied by nodule density had a higher malignant rate than those with microcalcifications, and the malignant rate was the lowest for those without any accompanied features. Cases with corresponding US abnormalities had a much higher malignancy rate than those without. Lastly, AD detected in fatty breasts had a higher malignancy rate, presumably due to the more clearly revealed features in a clean background.

## **CLINICAL RELEVANCE/APPLICATION**

Diagnosis of lesions presenting as architectural distortion on DBT can be improved with more understanding of associated features and tissue backgrounds, as well as the corresponding findings by using the supplementary ultrasound.

## **R5A-SPBR-7 Diagnosis of Architectural Distortion on Digital Breast Tomosynthesis Using Radiomics and Deep Learning**

Yang Zhang, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The objective of this study is to develop diagnostic models for patients showing architectural distortion in Digital Breast Tomosynthesis (DBT) images using two Artificial Intelligence (AI) techniques: radiomics and deep learning.

## **METHODS AND MATERIALS**

A retrospective review identified a total of 506 cases. The initial 298 cases were utilized for training, while the remaining 208 cases were allocated for independent testing. The training set includes 175 malignant and 123 benign cases. The architectural distortion areas on craniocaudal (CC) and mediolateral oblique (MLO) views were manually defined as for radiomics analysis. Features were extracted using PyRadiomics, followed by the application of the support vector machine (SVM) to select significant features and construct the classification model. Deep learning employed the ResNet50 algorithm, producing binary outputs for malignancy and benignity. The Gradient-weighted Class Activation Mapping (Grad-CAM) method was used to identify suspicious regions. Malignancy probabilities were utilized to create ROC curves. The model was further applied to a testing dataset consisting of 208 cases, including 122 malignant cases and 96 benign cases for independent testing.

## **RESULTS**

The radiomics model, created using combined CC+MLO features, resulted in an AUC of 0.82, sensitivity of 0.78, specificity of 0.68, and accuracy of 0.74. Using only CC features, the AUC was 0.77. The deep-learning model generated an AUC of 0.61, significantly lower than all radiomics models ( $p < 0.01$ ), likely due to the utilization of the entire image as input. The Grad-CAM method effectively localized architectural distortion areas. In the testing dataset, the radiomics model, built using combined CC+MLO features, yielded an AUC of 0.8, sensitivity of 0.82, specificity of 0.76, and accuracy of 0.74. When only CC features were used, the AUC was 0.74. The deep-learning model generated an AUC of 0.57.

## CONCLUSION

Radiomics models demonstrate satisfactory diagnostic accuracy, and high specificity within the benign group can help prevent unnecessary biopsies. Deep learning can be employed to localize architectural distortion areas, potentially offering an automated method for ROI delineation. The validation results on the testing dataset further confirm the reliability of the radiomics model in real-world scenarios.

## CLINICAL RELEVANCE/APPLICATION

This study demonstrates the promising potential of radiomics models in accurately diagnosing architectural distortion in DBT. Additionally, the study suggests that deep learning can effectively localize areas of architectural distortion, which could aid in the development of a fully automated computer-aided diagnosis system for breast cancer.

## R5A-SPBR- How Long Does It Take to Read a Mammogram? Investigating the Reading Time of Digital Breast Tomosynthesis Compared to 2D Mammography

Yan Chen, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Digital breast tomosynthesis (DBT) can increase cancer detection and reduce recall rates compared to 2D full-field digital mammography (FFDM) alone. We analysed DBT reading times in a national screening program, compared to FFDM, to investigate the impact of DBT implementation on reading times in double reading, high-volume breast screening programmes.

## METHODS AND MATERIALS

Reading time data were recorded as part of the PROSPECTS Trial, a prospective randomised trial comparing DBT plus FFDM or synthetic 2D mammography (S2D) to FFDM alone, in the UK National Health Service (NHS) breast screening programme, from January 2019 to February 2023. The time to report DBT+FFDM or DBT+S2D and FFDM alone was calculated per case and reading times were compared between modalities. Reporting times were also compared between readers from different professional groups - radiologists and radiographers (i.e. technologists); and with years of DBT reading. The effect of experience using DBT in the screening setting on reporting time was investigated.

## RESULTS

Following exclusions, 48 readers reported 1,242 FFDM clinics (34,210 FFDM cases) and 973 DBT clinics (13,983 DBT cases). DBT reading time was doubled compared to FFDM ( $2.09 \pm 0.64$  minutes vs.  $0.98 \pm 0.30$  minutes, respectively;  $p < .001$ ), and DBT+S2D reading was longer than DBT+FFDM ( $2.24 \pm 0.62$  minutes vs.  $2.04 \pm 0.46$  minutes, respectively;  $p = .006$ ). No significant difference was identified in reporting time between radiologists and radiographer readers ( $2.06 \pm 0.71$  minutes vs.  $2.14 \pm 0.46$  minutes, respectively;  $p = .71$ ). Readers with five or more years of experience reading DBT were quicker at reading DBT than those with less than five years' experience ( $1.86 \pm 0.56$  minutes vs.  $2.37 \pm 0.65$  minutes;  $p = .008$ ), and DBT reading time significantly improved after 6-months of accrued screening experience ( $p = .01$ ).

## CONCLUSION

DBT reading required greater time compared to FFDM, yet relatively short exposure with DBT in the screening setting (6-months) improved reporting time.

## CLINICAL RELEVANCE/APPLICATION

In double reading, high-volume breast screening programmes, caution needs to be exercised when considering DBT as a standard screening tool to prevent overwhelming screening workloads in high-volume screening programmes.

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## Abstract Archives of the RSNA, 2023

R5A-SPCA

### Cardiac Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPCA- Ultra-High Spatial Resolution of Photon Counting Detector Coronary CT Angiographies 1 Minimize Overestimation Bias Compared to Invasive Reference**

Moritz C. Halfmann, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ultra-high resolution coronary CT angiographies (UHR-CCTA) from Photon counting detector (PCD)-CT have recently been proven feasible in a patient population. However, data comparing it to quantitative coronary angiography as the clinical reference standard for stenosis assessment, is still missing. Therefore, it was the aim of the study to compare stenosis measurements of UHR-CCTA to QCA.

#### **METHODS AND MATERIALS**

For this retrospective study, the institutional database was searched for patients who had undergone UHR-CCTA for the assessment of coronary artery disease (CAD) and had a clinically indicated coronary angiography within 30 days from CCTA. Exclusion criteria were the chronic total occlusion (CTO) of a coronary artery as well as the presence of coronary stents prior to CCTA. This resulted in a total of 39 patients with 83 coronary stenoses. CCTA images were reconstructed with slice thicknesses of 0.6, 0.4 and 0.2 (UHR) mm using the vascular reconstruction kernels Bv44 (0.6/0.4mm) or Bv64 (0.2mm). Stenoses were assessed on all slice thicknesses by two cardiovascular radiologists and on QCA by two cardiologists. Measurements were compared using univariate analysis of variance with post-hoc testing and Bland-Altman plots.

#### **RESULTS**

Mean degrees of coronary stenosis continuously decreased with decreasing slice thicknesses ( $61.3 \pm 13.7\%$  vs.  $53.8 \pm 15.4\%$  vs.  $46.4 \pm 14.8\%$ , all  $p=0.001$ ). Both the 0.6 and the 0.4mm reconstructions showed significant differences between UHR-CCTA and QCA ( $44.1 \pm 15.1\%$ ,  $p<0.001$  and  $p=0.004$  respectively), while the 0.2mm reconstructions did not ( $p=0.428$ ). Bland Altman analysis revealed significant bias between 0.6mm (mean bias 17.6, limits of agreement -14.6 to 48.8) and 0.4mm (9.8, -24.0 to 43.6) reconstructions and QCA, respectively. UHR-CCTA reconstructions did not show a significant bias (2.1, -27.2 to 31.4) but the spread was broader than for QCA.

#### **CONCLUSION**

UHR-CCTA reconstructions minimized overestimation bias of coronary stenosis measurements in comparison to the clinical reference standard of QCA.

#### **CLINICAL RELEVANCE/APPLICATION**

Reduced overestimation bias from UHR-CCTA reconstructions can obviate the need for unnecessary referral for follow-up imaging including invasive coronary angiography.

#### **R5A-SPCA- Virtual Monoenergetic Reconstructions from Photon-Counting Detector CT Influence 3 Coronary Stenosis Quantification: Comparison Between Coronary CT, Coronary and Invasive Coronary Angiography**

Elias Wolf (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the influence of virtual monoenergetic image (VMI) reconstructions on the accuracy of coronary artery stenosis measurements on a clinical dual-source photon-counting detector computed tomography (PCD-CT) system in a dynamic phantom, and in a patient cohort with invasive correlation.

## METHODS AND MATERIALS

A rod phantom with two custom-built vessels (4mm diameter) and two different stenoses grades (50% and 25%) was mounted into an anthropomorphic thorax phantom and heartbeats were simulated with 10 different beats per minute (bpm), between 50 bpm and 80 bpm. In addition, 33 patients (26 (78.8%) male, mean age  $71.3 \pm 9.0$  years) who underwent coronary CT angiography (CCTA) and invasive coronary angiography as part of their clinical work-up for suspected coronary artery disease were retrospectively identified from the clinical database. A total of 9 different VMI levels from 40-140 keV were reconstructed with a slice thickness of 0.4 mm, Qr40 Kernel, and QIR strength level of 3 on a PCD-CT system. Reconstruction parameters for the phantom were matched with those of the clinical patient cohort. Percent diameter stenosis (PDS) measurements were compared to either the manufacturers data sheet (phantom) or quantitative coronary angiography (QCA) measurements (clinical cohort) as a ground truth.

## RESULTS

Variation of VMI reconstructions lead to significantly different stenosis measurements in the phantom and patients (e.g., mean PDS in patients:  $68.3\% \pm 9.6$  at 40 keV vs  $53.0\% \pm 9.7$  at 140 keV,  $p < 0.0001$ ). Across the entire range of artificial heart ranges, the phantom study indicated 100 keV (bias: -0.4%, limit of agreement (LoA): -4.5/3.7) for the 50% and 90 keV (bias: 1.4%, LoA, -1.9/4-8) for the 25% stenosis as an ideal VMI level with the least deviation to the reference stenoses. The tissue quality of the plaque (calcified, mixed, or soft) determined the ideal VMI level in the study group. For the in-vivo comparison to QCA as reference, 100 keV (bias: 17.2%, LoA, -1.2/35.7) for calcified, 140 keV (bias: 5.0%, LoA, -24.5/34.4) for mixed and 40 keV (bias: -0.5%, LoA, -21.5/20.5) for soft plaques led to the best agreements.

## CONCLUSION

VMI reconstructions have the potential to improve the accuracy of coronary CT angiography (CCTA) for the quantification of different stenoses types.

## CLINICAL RELEVANCE/APPLICATION

VMI reconstructions can help overcome current limitations of CCTA due to calcium blooming thereby help reduce bias in stenosis quantification compared to QCA.

## R5A-SPCA- Quantification and Detection of Calcium Using Multimodal Fusion Approach

6

Paddy Raghav, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Calcium detection and quantification from computed tomography (CT) scans of the heart is an important tool for the early diagnosis of coronary artery disease (CAD). However, manual identification of calcium can be time-consuming and subject to inter- and intra-observer variability. The majority of current clinical solutions to identify and quantify coronary artery calcium score are semi automatic and are developed for unenhanced ECG gated Cardiac CT scan. The proposed method uses a multimodal fusion based approach, is automatic and precisely quantifies and classify calcium in different arteries.

## METHODS AND MATERIALS

We developed a multimodal fusion based approach that utilizes both Cardiac CT and Chest CT. The core of it is a in-house developed segmentation model that segments heart and calcium. One major challenge we faced was due to the variability in scan resolution, orientation, and heart size across different patients. To address this, we normalized the scans to fit a scaled coordinate system. To detect calcium deposits, an intensity threshold was applied to filter out the areas of the scan with higher calcium density, followed by connected-components labeling to identify the connected legions of calcium. To classify calcium deposits based on their location within the heart, a likelihood model based on spatial features and location was built. This helped to determine the probability that a given calcium deposit belongs to a specific region of the heart.

## RESULTS

The solution was tested on 200 cardiac patients and 1000 chest patients. The Pearson correlation coefficient between the reference actual and the computed predictive scores on the test set show a high level of correlation (0.84;  $p < 0.001$ ) and high limits of agreement in Bland-Altman plot. The proposed method correctly classifies the risk group in 75.2% of the cases and classifies the subjects in the same group. For the presence/absence of coronary artery calcifications, the deep learning model achieved a sensitivity of 90 % and a specificity of 94 %.

## CONCLUSION

Fully automated deep learning-based calcium quantification on cardiac-CTs shows good correlation compared to reference standards. Automating this process may reduce evaluation time and potentially optimize clinical calcium scoring.

## CLINICAL RELEVANCE/APPLICATION

AI-powered calcium detection has the potential to improve the accuracy, efficiency, and consistency of heart disease diagnosis, ultimately leading to better patient outcomes. By analyzing data from multiple imaging modalities, AI algorithms



can identify patterns and correlations that may be missed by a single imaging modality. This can help clinicians to identify patients at high risk for future cardiovascular events and take preventative measures to reduce that risk.

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## Abstract Archives of the RSNA, 2023

R5A-SPCH

### Chest Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPCH- Positional Effects on Cardiopulmonary Function Measured by 4D-Flow and 3D-cine MRI with Blanket-Like Coil** 1

Ryogo Enoki, RT (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Hemodynamic changes caused by positional changes are known in patients with heart failure or pregnant women, but clinically applicable noninvasive testing methods have not been well established. This study aims to assess the feasibility of assessing cardiac function and collecting normal values for pulmonary blood flow measurements by changing body position.

#### **METHODS AND MATERIALS**

CMR imaging was performed on 10 healthy volunteers who gave consent for imaging using a 3T MRI and a blanket-like coil; 3D cine was performed using the Hyperkat acceleration in the horizontal section, and 4D flow using Hyperkat was performed to measure the flow of the mediastinal region. These images were taken in the supine, right lateral recumbent, and left lateral recumbent positions. A questionnaire was obtained from the participants regarding imaging in different positions. The left and right ventricular volume parameters (end-diastolic volume, end-systolic volume, and ejection fraction) were then calculated from the 3D cine. 4D flow data were used to measure the flow volume(ml/heartbeat) of the Aorta, main pulmonary artery (PA), right PA, left PA, SVC, and IVC, respectively. Differences in each flow volume between body positions were compared.

#### **RESULTS**

Positional changes did not significantly alter right or left ventricular volumetric parameters. Flow volume did not change with position in Aorta (74 ml, 76 ml, 75 ml) and main PA (81 ml, 71 ml, 83 ml). Right PA (36 ml, 42 ml, 27 ml) increased in the right lateral position and significantly decreased in the left lateral position compared with the supine position ( $P=0.09$ ,  $0.02$ , respectively). Left PA (32 ml, 21 ml, 44 ml) significantly decreased in the right lateral position and significantly increased in the left lateral position ( $p=0.02$ ,  $0.01$ , respectively). Blood flow in SVC (21 ml, 24 ml, 19 ml) and IVC (42 ml, 33 ml, 39 ml) was not significantly different by position. The proportion of right/left distribution of pulmonary flow was 0.53 in the supine position, 0.67 in the right recumbent position, and 0.39 in the left recumbent position, showing significant differences between positions ( $p<0.01$ ). The total imaging time for cine and 4D flow was approximately 30 minutes, including positional changes.

#### **CONCLUSION**

4D flow and cine imaging with a blanket-like coil had clinically applicable imaging times. Cardiac function in healthy volunteers did not differ by positioning, but the left or right pulmonary blood flow increased on the gravity side.

#### **CLINICAL RELEVANCE/APPLICATION**

The measurement of hemodynamic changes due to positional differences can be performed noninvasively, enabling the evaluation of pathological conditions such as heart failure patients.

#### **R5A-SPCH- Radiologist and Surgical Agreement in Classification of Chronic Thromboembolic Pulmonary Hypertension (CTEPH)** 2

Lewis D. Hahn, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Determine agreement between radiologists (rads) and surgeons in localizing level of disease in CTEPH and determine factors that affect agreement.

## METHODS AND MATERIALS

6 rads (3 local and 3 external) localized CTEPH level on CTPA on consecutive patients who underwent pulmonary thromboendarterectomy (PTE) surgery at a leading CTEPH surgical center from 1/7/21-10/22/22. Rads graded the level of most proximal disease in the left and right PAs using a locally developed surgical level classification: level 1= disease in main PA; level 2= disease distal to level 1 to segmental ostia; level 3=segmental disease; level 4=subsegmental disease; level 0=no disease. 10 cases were used for training. The time between CTPA and surgery, minimum slice thickness of CTPA, and number of positive CTEPH cases each radiologist read/year was recorded. Excluded patients (number in parenthesis) included those w/o CTPA study (30), time between CTPA and surgery was >180 days (110), slice thickness was >3mm (2), study was not CTPA protocol (4), path diagnosis of PA sarcoma (4), presence of acute PE (4), patients <18 y/o (3). Surgical notes were reviewed to determine surgical level of disease. Weighted kappa and multivariate analysis were performed.

## RESULTS

330 patients had PTE over 22 months. After 157 exclusions +10 training cases, rads reviewed 163 CTPAs. Agreement was substantial ( $\kappa=0.62-0.77$ ) between all rads except for moderate agreement between rads 2 and 4 and rads 4 and 5. Agreement between reader 1 and surgical level was substantial ( $\kappa=0.724$ ) and moderate for readers 2-6 ( $\kappa$  range 0.49-0.58). Agreement was significantly better with less time between CTPA and PTE ( $p=0.006$ ) with <50% agreement when CTPA >118 days old. Agreement between rads and surgery for proximal (level 1+2) disease did not change with slice thickness. There was a significant drop with distal (level 3+4) disease in studies with slice thickness =1mm ( $\kappa$  range 0.06-0.327) vs thickness <1mm ( $\kappa$  range 0.34-0.6) ( $p=0.03$ ). No difference was seen between rads agreement and CTEPH level or laterality. Reader experience was marginally correlated with surgical agreement.

## CONCLUSION

Using this CTEPH surgical classification system, agreement between rads was substantial and was moderate to substantial between rads and surgeons. Slice thickness <1mm must be used to accurately localize segmental and subsegmental disease. Agreement decreased as time between CTPA and surgery increased.

## CLINICAL RELEVANCE/APPLICATION

There is a high level of agreement between rads and surgeons for grading CTEPH. Slice thickness <1mm should be used as experienced surgeons can treat distal disease. Given evolution of disease, patients with studies >4 months old could undergo repeat CTPA prior to PTE to more accurately localize disease for surgeons.

## R5A-SPCH- 3 **Monitoring Changes in Lung Perfusion of Patients with Acute Pulmonary Embolism under Therapy Using Free Breathing Arterial-spin Labeling (ASL-)MRI: Preliminary Results of an Ongoing Study**

Max Munz (*Presenter*) Nothing to Disclose

## PURPOSE

Organ perfusion can be imaged non-invasively with ASL-MRI. The aim of this study was to evaluate changes of lung perfusion in patients with acute pulmonary embolism (PE) under therapy using ASL-MRI.

## METHODS AND MATERIALS

Between 11/2020 and 12/2022, 15 patients (median/min/max 55/24/90 y/o, 9f) with PE before and after treatment initiation (min/max/mean/median 5/243/165/174 days in-between) were examined by ASL-MRI under free breathing in a prospective study. The study was approved by the local ethic committee and all patients gave written informed consent. Initially, patients were treated with heparin (n=9), alteplase and heparin (n=1) or oral anticoagulation (n=5). One patient additionally underwent catheter-directed embolectomy. After the initial therapy patients were treated with Rivaroxaban (n=5), Apixaban (n=8) or low molecular weight heparin (n=2). The examinations were performed on a 1.5T MRI. Pulmonary perfusion was assessed using free-breathing ECG-triggered pseudo-continuous ASL-MRI. The pulmonary trunk was labeled during systole, and images were acquired during diastole of the subsequent cardiac cycle. Additionally, multisection coronal, balanced steady-state-free-precession imaging was carried out. The proportion of perfusion deficit caused by pulmonary embolism was categorized for each lung lobe: I) 0-25 %, II) 26-50 %, III) 51-75 %, IV) >75 %

## RESULTS

Before treatment, perfusion deficits caused by PE were found in all patients in 59 lobes: I) n=5, II) n=10, III) n=17, IV) n=27. At follow-up imaging, perfusion deficits were found in 25 lobes of 8 patients: I) n=7, II) n=8, III) n=6, IV) n=4. Improved lung perfusion was seen in all patients. Perfusion deficits resolved completely in 7/15 patients.

## CONCLUSION

This is the first study using ASL-MRI to evaluate changes of lung perfusion during and after therapy of patients with PE. After therapy, improvements of lung perfusion were seen in all patients. However, in some patients, persistent perfusion deficits could be observed.

## CLINICAL RELEVANCE/APPLICATION

The clinical relevance of these findings needs to be evaluated in future studies. Nonetheless, ASL-MRI might be useful to monitor non-invasively the treatment effects in patients with PE.

### **R5A-SPCH- Assessment of Missed Incidental Pulmonary Embolisms on Chest CT with an AI-algorithm** 4

Vera Inka Josephin Graeve, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Pulmonary embolism (PE) is the third most frequent cause of cardiovascular related death and occurs in 1 of 1000 patients in the European population. In symptomatic patients a CT angiography reveals a detection rate of more than 95%, while the diagnostic performance for occlusions of pulmonary arteries massively decreases in CT scans, performed due to other reasons than suspected PE. A recent study estimates, that radiologists diagnose nearly as much of those incidental pulmonary embolisms (iPE) than they miss. The aim of this study was a retrospective assessment of iPE missed by radiologists on chest CT with an artificial intelligence (AI) algorithm including prevalence, anatomic distribution pattern and daytime of diagnosis of the CT scans.

#### **METHODS AND MATERIALS**

This IRB approved, retrospective single center study included 1965 chest CT scans acquired during venous or arterial contrast, performed due to other reasons than suspected PE, analyzed by an FDA-approved AI algorithm for diagnosing iPE (Aidoc Medical). The appearance of iPEs, their location and the studytime were retrieved from the radiological reports and compared to all positive findings of the AI algorithm, verified by an experienced radiologist, serving as the gold standard. For statistical analysis SPSS was used (Version 28, 2021).

#### **RESULTS**

Of the 1966 cases 63 suspicious iPEs were displayed by the AI of which 42 were true iPEs (Sensitivity 95%, Specificity 99%). Prevalence of iPE was 2,4%, while half of the positive cases were missed by radiologists (PPV: 66%; NPV: 99%). In nearly 76% (16/21) the retrospectively identified missed iPEs were allocated in the right lower lobe, while the non-missed iPEs showed a nonspecific distribution affecting all lung segments. Most of the reports which missed an iPE were generated between 1:00 and 5:00pm (57%).

#### **CONCLUSION**

Nearly 50% of cases with iPE were missed by radiologists, which indicates the need for a robust AI solution. Secondly, this study can pave the way for a better understanding of iPEs with regard to their anatomic distribution pattern and different external influences in order to prevent future misdiagnosis.

## CLINICAL RELEVANCE/APPLICATION

This study illustrates the poor diagnostic performance of radiologists diagnosing iPEs, focussing on their anatomic distribution and additional external influences that may cause misdiagnosis.

### **R5A-SPCH- Effects of Model-based Iterative Reconstruction Algorithm and Contrast Enhancement Boost** 5 **Postprocessing Technique on the Pulmonary CT Angiography: A Evaluation of Image Quality for Obese Patients**

Mei Ye (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate whether model-based iterative reconstruction [forward projected model-based IR solution (FIRST)] algorithm and contrast-enhancement-boost (CE-Boost) technique can improve the image quality in pulmonary CT angiography (CTA) for obese patients.

#### **METHODS AND MATERIALS**

This prospective study was conducted on 100 consecutive patients who underwent pulmonary CTA for suspected pulmonary embolism (PE). Patients whose body mass index (BMI) exceeded 25 (group 1) were performed with conventional hybrid iterative reconstruction [adaptive iterative dose reduction 3D (AIDR 3D)], FIRST, and CE-Boost. Non-obese patients (BMI<25, group 2) was subjected to AIDR 3D, considering as reference standard. CT numbers, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and image noise were quantitatively assessed by pulmonary arteries. Two chest radiologists independently reviewed the CT images (5, best; 1, worst) by four subjective characteristics including noise, visibility of pulmonary artery, overall image quality and diagnostic confidence. The Mann-Whitney U test and Independent Samples t-test were used for statistical analysis.

## RESULTS

Group 1 FIRST images had significantly lower image noise compared with group 2 AIDR 3D images ( $p < 0.05$ ), while group 1 CE-Boost AIDR 3D images were inferior to group 2 AIDR 3D images regarding to image noise. Both CE-Boost images and FIRST images showed higher SNR and CNR than group 2 AIDR 3D images (all  $p < 0.05$ ). When compared with group 2 AIDR 3D, group 1 AIDR 3D exhibits lower subjective scores, whereas group 1 FIRST and CE-Boost had markedly higher scores (all  $p < 0.05$ ). A major increase in diagnostic confidence was observed after the addition of FIRST or CE-Boost (all  $p < 0.05$ ).

## CONCLUSION

The postprocessing technique CE-Boost and FIRST reconstruction algorithm can both improve overall image quality and diagnostic confidence of pulmonary CTA in obese patients.

## CLINICAL RELEVANCE/APPLICATION

High-quality pulmonary CTA image provided by CE-Boost or FIRST enables a better visualization of the main pulmonary artery and its branch vessels. This may enable early diagnosis of PE and reduce exposure dose in obese patients.

## R5A-SPCH- Efficacy of Lung Dynamic CT Perfusion in Patients with Pulmonary Hypertension 6

Takuya Yokota (*Presenter*) Nothing to Disclose

## PURPOSE

We developed lung dynamic CT perfusion (LCTP) that can evaluate absolute lung blood flow. The purpose of this study was to investigate the incremental diagnostic value of LCTP over CT pulmonary angiography (CTPA) for detecting perfusion defect with perfusion scintigraphy.

## METHODS AND MATERIALS

This retrospective single-center study included 23 patients (mean age, 61 years  $\pm$  16 [SD]; 15 women) who were suspected of pulmonary hypertension underwent LCTP and perfusion scintigraphy from January 2021 to March 2023. LCTP data was obtained by electrocardiogram-gated axial scan targeted at systolic phase using a 320-row CT. The acquisition was performed separately in the upper and the lower lung fields, and these data were combined for analysis. Deconvolution method was used to calculate the blood flow of the lungs using a workstation. The phase in which the pulmonary artery was most contrasted during LCTP scan was selected to reconstruct CTPA. Six regions of interest were placed in each lobe to calculate quantitative perfusion ratio. Diagnostic performance of CTPA and CTPA plus quantitative perfusion ratio was compared to detect perfusion defect with perfusion scintigraphy. The analysis was performed for each lobe (right upper, right middle, right lower, left upper, left lingula, and left lower lobe).

## RESULTS

Of the 138 lobes, 86 lobes (62%) showed perfusion defects on scintigraphy. Adding LCTP to CTPA increased sensitivity from 29.1% (95% CI: 20, 40%) to 95.3% (95% CI: 89, 99%;  $p < 0.001$ ) and accuracy from 54.3% (95% CI: 46, 63%) to 92.7% (95% CI: 87, 96%;  $p < 0.001$ ) while maintaining specificity (96.2% [95% CI: 87, 100%] vs. 88% [95% CI: 77, 96%];  $p = 0.13$ ). The area under the receiver operating characteristics curve increased from 0.63 (95% CI: 0.57, 0.68) to 0.96 (95% CI: 0.94, 0.99;  $p < 0.001$ ) when LCTP was included. The mean radiation dose and contrast medium amount was 5.1 mSv  $\pm$  1.3 and 78 ml  $\pm$  15, respectively.

## CONCLUSION

Adding LCTP to CTPA improves the diagnostic performance to detect perfusion defect in perfusion scintigraphy by increasing sensitivity.

## CLINICAL RELEVANCE/APPLICATION

Quantitative evaluation of pulmonary blood flow using dynamic lung CT perfusion enables accurate diagnosis compared to CT pulmonary angiography alone with acceptable radiation and contrast medium dose.

## R5A-SPCH- The Effects of Age on Lung Structure Parameters in Healthy People by Low-dose Computed 7 Tomography

Anqi Liu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This article mainly focuses on the associations of lung structure parameters in healthy people with age. We quantified these changes by indicators derived from LDCT such as lung volumes, pulmonary vascular volumes and fractal dimensions, artery diameters, etc.

## **METHODS AND MATERIALS**

1500 participants aged 20-69 years (mean age, 45±14 years; 51.4% men) with normal chest imaging manifestations were included in this study. The MPAd (main pulmonary artery diameter) at the bifurcation of the pulmonary artery and the AAd (ascending aorta diameter) at the same level in cross section were measured. We calculated the ratio PA by dividing MPAd by AAd. The lung volumes and pulmonary vascular volumes (small, middle, large vessels/arteries/veins) were computed by 3-dimensional(3D) reconstructions using LDCT images of the study population, and vessel fractal dimensions, normalized lung volumes (divided by body surface area) and normalized pulmonary vascular volumes (divided by total lung volume) were calculated.

## **RESULTS**

We chose the young group (20-44-year-old group) as a reference, the MPAd of middle-aged group (45-59-year-old group,  $\beta=1.040$ ,  $p<0.001$ ) and old group (60-69-year-old group,  $\beta=1.778$ ,  $p<0.001$ ) increased compared to the young group after being adjusted for bias, so did AAd. Increasing total and right lung volumes were associated with age-based groups, the same phenomenon was observed when normalized by BSA, but the left lung volume ( $\beta=0.036$ ,  $p=0.215$ ) and normalized left lung volume ( $\beta=0.010$ ,  $p=0.546$ ) did not show statistically significant increase between the old and young groups. We found statistical differences ( $P<0.05$ ) of vascular volumes between the 3 age-based groups, but there was no association of vascular volumes in the 3 groups after adjustment. The normalized pulmonary vascular volumes except normalized pulmonary large artery and venous volumes presented lower levels comparing the middle-aged and old groups with young group. Vessel fractal dimensions have no associations with age. The 90th percentile cutoff values of MPAd were 27.63, 28.80 and 29.60mm, AAd were 32.28, 37.11 and 40.06mm, ratio PA were 0.97, 0.90, 0.86 for young group, middle-aged group and old group respectively.

## **CONCLUSION**

MPAd, AAd, total and right lung volumes increased when compared the old and middle-aged people to young people, while the normalized pulmonary vascular volumes except normalized pulmonary large artery and venous volumes presented lower levels comparing the old and middle-aged people with young people.

## **CLINICAL RELEVANCE/APPLICATION**

Changes in LDCT-related lung structure parameters with age may provide normal reference values for healthy people in different age stage, which can also be potential markers of lung aging.

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## Abstract Archives of the RSNA, 2023

R5A-SPER

### Emergency Radiology Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPER- Necessity of Whole Body CT in Trauma Patients After Vehicle Accidents - Predictive Parameters for a Negative CT Examination** 1

Daniel Ginzburg (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To rule out serious findings in trauma patients, immediate CT imaging poses a major aspect in the Advanced Trauma Life Support scheme. In order to assess the necessity for whole body CT in patients after a vehicle accident a detailed analysis of this patient group is required. We aimed to identify patients after vehicle accidents that do not benefit from CT imaging in regard to the chest and abdomen.

#### **METHODS AND MATERIALS**

In this retrospective study, all patients that received a trauma CT in our emergency department after vehicle accidents between 03/2017 and 08/2019 were evaluated regarding trauma mechanisms as well as initial clinical assessment including the extended Focused assessment with sonography for Trauma (eFAST). Inclusion criteria were: vehicle accident, CT scan of the chest and abdomen and GCS = 13.

#### **RESULTS**

348/2525 patients (13.8 %) met the inclusion criteria. 151/348 patients (43.4 %) had an unremarkable physical examination according the ATLS scheme and a negative eFAST exam. 90/151 patients (59.6 %) had no injuries on CT, while the remaining 61 patients (40.4%) had only minor to moderate trunk injuries (Abbreviated injury scale - AIS < 3) not necessarily requiring CT evaluation (e.g. non-dislocated rib or sternal fractures). None of these patients required surgery, and apart from adjusted pain treatment, no changes were made to the therapeutic regimen based on the CT results. Of 197/348 (56.6%) patients with abnormal findings on physical examination and/or eFAST, 75 (38.1%) had severe trunk injuries (AIS = 3) requiring immediate clinical intervention on subsequent CT; 103 patients (52.3%) had mild/medium injuries (AIS < 3) and 19 patients (9.6%) had no trauma-related injuries.

#### **CONCLUSION**

While CT examinations remain an essential diagnostic pillar for the assessment of severely injured trauma patients, the indication for performing such examinations in patients with a GCS  $\geq$  13 without abnormalities on physical examination or eFAST could be approached in a more individualized way. These patients rarely benefit from a trauma CT scan in terms of adjusting their treatment regimen.

#### **CLINICAL RELEVANCE/APPLICATION**

With vehicle accidents being one of the most frequent causes of death especially in younger patients below the age of 45 the correct diagnostics and treatment of this patient group is of major clinical significance.

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## Abstract Archives of the RSNA, 2023

R5A-SPGI

### Gastrointestinal Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPGI-1 Pancreatic Volume Changes in Patients with Immunotherapy-induced Acute Pancreatitis and Diabetes Mellitus Type 3c**

Hiroaki Takahashi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Immune check-point inhibitors (ICI) therapy causes immune-related pancreatic injury (irPI) resulting in acute pancreatitis (AP) or glandular dysfunction including insulin-requiring diabetes mellitus type 3c (DM-3c). We investigated the chronological pancreatic volume changes in patients with ICI-associated AP and DM-3c.

#### **METHODS AND MATERIALS**

Patients treated with ICI therapy (pembrolizumab, ipilimumab or nivolumab) who developed ICI-associated AP or DM-3c from 2015 to 2019 at 3 centers in our network were included. CT or PET/CT examinations in each of following periods were reviewed: (1) Pre-treatment scans (prior to ICI administration), (2) pre-diagnostic scans (after ICI administration and prior to irPI diagnosis), (3) early post-diagnostic scans (0-90 days after irPI diagnosis), (4) midterm post-diagnostic scans (91-360 days after irPI diagnosis), and (5) late post-diagnostic scans (>360 days after irPI diagnosis). Each exam was anonymized and segmented by an experienced abdominal radiologist. The mean pancreatic volume was used as the representative value if multiple examinations were performed in each period. Normalized pancreatic volume (NPV) is calculated by the ratio of pancreatic volume in each period to that in the pre-diagnostic scan. Mann-Whitney U test was used to compute NPV statistical differences with  $P < 0.05$  considered statically significant.

#### **RESULTS**

Among 30 enrolled patients (12 males, 18 females, mean age: 63 [37-90] year-old), 21 patients developed AP and 9 patients developed DM-3c. No patient had concurrent AP and DM-3c diagnosis. The median duration from ICI administration to irPI diagnosis was 131 days (12-715 days) in patients with AP and 146 days (28-685 days) in patients with DM-3c. NPV (pre-treatment; pre-diagnostic; early post-diagnostic; midterm post-diagnostic; late post-diagnostic) was 1.05 (n=14, p=0.53); 1 (n = 21); 1.22 (n=19, p=0.41); 0.71 (n=12, p=0.04); 0.53 (n=5, p=0.14) in patients with AP and 0.80 (n=7, p=0.20); 1 (n=9); 0.71 (n=8, p=0.01); 0.62 (n=8, p < 0.001); 0.73 (n=5, p=0.01) in patients with DM-3c.

#### **CONCLUSION**

The pancreas shows increase in volume after ICI administration in patients with AP and DM-3c, but at different timing. Increase is seen prior to DM-3c diagnosis, and within 0-90 days after AP diagnosis. Pancreas volume decreases in 91- days after the diagnosis of DM-3c or AP and persists after 1 year. The degree of pancreatic atrophy is more severe in AP than DM-3c.

#### **CLINICAL RELEVANCE/APPLICATION**

CT pancreatic volumetry is a useful tool to assess irPI. Pancreatic volume loss could suggest previous irPI events. Pancreatic volume increase could suggest the future risk of ICI-associated DM-3c and recent AP events.

#### **R5A-SPGI-2 Time Dependency and Risk Factors of Splanchnic Vein Thrombosis Development in the Early Phase of Acute Pancreatitis: A Systematic Review and Meta-analysis**

Ruben Z. Borbely, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Splanchnic vein thrombosis (SVT) is a local complication of acute pancreatitis (AP) that may lead to subsequent complications such as portal hypertension, gastrointestinal bleeding, and mesenteric ischemia. Our aim was to analyze the temporal



progression and contributing risk factors of SVT occurrence during the early phase of AP.

## **METHODS AND MATERIALS**

We conducted a systematic search in four medical databases (Embase, MEDLINE via PubMed, Scopus, and CENTRAL) on October 27, 2022. Inclusion criteria were studies using appropriate radiological modalities to identify SVT in adult patients with AP, present data on early phase AP, and offer accurate information on the imaging timing. Exclusion criteria were studies with patients having malignant disease or recent surgical history. We used a random effects model, we calculated SVT-affected patient proportions, with 95% confidence intervals (CI), and conducted subgroup analyses. The study protocol was prospectively registered in the PROSPERO database.

## **RESULTS**

Our analysis included 14 studies encompassing 1,951 patients. We found that the proportion of patients who developed SVT during the early phase of AP (within 12 days post-symptom onset) was 0.13 (CI 0.08-0.22). SVT incidence was lowest at 0.05 (CI 0.02-0.15) within 0-3 days, increasing almost five-fold to 0.23 (CI 0.1-0.46) between 3-11 days. Factors influencing SVT occurrence included etiology (alcoholic 0.31 (CI 0.13-0.58), biliary 0.12 (CI 0.04-0.3),  $p=0.03$ ), and pancreatic necrosis (absent 0.09 (CI 0.06-0.15), under 50% 0.29 (CI 0.22-0.37), over 50% 0.46 (CI 0.36-0.56),  $p=0.01$ ). The proportions of distinct venous combinations affected by thrombosis included splenic vein (SV) 0.48 (CI 0.35-0.61), portal vein (PV) 0.28 (CI 0.18-0.42), superior mesenteric vein (SMV) 0.14 (CI 0.08-0.25), SV and PV 0.09 (CI 0.05-0.19), SV and SMV 0.06 (CI 0.02-0.14), PV and SMV 0.13 (CI 0.06-0.27), all three veins 0.1 (CI 0.05-0.19),  $p=0.01$ .

## **CONCLUSION**

One in six patients develops SVT in the early phase of AP. Alcoholic etiology and pancreatic necrosis increase the risk of SVT. In addition, this risk seems to increase with the duration of AP. The affected veins, in descending order, are the SV, PV, SMV, and combinations thereof.

## **CLINICAL RELEVANCE/APPLICATION**

Imaging should target high-risk patients and take into account the time-dependent nature of SVT incidence. Furthermore, when reporting, radiologists should have an increased suspicion of SVT if they observe pancreatic necrosis.

## **R5A-SPGI-4 Preoperative Assessment of Peripheral Vascular Invasion of Pancreatic Ductal Adenocarcinoma Based on High-resolution MRI**

Xiaoqi Zhou (*Presenter*) Nothing to Disclose

## **PURPOSE**

Preoperative imaging determination of vascular invasion is important for surgical resectability of pancreatic ductal adenocarcinoma (PDAC). The purpose of this study is to compare diagnostic accuracy of PDAC vascular invasion between high-resolution MRI (HR-MRI), conventional MRI (non-HR-MRI) and CT, and clarify the applicable diagnostic criteria for MRI and CT.

## **METHODS AND MATERIALS**

Pathologically proved PDAC with preoperative HR-MRI (79 cases, 58 with CT) and non-HR-MRI (77 cases, 59 with CT) from 2014 to 2022 were retrospectively collected. Vascular invasion was confirmed by surgical exploration and pathology. The degree of tumor-vascular contact, vessel narrowing and contour irregularity were reviewed respectively. Diagnostic criteria 1 (C1) is the presence of all three characteristics, and criteria 2 (C2) if any one of them is present. The diagnosis efficacy of different examination methods and different criteria was evaluated and compared.

## **RESULTS**

HR-MRI showed satisfying performance in assessing vascular invasion (AUC: 0.87-0.92), especially better sensitivity (0.79-0.86 vs 0.40-0.79) compared with non-HR-MRI and CT. HR-MRI was superior to non-HR-MRI, but evenly matched to C2 assessed CT. C2 was superior to C1 in CT evaluation (0.85 vs 0.79,  $P=0.03$ ). C1 was superior to C2 in venous assessment by HR-MRI (0.90 vs 0.87,  $P=0.04$ ) and arterial assessment by non-HR-MRI (0.69 vs 0.68,  $P=0.04$ ). Combining C1 assessed HR-MRI and C2 assessed CT yielded the best performance, significantly better than CT alone (0.96 vs 0.86,  $P=0.04$ ).

## **CONCLUSION**

HR-MRI can provide more accurate assessment of PDAC vascular invasion than conventional MRI. C1 may be more applicable to MRI assessment, while C2 may be more applicable to CT. The combination of HR-MRI and CT outperformed CT alone and should be the recommended preoperative examination option.

## **CLINICAL RELEVANCE/APPLICATION**

HR-MRI provides vital information for the assessment of PDAC vascular invasion and may contribute to the operative decision making. Combined C1 assessed HR-MRI and C2 assessed CT showed the best efficacy and is the preferred preoperative examination option for PDAC.



## **R5A-SPGI-5 Multivariate Quantitative Ultrasound Approach for the Assessment of Hepatic Steatosis in Chronic Liver Disease**

Hidekatsu Kuroda (*Presenter*) Nothing to Disclose

### **PURPOSE**

There is a need for a non-invasive, widely available, and highly accurate tool for assessing hepatic steatosis considering the global increase in the incidence of non-alcoholic fatty liver disease. This study focused on the acoustic properties of the integrated backscatter coefficient (IBSC) and signal-to-noise ratio (SNR) in addition to the ultrasound-guided attenuation parameter (UGAP). We attempted to construct a highly accurate model for the prediction of  $\geq 5\%$  steatosis in chronic liver disease (CLD) using a multivariate quantitative ultrasound approach.

### **METHODS AND MATERIALS**

This prospective multicenter study enrolled 582 patients with CLD between February 2020 and April 2021, who were grouped into steatosis (n=364) and non-steatosis (n=218) groups using magnetic resonance imaging proton density fat fraction (MRI-PDFF) values as a reference. Four models were created to compute the prediction equation for steatosis: Model 1 (UGAP alone), Model 2 (UGAP + IBSC), Model 3 (UGAP + SNR), and Model 4 (UGAP + IBSC + SNR). Receiver operating characteristic (ROC) analysis, category-free net reclassification improvement (cf-NRI), and integrated discrimination improvement (IDI) were used to examine the optimal model.

### **RESULTS**

The areas under the ROC curve for steatosis diagnosis in Models 1, 2, 3, and 4 were 0.923, 0.931, 0.953, and 0.959, respectively. Internal validation using the bootstrap method yielded a C-index of 0.923, 0.930, 0.952, and 0.958, respectively; Models 3 and 4 demonstrated statistically significant discriminative power over the other models ( $p < .001$ ) (95% confidence interval: 0.431-0.753,  $p < .001$ ). The cf-NRI and IDI were 0.592 (95% confidence interval: 0.431-0.753,  $p < .001$ ) and 0.019 (95% confidence interval: 0.005-0.031,  $p < .01$ ), indicating higher discriminative performance of Model 4 compared to Model 3.

### **CONCLUSION**

The multivariate quantitative ultrasound approach focused on the acoustic properties of UGAP, IBSC, and SNR is a promising method for assessing  $\geq 5\%$  steatosis in CLD.

### **CLINICAL RELEVANCE/APPLICATION**

We developed a predictive formula using multiple quantitative ultrasound parameters to diagnose  $\geq 5\%$  steatosis in CLD with high discrimination and calibration power. The three quantitative ultrasound parameters, namely ultrasound-guided attenuation parameter, integrated backscatter coefficient, and signal-to-noise ratio, strongly correlated with steatosis in CLD. The procedure also demonstrated the potential to diagnose and quantify hepatic steatosis, with an AUROC of 0.959 (95% confidence interval: 0.944, 0.973) using the multiple quantitative ultrasound model.

## **R5A-SPGI-6 Diagnostic Accuracy of Computed Tomography (CT) for Detection of Hepatic Steatosis: A Systematic Review and Meta-analysis**

Maryam Haghshomar, MD, MA (*Presenter*) Nothing to Disclose

### **PURPOSE**

CT is a widely accessible imaging method and has an important role for opportunistic diagnosis of fatty liver. Its accuracy and performance however have been inconsistent in various studies and no clear criteria have been established by the societies. Our objective is to conduct a comprehensive review and meta-analysis to assess the diagnostic accuracy of CT in detection of steatosis.

### **METHODS AND MATERIALS**

We searched through PUBMED, Embase, and Scopus databases between September 1977 to March 2023. We included studies evaluating diagnostic accuracy, such as sensitivity or specificity, cross-tabulations, or correlations of noncontrast CT (NCCT), contrast-enhanced (CECT), and dual-energy CT (DECT) in detecting fatty liver using either biopsy, proton-density fat fraction, or standard imaging as the reference standard.

### **RESULTS**

Thirty-six (4432 participants) studies were included. CT is a reliable method for detecting mild and moderate/severe fatty liver, with sensitivity/specificity of 80.2%/90% for NCCT, 82.3%/96.1%, for CECT, and 83.2%/90% for DECT. Additionally, the area under the curve of diagnostic accuracy for NCCT, CECT, and DECT were 0.891, 0.901, and 0.917, respectively. Stratifying by multiple clinically relevant characteristics did not eliminate the statistical heterogeneity. The heterogeneity was most prominent for DECT and CECT. The threshold range for diagnosing fatty liver was a liver attenuation  $< 38.5$ -58 HU, a liver minus spleen attenuation of  $< -19$  to  $-10.1$  HU, and a liver-to-spleen attenuation ratio  $< 0.89$  to 1.2.

## CONCLUSION

NCCT, CECT, and DECT are reliable methods for screening fatty liver in clinical settings. They can detect mild/moderate to severe fatty liver with high reliability and accuracy. It is important to remain cautious when interpreting these findings as there was significant heterogeneity observed, particularly for DECT and CECT.

## CLINICAL RELEVANCE/APPLICATION

CT is a major modality for opportunistic detection of hepatic steatosis. Results of this meta-analysis explore the performance of CT for this task and discuss the threshold values for diagnosis of steatosis.

## R5A-SPGI-7 The Application Value of FLIS Combined with T2\* Mapping in Preoperative Liver Function Assessment of sHCC

Shao Peng Li II, DO (*Presenter*) Nothing to Disclose

### PURPOSE

Using the 15 minutes indocyanine green retention rate (ICG R-15) as the reference standard, the diagnostic value of FLIS combined with T2\* mapping for preoperative assessment of liver reserve function in sHCC were compared with T1 mapping.

### METHODS AND MATERIALS

A retrospective analysis was conducted on 60 patients with sHCC who had preoperative imaging findings from July 2020 to March 2023. All patients underwent Gd-EOB-DTPA-enhanced MRI, including pre-injection (T1-pre) mapping, post-injection (T1-post) 20 min mapping, and T2\* mapping. The ROIs were selected at the same location and measurements were taken to calculate R2\* values, pre-injection (T1-pre), post-injection (T1-20 min) T1 relaxation times and calculated the T1 relaxation time reduction rate (T1-pre - T1-20 min / T1-pre). Three features of the hepatobiliary phase were assessed: normal liver parenchyma, biliary system and portal vein signal intensity, and FLIS was calculated. All patients underwent a ICG retention test and were divided into three groups (29 patients in group 1 <10%, 19 patients in group 2 10%-20% and 12 patients in group 3 =20%). The differences between the normal liver R2\* values, FLIS and T1 relaxation time reduction rates between the three groups were statistically analysed.

### RESULTS

The reduction rates of T1 relaxation time, R2\* values, FLIS between the 3 groups were (76.56±1.00)%, (62.12± (1.25)%, (53.19±2.25)% vs (39.75±2.57) Hz, (45.39±1.83) Hz, (55.41±2.34) Hz vs (4.90±0.90), (3.68±0.82) (1.58±0.79), the differences were statistically significant (P<0.01), R2\* values were negatively correlated with liver function grade, FLIS and T1 relaxation time reduction rate were positively correlated with liver function grade, Spearman's correlation coefficient Rs were -0.921, 0.821, 0.981. The area under the R2\* value, FLIS and T1 relaxation time reduction rate ROC were 0.883, 0.825 and 0.914 between group 1 and 2, and 0.867, 0.8 and 0.869 between groups 2 and 3. The T1 relaxation time reduction rate was the most efficient diagnostic between the 3 groups, followed by R2\* value and FLIS respectively, and the combined diagnostic efficacy of the two increased (0.945, 0.935).

## CONCLUSION

The FLIS and T2\* mapping can accurately assess the liver reserve function of patients with sHCC preoperatively, and their combined diagnostic efficacy is higher than the T1 relaxation time reduction rate.

## CLINICAL RELEVANCE/APPLICATION

The combined diagnostic efficacy of FLIS and T2\* mapping is higher than the T1 relaxation time reduction rate. And it can shorten scanning time.

## R5A-SPGI-8 Quantitative liver function analysis using T1 mapping on gadoxetic acid-enhanced MR imaging; the application of Dixon-based fat correction in look-locker inversion recovery sequence

Ye Rin Hwang, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To investigate the role of T1 map-derived quantitative imaging parameters for the assessment of liver function, and the impact of fat correction of T1 mapping on gadoxetic acid-enhanced MR imaging

### METHODS AND MATERIALS

A total of 228 patients with normal liver, chronic liver disease and liver cirrhosis who underwent 3T gadoxetic acid-enhanced MR including Dixon-based fat corrected look-locker inversion recovery (LLIR) sequence were included. Two readers measured pre- and postcontrast T1 relaxation times (preT1 and postT1) on conventional and water map T1 in two sessions with 2-week interval. The averaged preT1, postT1 values, changes between pre- and postcontrast T1 liver ( $\Delta T1$ ), and adjusted postcontrast T1 liver (postcontrast T1 liver - T1 spleen / T1 spleen) for both conventional T1 and water map T1, were analyzed for

assessment of clinical indices of liver function and hepatic enhancement grade on hepatobiliary phase (HBP). Liver fat fraction (FF) was calculated on MR-based proton density fat fraction (PDFF) map and correlation of T1 map-derived parameters with fat fraction were assessed. With the FF cut-off 6.4%, T1 map-derived parameters were compared between fatty liver and non-fatty liver groups. Multivariate linear regression (MLR) analyses were performed to determine significant variables for T1 value. Reproducibility of T1 values were also assessed.

## **RESULTS**

The inter-reader and intra-reader reproducibility showed near-perfect agreement (ICC 0.929-0.999). 68 subjects were included in fatty liver (FL) group (29.8%, 68/228; mean FF for FL group 10.77 %  $\pm$  4.92 vs. non-fatty liver (NFL) group 2.75 %  $\pm$  1.33). The water map preT1 was lower than preT1 in FL group, and showed significant difference between FL group and NFL group (669.4  $\pm$  274.21 vs. 760.67  $\pm$  207.05,  $p = 0.015$ ). The correlation of preT1 ( $r = 0.232$ ,  $p = 0.0005$ ) and delta T1 ( $r = 0.263$ ,  $p = 0.0001$ ) with FF were significant, however water map preT1 ( $r = -0.109$ ,  $p = 0.106$ ) and water map delta T1 ( $r = 0.039$ ,  $p = 0.569$ ) showed no correlation with FF. With MLR analysis, albumin, total bilirubin, HBP enhancement grade, FF and R<sup>2</sup>\* value were significantly associated with T1 map-derived parameters (preT1, postT1, delta T1, and adjusted postT1). For the same T1 map-derived parameters measured on water map, the effect of FF was eliminated while HBP enhancement grade, albumin, and R<sup>2</sup>\* value were persistently significant factors.

## **CONCLUSION**

T1 mapping on water map using Dixon-based fat corrected LLIR sequence can estimate liver function effectively free from the influence of hepatic steatosis.

## **CLINICAL RELEVANCE/APPLICATION**

With the fat corrected water map T1, T1 mapping of liver can be a useful and noninvasive imaging biomarker for the assessment of liver function regardless of hepatic steatosis.

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## Abstract Archives of the RSNA, 2023

R5A-SPGU

### Genitourinary Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPGU- Comparing the Diagnostic Performance of Biparametric with Multiparametric MRI using PI-RADS version 2.1 for Clinically Significant Prostate Cancer**

Danping Zhuang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the diagnostic performance of multiparametric MRI (mpMRI) with biparametric MRI (bpMRI) for clinically significant prostate cancer (csPCa) based on the Prostate Imaging Reporting and Data System (PI-RADS) version 2.1.

#### **METHODS AND MATERIALS**

1939 patients underwent prostate MRI from January 2019 to December 2021. This study finally enrolled 597 patients with 616 lesions who underwent mp-MRI (T2WI, DWI and DCE) before MRI/transrectal ultrasound fusion-targeted biopsy. All lesions were classified as 249 lesions in peripheral zone (PZ) with 81 csPCa and 367 lesions in transition zone (TZ) with 67 csPCa. We scored the lesions on the image according to the site of targeted biopsy using the PI-RADS v2.1 standard with blinding to PSA value and pathology results. There were four weeks in between reading sessions for bpMRI and mpMRI. On bpMRI, the overall category of lesions in PZ was determined solely based on the DWI category. The overall category of lesion in TZ was the same between bpMRI and mpMRI. A Student's t-test and a Mann-Whitney U test were employed to compare continuous variables. When using a cutoff of PI-RADS category =4, the ROC curves for bpMRI and mpMRI in the diagnosis of csPCa were drawn to calculate AUC values.

#### **RESULTS**

Patients with csPCa had higher PSA levels and PSAD values, but lower prostate volumes, and being older, compared to those with non-csPCa ( $P < 0.001$ ). The AUCs of bpMRI and mpMRI in PZ for the diagnosis of csPCa were 0.901 and 0.891, respectively ( $P > 0.05$ ). However, mpMRI had higher sensitivity (93.8%) but lower specificity (76.2%) compared to bpMRI (sensitivity: 74.1%; specificity: 89.9%). The same trend was observed in PZ+TZ lesions. In PZ, significantly fewer lesions were assigned to category 3 in mpMRI than in bpMRI due to some lesions with category 3 in bpMRI were up-scored to category 4 in mpMRI. For PZ, if biopsy had been performed in patients with PI-RADS categories 4 and 5, mpMRI detected 39 additional patients who needed biopsy compared to bpMRI and identified 16 cases of csPCa.

#### **CONCLUSION**

Both bpMRI and mpMRI using PI-RADS v2.1 exhibited similar diagnostic performance in diagnosing csPCa, yet mpMRI might decrease the probability of missing csPCa cases.

#### **CLINICAL RELEVANCE/APPLICATION**

Compared to mpMRI, bpMRI offers several advantages including contrast-free imaging, shorter scanning time, and lower costs. However, the application value of bpMRI in diverse clinical scenarios needs to be further researched. Our study demonstrated that mpMRI had the advantage of reducing the probability of missing csPCa cases.

#### **R5A-SPGU- Combined Real-time Elastography and Contrast-enhanced Ultrasound for the Detection of Clinically Significant Prostate Cancer**

Yunkai Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic performance of combined real-time elastography (RTE) and contrast enhanced ultrasound (CEUS) for the detection of clinically significant prostate cancer (csPCa).

## **METHODS AND MATERIALS**

This prospective study was approved by the local ethics committee. Between November 2019 and December 2022, 286 patients scheduled for prostate biopsy underwent RTE and CEUS evaluation before biopsy procedure. Men with suspicious lesions on RTE (defined as reproducible stiffness lesion) or CEUS (defined as increased focal contrast enhancement) underwent targeted biopsy (TB) in conjunction with systematic biopsy (SB). Men with negative RTE and CEUS underwent SB alone. The primary outcome was the detection of csPCa (Grade Group = 2) in correlation with the biopsy results.

## **RESULTS**

Among the 286 patients (median age, 67 years) enrolled in this study, mpUS identified suspicious lesion(s) in 204 patients. The biopsy histopathology confirmed the diagnosis of prostate cancer in 146 patients, including 110 patients with csPCa. The csPCa detection rate was 28% (80/286) for CEUS-TB, 26% (74/286) for RTE-TB and 25% (72/286) for SB (P = 0.73). The combination of CEUS-TB and RTE-TB could achieve a csPCa detection rate of 34% (101/286), significant higher than that of SB (P=0.02)

## **CONCLUSION**

Combined CEUS-TB and RTE-TB could achieved significantly higher csPCa detection rate than SB alone.

## **CLINICAL RELEVANCE/APPLICATION**

Combined CEUS-TB and RTE-TB could improve csPCa detection than either individual US and SB alone.  
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## Abstract Archives of the RSNA, 2023

R5A-SPHN

### Head & Neck Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPHN- The Added Values of Dynamic Contrast-enhanced Ultrasound in Diagnosis of Small Thyroid Nodules ( $\leq 10\text{mm}$ )<sup>1</sup>**

Yun-Lin Huang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the potential added values of dynamic contrast-enhanced ultrasound (DCE-US) for the diagnosis of small solid thyroid nodules.

#### **METHODS AND MATERIALS**

This bi-center prospective study was approved by the institutional review board and it was performed between January 2020 and October 2020. B-mode ultrasound and contrast-enhanced ultrasound (CEUS) images were obtained for solid thyroid nodules ( $= 1.0\text{ cm}$ ) confirmed by pathological results. The CEUS time-intensity curves (TICs) of thyroid nodules and surrounding parenchyma were created by VueBox® software (Bracco, Italy). The quantitative parameters of CEUS were analyzed after curve fitting. The weighted kappa statistic (?) was performed to assess the interobserver agreement and consistency between the diagnosis of CEUS and DCE-US. The diagnostic performance of CEUS and DCE-US was evaluated and compared.

#### **RESULTS**

Totally, 79 thyroid nodules in 79 consecutive patients (55 women; median age: 41 years) were enrolled; 70.9 % (56/79) were malignant and 29.1 % (23/79) were benign nodules. Hypoenhancement during the arterial phase of CEUS was associated with malignant nodules ( $P < 0.001$ ), with an AUC of 0.705, sensitivity of 71.4 %, and specificity of 69.6 %. The peak enhancement (PE), wash-in rate (WiR), and wash-out rate (WoR) of quantitative parameters of DCE-US in malignancies were significantly lower than those in benign nodules ( $P < 0.05$ ). For detecting malignant small solid thyroid nodules ( $= 1.0\text{ cm}$ ), the AUCs of PE, WiR, and WoR were 0.642 (sensitivity 65.2 %, specificity 67.9 %), 0.643 (sensitivity 43.5 %, specificity 91.1 %), and 0.667 (sensitivity 69.6 %, specificity 69.6 %), respectively. Comparing the quantitative parameters between small solid thyroid nodules and surrounding normal thyroid parenchyma, the PE, wash-in area under the curve, WiR, wash-in perfusion index, wash-out AUC, wash-in and wash-out AUC, and WoR of the nodules were significantly lower than those of normal thyroid tissue ( $P < 0.05$ ). A total of 20.3 % (16/79) nodules showed iso-enhancement during the arterial phase of CEUS, and the median PE ratio of surrounding tissue and thyroid nodules was 1.70 (IQR 1.33 - 1.89).

#### **CONCLUSION**

DCE-US using VueBox® perfusion analysis could provide added values for differential diagnosis of small solid thyroid nodules. VueBox® is a helpful tool for the evaluation of dynamic microvascularization of lesions.

#### **CLINICAL RELEVANCE/APPLICATION**

This bi-center prospective study highlights the practicality of DCE-US using VueBox® perfusion analysis for the evaluation of dynamic microvascularization of thyroid nodules and differential diagnosis of small solid thyroid nodules.

#### **R5A-SPHN- The Value of Deep Learning Reconstruction Algorithms Combined with Organ Dose Modulation Techniques to Improve Thyroid CT Scan Image Quality and Reduce Radiation Dose<sup>2</sup>**

Ren-feng LV (*Presenter*) Nothing to Disclose

## PURPOSE

Study the deep learning reconstruction (DLIR) algorithm combined with organ dose modulation (ODM) technology to improve the quality of thyroid CT scan images and reduce the radiation dose value.

## METHODS AND MATERIALS

Using APEX CT, 36 patients with thyroid examination in our hospital were scanned and divided into non-ODM (N-ODM) and ODM groups according to whether the ODM technique was used or not, with 18 cases in each group. According to the different reconstruction algorithms, the two groups respectively reconstructed 2.5 mm images using adaptive statistical iterative reconstruction (ASIR-V, 30%) and deep learning reconstruction (DLIR). Scan start position is 14 cm below the plane of the thyroid cartilage, the ODM area contains a fixed length of 5 cm of the thyroid. At the level of maximum thyroid display in the transectional position, the CT values and noise (SD) of the thyroid and muscle in the same layer were recorded, the contrast noise ratio (CNR) and radiation dose (ED) were calculated, the image quality was evaluated subjectively by two imaging physicians using a 5-point scale.

## RESULTS

There was no statistical difference in CT values of thyroid and muscle tissue in the four groups ( $P > 0.05$ ). The SD, CNR and image quality subjective scores of the N-ODM-DLIR and ODM-DLIR groups were better than the N-ODM-ASIR and ODM-ASIR groups (all  $P < 0.05$ ), the overall image noise of DLIR group is significantly better than that of ASIR group, which can provide a clear image of the neck hierarchy. The radiation dose reduction was about 23% in the ODM group compared to the N-ODM group ( $2.20 \pm 0.07$  vs.  $2.89 \pm 0.04$ ,  $t = 35.04$ ,  $P < 0.05$ ).

## CONCLUSION

In thyroid CT scans, using the DLIR reconstruction algorithm can significantly improve the image quality, combined with the ODM technique effectively reduces the radiation dose.

## CLINICAL RELEVANCE/APPLICATION

During thyroid scan, because the thickness of the X-axis of the human neck and shoulder is much greater than the Y-axis, the adaptive statistical iterative reconstruction algorithm can not improve the noise of the lower neck scan image well, while the DLIR algorithm can effectively suppress the noise. The thyroid is a highly sensitive tissue organ, ODM technology can conduct low-dose imaging of thyroid area in the process of scanning, combined with DLIR algorithm can improve the image quality.

## R5A-SPHN- Evaluation of Ultrasound Characteristics of Two Topical Hemostatic Agents after Thyroid Surgery

Vincenzo Dolcetti (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of the study is to describe the ultrasound appearance of topical hemostatics after thyroidectomy, in order to recognize their main features to avoid diagnostic errors and pitfalls.

## METHODS AND MATERIALS

We enrolled 84 patients who underwent hemithyroidectomy or total thyroidectomy and treated with two types of topical hemostats, 49 with an absorbable hemostat of oxidized regenerated cellulose (Oxitemp®) and 35 with a fibrin glue-based hemostat (Tisseel®). All patients were examined with B-mode ultrasound to evaluate post-surgical changes and the presence or absence of residual swab at the level of the thyroid lodge in each patient. A regression analysis was performed for positive cases correlating the size of the residual swab with the time elapsed since surgery.

## RESULTS

In 39 patients of the first group (approximately 80%) was detected a haemostatic residue which could potentially be confused with a native gland residue, or with cancer recurrence in oncological patients. No residue was detected in patients in the second group. The main ultrasound characteristics of the swab were analyzed and arranged according to predefined patterns, providing suggestions to recognize it and avoid wrong diagnoses. A part of the group of patients with tampon residue was re-evaluated after 6-12 months, ensuring that the swab remained for months after the maximum resorption time declared by the manufacturer. The regression analysis showed a weak not statistically significant correlation between time elapsed from surgery and the size of the residue.

## CONCLUSION

Since the two materials showed the same efficacy in post surgical hemostasis, the fibrin glue pad is more favorable in the ultrasound follow-up because it creates reduced surgical outcomes.



## CLINICAL RELEVANCE/APPLICATION

It is important to know and recognize the ultrasound characteristics of oxidized cellulose based hemostats in order to reduce the number of diagnostic errors and the inappropriate diagnostic investigations.

## R5A-SPHN- Utility of Repeat FNA for Benign Thyroid Nodules

6

Sam Afshari, BS (*Presenter*) Nothing to Disclose

### PURPOSE

For a large portion of patients with suspicious thyroid nodules, fine-needle aspiration (FNA) yields a benign diagnosis. There is a paucity of data to help determine which of these patients require a repeat FNA. The primary aim of this study is to evaluate the incidence of malignancy from repeat FNA of thyroid nodules in patients with initially benign pathology. Additionally, we assess if there are any demographic indicators or image features that may predict a need for repeat biopsy.

### METHODS AND MATERIALS

We retroactively identified patients who underwent more than one thyroid FNA at our institution between May 2010 and September 2022. From this cohort, we found 383 patients who underwent a total of 791 biopsies. Of these, 110 nodules had a cytopathologic diagnosis of Benign Follicular Nodule (BFN) based on the Bethesda System at the time of initial FNA. 38 of the 110 had a corresponding second biopsy of the same nodule on a later date. Demographic variables and pertinent risk factors were recorded. Associated TI-RADS descriptors, TI-RADS score, and size of the nodules were documented for each biopsy when available.

### RESULTS

Of the 38 biopsies that were initially benign and underwent repeat biopsy, 36 were confirmed as benign (94.7%) on repeat biopsy. One nodule had a non-diagnostic sample on repeat biopsy and was lost to follow-up (2.6%). Only one nodule was ultimately diagnosed as malignant (2.6%). The mean age (SD) at time of first biopsy was 51.2 (16.1) years. Initial cytopathology from repeat FNA identified 30 BFN (79%), 6 atypical follicular cells of undetermined significance (AFCUS) (15.8%), 1 follicular neoplasm (2.6%) and 1 nondiagnostic (2.6%). Of the six biopsies that were classified as AFCUS, three underwent Afirma genomic sequencing and were determined to be benign (50%). One of the three AFCUS nodules that did not undergo Afirma was surgically removed and identified as a micropapillary thyroid carcinoma. The nodule that was classified as a follicular neoplasm on repeat FNA was diagnosed as an adenomatous hyperplastic nodule on surgical pathologic examination. The mean time (SD) between first and second FNA was 69.6 (40.6) months. Mean increase in nodule size was 0.46 cm between initial and repeat biopsy.

### CONCLUSION

In this retrospective study of patients who underwent a repeat FNA of thyroid nodule initially categorized as benign on initial FNA, only 1 of 38 patients (2.6%) was found to have malignant pathology on final diagnosis. The single nodule with initial benign cytology subsequently found to be malignant had no interval increase in size.

## CLINICAL RELEVANCE/APPLICATION

Our data suggest a low risk of malignancy for thyroid nodules biopsied based on TI-RADS recommendations, suggesting that re-biopsy of nodules with benign cytology is likely unnecessary.

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## Abstract Archives of the RSNA, 2023

R5A-SPIN

### Imaging Informatics Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### R5A-SPIN-1A New Automatic AI Tool for MR Urography Functional Analysis in Children

Luca Basso, MD (*Presenter*) Nothing to Disclose

##### PURPOSE

Magnetic resonance urography (MRU) is a technique used to evaluate urinary tract abnormalities in children, with the advantage of being noninvasive and allowing both morphologic and functional assessments. Currently, MRU analysis is usually performed with semiautomated software that typically requires manual segmentation of the kidney and pelvis and other time-consuming interactions. In recent years, artificial intelligence (AI) techniques have been used in various domains to solve segmentation, classification, diagnosis tasks. In this work, we propose a deep learning-based approach to automate the functional analysis of the MRU. The proposed approach is integrated into a commercial web viewer (DicomVision) so that it can be used easily included into the clinical routine.

##### METHODS AND MATERIALS

The developed pipeline first employs an Attention U-Net for automatic segmentation of the kidneys and pelvis on morphological MR and then an image registration process to align the segmentations on functional MR. Morphological and functional MR scans are navigable and analyzable on the web viewer along with the automatic segmentations provided by the pipeline. The web viewer allows the automatic segmentations to be edited manually if necessary. Finally, functional analysis is automatically performed by considering the entire 3D anatomy of the kidneys and pelvis, thus assessing the functioning of the renal system in its entirety. The results produced by the analysis, that include excretion curves and split renal functions (with volumetric, area under the curve (AUC), and Rutland Patlack methods) together with derived parameters, are presented in an automatically generated report within the web viewer.

##### RESULTS

The automatic segmentation of morphological MR has been tested on 107 patients using cross validation, achieving a Dice Score of  $0.87 \pm 0.15$  and  $0.91 \pm 0.11$  for left and right kidney, and a Dice Score of  $0.75 \pm 0.24$  and  $0.71 \pm 0.25$  for the left and right pelvis respectively. The registration process, used to align the morphologic segmentations on functional MRU scans, produced functional segmentations that did not require manual retouching in 74% of cases.

##### CONCLUSION

Our analyses demonstrate that the automated web viewer enables rapid and comprehensive analysis of children's MRUs. In particular, the use of such software reduces the time required for segmentation and enables functional analysis on the entire 3D anatomical structure of the kidneys and pelvis.

##### CLINICAL RELEVANCE/APPLICATION

This AI tool for MRU performs faster and better for functional evaluation of SRF and opens the door assessment of new quantitative parameters for obstructive and non-obstructive pathologies which can be useful for surgical planning.

#### R5A-SPIN-2 Generative Adversarial Networks for Brain MRI Synthesis: Impact of Training Set Size on Clinical Applications

Gian Marco Conte, MD, PhD (*Presenter*) Nothing to Disclose

##### PURPOSE

To test the impact of training set size on generative adversarial networks (GANs) trained to synthesize brain MRI sequences.

## METHODS AND MATERIALS

We previously trained two GANs to generate pre-contrast T1 from post-contrast T1 (T1 model) and FLAIR from T2 (FLAIR model) sequences (baseline models). The reference models were trained on 135 from the BraTS 2017 dataset. Here, we trained the same models using 1251 subjects from the BraTS 2021 dataset using the same architecture and hyperparameters from the original model: a batch size of 1, learning rate  $2 \times 10^{-4}$ , Adam optimizer, cross-entropy, and L1 loss. We trained two versions of the updated models: one stopped at an early checkpoint (early models) and one after 50 epochs (late models). We tested all models on a dataset of newly diagnosed 487 IDH-wt gliomas (Fig.1 A, B). The generated T1 and FLAIR sequences were compared with the original MRIs using the structural similarity index (SSI) and mean squared error (MSE). To assess the practical impact of using synthetic data, we simulated scenarios where either the T1, FLAIR, or both were missing and used their synthetic version as inputs of a segmentation model (HD-GLIO) with the original post-contrast T1 and T2. We compared the segmentations obtained in all scenarios using the dice similarity coefficient (DSC) for the contrast-enhancing area, non-enhancing area, and the whole lesion (Fig. 1B, C). We used Friedman and Dunn's test to compare the DSC scores and correct for multiple comparisons.

## RESULTS

The median SSI on the test set for the generated T1 were .957, .947, and .947 and the median MSE were .006, .014, and .008 for the baseline, early, and late models. For the generated FLAIR, the median SSI were .924, .908, and .915 and the median MSE were .016, .016, and .019 for the baseline, early, and late models. The range DSC on the test set for the baseline, early and late models were .655 - .953, .420 - .952, and .610 - .952 (Fig. 1D). Overall, the baseline and late models did not show any statistically significant differences in DSC, but both performed significantly better than the early models.

## CONCLUSION

Generative models trained on a relatively small cohort performed similarly to those trained on a cohort 10 times larger. Overall, synthesizing FLAIR is more challenging than T1; consequently, segmentation of the contrast-enhancing areas is more robust to the use of synthetic data.

## CLINICAL RELEVANCE/APPLICATION

Incomplete MRI exams reduce the possibility of applying AI models in practice. We show that GANs can generate missing MRIs with relatively low data, making them a viable option for rare diseases or institutions with limited computing resources.

## R5A-SPIN-3 Clinical Validation Study of Machine Learning Algorithms for Liver Transplant Planning Including Vessel Segmentation

Beck Olson (*Presenter*) Nothing to Disclose

## PURPOSE

Accurate volumetric measurements have been shown to improve the outcome of liver transplant operations for both donor and recipient. [1] Preparation involves the segmentation of the donor liver in order to ensure acceptable tissue volume to support a good outcome for both the donor and the recipient. Ideally, vasculature would be excluded from these measurements however this process can take up to 1 hour for a highly trained specialist. A reliable, automated machine learning model was developed on order to significantly reduce the time required for generating this vital data.

## METHODS AND MATERIALS

Materials: 35 retrospective liver donor venous phase CT images were collected from historical records in order to train the initial model. Three rounds of evaluation were performed by three separate readers with 10 patients each round. Between rounds the model was re-trained with all previous results. The final model had a total training set of 64 images. Methods: A 3D CNN (NVIDIA Clara segresnet [2, 4-5]) was trained using 44 retrospective cases. Training labels for the right lobe, left lobe and vessels were extracted from venous phase CT images using the EDDA [3] software package by an expert analyst. The model performance was compared to segmentations performed by two readers, one novice to liver segmentation and the other a highly trained specialist in liver segmentation. All 3 results were uploaded to an XNAT [6] server for review. Clinicians performed a blinded review of all 3 segmentations for quality using the OHIF plugin [7].

## RESULTS

The final model was trained using a total of 44 retrospective and 20 prospective clinical cases showing mean dice scores of 0.96 for the right lobe, 0.930 for the left lobe, and 0.725 for the vessels. Three metrics commonly used in liver transplant planning including graft weight to recipient weight ratio (GWRW), future liver remnant (FLR), and graft volume to standard liver volume ratio (GVSTL) were calculated and compared between the ML result and the expert assuming the right lobe as the graft. The median difference between the expert and ML for GWRW was 2% with a mean of 4.5%  $\pm$  0.1%, for FLR the median difference was 7% with an average of 12%  $\pm$  0.2%, and for GVSTL the median difference was 6% with an average of 8%  $\pm$  0.2%.

## CONCLUSION

The presented machine learning model for liver donor segmentation was able to efficiently provide accurate estimates for liver volumetrics in order to support surgical planning.

## CLINICAL RELEVANCE/APPLICATION

Accurate volumetrics are critical for predicting outcome in liver donor transplant cases. A CNN was trained to quickly and automatically segment the right and left lobes excluding vessels for liver donor transplant surgery planning.

## R5A-SPIN-4 Evaluating ChatGPT as an Adjunct for Radiologic Decision-Making

Arya S. Rao (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate ChatGPT's capacity for clinical decision support in radiology via the identification of appropriate imaging services for two important clinical presentations: breast cancer screening and breast pain.

### METHODS AND MATERIALS

We compared ChatGPT's responses to the American College of Radiology (ACR) Appropriateness Criteria for breast pain and breast cancer screening. Our prompt formats included an open-ended (OE) format, where ChatGPT was asked to provide the single most appropriate imaging procedure, and a select all that apply (SATA) format, where ChatGPT was given a list of imaging modalities to assess. Scoring criteria evaluated whether proposed imaging modalities were in accordance with ACR guidelines. Three replicate entries were conducted for each prompt, and the average of these was used to determine final scores.

### RESULTS

ChatGPT achieved an average OE score of 1.83 (out of 2) and a SATA average percentage correct of 88.9% for breast cancer screening prompts, and an average OE score of 1.125 (out of 2) and a SATA average percentage correct of 58.3% for breast pain prompts.

### CONCLUSION

ChatGPT achieves moderate accuracy in identifying appropriateness of common imaging modalities for breast cancer screening and breast pain. Our results demonstrate the feasibility of using ChatGPT for radiologic decision making.

## CLINICAL RELEVANCE/APPLICATION

Our pilot study of the use of ChatGPT in radiology demonstrates the potential to improve clinical workflows and responsible use of radiology services. Potential use cases include triage and imaging resource allocation.

## R5A-SPIN-5 Modified Turing Test Unveiled: AI-Generated Radiology Editorials Compete with Human Expertise

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The aim of this study was to assess the performance of AI-generated editorials in comparison to human-written editorials in the field of radiology, examining various dimensions including ease of comprehension, English proficiency, technical knowledge and expertise, persuasiveness and convincingness of arguments, and consistency of content.

### METHODS AND MATERIALS

16 human-written editorials were collected from eight radiology journals, including AJNR, Radiology, AJR, Academic Radiology, Journal of Neurointerventional Surgery, Stroke, JACR, and Clinical Neuroradiology, with two editorials authored by the same person from each journal. GPT-4.0 was used to generate corresponding AI-written editorials based on the topics provided. A total of 32 editorials were reviewed by five different reviewers, four of whom were editorial board members of AJNR, and one was an editor at The Neuroradiology Journal. The reviewers scored the texts using a 1-5 scale for the aforementioned dimensions. They were blinded to the origin of the texts, and the AI-generated and human-written editorials were presented in separate batches, ensuring that the counterparts were not assessed within the same batch. The Mann-Whitney U test was employed to compare the performance of the texts, and Fleiss's kappa was used to assess inter-rater reliability.

### RESULTS

The analysis revealed no statistically significant differences between AI-generated and human-written editorials in any of the assessed dimensions. In terms of ease of comprehension, English proficiency, technical knowledge and expertise, persuasiveness and convincingness of arguments, and consistency of content, AI-generated texts performed similarly to

human-written texts. Fleiss's kappa results indicated low inter-rater agreement in scoring the editorials based on the provided scoring criteria. Reviewers' accuracies in identifying AI-generated vs. human-written texts were 14/32, 27/32, 25/32, 30/32, and 7/32, respectively.

## **CONCLUSION**

AI-generated editorials, as exemplified by GPT-4.0, demonstrate comparable performance to human-written editorials. Reviewers had a hard time differentiating the texts highlighting the challenge faced by even expert reviewers in differentiating the editorials. These findings suggest that AI-generated texts may be on par with human-written texts in terms of the evaluated qualities.

## **CLINICAL RELEVANCE/APPLICATION**

The use of AI-generated content in radiology journals could potentially augment editorial writing, enhance the efficiency of content generation, and contribute to the growing body of literature in the field. Further research and development of AI systems may lead to improved capabilities and applications within the radiology community and beyond.

## **R5A-SPIN-6Data Mining with Natural Language Processing on Radiology Chest X-Ray Reports**

Michael Welsh, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

Radiology reports are a rich source of diagnostic information. Structured reports particularly lend themselves to data mining and artificial intelligence (AI). However, even structured reporting templates demonstrate inconsistent formatting and large variability in terminology, which hinders large-scale text analysis. We developed an AI system, based on natural language processing (NLP) methods, that extracts the fields from reports and can be used to identify relevant features on an image, such as an endotracheal tube.

## **METHODS AND MATERIALS**

In this retrospective, IRB-approved study, 1492 pediatric chest radiographs with corresponding radiology reports were obtained at our institution from 2014 to 2019. Two pediatric radiologists labeled the 1492 images based on the presence/absence of metallic hardware, endotracheal tubes, tracheostomy tubes, and the number of lines and tubes, documented in the database software REDCap. Patient demographics were directly extracted from the DICOM header information. The labeled images were then used to train an AI system (train/valid/test splits of 60%/20%/20%), using NLP and supervised machine learning algorithms (scikit-learn v1.1.3) to automatically parse text data and predict the presence of hardware.

## **RESULTS**

The AI system was able to determine the presence of metallic hardware, tubes, and the number of lines and tubes using only a few sections of the report (notably the "history", "impression", and "finding" sections). The balanced accuracy of the system is more than 90% (type-I error of 5% and power of 80%) in most classification tasks by using the appropriate fields.

## **CONCLUSION**

We utilized NLP to reliably and automatically label images for the presence of lines and tubes, using radiology reports. The proposed system can be adapted for other external devices and has significant utility for identifying objects on the image, with important implications for image quality and patient safety.

## **CLINICAL RELEVANCE/APPLICATION**

The proposed system uses radiology reports to identify labeled structures on clinical images. This reduces time-consuming annotation efforts for radiology research and accelerates AI development.

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## Abstract Archives of the RSNA, 2023

R5A-SPIR

### Interventional Radiology Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPIR-1 Intra-arterial CT Perfusion is Feasible During Liver-directed Therapy Procedures**

Rajesh P. Shah, MD (*Presenter*) Research support, Merit Medical Systems, Inc; Consultant, Intuitive Surgical, Inc; Consultant, F. Hoffmann-La Roche Ltd; Research support, Lucence Health; Consultant, Histosonics, Inc; Consultant, Artio Medical, Inc

#### **PURPOSE**

To determine feasibility and baseline statistics of intra-arterial CT perfusion during Interventional Radiology (IR) liver-directed therapy procedures.

#### **METHODS AND MATERIALS**

This was a prospective observational study approved by the local institutional review board. Nine patients undergoing intra-arterial therapy (IAT) for hepatocellular carcinoma (HCC) without treatment in the prior year were enrolled. Subjects underwent injection of a 50% dilution of Iohexol 300 mgI/mL from either the celiac artery at 3 mL/sec for a total volume of 24 mL for conventional hepatic arterial anatomy, or from the superior mesenteric artery (SMA) for replaced anatomy at a rate of 5 mL/sec for a total volume of 40 mL to account for flow into mesenteric vessels. Perfusion scanning was performed continuously for 11 sec, then every 2 sec to a total scan time of 40 sec to capture arterial, portal venous, and washout phases at 100 kV and 60 mA. Radiation dose was recorded. A region of interest (ROI) was drawn on the common hepatic artery, portal vein, spleen (celiac injection) or small bowel (SMA injection), and non-tumor liver by a single Radiologist. Arterial blood flow (AF), portal venous blood flow (PVF), and perfusion index (PI) were calculated from an ROI drawn on a single index tumor 1.5 cm or larger in size without prior treatment. Descriptive statistics were calculated. The Wilcoxon Rank-Sum test was used to determine the significance of peripheral vs. central tumor and any prior treatment (more than 1 year prior) on perfusion values. Analysis of Variance was used to determine impact of tumor segment on perfusion values. A p-value < 0.05 was considered significant. A Pearson Correlation coefficient was calculated to determine impact of tumor size.

#### **RESULTS**

All 9 patients successfully underwent perfusion CT. Celiac artery injection occurred in 7 patients, while 2 patients had injection via SMA. Median (IQR) radiation dose was 525.3 (524.4-528.6) mGy·cm. Mean (Range) index tumor diameter was 2.46 (1.5-4.5) cm. Index tumors were distributed in segments 2, 5, 7, and 8 (2 subjects each) as well as segment 4 tumor in 1 subject. Three tumors were central while 6 were peripheral. Median (IQR) AF, PVF, and PI were 509.9 (389.6-524), 291.1 (71-859.4), 58.3 (41.9-87.6) mL/min/100 mL, respectively. Treatment more than 1 year prior, tumor segment, and peripheral location of tumor were not significant for perfusion values ( $p > 0.05$ ). Higher AF was strongly correlated with larger tumor ( $r = 0.6$ ).

#### **CONCLUSION**

Intra-arterial perfusion CT is feasible during IAT for HCC. A wide range of AF and PVF is seen in HCC and these values can provide a baseline for evaluating dosing of IAT such as radioembolization.

#### **CLINICAL RELEVANCE/APPLICATION**

CT perfusion of HCC is feasible and may help better personalize IR treatments.

#### **R5A-SPIR-2A Surprising Effect of Metformin Plus Transarterial Chemoembolization on Hepatocellular Carcinoma Patients with Type II Diabetes**

Linxia Wu (*Presenter*) Nothing to Disclose

## PURPOSE

Diabetes is common in the patients with hepatocellular carcinoma (HCC) and can lead to poor prognosis for these patients. Metformin is a hypoglycemic drug with anti-tumor effects. Whether metformin can have a positive effect on HCC patients receiving interventional embolization (transarterial chemoembolization, TACE) is still unclear. The study was conducted to explore the effect of metformin plus TACE on HCC patients with type II diabetes.

## METHODS AND MATERIALS

From January 2014 to June 2021, 385 consecutive HCC patients with type II diabetes from three medical centers were retrospectively reviewed. All of them received TACE, and 216 patients received metformin. Propensity Score Matching (PSM) was used to reduce selective bias. Competing risk model was used to reduce the influence of deaths caused by other factors (not cancer) on the results.

## RESULTS

The median overall survival (mOS) (35 months, 95%CI: 28-44 months vs 20 months, 95%CI: 16-24 months;  $P < 0.001$ ) and median progression-free survival (mPFS) (11 months, 95%CI: 10-14 months vs 8 months, 95%CI: 6-11 months;  $P < 0.001$ ) for patients with metformin were longer than those without metformin before PSM. Similar results were presented after PSM. The multivariate regression analysis presented that metformin could reduce mortality risk of patients (HR: 0.56, 95%CI: 0.44-0.71;  $P < 0.001$ ) and tumor progression risk (HR: 0.67, 95%CI: 0.53-0.84;  $P < 0.001$ ) before PSM. The subgroup analysis showed that patients with BCLC stage A, BCLC stage B, BCLC stage C, Child-Pugh A and Child-Pugh B who received metformin could receive survival benefits from metformin. After excluding the influence of deaths caused by other factors (such as heart disease, diabetes, etc), metformin could still reduce mortality risk of patients and tumor progression risk. The adverse events evaluation was based on the NCI-CTCAE 5.0. The results showed metformin did not increase severe adverse events (grade III or grade IV).

## CONCLUSION

Metformin might bring survival benefits for HCC patients with type II diabetes who received TACE. Metformin could achieve the effect of "killing two birds with one stone" for these patients.

## CLINICAL RELEVANCE/APPLICATION

Metformin has been proved to have anti-cancer effects in preliminary studies. However, there are few clinical studies on metformin against cancer. We included 385 patients from three medical centers to conduct the study to explore the effect of metformin on hepatocellular carcinoma patients with TACE. Our results presented metformin could prolong the survival of patients, which could provide new evidence for clinical decision for HCC patients with type II diabetes.

## R5A-SPiR-5 Development of PLGA-loaded Ticagrelor Magnetic Microspheres: Towards Prevention of Post PCI Thrombosis

Kunkun Liu (*Presenter*) Nothing to Disclose

## PURPOSE

After percutaneous coronary intervention (PCI), dual antiplatelet therapy (DAPT) was required to prevent thrombosis. Systemic DAPT may increase the bleeding risk, especially in populations at high risk of bleeding. Moreover, patients who require non-cardiac surgery during DAPT, have to make decision between postpone surgery and discontinue medication. The aim of this study was to develop PLGA-Fe<sub>3</sub>O<sub>4</sub>-Ticagrelor microspheres (PFTm), which were local infused to aortic wall for local antiplatelet therapy.

## METHODS AND MATERIALS

We designed and prepared PLGA loaded with ticagrelor magnetic microspheres by improved emulsified solvent evaporation method. For in vitro study, the morphology, relaxation rate, drug release rate, encapsulation efficiency, and biocompatibility of PFTm were evaluated. For animal experiment, twenty Japanese rabbits were divided into four groups, including local PFTm therapy group, systemic PFTm therapy group, non-therapy control group, and healthy control group. The last two groups shared one group of animals. The first three groups underwent balloon injury for the abdominal aorta. The first group received balloon PFTm infusion immediately after the injury, while the second group received intravenous PFTm. The other two groups did not receive treatment. MR T2WI was performed pre-operation and post-operation at day0, day2 and day3 to detect PFTm distribution. Then, the targeted aorta was harvest for pathological.

## RESULTS

The characterization of PFTm showed that it was spherical. The size of the PFTm was  $930.5 \pm 134$  nm, with SPAN=0.35. The overall size of the PFTm was uniform. The drug encapsulation efficiency of the PFTm was  $82\% \pm 2\%$ , the release rate of ticagrelor from the microspheres reached 90% within 96 hours. The  $r_2$  of the PFTm was  $332.0 \text{ mm}^{-1} \text{ s}^{-1}$ . The PFTm were nontoxic for the cells by CCK-8. Twenty rabbits (3~4kg) were used. All rabbits were successfully established aorta injury model, in which the first two animals in the local PFTm therapy group were found intramural hematoma during PFTm infusion, resulting in animal death. The results of animal experiments showed that PFTm was infused into aortic wall with no

thrombus detected in the local PFTm therapy group. The thrombosis area in the systemic PFTm therapy group was significantly smaller than that in the non-therapy control group ( $0.37 \pm 0.04 \text{ mm}^2$  vs  $0.58 \pm 0.03 \text{ mm}^2$ ,  $P < 0.0001$ ).

## **CONCLUSION**

PFTm was successfully developed, which can effectively inhibit thrombosis. This study provides a new concept of local infusion for prevention of thrombosis after PCI.

## **CLINICAL RELEVANCE/APPLICATION**

The study validated new concept for local antiplatelet therapy after PCI, which may decrease systemic risk of bleeding and provide chance for non-cardiac surgery during anticoagulation therapy.

## **R5A-SPIR-6 Single vs Double Lumen Ports Placements: Infection and Complication Rates**

Konrad Kozlowski, BA (*Presenter*) Nothing to Disclose

## **PURPOSE**

Port-a-cath (subcutaneous port) placements are implanted intravascular ports that allow for easy venous access. With the rise in port placements performed by Interventional Radiologists (IR), it is important to determine whether there are differences in infection and complication rates between double and single lumen ports.

## **METHODS AND MATERIALS**

We retrospectively analyzed 1582 port placements and removals during a 2-year period (April 2019-March 2021) at the University of Miami(UM) Health System. Patients were grouped by single and double lumen port subgroups and information on infection (bacteremia/port site infection), malfunctions (fibrin sheath, thrombosis, catheter malposition, extravasation), wound dehiscence, and hematoma rates were collected. Chi-square and Fisher t-test analyses were performed on the data in IBM SPSS 2022.

## **RESULTS**

On average, patient age was 58.7 years, BMI 27 kg/m, with 616 port placements in males (38.9%) and 966 in females (61.1%). We identified 684 single lumen (43.2%) and 898 double lumen port placements (56.8%). Double lumen ports sustained bacteremia at a significantly higher rate than single lumen ports (3.5% vs 1.2%,  $p = 0.005$ ), with the most common causes of bacteremia being *S. Aureus* (65%), *E. Faecalis* (16.1%), and *E. Coli* (12.9%). Moreover, double lumen ports experienced significantly higher rates of fibrin sheath (2.5% vs 0.4%,  $p = 0.002$ ), catheter tip malposition (1.3% vs 0%,  $p = 0.002$ ), and thrombosis (1.2% vs 0%,  $p = 0.007$ ) compared to single lumen ports. Furthermore, double lumen ports encountered more wound dehiscence ( $n = 8$  vs  $2$ ), port site infections ( $n = 12$  vs  $5$ ), extravasation ( $n = 4$  vs  $1$ ), and hematoma ( $n = 4$  vs  $1$ ) compared to single lumen ports, although these differences were not statistically significant.

## **CONCLUSION**

This study found significantly higher rates of infectious complications and malfunctions of double lumen ports compared to single lumen ports, suggesting that structural differences inherent to double lumen ports may be conducive to bacterial growth and catheter malfunction.

## **CLINICAL RELEVANCE/APPLICATION**

These results indicate that oncologists and their IR colleagues may consider placing single lumen ports if clinically feasible, however future studies are still needed to determine clinical significance. Limitations of this study include retrospective nature and potential loss of patient follow-up.

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## Abstract Archives of the RSNA, 2023

R5A-SPMK

### Musculoskeletal Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPMK- Dual Energy CT-derived Effective Atomic Number and Electron Density for Differentiation of Bone Tumors: Initial Experience** 1

Tomohito Hasegawa (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine whether dual-energy CT parameters including electron density (ED) and effective atomic number (Zeff) could be quantitative imaging markers for differentiating benign from malignant bone tumors.

#### **METHODS AND MATERIALS**

Fifty-eight patients (34 males and 24 females, age range from 9 to 86 years) with histopathologically proven osteolytic bone tumor who underwent spectral detector CT scan were included in this retrospective study. Images of the conventional CT value (CTconv, HU), electron density relative to water (ED, %), and Zeff (AU) were obtained. Regions-of-interest were manually placed on the largest cross-section of tumor avoiding calcification to obtain the mean parametric values. Histopathologically, the tumors were divided into two groups: benign and intermediate malignant tumor (n=14), malignant tumor (n=44). Mann-Whitney U test was used to compare the DECT parameters between two groups. ROC curve analysis was used to assess the discriminative abilities of the DECT parameters.

#### **RESULTS**

The mean Zeff of benign and intermediate malignant tumors was significantly higher than that of malignant tumors ( $7.47 \pm 0.11$  vs  $7.38 \pm 0.12$ ,  $p=0.011$ ), whereas the mean CTconv and ED showed no significant difference between the two groups ( $44.28 \pm 7.00$  vs  $41.89 \pm 11.92$ ,  $p=0.490$  and  $103.54\% \pm 0.66$  vs  $103.60\% \pm 0.92$ ,  $p=0.637$ ). The AUC for Zeff was 0.727, with a sensitivity of 72.73%, specificity of 64.29% and accuracy of 70.69% (cut off, < 7.44).

#### **CONCLUSION**

The mean Z<sub>eff</sub> may be helpful in differentiating benign and intermediate malignant bone tumors from malignant tumors. Their difference in Z<sub>eff</sub> may reflect differences in elemental composition which are inaccessible with conventional CT.

#### **CLINICAL RELEVANCE/APPLICATION**

The mean Zeff may be helpful in differentiating benign and intermediate malignant bone tumors from malignant tumors.

#### **R5A-SPMK- A New Approach to Detect Rib Metastases Using Deep Learning with Hounsfield Unit-augmentation** 2

Misato Sone, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

With the recent developments of cancer treatments, the number of patients with bone metastases is increasing. CT can well define cortical destruction in bone metastases due to its high spatial resolution. However, detection of bone metastases on CT is challenging for radiologist because of the three types of metastases (osteoblastic, osteolytic, and mixed) to evaluate. Hounsfield Unit (HU)-augmentation, using multiple HU windows in the HU normalization is available for deep learning (DL) algorithm. Thus, HU-augmentation using the appropriate CT values for the three types of bone metastases has the potential to improve detection accuracy. This study aimed to investigate whether the accuracy of the DL algorithm for detecting rib metastases on CT can be improved by HU-augmentation method.



## METHODS AND MATERIALS

All images of bone metastases were obtained retrospectively from the clinical databases of a single institution between April 2011 and September 2019. Delayed phase axial images of contrast-enhanced CT with soft tissue kernel reconstruction were used. Both training and validation datasets, ground truth labels were established using bounding boxes by two radiologists. After manually extracting thoracic region from the torso CT, faster region-based convolutional neural network is utilized for rib metastasis detection. HU augmentation was performed with three HU windows; osteoblastic (WW 700 HU/WL 450 HU), osteolytic (WW 900 HU/WL 200 HU), and mixed (WW 1300 HU/WL 80 HU), in both training and testing phase. Training and evaluation of DL were performed by 5-fold cross validation. The mean Average Precision (mAP), F-measure, precision, and recall were calculated and compared with and without HU-augmentation.

## RESULTS

A total of 4218 positive slice images in 159 patients with rib metastases (mean age, 62±11 years; 78 male) were used for model development and test. Primary lesion of 159 patients were following; 47 were breast, 46 were lungs, 17 were prostate, and 49 were other origins. The mAP and F-measure with HU-augmentation were 0.609 and 0.591, compared with 0.553 and 0.571 without HU-augmentation. The precision and recall with HU-augmentation were 0.741 and 0.492, compared with 0.667 and 0.503 without HU-augmentation.

## CONCLUSION

HU-augmentation improved DL algorithm to detect rib metastases on CT.

## CLINICAL RELEVANCE/APPLICATION

This study reveals that HU-augmentation using the appropriate CT values for the three types of bone metastases (osteoblastic, osteolytic, and mixed) improves the detection accuracy of rib metastases.

## **R5A-SPMK- Retrospective Validation of the Birmingham Atypical Cartilage Tumor Imaging Protocol (BACTIP) in a Single US Tertiary Care Center**<sup>3</sup>

Sonja Opper, DO (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to retrospectively validate the Birmingham Atypical Cartilage Tumor Imaging Protocol (BACTIP) in a US tertiary care center. This study will provide the necessary groundwork for prospective validation in real-time patients.

## METHODS AND MATERIALS

Institutional review board approval was obtained. A keyword search within our institutional PACS for the words chondroid, enchondroma and chondrosarcoma in the text of MRI reports from 2014 - 2022. Lesions in the proximal humerus, distal femur, and proximal tibia of adults were included in the study. Lesions were categorized into 1 of 7 BACTIP categories based on size and presence/absence of endosteal scalloping. Rate of malignancy for each BACTIP category was calculated and based on follow up protocol, evaluation of delayed diagnosis was recorded.

## RESULTS

The PACS keyword search resulted in 305 patients that met inclusion criteria. Preliminary results are below: Of these 305 MRI exams, 75% had no additional MRI exams and clinically presumed benign enchondromas. The remaining 25% of patients had 1 or more follow up MRI exam(s). The length of time between MRI exams varied widely from 2 months to 8 years. BACTIP Type IA (47% of lesions, 2% biopsy rate), IB (20%, 3%), IC (10%, 18%), IIA (6%, 0%), IIB (4%, 28%), IIC (11%, 32%), and III (2%, 100%), respectively. Biopsy rate increased with BACTIP category. Type IA and IB lesions had a malignancy rate of 0%. Malignancy rate for type IC was 33%, and 50% for IIB. Type IIC lesions had a 50% malignancy rate. Type III has a biopsy rate of 100% and malignancy rate of 75%. Malignancy rate increased with BACTIP category.

## CONCLUSION

Retrospective validation of the BACTIP in a single US tertiary care center showed similar results to those reported by Davies et al in 2019. There were no cases where the application of BACTIP would have led to a delayed diagnosis. The BACTIP would serve as a conservative and appropriate imaging follow-up guideline for patients with central cartilage tumors around the shoulder and knee joint.

## CLINICAL RELEVANCE/APPLICATION

Central cartilage tumors are common incidental lesions around knee and shoulder joints. Differentiation of low grade chondroid lesions, such as enchondroma from low grade chondrosarcoma, is often difficult even on MRI given pathologic and radiologic similarities. The BACTIP was introduced in UK literature in 2019 and provides a guide to initial assessment, diagnosis, and imaging follow-up plan for incidental indeterminate central cartilage tumors (Fig 1). This imaging protocol was retrospectively validated in an article published by Davies et al in 2019. However, this protocol has not been widely accepted and has not been validated in the US population.

## **R5A-SPMK- Iodine Quantification in Bone Marrow Using Photon-counting Detector CT: A Phantom Study**

4

Tatsuhito Yamamoto (*Presenter*) Nothing to Disclose

### **PURPOSE**

Detecting intertrabecular bone metastases, which replace bone marrow without destroying the bony structures, is a challenging task to diagnose on CT. Photon-counting detector CT (PCD-CT) enables a simultaneous multi-energy acquisition that offers further qualitative and quantitative information in a single scan. This study aimed to investigate the accuracy of iodine quantification using a PCD-CT and to assess the feasibility of measuring iodine concentrations in the tissue that has penetrated into the bone.

### **METHODS AND MATERIALS**

A bone marrow phantom was constructed using cellulated calcium sulfate plaster that was impregnated with iodinated contrast medium at various concentrations (0, 0.75, 1.5, 3, 6, 12, 24, 48, and 96 mgI/mL). Images were acquired using a PCD-CT scanner (NAEOTOM Alfa, SIEMENS, Germany) with a detector size of 0.2 mm and a tube voltage of 120 kVp. The acquired images were reconstructed with a 1-mm thickness using a Qr40 kernel. The CT numbers and calculated iodine quantification values were measured by placing circular regions-of-interest (ROIs, approximately 10 cm<sup>2</sup>) on the iodine maps and quantification maps, respectively, at the top, middle, and bottom of each phantom. Statistical analysis was performed using a two-way ANOVA. P-values less than 0.05 considered as statistically significant.

### **RESULTS**

The CT values (mean  $\pm$  SD) for each ROI on the iodine maps of the phantom were as follows: 553  $\pm$  24, 532  $\pm$  20, 504  $\pm$  24, 587  $\pm$  23, 554  $\pm$  14, 708  $\pm$  20, 738  $\pm$  4.4, 1130  $\pm$  17, and 1450  $\pm$  200 H.U. at iodine concentrations of 0, 0.75, 1.5, 3, 6, 12, 24, 48, and 96 mgI/mL, respectively. The quantified iodine values for the phantom were 16.4 $\pm$ 0.90, 16.2 $\pm$ 1.1, 16.3 $\pm$ 0.82, 17.1 $\pm$ 0.57, 19.3 $\pm$ 0.49, 22.3 $\pm$ 0.54, 26.5 $\pm$ 0.047, 36.6 $\pm$ 0.12, and 49.9 $\pm$ 3.6mg/mL, respectively. There were significant differences in either CT values on the iodine maps or quantified iodine values between phantoms with iodine concentrations greater than or equal to 6 mg/mL (P < 0.05). However, there were no differences between phantoms with other iodine concentrations.

### **CONCLUSION**

There was a correlation between iodine concentrations and both the CT values on the iodine map and the iodine quantification values in higher iodine solutions, but no clear difference was observed in lower iodine solutions when compared to the iodine quantification values in the water-impregnated bone phantom. The iodine value was overestimated in the phantom without iodine, and appropriate correction would be necessary when applied to clinical cases.

### **CLINICAL RELEVANCE/APPLICATION**

PCD-CT has the potential to detect intertrabecular bone metastases that may not be visible on conventional CT scans and evaluate their vascularity.

## **R5A-SPMK- Is Semi-automatic Segmentation with Quantitative Analysis of Whole-body DWI-MRI Images a Feasible Parameter for Assessing Treatment Response in Multiple Myeloma Patients?**

5

Miguel Barrio Piqueras I, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To study the feasibility of quantitative whole-body diffusion-weighted MRI (DWI) analysis using a semi-automatic segmentation technique for the assessment of treatment response in patients with multiple myeloma.

### **METHODS AND MATERIALS**

34 patients with multiple myeloma underwent whole-body MRI at our center. Images were acquired and reported according to MY-RADs (Myeloma Response Assessment and Diagnosis System) guidelines. Patients were classified as responders or non-responders according to their MRI- Response Assessment Category (RAC) and the response category given following the International Myeloma Working Group (IMWG) criteria, considering the latter one as the gold standard. Quantitative analysis of DWI images of each MRI was performed after semi-automated segmentation. Data analysis was performed with SPSS 25.0 software (Chi-square and Student's t-tests). Two-tailed p-values were used for all statistical evaluations and a p-value < 0.05 was considered statistically significant.

### **RESULTS**

13 patients (38.2%) did not respond to treatment according to IMWG response criteria. They showed no statistically significant differences in total diffusion volume (tDV: 240.82 cm<sup>3</sup> vs. 196.08 cm<sup>3</sup>; p = 0.507) or mean global apparent diffusion coefficient (gADC: 694.92  $\times$  10<sup>-6</sup> mm<sup>2</sup>/s vs. 779.4  $\times$  10<sup>-6</sup> mm<sup>2</sup>/s; p = 0.123) in quantitative analysis of DWI before and after treatment, respectively. Among the remaining 21 responding patients (61.8%), tDV significantly decreased (214.93

cm<sup>3</sup> vs 111.41 cm<sup>3</sup>; p = 0.01) and gADC significantly increased (738.82 x 10<sup>-6</sup> mm<sup>2</sup>/s vs 1126.29 x 10<sup>-6</sup> mm<sup>2</sup>/s; p = 0.002) after treatment. Furthermore, the percentage of high ADC values (=1400 x 10<sup>-6</sup> mm<sup>2</sup>/s) of tDV was higher in responder patients after treatment (36.57 %) than in non-responders (7.8 %), with significant differences (p < 0.001).

#### **CONCLUSION**

Total diffusion volume (tDV) and global apparent diffusion coefficient (gADC) may be feasible parameters for assessing treatment response in patients with multiple myeloma.

#### **CLINICAL RELEVANCE/APPLICATION**

The utilization of novel imaging techniques for the follow-up and monitoring of multiple myeloma treatment represents a rapidly expanding field, which has the potential to provide dependable data and enhance the precision of radiological reports.

#### **R5A-SPMK- Measurement of Tumor Total Diffusion Volume (tDV) of Metastatic Bone Lesions from Prostate Cancer Using Whole-Body MRI(WB-MRI)-Evaluation for Therapeutic Effect**

6

Katsuyuki Nakanishi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To measure the total diffusion tumor volume (tDV) of metastatic bone lesions from prostate cancer using whole body MRI(WB-MRI) including whole body diffusion weighted images (DWI) and to research the correlation for serum PSA level and to assess the reliability and reproducibility of our diagnostic methods.

#### **METHODS AND MATERIALS**

Nine cases of prostate cancer during various treatment in which WB-MRI was performed twice were retrospectively evaluated. In all patients, serum PSA was measured at the same time of MRI examinations. 3.0T MR scanners were used (Siemens Prisma). The pulse sequences were 1. axial direction of DWI of the level from lower neck and bottom of pelvis. 2. Sagittal direction of T1WI and STIR of total spine 3. Coronal direction of in phase and out of phase of T1WI. In all cases, two radiologists measured tDVs using BD-score (PixSpace. Inc.) which had been developed for calculating ADC value of the lesions and their volume correspond to the tumor automatically by defining the threshold of ADC value. In this study, the threshold was defined as 1.8mm<sup>2</sup>/S. We calculated tDV variation (?tDV) and serum PSA variation (?PSA) before and after therapy in each patient, and examined the relation of ?tDV and ?PSA with Spearman's rank correlation coefficient (rs). Also, the bias between the data of the data of two radiologists was assessed calculating the cross-correlation coefficient.

#### **RESULTS**

In the data of both radiologists, ?tDV and ?PSA were positive correlated strongly by Spearman's rank correlation coefficient (radiologists 1 r=0.99, p=0.000002, radiologist 2 r=0.88, p=0.002). The cross-correlation coefficient of two radiologists was 0.98 (p=0.000002).

#### **CONCLUSION**

tDV was proved to be a reliable mark for evaluating the grade of bone metastases from prostate cancer. Using BD score for calculating tDV showed less dispersion between the readers.

#### **CLINICAL RELEVANCE/APPLICATION**

Calculating the disease volume rapidly from WBMRI returns to earth.

#### **R5A-SPMK- Diagnostic Performance of Magnetic Resonance Imaging for Detecting Meniscal Ramp Lesions in Patients with Anterior Cruciate Ligament Tears. A Meta-analysis**

8

Seong Jong Yun, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The clinical importance of meniscal ramp lesions in patients with anterior cruciate ligament (ACL) tear has emerged as a major issue. However, the diagnostic accuracy of magnetic resonance imaging (MRI) for detecting ramp lesions has a wide range. This meta-analysis was aim to meta-analyze the diagnostic performance of MRI for diagnosing ramp lesion in patients with ACL tear

#### **METHODS AND MATERIALS**

Literature search of PubMed, EMBASE, and the Cochrane Library was performed based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines. Diagnostic performance studies using MRI as the index test and arthroscopy as the reference standard for ramp lesion were included. Bivariate and hierarchical summary receiver operating characteristic modeling was used to evaluate the diagnostic performance. We performed meta-regression analyses for potential sources of heterogeneity.

## **RESULTS**

Nine studies from eight articles (883 patients with ACL tear) were included. The summary sensitivity, summary specificity, and area under the hierarchical summary receiver operating characteristic (AUC) for ramp lesion were 0.71 (95% confidence interval [CI], 0.59-0.81) and 0.94 (95% CI, 0.88-0.97), and 0.90 (95% CI, 0.87-0.92), respectively. Among the potential covariates, magnet strength ( $P < 0.01$ ), patients' knee position ( $P = 0.04$ ), and MRI interpreter ( $P = 0.04$ ) were associated with heterogeneity in terms of sensitivity, whereas, magnet strength ( $P = 0.03$ ) was associated with heterogeneity in terms of specificity.

## **CONCLUSION**

MRI demonstrated moderate sensitivity and excellent specificity for diagnosing ramp lesion. For increase sensitivity, use of 3T MRI with the patients' knee in the neutral position (about 30° flexion), and the involvement of musculoskeletal radiologist for MRI interpretation may be needed.

## **CLINICAL RELEVANCE/APPLICATION**

We recommend routine arthroscopic assessment for the presence of ramp lesion, although it was not suspected on MRI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-SPMS

### Multisystem Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPMS- Functional and Structural Brain Alterations in Patients Recovered from COVID-19 with Anosmia** 1

Francisco Zamorano, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate functional and morphological brain alterations in recovered COVID-19 patients.

#### **METHODS AND MATERIALS**

72 recovered COVID-19 patients (33 females, mean age 42, range [18-66]; 38 with anosmia during infection; 29 hospitalized because of respiratory symptoms) were asked to resolve a Reversal Learning Task (RLT) while their brain activity was measured with fMRI. Images were acquired with a 3T Siemens Skyra scanner. Neuropsychological alterations were assessed with Addenbroke II and INECO tests. In the RLT, the participants had to choose between two options that were presented with different probabilities of obtaining reinforcement (0.8 vs 0.2 and 0.7 vs 0.3). Through trial and error, participants were able to learn the most advantageous option. After a certain number of repetitions, the probabilities associated with each option could be reversed, and the subject had to learn the new association. Behavior was modeled using a Rescorla-Wagner learning algorithm and Cumulative Prospect Theory. This model uses a learning rate that updates the subjective probability of being rewarded and a multiplicative approach to calculate the expected utility of each option. Brain activity associated with the decision-making period was analyzed with FSL in regard to the expected utility, controlled by reaction time as a proxy of difficulty. Cortical thickness was analyzed with Freesurfer using HCP pipeline and SurfStat from Matlab.

#### **RESULTS**

There was a decrease of activity in several prefrontal and subcortical regions in those patients that had anosmia, regardless of the severity of respiratory symptoms. There was cortical thinning in the left superior frontal gyrus in those patients that had anosmia, regardless of the severity of respiratory symptoms. This indicates that recovered COVID-19 patients that presented anosmia during the infection have functional and structural brain alterations.

#### **CONCLUSION**

Our results suggest that anosmia can be used as a marker of brain alterations in patients recovered from COVID-19. It could be important to follow the track of these patients in order to investigate possible long term consequences of COVID-19 on the nervous system.

#### **CLINICAL RELEVANCE/APPLICATION**

While COVID-19 primarily affects the respiratory system, the brain can also be involved. Increasing evidence indicates that recovered patients present neuropsychiatric alterations and thinning of certain cerebral cortex areas, especially those connected to the primary olfactory cortex. Given this background it is highly relevant to evaluate the possibility of alterations at the brain level in recovered COVID-19 patients, which, as we find, seem to extend to other regions.

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## Abstract Archives of the RSNA, 2023

R5A-SPNMMI

### Nuclear Medicine & Molecular Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPNMMI-1 First Application of Novel Human Granzyme B Imaging Agent in a Humanized Melanoma Mouse Model Treated with Immune Checkpoint Inhibitor Therapy**

Priska Summer, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We have previously shown that granzyme B (GZB) PET imaging can determine treatment response in cancer immunotherapy. This study evaluates whether a novel human granzyme B imaging agent CYT-200 (Cytosite) labeled with  $^{68}\text{Ga}$  can be used as a reliable, non-invasive biomarker of intra-tumoral GZB levels and efficacy immune checkpoint inhibitor therapy in vivo.

#### **METHODS AND MATERIALS**

All animal studies were approved and conducted according to the IACUC guidelines. Naïve NSG mice received human untransduced T cells intravenously for immune reconstitution 14 days prior to subcutaneous implantation of human melanoma cells (G361) into the left shoulders. Mice received three intraperitoneal doses of pembrolizumab (200  $\mu\text{g}$ ) and anti-CTLA-4 (100  $\mu\text{g}$ ) combined, administered in three days intervals, starting from when the tumors reached  $336\pm 38\text{ mm}^3$ . PET imaging was performed prior to treatment initiation (baseline), such as on days 4, 7, and 14 after the first treatment dose. Tumor-bearing mice were injected with  $4.6\pm 0.30\text{ MBq}$  of CYT-200 labeled with  $^{68}\text{Ga}$  60 $\pm$ 5 min prior to PET image acquisition. Intra-tumoral T-cell activity was measured by tumor-to-blood ratio (TBR), calculated by the standard uptake values (SUVs) of the tumors normalized against the heart blood pool. Treatment response was assessed by tumor growth measurements over 30 days after tumor implantation.

#### **RESULTS**

PET imaging on day 4 after treatment initiation showed the highest TBR compared to the baseline ( $3.08\pm 0.98$  vs.  $1.22\pm 0.48$ ) with a gradual decrease of the TBRs on day 7 ( $2.76\pm 1.85$ ) and 14 ( $1.91\pm 0.23$ ). A combination of pembrolizumab and anti-CTLA-4 therapy decreased tumor size on days 4 and 7 after treatment initiation ( $336\pm 38\text{ mm}^3$  vs.  $154\pm 31\text{ mm}^3$  and  $131\pm 129\text{ mm}^3$ , respectively). However, tumor growth resumed 12 days after treatment initiation ( $181\pm 112\text{ mm}^3$ ), correlating with the reduced T-cell activity shown by declining CYT-200 PET uptake values.

#### **CONCLUSION**

These preliminary results demonstrate that the novel human granzyme B PET imaging agent CYT-200 labeled with  $^{68}\text{Ga}$  can detect intra-tumoral T-cell activity associated with tumor-killing following immune checkpoint inhibitor therapy in a humanized mouse model for melanoma.

#### **CLINICAL RELEVANCE/APPLICATION**

Granzyme B PET imaging is a tool for monitoring response to immunotherapy in melanoma patients, which could lead to more effective treatment decisions and improved patient outcomes.

#### **R5A-SPNMMI-2 Incidental Detection of Focal F-18 FDG Uptake in the Prostate of Oncologic Patients with Application of Logistic Classification**

Kyung Hoon Hwang, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Although prostate cancer has been refocused in the field of nuclear medicine with the advent of FDA-approved PSMA-targeted PET imaging radiopharmaceuticals, however, F-18 FDG still remains the most used drug in oncologic PET imaging. This

retrospective study was to assess the incidentally observed focal prostate F-18 FDG uptake in non-prostate cancer patients, and to apply Logistic classification to improve the diagnostic accuracy.

## **METHODS AND MATERIALS**

The reports of F-18 FDG PET/CT performed in non-prostate male cancer patients at our hospital were retrospectively reviewed to identify unexpectedly observed suspicious focal prostate uptake. Among them, those with final histopathological reports of the corresponding FDG uptake sites were included in this study. The focal uptakes were classified as malignant or benign according to the histopathological reports. SUV parameters such as SUVmax, SUVpeak, MTV of each focal uptake was measured, and compared between malignant and benign lesions. Logistic classification was applied to the SUV parameters using R software to improve the diagnostic accuracy. Statistical significance was set at  $p < 0.05$ .

## **RESULTS**

About half of the focal uptakes were malignant. Among the calculated FDG parameters, maximum SUV differentiated malignant from benign lesions with the best accuracy. Application of Logistic classification didn't improve the diagnostic accuracy.

## **CONCLUSION**

About half of the incidental focal prostate F-18 FDG uptake was proved to be malignant. This finding could justify the application of PET imaging to cancer patients and subjects at high risk of developing cancer. A further study with a larger number of subjects and more dedicated machine Learning algorithms might be warranted.

## **CLINICAL RELEVANCE/APPLICATION**

Authors investigated the clinical significance of incidental prostate FDG uptake and the usefulness of application of machine Learning algorithm such as Logistic classification in the diagnostic accuracy.

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## Abstract Archives of the RSNA, 2023

R5A-SPNPM

### Noninterpretive Skills (Beyond Imaging) Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPNPM-1 Sterile Gown and Drape, and Bouffant Cap for Thyroid FNA: Preventing Infections or Producing Unnecessary Medical Waste**

Scott Tseng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ultrasound-guided fine needle aspiration is a very low-risk procedure. Despite this, there remains great variability with extensive protective equipment use. Given the inherent monetary and environmental costs of protective equipment, this study aims to assess the difference in infection rate when conducted with full versus limited (without bouffant/cap, sterile gown, and full body sterile drape) protective equipment use.

#### **METHODS AND MATERIALS**

A total of 310 consecutive patients were retrospectively reviewed for thyroid fine needle aspirations at the main hospital and outpatient clinic site from December 1, 2020 to May 15, 2022. The hospital site operated with full protective equipment (bouffant, sterile gown, sterile gloves, and full body sterile drape), and the outpatient site operated with limited (sterile gloves, limited sterile paper drape) protective equipment. Two patients were excluded as no procedure was performed. Review for signs of infection within 30 days of procedure was performed using medical records blindly to the degree of protective equipment utilization. Descriptive statistics and confidence intervals were provided to compare the two groups.

#### **RESULTS**

No infections were identified in either group, with 0/230 (0%, 95CI% 0 - 2%) in the full protective equipment group vs. 0/78 (0%, 95CI% 0 - 6%) in the limited protective equipment group. There was no statistically significant difference in infection rate between full and limited protective equipment use in thyroid fine needle aspiration (FNA) in the included 308 procedures with 95% confidence interval of -6% - 2%. Two patients out of 230 (0.9%) in the full protective equipment group developed mild allergic reaction to topical antiseptic. The 78 procedures with limited protective equipment represents a saving of at least 70,590 grams of carbon dioxide equivalents compared to full protective equipment procedures.

#### **CONCLUSION**

Decreasing the extent of protective equipment does not impact the infection rate for thyroid FNA. Given the inherent costs involved in the procurement and waste of protective equipment, reducing protective equipment use is warranted to reduce both the monetary and environmental impacts of waste.

#### **CLINICAL RELEVANCE/APPLICATION**

Using limited protective equipment (sterile gloves and limited drape) for thyroid FNA does not increase infection rate as compared to full protective set, while saving significant grams of carbon dioxide equivalents.

#### **R5A-SPNPM-2 Dual Energy CT: Less is More**

Caterina Di Manna, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the reduction of iodinated contrast agent and radiation dose using Dual Source Dual Energy CT, maintaining the same image quality.



## **METHODS AND MATERIALS**

This single-center randomized prospective study enrolled 121 oncologic patients who underwent the first CT exam acquired with a single energy (SE) 128-slice CT (LightSpeed VCT) and the subsequent using a Dual Source Dual Energy CT (Somatom Force) (DSDECT). In the first exam, was administered a dose of contrast agent (CA) (Iomeron 350) of 0.7mg of iodine per kg of lean body mass (LBM). In the second exam with DSDECT the dose of CA was reduced to 0.5mg of iodine per kg of LBM. The mean value of CA administered to patients were compared between the two exams. The difference in radiation dose between the two exams was considered as secondary outcome. Quantitative image analysis was performed considering enhancement of porta, liver parenchima and aorta, and noise metrics. Image quality was evaluated considering visual perception of enhancement, noise, and artifacts based on a 5-point Likert scale.

## **RESULTS**

The mean CA dose administered to patients in the first exam (SE) was 105.4ml ( $\pm 13.19$ ), with a mean iodine dose of 36.91g ( $\pm 4.62$ ); in the second control (DE), an average of 81.23ml of CA ( $\pm 14.68$ ) was administered, with an average iodine dose of 28.53g ( $\pm 5.20$ ). Qualitative analysis demonstrated comparable image quality in scans with DECT. Our study also demonstrated a reduction in the average radiation dose delivered to the patient by 36% using DECT.

## **CONCLUSION**

Our study confirms the advantages of DSDECT in the follow-up of oncologic patients. Using DSDECT it is possible to reduce the amount of iodinated CA by 30% and radiation dose by 36% maintaining the same image quality.

## **CLINICAL RELEVANCE/APPLICATION**

Dual Energy CT is a promising technique to evaluate oncologic patients using a reduced amount of contrast media and radiation dose. These advantages are crucial in patients which, due to their pathology, frequently undergo a follow-up CT scans.

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## Abstract Archives of the RSNA, 2023

R5A-SPNR

### Neuroradiology Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPNR- Prediction of Future Dementia for MCI Patients from Neuroimaging and Other Multimodal Data Using a Novel Machine Learning Framework** 1

Andrew Cirincione, MS, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Prediction of future dementia for patients with mild cognitive impairment (MCI) is a significant clinical goal, so that the identified cases can benefit from available treatments. Currently, the clinical standard for diagnosing dementia utilizes neuroradiological findings from multimodal imaging modalities such as MRI and PET scans, as well as cognitive tests and biomarkers like tau and amyloid uptake levels in cerebrospinal fluid. However, efficiently and objectively analyzing these complex and disparate data can be difficult in clinical settings, contributing to high rates of underdiagnosis or misdiagnosis of dementia at early stages. Machine learning (ML) offers a potentially more efficient and objective methodology to predict future dementia for MCI patients from these multimodal data.

#### **METHODS AND MATERIALS**

We recently developed Ensemble Integration (EI), an ML framework designed to advance predictive modeling from multimodal data by leveraging complementarity among the data modalities (Li et al, *Bioinformatics Advances*, 2022). In this work, we assessed EI's ability to predict the future development of dementia among MCI patients using processed T1-weighted MRI imaging and other multimodal data from The Alzheimer's Disease Prediction of Longitudinal Evolution (TADPOLE) challenge (Marinescu et al, *Predictive Intelligence in Medicine*, 2019). Specifically, we developed an EI-based predictive model of dementia from data of 672 MCI patients collected at their first visit (baseline), and rigorously evaluated this model and benchmark methods from two separate test sets.

#### **RESULTS**

For predicting the future development of dementia among MCI patients, the EI-based model performed better on the two test sets (AUROC=0.77/0.78, sensitivity=0.71/0.75, specificity=0.74/0.75) than commonly used XGBoost (AUROC=0.66/0.67, sensitivity=0.59/0.63, specificity=0.73/0.71) and deep learning (AUROC=0.63/0.64, sensitivity=0.78/0.62, specificity=0.41/0.55) approaches. Among the most predictive features in this EI model were MRI-derived measurements of the white matter volume of the thalamus, a region associated with dementia (Aggleton et al, *Brain*, 2016; Ryan et al, *Brain*, 2013).

#### **CONCLUSION**

EI is an effective framework for predicting if an MCI patient will develop dementia in the future from neuroimaging and other multimodal data collected at baseline. EI identified several neuroimaging features associated with progression to dementia that may have gone unidentified using traditional statistical methods.

#### **CLINICAL RELEVANCE/APPLICATION**

By integrating neuroimaging and other multimodal data using an effective method like Ensemble Integration, it is possible to accurately predict the development of future dementia among MCI patients.

#### **R5A-SPNR- Performance of Dual-Layer Spectral Detector CT in Identifying Early Ischemic Changes in Acute Ischemic Stroke Patients** 11

Keiichi Honda (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to evaluate the efficacy of spectral imaging using computed tomography (CT) equipped with a dual-layer detector for diagnosing acute ischemic stroke.

## METHODS AND MATERIALS

We retrospectively analyzed CT spectral images of 26 regions in 15 patients diagnosed with acute ischemic stroke. We performed non-contrast brain CT using dual-layer detector CT non-contrast brain MRI on the same day. We compared the conventional CT values, relative electron density (ED), effective atomic number (Zeff) of the ischemic stroke region the contralateral normal region. We used the Mann-Whitney U test to compare each imaging parameter in the ischemic region the normal region. Receiver operating characteristic (ROC) analysis was conducted to determine the area under the ROC curve (AUC) for the differentiation of acute ischemic stroke.

## RESULTS

The CT value ( $28.2 \pm 3.93$  HU vs.  $33.4 \pm 2.34$  HU,  $P < 0.001$ ) the ED ( $102.43 \pm 0.411$  vs.  $102.95 \pm 0.170$ ,  $P < 0.001$ ) showed a significant difference between the ischemic stroke region the contralateral normal region. There was no significant difference in Zeff ( $7.357 \pm 0.0465$  vs.  $7.365 \pm 0.0365$ ,  $P = 0.47$ ). The AUC for the diagnosis of acute ischemic stroke using conventional CT, ED, and Zeff were 0.846, 0.904, and 0.615, respectively. With an optimal threshold of ED of 102.65, the sensitivity, specificity, PPV, NPV, and accuracy of differentiation of acute ischemic stroke were 80.8%, 100%, 100%, 83.9%, and 90.4%, respectively.

## CONCLUSION

Our results suggest that electron density images derived from dual-layer detector CT can improve the detection of acute ischemic stroke compared to conventional non-contrast CT imaging.

## CLINICAL RELEVANCE/APPLICATION

Improved discrimination of early ischemic changes region with electron density images, as compared to conventional images, is expected to lead to easier CT diagnosis of acute ischemic stroke.

## R5A-SPNR- Neurotransmitters Release in the Brain Extracellular Space Following Neuronal Excitation 13 can be Tracked by Tracer-based MRI

Yuanyuan Li (*Presenter*) Nothing to Disclose

## PURPOSE

The interstitial fluid (ISF) within the brain extracellular space (ECS) is a direct microscopic environment in which brain cells survive and function, however, the dynamic modulatory processes that occur in the ECS upon stimulation, as well as their underlying mechanisms, have not been elucidated. Given the potentially important capacity of tracer-based magnetic resonance imaging (MRI) in visualizing the drainage of ISF in brain ECS and analyzing the diffusion characteristics of ECS in the deep brain, it is pertinent to explore the underlying biophysical mechanisms.

## METHODS AND MATERIALS

In the present study, by using an algorithm-optimized tracer-based MRI and DECS-Mapping techniques, we quantitatively measured the dynamic biophysical parameters of the brain ECS structure and ISF drainage in the thalamus following neuronal excitation in an electric pain stimulation rat model. Immunofluorescence assays and western blot were used to confirm the morphological basis for structural changes in ECS. Additionally, the release and distribution of neurotransmitters were mapped at different time-points following pain stimuli by using mass spectrometry imaging (MSI). The same examinations were performed in an aquaporin-4 (AQP4) gene knockout rat model to explore the roles of AQP4 in regulating ECS structure and ISF drainage.

## RESULTS

Significantly decreased diffusion coefficient (DECS) and volume fraction ( $\alpha$ ) of the brain ECS were found in the thalamus caused by neuronal excitation, accompanied with the slowdown of ISF drainage. The morphological basis for structural changes in ECS was local spatial deformation of astrocyte foot processes. An AQP4 knockout rats model was used in which the changes of the ECS structure were reversed and found that the slowed DECS and ISF drainage persisted. Meanwhile, the dynamic changes of DECS were found to be synchronized with the release and elimination processes for neurotransmitters following neuronal excitation.

## CONCLUSION

In conclusion, tracer-based MRI represents a promising technique to reflect neuronal activity, the down-regulation of ISF drainage following neuronal excitation is caused by the restricted diffusion in the brain ECS, and  $D_{ECS}$  might be used to track the neurotransmitters release following neuronal activities in the deep brain.

## CLINICAL RELEVANCE/APPLICATION

Tracer-based MRI represents a promising technique to reflect neuronal activity. Brain ECS and ISF drainage within it will become a new target for monitoring neural network excitation, which will open up new research avenues for understanding the physiology and pathology of central nervous system diseases.

## R5A-SPNR- Investigating ChatGPT's Capability to Generate Differential Diagnoses from Transcribed Radiological Findings in Neurological Imaging

2

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

### PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of neuroradiology cases.

### METHODS AND MATERIALS

A sample of 32 neuroradiology cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

### RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 37.5% compared to 56.3% ( $p=0.065$ ) and 9.4% compared to 15.6% ( $p = 0.23$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 44.3% compared to 52.5% ( $p=0.25$ ). ChatGPT3.5 and ChatGPT4 hallucinated 36.5% versus 12.2% ( $p=0.012$ ) of the references provided and generated 7 total false statements versus 3 total false statements, respectively.

### CONCLUSION

The ChatGPT algorithms were able to produce a differential diagnosis for prompts containing descriptive radiological findings. The responses matched the expert literature from which the cases originated a minority of the time, though a non-statistically significant improvement was made in the accuracy categories from 3.5 to the 4th generation algorithm. The renowned hallucination effect appeared more frequently in generated citations compared to algorithm-produced statements, with both showing improvement in the latest generation.

## CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) hold significant potential to influence both clinical and educational aspects of medicine. Familiarity with the precision and potential errors of these algorithms can offer a deeper insight into the constraints of these emerging tools.

## R5A-SPNR- Deep-Learning Augmented Contrast Enhancement Improves the Detection of Cerebral Vessel Occlusions in CT-Angiography of Acute Stroke Patients

3

Sebastian Steinmetz, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To examine the impact of deep-learning augmented contrast enhancement on diagnostic performance of poorly contrasted computed tomography angiography (CTA) in acute stroke.

### METHODS AND MATERIALS

This retrospective single center study included patients with suspected ischemic stroke who underwent comprehensive CT imaging including cranial computed tomography (CCT), whole brain volume perfusion CT (VPCT) and computed tomography angiography (CTA) and had poorly contrasted CTA (defined as  $<350\text{HU}$  in the proximal MCA) between 01/2021 and 12/2022. 58/102 patients had vascular occlusion with correlate in perfusion. All CTA datasets were reconstructed conventionally using iterative reconstruction (conventional CTA, cCTA) and additionally using an AI-powered Augmented Contrast Enhancing tool (ClariACE, ClariPi, Seoul South Korea), which is a pre-trained deep learning model allowing selective boosting of contrast agent components in CT images (enhanced CTA, eCTA). The quantitative features including slope, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), noise, entropy and density values were examined by software and were calculated standardized and compared. Datasets were then evaluated by two blinded radiologists, who applied 4-point-Likert-scales to

general and vessel specific measures of both cCTA and eCTA datasets (overall image quality, overall contrast, artifacts, diagnostic confidence, image noise, assessability of proximal, intermediate and subcortical vessels). Furthermore, readers evaluated both datasets for presence / absence of cerebral vessel occlusions with VPCT serving as reference standard for calculating sensitivity and specificity.

## RESULTS

This study included 102 patients (mean age=67.69±13.18y; 32 women). Objective image evaluation revealed an increase in iodine contrast by ca. 100%. eCTA revealed significantly higher subjective contrast, diagnostic confidence and overall image quality ( $p < .001$ ). Both readers achieved significantly improved sensitivity with eCTA as compared to cCTA (Reader 1: 55/58 [95%; 95%-CI: 85.62% to 98.92%] vs. 48/58 [83%; 95%-CI: 70.57% to 91.41%]; Reader 2: 53/58 [91%; 95%-CI: 81.02.% to 97.14%] vs. 46/58 [79%; 95%-CI: 66.65% to 88.83%]). Reader 1 yielded no false positive findings on cCTA or eCTA (specificity 44/44 [100%; 95%-CI: 91.96% to 100%]), reader 2 yielded no false positive findings on cCTA and 1 false positive on eCTA (reader 2: 43/44 [98%; 95%-CI: 87.98% to 99.94%]).

## CONCLUSION

Deep-learning augmented contrast enhancements significantly increases image quality and diagnostic performance of poorly contrasted CTA.

## CLINICAL RELEVANCE/APPLICATION

Enabling faster and more accurate care for stroke patients.

## R5A-SPNR- Use of a Computer-based Program to Classify Injuries from the Upper Cervical Spine According to AO Spine Classification

David E. Timaran Montenegro, MD (*Presenter*) Nothing to Disclose

## PURPOSE

AO classification is a detailed, laborious, and challenging standardized assessment to describe imaging findings of UCST. To improve efficiency reducing assessment time, a computerized program was developed to determine AO Classification from standardized imaging report system from Cervical Spine Imaging CT and MRI called, PAUCI: Program for Analysis of Upper Cervical Injury.

## METHODS AND MATERIALS

The computer program utilizes a series of 44 dichotomic questions based on the presence or absence of imaging findings. Initially, registration of lesions was performed retrospectively by two neuroradiologist after consensus was achieved. Then, the database was reviewed by PAUCI and a third blinded neuroradiologist to determine AO classification. Statistical analysis included calculation of agreement coefficients between the neuroradiologist assessment and AO classification according to anatomic level and severity type of injuries.

## RESULTS

Initially, 170 subjects with UCST were included in our study and registered in the database. All patients showed lesions in the upper cervical spine on CT or MRI. Among them, 70 subjects were randomized to be assessed by the third blinded evaluator and PAUCI. Second-order agreement coefficients indicated that PAUCI and the neuroradiologist demonstrated a statistically significant degree of agreement regarding AO injury level (Level I: AC2 0.886, Level II: AC2 0.874, Level III: 0.675;  $Pr > |Z|$  ( $p$  value)  $< 0.0001$  for all). There was also significant agreement regarding AO injury severity at each level (Type A: 0.980; Type B: 0.864 Type C: 0.639;  $Pr > |Z| < 0.001$  for Type A and B and 0.0064 for Type C).

## CONCLUSION

AO classification for the upper cervical spine injury determined by PAUCI and neuroradiologist demonstrated a statistically significant degree of agreement. Stronger agreement was identified with lesions occurring at the anatomic Level I. More modest agreement was found with lesions at Level III with severity type C. PAUCI represents an opportunity to determine AO classification efficiently and accurately from cervical spine imaging in cases of upper cervical spine injury.

## CLINICAL RELEVANCE/APPLICATION

Detailed description of imaging findings in patients with upper cervical spine trauma using a standardized system is needed to assess prognosis and outcomes. Currently, AO spine is a reliable classification system. Main limitations include difficulty and time consumption in busy real life practice. Computerized systems can help to expedite the process to classify lesions.

## R5A-SPNR- Correlation of Brain Stiffness Measured Using Virtual MR Elastography Based on DWI with Enlarged Perivascular Space

Miran Han, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Enlarged perivascular spaces (EPVS) have been known to be associated with various degenerative disease. However, since they were also frequently observed in healthy population, it is not clear how severe EPVS burden can be considered pathologic. Therefore, we investigated the relationship EPVS and brain stiffness which is also considered as biomarker of neurodegenerative disease, using the virtual magnetic resonance elastography (vMRE). That is a non-invasive and novel technique based on diffusion weighted imaging (DWI)

## METHODS AND MATERIALS

We retrospectively reviewed healthy adults who performed MR imaging for routine medical examination from March 2021 to June 2022. EPVS were rated on visual grading [grade 0, 1, 2, 3, 4 for 0, 1-10, 11-20, 21-40, >40 EPVS at centrum semiovale (CSO) and basal ganglia (BG) of either hemisphere]. We excluded patients who had high SI at white mater (> Fazekas scale 1), EPVS at BG > grade 1, hypertension, cardiovascular disease, and diabetes to minimize the effect of confounding factors. We randomly selected age matched patients according EPVS grade at CSO. Shifted apparent diffusion coefficient was calculated from DWI ( $b=200$  and  $1500\text{sec}/\text{mm}^2$ ) and converted to DWI-based virtual shear modulus ( $\mu$ ). Brain stiffness was measured in centrum semiovale area, but also in whole brain. Multiple comparison test were performed for evaluating relationship between EPVS grade and brain stiffness.

## RESULTS

Finally 248 patients (50 patient for grade 0, 1, 2, 3 and 48 patients for 4, 107 female, 141 male) were included. There were no differences in brain volume between EPSV groups ( $P = 0.109$ ), the virtual shear modulus ( $\mu$ ) decreased not only in CSO but also in whole brain, as the EPSV grade increased ( $P < 0.001$ ). In post hoc analysis, there is no significant differences of brain stiffness between G0 and G1 ( $P = 0.939$  for CSO,  $P = 0.984$  for total brain), G2 and G3 ( $P = 0.893$  for CSO,  $P = 0.418$  for total brain). When the EPVS was re-graded as normal (G0-1), mild (G2-3) and high (G4), the change of brain stiffness parameters were significant according to EPSV grade (Normal vs Mild,  $P = 0.001$ ; Mild vs High,  $P = 0.015$  for CSO and  $P = 0.001$ ;  $P = 0.016$  for total brain).

## CONCLUSION

The higher degree of EPVS at CSO presented lower value of brain stiffness parameter. The rating system of EPVS needs to be revised in consideration of clinical impact.

## CLINICAL RELEVANCE/APPLICATION

The enlarged perivascular space showed negative correlation with brain stiffness measured using virtual MR elastography, new rating system of EPVS based on brain stiffness could be suggested.

## R5A-SPNR- Harmonized Tract Based Spatial Statistics (TBSS) with Multiple Diffusion Models of the Alzheimer's Disease Connectome Project (ADCP)

John W. Roberts, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Alzheimer's Disease (AD) has been mainly thought of as a disease involving gray matter changes. Gray matter atrophy is observed primarily in fronto-temporal regions, but less is known about the disruptions to white matter. This study investigates disruptions to white matter in the AD continuum (cognitive unimpaired (CU) or healthy controls (HCs); cognitive impaired (CI) - Mild Cognitive Impairment (MCI) and AD) using diffusion tensor imaging (DTI) and multi-tissue neurite and orientation dispersion and density imaging (mtNODDI) models of the multi-shell connectome diffusion MRI (ms-dMRI) data from the Alzheimer's Disease Connectome Project (ADCP).

## METHODS AND MATERIALS

Data from 121 participants (Cognitive Unimpaired (26 M, 43 F) mean age  $67 \pm 7.2$ ; Cognitive Impaired (31 M, 21 F) mean age  $73.2 \pm 8.8$ ) in the ADCP with ms-dMRI were pre-processed using DESIGNER processing guidelines using tools implemented in FSL, ANTS, and MRtrix3. TBSS pre-processing was performed, and parametric ComBat data harmonization was applied to the skeletonized data for the DTI and mtNODDI parameters. The effects of cognitive impairment on these parameters were statistically evaluated using permutation testing and threshold free cluster enhancement with family wise error corrected threshold of  $p < 0.05$ , controlling for age and sex.

## RESULTS

Analysis of DTI and NODDI measures revealed significant differences in mtCSF (partial volume fraction of cerebrospinal fluid), mtODI (orientation dispersion index of neurites), and mtVFEXTRA (partial volume fraction of extracellular free water) between CI and CU individuals. Specifically, CI individuals had higher mtVFEXTRA (1 cluster) and mtODI (6 clusters), and lower mtCSF (1 cluster) and mtODI (1 cluster) than CU individuals. All results are statistically significant with family-wise error corrected p-values with an a level of 0.05.



## CONCLUSION

Cognitively impaired individuals were found to have decreased axonal coherence in the brainstem and surrounding cerebellar regions as well as in frontal lobe sub gyral white matter, suggesting increased neurodegeneration in these regions. Conversely, cognitively impaired individuals were found to have reduced extracellular fluid in cerebral white matter and decreased tissue complexity in the gray matter of the posterior corona radiata. Further research is needed to replicate and extend these findings and investigate potential confounding factors.

## CLINICAL RELEVANCE/APPLICATION

Neurite complexity tends to decrease in the posterior white matter and increase in the brainstem and sub gyral frontal white matter in cognitively impaired individuals on the AD continuum.

## R5A-SPNR- Pretreatment MR-Based Radiomics in Patients With Glioblastoma: A Systematic Review and Meta-Analysis of Prognostic Endpoints

Su Jeong Yang, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Recent studies have shown promise of MR-based radiomics in predicting the survival of patients with untreated glioblastoma. This study aimed to comprehensively collate evidence to assess the prognostic value of radiomics in glioblastoma.

## METHODS AND MATERIALS

PubMed-MEDLINE, Embase, and Web of Science were searched to find original articles investigating the prognostic value of MR-based radiomics in glioblastoma published up to March 6, 2022. Concordance indexes (C-indexes) and Cox proportional hazards ratios (HRs) of overall survival (OS) and progression-free survival (PFS) were pooled via random-effects modeling. For studies aimed at classifying long-term and short-term PFS, a hierarchical regression model was used to calculate pooled sensitivity and specificity. Between-study heterogeneity was assessed using the Higgin inconsistency index (I<sup>2</sup>). Subgroup regression analysis was performed to find potential factors contributing to heterogeneity. Publication bias was assessed via funnel plots and the Egger test.

## RESULTS

Among 596 abstracts, 17 studies were included. Respective pooled C-indexes and HRs for OS were 0.65 (95% confidence interval [CI], 0.58-0.72) and 2.88 (95% CI, 2.28-3.64), whereas those for PFS were 0.61 (95% CI, 0.55-0.66) and 2.78 (95% CI, 1.91-4.03). Among 4 studies that predicted short-term PFS, the pooled sensitivity and specificity were 0.77 (95% CI, 0.58-0.89) and 0.60 (95% CI, 0.45-0.73), respectively. There was a substantial between-study heterogeneity among studies with the survival endpoint of OS C-index (n=9, I<sup>2</sup>=83.8%). Publication bias was not observed overall.

## CONCLUSION

Pretreatment MR-based radiomics provided modest prognostic value in both OS and PFS in patients with glioblastoma.

## CLINICAL RELEVANCE/APPLICATION

Pretreatment MR-based radiomics provided modest prognostic value in patients with glioblastoma with pooled C-indexes for overall survival and progression-free survival as 0.65 and 0.61, respectively.

## R5A-SPNR- Imaging Findings of IIH: The Value of MRI in Predicting the Presence of Disease

Zachary Miles (*Presenter*) Nothing to Disclose

## PURPOSE

Idiopathic intracranial hypertension (IIH) is a condition characterized by an increase in cerebrospinal fluid (CSF) with a lack of identifiable structural cause or etiology. This condition is expected to rise in incidence along with an increase in obesity in the coming years. Brain imaging has been successfully used to identify this disease with specific findings prompting further evaluation. We believe that MR imaging findings can predict the presence of IIH and we attempted to reproduce and reinforce existing knowledge in the literature.

## METHODS AND MATERIALS

This study was a retrospective data analysis of MRI imaging reports completed during the calendar year 2020 at John Peter Smith hospital. Any MRI report including the phrase "Idiopathic intracranial hypertension" was reviewed and patients with a lumbar puncture confirming the diagnosis of IIH were included. The study sample was 64 IIH cases and 41 normal MRI brains as a control. All cases were deidentified and randomized. These MRI studies were reviewed by three different neuroradiologists who were blinded to the diagnoses. The presence or absence of four imaging findings was noted—empty pituitary sella, posterior globe flattening, bilateral transverse sinus stenosis, and enlarged optic nerve sheaths. Inter-rater reliability (IRR) was analyzed as well as Odds Ratios for each finding using a generalized linear mixed model.

## RESULTS

Our results demonstrated substantial and almost perfect agreement amongst radiologists when identifying empty pituitary sella, enlarged optic nerve sheaths, and posterior globe flattening (IRR value >0.6). However, there was only moderate agreement amongst radiologists when assessing bilateral transverse sinus stenosis (? value 0.569). Odds ratios for each imaging finding were statistically significant (p value <.0001). Posterior globe flattening had the highest odds ratio and was never seen in controls.

## CONCLUSION

Our results reinforce existing evidence that specific MR imaging findings can predict the presence of IIH. A limitation to this study was the lack of vascular imaging such as MR Venography, which is likely responsible for the low IRR in identifying bilateral transverse sinus stenosis. A future study could look at CT or MR venography alone or combined with these findings to predict the presence of IIH.

## CLINICAL RELEVANCE/APPLICATION

As the incidence of IIH increases in the population, it is increasingly important to recognize MR findings which predict the presence of this disease. In addition, vascular imaging should be included in the diagnostic workup of IIH.

## R5A-SPNR- Reduction of Injected Volume of Intravenous Contrast Media for Brain CT: Problem or Opportunity

Goni Merhav (*Presenter*) Nothing to Disclose

## PURPOSE

This study investigates whether reducing the volume of intravenous iodinated contrast material injected during brain computed tomography (CT) provides reliable and accurate enhanced imaging without compromising diagnostic accuracy.

## METHODS AND MATERIALS

In this prospective IRB approved study of 102 consecutive patients all of whom received informed consent, enhanced brain CT was done for indications such as headache and dizziness. 47 patients then received a reduced dose of 60 ml of Omnipaque 350 iv, while the control group of 55 patients received the usual 80 cc of Omnipaque 350 iv as suggested on the package insert. All CTs were done on a Siemens Somatom Definition Flash scanner or Siemens Somatom AS 64 with the same parameters: 100kV, 300-400 mA, 3 mm slice thickness, 12/3200 window width, data collection diameter 500. Three neuroradiologists blinded to the amount of injected contrast material rated the CT scans for image quality and lesion detection using a 5-point Likert scale. Readings were controlled for age and gender. Visibility of six anatomic structures was recorded by each reader. Inter-rater reliability was tested using intra class correlation (ICC, two-way random effect model, single rater, agreement) based on the 95% confidence interval of ICC estimates. Multiple linear regression was used to predict overall diagnostic accuracy.

## RESULTS

Readers' ratings had a high intra class correlation coefficient (ICC) value of 0.873 (CI 95% 0.831-0.908). No significant demographic or clinical differences were noted between the two groups. The 80cc group had significantly higher enhancement ratings compared to the 60cc group for six anatomical structures. However the mean difference scores between the study group and the control group for the six items were less than 0.5 (p<0.001).

## CONCLUSION

The rankings of the raters for both the test and control groups did not differ significantly. Therefore, the overall diagnostic quality did not show a clinically significant difference between the two groups. The potential advantages of reduced contrast volume include shortened scan duration, lower radiation exposure, lower risk of adverse effects such as contrast induced nephropathy or cardiac failure, and cost minimization. Conservation of iodinated contrast media is a timely concern given the recent global shortage of iodinated contrast material in the year 2022.

## CLINICAL RELEVANCE/APPLICATION

Reduced IV contrast volume for brain CT yields accurate imaging, may reduce adverse effects (nephropathy or cardiac failure), is cost minimizing, has shorter scan times, and mitigates future supply chain contrast shortages.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5A-SPPD

### Pediatric Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPPD- Developing an Evidenced-Based Pediatric Pituitary Magnetic Resonance Imaging Protocol: 1 How We Did It**

Michael Nance, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop a protocol to facilitate appropriate intravenous contrast use based on various pediatric pituitary imaging indications.

#### **METHODS AND MATERIALS**

A retrospective review of pediatric pituitary MRI protocols at Children's Healthcare of Atlanta was performed from July 2021 to June 2022 using the Empower database and review of patient records. Information for ordering specialty, imaging indication, and MRI protocol including the use of Gadolinium (Gd) were obtained. A comprehensive systematic and manual literature search was performed. PubMed MESH search criteria: (pediatrics OR child) AND magnetic resonance imaging AND (sella OR pituitary OR hypophysis), and patient age from newborn (birth-1 month) to adolescent (13-18 years). Included articles informed the magnetic resonance imaging technique for: precocious puberty, hypopituitarism, septo-optic dysplasia, Sellar mass, diabetes insipidus and pituitary adenoma. The systematic search resulted in 1,778 citations which yielded 57 articles after screening inclusion/exclusion criteria. Manual search contributed an additional 18 articles.

#### **RESULTS**

From July 2021 to June 2022, a total of 375 studies were performed (235 female, 140 male) with an age range of 6 weeks to 20 years (mean 10.7 years). The most frequent imaging indications were growth hormone deficiency (GHD) (44.1%) followed by precocious puberty (33.2%). Other indications included adenoma (13.1%) and pituitary mass (9.6%). Ordering provider specialty was predominantly endocrinology (70.9%). A total of 284 studies were ordered with Gd (75%). Based on indication, there was substantial institutional variance in the use of Gd. Adenoma (96% with Gd), GHD (59% with Gd), mass (75% with Gd), and precocious puberty (90% with Gd). Preliminary review of the literature also showed variation with included references describing Gd use in 93.3% (28/30) for pituitary mass, 50% (13/26) for hypopituitary/GHD, and 80% (4/5) for precocious puberty.

#### **CONCLUSION**

Standardized pediatric pituitary imaging protocols are not widely available potentially causing variance in the diagnostic efficacy. We demonstrate that there is substantial intra-institutional variance in the use of Gd based on pediatric pituitary imaging indication at a single institution quaternary children's hospital. We developed imaging protocol recommendations for each pituitary imaging indication based on our literature review. This will be presented to our endocrinologists for review and modifications to meet our local practice demands.

#### **CLINICAL RELEVANCE/APPLICATION**

We developed an institutional evidenced based pediatric pituitary imaging protocol to inform the appropriate use of Gd contrast for diagnostic efficacy.

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## Abstract Archives of the RSNA, 2023

R5A-SPPH

### Physics Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPPH- Comparison of Scan Protocols with Different Automatic Exposure Control Software Using Water Equivalent Diameter Calculated from CT Images** 1

Hsiang-Chi Kuo, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study evaluated the patient dose and size difference when translating clinical scan protocols from one CT scanner to a new PETCT scanner with different automatic exposure control (AEC) software.

#### **METHODS AND MATERIALS**

Reference clinical protocols were built on a Philips big bore scanner (P) using 3D DOM version of Dose Right (DR) for AEC with different DR levels at various anatomical sites. These protocols were translated to a new Siemens Biograph V600 PETCT scanner (S) which utilizing CareDose 4D as AEC to modulate mAs in different strength from very weak to very strong with different Quality Reference mAs (Q. RefmAs). The average CareDose strength was applied. The RefmAs of the RT protocols from S were used with minor edits. An anthropomorphic phantom, wrapped with 0 and 5 cm bolus, was scanned using thorax and abdomen protocols at S and P scanners. The cross-sectional size of the phantom on the CT image was calculated as the water equivalent diameter (wED) based on the method described in AAPM TG 220 report. The CTDIvol for each slice was extracted from the DICOM header. The wED, and the CTDIvol data from each scanned protocol were statistically analyzed using the Spearman coefficient to determine the correlation. 85 patient scans on both scanners were compared to the CTDIvol as a function of wED across scanners and anatomical locations.

#### **RESULTS**

In phantom images' analysis, the P scanner using DR showed a higher correlation to wED ( $>0.83$  vs.  $<0.8$ ) than the S scanner, which applied RefmAs. Comparing the statistical results among protocols from both scanners, the subgroup of the scans from the same scanner (DR=17 vs. DR=21 vs. DR=25; Thorax Q. RefmAs=160 vs. Abdomen Q. RefmAs=250) showed a strong correlation (0.98). The scan results from different scanners (S vs. P) showed a weaker ( $<0.83$ ) correlation. Comparing patient scans, the images of the S scanner demonstrated a significantly higher exposure variance with wED and a sharper CTDIvol increase at wED between 25-30 cm resulting in a higher scanning dose with the pre-estimated patient size larger than  $\sim 28$  cm. P scanner had a maximum exposure limit so that CTDIvol could be kept below 27.6 mGy in the body site. S scanner did not limit maximum exposure from software such that the CTDIvol exposure could be more than 40 mGy, and in the case when scanned with the hand positioned on the chest, the CTDIvol could be more than 60 mGy.

#### **CONCLUSION**

This study highlights that assessing CTDI vs. wED can be a practical approach to evaluating clinical scan protocols for different AEC software and scan protocols.

#### **CLINICAL RELEVANCE/APPLICATION**

Translating CT scan protocols.

#### **R5A-SPPH- Patient-specific Analysis of Organ Doses and Image Quality in Abdominal Single Energy and Dual Energy CT Examinations** 10

Keisuke Fujii, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aims of this study are to evaluate organ doses for individual patients in abdominal CT examinations with conventional 120 kV single energy CT (SECT) and 80/135 kV dual energy CT (DECT), and to compare organ doses and image quality of

the CT images in DECT scans with them in SECT scans.

## **METHODS AND MATERIALS**

Monte Carlo (MC) simulations for each voxelized phantom of 40 adult normal weight and overweight patients undergoing abdominal CT examinations with Aquilion Precision as a SECT scanner and Aquilion ONE / PRISM Edition as a DECT scanner (Canon Medical Systems) were performed by inputting the CT images, descriptions of each CT scanner, and scanning parameters including our estimated tube current modulation profiles into MC simulation software ImpactMC (Advanced Breast CT, GmbH). Region of interests (ROI) of seven radiosensitive organs (thyroid, lung, esophagus, breast, liver, stomach, and bladder) were set on the simulated dose distribution images, and organ doses for each organ were calculated as average doses within each organ ROI. Next, we evaluated image quality of abdominal CT images from SECT scans and 70 keV virtual monochromatic images (VMI) images from DECT scans, which were reconstructed with deep learning reconstruction algorithms. We set ROIs on liver region of plain SECT and VMI images, applied moving average filters in the ROI, and evaluated apparent noise (which showed the correlation with the subjective recognition of image noise on CT images) from standard deviation of the mean CT values for each filter size. Image contrast was calculated as differences between CT values of aorta at the early phase and those of liver region on plain SECT and VMI images, and contrast-to-noise ratio (CNR) was also calculated as the ratio of the contrast and apparent noise of each image.

## **RESULTS**

Organ doses for liver and stomach within scan range of normal and overweight patients in abdominal SECT scans were 22-32 mGy while the organ doses for the patients in abdominal DECT scans were 16-21 mGy. Apparent noise of the VMI images obtained from DECT scans was approximately 30% lower than that of SECT images, and contrast of the VMI images was approximately 30% higher than that of SECT images. From these results, CNR of the VMI images was approximately 2 times higher than that of SECT images.

## **CONCLUSION**

DECT examinations allow for the reduction of organ doses for organs within scan range by approximately 30% compared to conventional SECT examinations, and VMI images obtained from DECT scans also provide higher signal detectability than SECT images.

## **CLINICAL RELEVANCE/APPLICATION**

DECT examinations can be performed with lower radiation doses than conventional SECT examinations, and VMI images obtained from DECT scans can provide higher signal detectability than SECT images.

## **R5A-SPPH- Ultra-low Dose CT Imaging with a Denoising AI model in Body Composition Analysis**

11

Hooney D. Min, MD, MS (*Presenter*) Nothing to Disclose

## **PURPOSE**

Body composition analysis (BCA) is a crucial clinical application. CT is regarded as the gold standard for BCA, but DEXA is more common due to lower radiation exposure. This study evaluated the feasibility of using an ultra-low dose CT protocol with a denoising AI model to reduce radiation exposure without compromising reliability.

## **METHODS AND MATERIALS**

A prospective study of 100 subjects (26 males and 74 females, aged 23-62 years, mean BMI:  $23.2 \pm 3.25$  kg/m<sup>2</sup>) was conducted. Participants underwent a standard dose CT scan (120 mAs, 120 kVp, 0.066 mSv) and were randomly assigned a second CT scan with varying doses: 1) standard dose: 0.066 mSv, 2) half dose: 0.034 mSv, 3) quarter dose: 0.018 mSv, 4) ultra-low dose: 0.007 mSv. All effective doses included a scout view, obtained with a tin filter. Ultra-low dose CT used 10mAs, the lowest achievable on CT. CT scans captured a single 5 mm slice thickness axial image at the third lumbar spine. Standard dose CT scans were reconstructed using the Filtered Back Projection (FBP) method. Low dose CT images were reconstructed using the FBP method and a denoising AI model. CT scans were segmented using a commercially available software to obtain areas relevant to BCA (muscle, subcutaneous fat, and visceral fat). Intraclass correlation was used to compare BCA area values from low dose CT images to that of standard dose CTs. Muscle area was further divided into normal attenuation muscle (NAM) and low attenuation muscle (LAM). Wilcoxon signed rank test was used to compare NAM and LAM values from low dose CT images to that of standard dose CTs.

## **RESULTS**

Body composition parameters (muscle, subcutaneous fat, and visceral fat) from low dose CT scans (even without denoising) demonstrated high agreement with standard-dose CT scans, with intraclass correlation coefficients exceeding 0.95. Total muscle area was uniform across doses, but when divided into NAM and LAM, NAM was underestimated and LAM was overestimated as CT dose became lower. NAM and LAM values differed significantly in low-dose CTs compared to standard-dose CTs. The denoising AI model decreased the differences in NAM and LAM area at half-dose CTs ( $p > 0.05$ ).

## CONCLUSION

Ultra-low dose CT provided accurate BCA without added radiation exposure, even without AI denoising. A denoising AI model enhanced the accuracy in differentiating LAM and NAM in low dose CT scans.

## CLINICAL RELEVANCE/APPLICATION

Ultra-low dose CT imaging (0.007 mSv) offers accurate and safe BCA with a lower effective dose than a single DEXA scan (0.013 mSv), suggesting better BCA without additional radiation exposure.

## R5A-SPPH- Improved Detectability of Low Contrast Objects with Deep Learning-based Denoising on Legacy CT Machine: A 10-Reader Phantom study

Jisu Kim, MD (*Presenter*) Nothing to Disclose

### PURPOSE

This study aims to assess the detectability of low-contrast objects through a human reader test by comparing denoised images obtained from a legacy CT machine with those acquired from a recent CT machine. Additionally, the study compares the low contrast detectability of the original and denoised images obtained from the legacy CT machine.

### METHODS AND MATERIALS

A Catphan® low-contrast phantom module was used for evaluation, with an added soft tissue-mimicking ring, resulting in a total phantom diameter of 30 cm (simulating adult body size). Images were acquired using a legacy CT machine (Philips Brilliance 64) set to 12mGy and a recent CT machine (Siemens Force) set to 32mGy. The images were reconstructed using the Filtered Back Projection (FBP) method. A vendor-agnostic deep learning-based denoising model was employed to process the images from the legacy CT machine. Based on the sample size calculation using a non-inferiority test with a non-inferiority margin of 0.05 in the area under the curve (AUC), 10 human readers and 100 images were required for each setting (denoised and original 12mGy images on legacy CT, and original 32mGy images on recent CT), resulting in a total of 300 images being tested. Of the 100 images, 50 were set to include a 15 mm object with a contrast of 10 HU, and 50 were set to not include. Ten radiologists with varying years of experience evaluated the images using a 5-point Likert scale for the presence of the object, and AUC values were calculated for each setting. A non-inferiority test was performed to compare denoised images with images obtained from the recent CT. An additional superiority test was performed between denoised and original FBP images acquired from the legacy CT.

### RESULTS

The AUC for the original FBP image from the legacy CT was 0.895, while the denoised image from the same machine had an AUC of 0.988. The recent CT had an AUC of 0.993. The low-contrast detectability of denoised FBP images from the legacy CT was found to be non-inferior to the FBP images obtained from the recent CT ( $p < 0.01$ ). Furthermore, denoised FBP images exhibited superior low-contrast detectability compared to the original FBP images acquired from the legacy CT ( $p < 0.01$ ).

## CONCLUSION

The deep learning-based denoising model significantly improved low-contrast detectability on legacy CT and was non-inferior to images obtained from recent CT.

## CLINICAL RELEVANCE/APPLICATION

The application of this vendor-agnostic denoising model may offer a potential solution to improve the detectability of low-contrast objects in clinical settings that still use legacy CT machines.

## R5A-SPPH- Agreement of Size-specific Dose Prediction and Site-specific Diagnostic Reference Level in Adult Abdominal CT Examinations

Shengwen Deng, PHD (*Presenter*) Nothing to Disclose

### PURPOSE

CT doses range across population can be predicted prospectively with size-specific phantoms or reviewed in dose monitoring software, but the agreement between the two methods lack large population confirmation<sup>1</sup>. We aimed to compare predicted size-specific dose to reported values across multiple vendors in our hospital system, and also, to develop strategies to convert between size-specific prediction with Mercury phantom and retrospective site-specific local diagnostic reference level.

### METHODS AND MATERIALS

The overall study design was illustrated (Fig a). Diagnostic reference levels across academic hospitals (n=9) and community sites (n=13) in the past 3 years were quantified with quantile summary of CT DIvol for different BMI groups (n>30 per group), using de-identified meta-data from dose monitoring software (DoseTrack, Sectra, Fig b), retrospectively. Patient sizes (water equivalent diameter, Dw) in Mercury 4.0 phantom were converted to BMI with a reported equation<sup>2</sup>, with an assumed error of 10%. The phantom was scanned using clinical abdomen protocols with identical tube current modulation settings

(reference mAs, DRI or CareDose Index, n=11). Phantom CTDIvol and Dw were calculated with imQuest3. The distributions of CTDIvol for different patient sizes from DoseTrack were compared with phantom-acquired CTDIvol data.

## RESULTS

Retrospective DRLs across hospitals (academic vs community) and vendors (Philips vs Siemens) were shown (Fig c,d), generally agree within BMI groups. Phantom scans with same protocols had lower CTDIvol across all patient sizes compared to local DRL. For Siemens, considerable agreement of median CTDIvol between predicted and reported was identified ( $3.4 \pm 1.8\%$  for academic,  $5.3 \pm 1.8\%$  for community). For Philips, maximum CTDIvol predicted was close to DRL reported median CTDIvol ( $9.1 \pm 5.7\%$  for academic,  $6.9 \pm 5.4\%$  for community).

## CONCLUSION

Size-specific CTDIvol estimated with Mercury phantom has considerable agreement with actual dose range of respective BMI population, with conversion of BMI and Dw. It is feasible to use size-specific phantom to estimate retrospective site-specific dose distribution, with proper optimization for different vendors and protocols.

## CLINICAL RELEVANCE/APPLICATION

Estimating CT dose range prospectively is crucial for imaging protocol optimization. Our findings suggest it is feasible to predict population patient-size-specific CTDIvol for tube-current modulated protocols using size-specific phantom.

## R5A-SPPH- Application of Deep Learning Image Reconstruction Algorithm to Reduce Radiation Dose in Brain CT Perfusion

Fang Wang, PhD, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

o improve the improvement of deep learning image reconstruction (DLIR) algorithm in CT perfusion (CTP) in suspected acute stroke.

### METHODS AND MATERIALS

Patients with suspected acute ischemic stroke were selected for CTP imaging. Scanning tube voltage was 80 kV and low dose current was set at 50 mA. Image reconstruction of low-dose scan data was performed using hybrid iterative reconstruction-40% (ASiR-V) and DLIR intensity (medium and high), respectively. Perfusion parameters were reconstructed for three sequential images: cerebral blood flow (CBF), brain volume (CBV) and mean passage time (MTT). Comparing the differences in parameter means and correlation of the 3 sequences. Objective evaluation and subjective evaluation (integral system) Image quality: objective evaluation mainly measures the CT value and noise of the lateral ventricle and middle cerebral artery during the peak period, calculates the signal-to-noise ratio (SNR) and contrast noise ratio (CNR); measurement data are expressed in the form of "median  $\pm$  quartile", and the objective score of the peak images of the three groups are compared. Differences between groups were compared by Friedman test and pairwise comparisons by Wilcoxon signed rank test with bonferroni correction, and  $P < 0.05$  was considered statistically significant.

### RESULTS

40% CBF and CBV differences for sir-v, DLIR-M in frontal, temporal, occipital and basal ganglia ( $36.5 \pm 12.3$  vs  $30.2 \pm 7.8$  vs  $33.6 \pm 9.4$ ,  $p < 0.001$ )( $2.5 \pm 0.4$  vs  $1.8 \pm 0.3$  vs  $2.1 \pm 0.5$ ,  $p < 0.001$ ), And the mean CBF and CBV in order from large to small: 40% Air-v > DLIR-H > DLIR-M, Pairwise comparisons were statistically different ( $P < 0.05$ ). The three perfusion parameters of the DLIR sequence were correlated with 40% AIDS-v ( $P < 0.05$ ), and the CBF and CBV values (R values) for the 40% AR-v were higher (0.84, 0.66) than the DLIR-M sequence (0.50, 0.61). SD values in DLIR-M and DLIR-H arteries were lower than 40% Asia-v ( $P < 0.001$ ), with the highest SNR and CNR in the DLIR-H sequence ( $p < 0.001$ ).

### CONCLUSION

DLIR-H can significantly improve the peak period image quality of low-dose cerebral CTP arteries, and the reconstructed perfusion parameters are better correlated with 40% Asia-v.

### CLINICAL RELEVANCE/APPLICATION

The DLIR reconstruction algorithm can improve the image quality of arterial vessels during the peak period without affecting the accuracy of perfusion parameters, and further validate that the reconstruction algorithm of DLIR-H is more suitable for intracranial vessels.

## R5A-SPPH- Clinical Value of Deep Learning Image Reconstruction in the Diagnosis of Pulmonary Nodule in Ultra-low Dose Chest CT

Zheng Zhijuan (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the image quality, lung nodule detectability and accuracy of quantitative analysis of deep learning image reconstruction (DLIR) and adaptive statistical iterative reconstruction-Veo (ASIR-V) in Ultra-low dose (ULD) CT for helping large-scale lung cancer screening in clinical.

## METHODS AND MATERIALS

102 patients required lung examination who underwent simultaneously non-contrast ULD CT and standard chest CT scan were included in this prospective study. Standard chest CT was reference standard using ASIR-V at 50% strength (50%ASIR-V). They are divided into two groups: ULD CT scanning were divided into two groups: ULD-CT (UL-A group, n= 46, 100 kVp and 50mA) using 50%ASIR-V and DLIR at high level (DLIR-H); ULD-CT (UL-B group, n = 56, 100 kVp and 30 mA) using 50%ASIR-V and DLIR-H. Radiologists detected and measured nodules. The size, maximum layer area, volume, maximum floor area, 3D long diameter, CT value and standard deviation (SD) of nodules were measured. The signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were to calculate. Two experienced radiologists were subjectively scored image quality and special morphological signs of partial pulmonary nodules using a 5-point method. The Difference between ULD and reference images were compared.

## RESULTS

304 nodules in 294 (96.71%) for UL-A group (50%ASIR-V and DLIR-H), 297 nodules in 280 (94.28%) for UL-B group (50%ASIR-V and DLIR-H) were detected. The detection rate of solid nodules of 99.59%, pure ground glass nodules of 84.48%, and partial solid nodules of 100% for UL-A group, and the detection rate of solid nodules of 97.19%, pure ground glass nodules of 78.26% and partial solid nodules of 100% for UL-B group, respectively, with the same performance observed at different nodule types between 50%ASIR and DLIR. There were no differences in the size, CT value, SD, total volume, maximum layer area, and 3D long diameter of pure ground glass nodules and solid nodules and SNR in low-dose and standard-dose images for UL-A and UL-B group ( $p>0.05$ ). The DLIR-H images had significantly higher CNR of nodules, lower lung tissue noise than ASIR-V% images for UL-A and UL-B group (all  $P < 0.001$ ). There was no difference in the subjective score of overall image quality between ASIR-V and DLIR-H for UL-A and UL-B group ( $p>0.05$ ).

## CONCLUSION

Compared with ASIR-V, DLIR-H can significantly improve image quality. The lung lesion measurements in ULD CT scan images based on DLIR reconstruction have high correlation and low difference with CT images of standard dose.

## CLINICAL RELEVANCE/APPLICATION

DLIR can reduce the noise of CT images and provide high image quality. Low-dose chest CT combined with DLIR is conducive to the wide clinical application under the condition of greatly reducing radiation dose.

## R5A-SPPH- Impact of the Third Generation and Deep Learning Iterative Reconstructions on Spatial Resolution with Dual energy CT-Dependency on Contrast and Dose

Yifang Zhou, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The effects of third generation and deep learning iterative reconstruction (ASIR-V and DLIR) are non-linear. The degree of the impact may depend on the lesion contrast and radiation dose. The objective of this study was to quantify this impact in the context of spatial resolution versus noise reduction.

## METHODS AND MATERIALS

An anthropomorphic liver phantom was used. The liver contains various lesions of different contrast and shapes. The phantom was scanned using a GE Revolution CT at the dual-energy mode with CTDIvol of 14 mGy and 5.6 mGy (slice thickness 2.5 mm). ASIR-V from 0 to 100% and DLIR low, medium, and high were applied to images reconstructed using 70 keV. Thin rectangular regions of interest (ROI of 3 pixels width) were drawn across the boundary of the selected lesions and the horizontal profiles were obtained. The average slopes of the profiles were used as a metric delineating the lesion edge sharpness (a surrogate for spatial resolution). Meanwhile, the contrast-to-noise ratio (CNR) and noise suppression ratio (NSR), defined as the noise divided by noise at ASIR-V 0 of each lesion were also measured at both doses. For each lesion, the normalized edge sharpness was defined as the profile slope divided by the slope at ASIR-V 0 and CTDIvol of 14 mGy.

## RESULTS

The lesion edge sharpness was found significantly reduced at low dose (5.6 mGy). The application of ASIR-V and DLIR further reduced the sharpness albeit improving CNR, but DLIR enhanced the sharpness as compared with higher ASIR-V fractions (above 70%) with improved NSR. Furthermore, the effect of ASIR-V and DLIR depends on the contrast itself: the lower the contrast is, the more blurred the edge is. For the contrast higher than 70 HU, the edge blurring is much less. In addition, the noise suppression was also contrast dependent with the biggest suppression at lowest contrast.



## CONCLUSION

The degree of spatial resolution loss was found to be dependent on the lesion contrast and radiation dose for a given ASIR-V fraction or DLIR strength. The noise suppression also increases as the contrast decreases. DLIR enhances the sharpness as compared with higher ASIR-V fractions (above 70%) with improved NSR.

## CLINICAL RELEVANCE/APPLICATION

Assist adequate use of iterative reconstructions for low contrast lesions

## **R5A-SPPH- Assessment of Semi-automatic Whole-body Fat Quantification Using Ultra Low Dose CT Using Iterative and Artificial Intelligence-based Reconstruction in an In-vivo Swine Model: An Intra Individual Analysis**

Josephine Berger (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the stability of semi-automatic body fat quantification in real low-dose swine CT scans using iterative and AI-based reconstruction.

## METHODS AND MATERIALS

Ten sedated swines received CT scans with fixed tube voltage and tube-current on the same 3rd generation dual-source scanner. Consecutive scans with reduced mAs to 50%, 25%, 10%, and 5% were performed. All scans were reconstructed using iterative reconstruction strength 2 (IR2) and a novel AI-based reconstruction algorithm (AIR), resulting in 10 datasets per swine. 100% IR2 served as the reference standard. Whole-body fat tissue volume was measured using threshold-based semi-automated segmentation (-200 HU to -40 HU). Total body fat volume, mean HU values and noise (standard deviation of HU) were extracted and compared via adequately corrected mixed-effects analysis.

## RESULTS

The volumetric segmentations were stable down to 25% ( $p=0.104$ ) using IR2 and down to 5% with AIR. Compared to the reference standard, mixed effects analysis showed stable CT values in both groups down to 10% mAs but significant HU bias at 5% IR2 ( $p<0.001$ ), while AIR results were still stable ( $p=0.136$ ). Both datasets had significantly increased image noise at lower radiation doses. Interestingly, 25% AIR produced similar noise to 100% IR2.

## CONCLUSION

Body fat volume analysis is possible down to 25% radiation dose using conventional iterative reconstruction, although there is significantly higher image noise. AI-based reconstruction mitigates this limitation at the same dose level by enabling comparable noise levels to 100% IR2. Furthermore, AI-based reconstruction preserves CT values and volumetric results better than iterative reconstruction at only 5% mAs.

## CLINICAL RELEVANCE/APPLICATION

In conclusion, our study strongly suggests that by employing AI-based reconstruction, accurate semi-automated quantification of adipose tissue volume can be accomplished with minimal radiation exposure to the patient, thus further empowering CT as a valuable tool in body composition analysis.

## **R5A-SPPH- Impact of the Tube Start Angle on Patient Dose in Single and Dual Source Spiral CT**

Edith Baader (*Presenter*) Nothing to Disclose

## PURPOSE

To determine the radiation dose in single source CT (SSCT) and dual source CT (DSCT) scans as a function of tube start angle and spiral pitch value to identify the dose reduction potential by selecting the optimal start angle.

## METHODS AND MATERIALS

Previous studies have shown that dose to certain radiosensitive organs in spiral CT scans could substantially be reduced by optimizing the tube start angle [MedPhys 36: 5654-5664, 2009][MedPhys 38(6):3177-85, 2011]. This applies particularly to small peripheral organs. This study investigates the impact of the tube start angle on the effective dose as a measure of the overall radiation risk. Furthermore, in addition to SSCT systems with constant tube current (noTCM) as in the previous studies, also today's standard tube current modulation minimizing the mAs-product (mAsTCM) and DSCT systems were considered. Using Monte Carlo simulations, dose values for different tube positions with an angular increment of  $10^\circ$  and a longitudinal increment of 5 mm were simulated in the thorax region of six adult patients based on clinical CT data. The thorax region was chosen as short scan times and thus high pitch values are particularly relevant in this body region; in total, dose simulations were performed over a scan range of 35 cm with a collimation of 38.4 mm. From the resulting dose distributions, organ doses and effective dose were determined as a function of tube angle and longitudinal position. Using these per view dose data, the individual organ doses, as well as the total effective dose, were determined for spiral scans with (mAsTCM)

and without (noTCM) tube current modulation with pitch values ranging from  $p=0.5$  to  $1.5$  for SSCT and up to  $p=3.0$  for DSCT. The dose reduction of the optimal start angle relative to the worst start angle in terms of dose was determined.

## RESULTS

Dose reductions for single organs are highly organ-specific. While the tube start angle affects the lung dose less than 5%, higher variations occur e.g. for the dose to the thyroid gland and the stomach. The impact of mAsTCM depends on the organ and the pitch value; however, the dose reductions are in the same order of magnitude. For the effective dose, dose reductions of up to 7% for SSCT and up to 20% for DSCT can be achieved in particular for high pitch values when selecting the optimal start angle for the simulated patients.

## CONCLUSION

Variation of the tube start angle in spiral scans exhibit substantial differences in radiation dose for high pitch values. Vendors should provide a method to automatically select the optimal scan start angle to minimize patient risk.

## CLINICAL RELEVANCE/APPLICATION

By controlling the start angle in spiral scans, radiation dose to various organs and effective dose and thus patient risk can be significantly reduced.

## R5A-SPPH- Fetal Doses in the Most Frequent Diagnostic Radiology Procedures in a Pregnant Patient: Results of In-phantom Measurements

Vjekoslav Kopacin, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Emergencies during pregnancy do happen! Cardio/cerebrovascular, urologic, GI emergencies and trauma can be singled out. The medical team may be in doubt when choosing proper diagnostic imaging that uses ionizing radiation, potentially causing a delay in diagnosis and treatment. The purpose of this research was to experimentally measure the dose to the fetus during diagnostic imaging and fluoroscopy-guided minimally invasive procedure on a newly developed, anthropomorphic phantom of a pregnant female.

## METHODS AND MATERIALS

A Tena phantom, representing a pregnant female in 2nd trimester, was scanned with imaging modalities that use ionizing radiation (Figure 1). Appropriate protocols for probable clinical emergencies in pregnant females were used: NC CT and CTA in stroke protocol, DSA in ischemic stroke endovascular treatment, PA CTA, trauma CT, abdomen/pelvis NC CT, abdominal radiography and fluoroscopy in nephrostomy placement. RPL dosimeters were placed in the fetal head and body, placenta and adjacent structures of interest, and experimental measurements were performed.

## RESULTS

The highest measured doses in the fetal head and body were recorded in the trauma CT and abdomen/pelvis NC CT. 34,7 mGy and 23,7 mGy were measured in the head, and 32,5 mGy and 19,6 mGy in the body. In all other scanning protocols, the dose to the fetal head and body did not exceed 2 mGy.

## CONCLUSION

For most imaging scenarios, measured fetal doses were below 2 mGy except in scanning protocols where the fetus was in the field of direct ionizing radiation. The highest measured dose to the fetal head of 34,7 mGy in the performed WBCT was below 50 mGy and well below the 100 mGy recommended by the ICRP above which the deterministic effects on the developing fetus rise. The measured fetal doses for all clinical scenarios are consistent with published data.

It should be kept in mind that the fetus in a developed phantom is with its head faced cranially. As fetuses in 2<sup>nd</sup> trimester are freely movable in the uterus, in a different position, measured doses could be even lower.

The research has limitations as it can be seen as a case report. Patient-specific physical phantoms and computational models are time-consuming and matching anthropomorphic physical phantoms to the size and location of the fetus within the maternal body is almost impossible. This is the reason why faster methods are used for fetal dose estimation in clinical practice. Such methods usually use typical doses from references or use one of a number of available dosimetry software.

## CLINICAL RELEVANCE/APPLICATION

Although there have been guidelines that state how it is possible to carry out imaging diagnostics based on ionizing radiation in pregnant women, their application may still cause anxiety to some radiologists.

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## Abstract Archives of the RSNA, 2023

R5A-SPVA

### Vascular Imaging Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-SPVA- The Application Value of Black Blood Imaging Based on CT Flexible Subtraction Technology** **1** **in Carotid Artery**

Tao Zhou (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The CT black blood images may potentially offer more insightful information. In this study, we utilized MR vessel wall imaging of carotid arteries as a gold standard to investigate the improvement effect of carotid soft plaque image quality in CT black blood images.

#### **METHODS AND MATERIALS**

After carotid artery CT angiography (CTA) examination, the images underwent reverse flexible contrast enhancement and CE-BOOST technology to achieve CT black blood. The study was divided into four groups, with Group A being the cervical artery CTA examination group, Group B being the CTA delayed scan group, Group C being the CT black blood group with image reconstruction after 4 minutes and 30 seconds of delay, and Group D being the MR vascular wall imaging group. The subjective evaluation score was 5 points, analyzing multiple dimensions such as the lumen display's clarity, the vessel wall's sharpness, and the presence of plaques. The objective scoring was conducted on the neck artery CTA images, CTA delayed scanning group, and CT black-blood group. The evaluation was based on the SD value of the cervical artery plaque lesion adjacent to the sternocleidomastoid muscle,  $CNR = \frac{CT_{lumen} - CT_{sternocleidomastoid\ muscle}}{SD_{sternocleidomastoid\ muscle}}$ , and  $SNR = \frac{CT_{lumen}}{SD_{lumen}}$ . We conducted the one-way ANOVA, the non-parametric test and Kappa analysis for subjective evaluation score, with  $p < 0.05$  indicating a statistically significant difference.

#### **RESULTS**

The study included a total of 20 patients, of whom 12 were male and 8 were female, with an average age of 63 years. The differences in BMI (23.3 vs. 23.5 vs. 24.0) were not statistically significant ( $p < 0.05$ ). Objective scoring: in the comparison between groups A, B, and C, group A showed advantages in CNR ( $88.64 \pm 30.14$  vs.  $3.74 \pm 3.85$  vs.  $-50.25 \pm 15.44$ ,  $p = 0.000$ ) and in SNR ( $61.27 \pm 27.60$  vs.  $6.99 \pm 3.91$  vs.  $-19.50 \pm 6.91$ ,  $p = 0.000$ ); there was no statistically significant difference in SD values ( $5.29 \pm 1.34$  vs.  $5.28 \pm 2.36$  vs.  $3.96 \pm 1.24$ ,  $p = 0.487$ ). Subjective scoring: group D > group C > group A > group B, ( $4.8$  vs.  $4.3$  vs.  $4$  vs.  $3.6$ ,  $p = 0.025$ ).

#### **CONCLUSION**

Flexible contrast-enhanced cervical artery CT black blood imaging has a high diagnostic value with a transparent vessel wall and plaque morphology display. Its diagnostic value is superior to conventional CTA scans. Therefore, we recommend adding a delayed scan with flexible contrast-enhanced CT black blood imaging during cervical artery CTA scanning.

#### **CLINICAL RELEVANCE/APPLICATION**

The CT black-blood imaging technology of the carotid arteries enables clear visualization of the anatomy and structure of the vessel wall, overcoming the limitations of traditional carotid CTA. Compared with MR vascular wall imaging, CT black-blood imaging of the carotid arteries also has good diagnostic value.

#### **R5A-SPVA- Performance of an Artificial Intelligence Algorithm for Quantifying the Maximum Thoracic** **2** **Aortic Diameter in Patients with Aortic Pathologies**

Nicola Fink, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Given the high mortality associated with acute aortic events, early detection and appropriate monitoring of aortic dilatation and aneurysm are crucial. However, accurate follow-up CT measurements remain tedious and time-consuming. In this context, artificial intelligence (AI) reduces missed findings and inter-/intra-reader variability. However, most studies evaluated this at predefined landmarks only, which may not necessarily correspond to the largest diameter. This study aimed to assess the performance of a deep neural network (DNN)-based algorithm in quantifying aortic diameters at the most dilated location in a heterogeneous population.

## METHODS AND MATERIALS

A total of 100 patients (67.2 [56.0-73.4] years; 60.0% male) with thoracic aortic dilatation/aneurysm were scanned according to institutional CT protocols. Nearly two third of the included patients (n=62) had pathologic findings of the thoracic aorta due to prior repair (n=29 surgical; n=17 endovascular; n=10 both) and/or aortic dissection (n=42). Segmentation and measurements of the thoracic ascending (AA) and descending Aorta (DA) were performed on non- and contrast-enhanced CT scans using a combination of multiple DNN models which were previously trained on 1582 CT datasets. All measurements were compared to manual measurements performed by two radiologists, overall as well as in the following subgroups: 1) AA vs. DA; 2) non-obese vs. obese patients (BMI=30kg/m<sup>2</sup>); 3) patients without vs. with aortic repair; 4) patients without vs. with aortic dissection.

## RESULTS

Mean AI-based automated and manual diameters significantly differed (non-contrast: 40.9mm [37.3-48.2] vs. 42.9mm [38.9-50.0],  $p<0.001$ ; contrast-enhanced: 40.9mm [37.3-48.2] vs. 40.3mm [36.6-46.9],  $p<0.01$ ) but showed excellent correlation and agreement ( $r>0.85$ ;  $ICC>0.9$ ). Depending on the subgroup, automated and manual values were similar in the AA but significantly different in the DA ( $p<0.001$ ), similar in obese but significantly different in non-obese patients ( $p<0.01$ ), and similar in patient without aortic repair or dissection but significantly different in patients with such pathological conditions of the aorta ( $p<0.001$ ). However, in all subgroups automated diameters showed strong correlation and excellent agreement with corresponding manual values ( $r>0.84$ ;  $ICC>0.9$ ).

## CONCLUSION

This DNN-based algorithm enables accurate automated assessment of the largest aortic diameter in a heterogeneous patient population with various aortic pathologies.

## CLINICAL RELEVANCE/APPLICATION

By showing high agreement with manual measurements, this algorithm offers the possibility to support radiologists in clinical practice, thus increasing efficiency, with good results even in a heterogeneous population.

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## Abstract Archives of the RSNA, 2023

R5B-SPBR

### Breast Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPBR- Comparison of Advanced Breast Cancers by Ethnicity: Digital Breast Tomosynthesis versus Digital Mammography** 1

Liane E. Philpotts, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Increasing early detection of nonlethal breast cancers is the main function of screening. Advanced cancers - characterized by larger size, lymph node involvement, or aggressive molecular subtypes - are those that carry a worse prognosis. Our prior data demonstrated a significant decrease in the rate of advanced cancers with digital breast tomosynthesis (DBT) screening compared with 2D full-field digital mammography (DM). The purpose of this study was to examine how the rate of advanced cancers varied with patient race/ethnicity.

#### **METHODS AND MATERIALS**

Our detailed database of 1407 breast cancers (142 DM, 1265 DBT) was analyzed over 13 years (DM 2008-2011, DBT 2011-2021) of screening with DBT was analyzed. Advanced cancers were defined by TMIST criteria (invasive cancers >2cm, HER2+ or triple negative cancers >1cm, one or more positive axillary lymph nodes, distant organ spread). The rates of advanced compared with non-advanced cancers were assessed by patient race/ethnicity. Statistical analysis was performed using unpaired T-tests and Chi Square with  $p < 0.05$  considered significant.

#### **RESULTS**

Of 1265 DBT cancers, race/ethnicity data was available in 1246 (98.5%) and was as follows: 935 (75%) White, 177 (14%) Black, 73 (6%) Hispanic, 28 (2%) Asian, 33 (3%) other. Of 968 invasive cancers, the ethnicity data was available in 952 (98.3%): 732 (77%) White, 129 (14%) Black, 45 (5%) Hispanic, 18 (2%) Asian, 28 (3%) other. Of the 968 invasive cancers, 316 (32.6%) were considered advanced. The rate of advanced to non-advanced invasive cancers was not significantly different by ethnic group, although it trended higher among Black and Asian patients: White 230/732 (31.4%), Black 47/129 (36.4%), Hispanic 14/45 (31.1%), Asian 7/18 (38.9%), Other 8/28 (28.6%). Similarly for the DM cohort, no significant differences were noted in the rates of advanced cancers between ethnic groups: White 23/58 (39%), Black 9/15 (60%), Hispanic 3/9 (33%), Asian 1/3 (33%), other 7/14/(50%). However, when comparing the rates between DBT and DM, significant reduction was noted in the White and Black groups: White 31.1% vs 39% and Black 36.4% vs 60%, DBT vs DM respectively ( $p < 0.07$ ).

#### **CONCLUSION**

With DBT, advanced cancers rates varied slightly among ethnic groups but overall was not significantly different. However, when compared to DM screening, advanced cancers were significantly reduced in the White and Black populations.

#### **CLINICAL RELEVANCE/APPLICATION**

Screening with DBT helps reduce advanced cancers, particularly in the White and Black/African American populations.

#### **R5B-SPBR- Breast Ultrasound Optimization Training for Radiology Residents Utilizing an Interactive Online Module** 3

Rebecca T. Sivarajah, MD (*Presenter*) Spouse, Medical Director, AstraZeneca PLC

#### **PURPOSE**

The primary goal of the project was to create an interactive online learning module to teach breast ultrasound optimization to radiology residents and then assess whether the learning module was effective at teaching these concepts to radiology residents.

## METHODS AND MATERIALS

An on-line interactive module teaching concepts of breast ultrasound optimization was created by the lead author utilizing Articulate Storyline 3 Software. The on-line module included navigational toolbars, clickable parameters, and real breast ultrasound examples illustrating concepts of breast ultrasound optimization. Residents were assigned an anonymous study identification number. Participating radiology residents first filled out an on-line questionnaire asking them to rate their subjective breast ultrasound optimization knowledge. They then completed an on-line pre-test consisting of 24 multiple choice questions. Then, participants engaged in the interactive online training module. After completing the online training module, participants completed an online post-test (same questions as the pre-test). They also then completed a questionnaire rating new subjective breast ultrasound optimization knowledge and a questionnaire rating the effectiveness of the training module.

## RESULTS

Overall pre-test mean test scores were 54.4 +/- 4.4% and overall post-test mean scores were 78.9 +/- 3.4%. The mean score significantly improved between the pre-test and post-test by 24.4% (95% CI: [14.2%, 34.6%], P=0.0002). The mean subjective knowledge score significantly improved between the pre-test and post-test by 1.4 (95% CI: [0.9, 1.9], P less than 0.0001). Subjective satisfaction with the effectiveness of the module was high: 4.4 +/- 0.2 out of 5.

## CONCLUSION

This study suggested that an interactive online module could be effective at teaching concepts of breast ultrasound optimization to radiology residents and that learners found it to be a useful activity.

## CLINICAL RELEVANCE/APPLICATION

A breast ultrasound must be properly optimized to avoid errors in interpretation and management. Therefore, radiologists who perform breast ultrasound exams must be proficient at recognizing suboptimal images and be familiar with techniques used to optimize the breast ultrasound image. However, there is no formal program to teach these skills to radiology residents at our institution. In addition, it can be difficult to cover all of the detailed concepts of breast ultrasound optimization during a busy clinical day when scanning time and faculty teaching time can be limited. Online interactive modules can be helpful to teach such concepts allowing flexibility of learning.

## R5B-SPBR- Comparison of Automated Breast Ultrasound and Hand-held Breast Ultrasound in 5 Preoperative Evaluation of Early-stage Breast Cancer: A Multicenter Prospective Study

Ji Soo Choi, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To compare automatic breast ultrasound (ABUS) and hand-held breast ultrasound (HHUS) as an adjunct to full-field digital mammography (FFDM) for the preoperative evaluation of local tumor extent in women with newly diagnosed early-stage breast cancers

## METHODS AND MATERIALS

This multicenter prospective study included consecutive women with early-stage breast cancers (clinical Tis, T1-2/N0) treated by surgery who had undergone ABUS and HHUS adjunct to FFDM for preoperative local tumor staging between Oct 2019 and Apr 2021. Radiologists independently sought the index cancer and additional ipsilateral and contralateral cancers using ABUS plus FFDM (ABUS/DM) or HHUS plus FFDM (HHUS/DM). Pathologic diagnoses of all suspected lesions were used as reference standards. Sensitivity and specificity obtained for ABUS/DM and HHUS/DM were compared. Noninferiority of ABUS/DM was assessed in sensitivity at a margin of 5%.

## RESULTS

A total of 659 women (mean age, 50.5 years  $\pm$  9 [SD]) were included in the study. Seventy-nine women (12.0%, 79/659) exhibited additional cancers: 64 additional ipsilateral cancers (51 multifocal and 13 multicentric) and 15 contralateral cancers. For index cancers, both ABUS/DM and HHUS/DM showed sensitivities of 100%. ABUS/DM showed non-inferior sensitivity to HHUS/DM for additional ipsilateral cancers (71.9% [46/64] vs. 75.0% [48/64]; P=0.617) and higher sensitivity than HHUS/DM for contralateral cancers (86.7% [13/15] vs. 60.0% [9/15]; P=0.046). Specificities were not significantly different between ABUS/DM and HHUS/DM for both additional ipsilateral cancers (97.7% [581/595] vs. 97.0% [577/595]; P=0.317) and contralateral cancers (97.8% [630/644] vs. 98.3% [633/644]; P=0.467).

## CONCLUSION

ABUS/DM showed non-inferior sensitivity to HHUS/DM with similar specificity in diagnosing additional ipsilateral and contralateral breast cancers in women with early-stage breast cancers. Thus, ABUS may be used as an alternative to HHUS as a preoperative staging tool for early-stage breast cancer.

## CLINICAL RELEVANCE/APPLICATION

There is limited literature on ABUS for preoperative evaluation of newly diagnosed breast cancer patients. ABUS may be used as an alternative to HHUS as a preoperative staging tool for early-stage breast cancer, for whom preoperative axillary US is not essential.

### **R5B-SPBR- Using Artificial Intelligence To Assess The Risk Of Malignancy In Breast Lesions Identified On Second-Look Ultrasound** 6

Rachel M. Cruz, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the results of an artificial intelligence (AI) algorithm-based software for predicting the risk of malignancy in breast lesions identified on second-look ultrasound.

#### METHODS AND MATERIALS

This was a retrospective and single-center study, approved by the Institutional Review Board, which evaluated 628 second-look ultrasound examinations performed between January and December 2022 at a reference cancer center. 486 cases were excluded because they did not have had prior magnetic resonance imaging (MRI) or biopsy performed in the same institution, or because no corresponding lesion was found on second-look ultrasound. MRI and ultrasound features were classified according to the BI-RADS lexicon criteria. Subsequently, the images were analyzed using Koios DS Breast software (Koios Medical, USA). The software results were divided into: benign or probably benign (BIRADS 2/3), low or intermediate suspicion (BIRADS 4A/4B), high suspicion or probably malignant (BIRADS 4C/5). The histopathological result was considered the gold standard.

#### RESULTS

164 lesions from 142 patients were included. The mean age of the patients was 48 years (21-78 years) and the mean mass size on ultrasound was 17 mm (3-70 mm). At MRI, 25 lesions (15.2%) were classified as BIRADS 3, 120 (78.0%) as BIRADS 4, and 11 (6.7%) as BIRADS 5. At ultrasound, there were 93 masses (56.1%) and 72 non-mass findings (43.9%), of which 15 lesions (9.1%) were classified as BIRADS 3, 141 (86.0%) as BIRADS 4, and 8 (4.9%) as BIRADS 5. Analysis using the software classified 23 lesions (14.0%) as BIRADS 2/3, 113 (68.9%) as BIRADS 4A/4B, and 28 (17.1%) as BIRADS 4C/5. Core needle biopsy was performed in 129 (78.7%) and vacuum-assisted biopsy in 35 (21.3%), which yielded 131 (79.9%) benign histologic findings (24 with associated atypia) and 33 (20.1%) malignant results. None of the lesions classified as BIRADS 2/3 using the software were malignant, while 2 lesions classified as BIRADS 3 on MRI and 1 lesion classified as BIRADS 3 on ultrasound were malignant. The predictive positive value (PPV) of lesions classified as BIRADS 4A/4B and BIRADS 4C/5 by the software were 17.7% and 46.4%, respectively.

#### CONCLUSION

The AI software demonstrated high sensitivity to predict the risk of malignancy in lesions identified on second-look ultrasound, contributing to a more accurate indication of percutaneous biopsies. It can be used to avoid unnecessary biopsies in lesions classified as benign or probably benign (BIRADS 2/3).

## CLINICAL RELEVANCE/APPLICATION

AI can be used to predict the risk of malignancy in lesions identified on second-look ultrasound, and to avoid unnecessary biopsies.

### **R5B-SPBR- Multimodal Artificial Intelligence (AI) in Diagnostic Imaging: Added Value of Breast Ultrasound (US) in Symptomatic Patients** 7

Beatriu Reig, MD, MPH (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to explore the accuracy of US alone, full-field digital mammography (FFDM) and/or digital breast tomosynthesis (DBT) alone, and multimodal AI in the diagnostic evaluation of the symptomatic patient.

#### METHODS AND MATERIALS

In this retrospective and IRB-approved study, our IRB-approved multimodal AI system included full-field digital mammography (FFDM), digital breast tomosynthesis (DBT) and hand-held breast ultrasound (US) examinations performed 2010-2020, with 1,964,416 exams in 324,978 patients. We used a patient-based training/validation/testing split of 60%/10%/30%. Our test set consisted of 1371 women (1490 exams) who underwent both diagnostic FFDM or FFDM/DBT with targeted ultrasound for a symptomatic indication (pain, palpable area of concern, nipple discharge). Accuracy of the AI system was evaluated for malignancy for DBT/FFDM alone, US alone, and multimodal AI by calculating AUROC, sensitivity, specificity, PPV and NPV. Cancer types (pathology-confirmed with 120 days of the imaging) detected by DBT/FFDM alone, US

alone, and multimodal AI were compared. We dichotomized AI's probabilistic predictions into biopsy vs. no biopsy decisions by matching the clinical biopsy rates. Specificity was therefore standardized across categories.

## RESULTS

Of 1,371 patients who underwent same day diagnostic FFDM/DBT and US (average age 54.4, standard deviation 11.63), the AI model AUROC for breast cancer detection was 0.956 for multimodal AI, 0.864 for FFDM/DBT only, and 0.944 for US only. Sensitivity was 89.2% (58/65 cancers) for multimodal, 60% (39/65) for FFDM/DBT only, and 84.6% (55/65) for US only. 61.6% (845/1371) of women had dense breasts. For women with dense breasts, AUROC was 0.98 for multimodal, 0.848 for FFDM/DBT only, and 0.963 for US only, with sensitivity of 92.7% (38/41), 58.5% (24/41) and 92.7% (38/41). For women with non-dense breasts, AUROC was 0.919 for multimodal, 0.895 for FFDM/DBT only, and 0.900 for US only, with sensitivity of 83.3% (20/24), 62.5% (15/24) and 70.8% (17/24). 4.61% (3/65) cancers were in women under 40. For women under 40, multimodal AUC=0.982, FFDM/DBT AUC=0.894, US=0.994.

## CONCLUSION

A multimodal AI system showed higher performance for breast cancer detection in symptomatic diagnostic evaluations than FFDM/DBT or US models, including women with both dense and non-dense breasts. An US-only model outperformed other models for women < 40.

## CLINICAL RELEVANCE/APPLICATION

Diagnostic workup in symptomatic patients often requires both mammography and ultrasound. Use of multimodal AI in the diagnostic breast cancer setting improves cancer detection regardless of breast density.

## R5B-SPBR- Comparison of Screening Recall Rates When Automated Breast Ultrasound is Coupled or Uncoupled with Screening Mammogram

Daniela E. Wermuth, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the screening recall rates (RR) for women with dense breast tissue who underwent automated breast ultrasound (ABUS) either as a coupled exam following same day screening mammogram or at a future date within the one-year screening interval.

## METHODS AND MATERIALS

This single-institution retrospective review included women aged 35-90 with heterogeneously dense or extremely dense breast tissue who had a screening mammogram from June 2016 to June 2021 and an ABUS within the one-year screening interval. The RR for patients who underwent screening mammogram coupled with ABUS on the same day were compared to the RR for those who had screening mammogram followed by ABUS 1-364 days later. Cancer detection rates (CDR) between the two groups were also compared.

## RESULTS

A total of 5,813 screening mammograms were performed on patients who met inclusion criteria. The study population RR was 2.5% (147/5,813) for mammogram and 4.3% (249/5,813) for ABUS, with a CDR of 5.3/1,000 (31/ 5,813). Of the 5,813 patients, same day ABUS was performed on 3,347 (58%) and 2,466 (42%) underwent ABUS 1-364 days following mammogram. The combined RR for the coupled screening mammogram and ABUS group was 5.9% (196/3,347) with 3.1% (105/3,347) RR on mammogram, 3.4% (114/3,347) RR on ABUS, and CDR of 4.2/1,000 (14/3,347). For mammogram and ABUS performed independently, the mammogram RR was 1.7% (42/2466) and the ABUS RR was 5.5% (135/2466), with a CDR of 6.9/1,000 (17/2,466). There was a statistically significant difference in the combined RR of coupled mammogram and ABUS compared to mammogram performed independent of ABUS ( $p < 0.0001$ ), between coupled and uncoupled mammogram ( $p = 0.0008$ ), and between coupled and uncoupled ABUS ( $p = 0.0002$ ). There was no statistically significant difference in CDR between the coupled and uncoupled groups ( $p = 0.2223$ ).

## CONCLUSION

Mammogram and ABUS interpreted as a same day, coupled exam increases both the individual mammogram RR and the combined mammogram/ABUS RR. Conversely, the ABUS RR is lower when ABUS is interpreted as a coupled exam compared to ABUS uncoupled from mammography. There is no statistically significant difference in CDR when ABUS is coupled or uncoupled with screening mammogram.

## CLINICAL RELEVANCE/APPLICATION

This study supports scheduling of ABUS according to patient preference or optimal practice workflow as there is no overall screening outcomes benefit to preferential scheduling of ABUS as a coupled or uncoupled exam.



## Abstract Archives of the RSNA, 2023

R5B-SPCA

### Cardiac Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPCA- Simultaneous Single-breathhold Cardiac T1, T2, T2\*, and Fat Fraction Mapping with Rosette MR Fingerprinting** 1

Evan Cummings (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In this work, we present a method for mapping cardiac T1, T2, T2\*, and fat fraction during a single breathhold acquisition. Quantitative MRI can be used to diagnose and evaluate a wide range of cardiac pathologies: T1 mapping for myocarditis, myocardial infarction, and myocardial amyloidosis<sup>1</sup>; T2 mapping for myocardial edema injury<sup>1</sup>; T2\* mapping for iron deposition<sup>2</sup>; and fat fraction mapping to determine fat content of the myocardium<sup>3</sup>. MR Fingerprinting (MRF) is a method for rapidly measuring multiple tissue properties, including T1 and T2<sup>4,5</sup>. MRF data can be collected along a rosette trajectory<sup>6</sup>, a multi-echo trajectory which has previously been used in cardiac applications to map T2\*<sup>7</sup> and fat fraction<sup>8</sup>. In this work, MRF with the rosette trajectory is extended to enable T1, T2, T2\*, and fat fraction mapping in a single breathhold.

#### **METHODS AND MATERIALS**

A healthy volunteer was scanned on a 1.5T MAGNETOM Sola (Siemens Healthineers, Erlangen, Germany) using a breathhold 15 heartbeat ECG-triggered sequence with the following parameters: TR=20.41 ms, TE=0.84 ms, variable flip angles up to 20°, 1.6x1.6x8mm voxel size, 300x300 mm<sup>2</sup> FOV, with multiple inversion and T2 preparation pulses. Data were acquired with a 23 lobe rosette with an 18.5 ms readout and 0.8 ms echo spacing. Images were reconstructed using an iterative approach with a cluster-based sparsity regularizer. T1 and T2 values were mapped using pattern matching<sup>4</sup>, T2\* values were calculated by fitting decay curves along the rosette echo images<sup>7</sup>, and fat fraction was extracted using Hierarchical IDEAL<sup>9</sup>. The technique was validated in phantoms for accuracy. Volunteer reference T1, T2, and T2\* maps were collected using Siemens Myomaps sequences.

#### **RESULTS**

Mean myocardial measurements were: T1= 1137±102 ms, T2= 44.5±7.8 ms, T2\*= 22.4±5.0 ms, PDFF= 3.6±3.7%. Rosette MRF T1 values are higher than published MOLLI T1 values<sup>10</sup>, and T2 values are lower than published T2-prep bSSFP values<sup>11</sup>, similar to prior MRF studies<sup>5,8</sup>. T2\* and PDFF values agree with published literature<sup>3,4</sup>.

#### **CONCLUSION**

Rosette MRF can be used to simultaneously map T<sub>1</sub>, T<sub>2</sub>, T<sub>2</sub>\*, and fat fraction in the heart in a single-breathhold acquisition.

References: 1. Messroghli DR et al. *JCMR* 2017 2. Triadyaksa P et al. *JMRI* 2020 3. Ng ACT et al. *Circ Cardiovasc Imaging* 2018 4. Ma D et al. *Nature* 2013 5. Hamilton J et al. *MRM* 2017 6. Noll D *IEEE Trans Med Imaging* 1997 7. Bush AM et al. *JMRI* 2020 8. Liu Y et al. *Front Cardiovasc Med* 2022 9. Tsao J Jiang Y. *MRM* 2013 10. Dabir D et al. *JCMR* 2014 11. Hanson CA et al. *Radiology* 2020

#### **CLINICAL RELEVANCE/APPLICATION**

We present a method for mapping cardiac T1, T2, T2\*, and fat fraction in a single breathhold acquisition with the aim of reducing patient scan times while providing comprehensive quantitative information for myocardial assessment.

#### **R5B-SPCA- To Investigate the Enhancement Effect Between High and Low Concentration Contrast Medium in Coronary Computed Tomography Angiography (CCTA).** 2

Wenbin Liang (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the enhancement effect between high and low concentration contrast medium in coronary computed tomography angiography (CCTA)

## METHODS AND MATERIALS

A total of 163 patients suspected of coronary disease (CAD) were randomly assigned into two groups with different contrast concentrations, 25mgI/kg/s injection rate for 10s. A high concentration contrast medium (Iomeprol, 400mgI/ml) was used in group A (n=85), while a lower concentration one (Iohexol, 350mgI/ml,) was used in group B (n=78). All patients were scanned with free breathing with a fixed tube voltage of 100 kVp, smart mA with tube current range from 320 to 720 mA. 50% adaptive statistical iterative reconstruction (ASIR-V50%) was used for the pre-scan dose adjustment and post-scan reconstruction. All CT images were reviewed in randomized order by two experienced radiologists blinded to scan and contrast protocol. Both quantitative measurements including CT value, standard deviation (SD, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR)) and subjective scores (1-5) were obtained and compared between the two groups.

## RESULTS

There was no significant difference in gender, age, body mass index (BMI), heart rate and radiation dose between the 2 groups (all P value >0.05). Both quantitative measurements (CT value, SD,SNR and CNR) and subjective scores were also similar between the two groups (P>0.05). However, there were statistically significant difference in contrast medium dosage and flow rate between the two groups (P value was 0.000 and 0.001, respectively).The low concentration contrast medium group had statistically higher in contrast medium dosage and flow rate than the high concentration contrast medium group [43.34±8.35 vs 49.01±8.50ml;4.2±0.7vs 4.6±0.5](P value was 0.000 and 0.001, respectively).

## CONCLUSION

Under the premise of maintaining the same contrast agent injection scheme, there is no significant difference in image quality and radiation dose between high and low contrast agents with different concentrations, but under the condition of constant total iodine, high concentration contrast agent can achieve a relatively low injection rate.

## CLINICAL RELEVANCE/APPLICATION

High concentration contrast agent but with low injection rate can applied in coronary computed tomography angiography.

## R5B-SPCA- Zero-Contrast Imaging for the Assessment of Transcatheter Aortic Valve Implantation in Candidates with Renal Dysfunction

Paula Terra M. Amaral, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Candidates for transcatheter aortic valve implantation (TAVI) are currently evaluated using computed tomography angiography and invasive cardiac catheterization as an essential part of case selection and pre-procedure interventional planning. However, both imaging methods utilize iodinated agents, which may cause contrast-induced nephropathy, particularly in patients with baseline renal dysfunction. This study aimed to describe a zero-contrast imaging protocol for pre-TAVI evaluation in patients with advanced renal impairment.

## METHODS AND MATERIALS

The pre-TAVI zero-contrast scheme consisted of the following multi-modality combinations:1) gadolinium-free magnetic resonance imaging (three-dimensional navigator-echo with electrocardiogram-gated steady-state free-precession series); 2) iodinated-free multislice computed tomography electrocardiogram-gated; 3) lower limb arterial duplex scan ultrasound; and 4) transesophageal echocardiography. Ultimately, TAVI was performed for those deemed good candidates, and contrast was allowed during the intervention; however, operators were strongly advised to utilize the least volume possible of iodinated agents. This pilot survey included ten patients with symptomatic aortic stenosis and renal dysfunction who underwent zero-contrast multi-modality imaging.

## RESULTS

All the patients ultimately underwent TAVI. The intervention was successful in all cases, without = moderate residual aortic regurgitation, prosthesis embolization, annulus rupture, major vascular complications, stroke, or death during index hospitalization. The creatinine clearance remained stable throughout the observation period (baseline:26.85 ±12.55 ml/min; after multi-modality imaging: 26.76 ±11.51ml/min; post-TAVI at discharge:29.84 ±13.98 ml/min; p=0.3 all).

## CONCLUSION

The proposed contrast-free imaging protocol appears to be a promising clinical tool for pre-TAVI evaluation in patients with severe renal dysfunction.



## CLINICAL RELEVANCE/APPLICATION

Chronic renal dysfunction is common in individuals with aortic stenosis and is often challenging for the evaluation of TAVI candidates. The occurrence of acute kidney injury (AKI) following pre-TAVI evaluation using methods based on angiographic contrast has been largely underreported, but everyday practice and common sense indicate that it is a major clinical issue. In this context, we developed a zero-contrast diagnostic routine for patients with severe aortic stenosis and renal dysfunction who are considered for TAVI.

### R5B-SPCA- Feasibility, Image Quality and Radiation Dose Evaluation of Coronary CT Angiography (CCTA) in Patients with Arrhythmia by Using the 16cm Wide Detector CT

Wenbin Liang (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the feasibility, image quality and radiation dose of a 16cm wide detector CT for coronary CT angiography (CCTA) within single cardiac cycle in patients with arrhythmia.

#### METHODS AND MATERIALS

A total of 70 patients with suspected coronary heart disease underwent CCTA were divided into two groups for analysis: Group A (n=35, arrhythmia) and Group B (n=35, sinus rhythm). All examinations were performed under free breathing on a 16cm wide detector CT (GE Healthcare) by using the SmartPhase technique for scanning and reconstruction and SSF technique for coronary artery motion correction. Both groups used the same contrast dose rate of 25 mgI/kg/s. CT value and standard deviation in aortic sinus (AS), right coronary artery, left anterior descending, left circumflex and pericardial fat were measured. Contrast-to-noise ratio for vessels was calculated. Two experienced Radiologists independently reviewed the image quality by using a 5-point scale[1] (1: nondiagnostic and 5: excellent). Image quality and radiation dose of the two groups were compared. The Mann-Whitney test and independent sample t test were used for statistical analysis, P<0.05 was considered statistically significant.

#### RESULTS

There was no difference in contrast dose, radiation dose, quantitative and qualitative image quality[1] between the two patient groups (all p>0.05). The arrhythmia group had statistically higher heart rate and higher heart variation than the sinus rhythm group [84.77±35.02 vs. 67.80±12.53 beats/min] (P=0.009). The effective radiation dose in the arrhythmia group [(2.86±1.07) mSv] was higher than that in the sinus rhythm group [(2.22±0.64) mSv] which was statistically significant (P=0.004).

#### CONCLUSION

CCTA is feasible in arrhythmia patients by using 16cm wide detector CT providing good image quality, but requires slightly higher radiation dose compared with that of sinus rhythm patients.

## CLINICAL RELEVANCE/APPLICATION

CCTA is feasible in atrial fibrillation patients using a new generation 256-MDCT providing good image quality and low radiation dose in this challenging population

### R5B-SPCA- Improved Detection of Subendocardial Infarction using Synthetic Double Inversion Late Gadolinium Enhancement

Jong Eun Lee, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

A novel imaging technique called Synthetic double inversion LGE using T1 mapping has been developed. This study aimed to increase the conspicuity of the enhanced region in patients with MI, particularly those with subendocardial infarction by nulling the signal of normal myocardium and blood cavity.

#### METHODS AND MATERIALS

To validate the proposed method, phantom experiment was conducted using a commercial phantom (T1 MES) that mimics nine different T1 values of myocardium and blood pre- and post- enhanced at 1.5T and 3T environment. Synthetic LGE that is generated using the post T1 map allows for the nulling of signal intensity from single tissue with a specific T1 value, depending on the inversion time (TI). The proposed method employs two numerical inversion pulses, which null 2 types of tissues. For the evaluation of our method, 30 cases of MRI study from patients with subendocardial infarction were retrospectively collected, which included T1 maps and LGE images. We generated synthetic LGE for each patient using mathematical equation and nullified the signal from normal myocardium and blood cavity. This can increase contrast with infarct myocardium in MI patients as intended in this study.

## **RESULTS**

In the phantom experiment, proposed method generated a synthetic LGE that accurately nullified the signal from the regions corresponding to the two selected T1 values. This result demonstrated the effectiveness of our approach. In the in-vivo experiment, the result showed significantly higher contrast compared to conventional LGE. The proposed method demonstrated significantly higher contrast ratios for remote/enhanced and blood/enhanced regions, with values of 2.59E-05 and 2.07E-05, respectively, compared to conventional LGE with values of 0.06 and 0.91. This represents an increase in contrast of over 400-fold for blood cavity and 23-fold for remote regions compared to conventional LGE.

## **CONCLUSION**

Using synthetic double inversion LGE, contrast enhancement was observed in subendocardial infarction, with improved conspicuity compared to conventional LGE. This technique nulling healthy myocardium and blood cavity can improve detection of myocardial infarction.

## **CLINICAL RELEVANCE/APPLICATION**

This study proposes a new imaging technique, Synthetic double inversion LGE, to overcome the challenges in identifying subendocardial infarction using conventional LGE. This technique has shown promising results in nulling normal myocardium and blood cavity, which can improve the contrast with infarct myocardium in MI patients.

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## Abstract Archives of the RSNA, 2023

R5B-SPCH

### Chest Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPCH- Free-Breathing Ultra-High-Pitch Pulmonary Angiography by Means of Photon-Counting 1 Detector CT for Diagnosis of Acute Pulmonary Embolism**

Pauline Pannenbecker, MD, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess image quality (IQ) and required radiation dose of an ultra-high-pitch CT pulmonary angiography (CTPA) protocol with a low contrast medium (CM) dose in free-breathing technique for diagnosis of acute pulmonary embolism (PE) using a clinical photon-counting detector (PCD) CT scanner in comparison to a matched conventional energy-integrating detector (EID) based Single-Energy CTPA protocol.

#### **METHODS AND MATERIALS**

51 CTPAs performed on a clinical PCD CT (Naeotom Alpha, Siemens Healthcare GmbH) were prospectively compared to 51 CTPAs performed on a 3rd generation Dual-Source EID CT (Somatom Force, Siemens Healthcare GmbH). All CTPAs were acquired with an ultra-high-pitch CTPA scan protocol in free-breathing technique (matched parameters: 40ml CM, flow rate 4ml/sec, pitch 3.2) at 140 kV (PCD) and 70-100 kV (EID). Based on spectral CTPAs acquired on the PCD scanner, iodine-distribution maps were reconstructed. As ultra-high-pitch EID CTPA could only be performed in Single-Energy mode due to technical limitations, reconstruction of iodine-maps was not possible in this subgroup. For evaluation of objective IQ, CT attenuation within pulmonary arteries, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were compared. To assess subjective IQ, three readers rated CTPAs (at 60 keV using virtual monoenergetic imaging for PCD and at standard reconstruction for EID) and iodine-maps based on a four-point scale. For radiation dose analysis, effective dose (ED), CTDIvol, dose length product, and size-specific dose estimates were compared.

#### **RESULTS**

CT attenuation was higher within all pulmonary vessels in the PCD-group (all  $p < 0.05$ ). While CNR and SNR were higher in the lobar pulmonary arteries in PCD CTPAs ( $p < 0.05$ ), they were similar within the pulmonary trunk ( $p > 0.05$ ). Subjective IQ of PCD scans was rated best by all three reviewers (excellent or good IQ in 96.1% of PCD CTPAs vs. 50.9% of EID CTPAs, ICC = 0.795). All evaluated radiation dose parameters were lower in the PCD group, as is exemplified with a mean ED of 1.33 ( $\pm 0.47$ ) mSv vs. 1.80 ( $\pm 0.82$ ) mSv (PCD vs. EID; all  $p < 0.05$ ).

#### **CONCLUSION**

Ultra-high-pitch CTPA acquisition in free-breathing technique with PCD CT allows for superior objective and subjective image quality with reduced radiation dose, while providing full spectral assessability. Moreover, in this protocol setting, PCD CTPA enables reconstruction of color-coded iodine-distribution maps, offering additional functional information compared to matched ultra-high-pitch EID CTPA.

#### **CLINICAL RELEVANCE/APPLICATION**

In PCD CT, pulmonary arteries can be fully spectrally assessed despite ultra-high-pitch settings, overcoming the need for breath-holds in the context of pulmonary embolism where dys- and tachypnea are common symptoms.

#### **R5B-SPCH- Prediction of the Treatment of Pulmonary Embolism using CT Texture Analysis 2**

Ki Yeol K. Lee, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the utility of computed tomography texture analysis (CTTA) parameters in predicting the treatment outcome in pulmonary thromboembolism (PTE).

## METHODS AND MATERIALS

We evaluated 88 patients diagnosed with PTE on whom chest computed tomography (CT) for detecting PTE was performed. Texture analysis was performed on the acute PTE detected on chest CT. Using the software, the groups in which PTE disappeared and remained after treatment were compared. The mean, standard deviation (SD), entropy, mean of positive pixels (MPP), skewness, and kurtosis of parameters on the spatial scaling factor (SSF) 2-6 were compared between the groups. The gray-level co-occurrence matrix (GLCM) texture features were used for SSF 0 images.

## RESULTS

PTE disappeared after treatment in 51 patients, whereas it remained in 37 patients. Entropy was significantly different in SSF 3,4,5,6 ( $p < 0.05$ ). The mean and MPP on SSF 0 and the SD on SSF 4,5,6 were also significantly different ( $p < 0.05$ ). Other parameters, such as the mean, standard deviation, MPP, skewness, and kurtosis, on other SSFs were not significantly different. Among the GLCM parameters, several parameters such as joint energy and entropy, perimeter, area, and long and short axis were significantly different ( $p < 0.05$ ).

## CONCLUSION

CTTA allows the prediction of whether the PTE will dissolve or remain after treatment. The mean and MPP on non-filtered images, entropy, and SD values on highly filtered SSFs had the best performance in predicting the anticoagulation treatment effects. The results suggest that several parameters of GLCM texture features can be used to predict anticoagulation treatment effects.

## CLINICAL RELEVANCE/APPLICATION

CTTA can be used to predict whether PTE will dissolve or remain in the patient after treatment.

## R5B-SPCH- Impact of an AI Based Triage and Prioritization Solution for Incidental Pulmonary Embolism Findings on Contrast CT in an Outpatient Setting

Seyedali Nabipoorashrafi, MD, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To measure the impact of a computer aided triage and prioritization AI solution for patients with incidental pulmonary embolism (iPE) undergoing CT scan of the chest and/or abdomen.

## METHODS AND MATERIALS

Cases from a large academic health system were collected from the outpatient setting between April 2022 and April 2023. A wait time metric was calculated for AI-notified cases with suspected positive iPE findings and compared to negative non-AI-notified cases. Wait time was defined as the difference between the time of study acquisition completion to the time a radiologist opens the case for dictation. The median wait times were calculated for the AI-notified and non-AI-notified cases. A Mood's median test was used to test for statistical significance.

## RESULTS

A total of 28,914 CT contrast examinations that included the lungs (12,564 chest/abdo/pelvis and 16,350 chest only) were collected. The AI solution provided suspected positive prioritization notifications (AI-notified) on 269 cases (87 chest/abdo/pelvis and 182 chest only). The median wait time was 86 minutes (AI-notified) compared to 242 minutes (non-AI-notified). The observed median wait time reduction was 64.4% (156 minutes,  $p$ -value $<0.001$ ). The median wait time was 76 minutes (AI-notified) compared to 461 minutes (non-AI-notified) and 87 minutes (AI-notified) compared to 172 minutes (non-AI-notified) for chest/abdo/pelvis and chest only cases respectively. The chest/abdo/pelvis subcohort had the largest observed median wait time reduction (83.5%, 385 minutes,  $p$ -value $<0.001$ ) compared to chest only cases (50.6%, 85 minutes,  $p$ -value: 0.009).

## CONCLUSION

A computer aided triage and prioritization AI solution decreased wait times for contrast CT examinations with suspected iPE potentially saving hours of diagnosis delays in the outpatient setting.

## CLINICAL RELEVANCE/APPLICATION

Using an AI solution to prioritize radiologist interpretation of CT scans with iPE findings decreases wait time. Time saved has the potential to prioritize diagnosis and facilitate earlier treatment initiation.

## R5B-SPCH- Impact of the Recent Global Iodinated Contrast Agent Shortage on Observed Positivity Rate for Pulmonary Embolism in CT Pulmonary Angiograms at a Major US Healthcare System

Axel Wismueller, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To quantitatively track the impact of the recent global shortage of iodinated contrast agents on observed Pulmonary Embolism (PE) positivity rate in CT Pulmonary Angiogram (CTPA) exams using AI-based image analysis at a major US healthcare system.

## METHODS AND MATERIALS

Using software of a commercial AI-based image analysis vendor (Aidoc Medical, Tel Aviv, Israel), we analyzed daily volumes and PE positivity rates for a total of 2,407 Computed Tomography Pulmonary Angiogram (CTPA) exams before and during the recent contrast agent shortage (both comprising 04/01/2022 through 07/01/2022). For comparison with a non-contrast CT exam type, we analyzed daily volumes and positivity rates for Intracranial Hemorrhage (ICH) on 10,843 non-contrast head CT exams during the same time period. Specifically, we compared two observational periods, namely (i) a pre-shortage control period from 04/14/22 through 05/05/2022, and (ii) a contrast shortage period from 05/21/2022 through 06/11/2022. Percentage change metrics of case volumes and positivity rates for PE and ICH were calculated, where we report relative changes with regard to a baseline measurement period from 04/01/2022 through 04/14/2022. The two observational periods were compared for statistically significant differences using Welch's unequal variances t-test.

## RESULTS

Case volumes of contrast-enhanced CTPA exams dropped from baseline during the contrast agent shortage period by 42.88%  $\pm$  20.22% while PE positivity rates increased by 47.8%  $\pm$  13.7%, where statistical differences between observational periods were highly significant ( $p < 10^{-4}$ ). For comparison, non-contrast head CT volumes dropped by only 7.55%  $\pm$  2.98%, and ICH positivity rates increased by only 12.5%  $\pm$  1.87%, with no significant difference between pre-shortage and shortage observational periods ( $p > 0.05$ ).

## CONCLUSION

Our results suggest a significant increase of PE positivity rate in CTPA exams at significantly decreased CTPA total exam volumes during the observed global contrast agent shortage period, while non-contrast head CT exam volumes and ICH positivity rates remained essentially stable. Our observations can be explained by more restrictive ordering patterns for CTPA studies during the acute contrast agent shortage period, limiting access to such exams only to patients with high clinical pre-test probability.

## CLINICAL RELEVANCE/APPLICATION

Using AI-based image analysis can quantify effects of unexpected healthcare challenges on critical radiology findings, such as for pulmonary embolism during the observed global contrast agent shortage.

## R5B-SPCH- **Diagnostic Ability for the Presence and Severity of Pulmonary Hypertension on Super-high-resolution Non-enhanced Chest Computed Tomography**

Yukihiro Nagatani, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the detectability of pulmonary hypertension (PH) and the predictability of its severity by cross-sectional vessel area (CSA) on super-high-resolution (SHR) non-enhanced chest computed tomography (CT)

## METHODS AND MATERIALS

Thirty patients including 11 patients diagnosed as PH, 9 patients with connective tissue disease (CTD) associated interstitial pneumonia (CTD-IP) without PH and 10 age-matched controls, underwent UHR non-enhanced chest CT. Mean pulmonary arterial pressure (PAP) were measured at right heart catheterization performed within 1 month of the chest CT examination date for the 11 PH patients. Image data were obtained using iterative reconstruction algorithm with normal-resolution simulation (NRsim) mode (512 $\times$ 512 matrix size, 0.5-mm slice thickness), and using deep-learning-based reconstruction algorithm with SHR mode (1024 $\times$ 1024 matrix size, 0.25-mm slice thickness). By using binary images with the optimal threshold of -720 HU at three predefined trans-axial levels including aortic arch, tracheal bifurcation and right proximal pulmonary vein, average vessel dimension (AVD) and the percentage of the total CSA for the lung field area (%CSA) for dimensions of less than 0.5, 0.5 to 1, 1 to 2 and 2 to 5 mm<sup>2</sup> were quantified for CT data both at NRsim and SHR mode. AVD and %CSA were compared among PH, CTD-IP and age-matched controls with Kruskal-Wallis test, and correlated with mean PAP for PH with Spearman's rank coefficient.

## RESULTS

On CT images at SHR mode, AVD for dimensions of less than 0.5 mm<sup>2</sup> for PH (0.226 $\pm$ 0.008 mm<sup>2</sup>) were smaller as compared with those for CTD-IP (0.239 $\pm$ 0.008 mm<sup>2</sup>) and age-matched controls (0.245 $\pm$ 0.004 mm<sup>2</sup>). ( $p < 0.01$ ) AVD for dimensions of 1 to 2 mm<sup>2</sup> correlated negatively with mean PAP ( $r = -0.67$ ,  $p = 0.048$ ). In contrast, on CT images at NRsim mode, although %CSA for dimensions of less than 0.5 mm<sup>2</sup> correlated positively with mean PAP ( $r = 0.71$ ,  $p = 0.032$ ), the %CSA for PH (0.61 $\pm$ 0.38%) was larger than that for CTD-IP (0.53 $\pm$ 0.30%) and comparable to that for age-matched controls (0.60 $\pm$ 0.25%).

## CONCLUSION

AVD for dimensions of less than 2 mm<sup>2</sup> at SHR mode on non-enhanced chest CT images has the potential to indicate the presence and severity of PH.

## CLINICAL RELEVANCE/APPLICATION

Quantification of pulmonary smaller peripheral vessels of less than 2 mm<sup>2</sup> depicted at SHR mode may be useful for direct assessment of peripheral arterial remodeling in PH.

## R5B-SPCH- Dual-Layer Dual-Energy CT-Derived Pulmonary Perfusion for the Differentiation of Acute Pulmonary Embolism and Chronic Thromboembolic Pulmonary Hypertension

Roman J. Gertz, MD (*Presenter*) Institutional research contract, Koninklijke Philips NV

## PURPOSE

To assess the ability of dual-layer dual-energy computed tomography (dI-DTECT)-derived pulmonary perfusion maps to differentiate between acute pulmonary embolism (PE) and chronic thromboembolic pulmonary hypertension (CTEPH).

## METHODS AND MATERIALS

57 patients with acute PE, 52 patients with CTEPH and 22 controls, all of whom underwent CT pulmonary angiography on a dI-DTECT were included in this retrospective study. Normal and malperfused areas of lung parenchyma were semiautomatically contoured using iodine density overlay maps (IDOs). First order histogram features of normal and malperfused lung tissue were extracted. Iodine density (ID) was normalized to the mean pulmonary artery (MPA) and the left atrium (LA). Group differences were analyzed using the t-test and the Mann-Whitney U test. The data was split into training and validation sets to assess the diagnostic accuracy of the derived histogram features using the area under the receiver operating characteristic curve (AUC).

## RESULTS

In acute PE, normal perfused lung areas revealed a higher mean and peak iodine uptake normalized to the MPA than in CTEPH (both  $p < 0.001$ ). After normalizing mean ID in perfusion defects to the LA, patients with acute PE revealed a reduced average perfusion (ID<sub>mean,LA</sub>) compared to both CTEPH patients and controls ( $p < 0.001$  for both). ID<sub>mean,LA</sub> allowed for a differentiation between acute PE and CTEPH with moderate accuracy (AUC: 0.72, sensitivity 74%, specificity 64%), resulting in a PPV and NPV for CTEPH of 64% and 70%.

## CONCLUSION

dI-DTECT enables quantification and characterization of pulmonary perfusion patterns in acute PE and CTEPH, enabling the differentiation between the two diseases.

## CLINICAL RELEVANCE/APPLICATION

The identified parameters yield the potential to enable more timely identification of patients with chronic thromboembolic pulmonary hypertension.

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## Abstract Archives of the RSNA, 2023

R5B-SPER

### Emergency Radiology Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPER- Disentangling the Knot: Our Experience with Ultrasound Assisted Manual Testicular 1 Detorsion in the Radiology Department**

Mauricio J. Fernandez, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Testicular torsion (TT) is an emergency. Prompt diagnosis and management are key to preserve the testicle. Our objective is to show our experience with intravaginal TT sonographic diagnosis and ultrasound (US) assisted manual detorsion (MD).

#### **METHODS AND MATERIALS**

A prospective, randomized, controlled trial over an 8-year period with a total of 108 patients diagnosed with TT. Mean age was 14 years, age range 1-48 years. US was performed in 106 patients (98%). Testicular flow was absent in 73 (69%), diminish in 27 (25%), normal in 6 (6%). Torsion of the cord was documented in 103 patients (97,2%) and not demonstrated in 3 (2,8%). In the first group of 59 patients, 57 underwent surgery following sonographic diagnosis of TT and 2 went directly to surgery. In the second group, 49 patients underwent US assisted MD attempt immediately after sonographic TT confirmation and posterior surgery. MD is attempted following US TT confirmation, explaining the procedure and obtaining consent. It is performed with US assistance and without sedation or analgesia thus enabling clinical monitoring and expediting the procedure. US assisted MD was performed by 14 staff radiologist, 1 pediatric surgeon and 8 radiology residents under staff supervision.

#### **RESULTS**

In the first group, testicular echotexture was preserved in 33 (58%) and altered in 24 (42%). 15 orchiectomies were performed (25,4%) and 44 (76,4%) testicles were fixated including 4 that showed later atrophy (9%). 1 of the patients that did not undergo US exam turned out to be a false positive. 4 underwent spontaneous detorsion while performing the US. 2 patients had inguinal torsion. 1 patient with Asperger syndrome barely cooperated with the diagnostic US exam. In the second group, testicular echotexture was preserved in 44 (89,8%) and altered in 5 (10,2%). MD achieved testicular reperfusion and symptoms relief in 42 patients (85,7% success rate). 1 orchiectomy was performed (2%) and 48 testicles were fixated including 2 that showed later atrophy (4%). There were no complications related to US assisted MD.

#### **CONCLUSION**

US confirms the diagnosis of TT, evaluates pre-detorsion testicular viability, assists MD and verifies restoration of testicular flow. MD is a non-invasive, simple, feasible, quick, safe and effective maneuver that improves testicular viability by immediately restoring testicular flow if successful, relieves patient's symptoms and improves his comfort and facilitates posterior surgery.

#### **CLINICAL RELEVANCE/APPLICATION**

Sonographic diagnosis of TT and US assisted MD adds value to the radiologist role in this emergency clinical setting performing a medical act that is both diagnostic and therapeutic.

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## Abstract Archives of the RSNA, 2023

R5B-SPGI

### Gastrointestinal Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPGI-1 Measurement of Spleen Volume Using CT Images with Deep Learning Segmentation: Definition of Normal Spleen and Splenomegaly**

Kotaro Fujita, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and evaluate a fully automated algorithm for segmenting the spleen and to establish thresholds for splenomegaly from CT.

#### **METHODS AND MATERIALS**

The dataset used to develop this deep learning software on Python consisted of anonymized non-contrast CT images of the abdomen of 138 patients provided by PSP Inc. These 138 images were divided into a training set, a validation set, and a test set. A Bayesian 3D U-Net was trained on the labeled spleen data. The initial study cohort consisted of generally healthy, asymptomatic adult outpatients who were potential renal donors, liver donors, scheduled to undergo CT colonography or abdominal CT for physical examination between April 2011 and April 2022, at a single medical center. A subanalysis was conducted prior to the clinical study. One hundred and twenty patients were randomly selected from the clinical study population. Multiple regression analysis was used to evaluate the relationship between demographic and clinical data and spleen capacity data.

#### **RESULTS**

The final sample consisted of 2554 asymptomatic adult outpatients (mean age  $\pm$  standard deviation,  $65.0 \pm 15.3$  years, including 1736 men and 821 women). The mean height  $\pm$  standard deviation of the patients was  $162.1 \pm 9.4$  cm, and the mean weight of the patients was  $62.3 \pm 13.7$  kg. The deep learning tool was used to successfully segment the spleen in all scans. The mean standardized spleen volume  $\pm$  standard deviation was  $123.2 \pm 59.2$  mL, showing a normal distribution. Patient weight was the major determinant of spleen volume and demonstrated a linear relationship. From this result, a linear weight-based upper limit of normal spleen threshold volume was derived:  $\text{splenomegaly} = 1.87 \times \text{weight (kg)} + 124.67$  mL. In the subset of 100 patients, the median difference in spleen volume between the deep learning tool and the manual method was 2.3%: mean Dice score was 0.95 (0.72-0.97).

#### **CONCLUSION**

Weight-based thresholds for objective normal spleen and splenomegaly were derived from a spleen volume database using CT images, based on deep learning.

#### **CLINICAL RELEVANCE/APPLICATION**

Splenomegaly is defined as an abnormal enlargement of the spleen resulting from various clinical conditions such as infections, hematologic diseases, congestion, autoimmune diseases or tumors. Splenomegaly is often a diagnostic entry point for various background diseases, and accurate detection of splenomegaly is clinically important. The purpose of our study is to establish the normal distribution of splenic volume in healthy adults using automated organ segmentation techniques on abdominal CT images. Furthermore, this data will be used to establish a potential threshold for splenomegaly.

#### **R5B-SPGI-2 Imaging Practices and Clinical Outcomes Following Suboptimal Visualization Score on Hepatocellular Carcinoma Ultrasound Screening**

Seoiyoung Ahn, MS (*Presenter*) Nothing to Disclose



## PURPOSE

The Ultrasound Liver Imaging Reporting and Data Systems (US LI-RADS) provides standardized terminology and reporting of ultrasound (US) screening for hepatocellular carcinoma (HCC). However, limited data exists on the clinical relevance of US LI-RADS suboptimal visualization scores of B/C. The aim of this study is to identify predictors of suboptimal visualization on HCC US screening and investigate follow-up imaging practices and clinical outcomes.

## METHODS AND MATERIALS

Retrospective analysis was performed on patients who underwent initial HCC US screening from 2017-2021. Clinical factors, including demographics, body mass index (BMI), laboratory findings, hepatitis/cirrhosis status, surgical pathology, initial US and follow-up imaging, diagnosis of HCC/cirrhosis, and liver transplant, were collected. Multivariable analysis was performed to determine predictors for suboptimal (B/C) visualization on HCC US screening. Chi-square test and independent t-test were performed to compare follow-up imaging practices and clinical outcomes between scores of A and B/C. Only patients with US LI-RADS visualization scores were included.

## RESULTS

Of 396 patients, 56% (221/396) had a score of A, while 44% (175/396) had suboptimal scores of B/C. Multivariable analysis revealed that BMI (OR:1.05, 95% CI:1.01-1.09,  $p=0.01$ , per 1 score increase) and cirrhosis (OR:2.64, 95% CI:1.11-6.27,  $p=0.027$ ) predicted suboptimal visualization. Further analysis showed that 42.53% (94/221) of the patients with a score of A had follow-up imaging, compared to 45.71% (80/175) with scores of B/C. The mean time to follow-up imaging was not significantly different. However, US was more frequently performed in patients with a score of A (65.96% vs. 43.75%,  $p=0.003$ ), while CT was performed more frequently among patients with scores of B/C (23.40% vs. 38.75%,  $p=0.028$ ). Clinically, liver transplant was more common within one year from initial US among patients with scores of B/C (13.75% vs. 9.57%,  $p=0.0284$ ), while subsequent diagnosis of HCC/cirrhosis after the initial US was not significantly different.

## CONCLUSION

Our findings suggest that patients with suboptimal visualization scores of B/C on initial HCC US screening were followed at similar intervals as those with a score of A. However, patients with scores of B/C underwent CT follow-up and liver transplant more frequently than those with a score of A. This study highlights the need for establishing recommendations for imaging and clinical management following suboptimal visualization on HCC US screening.

## CLINICAL RELEVANCE/APPLICATION

Suboptimal visualization scores on initial HCC US screening impact follow-up imaging and clinical outcomes, and thus standardized recommendations are warranted for optimal care.

## R5B-SPGI-3 Effect of Liver Fibrosis on the Correlation between US-ATI and MRI-PDFF

Riwa Kishimoto, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

With the increasing number of liver diseases caused by obesity and metabolic syndrome, the assessment of fatty liver by ultrasound attenuation imaging (ATI) is widely used clinically. It has been reported that ATI correlates well with MRI-derived proton density fat fraction (PDFF). On the other hand, the influence of liver fibrosis on ATI has been discussed. In the present study, we investigated whether the degree of fibrosis affects the correlation between ATI and MRI-PDFF when divided into high and low fibrosis groups using shear wave speed (SWS) and Fib-4 index.

## METHODS AND MATERIALS

Seventy-four patients with ultrasound (US) and MR examinations performed within two weeks were included. Canon Medical Systems Aplio i800 with an i8CX1 probe was used, and SWS and ATI were obtained simultaneously using an advanced SWE application. After at least 4 hours of fasting, five measurements were taken with a right intercostal procedure avoiding large blood vessels at neutral breathing during a breath hold. MRI was performed using a Philips Achieva 1.5T, and the m-Dixon method was used. ROI of about 10 mm diameter was placed in the center of the right lobe, same as US. The correlation between ATI value and MRI-PDFF was investigated. To evaluate the effect of fibrosis, the patients were divided into two groups using SWS and Fib-4 index, which is considered highly likely to be associated with fibrosis: those with SWS = 1.6 m/s and those with SWS <1.6 m/s, and those with Fib-4 index = 2.67 and < 2.67. The analysis of covariance (ANCOVA) was performed.

## RESULTS

Fifty-five patients were included, excluding those due to low reliability whose interquartile range (IQR)/median of SWS and ATI was over 0.3. The correlation between ATI value and MRI-PDFF of the liver was good,  $R=0.74$ . In a study in which the patients were divided by SWS and Fib-4 index, the correlation coefficients were similar: 0.78 for the high SWS group and 0.74 for the low SWS group, and 0.74 for the high Fib-4 index group and 0.77 for the low Fib-4 index group, respectively. The degree of liver fibrosis did not significantly affect the correlation between ATI and MRI-PDFF using ANCOVA.

## CONCLUSION

We hypothesized that the correlation between ATI and MRI-PDFF would be worse in cases with liver fibrosis, but no difference was found in the study divided into high and low fibrosis groups using SWS and Fib-4 index. The correlation was good in both groups with  $R > 0.7$ , and fibrosis had no confounding effect.

## CLINICAL RELEVANCE/APPLICATION

The degree of liver fibrosis did not significantly affect the correlation between ATI and MRI-PDFF.

## R5B-SPGI-4 Shear Wave Elastography Assessment of the Spleen Before and After Transjugular Intrahepatic Portosystemic Shunt (TIPS)

Robert Turner, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Transjugular intrahepatic portosystemic shunt (TIPS) creation is an effective intervention to minimize complications of portal hypertension. However, periodic surveillance of TIPS is required to detect asymptomatic shunt stenosis or occlusion. Spleen shear wave elastography (SWE) has previously been shown to correlation with portal pressure, therefore it may be a surrogate marker for surveillance of TIPS patency. The goal of this study was to evaluate the changes in splenic stiffness using SWE immediately before and after TIPS placement, to determine how acute changes in portal pressure effect the spleen.

### METHODS AND MATERIALS

This prospective cohort study included adult patients with portal hypertension who underwent nonemergent TIPS creation at a single institution from 10/31/2017 - 5/20/2021. Individuals were excluded if they had a prior splenectomy. Patients were evaluated with spleen SWE immediately before and after TIPS placement. Spleen length was measured by ultrasound in each individual during the pre-TIPS scan. Paired t-test analysis was performed to compare median splenic stiffness before and after the procedure and spleen length between patient groups.

### RESULTS

Thirty patients were enrolled with a mean age of 58 years (SD=14.8). There was a decrease in median spleen shear wave velocity (SSWV) in 70% of patients following TIPS creation ( $p=0.03$ , binomial 95% CI=54% - 86%). The average decrease in SSWV after TIPS creation was 0.21 m/sec ( $p=0.01$ , 95% CI=0.38 - 0.05). Spleen length trended higher in patients who showed a decrease in SSWV (mean=16.2 cm, SD=2.99) compared to those who had an increase in SSWV (mean=15.3 cm, SD=2.51), though this difference was not statistically significant ( $p=0.43$ ).

## CONCLUSION

There was a statistically significant decrease in SSWV immediately after TIPS placement, indicating that spleen stiffness is acutely affected by changes in portal pressure. Spleen SWE may be a useful tool in longitudinal surveillance of TIPS patency, using the patient as a self-control.

## CLINICAL RELEVANCE/APPLICATION

Spleen shear wave elastography may be a complementary, non-invasive tool for monitoring TIPS patency and portal hypertension complications.

## R5B-SPGI-5 US-LIRADS: Outcomes of Category 1B and 1C Examinations on Multiphase CT/MRI

Tyler Sevco, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The purpose of this study is to evaluate the outcomes of ultrasound (US) LI-RADS category US-1B and US-1C examinations performed for hepatocellular carcinoma (HCC) screening and surveillance on the basis of subsequently performed multiphase MRI or CT.

### METHODS AND MATERIALS

In this retrospective analysis, 211 patients at high risk for HCC (127 men and 84 women; mean [±SD] age, 59.8 ±13.1 years) underwent screening liver US between June 2019 and September 2022 and were assigned US-1B (111 patients) or US-1C (100 patients) on a prospective clinical basis using the US-LIRADS algorithm. The results of follow-up imaging studies were analyzed.

### RESULTS

US visualization scores were assigned as B (52.6% [111/211]) and C (47.4% [100/211]). The most common reasons for US-1B and 1C visualization scores included overlying bowel gas (52.6% [111/211]), parenchymal heterogeneity/echogenicity

(26.5% [56/211]), and body habitus/poor acoustic window (10.0% [21/211]). Follow-up US for ongoing HCC screening was available for 57.8% (122/211) of patients. On follow-up US, 98.4% of patients remained US-LIRADS category 1 (120/122), 0.8% were category 2 (1/122), and 0.8% were category 3 (1/122). Subsequently-performed multiphase contrast-enhanced MRI or CT was available for 38.3% (81/211) of patients including 43.0% (43/100) of 1B patients and 34.2% (38/111) of 1C patients with a time interval between screening US and CT/MR of 287.9 +/- 265.5 days. Multiphase CT or MRI results for patients with US-1B and US-1C visualization scores included no abnormality at CT or MRI (70.3% [57/81]), a benign lesion (6.2% [5/81]), a LI-RADS category 3 (LR-3) observation (16.0% [13/81]), a LI-RADS category 4 or 5 (LR-4 or LR-5) observation (5.0% [4/81]), and an LR-M observation (2.5% [2/81]). Within the US-1B cohort, an LR-4 or LR-5 observation was seen in 4.6% (2/43) and an LR-M observation was seen in 2.3% (1/43). In the US-1C cohort, an LR-4 or LR-5 observation was seen in 2.6% (1/38) and an LR-M observation was seen in 5.3% (2/38). The incidence of probable or definite HCC on CT/MR for US-1B or US-1C examinations was 5.0% (4/81) and for any malignancy was 7.4% (6/81).

## **CONCLUSION**

In the HCC screening population, approximately 5% of US-1B and US-1C examinations have probable or definite HCC and 7.4% have malignant findings on multiphase CT or MR. Despite this, only 38.3% of patients with US-1B or US-1C examinations underwent multiphase CT or MRI, meaning that the majority of clinical providers are currently opting for continued ultrasound surveillance despite limited liver visualization.

## **CLINICAL RELEVANCE/APPLICATION**

Patients in the HCC screening population with US-1B or US-1C examinations due to suboptimal liver visualization may benefit from further evaluation with multiphase CT or MRI.

## **R5B-SPGI-6 Repeatability and Reproducibility of Multi-parametric Ultrasound in Liver Assessment**

Reinhard I. Kubale, MD (*Presenter*) Research Consultant, Siemens AG

### **PURPOSE**

Quantitative ultrasound-based techniques, such as ultrasound derived fat fraction (UDFF) and point shear wave elastography (pSWE), have become promising noninvasive tools for evaluating liver fibrosis and steatosis. However, the repeatability and reproducibility of these techniques remain critical factors for their broader clinical adoption. This study aims to assess the sonographer reproducibility and measurement repeatability of UDFF and pSWE in liver assessment within a cohort of 31 subjects.

### **METHODS AND MATERIALS**

Three experienced sonographers performed five acquisitions each on the subjects' livers using the Siemens Sequoia ultrasound system. The intraclass correlation coefficients (ICCs) and Bland-Altman analysis were employed to evaluate the repeatability within each sonographer and the reproducibility across the sonographers for both UDFF and pSWE measurements.

### **RESULTS**

The results demonstrated good sonographer reproducibility and measurement repeatability for both UDFF and pSWE. The ICC for UDFF repeatability ranged from 0.97 (95% CI: 0.95-0.98) to 0.99 (95% CI: 0.98-1.0), while the ICC for pSWE repeatability ranged from 0.94 (95% CI: 0.89-0.97) to 0.96 (95% CI: 0.93-0.98). Additionally, the ICC for sonographer reproducibility was 0.93 (95% CI: 0.88-0.96) for UDFF and 0.62 (95% CI: 0.43-0.77) for pSWE. Bland-Altman analysis revealed a mean difference of 0 % for UDFF and 0 m/s for pSWE, indicating no bias between the sonographers, and the limits of agreement were within  $\pm 3.51\%$  for UDFF and  $\pm 0.2$  m/s for pSWE, demonstrating acceptable agreement.

## **CONCLUSION**

These findings support the repeatability and reproducibility of UDFF and pSWE measurements in liver assessment, highlighting their potential as reliable tools for noninvasive liver fibrosis and steatosis evaluation. Further research is warranted to optimize measurement protocols and investigate their performance in various clinical settings.

## **CLINICAL RELEVANCE/APPLICATION**

This study demonstrates that ultrasound-derived fat fraction (UDFF) and point shear wave elastography (pSWE) show good repeatability and reproducibility for assessing liver fibrosis and steatosis, making them promising noninvasive tools in clinical settings. The high intraclass correlation coefficients and Bland-Altman analysis results support their reliability across different sonographers, highlighting the potential for these techniques to be adopted more widely in liver assessment. Future research should focus on optimizing measurement protocols and evaluating their performance across various clinical contexts to further solidify their clinical utility.

## **R5B-SPGI-7 Ultrasound Point Shear Wave Elastography is Feasible Across All Ages to Evaluate for Sinusoidal Obstruction Syndrome after Hematopoietic Stem Cell Transplantation**

Kelly R. Dietz, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Veno-occlusive disease or sinusoidal obstruction syndrome (VOD/SOS) is a known potential complication of HCT and usually involves the liver. Hepatic VOD is characterized by damage to blood vessels in the liver and surrounding liver cells, with significant associated morbidity. Ultrasound point shear wave elastography (PSWE) is an imaging technique that has high sensitivity and specificity in detecting tissue stiffness, which is hypothesized to increase in VOD/SOS. A prospective, observational pilot study was performed to evaluate the feasibility and value of shear wave elastography (SWE) in the diagnosis of hepatic VOD/SOS after hematopoietic cell transplantation (HCT).

## **METHODS AND MATERIALS**

Pediatric and adult patients undergoing autologous or allogeneic HCT at a single academic institution, and who received myeloablative conditioning were consented to participate in this study. Pre-transplant liver and other organ evaluation was performed. Post-transplant evaluation and SWE imaging was performed on all subjects at day +5, day +10, day +14, day +21, day +100.

## **RESULTS**

A total of 42 patients were enrolled in the study, of which 62% were males with median age of 15 years (range: 1-50 years). Underlying malignancy was the primary indication for HCT in 73% of patients.; 95% underwent an allogeneic HCT with a median age of participation of 15 years (range: 1-50 years). No patients were diagnosed with VOD and there was no statistical significance in the median liver stiffness before and after engraftment (1.4 (1.1-2.6) vs. 1.4 (1.2-2) m/sec;  $p=0.81$ ). Trends were observed by ultrasound during the course of observation including hepatic enlargement, gallbladder wall thickening and sludge, alterations in portal and hepatic venous flow, and the development of ascites, all despite the lack of VOD diagnosis.

## **CONCLUSION**

PSWE is feasible in children and adults to assess the flow dynamics in hepatic and portal vasculature. Further studies need to be performed to evaluate its utility in diagnosis of VOD/SOS and assessing the therapeutic response.

## **CLINICAL RELEVANCE/APPLICATION**

Performing point shear wave elastography is feasible across all ages. Though there were no VOD/SOS cases, this study successfully demonstrates the radiologic changes in hepato-portal venous flow changes and organ changes after HSCT.

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## Abstract Archives of the RSNA, 2023

R5B-SPGU

### Genitourinary Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPGU- Estimation of Renal Function Using Iodine Maps in Dual-energy Spectral Computed Tomography Urography: A Feasibility and Accuracy Study**

Shigeng Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the feasibility of measuring glomerular filtration rate (GFR) using iodine maps in dual-energy spectral computed tomography urography (DEsCTU).

#### **METHODS AND MATERIALS**

One hundred and eighty patients with renal tumors referred for DEsCTU were prospectively enrolled. The DEsCTU protocol included non-contrast, nephrographic, and excretory phase imaging. The CT-derived GFR was calculated separately using the above 3-phase iodine maps (CT-GFRiodine) and 120 kVp-like images (CT-GFR120kvp). CT-GFRiodine and CT-GFR120kvp were compared with estimated GFR (eGFR) using paired t-test, correlation analysis, and Bland-Altman plots. The receiver operating characteristic (ROC) curves were used to test the renal function diagnostic performance with CT-GFR120kvp and CT-GFRiodine.

#### **RESULTS**

There were 100 patients with normal renal function and 80 patients with decreased renal function. The difference between eGFR ( $91.71 \pm 14.17 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ) as reference standard and CT-GFRiodine ( $93.42 \pm 14.04 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ) was not statistically significant, showing excellent correlation ( $r=0.88$ ,  $P<0.001$ ) and agreement ( $\pm 15.65 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ,  $P=0.091$ ). The correlation between eGFR and CT-GFR120kvp ( $84.71 \pm 21.76 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ) was poor ( $r=0.58$ ,  $P<0.001$ ), and the agreement was poor ( $\pm 45.75 \text{ ml} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ ,  $P=0.004$ ). The CT-GFRiodine had the largest area under the curve (AUC) for distinguishing between normal and decreased renal function (AUC=0.974).

#### **CONCLUSION**

The GFR can be calculated accurately using iodine maps in DEsCTU.

#### **CLINICAL RELEVANCE/APPLICATION**

This study explored the potential information of iodine maps in DEsCTU and demonstrated that DEsCT could be a non-invasive and reliable one-stop-shop imaging technique for evaluating both the urinary tract morphology and renal function, thereby providing more quantitative parameters for clinical practice and bringing more benefits to patients.

#### **R5B-SPGU- AI-based Urinary Calculi Detection, Localization, and Quantification on Abdomen-pelvis CT: A Multicenter, International Internal Testing and External Validation Study**

Parisa Kaviani, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Detection and localization of urinary calculi have a crucial role in patient management and in choosing the best course of therapy. Therefore, we performed a multicenter, international study to assess the performance of an AI algorithm for urinary calculi detection, localization, and quantification on abdomen-pelvis CT.

#### **METHODS AND MATERIALS**

Our retrospective IRB-approved study included 980 patients (mean age  $60 \pm 14$  years; M:F 509:471) who underwent non-contrast abdomen-pelvis CT for the evaluation of suspected urinary calculi at one of the 8 hospitals (4 sites in India,  $n=451$

patients; 4 in the US, n=529 patients). The training (n>1000 CT) and internal testing data (n=451 CT) belonged came from the Indian sites while the US sites contributed data for the external model validation. Patients with surgical clips, stent, and metal related artifacts were excluded. All CT exams were reviewed by one of the three radiologists from India and US, and separately processed with Urologiq AI algorithm (Biocliq Technologies PVY LTD, India) to obtain information on the size of urinary calculi (n= 451) as well as to determine the urinary calculi presence and location, and hydronephrosis/hydronephroureter presence/severity (n=980). Deidentified DICOM images were imported to a secure platform CARING Analytics platform (CARPL) for ground truthing. The sensitivity, specificity, and area under the curve of receiver operating characteristics (ROC-AUC) were estimated to assess the AI model performance.

## **RESULTS**

Our AI algorithm was able to detect the presence of urinary calculi with sensitivities, specificities, and AUCs of 97.3%, 94.2%, 0.958 (internal testing data) and 100%, 100%, 0.958 (external validation set), respectively. Likewise, the AI model differentiated the location of the renal calculi with sensitivities, specificities, and AUCs of 100%, 69.2%-99.6%, and 0.700 - 0.996 (internal testing data) and 92.9%-100%, 75.5%-100%, and 0.79-1 (external validation data) at different locations including (renal, ureteric, bladder levels), respectively. There was a strong correlation of 0.941-0.963 between AI and radiologist measured stone dimensions ( $p<0.001$ ) with a <5% differences between the two measures.

## **CONCLUSION**

The assessed AI algorithm was generalizable and accurate for detection, localization, and quantification of urinary calculi in both internal testing and external validation sites.

## **CLINICAL RELEVANCE/APPLICATION**

The assessed AI model can help improve reporting accuracy and efficiency of abdominal-pelvis CT examinations for kidney stones.

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## Abstract Archives of the RSNA, 2023

R5B-SPHN

### Head & Neck Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPHN- New Strategies in the Diagnosis of Thyroid Nodule: TI-RADS Risk Stratification Systems Versus Computer Aided Diagnosis Software** 1

Vincenzo Dolcetti (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare thyroid nodules evaluation of an expert radiologist (based on ACR-TIRADS classification) to the CAD System S-Detect, in a cohort of patients who performed FNAC.

#### **METHODS AND MATERIALS**

140 patients with an age range of 34 to 78 years with one and no more than three thyroid nodules were enrolled prospectively. The B-mode ultrasound evaluation of the nodule was integrated by a CAD System S-detect evaluation on each patient, and the two were put in comparison with cytology as gold standard. The exclusion criteria were the presence of cystic or mixed predominantly cystic (fluid >50%) lesions, and nodules smaller than 5 mm. All nodules were characterized in terms of size, shape, margins, composition, echogenicity, presence of calcifications or punctate echogenic foci and extrathyroidal extension. Afterward, the S-Detect software was used to automatically determine the shape, composition, echogenicity, and margins of the same nodule.

#### **RESULTS**

At the cytological examination, 102 benign and 38 malignant nodules were identified. At the B mode evaluation, 99 benign nodules (TIRADS 2/3) and 41 malignant nodules (TIRADS 4/5) were identified with a sensitivity of 98%, a specificity of 93%, a positive predictive value of 97% and a negative predictive value of 97%. The S-Detect software identified 97 benign and 43 malignant nodules, with a sensitivity of 97%, a specificity of 92%, a PPV of 95%, a NPV of 95%. A high agreement (>95%) was therefore demonstrated between the evaluation of thyroid nodules performed by the radiologist at the B-mode US using the ACR-TIRADS classification system and the automatic CAD classification provided by the S-Detect software.

#### **CONCLUSION**

ACR-TIRADS shows high agreement with the S-Detect and both show high agreement with cytology results.

#### **CLINICAL RELEVANCE/APPLICATION**

S-Detect is a viable tool for the characterization of thyroid nodules and it has a potential role as a teaching or support tool for the less experienced operators.

#### **R5B-SPHN- Preoperative Diagnosis of Cervical Lymph Node Metastasis in Patients with Thyroid Cancer: Integrative Analysis of CT Imaging Features Based on US** 2

Meesun Lee, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ultrasound (US) is widely used as a primary imaging modality for the evaluation of cervical lymph node (LN) metastasis in thyroid cancer, but its diagnostic accuracy is limited. Computer tomography (CT) is often employed as a complementary modality, but there is no clear consensus on how to integrate the findings from the two modalities. We conducted a study to evaluate the concordance between suspicious imaging features observed on US and CT and to determine the clinical significance of concordant and discordant cases.



## METHODS AND MATERIALS

This retrospective study included consecutive thyroid cancer patients who underwent US, CT examinations, and LN biopsy before surgery between December 2006 and June 2015. We analyzed US and CT images of LNs based on the lexicons of the Korean Society of Thyroid Radiology risk stratification system on a node-by-node basis. The concordance rate was calculated by matching US hyperechogenicity/abnormal vascularity with CT strong/ heterogeneous enhancement, US cystic changes vs. CT cystic changes, and US echogenic foci with CT calcifications. The malignancy rate of LNs was further compared according to the presence of specific suspicious features on US with their concordance with CT features.

## RESULTS

A total of 277 cervical LNs (228 patients, mean age  $47.4 \pm 13.6$  years, female 73.2%) were analyzed, with 53.1% of them were metastatic. The positive concordance rate of suspicious features between US and CT were generally high (US hyperechogenicity vs. CT strong/heterogeneous enhancement, 89.1%; US abnormal vascularity vs. CT strong/heterogeneous enhancement, 86.4%; US cystic changes vs. CT cystic change, 70.6%; US large echogenic foci vs. CT macrocalcification, 87.0%), except for punctate echogenic foci (PEF) (vs. CT microcalcification, 6.5%). Positive concordant cases of US hyperechogenicity/abnormal vascularity showed higher malignancy risk (93.5%) than that of discordant cases (41.2%,  $P < .001$ ). The presence of cystic change or EF on US indicated a high risk of malignancy (82.6-95.8%), irrespective of presence of corresponding CT features.

## CONCLUSION

Suspicious imaging features of cervical LNs observed on US and CT were generally concordant, except for PEF. Heterogeneous or strong enhancement features of CT reinforces the diagnostic significance of hyperechogenicity or abnormal vascularity on US. However, when cystic changes or echogenic foci are observed on US, malignancy should be suspected regardless of CT findings.

## CLINICAL RELEVANCE/APPLICATION

An integrative evaluation of the suspicious features with both US and CT can enhance the diagnostic ability for detecting cervical lymph node metastasis in thyroid cancer patients.

## R5B-SPHN- Evaluating the Diagnostic Performance of a Deep Learning Model for Detecting Thyroid Nodule Malignancy: An Expert Evaluation Study

Sanaz Vahdati, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Thyroid cancer is the most common endocrine malignancy. Ultrasound is the primary imaging modality for evaluating thyroid nodules. Based on the radiologist's assessment, further management, including fine needle aspiration, which is an invasive and costly procedure, may be requested. Thyroid nodule assessment relies on the expertise of radiologists and is subjective to an intrareader agreement. In recent years many deep-learning applications have been developed for thyroid nodule characterization. However, the evaluation of the deep learning model's performance in real-world radiology settings has been limited. In the current work, we aim to evaluate the performance of our previously developed model for thyroid nodule classification into benign and malignant with a radiologist using the American College of Radiology Thyroid Imaging Reporting and Data Systems scoring (TIRAD).

## METHODS AND MATERIALS

The proposed model was trained on the ultrasound images of thyroid nodules from 983 patients with confirmed diagnostic reports from 2008 to 2018. 81 cases were held out as a testing set, and the rest of the data was used for training purposes. One radiologist with more than ten years of experience in ultrasound imaging evaluated the same images of the test set based on the TIRAD scoring system. The radiologist's thyroid nodule evaluation was recorded while the radiologist was blinded regarding the model's prediction and final pathological diagnosis of the patients.

## RESULTS

The whole pipeline from the developed model reached an AUROC of 0.84 (CI 95%: 0.75-0.91) with sensitivity and specificity of 84% and 63%, respectively. The TIRAD evaluation of the test set had a sensitivity of 76% and specificity of 34% which was comparably lower than the model's prediction ( $p$ -value=0.003). A comparison of our model's performance with ground truth and the TIRAD score based on an expert radiologist's evaluation was analyzed. In 28% of the cases, the model predicted benign nodules as benign with TIRAD >3 reports from an expert radiologist. In 19% of cases, our model predicted benign nodules with TIRAD =3 as benign, and in 33% of cases, our model predicted malignant nodules correctly with the TIRAD >3. In addition, our model predicted no nodule as malignant, while the nodule had a benign biopsy report with a TIRAD =3.

## CONCLUSION

We demonstrate the potential diagnostic performance of the deep learning model by comparison of its predictions with TIRAD scores from an expert radiologist.



## CLINICAL RELEVANCE/APPLICATION

Thyroid nodule assessment in ultrasound is subjective to inter and intra-reader agreement. Our deep learning model can provide further assistance to radiologists for thyroid nodule evaluation.

## R5B-SPHN- Real-World Costs Associated with Incidental Thyroid Nodule Workup at an Academic Medical Center

Brandon K.K. K. Fields, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Incidental thyroid nodules (ITN) are a frequent finding on cross-sectional imaging, occurring in up to 18% of CT neck studies with a malignancy rate of up to 11% in the reported literature. The rising incidence of thyroid cancer in the United States, due largely to low-risk papillary thyroid cancers detected as ITNs, has been termed an "epidemic of overdiagnosis". ITN workup, including thyroid ultrasound, labs, and biopsy, may therefore cause resource burden on the healthcare system with questionable clinical benefit. The purpose of our study was to prospectively quantify the cumulative financial burden of ITN workup within a single hospital system using real-world data.

### METHODS AND MATERIALS

Starting in August 2022, all ITNs discovered on CT and MR studies that include the neck at a single hospital system were flagged using a key phrase within the radiology report. The patient's age, nodule size, nodule characteristics, and results of any further tests including thyroid labs, thyroid ultrasound, ultrasound-guided fine needle aspiration, and thyroidectomy, were recorded. The cost of thyroid labs, thyroid ultrasound, ultrasound-guided fine needle aspiration, and thyroidectomy was estimated using national 2023 Medicare reimbursement rates for each test.

### RESULTS

From August 2022 to April 2023, ITNs were found on imaging studies including the neck of 355 patients. The overall incidence of thyroid nodules in a representative selection of studies was 4.0%. Further workup was recommended in 130 of 355 patients based on American College of Radiology guidelines. Fifty of 130 patients underwent laboratory testing with TSH, total T4, free T4, and/or free T3 assays. Thus far, 28 ultrasounds and six fine needle aspiration biopsies have been performed. Of the six biopsies, only one showed malignancy and that patient has not yet undergone surgical workup. One patient underwent right partial thyroidectomy for an indeterminate ultrasound result; final surgical pathology was benign and the patient is currently euthyroid. The total cost of thyroid nodule workup thus far has been \$5,780.96 for one malignancy diagnosed. Assuming the patient with diagnosed malignancy in our cohort undergoes a partial thyroidectomy and remains euthyroid, the total cost for one malignancy diagnosed and treated will be \$6,499.37.

### CONCLUSION

In this single center prospective cohort study, the total cost of thyroid nodule workup from August 2022 to April 2023 was \$5,780 for one malignancy diagnosed, and \$6,499 for one malignancy diagnosed and treated.

## CLINICAL RELEVANCE/APPLICATION

Incidental thyroid nodule (ITN) workups cause financial burden on a healthcare system with questionable clinical benefit. Quantifying this financial burden is an important step toward cost-effective healthcare.

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## Abstract Archives of the RSNA, 2023

R5B-SPIN

### Imaging Informatics Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### R5B-SPIN-1 Using a Large Language Model for Identifying Findings in Chest X-ray Reports

Pritam Mukherjee, PhD (*Presenter*) Nothing to Disclose

##### PURPOSE

To evaluate Vicuna-13B, a publicly available large language model (LLM), on the task of identifying chest x-ray reports that are positive for a set of findings.

##### METHODS AND MATERIALS

This retrospective study used 25,596 chest x-ray reports from 2797 patients (M: 1,557 (56%), median age: 47, IQR: [32, 58]), corresponding to the test set of the publicly available NIH Chest X-Ray dataset. For the 13 Chexpert findings (atelectasis, cardiomegaly, consolidation, edema, enlarged cardiomeastinum, fracture, lung lesion, lung opacity, pleural effusion, pleural other, pneumonia, pneumothorax, and support devices) we considered the following multi-label binary classification task: the class label for a finding is True if the report contains a positive mention of the finding, and False otherwise. The LLM we chose is Vicuna-13B, a finetuned version of the LLaMA foundation model. We used a rule-based interactive prompting strategy, where each step is a natural language question in English. To avoid randomness in outputs, we set the "temperature" hyperparameter to 0. Since "gold label" radiologist annotations for the large dataset were not available, our primary goal was to assess the agreement of Vicuna's outputs with two popular and state-of-the-art labelers - a rule-based NLP tool Chexpert, and a deep learning model ChexBert - using the Fleiss' kappa statistic performed in a pairwise manner. A subset of 100 reports was manually annotated by a senior radiologist with more than 25 years of experience according to the Chexpert labeling rules. Receiver operating characteristics (ROC) analysis was performed using the radiologist annotations as the reference to assess the reliability of Chexpert, ChexBert and Vicuna.

##### RESULTS

Chexpert and ChexBert showed very high agreement with one another with a kappa value of 0.84 for the NIH dataset. Vicuna showed moderate agreement, with kappa values of 0.54 ( $P < .001$ ) vs Chexpert and 0.56 ( $P < .001$ ) vs ChexBert. When compared to radiologist annotations for 100 reports, Vicuna outperformed ChexBert on 4/11 findings (atelectasis, consolidation, enlarged cardiomeastinum, and pleural other), and Chexpert on 5/11 findings (atelectasis, cardiomegaly, enlarged cardiomeastinum, and pleural other); the mean AUROC over 13 labels was 0.85 for all models.

##### CONCLUSION

LLMs such as Vicuna present promising alternatives to custom-built NLP or deep learning tools for analyzing radiology reports. Vicuna showed satisfactory performance on our task - without any additional training or finetuning.

##### CLINICAL RELEVANCE/APPLICATION

Vicuna can be run locally without risking patient privacy and can accurately determine the presence or absence of findings in reports without the need for any training or custom NLP rules.

#### R5B-SPIN-2 Performance Evaluation and Return on Investment Estimation of a High-Sensitivity Normal-Abnormal Chest X-ray Classifier for Enhanced Clinical Workflow

Shraddha Mittal (*Presenter*) Employee, CARPL.ai Pvt Ltd

##### PURPOSE

To evaluate the performance of a high-sensitivity normal-abnormal chest X-ray classifier, in improving the clinical workflow through efficient batching of normal and abnormal cases.

## **METHODS AND MATERIALS**

The IRB-approved study used an enriched retrospective dataset consisting of 2405 normal cases and 2356 abnormal cases. The abnormal cases included clinically significant findings including but not limited to consolidation, nodule, cavitation, pleural effusion, pneumothorax, pneumoperitoneum, cardiomegaly, and rib fractures. These studies were evaluated using ChestLink by Oxipit.ai to classify the chest X-rays into normal and abnormal categories. The algorithm was orchestrated and the inferencing results were analyzed on the CARPL.AI platform.

## **RESULTS**

The AI classifier identified 1859 normal and 2902 abnormal cases, with 12 false negatives and 568 false positives. The calculated sensitivity (recall or true positive rate) of ChestLink is 99.49%, and its specificity (true negative rate) is 76.38%. The positive predictive value (PPV) is 80.77%, while the negative predictive value (NPV) is 99.35%. In the existing workflow with a 30% time reduction for normal cases, the ROI is 26.4%. In the auto-batch workflow, where radiologists take 10 seconds to approve normal cases, the return on Investment (ROI) increases to 180.6%.

## **CONCLUSION**

AI solutions can effectively improve the clinical workflow by batching normal and abnormal cases, allowing for the prioritization of abnormal cases for radiologists' review. This minimizes the time spent on normal cases and ensures faster diagnosis and treatment of patients with chest abnormalities. The low false-negative rate further emphasizes its potential to reduce missed abnormal cases, leading to improved patient outcomes. It also demonstrates a positive ROI in both scenarios, significantly improving the efficiency of radiology departments, especially in the auto-batch workflow.

## **CLINICAL RELEVANCE/APPLICATION**

Implementing ChestLink can lead to faster diagnosis and reporting for patients, while reducing radiologists' workload by optimizing their time spent on normal cases. The auto-batch workflow further enhances these benefits, making it a valuable solution for radiology departments seeking to increase productivity and efficiency.

## **R5B-SPIN-3 Development and Clinical Validation of a Radiological Impression Summarization System with Large Language Models**

Adrian Serapio (*Presenter*) Nothing to Disclose

## **PURPOSE**

To develop and clinically validate a large language model that automatically generates impressions to summarize radiology reports.

## **METHODS AND MATERIALS**

This retrospective model development study included 204,540 consecutively collected CT, MRI, US, and PET radiology reports from January 2021 to December 2021 from a single academic institution. We devised a text summarization task using a T5 large language model pretrained on the C4 dataset to generate the impression section from the clinical history, comparison, and findings sections of the radiology reports. Repetitive, non-informative phrases such as "No wet reading was provided for this report" and "The above findings have been communicated to the referring physician" were removed from the reports to improve model performance. The Recall-Oriented Understudy for Gisting Evaluation (ROUGE) score, a standard metric for measuring the quality of summaries, was used to evaluate model performance, and a five-reader performance study was conducted to validate clinical utility derived from impression generation. For each of sixty reports, readers were presented with either the report or model-generated impressions and were asked to edit the impression. Impressions were rated for their clinical accuracy, grammatical accuracy, stylistic quality, with the edit distance between their edited impression and the original impression, and time taken to edit also recorded.

## **RESULTS**

On a UCSF general test dataset composed of 19,710 reports, the model achieved average ROUGE-1, ROUGE-2, and ROUGE-L scores of 54.05, 36.94, and 46.92. For the reader performance study, the model achieved mean ratings of 3.6/4, 3.9/4, and 3.4/4 for clinical accuracy, grammatical accuracy, and stylistic quality respectively and a mean edit distance and edit time of 11.75 words and 18.79 seconds respectively, of a similar performance to the radiologist baseline. The reader performance study demonstrated a moderate level of interexpert agreement (ICC: 0.57).

## **CONCLUSION**

Using the clinical history and findings section of a radiology report, large language models can automatically generate radiological impressions with clinical accuracy, stylistic quality, and grammatical accuracy.

## **CLINICAL RELEVANCE/APPLICATION**

We demonstrate that a large language model can be used to automatically generate excellent quality radiologic impressions, which could potentially improve report quality and workflow efficiency.

## **R5B-SPIN-4 Evaluation of A Natural Language Processing Model for Automated Protocolling of CT/MRI Requisitions**

Jia Cheng Yao, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Assess the accuracy of a natural language processing (NLP) model for automatically protocolling CT and MRI requisitions.

### **METHODS AND MATERIALS**

Image requisitions of all CT/MRIs performed between January 2018-September 2022 at our institution were extracted from the Electronic Medical Record. A total of 234,193 records were obtained containing study requisition text, patient location (outpatient, emergency, inpatient), WTIS triage priority (P1-P4) and selected protocol. Studies were excluded if they did not include a priority or standardized protocol, or were for an interventional radiology procedure (n = 10,150). A total of 224,043 studies were included, with 569 unique protocols (140 CT and 429 MRI). Studies were stratified by triage priority, then randomly split into training, validation and test datasets based on a 80-10-10% split. Data was pre-processed (lower casing, punctuation removal, stop-word removal, lemmatization) using standard techniques. Two independent pre-trained Bidirectional Encoder Representations from Transformers (BERT) models for study protocol and triage priority were fine-tuned using the training dataset based on the optimal hyperparameters (batch size = 10, learning-rate 3e-4) for 5 epochs. Results were analyzed for precision/recall and accuracy, with sub-analysis based on patient location and imaging modality.

### **RESULTS**

For study protocol, weighted-mean F1-score, precision and recall were 0.813, 0.848 and 0.792, respectively. Overall accuracy was 0.848 (Top-3 accuracy 0.960, Top-5 accuracy 0.973). Stratified by location, accuracy for outpatient (OP), emergency department (ED), and inpatient (IP) studies were 0.832, 0.987 and 0.856, respectively. Accuracy for CT and MRI were 0.899 and 0.762, respectively. Micro-averaged one-vs-rest (OvR) area under the curve (AUC) was 0.998. For study protocol, weighted-mean F1-score, precision and recall were 0.847, 0.845 and 0.849, respectively. Priority 1 studies demonstrated high F1, precision and recall, 0.952, 0.948 and 0.956, respectively. Overall accuracy was 0.849 (Top-2 accuracy 0.982). Stratified by location, accuracy for OP, ED, and IP studies were 0.832, 0.987 and 0.856, respectively. Accuracy for CT and MRI were 0.831 and 0.881, respectively. Micro-averaged OVR AUC was 0.974.

### **CONCLUSION**

Natural language processing models are a feasible solution for automated protocolling of CT/MRI requisitions.

### **CLINICAL RELEVANCE/APPLICATION**

Applications include workflow optimization, protocol suggestion and study flagging. Given a relative lack of protocol standardization, automated methods also provide opportunities for standardization between institutions and radiologists.

## **R5B-SPIN-5 Lifelike Pixel Print Phantoms for Clinical Evaluation of a Deep Learning CT Reconstruction Algorithm**

Jessica Y. Im, BEng (*Presenter*) Nothing to Disclose

### **PURPOSE**

Deep learning CT reconstruction (DLR) has become increasingly popular as a method of improving image quality and reducing radiation exposure. Due to their nonlinear nature, these algorithms exhibit object-dependent resolution and noise performance. Therefore, traditional phantoms, which lack tissue morphology, in combination with image quality metrics, such as contrast-to-noise ratio (CNR), have become inadequate indicators of clinical imaging performance. In this study, we propose to utilize lifelike 3D-printed PixelPrint lung phantoms to evaluate DLR performance over a wide range of radiation doses.

### **METHODS AND MATERIALS**

A lung phantom generated from a patient chest CT with ground glass opacities (GGO) was fabricated using PixelPrint technology. The phantom was scanned with a conventional CT (Incisive CT, Philips Healthcare) at five radiation dose levels (CTDIvol 4.4, 5.6, 9.8, 14.4, 17.0 mGy). At each radiation dose, three scans were acquired, and each was reconstructed with filtered back projection (FBP), iterative reconstruction at one level (iDose4, Level 3), and AI-enabled DLR (Precise Image (PI)) at five levels (Sharper, Sharp, Standard, Smooth, Smoother). Noise and CNR were calculated for each radiation dose and reconstruction technique. With FBP at 17.0 mGy as the reference, structural similarity index measure (SSIM), multi-scale SSIM (MS SSIM), root mean square error (RMSE), and standard deviation (SD) of difference images were also calculated. A two-sample t-test with Bonferroni post hoc test was then performed to evaluate the performance of each dose and reconstruction combination in comparison to the reference for each metric.

## RESULTS

The PixelPrint phantom produced clinically realistic images. iDose4 and DLR demonstrated superior performance at lower radiation doses compared to FBP across all metrics. To match or exceed the performance of the reference for every metric, iDose4 and varying levels of DLR required 9.8 mGy and between 4.4 and 9.8 mGy, respectively. These doses corresponded to dose reductions of 42% for iDose4 and 42% to 75% for DLR.

## CONCLUSION

DLR has been shown to reduce radiation dose compared to FBP without compromising diagnostic image quality, surpassing the dose reduction achieved through iterative reconstruction. PixelPrint phantoms offer a valuable option for evaluating non-linear and object-dependent reconstruction algorithms, including various flavors of DLR.

## CLINICAL RELEVANCE/APPLICATION

The use of PixelPrint in evaluating novel CT technologies offers a more realistic testing environment compared to traditional phantoms. This, in turn, promotes the translation of new technologies, such as DLR, into clinical practice.

## **R5B-SPIN-6 Evaluation of Segmentation Performance using Multiple Reference Standards for Accurate Orbital Bone Modeling in Cranio-maxillofacial Surgery: Based on MSDA-Net Deep Learning Segmentation**

Min Jin Lee, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Accurate segmentation and modeling of orbital bone on facial CT images are essential for creating customized bone templates in craniomaxillofacial surgery. This study proposes MSDA-Net, a segmentation algorithm that considers varying characteristics of orbital bone in terms of intensity and thickness, and evaluates its performance using reference standards generated through manual labeling by observers and label combination methods.

## METHODS AND MATERIALS

A dataset of 355 facial CT images was divided into 228 training, 56 validation, and 71 test sets. MSDA-Net includes multiscale hierarchy module that considers various bone thicknesses and dual-attention module that focuses on meaningful features of thin bone. Three reference standards were obtained from observers, including a neurosurgeon with over 15 years of experience and two senior medical students. Three additional reference standards were generated using label combination methods, such as label fusion, majority voting, and the STAPLE algorithm. Segmentation performance was evaluated using six reference standards, with the evaluation ROI divided into three regions: whole orbital bone, medial wall, and orbital floor.

## RESULTS

The proposed method outperformed with a DSC of over 89.75% for whole orbital bone and DSCs of 74.38% and 81.42% for the medial wall and orbital floor, respectively. However, differences in reference standards generated by observers and label combination methods resulted in varying levels of precision and recall. Observer 1 tended to generate thick labels, resulting in high precision, while Observers 2 and 3 produced relatively thin labels, leading to high recall values. Label fusion tended to generate thick labels, resulting in high precision, while majority voting and STAPLE generated similar reference standards with high recall. No significant difference in all segmentation measurements was observed between majority voting and STAPLE using the reference standards.

## CONCLUSION

MSDA-Net provides accurate segmentation results by considering varying thickness and intensity of the orbital bone. Our study emphasizes the importance of using multiple reference standards to evaluate segmentation algorithms for structures prone to inter-observer variability. (This research was supported by a grant from the Korea Health Technology R&D Project through the Korea Health Industry Development Institute, funded by the Ministry of Health & Welfare (HI22C1496))

## CLINICAL RELEVANCE/APPLICATION

Our study can assist in creating customized implants and surgical guides for reconstructing fractured or defective bones and establish reference standards for evaluating automatic segmentation algorithms.

## **R5B-SPIN-7 Evaluating the Reliability of ChatGPT as a Tool for Imaging Test Referral: A Comparative Study with a Clinical Decision Support System**

Shani Rosen (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to investigate the feasibility of using Chat Generative Pre-trained Transformer (ChatGPT) to provide accurate imaging referrals for clinical use, as compared to the existing ESR iGuide system. With the continuous evolution and advancement of technology, Artificial Intelligence (AI) is increasingly being used to make diagnosis and

decisions, including suggesting the most appropriate imaging referrals. This study aims to explore whether ChatGPT can provide equally or more accurate imaging referrals compared to the ESR iGuide. By evaluating the accuracy and effectiveness of ChatGPT, this study can contribute to the development of AI-based tools for clinical decision-making and potentially improve patient outcomes.

## **METHODS AND MATERIALS**

A comparative study was conducted in a tertiary hospital. Data was collected from 97 consecutive cases that were admitted to the emergency department with abdominal complaints. We compared the imaging test referral recommendations suggested by the ESR iGuide and the ChatGPT and analyzed cases of disagreement. In addition, we selected cases where ChatGPT recommended a Chest Abdominal Pelvis (CAP) CT (n=66), and asked four specialists to grade the appropriateness of the referral.

## **RESULTS**

ChatGPT recommendations were consistent with the recommendations provided by the ESR iGuide. No statistical differences were found between the appropriateness of referrals by age or gender. Using a sub-analysis CAP cases, high agreement between ChatGPT and the specialists was found. Cases of disagreement (12.4%) were further analyzed and presented themes of vague recommendations such as "it would be advisable" and "this would help to rule out".

## **CONCLUSION**

ChatGPT's ability to guide the selection of appropriate tests may be comparable to some degree with the ESR iGuide. Features such as the clinical, ethical, and regulatory implications are still warranted and need to be addressed prior to clinical implementation. Further studies are needed to confirm these findings.

## **CLINICAL RELEVANCE/APPLICATION**

The article explores the potential of using advanced language models, such as ChatGPT, in healthcare as a CDS for selecting appropriate imaging tests. Using ChatGPT can improve the efficiency of the decision-making process

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## Abstract Archives of the RSNA, 2023

R5B-SPIR

### Interventional Radiology Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPIR-1 Image-guided Intratumoral Radiofrequency Hyperthermia-Enhanced Herpes Simplex Virus Thymidine Kinase Gene Therapy of Non-Small Cell Lung Cancer: The Underlying Molecular Mechanisms**

Hui Zheng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To validate the feasibility of image-guided interventional radiofrequency hyperthermia (RFH)-enhanced direct suicide gene therapy of orthotopic non-small cell lung cancer (NSCLC) and the underlying molecular mechanisms.

#### **METHODS AND MATERIALS**

This study included (a) in vitro experiments to prove the principle of the concept of "RFH-enhanced killing efficacy of Herpes Simplex Virus Thymidine Kinase (HSV-TK) /ganciclovir (GCV) gene therapy" on NSCLC cells, which was confirmed by confocal microscopy, MTS assay and apoptosis analysis; (b) in vivo experiments to validate the feasibility of the new interventional oncology technique, "image-guided intratumoral RFH-enhanced local HSV-TK/GCV gene therapy of NSCLC " by using a multifunctional perfusion-thermal RFH electrode for the rat models of orthotopic lung cancer; and (c) to investigate the related biomolecular mechanisms through three potential pathways, including apoptosis, heat shock protein and immunomodulatory. Both in-vitro and in-vivo experiments were divided into four study groups (n=6/group) with different treatments: (1) combination therapy of RFH+ HSV-TK/GCV; (2) RFH alone at 42°C for 30 min; (3) gene therapy with HSV-TK/GCV; and (4) control with saline.

#### **RESULTS**

In in-vitro experiments, bioluminescence optical imaging of cells confirmed that the relative photon signal intensity in the combination therapy group was significantly lower than those in the other three groups ( $p < 0.001$ ). Confocal microscopy and MTS assay also demonstrated significant decrease in cell viability in combination therapy group, compared with other three groups ( $p < 0.001$ ). Flow cytometry showed remarkably increased apoptosis in the combination therapy group ( $p < 0.01$ ). In in-vivo experiments, follow-up bioluminescence imaging demonstrates a significantly lower relative photon signal intensity of tumors in the combination therapy group than in the other groups ( $p < 0.05$ ). Immunohistochemical staining revealed the significantly decreased expression of Bcl-2 ( $p < 0.01$ ), and significantly increased expression of Bax ( $p < 0.05$ ) and Caspase-3 ( $p < 0.01$ ) in the combination therapy group. Immunohistochemical staining also displayed the up-regulation of HSP-70 ( $p < 0.01$ ), IL-2 ( $p < 0.01$ ) and CD94 ( $p < 0.01$ ) in combination therapy.

#### **CONCLUSION**

This study validated the feasibility of image-guided interventional RFH-enhanced direct suicide gene therapy of orthotopic NSCLC, which is activated through the mechanisms of augmenting Bax/Bcl-2/caspase-3-dependent apoptosis and the HSP-70/IL-2 dependent anti-tumor immunity regulation pathway.

#### **CLINICAL RELEVANCE/APPLICATION**

This study has established ground works for developing a new interventional oncology therapy to effectively manage NSCLC.

#### **R5B-SPIR-3 Outcomes of Percutaneous Transluminal Angioplasty and/or Stenting (PTAS) as Treatment for Transplant Renal Artery Stenosis (TRAS)**

Dhane F. Stomp, MD (*Presenter*) Nothing to Disclose



## PURPOSE

The objective of this study was to investigate the efficacy of percutaneous transluminal angioplasty and/or stenting (PTAS) for treatment of transplant renal artery stenosis (TRAS).

## METHODS AND MATERIALS

This single-center, retrospective study analyzed a total of 91 patients with TRAS (median age = 61; 62.46% male and 37.36% female) who underwent 114 PTAS procedures between August 2013 and March 2020. We manually measured renal artery stenosis diameters from pre- and post-intervention angiographic images in the picture archiving and communication system (PACS) for each procedure. Technical success was defined as the ability to successfully dilate the stenosis with angioplasty and/or stent without significant residual stenosis. Baseline and post-intervention peak systolic velocities (PSV) [cm/s] and serum creatinine levels [mg/dL] at regular intervals for at least 24 months were recorded. Baseline and post-intervention results were compared using a two-sided paired samples T-test, with statistical significance defined by a p-value < 0.05.

## RESULTS

Regardless of intervention type, primary technical success was notably high (96.70%). The most performed procedure was stenting (75.44%). Angioplasty alone resulted in a higher reintervention rate compared to stenting (44.44% vs. 20.55%;  $p = 0.037$ ). Serum creatinine was measured for a median of 12 months; PSV was measured for a median of 6 months. There was a statistically significant reduction in PSV up to 12 months (mean reduction 233 cm/s;  $p < 0.001$ ). There was also a significant reduction in creatinine from baseline to nadir (mean reduction 0.84 mg/dL;  $p < 0.001$ ), achieved at a median of 4 months. The reduction in PSV did not correlate with the reduction in creatinine (Pearson correlation coefficient = 0.33;  $p = 0.79$ ). Fourteen (12.28%) procedural complications occurred, including six minor (e.g., perinephric hematoma, puncture site hematoma, stent kinking) and eight major complications (e.g., dissection, pseudoaneurysm, thromboembolism). Four deaths occurred during the study period, none of which were attributed to study interventions (SIR adverse event class E-F).

## CONCLUSION

PTAS is an effective, safe treatment for TRAS with a high rate of technical success. A higher reintervention rate was seen with angioplasty alone compared to stenting. Following PTAS, there was a statistically significant reduction in both PSV at 12 months and serum creatinine to nadir. No permanent adverse sequelae or death resulted from any procedure.

## CLINICAL RELEVANCE/APPLICATION

Percutaneous transluminal angioplasty and/or stenting (PTAS) may serve as a safe, effective treatment option for patients with transplant renal artery stenosis (TRAS), which is procedurally and clinically applicable.

## R5B-SPIR-4 New Method of Knee OA Treatment with Intra Genicular Artery Injection of Mesenchymal Stem Cells

Maedeh Rouzbahani (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this study was to evaluate the role of intra-arterial mesenchymal cell injection in the management of knee osteoarthritis.

## METHODS AND MATERIALS

After IRB and the ethics committee's approval, 30 patients with moderate knee osteoarthritis (OA) were treated. All patients had an MRI prior the procedure confirming the OA. After accessing the contralateral femoral artery, the genicular artery leading to the vascular blush was catheterized. The solution of mesenchymal stem cells (70 million allogenic cells) was then injected in the vessel. All the patients were admitted for one day following the procedure. MRI of the knee is planned in all patients at one month. WOMAC scores were obtained before and weekly after the intervention.

## RESULTS

Technical success rate was 100%. 30 patients have completed clinical, and imaging follow up at one month. They were divided to four age groups and their womac score results recorded in 4 weeks as described below: A) Womac Score for age > 55 (n=16) : "32.63" reduced to "7.69" B) Womac Score for age ≤ 55 (n=14): "25.14" reduced to "3.36" C) Womac Score for weight > 70 (n=17): "27.76 reduced to 5.47" D) Womac Score for weight ≤ 70 (n=13): "30.92 reduced to 5.92" The average WOMAC score before the intervention, was about (25.14 - 32.63), and it dropped to about (7.69 - 3.36) on one month. This reduction on mean WOMAC numbers is statistically significant. Patient symptoms improved significantly. MRIs of the knee have demonstrated a significant regeneration of the affected cartilage and the subchondral lesions.

## CONCLUSION

This preliminary study is promising demonstrating that intra-Genicular artery injection of mesenchymal Stem Cells not only improves clinical symptoms, but also results in early cartilage regeneration. In addition to pain improvement and cartilage regeneration, MRI Pictures demonstrate that in some patients subchondral changes improved significantly



## CLINICAL RELEVANCE/APPLICATION

new method to pain management for OA patients.

## R5B-SP1R-5 All-payer Utilization of Arterial and Venous Thrombectomy for VTE in the United States

Stephanie McNamara, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

An estimated one million venous thromboembolism (VTE) events occur annually in the U.S. and the use of thrombectomy to treat VTE is becoming increasingly common. Here, we assess utilization trends of arterial and venous thrombectomy to treat VTE for commercial and Medicare beneficiaries between 2017 and 2021.

### METHODS AND MATERIALS

A claims search was performed through the Standard Analytical File (SAF) and claims clearinghouse databases to collect utilization data for arterial and venous thrombectomy across commercial and Medicare payers between January 2017 and December 2021 using Common Procedural Terminology (CPT codes). Thrombectomy CPT codes (37184-37188) were cross-referenced against ICD-10 codes for venous thromboembolism (VTE). Cross-referencing with COVID-19 ICD-10 codes was performed for 2020 and 2021 data. Claim counts and percentages were tabulated, and p-values calculated using chi square in GraphPad Prism.

### RESULTS

Between January 2017 to December 2021, 79,925 claims for arterial and venous thrombectomy to treat VTE were identified. There was a 125% 5-year increase in total claims. Although there were significantly more venous thrombectomy (VT) claims than arterial thrombectomy (AT) (64,258 vs. 15,667,  $p < 0.001$ ), a greater 5-year increase in AT claims was observed compared to VT (5.5- vs. 1.8-fold). AT was more often billed through commercial insurers (62.1%) than Medicare (37.9%) ( $p < 0.001$ ) with the opposite true of VT (53.2% Medicare, 46.8% commercial,  $p < 0.001$ ). Interventional Radiology (IR) performed significantly more AT and VT procedures across all payers from 2017 to 2021 (IR: 46.7%, all cardiology: 23.1%, all surgery: 4.2%, vascular surgery: 25.9%,  $p < 0.001$ ). However, cardiology subspecialties saw a greater rise in AT and VT across all payers from 2017 to 2021 compared to IR (AT: 6.6- vs. 6.0-fold, VT: 2.6- vs. 1.5-fold). The Midwest and Southeast had the highest utilization of AT and VT regardless of payer. In COVID-19 patients, AT claims in 2021 were 3-fold higher than in 2020 (393 vs. 135 claims,  $p < 0.001$ ) irrespective of payer. Top ICD-10 codes associated with AT and VT were "pulmonary embolism without acute cor pulmonale" (61% of AT) and "embolism/thrombosis of iliac/femoral/popliteal veins" (49% of VT), respectively.

### CONCLUSION

From 2017 to 2021, the number of claims for arterial or venous thrombectomy to treat VTE across all payers increased significantly. While a majority of these were VT, a greater rise in the number of AT claims was observed. IR performed more AT and VT procedures than any other specialty over this 5-year period.

## CLINICAL RELEVANCE/APPLICATION

The use of thrombectomy to treat VTE is growing rapidly. Nonetheless, it remains a small percentage of total VTEs occurring nationally each year.

## R5B-SP1R-6 The Benefit of Filtered Blood Reperfusion in Suction Thrombectomy of Submassive Pulmonary Embolism

Ryan Bitar, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Catheter-directed suction thrombectomy has emerged as a major tool for reducing right heart strain in the management high-intermediate risk pulmonary embolism (PE); however, suction thrombectomy presents a potential concern for significant blood loss during clot aspiration. The purpose of this study is to assess the benefit and safety of utilizing a blood reperfusion filtration device (BRFD) during thrombectomy which is able to filter and return aspirated blood in an attempt to minimize blood loss.

### METHODS AND MATERIALS

A single-institution retrospective cohort study was conducted on patients who underwent suction thrombectomy from 2018-2022. Patients were categorized into cohorts based on the use versus nonuse of a BRFD. Inclusion criteria involved adult patients with submassive PE (either imaging and/or biomarkers indicative of right heart strain) who underwent suction thrombectomy. Patients with massive PE, preceding cardiac arrest, or contraindication to anti-coagulation were excluded. Critical data points included age, gender, pre-procedural vitals and labs, procedural change in pulmonary arterial pressure (PAP), immediate post-procedural vitals and labs, admission length, blood transfusions, and 30-day post-procedural complications.

## **RESULTS**

50 patients were recruited for each cohort. No significant difference in patient demographics, preprocedural vitals or labs, pre-procedural PAP, or thrombectomy-related decrease in PAP was observed. Post-procedural decrease in heart rate was -12.4 bpm in the non-BRFD cohort versus -20.6 bpm in the BRFD cohort ( $p = 0.039$ ). 24-hour post-procedural complete blood count demonstrated a significantly increased drop in hemoglobin in the non-BRFD cohort (-2.54g/dL) in comparison to the BRFD cohort (-1.54g/dL) ( $p=0.00004$ ). Of note 24-hour post-procedural platelets, white blood cells, creatinine, and potassium did not demonstrate a significant change between the two cohorts. 20% of the non-BRFD cohort and 4% of the BRFD cohort required blood transfusions ( $p= 0.028$ ). No significant difference was observed in days of admission or number of complications between the two cohorts.

## **CONCLUSION**

The results of this study indicate that using a BRFD is a safe means of minimizing blood loss during suction thrombectomy, as evidenced by an attenuated drop in hemoglobin and a reduction in blood transfusions. Of note, the study poses limitations intrinsic to that of a low-power single-institution retrospective cohort study.

## **CLINICAL RELEVANCE/APPLICATION**

Employment of a BRFD during suction thrombectomy should be considered as a beneficial tool for decreasing the risk of post-procedural anemia and the need for potential transfusions, improving patient energy/recovery and sparing precious blood products.

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## Abstract Archives of the RSNA, 2023

R5B-SPMK

### Musculoskeletal Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### R5B-SPMK- Are Isolated Ulnar Fractures a True Marker for Intimate Partner Violence?

1

Tammy Sung, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

What is the prevalence of confirmed or high risk for intimate partner violence (IPV) among adult women with isolated ulnar shaft fractures within a large integrated health system? Are there injury or sociodemographic characteristics associated with IPV in patients with isolated ulnar fractures?

#### METHODS AND MATERIALS

Adult women, age 18 to 65, with ulnar fractures from 2016 through 2021 were identified through electronic health record (EHR) query. Patients were categorized into two groups, one with isolated ulnar fractures and another with fractures of both the radius and ulna. Sociodemographic and clinical data, referral data, reported mechanism of injury and IPV documentation were collected. IPV stratification into four groups: confirmed IPV, high risk for IPV, low risk for IPV and not IPV based on ICD 9/10, internal IPV diagnosis codes and clinical chart review. Radiographs of isolated ulnar fracture group were evaluated for fracture side, location, pattern and displacement.

#### RESULTS

29% of 148 patients with isolated ulnar fractures were high risk or confirmed IPV, compared to 10% of the 147 patients who had non-isolated ulnar fractures ( $p < .01$ ). 95% of patients had formal documentation of screening within their EHR and 9% at time of fracture presentation. Within isolated ulna fracture group, confirmed or high-risk for IPV was associated with reported mechanism of injury of assault (37% versus 1%;  $P < .01$ ) but not other injury characteristics. Confirmed or high-risk for IPV was associated with previously reported IPV correlates of alcohol abuse history (30% versus 15%,  $p = .04$ ), depression history (42% versus 15%,  $p < .01$ ), and anxiety history (42% versus 22%,  $p = .01$ ). Increased number of prior documented emergency visits (median 2.0; interquartile range 0.0-6.0 versus median 0.0; interquartile range 0.0-1.0;  $p < .01$ ) was also associated with confirmed or high-risk for IPV.

#### CONCLUSION

Prevalence of confirmed or high-risk IPV in isolated ulnar fracture patients was significantly higher than those with non-isolated ulnar fractures. Frequent emergency department visits, alcohol abuse history and psychiatric history would favor IPV etiology.

#### CLINICAL RELEVANCE/APPLICATION

IPV is a global public health emergency which is challenging to diagnose. Prior research reported up to a third of 62 adult female patients with isolated ulnar fractures at three Level 1 trauma centers in urban setting may be associated with IPV. We found that 29% of adult female patients with this fracture identified in outpatient, urgent care, and emergency settings across a large multicenter health system had confirmed or were high risk for IPV. Our research supports isolated ulnar fracture as a true marker for IPV and highlights the importance of IPV screening at time of fracture evaluation.

#### R5B-SPMK- Association Between Pelvic Bone CT-Derived Body Composition and Patient Outcomes in Older Adults With Proximal Femur Fracture

2

Taeran Ahn, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the association between pelvic bone computed tomography (CT)-derived body composition and patient outcomes in older adult patients who underwent surgery for proximal femur fractures.

## METHODS AND MATERIALS

We retrospectively identified consecutive patients aged = 65 years who underwent pelvic bone CT and subsequent surgery for proximal femur fractures between July 2018 and September 2021. Eight CT metrics were calculated from the cross-sectional area and attenuation of the subcutaneous fat and muscle, including the thigh subcutaneous fat (TSF) index, TSF attenuation, thigh muscle (TM) index, TM attenuation, gluteus maximus (GM) index, GM attenuation, gluteus medius and minimus (Gmm) index, and Gmm attenuation. The patients were dichotomized using the median value of each metric. Multivariable Cox regression and logistic regression models were used to determine the association between CT metrics with overall survival (OS) and postsurgical intensive care unit (ICU) admission, respectively.

## RESULTS

A total of 372 patients (median age, 80.5 years; interquartile range, 76.0-85.0 years; 285 females) were included. TSF attenuation above the median (adjusted hazard ratio [HR], 2.39; 95% confidence interval [CI], 1.41-4.05), GM index below the median (adjusted HR, 2.63; 95% CI, 1.33-5.26), and Gmm index below the median (adjusted HR, 2.33; 95% CI, 1.12-4.55) were independently associated with shorter OS. TSF index (adjusted odds ratio [OR], 6.67; 95% CI, 3.13-14.29), GM index (adjusted OR, 3.45; 95% CI, 1.49-7.69), GM attenuation (adjusted OR, 2.33; 95% CI, 1.02-5.56), Gmm index (adjusted OR, 2.70; 95% CI, 1.22-5.88), and Gmm attenuation (adjusted OR, 2.22; 95% CI, 1.01-5.00) below the median were independently associated with ICU admission.

## CONCLUSION

In older adult patients who underwent surgery for proximal femur fracture, low muscle indices of the GM and gluteus medius/minimus obtained from their cross-sectional areas on preoperative pelvic bone CT were significant prognostic markers for predicting high mortality and postsurgical ICU admission.

## CLINICAL RELEVANCE/APPLICATION

CT metrics of the gluteus muscle group and subcutaneous fat can be utilized as risk stratification factors in elderly patients with proximal femur fractures.

## R5B-SPMK- Prediction of Histopathological Subtypes of Dermatofibrosarcoma Protuberans Based on MRI 4 Radiomics Machine Learning Model

Siyu Liu (*Presenter*) Nothing to Disclose

## PURPOSE

To establish a diagnostic model for classic DFSP and FS-DFSP image information to explore the feasibility of predicting DFSP histological subtypes.

## METHODS AND MATERIALS

53 DFSPs were retrospectively included in this study: 9 subjects with FS-DFSP and 44 subjects with classic DFSP. Their T1WI and FS-T2WI images constituted the primary dataset used to train multiple machine learning algorithms for constructing DFSP histological subtype prediction model. The subjects were randomly divided into training group and testing group. The training group was used for machine learning and the testing group was used to evaluate the training model. All patients were scanned using a 3.0T MR scanner. ROIs were manually delineated by open-source software on each slice of the T1WI and FS-T2WI images by one musculoskeletal radiologist with 5 years of professional experience, and each ROI segmentation was tested by another radiologist with 10 years of experience. LASSO was used to select features from preoperative imaging data. The prediction models of RF and KNN classifiers were constructed on T1WI and FS-T2WI respectively by using the extracted imaging features. The prognostic performance was assessed in training cohort and testing cohort by means of AUC, sensitivity, specificity and accuracy.

## RESULTS

15 imaging features were selected by using LASSO algorithm. The AUC of RF based on T1WI was 0.902; sensitivity, 91.2%; specificity, 89.2%; and accuracy, 90.4%. The AUC of RF based on FS-T2WI was 0.913; sensitivity, 90.7%; specificity, 91.1%; and accuracy, 88.9%. The AUC of KNN based on T1WI was 0.798; sensitivity, 88.7%; specificity, 89.7%; and accuracy, 80.1%. The AUC of KNN based on FS-T2WI was 0.815; sensitivity, 83.5%; specificity, 86.3%; and accuracy, 82.1%.

## CONCLUSION

This study puts forward for the first time the application of radiomics to distinguish the histopathological subtypes of DFSP, which provides a new and effective assistant diagnostic method for recognizing DFSP variants. The non-invasive machine learning method based on T1WI and FS-T2WI imaging is potential prognostic tool by distinguishing different levels of DFSP pathological subtypes before operation to improve the treatment strategy.

## CLINICAL RELEVANCE/APPLICATION

DFSP is a rare low to intermediate grade soft tissue sarcoma of skin, but the FS-DFSP is a clearly malignant pathological subtype. The identification of malignant pathological subtypes by radiomics plays an important role preoperatively. The non-

invasive machine learning method based on T1WI and FS-T2WI imaging is potential prognostic tool by distinguishing different levels of DFSP pathological subtypes before operation in this study to provide a new idea for the diagnosis and treatment of DFSP.

## **R5B-SPMK- Radiomics Signature on Magnetic Resonance Imaging: A Feasible Imaging Biomarker for 5 Prediction of the Histopathological Grade of Soft Tissue Sarcomas**

Lei Xu, DC (*Presenter*) Nothing to Disclose

### **PURPOSE**

Radiomics analysis is more comprehensive and reliable to better provide the features of tumor characteristics and heterogeneity. It is important to identify the pathologic grade of soft tissue sarcomas before receiving treatment. Thus, we aimed to build a radiomics signature on the basis of magnetic resonance imaging and evaluate its ability for preoperatively identifying the grade of Soft tissue sarcoma (STS).

### **METHODS AND MATERIALS**

99 patients (55 low grade STS and 44 high grade STS) were at random segmented into a training cohort (39 low grade STS and 31 high grade STS) and a validation cohort (16 low grade STS and 13 high grade STS) with a portion of 7:3. T2 with fat saturation and T1 with fat saturation and gadolinium contrast images were used to extract radiomics features. Radiomics signature was developed by the least absolute shrinkage and selection operator (LASSO) logistic regression model. The receiver that operated characteristics curve (ROC) analysis was used to assess radiomics signature's prediction performance.

### **RESULTS**

A radiomics was developed by 8 radiomics features achieved favorable predictive efficacy. High-grade STS showed higher radiomics score than low-grade STS in both groups. An excellent prediction performance was indicated by the radiomics signature in both groups. The training cohorts and validation cohorts had an area under curves (AUCs) of 0.888 and 0.861, respectively.

### **CONCLUSION**

A radiomics signature on the basis of MRI images could help identification the grade of STS, which could help guide clinical treatment strategies

### **CLINICAL RELEVANCE/APPLICATION**

In this study, we build a radiomics signature on the basis of magnetic resonance imaging and evaluate its ability for preoperatively identifying the grade of Soft tissue sarcoma (STS). We found that the radiomics signature on the basis of MRI images could help identification the grade of STS, which could help guide clinical treatment strategies.

## **R5B-SPMK- Shear Wave Elastography in Benign vs Malignant Fatty Tumors 6**

Ilyan Mezinskiy Kushnerev, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Lipomas are the most frequent soft tissue tumors of the general population, but they are not always easy to differentiate from liposarcomas. The goal of the study was to assess if shear wave elastography (SWE) could help differentiate malignant and benign iso/hyperechoic lipomatous lesions.

### **METHODS AND MATERIALS**

We retrospectively review patients with fatty lesions that underwent percutaneous core needle biopsy in a University Hospital during 2021. All patients underwent ultrasonography followed by SWE to measure elasticity in kPa before biopsy. We compared benign and malignant tumors. The biopsy findings and, in some cases, the surgical-specimen histology were used as gold-standard.

### **RESULTS**

We included 27 patients with lipomatous lesions, 22 with benign (16 lipomas, 3 spindle cell lipomas and 3 hibernomas) and 5 with malignant tumours (well differentiated liposarcomas). Malignant fatty lesions had significantly higher mean (19.07 (6.1-53.6) vs 46.86 (20.6-78.8);  $p=0.006$ ), max (74.4 (36.2-102.7) vs 33.69 (6.4-110.4);  $p=0.013$ ) and Standard Deviation (16.86 (9.8-24.3) vs 7.6 (0.5-25.2)  $p=0.008$ ) elasticity values compared to benign ones. Differences between benign subgroups do not achieve statistical significance.

### **CONCLUSION**

SWE had good specificity and sensitivity for separating benign from malignant soft-tissue lipomatous masses, while differentiation between benign subgroups was not possible. Malignant lesions were stiffer and had more heterogeneous elasticity values than their benign counterparts.

## CLINICAL RELEVANCE/APPLICATION

The primary objective of this study is to enhance the comfort of patients by reducing the time taken to arrive at a diagnosis and minimizing the need for unnecessary biopsies. This is a critical consideration because biopsies can be invasive, uncomfortable, and carry a risk of complications. Moreover, unnecessary biopsies can result in increased healthcare costs and undue stress for patients. By increasing the speed and accuracy of diagnosis, SWE has the potential to significantly improve patient outcomes and reduce healthcare costs.

## R5B-SPMK- Feasibility of Dual-layer Spectral CT Histogram Analyses for Differentiation Between Benign and Malignant Myxoid Soft Tissue Tumors: A Preliminary Study 7

Tomohito Hasegawa (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the usefulness of electron density (ED) and effective atomic number (Zeff) for differentiation between benign and malignant myxoid soft tissue tumors.

### METHODS AND MATERIALS

Twenty-two consecutive patients (mean age 60.5 years) with pathologically proven soft tissue tumors including 11 benign myxoid soft tissue tumors (BMSTTs) and 11 malignant myxoid soft tissue tumors (MMSTTs) were retrospectively analyzed. For all patients, preoperative dual-energy CT examination was performed using a dual-layer spectral detector CT scanner between February 2018 and March 2023. ROIs were drawn to fill the solid parts within each tumor avoiding calcified areas, and placed onto exactly the same locations in the images of Zeff, ED and conventional CT (120 KeV, CTconv). The histogram indices (the mean, skewness, kurtosis and 10th, 25th, 50th, 75th, and 90th percentiles) of the CTconv, Zeff, and ED values were compared between BMSTTs and MMSTTs using the Mann-Whitney U test. ROC curve analysis was carried out to assess the ability of each index to differentiate MMSTTs from BMSTTs. Sensitivity and specificity were calculated with a threshold criterion that would maximize the average of sensitivity and specificity by the largest Youden's index.

### RESULTS

The skewness of ED was significantly lower in MMSTTs ( $-0.11 \pm 1.32$ ) than in BMSTTs ( $0.73 \pm 0.49$ ) ( $P = 0.013$ ), while no significant difference was shown in any other parameters. The area under the ROC curve for diagnosing MMSTTs was 0.81 for ED skewness. With a cut-off value of 0.62, the sensitivity and specificity to predict MMSTTs were 90.91% and 72.73%.

### CONCLUSION

The skewness of ED may be useful in differentiating MMSTT from BMSTT.

## CLINICAL RELEVANCE/APPLICATION

Histogram analysis of dual-energy CT parameters, especially skewness of electron density may be useful in differentiating malignant from benign myxoid soft tissue tumors.

## R5B-SPMK- The Diagnostic Role of Ultrasound in Merkel Cell Carcinoma: Our Experience 8

Elena Julian Gomez, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Merkel cell carcinoma (MCC) is a rare and very aggressive type of skin cancer (<1% of all cutaneous malignancies), predominantly affecting old and/or immunosuppressed patients. Our purpose is to describe and illustrate the main sonographic features of this tumor.

### METHODS AND MATERIALS

We retrospectively reviewed the images of MCC diagnosed in our institution during the last 10 years. We evaluated the demographic and clinical characteristics of the patients, the gray-scale and color Doppler sonographic findings of the lesions, and the locoregional lymph node involvement.

### RESULTS

Ultrasound images of 8 patients were available, 6 women and 2 men with ages between 69 and 94 years. All but one of the tumors were in photoexposed areas. 7 patients debuted with a fast-growing nodular dermal lesion. In those 7 patients who clinically showed a cutaneous nodule, ultrasonographically the tumors were dermohypodermal, hypoechoic, non-encapsulated, with infiltrative margins through the relatively homogeneous subcutaneous septa, and with extensive vascularization that respects the architecture of the cutaneous plexuses. In 4 of the tumors, there was a "sandwich" pattern with an area of elongated dermal involvement and a parallel zone deep in the subcutaneous cellular tissue connected by infiltrated interlobular septa. Locoregional adenopathies and in-transit metastases were detected in almost half of the patients at the time of diagnosis.

## **CONCLUSION**

Ultrasound is the imaging test of choice in the evaluation of cutaneous and superficial tumors. Despite its rarity, the presence of a dermohypodermal tumor with infiltrating borders through the lobular septa, high vascularization, relatively respected architecture and particularly, the appearance of a "sandwich" pattern, should make us include MCC in the differential diagnosis and force us to study on the spot the locoregional adenopathies and possible in-transit metastases.

## **CLINICAL RELEVANCE/APPLICATION**

Recognizing the sonographic findings described above is of great importance to suggest the diagnosis of this rare entity, as well as to perform the locoregional extension study in the same exploration. All this means a considerable clinical benefit, since it allows an early management of this condition.

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## Abstract Archives of the RSNA, 2023

R5B-SPNMMI

### Nuclear Medicine & Molecular Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPNMMI-1** Dynamic Multi-phase <sup>18</sup>F-NaF PET/MRI in Pediatrics

Kip E. Guja, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Skeletal imaging with <sup>18</sup>F-NaF offers improved imaging characteristics and biodistribution compared to conventional bone scintigraphy with <sup>99m</sup>Tc methylene diphosphonate (MDP) and hydroxydiphosphonate (HDP) but is typically acquired in a single delayed phase. Early blood pool phase imaging plays a vital role in pediatric skeletal scintigraphy due to its ability to reveal evidence of hyperemia, inflammation, marrow infiltration, and soft tissue abnormalities. Here we report an initial pilot study combining the superior imaging characteristics of NaF PET and the increased sensitivity of blood pool phase imaging by performing dynamic multiphase <sup>18</sup>F-NaF PET/MRI in pediatric patients.

#### **METHODS AND MATERIALS**

Dynamic PET images were acquired in a single bed position focused on the area of clinical concern using fast list-mode starting just after injection of the radiopharmaceutical for a duration of 10 minutes. This was followed by standard delayed phase acquisition for the second portion of the exam. Dynamic blood pool phase images were reconstructed at 2.5 minutes per frame for a total of 10 minutes. Additional static blood pool phase images were reconstructed using the entire first 10 minutes of the exam. For the MRI component of the dynamic phase, zero echo time (ZTE) proton-density weighted MRI images were acquired.

#### **RESULTS**

In this prospective pilot study, a total of eight <sup>18</sup>F-NaF PET/MRI examinations were performed on seven pediatric patients, ranging from 5 years old to 20 years old. Four of the exams were performed with traditional single delayed phase imaging only and four were acquired with dynamic and static early blood pool phase imaging in addition to the standard whole body delayed phase. Diagnoses included osteomyelitis, mastoiditis, CRMO, and one indeterminate lesion with subsequently improved after conservative therapy with NSAIDs.

#### **CONCLUSION**

Dynamic early blood pool phase <sup>18</sup>F-NaF pediatric PET/MRI can improve imaging evaluation of children with skeletal complaints by combining the superior imaging characteristics of <sup>18</sup>F-NaF PET with the added sensitivity of blood pool phase images and superior contrast with reduced radiation exposure of MRI. Further studies in larger cohorts of pediatric patients with a variety of skeletal pathologies are needed.

#### **CLINICAL RELEVANCE/APPLICATION**

Skeletal scintigraphy is one of the most common indications for pediatric radionuclide imaging. Combining the strengths of <sup>18</sup>F-NaF PET with dynamic early blood pool imaging in PET/MRI offers unique and important benefits in evaluating children with skeletal complaints.

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## Abstract Archives of the RSNA, 2023

R5B-SPNPM

### Noninterpretive Skills (Beyond Imaging) Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPNPM-1 Increased Adverse Iodine Contrast Agent Reactions and Resistance to Epinephrine in the Setting of Beta-blocker Therapy: A Multi-Institutional Analysis of 209,482 Patients**

Brittany Q. Dang, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Adverse allergic reactions to iodine contrast agents are not common but can result in urticaria, nausea, vomiting, and potentially anaphylaxis. Beta-blockers, however, are a widely used class of medications that have been associated with an increased risk and severity of anaphylactic reactions. The purpose of this research is to investigate the relationship between beta blockers and adverse iodinated contrast agent reactions and response to epinephrine.

#### **METHODS AND MATERIALS**

The TriNetX research network provides access to de-identified medical record information for more than 111 million patients in 76 large healthcare organizations and was used for this study. Two patient cohorts were created. Beta-blocker utilization was identified by any of the following medication names and codes: acebutolol (149), atenolol (1202), bisoprolol (19484), metoprolol (6918), nadolol (7226), nebivolol (31555), and propranolol (8787). Contrast exposure was identified by ioxilan (27793), iopromide (27781), ioversol (27792), iopamidol (5966), and iohexol (5956). Both cohorts had exposure to one of the contrast agents at the time of a CT of the chest (CPT code 71260). One group was simultaneously on treatment with a beta blocker, while the other group was excluded from them. The cohorts were balanced for age, race, gender, and ethnicity by propensity score matching via the greedy nearest neighbor algorithm, resulting in 104,741 patients in each arm. They were then evaluated for subsequent ICD-10 code for "adverse effect of diagnostic agents" (T50.8X5), and medication codes for "use of epinephrine" (3992), and "use of glucagon" (4832).

#### **RESULTS**

Patients on beta blockers were 2.3 times more likely to have an adverse reaction to iodinated contrast agents (RR 2.3, 95% CI (1.65,3.29), p-value <0.0001). They were also 50% more likely to require treatment with epinephrine (RR 1.49, 95% CI (1.43,1.56), p-value <0.0001) and 2.6 times more likely to require treatment with glucagon (RR 2.6, 95% CI (2.43,2.7), p-value <0.0001).

#### **CONCLUSION**

The results from this large global data set support the idea that beta blockers increase the risk of allergic reactions to substances such as iodinated contrast agents and are associated with a reduced response to epinephrine. With the increasing use of beta blockers and iodine contrast agents, awareness of the potential adverse reactions and resistance to epinephrine is important.

#### **CLINICAL RELEVANCE/APPLICATION**

The current research is significant because understanding the increased risk of adverse reactions to iodine contrast agents and resistance to epinephrine in the setting of beta blockers will lead to improved safety of evaluation and treatment for patients requiring radiologic imaging with contrast.

#### **R5B-SPNPM-2 How Many "Lives" Does a Radiologist Save in a Career? A Modeling Analysis and Estimation**

Alexander Kuehne, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Medical imaging has unquestionably revolutionized medical care over the past century. Due to radiologists playing a supportive role in the care of a large number of patients, our total impact is difficult to quantify. The purpose of this analysis

is to estimate the total value, in Quality Adjusted Life Years (QALYs) and average "lives" saved during the course of a usual career in radiology.

## **METHODS AND MATERIALS**

We use figures from recent literature to calculate a point estimate as well as plausible ranges for the value of radiologic work over the course of a usual career. Input parameters include the average of a career (30 years), studies read per year (9671-12,669), annual work RVUs (9,264), total/work RVU ratio (1.97), cost per RVU (\$32.41), cost-effectiveness and willingness-to-pay for QALYs in the US (50-200K/QALY), average age of the US population (39), and remaining QALYS for the average person (~35). Deterministic and probabilistic sensitivity analyses were performed to assess plausible ranges and the sensitivity of health utility impact from the career in radiology. Results are reported in 2021 US Dollars.

## **RESULTS**

The average radiologist is expected to provide health services with estimated value of \$18 million during the course of their career, reporting on the order of 300K-400K examinations (impacting at most as many patients). When the average cost-effectiveness of imaging is \$50,000/QALY, a radiologist is expected to provide 355 QALYs during a career or "save" the equivalent QALYs remaining in ~10 average lives. A pessimistic estimation, based on a higher proportion of low-value care (lower cost-effectiveness), could reduce the health utility impact by approximately 75%. Deterministic and probabilistic sensitivity analyses recapitulate the major findings, and emphasize that the health utility consequences of radiologic practice is highly dependent on the cost-effectiveness of imaging.

## **CONCLUSION**

Radiologists provide a large volume of clinical care during the course of a career, impacting hundreds of thousands of patients. The total sum of our impact however, is highly sensitivity to health system variables, most importantly, the cost-effectiveness of radiologic imaging. Efforts to advance both value-based care could have an outsized effect on the utility of radiologic practice as a whole.

## **CLINICAL RELEVANCE/APPLICATION**

Due to radiologists playing a supportive role in the care of a large number of patients, our total impact is difficult to quantify. Further knowledge and analysis of various system wide factors and, the sensitivity of radiology to these variables, can raise awareness of our overall impact on the US health system and potentially point towards ways of further value-basis analysis of radiologic imaging cares.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-SPNR

### Neuroradiology Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPNR- Independent Component Analysis vs. Block Design: A Comparison of Methods for Sedated Language Mapping in Pediatric Epilepsy** 1

Elmira Hassanzadeh, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Passive task-based fMRI under anesthesia is done for presurgical language mapping in pediatric epilepsy patients who cannot complete an awake study. In our previous study, using standard block design task paradigm-based analysis methods, we observed more atypical language patterns in task fMRI under anesthesia compared to wakefulness. We hypothesize that due to the effect sedation has on the brain, unconstrained data driven methods of analyses may be more likely to reveal the language network.

#### **METHODS AND MATERIALS**

We retrospectively identified patients with focal epilepsy who underwent presurgical functional MRI under anesthesia, including Auditory Descriptive Decision Task paradigm at our institution from 2014-2022. We used two methods to extract language activation maps: 1) paradigm-based block design general linear model (GLM), and 2) data-driven independent component analysis (ICA). A laterality index (LI) was calculated separately in the Frontal and Temporal language regions of interest (ROI). We considered positive laterality indexes as left dominant, negative laterality indexes as right dominant, and absolute laterality indexes less than 0.2 as bilateral. We defined 2 language patterns: typical (i.e., primarily left-sided) and atypical (Fig 1a).

#### **RESULTS**

Twenty-four patients, mean age 7 years old (SD=3.2), 36% female, met the inclusion criteria and were analyzed. Figure 1 (b-d) shows LI distribution in each ROI based on the analysis method. The language pattern of 16% of the patients is categorized as typical with GLM, compared to 69% with ICA. There is a significant positive correlation between the Frontal and Temporal LI with the ICA (pearson  $r = 0.44$ ,  $P=0.03$ ) compared to GLM (pearson  $r = 0.3$ ,  $P=0.15$ ). There is a significant negative correlation of Temporal LI between the two methods. This is manifested as more left-dominant (typical) patterns with ICA. There is no correlation between the Frontal LIs between the two methods.

#### **CONCLUSION**

In this fMRI dataset under anesthesia, ICA analysis demonstrates a stronger expected correlation of the frontal and temporal laterality indexes. ICA may be a useful analysis method for sedated scans. However, the possibility of an increased typical pattern with ICA needs further analysis with larger samples.

#### **CLINICAL RELEVANCE/APPLICATION**

Prior research indicates that anesthesia impacts bold signal of Frontal brain regions disproportionately when compared to Temporal brain regions, which exhibit more robust signal under sedation. The presurgical pattern derived from passive task-based fMRI under anesthesia requires caution in interpretation and further data driven analysis method may improve accuracy of language pattern assignment.

#### **R5B-SPNR- Deep Learning Enhances Reliability of Dynamic Contrast-Enhanced MRI in Diffuse Gliomas: Bypassing Post-processing and Providing Uncertainty Maps** 10

Youngwook Lyoo, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To propose a deep learning-based probabilistic model for directly estimating and reliably generating pharmacokinetic (PK) parameter maps from dynamic contrast-enhanced (DCE)-MRI, bypassing the limitations of low reliability due to irreproducible arterial input functions (AIFs), and incorporating uncertainty maps.

## METHODS AND MATERIALS

From Apr 2010 to Feb 2018, we retrospectively enrolled 341 consecutive patients (mean age, 55±15 years; 202 (59.2%) male) with adult-type diffuse gliomas, who underwent preoperative DCE-MRI. We developed a neural network model combining a temporal convolutional network and a probabilistic U-net to estimate PK maps directly without using the AIF. Structural Similarity Index Measure (SSIM) between generated and ground truth (GT) maps was calculated for quantitative validation of map generation. The reliability of the PK parametric maps was evaluated by comparing the intraclass correlation coefficient (ICC) of two Ktrans, Vp, and Ve measurement, averaged for tumor subregions-of-interest, obtained twice independently, using: 1) conventional PK map generation using commercial software; 2) generated PK maps from the neural network model. For clinical validation, Area Under the Receiver Operating Characteristic Curve (AUROC) was obtained for differentiating WHO grade (low- vs high-grade) and IDH mutation.

## RESULTS

Generated Ktrans, Vp, Ve maps showed high SSIM (0.949±0.02, 0.746±0.021, 0.745±0.023) compared to the GT maps, respectively. The ICC of PK maps was significantly higher in generated PK maps compared to the conventional approach: 0.984 vs 0.119, p<0.001 for ktrans, 0.994 vs 0.465, p<0.001 for Ve, 0.984 vs 0.563, p<0.001 for Vp. In the IDH-mutation prediction and glioma grading, PK values of enhancing tumor portion obtained from generated and GT maps was comparable in AUROC: 1) Ktrans, 0.844 vs 0.836 (p=0.78); Vp, 0.846 vs 0.846 (p=0.97); and Ve, 0.837 vs 0.826 (p=0.76) for IDH prediction; and 2) Ktrans, 0.892 vs 0.872 (p=0.58); Vp, 0.908 vs 0.875 (p=0.51); and Ve, 0.910 vs 0.863 (p=0.39) for glioma grading.

## CONCLUSION

PK maps generated from DCE-MRI using a deep learning-based probabilistic model showed improved reliability without compromising diagnostic performance in glioma grading.

## CLINICAL RELEVANCE/APPLICATION

Quick generation of PK maps from DCE-MRI bypassing post-processing using deep-learning with improved reliability may accelerate the application of DCE-MRI to clinical practice, benefiting treatment response monitoring in diffuse gliomas.

## R5B-SPNR- Correlations of Computational Modeling of Interstitial Fluid Pressure and Velocity with IDH1 Expression and Ki-67 Level in Glioblastoma

Jianan Zhou (*Presenter*) Nothing to Disclose

## PURPOSE

The immunohistochemistry features of glioblastoma have important influence on its occurrence and prognosis. This study aimed to explore correlation of computational modeling of interstitial fluid pressure (IFP) and velocity (IFV) based on dynamic contrast enhanced (DCE)-MRI with IDH1 expression and Ki-67 level in glioblastoma.

## METHODS AND MATERIALS

Patients diagnosed as glioblastoma between 2020 and 2021 were included. All patients underwent examination before surgery in a 3.0T MR scanner (uMR770, United Imaging Healthcare). DCE-MRI (transverse T1-weighted spoiled gradient-echo sequence, 100 time-points, temporal resolution 2.5s) were performed before, during and after the injection of contrast agent (gadodiamide injection, 0.2mL/kg, 3.5mL/s). IDH1 expression and Ki-67 level were evaluated by immunohistochemistry of tumor samples after surgery. The permeability parameters were calculated from extended-Tofts model. Volume-of-interests were delineated manually including the whole tumor on late DCE images. The partial differential equation of IFP and IFV was formulated from the continuity equation and solved in MATLAB. All modeling parameters were decided according to foreknowledge from previous studies. Spearman's test was used to assess the relationship between IFP and IFV indicators (mean, standard deviation, kurtosis, skewness) and immunohistochemistry markers. Significance criteria was P<0.05 for all statistic results.

## RESULTS

Thirty-four patients were included (mean age 57.2±10.4, 17 females). IFP and IFV mappings were obtained for each patient. The IDH1 expression was negatively correlated with IFPmean (P=0.031, r=-0.382), IFPkurtosis (P=0.031, r=-0.383) and IFVmean (P=0.038, r=-0.369) and positively correlated with the IFPskewness (P=0.023, r=0.402). Ki-67 level was negatively correlated with IFVkurtosis (P=0.042, r=-0.351). No significance was found in other statistic results.

## CONCLUSION

Computational modeling of IFP and IFV based on DCE-MRI has significant correlation with IDH1 expression and Ki-67 level of glioblastoma.

## CLINICAL RELEVANCE/APPLICATION

This study found that computational modeled IFP were associated with the expression of IDH1 in glioblastoma. IFP is closely associated with tumor permeability, and could be affected by the microvascular properties within the tumor. Compared with IDH mutant, IDH wild-type glioma has faster tumor cell proliferation, richer neovascularization and higher permeability. Ki-67 reflects the proliferation of tumor cells and can be used to distinguish low-grade glioma from high-grade glioma. Therefore, IFP indicators have potential significance in predicting the molecular classification, tumor recurrence and prognosis of glioma.

## R5B-SPNR- Usefulness of Perfusion Imaging with Super-selective pCASL for Meningioma 12

Takashi Katsube (*Presenter*) Nothing to Disclose

## PURPOSE

Identification of meningioma's feeding arteries and brain invasion is important for transcatheter arterial tumor embolization (TAE) or tumor resection. Super-selective pseudo-continuous arterial spin labeling (SS-ASL) is capable of selectively labeling the major arteries in the neck and noninvasively assessing the perfusion area of that artery. The purpose of this study is to investigate whether SS-ASL can identify the feeding arteries of meningioma and determine the presence or absence of meningioma brain invasion.

## METHODS AND MATERIALS

The subjects were 19 patients (18 women and a man, mean age 64.6) who had SS-ASL of MRI and angiography and were pathologically diagnosed meningioma. The average major axis of the tumors on MRI is 37.7mm (15-58 mm). SS-ASL was selectively labeled for an external carotid artery, an internal carotid artery, or bilateral vertebral arteries, respectively, and two to five SS-ASL images were taken in each case, with different arteries selected depending on the localization of the tumor. Two observers separately identified the feeding arteries of meningioma by SS-ASL and compared them to angiography to assess their accuracy. Also, increased perfusion in the region of the tumor bordering the brain parenchyma on SS-ASL with selected internal carotid or vertebral arteries was considered as having brain invasion, and the findings was compared with surgical and pathological findings. The image quality of SS-ASL was evaluated on a 4-point scale (grade 1-4).

## RESULTS

One case in which the feeding artery could not be clearly identified on angiography was deleted, resulting in 18 cases being evaluated. In 16 cases (88.9%) for observer 1 and 15 cases (83.3%) for observer 2, the feeding arteries noted on SS-ASL were consistent with the angiographic findings. Surgery and pathology were able to correctly determine the presence or absence of brain invasion of meningioma in 14 cases, with 3 cases showing brain invasion. And 10 cases (71.4%) were correctly evaluated by SS-ASL. All 7 cases judged as no brain invasion by SS-ASL had no brain invasion. A total of 61 SS-ASL images were obtained in 18 cases. The images graded 3 or 4, which can be judged as good, were 55 (90.2%) for observer 1 and 52 (85.2%) for observer 2.

## CONCLUSION

SS-ASL is expected as a non-invasive method for estimating the feeding arteries of meningioma and may be useful for surgical information and TAE decisions.

## CLINICAL RELEVANCE/APPLICATION

SS-ASL can noninvasively assess blood flow in intracranial lesions. The ability to identify the distribution of blood flow in meningioma with SS-ASL provides useful information for angiography and surgery.

## R5B-SPNR- Spinal CSF Outflow using Spin Labeling MRI 13

Mitsue Miyazaki, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

In comparison to the brain, the mechanisms of intrinsic CSF spinal outflow are ones that remain to be unclear. The purpose of this research work is to investigate the location of CSF spinal outflow using novel MRI non-contrast, spin-labelling of endogenous CSF.

## METHODS AND MATERIALS

Seven healthy subjects were imaged using a clinical 3 Tesla MR imager with a 16-channel spine coil. Coronal T2-weighted 2D fluid attenuated inversion recovery (FLAIR) and coronal T2-weighted 3D centric ky-kz single-shot FSE (cSSFSE) were used to locate the lumbar regions of the spinal canal, while axial T2-weighted imaging was used to locate a spin-labeling, time-spatial

labeling inversion pulse (Time-SLIP). To prevent blood contamination, an effective TE (TE<sub>eff</sub>) of 300 ms was used in the Time-SLIP experiments.

## RESULTS

Using non-invasive, non-contrast techniques, we demonstrate both proximal to distal and cranial to caudal flow gradients, with the highest level of CSF flow along the L3 and L4 nerve roots. Interestingly, the slowest outflow was in ROI 1 and 2 (L1) which also demonstrating overall increased Time - to - Peak (TTP) relative to L2-4.

## CONCLUSION

Our work is the first to validate the use of non-invasive, non-contrast MR techniques to identify and quantify intrinsic CSF spinal outflow metrics. Our quantitative results demonstrate high CSF outflow along the lumbar nerve roots as the first direct visualization of dispersed CSF egress from the nerve root sheaths into the adjacent paraspinal space.

## CLINICAL RELEVANCE/APPLICATION

New avenue for spinal CSF flow study, with implications for intrathecal drug design/delivery, identifying flow abnormalities related to CSF issues, and as biomarker for neuropathy/radiculopathy.

## R5B-SPNR- Does Resting-state fMRI have the Potential for Presurgical Functional Mapping?

2

Ruchi Sharma, MS, BS (*Presenter*) Nothing to Disclose

## PURPOSE

In research, the potential of resting state has been explored for several decades, however, task-based functional MRI (tb-fMRI) is the status quo for presurgical planning where eloquent functional networks of the brain such as language and movement are mapped. But, reliable tb-fMRI mapping requires task compliance whereas resting-state fMRI (rs-fMRI), which utilises the inherent synchronisation of fMRI BOLD signals between brain areas, enables this mapping even in sleep/anaesthesia conditions. Further, several functional networks can be mapped at once. To leverage the capabilities of rs-fMRI in clinical settings, a comparison of the two is crucial. The purpose of this study was to compare rs-fMRI and tb-fMRI.

## METHODS AND MATERIALS

The raw rs-fMRI data and partially pre-processed tb-fMRI data (n=75 language, n=80 motor) from a healthy cohort were obtained from HCP dataset. After relevant pre-processing steps including artefact correction, skull-stripping, and denoising. Independent component analysis was performed on the rs-fMRI time series using standardized reproducible pipelines in Python. The components were compared with functional atlases - Schaefer (sensory-motor) and SENSEAAS (language) using Dice coefficients, and the component with the largest coefficient was chosen for subsequent analyses. For tb-fMRI, cluster-based z-statistic maps were generated at a significance level of p=0.05 using a threshold of z = 3.69 using the FSL toolbox. Following this, four metrics were computed- sensitivity and specificity of rs-fMRI with respect to tb-fMRI (masked with an average of both to avoid null voxels), concordance of lateralization (left, right, bilateral) between rs-fMRI and tb-fMRI, the distance between the centre of mass (COM) of peak clusters in rs-fMRI and tb-fMRI, and product of group-averaged tb-fMRI and rs-fMRI maps.

## RESULTS

The tb-fMRI produced more lateralized activations than rs-fMRI. The concordance between the lateralization side indicated by rs-fMRI to that by tb-fMRI was 36 % for the language network.

## CONCLUSION

The sensitivity and specificity values were in an acceptable range. The distance between rs-fMRI and tb-fMRI COMs as well as lateralisation concordance were similar to previous studies on tumours. The product of rs-fMRI and tb-fMRI maps indicate good topographic concordance. Taken together, the results reflect that rs-fMRI is comparable to tb-fMRI but doesn't have a very high concordance, likely reflecting the unique activations captured by rs-fMRI.

## CLINICAL RELEVANCE/APPLICATION

Pre-surgical planning based on rs-fMRI can be used for patients non-compliant with tb-fMRI such as comatose, paralyzed, cognitively challenged, claustrophobic, etc.

## R5B-SPNR- ABC/2 and Ice Cream Cone Method for Volumetric Assessment of Vestibular Schwannomas: Reliability of These Methods

3

Nader Ashraf, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Vestibular schwannomas are three-dimensional tumors that cannot be accurately assessed with linear measurements or simple volume calculations. Volumetric analysis, using software that segments images, provides a more robust tool for measuring tumor volume, growth rate, and volumetric change. However, this software is not widely accessible and can be



time-consuming. As a result, volume-estimating formulas such as ABC/2 and ice cream cone have become popular. This study aimed to evaluate the accuracy of volume estimation using these formulas compared to manual segmentation, using magnetic resonance imaging (MRI).

## **METHODS AND MATERIALS**

The study analyzed 46 cases of unilateral vestibular schwannomas confirmed by pathology and examined using MRI. Volumetric analysis was conducted using a 3-D, T1-weighted, magnetization-prepared rapid gradient echo (MPRAGE) sequence with manual image segmentation. Two-dimensional metrics were used to calculate tumor volume using ABC/2 ( $AP*ML*CC/2$ ) and ice cream cone formulas. The largest anteroposterior (AP) and craniocaudal (CC) dimensions were compared for each tumor. Differences greater than 10% between these dimensions were used to assess the difference between the lesions. Unpaired t-tests were used to analyze the results, with significance set at  $p < 0.05$ .

## **RESULTS**

Of the 46 patients, 34 (74%) had intracanalicular and cisternal components, while 10 (22%) had only intracanalicular component. The comparison of volume estimation was done on a subgroup of 31 patients. The mean tumor volumes obtained by manual segmentation, ABC/2, and ice cream cone methods were 1244.41 ( $\pm 982.35$ ) mm<sup>3</sup>, 1557.23 ( $\pm 1484.05$ ) mm<sup>3</sup>, and 1043.64 ( $\pm 891.13$ ) mm<sup>3</sup>, respectively. There was no statistically significant difference between ABC/2 and manual segmentation ( $p=0.16$ ), ice cream cone and manual segmentation ( $p=0.20$ ), and ABC/2 and ice cream cone ( $p=0.52$ ) measurements. Of the tumors, 26 (57%) had longer AP dimensions, while 6 (13%) had longer CC dimensions.

## **CONCLUSION**

Linear measurement applications such as the ABC/2 and ice cream cone methods can serve as substitutes for calculating tumor volumes, given their ease of use and accessibility. However, the ABC/2 formula tends to overestimate the tumor volume, while the ice cream cone formula tends to underestimate it. Furthermore, while the majority of vestibular schwannomas are ovoid, 13% of tumors grow predominantly in a CC fashion, which may result in preferential trigeminal nerve involvement.

## **CLINICAL RELEVANCE/APPLICATION**

The ABC/2 and ice cream cone formulas are reliable and time-efficient alternatives to manual segmentation for accurately estimating the volume of vestibular schwannomas.

## **R5B-SPNR- Applying ChatGPT to Predict Imaging Modalities Given Neuroradiological Patient Presentation**

Lleayem Nazario-Johnson, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

The aim of this project is to explore the ability of large language models (LLMs) to predict the best neuroradiologic imaging modality given specific clinical presentations. In addition, we seek to determine if LLMs can outperform an experienced neuroradiologist in this regard.

## **METHODS AND MATERIALS**

We utilized ChatGPT, an LLM built by Open AI that is trained on general data, as well as GlassAI, an LLM built by Glass Health that is trained on medical text. We prompted ChatGPT to rank the three best neuroimaging modalities, while taking the best responses from GlassAI and the neuroradiologist. We compared the responses to the American College of Radiology (ACR) Appropriateness Criteria for 147 conditions under the Neurologic Panel. Clinical scenarios were passed into each LLM twice, to account for stochasticity. Each output was scored out of 3, where 3 is "usually appropriate", 2 is "may be appropriate", 1 is "usually not appropriate", and 0 is not listed. Partial scores were given for non-specific answers. Scores were averaged across neurological topics. Statistical significance was determined using a two-sided student's T-test.

## **RESULTS**

ChatGPT achieved a score of 1.75 with a standard deviation of .81, while GlassAI achieved a score of 1.83 with a standard deviation of .81 across all neurological clinical scenarios. The difference between them was not found to be statistically significant ( $p > .05$ ). The neuroradiologist achieved a score of 2.19, with the difference of the scores being statistically significant when compared to LLMs ( $p < .05$ ). ChatGPT was also found to be the more inconsistent of the two LLMs, with the score difference between both outputs being statistically significant ( $p < .01$ ). It was also found that the score between different ranks outputted by ChatGPT was statistically significant ( $p < .001$  for each).

## **CONCLUSION**

LLMs perform well selecting an appropriate neuroradiologic imaging procedure when prompted with a specific clinical scenario. ChatGPT, a general model, performed the same as GlassAI, a medical-specific model, suggesting that with medical text training, ChatGPT could significantly improve its function in this application. LLMs did not outperform an experienced neuroradiologist, indicating the need for their continued improvement in the medical context.

## CLINICAL RELEVANCE/APPLICATION

LLMs such as ChatGPT and GlassAI are able to comprehensively analyze large volumes of patient data and provide practitioners with accurate and reliable recommendations. This ability can improve diagnostic accuracy, reduce unnecessary testing and radiation exposure, and ultimately improve patient outcomes. Though LLMs do not yet outperform a neuroradiologist, our investigation indicates a proof of concept for their clinical implementation.

### **R5B-SPNR- Photon-counting Detector CT Could Visualize Brachial Plexus: A New Method to Evaluate Nervous System**

Masahiro Nakashima, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

MRI is widely used to evaluate brachial plexus, however, it is often difficult to visualize it because of field inhomogeneity and anatomical complexity. Recent advent of photon-counting detector CT (PCD-CT) could provide the higher spatial resolution with better tissue characterization. The purpose of this study was to investigate the optimal reconstruction function of the PCD-CT to maximize the quality of imaging for it.

#### METHODS AND MATERIALS

This retrospective study included patients who underwent neck PCD-CT for screening between March 1 and April 3, 2023 in our institution. Patients with radiological abnormalities, such as masses and postoperative cervical spine, were excluded. To evaluate the appropriate reconstruction function (kernel), the signal-to-noise ratio (SNR) was quantitatively compared in eight different kernels for each patient while other parameters, including matrix size (512×512mm), degree of iterative reconstruction (QIR2), and slice thickness (0.4mm), were fixed. Radiation dose levels were CTDIvol 11.0-13.8mGy. The kernels of quantitative regular (Qr) series from Qr40 to Qr72 (Qr40, Qr44, Qr48, Qr56, Qr60, Qr64, Qr68, and Qr72), the standard kernel for quantitative evaluation, were used. The SNR was measured on a reconstructed 1mm-thick coronal section image by setting six regions of interest (ROIs) with 3 mm<sup>2</sup> on each of the bilateral C5-C7 nerves, and the average and standard deviations (SDs) of the SNRs were calculated. All the ROIs within each subject were copied and pasted to the images with different kernels to ensure locational accuracy. The SNR was measured by a board-certified neuroradiologist with 8 years of experience. Statistical analyses were performed with the Friedman test, and the Wilcoxon signed-rank test.

#### RESULTS

Ten subjects (5 males and 5 females; median 73 [range65-78]years) were evaluated. The SNR (mean±SD) was 3.39±1.30, 2.93±0.96, 2.66±0.95, 2.05±0.72, 1.74±0.59, 1.44±0.48, 1.14±0.37, 1.14±0.37, for Qr40, Qr44, Qr48, Qr56, Qr60, Qr64, Qr68, and Qr72, respectively. The SNRs exhibited a constant decrease with each increase in the Qr number. The SNRs were significantly different (P<0.05) between any of the two groups, except for Qr68 vs Qr72. The kernel with the smaller Qr number demonstrated a better SNR in the evaluation of the brachial plexus.

#### CONCLUSION

On PCD-CT, the kernel with a smaller Qr number was more suitable to evaluate the brachial plexus. Qr40, in particular, was found to have the highest SNR and was seemed to be clinically useful.

## CLINICAL RELEVANCE/APPLICATION

While MRI has been the mainstay for the evaluation of the brachial plexus, the heterogeneity of magnetic fields hampers image evaluation. PCD-CT, with its improved tissue resolution, may help in the assessment of the brachial plexus.

### **R5B-SPNR- Large-scale Granger Causality (IsGC) for Identifying Autism Spectrum Disorder Patients Using Functional MRI - A Multivariate Brain Connectivity Analysis**

Ali Vosoughi (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to create and test a new machine-learning approach for identifying individuals with Autism Spectrum Disorder (ASD). This approach uses large-scale Granger Causality (IsGC) to analyze differences in connectivity seen in resting-state functional MRI (rsfMRI).

#### METHODS AND MATERIALS

We have selected a subset of 59 rsfMRI data sets from ASD patients and healthy controls from the Olin Institute of Living at Hartford Hospital. This subset is part of the publicly available preprocessed Autism Brain Imaging Data Exchange II (ABIDE II) data repository and specifically represents the Longitudinal Sample. To calculate directed functional connectivity between brain regions, we used the large-scale Granger Causality (IsGC) algorithm. This algorithm has recently been developed and leverages dimensionality reduction for causal modeling in high-dimensional fMRI time series. We applied a 100-iteration cross-validation approach with a 90%/10% train/test ratio. During the feature selection process, Kendall's tau rank correlation was used, followed by support vector machine classification. To evaluate the diagnostic accuracy of IsGC in



classifying ASD patients and normal controls, we compared its performance with both a deconfounding partial correlation and the current clinical fMRI analysis standard of cross-correlation (CC). We reported accuracy, area under the ROC curve (AUC), and f1-score to quantitatively evaluate the performance of IsGC.

## RESULTS

The IsGC rsfMRI analysis method demonstrated superior performance compared to both the partial correlation and clinical standard CC techniques in classifying ASD patients from healthy subjects. With an accuracy/AUC/f1 score of 97.9%/1.0/96.4% for IsGC, 75.4%/0.79/60.5% for partial correlation, and 80.1%/0.85/66.8% for CC, respectively, it is suggested that the IsGC rsfMRI analysis method is a favored choice for accurate classification.

## CONCLUSION

Our results demonstrate that IsGC significantly enhances the diagnostic accuracy of identifying patients with ASD from rsfMRI neuroimaging. Based on our findings, we conclude that IsGC is better equipped to capture disease-related changes in brain network connectivity in ASD patients compared to both conventional CC analysis and partial correlation.

## CLINICAL RELEVANCE/APPLICATION

The IsGC method successfully classifies Autism Spectrum Disorder (ASD) patients and controls through identifying key changes in fMRI connectivity, clearly demonstrating its potential usefulness as a novel diagnostic imaging biomarker for neurologic disease.

## R5B-SPNR- Adaptive Changes of Hypoxia Exposure in Normal Adults at High Altitude and Comparison of Brain Structure and Function between Insomnia and Non Insomnia by f-MRI

Mingguang Yang (*Presenter*) Nothing to Disclose

## PURPOSE

To observe the brain adaptation changes in normal adults after exposure to hypoxia at high altitude and the differences in brain structure and function in patients with secondary insomnia

## METHODS AND MATERIALS

26 subjects of aid workers in Tibet were prospectively enrolled, and high-resolution three-dimensional T1-weighted structural images and resting state functional magnetic resonance imaging (rs-fMRI) were collected. MRI scans were taken as baseline data before admission to Tibet. Six months after emigration to Tibet, 26 subjects were divided into insomnia group (8 cases) and non-insomnia group (18 cases) according to Pittsburgh Sleep Quality Index (PSQI), and MRI scanning was performed again. Based on voxel morphology (VBM), local consistency (ReHo), low-frequency amplitude ratio (fALFF), and degree center (DC), 26 subjects were analyzed before and after entering Tibet, and the insomnia and non insomnia groups were analyzed respectively.

## RESULTS

Compared with the pre Tibet group, the gray matter volume (GMV) atrophy of 26 subjects in the post Tibet group was located in the middle frontal gyrus, parahippocampal gyrus and right parietal inferior marginal angular gyrus, with significant differences ( $P < 0.01$ ). The ReHo value between pre Tibet and post Tibet groups were statistically significant ( $P < 0.01$ ). The brain area with increased ReHo value was located in the right cerebellar hemisphere. The fALFF values between the pre Tibet and post Tibet groups were statistically significant ( $P < 0.01$ ). The brain regions with increased fALFF values were located in the left lingual gyrus, the left middle temporal gyrus, and the cortex around the left talate fissure; The fALFF value between the insomnia group and the non insomnia group was statistically significant ( $P < 0.01$ ). The brain area with increased fALFF value was located in the left posterior cingulate gyrus. The DC value between the insomnia group and the non insomnia group was statistically significant ( $P < 0.01$ ). The brain area with reduced DC value was located in the left orbital superior frontal gyrus.

## CONCLUSION

The structure and function of several brain regions were changed in normal adults after migrating to high altitude and secondary insomnia.

## CLINICAL RELEVANCE/APPLICATION

In this study, people exposed to low oxygen in high altitude areas were tracked, and the brain function and morphology were compared with insomnia and non-insomnia after migration to high altitude areas and before and after their own migration, and multiple brain regions with abnormal brain structure and function were found

## R5B-SPNR- Brain Image Reconstruction using Deep Learning CT Image Quality

8

Michaela Cellina (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the image quality of brain computed tomography (CT) images reconstructed with deep learning-based image reconstruction, Advanced intelligent Clear-IQ Engine (AiCE), and Iterative Reconstructions (AIDR3D)

## METHODS AND MATERIALS

150 consecutive patients underwent unenhanced brain CT scans with the following acquisition parameters: 120 kV, 50 mAs, slice thickness 0.5 mm, rotation time 1.5 sec, field of view, 250 mm; matrix, 512 × 512. Each dataset was reconstructed with AIDR3D and AiCE at 1 mm thickness and 1 mm increment. All images were evaluated using a dedicated PACS system. Image quality on a 4-point scale (excellent, good, sufficient, poor quality), gray matter-white matter differentiation, and anatomical detail (based on the visualization of basal ganglia, internal and external capsule) were independently assessed by two experienced readers. Interobserver agreement was assessed. Posterior fossa artifact index, the contrast to noise ratio (CNR) basal ganglia and the background image noise were evaluated.

## RESULTS

No significant difference was observed in image quality ( $p=0.06$ ). The gray matter-white matter differentiation was higher in AiCE reconstructions ( $p=0.003$ ), as well as the anatomical detail ( $p=0.04$ ). Image noise and artifact index of the posterior cranial fossa were significantly lower in images reconstructed with AiCE ( $p=0.003$ , and  $=0.005$ ) respectively. CNR was higher in deep learning based reconstruction ( $p=0.004$ ).

## CONCLUSION

In brain CT, deep learning based reconstructions allow significant reduction of noise and artifacts and better subjective image quality compared with iterative reconstructions.

## CLINICAL RELEVANCE/APPLICATION

Deep learning based reconstructions improve image quality when compared to iterative reconstruction: this fact may allow the reduction of CT acquisition parameters and radiation exposure in CT protocols.

## R5B-SPNR- Reduction of Posterior Fossa Artifacts using Spectral Monoenergetic CT Images 9

Helena Mellander (*Presenter*) Nothing to Disclose

## PURPOSE

The radiological evaluation of the posterior fossa in conventional brain computed tomography (CT) is often interfered by beam hardening artifacts. Dual energy CT has been increasingly evaluated regarding for example reduction of metal artifacts and general image quality. Artifact reduction that could improve the assessment of the posterior fossa would be of great value since the symptoms of pathology may be non-specific such as headache, nausea, vertigo and ataxia. Patients could receive suboptimal level of care or incorrect treatment if not correctly diagnosed or while awaiting further work-up. The purpose of this study was to evaluate posterior fossa artifacts in virtual monoenergetic images (VMIs) compared to conventional CT images.

## METHODS AND MATERIALS

We included consecutive exams from adult (over 18 years) patients at our center who had undergone non-contrast spectral brain CT and whose exam was assessed as normal (e.g. no findings of ischemia, expansivities or hemorrhages). Regions of interest (ROIs) were drawn in predefined areas in posterior fossa grey matter (GM) and white matter (WM), in the interpetrous part of pons and in reference supratentorial GM and WM. Mean Hounsfield values and standard deviation (SD, considered image noise) were noted for the conventional images (CIs) and retrieved in spectral diagrams for monoenergetic series at 40-200 keV. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. The SD of the ROI in interpetrous pons was considered PFAI (posterior fossa artifact index). Visual assessment was performed by independent review by neuroradiologists blinded to reconstruction details.

## RESULTS

In the objective part of the study 188 patients were included and of them, forty consecutive patients were included in the subjective part. SNR was significantly higher compared to CIs in VMIs at 50 keV and higher for all measure points and CNR was higher in VMIs from 40 to 80 keV compared to CIs (Figure 1). Compared to CIs, mean image noise was lower for cerebellar WM in VMIs at and above 50 keV and for cerebellar GM the noise values were significantly lower in VMIs at and above 60 keV. The PFAI was significantly lower in VMIs above 50 keV compared to in CIs. VMIs at 60 keV received the highest visual assessment scores regarding overall image quality and artifact severity (higher scores indicating less artifacts) in the interpetrous pons.

## CONCLUSION

Our results indicate that VMIs may improve objective and subjective image quality and artifact severity in the posterior fossa.

## **CLINICAL RELEVANCE/APPLICATION**

CT is the most used neuroradiological imaging modality in clinical routine care. Improving the diagnostic strengths of the images regarding posterior fossa pathology could have a direct impact for the patient outcome.

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## Abstract Archives of the RSNA, 2023

R5B-SPPH

### Physics Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPPH- Clinical Comparison of Commercial Dosimetry Software Platforms for Y-90 1 Radioembolization Treatment**

Judy R. James, PHD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Patient dosimetry is an evolving field for therapy procedures in Nuclear Medicine. Post imaging dosimetry verification is gaining importance to validate prescribed dose with delivered dose in tumor and normal tissues. In Yttrium-90 (Y-90) radioembolization, specific targeted amounts of Y-90 radiation (Gy) is prescribed to preferentially destroy the cancerous cells. Different approaches to clinical dosimetry in NM have been proposed, with planar and SPECT images. Aim of this study was to compare clinically available dosimetry softwares to evaluate patient liver tumor dose following Y90 Treatment and the associated challenges with the software calculations.

#### **METHODS AND MATERIALS**

Dosimetry analysis was performed on a patient that received Y-90 treatment to the right anterior lobe with a prescribed dose of 301 Gy. The lung shunt fraction was at 2.7%. SPECT/CT was acquired following Y-90 administration on two separate gamma cameras: GE CZT and Philips Bright view (BV) and quantitative SPECT images were reconstructed. Following the required segmentations of the liver and tumor, the maximum absorbed dose to the hottest area of the tumor was obtained and compared using 3 dosimetry software platforms: 1) MIM Y90 Sure Plan<sup>TM</sup>, 2) HERMES Voxel dosimetry<sup>TM</sup> and 3) Simplicity<sup>TM</sup>.

#### **RESULTS**

Variability was observed in steps leading to computation and calculation of the absorbed radiation dose. The three platforms required a post Y-90 reconstructed SPECT, CT, and the administered dose. In addition, the needs for a) MIM lung shunt fraction (LSF), b) HERMES: duration between administration and scan time; c) Simplicity a pre Y-90 planning CT or MR and LSF. Segmentation and contouring workflow variability was also observed. MIM has a streamlined workflow for contouring and calculating the maximum dose compared to HERMES and Simplicity. Maximum reported doses were: a) MIM: 522.4 Gy with 95% of tumor: 496.28 Gy (CZT) and 196.04 Gy with 95% of tumor: 186.24 Gy ( BV); b) HERMES: 184.27 Gy (CZT) and 200.44 Gy (BV); c) Simplicity: 433.7 Gy (CZT) and 574.2 Gy (BV), where the true prescribed dose was 301 Gy. The doses computed by the three software had >20% deviation from the actual prescribed dose.

#### **CONCLUSION**

Initial results of a dosimetry software comparison provided evidence that variability exists in the calculation of absorbed dose estimates on SPECT/CT images.

#### **CLINICAL RELEVANCE/APPLICATION**

Absorbed dose calculation in Y-90 radioembolization treatments are feasible clinically. However, dosimetry still faces challenges of standardization among different calculation platforms, imaging scanners, dose calculation models, and target area segmentation.

#### **R5B-SPPH- Radiation Effect Measurement in Brain Tumor using MR-based Conductivity Imaging 10**

Hyun Chul Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The ionizing radiation produces ions inside the human body that can kill cancerous tissues by damaging DNA directly or creating charged particles that damage DNA. MR-based electrical conductivity imaging is a sensitive technique for evaluating

the response of normal tissues immediately after irradiation, but it is necessary to verify responses of cancer tissues to become a reliable tool for evaluating therapeutic effects in clinical practice. In this study, we used MR-based electrical conductivity imaging to evaluate the responses of irradiated and non-irradiated tissues during the peri-irradiation period in mouse brain tumors.

## **METHODS AND MATERIALS**

For intracranial tumors, C6 glioma cells were injected into the right caudate-putamen of 14 Balb/c nude mice for in vivo imaging. Tumor growth was confirmed on MR images using a 9.4T MRI 2 weeks after tumor cell inoculation. The mice were divided into an irradiated group (n = 7) and a non-irradiated group (n = 7). In the irradiated group, the mean dose rate was 0.98 Gy/min, and the field size was 5 × 30 cm under a Co-60 gamma-ray irradiation unit. Imaging experiments were performed before and at 0, 1, 2, 3, 7, and 10 days after irradiation in both groups. For electrical conductivity imaging, a multi-echo spin-echo pulse sequence was applied to obtain a B1 map, which was used to calculate high-frequency conductivity images.

## **RESULTS**

Figure 1 shows full time-course MR and electrical conductivity images of tumor with and without irradiation. Morphology of tumor region in MR images showed a similar pattern over time in both groups. However, conductivity images showed clear contrast changes between the two groups over time. In line graphs, the percentage change of the normal region with irradiation increased by 27.2% up to 2 days and then decreased to 12.4%. The change of the normal region without irradiation was not observed. Meanwhile, the change of the tumor region with irradiation increased by 61.1% up to 3 days and then decreased to 52.9%. The change of the tumor region without irradiation was not observed until 3 days after irradiation, but increased to 23.2% at 10 days after.

## **CONCLUSION**

Conductivity image provides information on cellularity and amounts of electrolytes in tissues, it shows potential as a tool for quantifying therapeutic effects of radiation on tumor.

## **CLINICAL RELEVANCE/APPLICATION**

The goal of radiation therapy in cancers is to maximize suppression of local tumors and minimize side effects on normal tissue. MR-based electrical conductivity imaging showed potential as a tool with high sensitivity for measuring and evaluating tissue response after irradiation.

## **R5B-SPPH- Evaluation of the Feasibility of Injectable Lipiodol and Tissue Glue Fiducial Markers for CyberKnife Tracking**

Xianzhi Deng (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate combinations of lipiodol and tissue glue using phantom and rabbit models, for feasibility in computed tomography (CT) image quality and image recognition of the Cyberknife system.

## **METHODS AND MATERIALS**

The gold and lipiodol fiducial markers were inserted into tissue-equivalent phantom. CT was performed to assess images in terms of contrast to noise ratio (CNR), signal to noise ratio (SNR), and streak index (SI). To investigate the performance of combination of lipiodol and tissue glue, a study is conducted in the spine phantom which was placed in such a way that the lipiodol fiducial marker was overlapped with the bone in TLS. CT values, deformation, displacement, and diffusion of lipiodol fiducial markers were evaluated one week after injected into the livers of six rabbit models. Tracking accuracy of the gold fiducial markers and the lipiodol fiducial markers were analyzed and compared.

## **RESULTS**

The phantom show that the fiducial markers in each group could be seen clearly visible on the CT scans. Compared to lipiodol fiducial markers, gold fiducial markers had a greater SI and poorer CNR and SNR. Groups of lipiodol fiducial markers overlapped with the spine can be identified and successfully tracked. Both the pairing tolerance and uncertainty values did not exceed the systematic threshold. There were no adverse reactions such as rupture, necrosis and infection were observed in the injection site. Over the course of a week, the volume of lipiodol glue fiducial marker decreased by 30% while CT value stayed above 1000 HU. The registration translation deviation of gold fiducial markers tracking was lower than that of lipiodol glue fiducial markers tracking in supero-inferior, left-right and antero-posterior directions ( $Z = -2.276$ ,  $-10.226$ ,  $Z = -6.378$ ,  $P < 0.05$ ).

## **CONCLUSION**

Fiducial markers composed of a combination of lipiodol and tissue glue were well visualized in a phantom on CT and produce less artifact than the gold fiducials. Lipiodol fiducial markers were successfully recognized and tracked using the Cyberknife Xsight-Lung tracking system in rabbit models.

## CLINICAL RELEVANCE/APPLICATION

Compared with solid markers, combinations of lipiodol and tissue glue possess the following advantages: ? it can be injected through the liver via a thinner needle, reducing the risk of pain and complications during puncture. ? The corresponding volume can be injected according to the size of the tumor, especially the tracking method combined with Cyberknife only needs one injection, which can reduce the number of punctures and simplify the process. ? The visibility of the markers on the imaging device can be adjusted by changing the ratio of lipiodol to tissue glue.

## R5B-SPPH- Clinical and Radiation Risk Across One Million Patients in Computed Tomography: Influence of Age, Size, and Race<sup>2</sup>

Francesco Ria, DMP (*Presenter*) Metis Health Analytics

### PURPOSE

We recently developed a mathematical model to balance radiation risk and clinical risk, namely the risk of misdiagnosis due to insufficient image quality. In this work, we applied this model to a population of one million CT imaging cases to evaluate the risk stratification with different ages, sexes, and races.

### METHODS AND MATERIALS

The demographics were informed by literature and census information simulating a clinical liver cancer population. The Total Risk (TR) was calculated as the linear combination of radiation risk and clinical risk. The model included factors for the radiation burden for different age and sex; the prevalence of the disease; the false positive rate; the expected life-expectancy loss for an incorrect diagnosis for different ages, sex, and race; and a typical false positive rate of 5%. It was assumed that each case received an average radiologist interpretative performance of 0.75 AUC for a hypothetical lesion without any changes in radiation dose beyond routine practice. We further, for each patient, simulated 2,000 imaging conditions with CTDIvol varying from 0.1 and 200 mGy with 0.1 mGy increments. Per each CTDIvol value, the anticipated AUC was calculated by applying the established asymptotic relationships between CTDIvol and image quality. The AUC distribution was then used to calculate the theoretical minimum total risk (TRmin) per each patient.

### RESULTS

For the routine practice, the median theoretical total risk was estimated to be 0.058 deaths per 100 patients (range: 0.002 - 0.154) comprising of the median radiation risk of 0.009 (range: 0.001 - 0.069), and of the median clinical risk of 0.049 (range:  $7.0 \times 10^{-5}$  - 0.094). Considering the varying scanner output conditions, the median TRmin was 0.054 deaths per 100 patients for White male patients, 0.054 for Blacks, 0.057 for Hispanics, and 0.065 for Asians. For female patients, the median TRmin values were 0.049, 0.056, 0.054, and 0.061 deaths per 100 patients, respectively.

### CONCLUSION

For each demographic condition, the clinical risk was found to largely outweigh the radiation risk by at least 500%. Total risk showed different stratifications with patient age and race.

## CLINICAL RELEVANCE/APPLICATION

To optimize CT conditions for specific patients and/or population, both radiation risk and clinical risks should be accounted together with demographic information. We demonstrated a methodology that allows a complete depiction of total risk in CT, considering radiation and clinical risks at comparable units, and patient demographic.

## R5B-SPPH- Attenuation Correction for Total-body Positron Emission Tomography by Exploiting Anatomical Priors<sup>3</sup>

Wenbo Li (*Presenter*) Nothing to Disclose

### PURPOSE

During positron emission tomography (PET) scanning, additional computed tomography (CT) imaging is utilized to provide attenuation coefficient maps to achieve more precise quantification on PET images. However, this not only exposes patients to extra doses of ionizing radiation but also makes attenuation correction (AC) difficult for PET/MR or PET-only scanners. Recently, many efforts have been applied to address this issue but the majority of these methods have been implemented on specific anatomical tissue, ignoring the structural differences among various human body sites.

### METHODS AND MATERIALS

Experiments were performed on total-body scans of 20 patients that contained paired NAC PET and AC PET images of different sites, including the head and neck, chest, abdomen, pelvis, and extremities. Considering the anatomical disparities, we utilized the cycle-consistent generative adversarial network (Cycle GAN) as a foundation and modified its discriminator to differentiate between the authenticity of the input and its corresponding anatomy. In addition, the training process included the integration of a discriminative loss that relied on anatomical structures to enhance the quality of the generated AC PET images.

## RESULTS

The results showed that our method yielded superior quantification outcomes with a peak signal-to-noise ratio (PSNR) of  $38.02 \pm 5.52$  dB and a structural similarity index (SSIM) of  $0.96 \pm 0.05$ . Compared to nonattenuation-corrected PET (NAC PET) images ( $33.30 \pm 12.35$  dB,  $0.84 \pm 0.552$ ), our method resulted in a 14% increase in both PSNR and SSIM, indicating its effectiveness in converting NAC PET images into AC PET images.

## CONCLUSION

Our work accounts for differences in the anatomy of various human body sites and applies this information as a priori knowledge in the generation of AC PET images from NAC PET images. By incorporating prior factors, we achieved remarkable quantitative results, as evidenced by significant improvements in both PSNR and SSIM metrics compared to NAC PET images in different body sites.

## CLINICAL RELEVANCE/APPLICATION

Considering anatomical prior information, our work utilizes deep learning techniques to generate AC PET images directly from NAC PET images, bypassing the PET reconstruction step, which facilitates attenuation correction of PET images in PET/MR or PET-alone scanners.

## R5B-SPPH- Performance Evaluation of a Super Resolution Deep Learning Reconstruction Algorithm for Chest CT

Patrik Rogalla, MD, MBA (*Presenter*) Institutional Research Grant, Canon Medical Systems Corporation; Institutional Research Grant, KA Imaging

## PURPOSE

To evaluate the effect of Super Resolution Deep Learning Reconstruction (SR-DLR) using 1024 matrix on image quality in chest CT compared to standard-of-care reconstruction methods.

## METHODS AND MATERIALS

A DCNN-based Super Resolution Deep Learning Reconstruction (SR-DLR) model was developed for lung imaging. For training, standard-dose image data acquired using an ultra-high resolution CT scanner (Canon Aquilion Precision) served as target and low-dose image data from the normal resolution mode served as input. Projection data from 31 standard-of-care CT acquisitions (Canon Aquilion ONE PRISM) of the chest were reconstructed with 3 different methods: Hybrid iterative reconstruction (AIDR-3D for lung and body) at 512 matrix (series I), deep learning reconstruction (AiCE, lung and body algorithm) at 512 matrix (series II), and SR-DLR (lung algorithm) at 1024 matrix (series III), all at 3 mm slice thickness with 2.5 mm spacing. Images were also reconstructed using SR-DLR at 1024 matrix and 0.5 mm slice thickness (series IV). All 4 series, synchronized and without annotation, were reviewed in both window settings by 3 chest radiologists blinded to technical details on a 4K monitor with a 4x2 hanging protocol for the following categories on a scale of 1-5: lung resolution; soft tissue contrast; noise texture/level (lung, tissue), artifact (lung, tissue); overall image quality (lung, tissue). Forced ranking of the overall diagnostic confidence was also recorded (1 = highest, 4 = lowest). Image noise (SD) was measured in tissue and air.

## RESULTS

P values refer to series I vs III and I vs IV. The mean rating of series I-IV was 3.1/3.7/4.2/4.7 for lung resolution (both  $p < 0.001$ ); 3.2/4.1/4.1/3.5 for tissue contrast ( $p < 0.001$ ,  $p = 0.002$ ); 3.0/3.8/4.4/4.7 for lung noise (both  $p < 0.001$ ); 3.0/4.2/4.2/3.5 for tissue noise (both  $p < 0.001$ ); 4.3/4.3/4.4/4.4 for lung artifacts ( $p = 0.06$ ,  $p = 0.03$ ); 4.2/4.4/4.3/4.2 for tissue artifacts ( $p = 0.25$ ,  $p = 0.79$ ); 3.1/3.8/4.3/4.7 for overall image quality lung (both  $p < 0.001$ ) and 3.1/4.1/4.0/3.5 for overall image quality tissue (both  $p < 0.001$ ); the mean overall diagnostic confidence ranking was 3.9/2.8/2.1/1.1 for lung (both  $p < 0.001$ ) and 3.5/1.8/1.9/2.7 (both  $p < 0.001$ ) for tissue, respectively. For series I vs IV, mean image noise in tissue was 17.4/17.5 HU ( $p = 0.97$ ) and 45.9/12.5 in air ( $p < 0.001$ ).

## CONCLUSION

The SR-DLR using a 1024 matrix provides superior clinical image quality in chest CT; SR-DLR thin slices are overall preferred for lung parenchyma. SR-DLR holds promise to eliminate the need for separate reconstructions for the lung parenchyma and soft tissues.

## CLINICAL RELEVANCE/APPLICATION

The SR-DLR outperforms current clinical standard-of-care reconstructions and may contribute to improving the diagnostic value of chest CT

## R5B-SPPH- K-RCPS: Uncertainty Quantification for Diffusion Models via Conformal Prediction and Conformal Risk Control in CT Denoising

Jacopo Teneggi (*Presenter*) Nothing to Disclose



## PURPOSE

Diffusion models can generate varied and high-quality samples. It is paramount to estimate the uncertainty of these models when used for inverse problems in medical imaging (e.g., CT denoising). We propose a novel uncertainty quantification procedure to construct pixel-wise intervals that provably contain future samples as well as the ground-truth image while minimizing the mean interval length.

## METHODS AND MATERIALS

A diffusion denoising model was trained and validated on the AbdomenCT-1K dataset comprising 1,112 CT scans (170,000 images) from 12 different medical centers. Uncertainty quantification was carried out on random subsets of 640 images not shown during training. Every image in the subset was perturbed with isotropic Gaussian noise ( $\text{std}=0.4$ ) and the diffusion model was used to reconstruct 128 noiseless samples (81,920 total images). We compute the pixel-wise calibrated quantiles over the samples to guarantee that with probability at least 80% every pixel in a new sample from the diffusion model on the same noisy observation will be contained in its respective interval. We then conformalize the intervals such that with probability greater than 90% no more than 5% of the pixel in the ground-truth high-quality image will fall outside of the intervals on future, unseen noisy observations. We propose a novel convex optimization extension of the original Risk Controlling Prediction Sets (RCPS) procedure, K-RCPS, that provably minimizes the mean interval length. We compare with existing uncertainty quantification approaches in terms of guarantees provided and mean interval length over 20 draws of the 640 images.

## RESULTS

K-RCPS provides the shortest mean interval length ( $0.1391 \pm 0.0025$ ) compared to quantile regression ( $0.3522 \pm 0.0085$ ), naïve (i.e., not calibrated) empirical quantiles ( $0.1401 \pm 0.0024$ ), and the existing RCPS procedure ( $0.1614 \pm 0.0020$ ). K-RCPS is currently the only high-dimensional uncertainty quantification approach that guarantees both coverage of future samples on the same noisy observation and risk control on future observations.

## CONCLUSION

Conformal prediction and conformal risk control can be deployed for diffusion models in CT denoising to construct uncertainty intervals that provide finite-sample and distribution-free guarantees on the generated noiseless images. K-RCPS provably minimizes the mean interval length, and it consistently outperforms existing methods.

## CLINICAL RELEVANCE/APPLICATION

Statistically valid uncertainty quantification techniques build radiologists' confidence in diffusion models used for inverse problems in medical imaging.

## R5B-SPPH- Comparing Machine Learning Algorithms for Predictive Radiomic Features of Tumor Response after Pancreatic SBRT

Amit Jethanandani, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

Pancreatic cancer is a debilitating malignancy with a short life expectancy. While pancreatic SBRT has shown robust tumor control, identifying patients that respond to SBRT remains challenging. The aim of this study was to compare ML algorithms for prediction of pancreatic tumor response utilizing radiomic features extracted from MR-guided SBRT set-up imaging. We also evaluated whether static radiomic features (e.g. obtained at first SBRT fraction) differed in this predictive potential compared to delta radiomic features (e.g. net change in features between SBRT fractions 1-2 and 1-3)

## METHODS AND MATERIALS

58 pancreatic cancer patients treated with MR-guided SBRT at our institution were analyzed. Gross tumor volumes were delineated on daily set-up MRIs prior to each fraction. Patients were treated to the pancreas at a dose of 35-50 Gy in 5 fractions. Tumor response was defined using TRG-CAP for patients who underwent resection. For patients who remained unresectable post-SBRT, tumor response was determined with RECIST v.1.1 criteria on imaging at 1-3 months. MRI scans were normalized in signal intensity and 39 texture features were extracted. Features were ranked by predictive importance using RF, LASSO, and MRMR algorithms. Top 1-4 importance features from each model were analyzed using logistic regression to determine predictive performance. Logistic regression was used to obtain the area under the curve (AUC) and the Akaike information criterion (AIC) in order to compare models.

## RESULTS

For the static feature model, an MRMR algorithm of the top 2 importance features outperformed other approaches (AUC: 0.656; AIC: 55.12). For the first delta radiomics model (fractions 1-2), an RF model of the top 3 importance features demonstrated the best performance (AUC: 0.681; AIC: 52.1). For the second delta radiomics model (fractions 1-3), LASSO - using the top importance feature only - demonstrated the best performance (AUC: 0.603; AIC: 53.76).



## CONCLUSION

Leveraging an RF algorithm to rank delta radiomic features from SBRT fractions 1-2 demonstrated the best prediction of pancreatic tumor response.

## CLINICAL RELEVANCE/APPLICATION

Radiomic features of pancreatic tumors may contain predictive information about local control following MR-guided SBRT. These features could be used to personalize adaptive approaches to SBRT by identifying non-responders prior to completion of treatment.

## R5B-SPPH- Technical Performance Comparison of Super Resolution Deep Learning Reconstruction Algorithm on a Wide Area, Conventional Energy-Integrating Detector vs Conventional Reconstruction Algorithms on a Photon-Counting Computed Tomography System

Kirsten Lee Boedeker, PhD (*Presenter*) Employee, Canon Medical Systems Corporation

### PURPOSE

The purpose of this work is to systematically compare fundamental image quality between data reconstructed with a Super Resolution Deep Learning Reconstruction (SR-DLR) algorithm acquired on a wide volume, energy-integrating detector (EID) Computed Tomography (CT) system vs data reconstructed with Hybrid Iterative Reconstruction (HIR), as well as Filtered Backprojection (FBP), acquired on a Photon-Counting CT System (PCCT) in standard resolution mode.

### METHODS AND MATERIALS

A Catphan<sup>TM</sup> embedded in a 25-35cm body ellipse was scanned at six dose levels from 1.9mGy-19.7mGy on a wide volume EID as well as on a CZT-based PCCT in standard resolution mode (Canon Medical Systems Corporation, Otawara, Japan). Images generated from the EID system were reconstructed with FBP and an SR-DLR for cardiac to a 512 matrix and 1024 matrix. Two clinically realistic fields of view (FOV), 180mm and 360mm, were evaluated. Counting images from the PCCT were generated based on total counts registered over five energy bins and reconstructed with HIR cardiac kernels. Resolution was assessed via task-dependent Modulation Transfer Function (MTF) for three contrast levels. Noise was assessed by measuring the standard deviation (SD) and Noise Power Spectrum (NPS). Noise Equivalent Quanta (NEQ) and Low Contrast Detectability (LCD) were also assessed.

### RESULTS

For FBP, PCCT exceeded the spatial resolution of EID. However, the spatial resolution for SR-DLR with both a 512 and 1024 matrix on the EID system exceeded that of both conventional reconstruction algorithms on PCCT for all contrasts, by up to 5lp/cm at the 10% of the MTF, except at the lowest dose/contrast combinations. For FBP, PCCT decreased noise at low dose relative to EID. SR-DLR had lower noise magnitude, by 20-45%, than FBP and HIR on PCCT for all conditions. Both HIR on PCCT and SR-DLR on EID have noise shifted to lower frequencies, although with 1024 matrix the higher frequency content increases. NEQ is significantly greater for SR DLR for all conditions, leading to better LCD.

## CONCLUSION

While PCCT provides benefit over EID when reconstructed with equivalent reconstruction algorithms, SR-DLR improves EID image quality above that of PCCT in standard resolution mode with HIR and FBP.

## CLINICAL RELEVANCE/APPLICATION

SR-DLR using both 512 and 1024 matrix sizes leads to significant image quality benefits in spatial resolution and noise relative to conventional reconstruction algorithms on EID CT and PCCT.

## R5B-SPPH- Evaluation of Regularized Model-Based Cone-Beam Computed Tomography Image Reconstruction for Image-Guided Radiation Therapy: A Phantom Study

Shih-Chi Lin, MS (*Presenter*) Nothing to Disclose

### PURPOSE

This study investigates the potential improvement in Cone-Beam Computed Tomography (CBCT) image quality for adaptive image-guided radiotherapy (IGRT) planning using regularized model-based image reconstruction methods. We evaluate maximum likelihood proximity gradient algorithms using higher-order total variation (PGA-ML-HOTV) and tight framelets (TF) regularization to improve CBCT image quality over conventional image reconstruction methods.

### METHODS AND MATERIALS

The Tomographic Iterative GPU-based Reconstruction toolbox (TIGRE) was used for projection processing, code development, and image reconstruction. The filtered back-projection algorithm (FDK), with scatter correction and a ramp filter, was used as the baseline (BL) due to the similarity to the vendors' algorithm. PGA-ML (HOTV/TF) and row-action maximum likelihood algorithm (RAMLA; for comparison) were implemented using a Poisson noise model without scatter correction. These

reconstructions were initialized with an FDK and a uniform image using 50, 100, 150, and 200 iterations. A Catphan phantom was scanned using CBCT Head Protocol on a Varian TrueBeam LINAC Image quality was evaluated using the square root of the area under the 2D noise power spectrum curve (NPS2D), contrast (?HU), contrast-to-noise ratio (CNR), target transfer function value at 50% and 10% (TTF-50 and -10), and a model observer with eye filter detectability index (DI) of the -138 HU, 12.2-mm diameter polystyrene plug.

## **RESULTS**

PGA-ML performances with HOTV and TF were indistinguishable. The highest performance improvement over BL was seen using PGA-ML with 150 iterations initialized with FDK. In this case, NPS2D, ?HU, TTF, CNR, and DI improved by 15%, 12%, 51-52%, 4%, and 21%, respectively. It was noted that there is a trade-off in image quality with this method. Specifically, images initialized with a uniform image and 200 iterations had better NPS2D, CNR, and DI by 56-57%, 82-83%, and 111-112%, respectively. When initializing with an FDK image, ?HU decreased by 12%, but CNR increased (4%) due to lower noise. ?HU declined with increased iterations. ?HU and TTF improved with increasing iterations with a uniform image, while NPS2D and DI worsened, outperforming FDK. CNR increased initially but decreased beyond 150 iterations due to increased noise.

## **CONCLUSION**

The study demonstrates that regularized model-based image reconstruction methods can provide better image quality than FDK with optimized iteration and penalty settings and thus enhance target delineation during adaptive IGRT. Task-based performance assessment of these methods is necessary to enable integration into CBCT-based adaptive radiotherapy.

## **CLINICAL RELEVANCE/APPLICATION**

CBCT quality is important for CBCT-based adaptive IGRT planning.  
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## Abstract Archives of the RSNA, 2023

R5B-SPVA

### Vascular Imaging Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-SPVA- Spectral CT Monochromatic Imaging With Metal Artifact Reductions In Assessment Of Stent Lumen In Portal Venography After TIPS: A Retrospective Study**

Xingpeng Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the clinical value of spectral CT monochromatic imaging with metal artifact reductions in assessment of stent lumen in portal venography after transjugular intrahepatic portosystemic shunt (TIPS).

#### **METHODS AND MATERIALS**

Twenty-seven patients with TIPS for portal hypertension were performed spectral CT portal venography (CTPV) in our study. All raw data were reconstructed as 120 kVp-like imaging, and 6 groups of monochromatic imaging from 45 keV to 70 keV with 5 keV as an interval, respectively. Four slices CTPV images were evaluated, including main portal vein, proximal, middle and distant level of stent. Objective indexes for portal vein and stent included artifact index (AI), signal intensity (SI), standard deviation (SD), signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). Subjective indexes were assessed by two radiologists with 5-point scale separately. Patients with portal vein thromboses were recorded, and statistical analyses were analyzed.

#### **RESULTS**

According to Child-Pugh staging in all 27 patients, 3 were classified into grade A, 14 were grade B, and 10 were grade C. For objective indexes in portal vein and stent lumen, all SI, SNR and CNR decreased with the increase of keV (all  $P < 0.01$ ), and 45 keV demonstrates the highest SI, SD, SNR and CNR. The enhancement of portal vein and stent lumen were higher than 200 HU only in 45, 50, 55 and 60 keV, and there is no statistical significance for all indexes between 70 keV and 120 kVp-like group (all  $P > 0.05$ ). With MARs technique, AI decreased significantly for all 45 to 70 keV images. For subjective indexes, 60 keV group manifested best image quality scores and diagnostic confidence among all 7 groups. 1 stent thrombosis was detected in TIPS stent by CTPV, including 7 patients with portal vein cavernous transformation.

#### **CONCLUSION**

Combined with subjective and objective assessments of image quality, spectral CT monochromatic imaging at 60 keV with MARs technique increased SI, SNR, CNR in assessment of TIPS stent lumen and portal vein for liver cirrhosis, which is feasible in evaluation of stent lumen and portal vein after TIPS.

#### **CLINICAL RELEVANCE/APPLICATION**

Spectral CT monochromatic imaging at 60 keV with MARs technique demonstrated feasibility in evaluation of stent lumen and portal vein after TIPS.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-SPBR

### Breast Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPBR- Performance of an Artificial Intelligence System on Screening Breast Tomosynthesis Cases** **1**

Roger S. Yang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the performance of artificial intelligence (AI) on screening tomosynthesis mammograms

#### **METHODS AND MATERIALS**

This retrospective study included 28,278 DBT screening exams and the subsequent BIRADS 0 workups, consecutively collected from February to July 2022 from multiple outpatient imaging centers within a private practice. The screening exams (Hologic) were evaluated by 36 MQSA radiologists and scored according to the Breast Imaging Reporting and Data Classification System (BIRADS). BIRADS 0 cases were recalled for additional evaluation and potential biopsy. All DBT screening exams were analyzed by an AI system (Transpara 1.7.1, ScreenPoint Medical), which assigned an exam score between 1-10 indicating an increasing likelihood of malignancy. The positive predictive value (PPV) of radiologists and the performance of the AI system were evaluated.

#### **RESULTS**

Out of 28,278 screening exams, 4170 exams were labeled as BIRADS 0, resulting in a recall rate of 14.75%. Of the 4,170 patients recalled, 3,531 returned to one of our facilities for diagnostic imaging. There were 581 diagnostic exams labeled as BIRADS 4-5 and recommended for biopsy. Biopsy results were available for 335 cases at the time of analysis, revealing 70 biopsy-proven cancers. A BIRADS-0 rating corresponded to a PPV of 3.4%. A BIRADS 4-5 rating based on DBT and subsequent workup yielded a PPV of 20.9%. AI identified 92.9% of cancers (65/70) with an exam score between 8 and 10, 84.3% of cancers (59/70) were flagged with the highest AI score of 10.

#### **CONCLUSION**

AI score 8-10 has a strong predictive value for cancer. This system can be used to aid radiologists when evaluating screening mammograms.

#### **CLINICAL RELEVANCE/APPLICATION**

An AI tool that reliably indicates the probability of malignancy on the initial mammogram could serve as clinical decision support reducing biopsy and recall rates and increasing cancer detection rates.

#### **S3A-SPBR- Improving Video-Based Ultrasound Diagnostic Performance for Breast Cancer to Expert-** **2 Level Using Deep Learning: A Retrospective, Multicenter, Diagnostic Study**

Fajin Dong JR, MD,MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

we aim to propose and validate a new automated deep learning framework based on standard video recordings of ultrasound examination.

#### **METHODS AND MATERIALS**

We designed a video-based framework for breast screening cineclips and integrated three classic AI models, DenseNet121, MobileNet, and Xception as backbones. For comparison, image-based framework is also constructed using the same three backbones with physician selected images, since image-based diagnosis is the current standard practice. In total, 3907 patients from two major medical centers were enrolled between July 2015 and January 2022. Both images and videos of the

patients are utilized to train and evaluate models, including retrospective real-world data and prospective test data. Cineclip model tests, image model tests, and reader studies with human experts are performed on both retrospective and prospective data.

## RESULTS

The accuracy of cineclip models is 87.40 to 92.59%, exceeding the accuracy of 76.00 to 85.60% achieved by all physicians with 7 to 10 years of experience in reader studies. In both real-world and prospective tests, cineclip models surpass image models among all evaluation metrics, including accuracy (87.40-92.59% vs. 80.80-85.83%), sensitivity (86.00-93.33% vs. 80.00-91.07%), specificity (83.10-92.00% vs. 78.87-86.67%), F1 (0.876-0.927 vs. 0.807-0.861) and AUROC (Area under Receiver Operating Characteristic Curve, 0.926-0.962 vs. 0.843-0.936). The difference in AUROC between cineclip models and image models with DenseNet121 and Xception backbone is statistically significant in real-world test under significance level ( $p=0.049$  for DenseNet backbone, and  $p=0.008$  for Xception backbone).

## CONCLUSION

Cineclip models can achieve higher accuracy along with better robustness than image-based models, outperforming human experts. Our video-based AI framework might better aid breast cancer diagnosis and alleviate the scarcity of experienced physicians.

## CLINICAL RELEVANCE/APPLICATION

Ultrasound is one of the most widely used methods for breast cancer screening. However, its popularity is prohibited by its high operator dependence and the scarcity of skilled ultrasound specialists. This study can reduce the skill requirement and inter-operator variations.

## S3A-SPBR-3 Deep Learning-Based MRI Model to Predict Pathologic Complete Response After Neoadjuvant Chemotherapy in HER2-Positive and Triple-Negative Breast Cancer

Sooyeon Kim, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

There are limited studies on the prediction of pathologic complete response (pCR) after neoadjuvant chemotherapy (NAC) using deep learning technique. We aimed to develop a deep learning-based MRI model to predict pCR in women with human epidermal growth factor receptor 2 (HER2)-positive or triple-negative breast cancers.

## METHODS AND MATERIALS

In this IRB-approved single center retrospective study, a total of 852 women (mean age $\pm$ standard deviation, 51 $\pm$ 10 years old) with HER2-positive or triple negative breast cancer who underwent NAC followed by surgery between 2017 and 2021 were included. They were divided into a training set ( $n=724$ ) and a validation set ( $n=128$ ) in a ratio of 8.5:1.5. Post-NAC dynamic contrast-enhanced (DCE)-MRI data (subtraction images of the 1st, 3rd, and 5th dynamic phase) and clinical data (age, clinical T stage, clinical N stage, estrogen receptor, progesterone receptor, HER2, Ki-67, histologic grade, histologic type, and initial MRI size) were collected. pCR was defined as the absence of both invasive and in-situ residuals in the breast in the surgical specimen. For each woman, tumor bed or residual enhancing lesions on post-NAC MRI were annotated using the three rectangular region-of-interests for the initial, intermediate (center), and endpoints, respectively. After pre-processing, the deep learning models were developed using 3D ResNet 50 architecture, 5-fold cross validation, and Python 3.6. Clinical data model, each phase model of DCE-MRI, and the combined model were developed, and each performance was evaluated using an area under the receiver operating characteristics curve (AUC). DeLong method was used to compare AUCs.

## RESULTS

The AUCs of the 1st, 3rd, and 5th dynamic MRI model were 0.63, 0.70, and 0.67, respectively. Compared to the 3rd dynamic MRI model with the highest AUC value of 0.70, the combined MRI model obtained from all dynamic images showed a lower AUC value of 0.66 albeit without statistical significance (0.70 vs 0.66,  $P=0.09$ ). The AUC of the clinical data model was 0.57. The combined model of the clinical data and all dynamic MR images showed an AUC value of 0.65, which was significantly lower than that of the 3rd dynamic MRI model (0.65 vs 0.70,  $P=0.02$ ).

## CONCLUSION

The deep learning model based on the 3<sup>rd</sup> dynamic phase of DCE-MRI showed the best performance in predicting pCR in women with HER2-positive or triple-negative breast cancers.

## CLINICAL RELEVANCE/APPLICATION

Our deep-learning based MRI model demonstrates the potential to predict pCR in women with HER2-positive or triple-negative breast cancer. This information, after careful validation in further studies, can be utilized in a prospective trial to omit breast cancer surgery for women with a high possibility of pCR.

Yi Dai, MD, PhD (*Presenter*) Nothing to Disclose

## **S3A-SPBR- 4 Combining with Convolution Neural Network and Graph Convolution Network for Predicting Axillary Lymph Node Metastasis in Breast Cancer Based on DCE-MRI: A Multicenter Study**

### **PURPOSE**

This study aims to develop a deep learning model combining convolution neural network (CNN) and graph convolution network (GCN) based on dynamic contrast-enhanced (DCE)-MRI for predicting axillary nodal status in breast cancer as well as to explore the biological mechanism by employing gene analysis of RNA-sequencing data.

### **METHODS AND MATERIALS**

A total of 935 patients with breast cancer who underwent preoperative DCE-MRI from four institutes were retrospectively analyzed. 742, 83 and 110 patients were grouped into the training, internal test and independent external test sets, respectively. The regions of interest of the breast lesions were cropped manually by two radiologists. Three conventional CNNs, namely, 3D ResNet, 3D-Xception and HRNet (high-resolution Net) were used as the backbone architecture for axillary lymph node (ALN) metastasis identification based on the tumor, ALN, and combined tumor-ALN regions on the images. The feature maps obtained by CNNs are globally pooled and fused with the spatial structure features obtained by high resolution GCN. RNA-sequencing data from 11 patients were used to explore the underlying biological basis of the AI prediction. To select the most powerful CNN or CNN-GCN model for ALN-metastasis prediction, the performance of three CNN models and three CNN-GCN models was compared with area under the receiver operating characteristic (ROC) curve (AUC), accuracy, sensitivity and specificity. The performance of these models was compared with radiomics models, the Memorial Sloan-Kettering Cancer Center (MSKCC) model, and three radiologists.

### **RESULTS**

The optimal HRNet-GCN\_tumor+ALN model, achieved an AUC of 0.873 in the internal test cohort, as well as an AUC of 0.870 in the external test cohort, which was better than the best performing radiomics model (logistic regression, AUC: 0.790) and MSKCC model (AUC: 0.752). Additionally, with the assistance of HRNet-GCN\_tumor+ALN, the radiologists' performance was improved (external test cohort,  $P < 0.05$ ). In the biological basis exploration, the high-risk group was associated with the downregulation of pathways mediating tumor proliferation and the promotion of anti-tumor immune cell infiltration in the microenvironment.

### **CONCLUSION**

The proposed GCN-CNN fusion deep learning model could effectively predict ALN status preoperatively in breast cancer patients.

### **CLINICAL RELEVANCE/APPLICATION**

This study successfully demonstrated a CNN-GCN model base on DCE-MRI, which could non-invasively and preoperatively predict ALN metastasis of breast cancer with high accuracy. This model may assist and guide for radiologists to make more precise evaluation of ALN status.

## **S3A-SPBR- 5 Patient Race Impacts the Screening Mammogram False Positive Rate of a Commercially Available AI Algorithm**

Derek L. Nguyen, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To evaluate a commercially available AI algorithm's ability to accurately interpret negative screening mammograms and the impact of patient demographics on its performance.

### **METHODS AND MATERIALS**

This retrospective cohort study identified 27,681 negative screening tomosynthesis mammograms from our academic institution from 1/1/16 to 12/31/19. All patients had two years of follow up without a diagnosis of atypia or malignancy. Patients with prior breast surgery or implant augmentation were excluded. A subset of unique patients was randomly selected to provide a broad distribution of race/ethnicity. This final cohort was interpreted by an FDA approved, commercially available AI algorithm (ProFound AI 3.0, iCAD, Inc) which was trained prior to the study using an enriched multi-vendor screening population dataset from at least 20 institutions. The algorithm generated case and risk scores for each mammogram. Per vendor, case scores  $> 49$  (range 0-100) have a high certainty for malignancy and risk scores  $> 0.8$  (range 0-1) are at high-risk for developing a malignancy on the subsequent screening mammogram (1-year cancer risk). Patient demographics (age, race/ethnicity, and breast density) were compared with case and risk scores using bivariate and multivariate logistic regression.

### **RESULTS**

4855 unique patients (median age: 54 years [46-63]) were included. The false positive rate for case and risk scores was 17% (816/4855) and 5% (240/4855), respectively. Every patient demographic was significantly associated with patients' case and risk scores on bivariate analysis,  $p < 0.001$ . On multivariate analysis, Black patients were significantly more likely (OR: 1.45,

95% CI 1.19-1.77) to have case scores > 49 compared to White patients. Asian patients were significantly less likely (OR: 0.68, 95% CI 0.54-0.86) to have case scores > 49 when compared to White patients. Breast density did not influence case scores after adjusting for age and race. On multivariate analysis, only Black patients were significantly more likely (OR: 1.46, 95% CI 1.05-2.03) to have risk scores > 0.8 compared to White patients. Increased breast density was associated with risk scores > 0.8 (fatty - reference; scattered - OR: 1.99, 95% CI 1.33-3.05; heterogeneous - OR: 2.00, 95% CI 1.25-3.55; extremely - OR: 2.80, 95% CI 1.26-5.84).

## **CONCLUSION**

Patient race influenced the performance of a commercially available AI algorithm analyzing negative screening mammograms. False positive rates for suspicious case and risk scores were 17% and 5%, respectively.

## **CLINICAL RELEVANCE/APPLICATION**

Radiologists should be aware that the performance of FDA approved, commercially available AI software will vary by patient demographics and efforts to train on diverse datasets are needed.

## **S3A-SPBR- AI for Diffusion-Weighted Breast MRI**

6

Dimitrios Bounias, MSc (*Presenter*) Nothing to Disclose

## **PURPOSE**

Diffusion-weighted imaging (DWI) is a rapidly emerging MRI technique in oncologic breast imaging that requires no contrast agent administration, rendering it an attractive potential future supplement or even alternative to mammography and dynamic contrast-enhanced MRI. Artificial intelligence (AI) has the potential to assist radiological decisions on this emerging MR technique, facilitating a quicker adoption into clinical routine. In this work, we utilized nnDetection, a state-of-the-art self-configuring Retina U-Net based object detection model, with certain breast cancer-specific extensions to create a robust model trained on a large dataset of unenhanced breast MRI acquisitions.

## **METHODS AND MATERIALS**

The IRB approved study included n=818 patients. Histopathologically proven malignant lesions accounted for n=618 lesions in n=268 patients. All patients underwent a clinically indicated multiparametric breast 3T MRI examination, including a multi-b-value DWI acquisition (50,750,1500). The nnDetection AI model was trained with the following extensions: (i) Apparent Diffusion Coefficient (ADC) as additional input, (ii) random bias field, random spike, and random ghosting augmentations, (iii) a size-balanced data loader to ensure that the fewer large lesions were given an equal chance to be picked in a mini-batch and (iv) replacement of the loss function with a size-adjusted focal loss, that increases as false positive predictions get smaller or as true positive predictions get larger. This adapted loss function prioritizes finding the primary lesion while disincentivizing small indeterminate false positives. The Area Under the Receiver Operating Characteristic (AUROC) was used as the metric for patient-level performance in 5-fold cross-validation.

## **RESULTS**

The nnDetection AI model was able to achieve an AUROC of 0.88 using only the abbreviated unenhanced DWI MRI acquisition, and compares favorably against multireader performance metrics reported for mammography ((i)0.81, (ii) 0.87, (iii) 0.81). The model was also able to achieve 0.70 FROC (Free-response Receiver Operating Characteristic) for primary lesions, indicating a relevant localization ability.

## **CONCLUSION**

This study shows that AI has the ability to complement the assessment of breast MRI in abbreviated unenhanced examinations based on DWI, even before radiologists are involved in the diagnostic process.

## **CLINICAL RELEVANCE/APPLICATION**

This work supports personalization in breast cancer screening by enabling radiologists to use advanced imaging techniques such as abbreviated diffusion-weighted imaging (DWI), potentially supplementing the diagnostic toolbox.

## **S3A-SPBR- Risk-aware AI for Lesion Detection and Characterization in Breast MRI**

7

Dimitrios Bounias, MSc (*Presenter*) Nothing to Disclose

## **PURPOSE**

AI methods for medical object detection revolve around discovering and rating structures of potential relevance to the patient. Performance is commonly calculated with Free-response Receiver Operating Characteristic (FROC) analysis, which calculates sensitivity at predefined thresholds of false positives (FPs) per case. FROC weighs all lesions equally, but in practice not all lesions might be considered as having identical instantaneous impact for the further clinical pathway of a patient, revealing a risk imbalance. Here we describe the development and evaluation of such a risk-aware model for breast cancer using diffusion-weighted imaging (DWI) MR acquisitions.



## **METHODS AND MATERIALS**

For this IRB approved study we used a dataset with n=818 women undergoing clinically indicated 3T breast MRI including multi-b-value DWI (50,750,1500), containing n=618 histopathologically verified malignant lesions in n=268 patients. The risk function was calculated using reported 15-year breast cancer mortality based on lesion size, from a multi-year study involving n=819,647 patients from Sopik et al, 2018. A risk-adjusted adaptation of FROC (raFROC) is proposed, where true positive predictions and ground truth samples are weighted by the associated risk. FPs are weighted by 1-risk, due to the desire to minimize unneeded biopsies and the lower value of low risk lesions. To accommodate for the metric, we also propose a risk-adjusted focal loss (raFocal) that applies similar weighting. A focal loss and a raFocal model were trained using 5-fold cross validation. Evaluation took place using traditional methods and raFROC.

## **RESULTS**

The risk-aware (raFocal) model improved both the AUROC (Area Under the Receiver Operating Characteristic curve) and AP (Average Precision) patient-level performance (AUROC/AP 0.86/0.77) compared to the standard "focal" model (0.84/0.70). The proposed raFROC portrays a difference (focal 0.60, raFocal 0.65) between the models across all FP thresholds, being able to better mirror patient-level improvement. In contrast, a lesser difference was present for regular FROC (focal 0.50, raFocal 0.52), appearing only in lower thresholds.

## **CONCLUSION**

This work showcases a first step for risk-aware AI model training and validation in medical object detection. Accounting for clinical risk and outcome is very important in medical diagnosis, as it allows balancing the trade off between FP findings and missing pathologies, significantly influencing the clinical outcome of the individual patient.

## **CLINICAL RELEVANCE/APPLICATION**

This work showcases how to incorporate risk into the training and evaluation of object detection models for breast cancer screening, which previously considered all lesions equal, bringing AI closer to clinical needs.

## **S3A-SPBR- Chat GPT: How Far Has It Gone Yet?**

8

Marcela C. Lauer, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Chat GPT is an artificial intelligence (AI) language model trained on a dataset of human language, making it capable of understanding and generating complex sentences and paragraphs, including medical literature. The objective of this study is to analyze Chat GPT's accuracy and reproducibility in answering questions about breast radiology.

## **METHODS AND MATERIALS**

Questions were gathered from nationally regarded professional societies, as well as elaborated from breast radiologists with over 15 years of experience. We formulated 10 questions that were answered by medical residents (12 from the 1st/2nd year and 12 from the 3rd/4th year) and 12 professionals specialized in breast imaging. All questions had only one correct answer. The alternatives included the options of "more than one alternative is correct" and "all alternatives are incorrect", for the cases in which Chat GPT could not provide one correct answer for the question. Reproducibility was determined by asking the model each question ten times from at least 5 different devices in at least 3 different locations.

## **RESULTS**

The mean average of the residents in the 1st and 2nd years was 40% of correct answers, for 3rd and 4th years residents it was 60%, for breast imaging specialists it was 80% and the average of correct responses by Chat GPT-4 was 45%, and varied from 30% to 60% correct answers. Chat-GPT did not demonstrate an increasing or decreasing pattern of number of correct answers thought time that would allow us to infer that it was learning through the questions. Concerning reproducibility, Chat GPT answered the same item in all 10 attempts for only 4 questions.

## **CONCLUSION**

ChatGPT could provide accurate responses in 45% of questions related to breast imaging, which is more than a 1st or 2nd year radiology resident but less than a 3rd or 4th year resident. Although it is expected that it will evolve over time, we could not state that in our study. We encourage future studies to further examine how trustworthy are the information provide by it and to analyse if this technology will continue evolving over time, as we hope this technology may improve education for medical doctors, and even patient's outcomes and quality of life.

## **CLINICAL RELEVANCE/APPLICATION**



ChatGPT is an AI language model launched in November 2022, trained on a dataset covering a broad range of topics, including the medical literature. Discussion regarding the potential of ChatGPT to in all fields of academia is ongoing, and its applicability is under investigation. Although there is one study that tests how Chat GPT would answer questions about screening breast cancer recommendations (Haver et. al), there are currently no studies examining Chat GPT's applicability as a learning tool for professionals consult.

### **S3A-SPBR- Preliminary Interim Analysis of AI-STREAM (Artificial Intelligence for Breast Cancer Screening in Mammography): A Prospective Multicenter Study Design in Korea Using AI-based CADe/x**

Yun Woo Chang, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study is to compare the diagnostic accuracy of radiologists with and without the use of AI-based CADe/x in mammography reading for breast cancer screening of Korean women with average breast cancer risk.

#### **METHODS AND MATERIALS**

Total of 24,601 participants were enrolled between February 2021 and December 2022 at six study sites in Korea. The mammograms were read by breast imaging radiologist (BR) without using AI-based CADe/x through single reading, and results were recorded on the study platform (BEST image). Then, the radiologists reviewed the mammograms with the assistance of AI-based CADe/x and recorded the results on the study platform based on the radiologist's decision after considering both with and without AI-based CADe/x. These BR were experts in breast imaging at an academic hospital for over ten years. If a recall was required, further diagnostic workup was conducted to confirm the cancer detected on screening. In the simulation study, the same participants' mammograms were read by general radiologists (GR) in the same setting of the reading process, without and with use of AI-based CADe/x. GR are radiologists not specializing in breast imaging. The diagnostic accuracy of GR and BR, with or without the use of AI-based CADe/x was compared with AI-based CADe/x for mammography reading for breast cancer screening.

#### **RESULTS**

By the end of patient enrollment, breast cancer was confirmed in 131 patients. GR without AI found 86 cancers, GR with AI found 110 cancers, BR without AI found 110 cancers, and BR with AI found 124 cancers. When a 10% cutoff was applied to AI, it detected 118 cancers. Stand-alone AI-based CADe/x detected significantly higher cancer detection than GR without AI. AI detected slightly more cancer than BR without AI or GR with AI, but there was no statistical significance. BR with AI had the highest cancer detection rate compared with AI stand-alone, BR without AI, or GR with AI, but there was no statistical significance. There was no difference between GR and AI in the recall, but recall in BR was significantly lower.

#### **CONCLUSION**

AI-based CAD e/x could be helpful for radiologists with less experience in mammography reading. BR with AI had the highest accuracy in cancer detection and a lower recall rate compared with other situations. This is a preliminary interim analysis of the prospective study as cancer registry data will be available at least 26 months after the year of interest.

#### **CLINICAL RELEVANCE/APPLICATION**

This prospective multicenter cohort study aims to generate real-world evidence to compare the diagnostic accuracy of radiologists with and without AI-based CADe/x in mammography reading for breast cancer screening.

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## Abstract Archives of the RSNA, 2023

S3A-SPCA

### Cardiac Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPCA- Total Cardiac Volume Segmentation Model for Pediatric Heart Transplant Donors and Patients using Transfer Learning** 1

Elanchezhian Somasundaram, PhD, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop an optimized model to predict total cardiac volumes (TCV) in donors and pediatric heart transplant patients using transfer learning techniques on pretrained models predicting individual heart segments.

#### **METHODS AND MATERIALS**

An internal, clinical chest computed tomography (CT) dataset (n=275), consisting of non-contrast and contrast-enhanced exams, was included for the study. 251 exams were used for model training while 27 were retained for model testing. TCV was segmented as part of clinical workflow using Mimics (Materialize NV, Leuven, Belgium). Additionally, heart chamber segments from a large public dataset (n= 866) curated by the University Hospital Radiology Department (Basel, Switzerland) was included for transfer learning. A dynamic U-net (DynUNET) architecture within the MONAI framework was first pre-trained on the public dataset for 100 epochs, using a 0.8/0.2 split for training/validation respectively, and then trained on the internal TCV dataset. Another DynUNET model was trained only on the internal TCV dataset. Experiment tracking and hyperparameter search tools were used to find the training parameters that produced the best validation dice score. Both models were tested on the internal test dataset (n=27) as well as 20 adult, chest CT scans from multiple institutions, shared by UNOS (United Network for Organ Sharing) through a formal research agreement. UNOS exams were segmented for TCV using 3D Slicer. Relative volume error (RVE) and Dice coefficients (DSC) were calculated for model performance evaluation and comparison.

#### **RESULTS**

The most optimal DynUNET model trained with pre-trained weights had an initial learning rate of 0.0005 with an exponential learning rate scheduler and an Adam optimizer. The mean ( $\pm$  standard deviation) RVE and DSC was 3.3 ( $\pm$  3.0%) and 0.95 ( $\pm$  0.02) respectively for the internal dataset and 6.9 ( $\pm$  10%) and 0.90 ( $\pm$  0.10) respectively for the UNOS dataset. The most optimal DynUNET model trained only on the internal TCV dataset had an initial learning rate of 0.003 using a cosine learning rate scheduler and Adam optimizer. The mean ( $\pm$  standard deviation) RVE and DSC was 5.3 ( $\pm$  5.5%) and 0.93 ( $\pm$  0.02) respectively for the internal dataset and 11 ( $\pm$  16%) and 0.87 ( $\pm$  0.15) for the UNOS dataset.

#### **CONCLUSION**

Transfer learning using pre-trained weights from a large public dataset improved model performance for prediction of TCV in an internal clinical dataset as well as a set from UNOS, where exams span various institutions, scanner manufacturers, and protocols.

#### **CLINICAL RELEVANCE/APPLICATION**

Total cardiac volume (TCV) is an important metric for recipient-donor organ matching for organ transplantation. A clinically deployable, optimized deep learning TCV segmentation model is useful for such organ size matching.

#### **S3A-SPCA- Comparison of Prognostic Value Between CAD-RADS 1.0 and CAD-RADS 2.0 Evaluated by Convolutional Neural Networks Based CCTA** 2

Zengfa Huang (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of the present study was to investigate the prognostic value of the novel coronary artery disease reporting and data system (CAD-RADS) 2.0 compared with CAD-RADS 1.0 in patients with suspected CAD evaluated by convolutional neural networks (CNN) based coronary computed tomography angiography (CCTA).

## METHODS AND MATERIALS

A total of 2131 consecutive inpatients with suspected CAD were evaluated by CCTA for CAD-RADS 1.0 and CAD-RADS 2.0 classifications. Kaplan-Meier and multivariate Cox models were used to estimate major adverse cardiovascular events (MACE) inclusive of all-cause mortality or myocardial infarction (MI). The C-statistic was used to assess the discriminatory ability of the two classifications.

## RESULTS

In total, 94 (5.2%) MACE occurred over the median follow-up of 45.25 months (interquartile range 43.53 to 46.63 months). The annualized MACE rate was 0.014 (95% CI: 0.011-0.017). Kaplan-Meier survival curves indicated that the Coronary Artery Disease Reporting and Data System (CAD-RADS) classification, segment involvement score (SIS) grade, and Computed Tomography Fractional Flow Reserve (CT-FFR) classification were all significantly associated with the increase in the cumulative MACE (all  $P < 0.001$ ). CAD-RADS classification, SIS grade, and CT-FFR classification were significantly associated with endpoint in univariate and multivariate Cox analysis. CAD-RADS 2.0 showed a further incremental increase in the prognostic value in predicting MACE (c-statistic 0.702, 95% CI: 0.641-0.763,  $P = 0.047$ ), compared with CAD-RADS 1.0.

## CONCLUSION

The novel CAD-RADS 2.0 evaluated by CNN-based CCTA showed higher prognostic value of MACE than CAD-RADS 1.0 in patients with suspected CAD.

## CLINICAL RELEVANCE/APPLICATION

The novel CAD-RADS 2.0 evaluated by CNN-based CCTA showed good performance for predicting major adverse cardiac events (MACE) in patients with suspected CAD and may serve as a non-invasive imaging marker for risk stratification in future clinical practice.

## S3A-SPCA- 3 **Diagnostic Utility of Artificial Intelligence in Detecting Coronary Artery Disease on CT Coronary Calcium Score Using Manual Calcium Scoring as Reference Standard- A Meta-Analysis**

Sarah Agnes Mary R. Lim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The amount of coronary artery calcification is said to be a strong and independent predictor of coronary heart disease events. Calcium scoring is a non-invasive procedure wherein calcifications within the coronary arteries are quantified and this is interpreted by trained radiologists. However, this is known to be tedious and time-consuming. Artificial intelligence (AI) is now being used as an adjunct tool in cardiovascular imaging. "Machine learning or deep-learning algorithm is a subset of AI that utilizes algorithms to combine voluminous data comprising clinical information and coronary anatomical variables for optimal prediction of major adverse cardiac events" (Wang, 2019). The aim of this study is to determine the accuracy of AI in detecting coronary artery disease on CT coronary calcium score using manual counting as reference standard.

## METHODS AND MATERIALS

We searched PUBMED, Google Scholar for studies on AI in detecting CT coronary calcium using manual counting as the reference standard. Pooled sensitivity, specificity, positive and negative likelihood ratios were calculated. Two investigators (ISB and SRL) independently extracted the data.

## RESULTS

Out of 45 articles, three (3) were included in the study. A total of 769 calcium score procedures were included in the analysis. Overall pooled sensitivity of 0.952 (CI=95%, 0.926-0.970), pooled specificity of 0.949 (CI=95%, 0.921-0.970), positive likelihood ratio of 12.1 (CI=95%, 2.304-63.636) and negative likelihood ratio of 0.055 (CI=95%, 0.036-0.084).

## CONCLUSION

Deep learning A.I. on coronary artery calcium score can be used to detect coronary artery disease. Further study to compare utility of machine learning with deep learning using manual counting as reference standard.

## CLINICAL RELEVANCE/APPLICATION

Artificial intelligence is now used in a myriad of applications not only in medicine but also in daily life. AI has a potential to improve the workflow in radiology through automation of CT coronary calcium score determination, a task which is known to

be time-consuming. If A.I. may be used in the clinical setting, more people may be screened for coronary artery disease in a given amount of time. This may also help in improving the efficiency of radiologists.

#### **S3A-SPCA- Accuracy of Machine Learning Algorithms for Calcium Scores on Chest Computed 4 Tomography: A Systematic Review and Meta-analysis**

Pedro A. Pereira, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the diagnostic accuracy of artificial intelligence (AI) algorithms for quantifying coronary artery calcium (CAC) on chest computed tomography (CT) images.

##### **METHODS AND MATERIALS**

PubMed, EMBASE, and Cochrane Central databases were systematically searched for studies published up to April 1st. Studies were included if they compared ML-derived calcium score categories (Agatston score) with expert manual analysis in gated and non-gated studies. The main outcome was the percentage of agreement between automatic and manual analyses of the Agatston score categories. We also calculated the rates of the underestimated and overestimated categories using automatic analysis. Heterogeneity was examined using I<sup>2</sup> statistics. A random effects model was used to perform the meta-analysis. The study protocol was registered a priori in the International Prospective Register of Systematic Reviews (Prospero Protocol CRD42023407318).

##### **RESULTS**

A total of 23 studies comprising 9788 subjects with gated CT and 4967 with non-gated CT were included. The mean age of the sample was 58.9 years. The percentage of Agatston score agreement between automatic and manual analyses for gated studies was 93.1% (95% CI, 90.8-94.8%). Automatic analysis overestimated the Agatston category by 4.2% (95% CI, 2.8-6.2%) and underestimated it by 2.3% (95% CI, 1.8-2.9%). The percentage agreement for non-gated studies was 79.8% (95%CI, 68.0-88.0%). Automatic models overestimated or underestimated the Agatston category by 10% (95%CI, 4.7-20.0%) and 5% (95%CI, 2.1-11.1%), respectively. Significant heterogeneity was observed in the analyzed outcomes (I<sup>2</sup> >50%).

##### **CONCLUSION**

Our findings demonstrate a high degree of agreement in calcium score analysis using machine learning algorithms, particularly in gated studies.

##### **CLINICAL RELEVANCE/APPLICATION**

The use of AI algorithms could improve CT interpretation workflow, offering automatic quantification coronary calcium with high accuracy to both cardiac-gated and non-cardiac-gated chest CTs.

#### **S3A-SPCA- Deep Learning-Based Measurement of Left Atrial Volume on Calcium Scoring CT: 5 Observations in the Dallas Heart Study**

Fernando U. Kay, MD, PhD (*Presenter*) Research Grant, Edwards Lifesciences Corporation

##### **PURPOSE**

Coronary calcium scoring CT (CAC-CT) imaging data is currently underutilized. Left atrial (LA) enlargement is associated with atrial arrhythmias and stroke. In this study, we aimed to evaluate the accuracy of an AI-based segmentation algorithm for estimating LA volumes on CAC-CT and compare the results with other clinical variables in the Dallas Heart Study phase 2 (DHS2).

##### **METHODS AND MATERIALS**

Participants with both CAC-CT and cardiac MRI (CMRI) were eligible for inclusion. We developed a 3D Unet Deep Learning model using a semi-supervised approach with nested cross-validation. A cardiac imager created reference cardiac chamber segmentation on CAC-CT for 70 randomly selected participants, using epicardial margins. This initial model generated synthetic segmentations in 1,931 additional scans, which were utilized for model refinement. LA volume was derived using Pyradiomics. In 749 participants, maximum LA volume was independently assessed on CMRI via the biplane method. Clinical variables were collected for analysis. We included a subset of 735 participants without prior events for a Kaplan-Meier analysis of incident atrial fibrillation, stroke, or transient ischemic attack.

##### **RESULTS**

The segmentation model achieved a Dice score of  $0.93 \pm 0.01$  (mean  $\pm$  SD) when compared to manual segmentation. The cohort consisted of 445 females and 304 males with a median age of 50 years (IQR: 43 - 57). The intraclass correlation coefficient between CAC-CT-derived LA volume and maximum LA volume on CMRI was 0.67 (95% CI: 0.63 - 0.71). CAC-CT LA volume had an AUC curve of 0.82 (95% CI: 0.78 - 0.86) for detecting participants in the 4th quartile of maximum LA volume on CMRI. In multivariable linear analysis, CAC-CT LA volume indexed to BSA was significantly associated with male

sex (Beta coefficient: 1.6\*\*), age (0.3\*\*\*), smoking habit (-0.7\*), and hypertension (2.9\*\*\*) (P: \* $<0.1$ , \*\* $<0.05$ , \*\*\* $<0.01$ ). The 4th percentile of indexed LA volume on CAC-CT was associated with incident composite events (N = 15) during follow-up when compared to the 1st-3rd percentiles (P = 0.01).

## CONCLUSION

We developed a segmentation model capable of extracting LA volume from CAC-CT, demonstrating moderate correlation with LA maximum values derived from CMRI. This CAC-CT biomarker was significantly associated with clinical variables, including incident atrial fibrillation and cerebrovascular events in the DHS2.

## CLINICAL RELEVANCE/APPLICATION

AI-derived segmentation algorithms have the potential to enhance the extraction of LA volume from CAC-CT, enabling more comprehensive risk stratification beyond traditional calcium scoring.

## S3A-SPCA- 7 Right Ventricular Strain and Abnormal Muscle Formation on Cardiac CT: To Identify Pulmonary Hypertension in Repaired Tetralogy of Fallot

Yamato Shimomiya (*Presenter*) Employee, Ziosoft, Inc

## PURPOSE

In the long-term period of repaired tetralogy of Fallot (TOF), right ventricular (RV) volume augmentation due to pulmonary regurgitation is frequent, and right heart failure due to its aggravation is prognostic. Transcatheter pulmonary valve implantation (TPVI) is becoming increasingly popular as a minimally invasive treatment, but it must be carefully indicated in cases of RV pressure overload. We used multi-phase cardiac CT to assess RV volumetry, strain, and morphology to identify pulmonary hypertension in patients with repaired TOF scheduled for TPVI.

## METHODS AND MATERIALS

Forty-four patients with repaired TOF scheduled for TPVI were enrolled to undergo cardiac CT, MRI, and right heart catheterization. Pulmonary hypertension (PH) was defined as a mean pulmonary artery pressure of 25 mmHg or greater by right heart catheterization. CT-RV strain was calculated using ECG-gated CT data with motion coherence image processing. The association of PH with RV strain and abnormal muscle bundles in the right ventricular outflow tract on cardiac CT was evaluated. Additionally, RV volumetry was compared between cardiac cine MRI and CT.

## RESULTS

Eleven of the 44 patients had PH. CT-RV strain was significantly lower patients with PH than those without PH ( $-8.7 \pm 1.6$  % vs.  $-11.3 \pm 2.33$  %;  $p < 0.001$ ). Receiver-operating-characteristic curve analysis revealed that with optimal RV strain  $-10.4$  %, patients with PH can be diagnosed with an area under the curve 0.97, sensitivity 100%, and specificity 89%. The frequency of formation of abnormal muscle bundles in the RV outflow tract was significantly greater in patients with PH (7/11, 64%) than in patients without PH (11/33, 35%). RV volumes calculated from CT and MRI showed a strong positive correlation, but CT tended to increase volume more than MRI (RV-EDVi: CT vs. MRI,  $176.2 \pm 47.9$  ml/m<sup>2</sup> vs.  $147.0 \pm 42.1$  ml/m<sup>2</sup>; Pearson  $r = 0.90$ ; RV-ESVi: CT vs. MR:  $98.7 \pm 36.9$  ml/m<sup>2</sup> vs.  $79.8 \pm 28.4$  ml/m<sup>2</sup>; Pearson  $r = 0.91$ ).

## CONCLUSION

The reduction of RV strain and the presence of abnormal muscle bundles in the RV outflow tract obtained from multi-phase CT indicate PH in repaired TOF and should make one cautious about the indication for TPVI.

## CLINICAL RELEVANCE/APPLICATION

Cardiac CT provides not only accurate anatomical information from the RV to the pulmonary artery, but also noninvasive evaluation of pulmonary hypertension.

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## Abstract Archives of the RSNA, 2023

S3A-SPCH

### Chest Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPCH- Assessment of Solitary Pulmonary Nodules Using Dual-layer Spectral Detector Computed Tomography** **1**

Ko Tsepang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

With lung cancer being the most common malignancy diagnosed worldwide, differentiating between malignant solitary pulmonary nodules (SPNs) and other lung diseases remained a substantial challenge. The aim of this study was to examine the usefulness of Dual-layer Spectral Detector Computed Tomography in solitary pulmonary nodule (SPN) assessment.

#### **METHODS AND MATERIALS**

Between September 2021 and December 2022, dual-layer spectral images of 71 patients confirmed by pathology were retrospectively analyzed in the venous phase. Patients were classified into the malignant group and the benign group. The iodine concentration (IC) values of the SPN, normalized IC of the SPN to aorta/pulmonary artery/pulmonary vein (NICa/NICpa/NICpv), CT values of 40 keV (HU40keV) and 80keV (HU80keV) monochromatic images, and the slope of spectral HU curve were calculated and compared between the benign and malignant groups. ROC curve analysis was performed to assess the diagnostic performance of the above parameters.

#### **RESULTS**

IC, NICpa, HU40keV, and slope HU had significantly higher values in the malignant group than in the benign group (all  $P < 0.05$  in Mann-Whitney U test). Iodine density (AUC = 0.78) of 1.74 mg/ml yielded a sensitivity of 95% and a specificity of 57%. Slope HU (AUC = 0.79) of 2.9 yielded a sensitivity of 95% and a specificity of 57%.

#### **CONCLUSION**

Both virtual monochromatic images and iodine concentration maps prove to be highly useful in differentiating benign and malignant pulmonary nodules.

#### **CLINICAL RELEVANCE/APPLICATION**

Dual-layer Spectral Detector Computed Tomography can help to differentiate benign from malignant SPNs.

#### **S3A-SPCH- Combination of Clinical and Spectral CT Parameters for Predicting Lymphovascular Invasion** **3** **in N0 Stage Non-small Cell Lung Cancer**

Liangna Deng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the predictive value of spectral CT quantitative parameters for lymphovascular invasion in N0 stage non-small cell lung cancer, a diagnostic model was constructed and visualized as a nomogram to assist clinical preoperative treatment decisions.

#### **METHODS AND MATERIALS**

107 patients with N0 stage non-small cell lung cancer underwent spectral CT before surgery and were divided into two groups: positive group and negative group. Clinical baseline characteristics included age, gender, biochemical markers, serum tumor markers and Immunohistochemical markers. Imaging features included lobe location, tumor boundary, lobulation sign, spiculation, bubblelike lucency, air bronchogram, vascular convergence and pleural retraction. A radiologist delineated the regions of interest on the layer of maximum tumor diameter and the nearest upper and lower layers in axial enhanced



images and calculated the average value. Monoenergetic CT value, effective atomic number (Eff-Z), iodine concentration (IC) of tumor and artery were acquired to calculate normalized iodine concentration (NIC,  $NIC = IC_{tumor} / IC_{artery}$ ).  $\chi^2$  test, t-test and U test were used for calculated differences between groups. Then, least absolute shrinkage and selection operator (LASSO) regression and multivariate logistic regression were used to select the most discriminating features, build a predictive model and visualize the model as a nomogram. ROC curves, calibration curves and decision curves analysis (DCA) were used to evaluate prediction performance and clinical utility.

## RESULTS

41 patients had lymphovascular invasion in 107 N0 stage non-small cell lung cancer patients. The gender, TIF-1 and lymphocyte count differed between the two groups ( $P < 0.05$ ). After feature selection, the six variables included 70keV, 90keV and Eff-Z in the dual phase were screened by LASSO regression to construct the nomogram. The AUC of the clinical-spectral CT model were 0.93 (95%CI: 0.88~0.98). The sensitivity and specificity were 0.89 and 0.88, respectively. The model showed good calibration, and the DCA demonstrated that the model has a higher net benefit than the best single variable.

## CONCLUSION

There were differences in gender, TIF-1 and lymphocyte count and spectral CT parameters in lymphovascular invasion status. The nomogram based on Clinical characteristics and 70keV, 90keV and Eff-Z in the dual phase is helpful for the preoperative determination of lymphovascular invasion status in non-small cell lung cancer.

## CLINICAL RELEVANCE/APPLICATION

The nomogram is helpful for the preoperative determination of lymphovascular invasion status in N0 stage non-small cell lung cancer, which can assist in clinical preoperative decision-making and patient risk stratification.

## S3A-SPCH- Quantitative Lung and Lobar Perfusion from Dual-source, Dual-energy CTPA in Chronic Thromboembolic Pulmonary Hypertension and Acute Pulmonary Embolism

5

Jacob V. Hansen, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the differences in quantitative lung and lobar perfusion metrics between patients with chronic thromboembolic pulmonary hypertension (CTEPH) and acute pulmonary embolism (PE).

## METHODS AND MATERIALS

Under IRB approval, 162 adult patients (>21 years) diagnosed with acute PE or CTEPH were scanned clinically using dual-source, dual-energy CT (Siemens SOMATOM Flash) pulmonary angiography (DE-CTPA) between 2019 and 2023. De-identified, thin-section DE-CTPA images from 81 PE patients (M:F 45:36; median age 69 years [60; 76]) and 81 CTEPH patients (M:F 46:35; median age 71 [61; 78]) were processed using the automated, machine-learning based eXamine DE Lung Isolation software (Siemens Healthineers) to obtain quantitative lung and lobar perfusion data. Clinical data was retrieved from electronic patient journals. Statistical analysis was performed using R (RStudio) with Mann-Whitney U test (individual perfusion parameters), PERMANOVA (for multivariate comparison) and multiple logistic regression (for correlation between perfusion parameters and clinical data and biomarkers).

## RESULTS

Whole lung blood volume was lower ( $p < 0.001$ ) in PE patients (median 3399 mL [2554, 4284]) than in CTEPH patients (median 4094 mL [3397, 4818]). The same was observed at single lung and lobar level (figure 1A). The multivariate comparison encompassing all perfusion variables (figure 1A-C) showed a difference between the two groups ( $F = 6.15$ ,  $Pr > (F) = 0.004$ ) after testing for homogeneity of variance. We found poor correlation ( $r < 0.3$ ) between perfusion parameters and right heart catheterization parameters, 6-minute walking distance, and tricuspid annular plane systolic excursion (TAPSE) in CTEPH patients as well as with TAPSE, mean arterial blood pressure, and saturation in PE patients. In CTEPH, right upper lobe contrast uptake (CU), left upper lobe volume and CU, and left and lower lobe contrast concentration (CC) predicted whether patients had high ( $> 4$  L/min) cardiac output (CO) ( $p = 0.01 - 0.03$ ).

## CONCLUSION

Lung and lobar perfusion are lower in patients with acute PE than patients with CTEPH as highlighted by differences in DECT-derived pulmonary blood volume parameters. This might be explained by the differences between an acute, decompensated disease phenotype and a chronic, compensated disease phenotype. Perfusion parameters correlate poorly with hemodynamic and clinical parameters in both diseases, but might predict severity.

## CLINICAL RELEVANCE/APPLICATION

Fully automatic estimation of quantitative pulmonary perfusion from dual-source, dual-energy CTPA can help assess differences in patients CTEPH and PE.

## S3A-SPCH- Application Value of Spectral CT Multi-Parameter Imaging in the Detection of Emboli and Assessment of Thrombus Burden in Acute Pulmonary Embolism

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Cao (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to investigate the efficacy of spectral CT multi-parameter (Spectral Based Image) imaging compared to regular CT (rCT) imaging in the detection of emboli and assessment of thrombus burden in acute pulmonary embolism (PE).

## METHODS AND MATERIALS

102 suspected pulmonary embolism (PE) patients who underwent dual-layer spectral CT (DLCT) pulmonary angiography (CTPA) were prospectively enrolled. Spectral data were reconstructed into conventional images (CI), iodine density maps (ID), effective atomic number (Zeff) maps, and ID-Zeff fusion maps (ID-Zeff). The detection rate of acute PE in each group was evaluated, and the diagnostic efficiency for PE was assessed using receiver operating characteristic (ROC) curves and area under the curve (AUC) for each type of image. The diagnostic efficiency for PE was evaluated separately in pulmonary lobes and main pulmonary arteries, pulmonary segmental arteries, and subsegmental pulmonary arteries. In diagnosed acute PE patients, the total number of thrombi and the number of thrombi detected in three level of pulmonary artery were counted, and the thrombus burden was compared among groups using the Qanadli (Q) score. Independent sample t-tests and chi-square tests were used for quantitative and qualitative data, respectively.

## RESULTS

Among the 102 suspected PE patients, a total of 63 cases were diagnosed based on imaging, laboratory tests, and clinical data. Among them, the CI, ID, Zeff, and ID-Zeff respectively diagnosed 53, 55, 60, and 60 cases. The ID-Zeff image (AUC: 0.989, sensitivity: 97%, specificity: 100%) significantly improved the detection rate of PE compared to the CI image (AUC: 0.892, sensitivity: 84%, specificity: 94%). The total number of thrombi detected by the CI image and each spectral image group in each three level of pulmonary artery were as follows: CI (172, 25, 75, 72), ID (217, 25, 82, 100), Zeff (222, 25, 85, 112), and ID-Z-eff (230, 25, 85, 120). The Q scores for each spectral image group were as follows: CI (15.64±5.28), ID (19.25±6.42), Zeff (19.87±6.86), and ID-Zeff (20.46±6.6). The Q scores in each spectral image group were statistically significant compared to the CI group ( $p < 0.001$ ).

## CONCLUSION

DLCT multi-parameter ID-Zeff maps exhibit better detection rates and thrombus detecting efficacy in PE compared to CI images, especially in subsegmental PE. Additionally, the ID-Zeff map provides more accurate Q scores.

## CLINICAL RELEVANCE/APPLICATION

ID-Zeff imaging can use the wedge-shaped perfusion defect region to detect subsegmental and micro thrombi, significantly improving the detection efficacy of peripheral micro emboli in PE. This provides more accurate imaging data for the precise assessment of thrombus burden, risk stratification, and prognosis prediction.

## S3A-SPCH- CT-based Automated Measure of Vertebral Fracture Associates with COPD Severity, Sex and Age in Smokers

Syed Ahmed Nadeem, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Osteoporosis is a major comorbidity of chronic obstructive pulmonary disease (COPD) contributing to high prevalence of vertebral compression fractures (VCF). Alteration in spine morphology due to VCF reduces rib-cage mobility and chest space, hinders lung expansion and function, and adversely impacts mobility, quality of life, and clinical outcomes. This retrospective study examines the association of VCF with COPD severity, sex, and age using a CT-based automated method.

## METHODS AND MATERIALS

Twelve thoracic and the first lumbar vertebrae were automatically segmented and labeled from chest CT scans using a previously validated deep learning-based method. Following the Genant's principle, an automated VCF assessment method was developed and applied to individual vertebral volume. Inspiratory or total lung capacity chest CT scans from the Iowa cohort of the Genetic Epidemiology of COPD (COPDGene) study at baseline visits were used. Four COPD severity groups were defined—(1) preserved lung function (GOLD 0), (2) mild COPD (PRISm and GOLD 1), (3) moderate COPD (GOLD 2), and (4) severe COPD (GOLD 3 and 4). A generalized linear model of the VCF count with age, sex, height, weight, smoking history, and COPD severity was developed.

## RESULTS

Study participants ( $n=1221$ ; age (mean±SD): 59.29±8.98 years; 581 female) in the preserved lung function and mild, moderate, and severe COPD groups had 0.61±1.27, 0.66±1.37, 0.85±1.53, and 1.03±1.75 VCF counts, respectively. As compared to the preserved lung function group, moderate and severe COPD were associated with significantly higher VCF counts ( $p=0.047$  and  $p=0.00048$ , respectively), while the observed higher VCF counts in mild COPD were not significant ( $p=0.084$ ). Females ( $p < 0.0001$ ) were associated with lower VCF counts. Aging was positively correlated with the VCF count ( $p < 0.0001$ ).



## CONCLUSION

A CT-based automated measure of VCF is presented, and its association with COPD severity, sex, and age is demonstrated. Automation of the CT-based method will facilitate its application to nationwide repositories chest CT scans exploring associations of demographic, lifestyle, and clinical factors on osteoporosis and VCF and their impacts in COPD and other lung diseases.

## CLINICAL RELEVANCE/APPLICATION

The new method offers CT-based automated quantification of VCF, which may be useful to investigate the osteoporosis comorbidity in COPD and its impact on lung function and clinical outcomes.

## S3A-SPCH- Deep Neural Network to Detect Emphysema on Chest Radiographs.

8

Seowoo Lee, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Chronic obstructive lung disease (COPD) remains underdiagnosed globally, and chest radiographs are typically obtained for patients with respiratory symptoms. This study aimed to develop a deep neural network to detect emphysema on chest radiographs.

## METHODS AND MATERIALS

We retrospectively collected chest radiographs and CT scans between 2009 and 2020 from patients with emphysema, as identified in CT reports, at a single tertiary referral center for the model development. The emphysema index was calculated from the CT scans and dichotomized at a cutoff of 10% to determine the presence of CT-defined emphysema. A U-Net-based deep neural network was trained to predict CT-defined emphysema on chest radiographs. Chest radiographs were processed to generate three-channel images, consisting of a native chest radiograph, a segmented lung image, and a pulmonary vessel map. Lung segmentation and pulmonary vessel map extraction guided the model to focus on anatomical structures relevant to emphysema pathophysiology. The diagnostic performance of the model was evaluated using the area under the receiver operating characteristic curve (AUC) in the temporally separated internal test set and two external test sets. The prognostic value of model-defined emphysema on chest radiographs for overall survival was assessed using a Cox proportional hazards model in an independent internal set of patients with COPD.

## RESULTS

A total of 2,579 chest radiographs and 11,284 chest computed tomography (CT) scans from 9,192 adult patients were included in the training. The deep neural network achieved AUCs of 0.90, 0.90, and 0.87 in the internal test set (n=184), external test set 1 (n=491) and external test set 2 (n=559), respectively. In an independent internal set (n=4,919), survival analysis demonstrated that the presence of emphysema, as predicted by the deep learning model, was associated with worse overall survival on multivariable analysis (adjusted hazard ratio: 1.3; 95% confidence interval: 1.2-1.5; P < .01).

## CONCLUSION

The deep neural network accurately detected emphysema presence on chest radiographs.

## CLINICAL RELEVANCE/APPLICATION

The deep neural network can help overcome the global underdiagnosis of COPD using chest radiographs.

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## Abstract Archives of the RSNA, 2023

S3A-SPER

### Emergency Radiology Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### S3A-SPER-1 Detection of Pooled Intracavitary Torso Hemorrhage on CT with Deep Learning

Nathan Sarkar, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Internal hemorrhage caused by traumatic injury is a potentially life-threatening condition requiring rapid treatment. Hemorrhage accounts for 30-40% of all trauma-related deaths, and approximately 50,000 people die from trauma-related hemorrhage in the US annually. WBCT reports are time consuming, and automated algorithms that detect hemorrhage could be used for early notification, however to our knowledge, no such methods have been described. We develop and test DL algorithms for detection of three forms of pooled hemorrhage at CT- hemothorax, hemoperitoneum, and pelvic hematoma.

#### METHODS AND MATERIALS

Three datasets of patients with hemothorax (n=77), hemoperitoneum (n=150), and pelvic hematoma (n=253) served as positive cases for each feature and 373 negative WBCT scans were used as controls in three separate experiments using a ResNeXt-101 architecture with fully connected layer pre-trained on ImageNet. Positive slices were identified using existing label masks. All scans were resampled to a uniform slice thickness of 1.5 mm, and pre-processed using an abdominal/mediastinal window [HU -175, 250]. Data augmentation was performed using rotation, translation, scaling, and shear transformations. 3 consecutive slices were used as input. Training, validation, and testing was conducted using a 70:10:20 split of the data. Models were trained on an NVIDIA Titan RTX graphics card with 24GB memory. Decision thresholds were optimized for high sensitivity for this screening task. If a single slice was determined to be positive for a given feature, the patient was predicted to be positive. Performance was measured using standard accuracy metrics. Grad-CAM saliency maps were used for explainability.

#### RESULTS

Patient level accuracies in the test sets were as follows: 1. For pelvic hematoma (test n=125 CTs), accuracy, precision (PPV), recall (sensitivity), and NPV were 97%, 93%, 100%, and 100%, respectively. 2. For hemoperitoneum (n=105), these were 97%, 97%, 93%, and 97%, and 3. For hemothorax (n=90), these were 99%, 94%, 100%, and 100%. Hemoperitoneum was the only feature with false negatives and both occurred at low segmented volumes (18 and 23 mL). Saliency maps showed that attention corresponded with areas of pooled blood.

#### CONCLUSION

Our models were highly accurate and could be used to accelerate the activation of life-saving treatment protocols in patients at risk for exsanguination.

#### CLINICAL RELEVANCE/APPLICATION

In future work, these classification algorithms can be scaled to larger datasets and included in a pipeline with segmentation algorithms to serve combined early notification (CADt) and precision medicine (CADx) purposes, thus reducing time to diagnosis and assisting with surgical decision-making in positive patients.

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## Abstract Archives of the RSNA, 2023

S3A-SPGI

### Gastrointestinal Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPGI-1 Predictive Value of a Radiomics Nomogram Model Based on Contrast-enhanced Computed Tomography for KIT Exon 9 Gene Mutation in Gastrointestinal Stromal Tumors**

Yuze Wei (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish and validate a radiomics nomogram model for predicting the KIT exon 9 mutation status of gastrointestinal stromal tumors (GISTs) before surgery.

#### **METHODS AND MATERIALS**

All imaging and clinicopathological data of 87 patients diagnosed with pathologically confirmed GISTs were retrospectively collected and randomly assigned to the training set (n = 60) and test set (n = 27) at a ratio of 7:3. Based on contrast-enhanced CT (CE-CT) arterial and venous period images, the region of interest (ROI) of the tumors were manually drawn layer by layer, and the radiomics features were extracted. The ICC (intra-class correlation coefficient) was used to test the consistency between observers and least absolute shrinkage and selection operator regression (LASSO) was used to further screen the features. The nomogram of integrated radiomics score (Rad-Score) and clinical risk factors (extra-gastric location and distant metastasis) was drawn on the basis of multivariate logistic regression. The area under the receiver operating characteristic curve (AUC) and the correction curve were used to evaluate the predictive efficiency of the nomogram, and the clinical benefits that the decision curve evaluation model might bring to patients.

#### **RESULTS**

The AUC, sensitivity, specificity, and accuracy in the nomogram model were 0.902 (95% confidence interval [CI]: 0.798-0.964), 85.7%, 86.9%, and 91.7% for the training group, and 0.907 (95% CI: 0.732-0.984), 77.8%, 94.4%, and 88.9% for the test group.

#### **CONCLUSION**

The radiomics nomogram model based on CE-CT can effectively predict the KIT exon 9 mutation status of GISTs and may be used for selective gene analysis in the future, which is of great significance for the accurate treatment of GISTs.

#### **CLINICAL RELEVANCE/APPLICATION**

Our models show that radiomics has great potential for predicting GIST gene mutations, which may enable clinicians to optimize clinical decisions in patients with GIST.

#### **S3A-SPGI-3 Identification of Macrotrabecular-massive Hepatocellular Carcinoma (MTM-HCC) using Gadoteric Acid-enhanced MRI and User-friendly Radiomics Analysis Suite**

Jongjin Yoon, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiomics analysis is often challenging for radiologists due to time-consuming pre-processing, tumor segmentation, and complex analysis. The purpose of this study was to attempt to develop a radiomics model for identifying macrotrabecular-massive HCCs (MTM-HCCs) using radiomics analysis suite that provides semi-automatic segmentation and user-friendly analysis tools, and to compare the model's performance to that of conventional radiomics analysis.

## **METHODS AND MATERIALS**

We enrolled 3 independent cohorts from 2 tertiary care centers. The 3 cohorts consisted of a total of 464 patients who underwent gadoteric acid-enhanced MRI and surgical resection for treatment-naïve single HCCs between December 2007 and December 2014. Independent review of histopathology by two pathologists was performed for each cohort. The arterial phase images were semi-automatically segmented by reviewer 1 (faculty radiologist) in training set, and by reviewer 1, reviewer 2 (resident radiologist), and reviewer 3 (research assistant) in validation cohorts. Inter-observer agreement was evaluated using intraclass correlation coefficient (ICC). A commercial radiomics suite (syngo.via, Siemens Healthineers) was used to calculate and analyze 1,234 radiomics features. Additionally, the same radiomics features were analyzed using conventional radiomics analysis method. Area under a receiver operating characteristic curve (AUROC) was the performance metric.

## **RESULTS**

ICC values in internal and external validation sets mostly exhibited excellent agreement. The training cohort AUROC for the radiomics suite random forest model was 0.72 for reviewer 1. The internal validation cohort AUROC values were 0.63, 0.71, and 0.73, while external validation set values were 0.72, 0.75, and 0.73 for reviewer 1, 2, and 3, respectively. The radiomics suite model demonstrated comparable or superior AUROC values compared to conventional techniques. In the pooled internal and external validation cohort (n=250), the predicted MTM-HCC by radiomics suite was significantly associated with frequent early recurrence and extrahepatic metastasis, and poor overall survival for all reviewers (P<0.05 for all)

## **CONCLUSION**

We developed radiomics models to classify histopathologic subtypes of HCCs using a user-friendly radiomics suite. The models' diagnostic performance was comparable to conventional methods and consistent across varying user experience levels. The model showed potential in predicting prognostic factors in a pooled validation cohort.

## **CLINICAL RELEVANCE/APPLICATION**

This simple, user-friendly approach of developing radiomics models is expected to make radiomics more accessible to radiologists and facilitate real-world application.

## **S3A-SPGI-5 Deep Learning of Two- Dimensional Shear Wave Elastography for Assessment of Clinically Significant Portal Hypertension**

Youngseo Cho, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

We aimed to make a deep-learning model of 2D-shear wave elastography (SWE) images to detect clinically significant portal hypertension (CSPH) [DL-CSPH] using long short-term memory (LSTM) architecture, and to compare the diagnostic performance with conventional diagnostic method.

### **METHODS AND MATERIALS**

A retrospective study was conducted using 2D-SWE image data collected in a single center, and the subject were divided into training (n=168) and test (n=113) sets. CSPH was diagnosed by hepatic venous pressure gradient measurement. With the training set, the DL-CSPH model using convolution neural network (CNN) and long short-term memory (LSTM) architecture of the 2D-SWE measurement image was derived. Especially, sequential order of liver stiffness (LS) measurement was applied into the LSTM model and compared with the LSTM model with random selection. As a conventional diagnostic method, the cut-off value of LS was calculated via a receiver operating curve analysis in the training set and applied the cut-off value in the test set.

### **RESULTS**

In the prediction of CSPH using the deep-learning model, the LSTM model with sequential order showed better performance than the CNN model (sensitivity: 94.3% VS 85.7%, specificity: 86.1% VS 79.1%, accuracy: 91.2% VS 83.2%, AUC: 0.824 VS 0.902). The difference in AUC value was statistically significant. (P=0.03) Although the DL-CSPH model in sequential order performed better in predicting CSPH compared to the LS or APRI cutoff values, this difference was not statistically significant (P=0.53, 0.19, respectively). However, the DL-CSPH model in sequential order exhibited a significant improvement over FIB4 in predicting CSPH (P=0.01).

### **CONCLUSION**

DL-CSPH model in sequential order demonstrates excellent overall performance in predicting CSPH.

### **CLINICAL RELEVANCE/APPLICATION**

The DL-CSPH model has practical value as it enables non-invasive, automated monitoring of portal pressure in patients with chronic liver disease in a robust and reproducible manner.

## **S3A-SPGI-6 Identification of a Radiomic Signature to Predict the Risk of Hepatocellular Carcinoma in Cirrhotic Patients**

Bazzini (*Presenter*) Nothing to Disclose

## **PURPOSE**

Patients with cirrhosis are at increased risk of Hepatocellular Carcinoma (HCC); currently, clinical and radiological scores for an accurate early prediction of the development of HCC are lacking. The study aims to assess if radiomics can assist in accurately identifying cirrhotic patients at risk of HCC.

## **METHODS AND MATERIALS**

98 patients (M:F=64:34; mean age 67 years  $\pm$ 9,81) were included in this retrospective monocentric study. Two groups were identified: group (a) with 49 patients (M:F=31:18; mean age 67,4 years  $\pm$ 9,12) who had a baseline CT with radiological signs of cirrhosis, without evidence of HCC in follow-up CT (LI-RADS 1-3); group (b) with 49 patients (M:F=33:16; mean age 67,5 years  $\pm$ 10,5) who had a baseline CT with radiological signs of cirrhosis and evidence of HCC in one follow-up CT scan (LI-RADS 4/5). Four radiologists (3 years of experience) provided complete liver segmentations, manually drawing volumes of interest (VOI) on non-enhanced baseline CT scans. 851 radiomic features (RF) were extracted from each VOI. Redundant RF (Spearman correlation coefficient = 0.99) were removed. The dataset was split into train:test set (70%:30%). Decision Tree classification algorithm and a 3-fold cross-validation were performed on train dataset to explore different cost complexity parameters to set the best pruning. The final model was validated on the test set in terms of accuracy, sensibility, sensitivity, precision, areas under the receiver operating characteristic (ROC) curve and under the precision-recall curve (PRC).

## **RESULTS**

The tree-based model included the "wavelet-LLH\_glcm\_DifferenceAverage" RF, classifying patients as positive when higher than 0.97. The final model predicted the risk of developing HCC with an accuracy, sensitivity, specificity and precision of 0.73, 0.93, 0.56, and 0.65, respectively. Areas under ROC curve and PRC were 0.74 and 0.81.

## **CONCLUSION**

A radiomic model identified a RF for stratification of cirrhotic patients at risk of developing HCC, showing high sensitivity. To increase the specificity of the model, we aim to integrate this radiomic approach with clinical and radiological parameters.

## **CLINICAL RELEVANCE/APPLICATION**

Radiomics can non-invasively predict the development of HCC in cirrhotic patients and may assist clinicians in creating a tailored monitoring path for each patient.

## **S3A-SPGI-7 Added Value of Diffusion-weighted MR Imaging in the Diagnosis of Cholangiocarcinoma Recurrence**

Keiichiro Yamada, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate the added value of magnetic resonance (MR) imaging including diffusion-weighted imaging (DWI) in the diagnostic performance of contrast-enhanced computed tomography (CECT) for diagnosis of cholangiocarcinoma recurrence.

## **METHODS AND MATERIALS**

Thirty-three consecutive patients who underwent follow-up CECT and MR imaging after cholangiocarcinoma resection were included: 20 with recurrence and 13 without recurrence. Two observers independently reviewed CECT and subsequently reviewed combined CECT and MR imaging including DWI (b value, 1000 s/mm<sup>2</sup>). A five-point scale rating for the likelihood of cholangiocarcinoma recurrence was assessed. Both observers reviewed each image set twice. Diagnostic performance (receiver operating characteristic [ROC] curve analysis), accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were evaluated. To evaluate the intra-observer and inter-observer agreement with regard to the correct diagnosis of recurrence, kappa statistics were used.

## **RESULTS**

For both observers, diagnostic performance (area under curve [AUC] of ROC) improved after additional review of MR imaging including DWI; AUC improved from 0.614 to 0.918 ( $P < 0.01$ ) in the first reading session of Observer A, and from 0.820 to 0.928 ( $P = 0.20$ ) in the second reading session of Observer A, from 0.566 to 0.858 ( $P < 0.01$ ) in the first reading session of Observer B, from 0.753 to 0.930 ( $P < 0.01$ ) in the second reading session of Observer B. Diagnostic accuracy, sensitivity, specificity, PPV, and NPV were higher than CECT alone in the first reading session of Observer A and both reading session of Observer B. Intra-observer agreement of confidence levels improved after the addition of MR imaging: kappa value improved from 0.423 to 0.636 for Observer A, from 0.199 to 0.479 for Observer B. Inter-observer agreement of confidence levels also improved after the addition of MR images: kappa value improved from 0.093 to 0.230 for the first reading session, from 0.140 to 0.460 for the second reading session.

## **CONCLUSION**

The addition of MR imaging including DWI to CECT, improves the detection of cholangiocarcinoma recurrence when compared with CECT alone.

## **CLINICAL RELEVANCE/APPLICATION**

The addition of MR imaging including DWI to CECT, helps to detect early-stage resectable recurrence lesions of cholangiocarcinoma.

## **S3A-SPGI-8 To Predict Hepatic Decompensation Status using Computed Tomography-Based Radiomics Signature with the Body Composition Model**

Yashbir Singh, PhD, MEng (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study was to investigate the potential value of computational radiomics in predicting hepatic decompensation using body-composition model in the patients with Primary Sclerosing Cholangitis (PSC), a chronic cholestatic liver disease that can lead to hepatic decompensation.

## **METHODS AND MATERIALS**

A total of 220 patients diagnosed with PSC and with an available abdomen CT acquired during the portal venous phase were included in the study. We used an in-house developed U-Net model that assesses body composition using the subcutaneous adipose tissue (SAT), skeletal muscle (SKM), visceral adipose tissue (VAT), and intermuscular adipose tissue (IMAT). The PyRadiomics library was used to extract radiomic features on the region of interest (ROI) created by the body composition model. Out of 100 radiomics features, 23 features were identified to be significant using statistical analysis (t-test). We aimed to develop a classification model using radiomics features based on a traditional machine learning approach (random forest classification).

## **RESULTS**

The machine learning model achieved a prediction accuracy of 97% in the validation set, which was evaluated in terms of the AUC. This study is a first step in this proof-of-concept application of combining Radiomics Signature and the Body Composition Model with imaging data and the model was designed to predict short-term outcomes.

## **CONCLUSION**

The study revealed the potential for prognostic features for hepatic decompensation patients in PSC and provided hidden information that may help in discovering new differentiating imaging features. This methodological approach may also have the potential for detecting other PSC-related complications such as cholangiocarcinoma and applications in other chronic liver diseases such as non-alcoholic fatty liver disease.

## **CLINICAL RELEVANCE/APPLICATION**

The use of radiomics with Body composition model in predicting hepatic decompensation in PSC patients may aid in early detection and intervention. The approach may also be useful in detecting other complications associated with PSC and other chronic liver diseases, thereby contributing to better clinical management and improved patient outcomes.

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## Abstract Archives of the RSNA, 2023

S3A-SPGU

### Genitourinary Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPGU- Prediction of Bladder Cancer Based on Biparametric MRI Radiomics: Comparison with Traditional MRI** 1

Li Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare biparametric (bp) MRI radiomics signatures and traditional MRI model for the preoperative prediction of bladder cancer (BCa) grade.

#### **METHODS AND MATERIALS**

This retrospective study included 255 consecutive patients with pathologically confirmed 113 low-grade and 142 high-grade BCa who underwent preoperative MRI, including T2-weighted imaging (T2WI) and apparent diffusion coefficient (ADC). The traditional MRI nomogram model was developed using univariate and multivariate logistic regression by the mean apparent diffusion coefficient (mADC), vesical imaging reporting and data system (VI-RADS) scoring, tumor size and number of tumors. Volumes of interest were manually drawn on T2WI and ADC maps by two radiologists. Using ANOVA, correlation and LASSO methods to select features. Then, a logistic regression (LR) classifier was used to develop the radiomics signatures in the training set and assessed in the validation set. Receiver operating characteristic (ROC) analysis was used to compare the diagnostic abilities of the radiomics and traditional MRI models by the DeLong test. Finally, decision curve analysis (DCA) was performed by estimating the clinical usefulness of the two models in both the training and validation sets.

#### **RESULTS**

The areas under the ROC curves (AUCs) of the traditional MRI model were 0.841 in the training cohort and 0.806 in the validation cohort. The AUCs of the three groups of radiomics model [ADC, T2WI, bp-MRI (ADC and T2WI)]-based logistic regression analysis algorithms were 0.888, 0.875 and 0.899 in the training cohort and 0.863, 0.805 and 0.867 in the validation cohort, respectively. The combined radiomics model achieved higher AUCs than the traditional MRI model and was compared using the DeLong test ( $P = 0.026$  and  $0.023$  in the training and validation cohorts, respectively). DCA indicated that the radiomics model had higher net benefits than the traditional MRI model.

#### **CONCLUSION**

The bp-MRI radiomics model may be helpful for distinguishing high-grade and low-grade BCa and outperformed the traditional MRI model. Multicenter validation is needed to acquire high-level evidence for its clinical application.

#### **CLINICAL RELEVANCE/APPLICATION**

Our study shows that the bp-MRI radiomics model presented superior diagnostic performance to the traditional MRI model. This may assist doctors in obtaining the preoperative histological grading of the tumor, which is convenient for determining the treatment strategy for BCa.

#### **S3A-SPGU- Comparison of Single-shot EPI, Multi-shot EPI, and Reduced Field-of-view in Bladder DWI at 3.0 T** 2

Tsutomu Tamada, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the image quality of single-shot echo-planar diffusion-weighted imaging (SS-EPI DWI), multi-shot EPI DWI (MS-EPI DWI), and reduced field-of-view DWI (rFOV DWI) in bladder cancer and their diagnostic ability for muscle invasion.



## **METHODS AND MATERIALS**

Seventy-three patients who had a multiparametric MRI including SS-EPI DWI, MS-EPI DWI, and rFOV DWI as a preoperative examination for bladder cancer between August 2020 and February 2023 were included in the study. Qualitative image quality was evaluated by three radiologists. Regarding the SS-EPI DWI, MS-EPI DWI, and rFOV DWI, the three items of distortion, wall clarity, and lesion conspicuity were graded in four stages: 1: poor, 2: fair, 3: good, and 4: excellent. Quantitative image quality assessment was performed by a radiologist. The signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and signal intensity ratio (SIR) were used as measures of quantitative evaluation. The control was set to the iliopsoas muscle. Three radiologists assessed the presence of muscle invasion of bladder cancer using Vesical Imaging-Reporting and Data System. Clinical information and pathology results were not known to the readers. The Wilcoxon matched pairs signed ranks test was used to compare qualitative and quantitative scores. The McNemar test and ROC analysis were used to compare diagnostic performance. A p-value < 0.05 was considered significant.

## **RESULTS**

The qualitative scores for distortion were MS-EPI DWI (2.95 to 3.42), rFOV DWI (2.74 to 3.18), and SS-EPI DWI (2.33 to 3.00) in descending order, with significant differences for all combinations. The wall clarity scores were MS-EPI DWI (3.00 to 3.34), SS-EPI DWI (2.86 to 3.16), and rFOV DWI (2.44 to 2.86) in descending order, and the three readers were in agreement, with significant differences between rFOV DWI and the other two types of DWI. Quantitative evaluation showed no significant difference in SNR and CNR between each test. SIR was higher for MS-EPI DWI (average, 10.5; SD, 4.4), rFOV DWI (average, 6.5; SD, 2.1), and SS-EPI DWI (average, 5.6; SD, 1.5), in that order, with significant differences between each DWI. The diagnostic performance of muscle invasion was good for all DWIs. AUC values were 0.83 to 0.88 for SS-EPI DWI, 0.85 to 0.90 for MS-EPI DWI, and 0.83 to 0.93 for rFOV DWI. There was no significant difference between sequences.

## **CONCLUSION**

MS-EPI DWI and rFOV DWI reduced image distortion and MS-EPI DWI improved bladder wall visibility compared to SS-EPI DWI, but did not contribute to improve diagnostic performance of muscle layer invasion.

## **CLINICAL RELEVANCE/APPLICATION**

If distortion or bladder wall obscuration is seen on SS-EPI DWI during examination, additional MS-EPI DWI can improve image quality.

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## Abstract Archives of the RSNA, 2023

S3A-SPHN

### Head & Neck Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPHN- Osteogenesis Imperfecta: Implications of Using Micro-CT for Visualizing Developmental Variation in the Middle and Inner Ear of OIM Mice** 1

Dallin Judd (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our research is to visualize and document anatomic variation in the ears of mice bred to have the Type III OI genetic variant in order to better understand the cause of OI-related hearing loss.

#### **METHODS AND MATERIALS**

3D models of the middle and inner ears were created from micro-CT scans that also employed two new contrast-enhanced methods to visualize the cochlea and middle ear (malleus, incus, and stapes). All CT scanning were done using the new Small Animal Imaging Facility (SAIF). The scan resolution was approximately 20 $\mu$ m. The studied WT and OIM mouse samples include three time points intended to capture a developmental sequence: 0-day-old (WT=20, OIM=29), 7-day-old (WT=23, OIM=23), and 14-day-old mice (WT=22, OIM=18). The visualization software Avizo was then used to digitally segment the bone of the inner ear and middle ear.

#### **RESULTS**

In OIM inner ears, the surrounding otic capsule tended to be more demineralized, exhibiting lower threshold values than WT. This contrasts with WT specimens, where the ossified bone was more distinct from the hollow space of the inner ear. Intrusions in the vestibule were observed in both the 2D slices and the reconstructed 3D models of the OIM inner ears. Comparison of volumes for the right OI and WT inner ears and left OI and WT inner ears indicated statistically significant differences between the genotypes.?

#### **CONCLUSION**

Bony intrusions observed in the vestibules of OIM mice may negatively affect fluid movement within the semicircular canals and vestibule (utricle and saccule), possibly altering the balancing and body positioning abilities of OI mice. This is ongoing research employing additional contrast enhanced CT (CE-CT) methods to visualize not only the bony labyrinths, but also soft tissue, including muscle and cartilage. In addition, more age-points are currently being collected with the aim of elucidating the pathogenesis of osteogenesis imperfecta during different stages of ear development.

#### **CLINICAL RELEVANCE/APPLICATION**

This research uses micro-CT imaging designed to capture a developmental sequence, giving us the potential to elucidate how and when the bony intrusions are impacting surrounding structures. Insight into this anatomical damage may help disambiguate the OI-related pathology, including the distinction between sensorineural vs. mixed hearing loss, unilateral vs. bilateral pathology, and the asymmetric nature of the disease in the ear. Upon completion, this research will demonstrate the efficacy of using these new imaging approaches for studying minute structures of the ear and may markedly advance our understanding of the pathogenesis of OI-related hearing loss.

#### **S3A-SPHN- Magnetic Resonance Neurography of Peripheral Trigeminal Nerves: Correlation of Sunderland Class of Nerve Injury on Imaging versus Clinical Neurosensory Testing and its Diagnostic Efficacy** 2

Shuda Xia (*Presenter*) Nothing to Disclose

## PURPOSE

Iatrogenic or traumatic injuries to the peripheral trigeminal nerve (PTN) can cause loss of sensation and neuropathic pain in the face and oral cavity. Clinical neurosensory testing (NST) is currently the reference standard for diagnosis but is less reliable within the first 3 months following injury and cannot precisely identify the location of the nerve injury. MR neurography (MRN) has been studied for PTN injury diagnosis but with small sample sizes. The aim of this cross-sectional study was to evaluate the correlation between Sunderland class of nerve injury on MRN and NST and obtain diagnostic efficacy with surgical findings as reference standard.

## METHODS AND MATERIALS

An Institutional Review Board approved this retrospective cross-sectional study of adult patients of all genders with suspected injury of PTN who had both clinical NST by an experienced oral maxillofacial surgeon and MRN interpreted by an expert radiologist. A total of 297 patient records with a chief complaint of PTN neuralgia were identified from the university database. All patient charts were reviewed to identify Sunderland injury class on NST and MRN, previous surgeries, whether surgery was performed after the MRN, and surgical outcomes. Of the cohort, 87 patients had both NST injury grade and Sunderland class injury in their records, and 45 of these patients had surgery. Pearson correlation was obtained and the accuracy of NST and MRI was obtained with surgical and histopathology findings as reference standards. Cohen's weighted Kappa was also calculated.

## RESULTS

There were 20 men and 67 women with an age range of 15 to 81 years. Most (69/87, 79%) injuries resulted from tooth extractions and implants. On MRN, there were no class I injuries, 26 class II injuries, 26 class III injuries, 26 class IV injuries, and 9 class V injuries. There was a very strong positive correlation between injury grade on MRN and the NST injury class ( $p < .001$ ). There were substantial agreements between NST, MRN, and surgical findings.

## CONCLUSION

The results of this study confirm that MRN adequately provides the injury grade better than NST with improved diagnostic accuracy.

## CLINICAL RELEVANCE/APPLICATION

Prompt non-invasive and accurate diagnostic evaluation of suspected PTN injury is critical for successful management. MRN provides the needed pre-operative information on injury grade and its anatomic localization.

## S3A-SPHN- Relationship Between MRI and Clinical Findings of Anatomic Risk Factors in Adult Patients Affected by Obstructive Sleep Apnea/hypopnea Syndrome (OSAHS)

Maria Paola Belfiore (*Presenter*) Nothing to Disclose

## PURPOSE

Identify specific anatomical abnormalities associated with Obstructive Sleep Apnea/hypopnea syndrome (OSAHS), and establish a correlation between the pathological condition and the anatomical changes and enhance treatment planning for future management

## METHODS AND MATERIALS

This case-control study conducted in 2022 investigated the potential of MRI in identifying the causes of upper airway obstruction in OSAHS patients. The study included 30 participants diagnosed with OSAHS and 16 healthy subjects enrolled as a control group, matched for gender, age, height, and weight. All participants underwent MRI examination of the cervical maxillofacial district in the bore of the same 1.5 T magnet. MRI exams revealed significant differences in the upper airway volume, midsagittal nasopharyngeal antero-posterior distance, axial CSA of the nasopharyngeal airway, midsagittal tongue area, soft palatal length, midsagittal soft palatal area, and axial volume of the right and left parapharyngeal adipose tissue in patients with OSAHS compared to controls. Furthermore, the study analyzed the correlation between cephalometric and anatomical measurements and OSAHS severity.

## RESULTS

The results showed a significant association between the severity of OSAHS and soft palate length, soft palate area, Hyoid-Sella distance, and Hyoid-Nasion distance. Soft palate length was closely associated with Hyoid-Sella distance, Hyoid-Nasion distance, and tongue area. The study also evaluated the facial skeletal structure, showing significant differences in intermandibular distance, mandibular depth, and the position of both the maxilla and mandible between the two groups.

## CONCLUSION

Multiple soft tissue and skeletal structures surrounding the upper airways may contribute to the symptoms and clinical severity of OSAHS; in some cases, they may even play a dominant role. MRI has enormous potential in evaluating the three compartments of obstruction: air lumen, soft tissues, and facial skeleton.

## CLINICAL RELEVANCE/APPLICATION

This study highlights the potential of MRI in identifying the causes of upper airway obstruction in adult OSAHS patients. While polysomnography remains the gold standard for OSAHS diagnosis, MRI can offer a valuable alternative method for evaluating the craniomaxillofacial morpho-volumetric characteristics contributing to airway size reduction. This information can assist in determining the most appropriate therapeutic approach and surgical intervention, ultimately improving OSAHS patient outcomes.

### S3A-SPHN- Cochlea-carotid Dehiscence: An Underappreciated Condition

4

Charles Tandler, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Cochlea-carotid artery dehiscence (CCD) is the erosion of the bony plate between the cochlea and the petrous segment of the internal carotid artery. In one study of 1,000 temporal bones, there is a histologic prevalence of cochlea-carotid artery dehiscence of 7.7%. It has been reported to be associated with pulsatile tinnitus, conductive hearing loss, sensorineural hearing loss, vertigo, and other otologic disorders. However, the clinical significance of cochlea-carotid artery dehiscence is unknown. Other than a small number of case reports, no large-scale study investigates the radiographic prevalence of CCD and its clinical significance. This study hopes to highlight its clinical significance by retrospectively reviewing a large volume of temporal bone computed tomography (CT) exams and patients' symptoms.

#### METHODS AND MATERIALS

This retrospective single-center cross-sectional study was conducted after the institution's IRB approved the study. Consecutive 1,000 patients (2,000 ears) who underwent CT temporal bones were reviewed. CT images were obtained with 0.625 mm thick and 0.3 mm reconstruction interval. First, a radiology resident reviewed all exams for possible CCD. Then, selected cases were reviewed by two board-certified neuroradiologists independently. The discrepancy was resolved by consensus. Possible CCD ears were divided into three categories: 1) dehiscence, 2) thinning/possible dehiscence, and 3) no dehiscence. The location of the dehiscence or thinning/possible dehiscence was recorded. The results were correlated with clinical findings. Duplicated exams and age less than 18 years old were excluded.

#### RESULTS

Thirteen temporal bones with CCD were identified in twelve patients, including one patient with bilateral CCD (8 men, 4 women, age: 36-78). The basal turn was affected in eleven ears, and the apical turn was affected in two ears. One patient had progressive sensorineural hearing loss of high frequency of the affected ear. Another patient had bilateral hearing loss, more profound in the affected ear, with episodic dizziness. One patient had no documented otological finding in the chart. Other patients did not have symptoms that might be associated with CCD.

#### CONCLUSION

CCD is a rare condition, as reported in the literature. Its clinical significance is still unknown, although pulsatile tinnitus, conductive hearing loss, sensorineural hearing loss, vertigo, and other otologic disorders have been reported in the literature.

## CLINICAL RELEVANCE/APPLICATION

CCD is a rare condition as reported in the literature. Its clinical significance is still unknown, although pulsatile tinnitus, conductive hearing loss, sensorineural hearing loss, vertigo, and other otologic disorders have been reported.

### S3A-SPHN- Combining Virtual Monoenergetic Imaging and Iterative Metal Artifact Reduction in Photon-counting CT of Patients with Dental Implants

5

Theresa Sophie Patzer, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Virtual monoenergetic imaging (VMI) and iterative metal artifact reduction (MAR) are established techniques in energy-integrating detector (EID) CT. The artifact suppressing effect of both approaches is not thoroughly investigated in photon-counting detector (PCD) CT. This study aims to evaluate the potential of VMI, MAR, and combinations thereof in PCD-CT for metal artifact reduction in patients with dental implants.

#### METHODS AND MATERIALS

In 50 patients with dental implants (25 women; mean age  $62 \pm 9.92$  years), conventional 120 kVp imaging (T3D), VMI, T3DMAR and VMIMAR were compared. VMI datasets were reconstructed at 40, 70, 110, 150 and 190 keV. Objective image quality was assessed by ROI-based measurements of attenuation and respective standard deviations in the most hyper- and hypodense artifacts, as well as in artifact-impaired soft tissue of the mouth floor. Three readers evaluated artifact extent and soft tissue interpretability separately on a five-point scale. The introduction of new artifacts and/or overcorrection of pre-existing artifacts was assessed subjectively.

## RESULTS

MAR substantially reduced hyperdense and hypodense artifacts (T3D 1305.0/-1418.4 HU; T3DMAR 103.2/-46.9 HU), soft tissue impairment (T3D 106.7 HU; T3DMAR 39.7 HU) and image noise (T3D 16.9 HU; T3DMAR 5.2 HU) compared to non-MAR datasets (all  $p=0.001$ ). While VMIMAR =150 keV did not enhance artifact reduction over T3DMAR objectively (all  $p=0.081$ ), VMIMAR =110 keV received superior subjective ratings (all  $p=0.023$ ). Without MAR, VMI displayed no measurable artifact extent reduction (all  $p=0.186$ ). However, VMI =110 keV reduced soft tissue impairment over T3D (all  $p=0.009$ ). VMI facilitated no significant denoising over T3D with or without MAR (all  $p=0.366$ ). VMIMAR =110 keV resulted in less overcorrection than T3DMAR (all  $p=0.001$ ).

## CONCLUSION

While VMI alone presented only minimal metal artifact reduction potential, post-processing using MAR enabled a substantial reduction of hyperdense and hypodense artifacts. The combination of both provided a considerable benefit in subjective artifact reduction compared to MAR alone.

## CLINICAL RELEVANCE/APPLICATION

Combining iterative MAR with VMI represents a potent tool for maxillofacial PCD-CT with dental implants achieving substantial artifact reduction. Thus, these approaches allow for improved image quality, improving delicate detection and evaluation of oral pathologies.

## S3A-SPHN- Application of parotid gland ASL and T2 mapping MRI in Sjögren's syndrome

7

Zhang Gaozhengbo, MA (*Presenter*) Nothing to Disclose

## PURPOSE

This study aims to explore the application value of ASL and T2 mapping techniques in the assessment and early diagnosis of parotid gland injury in Sjögren's syndrome(SS) patients.

## METHODS AND MATERIALS

This study prospectively included 54 first-time confirmed SS patients and 30 healthy volunteers from a tertiary hospital from August 2021 to October 2022. Non parametric Mann Whitney U test was used to compare various parameters between SS patients and healthy volunteers. LSD test was used to compare the differences in parameters between adjacent MRI morphological grading. Spearman rank correlation test was used to analyze the correlation between parotid gland MRI morphological grading and various parameters of SS patients. The combination of logistic regression and receiver operating characteristics is used to evaluate the diagnostic efficacy of various parameters and their combination in distinguishing healthy volunteers from early SS patients and all SS patients.

## RESULTS

The parotid gland BF of all SS patients and 0-3 grade SS patients was higher than that of healthy volunteers. There was no statistically significant difference in BF between grade 4 SS patients and healthy volunteers. The T2 value and standard deviation of T2 value in the parotid gland of all SS patients and 0-4 grade SS patients were higher than those of healthy volunteers. The morphological grading of parotid gland MRI (0-3 grades) showed a strong positive correlation with BF ( $r=0.785$ ,  $P<0.001$ ), a moderate positive correlation with T2 value ( $r=0.547$ ,  $P<0.001$ ), and a moderate positive correlation with T2 standard deviation ( $r=0.622$ ,  $P<0.001$ ). The area under the curve of BF is 0.813; The AUC of T2 value is 0.810; The AUC of T2 standard deviation is 0.649. The AUC of the combined diagnosis of BF, T2 value, and T2 value standard deviation is 0.842. The diagnostic efficacy of BF, T2 value, and combined diagnosis is higher than the T2 value standard deviation, while the diagnostic efficacy of combined diagnosis is higher than BF or T2 value.

## CONCLUSION

The BF, T2 values, and standard deviation of T2 values of the parotid gland can distinguish between healthy volunteers and SS patients, reflecting the corresponding changes in the parotid gland of SS patients at different stages. The combination of the three can improve diagnostic efficiency. ASL technology and T2 mapping technology have certain significance in the evaluation and early diagnosis of parotid gland injury in SS patients, and are important supplementary tools for routine MRI diagnosis.

## CLINICAL RELEVANCE/APPLICATION

ASL technology and T2 mapping technology have certain significance in the evaluation and early diagnosis of parotid gland injury in SS patients, and are important supplementary tools for routine MRI diagnosis.

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## Abstract Archives of the RSNA, 2023

S3A-SPIN

### Imaging Informatics Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPIN-2 Development of a Three-Dimensional Expression Method for Ultrasound Images Using Mixed Reality Head-Mounted Displays**

Do Hyung Lee (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This research aimed to develop a real-time three-dimensional (3D) expression of ultrasound images in mixed reality (MR) space to enhance the intuitiveness and understanding of ultrasound images, and to compare its performance with conventional two-dimensional (2D) ultrasound.

#### **METHODS AND MATERIALS**

An MR ultrasound system was developed using the Microsoft HoloLens 2™ MR head-mounted display (HMD), incorporating a 3D camera for SLAM (Simultaneous Localization and Mapping) of the ultrasound transducer. Technical performance was evaluated for MR 2D and MR 3D ultrasound modalities. User evaluation involved 20 healthcare workers (10 medical doctors (MD) group, and 10 non-MD group; 4 nurses, and 6 radiology technicians) who assessed elapsed time, target object position identification score (both of horizontal and vertical position), and shape identification score for every three modalities: 1) conventional 2D ultrasound, 2) MR 2D ultrasound, and 3) MR 3D ultrasound. For each correct identification of the position and shape for a single target object, a score of 1 point was given. The user satisfaction assessment was also conducted regarding the intuitiveness of shape recognition, location recognition, and ease of use in the 3D accumulation process on a scale of 5.

#### **RESULTS**

User evaluation revealed no significant difference in elapsed time, and position identification among the three modalities. Shape identification score was significantly improved with MR 3D ultrasound compared to conventional 2D and MR 2D ultrasound (conventional 2D:  $1.05 \pm 0.76$  [average  $\pm$  standard deviation], MR 2D:  $1.30 \pm 1.13$ , MR 3D:  $3.00 \pm 0.00$ ,  $p < 0.001$ ). All evaluators identified the correct shapes of all target objects, eliminating differences between groups in using MR 3D ultrasound. User satisfaction score in the intuitiveness of shape identification with MR 3D ultrasound was as high as  $4.85 \pm 0.37$ .

#### **CONCLUSION**

Incorporating 2D ultrasound into the MR space and expressing it in three dimensions through a user-driven 3D accumulation process were both technically feasible to implement. Moreover, the MR 3D ultrasound display was superior to both conventional 2D and MR 2D ultrasound in discerning the shape of the target object, providing a more intuitive visualization.

#### **CLINICAL RELEVANCE/APPLICATION**

HoloLens offers the function for multiple users to simultaneously share the same MR space, which can be implemented when several users are each wearing their own HoloLens device. By employing the technology developed in this study to reconstruct and display the images as 3D MR, it is expected to facilitate sharing of examination contents and promote intuitive understanding among patients with limited anatomical knowledge and clinical support staff.

#### **S3A-SPIN-3 A Novel 18F-FDG-PET Based Signature for Non-Small Cell Lung Cancer Prognostication**

Mitchell Chen, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop a novel 18F-fluorodeoxyglucose-positron emission tomography (FDG-PET) radiomics predictive model combined with metabolic hotspot to centroid (HOC) metric for patient prognostication in non-small cell lung cancer (NSCLC).

## METHODS AND MATERIALS

Pre-therapy FDG-PET scans from 301 NSCLC patients (age:  $69.1 \pm 9.8$ , male: female (M: F) = 183:118) were acquired between July 2009 and November 2018 and included as the training data. Independent external FDG-PET data were acquired from five centers ( $n = 257$ ) and used for model validation. Two board-certified clinical radiologists with 8 and 13 years of professional experience segmented the primary tumor using metabolic tumor volume 40% (MTV40) threshold. Additional regions of interests (ROI) were acquired from the peri-tumoral penumbra as annular shells of 1cm in thickness, and from the background lung parenchyma as spheres of 3cm in diameter. Following pre-processing, radiomics features compliant with the Image Biomarker Standardization Initiative (IBSI) were extracted using PyRadiomics from each ROI, normalized and aggregated to form a feature space. Non-reproducible features with an inter-class correlation (ICC) of less than 0.8 were excluded. Cox regression with elastic net regularization was performed to develop a radiomics model with patients' 3-year overall survival as the response vector. Using multivariable regression, this was combined with a novel PET metric developed based on the clonal driver mutation theory of cancer growth, namely the FDG HOC distance, to develop a composite radiomics predictive vector (RPV). Model performance for disease prognostication was tested by stratifying the patients into a high and low risk group using k-means clustering based on RPV.

## RESULTS

In all external testing cohorts, statistically significant stratification of the patients into high and low risk groups was achieved using RPV ( $p$ -value  $< 0.05$ ).

## CONCLUSION

A model developed based on PET radiomics and HOC can achieve patient prognostication in NSCLC. Comparing to models based on CT or PET radiomics alone, this novel signature captures explainable information on tumour growth, and demonstrates a role of the latter for predicting patient survival in NSCLC.

## CLINICAL RELEVANCE/APPLICATION

Imaging-based metrics such as FDG-PET radiomics and HOC offer a non-invasive way of assessing neoplasms at the time of diagnosis. This can aid in clinical decision making, particularly in cases where tissue sampling is challenging or shows inconclusive results. The information presented by these measurements can additionally give insight into tumor composition and metabolism, thereby advancing an understanding of cancer biology that is not otherwise achievable in vivo.

## S3A-SPIN-4 AI-assisted Volumetric Segmentation for Metastases in Follow-up CT Scans: A Multi-institutional Reader Study

Alessa Hering, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

AI-assisted techniques for lesion registration and segmentation have the potential to make CT-based tumor follow-up assessment faster and less reader-dependent. However, empirical evidence on the advantages of AI assistance for lymph node and soft tissue metastases in follow-up CT scans is lacking. Therefore, the aim of this study was to assess the efficiency, quality and inter-reader variability of an AI-assisted workflow for volumetric segmentation of lymph node and soft tissue metastases in follow-up CT scans. Three hypotheses were tested: (H1) Assessment time for follow-up lesion segmentation is reduced using an AI-assisted workflow. (H2) The quality of the AI-assisted segmentation is non-inferior to the quality of fully manual segmentation. (H3) The inter-reader variability of the resulting segmentations is reduced with AI assistance.

## METHODS AND MATERIALS

This multi-institutional reader study retrospectively analyzed 126 lymph nodes and 135 soft tissue metastases from 55 patients diagnosed with stage IV melanoma. Given segmentations of these lesions on the baseline scan, three experienced readers from two institutions performed both AI-assisted and manual segmentations on the follow-up scans. The results were then statistically analyzed and compared to a manual segmentation reference standard to assess the quality and accuracy of the AI-assisted workflow.

## RESULTS

AI-assisted segmentation reduced user interaction time significantly by a third (222s vs 336s per patient), achieved similar Dice scores (0.80-0.84 vs 0.81-0.82) and decreased inter-reader variability (median Dice 0.85-1.0 vs 0.80-0.82), compared to manual segmentation. In over 50% of the segmentation propositions within the AI-assisted workflow, two radiologists accepted the results without any further corrections.

## CONCLUSION

AI-assisted segmentation reduced user interaction time significantly by a third, achieved similar Dice scores and decreased inter-reader variability, compared to manual segmentation. In over 50% of the segmentation propositions within the AI-assisted workflow, two radiologists accepted the results without any further corrections.



## CLINICAL RELEVANCE/APPLICATION

AI-assisted lesion segmentation makes accurate quantification of volumetric tumor growth and other characteristics feasible in clinical routine, enabling earlier and better response assessment.

### S3A-SPIN-5 Graph-Theoretic Automatic Lesion Tracking and Detection of Patterns of Lesion Changes in Longitudinal CT Studies

Leo Joskowicz, PhD (*Presenter*) Officer, HighRAD Ltd

#### PURPOSE

To evaluate the performance of a novel generic method for tracking individual lesion changes and detecting patterns in liver and lung metastatic lesions in longitudinal CT.

#### METHODS AND MATERIALS

We define seven individual lesion change classes: new, disappeared, unique, lone, merged, split, and complex lesion and five lesion change patterns: single, linear, merged, split, and complex pattern to summarize the evolution of lesions over time. The method automatically computes the lesion matchings, the labels of the changes in individual lesions, and the patterns of the lesion changes. It uses a graph-based technique where lesions are vertices and edges are pairings of matched lesions. The inputs are the scans and the organ and lesion segmentations in each scan. It performs pairwise deformable registration of consecutive scans, organs and lesion segmentations, matches overlapping lesions, and computes the changes from the resulting graph. The method was evaluated on lung and liver metastases datasets with 83 scans from 19 patients (mean  $126 \pm 81$  days apart) and 77 scans from 19 patients (mean  $109 \pm 93$  days apart). Ground truth manual lesion segmentations, matchings and changes classification were obtained by an expert radiologist.

#### RESULTS

The lung and liver metastases overall individual lesion change class accuracy is 97% and 87%. The patterns of lesion changes were identified with an accuracy of 94% and 80%. The highlighting of unusual lesion labels and lesion change patterns helped the radiologist find missed lesions (57 lungs, 52 liver) and wrongly annotated lesions (1 lungs, 18 liver), accounting for 4.9% and 8.7% of the original ground-truth lesions.

#### CONCLUSION

Our method accurately classifies changes in individual lesion and reliably identifies patterns of lesion changes in liver and lung longitudinal CT studies.

## CLINICAL RELEVANCE/APPLICATION

Automatic lesion change classification and pattern detection in longitudinal CT studies may improve the accuracy and efficiency of radiological interpretation and disease status evaluation.

### S3A-SPIN-6 Accurate Coverage Assessment in MRI using Deep Learning-Based Landmark Detection

Ryan Chamberlain, PhD (*Presenter*) Employee, ImBio, LLC

#### PURPOSE

This study aims to develop a deep learning-based MRI coverage detection model. By introducing key points to define coverage, using self-supervised learning to overcome annotation challenges, the model addresses crucial coverage detection obstacles and promotes patient-centered care.

#### METHODS AND MATERIALS

**Datasets:** We used three datasets for train and evaluate the model: Lumbar Spine Open dataset1 (464 T1 and T2-weighted lumbar spine MRI images); IXI MRA dataset2 (nearly 600 MR images from healthy subjects); and TubeTK MRA dataset (100 T1-weighted MRA images from healthy patients). No manual annotations of key points needed. **Model:** Adapted from Frueh et al.'s paper<sup>3</sup>, we employed the Template Matching Network (TMN) with separate feature encoders for the source image and augmented extracted patch. The stacked feature vectors feed into three fully connected layers, the localizer. We added a detector branch for coverage detection, sharing the localizer's architecture, but yielding binary results (Figure). **Augmentation:** Techniques include affine transformation, gamma adjustment, and Gaussian blurring. Images and patches are cropped before resizing to the model's input size of  $224 \times 224$ , ensuring flexible image scope and dynamic image/patch size ratios, enhancing model robustness and adaptability. **Training:** Loss functions comprise log negative likelihood loss for the localizer and cross-entropy loss for the detector, using multi-purpose optimization. StepLR manages learning rate scheduling, and early stopping ensures an efficient training strategy.

#### RESULTS

We evaluated our deep learning-based coverage detection model in spine and MRA scenarios. The spine model demonstrated a 4.84mm mean distance in localizing key points, and correctly identified vertebral levels in 55% of cross subject test cases.

The model achieved an F1 score of 0.799 in detecting coverage in partial lumbar spine images. The MRA model achieved a 6.65mm mean distance in localization, and qualitatively identified correct locations in two randomly selected cross subject images (see figure).

## **CONCLUSION**

Our coverage detection model exhibits strong performance in spine imaging and MRA studies, with promising results in localizing random or manually labeled key points as well as detecting coverage in partial images.

## **CLINICAL RELEVANCE/APPLICATION**

By ensuring accurate coverage of relevant anatomical structures, our deep learning-based model has the potential to reduce repeat imaging and patient revisits, conserving resources and minimizing risks for patients. By automating the coverage assessment process, the model alleviates the burden on clinicians to manually review images. This innovation ultimately boosts efficiency, and promotes better patient care.

## **S3A-SPIN-7 Discrimination of the Pulmonary Nodules Using the Chest CT Image Features by Homology Method**

Akira Sato, MSc (*Presenter*) Nothing to Disclose

## **PURPOSE**

The degree of lung adenocarcinoma (LAc) invasion is important in determining treatment strategy, but it is not revealed until the pathological diagnosis at surgical treatment. So, we developed a method to determine it from preoperative CT images, but it is also necessary to discriminate the lesion of LAc from normal tissues. Homology is one of the topological concepts and quantifies contact. Homology-based image analysis (HA) can explain the reason for inference based on mathematics. So, we have aimed to discriminate LAc and normal tissues in CT image based on HA.

## **METHODS AND MATERIALS**

This study uses chest CT images of patients with LAc. Fifty ROIs (regions of interest) were created for each LAc lesion, lung field (no lesion), blood vessels in the lung field, bronchi, and ribs. Next, binarized images were created while varying the CT value. The Betti numbers ( $b_0$ ,  $b_1$ : the number of isolated areas and holes) in the ROI were measured and normalized with the area of ROI. These indices were used as imaging features and compared using Mann-Whitney U test. The relationship between HU and imaging features was plotted as a homology profile. Moreover, we developed a binary classification model based on the support vector machine (SVM) that classifies the ROI for LAc or normal tissue, and five-fold cross-validation was used.

## **RESULTS**

U test showed that each normal tissue significantly differed for nodules ( $p < 0.05$ ). The performances of SVM-based model are as follows (mean  $\pm$  SD). The discrimination between lung fields and LAc had an accuracy of  $1.00 \pm 0.00$  and area under the ROC curve (AUROC) of  $1.00 \pm 0.00$ , while the discrimination between ribs and LAc had an accuracy of  $0.99 \pm 0.01$  and AUROC  $1.00 \pm 0.00$  were the best results. For the best discrimination between blood vessels and LAc, an accuracy of  $0.91 \pm 0.03$  and AUROC of  $0.97 \pm 0.01$  were obtained, while for the discrimination between bronchi and LAc, an accuracy of  $0.97 \pm 0.01$  and AUROC  $1.00 \pm 0.00$ .

## **CONCLUSION**

The results suggest that it is possible to extract image features for each tissue by using HA, and that the classification model using those features can classify with excellent performance. Therefore, we will discriminate the ROIs obtained from the automatic contouring technique using the multi-classification model in the future. In conclusion, we succeeded in discriminating the ROI obtained from chest CT images for LAc and normal tissues using the SVM-based model that discriminates the image features by HA.

## **CLINICAL RELEVANCE/APPLICATION**

We will develop the hybrid model, including this proposed model and our developed model that classifies the invasiveness degree of LAc on preoperative CT images. The hybrid model may not only help in early diagnosis and predicting prognosis but also lead to the discovery of novel valuable indices.

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## Abstract Archives of the RSNA, 2023

S3A-SPIR

### Interventional Radiology Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPIR-1 Comparison of Micro Flow Imaging and Contrast Enhanced Ultrasound in Microwave Ablation of Benign Thyroid Nodules**

Min Zhuang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the application value of micro-flow imaging (MFI) in microwave ablation (MWA) of thyroid nodules by comparing it with contrast-enhanced ultrasound (CEUS).

#### **METHODS AND MATERIALS**

From January 2020 to March 2022, 50 patients with 55 thyroid nodules who underwent MWA in the ultrasound department of our hospital were included. According to the different ablation evaluation methods, they were divided into the CEUS group and the MFI group. Before the operation, CEUS and MFI were used to evaluate the consistency of blood flow inside the nodule. Immediately after ablation, CEUS or MFI was used to evaluate whether the ablation was complete. Follow-up was conducted at 1, 3, and 6 months after the operation and every 6 months thereafter to record the diameter and volume of the nodule, CEUS and MFI were used to evaluate the suspected recurrent nodules.

#### **RESULTS**

There was no significant difference between MFI and CEUS in assessing the internal blood flow of nodules ( $P > 0.05$ ), and the consistency between them was very strong ( $\kappa$  value = 0.81). All nodules showed complete ablation. At 1, 3, 6, and 12 months after the operation, the VRR in the CEUS group was 41%, 61%, 78%, and 89% respectively, and in the MFI group was 41%, 55%, 71%, and 83% respectively, there was no significant statistical difference between the two groups ( $p > 0.05$ ). No serious complications occurred after the operation.

#### **CONCLUSION**

The application effect of MFI in MWA of benign thyroid nodules is consistent with CEUS, and when CEUS cannot be used or unconditionally to use, MFI can be an alternative.

#### **CLINICAL RELEVANCE/APPLICATION**

CEUS can sensitively display the micro blood perfusion in tissues and can be used to differentiate benign and malignant tumors, it plays an essential role in the whole ablation process, which can determine the ablation area before ablation and evaluate the therapeutic effect after ablation. However, CEUS is an invasive and expensive examination, and not suitable for patients with severe cardiopulmonary dysfunction or hypersensitivity to ultrasound contrast agents. Explore a new, non-invasive way to evaluate the efficacy of thyroid nodule ablation will not only help to reduce the cost of patients. Micro-flow imaging (MFI) is a new ultrasound technology that can eliminate tissue motion artifacts while maintaining sensitivity to low-speed blood flow signals by using effective algorithms to visualize microvascular, it has the advantages of being non-invasive, fast, and convenient. In recent years, MFI has gradually been widely used in clinical practice. There are only a few studies on the application of MFI in the thermal ablation process of thyroid nodules. This paper aims to further study the application value of MFI in the MWA process of thyroid nodules by comparing it with CEUS.

#### **S3A-SPIR-2 Reperfusion of Pulmonary Arteriovenous Malformations Treated by Catheter Embolization**

Guenther K. Schneider, MD, PhD (*Presenter*) Research Grant, Siemens AG; Speakers Bureau, Siemens AG; Speakers Bureau, Bracco Group; Research Grant, Bracco Group

## PURPOSE

339 patients with HHT (Osler disease) underwent screening for manifestation of the disease in the brain, the lung and the liver by one CE MRI study. In 144 patients at least one pulmonary AVM was found and catheter embolization using platinum coils or vascular plugs was performed with initial complete occlusion of the PAVM. However, especially in the lung reperfusion may occur due to reopening of the treated vessel itself or newly developed collateral vessels. The aim of our study was to evaluate patients post treatment of pulmonary AVM's for possible reperfusion.

## METHODS AND MATERIALS

Of 144 patients with previous treatment of PAVMs 117 patients underwent follow-up studies to detect reperfused PAVM by CE MRA. The mean follow-up period was 4 yrs and 8 month. For follow-up a time-resolved MRA was used with injection of a small CM bolus (0.025 mmol/kg BW MultiHance, Bracco). The temporal resolution of the sequence was < 3 sec/dataset with a total number of 72 slices. Thereafter a high resolution CE MRA (0.075 mmol/kg BW MultiHance) was performed. Images were evaluated regarding enhancement of the AVM and if detected, time of enhancement of the draining vein.

## RESULTS

In 77 of 117 patients no reperfusion in follow-up studies was found. In 35 patients reperfusion of the treated vessel and in 5 patients reperfusion of the PAVM was detected due to collateral vessels supplying the PAVM. In one patient reperfusion occurred due to systemic arterial supply from collaterals arising from the intercostal arteries. The mean time between embolization and detection of reperfusion in patients treated at our department was 6 years. 36 of 40 patients with reperfused PAVM were confirmed by DSA and underwent reembolization. In 4 cases supplying vessels were < 2mm and only further follow-up studies were performed. Reperfusion was detected both after coil embolization and implantation of Amplatzer vascular plug 4. The mean diameter of reperfused vessels was 4.6 mm (SD 1.4).

## CONCLUSION

Reperfusion of initially completely occluded PAVMs might even occur after longer time intervals thus regular follow-up studies are mandatory. CE MR-Angiography can reliably depict reperfusion of PAVM and evaluation of the enhancement kinetics of the draining vein was helpful to distinguish between retrograde filling, filling of the still dilated draining vein via normal lung tissue and reperfusion by reopening of shunt vessels or new collateral supply.

## CLINICAL RELEVANCE/APPLICATION

Reperfusion of embolized PAVM can occur in up to 35 percent of patients and early detection is mandatory to avoid complications e.g. stroke. Dynamic CE MRA directly depicts early enhancement of the draining vein as a sign of reperfusion and thus can give important additional information not gained in conventional acquisitions or CT.

## **S3A-SPiR-3 Comparative Prospective Analysis of Digital Variance Angiography and Digital Subtraction Angiography in Prostatic Artery Embolization: A Potential Solution for Radiation Dose Reduction**

Leona Alizadeh, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Prostatic Artery Embolization (PAE) is a complex vascular intervention that requires the use of X-ray angiography imaging with high doses of radiation and iodinated contrast agent. The purpose of this study was to compare the performance of Digital Variance Angiography (DVA) with standard Digital Subtraction Angiography (DSA) in PAE and to evaluate the potential of DVA to reduce radiation exposure and contrast agent use.

## METHODS AND MATERIALS

A prospective observational study was conducted on 26 patients (mean age 72, SD 14.6, range 49-89) in two groups (n=13): Group 1: standard CARE imaging protocol and Group 2: reduced detector dose and image quality pre-settings. All patients underwent PAE at our institution between January and December 2022. The study included a total of 107 acquisitions, from which DSA and DVA images were generated from the same raw series. The Contrast-to-Noise Ratio (CNR) values were calculated, and the image quality was assessed by four experienced readers using a 5-grade-Likert-scale in a randomized blinded survey. Radiation dose data was evaluated by assessment of dose-area-product (DAP) reference point air-kerma (RP), fluoroscopy times and image frames.

## RESULTS

The DVA images provided significantly higher CNR values compared to DSA images, with a median CNR of  $32.2 \pm 9.5$  in Group 1 and  $24.8 \pm 9.9$  for Group 2 vs.  $8.1 \pm 11.1$  for Group 1 DSA and  $7.3 \pm 9.3$  for Group 2 DSA,  $p < 0.001$ . Furthermore, the DVA images received significantly higher Likert scores compared to DSA images, with a median (IQR) value of 4.52 (4-5) for Group 1 DVA 4.12 (3-5) for Group 2 and 3.24 (3-4) for Group 1 DSA and 2.9 (2-4) for Group 2,  $p < 0.001$ . Mean radiation burden in Group 1 was significantly higher by -49% / -45% with a DAP  $17.85 \mu\text{Gy} \cdot \text{m}^2 / \text{frame}$  and RP 0.89 / frame compared to Group 2 with a DAP  $9.62 \mu\text{Gy} \cdot \text{m}^2 / \text{frame}$  and RP 0.49 / frame ( $p < 0.001$ ).

## CONCLUSION

The results of this study demonstrate that DVA has significantly higher CNR compared to DSA for both Groups in PAE procedures. The use of DVA could potentially provide a quality reserve that can be utilized for significant reduction of radiation exposure and iodinated contrast agent in PAE, up to 50-70% without compromising image quality. This may have a significant impact on patient safety during complex procedures such as PAE.

## CLINICAL RELEVANCE/APPLICATION

The implementation of DVA in PAE can significantly reduce radiation exposure, which is a critical factor for improving patient safety during complex vascular interventions. These findings suggest that DVA should be considered as an alternative to DSA in PAE and other similar procedures that require high-quality imaging while minimizing the risk of radiation exposure and potentially also contrast agent use.

## S3A-SPIR-4 Quantitative MRI-based Volumetric Analysis of Percutaneous Sclerotherapy Outcomes in Peripheral Extremity Venous Malformations

Amanda Laguna, BS (*Presenter*) Nothing to Disclose

### PURPOSE

To study the changes in MRI radiomic features occurring in peripheral venous malformations (VMs) after treatment using percutaneous sclerotherapy (PS).

### METHODS AND MATERIALS

Our vascular anomalies database was searched for patients with peripheral extremity VMs who were treated by image-guided PS and had completed their treatment plan, and clinical and imaging follow-up between 2005-2022. VMs were manually segmented on pre- and post-treatment T2-weighted (T2-WI) MRI using 3D Slicer software to assess changes in lesion volume and signal intensity (SI). To account for signal parameter differences between pre- and post-treatment T2-WI, the post-treatment T2-WI MRI signal was re-scaled to the pre-treatment T2-WI volume using a simple histogram matching algorithm, which allowed for precise and true calculation of SI change after PS. Therapeutic response was categorized as 0=worse or unchanged, and 1=improvement based on clinical evolution after treatment. Clinical outcome assessment was also scored on a 7-point scale, ranging from -3 (worst) to +3 (maximum improvement), based on patient's perception of symptom improvement. Spearman's rank correlation coefficient (?) and Paired t-test were used for statistical analysis.

### RESULTS

Eighty-one patients (mean age: 20±14 years; 47 females) with upper (23 lesions) and lower (58) extremity VMs underwent 125 PS treatments (range: 1-6). Different sclerosants were used: alcohol (52 sessions), bleomycin (38), and sotradecol (35). Most patients (77) reported clinical improvement following PS, including mild (8 patients), moderate (22), and significant (47) improvement. The mean change in lesion volume was  $-7.9 \pm 24.6 \text{ cm}^3$  ( $P=.005$ ) and in mean SI was  $-123.1 \pm 162.9$  ( $P<.001$ ). Overall, there was a significant correlation between change in lesion volume and treatment response ( $r=-.3$ ,  $P=.004$ ). On subgroup analysis, SI change correlated with clinical outcomes of VMs treated in one session ( $n=51$ ;  $r=-.3$ ,  $P=.01$ ), and VMs treated with bleomycin ( $n=22$ ;  $r=-.4$ ,  $P=.04$ ). While lesion volume change correlated with clinical outcomes of pediatric patients ( $n=50$ ;  $r=-.3$ ,  $P=.03$ ), VMs treated with sotradecol ( $n=17$ ;  $r=-.5$ ,  $P=.02$ ), and VMs located in the foot ( $n=10$ ;  $r=-.6$ ,  $P=.04$ ).

### CONCLUSION

MRI radiomic features including lesion volume and signal intensity correlate with the clinical outcomes for peripheral VMs treated using PS.

### CLINICAL RELEVANCE/APPLICATION

This study is first to investigate the relationship between signal intensity change of VMs and clinical outcome after PS. The study represents first step for application of complex, comprehensive radiomics in vascular malformations.

## S3A-SPIR-5 Efficacy of 50% Acetic Acid Sclerotherapy for Treatment of Simple Renal Cysts - Comparison of 5-Minutes Dwell time Technique and 3-Minutes Dwell Time Technique

INKEON YEO, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To compare long term follow-up treatment results of single-session sclerotherapy for renal cyst using 50% acetic acid 3-minute dwell technique with those using 50% acetic acid 5-minute dwell technique.

### METHODS AND MATERIALS

Total 101 simple renal cysts of 97 patients (M:F = 43:54, mean age - 63 ± 12.8 years) underwent single-session 50% acetic acid sclerotherapy using less than 5 minutes (35 cysts, Group I) or 3 minutes (66 cysts, Group II) dwell technique in our

institution. An acetic acid volume corresponding to a 5 ~ 40% (mean percentage- 13%) of the aspirated cyst volume was injected into the cysts and removed in less than 5 minutes or 3 minutes with position changes. Follow-up examination was performed using ultrasound or CT images at 3 to 6-months intervals for a minimum of 1 year. All patients were retrospectively reviewed on the therapeutic response and complications. The response was classified as either complete remission (volume reduction, = 95%), partial remission (volume reduction, 50-95%), or failure (volume reduction, = 50%).

## **RESULTS**

In 97 simple renal cysts, complete remission on follow-up was observed in 22 of 35 cysts (62.9%) in group I and 46 of 66 cysts (69.7%) in group II. The partial remission on follow-up was observed in 11 of 35 cysts (37.1%) in group I and 20 of 66 cysts (30.3%) in group II. There was no failure in both groups. There were no statistically significant differences in the complete remission and partial remission between the two groups. There was mild post procedure complication in 25 patients, but no major procedure related complication.

## **CONCLUSION**

Single-session 50% acetic acid sclerotherapy for the treatment of simple renal cysts using less than 3 minutes dwell technique is an effective and safe therapeutic option for simple renal cyst. 50% acetic acid sclerotherapy with a 3 minutes dwell time, using a volume of about 10% of the aspirated volume, is sufficient for satisfactory results of simple renal cyst sclerotherapy when compared with 50% acetic acid sclerotherapy using 5 minutes dwell time.

## **CLINICAL RELEVANCE/APPLICATION**

50% acetic acid sclerotherapy show higher complete remission rate than any other ethanol one session sclerotherapy and, also show acetic acid sclerotherapy with 3 minute dwell time is sufficient for complete remission of renal cysts.

## **S3A-SPiR-6 Quantification and Analysis of Radiation Dose from Fluoroscopically Guided Prostate Artery Embolization Procedures**

Rasha S. Makkia, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To quantify patient radiation exposure during PAE and provide radiometric data to inform clinical decision-making regarding the radiation-related deterministic and stochastic risks versus the relative benefits of PAE.

## **METHODS AND MATERIALS**

121 PAE procedures were performed between 2018 and 2021 at Yale New Haven Hospital, CT. The collected patient data followed an IRB-approved protocol, including age, height, body weight, and metal implants or contrast in the bladder during the procedure. Dosimetric data included total procedure time, total fluoroscopy time, Cumulative-Air-Kerma (CAK), Kerma-Area-Product (KAP) from fluoroscopy, and total KAP. These dosimetric data were analyzed using Radimetrics software (Bayer HealthCare, NJ). As a surrogate for stochastic risk, the effective dose from each PAE was computed by multiplying the total KAP using a conversion factor of 0.11mSv.Gy-1.cm-2 derived from values in published literature. PAE effective doses were then compared to abdominal-pelvic CT exams for patients who had individual abdominal-pelvic CTs. The CT effective dose was calculated by multiplying the DLP using the standard conversion factor of 0.015mSv.Gy-1.cm-1. To account for patient size, for each patient, a ratio was derived between the effective dose from PAE and that from abdominal-pelvic CT. To examine the likelihood of deterministic effects, peak skin dose (PSD) calculations were performed for PAE patients with a CAK greater than 3Gy using an in-house Matlab algorithm (MathWorks, MA).

## **RESULTS**

The average PAE procedure and fluoroscopy took 150 minutes and 37.1 minutes, accordingly. KAP and CAK had a mean value of 280Gy.cm<sup>2</sup>, and 2.145Gy. The average effective dose from PAE fluoroscopy was 30.8 mSv and the effective dose from CT was 9.1mSv. The average ratio was 4.1; however, patients with CTs had a higher average PAE dose than patients without CTs due to greater use of CBCT, DSA, and larger field sizes in earlier patients. PSD was calculated for any PAE exam with a CAK greater than 3Gy. 12 exams had a CAK between 3 and 4Gy, 6 had a CAK between 4 and 5Gy and only 2 had a CAK greater than 5Gy. The maximum PSD calculations were 4Gy and 4.1Gy. There were no deterministic complications reported within 90 days after PAE.

## **CONCLUSION**

This quantification data helps provide a standard for which clinicians can draw accurate judgments regarding the risks of PAE and can provide a standard for interventionalists to compare their own procedural radiation dosages during PAE.

## **CLINICAL RELEVANCE/APPLICATION**

Benign prostatic hyperplasia is a worldwide health problem that significantly impacts men's quality of life. When radiation safety guidelines are followed, it offers effective treatment with a low risk of deterministic or stochastic radiation-related injuries.

## Abstract Archives of the RSNA, 2023

S3A-SPMK

### Musculoskeletal Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPMK- Shear Wave Elastosonography Applied to Synovitis: A Preliminary Study**

1

Salvatore Marsico (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to evaluate the utility of shear wave elastosonography (SWE) to identify synovitis in patients who had a history of arthritis within the diagnosis of a defined rheumatological disease.

#### **METHODS AND MATERIALS**

We performed a B-mode and SWE (US) to a total number of 58 participants divided in 2 groups: group 1 included 29 patients with confirmed active wrist and/or hand synovitis; group 2 included 29 healthy volunteers without suspicion of synovitis. In a subset of patients (n=8), the joint count and the rest of the disease evaluation were performed to the elastosonography to study the correlation between the clinical and radiological findings.

#### **RESULTS**

The difference in both the mean maximum kPa value and the average joint kPa value was statistically significant between cases and controls: maximum kPa value cases  $38.14 \pm 35.08$  kPa, controls  $4.72 \pm 5.93$  kPa; average joint value cases  $29.77 \pm 26.07$ , controls  $4.17 \pm 5.22$ . The most frequent place to find joint effusion in both cases and controls was the dorsal radiocarpal joint: 41.4% of controls, mean kPa value of  $7.66 \pm 5.39$  kPa, 58.6% of cases, mean kPa value  $40.61 \pm 40.76$  kPa (p-value 0.004). kPa values correlated with disease activity measurements in the 8 patients clinically evaluated at the moment of the SWE.

#### **CONCLUSION**

SWE is a promising technique that may have a role in the diagnosis and assessment of synovial inflammatory activity.

#### **CLINICAL RELEVANCE/APPLICATION**

New semiquantitative ultrasound technique in the diagnosis and in monitoring of therapy of synovitis.

#### **S3A-SPMK- Zero Time-to-Echo Imaging of the Hand and Wrist in Patients with Rheumatoid Arthritis: Comparison with Radiography and Conventional MRI using CT as Gold Standard**

2

Jun Tsukamoto, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Zero echo time (ZTE) imaging has been developed to detect signals from the objects with extremely short T2\* value, and this sequence can generate CT-like images from MRI after gray-scale inversion. The aim of this study is to compare ZTE imaging with radiography for the detection of hand and wrist bone erosions in patients with rheumatoid arthritis (RA), using CT as the reference method.

#### **METHODS AND MATERIALS**

The study was approved by the local ethics committee, and written consent was obtained from all patients. From December 2022 to April 2023, nine consecutive patients with RA were included in this prospective study. They underwent radiography, MRI at 3T (conventional T1-weighted and fat-suppressed T2-weighted imaging, and ZTE imaging), and CT of the bilateral hand and wrist on within 2 weeks. MRI evaluation was performed according to the Outcome Measures in Rheumatology Clinical Trials (OMERACT) recommendations. Two certificated radiologists evaluated the images from the three imaging modalities. Bone erosion on images was independently reviewed by the 2 certificated radiologists with a four-point scale (0;

normal, 1; discrete erosion, 2; less than 50% of the joint surface, 3; more than 50% of the joint surface). The images were evaluated for bone erosion in 25 sites in each finger and wrist, including the distal radius, the distal ulna, the 8 carpal bones, the first through fifth bases of metacarpal bones, and the proximal and distal aspects of first through fifth metacarpophalangeal joints. One experienced musculoskeletal radiologist performed the CT evaluation and set the findings as gold standard.

## RESULTS

With CT as the reference method for bone erosions, the sensitivity and specificity of plain radiography, conventional MRI, and ZTE were 51.6/95.3%, 71.1/90.4%, and 93.8/96.3%, respectively. Overall diagnostic performance was significantly better at ZTE than at radiography and conventional MRI images ( $P < .01$ ). Interobserver agreement on bone erosion assessment was excellent for ZTE imaging ( $\kappa$  value of 0.815) but was not excellent for radiography ( $\kappa$  value of 0.496) and conventional MRI ( $\kappa$  value of 0.648).

## CONCLUSION

Zero time-to-echo imaging can provide reliable bone erosion assessment in RA patients.

## CLINICAL RELEVANCE/APPLICATION

Zero time-to-echo imaging is superior to plain radiography and almost comparable to CT for the detection of bone erosion in RA patients. It can be readily incorporated into the clinical workflow in addition to conventional MRI.

## S3A-SPMK- Ultra-high-resolution Photon-counting Detector CT Arthrography of the Ankle: A Feasibility Study

Karsten S. Luetkens, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Assessing the stability of chondral lesions represents a crucial diagnostic imaging task in musculoskeletal imaging, as chondral delamination and subchondral pathologies may not be visible in direct arthroscopy but impact therapeutic concepts. This study was designed to investigate the image quality of ultra-high-resolution ankle arthrography employing photon-counting detector CT.

## METHODS AND MATERIALS

A board-certified radiologist with nine years of experience in musculoskeletal imaging performed bilateral ankle arthrographies in all four cadaveric specimens using ultrasound for guidance. Bilateral arthrograms were acquired in four cadaveric specimens with full-dose (10 mGy) and low-dose (3 mGy) scan protocols. Three convolution kernels with different spatial frequencies were utilized for image reconstruction ( $\#50$ ; Br98: 39.0, Br84: 22.6, Br76: 16.5 lp/cm). Seven radiologists subjectively assessed image quality regarding the depiction of bone, hyaline cartilage, and ligaments. Additional quantitative assessment comprised the measurement of noise and computation of contrast-to-noise ratios (CNR).

## RESULTS

While optimal depiction of bone tissue was achieved with the ultra-sharp Br98 kernel ( $p=0.043$ ), visualization of cartilage improved with lower modulation transfer functions at each dose level ( $p=0.014$ ). Interrater reliability was good to excellent for all assessed tissues (intraclass correlation coefficient = 0.805). Noise levels in subcutaneous fat decreased with reduced spatial frequency ( $p < 0.001$ ). Notably, low-dose Br76 matched CNR of full-dose Br84 ( $p > 0.999$ ) and superseded Br98 ( $p < 0.001$ ) in all tissues. No dose-dependent difference was ascertained for any of the tissues with Br98 ( $p > 0.999$ ).

## CONCLUSION

Based on the reported results, photon-counting detector CT arthrography of the ankle with ultra-high-resolution collimation offers stellar image quality and tissue assessability. While bone depiction was found to be superior in combination with an ultra-sharp convolution kernel, soft tissue evaluation benefited from employing lower spatial frequency.

## CLINICAL RELEVANCE/APPLICATION

Photon-counting detector CT arthrography is feasible and allows for depicting even minute anatomy at low radiation dose. The inherent advantages regarding imaging of thin layers of hyaline cartilage ought to be pursued further.

## S3A-SPMK- Frequency of Peroneal Compartment Pathology in a Large Series of Ankle MRIs from a Tertiary Care County US Hospital: Imaging-based Epidemiological Study

Muhammad R. Akram, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Peroneal compartment pathology is a frequently misdiagnosed finding or underdiagnosed as simple ankle ligament sprains in patients presenting to the healthcare system with ankle injuries. High-resolution magnetic resonance imaging allows timely identification of these injuries for outlining appropriate treatment. However, these lesions have been studied in only a few



small case series, convenient samples, or review articles. The aim of this study was to elucidate the frequency of peroneal compartment pathology in a large series of patients presenting for ankle MRIs with ankle pain and/or injury in our tertiary care county system with the hypothesis that peroneal lesions are a frequent finding.

## **METHODS AND MATERIALS**

A consecutive series of 373 patients with suspected ankle internal derangement at a tertiary care county hospital (ages 13-87 years, all genders) were included. All had undergone 3 Tesla ankle MR imaging with standardized institutional MR imaging protocols. The structured reports were data-mined, and all scans were re-reviewed by a fellowship-trained musculoskeletal radiologist. Any scans performed for tumors or infections were excluded. The scans were re-analyzed for peroneal longus (PL) and peroneal brevis (PB) tenosynovitis and tendinopathy using previously described criteria for pathology in the literature. Descriptive statistics were performed.

## **RESULTS**

There were 404 MRIs from 373 patients, with 292 MRIs (72.3%) from 267 females and 112 MRIs (27.7%) from 106 males. Only 98 (24.3%) MRIs had normal peroneal compartments, and 306 MRIs (75.7%) had ankles with peroneal findings. There were 51 (12.6%) cases of PB tenosynovitis, 57 (14.1%) cases of PL tenosynovitis, 148 (36.6%) cases of PB tendinopathy, 239 (59.2%) cases of PL tendinopathy, 95 (23.5%) partial PB tendon tears, 8 (2.0%) partial PL tendon tears, 2 (0.5%) complete PB tendon tears, and 1 (0.2%) complete PL tendon tear. Peroneal longus tendinopathy was the most common finding.

## **CONCLUSION**

Peroneal compartment pathology is frequent on high-resolution 3T ankle MRIs performed for internal derangements.

## **CLINICAL RELEVANCE/APPLICATION**

The ankle MRI reader should pay close attention to peroneal compartment lesions while evaluating for ankle derangement, as these lesions are frequent.

## **S3A-SPMK- Clinical Application of a Deep Learning Model for Osteoporosis Screening using Chest X-rays Taken During Lung Cancer Screening**

YOICHI SATO, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The number of patients suffering from age-related osteoporosis is increasing worldwide. In Japan, osteoporosis screening is conducted in municipalities throughout the country for early detection and treatment, but the screening uptake rate remains at around 5%. To address this issue, we developed a deep learning model to test for osteoporosis from chest X-rays as a new screening method. In Japan, approximately 40 million people undergo lung cancer screening annually, which includes chest X-rays. We focused on this point and conducted a demonstration experiment, believing that it would be possible to screen a large number of citizens for osteoporosis by simultaneously assessing osteoporosis using chest X-rays taken during lung cancer screening.

## **METHODS AND MATERIALS**

The demonstration was conducted in a medium-sized city in Japan with a population of 80,000 from Apr 2022 to Apr 2023. In this city, a medical association was contracted by the local government to conduct lung cancer screening. The examinees had chest X-rays taken at 25 clinics in the city. The chest X-rays are then sent to the medical association's health checkup center for secondary reading. We installed an AI algorithm at the center and performed AI analysis on the chest X-rays of the examinees who had given their consent in advance. The examinees who were found to be in need of further examination (YAM<80%) visited an orthopedic hospital in the city and underwent a bone density test using the DEXA method. Based on the examination and test results, medication was started for those examinees who needed therapeutic intervention. The study obtained the number of people who underwent lung cancer screening, the number of people who consented to AI analysis, the number of people who required inspection, the number of people who visited orthopaedic clinics, and the number of people diagnosed and treated for osteoporosis.

## **RESULTS**

5,290 patients underwent lung cancer screening. Of these, 3,324 patients consented to AI analysis, excluding those already undergoing osteoporosis treatment. Of these, 1,848 patients required further examination. After examination and DEXA, 497 patients were diagnosed with osteoporosis, and treatment was initiated.

## **CONCLUSION**

The study suggested the usefulness of screening for osteoporosis using chest X-rays taken during lung cancer screening.

## **CLINICAL RELEVANCE/APPLICATION**

The conventional osteoporosis screening examined 185 individuals yearly. By utilizing chest radiographs for screening, 3,324 people could be screened, roughly 18 times more. This method detected about 497 osteoporosis patients, enabling treatment

initiation. It's estimated that this approach could prevent 16 hip fractures and reduce medical and nursing care costs by about 29 million yen.

### **S3A-SPMK- Application of a Deep Learning Algorithm in Detection of Hardware Complications for the Post-Operative Hip**

Jin Rong Tan, MD, FRCR (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The most common mechanical failure in the internal fixation of trochanteric hip fractures is the cutout of the sliding screw through the femoral head, with the incidence ranging from 0 to 16.5%. Radiography remains the mainstay for evaluation, both in the immediate postoperative period and at long-term follow-up. The clinical and radiological progression of hardware complications including cutout is often insidious, and can be missed especially in limited resource settings. There is relatively limited literature on the application of deep learning to assess hardware complications on radiographs. Hence, we aim to evaluate the performance of a deep convolutional neural network (DCNN) in detecting and localising implant cutout on plain frontal pelvic radiographs.

#### **METHODS AND MATERIALS**

A DCNN was developed using 32,152 pelvic radiographs containing fixation hardware acquired from the emergency department and orthopaedic clinics between January 2016 and December 2020, of which 24,114 and 8,038 were allocated for training (75%) and validation (25%) sets respectively. Presence of cutout was defined as protrusion of the fixation hardware beyond the cortical margins. To determine ground truth labels (cutout present or absent), all radiographs were individually read by 2 board-certified consultant musculoskeletal subspecialty radiologists blinded to the accompanying radiology reports. In doubtful cases, the accompanying report and all imaging performed in the following 6 months were reviewed. Final decision was made by consensus between the 2 musculoskeletal radiologists. Algorithm performance was evaluated with a hold-out test dataset of 8,039 radiographs of which 53 (0.66%) were positive for cutout. The authors also used the visualization algorithm gradient-weighted class activation mapping (Grad-CAM) to assess localization accuracy.

#### **RESULTS**

The algorithm achieved an accuracy of 99.5%, a sensitivity of 83%, a specificity of 99.6%, and an AUC of 0.992 for identifying implant cutout. The visualization algorithm showed an accuracy of 25%. Of the 44 true positive cases accurately predicted, there were 11 (25%) instances where the model correctly identified an activation site.

#### **CONCLUSION**

A DCNN can detect implant cutout on PXR with a high accuracy and might assist clinicians to assess the presence of post-operative hardware complications including implant cutout. However, the visualization algorithm is unable to accurately localize the site of cutout; this is work in progress at time of abstract submission

#### **CLINICAL RELEVANCE/APPLICATION**

A DCNN can detect implant cutout on PXR with a high accuracy and might assist clinicians to assess the presence of post-operative hardware complications including implant cutout.

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## Abstract Archives of the RSNA, 2023

S3A-SPMS

### Multisystem Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### S3A-SPMS-1 **Metabolic Outcomes of Aging and Obesity: A Longitudinal Study of the Dallas Heart Study Cohort**

Parker Davis, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to examine the metabolic risk factors in the longitudinal Dallas Heart Study (DHS) cohort. The baseline exam (DHS1) was conducted in 1999-2000, and the current 3rd phase exam (DHS3) has been enrolling since 2020.

#### METHODS AND MATERIALS

Subjects underwent a multi-2D axial T2-weighted spin-echo abdominal MRI (10mm axial section) in DHS1 on Philips 1.5T Intera at the baseline exam and a 3D volumetric T1-weighted gradient-echo whole-body MRI (5mm axial section) in DHS3 on Siemens 3T Prisma. Based on the DHS1 data, manual fat segmentation was previously completed on a single slice at L2-L3 measuring subcutaneous (SAT) and visceral (VAT) cross-sectional areas. On the DHS3 images, fat segmentations were performed on the same slice location corresponding with the subject's DHS1 segmentation. Changes in the segmented SAT and VAT areas between DHS1 and DHS3 were calculated. Subjects' height, weight, and serum laboratory values (lipids, cholesterol, glucose, and insulin) were collected for DHS1 and -3 exams, from which metabolic syndrome (MetS) risk factors were recorded (waist circumference  $\geq 88$ in for women,  $\geq 102$ in for men; blood pressure  $\geq 130/85$ ; LDL  $\geq 130$ ; HDL  $\leq 50$  for women,  $\leq 40$  for men; total cholesterol  $\geq 200$ ; triglycerides  $\geq 150$ ; fasting glucose  $\geq 100$ ; HOMA-IR  $\geq 2.73$ ) for both time points, and metabolic health was categorized as unhealthy ( $\geq 3$  risk factors) or healthy ( $\leq 3$  risk factors). The association between metabolic health and abdominal adiposity (SAT and VAT) was assessed using logistic regression, adjusting for age and sex as covariates.

#### RESULTS

192 subjects from the original DHS1 cohort have thus far returned for DHS3 examination. The median age of this interim cohort is 64 years (43 years at baseline). Over the 21 years, the median weight gain was +3.2 [interquartile range, -3.3, +9.3]kg, BMI gain +1.3 [-0.6, +3.6]kg/m<sup>2</sup>, SAT change +82 [18, 154]cm<sup>2</sup>, VAT change +33 [-9, +69]cm<sup>2</sup>. The prevalence of MetS increased from 53.6% to 63.3%, with 53.9% of previously metabolically healthy subjects becoming metabolically unhealthy in the interim, whereas 29.1% of previously metabolically unhealthy subjects became metabolically healthy. After adjustment for age and sex, VAT, but not SAT, was consistently associated with MetS over 20 years of aging. Gain in VAT was also associated with interval development of MetS in previously metabolically healthy subjects.

#### CONCLUSION

Visceral fat, rather than subcutaneous fat, is consistently associated with MetS through aging, and the gain in visceral fat is associated with the development of MetS.

#### CLINICAL RELEVANCE/APPLICATION

Our preliminary finding in this 20-year longitudinal cohort further strengthens the evidence that visceral fat is implicated in metabolic health.

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## Abstract Archives of the RSNA, 2023

S3A-SPNMMI

### Nuclear Medicine & Molecular Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPNMMI-2 Clinical Impact of Digital PET/CT Compared to Conventional PET/CT in Patients with Malignant Tumor for Initial Staging**

Naoto Kawaguchi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Digital PET/CT (dPET) systems have improved the detection of small lesions by increasing spatial and temporal resolution and have the potential to allow for accurate staging in patients with malignant tumor. The purpose of this study is to compare 18F-fluorodeoxyglucose (FDG) uptake of lesions and the diagnostic performance for initial disease staging of the dPET with conventional PET/CT (cPET).

#### **METHODS AND MATERIALS**

Between April and August 2020, 60 patients (mean age, 66±13 years; 31 males) with malignant tumors underwent a single FDG injection and both dPET and conventional cPET with a randomized scan order. We measured the maximum standardized uptake values (SUVmax) in up to 5 FDG-positive lesions per patients and compared them between the two scanners. Furthermore, two experienced readers independently diagnosed the initial disease staging using the TNM score (The eighth edition of the Union for International Cancer Control) or Lugano classification on both PET imaging. Cases of inconsistency between the two readers were finally determined by the third experienced reader. The final staging results for the two PET modalities were compared with the pathological diagnosis. The institutional ethics committee approved this study protocol in accordance with the ethical guidelines of the Declaration of Helsinki, and all patients provided informed consent.

#### **RESULTS**

One hundred and twenty-three lesions were analyzed. 14 lesions could only be measured only with dPET. In the remaining 109 lesions, SUVmax was significantly higher on the dPET compared to the cPET (12.0±7.8 vs. 8.5±7.0, p<0.01). Especially in 36 lesions less than 10 mm in diameter, the SUVmax with the dPET was higher in all lesions. 8 of the 60 cases showed differences in staging between the two PET modalities. dPET detected new lymph node metastases in five cases and bone metastasis in one case compared to cPET, four were true positives and two were false positives. Otherwise, the N-factor was changed in two cases on dPET compared to cPET, but one was true negative, and one could not be judged pathologically.

#### **CONCLUSION**

Our study showed that the dPET can better detect small lesions compared to cPET. dPET can have an impact on the diagnosis of metastasis in the initial staging of malignant tumor compared to cPET.

#### **CLINICAL RELEVANCE/APPLICATION**

New digital PET/CT can have a big impact on the diagnosis of metastasis in the initial staging of malignant tumor.

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## Abstract Archives of the RSNA, 2023

S3A-SPNPM

### Noninterpretive Skills (Beyond Imaging) Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPNPM-1** **Increasing Cost-effectiveness of CT-based Mobile Stroke Units in Germany: A Model-based Economic Analysis**

Johann S. Rink, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To analyze the design of Computed Tomography (CT) based Mobile Stroke Unit (MSU) programs and operating modes in order to identify major determinants and cut-offs that help improve cost-effectiveness and enable large-scale implementation of MSUs.

#### **METHODS AND MATERIALS**

Costs of different possible operating modes, varying operating hours including weekend and non-weekend coverage, and personnel were simulated for the German healthcare system. Ischemic stroke incidence, circadian distribution, rates of alternative diagnoses and stroke mimics were included as well as missed cases to model case coverage and patient-level costs in acute stroke care. Based on internationally reported stroke outcomes, a 5-year Markov-Model was used to analyze cost-effectiveness outcomes for varying catchment zone populations.

#### **RESULTS**

For a catchment zone of 400,000 inhabitants, the 7-day/16-hour MSU coverage resulted in the lowest cost of MSU deployment per ischemic stroke (USD 5,667) whereas the 7-day/24-hour model caused the highest costs (USD 8,285). Comparing stroke care delivered by MSU to regular emergency medical services, MSU achieved an incremental 0.06 quality-adjusted life years (QALY) on average, with an incremental cost-effectiveness ratio of USD 37,348 per QALY. Sensitivity analyses revealed that a catchment zone population below 400,000 inhabitants together with the effect of missing stroke cases at dispatch significantly increased patient-level costs of MSU care.

#### **CONCLUSION**

When setting up prospective MSU programs, cost-effectiveness can be addressed by taking into account major determinants of MSU operation: For the German healthcare system, the catchment zone should cover at least 400,000 inhabitants and operating modes should include weekend coverage and 12 to 16 hour daytime coverage. Measures to reduce the rate of missed strokes are advised.

#### **CLINICAL RELEVANCE/APPLICATION**

The economic evaluation of MSU programs aiming at identifying major determinants and thresholds could optimize efficient resource allocation and maximize MSU cost-effectiveness.

#### **S3A-SPNPM-2** **Economic Impact in the MRI Department using Artificial Intelligence in MRI Acquisitions**

Patricia M. Carrascosa, MD, PhD (*Presenter*) Speakers Bureau, General Electric Company

#### **PURPOSE**

The objective of this work is to project the economic impact of the use of Artificial Intelligence (AI) in an MRI scanner of our institution that has a high demand of scheduled studies between 8 AM to 8 PM. We previously performed an optimization of protocols and validated the new algorithm with AI in terms of image quality and diagnostic accuracy versus conventional studies determining the new time duration of the studies.

## METHODS AND MATERIALS

During one month we worked with AI system (AIR Recon DL, GE) in two 3T MRI scanners (Signa Architect; GE) in order to obtain the best sequences in terms of image quality, signal to noise and time duration of the studies. After finishing that phase we performed a research comparing the new length time for the sequences and agenda times for each study type, image quality and diagnostic accuracy between two experienced observers to analyzed AI and conventional studies of the same patient respectively. Results have shown no differences regarding diagnosis and image quality but with a significant reduction in scanning times. With that information we will project the economic impact of using AI system in the two scanners per month. The time reduction of the studies varied according to the region. We calculated according to the normal distribution of studies the total minutes regarding each type, we projected the new duration time applying AI, the gained difference in minutes and the additional studies that could be carried out. We calculated the increment in the percentage regarding the number of studies performed in the same time range and also in relation to the total number of patients.

## RESULTS

The most required studies at our centers were selected for the projection (knee, spine and brain MRI scans). Both scanning times and the assigned agenda time were reduced significantly using AI. The mean scan time without AI technology was 10.3 minutes, while using AI technology was 5.7 minutes. The mean assigned agenda time without AI technology was 16.6 minutes, while using AI technology was 10 minutes. The time reduction in the projected studies allowed to be able to perform a 638,5 more studies in both scanners in the same time that only 1111 were done. This corresponds to an increment of 57,64% .The global impact regarding the total scanners production would be a 36,6%.

## CONCLUSION

AI in MR is an excellent opportunity to increment the number of studies in centers with high demand and delayed accessibility .In this projection selecting only the more frequent studies required we could project an increment of 35 % in our monthly billing.

## CLINICAL RELEVANCE/APPLICATION

Artificial intelligence in MRI scan opens new horizons in terms of image quality, patients experience and cost effectiveness of the MRI department

## S3A-SPNPM-3 Testing the Ability of ChatGPT to Generate Differential Diagnoses from Transcribed Radiological Findings in Chest and Cardiac Imaging

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of specific chest and cardiac radiology cases.

## METHODS AND MATERIALS

A sample of 52 cases from adult and pediatric chest and cardiac imaging were evaluated. Cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

## RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 57.7% compared to 69.2% ( $p=0.11$ ) and 11.5% compared to 15.4% ( $p=0.28$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 48.1% compared to 55.8% ( $p=0.21$ ). ChatGPT3.5 and ChatGPT4 hallucinated 34.2% versus 9.6% ( $p=0.001$ ) of the references provided and generated 10 total false statements versus 4 total false statements, respectively.

## CONCLUSION

The two generations of ChatGPT were able to generate a differential diagnosis for prompts containing descriptive radiological findings. The contents of these responses matched the expert literature from which the cases originated a minority of the time, though a non-statistically significant improvement was made in the accuracy categories from 3.5 to the 4th generation algorithm. The well-known hallucination effect was encountered more commonly in citations produced than in statements made by the algorithm, both of which improved with the newest generation.

## **CLINICAL RELEVANCE/APPLICATION**

ChatGPT and Large Language Models (LLM) have a large potential to impact clinical and educational medicine. Knowledge of the accuracy and erroneous possibilities of these algorithms will provide a better understanding of the limitations of these new tools.

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## Abstract Archives of the RSNA, 2023

S3A-SPNR

### Neuroradiology Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPNR- Causal Associations of Genetically Determined Tinnitus with Neuroimaging Traits: Evidence from a Mendelian Randomization Study** 1

Jing Sun, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Potential reverse causality and unmeasured confounding factors are common biases in previous studies of the relationship between tinnitus and neuroanatomical features. Additionally, the causal association between neuroimaging features and the presence of tinnitus is unclear. The aim of this study was to investigate the causal role of tinnitus in the alteration of brain volumetric measures using Mendelian randomization (MR).

#### **METHODS AND MATERIALS**

Summary-level data from a genome-wide association study (GWAS) of tinnitus were derived from the UK Biobank (n = 117,882). GWAS summary statistics for total brain volume, white and gray matter volume and cerebrospinal fluid volume were also obtained (n = 33,224). A bidirectional MR analysis was performed to investigate the causal relationship between tinnitus and neuroanatomical features.

#### **RESULTS**

Genetic susceptibility to tinnitus was causally associated with increased white matter volume (odds ratio [OR] = 2.36, 95% confidence interval [CI] 1.03-5.39, p = 0.04) and total brain volume (OR = 2.39, 95% CI 1.05-5.46, p = 0.04) but inversely associated with cerebrospinal fluid volume (OR = 0.36, 95% CI 0.16-0.83, p = 0.02). However, no causal effect of total brain volume, white matter volume, gray matter volume, or cerebrospinal fluid volume on the presence of tinnitus was detected in the reverse MR study.

#### **CONCLUSION**

The genetically predicted risk of tinnitus was causally associated with higher white matter volume and total brain volume, independent of any confounding factors, while neuroanatomical features were not causally associated with the presence of tinnitus. Our findings provide evidence supporting the hypothesis that tinnitus has a neurodevelopmental origin at the genetic level.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings provide evidence supporting the hypothesis that tinnitus has a neurodevelopmental origin at the genetic level, further elucidating the underlying pathophysiological mechanisms of tinnitus-related brain anatomical impairment.

#### **S3A-SPNR- Improving Image Quality of Skull Base with Volume High Definition Reconstruction in a Wide-detector CT System** 10

Yanan Zhu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the image quality improvement for the skull base with a volume high definition (VHD) reconstruction algorithm on a 16cm wide-detector 256-row CT.

#### **METHODS AND MATERIALS**

Prospectively enrolled 40 adults (Group 1) for non-enhanced head CT on a 16cm wide-detector 256-row Revolution CT scanner. The CT numbers and their standard deviation (SD) of Medulla Oblongata, cerebellum, brain stem, basal frontal lobe

and centrum ovale (used as background) were measured to calculate signal to noise ratio (SNR) and artifact index (AI):  $AI = \sqrt{SD2(ROI) - SD2(\text{centrum ovale})}$ . These values were compared with those of 40 adults in Group 2 who underwent a non-enhanced head CT on a 64-row VCT. All subjects were scanned with a protocol of 120 kVp, and 1.0s rotation time. The tube currents were adjusted to have similar CT dose index (CTDI) for the two systems.

## RESULTS

There was no statistical difference in the age, thickness of occipital tuberosity, anteroposterior or trans diameters between the two groups. Compared with 64-row CT, the image noise (in HU) with the 256-row CT was reduced by 27% ( $4.39 \pm 0.68$  vs.  $6.00 \pm 1.10$ ) at the Medulla Oblongata, 24% ( $4.48 \pm 0.51$  vs.  $5.86 \pm 0.57$ ) at cerebellum, 33% ( $4.14 \pm 0.51$  vs.  $6.17 \pm 0.74$ ) at brain stem, 39% ( $3.84 \pm 0.58$  vs.  $6.30 \pm 1.19$ ) at the basal frontal lobe and 28% ( $3.16 \pm 0.37$  vs.  $4.36 \pm 0.42$ ) at centrum ovale. This resulted in an increase of 43%, 42%, 76% and 65% in SNR in the four regions, respectively. In addition, the artifacts index was significantly reduced with 256-row CT by 25% ( $2.95 \pm 0.95$  vs.  $3.93 \pm 1.61$ ) at Medulla Oblongata, 20% ( $3.05 \pm 0.93$  vs.  $3.83 \pm 0.88$ ) at cerebellum, 40% ( $2.54 \pm 0.92$  vs.  $4.26 \pm 1.14$ ) at brain stem, and 54% ( $2.00 \pm 1.14$  vs.  $4.33 \pm 1.83$ ) at the basal frontal lobe.

## CONCLUSION

The CT image quality of the skull base in terms of noise and artifacts was significantly improved on a 256-row wide-detector CT with VHD reconstruction algorithm, compared with a 64-row system at similar radiation dose.

## CLINICAL RELEVANCE/APPLICATION

Improved images of the skull base can be obtained on a wide-detector CT with VHD to overcome physical challenges such as cone beam and scattering, when keeping similar dose to 64-row CT.

## S3A-SPNR- Geniculate Ganglion Diverticulum: A Novel MRI Finding in Patient with Idiopathic Intracranial Hypertension

Ahmed Abdelmonem, MD, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

While patients with idiopathic intracranial hypertension (IIH) typically present with headache and/or visual disturbance, pulse-synchronous tinnitus (PST) and hearing loss can be the primary manifestations of this condition in a group of patients. The correct diagnosis for this group can be delayed. Although several MRI signs have been previously described to be associated with IIH, none have been proven to have a high positive predictive value (PPV). In this study, we tested the hypothesis that the presence of the geniculate ganglion diverticulum (GD) is a novel marker for the detection of IIH.

## METHODS AND MATERIALS

This is an IRB-approved single institution retrospective observational study. Brain MRI exams of patients referred by Otolaryngology division over the period of 10 years were reviewed. 400 MRI exams fulfilling inclusion and exclusion criteria were screened for presence of GD by two Neuroradiology fellows independently. In cases of discrepancy in image interpretation, an agreement was reached by reviewing images jointly. A matched control group of cases without GD was compiled. Brain MRI studies of all patients in this study were reviewed for presence of an "empty" sella appearance (ES), a known MRI sign of IIH. Electronic medical records of patients in this study were reviewed for presence of clinical manifestations of IIH. Receiver operator characteristic (ROC) curves were generated to estimate accuracy of each covariate in diagnosing IIH. Area under each ROC curve (AUC) was calculated to identify an accurate prognostic covariate. Statistical analysis was done using R programming language V 4.2.2.

## RESULTS

GD was visualized in MRI exams of 41 patients. GD was not present in the MRI exams of 359 patients. 61 patients were randomly selected from group of 359 patients that did not have GD. A total of 102 patients were included in this study. Studied groups had no significant differences in terms of age, gender, and BMI. GD and ES have a statistically significant correlation with IIH (P-value: < 0.001). There was no correlation between PST and GD (P-value: 0.83). Presence of unilateral or bilateral GD has a similar correlation with IIH (P-value: <0.001). AUC based on GD for predicting IIH was 0.84 (0.79- 0.89) and based on ES was 0.93 (0.89- 0.96). Negative predictive value of both GD and ES for IIH was 100%. PPV of GD for IIH was 31% and this value for ES was 52%.

## CONCLUSION

There was a statistically significant correlation between the presence of GD and the presence of IIH. There was no statistically significant correlation between the presence of GD and the presence of PST.

## CLINICAL RELEVANCE/APPLICATION

The presence of GD should raise the possibility of IIH, particularly in patients presenting with otologic manifestations such as PST and low-frequency hearing loss.

S3A-SPNR- Fenghua Long (*Presenter*) Nothing to Disclose  
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# Treatment Response Prediction in Major Depressive Disorder using Brain Magnetic Resonance Imaging: A Systematic Review and Meta-analysis

## PURPOSE

To quantify the value of

brain magnetic resonance imaging (MRI) in predicting major depressive disorder (MDD) treatment efficacy and to assess performance variations among interventions and biomarkers.

## METHODS AND MATERIALS

We searched eligible studies in PubMed, Embase, Web of Science, and Science Direct databases before March 22, 2023, using keywords "depress\*", "major depress\*", "MDD", "treatment outcome", "remission", "response", and "MRI". Information including individuals as responders/remitters or non-responders/non-remitters, sensitivity, and specificity were extracted. Logarithm of diagnostic odds ratios [ $\log(\text{DOR})$ ] was summarized, and forest plot was drawn. Sensitivity and specificity were conducted using Reitsma's random effect model. Area under curve (AUC) of summary receiver operating characteristic (SROC) curve was calculated. We conducted Deek's funnel plot asymmetry test to evaluate impact of publication bias. Subgroup analyses were conducted based on MRI modalities (structural MRI [sMRI], resting-state functional MRI [rs-fMRI], task-based fMRI [tb-fMRI]) and interventions (antidepressant and electroconvulsive therapy [ECT]). Antidepressants were subdivided into selective serotonin reuptake inhibitors (SSRI) and mixed medication groups. Meta-regression was conducted among subgroups.

## RESULTS

We included 44 studies with 2623 MDD participants. Overall, the SROC AUC was 0.875, sensitivity was 77.1%, specificity was 74.1%, and  $\log(\text{DOR})$  was 2.381. Deek's test indicated a negative correlation between effective sample size and  $\log(\text{DOR})$  ( $P = 0.008$ ). Rs-fMRI subgroup had higher predictive performance (79.3% sensitivity, 78.2% specificity, AUC 0.891) than tb-fMRI subgroup (74.9% sensitivity, 68.9% specificity, AUC 0.854) in terms of specificity in predicting treatment efficacy ( $P = 0.01$ ). No significant difference was found between sMRI and other modalities. No significant predicting differences were found in antidepressants and ECT, or among ECT, SSRI, and mixed group. Brain biomarkers located in limbic system and frontal were more frequently revealed contributing to prediction in antidepressant subgroup, such as functional connectivity between amygdala and anterior cingulate cortex, while those for ECT were often located in limbic system.

## CONCLUSION

Brain MRI has potential to predict MDD treatment efficacy, with rs-fMRI showing higher predictive performance. No significant difference were found between different interventions, but brain biomarkers located in limbic system and frontal lobe may provide clinical relevance.

## CLINICAL RELEVANCE/APPLICATION

Brain MRI biomarkers can predict treatment efficacy of MDD, reducing the financial burden, time of trial, and poor prognosis for patients.

## S3A-SPNR- 14 Comparative Analysis of Normative Brain Structural Volumes Between Singapore (SG) and Caucasian Population

Chi Long Ho, MD, FRCR (*Presenter*) Nothing to Disclose

## PURPOSE

Structural brain volumes vary due to differences in age, gender [males(M), females(F)], geographical location and ethnicity. Currently, MNI is most widely used brain template but it is limited to young/healthy Western population and not representative of other populations. We aim to compare differences between SG Chinese and Caucasian (Cau) brain volumes to address the need for age, gender-and-ethnicity-specific brain templates for accurate stereotactic standardization across structural brains from different individuals. Our aim is also to build a brain volumetry database for SG Chinese population (for now), which is currently lacking in Singapore.

## METHODS AND MATERIALS

Retrospective T1W MPRAGE brain (N:248) gathered from Parkinson's Progression Markers Initiative (PPMI-Caucasian) database and SG data (N:360) obtained from Sengkang General Hospital. FastSurfer (v2.0.4) used for brain segmentation into 21 regions (some left and right regions combined); brain volumes were normalized using total intracranial volume. Subjects divided into 5 age-groups: 31-40, 41-50, 51-60, 61-70, 71-80 years. If > 2 outliers were present, subjects were removed while the rest of outliers imputed with median (age-and-gender-matched). Wilcoxon tests (Bonferroni corrected) used for comparisons between SG and Cau.

## RESULTS

In 41-50 age-group, SG(M) have significantly greater cerebral white-matter than Cau(M), but the reversed is true for lateral ventricular volumes, while SG(F) have greater thalamus than Cau(F). SG(M+F) 51-60 age-group have significantly greater 3rd ventricle while SG(M) 71-80 age-group have greater inferior lateral ventricle and CSF compared to Cau(M). In SG 41-50 age-group, M have significantly smaller caudate, pallidum, sub-cortical gray matter, cortex, cerebellum white matter, corpus



callosum, cerebellum cortex, total gray matter, hippocampus, putamen, and thalamus than F. In SG 51-60 age-group, M have significantly greater 3rd ventricles than F while reversed is true for cerebellum white matter. In SG 71-80 age-group, M have significantly smaller caudate than F.

## **CONCLUSION**

There are differences in brain structure/volumes between SG and Cau across ages and gender. Building an age, gender-and-population-specific brain volumetry database is paramount to ensure accurate comparison and greater accuracy during brain registration, especially if comparison to neurological diseased states has to be made.

## **CLINICAL RELEVANCE/APPLICATION**

Normative brain volumetry database for specific age-group, gender and ethnicity ensures reliable differentiation of healthy from neurological diseased brains for early diagnosis and interventions.

## **S3A-SPNR- Brain Functional Connectivity Alterations in the Depressed Adolescents with Suicide Behaviors**

Wei Peng (*Presenter*) Nothing to Disclose

### **PURPOSE**

To investigate abnormalities of brain functional connectivity (FC) in both gray matter (GM) and white matter (WM) of depressed adolescents with suicide behaviors.

### **METHODS AND MATERIALS**

Participants included 38 depressed adolescents with suicide behaviors (SA) and 28 healthy control (HC) subjects. FC differences in both gray and white matters between the two groups were identified at whole brain level with FDR corrected, based on resting-state blood oxygenation level-dependent signals. Correlation analyses were further conducted to explore the relationships between FCs and cognitive ability reflected by Wsconsin card sorting test.

### **RESULTS**

Age and gender were well matched between two groups (SA mean age =14.8, HC mean age =15.0; 6males and 32 females in SA, 8 males and 20 females in HC). Compared to HC, SA group presented lower FCs in left orbitofrontal area-middle cerebellar peduncle (GM10WM22,  $t=5.43$ ), left orbitofrontal area-right superior cerebellar peduncle (GM10WM45,  $t=5.28$ ), left orbitofrontal area-right corticospinal tract (GM10WM48,  $t=5.18$ ), left ventral posterior cingulate cortex-left sagittal stratum (GM18GM13,  $t=4.47$ ), right ventral posterior cingulate cortex-left sagittal stratum (GM65WM13,  $t=4.55$ ), right associative visual cortex-left sagittal stratum (GM69WM13,  $t=3.57$ ), right primary visual cortex-left sagittal stratum (GM71WM13,  $t=4.79$ ), right superior temporal gyrus-left internal capsule (GM66WM8,  $t=4.00$ ), left middle temporal gyrus-left superior corona radiata (GM16WM10,  $t=6.91$ ), right anterior prefrontal cortex-right tapetum (GM73WM28,  $t=3.56$ ), left cingulate gyrus-right tapetum (WM15WM28,  $t=3.47$ ), and left orbitofrontal area-right tapetum (GM10WM28,  $t=4.95$ ). Correlation analyses further revealed that, FCs in GM18WM13 and GM65WM13 were positively associated with the percentage of correct response and negatively correlated with the perseverative response; FC in GM18WM13 was negatively associated with the percentage of perseverative errors; FC in GM71WM13 was positively associated with the percentage of correct response, and negatively associated with the perseverative response and the percentage of perseverative errors; FC in GM69WM13 was negatively correlated with the perseverative response and the percentage of perseverative errors.

### **CONCLUSION**

This study identified reduced FCs in essential brain areas of depressed adolescents with suicide behaviors, mainly located in the default mode network and visual network, which was related with impaired cognition.

### **CLINICAL RELEVANCE/APPLICATION**

The findings suggested the pathophysiology of suicide behaviors in depressed adolescents and might imply targeted brain areas for future treatment of suicide.

## **S3A-SPNR- Concurrent Structural and Perfusion Changes in the Brain in Migraineurs with Patent Foramen Ovale: A Perfusion Functional Magnetic Resonance Imaging Study**

Xiangcao Li, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To investigate the structural and perfusion alterations in the brain and their neural mechanisms in migraineurs with patent foramen ovale (PFO) by jointly applying magnetic resonance imaging in both structural and perfusion modalities.

### **METHODS AND MATERIALS**

Participants included migraineurs with PFO ( $n=20$ ) and healthy controls ( $n=28$ ), matched for age and gender. MRI data acquisition for all subjects was performed on a GE Discovery MR750W 3.0T. Scans were performed during the interictal period

of headache attacks in patients. The scanned sequences included T1 Flair, T2 Flair, T2 Propeller, 3D T1 Bravo, 3D pcASL sequences. Magnetic resonance image preprocessing and statistical analysis were performed on SPM8, SPM12, CAT12 in MATLAB 2018b. CAT12 and BrainNetViewer software were used to present the results.

## RESULTS

1. There was no statistical difference between the two groups of subjects in terms of gender and age composition ( $P > 0.05$ ). 2. VBM analysis was performed using total intracranial volume (TIV), gender, and age as covariates. The gray matter density was found to be reduced in the midbrain and the precuneus in the left inferior temporal gyrus, left middle temporal gyrus, left middle occipital gyrus, left lingual gyrus, left inferior occipital gyrus, and left hippocampus in the patient group ( $P > 0.05$ ). 3. SBM analysis was performed using age and gender as covariates. The depth of the sulcus in the insula, superior temporal gyrus, inferior frontal gyrus triangle, temporal pole, lateral prefrontal cortex, internal olfactory cortex, lingual gyrus, hippocampal gyrus, and talar parietal gyrus was found to be reduced in the patient group. The gyrification was reduced in the lateral occipital lobe, superior parietal lobule, cuneus, and precuneus ( $P > 0.05$ ). Comparisons between CBF groups were made using age and sex as covariates. CBF values were found to be elevated in the cerebellum as well as in the left perirhinal cortex, left lingual gyrus, and right lingual gyrus in the patient group. CBF values were decreased in the right middle frontal gyrus, right superior temporal gyrus, and right insula ( $P > 0.05$ ).

## CONCLUSION

Migraineurs with PFO were found to have multiple eigenvalue changes in brain structure and perfusion, and the brain regions with two or more eigenvalue changes were mainly located in the temporal lobe, frontal lobe, occipital lobe, insula, cuneus, precuneus, and cerebellum. It is suggested that subsequent studies could focus on observing the relevant brain regions.

## CLINICAL RELEVANCE/APPLICATION

This study lays the foundation for the pathological mechanism of the disease and the discovery of relevant imaging markers. It provides a basis for further research on the relatively specific brain mechanisms as well as the treatment of migraineurs with PFO.

## S3A-SPNR- Schizophrenia and Gray Matter Heterotopia in the Frontal Lobe: A Finding with Hitherto Little Attention Despite Nowadays High Resolution 3D MR Imaging

Christophe Arendt, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Only a handful of cases with gray matter heterotopia (GMH) in schizophrenia are described in the literature from the late '90s through MRI. Yet, postmortem studies detected heterotopic neurons in the white matter (WM) more frequently. The aim was to demonstrate their prevalence using images with higher spatial resolution than before.

## METHODS AND MATERIALS

Inpatients with schizophrenia and an institutional MRI were included in this retrospective study, and consecutive data sets of non-schizophrenic persons served as controls. Two independent radiologists, trained for neuroimaging and blinded to any clinical information, evaluated 3D T1-weighted gradient echo sequences (1 mm<sup>3</sup> voxel size; 1.5 and 3.0 T) to look for GMH. Number and location (periventricular/deeper WM; frontal, parietal, temporal or occipital) of GMH were assessed. Presence of periventricular cysts (PVC), enlarged clefts of the septum pellucidum (ECSP), dysgenesis of the corpus callosum (DCC), focal cortical dysplasia (FCD) and polymicrogyria (PMG) were noted, if present. A consensus for cases with disagreements was made in a second read. Fisher's exact and Pearson's  $\chi^2$  test were used to test for differences and relationships, respectively.

## RESULTS

From 01/2013 till 07/2021, MR scans of 214 cases (mean age, 42 yrs; 69% males) and 141 controls (mean age, 46 yrs; 50% males) were analyzed. There was a prevalence of 2.8% ( $n=6/214$ ) of GMH in the patient cohort versus 0% in non-schizophrenic persons ( $p=0.046$ ). All seven lesions were located in the frontal lobe; two of them on both sides in one patient and two patients with GMH in the deeper and not in the periventricular WM. Another finding that was found solely in the patient cohort was the presence of PVC ( $n=3/214$ , 1.4%;  $p=0.218$ ). ECSP were detected in both groups ( $n=6/214$ , 2.8% vs.  $n=4/141$ , 2.8%;  $p=0.613$ ). Raters did not detect DCC, FCD or PMG in both cohorts. There were no relationships between GMH and PVC ( $\chi^2=0.052$ ;  $p=0.950$ ), GMH and ECSP ( $\chi^2=0.177$ ;  $p=0.841$ ), and PVC and ECSP ( $\chi^2=0.088$ ;  $p=0.918$ ). No associations between GMH and baseline characteristics or pre-existing conditions could be made.

## CONCLUSION

GMH in schizophrenia were found more frequently than expected, as indicated by a prevalence of 2.8%, which might be due to the nowadays higher resolution of structural MRI. All lesions were found in the frontal lobe and even in the deeper WM. Other findings were PVC and ECSP, the latter being also present in controls with almost the same frequency. Interestingly, there were no associations between GMH and epilepsy.

## CLINICAL RELEVANCE/APPLICATION

High resolution 3D T1-weighting detected GMH in 2.8% of schizophrenic patients. These findings may inform personalized approaches to intervention such as in treatment-resistance despite good compliance.

### **S3A-SPNR- Multiclass Radiomics-based Models for Pediatric Low-Grade Neuroepithelial Tumors** **7 Molecular Subtype Identification Based on Open-Radiomics Protocol**

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Pediatric Low-Grade Neuroepithelial Tumor (PLGNT) is the most common type of brain tumor in children, and radiomics-based machine learning (ML) models have been shown to be effective for classifying BRAF fusion and BRAF V600E mutation PLGNT molecular subtypes. We investigate the effect of MRI sequence, image normalization, and radiomics extraction hyperparameters using the Open-Radiomics protocol to provide reproducible results.

#### **METHODS AND MATERIALS**

Our REB-approved retrospectively acquired study cohort consisted of 339 children with PLGNT including 143 with BRAF fusion, 71 with BRAF V600E mutation, and 125 tumors with other molecular subtypes. MRI sequences included Fluid-Attenuated Inversion Recovery (FLAIR), T1-weighted (T1), gadolinium-based contrast agent (GBCA) enhanced T1-weighted (T1CE), and T2-weighted (T2) sequences images. Tumor segmentations were provided by a pediatric neuroradiology fellow and verified by a senior pediatric neuroradiologist. PyRadiomics was used for extracting the radiomics features from the regions of interest. We created 72 radiomics datasets using a combination of 4 sequences, 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), and 6 image normalization methods (NoNormalization, MinMax, ZScore, Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient). We used Random Forest classifiers. For each radiomics dataset, we repeated the train-validation-test (60/20/20) experiment with different data splits and model random states 100 times (7200 tests) and calculated the Area Under ROC Curve (AUC).

#### **RESULTS**

We achieved a test AUC of 0.880 with 95% Confidence Interval (CI) [0.879, 0.882] for BRAF fusion vs BRAF V600E mutation binary classification. The highest average test performance for a specific dataset was achieved using MinMax normalization and binWidth of 25 on T1CE (AUC: 0.890). For 3-class classification, the average one-vs-the-rest (OvR) AUC was 0.789 with 95% CI [0.786, 0.792]. The top-performing dataset was ZScore, binWidth 15, FLAIR, with an average test AUC of 0.816. Unlike binWidth and image normalization, different imaging sequences resulted in statistically significant differences in AUC in both binary and multiclass scenarios.

#### **CONCLUSION**

Among the four imaging sequences in the dataset, T1CE was the best for separating BRAF fusion from V600E mutation. However, radiomic features extracted from FLAIR images outperformed other sequences at differentiating BRAF fusion and mutation from the other subtypes.

## CLINICAL RELEVANCE/APPLICATION

Identification of the molecular subtype of PLGNT is important for treatment planning. Our comprehensive approach ensures that we capture best-performing and reproducible models.

### **S3A-SPNR- Multiclass Radiomics-based Machine Learning Models for Medulloblastoma Molecular** **8 Subtype Identification**

Khashayar Namdar, MSc, MEng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Medulloblastoma (MB) is an aggressive brain tumor in children and qualitative MR imaging features including tumor location within the cerebellum have been shown to differentiate MB subtypes. We develop radiomics-based machine learning (ML) models using MRI Fluid-Attenuated Inversion Recovery (FLAIR) images to classify four MB molecular subtypes (WNT, SHH, group 3, group 4). We follow the Open-Radiomics protocol to achieve reproducible results.

#### **METHODS AND MATERIALS**

Our REB-approved and retrospective study includes 104 pediatric patients with an age range of 1 to 17.2 years (mean age  $7.8 \pm 3.95$  years, 71 males, 68%). Tumor segmentations were provided by two pediatric neuroradiologists. PyRadiomics was used for extracting the radiomics features from the regions of interest (ROIs). The four MB molecular subgroups were identified based on next-generation sequencing panels, fluorescence in situ hybridization, and specialized testing (including RNA methylation array and DNA methylation array). The dataset included 44, 28, 20, and 12 cases of the WNT, SHH, group 3, and group 4 subgroups, respectively. We created 18 radiomics datasets using 3 sets of radiomics extraction hyperparameters (binWidth of 15, 25, 35), and 6 image normalization methods (NoNormalization, MinMax, ZScore,

Histogram Equalization, Gamma normalization with 0.5 and 1.5 as gamma coefficient). We used Random Forests as classifiers. For each radiomics dataset, we repeated the experiment with different data splits and model random state 100 times (1800 tests) and calculated the Area Under Receiver Operating Characteristic Curve (AUC).

## RESULTS

When classifying group 3 versus all other subgroups, we achieved an overall test AUC of 0.619 with 95% confidence interval (CI) [0.607, 0.631]. On 4-class classification, the average one-vs-the-rest AUC was 0.703 with 95% CI [0.690, 0.716]. The top-performing dataset was ZScore with binWidth 25, where we achieved average test AUC of 0.750. Analyzing per-class AUCs on the top-performing setting, the highest performance was noted for SHH vs others, where we achieved an average test AUC of 0.845. We also observed significantly higher AUC for group 3 vs others when switched to multiclass classification (0.668).

## CONCLUSION

Performance of radiomics-based ML models for identifying MB subtypes using MR images depends on the subtype, how the model is trained, and how the image is normalized. Our results show ZScore is the best image normalization technique and multiclass classification can improve per-class performance of the models.

## CLINICAL RELEVANCE/APPLICATION

Pretherapeutic identification of MB subtype is important for treatment planning for which we train and evaluate reproducible machine learning models.

## S3A-SPNR- Nodal Properties of Resting-State Brain Functional Network in Childhood and Adolescence

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Yu Tian (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to describe and compare the characteristics of changes in the nodal properties of brain functional networks during childhood and adolescence, revealing the developmental trajectories of different brain structures during development.

## METHODS AND MATERIALS

In this study, 42 healthy volunteers aged 6-18 years were right-handed primary and middle school students were recruited, and the subgroup analysis included children (6-12 years,  $n = 19$ ) and adolescents (13-18 years,  $n = 23$ ). Resting-state functional magnetic resonance imaging (fMRI) data were collected using a 3.0T MRI scanner. The topological properties of the functional brain network were analyzed using graph theory.

## RESULTS

Compared with the children group, the nodal efficiency of the superior frontal gyrus, middle frontal gyrus, left dorsolateral fusiform gyrus, and other brain regions in the adolescent group was significantly increased ( $P < 0.05$ , FDR correction) and positively correlated with age. The degree of centrality of the superior frontal gyrus, bilateral inferior frontal gyrus operculum, left medioventral fusiform gyrus, and other brain regions increased significantly ( $P < 0.05$ , FDR correction) and were positively correlated with age. The degree of centrality of the left dorsolateral fusiform gyrus, left rostral cuneus gyrus, and right medial superior occipital gyrus was significantly reduced ( $P < 0.05$ , FDR correction) and negatively correlated with age. The nodal shortest paths in the superior frontal gyrus, left ventrolateral fusiform gyrus, right superior parietal lobule, and other brain regions were significantly reduced ( $P < 0.05$ , FDR correction) and negatively correlated with age.

## CONCLUSION

The transmission efficiency of the brain core network gradually increased, and the subnetwork function gradually improved in children and adolescents with age. The functional development of each brain area in the occipital visual cortex was uneven and internally functionally differentiated.

## CLINICAL RELEVANCE/APPLICATION

Changes in the topological properties of brain functional network nodes during childhood and adolescence can provide more detailed and intuitive information on the rules of brain development. We believe that our study makes a significant contribution to the literature because it provides evidence-based findings that clinicians and healthcare providers can adopt in actual clinical settings.

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## Abstract Archives of the RSNA, 2023

S3A-SPOB

### OB/Gynecology Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPOB- Value Addition of Subspecialty Trained Experienced Readers for O-RADS MRI Scoring and Guiding Management for Patients with Adnexal Mass Referred to Gynecology Oncology Multidisciplinary Rounds in a Tertiary Center** 1

Ankush Jajodia, MBBS, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Assess the diagnostic accuracy, interobserver variability, and common lexical errors of the ACR O-RADS scoring system in staff radiologists with less experience and non-fellowship trained.

#### **METHODS AND MATERIALS**

Patients with an adnexal mass on standard post-contrast pelvic MRI and referred after initial interpretation by a staff radiologist (R3-lacking experience and fellowship experience) to gynec-oncology rounds in a tertiary center. Two fellowship-trained radiologists with different experience levels, R2 (2 years) and R1 (10 years), assigned O-RADS MRI scores independently. Diagnostic accuracies (ROC curve analysis) and agreement between readers were analyzed for each reader. Scores 4 and 5 were assigned malignant. R1 independently assigned misclassification if a malignant lesion scored = 3, a benign lesion scored = 4, or a non-adnexal mass was incorrectly categorized as benign or malignant.

#### **RESULTS**

Twelve malignant and 36 benign lesions included in the study were assigned O-RADS MRI score malignant (4,5) and benign (1,2,3) in 10 (20.8%) and 38 (79.2%), 15 (31.2%) and 33 (68.8%) and 45 (93.7%) and 3 (6.3%) by R1, R2, and R3 respectively. MR O-RADS score (4,5) associated with malignancy with diagnostic efficacy and areas under the curve values of 0.942 (95 % CI, 0.834-0.989), 0.579 (95 % CI, 0.428-0.720), and 0.553 (95 % CI, 0.403-0.697) obtained for readers R1, R2, and R3 respectively, with statistically significantly different between R1-R2 and R2-R3. Two and eleven lesions were incorrectly classified as benign by R1 and R3 readers. Inter-observer agreement interpretation obtained k values was fair between all readers; 0.435 (95 % CI, 0.224-0.646) for R1-R2, 0.441 (95 % CI, 0.238-0.645) for R2-R3, and 0.440 (95 % CI, 0.192-0.687) for R2-R3 respectively. There were nine correct upgrades and seven correct downgrades to malignant and benign categories by experienced R1 readers. Misclassification in nonexperienced readers was due to misinterpretation of solid tissue (n=14), incorrect interpretation of diffusion images (n=10), and incorrect interpretation of non-dynamic contrast enhancement (n=7).

#### **CONCLUSION**

Additional interpretation by experienced readers provides incremental diagnostic accuracies in the MR O-RADS score.

#### **CLINICAL RELEVANCE/APPLICATION**

Experienced readers correctly upgraded 18% malignant lesions with fair inter-observer agreement among readers with various experiences, although the diagnostic accuracies were significantly different between readers. Unnecessary biopsy was avoided in 14.5% by correct downgrading by experienced readers. Incorrect classification of 16% of lesions by experienced readers potentially highlights need to simplify the existing scoring system.

#### **S3A-SPOB- Accuracy of the Characterization of Adnexal Masses, Indeterminate at Ultrasonography, Using a Magnetic Resonance Imaging (MRI) Protocol without Contrast: External Validation of the Non-contrast MRI Adnex Score in a Multicentre setting** 2

Camilla Panico, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

The characterization of adnexal masses is critical to guide appropriate patient management. Up to 20% of adnexal masses remain uncharacterized after ultrasound and MRI is needed. The O-RADS MRI score relies on gadolinium-based contrast; however, avoiding contrast is sometimes preferable due to logistical and patient factors. A recent study proposed an alternative (Non-contrast MRI Adnex Score -NCMAS). The purpose of our study is to show the preliminary data of a multicentric prospective evaluation of the NCMAS in characterizing the adnexal masses.

## **METHODS AND MATERIALS**

A multicenter observational prospective study has been set up including 16 standing Italian Centers. NCMAS is the Index Test; its aim is to predict the malignancy of the ovarian lesions on the basis of a NCMAS. The score is based on 5 categories. Two radiologists for each center (one senior and one junior) read the images, blinded to the clinical information of the patients except for age. The diagnostic end-point (absence/presence of the malignant tumor) is verified through histopathology after surgery or through radiological follow-up at 12 months. The diagnostic accuracy of NCMAS is evaluated by measuring sensitivity, specificity, positive and negative predictive values, and ROC curve with area under the curve (AUC). To measure agreement between senior and junior radiologist Kappa statistics is performed. This preliminary analysis includes 45 patients representing about 15% of the total patients to be recruited.

## **RESULTS**

Fifteen out of the 45 patients were classified as malignant using the NCMAS. Comparing these diagnoses with the gold standard we found: sensitivity of 85.71% (95% Conf. Int. 66.13%-98.22%), specificity of 90.32% (Conf. Int. 78,58%-97.96%), positive predictive value of 80% (Conf. Int. 59.54%-95.67%), negative predictive value 93.33% (Conf. Int: 52.78%-99.18%). The malignant lesions correctly classified were 88.89% (Conf. Int. 77.78%-96.29%). The AUC was 88.02% (Conf. Int. 77.14%-98.90%). As to the comparison between senior and junior radiologists, for a diagnosis of a malignant lesion, the agreement was 90.24%, with a Kappa statistic of 0.79 (Conf. Int. 0.59-0.985).

## **CONCLUSION**

The performance of NCMAS score was externally and prospectively confirmed. Even if found in about 15% of the total calculated sample size, the results are promising. If confirmed, the use of NCMAS may add an important tool in clinical practice when contrast imaging cannot be used for logistic or patient factors.

## **CLINICAL RELEVANCE/APPLICATION**

The results of this study may represent a confident support to the clinical use of non-contrast MRI in diagnosing adnexal masses, undetermined at ultrasonography

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## Abstract Archives of the RSNA, 2023

S3A-SPPD

### Pediatric Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPPD- Cardiac Computed Tomography Angiography with and without Bolus Tracking Methods in Infants with Congenital Heart Disease** 1

Takayuki Yoshiura, BA, RT (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cardiac computed tomography angiography (CCTA) is useful in congenital heart disease (CHD) diagnosis and plays a major role in treatment. The bolus tracking (BT) methods can accurately predict the optimal scan delay that reflects the hemodynamics of the individual, but the drawback is the increased radiation dose due to pre-monitoring scans. This study aimed to compare the radiation dose, vascular CT number, and image quality of CCTA with and without BT methods for infants with CHD.

#### **METHODS AND MATERIALS**

This study retrospectively studied 72 consecutive patients with suspected CHD who underwent infant CCTA from December 2017 to April 2022, divided into groups with and without BT methods, in our information system. All scans were performed using a 64-detector row CT scanner (Lightspeed VCT; GE Healthcare, Milwaukee, Wisconsin) with the following parameters: rotation: 0.4 s, helical pitch: 1.375, slice thickness: 0.625 mm, tube voltage: 80 kVp, and automatic tube current modulation with a noise index of 40, iterative reconstruction (IR, blending of 30% of ASIR with FBP) algorithms under the standard kernel/filter reconstruction. Volume CT dose index (CTDI<sub>vol</sub>) and dose length product (DLP) were recorded for all CT scanning, and an effective dose was obtained using conversion factors. The CT number of the ascending aorta (AO) and pulmonary artery (PA), image noise of muscle tissue, and contrast-to-noise ratio (CNR) were measured and calculated.

#### **RESULTS**

The median values in the groups with and without BT were 2.20 mGy vs. 0.44 mGy for CTDI<sub>vol</sub>, 8.10 mGy·cm vs. 6.20 mGy·cm for DLP, and 0.66 mSv vs. 0.51 mSv for effective dose. The mean values in the groups with and without BT were 471.2 Hounsfield units (HU) and 515.6 HU for AO and 463.2 HU and 512.5 HU for PA, respectively. The mean image noise was 17.3 HU and 17.0 HU in the groups with and without BT ( $p = 0.76$ ), and the mean CNR was 23.9 and 26.5 in both groups ( $p = 0.21$ ).

#### **CONCLUSION**

CCTA for infants with CHD without BT methods can reduce the radiation dose while maintaining the CT enhancement of the vessels and image quality compared to CCTA with BT methods.

#### **CLINICAL RELEVANCE/APPLICATION**

CCTA for infants with CHD can ensure good image quality and reduce radiation dose without using the BT method.

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## Abstract Archives of the RSNA, 2023

S3A-SPPH

### Physics Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPPH- Improved Single-Shot GRASE with Flyback Variable Density Sampling and Deep Neural- 1 Network**

Zheng Zhong, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To enable highly accelerated (12X) single shot gradient and spin echo (ss-GRASE) sequence without appreciable image artifacts by incorporating flyback variable density sampling coupled to a deep neural network.

#### **METHODS AND MATERIALS**

**SS-GRASE with flyback variable density sampling:**The sequence diagram was shown in Figure A, where a 3-fold acceleration was achieved using three gradient echoes after each refocusing pulse. This was coupled with variable density sampling for a total of 12-fold acceleration. To minimize phase inconsistency among the gradient echoes, flyback acquisition was employed with three echoes each grouped into different regions of the k-space.**Data Acquisition:**With IRB approval, images were acquired using ss-GRASE on phantom and human brains on a GE 3T Premier scanner. Key sequence parameters were: TR/TE=300/100ms, slice thickness=3mm, FOV=28cm<sup>2</sup>, matrix=256×224, slices=30 to 40, parallel imaging factor=3. A total of 90 slices of phantom and 320 slices of the human brain were acquired. The experiment was repeated using variable density sampling SSFSE with the same parameters except for TR=700ms.**Image Reconstruction:**The acquired data from both ss-GRASE and SSFSE was reconstructed using the parallel imaging compressive sensing (PICS) algorithm provided by BART and fed into the neural network as input and output, respectively. A U-Net architecture was tailored to further remove artifacts from PICS reconstruction. The U-Net consists of a downsampling encoder and an upsampling decoder network with a mirrored and reversed encoder structure (Figure B). The network was trained on an NVIDIA Titan Xp 16GB graphics card. To avoid overfitting, weight-decay (0.01) and random rotation for data augmentation were applied. Adam optimizer was used with a learning rate of 0.0005 for 1000 epochs guided by MSE loss until convergence.

#### **RESULTS**

The second column of Figure C illustrates the artifacts of PICS reconstruction arising from the phase inconsistency of the three gradient echoes in ss-GRASE. The artifacts can be largely removed using the deep neural network, as evidenced by the improved image quality from both phantom and human brain images (third column).

#### **CONCLUSION**

The performance of the ss-GRASE sequence was substantially improved with a combination of flyback variable density sampling and a deep neural network. The deep neural network enables reduction of the artifacts which PICS reconstruction fails to address in ss-GRASE.

#### **CLINICAL RELEVANCE/APPLICATION**

The proposed approach of ss-GRASE enables improved acquisition speed (300ms/slice) and less SAR issue as compared to conventional SSFSE, implying further applications of the technique in freezing motion such as bowel imaging, and SAR-sensitive situations such as pediatric imaging.

#### **S3A-SPPH- Unpaired MR-CT Translation using Diffusion Model and Cross-modality Structure Extractor 10**

Junghyun Roh, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

For the breast cancer patients after surgery, MRI scans are required to identify the surgical site and determine the treatment plan, but radiotherapy planning requires extra CT scans. By developing the deep learning model to synthesize CT from MRI



images, physicians can reduce the time consumption and do treatment efficiently. Since a dataset containing paired MR and CT images with registration is difficult to be retrieved because of anatomical changes, unpaired MR-CT translation is the key to solve this problem. However, due to the information difference within MRI and CT, unpaired translation across the modalities is still a hard task to be done. In this paper, we propose a novel structure using a cycle-structured diffusion model and an extra algorithm for structure preservation.

## **METHODS AND MATERIALS**

The dataset we used is composed of 2D MRI (T2) and CT scans of the patients who underwent partial resection for breast cancer or did radiation therapy. Train set is composed of 3,606 MR scans and 2,770 CT scans from 62 patients, and 543 pairs of MRI and CT from 15 patients were used for test. The proposed model is composed of two generators: Diffusive and Non-Diffusive. Non-diffusive generator  $G'$  is used to make a reference for the diffusive generator  $G$ . Using the image  $G'(x)$  and noisy input  $x_t$ , the diffusive generator focuses on learning the target domain's structure and reconstructing the input image  $x$ . The Modality independent neighborhood descriptor (MIND) algorithm extracts the structural information using the similarity among adjacent patches. This descriptor makes a similar output for the same object regardless of its modality, so it can guide the unsupervised model to keep the structure. We compared our model's result with other unsupervised translation models by quantitative metrics: MSE, PSNR, and SSIM.

## **RESULTS**

By the metrics, we can know that our proposed model generates the most similar result with ground truth for both sides: MR to CT and CT to MR. The resulting image shows that the diffusive generator contributed well to build realistic images. Also, the MIND loss helped to solve the structure deformation problem, especially in CT to MR conversion.

## **CONCLUSION**

In this study, we showed bidirectional MR-CT unpaired translation functionality can be raised by adapting a diffusive generator as translation model. In addition, the proposed loss function in this paper can help maintain the structural information and compensate for the essential problem of unpaired translation.

## **CLINICAL RELEVANCE/APPLICATION**

The synthetic CT image generated by the proposed model and MRI can be used for dose calculation in radiation treatment planning for breast cancer. This method can help physicians to reduce the time consumption and establish precise treatment regions.

## **S3A-SPPH- The Superiority of Low-kV Renal Triphasic-enhanced CT with Deep Learning Image Reconstruction in Patient Care over the Conventional Enhanced CT Exam**

Xiaobo Ding, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate whether the deep learning image reconstruction (DLIR) can provide more patient care through the reduction of radiation dose and contrast agent volume for renal enhanced CT exam.

## **METHODS AND MATERIALS**

148 patients suspicious of renal lesion were included, 118 patients in the DLIR group and 30 in the conventional enhanced CT (CECT) group. The parameters for DLIR group: rotation speed of 0.5 s, collimation of 128×0.625 mm, pitch of 0.992:1, 50% ASIR-V, noise index (NI) of 9, automatic current modulation, standard kernel, 100 kV and mA range of 100-550 in the arterial phase (AP) and excretion phase (EP) and 120 kV and mA range of 150-500 in the parenchymal phase (PP); retrospective algorithm of DLIR. The volume and injection rate of contrast agent (320 mgI/ml) were 0.9 ml/kg and 3 ml/s. In CECT group: 120 kV, 281 mAs, collimation of 128×0.625 mm, pitch of 0.914:1, level 3 of iDose4, standard(B) filter for all phases. The volume and injection rate of contrast agent (320 mgI/ml) were 1.2 ml/kg and 2.7 ml/s. CT values and standard deviation (SD) of cortex, medulla, subcutaneous adipose tissue (SAT) on AP, parenchyma, pelvis and psoas muscle (PM) and SAT on PP, middle calyx (MC), upper ureter and middle ureter on EP were measured to calculate signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). SD of SAT was defined as background noise. Images were assessed by two readers using a 4-point scale (1. poor; 2. moderate; 3. good; 4. excellent). The CTDIvol and dose-length-product (DLP) was recorded. Student's t-test and Mann Whitney U test were used to analyze the differences between 2 groups.

## **RESULTS**

There was no difference in BMI between two groups (24.4 vs. 23.4,  $p>0.05$ ). CTDI, DLP and contrast agent volume of DLIR group were significantly lower than those of CECT group (23.7 vs. 70.8 mGy,  $p<0.001$ ; 744.1 vs. 2197.4 mGy[[Unsupported Character - Symbol Font #158;]]cm,  $p<0.001$ ; 62.4 vs. 77.8 ml,  $p<0.001$ ). SNR of parenchyma and upper ureter and CNR of cortex to medulla in DLIR group were significantly higher than those in CECT group (10.83 vs. 7.52; 19.45 vs. 7.12; 11.83 vs. 6.59;  $p<0.001$  each). The SD of SAT was lower in DLIR group, compared to CECT (9.08 vs. 11.11,  $p<0.001$ ). No differences in subjective scores were observed between two groups.

## CONCLUSION

Low-kV enhanced CT exam combined with DLIR algorithm is a feasible method for better patient care, compared to conventional enhanced CT exam.

## CLINICAL RELEVANCE/APPLICATION

The scan speed is faster and image quality is better for the deep learning algorithm of low-dose renal three-phase scan of GE revolution 256 row CT than that of conventional renal three-phase scan of Philips 128 row CT, which could significantly reduce the radiation dose and contrast agent dosage of patients, and reduce the burden of liver and kidney of patients.

## S3A-SPPH- Performance of an Artificial Intelligence-Based Real-time System for Breast Positioning Evaluation and Image Quality Control in Mammography 12

Ying Guo (*Presenter*) Nothing to Disclose

### PURPOSE

To investigate the effectiveness of an artificial intelligence (AI) system for automated assessment of breast positioning and image quality in mammography.

### METHODS AND MATERIALS

Assessment of breast positioning and image quality was performed by AI system and by two radiographers on 360 images of 90 women. Nine image quality criteria evaluating the appearance of the nipple, breast rotation, pectoral muscle, inframammary fold, pectoral nipple line, shoulder overlap shadow, abdominal skin, contralateral breast and foreign body were used for craniocaudal and mediolateral-oblique views. Image quality of cases were also evaluated with the standards of Mammography Quality Standards Act (MQSA) as grade "adequate" or "inadequate". Intraclass correlation and Cohen's kappa coefficient ( $\kappa$ ) were used to investigate the correlation and agreement between the radiographer's assessments and AI. The performance of the AI system was evaluated using accuracy, sensitivity, and specificity.

### RESULTS

The AI algorithm demonstrated high accuracy in distinguishing between adequate and inadequate images, with an overall accuracy of 93%, sensitivity of 94% and specificity of 92%. In terms of breast positioning, the AUC of poor imaging quality prediction by AI system according to incomplete gland, incomplete pectoralis muscle, over or insufficient exposure was (0.903 vs 0.937 vs 982). Overall accuracy of AI system was 0.958. Inter-observer agreement for breast positioning assessment indicating substantial agreement between the radiographers and AI system ( $\kappa=0.75$ ). A substantial to almost perfect agreement was observed between the radiographers and AI on the nipple in profile ( $\kappa = 0.93$ ) and contralateral breast criterion ( $\kappa = 0.82$ ). We observed a slight to moderate agreement for the other criteria ( $\kappa = 0.55-0.79$ ).

## CONCLUSION

The AI algorithm demonstrated high accuracy in distinguishing between high and low-quality images and detecting suboptimal breast positioning in mammography. The results showed a high level of agreement between the AI system and the radiographers.

## CLINICAL RELEVANCE/APPLICATION

The high accuracy, sensitivity, and specificity of an AI system for quality control in mammography suggest its potential as a valuable tool for radiologists and technologists in the clinical setting, particularly in low-resource areas where access to experienced radiologists may be limited.

## S3A-SPPH- Artificial Intelligence-based Triage of Breast Cancer Screening Mammograms in a Swiss Region: Possible Impact of AI Region's Score Cutoff on Radiologist Workload 13

Federica Zanca, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

To identify the optimal region's score cutoff when using an artificial intelligence (AI) cancer-detection software to triage negative screening examinations into a one-click reporting radiologist work stream, e.g. reader validation of the AI negative result.

### METHODS AND MATERIALS

This prospective multi-center simulation study aims at collecting about 10000 exams from a Swiss screening program. Preliminary data includes 3 months of screening mammograms. AI cancer-detection software (Transpara, Screenpoint Medical, v1.7.1) was used as a concurrent reading to detect potential abnormalities, for all exams collected. The software computes a region score for every marked area (soft tissue lesions and microcalcifications), indicating the likelihood of cancer on a scale from 0-98. Higher scores represent a higher likelihood of cancer. Based on these AI prediction scores, various cutoff points for the highest region score at the exam level (42, 49, 60, 74) were evaluated as thresholds to potentially

channel women to the one-click reporting work stream. The different cutoff points were assessed in terms of missed abnormalities. Mean, median and variance of the AI scores were calculated. Data were also stratified per lesion type and breast density.

## RESULTS

500 exams were examined, of which 12 were recalled for further examination (recall rate: 2.4%). Of these, 4 did not return, 5 were benign and 3 were diagnosed as cancer (biopsy proven), resulting in a 0.6% cancer incidence over one screening interval of 2 years. The mean, median and variance of AI scores were, respectively, 13, 0 and 564. There were respectively 0, 1, 2 and 2 missed cancers in case an AI score cutoff of 42, 49, 60 and 74 was used, corresponding to 0%, 0.2%, 0.4% and 0.4% of all screen-detected cancers in the population. The cutoffs of 42/49/60/74 correspond to 79%/87%/93%/99% of the workload. More data collection and stratification per lesion type and breast density is ongoing.

## CONCLUSION

Preliminary data suggests that a cutoff score of 42 would allow triaging breast cancer screening mammograms with a 99.9% negative predicted value (NPV) into a one-click reporting.

## CLINICAL RELEVANCE/APPLICATION

Using commercial AI software to triage mammogram workflow based on a 99.9% NPV could reduce radiologist workload by 78%.

### **S3A-SPPH- 2 Development of a Machine Learning Algorithm for Fat-free Mass Estimation: Application to Personalized Contrast Injection in Computed Tomography**

Natalie Heracleous, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Using fat-free mass (FFM) to personalize i.v. contrast volume injection enables reproducible target liver enhancement. However, measuring FFM requires expensive equipment and is time-consuming, limiting its applicability in clinical practice. This study aims at developing a Machine Learning (ML) model to accurately estimate the patient FFM.

## METHODS AND MATERIALS

Previously collected abdominal CT data from 689 adult patients referred for liver lesion characterization or cancer follow-up was used (11 centers, different CT vendors, 2018-2022). This dataset includes various patient characteristics and measurements such as age, gender, weight, height, Body Mass Index (BMI), Size Specific Dose Estimate (SSDE), and FFM measured with Bioelectrical Impedancemeter (ground truth (GT)). A multivariate linear regression model was developed for FFM estimation. The correlations of the investigated variables with measured FFM were studied, and the most correlating variables were retained in the final model. The data was divided into training and test sets following the 80/20 rule and were validated using the K-fold technique. The model's performance was evaluated against the GT using Mean Absolute Percentage Error (MAPE), Root Mean Squared Error (RMSE) and R-squared. Our algorithm was also benchmarked against models already existing in the literature by comparing the distributions of the relative differences between theoretical and measured FFM values when applied to our data.

## RESULTS

Preliminary results show a very good performance in predicting the FFM for our patient data sample. The cross-validation results showed the model to be robust for the typical patient profiles in our clinical settings. Specifically, the model showed low MAPE (0.033 +/- 0.003), high R2 (0.91 +/- 0.02) and relatively low standard deviation of residuals RMSE (2.13 +/- 0.23).

## CONCLUSION

Our model can reliably and efficiently estimate the patient FFM to personalize i.v. contrast volume in adult abdominal CT examinations, reducing the time required for its measurement and avoiding the need for expensive equipment.

## CLINICAL RELEVANCE/APPLICATION

The ability to accurately estimate FFM enables effortless personalization of contrast volume injection for a reproducible liver enhancement in clinical practice.

### **S3A-SPPH- 3 Evaluation of Unsupervised Low-dose Digital Breast Tomosynthesis Denoising using Cycle-consistent Generative Adversarial Network**

Tsutomu Gomi, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to evaluate the image quality improvement in digital breast tomosynthesis (DBT) with unsupervised cycle-consistent generative adversarial networks (cycle-GANs) during pre-reconstruction processing under low radiation exposure.

## METHODS AND MATERIALS

The cycle-GAN pre-reconstruction manipulation with filtered back projection (FBP) was compared with and without relative GAN techniques (unsupervised image-to-image translation: UNIT and supervised image-to-image translation: pix2pix). The peak signal-to-noise ratio (PSNR), mean square error (MSE), structural similarity (SSIM), and detectability index ( $d'$ ) in the in-focus plane and artifact spread function (ASF) in the longitudinal direction using a phantom (training; BR3D [model 020, CIRS Inc.], testing; DBT quality control [model 021, CIRS Inc.] and TOR-MAM [Leeds Test Objects Inc.]) at various radiation doses (automatic exposure control reference dose: 1.36 mGy: approximately 50% reduction of reference dose: 0.66 mGy; approximately 75% reduction of reference dose: 0.31 mGy) were used to compare noise reduction and preserved contrast rates.

## RESULTS

PSNR and MSE were similar to the references with cycle-GAN at 75% and pix2pix at 50% radiation dose reductions of reference, respectively (PSNR: cycle-GAN: 25.19 and 25.81, UNIT: 23.81 and 18.68, pix2pix: 26.46 and 25.92, without GAN (w/o-GAN): 26.03 and 24.07; MSE: cycle-GAN: 0.003 and 0.002, UNIT: 0.004 and 0.013, pix2pix: 0.002 and 0.002, w/o-GAN: 0.002 and 0.003, at 50% and 75% reduced radiation dose, respectively). The SSIM of the images generated by the cycle-GAN model at a 50% reduced radiation dose was similar to that of the reference images acquired at full radiation dose (cycle-GAN: 0.66 and 0.64, UNIT: 0.62 and 0.59, pix2pix: 0.64 and 0.62, w/o-GAN: 0.61 and 0.50 at 50% and 75% reduced radiation dose, respectively).  $d'$  was similar to the reference in cycle-GAN and pix2pix at 50% radiation dose reduction of reference (reference: 2.79, cycle-GAN: 2.80 and 2.71, UNIT: 2.64 and 2.46, pix2pix: 2.82, and 2.58, w/o-GAN: 2.73 and 1.89 at 50% and 75% reduced radiation dose, respectively). ASF revealed a similar distribution (symmetry) to the reference, except for pix2pix. Pix2pix spread the distribution and became asymmetric.

## CONCLUSION

This phantom experiment revealed the highest usefulness of cycle-GAN in low-dose conditions considering the image quality in the in-focus plane and longitudinal direction, as well as a 50% reduction in the reference.

## CLINICAL RELEVANCE/APPLICATION

The cycle-GAN pre-reconstruction manipulation with FBP can significantly reduce noise with preserved contrast and radiation dose reduction in clinical practice.

## S3A-SPPH- MRI Image Generation from CT Images for Cerebral Ischemic Stroke Patients Using Deep Learning

Zhihua LI (*Presenter*) Nothing to Disclose

## PURPOSE

Cerebral ischemic stroke is a leading cause of death and disability worldwide, and timely diagnosis and treatment are crucial for improving patient outcomes. Computed tomography (CT) and magnetic resonance imaging (MRI) are both widely used imaging modalities for diagnosing stroke. However, CT is often the first choice due to its accessibility and speed, while MR provides higher sensitivity and specificity. This study aims to investigate the feasibility of converting CT images of cerebral ischemic stroke patients to MRI using deep learning techniques.

## METHODS AND MATERIALS

The proposed method utilizes a Cycle Generative Adversarial Network (Cycle-GAN) raised by Jun et al. to learn the mapping between the two modalities and generate synthetic MRI from CT scans. We have added a new attribute to the network, based on the observation that stroke lesions are highly discernible on MR images. The dataset used in this study consists of CT and MR images from 120 patients at Longgang Central Hospital of Shenzhen. Only the MRI input contains attribute information, where the presence or absence of lesions is encoded as one-hot codes. To address the challenge of detecting lesions in CT images and improve the network's feature extraction capabilities, we adjusted the window width and center of the original CT image to 60 and 35, respectively.

## RESULTS

Experimental results demonstrate that the proposed approach can effectively generate high-quality MRI from CT scans, achieving a peak signal-to-noise ratio (PSNR) of 24.4 dB and a structural similarity index (SSIM) of 0.78. Furthermore, our method outperforms existing image-to-image translation methods in terms of visual quality and quantitative evaluation metrics.

## CONCLUSION

Deep learning has shown promising results in extracting subtle lesion features from CT images, although the outcomes may differ from those of the original MRI. Nonetheless, the algorithm can still provide valuable insights to medical professionals. While some progress has been made in this area, there is still significant room for improvement. Future research will focus on refining the algorithm and conducting comparative studies with related algorithms.

## CLINICAL RELEVANCE/APPLICATION

Timely diagnosis of Cerebral ischemic stroke is critical. However, traditional MRI scans are time-consuming, while CT imaging is widely available. By using deep learning to convert CT images to MRI, medical professionals can diagnose the condition more quickly and develop appropriate treatment plans.

### S3A-SPPH- Semi-Automatic Segmentation of Thymic Epithelial Tumors using U-Net 5

Nathan S. Lay, PhD (*Presenter*) Inventor, ScanMed

#### PURPOSE

Volumetric analysis of thymic epithelial lesions can be more informative than RECIST for oncologic follow up but requires laborious segmentation with low reproducibility when done manually. To propose and quantify performance of a U-Net artificial intelligence (AI) model for segmenting thymic epithelial tumors in CT scans with user-provided 3D regions-of-interest.

#### METHODS AND MATERIALS

A consecutive cohort comprised of 85 CT scans from 60 thymoma patients (mean age: 55 range: 32-75) was queried from a single institution database. Thymic tumors in the thorax were then manually segmented slice-by-slice on axial CT images by trainees or volunteers under the supervision of an expert cardiothoracic radiologist. The cohort was then partitioned into training and validation sets containing 63 CT scans from 45 patients and 22 CT scans from 15 patients respectively. A 2D U-Net was then trained on cropped image slices from 141 tumors over 1000 epochs. Performance was measured using the arithmetic mean and standard deviation of Dice similarity coefficient (DSC) over 3D manual segmentation masks of the whole image. DSC produces a similarity score ranging from 0 to 1 with 1 being a perfect match.

#### RESULTS

U-Net model snapshots were validated every 10 epochs on cropped image slices coming from 49 validation tumors. The method achieved a peak overall validation Dice similarity coefficient of 0.59 +/- 0.17. This corresponds to validation tumor DSCs of 0.60 +/- 0.09 for thymoma lesions located in the lung parenchyma, 0.68 +/- 0.14 for pleural and 0.57 +/- 0.19 for mediastinal thymoma lesions.

#### CONCLUSION

The current DSC results of our U-net AI model show promise for volumetric analysis of thymic tumors. Thymic tumors present a complicated and often unnoticed appearance in CT and a larger dataset is likely to produce a more generalizable and performant U-Net model over our current results.

## CLINICAL RELEVANCE/APPLICATION

Thymic tumor progression is currently tracked using RECIST v1.1. RECIST is used because it is simple and reproducible, but it is not suitable for some types of pleural thymic tumors. Automatic volumetric analysis can be simple, reproducible and accurate for all thymic tumors.

### S3A-SPPH- Reproducibility of a Deep Learning COVID-19 Classification Model Based on Image 6 Acquisition Dates and Data Resampling

Mena Shenouda, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the impact of (1) image acquisition date and (2) data resampling, which was performed to create new training and test sets, on the ability of a deep learning (DL) model to predict COVID-19 diagnosis from chest radiographs (CXRs).

#### METHODS AND MATERIALS

A DL model using the DenseNet-121 architecture was trained on an original dataset of 9860 COVID+/- patients (disease prevalence: 15.5%) from a single institution. The model was validated on a more current cohort of 5893 patients (disease prevalence: 12.4%) from the same institution but achieved significantly lower performance as evaluated using area under the receiver operating characteristic curve (AUC). To investigate this performance discrepancy, this work (1) compared the International Classification of Diseases 10 (ICD-10) codes between the original dataset and current test set, (2) limited the image acquisition date range of the current test set to that of the original and compared COVID severity scores and age, and (3) retrained the model using a resampling of the original dataset to evaluate whether the original results were due to a statistical anomaly. No training was performed using the current test set.

#### RESULTS

The original dataset and current test set shared the same top-three ICD-10 codes: (1) screening for other viral disease, (2) age-related osteoporosis, and (3) unspecified osteoarthritis. COVID severity scores of patients with images obtained during the overlap of dates between the test sets failed to achieve a significant difference ( $p=0.06$ ); however, the DL prediction

scores indicated more “obvious” cases within the original test set, thus correctly labeling a greater portion of true-positive and true-negative CXRs. There was a significant difference ( $p < 0.001$ ) between cohort age, with the current test set having a larger mean ( $57.9 \text{ years} \pm 18.3$ ) than the original dataset ( $54.7 \text{ years} \pm 18.9$ ). Lastly, retraining the model by resampling the original dataset resulted in an AUC value [95% CI] of 0.71 [0.67, 0.74], significantly lower than the original AUC value of 0.76 [0.73, 0.79]. Importantly, the AUC value of the current test set was no longer statistically less than the AUC value obtained with this resampled original dataset ( $p = 0.11$ ).

## CONCLUSION

This work examined potential factors that may impact model performance. Resampling the dataset resulted in significantly lower performance, which may explain how different partitions of a dataset (or an entirely new dataset) may yield variable performance.

## CLINICAL RELEVANCE/APPLICATION

With the rise of DL use in medical applications, interpretability of models is essential for proper deployment, ensuring an understanding of how various factors may impact model performance and that results are comprehensible.

## S3A-SPPH- Model Calibration by Temperature Scaling of a U-Net Deep Learning Model Trained for the Segmentation of Mesothelioma Tumor: A Pilot Study

Mena Shenouda, BS (*Presenter*) Nothing to Disclose

## PURPOSE

To produce calibrated pixel-wise label probabilities in the task of mesothelioma segmentation, which will ensure proper generation of probability maps.

## METHODS AND MATERIALS

Temperature scaling (TS) is a post-processing probability calibration method to be used for multi-class classification. For medical image semantic segmentation tasks, the two classes would be “disease” or “no disease.” TS estimates a single scalar parameter temperature  $T > 0$ , using the logit  $z_i$  vector as input, where  $i$  is the  $i$ -th image. The temperature is typically optimized only on the validation images and using the negative log-likelihood cost function, as was performed in this work. The calculated temperature “softens” the output of the last activation layer with  $T > 1$  reducing model confidence (i.e., probability predictions),  $T = 1$  indicating no change to the original probability, and  $T < 1$  increasing model confidence. The temperature was calculated for four separate validation sets: left or right hemithorax displaying either tumor only or tumor plus effusion. For the left hemithorax, 275 sections displayed tumor only, and 97 sections displayed tumor plus effusion. For the right hemithorax, 216 sections displayed tumor only, and 101 sections displayed tumor plus effusion.

## RESULTS

The calculated temperatures for tumor only on the left hemithorax, tumor plus effusion on the left hemithorax, tumor only on the right hemithorax, and tumor plus effusion on the right hemithorax were  $T = 3.7, 3.4, 2.3, 2.1$ , respectively. All temperature values were greater than unity, which demonstrated the model’s overconfidence prior to calibration.

## CONCLUSION

This work demonstrated the overconfidence of the initial model, as all temperatures were greater than one. This finding is consistent with the literature, since modern neural networks have been reported to be overconfident in their predictions. With a correctly calibrated model, accurate probability maps can be generated, thus streamlining automation of the mesothelioma segmentation task.

## CLINICAL RELEVANCE/APPLICATION

Due to the widespread use of neural networks for medical image classification and segmentation tasks, there is a need to ensure that model outputs are properly calibrated so that the resulting probabilities are indicative of the model’s true confidence.

## S3A-SPPH- Adaptive Multimodality Medical Image Translation with Total-Body PET

Yuxi Jin (*Presenter*) Nothing to Disclose

## PURPOSE

To dynamically generate specified modality images from nonattenuation-corrected PET images according to user requirements.

## METHODS AND MATERIALS

To dynamically translate nonattenuation corrected (NAC) PET images to user-specified modality images, we embed a switch layer after each skip connection in the decoder of UNet. The switch layer learns the scale and offset parameters by two fully connected layers from the switch code. The switch codes are 001/010/100 for attenuation corrected (AC) PET/CT/MRI,



respectively, and are coded by one-hot coding. The proposed model can adaptively output the specified modality image by normalizing the input features into the specified modality with the scale and offset parameters. A total of 119 patients scanned with the uEXPLORER scanner and 225 patients scanned with the uPMR scanner were retrospectively enrolled. We selected 13 patient cases as an external validation set for quantitative analysis, and the remaining 108 PET/CT cases and 215 PET/MR cases were used as experimental data to train the proposed network. To better train the proposed model, we mix and slice these data along the axial orientation to obtain two-dimensional images. After excluding 6547 slices for negative samples, we obtained 104286 slice samples in total. We randomly select 83429 samples for training, 10428 samples for validation, and 10429 samples for testing. The quantitative performance is evaluated by PSNR, MAE, and SSIM. The qualitative performance is measured by the error map between the model output and the ground truth.

## RESULTS

Our results achieved small quantification errors (low bias), good image quality (high PSNR), and high similarity (high SSIM) in the different body regions. All modal translation results have a similar appearance as the ground truth. Qualitative and quantitative analyses demonstrated the outstanding performance of the proposed model.

## CONCLUSION

We design a novel deep learning model to realize adaptively multimodality translation. This work can complete one-to-many modality translation, including direct PET attenuation correction (NAC-AC), CT synthesis (PET-CT), and MRI synthesis (PET-MRI). The simulated multimodality images have small qualification errors, good image quality, and high image similarity, which demonstrates that the proposed method is a promising tool in preclinical research, such as tumor contouring, anatomical localization, and dose calculation of radiotherapy.

## CLINICAL RELEVANCE/APPLICATION

The proposed adaptive multimodality medical image translation model can provide more comprehensive and integrated image information, aiding doctors in better understanding a patient's physical condition and making more accurate diagnoses and treatment plans.

## S3A-SPPH- Large Language Model (LLM) Passes the Radiology Physics Quiz

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Shakthi K. Ramasamy, MD (*Presenter*) Nothing to Disclose

## PURPOSE

With the recent advances in natural language processing, large language models (LLMs) such as GPT-4 have become increasingly powerful in their ability to understand and generate natural language. This study aims to assess the knowledge quiz-taking capacity of GPT-4 and GPT-3.5 for the Radiology Physics quiz.

## METHODS AND MATERIALS

An IRB approval is not required. The study was conducted on a set of 62 multiple-choice questions compiled from the Radiology Core Physics App, which is used by radiology residents for their board preparations, and the sample questions for the Diagnostic, Nuclear, and Therapeutic content of the Initial Certification for Medical Physics from the American Board of Radiology (ABR) ([theabr.org](http://theabr.org)) website. Image-based questions were excluded from the study due to the limitations of the current GPT models. The questions were typed into the prompt of chat.openai.com models GPT-4 (subscription required) and GPT-3.5 (freely available to the public). The answers were correlated with the respective answer keys. The performance of the models was evaluated for a passing score of 75%. The performance of GPT-4 vs GPT-3.5 was compared using a two-proportion z-test.

## RESULTS

GPT-4 and GPT-3.5 took the Radiology Physics quiz, with GPT-4 achieving a success rate of 79% (49 correct) and GPT-3.5 achieving a success rate of 55% (34 correct). A two-proportion z-test was conducted to compare the performances of the two models. The calculated z-score is approximately 2.863, and the p-value is approximately 0.0042. Since the p-value (0.0042) is less than the significance level of 0.05, there is a statistically significant difference between the performances of GPT-4 and GPT-3.5 on the Radiology Physics quiz.

## CONCLUSION

The results indicate a significant difference between the performances of GPT-4 and GPT-3.5 on the Radiology Physics quiz. GPT-4 demonstrated a higher success rate, scoring above the passing score. GPT-3.5 had a notably lower success rate, indicating that the newer GPT-4 model has improved knowledge and understanding of radiology core physics compared to its predecessor.

## CLINICAL RELEVANCE/APPLICATION

The performance of GPT-4 in the Radiology Physics quiz highlights the potential application of large language models in medical education and training. GPT-4 could be a valuable resource for radiology residents, medical physicists, and other healthcare professionals seeking to enhance their understanding of radiology core physics principles. Additionally, the

significant improvement in performance between GPT-3.5 and GPT-4 demonstrates the rapid advancements in natural language processing, indicating a promising future for LLMs in the medical field.

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## Abstract Archives of the RSNA, 2023

S3A-SPRO

### Radiation Oncology Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPRO- Ten-Year Experience of 5-Fraction Lung Stereotactic Body Radiotherapy (SBRT) for Biopsy- 1 Proven Non-Small Cell Lung Carcinoma (NSCLC)**

John M. Watkins, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Describe the local control (LC) and correlative clinicopathologic prognostic factors in patients treated with 5-fraction lung SBRT for biopsy-proven NSCLC.

#### **METHODS AND MATERIALS**

Intradepartmental quality assurance database of SBRT patients was utilized to identify patients with biopsy-proven NSCLC treated with 5-fraction SBRT at a single institution. Overall survival (OS), disease-free survival (DFS), and LC were measured from SBRT completion to last clinical follow-up or death (with DFS/LC backdated to last clinical follow-up if death occurred more than 3 months after last imaging). Regression analyses were performed on clinical (age, gender, race, tobacco use), radiographic (maximal tumor dimension, T-stage), pathologic (histology), and treatment (target coverage by dose, frequency of SBRT, SBRT start to completion) factors for association with LC. Kaplan-Meier method was employed for survival estimation.

#### **RESULTS**

Between 2011-2021, 107 patients were identified for inclusion in the present analysis. There were 112 total NSCLC targets, 60 (54%) being adenocarcinoma. Median age at the time of treatment was 75 years old (range, 38-93). Median SBRT dose was 5000 cGy (4500-6000 cGy) delivered over a median treatment time of 9 days (4-45). Median maximal internal target volume (ITV) dose (D 0.1 cc) was 6554 cGy (4497-7660), with median ITV receiving 5000 cGy (V50) and 5500 cGy (V55) of 100% (0-100%) and 98.8% (0-100%), respectively. Median planning target volume (PTV) V50 and V55 were 96.6% (0-100%) and 67.4% (0-99.7%), respectively. At median follow-up of 21 months (1-139), 75 (70%) patients had died. Median survivor follow-up was 39 months (7-139) with an estimated 3-year overall survival of 42.6% (32.6-52.6%). Forty-three patients experienced disease recurrence, of whom 8 had local failures (4 biopsy-proven). Estimated 3-year local control was 86.2% (76.2-96.2%). Univariate analysis of factors associated with LC identified only ITV V50 and PTV V50 as being significantly associated with LC. Estimated 3-year LC for ITV V50 > 98% versus < 98% was 88% and 79%, respectively. Estimated 3-year LC for PTV V50 > 95% versus < 95% was 91% and 75%, respectively.

#### **CONCLUSION**

ITV V50 and PTV V50 were the most strongly associated factors with LC after 5-fraction lung SBRT in the present population.

#### **CLINICAL RELEVANCE/APPLICATION**

SBRT for early-stage NSCLC is an excellent option for inoperable patients or those who decline lobectomy. The present study demonstrates the importance of minimum target coverage on local control in a large population with mature follow-up.

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## Abstract Archives of the RSNA, 2023

S3A-SPVA

### Vascular Imaging Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### **S3A-SPVA- Perivascular Fat Attenuation on CT Angiography is a Biomarker to Identify the Inflammation of Culprit Plaques in Internal Carotid Atherosclerosis** 1

Ziyu Tian (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Our study aimed to evaluate the value of FAI as a tool for measuring plaque inflammation and identifying culprit plaques in internal carotid atherosclerosis.

#### **METHODS AND MATERIALS**

We analysed patients with internal carotid atherosclerosis who underwent neck CTA examination. The culprit plaque group and nonculprit plaque group were divided based on the clinical diagnosis. We compared the CTA characteristics, and baseline data between the two groups, as well as the FAI at the maximum stenosis, nonstenosis site and the whole ICA. A receiver operating characteristic (ROC) curve was used to determine the diagnostic accuracy of FAI for classifying culprit plaques in patients with bilateral ICA atherosclerotic stenosis.

#### **RESULTS**

In total, 101 and 94 patients were included in the culprit plaque (mean age, 64.78 years  $\pm$ 8.17; 84 men) and nonculprit plaque groups, respectively (mean age, 66.72 years  $\pm$ 7.51; 80 men). In the nonculprit plaque group, the perivascular FAI around the maximum stenosis site and around the whole ICA were lower than those in the culprit plaque group ( $P < 0.05$ ). In patients with bilateral extracranial ICA stenosis, ROC analysis of atherosclerotic stenosis in combination with FAI performed well in predicting the culprit plaque (AUC=0.863,  $P < 0.001$ ).

#### **CONCLUSION**

The perivascular FAI may be useful in identifying inflammation and the culprit plaque from ICA atherosclerosis and provides a new monitoring method for risk stratification.

#### **CLINICAL RELEVANCE/APPLICATION**

To our best knowledge, we first use the novel biomarker perivascular FAI to measure plaque inflammation and identify culprit plaques in internal carotid atherosclerosis. Our study first demonstrated that patients in the culprit plaque group had a higher level of perivascular inflammation measured by FAI than those in the nonculprit group. The noninvasive measurement of FAI can be used to evaluate and identify the local inflammation of culprit plaques in the ICA, which may help to monitor the inflammation progression of atherosclerotic plaques. Furthermore, FAI at the maximum stenosis site combined with stenosis can noninvasively predict the ICA culprit plaques, which enables the recognition of stroke risk patients and guides targeted treatments.

#### **S3A-SPVA- Dark Blood Computed Tomography Angiography Combined with Deep Learning Reconstruction for Thickened Carotid Artery Wall Imaging in Takayasu Arteritis Patients** 2

Tong Su, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the capability of a newly developed dark-blood CTA imaging, combined with deep learning reconstruction (DLR), to visualize the thickened carotid artery wall of Takayasu arteritis (TAK) patients, compared with conventional CTA images.

## **METHODS AND MATERIALS**

This prospective study continuously recruited fifty-three patients with TAK who underwent neck CTA scans. All acquisitions were performed with a 320 row-detector CT scanner (Aquilion ONE Genesis Edition). Arterial and Delayed phase images were reconstructed using HIR (Adaptive Iterative Dose Reduction [AIDR] 3D) and DLR (Advanced Intelligent Clear-IQ Engine [AiCE]). Afterward, these two groups of images processed with a dedicated software (SURESubtraction) to generate dark-blood images. Therefore, four groups of images were produced for analysis: Delayed-HIR, Delayed-DLR, Dark-blood-HIR, Dark-blood-DLR. Qualitative parameters, including overall image quality, vessel wall visualization ability, and diagnostic confidence index, were rated by two radiologists independently according to a five-point scale. Quantitative parameters, including SNR of vessel wall, CNR between the vessel wall and lumen, were computed and compared. The vessel wall thickness of thickened common carotid artery was measured and the inter-rater variability was evaluated.

## **RESULTS**

The qualitative scores of overall image quality presented Delayed-DLR was superior to Delayed-HIR and Dark-blood-DLR was superior to Dark-blood-HIR (all  $p < 0.001$ ). CTA images processed with dark-blood technique presented higher qualitative scores in terms of vascular wall display ability and diagnostic confidence index, superior to conventional CTA images (all  $p < 0.001$ ). For brachiocephalic trunk, bilateral subclavian arteries and common carotid arteries, the SNRs and the CNR of Dark-blood-DLR images were significantly higher than those of Dark-blood-HIR images. And for bilateral common carotid arteries, the CNR of DLR presented higher quantitative scores than HIR for both delayed and dark-blood phases (all  $p < 0.001$ ). CTA images processed with dark-blood technique presented higher quantitative scores superior to conventional CTA images (all  $p < 0.001$ ). The average vessel wall thickness of carotid arteries measured on dark-blood phases were thicker than delayed phases (all  $p < 0.001$ ). And the highest ICC value between two raters was obtained on Dark-blood-DLR image (ICC 0.958).

## **CONCLUSION**

Compared to HIR, dark blood method combined with DLR reconstruction improved CTA image quality, and enhanced the visualization of thickened vessel wall of TAK patients.

## **CLINICAL RELEVANCE/APPLICATION**

Dark blood method combined with DLR reconstruction is conducive to rapid and accurate measurement of vessel wall thickness.

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## Abstract Archives of the RSNA, 2023

S3B-SPBR

### Breast Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPBR- Evaluation of a Deep-Learning Based Software Tool to Automatically Detect and Quantify Breast Arterial Calcifications on Digital Mammography** 1

Bilel Ben Jedidia (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Breast arterial calcification (BAC) has been identified as an independent cardiovascular risk factor but is not routinely documented in mammography reports, partially because manually scoring by radiologists can be time-consuming. The aim of this study was to evaluate an artificial intelligence (AI) software that automatically detects and quantifies BAC.

#### **METHODS AND MATERIALS**

Women who underwent both 2D mammography and thoracic CT from 2009 to 2018 were retrospectively included in this single-center study. A deep learning based software (iCAD, Nashua, NH, USA) was used to automatically detect and quantify BAC with a 0 to 10 point BAC AI score. Results were compared with a previously described BAC manual score based on radiologists' visual quantification of BAC on the mammogram. Coronary Artery Calcium (CAC) score was manually evaluated using a 12-point scale on CT. Diagnostic performance of marked BAC AI score (defined as a BAC AI score = 5) for the detection of marked CAC (CAC score = 4) was analyzed. R software version 4.0.2 was used to perform the analysis.

#### **RESULTS**

502 women (mean age: 62 years  $\pm$  16) were included. BAC AI score was highly correlated with BAC manual score (Spearman's correlation 0.83,  $p < 0.01$ ). Marked BAC AI score for the detection of marked CAC had a sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 32.7%, 96.1%, 71.2%, 83.1% and 81.9%, respectively. Marked BAC AI score was associated with marked CAC with an adjusted odds ratio of 12.139, (95% CI 11.92-12.35,  $p < 0.001$ ).

#### **CONCLUSION**

Automatic BAC AI score shows a very strong correlation to manual BAC scoring. Marked BAC AI score is associated with marked CAC (CAC score  $\geq$  4).

#### **CLINICAL RELEVANCE/APPLICATION**

Automatic BAC AI score could be a useful tool to promote the integration of BAC in the mammography report and improve awareness of a woman's cardiovascular risk status.

#### **S3B-SPBR- Comparison of Supplemental Screening with Artificial Intelligence and Breast Ultrasound in Women with Dense Breast** 2

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Whether using artificial intelligence (AI) system for screening mammography in women with dense breasts can replace supplemental breast ultrasound (US) is not well known. This study aimed to assess the value of supplemental US and AI with screening mammography in women with dense breasts.

#### **METHODS AND MATERIALS**

A retrospective database search identified consecutive asymptomatic women who underwent digital mammography (DM) and supplemental screening US between January 2017 and December 2018. AI software was applied for mammography, and

four-view heat maps with a representative abnormality score per breast were evaluated. A BI-RADS category =3 on US and maximum abnormality score =10 on AI were considered positive results. The cancer detection rate (CDR) per 1000 examinations, sensitivity, specificity, and abnormal interpretation rate (AIR) were estimated and compared.

## RESULTS

Among 5708 women (mean age±standard deviation: 52.4±7.9), 33 cancers (13 ductal carcinoma in situ and 20 invasive carcinoma) were found. DM alone showed CDR of 2.8 (16/5708; 95% CI: 1.7, 4.5), sensitivity of 48.5% (16/33; 95% CI: 32.5, 64.8), specificity of 94.3% (5350/5675; 95% CI: 93.6, 94.9) and AIR of 6.0% (341/5708; 95% CI: 5.4, 6.6). DM combined with AI showed a CDR of 3.2 per 1000 examinations (18/5708; 95% CI: 1.9, 4.9), sensitivity of 54.5% (18/33; 95% CI: 38.0, 70.2), specificity of 95.3% (5409/5675; 95% CI: 94.7, 95.8) and AIR of 5.0% (284/5708; 95% CI: 4.4, 5.6). DM combined with US yielded a CDR of 5.3 per 1000 examinations (30/5708; 95% CI: 3.6, 7.5), sensitivity of 90.9% (95% CI: 30/33; 95% CI: 76.4, 96.9), specificity of 77.6% (4401/5675; 95% CI: 76.5, 78.6), and AIR of 22% (1304/5708; 95% CI: 21, 24). CDR and sensitivity of DM with supplemental US were significantly higher than that of DM alone ( $P < .001$ ), but with higher AIR and lower specificity ( $P < .001$ ). DM with AI showed higher specificity ( $P = .001$ ) with lower AIR ( $P = .002$ ) than DM alone, however with comparable CDR and sensitivity ( $P = .157$ ). AI correctly identified one invasive lobular cancer missed by DM and US. US alone detected additional 10 cancers, of which 90% were stage 0 ( $n=4$ ) and stage I ( $n=5$ ) invasive cancers, all node negative.

## CONCLUSION

DM with supplemental US showed higher cancer detection ability than with supplemental AI in women with dense breasts. Supplemental US detected additional early-stage cancers in women with dense breasts without AI recall.

## CLINICAL RELEVANCE/APPLICATION

The combined use of digital mammography with artificial intelligence cannot replace supplemental breast US in women with dense breasts yet.

## S3B-SPBR- Bias-Free Artificial Intelligence: Developing a Deep Learning Algorithm for Diverse Racial Populations in Breast Cancer Diagnosis

Dogan S. Polat, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to develop a deep learning (DL) algorithm to facilitate automated diagnosis of breast cancer using mammography.

## METHODS AND MATERIALS

The algorithm was trained on a total of 136,172 mammograms that includes an isolated partition of Optimam ( $n=103472$ ), DDSM ( $n=2812$ ), and multiple single and multi-institution datasets across southeast Asia, Africa, South America, and Europe ( $n=29888$ ). The algorithm was then tested on 9304 cases [Optimam ( $n=8980$ ) and independent blinded single institution ( $n=324$ )]. Cancers comprised 34.7% ( $n=3226$ ) of 9304 mammograms (23.6% invasive, 8.7% DCIS and 2.5% unknown types), while 65.3% ( $n=6078$ ) were benign/negative. Race was stratified into five categories: white ( $n=6943$ , 74.6%), Asian ( $n=555$ , 6%), black ( $n=411$ , 4.4%), other ( $n=235$ , 2.5%), and unavailable/withheld ( $n=1160$ , 12.5%). Chi-square tests compared categorical variables, while t-tests and ANOVA compared area under the curve (AUC) of the model for different groups and means. ROC curves are compared in pairwise manner using pROC library in R.

## RESULTS

Mean patient age was 61.1 ( $SD\pm 7.7$ ). While lesion type information either was not available or negative for 5604 (60.2%) patients, 2544 (27.3%) presented as soft tissue abnormality and 1156 (12.4%) as calcifications. The algorithm achieved AUC of 0.91, 0.95 sensitivity, 0.55 specificity, 0.92 negative predictive value (NPV) and 0.66 positive predictive value (PPV). When stratified by lesion type, the algorithm performed better in characterizing soft tissue lesions [compared to calcification and other lesion types with following parameters AUC, sensitivity, specificity, NPV and PPV: 0.87, 0.9, 0.59, 0.48, 0.93 vs 0.71, 0.8, 0.49, 0.55, 0.76, 0.71 ( $p<0.001$ )]. Similarly, better diagnostic performance was achieved in detecting invasive cancer than DCIS (AUC 0.87 vs. 0.72,  $p<0.001$ ), and cancer size  $>20\text{mm}$  vs  $<5\text{mm}$  (AUC 0.87 vs 0.77, respectively  $p<0.001$ ). Performance was comparable across racial groups with the following AUC, sensitivity, specificity, NPV, and PPV: White (0.90, 0.86, 0.76, 0.92, 0.63), Black (0.92, 0.89, 0.75, 0.96, 0.54), Asian (0.89, 0.86, 0.75, 0.94, 0.54), Other (0.91, 0.85, 0.82, 0.95, 0.59), and Unknown (0.90, 0.90, 0.75, 0.82, 0.86). All racial groups were compared to global AUC and found no significant difference ( $p=1$  for each).

## CONCLUSION

The algorithm's performance on datasets comprising diverse racial populations is comparable to that of breast radiologists, tested on datasets that include cases representative of real-world clinical settings.

## CLINICAL RELEVANCE/APPLICATION

The mammography DL algorithm showed high diagnostic performance across diverse datasets, comparable to US screening benchmarks, promising for large-scale screening triaging.

### S3B-SPBR- Simulating Synthetic Post-contrast Breast MRI from Single Pre-contrast MRI Sequence Using Deep Learning Model

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility of deep learning model for simulated post-contrast T1-weighted breast MR images generated using single pre-contrast MR image in patients with breast cancer. In addition, to validate the deep model network implemented with five pre-contrast sequences including T2-weighted and diffusion-weighted imaging.

#### METHODS AND MATERIALS

In this retrospective study, 363 women with breast cancer and contrast-enhanced breast MRI were identified between June 2019 and December 2019 at a single academic institution. An Extra-Dimensional U-net with visual geometry group was developed to simulate T1-weighted post-contrast images from single pre-contrast T1-weighted images. A total of 330 cases were used for the training set and 24 cases were used for validation set. In addition, we externally validated the deep learning model using five pre-contrast sequences (T1-weighted non-fat suppressed [FS], T1-weighted FS, T2-weighted FS, apparent diffusion coefficient, and diffusion-weighted imaging) [[https://github.com/ecalabr/breast\\_simulated\\_gad](https://github.com/ecalabr/breast_simulated_gad)]. Performance was evaluated qualitatively regarding lesion visibility and five point scale (5: excellent, 4: good, 3: acceptable, 2: poor and 1: unacceptable), and also quantitatively with metrics including peak signal to noise ratio (PSNR) and SSIM (structural similarity index).

#### RESULTS

The validation set of 24 MRI examinations in 24 women (mean age, 56 years; range, 43-73 years) were evaluated. There were 23 invasive ductal carcinoma, 1 ductal carcinoma in situ; 19 masses and 1 non-mass, 4 mass with nonmass lesions (mean size, 2.2cm; range, 1.1-7.0cm). With our model, 63% (15/24) were visible and were rated 50% (12/24) good or excellent or acceptable and 50% (12/24) unacceptable or poor. In comparison, with the open-source deep model, 70% (17/24) lesions were visible and rated 46% (11/24) good or excellent or acceptable, and 54% (13/24) unacceptable or poor. With our developed model, simulated post-contrast T1-weighted breast MR images showed PSNR of 27.10 and SSIM of 0.87.

#### CONCLUSION

Our developed model using single pre-contrast T1-weighted imaging is capable of producing the simulated post-contrast MR image, and is comparable to outcomes using suggested deep learning model.

## CLINICAL RELEVANCE/APPLICATION

There is increasing need for non-contrast breast MRI for cancer detection due to gadolinium retention and more accessibility of breast MRI.

### S3B-SPBR- Machine Learning-based Texture Analysis of Axillary LNs Using 3-T MRI for Predicting LN Metastasis in Breast Cancer

Na Lae Eun, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to determine whether texture analysis for 3-T magnetic resonance imaging (MRI) in axillary lymph nodes (LNs) can predict LN metastasis in breast cancer.

#### METHODS AND MATERIALS

This retrospective study included 204 patients who underwent breast and axillary surgery for breast cancer between March 2022 and December 2022. We assessed common features of axillary LNs, including clinicopathologic features and MRI assessment by radiologists, as well as texture features of axillary LNs on contrast-enhanced T1-weighted images using commercial software based on PyRadiomics. The index LN was determined as the LN with the largest cortical thickness. Logistic regression with feature selection was used to reduce the dimensionality of the data (14 clinicopathologic and 869 texture features). Using the selected features, we trained an XGBoost classifier to build common, radiomics, and combined common and radiomics models for predicting LN metastasis. The diagnostic performance of predictive models for LN metastasis was compared by using generalized estimating equation analysis.

#### RESULTS

Of the 204 women, 47 (23%) were diagnosed with LN metastases. The XGBoost classifier with common features, including clinicopathologic and MRI assessment, showed the lowest diagnostic performance (accuracy and area under the receiver

operating characteristic curve [AUC], 73.81% and 0.846). The radiomics and combined common and radiomics model with the XGBoost classifier showed better diagnostic performance than that the analysis of common features alone (accuracy and AUC, 90.48% and 0.939, 90.48% and 0.939 vs. 73.81% and 0.846,  $p < 0.05$ ). In addition, the combined common and radiomics model showed a positive predictive value of 100% for predicting LN metastasis.

## **CONCLUSION**

Texture analysis using an XGBoost classifier for axillary LNs on 3-T MRI may be a useful tool in predicting LN metastasis in patients with breast cancer.

## **CLINICAL RELEVANCE/APPLICATION**

Machine learning-based texture analysis of axillary LNs using 3T-MRI can help predict axillary LN metastasis and potentially de-escalate axillary surgery in patients with breast cancer.

## **S3B-SPBR- 6 Artificial Intelligence Helps General Radiologists and Breast Imaging Specialists Find Challenging-to-Detect Cancers**

Bryan Haslam, PhD (*Presenter*) Employee, RadNet, Inc

### **PURPOSE**

There is growing evidence that AI helps radiologists detect more breast cancers in screening mammography. However, there has been little explanation of how AI helps radiologists with varying levels of specialty. Here, we investigated how AI for DBT helps general radiologists and breast imaging specialists detect breast cancer lesions with varying degrees of how challenging the cancers are to detect.

### **METHODS AND MATERIALS**

Following an IRB approved protocol, a reader study was conducted to evaluate the interpretative performance of 18 radiologists including 9 general radiologists and 9 breast imaging specialists. Each reader read 240 retrospectively collected DBT screening exams (100 cancers and 140 non-cancers) once with and once without the aid of AI. General radiologists' and breast imaging specialists' performance, as measured by AUC, were examined with vs without AI. Additionally, cancer exams were sorted by degree of difficulty in two different ways. First, the cancer exams were grouped by the BIRADS assessment given at the time of original clinical interpretation: a) recalled cancers ( $n = 67$ ) were those given a BIRADS 0 and b) non-recalled cancers ( $n = 33$ ) were those given a BIRADS 1 or 2. The non-recalled exams are considered more difficult given that these are the clinically "missed" exams where the interpreting radiologist at the time of exam acquisition deemed there were no suspicious findings for a recall. Second, the cancer exams were subdivided into a) harder ( $n = 16$ ), b) medium ( $n = 11$ ) and c) easier ( $n = 73$ ) cancer cases based on the proportion of the readers in the study that recalled the exam when reading without the aid of AI ( $< 50\%$  recalled,  $50\%$  to  $75\%$  recalled, and  $> 75\%$  recalled, respectively).

### **RESULTS**

Overall, both general radiologists (AUC increase of 0.075) and breast imaging specialists (AUC increase of 0.050) demonstrated improved performance when reading with AI than without AI. Across both methods of sorting the cancer exams by difficulty, there were greater improvements with AI when radiologists interpreted more challenging (AUC increase for non-recalled: 0.100, harder: 0.176 and medium: 0.110) than less challenging cancers (recalled: 0.040 and easier: 0.027). The largest boost in performance was observed for general radiologists on the harder cancers with an AUC improvement of 0.186.

### **CONCLUSION**

AI helped both general radiologists and breast imaging specialists improve cancer detection performance overall and to a greater extent for the more challenging cancer cases.

### **CLINICAL RELEVANCE/APPLICATION**

AI for screening DBT helps radiologists with varying levels of specialty, especially on difficult to detect cancers that would likely go undetected until a future exam, suggesting that AI may help detect these cancers earlier.

## **S3B-SPBR- 7 Examining the Potential of ChatGPT to Derive Differential Diagnoses from Transcribed Radiological Findings in Breast and Ultrasound Imaging**

Shawn H. Sun, MD, MS (*Presenter*) Nothing to Disclose

### **PURPOSE**

To assess the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in producing a differential diagnosis from transcribed radiological findings of breast and ultrasound radiology cases.



## METHODS AND MATERIALS

A sample of 25 breast and ultrasound imaging cases were selected from a radiology textbook, from which the answers were used as the gold standard. The case images and history were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were fed into the ChatGPT3.5 and ChatGPT4 algorithms. Generated responses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracy were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

## RESULTS

The top 1 accuracy and top 3 accuracy, for ChatGPT3.5 versus ChatGPT4 were 32% compared to 40% ( $p=0.28$ ) and 8.0% compared to 12.0% ( $p = 0.32$ ), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 38.9% compared to 45.2% ( $p=0.33$ ). ChatGPT3.5 and ChatGPT4 hallucinated 32.0% versus 8.0% ( $p=0.017$ ) of the references provided and generated 6 total false statements versus 2 total false statements, respectively.

## CONCLUSION

The ChatGPT algorithms were able to produce a differential diagnosis for prompts containing descriptive radiological findings. The responses matched the expert literature from which the cases originated a minority of the time, though a non-statistically significant improvement was made in the accuracy categories from 3.5 to the 4th generation algorithm. The renowned hallucination effect appeared more frequently in generated citations compared to algorithm-produced statements, with both showing improvement in the latest generation.

## CLINICAL RELEVANCE/APPLICATION

ChatGPT and Large Language Models (LLM) possess considerable potential to transform clinical and educational medicine. Awareness of their accuracy and potential for mistakes will contribute to a more comprehensive understanding of the limitations of such new tools.

## S3B-SPBR- Improving Artificial Intelligence (AI) Risk Assessment with Multiple Imaging Modalities and Prior Imaging Data

Eliana Goldberg, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to evaluate the efficacy of multimodal AI algorithms (full field digital mammography (FFDM)/digital breast tomosynthesis (DBT), breast ultrasound (US) and prior imaging) into breast cancer risk assessment models

## METHODS AND MATERIALS

Our IRB-approved research utilized a multimodal AI system trained on a dataset of FFDM, DBT, and US exams. These exams were conducted between 2010 and 2020, involving 1,964,416 exams on 324,978 patients. We used a patient-based 60-10-30 split for training/validation/testing. The testing dataset comprised FFDM/DBT/US from patients not included in the training/validation sets, with histopathology/imaging stability as reference standard. The AI risk model was designed to predict cancer risk at multiple time points: 1 year, 3 years, 5 years, and 10 years based on imaging alone. We compared the model's AUROC, sensitivity, and specificity for each risk assessment interval. We also compared 10-year risk assessments to Tyrer-Cuzick (TC) scores.

## RESULTS

On a test set of 29,845 patients (average age 59.1, standard deviation 11.09, 74,024 exams), 3.05% (910/29845) were diagnosed with breast cancer within 10 years. The AI model achieved AUROC for breast cancer risk assessment as follows: 0.888 (1 year), 0.804 (3 years), 0.770 (5 years), and 0.760 (10 years). Sensitivity was 71.5% (1 year), 52.3% (3 years), 44.0% (5 years), and 40.7% (10 years). For women with dense breasts, AI model AUROC was 0.876 (1 year), 0.779 (3 years), 0.750 (5 years), and 0.739 (10 years). Sensitivity was 69.8% (1 year), 50% (3 years), 42.7% (5 years), and 39.8% (10 years). For women with non-dense breasts, model AUROC was 0.896 (1 year), 0.822 (3 years), 0.781 (5 years), and 0.774 (10 years). Sensitivity was 72.2% (1 year), 52.8% (3 years), 43.1% (5 years), and 39.5% (10 years). Specificity was held constant at 90% for model binarization thresholds. On a random subset of 134 patients with cancer and non-cancer patients, model AUROC was 0.826 (10 years), while TC scores was 0.644 (10 years). When patients were binarized into high or low risk, AI was more informative than was TC. For example, patients who were assessed as TC high risk but AI low risk had a low incidence of cancer (18.9%; 7/37), whereas patients who were assessed as TC low risk and AI high risk had a high incidence of cancer (89.1%; 33/37).



## CONCLUSION

Multimodal breast cancer risk assessment based on FFDM/DBT, US imaging and prior examinations outperforms standardized risk cancer assessment.

## CLINICAL RELEVANCE/APPLICATION

Integrating multiple imaging modalities and prior imaging into AI breast cancer risk assessment models enhances performance, enabling the development of a personalized, data-driven, and evolving screening schedule based on an individual's risk profile over time.

## S3B-SPBR- Self-Supervised Pretrained Vision Transformers for Breast Ultrasound Classification

George Zhou, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Develop a deep learning model for automated breast ultrasound classification. For computer vision tasks such as this one, convolutional neural networks (CNN) have been the gold standard. Here we study the application of Vision Transformers (ViT) for breast ultrasound classification. Specifically, we examine how the performance of ViT can be improved with self-supervised pretraining.

## METHODS AND MATERIALS

A total of 647 breast ultrasound images were collected. A label of either benign or malignant was given to each image by radiologists. Malignant cases were validated with histopathologic results from subsequent fine needle aspiration biopsies. The final dataset included 437 benign and 210 malignant US images (PMID: 31867417). The ViT explored in this study consists of 12 transformer encoder layers with 12 multi-attention heads. First the images are tokenized into patches. The patches are linearly projected and combined with positional encodings before input into the sequence of transformer encoders. We study three pretraining paradigms: random weight initialization, supervised pretraining on ImageNet, and self-supervised pretraining on ImageNet. In supervised learning, annotated labels are used during pretraining. In self-supervised learning, representations are learned without any explicit labels; instead, supervisory signals are derived from the data itself. After the models are pretrained, one fully connected layer is added on top of each model and trained to perform binary classification.

## RESULTS

We evaluate our models using five-fold cross validation. The ViT with random weight initialization achieves an AuROC of  $0.67 \pm 0.08$ . The supervised pretrained ViT achieves an AuROC of  $0.88 \pm 0.04$ . The self-supervised pretrained ViT achieves an AuROC of  $0.92 \pm 0.02$ . Visualization of the self-attention heat maps show that the self-supervised ViT can learn semantic segmentation information without any explicit segmentation masks.

## CONCLUSION

We show that self-supervised pretraining offers a performance boost compared to supervised pretraining ViT for breast ultrasound classification. Overall, our results show that with the advances being made in deep learning, it may be worthwhile to renew the discussion on the role of ultrasound in screening for breast cancer.

## CLINICAL RELEVANCE/APPLICATION

In the context of breast cancer screening, mammography is the gold standard. Breast ultrasound, despite being widely available and posing no radiation risk, is limited by a high rate of false positives, operator dependency, and a growing shortage of (breast) radiologists. However, advances in deep learning can potentially mitigate these limitations.

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## Abstract Archives of the RSNA, 2023

S3B-SPCA

### Cardiac Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPCA- Inferior Left Atrial Diverticulum Communicating with the Right Atrium or Inferior Vena Cava: CT and Clinical Features** 1

Hae Jin Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Interatrial communications in atypical locations are found at CT. However, information on imaging findings of atypical or nonseptal communications between two cardiac atria has not been known to dates. The purpose of this study was to evaluate the prevalence, location, size and morphological characteristics of left atrial (LA) diverticula communicated with right atrium on cardiac CT.

#### **METHODS AND MATERIALS**

This retrospective study included 222 consecutive patients who underwent cardiac computed tomography and showed incidental inferior LA diverticula (ILAD). The prevalence, number, size, morphological characteristics and location of ILAD communicating with the right atrium or inferior vena cava were analyzed. Shunts were defined as anatomical defects between the two structures with or without visible contrast flow or attenuation step up.

#### **RESULTS**

The prevalence of ILAD with shunt was 9.9% (22/222) among ILADs. Shapes of ILAD with shunt were tubular (n = 12, 54.5%), saccular (n = 8, 36.3%), and network-like appearance (n = 2, 9.1%). Mean ostial diameter of ILAD and mean size of shunt were 6.4 mm, 4.9 mm, respectively. Of the 22 patients, 7 (31.8%) had two or more shunts.

#### **CONCLUSION**

Cardiac CT helps to detect a new type of interatrial communications which can mimic classical atrial septal defects. Although their clinical significance remains unclear, radiologists should be aware of them and report their findings.

#### **CLINICAL RELEVANCE/APPLICATION**

Our study is the first study to visually assess the category using ECG gated cardiac CT for LA diverticulum with shunt to RA.

#### **S3B-SPCA- Cardiac CT-derived Global and Regional Epicardial Adipose Tissue Contributes to Atrial Fibrillation in Patients without Left Atrial Myopathy as Defined by Endocardial Voltage Mapping** 2

Aqeel Umar, BMBCh (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Atrial myopathy contributes to the pathogenesis of atrial fibrillation (AF), but many AF patients have no obvious atrial myopathy. Epicardial adipose tissue (EAT) has recently been shown to be greater in AF patients than those without AF. Our aim was to assess the relationship of EAT in AF patients with/without atrial myopathy defined by endocardial voltage mapping.

#### **METHODS AND MATERIALS**

75 AF patients with cardiac CT prior to pulmonary vein ablation were prospectively enrolled. Left atrial (LA) endocardial voltage mapping was performed in all patients. Left atrial myopathy was defined as the sum of all low voltage (<0.5mV) areas (LVA) exceeding 5% of total LA surface area. AF patients were assigned to either LVA- (<5% LVA) or LVA+ (=5% LVA) groups. 48 age-, sex- and BMI-matched patients without AF and structural heart disease/coronary artery disease, who had

undergone cardiac CT, were identified as a control group. Total, LA and right atrial (RA) EAT were quantified on CT using fat density thresholding (-195 to -30 HU) after segmenting areas of interest using standard 3D post-processing software. Differences between groups were assessed using one-way ANOVA and relationships were assessed using correlation analysis. Inter-observer variability of EAT analysis was assessed with correlation analysis and Coefficient of Variance (CV) using random subset of 35 AF patients.

## RESULTS

LVA- patients (n=50; 6% f) were younger than LVA+ patients (n=25; 44% f). BMI correlated with total EAT (Spearman  $r$  0.50;  $p < .01$ ), LA EAT ( $r$  0.47;  $p < .01$ ) and RA EAT ( $r$  0.41;  $p < .01$ ) in AF patients and similarly in controls. Between LVA+ and LVA- AF patients, there was no significant difference for total EAT ( $89.1 \pm 41.1 \text{ cm}^3$  vs  $83.5 \pm 31.1 \text{ cm}^3$ ;  $P = .5$ ), LA EAT ( $9.9 \pm 5.8 \text{ cm}^3$  vs  $8.9 \pm 3.5 \text{ cm}^3$ ;  $P = .6$ ) and RA EAT ( $7.4 \pm 3.8 \text{ cm}^3$  vs  $7.5 \pm 3.1 \text{ cm}^3$ ;  $P = .9$ ). Compared to controls, LVA- patients had greater total EAT ( $80.1 \pm 29.3 \text{ cm}^3$  vs  $56.5 \pm 22.1 \text{ cm}^3$ ;  $p < .001$ ), greater LA EAT ( $8.9 \pm 3.5 \text{ cm}^3$  vs  $4.5 \pm 1.9 \text{ cm}^3$ ;  $p < .001$ ) and greater RA EAT ( $7.5 \pm 3.1 \text{ cm}^3$  vs  $4.9 \pm 2.0 \text{ cm}^3$ ;  $p < .001$ ). There was good agreement for total EAT ( $r = 0.99$ ), LA EAT ( $r = 0.98$ ) and RA EAT ( $r = 0.98$ ) between observers (all  $p < .001$ ) with CV of 3.5%, 6.4% and 6.2% respectively.

## CONCLUSION

EAT does not differ between AF patient with or without LA myopathy, but EAT is significantly greater among AF patients without LA myopathy compared to controls without AF. These findings suggest that EAT may contribute to the pathogenesis of AF even in the absence of LA myopathy. Strategies to monitor and reduce EAT may help to improve rhythm control in these patients.

## CLINICAL RELEVANCE/APPLICATION

Increased EAT volume may play an important role in AF pathogenesis in patients without LA myopathy; further studies should analyse the effect of EAT reducing treatment and downstream effects on AF incidence.

## S3B-SPCA- Metabolic Syndrome is Associated with Impaired Left Atrial and Left Ventricular Deformation and Abnormal Atrioventricular Interaction in Patients with Myocardial Infarction

Jing liu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Metabolic syndrome (MetS) is a cluster of cardiovascular risk factors that predicts poor short - or long-term outcomes in patients with myocardial infarction (MI). However, the potential mechanisms influencing prognosis are still unclear. Thus, this study aimed to determine the effect of MetS on left atrial (LA) and left ventricular (LV) deformation and abnormal atrioventricular interactions in MI patients.

## METHODS AND MATERIALS

A total of 181 MI patients, including 119 without MetS (MI [MetS-]) and 62 with MetS (MI [MetS+]), and 58 controls who underwent 3.0 T cardiac magnetic resonance (CMR) were included. LA ejection fraction [LAEF] and deformation indices (reservoir, conduit, and booster pump function) and LV deformation parameter (global peak radial, circumferential, and longitudinal strain [PS]) based on CMR three-dimensions feature tracking were measured and compared among groups. Correlations of MetS and LV deformation and geometry with LA functional indices were assessed by multivariable linear regression analysis.

## RESULTS

LA reservoir function (total EF and total strain) and conduit function (passive strain) and LV deformation parameters (radial, circumferential, and longitudinal PS) significantly decreased from the control group, through the MI (MetS-), to MI (MetS+) group (all  $P < 0.05$ ). Compared with controls, the booster pump function (active EF and active strain) was decreased in the MI (MetS+) group (all  $P < 0.05$ ) but preserved in the MI (MetS-) group. Furthermore, multivariate linear regression demonstrated that MetS was independently associated with total and active LAEF, total and passive strain ( $\beta = -0.172$  to  $-0.200$ , all  $P < 0.05$ ) in MI patients; LA reservoir and conduit function were independently associated with LV circumferential PS ( $\beta = 0.230$  to  $0.394$ , all  $P < 0.05$ ) and longitudinal PS ( $\beta = 0.189$  to  $0.354$ , all  $P < 0.05$ ), LA passive strain and strain rate were independently associated with LV mass ( $\beta = -0.178$  and  $-0.298$ , all  $P < 0.05$ ).

## CONCLUSION

Coexisting MetS may exacerbate the adverse effects of MI on LA and LV dysfunction. LV circumferential and longitudinal PS are stable predictors of LA three-phasic function; LV hypertrophy is independently associated with LA conduit function.

## CLINICAL RELEVANCE/APPLICATION

These results suggest that metabolic disorders may be important in managing patients with myocardial infarction.

## S3B-SPCA- MRI Evaluation by T1 Mapping of the Post Myocardial Infarction Left Ventricular Thrombus

Samer Abi Khalil, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The objective of this study is to evaluate the post myocardial infarction left ventricular thrombus on cardiac MRI by measuring its T1 mapping value, thus to determine the age of thrombus.

## METHODS AND MATERIALS

This observational retrospective study was performed on all patients scheduled for 3.0 Tesla cardiac MRI post myocardial infarction on our institution from January 2015 to December 2022. 35 patients with a left ventricular thrombus that may be measurable on T1 mapping sequence were included. They were separated in two groups depending on the period of time between the infarct and the MRI - less than three months: group A; more than three months: group B. T1 mapping value was measured for all thrombi.

## RESULTS

T1 of thrombi was  $1098 \pm 61$  ms in group A and  $1316 \pm 75$  ms in group B,  $p < 10^{-4}$ . T1 of the myocardium was  $1224 \pm 73$  ms in group A and  $1254 \pm 48$  ms in group B,  $p = 0.139$ . T1 of the blood pool was  $1934 \pm 137$  ms in group A and  $2008 \pm 124$  ms in group B,  $p = 0.135$ .

## CONCLUSION

Recent thrombi had shorter mapping T1 than old thrombi.

## CLINICAL RELEVANCE/APPLICATION

This method represents a new approach for the age and the maturity of left ventricular thrombus. It provides complementary information for the recommendations of imaging control and anticoagulation therapy.

## S3B-SPCA- STEMI Patients: Who Gets What Imaging

5

Alex Zhang, BS (*Presenter*) Nothing to Disclose

## PURPOSE

Our study aims to determine if hospital and patient characteristics affect what type of imaging modality ST elevated myocardial infarction (STEMI) patients receive.

## METHODS AND MATERIALS

The National Emergency Department Sample (NEDS) database was retrospectively queried for patients with a primary diagnosis of STEMI. Logistic regression was used to determine the likelihood of receiving ultrasound and fluoroscopy based cardiac imaging with respect to hospital characteristics such as region, teaching status, and trauma level designations. We also looked at patient characteristics including hypertension, hyperlipidemia, and tobacco usage.

## RESULTS

Of the 175,700 patients with a primary diagnosis of STEMI, most were white (74.1%), seen at a non-trauma hospital (49.7%), and insured through medicare (44.8%). Female patients were less likely to get fluoroscopy imaging (OR: .927, 95%CI .871 - .987) than male patients. Black patients were also less likely to get fluoroscopy imaging relative to white patients (OR: .711, 95%CI .583 - .869). Patients with private insurance and patients at teaching hospitals were more likely to get fluoroscopy relative to medicare patients (OR: 1.211, 95%CI 1.069 - 1.371) and patients at non teaching hospitals (OR: 1.563, 95%CI 1.133 - 2.155). Patients at trauma hospitals level 1-3 were more likely to get fluoroscopic cardiac imaging compared to non trauma hospitals: Level 1 (OR: 1.593, 95%CI 1.022 - 2.486), Level 2 (OR: 2.489??, 95%CI 1.813 - 3.417), Level 3 (OR: 2.216 95%CI 1.544 - 3.180) Patients with private insurance were more likely to get ultrasound cardiac imaging compared to medicare patients (OR: 1.165, 95%CI 1.025 - 1.325). Trauma level had no effect on patients receiving ultrasound cardiac imaging compared to non trauma: Level 1 (OR: 1.548, 95%CI 0.856 - 2.801), Level 2 (OR: 1.548, 95%CI 0.796 - 2.266), Level 3 (OR: 0.941 95%CI .559 - 1.583)

## CONCLUSION

We found that females and black patients are less likely to receive fluoroscopy imaging relative to male and white patients, respectively. While ongoing gender and race disparities may play a role in these findings, further studies are needed to fully elucidate this relationship. Additionally, private insurance beneficiaries are more likely to get imaged with fluoroscopy. Proximity to hospitals with imaging capabilities and better access to resources may play a role in our findings

## CLINICAL RELEVANCE/APPLICATION

Hospitals and clinicians need to re-evaluate their imaging algorithm for black and female patients. We also found that type of insurance and teaching hospital drastically affects likelihood of receiving fluoroscopy. These findings indicate a deeper health inequality that hospitals and physicians should address together in order to make healthcare more equitable

## S3B-SPCA- STEMI Patients: Can Imaging Predict Cost of Stay and Mortality?

6

BS (*Presenter*) Nothing to Disclose

## PURPOSE

Our study aims to determine if imaging modality can predict cost of stay and mortality in patients who have a primary diagnosis of ST elevated myocardial infarction (STEMI).

## METHODS AND MATERIALS

The national emergency department sample (NEDS) database was retrospectively queried for patients who had a primary diagnosis of STEMI. A multivariate linear regression model was used to account for key clinical covariates including age, sex, race, insurance status, income quartile, teaching status, trauma level, and cardiac risk factors such as tobacco use, coronary artery disease, and hyperlipidemia to determine cost associated with cardiac imaging. Primary outcomes focused on cost associated with use of CT, MRI, fluoroscopy, and ultrasound. A secondary analysis, with the same multivariate model, was performed to determine if certain imaging corresponded to increased odds of death.

## RESULTS

Of the 175,700 patients, in our analysis, that presented to the emergency department with a primary diagnosis of a STEMI, most were female (69.3%), white (74.1%), and had a median income in the 1st quartile (29.4%). There was increased cost associated with all cardiac imaging modalities (relative to patients who did not receive an imaging modality); fluoroscopy (B: 27,630, 95%CI 15,748-39,311), CT (B: 32,757, 95%CI 4,036-61,478), MRI (B: 397,766 380980-414,751), x-ray (24,740, 95%CI 6,426-43,055) and ultrasound (B: 25,492, 95%CI 14,150-36,834). Patients who got imaging with ultrasound (OR: 0.76, 95%CI 0.64-0.90) or fluoroscopy (OR: 0.45 95%CI 0.39-0.53) were less likely to die relative to patients who did not get imaged by those modalities. There was no difference in death rate in patients who were imaged with X-ray (OR:0.79, 95%CI 0.47-1.35) or CT scan (OR: 0.62, 95%CI 0.37-0.1.04).

## CONCLUSION

STEMI patients who get imaging pay significantly more than patients who do not get imaging. However, the use of x-ray or CT scan imaging does not necessarily lead to better outcomes, as shown in the death rates we have found. Each imaging modality is found to increase cost of stay in the tens of thousands of dollars, with MRI, being the exception, increasing cost of stay by hundreds of thousands of dollars.

## CLINICAL RELEVANCE/APPLICATION

Hospitals and clinicians should be encouraged to rethink what type of imaging they order for STEMI patients. Our study shows that CT and X-ray do not decrease mortality rate, while increasing cost of stay for patients by tens of thousands of dollars.

## S3B-SPCA- 7 Diagnostic Accuracy of Dynamic Stress CT Myocardial Perfusion with Regadenoson for the Detection of Hemodynamically Significant Coronary Artery Disease

Cesar Urtasun Iriarte I, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the diagnostic performance of dynamic stress CT myocardial perfusion imaging (CT-MPI) in combination with coronary CT angiography (CCTA) to accurately identify hemodynamically significant coronary artery disease (CAD) compared to the gold standard (invasive coronary angiography, ICA; and invasive fractional flow reserve, iFFR).

## METHODS AND MATERIALS

Between December 2019 and February 2023, 141 patients with suspected or known CAD underwent CCTA and dynamic stress CT-MPI employing regadenoson as stressor. The presence of hemodynamically significant coronary lesions was determined by CCTA (CAD-RADS=3) and CT-MPI (myocardial blood flow relative to remote myocardium<0.85) compared to CCTA alone, using angiographic severity and a iFFR of =0.80 as reference.

## RESULTS

A total of 141 patients (113 males, mean 64.8±10.1 years old, 24 with prior stent implantation) were evaluated. CCTA and CT-MPI were positive in 67 (47.5%) and 50 (35.5%) patients, respectively. 43 patients (32 males, 65.6±11.1 years old; 93.3% with CAD-RADS =3) who underwent ICA were retained for the statistical analysis. Compared to ICA, the patient-based analysis of CCTA showed a sensitivity of 100%; specificity of 50%, negative predictive value (NPV) of 100% and a positive predictive value (PPV) of 92.5%. The approach comprising CCTA and dynamic stress CT-MPI increased the specificity (97.4%) and PPV (97.4%). The accuracy of the combination of the anatomical and functional techniques was also higher (97.7% vs 93%). Receiver operating curve (ROC) analysis showed improved discrimination accuracy for the combination of CCTA and CT-MPI (0.92; CI 0.74-1; p=0.001) compared with CCTA alone (0.75; CI 0.49-1; p=0.052).

## **CONCLUSION**

Dynamic stress CT-MPI with regadenoson offers incremental diagnostic value over CCTA alone for the detection of hemodynamically significant CAD.

## **CLINICAL RELEVANCE/APPLICATION**

Dynamic stress CT-MPI is an easy-to-perform diagnostic examination technique which increases the specificity and diagnostic accuracy of CCTA alone for the detection of hemodynamically significant CAD.

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## Abstract Archives of the RSNA, 2023

S3B-SPCH

### Chest Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPCH- Quantitative Analysis for Bronchiectasis using Artificial Intelligence-based Bronchial Tapering Ratio in Patients with Chronic Obstructive Pulmonary Disease**

Hyejin Park (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Bronchiectasis (BE) is associated with loss of lung function and increased morbidity and mortality. CT is the standard method used to assess bronchiectasis but current imaging methods are limited in assessing the extent of bronchiectasis on CT scans. This study aimed to automatically quantify the extent of bronchiectasis based on an artificial intelligence (AI)-based analysis of bronchial tapering ratio on chest CT and assess the association of quantified bronchiectasis score and exacerbations in patients with chronic obstructive pulmonary disease (COPD).

#### **METHODS AND MATERIALS**

We analyzed the longitudinal cohort data of COPD patients from the Korean Obstructive Lung Disease (KOLD) cohort. The bronchiectasis score accounting the extent of abnormal tapering of inner lumen compared with the proximal airway (bronchial tapering ratio = 1.1, a measure of airway dilatation) in each patients on chest CT scans was analyzed. Quantified bronchiectasis score was correlated with visual analysis by two thoracic radiologists. Multivariable logistic analysis was performed to assess the association between the bronchiectasis score and pulmonary exacerbations on follow-up adjusted by demographics, pulmonary functional measure, and airway CT parameters.

#### **RESULTS**

Total 337 patients (median age, 66 years; 328 men [97%]) were included. Among the 337 patients, 210 (62%) had a history of a least one exacerbation. Bronchiectasis was present based on visual analysis in 148 (43.9%) patients and bronchiectasis score significantly increased as extent of bronchiectasis on visual analysis increased ( $P = .02$ ). During a median 5-year follow-up, the bronchiectasis score was a significant independent predictor of acute exacerbation (adjusted odds ratio [OR], 1.12 [95%CI: 1.03-1.22];  $P = .007$ ) along with wall area percentage on CT (OR, 1.03 [1.01-1.06];  $P = 0.02$ ) and forced expiratory volume in 1 s (OR, 0.98 [0.97-0.99];  $P = 0.002$ ) in multivariable analysis.

#### **CONCLUSION**

In COPD, artificial intelligence-based CT measures of bronchiectasis based on bronchial tapering ratio were significant predictors for acute exacerbation.

#### **CLINICAL RELEVANCE/APPLICATION**

Evaluation of extent of bronchiectasis on chest CT using artificial intelligence-based bronchial tapering ratio were reliable and automatically quantified extent of bronchiectasis on CT had prognostic implications for COPD exacerbations.

#### **S3B-SPCH- Lymphatic Bubble Sign in Lung and Mediastinum: Special CT Feature for the Diagnosis of Pulmonary Lymphatic Malformation with Lymphatic-airway Leakage**

MENGKE LIU (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the special CT feature of lymphatic bubble sign (LBS) on HRCT for the diagnosis of pulmonary lymphatic malformation (PLM) with lymphatic-airway or alveolar leakage.



## METHODS AND MATERIALS

Eight hundred and ten patients diagnosed as PPL were collected in this retrospective study from January of 2006 to December of 2022, of which 62 cases with chylous phlegm and plastic bronchitis showed LBS in lung and/or mediastinum on HRCT or CT lymphography. The imaging features of LBS were blinded reviewed by two chest radiologists respectively, including the position, size, quantity, morphology, and dynamic changes of bubbles. All patients were followed up for HRCT within 1-6 months.

## RESULTS

LBS was seen in 62 (7.7%) of 810 patients with PPL, which was located in pulmonary interstitium in 30 cases, paraloobar-fissure with thickening in 5 and mediastinal fat area in 12, both in 20 patients. ALL the LBS manifested multiple lesions, no wall or thin wall and round-like with smooth edges with a size of 3-10mm. A dynamic changes of this sign was showed in all patients with obvious improvement in 56 cases, aggravation 6 and recurrent occurrence in 25 patients on the 1-6 months follow-up CT. In addition, similar lesions were showed in chest wall, ribs and pleural cavity, respectively. The associated-accompanying lesions include ground glass opacity, interlobular septal thickening, tree-in-bud, chylothorax, chylo-pericardium and mediastinal opacity. All the lesions is not related to thoracic puncture drainage or direct lymphangiography, but patients often have long-term medical history of dyspnea and chronic cough.

## CONCLUSION

This sign indicates the formation of lymphatic and airway leaks in the lungs, with chylous leakage leading to chylous pneumonia and plastic bronchitis. However, the air in the airway pours back into the lymphatic vessels due to pressure changes and other reasons, forming the LBS. Chest CT has important value in displaying this sign and helps to determine PLMs and chylous leakage and providing strong evidence for clinical treatment.

## CLINICAL RELEVANCE/APPLICATION

LBS strongly favors a diagnosis of pulmonary lymphedema and lymphatic dilatation with lymphatic-airway or alveolar leakage and plastic bronchitis.

## S3B-SPCH- Template Matching Method for Accurate Quantification of Cystic Tissue Volume in CT Scans of Diffuse Cystic Lung Disease

Katie J. Noonan, BEng, MEng (*Presenter*) Nothing to Disclose

## PURPOSE

Diffuse Cystic Lung Disease (DCLD) is a broad term used to describe rare lung diseases characterised by the presence of air-filled cysts within the parenchyma of the lungs. Due to their relative scarcity and visual similarity to more prevalent diseases such as emphysema, DCLDs are frequently mis-diagnosed, leading to significantly worse clinical outcomes and a higher burden on the healthcare system. Our research presents a method which accurately identifies cystic regions within DCLD CT scans, achieving a similar standard to expert defined manually annotated cases. Furthermore, the method quantifies cystic tissue volume in the sample, providing a reliable and efficient means of assessment.

## METHODS AND MATERIALS

Template matching methods involve the extraction of image features, such as shape, texture and colour, and correlates them with a pre-defined image template to identify regions of interest. In the context of a Lymphangioliomyomatosis CT scan, circular regions of low attenuation that exhibit high correlation to a black circle template were isolated and defined as potential cystic regions. The detected regions were then compared with related manually annotated cases which had previously outlined the presence of cystic regions as identified by an expert radiologist.

## RESULTS

The method's performance was evaluated by comparing its results with that of the manual annotations of an expert radiologist. The assessment yielded a Dice Similarity Coefficient of 86%, Precision of 79%, Specificity of 99% and an F1 Score of 88%.

## CONCLUSION

The high correlation observed between the template matching method and the manually annotated cases outlines the potential of semi-automated feature extraction methods as a faster and less labour-intensive method to quantifying cystic tissue volume across numerous cases. By computing the ratio between cystic and lung tissue volume, this method provides a reliable means of assessing the overall health of lung tissue. The use of such methods has broad implications in clinical settings, where accurate and efficient evaluation of numerous cases is essential.

## CLINICAL RELEVANCE/APPLICATION

The semi-automated method outlined identifies cystic regions comparably to expert radiologists, allowing development of a lung health score based on cystic/lung tissue volume ratio.



### **S3B-SPCH- 4 Clinical Course and Risk Factors for Development and Progression of Interstitial Lung Disease in Primary Sjögren's Syndrome**

Eunseo Lee (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the long-term course and prognostic factors of patients with primary Sjögren syndrome-associated interstitial lung disease (pSS-ILD).

#### **METHODS AND MATERIALS**

This single-center, retrospective study included 120 pSS patients who underwent at least two high-resolution computed tomography (HRCT) scans between March 2013 and February 2021. Clinical symptoms, laboratory data, HRCT findings, and pulmonary function test results were collected. HRCT were scored blindly by two expert thoracic radiologists: extent of ground glass opacities (GGO), fine/coarse reticulations, and honeycombing, and coarseness score of fibrosis.

#### **RESULTS**

In patients with pSS without ILD at baseline (n=81), no development of ILD was found on follow-up (median, 2.8 years). In patients with pSS-ILD (n=39), total disease extent, extent of coarse reticulation, and traction bronchiectasis increased on HRCT, whereas the extent of GGO decreased at follow-up (median, 3.2 years) (each  $p < 0.001$ ). In progressive group of pSS-ILD (n=19/39, 48.7%), the extent of coarse reticulation and coarseness score of fibrosis were increased at follow-up ( $p < 0.05$ ). Multivariate logistic regression analysis showed that LDH (OR, 1.012) and diffusing capacity for carbon monoxide (OR, 0.922) were independent risk factors for pSS-ILD at baseline. Usual interstitial pneumonia (UIP) pattern on CT (OR, 15.237) and follow-up duration (OR, 1.403) were independent risk factors for disease progression in patients with pSS-ILD. In response to glucocorticoid and/or immunosuppressants, GGO decreased, whereas the extent of fibrosis increased even after treatment.

#### **CONCLUSION**

In pSS patients with no ILD during baseline evaluation, no newly developed ILD was identified during follow-up over two years. Progression occurred in approximately half of the pSS-ILD patients with slow gradual deterioration. UIP pattern on CT and follow-up duration were independent risk factors for progression of pSS-ILD.

#### **CLINICAL RELEVANCE/APPLICATION**

HRCT is a crucial modality for determining the progression of lung fibrosis in patients with pSS, in addition to the initial screening evaluation for ILD.

### **S3B-SPCH- 5 Chest Radiography, Computed Tomography and Magnetic Resonance in Evaluation of Pulmonary Sarcoidosis in Assessment of Disease Progression and Comparison with Pulmonary Function Tests**

Stephan Altmayer, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare radiography, high resolution computed tomography (HRCT), and magnetic resonance imaging (MRI) in the assessment of disease progression in pulmonary sarcoidosis in comparison to pulmonary function tests.

#### **METHODS AND MATERIALS**

In this prospective study of 77 adults diagnosed with sarcoidosis, all subjects underwent baseline pulmonary function testing, chest radiography, HRCT and MRI. Chest radiographs were categorized using the Siltzbach classification system. HRCT and MRI were scored using the Scleroderma Lung Study I system. Pulmonary function was reassessed after 12 months, with progressive disease defined by  $\geq 5\%$  reduction of forced vital capacity (FVC). Differences in median imaging scores were assessed with Student's t-test and Wilcoxon rank-sum test. Correlation between imaging and pulmonary function was investigated using Pearson's and Spearman's rank correlation coefficients. FVC decline was the gold standard on multivariate analysis used to calculate the odds ratios (OR) for progression of disease predicted by imaging, with score thresholds determined by maximum Youden's index. The area under the curve (AUC) of the receiver operating characteristic plot was calculated for each imaging modality.

#### **RESULTS**

There is a strong correlation between chest radiography and MRI ( $r = 0.649$ ,  $P < 0.001$ ), and CT and MRI scores ( $r = 0.851$ ,  $P < 0.05$ ). CT and MRI scores correlated with FVC (MRI:  $r = -0.584$ ,  $P < 0.001$ ; CT:  $r = -0.308$ ,  $P = 0.049$ ) and diffusing capacity of the lung for carbon monoxide (MRI:  $r = -0.564$ ,  $P = 0.004$ ; CT:  $r = -0.216$ ,  $P = 0.017$ ). The AUCs for Radiography, MRI and CT scores were 0.70 (0.49-0.85), 0.51 (0.32-0.75), and 0.76 (0.56-0.90), respectively. Multivariate analysis demonstrated significant prediction of progressive disease by CT (OR = 1.236,  $p = 0.044$ ) and MRI (OR = 1.594,  $p = 0.021$ ).

## CONCLUSION

MRI may be a viable alternative to HRCT in lung assessment and prediction of disease progression in patients with pulmonary sarcoidosis.

## CLINICAL RELEVANCE/APPLICATION

MRI may be a viable tool for the assessment of disease progression in patients with pulmonary sarcoidosis, although further studies are necessary to validate this tool.

## S3B-SPCH- To Evaluate the Role of the F FDG PET CT in the Idiopathic Pulmonary Fibrosis and Diffuse Parenchymal Lung Disease

6

Sikandar M. Shaikh, DMRD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study was to evaluate the role of the (18)F-FDG PET/CT in patients with idiopathic pulmonary fibrosis (IPF) and diffuse parenchymal lung disease (DPLD).

## METHODS AND MATERIALS

Seventy-two patients (62 men and 10 women; mean age +/- SD, 68.7 +/- 9.4 y) with IPF (n = 36) or other forms of DPLD (n = 36) were advised whole body PET/CT and also high-resolution CT (HRCT), which were acquired simultaneously. 18 F FDG was done after injecting the radiotracer and whole-body PET-CT was done after 60 minutes of FDG administration. The amount of the uptake in the pulmonary (18)F-FDG metabolism was quantified as a standardized uptake value (SUV(max)). Along with this scan the HRCT lung was done for each patient and further analysis of the various HRCT patterns of parenchymal involvement as ground-glass opacities or reticulation/honeycombing. Along with this the patients underwent a global health assessment and pulmonary function tests.

## RESULTS

The pulmonary uptake metabolism in 72 of 72 patients was evaluated. The parenchymal pattern of the HRCT is seen as the maximal (18)F-FDG metabolism which was seen predominantly in ground-glass (14/72), reticulation/honeycombing (52/72), and mixed (6/72). The mean SUV(max) in patients with ground-glass and mixed patterns was 2.0 +/- 0.4, and in reticulation/honeycombing it was 3.0 +/- 1.0 (Mann-Whitney U test, P = 0.007). The mean SUV(max) in patients with IPF was 2.9 +/- 1.1, and in other DPLD it was 2.7 +/- 0.9 (Mann-Whitney U test, P = 0.862). The mean mediastinal lymph node SUV(max) (2.7 +/- 1.3) correlated with pulmonary SUV(max) (r = 0.63, P < 0.001). Pulmonary (18)F-FDG uptake correlated with the global health score (r = 0.50, P = 0.004), forced vital capacity (r = 0.41, P = 0.014), and transfer factor (r = 0.37, P = 0.042).

## CONCLUSION

The increased pulmonary (18)F-FDG metabolism is seen in all the patients with IPF and also other forms of DPLD was observed. Pulmonary (18)F-FDG uptake shows significant changes in the measurements of health and lung physiology in these patients. The analysis showed that the (18)F-FDG metabolism is higher at the site of maximal uptake which corresponds to the areas of reticulation/honeycombing on the HRCT scans other than with ground-glass patterns.

## CLINICAL RELEVANCE/APPLICATION

The role of the Whole body PET-CT is important in various forms of ILD and other pathologies in the chest

## S3B-SPCH- Predictors of Progressive Pulmonary Fibrosis: A Radiologic-Pathologic Correlation Study

7

Hyeong Ryun Cho, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Progressive pulmonary fibrosis (PPF), which is treatable with anti-fibrotic therapy, is defined as interstitial lung disease (ILD) other than idiopathic pulmonary fibrosis (IPF) that manifests progressive features regardless of standard management. This study evaluates the radiologic-pathologic correlations of PPF and identifies predictors associated with disease progression and survival.

## METHODS AND MATERIALS

Between January 2004 and December 2020, 75 patients diagnosed with ILD other than IPF who underwent surgical lung biopsy were retrospectively included. Three chest radiologists reviewed chest computed tomography (CT) features and fibrosis extent on baseline and follow-up CT, and patients were subdivided into PPF and non-PPF based on progression. Two pathologists reviewed cases for pathologic features and the presence of usual interstitial pneumonia (UIP). Overall and progression-free survival were calculated using the Kaplan-Meier method, and the Cox proportional hazard method was used to examine predictors for progressive pulmonary fibrosis and survival.

## RESULTS

Regarding radiologic-pathologic correlations, when the pathologic UIP pattern was present in the specimen, it was associated with radiologic honeycombing, traction bronchiectasis, and reticulation ( $p < 0.001$ ). Progression was seen in 42.7% (32/75) of non-IPF ILD patients, with a median progression time of 44 months. Radiologic traction bronchiectasis was identified as the only predictive factor of PPF on the multivariate Cox-proportional hazard method (hazard ratio [HR], 6.54;  $p = 0.003$ ). PPF (HR, 3.96;  $p = 0.013$ ) and advanced age (HR, 1.13,  $p < 0.001$ ) were associated with an increased risk of death in non-IPF ILD patients. The median survival time of PPF was 120 months.

## CONCLUSION

A radiologic pattern of traction bronchiectasis was a predictor of PPF, while PPF and advanced age were risk factors for low survival in non-IPF ILD patients.

## CLINICAL RELEVANCE/APPLICATION

Recognition of traction bronchiectasis is crucial for predicting PPF in patients with non-IPF ILD, emphasizing the importance of timely initiation of anti-fibrotic therapy in improving patient outcomes.

## S3B-SPCH- Granulomatous and Lymphocytic Interstitial Lung Disease in Common Variable 8 Immunodeficiency: CT Findings and Association with Pulmonary Function Tests

Nicholas Landini, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Common Variable ImmunoDeficiency (CVID) may be complicated by Granulomatous and Lymphocytic Interstitial Lung Disease (GL-ILD). GL-ILD includes a wide spectrum of ILD abnormalities, worsening CVID prognosis. We aimed to characterize chest Computed Tomography (CT) findings of GL-ILD, in comparison with CVID patients without GL-ILD, and their association with PFT worsening.

## METHODS AND MATERIALS

Patients with CVID followed from 2018 to 2021 were retrospectively evaluated. Inclusion criteria were: GL-ILD diagnosis, CT and PFT performed within one week. Patients on GL-ILD therapy or with the clinical suspicion of infection were excluded. Age and sex matched non GL-ILD subjects were searched. CT findings, evaluated in consensus by two chest radiologists, were: bronchiectasis, bronchial wall thickening, mucous plugs, tree in bud, mosaic perfusion, small nodules ( $\leq 10$ mm) and big nodules (multiple  $\geq 10$ mm), consolidation, ground glass opacities (GGO), reticulation, fibrotic ILD, cavitation/necrosis and bands. Small nodules main distribution (centrilobular, perilymphatic or random) was noted. CT abnormalities were assessed in upper, lower fields and whole lungs, describing disease predominance. Presence of enlarged nodes (axis  $\geq 10$  mm), pleural or pericardial effusion was also assessed. Fisher exact test was computed, assessing Odds Ratios (OR) for GL-ILD against non GL-ILD. A significant  $p$ -value was set as  $\leq 0.05$ , with Bonferroni correction for the following PFT: TLC, FEV1, FVC and DLCO, % predicted.

## RESULTS

38 GL-ILD subjects and 38 controls were identified. Most common GL-ILD CT findings in GL-ILD ( $\geq 50\%$  patients) were: bronchiectasis, multiple non-perilymphatic small nodules, GGO, consolidations, bands and enlarged nodes. The disease was usually predominant in lower fields (92%). Bronchiectasis, GGO, reticulations, fibrosis and bands were more frequent in lower fields. GGO was associated with TLC worsening, reticulation with all PFT worsening, fibrotic ILD with DLCO ( $p$ -value  $\leq 0.0125$ ). Considering whole lungs analysis, small nodules, consolidations, reticulations and fibrosis had an OR  $\geq 10$  in identifying GL-ILD versus non GL-ILD patients.

## CONCLUSION

GL-ILD usually manifests with bronchiectasis, non-perilymphatic nodules, GGO, consolidations, bands and enlarged mediastinal lymph nodes, with a lower field predominance. Reticulation is the main CT finding associated with functional worsening. Small nodules, consolidations, reticulations and fibrotic ILD are highly suggestive of GL-ILD in CVID subjects.

## CLINICAL RELEVANCE/APPLICATION

These results provide CT characteristics of GL-ILD that may be helpful in the diagnosis of a such polymorphic disease, verifying their relationships with PFT worsening

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## Abstract Archives of the RSNA, 2023

S3B-SPER

### Emergency Radiology Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### S3B-SPER-1 Self-Supervised Machine Learning to Triage Acute Chest Syndrome in Pediatric Patients with SCD

Syed M. Anwar, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Children with sickle cell disease (SCD) are at a high risk of poor outcome if they develop pneumonia or acute chest syndrome (ACS). We have developed a machine learning model for ACS prediction using chest radiographs (CXRs), hence triaging children for treatment presented to the emergency department.

#### METHODS AND MATERIALS

We performed a retrospective analysis of children with SCD who had a CXR performed at an urban pediatric emergency department between July 2015 and March 2023. A query of our clinical registry identified 1,115 pediatric SCD patients with "likely ACS" (n=601) or "likely not ACS" (n=514), based on diagnosis code and disposition. We manually reviewed the radiologist impression for each CXR and excluded 28.4% (n=171) of patients in the "likely ACS" group and 5.1% (n=26) of patients initially labeled "likely not ACS". A pre-trained, self-supervised machine learning model was fine-tuned using manually reviewed CXR impressions to predict ACS in future radiographic images. Our deep learning model used a vision transformer and was pre-trained on 400,000 CXRs from publicly available data. The model was earlier tested on other clinical conditions such as covid-19, age, and sex prediction. We report machine learning inference time and the time required to complete the radiologic assessment, reporting timing for both daytime and overnight studies because an attending radiologist is available to review new studies during daytime and evening hours but only reviews images overnight if they are paged directly with a question.

#### RESULTS

The average accuracy of our ACS prediction model was 0.85 with sensitivity of 0.77, specificity of 0.91, and AUC of 0.89. Machine learning inference time was 0.0068 (median) seconds (IQR:0.0065-0.0072) running on machine with NVIDIA RTX A5000 GPU with half-precision (FP16). Daytime studies, completed between 06:00 and 22:00 h, were read by a radiologist within 55.0 (median) minutes (IQR:23.0-115.0). Overnight studies, completed between 22:00 and 06:00 h, were read within 401.5 (median) minutes (IQR:245.25-535.75).

#### CONCLUSION

The model for ACS prediction from CXR has the potential to identify high risk SCD patients in the emergency department in a timely manner with clinically acceptable performance. Our inference time is real-time, allowing for prediction of ACS as soon as a CXR is recorded in the PACS.

#### CLINICAL RELEVANCE/APPLICATION

ACS is associated with mortality and severe morbidity in children with SCD and requires rapid recognition and intervention. At our single site, real-time machine learning prediction has the greatest potential to expedite diagnosis during overnight hours.

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## Abstract Archives of the RSNA, 2023

S3B-SPGI

### Gastrointestinal Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPGI-1 Clinical and Imaging Features of Focal Intrahepatic Biliary Stricture Visualized Only as Duct Dilatation**

Byoungje Kim, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

The percentage of patients with precursor lesions or malignancy due to focal intrahepatic stricture (FIHS) without radiographically demonstrable bile duct abnormality, visualized only as duct dilatation, is currently unknown. Moreover, it is unknown whether there is a variable to differentiate malignant or precursor lesions from non-precursor benign lesions. Therefore, we studied the proportion of patients with FIHSs that were precursor lesions or malignancies. Additionally, we evaluated the clinical variables and MRI features that may discriminate between non-premalignant benign and premalignant/malignant FIHSs.

##### **METHODS AND MATERIALS**

This retrospective study assessed patients who underwent surgery for FIHS between January 2010 and March 2022. The number and proportion of non-precursor benign lesions, precursors, and malignancies were calculated. Clinical variables and MRI features were compared between non-premalignant benign and premalignant/malignant FIHSs using independent t-tests and chi-square tests for continuous and categorical variables, respectively.

##### **RESULTS**

Twenty-five patients with confirmed histopathological diagnoses were identified. The study included 13 men (52.0%) and 12 women (48.0%). The median age of all the patients at the first imaging diagnosis was 65 years (range, 43-78 years). Of the 25 FIHS patients, 9 (36%) were diagnosed with cholangiocarcinoma and 6 (24%) were diagnosed with precursor lesions. Among the precursor lesions, five were intraductal papillary neoplasms of the bile duct, and one was biliary intraepithelial neoplasia. Therefore, 15 (60%) had malignant or precursor lesions, and 10 (40%) were diagnosed with non-precursor benign lesions. None of the clinical variables and imaging features used for analysis showed a statistically significant difference between the non-premalignant benign and premalignant/malignant FIHS groups ( $p < .05$ ).

##### **CONCLUSION**

More than half of FIHSs were malignant or precursor lesions. There were no predictive values for the clinical and imaging parameters. Therefore, a more active strategy for the diagnosis and follow-up imaging should be considered.

##### **CLINICAL RELEVANCE/APPLICATION**

Patients with FIHS require active treatment including surgical treatment and careful imaging follow-up.

#### **S3B-SPGI-2 MRI Screening with Machine Learning-supported Post-processing and Genetics of Multiple Biliary Hamartomas**

Philipp Schindler, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Multiple biliary hamartomas (MBH), also known as "von Meyenburg complexes", are benign and asymptomatic malformations of dilated bile ducts embedded in fibrous stroma, usually smaller than 10 mm. A detailed knowledge of these malformative cystic-like lesions is crucial because they may be misdiagnosed as malignant. The aim of this study was to investigate the feasibility of magnetic resonance imaging (MRI) screening for the detection of MBH with machine learning-supported post-processing and to explore the genetic characteristics of this rare condition.

## **METHODS AND MATERIALS**

Five consecutive patients with MBH were prospectively enrolled in this study. All patients underwent high-resolution (3.0 Tesla) contrast-enhanced hepatobiliary MRI and magnetic resonance cholangiopancreatography (MRCP) at baseline to provide a structured report of imaging features of MBH and at 12-month follow-up to exclude progression. A pipeline of 3D k-means clustering based image segmentation was used for detection of cystic-like lesions. Eccentricity was calculated to identify round and oval objects in the cluster and to exclude the biliary tree. Customized next-generation sequencing (NGS) was used to identify the underlying genetic cause of MBH.

## **RESULTS**

Baseline MRI showed innumerable small hepatic cystic lesions without contrast enhancement, even in the hepato-biliary phase, and without communication with the biliary tree, allowing the diagnosis of MBH. K-means clustering based image segmentation was feasible for annotation of MBH. Total liver lesion volume remained stable over time (mean volume: 104.8 ml; mean proportion of total liver volume: 8.1%). All patients had a heterozygous missense, truncating, or frameshift mutation in the polycystic kidney and hepatic disease 1 (PKHD1) gene encoding the multidomain integral membrane protein fibrocystin.

## **CONCLUSION**

This preliminary data suggests that machine learning-augmented MRI screening can be used for quantification of MBH. The genetic analysis revealed a potential association between multiple biliary hamartomas and mutations in the PKHD1 gene. These findings provide important insights into the diagnosis of this rare condition.

## **CLINICAL RELEVANCE/APPLICATION**

Knowledge of MRI findings and genetics of MBH is helpful for a prompt and correct diagnosis, avoiding unnecessary invasive procedures and/or an excessive number of radiological investigations.

## **S3B-SPGI-3A Comparison of the Diagnostic Accuracies of Ultrasound and CT in 82 Proven Cases of Acute Cholecystitis**

Joshua Thurgood (*Presenter*) Nothing to Disclose

## **PURPOSE**

To compare the efficacies of US imaging vs CT imaging in the diagnosis of acute cholecystitis in aiming to improve the diagnosis and treatment of patients with acute cholecystitis.

## **METHODS AND MATERIALS**

We retrospectively collected data on 100 patients with suspected acute cholecystitis and 100 control patients with studies occurring between 3/1/2015 and 3/31/2020. Of the 100 suspected acute cholecystitis patients, 50 had US imaging and 50 had CT imaging done. To be included as a proven case of acute cholecystitis, cases were then screened for cholecystectomy. Due to this, 7 US subjects and 11 CT subjects were removed as they did not undergo cholecystectomy or were treated via a different method. In the control group, 50 patients had US imaging and 50 had CT imaging. All studies were then reviewed by three radiologists of differing experience levels. The data from each reviewer was then combined and tabulated. One reviewer also tabulated data for patients that had both US and CT studies done, which amounted to 47 of the patients with confirmed acute cholecystitis.

## **RESULTS**

The sensitivity of CT for diagnosing acute cholecystitis was greater than the sensitivity of US, with these being 66.67% and 53.49% respectively. The negative predictive value of CT was also greater than that of US, which were 75.93% and 64.91% respectively. There were no false positives by any of the reviewers, so the specificities and positive predictive values were 100% for both CT and US modalities. Among the 47 patients who had both US and CT studies done, 24 had both positive US and CT for acute cholecystitis, 9 patients had a positive CT and negative US, 4 patients had a positive US and negative CT, and 10 patients had both negative US and CT studies.

## **CONCLUSION**

CT was significantly more sensitive and had a higher negative predictive value than US. However, both modalities had lower sensitivities and negative predictive values than what is found in the literature. All three reviewers performed better on CT than US with two performing significantly better with sensitivities improving by 20.63% and 15.98% respectively. The results of our study showed significantly higher performance using CT imaging over US imaging when evaluating for acute cholecystitis. However, we still suggest US as our first imaging test in patients with suspected AC. If the US is negative, CT should be performed. If the CT is negative and there is still strong clinical suspicion for AC, a HIDA scan should be done.

## **CLINICAL RELEVANCE/APPLICATION**

The research being conducted is significant because time to treatment of acute cholecystitis is most often imaging dependent and understanding the relative efficacies of the two most common initial imaging modalities will lead to increased efficiency



and time to treatment of these patients.

### **S3B-SPGI-4 Ultra-high-resolution Drip-infusion CT Cholangiography with Deep Learning-based Reconstruction: Comparison with Normal-resolution Simulation**

Atsushi Nakamoto, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the image quality and bile duct delineation of drip-infusion CT cholangiography (DIC-CT) using an ultra-high-resolution CT (UHR CT) with a 1024 x 1024 matrix combined with a deep learning-based reconstruction algorithm in comparison with simulated normal-resolution (NR) images.

#### **METHODS AND MATERIALS**

Twenty-five potential liver transplant donors (13 men and 12 women, age range, 21 to 61 years; mean age, 36.3 years) who underwent DIC-CT using the super-high-resolution (SHR) mode of a UHR CT scanner for preoperative evaluation were included in this retrospective study. SHR images were reconstructed with a 1024 x 1024 matrix and 0.25-mm slice thickness using a deep learning-based reconstruction algorithm. Simulated NR images were reconstructed from the same raw data with a 512 x 512 matrix and 0.5-mm slice thickness using a hybrid iterative reconstruction algorithm. Maximum CT value and contrast-to-noise ratio (CNR) of the common bile duct were compared between SHR and NR images using the paired t-test. Two radiologists independently reviewed the maximum intensity projection images and graded the image quality for delineation of the peripheral bile ducts, image sharpness, image noise, and the overall image quality using a 5-point scale, and the results were compared using the Wilcoxon signed-rank test.

#### **RESULTS**

The maximum CT number of the common bile duct was significantly higher on SHR images than on NR images ( $451.6 \pm 65.0$  vs.  $382.5 \pm 67.4$ ,  $P < .001$ ). CNR was significantly lower on SHR images than on NR images ( $19.8 \pm 4.0$  vs.  $38.9 \pm 12.4$ ,  $P < .001$ ). In qualitative analysis, NR scored significantly higher (i.e. less noise) than SHR for noise ( $4.0 \pm 0.2$  and  $4.1 \pm 0.3$  vs.  $2.0 \pm 0.2$  and  $1.9 \pm 0.3$ ,  $P < .001$ ), whereas SHR scored significantly higher for peripheral bile duct delineation ( $3.6 \pm 0.8$  and  $3.8 \pm 0.5$  vs.  $2.4 \pm 0.8$  and  $2.2 \pm 0.5$ ,  $P < .01$ ), sharpness ( $3.8 \pm 0.6$  and  $3.9 \pm 0.7$  vs.  $2.2 \pm 0.6$  and  $2.1 \pm 0.7$ ,  $P < .001$ ), and overall image quality ( $4.0 \pm 0.6$  and  $3.6 \pm 0.8$  vs.  $2.0 \pm 0.6$  and  $2.4 \pm 0.8$ ,  $P < .01$ ) for both readers.

#### **CONCLUSION**

UHR CT combined with a deep learning-based reconstruction provided drip-infusion CT cholangiography images with higher spatial resolution and improved the delineation of the peripheral bile duct, despite increased image noise and decreased CNR.

#### **CLINICAL RELEVANCE/APPLICATION**

Ultra-high-resolution CT combined with a deep learning-based reconstruction provides high-quality drip-infusion CT cholangiography and improves peripheral bile duct delineation.

### **S3B-SPGI-5 Breath-hold 3D Gradient- and Spin-echo (GRASE) MRCP Compared to Compressed-sensing Highly Accelerated Respiratory-triggered Technique**

Nobuyuki Kawai, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate breath-hold 3D gradient- and spin-echo (GRASE) MRCP compared to respiratory-triggered 3D turbo spin-echo (TSE) MRCP highly accelerated with the compressed sensing-sensitivity encoding (C SENSE).

#### **METHODS AND MATERIALS**

Fifty-eight consecutive patients (30 men, 28 women, mean age 67.2 years) with suspicious having pancreaticobiliary diseases underwent MRCP on a 3-T clinical scanner. All patients underwent breath-hold 3D GRASE MRCP with sensitivity encoding (SENSE) (BH-MRCP; SENSE factor, 2) and respiratory-triggered 3D TSE MRCP highly accelerated with the C SENSE (RT-MRCP; C SENSE factor, 11.6) in a random order. For quantitative image analyses, signal intensity (SI) of biliary ducts and main pancreatic duct (MPD), peribiliary ductal tissue, and peripancreatic ductal tissue were measured. The relative duct-to-periductal contrast ratios (RCs) of each pancreaticobiliary segments were calculated as  $(SI_{duct} - SI_{periduct}) / (SI_{duct} + SI_{periduct})$ , respectively. For qualitative image analyses, two radiologists coincidentally graded conspicuity of biliary ducts, MPD, and pancreatic cystic lesion, and overall image quality between the two sequences using a five-point rating scale. Artifacts were also graded using a four-point rating scale.

#### **RESULTS**

Mean acquisition times in BH-MRCP and RT-MRCP sequence were 23 and 29 seconds, respectively. RCs of all three segments of MPD in BH-MRCP were slightly lower than those in RT-MRCP ( $P = 0.002$ ). Conspicuity of central and peripheral segments of right and left hepatic duct, cystic duct, and common bile duct in BH-MRCP were significantly higher than those in RT-MRCP ( $P = 0.015$ ). Conspicuity of MPD and pancreatic cystic lesion was comparable between the two sequences. Overall image quality

in BH-MRCP was significantly higher than that in RT-MRCP ( $P = 0.038$ ). In BH-MRCP, the number of scans with the poor or non-diagnostic image quality (score = 2) in overall image quality was decreased compared with that in RT-MRCP [3.4% (2/58) vs. 8.6% (5/58),  $P = 0.242$ ].

#### **CONCLUSION**

BH-MRCP provided better image quality and a reduced number of poor or non-diagnostic images compared to RT-MRCP.

#### **CLINICAL RELEVANCE/APPLICATION**

Breath-hold 3D gradient- and spin-echo MRCP provided better image quality compared to respiratory-triggered 3D turbo spin echo MRCP highly accelerated with the compressed sensing-sensitivity encoding.

### **S3B-SPGI-7 Ultra-High Resolution T2-weighted PROPELLER MRI of the Rectum with Deep Learning Reconstruction: Assessment of the Image Quality and Diagnostic Performance**

Takahiro Tsuboyama, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to evaluate the impact of ultra-high resolution acquisition with a slice thickness of 1.2 mm and deep learning reconstruction (DLR) on the image quality and diagnostic performance of T2-weighted periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER) images for rectal cancer.

#### **METHODS AND MATERIALS**

This prospective study included 34 patients who underwent MRI for the assessment of pretreatment or post-chemoradiotherapy rectal cancer. Written informed consent was obtained. The following four types of axial T2-weighted PROPELLER imaging perpendicular to the tumor were obtained: a slice thickness of 3 mm with conventional reconstruction (3-CR) and DLR (3-DLR), and a slice thickness of 1.2 mm with CR (1.2-CR) and DLR (1.2-DLR). Three radiologists independently evaluated the image quality and assessed the extramural tumor spread, extramural venous invasion (EMVI), lymph node metastasis, and response to chemoradiotherapy if applicable by using a 5-point scoring system. The image quality was compared with Friedman's test. Agreement of the scores obtained with the four types of PROPELLER imaging was assessed by the intraclass correlation coefficient. The diagnostic performance by the three readers were compared with Friedman's test in 22 patients who underwent surgery after MRI.

#### **RESULTS**

In the image quality assessment, 1.2-DLR yielded significantly the best sharpness, rectal and tumor conspicuity, and overall image quality ( $P < 0.05$ ) for all readers. In the diagnostic performance, perfect agreement (ICC value  $> 0.80$ ) was not seen among the four PROPELLER images in all readers regarding extramural tumor spread, EMVI, and complete response. For the diagnosis of extramural tumor spread, specificity and accuracy were significantly lower with 3-DLR (mean, 0.64 and 0.74) and 1.2-DLR (mean, 0.58 and 0.74) than with 3-CR (mean, 0.75 and 0.79) and 1.2-CR (mean, 0.78 and 0.83) ( $P < 0.05$ ). For the diagnosis of venous invasion, sensitivity and accuracy were significantly higher with 1.2-CR (mean, 0.42 and 0.67) and 1.2-DLR (mean, 0.55 and 0.71) than with 3-CR (mean, 0.30 and 0.59) and 3-DLR (mean, 0.36 and 0.56) ( $P < 0.05$ ). There were no significant differences in the diagnostic accuracies of lymph node metastases and complete response.

#### **CONCLUSION**

Ultra-high resolution PROPELLER T2-weighted MRI using DLR could provide high image quality and accurate detection of venous invasion although it increased false-positive diagnoses of extramural tumor extension.

#### **CLINICAL RELEVANCE/APPLICATION**

Although DLR can provide thin-slice T2-weighted PROPELLER MRI with high image quality, extramural tumor spread should be carefully interpreted because DLR may increase false-positive results.

### **S3B-SPGI-8 Deep Learning Segmentation and Radiomics for Automatic Identification and Activity Assessment of CTE Lesions in Crohn's Disease**

Yankun Gao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this paper is to develop a deep learning automatic segmentation model for the segmentation of Crohn's Disease (CD) lesions in CTE images. Additionally, the radiomics features extracted from the segmented CD lesions will be analyzed, and multiple machine learning classifiers will be built to distinguish CD activity.

#### **METHODS AND MATERIALS**

This retrospective study includes two sets of CTE image data (segmentation dataset and classification dataset). The CD lesions in the segmentation dataset were manually segmented by radiologists, and a deep learning automatic segmentation model based on nnU-Net neural network was developed. The CTE images in the classification dataset were processed using



the automatic segmentation model to obtain segmentation results and extract radiomics features. The most optimal features were then selected to build five machine learning classifiers to distinguish CD activity. The performance of the automatic segmentation model was evaluated using the Dice similarity coefficient (DSC), while the performance of the machine learning classifier was evaluated using the area under the curve (AUC), sensitivity, specificity and accuracy.

## **RESULTS**

The segmentation dataset consisted of 84 CTE examinations of CD patients (60 males) and the classification dataset included a total of 193 CTE examinations of CD patients (136 males). The deep learning segmentation model achieved a DCS value of 0.824 on the testing set. Among the five machine learning classifiers, the Logistic Regression (LR) model showed the highest classification performance in the testing set, with an AUC, sensitivity, specificity and accuracy of 0.862, 0.697, 0.840 and 0.759, respectively.

## **CONCLUSION**

Our study demonstrates that a deep learning segmentation model based on the nnU-Net neural network can accurately segment CD lesions in CTE images and build a machine learning classifier to distinguish CD activity based on the extracted radiomics features. This approach can help clinicians assess the severity of patient's disease with greater accuracy.

## **CLINICAL RELEVANCE/APPLICATION**

Helps radiologists aid in diagnosis and improve diagnostic efficiency, which in turn helps clinicians assess a patient's condition and provide an idea for the next step in treatment.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPGU

### Genitourinary Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### S3B-SPGU- Predicting Renal Allograft Dysfunction using Shear-wave Dispersion Slope

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Taekmin Kim, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the role of shear-wave dispersion slope for predicting renal allograft dysfunction.

#### METHODS AND MATERIALS

We retrospectively reviewed 126 kidney transplant recipients (median age 57 years [interquartile range 47-62 years], 60 women) who underwent kidney biopsy for allograft evaluation from November 2022 to February 2023. All patients underwent shear-wave elastography (SWE) examination just before biopsy, and parenchymal stiffness and dispersion slope were obtained in cortex. To reduce subject-to-subject variations, we performed SWE in renal sinus fat for reference tissue. Clinical and pathologic factors related to renal stiffness and dispersion slope were evaluated by multivariable linear regression analysis. We conducted univariate and multivariate analysis to predict acute rejection using imaging parameters including SWE. Diagnostic performance of significant parameters in detecting acute rejection was evaluated by area under the receiver operating curve (AUC) values.

#### RESULTS

Acute rejection was found in 31 out of 126 (24.6%) of the patients. The median cortex-to-sinus stiffness ratio (SR) did not differ between the patients with acute rejection and without rejection (1.21 vs. 1.20,  $P=0.47$ ), while median cortex-to-sinus dispersion slope ratio (DSR) was higher in patients with acute rejection than in those without rejection (1.4 vs. 1.21,  $P<0.01$ ). Grade of interstitial fibrosis and tubular atrophy (IFTA) was the only determinant factor for both SR (coefficient, 0.13 per grade;  $P<0.01$ ) and DSR (coefficient, 0.10 per grade,  $P=0.01$ ). In multivariate analysis, mean resistive index (OR 1.06, 95% CI 1.02-1.15,  $P<0.01$ ) and DSR (OR 18.3, 95% CI 3.3-101.6,  $P<0.001$ ) were independent factors for predicting acute rejection. The AUC of resistive index, DSR, and combined two parameters were 0.64, 0.68, and 0.74, respectively.

#### CONCLUSION

Shear-wave dispersion slope obtained at SWE may be helpful for identifying renal allograft dysfunction.

#### CLINICAL RELEVANCE/APPLICATION

Shear-wave dispersion slope, which reflects the viscosity of tissue, might be used as a reliable noninvasive imaging modality that can help differentiate acute dysfunction from stable graft.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPHN

### Head & Neck Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPHN- Fluoroscopic Function in Cone-beam CT Provides Video Fluorographic Swallowing Study 1**

Yukihiro Iida, PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Videofluoroscopic swallowing study (VFSS) is a gold-standard radiological examination for dysphagic patients. Usually, VFSS is performed using whole-body x-ray fluoroscopic unit. This prevents oral radiologists without a whole-body x-ray fluoroscopic unit from performing VFSS. Recently, a cone-beam CT unit equipped with x-ray fluoroscopy has been put into practical use. In this study, we evaluated the cone-beam CT unit's fluoroscopic function whether it is suitable for VFSS.

##### **METHODS AND MATERIALS**

A cone-beam CT unit for maxillofacial region (VGi evo Evolved 3D Imaging, NewTom, Inc.) was used to take fluoroscopic images. The temporal resolution was 20 and 15 frames per second. The tube current was fixed at 3 mA and tube voltage at 110 kV. The contrast and gamma values of the images were adjusted to clearly observe. First, a phantom modeled living body was subjected. A 4 mm diameter tube was attached to the inside of the phantom and a 40w/v% barium solution (Barytgen HD, FUSHIMI Pharmaceutical Co., Ltd.) was through. Two 2 mm diameter iron balls were also attached to the pharynx of the phantom. One was on the epiglottic valley, and one on the piriform sinus. Then, two healthy adults with no history of dysphagia were subjected. Saliva (with no contrast media), a 40w/v% barium solution, a paste with barium solution (Fruche, House Foods Corp.), and a gelatin jelly with barium solution (Jelly Ace, House Foods Corp.) were used as test foods. Two subjects swallowed a spoonful or 3 ml of each test food. The subject's VFSS images were evaluated using the checking items in the VFSS guideline of the Japanese Society of Dysphagia Rehabilitation.

##### **RESULTS**

The image of barium solution passed through the tube and 2 mm iron balls were clear observed in the phantom's VFSS images. Swallowing movements without contrast medium allowed clear observation of the anatomical structures these were tongue, pharynx, soft palate, and others. All target evaluation items including the movement of the test food into the epiglottic valley, the piriform sinus, and the esophagus could be observed. The VFSS image of the phantom and two subjects were clear observed in both 20 and 15 frames per second.

##### **CONCLUSION**

Although there are restrictions on the body position of the subject, a cone-beam CT unit equipped with x-ray fluoroscopy could be applied for practical VFSS examination. It allows the oral radiologists to perform VFSS in minimal clinics. Then, the accurate diagnosis of swallowing function, treatment effects, and the progress of recovery of swallowing function will be possible.

##### **CLINICAL RELEVANCE/APPLICATION**

This method allows performing VFSS in minimal clinics. The accurate diagnosis of swallowing function, treatment effects, and the progress of recovery of swallowing function will be possible.

#### **S3B-SPHN- Application of Multidimensional Diffusion MRI in Nasopharyngeal Carcinoma: An Exploratory Cross-sectional Study 4**

Yingying Chen (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the potential of multidimensional diffusion MRI (Mdd-MRI) in assessing the microscopic diffusion characteristics of nasopharyngeal carcinoma (NPC) and explore its potential application in diagnosing and differentiating tumor pathological

subtypes and TNM stage, as well as determining Epstein-Barr virus (EBV) infection status.

## **METHODS AND MATERIALS**

Sixty-six patients with histologically-confirmed NPC were included in the study. Mdd-MRI was performed with multiple b values to obtain five microscopic diffusion metrics: anisotropic mean kurtosis (MKa), isotropic mean kurtosis (MKi), total mean kurtosis (MKt), and microscopic fractional anisotropy ( $\mu$ FA). For comparison with macroscopic diffusion characteristics, apparent diffusion coefficient (ADC) was obtained through conventional diffusion weighted imaging sequence. Diffusion-related measurements were compared using student t test between NPC tissue and normal nasopharyngeal tissue, among different histopathology, TNM stage, and EBV infection status. Spearman correlation analysis was performed between diffusion-related measurements and T stage.  $P < 0.05$  (two-tailed) indicates significant difference.

## **RESULTS**

Significant difference was found in ADC between tumor tissue and normal nasopharyngeal tissue ( $P = 6.023e-11$ ). Microscopic metrics and ADC showed significant differences among different primary tumor stages (T1-T4) and a significant correlation with T stage ( $\mu$ FA:  $\rho = 0.52$ ,  $P = 0.00001$ ; MKa:  $\rho = 0.38$ ,  $P = 0.002$ ; MKi:  $\rho = 0.27$ ,  $P = 0.03$ ; MKt:  $\rho = 0.32$ ,  $P = 0.009$  and ADC:  $\rho = -0.36$ ,  $P = 0.003$ ). However, no significant differences were observed in other subgroups, including histopathology, N stage, and M stage, and EBV infection status (all  $P > 0.05$ ).

## **CONCLUSION**

Mdd-MRI is a valuable tool for assessing the microscopic diffusion characteristics of NPC. However, it has limited value in diagnosing NPC, differentiating tumor pathological subtypes, N stage, and M stage, and predicting EBV infection status.

## **CLINICAL RELEVANCE/APPLICATION**

Mdd-MRI can be a useful technique in assessing the microscopic diffusion characteristics of NPC, providing insights into tumor heterogeneity from a novel diffusion perspective.

## **S3B-SPHN- Demonstrating the Facial Nerve in the Parotid Gland using 3 Dimension Fast Field Echo Imaging**

Yihua Wang (*Presenter*) Nothing to Disclose

## **PURPOSE**

To assess the performance of three-dimension fast field echo imaging (T2WI-3D-FFE) in displaying the intraparotid facial nerve (IFN) and localizing the tumor.

## **METHODS AND MATERIALS**

Seventy-nine patients with parotid tumors who underwent T2WI-3D-FFE were retrospectively enrolled (Table 1). The T2WI-3D-FFE images were reconstructed with curvilinear planar reconstruction (CPR) by two radiologists independently. The identification certainty of IFN was scored with an arbitrary scale of 0-3. The tumor locations were categorized as deep or superficial on the basis of direct and 2 indirect methods (the facial nerve line (FNL) and retromandibular vein (RMVL)). Surgical localization was considered as the criterion standard. The diagnostic accuracy, sensitivity and specificity for localizing parotid lesions using each method were calculated and compared using the McNemar tests.

## **RESULTS**

The main trunk, temporofacial division, and cervicofacial division of IFN were visualized in 100%, 52% and 46% of patients, respectively on the reconstructed T2WI-3D-FFE images. The diagnostic accuracy, sensitivity, specificity, positive predictive value, and negative predictive value for localizing deep lobe lesions using direct method were 96.2%, 88.9%, 91.7%, 80%, 98.6%, respectively. These findings were significantly higher than FNL and RMVL in sensitivity ( $P < 0.05$ ). The relationship between the tumor and the main trunk of the facial nerve was correctly predicted in 93.67% (74/79) of images (Table 3).

## **CONCLUSION**

T2WI-3D-FFE can provides detailed morphological information on the nerve relative to adjacent structures preoperatively.

## **CLINICAL RELEVANCE/APPLICATION**

Intraparotid facial nerve (IFN) imaging is a clinical challenge in MRI that it is difficult to differentiate parotid gland tumors from facial nerve on conventional MRI. It is great demand to develop new diagnostic technology to accurately display peripheral nerve and tumor for avoiding intraoperative injury.

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## Abstract Archives of the RSNA, 2023

S3B-SPIN

### Imaging Informatics Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### S3B-SPIN-1 Multi-parametric MRI Brain Tumor Diagnosis with Memorizing Transformer

Yiqing Shen (*Presenter*) Nothing to Disclose

##### PURPOSE

Deep learning has been widely utilized in MRI diagnosis. Among them, transformers have gained increasing popularity due to their ability to handle multiple modalities. However, its application has been hindered because acquiring large-scale multimodal MR data is expensive and time-consuming. To narrow the gap, we designed a transformer architecture with external memory, which memorizes the attention from the historical training process to reduce the reliance on large-scale dataset.

##### METHODS AND MATERIALS

During training, the external memory stores a paired query and value from each attention head. Importantly, this design is efficient and does not incur any additional computation cost. During inference, the cached memory is used to enhance local attention through K nearest neighbor lookup. This improves the overall performance of the model. We implemented this external memory design on an 8-layer vision transformer with 8 attention heads in each layer and the dimension of the tokens were set to 256, but it can be incorporated into any transformer-based model (Fig. a). Evaluations were performed on a dataset of 147 brain post-treatment malignant glioma cases, each of which included five MRI sequences, T1-weighted (T1w), T2-weighted (T2w), fluid-attenuated inversion recovery (FLAIR), gadolinium-enhanced T1w (GdT1w), and amide proton transfer-weighted (APTw) MR images, for classifying treatment effect and tumor recurrence. For each scan, the 3D APTw MRI protocol provided 15 slices, so all volumetric MR images had 15 instances. Each instance included T1w, T2w, FLAIR, GdT1w, and APTw images with the matrix shape of 5 (sequences) × 256 (pixels) × 256 (pixels). A proportion of 80% on the case-level was split as the training set (n=118) and the remaining 20% as the test set.

##### RESULTS

The baseline was the ViT without external memory. Our method achieved an AUC of 0.848 ( $p < 0.001$ ), which improves 5.15% of the plain ViT's AUC of 0.806 ( $p < 0.001$ ). The accuracy is 0.779, the precision is 0.625, the sensitivity is 0.818, the specificity is 0.818 and the F1-score is 0.709 (Fig. b).

##### CONCLUSION

In this work, we propose a memorizing transformer for the small-scale multi-parametric MR image analysis. The method stores the attention in the training process and applies them to the inference stage with KNN lookup, which thus costs no extra GPU run-in memory. The method can increase the plain transformer AUC by 5.15%, which confirms the effectiveness of our method.

##### CLINICAL RELEVANCE/APPLICATION

We propose a memorizing transformer for the small-scale multi-parametric MR image analysis that can increase the plain transformer AUC.

#### S3B-SPIN-2 Consistent and Efficient Image Segmentation in the German Nationwide RACOON Consortium

Bianca C. Lassen-Schmidt, PhD (*Presenter*) Nothing to Disclose

##### PURPOSE

Multi-center studies, including large cohorts, require software tools that ensure consistent and efficient segmentation of image data. In the RACOON project, all German university hospitals jointly work with identical software systems. Here we

analyze the segmentation tool of the first RACOON trial retrospectively and discuss the requirements for such a tool.

## **METHODS AND MATERIALS**

In this study, a cohort of 14,023 patients (47% female, mean age 54.6 years, mean BMI 23.4) from 36 German university hospitals was collected and evaluated by radiologists. The datasets included chest CT with 22 different disease groups. Of the total cohort, 20% (2394 datasets) were randomly selected and processed using the segmentation and annotation toolkit SATORI. This client-server application is highly configurable and was utilized to provide a guided lung segmentation workflow, including automated segmentation of the lungs, lung lobes, and ground glass opacities. Additionally, other anatomical structures and pathologies could be manually or semi-automatically segmented.

## **RESULTS**

The overall performance of SATORI was evaluated by 35 radiologists with varying levels of experience using the tool, ranging from 1 (less use) to 5 (frequent use) on a Likert scale of 1 (poor) to 5 (excellent). The mean overall performance rating for SATORI was 2.7. Analysis of the ratings from the different user groups, based on their intensity of use (IoU), revealed that 5/5/6/8/10 radiologists with an IoU 1/2/3/4/5 rated the performance as 1.8/2.2/2.3/2.9/3.4, respectively. A Wilcoxon rank sum test was performed to compare the ratings between inexperienced (IoU 1-3) and experienced (IoU 4-5) readers, and a difference was found ( $P = 0.01$ ). Seven radiologists reported occasional freezing or slowness as the reason for a negative rating.

## **CONCLUSION**

SATORI showed promise in achieving consistent image segmentation in the RACOON project. Users with more experience rated it higher, likely due to a learning effect. SATORI is being prepared for three more RACOON studies, with improvements to usability and network connection logging to address occasional freezing. Future enhancements include individual worklists for readers and a review tool for communication between reader and reviewer. Three key requirements for segmentation software in large multi-center studies to ensure consistent and efficient image segmentation are guided workflows, simultaneous use by multiple users, and highly automatic segmentation tools. "Funded by „NUM 2.0“ (FKZ: 01KX2121)".

## **CLINICAL RELEVANCE/APPLICATION**

Multi-center studies provide heterogeneous data, more readers, and enough data for studies with rare pathologies. Nonetheless, segmentation software needs to meet specific requirements.

## **S3B-SPIN-3 Clinical Study of Low Radiation Dose Combined with Deep Learning Image Reconstruction Algorithm for Detection of Liver Metastases**

Nana Liu (*Presenter*) Nothing to Disclose

## **PURPOSE**

The aim was to investigate whether low radiation doses combined with DLIR algorithms improve liver image quality and liver metastasis detection compared with ASiR-V algorithms.

## **METHODS AND MATERIALS**

195 patients with suspected liver lesions who needed abdominal enhanced CT scans were collected. Conventional radiation dose examination (tube current of 400 mA) was performed during the first venous phase and low radiation dose examination (200 mA or 120 mA) was performed during the second venous phase. Patients were divided into a 50% radiation dose reduction group and a 70% radiation dose reduction group according to the different tube currents at the second venous phase. All images were reconstructed with ASiR-V50%, DLIR-L, DLIR-M and DLIR-H. Quantitative parameters including subcutaneous fat noise, CT values and SNR of liver, pancreas, portal vein and muscle, and contrast-noise ratio of liver metastases were compared with one way ANOVA test. Qualitative parameters including image quality, noise, contrast, lesion conspicuity, and diagnostic confidence score were compared with Kruskal-Wallis H test. The number and size of liver metastases detected by the ASiR-V50% algorithm at standard radiation doses were used as a reference standard, and the detection rates of liver metastases of different sizes were calculated for each algorithm under low radiation dose conditions.

## **RESULTS**

Objective evaluation: The noise and SNR of ASiR-V50% at standard dose were comparable to DLIR-M at 50% lower dose and 70% lower dose, while DLIR-H at 50% lower dose and 70% lower dose had lower noise and higher SNR and CNR. Subjective evaluation: Compared with the ASiR-V50% of standard dose, both DLIR-M and DLIR-H with 50% reduced dose could maintain the image quality, and DLIR-M and DLIR-H with 70% reduced dose had reduced image quality but still met the diagnostic requirements with a subjective score  $>3$ . Lesion detection rate: The lesion detection rates for ASiR-V50%, DLIR-L, DLIR-M, and DLIR-H at 50% lower doses were 90.2%, 89.2%, 91.4%, and 89.9%, respectively. All algorithms were able to detect all lesions larger than 1 cm. The lesion detection rates were 69.4%, 70.5%, 73.3%, and 71.3% for ASiR-V50%, DLIR-L, DLIR-M, and DLIR-H at 70% lower doses, respectively.

## CONCLUSION

Compared to ASiR-V50%, DLIR can improve the objective and subjective image quality, as well as lesion conspicuity and diagnostic confidence of liver metastases. DLIR can maintain or improve image quality at 50% radiation dose reduction while preserving the detection of liver metastases larger than 1 cm.

## CLINICAL RELEVANCE/APPLICATION

DLIR can maintain or improve image quality at 50% radiation dose reduction while preserving the detection of liver metastases larger than 1 cm.

## S3B-SPIN-5 Prediction of T2DM using MRI Fat Fraction Maps of Ectopic Fat Deposition, Abdominal Wall Muscle Fat and Bone Marrow Adipose Tissue

Qi An (*Presenter*) Nothing to Disclose

### PURPOSE

The purpose of our study was to quantitatively assess the abdominal wall muscle adipose tissue (AMAT) and bone marrow adipose tissue (BMAT) content and ectopic adipose deposition in patients with Type 2 diabetes mellitus (T2DM) by MRI fat fraction maps to explore independent risk factors that can predict T2DM.

### METHODS AND MATERIALS

A total of 345 participants who underwent 1.5 T or 3.0 T MRI examination of upper abdomen were included in our study. The MRI images of all patients included IDEAL-IQ or mDixon Quant sequence. The fat fraction (FF) and area of visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT), AMAT were obtained at the level of the L1 and L2 vertebral bodies by Image J (National Institutes of Health, USA), and the FF and area of BMAT were automatically calculated at the level of the T12 and L1 vertebral bodies by the software where the mean of BMAT were computed. The hepatic fat fraction (HFF) and pancreatic fat fraction (PFF) were semi-automatically measured by Smart ROI on the post-processing platform (Intellispace Portal, ISP, Philips, Holland). The binary Logistic regression analysis and receiver operating characteristic (ROC) curve were used to evaluate the predictive ability of independent risk factors for T2DM.

### RESULTS

VAT area, VAT FF, HFF, PFF, BMAT FF, AMAT area and AMAT FF of the T2DM group were higher than the non-T2DM group and SAT FF was lower ( $P < 0.05$ ). However there was no statistically significant difference in SAT area of two groups ( $P > 0.05$ ). The binary logistic regression model analysis showed that SAT FF, VAT area and PFF were independent risk factors for T2DM, and OR values were 0.920, 1.007 and 1.073, respectively. The ROC curve shown that area under the curve (AUC) values of SAT FF, VAT area and PFF were 0.609, 0.681 and 0.786 respectively, and the sensitivity were 0.441, 0.676 and 0.750 respectively, and the specificity were 0.798, 0.625 and 0.773. The AUC values predicted by SAT FF combined with VAT area and PFF for T2DM were 0.787, with the sensitivity of 0.853 and the specificity of 0.661. The differences of AUC values were compared by DeLong test, and the results showed that the AUC values of PFF and their combination were higher than those of SAT FF and VAT area ( $P < 0.05$ ).

## CONCLUSION

In this study, we found that SAT FF, VAT area and PFF are independent risk factors for T2DM, and PFF is a better predictor of T2DM than SAT FF and VAT area.

## CLINICAL RELEVANCE/APPLICATION

Our findings further deepened our understanding of the relationship among ectopic fat deposition, AMAT and BMAT. In addition, we found that PFF is a better independent risk factor for T2DM, so quantitative evaluation of PFF fat content in patients with T2DM by non-invasive MRI fat maps can better predict and evaluate the occurrence, progress and prognosis of T2DM.

## S3B-SPIN-6 Cardiac CT to MR Image Conversion Using Generative Diffusion Models

Albert S. Song, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate whether 1) a generative diffusion model, trained exclusively with cardiac MRI data, could be used to perform intermodality image conversion from cardiac CTA to cine SSFP MRI and 2) if these synthesized SSFP images can be used as inputs for other MRI-specific CNNs.

### METHODS AND MATERIALS

With HIPAA compliance and IRB approval, we retrospectively collected 222 cardiac MRIs to train a diffusion model to synthesize SSFP images from image edges. MRI exams were split 70/15/15 for training, validation, and testing. To evaluate cross-modality image conversion, we retrospectively identified an additional 30 patients who underwent both cardiac CTA and



MRI within  $7 \pm 8$  months, between 4/2020 and 3/2023 (age  $47 \pm 20$  years, 13 male). The diffusion CNN was used to synthesize SSFP images from CTA. To show that synthesized SSFP images are superior inputs for MRI-specific CNNs, we used an existing MRI-trained 2D UNet to segment the synthetic SSFP and source CTA images and compared them against manual segmentations. Cardiac volumes were then compared between synthetic and real cine SSFP images. Statistical analyses included comparison of segmentation overlap using Dice and comparison of cardiac volumetry using Pearson correlation and paired t-test with a type I error threshold of 0.05.

## RESULTS

For the following results, segmentation Dice scores are presented in order of epicardium, myocardium, and endocardium. For short axis CTA images, median Dice was 0.900 (IQR:0.844-0.932), 0.689 (0.597-0.752), and 0.906 (0.853-0.938), respectively. For synthesized-SSFP images, median Dice was 0.926 (IQR: 0.893 - 0.945), 0.757 (0.682 - 0.812), and 0.920 (0.866 - 0.948), respectively. Mean Dice scores were significantly higher for synthetic SSFP images relative to CTA images ( $p < 0.001$  for each task, paired t-test). Volumetric measurements from synthesized and real SSFP images correlated well for EDV ( $r=0.77$ ), ESV ( $r=0.83$ ), and EF ( $r=0.88$ ).

## CONCLUSION

Diffusion models can be used to perform intermodality image conversion, including synthesizing SSFP images from CTA. Volumetric measurements of cardiac function using synthetic SSFP images generated from cardiac CTA correlated well with direct measurements from cardiac MRI.

## CLINICAL RELEVANCE/APPLICATION

Diffusion models may enable intermodality image conversion to facilitate cross-modality image quantification, segmentation, and comparison for cardiac CTA and MRI.

## S3B-SPIN-7 AI Enhancement: Emulating Radiologists' Approach for Automated Contrast Phase Detection in Abdominal CT Scans

Eduardo P. Reis, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The accurate determination of contrast phases in abdominal CT scans is essential for the deployment of downstream artificial intelligence (AI) applications and reliable quantification of imaging biomarkers. DICOM tags are often used to identify contrast phases, but they can be unreliable. To address this challenge, we present an image-based AI algorithm that emulates how radiologists visually assess the enhancement patterns of key anatomical structures to determine the contrast phase. Our goal is to enhance the reliability and generalizability of contrast phase detection, independent of DICOM tags, and to facilitate its integration into clinical workflows by open sourcing the tool through an easy-to-use AI pipeline.

## METHODS AND MATERIALS

We obtained 739 abdominal CT exams, and included 1545 axial series, split into a 1183 and 362 for training and testing. Each patient's data was exclusively allocated to one set. The series were labeled as non-contrast, arterial, venous, or delayed using the "Series Description" DICOM tag. A radiologist reviewed each series to confirm or correct labels. Key anatomical structures, such as aorta, portal vein, inferior vena cava, renal parenchyma, and renal pelvis, were segmented using our open-source AI toolbox and radiomic features were extracted. An Extreme Gradient Boosting (XGBoost) classifier was trained to classify CT images into four contrast phases. The performance was evaluated using accuracy, sensitivity, specificity and F1 scores on internal and external validation datasets. External validation was performed on 209 scans (582 series) from "VinDr-Multiphase CT", a publicly available dataset that included non-contrast, arterial and venous scans.

## RESULTS

In internal validation, we achieved an overall accuracy of 92% and F1 scores of 97% for non-contrast, 79% for arterial, 92% for venous, and 95% for delayed phases. In external validation, we achieved an accuracy of 89%, and F1 scores of 97% for non-contrast, 87% for arterial, and 81% for venous phases. The performance improvement of the arterial class on external validation shows generalization capability despite limited training examples for this class. The algorithm was made publicly available through an open-source platform.

## CONCLUSION

The proposed AI-based algorithm accurately detects contrast phases in abdominal CT scans independent of DICOM tags. The successful external validation demonstrates the algorithm's generalizability and robustness.

## CLINICAL RELEVANCE/APPLICATION

Contrast detection is crucial for deploying AI methods and ensuring the reliability of quantitative imaging biomarkers. The proposed algorithm serves as a valuable tool for enhancing AI applicability in medical imaging, allowing integration with other AI algorithms.



## Abstract Archives of the RSNA, 2023

S3B-SPIR

### Interventional Radiology Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPIR-1 Shear Wave Elastography Evaluates the Efficacy of Microwave Ablation on Thyroid Nodules**

Shishi Wang (*Presenter*) Nothing to Disclose

##### **PURPOSE**

As a minimally invasive technique, percutaneous microwave ablation (MWA) has been applied as an alternative to thyroid surgery for benign thyroid nodules. Coagulation necrosis occurs and stiffness changes in thyroid tissue after ablation. Shear wave elastography (SWE) has been used to differentiate the malignant thyroid from benign nodules. But it has seldom been applied to monitor the change of thyroid nodules after ablation. The study aimed to investigate the efficacy of MWA on thyroid nodules and the effect of stiffness on the efficacy of MWA.

##### **METHODS AND MATERIALS**

Sixty-seven thyroid nodules treated with MWA were included between June 2021 and April 2023. All nodules were pathologically confirmed benign, and the maximum diameter was within 3 cm. SWE was performed to quantify the stiffness of nodules. The size, volume, volume reduction rate (VRR), and stiffness value of thyroid nodules were recorded before and at one, three, and six months after ablation. Thyroid nodules are classified as hard nodules or soft nodules according to the value of SWE. Compare the VRR between hard and soft nodules during post-ablation follow-up.

##### **RESULTS**

All nodules were completely ablated, and no complications occurred. The VRR of thyroid nodules gradually increased after ablation, and the VRR at one, three, and six months after ablation were 52.3% [interquartile range (IQR): 35.6-74.1%], 57.6% (IQR: 37.2-78.4%), and 74.9% (IQR: 50.4-90.2%), respectively ( $P<0.05$ ). The study showed that the stiffness of the nodules increased post-ablation compared with pre-ablation ( $P<0.05$ ). The stiffness value peaked one month after ablation and then gradually decreased ( $P<0.05$ ). The mean of SWE before ablation, and at one, three, and six months after ablation were  $36.7\pm 9.5$ KPa,  $76.5\pm 10.2$ KPa,  $62.8\pm 11.4$ KPa, and  $46.9\pm 9.5$ KPa, respectively ( $P<0.05$ ). Compared with soft nodules, hard nodules have a lower VRR after ablation ( $P<0.05$ ).

##### **CONCLUSION**

SWE is a noninvasive, sensitive and repeatable technique which can be applied to evaluate the efficacy of MWA of thyroid nodules and postoperative follow-up.

##### **CLINICAL RELEVANCE/APPLICATION**

SWE has been used for noninvasive and quantitative evaluation of the efficacy of MWA on thyroid nodules and postoperative follow-up.

#### **S3B-SPIR-2 The Role of Contrast-enhanced Ultrasound in the Biopsies of Peripheral Pulmonary Lesions: A Retrospective Multicenter Study by using Propensity Score Analysis**

Xue-Yan Wang (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To compare the performance of conventional US and contrast-enhanced US (CEUS) as guiding tools in percutaneous transthoracic needle biopsy (PTNB) and evaluate the role of CEUS in PTNB for peripheral pulmonary lesions (PPLs).

## **METHODS AND MATERIALS**

Patients with PPLs who received PTNB between 2017 and 2022 were retrospectively enrolled at four medical centers. According to whether pre-biopsy CEUS was performed, patients were divided into CEUS and US groups. The sampling success rate and the diagnostic accuracy of PTNB stratified by lesion size were analyzed. One-to-one propensity score-matching (PSM) analysis was performed using the nearest-neighbor matching method.

## **RESULTS**

A total of 1027 lesions were analyzed: there were 634 in US group (mean age, 59 years +or- 13 [standard deviation], 413 men) and 393 in CEUS group (mean age, 61 years +or- 13 [standard deviation], 270 men). The CEUS group produced more acceptable samples than the US group (98.2% vs. 95.7%,  $p = .03$ ) and improved diagnostic accuracy (96.9% vs. 94.2%,  $p = .042$ ), and sensitivity (96.9% vs. 94.0%,  $p = .03$ ). PSM and stratified analyses ( $n = 358$  per group) indicated that the sample success rate (99.0% vs. 95.7%,  $p = .04$ ) and diagnostic accuracy (98.5% vs. 92.9%,  $p = .006$ ) of the CEUS group was higher than that of the US group for 2-7cm PPLs but not for lesions larger than 7cm (sample success rate: 96.9% vs. 97.1%,  $p = .93$ ; diagnostic accuracy: 95.0% vs. 99.0%,  $p = .08$ ).

## **CONCLUSION**

CEUS-guided PTNB has a higher sampling success rate and diagnostic accuracy than US in 2-7cm PPLs. For PPLs larger than 7cm, consistent diagnostic accuracy can be achieved by well-trained biopsy operators whether using US or CEUS as the guide tool.

## **CLINICAL RELEVANCE/APPLICATION**

This study aims to investigate the role of CEUS in guiding PTNB of PPLs. The findings of this study can provide a detailed reference for selecting biopsy imaging guidance with a stratification criterion.

## **S3B-SPIR-3 Comparison Between Percutaneous Transthoracic Co-axial Needle CT-guided Biopsy and Transbronchial Lung Biopsy for the Diagnosis of Persistent Pulmonary Consolidation**

Juan Wang (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study is to compare the diagnostic yield and the complication rate between percutaneous transthoracic CT-guided co-axial needle biopsy (PTCNB) and transbronchial lung biopsy (TBLB) in persistent pulmonary consolidation.

## **METHODS AND MATERIALS**

From January 1, 2016 to December 31, 2020, we have retrospectively enrolled a total of 155 consecutive patients with persistent pulmonary consolidation who underwent both TBLB and PTCNB. The diagnostic accuracy, specificity, sensitivity and complication rate of the two biopsy methods for persistent lung consolidation has been compared. According to histopathological and microbiological analysis, the results of biopsy specimens were categorized as follows: malignant, specific benign, non-specific benign and non-diagnostic. The final diagnosis was established by surgical resection or clinicoradiological follow-up for at least 12 months following biopsy. Diagnostic yield of PTCNB/TBLB was defined as the percentage of the true diagnosis from biopsy as malignant and specific benign lesions.

## **RESULTS**

According to the standard reference, the final biopsy diagnoses of 11 cases were confirmed true malignant based on the surgical resections, the remaining were confirmed by clinical and imaging follow-up for at least 12 months. The overall diagnostic accuracy, sensitivity and specificity of PTCNB for malignant diagnosis were 91.61%, 72.34% and 100%, whereas of TBLB were 87.74%, 59.57% and 100%. At the same time, the overall diagnostic accuracy, sensitivity and specificity of PTCNB for specific benign diagnosis were 84.25%, 64.71% and 100%, whereas of TBLB were 63.23%, 16.18% and 100%. The diagnostic yield of PTCNB and TBLB were 50.32% and 25.16% respectively. For the TBLB-based negative cases, PTCNB provided a definite diagnostic yield of 37.93%. There were 45(45/155, 29.03%), 22(22/155, 14.19%) and 13(13/155, 8.39%) patients who experienced pneumothorax, intrapulmonary hemorrhage and hemoptysis respectively in PTCNB, while there were only 5(5/155, 3.22%) cases of mild intraprocedural bleeding occurring in TBLB.

## **CONCLUSION**

PTCNB is an effective and safe modality, associated with higher diagnostic yield and better diagnostic accuracy compared to TBLB for persistent consolidation, especially as the complementary method for TBLB-based negative lung lesions.

## **CLINICAL RELEVANCE/APPLICATION**

In this study, we compared the diagnostic yield and the complication rate between percutaneous transthoracic CT-guided coaxial needle biopsy (PTCNB) and transbronchial lung biopsy (TBLB) of persistent pulmonary consolidation. Clinical physicians may choose appropriate biopsy method according to our study.

**S3B-SPIR-4** Yuze Wei (*Presenter*) Nothing to Disclose

## **PI3K $\delta$ Inhibitor PI-3065 Induces Apoptosis in Hepatocellular Carcinoma Cells by Targeting Survivin** PURPOSE

Hepatocellular carcinoma (HCC) is one of the most common malignant tumors worldwide, and its clinical treatment remains challenging. The development of new treatment regimens is important for effective HCC treatment. This research design to explore the anti-tumor function of PI3K  $\delta$  inhibitor PI-3065 on HCC and its potential mechanism.

### **METHODS AND MATERIALS**

CCK8 and flow cytometry were used to determine the activity of HCC cells treated with PI-3065. Apoptosis of HCC cells treated with PI-3065 were evaluated by hoechst staining and western blot. Mitochondrial staining and extraction were used to detect the mitochondrial state of HCC cells. SK-HEP-1 cells effectively transfected with survivin siRNA and plasmid overexpressed with survivin were treated with PI-3065, and then the apoptosis level of cells was evaluated by hoechst staining and western blot. The effects of PI-3065 on migration and colony formation of HCC cells were evaluated by wound-healing assay and colony formation assay. SK-HEP-1-derived xenograft tumor model in nude mice were constructed and administered by intragastric administration for 14 days. The control group were given the same dose of placebo. At the end point, the anti-hepatoma activity of PI-3065 in vivo was evaluated according to the volume, weight and protein changes of transplanted tumor.

### **RESULTS**

We found that PI-3065 dose- and time-dependently reduced HCC cell viability and induced apoptosis while posing no obvious apoptotic toxicity in normal liver cells. Further mechanistic analysis showed that PI-3065 induced apoptosis mainly by inhibiting survivin protein expression, decreasing mitochondrial membrane potential, and promoting cytochrome C release. Simultaneously, PI-3065 markedly suppressed the colony formation, migration, and epithelial-mesenchymal transition abilities of HCC cells. Furthermore, transplantation of nude mice with HCC tumors showed that PI-3065 inhibits HCC tumor growth in vivo by targeting survivin.

### **CONCLUSION**

PI-3065 specifically inhibited survivin expression and exerted anti-HCC activity in vivo and in vitro, suggesting that it may serve as an effective antitumor drug for HCC treatment, which warrants further study.

### **CLINICAL RELEVANCE/APPLICATION**

In this study, we confirmed for the first time that PI-3065 can exert anti-HCC activity by inducing cell apoptosis in vivo and in vitro, which indicated that PI-3065 has great potential in clinical practice. Further studies have confirmed that PI-3065 has no toxicity to normal hepatocytes, and its safety and efficacy may provide a new choice for the treatment of HCC patients.

## **S3B-SPIR-5 Sono-activated Oxygen/Sulfate Dual-Radical Nanotherapy for Combined Cancer Suppression & Infected Wound Repair**

Xiaohui Qiao (*Presenter*) Nothing to Disclose

### **PURPOSE**

To explore an all-in-one therapy for cooperatively fighting cancer, infection and boosting wound repair for patients with advanced superficial cancers or after surgical intervention to avoid multiple drug abuse and resultant adverse effects.

### **METHODS AND MATERIALS**

The ultrasound-activated nanosonosensitizer PHMP was dexterously designed for combined therapy of cancer and infected wound based on oxygen/sulfate dual-radical nanotherapy. Firstly, the in vitro cancer cell killing action was proved using CCK-8 assay and fluorescence staining after the cells being treated with PHMP + US. Then, the in vitro migration promoting and bacteriostatic action was assessed through scratch test and detecting the bacteria viability respectively. Finally, the in vivo tumor-suppressive effect and repair function to the infected skin defect of PHMP + US was evaluated by constructing the subcutaneous melanoma and full thickness *S. aureus* infected skin wound model, and then monitoring tumor size, wound area as well as analyzing histological characteristics.

### **RESULTS**

In the PHMP + US group, the descended cell viability and apparent cell death were observed, and the narrower scratch gap and fewer bacterial colonies were displayed. Simultaneously, the tumors undergoing PHMP + US disposal exhibited poor growth, distinct cell apoptosis and lower proliferation ability. In addition, the infected wounds in the PHMP + US group healed the fastest and demonstrated well-organized collagen fiber and skin structure.

### **CONCLUSION**

The *in vitro* and *in vivo* results suggests that US-activated PHMP can effectively inhibit tumor and promote infected wound repair.

## CLINICAL RELEVANCE/APPLICATION

This study highlights the overall treatment of later stage or postoperative cancers accompanied by infectious wounds with a single US-activated multifunctional intervention which bypasses the side effects of polypharmacy and systemic administration of anticancer drugs/antibiotics. Such a conception delves the maximum capacity of each member and meanwhile reduces the harm to the minimum, which is of vast prospect in clinical transformation.

## S3B-SPiR-6 Elucidation of the Microvascular Embolization Effects of Imipenem/Cilastatin! Evaluation at the Level of Microvessels using Monochromatic X-ray in Vivo Study

Hiroki Nakamura (*Presenter*) Nothing to Disclose

### PURPOSE

To elucidate the characteristics of Imipenem/Cilastatin (IPM/CS) as an embolic material in vivo.

### METHODS AND MATERIALS

Three healthy Japanese white rabbits (approximately 3 kg each) were used. A portion of one ear of each rabbit was injected subcutaneously with picibanil (0.5 KE) to create an inflammation-induced model. High spatial resolution microangiography was performed using monochromatic X-rays extracted from synchrotron radiation facility (Super Photon ring-8; SPring-8). Under anesthesia, an elastomer needle (26 G) was placed in the intermediate branch of the auricular artery, and pre-embolization angiography was performed. Then, embolization was performed from the intermediate branch of the auricular artery using a mixture of IPM/CS (0.2 g) and non-ionic contrast agent (2 ml). Angiography was performed during embolization, and at 3, 10, 20, 30, 40, 50, 60, 70, 80, and 90 minutes after embolization. The embolized vascular diameter was evaluated from the images during embolization, and the recanalization time was defined as after embolization time of "total artery area of post embolization / total artery area of pre embolization  $\times$  100" was  $\geq$ 100 %. ROIs were set in both normal (n=3) and inflammation-induced (n=3) sites, and comparisons were made between the two groups.

### RESULTS

The mean diameter of the embolized vessels immediately after embolization was  $267 \pm 58.35 \mu\text{m}$ , with a range of 174-363  $\mu\text{m}$ . In the follow-up observations after embolization, the normal vessels recanalized at an average of 70 minutes (case1: 101% on 70 min later, case2: 100% on 90 min later and case3: 101% on 50min later). In contrast, the vessels in the inflammation-induced areas did not show recanalization during the 90 minutes observation period.

### CONCLUSION

The characteristics of IPM/CS as an embolic material in vivo were elucidated. In vivo, much larger vessels are embolized than the actual particle size. It was also suggested that the embolization effect duration might differ between normal and inflammation-induced areas.

## CLINICAL RELEVANCE/APPLICATION

The analgesic effect of IPM/CS embolization for pain associated with chronic arthritis has been clinically confirmed, and it may potentially become a basic data for the development of new embolic materials as alternatives to IPM/CS.

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## Abstract Archives of the RSNA, 2023

S3B-SPMK

### Musculoskeletal Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### S3B-SPMK- Feasibility Study on Classification of Meniscus Damage Based on MRI Radiomics

1

Hongxing Fan (*Presenter*) Nothing to Disclose

#### PURPOSE

To explore the value of machine learning (ML) models based on MRI radiomics features in predicting the degree of meniscus injury.

#### METHODS AND MATERIALS

MRI images of 732 knee menisci were retrospectively analyzed. The menisci were randomly divided into a training group (n=512) and a validation group (n=220) at a ratio of 7:3. Radiomic features were extracted from the sagittal and coronal proton density-weighted fat suppression images. The Minimum redundancy maximum relevance (mRMR) and least absolute shrinkage and selection operator (LASSO) were used for data dimension reduction and feature selection. Then, based on the optimal features, we constructed a four-category classification model with different ML methods, and its diagnostic performance was quantified by the area under the receiver operating characteristic curve (AUC).

#### RESULTS

Eighteen significant radiomic features (10 from sagittal and 8 from coronal images) were selected for model construction. The Macro AUC of support vector machine, logistic regression, Gaussian process, random forest, quadratic discriminant analysis and Bagging decision tree model were 0.876, 0.871, 0.870, 0.869, 0.868 and 0.868, respectively. The best-performing models for each lesion grade were: random forest for normal meniscus (AUC=0.948), logistic regression for grade 1 meniscus injury (AUC=0.833), Bagging decision tree for grade 2 (AUC=0.805) and random forest (AUC=0.902) for grade 3 meniscus injury.

#### CONCLUSION

The ML models based on MRI radiomics features can accurately assess the type of meniscal injury.

#### CLINICAL RELEVANCE/APPLICATION

By accurately assessing the type of meniscal injury, ML can enhance the reliability and reproducibility of the diagnosis and help radiologists make clinical decisions.

#### S3B-SPMK- Enhancing Patient-Centered Radiology Reports with Generative Artificial Intelligence: Adding Value to Radiology Reporting

2

Jiwoo Park, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the efficacy of AI-generated radiology reports in terms of report processing and providing high-quality, easily understandable reports that can address patient questions and to estimate the accuracy and artificial hallucination of AI-generated radiology reports.

#### METHODS AND MATERIALS

A total of 100 spine MRI reports were retrieved from our hospital database, all of which had been approved by fellowship-trained board-certified radiologists with 6 to 18 years of experience. To ensure compliance with HIPAA regulations, all reports were deidentified by removing unique identifying information. Using generative AI, AI-generated radiology reports were then produced by inputting the original reports into a new session without any prior questions having been posed. The reports

were generated in four formats: (1) structured reports, (2) summary reports, (3) recommendations, and (4) patient-friendly reports. To evaluate the quality and accuracy of the AI-generated reports, they were compared with the original reports by a panel of radiologists in terms of: (1) the quality of the structured report, (2) the quality of the summary, (3) the concordance of the recommendations with those made by the radiologists, (4) the compatibility of the patient-friendly reports, and (5) the occurrence of artificial hallucinations. Two radiologists conducted qualitative and quantitative studies, independently (five-point scale).

## RESULTS

The scoring of the AI-generated radiology reports were  $4.95 \pm 0.24$  for structured report and  $4.69 \pm 0.67$  for summary. The agreements of radiologist recommendations and generative-AI recommendations was 95.96% (score  $4.88 \pm 0.54$ ). The compatibility for patient-friendly reports was 83 % (score  $4.71 \pm 0.71$ ). There were 3% artificial hallucinations in patient-friendly reports. This amounted to 3.6 times higher prevalence of easy understandable for the generative-AI powered patient friendly reports ( $P < .001$ ).

## CONCLUSION

Generative AI was employed to reproduce radiology reports in various useful formats. The potential benefits of using AI assistants to generate these reports include improved report quality, greater efficiency in radiology workflows for producing structured reports, summaries, and recommendations, and a move toward patient-centered radiology.

## CLINICAL RELEVANCE/APPLICATION

The use of large language model in radiology reports can have a significant impact on the quality and efficiency of radiology workflows. By producing high-quality, easily understandable reports that can address patient questions, AI-generated reports can improve patient care and satisfaction, moving towards patient-centered radiology, which places a greater emphasis on meeting the needs and expectations of patients.

## S3B-SPMK- Performance of Deep Learning based Vertebral Compression Fracture Detection Algorithm in Patients with Acute and Chronic Fractures

Jemyoung LEE, BS (*Presenter*) Nothing to Disclose

### PURPOSE

Although deep learning algorithms (DL) show promising detecting lesions, the robustness of DL in detecting vertebral compression fractures (VCFs) in patients with acute and chronic fractures was less well known. Therefore, the aim of this study was to investigate the robustness of a DL for detecting VCFs in patients with acute and chronic fractures.

### METHODS AND MATERIALS

We included 178 patient CT cases (excluding those who underwent surgery with cement or screw) diagnosed with VCF at a tertiary medical center (KUMC, Seoul). Each vertebra's reference standard was established by two radiologists. A total of 1200 vertebral bodies (VBs) were labeled for use in the evaluation of which 1000 VBs were normal, 104 chronic and 171 acute. We utilized a deep learning-based quantitative spine analysis program (ClariVCF, ClariPi Inc., Seoul) in which the vertebral body was segmented automatically by using a pre-trained CNN model followed by measurement of vertebral heights at anterior, middle, and posterior portions of each vertebra. Vertebral height loss was then calculated by measuring the ratio of height at the anterior or middle portion to that of the posterior portion. In addition, a formula was used to compare the vertebral heights between the consecutive vertebra above and below. We evaluated the detection performance of DL for acute and chronic VCFs with sensitivity and specificity by using a criterion of 20% height loss ratio according to the Genant classification.

### RESULTS

The detection performance of DL for the chronic VCFs was shown to be 94.23% (87.87-97.85%, 95% CI) in sensitivity and 86.91% (84.65-88.94%, 95% CI) in specificity. The performance was reduced for acute VCFs (N=171) to 78.95% (72.07-84.80%, 95% CI) in sensitivity and 86.91% (84.65-88.94%, 95% CI) in specificity. For the overall dataset, which included both acute and chronic VCFs, the sensitivity was 84.56% (79.71-88.64%, 95% CI) and the specificity was 86.91% (84.65-88.94%, 95% CI).

### CONCLUSION

The deep learning-based VCFs detection algorithm was more sensitive in detecting chronic VCFs than acute VCFs. However, the specificity remained unchanged for both chronic and acute.

### CLINICAL RELEVANCE/APPLICATION

It might be necessary to take cortical disruption or cortical step-off into account for acute VCFs, where some vertebral height loss might not be noticeable. This demonstrates the necessity for techniques other than height loss measurement. Additionally, a unique height loss measurement approach is necessary for each spinal location while taking into account the physiologic wedging of each vertebral level in order to prevent false positive results.

Alexander D. Weston, PhD (*Presenter*) Nothing to Disclose



## **S3B-SPMK- Describing the Effects of IV Contrast on CT Abdominal Body Composition Biomarkers**

4

### **PURPOSE**

Automated measures of body composition from abdominal CT images are becoming more common to quantify frailty, obesity, and to predict disease outcomes. However, measures may be biased by the presence of intravenous (IV) contrast, possibly leading to prior studies avoiding reporting skeletal muscle density measurements (e.g., Magudia 2021, Radiology). We evaluated the effect of IV contrast phase on six biomarkers of abdominal body composition.

### **METHODS AND MATERIALS**

We randomly sampled 244 persons with 258 abdominal CT radiologic exams (479 series) from a cohort representative of the general population. Series were manually annotated for IV contrast phase (noncontrast, arterial, venous, delayed, or nephrographic). We applied a deep-learning model to segment abdominal body composition centered at the L3 transverse process (previously validated mean Dice scores for subcutaneous fat area 0.98, visceral fat area 0.94, muscle area 0.96, and bone area 0.98). Muscle and bone density were defined as mean Hounsfield units (HU) of the segmented tissues. All available CT series were segmented and multiple acceptable series acquired at different IV contrast phases were used to calculate the difference in each body composition biomarker relative to the noncontrast CT series. Values are reported in scatter plots and significance was assessed using 2-sided paired-sample t-tests.

### **RESULTS**

Based on manual review, 256/258 CT studies (99%) had one or more series with acceptable quality for body composition analysis and 95/256 studies (37%) had a noncontrast series for comparison. Skeletal muscle density measurements were higher in venous phase versus noncontrast (difference of 5.9HU, 95% CI: 4.72 - 7.15HU) and delayed phase versus noncontrast (difference of 8.5HU, 95% CI: 7.35 - 9.69HU), significant after Bonferroni correction. Vertebral bone density measurements were higher in venous phase versus noncontrast (difference of 8.2HU, 95% CI: 4.9 - 11.5HU) and delayed phase versus noncontrast (difference of 11.5HU, 95% CI: 7.5 - 15.6). No significant differences were observed between arterial phase versus noncontrast series.

### **CONCLUSION**

Skeletal muscle density and vertebral bone density measurements on abdomen CT are slightly higher in the presence of IV contrast.

### **CLINICAL RELEVANCE/APPLICATION**

A correction factor may be needed to account for IV contrast phase when measuring skeletal muscle density and vertebral bone density biomarkers in CT-based body composition analysis.

## **S3B-SPMK- Distal Radius Fracture: Competent Radiology Reports Generated by ChatGPT Integrating RSNA Template Items and AO Classifier**

5

Wolfram A. Bosbach, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

While demand for radiology imaging grows worldwide, novel information technology tools promise an increase of reporting quality and as well quantity. Text report drafting tools are part of this development.

### **METHODS AND MATERIALS**

In the present study, cases of distal radius fracture are defined. Command files for the writing of a report following a template of the Radiological Society of North America (RSNA) and Arbeitsgemeinschaft Osteosynthese (AO) are given to the natural language processing tool ChatGPT.

### **RESULTS**

An overall high appraisal of ChatGPT radiology reports is obtained in an assessment by human radiologists. ChatGPT is able to adjust output files in response to minor changes in input command files. Shortcomings are the dealing with technical terminology and medical interpretation of findings.

### **CONCLUSION**

In the future, text drafting tools might well support the clinical work of radiologists. ChatGPT is seen by us as a substantial step forward toward that aim.

### **CLINICAL RELEVANCE/APPLICATION**

The amount of clinical imaging is growing because of reasons such as demographics and more complex imaging modalities. Tools which draft a text report allow the radiologist to increase output efficiency and to focus time on patient pathology.

## **S3B-SPMK- The Value of Incorporating Additional Carpal Tunnel Sequences in the Hand MRI for Patients Presenting with Trigger Finger Symptoms**

NA YOUNG LEE (*Presenter*) Nothing to Disclose

### **PURPOSE**

To determine the prevalence of carpal tunnel syndrome (CTS) in trigger finger patients and identify the MRI criteria necessary for its diagnosis, particularly in cases requiring surgical intervention by obtaining additional two sequence MRI of the carpal tunnel.

### **METHODS AND MATERIALS**

Fifty-five hands in 49 patients underwent MRI for evaluation of trigger finger prior to surgery. The dataset included variables such as age, sex, patients' symptoms, and measurements of median nerve signal intensity (SI) and shape, cross-sectional area of the median nerve (MNA), and retinacular bowing. Patients who underwent carpal tunnel release were classified as having severe CTS. The statistical analysis of these factors was conducted using a suite of methods including the independent Student's t-test, Chi-square test, and logistic regression. ROC curves were also drawn to evaluate the precision of CTS diagnosis and to predict severe CTS.

### **RESULTS**

A total of 22 hands underwent carpal tunnel release surgery for CTS with concomitant pulley release for trigger finger. The incidence of severe CTS in patients with trigger finger was observed to be 40%. One third of patients diagnosed with severe CTS exhibit the classical symptoms associated with CTS, including tingling sensations in their fingers. However, the remaining patients present with symptoms primarily related to trigger finger, such as pain in the fingers. Statistically significant differences were observed between patients with trigger finger and severe CTS, and those with trigger finger only groups, in relation to several key factors, including MNA, median nerve SI and shape, and retinacular bowing at the outlet ( $p < 0.001 \sim 0.005$ ). Among these factors, only MNA of proximal to inlet level (MNA-pi) and increased median nerve SI with nerve fascicle swelling exhibited a positive correlation with odds ratio of 1.657. Further analysis of ROC curves demonstrated a sensitivity, specificity, and accuracy of MNA-pi > 15 mm<sup>2</sup> of 77.27%, 72.73%, and 84.5%, and MNA of distal to outlet (MNA-do) > 13 mm<sup>2</sup> of 81.82%, 75.76%, and 84.8%.

### **CONCLUSION**

MRI is a highly accurate diagnostic modality for detecting severe CTS, which often requires surgical intervention.

### **CLINICAL RELEVANCE/APPLICATION**

Incorporating two additional sequences of MRI of the carpal tunnel with hand MRI for preoperative evaluation of trigger finger has the potential to aid in the detection of severe CTS and in facilitating optimal surgical planning.

## **S3B-SPMK- Usefulness of the Floating Fat Sign in the Extensor Tendon Sheath for Predicting Extensor Pollicis Longus Tendon Rupture in Distal Radius Fracture**

Bo Mi Chung, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To evaluate the usefulness of the floating fat sign for predicting extensor pollicis longus (EPL) rupture in distal radius fracture (DRF).

### **METHODS AND MATERIALS**

This retrospective study included patients with DRF, consisting of the EPL rupture ( $n = 9$ ) and non-rupture ( $n = 340$ ) groups. The floating fat sign was visually graded on a semi-quantitative Likert scale (0 to 2) for the second and third extensor compartments separately. The presence of bone fragment, Lister's tubercle fracture type, fracture gap, and presence of intra-articular fracture were assessed. Fisher's exact test was conducted to assess the correlation between the floating fat sign and EPL rupture. Univariate and multivariate analyses were performed, followed by ROC curve analysis.

### **RESULTS**

The sum of floating fat sign scores of the second and third compartments was significantly correlated with the odds of EPL rupture ( $p = 0.001$ ). Male sex, conservative treatment, floating fat sign score of the second and third extensor compartments, and sum of floating fat sign scores of the second and third extensor compartments were significant variables associated with EPL rupture. The floating fat sign in the third compartment was an independent predictive indicator for EPL rupture ( $p = 0.002$ ). ROC curve analysis revealed that the AUC was the highest (0.835) for the multivariate model, followed by the univariate model of the sum of floating fat sign scores of the second and third compartments.

### **CONCLUSION**

The floating fat sign in DRF could be a predictive indicator for EPL rupture.



## CLINICAL RELEVANCE/APPLICATION

The presence of the floating fat sign in distal radius fracture may assist in predicting the risk of extensor pollicis longus tendon rupture, which could aid in developing a treatment plan or providing warning of potential tendon rupture.

## S3B-SPMK- Investigation of Buffer Thickness for Reducing Artifacts from the Table in Computed Tomography Examinations During the Extremities Three-Dimensional Imaging

Yoshiki Kamihoriuchi (*Presenter*) Nothing to Disclose

### PURPOSE

If the hand is directly positioned on the computed tomography (CT) table mat, it is often difficult to separate the hand from the CT table mat due to artefacts from the CT table mat at the three-dimensional (3D) imaging. The objective of this investigation was to determine the optimal thickness of the buffer material utilized for 3D imaging, to alleviate artifact generation consequent to hand separation from the CT table mat.

### METHODS AND MATERIALS

The wrist phantom was placed on a CT table mat. Styrofoam and medical non-woven gauze were used as buffers, and 10 scans were acquired each with no buffer (none), one piece of gauze (gauze) and 1, 2, 3, 4 and 5 mm of Styrofoam. The scan parameter was following (tube voltage 135 kV, tube current 100 mA, rotation time 1.0 second, helical pitch 0.637, slice thickness 1.0 mm, field of view 150). For the 3D image, we utilized images with a reconstruction interval of 0.5 mm and reconstructed them using three different bone functions (FC30 AIDR3D mild: FC30, Aice Bone mild: BM, and Aice Bone standard: BS). Three regions of interest (ROIs) were set up within an identical image section, both in the absence of buffer and with a 5 mm Styrofoam buffer. Subsequently, profile curves were measured and the maximum CT values at the phantom edge were compared. A comparative analysis of the full-width at half-maximum (FWHM) was conducted among three scenarios: no buffer, gauze, and 1 mm buffer. Visualization scores were evaluated at three levels to assess the degree of artifacts caused by the CT table mat during 3D image creation.

### RESULTS

The results obtained indicate statistically significant differences between the scenarios without buffer and with gauze, gauze and 1 mm buffer for all cases. In terms of the maximum CT values at the phantom edges, the following comparisons were made: FC30 (none: 340 (229-348) HU, 5 mm: 289 (282-295) HU), BM (none: 446 (358-451) HU, 5 mm: 380 (366-387) HU), and BS (none: 269 (227-275) HU, 5 mm: 219 (215-222) HU) ( $p < 0.05$  for all). Furthermore, the full-width at half-maximum (FWHM) was analyzed for FC30 (gauze: 0.77 (0.71-0.85) mm, 1 mm: 1.08 (1.07-1.18) mm), Bone Mild (gauze: 0.72 (0.63-0.81) mm, 1 mm: 1.00 (0.99-1.08) mm), and Bone Standard (gauze: 0.77 (0.71-0.85) mm, 1 mm: 1.08 (1.07-1.18) mm) ( $p < 0.05$  for all).

### CONCLUSION

By inserting a buffer material with a thickness of at least 1mm between the hand and the CT table mat at creating 3D imaging, the separation of the hand and the CT table mat can be achieved easier for regardless of the conditions.

## CLINICAL RELEVANCE/APPLICATION

It was confirmed that using a buffer material of 1 mm or more can significantly reduce the effects of artifacts from the CT table mat, which can improve the quality of 3D imaging of the hand and increase flexibility in positioning.

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## Abstract Archives of the RSNA, 2023

S3B-SPMS

### Multisystem Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### S3B-SPMS- **STIR-based Volume Measurement Methods for Staging Primary Lower Extremity Lymphedema: A Single-center Study of Asymmetric Volume Difference** 1

MENGKE LIU (*Presenter*) Nothing to Disclose

#### PURPOSE

The staging of lower extremity lymphedema (LEL) is hard in clinical work. The perfect soft tissue contrast of Short Term Inversion Recovery (STIR) sequence of MRI enables quantitatively assess the clinical staging of primary LEL. This study aims to explore the clinical value of MRI-based asymmetric volume measurement in the clinical staging of primary LEL.

#### METHODS AND MATERIALS

92 patients with unilateral primary LEL underwent Short Term Inversion Recovery (STIR) sequence of MRI. The volume of the middle calf was calculated using the clinical dermatome method (VCI). Two radiologists measure the total volume (V), musculoskeletal volume (VM), and subcutaneous volume (VS) in the middle calves on MRI. The difference between the affected and unaffected calf regarding V (DV) and VS (DVS) was obtained. DV and DVS were defined as asymmetric volume difference. The volume of the middle calf (Vcl) and difference in volume (DVcl) were calculated using the clinical circumferential method. The relationship between asymmetric volume difference and clinical staging was evaluated. Interobserver consistency was assessed through intraclass correlation coefficient (ICC). Volume comparisons were performed using one-way analysis of variance (ANOVA) analysis or Kruskal-Wallis test among three groups. Spearman's correlation analysis was used to assess volume and clinical stage correlation. The receiver operating characteristic (ROC) curve was drawn to assess the value of asymmetric volume difference for clinical staging.

#### RESULTS

The asymmetric volume difference was statistically significant in stage I compared to stages II and III ( $p < 0.05$ ). The asymmetric volume difference (DV:  $r = 0.753$ ; DVS:  $r = 0.759$ ) correlated more with the clinical stage than the affected Vcl ( $r = 0.581$ ), V ( $r = 0.628$ ), VS ( $r = 0.743$ ) and DVcl ( $r = 0.718$ ). The area under ROC curve (AUC) for identifying the clinical stage by the asymmetric volume difference was greater than that for the affected Vcl, V, VS and DVcl, with DVS (AUC=0.951) having the highest area under the curve to distinguish between stages I and II.

#### CONCLUSION

STIR-based asymmetric volume difference can be used as an adjunctive measure for clinical staging of LEL with good reproducibility, and DVS could be the best indicator for differentiating between stages I and II.

#### CLINICAL RELEVANCE/APPLICATION

STIR can quantitatively assess the severity of primary lower extremity lymphedema, facilitating clinical decision making and improving prognosis.

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## Abstract Archives of the RSNA, 2023

S3B-SPNMMI

### Nuclear Medicine & Molecular Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPNMMI-1 PSMA PET/CT for Localization of Prostate Cancer after Focal Therapy**

Mahbod Jafarvand, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

PSMA-ligand PET has become the first-line imaging tool for staging and re-staging patients with prostate cancer. However its role in patients with prostate cancer who underwent focal therapy (HIFU, irreversible electroporation, photodynamic therapy, cryoablation, and laser therapy) is still unknown. In this study, we aimed to investigate the diagnostic performances of PSMA PET/CT to detect and localize biochemical recurrence after focal therapy.

#### **METHODS AND MATERIALS**

This was a retrospective single center study. Patients with the following inclusion criteria were included: focal treatment for prostate cancer, 68Ga-PSMA-11 PET with contrast enhanced CT performed for biochemical recurrence, and no therapy between focal therapy and PET. Three independent blinded readers performed the PET image analysis and a per-region (T, N, M1a, M1b, M1c) centralized majority rule was applied (positivity rate). Inter-reader agreement of the positivity rates was calculated with Fleiss' kappa. In a sub-cohort of patients with a MRI and biopsy performed within 3 months of PSMA PET, diagnostic accuracy was evaluated on a per-patient and per-segment analysis on standard WB +60 min and the delayed +90 min pelvic images. A single radiologist blinded to PSMA and pathology performed MRI interpretation. Twelve prostatic segments were defined, and for every segment, suspicion for recurrence was assessed.

#### **RESULTS**

Of the 3329 patients with either a PSMA PET scan or focal therapy performed at UCLA, 100 patients met the inclusion criteria. PSMA-PET positivity rate per majority rule was 85/100 (85%) for prostate, 17/100 (17%) for pelvic lymph nodes and 20/100 (20%) for distant metastases. The inter-reader agreement for positivity rate by region was moderate (kappa=0.5). 29 patients had MRI and post-therapy biopsy data available. In these, Per-patient analysis showed a sensitivity of 92% for PSMA and 88% for MRI. Per-segment analysis performed on 297 validated segments resulted in a sensitivity, specificity, positive predictive value and negative predictive value of 53%, 90%, 74% and 78% for PSMA at +60 min, 55%, 92%, 79% and 79% for PSMA at +90 min and 29%, 92%, 72% and 65% for MRI ( $p < 0.01$ ), respectively. All Patients with PSMA SUVmax = 10 had GG = 3 disease.

#### **CONCLUSION**

In this retrospective study of 100 patients treated with focal treatment for prostate cancer the PSMA-PET positivity rate was 85% for prostate. The sensitivity per-segment was 55% on delayed +90 min pelvic PSMA PET vs 29% for MRI with a similar specificity of 92%. results suggest that PSMA PET/CT has potential for localization of recurrent prostate cancer after focal therapy.

#### **CLINICAL RELEVANCE/APPLICATION**

PSMA PET appears promising for localization of biochemical recurrence after focal therapy.

#### **S3B-SPNMMI-2 Manufacturing Iodine-loaded Polymeric Microcapsules: Proof-of-Concept for Theranostics in Peritoneal Carcinomatosis**

Nils Grosse Hokamp, MD, PhD (*Presenter*) Research Grant, Koninklijke Philips NV;Speakers Bureau, Koninklijke Philips NV;Consultant, Bristol-Myers Squibb Company

## **PURPOSE**

Peritoneal carcinomatosis refers to shedding of tumor cells to the peritoneal cavity and often is indicative of incurable and/or end stage disease. Treatment options at this advanced stage include hyperthermic intraperitoneal chemotherapy (HIPEC) alongside cytoreductive surgery. Aiming for continuous chemotherapeutic delivery options, this study intended to provide proof-of-concept of polymeric microcapsules that allow incorporation of chemotherapeutic agents and that are furthermore loaded with iodine in order to allow in-vivo tracing using computed tomography.

## **METHODS AND MATERIALS**

For synthesis a solvent-emulsion evaporation technique has been used. Hydrophobic iodinated oils (e.g. Lipiodol) were used as inner phase of the capsule. A biodegradable polymer [poly(lactic-co-glycolic acid), PGLA] was used as outer shell material. A fluorescent dye was added for direct visualisation. Incorporation of hydrophilic drugs, was shown with an aqueous iodinated compound (iohexol), using a water-oil-water emulsion process. Light/fluorescence microscopy, UV/Vis spectroscopy and size distribution using a Coulter Counter were conducted in addition to spectral detector CT based quantification of iodine content (SDCT).

## **RESULTS**

The synthesis yielded polymeric capsules containing CT-imageable iodinated compounds with tuneable diameter. The obtained particle diameters were in the range of 0.1 - 15  $\mu\text{m}$ . Iodide concentration was further quantified using UV/vis spectroscopy. Here, Iodine to polymer ratio varied between 23 to 125 mg I/g corresponding to 0.01 to 0.03  $\mu\text{g}$  I/capsule); similar results were obtained using SDCT. In addition cytostatic drugs could be incorporated into the particles.

## **CONCLUSION**

Controlled formation of iodine-loaded polymeric microcapsules can be achieved. The capsules can be visualized using SDCT which furthermore allows for quantification of their iodine content (consistent with UV/vis-based measurements as standard of reference). Furthermore, cytotoxic drugs can be incorporated into these particles.

## **CLINICAL RELEVANCE/APPLICATION**

The described syntheses provide proof-of-concept for in-vivo traceable and quantifiable microcapsules. Attempts to alter longevity of these systems might allow for a continuous therapy of peritoneal carcinomatosis. Alternatively, advanced manufacturing might allow for targeted drug delivery, e.g. by incorporating receptors into the outer shell.

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## Abstract Archives of the RSNA, 2023

S3B-SPNPM

### Noninterpretive Skills (Beyond Imaging) Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPNPM-1 Disability, an Often-Overlooked Aspect of Equity, Diversity, and Inclusion Among Radiology Departments in Canada and the United States**

Ali Abbas, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Despite nearly a quarter of Canadians and Americans reported to be living with a disability, persons with disabilities continue to face both structural and cultural barriers with respect to careers in medicine. Equity, diversity, and inclusivity (EDI) statements can act as a first step in deconstruction of these cultural barriers. However, when compared to other EDI initiatives focused on gender, race, and ethnicity, persons with disabilities receive little attention.

#### **METHODS AND MATERIALS**

We conducted a cross-sectional analysis of all radiology residency program websites in Canada and the United States (US). Data was collected from each radiology department website including the presence or absence of an EDI statement or page; if present, we determined whether mention was made of persons with disabilities.

#### **RESULTS**

We reviewed the websites of 16 Canadian and 181 US radiology residency programs. Seven (44%) Canadian institutions had an EDI statement, with one (14%) mentioning persons with disabilities. In the US, 103 (57%) institutions had an EDI statement, with 42 (41%) mentioning persons with disabilities.

#### **CONCLUSION**

There were a significant proportion of radiology departments without EDI statements on their websites and an even smaller proportion that acknowledged persons with disabilities. Persons with disabilities are underrepresented in the medical profession and are often left out of radiology department EDI statements. This population faces many barriers to careers in medicine, underscoring the importance of physical and cultural accommodations.

#### **CLINICAL RELEVANCE/APPLICATION**

Patients with disabilities often report that healthcare providers lack understanding of their condition; thus, inclusion of persons with disabilities among the physician workforce may result in improved patient care. In recent years, there has been an increase in recruitment of medical students with disabilities. Therefore, it is important that post-graduate medical training programs implement the changes necessary to welcome and accommodate these individuals. An institution's public commitment to EDI, and specifically to patients and providers with disabilities, is central to implementing inclusive change going forward.

#### **S3B-SPNPM-2 Gender-specific Differences in Aspired Academic Qualification and Perceived Research Opportunities: Excerpts from a Nationwide German Survey**

Isabel Molwitz, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess gender-specific differences in aspired academic qualifications and perceived research opportunities.

#### **METHODS AND MATERIALS**

Questionnaires were sent to radiologists of different career levels via the German Roentgen Society, the European Society of Radiology's Radiological Trainee Forum, the Radiological Society of North America's Resident and Fellow Committee, and

manually to 4500 radiologists of the largest German hospitals. Statistical analyses were conducted with age-adjusted regression analyses only for participants from Germany, as international responses were scarce.

## RESULTS

Of 510 radiologists with German affiliations (female: 237, 46%, mean age 42 ±10 years) men were four times more likely to have a higher academic degree (PD, habilitation) than women (odds ratio 4.39 [95%-confidence interval 2.22-8.67]) and twice as likely to pursue such a degree (2.87 [1.47-5.61]). Stated reasons to pursue further academic qualification (PD) more frequently found among male participants were: to be eligible for a position as leading physician (2.56 [1.07-6.15]) and a research interest (2.36 [1.0-5.57]). There were no gender differences in motivations occurring from an interest in teaching (1.86 [0.84-4.14]), the wish for more opportunities (1.62 [0.73-3.59]), or a higher independency (0.95 [0.44-2.05]). Most male (84%) and female (74%) radiologists were satisfied with possibilities of congress participation. The odds for dissatisfaction were slightly smaller among men than among women (0.62 [0.39-0.98]). Among both genders, dissatisfaction was high concerning time off clinical duties for research purposes (women: 64%, men 57%; 0.69 [0.41-1.16]). Most female respondents (51%) were dissatisfied with options to be involved in research projects, while most men (61%) were satisfied with them. Differences between both genders were not significant (0.60 [0.35-1.01]). Likewise, dissatisfaction with possibilities to develop their own projects and apply for funding was slightly higher among women (48% vs. 40%) but differences not of statistical significance (0.77 [0.45-1.35]).

## CONCLUSION

Among German radiologists, men pursue academic qualification more frequently, with eligibility for a position as leading physician being a gender-specific motivational difference. Dissatisfaction with research opportunities tend to be higher among women.

## CLINICAL RELEVANCE/APPLICATION

To achieve gender equality in science and among leading academic positions, it is essential to understand differences in motivation and integration in research among male and female radiologists. Women may want more support than currently provided, in terms of integration into research projects, developing their own projects, and applying for funding.

## S3B- Gender Representation in Radiology Practices in the United States SPNPM-3

Elizabeth H. Dibble, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate gender representation in radiology practices in the United States

## METHODS AND MATERIALS

The ACR Human Resources Commission fielded the 2022 Workforce Survey 11/2022-12/2022. The sample drew from the ACR members (35,601), non-members (12,551), and RBMA members (1,482). Structured closed-end questions were used, consistent with earlier surveys. Responses were group practice deduplicated and weighted and compared to 2021 survey results.

## RESULTS

524 fully qualified (decision-maker) respondents completed the survey: 77% male and 20% female. 1278 partially qualified respondents completed it: 65% male, 29% female, and .002% nonbinary. Significantly fewer partially qualified respondents preferred not to self-report gender in 2022 vs 2021 (5% vs 8%,  $p=0.0046$ ). 325 respondents answered questions about practice size and gender composition. The median number of non-practice-leader radiologists per practice was 15 (interquartile range (IQR) 7,30); full-time 13 (IQR 6,24), part-time 2 (IQR 0,5). The median number of practice-leader radiologists was 4 (IQR 1,7); full-time 4 (IQR 2,7), part-time 0 (IQR 0,0). These numbers were not different from 2021 ( $p>0.05$ ). Of full-time non-practice-leader radiologists per practice, the median number of females age <40=0 (IQR 0, 1), 40-65=1 (IQR 0, 3), and >65=0 (IQR 0,0); the median number of males age <40=2 (IQR 0,4), 40-65=6 (IQR 3,12), and 66+= 0 (IQR 0,1). The mean number of non-practice-leader radiologists increased slightly from 2021 to 2022 across all ages and represented genders, although this did not reach significance ( $p>0.05$ ). Of full-time practice-leader radiologists, the median number of females age <40=0 (IQR 0, 0), 40-65=0 (IQR 0,1), and 66+=0 (IQR 0,0); the median number of males age <40=0 (IQR 0,0), 40-65=3 (IQR 1,5), and 66+=0 (IQR 0,0). The mean number of practice-leader females increased slightly across all age groups from 2021 to 2022. The mean number of practice-leader males increased for age <40 ( $p=0.0458$ ), decreased for 40-65 ( $p>0.05$ ), and increased for 66+ ( $p>0.05$ ). The mean and median number of radiologists identifying as nonbinary was 0 for all queries.

## CONCLUSION

Female and nonbinary radiologists are underrepresented in radiology practices. Significantly fewer respondents in 2022 preferred not to self-report gender compared to 2021. The median number of female and nonbinary radiologist practice leaders is 0. The mean number of female practice leaders increased slightly across all age groups from 2021 to 2022, although this did not reach significance.

## **CLINICAL RELEVANCE/APPLICATION**

Female and nonbinary radiologists are underrepresented in US radiology practices in both leadership and non-leadership roles.

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## Abstract Archives of the RSNA, 2023

S3B-SPNR

### Neuroradiology Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPNR- Association of Body Mass Index and Waist Circumference with Multimodal Magnetic Resonance Imaging Indicators of Brain Health in 9- to 10-year-olds in the US** 1

Simone Kaltenhauser, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the relationship of pre-adolescents' Body Mass Index (BMI) and waist circumference (WC) with magnetic resonance imaging (MRI) indicators of brain health (cortical morphometry, resting-state functional connectivity, white matter (WM) micro- and cytostructure) over two years.

#### **METHODS AND MATERIALS**

We retrieved baseline and two-year follow-up clinical and neuroimaging information of a sociodemographic diverse cohort of 11,878 9- to 10-year-olds enrolled in the Adolescent Brain Cognitive Development (ABCD) study across 21 centers in the US. Inclusion required absence of neurodevelopmental/psychiatric diagnoses and traumatic brain injury. T1- and T2-weighted structural MRI, diffusion tensor imaging, resting-state functional MRI, and restriction spectrum imaging were quantified in a region-of-interest based approach. At both time points, cross-sectional linear regression determined the association of BMI/WC with fractional anisotropy (FA), neurite density (ND), cortical thickness and resting-state functional connectivity, after correction for age, gender, puberty, race/ethnicity, handedness, socioeconomic status and scanner device. In longitudinal analyses, multivariate regression was used to examine associations of baseline BMI with interval changes in neuroimaging metrics.

#### **RESULTS**

At baseline, 4,576 children (48.3% female) at an average age of 10.0 years (7.6 months) were included. 1,567 enrollees aged 12.0 years (7.7 months) had complete follow-up. At both point in time analyses, higher BMI/WC were associated with pervasive bilateral reductions of FA ( $P < .001$ ) as well as ND ( $P < .03$ ). With higher BMI/WC, especially prefrontal cortical thickness was reduced in both hemispheres ( $P < .04$ ). We found predominantly negative associations of BMI/WC with intra- and inter-network functional coupling of salience and cingulo-opercular networks ( $P < .005$ ). Over a mean follow-up period of 23.8 (1.6) months, we observed overall interval cortical thinning and increase in averaged FA and ND. Higher BMI at baseline was associated with lower interval increment in FA and ND of several commissural, projection and association WM tracts as well as reduced interval cortical thinning of prefrontal regions.

#### **CONCLUSION**

Higher BMI and waist circumference among children are associated with reduced WM micro- and cytostructural integrity, cortical thickness, and functional connectivity. Our longitudinal analysis suggests contribution of higher BMI to hindered interval development of WM micro- and cytostructure and cortex morphology.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings highlight the neurodevelopmental implications of pre-adolescents' higher weight and point to the need for early targeting of brain health indicators.

#### **S3B-SPNR- Spatiotemporal Discoordination of Brain Spontaneous Activity in Major Depression Disorder** 10

Qunjun Liang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Major depressive disorder (MDD) is a world-wide debilitating mental illness. Despite extensive research, the pathogenesis of MDD remains unknown. Spatiotemporal psychopathology (STPP) posits that the symptoms of MDD arise from aberrant



spatiotemporal experiences in a patient's inner world, which may be reflected by their brain spontaneous activity. In the present study, we aim at determining the spatiotemporal discoordination of MDD patient's brain spontaneous activity using fMRI.

## **METHODS AND MATERIALS**

91 MDD and 91 demography-matched HC were recruited in this study. The fMRI data were preprocessed via fMRIPrep and the timeseries were extracted over Schaefer400 parcels. Spatiotemporal topology (SPT) of the brain activity was measured by the Euclidean distance of each pair of parcels in a 3-dimension coordinate composed by two functional gradients (Margulies et al., 2016) and time delay (Mitra et al., 2014). SPT was then averaged across Yeo's 7 network atlas, resulting in 7 intra- and 21 inter-network SPT. Repeated measures ANOVA was performed to test the mean difference of the SPTs between MDD and HC. A machine learning approach was employed to investigate the efficacy of SPT in discerning between HC and individuals with MDD.

## **RESULTS**

A significant difference in network-specific features between MDD and HC was found ( $F(27, 5040) = 2.9, p < .001$ ). Simple-effect test identified four inter-network SPT that showed a significant group effect, including control-somatomotor distance ( $F = 7.3, p = .007$ ), salience-dorsal attention distance ( $F = 11.1, p < .001$ ), salience-visual distance ( $F = 19.2, p < .001$ ), and somatomotor-visual distance ( $F = 19.2, p < .001$ ). The logistic model yielded an accuracy of 0.73 in predicting the group label, and the ROC curve showed an AUC value of 0.86.

## **CONCLUSION**

SPT may reflect the homeostatic fluctuation of neuronal activity in the brain, and it is a theoretical-driven measure inspired by STPP. The significant difference in SPT were found in the visual and somatomotor network. The machine learning approach demonstrated the effectiveness of SPT features in differentiating between individuals with MDD and HC. While SPT topology presents theoretical validity and potential clinical value, it is no more than a general evaluation of the current state of the brain. As a result, the precise interpretation of its magnitude and direction is not yet apparent.

## **CLINICAL RELEVANCE/APPLICATION**

In the long run, SPT topology may serve as an important reference index in diagnosing MDD using low-cost fMRI scans. In addition, SPT topology could potentially function as a prognostic marker for MDD intervention. However, in its current stage, its main value lies in fundamental research, such as enhancing our understanding of the neural abnormalities of MDD.

## **S3B-SPNR- 11 Mild Cognitive Impairment in Non-alcoholic Fatty Liver Disease is Associated with Abnormal Resting-state Functional Connectivity Between the Default Mode Network and Regions within the Reward System**

Jie Li, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Mild cognitive impairment (MCI) is commonly seen in patients with nonalcoholic fatty liver disease (NAFLD), but the neural mechanisms have not been elucidated. In this study, we used resting-state fMRI (RS-fMRI) to investigate the characteristics of spontaneous neural activity in NAFLD patients with MCI.

## **METHODS AND MATERIALS**

A total of 74 NAFLD patients and 62 demographic-matched healthy controls (HC) were enrolled. According to the Montreal Cognitive Assessment (MoCA) score, the patients were divided into two groups: 43 patients with MCI\_NAFLD and 31 patients with nonMCI\_NAFLD. All participants underwent 3.0T RS-fMRI scan and neurocognitive psychological assessment, and patients underwent liver MRI proton density fat fraction (PDFF) and blood biochemical indexes measurement. DPABI software was used to process the RS-fMRI data and obtain the whole brain amplitude of low-frequency fluctuations (ALFF) map. One-way analysis of covariance and post-hoc tests were used to compare the differences in ALFF maps among the three groups. The abnormal regions were selected as the regions of interest (ROI) to compare the differences in whole-brain seed-based functional connectivity (FC) between the two patient groups, and the correlation between abnormal FC values and clinical variables was analyzed.

## **RESULTS**

Compared with nonMCI\_NAFLD patients, MCI\_NAFLD patients had reduced ALFF values in the right cerebellum and right cuneus, and increased ALFF values in the left posterior cingulate gyrus (PCC), and the ALFF values in these different regions were significantly correlated with MoCA scores. Compared with nonMCI\_NAFLD patients, MCI\_NAFLD patients had enhanced FC between the left PCC and the left lingual gyrus, left parahippocampal gyrus, left medial orbitofrontal gyrus, left middle frontal gyrus, left postcentral gyrus and right postcentral gyrus, and reduced FC between the left PCC and the left insula and right supplementary motor area. Among them, the FC values between the left PCC and the regions related to the reward system were correlated with cognitive function, emotional symptoms, PDFF values and insulin function in NAFLD patients. In particular, the ALFF values of the PCC completely mediated the correlation between the FC values between the PCC and the orbitofrontal cortex and MoCA scores.

## CONCLUSION

The development of cognitive impairment in patients with NAFLD may be closely related to the dysfunction of the default mode network and dopamine pathway, in which visceral fat accumulation and insulin dysfunction also play a crucial role.

## CLINICAL RELEVANCE/APPLICATION

These special neuroanatomical abnormalities may help to shed light on the underlying pathophysiology and manifestations of MCI in patients with NAFLD.

### **S3B-SPNR- Altered Functional Connectivity of Olfactory Neural Circuits in Subjective Cognitive Decline 12 under Odor Stimulation**

Yajing Zhu (*Presenter*) Nothing to Disclose

#### PURPOSE

Olfactory involvement is an early feature of Alzheimer's disease. The purpose of this study was to investigate the functional connectivity(FC) changes of olfactory neural circuits in subjective cognitive decline (SCD) in olfactory task fMRI under specific odor stimulation.

#### METHODS AND MATERIALS

A total 56 normal controls(NC) and 57 SCD were included.All subjects were tested with cognitive scale, olfactory behavior assessment, and olfactory task fMRI. The FC difference of olfactory neural circuits between the two groups was analyzed by the method of generalized psychophysiological interaction (gPPI).

#### RESULTS

There was no significant difference in olfactory behavior between the two groups. In olfactory task-fMRI with specific odor stimulation, the FC from bilateral POCs to the right parahippocampal area in the SCD group was significantly reduced; while the FC from the right hippocampus to the right frontal lobe was significantly enhanced. The connectivities from bilateral POCs to the right parahippocampal area, the right parahippocampal, and the right hippocampal were significantly positively correlated with the memory cognitive threshold; the connectivities from bilateral POCs to the right parahippocampal area, the right parahippocampal, and the right fusiform gyrus were significantly positively correlated with the global cognitive function.

#### CONCLUSION

The olfactory behavior reflects the comprehensive performance of the olfactory function, while the olfactory task-fMRI reflects the FC of the olfactory neural circuits. The results of this study indicate that although the olfactory behavior of SCD is at a normal level, the FC of olfactory neural circuits(POC-hippocampus-frontal lobe) has changed.

#### CLINICAL RELEVANCE/APPLICATION

The results of this study suggest that the FC changes of olfactory nerve circuits in SCD subjects under specific odor stimulation conditions, and the correlation between the connectivity of olfactory nerve circuits and the global cognitive function and memory function, prove that the FC changes of olfactory nerve circuits in SCD patients may be used as an early identification marker of high AD risk.

### **S3B-SPNR- Altered Hippocampal Intra-networks in Mild Cognitive Impairment: A Structural MRI Study 14 in a General Elderly Japanese Population**

Sera Kasai (*Presenter*) Nothing to Disclose

#### PURPOSE

Although altered networks inside the hippocampus (hippocampal intra-networks) have been observed in dementia, the evaluation of hippocampal intra-networks using MRI is challenging. We employed conventional structural imaging and incident component analysis (ICA) to investigate the structural covariance of the hippocampal intra-networks. To our knowledge, there have been no population-based studies with large sample sizes to assess the association between MCI status and hippocampal intra-network connectivity. Our aim was to assess whether individuals with MCI have altered hippocampal intra-network connectivity as measured using source-based morphometry (SBM) that is a type of structural network when compared with cognitively normal older adults (CNOA).

#### METHODS AND MATERIALS

This was a cross-sectional study of 2122 residents who participated in a population-based prospective study of cerebro- and cardiovascular diseases and dementia in a large population of older Japanese individuals with 3T MRI (median age 69 years, 60.9% female). The participants were divided into 218 patients with MCI and 1904 cognitively normal older adults (CNOA). By employing 3D T1-weighted imaging and ICA, we extracted the structural covariance intra-networks in the hippocampus.

## RESULTS

The ICA extracted 16 intra-networks from the hippocampal structural images, which were divided into two bilateral networks and 14 ipsilateral networks. Of the 16 intra-networks, four (one bilateral network and three ipsilateral networks) were significant predictors of MCI from the CNOA after adjusting for age, sex, education, disease history, and hippocampal volume/total intracranial volume ratio (Figure) ( $p < 0.01$ ). In addition, the networks predicted MCI independent of hippocampal volume ( $p < 0.01$ ), although hippocampal volume was also a predictor of MCI ( $p < 0.01$ ).

## CONCLUSION

In this population-based study with a large sample size, we extracted four MCI-related hippocampal intra-networks based on SBM, which can be estimated using conventional structural imaging with 3T MRI. These hippocampal intra-networks predicted MCI independently of hippocampal volume, suggesting the altered networks may reflect a different pathology from that of brain atrophy.

## CLINICAL RELEVANCE/APPLICATION

By using conventional structural imaging and ICA, we found that the relationship between hippocampal intra-networks and MCI was independent from the hippocampal volume. This method provides additional information for understanding cognitive impairment.

### S3B-SPNR- Clinical Quantitative Brain MRI: Quantifying Age-related Changes in Tissue Volume 3

Artem Kaliaev, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The volumes of the brain and substructures change continuously throughout the human lifespan. Establishing normal development patterns can be useful for detecting abnormal developmental pathways by comparison. Our goal is to study the pattern of normal brain development for the general population of our hospital as stratified by sex using the high geometrical accuracy and precision of turbo spin echo-based quantitative MRI.

## METHODS AND MATERIALS

This retrospective single-center cross-sectional study was conducted on healthy, ethnically diverse patients with normal brain imaging. The institution's IRB approved the study, and participants were imaged by 3.0-T MRI. Dual-echo turbo spin echo (DE-TSE; PD/T2-weighted) and single-echo turbo spin echo (SE-TSE; T1-weighted) images were used for the MRI parameter calculation. The image processing pipeline (IPP) consisted of a qMRI-based segmentation process that was programmed with Python (version 3.8.11) and the Anaconda Navigator (version 2.2.4). The IPP required a Fiji-based preparation step (version 2.1.1) to edit intracranial matter (ICM), which includes the in toto brain tissue and cerebrospinal fluid (CSF). Then, the IPP was applied consecutively for all subjects' MRIs. Finally, the mean volume for the ICM, brain, white matter (WM), gray matter (GM), and CSF were calculated. Statistical significance and Pearson correlation methods were used for the statistical analysis.

## RESULTS

A total of 277 patients (146 females) with normal brain radiological reports were included in this study leading to 7 decadal age groups. The ICM, brain, GM, and CSF and CSF ventricles volumes were significantly different between the age groups ( $p$ -value 0.019,  $<0.001$ ,  $<0.001$ ,  $<0.001$ ,  $<0.001$  respectively). There was a significant negative association between age and the ICM, brain, and GM volumes ( $p$ -value 0.008,  $<0.001$ , and  $<0.001$ , respectively), while there was a significant positive association between age and CSF and CSF ventricles volume ( $p$ -value  $<0.001$  and  $<0.001$ ). Furthermore, the significant correlation between ICM, brain, GM, and CSF, CSF ventricle volumes, and age groups was different for male and female cohorts (0.028 and  $<0.001$ s, respectively).

## CONCLUSION

In an ethnically diverse cohort of 277 patients without neurological findings, we find that the volume of total GM decreases with age and appears to be largely replaced by CSF as the WM volume stays constant after twenty years of age.

## CLINICAL RELEVANCE/APPLICATION

Clinical quantitative brain MRI is a valuable tool for quantifying age-related changes in brain tissue volume, characteristic of normal development, which can aid in early diagnosis and monitoring of age-related neurodegenerative diseases.

### S3B-SPNR- Evaluation of Brain Stiffness Change According to Brain Development using Virtual MR 4 Elastography Based on DWI

You Na Kim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Viscoelastic property of brain have been demonstrated to be affected by aging and various neurological disease. Based on the knowledge that measured mechanical properties of brain reflect the microstructure composition and organization of neural

tissue, magnetic resonance elastography (MRE) parameters representing mechanical properties can be a potential imaging marker for brain development. However, conventional MRE acquisition has been limited in children due to its invasive property and long scan time. The virtual MRE (vMRE) is a non-invasive and novel technique to measure tissue mechanical property based on diffusion weighted imaging (DWI). The purpose of this study was to evaluate change of brain stiffness according to brain development in children and young adults using vMRE.

## **METHODS AND MATERIALS**

We retrospectively reviewed 247 children and young adults (6 months~30 years, 119 females, 128 males) without structural brain abnormality. Shifted apparent diffusion coefficient was calculated from DWI ( $b=200$  and  $1500\text{sec}/\text{mm}^2$ ) and converted to DWI-based virtual shear modulus ( $\mu$ ). Brain stiffness was measured in whole brain and thirteen brain regions; cerebrum, cerebral gray/white matter, basal ganglia, thalamus, frontal/ parietal/temporal/occipital lobe, cerebellum, middle cerebellar peduncle, hippocampus, amygdala. Multiple comparison test and linear regression were conducted to investigate changes in brain stiffness according to brain development.

## **RESULTS**

Sexual dimorphism was not observed in any brain region. The virtual shear modulus ( $\mu$ ) of whole brain increased until the age of 16 years and then reached plateau. The DWI based mechanical property parameter of whole brain was increased 1.15% per year ( $R^2=0.642$ ,  $P < 0.001$ ) until 16-year-old. The change of brain stiffness according to brain development showed regional differences. Changes of brain stiffness showed the earliest plateau (8-year-old) in cerebral gray matter and continued to increase in the basal ganglia until 30-year-old. Although steepest increase in occipital lobe (1.85% increase/year,  $R^2=0.659$ ,  $P < 0.001$ ), there was no significant difference in pattern of stiffness change according to brain lobar area.

## **CONCLUSION**

DWI-based brain stiffness parameters increased with brain development in pediatrics period with differences by region.

## **CLINICAL RELEVANCE/APPLICATION**

DWI-based brain stiffness parameters increased with brain development until 16-year-old and reached plateau. The change of stiffness showed different pattern across the regions.

## **S3B-SPNR- Comparing the Clinical Utility of Linear Versus Volumetric MRI in Enlarged Vestibular Aqueduct Syndrome Patients**

Amit Gupta, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Presently CT is established method (Cincinnati criteria) for diagnosis of EVAS. Recently studies showed that linear measurement on MR are similar to CT in terms of confidence of diagnosis and correlation with audiometric data. The purpose of this study was to confirm validity of linear MR measurements and explore role of volumetric MRI measurements in predicting the hearing outcomes in patients with EVAS.

## **METHODS AND MATERIALS**

A retrospective study design was used including 30 patients that fit the inclusion criteria for a total of 46 ears. Linear measurements were made using the vestibular aqueduct (VA) midpoint and VA opercular widths for determination of EVAS. Semiautomatic volumetric measurements were calculated from all slices containing both the VA and endolymphatic sac (VA-ELS) using MIM Software Platform (MIM Software Inc.). Air and bone conduction data was collected from medical records. Univariate and multivariate analyses were performed to assess for a correlation between volumetric measurements and audiometric hearing outcomes.

## **RESULTS**

Of the study population, 16 patients demonstrated bilateral EVA (53.3%). Average VA volume estimated by volumetric MRI analysis was  $0.19\text{ mm}^3$ ;  $sd = 0.17\text{ mm}^3$ . Volumetric MRI measurements significantly correlated to both midpoint length and operculum size for EVAS diagnosis. Univariate analysis and multivariate analyses adjusting for age, race, and gender did not reveal significant correlations between volumetric MRI measurements and audiometric hearing outcomes. Midpoint size and operculum size correlated only weakly with low frequency bone conduction hearing outcomes.

## **CONCLUSION**

These results suggests an excellent correlation between the linear and volumetric measurements for diagnosis of EVAS, however, with an unclear role for both MRI measurements in the predicting hearing outcomes. In our study, neither linear nor volumetric measurements showed strong correlations with audiometric hearing data.

## **CLINICAL RELEVANCE/APPLICATION**

Given the 3D structure of the VA-ELS, volumetric measurements may improve MRI diagnostic utility in EVAS. This study warrants further research into the relationship VA-ELS structure and hearing outcomes, and questions the previously

published results on this topic.

### **S3B-SPNR- A Normative Model of the Brain from the Adult Colombian Population**

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Jon Duque-Grajales, MEng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The brain changes throughout life. There is an increasing interest in development of normative models based on anatomical brain features, which are related to the genetics of the population (Elliott et al. *Nature*, 2018). However, the normative models published so far have been mostly based on European descent population (Bethlehem et al. *Nature*, 2022, Rutherford et al. *Elife*, 2022). Here, we propose a normative model of brain aging in a Colombian adult population based on their brain volumes.

#### **METHODS AND MATERIALS**

2256 healthy participants (age range: 18 - 80 years; 1058 females) were selected based on their radiological report in a retrospective cross-sectional study. This study was approved by the institution's ethical committee. Brain anatomical T1w MR were processed using FSL (V.5) (Smith et al. *Neuroimage*, 2004). The preprocessing included tissue segmentation and subcortical structures extraction. Additionally, we aggregate all the volumes in a new parameter, the delta age, defined as the deviation of the predicted age by a multiple linear model between the age and the volume of all brain structures. Participants with volumes above or below five mean absolute deviations from the mean population for the same sex were discarded. Six different models were evaluated as normative models based on their standardized mean squared error (SMSE) derived from a random five-fold cross-validation: centiles, locally estimated scatterplot smoothing (LOESS), Gaussian process (GP), generalized additive models of location shape and scale (GAMLSS) and linear quantile regression (quant).

#### **RESULTS**

We derived one normative model per sex due to gender differences in 7 out of the 10 brain structures analyzed ( $p < 0.05$ ). Besides the GP model, all models had similar SMSE values for every structure (SMSE range, female: 0.684 - 1.136, male: 0.698 - 1.165). However, the LOESS model showed a consistent minimum SMSE across structures, having the best performance with the delta age.

#### **CONCLUSION**

The LOESS model provided a consistent minimum SMSE across all brain structures. Nevertheless, the use of a composed metric aggregating the volumes from all brain structures, the delta age, outperformed the performance of the model on individual brain structures. Therefore, we propose a normative model of brain aging in a Colombian adult population based on a LOESS model in terms of the delta age, that could be evaluated on a larger dataset.

#### **CLINICAL RELEVANCE/APPLICATION**

We derived a normative model of brain aging in a Colombian adult population based on the brain volume of different structures, providing a reference of brain aging which could highlight deviations from it in neurodegenerative and mental disorders.

### **S3B-SPNR- Can fMRI be Used to Develop Neuroimaging Biomarkers for the Risk of Developing Schizophrenia? A fMRI Study Investigating Neural Context-adaptation in Visual Perception, Object Categorization, and Reward Processing Across the Schizotypy Spectrum**

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Anna O. Giarratana, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Schizophrenia can be understood to exist on a spectrum; from non-clinical individuals with higher levels of schizotypal personality traits to patients with schizophrenia. Studying schizotypy in non-clinical populations can be extremely informative, given that schizotypy is positively correlated with an increased liability for the eventual development of a schizophrenia spectrum disorder. By studying schizotypy, researchers may be able to detect biomarkers for early detection of psychosis and identify brain regions that may be targets for treatment. Our lab previously found using fMRI, that neural adaptation to reward range is impaired in both healthy individuals with stronger schizotypal personality traits and in patients with schizophrenia. However, it remained unclear whether these deficits are limited to the reward domain, or extend to other domains as well. To this end, we undertook the larger fMRI study described here.

#### **METHODS AND MATERIALS**

We recruited 98 participants who scored within the top 10%, bottom 10%, and middle 20% of the schizotypy scale as assessed by the Schizotypal personality questionnaire - brief revised (BPQ-BRU). Participants underwent three different tasks while in the fMRI. We investigated reward processing, utilizing a variant of the Monetary Incentive Delay task previously used in our lab. We investigated visual processing, using a task previously used in a collaborators lab based on the concept of surround suppression. Finally, we investigated object categorization, using a novel face-house identification task we developed for this purpose.

## RESULTS

We find that participants exhibit neural adaptation in the context of reward, visual processing, and object categorization. However, while our previous studies showed that reward range adaptation is impaired in individuals with higher schizotypy, we find no such deficit in visual processing or object categorization.

## CONCLUSION

Our findings suggest that the inability of those on the schizophrenia spectrum to adapt to the range seen in reward tasks does not generalize to the visual domain. These results may indicate that the deficits seen are specific to the dopamine reward pathways of the brain.

## CLINICAL RELEVANCE/APPLICATION

These findings highlight reward adaptation as a possible functional neuroimaging biomarker, and a potential target for future studies to investigate interventions (i.e. behavioral interventions or brain stimulation) in an effort to decrease progression along the schizophrenia spectrum.

## S3B-SPNR- Multi-site rTMS Combined with Cognitive Training Modulates Effective Connectivity in Patients with Alzheimer's Disease

Yuan-Yuan Qin, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Alzheimer's disease (AD) is an irreversible neurodegenerative disorder with recent understanding as a disconnection syndrome. As pharmacotherapy for AD is currently limited, attention has been paid to non-drug adjuvant interventions such as repetitive transcranial magnetic stimulation (rTMS). Multi-site rTMS associated with cognitive training (rTMS-COG) therapy has been shown to be probably effective for AD patients at early-stage. rTMS has been approved to be able to modulate local activity in a remote area that is functionally connected to cortical stimulation targets. However, the causal interactions between the stimulation targets and other brain regions has yet to be explored. The purpose of this study is to investigate the effective connectivity(EC) changes after multi-site rTMS- COG therapy.

### METHODS AND MATERIALS

Written informed consent of all participants were obtained according to the declaration of Helsinki before enrollment. 10Hz rTMS over left dorsal lateral prefrontal cortex (DLPFC) and lateral temporal lobe (LTL) were delivered for 4 weeks with COG. AD patients were divided into real (real rTMS+COG, n=11) or sham (sham rTMS+COG, n=8) group to undergo neuropsychological assessment, resting-state fMRI and 3D brain structural imaging before (T0), immediately at the end of (T4), and 4 weeks after treatment (T8). A 2x3 factorial design with "time" as within-subject factor (3 levels: T0, T4, T8) and "group" as between-subject factor (2 levels) were used to investigate the EC changes related to stimulation targets on the rest of brain, as well as the causal interactions among 7 resting state networks based on granger causality analysis (GCA).

## RESULTS

At voxel-level, the EC changes from left DLPFC out to left inferior parietal lobe and left superior frontal gyrus, as well as from left LTL out to left orbital frontal cortex had significant group x time interaction effect. At network level, significant interaction effect has been identified on the EC increment from limbic network out to default mode network. The EC decrease at voxel level and EC increase at network level were all associated with better functioning in the ability of daily living and cognition.

## CONCLUSION

Multi-site rTMS combined with cognitive training could modulate effective connectivity in patients with AD, doing better for the ability of daily living and cognitive function. Due to the longitudinal design, the sample size is limited. Further multi-center cohort study was further needed to validate our pilot study.

## CLINICAL RELEVANCE/APPLICATION

This study provides a novel explanation for the neurobiological mechanisms of multisite rTMS-COG therapy in AD patients and further shed light on the direction of targeted brain network modulation in future.

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## Abstract Archives of the RSNA, 2023

S3B-SPOB

### OB/Gynecology Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPOB- Risk of Malignancy in Ovarian-Adnexal Imaging Reporting & Data System (O-RADS) Ultrasound (US) version 2022 Score 2 Unilocular and Bilocular, Smooth Ovarian Cysts Without Solid Components**

Luyao Shen, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Ovarian-Adnexal Imaging Reporting Data System (O-RADS) Ultrasound (US) version 2022 (v2022) downgraded smooth bilocular cysts without solid components <10 cm to the O-RADS US 2 with a lower expected risk of malignancy (ROM) of <1% based on results from IOTA5 trial (Timmerman et al. JAMA Oncol. 2023;9(2):225-233). We aim to assess the ROM of unilocular and bilocular, smooth cysts without solid components <10 cm in a non-selected patient population presenting to academic radiology departments in the United States.

#### **METHODS AND MATERIALS**

In this IRB-approved, retrospective study from 6 institutions, pelvic US over 5 years were consecutively reviewed to include exams with ovarian cystic lesions. Lesions without surgical, imaging, or clinical follow-up were excluded. Malignant lesions were diagnosed by histopathology, and benignity determined by histopathology, diagnostic on CT/MRI, resolution, decreased size >10%, or stability by imaging or normal clinical exam >2 years. Investigators blinded to the final outcome recorded imaging features and scores per the O-RADS US. Mann-Whitney and Fisher's exact tests were performed (two-tailed  $p < 0.05$  significant).

#### **RESULTS**

Of 14302 pelvic US reviewed, 913 patients had cystic ovarian lesions. Of those, 319 patients with 337 cystic lesions with smooth walls and septations without solid components <10 cm were included. The median age was 45 years (interquartile range 35-53), and there were 212 (66%) pre-menopausal and 107 (34%) post-menopausal patients. There were 292 unilocular cysts (275 patients) and 45 bilocular cysts (45 patients). Differences in patient age, menstrual status, and lesion size were not statistically significant between the 2 groups ( $p=0.633$ ,  $0.865$ , and  $0.845$ , respectively). The ROM was 0.3% (1/292) for unilocular cysts and 2% (1/45) for bilocular cysts. ROM was not statistically significant between the 2 groups ( $p=0.250$ ). The 2 malignant tumors (1 unilocular, premenopausal patient, and 1 bilocular cyst, postmenopausal patient) were both borderline serous tumors.

#### **CONCLUSION**

A 2% ROM was noted with bilocular cysts in our cohort, which is higher than expected range for O-RADS US v2022 score 2 (<1%). ROM difference between unilocular and bilocular, smooth ovarian cysts without solid components <10 cm is not statistically different. Further investigations in a larger cohort should be undertaken to confirm these initial results.

#### **CLINICAL RELEVANCE/APPLICATION**

In bilocular, smooth cysts without solid components, measuring less than 10 cm, the ROM is greater than the O-RADS US v2022 expected range of <1%. Borderline tumors can have this morphology. Our results suggest further investigation in a larger cohort is needed to help determine the appropriate risk categorization for bilocular cysts.

#### **S3B-SPOB- Ovarian-Adnexal Reporting and Data System (O-RADS) MRI Score Effects of DWI and ADC Values**

Marco Gennarini (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this study is to evaluate the potential of integrating diffusion-weighted imaging (DWI) and quantitative assessment of apparent diffusion coefficient (ADC) into the O-RADS MRI system for prognostic purposes. Subsequently, to evaluate the validity and reproducibility of this approach among operators with different levels of experience in female pelvic imaging and to identify any correlations between the histology of malignant lesions and ADC values.

## METHODS AND MATERIALS

The study included 173 patients with 213 indeterminate masses in the adnexa that underwent MRI examination between January 2015 and June 2022. 140 patients with 172 masses met the inclusion criteria, which required them to be over 18 years old, have undergone a standard MRI exam, have no acute symptoms, and have had subsequent surgery with histopathological examination or stable follow-up for at least one year. Two radiologists with 4 and 1 year of experience in female pelvic imaging, respectively, blindly evaluated all masses according to the O-RADS MRI score system. To perform a quantitative analysis, a circular ROI was placed on the ADC map obtained from single-exponential DWI. If the lesion had multiple solid components, 4 to 6 ROIs were placed, and the ROI with the lowest ADC value was recorded. Lesions without enhanced solid tissue, with fluid, adipose, blood or fibrotic content, were considered benign (O-RADS 2) and excluded.

## RESULTS

The study showed excellent agreement between the two radiologists in classifying adnexal masses according to the O-RADS MRI score system ( $K = 0.936$ ; 95% CI). Two ROC curves were used to determine the best cut-off value for the ADC between O-RADS MRI categories 3-4 and 4-5, which allowed for some masses to be upgraded or downgraded compared to their original classification. The AUC for O-RADS MRI scores 3 and 4 was 0.951, with an optimal ADC cut-off value of  $1.411 \times 10^{-3}$  mm<sup>2</sup>/sec. Three adnexal masses originally classified as O-RADS MRI score 3 were upgraded to score 4, and four lesions with an ROI ADC  $> 1.411 \times 10^{-3}$  mm<sup>2</sup>/sec were downgraded to score 3. All 30 adnexal lesions classified as O-RADS MRI score 5 remained in that category. The AUC for O-RADS MRI scores 4 and 5 was 0.630, with an optimal ADC cut-off value of  $0.849 \times 10^{-3}$  mm<sup>2</sup>/sec. Twenty-two adnexal masses originally classified as O-RADS MRI score 4 were upgraded to score 5, and 36 adnexal lesions, in accordance with TIC type 2, remained in O-RADS MRI score 4. There was a significant correlation between ADC values and the histotype of ovarian carcinoma ( $p$  value  $< 0.001$ ).

## CONCLUSION

Our research reveals how DWI and ADC values can provide valuable prognostic information for the O-RADS MRI classification, leading to improved standardization and characterization of adnexal masses.

## S3B-SPOB- Comparison of O-RADS and Simple Rules Ultrasound Classifications to Predict Adnexal Malignancy

Andrew Nanapragasam, FRCPC, FRCR (*Presenter*) Nothing to Disclose

## PURPOSE

This study compares performance of US O-RADS (version 2022) and Simple Rules (SR) criteria in a cohort of asymptomatic pathology-proven adnexal masses and evaluates O-RADS and SR inter-observer agreement in a subset of patients.

## METHODS AND MATERIALS

We conducted retrospective analysis in consecutive patients who underwent surgical resection between January 2008 and December 2018 at two adult university hospitals. US cine clips were available for all examinations. One experienced radiologist, blinded to diagnosis, categorized all US imaging by O-RADS and SR criteria. SR assessment assigned the following features as benign: unilocular/multilocular cyst with uniform thin septa irrespective of cyst content/size; cystic or solid mass with attenuating component; cystic mass with  $< 3$  mm nodule(s) or completely calcified nodule(s). Malignant features included: non-attenuating solid mass; cystic mass with non-attenuating nodule, nodule(s)  $= 3$  mm; multilocular cysts with septa too close to be distinctly seen. A subset of cohort was randomly selected and reviewed by two blinded radiologists with fewer years of experience. Chi-square testing was used for comparison of ratios, and Kappa statistic for inter-observer agreement.

## RESULTS

791 adnexal masses in 762 patients were assessed, aged 18-92 ( $44 \pm 15$ ); 628 benign, 49 LMP, 114 malignant, measuring 1 to 39 cm ( $7.9$  cm  $\pm 4.2$ ). O-RADS categories were 2 ( $n=309$ ), 3 ( $n=165$ ), 4 ( $n=181$ ), 5 ( $n=136$ ) with malignant rates of 0.3%, 3%, 25%, and 82% respectively. Application of simple rules criteria identified 561 masses as benign and 230 as malignant. Combining O-RADS 4 and 5 categories as being malignant, sensitivity, specificity, NPV, PPV, and accuracy to detect invasive/LMP masses were 96% (CI:92-99%), 75% (CI:71-78%), 99% (CI:97-100%), 49% (CI:44-55%), and 79% (CI:76-82%). Corresponding results for SR were 96% (CI:91-98%), 89% (CI:85-91%), 99% (CI:98-100%), 68% (CI:61-74%), and 90% (CI:87-92%) with specificity, PPV, accuracy of SR being statistically significantly higher than O-RADS ( $p < 0.0001$ ). Inter-observer agreement between the three readers were 0.89, 0.91, and 0.93 for SR benign versus malignant categories and 0.71, 0.75, and 0.75 for O-RADS 2/3 from O-RADS 4/5.



## **CONCLUSION**

Adnexal mass ultrasound assessment with SR performs significantly better than O-RADS classification for specificity, PPV, and accuracy with similarly high sensitivity and NPV. High inter-observer agreement was found with both SR and O-RADS.

## **CLINICAL RELEVANCE/APPLICATION**

US risk stratification by experienced radiologists using SR criteria outperforms O-RADS and can result in a better triaging of patients to gynecologists versus gynecologists by predicting a more precise rate of malignancy.

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## Abstract Archives of the RSNA, 2023

S3B-SPPD

### Pediatric Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPPD- Automated Reconstruction and Segmentation of High-isotropic-resolution Fetal Brain MRI Data for Quantitative Brain Morphological Analysis**

Haoxiang Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Fetal MRI has gained increasing importance in prenatal diagnosis because of its superior soft tissue contrast. To compensate for fetal and maternal motion and limited spatial resolution, two-dimensional (2D) images are acquired across each anatomical direction. In this study, we develop and present an automated pipeline that reconstructs a high-isotropic-resolution fetal brain volume from three 2D thick-slice images and segments it into multiple brain structures using state-of-the-art MR image analysis methods. The accuracy of the pipeline is validated by evaluating the correlation between brain structure volumes and gestational age.

#### **METHODS AND MATERIALS**

Sixty pregnant women with normal fetal brain, aged between 20 to 36 weeks of gestation, were enrolled with informed written consent and IRB approval to obtain T2-weighted images along axial, coronal, and sagittal directions using a turbo spin echo (TSE) sequence. The NiftyMIC method was employed to perform slice-to-volume motion correction and reconstruct a single fetal brain volume at 0.8 mm isotropic spatial resolution from the three 2D TSE images. The reconstruction process included brain masking, bias-field correction, volumetric reconstruction in each subject's native space, and transformation to the template space. A deep learning-based segmentation neural network named FetalBrainParcellation was then utilized to segment each high-resolution brain volume into eight brain structures, including cortical grey matter, deep grey matter, white matter, corpus callosum, brainstem, cerebellum, intra-axial cerebrospinal fluid (CSF), and extra-axial CSF. Finally, the Pearson correlation coefficient between the volume of each brain structure and the gestational age was computed.

#### **RESULTS**

The quality of reconstruction and segmentation results of all 60 subjects were visually confirmed by two expert pediatric radiologists. The volume of each brain structure was highly ( $r > 0.9$  for five structures,  $r > 0.8$  for seven structures) and significantly ( $p < 0.001$ ) correlated with the gestational age, which was consistent with previous studies.

#### **CONCLUSION**

This study introduced a pipeline that automatically reconstructed and segmented fetal brain volumes and validated its robustness and accuracy for quantitative morphological analysis of normal fetal brains.

#### **CLINICAL RELEVANCE/APPLICATION**

The automated pipeline developed for reconstructing and segmenting fetal brain MRI data provides a novel tool for quantitative morphological analysis of fetal brains, which can aid in diagnosis and prognosis. Further research will assess its validity for fetal brains with pathologies and explore its potential clinical applications.

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## Abstract Archives of the RSNA, 2023

S3B-SPPH

### Physics Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPPH- Evaluating ChatGPT's Performance on a Radiology-physics Question Set**

1

Jaydev K. Dave, PhD (*Presenter*) Research Grant, Koninklijke Philips NV; Equipment support, Lantheus Medical Imaging; Equipment support, General Electric Company; Research Consultant, Curvebeam LLC; Consultant, Rayscan, Inc.

#### **PURPOSE**

Recent reports have evaluated ChatGPT's (OpenAI, San Francisco, CA) performance on several standardized examinations. The purpose of this work was to evaluate the performance of this text-based AI language model on a radiology-physics question set.

#### **METHODS AND MATERIALS**

A radiology-physics question set with 135 questions (RAPHEX, Radiological and Medical Physics Society of New York) was used to assess ChatGPT's performance. All questions were in the multiple-choice format with single correct answer and three to four distractors. The questions covered different imaging modalities, and included questions with images ( $n = 27$ ), calculations ( $n = 36$ ), and regulatory limits/accreditation requirements ( $n = 17$ ). Freely available, March 23, 2023 version of ChatGPT was used in this study. The questions were entered in multiple choice format with the stem and the options into the chat dialogue box. The responses were evaluated and scored. The justification provided in the ChatGPT responses was also reviewed for correctness.

#### **RESULTS**

Out of 27 image-based question, there were 8 questions in which interpretation of images was required and given that images are not accepted as input in ChatGPT, there were no responses for these questions. Thus, these 8 questions were not considered in the scoring. Other image-based questions either included description of artifacts/image content in the question stem or images with tabulated data. For these questions, responses were provided by ChatGPT and so these were included for assessment. From the 127 questions included in the analysis, correct responses/explanation were obtained for 79 (62.2%). For 2 questions the correct responses were obtained; however, the justification was incorrect. Evaluating the proportion of correct responses as a function of question type revealed that correct responses were obtained for 63.2% of the questions with images (12/19), 50.0% of the questions that involved calculations (18/36), and 35.3% of the questions involving regulatory limits/accreditation requirements (6/17). Modality-wise, the proportion of correct cases was 88% for radiography, 50% for mammography, 36% for fluoroscopy, 60% for computed tomography, 83% for ultrasound, 67% for magnetic resonance imaging, 43% for nuclear medicine, and 72% for fundamental questions including safety and radiobiology.

#### **CONCLUSION**

Leaving aside questions that rely on image interpretation, ChatGPT scored 62.2% on a radiology-physics question set covering different modalities and question categories. Image-interpretation questions remain unanswered.

#### **CLINICAL RELEVANCE/APPLICATION**

Analyzing the performance of chatbots will help target evaluation criteria for maintenance of certification/online longitudinal assessment.

#### **S3B-SPPH- Opportunistic Osteoporosis Screening with Bone Mineral Density Estimation on Computed Tomography using Multi-View Semi-Supervised Learning**

10

Heng Guo, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Computed tomography (CT) scans, which are widely used for other indications, can provide added-value for osteoporosis screening. We propose a novel method for estimating bone mineral density (BMD) using routine CT scans.

## METHODS AND MATERIALS

We proposed DeepBMD that consists of automatic spine vertebrae instance segmentation and BMD regression in this work. Patients who underwent both a routine CT and a Dual-energy X-ray Absorptiometry (DXA) examination within one month between December 2020 and December 2022 were retrospectively included. This led to 3,586 CT scans (81% chest CT, 19% abdomen CT) and 3,805 DXA results with lumbar BMD values (L1 - L4). After excluding scans with low quality, metal implants and bone fractures, a dataset of 2,633 CT-DXA pairs in patient-level were obtained. An automated vertebrae instance segmentation tool was developed to distinguish vertebrae with DXA gold-standard or not. Finally, we got 4,889 vertebrae with DXA gold-standard, and 30,400 not. The paired dataset was randomly split into 60%, 10%, and 30% for training, validation, and testing. We developed a multi-view semi-supervised learning framework for BMD regression. Specifically, 3D and 2.5D vertebrae patches were extracted under different augmentation parameters. A hybrid network consisting of a CNN and a Vision Transformer was used to extract features. For vertebrae without gold-standard, pseudo BMDs would be generated. An experienced clinical expert specialized in orthopedics checked the vertebrae identification results. The Pearson correlation coefficient, sensitivity, specificity, area under receiver operating characteristics (AUC) are reported.

## RESULTS

There are 1,005 osteoporotic patients (group A) and 1,628 non-osteoporotic patients (group B) in our dataset. Females account for 68.6% in group A and 48.6% in group B. The average ages of group A and group B are 65.56( $\pm$ 8.59) and 62.17( $\pm$ 9.12). For vertebrae identification, DeepBMD achieves a success rate of 98.7%, indicating that it is robust and reliable. DeepBMD achieves a great correlation coefficient of 0.909 on the testing set. According to the literature that a T-score of less than or equal to -2.5 is considered to be osteoporotic, DeepBMD achieves a sensitivity of 0.87, specificity of 0.90, and AUC of 0.96 for osteoporosis screening.

## CONCLUSION

The predictions of the proposed algorithm exhibit a strong correlation with DXA and can facilitate opportunistic osteoporosis screening.

## CLINICAL RELEVANCE/APPLICATION

Using routine CT for BMD estimation can provide the added-value for opportunistic osteoporosis screening. Beyond evaluating BMD in the lumbar vertebrae, our method can also assess the thoracic vertebrae, providing patients with a more comprehensive evaluation of their spine health.

## S3B-SPPH- 11 Development of a TOPAS Monte Carlo Model of a C-arm Cone Beam CT (CBCT) for Organ Dose Estimation

Nina McWilliams, BSc, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

C-arm cone beam computed tomography (CBCT) used in an interventional radiology (IR) setting provides the radiologist with cross sectional images to assist in performing and verifying a radiological intervention. To accurately estimate the radiation dose to the patient, knowledge of the doses delivered to major radiosensitive organs is required. However, the current approaches for CBCT dosimetry are still under development. Replication of system specific complexities such as automatic exposure control (AEC), rotational geometries, beam hardening and scatter contributions make the simulation and estimation of CBCT radiation doses challenging. The main aim of this research was to develop a novel TOPAS Monte Carlo (MC) dosimetry model of a C-arm CBCT incorporating AEC, and validate it with measurements using an anthropomorphic phantom.

## METHODS AND MATERIALS

A MC model of a Siemens Artis Q C-arm CBCT system [Siemens, Erlangen, Germany] was developed in TOPAS, version 3.9. A TOPAS extension to incorporate AEC functionality was implemented into the MC model. The system's energy spectrum, CBCT rotational parameters, system geometry and tube filtration were simulated according to manufacturer specifications. Experimental data was obtained using the Body CBCT protocol and a physical CIRS ATOM® adult female anthropomorphic phantom. Verification of the dose distribution and AEC functionality of the MC model was carried out using thermoluminescent dosimeters (TLDs) placed in the tissue-equivalent organ sections of the phantom mimicking patient organs. Measured doses were compared with MC simulated doses for different sites within the phantom acquisitions.

## RESULTS

This study presents details of the development of a novel AEC module in TOPAS MC simulations for incorporation into a C-arm CBCT MC model. The AEC module, the first of its kind, will shortly be released for public use in TOPAS. The CBCT MC model has been applied to abdominal acquisition protocols in IR and validated through anthropomorphic phantom dose distributions and organ dose measurements.

## CONCLUSION

A novel AEC module has been successfully developed in TOPAS which can be easily incorporated into other imaging application models that employ such dose modulation. The MC model allows for a more realistic dosimetry estimation, advancing the current CBCT dosimetry approaches.

## CLINICAL RELEVANCE/APPLICATION

Few studies have documented radiation doses from C-arm CBCT exposures in adults. The novel AEC module developed in this research, and its validation using an anthropomorphic phantom, is a step towards personalised dosimetry in CBCT.

### **S3B-SPPH- Development of an Ultra-high-Resolution Dental Cone-beam CT System** 12

Riku Koda (*Presenter*) Nothing to Disclose

#### PURPOSE

The dental cone-beam computed tomography (DCBCT) systems have been clinically used since early 2000s. They provide detailed images that can help dentists diagnose and plan treatment for different dental conditions. The spatial resolutions of DCBCTs are generally higher than those of multi-slice CT systems; however, the spatial frequency limits evaluated by 5% modulation transfer function (5%MTF) are approximately 2 mm<sup>-1</sup> and those are not necessarily sufficient for observing micro structural abnormalities in oral region. This study aimed to develop a new DCBCT (DCBCT<sub>new</sub>) that achieves a 5%MTF significantly higher than that of conventional DCBCT (DCBCT<sub>c</sub>) without increasing the radiation dose.

#### METHODS AND MATERIALS

A contact geometry, in which the X-ray detector is close to the object, for reducing the focus penumbra was adopted in this system. Furthermore, since the dentition is generally located anteriorly in the head, a half scan orbit was used to prevent collisions between the occipital region and the detector. The scan duration was 6.5 s; during that, projection data with 520 views were obtained using a CsI-based detector with 1488 × 660 pixels. The pixel size at the iso-center was 0.081 mm. For the DCBCT<sub>new</sub> and a DCBCT<sub>c</sub>, MTFs were measured from images obtained by scanning a copper wire with a diameter of 0.1 mm. The radiation dose of DCBCT<sub>new</sub> was measured according to the standard method for the weighted CT dose index (CTDI<sub>w</sub>); then, the effective dose was estimated from the result. An oral region in an anthropomorphic head phantom was scanned using both DCBCT<sub>new</sub> and DCBCT<sub>c</sub>.

#### RESULTS

The 5%MTF of DCBCT<sub>new</sub> was 3.80 mm<sup>-1</sup>, which was more than twice that of DCBCT<sub>c</sub> (1.65 mm<sup>-1</sup>). The estimated effective dose of DCBCT<sub>new</sub> was 0.084 mSv which was significantly lower than reported ones (around 0.2 mSv) of the DCBCT<sub>c</sub>. The phantom images of DCBCT<sub>new</sub> were remarkably sharper and clearer compared to those of DCBCT<sub>c</sub>.

## CONCLUSION

The developed DCBCT presented significantly higher spatial resolution and more suitable dental CT images to observe micro structures with a lower radiation dose, compared to a conventional DCBCT.

## CLINICAL RELEVANCE/APPLICATION

The developed DCBCT was able to provide high-resolution images with low dose scanning. This result suggested that there are sufficient rooms to improve the image quality of current clinical DCBCT systems.

### **S3B-SPPH- A Dose Based Method to Optimize Virtual Monoenergetic Cone-beam Computed Tomography** 13 **Imaging Parameters for Image-guided Radiotherapy**

Hyejoo Kang, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aims to optimize Virtual Monoenergetic (VM) cone-beam computed tomography (CBCT) protocols for Image Guided Radiation Therapy (IGRT) as functions of exposure and single frame acquisition rate while minimizing patient imaging dose.

#### METHODS AND MATERIALS

First, 7 CBCT sets acquired at 80 kVp and 140 kVp with various exposures and frame rates were used to determine the average normalized Air Kerma (K<sub>air</sub>) per exposure (mAs) for the X-ray Imaging (XI) system of a Truebeam linac (Varian Medical System, CA) with a calibrated 0.6cc air Kerma Farmer chamber. Then, 6 combined dual (80 and 140 kVp) energy CBCT protocols were optimized, ensuring that their estimated cumulative K<sub>air</sub> resulted in a lower imaging dose than K<sub>air</sub> of the default 140 kVp-Pelvis CBCT protocol (K<sub>air</sub> = 133 mGy). VM-CBCT projection images of a Catphan 604 (Phantomlab, NY) at specific energies were generated from DE-CBCT, and then were reconstructed using the Feldkamp-Davis-Kress (FDK) algorithm within an open-source TIGRE toolbox. The quality of VM-CBCT images at 50 keV were evaluated using quantitative metrics such as Hounsfield units (HU), contrast-to-noise ratios (CNR), and noise-level using in-house scripts.

## RESULTS

The average difference between estimated and measured cumulative  $K_{air}$  for all combined DE-CBCT protocols was  $2.2 \pm 2.1\%$ . Qualitative evaluation of VM-CBCT images at 50 keV showed comparable image quality between those with high- and low- $K_{air}$ . The HU of 20% bone material in the all low- $K_{air}$  VM-CBCT with were within 35 HU of the theoretical value of 298 HU. Additionally, the CNR and noise level between high- and low-  $K_{air}$  VM-CBCT images were within 1.6 ( $16.0 \pm 0.9$ ) and 3 HU ( $19.3 \pm 1.0$  HU) respectively.

## CONCLUSION

The proposed method of optimizing DE-CBCT acquisition parameters based on  $K_{air}$  provides imaging dose estimate within 3%. VM-CBCT generated from optimized DE-CBCT with reduced  $K_{air}$  showed comparable image quality to VM-CBCT generated from the highest  $K_{air}$  DE-CBCT based on both qualitative and quantitative assessments. Ongoing research aims to explore the impact of further reducing the framerates in CBCT acquisition and evaluating the use of iterative reconstruction to determine imaging parameters with reduced imaging dose while maintaining image quality for clinical applications.

## CLINICAL RELEVANCE/APPLICATION

VM-CBCT has shown promise in improving visualization of soft tissues compared to standard CBCT. However, the increased imaging dose associated with VM-CBCT remains a concern. We propose to determine imaging parameters using air Kerma measurement-based approaches of optimizing DE-CBCT imaging parameters. This approach has the potential to substantially reduce imaging dose for VM-CBCT without deteriorating image quality for clinical applications.

## S3B-SPPH- Adaptive Deep Learning MR Image Enhancement for Flexible Rapid MR Protocol Design 2

Zechen Zhou (*Presenter*) Nothing to Disclose

## PURPOSE

Deep Learning (DL) based image enhancement approaches can restore the image quality for accelerated Magnetic Resonance (MR) scans. However, a single DL model might not allow flexible MR protocol setup to achieve higher acceleration and resolution. In this work, we propose a Proximal Gradient Descent based unrolled Network (PGDNet) that can adaptively resolve different levels of noise amplification and image blurring. Preliminary performance evaluations were compared with traditional DL methods on various acquisition tasks.

## METHODS AND MATERIALS

PGDNet (Fig. A, PGDNet) incorporates the image degradation model into the image restoration process to jointly estimate the degradation kernel and the high quality image, which maintains the data consistency with the acquired image while performing adaptive image enhancement. 356 MR acquisitions with paired fully sampled and undersampled (i.e. fewer number of phase encodings [NPE] or signal averages [NSA]) images were collected for training (#pairs for reduced NPE: 101, #pairs for reduced NSA: 193, #pairs for both: 18) and testing (#pairs for reduced NPE: 11, #pairs for reduced NSA: 29, #pairs for both: 4). Three different models were trained: 1) Enhanced Deep Residual Networks (EDSR) (Fig. A, EDSR) trained with all data pairs; 2) EDSR model fine-tuned with the reduced NPE data pairs as the super-resolution expert (SRE) model; 3) PGDNet trained with all data pairs. Quantitative PSNR and SSIM metrics were used to evaluate the accuracy of the model outputs on 3 acquisition tasks.

## RESULTS

In denoising tasks (Fig. B, reduced NSA scans), PGDNet can better preserve small structures, and prevent over-smoothing, particularly the trabecular bone textures in MSK cases. In deblurring tasks (Fig. B, reduced NPE scans), PGDNet can still achieve similar/superior performance compared to the EDSR SRE model, and show improved structural consistency with the reference image. Compared to EDSR and EDSR SRE, PGDNet demonstrates its adaptation and robustness in the joint denoising and deblurring tasks (Fig. B, scans with reduced NSA and NPE). Quantitative measurements also supported the qualitative assessment.

## CONCLUSION

By explicitly leveraging the image degradation model, PGDNet outperforms the conventional DL methods in various acquisition tasks, particularly filling the gaps in acquisitions with both reduced NPE and NSA. This allows more flexible MR protocol design to achieve highly accelerated clinical exams or improved image quality for clinical diagnosis.

## CLINICAL RELEVANCE/APPLICATION

DL based image enhancement methods supporting different types of fast MR acquisitions allow more flexible rapid protocol design to achieve more efficient clinical workflow or improved image quality for clinical diagnosis.

## S3B-SPPH- Assessing Racial and Age-Related Fairness in Chest X-Ray Classification Algorithms 4

Yonghan Ting, FRCR (*Presenter*) Nothing to Disclose

## PURPOSE

Evaluate bias in two commercial (AI1, AI2) and one academic (AI3) chest x-ray classification algorithms. Estimate the fairness of these algorithms for different age and racial groups using the Aequitas package.

## METHODS AND MATERIALS

- 500 anonymized chest x-rays were collected from patients aged above 18, across 6 races at an academic hospital center in Singapore.
- Ground truth was established by an experienced radiologist.
- X-rays were analyzed by two commercial and one academic CXR classification model for normal-abnormal classification on the CARPL.AI platform
- Aequitas package preloaded on this platform was used to evaluate algorithm performance on metadata classes, including age group and race, with reference groups selected based on the majority population characteristics.
- False negative rate (FNR) metric was used to calculate inter-class scores of bias.

## RESULTS

- For age, AI1 showed FNR disparity for patients aged 48-99; AI2 showed FNR disparity for patients aged 19-31 and 48-99; AI3 showed FNR disparity across all age groups.
- For race, at a 60% disparity intolerance, FNR parity was observed for Chinese and Indian populations in AI1 and AI2, respectively; AI3 demonstrated FNR parity for Chinese and Malay groups.

## CONCLUSION

The study found the AI algorithms to have racial parity but at a reduced tolerance range. Both algorithms showed a certain degree of FNR disparity for certain age groups. We propose including bias evaluation as a core component of every AI solutions' validation pipeline.

## CLINICAL RELEVANCE/APPLICATION

By identifying disparities in the performance of these algorithms across different age groups and racial backgrounds, our findings can inform clinicians, healthcare institutions, and algorithm developers about the limitations and potential risks associated with the current AI-based diagnostic tools.

## S3B-SPPH- Improving Reconstruction in Accelerated MRI via Transferable Deep Learning

5

Yuxiang Zhou, PHD (*Presenter*) Nothing to Disclose

## PURPOSE

The objective of this study is to develop an attentive feature refinement-based transfer learning approach for vendor transfer in medical image, which will allow any pre-trained model to transfer knowledge across domains and adapt to novel domains with relatively limited datasets.

## METHODS AND MATERIALS

Variational Feedback Network (VFN) was adopted as the base architecture to conduct and evaluate the effectiveness of our proposed transfer learning strategy. We extend the transfer learning capability of VFN beyond existing transfer learning methods (i.e., pretrained weights finetuning) by selecting pretrained features that benefit reconstruction quality. To enable knowledge transfer from the source dataset to refine target tasks, we exploit the high-level features of reconstructions from VFN network. To refine the subsampled k-space, we propose a feature extraction and refinement (FER) module. We use more than 400 T1-weighted MRI ACR phantom images collected from MAGNETOM Skyra 3.0T (SIEMENS Healthcare) and Discovery 750W 3.0T (General Electric HealthCare) scanners as our two domains and analyze the transfer in both directions.

## RESULTS

The images were reconstructed with an acceleration factor of 4. Five AI models were developed in this study and tested on GE phantom dataset. The first model was trained with SIEMENS ACR data (400 samples) using the basic VFN network. The second model was trained with GE ACR data (100 samples) using the basic VFN network. The third model was trained with SIEMENS + GE ACR data (500 samples) using the basic VFN network. The fourth model was trained based on model 1 but fine-tuned with GE dataset without feature supervision. The fifth model was trained based on model 1 but fine-tuned with GE dataset with a feature extractor. The reconstruction quality is compared across implicit and explicit transfer learning methods. The testing results for GE 5 dataset of PSNR are 35.7 +/- 13.05, 43.73 +/- 15.6, 44.16 +/- 13.06, 42.61 +/- 13.76, 44.72 +/- 16.38, and SSIM 0.9024 +/- 0.12, 0.9718 +/- 0.06, 0.9806 +/- 0.03, 0.9631 +/- 0.08, 0.9893 +/- 0.09 for the above 5 models.

## CONCLUSION

Our study indicates that the reconstruction quality by using our newly developed feature refinement-based transfer learning is significantly better than those reconstructed with conventional Variational Feedback Network (VFN) with limited datasets.



## CLINICAL RELEVANCE/APPLICATION

This study established and tested a new DL model of feature refinement-based transfer learning with strong ability to handle data heterogeneity and variability at speeding up MRI scans up to 4~8 times faster. This method will be able to shorten clinical MRI scan time for improved patient experience and reduced cost while maintaining the quality for diagnosis.

### S3B-SPPH- Viability of an AI-enabled 0.5T Scanner to Improve MR Access 6

Arjun Narula, MBBS, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Access to MRI is known to have improved clinical outcomes. However, it is limited to high economic regions due to high cost, lack of infrastructure and unavailability of skilled labor. Lower field strength MRI along with lower gradient and RF specifications will reduce cost and infrastructure requirements. However, image quality from these derated systems have historically not been sufficient for clinical use. Recent developments in image acquisition and reconstruction with artificial intelligence (AI) could enable improvement of quality of images obtained from such systems to make it clinically viable. This abstract tests the hypothesis that an AI-enabled 0.5T system with low gradient and RF power would provide clinically sufficient information compared to a conventional 1.5T clinical scanner.

#### METHODS AND MATERIALS

Routine brain and cervical spine exams were collected from 197 patients (1188 series in total) on 0.5T, low gradient and low RF AI-enabled scanner with custom made 14-channel HNU coil. The same patients were also scanned on a commercial 1.5T scanner. The scan duration of the 0.5T AI-enabled scanner was comparable to the clinical scanner and at the most less than 2 times the clinical scanner's scan duration. Comparisons were made to study the clinical sufficiency for diagnosis of the AI-enabled 0.5T scanner images to those obtained from 1.5T scanner by at least 4 radiologists from a pool of 10 global radiologists. The radiologists rated the images on a Likert scale between 1 and 9 (1: clinically useless, 5: diagnostic quality, 9: better than reference).

#### RESULTS

The 0.5T scans were rated on an average as  $6.11 \pm 1.2$ ; significantly above diagnostic quality 5 ( $p < 1e-4$ ). On a subset of the data, conventional (non-AI) reconstructed images were compared with AI-reconstructed images. AI reconstruction significantly improved ( $p < 1e-14$ ) the rating average by  $2 \pm 0.96$  points on the Likert scale. Only a total of 81 series out of 1188 obtained an average rating below 5 (diagnostic) and were mostly due to motion artefacts. The rest were due to poor acquisition parameter choices in the early phase of the study.

#### CONCLUSION

This study has shown that AI-based image quality improvement can enable head and c-spine images from a 0.5T system to be diagnostically sufficient. Further assessment on other anatomies and additional AI methods for acceleration is required.

## CLINICAL RELEVANCE/APPLICATION

AI-enabled low-field systems can provide diagnostic image quality similar to clinically accepted 1.5T scanners and has good potential to help improve access of MRI to underprivileged regions.

### S3B-SPPH- Improving Juxta-vascular Pulmonary Nodule Detection Capability Using a Deep Learning-based AI Detection System in Low-dose Computed Tomography (LDCT) 7

Fang Wang, PhD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the performance of a deep learning computer aided diagnostic (CAD) system to improve detection rate for juxta-vascular pulmonary nodules in LDCT.

#### METHODS AND MATERIALS

104 healthy patients who underwent low-dose chest CT screening using a 256slice wide-detector CT (Revolution, GE Healthcare) were enrolled. Protocols were adjusted so that effective dose was set to approximately 1.5 mSv. All DICOM images were sent to a deep learning (DL) computer aided diagnostic system (InferRead CT Lung Research, Infervision) for automatic pulmonary nodule detection. Three methods were used to read the images. Method A: Independent reading of axial images by two radiologists to detect juxta-vascular pulmonary nodule (JVPN) reaching consensus. Method B: DL assisted reading result was analyzed by radiologists to judge whether they were JVPN. Method C: Based on method B results, radiologists read the films by combining the axial images. The total number and locations of nodules for each patient detected in each method were recorded. Two senior chief radiologists' consensus readings were used as the gold standard nodules. The detection rate and false positive rate of each method were calculated respectively.



## RESULTS

216 JVPNs were confirmed as gold standard. In method A, 158 nodules were detected, among which 156 were true positive JVPNs; in method B, 215 nodules were detected, among which 190 were true positive JVPNs; In method C, 212 nodules were detected, among which 208 were true JVPNs. In method C, the detection rate of all JVPNs was 96.29% which was higher than that in method A and B (72.22% and 87.96). The false positive rate for juxta-vascular pulmonary nodules detected by method C (4%) was significantly lower than that by method A (12%) and B (24%).

## CONCLUSION

The screening method of image reading combined with DL-CAD results interpreted by radiologists significantly improves the detection rate and reduce false positive rate of juxta-vascular pulmonary nodules in LDCT screening.

## CLINICAL RELEVANCE/APPLICATION

Reading combined with DL-CAD results interpreted by radiologists can improve the detection efficiency of juxta-vascular pulmonary nodules which could be used as a preferred method for LDCT screening of pulmonary nodules in high risk patients.

## **S3B-SPPH- Towards a Fully Autonomous Artificial Intelligence Volume-rendered Segmentation Workflow for CT Angiography of the Thoracic Aorta**

Ahmed S. Negm, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Three-dimensional (3D) surface rendering enables global qualitative assessment of aortic anatomy. Generating a surface model for 3D visualization requires time-consuming manual or semi-automated segmentation, taking an average of 32 minutes per case at our institution. This amounts to 2.74 FTE of 3D lab technologist time. To decrease manual effort, we developed a deep learning model to automate aortic segmentation and 3D surface model creation from CTA images, integrating an artificial intelligence (AI)-assisted workflow into the clinical practice. We then compared the visual quality of AI-assisted and fully automated surface renderings of the thoracic aorta.

### METHODS AND MATERIALS

An AI model was trained on 304 manually created segmentation maps created for clinical purposes at our institution. Processing time for the AI model was 6 minutes with GPU acceleration. In this IRB-approved study, we retrospectively analyzed the visual quality of 25 3D surface renderings for CTAs acquired at a single center. Twenty-five sets of renderings were then blindly assessed by two experienced cardiovascular radiologists, comparing deep learning segmentations to those that had been manually adjusted by an experienced 3D lab technologist. Comparisons were made using a 5-point Likert scale and covered multiple anatomic features as well as overall quality.

### RESULTS

The renderings based on the AI-only segmentations were assessed to be equivalent to the AI-corrected renderings ( $p \geq 0.19$ ) across all anatomic regions except for the coronary arteries ( $p = 0.06$ ), which favored the AI-corrected results. The coronary arteries are not consistently segmented across all exams, which may have caused the model to underperform in these features. The overall reader agreement was very good (Gwet AC1 = 0.68).

### CONCLUSION

Fully automated AI-based segmentation of the thoracic aorta produces 3D renderings of equal quality compared to the existing manual process, which may allow for significant time savings by fully automating 3D postprocessing.

### CLINICAL RELEVANCE/APPLICATION

An AI-only workflow yielded similar image quality for thoracic aorta segmentation indicating the potential to fully automate thoracic aortic CTA post-processing.

## **S3B-SPPH- Validation of the QuCAD Evaluation Tool to Quantify Wait-Time-Savings from a Computer-Aided Triage and Notification (CADt) Device**

Berkman Sahiner, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

This work validates our queueing theory-based QuCAD evaluation tool designed to quantify the wait-time savings that a computer-aided triage and notification (CADt) device may bring to chest CT and chest CT angiography (CTA) pulmonary embolism (PE) STAT cases from a tertiary academic medical center.

## **METHODS AND MATERIALS**

To validate the QuCAD evaluation tool, we retrospectively retrieved clinical reader timestamp data to characterize radiologists' work queue via the number of readers, image inter-arrival time to the PACS, and radiologists' effective reading time. The effective reading time of each radiologist was defined as the time between the opening of two consecutive readings. An exponential curve is fit to the distributions of inter-arrival times and effective reading times. We compared the wait-time savings predicted by QuCAD with the mean difference in clinical turnaround time from data before and after CADt adoption. Turnaround time is defined as the time from when an image entered the PACS to when the first review is completed by a radiologist. We stratified this comparison by cases arriving between 8am and 5pm (day shift) and those between 5pm and 8am (night shift).

## **RESULTS**

Between 2019 and 2022, 9,864 chest CT/CTA PE STAT cases were reviewed by 70+ radiologists. On average, 2 to 3 readers reviewed images at a given timepoint. The overall case arrival rate was 0.327/min, and the mean effective reading times were 20.1 min for positive PE studies and 14.9 min for negative PE cases. When having 2, 3, and 4 radiologists reviewing images, QuCAD predicts wait-time-savings for positive PE cases to be 14.9 min [95% CI: 13.3, 16.8], 1.27 min [1.00, 1.54], and 0.25 min [0.16, 0.33] respectively. From positive clinical PE cases, the mean difference in turnaround time before and after the use of CADt is 22.9 min during day shift hours. During night shift hours, the mean turnaround time difference drops to 8.26 min.

## **CONCLUSION**

Using 4 years of workflow data from a tertiary academic medical center, this study successfully validated the QuCAD tool designed to quantify potential wait-time-savings a CADt can bring to positive findings. Despite a large variability in clinical workflow, wait-time saving predictions from QuCAD estimates align with the turnaround time reduction from the clinical data.

## **CLINICAL RELEVANCE/APPLICATION**

CADt devices use artificial intelligence (AI) to process patient images and prioritize cases with suspected findings. Previous work developed an evaluation tool (QuCAD) that quantifies the time-saving benefits via queueing theory. This study validated QuCAD using timestamp data from a real clinic. QuCAD is now publicly available for evaluating the time-saving benefits of CADt devices.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-SPVA

### Vascular Imaging Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **S3B-SPVA- Improving Image Quality of Blood Vessels through Deep Learning-Based Denoising and Enhancement Method Based on Low-Energy DSA** 1

Ruizhi Hou (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This work investigates the feasibility and efficacy of a novel approach that combines low-energy digital subtraction angiography (DSA) images with a new denoising and enhancement framework for improving the image quality of blood vessels while reducing ionizing radiation during surgical procedures.

#### **METHODS AND MATERIALS**

Between December 2021 and December 2022, 140 patients participated in a retrospective study on DSA intervention therapy for cerebral arteries, renal arteries, coronary arteries, and lower limb arteries. The study had IRB approval and waived written consent. These patients were randomly divided into training, validation, and test sets, with 98, 14, and 28 patients, respectively. The denoising and enhancement network framework consisted of a noise estimator, a denoising network, and a refinement network. The network was trained using only the noisy DSA image for joint denoising and enhancement. An ROI measuring 256 x 256 was placed over the arterial angiography region, with the non-angiographic region serving as the background. Measurements of pixel values and standard deviation were taken for the artery, and the signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated for the ROI region. The image quality was assessed using the Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index Measure (SSIM). Images obtained through low-energy transmission with deep learning-based denoising and enhancement were assigned to the prediction group, while images obtained through normal-energy X-ray fluoroscopy were assigned to the ground truth group for objective evaluations.

#### **RESULTS**

Effective use of deep learning techniques can reduce image noise and increase CNR and SNR. Low-energy DSA, when combined with denoising and enhancement network (PSNR:  $40.72 \pm 2.85$ dB; SSIM:  $0.9370 \pm 0.0440$ ; SNR:  $34.86 \pm 3.46$ ; CNR:  $5.10 \pm 4.48$ ), proves to be superior to low-energy DSA (PSNR:  $26.05 \pm 0.03$ dB; SSIM:  $0.3770 \pm 0.0436$ ; SNR:  $20.71 \pm 1.19$ ; CNR:  $2.37 \pm 2.56$ ); A single image of 1024 x 1024 with a processing speed can be achieved in 0.051 seconds.

#### **CONCLUSION**

Low-energy DSA combined with deep learning denoising and enhancement techniques can enhance the contrast between arteries and surrounding tissues, optimize the quality of arterial images, reduce noise, and maintain real-time efficiency.

#### **CLINICAL RELEVANCE/APPLICATION**

Combining low-energy DSA with deep learning denoising and enhancement techniques can effectively reduce noise and enhance the shape of displayed arteries in real time, providing valuable assistance for various interventional procedures in clinical practice.

#### **S3B-SPVA- Quantitative Analysis of Lower Extremity Muscle Features Measured from Computed Tomography Angiography for Diagnosis of Peripheral Arterial Disease** 2

Ge Hu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore whether lower extremity muscle features can be used for the diagnosis of peripheral arterial disease (PAD).

## **METHODS AND MATERIALS**

Data of patients with PAD who visited our hospital between July 2016 and September 2020 were retrospectively collected. Two radiologists evaluated PAD severity on digital subtraction angiography (DSA) and computed tomography angiography (CTA) images using the runoff score. With the DSA score as reference standard, the patients were divided into two groups: mild PAD (DSA score = 7) vs. severe PAD (DSA score > 7). After segmenting lower extremity muscles from CTA images, 95 features were extracted for: univariable analysis, logistic regression model (LRM) analysis, and sub-dataset analysis (to verify whether PAD diagnosis can be realized through only part of the lower leg images).

## **RESULTS**

A total of 56 patients (69±11 years; 38 men) with 56 lower legs were enrolled in this study. The lower leg muscles of the mild PAD group (36 patients) showed higher CT values (44.6 vs. 39.5,  $P < 0.001$ ) with smaller dispersion (35.6 vs. 41.0,  $P < 0.001$ ) than those in the severe PAD group (20 patients). The area under the curve (AUC) of the CTA score, LRM-I (model constructed with muscle features), and LRM-II (model constructed with muscle features and CTA score) for PAD diagnosis were 0.81, 0.84, and 0.89, respectively. The highest diagnostic performance was observed in the image subset of the middle and inferior segments of the lower extremity (LRM-I, 0.83; LRM-II, 0.90).

## **CONCLUSION**

Lower extremity muscle features can be used for PAD diagnosis.

## **CLINICAL RELEVANCE/APPLICATION**

Quantitative analysis of lower extremity muscle features can be a useful supplement to the current clinical imaging diagnosis methods of PAD and compensate for the limitations of vascular stenosis diagnosis from the perspective of muscle ischemia evaluation.

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## Abstract Archives of the RSNA, 2023

T2-SPBR

### Breast Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPBR-1 Federated Deep Learning Model Predicts Breast Cancer Risk from Mammography Images**

Daly B. Avendano, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To externally validate Mirai, a DL breast cancer risk model based on mammography studies, applied in the Hispanic population with two distinct mammography vendors, utilizing a federated learning approach.

##### **METHODS AND MATERIALS**

This study retrospectively reviewed a database of 58,321 consecutive screening mammograms obtained from 24,060 women who received care at the TecSalud health system between January 1, 2014, and December 31, 2021. The Mirai model was utilized without the need for data sharing, using a federated learning approach. Cancer outcomes were obtained through the institutional tumor registry or imaging follow-up. The primary objective of this study was to evaluate the performance of the Mirai model in predicting the risk of breast cancer at 1-5 years from the time of the mammogram. We assessed the C-index as a measure of predictive accuracy.

##### **RESULTS**

Among the 23,340 patients with breast cancer-negative mammograms, 23,170 had no evidence of cancer in the following 5 years, while 170 were diagnosed with cancer during this timeframe. Mirai's performance was evaluated using a concordance index, which was found to be 0.74 (95% CI 0.71 to 0.77).

##### **CONCLUSION**

Our evaluation of MIRAI risk predictions indicates that the model is well calibrated, with an accurate accumulation of risk and estimations of risk over time. Our findings demonstrate that MIRAI's predictions align well with the observed number of events among both the full patient cohort and the case-matched control group.

##### **CLINICAL RELEVANCE/APPLICATION**

Breast cancer risk assessment is the angular stone for personalized screening. Artificial intelligence models have demonstrated promising results. The use of fair algorithms is essential for accurately assessing the overall population and avoiding the underrepresentation of minority groups. To enhance the effectiveness of these algorithms and ultimately lead to better outcomes. By adopting these practices, we can establish more equitable and inclusive systems that benefit everyone.

#### **T2-SPBR-2 Comparison of Quantitative Volumetric and Subjective BI-RADS Density Classification in Women with Dense Breasts**

Stuart S. Kaplan, MD (*Presenter*) Advisory Panel, Hologic, Inc; Advisory Panel, Delphinus Medical Technologies, Inc

##### **PURPOSE**

Increased breast density is an independent risk factor for breast cancer. A radiation-free tool for breast density assessment would be advantageous, especially for younger women. The purpose of this study was to determine the level of agreement between automated breast density based on whole breast ultrasound tomography volumetric data and commercially available volumetric breast density from 3D mammography in dense breasts. We examined agreement of quantitatively derived BI-RADS density from these two modalities with subjective mammography density assessment by breast radiologists and technologists.

## **METHODS AND MATERIALS**

448 women with heterogeneously or extremely dense breasts were enrolled in a prospective case collection registry between December 2016 and October 2019. Participants underwent their annual screening digital breast tomosynthesis (DBT) (Hologic) and same day SoftVue™ automated whole breast ultrasound tomography (SV). Technologists assessed breast density using the BI-RADS density composition scale. Radiologists interpreted the mammogram and SV simultaneously and included a final BI-RADS density assessment. Quantitative volumetric density data was gathered for each case from mammography with Volpara and from SV. The Volpara overall score was used. The SV density index, a number from 0 to 100 derived from the volume-averaged sound speed, was recorded for each breast and categorized as a through d. The densest rating from the two breasts was selected. Four-way and pairwise agreement was tested using Kendall's coefficient of concordance (W). Additional analysis was completed for the disagreement cohorts.

## **RESULTS**

In women with dense breasts, there was statistically significant good agreement between SV, Volpara, the radiologists' and technologists' BI-RADS density assessments. When SV was analyzed with each of the 3 other methods, there was statistically significant agreement with slightly higher concordance values. The SV BI-RADS was at a lower density level than Volpara in 12.1% of cases and at a higher density level in 13.3%.

## **CONCLUSION**

SV density index, algorithmically calculated from whole breast ultrasound transmission data, has good agreement with automated breast density assessments using 3D mammography. SV breast density index is comparable with both radiologist and technologist subjective BI-RADS assessments from mammography.

## **CLINICAL RELEVANCE/APPLICATION**

SV's ultrasound breast density offers accuracy comparable with DBT-based tools or rating by radiologists and technologists. Clinical risk assessment using breast density may be applied, especially to women under age 40, without unnecessary radiation.

## **T2-SPBR-3 Association of Breast Density Measured on Low-dose Chest Computed Tomography with Subsequent Breast Cancer Risk in Screened Population**

Hyo-Jae Lee (*Presenter*) Nothing to Disclose

## **PURPOSE**

Few studies identified the relationship between CT breast density and breast cancer risk, often with limited numbers of study cohorts and based on computer-aided quantitative methods which require laborious inputs by a trained user. This study aimed to determine the association between CT breast density grading by radiologists and breast cancer risk in a large screened population, furthermore the results were compared with mammographic density.

## **METHODS AND MATERIALS**

In a retrospective cohort study using screened population in a tertiary hospital, women aged at least 40 years without a history of cancer who underwent both mammographic screening and low-dose chest CT in 2007-2016 were followed up through December 2022. Two board-certified radiologists with each special expertise in mammography and CT independently reviewed the breast density on mammography and CT images and classified each case into one of the four BI-RADS grades. The primary outcome focused on the occurrence of new cases of breast cancer, including both invasive breast cancer and ductal carcinoma in situ. The hazard ratio (HR) was calculated using Cox proportional hazard regression and adjusted for other covariates. To compare the relationship between breast densities on mammography and CT, the Spearman's correlation coefficient was adopted. Interreader agreements for the mammographic density and CT density grades were determined by using the Cohen weighted kappa statistic.

## **RESULTS**

Among 1576 women (mean age, 65 years  $\pm$  9), the ascertainment of 17 incident breast cancers was obtained. CT density grade 4 showed a higher risk of breast cancer compared with those with grade 1 and 2 (HR, 10.502 [95% CI:1.227, 89.918],  $p = 0.032$  for reader 1; 6.368 [1.227, 33.049],  $p = 0.028$  for reader 2). There was a significant correlation on breast density between mammography and CT ( $r = 0.770$  and  $0.941$ , for reader 1 and 2, respectively) and the interreader agreement was good ( $\kappa = 0.613$  and  $0.701$ , for mammography and CT, respectively).

## **CONCLUSION**

In this preliminary result, CT density provided future breast cancer risk information and correlated well with that from mammography.

## **CLINICAL RELEVANCE/APPLICATION**

Low-dose chest CT scans for lung cancer screening can estimate breast density without sacrificing interreader agreement, and have an association with breast cancer risk, promising for future research on dedicated breast CT scans.

## **T2-SPBR-4 Early Adulthood Adiposity, Attained Adiposity and Breast Parenchymal Complexity in Premenopausal Women**

Sneha Das Gupta, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Adiposity measures such as weight, body-mass index (BMI) and body fat% are associated with breast cancer risk. We assessed the relationship of breast parenchymal complexity with early adulthood adiposity, changes in adiposity over the life course, and attained adiposity among premenopausal women, while also accounting for breast density.

### **METHODS AND MATERIALS**

We analyzed routine screening digital mammograms (Selenia Dimensions; Hologic) from 325 premenopausal women without breast cancer, recruited at the Joanne Knight Breast Health Center, Washington University in St. Louis, MO from December 2015 to October 2016. Trained research personnel assessed attained adiposity measures, while weight at ages 18 and 30 were self-reported. A wide array of radiomic features were automatically extracted from each mammogram using a validated computational imaging pipeline, standardized, and fused into a breast parenchymal complexity signature (BPCS). Volumetric percent density (VPD) was calculated using the Volpara software. Spearman correlations ( $r$ ) and multivariable linear regression models were used to evaluate the associations of adiposity measures with BPCS, adjusting for potential confounders (age, race, family history of breast cancer and parity) and VPD.

### **RESULTS**

BPCS was moderately correlated ( $r = 0.61$ ) with VPD. Higher BPCS was significantly ( $p < 0.05$ ) associated with lower weight and BMI at age 18 and at age 30, independently of age, race, family history of breast cancer and parity; inverse associations with BPCS were also found for absolute and annual weight changes between age 18 and attained age as well as between age 30 and attained age ( $-0.60 < r < -0.15$ ; linear regression coefficients ( $b$ ) for adiposity measures ranging from  $-0.672$  to  $-0.008$ ). Attained weight, BMI and body fat were also significantly inversely associated with BPCS. When further adjusting for VPD, statistical significance was preserved, yet slightly attenuated, for most adiposity measures ( $-0.60 < r < -0.25$ ;  $-0.498 < b < -0.012$ ). Among all adiposity measures, strongest associations with BPCS were preserved for annual weight change from age 18 to attained age and annual weight change from age 30 to attained age.

### **CONCLUSION**

Our preliminary data suggest that adiposity in early adulthood, as well as weight gain from early adulthood to attained age are inversely associated with breast parenchymal complexity among premenopausal women, and may have a lifelong impact on breast parenchymal tissue patterns, beyond breast density.

### **CLINICAL RELEVANCE/APPLICATION**

Deeper understanding of the pathways through which early-adulthood adiposity modifies breast parenchymal tissue, and possibly breast cancer risk, can open new avenues for preventive interventions in premenopausal women.

## **T2-SPBR-5 Predictive Performance of a Deep Learning Image-Based Five-Year Breast Cancer Risk Model Across Race/Ethnicity, Age, Breast Density and Family History of Breast Cancer**

Hari Trivedi, MD (*Presenter*) Founder, Lightbox AI ; Consultant, Sirona Medical, Inc ; Consultant, Flatiron Health ; Consultant, PMX Inc ; Research support, Kheiron Medical Technologies ; Research support, Clairity, Inc ; Research support, Nightingale Open Science ;

### **PURPOSE**

Traditional breast cancer risk models demonstrate modest predictive accuracy and are limited by worse performance in races/ethnicities outside of European Caucasian ancestry. We measured the performance of a deep learning (DL) image-based five-year breast cancer risk model across race/ethnicity, age, breast density, and family history of breast cancer.

### **METHODS AND MATERIALS**

This retrospective study included 31,047 consecutive bilateral 2D full field digital screening mammograms from 11,536 patients from January 2011 through December 2016 from six screening facilities. These exams were not part of model training. Self-reported race and ethnicity were categorized as Black, Asian, Hispanic, White, or as all other races and ethnicities. To account for the large number of White, non-Hispanic patients, race and ethnicity were further classified as White/non-Hispanic (W/NH) or as patients of color and/or Hispanic ethnicity (POC/H). Age ( $<50$  vs  $>50$ ), breast density (dense vs not dense), and first-degree family history of breast cancer were extracted from electronic medical records. Cancer outcomes were obtained from local tumor registries and included DCIS and any invasive breast cancer. Model prediction was estimated across subgroups using areas under the receiver operating characteristic curve (AUCs).



## RESULTS

We found point estimate AUCs consistently at or above 0.73 across all subgroups. AUC by subgroup: W/NH 0.75 [95% CI 0.73, 0.77] (n = 27,323), POC/H 0.75 [95% CI 0.68, 0.82] (n = 2,529); age < 50 0.73 [95% CI 0.70, 0.76] (n = 13,742), age ≥ 50 0.74 [95% CI 0.72, 0.77] (n = 16,110); dense 0.75 [95% CI 0.75, 0.76] (n = 17,146), not dense 0.79 [95% CI 0.78, 0.80] (n = 13,052); 1st degree relative with breast cancer 0.77 [95% CI 0.73, 0.80] (n=6,713), 1st degree relative without breast cancer 0.79 [95% CI 0.76, 0.83] (n=10,618), 1st degree relative with breast cancer (unknown) 0.76 [95% CI 0.74, 0.78] (n=13,172).

## CONCLUSION

The DL model performed consistently at or above 0.73 AUC in all subgroups of race/ethnicity, age, breast density and first-degree family history of breast cancer. No differences in performance were identified in patients identifying as POC/H compared to those identifying as W/NH. Performance was significantly higher in not dense vs dense exams. No significant differences were found between other subgroups. This DL image-based model appears to reduce differences in performance associated with traditional risk models.

## CLINICAL RELEVANCE/APPLICATION

A DL based breast cancer risk prediction model can perform consistently across key patient subgroups and appears to reduce limitations of traditional risk assessment, such as differences in performance across race/ethnic groups.

## T2-SPBR-6 Artificial Intelligence for Mammography to Predict Future Breast Cancer Risk : Incorporating Longitudinal Changes to Enhance a Feasibility

Sanghyup S. Lee, MD (*Presenter*) Employee, Lunit Inc

## PURPOSE

To investigate mammographic parenchymal patterns and longitudinal changes that are related to breast cancer beyond the mammographic breast density and develop an artificial intelligence (AI) model to predict future breast cancer risk.

## METHODS AND MATERIALS

We developed a mammography-based deep learning algorithm for an AI predictive model to show the risk score for future breast cancer. risk model using a total of 16,113 full-field digital mammograms (Hologic, 72.3%; Siemens, 27.7%) from 9,113 women in the United States, who underwent at least mammogram and have information of pathology-confirmed breast cancer outcomes within 5 years. To discover the feasibility of incorporating prior images to train longitudinal changes of mammographic parenchymal patterns, the baseline model (AI-1) trained prior mammograms of non-cancer women and women with breast cancer, respectively, and the other model (AI-2) additionally trained with paired current and prior examinations per woman. Discriminatory performance was assessed using C-indices and receiver operating characteristic (ROC) curves for 1- to 3-year outcomes. Mammographic breast density was evaluated for each mammogram according to the BI-RADS composition category.

## RESULTS

A total of 2,000 examinations, of which 500 cases were followed by a cancer diagnosis were evaluated with two AI predictive models. C-indices increased from 0.68 (95% CI: 0.65, 0.71) of AI-1 to 0.73 (95% CI: 0.70, 0.76) of AI-2 (P=0.004). The AI-2 model demonstrated the risk of breast cancer with AUC of 0.75 (95% CI: 0.70, 0.79) at 1-year, 0.76 (95% CI: 0.68, 0.83) at 2-year, and 0.73 (95% CI: 0.68, 0.78) at 3-year. The performance was comparable in fatty (C-index, 0.74; 95% CI, 0.70, 0.78) and dense (0.71; 0.65, 0.76) breasts. 1076 of 2000 examinations showed no longitudinal changes of mammographic density, and the performance of AI-2 for this subgroup was similar (C-index, 0.72, 95% CI, 0.70, 0.76) to the overall performance.

## CONCLUSION

This preliminary study demonstrated the feasibility of the AI predictive model to identify mammographic parenchymal features of future breast cancer. Incorporation of longitudinal changes might be feasible to enhance risk stratification of breast cancer.

## CLINICAL RELEVANCE/APPLICATION

The image-based risk model has a potential to be used to improve personalized screening of breast cancer.

## T2-SPBR-7 Performance of Traditional Breast Cancer Risk Models Compared to a Deep Learning Model Overall and by Race/Ethnicity

Hari Trivedi, MD (*Presenter*) Founder, Lightbox AI ; Consultant, Sirona Medical, Inc ; Consultant, Flatiron Health ; Consultant, PMX Inc ; Research support, Kheiron Medical Technologies ; Research support, Clarity, Inc ; Research support, Nightingale Open Science ;



## PURPOSE

To compare the performance of traditional breast cancer risk models to a new deep learning (DL) image-based five-year breast cancer risk model overall and by race/ethnicity.

## METHODS AND MATERIALS

This retrospective study included 10,101 consecutive bilateral 2D full field digital screening mammograms from 8,688 patients from February 2015 through December 2016 from a U.S.-based center that operates six screening facilities. Patient race/ethnicity and traditional risk model scores (Breast Cancer Risk Assessment Tool [BCRAT] and Tyrer-Cuzick v6 [TC6]) were extracted from electronic medical records. Patient self-reported race/ethnicity was used to create two groups: White, non-Hispanic (W/NH) and patients of color and/or Hispanic (POC/H). Cancer outcomes were obtained from local tumor registries. Cancer rates were defined as total cancers (DCIS and any invasive cancer) diagnosed within five years after the index mammogram/total exams. Model predictions were estimated using areas under the receiver operating characteristic curve (AUCs) and compared across risk models overall and by race/ethnicity using Chi-squared tests. NCCN thresholds were used to categorize predicted five-year risk scores as follows: average risk < 1.7%, intermediate risk > 1.7% and < 3.0%, and high risk > 3.0%.

## RESULTS

DL model five-year predictions significantly outperformed BCRAT and TC6 five-year predictions. Overall AUC [95% confidence interval] and number of exams (n) by risk model: DL 0.75 [0.72, 0.77] (n = 10,101), BCRAT 0.62 [0.59, 0.65] (n = 10,101), and TC6 0.59 [0.56, 0.62] (n = 10,101). Observed five-year cancer rates by race/ethnicity: W/NH 4.4% and POC/H 4.2%. Predictions by BCRAT and TC6 models, but not DL model, exhibited statistically significant differences across race/ethnicity groups. Comparing risk group distributions for W/NH to POC/H generated chi-squared statistic and p-values of: BCRAT 162.36 (p<.00001), TC6 84.49 (p<.00001), DL 0.954 (p=.621). Compared to POC/H, W/NH patients were 3.8 times more likely to be labeled high risk by BCRAT and 2.3 times more likely by TC6. The DL model assessed a nearly identical percentage of W/NH and POC/H as high risk.

## CONCLUSION

An image-based DL model outperformed traditional risk models in predicting five-year breast cancer risk. Traditional risk models exhibited meaningful differences in performance across race/ethnicity that was not observed in the DL model.

## CLINICAL RELEVANCE/APPLICATION

A deep-learning based approach to breast cancer risk prediction outperforms traditional risk models and appears to remove differences in performance observed across racial/ethnic groups associated with traditional risk models

## T2-SPBR-8 Cryoablation, Ultraconservative Treatment for Low-risk Early Breast Cancer ≤2cm: Analysis of its Efficacy

Maria Jose Roca Navarro, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate if in patients with Her2- luminal tumors =2cm and ultrasound negative axilla, after cryoablation guided by ultrasound, there is absence of infiltrating carcinoma in the lumpectomy specimen. To demonstrate that the placement of pre-surgical seed at the moment prior to cryoablation does not interfere subsequently in the disappearance of tumor cells by freezing.

## METHODS AND MATERIALS

Between April 2021 and March 2023 we performed preoperative cryoablation in 49 patients (aged 53-79 years) with 50 unifocal infiltrating ductal carcinomas (IDC) (between 4mm and 20mm). All IDCs were visible on ultrasound, were luminals low grade and ultrasound negative axilla. All patients were studied with mammography and tomosynthesis, staged and biopsied by ultrasound. MRI was performed to rule out extensive intraductal component in 16 of the 19 patients with associated intraductal carcinoma (DCIs) in the core needle biopsy (CNB). All of them underwent pre-surgical marking with ferromagnetic seed and cryoablation with 17G or 14G needle on the same procedure, taking advantage of the same anesthesia and cutaneous access. We used the ICEfx Galil Boston Scientific cryoablation system, applying the usual triple-phase protocol: freezing-passive thawing-freezing and duration of approximately 40 minutes. Subsequently we checked the correct placement of the seed with mammographic projection

## RESULTS

Out of 50 low-risk unifocal IDC: -31 were pure IDC (without associated intraductal component in the diagnostic CNB): in none there was residual IDC in the lumpectomy specimen after performing pre-surgical cryoablation. -19 were IDC mixed (with associated DCIs in the diagnostic CNB): In 4 cases residual IDC was found in the surgical specimen, with some IDC focus remaining in the periphery of the post-cryoablation necrosis. In 8 patients, DCIs foci were detected far from the cryoablation area. All the specimens were considered by the pathologist to have tumor-free margins. There was no relevant complication.

## CONCLUSION

Cryoablation is effective in 100% of cases for pure infiltrating tumors  $\leq 2$ cm. The presence of nests of DCIs away from the cryoablation area or millimeter foci of IDC at the margin of steatonecrosis in mixed IDC does not indicate failure of the technique, *as all surgical specimens were considered by the pathologist to have tumor-free margins*. Subsequent standard adjuvant treatment will equalize the risk of relapse to conventional lumpectomy, so it may be an alternative therapy in selected patients.

## CLINICAL RELEVANCE/APPLICATION

In the near future, after evaluating studies with a larger number of cases and follow-up, in selected patients with luminal tumors = 2cm, cryoablation could be an alternative therapy thus avoiding surgery.

## T2-SPBR-9 Upgrade of MRI Detected Papillomas in Asymptomatic High Risk Patients, Patients with a History of Cancer, and Patients with Known Malignancy

Kathryn W. Zamora, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose is to evaluate the upgrade of papilloma identified on MRI biopsy in patients with breast cancer and high-risk patients with or without a history of breast cancer.

## METHODS AND MATERIALS

In this HIPAA-compliant IRB-approved retrospective study, all MRI-guided biopsies from 1/1/2011 to 1/31/2020 yielding papilloma were reviewed. Only patients with an imaging indication of high-risk screening, known breast malignancy, or history of breast malignancy were included. Other indications, including breast symptoms such as palpable masses or nipple discharge, were excluded. All included patients had a surgical excision with clear pathology or, at minimum, a 2-year follow-up MRI after biopsy. All cases without surgical excision or imaging follow-up were excluded. All MRI biopsy procedures were performed on a GE 1.5 T magnet using a Suros Atec 9-gauge vacuum-assisted biopsy device.

## RESULTS

Of the initial 258 MRI-guided biopsies demonstrating papilloma, 45.3% (117/263) met inclusion criteria. Of the 141 patients excluded, 90 biopsies were excluded because of breast symptoms. Most examinations, 57% (67/117), were performed for high-risk screening, including a personal history of breast cancer. The other 43% (50/117) of examinations were performed for extent of disease. Of the 117 biopsies, 4.3% (5/117) were upgraded to malignancy. One biopsy (1/117, 0.9%) was upgraded to invasive malignancy and four (4/117, 3.4%) were upgraded to DCIS. Of the 117 biopsies, 31.6% (37/117) demonstrated atypia or additional high-risk pathology at time of percutaneous biopsy while 68.4% (80/117) demonstrated benign papilloma. The upgrade rate of benign papilloma at biopsy was 3.8% (3/80) with all cases non-invasive. The upgrade rate of papilloma with atypia or additional high-risk lesion at biopsy was 5.4% (2/37) with one non-invasive and one invasive malignancy. Age, race, ipsilateral malignancy, lesion type, or additional high-risk lesion at biopsy were not associated with upgrade rate.

## CONCLUSION

Surgical excision of biopsy-proven papilloma identified by MRI biopsy in asymptomatic high-risk patients and patients with known malignancy may not be necessary.

## CLINICAL RELEVANCE/APPLICATION

Excision is often recommended for papillomas in high-risk patients. In these patients with papillomas found on MRI, a low upgrade rate suggests surgical excision may not be necessary.

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## Abstract Archives of the RSNA, 2023

T2-SPCA

### Cardiac Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### T2-SPCA-2 Cardiac Magnetic Resonance Imaging Features of Myocardial Involvement in Psoriasis

Lorenzo Dominici, MD (*Presenter*) Nothing to Disclose

##### PURPOSE

Psoriasis is a systemic chronic inflammatory condition, primarily affecting skin and joints, associated with increased risk of developing major cardiovascular events (MACEs). Inflammatory myocardial involvement in psoriasis (P-IMI) has been reported but not thoroughly investigated. The aim of our study was to describe the findings at cardiac magnetic resonance (CMR) imaging in a series of patients with psoriasis related myocarditis.

##### METHODS AND MATERIALS

One hundred consecutive patients (62M, mean age  $55 \pm 13.7$  years) with psoriasis were screened by 2D echocardiography for cardiac abnormalities. Among them, five male patients showed hypokinetic dilated cardiomyopathy (HDCM). All patients with HDCM underwent invasive coronary angiography (ICA), CMR and endomyocardial biopsies (EMB) with real time PCR for cardiotropic viruses and western blot analysis for myocardial expression of Toll-Like Receptor 4 (TLR-4) and Interleukin-17A (IL-17A). CMR exams were performed on a 1.5 T scanner. Protocol included cine-bSSFP, T2-weighted STIR, T2-prep sequences for T2 mapping, MOLLI sequences for T1 mapping, acquired before and after gadolinium administration and CE T1w IR for late gadolinium enhancement images.

##### RESULTS

All patients presented with heart failure with reduced ejection fraction (HFrEF, EF  $19 \pm 2.8\%$ ), NYHA Class III-IV and various ECG abnormalities. ICA showed normal coronary arteries in all patients. All five patients were diagnosed with acute/subacute myocarditis on CMR imaging according to the updated 2018 Lake Louise Criteria. Among them, two patients showed myocardial edema on T2WI, three patients had positive LGE, while all of them had increased T1 and T2 mapping relaxation times. EMB confirmed imaging findings as an active virus-negative lymphocytic myocarditis was revealed in all patients with positive anti-heart autoantibodies, overexpression of TLR-4 and enhancement of IL-17A at western blot analysis.

##### CONCLUSION

P-IMI is an underrecognized condition in patients with psoriasis, presenting with severe ventricular dysfunction at echocardiography, lymphocytic myocarditis at EMB and with variable myocardial signal abnormalities at CMR.

##### CLINICAL RELEVANCE/APPLICATION

Timely detection of P-IMI is crucial due to its prognostic and therapeutic implications. CMR may play a pivotal role, as a reliable and accurate non-invasive tool to identify myocardial inflammation and ventricular dysfunction.

#### T2-SPCA-3 Left and Right Ventricle Feature Tracking CMR Strain in Patients with Thoracic Sarcoidosis

Juan J. Urbina, MD (*Presenter*) Nothing to Disclose

##### PURPOSE

Patients with sarcoidosis may have clinically silent disease in 20-25%. Early detection of disease is essential for adequate therapy and prevent negative outcomes. This study aims to assess cardiac magnetic resonance (CMR) feature tracking (FT) strain for detection of subclinical cardiac dysfunction in patients with biopsy-proven extracardiac sarcoidosis.

## METHODS AND MATERIALS

This retrospective study included patients who underwent chest CT and CMR examinations for biopsy-proven extracardiac sarcoidosis. For comparison age-matched controls with normal CMR were included. All CMR studies were performed with 1.5T or 3T scanners (Siemens). Chest CT examinations were conducted with 64-256 slice scanners (Siemens, General Electric). CMR used a standard protocol with b-SSFP cine sequences in long (2,3,4chamber) and short axis views for volumes/function analysis. Late gadolinium enhancement (LGE) sequences in the same orientation were performed >10 min after administration of Gadovist (0.1 mmol/Kg). CMR image analysis including strain (Global longitudinal, circumferential, or radial strain) was performed with dedicated software (CVI 42). Chest CT was analyzed by based on established criteria for the diagnosis of sarcoidosis.

## RESULTS

The cohort included 49 patients (58.2±9.5y, 26m). Subgroups were defined by extracardiac sarcoidosis with/without lymph adenopathy and parenchymal disease (+chest) or cardiac involvement (+CMR). Group 1 13/49 (56.7±8.6y, 8m) with +chest/+CMR, group 2 33/49 (57.7±9.4y, 16m) with +chest/-CMR and group 3 3/49 patients (70.3±9.0y, 2m) with -chest/-CMR for sarcoidosis. 10 studies (57.5±12.3y, 6m) served as controls. LVGLS was impaired in all three groups compared to controls. LVGLS was significantly different between Group 1 and controls (-13.0±5.1 vs. 17.9±1, p-value=0.0112) and Group 2 and controls (-13.8±3.3 vs. 17.9±1.7; p-value=0.0124). LVGRS LAX was significantly different between Group 1 and controls (20.6%±9.6 vs. 31%±3.6; p-value=0.0086) and Group 2 and controls (23%±7.2 vs. 31%±3.6 p-value=0.022). Positive LGE was detected in 13 patients: subendocardial 3/13, midmyocardial 6/13, midmyocardial/subepicardial 1/13, subepicardial/transmural 1/13 and subendocardial/midmyocardial/subepicardial in 2/13.

## CONCLUSION

In patients with biopsy-proven extracardiac sarcoidosis independent of cardiac involvement LV GLS and LV GRS are abnormal, even when LVEF is within normal range.

## CLINICAL RELEVANCE/APPLICATION

Therefore, LV strain can be used to detect subclinical LV dysfunction in patients with extracardiac sarcoidosis.

## T2-SPCA-4 Primary Chylopericardium: A Study Based on CT Lymphangiography

Yimeng Zhang (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the diagnostic value of CT lymphangiography (CTL) in primary chylopericardium.

## METHODS AND MATERIALS

The clinical and imaging data of 39 patients with primary chylopericardium were retrospectively analyzed. All patients underwent CTL scan. CTL evaluated abnormal contrast distribution and reflux in the neck, chest, abdomen, pelvis and abnormalities in the pericardium, mediastinum, and lungs. The composition ratio of qualitative data was used for statistical description.

## RESULTS

All 39 patients with CTL showed abnormal iodine oil deposition and reflux at different sites: (1) neck: 11 cases of the end of thoracic duct, 3 cases of the end of right lymphatic duct, 24 cases of cervical trunk reflux, 25 cases of subclavian trunk reflux; (2) chest: 23 cases of bronchial mediastinal trunk reflux, 22 cases of anterior mediastinum, 12 cases of main pulmonary artery window, 29 cases of peritracheal and bronchial, 30 cases of subcarina, 24 cases of posterior mediastinum, 7 cases of thoracic duct trunk reflux, 15 cases of pericardial reflux, 11 of which were transbronchial mediastinal trunk reflux, and 10 cases of abnormal distribution of intercostal, pleural, and Supra-diaphragm. (3) Abnormalities in the abdomen and pelvic region: 4 cases in the subdiaphragm, 18 cases of dilated and condensed iliac lymphatics on the contrast side, 21 cases of contralateral iliac reflux, 16 cases of abnormal distribution of contrast in the ipsilateral lumbar trunk, and 23 cases of contralateral lumbar trunk reflux. Extra-lymphatic manifestations of abnormalities: 39 cases showed fluid density in the pericardial cavity, 2 cases showed cloudy and swollen mediastinal soft tissues, 24 cases showed abnormalities in both lungs, 10 cases showed thickened lobular septa, 11 cases showed ground glass density, 10 cases showed thickened bronchovascular bundles, 5 cases showed thickened bronchial walls, 16 cases showed pleural effusion, and 11 cases showed pulmonary atelectasis or insufficiency. 16 patients were treated surgically and 7 cases were relieved after surgery.

## CONCLUSION

CT lymphangiography can show the abnormalities of thoracic duct and accessory branches in primary chylopericardium, and abnormal lesions of mediastinum, pericardium and lungs in this disease, which can help to explore the pathogenesis, diagnosis and differential diagnosis of this disease.

## CLINICAL RELEVANCE/APPLICATION

Exploring the CTL presentation features of primary chylomicronemia will help the pathogenesis study, diagnosis and differential diagnosis of this disease.

## T2-SPCA-6 Detection of Monosodium Urate Depositions & Atherosclerotic Plaques in the Cardiovascular System by Dual-energy Computed Tomography

Haolin Ren (*Presenter*) Nothing to Disclose

### PURPOSE

This study employed Dual-energy CT (DECT) material separation technology to quantitatively assess the urate accumulated in coronary plaques, and to compare this to the Coronary CTA (CCTA) Calcium score scan for distinguishing urate deposition from atherosclerosis. Additionally, this study aimed to explore the relationship between urate deposition and surrounding atherosclerotic plaques, and to confirm the contribution of urate deposition to the development of coronary atherosclerosis.

### METHODS AND MATERIALS

We investigated the role of dual-energy computed tomography (DECT) in diagnosis of coronary atherosclerotic plaques and urate depositions in the patients with clinically suspected coronary artery disease. The patients were examined with DECT imaging system, and their clinical data were collected.

### RESULTS

DECT showed among 872 patients, 441 patients had plaques in coronary arteries, the incidence of plaque was 50.6%. Among the patients with coronary plaques, there were 348 patients (78.9%) with simple atherosclerotic plaque (AP), 8 patients (1.8%) with simple urate depositions (UD), 85 patients (19.3%) with urate depositions and atherosclerotic plaques (UDAP). Compared with AP group, total plaque area and calcification score around the plaque in UDAP group were significantly increased, and urate deposition areas were correlated with surrounding atherosclerotic area ( $r=0.325$ ,  $p<0.001$ ). Compared with AP patients, cardiac ejection fraction in UDAP patients was slightly decreased ( $p<0.05$ ). There was no statistical difference in blood uric acid concentration and other clinical parameters between two groups.

### CONCLUSION

Notably, patients with gout or a history of hyperuricemia were more likely to exhibit urate deposition in their atherosclerotic plaques. Furthermore, we observed a strong correlation between urate deposition and atherosclerotic plaques with larger volumes and higher calcification. Cardiac ejection fraction in UDAP patients was slightly decreased compared with AP patients.

## CLINICAL RELEVANCE/APPLICATION

DECT may provide a relatively simple method for detection and identification of coronary urate deposition at risk for cardiovascular diseases.

## T2-SPCA-7 Periaortic Adipose Radiomics Texture Features Associated with Increased Coronary Calcium Score: First Results on a Photon-Counting CT

Isabelle Ayx, MD (*Presenter*) Research Consultant, AstraZeneca PLC

### PURPOSE

Cardiovascular diseases remain the world's primary cause of death. Identifying and treating patients at risk of cardiovascular events is as important as ever. Adipose tissue counts as a classic risk factor for cardiovascular diseases. It has been linked to systemic inflammation and is suspected to contribute to vascular calcification. To further investigate this issue, the use of texture analysis of adipose tissue using radiomics features could prove a feasible option.

### METHODS AND MATERIALS

In this retrospective IRB-approved single-center study, 55 patients (mean age 55, 34 male, 21 female) were scanned on a first-generation photon-counting CT. On axial unenhanced images, periaortic adipose tissue surrounding the thoracic descending aorta was segmented manually. Patients were divided into three groups for feature extraction, depending on coronary artery calcification (Agatston Score 0, Agatston Score 1-99, Agatston Score =100). 106 features were extracted using pyradiomics. R statistics was used for statistical analysis, calculating mean and standard deviation with Pearson correlation coefficient for feature correlation. Feature selection was performed using Random Forest classification and visualized using Boxplots and heatmaps. Additionally, monovariate logistic regression predicting an Agatston Score  $> 0$  was performed, selected features were tested for multicollinearity and a 10-fold cross-validation investigated the stability of the leading feature.

## **RESULTS**

Two higher-order radiomics features, namely "glcm\_ClusterProminence" and "glcm\_ClusterTendency" were found to differentiate between patients without coronary artery calcification and those with coronary artery calcification with respective mean values (Agatston Score 0/1-99/=100) of 92.77/79.23/77.05 for "original\_glcm\_ClusterProminence" ( $p = 0.019$ ) and 5.72/5.33/5.24 for "original\_glcm\_ClusterTendency" ( $p = 0.078$ ). As the leading differentiating feature "glcm\_ClusterProminence" was identified after assessing multicollinearity.

## **CONCLUSION**

Changes in periaortic adipose tissue texture seem to correlate with coronary artery calcium score, supporting a possible influence of inflammatory or fibrotic activity in perivascular adipose tissue. Radiomic texture features may potentially aid as corresponding biomarkers in the future.

## **CLINICAL RELEVANCE/APPLICATION**

The possible correlation between PAAT texture and coronary artery sclerosis may allow the hypothesis of possible texture changes through inflammatory or fibrotic processes in perivascular adipose tissue influencing the process of arteriosclerosis. A radiomics signature could serve as an imaging biomarker for cardiovascular prevention in the future.

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## Abstract Archives of the RSNA, 2023

T2-SPCH

### Chest Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPCH-1 Baseline Whole-lung CT Features Deriving from Deep Learning and Radiomics: Prediction of Benign and Malignant Pulmonary Ground-glass Nodules**

Wenjun Huang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate the model for predicting benign and malignant ground-glass nodules (GGN) based on the whole-lung baseline CT features deriving from deep learning and radiomics.

#### **METHODS AND MATERIALS**

This retrospective study included 385 GGN from 3 hospitals, confirmed by pathology. 239 GGN from Hospital 1 were used as the training and internal validation set. 115 and 31 GGN from Hospital 2 and Hospital 3 were used as the external test sets 1 and 2, respectively. Clinical and morphological features of GGN at baseline chest CT were evaluated, and the whole-lung radiomics features were extracted simultaneously. Besides, baseline whole-lung CT image features are further assisted and extracted using the convolutional neural network. Back propagation neural network was used to construct five prediction models based on different collocations of the features used for training. The area under the receiver operator characteristic curve (AUC) was used to compare the prediction performance among the five models. The Delong test was used to compare the differences in AUC between models pairwise.

#### **RESULTS**

The model integrated clinical-morphological features, whole-lung radiomic features, and whole-lung image features (CMRI) performed best among the five models, achieved the highest AUC in the internal validation set (Hospital 1), external test set 1 (Hospital 2), and external test set 2 (Hospital 3), which were 0.886 [95% confidence interval (CI): 0.841-0.921], 0.830 (95%CI: 0.749-0.893) and 0.879 (95%CI: 0.712-0.968), respectively. In all three sets, the differences in AUC between the CMRI model and other models were significant (all  $P < 0.05$ ).

#### **CONCLUSION**

The whole-lung baseline CT features were feasible to predict the benign and malignant GGN. The model combining clinical-morphological features, whole-lung radiomics, and whole-lung image features showed the best performance.

#### **CLINICAL RELEVANCE/APPLICATION**

The deep learning model based on whole-lung features can provide non-invasive and low-cost prediction and save the time of nodule segmentation.

#### **T2-SPCH-2 Deep Learning Models for Malignancy Estimation of Pulmonary Solid Nodules After Novel Classification**

Zichang Ma (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Identifying the malignancy of pulmonary solid nodules larger than 8mm remains a challenging task. Our study is to make a novel classification of pulmonary solid nodules based on the adjacent relationship between the pulmonary pleura and nodules and use deep learning models to diagnose the pathology-confirmed nodules divided by this classification on CT scans of the chest.



## **METHODS AND MATERIALS**

A total of 453 patients with pathology-confirmed solid nodules were enrolled from 2014 to 2022 and were randomly separated into training, validation, and test cohorts. Then we made a classification of solid nodules. Nodules that were adjacent to the pleura in the largest cross-sectional area were included in the pulmonary pleura solid nodules (PPSN) group. Nodules that were adjacent to only the lung tissues were included in the isolated solid nodules (ISN) group. Two groups were also divided into three cohorts. The Swin Transformer as a deep learning model, was used to identify the malignancy.

## **RESULTS**

Before classification, the area under the receiver operating characteristic curve (AUC), specificity, and sensitivity in the validation and independent test cohorts were 0.892 [95% CI: 0.864, 0.920], 0.765, and 0.858; 0.878 [95% CI: 0.831, 0.924], 0.741, and 0.871. After classification, AUC, specificity, and sensitivity in validation and independent test cohorts in the ISN group were 0.921 [95% CI: 0.884, 0.958], 0.809, and 0.868; 0.905 [95% CI: 0.873, 0.938], 0.809, and 0.868. In the PPSN group, AUC, specificity, and sensitivity in the validation and test cohorts were 0.875 [95% CI: 0.776, 0.974], 0.632, 0.934; 0.806 [95% CI: 0.735, 0.876], 0.425, 0.871. The AUC of two divided groups in the independent test cohort was significantly different as determined by the DeLong test ( $p = 0.012$ ). The AUC in the ISN group is greater than that in the whole group.

## **CONCLUSION**

When using deep learning models to predict pulmonary nodules, it is necessary to consider the surrounding tissues of the tumor, and detailed classification may help improve the prediction effect.

## **CLINICAL RELEVANCE/APPLICATION**

After specific classification, the accuracy of using deep learning models to predict lung nodules surrounded by lung tissue would be improved.

## **T2-SPCH-3 Prediction of Lung Malignancy Progression and Survival with Deep Learning Based on Pre-treatment FDG-PET/CT**

Yongheng Luo, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Artificial intelligence (AI) demonstrated potential for improved accuracy in the characterization of lung malignancies with fluorodeoxyglucose positron-emission tomography and computed tomography (FDG-PET/CT), but studies mostly relied on handcrafted features rather than deep learning, and focused on the prognostic utilities of CT and PET individually without investigating their additive value. The purpose of this study was to use deep learning with pre-treatment FDG-PET/CT to predict progression of lung malignancies and overall survival (OS).

## **METHODS AND MATERIALS**

A retrospective review across three institutions identified patients with a pre-procedure FDG-PET/CT and an associated malignancy diagnosis. Lesions were manually and automatically segmented, and convolutional neural networks (CNNs) were trained using FDG-PET/CT inputs to predict malignancy progression. Performance was evaluated using area under the receiver operating characteristic curve (AUC), accuracy, sensitivity, and specificity. Image features were extracted from CNNs and by radiomics feature extraction, and random survival forests (RSF) were constructed to predict OS. Concordance index (C-index) and integrated brier score (IBS) were used to evaluate OS prediction.

## **RESULTS**

1168 nodules ( $n=965$  patients) were identified. 792 nodules had progression and 376 were progression-free. The most common malignancies were adenocarcinoma ( $n=740$ ) and squamous cell carcinoma ( $n=179$ ). For progression risk, the PET+CT ensemble model with manual segmentation (accuracy=0.790, AUC=0.876) performed similarly to the CT only (accuracy=0.723, AUC=0.888) and better compared to the PET only (accuracy=0.664, AUC=0.669) models. For OS prediction with deep learning features, the PET+CT+clinical RSF ensemble model (C-index=0.737) performed similarly to the CT only (C-index=0.730) and better than the PET only (C-index=0.595), and clinical only (C-index=0.595) models. RSF models constructed with radiomics features had comparable performance to those with CNN features.

## **CONCLUSION**

CNNs trained using pre-treatment FDG-PET/CT and extracted performed well in predicting lung malignancy progression and OS. OS prediction performance with CNN features was comparable to a radiomics approach. The prognostic models could inform treatment options and improve patient care.

## **CLINICAL RELEVANCE/APPLICATION**



Features extracted from the deep learning models predict overall survival well. After prospective validation, this model based on FDG-PET/CT could predict lung malignancy progression and overall survival with high accuracy, and therefore help inform treatment options and improve patient care.

## **T2-SPCH-4 Effect of Emphysema on Lung Nodule Detection Performance of AI Software**

Nikolaos Sourlos (*Presenter*) Nothing to Disclose

### **PURPOSE**

Emphysema influences the appearance of the lungs in chest CT scans. It is unclear how well artificial intelligence (AI) based software performs in emphysema presence. The goal of this study is to check if there is a difference in lung nodule detection performance between an AI software and the human reader when emphysema is present.

### **METHODS AND MATERIALS**

We selected 121 participants with (n=39) and without (n=82) emphysema (mean age 61±8, 48% men) from the Imaging in Lifelines cohort. Detection of nodules sized 30-300mm<sup>3</sup> by a commercial AI software was compared to human reading, and findings only detected by the reader or AI (discrepancies) were reviewed by an expert panel of two radiologists (gold standard). Using the gold standard, the detection performance was compared between AI and human reader for emphysema and non-emphysema groups, based on sensitivity, F1 score, and FP/scan. McNemar's test was utilized to check if there are differences between findings detected by AI and human reader.

### **RESULTS**

The human reader detected 206 nodular findings and AI 223. The expert panel reviewed 211 discrepancies. Of these, 30 were actual lung nodules, 68 non-nodules, and 113 lymph nodes. In the emphysema group, AI sensitivity was 0.95 [95%CI 0.83-0.99] vs 0.87 [95%CI 0.73-0.94] for the human reader, with 0.51 FP/scan for AI vs 0.15 FP/scan for the human reader (for nodules p=0.45, for FPs p=0.01). In the non-emphysema group, AI's sensitivity was 0.87 [95%CI 0.77-0.93] vs 0.80 [95%CI 0.69-0.88] for the human reader, with 0.23 FP/scan for AI vs 0.28 FP/scan for the human reader (for nodules p=0.40, for FPs p=0.64). AI performance based on the F1 score was slightly lower than that of the human reader in participants with emphysema (0.77 [95%CI 0.68-0.84] vs 0.86 [95%CI 0.77-0.92] respectively), whereas performance of AI was slightly better than the human reader in non-emphysema participants (F1 score 0.81 [95%CI 0.74-0.87] vs 0.75 [95%CI 0.68-0.81] respectively).

### **CONCLUSION**

Overall, sensitivity of AI for lung nodules was higher than for the human reader but at the cost of higher false positive rate in emphysema presence. This resulted in slightly worse performance of AI (based on F1 score) in emphysema but slightly better than the human reader in non-emphysema.

### **CLINICAL RELEVANCE/APPLICATION**

AI software can sensitively detect lung nodules in individuals with and without emphysema at least as well as the human reader, but with a higher number of FPs in emphysema cases.

## **T2-SPCH-5 CT-derived Radiomics Signatures as a Prognostic Factor in Osteosarcoma Patients with Pulmonary Metastasis Treated with Tyrosine Kinase Inhibitors**

Shan Shui Zhou (*Presenter*) Nothing to Disclose

### **PURPOSE**

The tyrosine kinase inhibitors (TKIs) have become the main therapy in relapsed or advanced unresectable patients with osteosarcoma (OS). However, no accurate predictive biomarkers for response to TKIs have been found or reported. This study aims to explore the prognosis value of CT-based radiomics signatures and develop a multidimensional nomogram for predicting the progression-free (PFS) in OS patients with pulmonary metastasis treated with TKIs.

### **METHODS AND MATERIALS**

A total of 90 OS patients with pulmonary metastasis were retrospectively enrolled in this study and were randomly divided into a training cohort (60) and a testing cohort (30). A total of 854 radiomics features were extracted from the segmentation of regions of interest based on baseline chest CT images. The intra-class correlation coefficient (ICC) was implemented to evaluate the feature reproducibility and stability. Only features with ICC greater than 0.8 were retained. The random survival forest (RSF) was performed to select features and generate radiomics signatures. Kaplan-Meier survival analysis with log-rank test was implemented for univariate selection. Two multivariate cox proportional hazards regression models were established with radiomics signatures and clinical factors (R-model and C-model) respectively. A multidimensional nomogram was then built based on all predictive parameters (RC-model). The discrimination abilities, goodness of fit and clinical benefits of models were validated and compared on both training and testing sets.

## RESULTS

The R-model and radiomics signatures which was constructed with these 37 features showed good predictive ability and prognostic value in both training and testing cohorts (Training: C-index, 0.798, log-rank test,  $p < 0.0001$ ; Testing: C-index, 0.775, log-rank test,  $p = 0.04$ ). There are significant differences in C-index between the C-model from the R-model and RC-model in both training and testing cohorts (C-model: C-index, 0.567 and 0.556; RC-model: C-index, 0.798 and 0.773; all  $p < 0.05$ ). The calibration curves based on 12 and 24-month survival prediction showed better agreement between the predicted and actual probability of PFS in the R-model and RC-model than the C-model. The decision curve analysis curves showed that the R-model was similar to the RC-model, and gained much more net benefits than the C-model.

## CONCLUSION

Radiomics signature derived by chest CT images is a potential predictor for the response to TKIs in OS patients with pulmonary metastasis.

## CLINICAL RELEVANCE/APPLICATION

Radiomics could be promising for identifying whether OS patients with relapsed or advanced unresectable disease have a good prognosis after treatment with TKIs and personalize risk stratification and treatment decisions.

## T2-SPCH-6 Radiogenomics For EGFR Mutation Status Prediction in CT Images: Impact Of Model Design on Performance and Prospective Generalizability

Jacob Gordon, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

We hypothesized that design choices could affect predictive performance and generalizability of radiogenomic models. We investigated the impact of feature extraction and selection approaches on models developed to predict EGFR mutation status (EGFRm+/-) in NSCLC, assessing robustness on two different input CT image types.

## METHODS AND MATERIALS

We analyzed CT images from CT and PET/CT studies of US patients with NSCLC from TCIA (25% EGFRm+). Two feature extraction techniques were compared: hand-crafted features from segmented lesions and deep features from a pre-trained ResNet applied to a bounding box around the largest tumor. Principal component analysis (PCA) or Least Absolute Shrinkage and Selection Operator (LASSO) was used to select 5 features prior to classification by a support vector machine, with model performances evaluated via 5-fold cross validation AUC. Splits were stratified by EGFRm and disease stage. Prospective generalizability was evaluated using a temporal split (80:20 based on shifted dates). AUCs were reported as median and interquartile range.

## RESULTS

When predicting EGFR status from diagnostic CT images ( $n=171$ ), hand-crafted features selected either with PCA or LASSO resulted in effective stratification: AUC of 0.80 (0.73 - 0.80) and 0.80 (0.69 - 0.82), respectively, and encouraging prospective generalizability (0.86 for PCA and 0.76 for LASSO). By contrast, deep features showed poor performance using either PCA (0.60 [0.60 - 0.67]) or LASSO (0.46 [0.44 - 0.66]) as well as poor prospective generalizability (0.68 and 0.38, respectively). When utilizing low-fidelity CT from PET/CT studies ( $n=134$ ), hand-crafted features selected with PCA resulted in an AUC of 0.75 (0.73 - 0.77) vs. 0.66 (0.64 - 0.76) for LASSO. However, LASSO showed better prospective generalizability (0.79 vs 0.76). In this dataset, deep features combined with PCA showed improved predictive power compared with LASSO: AUCs of 0.72 (0.69 - 0.8) and 0.47 (0.46 - 0.67), respectively. With regard to prospective generalizability AUCs were 0.73 and 0.44 for PCA and LASSO, respectively.

## CONCLUSION

Performance and prospective generalizability for predicting EGFR mutation status varied widely across design settings. Tumor-based hand-crafted features filtered by PCA performed better than deep feature-based approaches regardless of image type. The effectiveness of the hand-crafted feature models supports the potential of radiogenomics in early identification of patients likely to harbor EGFR mutations.

## CLINICAL RELEVANCE/APPLICATION

Treatment planning in NSCLC depends on EGFRm. Radiogenomic models may help to rapidly identify patients who may harbor EGFRm. However, rigorous analysis of model design is key to successful model development.

## T2-SPCH-7 Impact of Body Composition on Lung Tumor Growth

Jiantao Pu, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Lung nodules, a sign of lung cancer, are common abnormal findings on low-dose computed tomography (LDCT). After a lung nodule is detected, the next step is to assess its likelihood of being cancerous, usually by monitoring its growth rate through follow-up CT scans. A nodule's growth rate can suggest its chance of being malignant and indicate the need for further tests such as biopsy or positron emission tomography (PET). This study aims to investigate the potential impact of body composition tissues as depicted on LDCT on tumor growth over time.

## METHODS AND MATERIALS

We conducted a study involving 109 subjects (55 male and 54 female) who had undergone multiple LDCT lung cancer screenings and were found to have lung nodules on their baseline CT scans. The nodules identified on both baseline and follow-up scans were segmented, and their doubling time (DT) in days was calculated. These subjects were grouped based on a DT threshold of 365 days. We also segmented five different body composition tissues depicted on the baseline LDCT scans were segmented, including skeleton muscle (SM), subcutaneous adipose tissue (SAT), visceral adipose tissue (VAT), intramuscular adipose tissue (IMAT), and bone, and computed their volumes and densities in Hounsfield unit (HU). The backward stepwise multivariable logistic regression analysis was used to identify the body composition features associated with DT while adjusting for potential confounding factors, such as age, gender, pack/year, and presence of emphysema. The multicollinearity was checked by the variance inflation factor (VIF), where  $VIF > 3.0$  indicates high collinearity. The area under the receiver operating characteristics (ROC) curve (AUC) was used to evaluate the performance of the prediction models using a 5-fold cross-validation method.

## RESULTS

The identified CT-derived body composition features significantly associated with DT include VAT volume ( $p=0.043$ ) and SAT volume ( $p<0.001$ ), while SM density is marginally significant ( $p=0.067$ ). Their combination achieved an AUC of 0.717 (95% CI: 0.619-0.814).

## CONCLUSION

Body composition characteristics are significantly associated with the growth rate of a lung nodule over time and may be considered as novel image biomarkers to facilitate the assessment of indeterminate lung nodules detected in the screening setting.

## CLINICAL RELEVANCE/APPLICATION

Approximately 50% of individuals who undergo LDCT lung cancer screening are found to have pulmonary nodules. Although the majority of lung nodules identified on CT scans (>95%) are not malignant, their presence can be worrisome for healthcare providers and anxiety-provoking for patients. Therefore, it is imperative to identify new biomarkers that can aid in the evaluation of indeterminate nodules.

## T2-SPCH-8 Preoperative CT-based Radiomics Model to Predict Tumor Status of Spread through Air Space in Non-small Cell Lung Cancer

Kaihua Lou (*Presenter*) Nothing to Disclose

## PURPOSE

This study is to establish radiomics model that can predict the spread through air space (STAS) of non-small cell lung cancer before surgery, and to explore whether the model efficiency can be improved by peritumoral information.

## METHODS AND MATERIALS

A total of 373 patients were retrospectively collected from the two centers between January 2015 to June 2022. Patients in Center 1 were randomly divided into the training group and the internal test group in a 7:3 ratio, with Center 2 serving as the external test group. Classical tumor region of interest (ROI) and expanded tumor ROI were delineated for each lesion on Shenrui scientific research platform. Correlation analysis and logistic regression are used for feature screening, and support vector machine classifier is used for the establishment of prediction model, which is verified in both internal and external test groups. Receiver operating characteristic curve and area under the curve (AUC) are used to evaluate the effectiveness of the prediction model.

## RESULTS

In this study, five models were established to predict the STAS status of patients with non-small cell lung cancer, including one clinical model, two radiomics models (classic tumor radiomics model and expanded tumor radiomics model) and two combined models (classic tumor combined model and expanded tumor combined model). In the external test group, the seven screened radiomics features show relatively good performance in predicting the STAS state alone, and most of the features had AUC values greater than 0.80. Among the prediction models, the clinical model shows relatively poor prediction efficiency, with AUC value of 0.63; The classic tumor combined model showed a relatively good prediction efficiency, with the AUC value of 0.84, which was higher than that of the single radiomics model (AUC was 0.82 and 0.71, respectively) and the expanded combined tumor model (AUC was 0.76).

## **CONCLUSION**

The results of this study showed that the seven selected radiomics features showed good efficiency in the identification of STAS status alone. The classical tumor radiomics model and the classical tumor combined model can predict the STAS status of patients well, but the expanded tumor ROI does not significantly improve the efficacy of the model.

## **CLINICAL RELEVANCE/APPLICATION**

STAS status affects the choice of surgical methods and prognosis of patients. The model established in this study can predict STAS status before surgery, which is conducive to guiding the selection of clinical surgical methods.

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## Abstract Archives of the RSNA, 2023

T2-SPER

### Emergency Radiology Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPER-1 The Impact of Dermoid Size on the Chance of Torsion and the Diagnostic Performance of CT Observations in Emergency Department Patients**

Maitray D. Patel, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Evaluate performance of CT observations for diagnosing twisted dermoids based on dermoid size..

#### **METHODS AND MATERIALS**

Text search of consecutive CT reports and pathology records between 1/1/2010 and 5/31/2022 identified ED patients with an ovarian dermoid, symptoms relevant to possible ovarian torsion, and absence of CT observations indicating alternative diagnosis. Operative and clinical notes established outcome...Three abdominal radiologists blinded to history, outcome, and cohort creation independently evaluated a maximum-size-matched review cohort containing all twisted dermoids with approximately twice as many non-twisted dermoids, scoring 6 adnexal torsion CT observations using a Likert scale:••• tubal thickening••• whirlpool sign••• concentric or asymmetric wall thickening••• adnexal deviation••• uterine deviation••• pelvic fat infiltration..Observation diagnostic metrics (sensitivity/specificity/accuracy/PPV/NPV) were based on presence of the observation indicated by at least two of the reviewers..

#### **RESULTS**

325 patients had 350 studies (19 patients with 2 studies, 3 patients with 3 studies, 10 patients with bilateral dermoids), showing 39 twisted dermoids and 321 non-twisted dermoids. The 10.8% overall torsion prevalence varied by dermoid size:••• <40 mm = 0/180 (0%)••• 40-69 mm = 6/96 (6.3%)••• 70-99 mm = 16/43 (37.2%)••• 100-159 mm = 15/30 (50.0%)••• =160 mm = 2/11 (18.2%)..Tubal thickening and whirlpool sign had highest diagnostic performance in the review cohort (39 twisted averaging 97 mm and 70 non-twisted averaging 99 mm; 35.8% torsion prevalence).••• For 84 dermoids =70 mm: the review cohort had all 51 of 51 non-twisted and 33 of 33 twisted dermoids of this size-----Tubal thickening: 84.8%/70.6%/76.2%/65.1%/87.8%-----Whirlpool sign: 63.6%/84.3%/76.2%/72.4%/78.2%••• For 25 dermoids 40-69 mm: to achieve size match, the review cohort had 19 of the 90 non-twisted and 6 of the 6 twisted dermoids of this size-----Tubal thickening: 50.0%/89.5%/80.0%/60.0%/85.0%-----Whirlpool sign: 33.3%/94.7%/80.0%/66.7%/81.8%..Applying 40-69 mm diagnostic metrics to all 96 dermoids that size reduced tubal thickening PPV to 24.1% and reduced whirlpool sign PPV to 29.5%, reflecting more false positives due to low torsion prevalence..

#### **CONCLUSION**

10.8% of ovarian dermoids in ED patients with relevant symptoms and no other CT-identified cause for symptoms were twisted, involving no dermoids <40 mm, 6.3% of dermoids 40-69 mm, and 39.3% of dermoids ≥70 mm. Tubal thickening and whirlpool sign showed highest accuracy (80%), but with substantially lower PPV for dermoids <70 mm.

#### **CLINICAL RELEVANCE/APPLICATION**

Consider US confirmation of suspected dermoid torsion on CT when <70 mm due to low torsion prevalence.

#### **T2-SPER-2 Determination of the Most Suitable Monoenergetic Level of Virtual Monochromatic Images in Dual-source CT for the Diagnosis of Bowel Obstruction and Colitis**

Djamel Dabli (*Presenter*) Nothing to Disclose

## **PURPOSE**

To determine the monoenergetic level with the best image quality for the diagnosis of colitis and bowel obstruction in an emergency context.

## **METHODS AND MATERIALS**

The images of 64 patients who benefited from an enhanced abdominal-pelvis scan in dual-energy CT (DECT) mode for the diagnosis of colitis or bowel obstruction were retrospectively analyzed. Acquisitions were performed on a third-generation dual-source CT (DSCT) scanner at portal phase. Acquisitions were performed at 100/Sn150kVp. Mixed images (simulating images at 120kVp) were generated as well as virtual monochromatic images (VMI) at 40/50/60/70keV. An objective image quality assessment was performed by measuring contrast, noise and contrast-to-noise ratio (CNR). Subjective analysis was performed by anonymous scoring of the images by two radiologists evaluating the noise, smoothing, overall quality and diagnostic quality on a Likert scale. The results were compared between the different images using the Mann-Whitney U test for paired samples.

## **RESULTS**

Of all the patients, 33 had intestinal obstruction, and 31 had colitis. The mean age was  $65\pm 20$  and  $49\pm 22$  years, respectively. The maximum CNR was measured in VMI at 60keV for both examination types, but the difference was significant only compared to 70keV for bowel obstruction and to 40keV, 70keV and mixed images for colitis. A good inter-observer agreement for all subjective criteria was found with a kappa index higher than 0.86. The VMI at 60keV presented higher scores for all criteria for bowel obstruction and colitis with no significant difference in smoothing score compared to mixed images ( $p=0.119$  and  $p=0.888$ , respectively).

## **CONCLUSION**

VMI at 60keV could provide better image quality compared with other low monoenergetic levels and mixed images for the diagnosis of bowel obstruction and colitis.

## **CLINICAL RELEVANCE/APPLICATION**

Improved diagnosis of colitis and digestive tract obstructions. Reduction of examination interpretation time in the emergency context by optimizing the DECT image workflow

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## Abstract Archives of the RSNA, 2023

T2-SPGI

### Gastrointestinal Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPGI-2 Improving Preoperative Prediction of High-risk Esophageal Varices in Cirrhotic Patients: A Logistic Regression Model Based on Dual Energy CT Combined with Platelets**

Jiewen Chen (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the significance of preoperative prediction of high-risk esophageal varices (EV) in cirrhotic patients using ultrafast synchronized KV/mA switching dual energy CT (DECT), and to investigate the effectiveness of regression models that incorporate quantitative DECT parameters in conjunction with platelet for preoperative prediction.

#### **METHODS AND MATERIALS**

59 cirrhotic patients who underwent upper abdominal enhanced DECT scanning (Revolution Apex CT, GE) and gastroscopy were retrospectively enrolled. The risk of EV bleeding was divided into a low-risk group (LRV, n=38) and a high-risk group (HRV, n=21) based on gastroscopic findings. Basic clinical characteristics, hepatic transient elastography parameters derived by ultrasound (US), and DECT parameters in EV including portal phase esophageal venous iodine concentration (IC<sub>ev</sub>) was recorded for all patients. Non-parametric test was used to identify independent risk factors. Logistic regression models were constructed based on mixed models of DECT combined, and US combined with clinical factors, respectively. The receiver operating characteristic (ROC) curves, area under the ROC curve (AUC) and confusion matrix were calculated for assessing performance of two models.

#### **RESULTS**

A total of 59 patients were included, 38 with low-risk esophageal varices and 21 with high-risk esophageal varices. Non-parametric tests revealed significant differences between the high- and low-risk groups in terms of clinical characteristics including platelets (PLT), US factors including Liver stiffness, and DECT parameters including IC<sub>ev</sub>. The mixed model of US and PLT showed a 78% precision and sensitivity of 61.9%, specificity of 86.8%, positive prediction rate of 39% and negative prediction rate of 86.8%, and an AUC of 0.817. The mixed model of DECT and PLT demonstrated a precision of 83.1%, sensitivity of 76.2%, specificity of 86.8%, positive prediction rate of 48.5% and negative prediction rate of 86.8%, and an AUC of 0.916.

#### **CONCLUSION**

IC<sub>ev</sub> based on DECT combined with platelets can effectively exclude high-risk EV and has higher diagnostic efficacy than liver stiffness combined with platelets.

#### **CLINICAL RELEVANCE/APPLICATION**

According to Baveno VI guidelines, patients with cACLD at liver stiffness <20 Kpa and platelet count >150,000/ul may not require gastroscopy. The predictive model constructed for combined IC<sub>ev</sub> and PLT had better performance than the model combined liver stiffness and PLT, and was a potential model for non-invasive screening of high-risk EV in cirrhotic patients and avoiding gastroscopy.

#### **T2-SPGI-3 Feasibility Study of Quantitative Parameters of Single-source Dual Energy CT Spectrum Analysis Parameters to Predict Ki-67 Expression in Gastrointestinal Stromal Tumor**

Hongyu Zhang (*Presenter*) Nothing to Disclose



## PURPOSE

To investigate the feasibility of preoperative prediction of Ki-6 expression in gastrointestinal stromal tumors(GIST)by multi-quantitative parameters of single-source dual-energy CT.

## METHODS AND MATERIALS

The imaging data of 64 patients with GIST confirmed by single-source dual-energy CT three-phase energy spectrum enhanced scan and surgical pathology immunohistochemical index including Ki-67 were retrospectively analyzed. According to the Ki-67 expression index (>6 for high expression, <6 for low expression) the patients were divided into high expression group (n=28) and low expression group (n=36). The single energy CT value and iodine concentration IC value of the parenchymal area of the two groups were measured at 40-70 kV, and the normalized iodine concentration NIC value and the slope of the energy spectrum curve were calculated. Univariate and multivariate Logistic regression analysis was performed on the two groups of patients to establish independent risk factors for predicting Ki-67 expression.

## RESULTS

The CT values of 40-70 keV and NIC value in the arterial phase of the Ki-67 high expression group were higher than those in the low expression group, and the differences were statistically significant ( $P < 0.05$ ), while the differences in the slope of the energy spectrum were not statistically significant ( $P > 0.05$ ); The differences in the venous 40-70 keV CT values, slope of the energy spectrum and NIC values between the two groups were not statistically significant ( $P > 0.05$ ). The CT values of 40~70 keV and slope of the energy spectrum value in the delayed phase of the Ki-67 high expression group were lower than those in the low expression group, and the differences were statistically significant ( $P < 0.05$ ), while the differences in NIC values were not statistically significant ( $P > 0.05$ ). Univariate and multivariate logistic regression showed that arterial phase, delayed phase 40KeV, 70KeV CT values, and standardized iodine concentration values were independent risk factors for predicting Ki67 high expression.

## CONCLUSION

Preoperative single-source dual-energy CT spectral parameters are helpful in predicting the expression of Ki-67 in gastrointestinal stromal tumors before surgery.

## T2-SPGI-4 Equilibrium Phase Imaging of the Abdomen on Photon-counting CT: Assessment of the Value of 50-keV vs 70-keV Imaging

Toru Honda, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Equilibrium phase (EP) imaging of the abdominal CT has several diagnostic values but suffers from low contrast. The aim of this study was to perform the quantitative and qualitative assessments of virtual monochromatic images (VMIs) generated by photon counting CT (PCCT) during abdominal EP.

## METHODS AND MATERIALS

This study included 20 patients who underwent abdominal dynamic contrast-enhanced CT using PCCT for the assessment of liver and pancreatic diseases including four patients with hepatocellular carcinoma and seven patients with pancreatic solid tumor. Portal venous phase (PVP) imaging was reconstructed to VMIs at 70 keV and EP imaging was reconstructed at 50 keV and 70 keV. One radiologist placed regions of interest on the three images and signal-to-noise ratio (SNR) were measured for the liver parenchyma, portal vein, hepatic vein, pancreas, and adrenal glands, as well as calculating the contrast-to-noise ratio (CNR) of the hepatic vessels and lesions. Two radiologists assessed the image quality using a 5-point scale regarding image noise, sharpness, organ and lesion conspicuity, and overall image quality. Friedman's test was used for the comparison among the three imaging.

## RESULTS

The SNRs at 50 keV-EP imaging were significantly higher for the hepatic vessels ( $p < 0.05$ ), equivalent for the pancreas and adrenal glands, and significantly lower for the liver parenchyma compared with 70 keV-EP imaging ( $p < 0.05$ ). SNRs at the 50 keV- and 70keV-EP imaging were significantly lower than those at the 70 keV PVP imaging for all structures ( $p < 0.05$ ) except for the equivalent SNR for the portal vein at 50 keV-EP. CNRs of the hepatic vessels at 50 keV-EP were significantly higher than those at 70 keV-EP, but significantly lower than those at 70 keV-PVP ( $p < 0.05$ ). There were no significant differences among the three images in the CNR of the lesions. In the qualitative analyses, 70 keV-EP and -PVP imaging showed significantly better noise, sharpness, and overall image quality than 50 keV-EP imaging for both readers ( $p < 0.05$ ). The conspicuity of the hepatic vessels at 50 keV-EP were significantly higher than that at 70-keV EP for both readers ( $p < 0.05$ ), and equivalent to that at 70 keV-PVP for one reader. Conspicuity of the lesions and adrenal veins were significantly the highest at 50 keV-EP.

## CONCLUSION

Although 50 keV-EP imaging had worse image quality, it provided the best conspicuity of hepatic or pancreatic lesions and adrenal veins compared with 70 keV-EP and 70 keV-PVP imaging.



## CLINICAL RELEVANCE/APPLICATION

Virtual monoenergetic imaging at 50 keV during the equilibrium phase of abdominal CT may be helpful for the assessment of hepatocellular carcinoma, pancreatic cancer, and adrenal veins.

### T2-SPGI-5 The Extracellular Volume Fraction with Iodine (water) Image of Dual-energy Computed Tomography in Predicting P53 Expression of Rectal Cancer

Chen Anliang (*Presenter*) Nothing to Disclose

#### PURPOSE

To assess the feasibility of extracellular volume (ECV) fraction determined with iodine(water) image of dual-energy computed tomography (DECT) for prediction of P53 expression of rectal cancer.

#### METHODS AND MATERIALS

A retrospective analysis was performed on 41 rectal cancer patients confirmed with P53 expression according to their postoperative pathology results who received abdominal enhanced DECT in our hospital. They were divided into group 1 (high-group; 21 patients; 14 male, 7 female, mean age: 67.95 years, range: 52-91 years) and group 2 (low-group; 20 patients, 15 male, 5 female, mean age: 64.60 years, range: 44-89 years) according to their P53 expression. Three ROIs were placed in the largest layer of rectal cancer in iodine(water) images created from equilibrium-phase contrast-enhanced DECT images. The iodine values of the left external iliac artery or femoral artery at the same layer with lesions were also measured. The ECV fraction were calculated and were analyzed with independent sample t-test. The ROC curve was generated using the ECV fraction, and the area under curve (AUC) was calculated to analyze the diagnostic performance of using the ECV fraction in predicting P53 expression of rectal cancer.

#### RESULTS

There was a statistically significant difference in the ECV fraction between high-group ( $45.83 \pm 9.76\%$ ) and low-group ( $55.81 \pm 12.83\%$ ) ( $p < 0.05$ ). The AUC, maximum Youden index and diagnostic threshold of using the ECV fraction for prediction of P53 expression of rectal cancer was 0.717, 0.407 and 56.73%, and the sensitivity and specificity were 55.0% and 85.7%, respectively.

#### CONCLUSION

ECV fraction determined with equilibrium contrast-enhanced iodine(water) image of DECT images was useful for predicting P53 expression of rectal cancer.

## CLINICAL RELEVANCE/APPLICATION

ECV fraction created from gemstone spectral imaging (GSI) has a prospective clinical application in predicting the P53 expression of rectal cancer for the treatment decision-making.

### T2-SPGI-6 Assessment of the Liver Low-density Lesions with a Spectral CT

Ying Xu (*Presenter*) Nothing to Disclose

#### PURPOSE

This study was aimed to compare and evaluate the image quality of intra-hepatic low-density lesions in spectrum computed tomography (CT) with different monochromatic energy images in the arterial phase, the portal vein phase, and the delayed phase, respectively, and to explore the exact monochromatic value of optimum image quality.

#### METHODS AND MATERIALS

Patients with intra-hepatic low-density lesions were prospectively enrolled in our institution. GE Revolution CT was used to perform enhanced upper abdominal scan. Adaptive statistical iterative reconstruction (ASIR-V) was set with 40%, 50%, 40%, and 30% for true non-enhanced abdominal scanning, enhanced abdominal scanning in the arterial phase, the portal vein phase, and the delayed phase, respectively. The arterial phase and the portal vein phase applied a spectral mode with fast switch 80/140 kV, and tube current was automatic (range from 100 to 600 mA). The average CT value and standard deviation (SD) of the lesions were measured and recorded at 50, 60, 70 and 80 keV in the arterial phase, the portal vein phase respectively, and the signal-to-noise ratio value was calculated and compared pair-to-pair. Paired-samples t-test was used to compare the mean value of SNR and SD in the arterial phase, the portal vein phase, and the delayed phase, respectively.  $P < 0.05$  was considered statistically significant.

#### RESULTS

A total of twenty patients were prospectively included finally (male: 5, female: 15; mean age: 65.4 years old), with a total of 35 lesions. For the arterial phase, the signal-to-noise ratio values of the lesion in the imaging with 80KeV was higher than those of 50, 60 and 70 keV ( $12.75 \pm 1.6$ ,  $0.49 \pm 1.18$ ,  $0.71 \pm 1.30$ ,  $0.94 \pm 1.41$ , respectively;  $? < 0.001$ ), and there was no statistically significant difference among the 50, 60, and 70 keV groups. For the portal vein phase, the signal-to-noise ratio

values of 50, 60, 70, and 80 keV groups were  $1.32\pm 1.08$ ,  $1.41\pm 1.26$ ,  $1.49\pm 1.44$ ,  $1.58\pm 1.61$ , respectively; and there was no statistical difference among the different keV groups ( $p>0.05$ ).

## CONCLUSION

The image quality with 80keV of single-energy imaging of spectrum CT was significantly better than that of other monochromatic energy (50, 60, 70 keV) imaging in the arterial phase. But for the portal vein phase imaging, there was no statistical difference in the imaging quality of the liver lesions in scans with different keV. As a result, it is supposed to reduce the radiation dose of scans by decreasing the keV in the portal vein phase without compromising the image quality prospectively, but not in the arterial phase.

## CLINICAL RELEVANCE/APPLICATION

It is supposed to reduce the radiation dose of scans by decreasing the keV in the portal vein phase without compromising the image quality prospectively, but not in the arterial phase.

## T2-SPGI-7 The Difference Between Virtual Non-enhanced Imaging and True Non-enhanced Imaging: A Comparison Study

Ying Xu (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the difference in image quality and radiation dose between virtual non-enhanced (VNE) images and true non-enhanced (TNE) images in the arterial and the portal phase.

## METHODS AND MATERIALS

Sixty-four patients were enrolled in this prospective study. GE Revolution CT was used for enhanced upper abdominal scanning. Adaptive statistical iterative reconstruction (ASIR-V) were set with 40%, 50%, 40%, and 30% for true non-enhanced abdominal scanning, enhanced abdominal scanning in arterial phase, portal vein phase, and delayed phase, respectively. The effective radiation dose (ED) and the size-specific dose estimation (SSDE) of virtual non-enhanced images and true non-enhanced images were calculated respectively. The mean CT values and standard deviation (SD) of liver parenchyma, spleen parenchyma and renal cortex in VNE images and TNE images were measured, and the signal-to-noise ratio (SNR) was calculated.

## RESULTS

For radiation dose, the ED of VNE images gained from portal vein phase was the highest, followed by VNE from arterial phase reconstruction, and the lowest ED belonged to TNE images ( $4.59\pm 1.98$ ,  $3.81\pm 1.44$ ,  $3.67\pm 1.71$ , respectively). The differences of ED between the latter two were significant compared with the portal phase. The significant difference was detected only between VNE images from the arterial (SSDEa) and the portal phase (SSDEp) ( $1.47\pm 2.27$  vs  $10.50\pm 2.03$ ,  $p=0.036$ ). For image quality: Liver There was no significant difference between the SNR of VNE images (SNRVNE) obtained from arterial phase and TNE (SNRTNE) ( $p=0.083$ ). The SNRVNE obtained from portal phase was better than that obtained from arterial phase and the SNRTNE. (SNRTNE vs portal SNRVNE:  $7.26\pm 1.32$  vs  $12.85\pm 2.21$ ,  $p<0.001$ ; arterial SNRVNE vs portal SNRVNE:  $6.53\pm 1.98$  vs  $12.85\pm 2.21$ ,  $p<0.001$ ). Spleen: The SNRVNE obtained from arterial phase and portal phase were better than that of SNRTNE and the difference was statistically significant (all  $p<0.001$ ). Kidney The SNRVNE obtained from arterial phase and portal phase were better than that of SNRTNE and the difference was statistically significant (all  $p<0.05$ ).

## CONCLUSION

In terms of the radiation dose, the dose of VNE from portal vein was still the highest for ED, but its SSDE was the lowest instead. In terms of image quality, the VNE images of some organs at certain phases (such as hepatic portal phase, splenic artery phase and portal vein phase, renal artery phase and portal vein phase) were better than that of TNE images.

## CLINICAL RELEVANCE/APPLICATION

Spectral CT was comparable to conventional CT in image quality, and even superior than it in the imaging of some organs, while radiation dose needed to be further verified.

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## Abstract Archives of the RSNA, 2023

T2-SPGU

### Genitourinary Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### T2-SPGU-1 From Biopsy to Resection: Using CT to Predict Histologic Upgrading of Renal Masses

Sandra Fiset, MD, BEng (*Presenter*) Nothing to Disclose

##### PURPOSE

Despite the popularity of renal mass biopsy, discordance can occur between the biopsy nuclear grade and the surgical specimen grade. Nuclear grade affects recurrence and mortality rates, and any discordance can lead to suboptimal management. The rate of tumor growth has been used to predict upgrade despite limited literature evidence. This study aims to create a risk prediction model for upgrading of clear cell renal cell carcinoma (ccRCC) based on CT imaging features and compare its performance against tumor growth rate.

##### METHODS AND MATERIALS

This IRB-approved single-center retrospective case-control study included 114 patients (76 male, median age=62 years) who underwent renal mass biopsy followed by surgical resection. The upgrade group (n=57) was defined as low grade ccRCC (ISUP 1 or 2) on biopsy and high grade (ISUP 3 or 4) on subsequent nephrectomy, while the control group (n=57) had no upgrade. The average growth in largest dimension per month and tumor volume doubling time were calculated using available cross-sectional imaging prior to resection. Twenty-two imaging features were assigned utilizing pre-biopsy renal triphasic CT. Features that had inadequate differentiation following univariable logistic regression were excluded. Remaining features were included in a multivariable logistic regression model using a stepwise model selection. The predictive performance of the final risk prediction model was evaluated using repeated 10-fold cross-validation and compared with measures of tumor growth.

##### RESULTS

Arterial enhancement, delayed enhancement, relative arterial enhancement, relative delayed enhancement, arterial wash-in and imaging necrosis were significantly different between the groups ( $p < 0.05$ ). Importantly, tumor growth rate and doubling time were not statistically different. Four features (1 qualitative, 3 quantitative) were included in the final risk prediction model: mass heterogeneity ("heterogeneous" or "homogeneous"; OR=0.53), arterial enhancement (OR=0.46), relative delayed enhancement (OR=0.64), and enhancement ratio (OR=4.01). Using this model, a nomogram was constructed to predict probability of upgrade. The final risk prediction model resulted in a mean AUC of 0.69 (SD=0.17). This model performed better than measures of tumor growth ( $p < 0.001$ ).

##### CONCLUSION

A model using CT imaging features performed better than measures of tumor growth and can be used to stratify the risk of renal mass upgrade at the time of surgical resection.

##### CLINICAL RELEVANCE/APPLICATION

This model identifies patients appropriate for active surveillance (low likelihood of upgrade) or immediate surgery (high likelihood of upgrade), avoiding the need for follow up imaging to assess tumor growth rates.

#### T2-SPGU-2 Beyond the Knife: A Retrospective Study on Surveillance-Based Management of Bilateral Multifocal Renal Oncocytomas

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

##### PURPOSE

Bilateral multifocal renal oncocytomas account for approximately 4-6% of renal oncocytomas, and their optimal management strategy is still not well-defined due to a lack of consensus guidelines. This study aims to compare clinical, functional, and

oncological outcomes of active surveillance (AS) versus surgical management in patients with bilateral multifocal renal oncocytomas, and to determine the appropriate management strategy for this group of patients.

## **METHODS AND MATERIALS**

We conducted an IRB-approved retrospective cohort study on 62 patients with histopathologically confirmed bilateral multifocal renal oncocytomas. Patients with genetic alterations as seen in Birt-Hogg-Dubé syndrome or inadequate follow-up were excluded. The cohort was divided into three subgroups based on management received: active surveillance (AS) only, single unilateral surgery followed by AS, and multiple/bilateral surgeries. Clinical and imaging data were analyzed for longitudinal monitoring of tumor growth, new tumor/recurrence, and renal function changes. Statistical analysis was conducted to compare outcomes between the three management strategies.

## **RESULTS**

The median age of the patients (n=62) was 64 years (IQR 57.5-69), and 49 (79%) were males. Patients were followed for an average of 5.5 years (2.8-7.2 years), and the median number of tumors per patient was 7, with no metastasis observed in any group. The overall median tumor growth rate was 0.3 cm/year (IQR 0.1-0.5), with no significant difference among the three management groups (p=0.73). The median age at death was 78.5 years (IQR 74.5-81.3, p=0.37), and no significant differences were found in serum creatinine levels between the three groups at the initial time point (p=0.67), final time point (p=0.5), or change in serum creatinine levels over the period of treatment (p=0.7).

## **CONCLUSION**

Management strategies for bilateral multifocal renal oncocytomas are challenging, and clinicians face difficulties in choosing between surgical management and active surveillance. Findings of our study suggest that active surveillance is a safe and viable alternative to surgical management in patients with bilateral multifocal renal oncocytomas, with no detrimental impact on clinical, oncological, or functional outcomes as compared to surgical management.

## **CLINICAL RELEVANCE/APPLICATION**

Active surveillance may be a safe alternative to surgical management of bilateral multifocal renal oncocytomas, especially for elderly patients or patients with comorbidities who are at a heightened risk of developing surgery-related adverse events.

## **T2-SPGU-3 Predicting Growth Rate of Clear Cell Renal Cell Carcinoma: A Comprehensive Analysis using Machine-Learning**

Pouria Yazdian, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Von Hippel-Lindau (VHL) syndrome is associated with multiple benign and malignant neoplasms, including renal cell carcinomas (RCC), resections of which overtime can lead to end-stage renal disease (ESRD). Active surveillance is recommended for small renal masses to avoid unnecessary surgeries while preserving renal function. However, there is currently no reliable method to predict the growth rate of renal lesions.

## **METHODS AND MATERIALS**

A single-center retrospective study of 55 patients with VHL was conducted from 2015 to 2021. Prior to partial or radical nephrectomy, patients underwent two MRI scans, and tumors were pathologically confirmed. Two abdominal radiologists assessed lesions based on 12 unique anatomical and sequence-specific imaging parameters using preoperative MRI scans. Lesions were divided into slow-growing (SG) and rapid-growing (RG) groups based on a 0.5 cm/year growth rate threshold. A stacked ensemble technique was employed to combine XGBoost and Random Forest algorithms, creating models that associate radiomic signatures with tumor grades. Optimal algorithm parameters were determined using 5-fold cross-validation, and performance was assessed on 100 different random test and train set combinations (85% train, 15% test) to identify the best model. Results were reported using positive predictive value (PPV), sensitivity, F1 score, and area under the Receiver Operating Characteristic curve (AUC-ROC). By using inter class correlation between two readers, they had moderate agreement.

## **RESULTS**

The stacked ensemble machine-learning model demonstrated promising performance in predicting the growth rate of clear cell renal cell carcinoma in VHL patients. The model demonstrated high accuracy (90%) and promising performance metrics, including a precision of 0.97 for SG tumors, recall of 0.98 for RG tumors, and an F1 score of 0.92 and 0.88 for SG and RG, respectively. The macro average for precision and recall was 0.89 and 0.92, respectively, with an overall F1 score of 0.90. The Matthews Correlation Coefficient (MCC) was 0.52, indicating a moderate correlation between the model's predictions and the true growth rates.

## **CONCLUSION**

This study demonstrates the potential utility of using a stacked ensemble machine-learning model for predicting the growth rate of clear cell renal cell carcinomas in VHL patients. The model's high performance suggests it could be a valuable tool for guiding patient management and improving clinical decision-making in the active surveillance of small renal masses.

## **CLINICAL RELEVANCE/APPLICATION**

This machine-learning model could help optimize patient care by reducing the need for unnecessary surgeries, preserving renal function, and enabling timely interventions for patients with renal neoplasms.

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## Abstract Archives of the RSNA, 2023

T2-SPHN

### Head & Neck Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPHN-2 Artificial Intelligence Model to Predict Bethesda Score in Thyroid Nodule CT Imaging**

Isabel Gomez Alonso, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this work is to predict the Bethesda score of thyroid nodules by performing radiomic analysis of these nodules on CT images.

#### **METHODS AND MATERIALS**

This retrospective cohort study was performed by selecting 57 adult patients with thyroid nodules who underwent a CT scan of the neck and a fine needle aspiration biopsy between 2013 and 2021. Segmentation of the thyroid nodules was performed by three PGY4 radiology residents using CT images. Subsequently, 3D Slicer was used to extract the radiomic data of every segmented section in each patient. Data were processed with Phyton, using logistic regression and Machine Learning algorithms to predict the different Bethesda scores (score II-V) based on the radiomic features obtained. Visual assessment of the nodules was also performed by the three PGY4 radiology residents. Results were processed using IBM SPSS Statistics software. The whole process was supervised by a 5 year experienced head and neck radiologist and a 30 year experienced neuroradiologist.

#### **RESULTS**

In differentiating Bethesda II and V nodules, both logistic regression and K means showed a low performance (45% precision, 33% sensitivity and 57% specificity for logistic regression and 51% precision for K means). Random Forest classifier displayed 69% precision, 100% sensitivity and 100% negative predictive value, being able to detect all Bethesda V nodules. Finally, Support Vector Machine classifier showed 77% precision (75% sensitivity, 77% specificity, 87% negative predictive value).

#### **CONCLUSION**

Texture analysis-based artificial intelligence algorithms have demonstrated a 77% precision in differentiating Bethesda II and V nodules on CT imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

Thyroid nodule management is complex and often requires to perform invasive diagnostic procedures. Radiologists using artificial intelligence models may help predicting nodule malignancy and, consequently, reducing limitations of current diagnostic algorithms.

#### **T2-SPHN-4 Pioneering a Multi-Modal Deep Learning Approach for Hypopharyngeal Cancer Segmentation: Comprehensive Evaluation and Performance Analysis using Diverse MRI Data Across Multiple Institutions**

HE LIN KU, MA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Accurately annotating tumors is a time-consuming process, thus it is crucial to design an approach that can automate this process while maintaining accuracy. The study aims to develop and evaluate a multi-modality deep learning-based segmentation model for accurate and efficient delineation of hypopharyngeal cancer from T1-weighted image, contrast-enhanced T1-weighted image (T1c), and T2-weighted MRI scans. We utilized the nnU-Net architecture, ensembling techniques, and multi-institution datasets to improve the performance of our model.

## METHODS AND MATERIALS

In this study, we used a dataset of 209 patients with hypopharyngeal cancer from National Taiwan University Hospital (NTUH) to train and ensemble three separate nnU-Net models on T1-weighted image, contrast-enhanced T1 (T1c), and T2-weighted MRI scans. To determine the best combination of models, we utilized nested five-fold cross-validation and ensembled the cross-validation results. The tumor annotations were performed by experienced oncologists on the patients treated between February 2011 and January 2015. We evaluated our model using various metrics on a testing dataset from Chang Gung Memorial Hospital (CGMH), which includes 91 patients treated between 2003 and 2013. The nnU-Net architecture was selected for this study due to its remarkable performance in various medical image segmentation challenges, which is expected to improve the segmentation results of hypopharyngeal cancer from multi-modality MRI scans. It consists of a 3D U-Net with an end-to-end pipeline that includes pre-processing, data augmentation, and post-processing.

## RESULTS

The average tumor size in our training dataset from NTUH was 27.5 cm<sup>3</sup>. Our ensemble model achieved a mean Dice similarity coefficient (DSC) of 0.92 during training. On the independent testing dataset from CGMH our model achieved an overall DSC of 0.75 and a Hausdorff distance of 19 mm, demonstrating its robustness and generalizability.

## CONCLUSION

The developed deep learning-based segmentation model can accurately and efficiently delineate hypopharyngeal cancer from multi-modalities and multi-institutional MRI scans, which has the potential to enhance clinical diagnosis and treatment planning for patients with hypopharyngeal cancer. The nnU-Net architecture and ensembling approach improve the segmentation performance and increase the robustness of the model, and have the potential to be applied to other cancer types and imaging modalities.

## CLINICAL RELEVANCE/APPLICATION

Our metric analysis showed that the model has the potential to efficiently optimize hypopharyngeal cancer segmentation workflows and to be implemented in clinical decision support.

## T2-SPHN-5 AI for Automatic Localization and 3D Segmentation of Lymph Node Metastasis in Head and Neck Cancer

Miriam Rinneburger, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Evaluation of an AI algorithm for localization and segmentation of lymph nodes (LNs) in contrast-enhanced computed tomography scans (CECTs) of the head and neck region on patients with head and neck cancer with confirmed LN metastasis.

## METHODS AND MATERIALS

We searched our local database for patients sent from the otorhinolaryngological department from January 2000 to January 2021 for staging of a head and neck cancer who had at least one untreated LN metastasis confirmed through central necrosis, PET/CT-positivity, positive histology and/or progression/regression in a follow up scan. All 125 CECTs had a slice thickness of 1-2.5 mm, were conducted supine with venous contrast enhancement and reconstructed with a soft kernel. Patient age was 61,96 +/- 10,7 years, 25 patients were female and 100 male. On this cohort, we applied our existing 3D LN segmentation model. Independently, all LNs with a short axis diameter of  $\geq 5$  mm were manually segmented by an experienced radiologist and double-checked by a second radiologist as a reference. Additionally, LN metastases were labelled to evaluate the AI model's performance specifically on LN metastases.

## RESULTS

In 125 CECT scans of the head and neck, the AI model marked 4271 LNs whilst 3656 LNs were segmented manually. Out of 544 LNs manually labelled as a clinical metastasis, the model detected 486. Overall, an average localization rate (LR) of 83.56% with 12.8 false positives (FPs) per CT scan was achieved. On average, only one of these FPs had an SAD of  $\geq 5$ mm. The model showed a statistically significant ( $p = 0.0029$ ) higher localization performance for metastatic LNs with an LR of 89.0% whilst for non-metastatic LNs, it reached an LR of 82.8%. The average global Dice accounts to 0.58 per CT scan. Segmentation accuracy was higher for non-metastatic LNs with a global Dice of 0.65 while it accounts to 0.42 for LN metastases. Sensitivity was higher in metastatic (0.69) than in non-metastatic LNs (0.58).

## CONCLUSION

Our existing AI model for 3D segmentation of cervical LNs generalizes well to metastatic LNs. Overall, LR and segmentation sensitivity are higher in metastatic than in non-metastatic LNs whilst Dice is slightly worse. Clinical applicability of this model for metastatic LNs appears feasible.

## CLINICAL RELEVANCE/APPLICATION

Automatic LN localization for N staging can speed up clinical practice. LN metastasis of head and neck cancer can differ from other malignancies in shape and texture. Thus, localization might need explicit training.  
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## Abstract Archives of the RSNA, 2023

T2-SPIN

### Imaging Informatics Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### T2-SPIN-1 TransUNet for Fully Automated Abdominal Multi-Organ Segmentation

Khoschy Schawkat, MD, PhD (*Presenter*) Nothing to Disclose

##### PURPOSE

The purpose of this study was to validate the efficacy of CNN-Transformer hybrid architectures for multi-organ segmentation when applied to an independent, in-house dataset consisting of abdominal CT scans. The goal is to achieve a fully automated and highly accurate abdominal multi-organ segmentation computational framework that can be applied to the routine clinical workflow.

##### METHODS AND MATERIALS

The dataset consisted of 200 abdominal CT scans with 59 axial non-contrast and 131 contrast-enhanced abdominal (20 arterial phase, 90 portal venous phase, 19 late venous phase, and 12 elimination phase) clinical CT image series. Each CT volume consists of 44-392 slices of 512 x 512 pixels. The organ segmentations were performed manually and semiautomatically with manual verification on the liver, pancreas, left and right kidney, and spleen using free software for medical image processing (3D Slicer, version 4.11.0). We use the TransUNet architecture for our network, and train it using 5-fold cross validation with splits of 160/20 scans. TransUNet is trained on 4 organs of interest; liver, pancreas, kidneys and spleen. The 4 highest individual performing models are then ensembled. We report the average dice scores on a test set of 20 scans.

##### RESULTS

DICE scores for the labelmaps generated by the network, when compared against our ground truth images, for the liver, pancreas, kidneys, and spleen were 96.51, 83.02, 94.08, and 95.42, respectively. All organs of interest outperform the original scores reported in the authors' paper.

##### CONCLUSION

TransUNet, a U-Net structure in combination with transformers, achieves excellent performance in CT based multi-organ segmentation as shown in our independent in-house dataset.

##### CLINICAL RELEVANCE/APPLICATION

Large scale application of this fully-automated CT based multi-organ segmentation model allows for efficient assessment of volumetric and radiomics data.

#### T2-SPIN-2 Semi-Automated Longitudinal Performance Monitoring for Deployed Large Vessel Occlusion Detection Algorithm

Chintan Shah, MD, MS (*Presenter*) Spouse, Employee, Merck & Co, Inc

##### PURPOSE

Real-world performance of artificial intelligence (AI) models can vary and degrade over time. However, local performance and monitoring are often overlooked and are resource-intensive. We built a semi-automated method in order to reduce the manual effort required for local performance monitoring of an AI algorithm, using intracranial large vessel occlusion (LVO) as a use case. We utilize a framework consisting of a combination of structured reporting (SR), language processing (LP), and manual review of reports to assess performance.

## METHODS AND MATERIALS

Between January and May 2022, 1702 CTAs of the head and neck for stroke alert were processed with a commercial LVO detection algorithm (Viz LVO, Viz.ai). Scans were done at 17 different sites, including 12 hospitals, and 5 standalone ERs. Exams were interpreted by a neuroradiologist, asked to indicate concordance via an SR template. An analytical pipeline was developed for processing the reports utilizing KNIME analytics software (KNIME AG, Switzerland). Radiologist concordance was determined using SR when available. Language processing (LP) was then applied utilizing regular expression searches to identify positive or negative reports. LP results were reviewed to determine accuracy. Indeterminate reports were manually reviewed and categorized, as were those marked as discordant by either SR or LP. Summary performance statistics were calculated.

## RESULTS

Radiologist compliance with the SR concordance statement was 57% (966/1702). Among the remainder, 74.3% (547/736) could be categorized as positive or negative reports utilizing LP, leaving 11% of original volume (189/1702) requiring manual review. Of exams marked as discordant in the SR template by the interpreting radiologist, 63% (42/67) were correctly categorized. The performance of LP in categorizing reports showed a sensitivity, specificity, negative- (NPV), and positive-predictive value (PPV) of 85, 95, 99, and 47%, respectively. After SR, LP and manual review, the sensitivity, specificity, NPV, and PPV of the commercial LVO detection algorithm were 77, 96, 98, and 59%, respectively.

## CONCLUSION

SR alone was insufficient due to incomplete compliance and errors in categorization. The combined pipeline substantially reduced the workload of manual review better than structured reporting alone. The benefits persist after accounting for LP errors, which occurred more often with discordant than concordant results. We were able to corroborate local performance in this large multi-hospital dataset similar to that previously published.

## CLINICAL RELEVANCE/APPLICATION

Incorrect AI inference can negatively impact patient care; local validation is necessary. A semi-automated pipeline can reduce the manual workload of this process.

## T2-SPIN-3 MRI-based Radiomic Features Fail to Accurately Predict Primary Tumor Histology of Brain Metastases in External Validation: An Investigation of Class Imbalance and the Impact of Oversampling Techniques

Quirin D. Strotzer, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Growing research demonstrates the ability to predict histology or genetic information of various malignancies using radiomic features extracted from imaging data. Our aim was to investigate MRI-based radiomics in predicting the primary tumor of brain metastases through internal and external validation, using oversampling techniques to address class imbalance.

## METHODS AND MATERIALS

The local ethics committee approved this retrospective multicenter study. We included non-small and small cell lung cancer, melanoma, breast, and colorectal cancer (five-class classification). Internal train/validation/test data were acquired between 2003-2021 from 159 patients (422 metastases). External validation was performed with 67 patients (260 metastases) from the publicly available Stanford BrainMetShare dataset ([aimi.stanford.edu/brainmetshare](http://aimi.stanford.edu/brainmetshare)). Pre-processing included brain extraction, bias correction, co-registration, intensity normalization, and semi-manual binary tumor segmentation. 2889 radiomic and three location features were extracted from T1w, post-contrast T1w, FLAIR, and wavelet transforms for each sequence (eight decompositions). The internal dataset was split 80-20 into train/validation and test sets. Patients with multiple metastases were assigned to either the train/validation or test set to prevent data leakage. Various oversampling and machine learning techniques (five-fold cross-validation) were tested and evaluated on the test sets using accuracy, precision, recall, F1 score, AUC-ROC, and cross-entropy loss.

## RESULTS

Baseline (no oversampling) internal test set performance was suboptimal with accuracy, F1 score, and AUC-ROC of 0.48, 0.27, and 0.66, respectively. Accuracy and F1 score were slightly improved after random oversampling of the training partition (0.49 and 0.39, respectively). The models were not able to generalize to the external test set. Incorrect data partitioning (oversampling before train/validation/test split) resulted in a massive overestimation of model performance.

## CONCLUSION

Radiomics models' capability to predict histologic or genomic data from imaging should be critically assessed.

## CLINICAL RELEVANCE/APPLICATION

Primary tumor histology of brain metastases is usually obtained by invasive biopsy, posing the risk of morbidity and mortality. AI methods could potentially noninvasively acquire this information.

## **T2-SPIN-4 Unsupervised Learning of Chest Radiographs and Clinical Data Accurately Predicts Time to ICU Admission of COVID-19 Patients**

Justin Lu (*Presenter*) Nothing to Disclose

### **PURPOSE**

To improve allocation of ICU resources to treat COVID patients, we developed an unsupervised learning pipeline that utilizes chest radiographs and clinical data to accurately predict time to ICU admission.

### **METHODS AND MATERIALS**

This HIPAA-compliant study was performed with a waiver for informed consent following institutional review board approval. The training dataset consisted of 1834 COVID positive patients from March 9 and July 20, 2020 and the external testing dataset consisted of 475 COVID positive patients between March 1 and July 18, 2020. A vision transformer (ViT) autoencoder model was used to extract unsupervised imaging features from chest radiographs before undergoing dimensionality reduction using PCA to concentrate pertinent imaging characteristics. We then combined these imaging features with age, sex and common comorbidities prior to feeding into a partially unsupervised deep clustering survival machine (DCSM) for time to ICU prediction. DCSM characterizes each instance's survival information as a weighted combination of the learned expert distribution, which allows our model to better capture patient heterogeneity.

### **RESULTS**

Of the 1834 patients (54.9+/-19.8 years old, 51% Female), 493 were admitted to the ICU (27%) within 1.88 +/- 3 days. The DCSM model predicted time to ICU admission with a c-index of .731 +/- .02 on the training dataset and .72 +/- .01 on the external patient dataset.

### **CONCLUSION**

We developed a pipeline with ViT autoencoder and DCSM models that incorporates radiography and clinical data to accurately predict time to ICU admission in COVID patients. This method can also be applied to other similar clinical problems.

### **CLINICAL RELEVANCE/APPLICATION**

An unsupervised learning approach does not require manual annotation by a radiologist or healthcare worker and can be readily deployed in the clinical setting where it can be used to triage patients for ICU admission.

## **T2-SPIN-5 Peritumoral and Intratumoral Texture Features Based on Multiparametric MRI and Multiple Machine Learning Methods to Preoperatively Evaluate the Pathological Outcomes of Pancreatic Cancer**

Xuhui Fan, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

Radiomics-based preoperative evaluation of lymph node metastasis (LNM) and histological grade (HG) might facilitate the decision-making for pancreatic cancer and further efforts are needed to develop effective models.

### **METHODS AND MATERIALS**

The pancreatic cancer patients from the main center (n = 126) were assigned to the training and validation sets at a 4:1 ratio. The patients from the other center (n = 40) served as external test sets. The multiparametric MRI used in this study were: T2-weighted imaging, diffusion-weighted imaging, and dynamic contrast enhancement T1-weighted imaging. Peritumoral and intratumoral radiomics features were extracted which contained first-order, shape-based, and texture features. The following three-step method was applied to reduce the feature dimensionality: SelectKBest (a function from scikit-learn package), least absolute shrinkage and selection operator (LASSO), and recursive feature elimination based on random forest (RFE-RF). Six classifiers (random forest, logistic regression, support vector machine, K-nearest neighbor, decision tree, and XGBoost) were trained and selected based on their performance to construct the clinical, radiomics, and combination models.

### **RESULTS**

12 significant features for LNM and 11 features for HG were obtained. Random forest and logistic regression performed better than the other classifiers in evaluating LNM and HG, respectively, according to the surgical pathological results. The best performance was obtained with the models that combined peritumoral and intratumoral features with area under curve (AUC) values of 0.944 and 0.892 in the validation and external test sets for HG and 0.924 and 0.875 for LNM.

## CONCLUSION

Radiomics holds the potential to evaluate LNM and HG of pancreatic cancer. The combination of peritumoral and intratumoral features will make models more accurate.

## CLINICAL RELEVANCE/APPLICATION

Radiomics is a noninvasive diagnosis and prediction method with theoretically high accuracy. In this two-center study, radiomics models for predicting LNM and HD of pancreatic cancer are successfully developed, and they enable radiologists to preoperatively stratify the risk of pancreatic cancer and provide explicit guidance for surgical options.

## T2-SPIN-6 CFTR Modulator Therapy Influences Body Tissue Composition in Adults with Cystic Fibrosis: AI-based CT Analysis

Marko Frings, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

A poor nutritional status is associated with worse pulmonary function and survival in patients with cystic fibrosis. CF transmembrane conductance regulator (CFTR) modulators can improve both pulmonary function and body weight, but more data is required to assess its effects on body composition.

## METHODS AND MATERIALS

A pre-trained, deep-learning network was used to perform a fully automated body composition analysis (BCA) on chest CTs from adult patients with CF before (baseline) and after (longitudinal data) receiving triple-combination elexacaftor/tezacaftor/ivacaftor therapy. Muscle and adipose tissue were quantified and divided by bone volume to obtain body size-adjusted ratios. Results from BCA were correlated with lung function parameters and laboratory results.

## RESULTS

At baseline, chest CT-based BCA was conducted in 85 patients, with 34 (40%) receiving either mono or dual-combination CFTR modulator therapy. Mono/ dual-combination CFTR modulator therapy was associated with higher adipose tissue ratios. Muscle ratio correlated with percent predicted FEV1 ( $r=0.465$ ,  $p<0.001$ ) and six-minute walk test ( $r=0.392$ ,  $p<0.001$ ). ETI therapy improved percent predicted FEV1 (+ 12 points,  $p<0.001$ ) in patients with CF at 3 months, independent of baseline BCA results. Follow-up chest CT scans were performed in 18 patients after starting elexacaftor/tezacaftor/ivacaftor therapy. Triple-combination therapy was associated with an increase of the total adipose tissue ratio (+27%,  $p=0.007$ ). However, muscle ratio remained stable ( $p=0.304$ ).

## CONCLUSION

Fully automated CT-based BCA showed significant correlations with pulmonary function and six-minute walk test. Our findings suggest that CFTR modulator therapies primarily affect adipose tissue, not muscle tissue, in adults with CF. BCA may provide information on the individual nutritional status of patients with CF each time a CT scan is performed.

## CLINICAL RELEVANCE/APPLICATION

Our work presents a state-of-the-art method to quantify all body tissues from routinely acquired chest CT scans, making body composition analysis useful for daily clinical practice.

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## Abstract Archives of the RSNA, 2023

T2-SPIR

### Interventional Radiology Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPIR-1 Preliminary Study on Changes in Biliary Microbiota Before and After Drainage of Malignant Biliary Obstruction**

Kai Yang (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To explore the changes in biliary microbiota before and after malignant biliary obstruction drainage, and to study the impact of biliary obstruction and drainage intervention on bile microbiota from the perspective of microbiota.

##### **METHODS AND MATERIALS**

42 patients with malignant biliary obstruction underwent percutaneous transhepatic catheter drainage (PTCD) in our department from January 2020 to December 2022. Under DSA guidance, a 22G drainage needle was inserted into the bile duct and confirmed by angiography to be located within the intrahepatic bile duct, after that 15-20ml of bile sample was extracted; Implantation of external or internal/external drainage tubes through guide wires; After 7 days, bile sample was extracted through a drainage tube; Two bile samples were sent for culture and next-generation sequencing. Collect and organize general patient information, including whether acute cholangitis has occurred and its severity, and whether antibiotics have been used for treatment.

##### **RESULTS**

Among the 42 patients, there were 20 cases of cholangiocarcinoma, 13 cases of pancreatic cancer, 3 cases of hepatocellular carcinoma, and 6 cases of hilar lymph node metastasis (gastrointestinal malignant tumor). The relative abundance of Burkholderia, Acinetobacter, Pseudomonas and Staphylococcus in the bile microbiota before drainage was high; After drainage, the abundance of Staphylococcus, Klebsiella, Enterobacteriaceae, Aeromonas, Paracoccus, Anaerococcus, Diplococcus, Campylobacter and Megabacterium in bile samples increased, and the diversity and evenness of other microbial species diversity in normal biliary tract decreased.

##### **CONCLUSION**

There is a stable microbiota in the normal biliary system, and the composition of the microbiota in malignant obstructive bile ducts is similar to that in non diseased bile ducts. After drainage, the abundance of Bacillus, Streptococcus, Staphylococcus and Klebsiella in bile increased, which inhibited the growth of other original bacteria in the bile duct ecology, leading to the reduction of species diversity and evenness of the microbial community. This imbalance of biliary microbiota can explain the clinical phenomenon that patients are more prone to biliary tract infections after biliary drainage.

##### **CLINICAL RELEVANCE/APPLICATION**

After biliary drainage, the microbial community in the bile duct undergoes dysbiosis, which may continue to occur with the invasion of more invasive dominant bacteria, leading to new biliary infections. Therefore, when patients continue to be infected, bile culture needs to be performed again and clinical medication needs to be adjusted.

#### **T2-SPIR-2 Characterization of Power and Microwave Ablation Volumes Following Arterial Embolization in an In Vivo Porcine Liver Model**

Hiro D. Sparks, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Combination therapy using transarterial embolization and microwave ablation (MWA) is increasingly utilized to treat hepatocellular carcinomas larger than 3 cm in diameter. Predicting the size of a MWA zone after transarterial embolization is an important component of combination therapy treatment planning, specifically to minimize damage to critical structures

while maintaining adequate tumor margins. Power-time settings found in manufacturer guidelines are not applicable in embolized liver lobes due to alterations in perfusion and related heat sink effects. This study aims to better characterize the relationship between ablation volume and power in an in vivo porcine liver model following embolization.

## **METHODS AND MATERIALS**

With animal IRB approval, ten female Yorkshire swine, underwent either right (n= 5) or left (n= 5) hepatic artery embolization under fluoroscopic guidance. Subsequently, ultrasound guided MWA was performed in each liver segment (left lateral, left medial, right medial, right lateral) at either 30 Watts (W) (n=4 lobes), 60W (n=4), 65W (n=20), 90W (n=4), 120W (n=4), or 140W (n=4) continuously for 5 minutes (Certus 140 and PR-15, NeuWave Medical Inc, Madison, WI). Post-procedural volumetric segmentation was performed on standardized T1-weighted postcontrast images in arterial, venous, and delayed phases.

## **RESULTS**

Paired Wilcoxon test demonstrated that ablation volumes in embolized lobes (16.9 +/- 8.9 cc) were significantly larger than non-embolized lobes (12.9 +/- 6.6 cc , P = 0.012, Figure 1). MWA power had a significant positive linear correlation with both embolized (Pearson R, P <0.01) and non-embolized lobes (P < 0.01, Figure 2). The slope of the linear model corresponded to a 0.21 cc/W and 0.12 cc/W increase in ablation volume per unit wattage in embolized and non-embolized lobes, respectively. Embolization had a larger effect on ablation volumes at higher Wattage with a projected convergence of trendlines at 26.7 W, suggesting minimal effect of embolization at lower powered ablation. Model-derived ablation volumes at varying power are displayed in Table 1.

## **CONCLUSION**

Linear models demonstrate a near two-fold increase in ablation zone volume per additional Watt when applied to embolized lobes relative to non-embolized lobes. Volumetric differences between embolized and non-embolized lobes were greater at higher power MWA.

## **CLINICAL RELEVANCE/APPLICATION**

In the setting of hepatic combination therapy, transarterial embolization decreased blood flow within the liver parenchyma and reduced heat dissipation during subsequent MWA. This work provides novel insight into of the interactions between power, embolization, and MWA volume, which are critically relevant to the safe planning of combination therapy.

## **T2-SPiR-5 Freiburg Index of Post-TIPS Survival (FIPS): Independent External Validation in a Cohort of Patients from a Low Socio-economic South Asian Country**

Zohaib M. Mallick, MBBS (*Presenter*) Nothing to Disclose

## **PURPOSE**

To externally validate the Freiburg Index of Post-TIPS Survival (FIPS) score in a new cohort of patients and assess its performance in predicting post-TIPS survival.

## **METHODS AND MATERIALS**

Study design: This is a retrospective study of patients who underwent TIPS placement between January 1, 2006, and January 31, 2022, at a tertiary care center. Study population: The study population consisted of 44 patients. This study adheres to the TRIPOD checklist to ensure transparent reporting and facilitate the interpretation and reproducibility of our findings. Predictor: The FIPS score was calculated for each patient in the validation cohort using the original FIPS score equation. Outcome: The primary outcome was post-TIPS survival at 28 days, 3 months and 6 months. Statistical analysis: The discrimination and calibration of the FIPS score were assessed using the c-statistic and calibration plot, respectively. The performance of the FIPS score was compared to its original validation study, as well as to other post-TIPS survival prognostic models.

## **RESULTS**

The FIPS score ranged from -4.2 to 2.44. The overall 6-month observed survival rate was 75.7%. Kaplan-Meier analysis showed that patients with a high-risk FIPS score ( $\geq 0.92$ ) demonstrated significantly reduced survival compared to those with a low-risk FIPS score ( $<0.92$ ;  $p=0.018$ ). The FIPS score demonstrated good discrimination in predicting post-TIPS survival in comparison to the MELD 3.0 score (c-statistic = 0.825 for FIPS vs 0.752 for MELD 3.0, 95%). The calibration plot showed good agreement between the observed and predicted 1-year survival rates. FIPS score showed better calibration compared to MELD 3.0 (Brier score 0.131 for FIPS vs 0.221 for MELD 3.0). The observed-to-predicted ratio (O:P) for FIPS was 1.354 and that for MELD 3.0 was 1.065. The performance of the FIPS score in the validation cohort was comparable to its original validation study.

## **CONCLUSION**

Our study provides an independent external validation of the FIPS score in a new cohort of patients undergoing TIPS placement. The FIPS score showed good performance in predicting post-TIPS survival, suggesting that it can be a valuable tool in clinical practice for estimating post-TIPS survival. Further studies are needed to explore the applicability of the FIPS score in other patient populations and settings.

## CLINICAL RELEVANCE/APPLICATION

Transjugular intrahepatic portosystemic shunt (TIPS) is a commonly performed procedure for patients with complications of portal hypertension. The Freiburg Index of Post-TIPS Survival (FIPS) score is a prediction model that was developed to estimate post-TIPS survival in patients with variceal bleeding and/or ascites. However, its performance has not yet been validated in South Asian populations.

## T2-SPIR-6 CT-based Deep Learning Model of Hepatic Venous Pressure Gradient for Predicting the Prognosis of Hepatocellular Carcinoma with Transarterial Chemoembolization (CHANCE-CHESS): A Multicenter Cohort Study

Yuqing Wang (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the impact of CT-based deep learning model of hepatic venous pressure gradient (HVPG) on prognosis of hepatocellular carcinoma (HCC) patients treated with transarterial chemoembolization (TACE) and systemic therapy.

### METHODS AND MATERIALS

A total of 261 consecutive HCC patients treated with TACE and systemic therapy, and had a contrast-enhanced abdominal CT as part of their pre-surgical work-up, were retrospectively collected between January 2010 and December 2021. A CT-based HVPG Score, whose computed formula was:  $17.37 - 4.91 * \ln(\text{Liver/Spleen volume ratio}) + 3.8[\text{If presence of peri-hepatic ascites}]$ , was used to diagnose CSPH (HVPG=10mmHg) with a cut-off value 11.606. The 3D liver and spleen volume were automate calculated by a deep learning segmentation model, and the presence of peri-hepatic ascites was diagnosed by two independent investigators in portal-venous phase CT. Overall survival (OS) as study endpoint was analyzed by Kaplan-Meier and Cox regression.

### RESULTS

Among 261 patients, 80(30.7%) were diagnosed with CSPH by CT-based HVPG Score. The median OS in CSPH group was significantly shorter than non-CSPH group (16.9 months vs. 20.7 months,  $P=0.022$ ). Multivariable analysis indicated that the presence of CSPH was a negative prognostic factor for OS (adjusted hazard ratio [HR], 1.423,  $P=0.045$ ).

### CONCLUSION

The segmentation model shows good performance in liver and spleen segmentation in HCC patients, which may help non-invasive HVPG assessment and other CT imaging studies in HCC patients. CT-based HVPG Score was significantly associated with poor outcome and should be taken into consideration when managing HCC patients underwent TACE and systemic therapy.

## CLINICAL RELEVANCE/APPLICATION

This real-world study builds a non-invasive CT-based approach for CSPH diagnosis using deep learning model, and also highlights importance of CSPH management on clinical decision-making and trial design in HCC patients treated with TACE and systemic therapy.

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## Abstract Archives of the RSNA, 2023

T2-SPMK

### Musculoskeletal Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPMK-1 Adipose Distribution Patterns as Novel Prognostic Factors in Patients with HCC: A Systematic Review and Meta-analysis**

Shuo Shi (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Obesity is the established risk factor for several cancers, with hepatocellular carcinoma (HCC) being strongly associated with it. However, obesity is a heterogeneous disease with high individual differences in the distribution of adipose tissue. Quantifying associations between adipose distribution patterns and the prognosis of HCC might provide vital support for the individualized management of patients. Therefore, we aim to find the optimal indicator of pretreatment adipose distribution patterns for predicting the prognosis of HCC patients through meta-analysis.

##### **METHODS AND MATERIALS**

A systematic retrieve was performed to identify studies investigating the association of adipose distribution patterns and the prognosis of HCC from the inception of PubMed, Embase, Cochrane Library, and Web of Science databases to April 27, 2022. Relevant survival data were extracted to conduct the meta-analysis.

##### **RESULTS**

30 studies were included in our studies. A total of 6,783 people were enrolled in the study, including 2,456 patients with HCV and 1,228 patients with HBV. The pooled results indicated that only pretreatment high visceral to subcutaneous adipose tissue area ratio (VSR) (univariate analysis of OS: HR=1.42, 95%CI=1.28-1.58, P<0.00001; multivariate analysis of OS: HR=1.45, 95%CI=1.27-1.65, P<0.00001; univariate analysis of RFS: HR=1.30, 95%CI=1.08-1.56, P=0.006; multivariate analysis of RFS: HR=1.36, 95%CI=1.10-1.67, P=0.004) was both related to worse OS and RFS. Meanwhile, no significant heterogeneities were found and pooled results were relatively robust.

##### **CONCLUSION**

Pretreatment VSR is the most valuable prognostic factor in adipose distribution patterns of HCC patients.

##### **CLINICAL RELEVANCE/APPLICATION**

This is the first meta-analysis to investigate how different adipose distribution patterns affect the prognosis of HCC patients. Our results demonstrate that pretreatment visceral to subcutaneous adipose tissue area ratio is the most valuable prognostic factor in adipose distribution patterns of HCC patients.

#### **T2-SPMK-2 Maintain Accuracy in Vertebral Density Measurement after Intravenous Injection using Material Decomposition Images in Dual-energy Spectral CT**

Hui Hao (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the ability of using the material decomposition (MD) images in dual-energy spectral CT in maintaining the vertebral bone mineral density (BMD) measurement accuracy in contrast-enhanced CT scans.

##### **METHODS AND MATERIALS**

Fifty-one abdominal patients (20 females, 31 males) who underwent dual-energy spectral CT imaging in the unenhanced and contrast-enhanced arterial phase (AP) and portal phase (PP) were included. The monochromatic images (40-140keV) and MD images using hydroxyapatite (HAP)-iodine as a base material pair were reconstructed. The HAP density was measured to



represent BMD in the three imaging phases at the level of L1 with a region-of-interest (ROI) placed in a homogenous area of trabecular bone in the upper part of the vertebrae, excluding the cortex and focal inhomogeneous areas. The CT value in the same ROI was also measured using the 120kVp-like images to simulate measurement in conventional CT. Measurements in different imaging phases were statistically analyzed.

## RESULTS

The CT value measurements for the L1 level vertebra in the unenhanced, AP and PP phases were  $154.17 \pm 52.47$  HU,  $175.44 \pm 58.40$  HU and  $181.10 \pm 52.84$  HU, respectively. There were differences between the unenhanced and AP and the unenhanced and PP phases with  $p < 0.05$  showing iodine contrast involvement and contamination in the measurement. On the other hand, the HAP density measurement (in mg/cm<sup>3</sup>) in these three phases were  $695.36 \pm 18.41$ ,  $695.34 \pm 23.35$ , and  $694.95 \pm 16.88$ , respectively with virtually no change ( $p > 0.05$ ). Post hoc analysis showed that no significant differences were present in HAP (Iodine) ( $p = 0.993$ ).

## CONCLUSION

Our results showed that the conventional CT attenuation measurement in the vertebra after contrast injection may be skewed by the iodine involvement. The material density (HAP) measurement using the material decomposition in dual-energy spectral CT eliminated the iodine influence and provided quantitative and consistent measurement for BMD of the vertebra.

## CLINICAL RELEVANCE/APPLICATION

The material density (HAP) measurement using the material decomposition in dual-energy spectral CT may be used to provide a quantitative and consistent vertebral bone mineral density measurement.

## T2-SPMK-3 Opportunistic Deep Learning 3D-CT for Osteoporosis: Optimizing Multimodal Strategies for DXA Estimation

Hanqing Yao (*Presenter*) Nothing to Disclose

## PURPOSE

Osteoporosis is a disease marked by reduced trabecular bone mass and increased fracture risk. Dual X-ray Absorptiometry (DXA) is the clinical standard for assessing spine bone mineral density (BMD) and diagnosing osteoporosis, but remains underutilized. With ~25 million annual CTs of the chest and abdomen in the US, there exists a potential to screen for osteoporosis using CT without incurring extra cost, patient time, or radiation exposure. We hypothesized that we can (1) optimize the structure of 3D spine ROIs from abdominal CTs for DXA T-score estimation; (2) predict osteoporosis incidence by combining image measures, scanner parameters, and demographic information.

## METHODS AND MATERIALS

Our study comprised 447 CT scans on 432 patients (332 women, mean age 65) who received a contrast-enhanced CT scan within 6 months of DXA screening (301/146 train/test scans). To optimize our 3D ROIs, we evaluated four methods for automatically segmenting and extracting 3D HU measures - (1) entire vertebra segmentations; (2) only vertebral bodies excluding spinous/transverse processes; (3) only vertebral bodies with HU constraints to exclude cortical bones; (4) 1 cm radius spherical ROIs placed at the centroids of the vertebral bodies. We augmented HU measures with tube voltage, contrast phase, slice thickness, sex, age and race in a linear regression model to predict DXA T-scores.

## RESULTS

Entire vertebra segmentations exhibited the highest correlation across all vertebral levels (L1-L4), with Pearson correlation coefficients of 0.59, 0.57, 0.52, and 0.52, which were significantly higher than correlations of the other 3D ROI methods ( $P < < 0.001$ ). Including additional covariates improved the correlations at every level: 0.67, 0.68, 0.67, and 0.67 for L1-L4. Spine HU, tube voltage, and age-range buckets starting from 65 years old were significant predictors of T-scores ( $P < < 0.001$ ) for all levels. Using a -2.5 T-score osteoporosis threshold, we obtained area under the receiver operator characteristic curves (AUCs) of 0.69 (95% CI 0.59 - 0.79) for L1, 0.65 (95% CI 0.56 - 0.75) for L2, 0.66 (95% CI 0.57 - 0.75) for L3, and 0.63 (95% CI 0.54 - 0.72) for L4.

## CONCLUSION

Optimizing the structure of 3D ROIs demonstrates the superiority of entire vertebra segmentations. Augmenting ROIs with scanner-based parameters can improve T-score estimates, highlighting the potential to correct for scanner-based variations. Our features significance analysis indicates that a combination of imaging, scanner-based, and demographic features are important for DXA estimation.

## CLINICAL RELEVANCE/APPLICATION

This study shows the feasibility of opportunistic CT to approximate DXA T-scores by accounting for scanner-based variations.

## T2-SPMK-4 Muscle Kinetics on Diffusion-weighted Imaging during Plantar Flexion for Age-related Muscle Quality in Healthy Calf Muscles

Xinyue Zhang (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate the feasibility of muscle kinetics on DWI during exercise for assessing age-related muscle quality in healthy skeletal muscles.

## **METHODS AND MATERIALS**

This prospective study recruited 43 healthy participants (20-60 years) from November 2021 to December 2022. A plantar flexion-tailored DWI protocol was sequentially implemented with one rest phase, one exercise phase, and recovery 1, 2, and 3 phases. Each phase was corresponding to one DWI scanning. Absolute apparent diffusion coefficient (aADC,  $\times 10^{-3}$  mm<sup>2</sup>/sec) of triceps surae (TRIC) was measured in the ADC maps by two radiologists to acquire aADC in the rest phase (aADC<sub>rest</sub>), aADC in the exercise phase (aADC<sub>exer</sub>), and aADC in recovery phases (aADC<sub>reco1, 2, and 3</sub>). Based on aADC, muscle kinetics on DWI was developed by additionally collecting relative ADC (rADC,  $\times 10^{-3}$  mm<sup>2</sup>/sec) and recovery duration: rADC in the exercise phase (rADC<sub>exer</sub>) as aADC<sub>exer</sub> - aADC<sub>rest</sub>; rADC in the recovery phases (rADC<sub>reco1, 2, and 3</sub>) as aADC<sub>reco1, 2, and 3</sub> - aADC<sub>exer</sub>; recovery duration recorded as 1min, 2min, 3min, or >3min when first aADC<sub>reco</sub> showed no statistically significant difference from aADC<sub>rest</sub>. The independent or paired t-test was performed for comparing differences. The receiver operating characteristic curves were constructed for significant indices.

## **RESULTS**

Two legs were imaged in all 43 participants (age range/mean, 23-58/41 $\pm$ 10 years; 22 male; 18 youth <40 years). Aged showed lower magnitudes of right-sided rADC<sub>exer</sub>, rADC<sub>reco1</sub>, rADC<sub>reco2</sub>, and rADC<sub>reco3</sub> than youth with  $P < .05$ ; aged had longer recovery durations of >3min than 2min in youth for left leg. Right-sided rADC<sub>exer</sub> (0.76[0.60, 0.91];  $P = .005$ ) performed best for age-related muscle quality.

## **CONCLUSION**

When implementing a plantar flexion-tailored DWI protocol, rADC<sub>exer</sub> performed best for age-related muscle quality in healthy TRIC.

## **CLINICAL RELEVANCE/APPLICATION**

Muscle kinetics on diffusion-weighted imaging during plantar flexion were feasible for assessing age-related muscle quality in healthy calf muscles.

## **T2-SPMK-5 Changes in Paraspinal Muscles Density in Young Patients with Chronic Non-specific Lower Back Pain Quantified by Using Dual-energy CT**

Jian Xiang (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study was to compare the muscle density of bilateral erector spinae muscles and multifidus muscles in chronic non-specific lower back pain patients with that of a normal control group.

## **METHODS AND MATERIALS**

This study was conducted as a prospective study and two groups of people were studied: CNLBP group, included 56 patients (age: 25.78 $\pm$ 1.963, sex ratio: 21 Male/35 Female), control group, included 51 healthy volunteers (age: 25.12 $\pm$ 1.812, sex ratio: 19 Male/32 Female). All individuals received spectral CT imaging on lumbar. Virtual monochromatic images at 70 keV were generated. CT value which indicated density of multifidus (L2/3 to L5/S1 levels) and erector spinae (L1/2 to L4/5 levels) muscles was measured in Hounsfield units (HU) on the left and right sides, and the mean value of left and right was calculated. Density of multifidus and erector spinae muscle among CNLBP patients and healthy volunteers were compared by using independent samples t-test.

## **RESULTS**

CNLBP group had lower muscle density at L4/5 level and L5/S1 level in multifidus muscle compared to control group (CNLBP vs. normal: 42.891 $\pm$ 6.232 vs. 47.381 $\pm$ 5.965 HU for L4/5,  $t = -3.8$ ,  $p < 0.001$ ; 34.778 $\pm$ 8.751 vs. 46.7265 $\pm$ 6.264 HU for L5/S1,  $t = -8.049$ ,  $p < 0.001$ ), however that for L2/3 (CNLBP vs. normal: 48.616 $\pm$ 4.439 vs. 49.908 $\pm$ 6.614 HU), L3/4 (CNLBP vs. normal: 47.034 $\pm$ 5.109 vs. 48.931 $\pm$ 6.961 HU) showed no statistical significance (both  $P > 0.05$ ). The difference in density of the erector spinae muscle at each level between the CNLBP group and normal control group was not statistically significant (CNLBP vs. normal: 48.814 $\pm$ 9.332 vs. 51.176 $\pm$ 9.488 HU for L1/2; 48.779 $\pm$ 3.481 vs. 49.086 $\pm$ 4.373 HU for L2/3; 46.755 $\pm$ 3.930 vs. 48.304 $\pm$ 4.826 HU for L3/4; 43.421 $\pm$ 7.018 vs. 45.352 $\pm$ 6.209 HU for L4/5; all  $P > 0.05$ ).

## **CONCLUSION**

Patients with CNLBP have lower density in the multifidus muscle at the L<sub>4/5</sub> and L<sub>5/S1</sub> levels than healthy volunteers.

## CLINICAL RELEVANCE/APPLICATION

The pathogenesis of CNLBP is unclear. Muscle density can be used to quantify the evaluation of fat and connective tissue infiltration. This study shows that the density of multifidus muscle at the L4/5 and L5/S1 levels is significantly lower in patients with CNLBP compared to healthy volunteers. Dual-energy CT measurement of muscle density can identify changes in the paravertebral muscles of patients with CNLBP, contributing the understanding of underlying mechanism, early diagnosis thus helping patients conducting interventions that can restore paravertebral muscle function and reduce recurrence of low back pain symptoms.

### **T2-SPMK-7 Non-expert usage of MRI-based Neuropathy Score Reporting and Data System (NS-RADS): Multi-Institutional Wider-usability Study of Peripheral Neuropathy Conditions**

Bayan Mogharrabi, MD, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of our study was to determine inter-reader reliability and diagnostic performance of classification and severity scales of NS-RADS among radiology readers of differing experience levels after limited teaching of the scoring system by expert radiologists at their centers. We hypothesized that participants across a broad range of experiences can exhibit good accuracy and inter-reader reliability using the scoring system.

#### **METHODS AND MATERIALS**

This is a multi-institutional, cross-sectional, retrospective study of MRI cases of nerves and proven peripheral neuropathy (PN) conditions. 31 radiology readers with varying degrees of training and experience levels were recruited from different institutions. Each reader attended and received a structured presentation that described the NS-RADS classification system containing imaging examples and illustrations, and a published article on this subject. After training, the readers were asked to perform NS-RADS scoring with designation of category, sub-category, and the most likely diagnosis. Inter-reader agreements were evaluated by Conger's kappa for all readers, trainees, and attendings. Diagnostic accuracy was calculated for each reader as the percent correct diagnosis. A linear mixed model was used to estimate and compare accuracy between the trainees and attendings.

#### **RESULTS**

Across all 31 total (trainee and attending) readers evaluating 150 different MRI cases, the agreement was good for NS-RADS category and fair for NS-RADS subcategory. Inter-reader agreements of trainees were comparable to the attendings. The estimated accuracy for attendings was 0.73 with 95% CI (0.62, 0.81) and for trainees was 0.69 (0.58, 0.78) without significant difference in average accuracies between the trainees and attendings ( $p = 0.5$ ).

#### **CONCLUSION**

Non-expert radiologists interpreted PN conditions with good accuracy and fair to good inter-reader reliability using the NS-RADS scoring system previously validated by expert radiologists.

## CLINICAL RELEVANCE/APPLICATION

With limited training, the readers of differing experience and training levels can use NS-RADS scoring system in their practice to standardize MRI reporting and prudently aid in the management of PN patients.

### **T2-SPMK-8 Feasibility Assessment of Deep-learning-based Automatic Segmentation of Intercostal Muscles on Computed Tomography Based on Bayesian U-Net**

Yoko Murakami, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the feasibility of deep-learning-based automatic segmentation of intercostal muscles (IMs) using Bayesian U-net on CT images in 110 patients suspected of lung cancer.

#### **METHODS AND MATERIALS**

Using an original training dataset based on manual segmentation of IM in 10 arbitrarily selected cases, automatic segmentation with Bayesian U-Net was obtained in remaining 100 cases. Automatic segmentation was improved by updated training dataset created by manual modification in 10 cases selected in order of larger segmentation uncertainty among the remaining cases, in addition to the original one. For 95 cases, total IM volume (IMV) quantified with automatic segmentation based on final training dataset after similar process was repeated five times, were compared with quantitative pulmonary function and geographic data. For another 16 cases included as an external data set, predictive labels (PL) were generated using the identical final training dataset, and two ground truth (GT1 and GT2) was obtained with independent manual segmentation of right IM by two radiologists in median coronal cross-sections with a thickness of 10mm. Accuracy of IM segmentation by the Bayesian U-Net was assessed with Dice score (DS) as well as Bland-Altman plot analysis for regional IMV between the PL and each of GTs.

## RESULTS

The mean values and limits of agreement for regional IMV between PL and GT1 and between PL and GT2 were -1.2 and 0.3 to -2.6, and -1.7 and 0.4 to -3.7 mm<sup>3</sup>, indicating excellent concordance and slight underestimation tendency for PL. The DSs between GT1 and GT2, between GT1 and PL, and between GT2 and PL were 0.78, 0.77, and 0.80, respectively. Total IMV was larger in males (378.7 ± 66.9 cm<sup>3</sup>) as compared with females (246.7 ± 41.2 cm<sup>3</sup>, and correlated positively with height (r=0.69), body weight (r=0.70), BMI (r=0.48), forced vital capacity (r=0.56), and forced expiratory volume in 1 second (r=0.47).

## CONCLUSION

Automatic segmentation of IM based on Bayesian U-Net was feasible and quantified total IMV correlated with body habitus and pulmonary function test parameters.

## CLINICAL RELEVANCE/APPLICATION

Automatic IM segmentation based on Bayesian U-Net can be applicable to evaluate the relation between IM impairment and respiratory functional disorder.

## T2-SPMK-9 Radiological Markers of Regenerative Maturity in Grade II Muscle Tears

Natalia B. Pugliese SR (*Presenter*) Nothing to Disclose

## PURPOSE

To establish radiological signs of regenerative maturity or immaturity of muscle tears using ultrasound (US) and magnetic resonance imaging (MRI).

## METHODS AND MATERIALS

Between August 2020 and April 2021, thirty six patients with grade 2 muscle tears diagnosed by ultrasound were included. Follow-up MRI and US was performed four weeks after diagnosis, and clinical follow-up four weeks later. According to the presence or absence of symptoms in these two instances, they were classified as immature or mature regeneration, respectively.

## RESULTS

At follow-up imaging, there were no significant differences (p= 0.08) regarding the characteristics of fibers between symptomatic and asymptomatic tears, with 12 (58%) of the asymptomatic tears showing effacement or retraction of the myotendinous junction. We found heterogeneous echogenicity in 13 (87%) symptomatic and 11 (52%) asymptomatic tears, and peripheral hypoechoogenicity in 1 (7%) symptomatic and 8 (38%) asymptomatic (p= 0.03). A positive Doppler signal was identified in 3 (14%) asymptomatic and 15 (100%) symptomatic (p <0.0001) tears. By MRI, the symptomatic tears showed greater signs of edema (p = 0.002), observing linear peripheral edema in 12 (57%) of the asymptomatic ones. The presence of positive Doppler was the variable statistically most related to the presence of symptoms, with an area under the ROC curve of 0.93 (95% CI 0.79-0.99).

## CONCLUSION

Peripheral linear edema by MRI and US is a frequent finding in asymptomatic patients with regenerative maturity. The absence of a Doppler signal in the ultrasound controls one month after the muscle injury, was the best predictor of regenerative maturity.

## CLINICAL RELEVANCE/APPLICATION

Diagnostic imaging studies provide information that influences the decision to return to play, being the absence of Doppler, a useful predictor of regenerative maturity.

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## Abstract Archives of the RSNA, 2023

T2-SPMS

### Multisystem Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPMS-1 Abbreviated Whole-Body MRI as a Novel Imaging Modality for Pediatric Lymphoma Follow-Up: A Multicenter Study**

Bingjie Zheng, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This multicenter prospective study aimed to evaluate the diagnostic confidence and reproducibility of a novel abbreviated 30-minute whole-body MRI (WB-MRI) for response assessment in children and adolescent patients with lymphoma.

#### **METHODS AND MATERIALS**

The study included 103 pediatric patients aged 0 to 18 years with pathologically confirmed lymphoma, who underwent both PET/CT and abbreviated WB-MRI at baseline and during follow-up. Image quality of abbreviated WB-MRI was evaluated using a 5-point Likert scale, and interobserver agreement was assessed. Sensitivity, specificity, and accuracy of abbreviated WB-MRI for detecting residual or recurrent disease were calculated, with PET/CT used as the reference standard.

#### **RESULTS**

The image quality of abbreviated WB-MRI was rated good or excellent in 97% of cases, with high interobserver agreement. Abbreviated WB-MRI demonstrated a sensitivity of 90%, specificity of 96%, and accuracy of 94% for detecting residual or recurrent disease, with excellent agreement between abbreviated WB-MRI and PET/CT findings.

#### **CONCLUSION**

Abbreviated WB-MRI is a feasible and accurate imaging modality for follow-up of pediatric lymphoma patients undergoing various treatments, with high diagnostic performance and excellent image quality. The non-invasive nature and lack of radiation exposure make it a favorable option compared to PET/CT, especially for pediatric patients.

#### **CLINICAL RELEVANCE/APPLICATION**

The results of this study suggest that abbreviated WB-MRI is a clinically relevant and useful imaging modality for follow-up of pediatric patients with lymphoma, offering high diagnostic accuracy and image quality. Abbreviated WB-MRI has the advantage of being non-invasive and without radiation exposure, making it an attractive alternative to PET/CT for monitoring disease progression and response to treatment in pediatric patients.

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## Abstract Archives of the RSNA, 2023

T2-SPNMMI

### Nuclear Medicine & Molecular Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPNMMI-1** Diagnosis of Primary Chyluria by $^{99}\text{Tc}^{\text{m}}$ -dextran Lymphography

Qi Hao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the diagnostic value of  $^{99}\text{Tc}^{\text{m}}$ -dextran (DX) lymphography in primary chyluria.

#### **METHODS AND MATERIALS**

Fifty patients with primary chyluria admitted and diagnosed in our hospital from January 2011 to 2020 were retrospectively collected, and all patients underwent  $^{99}\text{Tc}^{\text{m}}$ -DX lymphography with complete imaging data to observe the lymphatic reflux in bilateral lymphatic vessels of lower limbs, bilateral iliac lymphatics, bilateral lumbar trunks and thoracic duct, as well as the presence of abnormal radiological distribution in both kidney areas, abdominopelvic region and chest.

#### **RESULTS**

Among 50 patients with primary chyluria, early visualization was seen in the renal area in 20 cases (40%), including 11 cases (22.0%) unilaterally and 9 cases (18.0%) bilaterally; 13 cases (26.0%) had unilateral or bilateral slow lymphatic reflux in the lower extremities, 6 cases (12.0%) had abnormal increased radioactivity in the abdomen, 5 cases (10.0%) had abnormal increased radioactivity in the chest; In this study, the thoracic duct visualization was divided into three types: type I: 22 cases (44.0%) with obstruction at the end of the thoracic duct, which showed persistent widening of the venous angle visualization or abnormal drainage, type II: 14 cases (28.0%) with no visualization at the end of the thoracic duct, and type III: 14 cases (28.0%) with transient visualization at the end of the thoracic duct.

#### **CONCLUSION**

$^{99}\text{Tc}^{\text{m}}$ -DX is useful for observing abnormal renal reflux in patients with primary celiac disease, dynamically assessing systemic lymphatic reflux and thoracic duct reflux, and is a guide for the diagnosis of primary chyluria and for assisting in the search for its cause.

#### **CLINICAL RELEVANCE/APPLICATION**

It is a guide for the diagnosis of primary celiac disease and for assisting in the search for its cause.

#### **T2-SPNMMI-2** PSMA PET Imaging Response Following a Single Dose $^{225}\text{Ac}$ J591 Therapy in Metastatic Castration Resistant Prostate Cancer: A Lesion and Patient Based Analysis

Judith Stangl-Kremser, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radionuclide therapy with  $^{225}\text{Ac}$ -labeled PSMA targeting agents have been studied in clinical trials and emerged as a promising treatment option in the management of men with mCRPC. We hypothesized that bone, nodal or visceral metastatic sites may differ in response to this treatment.

#### **METHODS AND MATERIALS**

28 men with mCRPC were treated with  $^{225}\text{Ac}$ -PSMA-J591 from 2017 to 2020 at our center on a prospective single ascending dose phase 1 trial (NCT03276572). Molecular imaging, assessing PSMA expression, was performed in most patients but was not used to select trial participants. We retrospectively analyzed 20 cases that had both a baseline  $^{68}\text{Ga}$ -PSMA-11 PET/CT (bPET) and a post-treatment (fPET). On the patient-level, biochemical response was defined as  $\geq 50\%$  PSA decline after treatment (PSA50 response), and the overall response was assessed on the fPET using PERCIST criteria and on conventional



imaging in cases with measurable disease using RECIST guidelines. For the lesion-based analysis, the SUVpeak of the 3 most- and 3 least-avid lesions of the metastatic sites were measured. Pre- and post-treatment SUVpeak as well as percentage decline of SUVpeak were compared for every lesion. On the patient and lesion level, an objective imaging response was defined as complete or partial response. For the latter, the frequency of an objective imaging response was compared in bone, node, and visceral lesions.

## RESULTS

Twenty patients were analyzed. Of those, 13 men (65%) had prior 223Ra (n=5), 177Lu-PSMA (n=10), two had both. The baseline PSA was 192.5 ng/mL (IQR: 69.1-887.3). 11 men had a PSA50 response and 7 an overall objective imaging response on the fPET. 8 cases had measurable disease; the majority had stable disease and one had progressive disease. Men with a biochemical response trended to have higher odds of having an imaging response. Overall, 204 lesions were measured on the bPET. The median SUVpeak was 4.1 (IQR 1.6-10.5). The decline of post-treatment SUVpeak was significant within all metastatic categories. The median decline in SUVpeak from bPET to fPET was -40% (IQR -71;-1) in bone lesions, -52% (IQR -81;-14) in visceral lesions, and -23% (IQR -53;-6) in nodal lesions. The objective imaging response rate was different in bone lesions (52%), visceral lesions (71%), and nodal lesions (39%) (p=0.0273).

## CONCLUSION

225Ac-PSMA-J591 effectively treats all metastatic categories. However, bone and visceral lesions may respond better than nodal lesions. Our findings need further validation but are informative for trial design and patient counselling.

## CLINICAL RELEVANCE/APPLICATION

Metastatic patterns may influence treatment response to 225Ac-labeled PSMA targeting agents in men with mCRPC and should be considered in treatment planning.

## T2-SPNMMI-3 High-risk Prostate Cancer Staging: Predictors of Extra-prostatic Spread in <sup>18</sup>F-PSMA-1007 PET-CT Scans

Saptarshi Mukherjee, MBBS, FRCR (*Presenter*) Nothing to Disclose

## PURPOSE

PSMA PET-CT has superior diagnostic accuracy over conventional imaging in staging patients with high-risk prostate cancer due to its ability to detect occult extra-prostatic disease. High-risk is defined as per the National Comprehensive Cancer Network: PSA = 20 ng/ml, Gleason score = 8, or a clinical stage of =T3. We sought to explore the predictors of bony and nodal spread in our patient cohort of high risk patients.

## METHODS AND MATERIALS

A total of 411 <sup>18</sup>F-PSMA PET-CT studies were identified through local PACS database search which were done during the 18-month period between 01/01/2021 - 30/06/2022. A total of 192 consecutive patients who underwent a staging PSMA PET-CT scan for high risk disease over an 18 month period were retrospectively reviewed (duplicate records, re-staging studies and patients who had undergone prior treatment were excluded). Medical record search was also done to acquire data for parameters such as PSA, prostate volume (PSA density) Gleason score, MRI Staging and PI-RADS. The data was then categorized based on the PSMA PET-CT reports into extra prostatic disease and confined prostatic disease. Extra prostatic disease is defined for the purposed of this study, as any nodal involvement and/or bone metastases.

## RESULTS

Of the 192 patients, 68 (35%) had evidence of malignant spread to nodes, bones or both (PSMA spread +ve). The remainder (124) showed no evidence of nodal or bony metastatic disease. There was significant difference in PSA levels (p < 0.01; Mann-Whitney U test) between positive (46.3 ; n=68) and negative (26 ; n= 124). A significant proportion (47%) of node positive scans on PSMA were reported to have no nodal involvement on MRI. 50% of patients Gleason score = 8 showed extra-prostatic spread on PSMA PET-CT.

## CONCLUSION

PSA level and Gleason score were accurate predictors of extra-prostatic disease in patients with high-risk prostatic carcinoma. DRE staging was less accurate. A significant proportion of node positive PSMA scans were deemed to have no nodal involvement on MRI scans.

## CLINICAL RELEVANCE/APPLICATION

Within high-risk carcinoma of the prostate, Gleason score and PSA act as accurate predictors of extra-prostatic spread. The role of DRE staging alone as a parameter for high-risk classification needs to be explored further. Almost half of node positive disease on PSMA PET-CT were not picked up by MRI, reiterating the superiority of PET.

## Abstract Archives of the RSNA, 2023

T2-SPNPM

### Noninterpretive Skills (Beyond Imaging) Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPNPM- Widening Disparities in Noninvasive Diagnostic Imaging Volume and wRVU Utilization for Medicare Across Hospital Referral Regions** 1

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate all US Medicare imaging claims for potential healthcare disparities in medical imaging utilization across 306 US hospital referral regions (HRRs).

#### **METHODS AND MATERIALS**

All diagnostic imaging claims submitted to Medicare from 2013 to 2019 were extracted from the Medicare POSPUF dataset, including year, CPT code, wRVUs, and zip code. Dartmouth imaging atlas was used to assign each claim to an HRR via zipcode and gather the number of Medicare enrollees in each HRR. HRRs were aggregated into percentiles based on exam and wRVU utilization rates (highest 10th percentile, 25th, 50th, 75th, and 90th). Compound annual growth rates (CAGR) were calculated.

#### **RESULTS**

Imaging exams totaled 156,739,445 in 2013 and 176,297,932 (+19,558,487, +12.5%) in 2019. In 2013, there were 52,179,386 total imaging wRVUs, and 63,276,990 (+21.3%) in 2019. The exam utilization rate per 1,000 Medicare enrollees across all HRRs was 3188/1,000 US Medicare enrollees in 2013 and 3077 in 2019 (median 1940, standard deviation 948; -135/1,000 since 2013, CAGR -0.6%). The 2019 exam utilization rate across HRRs ranged from 288 in Terre Haute, IN to 9517 in Rochester, MN (33 fold, 188.3% difference). The exam utilization rate CAGR from 2013 to 2019 by HRR utilization rate percentile was 90th percentile +0.1%, 75th +0.2%, 50th -1.6%, 25th -1.9%, and 10th -2.9%. The wRVU utilization rate per 1,000 Medicare enrollees across HRRs was 1739 in 2013 and 2106 in 2019 (median 1940, standard deviation 948; +367.6 since 2013, CAGR +2.5%). The 2019 wRVU utilization rate across HRRs ranged from 237 in Sun City, AZ to 7237 in Rochester, MN (31 fold, 187.3% difference). The wRVU utilization rate CAGR from 2013 to 2019 by HRR wRVU percentile was 90th percentile +3.2%, 75th +3.7%, 50th +1.6%, 25th +1.6%, and 10th -0.01%.

#### **CONCLUSION**

Imaging volume is decreasing and wRVUs are increasing in the US Medicare population, suggesting substitution of lower wRVU exams for those of higher wRVUs. Imaging utilization rates vary by more than 30 fold across HRRs, with the gap widening from 2013 to 2019 and HRRs with high percentile wRVUs per capita growing nearly 3.5% faster than others, annually. These findings could reflect variations in resources and/or allocation of some services across HRRs, and raise potential concern that imaging disparities across HRRs could be increasing, especially access to higher wRVU advanced imaging services.

#### **CLINICAL RELEVANCE/APPLICATION**

Variations in imaging across hospital referral regions are increasing, raising potential concern about healthcare access disparities for some imaging services, especially high wRVU services.

#### **T2-SPNPM- Prevalence of Financial Hardship among Radiology Outpatients and Role of Price Transparency** 3

Desiree Caballero, MSc, BS (*Presenter*) Nothing to Disclose



## **PURPOSE**

The aim of this study was to assess the prevalence of medical financial hardship among patients receiving outpatient imaging at a tertiary center in Southern California and its correlation with price transparency

## **METHODS AND MATERIALS**

Between November 2022 and March 2023 adult patients receiving outpatient advanced imaging (MRI, CT, PET/CT) at a tertiary academic center in Southern California were asked to complete a 15-minute survey screening for financial hardship. Multivariable logistic regression models were used to assess the association between financial hardship and price transparency.

## **RESULTS**

430 patients were included (mean age:57.7 (SD15.6); 57.6% female; 45.9% Caucasian; 5% Black;19.2% Asian; 21.3% Hispanic). There were 14.2% Spanish speakers, and 4.4% Vietnamese. A total of 1.4% were uninsured, 11.7% and 37.3% had Medicaid and Medicare, respectively and 47.2% had commercial insurance. Mean score for financial worry measured by Comprehensive Score for financial Toxicity (COST score) was 24 (SD11) and 34% reported imaging was a financial hardship for them and their family. Material hardship (e.g., medical debt) was reported by 46% with less than 1% declaring bankruptcy. Cost related care nonadherence and imaging nonadherence were reported by 46% and 4.3%, respectively. Having interest in knowing imaging out-of-pocket cost (OOPC) prior to receipt of imaging was associated with lower likelihood of imaging hardship (OR 0.28;95% CI 0.15,0.52), material hardship (OR 0.47; 95% CI 25, 88), and cost-related care nonadherence (OR, 0.40; 95% CI 0.18, 0.90). There was no significant association between knowing imaging OOPC estimate prior to receipt of imaging and financial hardship.

## **CONCLUSION**

Financial hardship is common in outpatient radiology encounters. While those interested in knowing their imaging OOPC are less likely to experience financial hardship, knowing the OOPC does not impact financial hardship.

## **CLINICAL RELEVANCE/APPLICATION**

Given the high prevalence of financial hardship among radiology outpatients, interventions to mitigate financial hardship should be implemented at radiology practices. Price transparency alone may not decrease financial hardship.

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## Abstract Archives of the RSNA, 2023

T2-SPNR

### Neuroradiology Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPNR-1 Is MRI Sensitive Enough to Avoid Lumbar Puncture for the Diagnosis of Creutzfeldt-Jacob Disease?**

Shiva D. Yagobian, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess the yield of lumbar puncture (LP) to diagnose clinically suspected Creutzfeldt-Jacob disease (CJD) in the absence of suggestive MRI findings.

#### **METHODS AND MATERIALS**

This single-center retrospective study included 103 patients clinically suspected of having CJD who underwent MRI and LP within 3 months of each other between December 2014 and January 2023. MRIs were re-interpreted for the study by a fellowship-trained CAQ-certified neuroradiologist blinded to LP results and eventual CJD diagnosis. MRIs were categorized as negative, intermediate, or positive for findings suggestive of CJD. The diagnosis from imaging was then compared to the CJD diagnosis determined clinically by a CSF prion panel. Positive and negative predictive values (PPV, NPV), sensitivity, specificity, and accuracy were calculated. A chi-squared test was performed to examine the relationship between MRI prediction and clinical diagnosis, with a threshold of  $p < 0.05$ .

#### **RESULTS**

Of the 103 patients suspected, 25 were eventually diagnosed with CJD (24%). Of the 103 MRIs, 18 MRIs were positive, 13 were intermediate, and 72 were negative. The PPV for positive MRIs was 83% and the NPV was 96% (95% CI = 88 to 99%). 54% of the intermediate MRIs corresponded to patients who were eventually diagnosed with CJD. Specificity of MRI was 88%, sensitivity was 88%, and accuracy was 88%. MRI categories and eventual diagnosis of CJD were statistically significantly correlated (Chi-square = 56.18,  $p < .00001$ ).

#### **CONCLUSION**

In patients without MRI findings of CJD, the diagnostic yield of lumbar puncture is 4%. In these patients, the expense of a prion panel and an invasive procedure with potential complications may not be appropriate. MRI is an excellent screening tool in cases of clinically suspected CJD.

#### **CLINICAL RELEVANCE/APPLICATION**

Patients without MRI findings of CJD are very unlikely to have confirmation of the disease on lumbar puncture. Screening with MRI may be used to avoid performing an invasive procedure in patients suspected of CJD.

#### **T2-SPNR-10 Not ADC but Advanced Diffusion MRI Parameters can Differentiate Brain Metastases from Glioblastomas**

Kiyohisa Kamimura, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Our purpose was to determine whether advanced diffusion-weighted imaging (DWI) parameters, including time-dependent DWI parameters and microscopic fractional anisotropy ( $\mu$ FA) derived from double-diffusion-encoding (DDE) MRI, are useful for differentiating between glioblastomas and brain metastases.

## METHODS AND MATERIALS

A retrospective study was conducted involving 102 consecutive patients with pathologically proven brain tumors (74 with glioblastoma and 28 with brain metastasis) using a 3T scanner and advanced DWI sequences. Time-dependent DWI was performed using a sequence with oscillating motion-probing gradients (effective diffusion time ( $\tau_{\text{eff}}$ ) = 7.1ms) and a pulsed gradient sequence ( $\tau_{\text{eff}}$  = 44.5ms). In addition to ADC maps at the two diffusion times (ADC7.1ms and ADC44.5ms), maps of the ADC change (cADC) and the relative ADC change (rcADC) between the two diffusion times (cADC = ADC7.1ms - ADC44.5ms), [rcADC = (ADC7.1ms - ADC44.5ms)/ADC44.5ms × 100 (%)] were generated. From the data acquired using a DDE MRI sequence, maps of  $\mu$ FA were generated. The average values of ADC44.5ms, ADC7.1ms, cADC, rcADC, and  $\mu$ FA within enhancing areas of each tumor were measured using a ROI analysis, and those indices were compared between glioblastomas and brain metastases. The diagnostic performances of the parameters were evaluated using ROC curve analysis, and their AUCs were compared using the DeLong's method.

## RESULTS

There was no significant difference in ADC44.5ms nor ADC7.1ms between brain metastases and glioblastomas. The cADC ( $\times 10^{-3}$  mm<sup>2</sup>/s) and rcADC (%) of brain metastases were significantly higher than those of glioblastomas ( $0.25 \pm 0.12$  vs.  $0.14 \pm 0.03$ ;  $P < 0.0001$ ,  $23.6 \pm 9.4$  vs.  $14.5 \pm 5.7$ ;  $P < 0.0001$ ). The  $\mu$ FA of brain metastases were significantly higher than those of glioblastomas ( $0.472 \pm 0.148$  vs.  $0.371 \pm 0.134$ ;  $P = 0.0014$ ). The ROC curve analysis showed significance for cADC, rcADC, and  $\mu$ FA (AUC = 0.890, 0.834, and 0.705;  $P < 0.0001$ ,  $< 0.0001$ , 0.0014; respectively). The AUC for cADC, rcADC, and  $\mu$ FA were significantly greater than that for ADC44.5ms ( $P < 0.001$ , respectively).

## CONCLUSION

The time-dependent DWI parameters and  $\mu$ FA provide valuable information to differentiate between glioblastomas and brain metastases, whereas conventional ADC does not. The cADC may be the most efficient DWI index for distinct differentiation of the two tumor types.

## CLINICAL RELEVANCE/APPLICATION

Time-dependent DWI parameters and  $\mu$ FA may be helpful for differentiation between glioblastoma and brain metastasis.

## T2-SPNR-11 Clinical Feasibility of Multi-pool Model-based CEST Imaging in the Evaluation of Glioma Grading and Tumor Proliferation: Comparison with Apparent Diffusion Coefficient and Magnetization Transfer Ratio Asymmetry

Yasukage Takami (*Presenter*) Nothing to Disclose

## PURPOSE

Although magnetization transfer ratio asymmetry (MTRasym) analysis is often used as a chemical exchange saturation transfer (CEST), it is semiquantitative and entails some pitfalls. Recently, we developed new parameters for CEST imaging by the multi-pool model (MPM). The purpose of this study was to evaluate the clinical significance of the new parameters on CEST imaging by assessing the glioma grading and tumor proliferation on CEST imaging by MPM compared to conventional apparent diffusion coefficient (ADC) and MTRasym.

## METHODS AND MATERIALS

22 patients with gliomas underwent the preoperative MRI. MPM assumes the magnetization transfer (MT) between free water pool, APT pool, and binding water MT pool. "APT density" × "APT transfer rate" × ("Free water T1" or "T2") was visualized as APT\_T1 or APT\_T2, respectively. The maximum values of the parameters on CEST imaging and the minimum values of ADC were measured respectively by regions of interest analysis. Ki-67 index and the presence of isocitrate dehydrogenase 1 (IDH1) mutation were obtained from tumor specimens.

## RESULTS

There were significant positive correlations between MTRasym and Ki-67 index ( $r = 0.78$ ,  $p < 0.01$ ), and APT\_T1 and Ki-67 index ( $r = 0.68$ ,  $p < 0.01$ ). There existed significant negative correlations between T2/T1 and Ki-67 index ( $r = -0.52$ ,  $p < 0.05$ ), and ADC and Ki-67 index ( $r = -0.76$ ,  $p < 0.01$ ). Significant differences in APT\_T1 were observed between grades II and III ( $p < 0.05$ ) and grades III and IV ( $p < 0.05$ ), as well as between grades II and IV ( $p < 0.001$ ). Significant differences in MTRasym, T2/T1, and ADC were observed between grades II and IV ( $p < 0.001$ ). MTRasym and APT\_T1 of IDH1 mutant glioma patients ( $n = 10$ ) were significantly lower than that of IDH1 wild-type patients ( $n = 12$ ) ( $p < 0.001$ ). ADC and T2/T1 of IDH1 mutant glioma patients ( $n = 10$ ) were significantly higher than that of IDH1 wild-type patients ( $n = 12$ ) ( $p < 0.05$ ). APT\_T1 of IDH1 mutant glioblastoma patients ( $n = 2$ ) were significantly lower than that of IDH1 wild-type patients ( $n = 11$ ) ( $p < 0.05$ ). With respect to other parameters, there were no significant differences between IDH1 mutant glioblastoma patients and IDH1 wild-type glioblastoma patients.

## CONCLUSION

These preliminary results suggest that parameters on CEST imaging by MPM seem to correlate with the cell proliferation of gliomas as with MTRasym and ADC in patients with gliomas. APT\_T1 may be more useful than conventional parameters in

evaluating the grade of glioma and the presence of IDH1 mutation in gliomas.

#### **CLINICAL RELEVANCE/APPLICATION**

Parameters on CEST imaging by MPM appear to correlate with glioma cell proliferation as well as MTR<sub>asym</sub> and ADC. In assessing the grade of glioma and the existence of IDH1 mutation in gliomas, APT<sub>T1</sub> may be more helpful than conventional parameters.

### **T2-SPNR-12 Long-term Follow-up of Multinodular and Vacuolating Neuronal Tumors and Implications for Surveillance Imaging**

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The majority of multinodular and vacuolating neuronal tumors (MVNTs) are diagnosed and followed up with imaging, without any change over time. However, there are no surveillance guidelines or quantitative volumetric assessments of these tumors. We evaluated MVNT volumes over long follow-up periods using segmentation tools with the aim of accurate quantitative assessment.

#### **METHODS AND MATERIALS**

All patients with "MVNT" or "multinodular and vacuolating neuronal tumor" in a brain MRI report in our system were reviewed. Patients with only one brain MRI or where MVNT was not clearly the most likely diagnosis were excluded. All MVNTs were manually segmented. For all follow-up exams, absolute and percent volume change from immediately prior and initial exams were calculated.

#### **RESULTS**

48 patients (32 women, median age 50.5 years at first scan) underwent 158 brain MRIs. Median duration between the first and last scan was 15.6 months (interquartile range [IQR] 5.7 months -29.6 months, maximum 6.4 years) and between consecutive scans was 6.7 months (IQR 3.3 months-12.4 months, maximum 4.9 years). Across all 48 individual patients, the median MVNT volume on the original scan was 0.40 cm<sup>3</sup> (IQR 0.16 to 0.77 cm<sup>3</sup>) while the median MVNT volume on the last scan was 0.34 cm<sup>3</sup> (IQR 0.14 to 0.75 cm<sup>3</sup>; p=0.94). In comparison to the immediately prior scan, the median absolute change in volume across every follow-up scan was -0.02 cm<sup>3</sup> (IQR -0.06 to 0.02 cm<sup>3</sup>), while the median percent change in volume was -5.0% (IQR -13.7% to 7.9%). Pearson correlation coefficients between days since immediately prior scan versus absolute and percent volume change from immediately prior scan were r=0.05 (p=0.60) and r= 0.07 (p=0.45) respectively. For the relationship between days since the first scan versus absolute and percent volume change from the first scan, values were r=-0.06 (p=0.53) and r=-0.04 (p=0.67) respectively (Figure 1).

#### **CONCLUSION**

MVNT segmentation across follow-up brain MRI exams did not demonstrate significant volume differences over the follow-up period, suggesting these tumors don't change or enlarge over time. Hence, frequent surveillance imaging of newly diagnosed MVNTs may not be necessary. In particular, no further contrast is needed after a stable follow-up contrast-enhanced exam.

#### **CLINICAL RELEVANCE/APPLICATION**

We provide the first set of quantitative volumetric measurements demonstrating multinodular and vacuolating neuronal tumors do not significantly change over time.

### **T2-SPNR-13 Pretreatment ADC for Prediction of Relapsed and Refractory Primary Central Nervous System Lymphoma**

Ching-Chung Ko (*Presenter*) Nothing to Disclose

#### **PURPOSE**

A subset of primary central nervous system lymphoma (PCNSL) has been shown to undergo an early relapsed/refractory (R/R) period after first-line chemotherapy. This study investigated the pretreatment clinical and MRI features to predict R/R in PCNSL, emphasizing the apparent diffusion coefficient (ADC) values.

#### **METHODS AND MATERIALS**

This retrospective study investigated the pretreatment MRI features for predicting R/R in PCNSL. Only patients who had undergone complete preoperative and postoperative MRI follow-up studies were included. From January 2006 to December 2021, 52 patients from two medical institutions with a diagnosis of PCNSL were included (median follow-up time, 26.3 months). Among these, 24 (46.2%) had developed R/R (median time to relapse, 13 months). Cox proportional hazard regression analyses were performed to determine hazard ratios for all parameters.

## RESULTS

Significant predictors of R/R in PCNSL were female sex, complete response to first-line chemotherapy, and ADC value/ratio ( $P < 0.05$ ). Cut-off points of ADC values and ADC ratios for prediction of R/R were  $0.68 \times 10^{-3} \text{ mm}^2/\text{s}$  and 0.97, with AUCs of 0.78 and 0.77, respectively ( $P < 0.05$ ). Multivariate Cox proportional hazards analysis showed that failure of CR to first-line chemotherapy and low ADC values ( $< 0.68 \times 10^{-3} \text{ mm}^2/\text{s}$ ) were significant risk factors for R/R, with hazard ratios of 5.22 and 14.45, respectively ( $P < 0.05$ ). Kaplan-Meier analysis showed that lower ADC values and ratios predicted significantly shorter progression-free survival ( $P < 0.05$ ).

## CONCLUSION

Pretreatment ADC values and ratios for prediction of R/R offer valuable objective information for the treatment planning in PCNSL.

## CLINICAL RELEVANCE/APPLICATION

Pretreatment ADC for prediction of relapsed and refractory PCNSL offers valuable information in the treatment planning.

## T2-SPNR-14 Development of a Deep Learning Model Integrating Multisequence MRI to Assess EGFR Mutation Subtype in Brain Metastases

Ye Li (*Presenter*) Nothing to Disclose

### PURPOSE

There is a lack of studies evaluating epidermal growth factor receptor (EGFR) mutation status and subtype in non-small cell lung cancer (NSCLC) patients with brain metastasis (BM). The aim of this study was to establish a predictive model based on multisequence MRI using deep learning to identify wild-type (WT) EGFR, EGFR exon 19 deletion (19Del) and exon 21 point mutation (21L858R) simultaneously.

### METHODS AND MATERIALS

A total of 399 patients with proven brain metastases (BM) of non-small cell lung cancer (NSCLC) were retrospectively enrolled and divided into training ( $n=306$ ) and testing ( $n=99$ ) cohort separately based on two timepoints. All patients underwent brain MRI (including T2WI, T2 fluid-attenuated inversion recovery (T2-FLAIR), diffusion weighted imaging (DWI) and contrast-enhanced T1-weighted imaging (T1-CE)) scans. Radiomics features were extracted from each lesion based on four MR sequences. Then a novel algorithm that combined radiomics approach with graph convolutional networks (GCN) architecture (Radio-GCN) was designed for the prediction of EGFR mutation status and subtype. The receiver operating characteristic (ROC) curve analysis was used to evaluate the prediction capabilities of each model.

### RESULTS

We extracted 1290 radiomics features of each MRI sequence. The Radio-GCN model showed an excellent discrimination power for identifying EGFR 19 Del, 21 L858R, and WT in lesion-wise with the AUCs of  $0.9955 \pm 0.0038$ ,  $0.971 \pm 0.013$  and  $1.0 \pm 0$  on independent testing cohort. It also yielded excellent AUCs of  $1.0 \pm 0$ ,  $0.9913 \pm 0.0086$  and  $1.0 \pm 0$  for predicting EGFR mutations respectively in patient-wise. The kappa coefficient reached 0.7352 and 0.8121 in two ways, respectively.

### CONCLUSION

The study demonstrated that a Radio-GCN approach based on multisequence MRI can help to predict the EGFR mutation subtypes in NSCLC patients with BM, which is beneficial to guide individual treatment.

### CLINICAL RELEVANCE/APPLICATION

The constructed Radio-GCN model can be potentially considered as new tools to predict the EGFR mutation status and subtype in NSCLC patients with BM.

## T2-SPNR-2 Myocardial Involvement Characteristics by Cardiac MR Imaging in Neurological and Non-Neurological Wilson Disease Patients

Xiaohu Li, MD, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

To explore the characteristics of myocardial involvement in Wilson Disease (WD) patients by cardiac magnetic resonance (CMR).

### METHODS AND MATERIALS

We prospectively included WD patients and age- and sex-matched healthy population. We applied CMR to analyze cardiac function, strain, T1 maps, T2 maps, extracellular volume fraction (ECV) maps and LGE images. Subgroup analyzes were

performed for patients with WD with predominantly neurologic manifestations (WD-neuro+) or only hepatic manifestations (WD-neuro-).

## RESULTS

41 WD patients (age 27.9±8 years) and 40 healthy controls (age 25.4±2.9 years) were included in this study. Compared to the controls, the T1, T2, and ECV values were significantly increased in the WD group (T1 1085.1±39.1 vs. 1046.5±33.1 ms, T2 54.2±3.3 ms vs. 51.5±2.6 ms, ECV 31.8±3.6% vs. 24.3±3.7%) (all P < 0.001). LGE analysis showed that LGE in WD patients was mainly found in the right ventricular insertion point and interventricular septum. In addition, the WD-neuro+ group showed more severe myocardial damage compared with WD-neuro- group. The Unified Wilson Disease Rating Scale score was significantly correlated with ECV (Pearson's r = 0.64, P < 0.001).

## CONCLUSION

CMR could detect early myocardial involvement in WD patients without overt left ventricle dysfunction. Furthermore, characteristics of myocardial involvement were different between WD-neuro+ and WD-neuro-, and myocardial involvement might be more severe in WD-neuro+ patients.

## CLINICAL RELEVANCE/APPLICATION

We found that CMR T1 mapping could detect early myocardial involvement in WD patients without overt left ventricle dysfunction. Furthermore, characteristics of myocardial involvement were different between WD-neuro+ and WD-neuro-, and myocardial involvement might be more severe in WD-neuro+ patients.

## T2-SPNR-3 Efficacy of 3T Segmented Acquisition Fast Spin-Echo Diffusion-Weighted Imaging for Differentiating Pituitary Abscess from Other Sellar Cystic Lesions

SOICHIRO ISHIIUCHI, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Pituitary abscesses (PAs) are rare and often difficult to differentiate from other sellar cystic lesions (OSCLs). The split acquisition of fast spin-echo signals for diffusion-weighted imaging (SPLICE-DWI) sequence can reduce artifacts and distortion caused by susceptibility differences without sacrificing signal-to-noise ratio. We aimed to evaluate the efficacy of SPLICE-DWI for the differentiation between PA and OSCLs.

## METHODS AND MATERIALS

Our study included 5 PAs and 27 OSCLs (11 Rathke's cleft cysts, 11 cystic pituitary adenomas, and 5 craniopharyngiomas) in 32 consecutive patients who underwent sagittal T1-, T2- and contrast-enhanced T1- weighted imaging (T1WI, T2WI, CET1WI) and SPLICE-DWI at 3T. Two radiologists qualitatively evaluated the signal intensity of cystic components on T1WI, T2WI, and SPLICE-DWI using a 5-point grading system (from 1 [very hypointensity] to 5 [very hyperintensity]). They also assessed the presence of ring enhancement, pituitary stalk enlargement and sphenoid sinusitis, and the percentage of cystic components on CET1WI. In addition, two radiologists measured apparent diffusion coefficient (ADC) values of cystic components, and the difference in the mean ADC values between PA and OSCL groups was assessed. Interobserver agreement was determined by calculating the  $\kappa$  coefficient. Statistical analyses, including receiver operating characteristic curve (ROC) analysis were performed.

## RESULTS

Although the signal intensity of T1WI and T2WI, the presence of stalk enlargement, ring enhancement and sphenoid sinusitis, and the percentage of cystic components were not significantly different between PA and OSCL groups, the signal intensity of cystic components on SPLICE-DWI was significantly different (P = .04). Interobserver agreement for SPLICE-DWI was good ( $\kappa$  = 0.77). Mean ADC value was significantly lower for PA than OSCL (0.62 ± 0.07 vs. 1.83 ± 0.70 × 10<sup>-3</sup>mm<sup>2</sup>/s, P = .002). The area under the ROC curve of the ADC value was 0.952.

## CONCLUSION

Qualitative and quantitative assessment of SPLICE-DWI helps distinguish between PA and OSCLs.

## CLINICAL RELEVANCE/APPLICATION

SPLICE-DWI is a useful non-invasive imaging tool for diagnosing pituitary abscesses.

## T2-SPNR-4 The Experience of a Tertiary Center in South Brazil with Opportunistic Central Nervous Diseases of Immunocompromised Patients

Kelly R. Neves, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Our aim is to present a wide spectrum of opportunistic diseases, including unusual pathologies, that can affect the central nervous system of immunocompromised patients in two tertiary centers at south Brazil.



## METHODS AND MATERIALS

This is a cross-sectional retrospective study performed at two public tertiary centers in South Brazil. We selected a miscellanea of 10 illustrative cases of the various conditions that can affect the immunocompromised patients' central nervous system was selected.

## RESULTS

Amongst 322 patients evaluated during the last 5 years, 10 illustrative cases were selecting to represent a gamut of opportunistic infectious diseases that affect the central nervous system of immunocompromised patients. We show the following diagnosed cases: toxoplasmosis, progressive multifocal leukoencephalopathy (PML mimicking MSA-C), cryptococcosis, tuberculosis, nocardiosis, and paracoccidioidomycosis infections, HIV-encephalitis, HIV vasculopathy, AIDS-related lymphoma (mimicking toxoplasmosis), and a rare case of eosinophilic meningitis caused by *Angiostrongylus catanensis* (in a slug consumer).

## CONCLUSION

The Central Nervous System is frequently affected in immunocompromised patients, as many opportunistic diseases may involve the brain. The clinical manifestations are nonspecific and depend on the type and location of the lesions. As the diagnosis of these entities is frequently made with noninvasive methods, imaging studies, especially magnetic resonance imaging, are very useful tools for the diagnosis.

## CLINICAL RELEVANCE/APPLICATION

These pathological conditions can have similar clinical manifestations, so imaging plays a crucial role in the variable diagnostic conditions and the assessment of the extent of the disease, in order to decide the best therapeutic strategy to be followed.

## **T2-SPNR-5 Usefulness of Amide Proton Transfer Imaging Combined With Pseudocontinuous Arterial Spin Labeling Imaging and Apparent Diffusion Coefficient Map in Differentiating Intracranial Malignant Tumors From Benign Tumors in Young Patients**

Fumine Tanaka, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to assess combined diagnostic value of amide proton transfer (APT), tumor blood flow (TBF) obtained by pseudocontinuous arterial spin labeling (pCASL), and apparent diffusion coefficient (ADC) for differentiating intracranial malignant tumors (MTs) from benign tumors (BTs) in young patients.

## METHODS AND MATERIALS

A total of 20 patients with intracranial tumors aged 0-30 years old were enrolled. Fifteen patients were categorized into MTs by WHO 5th edition classification grade 3 or 4, or ICD behavior code /3, and five patients were categorized into BTs by WHO grade 1 or 2. All the patients were scanned with APT, pCASL, and diffusion-weighted image and evaluated by histogram analysis. Maximum (max), minimum (min), mean, 10th, 25th, 50th, 75th, and 90th percentiles, skewness, and kurtosis of APT, TBF, and ADC values were obtained by the region of interest method. The parameters were compared between the groups by Mann-Whitney U test. Diagnostic performance was evaluated by receiver operating characteristic analysis.

## RESULTS

MTs included diffuse midline glioma H3K27-altered, grade 4 (2), Diffuse paediatric-type high-grade glioma H3-wildtype and IDH-wildtype, grade 4 (2), astroblastoma, MIN1-altered (1), germinoma (3), immature teratoma (2), astrocytoma, NOS, grade 3 (1), atypical teratoid/rhabdoid tumor, grade 4 (1), rhabdomyosarcoma, NOS (1), medulloblastoma, histologically defined, grade 4 (1), and mixed germ cell tumors (1). BTs included pilocytic astrocytoma, grade 1 (1), astrocytoma, IDH-mutant, grade 2 (1), angiocentric glioma, grade 1 (1), posterior fossa ependymoma, group A, grade 2 (1), and supratentorial ependymoma, NOS, grade 2 (1). Mean, 10th, 25th, and 50th percentiles of APT ( $p=0.025$ , respectively), and ADC min showed significant differences ( $p=0.042$ ), while no parameter of TBF showed significant difference between the groups. Median values of APT mean (%), TBF max (mL/100g/min), and ADC min ( $\times 10^{-3}$  mm<sup>2</sup>/sec) were 3.26, 23.73 and 1.14 for MTs, whereas 1.92, 20.83, and 1.03 for BTs. Mean, 10th, 25th, and 50th percentiles of APT, TBF max, and ADC min were the highest AUC values among all parameters of each sequence (0.840, 0.760, and 0.813, respectively) and AUC value for combination of those was 0.933.

## CONCLUSION

Combination of APT, pCASL, and ADC may be useful in differentiating intracranial MTs from BTs in young patients.

## CLINICAL RELEVANCE/APPLICATION

Combination of APT, pCASL, and ADC map may help differentiating malignant and benign intracranial tumors in young patients.

## **T2-SPNR-7 Whole-tumor Histogram Analysis of Postcontrast T1-weighted and Apparent Diffusion Coefficient in Predicting the Grade and Proliferative Activity of Adult Intracranial Ependymomas**

Liu Xianwang (*Presenter*) Nothing to Disclose

### **PURPOSE**

To investigate the value of histogram analysis of postcontrast T1-weighted (T1C) and apparent diffusion coefficient (ADC) in predicting the grade and proliferative activity of adult intracranial ependymomas.

### **METHODS AND MATERIALS**

Forty-seven patients with histologically proven adult intracranial ependymomas were retrospectively collected. The histogram parameters, including minimum, maximum, mean, and Perc.01, Perc.05, Perc.10, Perc.25, Perc.50, Perc.75, Perc.90, Perc.95, Perc.99, as well as standard deviation (SD), variance, coefficient of variation (CV), skewness, kurtosis, and entropy of T1C and ADC images were extracted from the whole tumor using FireVoxel software. Differences in histogram parameters between grade 2- and grade 3- adult intracranial ependymomas were compared. Receiver operating characteristic curves and logistic regression analyses were conducted to determine the differential diagnostic performance. Spearman's correlation analysis was used to evaluate the relationship between histogram parameters and the Ki-67 proliferation index.

### **RESULTS**

Grade 3 intracranial ependymomas showed significantly higher Perc.95, Perc.99, SD, variance, CV, and entropy of T1C (all  $p < 0.05$ ), lower minimum, mean, Perc.01, Perc.05, Perc.10, Perc.25, Perc.50 of ADC, higher CV and entropy of ADC (all  $p < 0.05$ ), compared to grade 2 intracranial ependymomas. Entropy (T1C) and Perc.10 (ADC) have a higher diagnostic performance with AUCs of 0.805 and 0.827 among the histogram parameters of T1C and ADC, respectively. The diagnostic performance was further improved by combining the entropy (T1C) and Perc.10 (ADC), with an AUC of 0.857. Significant correlations were observed between significant histogram parameters of T1C and ADC and the Ki-67 proliferation index ( $p = 0.001-0.044$ ).

### **CONCLUSION**

Whole-tumor histogram analysis of T1C and ADC may be a promising approach in predicting the grade and proliferative activity of adult intracranial ependymomas.

### **CLINICAL RELEVANCE/APPLICATION**

Grading and proliferative activity significantly influence treatment decision-making in adult intracranial ependymomas. Whole-tumor histogram analysis of T1C and ADC are useful to preoperatively evaluate the grade and proliferative activity of adult intracranial ependymomas. The combination of entropy (T1C) and Perc.10 (ADC) achieved the best diagnostic performance.

## **T2-SPNR-8 Radiomics-based Prediction of TERT Promoter Mutation in Intracranial Meningiomas**

Burak H. Akkurt, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

In meningiomas, TERT promotor mutations are rare but qualify diagnosis of anaplasia, directly impacting adjuvant therapy. Effective screening for patients at risk for promotor mutations could enable more targeted molecular analyses and improve diagnosis and treatment.

### **METHODS AND MATERIALS**

Semiautomatic segmentation of the meningiomas was performed on preoperative magnetic resonance imaging. Discriminatory power to predict TERT promotor mutations was analyzed in grade 2/3 meningiomas using a random forest algorithm with an increasing number of radiomic features. Two final models with 5 and 8 features were built with both fixed and differing radiomics features. Each model has been fully developed 100 times to eliminate random effects and avoid overfitting.

### **RESULTS**

117 image sets including training (N=94) and test data (N=23) were analyzed. Established 5- and 8-feature models with both fixed and different radiomics features enabled prediction of TERT with similar but excellent performance. Of note, a significant increase in the average discriminatory power up to the fifth feature included was observed, while addition of further features up to N=8 features only slightly increased the performance. 5-feature (different/ fixed) model predicted TERT promotor mutation status with a mean AUC of 91.8%/94.3%, mean accuracy of 85.5%/88.9%, mean sensitivity of 88.6%/91.4%, mean specificity of 83.2%/87.0%, and a mean Cohen's Kappa of 71.0%/77.7%. 8-feature (different/ fixed) model predicted TERT promotor mutation status with a mean AUC of 92.7%/94.6%, mean accuracy of 87.3%/88.9%, mean sensitivity of 89.6%/90.6%, mean specificity of 85.5%/87.5%, and a mean Cohen's Kappa of 74.4%/77.6%.



## **CONCLUSION**

Radiomics based machine learning enables prediction of TERT promotor mutation status in meningiomas with excellent discriminatory performance. Future analyses in larger cohorts should include grade 1 lesions as well as additional molecular alterations.

## **CLINICAL RELEVANCE/APPLICATION**

Radiomics might help in the non-invasive characterization of meningiomas, impacting diagnosis and therapy.

## **T2-SPNR-9 Predicting Meningioma Recurrence/progression Based on MRI Radiomics**

Tao Han (*Presenter*) Nothing to Disclose

## **PURPOSE**

Preoperative prediction of meningioma recurrence/ progression should help in the selection of surgical options and provides a basis for guiding meningioma patients to achieve individualized treatment. However, only a few radiological features have been identified to aid in prediction. The aim of this study was to develop and validate an MRI-based nomogram to predict meningioma recurrence/progression.

## **METHODS AND MATERIALS**

This retrospective study collected 88 patients with surgically pathologically confirmed meningiomas, including 28 patients with postoperative tumor recurrence and 60 patients with non-recurrence. All cases were randomly divided into training and validation sets according to 7:3, and 1874 features were extracted from each of preoperative T2WI and T1WI-enhanced images, respectively, and least absolute shrinkage and selection operator (LASSO) regularization was used to determine the best combination of clinical and MRI features to predict meningioma recurrence/progression, and subsequently machine learning algorithms were applied to construct a meningioma recurrence risk assessment prediction model, using receiver operating characteristic (ROC) curve analysis to determine predictive performance, and calibration curve and decision curve analysis to validate the consistency and clinical validity of the nomogram.

## **RESULTS**

Finally, twelve radiomics features closely related to the risk of meningioma recurrence were screened to construct a nomogram of the RF model, and the results showed that the model had good predictive performance with AUCs of 0.950 and 0.852 in the training and validation sets, respectively.

## **CONCLUSION**

The predictive model based on MRI radiomics features has good predictive performance in predicting meningioma recurrence/ progression and can be applied to clinical practice.

## **CLINICAL RELEVANCE/APPLICATION**

Radiomics models based on T2WI and T1C are helpful for predicting meningioma recurrence/progression.

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## Abstract Archives of the RSNA, 2023

T2-SPOB

### OB/Gynecology Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPOB-1 Could the 40keV Monochromatic Images in Dual-Energy Spectral CT Increase the Value and Consistency of Peritoneal Cancer Index in Advanced Epithelial Ovarian Cancer for Junior Radiologists**

Bao Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the value of using 40keV virtual monochromatic images (VMI) in dual-energy spectral CT (DEsCT) to increase peritoneal cancer index (PCI) value in advanced epithelial ovarian cancer (EOC) for junior radiologists and their consistency with senior radiologists.

#### **METHODS AND MATERIALS**

Retrospectively analyzed 32 advanced EOCs (27 serous, 2 mucinous and 3 clear cell carcinomas, and 28 in stage III and 4 in stage IV) who underwent primary cytoreduction (11 in satisfied and 21 in dissatisfied groups). VMI of venous phase at 40keV and 70keV (equivalent to 120kVp) were reconstructed from abdominal and pelvic DEsCT. A senior and junior radiologist evaluated VMIs double-blindly in the degree of ascites, abdominal and pelvic anatomical structures using Sugarbaker PCI standards and performed CT-PCI scoring for the entire and upper abdomen separately. SPSS 27.0 and Medcalc 20.1.0 were used for statistical analyses. Binary logistic regression was used to analyze parameters influencing the outcome prediction of unsatisfactory tumor reduction surgery.

#### **RESULTS**

The satisfied group had lower serum CA-125 level than the unsatisfied group (112 vs. 654 u/ml,  $U=58$ ,  $P=0.023$ ). And the upper abdominal (2 vs. 6,  $U=43$ ,  $P=0.003$ ) CT-PCI scores than dissatisfied group. There was no significant difference in age, FIGO stage, histological type, and ascites degree between these two groups. The 70 keV CT-PCI score was an independent factor in causing initial tumor reduction dissatisfaction in advanced EOCs ( $OR=1.785$ ,  $95\% CI=1.024-3.111$ ,  $P=0.041$ ). The 70keV CT-PCI scores of senior and junior radiologists were all lower than that of the 40keV (senior: mean difference  $=-1.81$ ,  $t=-6.06$ ,  $P<0.001$ ; junior: mean difference  $=-2.84$ ,  $t=-6.99$ ,  $P<0.001$ ). The CT-PCI scores of the junior was lower than that of the senior when using 70keV VMI (mean difference  $=-1.13$ ,  $t=-4.52$ ,  $P<0.001$ ), but no significant difference using the 40keV VMI (mean difference  $=-0.09$ ,  $t=-1.36$ ,  $P=0.184$ ).

#### **CONCLUSION**

The use of 40keV VMI improves CT-PCI scores for both senior and junior radiologists and reduces their differences.

#### **CLINICAL RELEVANCE/APPLICATION**

The 40keV VMI in DEsCT increase the value and consistency of PCI in advanced EOC for junior radiologists, help clinical evaluation of tumor load in patients with advanced EOC, and guide the development of clinical treatment strategies.

#### **T2-SPOB-2 OvCA Finder: An Interpretable Hybrid Model Integrating Multimodal Information for Ovarian Cancer Diagnosis**

Huiling Xiang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop an interpretable hybrid model (OvcaFinder) from multimodal information that allows preoperative identification of ovarian cancer.

## METHODS AND MATERIALS

Consecutive patients with at least one pathology-confirmed adnexal lesion visible by transvaginal ultrasound were enrolled in this study. Ultrasound images of all lesions were independently assessed by five readers using the Ovarian-Adnexal Reporting and Data System (O-RADS). The following three models were built and internally validated using 724 cases from Hospital 1: a clinical model with variables including age, lesion diameter, and cancer antigen 125 concentration; an image-based DL predictive model; and our newly developed model, OvcaFinder, using multimodal information. The performance of the models was then externally validated using 387 cases from Hospital 2 and the diagnostic performances of the models were compared.

## RESULTS

The readers achieved mean areas under the receiver operating characteristic curve (AUCs) of 0.927 and 0.904, using the O-RADS for the internal and external test datasets, respectively. OvcaFinder outperformed the clinical model (AUC, internal dataset: 0.978 vs. 0.936,  $p = .007$ ; external dataset: 0.947 vs. 0.842,  $p < .001$ ) and the image-based DL predictive model (AUC, internal dataset: 0.978 vs. 0.970,  $p = .152$ ; external dataset: 0.947 vs. 0.893,  $p < .001$ ). Readers assisted by OvcaFinder showed significant improvements in AUCs (internal dataset: 2.3-8.0%; external dataset: 1.9-5.3%) and a reduction in false positive rate (internal dataset: 13.3%,  $p = 0.029$ ; external dataset: 8.3%,  $p = 0.033$ ) than those without.

## CONCLUSION

OvcaFinder, an interpretable hybrid model that integrates multimodal information, could be used by radiologists as a non-invasive tool for reliably diagnosing ovarian cancer, thus improving radiologists' diagnostic performance and helping to determine the appropriate treatment strategies.

## CLINICAL RELEVANCE/APPLICATION

OvcaFinder, a novel hybrid model constructed from multimodal information can effectively distinguish between ovarian cancer and benign lesions and thus significantly improve the diagnostic performance of radiologists.

## T2-SPOB-3 Subendometrial Enhancement and Peritumoral Enhancement in the Uterus: Assessment of the Optimal Timing with High Spatial-temporal Resolution Multiphasic Contrast Enhanced-MRI

Takahiro Tsuboyama, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The scanning protocol of dynamic contrast-enhanced MRI (DCE-MRI) for endometrial cancer has not been standardized due to the lack of evidence regarding the optimal timing for subendometrial enhancement (SEE) and peritumoral enhancement (PTE). The purpose of this study was to assess SEE and PTE with high spatial-temporal resolution multiphasic DCE-MRI using differential subsampling with cartesian ordering (DISCO).

## METHODS AND MATERIALS

Fifty women (mean age, 56.8; range, 25-91 years) who underwent DCE-MRI for the assessment of suspected uterine diseases were included. Nineteen of them were proved to have endometrial cancer. DCE-MR included 11 early phases obtained with DISCO (voxel size, 0.6\*1.0\*4.0 mm) in which the first 10 phases were acquired from 20 to 50 s after contrast injection with temporal resolution of 3 s, followed by 11th phase with a full k-space data sampling at 60 s. One radiologist placed regions of interest on the uterine structures, and time-intensity curves were generated. Enhancement ratios (ERs) and contrast ratios (CRs) were calculated and compared using Wilcoxon test and Friedman test. Correlation between the start of uterine enhancement and the start of the plateau or peak of SEE was evaluated using a correlation coefficient.

## RESULTS

SEE was detected in 48 of the 50 patients. It showed various degree of peak ER (range, 0.59-3.56). During the early phases, it reached a plateau in 25 patients and showed a progressive enhancement in the other 23 patients. The plateau started variably from 32 to 47 sec after contrast injection and had a moderate positive correlation with the contrast arrival time at the uterus ( $r = 0.52$ ,  $P < 0.01$ ). The mean ER of SEE on each phase was increased with time and was significantly the highest at 60 sec ( $P < 0.01$ ). CR between SEE and inner myometrium also increased with time and was the highest during 41 to 60 sec. PTE was detected in 15 patients with an endometrial cancer and displayed significantly higher peak ER and significantly earlier start of a plateau compared with SEE ( $P < 0.01$ ). The highest CR between PTE and SEE was observed during 32-44 s.

## CONCLUSION

SEE may show optimal enhancement and contrast at 60 s after contrast injection and have different enhancement patterns from those of PTE. Given some varieties in the enhancement patterns of SEE and PTE among patients, DISCO may be useful to catch the optimal timing for the detection of SEE and PTE.

## CLINICAL RELEVANCE/APPLICATION

Accurate assessment of SEE and PTE with high spatial-temporal resolution DCE-MRI using DISCO may increase the accuracies of preoperative staging of endometrial cancer.

### **T2-SPOB-4 Diagnostic Ability of Single-Shot Fast Spin-Echo T2-Weighted MRI with Deep Learning Reconstruction for the Assessment of Myometrial Invasion in Endometrial Cancer: A Comparison with Standard Sequences using PROPELLER and Fast Spin-Echo Imaging**

Takahiro Tsuboyama, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Single-shot fast spin-echo (SSFSE) T2-weighted MRI (T2WI) with deep learning reconstruction (DLR) is reported to achieve high image quality in an ultra-short acquisition time. The purpose of this study was to compare its diagnostic ability for the assessment of myometrial invasion in endometrial cancer with that of standard but time consuming T2WI using periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER) and fast spin-echo (FSE) imaging.

#### **METHODS AND MATERIALS**

Seventy-two consecutive patients who underwent preoperative dynamic contrast-enhanced (DCE) MRI for endometrial cancer were included. For the standard T2WI, para-axial FSE and parasagittal PROPELLER imaging were obtained. Para-axial and -sagittal SSFSE T2WI with DLR (SSFSE-DLR-T2WI) were also acquired. Two radiologists independently assessed the following four MRI sets; standard T2WI, standard T2WI+DCE, SSFSE-DLR-T2WI, and SSFSE-DLR-T2WI+DCE. Noise, artifacts, the visibility of the junctional zone and serosa of the uterus and that of the tumor were compared between standard T2WI and SSFSE-DLR-T2WI using the Wilcoxon signed-rank test. The diagnostic accuracies of the four MRI sets regarding superficial and deep myometrial invasion of the endometrial cancer were compared using the receiver operating characteristic analysis and the Cochran's Q test.

#### **RESULTS**

SSFSE-DLR-T2WI was significantly better than standard T2WI regarding noise, artifacts, and the visibility of the uterine structures and the tumor for both readers ( $p < 0.01$ ). As for the diagnosis of myometrial invasion, mean AUCs of standard T2WI, standard T2WI+DCE, SSFSE-DLR-T2WI, and SSFSE-DLR-T2WI+DCE by the two readers were 0.76, 0.83, 0.72, and 0.80, respectively for superficial myometrial invasion, and 0.87, 0.92, 0.82, and 0.91, respectively for deep myometrial invasion. There were no significant differences in AUCs, sensitivities, specificities, and accuracies between standard T2WI and SSFSE-DLR-T2WI and between standard T2WI+DCE and SSFSE-DLR-T2WI+DCE for both readers. Sensitivities for superficial myometrial invasion were significantly lower with standard T2WI than with standard T2WI+DCE and with SSFSE-DLR-T2WI+DCE for both readers ( $p < 0.05$ ).

#### **CONCLUSION**

For the assessment of myometrial invasion in endometrial cancer, SSFSE with DLR can provide better image quality and equivalent diagnostic accuracies compared with standard T2WI.

## CLINICAL RELEVANCE/APPLICATION

Standard T2WI can be replaced by SSFSE with DLR for the assessment of myometrial invasion in endometrial cancer, which can reduce the examination time considerably.

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## Abstract Archives of the RSNA, 2023

T2-SPPD

### Pediatric Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPPD-1 Pediatric H3K27 Altered Diffuse Midline Gliomas: Imaging Features in 37 Children of One Institution**

Elzbieta Jurkiewicz, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Pediatric diffuse midline glioma PDMG arises from the thalami, hypothalamus, pineal gland, brainstem, cerebellum, and spinal cord. Regardless the location, the prognosis of PDMG is poor with a 2-year survival rate of <10%. According the 2021 WHO classification pediatric diffuse high grade gliomas are recognized as: diffuse midline glioma, H3K27 altered, diffuse hemispheric glioma, H G34-mutant, diffuse pediatric high-grade glioma, H3-wildtype/IDH-wildtype and infant-type hemispheric glioma. The overexpression of EZHIP, or an EGFR mutation are also observed in these tumors. The possibility of surgical resection is often limited, due to the involvement of critical brain structures. Radiation or chemotherapy is standard. We present MR examinations of 37 patients with diffuse midline glioma, H3 K27-altered, aged from 40 months to 17 years; median age 9.6 years.

#### **METHODS AND MATERIALS**

All patients were examined on 1.5 T scanner with protocol including T2/FLAIR images, DWI, SWI, and T1-weighted images without and with contrast injection. We characterized the structural MR imaging features of these tumors: presence of calcifications, hemorrhage, necrosis, and leptomeningeal spread. The presence and degree of contrast enhancement were also assessed. A biopsy was performed in all patients. Pathological/microscopic and molecular characterization was carried out in all children.

#### **RESULTS**

Tumors were located in pons in 28 patients, midbrain in 12, thalamus in 6, medulla oblongata in 6, and in spinal cord in one child. All tumors were hypointense on T1- and heterogeneously hyperintense on T2/FLAIR images. Contrast enhancement was seen in 16 patients (punctate or rim), restriction diffusion in 9. Exophytic component was noted in one child. Hydrocephalus was present in 5, necrosis in 9, and hemorrhagic component in 3 patients. Leptomeningeal spread at the time of diagnosis were diagnosed in one case. The mutations c.83A>T H3F3A were recognized in 35 children and mutations c.83A>T HIST1H3B (H3C2) in 2 patients.

#### **CONCLUSION**

We found that midline gliomas with histone H3 K27M mutation centered within the thalamus and brainstem were solid with infrequent exophytic component and hemorrhage.

#### **CLINICAL RELEVANCE/APPLICATION**

Molecular characterization of the PDMG may be relevant to individual patients for personalized molecular therapies based on genomic analysis of the tumours.

#### **T2-SPPD-2 [<sup>11</sup>C] Methionine PET in Diagnosing Pediatric Low-grade Gliomas**

Yooyoung Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Positron emission tomography (PET) imaging of the brain with amino acid tracers, such as [<sup>11</sup>C] Methionine (MET), is helpful in the evaluation of brain tumors. Although MET-PET has been extensively used in adults and some pediatric brain tumors,

data on MET-PET imaging of pediatric low-grade gliomas (pLGG) are scarce. This study aimed to investigate the diagnostic performance of MET-PET in diagnosing pLGGs.

## **METHODS AND MATERIALS**

Fifteen patients with newly diagnosed pLGG and twenty-six previously treated pLGG patients were evaluated with MET-PET and magnetic resonance imaging. Biopsy or tumor resection was performed in all patients within 6 months of the MET-PET. Qualitative and semi-quantitative analysis that included tumor to brain uptake ratios (TBR) were performed. TBR was consisted of TBRmax, TBRpeak, and TBRmean analyses. TBR >1 was used to define a positive MET-PET test.

## **RESULTS**

The sensitivity of MET-PET for diagnosing newly diagnosed pLGG was 87% for TBRmax and TBRpeak, 80% for TBRmean, and 94% for qualitative interpretation. The sensitivity of MET-PET for diagnosing previously treated pLGG was 100% for TBRmax and TBRpeak, 81% for TBRmean, and 96% for qualitative interpretation. The sensitivity for the combined cohort was 95% for both TBRmax and TBRpeak, 80% for TBRmean, and 95% for qualitative evaluation.

## **CONCLUSION**

Both quantitative and qualitative MET-PET have high sensitivity in diagnosing pLGG, both newly diagnosed and previously treated.

## **CLINICAL RELEVANCE/APPLICATION**

With its high sensitivity, MET-PET can be used to complement equivocal MRI.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T2-SPPH

### Physics Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPPH-1 Quantification of Radial and Azimuthal Variation in Spatial Resolution due to Patient Positioning on Energy Integrating and Deep Silicon Photon Counting Detector CT**

Aria M. Salyapongse, BS (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Mispositioning in CT degrades spatial resolution. Existing CT technologies address this degradation using scan modes that increase view angle sampling. In this work, we investigate spatial resolution loss away from isocenter for a prototype deep silicon photon-counting detector (PCD) CT scanner and compare with existing energy-integrating detector (EID) CT.

##### **METHODS AND MATERIALS**

We performed three sets of scans on a wire phantom at four radial positions in the bore (isocenter, 6.7 cm, 11.8 cm, and 17.1 cm off isocenter). The acquisition modes were: 120 kV EID CT, 120 kV high-definition (HD) EID CT, and 120 kV PCD CT. HD mode used double the projection view angles as the "regular" EID scan mode. Diameter of the wire was calculated by taking the full width of half max (FWHM) of a profile drawn over the radial and azimuthal directions of the wire. Change in apparent size of the wire was assessed by taking the ratio of the radial or azimuthal diameter at each position to the radial or azimuthal diameter at isocenter.

##### **RESULTS**

The deep silicon PCD CT had the smallest change in the ratio of the wire diameter for both radial (ratio of  $1.00 \pm 0.09$  versus  $1.15 \pm 0.01$  and  $1.21 \pm 0.04$ ,  $p < .001$ ) and azimuthal (ratio of  $0.99 \pm 0.09$  versus  $1.36 \pm 0.01$  and  $1.12 \pm 0.01$ ,  $p < .001$ ) directions versus EID and HD EID respectively. HD EID CT had a smaller change in the ratio of the wire diameter in the azimuthal direction compared with EID CT ( $p < .001$ ), and a larger change in the radial direction compared with EID CT ( $p < .001$ ).

##### **CONCLUSION**

Deep silicon PCD CT exhibits less change in spatial resolution in both the radial and azimuthal directions compared with both regular and HD modes on EID CT.

##### **CLINICAL RELEVANCE/APPLICATION**

Deep silicon PCD CT better preserved spatial resolution away from isocenter compared to EID CT which could translate into better bone and lung detail in regions located far away from isocenter.

#### **T2-SPPH-10 Accuracy of Volume and Linear Dimension Measurements of Hepatic Lesions with Dual Energy CT**

Yifang Zhou, PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

It has been proposed to use the volumes of hepatic lesions as a better metric than linear dimensions. However, as compared to linear dimensions, lesion volumes are more susceptible to segmentation error, hence the measurement accuracy remains unknown. We aimed to study the accuracy of both lesion volume and linear dimension measurements with dual energy CT using a simulated multi-phase liver phantom.

## METHODS AND MATERIALS

The liver was simulated using material composition following ICRU 44. It was embedded in an abdomen phantom containing thoracic and lumbar spines. 34 lesions of iodine, iron, fat, and cyst were placed in the liver with known volumes (0.09 - 8.57 cc) and maximum linear dimensions (MLD) (10- 35 mm). The lesions are of various shapes (ellipsoidal and lobular), and contrast (-100 to 30 HU). The non-contrast, arterial, and venous phases were simulated by perfusing the parenchyma with different iodine concentrations (0, 0.68, and 1.89 mg/cc) in three consecutive slabs (40 - 50 mm thickness each). A GE Revolution CT was used at the dual-energy mode in three repeats with CTDIvol of 14 mGy (slice thickness 2.5 mm). 28 visually discernable lesions were contoured using GE AW-3.2 with auto segmentation and careful user correction for monochromatic reconstructed images of 50- 100 keV.

## RESULTS

Compared with the known values, the overall volumes were overestimated across different energies by 9.4% +12.5%, whereas the overall MLDs were found underestimated by 4.7% +8.3%. The cyst and fat volumes were found most accurate with 3.1%+5.7% and 8.8%+8.1%, respectively, whilst the corresponding MLDs were with accuracies of 1.1%+1.8%, and 9.7%+9.5%. The iron and iodine volumes were measured higher than the ground truth by 12%+10% and 10%+14%, respectively, whilst the corresponding MLDs were found lower by 6.3%+6.7% and 3.2%+8.3%. The optimal energy for the volumes of the cyst, fat, iron, and iodine was found to be  $\leq 70$  keV, 55 keV, 65 keV, and 70 keV, respectively. For MLD measurements, the results were less dependent on energy with the overall accuracy of 4.7%+8.4%.

## CONCLUSION

With the fast-kVp switch dual-energy CT, the liver lesion volumes were overestimated by 9.4%  $\pm$ 12.5%, and the optimal energies were identified with better accuracy. The MLD were underestimated with overall accuracy of 4.7%  $\pm$ 8.3% and the results were found less dependent on energy.

## CLINICAL RELEVANCE/APPLICATION

Provide hepatic lesion volume and linear dimension accuracy in multiphase liver CT scans.

## T2-SPPH-11 Assessment of a Low-Dose Single-Scan Dynamic CT Myocardial Perfusion Technique using a Helical Scan Mode

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

## PURPOSE

This study assessed the reproducibility and accuracy of a low-dose single-scan dynamic CT myocardial perfusion technique using a fast-pitch helical scan mode available on standard CT scanners.

## METHODS AND MATERIALS

A total of 6 Yorkshire Swine (48.7  $\pm$  7.4 Kg) were assessed under rest and stress conditions. Using a 320-slice CT scanner, 6 and 6 pairs of repeated CT perfusion measurements were obtained in helical and volume scan modes (100 kVp, 200 mA, and 2.5 s scan time), respectively. Myocardial perfusion measurements derived from a previously validated single-volume myocardial CT perfusion technique were used as a reference for accuracy assessment of measurements obtained from helical scans. Each helical pair was acquired following the acquisition of a volume pair, under the same perfusion conditions. Both contrast (0.5 mL/kg; 370 mgI/mL) and a diluted contrast/saline chaser (0.5 mL/kg; 30:70 contrast/saline) were injected peripherally at a rate of 5 mL/s. Following bolus tracking and triggering, a single scan was acquired at the peak of the aortic enhancement. Both the bolus tracking and the single scan data were used to derive perfusion in mL/min/g using a first-pass analysis model. The coronary perfusion territories of the left anterior descending (LAD), left circumflex (LCx) and right coronary artery (RCA) were automatically assigned for vessel-specific regional perfusion analysis. The reproducibility and accuracy of myocardial perfusion measurements in each coronary perfusion territory were assessed via regression analysis. The average CT dose index (CTDI) of perfusion measurements was recorded.

## RESULTS

The first (PHel1) and second (PHel2) helical CT perfusion measurements were related by  $P_{Hel2} = 0.89P_{Hel1} + 0.13$  ( $r = 0.91$ ; RMSE = 0.21 mL/min/g; RMSD = 0.20 mL/min/g) for the LAD, LCx, and RCA perfusion territories. The myocardial perfusion measurements obtained from helical and volume scans were also related by  $P_{Hel} = 0.98P_{Vol} + 0.02$  ( $r = 0.99$ ; RMSE = 0.04 mL/min/g; RMSD = 0.05 mL/min/g) when assessed in the whole myocardium, and by  $P_{Hel} = 0.95P_{Vol} + 0.04$  in LAD, LCx, and RCA perfusion territories. The average CTDI of CT perfusion measurement was 30.1 mGy and 13.3 mGy for helical and volume acquisitions, respectively.

## CONCLUSION

A standard CT scanner in a helical scan mode can provide reproducible and accurate myocardial perfusion measurement in mL/min/g using a low-dose single-scan dynamic CT myocardial perfusion technique, which enables the clinical applicability of the technique.



## CLINICAL RELEVANCE/APPLICATION

Using a standard CT scanner in a helical mode, this technique will provide a noninvasive tool that allows comprehensive concurrent evaluation of coronary anatomy and physiology for routine assessment of coronary artery disease.

### T2-SPPH-12 Urinary Stone Differentiation using Material Decomposition Images in Dual Energy CT Urography

Yannan Cheng, BS,BS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the feasibility of differentiating urinary stones using material decomposition (MD) images in dual energy CT urography (DECTU).

#### METHODS AND MATERIALS

108 consecutive patients (mean age:  $48.22 \pm 14.69$ y, male vs female: 75 vs 33) with suspected urinary stones and underwent triphasic DECTU were included. MD images with various basis material pairs at nephrographic (ENP) and excretory (EEP) phase were transferred to an AW4.7 for analysis. For stones larger than 3mm, regions of interest were defined as the largest circumference on the axial section of the images. MD densities of stones were measured using the GSI Viewer. Stones were divided into the pure calcium oxalate (pCaO: n=34), mixed calcium oxalate (mCaO: n=14) and mixed calcium phosphate (mCaP: n=70) according to the results of Fourier infrared spectrometer. One way ANOVA or Kruskal-Wallis H test was used to compare the MD density among the three stone groups with adjusted significance level. Thresholds for differentiating urinary stones were determined using receiver operating characteristics (ROC) analysis.

#### RESULTS

The MD densities of stones using different basis material pairs are listed in Tab.1. Significant differences on Calcium (Water) MD images at ENP were found between pCaO and mCaO; mCaO and mCaP. While COD (HAP) MD images at ENP provided higher ability to distinguish pCaO from mCaP. The ranges of AUC of using MD density on ENP images were 0.68-0.75 (Tab.2) and MD density on COD (HAP) based images at ENP provided higher ability to differentiate and display the three stones (Fig.1).

#### CONCLUSION

MD density on COD (HAP) based images at ENP provide relatively high accuracy in distinguishing calcium oxalate from calcium phosphate.

## CLINICAL RELEVANCE/APPLICATION

Material decomposition images may play a role in identifying calcium oxalate stones and calcium phosphate, especially COD (HAP) MD images.

### T2-SPPH-13 Diagnostic Value of CT Lymphangiography in Patients with Primary Chyluria

Qi Hao (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the application value of CT lymphangiography in diagnosis in patients with primary chyluria.

#### METHODS AND MATERIALS

Clinical and CTL imaging data of 79 patients diagnosed with primary chyluria were collected retrospectively. For CTL, the indexes were: ?Distribution of abnormal lymphatic vessels in the kidney: unilateral or bilateral kidney, renal sinus, renal parenchymal, suprahilum area and subhilum area; ?Distribution of perirenal and retroperitoneal abnormal lymphatic vessels: retroperitoneal, lumbar trunk, renal perivascular area, fatty capsule, adrenal area, etc; ?Distribution of dilated lymphatic vessels and lymphatic reflux in chest, abdomen and pelvis. The clinical characteristics and CTL signs of patients with primary chyluria were statistically described by the composition ratio of classification variables.

#### RESULTS

CTL showed abnormal lipiodol deposition in kidney in 74 cases (93.7%), single kidney in 55 cases (69.6%), bilateral kidneys in 19 cases (24.1%), renal sinus in 74 cases (93.7%), renal parenchyma in 37 cases (46.8%); suprahilum area in 61 cases (77.2%), 52 cases (65.8%) were unilateral and 9 cases (11.4%) were bilateral; subhilum area in 61 cases (77.2%), 47 cases (59.5%) were unilateral and 14 cases (17.7%) were bilateral; retroperitoneal area in 78 cases (98.7%); lumbar trunk area in 76 cases (96.2%), 20 cases (25.3%) were unilateral and 56 cases (70.9%) were bilateral; perivascular area in 72 cases (91.1%), 45 cases (57.0%) were unilateral and 27 cases (34.2%) were bilateral; fatty capsule in 14 cases (17.7%), 13 cases (16.5%) were unilateral and 1 case (1.3%) were bilateral; adrenal area in 12 cases (15.2%); bladder in 31 cases (39.2%), perivesical area in 12 cases (15.2%), perivascular area of the iliac in 73 cases (92.4%), abdominal and pelvic wall in 14 cases (17.7%), perineal area in 12 cases (15.2%), perirectal area in 14 cases (17.7%), mesentery in 26 cases (32.9%), intestinal wall

in 11 cases (13.9%), intestinal canal in 5 cases (6.3%), peripancreatic area in 15 cases (18.9%), perisplenic area in 2 cases (2.5%), perihepatic area in 7 cases (8.8%), hilus of the lung in 1 case (1.3%), mediastinum in 14 cases (17.7%), pericardium in 1 case (1.3%), extrapleural area in 25 cases (31.6%), chest wall in 2 cases (2.5%), skeleton in 2 cases (2.5%), end of thoracic duct in 70 cases (88.6%).

#### **CONCLUSION**

CTL can evaluate the distribution and range of intrarenal, perirenal and retroperitoneal dilated lymphatic vessels accurately, and evaluate the abnormal lymphatic vessels in the chest, abdomen and pelvis in patients with primary chyluria.

#### **CLINICAL RELEVANCE/APPLICATION**

CTL can provide image basis for the diagnosis, grading and treatment of primary chyluria.

### **T2-SPPH-2 Application of Silver Nanotriangles as a Novel Contrast Agent in Tumor Computed Tomography Imaging**

Huiquan Yang, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to prepare chitosan-coated silver nanotriangles (AgNTs) and assess their computed tomography (CT) contrast property by in vitro and in vivo experiments.

#### **METHODS AND MATERIALS**

AgNTs with a range of sizes were synthesized by a seed-based growth method, and subsequently characterized by transmission electron microscopy (TEM), ultraviolet-visible absorption spectroscopy and dynamic light scattering. The X-ray attenuation capability of all prepared AgNTs was evaluated using micro CT. The CT contrast effect of AgNTs with the highest X-ray attenuation coefficient was investigated in MDA-MB-231 breast cancer cells and a mouse model of breast cancer.

#### **RESULTS**

The TEM results displayed that all synthesized AgNTs were triangular in shape and their mean edge lengths ranged from 60 to 149 nm. All AgNTs tested exhibited stronger X-ray attenuation capability than iohexol at the same mass concentration of the active elements, and the larger the AgNTs size, the higher the X-ray attenuation coefficient. AgNTs with the largest size were selected for further research, due to their strongest X-ray attenuation capability and best biocompatibility. The attenuation coefficient of breast cancer cells treated with AgNTs increased in a particle concentration-dependent manner. In vivo CT imaging showed that the contrast of the tumor injected with AgNTs was significantly enhanced.

#### **CONCLUSION**

Our findings suggested that AgNTs could serve as an excellent contrast agent for CT imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

The current study provided a new thought for the development of highly efficient tumor CT contrast agents.

### **T2-SPPH-3 Improvement of Demonstrating Submillimeter Vessels by a Newly Developed Photon Counting Detector CT: Comparison with an Energy Integrating CT in a Vessel Phantom Model**

Shota Kondo (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Demonstrating submillimeter vessels is not easy for the conventional energy integrating detector CT (EID-CT). PCD-CT offers several advantages over conventional EID-CT, including improvements in spatial resolution, image noise, and contrast resolution of materials including iodine as PCD-CT directly measure photon energy of each incident photon using a single semiconductor layer. The purpose of our study was to evaluate diagnostic capability of a newly developed PCD-CT on the visualization of submillimeter vessels compared with conventional EID-CT in a vessel phantom model.

#### **METHODS AND MATERIALS**

We used a prototype PCD-CT scanner developed by Canon Medical Systems for this phantom study. A phantom (outer diameter 200 mm) including simulated 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, and 10.0 mm vessels was scanned with a PCD- and EID-CT (Aquilion Precision, Canon Medical Systems). The simulated vessels were filled with diluted iodine contrast material (15mgI/ml). The scanning parameters for PCD-CT and EID-CT were matched: 120 kV, 9.5-9.7mGy CT DIvol. Both scans were reconstructed with hybrid-iterative reconstruction. PCD-CT scans were reconstructed using 1024- [ultra-high resolution (UHR) mode] while EID-CT scans were reconstructed using 512 matrix sizes. Modulation transfer function (MTF) was calculated using the simulated vessel with diameter of 10.0 mm. Profile curves were generated along a horizontal line crossing through the center of each simulated small vessel (diameter less than 3.0 mm) and the slope at the 50% point of each curve was calculated.

## RESULTS

The margin of each simulated vessel was clearly demonstrate on PCD-CT- compared with EID-CT image. PCD-CT could barely demonstrate the simulated vessel with diameter of 0.5 mm but EID-CT could not .The MTF for PCD-CT showed higher response than for EID-CT in all frequency domains. The slope value for simulated small vessels was higher on PCD-CT than on EID-CT image especially for smaller vessels.

## CONCLUSION

PCD-CT with UHR mode showed higher spatial resolution and better demonstration of submillimeter vessels than conventional EID-CT in a phantom model.

## CLINICAL RELEVANCE/APPLICATION

PCD-CT with UHR mode may be able to demonstrate more detailed vascular anatomy such as the perforating branches of the brain than EID-CT; and PCD-CT has the potential to bring advances to medical practice.

## T2-SPPH-4 Quantification of Lower Extremity Blood Flow using a Low-dose CT Perfusion Technique

Alireza Shojazadeh, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To assess the reproducibility and accuracy of lower extremity perfusion measurements with a low-dose first-pass analysis (FPA) dynamic CT perfusion technique.

### METHODS AND MATERIALS

A total of sixteen Yorkshire Swine ( $46.3 \pm 7.2$ kg) were used in this study with twenty-two CT acquisitions for accuracy and thirty-three acquisition pairs for reproducibility assessments. In each animal, acquisition pairs were obtained at baseline blood flow and under various levels of femoral artery stenosis severity induced by a vascular occluder. Reference flow measurements were recorded for each acquisition using an ultrasound flow probe for comparison and accuracy assessment of the technique. Contrast agent (370 mg/mL iodine, 1 mL/kg) and saline chaser (0.5 mL/kg) were both injected peripherally at a rate of 5 mL/s. Bolus tracking was used, and a pre-contrast (120kVp; 50mA) and post-contrast (120kVp; 200mA) helical scan were acquired at the base and approximately the peak of the aortic enhancement (CT angiogram), respectively. The pre- and post-contrast helical scan data were then used as analytical inputs into a first-pass analysis model to derive perfusion in mL/min/g. The accuracy and reproducibility of lower extremity perfusion measurement were then assessed via linear regression, Bland-Altman analysis, and paired sample t-test (p-value). The average CT dose index (CTDI) for the perfusion measurements was recorded.

### RESULTS

The first (P1) and second (P2) CT perfusion measurements were related by  $P2 = 0.97 P1 + 0.00$  ( $r = 0.97$ ,  $RMSE = 0.11$  mL/min/g and  $RMSD = 0.11$  ml/min/g,  $P$ -value= 0.56). The blood flow calculation derived from the CT perfusion technique (QCT) and the reference standard ultrasound blood flow measurement (QUS) were related by  $QCT = 0.93 QUS + 9.83$  ( $r = 0.96$ ,  $RMSE = 16.34$ ,  $RMSD = 32.20$ ,  $P$ -value= 0.09). The average CTDI of perfusion measurement using this technique was only 9.1 mGy.

### CONCLUSION

This study shows that the low-dose quantitative CT perfusion technique can accurately measure lower extremity perfusion (mL/min/g) using only two helical scans. The CT angiogram and perfusion measurements can be used as a comprehensive technique for morphological and physiological assessment of limb ischemia.

## CLINICAL RELEVANCE/APPLICATION

Quantitative assessment of blood flow in peripheral extremities provides clinicians with a promising diagnostic tool for evaluating vascular diseases. Simultaneously acquiring CT angiography and providing accurate blood flow measurement can improve risk assessment and critical decision-making for patients across a wide spectrum of disease severity.

## T2-SPPH-5 Noise Reduction at Coronary CT Angiography with Photon-counting Detector CT: A Structured Phantom Study

Toru Higaki, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

Photon-counting detector CT (PCD-CT) features a semiconductor detector that enables high-resolution imaging with a high-density detector element, and low-noise imaging based on electrical noise cancellation. We developed a photon-counting detector CT scanner whose detector is made of CdZnTe. Here we evaluate the noise characteristics of PCD-CT using a structured phantom that simulates coronary CT angiography (CCTA).

## METHODS AND MATERIALS

Our CCTA structured phantom shown in Fig.1 uses a 3D printer (KEYENCE Agilista-3200). The vessels were filled with iodine contrast medium diluted to 20 mgI/ml. One simulated coronary artery harbored a 70% stenotic lesion, the other a stent graft (Medtronic, BeStent, 3.0 mm × 15 mm). We scanned the phantom on a PCD-CT scanner (Canon Medical Systems) in normal-resolution mode. The detector-element size was approximately the same as that of conventional EID-CT, the slice thickness was about 0.6 mm, the tube voltage was 120 kV, and the tube current was 250 mA. Comparisons were with a conventional energy-integrating detector CT (EID-CT, Aquilion ONE GENESIS, Canon Medical Systems). The structured phantom was scanned with a protocol that resulted in similar radiation exposure. All images were reconstructed with hybrid iterative reconstruction. To evaluate the image quality we measured the noise power spectrum (NPS) as a metric of the noise characteristics and the task-based modulation transfer function (MTF) as a metric of spatial resolution.

## RESULTS

The radiation dose (CTDIvol) was approximately 9.5 mGy. The image noise of PCD-CT was lower than of EID-CT (SD: 8.9 v.s. 13.8 HU, Fig. 2 left). The spatial resolution of PCD-CT and EID-CT were comparable (Fig. 2 right). Comparison of the images in Figs. 3 and 4 confirmed the low image noise on PCD-CT scans.

## CONCLUSION

Our PCD-CT suppressed the electrical noise and reduced the image noise on CCTA images.

## CLINICAL RELEVANCE/APPLICATION

As the normal resolution mode of PCD-CT can reduce the image noise it may be useful for reducing the radiation dose of CCTA.

## T2-SPPH-6 Radiation Dose and Image Quality at Coronary CT Angiography using a 256-detector Scanner at Different Heart Rates

Yuta Hirose (*Presenter*) Nothing to Disclose

## PURPOSE

To retrospectively assess radiation dose and image quality (IQ) at coronary CT angiography (CCTA) with a 256-detector CT scanner in patients with different heart rates (HRs).

## METHODS AND MATERIALS

From January 2022 through January 2023, consecutive 158 patients were included who underwent prospectively ECG-gated axial scanning of CCTA using the high-definition scan mode with the latest 256-detector CT scanner (Revolution CT Apex, GE). Each patient was classified into one of the following 3 groups based on mean HR and HR variability (HRV), defined as difference between maximum and minimum HRs, during the scanning: Group A, mean HR < 65 bpm and HRV < 20 bpm; Group B, mean HR = 65 bpm and HRV < 20 bpm; Group C, HRV = 20 bpm. Scan window was automatically selected based on mean HR and HRV just before the examination with dedicated software as follows: Group A, mid-diastole; Group B, end-systole to mid-diastole; Group C, entire cardiac cycle of a single heartbeat. Axial images of 0.625-mm slice were reconstructed with a deep-learning algorithm at optimal cardiac phase automatically selected with dedicated software. A motion correction algorithm was applied only when motion artifact remained significant. Standard deviation (SD) of CT value was measured in the ascending aorta as image noise. Two independent radiologists subjectively assessed IQ of the right coronary artery (RCA), left anterior descending artery (LAD), and left circumflex artery (LCX) regarding motion artifact using a 4-point scale (1, poor; 4, excellent; 2-4, acceptable). One-way ANOVA test was used to compare body mass index (BMI), SD, and dose-length product (DLP) and Kruskal-Wallis test was used to compare the IQ scores with Bonferroni correction among Groups A-C at the scanning. Weighted  $\kappa$  test was used to quantify inter-reader agreement.

## RESULTS

Whereas BMI ( $P = 0.557$ ) and SD ( $P = 0.065$ ) were comparable among Groups A-C, DLP was significantly higher in Group C than in Groups A and B ( $P < 0.05$  for both) but comparable between Groups A and B at the scanning ( $P = 0.341$ ). The IQ score for RCA was significantly higher in Group A than in Group B ( $P < 0.001$ ) and for LAD and LCX, in Group A than in Groups B and C ( $P < 0.05$  for all); otherwise, comparable among Groups A-C ( $P > 0.05$  for all). IQ was acceptable in all vessels except one RCA in Group A and one RCA and one LCX in Group C. Inter-reader agreement was good ( $\kappa = 0.76$ ).

## CONCLUSION

IQ regarding motion artifact was best in Group A but acceptable in all Groups whereas radiation dose was significantly increased in Group C at the CCTA.

## CLINICAL RELEVANCE/APPLICATION

Whereas acceptable IQ regarding motion artifact can be preserved at CCTA with the latest 256-detector CT scanner, adequate use of beta blockers to lower HR and HRV can reduce radiation dose and improve IQ and diagnostic performance.

## **T2-SPPH-7 Reproducibility of an Automated Lobar Lung Tissue Assignment Technique using Non-contrast CT**

Sabee Y. Molloy, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

### **PURPOSE**

Lobar segmentation is necessary for regional ventilation and perfusion analysis. This study evaluated the reproducibility of a vessel-specific minimum-cost path (MCP) technique used for lobar segmentation based on non-contrast CT.

### **METHODS AND MATERIALS**

A total of 16 Yorkshire Swine ( $49.88 \pm 4.69$  kg) were used in this study with 46 independent CT acquisitions. A helical scan mode was used (100kV, 50 mA, 24 cm Z-coverage and 2.5s scan time). Following image acquisition, lung tissue segmentation and pulmonary arterial tree centerline extraction was performed. The pulmonary arterial tree was then divided into six lobar subtrees for lobar assignment. The MCP technique was used to assign lobar territories by assigning every voxel of the lung tissue to the nearest arterial tree segment. The reproducibility of the MCP technique was evaluated by quantitatively comparing the MCP-derived lobar territories between two CT acquisitions by tissue mass and volume, using linear regression, root mean square error (RMSE), root mean square deviation (RMSD) and paired sample t-test (p-value). An interobserver and intraobserver analysis of the lobar measurements were also performed.

### **RESULTS**

The lobar mass measurements from the first (MLOBE1) and second (MLOBE2) CT acquisitions were correlated by  $MLOBE1 = 0.99MLOBE2 + 1.76$  ( $r = 0.99$ ) with a p-value of 0.120, RMSE = 7.99 g and RMSD = 7.91 g. The lobar volume measurements from the first (VLOBE1) and second (VLOBE2) CT acquisitions were correlated by  $VLOBE1 = 0.98VLOBE2 + 2.66$  ( $r = 0.99$ ) with a p-value of 0.160, RMSE = 15.26 mL and RMSD = 14.94 mL. The calculated whole lung mass measurements from the first (MLUNG1) and second (MLUNG2) CT acquisitions were correlated by  $MLUNG1 = 0.89 MLUNG2 + 76.32$  g ( $r = 0.96$ ) with a p-value of 0.306, RMSE = 29.13 g and RMSD = 26.10 g. The calculated whole lung volume measurements from the first (VLUNG1) and second (VLUNG2) CT acquisitions were correlated by  $VLUNG1 = 0.99 VLUNG2 - 3.27$  ( $r = 0.98$ ) with a p-value of 0.396, RMSE = 60.52 mL, RMSD = 59.49 mL.

### **CONCLUSION**

The whole lung and lobar mass and volume measurements show excellent reproducibility using a vessel specific assignment technique. This technique can potentially be used for automated lung lobar segmentation, enabling regional ventilation and perfusion analysis for clinical applications.

### **CLINICAL RELEVANCE/APPLICATION**

Assessment of lobar mass or volume in the lung lobes may allow for efficient treatment planning and region-specific treatment strategies for diseases such as pulmonary embolism and chronic thromboembolic pulmonary hypertension.

## **T2-SPPH-8 Reproducibility of a Low-Dose Single-Volume Dynamic CT Myocardial Perfusion Technique**

Logan Hubbard, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

The current methods for accurate diagnosis and assessment of the physiological effects of coronary artery disease (CAD) are limited. There have been previous reports of dynamic CT perfusion techniques capable of assessing CAD, but high radiation dose has hampered widespread clinical implementation of currently existing methods. This study assessed the reproducibility of myocardial perfusion measurements in mL/min/g using a low-dose single-volume dynamic CT myocardial perfusion technique.

### **METHODS AND MATERIALS**

A total of 13 Yorkshire Swine ( $54.3 \pm 12.3$  kg) were used in this study. Thirty-four pairs of prospective CT measurements were made under rest and stress conditions. One or two acquisition pairs were acquired in each animal with a 10-minute delay between each acquisition. Contrast (0.5 mL/kg; 370 mgI/mL) and a diluted contrast/saline chaser (0.5 mL/kg; 30:70 contrast/saline) were injected peripherally at 5 mL/s, followed by bolus tracking, triggering, and acquisition of a single volume scan (100 kVp; 200 mA) using a 320-slice CT scanner. The delay time for acquisition of the single volume scan after triggering was determined using a previously validated contrast injection timing method. Following CT acquisition, both the bolus tracking and single volume scan data were used to derive perfusion in mL/min/g using a first-pass analysis model. After which, the coronary perfusion territories of the left anterior descending (LAD), left circumflex (LCx) and right coronary artery (RCA) were automatically assigned using a previously validated minimum-cost path technique. The reproducibility of CT myocardial perfusion measurement within the LAD, LCx, RCA, and the whole myocardium was assessed via regression analysis. The average CT dose index (CTDI) of perfusion measurement was also recorded.

## RESULTS

The first (Pmyo1) and second (Pmyo2) single-volume CT perfusion measurements were related by  $P_{myo2}=1.01P_{myo1}-0.03$  ( $r=0.99$ ; RMSE=0.08 mL/min/g; RMSD=0.07 mL/min/g) for the whole myocardium, and by  $P_{reg2}=0.86P_{reg1}-0.13$  ( $r=0.91$ ; RMSE=0.31 mL/min/g; RMSD=0.29 mL/min/g) for the LAD, LCx, and RCA vessel-specific perfusion territories (Preg). The average CTDI of the single-volume CT perfusion measurement was 10.5mGy.

## CONCLUSION

The low-dose single-volume dynamic CT myocardial perfusion technique provides reproducible myocardial perfusion measurement in mL/min/g only requiring bolus tracking and a single whole-heart volume scan data.

## CLINICAL RELEVANCE/APPLICATION

This technique is a noninvasive tool that reproducibly measures myocardial perfusion and provides coronary CT angiogram, which allows for simultaneous anatomic-physiologic assessment of myocardial ischemia.

## T2-SPPH-9 High Temporal Resolution and Low-dose Dynamic Imaging of Airway using Photon-counting-detector CT

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Dynamic CT imaging can provide valuable information for diagnosing airway abnormalities. Existing dynamic CT techniques for airway imaging are susceptible to cardiac and respiratory motion artifacts due to limited temporal resolution. In this work, we aim to implement and evaluate a low-dose dynamic scanning technique with a temporal resolution as fast as 66 milliseconds for airway imaging using a dual-source photon-counting-detector (PCD)-CT.

## METHODS AND MATERIALS

An inflatable pig lung phantom (BioQuest,USA) that can mimic respiratory cycles through manual ventilation was used. Tubes with known diameters (2 and 3 mm) were attached to the lung as a measurement reference. The phantom was scanned on a whole-body PCD-CT scanner (Naeotom Alpha, Siemens) with two scanning modes, a dual-source prospectively-gated adaptive sequential mode with a slow (30 bpm) electrocardiogram (ECG) signal and a traditional dynamic cine mode, each at three dose levels (volume CT dose index (CTDIvol) = 0.8, 1.6, and 3.5 mGy). For the slow-ECG-gated mode, in order to utilize the rapid temporal resolution used for cardiac CT while providing multi-phase imaging and reconstruction of an entire breathing cycle, an ECG simulator was modified to generate a much slower signal simulating breathing cycles of 30 rpm. This slow ECG-gated mode has a temporal resolution of 66 ms, similar to cardiac CT. The techniques used for both dynamic CT scanning modes were adjusted to a low tube potential (90 kV) to achieve the lowest possible radiation dose. The rotation time was 0.25 seconds and field of view (FOV) 300 mm. Since the acquisition is performed with detector collimation of 144x0.4 mm minimum slice thickness for dynamic scan was 0.6 mm, while for adaptive sequential mode 0.4 mm. The diameters of the tubes were measured and compared with the truth to compare the impact of motion at the two scan modes.

## RESULTS

Motion artifacts were significantly reduced on images acquired from the slow ECG-gated scans compared to the traditional cine-mode scans. On the slow ECG-gated dynamic images, the shape of the attached tubes was maintained, which provided a more accurate measurement of diameter than images from the cine-mode scans:  $3.10\pm 0.02$  mm and  $1.9\pm 0.02$  mm for ECG-gated scans, and  $3.9\pm 0.6$  mm and  $2.6\pm 0.5$  mm for cine-mode scans, for tubes of 3 and 2 mm, respectively.

## CONCLUSION

Compared to conventional dynamic CT acquired in a cine mode, the proposed slow ECG-gated dynamic imaging technique on PCD-CT can achieve a better temporal resolution, which reduces motion artifacts and improves visualization and quantitation of airways.

## CLINICAL RELEVANCE/APPLICATION

Implementation of a slow ECG-gated imaging method on the dual-source PCD-CT may provide dynamic images of airways with reduced motion artifacts.

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## Abstract Archives of the RSNA, 2023

T2-SPRO

### Radiation Oncology Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### T2-SPRO-1 Preoperatively Identify Glypican-3 Positive HCC: Via Multi-phase CE-MRI Delta Radiomics

Yifan Pan (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of multi-phase contrast enhanced magnetic resonance imaging (CE-MRI) based delta radiomics for identifying the glypican-3 (GPC3) positive hepatocellular carcinoma (HCC).

#### METHODS AND MATERIALS

One hundred and twenty-six patients with pathologically-confirmed HCC (GPC3 positive : GPC3 negative = 95 : 31; training cohort: n = 88; test cohort: n = 38) were retrospectively recruited. Basic information was obtained from our medical records. Preoperative Multi-phase CE-MRI images were reviewed by abdominal radiologists and semantic features were evaluated. The 3D volume of interest (VOI) of whole tumor was segmented on non-contrast T1 weighted imaging (T1-NC), arterial phase (AP), portal venous phase (PVP), delayed phase (DP), hepatobiliary phase (HBP). Radiomic features were extracted from each phase and 3 types delta features (standardized subtraction, direct subtraction, and relative subtraction) were calculated. Feature data were resampled using Synthetic Minority Over-sampling Technique (SMOTE) algorithm. A two-step feature selection strategy was applied. First, minimal-redundancy-maximal-relevance (mRMR) was used to select 20 features and then recursive feature elimination (RFE) was used for further selection. Radiomics models were built using logistic regression and support vector machine. By combining the best radiomics model and clinical risk factors, a nomogram was constructed and evaluated.

#### RESULTS

Univariate analysis showed that serum alpha-fetoprotein (AFP) levels > 400 ng/ml ( $p = 0.013$ ) was significantly related to GPC3 positive HCC. The optimal radiomic model composed of 8 delta radiomic features had an AUC of 0.805 in training cohort and 0.851 in test cohort. Additionally, the nomogram integrated the radiomics score and AFP achieved the best performance (training cohort: AUC = 0.844; test cohort: AUC = 0.862). Calibration curve showed good agreement between the nomogram predicted probabilities and actual outcomes of GPC3 expression in both training and test cohort. Decision curve analysis further demonstrate the clinical practicality of the nomogram.

#### CONCLUSION

Multi-phase CE-MRI based delta radiomics model can non-invasively predict GPC3 positive HCC and could be a useful method for individualized diagnosis and treatment.

#### CLINICAL RELEVANCE/APPLICATION

Multi-phase CE-MRI based delta radiomics model can non-invasively predict GPC3 positive HCC and could be a useful method for individualized diagnosis and treatment.

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## Abstract Archives of the RSNA, 2023

T2-SPVA

### Vascular Imaging Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-SPVA-1 Assessment of the Utility of CT Angiographic Reports for Evaluation of Deep Inferior Epigastric Artery in Preparation for Rectus Flap Surgery**

Collin Larkin, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Current radiology literature details the anatomy of the deep inferior epigastric artery (DIEP) and reporting requirements. However, the surgical requirements are specific, and our current literature is short of addressing those. We aim to compare imaging and surgical findings of DIEP perforators on CT angiographic (CTA) studies for improving radiology reports tailored to help in the surgical flap selection.

#### **METHODS AND MATERIALS**

Retrospective review of CTA from 1/2021 to 1/2023 for indication of DIEP evaluation for breast reconstruction planning. There were 95 studies, and 40 were included after excluding examinations with a large field of view, >3 mm slice thickness, and suboptimal image quality. The CTA was reviewed for anatomy of DIEP: origin, branching pattern, number of perforators, and their sizes. Two readers- one abdominal imaging fellow and a fellowship-trained radiologist reviewed the studies independently. The medical records were queried for factors that affect flap selection, including prior abdominal surgery, preoperative surgical choices, patient preference, clinical indication, operative findings, the reason for selecting or rejecting a flap, and post-operative complications. Descriptive statistics and kappa statistics were performed.

#### **RESULTS**

The patients ranged from 30-71 years of age. The readers reported 68-80% studies were of good quality. Inter-reader agreement for assessment of branching type and number of >1.5mm perforators on each side was moderate (Cohen's kappa value ranging 0.41-0.5). Though there were smaller number of patients with perforators that were >1.5 mm diameter and below the umbilicus that was crucial in surgical decision making, there were more perforators (up to 6) that were below the umbilicus but <1.5 mm size criteria. Sixteen patients had bilateral flap reconstruction, 9- unilateral flap of which 4 had combined rectus flap and latissimus TRAM flap surgeries. Nine patients had post-operative complications, which were ischemia and necrosis due to thrombosis of perforator or intimal tearing of the perforator during surgery.

#### **CONCLUSION**

CTA is a viable modality for presurgical planning in anticipation of breast reconstruction and has acceptable inter-reader agreement and correlation with surgical findings. It is essential to revise our radiology reports to include DIEP perforators up to 4 perforators that are >1.5 mm thickness at the subfascial plane and below the umbilicus to help the surgeons in decision-making.

#### **CLINICAL RELEVANCE/APPLICATION**

Awareness of anatomy and reporting of the crucial details about the number and course of DIEP perforators can help in surgical planning and avoid accidental vessel tears or injury during surgery, leading to necrosis and failure of flap reconstruction.

#### **T2-SPVA-3 MRI Relaxation Properties of Ferumoxytol: A Comparison of Brand Name vs Generic**

Rianne A. Van der Heijden, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the MRI relaxation properties of brand name ferumoxytol (Feraheme®, AMAG Pharmaceuticals) with generic ferumoxytol (Sandoz).



## METHODS AND MATERIALS

A phantom experiment was performed using both brand name and generic ferumoxytol agents. Each agent was diluted in saline and also adult bovine whole blood at 5 concentrations ranging from 0.3-2.1mM within 30 ml vials, for a total of 20 vials. Prior to imaging, vials were placed in an MR compatible water bath at 37°C and imaged at both a 1.5T and 3.0T on clinical MRI systems (1.5T Artist, 3.0T Premier, GE Healthcare, Waukesha, WI) using a phase array torso coil (AIR coil). The protocol consisted of coronal acquisitions using 2D fast spin echo (FSE) inversion recovery with multiple inversion times to measure R1, 2D FSE sequence with multiple echoes to measure R2, and 3D multi-echo spoiled gradient echo chemical shift-encoded method (IDEAL-IQ) to measure R2\*. Relaxation rate constants, R1, R2, R2\* were measured in a manually drawn region of interest centrally located in each vial in three slices using Matlab. Differences in relaxivity between the agents were tested with chi-square with 2 or 3 degrees of freedom depending on the fitted model.

## RESULTS

The dependences of R1, R2 and R2\* on ferumoxytol concentrations were linear in saline and non-linear in blood. R1 values (represented by the slope of the equation and SE (s-1mM-1)) of saline for AMAG and Sandoz, respectively at 1.5 T ( $16.3 \pm 2.2$ ;  $14.3 \pm 1.3$ ;  $p=.22$ ) and 3.0 T ( $9.5 \pm 0.04$ ;  $8.8 \pm 0.01$ ;  $p<.001$ ). R2 values of saline for AMAG and Sandoz respectively at 1.5 T ( $59.4 \pm 0.35$ ;  $60.0 \pm 4.9$ ;  $p=.82$ ) and 3.0 T ( $61.3 \pm 3.9$ ;  $57.8 \pm 1.8$ ;  $p=.13$ ). R2\* values of saline for AMAG and Sandoz respectively at 1.5 T ( $59.4 \pm 2.1$ ;  $72.0 \pm 3.3$ ;  $p<.001$ ) and 3.0 T ( $64.2 \pm 3.3$ ;  $65.3 \pm 4.5$ ;  $p=.92$ ). R1 relaxivity of blood followed a quadratic relationship for AMAG and Sandoz respectively at 1.5 T ( $6.7x^2+1.23x+7.4$ ;  $8.3x^2-1.9x+7.6$ ;  $p=.22$ ) and 3.0 T ( $1.4x^2+6.6x+0.8$ ;  $1.6x^2+5.4x+0.7$ ;  $p<.001$ ), where x=concentration. R2 relaxivity of blood for AMAG and Sandoz respectively at 1.5 T ( $20.1x^2+45.7x+12$ ;  $20.7x^2+35.5x +13.3$ ;  $p=.07$ ) and 3.0 T ( $15.9x^2+41.6x +15.2$ ;  $30.2x^2+6.8x +22.7$ ;  $p=.44$ ). R2\* relaxivity of blood for AMAG and Sandoz respectively at 1.5 T ( $60.0x^2-3.31x+108.5$ ;  $41.7x^2+30.0x+80$ ;  $p<.001$ ) and 3.0 T ( $43.9x^2+24.2x+57$ ;  $38.5x^2+26.2x+56$ ;  $p<.001$ ).

## CONCLUSION

There were no statistically significant differences between the AMAG and Sandoz agents for most relaxivity values and those with differences were small and of doubtful clinical relevance.

## CLINICAL RELEVANCE/APPLICATION

Ferumoxytol is increasingly being used for MR angiography and in patients with contraindications to gadolinium. The use of generic agents may reduce cost without any clinically relevant differences in the relaxation properties.

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## Abstract Archives of the RSNA, 2023

T5A-SPBR

### Breast Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPBR- Screening after Breast Conserving Surgery with Acellular Dermal Matrix Reconstruction: Mammography, Ultrasonography and MRI**

Dawon Jung, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the findings of postoperative images of patients who underwent breast reconstruction with acellular dermal matrix (ADM) and assess which imaging modality is more feasible to detect local tumor recurrence: mammography(MG), ultrasound(US), or MRI.

#### **METHODS AND MATERIALS**

This retrospective study included consecutive women who were first diagnosed with breast cancer and underwent breast-conserving surgery between Jan 2015 and Aug 2021 and immediate reconstruction with MegaDerm®, followed by at least one MG, US, and MRI. Postoperative images were analyzed by breast radiologists and classified as positive for BI-RADS categories 0, 4, and 5 and negative for BI-RADS categories 1,2, and 3. The reference standard was defined with 1-year follow-up Imaging findings and pathologic reports. Diagnostic performances of each imaging modality was evaluated. Imaging features of ipsilateral recurrent breast cancers were reviewed.

#### **RESULTS**

207 women (mean age 46 years) were enrolled with a total 725 MG, 1097 US and 621 MRI. During the follow-up, the mean numbers of MG, US, and MRI scans of 3.5, 5.3, and 3.0 respectively, and a mean follow-up interval of 35.5 months (range 13-71 months). Among 207 women, total recurrence occurred in 15 (7.2%) patients and 11 (5.3%) patients recurred on the same breast. Sensitivity was 80 % for MG and 100% for both US and MRI. Specificity was 99% for MG, 99.4% for US and 96.9% for MRI. Diagnostic accuracy was 98.6% for MG, 99.4% for US and 96.9% for MRI. All 11 ipsilateral recurrence were suspicious on both US and MRI, while 3 cases (27.3%) were considered as benign on MG. All ipsilateral recurrences showed masses/nom-mass lesions with hypervascularity and enhancement, near the ADM.

#### **CONCLUSION**

Screenings with MG, US and MRI are useful imaging tool, after breast conserving surgery with ADM reconstruction. Especially, US and MRI are helpful modalities for the ipsilateral recurrence.

#### **CLINICAL RELEVANCE/APPLICATION**

After breast conserving surgery with ADM reconstruction, screening with MG, US and MRI might be hindered by ADMs. However, all screening modalities are useful, especially US and MRI. The most common findings of ipsilateral recurrence was mass/nom-mass lesion with hypervascularity and enhancement, near the ADM.

#### **T5A-SPBR- The Observation of VM1 Gadolinium Tumor Markers Placed in Fibroadenomas Over Time**

Lindsey K. Greenlund, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Fibroadenomas are one of the most common breast masses, affecting nearly 10% of women. These benign tumors most often appear in the 3rd and 4th decades of life, but can arise at any age. Fibroadenomas can be recognized on imaging by their characteristic smooth, solid, ovoid appearance, being narrower in the A/P diameter, and with discrete internal echoes. Gadolinium (Gd) tumor markers are the only markers visible on all imaging modalities. These markers also have the benefit of remaining stable during radiation treatment. Often, they are surgically resected, however, if they are placed in benign tumors, they may remain in the patient (pt) indefinitely. In this study, we followed scans of pts with Gd tumor markers placed

in biopsy-proven fibroadenomas. It was hypothesized that over time, the marker would remain the same intensity, would not migrate, and that the tumor bed would be unchanged.

## **METHODS AND MATERIALS**

Charts of pts who had VM1 Gd tumor markers placed between 2016 and 2020 for breast masses were reviewed. Initial scans were assessed, and those with masses characteristic of fibroadenomas were separated. Pts with biopsy-proven fibroadenomas were included. Subsequent imaging studies were reviewed, and the implanted tumor marker, as well as the tumor bed, were assessed for changes over time.

## **RESULTS**

Thirty-six pts who had VM1 tumor markers placed for discrete breast masses were identified and seven had biopsy-proven fibroadenomas diagnosed during the study period. Three pts had scans suitable for analysis, two had subsequent surgical resections, and two pts were lost to follow-up. One pts had imaging for six-months following VM1 marker placement, one pt had imaging for two years, and one pt had imaging for seven subsequent years. In these three pts, the VM1 tumor marker did not change in position, brightness, or intensity, nor did the fibroadenoma change in size or internal characteristics.

## **CONCLUSION**

In this study, we assessed the stability of VM1 Gd tumor markers placed in fibroadenomas. Although only a small group of pts were assessed, our study demonstrated that VM1 Gd tumor markers remain stable over time with regard to position and appearance. Additionally, the fibroadenomas in which the markers were placed did not change over time. Further studies should seek to include more pts over longer follow-up periods.

## **CLINICAL RELEVANCE/APPLICATION**

This study shows unresected VM1 Gd tumor markers remain stable in appearance and in place for up to seven years in subsequent imaging. The VM1 Gd marker is available as the first new FDA approved soft tissue marker in nearly 10 years and is visible on all imaging modalities (MRI, ultrasound, tomo, X-Ray). This information will aid radiologists in localizing breast masses over time and assessing them for future change.

## **T5A-SPBR- The Value of Imaging Combined with Clinicopathological Features in the Diagnosis of High-risk Breast Lesions**

Jiayin Zhou (*Presenter*) Nothing to Disclose

### **PURPOSE**

Comparing the diagnostic and predictive value of imaging features of different modes for breast high-risk lesions (HRLs) to improve image recognition and assist in clinical decisions.

### **METHODS AND MATERIALS**

We retrospectively reviewed 230 HRLs detected by mammography, ultrasound, and MRI before biopsy at the XXX Hospital from January 2017 to March 2018. The clinical features, imaging data according to the Breast Imaging Reporting and Data System (BI-RADS) lexicon, and tumor upgrade rates were received. Based on the different risks of upgrade reported, the lesions were classified into high-risk I (HR-I, with atypical hyperplasia (AH)) and high-risk II (HR-II, without AH). We analyzed the association between clinicopathological and imaging factors and upgrade. We used the receiver operating characteristic (ROC) curve to compare the efficacy of three imaging modes for predicting upgrade.

### **RESULTS**

We included 230 HRLs in 230 women in the study, and the overall upgrade rate was 20.4% (47/230). The upgrade rate was higher in HR-I compared to HR-II (38.5% vs. 4.1%,  $P < 0.01$ ). In patients with AH, estrogen receptor-positive (ER+) patients accounted for 81.0% (64/79). For all HRLs and HR-I, in clinical characteristics, age, maximum size of lesion, and menopausal status were significantly associated with upgrade ( $P < 0.05$ ). In imaging factors, MRI background parenchymal enhancement (BPE), signs of MRI and ultrasound were significantly correlated with upgrade ( $P < 0.05$ ). Patients with negative MRI or ultrasound manifestations had lower upgrade rates ( $P < 0.01$ ). For HR-II, only BPE showed a significant difference between groups ( $P = 0.001$ ). Multifactorial analysis of all HRLs showed that age and BPE were independent predictors of upgrade ( $P < 0.01$ ). AUCs for predicting upgrade in mammography, ultrasound, and MRI were 0.606, 0.590, and 0.913, respectively, indicating that MRI diagnosis was significantly better than mammography and ultrasound ( $P < 0.001$ ).

### **CONCLUSION**

HRLs with AH had a higher rate of upgrade and increased ER expression. Among three imaging modes, MRI was more effective than ultrasound and mammography in diagnosing the upgrade of HRLs. Older age and moderate to marked BPE can indicate malignant upgrade. MRI can provide a certain value for the diagnosis and follow-up of HRLs.

### **CLINICAL RELEVANCE/APPLICATION**

We explored the relationship between the imaging signs of different modes and the upgrade of HRLs, helping to suggest the correlation between HRLs and the risk of breast cancer, and providing references for clinical decision-making in the follow-up

treatment of HRLs.

#### **T5A-SPBR- Outcomes of Pre-operative MRI versus Ultrasound in Axillary Nodal Staging: Association with Clinicopathological Breast Cancer Features**

Firouzeh K. Arjmandi, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To compare the diagnostic accuracy of MRI versus ultrasound (US) in breast cancer axillary nodal evaluation in the same patient cohort.

##### **METHODS AND MATERIALS**

All breast cancer (BCA) patients that underwent dynamic contrast-enhanced breast MRI (N=529) for baseline staging between 2.2013-3.2016 at 2 hospitals (university and safety net) were reviewed. Race, clinicopathological features, size, and radiologist axillary assessment on imaging prior to biopsy [suspicious=Rad(+), benign=Rad(-)] were collected. Radiologist imaging assessment (regardless of biopsy result) was compared to surgical pathology [(SLNB or axillary node dissection (ALND), pN)]. We collected the sequence of US and MRI evaluation of axilla in diagnostic order to identify initial detection of a suspicious lymph node (LN) in 319/529 patients. Chi-square test was used to compare hormone status, multifocality, axillary imaging modality [MRI first vs US first] and Mann-Whitney-U to compare age, tumor size, and Ki67% between defined groups.

##### **RESULTS**

Mean age was 51.3 (SD±23.6) years and tumor size was 37.4 mm (SD± 23.6). Patients received US first (includes US+MRI and US+MRI+US groups) in 80.6% and MRI first [(includes MRI alone (MRI) and MRI followed by US (MRI+US))] in 19.4%. Axillae were Rad(+) in 52.4% and Rad(-) in 48.0%. FN values were calculated in Rad(-). Negative predictive value (NPV) for patients that underwent MRI first vs. US first was 85.1% vs. 70.1% (p<0.05). Hispanics and Blacks were more likely to have FN on MRI (22.2% and 18.2%) compared to non-Hispanic Whites (p=0.8) and on US, Hispanics were more likely than non-Hispanic Whites (37.5% vs. 27.7%, p=0.2). On both MRI and US, FNs were higher in younger age, higher clinical T stage (cT) and lower Ki67. FNs were lowest in triple negative (TNBC) and highest in HER2+ (p=0.2, p=0.4, respectively). Unifocal tumors had significantly lower FNs compared to multifocal/centric (21.2% vs. 44.7%, p=0.009) in the US first group but not in MRI first (14.7% vs. 15.4%, p=1). Overall sensitivity and specificity in MRI first was 93.4% and 72.7% (p<0.001) and in US first was 72.3% and 74.2% (p=0.8), respectively.

##### **CONCLUSION**

MRI performs better than US for LN metastasis with better NPV and higher sensitivity. For both MRI and US, FNs are highest in Hispanics (followed by Blacks on MRI), increase in younger age and higher cT, and are lowest in TNBC and highest in HER2+ subtypes.

##### **CLINICAL RELEVANCE/APPLICATION**

MRI performs better than US in LN metastasis, and NPV is affected by clinicopathological factors in both. MRI should be considered especially in higher cT stage.

#### **T5A-SPBR- Lymph Node Status in Breast Cancer Patients: Can Tumor Features Predict it More Accurately than Direct Axillary Imaging Evaluation**

Panagiotis Kapetas, MD,PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To compare the diagnostic performance of tumoral imaging and clinical characteristics with the direct evaluation of the axillary lymph nodes (LNs) for the prediction of the LN status in breast cancer (BC) patients.

##### **METHODS AND MATERIALS**

This retrospective, IRB-approved study included 513 patients with histologically confirmed invasive BC and a histological confirmation of their LN status (either pre-therapeutic, for patients undergoing neoadjuvant treatment, or at the time of surgery for all others). By search of the local PACS, the diagnostic examinations (mammography-MG, ultrasound-US and magnetic resonance imaging-MRI) of the patients were identified. Further clinical information (age, tumor proliferation index Ki-67 and hormone- and HER2-receptor status) were recorded as well. 4 readers (2 breast fellows and 2 experienced radiology residents who had completed both stages of their breast imaging rotation), blinded to the LN status of the patient, independently evaluated the images, assessing both the tumor according to BI-RADS descriptors and the depicted LNs, using standardized criteria. Logistic regression was used to identify independent predictors of metastatic LNs, both among the tumor and the LN descriptors and create respective models, based on the different imaging modalities and their combinations. The diagnostic performance of the models was evaluated using ROC curve analysis. Histopathology served as the standard of reference.

## RESULTS

114 patients (22.2%) had metastatic LNs. None of the clinical or tumoral MRI-based features reached predictive statistical significance. From the tumor-based models, the one combining MG and US features performed significantly better than the others, however at an AUC of 0.593. All models based on LN features (cortical thickening in US and MRI, short axis >1cm in MG) performed significantly better than the ones based on tumoral ones, with AUCs ranging between 0.648 and 0.719. There was no significant difference between the individual LN-based models, which were able to correctly predict 75.1-78.5% of all cases.

## CONCLUSION

Tumor characteristics in BC patients are less predictive of the LN status as compared to the imaging evaluation of the axillary LNs per se.

## CLINICAL RELEVANCE/APPLICATION

Direct imaging assessment of axillary lymph nodes in breast cancer patients remains more accurate than the prediction of their status based on imaging and clinical tumor features.

## **T5A-SPBR- 7 Mammographic Changes within Two Years Following Novel Breast Intraoperative Radiation Therapy**

Kassandra Tulenko, BA (*Presenter*) Nothing to Disclose

## PURPOSE

Intraoperative radiation therapy (IORT) is accelerated partial breast irradiation (APBI) that involves a single dose of RT at the time of breast conserving surgery (BCS). Precision Breast intraoperative radiation therapy (PB-IORT) is a novel form of IORT that combines CT-on-rails imaging to guide high dose rate (HDR) balloon brachytherapy to deliver 12.5 Gy of radiation to the lumpectomy bed at the time of BCS. The goal of the present study is to describe the short-term mammographic appearance of participants treated with PB-IORT.

## METHODS AND MATERIALS

All patients were part of a multi-institutional clinical trial with an inclusion criteria of age  $\geq$ 45 years, N0, and invasive or in situ tumors < 3 cm. Participants received annual diagnostic mammograms post PB-IORT and additional imaging was performed if warranted clinically. All participants with 2 years of follow-up were included in this study. Mammograms were reviewed and categorized by breast density and radiographic changes, including scar formation, trabecular thickening, fat necrosis, seroma, skin thickening, skin retraction, calcifications, asymmetry, or mass. Presence of suspicious findings (BI-RADS 4 or 5) and biopsy results were also recorded.

## RESULTS

The cohort included 567 mammograms in 291 participants. The median timing of mammograms included in the study was 23 months post IORT (6 to 30 months). Median age was 64 years (46 to 83 years) and mean tumor size was 9.76mm +/- 6.56mm. Scar and trabecular thickening were the most frequent imaging findings, occurring in 286 (98.3%) and 230 (79.0%) participants respectively. Fat necrosis occurred in 187 (64.3%), seroma in 80 (27.5%), skin thickening in 115 (39.5%), skin retraction in 140 (48.1%), calcifications in 78 (26.8%), asymmetry in 3 (1.0%), and mass in 6 (2.1%) of participants. Thirteen biopsies were performed in 12 participants: 8 were benign, 2 were atypical and 3 were malignant. When stratified by breast density, there were no statistically significant differences of mammographic findings or biopsy frequency between the dense and non-dense groups.

## CONCLUSION

Participants who underwent PB-IORT developed mammographic findings of scar, trabecular thickening, seroma, fat necrosis, skin thickening and skin retraction. Breast density does not have a significant impact on post PB-IORT imaging findings or biopsy rate. This study is unique as it compares post treatment mammographic findings with respect to breast density. Knowledge of the spectrum of radiographic changes after IORT can facilitate image interpretation and guide management.

## CLINICAL RELEVANCE/APPLICATION

Knowledge of the spectrum of imaging findings, biopsy rate, and impact of breast density after IORT can facilitate image interpretation and guide management.

## **T5A-SPBR- 8 Nomogram Based on US and Clinicopathologic Characteristics: Axillary Nodal Evaluation Following Neoadjuvant Chemotherapy in Patients with Node-Positive Breast Cancer**

Xiao-Qing Pei, PhD, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To avoid surgical over-treatment of the axilla in breast cancer patients with lymph node (LN) conversion following neoadjuvant chemotherapy (NAC), this study is designed to develop a convenient modality to predict the axillary response to NAC.

## METHODS AND MATERIALS

In this a multi-center study, breast cancer patients with biopsy-proven positive node receiving NAC followed by axillary lymph node dissection (ALND) were identified. A total of 1019 patients were randomly assigned to the training and validation groups at a ratio of 7:3. Clinicopathologic and ultrasound (US) characteristics of both primary tumors and LNs were used to develop corresponding prediction models, and a nomogram integrating clinicopathologic and US predictors was generated to predict the axillary response to NAC.

## RESULTS

Axillary pathological complete response (pCR) was achieved for 47.79% in patients with initially node-positive breast cancer. The expression of estrogen receptor, human epidermal growth factor receptor -2, Ki-67 score, and clinical nodal stage were independent predictors for the nodal response to NAC. Location and radiological response of primary tumors, cortical thickness and shape of LNs on US were also significantly associated with nodal pCR. In the validation cohort, the discrimination of US model (AUC, 0.76; sensitivity, 68.67%; specificity, 75.00%) was superior to clinicopathologic model (AUC, 0.68; sensitivity, 74.67%; specificity, 53.85%). AUCs of the nomogram based on clinicopathologic and US characteristics was 0.85, with a sensitivity of 83.33% and specificity of 73.72%.

## CONCLUSION

US characteristics of primary tumors and axillary LNs were independently associated with axillary status after NAC for breast cancer with initially positive-node. The nomogram constructed with readily available clinicopathologic features and US characteristics improved the predictive capability.

## CLINICAL RELEVANCE/APPLICATION

Even if patients with excellent response to chemotherapy may be potential candidates for omission of ALND, it is difficult to determine status of axillary LNs following NAC. Nomogram incorporating routine clinicopathologic and US characteristics of breast tumors and axillary LNs can predict nodal pCR after NAC and may be a feasible modality to aid in surgical decisions-making for axilla.

## T5A-SPBR- The Value of IVIM-DWI and DCE-MRI in Predicting Molecular Subtypes of Breast Cancer

Tingting Lin (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the value of IVIM-DWI and DCE-MRI in predicting the molecular subtypes of breast cancer.

## METHODS AND MATERIALS

187 patients with suspected breast cancer admitted to our hospital from March, 2019 to December, 2021 were enrolled in this study. Pathological examination was performed after MRI to observe the expression of ER, PR, HER-2 and Ki-67. The quantitative parameters of IVIM-DWI (ADC<sub>standard</sub>, ADC<sub>slow</sub>, ADC<sub>fast</sub>, f) and DCE-MRI (K<sub>trans</sub>, K<sub>ep</sub>, V<sub>e</sub>) were measured. SPSS software was used to analyze the relationship between all parameters and the expression of ER, PR, HER-2 and Ki-67 as well as the correlation between all parameters and the prognostic factors of breast cancer. The differences in parameters of IVIM-DWI and DCE-MRI of different molecular subtypes were compared. Receiver operating characteristic curve (ROC) was plotted for parameters with statistical significance and the area under curve (AUC) was calculated.

## RESULTS

180 cases of breast cancer were included. Containing 15 cases of LuminalA, 45 cases of LuminalB (HER-2-), 68 cases of LuminalB (HER-2+), 30 cases of HER-2 over expression, and 22 cases of triple negative. DCE:K<sub>ep</sub> and K<sub>trans</sub> showed statistically significant differences between HER-2 positive and negative groups and Ki-67 high and low expression groups, but no statistically significant differences between ER and PR positive and negative groups, while V<sub>e</sub> was significantly different between ER, PR, HER-2 positive and negative groups, but was not different between Ki-67 high and low expression groups. K<sub>ep</sub> still had predictive value for HER-2 status and V<sub>e</sub> still had statistical significance for PR status prediction in Logistic multivariate regression analysis. The prediction threshold of K<sub>ep</sub> (p<0.001, AUC=0.878) and V<sub>e</sub> (p<0.001, AUC=0.84) was 0.602 (specificity=87.5%, sensitivity=72.7%) and 0.547 (specificity=96.1%, sensitivity=58.6%), respectively. IVIM: ADC<sub>standard</sub> and ADC<sub>slow</sub> showed statistical significance between positive and negative groups of ER, PR and HER-2, but no statistical significance between high and low expression groups of Ki-67 (p> 0.05). K<sub>ep</sub>, K<sub>trans</sub>, V<sub>e</sub>, ADC<sub>standard</sub> and ADC<sub>slow</sub> showed statistically significant differences among different molecular subtypes of breast cancer.

## **CONCLUSION**

Kep, Ktrans, Ve, ADCstandard and ADCslow have certain predictive value for different molecular subtypes, and can provide an important reference for clinical development of personalized treatment.

## **CLINICAL RELEVANCE/APPLICATION**

Provide a non-invasive prediction method for the preoperative diagnosis of molecular subtypes of breast cancer, which lays a foundation for the accurate diagnosis of breast cancer and the formulation of personalized treatment programs.

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## Abstract Archives of the RSNA, 2023

T5A-SPCA

### Cardiac Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPCA-1 Association of Liver Multiparameter Quantitative Metrics Determined by Dual Layer Spectral Detector CT with Coronary Plaque Scores: A Preliminary Study**

Wang Min (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore potential impacts of the extent and severity of coronary artery plaques on the liver quantitative metrics measured by dual-layer spectral detector CT (SDCT).

#### **METHODS AND MATERIALS**

Patients who underwent an unenhanced SDCT scan of the upper abdomen and coronary computed tomography angiography (CCTA) were enrolled. The segmental stenosis score (SSS) and segmental involvement score (SIS) were used to evaluate the extent and severity of plaques and then grouped by SIS and SSS. The CT attenuation of liver assessed by polychromatic images and spectral metrics of the liver were assessed by virtual mono-energetic images at 40keV and 70keV, the slope of spectral attenuation curve and effective atomic number (written as CT40keV, CT70keV,  $\mu$ HU and Zeff, respectively). Logistic regression model was used to evaluate association of liver quantitative metrics with SIS and SSS.

#### **RESULTS**

644 patients were enrolled, including low SIS (<5) group (n=451), high SIS (=5) group (n=193), low SSS (<5) group (n=461) and high SSS (=5) group (n=183). Except for the CT70poly value (p=0.115) in SSS group, other liver spectral steatosis metrics were significantly different between SIS and SSS groups (All p<0.05). Compared with other collinearity spectral metrics, Zeff was more closely correlated with the SIS and SSS. Zeff was divided into four groups according to the interquartile interval. Compared with the patients in the lowest quartile of Zeff, the adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for SIS were 2.401 (1.284-4.493), 3.215 (1.661-6.224), and 4.126 (2.152-7.911) for those in the second, the third, and the fourth quartile of Zeff, whereas the corresponding ORs (95% CI) for SSS were 2.098 (1.130-3.894), 3.078 (1.602-5.916), and 3.582 (1.876-6.840) for the upper three quartiles of Zeff, especially among these who were < 60 years old, male and VAT/SAT < 1.18.

#### **CONCLUSION**

The quantitative parameter Zeff from SDCT, was an independent factor of the extent and severity of coronary artery plaques. Liver fat quantification may be useful for evaluating risk and prognosis of coronary artery disease.

#### **CLINICAL RELEVANCE/APPLICATION**

Liver multi-parameter metrics measured by SDCT may help to achieve the screening and primary prevention of high-risk population of coronary artery disease.

#### **T5A-SPCA-2 Feasibility of Fast Manual Left Atrial Long-axis Strain Using Cardiac Computed Tomography in Patients with Paroxysmal Atrial Fibrillation**

Takaaki Hosokawa (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Left atrial (LA) function is important for the prognosis of patients with atrial fibrillation (AF). LA strain (LAS) is a sensitive parameter that reflects the complex LA function. Recently, it can be evaluated using cardiac computed tomography (CT). However, LAS analysis requires a dedicated software and experience owing to complex LA anatomy (pulmonary veins and appendages). Semi-automatic fast long-axis strain is a novel simplified method for LAS analysis that improves reproducibility and reduces analysis time; however, it requires a dedicated software, limiting its availability. We hypothesized that LAS could



be evaluated manually without using a dedicated software with fast long-axis strain. We aimed to assess the feasibility of fast manual LA long-axis strain (FM-LALS) in patients with paroxysmal AF (PAF).

## **METHODS AND MATERIALS**

In this study, 40 patients with PAF who underwent cardiac CT and echocardiography were retrospectively enrolled. CT data of the entire cardiac cycle was reconstructed every 5% of RR intervals (RR; 0-95%). LA reservoir and pump strain were evaluated by conventional semi-automatic LAS (cLAS) and FM-LALS. FM-LALS was derived by measuring the distance between the left atrioventricular junction and LA posterior wall in three phases (end-diastole, end-systole, and mid-diastole). Moreover, LAS was assessed using speckle tracking echocardiography (STE). We assessed the correlations between cLAS, FM-LALS, and STE. Inter-observer reproducibility was evaluated in 15 randomly selected patients by two radiologists.

## **RESULTS**

FM-LALS showed an extremely strong correlation with cLAS ( $r = 0.93-0.94$ ,  $p < 0.001$ ). FM-LALS and cLAS showed moderate to strong correlations with STE ( $r = 0.67-0.77$ ,  $p < 0.001$ ). FM-LALS and cLAS showed good to excellent reproducibility (intraclass correlation coefficient 0.85-0.91). FM-LALS significantly reduced the analysis time compared to cLAS (median 92 vs 146 s,  $p < 0.001$ ), while cLAS consumed an additional 4 min for pre-processing.

## **CONCLUSION**

FM-LALS enables rapid and highly reproducible LAS analysis without using a dedicated software and is useful as a highly available LAS analysis method in patients with PAF.

## **CLINICAL RELEVANCE/APPLICATION**

FM-LALS can be assessed rapidly and easily without using a dedicated software, providing high clinical availability.

## **T5A-SPCA-3Dual Energy Computed Tomography to Evaluate Coronary Pericoronary Adipose Tissue Attenuation in Acute Aortic Dissection Patients**

Yongbo Tu, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Pericoronary adipose tissue (PCAT) attenuation is an indicator of active inflammation of perivascular adipose tissue and is supposed to increase in acute aortic dissection(AAD) patients. We aimed to investigate the PCAT attenuation values in acute aortic dissection patients with or without atherosclerosis of the coronary arteries.

## **METHODS AND MATERIALS**

Consecutive patients with chest pain were prospectively enrolled and underwent coronary computed tomography angiography (CCTA) and/or aorta computed tomography angiography. The patients were divided into two groups, AAD and non-AAD, according to the results of CTA. The PCAT attenuation values of three major epicardial coronary vessels were measured. The PCAT attenuation values were compared between the AAD and non-AAD subjects according to the atherosclerosis of the coronary arteries. Similarly, the PCAT attenuation values of the AAD patients were compared between the preoperative and postoperative steady states.

## **RESULTS**

A total of 136 patients (42 female, 94 male; mean age,  $63 \pm 11.9$  years) were divided into two groups according to the presence of aortic dissection on CTA. PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were significantly higher in AAD subjects than in non-AAD subjects, regardless of the presence of atherosclerosis of the coronary arteries ( $-85.1 \pm 9.3$  HU vs.  $-92.9 \pm 10.0$  HU;  $-83.2 \pm 7.4$  HU vs.  $-89.9 \pm 9.1$  HU;  $-77.5 \pm 8.4$  HU vs.  $-85.6 \pm 7.9$  HU,  $p < 0.05$  all). The preoperative PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were higher in the AAD patients than in postoperative steady-state subjects ( $-82.9 \pm 8.7$  HU vs.  $-97.6 \pm 8.8$  HU;  $-79.8 \pm 7.6$  HU vs.  $-92.8 \pm 6.8$  HU;  $-74.6 \pm 7.1$  HU vs.  $-87.7 \pm 6.9$  HU,  $p < 0.05$  all). According to multivariable logistic regression analysis, PCAT<sub>RCA</sub> and PCAT<sub>LAD</sub> were the parameters showing consistent difference between the AAD and non-AAD patients (OR=0.010; 95%CI:0.001 to 0.189;  $p=0.002$ , OR=0.115; 95%CI:0.023 to 0.563;  $p=0.008$ , OR=0.156; 95%CI: 0.032 to 0.770;  $p=0.023$  and OR=0.014; 95%CI:0.001 to 0.177;  $p=0.001$ , OR=0.041; 95%CI:0.008 to 0.210;  $p<0.001$ ).

## **CONCLUSION**

PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were significantly higher in AAD patients than in non-AAD patients regardless of atherosclerosis of the coronary artery. Similarly, in AAD patients with atherosclerosis of the coronary artery, PCAT<sub>RCA</sub>, PCAT<sub>LAD</sub> and PCAT<sub>LCX</sub> were significantly higher preoperatively than postoperatively.

## **CLINICAL RELEVANCE/APPLICATION**

It provides more clinical evidence for the relationship between macrovascular adipose tissue and extracardiac adipose tissue, and can provide more information for drug treatment for the mutual disease.

## **T5A-SPCA-4iPSC-based Engineered Heart Tissue for Myocardial Repair - An In-vivo Pilot Study**

Yi-Han Hasenauer (*Presenter*) Nothing to Disclose

## **PURPOSE**

Chronic heart failure as a result of myocardial infarction remains a major burden on the healthcare systems of the industrialized countries and the respective average life expectancy of their citizens. This calls for therapies targeting the regeneration of the underlying loss of cardiomyocytes. The aim of the project was a proof of concept for the remuscularization of the myocardium by the use of engineered heart tissue based on induced pluripotent stem cells (iPSC) in a macaque model (non-human primate).

## **METHODS AND MATERIALS**

Engineered heart tissue was implanted as functional tissue patches to 14 macaques in two cohorts. An epicardial midventricular position of the left ventricle was chosen for implantation. The heart function was quantified using 3T MRI. After two baseline measurements the first cohort received a single dose (40x20x1 mm cell cluster consisting of 40 million myocytes) and a monthly follow-up for three months. The second cohort received a five-fold dose (48x48x2.5 mm, 200 million cells) and an additional fourth follow-up measurement after six months. The evaluation was carried out by two different examiners. The animal experiments were carried out as part of an approved study.

## **RESULTS**

After three months the systolic and diastolic wall thickness of the left ventricle of all animals increased ( $7\pm 1$  mm to  $9\pm 2$  mm  $p=0.001$ ). At the end of the follow-up the left ventricular mass increased ( $12\pm 2$  g to  $13\pm 3$  g,  $p=0.11$ ). The left ventricular ejection fraction increased ( $59\pm 3\%$  to  $60\pm 5\%$   $p=0.001$ ) without a significant change in the cardiac output. The right ventricular ejection fraction and wall thickness did not change significantly. The longitudinal strain the 4-chamber view and vertical longitudinal axis did not show any significant changes during the observation period.

## **CONCLUSION**

The implantation of artificial heart tissue from iPSC resulted in a sustained increase in left ventricular mass and wall thickness in healthy animals without any adverse effects.

## **CLINICAL RELEVANCE/APPLICATION**

iPSC-based functional myocardial patches are a promising therapy of infarct-related chronic heart failure. This proof-of-concept study in a non-human primate shows feasibility and safety of this innovative approach. It is the first step towards its application in patients.

## **T5A-SPCA-6 Fat Fraction Analysis as a Novel Method for the Assessment of Pericoronary Adipose Tissue Inflammation**

Caterina B. Monti, MD, PhD (*Presenter*) Travel support, Bracco Group

## **PURPOSE**

The aim of our study was to assess pericoronary adipose tissue via the analysis of its fat fraction (FF), comparing it to conventional biomarkers such as pericoronary fat attenuation index (FAI) and the degree of coronary stenosis.

## **METHODS AND MATERIALS**

We retrospectively included all consecutive patients who underwent a dual-energy, unenhanced computed tomography (CT) scan for calcium scoring at our institution. For each patient, we processed the FF maps through a dedicated software, and segmented regions of interest around each coronary artery, namely the left anterior descending artery (LAD), circumflex artery (LCX) and right coronary artery (RCA) to obtain FF and FAI. We retrieved data concerning coronary stenosis from CT reports.

## **RESULTS**

Overall, 99 patients were included, 32 (32%) of whom females, with a median age of 66 years (interquartile range, IQR, 58-74 years). For each coronary artery, pericoronary FF displayed moderate, negative correlations with FAI (LAD:  $r=-0.617$ ,  $p<0.001$ ; LCX:  $r=-0.493$ ,  $p<0.001$ ; RCA:  $r=-0.506$ ,  $p<0.001$ ). Pericoronary FF displayed a weak negative correlation with coronary stenosis at the LAD ( $r=-0.220$ ,  $p=0.035$ ), whereas at the LCX and RCA no significant correlations were observed ( $p=0.572$ ).

## **CONCLUSION**

Our proof-of-concept analysis indicates that epicardial adipose tissue FF, which can be easily computed on dual-energy, unenhanced CT scans, could represent an additional biomarker of cardiovascular risk and coronary inflammation.

## **CLINICAL RELEVANCE/APPLICATION**

Evaluating pericoronary fat fraction at dual energy CT could provide data concerning the status of coronary arteries even from unenhanced cardiac CT.

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## Abstract Archives of the RSNA, 2023

T5A-SPCH

### Chest Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPCH-2 Clinical Values of Deep Learning-based Lung Nodule Detection System for Metastasis Evaluation in Patients with Colorectal Cancer: In-depth Analyses of Effects on Thoracic Radiologists**

Chul Hwan Park, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to evaluate the clinical values of a deep learning-based computer-aided diagnosis (DL-CAD) system with in-depth analyses of radiologists' performance and reading time in pulmonary metastasis evaluation on chest computed tomography (CT).

#### **METHODS AND MATERIALS**

The multi-reader study with a randomized cross-over design was performed during two reading sessions. For the six experienced thoracic radiologists, 64 chest CT scans from patients with colorectal cancer, including 77 pulmonary nodules, were prepared based on a pilot study's sample size calculation. Each reader evaluated nodule presence, size, and location with or without a commercially available DL-CAD system with a 4-week washout period. The reading platform automatically measured the reading time. Per-nodule sensitivity, false-positive per scan, and readers' reading time with or without the DL-CAD system were compared using logistic regression, Poisson regression, and linear mixed model, respectively. Inter-reader agreements for nodule detection and size measurement were analyzed with Fleiss kappa ( $k$ ) and concordance correlation coefficient (CCC).

#### **RESULTS**

Using the DL-CAD system, the pooled sensitivity of six readers for lung nodules significantly improved (from 0.703 [95% CI, 0.651-0.756] to 0.842 [95% CI, 0.782-0.902],  $p < 0.001$ ), reading time significantly reduced (from 212.8 s [95% CI, 198.9-226.7] to 165 s [95% CI, 151.1-178.8],  $p < 0.001$ ), and inter-reader agreements for nodule detection ( $k$ , 0.682-0.884,  $p < 0.001$ ) and size measurement (CCC, 0.385-0.543,  $p < 0.001$ ) enhanced. The improved sensitivity was significant for nodules located in the intraparenchymal (from 0.597 [95% CI, 0.359-0.836] to 0.986 [95% CI, 0.959-1.013],  $p = 0.002$ ) and perivascular (from 0.553 [95% CI, 0.383-0.723] to 0.649 [95% CI, 0.472-0.826],  $p = 0.006$ ) areas and those  $< 6$  mm in axial diameter (from 0.669 [95% CI, 0.611-0.728] to 0.823 [95% CI, 0.750-0.895],  $p < 0.001$ ). However, there was no significant change in the pooled false-positive per case without versus with the DL-CAD system (0.094 [95% CI, 0.052-0.168] vs. 0.094 [95% CI, 0.054-0.163],  $p > 0.999$ ).

#### **CONCLUSION**

With the DL-CAD system, the readers showed significantly improved performance for pulmonary nodule detection and reduced CT reading time without a false-positive increase in pulmonary metastasis evaluation on chest CT.

#### **CLINICAL RELEVANCE/APPLICATION**

The DL-CAD system show good enough performance to be clinically utilized as an assistant in the setting of pulmonary metastasis screening.

#### **T5A-SPCH-5 Conjugate Gradient (CG) Reconstruction vs. Grid Reconstruction: Capabilities for Acquisition Time Reduction, Image Quality and Nodule Detection on Pulmonary Thin-Section MR Imaging with Ultra-Short TE at *In Vitro* and *In Vivo* Studies**

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

## PURPOSE

Pulmonary thin-section MR imaging with UTE (UTE-MRI) has been reported its' clinical potential as substitution for thin-section CT for lung nodule detection or characterization in the last several years. However, one of its' drawbacks are relatively longer acquisition time because of high numbers of 3D radial sampling and grid reconstruction method. In this situation, we develop and clinically set conjugate gradient (CG) reconstruction for UTE-MRI to overcome this drawback. The purpose of this study was to directly compare utility for acquisition time reduction with keeping image quality and nodule detection capability among UTE-MRI obtained with different sampling spoke numbers and reconstructed with CG and grid reconstructions at in vitro and in vivo studies.

## METHODS AND MATERIALS

At in vitro study, commercially available MR phantom for evaluation of image distortion was scanned by UTE-MRI sequence with original (n=1), 1/2, 1/4 and 1/6 sampling spoke numbers at five times, and each UTE-MRI data was reconstructed with CG and grid reconstructions. Moreover, at in vivo study, 40 patients suspected with lung nodule underwent thin-section CT and UTE-MRI by same sequence with original, 1/2, 1/4 and 1/6 sampling spoke numbers. Then, all UTE-MRI data were also reconstructed with CG and grid reconstructions. Standard protocol in this study was UTE-MRI obtained with original sampling spoke number and reconstructed with grid reconstruction. To determine the influence of sampling spoke number reduction and reconstruction method difference at in vitro study, full width at half maximum (FWHM) of each phantom was measured. At in vivo study, lung signal-to-noise ratio (SNR), overall image quality, artifact and probability for nodule presence were assessed by ROI measurement or 5-point scales. FWHM and SNR were compared between each UTE-MRI and standard protocols by Student's t-test. All qualitative indexes were compared by Wilcoxon's signed rank test between each UTE-MRI and standard protocols.

## RESULTS

FWHM and SNR of standard protocol had significant differences with those of all UTE-MRI protocols except UTE-MRIs obtained with original and 1/2 sampling numbers and reconstructed with CG reconstruction ( $p < 0.05$ ). Each qualitative index of standard protocol had significant differences with those of all UTE-MRI protocols except UTE-MRIs obtained with original and 1/2 sampling numbers and reconstructed with CG reconstruction ( $p < 0.05$ ).

## CONCLUSION

CG reconstruction is useful for reducing acquisition time without any influence on image quality and nodule detection on UTE-MRI.

## CLINICAL RELEVANCE/APPLICATION

CG reconstruction is useful for reducing acquisition time without any influence on image quality and nodule detection on UTE-MRI.

## T5A-SPCH- 6 Low-Field (0.55T) Fourier-Decomposition Magnetic Resonance Imaging for Ventilation and Perfusion Defect Evaluation of Pulmonary Diseases

Dante Capaldi, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Low field (0.55T) MRI has recently shown great potential for lung imaging, with reduced susceptibility artifacts and superior image quality for anatomical assessment as compared to higher field MRI. Fourier decomposition MRI (FDMRI) offers a non contrast enhanced, free breathing method to generate both pulmonary ventilation and perfusion maps over a short tidal breathing duration. Our objective was to evaluate for both pulmonary ventilation and perfusion in volunteers and lung disease patients using low field FDMRI. As patients with lung pathology are more frequently known to have ventilation or perfusion defects, we hypothesize that FDMRI ventilation and perfusion defects would be visible and elevated in these patients as compared to our volunteers.

## METHODS AND MATERIALS

We prospectively enrolled 17 patients with heterogeneous lung disease diagnoses ( $57 \pm 17$  yrs, interstitial lung disease=4, sarcoidosis=1, bronchiectasis=1, non small cell lung cancer=4, chronic thromboembolic pulmonary hypertension=2, emphysema=1, benign nodules=4) and four volunteers ( $48 \pm 17$  yrs) who provided written informed consent. Multi slice coronal plane (anterior, center, posterior) free breathing 1H MRI were acquired over a period of 90s per plane using an optimized balanced steady state free precession sequence on a 0.55T scanner (MAGNETOM Free.Max, Siemens Healthineers, Erlangen, Germany). FDMRI analysis was performed using an inhouse software (MATLAB) and the ventilation (VDP) and perfusion defect percent (QDP) were generated using a hierarchical k means clustering approach to extract the ventilation and perfusion defect volumes and a seeded region growing algorithm to segment the thoracic cavity volume. Quantitative comparisons between volunteers and patients with lung disease were performed using unpaired t tests.

## RESULTS

Low field fDMRI ventilation and perfusion maps showed visible ventilation heterogeneity (i.e. V/Q mismatch) in the lung disease patients, such as visible ventilation defects in fibrotic sarcoidosis patients and perfusion defects in a patient with pulmonary hypertension, as compared to the volunteers. Quantitatively as compared to the volunteers, both VDP (volunteer=1.9±0.6%, disease=5.1±3.8%; p=0.03) and QDP (volunteer=2.5±0.3%, disease=7.8±4.4%; p=0.03) were significantly elevated in lung disease patients.

## CONCLUSION

In patients with lung disease, low field fDMRI ventilation and perfusion defects were qualitatively visible and quantitatively elevated, as compared to volunteers.

## CLINICAL RELEVANCE/APPLICATION

Low field (0.55T) free breathing MR ventilation/perfusion (MRVQ) holds promise to functionally evaluate pulmonary diseases without needing intravenous/inhaled contrast agents or ionizing radiation.

## T5A-SPCH- Free Breathing 19F MRI Detects Lobar Differences in Ventilation Kinetics 7

Courtney Wing, MD (*Presenter*) Nothing to Disclose

### PURPOSE

This study was conducted to interpret lobar ventilation kinetics in both healthy supine subjects using a free-breathing 19F MRI ventilation technique.

### METHODS AND MATERIALS

5 healthy volunteers completed a single MR session on a Siemens 3T Prisma. 1H ultrashort-echo time (UTE) MRI sequences were used for registration and masking, and ventilation images with 19-Fluorine (19F) MRI were obtained while the subjects breathed a normoxic mixture of 79% perfluoropropane and 21% oxygen (O<sub>2</sub>). 0.4 second spiral 19F MR imaging was performed during a free breathing recovery breath. The 19F spiral data were denoised using a low-rank matrix recovery approach. Lobar ventilation mapping was created via manual segmentation tools available using 3D Slicer software on the UTE images. Time constants for wash-in and wash-out kinetics (t<sub>1</sub>(s), t<sub>2</sub>(s), respectively) taken from right upper lobe (RUL), right middle lobe (RML), right lower lobe (RLL), left upper lobe (LUL), and left lower lobe (LLL) were used to measure physiologic lobar differences in ventilation kinetics among healthy supine patients.

## RESULTS

19F gas wash-in and wash-out rate constants (t<sub>1</sub>(s), t<sub>2</sub>(s)) were used to measure efficiency of gas exchange in the inspiratory and expiratory phases. On average, bilateral lower lobes demonstrated the most rapid wash-in and wash-out rates in supine subjects (average t<sub>1</sub>(s) RLL = 69.42, RML = 73.3, RUL = 83.5, LUL = 68.0, LLL = 58.1, average t<sub>2</sub>(s) LUL = 27.5, LLL = 22.8).

## CONCLUSION

This follows known physiologic principles in standing patients, in which maximum perfusion in the lower lung zones allows for the largest potential for gas exchange. In order to maintain the most efficient rates of gas exchange in bilateral lower lobes, "standing" pulmonary perfusion ratios must be maintained. This may be explained by supine pulmonary blood flow regulatory mechanisms that are not yet studied. Ventilation mapping with free-breathing 19F MRI is sufficiently sensitive to detect known lobar differences in ventilation kinetics among healthy supine subjects.

## CLINICAL RELEVANCE/APPLICATION

Free breathing 19F MRI has already been proven valuable in monitoring treatment outcomes in CF as well as progression of disease. Here, we offer its utility in studying regional ventilation kinetics in supine subjects, which is not possible with current standard ventilation-space MRI techniques. 19F also lacks dependence on hyperpolarization protocols needed for current functional MRI (Helium-3 (3He), Xenon-129 (129Xe)), so it can be offered at institutions that may lack the resources for hyperpolarization protocols.

## T5A-SPCH- Assessment of Lung Density in Preterm Infants Using Three-dimensional Ultrashort Echo-time MRI 8

Yujie Chen, BS (*Presenter*) Nothing to Disclose

### PURPOSE

Postnatal Lung development is important in infants, especially in preterm children, while relevant imaging data is scarce. Recent studies have shown that normalized lung signal intensity using UTE-MRI could be correlated to lung density comparable to CT, so we aim to explore the quantitative ability of UTE-MRI for assessing lung tissue density and analyze the differences in lung signal intensity among premature infants.

## **METHODS AND MATERIALS**

A prospective recruitment from March 2021 to October 2022 was conducted at the West China Second University Hospital of Sichuan University for infants aged 0-2 years. A total of 101 subjects were enrolled and divided into three groups based on gestational age (GA): extremely-to-very preterm group (GA<28 weeks, n=33), mid-to-late preterm group (GA>28 weeks and <37 weeks, n=34), and full-term group (GA=37 weeks, n=34). All subjects underwent pulmonary MRI using a 3.0-Tesla pediatric-specific MRI scanner (UIH uMR Alpha), including UTE sequence scanning. The lung-to-muscle ratio (LMR) was used to normalize lung signal intensity and quantify lung tissue density, and investigate the anterior-to-posterior(A-P) gradient of lung tissue and the inter-group differences among premature infants.

## **RESULTS**

LMR-A and LMR-P based on UTE-MRI were found to be linearly correlated ( $R^2=0.582$ ,  $P<0.001$ ), indicating a A-P gradient in lung density. There is a gradually decreased tendency of the mean LMR in full-term, mid-to-late preterm, and extremely-to-very preterm infants, the whole lung LMR averages were 45.1, 48.7 and 50.8, respectively, with a statistically-significant difference between extremely-to-very preterm and full-term group ( $P=0.045$ ), and a nearly statistically-significant difference between extremely-to-very preterm and mid-to-late preterm group ( $P=0.083$ ), but the difference between mid-to-late preterm and full-term group was not statistically significant ( $P=0.290$ ).

## **CONCLUSION**

UTE-MRI shows the quantitative ability for assessing lung tissue density, and extremely-to-very preterm infants had lower lung tissue density compared to term infants.

## **CLINICAL RELEVANCE/APPLICATION**

Our study reflects that, the extremely-to-very preterm infants with GA<32 weeks, especially those with bronchopulmonary dysplasia (BPD), may have persistent structural abnormalities, such as alveolar simplification and impaired vascular growth, thereby lead to hyperinflation or cysts manifested as reduced signal intensity on UTE-MRI. Our results provides structural evidence for that, extremely-to-very preterm infants may have persistently reduced lung function compared to full-term infants, and have higher risk to get early-onset chronic obstructive pulmonary disease (COPD), as previous studies suggested.

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## Abstract Archives of the RSNA, 2023

T5A-SPER

### Emergency Radiology Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPER-1 Optic Nerve Sheath Diameter Measurement for Predicting Raised Intracranial Pressure in Pediatric Patients: A Meta Analysis**

Seong Jong Yun, MD, PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

This meta-analysis was aim to evaluate the diagnostic performance of optic nerve sheath diameter (ONSD) for diagnosis of raised intracranial pressure (ICP) in pediatric patients.

##### **METHODS AND MATERIALS**

A database search of PubMed and EMBASE was performed to identify relevant studies. Bivariate modelling and hierarchical summary receiver operating characteristics (HSROC) modelling were performed to evaluate diagnostic performance. A pooled diagnostic odds ratio (DOR) with a 95% confidence interval (CI) not including 1 was considered informative. Subgroup analysis was performed according to the modality (ocular ultrasound vs. brain computed tomography [CT]/magnetic resonance imaging [MRI]). We performed meta-regression analyses for heterogeneity exploration.

##### **RESULTS**

Eleven studies including 546 patients were included. According to pooled DORs, ONSD was informative for evaluation of the raised ICP (DOR, 47; 95% CI, 11-206). ONSD showed a pooled sensitivity of 0.88 (95% CI, 0.79-0.94), a pooled specificity of 0.86 (95% CI, 0.70-0.95), and an area under the HSROC curve of 0.93 (95% CI, 0.91-0.95) for diagnosis of raised ICP. According to the subgroup analysis, ocular ultrasound (sensitivity, 0.91 [95% CI, 0.81-0.96]; specificity, 0.86 [95% CI, 0.65-0.96]) showed higher sensitivity and comparable specificity than ONSD measured on brain CT/MRI (sensitivity, 0.75 [95% CI, 0.51-0.99]; specificity, 0.91 [95% CI, 0.74-1.00]). On meta-regression analysis, study design, number of patients, and reference standard were sources of heterogeneity.

##### **CONCLUSION**

ONSD may be a useful method for predicting raised ICP in pediatric patients.

##### **CLINICAL RELEVANCE/APPLICATION**

We recommend that measurement of ONSD be performed using ocular ultrasound for more accurate diagnosis of raised ICP in pediatric patients.

#### **T5A-SPER-2 Is it Necessary to Perform Triple Rule-out Computed Tomography Angiography that Includes Abdominal Aorta in Patients with Chest Pain: A Study with More than 1000 Patients**

Tingting Qu (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To investigate whether it is necessary to perform the triple rule-out (TRO) computed tomography angiography (CTA) that includes abdominal aorta in patients with chest pain.

##### **METHODS AND MATERIALS**

A total of 1482 patients with nontraumatic chest pain (chief complaints: chest pain, difficulty in breathing, or hemoptysis) were included in this retrospective study. Four hundred and fourteen patients underwent the conventional TRO-CTA scans, and 1068 patients underwent TRO-CTA that included the abdominal aorta (TRO-CTA<sub>AAA</sub>) under the request of clinicians. All scanning parameters were the same only the scanning range for the third phase in TRO-CTA was different: conventional TRO-



CTA covered only the thoracic aorta, while TRO-CTAwAA extended to the entire aorta. Patient etiology was investigated and the detection rates of major vessel abnormalities (aortic dissection, aneurysm, penetrating ulcer, vascular occlusion, and thrombosis) between the two groups and within the TRO-CTAwAA group (thoracic aorta vs. entire aorta) were compared using chi square tests and paired chi square tests. The radiation dose (CTDIvol and DLP) between the two groups was compared using analysis of variance (ANOVA).

## **RESULTS**

The TRO-CTAwAA had significantly higher detection rate of major artery abnormalities than the TRO-CTA group (38.8% Vs. 8.5%,  $P < 0.001$ ). Within the TRO-CTAwAA group, only 28.4% abnormalities happened in thoracic aorta, which means the vessel abnormalities of 111 patients (27%) in this group would be missed with the conventional scan range. The TRO-CTAwAA group had slightly higher CTDIvol ( $5.64 \pm 1.44$  mGy) and DLP ( $473.64 \pm 146.50$  mGy\*cm) values for the complete examination than the TROCTA group ( $5.25 \pm 1.38$  mGy and  $453.03 \pm 139.22$  mGy\*cm, respectively). However, the differences were not statistically significant (all  $P > 0.05$ ).

## **CONCLUSION**

TRO-CTA with scan range including the abdominal aorta significantly improves the detection rate for major vessel abnormalities in patients with chest pain with minor radiation dose increase.

## **CLINICAL RELEVANCE/APPLICATION**

For chest pain patients, the scan range of triple rule-out CTA should be extended to include abdominal aorta since about quarter of the major vessel abnormalities happen beyond the thoracic aorta.

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## Abstract Archives of the RSNA, 2023

T5A-SPGI

### Gastrointestinal Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPGI-1 Correlation between Triglyceride/high-density Lipoprotein Cholesterol Ratio and Spectral Parameters Measured on a Fast kVp Switching Dual-energy CT**

Anjie Xie (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the correlation between triglyceride/high-density lipoprotein cholesterol (TG/HDL-C) ratio and spectral parameters measured on a fast kVp switching dual-energy CT

#### **METHODS AND MATERIALS**

This study included 50 patients with non-alcoholic fatty liver disease (NAFLD) and 46 healthy individuals, all received TG and HDL-C examination and TG/HDL-C was calculated. According to TG/HDL-C, the individuals were divided into two groups: low-ratio group (TG/HDL-C =1.5, n=56), and high-ratio group (TG/HDL-C >1.5, n=40). Abdominal spectral imaging was performed on all individuals. Virtual monochromatic images at 50keV, 70keV, 90keV, and 100keV were reconstructed, the CT value of liver at 50-100 keV (HU50-100 keV) and that of spleen at 70keV were measured and the CT value of liver/ CT value of spleen ratio (HUL/S) was calculated. Mann Whitney U or two-sample t test was used to compare the differences between two groups, Spearman or Pearson correlation analysis was used to analyze the correlation between TG/HDL-C ratio and CT quantitative parameters, and ROC curve was used to analyze the performances of those parameters in predicting TG/HDL-C ratio.

#### **RESULTS**

Correlation analysis showed that TG/HDL ratio was negatively correlated with HU50keV, HU70keV, HU90keV, HU100keV, HUL/S, and the correlation coefficients were -0.4171 (-0.5740 to -0.2307,  $p<0.0001$ ), -0.6129 (-0.7272 to -0.4655,  $p<0.0001$ ), -0.6878 (-0.7830 to -0.5612,  $p<0.0001$ ), -0.7006 (-0.7923 to -0.5778,  $p<0.0001$ ), -0.7513 (-0.8291 to -0.6450,  $p<0.0001$ ). HU50keV, HU70keV, HU90keV, HU100keV, and HUL/S in high-ratio group were lower than those in low-ratio group ( $p<0.05$ ). When using HU50keV (threshold 68.625), HU70keV (57.71), HU90keV (58.785), HU100keV (55.89) and HUL/S (threshold 1.105) to predict TG/HDL-C ratio, the sensitivities were 0.804, 0.821, 0.625, 0.732 and 0.804, the specificities were 0.69, 0.714, 0.952, 0.8821 and 0.833, and AUC were 0.723, 0.803, 0.832, 0.835 and 0.837, respectively.

#### **CONCLUSION**

Conclusion The quantitative spectral parameters (HU<sub>50keV</sub>, HU<sub>70keV</sub>, HU<sub>90keV</sub>, HU<sub>100keV</sub>, HUL/S) were all correlated with TG/HDL-C ratio and had high performance to predict TG/HDL-C in NAFLD patients.

#### **CLINICAL RELEVANCE/APPLICATION**

Spectral imaging can help predict cardiovascular events in NAFLD patients, which is valuable for therapy and prognosis.

#### **T5A-SPGI-2 Opportunistic Screening for Bone Mineral Density Changes using Virtual Non-calcium of Spectral CTE in Patients with Inflammatory Bowel Disease**

Shaotong Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Objective The purpose of this study was to explore the feasibility of opportunistic screening for bone mineral density (BMD) changes in patients with inflammatory bowel disease using virtual non-calcium of spectral computer tomography enterography (CTE)

## **METHODS AND MATERIALS**

Materials and Methods Twenty patients (10 males, 10 females, average age  $38.2 \pm 11.5$ ) confirmed with inflammatory bowel disease (IBD) were prospectively enrolled. And 19 patients with non-inflammatory bowel disease (10 males, 9 females, mean age  $37.8 \pm 10.1$ ) were enrolled as control group. Patients were excluded if they had the following conditions: (a) no informed consent; (b) fracture in spine; (c) primary or metastatic bone tumors in the spine; (d) incomplete CT images; (f) Severe degenerative changes. Dual energy CTE was performed at 100/Sn150kVp using a 3rd generation dual-source CT scanner (SOMATOM Force, Siemens Healthcare). Dual energy images were reconstructed with a) virtual non-contrast images (VNC), b) virtual non-calcium images (VNCa). The CT value for contrast media (CM), the contrast agent density (CaD) which correspond to the CT value of calcium density, CT value of 50% mixed- energy imaging (CTmix) and fat fraction (FF) for 1st lumbar were measured, respectively.

## **RESULTS**

Results FF and CaD of IBD group were significantly higher than those of control group ( $p < 0.05$ ). But CM and CTmix were similar between two groups ( $p > 0.05$ ). The results were shown in Table 1.

## **CONCLUSION**

FF and CaD measurements on VNCa images in spectral CT could provide feasibility of BMD quantification in patients with IBD by spectral CTE.

## **CLINICAL RELEVANCE/APPLICATION**

Clinical application Spectral CTE prescribed for IBD evaluation could also provide opportunistic screening for BMD changes, extending the clinical application of Spectral CT without additional radiation to patients.

## **T5A-SPGI-3 Feasibility of Diagnosing Non-alcoholic Fatty Liver Disease using Spectral Imaging and Multi-material Decomposition Technique on Dual-energy CT**

Anjie Xie (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate the feasibility to diagnose non-alcoholic fatty liver disease (NAFLD) using multi-material decomposition (MMD) measured liver fat fraction (FF) and spectral parameters.

## **METHODS AND MATERIALS**

Fifty patients with clinically diagnosed NAFLD (reference of ultrasound examination or liver biopsy results) and 46 without NAFLD volunteers (N-NAFLD) were included in this study. Abdominal spectral imaging was performed on all individuals. Then visceral fat content (FV) and visceral fat content percentage (FCV) were measured by an auto measurement software. The FF in the left lobe of liver (FFL), right anterior lobe of liver (FFRA), and right posterior lobe of liver (FFRP) were measured using MMD. Virtual monochromatic images at 50keV, 70keV, 90keV, and 100keV were reconstructed, the CT value of liver at 50-100 keV (HU50-100 keV) and that of spleen at 70keV were measured. CT value of liver/ CT value of spleen ratio (HUL/S) and slope of spectral curve  $\Delta HU$  which was defined as  $“(HU100keV - HU40keV) / (100 - 40)”$  were calculated. Differences between groups were compared using Mann Whitney U. Receiver operating characteristic curves were used to analyze the performances of those parameters in the diagnosis of NAFLD, sensitivity, specificity and area under the curve (AUC) were calculated.

## **RESULTS**

Comparing to N-NAFLD group, NAFLD group had higher FFL, FFRA, FFRP, FV, FCV ( $p < 0.05$ ), and lower HU50keV, HU70keV, HU90keV, HU100keV, HUL/S ( $p < 0.05$ ).  $\Delta HU$  was not statistically different between two groups. When using FFL (threshold of 0.981%), FFRP (1.065%), FFRA (4.2635%), and FV (68.8%), FVC (13013mm<sup>2</sup>), HU50keV (67.29 HU), HU70keV (58.05 HU), HU90keV (54.8 HU), HU100keV (55.678 HU), and HUL/S (1.1) to diagnose NAFLD, the sensitivities were 0.96, 0.96, 0.96, 0.52, 0.92, 0.978, 1, 1, 0.935 and 0.978, the specificities were 0.957, 0.935, 1, 0.891, 0.674, 0.72, 0.8, 0.84, 0.94 and 0.88, the AUC were 0.991, 0.989, 0.999, 0.743, 0.873, 0.84, 0.934, 0.978, 0.984 and 0.968, respectively. Therein, FFL, FFRA, FFRP had highest diagnostic performances.

## **CONCLUSION**

CT spectral scanning could provide additional quantitative parameters for diagnosis of NAFLD, and FF measured by MMD had highest performance.

## **CLINICAL RELEVANCE/APPLICATION**

MMD technique in spectral imaging mode has great potential in rapid and non-invasive diagnosis of NAFLD.

## **T5A-SPGI-4 Photon Counting CT of the Abdomen and Pelvis: A Clinical Comparison of Image Quality to Dual Energy CT Across Different Virtual Monoenergetic Images**

Winston Joe, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Photon counting detector computed tomography (PCCT) represents the latest step forward in CT technology with early experience demonstrating improvements in spatial resolution, artifact reduction, material decomposition, and dose reduction, yet there are few studies documenting how these advancements translate to improved clinical utility, especially when compared to prior state of the art dual energy integrating detector CT (DECT). The purpose of this work is to evaluate the spectral capabilities of PCCT by comparing image quality of PCCT to that of DECT across a range of virtual monoenergetic images (VMI).

## **METHODS AND MATERIALS**

In this institutional review board-approved retrospective study, we identified patients who underwent both routine contrast enhanced CT of the abdomen and pelvis on a clinical PCCT scanner (NAEOTOM Alpha, Siemens Healthineers) and a clinical DECT (SOMATOM FORCE, Siemens Healthineers) since December 2021 (n = 12). Individual subjects received the same iodine contrast dose for both examinations. PCCT was performed at a tube voltage of 120 kVp, and DECT performed with a tube voltage pair of 100/150 kVp. Subsequently, VMIs from both scans were reconstructed at 40, 50, 60, 70, 100, and 150 keV. For both PCCT and DECT examinations, contrast-to-noise ratios (CNR) were calculated relative to the psoas musculature for select organs and vessels (aorta, liver, spleen, renal cortex, and pancreas). Quantitative signal-to-noise ratios (SNR) were calculated. PCCT versus DECT were evaluated with respect to CNR and SNR at each virtual monoenergetic image reconstruction. Average radiation doses were compared between PCCT and DECT.

## **RESULTS**

PCCT has superior CNR of the aorta at 40 keV and SNR at 40 keV and 50 keV and superior CNR and SNR for renal cortex at 40 keV. There was no significant difference in CNR of the liver or pancreas for all evaluated VMIs, while DECT showed slightly improved CNR in the spleen at 100 keV and 150 keV. PCCT achieved a statistically significant 16% radiation dose reduction compared to DECT.

## **CONCLUSION**

At lower keV virtual monoenergetic images, PCCT offers improved CNR and SNR with respect to the aorta and renal cortex. Comparable contrast and signal to noise characteristics were observed for the liver, spleen, and pancreas at lower keV reconstructions. Importantly, these findings were achieved at a statistically significant 16% radiation dose reduction compared to DECT.

## **CLINICAL RELEVANCE/APPLICATION**

At low keV monoenergetic image reconstructions, PCCT enables quantitatively comparable to improved image quality compared to DECT while allowing for a statically significant reduction in radiation dose.

## **T5A-SPGI-5 Longitudinal Intra Individual Consistency of Virtual Unenhanced Images Derived from Spectral Detector CT**

Nils Grosse Hokamp, MD, PhD (*Presenter*) Research Grant, Koninklijke Philips NV; Speakers Bureau, Koninklijke Philips NV; Consultant, Bristol-Myers Squibb Company

## **PURPOSE**

Virtual non-contrast images (VNC) images obtained from different dual energy approaches are frequently suggested to serve as problem-solvers in case of missing true unenhanced acquisitions and even as replacement of the latter. While ex vivo consistency have been reported as accurate in literature, data on longitudinal, intra-individual consistency is lacking, yet another helpful measurement of their clinical utility. The objective of this study is the evaluation of longitudinal, intraindividual consistency of virtual unenhanced images (VNC) reconstructed from spectral detector CT (SDCT) in large patient cohort.

## **METHODS AND MATERIALS**

Baseline and follow-up examinations of 166 patients with malignant melanoma were retrospectively included, resulting in a total of 323 scans. All patients underwent clinically indicated SDCT examinations of the chest and abdomen. In all patients, contrast administration, image acquisition and reconstruction wer performed using a standardizes protocol. Using additional cross-sectional follow-up imaging (=3 months), macroscopic tumor burden was excluded. A total of 35 ROI in parenchymatous organs, vessels and connective tissue were placed in contrast-enhanced scans (to allow for exclusion of unrepresentative tissues such as fasciae or vessels). To allow for identical ROI placement, baseline and follow-up images were displayed side-by-side using a dedicated software for oncologic image analysis (MintLesion Research, MintMedical, Heidelberg). The software then automatically copied and pasted all ROI on VNC images and collected attenuation and its standard deviation in VNC images for all ROI. Data was statistically assessed using a normalized deviation parateter:  $NDP = \frac{|(TP1;TP2)|}{\text{mean}(TP1;TP2)}$ .

## RESULTS

As suggested earlier, a difference = 1 standard deviation was considered indicative of excellent reproducibility and found in 85% of cases. Good reproducibility (indicated by NDP = 2 standard deviations) was found for 91% of all ROI. While good reproducibility was found for arterial vessels and all parenchymatous organs of the upper abdomen as well as connective tissues; differences in pelvic organs and venous vessels showed greater variation.

## CONCLUSION

SDCT-derived VNC reconstructions demonstrate little intraindividual, longitudinal variations and good reproducibility. These findings substantiate the validity of VNC calculations and further underline the clinical applicability of VNC reconstructions.

## CLINICAL RELEVANCE/APPLICATION

VNC are more commonly used as a replacement for a true unenhanced acquisition, our data provides further substantiation that this is a valid approach.

## **T5A-SPGI-6 Four-Dimensional Esophageal Computed Tomography Imaging: Assessment of Treatment Effect for Esophagogastric Junction Outflow Disorders after Per-oral Endoscopic Myotomy**

Hikaru Nishiyama (*Presenter*) Nothing to Disclose

### PURPOSE

Per-oral endoscopic myotomy (POEM) is a novel minimally invasive treatment method for Disorders of EGJ outflow (disorders of EGJO). However, there is no consensus on the method for evaluating the therapeutic effect of esophageal achalasia treatment other than the subjective clinical symptom score called the "Eckardt score". This study aimed to examine the clinical feasibility of four-dimensional esophageal computed tomography imaging (4D-ECT) for assessing treatment effect for esophageal achalasia after POEM.

### METHODS AND MATERIALS

This prospective study included 24 patients with esophageal achalasia or EGJO obstruction who underwent 4D-ECT using 320detector-row CT scanner before and after POEM. The patients were seated on the chair in a semi-reclining position at a 45-60 degree angle. Dynamic volume CT scan was performed during swallow of 5% diluted contrast medium (Ioversol, 320mgI/mL). Scanning was performed in sequence over a 10 s duration for swallow, and scan range was from thoracic esophagus to gastric cardia including lower esophageal sphincter (LES). CT images were reconstructed in 102 phases at an interval of 0.1 s. The maximum esophageal length and area at LES level. The volume integral with time (VIT) of contrast medium during scanning was calculated to evaluate esophageal clearance. Additionally, the Eckardt score was recorded to assess treatment effect of POEM. These results were compared between pre- and post-POEM using Wilcoxon signed-rank test.

## RESULTS

For all patients, POEM were successful without major complications, and the median Eckardt score was significantly improved after POEM (7.0 [5.0-.8.8] vs. 0.5 [0-1.0],  $p < 0.0001$ ). The median of maximum esophageal length at LES level was significantly longer (2.1 [0.7-4.9] vs 7.7 [5.6-9.4] mm,  $p = 0.0001$ ), and the median of maximum esophageal area at LES level was significantly larger after POEM (2.0 [0.2-10.8] vs 23.0 [12.4-47.0] mm<sup>2</sup>,  $p = 0.0001$ ). The VIT was significantly smaller after POEM (602.1 [216.4-717.3] vs 92.9 [50.3-333.1] ml& 1;s,  $p < 0.0001$ ).

## CONCLUSION

4D-ECT allowed for the quantitative assessment of improving both impaired relaxation of LES and esophageal clearance after POEM.

## CLINICAL RELEVANCE/APPLICATION

4D-ECT is a novel imaging technique for the assessment of esophageal dynamics, and provides quantitative parameters for evaluating esophageal morphology, motility, and clearance. 4D-ECT enables quantitative and objective assessment of treatment effect for EGJO disorders after POEM.

## **T5A-SPGI-7 Quantitative Spectral Computed Tomography Parameters as Pre-operative Prediction Factors for Ki-67 Expression in Hepatocellular Carcinoma**

Caiyun Li, BMedSc, BS (*Presenter*) Nothing to Disclose

### PURPOSE

To investigate the performance of spectral parameters measured by a dual-energy CT for predicting the Ki-67 expression in hepatocellular carcinoma (HCC).

## **METHODS AND MATERIALS**

This study retrospectively analyzed 91 patients with HCC who underwent both Ki-67 immunohistochemistry and two-phase contrast-enhanced spectral CT imaging. These patients were divided into two groups according to the positive rate of Ki-67 (Ki-67%): high expression (Ki-67% > 20%, n = 51) and low expression (Ki-67% = 20%, n = 40). CT values on 100 and 140 keV monochromatic energy images (HU100-140keV), normalized effective atomic number (Neff-Z), water density (Dwater) and fat density (Dfat) were measured and calculated. Receiver Operating Characteristics (ROC) curves were utilized for evaluating the predicting performance, area under curve (AUC), sensitivity and specificity were calculated, and multi-variable logistic regression analysis were conducted.

## **RESULTS**

In prediction of Ki-67 expression, the AUCs of Neff-Z, Dfat, HU100-140keV and Dwater were 0.650, 0.677, 0.692-0.750, 0.777, with thresholds of 0.68, 995.28, 64.42-48.79 and 1035.17 respectively. The corresponding sensitivities were 0.647, 0.804, 0.529-0.824 and 0.961, respectively. The specificities were 0.600, 0.525, 0.825-0.625 and 0.475, respectively. Dwater was an independent predicting factor for high Ki-67 expression (OR=1.286, P<0.001), and had the highest prediction efficiency with area under the curve (AUC) of 0.777. The multi-variable analysis combining spectral CT parameters and morphological characteristics improved the prediction efficiency (AUC=0.814).

## **CONCLUSION**

Spectral CT provides a non-invasive method to evaluate the proliferation status of HCC cells, and the efficiency would be improved by combining spectral CT parameters and morphologic features.

## **CLINICAL RELEVANCE/APPLICATION**

Ki-67 was a significant marker for HCC prognosis and clinical decision, however current method to evaluate Ki-67 always needs surgery, which is detrimental for assessing patients who lost surgery chance. Contrast-enhanced spectral imaging on dual-energy CT provides various parameters to predict cell proliferation in HCC with good performance, shedding lights in clinical diagnosis and therapeutic strategy decision.

## **T5A-SPGI-8 Imaging, Pathological and Molecular Characteristics of Programmed Cell Death Ligand 1 Positive Hepatocellular Carcinoma**

Azusa Kitao, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Immunotherapy has been rapidly developed and is being applied for increasing number of hepatocellular carcinoma (HCC) patients. The purpose of this study is to clarify the imaging, pathological and molecular characteristics of hepatocellular carcinoma showing programmed cell death ligand 1 (PD-L1) expression, for the prediction of immunotherapy reactivity.

## **METHODS AND MATERIALS**

We enrolled surgically resected 353 HCCs from April 2008 to July 2018 at our institution and classified into PD-L1 positive HCCs and PD-L1 negative HCCs by immunohistochemistry. We compared the qualitative and quantitative findings on dynamic CT and gadoxetic acid-enhanced MRI, pathology and immunohistological expression of P53, beta-catenin, glutamine synthetase and organic anion transporting polypeptide 1B3 (OATP1B3). Mann-Whitney test, chi-square test, multivariable analysis and Pearson's correlation analysis were used for statistical analyses.

## **RESULTS**

PD-L1 positive HCC (n=82) frequently showed arterial phase rim enhancement or heterogenous hypo-hyperenhancement compared to PD-L1 negative HCC (n=271) (52.4% vs 29.0%, P<0.001, odds ratio=5.00, 95% CI 2.34-10.68). Apparent diffusion coefficient (ADC) in PD-L1 positive HCC was lower than in PD-L1 negative HCC ( $1.13 \times 10^{-3}$  mm<sup>2</sup>/s vs  $1.30 \times 10^{-3}$  mm<sup>2</sup>/s, P=0.01, odds ratio=0.45 [cutoff value  $1.18 \times 10^{-3}$  mm<sup>2</sup>/s], 95% CI 0.24-0.82). Patients with PD-L1 positive HCC showed higher serum AFP level than those without PD-L1 positive HCC (median 20 ng/ml vs 10 ng/ml, P<0.001). Poorly differentiated HCC was frequent in PD-L1 positive HCC (37.8% vs 19.9%, P<0.001). PD-L1 expression grade showed a significant positive correlation with P53 expression grade (P<0.0001, R=0.36), however, no correlation with the other molecules.

## **CONCLUSION**

Imaging characteristics of PD-L1 positive HCC are arterial phase rim enhancement or heterogenous enhancement and lower ADC value. PD-L1 positive HCC showed higher serum AFP level, higher percentage of poorly differentiated HCC and a positive correlation with p53 expression, indicating aggressive biological natures.

## **CLINICAL RELEVANCE/APPLICATION**

Imaging characteristics of PD-L1 positive HCC with more aggressive natures, namely arterial phase rim enhancement or heterogenous enhancement in dynamic CT and low ADC value will be useful to predict immunotherapy response in personalized medicine.

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## Abstract Archives of the RSNA, 2023

T5A-SPGU

### Genitourinary Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPGU- An MRI-based Grading System for Preoperative Risk Estimation of Positive Surgical Margin 1 after Radical Prostatectomy**

Lili Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to construct a simplified grading system based on MRI features to predict positive surgical margin (PSM) after radical prostatectomy (RP) and then validate it internally.

#### **METHODS AND MATERIALS**

Patients who had undergone prostate MRI followed by RP at our institution between January 2017 and January 2021 were retrospectively enrolled as the derivation group, and those between February 2021 and November 2022 were enrolled as the validation group. One radiologist evaluated tumor-related MRI features, including the capsule contact length (CCL) of lesions, capsular irregularity or bulge, neurovascular bundle asymmetry, obliteration of rectoprostatic angle, frank extraprostatic extension (EPE), and apex abutting. Binary logistic regression and decision tree analysis were used to select risk features for PSM among the significant variables from univariate analysis. The area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of different systems were calculated and then compared. The interreader agreement of the scoring systems was evaluated using the kappa statistic.

#### **RESULTS**

A total of 42 (29.8%) and 32 (36.4%) patients had PSM in the derivation and validation cohorts, respectively. The first grading system was proposed (mrPSM1) using two imaging features, namely, CCL = 20 mm and apex abutting. After combining the radiologist's perspective, the grading system was updated by adding frank EPE (mrPSM2) as follows: Grade 1, CCL < 20 mm without apex abutting; Grade 2, CCL = 20 mm or apex abutting; Grade 3, CCL = 20 mm and apex abutting, or frank EPE. In the derivation group, the AUC was 0.705 for mrPSM1 and 0.713 for mrPSM2. In the validation group, our grading systems showed slightly higher AUC than Park et al.'s model (0.672-0.686 vs. 0.646,  $p > 0.05$ ) and significantly higher specificity (0.732-0.750 vs. 0.411,  $p < 0.001$ ). The kappa value was 0.764 for mrPSM1 and 0.776 for mrPSM2. Decision curve analysis showed a higher net benefit for mrPSM2.

#### **CONCLUSION**

The proposed grading systems based on MRI have feasibility in predicting PSM and are easily interpretable.

#### **CLINICAL RELEVANCE/APPLICATION**

Our proposed MRI-based grading systems for PSM might benefit the management of prostate cancer.

#### **T5A-SPGU- Performance of an Ultra-fast Deep-learning Accelerated MRI Screening Protocol for Prostate 3 Cancer Compared to a Standard Multiparametric Protocol**

Benedict Oerther, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish and evaluate an ultra-fast MRI screening protocol for prostate cancer in biopsy-naïve men regarding PI-RADSv2.1 classification in comparison to the standard multiparametric protocol.



## **METHODS AND MATERIALS**

This prospective monoinstitutional study included consecutive patients with suspected prostate cancer without prior biopsy. A PI-RADSV2.1 conform mpMRI protocol was acquired in a 3 T MRI scanner (triplanar T2 TSE, axial T1 DIXON native and contrast-enhanced, DWI, DCE; scan time: 23min, 43sec). Additionally, two deep-learning accelerated sequences (axial T2-weighted TSE and diffusion-weighted „ZOOMit“) were acquired (scan time: 3min 28sec). Two experienced readers independently evaluated the images for image quality (Likert-scale; 1=non-diagnostic, 5=excellent) and the presence of prostate cancer according to PI-RADSV2.1 criteria. In a first reading session, only the screening protocol (axial T2-weighted and ZOOMit imaging was available). Subsequently, the full conventional mpMRI protocol was assessed (blinded to the results of the first session) and served as a reference standard. Intrareader-agreement was assessed using weighted kappa statistics.

## **RESULTS**

The final cohort after exclusions consisted of 77 patients. Diagnostic performance of the screening protocol was excellent with a sensitivity and specificity of 87.5%/100% and 100/100% (cut-off = PI-RADS 4) for reader 1 and reader 2, respectively. Mean image quality was 4.4 (R1) and 3.9 (R2) for the standard protocol vs. 4.6 and 4.7 for the accelerated T2- and diffusion-weighted images ( $p < 0.05$ ). Intrareader-agreement was substantial ( $k=0.72$ ) for reader 1 and excellent ( $k=0.98$ ) for reader 2.

## **CONCLUSION**

An abbreviated screening protocol for prostate cancer in biopsy-naïve men proved similar diagnostic performance and better imaging quality compared to the conventional extensive mpMRI protocol, requiring just 15% of scan time.

## **CLINICAL RELEVANCE/APPLICATION**

Ultra-fast deep-learning accelerated MRI protocols can render prostate cancer screening more time efficient.

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## Abstract Archives of the RSNA, 2023

T5A-SPHN

### Head & Neck Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### T5A-SPHN- CT Diagnosis of Cricoarytenoid Joint Dislocation

1

Xueming Zeng (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the value of CT in diagnosis of cricoarytenoid joint dislocation, and evaluate the diagnostic points of different types of dislocation.

#### METHODS AND MATERIALS

41 patients who had been diagnosed with cricoarytenoid joint dislocation retrospectively reviewed, all patients were treated by reduction forceps, and the voice returned to normal or significantly improved. Including respiratory phase and phonation phase CT images. Observe the exposure of arytenoid articular surface of cricoid cartilage on VR images: complete exposure means total dislocation, incomplete exposure means subluxation; posterior part exposure means anterior dislocation, anterior part exposure means posterior dislocation; lateral part exposure means medial dislocation, medial part exposure means external dislocation (respiratory phase). Observe laryngoscopic video of each case, judge the direction of dislocation (anterior and posterior) according to morphology of vocal folds; compare the results with CT judgment. The characteristics of MPR CT images in each case were analyzed based on VR images.

#### RESULTS

On VR images, there were 38 cases of cricoarytenoid subluxation (92.7%, 38/41), 3 cases of complete dislocation (7.3%, 3/41); 32 cases (78.0%, 32/41) of left dislocation, 9 cases (22.0%, 9/41) of right dislocation; Posterior dislocation in 37 cases (90.2%, 37/41), anterior dislocation in 4 cases (9.8%, 4/41); There were 32 cases of medial dislocation (78.0%, 32/41), 2 cases of external dislocation (4.9%, 2/41), 7 cases without obvious internal/external dislocation (17.1%, 7/41). 3 cases of complete dislocation were left posterior and internal dislocation. On laryngoscopy, there were 24 cases of posterior dislocation (58.5%, 24/41), 12 cases of anterior dislocation (29.3%, 12/41), 5 cases were difficult to assess (12.2%, 5/41). Laryngoscopy diagnosis were consistent with CT in 20 cases (55.6%, 20/36), inconsistent in 16 cases (44.4%, 16/36). On MPR CT images, dislocated arytenoid cartilage ridged on the top of cricoid cartilage plate in all 3 cases of complete dislocation. The manifestations of 38 cases of cricoarytenoid joint subluxation on MPR CT images are shown in Table 1. ( Fig.1~6)

#### CONCLUSION

VR images can display dislocation of cricoarytenoid joint visually and accurately. MPR images can compensate for the poor evaluation of VR in younger patients.

#### CLINICAL RELEVANCE/APPLICATION

This study is based on the diagnostic method of limb joint dislocation and has high diagnostic accuracy. Reduction forceps adopts different techniques for total dislocation and subluxation, only CT can distinguish them currently.

#### T5A-SPHN- Identification of Methicillin-resistant Staphylococcus Aureus (MRSA) via Head and Neck Imaging

2

Alice Yun, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

It is currently unclear how methicillin-resistant Staphylococcus aureus (MRSA) infection presents in medical imaging uniquely from other types of acute infection. The characteristics of MRSA neck infections in radiological exams have not yet been established. This study aimed to compare the presentation of MRSA positive patients to that of patients with other types of acute neck infection in radiological exams.

## **METHODS AND MATERIALS**

A retrospective review of children and young adults aged 0 to 24 years who underwent medical imaging for suspected acute infection at our pediatric hospital between January 2013 and September 2022 was conducted. A blinded radiologist reviewed initial and follow-up head and neck CT and MR imaging of patients with and without MRSA infection. Noted features included nodal necrosis, pattern of fat stranding, discrete abscess, and retropharyngeal edema. MRSA diagnosis was determined using microbiology lab results.

## **RESULTS**

A total of 18 patients were reviewed, with a mean age of  $6.4 \pm 7.7$  years old (range 0-24) at time of diagnosis. 7 patients were female and 12 patients were male. 8 patients were positive for MRSA (MRSA-P), and 10 patients were MRSA negative but had acute neck infection (MRSA-N). Statistical analysis was conducted using SPSS 28.0.1.0 (142). No significant difference was found in age or sex between MRSA-P and MRSA-N groups. More MRSA-P patients (5/8, 62.5%) had nodal necrosis compared to the MRSA-N group (2/10, 20.0%), a borderline significant difference in proportions of 0.425,  $p = 0.145$ . All but one MRSA-P patients (7/8, 87.5%) had a diffuse pattern of fat stranding compared to the MRSA-N group (6/10, 60.0%), but we failed to find a significant difference in proportions ( $p > 0.10$ ). A higher number of MRSA-P patients (7/8, 87.5%) had discrete abscess compared to MRSA-N patients (5/10, 50.0%), with the 0.375 difference in proportions being borderline significant,  $p = 0.152$ . More MRSA-P patients (4/8, 50.0%) had retropharyngeal edema compared to the MRSA-N patients (1/10, 10.0%), with a borderline significant difference in proportions of 0.400,  $p = 0.118$ .

## **CONCLUSION**

MRSA neck infections show a higher proportion of observed nodal necrosis, diffuse pattern of fat stranding, discrete abscess, and retropharyngeal edema than acute neck infections unrelated to MRSA. However, these differences are not necessarily significant and further investigation with a larger patient sample size is needed to validate the significance of our findings and establish their potential use in clinical practice.

## **CLINICAL RELEVANCE/APPLICATION**

The differences in presentation between neck infections due to MRSA vs. other pathogens in head and neck MR and CT exams will allow for enhanced ability to identify MRSA from other types of neck infection.

## **T5A-SPHN- MRI in the Evaluation of Facial Dermal Fillers**

3

Marco Di Girolamo, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To ascertain with MRI the presence of filler injected in facial soft tissue and to evaluate contrast-enhancement in filler-related complications.

## **METHODS AND MATERIALS**

45 pts after filler augmentation underwent MRI. 19 pts (10 after temporary and 9 after permanent filler) had no problem while 26 pts had filler-related problems. TSE-T1-weighted, TSE-T2-weighted, fat-saturated TSE-T2-weighted and TIRM scans on axial and coronal plane were performed. In filler-related complications, fat-suppressed TSE-T1-weighted scans were performed after i.v. administration of Gadolinium-DOTA. Skin biopsy was performed in patients with soft tissue enhancement and in 5 pts without any enhancement who haven't any clinical improvement after antibiotic therapy. Fisher's exact test was used for statistical analysis. In complicated cases, cervical lymph node enlargement was evaluated (longitudinal axis > 10mm).

## **RESULTS**

MRI always identified and quantified the filler in soft tissue. Temporary dermal fillers appeared as spots hypointense on T1-weighted and hyperintense on T2-weighted images. Permanent fillers appeared as hypointense spots on T1-weighted images while the signal intensity on T2-weighted images varied. In patients with complications, on T2-weighted images they appeared hyperintense in 20 pts and hypointense in 16 pts. When a positive subcutaneous contrast-enhancement was detected (9 pts), skin biopsy always found an inflammatory granulomatous reaction which wasn't found in 5 pts without contrast-enhancement. Fisher's exact test found a significant correlation ( $P < 0,001$ ) between subcutaneous contrast-enhancement and granulomatous reaction. Cervical lymph nodes enlargement was found in 16 complicated patients and their levels determined (IA,IB,IIA,IIB).

## **CONCLUSION**

MRI is a useful and non-invasive tool for visualization of facial dermal filler and i.v. Gadolinium administration is advised in complicated cases.

## **CLINICAL RELEVANCE/APPLICATION**

MRI criteria to evaluate patients after facial dermal filler implants in normal and pathological cases and to diagnose a possible granulomatous reaction using i.v. administration of paramagnetic contrast media.

#### **T5A-SPHN- Feasibility of Paranasal Sinus MR Imaging at 0.5T: Comparison with CT and 1.5T MR**

4

Arjun Narula, MBBS, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

CT is imaging modality of choice for medical and surgical management of the paranasal sinus (PNS) such as for inflammation, ESS and DNS. It is however associated with radiation exposure especially to eyes and in young individuals. Usage of CT also limits the repeat imaging follow-up of the PNS patients. It has been shown that MRI can be used in place of CT and can give additional information about various soft tissues in sinus. However due to the sensitivity of MRI to metal such as that present in dental crowns can limit the use of MRI. 0.5T is impacted much less by the metal and can be used to replace CT for sinus evaluation.

##### **METHODS AND MATERIALS**

Over the period of 3 weeks, all patients who visited the diagnostic centre for PNS CT was given an option to participate in IRB approved MRI study. Further patients undergoing MRI exam and have sinus related issues were given option to participate in the study. These patients were scanned with thin section CT and high-resolution thin slice MRI scan (Cor T2w, Cor T2 STIR, Ax T2, Cor T1w) at both 1.5T commercial MRI scanner and 0.5T MRI scanner. 2 expert radiologists reviewed the CT, and MR images from 1.5T and 0.5T independently and reported their findings. These findings were then compared to access if any clinical finding is missing in any of CT, 1.5T and 0.5T MRI reports.

##### **RESULTS**

3 patients were scanned at CT and both the MRI scanners and additional 5 patients were scanned at both the MRI scanners. Scans were successfully completed. No clinical finding was missed at either of the CT, 1.5T and 0.5T MRI reports of the two radiologists. MRI was preferred by the two-radiologist due to additional soft tissue information in MRI. One patient has large dental cap which was causing susceptibility artifact in 1.5T MRI over the maxillary sinus but reduced extent of artifact was observed for 0.5T MRI with clear diagnosis over the maxillary sinus area.

##### **CONCLUSION**

Compared to CT 1.5T and 0.5T MRI showed similar clinical diagnosis for medical and surgical management of the sinus patients. Unlike 1.5T MRI 0.5T is minimally affected by the metal and can be used in imaging with metal embeddings like dental fillings and crown. Therefore 0.5T can potentially replace CT for imaging management of sinus diseases and clinically superior for soft tissue tumors and fungal soft tissue involvement.

##### **CLINICAL RELEVANCE/APPLICATION**

CT imaging for PNS leads to unwanted exposure to eyes and in young patients where DNS surgery is typically performed. The usage of 0.5T MRI will enable sinus imaging even in the presence of metal such as dental crowns and braces. AI augmented 0.5T MRI could be more accessible to cities and patients where MRI was previously not accessible.

#### **T5A-SPHN- Feasibility, Diagnostic Efficacy, and Safety of Core Needle Biopsy as a First-Line Biopsy Method for Cervical Lymph Nodes**

5

Chan Yeop Jeong, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

The role of ultrasound-guided core needle biopsy (CNB) as a first-line method for cervical lymph nodes (LNs) has not yet been established. This retrospective study aimed to determine the feasibility, diagnostic efficacy, and safety of ultrasound-guided CNB as a first-line biopsy method for cervical LNs in patients with cervical nodal disease of non-thyroid origin.

##### **METHODS AND MATERIALS**

From March 2017 to October 2022, CNB was routinely applied as a first-line biopsy method by an experienced radiologist to 1331 cervical LNs in 995 consecutive patients with cervical nodal disease of non-thyroidal origin. CNB was performed by using 18-gauge, single- or double action spring-activated needles and the number of CNB sampling was 2-4 times in most cases. The hydrodissection technique was selectively used for high risk LNs located adjacent to large vessels and critical neck nerves. The results of CNB were categorized into four categories of inadequate, benign, indeterminate, and malignant. The feasibility of CNB was evaluated by the technical success rate. The diagnostic efficacy was evaluated by the inadequacy rate and diagnostic accuracy (sensitivity, specificity, and accuracy) for malignant LNs. The diagnostic accuracy was estimated by two criteria for test positivity (criterion 1, malignant; criterion 2, malignant or indeterminate) in 1097 LNs with final diagnoses (634 benign and 463 malignant LNs). The safety of the CNB procedure was evaluated by the major and minor complication rates.

## RESULTS

The technical success rate was 99.4 % (987/995 patients) and CNB procedure technically failed in six patients with small LNs adjacent to the lung apex and two patients with poor cooperation. The CNB results were inadequate in 15 (1.1%), benign in 659 (49.5 %), indeterminate in 53 (4.0 %), and malignant in 604 (45.4 %) of 1331 LNs. The sensitivity, specificity, and accuracy of CNB for malignant LNs were 95.3%, 100%, and 97.3% with criterion 1 and those were 99.5%, 97.4%, and 98.8 % with criterion 2. The sensitivity and specificity of CNB for diagnosis of lymphoma were 73.2% and 100% with criterion 1 and those were 98.2%, 97.4% with criterion 2. There were no major complication such as large symptomatic hemorrhage requiring admission or needle tract seeding. Minor complication (asymptomatic small hematoma) was found only in 8 (0.8%) patients.

## CONCLUSION

CNB was technically feasible, effective, and safe as a first-line biopsy method for cervical LNs in patients with cervical nodal disease of non-thyroid origin with high diagnostic accuracy for malignant nodal disease.

## CLINICAL RELEVANCE/APPLICATION

CNB can be used as an effective first-line diagnostic method for LNs in patients with cervical nodal disease of non-thyroid origin.

## T5A-SPHN- Stellate Ganglion Block with CT Guidance for Post-COVID Parosmia 6

Adam C. Zoga, MD, MBA (*Presenter*) Nothing to Disclose

## PURPOSE

Long term anosmia and parosmia are known late sequelae of COVID-19. While promising treatments for anosmia have evolved, parosmia is often refractory to pharmaceutical and topical therapies, leading to mood disorders, weight loss, and decreased quality of life. We worked with ENT colleagues to assess the potential benefits of CT-guided stellate ganglion block (SGB) in patients with long term post-COVID parosmia.

## METHODS AND MATERIALS

Subjects were referred from an ENT olfactory subspecialist after at least 6 months of post-COVID parosmia, refractory to pharmaceutical/topical therapies. Situs was selected based upon hand dominance. CT guidance was used to position a 25-gauge spinal needle anterior to the lateral margin of the longus coli muscle at the level of T1 and positioning was confirmed with iodinated contrast. 1cc Lidocaine was injected and any Horner's syndrome was documented. In this location, 40mg of Depo Medrol and 2cc of were injected at the stellate ganglion. Change in symptoms was monitored through scheduled survey responses.

## RESULTS

54 subjects presented for SGT (74% female, mean age 46 and range 14-71). Follow-up was obtained for 65% (37/54) of patients among whom 59% (22/37) reported improved symptoms at 1 week post injection. 82% (18/22) experienced progressive improvement with significant increase in mean reported improvement by 1 month post procedure ( $p=0.02$ , Figure 1). At 3 months, responders to SGB reported a mean of 49% improvement in symptoms (range 10-100%). 26 subjects returned for a contralateral injection with at least a 6 week interval. Of these, 100% (8/8) who reported no improvement after the 1st injection had no improvement after the 2nd injection. 86% (12/14) of subjects who reported some improvement after the 1st injection reported additional improvement after subsequent contralateral injection. For all injections, a Horner's syndrome was confirmed by exam in 95% (76/80), and all signs of Horner's syndrome resolved within 30 minutes of the injection. No complications or adverse events were reported.

## CONCLUSION

Percutaneous SGB shows promise for patients with long term post-COVID parosmia, and CT provides ideal efficiency and guidance. For patients with improvement post SGB, and 2nd contralateral treatment may provide additional benefit.

## CLINICAL RELEVANCE/APPLICATION

CT-guided stellate ganglion block is a new, minimally invasive and potentially impactful image guided therapy for patients with longstanding post-COVID parosmia.

## T5A-SPHN- Preoperative Prediction of Pathologic Response to Neoadjuvant Immunotherapy in 7 Resectable Locally Advanced Head and Neck Squamous Cell Carcinoma Using Multiparametric MRI

Yaqin Zhang, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study aimed to evaluate the value of quantitative changes in MRI imaging after neoadjuvant immunotherapy in predicting pathologic response in resectable locally advanced head and neck squamous cell carcinoma(HNSCC) patients.

## **METHODS AND MATERIALS**

Fifteen patients with resectable locally advanced HNSCC who were enrolled in the prospective phase Ib clinical trial were included in the current retrospective analysis. In this current analysis, patients have underwent contrast-enhanced MRI and diffusion-weighted MRI scanning before neoadjuvant immunotherapy and radical resection of the tumor respectively. Response to neoadjuvant immunotherapy was based on histopathological evaluation of the resected specimen. The volume of the primary tumour and the value of the apparent diffusion coefficient(ADC) was measured. The difference between the two groups of treatment response (good response and poor response) was assessed using Fisher's exact test and the Mann-Whitney U test. The ability of the relative changes of the ADC value and tumour volume to discriminate between different pathologic response groups was quantified using the area under the receiver operating characteristic curve.

## **RESULTS**

Good response was found in 33.3% of all patients. Relative changes in primary tumour volume ( $\Delta V_{\text{primary}}$   $p=0.001$ ) and in DW-MRI parameters( $\Delta \text{ADC}_{\text{primary}}$   $p=0.03$ ) after neoadjuvant immunotherapy were significantly different between the groups of good response and poor response. When the relative changes in tumour volume were used for predicting treatment response, the area under the receiver operating characteristics curve (AUC) was 0.98 with a sensitivity of 100% and a specificity of 90%. Change in ADC value achieved an AUC of 0.89 with a sensitivity of 100% and a specificity of 71% for the prediction of treatment response.

## **CONCLUSION**

Changes in tumour volume and ADC value after neoadjuvant immunotherapy can help identify patients with good response to neoadjuvant immunotherapy in HNSCC.

## **CLINICAL RELEVANCE/APPLICATION**

Accurate preoperative prediction of pathologic response to Neoadjuvant immunotherapy in patients with HNSCC could guide clinical selection and the patients could also be spared from ineffective and unnecessary toxicity. Although the use of MRI to evaluate the progression of immunotherapy has been explored in other types of tumors, information on HNSCC is limited. As far as we are aware, there are no published studies that use the gold standard of surgical histopathology to assess the response of neoadjuvant immunotherapy for HNSCC on imaging. The results of this study showed that the changes of tumor volume and ADC value can effectively evaluate the immunotherapy response of HNSCC in clinical work.

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## Abstract Archives of the RSNA, 2023

T5A-SPIN

### Imaging Informatics Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPIN-1 Transitioning to Fully-Supervised Pre-Training with Large-Scale Radiology ImageNet for Improved AI Transferability in Three-Dimensional Medical Segmentation**

Zongwei Zhou, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Fully-supervised pre-training has experienced long-standing success in the realm of computer vision, largely attributable to the extensive annotated ImageNet dataset. This research examined the transferability of medical AI fully supervised pre-trained on a similarly sized Radiology ImageNet.

#### **METHODS AND MATERIALS**

We first constructed a large-scale dataset by assembling 3,410 publicly available abdominal CT scans with partially annotated 25 organs and 6 tumors. We then completed the missing annotations using an efficient human-in-the-loop approach, resulting in Radiology ImageNet. This dataset enabled us to pre-train an AI model using full supervision. Segmentation, partitioning an image into multiple segments, can be viewed as a per-voxel classification. Therefore, the per-voxel annotations in our Radiology ImageNet (2,109 million annotated voxels) provided an order of magnitude larger than the per-image annotations in ImageNet (14 million images). AI transferability was evaluated on three medical segmentation tasks, i.e., 19 cardiovascular structures, 22 muscles, and 18 organs, using two external datasets, i.e., TotalSegmentator and JHH, comprising 6,062 CT scans. Dice Similarity Coefficient (DSC) was used as the evaluation metric. For a comprehensive comparison, we benchmarked fully-supervised pre-training against three dominant AI models pre-trained on 5,050, 5,022, and 888 unlabeled CT scans, respectively.

#### **RESULTS**

Fully-supervised pre-training demonstrated improved transfer learning performance compared to self-supervised counterparts, with increases from 86.5% to 90.9%, 89.9% to 94.4%, and 85.8% to 90.4% for the segmentation of cardiovascular structures, muscles, and organs in CT scans, respectively, using the TotalSegmentator dataset. As the annotated CT scans became more limited, fully-supervised pre-training achieved substantially better performance than self-supervised pre-training, with improvements of 17.5%, 12.1%, and 16.6% for 5-shot, 10-shot, and 20-shot transfer learning in the JHH dataset.

#### **CONCLUSION**

We created Radiology ImageNet and demonstrated its importance in the field of medical image analysis. Pre-training medical AI on this dataset led to an improved transferability for segmenting various anatomical structures in the human body. Our investigation suggested that fully-supervised pre-training mitigated the marked difference between self-supervised and segmentation tasks. This highlighted the potential of fully supervised pre-training to advance precision medicine.

#### **CLINICAL RELEVANCE/APPLICATION**

Medical AI, pre-trained on our Radiology ImageNet, excelled in the segmentation of anatomical structures, executing its vast potential in robotic surgery and treatment planning.

#### **T5A-SPIN-2 Nomogram based on CT-derived extracellular volume to predict pathological grading of hepatocellular carcinoma: a multicenter study**

Jie Li (*Presenter*) Nothing to Disclose



## PURPOSE

To evaluate the potential of CT-derived extracellular volume (ECV) to predict the pathological grading of hepatocellular carcinoma (HCC), and to develop two nomograms that combine clinical factors to predict high-grade HCC preoperatively.

## METHODS AND MATERIALS

A total of 230 patients diagnosed with HCC were collected from Hospital X and Hospital Y. Due to the presence of multiple lesions in some patients' livers, a total of 238 lesions were included in the study. Due to the imbalance in data, we have used oversampling techniques (SMOTE) to balance it. After balancing, patients from Hospital X were included in the training and internal validation sets at a ratio of 7:3, while patients from Hospital Y were used as an independent external validation set. Absolute enhancement values of the liver tumor and the abdominal artery were calculated using non-contrast enhanced and delayed phase images. The ECV was calculated using the following formula:  $ECV (\%) = \frac{HU_{tumor} - HU_{aorta}}{HU_{aorta} - HU_{Hct}} [100 - Hct(\%)]$ . Two machine learning algorithms (logistic regression and random forest) were selected for modeling the nomogram.

## RESULTS

According to the logistic regression algorithm, CT-derived ECV is an independent predictive factor for distinguishing high and low-grade HCC, with statistically significant differences ( $p < 0.001$ ). In the training, internal, and external validation cohorts, the AUCs of CT-ECV for evaluating the pathological grading of high-grade HCC were 0.895, 0.832, and 0.740, respectively. The logistic regression-nomogram model had AUCs of 0.899, 0.853, and 0.750 in the training, internal, and external validation cohorts, respectively. The random forest-nomogram model had AUCs of 0.905, 0.847, and 0.812 in the training, internal, and external validation cohorts, respectively. Both models had satisfactory goodness of fit in the training and validation cohorts, and good clinical net benefit.

## CONCLUSION

CT-derived ECV may represent a new quantitative CT marker for the identification of HCC pathological grading, providing incremental diagnostic value. The nomogram presents the predicted results in a visual and easy-to-understand manner, which helps physicians and patients better understand the disease progression and prognosis.

## CLINICAL RELEVANCE/APPLICATION

ECV is an indicator that reflects the changes in the microenvironment of liver tumors, which can calculate the percentage of extracellular space in the total volume of liver tumor tissue through contrast agent kinetic characteristics. The level of ECV is closely related to the malignancy and prognosis of liver tumors, and therefore has important significance in the diagnosis and treatment of liver tumors.

## T5A-SPIN-3 Deep Learning for Automated Measurement of Patellofemoral Anatomic Landmarks

Alexander Zhou, BA, MS (*Presenter*) Nothing to Disclose

### PURPOSE

To train a deep learning model to identify patellofemoral anatomic landmarks and enable the automated measurement of anatomical parameters.

### METHODS AND MATERIALS

This is an IRB-approved retrospective study with CT knee imaging from 483 patients acquired from April 2017-May 2022. Patients were selected from two cohorts: a pathological cohort of patients scheduled for knee arthroplasty (KA), and one of patients with healthy knee anatomy. 14,652 CT images were annotated with the location of 7 patellofemoral landmarks by trainees and approved by a senior musculoskeletal radiologist. A two-stage deep learning model was trained to predict landmark coordinates. A modified ResNet50 architecture was used, with an additional supervision mechanism. Models were initialized with self-supervised learning pre-trained weights on the RadImageNet radiological imaging database.

### RESULTS

Spatial accuracy is critical for model performance, as all patellofemoral measurements are calculated based on the predicted landmark coordinates. The mean absolute error between predicted and ground truth landmarks was 3.70 pixels in the healthy cohort and 5.33 pixels in the KA cohort at a 512x512 resolution. Various patellofemoral parameters were calculated, including transepicondylar axis (TEA) length, TEA-posterior femur axis angle, sulcus medial asymmetry ratio, and sulcus angle. There was no statistically significant difference ( $p > 0.05$ ) between the predicted and ground truth measurements for all four parameters in both cohorts, except for the sulcus angle in the healthy cohort.

### CONCLUSION

We have developed a deep learning model that accurately identifies key anatomic landmarks of the patellofemoral compartment with 3-5 pixel accuracy on a 512x512 image and produces measurements with no statistically significant difference from human-derived measurements on healthy and pathological knees. This work represents the first deep learning regression model for automated patellofemoral annotation trained on both physiologic and pathologic CT imaging at



this scale. This novel model has the potential to enhance our ability to analyze anatomy of the patellofemoral compartment at scale.

#### **CLINICAL RELEVANCE/APPLICATION**

KA procedures are among the most common surgeries, but morbidity has been associated with patellofemoral compartment-related complications in up to 20% of cases. Understanding this anatomy is crucial for restoring anatomic knee morphology and function, but patellofemoral anatomy has not been well-characterized. Developing a tool that enables the automated annotation of key landmarks would enable the measurement of anatomical parameters at scale in a precise, reproducible, and time-sensitive fashion free of inter- and intra-rater variability.

#### **T5A-SPIN-4 Development of a Small-data Deep-learning Model Based on an MTANN for Soft Tissue Sarcoma Diagnosis in MRI**

Yuqiao Yang, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Deep learning requires a large number of training cases (i.e., 10k to 100k), which makes the development of AI for rare cancer less feasible. Our purpose was to develop a "small-data" deep-learning model based on a massive-training artificial neural network (MTANN) to accurately discriminate between benign and malignant soft-tissue tumors in MRI.

#### **METHODS AND MATERIALS**

We collected T2-weighted MRI of 146 patients with 96 benign and 50 malignant soft-tissue tumors in this study, where tumors were segmented by a radiologist and reviewed by an orthopedic surgeon. The proposed scheme used a patch-wise neural network called an MTANN which was trained in a patch-to-pixel manner. Desired teaching images were generated with a Gaussian-blurred manual tumor segmentation mask for malignancy and a completely dark image for benignancy. During the training phase, the input was a 3D image patch extracted from input MR images. The neural network predicted a probability of malignancy for the input patch. The cross-entropy was used as the loss function to train the model. Once the MTANN model was trained, the entire image was computed as the likelihood map of malignancy by shifting the patch-wise window over the input image in a convolutional manner. Finally, a fully-connected classification layer with the image features extracted from the likelihood maps in a feature-scoring layer was used to classify the known tumor.

#### **RESULTS**

Our small-data MTANN model was able to be trained with only 77 benign and 40 malignant soft-tissue tumors. Our experiment showed that our MTANN model outperformed several state-of-the-art radiomics and other deep learning models in discriminating between benign and malignant tumors and achieved an area under the curve (AUC) of 0.78 which was higher than that (0.73) of the best-performing state-of-the-art model with a p-value <0.05.

#### **CONCLUSION**

Our small-data patch-wise deep-learning model based on an MTANN showed higher performance in discriminating between benign tumors and malignant soft-tissue tumors, which are rare cancer, in MRI, compared with several state-of-the-art radiomics and deep-learning models.

#### **CLINICAL RELEVANCE/APPLICATION**

Our small-data MTANN deep-learning model makes the development of deep learning for rare cancer possible. It can potentially prevent non-expert radiologists from diagnosing rare cancer inaccurately.

#### **T5A-SPIN-5 Deep Learning-enabled CT Number Neutralization in Heterogeneous Tube Voltage CT Imaging: A Pilot Study**

Dongok Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Depending on types of examinations and image applications, CT images are frequently taken with various tube voltages which results in differing Hounsfield units for the same tissue. This causes difficulties in quantification of imaging biomarkers in various applications. We postulated that application of deep learning might enable neutralization of CT numbers in heterogeneous tube voltage CT imaging. This study presents a pilot experimental result.

#### **METHODS AND MATERIALS**

We used datasets of abdomen which were acquired from Siemens Somatom Force Dual Energy CT where A tube has 80 kV and B tube has 150 kV tube voltage. Among the total of 211 cases, 200 were used for training/validating and 11 were used for testing. A generative deep learning model architecture was employed consisting of a generator and a discriminator. The generator was designed to have five residual blocks and a skip connection which connects the first block with the last block. It takes in 80 kV CT images and outputs 150 kV CT images. Since true 150 kV CT images are available, the discriminator is given both images, generated-150 kV CT images made by the generator and real-150 kV CT images and trained to discern

between the two. The loss is fed back into the generator to produce more accurate 150 kV CT images. The average Hounsfield unit for 80 kV, generated-150 kV and real-150 kV are compared using t-test on homogeneous regions of organs, such as liver, aorta and thoracic spine in order to observe statistical difference between them. Also scatter plot was used to compare between generated-150 kV and real-150 kV with linear equation and R-squared calculated.

## RESULTS

The average Hounsfield unit for 80 kV, generated-150 kV and real-150 kV were 80.4, 61.6 and 63.0 for liver, 513.4, 181.1 and 180.0 for aorta, and 226.6, 111.6 and 111.5 for thoracic bone, respectively. For all tissues, p-value between 80 kV and real-150 kV was less than 0.001, indicating both are significantly different and p-value between generated-150 kV and real-150 kV ranged from 0.14 to 0.77, indicating both are not significantly different. The scatter plot results in a linear equation  $y = 1.01 * x - 2.28$  and  $R^2 = 0.9911$ .

## CONCLUSION

From given 80 kV CT images, the network was able to produce generated-150 kV CT images statistically indistinguishable to that of real-150 kV CT images. Our study demonstrated the application of deep learning enabled neutralization of CT numbers from CT images taken with different tube voltage settings.

## CLINICAL RELEVANCE/APPLICATION

The work has shown the ability to convert 80 kV CT images to 150 kV CT images. In the future, it could be possible to convert any CT images taken with a different kV to single standard kV CT images, and thus neutralize CT numbers in heterogeneous tube voltage CT imaging.

## T5A-SPIN-6 Improved Prognostic Prediction of Pancreatic Cancer Using Multi-Phase CT by Integrating Neural Distance and Texture-Aware Transformer

Hexin Dong (*Presenter*) Nothing to Disclose

## PURPOSE

Pancreatic ductal adenocarcinoma (PDAC) is a highly lethal cancer in which the tumor-vascular involvement greatly affects the resectability and, thus, overall survival of patients. We propose a novel learnable neural distance that describes the precise relationship between the tumor and vessels. Combined with dynamic tumor-related texture features in multi-phase contrast-enhanced CT (CECT), We aim to develop a new deep learning-based CT imaging-derived biomarker for predicting PDAC survival.

## METHODS AND MATERIALS

We conducted a multicenter study with 1,070 patients to validate our method, using one center (892 patients) for training and the other three centers (178 patients) for independent testing. The CECT protocol included non-contrast, pancreatic, and portal venous phases. We constructed a prognostic biomarker - NDTAT-PDAC - which captures both tumor enhancement patterns and tumor-vascular involvement for OS prediction. The marker was tested in both nested 5-fold cross-validation and external validation cohorts to evaluate its performance, robustness, and clinical usefulness.

## RESULTS

The continuous NDTAT-PDAC score performed a c-index of 0.656 (95% CI 0.639-0.673) and a AUC of 0.695 (95% CI 0.672-0.718) in the nested 5-fold cross-validation cohort, and a c-index of 0.710 and a AUC of 0.792 in the external validation cohort. We used univariate and multivariate Cox proportional-hazards models to evaluate our signature and other clinicopathologic factors in the independent test set. The proposed risk stratification was a significant prognostic factor, along with other factors like pathological TNM stages. After selecting significant variables ( $p < 0.05$ ) in univariate analysis, our proposed staging remained strong in multivariable analysis (HR=1.847,  $p=0.027$ ) after adjusting for important prognostic markers like pT (HR=2.438,  $p < 0.0001$ ) and resection margins (HR=1.681,  $p=0.091$ ). Notably, our proposed marker remained the strongest among all pre-operative markers, such as tumor size and CA 19-9.

## CONCLUSION

We developed a new deep learning-based CT imaging-derived biomarker for predicting PDAC survival. The new biomarker was the strongest predictor of overall survival among preoperative factors and it has the potential to be combined with established clinical factors to select patients at higher risk who might benefit from neoadjuvant therapy.

## CLINICAL RELEVANCE/APPLICATION

Our novel tool sets a new standard in this area, and can benefit clinicians by selecting patients who might benefit from neoadjuvant chemotherapy with aggressive tumor types. Our represents a significant advancement in the development of prognostic models and may lead to improved clinical decision-making, ultimately resulting in better patient outcomes.

## Abstract Archives of the RSNA, 2023

T5A-SPIR

### Interventional Radiology Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPIR-1 A Multi-institutional One-year Prospective Follow-up of Fluoroscopic, Cholangioscopy-assisted Large Bore Gallstone Extraction for Inoperable Calculous Cholecystitis**

Venkatesh Balaji, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study is to assess for recurrent cholelithiasis on one-year imaging post percutaneous large bore (24-30 French) gallstone extraction for a subset of patients who are poor surgical candidates for cholecystectomy.

#### **METHODS AND MATERIALS**

This is a multi-institutional Institutional Review Board approved prospective observational review of patients at two large academic centers who present with acute calculous cholecystitis and were deemed high-risk surgical candidates. Review parameters include procedural technical and clinical data, clinical presentation, average hospital length of stay, and post-intervention symptom reduction. Technical success was defined as the removal of all stones during the procedure. Clinical success was defined as stone-free on 12-month follow-up imaging.

#### **RESULTS**

Fifteen patients (mean age 77.9yr, range 52-94yr; 8 male and 7 female) underwent large bore sheath (24-30Fr) cholangioscopy assisted gallstone extraction. The size of the gallstones ranged from 0.5-4.0cm. All patients had prior transhepatic or transperitoneal cholecystostomy access for 3-6 weeks prior to gallstone extraction. All patients' indwelling accesses were upsized to 24Fr or 30Fr sheaths using the NephroMax balloon sheath system (Boston Scientific, Marlborough, MA). There was 86.7% technical success rate with no major procedure-related complications. 86.7% were symptom and pain-free immediately post-procedure. There were no major complications. Median hospital stay was 1-day post-procedure. Of the fifteen patients, twelve patients had 12-month follow-up US or CT. 75% did not have recurrent cholelithiasis on imaging.

#### **CONCLUSION**

Majority of patients were stone-free and asymptomatic on one-year follow-up imaging after percutaneous fluoroscopic-guided large bore (24 -30 French) gallstone extraction.

#### **CLINICAL RELEVANCE/APPLICATION**

High risk patients diagnosed with calculous cholecystitis who are poor candidates for cholecystectomy may benefit from a cholangioscopy-assisted large bore gallstone extraction for symptom reduction. This proved to be a safe and effective procedure with no major complications and a median hospital stay of 1 day. The majority of cases achieved technical and clinical success with no recurrent cholelithiasis.

#### **T5A-SPIR-2 Combined Multiple Regional Anesthesia for Microwave Ablation of Liver Tumors Initial Experience**

Man Lu, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the feasibility and safety of combined multiple regional anesthesia (CMRA) in reducing pain and intravenous analgesic requirements during and following the ultrasound guided microwave ablation (US-guided-MWA) of liver tumors.

## **METHODS AND MATERIALS**

A total of 75 patients with 99 liver tumors who received US-guided-MWA of liver tumors were recruited. They were randomly divided into three groups: A, B, C. Before ablation, patients in group A received hepatic hilar block (HHB), Transversus abdominis plane block (TAPB) and local anesthesia (LA). Patients in group B received HHB+LA. Patients in group C received TAPB+LA. Numerical Rating Scale (NRS) scores, morphine intake, complications and the factors influent perioperative pain were evaluated.

## **RESULTS**

All the patients were successfully received the US-guided-MWA. The maximum NRS score for pain during ablation of the three groups were  $2.36 \pm 1.19$ ,  $3.28 \pm 1.59$  and  $4.24 \pm 1.42$  respectively ( $P < 0.01$ ), while the number of patients used morphine were 4/25, 8/25, 13/25 respectively ( $P < 0.01$ ). NRS scores of the three groups at 4, 8, 12, 24 and 36 hours after operation all showed a trend of rising first and then decreasing, and the order at each time point was:  $A < C < B$ . The patients with larger tumor, more tumors, longer procedure and ablation time experienced more pain ( $P < 0.05$ ). There were no major complications occurred among the three groups.

## **CONCLUSION**

For patients not suitable for or unwilling to undergo general anesthesia, combined multiple anesthesia is an effective and safe way to control pain during and after microwave ablation of liver tumors. Factors influencing pain during microwave ablation include tumor size, number of tumors, procedure time, ablation time and shortest distance from lesional edge to live capsule.

## **CLINICAL RELEVANCE/APPLICATION**

Percutaneous thermal ablation is now a frontline treatment option for liver tumors. During the procedure, general anesthesia and conscious sedation are often used for pain control. But some patients can't use general anesthesia. Regional anesthesia is a crucial component of anesthesia. Especially in the last 2 or 3 decades, the practice of regional anesthesia regimens has changed considerably and it is extensively be applied to provide peri-procedural pain control. Our study presents a feasibility and safety study of combined multiple regional anesthesia (CMRA) in an effort to reduce pain and intravenous analgesic requirements during and following the ultrasound guided microwave ablation (US-guided-MWA) of liver tumors. For patients not suitable for or unwilling to undergo general anesthesia, CMRA is an effective and safe way to control pain during and after US-guided-MWA of liver tumors.

## **T5A-SPiR-3 Radiofrequency Ablation Followed by Cavity Creation and Cement Augmentation with Steerable Devices in the Management of Painful Spinal Metastases**

Claudio Pusceddu, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

In the treatment of spinal metastases, cement distribution following radiofrequency ablation can be unpredictable due to several tumor factors. Achieving satisfactory filling of the vertebrae requires advanced devices to prevent cement leakage. This study aimed to assess the safety and efficacy of using steerable technologies with an articulating radiofrequency ablation (RFA) probe and targeted cavity creation before vertebral augmentation to manage painful spinal metastases.

## **METHODS AND MATERIALS**

Sixteen patients (mean age, 67 years) underwent RFA with vertebral augmentation after the creation of a targeted balloon cavity for metastatic spinal disease. The patients were followed up for six months, and pain and functional mobility were assessed pre-treatment and post-treatment using the Visual Analogue Score (VAS) and Functional Mobility Scale (FMS). Data on complications, predictability of cement distribution, anatomical restoration, and local recurrence were collected. Technical success was defined as successful intraoperative ablation and predictable cement distribution after cavity creation without major complications.

## **RESULTS**

Sixteen patients with 21 lesions in the thoracolumbar spine were treated. All treatments were technically successful and were followed by targeted cavity creation and vertebral augmentation. A significant reduction in median VAS score was observed one week after RFA treatment ( $p < 0.001$ ). Of the seven patients who reported limited painful ambulation before treatment, six reported normal ambulation one month after treatment, while the remaining patient reported no improvement. Patients who reported wheelchair use before treatment improved to normal ambulation (four/eight) or limited painful ambulation (four/eight). The improvement in mobility before and after treatment was statistically significant ( $p = 0.002$ ). Technical success was achieved in all the combined procedures.

## **CONCLUSION**

The combination of RFA and vertebral augmentation with a steerable platform that allows the creation of a targeted cavity before cement injection is a safe and effective procedure for managing painful spinal metastases. The procedure resulted in improved quality of life as assessed by the VAS and FMS.

## CLINICAL RELEVANCE/APPLICATION

New technique combined with steerable devices to cement and treat complex vertebral metastases with radiofrequency ablation

### **T5A-SPiR-4 Minimally Invasive Treatment of Vertebral Metastases with Combined CT-Guided Percutaneous Microwave Ablation, Pedicle Screw Fixation, and Vertebroplasty**

Salvatore Marsico (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this retrospective study was to assess the safety and effectiveness of the combined approach of percutaneous microwave ablation (MWA) guided by CT and pedicle screw fixation followed by vertebroplasty (MASFVA) for the treatment and stabilization of painful vertebral metastases involving vertebral pedicles.

#### **METHODS AND MATERIALS**

We retrospectively evaluated the records of 11 patients with 16 vertebral metastatic lesions who underwent MASFVA between January 2015 and January 2018. The technical success, complication rate, and pain relief using the visual analogue scale (VAS) and Oswestry Disability Index (ODI) were analyzed along with local tumor control.

#### **RESULTS**

Technical success was achieved in all cases without any significant complications. The VAS and ODI scores improved significantly after the procedure (VAS from  $6.8 \pm 0.7$  to  $0.6 \pm 0.6$  and ODI from  $3.1 \pm 0.7$  to  $1.2 \pm 0.4$ ). All patients could walk independently without neurological complications one week after the procedure. During the 12-month follow-up, no new bone fractures or local disease recurrence occurred.

#### **CONCLUSION**

The combination of MWA, percutaneous pedicle screw fixation, and vertebroplasty is a safe and effective treatment for painful vertebral metastases with vertebral pedicle involvement, providing both pain relief and local tumor control.

## CLINICAL RELEVANCE/APPLICATION

First description of combined treatment of vertebroplasty, microwave ablation and pedicle fixation in complex vertebral metastases with pedicle extension.

### **T5A-SPiR-5 Evaluation of Ice-ball Size and Temperature Change During Cryoablation in a Lard Phantom**

Nai-Wen Chang, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cryoablation is a minimally invasive technique to treat various kinds of soft tissue tumors. It may be applied in tissues with various water and fat composition. Whether the fat concentration of the ablation target or environment will influence the ice-ball size and temperature change has not yet been explored. In this in-vitro study, we aim to evaluate how different concentrations of lard affect temperature change and ice ball size during cryoablation.

#### **METHODS AND MATERIALS**

We constructed a phantom with 6 glass bottles, including one bottle of 0.9% normal saline (NS) as control, and the others contains 100ml of agar phantoms with lard and NS mixed in five different fractions (0%, 10%, 40%, 70% and 100% of lard). A total of 6 Endocare V-Probes (Cryocare cryoablation system, Varian Medical system, Palo Alto, California, US), with 2.5cm cool-tip, were placed into each bottle aiming at the center. The freezing started simultaneously in 6 bottles with a starting temperature at 20°C. The temperature readings of the probes were documented every 10 seconds during the 9-minute freezing. Axial CT scans of the bottles were done before and 3, 6, 9 minutes after initiation of freezing, and the largest diameter of the ice-ball in each bottle was measured with the longitudinal view (coronal view) in the 1mm reconstructed image.

#### **RESULTS**

The probe temperature of the NS and 0% lard agar phantom (which contains 0.9% NS agar) have a similar freezing rate, reaching -80°C at about 320 seconds of freezing, and stabilized until 540 second. The rest of the agar phantoms that contain lard showed an increased freezing rate with increased concentration of lard, and all stabilized at around -150°C after 490 seconds of freezing until 540 second. The ice ball diameter was largest in the 0% and 10% lard agar phantom, both reaching 3.4 cm at 9 minutes of freezing. We observed a marked decrease in diameter of the ice ball with increased concentration of lard, with only 0.9cm at 9 minutes in the 100% lard agar.

## **CONCLUSION**

Different concentrations of lard may affect the temporal temperature change and ice ball size during cryotherapy.

## **CLINICAL RELEVANCE/APPLICATION**

This ex-vivo study demonstrated that the fat composition may influence the temperature change and ice-ball size during cryoablation and should be taken into consideration when treatment planning.

## **T5A-SPiR-6 Oligoprogression in Neuroendocrine Liver Metastases - CT-guided HDR-brachytherapy to Delay Systemic Therapy Escalation**

Uli Fehrenbach, MD (*Presenter*) Grant, Siemens AG; Grant, Bayer AG; Grant, Ipsen SA; Grant, Asahi Intecc Co, Ltd; Grant, ESGAR; Grant, General Electric Company

## **PURPOSE**

Heterogeneous growth behavior of hepatic metastases are not uncommon in gastroenteropancreatic neuroendocrine tumors (GEP-NETs). Rapid progression of one or two metastases make therapy escalation necessary despite the otherwise stable disease. If these progressive metastases could be controlled by local therapy, the patients could be managed further with their current strategy. The present study aims on determining the period by which CT-guided high-dose-rate brachytherapy (CT-HDR-BT) of rapidly growing liver metastases can delay the indication of systemic therapy escalation.

## **METHODS AND MATERIALS**

In this retrospective, monocentric observational study a total of 23 patients from our ENETS center of excellence were retrospectively included. A total of 37 CT-HDR-BT sessions were performed in these patients. In addition to the parameters described in previous studies (local tumor control (LTC), progression-free survival (PFS), overall survival (OS)), this study evaluated the delay of a systemic therapy escalation.

## **RESULTS**

Median follow up was 46 months. 82% OS was shown after 102 months. Mean LTC was 64 months (95%-CI: 55-74; median was not reached), median PFS (not RECIST based) was 6 months (95%-CI: 2-10) and mean OS was 75 months (95%-CI, 55-96; median not reached). No further escalation of therapy (Watch and wait- and/or SSA-therapy) after CT-HDR-BT was necessary in 6/23 cases (26%). A median delay of 19 months (median; 95%-CI, 9-29 months) to the escalation of systemic therapy could be achieved.

## **CONCLUSION**

In oligotopic progression of liver metastases and otherwise stable disseminated GEP-NET, CT-HDR-BT as a safe one-time procedure can delay the onset of systemic therapy escalation. This offers a significant interval without drug related side effects and costs and saves the patients systemic treatment options for a later date.

## **CLINICAL RELEVANCE/APPLICATION**

Our study reveals that CT-HDR-BT can significantly postpone the need for systemic therapy escalation in patients with oligotopic progression of neuroendocrine liver metastases. This approach offers patients a valuable interval without the burden of drug-related side effects and associated costs, while also preserving other therapeutic options for future disease progression. As systemic therapy options for this condition are limited, CT-HDR-BT may prove to be a safe and effective alternative in select cases.

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## Abstract Archives of the RSNA, 2023

T5A-SPMK

### Musculoskeletal Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPMK- Neurovascular Crossovers between Leash of Henry and Deep Branch of Radial Nerve: Implications for Diagnostic Imaging and Neurointervention**

Aurea V. Mohana-Borges, MD, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To identify the crossing patterns of the LoH and DBRN, specifically the ascending branch of the radial recurrent artery (RRAab) and the transverse muscular vessels to the mobile wad by high-resolution ultrasound (HRUS), using B-mode and Doppler.

#### **METHODS AND MATERIALS**

In this cross-sectional study, HRUS was performed in the short axis of the DBRN in asymptomatic participants, bilaterally and in two different forearm positions (pronation and supination), enrolled over a 6 month period. Inclusion criteria included asymptomatic volunteers of both genders over 15 years of age. Exclusion criteria were as follows: a) previous interventional procedure or surgery in the radial tunnel and elbow, and b) incidental masses compressing the nerve. HRUS was performed with an 18-5 MHz linear transducer (Philips, Affiniti 50) by a single musculoskeletal radiologist with more than 20 years of experience. B-mode and Doppler cine clips taken in the short axis of the nerve were acquired and saved for offline analysis. Images were evaluated in consensus by two radiologists. The crossings were evaluated in the nerve segment between the origin from the radial nerve to the superior arcade of the supinator muscle. They were classified as occurring above or below the DBRN. The pattern was characterized as unrelated when no observed vessel was seen crossing the nerve. Welch's test was used as appropriate.

#### **RESULTS**

The study population consisted of 102 nerves from 55 asymptomatic participants (median age, 37.0 years; interquartile range [IQR], 23.5 - 51.0 years; age range, 16-63 years; 29 [52.7%] women), with 48 participants with bilateral evaluation. Eight DBRN relationships were excluded from the analysis because of Doppler unavailability (N= 6 limbs, 3 right sides) and the undetectability of the muscular branch on B-mode (N= 2 limbs bilaterally). Age was not significantly different between women (median 37 years, IQR, 24.0 - 50.0 years) and men (median 36.5 years, IQR, 22.8 - 52.8 years) with  $p = 0.74$ . The neurovascular crossings were as follows: a) RRAab above DBRN = 15 (14.7%) and muscular branch above= 12 (11.7%), below= 0 (0%), and unrelated= 3 (2.9%), and b) RRAab below DBRN = 87 (85.3%) and muscular branch above= 53 (52.0%), below= 28 (27.4%), and unrelated= 6 (5.9%).

#### **CONCLUSION**

There is a predominant pattern of neurovascular crossings, with the RRAab mainly crossing below the DBRN from an inferomedial position and the transverse vessels of LoH crossing above the nerve, proximal to the arcade of Frohse.

#### **CLINICAL RELEVANCE/APPLICATION**

Anatomic variations in the relationship of the neurovascular crossover of the Leash of Henry (LoH) and the deep branch of the radial nerve (DBRN) are relevant for diagnostic imaging and interventional procedures, but poorly described in the literature.

#### **T5A-SPMK- Undifferentiated and Preclinical Rheumatoid Arthritis and Longitudinal Thigh Muscle Loss: Deep-Learning Derived Data from Osteoarthritis Initiative**

Kamyar Moradi (*Presenter*) Nothing to Disclose

## PURPOSE

Undifferentiated Arthritis (UA) and Preclinical Rheumatoid Arthritis (Pre-RA) are considered as early-stage inflammatory arthropathy before clinical RA occurrence. Pre-RA is retrospectively defined as the early stage prior to development of clinical RA. UA is defined as a type of arthritis when criteria for RA or other connective tissue diseases are not met. UA/Pre-RA could potentially cause generalized muscle degeneration by provoking systemic inflammation and autoimmunity akin to established RA that is clearly associated with Rheumatoid Cachexia. Aim of this study was to investigate the association of UA/Pre-RA with longitudinal changes in muscle quality.

## METHODS AND MATERIALS

All the 4,796 participants of the Osteoarthritis Initiative (OAI) were initially included as established RA were excluded from this cohort. OAI participants were categorized to UA, Pre-RA (not exclusionary to the OAI), and control groups in baseline (Fig. 1). Longitudinal 4-year changes of thigh muscles quality in Pre-RA and UA groups were compared with their propensity score (PS)-matched control groups. PS matching was conducted to minimize the potential effect of confounding variables. For measurement of thigh muscle quality, we used our previously validated deep learning model to segment and quantify all available MRIs of thigh muscles at baseline, year 2-4 of the cohort. Outcome measures were MRI biomarkers of thigh muscle mass [i.e., cross-sectional area (CSA)] and composition [i.e., intramuscular adipose tissue (intra-MAT) and contractile percentage (non-fat muscle CSA/total muscle CSA)] in the thigh muscle groups (Fig. 2).

## RESULTS

After PS-matching of the groups for confounding variables (Table 1), regression models of comparison of MRI biomarkers of total thigh muscles between Pre-RA and control group over a 4-year period showed that presence of Pre-RA is associated with decreased CSA (MD, 95% CI: -220.12 mm<sup>2</sup>, -310.58 - -129.66) but a similar change in intra-MAT (MD, 95% CI: 11.57 mm<sup>2</sup>, -167.16 - 190.30) and contractile percentage (MD, 95% CI: -0.50 %, -1.98 - 0.97) (Table 2). On the other hand, comparison of MRI-derived biomarkers between UA and matched control group showed that neither of changes in CSA, intra-MAT, and contractile percentage are significantly different between the groups (Table 2).

## CONCLUSION

Presence of Pre-RA is associated with a longitudinal decrease in CSA but not increase in Intra-or Inter-MAT akin to rheumatoid cachexia seen in established RA patients. Causal effect of Pre-RA on muscle quality requires further attention.

## CLINICAL RELEVANCE/APPLICATION

Results of this study could promote the role of secondary preventive treatment (e.g., low dose DMARD) to mitigate accelerated muscle degeneration among Pre-RA subjects.

## T5A-SPMK- Improving Sonographic Visualization of the Ulnar Nerve and Morphology

4

Shabber H. Syed, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Cubital Tunnel Syndrome (CuTS) is defined as ulnar nerve compression in the cubital tunnel of the elbow, the second most common upper extremity peripheral nerve entrapment. CuTS often remains undiagnosed until patients present with progressive motor deficits, usually indicating severe nerve injury. Quantitative diagnostic criteria for ultrasound have been developed for other nerve entrapment syndromes, including carpal tunnel syndrome, however greater variability of diagnostic criteria is in use for the diagnosis of CuTS. New transducer technology may enable better imaging of the ulnar nerve and development of new diagnostic criteria for CuTS. Our study aimed to objectively evaluate this newer transducer technology compared to conventional transducers in the evaluation of the ulnar nerve and to assess a reproducible ratio for more reliable nerve measurement.

## METHODS AND MATERIALS

Seven fresh frozen cadaveric specimens were examined using both 18 MHz and 24 MHz transducers (GE Healthcare, Milwaukee, WI). The number of ulnar nerve fascicles was measured in each specimen just proximal to the cubital tunnel with both transducers. Two examiners assessed the number of nerve fascicles with consensus agreement reached on the final count. The cross-sectional area of the ulnar nerve was measured proximally at both the cubital tunnel and distally at the anatomical location where the ulnar artery and nerve meet in the distal forearm.

## RESULTS

The 24 MHz probe visualized more fascicles of the ulnar nerve (mean 8.7, std dev 2.3) compared to the 18 MHz transducer (mean 4.4, std dev 2.7,  $p < 0.005$ ). The mean of the proximal ulnar nerve cross-sectional area (CSA) measured 7.08 mm (std dev 2.40). The mean distal ulnar nerve CSA was 5.08 mm (std dev 1.21,  $p = 1.21$ ). The cross-sectional area of the proximal ulnar nerve was not found to be statistically different compared to the distal CSA of the ulnar nerve, 7.1 mm<sup>2</sup> (std dev 2.4) vs. 5.1 mm<sup>2</sup> (std dev 1.2),  $p = 0.112$ .



## CONCLUSION

A higher frequency 24 MHz transducer can visualize more fascicles of the ulnar nerve at the cubital tunnel compared to a conventional 18 MHz transducer. Utilizing this 24 MHz transducer, there was no statistical difference in the measurement of the cross-sectional area of the ulnar nerve proximal and distal to the cubital tunnel in our cadaver specimens. Further investigation of ulnar nerve morphology and of the ratio of nerve measurement of symptomatic cubital tunnel syndrome patients and normal controls with new higher frequency transducers may enable the development of better diagnostic criteria for CuTS.

## CLINICAL RELEVANCE/APPLICATION

Nerve fascicle count and size in addition to the use of nerve ratios for size assessment may help to more accurately differentiate demyelinating neuropathies from nerve entrapment.

## **T5A-SPMK- Improved Visualization of the Brachial Plexus MR Neurography with Deep Learning Reconstruction in Conventional and Accelerated Sequences: Study of Healthy Volunteers**

ILKWON KO (*Presenter*) Nothing to Disclose

## PURPOSE

To prospectively compare the effectiveness of deep learning reconstruction(DLR) for brachial plexus MR imaging with that of a conventional and accelerated MR imaging protocol in healthy volunteers.

## METHODS AND MATERIALS

This prospective study included 14 healthy volunteers (7 men, 7 women; mean age, 24.3 ± 3.5 [SD] years) who underwent 3-T brachial plexus contrast enhanced STIR sequence . Examinations included conventional sequence with parallel factor(PF) 3 (scan time, 7 minutes 5 seconds) and accelerated sequences with PF 5 (4 minutes 39 seconds), Standard(PF3) and accelerated sequences(PF 5) were acquired with and without DLR.Two musculoskeletal radiologists qualitatively evaluated examinations for brachial plexus visualization (1-3, none to full), and motion artifact , visualization of the supraspinatus and axillary nerve (1-4, none to complete), which was scored individually at three separate regions along the brachial plexus: supraclavicular (extraforaminal roots, trunks, and proximal divisions), retroclavicular (distal divisions), and infraclavicular (cords). Interobserver agreement between two readers for the image quality were assessed using weighted kappa statistics. Comparisons of quantitative scores were performed with use of student T-test. P < .05 was deemed statistically significant.

## RESULTS

A total of 28 brachial plexus images were included in 14 subjects. Standard(PF3) and accelerated sequences(PF 5) with DLR enabled significantly improved visualization of the brachial plexus (P < .001) and motion artifact (P < .05) in the all three regions for two readers except for PF3 at the supraclavicular area(p=0.09) and retroclavicular area(p=0.06) in reader 1.For visualization of the axillary nerve, only PF5 with DLR images significantly improved image quality(p=0.007-0.037). However, there was no improvement in image quality with DLR for visualization of suprascapular nerve in PF3 and PF5(p=0.07-0.71) except for PF3 at the retroclavicular area in reader 2(p=0.0014). Agreement between image two readers ranged from a kappa of 0.5-0.83 in brachial plexus visualization 0.5-0.77 in motion artifact , 0.59-0.91 in suprascapular nerve and 0.58-0.85 in axillary nerve.

## CONCLUSION

Accelerated sequences with DLR effectively reduce scan time and artifacts , providing similar subjective image quality to conventional sequences for brachial plexus MR imaging.

## CLINICAL RELEVANCE/APPLICATION

Accelerated sequences with DLR may provide an alternative to standard sequences for clinical brachial plexus MRI

## **T5A-SPMK- The Diagnostic Value of Multimodal Imaging for Primary Lower Limb Lymphedema**

MENGKE LIU (*Presenter*) Nothing to Disclose

## PURPOSE

To retrospectively analyze the imaging characteristics of primary lower limb lymphedema on CT and MRI multi-modal sequences, compare the diagnostic value of multi-modal imaging examinations for lower limb lymphedema, and identify the optimal techniques or methods for displaying lymphedema.

## METHODS AND MATERIALS

A retrospective analysis was conducted on patients with primary lower extremity lymphedema (LEL) admitted to our lymphatic surgery department from January to December 2019. All patients underwent both CT and MRI examinations of the lower extremities. The MRI multi-modal sequences included Short Time Inversion Recovery (STIR) and mDIXON sequences. Image analysis and scoring were independently performed by two radiologists, including assessment of skin thickening, fat

separation, fascial effusion (effusion above and below the fascia). Skin thickening was defined as dermal thickness >2mm; fat separation was defined as abnormal signal and density shadows distributed in a mesh-like or honeycomb-like pattern around the fat lobules; fascial effusion was defined as abnormal signal or density shadows in a strip or crescent shape on the fascial surface or below the fascia. The frequency of appearance of CT and MR manifestations in the affected limb was recorded. The sensitivity of lesions displayed by CT and MR sequence were evaluated as clear, general, or unidentifiable, and the best imaging method for displaying edema was selected. The frequency differences of multi-modal imaging manifestations of lower extremity lymphedema were compared using chi-square test or Fisher's exact test.

## RESULTS

A total of 36 patients were included in the study. There was no statistically significant difference in the detection rate of skin thickening among other imaging methods ( $P>0.05$ ). The detection rate of fascial superficial lymphatic fluid by mDIXON-FAT was significantly lower than that by other imaging methods ( $P<0.05$ ), and there was no statistically significant difference in the detection rate of fascial superficial lymphatic fluid among other imaging methods ( $P>0.05$ ). STIR had higher sensitivity than CT and mDIXON sequences for detecting fat septa, subfascial/epifascial effusion, and dilated tubular shadows

## CONCLUSION

Multi-modal imaging has high diagnostic value for primary lower extremity lymphedema. The STIR sequence is more sensitive than other CT and MRI sequences for detecting primary lower extremity lymphedema, and can be used as the preferred imaging sequence for the diagnosis and evaluation of lymphedema

## CLINICAL RELEVANCE/APPLICATION

Multi-modality imaging can accurately diagnose primary lower extremity lymphedema, with STIR sequence having the highest sensitivity for detecting edema

## T5A-SPMK- Optimization of keV for Radiomics Extracted from Spectral Virtual Monochromatic Images to Predict Osteoporosis

Jinling Wang (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate the effect of radiomics obtained from different virtual monochromatic images (VMIs) by dual-energy computed tomography (CT) on the prediction of osteoporosis.

## METHODS AND MATERIALS

A retrospective study of 62 participants who underwent both single source dual-energy CT and quantitative computed tomography (QCT) lumbar-spine examination were enrolled. With QCT as the reference standard, the patients were divided into two groups according to the guidelines introduced by the International Society for Clinical Densitometry (ISCD) and American College of Radiology (ACR), osteoporosis ( $n=16$ ) of the spine was defined as a BMD value  $<80$  mg/cm<sup>3</sup>, and non-osteoporosis ( $n=46$  [osteopenia and normal]) was defined as a BMD value  $\geq 80$  mg/cm<sup>3</sup>. Radiomics scores (RSs) for osteoporosis prediction were constructed from 11 sets of VMIs (40-140 keV, 10 keV interval). Receiver operating characteristic (ROC) curves were drawn and the area under the curves (AUCs) was calculated to evaluate the discriminatory power of RS for each VMI.

## RESULTS

The AUC values for osteoporosis prediction with RS of 40-140 keV VMIs were 0.995, 0.996, 1.000, 1.000, 1.000, 1.000, 0.793, 0.787, 0.807, 0.821, 0.846. The accuracies of RS of VMIs were 0.952, 0.968, 0.984, 1.000, 1.000, 1.000, 0.705, 0.721, 0.746, 0.742, 0.770. The sensitivities of RS of VMIs were 0.882, 0.938, 0.941, 1.000, 1.000, 1.000, 0.400, 0.375, 0.444, 0.444, 0.545. The specificities of RS of VMIs were 0.978, 0.978, 1.000, 1.000, 1.000, 1.000, 0.765, 0.774, 0.796, 0.792, 0.820. The negative prediction values of RS of VMIs were 0.957, 0.978, 0.979, 1.000, 1.000, 1.000, 0.867, 0.891, 0.896, 0.894, 0.891. And the positive prediction values of RS of VMIs were 0.938, 0.938, 1.000, 1.000, 1.000, 1.000, 0.250, 0.200, 0.267, 0.267, 0.400.

## CONCLUSION

The RS obtained from multiple VMIs in dual-energy CT had a good ability to predict osteoporosis. And the RS of 40-90 keV VMIs showed higher performance than the RS of 100-140 keV VMIs.

## CLINICAL RELEVANCE/APPLICATION

The prevalence of osteoporosis in the population is increasing year by year. One of the reference standards for the diagnosis of osteoporosis today is the volumetric BMD measured by QCT, but the QCT post-processing process is very complex and requires additional phantom calibration, etc. Spectral CT imaging provides VMIs to improve the image quality thereby radiomics efficacy, however the optimized keV for radiomics extraction was still obscure. Our proposed RS models obtained from 40-90 keV VMIs can serve as useful tools for osteoporosis prediction and have the potential to be applied in clinical treatment planning in the future.

Na Gao (*Presenter*) Nothing to Disclose

# **T5A-SPMK- Quantitative Analysis of Bone Mineral Density in Patients with Chronic Kidney Disease by Revolution CT Substance Separation Technique**

## **PURPOSE**

Patients with chronic kidney disease are prone to fracture and other serious complications. Early and accurate measurement of Bone mineral density (BMD), an important index of bone mass in human body, is of great clinical significance for predicting the risk of fracture in patients with CKD . X-ray attenuation images of Revolution CT scanned by high and low voltages can be expressed as density maps of two substances, thus realizing substance separation of single voxel. Therefore, this study explored the value of Revolution CT in the diagnosis of BMD in patients with CKD.

## **METHODS AND MATERIALS**

Total abdominal energy spectrum plain scan data of 48 patients with CKD were collected. According to the principle of three quantiles, the patients were divided into three groups: Group A (= 48 years old), Group B (49-61 years old) and Group C (= 62 years old). GSI scanning mode combined with 40% ASiR-V, at automatically modulated tube current (Smart mAs), noise index was 9. Using GSI Viewer software, the images of HAP (FAT)-based material pairs were reconstructed from 0.625mm thick images, and the Region of interest (ROI) was placed in the middle layer of L3 vertebral body (ROI was about 100mm<sup>2</sup> ), and the HAP concentration was recorded. One-way analysis of variance was used to compare the concentration of HAP in vertebral body of L3 in different age groups of patients with CKD. Pearson correlation analysis was used to analyze the concentration of HAP in vertebral body of L3 in three age groups. The difference was statistically significant with  $P < 0.05$ .

## **RESULTS**

The concentrations of HAP in vertebrae of L3 were  $(185.12 \pm 11.83) \text{mg/cm}^3$ ,  $(138.55 \pm 12.58) \text{mg/cm}^3$ ,  $(96.38 \pm 10.16) \text{mg/cm}^3$  in each age group of patients with CKD, and there was statistical differences between three groups ( $P < 0.05$ ). There was a negative correlation between the age of the three groups and the concentrations of HAP ( $r = -0.309, -0.211, -0.028$ ,  $P < 0.05$ ).

## **CONCLUSION**

The HAP concentration measured by energy spectrum CT in L3 vertebral cancellous of patients with CKD is related to age, and the HAP concentration in vertebral body of CKD patients gradually decreases with age after 48 years old.

## **CLINICAL RELEVANCE/APPLICATION**

Revolution CT based material imaging technology provides a new idea for BMD measurement. HAP (FAT) as a base material pair can reflect the change of BMD with age. For patients with CKD, Revolution CT can find the changes of bone mass as early as possible, and provide basis for making personalized diagnosis and treatment plans.

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## Abstract Archives of the RSNA, 2023

T5A-SPMS

### Multisystem Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPMS- A Cross-sectional Study to Quantify Cardiac, Hepatic and Pancreatic Iron Overload on MR 1 Imaging in Beta Thalassemia Major Patients**

Reissa Maria Ribeiro, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Regular blood transfusions are the mainstay in beta thalassemia major; however, it may cause cardiac and hepatic hemosiderosis - the most common cause of death in these patients. Chelation requires constant adjustments to avoid either iron or chelator toxicity. In recent years, various MRI methods have been validated for quantifying iron overload.

#### **METHODS AND MATERIALS**

31 beta-thalassemia major patients (22 males and 9 females) (age range 8-18 years) receiving regular blood transfusions and chelation therapy were enrolled. Patients were scanned on 3-Tesla MRI and mFFE T2\* and R2\* weighted sequences were acquired with parameters mentioned in Figure 1. LIC and MIC values were calculated using the formulae:  $0.032 \times R2^* - 0.14$  and  $(0.0254 \times R2^*) + 0.202$  respectively. They were then graded as follows: For LIC Normal < 2 Light 2-7, Moderate 7-15, Severe >15. For MIC Normal <1.16, Light 1.16-1.65, Moderate 1.65-2.71, Severe >2.71. For pancreas Normal <30, Mild 30-100, Moderate 100-400, Severe >400.

#### **RESULTS**

This is an interim analysis of an ongoing study. Liver R2\* had a very weak but insignificant positive correlation with SF levels ( $r = 0.167$ ,  $p 0.397$ ). Cardiac R2\* had a moderate but significant positive correlation with SF levels ( $r = 0.535$ ,  $p 0.003$ ). Pancreatic T2\* had a weak but insignificant positive correlation with SF levels ( $r = 0.281$ ,  $p 0.165$ ). LIC had a very weak but insignificant positive correlation with SF levels ( $r = 0.146$ ,  $p 0.459$ ). MIC had a moderate but significant positive correlation with SF levels ( $r = 0.427$ ,  $p 0.024$ ). Liver T2\* had a weak but insignificant positive correlation with serum total bilirubin levels ( $r = 0.258$ ,  $p 0.223$ ). LIC had a very weak but insignificant positive correlation with SGPT ( $r = 0.170$ ,  $p 0.439$ ). LIC had a weak but insignificant positive correlation with SGOT ( $r = 0.270$ ,  $p 0.212$ ). No statistically significant difference in mean SF, LIC and MIC values between 2-weekly, 3-weekly and 4-weekly transfusion regimens.

#### **CONCLUSION**

LIC had a very weak positive correlation with serum ferritin. Whereas, MIC had a moderate and significant positive correlation with serum ferritin. Pancreatic T2\* and R2\* values had a weak positive correlation with serum ferritin. LIC showed a weak and insignificant positive correlation with liver function tests (LFTs). No statistically significant difference was seen in the mean serum ferritin, LIC and MIC values between 2-weekly, 3-weekly and 4-weekly transfusion regimens. However, a larger sample size is required to determine true statistical significance and we plan to achieve the same in the near future.

#### **CLINICAL RELEVANCE/APPLICATION**

At present, our study shows that T2\*/R2\* MRI prove to be a valuable non-invasive method for evaluating iron overload, especially when compared to a liver biopsy.

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## Abstract Archives of the RSNA, 2023

T5A-SPNMMI

### Nuclear Medicine & Molecular Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPNMMI-1 Differential FDG Uptake in the Brain at Early and Delayed Imaging Assessed by Dual Time-point Total-body PET**

Shashi B. Singh, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of the study was to examine the changes in the global FDG uptake in the brain from early to delayed scans in dual time-point imaging (DTPI) before and after treatment in patients with lymphoma, using total-body PET/CT. We also assessed uptake in the brain before and after 2 cycles of chemotherapy.

#### **METHODS AND MATERIALS**

FDG-PET/CT data from 20 patients referred for initial staging of non-Hodgkin's lymphoma at UC Davis- age 12 to 74.9 years (mean =  $44.12 \pm 19.70$  years; males = 9; females = 11) were analyzed. It included 40 scans conducted 60 and 120 minutes following intravenous injection of 8 mCi of FDG. Interim scans after 2 cycles of chemotherapy (6/20 patients) were assessed at both 60 and 120 minutes after injection of 8 mCi of FDG. The FDG-PET/CT scans were analyzed using OsiriX MD software v. 12.5.2 (Pixmeo SARL, Bernex, Sweden). A region of interest was manually placed on fused PET/CT images for global assessment of FDG uptake in the entire brain, including the supratentorial region, cerebellum, midbrain, and medulla but excluding spinal cord. Metabolic activity was assessed by calculating global SUVmean across all slices. Finally, global SUVmean scores were compared at 60 and 120 minutes of scan in both baseline and post-treatment scans.

#### **RESULTS**

For the baseline scans, an overall increase in FDG uptake in the brain was observed from 60 minutes to 120 minutes. The average SUVmean at 60 minutes was  $7.48 \pm 2.10$  (range: 3.81 to 11.99) whereas at 120 minutes was  $8.51 \pm 2.32$  (range: 4.36 to 12.88) at baseline. The difference in the average SUVmean at 120 minutes and 60 minutes was found to be  $1.03 \pm 0.66$  (range: 0.45 to 3.17) ( $p < .00001$ ) and the average 60-120 min percent change was  $14.32 \% \pm 10.25 \%$  (range: 7.28 % to 53.21 %). Similarly, for post-treatment scans, an overall increase in FDG uptake in the brain was observed from 60 minutes to 120 minutes. The average SUVmean at 60 minutes was  $6.97 \pm 2.45$  (range: 3.71 to 10.43) whereas at 120 minutes was  $7.56 \pm 2.47$  (range: 4.40 to 11.18). The difference between the average SUVmean at 120 minutes and 60 minutes was found to be  $0.59 \pm 0.30$  (range: 0.006 to 0.84) ( $p = 0.00518$ ) and the average 60-120 min percent change was  $9.64 \% \pm 6.21 \%$  (range: 0.08 % to 18.76 %).

#### **CONCLUSION**

FDG uptake in the brain increases from 60 minutes to 120 minutes during DTPI of the brain with total body FDG PET/CT. Therefore, early imaging of the patients with suspected brain tumors may help to identify the lesions more clearly than delayed imaging due to relatively lower background uptake. In addition, this study demonstrated an initial possible decrease in brain uptake after 2 cycles of chemotherapy.

#### **CLINICAL RELEVANCE/APPLICATION**

It may be possible to distinguish the lesions more clearly with early imaging than with delayed imaging in patients with suspected brain tumors.

#### **T5A-SPNMMI-2 Comparison of Diagnostic Image Quality and Radiation Dose of Directly Contrast-enhanced CT for FDG-PET Image Attenuation and Co-registration to Sequential Non-enhanced PET/CT Followed a Dedicated Diagnostic CT**

Thomas F. Hany, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To compare diagnostic image quality and extent of attenuation correction artifacts due to iodinated contrast in PET images and total radiation dose of the CT-component of sequential partial body (head to thigh) non-enhanced CT F-18 Fluorodeoxy (FDG) - PET/CT followed by a dedicated diagnostic contrast-enhanced CT (thorax/abdomen/neck) (cePET/CT) protocol to directly intravenous contrast-enhanced FDG-PET/CT protocol (head to thigh) (dicePET/CT) in the same oncological patient population.

## METHODS AND MATERIALS

An inter-group comparison of 48 patients (m=20, f=28, initial mean age 65.8 y; 33-81 y) undergoing cePET/CT and dicePET/CT in clinical oncological routine on the same PET/CT scanner (Siemens mCT128) within an average of 529 d (76 - 949d) were compared. PET-image quality were objectively (standard uptake value SUV<sub>c</sub> cerebellum, SUV<sub>bp</sub> blood pool, SUV<sub>lu</sub> lung and SUV<sub>li</sub> liver) and subjectively evaluated for the presence of attenuation artifacts. Average effective CT radiation dose (aeCTRD) of the CT component for both groups were determined.

## RESULTS

Average dose for scePET/CT and dcePET/CT was 3.48 and 3.50 MBq/kg, respectively. Significant attenuation artifacts in PET image quality was seen in both groups only by mis-match in the brain and liver (n=2) not in the vasculature. No significant differences were found in the SUV values for the scePET/CT and dcePET/CT - SUV<sub>c</sub> 12.3 vs. 12.3 (p=0.93), SUV<sub>bp</sub> 3.0 vs. 3.2 (p=0.07), SUV<sub>lu</sub> 0.80 vs. 0.85 (p= 0.13), SUV<sub>li</sub> 3.9 vs. 4.1 (p= 0.08). aeCTRD for scePET/CT and dcePET/CT was 15.03 mSv vs. 7.08 mSv, respectively (Difference 52.3%).

## CONCLUSION

If a ceCT in the FDG-PET/CT protocol is needed, a direct contrast enhanced CT protocol is favorable due to significant radiation dose reduction without constraints in PET image quality and quantitative analysis since a non-enhanced CT head-to-thigh for attenuation correction can be omitted and attenuation artifacts due to intravenous enhancement is negligible.

## CLINICAL RELEVANCE/APPLICATION

If a ceCT in the FDG-PET/CT protocol is needed, a direct contrast enhanced CT protocol is favorable due to significant radiation dose reduction.

## T5A- SPNMMI-3 Evaluating the Ability of ChatGPT to Create a Differential Diagnosis from Transcribed Radiological Findings in Nuclear Medicine

Gilleen A. Cortes, DO (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the accuracy and reliability of ChatGPT3.5 and ChatGPT4 in creating a differential diagnosis from transcribed radiological findings of specific nuclear medicine cases.

## METHODS AND MATERIALS

A sample of 50 cases specific to nuclear medicine imaging was selected from a radiology textbook, from which the answers were used as the gold standard. The history and case images were converted into standardized prompts that contained purely descriptive language of the cases and a query for the most likely diagnosis, the top three differential diagnoses, and the corresponding explanations and references from the medical literature. These prompts were entered into the ChatGPT3.5 and ChatGPT4 algorithms. The output diagnoses were analyzed for accuracy by comparison with the original literature and reliability through manual verification of the generated explanations and citations. The top 1 accuracy and the top 3 accuracies were defined as the percentage of generated responses that matched the original diagnosis and the complete differential provided by the original literature. An additional differential diagnosis score was defined as the proportion of differentials that matched the original literature's answers for each case. Comparisons were made between the results of the two algorithms using a one-tailed two proportion z-test method.

## RESULTS

The top 1 accuracy and top 3 accuracy for ChatGPT3.5 versus ChatGPT4 were 60.0% compared to 70.0% (p = 0.15) and 12.0% compared to 10.0% (p = 0.37), respectively. The average differential diagnosis score of ChatGPT3.5 versus ChatGPT4 was 58.1% compared to 58.7% (p = 0.48). ChatGPT3.5 and ChatGPT4 hallucinated 41.5% versus 8.3% (p = 0.00006) of the references provided and generated 6 total false statements versus 4 total false statements, respectively.

## CONCLUSION

While ChatGPT has shown some potential in generating accurate diagnoses, this technology requires further development before it can be implemented into clinical and educational practice. It is important to acknowledge that the most recent version of ChatGPT has made slight improvements in the accuracy of its diagnoses as well as reducing the hallucination effect.

## **CLINICAL RELEVANCE/APPLICATION**

ChatGPT and Large Language Models have the potential to impact clinical and educational medicine. Knowledge of the accuracy and possible errors of these algorithms can provide a better understanding of the limitations of these tools.  
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## Abstract Archives of the RSNA, 2023

T5A-SPNPM

### Noninterpretive Skills (Beyond Imaging) Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPNPM-1 The Association Between Food Security and Mammography Screening: Cross-Sectional Survey Results from the National Health Interview Survey**

Jade A. Anderson, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In one prior randomized control trial, providing food vouchers and a food pantry to food insecure individuals was associated with a 94.6% cancer treatment completion percentage. There is limited data about food insecurity within the cancer screening setting. To inform the potential need for food insecurity interventions, our study evaluated the association between food security and mammographic screening among eligible participants.

#### **METHODS AND MATERIALS**

Female survey respondents aged 40-74 in the 2019 National Health Interview Survey (NHIS) without history of breast cancer were included. Food insecurity was assessed using the Six-Item Food Security Scale developed by the National Center for Health Statistics. Scores from the six questions were aggregated to assign food security status. Individuals with low or very low food security were defined as food insecure. Proportion of patients who reported mammographic screening within the last year was estimated, stratified by food security status. Multiple variable logistic regression analyses were conducted to evaluate the association between food security and mammography screening, adjusted for potential confounders. All analyses were performed accounting for complex survey design features.

#### **RESULTS**

9,139 weighted survey respondents met inclusion criteria. Due to lack of money for food, 11.8% of participants indicated that the food they bought wouldn't last, 10.9% couldn't afford to eat balanced meals, and 10.1% worried that food would run out. 90.1% were classified as having high or marginal food security of whom 56.6% reported mammography screening. 6.1% were classified with low food security of whom 42.1% reported screening. 3.8% were classified with very low food security of whom 43.1% reported screening. In our unadjusted analyses, participants with low food security (OR 0.56, 95%CI 0.44 to 0.70,  $p < 0.001$ ) and very low food security (OR 0.58, 95%CI 0.44 to 0.77,  $p < 0.001$ ) were less likely to report mammography screening within the last year. In our adjusted analyses, participants with very low food security (OR 0.54, 95%CI 0.33 to 0.88,  $p = 0.013$ ) were less likely to report mammography screening within the last year.

#### **CONCLUSION**

In a nationally representative cross-sectional survey, 9.9% of eligible participants experienced food insecurity. In our unadjusted and adjusted analyses, food insecurity was associated with significantly reduced mammography screening percentages.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiology practices should consider screening patients for food insecurity and other social determinants of health using validated instruments. Evidence-based food insecurity interventions should be made available to participants experiencing food insecurity.

#### **T5A-SPNPM-2 Can ChatGPT help promote health literacy?: Generating, summarizing and simplifying patient-facing information about breast cancer prevention and screening**

Hana L. Haver, MD (*Presenter*) Nothing to Disclose



## PURPOSE

Disparities in health literacy are known to impact patient decision-making, particularly in the context of breast cancer prevention and screening. We evaluated the use of the large language model ChatGPT as a tool to generate and simplify responses to common questions about breast cancer.

## METHODS AND MATERIALS

ChatGPT was asked to simplify responses to 25 fundamental questions about breast cancer prevention and screening to a 6th grade reading level from a prior study by Haver et al. (Radiology 2023). The simplified responses were evaluated for clinical appropriateness by a fellowship-trained breast radiologist. Language complexity was assessed on the Flesch Reading Ease scale and readability was assessed on 5 scales: Flesch-Kincaid Grade Level, Gunning-Fog Index, Coleman-Liau Index, Automated Readability Index, and the Simple Measure of Gobbledygook. Paired t-tests of mean language complexity and mean readability scores for the original and simplified for each question were analyzed. Based on NIH guidelines, we considered language complexity score of <60 and readability score > 8th grade reading level to be too difficult for the average adult patient.

## RESULTS

For ChatGPT's original responses, the average language complexity was 45 and the average readability of 13.2 grade level which was considered too difficult for the average adult patient. The responses that had been simplified by ChatGPT to a "6th grade" reading level had improved readability metrics with an average language complexity of 59 (higher is better) and 11th grade readability level ( $p < 0.005$  across all scales compared to original responses) [Figure 1]; these were still considered too difficult for the average adult patient, however. The simplified responses were appropriate 88% of the time upon review by a board-certified breast imaging radiologist, which is the same as that of the original responses by ChatGPT, as reported previously by Haver et al. (Radiology 2023).

## CONCLUSION

ChatGPT provides health information about breast cancer screening that is accurate and appropriate 88% of the time, albeit at high reading levels inappropriate for the average adult patient. When provided with an appropriate prompt, ChatGPT can simplify its responses' readability by >2 grade levels while retaining the appropriateness of its responses. With improved prompt engineering, these readability levels will likely be able to be further improved, which our group is actively working on next.

## CLINICAL RELEVANCE/APPLICATION

ChatGPT's answers to questions about breast cancer are difficult to read. This model can be prompted to simplify this information, though it underestimates the readability level of the output.

## T5A-SPNPM-3 Ecodesign and Operational Strategies to Reduce MRI Energy Consumption: Cost Savings and Reduced Carbon Footprint

Sean A. Woolen, MD, MS (*Presenter*) Research Grant, Siemens AG; Investigator, Siemens AG

## PURPOSE

To determine the energy, cost, and carbon savings that could be achieved through different MRI scanner power management strategies.

## METHODS AND MATERIALS

Four outpatient MRI scanners from three vendors were individually equipped with power meters (1-Hz sampling rate). Power measurement logs were extracted over 39 days. Data were segmented into off, idle, prepared-to-scan, scan, or Eco-Power (one vendor's power-saving mode) modes for each scanner. Energy, cost (assuming a mean cost of \$0.14 per kWh), and carbon savings were calculated for the lowest scanner activity modes.

## RESULTS

Projected annual energy-consumption per scanner ranged from 82.7-171.1 MWh, with 72-91% defined as non-productive. Power draws for each mode were measured as  $6.4 \pm 0.1$  kW (Eco-Power),  $7.3 \pm 0.6$  kW to  $9.7 \pm 0.2$  kW (off),  $9.5 \pm 0.9$  to  $14.5 \pm 0.5$  kW (idle),  $17.3 \pm 0.5$  to  $25.6 \pm 0.6$  kW (prepared-to-scan), and  $28.6 \pm 8.6$  to  $48.3 \pm 11.8$  kW (scan). Switching MRIs from idle to off mode for 12 overnight hours reduced power-consumption by 25-33%, translating to a potential annual savings of 12.3-21.0 MWh, \$1,717-\$2,943 USD, and 8.7-14.9 mt CO<sub>2</sub>eq. The Eco-Power mode further reduced consumption by 28% compared to off mode, potentially saving an additional 11.0 MWh, \$1,533 USD, and 7.8 mt CO<sub>2</sub>eq per year for 12 hours overnight. Turning off a fleet of 30 MRIs for 12 hours overnight offers a potential savings of 367.9-630.7 MWh, \$51,509-\$88,301 USD, and 260.9-447.2 mt CO<sub>2</sub>eq. Overnight implementation of Eco-Power mode on all outpatient MRI in the U.S. could save U.S. healthcare 73,354.1 MWh, \$10.3 million USD, and 52,008 mt CO<sub>2</sub>eq.

## **CONCLUSION**

Powering down MRIs when not needed can make radiology departments more energy efficient and gain substantial sustainability and cost benefits.

## **CLINICAL RELEVANCE/APPLICATION**

Our data details how an ecodesign approach by scanner vendors and strategic changes to routine MRI operations by healthcare systems can be effectively used to reduce cost and impact environmental sustainability. These results should help radiologists, healthcare administrators, and corporate partners understand the benefits of energy-efficient MRI operations.

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## Abstract Archives of the RSNA, 2023

T5A-SPNR

### Neuroradiology Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPNR- Multisequence MRI-Based Radiomics Signature as Potential Biomarkers for Predicting KRAS Mutations in Brain Metastases** 1

Xinna Lv (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Kirsten rat sarcoma virus (KRAS) has evolved from a genotype with predictive value to a therapeutic target recently with the observation of novel agents. The aim of this study was to establish non-invasive radiomics models based on MRI to discriminate Kirsten rat sarcoma virus (KRAS) from epidermal growth factor receptor (EGFR) or anaplastic lymphoma kinase (ALK) mutations in lung cancer patients with brain metastases (BM), then further explore the optimal sequence for prediction.

#### **METHODS AND MATERIALS**

This retrospective study involved 317 patients with proven BM of lung cancer (218 patients in the training cohort and 99 patients in the testing cohort) who had confirmed of KRAS, EGFR or ALK mutations. Radiomics features were separately extracted from T2WI, T2 fluid-attenuated inversion recovery (T2-FLAIR), diffusion weighted imaging (DWI) and contrast-enhanced T1-weighted imaging (T1-CE) sequences. Synthetic minority oversampling technique was used in the training cohort to separately balance KRAS to EGFR or ALK mutations in consideration of the unbalanced nature of the training dataset. The maximal information coefficient and recursive feature elimination method were used to select informative features based on these four regular sequences respectively. Then we separately construct four radiomics models for differentiating KRAS from EGFR or ALK mutations using random forest classifier. ROC curves were used to validate the capability of the models in the training and testing cohorts.

#### **RESULTS**

The four radiomics models for discriminating KRAS from EGFR mutations all worked well, especially DWI and T2WI model with AUCs of 0.942 and 0.949, 0.942 and 0.954 in the training and testing cohorts. The T1-CE and T2-FLAIR models yielded AUCs of 0.918 and 0.954, 0.956 and 0.838 in the two cohorts. When KRAS compared to ALK mutations, the AUCs were 0.947 and 0.850, 0.917 and 0.824, 0.896 and 0.795, 0.892 and 0.790 in DWI, T2-FLAIR, T2WI and T1-CE sequences in training and testing cohorts respectively. The DWI and T2-FLAIR models showed excellent performance in distinguishing KRAS from ALK mutation.

#### **CONCLUSION**

The radiomics classifiers integrating MRI may have potential to discriminate KRAS from EGFR (DWI and T2WI model) or ALK mutations (DWI and T2-FLAIR model) that could guide targeted therapy.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiomics classifiers integrating multisequence MRI may have potential to identify KRAS mutations, which are helpful to guide clinical therapeutic strategies and facilitate the discovery of new approaches capable of achieving this long-sought goal of cure in populations of patients with KRAS-mutant lung cancer.

#### **T5A-SPNR- Prediction of IDH and EGFR Mutation Status in Diffuse Glioma Patients Using Dynamic Susceptibility Contrast Imaging-derived Oxygenation and Microvascular Transit Time Heterogeneity Biomarkers** 10

Yunhwa Roh, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To obtain tumor microvascular and oxygenation information and evaluate their potential for noninvasive assessment of IDH and EGFR mutation status in diffuse glioma patients using perfusion MRI.

## METHODS AND MATERIALS

This retrospective single-institution study included patients with adult diffuse glioma who had undergone preoperative dynamic susceptibility contrast (DSC) perfusion MRI. Contrast-enhancing lesion (CEL) and non-enhancing lesion (NEL) were segmented using deep learning segmentation. Imaging parameters of cerebral blood volume (CBV), cerebral blood flow (CBF), capillary transit time heterogeneity (CTH), oxygen extraction fraction (OEF), and cerebral metabolic rate of oxygen (CMRO<sub>2</sub>) were obtained using the capillary function-based perfusion model (Cercare Medical Neurosuite) for CEL and NEL, respectively. The diagnostic abilities of the imaging biomarkers for predicting IDH and EGFR mutation status were independently assessed. Predictors were selected using logistic regression analysis, and performance was measured with the area under the receiver operating characteristics curve (AUC) analysis.

## RESULTS

A total of 110 patients were included (mean age, 58.8 years; range, 25-82; 49 women), with 25 cases of IDH mutation. Of the 85 patients with IDH wild-type glioblastoma, 34 patients showed EGFR mutation. Lower rCBV (Odds ratio [OR] 0.69; 95% confidence interval [CI]: 0.55-0.82, P<.001) and lower rCMRO<sub>2</sub> (OR 0.7; 95% CI: 0.54-0.85, P=.002) measured in CEL were predictive for the presence of IDH mutation. The combination of rCBV and rCMRO<sub>2</sub> showed an AUC of 0.85 in predicting IDH mutation status. In IDH-wild type gliomas, higher rCMRO<sub>2</sub> (OR 1.15; 95% CI: 1.02-1.31, P=.029) in CEL and higher rCBF (OR 1.38; 95% CI: 1.06-1.87, P=.023) in NEL was predictive of EGFR mutation. The combination of the parameters showed an AUC of 0.66 in predicting EGFR mutation status.

## CONCLUSION

Perfusion MRI utilizing the cerebral metabolic rate of oxygen, vascular density, and flow parameters provided the diagnostic value of predicting IDH and EGFR mutation status in glioma patients. Lower rCMRO<sub>2</sub> is indicative for IDH mutation, while higher rCMRO<sub>2</sub> is indicative for EGFR mutation.

## CLINICAL RELEVANCE/APPLICATION

The molecular status of IDH and the EGFR mutation have prognostic significance in glioma. Our study on perfusion MRI used a capillary function-based model and calculated the cerebral metabolic rate of oxygen (CMRO<sub>2</sub>) along with vascular density and flow parameters. The tumor oxygenation parameters enabled noninvasive diagnosis of IDH and EGFR mutation status, which may support the clinical standard of care in glioma patients.

## **T5A-SPNR- 11 Role of DOTATATE PET/MRI in Evaluating WHO grade 3 Meningiomas: Potential for Differentiating Secondary Progressive and De novo Tumors**

Joon Tae Kim, BS (*Presenter*) Nothing to Disclose

## PURPOSE

MRI has significant limitations in meningioma evaluation, especially in intermediate- and high-risk tumors. [68-Ga]-DOTATATE PET has demonstrated high utility in meningioma evaluation and treatment planning. While rare, and thus understudied, WHO grade 3 meningiomas (WHO3-M) are particularly aggressive with higher propensity for recurrence, metastases, and worse clinical outcomes compared to lower grade meningiomas. There thus exists a marked unmet need for improved targeted imaging strategies in the management of WHO3-M. Here, we evaluate the clinical, pathology, imaging characteristics and outcomes of patients with WHO3-M in our larger prospective cohort of patients with meningiomas undergoing DOTATATE PET/MRI and explore differences in PET findings between patients with de novo versus secondary progressive WHO3-M, as the latter are known to have worse prognosis.

## METHODS AND MATERIALS

Inclusion criteria were patients with WHO3-M who underwent DOTATATE PET/MRI. Clinical chart review was performed to document clinical course, surgical and radiation (RT) therapy, WHO grade, and molecular pathology. Progression free survival (PFS) was determined by applying RANO criteria to follow-up MRI. Mann-Whitney Tests were used to determine statistical significance.

## RESULTS

15 patients were included, 8 with secondary progressive and 7 with de novo WHO3-M. Secondary progressive cohort had significantly higher per-patient number of surgeries (4.0 vs 1.6; p = 0.012) and a trend for higher number of RT courses (2.5 vs 1.6; p = 0.23), higher cumulative RT dose (106 vs 68.3; p = 0.31), and decreased PFS (20.9 vs 37.7 months; p = 0.17). Secondary progressive tumors had distinct molecular pathology profiles with higher number of mutations (3.6 vs 1.3; p = 0.037). DOTATATE PET demonstrated significantly higher SUV in secondary progressive tumors (17.1 vs 12.4; p = 0.0052).

## CONCLUSION

This is the first study evaluating clinical characteristics and the utility of DOTATATE PET/MRI in WHO3-M and comparing secondary progressive and de novo cohorts. In addition to distinct molecular profiles, we report significantly increased SUV in secondary progressive WHO3-M compared to de novo WHO3-M. This work further supports DOTATATE PET/MRI as a useful management strategy in WHO3-M and raises the possibility of differentiating secondary progressive and de novo WHO3-M with PET/MRI in the clinical context. This work raises important questions regarding meningioma biology such as the potential role of SSTR2 signaling in WHO3-M.

## CLINICAL RELEVANCE/APPLICATION

DOTATATE PET/MRI may be of particular clinical benefit in WHO3 meningiomas, improving diagnosis and treatment planning as well as identifying the secondary progressive subtype which conveys worse clinical outcomes.

## **T5A-SPNR- 12 Radiomics Nomogram Based on Multiparametric MRI Features for Preoperative Prediction of MGMT Promoter Methylation Status in Glioblastomas**

Jun Lu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Preoperative identification of O6-methylguanine-DNA methyltransferase (MGMT) promoter methylation status is of great clinical significance in selecting potential patients who might benefit from therapy. This study aimed to establish and validate a radiomics nomogram using the radiomics features and clinical characteristics for preoperative prediction MGMT promoter methylation status in glioblastomas.

## METHODS AND MATERIALS

216 patients in local institution and 68 patients from The Cancer Genome Atlas (TCGA) were enrolled. 851 radiomics features were extracted from the apparent diffusion coefficient (ADC) and isotropic volumetric contrast-enhanced T1 (ISO-CE-T1) weighted images, respectively. The features were selected using Mann-Whitney U-test, followed by refining using least absolute shrinkage and selection operator (LASSO) regression combining 10-fold cross-validation. Three radiomics signatures were built based on ADC, ISO-CE and joint radiomics features. The optimal radiomics signature with age and sex were processed by multivariate logistic regression analysis to construct a prediction model, which was developed in the training dataset and tested in the test and independent external validation dataset from TCGA. A radiomics nomogram was plotted to represent the prediction model. The performance of the radiomics nomogram was evaluated using discrimination, calibration, and decision curves.

## RESULTS

Three radiomics signatures comprising of five, five and six robust features were built. The joint signature showed the highest area under the curve (AUC) of 0.811/0.790 in the test and validation dataset. The accuracy, sensitivity, specificity and AUC were 84.62%, 82.76%, 86.11%, 0.903(0.804-0.963) and 80.88%, 81.25%, 80.56%, 0.845(0.737-0.922) in the test and external validation dataset, respectively. The radiomics nomogram with clinical data outperformed the radiomics signature alone. The Hosmer-Lemeshow test concluded that the radiomics nomogram showed goodness of fit (all  $p > 0.05$ ). Decision curve analysis demonstrated the clinical value of the radiomics nomogram.

## CONCLUSION

The radiomics nomogram based on multiparametric MRI features is a promising approach for preoperatively predicting the MGMT promoter methylation status in glioblastomas noninvasively. The combination of radiomics features from different sequences and the addition of clinical characteristics to the nomogram showed incremental predictive value.

## CLINICAL RELEVANCE/APPLICATION

This study aimed to find imaging biomarkers for noninvasively predicting the MGMT promoter methylation status for a tailored treatment plan and prognosis assessment in GBM patients from the initial stage of the tumor diagnosis.

## **T5A-SPNR- 13 Diagnostic Performance of T1 $\rho$ Imaging and Diffusion-weighted Imaging (DWI) in Glioma IDH Mutation Status Prediction: A Pilot Study**

Guanxun Cheng, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study is to evaluate the diagnostic performance of T1 relaxation time in a rotating frame (T1 $\rho$ ) and apparent diffusion coefficient (ADC) in glioma IDH mutation status prediction

## METHODS AND MATERIALS

15 glioma patients (10 IDH-wild-type gliomas, 5 IDH-mutant-type gliomas) were prospectively imaged with multiparametric MRI on 3-T, including T1 $\rho$  imaging and DWI before surgery. In addition, since T1 $\rho$  relaxation time (T1 $\rho$ ) depends not only on the

structure characteristics, but also on spin lock frequency(FSL), we have set up three different spin lock frequencies (FSL = 100Hz, 200Hz, 500Hz) to compare whether there are differences between them. For ADC and T1 $\rho$  measurement, place the target ROIs, avoid tumor necrosis, cysts, and hemorrhagic areas by the help of conventional MR sequences and SWI images. Statistical significance was tested by using the Mann-Whitney U test. Receiver operating characteristic curve (ROC) analysis was performed to evaluate the diagnostic performance.

## RESULTS

Table1 summarizes the characteristics of the evaluated tumor patients. A total of 15 glioma patients(five male and ten female) were included in this study,containing five IDH-m patients(4 with diffuse astrocytomas ,WHO grade II;1 with anaplastic astrocytoma ,WHO grade III) and ten IDH-w patients(WHO grade II/III/IV,1/2/6 ;1 can't be graded due to imperfect molecular pathological detection). Differences in mean ADC values and T1 $\rho$  relaxation time (T1 $\rho$ ) between IDH-m and IDH-w groups are shown in Table2 and depicted in Figure1 and 2. Mean ADC values of the tumor parenchymal area of IDH-w gliomas were significantly lower than that of IDH-m gliomas( $0.852 \times 10^{-3} \text{mm}^2/\text{s}$  vs  $1.324 \times 10^{-3} \text{mm}^2/\text{s}$ ,respectively; $p=0.019$ ). Whether FSL(spin lock frequency) is equal to 100, 200 or 500 Hz, the T1 $\rho$  values of the tumor parenchyma of IDH-w gliomas were significantly lower than that of IDH-m gliomas (87.50/86.72/84.21ms vs 112.92/120.67/122.17ms, respectively; $p<0.05$ ). The AUC value of the ADC (0.880) revealed lower diagnostic performance compared with the T1 $\rho$  relaxation time. The AUC value (0.960) of the T1 $\rho$ (FSL=100Hz) was the same as that of T1 $\rho$  (FSL=500Hz). Logistic regression analysis showed that the combination of the ADC and T1 $\rho$ (FSL=500Hz) did not improve the diagnostic performance.

## CONCLUSION

This pilot study demonstrate that the T1 $\rho$  values may be feasible noninvasive imaging parameter for predicting the glioma IDH mutation status. Different spin -lock frequencies have similar diagnostic performance to IDH mutation status.

## CLINICAL RELEVANCE/APPLICATION

All patients included in the study were in accordance with the ethical standards of the institutional and/or national research committee.

## T5A-SPNR- A Deep Learning Framework Enables Non-invasive Detection of Tumor Mutational Burden in Brain Metastases

Syed Rakin Ahmed (*Presenter*) Nothing to Disclose

## PURPOSE

Brain metastases (BM) are the most common central nervous system malignancy and are an emerging unmet need in modern oncology. While precision medicine for BM has demonstrated impressive responses, many patients are not able to benefit from this treatment paradigm given the morbidity associated with tissue sampling. Tumor mutational burden (TMB), defined as the number of non-synonymous somatic mutations per megabase (Mb), is a predictive biomarker for efficacy of immune checkpoint inhibition (ICI) for BM. Here, we present a non-invasive technique, using deep neural networks (DNN), to quantitate TMB within BM to inform rational use of ICI.

## METHODS AND MATERIALS

We conducted our experiments on 297 multiparametric MRI (mpMRI) scans of BM patients of diverse histologies from MGH/DFCI, split into 75% train : 15% validation : 15% test. Consistent with prior literature, we binarized the TMB by defining values greater than 12 per Mb as "high", and the converse as "low". We limited our initial analysis to FLAIR, T1 pre- and T1 post-contrast MRI sequences. We employed a multi-step preprocessing pipeline involving skull stripping, isotropic resampling, registration, N4 bias correction and intensity normalization. We additionally investigated several unique input strategies to our DNN that incorporated combinations of MRI sequences and slice orientations, using the corresponding maximum intensity projection (MIP) image stack. We conducted our experiments both with and without five-fold cross validation, utilizing several classification architectures, and cross entropy loss with weighted sampling.

## RESULTS

Using a resnet18 architecture, our best performing model achieved an area under the receiver operating characteristics curve (AUROC) of 0.88 on the held-aside test set and comprised the axial FLAIR MIP image as input. Across all types of inputs and architectures investigated, our AUROCs ranged from 0.72 - 0.88. These results were consistent across each fold for the five-fold cross validation experiments.

## CONCLUSION

To fully translate clinically actionable genomic alterations within BM into clinical medicine, non-invasive biomarkers are desperately needed. To this end, we demonstrate that a DNN displays strong performance in quantifying TMB within BM. We are optimizing performance of this model with an expanded mpMRI dataset, as well as performing additional studies to noninvasively identify oncogenic drivers in BM (e.g. CDK, PI3K pathway alterations), which can help guide choice of targeted therapy.

## CLINICAL RELEVANCE/APPLICATION

We developed a deep learning model, using mpMRI, that achieves strong performance in quantifying TMB status within BM, which can augment clinical decision making through facilitating rational use of ICI in patients.

### **T5A-SPNR- Usefulness of Pituitary High-resolution 3D MRI using Deep-learning-based Reconstruction for Pre- and postoperative Evaluations in Patients with Pituitary Adenoma/pituitary Neuroendocrine Tumor**

Yuka Ishimoto (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In the management of pituitary adenomas, an MRI sequence with high sensitivity for detecting small lesions and high precision for delineating the normal pituitary glands is desirable. The recently developed deep-learning-based reconstruction (DLR) improves the image quality of thin-slice MRI. The previous investigators applied DLR to a 2D spin-echo sequence and showed that for the postoperative evaluation of pituitary adenoma, 1-mm-slice-thickness 2D CE-T1WI with DLR (1-mm 2D T1WI with DLR) showed greater diagnostic performance than conventional 2D CE-T1WI with 3-mm slice thickness. However, there were no study which applied DLR to a 3D fast spin-echo sequence. Therefore, for contrast-enhanced (CE) MRI, we assessed the diagnostic value of T1-weighted 3D fast spin-echo sequence (CUBE) with DLR for evaluating pituitary adenoma.

#### **METHODS AND MATERIALS**

We assessed 24 patients with pituitary or residual adenoma who underwent 3D CUBE with and without DLR (imaging time: 5 min, 7 sec), 1-mm-slice-thickness 2D spin-echo T1WI (1-mm 2D T1WI) with DLR, and 3D spoiled gradient echo sequence (SPGR) as CE-T1WI. For these MRI sequences, the depiction of the pituitary adenoma and parasellar region(cavernous sinus) was scored by two neuroradiologists, and the contrast-to-noise ratio (CNR) between the pituitary adenoma and the brain parenchyma was calculated.

#### **RESULTS**

Scores for the depictions of pituitary or residual adenoma were significantly higher with 3D CUBE with DLR than with 3D CUBE without DLR, 1-mm 2D T1WI with DLR, and 3D SPGR ( $P < .001$ ). In one patient, 3D CUBE with DLR identified a microadenoma that was not observed on other sequences (1-mm 2D T1WI with DLR and 3D SPGR) (Figure). The score for the depiction of the boundary between the adenoma and the cavernous sinus was higher with 3D CUBE with DLR than with 1-mm 2D T1WI with DLR and 3D SPGR. For the evaluation of adenomas, 3D CUBE with DLR provided better interobserver agreement than 1-mm 2D T1WI with DLR (0.75 vs. 0.41). For the CNR, the 3D CUBE with DLR was significantly higher than that with 3D SPGR, but there were no significant differences between the 3D CUBE with DLR and the 1-mm 2D T1WI with DLR.

#### **CONCLUSION**

For 3D evaluation of the pituitary and parasellar regions, DLR may be a useful method to shorten the acquisition time while maintaining sufficient image quality. Compared to 1-mm 2D T1WI with DLR, 3D CUBE with DLR provided better image quality for depicting pituitary adenoma, with better interobserver agreement.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-based reconstruction technique can allow 3D fast spin-echo T1WI with high spatial resolution, which is superior to 1-mm-slice-thickness 2D T1WI for the pre- and postoperative evaluation of pituitary adenomas.

### **T5A-SPNR- Meningiomas: Correlation between Tumors' Cellularity and Recurrence**

Luiz F. Borella (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Meningiomas are the most frequent tumors of the central nervous system. According to the World Health Organization, they can be categorized into 3 categories. There are benign tumors or grade I lesions. Secondly, grade II or atypical meningiomas (intermediate). Lastly, grade III meningiomas (malignant). In recent years, tools to predict patient's outcome have been proposed. In this study, we evaluate the meningioma's densities on CT and their mean values in ADC and correlate these variables with tumor recurrence. The main hypothesis was the greater the cellularity of the tumor (reflected by higher CT density and lower ADC mean value), more frequent tumors' recurrence.

#### **METHODS AND MATERIALS**

We listed 32 patients of our institution with histological diagnosis of meningioma that were submitted to CT and MRI evaluation before and after surgical exploration, between 2012 and 2020. To predict tumors' cellularity, we measure their CT density and ADC mean value using the largest ROI possible to englobe the lesion.



## RESULTS

To find statistical correlation between tumors' cellularity and recurrence, we discriminated CT densities (in HU) and ADC mean values (in  $10^{-3}$  mm<sup>2</sup>/s) and the patient's outcome in "recurrence" and "non-recurrence". We applied two different analyses: Pearson's correlation test found that there is correlation between CT density and tumor recurrence, classified as moderated and directly proportional. Also, there is correlation between ADC mean value and tumor recurrence, classified as moderated and inversely proportional ( $r = + 0.49$ ,  $p < 0.05$ ). Logistic regression also demonstrates correlation between CT density and tumor recurrence, and between ADC mean value and tumor recurrence ( $p = 0.01$ ;). This test demonstrated ROC curve 84.4% (sensitivity = 80%, specificity = 83.3%).

## CONCLUSION

Our analysis showed moderated correlation between tumor's presumed cellularity (reflected by higher CT density and lower ADC mean value) and meningiomas' recurrence.

## CLINICAL RELEVANCE/APPLICATION

Measuring CT densities and ADC mean values, especially before surgical exploration, can be used as tools to predict meningiomas' recurrence. Tumors with higher cellularity can be submitted to follow-up exams more often than the others.

## **T5A-SPNR- Diffusion Kurtosis Imaging in Detecting Changes in the White Matter of the Brain Non-visible on Conventional MRI in Patients with Brain Gliomas**

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Aram Tonoyan, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Ki-67/MIB-1 labeling index (LI) characterizes cellular proliferation and is used in glioma grading and predicting glioma prognosis (Louis et al., 2021; Louis et al., 2007). Some researchers consider diffuse gliomas as a systemic disease of the brain rather than a local tumor. Application of antibodies specific to the R132H protein, which is present in cells of gliomas with IDH-1 mutation and absent in normal neuroglial cells, showed the presence of tumor cells in brain regions significantly distant from the glioma, including the opposite brain hemisphere (Agarwal et al., 2011; Sahm et al., 2012). The aim of this study was to assess the ability of diffusion kurtosis imaging (DKI) to find a correlation between Ki-67/MIB-1 LI of gliomas and diffusion kurtosis parameters in the normal-appearing on conventional MRI white matter of the opposite hemisphere of the brain.

## METHODS AND MATERIALS

84 patients with newly diagnosed brain gliomas underwent 3T MRI before treatment. In all cases, the diagnosis was confirmed by biopsy or surgical resection. 49 patients had high-grade gliomas (HGG), and 35 patients had low-grade gliomas (LGG). The age of patients with HGG was  $43.8 \pm 14.7$ , and with LGG was  $37.7 \pm 9.6$ . DKI was performed using b values of 0, 1000, and 2500 s/mm<sup>2</sup> and 60 gradient directions. The following parameters were obtained using DKI: mean kurtosis (MK), axial kurtosis (AK), radial kurtosis (RK), kurtosis anisotropy (KA), mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD), fractional anisotropy (FA), relative anisotropy (RA). The Spearman correlation coefficient was calculated between Ki-67/MIB-1 LI of gliomas and diffusion kurtosis parameters in the normal-appearing on conventional MRI white matter of the opposite hemisphere of the brain ( $p < 0.05$  significance level). Conventional MRI included T1, T1+Gd, T2, T2-FLAIR weighted images.

## RESULTS

Statistically significant correlation of glioma Ki-67/MIB-1 LI was found with (r = -0,28, ? = 0,01), RD (r = 0,3, ? = 0,02), FA (r = -0,27, ? = 0,003) and RA (r = -0,27, ? = 0,004) in the white matter of the opposite hemisphere of the brain. A decrease of RK ( $p < 0.05$ ) and an increase of RD ( $p < 0.05$ ) in the white matter of the opposite hemisphere of the brain with higher Ki-67/MIB-1 LI of gliomas can be due to the decreased axonal density. A decrease of both FA ( $p < 0.05$ ) and RA ( $p < 0.05$ ) with higher Ki-67/MIB-1 LI of gliomas can reflect higher cellularity and decreased axonal density in the contralateral white matter.

## CONCLUSION

DKI demonstrated a potential to detect changes in the white matter of the brain non-visible on conventional MRI in patients with gliomas.

## CLINICAL RELEVANCE/APPLICATION

Understanding the changes occurring in brain areas distant from the tumor is crucial for treatment and patient care.

## **T5A-SPNR- Covariance Structural Abnormalities: The Key Networks of Heterogeneous Mild Traumatic Brain Injury - A Result from Longitudinal Study with EZ-MAP for Detection of Regional FA Abnormalities**

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Yanan Zhu (*Presenter*) Nothing to Disclose



## PURPOSE

To explore the covariance structural abnormalities of heterogeneous mild traumatic brain injury (mTBI) at subacute phase and 1-3 months, 6-12 months post-injury.

## METHODS AND MATERIALS

: Diffusion tensor imaging tractography of whole brain and conventional MR were performed in 72 mTBI patients of subacute phase, 27 mTBI patients of 3 months and 21 mTBI patients of 6-12 months post injury. 46 age- and gender-equivalent healthy controls were also involved, 10 healthy controls and 11 healthy controls were scanned respectively 1 month, 6-12 months later. Voxelwise assessment methods of Enhanced Z-score Microstructural Assessment of Pathology (EZ-MAP) were used to detect regional FA abnormalities in each patient's fractional anisotropy (FA) maps. All subjects were administered the following neuropsychological tests: the Mini-Mental state examination (MMSE), Hamilton Depression (HAMD), Fatigue Severity Scale (FSS), Clinical Dementia Rating (CDR), Postconcussive Symptoms Scale (PSS), the Trail Making Test A, the Trail Making Test B, State Trait Anxiety Inventory (STAI-Y). Pearson's correlation coefficients between the FA values of covariance location with clinical measurements at all 3 time points post injury were calculated.

## RESULTS

Respectively, 29.17% of subacute phase, 37.03% of 3 months post injury, 38.09% of 6-12 months post injury mTBI patients had abnormal brain MRI. During the period of post injury from subacute phase to 6-12 months, general pattern of reduced FA and /raised MD were present in various white matter tracts such as Body of corpus callosum, Splenium of corpus callosum, Fornix, Cerebral peduncle L, Anterior limb of internal capsule L, Posterior limb of internal capsule L, Anterior corona radiata L, Superior corona radiata L, Anterior limb of internal capsule R, Anterior corona radiata R, and Superior corona radiata R. In subacute phase, raised FA in Posterior limb of internal capsule L, Cerebral peduncle L, Anterior corona radiata R and Superior corona radiata R were in correlation with better clinical performance in MMSE, Traveling-A, and CDR.

## CONCLUSION

Covariance structural abnormalities were the key networks of heterogeneous mild traumatic brain injury, serving as indicator and predictor of mTBI.

## CLINICAL RELEVANCE/APPLICATION

To assess covariance structural abnormalities provided a new method to serve as indicator and predictor of heterogeneous mTBI.

## T5A-SPNR- Abnormal Functional Connectivity in Mild Traumatic Brain Injury at Subacute Phase and 1-3 Months Post-injury by Independent Component Analysis

Yanan Zhu (*Presenter*) Nothing to Disclose

## PURPOSE

To examine the resting state networks of homogeneous mTBI patients and investigate the dynamic changes of brain networks at both subacute phase and 1-3 months post-injury

## METHODS AND MATERIALS

: A total of 60 first-episode mTBI patients at subacute phase (within 21 days post-injury) were recruited from the Local Emergency Department, and 35 mTBI patients who conducted the follow-up 1-3 month post-injury were enrolled. 43 healthy volunteers who matched with age, sex, and educational level were recruited as normal controls. Neuropsychological tests and self-reported symptoms were assessed within 24 hours after MR scan for all the participants. Independent component analysis (ICA) was carried out by using Multivariate Exploratory Linear Optimized Decomposition into Independent Components (MELODIC) implemented in FSL. A dual regression approach was used to perform voxel-wise comparisons of functional connectivity between groups. the Pearson's correlation coefficients between the averaged Z score in regions and clinical measurements both at subacute and 1-3month post injury subgroup were calculated.

## RESULTS

Decreased functional connectivity within the default mode network (DMN) and increased network strengthen in the frontoparietal network (FPN) in mTBI patients at subacute phase were found, and the abnormality of the DMN function was specifically predicated by with the individual cognitive impairments. After 1-3months post-injury, increased connectivity in the DMN and decreased connectivity in the dorsal attention network (DAN) emerged. Reduced functional connectivity in the anterior cingulate cortex was correlated with aggravated syndrome of fatigue.

## CONCLUSION

Alterations of connectivity in multiple intrinsic networks exist early after and during recovery of injury, which may underlie the mechanisms of the reduced and improved performance in neurocognitive testing.

## CLINICAL RELEVANCE/APPLICATION

Whole brain functional connectivity, especially DMN, can serve as indicator and predictor to monitor disease progression or recovery of mTBI.

### **T5A-SPNR- Local and Global Functional Connectome Disruption in Patients with Gliomas** 7

Giulia Sprugnoli, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the disruption of functional connectome patterns in patients with brain tumors, based on resting-state functional magnetic resonance imaging (rs-fMRI) data in patients with gliomas.

#### **METHODS AND MATERIALS**

Fifty-four patients with newly diagnosed or recurrent gliomas were included (M = 34, Mean Age = 50.8 yr). Manual segmentation of solid lesions was performed on T1w and T2w MRI scans following RANO criteria. Rs-fMRI was acquired before surgery on a 3T scanner. Whole-brain network measures of centrality, modularity, integration and segregation were computed for a set of Regions of Interest (ROIs) including the Harvard Oxford (HO) anatomical atlas and tumor-related ROIs (i.e., edema, solid tumor, necrotic core). A  $p < 0.05$ , two-sided, FDR corrected threshold was used for statistical analysis; analysis was performed on connectivity matrices representing multiple sparsity levels ranging from 50% to 100%.

#### **RESULTS**

In newly diagnosed patients (n = 18), we found a decrease of Integration (Degree, Global Efficiency) and Centrality (Betweenness centrality), and an increase of Segregation (Clustering Coefficient) in the tumor ROIs respect to healthy brain regions. Such an integration/segregation imbalance pattern seems to follow a gradient moving from the edema to the solid tumor and the necrotic core (i.e., less altered in the edema, more altered in the necrotic core). In the entire "Network" composed by all the brain regions of the HO atlas plus all the tumor ROIs, its indexes fit between those of the healthy grey matter (frontal poles, blue bars) and the tumor ROIs, confirming the relevance of the alteration induced by the tumor across the whole brain functioning system. In patients at recurrence (n = 36), the same pattern was found, though with a less clear separation between tissue classes within the tumor. This might be due to an altered environment caused by functional plastic rearrangement and the neurocognitive effects of multiple interventions (i.e., surgery, chemotherapy, radiation damage).

#### **CONCLUSION**

We found significant alteration of functional connectome measures in brain regions affected by the tumor (i.e., tumor mass, necrotic core and edema), with a decrease of network integration and an increase of network segregation measures. Notably, a linear change in integration/segregation ratio was observed from the necrotic core to the edema, possibly reflecting tumor progression and therefore possibly capturing neuronal damage.

## CLINICAL RELEVANCE/APPLICATION

Connectome-level markers of glioma functional behavior could deepen our understanding of glioma pathophysiology, provide insight on neurocognitive sequelae, as well as be investigated as a potential marker of tumor progression.

### **T5A-SPNR- Value of Contrast-Enhanced T1 WI Histogram Analysis in the Differential Diagnosis of** 8 **Prolactin and Non-Prolactin Pituitary Macroadenomas**

Wei Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Based on the World Health Organization's classification for pituitary neuroendocrine tumors in 2022, this study aims to investigate the value of contrast-enhanced T1 weighted imaging (CE-T1WI) histogram analysis in distinguishing prolactin pituitary macroadenomas and non-prolactin pituitary macroadenomas.

#### **METHODS AND MATERIALS**

A retrospective analysis was conducted on data from 10 patients with prolactin pituitary macroadenomas and 13 patients with non-prolactin pituitary macroadenomas who were diagnosed by histopathology. All procedures of this study were approved by the Ethics Committee of our hospital. Written informed consent was obtained from all patients. The 3D Slicer software was used to draw the region of interest (ROI) of the tumor at the best plane, followed by gray-level histogram analysis to extract seven histogram parameters including Perc.10%, Perc.90%, kurtosis, mean, median, maximum and minimum values. Independent sample T-tests or Mann-Whitney U-tests were used to compare metric data between the two groups. Receiver operating characteristic (ROC) curves were plotted, and the area under the curve (AUC) was calculated to evaluate the diagnostic performance of the relevant parameters in distinguishing prolactin pituitary macroadenomas from non-prolactin pituitary macroadenomas.

## RESULTS

In CE-T1WI histogram parameters, Perc.10%, mean, minimum value, and total parameters showed significant differences between the two groups of tumors with P values of 0.014, 0.0347, 0.0057, and <0.001, respectively. Table 1 presented the mean values and standard deviations of each parameter in the two groups. The area under the ROC curve, sensitivity, and specificity for each parameter were 0.808 (0.700, 0.923), 0.769 (0.700, 0.923), and 0.892 (0.800, 0.846), respectively, indicating good diagnostic accuracy. The AUC for the total parameter model was 0.954 (0.800, 1.000), significantly higher than that of individual parameters, suggesting that the combination of multiple parameters can improve the diagnostic accuracy.

## CONCLUSION

CE-T1WI histogram analysis has certain value in the differential diagnosis of prolactin pituitary macroadenomas and non-prolactin pituitary macroadenomas, and can be used as an auxiliary method for distinguishing pituitary nerve prolactinomas.

## CLINICAL RELEVANCE/APPLICATION

Since prolactin pituitary macroadenomas can be treated with medication only, while non-prolactin pituitary macroadenomas require surgery, which can be invasive, accurately differentiating between the two can help avoid unnecessary surgical trauma.

## T5A-SPNR- Effective Atomic Number as a Novel Quantitative CT Imaging Marker for Differentiating Glioblastomas, Brain Metastases and Primary Central Nervous System Lymphomas

Tsubasa Nakano (*Presenter*) Nothing to Disclose

## PURPOSE

To determine whether dual-energy CT parameters including effective atomic number ( $Z_{\text{eff}}$ ) and electron density (ED) could be quantitative imaging markers for differentiating glioblastomas (GBMs), brain metastases and primary central nervous system lymphomas (PCNSLs).

## METHODS AND MATERIALS

This study included 102 consecutive patients with pathologically proven GBMs ( $n = 56$ ), metastases ( $n = 23$ ) and PCNSLs ( $n = 23$ ). For all patients, preoperative non-contrast dual-energy CT examination was performed using a spectral detector CT scanner. Images of conventional CT (CTconv), ED,  $Z_{\text{eff}}$  were obtained. These CT images and MR images (T2WI, FLAIR, ADC map and post-contrast T1WI) were co-registered using SPM12. For each lesion, semiautomatic tumor segmentation was performed to delineate contrast enhanced area of tumors using ITK-SNAP, and VOIs were placed on each image. The mean CTconv, ED,  $Z_{\text{eff}}$  and ADC values were compared between 3 groups using Mann-Whitney U test. ROC curve analysis was performed to assess the diagnostic abilities of each parameter and their combinations.

## RESULTS

$Z_{\text{eff}}$  showed significant difference across all three groups, whereas ED showed no significant between-group differences. CTconv and ADC showed significant differences between GBMs and PCNSLs and between metastases and PCNSLs, but not between GBMs and metastases. Between GBMs and metastases, only  $Z_{\text{eff}}$  showed significant difference ( $P = 0.02$ ), and the area under the ROC curve (AUC) for their differentiation was 0.667. In discriminating between metastases and PCNSLs,  $Z_{\text{eff}}$  showed the best diagnostic performance (AUC = 0.827), followed by ADC (0.761) and CTconv (0.701). The AUC further improved up to 0.921 when  $Z_{\text{eff}}$  was combined with ADC. Between GBMs and PCNSLs, the AUCs were 0.744, 0.681 and 0.798 for CTconv,  $Z_{\text{eff}}$  and ADC, respectively. Although  $Z_{\text{eff}}$  had lower diagnostic performance compared to CTconv and ADC, AUC improved up to 0.829 with the combination of CTconv,  $Z_{\text{eff}}$  and ADC.

## CONCLUSION

Our preliminary results suggested that  $Z_{\text{eff}}$  can be a novel quantitative CT imaging marker that captures inherent characteristics of the tumors which are not reflected in conventional images, and it may be useful for differentiating GBMs, brain metastases and PCNSLs.

## CLINICAL RELEVANCE/APPLICATION

The effective atomic number can be a novel quantitative CT imaging marker for differentiating GBMs, brain metastases and PCNSLs.

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## Abstract Archives of the RSNA, 2023

T5A-SPOB

### OB/Gynecology Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPOB- Does Abdominal Fat Distribution Impact Endometrial Cancer Prognosis**

1

Kristine E. Fasmer, PhD, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To quantify abdominal fat distribution from clinically acquired computed tomography (CT) scans at primary diagnosis and at follow-up in a large endometrial cancer (EC) cohort, and to explore its relation to disease progression and prognosis.

#### **METHODS AND MATERIALS**

From CT images of 293 EC patients at primary diagnosis ( $n_{\text{primary}}$ ), total- (TAV), subcutaneous- (SAV), visceral abdominal fat volume (VAV), and visceral-to-total abdominal fat ratio (VAV/TAV) were derived using iNtuition (TeraRecon Inc., USA). The obesity markers were assessed in relation to body mass index (BMI) using Spearman's rank order correlation ( $\rho$ ), and to tumor histology from surgical specimen (endometrioid EC (EEC) grade 1-3, non-endometrioid EC (NEEC)) using Mann-Whitney U test. Time-dependent receiver operating characteristic curves, and Cox hazards ratios (HRs) were used to assess the obesity markers in relation to progression-free survival (PFS). Delta ( $d$ ) fat changes from primary diagnosis to follow-up 13 (2-41) [median (range)] months after diagnosis, were derived for 152/263 patients ( $n_{\text{follow-up}}$ ) with follow-up CT.  $d$ TAV,  $d$ VAV,  $d$ SAV, and  $d$ (VAV/TAV) were compared for patients with progression versus patients with no signs of progression, using Mann-Whitney U-test.

#### **RESULTS**

At primary diagnosis ( $n_{\text{primary}}=293$  patients), TAV, VAV, and SAV were all highly correlated to BMI ( $\rho=0.78$ ), while VAV/TAV ratio was not ( $\rho=-0.12$ ). Patients with high-risk histology (EEC grade 3/NEEC) had significantly lower TAV, SAV, and BMI ( $p=0.03$ ), while higher VAV/TAV ratio ( $p=0.001$ ) than patients with low-risk histology (EEC grade 1-2). High VAV/TAV ratio ( $=36\%$ ) predicted poor PFS both in univariable analysis (HR=2.4,  $p=0.04$ ), and when stratified for surgicopathologic International Federation of Gynecology and Obstetrics (FIGO) stage I-IV (HR=2.8,  $p=0.02$ ). At follow-up ( $n_{\text{follow-up}}=152$  patients), median TAV, VAV, and SAV were significantly lower than at primary diagnosis ( $p<0.001$  for all), while no significant difference was observed for VAV/TAV ratio ( $p=0.31$ ). Patients experiencing progression had a larger reduction in visceral fat compartments ( $d$ VAV=-19%,  $d$ VAV/TAV=-2%), than patients with no signs of progression ( $d$ VAV=-11%,  $d$ VAV/TAV=0%,  $p=0.04$  for both).

#### **CONCLUSION**

High VAV/TAV ratio, measured at primary diagnosis, is associated with high-risk histology and reduced survival in EC. Patients experiencing disease progression have a more pronounced reduction in visceral fat volume than patients with no signs of progression at follow-up.

#### **CLINICAL RELEVANCE/APPLICATION**

Abdominal fat distribution markers from preoperative abdominal CT predict endometrial cancer prognosis, and higher visceral fat loss during/following therapy is associated with disease progression.

#### **T5A-SPOB- Early Treatment Response is Captured by Whole-tumor MRI Radiomics in Patient-derived Organoid Endometrial Cancer Models**

2

Kristine E. Fasmer, PhD, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiomics can capture microscale information in medical images beyond what is visible to the naked human eye. Using a clinically relevant mouse model for endometrial cancer, the purpose of this study was to develop and validate a radiomic

signature (RS) predicting response to standard chemotherapy.

## **METHODS AND MATERIALS**

Mice orthotopically implanted with a patient-derived grade 3 endometrioid endometrial cancer organoid model (O-PDX) were allocated to chemotherapy (combined paclitaxel/carboplatin, n=11) or saline/control (n=13). During tumor progression, the mice underwent weekly T2-weighted (T2w) MRI. Segmentation of primary tumor volume (vMRI) allowed radiomic feature extraction from whole-volume tumor masks. A radiomic prediction model employing least absolute shrinkage and selection operator (LASSO) statistics for predicting treatment group (chemotherapy vs. control) was derived using endpoint images in the orthotopic O-PDX, and subsequently applied on the earlier study timepoints (RS\_O at baseline, and week 1-3). For external validation, the radiomic prediction model was further tested in a separate T2w-MRI dataset on segmented whole-volume subcutaneous tumors (RS\_S) from the same O-PDX model, imaged at three timepoints (baseline, day 3 and day 10/endpoint) after start of chemotherapy (combined paclitaxel/carboplatin) (n=8 tumors) or saline/control (n=8 tumors).

## **RESULTS**

The RS\_O yielded rapidly increasing area under the receiver operating characteristic curves (AUCs) for predicting treatment groups, from baseline until endpoint; AUC=0.38 (baseline); 0.80 (week 1), 0.85 (week 2); 0.96 (week 3) and 1.0 (endpoint). In comparison, vMRI yielded AUCs of 0.37 (baseline); 0.69 (week 1); 0.83 (week 2); 0.92 (week 3) and 0.97 (endpoint). When tested in the external validation dataset, RS\_S yielded high accuracy for prediction of treatment group at day 10/endpoint (AUC=0.85), and tended to yield higher AUC than vMRI (AUC=0.78, p=0.18). Neither RS\_S nor vMRI predicted treatment groups at day 3 in the external validation set (AUC=0.56 for both).

## **CONCLUSION**

We have developed and validated a radiomic signature that was able to capture treatment response prior to a decrease in tumor volume. This study supports the promising role of preclinical imaging with radiomic tumor profiling to detect early treatment response in cancer models.

## **CLINICAL RELEVANCE/APPLICATION**

Radiomic MRI signatures capture treatment response prior to visible decrease in tumor volume in a preclinical endometrial cancer model and represent a promising approach for capturing early treatment response.

## **T5A-SPOB- Magnetic Resonance Imaging of Primary Ovarian Carcinosarcoma: Is the "Mille-feuille Sign" Useful in Diagnosis**

Yuriko Watanabe, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Primary ovarian carcinosarcoma (POC) is a rare and aggressive variant of ovarian cancer with a poorer prognosis than that of high-grade serous ovarian cancer. Thus, preoperative imaging diagnosis is crucial; however, few reports on MRI of POC exist. Kurokawa et al. proposed a new morphologic classification of ovarian tumors on imaging and reported that the mille-feuille sign, with a layered structure in the cystic tumor, indicates ovarian metastasis from colorectal carcinoma with high specificity and is useful in the differential diagnosis of primary ovarian carcinoma (Eur J Radiol. 2020; 124: 108823). In this presentation, we analyzed the MRI findings of 12 cases of POC and investigated the imaging features, including a new morphologic classification.

## **METHODS AND MATERIALS**

MRI scans of 12 POC patients were obtained. The following features were evaluated: (1) tumor size; (2) ADC values of the solid component; (3) intratumoral hemorrhage; (4) signal intensities compared to the skeletal muscle and heterogeneity of the solid component on T2WI; (5) heterogeneity of enhancement of the solid component on Gd-enhanced T1WI; and (6) tumor morphology on T2WI and Gd-enhanced T1WI, according the following four categories: "mille-feuille sign," "solid and cystic," "multicystic without nodules," and "multicystic with nodules." Among (3)-(6), three radiologists who were blinded to prior clinical information were evaluated. In case of disagreement among the readers, the diagnosis was determined through a majority decision. Interobserver agreement for subjective image quality was calculated using the Fleiss' kappa statistic.

## **RESULTS**

(1) tumor size: mean, 133.7±127.5 mm, (2) ADC values: mean, 0.80±0.26×10<sup>-3</sup> mm<sup>2</sup>/s, (3) intratumoral hemorrhage: 11/12 (?=0.54), (4) heterogeneously high intensity: 12/12 (?=1), (5) heterogeneous enhancement: 12/12 (?=1), (6) tumor morphology on T2WI: solid and cystic (n=10) and mille-feuille sign (n=2) (?=0.56), tumor morphology on Gd-enhanced T1WI: solid and cystic (n=7) and mille-feuille sign (n=5) (?=0.89).

## **CONCLUSION**

POC shows relatively large ovarian tumors with hemorrhage, heterogeneous solid components, and low ADC values. Gd-enhanced T1WI showed solid and cystic or mille-feuille signs with excellent interobserver agreement. We considered the mille-feuille sign as a suspicious finding for POC in addition to ovarian metastasis from colorectal carcinoma.

## CLINICAL RELEVANCE/APPLICATION

Primary ovarian carcinosarcomas (POCs) are aggressive and have a poor prognosis; therefore, preoperative imaging diagnosis is crucial. The "mille-feuille sign" on Gd-enhanced T1WI can be useful to suspect POC preoperatively.

## T5A-SPOB- Habitat-based Radiomics Enhances the Ability to Predict Lymphovascular Interstitial Infiltration in Cervical Cancer: A Multicenter Study

Jingshan Gong, MD (*Presenter*) Nothing to Disclose

### PURPOSE

As lymph-vascular space invasion (LVSI) was closely related to lymph node metastasis and prognosis, the preoperative assessment of LVSI in cervical cancer is crucial for patients. As such, we investigated the potential of habitat analysis as a novel tumor biomarker in predicting LVSI in cervical cancer.

### METHODS AND MATERIALS

This retrospective study of 300 patients with cervical cancer who had received surgical treatment at two institutions, with data from institution 1 as the training (n = 198) cohort and institution 2 as the validation (n = 102) cohort. Based on the voxel and entropy values of CE-T1WI images clustered by K-means method, the VOI was divided sub-regions and the radiomics features were extracted from the sub-regions respectively. Pearson correlation coefficient and LASSO regression methods were used for feature selection. Pearson correlation coefficient and LASSO regression methods were used for feature selection. The SVM machine learning model was used to construct prediction models for each sub-region radiomics features and the model effects were evaluated by an external test cohort.

### RESULTS

The voxels and entropy values of CE-T1WI images are clustered into 3 sub-regions. In the training cohort, AUCs of the SVM models based on the radiomics features derived from all tumor, Habitat1, Habitat2 and Habitat3 were 0.805 (95% CI: 0.745 - 0.864), 0.873(95% CI: 0.824 - 0.922), 0.869 (95% CI: 0.821 - 0.917) and 0.870(95% CI:0.821 - 0.920), respectively. Comparing with all tumor, the predictive performances of Habitat1-3 were higher with statistical significant. The Habitat3 model archived the highest AUC in the external test cohort (0.780 [95% CI: 0.692 - 0.869]). The difference was not statistical significant (p=0.073). The accuracy, sensitivity, specificity, positive predictive value and negative predictive value for LVSI were 0.745, 0.741, 0.75, 0.769 and 0.720, respectively.

### CONCLUSION

A tumor sub-regional habitat-based radiomics model could obtain higher predictive performance for LVSI in cervical cancer the radiomics derived from all tumor, which might be a potential noninvasive approach to facilitate treatment decision-making in clinical settings

## CLINICAL RELEVANCE/APPLICATION

Pretreatment acknowledge of LVSI status in patients with cervical cancer can facilitate personalized therapeutic strategy. The current work provided a noninvasive approach for assessing LVSI without radiation, which is very important for the women of childbearing age, who have the intention for fertility preservation.

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## Abstract Archives of the RSNA, 2023

T5A-SPPD

### Pediatric Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPPD- Abnormal Brain Functional Connectivity in Children with Spastic Cerebral Palsy: A Resting-state Functional Magnetic Resonance Imaging Study**

Ying Peng (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cerebral palsy (CP) is the most common dyskinesia syndrome in children, and spastic cerebral palsy (SCP) is the most common clinical type. Existing neuroimaging studies have found that there are extensive structural and functional changes in children with SCP. However, few studies focus on the intrinsic functional features of network organization throughout the brain. Therefore, the purpose of this study was to use degree centrality (DC) analysis at the voxel level to characterize the potential pattern of intrinsic connectivity disorders in the whole brain functional network in children with SCP.

#### **METHODS AND MATERIALS**

34 children with SCP and 17 demographically matched healthy controls (HCs) participated in the study. All subjects were evaluated for gross motor function and hand function, and underwent resting state functional magnetic resonance imaging. DC is a graph theory-based measure that represents the total number of functional connections between a voxel and other voxels. We used DC analysis and seed-based functional connectivity (FC) analysis to identify abnormal FC.

#### **RESULTS**

The DC values of the left supplementary motor area (SMA), bilateral medial cingulate gyrus (MCC) and left precuneus were significantly lower than the HCs group. Further seed-based FC analysis showed that, compared with the HCs group, when seed was located on the left SMA, the SCP group showed decreases connections with the left anterior cingulate gyrus, parahippocampal gyrus, ventrolateral prefrontal cortex and right anterior cingulate gyrus, thalamus, amygdala, and putamen. When seed was located in the left precuneus, the SCP group showed decreases connections with the left thalamus, right hippocampus, precuneus, lingual gyrus, and putamen. When seed was located in the left MCC, the association with the left insula, precuneus, medial prefrontal cortex, right putamen and thalamus was reduced in the SCP group. When seed was located in the right MCC, the association between the left cuneus and the right lingual gyrus, precuneus and thalamus was reduced in the SCP group. Correlation analysis showed that the FC between the left SMA and the right putamen was negatively correlated with the hand function evaluation grade.

#### **CONCLUSION**

The brain functional network in children with SCP had extensive internal connectivity disorders, including the damage of the default brain network, the central executive network and the salient network in addition to the sensorimotor network.

#### **CLINICAL RELEVANCE/APPLICATION**

The changes of brain functional network provide a basis for understanding the pathophysiological mechanism of SCP motor and cognitive impairment, and may provide a new therapeutic target for the treatment of children with SCP.

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## Abstract Archives of the RSNA, 2023

T5A-SPPH

### Physics Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPPH- 1 Assessing Coronary Artery Calcium Scoring in Lung Cancer Screening: A Dynamic Cardiac Phantom Study**

Chao Guo, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Calcification of coronary arteries is strongly associated with cardiovascular diseases. Low dose lung cancer screening (LCS) is gaining popularity in practice. For asymptomatic patients, the feasibility of using LCS scans for coronary artery calcium scoring (CACs) has not been explored apart from incidental findings. We aimed to quantify the calcium score using LCS scans in comparison with the ground truth obtained by ECG gated CACs.

#### **METHODS AND MATERIALS**

The CIRS Dynamic Cardiac Phantom was utilized with 12 calcification inserts of various density (50, 100, 250 and 400 mg/cc) and diameters (1.2, 3 and 5 mm). Scans were performed with simulated ECG with the heart rate from 50 to 100 beats per minute, using the non-gated LCS (CTDIvol = 0.17 mGy) and gated CACs (CTDIvol = 1.74 mGy) protocols. The gated CACs scans served as the ground truth. A FOV of 200 mm was used throughout this study. Additionally, 4 seconds breath motion was added during the LCS scan for comparison purposes. Siemens SyngoVia was used to score the calcifications by individual readers.

#### **RESULTS**

The visibility of calcium inserts from LCS scans were affected by cardiac motion, which caused blurring and distortion, particularly for small-diameter inserts. As compared with the ground truth, Agatston scores were found lower by 39.5% to 56.7% depending on the heart rate. Within the non-gated scans, the added breathing motion generated additional score difference up to 17.6%. It was found that the calcification detectability is sensitive to the insert density. Calcifications of density higher than 250 mg/cc were detectable. However, inserts with densities 100 mg/cc or lower were not detectable at any heart rate.

#### **CONCLUSION**

As compared to the ground truth, CAC score using non gated LCS scans is underestimated by 39.5% to 56.7%. It was found that calcium density exceeds 250 mg/cc was detectable. However, calcifications with a density lower than 100 mg/cc cannot be scored with CACs and LCS protocols, regardless of heart rate. Although heart rate may affect the calcium scoring, major calcifications can still be accurately assessed with a significant reduction in patient dose.

#### **CLINICAL RELEVANCE/APPLICATION**

Using coronary artery calcium scoring as a screening tool has the potential to detect major coronary artery events. Incorporating it into lung cancer screening exams could provide an opportunity for further simultaneous diagnosis.

#### **T5A-SPPH- 10 CNN-Based Metal Artifact Reduction Method with Mask for Planning CT in Radiation Treatment**

Won Jin Lee, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

For radiation treatment of cancer, CT scans are essential. Metal artifacts are generated during CT scans by metal objects inserted into the body for various reasons, which make accurate dose calculation for radiation therapy impossible. Recently, many metal artifacts reduction methods applying deep learning have been proposed. However, compared to other human body parts, metal artifacts are not effectively removed by the existing methods in the head neck area, which has a relatively



complex structure and has strong artifacts due to the insertion of dental filling and implant. In this study, we proposed a CNN-based deep learning model using a pre-trained mask extraction model that reduces strong metal artifacts in the head neck area.

## **METHODS AND MATERIALS**

The training process was divided into two steps. In first step, a model to extract masks including bone and metal was trained using supervised contrastive learning(SCL) with 30 patients. The tissue pixel distribution includes more of patient's identity and effects of metal artifacts than the bone pixel distribution. Therefore, a bone mask was obtained by separating the tissue distribution from the bone distribution through SCL. In second step, a model for reducing metal artifacts was trained with 85 patients. Metal and bone have a wide pixel range, while tissues concentrate in narrow range of values, resulting in a more than ten-fold difference in the MSE for each area. Therefore, Instead of calculating the loss for the entire image including bones, metal, and tissues, a masked MSE was applied using the bone mask extracted in the first step. As a result, a weighted masked MSE was applied to remove metal artifacts from both tissue and bone.

## **RESULTS**

In the evaluation metrics for the synthetic dataset, our proposed model showed average scores of MSE, SSIM, PSNR, and PCC of 0.000106, 0.9986, 42.4130, and 0.9944. Overall evaluation values ??showed improved results than baseline and others. In the qualitative results, the proposed model showed higher performance compared to a commercial software and other models in real-world data.

## **CONCLUSION**

In this study, we proposed a CNN-based metal artifacts reduction model with weighted masked MSE. Our proposed model demonstrated the best performance on both generated and real-world data, effectively removing strong artifacts near metal as well as stripe-shaped artifacts located far from metal.

## **CLINICAL RELEVANCE/APPLICATION**

Our proposed model effectively resolves severe artifacts in complex structures such as head neck regions. Therefore, the proposed model is expected to be applied to CT metal artifact reduction in radiation treatment planning process, especially dose calculation for patients with metal implants inserted in the head neck where strong artifacts appear.

## **T5A-SPPH- Reconstruction of Fast Acquisition MRI with Under-sampled K-space Data by Using Massive-11 Training Artificial Neural Networks (MTANNs)**

Kenji Suzuki, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Accelerated MRI acquisitions by taking fewer samples in the K-space involves a trade-off between image quality degradation and acquisition time. We aimed to reduce artifacts in MR images reconstructed from under-sampled k-space data in fast-acquisition MRI by using our MTANN deep learning.

## **METHODS AND MATERIALS**

We developed a scheme consisting of several iterable cross-domain massive-training artificial neural network (MTANN) modules, namely, an MTANN in the image space (iMTANN) with multiple kernels and multiple frequency-specific MTANNs in the K-space (kMTANNs) to improve the image quality in both spaces in fast acquisition MRI with under-sampled k-space data. A public dataset used in this study contains 20 full k-space volumes of 795 images. Simulated accelerated under-sampled (1/8) MR images were created with a universal sampling pattern. Our MTANN model was trained with the simulated under-sampled MR data as input and the corresponding fully-sampled MR data as "teaching" images.

## **RESULTS**

To evaluate the image quality quantitatively, we used the structural similarity index (SSIM) and mean squared error (MSE) between the predicted MR and fully-sampled MR images. Compared with the state-of-the-art XPDNet, the SSIM and MSE for our scheme were improved from 0.885 and 31.95 to 0.900 and 23.97, respectively. The differences were statistically significant ( $P < 0.05$  in paired t-tests). In the comparison experiment, our hybrid MTANN preserved the anatomical structure of the knee better than XPDNet. XPDNet changed the appearance of the original anatomical structures, causing significant errors in the reconstruction of MR images, whereas our hybrid MTANN removed the artifacts substantially while preserving those important anatomical structures from the under-sampled MR images.

## **CONCLUSION**

Our hybrid MTANN improved the image quality by reducing truncation artifacts substantially in 8-times faster acquisition MRI, while anatomic structures were preserved well.

## **CLINICAL RELEVANCE/APPLICATION**

Our scheme was able to shorten the acquisition time of MRI by a factor of 8, while preserving important anatomical structures, which improves the throughput of MR exams.

## **T5A-SPPH- 12 Feature Map Visualization for Explaining Black-Box Deep Learning Model in Liver Tumor Segmentation**

Ze Jin, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

A chief limitation of current artificial-intelligence (AI)-aided diagnosis is the lack of transparency in a black-box deep learning model in the AI system, it would lose radiologists' trust in AI decisions. To address this issue, we developed an explainable AI (XAI) method to visualize the functions of groups of hidden units in a massive-training artificial neural network (MTANN) model for liver tumor segmentation in CT.

### **METHODS AND MATERIALS**

The dataset used in this study came from the public LiTS database which contained dynamic contrast-enhanced CT scans. Seven and 24 cases were selected for training and testing, respectively. To segment liver tumors, a patch-based MTANN model was trained with input liver CT images and corresponding "gold-standard" manual liver segmentation by radiologists as "teaching" images. Our proposed sensitivity-based structure optimization algorithm was applied to the trained model to obtain a compact yet comparable model from a larger one by removing "redundant" hidden units of the model. After the optimization, we grouped the hidden units into several groups of similar functions by using an unsupervised hierarchical clustering algorithm. In this way, the functions of the model were characterized by visualizing the feature maps of each group. Light, gray, and dark pixels in the feature maps indicated enhancement, doing nothing, and suppression, respectively.

### **RESULTS**

We used a Dice score to compare the performance of the models. The initial MTANN model with 80 hidden units (Dice = 0.714) was optimized with our algorithm and resulted in a compact model with 9 hidden units (Dice=0.701). These 9 hidden units were clustered into three groups by using the clustering algorithm according to a distance function among the weighted feature maps of the hidden units. Their functions were revealed and explainable by visualizing the feature maps as follows: (a) enhancing the liver area, (b) suppressing non-tumor areas, and (c) suppressing the liver's boundary and reducing the false positive pixels inside the liver. In addition, our experimental analysis by tumor sizes did not change the functions of three groups, demonstrating the robustness of our method. The modified model using only groups A and B achieved a higher performance in tumor segmentation, as they showed improved agreement with the tumor region boundary.

### **CONCLUSION**

This study demonstrated how our optimization and clustering algorithm could be used to understand and explain the functions of the MTANN model in liver tumor segmentation. It provided a valuable tool to analyze the behavior of black-box models better.

### **CLINICAL RELEVANCE/APPLICATION**

Our XAI method aiming to improve the transparency of an MTANN deep learning model would help radiologists gain their trust in AI's decisions.

## **T5A-SPPH- 13 Weakly Supervised Deep Learning Model for Automatically Delineating the Skeleton and Soft Tissue Organs from Whole-Body Diffusion Weighted Imaging (WBDWI)**

Antonio Candito, PhD, MSc (*Presenter*) Nothing to Disclose

### **PURPOSE**

WBDWI is a non-invasive, radiation-free, and quantitative technique for staging and therapy response assessment in patients with malignant bone lesions and metastatic visceral disease. The technique offers excellent contrast between disease and tissue background and allows measuring the Total Diffusion Volume (TDV in millilitres) and the Apparent Diffusion Coefficient (ADC), a surrogate imaging biomarker of tumour cellularity. However, clinicians still need to perform tedious and time-consuming delineations to obtain these biomarkers. Therefore, the development of automated segmentation tools is desirable. As an initial step, we have developed a supervised deep learning model from "weak annotations" for automatically delineating the skeleton and soft tissue from WBDWI data.

### **METHODS AND MATERIALS**

A 3D patch-based U-Net model was developed for delineating ten body regions from WBDWI: six skeleton regions (long bones, pelvis, lumbar/thoracic/cervical spine, ribcage) and bladder, kidneys, liver and spleen. WBDWI multi-centre datasets were used to train and validate the U-Net model: a dataset of 189 patients with Advanced Prostate Cancer (APC with baseline and follow-up scans) and 35 patients with Multiple Myeloma (MM with only baseline scan). The network employed a 2-channel input (i) the ADC map and (ii)  $b=0$  s/mm<sup>2</sup> image, derived from the mono-exponential fitting of the diffusion data.

Annotations were automatically defined through a set of uncertainty maps (non-binary segmentations) derived from a computationally expensive atlas-based segmentation algorithm.

## **RESULTS**

The trained U-Net model was able to generate the body region segmentation maps within 20 seconds on CPU (2.4 GHz Quad-Core). On average, the dice score for skeleton regions on 15 test datasets was 0.62, with precision and recall of 0.67 and 0.72, respectively. Average dice score for soft tissue organs was 0.75, with precision and recall of 0.73 and 0.78, respectively.

## **CONCLUSION**

Our deep learning model could facilitate the development of signal-based automated tool for delineation and quantification of malignant bone lesions and metastatic visceral disease in patients with APC and MM.

## **CLINICAL RELEVANCE/APPLICATION**

Our model could assist clinicians in detecting and quantifying disease from WBDWI in patients with MM, APC, advanced breast and melanoma cancer, and, for screening subjects with high-cancer risk.

## **T5A-SPPH- Optimizing Image Quality in Breast Screening: A Medical Physics 3.0 Approach**

2

Niall Phelan, MS (*Presenter*) Nothing to Disclose

### **PURPOSE**

In order to maximize sensitivity and specificity in population based breast screening, image quality should be optimized but equally must be consistent for all women screened. Imaging optimization projects have largely been underpinned by equipment performance metrics, established by technical image quality and dose indicators from physics quality control (QC) tests. However, the correlation between phantom image quality and impact on the clinical outcome is poorly understood and tenuous in many cases. We have applied the principles of Medical Physics 3.0 to combine medical physics QC data with screening outcome data to drive optimization and consistency of technical quality in a national breast screening programme.

### **METHODS AND MATERIALS**

The screening programme data management system enables collection and analysis of performance data including cancer detection rate (CDR) by individual mammography system for quality audit and reporting. However the requirement to accumulate sufficient data means these reviews can only be done retrospectively. We have used CDR analysis of more than 2 million screening examinations as a proxy indicator for comparison of equipment performance, correlated with routine medical physics image quality tests to monitor and audit quality and consistency.

### **RESULTS**

Following a large scale imaging equipment replacement with two new mammography system types, we observed that while the performance of both systems was consistent with previous system types and exceeded programme standards for cancer detection, significant differences were observed between them. This result offered an opportunity to review and standardize technical performance to achieve consistency across the programme. Experimental imaging and simulation studies were carried out to determine improved automatic exposure control (AEC) system set-up which was then implemented across the programme by the vendor. Operational radiation dose increased but remained lower than European (EUREF) guidelines. Subsequent retrospective analysis demonstrated convergence of technical image quality and CDR for the two systems.

### **CONCLUSION**

Differences in mammography equipment technical performance were identified through medical physics QC monitoring and correlated with screening outcome data, providing an opportunity for successful optimization and quality improvement.

### **CLINICAL RELEVANCE/APPLICATION**

Using Medical Physics 3.0 principles to incorporate the use of aggregated screening data and clinical outcome measures in support of medical physics quality assurance processes has demonstrated potential to deliver optimization of quality for individual women and for the screened population.

## **T5A-SPPH- Diagnostic Value of Direct Lymphangiography in Primary Chyluria: A Retrospective Study**

3

Qi Hao (*Presenter*) Nothing to Disclose

### **PURPOSE**

To investigate the diagnostic value of direct lymphangiography (DLG) in primary chyluria.

### **METHODS AND MATERIALS**

Thirty-seven patients diagnosed as primary chyluria were recruited in this retrospective study. All patients were examined by DLG. The DLG examination was performed using the American GE Innova 2000-IQ DSA machine. According to the patient's

clinical condition, one side of the foot was selected for lipiodol injection, and if the patient had combined lower limb lymphedema, the healthy side of the foot was selected. The patient was placed in a supine position, and a mixture of methylene blue and 2% lidocaine (1:1) was injected intradermally and subcutaneously between the roots of the 1st to 3rd toes on one side of the foot about 1-2 ml. A blue-stained shallow lymphatic was found under the skin, and the lymphatic was entered by puncture with a lymphography needle, and a total of about 7-15 ml of lipiodol was injected at a flow rate of 6-8 ml/h. The lipiodol development and regurgitation were observed dynamically under DSA until the lipiodol entering at the end of the thoracic duct was revealed, and the observation time ranged from 1.5 to 4.0h. For DLG, the indexes were: Distribution, reflux and dilatation of abnormal lymphatic vessels in the urinary system, chest and abdomen. The DLG signs of primary chyluria patients were statistically described by composition ratio of classification variables.

## RESULTS

DLG showed ipsilateral iliac lymphatic tortuosity and dilatation in 30 cases (81.1%); contralateral iliac lymphatic reflux in 17 cases (45.9%); ipsilateral lumbar trunk tortuosity and dilatation and reflux in 19 cases (51.4%); contralateral lumbar trunk reflux in 21 cases (56.8%); ipsilateral pelvic sinus reflux in 17 cases (45.9%); contralateral pelvic sinus reflux in 21 cases (56.8%); thoracic duct reflux obstruction in 37 cases (100.0%); 7 cases (18.9%) of bronchial mediastinal trunk reflux, including 1 case (2.7%) of hilar reflux and 3 cases (8.1%) of intercostal reflux (Figure 11%); 4 cases (10.8%) of perineal reflux; 1 case (2.7%) of abdominal reflux; 21 cases (56.8%) of cervical trunk and subclavian trunk reflux.

## CONCLUSION

DLG is able to visualize lymphatic reflux and abnormal reflux dynamically, evaluate lymphatic vessel morphology accurately, and achieve a diagnostic rate of 81.8% for primary chyluria.

## CLINICAL RELEVANCE/APPLICATION

DLG can provide an important imaging basis for the diagnosis and preoperative evaluation of primary chyluria.

## T5A-SPPH- Retrospective Analysis of Doses Delivered during Embolization Procedures over the Last 10 Years

Joel Greffier, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

This study aimed to retrospectively analyze dosimetric indicators recorded since 2012 for thoracic, abdominal or pelvic embolizations to evaluate the contribution of new tools and technologies in dose reduction.

## METHODS AND MATERIALS

Dosimetric indicators (dose area product (DAP) and air kerma (AK)) from 1449 embolizations were retrospectively reviewed from August 2012 to March 2022. A total of 1089 embolizations were performed in an older fixed C-Arm system (A1), 222 in a newer fixed C-Arm system (A2) and 138 in a 4DCT system (A3). The embolization procedures were gathered to compare A1, A2 and A3.

## RESULTS

DAP were significantly lower with A2 compared to A1 for all procedures (median -50% +/- 5%,  $p < 0.05$ ), except for uterine elective embolizations and gonadal vein embolization. The DAP values were significantly lower with A3 than with A1 ( $p < 0.001$ ). CT scan was used for guidance in 90% of embolization procedures.

## CONCLUSION

This monocentric retrospective analysis of the doses delivered during thoracic, abdominal and pelvic embolization procedures over a 10-year period showed the contribution of the new IR tools in dose reduction and patient management. The last C-arm technology reduced the image noise and improved image quality, allowing a 50% reduction of the air kerma and showing a significant dose reduction. The implementation of a CT scan inside the IR room allowed a more precise 3D guidance without increasing the dose delivered to the patients.

## CLINICAL RELEVANCE/APPLICATION

The last C-arm technology reduced the image noise and improved image quality, allowing a 50% reduction of the air kerma and showing a significant dose reduction. The implementation of a CT scan inside the IR room allowed a more precise 3D guidance without increasing the dose delivered to the patients.

## T5A-SPPH- Relationship between Presurgical DTI Motor Tract Maps and Intraoperative Evoked Potentials

Juan Jose Sanchez Fernandez, DPhil, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To study the accuracy of DTI in the presurgical identification of the motor tract and its correlation with evoked potentials obtained during brain tumor surgery.

## METHODS AND MATERIALS

54 pyramidal tractographies based on DTI images were performed before and after surgery in patients with glioma tumours histologically confirmed (17 diffuse anaplastic gliomas, 8 oligoastrocytomas and 29 multiform glioblastoma) which were immediately adjacent or in direct contact to the pyramidal tract. During surgery, central sulcus was identified and confirmed by evoked potentials. For evoked potential a direct phase technique for cortical stimulation with high frequency (250Hz) monopolar electrodes was used. For cortical stimulation an 8 contacts electrode was used whereas a current waveform with eight electromyograms was used for evoked potentials continuous monitoring. When resection approaches the pyramidal tract, subcortical stimulators were used and the electromyographic response was observed after subcortical stimulation. The minimum distance ratio between the resection cavity and subcortical stimulation intensity, in relation to the pyramidal tract, was studied using regression and ANOVA correlation analysis. The p-value was considered as  $p < 0.05$

## RESULTS

The distance between the resection cavity and the motor tract in tractographic sequences postoperatively were 2.5 to 23.7 mm. The results were correlated with data obtained from cortical evoked potentials monitored during surgery. There was a significant linear correlation of 1.08 by applying a regression test between distance and stimulus intensity ( $R^2 = 0.8202$ ,  $P < 0.001$ ).

## CONCLUSION

Correlation was demonstrated between the electrophysiological and DTI in the analysis of the pyramidal tract by imaging based on the use of direct subcortical stimulation. The DTI should be systematically included in the standard imaging protocol for the study of brain tumours both for etiologic diagnosis to treatment planning in order to preserve the maximum motor tract as possible.

## CLINICAL RELEVANCE/APPLICATION

The identification by DTI of the corticospinal tract prior to brain glioma surgery allows the neurosurgeon an accurate planning of the maximum tumour removal with motor tract preservation. Monitorization with intraoperative evoked potentials showed correlation with presurgical tractography MR studies.

## T5A-SPPH- CRLM-GAN: The Optimization Effect on Automatic Segmentation of T2-weighted Images for Colorectal Liver Metastases Combining with Transfer Learning and Generative Adversarial Network under Small-scale Sample

Shaojun Xia (*Presenter*) Nothing to Disclose

## PURPOSE

Colorectal cancer liver metastase (CRLM) is a ubiquitous digestive tract tumor, it is estimated that more than 50% colorectal cancer patients will eventually develop liver metastases during the course of illness. As for the diagnosis of CRLM, T2WI can serve as an important supplementary modality beyond the conventional examination of contrast-enhanced CT or DWI MRI. In this study, we proposed a modified hybrid auto-segmentation model based on transfer learning (TL) and generative adversarial network (GAN), i.e. CRLM-GAN, to explore the optimization effect under small-scale sample, thus expanding the application potential of T2WI images in intelligent diagnosis for CRLM.

## METHODS AND MATERIALS

A retrospective cohort was enrolled involving 70 patients with pathologically confirmed CRLM. All the images were acquired by the axial fast recovery, fast spin-echo and T2WI sequence, sourced from a 1.5-T MRI scanner using an 8-channel phased array body coil. In the fore-end of the network, UNet++ was employed as the generator to initially segment probabilistic maps. Then the generated probabilistic maps and real labels were multiplied with the original images respectively, resulting in the predicted tumor and the real tumor images. Both of them were input into the discriminator-a pre-trained ResNet-50 to extract and fuse the deep convolutional features. Ultimately, a comprehensive loss function was computed by combining the binary cross-entropy, Dice, and the multiscale loss. Moreover, Tversky Loss was incorporated into the training to optimize the final results.

## RESULTS

20% of the patients were used for the independent testing, and the model performance was assessed by five typical metrics, with Dice, Jaccard, Recall, Precision, F1-score of 0.7163, 0.5580, 0.5898, 0.9118, 0.7040. Our method achieved an average improvement of 6.23%, 4.32%, and 4.32% for the Dice, Jaccard, and F1-score compared with UNet. In contrast to UNet++, the three indicators increased by 2.29%, 1.91%, and 1.86%, respectively. When taking into account the addition of the Tversky loss, the Dice and Jaccard still improved by 0.16% and 0.20%, separately.

## CONCLUSION

This study designed a novel segmentation network based on TL and GAN. The results demonstrated that it can significantly enhance the accuracy under small-scale sample. Future work will focus on the generalization of the model in multi-center and medium-sized samples, so as to further expand the application scope.

## CLINICAL RELEVANCE/APPLICATION

The work provides a relatively reliable auto-segmentation tool for radiologists in the case of small samples. Besides, it also extends the application value of T2WI images in intelligent diagnosis on CRLM, compared to the auto-segmentation of routine image modalities such as CT or DWI.

## T5A-SPPH- Two-stage Few-shot Segmentation Framework on Lung Nodule CT Images

7

Mengxiao Geng (*Presenter*) Nothing to Disclose

### PURPOSE

Although deep learning has demonstrated remarkable results for lung nodules, it is limited by the need for extensive manual labeling and high computational costs. Similarly, traditional active contour-based methods require manual adjustment and can be sensitive to the selection of initial contours. As such, there is a need for novel segmentation frameworks that address these challenges.

### METHODS AND MATERIALS

Our proposed few-shot segmentation framework (FSSF) combines deep learning with an optimized active contour model to segment lung nodules. First, deep learning is used to obtain prior position information based on a small amount of data. This prior information is then input as the initial contour into the optimized active contour model (OACM), which significantly enhances the segmentation accuracy of the deep network for lung nodules in small sample situations. Specifically, the active contour model includes heat kernel convolution to reduce computational complexity, while adaptive weighted functions and high-order total variation maintain segmentation accuracy. To solve the model efficiently, we used the alternating direction method of multipliers to split it into subproblems. In the experiment, the clinical CT dataset was acquired from Guangdong Provincial People's Hospital using a Siemens CT scanner (SENSATION 16 SLICE). The dataset included 199 subjects (102 males and 97 females, aged  $58.9 \pm 11.89$  years [range of 32-89]) who were collected from January to December 2020. To evaluate the proposed few-shot segmentation method, lung CT images from 10 patients were used for presegmentation model training, with 20 slices selected as test images.

### RESULTS

Our proposed method was compared against state-of-the-art methods such as U-Net, WBHV, WBHV+, ICTM, and ICTM+ in terms of their segmentation effectiveness. The results demonstrate that our proposed method showed significant improvement compared to other methods, with Dice improving by 6.9%, JS improving by 9.9%, and ? improving by 7.0%. Compared to the state-of-the-art methods, our method still achieves much better performance.

## CONCLUSION

Compared to other segmentation methods, our proposed method demonstrates superior performance in both visual and quantitative evaluations.

## CLINICAL RELEVANCE/APPLICATION

CT image segmentation of pulmonary nodules is a useful technique for early detection, quantitative evaluation, and monitoring of lung cancer and other diseases. This technique separates nodules from surrounding tissue and calculates morphological features, providing support for clinical medicine.

## T5A-SPPH- Improving Image Quality in Low-dose Abdominal and Pelvic CT Angiography Using Deep Learning Image Reconstruction: Comparison with Filtered Back-projection and Iterative Reconstruction

8

Tingting Qu (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate image quality among the traditional FBP, adaptive statistical iterative reconstruction (ASIR-V) and deep learning image reconstruction (DLIR, TrueFidelity) algorithms in low-dose abdominal and pelvic CT angiography (CTA).

### METHODS AND MATERIALS

Forty-six abdominal and pelvic CTA patients were included. All patients underwent low-dose CTA with 80kVp and smart tube current modulation (100-720mA). Images were reconstructed using FBP, ASIR-V with strength of 50% (AV-50) and 100% (AV-100), TrueFidelity with medium (TF-M) and high (TF-H) strength. The CT value and standard deviation (SD) value of abdominal aorta, psoas major muscle and subcutaneous fat were measured, signal-to-noise ratio (SNR) and contrast-to-noise



ratio (CNR) were calculated. The CT value skewness in psoas major muscle with uniform density was also measured to reflect the image texture change. A 5-point scoring method was used to evaluate the granularity, fuzziness and beam hardening artifacts of all images. The above indexes of the five image groups were compared.

## RESULTS

The volume CT dose index was low at  $1.09 \pm 0.37 \text{mGy}$ . CT values were all similar among the five groups ( $P > 0.05$ ). But, SD values were different among groups with FBP being the largest and AV-100 the smallest which resulted in different SNR and CNR values opposite of the SD values. AV-100 and TF-H also had the best score in granularity while FBP had the worst. However, AV-100 had significantly higher skewness and fuzziness than other four groups ( $P < 0.001$ ), with FBP and DL-M had the smallest and TF-H marginally higher. The TF-H group had the best beam hardening artifact score while FBP and AV-50 group had the worst ( $P < 0.001$ ).

## CONCLUSION

Compared with FBP and ASIR-V, TrueFidelity reconstruction algorithm better balances image noise, smoothness, image texture, and artifacts in low-dose abdominal and pelvic CTA, with TF-H provides the best overall image quality.

## CLINICAL RELEVANCE/APPLICATION

TrueFidelity with high (TF-H) strength reconstruction algorithm provides the best image quality in low-dose abdominal and pelvic CTA.

## T5A-SPPH- Metal Artifact Reduction for Head and Neck CBCT with Attentional Dual Encoder Fusion UNet

Jungmok Lee (*Presenter*) Nothing to Disclose

## PURPOSE

Since the insertion of metallic implants in surgical method has been grown, there also have been severe metal artifact in CT and CBCT. So the metal artifact reduction methods became on the rise. In addition, the application of convolutional neural network based structure in metal artifact reduction has shown a great performance, still it lacks of extracting features which both efficiently removes artifact and restores the tissue structure. In this study, we propose the dual encoder fusion UNet structure for effective cone-beam CT metal artifact reduction, which can extract both the artifact removal feature and tissue structure feature through dual encoder network.

## METHODS AND MATERIALS

Our model architecture is based on UNet architecture with two encoders. The first encoder mostly focuses on removing metal artifact rather than restoring the tissue structure, and the second encoder focuses on restoring the tissue structure instead of removing metal artifacts. Two bottleneck features are fused through attentional fusion, which consist of spatial and global attention. Similar to bottleneck feature fusion, the encoder features for skip connection is fused using attentional fusion. Our model was trained in generated synthetic dataset for 100 epochs with mean squared error and auxiliary loss. Auxiliary loss was calculated by direct mean squared error between the encoder feature and target. And our model was evaluated on mean squared error (MSE), peak signal-to-ratio (PSNR), pearson correlation coefficient (PCC), and structural similarity (SSIM). The quantitative analysis has also done in real patients.

## RESULTS

Compared to single encoder architectures with similar parameter numbers, our model has shown the noticeable performance in both synthetic data real patients without ground truth. The evaluation metric (MSE, PSNR, PCC, SSIM) in synthetic data is 0.000086, 41.859071, 0.993072, 0.993681. Our model has removed the metal artifact effectively, and shown the best structure restoration in real patients while other models has made the greyish artifacts for the restoration.

## CONCLUSION

In this study, we proposed the dual encoder UNet architecture for effective metal artifact reduction, and it has shown that model can focus on both effective artifacts reduction and tissue structure restoration. We also showed that attention-fused features helps in performance of artifact removal and tissue restoration.

## CLINICAL RELEVANCE/APPLICATION

We expect that our proposed model can be successfully applied to the metal artifact reduction especially in CBCT for radiation treatment, since there is no artifact reduction software for CBCT at this moment.

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## Abstract Archives of the RSNA, 2023

T5A-SPRO

### Radiation Oncology Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPRO- The Application Value of Energy Spectrum CT Iodine-water Scatter Plot in Predicting Surgical Margins of Pancreaticoduodenectomy** 1

Ruibo Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To predict the surgical margins of pancreaticoduodenectomy by analyzing the energy spectrum CT iodine-water scatter plot of patients with duodenal malignant tumors and adjacent normal tissues, and to guide the optimal selection of clinical surgical targets.

#### **METHODS AND MATERIALS**

28 patients with duodenal malignant tumor were selected as research objects, and the patients were retrospectively collected with surgical pathological confirmation and complete energy spectrum CT scan data before surgery, and multi-point delineation and analysis of iodine-water scatter plots were performed in the solid part of duodenal malignant tumor and the area of interest of surgical margin. Statistical analysis of iodine-water scatter plot and postoperative pathology diagnosis rate.

#### **RESULTS**

There was a clear demarcation between the solid part of the lesion and the iodine-water scatter plot of the surgical margin, and the diagnosis rate with the postoperative pathology was 100%, with a statistically significant difference ( $p < 0.05$ ).

#### **CONCLUSION**

The negative/positive surgical margins of pancreaticoduodenectomy can be distinguished by using energy spectrum CT iodine-water scatter plot to maximize the preservation of normal tissues around the margins.

#### **CLINICAL RELEVANCE/APPLICATION**

The application value of energy spectrum CT iodine-water scatter plot in predicting surgical margins of pancreaticoduodenectomy

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## Abstract Archives of the RSNA, 2023

T5A-SPVA

### Vascular Imaging Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-SPVA- Magnetic resonance Lymphangiography - An Initial Clinical Experience**

1

Robert M. Siepmann, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Lymphedema is defined by chronic accumulation of fluid in soft tissue. Due to an increasing number of lymphonectomies associated with breast or pelvic surgery in the past years, secondary lymphedema has become more prevalent. Many patients fail conservative treatment and need surgery, e.g. lymphaticovenous anastomosis (LVA). For surgical treatment planning, visualization of lymphatic vessels is crucial. Established lymphography procedures like lymphoscintigraphy and indocyanine lymphography suffer from poor spatial resolution or in case of conventional lymphangiography require surgical isolation. Magnetic resonance lymphangiography (MRL) is an emerging imaging technique, allowing non-invasive visualization of lymphatic vessels. We report on our initial experience with MRL in patients with suspected lymphedema including patients after microsurgical therapy.

#### **METHODS AND MATERIALS**

11 consecutive patients (11 female; mean age 46 years) undergoing MRL between 05-2022 and 04-2023 were included. In 10/11 (91%) patients with suspected lymphedema final work-up confirmed the diagnosis. 9/10 had secondary lymphedema (7 after lymphonectomy, 1 after liposuction; 1 postpartum) and 1/10 patients had idiopathic lymphedema. The remaining patient suffered from chronic venous obstruction. 10/11 (91%) showed edema in the lower extremities, 1/11 (9%) in the upper extremities. 3 patients underwent LVA-surgery prior to MRL resulting in a total of 10 anastomoses. MRL was performed on a 1.5 T system. For evaluation of the extent of edema a T2w TSE DIXON was obtained. To visualize the lymphatic system a T1w GRE with fatsat was obtained after interstitial transpedal injection of a gadolinium-based contrast agent (Gadobutrol). Analysis included location and extent of edema, technical success rate and qualitative assessment of the MRL images.

#### **RESULTS**

In all patients MRL was technically successful without complications and allowed direct visualization of the lymphatic vessels. 8/10 LVAs were identified on MRL. In one patient, lymphatic inflow to iatrogenic lymphoceles after liposuction was directly visualized by MRL. Based on MRL 9/10 patients were correctly diagnosed with lymphedema. MRL correctly identified the one patient with chronic venous obstruction. MRL led to either performed or scheduled LVA surgery in 6/10 cases. Three patients continued to be treated conservatively.

#### **CONCLUSION**

MRL appears to be a safe and precise for diagnosis of lymphedema and allows reliable visualization of the lymphatic vessels including LVAs.

#### **CLINICAL RELEVANCE/APPLICATION**

MRL seems to be a promising addition to established lymphography procedures, particularly for treatment planning in patients scheduled for LVA or for postoperative follow-up after LVA.

#### **T5A-SPVA- Single-phase Steady-state Ferumoxytol-enhanced MR Angiography of Neck, Chest, Abdomen, and Pelvis: A Feasibility Study**

3

Soheil Kooraki, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Comprehensive vascular imaging is often required as part of the pre-multi visceral transplant workup. This study aimed to assess the feasibility of single-phase steady-state Ferumoxytol-enhanced (Fe-MRA) for vascular mapping of neck, chest,

abdomen and pelvic arteries and veins.

## **METHODS AND MATERIALS**

In this IRB-approved, HIPAA-compliant, single-center study, eleven patients (5 females, median age of 24 years, ranging from 5-93) underwent a single-phase Fe-MRA of neck, chest, abdomen, and pelvis as part of the pre-multi visceral transplant assessment. The Fe-MRA was achieved by slow intravenous infusion of 4 mg/kg ferumoxytol and using a 1.5 or 3 Tesla MR scanner. The time from localizer image acquisition to completion of the angiographic acquisition was measured. Two radiologists independently scored images for overall quality, motion artifact, diagnostic confidence for assessment of arterial and venous segments, using a 5-point Likert scale (5: excellent, 4: good, 3: diagnostic, 2: limited, 1: non-diagnostic). Inter-observer agreement was assessed using Intraclass Correlation Coefficient.

## **RESULTS**

The scans were technically successful, with an average scan time of 11 minutes (ranged 5-25 minutes) and without any major adverse effects. The overall image quality was excellent in 7, good in 3 and diagnostic in one patient(s), and there were no non-evaluable vascular segments in any of the scans. A total of 545 named vascular segments were scored, of which the image quality for diagnostic confidence was good to excellent in 91.7% (500/545). There were not any motion artifacts to impede the diagnostic assessment (all scores = 3). There was excellent inter-reader agreement for scoring diagnostic confidence in each vascular segment (all  $\kappa > 0.9$ ).

## **CONCLUSION**

This study demonstrated the feasibility, high image quality and diagnostic confidence of Fe-MRA for comprehensive vascular mapping in pre-multi visceral transplant workup. The scan can be completed in as little as 5 minutes.

## **CLINICAL RELEVANCE/APPLICATION**

Non-nephrotoxic Fe-MRA is a quick and feasible method for comprehensive vascular mapping in patients who are undergoing multi-visceral transplant, with the advantage of obtaining both arteriogram and venogram in a single-phase image.

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## Abstract Archives of the RSNA, 2023

T5B-SPBR

### Breast Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPBR- Artificial Intelligence DWI without Segmentation Has Comparable Diagnostic Performance with Standard Breast MRI in the Differentiation of Malignant and Benign Breast Tumors** 1

Mami Iima, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Our aim was to develop a machine-learning model that can differentiate benign and malignant breast tumors using diffusion-weighted MRI.

#### **METHODS AND MATERIALS**

This prospective study included 530 breast lesions. 334 breast lesions with confirmed histology or no enlargement on follow-up were analyzed. The data was divided into dataset for train and 10-fold cross-validation (139 malignant 67 benign) and test dataset (85 malignant, 43 benign) with no overlap of patients. 3T breast MRI DWI was acquired with 5 b values up to 1500 s/mm<sup>2</sup> in addition to DCE-MRI. Only the lesion slice was selected without lesion segmentation. To develop a deep-learning model that can differentiate between benign and malignant tumors, we compared various combinations of basic data augmentations: A: random elastic deformation, B: random affine transformation/random noise, and C: mix-up. The small 2D CNN model was also compared to 3D CNN and ResNet18. The diagnostic performance of the deep learning model obtained from DW images and standard breast DCE MRI based on BI-RADS was evaluated using ROC analysis.

#### **RESULTS**

The augmentations improved accuracy in all experiments (AUC:0.86-0.90 VS. 0.86 in validation dataset, and AUC:0.85-0.88 VS. 0.87 in test dataset) except augmentation C (AUC:0.86 and 0.83). The result using 2D CNN resulted in a better AUC than 3D CNN (AUC:0.88-0.90 VS. 0.72-0.75). All results of 10-fold cross validations showed small 2D CNN with data augmentation A and B to be the best model (AUC: 0.90), and it was also the best against test dataset (AUC:0.88) that was comparable to standard breast MRI (0.89 and 0.87). Specificity tended to be higher in the deep learning model with 2D CNN from DW images than in standard breast MRI (85% VS. 81% in validation dataset, and 81% VS. 74% in test dataset), with higher sensitivity in standard breast MRI (80% VS. 98% in validation dataset, and 86% VS. 99% in test dataset).

#### **CONCLUSION**

While some studies evaluated the diagnostic performance of breast MRI using deep learning, so far as we know, no study has yet evaluated using only breast DWI with a deep learning model. AI can achieve good performance comparable to standard breast MRI for differentiating between malignant and benign breast tumors. DWI-AI provided better specificity than standard breast DCE-MRI, while the sensitivity was slightly inferior. Those results underline the great potential of supplementing the diagnostic performance of standard breast MRI with variable specificity, without additional reading time by breast radiologists, and beneficial in patients who are allergic to contrast agents.

#### **CLINICAL RELEVANCE/APPLICATION**

A machine-learning model with diffusion-weighted MRI has the potential to improve specificity in distinguishing between benign and malignant breast tumors.

#### **T5B-SPBR- Breast Lesion Morphology Assessment with High and Standard b Values in Diffusion-weighted Breast MRI at 3.0 Tesla** 3

Sara A. Christner, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This investigation compared diffusion weighted imaging (DWI) with b values of 800 and 1600 s/mm<sup>2</sup> to dynamic contrast-enhanced imaging (DCE) for lesion morphology assessment in high-resolution breast MRI at 3.0 Tesla - an area that has been occupied traditionally by DCE.

## METHODS AND MATERIALS

Multiparametric breast MRI was performed in 91 patients with 93 histopathologically proven lesions (31 benign, 62 malignant). Two radiologists evaluated three datasets per patient independently and assessed lesion visibility and BIRADS morphology criteria. Bland-Altman analyses were conducted for lesion size comparisons. In addition, diagnostic accuracy was calculated for each reader and dataset.

## RESULTS

The visibility of carcinomas was considered better compared to benign findings in both DWIb800 and DWIb1600 ( $p < 0.001$ ) with no b value-dependent difference. Similarly, mass lesions were easier assessable compared to non-mass lesions, irrespective of the DWI images' b value ( $p < 0.001$ ). Intra-reader reliability for the analysis of morphologic BIRADS criteria among DCE and DWI datasets was at least moderate ( $\kappa = 0.557$ ), while at least substantial inter-reader agreement was ascertained over all assessed categories ( $\kappa = 0.776$ ). In pairwise Bland-Altman analyses, the measurement bias between DCE and DWIb800 was 0.7 mm, whereas the difference between DCE and DWIb1600 was 2.8 mm. DWIb1600 images allowed for higher specificity than DCE ( $p = 0.007/0.062$ ).

## CONCLUSION

DWI can be employed for reliable morphologic lesion characterization in high-resolution breast MRI. The use of high b values increases diagnostic specificity, while lesion size assessment is more precise with standard 800 s/mm<sup>2</sup> images.

## CLINICAL RELEVANCE/APPLICATION

Given ongoing concerns regarding the safety of Gd-based contrast media and continuing efforts on abbreviated breast MRI protocols, morphology assessment using DWI shows promising results in the differentiation of malignant from benign breast lesions.

## T5B-SPBR- Association of Preoperative MRI with Breast Cancer Treatment and Survival: A Single Institution Observational Study

4

Berat Bersu Ozcan, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the association between preoperative breast MRI with surgery type, contralateral cancer, recurrence-free (RFS) and overall survival (OS) in women with early stage breast cancer.

## METHODS AND MATERIALS

In this single institution, retrospective study, we identified women with Stage I-III breast cancer diagnosed between 03/01/2014-03/31/2021 with available follow-up. Patient and tumor characteristics were recorded. Two cohorts were created based on the use of preoperative MRI (PMRI) versus not (NoMRI) with Wilcoxon signed-rank and  $\chi^2$  tests utilized for cross-group comparisons. Kaplan-Meier method and log-rank tests were used to compare RFS and OS in women with and without MRI. Multivariable Cox proportional hazards model analysis was performed to evaluate RFS and OS by preoperative MRI status while controlling for other variables that could adversely impact outcomes.

## RESULTS

593 eligible patients were included [322 (54.3%) with PMRI, 271 (45.7%) noMRI]. Mean patient age was younger ( $53.8 \pm 11.8$  vs  $59.3 \pm 12.6$  years,  $p < 0.001$ ) and dense breasts more common (51.4% vs 22.0%,  $p < 0.001$ ) in PMRI group. Seventeen bilateral cancers (2.9%) were in PMRI (14/17, 82.4% only detected on MRI) vs 10 (1.7%) in no-MRI ( $p = 0.34$ ). No significant difference between clinical Tstage rates (cT0-2 88.8% ; 91.9% ,  $p = 0.22$ ) or invasive molecular subtype (luminal A, 22.7% vs 28.5%; luminal B, 56.3% vs 46.6%; HER2, 5.4% vs 4.1%; triple negative, 15.5% vs 20.7%,  $p = 0.13$ ) in MRI vs no-MRI groups, respectively. PMRI group had higher rates of cN+ (27.3% vs 18.1%,  $p < 0.01$ ), and neoadjuvant therapy (41.3% vs 18.8%,  $p < 0.001$ ). Total mastectomy (57.8% vs 51.3% ,  $p = 0.12$ ), margin positivity (6.2% vs 7.4%,  $p = 0.57$ ), recurrence (10.2% vs 7.0%,  $p = 0.17$ ) and death rates (8.1% vs 7.7%,  $p = 0.88$ ) were similar in PMRI vs noMRI, respectively. At median follow-up of 69 months (IQR, 61-75), time to recurrence was [24 (IQR, 18-48) vs 23 (IQR, 9-30) months,  $p = 0.05$ ]. Mastectomy rates remained comparable after adjusting for age and breast density ( $p = 0.28$ ). Contralateral cancers were identified sooner and more frequently in the no-MRI group [4 (2.1%) vs 2 (0.9%) cancers,  $21 \pm 20$  vs  $48 \pm 13$  months].

## CONCLUSION

In this single-institution retrospective study, the use of preoperative MRI is not associated with improved surgical margin, RFS or OS. At surveillance contralateral cancers are identified earlier and more frequently in the noMRI group.

## CLINICAL RELEVANCE/APPLICATION

Detecting clinically and mammographically occult contralateral breast cancers on preoperative MRI may help decrease contralateral cancer events at early surveillance.

### **T5B-SPBR- Do Breast Oedema and Shrinkage Pattern during NAC Provide Additional Value for Predicting Treatment Response in Locally Advanced Luminal Breast Cancer?**

Shiyun Sun (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the predictive value of oedema and shrinkage patterns for the neoadjuvant chemotherapy (NAC) response in luminal breast cancer and whether they have added value when combined with traditional MRI features such as tumour size and apparent diffusion coefficient.

#### **METHODS AND MATERIALS**

Patients with luminal breast cancer were consecutively enrolled in this retrospective study to assess the relationship between MRI features and treatment response (including pCR and Miller-Payne [M-P] grade). Patients were classified into the development cohort and validation cohort. The traditional MRI features, breast oedema and shrinkage pattern were assessed before and early NAC (within 2 cycles of NAC). Oedema was divided into four categories (grade 1: no oedema, grade 2: peritumoral oedema, grade 3: prepectoral or subcutaneous oedema, grade 4: diffuse oedema), and regression was refined into two categories (concentric shrinkage and eccentric shrinkage). Univariate and multivariable analyses were used to identify independent imaging markers for pCR and MP grade. Prediction models were developed and evaluated for discrimination, calibration, and clinical applicability.

#### **RESULTS**

In total, 267 eligible patients were consecutively enrolled and divided into the development cohort (n=187) and validation cohort (n=81). Early diffuse oedema was a shared unfavourable biomarker in the prediction of both M-P grade and pCR (OR = 0.36 and 0.27). Peritumoral oedemas before and early NAC were another predictors of non-pCR (OR = 0.69 and 0.23), while unchanged or increased oedema grade during NAC (OR = 0.25 and 0.20) were another predictors of ineffective treatment, respectively. The addition of oedema improved the predictive value of tumour size for M-P grade (AUC from 0.64 to 0.71) and pCR (AUC from 0.67 to 0.74). The shrinkage pattern showed potential predictive value for M-P grade (P = 0.049) and pCR (P = 0.041) in the univariate analysis but was not an independent indicator. Prediction models showed comparable performance for predicting M-P grade and pCR in both the development (AUC = 0.82 and 0.81) and validation cohorts (AUC = 0.79 and 0.78).

#### **CONCLUSION**

Breast oedema is a valuable predictor of treatment response in luminal breast cancer in that it improves the performance of tumour size. The predictive value of the shrinkage pattern remains to be further studied.

## CLINICAL RELEVANCE/APPLICATION

The goal of this work is to develop an MRI-based model for a more accurate prediction of response to NAC in patients with luminal breast cancer. The model utilizes conventional MRI features instead of radiomics and novelty is introduced to the model by describing four types of edema that have long been shown to be predictive and prognostic that are readily available in clinics.

### **T5B-SPBR- Diagnosis of Breast Lesions on MRI using BI-RADS and Kaiser Scores in Mass and Non-Mass Enhancement: Benefit of KS and KS+ for Readers with Different Experience Levels**

Jiejie Zhou, PhD, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Kaiser score (KS) is a machine learning-derived clinical decision rule based on MRI BI-RADS descriptors, which provides the structure of an intuitive flowchart to guide the reader through a stepwise lesion assessment. The main considered features are root sign, DCE pattern, internal enhancement, and peritumoral edema. This study is aiming to: (1) compare the diagnostic performance of three readers with different experiences for breast cancer using BI-RADS and KS systems; (2) evaluate the benefit of the modified KS+ when diffusion was considered; and (3) separately assess the diagnostic performance in mass and NME lesions.

#### **METHODS AND MATERIALS**

A total of 630 patients including 393 malignant and 237 benign pathological confirmed lesions were analyzed. Based on the morphology, the cases were separated into 458 masses and 172 NMEs. Three radiologists with different levels of experience in breast MRI (3, 6, and 13 years) reviewed the cases to make a diagnosis using BI-RADS descriptors and KS. Of the 630 cases, 596 cases (434 mass and 162 NME) had DWI, and the apparent diffusion coefficient (ADC) was measured to modify

KS to KS+. For lesions with ADC =  $1.4 \times 10^{-3}$  mm<sup>2</sup>/s, the KS was reduced by 4. The diagnostic AUC of KS and KS+ made by three readers in mass and NME were compared to evaluate the benefit of KS+.

## RESULTS

The diagnostic performance increased with years of experience among three readers. When using BI-RADS, AUC was 0.878, 0.915, and 0.941 for mass, and 0.771, 0.838, 0.902 for NME for Reader-1, 2, and 3, respectively (Table 1). When using KS compared to BI-RADS, the AUC was improved for the less experienced Readers. For Reader-1, AUC was increased from 0.878 to 0.916 for mass ( $p=0.005$ ), and from 0.771 to 0.822 for NME ( $p=0.124$ ). For Reader-2, AUC was about the same for mass (0.915 to 0.921) and increased from 0.838 to 0.883 for NME ( $p=0.114$ ). For the most experienced Reader-3, the results made by BI-RADS and KS were about the same. When ADC was considered to change to KS+, the AUC was significantly improved for all three readers for the mass lesions, but AUC was about the same for NME.

## CONCLUSION

The benefit of KS was more remarkable for mass than for NME, especially for the less experienced reader. The root sign and internal enhancement were not well defined for NME, and since many NMEs would show the plateau DCE pattern, this feature was not helpful either. When considering ADC to modify KS to KS+, again, the benefit was mostly seen for mass, possibly due to the use of the cut-off threshold of  $1.4 \times 10^{-3}$  mm<sup>2</sup>/s developed from mass lesions.

## CLINICAL RELEVANCE/APPLICATION

Kaiser Score provides an intuitive method for lesion interpretation, which is mostly helpful for mass lesions read by less experienced readers. KS+ is mainly applicable to mass lesions. For NME, the KS criteria need to be improved.

## T5B-SPBR- A Pilot Study on the Correlation between the Parameters of Oscillating Gradient Spin Echo based Diffusion Weighted MRI and Pathological Lymphatic Vessel Invasion in Breast Cancer

Lanqing Yang (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the value of oscillating gradient spin echo (OGSE) based diffusion weighted MRI in predicting the lymphatic vessel invasion (LVI) status in patients with breast cancer.

## METHODS AND MATERIALS

22 biopsy proved breast cancer patients were prospectively enrolled in this study. They all received preoperative clinical routine breast MRI, including T2 weighted imaging (T2WI), T1 weighted imaging (T1WI), diffusion weighted imaging (DWI), and contrast dynamic enhancement (DCE); and OGSE DWI sequences, including pulsed gradient spin echo (PGSE), OGSE(N=1), and OGSE (N=2). Patients were grouped into LVI negative (n=16) and positive (n=6) groups, with reference to pathological reports of surgical specimens. ROIs delineation was independently performed by two radiologists on three largest slices of tumor on  $b=1000$  s/mm<sup>2</sup> images. Then, four quantitative parameters of Vin (intracellular volume fraction), Dex (mean extracellular diffusivity), D (mean cell size) and cellularity were derived from MATLAB software. Interobserver agreement assessment, independent t test, Mann-Whitney U test, ROC analysis, and spearman correlation analysis were used for statistical analyses.

## RESULTS

The overall interobserver agreement was excellent for two radiologists of Dex value (intraclass correlation coefficient, ICC=0.865). Patients with LVI positive status had significantly lower Dex value compared with LVI negative group ( $1.686 \pm 0.170$  vs.  $2.107 \pm 0.183 \times 10^{-3}$  mm<sup>2</sup>/s,  $P=0.007$ ). ROC results showed that Dex presented a high AUCs of 0.958 in predicting LVI status. In addition, there was also significant strong negative correlation between LVI status and the value of Dex, with a spearman rank correlation coefficient of 0.710 ( $P=0.014$ ). Other parameters including Vin, D, and cellularity showed no significant difference between two groups.

## CONCLUSION

Dex (mean extracellular diffusivity) value calculated from OGSE DWI sequences could help to predict the LVI status of breast cancer.

## CLINICAL RELEVANCE/APPLICATION

lymphatic vessel invasion (LVI) is a high-risk factor for blood metastasis of breast cancer, which suggests that breast cancer patients have a higher risk of recurrence and metastasis, and a poor prognosis. Preoperative evaluation of LVI status with MRI could help risk stratification, thus may guide the clinical management of patients with breast cancer.

## Abstract Archives of the RSNA, 2023

T5B-SPCA

### Cardiac Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPCA-1 Vascular Enhancement and Radiation Dose on 256-slice CT Angiography with Reduced Iodinated Contrast Volume for Pre-operative TAVI: Comparison of 64-slice CT Angiography with Standard Iodinated Contrast Volume**

Takayuki Yoshiura, BA, RT (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Multi-slice CT is now the standard noninvasive imaging method for preoperative evaluation of transcatheter aortic valve implantation (TAVI). The purpose of this study is to evaluate the vascular attenuation and radiation dose on 256-slice CT with reduced iodinated contrast volume for pre-operative TAVI as compared to 64-slice CT with standard iodinated contrast volume.

#### **METHODS AND MATERIALS**

The study included 52 patients who underwent pre-TAVI CT scan with the 64-slice CT (Lightspeed VCT; GE Healthcare, Milwaukee, Wisconsin) and 47 patients who underwent pre-TAVI CT scan with the 256-slice CT (Revolution Apex; GE Healthcare, Milwaukee, Wisconsin). A contrast dose was injected at 450 mgI/kg over 22 seconds on 64-slice CT and 300 mgI/kg over 20 seconds on 256-slice CT, respectively. Measurements were performed on the CT enhancement of the ascending aorta (AAO), abdominal aorta (Abd AO), both subclavian arteries (SCA), and both femoral arteries (FA) as well as for the image noise of muscle tissue; then the contrast-to-noise ratio (CNR) and signal-to-noise ratio (SNR) were calculated. The volume CT dose index (CTDIvol) and dose length product (DLP) were recorded for both CT scans.

#### **RESULTS**

Despite the reduced iodinated contrast volume on 256-slice CT, the vascular enhancement of both SCA were significantly higher than those for 64-slice CT ( $p < 0.01$ ), with no significant differences in the other access routes in both CT scans. The CNR for AAO, Abd AO and both SCA was significantly higher the 256-slice CT, with no significant differences in the other access routes ( $p > 0.01$ ). The SNR was significantly higher the 256-slice CT for Abd AO and both SCA, with no other significant differences. The radiation dose for 64-slice and 256-slice CT scans were 82.4 mGy and 68.3 mGy for CTDIvol, and 2342.9 mGy-cm and 2066.7 mGy-cm for DLP, respectively. The radiation dose with 256-slice CT was obtained lower values.

#### **CONCLUSION**

The 256-slice CT with reduce iodinated contrast volume for pre-operative TAVI resulted in reduction of radiation dose and maintained or improved the vascular enhancement of the aortic annulus and access route vessels, compared to 64-slice CT, despite using approximately 52% less iodinated contrast volume.

#### **CLINICAL RELEVANCE/APPLICATION**

256-slice CT with reduced iodinated contrast volume for pre-operative TAVI maintains image quality and reduced radiation dose.

#### **T5B-SPCA-2 Estimation of High Coronary Artery Calcium (CAC) Score from Aortic Arch Calcification: An Efficient Tool for Selection of Non-optimal Candidates for Coronary CTA?**

Pietro Giacomo Lacaita, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Overutilization of healthcare resources is causing a high economic burden. Patients with high-CAC scores  $> 1000$  AU are not optimal candidates for coronary CTA and can be more efficiently examined with other modalities (myocardial perfusion testing



or a direct-to-ICA strategy). Therefore the objective of our study was to evaluate whether a 4-scale aortic arch calcification severity score predicts high-CAC scores (>1000AU and >800AU).

## **METHODS AND MATERIALS**

162 patients referred to coronary/aortic CT Angiography and non-enhanced CAC score were enrolled (age 76.3 years, 45% females). Patients with prior PTCTI/STENT and CABG were excluded. The severity of aortic arch calcification was scored on a 4-point scale as 0=absent, 1=minimal (<25% of circumference) 2=mild (25-50%), 3=moderate (50-75%) and 4=severe (100% of circumference) on thoracic CT (coronal MPR reformations).

## **RESULTS**

In 130 patients, the absence of aortic arch calcification was highly accurate to rule out CAC>1000AU (sens. 100%). No or minimal (grade 1) calcification had a high NPV of 95.6% , and no, minimal and mild (grade 1+2) a NPV of 86.96% to rule out CAC>1000AU. There was a moderate correlation between grading of aortic arch calcification severity and CAC ( $r=0.663$ ,  $p<0.001$ ) by CT. In patients with severe aortic arch calcium (grade 4), the prevalence of CAC >1000 was with 32/45 (71.1%) significantly higher as compared to other groups with 13/45 (28.8%)( $p<0.001$ ). The AUC for the 4-scale aortic arch calcium severity score to predict CAC >1000 was  $c=0.84$  ( $p<0.001$ ; 95%CI:0.771-0.91) and similar for prediction of CAC>800 AU with  $c=0.813$  ( $p<0.001$ ;95% CI:0.686-0.865). AUC for prediction of CAC >1000 was slightly lower with  $c=0.792$  for moderate-to-severe (grade 3+4) and  $c=0.775$  for severe (grade 4) aortic arch calcification ( $p<0.001$  for both).

## **CONCLUSION**

Patients with moderate-to-severe aortic arch calcium have a high probability of CAC >1000 AU, but not those with no, minimal and mild calcifications. The absence of aortic arch calcium rules out CAC>1000 AU.

## **CLINICAL RELEVANCE/APPLICATION**

Estimation of aortic arch calcium severity is a valuable tool for a quick decision-making on the optimal non-invasive testing strategy (coronary CTA vs myocardial perfusion testing or a direct-to-ICA approach) for coronary artery disease in clinical routine.

## **T5B-SPCA-3 Using 7.0T Cardiac MR to Explore Cangai Volatile Oil Treat Different Degrees of Myocardial Hypertrophy in Rats Exposed to Chronic Hypobaric Hypoxia at Plateau**

Boshen Liang (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study was intended to investigate whether cardiovascular magnetic resonance (CMR) imaging could reveal the protective effect of Cangai volatile oil (CAVO) on the heart of rats with chronic hypobaric hypoxia at plateau. On this basis, further explore the therapeutic effect of CAVO on isoproterenol induced myocardial hypertrophy in rats.

## **METHODS AND MATERIALS**

Seventy rats were randomized into the Control group (CON), plateau group (P group), P+ CAVOh (plateau + CAVOh), P+ CAVOI(plateau + CAVOI), P+MH (plateau+ myocardial hypertrophy,PM), P+MH+CAVOh(PM+ CAVOh), P+MH+CAVOI (PM+CAVOI). Except the Control group (altitude: 500 m), rats in other groups were transported to Yushu (altitude: 4,250m) for two months, where the group of PM,PM+CAVOh,PM+CAVOI were underwent intraperitoneal injection of ISO (3 mg/kg for 14 days) and P, P+CAVOh,P+CAVOI group were underwent intraperitoneal injection of saline in the same time. Left ventricular function, global strain of the rats can be measured by 7.0T high-field CMR and analyzed using the cine tissue tracking. Biochemical tests, histopathology and electronic microscopy were used to evaluate the protective effect of CAVO on the heart tissue of cardiac damage rats exposed to a high-altitude environment.

## **RESULTS**

The left ventricular ejection fraction (LVEF) and global strains were improved in all group after treat by CAVO compared with the Hypobaric Hypoxia group ( $p<0.05$ ). Furthermore, the oxidative stress injuries were after CAVO treatment, evidenced by the increases of SOD, GSH-Px, while the decreases of MDA and LDH contents (all  $p<0.05$ ). The results of western blot indicated that CAVO treatment dramatically restrained Keap-1, COL-1,  $\alpha$ -SMA protein expressions in cardiac tissues of mice, NRF2, HO-1 protein expression increased.

## **CONCLUSION**

CAVO can reduce cardiac damage caused by hypobaric hypoxia and ventricular hypertrophy induced by Isoprenaline (ISO) at plateau through oxidative stress-related indicators, this effect can be measured by 7.0T high-field CMR.

## **CLINICAL RELEVANCE/APPLICATION**

This experiment provides a new treatment approach for different degrees of ventricular hypertrophy in plateau for clinical practice.

**T5B-SPCA-4** Ao Liu (*Presenter*) Nothing to Disclose



# Feasibility Analysis of Non-ECG-triggered Chest LDCT using a kV-independent Reconstruction Algorithm for Predicting Cardiovascular Disease Risk in Patients Receiving Maintenance Hemodialysis

## PURPOSE

This study aimed to explore the

feasibility and accuracy of non-electrocardiogram (ECG)-triggered chest low-dose computed tomography (LDCT) with a kV-independent reconstruction algorithm in assessing the degree of coronary artery calcification (CAC) and the risk of cardiovascular diseases in patients receiving maintenance hemodialysis (MHD).

## METHODS AND MATERIALS

181 patients receiving MHD who needed chest CT and coronary artery calcium score (CACS) scans underwent non-ECG-triggered, automated tube voltage selection, high-pitch chest LDCT scan using a kV-independent reconstruction algorithm (research scan) and ECG-triggered standard CACS scan (standard scan) sequentially. The image quality, radiation doses, CACS and cardiac risk classifications of the two scans were compared.

## RESULTS

Among the 181 patients, 89, 83, and 9 underwent scanning at 100, 110, and 120 kV, respectively. Excluding those scanned at 120 kV, 172 patients were enrolled. The Visual Scores (VSs) of the research scan showed high interobserver agreement (ICC = 0.944; 95% CI: 0.925-0.958). A significant difference was observed between the non-ECG-triggered VS and the standard CACS Agatston score (AS) on cardiac risk classification ( $\chi^2 = 34.333$ ,  $P < 0.001$ ; weighted kappa value = 0.813; 95% CI: 0.756-0.869). The accuracy of cardiac risk classification of non-ECG-triggered VS was 77.91% (134/172), considering the cardiac risk classification of standard CACS AS as the gold standard. Although the ASs obtained from the research scan were lower than those obtained from the standard scan ( $739.90 \pm 1098.38$  vs  $801.56 \pm 1129.60$ ;  $P < 0.001$ ), the agreement and correlation of them were excellent, and ICCs and Pearson's correlation coefficients were both  $>0.96$ . No significant difference was observed in cardiac risk classifications between the two scans ( $\chi^2 = 3.933$ ,  $P = 0.269$ ), and the agreement was excellent (weighted kappa value = 0.936; 95% CI: 0.903-0.970). The accuracy of cardiac risk classification based on non-ECG-triggered AS was 92.44% (159/172). The effective radiation doses (ED) of the standard scan and the research scan were  $1.34 \pm 0.74$  mSv and  $1.04 \pm 0.35$  mSv. With the equivalent image quality, the average ED and CTDIvol of the research scan were reduced by 21.77% and 59.93%, respectively.

## CONCLUSION

A CT protocol using the non-ECG-triggered, automated tube voltage selection, high-pitch chest LDCT protocol with a kV-independent reconstruction algorithm can accurately demonstrate the degree of CAC, maintain the overall cardiac risk classification and significantly reduce the radiation exposure of patients.

## CLINICAL RELEVANCE/APPLICATION

This protocol can implement one-stop scanning of the chest and CACS and significantly reduce the radiation dose.

## T5B-SPCA-6 Novel Technique of Multi-slice Acquisition of Simultaneous Myocardial T2-weighted Imaging (T2WI) and Multi-echo T2 Mapping using Deep Resolve Reconstruction (MS-T2WI/Map)

Yui Tanaka, RT (Presenter) Nothing to Disclose

## PURPOSE

Myocardial T2-weighted image (T2WI) and T2 mapping, which are used to assess the edema and inflammation, require the long acquisition time, and mapping is acquired only single slice per single breath hold. Deep Resolve (DR) technique, which is novel reconstruction with denoising and increased sharpness based on deep learning architecture, permit the shortening scan time with maintaining image quality. The aim was to evaluate the feasibility of multi-slice acquisition of simultaneous T2WI and T2 mapping using DR technique (MS-T2WI/Map) for myocardial T2 characterization.

## METHODS AND MATERIALS

We obtained the MS-T2WI/Map and conventional single-slice T2 map and T2WI in 10 volunteers and 14 patients with cardiomyopathy at short-axial slice, and volunteers underwent in repeated three times. MS-T2WI/Map consists of triple-contrast spin-echo (TE=13, 56 and 107 msec) with black-blood and fat suppression, and can acquire simultaneously 3 slices in a single breath-hold. The obtained images were reconstructed using DR method. T2 map was obtained using 3 TE images. Further, images with TE=56 msec yield T2WI. In T2WI, image quality using the 4-point scale and contrast ratio (CR) between myocardium and muscle were evaluated. In T2 map, we measured the T2 values at septal wall and obtained coefficient of variation (CV) in three times. In patients, the detection of focal abnormality in T2WI and T2 value (defined as  $>2SD$  of normal) were also evaluated.

## RESULTS

The mean acquisition time of MS-T2WI/Map was 26 sec, which was 75% shorter than the conventional scans. There were no significant differences in image quality of T2WI between both scans. CR in MS-T2WI/Map showed good correlation with that in reference (volunteers:  $r=0.68$ , patients:  $r=0.86$ ). T2 values obtained from MS-T2WI/Map underestimated compared with

conventional T2 map, but there were good correlation and agreement between two methods (volunteers: $r=0.94$ , patients: $r=0.65$ ). Further, CV in MS-T2WI/Map showed comparable reproducibility with conventional map. Abnormal myocardial changes were identified in all participants with MS-T2WI/Map in similar to conventional T2-based imaging.

#### **CONCLUSION**

MS-T2WI/Map with DR is a promising tool for shortening acquisition time with equivalent image quality and T2 measurement to conventional sequences, enabling the multi-slice simultaneous myocardial T2 characterization in single-breath-hold.

#### **CLINICAL RELEVANCE/APPLICATION**

MS-T2WI/Map permits the simultaneous myocardial T2WI and T2 map with equivalent image quality and quantification to conventional methods, enabling multi-slice assessment of focal disease. Our proposed method is useful and practical approach for the reduction of acquisition time and the integrated assessment of both T2WI and T2 map.

#### **T5B-SPCA-7 Improving In-stent Stenosis Visibility for Prototype Photon Counting Detector CT with High-resolution Plaque Kernel**

Yoshinori Funama, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Photon counting detector CT (PCD-CT) with dedicated high-resolution (HR) plaque kernel is newly introduced for improving in-stent stenosis visibility in coronary CT angiography. PCD-CT with HR-plaque kernel enable improved visualization and accurate assessment of coronary plaques. The present study aimed to investigate the performance of PCD-CT with HR-plaque kernel as compared with conventional energy-integrating detector CT (EID-CT) in terms of lumen size and in-stent stenosis visibility.

#### **METHODS AND MATERIALS**

A vessel tube with non-calcified plaque in a 3.0-mm stent was scanned by using EID-CT (FUJIFILM Healthcare Corporation, Tokyo, Japan) and prototype PCD-CT (Ultra-High Resolution mode, FUJIFILM Healthcare Corporation) with HR-plaque kernel at 3 stent directions (0, 45, and 90 degrees). The tube voltage and tube current-time product were set at 120 kVp and 300 mAs. A rectangular region of interest was set across both sides of the stent struts with a 50% stenotic portion on multiplanar reformation (MPR) images. The profile curves were obtained from two types of PCD- and EID-CT images. The lumen size was calculated from the distance between the inner strut positions. The 50% stenotic portion was also measured using the profile curve.

#### **RESULTS**

The lumen sizes for PCD-CT and EID-CT images were 2.13 and 1.80 mm at 0 degree, 2.20 and 1.17 mm at 45 degrees, 2.27 mm and 1.67 mm at 90 degrees. The lumen sizes for PCD were wider than those for EID-CT regardless of the stent directions. The measurements of in-stent stenosis were 67.6% - 72.7% at 0 - 90 degrees in PCD-CT. For EID-CT, the measurements of in-stent stenosis were 90.7% - 90.0% at 0 - 90 degrees. The stenotic portion for PCD-CT images enabled more accurate measurements than that for EID-CT. PCD-CT images and MPR images showed fewer blooming artifacts and better plaque conspicuity and iodine enhancement than EID-CT images.

#### **CONCLUSION**

PCD-CT images with HR-plaque kernel showed improved lumen size and accurate measurements of in-stent stenotic portion as compared with conventional EID-CT images regardless of the stent directions.

#### **CLINICAL RELEVANCE/APPLICATION**

The PCD-CT with HR-plaque kernel provide better visibility of the coronary plaque and iodine enhancement and accurate assessment of the stenotic portion on coronary CT angiography.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPCH

### Chest Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPCH- A Study Design for Quantitative Characterization of Pulmonary Gas Exchange in Long COVID** **1 Using Hyperpolarized $^{129}\text{Xe}$ MRI**

Aiah Alatoum, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The use of hyperpolarized Xenon (HP-Xe) was approved by the FDA (Xenoview<sup>TM</sup>) for MRI-based evaluation of lung function in adults and pediatric patients over 12 years. Quantitative characterization of ventilation and gas exchange metrics is critical in ensuring the accuracy and reliability of HP-Xe MRI as a diagnostic tool. This study provides a framework for quantitative validation using dual-energy computed tomography (DECT).

#### **METHODS AND MATERIALS**

15 participants with a history of COVID-19 (diagnosed 17+-5 months prior) of varying severity, were recruited. HP-Xe imaging of regional ventilation and gas exchange and contrast-enhanced perfusion imaging was performed on a 3T scanner. Gas exchange HP-Xe using a 1-point Dixon technique was used to estimate Xenon transfer into the pulmonary tissues and plasma (Membrane), as well as the red blood cells (RBC). The ratio of these signals, (RBC: Membrane), was used as the surrogate marker for gas exchange. The participants also underwent ventilation/perfusion (V/Q) imaging on DECT using non-contrast Total Lung Capacity (TLC) to virtual non-contrast Functional Residual Capacity (FRC) warping for V and DECT perfused blood volume (PBV as a surrogate for Q) at FRC. The heterogeneity of gas exchange was characterized using the 2nd moments of the normalized V and PBV distributions vs. V/Q ratio in the log scale (lnSDV and lnSDQ) in a 50-compartment model, similar to classical techniques for VQ matching. These metrics rely on absolute quantification of true ventilation and perfusion and have been adapted to the normalized CT-derived datasets.

#### **RESULTS**

Our study confirmed, as shown in previous literature, the correlation between RBC: Membrane from HP Xenon MRI and DLCO ( $R^2 = 0.74$ ,  $p=0.0005$ ) in our 15 participants. The baseline data from the 7 participants in the preliminary analysis showed that the RBC: Membrane ratio from HP-Xe MRI was significantly correlated to the CT-derived lnSDQ ( $R^2 = 0.58$ ,  $p=0.047$ ), indicating agreement between modalities in assessing heterogeneity of gas exchange.

#### **CONCLUSION**

Preliminary data supports quantitative comparisons between hyperpolarized Xe MRI and CT-derived assessments of gas exchange. Cross-sectional analyses using disease severity at diagnosis, longitudinal follow-up, and comprehensive assessment of spatially-matched ventilation and perfusion distributions are in process for direct regional comparisons between modalities.

#### **CLINICAL RELEVANCE/APPLICATION**

Hyperpolarized Xe imaging provides a non-ionizing alternative to DECT, allowing for regular follow-up in patients with persistent symptoms beyond their initial diagnosis.

#### **T5B-SPCH- Quantitative Chest of Marijuana Use**

**2**

Ozgu Alcali, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recreational and medical marijuana use has increased in recent years, in part due to legalization driven by arguments that marijuana is relatively safe and with numerous health benefits. We aimed to investigate marijuana's effect on the lungs through quantitative analysis as well as image review.

## METHODS AND MATERIALS

By searching the electronic medical record, we identified patients who were marijuana users who never smoked; current smokers; and non-marijuana never smokers, who underwent chest CT in our healthcare system in 2019. We generated a random sample of 100 marijuana users as well as 100 each age- and sex- matched controls from the current smoker and never smoker groups. Quantitative CT lung density analysis was performed to measure total lung volume (TLV) and percent high attenuation area (HAA, -600 to -250 HU). We defined >3% HAA as abnormal. A thoracic radiologist reviewed chest CTs in a blinded fashion for presence of emphysema.

## RESULTS

TLV was higher in smokers than marijuana users and non-smokers ( $p < .01$  for both). By visual analysis, 62% of smokers had emphysema versus 4% of marijuana users ( $p < .001$ ). Marijuana users were more likely to have increased HAA (18%) compared to smokers (7%) or non-smokers (9%),  $p = 0.04$ . In a multivariable analysis, larger pulmonary artery (PA) size (OR 1.1 per mm,  $p = 0.01$ ) and marijuana use (OR 3.5 versus smoking,  $p = 0.02$ ) were associated with increased HAA.

## CONCLUSION

While emphysema and hyperinflation were common in smokers, they were rare in marijuana users. However, marijuana users had more high-attenuation, which also correlated with enlarged pulmonary arteries, suggesting a vasoactive effect of marijuana on the pulmonary arterial system.

## CLINICAL RELEVANCE/APPLICATION

While it does not appear to cause emphysema, marijuana use does affect the lungs, potentially through the pulmonary arterial system, and may not be as safe as initially assumed.

## T5B-SPCH- High Spatial Resolution Data Improves Diagnostic Performance of Machine-Learning Radiomics Model: Prediction for Invasive Adenocarcinoma of the Lung

Masahiro Yanagawa, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

First, to construct two machine-learning radiomics models to predict invasive adenocarcinoma (IVA) using training data from normal-spatial resolution (NR) and high spatial resolution (HR), respectively. Second, in another test cohort, to validate diagnostic performance of two models (model-NR and -HR) while comparing results by two independent radiologists with and without model-HR.

## METHODS AND MATERIALS

Enrolled were 447 patients with 465 nodules ( $n = 97$ , non-IVA; and  $n = 368$ , IVA) who underwent 160-row high-spatial-resolution CT (Aquilion Precision, Canon Medical Systems). All CT images were reconstructed using iterative reconstruction method with NR data (512×512 matrix size, 0.5-mm slice thickness) and HR data (2048×2048 matrix size, 0.25-mm slice thickness), respectively. 465 nodules were divided into the training set ( $n = 61$ , non-IVA;  $n = 165$ , IVA) and the test set ( $n = 36$ , non-IVA;  $n = 203$ , IVA). Two models were developed by selecting 15 significant factors from 172 radiomics features in the training set, using correlation analysis and variance inflation factor, and establishing a random forest. In the test set, the area under the receiver operator characteristic curves (AUC) were statistically analyzed using DeLong's test to compare between model-NR and -HR. To compare accuracy (acc), sensitivity (sen), and specificity (spc) of two radiologists (R1, R2) with and without model-HR using McNemar test. P values  $< 0.05$  were considered significant.

## RESULTS

In the training set, AUC of the model-HR (0.839) was significantly higher than model-NR (0.723) ( $p < 0.05$ ). In the test set, AUC of the model-HR (0.863) was also significantly higher than model-NR (0.718) ( $p < 0.05$ ). Without the model-HR, acc, sen, and spc of the radiologists were as follows: R1, 77.0%, 79.3%, and 63.9%; and R2, 83.7%, 85.7%, and 72.2%, respectively. With the model-HR, acc, sen, and spc of the radiologists were as follows: R1, 86.6%, 93.1%, and 52.8%; and R2, 83.7%, 86.7%, and 66.7%, respectively. Acc and sen of R1 was significantly higher with than without the model-HR ( $p < 0.0001$ ). Acc and sen of R2 was equal or higher with than without the model-HR, but not significant ( $p > 0.50$ ). Spc of R1 and R2 tended to decrease with AI, but not significant ( $p > 0.21$ ).

## CONCLUSION

High spatial resolution significantly improved diagnostic performance of IVA by the machine-learning radiomics model. When used by radiologists, the present model tended to increase the accuracy and sensitivity of IVA diagnosis at the expense of specificity.

## CLINICAL RELEVANCE/APPLICATION

Machine-learning radiomics model trained by high spatial resolution data can greatly enhance diagnostic performance of invasive adenocarcinoma, providing support to radiologist, especially in improving accuracy and sensitivity.

## **T5B-SPCH-4 Radiological-Histological Correlation on Ultra-High-Resolution CT Using Cadaveric Human Lungs: Nodule and Airway Analysis**

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To assess the performance of ultra-high-resolution CT (UHR-CT) to evaluate nodules and airways (bronchioles and bronchi) compared with conventional CT (C-CT) using cadaveric human lungs.

### **METHODS AND MATERIALS**

Image data of 20 cadaveric lungs were acquired by C-CT and UHR-CT at radiation dose with a noise level equivalent to the diagnostic reference level image (CTDIvol: 9.1mGy). C-CT images were reconstructed with 512 matrix, 0.5 mm thickness, and hybrid iterative reconstruction (hIR). UHR-CT images were reconstructed with three settings; UHR-512: same as C-CT; UHR-DLR: 1024 matrix, 0.25 mm thickness, and DLR; UHR-2048: 2048 matrix, 0.25 mm thickness, and hIR. Two specimens per lung were obtained and examined using hematoxylin and eosin stains. The CT images were evaluated for nodules and airways on a 5-point scale comparing with histology (1=Not identifiable, 2=Barely identifiable, 3=Identifiable, but difficult to assess detail, 4=Partially consistent with histology, 5=Nearly consistent with histology). For identifiable nodules, error rates were calculated as the absolute difference between diameters on CT and true diameters on histology divided by the true diameters. Objective noise was evaluated by measuring standard deviation. The Wilcoxon signed-rank test with Bonferroni correction was used for statistical analyses.

### **RESULTS**

In total, 70 nodules (median 1195  $\mu$ m, range 235 - 8803  $\mu$ m) and 91 airways (median 855  $\mu$ m, range 204 - 3324  $\mu$ m) in 40 specimens were evaluated. In terms of nodules, UHR-2048, UHR-DLR, UHR-512, and C-CT scored significantly higher in that order (C-CT, 2.6 $\pm$ 1.1; UHR-512, 2.9 $\pm$ 1.2; UHR-DLR, 3.4 $\pm$ 1.4; UHR-2048, 3.6 $\pm$ 1.5; all  $p$ <0.002). The error rate on UHR-CTs tended to be lower than that of C-CT, but there was no significant difference (C-CT, 0.17 $\pm$ 0.13; UHR-512, 0.13 $\pm$ 0.16; UHR-DLR, 0.12 $\pm$ 0.13; UHR-2048, 0.12 $\pm$ 0.10; all  $p$ >0.05). In terms of airways, UHR-DLR and UHR-2048 scored significantly higher than C-CT and UHR-512 (C-CT, 1.9 $\pm$ 1.5; UHR-512, 2.1 $\pm$ 1.5; UHR-DLR, 2.9 $\pm$ 1.7; UHR-2048, 2.7 $\pm$ 1.7). UHR-DLR tended to score higher than UHR-2048, but there was no significant difference ( $p$ =0.022>0.0083 [Bonferroni correction]). Objective noise was significantly larger for UHR-2048, UHR-512, UHR-DLR, and C-CT in that order (C-CT, 21 $\pm$ 4HU; UHR-512, 41 $\pm$ 5HU; UHR-DLR, 33 $\pm$ 6HU; UHR-2048, 50 $\pm$ 4HU; all  $p$ <0.001).

### **CONCLUSION**

UHR-CT images with high resolution reconstruction setting outperformed C-CT in the assessment of nodules and airways. Hybrid IR with 2048 matrix showed a better score than DLR with 1024 matrix for nodule assessment.

### **CLINICAL RELEVANCE/APPLICATION**

UHR-CT is suitable for the assessment of nodules and airways in detail. Hybrid IR with 2048 matrix may be the most advantageous for the assessment of the fine morphology of nodules.

## **T5B-SPCH-6 Motion Artifact Correction using a New Deep Learning Reconstruction (MC-DLR) in the Chest Computed Tomography**

Yoichiro Ota, RT (*Presenter*) Nothing to Disclose

### **PURPOSE**

A new motion correction method, motion correction - deep learning reconstruction (MC-DLR), has been developed using a deep learning framework to estimate patient motion in chest computed tomography (CT). This study aimed to assess the effect of MC-DLR in emergencies.

### **METHODS AND MATERIALS**

This single-institution retrospective study was approved by our institutional review board. The requirement for written informed patient consent was waived. The subjects included 20 emergency cases (15 of whom were male patients, with a median age of 78) during July and August 2022. All CT scans were obtained using a 320-row CT scanner (Aquilion One Genesis, Canon Medical Systems, Otawara, Tochigi, Japan) at 120 kVp using automatic exposure control. Two types of images were reconstructed, with and without MC-DLR, both with a 512  $\times$  512 matrix size and 0.5-mm slice thickness. A technologist developed a multi-planer image obtained at the sino-tubular junction of the ascending aorta in each CT image (Fig.1). Six radiologists and six technologists measured the maximum aortic diameter and its perpendicular diameter on each image, in a randomized and independent manner, without any prior information. Additionally, they scored the motion artifact of the aorta using a four-step scale (0 = none, 1 = slight, 2 = mild, 3 = severe). Three certified chest radiologists compared all CT images with and without MC-DLR sets side by side and graded the motion artifact in the ascending aorta, coronary arteries, the left lower lobe of the lung, and other areas of the lung using a four-step scale. The total artifact score was determined as the sum of these individual scores. We compared these aortic diameters and scores using a paired t-test.

## RESULTS

The mean artifact score in the MPR image evaluation decreased significantly from  $1.64 \pm 0.96$  in the image without MC-DLR to  $1.32 \pm 1.03$  in the image with MC-DLR ( $p < 0.001$ ). The mean aortic diameter did not differ significantly between the two image sets, measuring  $33.0 \pm 3.3$  mm without MC-DLR and  $33.0 \pm 3.5$  mm with MC-DLR. However, the mean perpendicular diameter increased significantly, measuring  $30.7 \pm 3.3$  mm without MC-DLR and  $31.4 \pm 3.5$  mm with MC-DLR ( $p < 0.001$ ). When CT images were evaluated by certified radiologists, the total motion artifact score decreased significantly from  $6.8 \pm 2.8$  in the images without MC-DLR to  $4.6 \pm 2.9$  in those with MC-DLR ( $p < 0.001$ ).

## CONCLUSION

MC-DLR, a new motion correction method, decreases motion artifacts in chest CT images.

## CLINICAL RELEVANCE/APPLICATION

Obtaining high-quality CT images is often challenging in emergency cases. MC-DLR effectively reduces motion artifacts in post-processed images, improving the image quality.

## T5B-SPCH- Assessment of Lung Perfusion using Dynamic Digital Radiography and Comparison with Nuclear Medicine Lung Scintigraphy

Naga Sai Rasagna Mareddy, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

Assessment of lung perfusion is an important element in the preoperative evaluation of patients being considered for lung transplant or resection. Dynamic digital radiography (DDR) is a newer radiographic technique acquiring rapid sequential diagnostic radiographs of the chest throughout multiple respiratory cycles. The regional lung perfusion can be estimated using DDR by assessing pixel signal changes throughout the cardiac cycle. This study will compare the results of the differential lung perfusion estimated using DDR with the same results obtained from Nuclear Medicine (NM) lung scintigraphy, a conventional imaging modality.

## METHODS AND MATERIALS

A retrospective review of patients evaluated with both nuclear medicine lung scintigraphy and DDR was performed. The DDR examinations were performed between January 14, 2022 and April 25, 2023. Each patient had a lung scintigraphy perfusion study within 6 months of the DDR examination. The percent differential of perfusion between the lungs was calculated using both modalities and the results were analyzed for statistical correlation.

## RESULTS

Results for 53 patients were reviewed (mean age - 56 years, 21 females). The mean absolute percent differential in perfusion between the right and left lungs was ( $14.6 \pm 24.9\%$ ) using DDR and ( $16.4 \pm 25.7\%$ ) using lung scintigraphy. There was only one patient in which there was a discrepancy between the two modalities in determining which lung was better perfused. The perfusion results obtained using the two modalities were strongly correlated ( $r = 0.923$ ,  $p < .001$ , 95% CI [0.870,0.955]).

## CONCLUSION

Differential lung perfusion estimated by DDR is strongly correlated with the same result obtained using lung scintigraphy. The speed and cost effectiveness of DDR make it an attractive option for clinicians, potentially reducing wait times and healthcare cost for patients.

## CLINICAL RELEVANCE/APPLICATION

Dynamic digital radiography (DDR) is a novel functional imaging modality for assessment of lung perfusion, with strong correlation to nuclear medicine lung scintigraphy making it a faster and more cost-effective option for preoperative evaluation of lung transplant/resection candidates.

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## Abstract Archives of the RSNA, 2023

T5B-SPER

### Emergency Radiology Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPER-2 Prediction Of Enhancement Peaking Time Of Pulmonary Artery Computed Tomography Angiography: Based On Physiological Data And Random Forest Model**

Tuo He (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate a random forest model for preoperative prediction of contrast peaking time in pulmonary computed tomography angiography using patient physiological data.

#### **METHODS AND MATERIALS**

A total of 511 patients with 53 sets of physiological data (including baseline, clinical, hemodynamic, radiographic structural) and pulmonary artery contrast peaking time were enrolled. Peaking times were extracted from time-density curves obtained from previous low-dose contrast tests performed with pulmonary CTA. The region of interest was placed in the pulmonary artery trunk. The prediction model was developed in a primary cohort that consisted of 409 patients. Least absolute shrinkage and selection operator (LASSO) regression model was used for data feature selection, and signature building. Random forest method was used to develop the predicting model. An independent validation cohort contained 102 consecutive patients, 10-fold cross-validation was used to validate the peaking time prediction model. The predictive efficacy of the model was assessed using the area under the receiver operating characteristic (ROC) curve (AUC), sensitivity, and specificity in primary and validation cohort. All examinations were performed on a 256-row Revolution CT. Statistical analysis was conducted with R software. The reported statistical significance levels were all two-sided, with statistical significance set at 0.05.

#### **RESULTS**

16 selected feature variables including COPD history, cardiac function classification (NYHA), hypothyroidism, hypertension classification and risk stratification, coronary heart disease history, valvular disease history, Injection site, Sex, Age, Contrast agent dose, Superior vena cava size (long diameter and short diameter), Pulmonary artery width, Pulse rate and Diastolic pressure were significantly associated with peaking time. The AUC, sensitivity and specificity of the peaking time prediction based on the proposed model was 0.795, 0.047, 0.997 in the primary cohort, and 0.738, 0.056, 0.796 in the validation cohort.

#### **CONCLUSION**

A random forest model that incorporates various physiological data may be used to preoperatively predict contrast peaking time to optima contrast use in pulmonary CTA.

#### **CLINICAL RELEVANCE/APPLICATION**

The empirical time method, small-dose contrast agent test method, and the dynamic tracking threshold trigger method are commonly used in the current peak time calculation for contrast-enhanced examinations. However, these methods have the disadvantages of insufficient accuracy, increased contrast injection and increased radiation dose to the patient, respectively. In contrast, the prediction of peak time by random forest models can perfectly solve these drawbacks mentioned above.

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## Abstract Archives of the RSNA, 2023

T5B-SPGI

### Gastrointestinal Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPGI-1 High Resolution CT Imaging with a 1024 Matrix: Impact of Matrix Size, Slice Thickness, Reconstruction Algorithm, and Reslicing on Radiomic Feature Quantification in Hepatocellular Carcinoma**

Masatoshi Hori, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation

#### **PURPOSE**

Following the emergence of ultra-high-resolution (UHR) CT or photon-counting CT systems, 1024-matrix abdominal imaging has become clinically relevant. These depictions offer superior spatial resolution compared to conventional images. However, the impact of matrix size, slice thickness, reconstruction algorithm, and reslicing on radiomic evaluations remains poorly understood. The aim was to elucidate the consequences of these parameters on CT radiomic feature quantification in hepatocellular carcinoma (HCC).

#### **METHODS AND MATERIALS**

This retrospective analysis involved 29 subjects (16 males, 13 females; median age, 73 years) diagnosed with HCC, who underwent contrast-enhanced CT during late arterial and portal venous phases employing super-high-resolution mode with a UHR CT scanner (Aquilion Precision; Canon). Lesions exhibited a median diameter of 32.6 mm (range, 11.1-113.6mm). UHR CT images with a 1024-matrix were reconstructed utilizing filtered back projection and hybrid iterative reconstruction. Slice thicknesses comprised 0.5, 1.0, and 5.0 mm. CT images with a 512-matrix were also reconstructed with the normal-resolution simulation algorithm. A representative tumor was three-dimensionally segmented per patient. Subsequently, 120 radiomic features, with and without reslice at 1-mm voxel, were calculated in three dimensions for each image set. Features were categorized as first-order (n=19), shape (n=26), and texture (n=75). A linear mixed-effects model evaluated the impact of imaging parameters on features, deeming P-value < 0.05 divided by 120 for Bonferroni correction significant.

#### **RESULTS**

Within both arterial and portal venous phases, among 120 features, slice thickness significantly impacted 30 (25.0%) and 28 (23.3%) features, respectively. The 1024-matrix affected 19 (15.8%) and 18 (15.0%) features, whereas reslicing influenced 14 (11.7%) and 16 (13.3%) features, respectively. Conversely, the reconstruction algorithm exerted minimal effect on 2 (1.7%) and 0 (0.0%) features.

#### **CONCLUSION**

Slice thickness emerged as the most influential factor affecting the measurement values of features. Subsequently, when employing UHR images (1024 matrix) compared to conventional-resolution images (512 matrix), significant differences were observed in 15-16% of feature measurements in both arterial and portal venous phases. The effects of reslicing were discernible in approximately 10% of features, while the impact of the reconstruction algorithm was minimal.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiomic features procured from UHR CT employing a 1024 matrix diverge from those garnered through conventional CT. Slice thickness prevails as the primary determinant, with the 1024-matrix as the subsequent influencer.

#### **T5B-SPGI-2 Predictive Value of LI-RADS v2018 Combined ADC for Hepatocellular Carcinoma and Other Primary Hepatic Malignancies in the LI-RADS M Classification**

Jiangyang Pan (*Presenter*) Nothing to Disclose



## PURPOSE

To investigate the predictive value of LI-RADS v2018 MR imaging features, ADC values to identify hepatocellular carcinoma (HCC) and other hepatic primary malignancy (OM) in the LI-RADS M (LR-M) classification.

## METHODS AND MATERIALS

MR imaging of 142 patients with primary liver cancer were classified as LR-M by two radiologists, 62 in the HCC group and 80 in the OM group. Comparing ADC and general clinical data including age, gender, location, AFP, CA19-9, length diameter of patients between the two groups, as well as LI-RADS MR imaging features: nonperipheral "washout", enhancing "capsule", nodule-in-nodule, mosaic architecture, blood products in mass, fat in mass, rim APHE, peripheral "washout", delayed central enhancement, targetoid restriction, bile duct dilatation. ADC were converted to dichotomous variables by ROC curves, and the independent predictors of HCC and OM in LR-M were screened by single-factor and multi-factor regression analysis, and the predictive value of each independent predictor and predictive model was analysed by ROC curves.

## RESULTS

Elevated AFP (42/62, 67.7%), enhancing "capsule" (41/62, 66.1%) and blood products in mass (13/62, 21%) were seen in a higher rate in the HCC group, with ADC =  $1.083 \times 10^{-3}$  mm<sup>2</sup>/s. The OM group showed elevated CA19-9 (42/80, 52.5%), a higher rate of delayed central enhancement (51/80, 63.8%), targetoid restriction (41/80, 51.3%) and bile duct dilatation (41/80, 51.3%), and ADC >  $1.083 \times 10^{-3}$  mm<sup>2</sup>/s. The differences in these parameters were statistically significant (P < 0.05). Multi-factor regression analysis showed that AFP, enhancing "capsule", ADC classification, and bile duct dilatation were independent predictors of the HCC and OM groups, and ROC curves showed the highest AUC of 0.950 for the prediction model, with a sensitivity of 85.5% and a specificity of 91.2%.

## CONCLUSION

The ADC classification is an independent predictor for differentiating HCC and OM in the LR-M classification. Combined with elevated AFP, enhanced capsule, and bile duct dilatation, ADC classification can effectively improve the ability to distinguish HCC from OM.

## CLINICAL RELEVANCE/APPLICATION

LI-RADS v2018 combined with ADC values can effectively predict hepatocellular carcinoma (HCC) and other hepatic primary malignancy (OM) in the LR-M classification.

## T5B-SPGI-3 Association of CEUS and CT/MRI LI-RADS Major Feature with Hepatocellular Carcinoma: Comparison of Cirrhosis and Hepatitis B Risk Factors using Individual Participant Data Meta-analysis

Robert G. Adamo (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the association of LI-RADS major features with HCC and positive predictive value (PPV) for HCC of LI-RADS categories in patients with cirrhosis, HBV-related cirrhosis, and non-cirrhotic chronic-HBV using Individual Participant Data (IPD) meta-analysis.

## METHODS AND MATERIALS

IPD was extracted from studies evaluating CT, MRI and contrast-enhanced ultrasound (CEUS) for diagnosis of HCC using LI-RADS (v2014-2022) (protocol link). Mixed models were applied. Odds ratios (ORs) for each major feature and PPV for each LI-RADS category were determined using multivariable logistic regression in three subgroups: Group-A (cirrhosis), Group-B (HBV-related cirrhosis), and Group-C (HBV without cirrhosis). Risk of bias was assessed using QUADAS-2.

## RESULTS

29 studies (3453 patients) were included: Group-A (3453/4448 patients/observations), Group-B (1106/1232), and Group-C (721/781). CT/MRI major features [threshold growth not assessed, low data] were all associated with HCC: Group-A OR ranges 1.84-5.25; Group-B OR ranges 2.36-8.18; Group-C OR ranges 2.63-5.92. CEUS features associated with HCC: Group-A OR ranges 2.78-6.90, Group-B OR 9.88, and Group-C insufficient data (n=44). In CT/MRI and CEUS, the PPVs were comparable for LI-RADS categories 4 (LR-4) and 5 (LR-5) between Group-A, Group-B, and Group-C. Twenty-two studies (79%) had high risk of bias in at least one QUADAS-2 domain.

## CONCLUSION

CT/MRI, LI-RADS major features (other than TG) were independently associated with HCC in patients with non-HBV cirrhosis, HBV-cirrhosis, and non-cirrhotic HBV, suggesting that LI-RADS major features are applicable in patients with HBV, regardless of cirrhosis status. CEUS, there were insufficient data to evaluate differences among groups. CT/MRI and CEUS, PPV was comparable between groups for LR-4 and LR-5.

## CLINICAL RELEVANCE/APPLICATION

The CT/MRI LI-RADS major features show similar independent associations with HCC, and the positive predictive value (PPV) for LR-4 and LR-5 in CT/MRI and CEUS is comparable between cirrhosis (Group A), HBV-related cirrhosis (Group B), and non-cirrhotic HBV (Group C) patients. Therefore, this study supports the current LI-RADS v2018 approach, which does not adjust major imaging features based on different patient populations.

## **T5B-SPGI-4 Nontarget Y90 Transarterial Radioembolization (TARE): Can It Affect Post-Treatment HCC Localization and LIRADS-Treatment Response Algorithm (LR-TRA)?**

Charis Wang, BA (*Presenter*) Nothing to Disclose

### PURPOSE

In a prior study, we assessed the accuracy of the LIRADS-TRA in categorizing post-therapy response of HCC treated with TARE with yttrium-90, using liver explant pathology as the reference standard. However, Y90 TARE can cause variable non-target/background liver radiation features, confounding congruent LR-TRA assessment between readers. This study aimed to assess multireader variability of post-treatment lesion localization and the confounding effect of non-target radiation on the LR-TRA.

### METHODS AND MATERIALS

96 patients who had liver explant pathology after Y90 treatment for HCC between Oct 2015 and Oct 2021 were identified using data science tools. Patients with less than 90 days between Y90 treatment and pre-transplant MRI or CT were excluded due to immediate post-treatment enhancement confounding LR-TRA assessment. From the remaining 69 patients, there were 64 MRIs and 5 CTs completed before liver transplant, with 9 excluded for technical issues. Using post-contrast sequences, three readers independently reviewed each patient's exams and indicated the location of the pre-treatment lesion on the post-treatment image with an arrow. Arrow locations were compared and marked as congruent or noncongruent. Fisher's exact test was used to analyze interreader congruency of post-treatment lesion localization LR-TRA assessments of treatment response, and the respective correlations with the presence of non-target post-radiation changes.

### RESULTS

Lesion localization data was obtained for 60 exams. Among the 34 patients without nontarget changes, 32 (94.1%) demonstrated lesion localization congruency; while among the 26 patients without nontarget changes, only 13 (50%) were congruent ( $p < 0.001$ ). For LIRADS TRA classification, 76.5% (26/34) were congruent on exams without nontarget changes, while 42.3% (11/26) were noncongruent. ( $p = 0.05$ ). LR-TRA classification noncongruency was highest for the equivocal vs nonviable subcohort (30.8%; 8/26).

### CONCLUSION

Although non-target/background liver post-treatment (Y90) radiation changes can be variable, its presence can significantly impact interreader congruency for lesion localization and LIRADS-TRA classification.

## CLINICAL RELEVANCE/APPLICATION

The effect of non-target radiation changes on accurate lesion localization and LR-TRA classification should be taken into account when assessing therapeutic response of HCC treated with TARE with Y90.

## **T5B-SPGI-5 LI-RADS Treatment Response Algorithm v2023 versus v2018: Assessing Diagnostic Performance and Inter-reader Agreement in Patients with Hepatocellular Carcinoma Treated with Stereotactic Body Radiotherapy**

Joshua Breeden, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate the accuracy and inter-reader agreement of the updated LI-RADS Treatment Response Algorithm (LR TRA) v2023 for assessing tumor viability of hepatocellular carcinoma (HCC) treated with stereotactic body radiotherapy (SBRT) using explant as the gold standard.

### METHODS AND MATERIALS

This retrospective IRB approved study included patients who underwent SBRT for treatment of HCC between 2008 and 2021 with subsequent liver transplantation. Five readers independently reviewed all treated lesions according to LR TRA v2023, LR TRA v2018 and mRECIST. Observations were characterized as Viable, Non-viable, Nonprogressing (using v2023), or Equivocal (using v2018) based on LR TRA and complete response, partial response, stable disease, or progressive disease based on mRECIST. Predictive values for Viable and Nonviable categories were compared to pathology results using 100% as complete pathologic necrosis and less than 100% as incomplete pathologic necrosis. Performance metrics for assessing Viability and Nonviability of treated observation were calculated for each reader and reader agreement was determined for v2023 and v2018.

## RESULTS

44 lesions in 27 patients (median age: 63 [59-65 years]; 25 males) were included. Overall reader agreement for final category was 33%, 31%, and 30% for v2023, v2018 and mRECIST, respectively. Reader agreement amongst faculty and trainees for v2023, v2018 and mRECIST was 33%, 29%, and 31% and 42%, 33%, and 41%, respectively. There was increased reader agreement amongst faculty assigning Viable category from v2018 to v2023 (v2018: 25%; v2023: 35%) compared to Non-viable and Equivocal/Nonprogressing category (Nonviable v2018 to v2023: 37% to 37% and Equivocal v2018 to Nonprogressing v2023: 22% to 28%, respectively). Sensitivity and negative predictive value for predicting complete necrosis was 69% and 71% (v2023) and 63% and 70% (v2018), respectively, when Nonprogressing/Equivocal category were treated as Viable, accounting for subject clustering. Sensitivity and positive predictive value for predicting incomplete necrosis was 96% and 62% (v2023) versus 94% and 62% (v2018), respectively, when the Nonprogressing/Equivocal category was treated as Nonviable.

## CONCLUSION

LR TRA v2023 demonstrates improvement in reader agreement using newly defined terminology for persistently enhancing SBRT-treated HCC. LR TRA v2023 demonstrates similar diagnostic performance compared to v2018 for predicting incomplete and complete necrosis.

## CLINICAL RELEVANCE/APPLICATION

SBRT-treated HCC undergo slow necrosis and show persistent post-treatment APHE which should not be retreated. LR-TR Nonprogressing is a new category aiming to improve reporting consistency to reduce unnecessary early retreatment.

## T5B-SPGI-6 Intelligent Radiomics for Individualized Evaluation of Target in Patients with Advanced Hepatocellular Carcinoma

Mingguang Yang (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the use of intelligent imaging methods to develop intelligent imaging markers based on CT images and construct a visualization Nomogram to individually predict the efficacy of ronvatinib in patients with advanced hepatocellular carcinoma.

## METHODS AND MATERIALS

This study retrospectively analyzed 168 patients with hepatocellular carcinoma treated with ranvastinib and divided them into two independent study cohorts. First, image features were extracted from baseline CT images of 79 patients in cohort 1 using image omics analysis. A nested 10-fold cross-validation and Cox proportional hazard regression model were used to construct intelligent image omics markers combined with LASSO algorithm to predict treatment failure time TTF and overall survival OS in advanced HCC patients receiving targeted therapy. The efficacy of intelligent imaging markers was verified in a cohort of 89 patients.

## RESULTS

The nested 10-fold cross-verified training was repeated for 100 rounds, and the average consistency index C-index was 0.682 (t test  $P < 0.001$ ). Ultimately, intelligent imaging markers consisting of eight image features were significantly associated with TTF and OS ( $P < 0.001$ ), and were able to classify advanced HCC patients receiving targeted therapy into low-risk and high-risk groups, with 1-year treatment failure rates of 53.2% and 6.8%, respectively. The 2-year survival rates were 62.3% and 15.6%, respectively. Multivariate analysis showed that smart imaging markers were independent prognostic factors for TTF (HR: 4.840, 95%CI: 2.554-7.468,  $P < 0.001$ ) and OS (HR: 4.325, 95%CI: 2.034-11.225,  $P < 0.001$ ). A Nomogram integrated with intelligent imaging markers and clinicopathological parameters further improves the prediction performance.

## CONCLUSION

Intelligent imaging markers based on CT images can effectively predict treatment failure time and overall survival in advanced HCC patients receiving targeted therapy with ranvatinib. A Nomogram model was synthesized by fitting intelligent imaging markers and clinicopathological parameters to guide individualized targeted therapy for patients with advanced HCC.

## CLINICAL RELEVANCE/APPLICATION

In this study, intelligent imaging markers based on CT images combined with artificial intelligence technology can be used to guide individualized targeted therapy for patients with advanced HCC.

## T5B-SPGI-8 Machine Learning for Malignant versus Benign Focal Liver Lesions on US and CEUS: A Systematic Review and Meta-Analysis

Carlos Alberto Campello Jorge, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To perform a meta-analysis of the diagnostic performance of learning (ML) algorithms (conventional and deep-learning algorithms) for the classification of malignant versus benign focal liver lesions (FLLs) on US and CEUS.

## **METHODS AND MATERIALS**

Available databases were searched for relevant published studies through September 2022. Studies met eligibility criteria if they evaluate the diagnostic performance of ML for the classification of malignant and benign focal liver lesions on US and CEUS. The pooled per-lesion sensitivities and specificities for each modality with 95% confidence intervals were calculated.

## **RESULTS**

A total of 8 studies on US, 11 on CEUS, and 1 study evaluating both methods met the inclusion criteria with a total of 34,245 FLLs evaluated. The pooled sensitivity and specificity of ML for the malignancy classification of FLLs were 81.7% (95% CI, 77.2-85.4%) and 84.8% (95% CI, 76.0-90.8%) for US, compared to 87.1% (95% CI, 81.8-91.0%) and 87.0% (95% CI, 83.1-90.1%) for CEUS. In the subgroup analysis of studies that evaluated deep learning algorithms, the sensitivity and specificity of CEUS (n=4) increased to 92.4% (95% CI, 88.5-95.0%) and 88.2% (95% CI, 81.1-92.9%). Studies assessing multiple malignant and benign etiologies for FLLs had no lower diagnostic performance than those comparing only one etiology in each group for both methods.

## **CONCLUSION**

The diagnostic performance of ML algorithms for the malignant classification of FLLs was high for both US and CEUS with overall similar sensitivity and specificity. The similar performance of US may be related to the higher prevalence of DL models in that group.

## **CLINICAL RELEVANCE/APPLICATION**

Machine learning algorithms applied for the classification of focal liver lesions demonstrated high accuracy for both CEUS and US.

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## Abstract Archives of the RSNA, 2023

T5B-SPGU

### Genitourinary Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPGU- Global Variation in Magnetic Resonance Imaging of the Prostate using PI-QUAL: A Multicentre Study** 1

Francesco Giganti, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

High variability in prostate MRI quality reduces the accuracy of this technique in the detection of prostate cancer. The Prostate Imaging Quality (PI-QUAL) score is the first standardised scoring system that evaluates image quality using five points, where a score of 5 means the scan is of optimal diagnostic quality and a score of 1 means that all sequences are below the minimum standard for diagnostic quality. We aimed to assess prostate MRI quality following the application of PI-QUAL in the scans from different centres across the world undergoing quality control as part of an ongoing trial. We determined whether appropriate modifications to MRI protocols could optimise their diagnostic quality.

#### **METHODS AND MATERIALS**

For each scanner, centres submitted 5 consecutive MRI scans and the MRI protocols (Phase 1). Submitted data were evaluated in consensus by two expert genitourinary radiologists using PI-QUAL. Feedback was provided for scanners not reaching PI-QUAL 5, and centres were invited to resubmit a new study using the modified protocol (Phase 2).

#### **RESULTS**

In Phase 1, 41 centres from 18 countries submitted a total of 355 MRI images from 71 scanners, with 9 (13%), 39 (55%) and 23 (32%) scanners scoring a PI-QUAL score of 3, 4 and 5, respectively. Of the 48/71 (68%) scanners which received feedback to improve, the dynamic contrast enhanced sequences were those with the highest variability (44/48, 92%), followed by diffusion-weighted imaging (20/48, 42%) and T2-weighted imaging (19/48, 40%). 36 centres from 17 countries resubmitted revised studies, resulting in a total of 62/64 (97%) scanners completing Phase 2, scoring PI-QUAL 5.

#### **CONCLUSION**

We observed significant variation in prostate MRI quality, particularly with dynamic contrast enhanced sequences. Basic evaluation and modifications to MRI protocols using PI-QUAL can lead to substantial improvements in the global quality of prostate MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

There is significant global variation in prostate MR image quality, particularly in the dynamic contrast enhanced sequences. However, quality can be optimised with basic modifications to MRI protocols. Basic changes using the PI-QUAL score (that includes adherence to technical recommendations outlined in the PI-RADS guidelines) markedly improved the quality of scanners, with 97% and 3% of scans obtaining a PI-QUAL score of 5 and 4, respectively.

#### **T5B-SPGU- More with Less: A Quality Improvement Initiative to Evolve Multiparametric MR Prostate Imaging beyond the Endorectal Coil** 2

Scott H. Robertson, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish a consistent, efficient, and patient-friendly 3 Tesla MRI protocol for performing high-quality prostate MRI without an endorectal coil (ERC).

## METHODS AND MATERIALS

As part of the ACR Prostate MR Image Quality Improvement Collaborative, this single-center quality improvement (QI) project audited image quality across three project phases: pre-improvement, improvement, and post-improvement. Approximately 30 exams were audited each week (1114 exams total). All prostate exams were obtained on a 3T Siemens Magnetom Skyra (Syngo MR E11, Siemens Healthineers, Erlangen, Germany) with multiplanar T2-weighted imaging, DWI and ADC maps, and DCE imaging series following PI-RADS v2/2.1 guidelines. During the pre-improvement phase, our QI team regularly observed the imaging department using Gemba Walks, mapped out the imaging process, performed current state analysis, investigated root causes, and identified key drivers. Four months of pre-improvement exams were audited to quantify baseline performance and establish our SMART goal: achieving PI-QUAL = 4 for 85% of non-ERC MRI exams by the end of the 9-month Collaborative. In the improvement phase, interventions were implemented in rapid Plan-Do-Survey-Act cycles. A prostate phantom was developed for intervention testing to minimize the effects of patient variability. Progress was tracked on a run chart plotting the percentage of cases achieving PI-QUAL = 4. During the post-improvement phase, we tracked image quality to see how well the results were sustained. Educational materials for training technologists were developed by comparing image quality between ERC and non-ERC exams.

## RESULTS

Pre-improvement, 64.8% (318/491) of baseline exams achieved PI-QUAL = 4. Performance improved to 79.4% (181/228) after introducing a 200-lb. weight-limit for ERC usage and switching to R/L phase encoding. This increased further to 89.1% (212/238) after enabling the abdomen shimming mode and expanding the shim box to encompass the full pelvis. Following the Collaborative, these improvements have been sustained for three months with 93.9% (245/261) of exams achieving PI-QUAL = 4.

## CONCLUSION

Following the structured and data-driven QI process laid out by the ACR Learning Network, we can now routinely obtain high-quality prostate MRI without an ERC, and in some cases, forgoing the ERC even offers advantages.

## CLINICAL RELEVANCE/APPLICATION

While providing prostate MRI exams without an ERC offers clear advantages for patients, staff, and clinical workflow, it's crucial to ensure sufficient image quality for accurate diagnosis. Therefore, transitioning away from ERC usage in prostate MRI requires a thoughtful and evidence-based improvement process.

## T5B-SPGU- Association of Quantitative Multiparametric MRI Parameters and Aggressive Prostate Cancer Morphologies

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the relationship between 3 Tesla quantitative multiparametric magnetic resonance imaging (qmpMRI) and pathologic features of aggressive prostate cancer (PCa) including cribriform morphology and intraductal carcinoma (IDC).

## METHODS AND MATERIALS

This IRB-approved, HIPAA compliant study involved patients with PCa who underwent robotic radical prostatectomy between 2019 and 2022 and pre-operative mpMRI. Both mpMRI and whole mount histopathology (WMHP) were re-reviewed during a multidisciplinary meeting to assess imaging and pathology lesion matching and the presence of cribriform and IDC. All UCLA and PIRADSV2.1=3 lesions on mpMRI were contoured and the following quantitative parameters were extracted: mean apparent diffusion coefficient (ADC,  $\times 10^{-6}$ mm<sup>2</sup>/s) and perfusion parameters including K<sub>trans</sub> (min<sup>-1</sup>), K<sub>ep</sub>(min<sup>-1</sup>), iAUC(mMsec). The cohort was divided into three subcohorts with increasing aggressiveness: (1) cribriform-/IDC-, (2) cribriform+/IDC-, and (3) cribriform+/IDC+. The cohort was also divided a binary manner into cribriform-/IDC- (subcohort 1) and cribriform+/IDC $\pm$  (subcohort 2 and 3). We used one-way ANOVA to assess group differences, Jonckheere test to evaluate trends, and a classification and regression tree (CART) model to estimate the discrimination ability by using all qmpMRI parameters.

## RESULTS

The study cohort comprised of 130 patients (mean age and PSA: 62.6 $\pm$ 7.2 years and 9.3 $\pm$ 6.2 ng/mL) with 141 PCa lesions on mpMRI with 41/141, 49/141, and 51/141 in subcohorts 1, 2, and 3, respectively. The mean ADC and iAUC were 892 $\pm$ 202 and 5.4 $\pm$ 2.5, 826 $\pm$ 209 and 6.7 $\pm$ 3.0, 763 $\pm$ 163 and 6.9 $\pm$ 3.5 in subcohorts 1, 2, and 3, respectively (mean ADC, p=0.007; iAUC, p=0.037). The mean ADC, K<sub>ep</sub>, and iAUC of cribriform+/IDC $\pm$  (subcohort 2 and 3) were 794 $\pm$ 188, 1.9 $\pm$ 1.3, and 6.8 $\pm$ 3.2 which were significantly different compared to cribriform-/IDC- (subcohort 1) with p=0.007 (mean ADC), p=0.019 (K<sub>ep</sub>), p=0.011 (iAUC). As aggressive PCa hosts increased cellularity and increased vascularity leading to low diffusion and high perfusion parameters, the Jonckheere test confirmed that mean ADC (p=0.004) was negatively correlated, and K<sub>ep</sub> (p=0.048) and iAUC (p=0.037) were positively correlated with increasing PCa aggressiveness. Using mean ADC and iAUC cutoffs of 893 and 5.7, the CART model correctly allocated 62%, 60%, and 45% of PCa lesions to subgroups 1, 2, and 3.

## **CONCLUSION**

3T qmpMRI diffusion and perfusion parameters were significantly correlated with increasingly aggressive PCa histological findings including presence of cribriform and IDC.

## **CLINICAL RELEVANCE/APPLICATION**

Quantitative mpMRI parameters show significant association with aggressive prostate cancer morphologies aiding to the diagnostic performance of mpMRI.

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## Abstract Archives of the RSNA, 2023

T5B-SPHN

### Head & Neck Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPHN- Diagnosing Cervical Lymph Node Metastasis in Oral Squamous Cell Carcinoma based on Third-generation Dual-source, Dual-energy Computed Tomography**

Yongheng Luo, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the potential of dual-energy computed tomography (DECT) parameters in identifying metastatic cervical lymph nodes in oral squamous cell carcinoma (OSCC) patients and to explore the relationships between DECT and pathological features.

#### **METHODS AND MATERIALS**

Clinical and DECT data were collected from patients who underwent radical resection of OSCC and cervical lymph node dissection between November 2019 and June 2021. Microvascular density was assessed using the Weidner counting method. The electron density (ED) and effective atomic number (Z<sub>eff</sub>) in non-contrast phase and iodine concentration (IC), normalized IC, slope of the energy spectrum curve (?HU), and dual-energy index (DEI) in parenchymal phase were compared between metastatic and non-metastatic lymph nodes. Student's t-test, Pearson's rank correlation and receiver operating characteristic curves were performed.

#### **RESULTS**

The inclusion criteria were met in 399 lymph nodes from 103 patients. Metastatic nodes (n=158) displayed significantly decreased ED, IC, normalized IC, ?HU, and DEI values compared with non-metastatic (n=241) nodes (all p < 0.01). Strong correlations were found between IC (r = 0.776), normalized IC (r = 0.779), ?HU (r = 0.738), DEI (r = 0.734), and microvascular density. Area under the curve (AUC) for normalized IC performed the highest (0.875) in diagnosing metastatic nodes. When combined with the width of nodes, AUC increased to 0.918.

#### **CONCLUSION**

DECT parameters IC, normalized IC,  $\lambda_{HU}$ , and DEI reflect pathologic changes in lymph nodes to a certain extent, and aid for detection of metastatic cervical lymph nodes from OSCC.

#### **CLINICAL RELEVANCE/APPLICATION**

1. Electron density, iodine concentration, normalized iodine concentration, ?HU, and dual-energy index values showed significant differences between metastatic and non-metastatic nodes. 2. Strong correlations were found between iodine concentration, normalized iodine concentration, slope of the spectral Hounsfield unit curve, dual-energy index, and microvascular density. 3. DECT qualitative parameters reflect the pathologic changes in lymph nodes to a certain extent, and aid for the detection of metastatic cervical lymph nodes in patients with OSCC and aid clinical decision-making.

#### **T5B-SPHN- To Evaluate the Role of the 18 F FDG PET/CT in the Evaluation of the Post Head and Neck Surgery Prognosis and Survival**

Sikandar M. Shaikh, DMRD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of the study was to evaluate the various clinical and preoperative PET/CT findings in evaluation of the overall survival (OS) and for the evaluation of the distant metastasis for the diagnosis of the disease free survival (DMFS) in the cohort of head and neck squamous cell carcinoma patients who were treated with surgery. This study also correlates the prognostic model of OS and DMFS, by which there can be validation of the prognostic model with an independent cohort.



## METHODS AND MATERIALS

This was the retrospective study comprising of the 382 patients who had diagnosed head and neck squamous cell carcinoma, and this was further divided into training (n = 318) and validation (n = 64) cohorts. This was based on the various parameters like various PET/CT parameters which were analysed: clinical parameters, SUVmax, SUVmean, metabolic tumor volume (MTV), total lesion glycolysis, and distance parameters for the primary tumor and lymph nodes and these were defined by 2 segmentation methods (relative SUVmax threshold and absolute SUV threshold). The Cox analyses was also performed for OS and DMFS in the training cohort. The concordance index (c-index) was used to identify highly prognostic parameters in this study. All these prognostic parameters were externally tested in the validation cohort and were validated

## RESULTS

In multivariable analysis, the various important parameters for OS were T stage and nodal MTV, with a c-index of 0.64 (P < 0.001). For the DMFS, the various parameters were T stage, nodal MTV, and maximal tumor-node distance, with a c-index of 0.76 (P < 0.001). There were many combinations of parameters and all this were validated externally with c-indices of 0.63 (P < 0.001) and 0.71 (P < 0.001) for OS and DMFS, respectively

## CONCLUSION

The nodal MTV and the maximal tumor-node distance was significantly correlated with the risk of DMFS. And this parameter was associated with significant increase in the higher risk of death. These all prognostic factors will be used as tailor-made concept for the individualized treatment

## CLINICAL RELEVANCE/APPLICATION

PET-CT is the important modality for the evaluation of the post-operative status of the head and neck cancers

### **T5B-SPHN- Multi-parametric MRI-based Radiomics Approach with Deep Transfer Learning for Preoperative Prediction of Ki-67 Status in Sinonasal Squamous Cell Carcinoma**

Naier Lin, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Preoperative prediction of Ki-67 status in sinonasal squamous cell carcinoma (SNSCC) is critical for individualized treatment. Based on comparison of different machine learning (ML) models, we developed the model that integrates traditional hand-crafted (HC) features and deep transfer learning (DTL) features from multi-parametric MRI to predict Ki67 status in SNSCC.

## METHODS AND MATERIALS

231 SNSCC patients were retrospectively reviewed [training cohort (n= 185), test cohort (n = 46)]. Clinical data and conventional MRI characteristics were analyzed to choose the independent predictor. HC and DTL radiomics features were extracted from fat-saturated T2-weighted imaging, contrast-enhanced-T1WI and apparent diffusion coefficient map. In this study, ResNet50 was chosen as the pretrained CNN model and it was trained on the ILSVRC-2012 dataset. Then, HC and DTL features were fused to formulate the deep learning-based radiomics (DLR) features. After features selection and radiomics signature (RS) building, we compared the predictive ability of RS-HC, RS-DTL and RS-DLR.

## RESULTS

No independent predictors were found based on clinical and conventional MRI characteristics. After features selection, 42 HC and 10 DTL radiomics features were retained. The ML algorithm of Support Vector Machine (SVM), LightGBM and ExtraTrees (ET) were the best classifier for RS-HC, RS-DTL and RS-DLR, respectively. In the training cohort, the predictive ability of RS-DLR was higher than those of RS-DTL and RS-HC. In the test set, the area under curve (AUC) of RS-DLR was also the highest (AUC = 0.817, 95% CI: 0.697 - 0.937), better than those of RS-DTL (AUC = 0.650, 95% CI: 0.487 - 0.812) and RS-HC (AUC = 0.803, 95% CI: 0.679 - 0.927).

## CONCLUSION

Based on ET algorithm classifier, the integrated RS-DLR, which combine the HC and DTL features from multiple MR sequences, yielded more biological information about tumor and showed great potential in improving the prediction of Ki67 status in SNSCC.

## CLINICAL RELEVANCE/APPLICATION

As a noninvasive and convenient method, the integrated RS-DLR represented an opportunity to advance precise prediction for the proliferation status in SNSCC preoperatively and benefit individualized treatment.

### **T5B-SPHN- The Value of Synthetic MRI in Differentiating Metastatic and Non-metastatic Lymph Nodes in Nasopharyngeal Carcinoma, Compared with Size Criteria**

Fan Yang (*Presenter*) Nothing to Disclose

## PURPOSE

The accurate diagnosis of metastatic lymph nodes (LNs) affects the target delineation and dose distribution of radiotherapy in nasopharyngeal carcinoma (NPC). The purpose was to explore the potential value of synthetic MRI (SyMRI) combined with histogram analysis in diagnosing LN metastasis (LNM) and how it compares to size criteria.

## METHODS AND MATERIALS

Fifty-three consecutive patients with pathologically proven NPC were enrolled in this prospective study, and 377 cervical LNs with a maximum short axis diameter (MSAD) = 4 mm were evaluated. All patients underwent standard treatment and the median follow-up time after treatment was 36.13 (17.62, 42.19) months. Two senior radiologists (with 21 and 18 years of tumor-imaging experience) independently evaluated and labelled LNs, and any disagreement was resolved by discussion. A cervical LN was considered to be metastatic if it resolved after the patients completed treatment or showed stable size after treatment but progressed during the follow-up MRI. A cervical LN was considered to be non-metastatic if it showed stability in size after the completion of treatment and the patient remained disease-free during the follow-up MRI (Fig.1). Therefore, 297 and 80 LNs were diagnosed with metastatic and non-metastatic. Histogram features were extracted from the T1, T2, and proton density (PD) maps and MSAD was recorded. According to the Size criteria for cervical LNs, MASD of LNs = 5 mm in the retropharyngeal region, = 11 mm in level II and = 10 mm in other levels of neck were considered metastatic, otherwise, LNs were divided into the non-metastatic group. The dataset was assigned in a 7:3 ratio to either training group or validation group. Multivariate logistic regression analysis and ROC analysis were used to explore the performance in the diagnosis of cervical LNs and level II LNs. Then the DeLong test was used, and nomogram and calibration curves were constructed.

## RESULTS

T1\_10th Percentile, T1\_Variance, PD\_10th Percentile, and PD\_Minimum were used to construct SyMRI model (AUC: 0.895 and 0.903 in the train and validation group), which is higher than Size criteria model (AUC: 0.824 and 0.797), with both  $P = 0.023$ . Moreover, SyMRI + Size criteria model showed the highest performance (AUC: 0.941 and 0.938) compared with SyMRI model only (both  $P = 0.043$ ) and Size criteria model only (both  $P = 0.007$ ).

## CONCLUSION

SyMRI derived histogram parameters could effectively differentiate metastatic from non-metastatic whether in cervical LNs or level II LNs. Moreover, the combination of SyMRI and Size criteria could significantly improve diagnostic performance.

## CLINICAL RELEVANCE/APPLICATION

The model built by SyMRI makes it possible to effectively evaluate individual LN within the MRI scan.

## T5B-SPHN- Uniting Dual-Modal MRI/Chemiluminescence Nanotheranostics: Spatially and Sensitive Self-Reporting Photodynamic Therapy in Oral Cancer

Ying-Sheng Cheng (*Presenter*) Nothing to Disclose

## PURPOSE

In order to achieve precise and efficient diagnosis and treatment of tumors, the integrated nanosystem has been recognized by many interdisciplinary fields and has broad development prospects. However, there are still many challenges in real-time monitoring of targeted delivery and efficacy control of nanomedicines. Firstly, the unpredictable in vivo behaviors of nanotheranostics, that is, real-time tracking where, when, and how nanodrugs delivered. Next, limited by the uncontrollability of the therapeutic dose, how to monitor the treatment behavior and control the curative effect is the main bottlenecks. Therefore, inspired by the Boolean logic idea, designing sequence-activated nanotheranostics strategy is expected to become a breakthrough to solve the above difficulties and realize high-performance diagnosis and treatment applications.

## METHODS AND MATERIALS

A sequence-responsive MRI/chemiluminescence (CL) dual-mode strategy was constructed through uniform spatio-temporal resolution. The nanotheranostics system Pa-MnCH-A@P was prepared by combining the Mn<sup>2+</sup> chelated photosensitizer (Pa) and the CL molecule (CH-A) through FNP technology. Then we explored the structural characterization, spectral properties, MR properties and CL properties of the nanomaterials. The human oral squamous cell carcinoma cell CAL27 was selected as cell model of the tumor to further explore the PDT properties and CL imaging to further explore the photodynamic properties and chemiluminescence imaging properties in cells, as well as the dual-modality imaging were performed in tumor model of oral cancer in mice.

## RESULTS

We innovatively combined MR and CL imaging through FNP (flash nanoprecipitation) technology to quantitatively monitor in vivo distribution and PDT performance, overcoming the dilemma between spatial resolution and sensitivity.

## CONCLUSION

Based on near-infrared fluorescence imaging, chemiluminescence imaging, magnetic resonance imaging and photodynamic therapy, this research combined diagnosis and treatment to construct nanotheranostics system. We successfully designed

nanoprobes Pa-Mn&CH-A@P to real-time tracking unpredictable biological distribution and behavior *in vivo* and PDT feedback, which expanded the application of sequence-activated nanotheranostics system.

#### **CLINICAL RELEVANCE/APPLICATION**

Integration of diagnosis and treatment of oral cancer.

### **T5B-SPHN- The Impact of the COVID- 19 Pandemic on Nasopharyngeal Carcinoma Extent at FDG PET/MR Staging: The NPCOVI PET Study**

Yuanfan Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the impact of coronavirus disease 2019 (COVID-19) pandemic on disease extent in nasopharyngeal carcinoma (NPC) patients using 18 fluorodeoxyglucose (FDG) positron emission tomography (PET)/magnetic resonance imaging (MRI) staging as surrogate measure.

#### **METHODS AND MATERIALS**

Retrospective observational study including biopsy-proven, newly diagnosed NPC patients using whole-body FDG PET/MR staging in two selected intervals: May 1, 2017 to January 31, 2020 (Group A), and February 1, 2020 to June 30, 2021 (Group B). Data regarding primary tumour, regional lymph nodal (N) status and number of involved regional lymph nodal stations, and presence and number of distant metastases (M) were collected.

#### **RESULTS**

Three hundred ninety patients were included (201 in Group A vs 189 in Group B, respectively). The median intervals to PET/MR from the initial symptom in group A and group B were 2.5 (0.1-60.4) and 3.4 (0.2-56.3) months, respectively ( $p>0.05$ ). The median intervals to treatment from the initial symptom in group A and group B were 2.8 (0.2-60.5) and 3.6 (0.3-56.3) months, respectively ( $p>0.05$ ). No significant difference was observed in terms of T classification, N classification, overall stage, N stations and M stations between the two groups ( $p>0.05$ ). For the the involved neck node levels, more patients had developed level Vc metastasis in the group B ( $p=0.044$ ).

#### **CONCLUSION**

For NPC, staging by PET/MR and therapy were not significantly delayed after quarantine restrictions initiated. Although the overall stage was not affected, more NPC patients had developed level Vc metastasis in the era of COVID-19.

#### **CLINICAL RELEVANCE/APPLICATION**

None

### **T5B-SPHN- Use of 18F-FDG PET/MR as an Initial Staging Procedure for Nasopharyngeal Carcinoma**

Yuanfan Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study was to determine the clinical value and cost-effectiveness of PET/MR as an initial staging procedure for nasopharyngeal carcinoma (NPC) compared with the conventional work-up (CWU).

#### **METHODS AND MATERIALS**

From May 2018 to March 2021, 1020 consecutive patients with biopsy-proven, newly diagnosed NPC in our center were enrolled in this study. Among them, 343 patients underwent PET/MR before treatment and the remaining 677 patients only underwent CWU. For PET/MR and CWU, charges were used as issued in 2021 by the Medical Insurance Administration Bureau of Zhejiang, China. Incremental cost-effectiveness ratio (ICER) measured cost of using PET/MR per percent of patients who avoided a false-positive (FP).

#### **RESULTS**

For the whole group, the de novo metastatic disease rate was 5.2% (53/1020). A total of 187 patients with FP results were observed. More patients with FP results were observed in the CWU group (25.6% vs. 4.1%,  $p<0.001$ ). The mean interval from pathological diagnosis to initiation of treatment was 13.1 days in the CWU group versus 7.9 days in the PET/MR group ( $p<0.001$ ). Mean cost per patient was \$417 for CWU and \$1585 for PET/MR. The ICER was \$54 for each percent of patients who avoided a FP.

#### **CONCLUSION**

Compared with CWU, PET/MR reduced FP risk and decreased workup of incidental findings, allowing for earlier treatment start. PET/MR may be cost-effective in initial staging procedure for NPC.

**CLINICAL RELEVANCE/APPLICATION**

None

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## Abstract Archives of the RSNA, 2023

T5B-SPIN

### Imaging Informatics Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPIN-1 Knee Osteoarthritis Deep Learning Models Demonstrate Greater Biases Based on Sex Than Race**

Bardia Khosravi, MD, MPH (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Deep learning (DL) models for chest x-ray (CXR) diagnosis have demonstrated biases against historically disadvantaged groups across sex, and race, raising concerns about the equitable use of these tools. It is unclear, however, if similar biases exist for DL models in other body parts like the knee. The purpose of our study was to evaluate for sex and race-based bias in a DL model for knee osteoarthritis (OA) severity grading.

#### **METHODS AND MATERIALS**

We used the Osteoarthritis Initiative (OAI) dataset of weight-bearing AP knee radiographs for DL model development and testing. We first trained a YOLO-v5 object detection model to localize the right and left knees using 4,490 bilateral knee radiographs with bounding box annotations split at the patient-level into 70%/10%/20% splits for training/validation/test sets. We then used this localization model to crop knee joints from 19,777 knee radiographs used to train and test the knee OA severity grading (groundtruth Kellgren-Lawrence grades [KLG] provided by OAI); there were 42% males and 81% white patients. These images were split based on race and sex at the patient level, using 20% for testing and the rest for five-fold cross-validation (Figure 1A). The model's performance was evaluated on the test set with AUROC subgroup analysis based on sex and race (white vs. not white).

#### **RESULTS**

The knee joint localization model achieved a mean average precision (mAP) of 0.97. The OA grading model had an average AUROC of 0.91 on the five validation folds and an AUROC of 0.90 on the entire test set. Subgroup analysis showed biases favoring males for all KLG groups, except for KLG 3, which favored females; for example, for KLG 1 grading, AUROC for males was 0.8 compared to 0.76 for females (Figure 1B). Race-based bias was less pronounced, with no difference in AUROC between white and non-white patients for KLG 0 and 2, and differences of 0.02 for KLG 1, 3, and 4 (Figure 1C).

#### **CONCLUSION**

Our DL OA severity grading model performed at a state-of-the-art level, but demonstrated sex-based biases favoring males in 4/5 KLG categories, echoing previous findings for DL models for CXR diagnosis. The model demonstrated less pronounced race-based biases, however, indicating that demographic-based biases in DL models may vary between specific diagnostic use cases and body parts. We recommend further study to elucidate the mechanisms behind these demographic biases in DL models in radiology.

#### **CLINICAL RELEVANCE/APPLICATION**

We show that deep learning models can diagnose knee osteoarthritis with high accuracy, but can also exhibit biases based on sex and, to a lesser extent, race. Evaluation of demographic bias is critical to ensure the equitable use of these exciting technologies that hold much promise to transform medical imaging.

#### **T5B-SPIN-2 "Radiobiometry": Deep-learning-based re-identification of Patients from De-identified Medical Images**

Alistair Yap, BEng (*Presenter*) Nothing to Disclose

## PURPOSE

When two radiographs are presented for follow-up evaluation, a radiologist must ensure they are from the same patient, which is not a trivial task. In some cases, patients may be misregistered, potentially leading to a medical error. Thus, the purpose of the study was to develop and assess a deep-learning "radiobiometry" method to determine whether two radiographs are from the same or different patients.

## METHODS AND MATERIALS

Convolutional Neural Networks (CNN) were trained with contrastive learning to distinguish radiographs of different patients. Using the MIMIC-CXR dataset, CNNs for frontal chest radiographs and multi-view chest radiographs (frontal and lateral) were trained. Additionally, CNNs were trained on radiographs from the Osteoarthritis Initiative (OAI) for 4 other anatomic regions: pelvis, bilateral knees, bilateral hands, and right hand.

## RESULTS

After preprocessing, 247,522 frontal chest radiographs from 64,564 patients of the predefined MIMIC-CXR training set were used to train the frontal chest-radiograph CNN. This model was tested on 3,630 images from 292 patients of the internal test set, as well as the test set of the ChestX-ray8 dataset consisting of 25,596 images from 2,797 patients. A further 120,973 lateral chest radiographs from MIMIC-CXR were used in combination with the frontal radiographs above to train the multi-view chest-radiograph CNN. This was similarly evaluated on the internal test set with an additional 1,501 lateral images. For CNNs trained on OAI data, 4-fold cross-validation was performed on 26,524, 11,357, 6,165, and 1,799 radiographs of bilateral knees, pelvis, bilateral hands, and right hand, from 4,796, 4,763, 3,504, and 1,000 patients, respectively. In all-pairs-similarity evaluation, all models achieved a test AUROC and rank-1 accuracy in excess of 0.99. Despite a minor drop in performance, the multi-view chest-radiograph CNN maintained an AUROC and rank-1 accuracy of over 0.99 when matching radiographs of differing laterality.

## CONCLUSION

While falling short of mature biometric modalities with enormous and specialized datasets, initial results using modestly sized medical imaging datasets demonstrate the potential for radiographs as a novel biometric modality for identification and authentication systems. While radiobiometry can be useful for verifying patients in radiology clinical practice, it may also raise concerns for the re-identification of public anonymized medical imaging data.

## CLINICAL RELEVANCE/APPLICATION

"Radiobiometry" systems for identifying patients from radiographs can help to reduce bookkeeping errors in clinical follow-up evaluation, protecting against misdiagnoses while consolidating mislabeled imaging records.

## T5B-SPIN-3 Efficient Deformable Registration with Local Self-similarity for Multi-Phase Abdominal CT Images

Tony C. W. MOK, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

We developed a fast deformable multi-phase abdominal CT registration algorithm, which addresses the non-linear misalignment of the intra-patient multi-phase abdominal CT images in real time.

## METHODS AND MATERIALS

Our model is a learning-based method. The training data includes 1,503 cases of three-phase (non-contrast, arterial, and venous) CT volumes from one hospital, including 399 with pancreatic ductal adenocarcinoma (PDAC), 751 with non-PDAC, and 353 normal. We trained the model in a semi-supervised manner. To address the large non-linear misalignment and inhomogeneous image intensity across multi-phase CT, we developed a novel multi-level convolutional neural network to learn to maximize the local self-similarity of the images. To further improve the registration accuracy, we leverage anatomical delineations segmented by a robust multi-organ segmentation model to co-supervise the registration model. The model was independently evaluated on a combined internal test set of 25 cases (5 PDAC, 15 non-PDAC, and 5 normal).

## RESULTS

The registration accuracy, robustness and smoothness of the deformation field are quantified with the Dice coefficient (DSC) of six anatomical delineations (Left and right kidneys, spleen, liver, stomach, and pancreas), the 30% lowest DSC (DSC30), and the standard deviation of the Jacobian determinant (SDLogJ), respectively. In arterial to non-contrast phase registration, our method's registration accuracy (DSC 93.6%) and robustness (DSC30 91.5%) are higher than the mean performance (DSC 92.7% and DSC30 88.8%) of the best-performing conventional multi-modal registration tool (DEEDs). Similar trends are observed in the venous to non-contrast phase registration. Our method outperforms the conventional image registration by a significant margin of 1.2% and 1.4% in DSC and DSC30, respectively, while maintaining a comparable smoothness in the solution (SDLogJ 0.152 vs 0.154). Our method circumvents the costly iterative optimization in the conventional method, which requires a mean running time of 119.5 seconds, and achieves real-time registration (0.33 sec per registration) for multi-phase CT images.

## CONCLUSION

Our method can efficiently register multi-phase abdominal CT images, outperforming the registration performance of the conventional method by a significant margin.

## CLINICAL RELEVANCE/APPLICATION

Our time-efficient registration method can be used in image fusion of multi-phase abdominal images, facilitating daily work of radiologists in imaging reading across multiple phases, and aggregating diverse image features for learning-based diagnostic systems. Our work suggests good feasibility in high-throughput environments that need to process dozens to thousands of multi-phase CT scans.

### **T5B-SPIN-4 Identifying Metastatic Lymph Node Stations using a Local-Global Deep Hybrid Network with Prior-guided Supervision in Esophageal Cancer Patients**

Dazhou Guo (*Presenter*) Nothing to Disclose

## PURPOSE

The diagnosis of lymph node (LN) metastasis in computed tomography (CT) is an essential yet challenging task in esophageal cancer staging and treatment planning. Although criteria (e.g., RECIST, morphological/texture features) are proposed to predict LN metastasis, the diagnostic accuracy remains low with sensitivity <50% and specificity <75%, as reported in previous studies. Deep learning (DL) has the potential to address this issue by learning from large-scale labeled data. However, due to the practical surgery procedure in LN dissection, it is difficult to pair the metastasis of individual LN reported in the pathology report to the LN instance found in the CT image. Hence, in this study, we first use pathology reports to determine the lymph node station (LNS) metastasis, then develop a multiple instance deep learning (MIDL) model to predict LNS metastasis.

## METHODS AND MATERIALS

We collected data from 1,205 esophageal cancer patients who underwent preoperative contrast-enhanced CT scans. Using a recently developed automatic mediastinal LNS segmentation model, we segmented LNS 1 to 8 based on the IASLC protocol. For each LNS, we cropped the local CT region of interest (ROI) to generate station-wise CT patches, labeling the LNS as metastatic if at least one metastatic LN was indicated in the pathology report. We trained a 3D CNN-Transformer hybrid network using these CT patches. To incorporate LN position priors, we segmented LN instances (with a short axis =5mm) and added them as auxiliary input to the MIDL model. We also proposed a lymph node prior attention loss to supervise the transformer's attention map using LN instance masks. We conducted a five-fold cross-validation to evaluate the MIDL model's performance, reporting sensitivity, specificity, and AUC as classification metrics.

## RESULTS

The proposed MIDL model exhibited an overall AUC of 0.8574, significantly outperforming the second best comparing method (MobileNetV2) by 4.78% (0.8574 vs. 0.8096). The specificity was assessed at a threshold yielding a recall of 0.8, at which point the MIDL model achieved a specificity of 0.7735 (MobileNetV2: 0.6553). Additionally, the sensitivity was evaluated at a threshold leading to a specificity of 0.8, where the MIDL model obtained a sensitivity of 0.7719 (MobileNetV2: 0.6309).

## CONCLUSION

The proposed MIDL model can substantially improve the LNS metastasis prediction and has the potential to play an essential role in cancer staging, treatment planning, and prognostic analysis.

## CLINICAL RELEVANCE/APPLICATION

The proposed algorithm can identify the metastasis lymph node stations in CT scan with high accuracy. The model may be applied in the clinical workflow to assist the diagnosis and treatment for esophageal cancer patients.

### **T5B-SPIN-5 Fully Automated CT-Based Body Composition Tools Identify Increased Risk Factors for Adverse Health Outcomes in Socioeconomically Disadvantaged Individuals**

Matthew H. Lee, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Socioeconomic disadvantage is associated with adverse health outcomes. The purpose of this study is to evaluate the relationship between socioeconomic disadvantage and CT-based body composition (BC) measures derived from a panel of fully automated artificial intelligence (AI) tools to identify individuals at increased risk for death and major adverse cardiovascular events (MACE).

## METHODS AND MATERIALS

A fully automated panel of AI body composition tools quantifying abdominal aortic calcium (AoCa, Agatston score), abdominal fat (visceral adipose tissue area [VAT], visceral-to-subcutaneous fat ratio [VSR]), and muscle attenuation (muscle HU; mean



at L3 level) was applied to non-contrast CT examinations in asymptomatic adults undergoing screening CT colonography (CTC). Patients were partitioned into 5 socioeconomic groups based on the national area deprivation index (ADI). One-way analysis of variance was used to compare means across groups. Odds ratios (ORs) were generated from high specificity (90% specificity) BC thresholds with more disadvantaged groups being compared to the least disadvantaged group (ADI<20) for each body composition measure.

## RESULTS

7785 asymptomatic adults (mean age, 57 years; 4361:3424 F:M) underwent screening CTC from April 2004-December 2016. Median ADI was 31 (IQR 22-43). Significant correlation was observed for all measures (all  $p<0.001$ ). More socioeconomically disadvantaged groups had significantly higher AoCa, higher VAT, higher VSR, and lower muscle attenuation. Compared with the least disadvantaged group, mean differences for the most disadvantaged group (ADI>80) were: AoCa=567, VAT=27 cm<sup>2</sup>, VSR=0.1, and muscle HU=-6 HU (all  $p<0.05$ ). Compared with the least disadvantaged group, the most disadvantaged group had significantly higher odds of having high-risk body composition measures: AoCa OR=3.8, VAT OR=2.5, VSR OR=2.0, and muscle HU OR=3.1(all  $p<0.001$ ).

## CONCLUSION

Fully automated CT-based AI body composition tools show that socioeconomic disadvantage is associated with high-risk BC measures and can be used to identify individuals at increased risk for death and MACE.

## CLINICAL RELEVANCE/APPLICATION

Fully automated AI body composition tools are promising for opportunistic screening to identify markers of increased risk of death and MACE associated with socioeconomic disadvantage using data that typically go unused in clinical practice offering added value without additional patient time or dose.

## T5B-SPIN-6 Deep learning-based Model for Prediction of Hepatocellular Carcinoma Recurrence in Pre-operative Computed Tomography after Curative Surgery

Wan Hang K. Chiu, FRCR (*Presenter*) Nothing to Disclose

## PURPOSE

Curative surgery is the treatment of choice for early-stage hepatocellular carcinoma (HCC) yet recurrence occurs in over 70% of cases. Recurrence, particularly within the first 5 years, is associated with poor prognosis and currently, few clinical risk scores can accurately predict recurrence. While histological microvascular invasion (MVI) predicts recurrence, it can only be confidently ascertained from surgical specimens thus unable to provide pre-treatment prognostication. Here, we developed a deep learning-based model for the prediction of HCC recurrence.

## METHODS AND MATERIALS

Chinese patients with resected histology-confirmed HCC were recruited from 5 centers in Hong Kong. They were randomly divided in an 8:2 ratio to training and internal validation. A residual-network deep learning-based model to predict HCC recurrence was developed through the training-validation-testing approach utilizing pre-operative CT and clinical data (age, sex, comorbidities, and baseline blood tests). The model was externally tested using an independent cohort from Taiwan. Area-under-curve (AUC), positive and negative predictive values (PPV/ NPV) were calculated and survival analyses were also performed and compared with tumour MVI status.

## RESULTS

This interim analysis included 1,254 patients (82.9% male, age 62.2 +/- 10.8 years, median follow-up 7.8 [5.8-10.0] years), with 368 (29.3%) and 710 (56.6%) developing recurrence within 1 and 5 years respectively. Of those, 551 (43.9%), 140 (11.2%), and 563 (44.9%) patients were included in the training, internal validation, and external testing cohorts. The model was trained for 42 epochs and the model achieved AUCs of 0.855 (95% CI 0.682-0.907; PPV 75.4%; NPV 84.3%) and 0.803 (95% CI 0.631-0.859; PPV 89.7%; NPV 55.1%) for predicting HCC recurrence at 1 and 5 years. In the external testing cohort, the deep learning-based model achieved AUCs of 0.775 (95% CI 0.536-0.840; PPV 49.7%; NPV 85.2%) and 0.733 (95% CI 0.539-0.766; PPV 87.0%; NPV 45.8%) for HCC recurrence at 1 and 5 years, significantly higher than MVI (AUCs 0.617 [0.496-0.725]; PPV 32.9%; NPV 88.5% and 0.560 [0.418-0.688]; PPV 67.9% NPV 46.4%) respectively. Furthermore, the deep learning-based model had superior discriminative ability on 1 and 5-year recurrence risk compared with MVI (49.7% vs 32.9% and 87.0% vs 67.9% respectively, both  $p<0.05$ ).

## CONCLUSION

Our deep learning-based model can accurately predict HCC recurrence after curative surgery in early-stage HCC outperforming MVI in risk stratification.

## CLINICAL RELEVANCE/APPLICATION

Deep Learning can combine radiological images and clinical data and develop models that have the potential to become novel tools for pre-treatment prognostication for short- and intermediate-term outcomes in HCC.



## Abstract Archives of the RSNA, 2023

T5B-SPIR

### Interventional Radiology Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPIR-1 Timing Matters: Which CT Phase for Colorectal Liver Metastasis Segmentation is Better for Ablative Margin Quantification in Predicting Local Outcomes?**

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the use of three-dimensional minimal ablative margin (MAM) quantified by tumor segmentation using hepatic arterial (HAP) versus portal venous (PVP) phases CT for predicting residual tumor and local tumor progression (LTP) following colorectal liver metastasis (CLM) thermal ablation.

#### **METHODS AND MATERIALS**

This two-institution retrospective study included patients undergoing microwave and radiofrequency ablation between 2010 and 2021 with intraprocedural pre-ablation HAP and PVP and post-ablation PVP CT. Patients with follow-up less than one year without residual tumor or LTP were excluded. Tumors were segmented on pre-ablation HAP and PVP CT and ablation zones were segmented on post-ablation PVP CT. MAMs were quantified by a biomechanical deformable image registration method. Prognostic value of MAM in predicting residual tumor and one-year LTP was investigated using area under the receiver operating characteristic curve (AUC) and the association with LTP was tested using Fine-Gray subdistribution hazard regression model.

#### **RESULTS**

A total of 80 patients (mean age, 60 years  $\pm$  12 [SD]) with 151 CLMs were included. During a median follow-up of 27.3 months, 5 residual tumors were noted, and the LTP rate was 15.7% (23/146). The median tumor volume was 1.6 mL and 1.2 mL segmented on HAP and PVP CT, respectively ( $P=0.006$ ), with corresponding median MAM of 2.2 mm and 4.0 mm, respectively ( $P=0.007$ ). The AUC in predicting residual tumor and one-year LTP by HAP and PVP were 0.75 (95% confidence interval [CI]: 0.67, 0.84) and 0.81 (95% CI: 0.74, 0.89), respectively ( $P=0.006$ ). MAM of 0 mm on PVP CT was an independent predictor of LTP with a subdistribution hazard ratio of 7.7 (95%CI: 3.0, 19.6;  $P<0.001$ ), compared to 4.7 (95%CI: 1.8,12.0,  $P=0.001$ ) on HAP CT.

#### **CONCLUSION**

Ablative margin quantification using intraprocedural portal venous phase CT for colorectal liver metastasis segmentation significantly outperformed arterial phase CT in predicting ablation outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

Ablative margins should be quantified on intraprocedural portal venous phase CT instead of arterial phase CT, as the latter may overestimate tumor size.

#### **T5B-SPIR-2 Microwave Ablation in Hepatocellular Carcinoma: Dynamics of Extracellular Vesicles and Immunological Response**

Thomas J. Vogl, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To characterize extracellular vesicles by liquid biopsy in preinterventional patients with primary and secondary hepatic malignancies treated with microwave ablation (MWA).

## **METHODS AND MATERIALS**

Blood samples of 38 HCC patients and 15 patients with hepatic metastases were collected immediately pre and post-interventional. Subsequently, the characterization of 37 surface epitopes of EVs by magnetic bead-based particle sorting and fluorescence-associated cell scanning (FACS) was conducted.

## **RESULTS**

The HCC-group before intervention revealed an activation of T-cell-associated EV protein expressions with significantly increased CD40, CD86 and CD8, ( $p=0.022$ ;  $p=0.003$  and  $p=0.024$ , respectively) vs. the non-HCC group. Additionally, the pre- and post-interventional HCC group showed an increment of the B-cell associated marker CD20 vs. the non-HCC group,  $p=0.005$  and  $p=0.014$ , respectively. The tumor cell associated surface epitopes, CD44, CD133 and CD24 were significantly higher expressed in the pre-interventional HCC vs. non-HCC group ( $p=0.029$ ,  $p=0.009$ ,  $p=0.004$ ). Regarding the clinical parameters, the HCC group showed a significantly higher expression of CD9 in patients with recurrent HCC, nonalcoholic steatohepatitis (NASH)-related HCC and cirrhotic HCC. Furthermore, the subgroup analysis of HCC patients showed a significantly lower expression of CD44 in NASH-related HCC and cirrhotic HCC. Pre-interventional cytokine levels of TH1 and Treg cells (IL2 and IL17) correlated strongly with elevated CD44 levels in HCC patients. Additionally, pre-interventional IL6 levels correlated strongly with a high expression of CD19 and CD86. Regarding the post-interventional changes increased CD19, CD20 and CD44 levels correlated strongly with an elevated CD4/CD8 ratio and negatively correlated with CD4/CD8 ratio changes.

## **CONCLUSION**

EV surface expressions correlated with cytokine levels in pre-interventional HCC patients showed a CD4+ TH1 response, associated with CD44 expression.

## **CLINICAL RELEVANCE/APPLICATION**

EV surface expressions can be used as a prognostic parameter in MWA of HCC.

## **T5B-SPiR-3 Microwave Ablation versus Laser-induced Thermotherapy in the Treatment of Hepatocellular Carcinoma: Evaluation of Therapy Response and Survival Rates**

Thomas J. Vogl, MD, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To retrospectively compare CT-guided microwave ablation (MWA) with MR-guided laser-induced thermal ablation (LITT) of hepatocellular carcinoma (HCC) regarding therapy response and overall survival (OS)

## **METHODS AND MATERIALS**

In total, 303 patients (64f, 239m) were treated with 521 sessions of thermal ablation: 250 patients (52f, 198m; mean:  $66\pm 10$  years) with 445 CT-guided MWAs and 53 patients (12f, 41m; mean:  $67.5\pm 8$  years) with 76 MR-guided LITTs. Diameter of HCC lesions, technical success, complete ablation, local tumor progression and OS rates were evaluated in all cases.

## **RESULTS**

Mean tumor diameter was 2.16 cm in the MWA group vs. 2.4 cm in the LITT group. Technical success was achieved in all ablations in both groups. Complete ablation was achieved in 97.7% of the tumors in the MWA group and in 98.7% in the LITT group. In the MWA group 6% of the patients and in the LITT group 3.8% developed local tumor progression. The 1-, 3-, and 5-year OS rates starting at the date of ablation were 86.6%, 53.4% and 40.4% in the MWA group and 85%, 37.7% and 17% in the LITT group, respectively. ( $p$ -value:0.001). No peri-procedural deaths were reported in both groups.

## **CONCLUSION**

Image-guided thermal ablation like LITT and MWA are both effective and safe for the local treatment of HCC. Patients in the MWA group had an overall longer survival time, but with higher rate of local tumor progression than the patients in the LITT-group.

## **CLINICAL RELEVANCE/APPLICATION**

Both MWA and LITT provide long OS with low complication rates in patients with HCC

## **T5B-SPiR-4 Transarterial Chemoembolisation (TACE) for Unresectable or Recurrent Hepatic Cholangiocarcinoma: Added Value of Local Thermal Ablation**

Thomas J. Vogl, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To retrospectively evaluate the local tumor control and survival rates after targeted local therapy using transarterial chemoembolisation (TACE) with or without local thermal ablation in patients with unresectable or recurrent hepatic cholangiocarcinoma (CCA).

## METHODS AND MATERIALS

From January 2007 to December 2017, 152 patients (69 males and 83 females; mean: 58.7 years) with cholangiocarcinoma (CCA) were retrospectively evaluated. The study included patients with both unresectable (80.2%) and recurrent lesions (19.8%). Patients were treated with at least three therapeutic cycles of TACE (3-26 cycles). 32 patients received combined TACE and local thermal ablation. Local tumor response was assessed by contrast-enhanced magnetic resonance imaging (CE-MRI) based on the modified RECIST criteria (mRECIST) and the survival evaluated using the Kaplan-Meier method.

## RESULTS

The mean survival for all patients was 28.7 months (CI:21.8-35.7). Patients who received additional ablation sessions showed significantly longer survival compared to those who received only TACE (median 28 and 18 months respectively;  $P < 0.007$ ). The tumor response after three cycles of TACE was either stable (35.5%), partial response (41.4%) progressive (23%) or complete response (0%) and the response at the last follow up was 25.7%, 15.2%, 59.2% and 3.5 % respectively. The following significant prognostic factors were found: nodal and/or systemic metastases, pre-therapeutic tumor load, initial local tumor response and associated application of local thermal ablation.

## CONCLUSION

Targeted therapy of unresectable or recurrent CCA using TACE with an added value of thermal ablation treatment may provide a therapeutic option for local tumor control and may improve patient's survival.

## CLINICAL RELEVANCE/APPLICATION

TACE is a relevant targeted therapy tool in the regional treatment of CCA.

## **T5B-SP1R-5 KRAS Gene Mutation Influence after Ablation of Colorectal Cancer Lung Metastases: Prediction of Local Recurrence and Chemotherapy-free Survival Time**

Marcelo Liberato Coelho Mendes De Carvalho, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The primary objectives of the study were to evaluate if KRAS gene mutation predicts local recurrence in patients undergoing ablation of colorectal cancer lung metastases and to evaluate the chemotherapy-free interval of these patients. The secondary objective was to assess overall survival rate of these patients.

## METHODS AND MATERIALS

This is a retrospective observational study of the medical records of patients who underwent lung ablation of colorectal cancer metastases, performed at a quaternary hospital. Radiofrequency (RFA) and microwave (MWA) ablations were used. Intraoperative planning and overlaps were defined by the assistant team of interventional radiologists, based on the size and location of the metastases. A review of pre-, intra-, and post-procedure images was performed by one of the authors. The data were then charted in Microsoft® Excel® and exported for statistical analysis to IBM® SPSS® Statistics version 20. Statistical significance was evaluated using Fisher's exact test.

## RESULTS

Data were obtained from the medical records of 59 patients who underwent ablation of lung metastases from colorectal cancer. The gender distribution was homogeneous (30 men and 29 women), and mean age was 60.8 years. In 31 cases the initial location of the cancer was in the rectum, in 17 in the sigmoid, and in 11 in the colon and cecum. Before ablation, 50 patients had had a chemotherapy cycle, and 11 had had a surgical resection. RFA was performed in 58 patients, and MWA in 1. There were no complications in 55 patients, and 4 had pneumothorax. The number of nodules ablated varied, as follows: 1 nodule in 40 patients, 2 in 10 patients, 3 in 4 patients and 4 in 5 patients. There was recurrence in 27 patients: 2 local and 25 distant. There was no statistically significant association between KRAS gene mutation and local ( $p 0.407$ ), distant ( $p 0.710$ ) or global ( $p 0.999$ ) recurrence. There was no statistically significant association between local recurrence ( $p 0.999$ ) and proximity to the bronchi or vessels. The chemotherapy-free interval was 19.3 months (95% CI: 14.8-23.8), and overall survival (OS) at 67 months of follow-up was 49.3% (1-year OS: 93%; 3-year OS: 80%).

## CONCLUSION

Ablation of lung metastases is an effective and safe method. Mutation of the KRAS gene did not show to be a predictive factor in the rate of recurrence of lung metastases from colorectal cancer. Ablation allows an overall survival similar to surgical treatment. The longer chemotherapy-free interval provides better quality of life for patients.

## CLINICAL RELEVANCE/APPLICATION

Mutation of the KRAS gene determines a higher rate of local recurrence after liver ablations, but there was no description in the literature about its influence in pulmonary ablative treatments.

### **T5B-SPIR-6 Percutaneous Cryoablation of Progressing Extra-abdominal Desmoid Tumors (DT)**

Andrea Vanzulli, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the efficacy of percutaneous cryoablation of extra-abdominal desmoid tumors (DT) progressing after first-line treatments, including active surveillance, non-steroidal anti-inflammatory drugs and chemotherapy.

#### **METHODS AND MATERIALS**

We retrospectively evaluated baseline and post-treatment MRI and/or CT imaging of 19 patients with progressing extra-abdominal DT (average diameter 80,2 mm; range 40-125 mm) treated with percutaneous cryoablation at our Institution between May 2021 and November 2022, with a median imaging follow-up time of 149 days. Response to treatment was evaluated both with standard and modified (m) RECIST1.1 criteria, as tumor shrinkage alone does not take into account tissue viability/necrosis and therefore incompletely describes responses to local treatments. Tumor locations included the cervical district (3), the thoracic (3) and abdominal wall (11), the lumbo-sacral (1) and gluteal region (1).

#### **RESULTS**

Both standard and modified RECIST1.1 criteria classified all 19 patients as non-progressive. According to standard RECIST 1.1, 16 patients showed stable disease (SD) and 3 patients displayed a partial response (PR). According to modified RECIST criteria, 9 patients presented with SD, 4 patients with PR and one patient with a complete response (CR), with 2 RECIST-SD patients being reallocated to PR and CR categories, respectively. Five patients didn't have adequate pre-treatment imaging and couldn't therefore be categorized with mRECIST. No major periprocedural complications were registered, with 84% of patients reporting significant improvement of symptoms and quality of life.

#### **CONCLUSION**

Desmoid tumors are rare (5-6 cases/million/year), locally aggressive fibroblastic proliferations characterized by infiltrative growth and a tendency to local recurrence. Although unable to metastasize, DT can cause significant morbidity through invasion of surrounding structures, causing chronic pain, functional impairment, and deformities. Due to high rates of recurrence after surgery and frequent spontaneous regression or stabilization, active surveillance generally represents the first-line treatment. Available therapeutic strategies achieve poor response rates, with many patients suffering from disease progression. In such context, cryoablation is emerging as a feasible and effective treatment to reduce tumor burden of extra-abdominal DT progressing after multiple lines of treatment. Furthermore, we report that mRECIST outperform standard RECIST1.1 criteria to evaluate DT response to cryoablation.

## CLINICAL RELEVANCE/APPLICATION

To the best of our knowledge, this study represents one of the biggest casuistries of progressing extra-abdominal DT treated with percutaneous cryoablation.

### **T5B-SPIR-7 Response Post Local Tumor Ablation in HCC is Dependent Upon Interferon-gamma Linked Pathways with Associated C-X-C Chemokine Ligand Family Proteins**

Maurice M. Heimer, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To uncover post-therapeutic systemic pathways and their potential as biomarkers in HCC patients treated by CT-guided local tumor ablation.

#### **METHODS AND MATERIALS**

Twenty-four consecutive HCC patients treated with CT-guided high-dose rate brachytherapy (HDR-BT) (1x15 Gy) were included in this prospective IRB-approved study. Ninety-two proteins were quantified in blood samples acquired at baseline and 48hr post-HDR-BT and analyzed with a multimarker tool (Olink proteomics Target 96 immuno-oncology panel with Proximity Extension Assay technology). Ratios post-therapy in comparison to baseline (reported as fold change; FC) were calculated to detect a threshold of 30 % elevation or decrease. Patients were classified as responders (R, n=12) in absence of local progression within 6m and no systemic progression within 2yr observed on follow-up MRI or CT imaging. Non-responders (NR, n=12) had recurrence within 6m and/or tumor progression with more than 3 nodules or individual lesion diameter more than 3 cm or extrahepatic disease within 2yr. Statistical analyses was performed comparing the two groups using paired and unpaired t-tests.

## RESULTS

For all patients regardless of outcome, the most prominent pathway change was a decrease in interferon-gamma (IFN- $\gamma$ , FC 0.48,  $p=0.001$ ) and 2 downstream members of the CXC family (CXCL9 FC 0.73,  $p=0.001$  and CXCL10 FC 0.65,  $p=0.001$ ). Moreover, non-responders showed increased values in pro-neutrophil and angiogenic CXCL5 in comparison to a decrease for responders (NR FC 1.51, R FC 0.78,  $p=0.043$ ) and increased values in pro-tumorigenic CXCL12 in comparison to responders (NR FC 1.06, R FC 0.89,  $p=0.042$ ). Accompanying CXCL5, granzyme-B, an additional neutrophil marker was significantly decreased in responders (FC 0.57,  $p=0.003$ ), but unchanged in non-responders (FC 1.01,  $p=0.942$ ). No significant differences were seen between responders and non-responders for other IFN- $\gamma$  pathway-associated proteins including CXCL1, CXCL9, CXCL10, CXCL11 and CXCL13.

## CONCLUSION

HDR-BT induces decreases of circulating IFN- $\gamma$  and associated pathway chemokines potentially contributing to inhibition of immune cell infiltration, alteration of neutrophil activation, and angiogenesis post-therapy. Chemokine ligands CXCL5 and CXCL12 may enable differentiation between responders and non-responders post-therapy and potentially serve as biomarkers for response prediction.

## CLINICAL RELEVANCE/APPLICATION

Elucidating the molecular pathways associated with interventional oncologic therapies can potentially generate biomarkers predicting outcome and offer rational targets for combination adjuvant therapy.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-SPMK

### Musculoskeletal Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPMK- High-Resolution Bone Image from Shoulder MRI using Deep Neural Network on 3-D Accelerated Dixon GRE (CAIPIRINHA Dixon)** 1

Jooyeon Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To test the feasibility of generating high-resolution bone image resembling CT from shoulder 3-D CAIPIRINHA Dixon MRI data using deep neural network.

#### **METHODS AND MATERIALS**

In this IRB-approved retrospective study, patients with 3.0T MRI for shoulder pain were enrolled. Those without CT or 3D VIBE CAIPI-DIXON were excluded. The 3D VIBE CAIPI-DIXON protocol was ; TR/TE 12.7 /2.5,+3.6ms; FA 10°; FOV 159 x 159 mm; spatial resolution 0.4x0.4 mm<sup>3</sup>; acquisition time 3.02 min (Magnetom Vida, Siemens Healthineers, Germany). The dicom files were reconstructed using a commercially available DNN-based denoising and resolution enhancement algorithm (SwiftMR, AIRS Medical, Korea). The in-phase and opposed phase CAIPI-Dixon original PACS image ("CAIPI-i-ori", "CAIPI-o-ori"), and the corresponding CAIPI-Dixon after DNN processing images ("CAIPI-i-dn", "CAIPI-o-dn") were viewed after gray-scale inversion, and quantitatively and qualitatively evaluated by two radiologists. The images were first orthogonally rotated to measure the diameters of the glenoid. Studies were scored from 1 to 5 for the clarity of the cortical outline and trabecular bone of the humeral head and glenoid, any pseudolesion, visibility of fractures. The humeral head, glenoid neck, deltoid, and infraspinatus muscles were marked with regions of interest. ROIs were drawn on vacant quadrants for noise. CT was used to compare the glenoid dimension measurements, ROI values, SNR, and CNR. For statistical analysis, Kruskal-Wallis and Spearman tests were used ( $p < 0.05$ ).

#### **RESULTS**

Final group included 10 patients (4 females, mean age 60.6 years). The glenoid diameters measured from CAIPI-i-dn, o-dn, CAIPI i-ori, o-ori, and CT did not differ significantly ( $p > 0.05$ ). CAIPI-i-dn, o-dn, and CAIPI-o-ori had higher humerus cortical scores than CAIPI-i-ori ( $4.94 \pm 0.236$ ,  $3.611 \pm 0.195$ ,  $4.39 \pm 0.916$ , vs  $3.00 \pm 0.29$ ). CAIPI-i-o-dn showed higher glenoid cortical scores than CAIPI-i-o-ori ( $4.17 \pm 1.043$  than  $3.56 \pm 1.247$ ,  $p < 0.05$ ). SNR of humerus and glenoid significantly improved with CAIPI-dn compared to CAIPI-ori (4 from 1.07,  $p < 0.05$ ). CT density negatively correlated with CAIPI-o-dn ROI in the humerus and glenoid (correlation coefficient -53.3, and -60.3,  $p < 0.05$ ). ICC value of the semiquantitative scores of CAIPI-i- o-dn (eg. cortical and trabecular outline) was 79.5 among the two readers. ICC value of quantitative scores (eg. ROI) was 96.4 ( $p < 0.05$ ).

#### **CONCLUSION**

Combining 3D VIBE CAIPI-DIXON MRI and the DNN algorithm enabled high resolution cortical and trabecular bone imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

High resolution CT-like bone images could be generated from 3D MRI with DNN processing. Cortical and trabecular information can be obtained. Quantification may be comparable to that of CT.

#### **T5B-SPMK- Multivariable Logistic Regression Analysis of Risk Factors for Pericollapse Stage of Osteonecrosis of the Femoral Head: Collapse-related Changes with CT and MRI** 2

Ji Young Kim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to determine the diagnostic values of collapse-related changes to distinguish between Association Research Circulation Osseous (ARCO) stage 2 and 3A (named as pericollapse stage) in patients with osteonecrosis of the femoral head (ONFH).

## METHODS AND MATERIALS

A retrospective analysis was conducted in 124 hips with ONFH of either ARCO stage 2 (n = 49; 23 females; mean age, 50.7 years) or 3A (n = 75; 20 females; mean age, 53.2 years), in patients who underwent CT and MRI from May 2017 to August 2022 in our hospital. We assessed four types of collapse-related changes; on CT- 1) bone resorption area, 2) cystic change, and on MRI- 3) bone marrow edema, 4) joint effusion. We compared these collapse-related changes between stage 2 and 3A, analyzed the diagnostic performance of each variable for detecting stage 3A, and finally performed multivariate analysis to find the best predictor variable for stage 3A. ARCO stage 3A referred to the pericollapse stage as a period from the occurrence of subchondral fracture to early collapse (=2mm).

## RESULTS

All four types of collapse-related changes were significantly more common in stage 3A than in stage 2 (bone resorption area [72.0% vs. 4.1%]; cystic change [52.0% vs. 0.0%]; bone marrow edema [93.5% vs. 43.6%]; joint effusion [76.0% vs. 24.5%],  $p < 0.001$  in all). The sensitivity, specificity, and diagnostic accuracy for stage 3A were 72.0%, 96.0%, and 81.0% for bone resorption area; 52.0%, 100%, and 71.0% for cystic change; 93.0%, 56.0%, and 76.0% for bone marrow edema; and 76.0%, 76.0%, and 76.0% for joint effusion. In the multivariate analysis, bone resorption area (OR=32.952,  $p=0.002$ ), cystic change (OR=26.281,  $p=0.008$ ), and joint effusion (OR=9.603,  $p=0.004$ ) were independent predictors of stage 3A. Combination model of bone resorption area and cystic change showed the best area under the curve (AUC, 0.900) for stage 3A.

## CONCLUSION

Collapse-related changes were significantly more frequent in stage 3A than in stage 2. Bone resorption area and cystic change were highly specific findings favoring stage 3A, while bone marrow edema and joint effusion were highly sensitive findings for stage 3A. Among them, bone resorption area was the best single predictor for stage 3A by multivariate logistic regression analysis. Combination of bone resorption area and cystic change was the best model in diagnosis of stage 3A with AUC of 0.900.

## CLINICAL RELEVANCE/APPLICATION

The accurate diagnosis of ARCO stage 3A is essential for future treatment plan in ONFH. It is often difficult to clearly distinguish this pericollapse stage by subchondral fracture alone. Imaging findings of collapse-related changes on CT and MRI can help to detect stage 3A as pericollapse period.

## T5B-SPMK- Application of Deep Learning Reconstruction Algorithm (AiCE) in Low-dose CT Scanning of Sacroiliac Joints

Likun Cao, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the effect of deep learning reconstruction(DLR) in improving the image quality and reducing radiation dosage of low-dose sacroiliac joint CT scans by comparing with hybrid iterative reconstruction(HIR).

## METHODS AND MATERIALS

A total of 76 patients who underwent sacroiliac joint CT scans in our hospital from May 2021 to March 2022 were prospectively included. All patients gave written informed consent for the acquisition of low-dose CT(LDCT) after a clinically indicated standard-dose CT(SDCT). The SDCT series were reconstructed with HIR and the LDCT were reconstructed with DLR and HIR. The effective dose(ED) and size-specific dose estimate(SSDE) were calculated. All images were evaluated objectively, including the background noise(BN) of images, signal to noise ratio(SNR) and contrast to noise ratio(CNR) of the first sacral vertebra and iliac bone. Subjective 5-point Likert scale was used to score the reconstructed images of the three groups, and bilateral sacroiliac joints were graded according to the New York classification standard. All patients were divided into 3 groups(normal weight, overweight and obese groups) according to the BMI. The differences of objective and subjective evaluation were compared among the 3 kinds of reconstructed images.

## RESULTS

The ED and SSDE of LDCT were significantly lower than those of SDCT ( $p < 0.001$ ) and the reduction rates of ED and SSDE increased with the increase of the BMI. The BN, SNR, CNR and subjective scores showed significant differences ( $p < 0.001$ ) among SD-HIR, LD-HIR and LD-DLR images. The BN values were lower, and SNR and CNR values were higher on LD-DLR than those of SD-HIR and LD-HIR images ( $p < 0.05$ ). The subjective scores of LD-DLR images were significantly higher than those of LD-HIR images ( $p < 0.001$ ), and had no significant differences compared with SD-HIR ( $p = 0.808$ ). In addition, the



diagnostic consistency of SD-HIR and LD-DLR images for sacroiliac arthritis grading was superior with Kappa value=0.888 ( $p < 0.001$ ).

#### **CONCLUSION**

The use of DLR can reduce the radiation dose and improve the image quality of sacroiliac joint CT, with comparable efficacy of diagnosis to HIR. Thus, DLR algorithm is helpful to improve the safety of CT scanning of sacroiliac joint.

#### **CLINICAL RELEVANCE/APPLICATION**

The DLR algorithm, Deep Learning Reconstruction algorithm (AiCE), can help improve image quality and detect sacroiliac joint diseases with extremely low radiation dose for pelvis area of patients.

#### **T5B-SPMK- Anatomic Variants of the Acetabular Labrum of the Hip**

4

Brandon Knight, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The acetabular labrum is a ring of fibrocartilaginous tissue continuous with the distal edge of the acetabulum and completed inferiorly in its arc by the transverse acetabular ligament. Tears of the acetabular labrum can occur due to various factors and are diagnosed by clinical signs and imaging. Because of their similar appearance on imaging to non-pathologic labral variants, such as labral sulci, proper differentiation of labral tears from non-pathologic anatomic variants is essential for correct diagnosis and prevention of unnecessary treatment. However, few studies have collected observational data on labral sulci. This study aimed to observe the prevalence and locations of non-pathologic anatomic variants of the acetabular labrum, including sublabral sulci and transverse sulci. Teaching points will also be highlighted in the identification of sulci.

#### **METHODS AND MATERIALS**

Hip MR imaging from 109 patients who presented to our hospital system for hip arthroscopy was retrospectively analyzed. Surgical findings were used to determine the presence of labral tears, while MR imaging was available and reviewed for all cases to determine the presence of labral sulci, which was then confirmed by surgical findings of labral sulci or by a lack of abnormal surgical findings at that location (with imaging findings being analyzed alongside surgical findings when available). Prevalence, location, and other attributes were observed of these anatomic variants, as well as of labral tears and paralabral cysts.

#### **RESULTS**

After retrospective analysis, 130 acetabular labral tears out of 135 total cases were found in surgery, with 19% of those cases associated with paralabral cysts. A total of 43% of the patient population was observed to have at least one sublabral sulcus. The majority of sulci were found in the posteroinferior quadrant. Among all patients a total of 64 sublabral sulci were found, with some patients presenting with multiple sulci unilaterally or bilaterally. In 44% of cases, 49% of patients displaying at least one transverse sulcus were found on imaging.

#### **CONCLUSION**

Normal anatomic variants occur commonly in the hip joint, including sublabral sulci and transverse sulci, and may be mistaken on imaging for acetabular labrum tears. Understanding their prevalence improves the proper differentiation of these anatomic variants from labral tears, increasing the specificity of acetabular labral tear diagnosis and thus decreasing false positive rates and improving patient outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

Acetabular labral tears account for a large proportion of groin/hip pain patients and may be mistaken for sulci on imaging. Properly differentiating labral sulci and labral tears on imaging increases the specificity of labral tear diagnosis.

#### **T5B-SPMK- Additional Pain Generators on Lumbosacral Plexus Magnetic Resonance Neurography**

5

Hanna Tomsan, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Pain in sciatic nerve distribution is a common cause of disability worldwide with a reported prevalence of 43%. Identifying the cause of sciatica-type symptoms is clinically problematic, particularly when the symptoms are non-discogenic in origin. Magnetic resonance imaging (MRI) of the lumbosacral plexus has become a study of choice for sciatica, providing excellent anatomic detail and allowing comprehensive assessment of peripheral nerves, however, it demonstrates positive nerve findings in only 36-45% of patients according to literature. Our aim was to evaluate the prevalence of additional pain generators in patients undergoing lumbosacral plexus MRI, that commonly contribute to sciatica symptoms.

#### **METHODS AND MATERIALS**

A retrospective review of 125 lumbosacral plexus MRI examinations performed from September 2015 through September 2022 on a 3T scanner was undertaken. The studies were independently reviewed in a blinded fashion by 3 radiologists. The



findings were graded on a 0-3 scale depending on the presence or absence of particular non-neurologic pain confounders and the diagnostic quality of the study. Fleiss' Kappa (FK) was used to evaluate the interreader agreement.

## RESULTS

The presence of additional pain generators was demonstrated in 91% of examinations. Common etiologies observed included labral tears (62.4%, FK 0.7), hamstring tendinopathy/tears (57.6%, FK 0.72), gluteus tendinopathy/tears (56%, FK 0.63), greater trochanteric bursitis (40%, FK 0.65), ischiofemoral impingement (20.8 %, FK 0.75), sciatic nerve compression or variant anatomy (11.2%, FK 0.77), paralabral cysts (8%, FK 0.8), and moderate/severe hip osteoarthritis (8%, FK 0.72). Other incidental findings observed included disc herniation with nerve root compression (4%), sacral insufficiency fractures (1.6%), femoral head avascular necrosis (0.8%), and calcific tendinosis (0.8%). Of note, lumbosacral nerve abnormalities were only detected in 48% of the study group.

## CONCLUSION

Lumbosacral plexus MRI examinations permit accurate detection and localization of additional pain generators in patients with non-discogenic sciatica. Our study demonstrated substantial interreader agreement regarding the presence or absence of sciatica/buttock pain confounders and a high level of confidence in their detection by radiologists.

## CLINICAL RELEVANCE/APPLICATION

Extra-neural causes of sciatica can be consistently identified on lumbosacral plexus MR neurography studies, both on conventional T1/T2-weighted and lumbosacral plexus-specific series. This becomes particularly important when no nerve pathology is detected, as it can serve as a cost-effective initial imaging strategy.

## T5B-SPMK- Deep Learning-based Fully Automated Fat Quantification of the Supraspinatus Muscle on MRI

Woonyoung Baek, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purposes were to (1) measure the total volume and fat-fraction (FF, %) of the supraspinatus muscle (SSm) with deep learning (DL)-based fully automated fat quantification algorithm from a 6-point Dixon sequence according to retraction grade and tear severity; and (2) determine the whether the standard assessment for muscle fatty infiltration at a single image slice is representative.

## METHODS AND MATERIALS

Between December 2020 and November 2022, 107 patients were retrospectively enrolled in this study with extended oblique sagittal T1-weighted images and FF map generated from 6 point Dixon sequence including total SSm. A DL-based fully automated muscle segmentation using a FF map was developed by modifying our institute's previously developed muscle segmentation method. The total volume and fat content of SSm were obtained from this algorithm. The FF at a single image slice was measured by manually drawing an ROI at a Y view or Fossa view (2~3 slices medial to Y view). Then, the FF of SSm at a single slice image (FFy or FFfo) and total MR slices (FFt) were compared. The influence of retraction grade and tear severity was evaluated.

## RESULTS

Total supraspinatus volume and fat fraction were easily measured with a DL-based fully automated segmentation algorithm using a FF map. A comparison of FFy, FFfo and FFt was done by using the Wilcoxon signed rank test ( $P < 0.001$ ). There was significant difference if FFy was included, and no significant difference between FFfo and FFt. Dividing the patients by retraction grade and fat degeneration grade, there was significant difference in grade 0 of retraction ( $P < 0.001$ ) and grade 1 of fat degeneration ( $P < 0.001$ ). Dividing by tear severity, there was significant difference in patients with no tear ( $P < 0.001$ ) and partial tear ( $P = 0.014$ ). Regarding the FFt as the gold standard, we verified the value of Y view and the proposed method (fossa view). Both methods showed high correlation with FFt (Y-view correlation coefficient=0.894 ( $P < 0.001$ ) and fossa view correlation coefficient=0.874 ( $P < 0.001$ )). But the precision is slightly decreased at proposed method, referring to Bland-Altman plot.

## CONCLUSION

Regardless of retraction grade and fat degeneration, the FF evaluated through the proposed method provides a better representation of the total FF of the entire SSm than the conventional method with high accuracy. However, the precision was slightly lower than Y view.

## CLINICAL RELEVANCE/APPLICATION

DL based automatic quantification could allow accurate and rapid fat quantification of total SSm. If we should choose to pick one MR slice instead of measuring the fat fraction of the entire SSm, fossa view could be a better representation than conventional view. It could be a more accurate preoperative factor to predict surgical outcome.

## T5B-SPMK- CT with Tin-filtration for Bone Imaging: Dose Optimization using an Ex-vivo Pig Model

7

PhD (*Presenter*) Nothing to Disclose

## PURPOSE

CT via tin-filtration (CTTF) is an effective strategy in reducing radiation dose without sacrificing image quality. A parametric study via an ex-vivo pig model may be the most clinically relevant approach to better understand the trade-off between image quality and radiation dose. As skeletal assessment is a common clinical application for CT, we began by optimizing CTTF for bone imaging. As such, the objective of this study was to utilize an ex-vivo pig model to characterize the image quality of CTTF as a function of radiation dose for bone imaging.

## METHODS AND MATERIALS

We imaged a pig shoulder (1.7 kg) using Siemens SOMATOM Force dual-source CT scanner at different volume CT dose index (CTDI<sub>vol</sub>). The following parameters were used for image acquisition: tube voltage of 100kV with the tin filter (100Sn), rotation time of 250 ms, and ultra-high pitch of 2.45, and slice thickness of 3 mm. We conducted a parametric study by adjusting the mAs settings to achieve 5 different levels of CTDI<sub>vol</sub>. Specifically, we used the following five mAs settings: 242, 182, 122, 60, and 30. Reconstruction kernel Br69, ADMIRE strength of 3 were used for bone image reconstruction. We used the 3D slicer software to generate the 3D volume renderings. For the CTTF images acquired at each CTDI<sub>vol</sub>, we calculated the contrast-to-noise ratio (CNR) of the bone-to-muscle; and judged the CTTF image quality based on the following three subjective criteria: (1) clarity of the depicted anatomy (i.e., foreground bone versus background soft tissue); (2) image noise; and (3) contours of the 3D surface renderings.

## RESULTS

The CNRs of bone-to-muscle were 6.9, 6.2, 4.8, 3.4, and 2.9 at CTDI<sub>vol</sub> dose levels of 0.8 mGy, 0.6 mGy, 0.4 mGy, 0.2 mGy, and 0.1 mGy, respectively. However, despite this decreasing CNR, we found that the CTTF images at radiation doses as low as 0.2 mGy were deemed of comparable subjective quality to the CTTF images at the maximum dose of 0.8 mGy.

## CONCLUSION

Based on our parametric study, we conclude that there was no substantial deterioration in subjective image quality of CT<sub>TF</sub> when the radiation dose was reduced down to CTDI<sub>vol</sub> = 0.2 mGy. We postulated that the inherent high contrast between the foreground bone and the background soft tissue combined with a strong non-linear dose reduction by ADMRE was able to overcome the decreasing CNR to maintain diagnostic image quality at ultra-low radiation dose during CT<sub>TF</sub> bone imaging.

## CLINICAL RELEVANCE/APPLICATION

The results of our study are the initial steps in optimizing CT with tin-filtration for bone imaging.

## T5B-SPMK- Clinical and MRI-based Radiomics Models for Predicting Hidden Blood Loss during Surgery for Spinal Metastasis<sup>8</sup>

Weili Zhao (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the role of clinical and MRI-based radiomics models for predicting the risk of hidden blood loss (HBL) in patients undergoing spinal metastasis surgery.

## METHODS AND MATERIALS

Consecutive patients who underwent surgery for spinal metastasis between January 2018 and December 2021 at our institution were retrospectively analyzed. Baseline demographic, clinical, and surgical data were collected. HBL was calculated using the Gross formula. Potential clinical risk factors were accessed using univariate and multivariate logistic regression analyses. Radiomics features were extracted from sagittal T1-weighted and fat-suppressed T2-weighted imaging sequences, and manual delineation was performed by two radiologists. The datasets were Z-score normalized, and features with intraclass correlation coefficient values  $\geq 0.80$  were excluded. The least absolute shrinkage and selection operator method was employed for optimal feature selection. Clinical, radiomics, and combined clinical-radiomics models were established. Clinical utility of the best prediction model was evaluated using calibration and decision curves.

## RESULTS

A total of 202 patients were included, 149 and 53 of whom were classified as low and high HBL. Extraspinal metastases, New York Heart Association grade, operation site, and operation time were identified as independent predictors of high HBL ( $P < 0.05$ ). The best predictive efficacy was shown in the combined clinical and T2WI-based radiomics model (AUC value of 0.893 and 0.816, and ACC of 80.2% and 77.3% respectively in the training and validation cohort). Additionally, the proposed clinical-radiomics nomogram demonstrated good clinical utility.

## CONCLUSION

Our combined clinical-radiomics model may serve as a promising prediction tool for the risk of HBL in patients undergoing spinal metastasis surgery, and guide perioperative planning to improve surgical outcomes.

## CLINICAL RELEVANCE/APPLICATION

- Our study aimed to develop and evaluate the predictive efficacy of clinical and MRI-based radiomics models for high HBL during spinal metastasis surgery.
- The combined clinical and T2WI-based radiomics model achieved the best predictive performance in both the training and testing cohorts.
- Our proposed clinical-radiomics nomogram demonstrated promising clinical utility in guiding the indications of preventative and treatment interventions in such patients.

## T5B-SPMK- Musculoskeletal Diffusion Tensor Imaging in Adolescent Elite Rowers and Association of 9 Imaging Findings with Rowing Technique

Jonas Alexander Leppig, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Muscular overuse injuries are a common health issue in elite athletes. Changes in the muscular microenvironment can be depicted by Diffusion Tensor Imaging (DTI). We hypothesize that the biomechanics of different rowing techniques plays a role in tissue injury and tested our hypothesis by examining the lumbar spine muscles of adolescent rowers using DTI.

## METHODS AND MATERIALS

Sixteen male elite rowers underwent 3 Tesla multiparametric MRI of the lumbar spine 6 hours after cessation of training. Axial diffusivity (AD), radial diffusivity (RD), apparent diffusion coefficient (ADC), and fractional anisotropy (FA) were calculated for the erector spinae (ES) and multifidus (MF) muscles. These DTI parameters were correlated with demographic data, training data, and low back pain (LBP) questionnaire scores.

## RESULTS

ADC values in ES and MF were significantly higher ( $p = 0.039$ ) and FA values significantly lower ( $p < 0.001$ ) in sweep rowers compared to scull rowers. Training-related LBP episodes in the last 12 months were reported by 88.9% of participants. There was no significant association between DTI parameters and training volume or LBP questionnaire scores.

## CONCLUSION

Our DTI results show that lumbar spine muscle diffusivity is higher in sweep rowers than in scull rowers. Altered muscle diffusivity is suggestive of microscopic tissue disruption and might be attributable to biomechanical differences between rowing techniques.

## CLINICAL RELEVANCE/APPLICATION

The differences identified with DTI are not detectable with conventional MRI techniques. Therefore, DTI might have a role in the early noninvasive detection of overuse injuries in athletes before symptoms develop.

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## Abstract Archives of the RSNA, 2023

T5B-SPMS

### Multisystem Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPMS- Virtual Non-calcium Imaging for Qualitative and Quantitative Assessment of Bone Marrow Involvement in Multiple Myeloma: Our Experience with Dual-energy Computed Tomography**

Alessandro Onori, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aim of this study was to compare the diagnostic performance of virtual non-calcium imaging (VNCa) and Conventional Computed Tomography imaging (CCT) in the evaluation of bone marrow (BM) involvement in patients affected by multiple myeloma and to investigate the impact of VNCa values on patients' prognoses.

#### **METHODS AND MATERIALS**

In this mono-centred retrospective study, consecutive patients with MM who underwent Dual Energy Computed Tomography (DECT) in the last 12 months were enrolled. Two readers randomly and independently reviewed two datasets of images per patient (VNCa and monochromatic 120kVp-like) for the presence of BM involvement. The number and dimension of BM lesions were compared on a per segment analysis. CT numbers of BM lesions and unaffected bone were measured on VNCa images. Results were stratified according to the disease status (stable or progression).

#### **RESULTS**

Significantly more lesions ( $n=748$ ) were identified on VNCa images compared to CCT ( $n=502$ ) ( $p<0,0001$ ). No significant differences were observed for lesions' dimensions ( $18,72\pm 9,68$  mm,  $p=0,6352$ ). VNCa CT numbers showed a significant difference between lesions in patients with stable disease and lesions in patients with progressive disease ( $-143,67\pm 202,63$  HU vs  $4,54\pm 51,95$  HU;  $p=0,0087$ ). There was almost perfect agreement for both number and dimension of the lesions among readers (ICC = 0.93 [95% CI 0.84-0.71] and ICC = 0.89 [95% CI 0.75-0.96], respectively).

#### **CONCLUSION**

VNCa is superior to CCT in identifying BM involvement in MM and ROI-based analysis of the lesions could also be an interesting tool for its prognostic implications.

#### **CLINICAL RELEVANCE/APPLICATION**

VNCa imaging may be a promising technique to easily assess with good confidence the presence of bone lesions in patients with MM. Quantitative analysis and its prognostic implications may be useful for risk stratification and for personalized therapeutical planning.

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## Abstract Archives of the RSNA, 2023

T5B-SPNMMI

### Nuclear Medicine & Molecular Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPNMMI-1 Semi-quantification Approach of Amyloid PET: A Study of Familial Alzheimer's Disease Associated with Heterozygous NPC1 Mutation**

Anna Lisa Martini (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Many studies try to develop model to compare and integrate visual reading of amyloid PET with independent semi-quantification methods. Here we describe new semi-quantification approach of amyloid PET in a family with apparently autosomal dominant Alzheimer's disease (AD) harbouring a novel NPC1 mutation in heterozygous state.

#### **METHODS AND MATERIALS**

All 5 living siblings were evaluated. We performed clinical assessment, neuropsychological tests, genetic analysis, assessment of cerebrospinal fluid markers. Patients n. 1, 2, 4 and 5 underwent early and late amyloid PET that should be read using qualitative analysis but also investigated by innovative visual and automatic semi-quantification analyses using: Standardized Uptake Values Ratio, the ratio of counts in one or more regions of interest to a reference region; Evaluation of Brain Amyloidosis, evaluates the geometric distribution of contrast without fixed, reference or segmentation ROIs and measures the geometric properties of the iso-intensity surfaces, the changes are related to the amyloid burden; Time-delayed ratio, a level of contrast between early and late scans; uptake and baseline ROIs are extrapolated from the early scan and track high-flow districts.

#### **RESULTS**

In 4 of them, a diagnosis of AD was defined according to biomarkers (A+, T+, N+) and serum oxysterol analysis. Early PET images of patients n.1 and 2 showed rather severe hypoperfusion in bilateral temporal, posterior parietal, posterior cingulate and precuneus cortices. In these patients, late amyloid PET images detected high rate of amyloid burden in bilateral frontal, temporal, posterior parietal, precuneus and posterior cingulate areas and final likelihood for positive scan. In patient n.4, early PET scan showed a mild hypoperfusion in left temporal, left posterior parietal and right precuneus cortices. In this patient, late amyloid PET images showed a moderate amyloid accumulation in left temporal, left posterior parietal and left frontal cortices with a positive scan. Finally, slight amyloid accumulation in frontal cortex consistent with negative scan without clear perfusion pattern of AD was found in patient n.5.

#### **CONCLUSION**

The present results demonstrated that early and late acquisitions images supported use of amyloid PET to study cerebral perfusion and amyloid deposition. Finally, the new semi-quantitative approach of amyloid PET provides data on the regional amyloid deposition allowing a better longitudinal evaluation of patients that could benefit from already available drugs against NPC.

#### **CLINICAL RELEVANCE/APPLICATION**

This study supports use of early amyloid PET acquisitions and of this novel semi-quantitative approach on regional amyloid deposition to improved longitudinal assessment of patients.

#### **T5B-SPNMMI-2 In Vivo Assessment of Regional Tau Deposition, Gray Matter Volume and Cognition in Alzheimer Disease: A Head-to-head <sup>18</sup>F-flortaucipir PET/MR study**

Xinru Xu (*Presenter*) Nothing to Disclose

## PURPOSE

Despite the associations of A $\beta$  deposition with connectivity alterations, atrophy, and cognition, the exact role of tau and regional atrophy on cognition in Alzheimer's disease remains unclear. This study aimed to investigate the relationship between regional tau pathology, gray matter volume in vivo and their effects on cognitive function improving effective clinical trials and future therapeutic strategies for AD.

## METHODS AND MATERIALS

Thirty-four patients with amyloid-positive mild cognitive impairment or dementia and 23 healthy controls underwent standardized clinical and neuropsychological assessments followed by 18F-fortaucipir positron emission tomography imaging and 3D T1-weighted magnetic resonance imaging. The regional tau standardized uptake value ratio and gray matter volumes (GMV) were measured. Group differences in the two imaging modalities were compared. Partial correlations and mediation analysis were then performed in brain regions showing an association between cognition and both 18F-fortaucipir uptake and gray matter volume.

## RESULTS

The 18F-fortaucipir retention was observed in the entorhinal cortex, hippocampus, parietal lobe, temporal lobe, precuneus and posterior cingulate. The regional tau deposition was associated with GMV in medial temporal and lateral temporal regions (range standardized  $\beta$ s of residual=-0.45--0.77,  $p<0.05$ ) in MCI/AD patients. Both increased 18F-fortaucipir SUVR and decreased GMV in the medial temporal lobes and medial parietal lobes were related to cognitive impairment. The GMV of the entorhinal cortex and medial parietal lobes mediated the effect of local region 18F-fortaucipir SUVR on cognitive impairment (mediation effect=0.54,0.93; explained variance=32.86%, 37.94%, respectively). The GMV of the medial parietal lobes and medial temporal lobes mediated the effect of distant region 18F-fortaucipir SUVR on cognitive impairment (mediation effect=0.75-0.85; explained variance=57.01%-58.14%).

## CONCLUSION

Tau pathology was associated with local and distant areas of brain atrophy in the brains of MCI and AD patients. The mediation analysis enabled data fusion across multiple imaging modalities (PET and MRI), local and distant atrophy played a mediating role between tau binding and cognitive impairment in these patients.

## CLINICAL RELEVANCE/APPLICATION

tau PET/MR can be a potentially useful imaging biomarker for predicting the risk of developing clinical AD based on more than one pathology and determining when is the optimal time for anti-tau target treatment.

## T5B- SPNMMI-3 Validation of SSTR2 Expression and Assessing Correlation of Variable F<sup>18</sup>-FDG PET/CT Parameters in EBV Associated Nasopharyngeal Cancer

Thangalakshmi Sivathapandi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Epstein-Barr virus (EBV), a known nasopharyngeal carcinoma (NPC) driver, promotes somatostatin receptor 2 (SSTR2) expression via NF $\kappa$ B, detectable by immunohistochemistry. To assess the correlation of EBV associated NPC and SSTR2 expression and evaluate the association between F18-FDG PET CT parameters and EBV associated NPC

## METHODS AND MATERIALS

In this retrospective study done between 2017-2022, SSTR2 immunohistochemistry on our cohort of EBV NPC (n=15), HPV-positive sinonasal SCC (n=7, HPVSCC), and virus-negative sinonasal SCC (n=8, VNSCC), reviewed by two board-certified pathologists. The F18-FDG PET/CT was reviewed by two board-certified nuclear medicine physicians. Histopathology was scored as positive or negative in a binary system. H-score was calculated using the intensity and extent of tumor staining. The association between various parameters of F18-FDG PET/CT (primary tumor and nodes) and SSTR2 expressing EBV positive nasopharyngeal carcinoma were analyzed

## RESULTS

Using a positive/negative system, 93.3% EBVNPC (n=14/15), 14% HPVSCC (n=1/7), and 25% VNSCC (n=2/8) demonstrated multifocal to diffuse strong SSTR2 expression. The sensitivity, specificity, negative predictive value, and positive predictive values for SSTR2 IHC were 93.3%, 80%, 92.3%, and 82.4%, respectively. The median H-score for EBVNPC was 180 (range 12-295; mean 179), whereas the median H-scores for HPVSCC and VNSCC were 0 (range 0-56; mean 8) and 0 (range 0-125; mean 31), respectively ( $p<0.001$ ). No significant association was found between SUV max, metabolic tumor volume (MTV) and total lesion glycolysis (TLG) between EBV associated and other types of HNSCC ( $p$  value $>0.005$ ). The SUV max range for primary tumor was found to be 6.67-29.95 and SUV max range for metastatic nodes was 4.11-25.53. Among the 15 EBVNPC patients 53% of patients had overlap of primary tumor uptake with physiologic FDG brain activity

## **CONCLUSION**

EBV associated NPC showed stronger expression of SSTR2 comparing to HNSCC in other subsites. No significant difference in F18-FDG PET/CT parameters between EBV positive NPC and other types of HNSCC. Future directions would include assessing the role of Cu<sup>64</sup>-DOTATATE PET/MRI in evaluation of EBV positive NPC and its impact on radiation therapy planning.

## **CLINICAL RELEVANCE/APPLICATION**

The strong correlation between EBV positive NPC and SSTR2 expression infers that Ga68/Cu64- DOTATATE PET imaging could be a valuable tool in accurate staging, therapy planning and surveillance of these patients. Peptide receptor radionuclide therapy (PRRT) using therapeutic nuclide-labeled DOTA-peptide may be a potential therapeutic tool in these patients with metastases

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## Abstract Archives of the RSNA, 2023

T5B-SPNPM

### Noninterpretive Skills (Beyond Imaging) Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPNPM-1 Radiologist's Impact on the Frequency of Pediatric Head CT for Trauma: A Machine Learning Model Analysis using a Nationwide Claims Database**

Kanako K. Kumamaru, MD, PhD (*Presenter*) Research Grant, General Electric Company

#### **PURPOSE**

The purpose of this study is to develop a machine-learning model that can predict factors that independently affect the frequency of pediatric head CT for trauma (pHCTT). The study also aims to evaluate the impact of the number of radiologists per population (radiologist density) on the frequency of pHCTT.

#### **METHODS AND MATERIALS**

The study used data on the number of outpatient pHCTT performed in 254 medical areas in Japan for the fiscal year 2020, extracted from the national open database of health insurance claims. Over a hundred regional variables, such as population, number of hospitals, and number of pediatricians, were used to train 34 algorithms to predict the number of pHCTT per 10,000 child population, without including radiologist density measure. The best-performing machine-learning algorithm, based on poisson deviance ranking, was then identified. We compared the radiologist density between medical areas that exceeded the predicted pHCTT frequency and those that fell below the prediction, as an indicator of radiologist's impact on pHCTT frequency.

#### **RESULTS**

A total of 18,313 outpatient pHCTT were performed in 2020 in Japan, with a large variability in the number of pHCTT per 10,000 child population across medical areas (range: 0-114, median: 2.94). The random forest regressor model showed the highest prediction power with a poisson deviance of 11.61 on cross-validation, identifying total population density, the proportion of elderly people, the total number of stroke care units, growing care units, and CT examinations per population as strong predictors. The number of doctors working in clinics per population also had a significant influence on the prediction. The radiologist density was significantly lower in the medical areas where pHCTTs were performed more frequently than predicted, compared to the medical areas where pHCTTs were performed below the prediction (radiology density, median (IQR): 27.5 (19.5, 49.5) vs. 48 (22, 76),  $p=0.037$ ).

#### **CONCLUSION**

The number of pHCTT per child population varied significantly across different medical areas. In medical areas where pHCTTs were performed more frequently than predicted by the machine-learning algorithm, the radiology density was lower, which may suggest the impact of radiologists on appropriate pediatric imaging.

#### **CLINICAL RELEVANCE/APPLICATION**

Increasing the number and involvement of radiologists may reduce the variability in the frequency of pediatric head CT for trauma and promote appropriate utilization.

#### **T5B-SPNPM-2 Computed Tomography-based Sarcopenia: Diagnostic Cutoff Values in Patients with Chronic Liver Disease and Mortality: A systematic Review and Meta-analysis**

Joao Rafael T. Vicentini, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Sarcopenia is a known complication of patients with Chronic Liver Disease (CLD). The assessment of psoas muscle mass by Computed Tomography (CT) can be done using the Psoas Muscle Index (PMI). This method is easy to perform using regular



CT scans and not easily altered by ascites. We aimed to investigate the influence of sarcopenia diagnosed by CT using the PMI method as a predictor of mortality in patients with CLD after liver transplantation.

## **METHODS AND MATERIALS**

The protocol was registered with the international prospective register of systematic reviews (PROSPERO CRD42022370684). We systematically searched PubMed, Scopus, and Cochrane Central Register of Controlled Trials from inception to November 2022 with the following search terms: (sarcopenia OR muscle mass OR psoas muscle) AND (chronic liver disease OR CLD OR cirrhosis OR liver transplantation OR liver transplant) AND (Computed Tomography OR CT OR psoas muscle). Cochran's Q test and I2 statistics were used to assess for heterogeneity; P values inferior to 0.10 and I2>25% were considered significant for heterogeneity. We used a fixed-effect model for outcomes with low heterogeneity (I2 < 25%). We calculated standard effect estimates and random effects (odds ratio) for meta-analysis with binary outcome data. Clustering was performed by the Mantel-Haenszel method.

## **RESULTS**

The initial search yielded 1,414 results. After removal of duplicate records and ineligible studies, 163 remained and were fully reviewed based on inclusion criteria. Of these, a total of 11 studies were included in qualitative synthesis and 4 studies were included in quantitative analysis (meta-analysis) comprising 382 patients. Patients diagnosed by CT scan using the PMI method with muscle mass loss after liver transplantation had a 4.1 times higher risk of death than non-sarcopenic patients (Random effects model OR 4.1386; 95% CI 2.4215- 7.0730; P < 0.0001). Heterogeneity among studies was assessed by visual inspection of the graphs, the I2 statistic, Cochran's Q test, and Tau2. Interpretatively, a scale with an I2 value close to 0% indicates no heterogeneity. The other criteria also did not reject the hypothesis of homogeneity among the articles.

## **CONCLUSION**

Patients with sarcopenia diagnosed by CT using the PMI method had a fourfold increase in mortality risk after liver transplantation.

## **CLINICAL RELEVANCE/APPLICATION**

The findings reinforce the need to identify sarcopenic patients preoperatively to optimize liver transplantation outcomes. Opportunistic diagnosis by CT using Psoas Muscle Index (PMI) can be helpful in this setting.

## **T5B-SPNPM-3 Autonomous AI-based CXR Interpretation for Predicting Congestive Heart Failure: A Multicenter Study**

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Favorable treatment outcomes of a progressive disease like heart failure (HF) depend on early detection. We conducted a multicenter study to assess if an autonomous AI model can help identify chest radiography (CXR) signs of HF in patients without a previous cardiovascular history or diagnosis.

## **METHODS AND MATERIALS**

Our retrospective, standalone study included 1455 patients (age range 69 +/- 13 years; M:F 670:785) with an AP/PA CXR. A total of 751 patients had the CXR taken within one year before their HF diagnosis. The rest (n= 704) of the CXR were selected from patients without any NT-proBNP exam, echocardiography or HF diagnosis after the radiological examination date. All patients belong to 17 sites including two quaternary care hospitals and 15 community hospitals and outpatient clinics. 1455 deidentified CXRs were processed with the AI algorithm for HF (qXR-HF, Qure.AI) to obtain information on enlarged cardiac silhouette, pleural effusion, and an HF-index. CXRs were stratified based on their lead time from HF diagnosis (<3 months, 3-6 months, 7-9 months, 9-12 months). Data were analyzed using R version 3.6.2 to derive accuracy, sensitivity, specificity, and area under the curve (AUC) for the receiver operating characteristics (ROC).

## **RESULTS**

Among the 1455 patients, 751 patients had HF while the remaining 704 patients did not have HF. We report 0.80 ROC AUC (95% CI 0.78-0.82), 0.70 accuracy, 0.57 sensitivity, and 0.83 specificity for the overall AI performance for predicting HF. AI AUCs (< 3 months: 0.83; 4-6 months: 0.81, 7-9 months: 0.79, 10-12 months: 0.79), specificity (constant: 0.83) and accuracy (0.77-0.78) remained stable, but sensitivity declined with increasing lead time from HF diagnosis (< 3 months: 0.6; 10-12 months: 0.5). The performance of CXR-AI derived HF index was significantly higher compared to enlarged cardiac silhouette (0.75) and pleural effusion (0.74, p<0.01).

## **CONCLUSION**

Our autonomous AI model can help identify signs of HF up to 12 months prior to the clinical diagnosis of HF with a high and consistent AUC and accuracy, regardless of patient gender, age group (>45 years), and imaging site.

## **CLINICAL RELEVANCE/APPLICATION**

Detection of HF signs with an autonomous CXR-based AI algorithm can help in early diagnosis and treatment of unsuspected HF.

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## Abstract Archives of the RSNA, 2023

T5B-SPNR

### Neuroradiology Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPNR- Systematic Review of the Determination of EGFR Status in Glioblastomas by Feature Characterization on MR** 1

Joseph Duero (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Glioblastoma (GBMs) is the most common and deadly type of adult brain tumor. The clinical treatment for GBMs varies depending on genetic profile. There has been a push to identify imaging markers of genes implicated in GBMs. Epidermal growth factor receptor (EGFR) represents one such gene. Multiple studies have described relative cerebral blood volume (rCBV) as a potential marker for EGFR status, but a systematic review of those studies has not been performed. The objective of this review is to objectively summarize the current literature on the potential for rCBV to serve as a marker for EGFR status in patients with diagnosed GBM.

#### **METHODS AND MATERIALS**

A systematic review was conducted following PRISMA guidelines with a strategy to identify articles pertaining to radiologic markers of GBM. Examples of pertinent MeSH terms to be used are as follows: "glioma", "glioblastoma", "EGFR", "epidermal growth factor receptor", and "magnetic resonance imaging." Studies were included or excluded based on pre-established criteria. A primary review will be conducted by two separate independent researchers blinded to each other's results to determine which papers meet inclusion/exclusion criteria. Discrepancy between reviewers will be resolved via consensus. The bias of studies will be assessed via QUADAS2 bias assessment tool.

#### **RESULTS**

A preliminary review was conducted to collect papers from Pubmed and Scopus databases. This search resulted in 14 papers eligible for primary review, including 1864 of tumors, with (818) EGFR amplified and (1046) EGFR wild type tumors. Chi square analysis will be done to compare cerebral blood volumes and/or tumor location. Odds ratios and forest plots will be generated for inter group comparisons.

#### **CONCLUSION**

Based on preliminary review, a direct correlation is expected to be observed between eGFR amplification and increased rCBV. Significant differences in location, diffusion coefficient, transfer coefficient, and relative plasma volume may also be shown.

#### **CLINICAL RELEVANCE/APPLICATION**

Identifying rCBV as a radiologic marker of EGFR status in GBM patients will allow for non-invasive and faster identification of the best treatment plan.

#### **T5B-SPNR- BT-RADS Posttreatment Brain Tumor Response: An Interobserver Agreement Analysis** 10

Fabiano Reis (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In recent years, synoptic reporting has been shown to improve the consistency, reproducibility, quality, readability, and clarity of radiological reports; which is supported by the success of previous models such as BI-RADS. In light of these favorable results, Weinberg et al proposed a brain tumor reporting data system (BT-RADS) to assess the treatment response of brain tumors. In this study, we evaluate the consistency of the BT-RADS model by measuring the agreement of the reports between two radiologists.

## METHODS AND MATERIALS

We compiled a list of brain MRI studies from patients with brain tumors, along with relevant medical records, and provided it to two radiologists for categorization. The first one had one year of experience as a radiologist, while the second one, a university professor specialized in neuroradiology, had over thirteen years of experience. For each study, the radiologists gave a report based on the BT-RADS model unbeknownst to the score given by their peers in the same studies.

## RESULTS

Both radiologists reviewed 85 exams, of which 23 were BT-RADS 0 by default. The BT-RADS 0 score is meant for studies that will serve as a baseline for future studies; this includes the first study after surgery or before chemoradiotherapy. Sixty-two studies remained for analysis. We applied Cohen's Fleiss' kappa to measure inter-rater reliability between the two radiologists. The Cohen's kappa value was equal to 0.94, with a confidence interval of 95% and an alpha value of  $p=0.05$ . The lower bound was 0.88, while the upper bound was 0.99. We also calculated Fleiss' kappa for each category, and each showed a high agreement rate, except for category 3c.

## CONCLUSION

Our analyses showed a strong inter-rater reliability agreement despite the difference in experience between the two observers.

## CLINICAL RELEVANCE/APPLICATION

The BT-RADS demonstrated a high inter-observer agreement rate, despite the experience gap between the two radiologists. This finding is promising for the validation of BT-RADS for future broad use. The BT-RADS model is still in development, so some changes in its protocol are still expected to happen.

## **T5B-SPNR- Leveraging CT Imaging and Machine Learning: Enhancing Prognostic Accuracy for Functional Outcomes in Anterior Circulation Large Vessel Occlusion Stroke Patients**

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

## PURPOSE

We aimed to predict the functional outcome of acute ischemic stroke patients with anterior circulation large vessel occlusions (LVOs) using only imaging parameters in machine learning (ML) models, regardless of how they were treated or the severity of the stroke at admission, and to investigate the precision of imaging parameter utilization in ML models.

## METHODS AND MATERIALS

Patients with acute ischemic stroke (AIS) due to anterior circulation LVO, as confirmed by computed tomography angiography (CTA) and CT perfusion (CTP) scans, were screened in this retrospective study. Demographic and clinical data, such as sex, age, race, admission NIHSS score, modified Rankin Score (mRS) at 90 days, and treatment information, were extracted. Radiological variables were collected by a neuroradiologist, who recorded the spatial location, and assessed the baseline ASPECTS, occluded vessel, occluded segment, occlusion laterality, and presence of hyperdense MCA. Additional data, such as rCBF, Tmax, CBV, mismatch volume, mismatch ratio, hypoperfusion index, DSA collateral score, clot burden score, single-phase CTA collateral score, and multiphase CTA collateral score, were extracted. These data were used as input, and the outcome was mRS at 90 days, which was dichotomized as mRS 0-2 (good outcome) and mRS 3-6. To address missing data, imputation techniques were employed for both infinite values and missing values using k-nearest neighbor imputation. The sample was divided into training (60%), validation (20%), and test (20%) sets. CatBoost, XGBoost, and Random Forest ML algorithms were employed. The SHAP method was employed to determine the relative importance of predictor elements.

## RESULTS

180 patients were included. 88 patients had an mRS between 3-6 and 92 had an mRS between 0-2. The best algorithm was XGBoost, with an area under the receiver operating characteristic curve of 0.907 (95% CI: 0.686 - 0.979) and an area under the precision recall curve of 0.827 (95% CI: 0.703 - 0.951). The top three most significant features were multiphase CTA collateral score, CBV < 42%, and mismatch volume.

## CONCLUSION

Our model was highly accurate using only imaging parameters, indicating that imaging parameters may be as accurate as conventional predictors. The multiphase CTA collateral score was the most predictive variable, highlighting the importance of collaterals and demonstrating that incorporating them into ML models could lead to accurate prediction.

## CLINICAL RELEVANCE/APPLICATION

This study emphasizes the importance of imaging parameters, particularly collateral circulation markers, in predicting functional outcomes for AIS patients, regardless of stroke severity at admission or treatment method that physicians can tailor to improve patient prognosis.

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

## **T5B-SPNR- 12 Decoding the Enigma of Distal Medium Vessel Occlusions: Harnessing Machine Learning for Prognostic Predictions in Acute Ischemic Stroke Patients**

### **PURPOSE**

We hypothesized that machine learning (ML) algorithms using CT perfusion (CTP) and clinical variables as input parameters can successfully predict the outcome in distal medium vessel occlusion (DMVO) acute ischemic stroke (AIS) patients regardless of the preferred treatment method, given CTP's expected impact on stroke diagnosis and management.

### **METHODS AND MATERIALS**

DMVO-AIS patients with available CTP scans were screened in this retrospective cohort study. Demographic, clinical, and radiologic data were collected, including blood samples and radiologic variables such as occlusion location, ASPECTS, rCBF, Tmax, CBV, mismatch volume, hypoperfusion index, and diffusion-weighted imaging (DWI) volume on follow up MRI within seven days of symptom onset. These data were used as input, and the outcome was National Institutes of Health Stroke Scale (NIHSS) shift score (admission NIHSS score - discharge NIHSS score). Patients with an NIHSS shift score above the median score and patients with an NIHSS shift score below the median score were assigned to the favorable outcome group and the unfavorable outcome group, respectively. Since admission and discharge NIHSS scores are directly related with our outcome, NIHSS shift, they were not included in the predictor variables. Data preprocessing involved imputation of missing values, scaling of continuous variables, normalization, and encoding of categorical variables. Recursive feature elimination (RFE) was used for feature selection. Five supervised machine learning algorithms were employed. SHAP were used to examine the relative weights of predictor variables.

### **RESULTS**

There were 35 patients who had a favorable outcome and 34 patients who had an unfavorable outcome. RFE produced ten features, the top three most important of which were mismatch volume, Tmax > 6s, and DWI volume. XGBoost showed the best performance in predicting unfavorable outcome with an area under the curve of receiver operating characteristic curve of 0.865 and an area under the precision-recall curve of 0.811.

### **CONCLUSION**

In patients with DMVO-AIS, our ML model trained on baseline quantitative CTP parameters and laboratory data was able to predict the short-term outcome, NIHSS shift score. The most important variable was the mismatch volume in the best-performing model. Notably, neither the admission NIHSS score nor the patient's age were used in our model to predict the prognosis of AIS patients, despite the fact that these factors are normally very important predictors of prognosis.

### **CLINICAL RELEVANCE/APPLICATION**

We were able to accurately predict the prognosis of DMVO-AIS patients using CT perfusion parameters, demonstrating the importance of imaging. These preliminary findings may aid clinicians in predicting patient prognoses.

## **T5B-SPNR- 13 Effect of Statins on Different Intracranial Plaques & Its Influencing Factors: A High-Resolution Magnetic Resonance Vessel Wall Imaging Study**

Jiayuan Hu (*Presenter*) Nothing to Disclose

### **PURPOSE**

High-resolution magnetic resonance vessel wall imaging (HRMR-VWI) is a non-invasive examination that can evaluate intracranial atherosclerotic plaque stability. This study applied HRMR-VWI to evaluate the effect of statins on vulnerable and stable intracranial plaques and explore the influencing factors of statin therapy.

### **METHODS AND MATERIALS**

Between July 2017 and August 2021, patients with intracranial atherosclerosis treated with statins underwent HRMR-VWI. The plaque characteristics were measured using PACS system and Vessel Explorer software, including plaque length, thickness, burden, luminal stenosis, plaque enhancement, and plaque location. According to the baseline plaque enhancement, each plaque was classified into a vulnerable plaque group or stable plaque group. The plaque characteristics before and after treatment were compared by using the signed-rank test and paired-samples t-test. The plaque characteristics after treatment between the two groups were compared by using Wilcoxon rank sum test. According to the tri-sectional quantiles of plaque enhancement rate change, each plaque was classified into a good or poor effect group. The baseline plaque characteristics between the two groups were compared by using the independent-samples t-test or Wilcoxon rank sum test. Multiple linear regression was used to investigate the relationship between baseline plaque characteristics and the effect of statin therapy.

### **RESULTS**

This study included 53 patients with a total of 107 plaques, including 61 stable plaques and 46 vulnerable plaques. In the vulnerable plaque group, plaque enhancement ( $P < 0.001$ ), plaque burden ( $P < 0.023$ ), and luminal stenosis ( $P < 0.027$ ) in the follow-up period were significantly reduced compared to baseline. The extent of reduction in plaque enhancement was

significantly higher in the vulnerable plaque group than that in the stable plaque group ( $P < 0.025$ ). Compared with the poor effect group, the baseline plaque burden was greater ( $P < 0.025$ ) and luminal stenosis was higher ( $P < 0.024$ ) in the good effect group. Multiple linear regression showed that plaques located in anterior circulation ( $B = 0.16, P = 0.014$ ) and those with obvious enhancement at baseline ( $B = -0.0218, P = 0.007$ ) were positively correlated with a decreased rate of plaque enhancement after statin treatment.

#### **CONCLUSION**

This study confirmed by HRMR-VWI that statins have certain effects on vulnerable plaques, and their efficacy is better than that on stable plaques. The treatment benefit may be greater for plaques located in the anterior circulation and have a higher baseline enhancement degree.

#### **CLINICAL RELEVANCE/APPLICATION**

This result may provide a theoretical basis for individualized treatment for patients with intracranial artery stenosis.

### **T5B-SPNR- 14 Automated Machine Learning Based on Clinical Factors and Multimodal Radiomics of Diffusion Kurtosis Imaging and Conventional Magnetic Resonance Imaging Predicts the Functional Outcome of Acute Ischemic Stroke**

Yiran Zhou (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to investigate the predictive value of the radiomics from diffusion kurtosis imaging (DKI) for the functional outcome of acute ischemic stroke (AIS) patients and develop a prediction model based on radiomics and clinical factors using automated machine learning to accurately predict the functional outcome.

#### **METHODS AND MATERIALS**

The clinical and imaging data of 203 patients with AIS were retrospectively collected and randomly divided into the training cohort ( $n = 163$ ) and testing cohort ( $n = 40$ ). Based on the modified Rankin Scale (mRS) at three months after hospital discharge, the functional outcome was dichotomized into good ( $mRS = 2$ ) and poor ( $mRS > 2$ ). Radiomics features were extracted from DKI parametric maps, T2 fluid-attenuated inversion recovery (FLAIR), diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) maps and categorized into four feature sets (set 1: DWI and ADC maps; set 2: T2 FLAIR, DWI and ADC maps; set 3: DKI parametric maps including mean diffusivity, mean kurtosis and fractional anisotropy maps; set 4: all of the above features). The tree-based pipeline optimization tool (TPOT) was applied to establish the prediction models based on the simple feature sets and the combination of the radiomics score and clinical factors, respectively. For each feature set, TPOT was repeated 10 times to obtain a best model. Then the best models were validated on the testing cohort. The area under the curve (AUC), average precision, accuracy, sensitivity and specificity were used to evaluate the performance of the models.

#### **RESULTS**

Four radiomics models and four radiomics-clinical models were developed by TPOT. The models combining radiomics score from DKI parametric maps and clinical factors achieved the best performance in the testing cohort (AUC = 0.923, average precision = 0.896, accuracy = 0.775, sensitivity = 0.800, specificity = 0.760). The 5 most important factors were radiomics score, baseline National Institute of Health stroke scale score, age, infarct volume and baseline mRS. In addition, the AUC of DKI-based radiomics model was higher than the models based on conventional magnetic resonance imaging.

#### **CONCLUSION**

The DKI-based radiomics could further improve the performance for predicting the AIS outcome compared with conventional magnetic resonance imaging. The models developed by TPOT based on radiomics score from DKI parametric maps and clinical factors could predict the functional outcome of AIS patients with a high discriminatory accuracy.

#### **CLINICAL RELEVANCE/APPLICATION**

The model developed by TPOT could assist clinicians to accurately predict the outcome of AIS patients and formulate individual treatment plans at the early stage of onset, which may improve the prognosis of AIS patients.

### **T5B-SPNR- 2 Double Expressor Lymphoma Subtype in Primary Central Nervous System Lymphoma: Its MR Imaging Features and Clinical Relevance**

Goh Sasaki, PhD, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Unlike most B-cell lymphomas, double-expressor lymphomas (DELs) can lead to increased risk of relapse and worse prognosis. To date, there are no studies evaluating MRI findings in primary central nervous system lymphoma (PCNSL) patients with DEL (PCNSL-DEL). We aimed to determine whether PCNSL-DEL has MR imaging and clinical features compared to non-DEL.

## METHODS AND MATERIALS

This retrospective study included 36 patients with PCNSL, 16 of whom were pathologically confirmed with DEL and 20 with non-DEL. All patients underwent preoperative 3-T MRI including diffusion-weighted imaging (DWI) and dynamic susceptibility contrast (DSC) perfusion studies. Cerebral blood volume (CBV), leakage-corrected CBV (cCBV) and K2 were calculated by using a block-circulant deconvolution method. The regions of interest (ROIs) were placed at enhancing lesions with high DWI intensity, while control ROIs were set at the contralateral portions. Mean apparent diffusion coefficient (ADC), CBV, cCBV ratios and K2 value were compared between DEL and non-DEL groups using the Mann-Whitney U test. The Kaplan-Meier method was used to estimate progression-free survival (PFS) differences.

## RESULTS

Compared with non-DEL group, DEL group had significantly lower mean CBV ratio ( $0.23 \pm 0.55$  vs.  $0.25 \pm 0.27$ ,  $p = 0.016$ ) and cCBV ratio ( $1.48 \pm 0.98$  vs  $2.08 \pm 0.80$ ,  $p = 0.028$ ). There was no significant difference in ADC ratio ( $1.07 \pm 0.23$  vs  $0.97 \pm 0.22$ ,  $p = 0.14$ ) and K2 ( $481 \pm 287$  vs  $421 \pm 276$ ,  $p = 0.336$ ) between the two types of PCNSL. PFS was shorter for DEL than non-DEL, but there was no significant difference.

## CONCLUSION

In PCNSL, DEL has lower CBV and cCBV and tends to have shorter PFS than non-DEL.

## CLINICAL RELEVANCE/APPLICATION

DSC perfusion imaging is a promising tool for identifying DEL, a subtype of PCNSL.

## T5B-SPNR- MRI Histogram Analysis of TERT Mutation Status in Patients with IDH-wildtype Glioblastoma 3

Bin Zhang (*Presenter*) Nothing to Disclose

## PURPOSE

TERT mutation is an important predictor of poor prognosis in IDH wild-type glioblastoma patients. To investigate the value of MRI histogram analysis in predicting TERT mutation status of IDH wild-type glioblastoma.

## METHODS AND MATERIALS

POPULATION and SEQUENCE: T1WI contrast-enhanced (T1C) and T2WI images of 182 patients with IDH-wildtype glioblastoma confirmed by surgery and molecular pathology were retrospectively collected. IMAGE ANALYSIS: Two radiologists imported images in the Dicom format into Firevoxel (current version: 416C, NYU School of Medicine, NY, <https://wp.nyu.edu/firevoxel/downloads/>) to independently analyze the entire lesion. Subsequently, the largest lesion slice was selected. Based on the T1WI and T2WI images, two radiologists manually traced the ROIs in all 182 GBM margin along the axial T1C without the surrounding brain tissue, and oedema. The software automatically generated a grayscale histogram of the ROI. Histogram analysis was performed using the largest slices to obtain the following histogram parameters: maximum, minimum, mean, standard deviation (SD), variance, coefficient of variation (CV), skewness, kurtosis, entropy, and 1st-99th percentiles. The necrotic/necrotic ratio of the maximum tumor layer was calculated by delineating the necrotic/necrotic area. STATISTICAL TESTS: Pearson's and Spearman's - rho correlation analysis was used to analyze the correlation. Receiver operating characteristic (ROC) analysis was used to evaluate the utility of the T1C histogram parameter in the TERT mutation state. All statistical analyses were performed using SPSS (IBM SPSS Statistics version 25.0; Chicago, IL, USA) software.

## RESULTS

In the T1C histogram features, the maximum value, standard deviation, variance, 99th percentile and coefficient of variation (CV) were positively correlated with TERT mutation status ( $P < 0.05$ ). ROC curve analysis showed that when  $CV=0.319$ , the AUC value was the highest (0.775; 95% confidence interval (CI) :0.702-0.848), and the sensitivity and specificity were 0.803 and 0.729, respectively. In addition, CV was positively correlated with the ratio of maximum level necrosis to cystic degeneration.

## CONCLUSION

Preoperative T1C histogram analysis has predictive value for TERT mutation status in IDH wild-type GBM patients.

## CLINICAL RELEVANCE/APPLICATION

CV in the T1C histogram can objectively and comprehensively reflect the intrinsic heterogeneity of the tumor, and can predict the TERT mutation status of IDH wild-type glioblastoma before surgery. We performed interpretative analysis of the histogram characteristic parameters and concluded that CV was positively correlated with the ratio of necrosis to cystic degeneration at the maximum tumor level.

## T5B-SPNR- Impaired Peritumoral Cerebrovascular Reactivity Measured with Arterial Spin Labeling in 4 Gliomas. Emerging Techniques in the Pre-surgical Workup of Brain Tumors



## **PURPOSE**

The purpose of our study was to evaluate the feasibility of cerebrovascular reactivity (CVR) mapping with arterial spin labeling (ASL) technique using a breath-holding task, and its potential to depict infiltrative tumor beyond the limits of contrast enhancement and non-enhancing components.

## **METHODS AND MATERIALS**

16 newly diagnosed patients with grade 4 brain gliomas (WHO 2021, biopsy confirmed) who underwent presurgical brain MRI were prospectively recruited. A non-invasive PCASL sequence with apnea challenge consisting of 10 cycles of 21s of apnea/breath-hold task and 42s of normal breathing was added to the clinical protocol, for CVR mapping. All studies were performed in a 3T Siemens Skyra MRI scanner with 32-channel head coil. Informed written consent was obtained. Automatic segmentation masks of gray matter (GM), white matter (WM), were obtained in SPM, with a threshold of 0.9. Contrast enhanced tumor (CE) and non-contrast enhanced tumor (nCE) masks were manually drawn by an experienced neuroradiologist on each patient T1 weighted image. Several expanding volume-of-interest (VOI) rings of 6 mm width were evaluated in the peritumoral area to assess the infiltrative lesion. Cerebral blood flow (CBF) and CVR of the affected side, contralateral hemisphere, tumor lesion (merging CE and nCE components when applicable) and in the perilesional expanding VOIs were recorded. CVR was evaluated as percentage signal change (PSC) in CBF. Data were analysed for normality using Shapiro-Wilk test. Differences in CBF were assessed in the tumor lesion versus the homologous contralateral region, with paired T-test. Differences in CVR were assessed for the tumor and perilesional VOIs with paired T-test, corrected for multiples comparisons using false discovery rate test.

## **RESULTS**

A total of 16 patients were included (11 men, mean age  $56.19 \pm 10.73$  years). Mean CBF in the tumor was  $57.62 \pm 38.12$  ml/100g/min, significantly higher compared to the contralateral side ( $p = 0.021$ ). CVR in the tumor was decreased compared to the contralateral homologous region (ipsilateral PSC =  $22.03 \pm 14.25$  vs contralateral PSC =  $31.94 \pm 11.04$  PSC;  $p = 0.028$ ). Perilesional CVR was also impaired in the periphery of the tumor, reaching a plateau in the last two VOIs (18 to 24 mm from the tumor). Significant differences in CVR between the contralateral and ipsilateral VOIs were found ( $p$ -values, VOI 6mm = 0.009, VOI 12mm = 0.028, VOI 18mm = 0.029, VOI 24mm = 0.045).

## **CONCLUSION**

CVR mapping is feasible with ASL and can provide information about the perilesional environment of the tumor that may help to detect infiltrative disease.

## **CLINICAL RELEVANCE/APPLICATION**

Trying to precisely delineate the infiltrative glioma region for an accurate complete resection is a challenge in glioma imaging.

## **T5B-SPNR- The Cavernous Sinuses Lesions - A South Brazilian Experience**

5

Kelly R. Neves, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

We aim to present our experience at South Brazil of the various and unusual pathologies that can affect the cavernous sinuses. They have great clinical importance, and this review and iconographic essay help us to keep these conditions in mind at the moment we face them in our daily practice.

## **METHODS AND MATERIALS**

This is a cross-sectional retrospective study performed at two large institutions in South Brazil. We did a research from April 2013 to April 2023, then selected a miscellanea of 16 very illustrative and representative cases of the variable conditions that can affect the cavernous sinuses.

## **RESULTS**

Our research showed as results inflammatory/infectious, neoplastic, vascular, and cryptogenic pathologies, as we illustrate: fusiform aneurysm, carotid cavernous fistula, septic thrombosis, hemangioma, dermoid cyst, adenoid cystic carcinoma, hypertrophic pachymeningitis, macroadenoma, lymphoma, meningioma, plexiform neurofibroma, mucormycosis, oculomotor mononeuropathy, and Tolosa-Hunt.

## **CONCLUSION**

The cavernous sinuses are interconnected venous plexuses situated in the floor of the middle cranial fossa on either side of the sella turcica and sphenoid sinus. They can communicate with the orbit, pterygopalatine fossa, infratemporal fossa, nasopharynx and posterior cranial fossa through various foramina, fissures and channels at the base of the skull. In addition, it contains important vascular and nerve structures, including the internal carotid arteries, the oculomotor and abducens cranial nerves, and the ophthalmic and maxillary branches of the trigeminal nerve.

These pathological conditions can have similar clinical manifestations, so imaging plays a crucial role in the diagnosis,



assessment of the extent of the disease, biopsy planning, when necessary, and aid in the decision of the best therapeutic strategy to be followed, including radiotherapy, microsurgery or clinical treatment.

#### **CLINICAL RELEVANCE/APPLICATION**

Because of all these reasons, the diagnosis may be very challenging and knowing these possibilities in advance must make us aware to keep them in mind for prompt suspicion.

### **T5B-SPNR- Clinical Significance of Apparent Diffusion Coefficient in Differential Diagnosis of Primary Central Nervous System Lymphoma and Meningioma**

6

Fengyu Z. Zhou (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To analyze the clinical significance of apparent diffusion coefficient in differential diagnosis of primary central nervous system lymphoma and meningioma.

#### **METHODS AND MATERIALS**

Thirty-five patients with primary central nervous system lymphoma and 35 patients with meningioma confirmed by surgery and pathology were selected as Group A and Group B respectively. The average ADC value, the minimum ADC value, the maximum ADC value and the contralateral normal white matter, the average (contralateral) ADC value were obtained, logistic regression analysis and ROC curve were used to analyze the diagnostic efficacy of each index.

#### **RESULTS**

The mean ADC value, minimum ADC value, maximum ADC value and contralateral ADC value in group A were statistically different ( $P<0.05$ ); the minimum ADC value and contralateral ADC value in group B were not statistically different ( $P>0.05$ ), while the rest of items were statistically different ( $P<0.05$ ); the mean ADC value, minimum ADC value and maximum ADC value in group A were lower than those in group B ( $P<0.05$ ). The logistic regression analysis showed that the maximum ADC value was an independent risk factor, while the mean ADC value and the minimum ADC value were protective factors ( $P<0.05$  and  $P<0.01$ , respectively). The AUC of the combined indices was 0.926, with an accuracy of 93.5%, sensitivity of 90.3%, and specificity of 94.7% ( $P=0.000$ ).

#### **CONCLUSION**

Different ADC values in tumor parenchyma provide the molecular imaging basis for noninvasive differential diagnosis of primary central nervous system lymphoma and meningioma, and the combined diagnosis of the three parameters can effectively improve the diagnostic efficiency by using logistic regression model.

#### **CLINICAL RELEVANCE/APPLICATION**

Accurate differential diagnosis of primary central nervous system lymphoma and meningioma is essential for early intervention and survival. Conventional MRI findings of some primary central nervous system lymphoma often overlap with meningiomas and are difficult to differentiate. Diffusion-weighted imaging (DWI) can reflect the characteristics of the lesions from the molecular diffusion level before the morphology. The apparent diffusion coefficient (ADC) of DWI can quantitatively reflect the density and malignant degree of the tumor cells. This study was to investigate the value of ADC in the differential diagnosis of primary central nervous system lymphoma and meningioma, and to provide valuable reference for the early diagnosis and early intervention of the two diseases.

### **T5B-SPNR- Comparison between Postcontrast T1-weighted Thin-slice 2D Spin Echo and 3D SPACE Sequences in the Detection of Brain Metastases at 1.5T and 3T**

7

Aaron Rulseh, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The accurate detection of metastatic brain lesions (MBL) before radiotherapy is critical. Although spin echo (SE) are superior to gradient echo sequences in detecting small MBL, thin-slice whole-brain coverage is time consuming. The sampling perfection with application optimized contrasts using different flip angle evolution (SPACE) sequence shares many advantages with SE, but with faster acquisition and greater resolution while achieving whole-brain coverage.

#### **METHODS AND MATERIALS**

Fifty-six patients with MBL were included and underwent a standard protocol (1.5T  $n=37$ , 3T  $n=19$ ), including postcontrast T1-weighted SE and SPACE (postcontrast order: SE first  $n=26$ , SPACE first  $n=30$ ). Rating was performed by 3 raters in 2 sessions  $>6$  weeks apart; images were de-identified and order randomized, only SE or SPACE per-subject per-session. The true number of MBL was determined using all available imaging including follow up. Intraclass correlations were determined; consistency for intra-rater (SE vs. SPACE) and agreement for inter-rater (same sequence). A paired t-test was used to evaluate postcontrast sequence order.

## RESULTS

A total of 135 MBL were identified (mean/subject 2.41, SD 6.4). Relatively fewer lesions were identified on the first postcontrast sequence (SE/SPACE), however the difference was not significant ( $p=0.08$ ). Intra-rater consistency (SE vs. SPACE) was excellent (ICC: R1, 0.984; R2, 0.971; R3, 0.946), as was inter-rater agreement, with ICC values of 0.984 and 0.969 for SE and SPACE sequences, respectively. Finally, agreement between individual sequences and the true number of lesions was excellent (SE ICC: R1, 0.981; R2, 0.973; R3, 0.977; SPACE ICC: R1, 0.984; R2, 0.971; R3, 0.965).

## CONCLUSION

The emergence of fast computer-assisted treatment planning of targeted radiosurgery techniques in the management of MBL requires precise, fast and reliable MRI workup. The reliable detection of MBL with MRI depends on a number of factors, particularly pulse sequence and contrast agent type, dose and application delay. Although SE sequences are superior to gradient echo sequences in the detection of small brain metastases, they have relatively long acquisition times and are prone to artifacts. To our knowledge this is the first comparison between thin-slice T1-weighted SE and SPACE sequences in the detection of brain metastases at 1.5 Tesla and 3 Tesla. Our results show that T1-weighted SPACE is not inferior to standard thin slice SE sequences in the detection of brain metastases.

## CLINICAL RELEVANCE/APPLICATION

The T1-weighted SPACE sequence has several advantages over other sequences commonly used in the detection of metastatic brain lesions while maintaining excellent consistency with ratings on standard thin-slice spin echo images.

## T5B-SPNR- Predicting IDH-Mutation in Low Grade Glioma using Different MRI Sequences 8

Gala Nacul Mora, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Low grade gliomas are classified by analyzing molecular characteristics such as IDH mutation status. In this retrospective study we applied radiomics to different MRI sequences to determine which one is the most suitable.

## METHODS AND MATERIALS

In our retrospective study, we used MR images of 106 patients with histologically confirmed glioma. All MR images were acquired with four MRI sequences each: T1 without and with administration of a contrast agent (T1 native and T1 CE), T2 and Flair. We performed image segmentation of the tumours semi-automatically using the open-source software platform 3D Slicer and extracted a total of 107 radiomic features from each of the images. We subsequently tested different conventional machine learning algorithms and a neural network to predict the IDH mutation status and to find the most suitable MR sequence for this task.

## RESULTS

In our analyses, the T1 CE sequence was found to be the most suitable for predicting IDH mutation status. Using independent test data and a 9-feature model constructed with Lasso (Least Absolute Shrinkage and Selection Operator) regression, we achieved an AUC of 0.849, an accuracy of 0.801, a sensitivity of 0.849, and a specificity of 0.704. The second-best results were achieved with the Flair sequence, and the T2 sequence proved to be the most unsuitable.

## CONCLUSION

Although radiomics applied to different MRI sequences is suitable to predict the IDH mutation in low grade gliomas, the most accurate results were achieved analyzing T1 CE sequences.

## CLINICAL RELEVANCE/APPLICATION

MRI based radiomics helps predicting molecular status of low grade gliomas.

## T5B-SPNR- Tumor Characteristics, Brain Functional Activity and Connectivity of Tinnitus in Patients with Vestibular Schwannoma: A Pilot Study 9

Jiayu Huang (*Presenter*) Nothing to Disclose

## PURPOSE

Tinnitus in patients with vestibular schwannoma (VS) can negatively affect their mental health, focus, sleep quality, and social life. However, the mechanism of tinnitus is still unclear. Therefore, this study aims to explore the correlation between preoperative clinical characteristics of VS, postoperative changes in brain function, and tinnitus in patients with VS.

## METHODS AND MATERIALS

We collected data from 80 VS patients before surgery and from 28 VS patients before and after surgery, and recruited 28 healthy controls. We used paired t-tests to identify brain regions where patients had significant changes in amplitude of low

frequency fluctuations (ALFF) and regional homogeneity (ReHo) after surgery. Tinnitus severity was evaluated using the Tinnitus Handicap Inventory (THI) and Visual Analog Scale (VAS). And Pearson correlation were applied to assess the relationship between the changes in ALFF and ReHo and the changes in THI and VAS scores postoperatively. Finally, we also conducted seed- and ROI-based functional connectivity (FC) analyses.

## **RESULTS**

Prior to surgery, VS patients with tinnitus had smaller tumors ( $t = 3.293$ ,  $p < 0.001$ ), more solid tumor ( $p = 0.033$ ), and less extrusion into the cerebellum brain stem ( $p = 0.001$ ) than those without tinnitus. After surgery, 28 VS patients showed a significant reduction in ALFF in the left cerebellum crus 2 (ROI 1) and a significant reduction in ReHo in the left cerebellum crus 1 (ROI 2) and the right precuneus (ROI 3). Conversely, ReHo was significantly increased in the right precentral gyrus (ROI 4) (cluster-level  $p$  value family-wise error [pFWE]  $< 0.05$ ). Additionally, the changes in ALFF values were negatively correlated with changes in the VAS score on the left side ( $r = -0.32$ ,  $p < 0.05$ ). Moreover, the FC strengths of patients between ROI 2 and the left and right posterior cingulate gyrus respectively were significantly decreased after the surgery (FDR correction,  $p < 0.05$ ).

## **CONCLUSION**

Preoperative tinnitus in patients with VS may be influenced by tumor size, tumor nature, and degree of extrusion into the cerebellum brain stem. Additionally, the functional activities of the default mode network, the somatomotor network, and the cerebellum are altered postoperatively. Notably, the changes in ALFF in the left cerebellum are correlated with tinnitus severity.

## **CLINICAL RELEVANCE/APPLICATION**

Clinical characteristics and brain regions related or unrelated to hearing can influence tinnitus symptom in VS patients, which may be potential therapeutic targets for tinnitus in VS patients.

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## Abstract Archives of the RSNA, 2023

T5B-SPOB

### OB/Gynecology Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPOB- Uterine Sarcoma or Degenerating Fibroid? Validating the New Consensus MRI Algorithm for Evaluating Atypical Uterine Masses** 1

Aja Green Walker, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of our study is to evaluate the validity of a recently published consensus MRI diagnostic algorithm (PMID: 36194109) for differentiating benign degenerating leiomyomas and malignant uterine sarcomas.

#### **METHODS AND MATERIALS**

Atypical uterine masses on pelvic MRI were identified through the Radiology information system and report search engine using "atypical leiomyoma", "atypical fibroid", and "sarcoma", and the electronic medical record was reviewed for pathologic proof. Two radiologists blinded to clinical, surgical, and pathologic reports retrospectively and independently reviewed 40 pelvic MRI examinations dated 1/2007-9/2022 to determine if the masses by imaging were benign or malignant, using the 2022 consensus atypical uterine mass flow chart. Imaging features assessed included: peritoneal metastases, abnormal lymph nodes, intermediate/high signal intensity (SI) at T2-weighted imaging, high DWI SI (equal or higher SI than endometrium or lymph nodes on high b value imaging), and ADC value =  $0.905 \times 10^{-3}$  mm.

#### **RESULTS**

Of the 40 atypical uterine mass cases, 24 masses were benign (22 leiomyomas, 1 adenomyoma, and 1 borderline ovarian tumor) and 16 masses were malignant (6 leiomyosarcomas, 6 carcinosarcomas, 3 endometrial sarcomas, and 1 low grade uterine sarcoma). Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) to determine if masses were benign or malignant were 75%, 95.8%, 92.3%, and 85% for reader 1, and 81.2%, 91.7%, 86.7%, and 88% for reader 2 respectively. Interreader agreement was strong, kappa: 0.89. Endometrial sarcomas had higher T2 signal and higher ADC values than leiomyosarcomas.

#### **CONCLUSION**

The new consensus pelvic MRI algorithm for evaluating atypical uterine masses has good specificity, sensitivity, PPV, and NPV for determining malignancy, particularly for uterine sarcomas that are predominantly myometrial origin (leiomyosarcoma), with  $ADC \leq 0.905 \times 10^{-3}$ mm. However, if ADC is near but not below  $0.905 \times 10^{-3}$ mm, the mass may be malignant, especially if using b value lower than 1000. If the atypical uterine mass is predominantly endometrial, morphology should guide suspicion.

#### **CLINICAL RELEVANCE/APPLICATION**

The 2022 consensus algorithm to distinguish benign from malignant atypical uterine masses has important clinical implications, as surgical and medical management for degenerating fibroids is very different from uterine sarcomas.

#### **T5B-SPOB- Cer-ConvN3Unet: An End-to-end Multimodal Pipeline for Auto-detection and Auto-segmentation of Cervical Cancer based on ConvNeXt and Double U-Net** 3

Shaojun Xia (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cervical cancer is a common gynecological pelvic tumor with an incidence rate of 3.1% and mortality rate of 3.4%, ranking eighth and ninth among all cancers worldwide. The routine MRI examination typically includes multi-planar T2WI, DWI and CE-T1WI. Hence, it is of paramount importance to extract the multimodal information for subsequent volume calculation, radiomics analysis, radiotherapy dose optimization, surgical preparation, and etc. In this study, we proposed an innovative

two-phase pipeline for auto-detection and auto-segmentation on multimodal cervical cancer MRI images, which integrated the advantages of ConvNeXt and Double U-Net, thereby providing an end-to-end multimodal outlining tool for gynecologists.

## **METHODS AND MATERIALS**

Totally 100 patients underwent pelvic MRI examinations consisting of T2WI, DWI and CE-T1WI. Patients with no contraindications received an intramuscular injection of 10mg raceanisodamine hydrochloride before image acquisition to reduce bowel motion artifacts. 2533 DWI slices, 2448 T2 slices, and 7176 CE-T1 slices were obtained by extracting 3D MRI images layer-by-layer from axial plane. In the auto-detection phase, a six-classifier was designed based on ConvNeXt blocks for the multimodal recognition. In the second stage, the whole identified tumor slices were separately input into auto-segmentation module developed by 3-channel Double U-Nets. The accuracy, precision, recall, Kappa and F1-score were used to evaluate the classification performance, while DSC and Jaccard were applied to quantitative analysis the segmentation performance.

## **RESULTS**

20 patients were excluded from the modeling process for independent testing. The initial auto-detection module achieved the average results of 92.37%, 83.60%, 77.65%, 75.70%, 0.8045 for accuracy, precision, recall, Kappa and F1-score. And no error occurred in the distinguishment between the three modalities. Entering into segmentation stage, the mean values of DSC and Jaccard on DWI, T2, CE-T1 were (83.25%, 71.49%), (78.62%, 65.17%), (73.62%, 58.81%), respectively.

## **CONCLUSION**

Strict independent experiments demonstrated that the end-to-end multimodal pipeline was capable of getting high recognition and segmentation accuracy with less manual intervention. In the future, the clinical utility will be further optimized in large-sample and multi-center prospective cohorts and generalized to more MRI modalities.

## **CLINICAL RELEVANCE/APPLICATION**

The pipeline has high potential to be an alternative tool for gynecologists in routine MRI image reading and processing of cervical cancer. Meanwhile, it can also serve as the basis for a series of scientific research works related to tumor lesions, liberating from labor-intensive manual delineation.

## **T5B-SPOB- Intratumoral and Peritumoral MRI Radiomics Nomogram for Predicting Parametrial Invasion in Patients with Early-stage Cervical Adenocarcinoma and Adenosquamous Carcinoma**

Le Fu (*Presenter*) Nothing to Disclose

## **PURPOSE**

To develop a comprehensive model based on MRI intra- and peritumoral radiomics signatures and independent risk factors for predicting parametrial invasion (PMI) in patients with early-stage cervical adenocarcinoma (AC) and adenosquamous carcinoma (ASC).

## **METHODS AND MATERIALS**

In total, 747 patients with IB to IIB cervical AC and ASC who underwent radical trachelectomy/hysterectomy were retrospectively reviewed and divided into the primary, internal validation cohort, and external validation cohorts. The original (Ori) and original-wavelet (Ori-Wav) feature-based radiomics signatures from the primary tumor (RST) and 3 mm- and 5 mm-peritumoral regions (RS3 and RS5) were respectively built to investigate their diagnostic values in predicting PMI. The feature selection includes the following steps: 1) feature reproducibility assessment; 2) Pearson correlation test; 3) maximum relevance and minimum redundancy (mRMR); 4) the least absolute shrinkage and selection operator (LASSO). Finally, a nomogram was constructed by integrating optimal intra- and peritumoral signatures and independent risk factors.

## **RESULTS**

FIGO stage, disruption of the cervical stromal ring (DCSRMR), parametrial invasion on MRI (PMSMR), and serum CA-125 were found to be independent risk factors. The combined nomogram constructed by integrating independent risk factors, Ori-Wav features-based RST, and RS5 yielded AUCs of 0.874 (0.810-0.922), 0.885 (0.834-0.924) and 0.966 (0.887-0.995) for assessing PMI in the primary, internal and external validation cohorts, respectively. Furthermore, the combined nomogram was significantly superior to radiomics signatures and clinical models for assessing PMI in the three cohorts.

## **CONCLUSION**

This study demonstrated that the combined nomogram can preoperatively, accurately, and noninvasively identify PMI in patients with early-stage cervical AC and ASC

## **CLINICAL RELEVANCE/APPLICATION**

As important parts of cervical cancers, AC and ASC have an increasing incidence and mortality, especially in young women. The preoperative and accurate identification of PMI can facilitate precise treatment decisions of chemoradiotherapy or radical hysterectomy in patients with early-stage cervical AC and ASC. The combined nomogram integrating independent risk

factors, Ori-Wav features based RST, and RS5 can preoperatively, accurately, and noninvasively identify PMI in patients with early-stage cervical AC and ASC.

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## Abstract Archives of the RSNA, 2023

T5B-SPPD

### Pediatric Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPPD- Radiation Dose Reduction of Newborns without Anti-scatter Grids in X-ray Fluoroscopic Imaging Systems with Flat Panel Detectors: A Newborn Whole Body Phantom Study of Dosimetry and Visual Assessment** 1

Noriyuki Sakai, MSc, RT (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Anti-scatter grids (ASG) effectively improve image contrast by absorbing scattered X-ray caused by a thick adult body. We hypothesized that removal of ASG would reduce radiation dose of a thin newborn body without loss of diagnostic value in X-ray fluoroscopic examinations. Our purpose was to compare radiation dose and visibility of image findings of a peripherally inserted central catheter (PI catheter), a nasogastric tube (NG tube) and contrast agent using a newborn whole body phantom between with and without ASG in X-ray fluoroscopic imaging systems with flat panel detectors.

#### **METHODS AND MATERIALS**

This study consisted of dosimetry and visual assessment. A newborn whole body phantom was used. In the dosimetry, continuous fluoroscopy for 300 seconds and twenty consecutive radiographs were performed with and without ASG. The entrance surface dose (ESD) of each dosimetry was measured by dosimeters placed on the chest and abdomen of the phantom, respectively. In visual assessment, the PI catheter and NG tube with and without inserting guidewire were placed on the phantom, respectively. Cylinders filled in contrast agent diluted by water (1/2, 1/4, 1/6, 1/8 and 1/10 dilutions) were inserted into the rectum of the phantom. Images of the PI catheter, NG tube and contrast agent were obtained by performing fluoroscopy and radiography with and without ASG, respectively. The obtained images were visually scored on a four-point scale by two observers (a board-certified diagnostic radiologist and a radiological technologist). We used the Wilcoxon signed-rank test to identify any significant differences between with and without ASG in the mean ESD and the mean visual scores. A P-value less than 0.05 was considered significant. Inter- and intra-observer agreement were calculated by weighted kappa statistics.

#### **RESULTS**

There were significant differences in the mean ESD between with and without ASG in both the fluoroscopy (chest, 1.7 vs. 1.1 mGy; abdomen, 2.0 vs. 1.3 mGy) and the radiography (chest, 3.5 vs. 2.0 mGy; abdomen, 4.1 vs. 2.4 mGy), respectively ( $P < .05$ ). There was no significant difference in the visual scores between with and without ASG in all comparisons of two observers ( $P > .05$ ). Inter- and intra-observer agreement were almost perfect in all comparisons (range, 0.87-1.00).

#### **CONCLUSION**

Removal of ASG significantly reduced radiation dose of a newborn phantom with acceptable image quality in X-ray fluoroscopic imaging systems with flat panel detectors.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiation dose reduction of newborn infants could be achievable in X-ray fluoroscopic examinations without loss of diagnostic value by removal of ASG.

#### **T5B-SPPD- Cranial Suture Ultrasound: Its Value in the Diagnosis and Radiation-reduction Potential of Suspected Craniosynostosis** 2

Sara C. Albort Verges, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Given the growing concern about the use of ionizing radiation in the pediatric population, in the last years, ultrasound (US) has emerged as an alternative modality in the assessment of cranial sutures. This study aims to determine the accuracy of cranial ultrasound in the diagnosis of craniosynostosis in patients with clinical suspicion, its advantages and limitations, based on the hypothesis that it is a useful technique for this purpose and that it can potentially reduce the performance of tests using ionizing radiation.

## **METHODS AND MATERIALS**

A retrospective study was performed reviewing the US findings and clinical records of the patients who underwent a cranial suture US in our institution between 2021-2022 for clinical suspicion of craniosynostosis. The main variables analyzed were: age, gender, suspected diagnosis and US findings. The results were classified as positive, negative or inconclusive for early suture closure. Subsequently, it was analyzed in which cases US findings and clinical follow-up were sufficient, or which required further confirmatory studies.

## **RESULTS**

326 infants (214 male and 112 female), 4 of them with relevant pathologic history. Ages between 1 - 13 months. 283 patients had a negative US result for early suture closure (87%), 13 positive (4%) and 30 inconclusive (9%). Of the 283 negatives, 22 underwent subsequent studies, of which only 2 were positive (not considered false negatives, since in one case the CT scan was performed 9 months after the US, and the other case was positive for early closure of the right sphenofrontal suture, not explored with US). Of the 13 positives, 11 underwent complementary studies for confirmation, of which 7 were positive (4 false positives). Of the 30 inconclusive, 28 underwent complementary studies, of which only 2 were positive. Of the sample of 326 children, only 61 patients (19%) required complementary X-ray and CT scans, so we can deduce that the use of ionizing radiation was avoided in 265 patients (81%).

## **CONCLUSION**

Cranial suture US is a valid and accurate technique in the diagnosis of suspected craniosynostosis. This method has numerous advantages, such as the short examination time, the possibility to perform a targeted scan of the "suspicious suture", as well as the non-use of ionizing radiation and sedation. The main documented limitations included, its operator-dependent nature, the patient's lack of collaboration, hair growth or structural features of the skull.

## **CLINICAL RELEVANCE/APPLICATION**

We can conclude that the cranial suture US it is a useful, valid and accurate technique in the diagnosis of craniosynostosis, which avoided the use of ionizing radiation techniques in 81% of patients of our sample, a fact of special relevance given that we are dealing with a pediatric population.

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## Abstract Archives of the RSNA, 2023

T5B-SPPH

### Physics Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPPH- Simultaneous Denoising and Super Resolution in Clinical CT Images using Deep learning with Simulated Training Data** 1

Bruno De Man, PhD, MSc (*Presenter*) Employee, General Electric Company

#### **PURPOSE**

Improved CT image resolution and noise characteristics can improve visualization of small anatomical structures, including small lung nodules and coronary artery calcifications. This work reports a deep learning (DL)-based simultaneous denoising and super-resolution approach and its initial evaluation on clinical images.

#### **METHODS AND MATERIALS**

A challenge for DL-based denoising and super-resolution applied to clinical images is the lack of easy ways to generate high quality training data. We propose a method to build super-resolution digital phantoms based on sharpened and denoised clinical patient images, and then simulate the CT imaging chain and generate the relatively low-resolution training inputs. We also shrink the image voxel size of the phantom to introduce miniature anatomical structures beyond the intrinsic resolution of the clinical image. Here, we report initial evaluation of the method as applied to clinical data. Thirteen patient cardiac images were acquired using clinical settings. Ten cases were used for training a deep convolutional neural network (CNN), one for validation, and two for evaluation. During inference, the network was applied to patient CT images reconstructed with filtered back-projection (FBP) images for a 20 cm field of view.

#### **RESULTS**

The CNN network was tested on two datasets. The first contains the held-out testing cases where low-resolution data were simulated from the high-resolution phantoms. The second is composed of the real CT images acquired using clinical settings. In both cases, the enhanced images produced by the CNN network are visually sharper and contain less noise than their corresponding input images. Compared to the real CT input image, the network output improves the full width at half maximum by  $\sim 20\%$  along a small blood vessel. The contrast-to-noise ratio between ascending aorta and the surrounding tissue is increased by  $\sim 32\%$  (from 52.2 dB to 69.1 dB).

#### **CONCLUSION**

Simultaneous CT image denoising and resolution enhancement was achieved by using a DL method on clinical cardiac data. To overcome the difficulty in acquiring high quality data as training labels, we trained the model on simulation data and adapted the model to images reconstructed using standard clinical settings. This technique greatly facilitates the creation of high-resolution, low noise CT images in clinical applications.

#### **CLINICAL RELEVANCE/APPLICATION**

Deep learning-based denoising and super-resolution approach may provide improved image quality and clinical diagnosis confidence for CT imaging.

#### **T5B-SPPH- Quantitative Evaluation of the Accuracy of MR Thermometry in the Presence of RNS Using a 3D Printed Realistic Head Phantom** 11

Chen Lin, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The Responsive Neurostimulator (RNS), a device for seizure treatment, is implanted on the skull. It can cause severe artifacts in brain MRI, including MR thermometry, which is used for monitoring tissue temperature change during intervention

procedures such as laser interstitial thermal therapy (LITT). The purpose of this study is to evaluate the impact of temperature mapping in the brain due to RNS.

## **METHODS AND MATERIALS**

To simulate MR-guided LITT of brain lesions in the presence of RNS, a realistic head phantom was 3D printed based on head CT images. Two indentations for mounting RNS were created at clinically appropriate locations. The inside of head phantom was filled with polyacrylic acid (PAA) gel per ASTM F2182 standards to mimic brain tissue. Black ink was when preparing the gel to increase the absorption of laser light. MR-guided LITT was performed on the phantom using a Philips 1.5T MR scanner with the Visualase™ MRI-guided laser ablation system and a laser probe with a 15mm diffuser. In each LITT session, the laser was turned on for 2 minutes at 50% of the maximum power of 10 watts. Four NetOptix fiber optic temperature sensors (FOTS) were placed 10mm away and shielded from direct laser exposure. Temperature maps (TMAP) were acquired with a 4ch flex coil and a 3D GRE sequence with receiver bandwidth of 100Hz/pixel. Five LITT sessions were performed with cooling periods in between. In sessions 1 and 5, no RNS was present in order to evaluate the accuracy and reproducibility of MR thermometry. In sessions 2 and 3, the RNS was implanted on the ipsilateral side of the ablation zone with different distances from the region of temperature mapping. In session 4, the RNS was moved to the contralateral side.

## **RESULTS**

The temperature changes at the tips of the four FOTS measured by both FOTS and MR thermometry, were plotted and compared. Both FOTS and TMAP were reproducible in sessions 1 through 5. The differences in the measured temperature change in MR thermometry without and with RNS appeared to be within the variation of MR thermometry itself. Good correlations of TMAP results without and with RNS at ipsilateral side close to ablation zone and the TMAP results between the first and last sessions both without RNS were observed. There was a large systematic difference between FOTS and TMAP for each session. The sources of such a difference require further investigation as subsequent testing and calibration of FOTS found them to be accurate.

## **CONCLUSION**

Despite the systematic difference between FOTS and TMAP, MR thermometry results are consistent without and with RNS at clinically acceptable locations.

## **CLINICAL RELEVANCE/APPLICATION**

MR thermometry at 1.5T is relatively robust with regard to the potential artifact and impact from RNS.

## **T5B-SPPH- Longitudinal Relaxivity Estimation of Gadolinium-Based Contrast Agents at 64 mT** **13**

Sudarshan S. Ragnathan, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Point of care (POC) MRI scanners have been shown to improve accessibility to imaging for patients in different clinical environments, particularly in the neurocritical care units<sup>1</sup>. The use of contrast agents is prevalent at conventional field strengths (e.g., 1.5 and 3 T) for enhancing visualization and characterization of pathologies. However, the use of contrast agents at ultra-low-field (ULF) has not been characterized to the same extent as at conventional field strengths. Gadopiclenol is a high relaxivity gadolinium-based contrast agent (GBCA) that has demonstrated similar pathology enhancement compared to other commercially available GBCAs at half the dose<sup>2</sup>. The aim of this study is to estimate the longitudinal relaxivity of gadopiclenol at 64mT.

## **METHODS AND MATERIALS**

The study was performed using a 64 mT portable MR system (Swoop®, Hyperfine, Inc., Guilford, CT) fitted with a standard head coil and two phantoms, each comprised of different concentrations of gadolinium-based contrast agents (GBCAs) namely gadobutrol (Gadavist, Bayer HealthCare Pharmaceuticals, Whippany, NJ), and gadopiclenol (Elucirem, Guerbet LLC, Princeton, NJ). Data were obtained using an inversion recovery fast spin-echo (FSE) sequence with TR = 4 s, TE = 5.9 ms, voxel size = 1.56 mm x 1.56 mm x 5.0 mm, and inversion times (TI) in 12 intervals ranging from 100 ms to 800 ms. Longitudinal relaxation rates (R1) were calculated using a three-parameter nonlinear curve fitting algorithm (MATLAB, Natick, MA) of the median signal magnitude as a function of TI. Longitudinal relaxivity (r1) was obtained as the rate of change of R1 with respect to GBCA concentration. The median signal magnitude values were used for quantitative analysis to mitigate the influence of outliers.

## **RESULTS**

The average longitudinal relaxivities of gadopiclenol and gadobutrol were 32.6 mM<sup>-1</sup>.s<sup>-1</sup> and 8.7 mM<sup>-1</sup>.s<sup>-1</sup>, respectively. These values of r1 for gadopiclenol were observed to be higher at 64 mT than those reported at 0.47 T and 1.5 T<sup>2</sup>.

## **CONCLUSION**

The relaxivity of gadopiclenol was observed to be greater than 3 times that of gadobutrol. These values indicate that optimizing sequence parameters would enable a significant improvement in contrast to noise (CNR) ratio when using gadopiclenol, with the potential to enhance visualization of pathologies, such as metastatic tumors and multiple sclerosis, using POC MRI.

## CLINICAL RELEVANCE/APPLICATION

Contrast-enhanced POC MRI critically ill patients for whom conventional imaging would not be possible.

### **T5B-SPPH- Quantifying Accuracy in Deformable Image Registration: An Informed Selection of CT Image Pairs with Applications in Longitudinal Imaging**

Amanda J. Gong, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Image registration to align images for comparison reads has broad applications in assessment for interval change, including cancer screening and treatment response assessment. The accuracy of this registration has a meaningful impact on the validity of downstream image processing and automated tasks such as new lesion detection and lesion monitoring. We compare 3 metrics of deformable registration accuracy to inform the selection of a CT image pair (simulated baseline/follow-up) and evaluate CNN performance in new liver lesion detection in simulated longitudinal CT.

#### **METHODS AND MATERIALS**

We used two public CT datasets: 1) diseased liver (DL) a subset of DeepLesion [1] 2) healthy liver (HL) from potential liver donors [2]. We registered each DL scan with each HL scan using sequential translation, affine, and B-spline transformations, creating image pairs that simulate a new liver lesion from healthy baseline. We utilized 3 metrics to define 3 subsets of the registered image-pairs; each metric informed the selection of one simulated baseline from a pool of candidate healthy scans. Our metrics: 1) Dice Similarity Coefficient (DSC) on liver segmentations 2) the product of DSC and mutual information in liver only (DSC-MI-liver), and 3) the product of DSC and mutual information in full CT (DSC-MI-full). We trained 3 models (ResNet50 architecture), one on each data subset, and compared performance on an image classification task that relies on quality registration: automated new lesion detection in paired image-patches. 5-fold cross validation and one-way ANOVA compared AUC. Ref: 1. doi: 10.1117/1.JMI.5.3.036501; 2. Med Image Anal 69 (2021) 101950

#### **RESULTS**

Of 10,594 CT studies (4,427 patients) in DeepLesion, we registered 1595 DL scans (819 patients with liver lesions < 3cm longest diameter) with each of 20 registered HL scans (20 patients), creating 31,804 registered image pairs. Each metric selects a data subset of 1595 HL/DL image pairs, simulating baseline/follow-up. The model using the DSC metric outperformed the DSC-MI-liver and DSC-MI-full models, with AUC 0.928, 0.916, and 0.901, respectively (p=0.0379).

#### **CONCLUSION**

When comparing similarity metrics for quantifying image registration accuracy, DSC outperformed DSC-MI-liver and DSC-MI-full in the selection of simulated baseline/follow-up CT images for new liver lesion detection.

## CLINICAL RELEVANCE/APPLICATION

In longitudinal imaging, image registration supports the assessment for interval change, including treatment response assessment. The quantification of registration accuracy can inform the selection of a comparison study.

### **T5B-SPPH- Evaluation of Deep Learning Denoising Algorithms for Digital Mammography by Assessing Objective Task-based Performance using Computer Simulations**

Stephen J. Glick, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recent research suggests that degradation of image quality with reduced radiation exposure in full-field digital mammography (FFDM) can be mitigated by post-processing mammograms with denoising algorithms based on convolutional neural networks. In this work we use an in silico study to assess a deep learning denoising method and evaluate microcalcification detection accuracy when denoising is applied to scans of reduced dose.

#### **METHODS AND MATERIALS**

A previously published deep learning denoiser was trained and tested using an anthropomorphic breast phantom and simulated Monte Carlo mammography images containing small (100-240 micron) microcalcifications within a cluster containing 5-10 microcalcifications. Two different algorithms were tested, one with training on a dataset composed of 100% signal absent (SA) images (i.e., no MCC cluster), and one with training on a dataset composed of 50% signal absent (SA) and 50% signal present (SP). Human reader studies were conducted to assess and compare image quality in a set of binary signal detection 4-AFC experiments, with 4-AFC proportion of correct (PC) responses being the performance metric.

#### **RESULTS**

Microcalcification detection accuracy was decreased significantly when reducing the phantom dose from a full-dose level to a half-dose level. Deep learning denoising visually reduces the noise in the half-dose images, with a similar appearance to the full-dose images. For the algorithm trained on 100% SA images, no improvement in task-based performance (i.e., PC) was

observed between half-dose images and denoised half-dose images. However, a statistically-significant improvement in PC was observed when using the algorithm trained on 50% SA and 50% SP. (see Figure below)

## **CONCLUSION**

Deep-learning denoising algorithms applied to FFDM produced visually appealing images and improved global similarity metrics of MSE and SSIM. However, task-based assessment of microcalcification detection shows that deep-learning denoising applied to half-dose FFDM images resulted in decreased performance compared to that with full-dose FFDM images. In addition, our findings conjecture that deep learning denoising algorithms may benefit from enriching training datasets with signal-present regions of interest, at least in cases involving the detection of microcalcification clusters with smaller size microcalcifications.

## **CLINICAL RELEVANCE/APPLICATION**

A study of Deep Learning denoising shows; 1) global metrics such as MSE and SSIM might not correlate with task-based performance; and 2) the importance of adequately including images with features of diagnostic interest when training the network.

## **T5B-SPPH- 4 Fast and Robust Ring Artifact Correction in Photon-counting CT using a Conditional Score-based Diffusion Model with Hijacked Reverse Diffusion**

Dennis Hein (*Presenter*) Research Collaborator, General Electric Company

### **PURPOSE**

Diffusion models have emerged as the current state-of-the-art, outperforming even generative adversarial networks (GANs), for a wide range of image generation tasks and show great potential for denoising and artifact correction in medical imaging. However, long inference times have so far been a limiting factor. We propose an accelerated conditional score-based diffusion model and evaluate its performance for the task of image-domain ring artifact correction in photon-counting CT.

### **METHODS AND MATERIALS**

Diffusion models exhibit an inherent tradeoff between speed and image quality negotiated by the number of steps, or noise scales, in the diffusion process. We suggest mitigating this tradeoff by "hijacking" the reverse diffusion at some step  $n$ . For a total number of steps  $N$ , we inject the condition image diffused  $N-n$  steps into step  $n$  of the reverse diffusion. We demonstrate the clinical utility of diffusion models and our suggested hijacking approach for the task of ring artifact correction in photon-counting CT. A conditional score-based diffusion model (cSBDM) is trained on 2576  $512 \times 512$  slices from 6 neuro patients scanned by CT systems from various vendors. Artificial ring artifacts are injected directly in the image domain to generate paired data. The NCSN++ network was trained to estimate the time-dependent conditional score function on extracted  $256 \times 256$  patches, with a batch size of 32, and  $N=2000$ , on one A6000 GPU for 150000 iterations. The predictor-corrector scheme was used for sampling. The network is evaluated on  $1024 \times 1024$  images of skull, water, and Lungman phantoms scanned by a prototype photon-counting system from GE HealthCare with the default ring correction disabled.

### **RESULTS**

Our results indicate strong performance across the phantoms considered. On a A6000 GPU with batch size 1, cSBDM\_2000 (full diffusion) takes about 11 minutes and cSBDM\_5 (hijacked at step 1995) takes about 1.6 seconds. In other words, our suggested method achieves 400 times faster sampling. This gain in evaluation speed appears to come with a negligible drop in performance and image quality.

### **CONCLUSION**

This work has suggested a ring artifact correction technique in photon-counting CT using a conditional score-based diffusion model. By hijacking the reverse diffusion, we achieve 400 times faster sampling than a vanilla cSBDM, with negligible drop in performance, pushing the required time on a medium range GPU from 11 minutes to 1.6 seconds per slice and thereby making the approach clinically viable. The method is robust to previously unseen anatomy.

## **CLINICAL RELEVANCE/APPLICATION**

With photon-counting CT scanners now clinically available, the proposed method improves workflow by correcting for ring artifacts without the need for time-consuming detector calibration.

## **T5B-SPPH- 5 Deep Learning Image Reconstruction Algorithm to Improve the Quality of Vascular Imaging during the Peak Phase of Brain CT Perfusion**

Fang Wang, PhD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To explore the degree of deep learning image reconstruction (DLIR) algorithm to improve the peak arterial quality of CT perfusion (CTP) images in acute stroke cases.

## METHODS AND MATERIALS

Clinically suspected acute stroke patients were selected for one-stop CTP imaging and randomly divided into two groups. The scanning tube voltage was 80 kV, and the current of low and high dose tube was set to 50 and 150 mA, respectively. Low dose scan data image reconstruction used DLIR 3 different intensities (low, medium and high), and only FBP was used for high dose scan data images reconstruction. Objective evaluation and subjective evaluation (point system) Image quality: The objective evaluation mainly measures the normal measurement of arterial peak period, the CT value and noise of the middle cerebral artery, calculates the signal-to-noise ratio (SNR) and the contrast noise ratio (CNR); the subjective evaluation uses arterial reinforcement, small artery detail display, image noise and venous pollution, each with 0-2 points: 0, poor; 1, medium; 2 points, good. Radiation dose was compared by t-test and image objective score by one-way ANOVA (ANOVA). The subjective scores of image quality were compared using the Cruskal-Wallis test.  $P < 0.05$  were considered to be statistically significant.

## RESULTS

The mean effective radiation dose between the high dose and low dose scanning regimen was 3.25 and 1.08 mSv, respectively, significant ( $t = -1303.629$ ,  $P < 0.001$ ). The image obtained at low dose gradually decreased with the increase of DLIR intensity, and the image SNR and CNR were gradually increased ( $F = 5.397, 3.450, 2.934$ ,  $P < 0.05$ ). The noise of high-intensity DLIR images and high-dose FBP images was ( $33.9 \pm 2.7$ ), ( $40.5 \pm 11.3$ ), SNR ( $14.3 \pm 6.8, 12.2 \pm 1.9$ ), and CNR ( $13.1 \pm 6.5$  and  $10.6 \pm 1.8$ ), respectively. The differences were statistically significant (t-values were -1.961, -0.989, -1.288, and P-values  $< 0.05$ ). The subjective scores of high intensity DLIR images and high dose FBP images were ( $6.17 \pm 0.4$ ) and ( $4.31 \pm 0.5$ ), respectively, which were statistically significant ( $Z = -4629$ ,  $P < 0.001$ ).

## CONCLUSION

The application of high-intensity DLIR algorithm is beneficial to achieve low-dose brain CTP, which can significantly improve the image quality and improve the peak period vascular assessment.

## CLINICAL RELEVANCE/APPLICATION

Deep learning algorithm improves the quality of vascular imaging in the peak period of low-dose cerebral perfusion artery, and provides clinical basis for the realization of one-stop cerebrovascular and cerebral perfusion imaging.

## T5B-SPPH- Class-wise Combination of Data Augmentation Can Enhance Learning on Class Imbalanced Dataset

Helen Hong, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Data augmentation (DA) plays an essential role in enhancing learning efficiency and avoiding overfitting in medical image analysis, particularly faced with limited training data or class imbalance. However, recent studies indicate that the effect of DA can differ among classes. We investigated the individual class effects of MixUp and AugMix DAs on focal liver lesions (FLLs) classification in CT images, and proposed a class-wise combination of these DAs with different ratios for each class to address class imbalance.

## METHODS AND MATERIALS

Our dataset included CT scans from 502 colorectal cancer patients with 1290 FLL images with 676 cysts, 130 hemangiomas, and 484 metastases. We proposed a class-wise combination of MixUp and AugMix DAs by applying them at different rates for each class. For the major classes, cyst and metastasis, MixUp and AugMix are applied at an equal ratio of 50% each, while for the minor class, hemangioma, the rate is adjusted to 75% MixUp and 25% AugMix. We trained a VGG-16 network on these augmented training images to classify FLLs. To evaluate the effectiveness of our method in class imbalance learning, we assessed the accuracy, F1 score, sensitivity, and specificity and analyzed the t-SNE feature distribution of the classification results.

## RESULTS

Our performance evaluation and feature distribution analysis showed that MixUp improved the sensitivity of the major classes by augmenting the data in the boundary area between classes, while AugMix enhanced the sensitivity of the minor class by augmenting the data within the class itself. By applying these two DAs in different ratios for each class, our method improved the F1 score and the sensitivity for cyst and hemangioma compared to using MixUp and AugMix alone.

## CONCLUSION

We observed that MixUp and AugMix had different effects on each class within the class imbalanced dataset for FLL classification in CT images. By applying these two DAs at different ratios for each class, our method enhanced the learning efficiency for both major and minor classes in class imbalance learning. (This work was supported by the National Research Foundation of Korea Grant funded by the Korea government (No. RS-2023-00207947))

## CLINICAL RELEVANCE/APPLICATION

Our proposed method can be applied to various medical image analysis tasks to enhance learning efficiency by utilizing multiple DA methods.

## T5B-SPPH- Evaluation of Extracellular Volume Changes using Conductivity Tensor Imaging

Jin Woong Kim, MD, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

Changes in extracellular volume (ECV) could be an effective biomarker of a disease state, such as fibrosis, edema, and cell swelling. Conductivity tensor imaging (CTI) using MRI has been developed to improve the limitations of existing MR-based conductivity imaging. Without injecting currents into the imaging object, CTI utilizes information on intracellular and extracellular compartments to produce both low-frequency and high-frequency conductivity images. The ECV fraction is one of the parameters that needs to be measured in CTI. In addition, it would have clinical utility if it can be measured reliably. The purpose of this study was to experimentally verify CTI parameters, with a specific focus on ECV fraction, by using a phantom with position-dependent ECV fractions.

### METHODS AND MATERIALS

Giant vesicle suspension (GVS) was prepared using the reverse phase method. An acrylic phantom was used for the CTI imaging experiment. The changes in ECV were controlled by the GVS chambers with four different densities: electrolyte only and low (GVS #1), middle (GVS #2), and high (GVS #3) densities of GVS. The CTI experiment was performed using a 9.4T MR scanner with a single-channel body coil. A multi-echo spin-echo MR pulse sequence was applied to the phantom to acquire B1 phase maps to reconstruct high-frequency conductivity (sH) images. The single-shot spin-echo echo-planar imaging sequence was used for multi-b-value diffusion-weighted imaging

### RESULTS

Figure 1 shows the CTI parameters obtained from the imaging experiment of the GVS phantom. MR image shows the morphology of the phantom. The signal intensity was found to be highest in the chamber with electrolyte only, but there was no clear difference in signal intensity between the chambers with different GVS densities. The sH image did not show a clear difference in terms of contrast between the four different densities of GVS. However, a, dw, and sL all showed clear differences in contrast depending on the densities of GVS. Specifically, the contrast of these parameters was decreased as the density of GVS increased. Meanwhile, the contrast of diw was slightly increased with increasing of GVS density. There was no contrast in the chamber of electrolyte only due to the absence of GVS.

### CONCLUSION

The ECV fraction is a key parameter for measuring CTI because the electrolytes inside and outside of the giant vesicle have similar ionic concentrations. As the vesicle density increased, the ECV decreased, resulting in decreased low-frequency conductivity.

## CLINICAL RELEVANCE/APPLICATION

Changes in the extracellular space can be indicators of disease progression, such as fibrosis, edema, and cell swelling. CTI can provide information about changes in the extracellular space, such as the ECV fraction.

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## Abstract Archives of the RSNA, 2023

T5B-SPVA

### Vascular Imaging Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-SPVA- Comparison of 4D Flow MRI-derived Aortic Flow Profiles in Patients with Abdominal Aortic Aneurysms below and above Intervention Threshold** 1

Inka Ristow, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare 4D flow MRI-derived aortic flow profiles in patients with abdominal aortic aneurysms (AAA) below and above intervention threshold.

#### **METHODS AND MATERIALS**

We prospectively performed 4D flow MRI of the abdominal aorta at 3T in 22 male AAA patients (72±9 years). Maximum aneurysm diameters were assessed using non-contrast 3D MR angiography. Based on the threshold for intervention, patients were divided into two groups: patients under surveillance with aortic diameters <5.5 cm (n=11) and ii) patients with diameters ≥5.5 cm with indication for therapeutic intervention (n=11). 4D flow MRI-derived flow rates and velocities were determined at the level of the maximum aneurysm diameter. Presence or absence of vortical flow in the infrarenal aorta was evaluated using a 3-point scale (0: no vortex, 1: local vortex, 2: global vortex). Data were statistically compared using unpaired Mann-Whitney U tests.

#### **RESULTS**

Mean AAA diameters of patients above intervention threshold were significantly higher as compared to patients under surveillance (4.3±0.7 cm vs. 5.8±0.5, p<0.001). Peak flow rate was significantly higher in patients above intervention threshold when compared to patients under surveillance (165±40ml vs. 108±37, p<0.05). Forward and backward stroke volume of patients above intervention threshold were also significantly higher as compared to patients under surveillance (50±18 ml vs. 30±16 ml and -16±8 vs. -10±0.9 ml, both p<0.008). Pathological vortical flow patterns were present in all (11/11) patients (100%) above surgical threshold as compared to 6/11 patients (55%) under surveillance, resulting in average vortical flow ratings of 1.5±0.5 vs. 0.9±1.0.

#### **CONCLUSION**

Quantitative and qualitative 4D flow MRI-derived blood flow profiles are significantly altered in AAA patients above intervention threshold when compared to AAA patients under surveillance.

#### **CLINICAL RELEVANCE/APPLICATION**

Our 4D flow MRI study revealed in about half of the patients under surveillance pathological flow profiles, warranting to investigate if these pathological flow profiles may serve an imaging biomarker to predict future aortic dilation.

#### **T5B-SPVA- Micro-vascularity of the Feet and Toes using Non-contrast MR Perfusion** 2

Mitsue Miyazaki, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop novel non-contrast 3D MR perfusion techniques for assessing micro-vascularity of the feet and toes in human subjects.

#### **METHODS AND MATERIALS**

All experiments were performed on a clinical 3T scanner using non-contrast MR perfusion using arterial spin labeling (ASL). Seven healthy subjects (30 to 72 years old, 5 males and 2 females) were enrolled and bilateral feet were imaged with tag-on

and tag-off alternating inversion recovery spin labeling for determining perfusion in micro-vascularity. We compared an ASL technique with 1-tag pulse against 4-tag pulses. For perfusion, we determined signal increase ratio (SIR) at varying inversion times (TI) from 0.5 to 2 sec. SIR versus TI data were fit to determine perfusion metrics of peak height (PH), time to peak (TTP), mean transit time (MTT), apparent blood volume (aBV) and apparent blood flow (aBF) in the distal foot and individual toes. Using analysis of variance (ANOVA), effects of tag pulse and ROI on the mean perfusion metrics were assessed.

## **RESULTS**

Using MR perfusion techniques, SIR versus TI data showed well-defined leading and trailing edges, with a peak near TI of 0.75 to 1.0 sec and subsiding quickly to near zero by TI of 2 sec, particularly when 4-tag pulses were used. In our normal subjects imaged with 1-tag pulse, the overall (of all ROIs and subjects) mean  $\pm$  standard deviation values of PH, TTP, MTT, aBV, and aBF were  $6.5\pm 4.5\%$ ,  $0.65\pm 0.26$  sec,  $0.60\pm 0.23$  sec,  $8.4\pm 4.6\%$ ·sec, and  $15.0\pm 9.0\%$ , respectively. When imaged with 4-tag pulse sequence, we found a significantly greater values in PH ( $13.4\pm 7.3\%$ ,  $p<0.00001$ ), TTP ( $0.60\pm 0.25$  sec,  $p=0.005$ ), aBV ( $13.7\pm 6.3\%$ ·sec,  $p<0.00001$ ), and aBF ( $25.4\pm 16.1\%$ ,  $p=0.008$ ).

## **CONCLUSION**

Feasibility of MR perfusion imaging of the distal foot was studied, and advantages of the 4-tag pulse technique were studied, showing greater SIR and perfusion metrics compared to 1-tag pulse technique. This will likely benefit those with low perfusion due to aging or diseases such as PAD and diabetic foot.

## **CLINICAL RELEVANCE/APPLICATION**

Our study demonstrated the feasibility of a novel application of a 3D ASL technique for the feet and toes, with a greater possibility of evaluation of diabetic foot.

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## Abstract Archives of the RSNA, 2023

W2-SPBR

### Breast Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPBR-2 Preoperative Diagnosis of Multifocal, Multicentric and Contralateral Breast Cancer: Additional Benefit of Diffusion-Weighted Magnetic Resonance Imaging**

HAJUNG KIM (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the diagnostic performance of dynamic contrast enhanced (DCE) MRI and diffusion weighted (DW) MRI, named multi-parametric MRI, for the diagnosis of multifocal, multicentric and contralateral breast cancer in patients with newly diagnosed breast cancer.

#### **METHODS AND MATERIALS**

Between June 2019 to June 2021, our database search identified consecutive women who were diagnosed with invasive breast cancer, underwent MRI, and had at least one DCE MRI detected additional lesion. Two experienced breast radiologists retrospectively measured apparent diffusion coefficient (ADC) values. A BI-RADS category = 4 was considered positive result. The reference standard was histopathology or 1-year follow-up. The ADC cut-off for differentiation between benign and malignant lesions was calculated and performance measures of DCE MRI alone and multi-parametric MRI were compared. In addition, we validated ADC value of  $1.3 \times 10^{-3} \text{ mm}^2/\text{s}$ , recommended by the European Society of Breast Radiology (EUSOBI) guideline.

#### **RESULTS**

Among finally included 219 patients (mean age, 50.9 years) with 298 lesions, 169 (57%) were benign (mean size, 1.4cm) and 129 (43%) were malignant (mean size, 1.7cm). There were 45 masses (27%) and 124 nonmass (73%) among benign lesions and 33 (26%) masses and 76 (74%) nonmass among malignant lesions. The median ADC of benign lesion was  $1.23 \times 10^{-3} \text{ mm}^2/\text{s}$  and median ADC of malignant lesion was  $0.88 \times 10^{-3} \text{ mm}^2/\text{s}$  ( $P < .001$ ). The best ADC cut-off to differentiate benign from malignant lesions determined using ROC-curve was  $1.0 \times 10^{-3} \text{ mm}^2/\text{s}$ , which yielded sensitivity of 74.4% and specificity of 76.9%. The area under the ROC curve was 0.80 (95% CI: 0.75-0.86). With DCE MRI alone, sensitivity was 98.5% (127 of 129, 95% CI: 96.3, 100.0), specificity was 29.6% (50 of 169, 95% CI: 22.7, 36.5) and accuracy was 59.4% (177 of 298, 95% CI: 53.8, 64.9). In comparison, multi-parametric MRI showed decreased sensitivity of 75.2% (97 of 129, 95% CI: 67.7, 82.6;  $P = .01$ ), but improved specificity of 76.3% (129 of 169, 95% CI: 69.9, 82.7;  $P < .001$ ) and accuracy of 75.8% (226 of 298, 95% CI: 70.9, 80.7;  $P < .001$ ). With ADC value of  $1.3 \times 10^{-3} \text{ mm}^2/\text{s}$ , sensitivity of 96.2% (124 of 129; 95% CI: 92.8, 99.4), specificity of 38.5% (65 of 169, 95% CI: 31.1, 45.8) and accuracy of 63.4% (189 of 298, 95% CI: 57.9, 68.9) were observed.

#### **CONCLUSION**

Multi-parametric MRI can increase the specificity and maximize accuracy of DCE MRI detected additional lesions in patients with newly diagnosed breast cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

In patients with newly diagnosed breast cancer, multi-parametric MRI with implementation of DW MRI can help increase specificity and accuracy of DCE MRI detected additional lesions.

#### **W2-SPBR-6 MR Imaging Features Associated with High and Low Expression of Tumor-Infiltrating Lymphocytes: Stratified Analysis According to Molecular Subtypes**

Jiejie Zhou, PhD, MD (*Presenter*) Nothing to Disclose

## PURPOSE

It is known that the expression of tumor-infiltrating lymphocytes (TILs) is different in different molecular subtypes of breast cancer (BC); and thus, the studies analyzing the mixed subtypes would be heavily dependent on the composition of subtypes, and the obtained results are not generalizable. To investigate the association of MRI features with TILs and subtypes, three analyses were performed: (1) Comparison of the rate of high vs. low TILs in 3 subtypes: Hormonal-Receptor positive, HER2 negative (HR+/HER2-), HER2 positive (HER2+), and Triple negative (TN); (2) Comparison of the MR imaging features among 3 subtypes; (3) In each subtype, the comparison of imaging features between high vs. low TILs cases.

## METHODS AND MATERIALS

A total of 457 patients with pathologically diagnosed BC were included in this study. Breast MRI with 3.0 T scanner was performed, including T2, DWI, and DCE-MRI. The expression of TILs was evaluated on HE-stained slides according to the recommendations by an International TILs Working Group 2014. The percentage of TILs in the stroma adjacent to the tumor cells was assessed, stratified as low (< 10%) and high (≥ 10%). MRI features, including morphology as mass or non-mass enhancement (NME), shape, margin, internal enhancement, peritumoral edema, and the DCE kinetic pattern were assessed and compared between groups.

## RESULTS

Of the 241 HR+/HER2- cases, 82% had low TILs, and only 18% had high TILs. There were 134 HER2+ cases, 63% low TILs and 37% high TILs. Of the 82 TN, 56% had low TILs and 44% had high TILs. The composition of high TILs was significantly increased from HR+ to HER2+ to TN ( $p < 0.001$ ). For MRI features among the 3 subtypes (Table 1), the size was smaller for HR+/HER2- ( $p < 0.001$ ); HER2+ was more likely to present as NME ( $p = 0.031$ ); homogeneous enhancement was more seen in HR+ ( $p < 0.001$ ); and the peritumoral edema was present in 45% HR+, 71% HER2+, and 80% TN ( $p < 0.001$ ). The MRI features between low and high TILs in each subtype are listed in Table 2. In HR+/HER2-, the peritumoral edema was more likely to be present in high TILs (70%) than in low TILs (40%,  $p < 0.001$ ). In TN, high TILs were more like to present a regular shape (33%) than low TILs (13%,  $p = 0.029$ ); and more like to present the circumscribed margin (19%) than low TILs (2%,  $p = 0.009$ ).

## CONCLUSION

HER2+ and TN cancers have significantly higher TILs compared to HR+ cancers. In HR+, high TILs cases were more likely to present peritumoral edema. In TN, high TILs cases were more likely to present regular shapes and circumscribed margins.

## CLINICAL RELEVANCE/APPLICATION

TILs expression increases from HR+ to HER2+ to TN. MRI features in different molecular subtypes show substantial variations. When building MR radiomics models to predict TILs, different models should be built for different subtypes.

## W2-SPBR-7 Interpretation of Unenhanced Breast MRI with Diffusion-Weighted Imaging for Breast Cancer Detection: Effect of Training on the Performance and Agreement of Radiologists

Su Min Ha, MD, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To investigate whether training improves the performance and agreement of radiologists interpreting unenhanced breast magnetic resonance imaging (MRI) with diffusion-weighted imaging (DWI).

## METHODS AND MATERIALS

A reader study of 96 breasts (35 screening-detected cancer cases and 61 benign or negative cancer cases) of 48 asymptomatic women was performed. High-resolution DWI (in-plane resolution  $< 1.3 \times 1.3$  mm) was performed using a 3.0-T system and b values of 0, 800, and 1200 sec/mm<sup>2</sup>. Sixteen breast radiologists independently reviewed DWI, apparent diffusion coefficient maps, and T1-weighted MRI and recorded the Breast Imaging Reporting and Data System (BI-RADS) assessment category for each breast. After a 2-hour training session and 5-month washout period, they re-evaluated the BI-RADS assessment categories. A BI-RADS category of 4 or more was considered a positive reading. The diagnostic performance of each reader for each breast during the first review and that during the second review were compared. Inter-reader agreement regarding the final assessment was evaluated using a multi-rater  $\kappa$  analysis.

## RESULTS

Before training, the mean sensitivity, specificity, and accuracy of 16 readers who performed unenhanced MRI assessments were 70.7% (95% confidence interval [CI]: 59.4-79.9), 90.8% (95% CI: 85.1-94.2), and 83.5% (95% CI: 78.6-87.4), respectively. After training, significant improvements in specificity (95.2%; 95% CI: 90.8-97.5;  $P = 0.001$ ) and accuracy (85.9%; 95% CI: 80.9-89.8;  $P < 0.001$ ) were observed, but no difference in sensitivity (69.8%; 95% CI: 58.1-79.4;  $P = 0.58$ ) was observed. Regarding inter-reader agreement, the  $\kappa$  values were 0.57 (95% CI: 0.52-0.63) before training and 0.68 (95% CI: 0.62-0.74) after training, with a difference of 0.10 (95% CI: 0.02-0.18), which was statistically significant ( $P = 0.01$ ).

## CONCLUSION

Minimal training improved the performance and agreement of interpretations by radiologists using unenhanced MRI with DWI.

## CLINICAL RELEVANCE/APPLICATION

To use DWI as an effective screening tool, besides the need for standardization of DWI acquisition, training for standardized interpretation is required.

## W2-SPBR-8 Standardizing Qualitative and Quantitative Breast Parenchymal Enhancement Assessment in Breast MRI

Gustav Mueller-Franzes, MSc (*Presenter*) Nothing to Disclose

### PURPOSE

Despite being a crucial research focus in the field of breast cancer studies, Background Parenchymal Enhancement (BPE) lacks standardized qualitative and quantitative assessments, which poses an obstacle in its evaluation as a breast cancer risk marker. The purpose of this study was to examine the relationship between and to compare qualitative and quantitative assessments of BPE.

### METHODS AND MATERIALS

In this retrospective study of 5773 breast MRI examinations from 3207 women acquired between January 2010 and December 2019, the BPE was rated as part of the clinical routine as minimal, mild, moderate, and strong following the ACR BI-RADS guidelines. For the quantitative assessment of BPE, the fibroglandular tissue (FGT) was segmented in the pre- and post-contrast T1-weighted sequences. Four quantitative BPE calculation methods were identified as most commonly used by previous studies and were applied to the given dataset. Correlation and agreement between qualitative and quantitative assessments were calculated using the Spearman correlation ( $r$ ) coefficient.

### RESULTS

The mean age of the patients was 60 years  $\pm$  10 [SD] and the average volumetric fraction of FGT to the full breast was 17%  $\pm$  12 [SD]. Radiologists rated the BPE in 3787 (66%) of the examinations as minimal, 1380 (24%) as mild, 543 (9%) as moderate, and 63 (1%) as marked. Among the four quantitative BPE definitions tested, the definition that measured the relative difference in the signal intensity before and after contrast agent injection had the highest correlation to human rating with  $r=0.56$ . The lowest correlation ( $r=0.50$ ) to expert radiologists was found for the BPE definition that measured the ratio of the enhancing FGT volume to the entire breast volume.

## CONCLUSION

The agreement between qualitative and quantitative BPE assessments was found to be, at most, fair. Further studies are needed to investigate the consequences of differences between qualitative and quantitative assessment as well as the differences among quantitative definitions on the prognostic value as a diagnostic marker for breast cancer and treatment response.

## CLINICAL RELEVANCE/APPLICATION

Given the at most fair agreement between qualitative and four quantitative assessments of BPE demonstrated in our study, and the known relation between BPE and breast cancer risk, it is essential to further research the relation between breast cancer risk and quantitative BPE measurements.

## W2-SPBR-9 Optimising Axillary Management following Neoadjuvant Chemotherapy in Patients with Breast Cancer

Anum Pervez, MBBS, FRCR (*Presenter*) Nothing to Disclose

### PURPOSE

Optimal management of the axilla in breast cancer following neoadjuvant chemotherapy (NAC) remains uncertain. Current practice at our institution is dictated by the initial nodal burden. For N1 disease (=3 nodes), a sentinel lymph node biopsy (SLNB) is performed and in N2 disease (=4 nodes) patients proceed to an immediate axillary nodal clearance (ANC). However, this pathway fails to take into account response to NAC. If there is node normalization on the post-treatment MRI, an ANC is arguably overtreatment. Whereas, an SLNB becomes undertreatment in cases of limited MRI response as patients undergo a second stage completion ANC. In this study, we examine the predictive role of the post-treatment MRI. We also investigate the importance of HER-2 status and how, in combination with the post-treatment MRI, it can offer a more tailored approach.

### METHODS AND MATERIALS

A retrospective analysis was performed on NAC patients between 2017-2022. Ultrasound guided-core biopsy confirmed axillary nodal involvement, along with the tumor HER-2 status. The baseline MRI was reviewed with registration of number of

abnormal nodes, followed by the post-treatment MRI and surgical histopathology.

## **RESULTS**

148 patients identified with node positive axillary disease prior to NAC, of which 54 were HER-2 positive. 103 (70%) had node normalization on imaging. The post-treatment MRI demonstrated 86% specificity and 42% sensitivity. MRI also showed 82% positive predictive value (PPV) but 50% negative predictive value (NPV) for residual axillary disease. Of the HER-2 positive patients, 44 (81%) had node normalization on imaging with 28/44 (63%) complete pathological response at surgery. In particular, in N2 disease and node normalization (n=12), 67% were HER-2 positive. Hence HER-2 positive patients are more likely to respond to NAC, irrespective of initial nodal burden. In our study, 22 patients with N1 disease could have undergone an immediate ANC rather than a two-stage completion ANC. Whereas 12 patients with N2 disease could have avoided an ANC all together.

## **CONCLUSION**

We have established high specificity and PPV of the post-treatment MRI. Thus, a core biopsy should be offered for initial N1 status and residual axillary disease, with a positive result leading to an immediate ANC rather than the traditional SLNB. In addition to this, consideration should be given to de-escalating axillary treatment with an SLNB rather than an immediate ANC in the subset of patients with N2 disease, imaging node normalization and a HER-2 positive status.

## **CLINICAL RELEVANCE/APPLICATION**

Persistent MRI nodal disease should be a reason to offer a core biopsy, followed by an immediate ANC if positive. Whereas, immediate ANC may be avoided in N2 disease with MRI node normalization and HER-2 positive status.

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## Abstract Archives of the RSNA, 2023

W2-SPCA

### Cardiac Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPCA-1 Diagnostic Performance of 4D-CT Myocardial Maximum Principal Strain to Detect Reduced Myocardial Viability**

Shigeo Okuda, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

A new technique enables to demonstrate myocardial maximum principal strain (MPS) on 4D-CT. The purpose of this study is to evaluate the diagnostic performance of MPS to detect reduced myocardial viability defined by late gadolinium enhancement (LGE) in patients with known coronary artery disease.

##### **METHODS AND MATERIALS**

A total of 82 patients (63 men, 66.3±9.6 years old) with a history of myocardial infarction were prospectively enrolled in this study at five university hospitals. ECG-synchronized 4D-CT studies were performed with wide-detector scanners (Aquilion ONE, Canon, Japan). Full-cardiac cycle CT data was reconstructed into 20 phases at 5% intervals. The MPS was demonstrated on the color chart of AHA-17 segments excluding the apex (#17) on a workstation (Ziostation 2, Ziosoft, Tokyo, Japan). The LGE was also obtained in cardiac MRI which was performed during the period before or after 3 months of the 4D-CT. On LGE of MRI, the reduced myocardial viability was defined as the segments with a >50% extent of LGE in the myocardial wall. The MPS color charts were independently interpreted by two other readers with more than 10 years-experience of cardiac imaging for detecting segments which had >50% LGE extent on MRI. The readers were provided three sets of MPS chart and MRI LGE for directly comparing between them before blind reading as a training. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated for detecting segments demonstrating LGE extent with >50% LGE on the 79 patients. The quantitative MPS values were statistically compared between two groups with or without >50% LGE using Mann-Whitney U test.

##### **RESULTS**

A total of 1264 segments were analyzed, including 316 (25 %) segments with >50% LGE extent. The sensitivity, specificity, accuracy, PPV and NPV averaged between two observers to diagnose segments with >50% of LGE were calculated as follows: 81.0% (256/316), 48.2% (492/948), 35.9% (256/712), 89.1% (492/552), and 59.1% (748/1264), respectively. The agreement of reduced MPS between two readers was 83.9% and kappa coefficient of 0.556 on the presence of >50% LGE extent of myocardial wall. The mean MPS value in segments with preserved viability was significantly higher than one with reduced viability (40.0 ± 15.7 vs. 32.0 ± 13.6, p<0.0001).

##### **CONCLUSION**

Because of its excellent NPV, the myocardial MPS analysis can be used for detecting viable myocardium with a good agreement between two readers.

##### **CLINICAL RELEVANCE/APPLICATION**

4D-CT myocardial maximum strain analysis can be a new option to evaluate and quantify myocardial viability particularly in patients with contraindication for cardiac MRI.

#### **W2-SPCA-2 Exploring the Impact of Flip Angle and Contrast Agent on Single Breath-hold Cardiac Magnetic Resonance Compressed Sensing Cine for Biventricular Strain Analysis**

Fuyan Wang (*Presenter*) Nothing to Disclose

## PURPOSE

Compressed sensing (CS) cine has been shown to provide comparable images to conventional balanced steady-state free precession (bSSFP) cine. As an important tool for strain analysis, cardiovascular magnetic resonance (CMR) cine-based tissue tracking could reliably detect the displacement of myocardial segments. However, the effects of CS technique on feature tracking (FT) need to be carefully studied. In this study, we aimed to investigate the impact of gadolinium contrast agent and flip angle on biventricular strain analysis of single breath-hold CS cine in patients with different kinds of cardiac dysfunction.

## METHODS AND MATERIALS

102 participants with 12 different cardiovascular etiologies (75 men, with a mean age of  $46.5 \pm 17.1$  (SD) years) were enrolled in this study. Each patient underwent four consecutive cine sequences with same slice localization, including the reference multi-breath-hold bSSFP (bSSFPref) cine, the single breath-hold CS cine with the same flip angle as bSSFPref before (CS45) and after (eCS45) contrast enhancement, and the CS cine (eCS70) with 70-degree flip angle after contrast agent injection.

## RESULTS

Global strain parameters of both ventricles, including global radial strain (GRS), global circumferential strain (GCS), and global longitudinal strain (GLS), obtained from CS cine were found to be significantly lower than those obtained from bSSFPref (all  $p < 0.001$ ). However, the GRS and GCS values of the left ventricle derived from both CS45 and eCS70 cine sequences showed no difference. Similarly, the GRS, GCS, and GLS values of the right ventricle obtained from eCS45 and eCS70 cine sequences showed no significant difference as well. Evaluation of CS45 and eCS45 cine sequences demonstrated that the use of contrast agents can result in a reduction in GRS and GCS values of both ventricles (all  $p < 0.001$ ), but did not have any effect on the GLS values.

## CONCLUSION

Despite the use of contrast agents and increased flip angle, CS cine consistently produced lower values for GRS, GCS, and GLS of both ventricles compared to conventional bSSFP cine. However, the impact of contrast agents on left ventricular GRS and GCS can be compensated by increasing the flip angle of CS cine. In contrast, increasing the flip angle of CS cine did not affect the GRS, GCS, and GLS values of the right ventricle. Furthermore, the administration of contrast agents resulted in a reduction of biventricular GRS and GCS values derived from CS cine.

## CLINICAL RELEVANCE/APPLICATION

Feature tracking based on routine CMR cine could reliably detect the displacement of myocardial segments, however, the effect of drastically increased using compressed sensing cine on strain analysis need to be carefully studied.

## W2-SPCA-3 Single Breath-hold Assessment of Cardiac Function and Strain using a 3-dimensional Cine Enhanced SENSE by Static Outer-volume Subtraction Acquisition

Pu Qian (*Presenter*) Nothing to Disclose

## PURPOSE

To validate the clinical feasibility of a novel 3-dimensional (3D) ultrafast cardiac magnetic resonance (CMR) protocol for the assessment of ventricular function and strain in a single breath-hold.

## METHODS AND MATERIALS

A total of 26 patients were enrolled prospectively, and all patients underwent CMR using both the standard breath-hold 2D cine balanced steady-state free precession acquisition (2D cine bSSFP) and single-breath-hold 3D cine Enhanced sensitivity encoding (SENSE) by Static Outer-volume Subtraction acquisition (3D cine ESSOS). Images of 3D cine were reconstructed and the left ventricular ejection fraction (LVEF), right ventricular ejection fraction (RVEF), global circumferential strain (GCS), global radial strain (GRS) and global longitudinal strain (GLS) of 3D and 2D cine were assessed by post-processing software. The difference and agreement of the two sequences were assessed.

## RESULTS

Two patients could not hold their breath well and the image quality could not satisfy the quantitative analysis. The 3D cine images of the remaining 24 patients were of good quality and allowed quantification. Mean acquisition time was  $23 \pm 1$ s versus  $273 \pm 20$ s for 3D and 2D cine imaging, respectively. LVEF by 3D and 2D cine were  $58.27$  (95% confidence interval [CI],  $50.85$  to  $61.89$ ) and  $59.03$  (95% CI,  $51.15$  to  $61.67$ ), respectively, with excellent agreement (intraclass correlation coefficient [ICC]:  $0.99$ , 95% CI,  $0.98$  to  $0.99$ ) and insignificant bias. RVEF by 3D and 2D cine were  $52.20$  (95% CI,  $44.17$  to  $53.76$ ) and  $51.65$  (95% CI,  $44.93$  to  $53.72$ ), respectively, with excellent agreement (ICC:  $0.83$ , 95% CI,  $0.65$  to  $0.92$ ) and insignificant bias. GCS by 3D and 2D cine were  $-15.95$  (95% CI,  $-17.58$  to  $-13.18$ ) and  $-18.20$  (95% CI,  $-19.60$  to  $-15.30$ ), respectively, with acceptable agreement (ICC:  $0.77$ , 95% CI,  $0.54$  to  $0.89$ ) and insignificant bias. GRS by 3D and 2D cine were  $28.20$  (95% CI,  $21.08$  to  $31.05$ ) and  $31.15$  (95% CI,  $23.05$  to  $33.95$ ), respectively, with excellent agreement (ICC:  $0.83$ , 95% CI,  $0.64$  to  $0.92$ ) and insignificant bias. GLS by 3D and 2D cine were  $-10.4$  (95% CI,  $-13.45$  to  $-6.75$ ) and  $-16.10$  (95% CI,  $-17.93$  to  $-11.78$ ), respectively, with acceptable agreement (ICC:  $0.76$ , 95% CI,  $0.53$  to  $0.89$ ) and insignificant bias. Although the



differences in cardiac function and strain between 2D and 3D cine were statistically significant, their differences were within the clinically acceptable range.

#### **CONCLUSION**

We demonstrate that the image quality of 3D cine is slightly lower than 2D cine, but it can realize the rapid acquisition of cine images and good consistency. 3D cine ensures rapid assessment of cardiac function and strain.

#### **CLINICAL RELEVANCE/APPLICATION**

ESSOS sequence can be used as an examination method for heart disease screening and for patients who cannot tolerate a long examination.

### **W2-SPCA-4 Coronary Stent Evaluation by CCTA using Super-Resolution Deep Learning Reconstruction: Compared with Invasive Coronary Angiography**

Cheng Xu (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the impact of a novel super-resolution deep-learning reconstruction (SR-DLR) algorithm on the visible and diagnostic performance of coronary CT angiography (CCTA) in stents evaluation.

#### **METHODS AND MATERIALS**

This retrospective study included 20 patients with 28 coronary stents who underwent CCTA on a 320-row scanner. Raw data were reconstructed with hybrid iterative reconstruction (HIR, AIDR 3D, FC04), DLR (AiCE), and SR-DLR (PIQE). The maximum visible in-stent lumen diameter were measured. CT attenuation profiles across the stents were generated, then the width of the edge rise distance (ERD) and the edge rise slope (ERS) were measured. The diagnostic confidence was evaluated using a 4-point scale (1=poor, 4=excellent). The patency of stent were evaluated and in-stent restenosis was defined as = 50% stenosis. Invasive coronary angiography served as reference standard.

#### **RESULTS**

SR-DLR images showed the largest in-stent lumen diameters among all reconstruction approaches (all  $P < 0.05$ ). There was no significant difference in the ERD between different reconstruction approaches ( $P = 0.10$ ), but the ERS on SR-DLR images ( $416.05 \pm 135.45$  HU/mm) was greater than that on HIR images ( $170.27 \pm 90.24$  HU/mm;  $P < 0.05$ ) or DLR images ( $195.06 \pm 96.35$  HU/mm;  $P < 0.05$ ). The diagnostic confidence was comparable for SR-DLR and DLR ( $3.70 \pm 0.79$  vs.  $3.60 \pm 0.56$ ,  $P = 0.40$ ), but higher than HIR ( $3.30 \pm 0.65$ , all  $P < 0.05$ ). SR-DLR images provided optimal diagnostic performance in the evaluation of in-stent patency, the diagnostic accuracy were 86.7%, 83.3% and 76.7% for SR-DLR, DLR and HIR images, respectively (all  $p < 0.05$ ).

#### **CONCLUSION**

Compared with HIR and DLR algorithm, SR-DLR improves the visible and diagnostic performance of CCTA in stents evaluation.

#### **CLINICAL RELEVANCE/APPLICATION**

SR-DLR algorithm improves the diagnostic accuracy and confidence of coronary stent evaluation.

### **W2-SPCA-5 Optimizing Residual-Dense Blocks for Myocardial Delayed Enhancement CT Denoising for Future Edge-Based AI**

Takuma Kobayashi, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In myocardial delayed enhancement (MDE) CT, post hoc denoising methods using residual-dense networks (RDN)s have been reported to improve diagnostic performance. RDNs maintain hierarchical information and deepen the network using residual-dense blocks (RDBs). Optimization of the number of RDBs for each target task is crucial. This study aimed to determine the effect of the number of RDBs on MDE CT denoising. As the number of blocks was reduced, we evaluated denoising precision, inference time, and image similarity to the reference 20-block (RDB20) image.

#### **METHODS AND MATERIALS**

We retrospectively reviewed 100 consecutive cases who underwent MDE CT. RDNs were trained on a denoising task using pre- and post-additive averaged images as teacher data. We prepared models with 1, 3, 5, 10, and 20 blocks, using RDB20 as a reference. For the hold-out test group (other 40 patients), we performed inference on five models to create denoised images and recorded processing times. We measured CT values and standard deviations (SD) of the blood pool and myocardium, determined image noise and contrast noise ratios for the blood pool and myocardium, and assessed image similarity using structural similarity (SSIM), peak signal to noise ratio (PSNR), learned perceptual image patch similarity

(LPIPS), and visual information fidelity (VIF) compared to the reference RDB20 image. We used the Wilcoxon signed-rank sum test with Holm's multiple testing correction for comparisons.

## RESULTS

The RDN achieved 30% image noise from only one block, gradually increasing with increasing blocks ( $p < .001$  for all), especially in the low-frequency range. Processing time per patient was 24.6s in RDB20, and significantly decreased to 12.6s (51%) in RDN10, 6.6s (27%) in RDB5, 4.2s (17%) in RDB3, and 1.8s (7%) in RDB1, respectively. Increased RDBs achieved significantly high similarity with reference ( $p < .001$  for all); RDB10 showed an SSIM of 0.99996, PSNR of 77.9, LPIPS of 0.0006, and VIF of 0.83, indicating high similarity to RDB20 with half computation costs.

## CONCLUSION

Increasing RDBs significantly improved denoising effects and similarity to the reference image. However, computational costs also increased.

## CLINICAL RELEVANCE/APPLICATION

Our findings on optimizing the trade-off between denoising effects and computational costs in RDNs can guide the development of edge-based AI denoising applications in clinical settings.

## W2-SPCA-7 Super-resolution Deep-learning Reconstruction: Image Quality and Myocardial Homogeneity in Coronary Computed Tomography Angiography

Sung Min Ko, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

The present study aimed to investigate whether super-resolution deep learning reconstruction (SR-DLR) has advantages in the overall image quality including signal-to-noise ratio (SNR), contrast to noise ratio (CNR) and sharpness as well as intensity homogeneity on coronary CTA with 4 different approaches; filtered-back projection (FBP), hybrid iterative reconstruction (IR), DLR and SR-DLR.

## METHODS AND MATERIALS

Sixty-three patients (mean age,  $61 \pm 11$  years; range, 18-81 years; 40 men) who had undergone coronary CT angiography between June-October 2022 were retrospectively included. Image reconstruction was performed using FBP, hybrid IR, DLR, and SR-DLR. Image noise, SNR, and CNR were quantified in both proximal and distal segments of the major coronary arteries. The left ventricle myocardium contrast homogeneity was analyzed. Two independent reviewers scored the overall image quality, image noise, image sharpness, and myocardial homogeneity.

## RESULTS

Image noise in HU was significantly lower ( $p < 0.001$ ) for the SR-DLR ( $11.2 \pm 2.0$ ) compared to those associated with other image reconstruction methods including FBP ( $30.5 \pm 10.5$ ), hybrid IR ( $20.0 \pm 5.4$ ), and DLR ( $14.2 \pm 2.5$ ). SR-DLR significantly improved SNR and CNR in both the proximal and distal segments of the major coronary arteries (Fig.1). No significant difference ( $p = 0.345$ ) was observed in the myocardial CT attenuation with SR-DLR. Conversely, FBP and hybrid IR (both,  $p < 0.001$ ) resulted in inhomogeneous myocardial CT attenuation (Fig.2). Two reviewers graded subjective image analyses with SR-DLR images higher than other image reconstruction techniques (Fig. 3-4).

## CONCLUSION

SR-DLR improved image quality, demonstrated clearer delineation of distal segments of coronary arteries, and was seemingly accurate for quantifying CT attenuation in the myocardium.

## CLINICAL RELEVANCE/APPLICATION

The results of this study demonstrate that SR-DLR achieves higher image quality, better visualization of small distal segments of coronary arteries, and minimum inhomogeneous myocardium attenuation on coronary CT angiography than those associated with FBP, hybrid IR, and DLR.

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## Abstract Archives of the RSNA, 2023

W2-SPCH

### Chest Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

### W2-SPCH-2 Comparison of CT and Wide-angle Stationary Digital Chest Tomosynthesis in the Detection of Pulmonary Nodules

Alan H. Zhao, BS (*Presenter*) Nothing to Disclose

#### PURPOSE

Lung cancer remains the number one cause of cancer death. Screening remains underutilized despite the clear evidence of benefit. A need exists for a safe, mobile, low radiation dose, intra-procedural method to localize biopsy instruments within target nodules. This retrospective cross sectional reader feasibility study evaluates the ability of clinicians to identify pulmonary nodules using a wide angle carbon nanotube x-ray enabled stationary digital chest tomosynthesis system.

#### METHODS AND MATERIALS

A "LUNGMAN" phantom with pulmonary nodules was scanned with both CT and the tomosynthesis system. Nodules of varied size (3, 5, 8, 10, 12 mm) and radiodensity (HU-800, -600, +130) were placed randomly into different lobes of the phantom. For each test case, 3 nodules (one of each density) were randomly placed into the phantom. A total of 8 nodule test cases were recorded. CT scanning was performed under the ACR recommended lung cancer screening protocol. Chest tomosynthesis imaging was performed with a custom built "wide-angle" CNT system consisting of a meter long x-ray source with 60 independent activated x-ray sources opposite a digital detector, representing a 40 degree angular span. Imaging was performed at 120kV and total mAs of 2.358. Tomosynthesis images were reconstructed into the coronal plane with 3 mm slice thickness and presented to readers on PACS compliant monitors. Two board certified radiologists participated as readers. Each scan (CT or tomosynthesis) was independently reviewed, and the positions of lung nodules were documented by each reader.

#### RESULTS

The specificity of both the CT and tomosynthesis in detecting any sized pulmonary nodules was 1. For actionable pulmonary nodules, or those 8 mm or greater in size, both the CT and tomosynthesis had a specificity of 1. The sensitivity of CT and tomosynthesis in detecting any sized pulmonary nodules is 0.929 and 0.708, respectively. The sensitivity of CT and tomosynthesis in detecting actionable pulmonary nodules is 0.958 and 0.850, respectively. The sensitivity of tomosynthesis increases with dense pulmonary nodules, with actionable pulmonary nodules of HU+130 being detected with a sensitivity of 1.

#### CONCLUSION

Wide-angle tomosynthesis was found to consistently identify dense nodules of at least 8 mm in size. Further studies are needed to evaluate the sensitivity and specificity of the system to actionable lung nodules. With system and carbon nanotube array optimization, we hypothesize the detection rate for nodules will improve. Additional study is needed to evaluate its use in target and tool co-localization and target biopsy.

#### CLINICAL RELEVANCE/APPLICATION

The development of an effective, low-radiation and mobile method for pulmonary nodules could improve screening of lung cancer.

### W2-SPCH-3 Value of Deep Learning Reconstruction Algorithm Combined with Low Tube Voltage in Routine Lung CT Scanning

Ren-feng LV (*Presenter*) Nothing to Disclose

## PURPOSE

To study the effect of deep learning reconstruction (DLIR) algorithm combined with low tube voltage (100 KVp) on lung CT scan image quality and radiation dose.

## METHODS AND MATERIALS

50 patients with routine lung CT scans were selected and were divided into 120 KVp group and 100 KVp group according to the difference of tube voltage, 25 patients in each group. Among them, Group A: Tube voltage 120 KVp, adaptive statistical iterative reconstruction (ASiR-V, 30%) algorithm, reconstruction mode (lung). The raw data of 100KVp group were reconstructed according to different reconstruction algorithm and reconstruction mode, Group B: Deep learning reconstruction (DLIR-H) algorithm, standard reconstruction mode (Std). Group C: Deep learning reconstruction (DLIR-H) algorithm, standard reconstruction mode (Std) + image enhancement filter (LU). All scans using a tube current of 100 ma, other parameter settings are the same. The thickness of 1.25mm was reconstructed image. The CT values, noise (SD), CTDI, within the subcutaneous fat and lung tissue on both sides of the same location were recorded, signal noise ratio (SNR) and radiation dose (ED) were calculated, two chest doctors evaluated the image quality subjectively and made statistical analysis of the data between the three groups.

## RESULTS

There was no statistical difference in the CT values measured in all three groups of lung images ( $P > 0.05$ ); The SD, SNR and image quality evaluation were statistically different between the three image groups ( $P < 0.05$ ), the noise of the images of B and C groups is significantly lower than that of group A, group C images provide better sharpness and clearly shows the structure and branches of lung markings; The radiation dose of the 100 KVp group was significantly lower than the 120 KVp group ( $P < 0.05$ ).

## CONCLUSION

Using tube voltage 100 KVp combined with DLIR algorithm significantly reduces the radiation dose. Compared with ASiR algorithm, using DLIR algorithm combined with image enhanced filter (LU) reconstruction mode can significantly lower the image noise, and improved the display ability of lung tissue and lung markings.

## CLINICAL RELEVANCE/APPLICATION

Routine low-dose lung CT examination used low tube current combined with iterative algorithm, the noise suppression and radiation dose reduction are not obvious, DLIR algorithm combined with low tube voltage imaging can significantly reduce the radiation dose, the DLIR algorithm standard reconstruction mode combined with image enhancement filtering (LU) can provide a good contrast image of the lung tissue. Due to the significant noise suppression of the DLIR algorithm, the application of routine lung CT physical examination and lung nodule screening using a tube voltage of 80 KVp or even lower becomes possible.

## W2-SPCH-4 CT Pulmonary Angiograms (CTPA) in Pregnant Patients: Multicenter Study on Imaging Findings, Management, and Follow-up of Patients beyond an Optimal and Suboptimal CTPA

Shadi Ebrahimian, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Risk of pulmonary embolism (PE) is increased in pregnancy. However, CTPA usage is limited given the risks of radiation exposure to the mother and fetus. The aim of this study was to assess the frequency of suboptimal CTPAs in pregnant population, the factors related to sub-optimality, and factors contributing to patients' outcome.

## METHODS AND MATERIALS

Our IRB approved, retrospective study included 440 consecutive CTPA examinations of pregnant patients scanned between 2015-2021 at one of the five participating quaternary and community hospitals. For the control group, we included 474 consecutive, female patients who underwent CTPA. All CTPA exams were reviewed for diagnostic evaluability (optimal or suboptimal) as well as the presence of PE. In addition, we recorded patients' age, gestational age at the time of CTPA, weight, imaging data (Doppler US, chest radiograph, and ventilation perfusion scan), and information on patient and pregnancy outcomes following CTPA.

## RESULTS

PE positive CTPA rates in pregnant (3.4%) and non-pregnant (9.7%) patients were significantly different ( $p=0.004$ ). The frequency of suboptimal CTPA (11.2%, 49/440) in pregnant and non-pregnant patients (11.2% vs 8.2%;  $p=0.657$ ) was not significantly different. Pregnant patients with suboptimal CTPA had higher weight (92 kg vs 77 kg), and advanced gestational age ( $\geq 20$  weeks vs  $< 20$  weeks) in comparison with optimal CTPA. Additional imaging including CXR (46.9%), Doppler (46.9%), repeat CTPA (10.2%), and V:Q (2.0%) were performed in less than 50% of patients with suboptimal CTPA. Although patients with suboptimal CTPA had a higher rate of hospitalization than those with optimal CTPA (40.8% vs 29.9%), it was not significantly different. Non-PE findings such as pneumonia, edema, and pleural effusions, were more frequent findings in CTPAs. CTDI<sub>vol</sub> and DLP were significantly higher in suboptimal CTPA (CTDI: 9 vs 8, DLP: 271, 238,  $p < 0.001$ ).

## CONCLUSION

The low rate of PE-positive CTPA in pregnant patients comparing to non-pregnant patients as well as additional testing performed following suboptimal CTPA suggest over-utilization of CTPA in pregnant population. Pregnancy does not attribute to higher suboptimality rate in CTPAs. However, suboptimal CTPA is more expected in patients with higher body weight and age of pregnancy. Although not statistically significant, the higher rate of hospitalizations among patients with suboptimal CTPA suggests presence of a more severe underlying disease. Suboptimal CTPA exposes extra radiation dose to patients comparing to optimal CTPA.

## CLINICAL RELEVANCE/APPLICATION

Over-utilization of CTPA in pregnant populations leads to unnecessary exposure of radiation and contrast to mother and fetus.

### W2-SPCH-5 Performance Evaluation of a 3D Camera System for Automated Patient Positioning in Routine Chest and Abdominal CT

Tim Busselot (*Presenter*) Nothing to Disclose

## PURPOSE

Patient out-of-center positioning in computed tomography (CT) scanning is a common issue, possibly resulting in inferior image quality and/or increased patient dose due to suboptimal tube current modulation. Automated patient positioning, using a three-dimensional (3D) camera promises more accurate and robust positioning. This study aimed to compare manual versus 3D camera based patient positioning in the clinical workflow.

## METHODS AND MATERIALS

A total of 6618 routine thoracic and abdominal scans of adult patients were included in the study. The scans were performed on 2 CT scanners, one of which was equipped with a 3D camera system (Naeotom Alpha CT by Siemens Healthineers), which automatically positions the patient; the 3D camera was used in the 1597 scans. The patient positioning after each scan, as well as the corresponding patient effective diameter (ED), were calculated by DOSE (Qaelum), the dose monitoring system used in the hospital. An extensive study was performed by evaluating the positioning of each scan taking into account the scan region, the patient size (in terms of ED) and the gender. A vertical bidirectional offset from the CT isocenter smaller than 10 mm (threshold) was defined as 'accurate positioning', since no significant impact on image quality and patient dose was found in literature. Before using the positioning calculations of DOSE, a validation was executed.

## RESULTS

Mean manual patient positioning was 16.55 mm 95% CI [16.05, 17.06], while positioning with the 3D camera resulted in a significantly different ( $p < 0.0001$ ) mean positioning of -3.33 mm, 95% CI [-4.27, -2.39]. Positioning distribution indicated a more centralized positioning with the 3D camera (53%) compared to manual positioning (31%). Sub-analysis regarding the scan region resulted in significant differences ( $p = 0.001$ ) between manual and automatic positioning in both thorax and abdomen exams. Patient size comparisons showed that small patients ( $ED = 28\text{cm}$ ) were on average worse positioned compared to medium ( $28\text{cm} < ED < 31\text{cm}$ ) and large ( $ED = 31\text{cm}$ ) patients, in both manual and automatic positioning. Still, automatic positioning was significantly ( $p = 0.001$ ) more accurate. Gender wise comparison provided evidence of the superiority of the automatic positioning in all patients, independent on the gender.

## CONCLUSION

Automated patient positioning using a 3D camera resulted in a significantly more accurate positioning of the patient in the CT scanner, compared to manual positioning. Sub-analyses regarding scan region, patient size and gender showed an overall improvement, indicating the camera based positioning is robust.

## CLINICAL RELEVANCE/APPLICATION

Automated 3D camera positioning was shown to provide more accurate and robust positioning in routine CT practice.

### W2-SPCH-6 The Effect of Pitch and Rotation Time on the Quantitative Analysis of Lung Nodules by Artificial Intelligence in Low-dose Lung CT Screen

Xuan Su (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the influence of the choice of pitch and rotation time on the quantitative analysis of lung nodules by artificial intelligence in low-dose lung CT screening.

## METHODS AND MATERIALS

A thorax anthropomorphic phantom (Lungman, Kyoto Kagaku Inc.) was scanned by with a 256-row CT (Revolution CT, GE Healthcare), which contained 9 simulated nodules (CT value, 100 HU, -630HU and -800HU; diameter: 8mm, 10mm, 12mm). Six groups of images were obtained with same tube voltage and current (120kV, 45mA) but different combination of

pitch and rotation time (Group 0: 0.984, 0.28s; Group 1: 0.992, 0.35s; Group 2: 0.992, 0.28s; Group 3: 1.375, 0.5s; Group 4: 1.531, 0.5s ; Group 5: 0.984, 0.35s). The images with different group were analyzed by an artificial intelligence software (Intelligent 4D Imaging System for Chest 5.5, YITU Healthcare). The CT value, SD of pulmonary nodules and air in front of sternum at the same slice were measured. CT dose index (CTDI), the product of dose length (DLP) of each scan were recorded. Signal-to-noise ratio ( $SNR = \frac{CT_{\text{nodule}}}{SD_{\text{nodule}}}$ ) and contrast signal to noise ratio ( $CNR = \frac{CT_{\text{nodule}} - CT_{\text{air}}}{SD_{\text{air}}}$ ) were calculated. All statistical analyses were performed using SPSS statistical software (version 22.0).

## RESULTS

Changing pitch and rotation time at low dose has no effect on the size of lung nodules measured by AI (mean diameter,  $P > 0.05$ ; diameter difference percentage,  $P > 0.05$ ); changing the scan pitch and rotation speed does not affect the CT of lung nodules Measurement of values (average CT value,  $P > 0.05$ ; percentage difference in CT value,  $P > 0.05$ ). The changes of scanning pitch and rotation speed have no effect on the image quality ( $SNR$ ,  $P > 0.05$ ;  $CNR$ ,  $P > 0.05$ ). The CT effective dose is different under different conditions (CTDL,  $P < 0.05$ , DLP,  $P < 0.05$ ), the DLP value is the lowest when the scanning pitch is 0.984 and the rotation speed is 0.28s (DLP = 27.79 (mGy \* cm)).

## CONCLUSION

In low-dose lung screening, changes in scan pitch and rotational speed will not affect image quality. Choosing a distance of 0.984 and a rotational speed of 0.28s can provide lung screening with lower radiation dose.

## CLINICAL RELEVANCE/APPLICATION

In clinical workflow, it is of great significance to minimize radiation dose while keep image quality constantly.

## W2-SPCH-8 Value of Deep Learning Reconstruction of Chest Low-dose CT for Image Quality Improvement and Lung Parenchyma Assessment on Lung Window

Jinhua Wang, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To explore the performance of low-dose computed tomography (LDCT) with deep learning reconstruction (DLR) for the improvement of image quality and assessment of lung parenchyma.

## METHODS AND MATERIALS

Sixty patients underwent chest regular-dose CT (RDCT) followed by LDCT during same patient encounter. RDCT images were reconstructed with hybrid iterative reconstruction (HIR) and LDCT images were reconstructed with HIR and DLR, both using lung algorithm. Radiation exposure was recorded. Image noise, signal-to-noise ratio, and subjective image quality of normal and abnormal CT features were evaluated and compared using the Kruskal-Wallis test with Bonferroni correction.

## RESULTS

The effective radiation dose of LDCT was significantly lower than that of RDCT ( $0.29 \pm 0.03$  vs  $2.05 \pm 0.65$  mSv,  $p < 0.001$ ). The mean image noise  $\pm$  standard deviation was  $33.9 \pm 4.7$ ,  $39.6 \pm 4.3$  and  $31.1 \pm 3.2$  HU in RDCT, LDCT HIR-Strong and LDCT DLR-Strong, respectively ( $p < 0.001$ ). The overall image quality of LDCT DLR-Strong was significantly better than that of LDCT HIR-Strong ( $p < 0.001$ ) and comparable to that of RDCT ( $p > 0.05$ ). LDCT DLR-Strong was comparable to RDCT in evaluating solid nodules, increased attenuation, linear opacity, and airway lesions (all  $p > 0.05$ ). The visualization of subsolid nodules and decreased attenuation was better with DLR than with HIR in LDCT but inferior to RDCT (all  $p < 0.05$ ).

## CONCLUSION

LDCT-DLR can effectively reduce image noise and improve image quality. LDCT-DLR provides good performance for evaluating pulmonary lesions, except for subsolid nodules and decreased lung attenuation, compared to RDCT-HIR.

## CLINICAL RELEVANCE/APPLICATION

DLR enables LDCT maintaining image quality even with very low radiation doses.

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## Abstract Archives of the RSNA, 2023

W2-SPER

### Emergency Radiology Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPER-1 Imaging Findings of Elder Abuse on the Trauma Service: A retrospective Case-control Study of Two Institutions**

Omar Yaghi, BS, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Elder abuse is common and consequential for its victims, with impact ranging from reduced quality of life to physical injury and death. Screening is a recognized strategy for detection, but less effective in elders with diminished ability to communicate or psychosocial reasons to fear disclosure. This study aimed to identify imaging findings of elder abuse.

#### **METHODS AND MATERIALS**

Preliminary data from this retrospective case control study identified 17 patients above 60 years of age with keywords "assault" and "abuse" from two institutional trauma registries from 2015-2022, as well as 17 age and gender matched controls. Demographic information, clinical information, and imaging findings were reviewed.

#### **RESULTS**

Majority of the abuse victims were women (71%) and White (88%), with mean age of 74 years (range 61-91 years). Known risk factors for elder abuse were common. The alleged abuser was most frequently the patient's child, followed by partner. Blunt trauma was more common (14/17). Rib fractures (7/17), head (8/17) and facial (5/17) injuries were the most frequent imaging findings. Central injuries (to neck, torso) were more common in elder abuse victims compared to control trauma patients, while the latter more frequently had extremity injuries. Abuse victims with extremity injuries demonstrated tendency towards distal injury particularly of the upper extremity (forearm, hand), while control patients tended towards proximal injury (humerus, femur).

#### **CONCLUSION**

This study demonstrated that radiologists can be helpful in assessment of elder abuse, identified injuries to the head/face, central body, and distal upper extremity as warning signs of elder abuse, and highlighted the importance of further research to identify imaging patterns of abuse in this vulnerable population.

#### **CLINICAL RELEVANCE/APPLICATION**

Radiologists can help in recognition of elder abuse by identifying injuries occult to physical examination in victims who are unable or unwilling to disclose abuse.

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## Abstract Archives of the RSNA, 2023

W2-SPGI

### Gastrointestinal Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### W2-SPGI-1 A Pilot Study on the Classification of Focal Liver Lesions using Normalized Viscoelastic Parameters with Intrinsic MR Elastography

Amirhosein Baradaran Najar, MSc, BSc (*Presenter*) Nothing to Disclose

##### PURPOSE

Evaluate the accuracy of nonlinear inversion-intrinsic magnetic resonance elastography (NLI-iMRE), which uses natural pressure pulse and cardiac induced motion, for determining the viscoelastic properties of liver lesions and distinguishing between benign and malignant tumors.

##### METHODS AND MATERIALS

This prospective, cross-sectional study was approved by an institutional review board and patient consent was obtained. Adult patients undergoing 3T clinical MRI for characterization of liver lesions were included. A 4D-phase contrast quantitative sequence with retrospective cardiac gating was acquired to encode motion. Using the 3D displacement field at eight cardiac cycle phases, viscoelastic parameters  $G'$  (storage modulus),  $G''$  (loss modulus), and  $|G^*|$  (magnitude of the complex shear modulus) were computed within the imaging volume using the subzone-based NLI-iMRE reconstruction method. To ensure comparability between subjects, viscoelastic properties were calculated for the liver and spleen, and liver properties were normalized by the mean spleen property values. The composite reference standard included lesion classification by clinical MRI or histopathology. Unpaired t-tests and receiver operating characteristic (ROC) curves were used to compare benign and malignant lesions.

##### RESULTS

34 patients with 34 lesions were included. Normalized  $G'$  values showed significant differences between hemangiomas and LR-4 ( $p < 0.01$ ), LR-5 ( $p = 0.02$ ), and metastasis ( $p < 0.01$ ) and between focal nodular hyperplasias (FNH) and LR-4 ( $p < 0.01$ ), LR-5 ( $p = 0.03$ ), and metastasis ( $p < 0.01$ ). The  $|G^*|$  values showed significant differences between FNH and LR-4 ( $p < 0.0001$ ), LR-5 ( $p = 0.03$ ), and metastases ( $p = 0.04$ ). ROC curves were used to differentiate benign and malignant lesions, with the area under the curves for  $G'$ ,  $G''$ , and  $|G^*|$  being 0.90, 0.61, and 0.71, respectively.

##### CONCLUSION

This study shows that cardiac activated iMRE which has the advantage of not requiring external mechanical stimulation, is a promising method for differentiating benign and malignant liver lesions using normalized  $G'$  and  $|G^*|$ , with results consistent with prior findings from extrinsic MRE studies, while the normalized  $G''$  did not show a meaningful trend for different lesion types.

##### CLINICAL RELEVANCE/APPLICATION

This study found that NLI-iMRE accurately distinguishes between benign and malignant liver lesions using viscoelastic properties, with normalized  $G'$  and  $|G^*|$  values showing significant differences between lesion types. This non-invasive method, based on standard clinical imaging sequences, has the potential for clinical use without the need for external actuation.

#### W2-SPGI-2 Multimodal Imaging Evaluation of Hepatic Alveolar Echinococcosis in Children

Hai Hua Bao (*Presenter*) Nothing to Disclose

##### PURPOSE

Hepatic alveolar echinococcosis (HAE) has an aggressiveness similar to that of malignant tumors. Children have a rich blood supply to the liver, and the lesions grow rapidly after infection, which makes the disease serious and difficult to treat. The



purpose of this study is to investigate the growth characteristics of HAE in children through various imaging techniques.

## **METHODS AND MATERIALS**

Fifty pediatric patients (age range 1-14 years, mean age  $11.24 \pm 2.82$  years) diagnosed with HAE at the Affiliated Hospital of Qinghai University from 2014 to 2020 were included for imaging (low-dose abdominal CT plain + enhancement, abdominal T1WI, T2WI, MR enhancement, DWI) and clinical examination, we obtained morphological features of the lesions based on images, imaging staging and PNM staging, intrahepatic vascular and bile duct invasion, marginal zone continuity and ADC values, and assessed the liver function and systemic nutritional status of the children based on clinical test results such as glutamate transaminase (ALT) and hemoglobin (Hb), and comprehensively evaluated the growth characteristics of HAE lesions in children.

## **RESULTS**

All children underwent CT plain scan(1), of which 41 had CT-enhanced scans(2), and a total of 27 had MR scans(3-8). Both the right and left lobes of the liver were invaded in 48% of the cases, the left lobe only in 14%, and the right lobe only in 38%. 96% of cases had calcification formation; 52% of cases had vascular and bile duct involvement (Table 1); P1 stage lesions accounted for the most PNM staging and parenchymal type accounted for the most imaging staging; P1 stage lesions had higher marginal zone activity than P2+P3 stage (There was no statistically significant difference in ADC values between P2 and P3 phases, so the joint comparison with P1 phase; P4 phase had a small sample size, so no statistics were done). Large lesions, parenchymal lesions, and P2 stage lesions have a greater impact on liver function in pediatric patients; parenchymal lesions have a greater impact on the nutritional status of the children.

## **CONCLUSION**

CT images can clearly show the calcification within the lesion, MR images can clearly show the invasion of hepatic vessels and bile ducts by the lesion, DWI and ADC values can determine the activity of the marginal zone of the lesion, and the characteristics of HAE lesions can be effectively evaluated by using multimodal imaging techniques.

## **CLINICAL RELEVANCE/APPLICATION**

HAE infection is asymptomatic in the early stage, and most of them are in the advanced stage when there are obvious symptoms, and children are poorly tolerated and difficult to treat surgically, early diagnosis and knowledge of its growth characteristics are crucial for clinicians to choose the appropriate treatment plan and thus reduce the mortality rate.

## **W2-SPGI-3 Amide Proton Transfer-Weighted MRI in Preoperative Assessment of Microvascular Invasion of Hepatocellular Carcinoma**

Xianfu Luo (*Presenter*) Nothing to Disclose

## **PURPOSE**

The purpose of this study was to explore the potential of APTw imaging in predicting microvascular invasion (MVI) of hepatocellular carcinoma.

## **METHODS AND MATERIALS**

32 patients with surgical pathologic confirmed hepatocellular carcinoma were studied. All patients underwent liver MR scanning on a 3.0-tesla scanner. Images at 52 frequencies were acquired for APTw, including 49 frequencies ranging from -600 to 600 Hz with an increment of 25 Hz. The applied saturation B1 power was  $2\mu\text{T}$  and the saturation duration was 2000ms. Three identical ROIs were placed in the solid component of tumor for each patient on unsaturated M0 images and were copied on MTRasym mapping. Large cystic cavities, large areas of necrosis were excluded from ROI selections. Averaged MTRasym values used for further analysis. The inter-class correction coefficient (ICC) was used to evaluate the inter-observer agreement of measuring APTw value between two radiologists. The comparisons between APTw value for MVI- and MVI+ groups were analyzed using the independent t test. Receiver operating characteristic (ROC) curves were generated for each APTw parameter value to assess the areas under the curve (AUC).

## **RESULTS**

MVI was pathologically confirmed from tumor resection including 13 cases with MVI (MVI+) and 15 without MVI (MVI-). The ICC of two observers' measurements of APTw was 0.912. The APTw value of MVI+ group was significantly higher than that of MVI- group [  $(1.33 \pm 0.76) \%$  vs  $(0.32 \pm 1.06) \%$ ;  $P=0.008$ ]. The cut-off APTw value for differentiating MVI+ and MVI- groups was 0.30% (sensitivity, 60%; specificity, 100%; AUC, 0.782, 95%CI: 0.609, 0.955)

## **CONCLUSION**

APTw imaging showed promising ability in differentiating MVI+ and MVI- hepatocellular carcinoma.

## **CLINICAL RELEVANCE/APPLICATION**

APTw could serve as a robust technique to predicting MVI of hepatocellular carcinoma without the use of contrast agents and providing additional auxiliary value for the selection of clinical treatment methods of hepatocellular carcinoma patients.

## **W2-SPGI-4 Free Breathing Acquisition using Radial Sampling and Compressed Sensing Improves Success Rate and Image Quality of Gadoxetic Acid Enhancing Liver MRI in Elderly Patients**

Masaya Kutsuna (*Presenter*) Nothing to Disclose

### **PURPOSE**

To compare successful rate of examination and clinical image quality of liver dynamic MR images using gadoxetic acid in elderly patients between free breathing acquisition using radial sampling and compressed sensing and conventional breath-hold acquisition.

### **METHODS AND MATERIALS**

This retrospective single-center study included 100 patients older than 60 years who underwent liver MR examination using gadoxetic acid using free breathing acquisition (FB group, n = 50) or conventional breath-hold acquisition (BH group, n = 50). All included examinations were performed on a 3.0-T MR scanner (Ingenia Elition, Philips). The representative parameters of FB group were as follows: pseudo-golden angle free breathing sequence using compressed sensing with soft-gating (SmartSpeed 4D-FreeBreathing); temporal resolution, 10 sec/phase; C-SENSE factor, 4. The parameters for BH group were as follows: spoiled gradient echo with compressed sensing (eTHRIVE); scan time, 14.9 sec; C-SENSE factor, 6. As qualitative analysis, all images of arterial (AP), portal venous (PVP), and transitional phase (TP) were evaluated by 2 independent radiologists using a 5-point scale (1 - 5, 5 is excellent quality) in terms of motion artifact, streak artifact, sharpness of liver edge, and overall quality. The cases with an overall quality score of 3 or above were regarded as diagnosable and successful examinations. As qualitative analysis, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were evaluated by board-certified another radiologist placing region-of-interest to each 5 segments of liver. P value less than 0.05 was regarded as statistically significant.

### **RESULTS**

The success rate was 100% (50/50) for the three phases in FB group, while in BH group, 82% (41/50, p = 0.005) for AP, 98% (49/50, p = 1.0) for PVP, and 100% (50/50, p = 1.0) for TP (Figure A). In the qualitative analysis, BH group showed better score in motion artifact and sharpness of liver edge in the three phases (p < 0.005, Figure B). There was no significant difference of overall quality in AP (p = 0.09). The SNR and CNR of BH group showed higher in PVP and TP. In the AP, the SNR and CNR of FB group tended to be higher but not significant (p = 0.19-0.76). Two representative cases were shown in Figure C.

### **CONCLUSION**

Free breathing acquisition using radial sampling and compressed sensing improved success rate and clinical image quality of gadoxetic acid enhancing liver MRI in elderly patients compared with conventional breath-hold acquisition.

### **CLINICAL RELEVANCE/APPLICATION**

Free breathing acquisition improves quality of liver MR examination using gadoxetic acid in elderly patients and has potential to improve diagnostic performance of hypervascular hepatic lesions.

## **W2-SPGI-6 Diagnostic Accuracy of Liver MR Elastography for Assessment of Liver Fibrosis in Children with AIH and Post LTx**

Paulina Chodnicka (*Presenter*) Nothing to Disclose

### **PURPOSE**

To evaluate the diagnostic accuracy of MRE in liver fibrosis staging using liver biopsy as the reference standard in pediatric patients with AIH and post LTx.

### **METHODS AND MATERIALS**

Overall, 48 patients with AIH and 25 patients post-LTx were included in the study. The median age of patients with AIH was 14.54 (range 2,82-17.98), the group included 22 boys and 26 girls. The median age of patients post-LTx was 14.16 (range 7.89-17.94), the group included 11 boys and 14 girls. All patients underwent MR elastography and liver biopsy. The liver stiffness value on MRE was independently measured by two radiologists. The weighted arithmetic mean was calculated from elastograms obtained at 4 levels of the liver in the axial plane. Biopsy samples were separately evaluated by two pathologists to stage liver fibrosis according to the Ischak fibrosis scale. Statistical analysis was performed, ROC curves were plotted with the optimal cut-off values and corresponding AUCs were calculated to evaluate sensitivity and specificity, inter-rater agreement was determined.

### **RESULTS**

In patients with AIH MRE detected fibrosis stage 4 or higher with a sensitivity of 100% and specificity of 70,6% for cut-off value >2,92, AUC 0,88, p<0.05, and fibrosis stage 5 or higher with a sensitivity of 83% and specificity 89% for cut-off value >3,65, AUC 0,90, p<0.05. In patients post-LTx MRE detected fibrosis stage 4 or higher with a sensitivity of 100% and



specificity of 90,5% for cut-off value >3,06, AUC 0,95,  $p < 0.05$  and fibrosis stage 5 or higher with sensitivity 100% and specificity 83% for cut-off value >3,06, AUC 0,91,  $p < 0.05$ . The weighted Kappa value calculated for inter-observer agreement between radiologists was 0,90.

#### **CONCLUSION**

MRE is a non-invasive technique that has high sensitivity and specificity in detecting advanced stages of liver fibrosis with a very good intraobserver strength of agreement.

#### **CLINICAL RELEVANCE/APPLICATION**

It may be possible to reduce the number of liver biopsies in patients with elevated liver stiffness identified with MRE.

### **W2-SPGI-7 The Role of Four-dimensional Flow MR Imaging as an Add-on Tool to Endoscopy for Predicting Actual Bleeding in Cirrhotic Patients with Esophageal Varices**

Eunju Kim (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate whether four-dimensional (4D) flow MRI with quantitative hemodynamic parameters could be used as an add-on tool to endoscopy for predicting actual bleeding in cirrhotic patients with esophageal varices.

#### **METHODS AND MATERIALS**

All the cirrhotic patients who were attributable to hepatitis B and/or C virus underwent 4D flow MRI using a 3-T scanner (Skyra; Siemens Healthcare, Erlangen, Germany). The velocity-encoding sensitivity for x, y, and z flow-encoding directions was set to 30 cm/s, 20 cm/s, and 20 cm/s, respectively. A total of 109 cirrhotic patients with endoscopically confirmed esophageal varices were divided into groups A (negative red color (RC) sign with no variceal bleeding,  $n = 60$ , 35 - 81 years), group B (negative RC sign with variceal bleeding,  $n = 13$ , 41 - 80 years), group C (positive RC sign with no variceal bleeding,  $n = 10$ , 49 - 81 years), and group D (positive RC sign with variceal bleeding,  $n = 26$ , 48 - 81 years). The presence of variceal bleeding was defined as the occurrence of active bleeding within one year after initial diagnosis of esophageal varices based on the endoscopic and clinical findings. The quantitative parameter of 4D flow MRI included the net flow rate (mL/s), mean flow rate (mL/s), peak flow rate (mL/s), and net forward volume (mL) in each vessels. The 4D flow MR parameters were compared among the groups using Mann-Whitney U test, and the receiver operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance.

#### **RESULTS**

The values of all 4D flow MR parameters in the PV of patients with a positive RC sign were significantly lower than those of patients with a negative RC sign ( $P < 0.05$ ). The patients with variceal bleeding in group B and D showed lower values in all MR parameters in the PV than those of patients with no variceal bleeding in group A and C, respectively ( $P < 0.05$ ). However, there were no significant differences among the groups regarding the MR parameters in the SV and SMV. In the ROC analysis for evaluating the diagnostic performance of actual variceal bleeding in order to distinguish patients with variceal bleeding from patients with non-variceal bleeding, the area under the curve (AUC) values were 0.762 and 0.770 ~ 0.787 in endoscopy alone and MR alone, respectively. However, in the combination of endoscopy and 4D flow MRI, the AUC value increased significantly to 0.844 ~ 0.864 ( $P < 0.05$ ).

#### **CONCLUSION**

The 4D flow MRI can be useful as an additional tool to endoscopy in predicting actual bleeding in cirrhotic patients with esophageal varices.

#### **CLINICAL RELEVANCE/APPLICATION**

4D flow MRI could significantly contribute to improving the diagnostic accuracy of endoscopy in predicting actual bleeding in cirrhotic patients with esophageal varices.

### **W2-SPGI-8 Intensive Respiratory Instruction Reduces Transient Motion Artifact in Liver Dynamic MR Examination using Gadoteric Acid**

Satoshi Funayama, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To validate the efficacy of intensive respiratory instruction during liver MR examination using gadoteric acid, especially whether it reduces transient severe motion artifact (TSMAs).

#### **METHODS AND MATERIALS**

This retrospective study reviewed 493 patients who underwent liver dynamic MR examination using gadoteric acid before and after intensive respiratory instruction (IRI) was started on May 2022. To determine population size, power analysis was performed based on the reported frequency of TSMAs (7.2%) and breath-hold failure in case of extracellular contrast agent

(2.2%) (power = 0.7, significant level = 0.05). All examinations were performed on a 3.0-T MR scanner (SIGNA Premier, GE Healthcare). The dual arterial phase was acquired using spoiled gradient echo sequence (LAVA-FLEX) with compressed sensing (HyperSense) with scan time of 11 sec/phase. The detail of the IRI procedure was as follows. First, patients were instructed to start deep breathing before starting of acquisition for pre or contrast agent injection and continue it until breath-hold command. Technologists started the injection after confirming 4 or 5 times of patients' deep breathing through the abdominal bellows signal curve. The breath-hold command was started when contrast agent reached abdominal aorta on FluoroTrigger real time imaging and the patient was in expiratory phase. In the conventional procedure, only auto breath-hold command was played on the scanner. To evaluate respiratory motion, abdominal bellows curve was classified into 6 classes (type 1 - type 6, Figure A) on pre, arterial (AP), and portal venous phase (PVP). A board-certified radiologist evaluated motion artifact using 5-point scale (1 - 5; 5, the best) on pre, first arterial (AP1), second arterial (AP2), and PVP. The motion artifact score of 3 or less was regarded as TSMA.

## **RESULTS**

Finally, 450 patients were included (225 for conventional group [Conv group]; 225 for IRI group). The successful breath-hold was more frequent in IRI group in AP ( $p < 0.001$ ) and PVP ( $p < 0.001$ ) (Figure A). The frequency of TSMA was 6.7% (Conv group) and 1.3% (IRI group,  $p = 0.007$ ) for AP1; 7.1% (Conv group) and 1.8% (IRI group,  $p = 0.01$ ) for AP2. The motion artifact score was significantly higher (better image quality) in IRI group on AP1 ( $p < 0.001$ ) and AP2 ( $p < 0.001$ ). The score was not significantly different on pre ( $p = 1.0$ ) and PVP ( $p = 0.341$ ) (Figure B).

## **CONCLUSION**

Intensive respiratory instruction improved success rate of breath-hold and significantly reduced transient severe motion artifact.

## **CLINICAL RELEVANCE/APPLICATION**

Intensive respiratory instruction improves quality of arterial phase in liver dynamic MR examination using gadoxetic acid and has potential to improve diagnostic performance of hypervascular hepatic lesions.

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## Abstract Archives of the RSNA, 2023

W2-SPGU

### Genitourinary Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPGU-1 Impact of Image Quality on Detection of Extraprostatic Extension on MRI: Evaluation with a Deep Learning-based AI Algorithm**

Yue Lin, BA (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess impact of image quality on extraprostatic extension (EPE) detection on MRI using a deep learning-based AI algorithm.

#### **METHODS AND MATERIALS**

This retrospective study included consecutive patients who were imaged with mpMRI and subsequently underwent radical prostatectomy (RP) from January 2007 to August 2022. One genitourinary radiologist prospectively evaluated each case using a previously published and validated grading system to assess the presence of EPE on mpMRI. EPE grade of 0 = no suspicion of EPE, 1 = long curvilinear contact or capsular irregularity/bulge, 2 = both long curvilinear contact and capsular irregularity/bulge, 3 = frank EPE. An EPE grading score =1 was considered as positive EPE call on mpMRI. Histopathologic EPE evaluation was performed at RP according to the International Society of Urological Pathology (ISUP) consensus statement. For each patient, T2WI and ADC maps were individually classified as non-diagnostic vs. diagnostic by an in-house AI algorithm. Fisher's exact tests were performed to compare EPE detection metrics (i.e., specificity) between non-diagnostic and diagnostic images.

#### **RESULTS**

A total of 812 patients (median age 62 [interquartile range 57-67] years; median prostate specific antigen level 6.7 [4.6-10.3] ng/mL) were evaluated. The median time from mpMRI to RP was 3 (1-5) months. At radical prostatectomy, 23% (188/812) of patients had EPE at pathology and 41% (133/324) of positive EPE calls on mpMRI were found to have EPE. For T2WI quality analysis, 35% (284/812) of sequences were classified as non-diagnostic and 65% (528/812) were categorized as diagnostic by the AI algorithm. For ADC maps, 32% (260/812) were classified as non-diagnostic and 68% (552/812) as diagnostic. Compared to non-diagnostic T2WI, diagnostic scans were associated with lower MRI/pathology mismatch for prediction of EPE (34% [97/284] vs. 28% [149/528],  $P=0.093$ ) and lower false positive rate (28% [80/284] vs. 21% [111/528],  $P=0.024$ ). Diagnostic T2WI also had significantly higher specificity for detection of EPE at mpMRI than non-diagnostic images (73% [294/405] vs. 63% [139/219],  $P=0.023$ ). No significant difference in EPE evaluation were observed between diagnostic and non-diagnostic ADC maps.

#### **CONCLUSION**

Our study successfully employed a deep learning-based AI algorithm to classify image quality of prostate MRI and demonstrated that preoperative T2WI quality is crucial for accurate EPE evaluation. Better quality T2WI was associated with higher specificity and fewer false positive calls for prediction of EPE at final pathology.

#### **CLINICAL RELEVANCE/APPLICATION**

Preoperative T2WI quality is critical for ruling out EPE at pathology using MRI, and AI can be used to objectively assess the quality of prostate MRI scans.

#### **W2-SPGU-2 Histopathological Validation of Prostate Cancer Characterization with Magnetic Resonance Fingerprinting and Apparent Diffusion Coefficient Mapping**

Barbara D. Wichtmann, MD, MSc (*Presenter*) Speaker, Koninklijke Philips NV

## **PURPOSE**

To evaluate the utility of magnetic resonance fingerprinting (MRF) and apparent diffusion coefficient (ADC) mapping for characterizing prostate lesions with histopathological validation.

## **METHODS AND MATERIALS**

This institutional review board-approved retrospective study included prospectively collected data of 91 biopsy-naive men with elevated PSA-levels suspected of having prostate cancer (PCa; 65.7 +/- 7.8 years). All patients underwent a multiparametric MRI examination at a 3T Philips Ingenia scanner (Philips Healthcare, Best, the Netherlands) and were classified by trained radiologists following the PI-RADS 2.1 scoring system. T1 and T2 mapping was performed using 2D fast imaging with steady-state precession-based MRF with spiral readout. ADC maps were calculated based on b-values = 100, 400, 800 s/mm<sup>2</sup>. Zonal segmentation of the prostate was performed using a convolutional neural network with subsequent revision by a trained radiologist. Lesions were manually segmented and correlated with histopathology after targeted biopsy/prostatectomy. Systematic differences of T1-/T2-relaxation times and ADC values between different histopathological ISUP scores were assessed using one-way analysis of variance with Tukey type post hoc comparisons to adjust for multiple testing.

## **RESULTS**

32 patients were classified as PI-RADS 2, 21 as PI-RADS 3, 21 as PI-RADS 4 and 17 as PI-RADS 5. In total 89 lesions were segmented, 72 in the peripheral zone (PZ), 17 in the central gland. In 3 patients clinically insignificant PCa was found in histology that had previously not been described on imaging. 4 patients did not undergo biopsy/surgery. Mean ADC values decreased significantly with increasing ISUP scores (e.g. mean ADC in PZ  $1.5 \times 10^{-3} \text{ mm}^2/\text{s}$  vs. mean ADC in ISUP 3 lesion  $1.0 \times 10^{-3} \text{ mm}^2/\text{s}$ ;  $p < 0.0001$ ). Mean T1-/T2-relaxation times decreased significantly particularly with higher ISUP scores, i.e.  $\geq 3$  (e.g. mean T1-/T2-relaxation time in PZ 1759.1/50.5 ms vs. mean T1-/T2-relaxation time in ISUP 3 lesion 1541.5/30.9 ms;  $p < 0.0001$  /  $p = 0.0012$ ).

## **CONCLUSION**

ADC and MRF based relaxometry allow quantitative characterization of prostate lesions that correlate with histopathology. MRF based relaxation times might aid in the diagnosis of clinically significant PCa. Further validation studies are needed.

## **CLINICAL RELEVANCE/APPLICATION**

There is growing interest in the clinical application of quantitative imaging techniques for more objective assessment of prostate lesions. MRF is a fast and efficient method that promises to differentiate low- and intermediate/high-grade PCa in the future. In particular, with regard to the application of artificial intelligence and deep learning this could be an interesting approach in addition to traditional ADC assessment.

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## Abstract Archives of the RSNA, 2023

W2-SPHN

### Head & Neck Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPHN-1 Evaluating the Application of Multiplexed Sensitivity Encoding (MUSE) Diffusion Weighted Imaging (DWI) in Nasopharyngeal Tumors: Comparison with Single-shot DWI with and without Deep Learning Reconstruction**

Akinori Hata, MD, PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To investigate the image quality of multiplexed sensitivity encoding (MUSE) diffusion weighted imaging (DWI) for the evaluation of nasopharyngeal tumors comparing with single-shot DWI with and without deep learning reconstruction (ssDWI-DL and ssDWI).

##### **METHODS AND MATERIALS**

This study retrospectively evaluated patients with nasopharyngeal tumors who underwent MRI from July 2022 to February 2023. All patients underwent ssDWI, ssDWI-DL, MUSE, and fat-suppressed T2-weighted imaging. Two radiologists evaluated the image quality on a 5-point scale (1= no-diagnostic quality, 2=substantial deficits in image quality, 3=moderate, 4=good, and 5=excellent) in terms of the distortion of the original tumor, lymph node morphology, and overall image quality. Apparent diffusion coefficient (ADC) values were calculated in the original tumor and the lymph node. The image quality scores and ADC values were compared among ssDWI, ssDWI-DL, and MUSE using the Wilcoxon signed rank test and paired t-test, respectively. Bonferroni correction was used for the multiple comparisons.

##### **RESULTS**

A total of 23 patients (age  $70 \pm 17$  years; 5 women) were included in this study. In terms of the original tumor, MUSE showed a significantly higher score than ssDWI and ssDWI-DL (ssDWI,  $2.89 \pm 0.88$ ; ssDWI-DL,  $2.85 \pm 0.90$ ; and MUSE,  $3.78 \pm 0.75$ ). MUSE, ssDWI-DL, and ssDWI showed significantly higher scores in that order for the lymph node and overall image quality (lymph node; ssDWI,  $2.14 \pm 0.54$ ; ssDWI-DL,  $3.06 \pm 1.12$ ; MUSE,  $3.36 \pm 0.78$ ; overall image quality; ssDWI,  $1.80 \pm 0.29$ ; ssDWI-DL,  $2.74 \pm 0.64$ ; MUSE,  $3.26 \pm 0.56$ ). There was no significant difference among ssDWI, ssDWI-DL, and MUSE (ssDWI,  $1.03 \pm 0.35$ ; ssDWI-DL,  $1.00 \pm 0.31$ ; MUSE,  $0.98 \pm 0.30$ ).

##### **CONCLUSION**

MUSE was advantageous in evaluation of nasopharyngeal tumors by decreasing the image distortion compared with ssDWI and ssDWI-DL.

##### **CLINICAL RELEVANCE/APPLICATION**

MUSE may be useful for imaging of nasopharyngeal tumors or lesions that are in contact with air and where distortion affects image quality.

#### **W2-SPHN-3 Application of Dual-energy CT Spectral Quantification in Diagnosing of Cervical Lymph Node Metastasis in Papillary Thyroid Carcinoma**

Qiyang Tang (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the value of spectral quantitative measurements on dual-energy CT (DECT) for preoperative diagnosis of metastasis to the cervical lymph nodes (LNs) in patients with papillary thyroid carcinoma (PTC).

## METHODS AND MATERIALS

Twenty-two consecutive patients with thyroid nodules who underwent spectral imaging on dual-energy CT before surgery were collected. Virtual monochromatic images at energy of 70 keV, water-calcium and fat-hydroxyapatite (HAP) decomposition images were reconstructed. For each lymph node, DECT-derived water and fat concentration were measured. Student's t test was used for continuous variables. Receiver operating characteristic (ROC) analysis was performed to evaluate the diagnostic efficacy of the continuous variables. The area under the curve (AUC), optimal cut-off value and the corresponding sensitivity and specificity were calculated.

## RESULTS

A total of 18 LNs (8 metastatic, 10 non-metastatic) from 15 patients (9 patients with PTC, 6 patients with benign thyroid nodules) were detected by spectral CT imaging with the reference of postoperative pathologic examination. Assessment of quantitative measurements revealed significant differences between metastatic and non-metastatic LNs in water concentration ( $1032.91 \pm 10.65$  mg/cm<sup>3</sup> vs  $1042.11 \pm 6.20$  mg/cm<sup>3</sup>;  $t=2.296$ ,  $P=0.036$ ) and fat concentration ( $986.85 \pm 8.02$  mg/cm<sup>3</sup> vs  $997.12 \pm 7.94$  mg/cm<sup>3</sup>;  $t=2.714$ ,  $P=0.015$ ), respectively. The AUCs of water and fat concentration for diagnosing lymph node metastasis were 0.750 and 0.838, respectively. The optimal cut-off values of water and fat concentration were 1031.48 mg/cm<sup>3</sup> (sensitivity, 62.5%; specificity, 100.0%) and 990.67 mg/cm<sup>3</sup> (sensitivity, 75.0%; specificity, 90.0%).

## CONCLUSION

Quantitative assessment with dual-energy spectral CT showed promising value for preoperative diagnosis of metastatic cervical lymph nodes in patients with PTC.

## CLINICAL RELEVANCE/APPLICATION

Preoperative assessment of LN metastasis in PTC by CT spectral imaging is of great clinical value to locate metastatic LNs accurately and reduce unnecessary lateral neck dissections.

## W2-SPHN-4 Amide Proton Transfer Imaging of Differentiation in Malignant and Benign Parotid Tumors

Yihua Wang (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the usefulness of amide proton transfer weighted imaging (APT<sub>w</sub>) in the differentiation of parotid gland tumors

## METHODS AND MATERIALS

Patients with parotid gland tumors who underwent APT<sub>w</sub> were retrospectively enrolled and divided into groups according to pathology. Two radiologists evaluated the APT<sub>w</sub> image quality independently with quality score=2 were enrolled. The maximum and average value of APT (APT<sub>max</sub> and APT<sub>mean</sub>) were measured (Figure 2). The APT<sub>max</sub> and APT<sub>mean</sub> were compared in differentiating between malignant and benign tumors (BTs), and in characterizing pleomorphic adenomas (PAs), Warthin tumors (WTs) and malignant tumors (MTs). Independent sample t test, Kruskal-Wallis H test and Receiver-operating-characteristic (ROC) analysis were used for statistical analysis.

## RESULTS

Seventy three patients were included for image quality evaluation (Figure 1). 32/73 parotid tumors and 29/73 were considering for score 4 and 3 respectively. After excluding lesions with quality score <2, the APT<sub>mean</sub> and APT<sub>max</sub> of MTs were ( $4.15 \pm 1.33$ )% and ( $7.43 \pm 1.61$ )%, higher than BTs ( $2.74 \pm 1.04$ )% and ( $5.25 \pm 1.54$ )% respectively ( $p < 0.05$ ). The area under the corresponding curve (AUC) of APT<sub>mean</sub>, and APT<sub>max</sub> was 0.819 and 0.821 respectively. MTs indicated significantly higher APT<sub>mean</sub> and APT<sub>max</sub> than PAs ( $p < 0.05$ ) and WT ( $p < 0.05$ ). (Table 3-6)

## CONCLUSION

Both APT<sub>max</sub> and APT<sub>mean</sub> can differentiate BTs and MTs, However, the images of parotid glands still needs to be improved to reduce artifacts. Most APT<sub>w</sub> images in parotid tumors had acceptable image quality to APT<sub>w</sub> value evaluation.

## CLINICAL RELEVANCE/APPLICATION

APT imaging is an usefulness method that can be performed without contrast enhancement for the differentiation of parotid tumors.

## W2-SPHN-5 Differentiation of Common Benign Parotid Gland Tumors by T2WI-Based Texture Analysis and Susceptibility-Weighted Imaging

Yihua Wang (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the role of T2WI-based texture analysis and its combination with susceptibility-weighted Imaging (SWI) in characterizing pleomorphic adenoma (PA) and Warthin's tumor (WT).

## METHODS AND MATERIALS

Thirty-seven patients (21 PA and 16 WT) who underwent T2WI and SWI at 3.0T (Ingenia CX, Philips Healthcare, the Netherlands) were retrospectively enrolled (Table 1). Two radiologists assessed MRI sequences retrospectively. Fat-suppressed T2-weighted image was used for texture analysis (TA) on the software 3D-Slicer and Intratumoral susceptibility signal intensities (ITSS) were measured in minimum intensity projection (SWI-MinP) according to the previous study. The ROI for TA was drawn to cover the lesion as completely as possible on each slice excluding necrotic and blood vessels (Figure 1). Histogram parameters including mean, median, entropy, skewness, kurtosis, maximum, minimum and 10th, 90th percentiles were calculated. The interobserver reliability was assessed via intraclass correlation coefficient (ICC) (good agreement if ICC > 0.75). The mean values from the two observers were used for the subsequent analysis. The independent sample t-test or Mann-Whitney U test was used to compare the differences in histogram parameters and ITSS between PA and WT. The diagnostic value was determined on receiver operating characteristic (ROC) analysis. Logistic regression was used to calculate the AUC of TA parameters combined with ITSS.

## RESULTS

Interobserver reliability between the two observers was good (Table 2~3). WT showed significantly lower values on mean, entropy and significantly higher values on skewness and kurtosis than PA ( $p < 0.05$ ). The differences in ITSS grades were statistically significant between PA and WT ( $p < 0.05$ ) (Table 2~3). The area under the corresponding curve (AUC) of mean, entropy, skewness, kurtosis and ITSS were 0.779, 0.726, 0.754, 0.687 and 0.718 respectively. The combined AUC of entropy and ITSS could improve diagnostic performance which was statistically different from ITSS ( $p = 0.04$ ) (Table 4~5, Figure 2).

## CONCLUSION

Mean, entropy, skewness, kurtosis and ITSS allowed the identification of PA and WT. The combination of four significant histogram parameters and ITSS may suggest the improvement in diagnostic performance.

## CLINICAL RELEVANCE/APPLICATION

PA and WT are the most common benign tumors in the parotid gland. PA can recur and had a tendency to be malignant. WT rarely has malignant transformation and only needs to be treated tumor resection.

## W2-SPHN-6 MR Imaging with 15-channel Dental Coil Compared with Standard 20-channel Coil in Patients with Head and Neck Tumors and Suspected Bone Invasion

Simon S. Martin, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the diagnostic accuracy of a high-resolution 15-channel dental coil with that of a standard 20-channel head and neck coil in MRI diagnosis of head and neck tumors with suspected bone invasion.

## METHODS AND MATERIALS

A total of 37 patients (20 men and 17 women; mean age,  $65.8 \pm 15.0$  years; range: 28-95 years) with head and neck tumors and clinical suspicion of bone invasion underwent staging MRI with both coils in the same examination before surgery. Two specialized radiologists with 4 and 10 years of experience retrospectively evaluated both image datasets for bone infiltration. Additionally, subjective image quality, metal artefacts, and delineation of the tumors were rated on a 5-point-rating-scale. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) of tumor lesions were calculated to quantitatively measure image quality. Sensitivity and specificity of the different coils in detecting bone invasion were evaluated by comparing the imaging results with postoperative histopathologic findings. Interobserver agreement was calculated using the Cohens Kappa.

## RESULTS

SNR and CNR values of tumor lesions were significantly higher with the 15-channel dental coil compared to the standard 20-channel head and neck coil (SNR averaged 12.1 versus 9.9, CNR 3.6 versus 1.5). The 15-channel dental coil was found to be more sensitive than standard head and neck coils (100% vs. 72%) and was more specific (98% vs. 88%) in detecting tumor bone invasion. Of 21 histopathologically confirmed tumors with bone invasion, 16 were detected using the standard 20-channel head and neck coil and 21 were detected using the 15-channel dental coil. The 15-channel dental coil was superior in terms of image quality, metal artifacts, lesion delineation, and assessment of jaw infiltration. A high degree of interinvestigator agreement was noted for overall image quality ( $\kappa = 0.93$ ), artifact reduction ( $\kappa = 0.82$ ), lesion delineation ( $\kappa = 0.80$ ), and assessment of jaw infiltration ( $\kappa = 0.89$ ).



## CONCLUSION

MR imaging with 15-channel dental coils has significantly better image quality and accuracy in detecting head and neck cancer compared with 20-channel head and neck coils.

## CLINICAL RELEVANCE/APPLICATION

The use of a 15-channel dental coil improves diagnostic accuracy in the detection and characterization of head and neck cancer especially with bone infiltration and contributes to more accurate cancer treatment.

## W2-SPHN-7 The Imaging Quality Assessment of Synthetic MRI in Nasopharyngeal Carcinoma: A Preliminary Study

Fan Yang (*Presenter*) Nothing to Disclose

## PURPOSE

To compare the imaging quality between the conventional and synthetic T1WI and T2WI.

## METHODS AND MATERIALS

Fifty-nine patients with nasopharyngoscope-confirmed nasopharyngeal carcinoma (NPC) were prospectively included between August 2018 and May 2019. The image quality was evaluated by two radiologists (1 and 2, with 21 and 2 years of tumor-imaging experience, respectively). The patient order was randomized, as was the review order of the conventional or synthetic T1WI and T2WI images. The image quality was assessed based on following 4 factors on a 5-point Likert scale. (1) Sharpness of the lesion edge (1 = not sharp; 2 = a little sharp; 3 = moderately sharp; 4 = well sharp; 5 = very sharp); (2) Lesion conspicuity (1 = difficult to find; 2 = minimally perceivable; 3 = recognizable; 4 = easy to detect, good contrast of lesion; 5 = excellent contrast of lesion); (3) Motion artifacts (1 = severe, difficult to diagnose; 2 = a little severe, accessible to diagnose; 3 = moderate; 4 = mild; 5 = absence of artifacts); (4) Overall image quality (the three factors above added together, 1 = unacceptable; 2 = poor; 3 = moderate; 4 = good; 5 = excellent). As for overall image quality, ratings of = 3 were considered acceptable overall. The Wilcoxon signed-rank test was adopted to compare the image quality scores between conventional and synthetic T1WI and T2WI. The inter-class agreement of image scores between two radiologists was evaluated by Kappa value (0.21-0.30, fair; 0.41-0.60, moderate; 0.61-0.80, good; 0.81-1.00, excellent).

## RESULTS

The interobserver agreements of image quality scores for conventional and synthetic T1WI and T2WI were good or excellent (Kappa values = 0.637-0.919). There were no statistically significant differences between conventional and synthetic T2WI in sharpness of the lesion edge, lesion conspicuity, motion artifacts, and overall image quality ( $P = 0.074-0.835$ , Table). However, conventional T1WI showed higher image quality than synthetic T1WI (all  $P = 0.007$ , Table). As for diagnostic quality scoring, all synthetic T1WI and T2WI images had scores = 3, which showed acceptable image quality in clinical practice.

## CONCLUSION

Synthetic T1WI and T2WI may be acceptable for clinical use in nasopharynx, and with its ability to generate other contrast images (including PDWI, FLAIR and so on) and three quantitative maps (T1, T2 and PD maps) in a single scan, SyMRI has good prospects for clinical application.

## CLINICAL RELEVANCE/APPLICATION

The application of SyMRI in clinical could shorten the scan time while maintain acceptable image quality, which can reduce workload and increase productivity.

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## Abstract Archives of the RSNA, 2023

W2-SPIN

### Imaging Informatics Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPIN-1 Reproducibility of Automated Segmentation of Abdominal Anatomical Structures on CT using the Total Segmentator**

Lorraine Abel, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the reproducibility of segmentation results of TotalSegmentator, an artificial intelligence based segmentation algorithm, on various anatomical structures across multiphasic computer tomography (CT) exams.

##### **METHODS AND MATERIALS**

We retrospectively collected 1483 multiphasic abdominal CT exams acquired at the University Hospital in Basel between 01.01.2012 and 31.12.2022, each consisting of non-contrast (NC), arterial (ART), and portal venous (PV) phase, totaling 4449 image series. Using the AI-based segmentation model TotalSegmentator (<https://github.com/wasserth/TotalSegmentator>), the volume of 34 abdominal organs and additional structures (including bone, muscles) were obtained on all 4449 series. Similarity of the segmentation across all contrast phases was evaluated for each exam with two metrics: the spatial overlap in terms of Dice Similarity Coefficient (DSC) and the difference of segmented volumes. Volume differences below 5% were considered reproducible, as they are not typically clinically relevant and lie close to human inter-rater variability. Thus, non-inferiority and non-superiority testing was performed using a 5% margin.

##### **RESULTS**

Overall, the automated segmentation demonstrated high reproducibility in terms of mean DSC regarding comparison of PV versus ART 0.887 (95% CI: 0.882, 0.891), ART versus NC 0.867 (95% CI: 0.861, 0.872) and PV versus NC 0.853 (95% CI: 0.848-0.859) for all structures. The liver showed the lowest variability among abdominal organs, with a DSC of 0.920 (95% CI: 0.917, 0.923). Reproducibility was particularly high for bones and muscles with a mean DSC of 0.922 (95% CI: 0.919, 0.926) and 0.939 (95% CI: 0.936, 0.942) respectively. Lower DSC scores were observed mainly in cases with anatomically relevant pathologies (e.g. organ bleeding) which blur the organ boundaries, and in smaller structures. The volume of 31 of the 34 structures varied less than 5% ( $p < 0.05$ ) between contrast phases: a volume difference greater than 5% was observed exclusively for the adrenal glands and the gallbladder when comparing NC to PV.

##### **CONCLUSION**

The automated segmentations produced by TotalSegmentator demonstrated high reproducibility for most of the evaluated abdominal structures when comparing different contrast phases in multiphasic abdominal CTs. Small and variable structures demonstrated lower reproducibility. Also, relevant pathologies blurring the organ boundaries hampered the segmentation performance.

##### **CLINICAL RELEVANCE/APPLICATION**

A clinically reliable automated segmentation tool (TotalSegmentator) segmenting multiple organs and structures while being aware of its disadvantages may further support radiological research and ultimately enhance the clinical impact of radiology.

#### **W2-SPIN-2 Deep Learning Assisted Curation of the CANDID-III Dataset with Free-text Reports**

Sijing Feng, MBChB, BMedSc (*Presenter*) Nothing to Disclose

##### **PURPOSE**

This project aims to curate the CANDID-III dataset, which consists of adult chest radiographs with comprehensive labels derived from both manual and AI-assisted annotation.

## METHODS AND MATERIALS

The CANDID-II dataset is an in-development chest radiograph dataset containing 33,486 anonymized free-text radiological reports. CANDID-III inherited the same 45 radiological labels from the CANDID-II dataset, which were mapped to UMLS ontology for standardization, forming the manually labelled portion of the CANDID-III dataset. An ensemble transformer-based label extraction model, combining three individual natural-language processing (NLP) algorithms, was trained and validated on the CANDID-II dataset in an 80:20 proportion. Each algorithm was individually trained on every radiological label, and the highest accuracy algorithm was chosen on a per-label basis for inclusion into the final ensemble model. The model was then used to automatically label the remaining CANDID-III dataset. An evaluation set of 552 reports, with balanced sampling across radiological findings from the AI-labeled portion of the CANDID-III dataset, was assessed by selected annotation team members, including a final-year radiology trainee and a fourth-year postgraduate medical doctor. Label-specific 'mention' F1 scores were calculated for the final ensemble model, with 'not mentioned' as negative and 'indeterminate, absent, present' as combined positive classifications.

## RESULTS

The completed CANDID-III dataset contains 322,473 images and 220,977 anonymized free-text radiological reports from 94,210 unique patients (1:1.04 M:F ratio). AI-assisted annotation was performed on 88% of the CANDID-III dataset. For the AI-assisted annotation portion of the CANDID-III dataset, the labelling model has a macro-F1 score of 0.88 and micro-F1 score of 0.94 across all findings. Seven labels are shared with CheXpert, with F1 scores ranging from 0.93 to 1.0. F1 scores for 30 CANDID-III labels are above 0.90, while 8 labels range between 0.80 and 0.90.

## CONCLUSION

The CANDID-III dataset provides a large, comprehensively labeled, and high-quality adult chest radiograph dataset with anonymized free text reports. The dataset adds numerous new clinically significant radiological annotations that are labelled to a high accuracy. It contributes to the repertoire of publicly available chest radiograph datasets for AI development. Instructions to access the dataset can be accessed at DOI: 10.17608/k6.auckland.22726004.

## CLINICAL RELEVANCE/APPLICATION

The CANDID-III dataset can be used to train and test AI algorithms for a variety of applications including triaging, lung cancer screening, image generation, and automated preliminary detection of radiographic abnormalities.

## W2-SPIN-3 Estimating the Impact of Chest Radiograph Triage using AI: A Real-life Multicenter Diagnostic Cohort Study

Louis L. Plesner, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Radiology worklist prioritization with AI can potentially reduce the turnaround time for remarkable cases. This study externally tested a chest radiograph (CXR) artificial intelligence (AI) tool for relocating remarkable CXRs to the top of the worklist and compared this model to the current standard, where CXRs are sorted due to a priority level set by the ordering physician.

## METHODS AND MATERIALS

In this retrospective external validation study, we included consecutive CXRs from the radiology departments of four hospitals in Denmark. The reference standard was based on two thoracic radiologists independently labelling all CXRs into remarkable or unremarkable CXRs. In case of disagreement, a third thoracic radiologist independently adjudicated the results. A commercially available CE-marked and partly FDA-cleared AI model was post-processed to output at probability score for CXR remarkableness. Binary clinical priority levels (urgent/routine) were extracted from the local RIS and compared to the AI tool priority (remarkable/unremarkable) output using McNemar tests, i.e., 'urgent' was juxtaposed to 'remarkable' and 'routine' to 'unremarkable'.

## RESULTS

The analysis was performed on 1990 consecutive CXRs after exclusion of 77 primarily due to insufficient lung visualization and 7 due to processing error by the AI. Of these; 1276 (64%) were remarkable and 717 (36%) unremarkable according to the reference. The AI model achieved an AUC of 0.926 [95% CI: 0.915-0.937]. At a pre-specified 90% sensitivity threshold the model predicted 1148 (57.7%) as remarkable with a sensitivity of 90% [88.2-91.5%], a negative predictive value (NPV) of 81.0% [77.8-83.9%], positive predictive value (PPV) of 87.2% [85.3-88.9%] and specificity of 76.5% [73.2-79.5%]. This binary clinical priority level had 1422 (71.5%) classified as 'urgent' giving a sensitivity of 78.5% [76.2-80.7%], NPV of 51.8% [47.6-55.9%], PPV of 70.5% [68.0-72.8%] and specificity at 41.2% [37.5-44.9%] ( $p < 0.001$  for all comparisons).

## CONCLUSION

An AI model achieved an excellent discrimination between unremarkable and remarkable CXRs in a consecutive multicenter cohort. The AI model was superior to the clinical priority levels for identifying remarkable and unremarkable CXRs.

## CLINICAL RELEVANCE/APPLICATION

This AI tool, specifically post-processed to output a probability score for remarkableness, can be used to prioritize CXR worklists, which can confer a significant benefit in terms of worklist prioritizing compared to the traditional clinical priority levels used today.

## W2-SPIN-5 Automatic Detection of Endotracheal Tube Positioning on Chest Radiograph

Nicholas J. Primiano, MD, MS (*Presenter*) Nothing to Disclose

### PURPOSE

Endotracheal tubes (ETTs) are poorly positioned in up to 25% of out of operating room intubations [1]. Misplacement of ETTs can lead to pneumothoraces and inadequate ventilation. Rapid identification of ETT positioning is essential to minimize adverse outcomes. Current deep learning (DL) methods involve classification of correct vs incorrect ETT placement or crude bounding box localization. These methods lack the ability to accurately identify both the carina and ETT tip [2]. The purpose of this study is to evaluate a DL model that automatically measures the distance between the tip of the ETT and the carina.

### METHODS AND MATERIALS

In this retrospective study, a region proposal keypoint convolutional neural network (R-CNN) was trained on a subset of the publicly available CLiP dataset consisting of 1320 frontal CXRs. The CLiP dataset contains 30083 radiographs from the NIH Clinical Center. The model identifies two keypoints corresponding to the tip of the ETT and the carina on each radiograph. Various augmentation techniques (brightness, contrast, noise, rotation) were applied to the training set. Predictive performance on a held-out test set with 5-fold cross-validation was evaluated by comparing the distance between ground truth and predicted keypoints.

### RESULTS

The model correctly identifies  $98.9 \pm 0.20\%$  (mean  $\pm$  SD) of these keypoints on a held-out test set consisting of 109 images. A correctly identified keypoint is defined as a prediction that falls within one centimeter of the corresponding ground truth keypoint. The average error in distance for each individual keypoint detection was  $0.72 \pm 0.24$  cm. This is comparable to inter-radiologist error, which has been reported as 0.7 cm [3]. The mean absolute error in ETT to carina measurement was  $0.35 \pm 0.12$  cm. For classification of correct vs incorrect placement, the model achieved an accuracy of  $93.1 \pm 0.9\%$  (precision  $95.4 \pm 2.7\%$ ; recall  $95.5 \pm 2.4\%$ ; NPV  $86.1 \pm 8.2\%$ ; specificity  $86.9 \pm 6.6\%$ ; F1  $95.4 \pm 0.6\%$ ).

### CONCLUSION

A deep learning model can correctly identify the tip of an ETT and the carina on CXR. It can accurately measure the distance between carina and ETT, thereby detecting misplaced ETTs at the time of image acquisition.

## CLINICAL RELEVANCE/APPLICATION

This method has the potential to expedite the detection of misplaced ETTs, thereby facilitating prompt interventions and improving patient outcomes. Furthermore, our findings surpass those of prior classification-only strategies, as our approach offers an estimate of the distance required to either advance or withdraw the ETT. Lastly, this versatile technique can be adapted for use in a wide range of measurement tasks on 2D imaging.[1] doi.org/10.1038/s41597-021-01066-8[2] doi.org/10.1016/j.acra.2022.04.022 [3] doi.org/10.1007/s10278-021-00495-6

## W2-SPIN-6 Opportunistic Breast Cancer Screening using Non-contrast CT Imaging

Wei Fang (*Presenter*) Nothing to Disclose

### PURPOSE

To develop a non-contrast CT based opportunistic breast cancer screening approach as an alternative to mammography for detecting breast cancer using artificial intelligence.

### METHODS AND MATERIALS

Our proposed model is a two-stage approach. In the first stage, we locate and crop out the two breasts using a breast segmentation model, which is trained using nnUNet. In the second stage, a customized multi-task U-net is employed to process the single cropped breast, producing simultaneous segmentation and classification results. The segmentation results include the breast and tumor masks, while the classification result outputs the approximate probability of breast cancer. The training dataset for the second stage includes 411 cancerous breasts and 411 healthy breasts as normal control, with confirmation through pathology reports. The external test dataset includes 386 cancerous cases from another institution and 905 normal cases from three other institutions (473/230/202). Additionally, the breast tumor masks were annotated on corresponding contrast-enhanced CT images by experienced radiation oncologists and then transferred to non-contrast CT.

## **RESULTS**

The proposed model achieved a performance comparable to the recently reported mammography-based AI breast cancer screening system. For the 5-fold cross-validation on the internal dataset, the model achieved an AUC of 0.970 (95% confidence interval (CI) 0.958-0.982), sensitivity of 0.824 (95% CI 0.783-0.866), and specificity of 0.982 (95% CI 0.966-0.994), which were superior to the mammography-based AI system. In addition, the proposed model demonstrated advantages in generalization ability on the external test dataset, with an AUC of 0.939 (95% CI 0.922-0.955), sensitivity of 0.762 (95% CI 0.717-0.805) and specificity of 0.961 (95% CI 0.949-0.974) compared to mammography-based AI system.

## **CONCLUSION**

The proposed non-contrast CT based opportunistic breast cancer screening approach using a two-stage model achieves a performance comparable to the recently reported mammography-based AI screening system, providing a promising way for opportunistic breast cancer screening.

## **CLINICAL RELEVANCE/APPLICATION**

The proposed approach of using non-contrast CT for breast cancer screening has the potential to overcome the limitations of mammography-based screening in developing countries where medical resources are limited. This could improve early detection and ultimately contribute to prolonged survival rates for breast cancer patients. Further studies are needed to confirm the effectiveness of this approach and to optimize its implementation in clinical settings.

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## Abstract Archives of the RSNA, 2023

W2-SPIR

### Interventional Radiology Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPIR-1 Gastrointestinal Tract Perforation after Radiofrequency Ablation for Hepatic Tumor: Incidence and Risk Factors**

Kyowon Gu, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the incidence of gastrointestinal (GI) tract perforation after radiofrequency ablation (RFA) for hepatic tumor and to assess its risk factors.

##### **METHODS AND MATERIALS**

The study included a retrospective cohort (n = 4,799) of patients with malignant tumors underwent RFAs (n = 7,206) between November 2008 and May 2020. Among them, 69 cases with thermal injury of GI tract were identified through a search of electronic medical records system. These patients were divided into presence of perforation (n = 8) or not (n = 61) based on the imaging review of following computed tomographic (CT) findings: (a) gastrointestinal wall defect and (b) pneumoperitoneum. Risk factors for GI tract perforation based on clinical, technical, and follow-up CT were identified with multivariate logistic regression analysis.

##### **RESULTS**

The incidence of thermal injury of GI tract and its perforation during observation period was 0.9% (69 of 7206) and 0.1% (8 of 7206), respectively. All perforation cases were not identified on CT immediately after RFA. The median time to its development was 7 days (range, 1-31 days). The type of adjacent GI tract and presence of diabetes mellitus were significantly different between the two groups (p < 0.05). Among the various risk factors, the type of adjacent GI tract (small bowel) was only significant factor for GI tract perforation after ablation (Odds ratio, 22.69; 95% confidence interval, 2.60-198.34; p = 0.005 [reference standard, stomach]).

##### **CONCLUSION**

GI tract perforation after RFA for hepatic tumor was rare, but it occurred late. Thus, the careful follow-up is needed when we treat the index tumor adjacent small bowels.

##### **CLINICAL RELEVANCE/APPLICATION**

GI tract perforation is a rare complication of liver RFA but can be missed on immediate post-ablation CT. Careful follow-up is recommended especially when the tumor is near small bowel and for DM patients.

#### **W2-SPIR-2 CT-guided Percutaneous Radiofrequency Ablation Therapy for Liver Malignancies Adjacent to the Heart: A Safety and Efficacy Analysis in 42 cases**

Hong-Tao Hu, MD, PhD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To explore the safety and effectiveness of CT-guided percutaneous radiofrequency ablation (RFA) in the treatment of hepatic malignancies adjacent to the heart.

##### **METHODS AND MATERIALS**

From January 2019 to December 2020, 412 patients who underwent RFA for hepatic malignancies were retrospectively analyzed, of which 42 patients had lesions less than 5 mm from the border of the heart. During the follow-up period, the complete ablation rate within 1 month and 24 months and the treatment-related complications within 30 days were recorded,

and the complete ablation rate of adjacent cardiac lesions and non-adjacent cardiac lesions was calculated. Univariate and multivariate Logistic regression analyzes were used to analyze the relevant prognostic factors affecting complete ablation.

## RESULTS

A total of 42 patients had 61 lesions. The average tumor size of 42 adjacent cardiac lesions was  $3.01 \pm 1.04$  cm, and the total diameter of intrahepatic lesions was 3.60 (2.98, 4.73) cm. During the 1-month follow-up, the complete ablation rates of lesions adjacent to the heart and non-adjacent to the heart were 85.7% (36/42) and 89.5% (17/19). The follow-up time ranged from 12 to 26 months, and 2 patients were lost to follow-up. The complete ablation rate of adjacent cardiac lesions was 82.5% (33/40), and the complete ablation rate of non-adjacent cardiac lesions was 88.2% (15/17). Univariate and multivariate Logistic regression analysis showed that liver metastases and not receiving preoperative TACE were independent risk factors affecting the rate of complete ablation ( $P < 0.05$ ). No serious complications related to RFA occurred during the treatment, and the overall safety was controllable.

## CONCLUSION

CT-guided radiofrequency ablation of tumors adjacent to the heart is safe and effective.

## CLINICAL RELEVANCE/APPLICATION

It provides a new safe and effective method for liver tumors near the heart

## W2-SPIR-3 Artificial Intelligence for Rapid Prediction of Tumor Coverage after RF Ablation of Hepatocellular Carcinoma

Nicole Varble, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the technical success of radiofrequency ablation (RFA) in patients with hepatocellular carcinoma (HCC), we developed an artificial intelligence (AI) model to promptly estimate the percent tumor coverage without the need for segmentation or registration tools.

## METHODS AND MATERIALS

From 550 patients in the OPTIMA trial (patients with solitary HCC lesions between 3-7 cm, randomized to RFA or RFA+LTLD), 185 patients were selected with well-defined pre-RFA tumor and devascularized (ablation) zones on enhanced CT, 1-month post-RFA. The isocenter of the tumor and of the ablation zones were identified and 2D axial images were extracted from CT and cropped with the region of interest (tumor/ablation) at the center. Images were augmented (Gaussian-noise and rotation applied), with a total of 1,456 image pairs available for training and testing. Feature extraction was performed on the image pairs using a Siamese network with CNN VGG16 and ImageNet weights, and predictive modeling was achieved using a 30-tree random forest classification algorithm. The percent of the tumor covered (ground-truth) was determined by semi-automatic 3D tumor and ablation zone image segmentation and elastic registration (3DSlicer). Cases were split into 4 classes: =50%, 50-70%, 70-90%, or =90% tumor coverage, depicting incomplete, partially incomplete, acceptable, or complete ablation given the technical difficulty of the ablation and potentially desired immune response. Training was done on 80% of cases ( $n=1,168$  image pairs), and 20% of cases were set aside for testing ( $n=288$  image pairs). The model was validated on 16 interventional radiology cases from a separate institution, with the key difference that confirmation images were taken immediately post-ablation in the external validation set.

## RESULTS

Overall model accuracy was 90% (AUC = 0.98, true positive rate = 0.87, and true negative rate = 0.96) reliably predicting the class of percent tumor coverage. Visual review of the test cases suggests that those with poor tumor coverage might be subject to an atypically rapid ablation zone shrinkage 1-month post-RFA whereas validation cases showed a more coherent percent tumor coverage immediately post-RFA, consistent with the AI model design.

## CONCLUSION

An AI model that uses 2D images at the center of the tumor and 1-month post ablation can accurately estimate ablation tumor coverage for immediate estimation of technical RFA success.

## CLINICAL RELEVANCE/APPLICATION

Clinical tools for ablation confirmation need to be efficient to hope for adoption and treatment optimization. AI models can achieve ablation confirmation without applying resource-intensive segmentation and registration models.

## W2-SPIR-4 Percutaneous Image-guided Liver Tumor Ablations: Analysis of the Registry of the German Society for Interventional Radiology and Minimally Invasive Therapy (DeGIR) 2018-2021

Sebastian Zensen, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Percutaneous image-guided tumor ablations are an essential tool in the treatment of liver malignancies. The aim of this evaluation was to analyze the use, technical success and complications of those interventions based on data from the prospectively managed multinational registry of the German Society for Interventional Radiology and Minimally Invasive Therapy (DeGIR, Deutsche Gesellschaft für Interventionelle Radiologie und minimal-invasive Therapie).

## METHODS AND MATERIALS

A total of 5792 percutaneous liver ablation procedures from 133 centers in Germany and Austria were examined. Median age was 67 years (IQR 58-75 years), 31.4% (1821/5792) of patients were female. For image guidance, CT was used in 91.4% (5293/5792), MRI in 2.4% (137/5792), ultrasound in 3.8% (222/5792), and combined imaging in 2.4% (140/5792). Ablation of the tumor with a safety margin was considered technical success.

## RESULTS

Microwave ablation (MWA) was used in 64.3% (3725/5792), and radiofrequency ablation (RFA) in 33.5% (1940/5792). A total of 3999 cases reported tumor etiology, in which 61.4% (2456/3999) were performed for liver metastases and 36.2% (1446/3999) for hepatocellular carcinoma (HCC). The median lesion diameter was 19 mm (IQR 12-27 mm). 90.6% (5247/5792) ablations were technically successful. The rate of technically successful ablations was significantly higher in MWA (93.4%, 3481/3725) than in RFA (84.8%, 1645/1940,  $p < 0.0001$ ). The total complication rate was 2.9% (170/5792). Compared to RFA, which had a complication rate of 1.0% (19/1940), MWA had a considerably higher complication rate of 3.9% (147/3725,  $p < 0.0001$ ). In 37.2% (2156/5792) of ablations additive needle track ablation was performed. Ablations with needle track ablation did not have a significantly higher rate of major complications (23.2%, (22/95) vs. 26.7% (20/75),  $p = 0.60$ ).

## CONCLUSION

MWA is the most frequent ablation method ahead of RFA. Percutaneous image-guided liver tumor ablations have a high technical success rate, which is higher for MWA than RFA. Though generally low, the rate of complications is higher with MWA than RFA.

## CLINICAL RELEVANCE/APPLICATION

For the treatment of liver malignancies, percutaneous image-guided liver ablations such as microwave ablation and radiofrequency ablation are efficient treatment options with low complication rates.

## W2-SPIR-5 Estimation of Recurrence and Survival in Breast Cancer Cryoablation: A Retrospective Multisite Analysis of Patients Excluded from Prospective Cryoablation Clinical Trials

Grayson L. Baird, PhD, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Estimation of recurrence and survival in breast cancer cryoablation patients excluded from clinical trials.

## METHODS AND MATERIALS

Cryoablation is a well-tolerated minimally-invasive alternative to surgical excision for treating breast cancer. In keeping with clinical trial inclusion criteria, the optimal candidate would have a unifocal invasive ductal carcinoma without significant intraductal component, less than 1.5 cm in size, Nottingham grade 1-2 of 3, ER/PR+ and HER2-, at least 0.5-1 cm from the overlying skin and 0.3 cm from the underlying muscle. Requiring only local anesthesia, cryoablation may be particularly useful in patients with medical comorbidities placing them at higher risk for surgery with general anesthesia. Patients included in this study were excluded from cryoablation clinical trials. A retrospective review of ipsilateral breast tumor recurrence (IBTR) encompassing true recurrence (TR) and new primary (NP) events was done for  $n = 123$  patients treated outside of clinical trials across 7 institutions over 5.4 years; all patients were women and median age was 72 (range 37-99). To control for death before recurrence, a Competing Risk Analysis (CRA) model was used; Kaplan Meier (KM) estimation was used.

## RESULTS

All procedures were technically successful. There were a total of 6 (4.9%) minor procedure complications rated 1 on CTCAE scale. In all, there were 8 TRs, 6 NPs, and 10 deaths before TR or NP, and 11 deaths total—only 1 death was cancer related. Using CRA, the cumulative incidence of TR was 4.1% at 1 year, 8.2% at year 2, and 11.8% at year 3. The cumulative incidence of NP was 2.7% at year 1 and 7% at year 2. Together, the cumulative incidence of IBTR was 6.7% at year 1, 13.1% at year 2, and 17.9% at year 3. Finally, the cumulative incidence of death was 2.9% at year 1, 5.9% at year 2, 14.6% at year 3 and 21.7% at year 4.

## CONCLUSION

Breast cancer cryoablation is a safe and feasible alternative to surgical excision for select patients, including older patients, patients excluded from trials and patients who are considered high-risk for general anesthesia and surgery.



## CLINICAL RELEVANCE/APPLICATION

Cryoablation is an alternative to surgical excision for patients with breast cancer, even when considered suboptimal for cryoablation in select cases, and this may be particularly true for patients with medical comorbidities placing them at higher risk for surgery with general anesthesia.

## W2-SPIR-6 Retrospective Analysis of MRI-guided Transurethral Ultrasound Ablation (TULSA) in Prostate Cancer Lesions at the Extreme Apex

Joseph J. Busch, MD (*Presenter*) Nothing to Disclose

### PURPOSE

Maintenance of urinary continence when treating prostate cancer (PCa) at the extreme apex is a challenge for surgery, radiation, and focal therapy. Regulatory studies of TULSA spared 3mm at the apex, and the performance of dual ultrasound frequency MRI-controlled ablation in short target radii near the external sphincter is not yet known. This single-center retrospective analysis reports functional, imaging, and cancer surveillance outcomes in TULSA patients with extreme apical lesions.

### METHODS AND MATERIALS

Men with apical PCa lesions abutting or involving the external sphincter were identified among 138 men with  $\geq$ 6 months follow-up after lesion-targeted or whole-gland TULSA. The target volume was defined based on disease factors and patient preference, using intraoperative DWI, ADC, and T2w images. A 10mm margin was targeted around the visible lesion when feasible. At the sphincter, a 5mm margin was targeted, including  $\approx$ 50% of the external sphincter. Patients were followed with daily communication for 2 weeks, PSA every 3 months, and MRI, IPSS, IIEF at 6-9 months. Post-TULSA mpMRI was assessed for local recurrence using PI-RR.

### RESULTS

42 patients with treatment of apical lesions (37 primary PCa, 5 salvage) were identified, with median age of 63 (IQR 59-68) years, and follow-up availability of 9 (6-16) months. The proportion of men with primary GG 1-5 PCa were: 7%, 54%, 20%, 12%, and 7%, all having an MRI visible lesion. Median target volume was 29cc (IQR 22-34, range 10-70), with 99% (IQR 98-99%) of the target volume achieving a lethal thermal dose  $\approx$ 240CEM43. PSA decreased from median 6.7 (IQR 4.7-9.7) to 0.9 (0.3-2.0) ng/mL. 93% of patients with follow-up mpMRI (n=28) had no evidence of residual disease; PI-RR scores 1-5 were: 8, 18, 0, 2, 0. Both men with PI-RR=4 underwent a repeat TULSA; 6 months after repeat ablation both had PI-RR=2 with PSA of 0.2 and 1.0 ng/mL. All patients are pad-free; two experienced urine leakage resolved by 3 months. 82% maintained baseline erection firmness sufficient for penetration (IIEF Q2=2). IPSS symptom scores were stable. 10 patients experienced Grade 1-2 adverse events (LUTS, mild hematuria, bladder spasms, and hydrocele) resolving within 4 weeks with oral medication. Two patients had Grade 3 events requiring endoscopic intervention (1 retention, 1 retention and bladder neck contracture). No grade  $\geq$ 4 events and no rectal injuries occurred.

### CONCLUSION

This retrospective analysis demonstrates promising safety and efficacy of TULSA in patients with extreme apical lesions, preserving urinary continence despite ablation near the external sphincter.

## CLINICAL RELEVANCE/APPLICATION

TULSA is a promising prostate cancer treatment with minimal impact on urinary continence for thermal ablation of extreme apical lesions.

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## Abstract Archives of the RSNA, 2023

W2-SPMK

### Musculoskeletal Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPMK-1 Clinically Relevant Incidental Findings Detected on MRI Lumbar Spine Examinations: Our Experience in 1450 Studies**

Dinesh S. Baviskar, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

The purpose of our study was to evaluate the types of incidental findings encountered during evaluation of MRI lumbar spine examinations and to ascertain their clinical relevance in view of the presenting symptoms.

##### **METHODS AND MATERIALS**

A total of 1450 patients (male-to-female ratio, 626:824; age range, 12-97 years) with history of low back pain / suspected herniated intervertebral disk, who underwent MRI of the lumbar spine between 1st June 2022 - 31st December 2022 were evaluated by trained Radiologists. The examinations were evaluated for the presence of any incidental findings. We defined incidental finding as any abnormal finding detected outside the Lumbar spine, bony canal, its contents and the paraspinal soft tissues. Incidence of the incidental imaging findings were calculated. For analysis, the relationship of incidental findings with clinical data of patient was used.

##### **RESULTS**

Overall, 128 patients (8.8%) had clinically relevant incidental findings. Uterine fibroids were the commonest (3.2% of total examinations) incidental findings seen in the females, whereas heterogeneous signal in the prostatic parenchyma was the commonest (3.8% of total examinations) findings in the male patients. Other findings encountered were - Pelvic Kidney, Adenomyosis of uterine myometrium, Pelvic congestion, Ovarian cyst, Dermoid cyst, Uterine polyp, Renal mass lesion, lymphadenopathy, etc.

##### **CONCLUSION**

Clinically relevant incidental findings detected on MRI examination of the lumbar spine were common and associated with symptoms confused with lumbar spine / backache causes. Most of the findings were benign, but we encountered one renal lesion which was later proven to be Renal cell carcinoma. An awareness of the prevalence of the clinically relevant incidental findings detected at MRI of the lumbar spine exams are helpful for diagnosing lesions which might be the primary cause of the presenting symptoms.

##### **CLINICAL RELEVANCE/APPLICATION**

Awareness about incidental findings on radiology examinations is very vital, particularly in cases where the symptoms might be overlapping and the primary cause might be the incidental finding detected on imaging. The clinical significance of these incidental finding has to be ascertained to avoid delay in initiating prompt and appropriate treatment to aid patient care.

#### **W2-SPMK-2 The Diagnostic Value of Electron Density Map from Dual-layer Detector Spectral CT in Acute and Chronic Osteoporotic Vertebral Fractures**

Dongfeng Xu (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To evaluate the diagnostic efficacy of electron density map (EDM) obtained from dual-layer detector spectral CT in acute and chronic osteoporotic vertebral fractures (OVFs).

## METHODS AND MATERIALS

Retrospective study was performed on 48 patients with 53 acute and 57 chronic OVs that were confirmed by MR. All the patients underwent DLCT plain scanning, and quantitative parameters such as electron density(ED), effective atomic number( $z_{eff}$ ) and the attenuation of conventional 120 kVp polyenergetic image(PI) and 40, 70 and 100 keV virtual monoenergetic images(VMI) were measured. CT signs are evaluated by the radiologist, including endplate interruption sign, bone cortical folds, increased vertebral density, intravertebral gas shadow, anteroposterior diameter of vertebral body increased and vertebral compression degree. The quantitative parameters and CT signals between acute and chronic OVs were compared using independent- samples t test or Chi-Square test. Logistic regression analysis was used to identify the independent risk factors and built predictive model. ROC curve was used to analyze the efficacy in the differential diagnosis of acute and chronic OVs.

## RESULTS

There were significant differences between acute and chronic OVs in endplate interruption sign, bone cortical folds, increased vertebral density, intravertebral gas shadow and vertebral compression degree (all  $P < 0.05$ ). There were significant differences between acute and chronic OVs in PI, 40, 70 and 100keV VMI attenuation value,  $z_{eff}$  and ED (all  $P < 0.05$ ). Attenuation values of PI (OR=0.876,  $P=0.023$ ), ED (OR=10.446,  $P=0.024$ ), bone cortical folds (OR=0.023,  $P=0.012$ ), increased vertebral density (OR=0.020,  $P=0.012$ ) were independent risk factors for acute OVs. The combined model obtained the highest AUC (0.977) by combining attenuation values of PI, ED, bone cortical folds and increased vertebral density, with a sensitivity of 98.1%, and a specificity of 94.7%.

## CONCLUSION

In the differential diagnosis of acute and chronic OVs, the diagnostic efficacy of EDM is higher than the CT values in PI and VMI; The efficacy is further enhanced when EDM is combined with CT values in PI, bone cortical fold, vertebral density increasing.

## CLINICAL RELEVANCE/APPLICATION

EDM can help clinicians make treatment decisions and improve patient prognosis by differentiating between acute and chronic OVs.

## W2-SPMK-3 Paraspinal Muscle Activation Quantified by Intravoxel Incoherent Motion Imaging (IVIM): Influence of Exercise Intensity on Muscle Perfusion in Adolescent Athletes

Adrian A. Marth, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Intravoxel incoherent motion (IVIM) imaging provides information on the perfusion of the muscular microstructure. This study aims to reveal relationships between IVIM signal changes and different levels of exercise intensity in adolescent athletes.

## METHODS AND MATERIALS

Twenty male athletes with a mean age of 15.7 years (SD 1.2) underwent magnetic resonance imaging (MRI) of the lumbar spine muscles at rest and after ergometer training at low intensity (50 Watt,  $n = 6$ ), moderate intensity (100 Watt,  $n = 8$ ) or high intensity (150 Watt,  $n = 6$ ). IVIM images were analyzed to calculate the diffusion coefficient (D), pseudo-diffusion coefficient ( $D^*$ ) and perfusion fraction (f). Analysis of covariance was used to compare mean values at rest and different exercise intensity levels.

## RESULTS

After exercise, IVIM parameters increased with exercise intensity and were significantly elevated compared with baseline (all  $p < 0.05$ ). The increase in f and D differed significantly between low and moderate intensity ( $p = 0.02$  and  $p = 0.007$ ), but not between moderate and high intensity ( $p = 0.58$  and  $p = 0.22$ ), while the increase in  $D^*$  showed significant differences between each intensity level ( $p = 0.008$  and  $p = 0.003$ ).

## CONCLUSION

IVIM parameters detected changes in muscular perfusion after activation. Our findings demonstrate a relationship between microvascular blood flow, blood volume and exercise intensity.

## CLINICAL RELEVANCE/APPLICATION

While these results need to be further validated, they suggest that IVIM parameters can further our understanding of physiological muscle response after activation. Moreover, IVIM may have a role in identifying individuals susceptible to impaired muscle perfusion.

## W2-SPMK-4 In Vivo Comparative Study of Fast kVp Switching Dual-energy Computed Tomography Based Two-material Decomposition Technique and Quantitative Computed Tomography in the Measurement of Lumbar Bone Mineral Density

MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate the feasibility of the fast kVp switching dual-energy computed tomography (DECT) based hydroxyapatite (HAP) - water decomposition technique in measuring human lumbar bone mineral density (BMD), and to investigate its accuracy in comparison with quantitative computed tomography (QCT).

## **METHODS AND MATERIALS**

This study was approved by our institutional review board and the requirement to obtain informed consent was waived. A total of 118 consecutive patients who simultaneously underwent both DECT and QCT of the spine were retrospectively enrolled in our study. The patients were 19-88 years old, 56 males and 62 females. The density of HAP (water) was measured along with BMD in the trabecular bone of lumbar level 2-4 by DECT and QCT, respectively. The regions of interest (ROI) were drawn by a radiologist who had 5 years of experience in general radiology. A musculoskeletal radiologist with more than 10 years of experience checked every case that the general radiologist measured. Pearson correlation analysis and paired sample t test were conducted to assess the correlation and difference between DECT- and QCT-derived BMD, respectively. Bland-Altman analysis would be done to evaluate the agreement between two measurements if paired sample t test shows no significant difference between them.

## **RESULTS**

Strong linear correlation was observed between DECT- and QCT-derived BMD ( $r = 0.962$ ,  $p < 0.01$ ). DECT-derived BMD (L2,  $110.76 \pm 35.83 \text{ mg/cm}^3$ ; L3,  $103.05 \pm 36.19 \text{ mg/cm}^3$ ; L4,  $105.53 \pm 34.57 \text{ mg/cm}^3$ ; L2-4,  $106.56 \pm 35.57 \text{ mg/cm}^3$ ) was slightly lower than QCT-derived result (L2,  $124.04 \pm 49.96 \text{ mg/cm}^3$ ; L3,  $115.08 \pm 49.74 \text{ mg/cm}^3$ ; L4,  $117.21 \pm 48.79 \text{ mg/cm}^3$ ; L2-4,  $118.92 \pm 49.50 \text{ mg/cm}^3$ ) and the difference was statistically significant ( $p < 0.01$ ).

## **CONCLUSION**

Fast kVp switching DECT based HAP-water decomposition technique enables in vivo BMD quantification of human lumbar vertebrae, and its measurement is slightly lower than QCT.

## **CLINICAL RELEVANCE/APPLICATION**

Osteoporosis is the most common chronic metabolic bone disease, which is associated with low bone mineral density (BMD). As BMD is an important life-long monitoring index for osteoporosis and fractures, especially for the women and older people. Therefore, it is important to obtain accurate BMD measurement. Besides dual-energy X-ray absorptiometry (DXA) and quantitative computed tomography (QCT), dual-energy computed tomography (DECT) is considered to be another potential technique to assess BMD. It is needed to evaluate the diagnostic performance of the new method.

## **W2-SPMK-5 Fast kVp-switching Dual-energy Computed Tomography Water-(hydroxyapatite) Display of Vertebral Fractures: Impact on Diagnostic Accuracy of Radiologists with Varying Levels of Experience in Correlation to Magnetic Resonance Imaging**

Xuee Zhu, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate whether a fast kVp-switching dual-energy computed tomographic (DECT) water-hydroxyapatite (HAP) decomposition technique can improve the detection rate of acute vertebral compression fractures in patients with that at magnetic resonance imaging (MRI) depending on the level of experience of the reading radiologist.

## **METHODS AND MATERIALS**

Fifty consecutive patients who underwent both DECT and MRI of the spine within 3 days after trauma were retrospectively enrolled in our study. Four independent radiologists with varying levels of experience blindly evaluated gray-scale CT scans for the presence of fractures and their suspected age. Then, water-(HAP)images were assessed by the same readers to detect bone marrow edema. Findings were compared with those from fat-suppressed T2-weighted MR images (the standard of reference). Sensitivity, specificity, accuracy, positive predictive value and negative predictive value analyses for diagnostic performance and matched pair analyses were performed on vertebral fractures and patient levels.

## **RESULTS**

In total, fifty-four fractures were classified as fresh and 38 as old at MR imaging. The diagnostic performance of all readers in the detection of fresh fractures improved with the addition of water-(HAP)reconstructions compared with that with conventional CT alone. The diagnostic accuracy of the least experienced reader with CT alone, 76%; accuracy with water-(HAP)images, 87%. The most experienced reader improved his accuracy with water-(HAP) images from 84% to 93%, coming closer to that with MR imaging. The number of vertebrae rated as unclear decreased by 70%-92% or from 12-23 to 1-7 in absolute numbers across readers. The number of patients potentially referred to MR imaging decreased by 71%-91% (from 11-14 to 1-4 patients). Considering the real decision-making gain with the water-HAP decomposition technique on a patient level, 10 to 11 MR examinations could have been avoided.

## CONCLUSION

Fast kVp-switching DECT based water-HAP decomposition technique can improve the ability of the radiologists with variable levels of experience to detect acute vertebral compression fractures.

## CLINICAL RELEVANCE/APPLICATION

Single-energy CT of the spine is the standard examination for fast exclusion or closer assessment of suspected vertebral fractures. However, it is sometimes difficult to distinguish between acute and chronic fractures, where further MRI is usually recommended for the differential diagnosis. Compared with single-energy CT, DECT based water-hydroxyapatite decomposition technique can help the radiologists to improve the detection rate of acute vertebral compression fractures, so as to reduce the number of patients requiring further MR scanning.

## W2-SPMK-6 Comparative Analysis of Cancellous Bone Mineral Density between Vertebral Body and Pedicle Screw Trajectory using Quantitative Computed Tomography

Xuee Zhu, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To evaluate quantitative computed tomography (QCT) for analysis of cancellous bone mineral density (BMD) of vertebral body and pedicle screw trajectory and to investigate whether there's any difference between them.

### METHODS AND MATERIALS

This study was approved by our institutional review board and the requirement to obtain informed consent was waived. A total of 99 consecutive participants (20~80 years old, 48 males and 51 females) who underwent lumbar QCT examinations were retrospectively analyzed. Each pedicle screw trajectory was further divided into intrapedicular segment (R1) and intracorporeal segment (R2). BMD of R1, R2, and the vertebral body (R3) were all measured in the trabecular bone of lumbar level 2,3 and 4 by a commercial QCT BMD analysis system. One-way ANOVA analysis was conducted to assess the differences of BMD among R1, R2, and R3. The paired t test was performed to evaluate the difference of BMD between R3 and the global pedicle screw trajectory.  $P < 0.01$  was considered statistically significant for all used tests.

### RESULTS

Mean pedicle screw trajectory BMD (R1,  $173.66 \pm 71.84$  mg/cm<sup>3</sup>; R2,  $113.81 \pm 48.83$  mg/cm<sup>3</sup>; global,  $143.73 \pm 55.49$  mg/cm<sup>3</sup>;) showed significant difference between R1-R2 ( $P < 0.01$ ) and there was no significant difference at both sides (left,  $143.14 \pm 70.06$  mg/cm<sup>3</sup>; right,  $144.33 \pm 66.56$  mg/cm<sup>3</sup>;  $P > 0.01$ ) or different lumbar levels (L2,  $141.25 \pm 50.32$  mg/cm<sup>3</sup>; L3,  $138.31 \pm 56.85$  mg/cm<sup>3</sup>; L4,  $151.64 \pm 58.62$  mg/cm<sup>3</sup>;  $P > 0.01$ ). Average BMD of R3 was not significantly different between lumbar level 2, 3 and 4 (L2,  $124.28 \pm 47.04$  mg/cm<sup>3</sup>; L3,  $115.36 \pm 46.34$  mg/cm<sup>3</sup>; L4,  $117.19 \pm 48.33$  mg/cm<sup>3</sup>;  $P > 0.01$ ). Mean R1-R3 was significantly different (R3,  $118.94 \pm 47.24$  mg/cm<sup>3</sup>;  $P < 0.01$ ) while comparison of R2-R3 did not reach significance ( $P > 0.01$ ). The global pedicle screw trajectory BMD was higher than R3 and the difference was statistically significant ( $p < 0.01$ ).

### CONCLUSION

QCT allows for BMD assessment both of the vertebral body and pedicles. BMD of the global pedicle screw trajectory is significantly higher than that of the same segmental vertebral body.

### CLINICAL RELEVANCE/APPLICATION

Pedicle screw fixation is the standard technique for spine stabilization with a potential complication of screw loosening. The screw fixation strength is clearly related to the bone mineral density (BMD) of vertebrae. Currently in clinical only BMD of the vertebral body was estimated, which may not represent the situation in the screw trajectory. Our study shows there's a significant difference of BMD between them. It indicates that measuring BMD of the screw trajectory using quantitative computed tomography (QCT) is needed to predict screw loosening.

## W2-SPMK-7 The Value of Magnetic Resonance Image Compilation (MAGIC) Sequence in the Diagnosis of Sacroiliac Joint Bone Marrow Edema and Activity in Early Axial Spondyloarthritis

Zhaorong Tian, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The study explored the feasibility of using Magnetic resonance image compilation (MAGIC) parameters to quantitatively evaluate changes of sacroiliac joint in axial spondyloarthritis (SpA), in order to provide a quantitative index for the evaluation of sacroiliac joint inflammatory activity in SpA. and to evaluate the correlations of MAGIC parameters with BASDAI and SPARCC scores.

## METHODS AND MATERIALS

A total of 68 SpA patients with sacroiliitis and 35 healthy controls were enrolled. All patients were scanned using a SIGNATM Architect 3.0T MRI scanner by T1WI, FS-T2WI and MAGIC sequence of the sacroiliac joints. According to whether subchondral bone marrow edema was present in the FS-T2WI sequence, the 68 patients were divided into an active group (40 cases) and an inactive group (28 cases). The T1, T2 and PD values of the subchondral bone marrow were measured in the active group, the inactive group, and the healthy control group using the MAGIC sequence. The T1, T2 and PD values of the active, inactive, and healthy groups were compared using one-way analysis of variance (ANOVA). Receiver operating characteristic (ROC) curves were used to analyze the diagnostic efficacy of T1, T2 and PD values for sacroiliitis. The correlations of the T1, T2 and PD values with the BASDAI and SPARCC scores were analyzed using Spearman's rho.

## RESULTS

T2 and PD values of active groups ( $119.00 \pm 9.56$ )ms, ( $86.03 \pm 14.79$ )pu were both higher than inactive groups ( $96.61 \pm 8.86$ )ms, ( $68.12 \pm 7.77$ )pu, higher than those in the healthy control group ( $78.94 \pm 6.20$ )ms, ( $53.71 \pm 6.69$ )pu, ( $T=15.332, T=15.972, \text{all } p < 0.001$ ); The T1 values ( $531.04 \pm 60.28$ )ms in the active group were lower than those in the inactive group ( $691.50 \pm 72.44$ )ms, lower than those in the healthy control group ( $933.23 \pm 100.98$ )ms, ( $T=-11.517, p < 0.001$ ). The areas under the ROC curves (AUCs) of T1, T2 and PD values between the active and inactive groups were  $0.976$  (95%CI,  $0.949-0.991$ ),  $0.988$  (95%CI,  $0.970-0.997$ ),  $0.887$  (95%CI,  $0.842-0.923$ ), respectively. The T1, T2 and PD values of the SpA patients were positively correlated with BASDAI scores, and the correlation coefficients (r) were  $-0.771, 0.914$  and  $0.846$  (all  $p < 0.001$ ), respectively. And positively correlated with SPARCC scores, and the correlation coefficients (r) were  $-0.924, 0.915$  and  $0.938$  (all  $p < 0.001$ ), respectively.

## CONCLUSION

MAGIC imaging can be helpful in quantitatively assessing the activity of sacroiliitis in SpA patients. In particular, T1 and T2 values of high value in distinguishing active sacroiliac arthritis.

## CLINICAL RELEVANCE/APPLICATION

MAGIC parameters can be used to quantitatively assess the activity of SpA, and provided imaging bases for the clinical diagnosis of sacroiliitis.

## W2-SPMK-8 Performance of SPECT MRI for Assessing Spinal Pain Generator Compared to MRI and SPECT CT Alone

Arman Parsai, MD (Presenter) Nothing to Disclose

## PURPOSE

Back pain is a common disease and affects a large portion of the musculoskeletal patient population. The imaging modalities used to assess the cause of the pain is usually MRI of the spine. More recently the use of SPECT CT has been shown to be useful in assessing the pain generators (3). Unfortunately despite these imaging modalities a large proportion of patients remain symptomatic and do not respond to standard care including physiotherapy and pain management with targeted nerve root injections. The cause of the back pain which can be related to nerve root compression is readily assessed on MRI. However, axial vertebral spondylosis and facet joint disease can be better assessed using SPECT CT. The SPECT CT assesses the osteoblastic activity of the bone and has been shown to demonstrate areas of increased bone remodelling related to stress and degenerative changes. The SPECT component of the study is registered with a low dose CT scan for attenuation correction and localisation. The aim of our study is to assess the utility of retrospective fusion of SPECT and MRI compared to SPECT CT and MRI alone in patients with chronic back pain refractory to initial medical management.

## METHODS AND MATERIALS

Between January 2014 and December 2022, 552 patients with chronic back pain initially assessed with spine MRI and SPECT CT were retrospectively reviewed. The initial diagnosis, patients history and management were reviewed. Out of the 552 patients, 138 (25%) were selected for their lack of response to initial management (targeted injection and/or physiotherapy) after 12 months with ongoing back pain. The baseline MRI and SPECT were retrospectively fused using a semi-automated software (Hermes Software®) and images were reviewed by two experienced readers blinded to the initial diagnosis. Potential pain generators were recorded and readers confidence graded using Likert score (graded 1 to 5). Results were compared to MRI and SPECT CT alone.

## RESULTS

In our preliminary analysis to date, SPECT MRI detected new sites of pain generators in 105 out of 138 patients (76%) compared to MRI or SPECT CT alone. The readers assessed that in 16 patients (15.3%) this would have potentially altered management. Readers confidence was higher for SPECT MRI compared to MRI and SPECT CT alone.

## CONCLUSION

Retrospective fusion of SPECT with MRI improves detection of pain generators in the spine and readers confidence.

## **CLINICAL RELEVANCE/APPLICATION**

The new sites of pain generator assessed on SPECT MRI would potentially impact patient's management. Further studies would be needed to assess if the potential new sites would be the cause of the absence of response to treatment.  
Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-SPMS

### Multisystem Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### W2-SPMS-1 Prospective Evaluation of 3T Whole Body MRI and <sup>18</sup>F-FDG PET/CT in the Assessment of Multiple Myeloma

Alice Rossi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the clinical relevance and diagnostic performance of Whole body-MRI (WB-MRI) and fluorine 18 (<sup>18</sup>F) fluorodeoxyglucose (FDG) PET/CT for the detection of bone marrow infiltration (BMI) in myeloma patients.

#### METHODS AND MATERIALS

Between January 2021 and March 2023, we enrolled myeloma patients in a prospective trial who underwent a 3 Tesla WB-MRI (conducted in accordance with the Myeloma Response Assessment and Diagnosis System, MY-RADS) and PET/CT to assess BMI, para and extramedullary disease, as well as clinico-laboratoristic data collection, all within a month. Two specialized haematologists agreed on management strategies based on International Myeloma Working Group (IMWG) standards after evaluating all the data. This was used to assess the diagnostic performance of WB-MRI and PET/CT.

#### RESULTS

The study included 135 patients (78 Male; mean age, 63 years  $\pm$  12 [SD]) divided into 3 clinical groups: 35 with a newly diagnosed High Risk Smoldering Multiple Myeloma (HR-SMM- group 1); 37 had a newly diagnosed Multiple Myeloma (MM- group 2); 38 were in follow-up after autologous stem cell transplantation and 25 were affected by relapsed/refractory MM with clinical or laboratorist data suspicious for relapse or progression (group 3). HR-SMM analysis showed discordance between the two imaging modalities in 23/35 (66%). 10 diffuse patterns of BMI without any overt focal lesions in WB-MRI (4 correlate with a nonspecific diffusion pattern in PET/CT) and 1 WB-MRI with an equivocal focal lesion emphasized the HR-SMM diagnosis. WB-MRI identified focal bone lesions in 4 patients, 3 of which were confirmed by PET/CT, and resulted in the diagnosis of MM and a change in treatment approach (11%). Analysis of the 100 patients in groups 2 and 3 revealed that WB-MRI and PET/CT were consistent in 79% of the instances and inconsistent in 21% of the cases. In 16/21 (76%, 12 cases of micronodular or diffuse pattern) of these, there was agreement with WB-MRI, whereas in 5/21 (24%) of cases, PET/CT accurately identified 3 positive and 2 negative cases. Overall sensibility and specificity of WB-MRI in the detection of MM was of 94% and 98%, whilst for PET/CT was 81% and 94%. WB-MRI led to an overall changing in therapeutic path in 49/135 cases (36%), PET/CT in 42/135 (31%), WB-MRI plus PET/CT in 53/135 (39%).

#### CONCLUSION

Our data highlight the pivotal role of functional imaging in the evaluation of BMI in myeloma patients with a superior sensibility of WB-MRI. The two techniques may play a complimentary role in cases of suspected relapsed or progressing MM.

#### CLINICAL RELEVANCE/APPLICATION

Our prospective trial supports the utmost role of WB-MRI and FDG PET/CT in the assessment of patients affected by high risk smoldering multiple myeloma and multiple myeloma at both diagnosis and relapse.

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## Abstract Archives of the RSNA, 2023

W2-SPNMMI

### Nuclear Medicine & Molecular Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPNMMI-1 The Impact of Preoperative [<sup>18</sup>F]FET-PET in Former Low Grade Glioma: Reclassification According to WHO CNS 2021**

Wolfgang Roll (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Amino acid PET with [<sup>18</sup>F]-fluoroethylthymosine (FET) is frequently used in the initial assessment of high grade glioma and suspected tumor recurrence. In low-grade gliomas, [<sup>18</sup>F]FET-PET can identify metabolically active tumor components and thus determine the surgical strategy. This study sheds light on the prognostic value of [<sup>18</sup>F]FET-PET for therapy-naive patients with low-grade gliomas.

#### **METHODS AND MATERIALS**

Retrospectively, all therapy-naive patients from 01/2012-03/2022 with [<sup>18</sup>F]FET-PET before microsurgical resection, diagnosed as former low-grade gliomas (WHO grade II according to WHO classification at the date of diagnosis) were included in the analysis. Diagnosis was updated following WHO CNS 2021. The [<sup>18</sup>F]FET-PET/CT or PET/MRI were quantitatively evaluated. In cases in which dynamic imaging was available, late uptake kinetics were graded as increasing vs. indifferent/decreasing. The primary oncologic outcome measure was progression-free survival (PFS).

#### **RESULTS**

Out of 103 patients, 26 patients were diagnosed with an oligodendroglioma and 57 patients with a WHO grade 2 astrocytoma IDH-mutated. 20 patients initially diagnosed as IDH-wildtype low grade tumors, were reclassified as IDH-wild-type glioblastoma following the new WHO 2021 classification. TBRmax values are significantly higher in oligodendrogliomas compared to IDH-mutated astrocytoma ( $p < 0.001$ ). Quantitative uptake parameters cannot predict the IDH status in this cohort. Increasing late kinetics is associated with a significantly longer PFS compared to indifferent/decreasing kinetics ( $p = 0.015$ ) in the entire cohort. In the subgroup of IDH-mutated astrocytomas without adjuvant treatment, patients with a TBRmax  $> 1.9$  showed significantly longer PFS compared to patients with lower TBRmax ( $p < 0.01$ ).

#### **CONCLUSION**

Preoperative [<sup>18</sup>F]FET-PET aids in tumor characterization in low-grade gliomas and can provide prognostic metrics.

#### **CLINICAL RELEVANCE/APPLICATION**

Prospective studies need to demonstrate whether [<sup>18</sup>F]FET-PET can be used as a decision support for or against adjuvant therapy after microsurgical resection.

#### **W2-SPNMMI-2 Association of ctDNA Levels and PET Radiomics Features in Patients with HPV-positive Head and Neck Squamous Cell Carcinoma**

Mitsuaki Tatsumi, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Circulating tumor DNA (ctDNA), which is circulating in the blood after being shed from cancer cells in the body, has recently gained attention as an excellent tumor marker. The purpose of this study was to evaluate if ctDNA levels associated with PET radiomics features in patients (pts) with human papillomavirus (HPV)-positive head and neck squamous cell carcinoma (HNSCC).



## **METHODS AND MATERIALS**

This study included 50 pts with oropharyngeal SCC (OPSCC) and 5 with SCC of unknown primary (SCCUP) before treatment. All of them had blood sampling to test ctDNA levels and FDG PET-CT examinations. ct-HPV type16 DNA (ctHPV16DNA) was analyzed as ctDNA using the droplet digital PCR system. Radiomics features in PET-CT included SUVmax, metabolic tumor volume (MTV), and texture features of the primary tumor (PT) and the largest metastatic lymph node (LN), and MTV of whole-body lesions (wbMTV) in each pt. Fifty-six TFs were evaluated in this study, and entropy, homogeneity, low- and high-gray-level zone emphasis (LGZE, HGZE), and short- and long- run emphasis (SRE, LRE) were included as recommended by Orhac, et al (JNM 2014). ctHPV16DNA levels were compared to TFs of PTs and other PET parameters in OPSCC pts (Group A) or TFs of the largest lesions (PTs or LNs) and other PET parameters in OPSCC and SCCUP pts (Group B). Spearman rank correlation test and multiple regression analysis were used to confirm the associations between ctHPV16DNA levels and PET parameters.

## **RESULTS**

ctHPV16DNA levels correlated with wbMTV ( $r=0.52$  and  $0.53$ , respectively,  $p < 0.0005$  for both), but not with SUV or MTV in Group A and B. In Group A, ctHPV16DNA levels exhibited a weak negative correlation with LGZE ( $r = -0.35$ ,  $p < 0.05$ ) among 56 TFs evaluated. In Group B, the largest lesions consisted of 40 PTs and 15 LNs (10 from OPSCC). ctHPV16DNA levels exhibited a weak negative correlation with LGZE ( $r = -0.36$ ,  $p < 0.01$ ) or contrast ( $r = -0.29$ ,  $p < 0.05$ ). Multiple regression analysis revealed that wbMTV ( $p < 0.0001$ ) and HGZE ( $p < 0.005$ ) were the significant factors for ctHPV16DNA levels in Group B. The parameter ctHPV16DNA/wbMTV to reduce the effect of tumor volume had a weak negative correlation with LGZE ( $r = -0.29$ ,  $p < 0.05$ ) in Group B. These results were not obtained in Group A.

## **CONCLUSION**

This study demonstrated that ctHPV16DNA levels correlated with the whole-body tumor burden visualized on FDG PET-CT in pts with HPV-positive HNSCC. ctHPV16DNA levels exhibited a weak correlation with the tumor heterogeneity, especially in the large OPSCC or LN lesions. This study provides new insights into the quantitative connection between gene expression and imaging biomarkers.

## **CLINICAL RELEVANCE/APPLICATION**

ctHPV16DNA levels were demonstrated to correlate with the whole-body tumor burden and tumor heterogeneity in HPV-positive HNSCC.

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## Abstract Archives of the RSNA, 2023

W2-SPNPM

### Noninterpretive Skills (Beyond Imaging) Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPNPM-An Accelerating Emergency: Trends in Nationwide Emergency Department Imaging Volume 1 from 2008 to 2020**

Husayn F. Ramji, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The emergency department (ED) is an essential provider of urgent and emergent care worldwide. As the demand and use of the ED has increased, so has the volume of patients seeking care and receiving diagnostic imaging. This study aims to benchmark multi-year multi-modality trends in imaging utilization in progressively overcrowded EDs, in order to inform future imaging guidelines, awareness, and stewardship efforts.

#### **METHODS AND MATERIALS**

This IRB exempt retrospective study utilized imaging data from the National Hospital Ambulatory Medical Care Survey (NHAMCS) for years 2008-2020. Data for X-ray, CT, Ultrasound, MRI, and the summation of all modalities in an "Any" category, as well as their year-by-year utilization rates, underwent normality testing followed by least squares regression analysis. Data was weighted, and analysis was performed using JMP Pro (SAS Institute Inc, Clara, NC) and SPSS (SPSS Inc, Chicago, IL).

#### **RESULTS**

From 2008-2020, there were statistically significant increases in the number (in thousands) of X-ray, CT, MRI, Ultrasound, and summation of Any imaging taking place in the ED. However, there were only statistically significant increases in utilization rates for CT (14.60% to 21.61%, +48.0%,  $p < 0.001$ ), MRI (0.58% to 1.04%, +79.3%,  $p < 0.001$ ), Ultrasound (3.1% to 5.7%, +83.8%,  $p < 0.001$ ), and Any (46.61% to 53.39%, +14.6%,  $p < 0.001$ ). The rate of utilization of X-ray did increase but was not found to be significant (35.52% to 37.57%, +5.7%,  $p > 0.05$ ).

#### **CONCLUSION**

Multiple modalities have seen significant increases in utilization in the ED from 2008-2020. Possible factors contributing to these increases includes increased access to technology, duplicate scans, challenges in health information exchange, communication or information gaps, or even ordering physician preference. Future studies utilizing NHAMCS data could consider stratifying the data by geographic region, patient variables such as insurance status, and comparing modality utilization by indication.

#### **CLINICAL RELEVANCE/APPLICATION**

Identifying trends in imaging utilization in nationwide cohorts can help inform future imaging stewardship guidelines and awareness campaigns. Further study should elucidate the underlying contributing factors to increase imaging in EDs nationwide.

#### **W2-SPNPM-An Examination of NIH Funded Radiology Research between Clinical Radiologists and Non-Clinicians 2**

Kyle Tegtmeyer, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Research in radiology is conducted by both clinical radiologists and non-clinical researchers. Little is currently known about the balance of research grant funding between clinician and non-clinician researchers, and the scale of grants awarded to clinician-scientists. This project seeks to characterize differences in funding and funding trends between clinician and non-clinician scientists in radiology.

## METHODS AND MATERIALS

Data on National Institutes of Health (NIH) grants awarded for all radiology projects were obtained from the NIH Reporter from 2012 through early 2023. A list of all practicing clinical radiologists was obtained from the National Plan and Provider Enumeration System (NPPES) from the Centers for Medicare and Medicaid Services. Using NPPES data, all available NIH grants were categorized based on whether the principal investigator was a practicing/billing radiologist.

## RESULTS

A total of \$5.01 Billion of NIH grant funding was awarded for radiology research between 2012 and early 2023 across a total of 11,056 projects, awarded to a total of 1762 unique principal investigators. Among those principal investigators, 264 (14.98%) were practicing radiologists. A total of \$700 million in financing was provided to 1613 projects led by practicing radiologists, accounting for 13.97% of all funds awarded for radiology research by the NIH. Clinician and non-clinician researchers received a median of four grants, with a mean of 6.2 and 6.3 grants and mean grant funding of \$2.6 million and \$2.9 million, respectively. While increased grant funding was seen across all radiology projects, the greatest growth was seen among clinician-researchers, with the number of grants and total funding increasing from \$40.7 million across 102 grants in 2012 to \$93.9 million across 224 grants in 2022. Among clinician researchers, 192 (72.7%) identify as male, and the remaining 72 (27.3%) identify as female. Primary specialties of clinician researchers within radiology are as follows: 138 (52.3%) within diagnostic radiology, 12 (4.5%) within interventional radiology, and 114 (43.2%) within radiation oncology.

## CONCLUSION

As imaging volumes continue to rise, with greater pressure placed on meeting the increased imaging volume demands, clinician scientists continue to offer great value and contribute significantly to the scientific advance of radiology. Despite comprising a relatively small percentage of grants and funding amongst the overall radiology specialty, clinical radiologists are seeing stronger increases in grant funding in recent years.

## CLINICAL RELEVANCE/APPLICATION

The proportion of NIH grant funding to clinical radiologists relative to the whole specialty, as well as funding levels and trends over time are currently not well known.

## W2-SPNPM-Accuracy of Disclosed Financial Relationships by Physicians publishing in Radiology Journal 3 in 2021

Dheeman Futela, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

Transparency of physician-industry relationships is required by law. The United States Congress passed the Physician Payments Sunshine Act in 2010, which requires drug, device, and medical supply manufacturers to report payments over a certain amount (\$12.69 for 2023) made to healthcare providers. The physicians are expected to disclose payments received from the medical industry when publishing. This study aims to assess the accuracy and completeness of self-disclosures by authors in the journal Radiology.

## METHODS AND MATERIALS

Manuscripts published in Radiology journal between January 1 and May 31, 2021 were retrospectively reviewed, and self-reported author disclosures were cross-referenced with the Open Payments database between 2019-2021.

## RESULTS

A total of 68 articles having 513 authorships by US physicians were published in Radiology journal during the inclusion period, out of which 199 (39 %) received payments from the industry. There were 2918 payments totaling \$32,826,946.99 made to these 199 authorships. The median total amount received per authorship was \$10,598.7 (IQR = \$748.70 - \$120,386.01). Out of the 199 authorships receiving payments, 128 (64 %) did not disclose OPD-recorded relationships. 51 (26 %) authorships disclosed some of the OPD-recorded payments and 20 (10 %) disclosed all payments. The total undisclosed payments amounted to \$15,452,628.72 in research, \$4,579,475 in ownership and \$3,102,833.69 in general payments with a median undisclosed amount per authorship being \$2,726.

## CONCLUSION

Our study shows that over a recent six-month period, 64 % of US physician authors with manuscripts published in Radiology did not disclose any industry relationship and another 26% disclosed only some of their payments. There is a significant discrepancy between physician authors' financial relationships with industry and their self-reported disclosures of the same.

## CLINICAL RELEVANCE/APPLICATION

Publishing physicians are expected to disclose financial relationships with the medical industry. Our study uncovers a significant lack of transparency, both in terms of the number of authors who did not disclose and the total undisclosed amount, from physician authors of Radiology in 2021.



## Abstract Archives of the RSNA, 2023

W2-SPNR

### Neuroradiology Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPNR-1 Impact of IA on Care Metrics for Stroke Patients during the COVID19 Pandemic: A Retrospective Analysis**

Pablo A. Diluca, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

The COVID-19 pandemic has presented unprecedented challenges to the healthcare system, including the management of time-dependent pathologies such as stroke. We aimed to evaluate the impact of implementing the AI software, RAPID.AI, for image analysis in patients with stroke due to large cerebral vessel occlusion (LVO) during the pandemic.

##### **METHODS AND MATERIALS**

We created two groups of patients with LVO who received intravenous reperfusion therapy plus endovascular (TEV) or direct TEV. Group 1 included patients admitted between January 2019 and June 2020, and Group 2 included patients admitted from July 2020 to December 2021 and studied with RAPID.AI. We analyzed demographic data, risk factors, temporal metrics, National Institute of Health Stroke Scale (NIHSS) score at admission, modified functional Rankin Scale (mRS) score at 90 days, and compared data according to arrival time.

##### **RESULTS**

Group 1 comprised 153 patients, and Group 2 comprised 133 patients. No significant differences were identified regarding age, gender, admission NIHSS, or risk factors. However, the median door-to-image time was significantly shorter in Group 2 (19 minutes vs. 25 minutes,  $p < 0.0001$ ), and the door-recanalization time was also shorter in Group 2 (73 minutes vs. 85 minutes,  $p = 0.042$ ). Between 8:00 a.m and 8:00 p.m patients admitted in Group 2 had a shorter imaging time despite including a chest CT. Patients admitted to Group 2 between 8:01 p.m. and 7:59 a.m. had longer onset-admission times, higher NIHSS scores, and lower proportions of mRS = 2 at 90 days. As a limitation to the study, the measures implemented to shorten the door-image time were not analyzed.

##### **CONCLUSION**

Our study demonstrates that the measures implemented during the pandemic together with the use of AI for image analysis in stroke patients during the COVID-19 pandemic resulted in improved door-to-image and door-to-recanalization metrics. Additionally, the use of AI compensated for delays in patient arrival, providing specific information for decision-making. These findings highlight the potential utility of AI in improving stroke care and outcomes during times of crisis.

##### **CLINICAL RELEVANCE/APPLICATION**

AI software can improve care metrics for stroke patients with large cerebral vessel occlusion, enhancing decision making.

#### **W2-SPNR-10 Radiomics Features on Computed Tomography Combined with Clinical and Radiological Factors Predicting Hemorrhage Expansion**

Huiming Lee (*Presenter*) Nothing to Disclose

##### **PURPOSE**

To develop an optimal model based on either intra- and peri-hematoma radiomics features as well as clinical data to predict hematoma expansion (HE) and compare their prediction performance.

## METHODS AND MATERIALS

Clinical and radiological data of 406 ICH patients were collected retrospectively, who underwent initial NCCT within 6 hours of ictus and follow-up CT within 48 hours after initial NCCT. The data were randomized into a training set and a testing set at a ratio of 7:3. Radiomics features were extracted from the intra- and perihematoma regions. Univariate and multivariable logistic regression analyses were implemented to screen clinical and radiological factors. Then radiomics (single or combined) models, a radiomics-radiologic model, and an integrated model were constructed in the training cohort using FAE. The receiver operating characteristic curve and Delong test evaluated the predictive performance of radiomics features from different regions.

## RESULTS

The predictive performance of intra- and perihematoma features was comparable in the training area under the receiver operating characteristic curve (AUC) 0.613 versus 0.645, which had no statistical difference. By incorporating intra- and perihematoma features, the model achieved an AUC of 0.620 in the test cohort. Regression analysis identified 4 risk factors, including 2 radiographic features and 3 clinical features. The radiological-radiomics (RR) model using radiographic features combined with the radiomics features achieved an area under the curve (AUC) of 0.744 in the test set. After incorporating the 2 clinical predictors and RR, the AUC of the radiologic-radiomics-clinical (RR-CL) model for discriminating early HE was 0.768. The RR-CL model's prediction performance was better than the RR model, while the predictive nomogram combining the radiomics features with clinical-radiological characteristics performed best. Delong test proved that the performance of radiomics-based features was boosted by incorporating radiological factors, with the volume of hematoma and blend sign ( $p < 0.05$ ). While, the clinical factors, with time from onset to scan, NEUT and PT being the most important contributors, made the RR-CL equivalent to RR model in diagnostic efficiency.

## CONCLUSION

NCCT models based on multivariable, clinical, and radiological features could improve the discrimination of early HE. The combined model was the best-recommended model to identify ICH patients at risk of early HE. And NEUT in the model may indicate early inflammatory reaction within perihematoma.

## CLINICAL RELEVANCE/APPLICATION

The combined model was the best-recommended model to identify ICH patients at risk of early HE.

## W2-SPNR-11 Comparison of Ultra-High-Resolution and Normal-Resolution CT-Angiography for Intracranial Aneurysm Detection in Patients with Subarachnoid Hemorrhage

Marius Frenzel (*Presenter*) Nothing to Disclose

## PURPOSE

Ruptured intracranial aneurysms (IAs) are the leading cause for atraumatic subarachnoid hemorrhage. In case of aneurysm rupture, patients may face life-threatening complications and require aneurysm occlusion. Detection of the aneurysm in CT imaging is therefore essential for patient outcome. This study provides an evaluation of the diagnostic accuracy of Ultra-High-Resolution CT-Angiography (UHR-CTA) and Normal-Resolution CT-Angiography (NR-CTA) concerning IA detection and characterization.

## METHODS AND MATERIALS

Consecutive patients with atraumatic subarachnoid hemorrhage who received Digital Subtraction Angiography (DSA) and either UHR-CTA or NR-CTA were retrospectively included. Three readers evaluated CT-Angiography datasets regarding image quality, diagnostic confidence and presence of IAs. Sensitivity and specificity were calculated on patient-level and segment-level with DSA-imaging serving as reference standard. Additionally, the CTA patient radiation exposure (effective dose) was assessed and compared.

## RESULTS

108 patients were identified (mean age=57.8±14.1years, 65 women). UHR-CTA revealed significantly higher image quality and diagnostic confidence ( $p < 0.001$ ) for all readers and significantly lower effective dose ( $p < 0.001$ ). Readers correctly classified =55/56 patients on UHR-CTA and =44/52 patients on NR-CTA. We noted significantly higher patient-level sensitivity for UHR-CTA compared to NR-CTA for all three readers (Reader 1: 41/41[100%] vs. 28/34[82%], Reader 2: 41/41[100%] vs. 30/34[88%], Reader 3: 41/41[100%] vs. 30/34[88%],  $p = 0.04$ ). Segment-level analysis also revealed significantly higher sensitivity for UHR-CTA compared to NR-CTA for all three readers (Reader 1: 47/49[96%] vs. 34/45[76%], Reader 2: 47/49[96%] vs. 37/45[82%], Reader 3: 48/49[98%] vs. 37/45[82%],  $p = 0.04$ ). Specificity was comparable for both techniques.

## CONCLUSION

We found Ultra-High-Resolution CT-Angiography to provide higher sensitivity than Normal-Resolution CT-Angiography for the detection of intracranial aneurysms in patients with aneurysmal subarachnoid hemorrhage while improving image quality and reducing patient radiation exposure.

## CLINICAL RELEVANCE/APPLICATION

In addition to achieving the universally sought-after reduction of radiation dose, the increased detection of intracranial aneurysms in UHR-CT imaging may facilitate therapeutic decisions and hence improve patient outcome.

### W2-SPNR- 12 **Delay Filling of Intracranial Blood Flow Distal to Thrombus Predict Clinical Outcome after Endovascular Thrombectomy**

Song Liu (*Presenter*) Nothing to Disclose

#### PURPOSE

Delay filling of intracranial blood flow evaluated by multiphase CT angiography (mCTA) can provide complementary information of hemodynamics. To investigate the relationship between phase of delay filling (PDF) and thrombolysis before EVT, and whether phases of delay filling (PDF) can help to predict clinical outcomes of patients with endovascular thrombectomy (EVT).

#### METHODS AND MATERIALS

In this retrospective study, patients with AIS treated with EVT were enrolled. All the patients underwent mCTA on admission. Based on the PDF, patients were classified into red PDF group (PDF with red on ColorViz of mCTA) and non-red PDF group (PDF with green or blue on ColorViz of mCTA). PDF of mCTA was acquired on the FastStroke research prototype. Chi-square test and Mann-Whitney test was applied to compare the difference between two groups. P value <0.05 was considered significant for all tests.

#### RESULTS

A total of 99 patients underwent EVT were included. In red PDF group, the percentage of thrombolysis before EVT was higher than non-red PDF group (8/28[28.57%] vs 2/60[3.33%], P = 0.005). Mismatch volume and Tmax > 10 seconds volume of red PDF group were lower than non-red PDF group (Mismatch volume: 129.00 [59.00-180.00] ml vs 152.80 [112.90-214.43] ml; Z = -2.209, P = 0.027; Tmax > 10 seconds volume: 41.00 [0.00-76.00] ml vs 59.00 [24.00-98.30] ml; Z = -2.285, P = 0.022). Clinical outcomes of red PDF group were more favourable than non-red PDF group (Score 6: 1 [2.94%] versus 5 [8.77%]; Score 5: 4 [11.76%] versus 5 [8.77%]; Score 4: 5 [14.72%] versus 5 [8.77%]; Score 3: 1 [2.94%] versus 18 [31.58%]; Score 2: 11 [32.65%] versus 10 [17.55%]; Score 1: 9 [26.47%] versus 13 [22.81%]; Score 0: 3 [8.82%] versus 1 [1.75%]; P = 0.041).

#### CONCLUSION

PDF was associated with thrombolysis before EVT, mismatch volume and Tmax > 10 seconds volume. More favourable outcomes was found in patients with red PDF than patients non-red PDF.

## CLINICAL RELEVANCE/APPLICATION

Phase of delay filling depicts the compensatory capacity of intracranial blood flow, and it may be associated with thrombolysis before EVT. Moreover, later delay filling of blood flow may indicate the poor outcome of patients.

### W2-SPNR- 13 **3.0T Three-dimensional High Resolution Vessel Wall MRI for Displaying Lenticulostriate Artery Changes of Cerebral Small Vessel Disease**

Yukun Zhang (*Presenter*) Nothing to Disclose

#### PURPOSE

To observe the value of 3.0T three -dimensional high resolution vessel wall MRI (3D HR-VMI) for displaying lenticulostriate artery (LSA) changes of cerebral small vessel disease (CSVD), and to explore the feasibility of taking LSA changes as imaging markers of CSVD.

#### METHODS AND MATERIALS

Fifty-eight CSVD patients (CSVD group, 26 males and 32 females with an average age of 63.0 ± 7.2 years) and 35 cases of other diseases with CSVD total burden scores of 0 (control group, 15 males and 20 females with an average age of 62.6 ± 7.2 years) were enrolled. The imaging characteristics, including the number, length, and tortuosity of LSA were observed on 3D HR-VMI reconstruction images (Fig.1). The general information and imaging characteristics were compared between 2 groups and logistic regression analysis was performed, the independent risk factors for the occurrence of CSVD and CSVD total burden scores were evaluated (Fig.2).

#### RESULTS

There were significant differences in the incidence of hypertension and the numbers of LSA between groups (both P < 0.05). CSVD total burden scores were negatively correlated with the number of LSA in CSVD patients (r = -0.48, P < 0.001). Hypertension and decreased number of LSA were independent risk factors for the occurrence of CSVD (Fig. 3), while aging,



alcohol consumption and a decrease in the number of LSA were independent risk factors for the increase of CSVD total burden scores (Fig. 4).

#### **CONCLUSION**

3.0T 3D HR-VMI could clearly display LSA changes of CSVD. Decreased number of LSA was an independent risk factor for the occurrence of CSVD and increased CSVD total burden scores, which could be taken as an imaging marker of CSVD.

#### **CLINICAL RELEVANCE/APPLICATION**

Early detection and characterize LSA in the brain may provide valuable information on risk stratification and therapeutic interventions for patients with cerebral small vessel disease.

#### **W2-SPNR-14 Predictive Value of Intracranial Atherosclerosis Coexisted with Atherosclerotic Plaques in Different Carotid Segments for Subsequent Vascular Event: A Magnetic Resonance Imaging Study**

Richen Zhao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aimed to examine the association between coexisting intracranial and extracranial carotid artery atherosclerotic plaque characteristics among different carotid segments, as detected using MR vessel wall imaging, and subsequent vascular events.

#### **METHODS AND MATERIALS**

Patients who recent cerebrovascular symptoms in anterior circulation and at least one carotid plaque were consecutively enrolled. All patients underwent multi-contrast MR vessel wall imaging for extracranial carotid arteries and 3D time-of-flight MR angiography for intracranial arteries at baseline. After baseline examination, all patients were followed-up for at least 1 year to record the vascular events. The coexisting cerebrovascular atherosclerosis was defined as the presence of atherosclerosis in both intracranial artery in anterior circulation and extracranial artery. Univariate and multivariate Cox regressions were used to calculate the hazard ratio (HR) and corresponding 95% confidence interval (CI) of co-existing plaques in predicting subsequent vascular events.

#### **RESULTS**

In total, 122 patients (mean age:  $62.2 \pm 11.9$  years; 89 males) were recruited. During the median follow-up time of 12.0 months, 36 (29.5%) patients experienced vascular events. Coexisting intracranial artery stenosis and atherosclerotic plaques in carotid bulb segment of carotid artery (HR, 2.51; 95% CI, 1.14-5.54;  $P = 0.023$ ) was significantly associated with subsequent vascular events, respectively. After adjusting for baseline confounding factors, this association remained statistically significant (HR = 3.08, 95% CI 1.18-8.07,  $P = 0.022$ , respectively). No significant association was found between intracranial stenosis coexistent with atherosclerotic plaque in other segments of carotid artery and vascular events (all  $P > 0.05$ ).

#### **CONCLUSION**

Coexisting intracranial artery stenosis and atherosclerotic plaque in the segment of carotid bulb was independently associated with subsequent vascular event.

#### **CLINICAL RELEVANCE/APPLICATION**

Our findings indicate that coexisting intracranial artery stenosis and atherosclerotic plaque in the segment of carotid bulb was independently associated with subsequent vascular event, indicating that coexisting intracranial stenosis and atherosclerotic plaque in carotid bulb may have a higher predictive value for vascular events than coexisting plaques in other carotid artery segments. Our findings indicate that it is valuable to assess the segmental distribution of coexisting intracranial and extracranial atherosclerosis.

#### **W2-SPNR-2 Low Proportion of Calcification in Large Volume Plaque as a Marker of Carotid Plaque Vulnerability in Embolic Stroke of Undetermined Source**

Yu Sakai, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Current focus has centered on non-calcified inflammatory plaque components [intraplaque hemorrhage (IPH) and lipid rich necrotic core (LRNC)] in nonstenotic carotid plaque in patients with embolic stroke of undetermined source (ESUS). Although calcified inflammatory plaque components, such as spotty calcifications, are associated in acute coronary syndromes, its role in ESUS-carotid plaque is unclear. We investigated the relationship of spotty calcifications and low calcific plaque burden in nonstenotic carotid plaque ipsilateral to stroke side in patients with ESUS.



## METHODS AND MATERIALS

Calcific carotid plaques were identified on neck CTAs from a retrospective dataset comprised of patients with unilateral anterior circulation ESUS. Blinded to stroke side, each carotid plaque calcification was manually scored (e.g., arc), annotated using 3D-Slicer, and segmented using a semi-automated plaque composition software (Elucid Bioimaging). Plaques were scored for presence of a spotty calcification (calcification <3mm in length and <90° arc of the lumen). IPH and LRNC volumes are summed as plaque inflammation (Inflmvol). Plaque burden (PB) is the sum of all plaque components (IPH, LRNC, calcification, matrix). Subgroup analysis of plaques with high plaque burden (HPB) was performed and defined as all cases above the median PB (median=858mm<sup>3</sup>). Plaques were defined as low relative calcific PB (Low%Calc) if the calcific plaque volume comprised =2% of total PB (1st quartile). Mann-Whitney U and Chi-squared tests were performed to test plaque features ipsilateral versus contralateral to stroke side.

## RESULTS

86 patients met criteria (mean age= 66.8; N=41 women). No statistically significant differences were observed between carotid plaques ipsilateral versus contralateral to stroke side for presence of spotty calcifications (p=0.42), Inflmvol (p=0.70), or Low%Calc plaque (p=0.26). Among plaques with HPB (N=66), there was no significant difference between ipsilateral versus contralateral plaques with spotty calcifications (p=0.76) or Inflmvol (p=0.57). Plaques identified as Low%Calc ipsilateral to stroke side were significantly more frequent than on the contralateral side [10/11 (91%), p = 0.02].

## CONCLUSION

Plaques with low relative calcific plaque burden may be a stronger vulnerable carotid plaque feature in patients with ESUS rather than the presence of spotty carotid plaque calcifications.

## CLINICAL RELEVANCE/APPLICATION

Volumetric based categories of plaque classifications should be considered when determining potential imaging biomarkers of nonstenotic culprit carotid plaque to capture the multidimensional and complex patterns of vulnerable plaque in patients with ESUS.

## W2-SPNR-3 Deep Learning-enabled Identification of Large Vessel Occlusion on Four-dimensional Computed Tomography Angiography(4D-CTA)

Yuling Peng, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the role of deep learning in aiding the detection of large vessel occlusion (LVO) on four-dimensional computed tomography angiography (4D-CTA).

## METHODS AND MATERIALS

This retrospective study involved 104 LVO patients and 105 non-LVO patients in the construction of the deep learning models. Another 30 LVO patients and 31 non-LVO patients formed the time-independent validation set. Four phases (arterial phase P1, arterial-venous phase P2, venous phase P3 and late venous phase P4) extracted from 4D-CTA were combined using two different input methods, namely combined input and superimposed input. Totally 26 deep learning models were constructed using a modified HRNet network. Assessment metrics included the areas under the curve (AUC), accuracy, sensitivity, specificity and F1 score. Kappa analysis was performed to assess inter-rater agreement between the best model and radiologists of different seniority.

## RESULTS

The P1+P2 model (combined input) had the best diagnostic performance. In the internal validation set, the AUC was 0.975 (95%CI: 0.878-0.999), accuracy was 0.911, sensitivity was 0.889, specificity was 0.944, and the F1 score was 0.909. In the time-independent validation set, the model demonstrated consistently high performance with an AUC of 0.942 (95%CI: 0.851-0.986), accuracy of 0.902, sensitivity of 0.867, specificity of 0.935, and an F1 score of 0.901. The best model showed strong consistency with the diagnostic efficacy of three radiologists of different seniority (k=0.84, 0.80, 0.70 for 8, 5, and 1 year of diagnostic experience, respectively).

## CONCLUSION

The proposed deep learning algorithm derived from 4D CTA can be very highly effective in detecting LVO, alerting radiologists to speed up the diagnosis. In particular, the combination of the arterial and arterial-venous phases can improve detection efficacy.

## CLINICAL RELEVANCE/APPLICATION

We introduced a high-performance deep learning algorithm for detecting large vessel occlusions in 4D-CTA, showing that the combination of multiple phases improved the detection of LVO and the combination of the arterial-venous phase with the arterial phase yielded the best deep learning model performance. The diagnostic efficacy of the best deep learning model was in good agreement between radiologists of different years of experience and was slightly better than that of less experienced

trainee radiologist. Our results showed that deep learning can be very effective in facilitating accelerated screening and diagnosis of LVO in urgent clinical settings.

## **W2-SPNR-4 Investigation of Radiologic Characteristics between Branch Atheromatous Disease and Cerebral Small Vessel Disease: A High-resolution Magnetic Resonance Vessel Wall Imaging Study**

Peipei Chang (*Presenter*) Nothing to Disclose

### **PURPOSE**

To compare lenticulostriate arteries (LSAs) morphology and other imaging features of branch atheromatous disease (BAD) and cerebral small vessel disease (CSVD) and to investigate whether the imaging features can distinguish the different etiological mechanisms of cerebral infarction in basal ganglia.

### **METHODS AND MATERIALS**

Fifty patients with suspected acute cerebral infarction in the LSA territory were prospectively enrolled. All subjects underwent multimodal magnetic resonance imaging (MRI) examination and were divided into BAD and CSVD groups, depending on whether there was plaque in the middle cerebral artery by high-resolution vascular wall MRI (3D HR VMI). The morphological characteristics of visible LSAs (the number of stems and branches, length, distance, and tortuosity) were quantitatively analyzed by two radiologists. Typical image features indexes of CSVD including white matter hyperintensities (WMHs), lacunes, enlarged perivascular spaces (EPVS), microscopic bleedings (CMBs) were assessed. Global cerebral blood flow (CBF) values obtained by arterial spin labeling (ASL) were used to analyze the whole brain differences of perfusion between two groups. To assess the imaging parameters between groups, independent-samples t test, nonparametric tests and Chi-square test were used. Binary logistic regression was used to explore the influencing factors of BAD and CSVD.

### **RESULTS**

There were significant differences in the sex, MRs (Modified Rankin Scale) and NIHSS (National Institutes of Health Stroke Scale) scores between the two groups, showing more significant neurological impairment in BAD group. The LSA branches of BAD were significantly reduced compared with the contralateral side, while with no significant difference to those observed in the CSVD group. CSVD was more likely to have EPVS. The length and distance of LSAs were influencing factor of BAD and CSVD.

### **CONCLUSION**

There are fewer LSA branches in BAD, and the length and distance of LSA are the influencing factors of BAD and CSVD.

### **CLINICAL RELEVANCE/APPLICATION**

The morphological characteristics of LSAs and image features indexes of CSVD might provide method to distinguish the different underlying mechanisms of cerebral infarction in basal ganglia.

## **W2-SPNR-5 Clinical Evaluation of Deep-learning Model for Classifying Stroke Patients of Emergent Large Vessel Occlusion on Non-contrast CT**

Dohyun Kim, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

The purpose of this clinical study is to evaluate the clinical applicability of a deep learning (DL) model that classifies patients with emergent large vessel occlusion (ELVO) through analysis of non-contrast CT (NCCT) images only. In clinical practice, if patients of suspected ELVO can be quickly screened through analysis of only NCCT images that can be scanned without contrast media, it has the advantage of improving the prognosis by reducing the time required for treatment of ELVO patients. Therefore, clinical effectiveness was evaluated by comparing the accuracy to classify ELVO patients through reading NCCT images with or without referring to the result of DL-based software by clinician.

### **METHODS AND MATERIALS**

The NCCT of 744 patients (ELVO positive: 519 cases) were used for learning the DL model. The primary endpoint of clinical test was the statistical difference of the sensitivity and specificity of ELVO patient classification according to whether or not the DL model results were referenced. 477 patients (ELVO positive: 112 cases) were registered in the clinical evaluation, and a reference standard was created based on the final diagnosis results. A wash-out period of 2 weeks was set between the two readings depending on whether or not the DL model was referenced, and both results of reading were derived by the consensus of five stroke experts. The sensitivity and specificity were calculated by comparing the both readings of consensus to the reference standard. Finally, through McNemar's test, statistical differences were evaluated according to whether or not the results of the DL model were referenced.

## RESULTS

In the classification result of ELVO patient, the sensitivity of experts' consensus was 75.89% when reading by only NCCT and 91.96% when the result of DL model was referred. In addition, the specificity of the experts' consensus was 83.01% when read only by NCCT and 92.6% when referring to the DL model results. As the result of the McNemar's test to compare the primary endpoint, it was confirmed that both sensitivity ( $p=0.0009$ ) and specificity ( $p<0.0001$ ) were significantly improved when the results of the DL model were referred to. Therefore, the primary endpoint of the clinical test was successfully accomplished.

## CONCLUSION

It was confirmed that the accuracy was significantly higher when referring to the results of the DL-based software in NCCT-based ELVO patient classification. Therefore, it is highly recommended to use for assisting clinicians in clinical environment.

## CLINICAL RELEVANCE/APPLICATION

This deep-learning model has been integrated into the commercial Heuron ELVO software. It will be a useful tool for clinicians to make fast decision, especially, it will be valuable in remote regions where clinical expert may be limited.

## W2-SPNR-6 Single-phase plus Dynamic CTA Accurately Identifies Favorable Outcomes in Patients with Acute Ischemic Stroke

Hui Li (*Presenter*) Nothing to Disclose

### PURPOSE

Sufficient collateral blood supply is crucial for favorable outcomes in patients with acute ischemic stroke (AIS) after endovascular treatment. In clinical practice, imaging of collaterals is often performed with single-phase computed tomography angiography (CTA) that is unable to precisely time the acquisition time-points, leading to the mislabeled collateral status. Dynamic CTA (dCTA) derived from CT perfusion source images is a novel method that contains more time points than single-phase CTA, and allows complete tracking of the transit of contrast bolus. We hypothesized that single-phase plus dCTA would predict clinical outcomes better than single-phase CTA.

### METHODS AND MATERIALS

Patients with AIS due to proximal middle cerebral artery occlusion or internal carotid artery occlusion after endovascular treatment were included. Patients underwent non-contrast CT, whole-brain CT perfusion, and single-phase CTA. dCTA were computed from CT perfusion source images with KWIA denoising, vessel filtering and MIP along 3 views. The pial collateral status was scored using Alberta Stroke Program Early CT Score on collaterals with single-phase CTA, dCTA, and single-phase plus dCTA. Good clinical outcomes included 90-day modified Rankin Scale (mRS) score of 0-2. Association between the pial collateral status and functional outcomes was assessed using multivariable binary logistic regression. Then, hypoperfusion intensity ratio (HIR) were computed on CT perfusion and combined with pial collateral status to assessed the total collateral status. 3 groups were defined: good collaterals (good pial collaterals and HIR), poor collaterals (poor pial collaterals and HIR) and mixed collaterals (remainder of patients). The predictive ability of total collateral status on functional outcomes were analyzed by receiver operating characteristic curve.

### RESULTS

One hundred and forty-four patients with a mean age of 68.5 years were included. Pial collateral status as assessed with single-phase plus dCTA was more strongly associated with functional outcomes (OR=3.14 [95% CI 1.65-5.96];  $p<0.001$ ) than with dCTA (OR=2.34 [95% CI 1.29-4.27];  $p=0.005$ ) or with single-phase CTA (OR=1.90 [95% CI 1.21-2.98];  $p=0.005$ ). Furthermore, good total collateral status could predict good functional outcomes (Area Under Curve (AUC)=0.67 for single-phase CTA and HIR, AUC=0.69 for dCTA and HIR, AUC=0.70 for single-phase plus dCTA and HIR).

### CONCLUSION

dCTA provides a more detailed assessment of collaterals than single-phase CTA. Collateral status is a strong predictor of clinical outcomes in patients treated by endovascular treatment.

### CLINICAL RELEVANCE/APPLICATION

dCTA derived from CT perfusion source images may be used to select AIS patients for endovascular treatment.

## W2-SPNR-7 Disparities in Access to Endovascular Thrombectomy for Patients with Large Vessel Occlusion

Mihir Khunte (*Presenter*) Nothing to Disclose

### PURPOSE

To assess the racial, socioeconomic, and geographic disparities that exist in both access to high volume endovascular care centers (ECCs) and receiving thrombectomy once admitted to an ECC in patients with large vessel occlusion (LVO).

## **METHODS AND MATERIALS**

A retrospective study was performed for the years 2016 - 2019 of the National Inpatient Sample for all adult inpatient admissions with LVO. International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis, and procedural coding system (PCS) were used to identify patients with LVO. Patient characteristics such as gender, age, race, and income quartile and hospital characteristics such as region, rural/urban status, and size were recorded. Hospitals that performed  $\geq 10$  EVT procedures in one year were classified as high-volume endovascular capable centers (ECCs).

## **RESULTS**

There were 727,010 patients with LVO during the 2016-2019 period. A total of 428,745 (59.0%) patients were admitted to a high volume ECC. Black patients were admitted to high volume ECCs at higher rates than white patients (61.0% vs 58.3%) but after adjusting for other factors using a multivariable logistic regression model, we found that when comparing Black to White patients, the OR of admission to a high volume ECC was 0.94 (95% CI 0.88 - 1.02). Among patients admitted to a high volume ECC, black patients were less likely to receive thrombectomy than white patients (17.6% vs 19.2%). This trend remained true after adjusting for other variables including the occlusion site. Comparing high volume ECC patients with private insurance to those with Medicare, the OR of receiving EVT was 1.13 (95% CI 1.06-1.20).

## **CONCLUSION**

Our study shows that disparities existed both in accessing an ECC after LVO and receiving thrombectomy after admission to an ECC. While Black patients with LVO were more likely to be admitted to a high volume ECC than white patients, they were less likely to receive EVT once admitted. Age, sex, income, region of the U.S., and insurance status also played a role in determining whether a patient received thrombectomy after admission to a high volume ECC.

## **CLINICAL RELEVANCE/APPLICATION**

EVT is an important treatment strategy for selected patients with LVO but significant barriers exist in accessing appropriate treatment.

## **W2-SPNR-8 Trends in Use of Endovascular Thrombectomy in Anterior Circulation Large-vessel-occlusion by Age**

Mihir Khunte (*Presenter*) Nothing to Disclose

## **PURPOSE**

To assess trends in US nationwide use of endovascular thrombectomy (EVT) in patients with large vessel occlusion (LVO) in different age groups.

## **METHODS AND MATERIALS**

The National Inpatient Sample database was queried to identify adult patients (18 years or older) with a primary diagnosis code for cerebral infarction due to unilateral internal carotid artery (ICA) or middle cerebral artery (MCA) thrombosis or embolism. The International Classification of Diseases, Tenth Revision, Clinical Modification [ICD-10-CM] diagnosis and procedural coding system (PCS) was used to identify patients with LVO and the interventions performed from 2016-2020. Patients with additional coding for occlusions in the vertebral, basilar, cerebellar, posterior cerebral, and anterior cerebral arteries were excluded. For each age category, trends in EVT utilization were evaluated and compared using Pearson's chi-square test.

## **RESULTS**

Among 316,290 patients with ICA/MCA occlusion from 2016-2020, 68,780 (21.7%) received EVT and 71,260 (22.5%) received tPA. The proportion of anterior circulation LVO patients receiving EVT increased from 15.7% in 2016 to 27.6% in 2020. The rate of EVT increased most in patients aged 75 to 84 years (14.6% in 2016 to 27.4% in 2020) and 85 years and older (12.6% in 2016 to 26.3% in 2020). The proportion increased by 10.3 percentage points in patients younger than 55 years (19.0% in 2016 to 29.3% in 2020), 10.1 percentage points in patients aged 55 to 64 (17.2% in 2016 to 27.3% in 2020), 11.3 percentage points in patients aged 65 to 74 (16.7% in 2016 to 28.0% in 2020). In contrast to in 2016, in 2020, the rate of EVT was not statistically significantly different between age groups ( $P = 0.328$ ).

## **CONCLUSION**

Our study results show a significant increase in use of EVT in patients with anterior circulation LVO across all age groups, with approximately 27.6% of patients receiving EVT in 2020.

## **CLINICAL RELEVANCE/APPLICATION**

From 2016-2020, there has been a significant increase in the use of EVT in older patients above 75 years of age with the rate of EVT use nearing that in younger patients.

## **W2-SPNR-9 Trends in the Use of Intravenous Thrombolysis and Endovascular Thrombectomy in Patients with Large Vessel Occlusion Stroke from 2016-2020 and the Impact of COVID-19 Pandemic**

Khunte (*Presenter*) Nothing to Disclose

## **PURPOSE**

To study the use of intravenous thrombolysis (IVT) and endovascular thrombectomy (EVT) nationally in the United States in patients with large-vessel-occlusion (LVO) in 2020, compared it to the previous 4 years, and evaluated their use specifically in COVID-positive patients.

## **METHODS AND MATERIALS**

The National Inpatient Sample database was queried to identify adult patients (18 years or older) with a primary diagnosis code for cerebral infarction due to unilateral internal carotid artery (ICA) or middle cerebral artery (MCA) thrombosis or embolism. The International Classification of Diseases, Tenth Revision, Clinical Modification [ICD-10-CM] diagnosis and procedural coding system (PCS) was used to identify patients with LVO and the interventions performed from 2016-2020. Patients with additional coding for occlusions in the vertebral, basilar, cerebellar, posterior cerebral, and anterior cerebral arteries were excluded. In the 2020 data, patients with a concomitant diagnosis of coronavirus disease 2019 (COVID-19) were identified. Rates of EVT and IVT were assessed by COVID-19 status.

## **RESULTS**

A total of 316,290 patients were hospitalized for acute ischemic stroke with an ICA/MCA occlusion from 2016-2020. Of these patients, 21.7% (N = 68,780) received thrombectomy and 22.5% (N = 71,260) received IVT. From 2019 to 2020, the fraction of patients receiving thrombectomy increased 2.1 percentage points from 25.5% in 2019 to 27.6% in 2020 ( $p = 0.020$ , Figure 1). Meanwhile, rates of thrombolysis remained relatively constant, (22.4% in 2016 vs 21.7% in 2020,  $p = 0.128$ , Figure 1). Among the 63,785 patients presenting with ICA/MCA occlusion in 2020, 1,170 (1.8%) had a co-diagnosis of COVID-19. The rate of EVT among COVID-19 and non-COVID-19 stroke patients with LVO in 2020 was 29.1% and 27.6% respectively ( $p = 0.605$ ). In addition, the proportion of patients receiving IVT was 21.8% and 21.7% for COVID-19 and non-COVID-19 stroke patients respectively ( $p=0.962$ ).

## **CONCLUSION**

The proportion of patients with an MCA/ICA LVO receiving IVT and EVT did not decline in 2020 compared to the previous four years. Specifically, COVID- positive patients received recanalization therapies in similar proportion to COVID-negative patients for the whole year.

## **CLINICAL RELEVANCE/APPLICATION**

COVID-positive patients with acute ischemic stroke received recanalization therapies in similar proportion to COVID-negative patients in 2020.

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## Abstract Archives of the RSNA, 2023

W2-SPPD

### Pediatric Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### W2-SPPD-1 Does Follow-up MRI after Esophageal Button Battery Ingestion Cause Thermal Injury: An In-vitro Study

Norihiro Shinkawa, MD, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

The button battery (BB) is a dangerous pediatric foreign body, and an ingested esophageal BB should be removed immediately. However, severe complications such as tracheoesophageal or aortoesophageal fistula may develop after endoscopic BB removal and patients require follow-up with magnetic resonance imaging (MRI). Since the injured area after BB removal can contain metallic debris such as iron, radiologists should be aware of the risk of thermal injury from the metallic debris during MRI examinations. This in vitro study investigated temperature and histological changes before and after MRI examination of tissues injured by BB.

#### METHODS AND MATERIALS

Two each of the following three types of chicken pectoralis minor muscle were prepared: untreated control; MRI-scanned BB injury; and non-MRI-scanned BB injury. The negative pole surface of an unused 3-V BB was brought into contact with the muscle tissue and left for 10 h to generate a BB injury. Computed tomography (CT) and histological Perls' Prussian blue staining were performed to confirm the presence of metallic debris in the injured area after BB removal. Temperatures were measured before and after MRI of BB-injured muscle specimens after BB removal and in untreated control specimens using a needle-type digital thermometer. Temperatures were measured at five sites for each specimen. MRI was performed according to the non-enhanced mediastinal sequence at our hospital, assuming tracheoesophageal and aortoesophageal fistula. Hematoxylin-eosin and Perls' Prussian blue staining were used to compare MRI-scanned and non-MRI-scanned BB injuries histologically. These steps were performed at room temperature (20-22°C).

#### RESULTS

BB injury showed high attenuation (mean: 242 Hounsfield units) on CT suggestive of the presence of metallic debris. Histologically, BB injury showed positive staining for Perls' Prussian blue, representing evidence of Fe<sup>3+</sup>. Both BB-injured specimens with or without MRI scans showed coagulation necrosis. Temperature before MRI was 21.7 ± 0.1°C for both BB-injured and control specimens. Temperature after MRI was 22.2 ± 0.2°C for both BB-injured and control specimens. No difference in histopathological findings was seen between specimens with or without MRI scans.

#### CONCLUSION

No temperature increase or histopathological findings suggestive of thermal injury due to metallic debris during MRI of BB injury were evident. However, radiologists should be aware of the potential for thermal injury from MRI as long as foreign metal is present in the body.

#### CLINICAL RELEVANCE/APPLICATION

Follow-up of esophageal BB injury by endoscopy or esophagography is invasive, and safer noninvasive MRI is needed.

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## Abstract Archives of the RSNA, 2023

W2-SPPH

### Physics Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **W2-SPPH- A Practical Approach to Sustainable Radiology 10**

Hans-Martin Klein, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To examine the effect of regenerative energy and energy efficient imaging technology on the energy balance in MRI.

#### **METHODS AND MATERIALS**

We built an energy saving bungalow with a 29.8 kWp rooftop solar array and a 10 kWh Li-Ion Battery. MR imaging was carried out using a 0.35T permanent magnet system with water-cooled gradients, installed in 2019 (Siemens Magnetom CI, Siemens Healthineers/Germany) and a 0.4 T permanent magnet system with air-cooling (Aperto Lucent Plus, Fujifilm healthcare/Japan) installed in 2022. Energy consumption was measured using the power management system of the solar array.

#### **RESULTS**

The 0.35T MRI consumed 9.5 kW/h during scan procedures (including cooling). Annual consumption of the imaging system was 16.100 kWh in 2020. Energy consumption including all practice components in 2020 was 38.810 kWh. Energy production of the solar array was 30.846 kWh in 2020. Net energy consumption for the whole project was therefore 8.397 kWh in 2020. The state of the art 0.4T MRI consumes 5 kW/h. In February 2023, the imaging system consumed 1.495,36 kWh. Compared with February 2020 (1.951,21 kWh), this is a reduction by 5.618 kWh or 23,4%. If all other parameters are kept constant, we expect a total practice net energy consumption of 2.780 kWh in 2023.

#### **CONCLUSION**

Using state of the art imaging technique and rooftop solar energy production, an energy neutral MRI site is possible.

#### **CLINICAL RELEVANCE/APPLICATION**

Optimizing the energy balance is a challenge. Radiology, as an energy intense discipline, can contribute considerably to sustainable medical care. For developing countries, energy neutral operation can help to provide medical care independent from (unstable) power grids.

#### **W2-SPPH- Quantitative Knee Evaluation using Deep-Learning in a Low-Field 0.55T MRI: In Vivo Study 11 of Healthy Controls**

Rupsa Bhattacharjee, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the performance of standard in-practice DL (bone, and cartilage segmentation) algorithms to generate bone shape and cartilage thickness maps in addition to compartment-wise cartilage thickness values in healthy controls at 0.55T

#### **METHODS AND MATERIALS**

Unilateral knees of four healthy controls (Age:  $28 \pm 3.8$  years, BMI:  $24.08 \pm 2.88$ , 2 females) were included in this IRB approved study. The subjects underwent MRI scanning on a 0.55T (MAGNETOM Free.Max, Siemens Healthineers, Erlangen, Germany), with knee wrapped in a Contour-S coil. Sagittal 3D PD fat-saturated SPACE images were acquired with FOV  $160 \times 160$  mm<sup>2</sup>, resolution  $0.6 \times 0.6 \times 0.6$  mm<sup>3</sup>, and 224 slices (TR/TE = 800/36 ms). The images underwent a modified 2D-CNN architecture<sup>1</sup> and a 3D V-Net architecture<sup>2</sup> respectively to segment the bones (femur, tibia, patella) and cartilages (femoral, tibial, patellar). Both the DL architectures were previously trained and validated on similar image contrasts at 3.0T and were

inferred on the 0.55T images. Mean cartilage thickness values for three cartilages were automatically computed using a Euclidean distance transform<sup>3</sup>. The overall segmentation quality was assessed using a 5-point Likert scale by a musculoskeletal radiologist with over three years of experience.

## RESULTS

Without any sort of pre-trainings, as an initial inference run, both the segmentation models were able to segment the three major bones and cartilage masks with moderate to substantial ability, demonstrated in figure 1. The cartilage thickness values estimated for femoral, tibial, and patellar cartilages were  $1.40 \pm 0.84$ ,  $1.54 \pm 0.62$ , and  $2.18 \pm 0.62$  mm respectively. The cartilage segmentation algorithm outperformed the bone segmentation module, in the femoral and tibial regions, in terms of precision in detecting smaller cartilage regions with confusing boundaries. However, both the segmentation modules, especially the cartilage one, suffered in the detection of the patellar region, due to non-sufficient training in low-SNR images. Nevertheless, it demonstrates a decent baseline of quantitative capabilities with possibilities for improvement using further training with 0.55T images, along with comparative assessment with paired 3T segmented data.

## CONCLUSION

Initial results demonstrate a moderate-to-substantial technical feasibility of translating existing quantitative deep-learning-based image segmentation techniques from 3T to 0.55T for knee MRI, especially in terms of measuring cartilage thickness.

## CLINICAL RELEVANCE/APPLICATION

The 0.55T low-field-value-MRI, can be technically useful for evaluating knee cartilage thickness and bone features aided by established DL algorithms, with potential for further improvement in biomarker quantification performance.

## W2-SPPH- Feasibility of ZTE-based Silent and Motion-robust Techniques for Neuroimaging 12

James Holmes, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Conventional MRI generates high levels of acoustic noise from the rapidly changing imaging gradients. This loud acoustic noise presents challenges for sensitive populations such as pediatrics and patients with hyperacusis including inner ear disorders, autism, and depression. Acquisition strategies including radial zero-echo time (ZTE) have been shown to reduce acoustic noise. Radial sampling methods can provide motion robustness or even allow correction, making the radial ZTE approach appealing. We present progress in developing multi-contrast ZTE imaging protocols with motion correction.

## METHODS AND MATERIALS

T1w and T2w 3D radial ZTE acquisitions with intermittent magnetization preparation pulses were acquired on a 3T clinical MRI (Premier, GE Healthcare) in two normal healthy volunteers under written consent and IRB approval. Each acquisition was performed twice, and volunteers were instructed to remain still for the first acquisition and to periodically move during the second. A modified HEALPix radial view order provided coverage of angles within each segmented readout. Motion was estimated from the k-space data using a deep learning approach and corrected during image reconstruction. Conventional Cartesian imaging was performed using 3D gradient echo T1w MPRAGE and 3D T2w FSE CUBE. Acoustic noise measurements of the maximum sound pressure level (SPL) were performed at the head coil in the MRI bore during volunteer scans.

## RESULTS

T2w and T1w ZTE images provided qualitatively similar image contrast to the Cartesian acquisitions. As expected, conventional Cartesian images were heavily impacted by subject motion however the ZTE combined with motion correction allowed for recovery of image quality with only modest loss compared to images when no motion was present. This included visualization of the middle cerebral arteries in T2w as well as sulci and ventricles on T1w. ZTE T2w and T1w (peak average SPL 71dBc and 69dBc respectively) were considerably quieter than the conventional Cartesian T2w and T1w (peak average SPL 89dBc and 87dBc respectively).

## CONCLUSION

We present progress to date on developing a ZTE-based silent and motion-robust neuroimaging protocol. ZTE with intermittent magnetization preparation and the HEALPix radial view order and motion correction provided motion robust standard T1w and T2w contrasts. The modified ZTE approach allowed SPL levels well below conventional Cartesian protocols while allowing motion correction. Future work will include studies in pediatrics and autism.

## CLINICAL RELEVANCE/APPLICATION

Sensitive patient populations struggle with MRI due to loud acoustic noise and inability to hold still. This work proposes a ZTE MRI acquisition and deep learning reconstruction to overcome these challenges.

## W2-SPPH- Comparison of Deep Learning-Based Accelerated Diffusion Weighted Imaging with 13 Conventional Diffusion Weighted Imaging in Female Pelvic Imaging

Lillian Chiu, MD (*Presenter*) Nothing to Disclose



## PURPOSE

To compare deep learning based accelerated diffusion weighted images (DL-DWI) and conventional DWI (c-DWI) of the female pelvis using qualitative and quantitative metrics.

## METHODS AND MATERIALS

Consecutive patients who had MRI of female pelvis from 12/16/2023-2/3/2023 were included if they had axial c-DWI and a prototype DL-DWI (Siemens, Erlangen, Germany, Bae et al, Eur J Radiol. 2022) acquired on 3T MRI. Exclusion criteria: prior hysterectomy/oophorectomy. c-DWI used b50, 400, 1000 s/mm<sup>2</sup> and DL-DWI used b50, 800, 1000 s/mm<sup>2</sup>. Axial T2, c-DWI or DL-DWI, and associated ADC maps of each were blinded, randomized and evaluated by 3 fellowship trained radiologists (17, 3, and 1 y exp) using a 5pt Likert scale (1 non diagnostic to 5 excellent quality) for strength of fat suppression, sharpness of uterine margin, conspicuity of ovary, conspicuity of endometrium, quality with respect to susceptibility artifact or other artifacts, and conspicuity of fibroids on b1000 DWI and ADC. The ADC value from a 1 cm diameter ROI of the myometrium and fibroid if present were also collected by a trainee and confirmed by a fellowship trained radiologist. Wilcoxon signed rank test was used to compare Likert scores. Paired T test and Bland Altman plot were used to compare ADC values.

## RESULTS

108 pts met criteria. Mean acquisition times: c-DWI: 2.44±0.45 min, DL-DWI: 1.03±0.16 min. Significantly different image quality scores: Strength of fat suppression (R1 c-DWI 4.96, DL-DWI 4.89, p=0.03, R3 c-DWI 4.33, DL-DWI 4.04, p<.001), Sharpness of uterine margin (R1 c-DWI 4.22, DL-DWI 4.28, p=0.04, R2 c-DWI 3.58, DL-DWI 3.74, p=0.02, R3 c-DWI 4.30, DL-DWI 4.56, p=0.01), Conspicuity of ovary (R1 c-DWI 4.26, DL-DWI 4.44, p=0.01, R3 c-DWI 4.31, DL-DWI 4.71, p<.001), Conspicuity of endometrium (R2 c-DWI 3.26, DL-DWI 3.10, p=0.05), Susceptibility artifact (5 excellent quality) (R1 c-DWI 3.80, DL-DWI 4.00, p=0.03, R2 c-DWI 3.60, DL-DWI 4.07, p<.001), Other artifact (5 excellent quality) (R3 c-DWI 4.34, DL-DWI 4.15, p=0.03), Conspicuity of fibroid on DWI (R3 c-DWI 3.93, DL-DWI 4.52, p<.001), Conspicuity of fibroid on ADC (R3 c-DWI 4.11, DL-DWI 4.65, p<.001). Mean ADC value of myometrium was c-DWI 1250±220 mm<sup>2</sup>/s, DL-DWI 1620±270 mm<sup>2</sup>/s, p<.001. Mean ADC value of fibroids (59/108) was c-DWI 890±210 mm<sup>2</sup>/s, DL-DWI 1170±220 mm<sup>2</sup>/s, p<.001.

## CONCLUSION

Image quality scores were similar between c-DWI and DL-DWI. All readers scored DL-DWI significantly higher than c-DWI for sharpness of uterine margin. ADC values were significantly higher on DL-DWI than c-DWI which may be due to smoothing process in DL reconstruction vs slightly different b values obtained.

## CLINICAL RELEVANCE/APPLICATION

Deep learning accelerated DWI showed excellent and comparative image quality despite 2 fold reduction in acquisition time.

## W2-SPPH-2 Meningioma Grade Discrimination using a Novel Ultrafast T2 Mapping Technique

Zongye Li (*Presenter*) Nothing to Disclose

## PURPOSE

Meningioma grade plays a significant role in treatment planning and prognosis prediction. Despite the numerous prior studies, preoperative diagnosis of meningioma grade remains challenging. Many studies demonstrated the unique value of T2 mapping MRI for characterizing disease pathology, yet often limited by the long scan time. In this study, we employed a deep learning-based single-shot ultrafast T2 mapping technique, which can acquire whole-brain T2 maps within 32 s, and conventional apparent diffusion coefficient (ADC) maps for the WHO grade discrimination of meningiomas.

## METHODS AND MATERIALS

Sixty-nine patients were enrolled, among which 59 were diagnosed with low-grade meningiomas (LGM, grade 1, 57.34 ± 9.40 years) and ten with high-grade meningiomas (HGM, grade 2 and 3, 58.18 ± 9.36 years). All the MRI examinations were performed on a 3.0 T scanner (MAGNETOM Prisma, Siemens Healthcare, Erlangen, Germany) with a 64-channel head coil. Axial T2 mapping, T2-dark-fluid imaging, diffusion-weighted imaging, and contrast-enhanced T1-weighted imaging were performed for all patients. With 3D Slicer (version 4.10.2, [www.slicer.org](http://www.slicer.org)), regions of interest were manually delineated on each slice of T2 maps by the consensus of two blind neuroradiologists. Necrosis, large vessels, and calcification were excluded. From each ROI, we calculated the following histogram parameters using FeAture Explorer (FAE; <https://github.com/salan668/FAE>): mean, median, maximum, minimum, ten percentiles (P10), 90 percentiles (P90), interquartile range (IQR), range, entropy, skewness, kurtosis, uniformity, and variance. Parameters were compared using the independent t-test or Mann-Whitney U test. Multivariate logistic regression and receiver operating characteristic (ROC) analysis were performed to evaluate their diagnostic efficiency. The significance level of p value is 0.05.

## RESULTS

Compared to HGM, there were significantly higher T2 (p = 0.021) and ADC (p = 0.012-0.002) histogram parameters in LGM. ADC P10 had the highest area under the ROC curve (AUC = 0.811) among all the ADC parameters and T2 kurtosis showed an AUC of 0.564. Notably, the combination of T2 and ADC exhibited the best diagnostic performance (AUC = 0.868).

## CONCLUSION

It has been demonstrated that T2 and ADC histogram parameters could be used to distinguish LGM from HGM, which is consistent with previous studies. Furthermore, the multivariate logistic regression model combining T2 and ADC was suggested to have the best diagnostic efficiency.

## CLINICAL RELEVANCE/APPLICATION

Meningioma grade is an essential factor that affects the treatment planning and recurrence rate. The combination of T2 and ADC values could provide significant value for the non-invasive prediction of meningioma grade.

## W2-SPPH-3 Deep Learning-Based Spatial Resolution Improving Algorithm (Precise IQ Engine: PIQE) for MRI: Capability for Scan Time Reduction and Image Quality Improvement as Compared with Deep Learning Reconstruction (DLR) with and without New Fine Reconstruction Algorithm

Yoshiharu Ohno, MD, PhD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Daiichi Sankyo Co, Ltd; Research Grant, Ministry of Education, Culture, Sports, Science and Technology

## PURPOSE

Deep learning reconstruction (DLR) with and without fine reconstruction algorithm (i.e. fine recon) has been clinically set for denoising MR images with and without increasing spatial resolution. In this time, deep learning-based spatial resolution improving algorithm with denoising (Precise IQ Engine: PIQE) is developed for MRI. The purpose of this study was to directly compare utilities of PIQE for scan time reduction and image quality improvement of MRI as compared with DLR with and without fine recon.

## METHODS AND MATERIALS

Sixty-eight consecutive patients suspected with 28 brain tumors, 14 musculoskeletal diseases, 14 uterine or ovarian tumors and 12 prostatic cancers were prospectively scanned with conventional MR protocols and new MR protocols, which were obtained same sequences with reducing matrix sizes ranged from 50% to 70%. Then, each conventional MR data was reconstructed with DLR with and without fine recon, and all new protocol data were reconstructed with PIQE as well as DLR with and without fine recon (total five data sets). To compare scan time reduction and quantitative spatial resolution improvement among all protocols, mean examination time including reconstruction time and edge slope width (ESW) between two different structures were compared among five protocols by Tukey's HSD test. To evaluate qualitative spatial resolution improvement, overall image quality and diagnostic confidence level were assessed by 5-point scales and compared among all protocols by Wilcoxon's signed rank test.

## RESULTS

Mean examination times of new MR protocols were significantly shorter than that of conventional protocols ( $p < 0.05$ ), although mean examination time had no significant differences among all new protocols. Mean ESW of new protocol with PIQE ( $1.1 \pm 0.3 \text{ mm}$ ) was significantly smaller than that of all protocols except conventional protocol with DLR and fine recon ( $1.4 \pm 0.4 \text{ mm} = \text{other ESWs} = 1.8 \pm 0.4 \text{ mm}$ ,  $p < 0.05$ ). Overall image quality and diagnostic confidence level of new protocol with PIQE were significantly higher than those of others except conventional protocol with DLR and fine recon (overall image quality:  $p < 0.0001$ , diagnostic confidence level:  $p < 0.0001$ ). Artifact of new protocol with PIQE was significantly smaller than those of others without conventional protocol with DLR and fine recon ( $p < 0.0001$ ).

## CONCLUSION

PIQE has superior potential to DLR with and without fine reconstruction for reducing temporal resolution and improving spatial resolution, although fine reconstruction can only improve image quality of DLR at conventional protocol.

## CLINICAL RELEVANCE/APPLICATION

PIQE has superior potential to DLR with and without fine reconstruction with reducing temporal resolution and improving spatial resolution.

## W2-SPPH-4 Early Detection of Myocardial Involvement by Noncontrast T1 $\rho$ Mapping of Cardiac Magnetic Resonance in Type 2 Diabetes Mellitus

Xiaohu Li, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the feasibility of T1 $\rho$  in detecting myocardial fibrosis in type 2 diabetes mellitus (T2DM) patients by comparing with native T1 and Extracellular volume (ECV) fraction.

## METHODS AND MATERIALS

35 T2DM patients free of cardiovascular symptoms and preserved ventricular systolic function and 30 healthy controls were prospectively enrolled for T1 mapping, T2 mapping T1 $\rho$  mapping, and late gadolinium enhancement (LGE) examination. ECV

mps were calculated using pre- and post-contrast T1 maps. Global native T1, T1?, ECV and 2D global longitudinal strain (GLS) values were generated in respective maps. Receiver operating curves were used to show the diagnostic performance of ECV, T1?, GLS and native T1 in distinguishing T2DM patients and controls. The Student's t-test, Pearson's chi-squared test, Pearson correlation coefficient (r) and Delong test were used in this study. P < 0.05 indicates statistical significance.

## RESULTS

The global ECV and T1? of T2DM group (ECV = 32.1±3.2%, T1? = 53.1±2.0 msec) were significantly higher than those of controls (ECV = 26.2±1.6 %, T1? = 51.6±3.8 msec) (all P < 0.001), whether there was no significant difference in native T1 between T2DM and controls (P = 0.264). The GLS decreased significantly in T2DM patients (-16.5±2.4% vs. -18.3±2.6%, P = 0.015). The T1? and native T1 were associated with ECV (Pearson's r = 0.50 and 0.25, respectively, both P < 0.001), the native T1, T1?, and ECV were associated with hemoglobin A1c (Pearson's r = 0.41, 0.52, and 0.61, respectively, all P < 0.05), the ECV were associated with diabetes duration (Pearson's r = 0.41, P = 0.016). The AUC of ECV, T1?, GLS, and native T1 were 0.869, 0.810, 0.659, and 0.524, respectively.

## CONCLUSION

In T2DM patients, T1p may be a new noncontrast cardiac magnetic resonance technique for identifying myocardial diffuse fibrosis, and T1p may be more sensitive than native T1 in the detection of myocardial diffuse fibrosis.

## CLINICAL RELEVANCE/APPLICATION

It has shown that T1? mapping allow early detection of myocardial diffuse fibrosis in diabetic monkeys. However, T1? has not been reported in patients with type 2 diabetes mellitus (T2DM). In this project, the purpose of this study is to evaluate the feasibility of T1? in detecting myocardial diffuse fibrosis in T2DM in a comparison with myocardial native T1 and ECV.

## W2-SPPH-5 Changes in Brain Susceptibility in Wilson's Disease Patients: A Quantitative Susceptibility Mapping Study

Xiaohu Li, MD, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

To reveal changes in the susceptibility of the caudate nucleus (CN), putamen (Put), and globus pallidus (GP) in patients with neurological and hepatic Wilson's disease (WD) by quantitative susceptibility mapping (QSM).

### METHODS AND MATERIALS

We retrospectively analyzed brain MRI images of 33 patients diagnosed with Wilson's disease (WD) and 20 age-matched controls. All subjects underwent brain T1-weighted, T2-weighted, and QSM images using a 1.5T MRI scanner. The QSM maps were calculated using STISuite toolbox. The quantitative susceptibility of the CN, Put, and GP was analyzed using region-of-interest analysis on QSM maps. The differences among the neurological WD patients, hepatic patients, and controls were compared.

### RESULTS

Susceptibility values were significantly higher in all examined structures (CN, Put, GP) in patients with neurological WD compared to controls (all P < 0.05) and hepatic WD patients (all P < 0.05). No statistically significant differences were found in susceptibility values between patients with hepatic WD and controls (all P > 0.05).

### CONCLUSION

The QSM technique is a valuable tool for detecting changes in susceptibility in the brain of WD patients, indicating abnormal metal deposition. Notably, our findings suggest that neurological WD patients exhibit more severe susceptibility changes than hepatic WD patients. Therefore, QSM can be utilized as a complementary method to detect brain injury in WD patients.

### CLINICAL RELEVANCE/APPLICATION

Quantitative magnetic susceptibility imaging (QSM) is an advanced MRI technique for magnetic susceptibility evaluation, providing accurate quantitative measurements of the spatial distribution of magnetic susceptibility

## W2-SPPH-6 Vendor-independent MRI Pulse Sequence Development to Increase Comparability in Cross-vendor Imaging Studies

Simon Konstandin, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

Magnetic Resonance Imaging is a complex and versatile imaging method, given by the ability to visualize various contrasts and physiological processes. MRI research is commonly achieved by implementing new pulse sequences in vendor-specific development environments. During the last years, vendor-independent MRI frameworks gained attention. Previously, we introduced a vendor-independent MRI pulse sequence development framework that provides a product-like experience on-site, called gammaSTAR [Cordes C et al. Magn Reson Med 2020;83(4):1277-90.]. Until today, none of these frameworks was

able to run the same MRI sequence on the MRI hardware of the three largest MRI vendors: Siemens, GE and Philips. In this abstract, for the first time, we show cross-vendor use of gammaSTAR MRI sequences on all three platforms.

## **METHODS AND MATERIALS**

A modular web frontend (free version here: [gamma-star.mevis.fraunhofer.de](http://gamma-star.mevis.fraunhofer.de)) is used to implement MRI sequences and export them into a generalized sequence format. This does not consist of fixed hardware instructions, but holds the fundamental calculation logic of the implemented MRI sequence, allowing for product-like interaction with the MRI sequence and protocol. gammaSTAR driver software is implemented using the vendors development environments to interpret the gammaSTAR sequences and translate events into the vendor-specific hardware commands.

## **RESULTS**

MRI experiments show the feasibility of running MRI sequences developed in the vendor-independent gammaSTAR framework on Siemens, GE and Philips MRI scanners. Image quality is similar to corresponding product MRI sequences and the framework allows for the same protocol interaction and positioning. Low cross-vendor comparability of conventional MRI arises from underlying implementation differences. The use of the same MRI sequence for execution on different MRI hardware allows, for the first time, a comparison of the exact same MRI sequence in a multi-vendor scenario.

## **CONCLUSION**

MRI sequences developed in gammaSTAR were for the first time executed on hardware platforms of all three major MRI vendors. This will eventually open up science and improve the significance of multi-vendor clinical trials by harmonizing imaging technology.

## **CLINICAL RELEVANCE/APPLICATION**

The current state of vendor-centric MRI pulse sequence development limits reuse of MRI applications for different MRI models, software versions. The execution of generalized MRI sequences on MRI hardware of the three largest MRI vendors presents a chance for higher comparability in multi-vendor clinical trials, between follow-ups acquired in different clinics and re-use of MRI sequences for opening up science and accelerating the way of innovation into clinical practice.

## **W2-SPPH-8 Egress Pathways of Intrinsic CSF Outflow Altered by Physical Exercise in Healthy Humans**

Mitsue Miyazaki, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate egress pathways of intrinsic CSF outflow and their quantitative metrics using a spin-labeling MRI technique on healthy adults with active and sedentary lifestyles. We also examined changes in the CSF outflow metrics in sedentary adults after they increased their physical activity levels for three weeks.

## **METHODS AND MATERIALS**

Eighteen healthy adults with informed consent were enrolled in this study using a clinical 3-Tesla MRI scanner. We classified participants into two groups based on reported time spent sitting per day (active group < 7 hours or an average of  $5.3 \pm 0.7$  and sedentary group = 7 hours or an average of  $10.4 \pm 1.7$ ). To reveal the effect of exercise, the sedentary individuals were asked to increase their activity to at least about 3.5 hours per week for 3 weeks. To elucidate intrinsic CSF outflow pathways and quantitative metrics, we studied a signal increase ratio (SIR) of time-resolved images at various inversion times (TI). Our hypothesis is that intrinsic CSF egress pathways of 1) dura mater to superior sagittal sinus (SSS), via parasagittal dura (PSD), and 2) the lower PSD pathway from the perivascular space of subcortical or bridging veins. We also measured quantitative outflow metrics at 5 segmented region-of-interests (ROIs); upper PSD, middle PSD, lower PSD, SSS, and entire SSS.

## **RESULTS**

The active lifestyle group shows greater intrinsic CSF outflow metrics in peak height (PH), relative CSF volume (rCFV), and relative CSF flow (rCFF) ( $p < 0.05$ ) in all above ROIs than the sedentary lifestyle group. However, the sedentary group shows increased outflow metrics after 3 weeks of increased physical activity. This improvement was notable at the PSD, where outflow metrics were highest among the active group and after exercise in sedentary group. These quantitative CSF results indicate a new pathway of CSF outflow from the lower PSD to the SSS that is most evident in physically active individuals.

## **CONCLUSION**

The results show that physical exercise alters CSF outflow metrics to a greater degree in the lower PSD pathway, which may be responsible for the perivascular space of cortical veins or subpial space.

## **CLINICAL RELEVANCE/APPLICATION**

Our findings in healthy adults with active and sedentary lifestyles reveal differences in quantitative CSF outflow metrics related to activity levels. These quantitative outflow findings at the lower PSD add credence to the hypothesis of a distinct, recruitable second pathway of CSF egress from the subpial space to the SSS, with potential implications for future use as a biomarker for cognitive decline and/or therapeutic targeting in aging and neurodegeneration.

## **W2-SPPH-9 A Robust Spectroscopic Imaging Sequence for 7T Brain Glioma Evaluation**

Jullie W. Pan, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To implement a robust fast targeted spectroscopic imaging sequence at 7T for brain tumors. While 3T single voxel spectroscopy is an excellent acquisition, with limited scan time, small voxel targets, and the need to place single voxels by the technologist can be difficult. These problems can be better managed with higher SNR at 7T; however, 7T can be difficult for spectroscopy with limited RF and susceptibility. We implement the decoupled transceiver coil and a high degree shim insert with an efficient spatial encoding strategy to assess its performance in glioma patients.

### **METHODS AND MATERIALS**

With IRB oversight, tumor patients were recruited from Tumor Board review (10 patients recruited; 9 completed). An 8 channel pTx Siemens 7T Terra, decoupled transceiver and very high order shim (VHOS) insert was used. After whole brain MP2RAGE imaging and RF shimming, the target regions were identified. For optimal shimming, single slices were studied, shimmed using a high accuracy field map with the VHOS insert. A moderate echo TE=40ms spectroscopic imaging sequence encoded with a noncartesian rosette trajectory was used (32x32 resolution, 4.5min single slice). First level SAR monitoring was used. Automated LCModel curve fit was used to determine metabolite ratios. Values of maximum Ch/NAA value in the region of the lesion were used to identify 3 groups of abnormality:  $\geq 1.7$ ,  $\geq 0.9$  to  $< 1.7$  or  $< 0.9$ . All studies were blinded to clinical and imaging data to independently compare clinical to spectroscopic imaging group.

### **RESULTS**

Fig. 1 shows data from a patient with two regions of interest. Based on literature and the patient data, the ratios for Ch/NAA and Ch/Cr were used for initial classification (control value for parenchymal Ch/NAA  $0.56 \pm 0.17$ , Ch/Cr  $1.03 \pm 0.15$ ). The spectroscopic group based on the maximum Ch/NAA in the region of tumor was compared with their clinical group, either active tumor, treatment effect or no change, Table 1. N=5 patients with Ch/NAA  $\geq 1.7$  were classified with active tumor; 1 patient classified as normal had low Ch/NAA  $< 0.9$ . The remaining 3 patients ( $0.9 \leq \text{Ch/NAA} < 1.7$ ) were clinically described as treatment effect (1), progression (1) or no change (1); the last "no change" patient was identified 6mos later to have progression.

### **CONCLUSION**

At 7T with the decoupled transceiver and high degree shim insert, the spectroscopic imaging was able to identify patients with active tumor. An intermediate threshold for Ch/NAA of 0.9 to 1.7 identified those with treatment effect or very early recurrence. With additional data, better classification may be possible.

### **CLINICAL RELEVANCE/APPLICATION**

We have implemented 7T methods that can acquire robust spectroscopic images in glioma patients which can contribute to a better or earlier understanding of the tumor state.

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## Abstract Archives of the RSNA, 2023

W2-SPRO

### Radiation Oncology Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### W2-SPRO-1 Deep Learning Prediction of Post-Radiation Magnetic Resonance Images to Inform Stereotactic Radiotherapy of Breast Cancer Metastases to the Brain

Natarajan Raghunand, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Changes on standard multiparametric MRI (mpMRI), including T1-weighted unenhanced (T1w) and contrast-enhanced (T1wCE), T2-weighted (T2w), Fluid-Attenuated Inversion Recovery (FLAIR), and Apparent Diffusion Coefficient of water (ADC) images are mechanistically relatable to voxel-level tumor response to Radiation Therapy (RT). While Stereotactic Radiosurgery (SRS) provides high local control rates for the management of Breast Cancer Metastases to the Brain (BCMB), tools to enable voxel-level optimization of RT dose plans for local tumor control with minimal toxicity to normal tissues do not exist. We have trained deep learning "forward models" to predict post-SRS T1w, T1wCE, T2w, FLAIR and ADC maps from the corresponding 5 pre-SRS mpMRIs and the delivered RT dose map. We also trained an "inverse model" to predict the delivered RT dose map from 5 pre-SRS and 5 post-SRS mpMRI images. The overarching goal is to enable the radiation oncologist to compute the RT dose map to achieve prescribed post-SRS values of ADC, T1wCE, T1w, T2w and FLAIR within the GTV, simulate mpMRI outcomes and iteratively optimize RT plans for local control of BCMB.

#### METHODS AND MATERIALS

Planning CT images and associated RT dose maps, and T1w, T1wCE, T2w, FLAIR images and ADC maps acquired pre-SRS, post-SRS, and at tumor recurrence were curated from 27 BCMB patients (18 Training, 9 Test) with confirmed controlled and locally recurrent metastases. Patients were treated with SRS dose of 1-40 Gy between 2013-2019. After co-registration to the planning CT, all mpMRIs were intensity-calibrated, variance-normalized and scaled. A pix2pix framework used to predict post-SRS MRIs from pre-SRS MRIs and the RT dose map (5 forward models). Another pix2pix model was trained to predict the RT dose map from pre-SRS and post-SRS MRIs (inverse model).

#### RESULTS

On testing, forward model accuracy for predicting the direction of post-SRS intensity change within the Gross Tumor Volume (GTV) was highest for T1wCE (83%), followed by T1w (77%), FLAIR (75%), T2w (68%), and ADC (46%). In agreement with expectations, higher RT doses within the GTV are predicted by the inverse model to achieve greater suppression of intensity on T1wCE and/or higher ADC within the GTV post-SRS.

#### CONCLUSION

We have demonstrated the feasibility of predicting post-RT mpMRI images from pre-RT mpMRIs and the delivered RT dose map. For a given set of pre-RT mpMRIs, we have also demonstrated the feasibility of predicting the RT dose map that would be required to achieve prescribed post-RT intensities within the GTV.

#### CLINICAL RELEVANCE/APPLICATION

We present a new paradigm in RT planning, viz., voxel-level optimization of SRS dose to achieve prescribed post-SRS mpMRI characteristics of treated tumors using the presented forward and inverse models.

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## Abstract Archives of the RSNA, 2023

W2-SPVA

### Vascular Imaging Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### W2-SPVA-1 Tele-robotic Ultrasound Usability Testing on a Phantom

Leah Groves, PhD (*Presenter*) Nothing to Disclose

##### PURPOSE

Annually, 16 million North American patients struggle to access diagnostic ultrasound (US) services due to sonographer shortages. Rural and remote patients are required to travel excessive distances to access diagnostic US services, which can be time-consuming and expensive resulting in patients failing to attend their appointments. The aim of this study is to validate a proof-of-concept tele-robotic US system which serves to make diagnostic healthcare more accessible.

##### METHODS AND MATERIALS

The equipment used in the study included the Kinova Gen 3 robot, Clarius L7 US probe, the Inverse3 (input device), and an advanced deep-vein thrombosis (DVT) phantom. First, seven sonographers performed freehand DVT scans on the phantom. After successful training, each sonographer performed a teleoperated DVT scan, where they controlled the robot using the input device. The required US images, clot diameter, and scan duration were recorded for the freehand and teleoperated scans. The users then completed a survey, where various parameters were ranked on a scale of 1-5, with 5 being optimal. Next, each user performed three teleoperated scans with three random and counter-balanced latencies (0, 300, 600 ms). They started at a standardized position, located the clot, and measured its diameter. The duration of each test was recorded.

##### RESULTS

The clot diameters collected using freehand and teleoperated US were  $1.1 \pm 0.2$  cm and  $1.0 \pm 0.3$  cm, respectively. The time associated with performing the freehand and teleoperated DVT scans were  $8.7 \pm 3.8$  min and  $8.0 \pm 2.0$  min, respectively. The usability survey yielded the following average rankings for input device features: naturalism and usable workspace, 3.4; ergonomics, 3.9; ease of use, 4.3. The rankings for the robotic system features were: smoothness, 3.1; naturalism, 3.4; range of motion, 3.6; and control accuracy, control ease, and synchronicity, 3.7. The clot diameter collected with teleoperated US were  $1.2 \pm 0.24$  cm,  $1.1 \pm 0.32$  cm, and  $1.1 \pm 0.24$  cm for 0, 300, and 600 ms latencies, respectively. The duration of the tests subject to 0, 300, 600 ms latencies were  $1.3 \pm 0.69$  min,  $1.4 \pm 0.69$  min, and  $1.9 \pm 0.68$  min, respectively.

##### CONCLUSION

This study provides a proof-of-concept for the use of teleoperated diagnostic US as sonographers were able to measure the clot diameter within 0.1 cm of their freehand equivalent without increasing the time required for the scan. Latencies up to 600 ms did not affect the accuracy of the resultant clot diameter or scan time.

##### CLINICAL RELEVANCE/APPLICATION

The results of this proof of concept study encourages the continued pursuit of teleoperated US research as there is a strong potential it could result in more patients obtaining diagnostic US, improved outcomes from earlier diagnosis, and safer pregnancies.

#### W2-SPVA-2 Diagnostic Accuracy of Photon-Counting CT Angiography in Lower Extremity Peripheral Artery Disease: A Head-to-Head Comparison with Invasive Angiography

Niklas Verloh, MD (*Presenter*) Speaker, Bayer AG; Research Funded, Bayer AG

##### PURPOSE

CT Angiography (CTA) has gained increasing importance in assessing the presence and severity of peripheral artery disease (PAD). However, the diagnostic performance of the lower leg vasculature remains challenging due to small vessel diameters and impaired image quality caused by the blooming of calcified plaques. Recently introduced photon-counting detector CT

(PCD-CT) technology may overcome these limitations. Therefore, we aimed to investigate and compare the diagnostic accuracy of PCD-CT for PAD of the lower leg with invasive digital subtraction angiography (DSA) as the reference standard.

## **METHODS AND MATERIALS**

Consecutive patients with suspected PAD of the lower leg, who underwent CT and DSA within 48 hours, were prospectively included. Five series were reconstructed using dedicated vascular kernels (Bv40, Bv44, Bv48, Bv56, and Bv60). DSA of the lower extremities was acquired in two orthogonal orientations as the gold standard. To assess and compare the diagnostic performance of the different PCD-CT reconstructions, two interventional radiologists assessed all PCD-CT and DSA data independently in random order. They were blinded to the type of reconstruction. First, overall image quality was rated on a 5-Point Likert scale (5=excellent). Secondly, the presence and diagnostic confidence (5-Point Likert scale; 5=excellent) of potentially hemodynamic-relevant stenosis (=50%) was assessed.

## **RESULTS**

Among twenty-three patients included in the final analysis (70±11 years, 39% female), six hemodynamic-relevant stenoses were detected on DSA. The highest overall image quality was found for the Bv56 and the Bv60 kernel (4 [4-4]; 4 [3-5];  $p=0.001$ ), followed by softer kernels. Also, the Bv56 kernel yielded the highest sensitivity (83.33%) and specificity (94.12%) for the detection of potentially relevant stenosis with the highest diagnostic confidence (4 [3-5];  $p=0.001$ ) and inter-reader agreement ( $k=0.7$ ), similarly followed by Bv60 and softer kernels.

## **CONCLUSION**

PCD-CT CTA with a sharp vascular kernel (Bv56) allows for detecting relevant stenosis in the lower leg vasculature with high diagnostic accuracy and confidence. These results can potentially strengthen the role of CTA in the workup of patients with known or suspected PAD and reduce the number of invasive diagnostic DSA.

## **CLINICAL RELEVANCE/APPLICATION**

CTA is important in the workup of PAD but remains challenging due to small vessel caliber and potential blooming artifacts. PCD-CT CTA with a sharp vascular kernel may improve image quality and, thus, patient management. Using PCD-CT may ultimately reduce the need for invasive diagnostic procedures.

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## Abstract Archives of the RSNA, 2023

W5A-SPBR

### Breast Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPBR- Correlation between Sarcopenia Evaluated with CT and Toxicity in Patients Affected by Breast Cancer during Adjuvant Chemotherapy** 1

Marco Di Girolamo, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Recent evidences suggest that in severe depletion of skeletal muscle, known as sarcopenia, the anti-cancer therapy is associated with poor prognosis and toxicity. Sarcopenia, often unrecognized, affects patients with low, normal or high body mass index (BMI). Aim of this study was to evaluate the association between lumbar skeleton muscle status (LSMI) evaluated with CT scans and toxicity in breast cancer patients receiving standard adjuvant chemotherapy

#### **METHODS AND MATERIALS**

22 breast cancer women (mean age:55) receiving epirubicin-based chemotherapy were enrolled in a prospective study. Skeletal muscle cross-sectional area at the third lumbar vertebra was measured by CT scans and sarcopenia was defined using the cut off point for LSMI of  $<38.5 \text{ cm}^2/\text{m}^2$ . BMI and BSA were measured at every cycle of chemotherapy. CT scan was performed before the first and fourth cycle of chemotherapy. Toxicity was assessed after every cycle of treatment and it was graded according to the National Cancer Institute Common Toxicity Criteria. Serum samples were evaluated at every cycle to determine drug concentrations.

#### **RESULTS**

Before the first cycle of chemotherapy, 86.36% of patients were classified as sarcopenic. The sarcopenia mean value was  $32.22 \text{ cm}^2/\text{m}^2$  (SD: 5.78), and no differences by age and BMI were found. The BMI mean value was 23.97 (SD: 4.32). After the fourth cycle of chemotherapy the BMI mean value was 24.19 (SD: 4.74; range) and the sarcopenia mean value was  $32.18 \text{ cm}^2/\text{m}^2$  (SD: 5.68). 18% of patients reported severe toxicities (grade 3 or 4). Sarcopenia mean values were found significantly different (p-value 0.048) in patients with severe toxicity compared with patients with absent/mild toxicities (mean value: 27.17, SD, 3.27 versus 33.30, SD, 5.55, respectively). Changes in LSMI were associated with significant changes in toxicities (p-value 0.004). In 18% of patients with a severe toxicity, a decrease in LSMI values after the 4th cycle of chemotherapy was always detected.

#### **CONCLUSION**

Preliminary analysis of available data showed an association between sarcopenia and toxicities, suggesting also that sarcopenia could be considered an early condition in breast cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

If the association between changes in sarcopenia and toxicities will be confirmed in larger population, the measure of LSMI with CT scan could be used to personalized the dose of chemotherapy

#### **W5A-SPBR- Complex Interplay of MRI and Clinicopathology Variables in pCR Prediction across Breast Cancer Subtypes** 2

Sarah Eskreis-Winkler, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Breast cancers exhibit different rates of pathologic complete response (pCR) according to tumor receptor status: HR+/HER2-, HER2+, and triple negative (TNBC). Deep learning (DL) models using MR have been developed for pCR prediction, but the comparative performance of pCR prediction for different subtypes has not yet been investigated. Herein, we build pCR

prediction models for each subtype, compare performance across subtypes, and explore relationships to clinicopathology (CP) models.

## **METHODS AND MATERIALS**

This IRB-approved HIPAA-compliant study included 719 breast MRs performed between 2014-2018 on breast cancer patients prior to neoadjuvant chemotherapy. Tumor subtype, pCR status, and CP variables were collected, including age, race, cancer history, clinical stage, nuclear grade, histological grade, and histology. A ResNet50-based architecture was built to predict pCR for each subtype using MR. Data was randomly split 80/10/10 into training, tuning and testing. Pre-contrast, post-contrast, subtraction, and T2 images were co-registered; tumor ROIs were automatically segmented and passed through the model. Final hyperparameters: 25 epochs; learning rate 2e-4, batch size 64. A penalized logistic regression model was built to predict pCR using CP variables alone. Patients were randomly assigned to training and testing with an 80/20 split. ROC curves were generated and AUCs were calculated for each subtype, for the MR and CP models. DeLong's test assessed statistical significance of differences in model performance.

## **RESULTS**

Breast MRs included 210 HR+/HER2- (5050 axial slices), 349 HER2+ (8325 axial slices) and 160 TNBC (4521 axial slices) cases. Test set AUCs for the MR models were 0.62 for HR+/HER2-, 0.48 for HER2+, and 0.78 for TNBC. The best AUC (i.e. TNBC) was statistically significantly higher than to the worst AUC (i.e. HER2+) ( $p < 0.001$ ). For the CP model, test set AUCs were 0.80 for HR+/HER2-, 0.68 for HER2+, and 0.55 for TNBC.

## **CONCLUSION**

DL-based MR model performance for pCR prediction varies by subtype with the TNBC (AUC = 0.78) significantly outperforming HER2+. In contrast, the CP model exhibited poor performance for TNBC (AUC = 0.55). This suggests synergistic potential for pCR prediction using medical images and CP. We are actively working to develop a composite model that integrates multimodality inputs to optimize pCR prediction across all patients and all tumor subtypes.

## **CLINICAL RELEVANCE/APPLICATION**

DL-based MR models for pCR prediction perform better on some tumor subtypes than others, providing complimentary information to clinicopathology variables. This suggests synergistic potential for pCR prediction using a multimodality approach, enabling optimization of treatment planning for all breast cancer patients.

## **W5A-SPBR- What is the Optimal Post Contrast Timing of Breast MRI to Evaluate Residual Tumor during the Course of Neoadjuvant Chemotherapy**

Phuong T. Duong, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Patients undergoing neoadjuvant chemotherapy (NAC) are often monitored using dynamic contrast enhanced (DCE)-MRI, a sensitive tool for residual tumor assessment. NAC can have antiangiogenic effects that can impact accurate assessment of residual tumors. Purpose of this study is to evaluate the optimal post contrast timing to evaluate residual tumor during the course of NAC.

## **METHODS AND MATERIALS**

An IRB approved study was performed. Publicly available 351 MRI exams from 117 breast cancer patients undergoing NAC in the ACRIN 6698 multi-institution trial were used for this study. The average age of patients was 49 y.o. (+/-11). Of 117 patients, 36 patients (30.8%) achieved pathologic complete response (pCR) and 81 patients (69.2%) did not (non-pCR). Of 117 patients, 36 patients (30.7%) had triple negative tumors (ER-,PR-,HER2-), 30 patients (25.6%) had HER2+ tumors and 51 patients (43.6%) had ER+/HER2- tumors. The MRI exams included those from pretreatment [T0], early NAC treatment [T1], and mid-NAC treatment [T2]. For each tumor, we calculated the time to peak (TTP) to achieve maximal tumor enhancement and evaluated changes in TTP over the course of NAC treatment. TTP was calculated by segmenting the tumor and calculating the phase with maximum signal intensity measured within the tumor. TTP subanalysis was performed comparing patients with tumors that achieved pCR vs non-pCR and between subtypes of breast cancer. Statistical significance was determined with  $p < 0.05$  from a 2-tailed paired t-test.

## **RESULTS**

The TTP increased significantly over the course of NAC treatment. The TTP at T1 was 265 sec (+/-151), at T2 was 314 s (+/- 314) and at T3 was 385 s (+/- 183). The average TTP increase of 159 s (+/- 146) from T0 to T2 was statistically significant ( $p < 0.05$ ). Tumors of patients that achieved pCR had significantly greater change in TTP from T0 to T1 compared to non-pCR [183 s (+/-147) vs. 15 s (+/- 103),  $p < 0.05$ ]. Patients with triple negative and HER2+ tumors had greater change in TTP from T0 to T1 compared to ER+/HER2- tumors [90 s (+/-212) and 63 s (+/- 209) vs. 5 s (+/- 229)] but was not statistically significant.

## CONCLUSION

The optimal post contrast timing of breast MRI increases with NAC likely due to antiangiogenic treatment effects. DCE-MRI protocol should include delayed post dynamic sequences inclusive of 314 s to 385 s to enable maximal tumor enhancement to best evaluate residual tumor during NAC, particularly in triple negative and HER2+ tumors. A significant increase in TTP from T0 to T1 could be a possible novel biomarker of pCR but needs further studies.

## CLINICAL RELEVANCE/APPLICATION

In the setting of NAC, the most optimal timing of breast MRI is likely on the delayed post contrast images and should be part of the evaluation to most accurately assess residual breast tumor.

## W5A-SPBR- Correlation of MRI and Pathological Responses after Neoadjuvant Chemotherapy with Disease-Free Survival in Breast Cancer Patients: Subtype Analysis

4

Ricardo Fernandes Da Cunha, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To correlate response evaluation after neoadjuvant chemotherapy (NAC), assessed by magnetic resonance imaging (MRI) and pathology, with disease-free survival (DFS) in breast cancer patients, according to the subtype.

## METHODS AND MATERIALS

This single-center, IRB-approved, retrospective cohort study included consecutive breast cancer patients who underwent NAC and preoperative breast MRI. Pathologic response was assessed through the residual cancer burden (RCB) system, and absence of invasive carcinoma in the breast and axilla was defined as complete pathological response (pCR or RCB-0). Radiological complete response (rCR) was defined as the absence of abnormal enhancement in the tumor site on MRI. Kaplan-Meier estimator was used to estimate the disease-free survival. Cox regression analysis was used to estimate hazard ratio (HR) values.

## RESULTS

750 patients were included with mean age of 47 years (range: 26-90 years). The most common immunophenotype was Luminal (n=362; 48.3%), followed by triple-negative (n=198; 26.4%) and Her-2 overexpressed (n=190; 25.3%). Most patients (n=474; 63.2%) had clinical stage III at diagnosis. Overall, 34.5% of the patients had rCR, while 30.3% had pCR. During a mean follow-up of 72 months, patients who had both rCR and pCR had a better DFS curve, while patients with non-rCR and non-pCR had worse DFS curve, and those who had rCR or pCR presented an intermediate curve (LogRank p=0.001). The statistically significant difference on DFS curves persisted for triple-negative (LogRank p<0.001) and Her-2 overexpressed subtypes (LogRank p = 0.014), but not for luminal tumors (LogRank p=0.495). Cox regression showed a higher risk of recurrence in patients with non-rCR and non-pCR (HR: 8.686; p=0.003), those who had non-pCR and rCR (HR: 7.658; p=0.008), and those who had pCR and non-rCR (HR: 3.644; p=0.109), when compared to patients with rCR and pCR.

## CONCLUSION

The association of MRI and pathological responses after NAC might better stratify the risk of recurrence and prognosis in breast cancer patients, particularly for the triple-negative subtype.

## CLINICAL RELEVANCE/APPLICATION

Association of response evaluation after neoadjuvant chemotherapy by pathology and MRI allows better stratification of prognosis than both criteria used alone.

## W5A-SPBR- Features of MRI Screen-Detected Breast Cancers

5

Naveen Ghuman, BS, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Breast cancer is a leading cause of death in women in the United States. Supplemental screening with breast MRI in addition to mammography is recommended annually for patients who have greater than 20% lifetime risk for breast cancer. While there is robust data regarding features of screen-detected breast cancer using mammography, there is limited data regarding MRI screen-detected cancers. This study aims to identify features of breast cancers initially detected by MRI.

## METHODS AND MATERIALS

In this institutional review board-approved retrospective study, breast MRIs performed between August 1, 2016 and July 30, 2022 identified 51 screen-detected breast cancers in 48 patients. Clinical and imaging features of all eligible cancers were recorded, as well as frequency of cancer type and clinical stage.

## RESULTS

During the study period, 51 MRI-screen detected cancers were identified in 48 patients. Most cancers (33/51, 64.8%) were invasive and most (45/51, 88.2%) were stage 0 or I at diagnosis. At the end of the study period, 1/48 (2.1%) had metastasis (in a patient with recurrent angiosarcoma), 1/48 (2.1%) had died from other causes, and 46/47 (97.9%) had no evidence of disease following treatment. Final pathology showed that 26/51 (51.0%) of MRI screen-detected cancers were invasive ductal carcinoma, 6/51 (11.8%) invasive lobular carcinoma, 1/51 (2.0%) angiosarcoma and 18/51 (35.3%) DCIS. MRI-screen detected cancers most commonly presented as a mass (26/51, 51%) or non-mass enhancement (NME) (25/51, 47.1%), with only 1/51 (2%) presenting as a focus. Internal T2 signal was hypointense to fibroglandular tissue in 4/51 (7.8%), isointense in 29/51 (56.9%) and hyperintense in 18/51 (35.3%). Of those cancers that presented as a mass, the majority 15/27 (55.6%) had an irregular shape, 13/27 (48.1%) had irregular margins, and 15/27 (55.6%) had homogeneous internal enhancement. Of those that presented as NME, the majority 13/24 (54.2%) were linear NME and had homogeneous internal enhancement 15/24 (62.5%). Many of the cancers were in patients who had prior MRI exams (37/51, 72.5%).

## CONCLUSION

MRI screen-detected cancers were most often invasive, rather than in situ, cancers. Cancers detected by MRI screening had an excellent prognosis in our study population, supporting the clinical utility of breast MRI in the early diagnosis of breast cancer. Common MRI presentations included an irregular mass and linear non-mass enhancement.

## CLINICAL RELEVANCE/APPLICATION

Screening MRI often detected small, invasive breast cancers, underscoring its clinical importance in women at high risk for breast cancer. Understanding the most common imaging presentations of MRI-screen-detected cancers may guide interpretation and diagnostic performance of the exam.

## **W5A-SPBR- Does the Addition of MRI Help in Cancer Detection in Women with Low Breast Tissue Density 6 in a Population-based High-risk Breast Screening Program**

David G. Martin, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The High-Risk Ontario Breast Screening Program (HROBSP) screens women ages 30-69 who are confirmed to be at high risk of developing breast cancer (gene mutation carriers or lifetime risk =25%) with annual mammography and breast MRI. Mammographic breast tissue density (BTD) is an independent risk factor for breast cancer, and the sensitivity of mammography is diminished in women with dense versus fatty breasts. We aimed to compare cancer detection rate (CDR) according to BTD and determine if breast MRI in HROBSP patients with fatty BTD is necessary given the improved sensitivity of mammography.

## METHODS AND MATERIALS

IRB approved retrospective review of all HROBSP breast MRIs performed at our institution from 04/04/2016 to 06/05/2022 was conducted. For each study, BI-RADS® BTD was recorded, and charts were reviewed to identify patients with breast cancers diagnosed during the screening period. Imaging was reviewed to determine if the cancer was seen on mammography, MRI or both.

## RESULTS

6468 MRIs were reviewed (2082 patients) over 6-year study period. 66 cancers were detected in all (cancer detection rate (CDR)=10.2/1000); 5(7.6%) detected in category A, 20(30.3%) in B, 34(51.5%) in C and 7(10.6%) in D. 468(7.2%) MRIs were performed in 12.5%(260/2082) women with category A, who had 4 cancers (80%) detected on MRI alone and 1 cancer on both mammography and MRI. There was no difference in CDR by BTD (CDR for category A=10.7/1000, B=8.6/1000, C=11.8/1000, and D=9.1/1000, p=0.7).

## CONCLUSION

Adjunctive screening with breast MRI in HROBSP patients is necessary for women with category A density breasts, despite the increased sensitivity of mammography in this patient population.

## CLINICAL RELEVANCE/APPLICATION

The HROBSP program with yearly mammography and breast MRI aids in early detection of breast cancer in all women, regardless of breast density.

## **W5A-SPBR- Outcomes of Supplemental Breast MRI in a High Risk Screening Program 7**

Stamatia V. Destounis, MD (*Presenter*) Medical Advisory Board, iCad, Inc

## PURPOSE

The Tyrer-Cuzick (TC) model has increasingly been used to identify high-risk women in breast imaging centers. The accuracy of the model has been studied in several patient cohorts, but, outcomes of using the TC model to make supplemental breast MRI recommendations are less reported. We studied the incidence of breast cancer and tumor characteristics at a community-based breast imaging center to better understand the outcomes of the risk assessment program.

## METHODS AND MATERIALS

A retrospective analysis of patients participating in the risk assessment program starting in December 2016 was performed. Patients with a TC lifetime risk score >20% were offered supplemental MRI screening and are defined as high-risk (HR) in this study. Data were collected from the electronic health record, including Breast MRI data and cancer outcomes, and was matched to the risk assessment and imaging studies data. We limited our cohort to those with at least 5 years of follow-up. Patients with history of breast cancer prior to the first risk assessment, patients who were under 40 or over 79 years old, and patients without a valid TC score were excluded.

## RESULTS

There were 54,706 patients who met study inclusion criteria with median age of 57, at median follow-up time of 5.2 years during which 2,259 cancers arose. The HR group was comprised of 8,737 (15.5%) patients (median age 52); LR group had a median age of 58 ( $P < 0.001$ ). Of HR patients, there were 2,108 (24.1%) who had breast MRI with a high-risk exam indication (median age 51). Odds ratio (OR) for breast cancer for the total HR group compared to the LR group was 1.50 (95% CI: 1.36 to 1.67,  $P < 0.0001$ ). OR for the HR group who were getting MRI compared to the LR group was 1.47 (95% CI: 1.21 to 1.78,  $P < 0.0001$ ). OR for the HR group who were not getting MRI compared to the LR group was 1.51 (95% CI: 1.35 to 1.70,  $P < 0.0001$ ). When considering tumor size of T2 or greater as large, the OR for a larger tumor when comparing the HR group to the LR was 0.57 (95% CI: 0.39 to 0.84,  $P = 0.0038$ ). For the HR group with MRI the OR was 0.39 (95% CI: 0.17 to 0.91,  $P = 0.029$ ) and the OR for HR group without MRI was 0.63 (95% CI: 0.42 to 0.96,  $P = 0.030$ ). Though not statistically significant, 12.9% of cancers in the LR group were node positive, compared to 6.4% in the HR group with MRI ( $P = 0.0698$ ).

## CONCLUSION

Supplemental MRI screening in high-risk women can lead to earlier detection of breast cancer, finding tumors at lower stage that may lower the burden of disease. Further investigation in how to improve the uptake of high-risk interventions such as breast MRI screening will be beneficial.

## CLINICAL RELEVANCE/APPLICATION

This study reports the impact of offering supplemental breast MRI as part of a large breast screening program. This high-risk cohort had an increased cancer rate and smaller tumors.

## W5A-SPBR- Application Value of Imaging Manifestations Combined with Tumor-Related Diffusion- 8 Weighted Imaging Models in Predicting Molecular Subtype of Breast Invasive Ductal Carcinoma

Cece Dong (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate and compare the value of MR imaging manifestations and 6 tumor-related DWI models in predicting the molecular subtypes of breast invasive ductal carcinoma (IDC).

## METHODS AND MATERIALS

This study included 100 patients with breast IDC confirmed by pathological examination in our hospital. All the patients underwent routine MRI and multiple-b-value DWI examinations on a 3T scanner (MAGNETOM Vida, Siemens, Erlangen, Germany). The scanning parameters are shown in Table 1. The patients were divided into three groups, including luminal ( $n=72$ ), HER-2 overexpressing ( $n=13$ ), and triple-negative ( $n=15$ ) subtypes. The value in predicting the molecular subtype of IDC was evaluated in terms of imaging manifestations and quantitative parameters of DWI models. All the 14 quantitative parameters (CTRW\_a, CTRW\_β, CTRW\_D, FROC\_β, FROC\_D, FROC\_μ, DKI\_D, DKI\_K, IVIM\_D, IVIM\_D\*, IVIM\_f, Mono\_ADC, SEM\_a, and SEM\_DDC) of the 6 DWI models were calculated by an in-house developed software called BoDiLab based on Python 3.7. All ROI measurements were done on the ITK-SNAP. Univariate and multivariate regression analysis were performed to screen independent predictive factors for different molecular subtypes, and a combined model was established, which was then visualized with a nomogram. ROC curves were used to assess the diagnostic performance of each parameters or model in discriminating molecular subtypes. All the analysis was performed using the software SPSS 26.0 and R language.

## RESULTS

Margin burr and rim enhancement were independent imaging manifestation-related predictors of triple-negative breast cancer (TNBC) ( $P < 0.05$ ), which showed high diagnostic performance when combined with CTRW\_a and DKI\_K (AUC/sensitivity/specificity value of 0.870/80.0%/88.2%) (Figure 1). Luminal IDC was more likely to appear with margin burrs ( $P < 0.05$ ), and the diagnostic performance was higher when combined with CTRW\_a, DKI\_K, and IVIM\_f. HER-2-

overexpressing IDC was commonly accompanied by peritumoral edema ( $P < 0.05$ ), and IVIM\_f showed high diagnostic value for this subtype (Table 2, 3). Nomogram for predicting the TNBC and luminal subtype were shown in figure 2.

### **CONCLUSION**

The combined diagnostic model based on imaging manifestations and multiple DWI quantitative parameters has high diagnostic value in predicting the molecular subtype of breast IDC, and the parameters may be used as non-invasive biomarkers in future clinical practice.

### **CLINICAL RELEVANCE/APPLICATION**

This study explored the value of MRI manifestations combined with different DWI quantitative parameters in predicting the molecular subtypes for breast IDC, which may have guiding significance for the formulation of individualized treatment strategies in clinical practice.

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## Abstract Archives of the RSNA, 2023

W5A-SPCA

### Cardiac Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPCA- Diagnostic Accuracy of Spectral CT Aortograms for the Detection of Acute Myocardial Infarction** 1

Dene Ellis, BMBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Acute myocardial infarction (MI) presentation is often atypical and unclear, justifying further investigations for other causes of chest pain. Thus, in modern practice CT aortograms (CTAs) are essential to exclude acute aortic syndrome (AAS). Despite being a non-dedicated study for the assessment of coronary heart disease (CHD), new spectral CT technologies may enable interrogation of coronary abnormalities or discernible myocardial perfusion defects. The aim of this study is to assess the diagnostic performance of gated-spectral CTAs in diagnosing acute MI. This will help to determine the prevalence of acutely presenting CT-imaging features by measuring myocardial Hounsfield Unit (HU) values indicative of evolving regional ischaemia.

#### **METHODS AND MATERIALS**

Retrospective consecutive cohort analysis was conducted to include acute chest pain patients that underwent urgent gated-spectral CTAs as a triple rule-out test for AAS at a large tertiary centre, over 12 months (Jan-Dec 2022). CTAs performed for reasons other than acute pain (e.g. trauma) were excluded. Data sources included patients' electronic records and the institution's PACS, to collate patients' demographics, clinical information, imaging findings, outcomes of further investigations and definitive management. This enabled correlation with troponin levels, ECG, and echocardiographic observations. On CTAs, LV myocardial hypo-enhancement HU was measured after visual assessment by two cardiac-trained radiologists to localise culprit diseased coronary arteries.

#### **RESULTS**

In a total of 309 CTAs, n=30 (9.7%) studies showed regional myocardial hypo-enhancement, confirmed later as acute MI. Of those, n=18/30 (60%); underwent urgent invasive angiography, where n=13 received percutaneous interventions and n=7 required urgent coronary artery bypass graft (CABG) surgery. Two patients died shortly after CTA acquisition, one of which had a post-mortem examination confirming a large territory MI. CTA yields an 90.9% sensitivity, 99.3% specificity and 98.4% accuracy in identifying acute MI (prevalence-adjusted). Ischaemic myocardial regional hypo-enhancement was (HU=50, SD=17.7) significantly lower ( $p<0.001$ ) than healthy myocardium (HU=126, SD=19.4).

#### **CONCLUSION**

At our institution, gated-spectral CTA has been utilised to investigate equivocal acute chest pain presentations in the emergency setting. The benefits of its excellent diagnostic accuracy can be achieved by educating reporting radiologists and cardiologists.

#### **CLINICAL RELEVANCE/APPLICATION**

Gated-spectral CTA can preclude the need for post-mortem examination, but it is most beneficial in reducing time-to-intervention by avoiding unnecessary further tests, especially in equivocal NSTEMI cases.

#### **W5A-SPCA- Measurement Accuracy of Aortic Valve Annulus with and without Whole-heart Motion Correction Algorithm in Multi-slice CT for Pre-operative TAVI: Compared to 3D Transesophageal Echocardiography** 2

Takayuki Yoshiura, BA, RT (*Presenter*) Nothing to Disclose



## PURPOSE

Accurate measurements of the aortic valve annulus with multi-slice CT (MSCT) are required for the success of pre-operative transcatheter aortic valve implantation (TAVI) procedure. The whole-heart motion correction (MC) algorithm is useful for reducing aortic annulus motion artifacts and is expected to measurement accuracy. The purpose of this study is to investigate the measurement accuracy of the aortic valve annulus with and without MC algorithm in MSCT compared to three-dimensional transesophageal echocardiography (3D TEE).

## METHODS AND MATERIALS

We retrospectively analyzed 15 patients who underwent TAVI. The three mutually perpendicular planes so that the cross-sectional plane just passed through the plane of the lowest point of the aortic valve leaflet attachment, and the resulting section was the aortic annulus plane. The axial plane was reconstructed for the minimum aortic annulus diameter, and the valsalva and aortic annulus diameter were measured using 256-slice CT (Revolution Apex; GE Healthcare, Milwaukee, Wisconsin). We created an annulus plane on 3D TEE (EPIQ CVx; Koninklijke Philips Ultrasound, USA) using the same method as CT, and measured the minimum diameter of the valsalva and aortic annulus in the sagittal plane. All CT images were using the with and without MC algorithms and compared to 3D TEE measurements.

## RESULTS

The measured mean diameter of valsalva for axial plane was 30.00 mm and 28.61 mm for with and without MC algorithms. The measured mean diameter of valsalva for the sagittal plane was 30.22 mm for 3D TEE, showing a significant difference between without MC algorithm and 3D TEE ( $p < 0.01$ ), but not between with MC algorithm and 3D TEE ( $p > 0.05$ ). The measured mean diameter of aortic annulus for the axial plane was 20.20 mm and 19.53 mm for with and without MC algorithms. The measured diameter of aortic annulus for the sagittal plane 20.50 mm for 3D TEE, showing a significant difference between without MC algorithm and 3D TEE ( $p < 0.01$ ), but not between with MC algorithm and 3D TEE ( $p > 0.05$ ).

## CONCLUSION

MC algorithm in MSCT enabled the accurate measurements of aortic valve annulus for pre-operative TAVI.

## CLINICAL RELEVANCE/APPLICATION

The application of MC algorithm in MSCT is useful for the accurate measurements of aortic valve annulus for pre-operative TAVI.

## W5A-SPCA- Association between Coronary Sinus Flow Estimated by Dynamic Coronary CT Angiography and 13N-ammonia PET-derived Myocardial Flow Reserve

Michinobu Nagao, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Coronary sinus (CS) flow is regulated by global myocardial blood flow (MBF) and directly affects myocardial flow reserve (MFR) reduction. We devised a new method for CS flow quantification using 320-row dynamic coronary CT angiography (CCTA) and investigated the relationship between CS flow determined via CCTA and MBF or MFR values obtained via 13N-ammonia positron emission tomography (NH3-PET).

## METHODS AND MATERIALS

Forty patients with moderate to severe coronary artery stenosis on dynamic CCTA who subsequently underwent adenosine-stress NH3-PET were enrolled in this study. Time-attenuation curves of the CS and the ascending aorta were extracted from dynamic CCTA data. The upslope of the CS was defined as the initial slope of the CS attenuation increase divided by that of the ascending aorta. CS start time (s) was defined as the timepoint between the peak aortic attenuation and the initial increase in CS attenuation. Global MBF was calculated from dynamic NH3-PET data. Global MFR was defined as the ratio of adenosine-stress MBF to the rest MBF.

## RESULTS

The CS upslope was moderately positively correlated with rest MBF (Pearson correlation coefficient  $r$ , 0.443;  $p = 0.004$ ), and CS start time was moderately negatively correlated with MFR ( $r$ , -0.540;  $p < 0.001$ ). The diagnostic performance predicting MFR  $< 2.0$  according to the following criteria: CS starting time  $> -0.36$  seconds was 86% sensitivity, 76% specificity, and an area under the curve of 0.83.

## CONCLUSION

Dynamic CCTA-estimated CS flow measurements were significantly correlated with NH3-PET-derived MBF and MFR values. A delayed CS start time can be used to predict a significant decrease in MFR in coronary artery disease.

## CLINICAL RELEVANCE/APPLICATION



This method may help estimate MFR even in facilities that do not have a PET scanner.

#### **W5A-SPCA- Impact of Super-Resolution Deep Learning Reconstruction Technique on Dynamic Myocardial Computed Tomography Perfusion Imaging**

Tomoro Morikawa, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Super-resolution deep-learning reconstruction (SR-DLR) is a novel computed tomography (CT) image reconstruction technique using a deep convolutional neural network that allows for improvement of spatial resolution on CT images as with ultra-high-resolution CT. This study aims to evaluate the impact of SR-DLR on the image quality and hemodynamic parameter of dynamic myocardial computed tomography perfusion (CTP) by comparing with hybrid iterative reconstruction (HIR) and DLR.

##### **METHODS AND MATERIALS**

This retrospective study included 26 patients who underwent dynamic myocardial CTP with pharmacological stress using 320-detector-row CT scanner for assessing coronary artery disease. The CTP images were reconstructed with HIR, DLR, and SR-DLR. For qualitative image quality assessment, overall visual score was evaluated on 4-point scale (1=poor, 4=excellent). For quantitative image quality assessment, CT attenuation and standard deviation in the myocardium (septum and lateral wall) and blood pool were recorded to calculate the image noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR). Additionally, the CT attenuation profile across the myocardium and blood pool was generated to measure the edge rise slope (ERS) and edge rise distance (ERD). For hemodynamic parameter assessment, overall CT-derived myocardial blood flow (CT-MBF) was quantified. These results were compared among three different CTP images reconstructed by HIR, DLR, and SR-DLR.

##### **RESULTS**

The mean visual image quality score on SR-DLR was better than on HIR and DLR (3.6 vs 2.2 and 2.8;  $p < 0.01$ ). The median image noise on SR-DLR was significantly lower than on HIR and DLR (15.6 vs 23.1 and 17.8;  $p < 0.01$ ). The mean SNR and CNR on SR-DLR were significantly higher than on HIR and DLR (SNR: 9.7 vs 7.3 and 7.9,  $p < 0.01$ ; CNR: 28.5 vs 20.1 and 23.4,  $p < 0.01$ ). The median ERD on SR-DLR was significantly shorter than on HIR and DLR (2.3 vs 3.0 and 2.6;  $p < 0.01$ ), and the mean ERS on SR-DLR was significantly steeper than on HIR and DLR (168.4 vs 126.1 and 151.2;  $p < 0.01$ ). There was no significant difference in mean CT-MBF among the three different CTP images reconstructed by HIR, DLR, and SR-DLR (2.37, 2.38 vs 2.39 mL/g/min).

##### **CONCLUSION**

SR-DLR was superior to HIR and DLR with respect to the image noise and the sharpness of myocardial margins without altering CT-MBF quantification in dynamic myocardial CTP imaging.

##### **CLINICAL RELEVANCE/APPLICATION**

SR-DLR allows for improving the image noise and sharpness more effectively than conventional reconstruction techniques in dynamic myocardial CTP imaging without requiring hardware changes. SR-DLR has a potential to improve the detectability of myocardial perfusion abnormality by taking advantage of the high spatial resolution and noise reduction capability.

#### **W5A-SPCA- Deep-Learning Image Reconstruction Algorithm: Impact on Plaque Analysis in Coronary Computed Tomography Angiography**

Domenico De Santis, MD (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Plaque composition in Coronary Computed Tomography Angiography (CCTA) relies on plaque density measurements and subsequent partition in different components: lipid, fibro-fatty, and calcified. Newly developed deep-learning image reconstruction algorithms (DLIR) hold promises to replace iterative reconstructions in CCTA, granting high image quality, low dose, and no detrimental effect on image texture; however, different strength levels may have an impact in plaque features extraction. The aim of this study was to assess the influence of DLIR at different strength levels on coronary plaque analysis.

##### **METHODS AND MATERIALS**

Forty consecutive patients (mean age  $61.9 \pm 15.4$  y) who underwent clinically indicated retrospectively ECG-gated CCTA were included in the study. CT scans were performed on a 128-row CT scanner (Revolution EVO, GE Healthcare) with the following parameters: tube voltage, 100 kV; tube current: 200 mA; detector collimation: .625 mm, rotation time: .6 s, automatically adjusted spiral pitch from .16 to .30, and matrix:  $512 \times 512$  pixels. A fixed amount (60 mL) of iodinated contrast medium (Iomeprol 400) was intravenously administered at a flow-rate of 5 mL/s. Raw data were reconstructed using ASiR-V 50% and DLIR at three strength levels (DLIR\_L, DLIR\_M, and DLIR\_H). Plaque analysis was performed using a dedicate software (SurePlaque, Canon Medical Systems, Japan): plaque burden, plaque volume, mean density, and plaque composition were

assessed on a per-vessel analysis. Statistical analysis was performed by means of Kruskal-Wallis H Test, followed by Dunn's test for pairwise comparisons.

## RESULTS

Fifty-seven plaques were analyzed for each reconstruction, for a total of 228 plaques. Total plaque burden was 61.1%, plaque volume was 132 mm<sup>3</sup>, and mean density was 179 HU. DLIR at different strength levels did not show statistically significant differences in the three parameters (all P = .906). In terms of plaque composition, no differences have been found for fibro-fatty and calcified components (P = .503 and = .821, respectively). The mean density of lipid plaques was statistically different among the four algorithms (P = .013), in particular pairwise comparison showed difference between DLIR\_L and DLIR\_H (P = .009).

## CONCLUSION

DLIR has no impact on overall plaque analysis compared to routinely applied ASiR-V; DLIR\_L might return lower density values for lipid plaque component.

## CLINICAL RELEVANCE/APPLICATION

DLIR grants reliable coronary plaque analysis; therefore, it can be safely implemented in CCTA examinations. DLIR\_L impact on lipid component should not hinder plaque analysis, since lower lipid density values broaden the density differences with fibro-fatty plaque component.

## W5A-SPCA- Evaluation of Dual-Source Photon-Counting CT Virtual Monoenergetic Imaging of Coronary Arteries in TAVI Patients

Daniel Overhoff, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Transcatheter aortic valve implantation (TAVI) is a widely utilized valve replacement procedure. The coronary arteries must be assessed before each procedure, which is usually done using invasive catheter angiography. The photon counting detector-CT (PCD-CT) yields the possibility to evaluate the specifications of the valve and the coronary arteries with a one-stop-shop approach. The aim of this study was to evaluate the impact of low energy virtual monoenergetic images (VMI+) objective image parameters (vessel enhancement, noise (standard deviation of vessel attenuation), signal to noise ratio (SNR), contrast to noise ratio (CNR)) of the coronary arteries in pre-TAVI CT examinations.

## METHODS AND MATERIALS

We retrospectively analyzed 125 pre-TAVI CT datasets from a first generation Dual-Source PCD-CT (Naeotom alpha, Siemens Healthineers, Forchheim Germany). The coronary arteries were analyzed in virtual monoenergetic images ranging from 40 to 100 keV in 15 keV steps. Maximum vessel density Hounsfield Units (HU) were measured for Left main (LM), Right coronary artery (RCA), Left circumflex (LCX) and Left anterior descending (LAD) at the proximal vessel segment. Signal-to-noise ratio and contrast-to-noise ratio were calculated.

## RESULTS

A total of 125 patients (73 male/52 female) were included in the final assessment. Maximum intraluminal enhancement of coronary arteries was measured for 40keV (1123±312HU) with decreasing density values with increasing keV values (100keV 220±55HU). SNR showed a significant reciprocal values with highest SNR at 100keV compared to 40keV (14.55±9.47 vs 10.68±6.68 p<0.001). The CNR, in turn, demonstrated significantly improved values at lower keV levels. (40keV vs 100keV/ 26.37±10.15 vs 8.50±3.50 p<0.001). There were no significant gender differences in the above changes.

## CONCLUSION

PCD-CT virtual monoenergetic images offer the possibility to improve the image quality for the assessment of the coronary arteries in pre-TAVI-CT. The highest vascular contrast and CNR are achieved at 40keV. SNR is highest at 100keV and decreases at lower keV levels.

## CLINICAL RELEVANCE/APPLICATION

PCD-CT virtual monoenergetic images yield the possibility of potential reduction of contrast media and an optimization of image quality with reduction of radiation dose for the analysis of coronary arteries in TAVI patients.

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## Abstract Archives of the RSNA, 2023

W5A-SPCH

### Chest Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPCH- Impact of Different AI User Interfaces on Lung Nodule and Mass Detection on Chest Radiographs** 1

Jennifer S. Tang, MBBS, FRANZCR (*Presenter*) Founder, STAT Innovations Pty Ltd

##### **PURPOSE**

To explore the impact of different user interfaces (UIs) for artificial intelligence (AI) outputs on radiologist performance and user preference in detecting lung nodules and masses on chest radiographs.

##### **METHODS AND MATERIALS**

A retrospective paired-reader study with a 4 week washout period was used to evaluate three different AI UIs compared with no AI output. Ten radiologists (8 radiology attendings and 2 trainees) evaluated 140 chest radiographs (81 with histologically confirmed nodules and 59 confirmed as normal by CT), with either no AI or one of three UI outputs: 1) text only, 2) combined AI confidence score and text, or 3) combined text, AI confidence score and image overlay. Areas under the receiver operating characteristic curve (AUCs) were calculated to compare radiologist diagnostic performance with each UI with performance without AI. Radiologists reported their user interface preference.

##### **RESULTS**

AUC improved when radiologists used the text-only output compared with no AI (0.87 vs 0.82, p-value<0.001). There was no difference in performance for the combined text and AI confidence score output compared with no AI (0.77 vs 0.82, p-value=0.46) and for the combined text, AI confidence score and image overlay output compared with no AI (0.80 vs 0.82, p-value=0.66). Eight of the 10 radiologists (80%) preferred the combined text, AI confidence score and image overlay output over the other two interfaces.

##### **CONCLUSION**

Text only UI output significantly improved radiologist performance compared with no AI in the detection of lung nodules and masses on chest radiographs, but user preference did not correspond with user performance.

##### **CLINICAL RELEVANCE/APPLICATION**

Understanding the impacts of how different user interfaces may alter reader performance is a crucial aspect of AI implementation in radiology.

#### **W5A-SPCH- Physics-based Data Augmentation to Improve Chest X-ray Abnormality Classification** 2

Heejun Shin, BS (*Presenter*) Nothing to Disclose

##### **PURPOSE**

Many AI methods to detect chest X-ray (CXR) abnormalities have demonstrated promising results by adopting image pre-processing techniques (e.g., histogram equalization (HE), contrast limited adaptive histogram equalization (CLAHE), and unsharp masking (UM)). However, those methods showed limited diagnostic performance when applied to CXRs with different image characteristics from various X-ray scanners. Here, we propose an X-ray physics-based data augmentation (i.e., XPA) that perturbs CXRs during AI training to overcome this problem.

##### **METHODS AND MATERIALS**

Unlike conventional image pre-processing methods (e.g., HE, CLAHE, and UM) that normalize CXRs before AI training and testing, XPA randomly perturbs image characteristics on training CXRs by applying a series of image processing methods

(e.g., gamma correction for contrast perturbation) to mimic hardware-related changes (e.g., voltage, current, etc.) during AI training. Seven datasets from different X-ray machines (digital radiography (DR) or computed radiography (CR)) and institutions were collected. One dataset was from a Vietnam hospital and annotated by a radiologist as normal or abnormal (e.g., opacity, etc.) for AI (7,202 CXRs for training; 1,278 CXRs for testing (VHDR1)). Four datasets were from Indonesian hospitals, including a dataset acquired from a portable X-ray machine (IHCR1,Portable:204; IHCR2 :227; IHCR3:356; IHDR2:1,909 CXRs) and annotated for AI testing. Two datasets (i.e., Shenzhen (SZDR3) and Montgomery (MGCR4)) were from public domains as testing data. We trained four AI models (EfficientNet-B6) using HE, CLAHE, UM, and proposed XPA to classify CXRs as normal or abnormal and compared their diagnostic performance. To check the capability of each method to cover CXRs from different machines, only the CXRs acquired using the DR system in the Vietnam hospital were utilized for training.

## RESULTS

For VHDR1 (internal test dataset), the diagnostic performance of all AI models was not statistically significant (i.e.,  $p$ -value $>0.05$ ). However, in most of the test datasets, the AI model with XPA outperformed the others, including the datasets acquired from the different CR detectors (IHCR2, IHCR3, and MGCR4), portable X-ray machine (IHCR1,Portable; AUC: 0.950 for XPA; 0.924 for HE; 0.920 for CLAHE; 0.891 for UM;  $p$ -value $<0.05$ ), and DR detectors (IHDR2 and SZDR3).

## CONCLUSION

The diagnostic performance of the AI model was improved with XPA for the CXR datasets from different X-ray machines (i.e., DR, CR, and portable machines) compared to those of the other AI models with conventional image pre-processing methods.

## CLINICAL RELEVANCE/APPLICATION

The proposed AI showed potential clinical usage when the CXRs were acquired using various X-ray scanners.

## W5A-SPCH- Investigating the Feasibility of Using AI to Detect Unreported Chronic Disease Findings on Chest X-Ray in a Retrospective Aged Patient Dataset

Jonathan S. Luchs, MD (*Presenter*) Nothing to Disclose

## PURPOSE

This study evaluates the feasibility of using an artificial intelligence (AI) model to retrospectively identify 27 chronic disease findings in an aged patient chest X-ray (CXR) dataset. The aim of this study was to investigate the ability of the AI model to identify findings not previously reported in the radiologists' report. This aims to validate the usefulness of AI as a quality improvement device to improve the characterization of patient cardiovascular disease risk.

## METHODS AND MATERIALS

The study dataset consisted of 1,261 CXRs from patients  $\geq 65$  years, collected from outpatient clinics. CXR images were retrospectively processed by the AI for the presence of predefined chronic disease findings. As a comparison, the radiologist report was manually reviewed for the presence/absence of these findings, with findings considered absent if they were not mentioned in the report. In cases where there was a discrepancy between the model and report, a radiologist adjudicator evaluated the CXR scan to determine ground truth (GT), i.e. if the finding was overcalled or under called by the AI model/radiologist.

## RESULTS

Reported prevalence of findings varied between the AI model and report. The AI model reported 505, 731, 650 and 783 instances of cardiomegaly, unfolded aorta (UA), aortic arch calcification (AAC) and spine arthritis (SA), compared to 194, 12, 622 and 562 in the report, respectively. There were 133, 48 and 29 instances of lower, upper, and diffuse interstitial thickening reported by the AI model, compared to 554, 553 and 557 in the report, respectively. Across all findings, Cohen's Kappa agreement was 0.17, indicating slight agreement. Comparison with the GT showed that cardiomegaly, UA, AAC and SA were underreported in the report compared to the AI model (report sensitivity (sens): 0.32, 0.02, 0.54, 0.44, vs. AI model sens: 0.83, 0.86, 0.75, 0.75, respectively). This resulted in 68%, 98%, 46%, and 56% of these findings being missed by the report, while 17%, 14%, 25%, and 25% were missed by the AI model. Conversely, diffuse, lower and upper interstitial thickening were over reported compared to the AI model, as shown by reduced specificity of the report (report; 0.58, 0.58, 0.58 vs. AI; 0.99, 0.92, 0.96, respectively).

## CONCLUSION

AI models in medical imaging have typically focused on radiological finding detection to provide diagnostic assistance to radiologists. Here we present evidence that a quality improvement AI device can enhance patient care and management through the detection of under and over reporting of chronic disease findings.

## CLINICAL RELEVANCE/APPLICATION

Chronic diseases are often incidentally detected on CXR but not reported due to their low-risk nature. However, these findings can be significant predictors of patient health risk.

Leon Chalil, MD, PhD (*Presenter*) Nothing to Disclose

## **W5A-SPCH- Multiclass Labelling of Foreign Hardware on Chest Radiographs using a Convolutional Neural Network**

### **PURPOSE**

To assess the accuracy of transfer learning with a pre-trained convolutional neural network (CNN) in detecting multiple classes of medical devices and other foreign bodies on chest radiographs.

### **METHODS AND MATERIALS**

A total of 2000 de-identified, publicly available chest radiographs were binary labelled for the presence of 18 different types of foreign bodies by two radiology fellows. The images were split into training and validation data sets (80:20 ratio). A pre-trained ResNet50 convolutional neural network model based on weights obtained from ImageNet was loaded from the TensorFlow environment. The top layer was removed and replaced with a single densely connected layer. The ResNet50 pretrained model expects a 224 x 224 x 3 channel input. The x-ray images were down sampled to 224 x 224 using simple averaging.

### **RESULTS**

After several epochs the neural network could correctly classify the presence or absence of different medical devices or foreign objects with an accuracy of 78-99% on the validation data set, and 10/17 classes were detected with >90% accuracy. This model did show high average specificity (98% [93-100%]) but variable sensitivity (57% [11-100%]) across classes, likely attributable to the small size of the dataset and high similarity in form and position of several devices.

### **CONCLUSION**

Transfer learning using a pre-trained neural network permits high accuracy classification of foreign bodies and medical devices on chest radiographs without the need for hyperparameter tuning. Larger datasets and improved annotation will be required to further improve the performance of future models.

### **CLINICAL RELEVANCE/APPLICATION**

These findings represents an important step towards more accurate and rapid confirmation of device presence in comparatively undifferentiated CXRs.

## **W5A-SPCH- Radiomics Analysis for Predicting Progression of Part-Solid Nodules on CT**

5

Shiny Weng, BA, BA (*Presenter*) Nothing to Disclose

### **PURPOSE**

Radiomics, with its diverse set of features, has the potential to reveal novel avenues for identifying malignant nodules and detecting subtle patterns not visible to the naked eye. In clinical practice, identifying progressive nodules is crucial for detecting malignancies. Hence, this study aims to explore the statistical significance of radiomic and clinical features in predicting overall growth in part-solid nodules (PSNs).

### **METHODS AND MATERIALS**

In this retrospective study, institutional chest CT scans between 2015 and 2019 were collected. Corresponding radiology reports were used to extract ground truth labels for nodules' growth status (i.e., increase vs. unchanged), as well as other related information such as nodule size, location, slice, component sizes, and compared studies. An automated NLP pipeline was used for the extraction, and manual review was used to ensure the dataset's accuracy. Additionally, associated CT scans were run through a commercial nodule characterization algorithm. The parameters generated from this algorithm, such as nodule size and location, were then compared and matched with the extracted features from the original radiology reports.

### **RESULTS**

The final dataset consists of 1276 PSNs, and ground truth labels are available for 1009 PSNs (830 unchanged, 166 growing, 13 decreasing). From this dataset and using radiomic (from pyRadiomics) and clinical features (e.g., patient age, gender), we developed various ML models for predicting growth in PSNs, of which Random Forests achieved the highest AUC of 0.78 on the validation set. Moreover, in the statistical analyses of the association of radiomic and clinical features with nodule progression, 88 radiomic features were statistically significant ( $p < 0.05$ ) based on a Mann-Whitney U Test. Such radiomic features include Surface Volume Ratio, Zone Variance, and Small Dependence High Gray Level Emphasis, all of which had high feature importance for identifying progressive nodules in the Random Forests model. Among clinical features, Patient Age exhibited high feature importance. 75 features were used for the Random Forests model, which were selected using random forest importance, recursive feature elimination, and univariate selection.

### **CONCLUSION**

We developed a model to identify nodule progression from a predictive set of radiomic and clinical features, achieving an AUC of 0.78 on the validation set. Additionally, we have assembled a labeled dataset of 1009 PSNs, which includes various attributes such as nodule size, type, and location.

## CLINICAL RELEVANCE/APPLICATION

By employing radiomics, statistical analysis, and machine learning, we may produce accurate early characterization of growing adenocarcinoma spectrum nodules and optimize management and outcomes.

### **W5A-SPCH- Artificial Intelligence System for Identification of Overlooked Lung Metastasis in Abdominal CTs of Patients with Malignancy** 6

Hye Soo Cho (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate whether an artificial intelligence (AI) system can identify metastatic nodules in basal lungs covered by abdominal CTs initially overlooked by radiologists.

#### **METHODS AND MATERIALS**

We retrospectively abdominal CT images with the following inclusion criteria: a) CTs obtained from patients with any solid organ malignancy between March 1st and 31st, 2019 in a single institution; b) abdominal CT interpreted as negative for metastasis in covered basal lungs. Patients who underwent chest CT on the same day with abdominal CT, and patients lost to follow-up within 3 years without clinical diagnosis of lung metastasis. The reference standards for the diagnosis of lung metastasis were confirmed by the review of medical records and subsequent CT images. An AI system that can automatically detect lung nodules in CT images was retrospectively applied. The AI results were reviewed by a radiologist to confirm the lesion is a true lung nodule with the possibility of metastasis. The detection yield (the proportion of true-positive results among entire patients), sensitivity, and positive predictive value (PPV) of the AI system and the radiologist who reviewed AI results were evaluated, for the identification of patients with basal lung metastasis overlooked during the initial interpretation.

#### **RESULTS**

A total of 878 patients (66% men; mean age 65 years) were included. The most common primary malignancy was hepatocellular carcinoma (411, 47%), followed by stomach (169, 19%) and colorectal cancer (11%). Lung metastases were diagnosed in 69 patients (7.8%) within 3 years from the abdominal CT. Among them, 12 patients (1.4%) had overlooked metastasis in the basal lungs covered by the abdominal CT. The AI system identified 319 lesions in 176 patients (positive rate, 20%). Among the 319 AI results, 261 (81.8%) were true lung nodules by the radiologists' review, and 25 (7.8%) were metastatic nodules overlooked during the initial interpretation. The detection yield, sensitivity, and PPV of the AI system to identify patients with overlooked basal lung metastasis were 1.4% (12/878), 100% (12/12), and 6.8% (12/176), respectively. Meanwhile, the radiologist's review of AI results resulted in the detection yield, sensitivity, and PPV of 1.4% (12/878), 100% (12/12), and 14% (12/86), respectively.

#### **CONCLUSION**

In patients with solid organ malignancies, an AI system exhibited excellent sensitivity for the identification of metastases in basal lungs covered by abdominal CTs that radiologists initially overlooked.

## CLINICAL RELEVANCE/APPLICATION

An AI system may help radiologists not overlook small lung basal lung metastasis in abdominal CTs by providing feedback to the radiologists in case of suspicions, which could be an efficient method to reduce interpretation errors.

### **W5A-SPCH- Surveillance Breeds Conformity! Multicenter, Post-market Surveillance of a Multi-finding AI** 7

Giridhar Dasegowda, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Post-market surveillance of AI algorithms can help assess real world performance and impact of AI algorithms. We performed a multicenter, post-market surveillance (PMS) of a multi-finding AI algorithm for the interpretation of chest radiographs (CXR).

#### **METHODS AND MATERIALS**

Our retrospective, multicenter study included 2066 consecutive CXRs obtained from 7 practices across 7 geographically diverse states in India. CXRs belonged to 1167 men and 899 women with a mean age of  $46 \pm 17$  years. All centers had Qure.AI CXR algorithm implemented in routine clinical interpretation of CXRs. For a fraction of CXRs, AI outputs were either unavailable due to technical difficulties or not used due to low confidence interval for the findings. All consecutive CXRs from the centers were de-identified and uploaded on the annotation platform. An experienced thoracic radiologist blinded to the AI output evaluated the CXRs to establish the ground truth. We compared the performance of AI-aided and unaided clinical interpretation of CXRs. Sensitivity, specificity, ROC AUC with 95% confidence interval were used to evaluate the performance.



## RESULTS

The AI output had a better standalone performance compared to radiology reports (AUC of 0.72 - 0.90, sensitivity 44%-83% and specificity 81%-100%). The overall reporting performance for cardiomegaly, nodule, opacities, blunted costophrenic angle, cavity and to differentiate normal from abnormal CXRs compared to the ground truth had an AUC of 0.62 - 0.75, 28%-88% sensitivities and 56%-100% specificities. The performance of radiologists improved significantly with AI-aided reporting over those CXRs reported without AI outputs at the time of reporting with an effective increase in 6%-19% in AUC ( $p < 0.01$ ).

## CONCLUSION

Our PMS study demonstrates an overall improvement in the radiologists' performance with AI-aided interpretation of CXRs.

## CLINICAL RELEVANCE/APPLICATION

In the real-world application, the assessed AI algorithm improves the interpretation of for CXRs.

## W5A-SPCH- The Path to Successful AI Adoption in Radiology: Investigating Hurdles in The Computer-Assisted Diagnosis Implementation within Hospital Settings

James H. Scrivner JR, MBA, ARRT (*Presenter*) Nothing to Disclose

## PURPOSE

To demonstrate that AI implementation in hospital radiological practice requires careful business assessment and planning: from the end-user experiences to training and workflow adjustments.

## METHODS AND MATERIALS

Radiologists who agreed to participate in quantitative and qualitative surveys were prospectively recruited from December 2022 to April 2023. To identify the challenges in AI adoption, this study measured the CAD technology acceptance and diffusion using an extended diffusion framework, namely the Extended Technology Acceptance Model (ETAM) based on 1) Unified Theory of Acceptance and Use of Technology (UTAUT) and 2) Diffusion of Technology (DOI). This integrated model evaluated the interaction of CAD and radiologists by incorporating the latent structures of trust, accuracy, efficiency, adoption, and diffusion from a behavioral, psychological, and social perspective. Following the ACR Data Science Institute Artificial Intelligence survey (2020), this study also collected information on AI usage, demographics, and AI performance evaluation.

## RESULTS

A total of 10 radiologists participated in qualitative interviews and 68 radiologists participated in quantitative surveys (~5% response rate). The overall perception of clinical AI usage is higher than national usage (39% versus 26%). The findings highlighted several challenges facing the adoption of AI in radiology. While most participants expressed trust in AI innovation, they demonstrated major hurdles in AI adoption, including interpretation time and time management issues. The major concerns are in the poor integration and usability caused by the lack of radiologists' involvement in user testing. As a result, many participants used AI only as a second reader or triage tool.

## CONCLUSION

While the potential benefits of AI in healthcare are widely acknowledged, it is important to recognize that the adoption of AI technology is not guaranteed simply by implementing AI tools. Successful AI adoption requires careful consideration of factors such as user training, workflow integration, and the development of appropriate governance and validation frameworks.

## CLINICAL RELEVANCE/APPLICATION

As the use of AI solutions for improving diagnostic accuracy gains significant attention, the need for an operational framework that would involve radiologists as end-users becomes increasingly apparent. Such a framework would guide the deployment, interoperability, and validation of AI in clinical practice, ultimately contributing to the development of safe and effective AI-based diagnostic tools. This study documents operational issues and proposes initial guidelines for clinical implementations.

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## Abstract Archives of the RSNA, 2023

W5A-SPER

### Emergency Radiology Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPER- Identifying and Communicating Urgent Findings in Emergency Radiology: A Scoping Review 1**

Lucas Corallo, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine existing published standards for the identification and communication of critical actionable imaging findings in emergency radiology. To identify the associated facilitators and barriers to the communication and management of critical imaging findings.

#### **METHODS AND MATERIALS**

A scoping review of published literature was performed through 2 databases (PubMed, Embase) with search terms pertaining to critical findings in emergency radiology. Articles and guidelines published in all languages from January 2010 to September 2022 were considered. Screening of database hits using pre-established inclusion criteria was performed by 3 analysts with reconciliation of discordance by consensus. A gray literature search for societal guidelines and high-impact policies was added to the database search. Data extraction included the following: year, country, resource type, scope/purpose, participants, context, standards to identifying/communicating critical findings, facilitators/barriers, method type, recommendations, applicability, and disclosures.

#### **RESULTS**

60 records were included in the final analysis, including 12 societal/commission guidelines. Among the included guidelines, no standardized lists of critical findings were identified, however, recommendations to create a local policy for critical findings were made in 5/12 guidelines. Reference to critical findings policies from the Joint Commission (16/60 articles), and ACR (30/60 articles) were most frequent. Standards used by centres for critical findings often applied a formal list of findings or classifications based on acuity. Among standards based on acuity (n=12), a 3-tier classification system was most common. Standards for communication included direct closed-loop communication for high acuity findings, with more flexible communication channels for less acute findings. Interventions for critical findings management most frequently fell into 4 categories: electronic (n=7), hybrid electronic/admin (n=5), feedback/education (n=5), and administrative (n=2).

#### **CONCLUSION**

There are variable standards, policies, and interventions for the management of critical findings in emergency radiology. ACR and Joint Commission standards were most frequently applied. Interventions applied EMR-based strategies, call-centres, and traditional phone/fax. Further research should seek to evaluate consistency and efficiency of closed-loop communication protocols, provider satisfaction, and patient outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

Summarizes the policies around critical results reporting in emergency radiology. Provides a guide for consensus building, innovation and rapid adoption towards greater patient safety, and provider satisfaction.

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## Abstract Archives of the RSNA, 2023

W5A-SPGI

### Gastrointestinal Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPGI- Sensitivity of MRI to Detect Microscopic Fat in Adrenal Adenomas: Comparison of 2D Dual Gradient-echo and 3D DIXON Techniques**

Abdullah Khan, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the sensitivity of 2D dual gradient-echo and 3D DIXON chemical shift MRI (CSI) for detecting microscopic fat in adrenal adenomas.

#### **METHODS AND MATERIALS**

We performed a retrospective study of 35 patients (15 male, 20 female, mean age 61.8 years) with adrenal nodules who underwent both 2D dual gradient-echo and 3D DIXON T1-weighted CSI on a 1.5T scanner. The signal intensity (SI) of the nodules was obtained using a single ROI in the center of the nodule (comprising at least 2/3rds the nodule diameter) and the signal intensity index (SII) was calculated [ $100 \times (\text{SI in phase} - \text{SI out of phase}) / \text{SI in phase}$ ]. Reference standard for the diagnosis of 29 adenomas was made by no change in nodule size or growth  $< 3\text{mm/year}$  in long axis for at least 1 year on follow up imaging ( $n=19$ ), unenhanced CT attenuation of  $< 10\text{ HU}$  ( $n=8$ ), or pathology ( $n=2$ ). The mean time to imaging follow up was 4.5 years (range 1.1-10.5 years). The diagnosis of metastasis was made by pathology ( $n=1$ ) and nodule growth  $> 3\text{mm/year}$  in a patient with known cancer ( $n=1$ ). There was one pheochromocytoma diagnosed by pathology. Three nodules had no adequate reference standard. Sensitivity for the diagnosis of adrenal adenoma was determined using a SII of  $> 16.5\%$ .

#### **RESULTS**

There were 35 nodules (mean size 22 mm, range 11-55 mm). The SII was higher on 2D CSI compared to 3D DIXON in 80% (28/35) of nodules by a mean of 14.4%. Of the 29 adenomas, the SII was higher on 2D CSI compared to 3D DIXON in 90% (26/29) of nodules. Among adenomas, the mean SII was 48% on 2D CSI and 33% on 3D DIXON ( $p=.02$ ). Sensitivity for the diagnosis of adenoma was 89.7% (26/29; 95% CI 72.7-97.8%) for 2D and 75.9% (22/29; 95% CI 56.5-89.7%) for 3D DIXON. None of the 3 non-adenomas had SII  $> 16.5\%$  on either technique.

#### **CONCLUSION**

2D dual gradient-echo CSI has a higher sensitivity for detection of microscopic fat in adrenal nodules and the diagnosis of adrenal adenoma than the 3D DIXON technique. The sensitivity of 2D dual gradient-echo CSI for adrenal adenoma is approximately 90%.

#### **CLINICAL RELEVANCE/APPLICATION**

Adrenal MRI protocols should include 2D dual gradient-echo CSI and not rely solely on 3D DIXON techniques for the diagnosis of adrenal adenomas.

#### **W5A-SPGI- Deep Learning Reconstruction Improves Image Quality of Acquired and Computed Diffusion-weighted MR Imaging of the Liver**

Hiromitsu Onishi, MD, PhD (*Presenter*) Research Grant, General Electric Company; Speakers Bureau, General Electric Company

#### **PURPOSE**

Image noise is the main problem in diffusion-weighted (DW) MR imaging. Deep learning reconstruction (DLR) can improve the image quality of MR imaging. The aim of this study was to determine whether DLR can improve the image quality of acquired and computed DW images of the liver.

## METHODS AND MATERIALS

This retrospective study included 44 consecutive patients with suspected focal liver lesions who underwent liver MR examinations with a 3.0-T system. DW images of the whole liver were acquired at b-values of 0 and 1000 s/mm<sup>2</sup> during breath-hold (TR/TE = 4500/76 msec, 5 mm thickness, and 96×96 matrix). Computed high b-value DW images (b = 1500 s/mm<sup>2</sup>) were synthesized from the acquired DW images. One radiologist measured the signal-to-noise ratio (SNR) of the liver parenchyma and the contrast-to-noise ratio (CNR) between malignant tumors and parenchyma on acquired and computed DW images with and without DLR. Another radiologist assessed image quality using a five-point visual scoring system (1 [unacceptable] to 5 [excellent]). Results were compared using paired t-test for quantitative assessment and Wilcoxon signed rank test for visual assessment of image quality.

## RESULTS

Both acquired and computed DW images with DLR had significantly higher SNRs and CNRs than DW images without DLR; mean SNR was 13.6 versus 9.4 for acquired images (P < .001) and 8.1 versus 5.9 for computed images (P < .001), and mean CNR was 56.6 versus 37.2 (P < .001) and 33.7 versus 23.6 (P < .001), respectively. Qualitative analyses showed that DLR significantly improved image noise and image sharpness (P < .001 for each), but did not change motion artifacts and signal loss just below the heart. DW imaging with DLR also demonstrated superior overall image quality compared to DW imaging without DLR; median score was 4 versus 2 for acquired images (P < .001), 3 versus 2 for computed images (P < .001).

## CONCLUSION

DLR efficiently reduced image noise and significantly improved the image quality of both acquired and computed DW MR images of the liver.

## CLINICAL RELEVANCE/APPLICATION

Deep learning reconstruction improves the image quality of liver diffusion-weighted images with a short acquisition time and can greatly contribute to the efficiency of liver MR examinations.

## W5A-SPGI- Radiologic Response and Association with Prognosis in Patients Treated with Transarterial Radioembolization or Stereotactic Body Radiation Therapy for HCC

Sangyun Lee, MS (*Presenter*) Nothing to Disclose

## PURPOSE

Transarterial radioembolization (TARE) and stereotactic body radiation therapy (SBRT) are locoregional therapies for potentially resectable and unresectable HCC. A limited number of studies have evaluated radiologic treatment response and association with prognosis in radiation-based therapy-treated HCC. We evaluated the radiologic appearance of post-TARE and SBRT-treated images of HCCs to assess treatment response and identify its association with prognosis.

## METHODS AND MATERIALS

We retrospectively identified 104 patients (77 males; mean age ± SD, 65.9 ± 12.6 years) treated with SBRT (68 patients, 83.4%) and TARE (36 patients, 34.6%) from 2015 to 2022. Pre- and post-treatment contrast-enhanced CT or MRI scans performed 3 months after treatment were evaluated for treatment response according to the following rules: no intralesional APHE as nonviable; stability or decrease in size and/or degree of intralesional APHE as non-progressing; new or increased size of intralesional APHE as viable disease. Pre- and post-treatment AFP levels, tumor and APHE component size, portal vein tumor thrombus, etiology of liver disease, overall survival (OS) and progression-free survival (PFS) were recorded. Cox proportional hazards model and Kaplan-Meier curves with log-rank test were used for statistical analysis.

## RESULTS

The mean size of HCC was 4.9 cm, and 25 patients (24%) had portal vein tumor thrombus. The mean AFP level was 2314.3 ng/mL. Median follow-up was 20.6 months (range, 3-142), with 29 (27.9%) deaths and 69 (66.3%) disease progressions. Sixty-three (60.6%) patients achieved non-viable disease at least once during follow-up. At the first 3-month follow-up, 40 (38.5%), 43 (41.3%), and 21 (20.2%) patients had nonviable, non-progressing, and viable disease, respectively. In univariate analysis, radiologic response at 3 months and nonviable disease ever during follow-up were significantly associated with OS, but only radiologic response at 3 months was the independent factor in multivariate analysis (ps = 0.009). For PFS, viable disease at the first 3-month follow-up, nonviable disease ever during follow-up, tumor size, male sex, and initial AFP level were the independent predictors in multivariate analysis (ps = 0.034). The type of radiotherapy did not affect OS or PFS. The 2-year cumulative OS for non-viable, non-progressing, and viable disease was 96.6%, 72.6%, and 67.9%, respectively.

## CONCLUSION

Response to radiotherapy at 3 months and during follow-up assessed by changes in radiologic APHE significantly correlated with OS and PFS.

## CLINICAL RELEVANCE/APPLICATION

Persistent APHE 3 months after radiotherapy for HCC may indicate a poor prognosis.

### **W5A-SPGI- Comparing Early Treatment Response as Assessed by RECIST 1.1, mRECIST, and Choi Criteria in HCC Treated with Atezolizumab plus Bevacizumab** 6

Seung Hoon Choi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Atezolizumab plus bevacizumab (Ate/Beva) is endorsed as first-line systemic therapy for unresectable HCC ineligible for transplantation or locoregional therapy. Given the anti-angiogenic effect of the regimen, RECIST version 1.1 may underestimate the treatment response, potentially leading to unnecessary early discontinuation of the therapy. We aimed to compare RECIST 1.1, modified RECIST (mRECIST), and Choi criteria in assessing early treatment response in Ate/Beva-treated HCCs and their correlations with overall survival (OS) and progression-free survival (PFS).

#### **METHODS AND MATERIALS**

From May 2022 to December 2022, 42 patients (36 men; mean  $\pm$  SD age, 61.9  $\pm$  12.9 years) who received Ate/Beva for unresectable HCC without prior systemic therapy were retrospectively included. Pre-treatment and the first post-treatment contrast-enhanced CT or MRI scans, performed after completion of at least three cycles of Ate/Beva, were reviewed by two abdominal radiologists to assess treatment response according to RECIST 1.1, mRECIST, and Choi criteria. OS and PFS were recorded. Kaplan-Meier curves with log-rank test and Cohen's kappa were used for the statistical analysis.

#### **RESULTS**

The median time from the start of Ate/Beva to the first response assessment was 99 days (range, 51-182 days). Responders (patients with a complete or partial response) were 10 (23.8%), 13 (31.0%), and 18 (42.9%) when evaluated by RECIST 1.1, mRECIST, and Choi criteria, respectively. One (2.4%) and two (4.8%) patients classified as having progressive disease (PD) by RECIST 1.1 were re-assessed as stable disease and partial response by mRECIST and Choi criteria, respectively. The inter-reader agreement  $\kappa$  for RECIST 1.1, mRECIST, and Choi criteria was 0.85, 0.75, and 0.85, respectively. Responders identified by RECIST 1.1 did not show a significant correlation with OS ( $p = 0.082$ ), while those identified by mRECIST and Choi were correlated with prolonged OS ( $ps = 0.049$ ). Responders identified by all three criteria showed a significant correlation with PFS ( $ps = 0.029$ ). Cumulative 1-year PFS rates for responders were 72%, 76.4%, and 78.4% for RECIST 1.1, mRECIST, and Choi, respectively, and 74.4%, 72.4%, and 66.7% for non-responders.

#### **CONCLUSION**

In Ate/Beva-treated HCC, only a small number of PDs identified by RECIST 1.1 were re-classified as non-PD by mRECIST and Choi, indicating similar performance in the assessment of treatment failure. mRECIST and Choi criteria identified more early responders to treatment than RECIST 1.1 and significantly correlated with prolonged OS and PFS.

## CLINICAL RELEVANCE/APPLICATION

mRECIST and Choi criteria may be more accurate than RECIST 1.1 in identifying early responders to Ate/Beva and may better assess prognosis.

### **W5A-SPGI- Value of Liver Volumetry for the Evaluation of Treatment Response to Hepatic Artery Infusion Chemotherapy Compared with RECIST 1.1 Criteria in Uveal Melanoma Patients with Liver Metastases** 7

Sebastian Zensen, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

In uveal melanoma patients with liver metastases, short-term evaluation of treatment response to hepatic artery infusion chemotherapy (HAIC) using the Response Evaluation Criteria in Solid Tumors (RECIST) 1.1 criteria is often challenging due to the diffuse metastatic spread to the liver. Because of the diffuse organ involvement, liver enlargement can frequently be observed and easily assessed by liver volumetry. Therefore, this study aims to compare RECIST 1.1 and LV for the evaluation of HAIC treatment response.

#### **METHODS AND MATERIALS**

Treatment response was evaluated in 143 patients by RECIST 1.1 and liver volumetry on CT imaging performed before and after first HAIC. The mean age was 65.1  $\pm$  10.9 years, 54% were female. To establish an appropriate threshold to differentiate between stable disease (SD) and progressive disease (PD) in liver volumetry, various increases in liver volume were assessed. Overall survival (OS) was calculated from first HAIC to patient death using Kaplan-Meier test. Multivariate analysis was performed for RECIST 1.1 and liver volumetry.

## RESULTS

The median OS (mOS) was 13.5 months (95% CI 11.2-15.8 months). In liver volumetry, a threshold of 10% increase in liver volume was suited to identify patients with significantly reduced OS (SD: 103/143 patients, mOS 15.9 months; PD: 40/143 patients, 6.6 months;  $p < 0.001$ ). Compared to RECIST 1.1, liver volumetry is the only significant prognostic factor that can identify a decreased OS.

## CONCLUSION

In uveal melanoma patients with liver metastases, a threshold of 10% increase in liver volume is suitable to identify patients with a significantly shortened life expectancy by liver volumetry.

## CLINICAL RELEVANCE/APPLICATION

Liver volumetry is an appropriate method for evaluating treatment response in uveal melanoma patients with liver metastases and offers advantages over RECIST 1.1 criteria.

## W5A-SPGI- DW-MRI of the Abdomen for the Preoperative Detection of Liver Metastasis from Pancreatic Cancer to Prevent Futile Surgeries: A Meta-analysis

Stephan Altmayer, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Recent studies have shown the superior diagnostic performance of diffusion-weighted magnetic resonance imaging (DW-MRI) for detecting liver metastasis. Despite the advantage of DW-MRI, the most recent 2022 National Comprehensive Cancer Network guidelines do not routinely recommend performing MRI on all patients who may have resectable disease. Our purpose was to perform a systematic review and meta-analysis to evaluate if diffusion-weighted magnetic resonance imaging (DW-MRI) adds value compared to contrast-enhanced computed tomography (CECT) alone in the preoperative evaluation of pancreatic cancer.

## METHODS AND MATERIALS

MEDLINE, EMBASE, and Cochrane databases were searched for relevant published studies through October 2022. Studies met eligibility criteria if they evaluated the per-patient diagnostic performance of DW-MRI in preoperative patients with pancreatic cancer compared to CECT. Our primary outcome was to determine the proportion of futile surgeries potentially prevented using DW-MRI, defined as those in which CECT was negative and DW-MRI was positive for liver metastasis. The secondary outcome was to determine the proportion of cases in which DW-MRI changes management, a composite outcome that includes false positive liver metastasis on CECT, indeterminate lesions on CECT, and the primary outcome. Per-patient sensitivity and specificity of DW-MRI were also calculated using a random-effects model.

## RESULTS

9 studies met the inclusion criteria with a total of 1121 patients, 172 of which had liver metastasis (15.3%). The average size of the hepatic lesions was smaller than 10 mm in all 6 studies that reported this data. The mean time between CT and MRI was reported for 7 out of 9 studies and was often fewer than 28 days. The proportion of futile surgeries potentially reduced by DW-MRI was 6.0% (95% CI, 3.0-11.6%), yielding a number necessary to treat of 16.6. The proportion of cases that DW-MRI changed management was 18.1% (95% CI, 9.9- 30.7), corresponding to an NNT of 5.5. The heterogeneity was high for both primary (of  $I^2 = 86%$ ) and secondary ( $I^2 = 94%$ ) outcomes. The per-patient sensitivity and specificity of DW-MRI was 92.4% (95% CI, 87.4-95.6%) and 97.3% (95% CI, 96.0- 98.1) with no heterogeneity.

## CONCLUSION

The potential NNT of DW-MRI to prevent potential futile surgeries in patients with pancreatic cancer and occult liver metastasis on CECT was 16.6.

## CLINICAL RELEVANCE/APPLICATION

A significant number of subcentimeter liver metastases are not identified in the preoperative staging of pancreatic cancer with CECT. DW-MRI may add value in the evaluation of these patients with a potential NNT to prevent one futile pancreatic resection of CECT of 16.

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## Abstract Archives of the RSNA, 2023

W5A-SPGU

### Genitourinary Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPGU-Quantitative PSMA PET and Multiparametric MRI features may help Predict Aggressive Prostate Cancer on Whole-Mount Histopathology** 1

Ida Sonni, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Two aggressive histopathological subtypes of prostate cancer (PC) include intraductal carcinoma (IDC) and the large cribriform growth pattern. The goal of this analysis was to assess which quantitative features of preoperative 68Ga-PSMA-11 PET/CT (PSMA PET) and multiparametric magnetic resonance imaging (mpMRI) correlate and predict cribriform/IDC patterns on post robotic prostatectomy (RALP) whole mount histopathology (WMHP).

#### **METHODS AND MATERIALS**

With IRB approval and HIPAA compliance, we derived a study cohort of PC patients who underwent PSMA PET <3 months prior to RALP and WMHP with description of the presence/absence of cribriform/IDC pattern between 05/2019 and 08/2022. A nuclear medicine physician contoured all PC lesions on PSMA PET, after matching them with a GU pathologist on WMHP. PSMA PET metrics (SUVmax, SUVmean, tumor volume, total lesion activity - TLA) were extracted. A sub-analysis was conducted on patients with available quantitative measures on pre-surgical mpMRI. All PIRADS=3 lesions on mpMRI were contoured and quantitative parameters were extracted: mean apparent diffusion coefficient (ADC,  $\times 10^{-6} \text{mm}^2/\text{s}$ ),  $K_{\text{trans}}$  ( $\text{min}^{-1}$ ),  $\text{Kep}$  ( $\text{min}^{-1}$ ),  $i\text{AUC}$  ( $\text{mMsec}$ ). All matching lesions were categorized as sub-cohort 1 (SC 1) cribriform+/IDC-, (SC 2) cribriform+/IDC+, and (SC 3) cribriform-/IDC-. One way-ANOVA assessed significant differences among the imaging parameters in the three sub-cohorts. The area under the curve (AUC) from ROC analysis was used to assess the ability of imaging metrics to predict the presence of aggressive PC features on WMHP.

#### **RESULTS**

The PSMA PET analysis comprised 77 patients (82 lesions) with mean PSA at time of RALP of  $9.07 \text{ ng/ml} \pm 5.8$ . On WMHP, SC 1, 2 and 3 comprised 21/83, 41/83, and 20/83 lesions with significant differences in SUVmean and TLA among these sub-cohorts ( $p=0.003$  and  $0.039$ ). On AUC analysis, SUVmean predicted the aggressive PC features on WMHP with 67% accuracy. The PSMA PET/mpMRI cohort comprised 52 patients (53 lesions) with mean PSA at time of RALP of  $9.67 \text{ ng/ml} \pm 6.76$ . On WMHP, SC 1, 2 and 3 comprised 17/53, 25/53, and 10/53 lesions with significant differences in SUVmean on PSMA PET and ADC on mpMRI among the three sub-cohorts ( $p=0.031$  and  $0.018$ ). On AUC analysis, SUVmean and ADC predicted aggressive PC on WMHP with 65% and 63% accuracy, respectively

#### **CONCLUSION**

Significantly elevated SUVmean on PSMA PET and lower ADC on mpMRI predicted the presence of aggressive PC features (cribriform pattern and IDC) on WMHP with moderate AUC on ROC analysis.

#### **CLINICAL RELEVANCE/APPLICATION**

The ability to predict the presence of pathology features of aggressive PC is critical in case WMHP is not available. Presurgical PSMA PET and mpMRI quantitative parameters can help identify these features with moderate accuracy.

#### **W5A-SPGU-Diagnostic Value of Very Early Diffusion Weighted Changes at MRI after Single-Dose Ablative Radiation Therapy (SDART) for Organ-confined Prostate Cancer** 2

Cammillo R. Talei Franzesi (*Presenter*) Nothing to Disclose

## **PURPOSE**

To investigate diagnostic value of diffusion-weighted (DWI) MRI early changes, 1 hour after treatment, in patients with organ confined unfavorable prostate cancer (PCa) treated with Single-Dose Ablative Radiation Therapy (SDART), in comparison with biochemical markers (PSA and testosterone).

## **METHODS AND MATERIALS**

Twenty four patients treated with a single fraction of 24 Gy to the whole prostate with urethra sparing in association with androgen deprivation therapy (ADT) were prospectively enrolled. MRI was performed before SDART (time 0), one-hour post-SDART (time 1), and 3-month after treatment (time 2). All patients were examined on a 3.0-T MRI scanner (Ingenia; Philips Healthcare) with a phased-array external coil, with bowel preparations and 20mg of butyl-scopolamine (Buscopan) intravenously administered; the bladder was filled with 120cc of saline solution, to simulate the same conditions during irradiation. MRI was performed with axial T1-weighted TSE sequences and high resolution multi-planar T2-weighted TSE sequences. Diffusion weighted imaging (DWI) was acquired with six b-values (0,50,100,150,800,1600mm<sup>2</sup>/s) and Apparent Diffusion Coefficient (ADC) (0,800) maps were calculated. Finally, axial contrast-enhanced dynamic imaging was obtained during intravenous injection of gadobutrol (0.1 mmol/kg, flow rate of 2.5 ml/s). ADC values were calculated at time 0,1, and 2 by placing region-of-interests (ROI) on ADC maps and the results were compared with PSA and testosterone blood levels at time 0 and 2.

## **RESULTS**

Median patient's age was 78 years (range 61-84). Median prostate volume was 36.2 cc (range 10-60). An increase of ADC value of tumor lesion of 27% (range 7%-69%) and 54% (range 20%-83%) was registered at time 1 and time 2 respectively, compared to the baseline. Median prostate volume was found unchanged at time 1, while decreased by about 25% (range 9%-59%) at time 2. At 3-months follow-up, all patients were found bNED with PSA and testosterone levels of <0.01 ng/ml and <0.20 ng/ml, respectively, and 9 of them obtained a complete response.

## **CONCLUSION**

Our findings demonstrated high diagnostic value of DWI imaging with good correlation between very early changes (one-hour after treatment) in ADC values after SDART and later tumor response (biochemical and imaging) in patients with unfavorable PCa.

## **CLINICAL RELEVANCE/APPLICATION**

DWI with ADC values could be used as an early biomarker of treatment outcome in patients treated with SDART of the whole prostate with urethra sparing.

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## Abstract Archives of the RSNA, 2023

W5A-SPHN

### Head & Neck Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPHN-Operating Characteristics of ATA 2015 Thyroid Nodule Risk Malignancy in Colombian Population** 1

Nicole Erazo Morera, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Determine the operating characteristics of the ATA 2015 ultrasound risk classification of thyroid nodules in Colombian population, to see if it can be standardized and applied as it is in American population.

#### **METHODS AND MATERIALS**

We conducted a retrospective quantitative diagnosing test study, where the operating characteristics for the ATA 2015 risk stratification scale was determined. The study was carried out between Sept 2020- Sept 2021. Population: Patients with thyroid nodules with thyroid US in the imaging department of the HUSI (a fourth level institution in Bogotá, Colombia) with an indication for biopsy or surgical removal of the nodule according to ATA 2015. Data collection was carried out by two radiologists from the Radiology Department of the HUSI, one of them with 6 yrs of experience and one of them in training with 3 yrs of experience. Patients with very low and low suspicion nodules according to the 2015 ATA classification were defined as negative whereas intermediate and high suspicion of malignancy were defined as positive. These results were compared with a mixed gold standard, where true negatives are Bethesda II or surgical specimen with benign pathological report, and true positives are Bethesda V/VI or surgical piece positive for malignancy.

#### **RESULTS**

For a "high" risk in the ATA classification, the Likelihood Ratio values for both cases yield results close to 4, being slightly higher when risk III of the BETHESDA classification is excluded. For the "intermediate" classification, the two combinations have a Likelihood Ratio close to 1, indicating an indeterminate result for those that cannot be classified as malignant and benign. For the "low" and "very low" classification, the LR is below 1, when risk III of the BETHESDA classification is excluded and taken into account.

#### **CONCLUSION**

The present study demonstrates that the ATA 2015 sonographic risk stratification scale can be used and implemented in the Colombian population in a similar way to the American population. It is especially applicable if the thyroid nodule evaluated by ultrasonography presents characteristics of "low" or "high" risk of malignancy with a confidence of 95% for an established risk of 5-10% or 70-90% respectively. The category with the lowest sensitivity and specificity is the "intermediate" which is not statistically significant in any of the analyses.

#### **CLINICAL RELEVANCE/APPLICATION**

Validation, of an already used risk stratification scale, in the Colombian population, understanding in which cases there must be a careful appliance (specifically intermediate risk nodule) in this population base.

#### **W5A-SPHN-Utility of Radiomics Features in Predicting Human Papillomavirus Status in Head and Neck Squamous Cell Carcinoma: A Systemic Review and Meta-analysis** 2

Golnoosh Ansari, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Human papilloma virus (HPV) is one of the main risk factors and a potential prognostic indicator for head and neck squamous cell carcinoma (HNSCC). We sought to analyze the value of radiomics features in the determination of HPV status in HNSCC as an alternative to immunohistochemical typing.

## METHODS AND MATERIALS

A systemic search was conducted on PubMed, Scopus and other major web-based repositories using the search terms HPV, Radiomics, HNSCC, head and neck, papilloma and oropharyngeal SCC. Diagnostic accuracy measures, and the confusion matrix of each study were extracted and the data were utilized to perform meta-analysis based on the random effects model. Fagan's nomogram was used to determine clinical utility. Deek's funnel plot was used to determine publication bias.

## RESULTS

Twenty six articles were included in the systemic review and 14 were used for the meta-analysis. The median radiomics quality score was 9 out of 36, showing an overall poor quality in the currently available literature. There was no significant publication bias among the publications included in the meta-analysis. The overall sensitivity of the included studies equaled 0.772 (0.73, 0.809) and the overall specificity equaled 0.763 (0.714, 0.806). The I<sup>2</sup> statistic showed that heterogeneities for sensitivity and specificity were medium (I<sup>2</sup> = 56.91%, and 55.44%, respectively). Only one percent of the heterogeneity witnessed was due to threshold effect. Diagnostic odds ratio equaled (DOR) 10.932 (7.847, 15.23). Using a radiomics model generated on cross-sectional imaging would increase the post-test probability to 82% from 58% with a positive likelihood ratio of 3 when the pretest was positive. When the pretest was negative the post-test probability decreased to 29% with a negative likelihood ratio of 0.3.

## CONCLUSION

Radiomics features showed moderate success in the determination of HPV status in HNSCCC and could be employed when conventional para-clinical laboratory methods are not available. More studies, especially those trained and tested on multiple independent datasets, are needed to determine the clinical utility of radiomics trained machine learning models in this regard.

## CLINICAL RELEVANCE/APPLICATION

As currently there are no FDA-approved diagnostic modalities for the determination of HPV status in HNSCC, radiomics features may be able to act as a means of "virtual biopsy" and alleviate the need for IHC staining.

## W5A-SPHN-The Value of Texture Features based on Dynamic Contrast-enhanced Magnetic Resonance Imaging in Predicting the Efficacy of Radiotherapy and Chemotherapy in Nasopharyngeal Carcinoma

Nan Wang (*Presenter*) Nothing to Disclose

### PURPOSE

the purpose of this study was to explore the value of texture features based on DCE-MRI in predicting the efficacy of radiotherapy and chemotherapy in primary NPC.

### METHODS AND MATERIALS

1. SubjectsForty-nine patients with NPC who underwent nasopharyngeal/cervical DCE-MRI examination and confirmed by pathology were analyzed retrospectively. According to the follow-up of MR and/or pathology after 6 months of treatment, the efficacy of radiotherapy and chemotherapy of NPC was divided into two groups: poor prognosis group (residue or recurrence) (n=22) and good prognosis group (no residue and recurrence) (n=27).2.Image analysis A 3.0T MR (Signa HDxt, GE Medical Systems, Milwaukee, WI, USA) scanner was used with an 8-channel phased array coil in the head and neck.The permeability parameters of the DCE-MRI images: Ktrans, Kep, and Ve functional maps were imported into 3D Slicer software. Two imaging diagnostic physicians manually sketched the ROI. (Fig. 1, 2). Record the texture feature parameters of each functional map respectively.

### RESULTS

1.DCE- measured by two observers. The texture feature parameters of the MRI function map are consistent (ICC values are all>0.75) (Table 1)2. the MinimumKtrans signal intensity and JointAverageKep of the good prognosis group were higher than those of the poor prognosis group, while the values of AutocorrelationKtrans, JointAverageKtrans, SumAverageKtrans, AutocorrelationKep, and SumAverageKep were lower than those of the poor prognosis group, and the difference was statistically significant (Table 2). However, there is no difference in the texture parameters of the Ve signal intensity map.3. ROC analysis of Ktrans and Kep signal intensity map texture parameters to identify NPC efficacy (Table 3). The area under the curve predicted by the threshold of Autocorrelation, JointAverage, and SumAverage of Kep signal strength was the largest, which was 0.684, the sensitivity was 81.48%, and the specificity was 59.09% (figure 3).

### CONCLUSION

The texture feature based on DCE-MRI has potential value in predicting the efficacy of radiotherapy and chemotherapy in nasopharyngeal carcinoma before treatment.

### CLINICAL RELEVANCE/APPLICATION

nasopharyngeal carcinoma is a tumor with significant geographical distribution and is a common malignant tumor of the head and neck in southern China. Radiotherapy and chemotherapy are considered the first choice of treatment, but there are still



patients with poor prognoses (residue or recurrence) due to treatment failure. Early prediction of the efficacy of radiotherapy and chemotherapy can optimize the treatment plan of NPC patients and improve the survival cycle, which has significant clinical significance.

## **W5A-SPHN-Multi-parameter Quantitative Magnetic Resonance in Early Assessment of Radiation Induced Parotid Damage in Nasopharyngeal Carcinoma Patients after Intensity Modulated Radiotherapy**

Zhifeng Xu (*Presenter*) Nothing to Disclose

### **PURPOSE**

The aim of this study was to investigate the value of Intravoxel Incoherent Motion Imaging (IVIM) and 3D Pulsed Continuous Arterial Spin Labeling (ASL) in assessing dynamic changes of parotid gland (PG) in nasopharyngeal carcinoma (NPC) patients after radiotherapy (RT).

### **METHODS AND MATERIALS**

A total of 18 patients with NPC underwent Intensity-Modulated Radiotherapy (IMRT) were enrolled. All patients underwent conventional MRI, and IVIM and ASL imaging for bilateral PGs within 2 weeks before RT (pre-RT), 1 week and 3 months after RT (post-RT). Pure diffusion coefficient (D), pseudo-diffusion coefficient (D\*), perfusion fraction (F) and blood flow (BF) were analyzed.

### **RESULTS**

From pre-RT to 1W post-RT, D and CBF values both increased significantly [change rate, 39.28% (38.23%) and 60.84% (54.88%)], and continued to increase significantly from 1W post-RT to 3M post-RT [change rate, 55.44% (40.56%) and 120.39% (128.74%)]. From pre-RT to 1W post-RT, F value increased significantly [change rate, 28.13% (44.66%)], and then decreased significantly from 1W post-RT to 3M post-RT, whereas no significant differences were found between pre-RT to 3M post-RT. From pre-RT to 1w post-RT and 1M post-RT, D\* value decreased significantly [change rate, -41.86% (51.71%) and -29.11% (42.67%)]. No significant difference was found between different post-RT time intervals. There was a significant positive correlation between percentage change in  $\Delta$ CBF1W and radiation dose ( $R=0.548$ ,  $p=0.001$ ).

### **CONCLUSION**

Both IVIM-DWI and ASL can help to detect/predict radiation-induced parotid damage in early stage after RT. They may contribute to clarify the correlations between damage of PGs and patient-/treatment-related variables by assessing individual microcapillary perfusion and tissue diffusivity.

### **CLINICAL RELEVANCE/APPLICATION**

To reveal the mechanism of parotid radiation injury, realize early non-invasive diagnosis, and allow patients to obtain timely treatment to improve the quality of life of patients

## **W5A-SPHN-Prognostic Significance of MRI-Defined Sarcopenia in Patients with Nasopharyngeal Carcinoma: A Propensity Score Matched Analysis of Real-World Data**

Shuyi Liu (*Presenter*) Nothing to Disclose

### **PURPOSE**

Image-defined sarcopenia is linked to increased mortality among patients with cancer. Nevertheless, its effect on patients with nasopharyngeal carcinoma (NPC) is incompletely established. This study's aim was to investigate the prognostic significance of MRI-defined sarcopenia at the level of the third cervical vertebra (C3) on the survival of patients undergoing concurrent chemoradiotherapy (CCRT)  $\pm$  inducing chemotherapy (IC) for NPC treatment

### **METHODS AND MATERIALS**

1,307 patients from two tertiary centers who had stage II-IVA NPC diagnosis between July 1, 2010, and September 30, 2019, were included in this retrospective study. Sarcopenia was defined using skeletal muscle index (SMI) determined through baseline MRI at the C3 level. The association of sarcopenia with overall survival (OS) and progression-free survival (PFS) was assessed by computing the Hazard ratios (HRs). Using 1:1 propensity score matching (PSM) analysis, Cox regression models were adjusted for age, body mass index (BMI), sex, and treatment. The PSM analysis revealed 331 pairs. We also conducted a stratification analysis using BMI and treatment strategies.

### **RESULTS**

The patients' median (range) age was 48 (18-80) years, with 821 patients (62.8%) presenting with sarcopenia. Before and after PSM, sarcopenia was an independent risk factor for both OS and PFS (all  $P < 0.05$ ). However, BMI was not substantially linked to tumor progression and overall mortality (all  $P > 0.05$ ). Sarcopenic patients showed lower rates of OS (HR = 2.00, 95% CI: 1.54-2.60,  $P < 0.001$ ) and PFS (HR = 1.67, 95% CI: 1.35-2.07,  $P < 0.001$ ) in contrast with nonsarcopenic patients. Similar findings were obtained after PSM. According to stratification analysis, being overweight was linked to a protective

effect in nonsarcopenic patients only. In addition, sarcopenic patients showed similar OS and PFS regardless of the treatment modality.

#### **CONCLUSION**

Sarcopenia is underrecognized in NPC patients. Measurement of sarcopenia using routine MRI scans in NPC patients provided significant prognostic information, outperforming BMI. Patients with sarcopenia failed to benefit from an additional IC regimen.

#### **CLINICAL RELEVANCE/APPLICATION**

Sarcopenia could be used as a marker for predicting NPC patients' prognoses before treatment utilizing MRI images.

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## Abstract Archives of the RSNA, 2023

W5A-SPIN

### Imaging Informatics Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPIN- Automated Quantification of Uncertainty for Emphysema Evaluation from CT Images using Hybrid Bayesian Deep Learning** 1

Antonio Porras Perez, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Emphysema quantification from computed tomography (CT) images is important to evaluate chronic obstructive pulmonary disease (COPD). Although volume-adjusted lung density (ALD) can be used for prognosis, it has shown sensitivity to variations between scanners and there are no metrics of its reliability. We present a hybrid Bayesian deep learning model to predict lung density from CT images that can quantify both the aleatoric and the epistemic uncertainty, which are associated with the imaging protocol and the prediction, respectively. These measures of reliability can be used during clinical evaluation.

#### **METHODS AND MATERIALS**

Inspiratory lung CTs from 1,936 COPD Gene participants (age  $59.36 \pm 9.00$  years; 1,038 female) were used. The data were randomly split into training (80%), validation (10%) and test images (10%). We trained a model to predict lung density at the 15th percentile of the CT histogram (Perc15) and quantify ALD. Our model consisted of convolutional blocks that quantify CT image features followed by fully connected layers. The final layer was Bayesian and weights were trained as probabilistic distributions instead of point estimates. ALD was calculated as the product of predicted Perc15 and the ratio of observed versus expected lung volume. Aleatoric and epistemic uncertainty were estimated over 50 stochastic forward passes in the test set. Deep learning ALD (DL-ALD) was compared to conventional ALD, and Cox proportional hazards models were used to determine the association between uncertainty and mortality.

#### **RESULTS**

The average root mean squared error for DL-ALD was 4.70 (95% CI: 4.68, 4.73). The mean aleatoric uncertainty was 23.77 (95% CI: 13.04, 34.51). The mean epistemic uncertainty was 1.22 (95% CI: 0.73, 1.71). DL-ALD was significantly associated with mortality ( $p < 0.001$ ) when adjusting for age, body mass index, smoking status, gender, and race. Adjusting for DL-ALD and demographics, epistemic uncertainty had a significant positive association with mortality ( $p = 0.013$ ) but aleatoric uncertainty did not ( $p = 0.134$ ).

#### **CONCLUSION**

DL-ALD performs as well as conventional ALD in predicting survival but it provides measures of uncertainty. This represents a substantial improvement over conventional methods that cannot estimate uncertainty. Aleatoric uncertainty associated with imaging protocol was higher than uncertainty from the model. Additionally, higher model uncertainty was associated with increased mortality risk, suggesting a need for reliability metrics to improve survival prediction through ALD.

#### **CLINICAL RELEVANCE/APPLICATION**

Uncertainty estimation when evaluating emphysema through hybrid Bayesian deep learning improves reliability of lung density measures over conventional image intensity-based analysis.

#### **W5A-SPIN- Deep Learning Model for Acute Respiratory Distress Syndrome (ARDS) Detection in the Pediatric Intensive Care Unit (PICU) Setting** 2

Vahid Khalkhali, MSc (*Presenter*) Nothing to Disclose

## PURPOSE

Acute respiratory distress syndrome (ARDS) is a significant cause of morbidity and mortality in the pediatric intensive care unit (PICU). ARDS diagnosis involves chest x-ray criteria combined with clinical and laboratory parameters. Machine learning models have demonstrated utility in the detection of ARDS on chest radiographs.

## METHODS AND MATERIALS

In this retrospective, IRB-approved study, we identified 368 children admitted to the PICU with a diagnosis of ARDS, at a large pediatric academic center from 2014 to 2019. A single randomly selected radiograph from all patients admitted to the PICU without a diagnosis of ARDS during 2018 was used to establish the control cohort, (n=1127). The train:validation:test ratio was 60/20/20. Using transfer learning, we utilized a pretrained convolutional neural network (CNN) structure to determine the diagnosis of ARDS (PyTorch, version 1.2). The criterion was to minimize weighted cross-entropy loss. Area under the receiver operating characteristics (AUROC) was the main performance metric. Two pediatric radiologists independently assigned labels of ARDS to the training-set, and interrater reliability was calculated. Correlations between radiologists and the models were calculated using Pearson correlation and Cohen's Kappa. All statistical analysis used Type-I error of 5% and power of 80%.

## RESULTS

The interrater reliability between the radiologists was 94.5% (Cohen's Kappa of 85.8%) for the training cohort. The ARDS diagnostic performance of two radiologists yielded an AUROC (balanced accuracy) of 72.5%, while the DenseNet161 model achieved 86.0% (AUROC of 92.5%) and ensemble of models reach to 83.7% (AUROC of 93.5%). Radiologist diagnoses were only 81% correlated (Cohen's Kappa 51.6%) with the DenseNet161 model and 83% (Cohen's Kappa 60.5%) with ensemble of models. While Pearson correlation between two radiologists were high (> 90%) on the test set, the difference between the detection of different models were statistically significant ( $p < 0.01$ ).

## CONCLUSION

Using transfer learning, we trained a CNN to reliably detect ARDS in the PICU and compared its performance with the diagnostic rates of two experienced radiologists. Machine learning can automatically detect ARDS on chest radiographs, with a performance which parallels those of radiologists.

## CLINICAL RELEVANCE/APPLICATION

Deep learning detection of ARDS could improve the triage of patients in the intensive care unit before the availability of dedicated pediatric radiologist reads.

## W5A-SPIN- Predicting the Occurrence of Immune Checkpoint Inhibitor-related Pneumonitis on Non-small Cell Lung Cancer Patients via Deep Learning

Janardhana Ponnatapura, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Immune-checkpoint inhibition (ICI) has conveyed a paradigm shift in advanced lung cancer treatment in recent years. However, ICI therapy related pneumonitis, which is an immune related adverse event (irAE), can limit delivery of treatment to some patients. With overall incidence of nearly 6%, it is considered one of the more common irAEs resulting in a significant burden of morbidity and mortality in the lung cancer population. Predicting ICI-pneumonitis is crucial for identifying at-risk patients and adjusting their treatment to prevent the occurrence of ICI-pneumonitis. We in this study try to predict ICI-pneumonitis based on patients' imaging and clinical data.

## METHODS AND MATERIALS

We collected data from 1,254 lung cancer patients who received immunotherapy between 2015 and 2021. In the dataset, 53 patients developed ICI-pneumonitis and were included in this study. Another 41 patients who received immunotherapy without developing ICI-pneumonitis were randomly selected and used as a control group. We proposed a deep learning framework to predict ICI-pneumonitis based on deep learning features and radiomics features. A vision transformer was first pre-trained on over 25,000 CT scans from the NLST dataset and then used to extract deep learning features. Radiomics features were extracted using the Python pyradiomics package after lung segmentation. After feature selection, 17 deep features and 20 radiomic features were used for prediction. A network with three fully connected layers was trained for ICI-pneumonitis prediction using five-fold cross-validation.

## RESULTS

Using only deep learning features, we achieved an AUC of 0.934 (95%CI: [0.883, 0.986]). Similarly, with only radiomics features, the prediction AUC was 0.928 (95%CI: [0.873, 0.982]). When combining deep features with radiomics features, the prediction accuracy further improved to an AUC of 0.958 (95%CI: [0.917, 0.999]).

## CONCLUSION

Our proposed method can predict the occurrence of ICI-pneumonitis with high accuracy, indicating the potential for using deep learning to predict ICI-pneumonitis in advanced lung cancer patients receiving immunotherapy. This approach could be valuable for treatment planning in the future.

## CLINICAL RELEVANCE/APPLICATION

Prediction of ICI pneumonitis will have an important positive impact as early detection and timely recognition are critical to initiate prompt treatment and prevent further morbidity and mortality for these oncology patients.

## W5A-SPIN- SAMConvex: Fast Discrete Optimization for Deformable CT Registration using Multi-scale Self-supervised Anatomical Embedding and Correlation Volume

4

Zi Li (*Presenter*) Nothing to Disclose

## PURPOSE

Deformable image registration is a fundamental medical image analysis task. Estimating displacement vector field via a cost volume computed in the feature space suffers excessive computation burdens. Moreover, existing feature descriptors only extract local features incapable of representing the global semantic information that is important for handling large transformations. To address these issues, we propose SAMConvex, a fast coarse-to-fine discrete optimization method for CT image registration. It includes a decoupled convex optimization procedure to obtain deformation fields based on a self-supervised anatomical embedding (SAM) feature extractor that captures both local and global information.

## METHODS AND MATERIALS

Our proposed model, named SAMConvex, consists of two major components: (1) A discriminative feature extractor based on a SAM that encodes global and local embeddings for each voxel. The global embeddings memorize the 3D contextual information of body parts on a coarse resolution level, while the local embeddings differentiate adjacent structures with similar appearances. (2) A lightweight correlation pyramid that constructs multi-scale 6D cost volume by taking the inner product of SAM embeddings. With coarse-to-fine strategy, we estimate a sequence of deformation fields. The final field is computed via the composition of all the deformation fields. We conduct the registration in 3 levels of resolutions. The registration performance is extensively evaluated in two inter-patient registration datasets, i.e., Abdomen CT (20 patients for train and 10 for test), and HeadNeck CT (62/10 patients for train/test) and intra-patient Lung CT (35 patients, each with inspiratory and expiratory breath-hold CT pairs). The average Dice score computed for the labeled organs is used to evaluate the accuracy.

## RESULTS

SAMConvex outperforms state-of-the-art registration methods, such as LapIRN, and Deeds, over all three datasets with an average 2.4% Dice score improvement as compared to the second-best performing method (Deeds). E.g., SAMConvex is consistently better than the second-best (Deeds) and third-best (LapIRN) registration methods on most examined abdominal organs, in 11 out of 13 organs. Moreover, as an optimization-based method, SAMConvex only takes ~2s for one paired scans, as compared to ~100s required by Deeds.

## CONCLUSION

The proposed deep registration model (SAMConvex) demonstrates state-of-the-art accuracy, good generalization, and high computation efficiency over previous leading models.

## CLINICAL RELEVANCE/APPLICATION

The proposed algorithm can accurately register the CT scans. The method can be applied in various downstream tasks such as longitudinal lesion quantification and image-guided radiotherapy.

## W5A-SPIN- Effective Opportunistic Screening for Colorectal Cancer using Abdominal or Chest Noncontrast CTs

5

Mingyan Qiu, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

We designed an AI model for detecting colorectal cancer (CRC) using noncontrast chest or abdominal CT scans, which offers the advantage of opportunistic screening a broad asymptomatic population.

## METHODS AND MATERIALS

The training data consisted of 1,561 3D noncontrast abdominal CTs from a single hospital, including 566 cases with pathology-confirmed CRC and 995 cases without CRC. The initial CRC masks in the training set were manually annotated on the venous phase CT by an experienced radiologist (10-yr), referring to reports as needed. We then employed a robust image registration method to register the annotated mask from venous to noncontrast CT for model training. Our AI model is a UNet

for segmentation of CRC and colorectum, which is further enhanced by a classification branch and is trained end-to-end to classify the patient as CRC or normal. To improve the differentiation of CRC tumor from colorectal content and normal tissues, we designed a content augmentation method and a contrastive loss. The model performance was evaluated on an internal hold-out test cohort comprising 147 patients with CRC and 153 normal cases, and external test cohorts comprising 181 abdominal CTs with CRC, one chest CT with CRC, and 2,477 normal chest CTs from three centers. One radiologist specialized in CRC imaging (20-yr) is invited for the reader study on the hold-out test cohort.

## RESULTS

On the internal test cohort, the model had an area under the curve of 0.978, sensitivity of 91.2%, and specificity of 97.4%; while the radiologist's sensitivity was 79.6% and specificity was 97.4%. Moreover, the model outperformed the radiologist in detecting early-stage CRC (T1 33.3% vs. 16.7%, T2 75.0% vs. 50.0%). On the external test cohorts, the model's sensitivity was 80.7% and 100% for abdominal CTs and chest CT, respectively; and the specificity was 99.6% for normal chest CT. Additionally, a preliminary comparison shows that our approach has comparable performance and may even outperform the established CRC screening tests in both sensitivity and specificity, such as CT colonography (Sens 90%, Spec 86%) and FIT (Sens 74%, Spec 95%).

## CONCLUSION

The proposed model could detect colorectal cancer tumors on chest and abdominal noncontrast CT scans with a high sensitivity and specificity, exceeding the sensitivity of an experienced radiologist specialized in CRC imaging.

## CLINICAL RELEVANCE/APPLICATION

Our study aims to investigate a novel, non-invasive, opportunistic screening solution for colorectal cancer using noncontrast CT and AI. The multi-center experimental results show that our solution achieves both high sensitivity and specificity, indicating that opportunistic population-based CRC screening in asymptomatic adults could potentially be performed in abdominal and chest CT.

## W5A-SPIN- Deep Learning Analysis of Chest Radiographs to Predict Coronary Artery Calcium and Triage Patients Deferrable from CT

Yisak Kim (*Presenter*) Nothing to Disclose

## PURPOSE

To develop a deep learning (DL) model to predict the coronary artery calcium (CAC) using chest radiographs (CRs), validate its performance in patients from different institution and investigate the clinical utility of the model as a triage tool for deferring additional computational tomography (CT) scan.

## METHODS AND MATERIALS

We retrospectively searched adult patients who had undergone both a calcium score CT and posteroanterior chest radiography within a 3-month period from three different institutions; a total of 4,858 radiographs (age  $60.6 \pm 12.2$ ; women 2,458) from institution A, 4,109 radiographs (age  $61.0 \pm 12.3$ ; women 1,823) from institution B, and 979 radiographs (age  $57.0 \pm 11.3$ ; women 334) from institution C. Patients from institution A and B were used as a developmental cohort, and institution C as an external test cohort. The total Agaston scores calculated from CT were divided into 5 grades: 0, 1-100, 11-100, 100-400, and over 400, and considered ground truth labels. Images were cropped to fit the lung and heart area and normalized using energy bands and a region of interest obtained by heart segmentation. total of six different image sets were generated; original, lung area and heart area for non-normalized and energy bands normalized. Separate DL models based on DenseNet-161 were individually trained for each of six image sets and the final performance was calculated using ensemble theses six models. Conditional Ordinal Regression for Neural Networks (CORN) method was used for 5 ordinal CAC grade classification.

## RESULTS

Binary classification between under and over 100 CAC scores attained AUCs of 0.81, 0.79, 0.83, 0.77 on validation dataset, internal test A, internal test B and external test respectively. All test datasets showed more than 99% sensitivity at a threshold of sensitivity rate 99% attained from validation, and showed specificity of 27%, 28%, 18% and 26% for validation dataset, internal test A, internal test B and external test respectively. Using a threshold of sensitivity rate 99% attained from validation dataset, the DL model correctly identified 23.7% (66 of 278) and 14% (101 of 722) of patients in the internal test set A and B as CAC score under 100 so that additional CT scan may be deferred. Among them, true individuals showing CAC score under 100 (NPV) were 100% (66 of 66) and 98% (99 of 101) in the internal test set A and B respectively. On the external test set, DL model was able to defer 21.5% of all patients (212 of 977), and the NPV was 99.1% (210 of 212).

## CONCLUSION

DL model could predict the CAC from CRs and could be used for helping clinical decision-makings such as taking additional CT.

## **CLINICAL RELEVANCE/APPLICATION**

The proposed model may assist in deferring additional CT scans using CRs by triaging patients with a under 100 CAC score.  
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## Abstract Archives of the RSNA, 2023

W5A-SPIR

### Interventional Radiology Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPIR- Uncovering Hidden Lesions - Incidental Ring Hyperenhancing Liver Micronodules in Computed Tomography during Hepatic Arteriography Guidance in Percutaneous Thermal Ablation of Colorectal Liver Metastasis**

Jessica A. Marques Silva, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To describe and evaluate the nature of incidental ring hyperenhancing liver micronodules (RHLMs) detected on computed tomography during hepatic arteriography (CTHA) in patients with colorectal liver metastases (CLM) undergoing percutaneous ablation.

#### **METHODS AND MATERIALS**

Twenty-two CLM patients who underwent 24 CTHA-guided percutaneous thermal ablation sessions (AS) for 41 CLMs were included. CTHA images were obtained before and after ablation for tumor targeting and ablation margins assessment. Two radiologists independently reviewed pre-ablation images, and the interobserver agreement was assessed using Cohen's kappa. Incidental RHLMs were defined as small nodules with continuous ring enhancement visible in late arterial phase on three planes, with an average Hounsfield Unit at least twice that of adjacent liver parenchyma, not detected on baseline imaging. The nature of incidental RHLMs was determined by histological confirmation and/or follow-up image assessment. A biomechanical deformable image registration (DIR) method was used to map incidental RHLMs and newly detected CLMs on follow-up CT imaging. RHLMs were considered as CLMs if their segmentations overlapped.

#### **RESULTS**

The median time from baseline contrast-enhanced cross-sectional and/or functional imaging to AS was 29.4 days ( $\pm$  19.1 days). 25 incidental RHLMs with a mean largest diameter of 0.8 cm (range 0.3-1.7) were identified in 41.7% (10 of 24) of the AS. The agreement between two observers on identifying incidental RHLMs was almost perfect ( $\kappa = 0.907$ ). 4 incidental RHLMs were ablated during the AS given their similarity to targeted CLMs. Of the remaining 21 incidental RHLMs, 71.4% (15 of 21) disclosed to be CLMs, with 20% (3 of 15) confirmed by histology and 80% (12 of 15) by follow-up imaging using a DIR method at a mean time of 52 days ( $\pm$  27.8 days) post-ablation. The nature of the last 28.6% (6 of 21) incidental RHLMs was unknown, but no intrahepatic progression was observed on follow-up after chemotherapy.

#### **CONCLUSION**

Incidental RHLMs can be an early indicator of small CLMs, as confirmed by histology and DIR-based imaging analysis. Further investigation is needed to evaluate their relevance, as CLM resection is the only potentially curative treatment for liver-limited disease.

#### **CLINICAL RELEVANCE/APPLICATION**

The presence of incidental ring hyperenhancing liver micronodules on computed tomography during hepatic arteriography can indicate early-stage colorectal liver metastasis, which could impact the treatment approach.

#### **W5A-SPIR- Added Value of Kupffer-phase Imaging of Sonazoid-enhanced Ultrasound in Liver Ablation**

Dae Woong Kim, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the usefulness of Kupffer-phase imaging (KPI) in Sonazoid-enhanced ultrasound (SZUS) for local ablation of liver tumors and to identify factors related to tumor conspicuity on the KPI of SZUS.



## METHODS AND MATERIALS

A total of 73 patients with 112 liver tumors (95 HCCs and 17 non-HCCs), who underwent gadoteric acid-enhanced MRI (Gd-EOB-MRI), B-mode planning US (BPUS), and SZUS-assisted radiofrequency ablation (RFA) from January 2020 to February 2023, were included. RFA was performed by an experienced radiologist using SZUS/MR image fusion, 30 to 50 minutes after intravenous injection of Sonazoid. The characteristics of both patients and liver tumors were evaluated. Tumor conspicuity was assessed sequentially using a 4-point scoring scale on hepatobiliary phase (HBP) of Gd-EOB-MRI, BPUS, and KPI of SZUS at 1-week intervals by the consensus of two experienced abdominal radiologists. The tumor echogenicity on BPUS were classified into hypoechoic and non-hypoechoic groups. Conspicuity scores of 1 and 2 were classified as the poor conspicuity group, while scores of 3 and 4 were classified as the good conspicuity group. We also investigated factors related to tumor conspicuity on the KPI of SZUS, as well as the technical success rate of RFA.

## RESULTS

The mean size of tumors was  $13.1 \pm 5.9$  mm. There was no significant difference in size or location between HCCs and non-HCCs. The tumor conspicuity score on KPI of SZUS ( $2.88 \pm 0.85$ ) was higher than that of BPUS ( $1.85 \pm 0.74$ ). The correlation between tumor conspicuity on KPI of SZUS and HBP of Gd-EOB-MRI was higher than that of BPUS and KPI of SZUS (HCCs [ $r=0.38$ ,  $p<0.001$ ], non-HCCs [ $r=0.76$ ,  $p<0.001$ ], and total [ $r=0.44$ ,  $p<0.001$ ] versus HCCs [ $r=0.33$ ,  $p<0.001$ ], non-HCCs [ $r=0.31$ ,  $p=0.224$ ], and total [ $r=0.34$ ,  $p<0.001$ ]). The factors related to tumor conspicuity on KPI of SZUS were hypoechoicity on BPUS and good conspicuity on HBP of Gd-EOB-MRI ( $p=0.034$  and  $p=0.01$ , respectively). The technical success rate of RFA using KPI was 97.3%.

## CONCLUSION

KPI of SZUS could be a valuable tool for successful liver ablation in cases where the tumor is not clearly visible on BPUS but is well-defined on the HBP of Gd-EOB-MRI.

## CLINICAL RELEVANCE/APPLICATION

When liver tumors are not clearly visible on ultrasound, performing liver ablation can be challenging. Although SZUS has the potential to improve tumor conspicuity, it is not widely used in liver ablation due to various limitations including its high cost, unpredictable effect on improving tumor visibility, short duration of the vascular phase, and long waiting time for KPI. However, using KPI of SZUS for liver ablation can significantly reduce procedure time and improve the technical success rate, especially when liver tumors are clearly visible on HBP of Gd-EOB-MRI.

## W5A-SPIR- Post Embolization Syndrome Following Histotripsy: An Indicator of Immune Activation

3

Nathan E. Loudon, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Post-embolization syndrome (PES) is a reported phenomenon that can occur following transarterial chemoembolization (TACE) or radioembolization (TARE). It is thought to occur as a result of immune and inflammatory response to cell death during tumor necrosis. The most commonly described symptoms are pain, fever, and leukocytosis. The purpose of this study was to determine whether these symptoms would be seen following histotripsy at higher or lower frequency compared to TACE or TARE.

## METHODS AND MATERIALS

This was a single center IRB approved retrospective cohort study which compared post-embolization syndrome symptoms of fever, right upper quadrant abdominal pain, and leukocytosis among patients who underwent ablation of liver tumors using histotripsy ( $n=10$ ), TARE ( $n=32$ ), or TACE ( $n=34$ ). Our analysis considered size of largest lesion, tumor type, LR category, and BCLC staging.

## RESULTS

When adjusted for the size of the lesion and tumor type (HCC vs non-HCC), the odds of experiencing fever were 7.17 times higher in patients who underwent histotripsy compared to TACE (95% CI = 1.16 - 52.33,  $p=.039$ ), and 50 times higher compared to TARE (95% CI = 5.74 - 1589.36,  $p=.003$ ). The odds of experiencing abdominal pain were 14.70 times higher in the histotripsy group compared to TACE (95% CI = 2.09 - 302.12,  $p=.02$ ) and 50 times higher compared to TARE (95% CI = 7.02 - 1307.34,  $p=.001$ ). The histotripsy group had a smaller change in WBC from pre to post treatment compared to TACE (2.49, 95% CI = 0.34 - 4.64,  $p=0.024$ ), and no statistically significant difference in WBC change compared to TARE.

## CONCLUSION

As histotripsy becomes a more widely available treatment offered to patients it is important to understand the range of expected clinical symptoms which can occur following ablation. This study suggests that patients who undergo histotripsy are more likely to experience fever and abdominal pain following ablation compared to TACE and TARE.

## CLINICAL RELEVANCE/APPLICATION

Histotripsy is a novel ablation modality and as such its expected post-treatment symptoms are still being elucidated. Pre-clinical data have shown that histotripsy is highly immunogenic on both a local and systemic level. PES is thought to be a result of inflammatory and immune response to tumor ablation. Studying the incidence of PES in this population could provide valuable insights into the clinical manifestations of immune activity following ablation.

### W5A-SPIR- Prediction of Initial Lung Microwave Ablation Zone Through Tumor and Ablation Characteristics

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To investigate the effect of tumor and ablation characteristics on dimensions and size of lung microwave ablation zone and establish a prediction model.

#### METHODS AND MATERIALS

This IRB-approved, HIPAA compliant study cohort involved patients who underwent CT-guided lung microwave ablation for their malignancy between 2012 to 2023. All patient demographics, treatment history, tumor characteristics, ablation duration, and maximum temperature (Tmax) reached were recorded. The peripheral location was defined as the area within 2cm from the edge of the visceral pleura. Ablation images without specific intraprocedural labels indicating post-initial ablation or cases without complete ablation details were excluded. The initial ablation zone was represented by the elliptical ground-glass opacity surrounding the target site and its dimensions were measured. Dataset was divided into 70% training and 30% test set and univariate and multivariate linear regression models were used to build a prediction model for the major axis, minor axis, and area of the ablation zone.

#### RESULTS

This study cohort was composed of 89 lesions that underwent microwave ablations. Of these ablations, 25 were with history of prior lung radiation therapy (Hrad) (28%) and 7 with history of prior lung surgery (Hsurg) (8%), and 45 lesions were located at the peripheral region. The median duration of the initial ablation was 1.5 minutes ranging from 0.5 to 10 minutes, the power used was 65W for all ablations, and mean of Tmax was  $100 \pm 17^\circ\text{C}$ . The measured mean major, minor axes, and area were  $3.1 \pm 0.8\text{cm}$ ,  $1.8 \pm 0.5\text{cm}$ , and  $4.7 \pm 2.5\text{cm}^2$ . A parsimonious prediction model was built keeping only the predictors with  $p < 0.15$ . For the major axis, duration ( $p < 0.001$ ), Tmax ( $p = 0.002$ ), Hsurg ( $p < 0.001$ ), and Hrad ( $p = 0.102$ ) were predictors. For minor axis, duration ( $p < 0.001$ ), Tmax ( $p < 0.001$ ), Hsurg ( $p = 0.001$ ), and peripheral location ( $p = 0.099$ ) were predictors. For the area, duration ( $p < 0.001$ ), Tmax ( $p < 0.001$ ), and Hsurg ( $p < 0.001$ ) were predictors. The fitted model equation for major axis was:  $3.176 + 0.597 * \log(\text{duration}) - 0.003 * (\text{Tmax}) - 0.302 * (\text{Hrad}) + 1.146 * (\text{Hsurg})$  with test root mean square error (RMSE)=0.55,  $R^2=0.29$ . The equation for minor axis was:  $1.575 + 0.332 * \log(\text{duration}) + 0.001 * (\text{Tmax}) + 0.022 * (\text{Hsurg}) + 0.106 * (\text{peripheral})$  with test RMSE=0.53,  $R^2=0.33$ . The equation for area was:  $5.772 + 2.431 * \log(\text{duration}) - 0.021 * (\text{Tmax}) + 1.658 * (\text{Hsurg})$  with test RMSE=2.11,  $R^2=0.40$ .

#### CONCLUSION

Lung tumor and ablation characteristics are shown to be significant predictors of microwave ablation dimensions and size which can be used to establish a prediction model.

## CLINICAL RELEVANCE/APPLICATION

Estimate of lung microwave ablation dimensions and size can aid in effective treatment of lung tumors.

### W5A-SPIR- Efficacy and Safety of Tract Cautery for Lung Microwave Ablation

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### PURPOSE

To evaluate the efficacy and safety of tract cautery for lung microwave ablation through comparison of post-procedure complication rate.

#### METHODS AND MATERIALS

This IRB-approved, HIPAA compliant study involved patients who underwent lung microwave ablation for their malignancy between 2012 to 2021. All patient demographics, treatment history, tumor characteristics, ablation details were collected. The study cohort was divided into whether tract cautery was conducted during probe removal. Immediate, persistent, and enlarging pneumothorax (PTX) were each defined as the observation of PTX on CT or chest radiograph during the termination of procedure, detection of non-expanding PTX, and expanding PTX for 3-5 hours post-procedure. Other complications including pleural effusion, delayed complication (more than one week), and post-procedural interventions needed for management of complications were recorded. A subgroup analyses of patients with no history of radiation therapy were also included. Univariate and multivariate logistic regression models were used to compare differences in complication rates.

## RESULTS

This study cohort was composed of 171 lung microwave ablation sessions of 62 patients (mean age 59±12). 58/171 were with history of radiation therapy of the lung (33.9%) and 33/171 were with history of lung surgery (19.3%). 80 ablations exhibited immediate PTX, 45 persistent PTX, 19 enlarging PTX, 26 pleural effusion, 8 delayed complications, and 14 required interventions. Tract cauterization was conducted in 126/171 ablations. Patients who did not receive tract cauterization had 10 times the odds of exhibiting delayed complications than patients who did receive tract cauterization (p=0.003). Ablations with tumor size less than 1cm and history of emphysema had 5.9 times (p=0.035) and 5.7 times (p=0.032) the odds of requiring interventions. Increasing the total ablation time by 1 minute was associated with a 24% reduction in odds of delayed complications. Furthermore, a subgroup of ablations composed of patients without history of lung radiation therapy included 81 ablations with and 32 without tract cauterization. This subgroup showed ablations conducted without tract cauterization had 3.0 times the odds of exhibiting enlarging PTX (p=0.026) and 5.3 times the odds of requiring interventions (p=0.026) compared to ablations conducted with tract cauterization.

## CONCLUSION

Utilizing tract cauterization in lung microwave ablation shows significant reduced incidence of post-ablation delayed complications and enlarging PTX and interventions in patient without history of lung radiation therapy.

## CLINICAL RELEVANCE/APPLICATION

Tract cauterization proves to be a useful method in reducing complications and interventions required for management of complications.

## W5A-SPIR- Pre-ablation Biopsy and the Effect of Histopathologic Grade on Thermal Ablation Outcomes 6 for Hepatocellular Carcinoma

Abinaya Ramakrishnan (*Presenter*) Nothing to Disclose

## PURPOSE

Thermal ablation has been increasingly used as a minimally invasive treatment for hepatocellular carcinoma (HCC), with clinical outcomes comparable to surgical resection. While prior studies have analyzed the influence of size, location, and morphology on ablation outcomes, few have examined the role of histopathologic grade. This is partly because standard of care in LI-RADS 5 HCCs does not require biopsy. In this study, we determined the relationship between histopathological grade of the tumor on the clinical outcome after thermal ablation using time to local tumor progression-free survival (LTPFS) and overall survival (OS).

## METHODS AND MATERIALS

Between February 2015 to November 2022, 186 patients with nodular LI-RADS 5 HCCs that underwent ablation (MWA=165, RFA=21 with biopsies within prior 3 months) were included in this single-center, retrospective cohort study. All tumors were histologically classified using WHO criteria as Poor (n=25), Moderately (n=119), or Well (n=42) differentiated. Patients underwent continuous follow-up imaging to determine local tumor progression free survival (LTPFS). After retrospective review of medical records and follow-up MRI examinations, the rates of LTPFS and OS hazard ratios from Kaplan-Meier method were calculated and compared among the groups.

## RESULTS

Pre-ablation histopathologic grade was identified as a significant predictor for post-thermal ablation outcomes. Poorly-differentiated HCCs had significantly shorter LTPFS compared to well-differentiated HCCs (hazard ratio [0.21, 0.07-0.6], p=0.008). Poorly-differentiated HCCs also had shorter LTPFS compared to moderately-differentiated HCCs (hazard ratio [0.68, 0.33-1.39], p=0.28), although this difference was not significant. In terms of OS, poorly-differentiated HCCs had significantly shorter OS compared to well-differentiated HCCs [0.20, 0.07-0.59, p=0.0035], p=0.0082) and moderately-differentiated HCCs [hazard ratio [0.61, 0.3-1.25], p=0.0035).

## CONCLUSION

Poorly-differentiated HCCs was an important prognostic biomarker correlating with shorter LTPFS as well as OS after thermal ablation of HCC. While not currently considered standard of care, HCC biopsy prior to ablation can help tailor more aggressive patient-specific treatment planning and surveillance protocol.

## CLINICAL RELEVANCE/APPLICATION

Pre-ablation biopsies in HCC patients can play a critical role in the management of patients post-ablation. Poorly differentiated tumors may benefit from more aggressive treatment and surveillance given shorter LTPFS and OS.

## Abstract Archives of the RSNA, 2023

W5A-SPMK

### Musculoskeletal Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPMK-Radiomics Analysis based on Dual-energy CT Hydroxyapatite (HAP)-fat Decomposition 1 Technique for Osteoporosis Prediction**

Jinling Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate a radiomics model based on the hydroxyapatite (HAP)-fat material decomposition (MD) images of dual-energy CT for osteoporosis prediction.

#### **METHODS AND MATERIALS**

83 patients who underwent dual-energy CT included L1-L5 and quantitative computed tomography (QCT) were collected. With QCT as the reference standard, the patients were divided into two groups according to the guidelines introduced by the International Society for Clinical Densitometry (ISCD) and American College of Radiology (ACR), osteoporosis of the spine was defined as a BMD value  $<80$  mg/cm<sup>3</sup>, and non-osteoporosis (osteopenia and normal) was defined as a BMD value  $\geq 80$  mg/cm<sup>3</sup>. Radiomic features were selected from HAP-fat MD images of dual-energy CT. A radiomics model was constructed from linear combinations of the selected features weighted by their coefficients. The ROC curve was performed to evaluate the performance of the radiomics model.

#### **RESULTS**

The radiomics model, which comprised 8 selected radiomics features (shape\_Maximum2DDiameterColumn, shape\_Maximum2DDiameterSlice, shape\_Sphericity, firstorder\_10Percentile, firstorder\_90Percentile, firstorder\_Skewness, gldm\_LargeDependenceHighGrayLevelEmphasis, gldm\_LargeDependenceLowGrayLevelEmphasis) based on HAP-fat MD images of dual-energy CT, showed excellent differential ability with AUC of 0.999 (95%CI, 0.987-1.000), sensitivity of 0.983, specificity of 1.000, negative prediction value of 0.960, positive prediction value of 1.000 in the cohort. The discrimination performance of the radiomics model to identify osteoporosis from non-osteoporosis (osteopenia and normal) showed high accuracy of 98.8% in the cohort.

#### **CONCLUSION**

The radiomics model comprised 8 selected radiomics features had excellent ability to predict osteoporosis based on dual-energy CT HAP-fat MD images.

#### **CLINICAL RELEVANCE/APPLICATION**

The prevalence of osteoporosis in the population is increasing year by year. One of the reference standards for the diagnosis of osteoporosis today is the volumetric BMD measured by QCT, but the QCT post-processing process is very complex and requires additional phantom calibration, etc. Our proposed radiomics model based on HAP-fat material decomposition images can serve as a useful tool for osteoporosis prediction and has the potential to be applied in clinical treatment planning in the future.

#### **W5A-SPMK-Clinical Impact of the Results of Spine Biopsy in Patients with Suspected Discitis- 3 Osteomyelitis**

Joey Mustafa (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Vertebral osteomyelitis is a serious and potentially life-threatening condition that is challenging to diagnose and treat. Image-guided biopsy is often performed to identify the causative microorganism. Previous studies have primarily focused on the yield of the cultures from these biopsies, but the impact of these results on clinical management has not been thoroughly

studied. The objective of this study is to evaluate the impact of image-guided biopsy on the clinical management of vertebral osteomyelitis.

#### **METHODS AND MATERIALS**

This retrospective study was conducted using patient data from a single academic institution in the USA, and included patients who underwent CT-guided biopsy for suspected vertebral osteomyelitis between January 2013 and April 2022. The study aimed to calculate the positivity rate of the biopsy sampling and assess how the biopsy results impacted the clinical management of patients with vertebral osteomyelitis. Specifically, the study examined whether clinicians changed the management of vertebral osteomyelitis through narrowing or broadening of antibiotic regimens based on the biopsy results.

#### **RESULTS**

The study included 92 patients who underwent CT-guided bone biopsy for suspected vertebral osteomyelitis. Cultures from biopsy sampling were positive in 35% of patients. In 18% of all cases, the antibiotic regimen was changed based on the biopsy results and the specific organism identified. In contrast, the biopsy results had no significant impact on the subsequent antibiotic protocol in 82% of cases ( $\chi^2=40.96$ ;  $P<0.0001$ ), either because the cultures were negative, the organism could have been predicted without biopsy, or other clinical factors.

#### **CONCLUSION**

The study highlights the challenges in diagnosing and treating vertebral osteomyelitis, as well as the limitations of image-guided biopsy in impacting the clinical management of this condition. The biopsy results did not lead to a change in the antibiotic regimen for the vast majority of cases. The risks and benefits of biopsy should be carefully considered in light of this knowledge.

#### **CLINICAL RELEVANCE/APPLICATION**

Spine biopsies can be challenging procedures and the yield of such procedures may be low. This is the only study we are aware of that examines the clinical impact of biopsies performed for suspected discitis-osteomyelitis and the results show that biopsy/culture results do not change clinical management in the majority of patients.

#### **W5A-SPMK-Prediction of High-Risk Cytogenetic Status in Multiple Myeloma using Dual-energy Spectral Computed Tomography**

Siya Shi (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the predictive value of quantitative parameters derived from dual-energy spectral computed tomography (DESCT) for a high-risk cytogenetic (HRC) status in multiple myeloma (MM) patients.

#### **METHODS AND MATERIALS**

This study involved 24 MM patients with 102 lesions who had undergone spinal DESCT. Among them, 5 patients with 18 lesions were diagnosed with HRC status, including the presence of at least one of the following cytogenetic abnormalities (CAs): del(17p), t (4;14), t (14;16), t (14;20), gain (1p), or p53 mutation. The quantitative parameters of DESCT were generated by the regions of interest defined on lesions. Univariate logistic regression was performed to determine the relevant variables with HRC status. The least absolute shrinkage and selection operator (LASSO) was used to build a model for predicting the HRC status. Waterfall plot was used to visualize the performance of the model. Receiver operating characteristic (ROC) analysis was performed to determine potential utility of the model and the sensitivity and specificity determined by the Youden Index were also calculated.

#### **RESULTS**

Statistical differences were observed according to univariate logistic regression including Mono 40- Kev, Ca (Fat), Ca (Water), Fat (Ca), Fat (HAP), HAP (Fat), HAP (Water), Water (Ca), Water (HAP) and Effective atomic number (Eff-Z) (all  $P < 0.05$ ). Fat (HAP) and Water (Ca) were selected according to LASSO to build a prediction model for HRC status. Waterfall plot demonstrated the favorable predictive performance of the model. ROC analysis indicated the area under the curve was 0.799 (95% confidence interval: 0.656-0.942) with sensitivity of 0.722, specificity of 0.857 and Youden index of 0.579.

#### **CONCLUSION**

Analysis of DESCT offers potential as a quantitative method to predict the HRC status in MM.

#### **CLINICAL RELEVANCE/APPLICATION**

The DESCT quantitative parameters could be used to predict HRC in MM patients and to facilitate treatment selection and prognosis prediction.

#### **W5A-SPMK-Opportunistic Screening for Acute Vertebral Fractures on Routine Abdominal or Chest CT using an Automated Deep Learning Model**

Jonghun Woo, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To develop an opportunistic screening model based on deep learning algorithm to detect recent vertebral compression fractures in abdominal or chest CT

## **METHODS AND MATERIALS**

This retrospective single center design study collected 1309 coronal reformatted images from abdomen, pelvis or chest CT, performed within the preceding two months in patients recently diagnosed with a vertebral compression fracture or normal spine on spinal MRI. They consists of 504 recent fracture labeled images (119 patients, mean age  $61.6 \pm 19.2$ [SD], M: F=64:55) and 805 normal unlabeled images (115 patients, mean age  $56.2 \pm 15.0$ [SD], M: F=68:47) from September 2018 to April 2022. One radiologic resident and one board certified musculoskeletal radiologist participated in image selection and manual labeling the fractured segment on each CT images. Image selection in recent fracture group was made on the condition that two out of three radiologic findings suggestive of a recent fracture such as cortical step-off, impaction of trabeculae, or visual fracture line were included and three images per each fractured vertebral segment were obtained. For the CT image of the normal patient group, 7 images were obtained at the same interval between the most anterior vertebral body and the posterior vertebral body in the coronal scan. The labeled 480 images and unlabeled 700 images was split randomly into training set, validation set, and internal test set in a ratio of 75%:10%:15%, respectively. Remained labeled 24 images and unlabeled 105 images was included for secondary internal validation set. The primary outcome was test accuracy, precession, and F1 score. Neuro-T (version 2.3.3; Neurocle Inc), a commercially available software was used in establishing algorithm

## **RESULTS**

For training, validation and internal test set, the algorithm achieved 99.86 % test accuracy, 91.22 % precision, and 89.18 % F1 score, respectively for detection of recent vertebral compression fracture. Then in secondary internal validation set, our system achieved 99.90% test accuracy, 74.93 % precision and 78.30 % F1 score, respectively.

## **CONCLUSION**

Automated deep learning model showed high accuracy in test set and also in internal validation set. If this algorithm is applied opportunistically to daily abdomen or chest CT evaluation, it will be helpful for early detection of vertebral compression fracture.

## **CLINICAL RELEVANCE/APPLICATION**

Automated deep learning model showed high accuracy in test set and also in internal validation set. If this algorithm is applied opportunistically to daily abdomen or chest CT evaluation, it will be helpful for early detection of vertebral compression fracture.

## **W5A-SPMK-Detection of Bone Marrow Edema in Vertebral Compression Fractures using Deep Learning Segmentation Quantitative Material Density Imaging in Fast kVp-switched Dual Energy CT**

Reisuke Nishihara (*Presenter*) Nothing to Disclose

## **PURPOSE**

Water (hydroxyapatite. [HAP]) material density images derived from dual energy CT (DECT) are used to detect bone marrow edema (BME) in vertebral compression fractures (VCF). However, task-irrelevant anatomy is also enhanced in water (HAP) images, and this can affect BME detection accuracy. This study investigates the diagnostic performance of BME in VCF using water (HAP) density images with deep learning (DL) bone segmentation.

## **METHODS AND MATERIALS**

172 vertebral bodies, from the images of 20 patients who underwent both DECT and MRI between Dec 2021 and Feb 2023 for suspected VCF, were included in this study. Vertebral bodies with heights of less than 4 mm, and those imaged after percutaneous vertebroplasty, were excluded. DECT was performed using a 256-row fast kVp switching dual energy CT (Revolution CT, GE HealthCare). Virtual monochromatic images (VMI, 70 keV with 0.625 mm-slices) were reconstructed and processed using dedicated software (Spectral Bone Marrow [SBM], GE HealthCare). SBM generates a bone mask using a DL-based DECT bone segmentation algorithm. This mask defines bone regions upon which water (HAP) material density images are overlaid on the base VMI. The window width and level of the color overlay images are set to optimize visualization of bone marrow. This fully automatic procedure yields 2.5 mm-slice axial, sagittal and coronal water (HAP) density-VMI fused images. Presence of BME was assessed by MRI. Two radiologists, blinded to the MRI results, evaluated each vertebral body for the presence of BME on the water (HAP) density-VMI fused image using a binary classification. Sensitivity, specificity, positive predicted value (PPV) and negative predicted value (NPV) were assessed using MRI as reference standard. Regions of interest (ROI) were placed on each vertebral body. Cut-off values of water (HAP) density were calculated using ROC analysis.



## RESULTS

The DECT-based algorithm detected BME with 100% sensitivity, 98% specificity, 96% PPV and 100% NPV. A cutoff value of 996.6 mg/cm<sup>3</sup> provided 96 % sensitivity and 99% specificity.

## CONCLUSION

The DECT BME detection algorithm demonstrates excellent performance in VCF, as evidenced by quantitative analysis as well as concordance with radiologist impressions.

## CLINICAL RELEVANCE/APPLICATION

Currently, BME diagnosis in VCF is mainly performed using MRI. This work demonstrates that, thanks to advances in deep learning-based segmentation, quantitative projection-based material decomposition direct from projection views, and VMI-water (HAP) image fusion, DECT may provide a viable alternative. DECT may improve patient throughput vs MRI owing to shorter scan time and increase availability because of lower cost per scan.

## W5A-SPMK-The Value of Trabecular Bone Score in the Reclassification of Bone Quality in Chinese Postmenopausal Women

Fang Wang (*Presenter*) Nothing to Disclose

### PURPOSE

To explore the clinical value of trabecular bone score (TBS) in the reclassification of bone quality in Chinese postmenopausal women.

### METHODS AND MATERIALS

The retrospective study included Chinese postmenopausal women who had dual X-ray absorptiometry (DXA) examination between September 2022 and April 2023. DXA images were analyzed to measure bone mineral density (BMD) at lumbar spine (LS), left hip (LH), and femoral neck (FN). was calculated by the TBS iNsight software (version 3.0.0.15). The degradation of bone microstructure was determined following the cutoff values: TBS = 1.310 (normal); 1.230 = TBS = 1.310 (partially degraded); and TBS < 1.230 (degraded). The DXA parameters and clinical characteristics were compared among different BMD categories (normal, osteopenia, osteoporosis) by using rank sum test. Factors related to TBS were determined by Spearman correlation analysis. P < 0.05 was considered statistically significant.

### RESULTS

A total of 300 subjects were included in this study, with 100 subjects per bone mass category. There was no significant difference in the age between any two of the groups (P>0.05). The TBS was significantly lower in osteoporosis ( $1.212 \pm 0.075$ , P < 0.001) and osteopenia groups ( $1.291 \pm 0.085$ , P < 0.001) than in normal BMD group ( $1.345 \pm 0.097$ ). Significant differences for BMI, weight and DXA parameters were also observed between any two of the groups. For normal BMD group, 3% of subjects still showed degraded microstructure. The number was obviously increased in both osteopenia (7.67%) and osteoporosis (19.66%) groups. For partially degraded microstructure, 8%, 11.33% and 11.34% of subjects were observed in normal BMD, osteopenia and osteoporosis groups, respectively. Spearman correlation analysis showed that the factors related to low TBS were age, weight, BMI, BMD and T-score.

### CONCLUSION

TBS and BMD were significantly lower in the osteoporosis group than in osteopenia and normal BMD groups. Low TBS was associated with age, weight, BMI, and BMD at lumbar spine, left hip and femur neck. It was notable that a proportion of Chinese postmenopausal women with osteopenia and normal BMD still suffered from degraded microstructure according to their TBS.

### CLINICAL RELEVANCE/APPLICATION

BMD and TBS are essentially two different and independent indices to describe bone quantity and quality, respectively. Patients with osteopenia may also have degraded bone, which is at higher risk of fracture but not easily detected in clinical. However, in combination of BMD, TBS is able to uncover the presence of these patients. Therefore, TBS is also of great value for the clinical management of Chinese patients with osteoporosis and those at risk of fracture, as well as for treatment decisions and recommendations.

## W5A-SPMK-TBS Helps Identify Degraded Bone Microstructure in Chinese PHPT Patients

Wang Ling, MBBS (*Presenter*) Nothing to Disclose

### PURPOSE

To explore the value of trabecular bone score (TBS) in evaluating the bone microstructure in Chinese primary hyperparathyroidism (PHPT).

## **METHODS AND MATERIALS**

We performed a retrospective study of Chinese PHPT patients who were diagnosed between August 2022 to April 2023. The patients all underwent dual-energy X-ray absorptiometry (DXA) examination. Patients without DXA or TBS examination, and suffering from disease that might affect bone metabolism were excluded. Normal control and case groups were matched for age and sex. TBS for each subject was evaluated based on their lumbar spine DXA image by the TBS iNsite software (version 3.0.0.15). The integrity of bone microarchitecture was evaluated based on different TBS cutoff values: TBS = 1.310 (normal microstructure), 1.230 = TBS = 1.310 (partially degraded microarchitecture), and TBS < 1.230 (degraded microarchitecture). The difference of DXA parameters, including TBS and BMD, and clinical information between the groups were analyzed by T-test and Rank sum test.  $P < 0.05$  was considered as significant.

## **RESULTS**

A total of 18 Chinese PHPT patients (female: male = 7: 2) and 35 age- and sex-matched controls were included in the study. The bone mass index (BMI) of the included patients was at 15-35kg/m<sup>2</sup>. There were 21 and 14 subjects with normal BMD and bone mass loss in the control group, respectively. Clinical characteristics, including height, weight and BMI, were not significantly different between the groups. A significant difference was observed for lumbar spine BMD ( $P = 0.000$ ) and TBS ( $P=0.026$ ), as well as left hip (LH) and femoral neck (FN) BMD ( $P = 0.000$  for both) between the control and case groups. In particular, in terms of the mean value, TBS of PHPT groups indicated degraded microstructure, while no degradation was observed in the control group. BMD and TBS were significantly correlated in both groups (PHPT:  $r=0.891$ ,  $p=0.000$ ; control group:  $r=0.569$ ,  $p=0.000$ ).

## **CONCLUSION**

Lumbar spine BMD and TBS was significantly lower in Chinese PHPT patients than control group. In addition, there was a significant correlation between TBS and BMD in PHPT and the control group. In the basis of BMD, TBS could be used to better evaluate the microstructure of Chinese PHPT patients and therefore their fracture risk.

## **CLINICAL RELEVANCE/APPLICATION**

BMD does not reflect bone microstructure and hence bone strength. Trabecular bone score (TBS) is a textural index that evaluates pixel gray-level variations in the lumbar spine DXA image, providing an indirect index of trabecular microarchitecture. TBS could be a useful tool to evaluate the bone microstructure of Chinese PHPT patients, providing a better evaluation of their fracture risk.

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## Abstract Archives of the RSNA, 2023

W5A-SPMS

### Multisystem Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPMS-Correlation between Volumetric CT Tumor Burden and Circulating Tumor DNA as Response Parameters in Patients with Advanced Metastatic Melanoma Undergoing Immunotherapy**

Anna Streckenbach, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Circulating tumor DNA (ctDNA) is a promising tool for treatment monitoring of patients with advanced melanoma, as it may serve as a measure of tumour burden. There is a need to understand the correlation between visual tumour burden assessed by imaging and ctDNA levels. Thus, the purpose of our study was to compare ctDNA values with volumetric tumor burden assessed by computed tomography as indicators for therapy response in melanoma patients undergoing immunotherapy.

#### **METHODS AND MATERIALS**

In this retrospective, institutional review board approved study, a total of 35 patients (19 male, 16 female, age 63 +/- 17) with histologically confirmed metastatic melanoma (AJCC v8 stages III/IV) underwent systemic immunotherapy. All patients received a baseline and at least 2 subsequent staging CT examination after initiation of therapy. This resulted in a total of 107 CT examinations, including a body CT scan (neck, chest and abdomen) as well as cranial CT or MRI. The volumetric tumor burden was measured separately in different anatomical regions (bones, lung, liver, lymph node, cutaneous and brain metastases) using a dedicated commercially available software tool. The total tumor burden as well as subgroup analysis of different metastatic sites were correlated with the plasma ctDNA levels at each follow-up time point. The detection of somatic mutations in plasma DNA included hotspot analyses in 5 different genes: BRAF, EGFR, KRAS, NRAS, PIC3CA.

#### **RESULTS**

Lymph node metastases were the most common metastatic site (53.6%), followed by lung metastases (30.7%) and subcutaneous metastases (26.9%) and brain metastases (26.9%). The mean ctDNA level was 0.99 %/mL and the mean volumetric total tumor burden was 118 mL. There was a statistically significant difference for relative changes in total tumor burden and ctDNA levels between non-responders (progressive disease [PD]) and responders (partial response [PR] and complete response [CR]). A strong and statistically significant correlation was observed between relative changes of ctDNA levels and total tumor burden ( $r= 0.87$ ;  $p<0.05$ ). Of note, subgroup correlation of the two most frequent sites of metastasis (lymph node, lung) between tumor burden and ctDNA levels was moderate ( $r= 0.6$ ;  $p<0.05$ ).

#### **CONCLUSION**

Changes in both total tumor burden and ctDNA can be used for precise response assessment in advanced melanoma patients undergoing immunotherapy. Given the strong correlation between the two markers, inherent challenges of immunotherapy response assessment such as pseudo-progression could be identified and differentiated earlier.

#### **CLINICAL RELEVANCE/APPLICATION**

Combining imaging with other biomarkers is vital to address inherent challenges of immunotherapy response assessment such as pseudo-progression.

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## Abstract Archives of the RSNA, 2023

W5A-SPNMMI

### Nuclear Medicine & Molecular Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPNMMI-1 Immuno-PET Imaging of B7-H4 Immune Checkpoint in Prostate Cancer**

Manoj Kumar, MS, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

B7-H4 is an immune checkpoint sibling of PD-L1 that suppresses T-cells' tumor-killing functions. In addition to cancer cells, B7-H4 is also expressed by tumor-associated macrophages (M $\phi$ ), comprising 30-50% of tumor stromal cell populations. This study aimed to design and develop a novel B7-H4 immunoPET probe and perform the first proof-of-concept B7-H4 immunoPET imaging.

#### **METHODS AND MATERIALS**

Anti-B7-H4 mAb was functionally characterized and tested using ELISA assay. The antibody was conjugated with chelator NODAGA-NHS and labeled with radioisotope copper-64 ( $^{64}\text{Cu}$ ). Tumor xenografts were generated in C57BL/6J mice by subcutaneously injecting TRAMP-C2 prostate cancer cells on the right flank. 5 mice/group were intraperitoneally injected with either PBS, B7-H4 mAb (10mg/kg) to block B7-H4, or chlodronate liposome (15mg/kg) to cause M $\phi$  depletion. MicroPET imaging was performed post-tail vein injection of 100 $\mu\text{Ci}$   $^{64}\text{Cu}$ -B7-H4-mAb. Radiotracer uptake was measured as the maximum percentage injected dose per gram body weight (max %ID/g). Statistical significance was determined using two-way ANOVA with Tukey correction for multiple testing.

#### **RESULTS**

Immunoconjugation yielded a chelator-to-antibody ratio of 1.8-2.2 and 94-98% radiochemical purity of radiotracer  $^{64}\text{Cu}$ -B7-H4-mAb with an average specific activity of 2645.45 mCi/ $\mu\text{mol}$ . The immunoreactivity of  $^{64}\text{Cu}$ -B7-H4-mAb was similar to that of naked B7-H4 mAb, with unaffected potency in targeting B7-H4 protein moiety. PET imaging demonstrated tumor uptake of radiotracer as  $13.12 \pm 4.867$ ,  $36.38 \pm 5.71$ , and  $42.16 \pm 11.95$  %ID/g at 4-, 24-, and 48 hours, respectively. By comparison, the radiotracer uptake in B7-H4 blocked tumors was  $10.56 \pm 2.26$ ,  $25.92 \pm 6.28$ , and  $27.20 \pm 11.01$  %ID/g at 4-, 24, and 48 hours, respectively. Blocking B7-H4 in vivo significantly reduced radiotracer uptake at the 48-hour time point ( $p=0.0088$ ). Depletion of M $\phi$  also demonstrated a non-significant tendency of reduced tumor uptake radiotracer ( $8.34 \pm 4.37$ ,  $26.04 \pm 4.08$ ,  $35.42 \pm 10.22$  at 4-, 24-, and 48 hours, respectively). Immunohistochemical staining of B7-H4 demonstrated significantly stronger protein levels in untreated tumors compared to B7-H4 blocked or M $\phi$  depleted group.

#### **CONCLUSION**

The new  $^{64}\text{Cu}$ -B7-H4-mAb radiotracer showed preferential tumor accumulation. In vivo B7-H4 blocking and M $\phi$  depletion reduced the tumor accumulation of the new radiotracer; however, a statistically significant difference was only observed between the control and the blocked group at 48 hours.

#### **CLINICAL RELEVANCE/APPLICATION**

The new B7-H4 immunoPET probe is a clinically translatable imaging biomarker that could inform clinical trial design immediately. B7-H4 PET imaging could guide clinical decision-making to improve therapeutic benefits.

#### **W5A-SPNMMI-2 Prostate-specific Membrane Antigen (PSMA) as a Novel Theranostic Target in Glioblastoma Multiforme (GBM): Feasibility Study in a Preclinical Xenograft Model**

Steven Pan, BSc (*Presenter*) Nothing to Disclose

## **PURPOSE**

Glioblastoma (GBM) is the most common and aggressive primary malignant brain tumor. Accurate differentiation of viable tumor versus treatment-related change and delivery of targeted therapies is critical to improving clinical outcomes. Prostate specific membrane antigen (PSMA) has recently entered clinical practice as a theranostic (ie diagnostic PET and radionuclide) target in malignancies such as prostate cancer, and PSMA expression in GBM has recently been shown. The purpose of our study was to confirm PSMA expression in GBM with immunohistochemistry (IHC), and to evaluate PSMA as a radionuclide target in a mouse model of GBM.

## **METHODS AND MATERIALS**

IRB and IACUC approval was obtained for the human tissue and in vivo mouse model components of the study. IHC was performed in tissue specimen from six GBM patients to validate PSMA expression. Subcutaneous xenografting of a mosaic tumor model consisting of a PSMA+ endothelial cell line and a GBM stem cell line was performed in 5 mice. Three mice were treated with 1 mCi of [Lu177]-PSMA, and tumor localization of radionuclide was validated using post-treatment single-photon computerized tomography (SPECT) imaging. Treatment response was assessed with longitudinal monitoring of tumor size using calipers to measure length (L) and width (W), and estimating ellipsoid volume (V) through the modeling formula,  $V = 0.5 \times L \times W^2$

## **RESULTS**

In 5/5 (100%) patient tumor specimen, IHC demonstrated PSMA expression in both tumor stroma as well as tumor vasculature, noting inter-patient heterogeneity. Post-therapy [Lu177]-PSMA SPECT demonstrated specific localization of radionuclide in the subcutaneous tumor xenograft in 3/3 (100%) mice, validating in vivo expression of PSMA in our mosaic model as well as delivery of radionuclide to the tumor site. Treated tumors demonstrated reduction in tumor volume and slowed growth compared to the untreated control group, although no animal demonstrated complete tumor killing.

## **CONCLUSION**

We validated previous pilot studies showing PSMA expression in human GBM specimen. We further demonstrate feasibility of PSMA-targeted radionuclide therapy in our in vivo mouse xenograft model, with evidence of partial response. Our findings support further evaluation of PSMA as an emerging theranostic target in GBM, both as a standalone approach and in combination with other therapeutic strategies. Future directions include correlative studies between PSMA expression and clinical outcomes to further elucidate its potential for personalized therapies and a predictor for clinical outcomes.

## **CLINICAL RELEVANCE/APPLICATION**

This study combines human GBM tissue and mouse model investigations to validate PSMA as an emerging theranostic target in GBM and has the potential to improve clinical outcomes.

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## Abstract Archives of the RSNA, 2023

W5A-SPNPM

### Noninterpretive Skills (Beyond Imaging) Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPNPM-1 Burnout Among Radiology Physicians: A Systematic Review and Call to Action**

Nader Ashraf, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Burnout is on the rise among physicians, including radiologists, with prevalence rates exceeding 50%. Burnout in healthcare can result in medical errors, malpractice suits, low patient satisfaction, and poor care delivery. Hence, we aimed to systematically review studies reporting the prevalence of burnout in physicians in the radiology department and to provide an overview of the factors associated with burnout among radiologists.

#### **METHODS AND MATERIALS**

Searches were run from inception until November 13th, 2022, in multiple databases. This systematic review included studies that addressed the prevalence of burnout in radiologists of any sample size, using a valid method of assessment, reporting estimates of overall burnout syndrome or its subdimensions, and were cross-sectional, observational, or prospective survey peer-reviewed studies, without restrictions on publication time or language, following the PICOS framework. Data were extracted into a standardized Excel® sheet and descriptive statistics were generated by the same program.

#### **RESULTS**

Twenty-two cross-sectional studies involving 4230 radiology physicians in 7 countries published between 1996 and 2022 reporting on burnout were included. Fifteen studies (68.2%,  $n = 3181$ ) were conducted in the United States. The studies had a range of participants from 26 to 460, with a median of 156 and an interquartile range of 89-265. Only 81.8% of the studies identified the gender of their sample, with 57.7% males and 42.3% females. The overall burnout prevalence estimates were reported by 13 studies (59.1%) and varied from 33% to 88%. High burnout prevalence estimates were reported by only 5 studies (22.7%) and ranged from 5% to 62%. Still, the prevalence estimates from these studies cannot be combined nor compared due to the variability in burnout assessment techniques, definitions, and outcomes, as well as statistical heterogeneity.

#### **CONCLUSION**

We identified 22 studies with a high degree of heterogeneity reporting prevalence estimates on burnout among radiologists. Burnout in radiology is increasing globally, with prevalence estimates reaching 88% and 62% for overall and high burnout, respectively, and a myriad of factors identified to be contributing to the increased prevalence. This data should be used as a starting point for discussion to evaluate and resolve these difficulties in the global radiology work environment.

#### **CLINICAL RELEVANCE/APPLICATION**

With the modest number of studies included and the significant methodological discrepancies, there is a need for further high-quality and methodologically robust studies conducted with standardization of burnout definition and assessment techniques.

#### **W5A-SPNPM-2 Exploring the Potential of Microsoft Bing Chatbot for Answering Patient Questions Regarding Radiologic Examinations and Procedures**

Ian J. Kuckelman, BS, MPH (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate the accuracy and completeness of AI chatbot responses to questions commonly asked by patients regarding radiologic examinations and procedures.

## METHODS AND MATERIALS

We developed ten conversational-style questions for three common radiologic examinations and procedures (CT abdomen, MRI spine, and bone biopsy) and asked them to the Microsoft Bing Chatbot in two trials across three different settings, "More Creative", "More Balanced", and "More Precise". Two reviewers, one an attending radiologist with eight years of experience and the other a fourth-year medical student, independently compared the responses provided by the Chatbot to a gold-standard resource—radiologyinfo.org—and rated them for accuracy and completeness on a scale of 1-3, (1-incorrect/incomplete, potentially harmful; 2-mostly correct/complete, unlikely to cause confusion or harm; and 3-entirely correct/complete). Descriptive statistics were calculated. Differences in accuracy and completeness ratings were compared by chatbot setting and exam type with a Kruskal-Wallis test. Inter-rater reliability was assessed using Cohen's kappa statistic.

## RESULTS

Of the 180 total responses collected, 166 (92%) were rated as "entirely correct" and 14 (8%) as "mostly correct". For completeness, 119 responses (66%) were rated "complete" and 61 (34%) "mostly complete." Both reviewers rated all responses as either "entirely correct/complete" or "mostly correct/complete", with no responses rated as "inaccurate" or "incomplete" by either reviewer. Neither completeness nor accuracy differed significantly by chatbot setting or exam type. Inter-rater agreement was moderate with a Kappa of 0.66.

## CONCLUSION

Our study shows that the Microsoft Bing Chatbot has potential as a tool for patient education regarding radiologic examinations and procedures. Directing patients to this online resource represents a potentially cost-effective way for health systems and providers to provide patients with important information regarding how to prepare for a procedure, as well as reduce patient anxiety and improve overall experience. Limitations include potential variability of responses based on question phrasing and the omission of important information not explicitly requested.

## CLINICAL RELEVANCE/APPLICATION

AI-powered chatbots show potential as a tool for patient education associated with radiologic examinations and procedures.

## W5A- SPNPM-3 Can ChatGPT Answer Questions about Lung Cancer and Screening

Hana L. Haver, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The recent surge of worldwide interest in dialogue-based artificial intelligence (AI) large language models (LLM) such as ChatGPT is prompting evaluation of information available on such platforms. Early studies have found that ChatGPT provides generally appropriate clinical recommendations in areas ranging from cardiovascular disease, antibiotic selection for infectious diseases and breast cancer. Lung cancer remains a leading cause of death in the United States, so we sought to evaluate how ChatGPT would respond to fundamental questions about lung cancer prevention, screening and the Lung CT screening Reporting and Data System (Lung-RADS).

## METHODS AND MATERIALS

In February 2023, we submitted 25 questions to ChatGPT and asked it to generate three answers, as inconsistencies among answers are reported. Three fellowship-trained cardiothoracic radiologists graded each set of responses based on clinical judgment as 1) "appropriate," 2) "inappropriate", or 3) "inconsistent" if the responses contained inappropriate or varied information, respectively. Final appropriateness for each set was determined by the majority of reviewer responses, which were summarized using descriptive statistics.

## RESULTS

ChatGPT-generated responses were determined to be appropriate for 76% (19/25) questions in both contexts by three fellowship-trained cardiothoracic radiologists. Four of 25 (16%) generated responses were characterized as inappropriate and 2/25 (8%) as inconsistent in both hypothetical contexts (Table 1). Inappropriate and inconsistent responses were related to lung cancer screening indication and frequency as well as those related to the Lung-RADS lexicon.

## CONCLUSION

ChatGPT demonstrates the potential to automate provision of healthcare information related to lung cancer prevention and screening. ChatGPT performed more poorly on topics about lung cancer compared to previous reports on clinically appropriate information to questions about cardiovascular disease and breast cancer. This difference could be due to lack of information about lung cancer versus cardiovascular disease in the model's training dataset. Radiologist oversight remains critical, given the inappropriate and inconsistent radiology-specific information. Future study of applications for LLMs to improve healthcare education and counseling is encouraged.

## CLINICAL RELEVANCE/APPLICATION

ChatGPT generates largely appropriate answers to questions about lung cancer prevention and screening, though gaps remain in specific radiology topics and physician oversight remains imperative.  
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## Abstract Archives of the RSNA, 2023

W5A-SPNR

### Neuroradiology Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPNR- Assessment for Carotid Atherosclerotic Plaque using Vessel Wall Magnetic Resonance Imaging: A Multi-reader ROC Study to Determine Optimal Sequence for Detecting Vessel Wall Calcification** 1

Hideki Ishimaru, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We aimed to compare conventional vessel wall MR imaging techniques and quantitative susceptibility mapping to determine the optimal sequence for detecting carotid artery calcification.

#### **METHODS AND MATERIALS**

Twenty-two patients who underwent carotid vessel wall MR imaging and neck CT were enrolled. Four slices of 6-mm sections from the bilateral internal carotid bifurcation were subdivided into 4 segments according to clock position (0-3, 3-6, 6-9, and 9-12) and assessed for calcification. Two blinded radiologists independently reviewed a total of 704 segments and scored the likelihood of calcification using a 5-point scale on T1-, T2-, PD-weighted imaging, the first echo-time images of FLASH, and quantitative susceptibility mapping. Quantitative susceptibility mapping was calculated using phase images of FLASH. The observer performance for detecting calcification was evaluated by a multireader, multiple-case receiver operating characteristic study. Weighted  $\kappa$  statistics were calculated to assess interobserver agreement with respect to calcification scoring.

#### **RESULTS**

Quantitative susceptibility mapping had a mean area under the receiver operating characteristic curve of 0.85, which was significantly higher than that of any other sequence ( $p < 0.01$ ) and showed substantial interreader agreement ( $\kappa = 0.68$ ). When a segment with a score of 3-5 was defined as positive and a segment with a score of 1-2 was defined as negative, the sensitivity and specificity of QSM were 0.75 and 0.87, respectively.

#### **CONCLUSION**

Quantitative susceptibility mapping was the most reliable MR sequence for the detection of plaque calcification.

#### **CLINICAL RELEVANCE/APPLICATION**

A low signal on quantitative susceptibility mapping is a reliable marker of carotid plaque calcification.

#### **W5A-SPNR- Contribution of Cerebral Microbleeds and Sleep Quality to Persistent Post-concussive Working-Memory Decline Through Glymphatic Clearance Dysfunction** 11

Yung-Chieh Chen, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Cerebral microbleeds (CMBs) and sleep disorders are linked to persistent cognitive decline after a concussion (mild traumatic brain injury, mTBI). However, the pathomechanism is not fully understood. We hypothesized that the inefficient glymphatic clearance function may contribute to prolonged working-memory dysfunction, which may be partially attributed to both poor sleep and concussion-related CMBs.

#### **METHODS AND MATERIALS**

We conducted a 1-year prospective magnetic resonance imaging (MRI) and neuropsychological study on patients with concussion (N=61) and demographically matched controls (N=61). Susceptibility-weighted MRI was used to detect CMBs. The

diffusion tensor imaging analysis along the perivascular space (DTI-ALPS) index was used to evaluate glymphatic function. The Pittsburgh sleep quality index (PSQI) and digit span (DS) scores were employed to assess participants' sleep quality and working memory, respectively. The baseline DTI-ALPS index, PSQI scores, and the demographic data were used to train the machine learning-based model to predict the 1-year DS score.

## RESULTS

Patients with CMBs demonstrated a lower DTI-ALPS index compared with patients without CMBs and controls. Additionally, patients demonstrated poorer sleep quality than controls. The 1-year DS score was significantly correlated with both glymphatic diffusivity (DTI-ALPS;  $r=0.592$ ,  $p<0.001$ ) and sleep quality (PSQI;  $r=-0.551$ ,  $p<0.001$ ) assessed at baseline. Potential baseline biomarkers, such as the number of CMBs, DTI-ALPS index, and PSQI score, the confounding factors, including age, sex, education level, and duration from injury to MRI, were employed as the potential feature factors to predict long-term working memory function (1-year DS score). We then developed several machine learning-based models using the key features selected by the Lasso method to predict the DS score at the 1-year follow-up. Among the models, the Gaussian Process Regression method yielded the best predictions of the 1-year DS score, with an  $R^2$  value of 0.78 and a root-mean-squared error of 2.8827.

## CONCLUSION

CMB and poor sleep quality are contributing factors for glymphatic dysfunction, as measured using the DTI-ALPS index, and related to persistent postconcussive working-memory impairment. Our systematic analyses not only further our understanding of glymphatic dysfunction after concussion but also provide a framework for precise and personalized predictions of protracted cognitive decline.

## CLINICAL RELEVANCE/APPLICATION

The study highlights the importance of monitoring sleep quality and glymphatic function in patients with concussion, and suggests a potential therapeutic target for preventing persistent cognitive dysfunction after concussion.

## W5A-SPNR- Magnetic Resonance Imaging in Traumatic Brain Injury Patients and Associations with In-12 hospital Outcomes: Analysis of a National Representative Sample

Nnamdi J. Omenuko, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

Magnetic Resonance Imaging (MRI) has gained increasing attention due to its superior ability to visualize brain tissue injury. Several studies have demonstrated the superior diagnostic accuracy of MRI compared to computed tomography (CT) which is the most used imaging modality in the acute setting. The presence of intracranial hemorrhage has been associated with poor outcomes in traumatic brain injury patients. Therefore, the appropriate use of imaging modalities is crucial in predicting outcomes and providing optimal care. We aim to study the use of MRI in Traumatic Brain Injury (TBI) patients and their associations with in-hospital outcomes.

## METHODS AND MATERIALS

The National Inpatient Sample (NIS) was queried for MRI use, discharge disposition, length of hospital stays, intracranial hemorrhage, and in-hospital mortality among those with TBI in 2015. The effect of MRI use on these endpoints was evaluated using bivariate and multivariate regression analysis independently, controlling for significant baseline differences in demographics, comorbidities, and hospital status.

## RESULTS

A total of 45293 patients admitted with a diagnosis of TBI were included in this study. 25.7 %, 35.6%, 24.0%, and 14.6% of the patients were in age groups 20-40, 40-65, 65-80, and >80, respectively. 55% of the patients were female. 58% were Whites, while Hispanic, Black, and other races accounted for 17%, 14%, and 9%, respectively. In the unadjusted analysis, inpatient CT brain was associated with lower rates of mortality (unadjusted OR 0.657, 95% CI 0.163-2.651) compared to those who did not have a CT scan. Inpatient CT use was also associated with lower odds of short hospital stays (unadjusted OR 0.810, 95% CI 0.729-0.900) compared to those who did not. After adjusting for confounders, MRI and CT use was not significantly associated with in-hospital mortality, discharge disposition, length of stay, or inpatient complications.

## CONCLUSION

We present that there seems to be no difference in inpatient outcomes and complications when MRI is used in the evaluation of traumatic brain injuries. Clinical decision-making regarding the use of MRI versus CT scan in TBI patients should be based on the severity of the injury and clinical presentation. Further research is needed to explore the long-term outcomes.

## CLINICAL RELEVANCE/APPLICATION

The clinical relevance of comparing MRI use versus CT scan in TBI patients lies in the potential to improve in-hospital outcomes. The appropriate imaging modality can provide accurate and timely diagnosis, which can lead to better treatment decisions and improved patient outcomes. Understanding the associations between these imaging modalities and in-hospital outcomes can aid in clinical decision-making and lead to better patient care.



## **W5A-SPNR-Quantitative Analysis of Calcification in Cerebral Microvasculature by Micro-computed Tomography (microCT)**

Janet Back, BS (*Presenter*) Nothing to Disclose

### **PURPOSE**

Vascular calcification (VC) is a predictor of both cardiovascular and cerebrovascular events. While it is known that coronary VC results in impaired vasomotor response and reduced myocardial perfusion, less is known about the prevalence and impact of VC in brain microcirculation. We examined the distribution of intracranial calcification in a cohort of human cadavers using micro-computed tomography (microCT). We aimed to exhibit the feasibility of quantifying calcification volume (CV) in cadaveric brain vasculature using microCT and apply this method to compare CV across brain regions in which VC has been incidentally noted in case studies.

### **METHODS AND MATERIALS**

In a cohort of elderly human donor cadavers with and without dementia documented at time of death, brain tissue was sampled bilaterally from basal ganglia (BG), substantia nigra (SN), subventricular zone (SVZ), hippocampus (Hc), and posterior cingulate cortex (PCC). Samples were scanned by microCT at 10  $\mu$ m resolution. 3D-reconstructed images were segmented into standardized regions of interest (ROI) and thresholded at the level of calcium detection (130 Hounsfield units). CV was defined as voxel quantity  $\geq$ 130 HU within each ROI; CVs exceeding .01% per ROI were considered "positive". Findings were confirmed by histologic evaluation using Alizarin red calcium-binding stain.

### **RESULTS**

All subjects exhibited parenchymal and/or vascular calcification in at least one region. Calcification volume exceeding .01% per ROI for the no dementia cohort (n=6) was 83% globus pallidus (GP), 66% SN, 17% SVZ, 17% Hc, and 33% PCC compared to the dementia cohort (n=6) which was 100% GP, 33% SN, 50% SVZ, 100% Hc, and 100% PCC. Prevalence of Hc and PCC was significantly greater in subjects with documented dementia compared to age-matched subjects (n=12, p<0.01).

### **CONCLUSION**

Our findings demonstrate the utility of microCT for quantifying CV in human brain tissue. All subjects exhibited calcification in at least one brain region, indicating that intracranial calcification is more prevalent than published estimates (~30% in general population). Consistent with the literature, VC was most prevalent in the GP. Subjects with dementia exhibited significantly higher Hc and PCC CVs than age-matched subjects without dementia. This finding supports recently published evidence of increased Hc and BG calcification in human cadaveric brains with Alzheimer's disease relative to age-matched controls. Expansion of our study cohort remains ongoing in order to further investigate this relationship.

### **CLINICAL RELEVANCE/APPLICATION**

Analyzing the patterns of VC in cerebral vasculature using microCT can aid in the development of therapeutics against cerebrovascular and neurodegenerative diseases.

## **W5A-SPNR- Predictors of Positive Remodeling in Patients with Acute Ischemia Stroke**

4

Li-Ping Ma, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

The aim of this study was to compare the differences in the culprit plaques characteristics between positive remodeling (PR) and non-positive remodeling (NPR) patterns in patients with acute ischemia stroke (AIS), and to evaluate potential relative risk factors for PR of intracranial atherosclerosis (ICAS).

### **METHODS AND MATERIALS**

Patients with AIS recruited and underwent the HR-VWI scan within 2 weeks after onset. Plaque morphological parameters, as well as clinical variables of both PR and NPR groups were compared using non-parametric tests. A binary logistic regression model was used to analyze the parameters promoting the development of PR, and further determine the independent predictors of PR. The sensitivity and specificity of the model were tested by receiver operating characteristic curve.

### **RESULTS**

In all, 84 eligible patients (mean age  $58.07 \pm 1.35$  years, 66 (78.6%) were male) were assigned to the PR (n=28, 33.3%) or NPR (n=56, 66.4%) group according to remodeling ratio (RR). Compared with the NPR group, the PR group had a greater plaque area (P<0.001), greater wall area (WA) (P<0.001), longer plaque length (P=0.018), larger RR (P<0.001), higher blood glucose (P =0.01) and a greater number of HBP (P=0.16). Binary Logistic regression analysis showed that plaque area was independently associated with PR (OR 3.71, 95% CI, 1.49-9.24).

## CONCLUSION

HR-VWI can identify positive remodeling in ICAS with large plaque area, suggesting a high burden of intracranial vascular lesions and promoting PR.

## CLINICAL RELEVANCE/APPLICATION

To evaluate the effect of plaque morphological properties and clinical parameters on cerebrovascular remodeling patterns to improve the classification of cardiovascular risk.

## W5A-SPNR- Early Brain Amyloid Accumulation on PET in Military Instructors Exposed to Sub-concussive Blast Injuries

Carlos Leiva-Salinas, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

Traumatic brain injury (TBI) is the leading cause of disability in young adults. Recurrent TBI is associated with a wide range of neurologic sequelae, but the contributing factors behind the development of such chronic encephalopathy are poorly understood. Purpose: To quantify early amyloid beta (A $\beta$ ) deposition in the brain of otherwise healthy adult men exposed to repeated subconcussive blast injury using amyloid PET.

### METHODS AND MATERIALS

In this prospective study from January 2020 to December 2021, military instructors routinely exposed to repeat blast events were evaluated at two different time points: baseline, prior to blast exposure from breacher or grenade, and approximately 5 months after baseline, after blast exposure. Age-matched healthy controls not exposed to blasts and without a history of prior brain injury were evaluated at similar two time points. Neurocognitive evaluation was performed with standard neuropsychological testing for both groups. Analysis of PET data consisted of SUV measurements in six relevant brain regions, and whole brain voxel-based statistical approach.

### RESULTS

All participants were men (9 controls, 9 blast-exposed). The median age of the controls was 33 years.; IQR: [32, 36]. That of the blast-exposed group was 33; IQR: [30, 34] (p=0.824). In the latter, four brain regions showed significantly increased amyloid deposition after blast exposure: infero-medial frontal lobe, precuneus, anterior cingulum and superior parietal lobule (P values=0.004, 0.02, 0.002, and 0.003 respectively). No amyloid deposition was observed in the controls. Discriminant analysis based on regional changes of amyloid accumulation correctly classified all 9 healthy controls as a healthy controls (100%) and 7 of the 9 blast-exposed (78%) as a blast-exposed. Based on the above voxel-based analysis, whole brain parametric maps of early abnormal early amyloid uptake were obtained. Conclusion: Early brain amyloid accumulation was identified and quantified on PET in otherwise healthy adult men exposed to repetitive subconcussive traumatic events.

## CONCLUSION

Early brain amyloid accumulation was identified and quantified on PET in otherwise healthy adult men exposed to repetitive subconcussive traumatic events.

## CLINICAL RELEVANCE/APPLICATION

Our results might have direct clinical implications; if the individuals that are at risk of developing amyloid-related neurotoxicity can be identified, therapies to clear A $\beta$  in the brain might reduce or slow the development of long-term secondary traumatic encephalopathy.

## W5A-SPNR- Optimizing Traumatic Brain Injury Prognosis Prediction: Leveraging Machine Learning with CT Imaging and GFAP/UCH-L1 Blood Biomarkers

Burak B. Ozkara, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The purpose of this study was to develop an interpretable machine learning (ML)-based predictive model that combines clinical variables, blood biomarkers, and imaging biomarkers to improve the prognostic prediction, triage management, and treatment strategy in traumatic brain injury (TBI) patients.

### METHODS AND MATERIALS

In this retrospective cohort study, 662 patients transported to the emergency department with a trauma alert and suspected TBI were screened. Data extraction from electronic medical records included demographic and clinical information. Blood samples were collected and analyzed for GFAP and UCH-L1 using a sandwich enzyme-linked immunosorbent assay. Non-contrast head CT scans were assessed by neuroradiologists for TBI common data elements (CDEs). The collected data was used as input for the ML models. Three outcomes were designed to predict: discharged or admitted for further management (prediction 1), in hospital mortality (prediction 2), and course of hospital stay (prediction 3). Machine learning models,

including XGBoost, Random Forest, decision tree, support vector machines, and logistic regression, were trained using the training sets to compare their performances. Cross-validation and hyperparameter tuning were employed. SHapley Additive exPlanations (SHAP) values were used to evaluate the relative significance of predictor factors.

## RESULTS

A total of 440 patients were finally included. Random Forest models achieved the best performance. For prediction 1 (discharged or admitted for further management), the test set accuracy was 0.95, and the Kappa value was 0.88. For prediction 2 (deceased or not deceased), the accuracy was 0.98, with a Kappa value of 0.49. In prediction 3 (admission only, prolonged stay, or neurosurgery performed), the Random Forest model achieved an accuracy of 0.82 and a Kappa value of 0.72 during the testing phase. SHAP analyses showed that the three most important features for prediction 1 were other major extracranial injury, hemorrhage, UCH - L1. The top three features for prediction 2 were Glasgow Coma Scale, age, GFAP. GFAP, subdural hemorrhage volume, and pneumocephalus were the five most significant features for prediction 3.

## CONCLUSION

Our study demonstrates the potential of ML models in predicting the hospital course and mortality of TBI patients using non-contrast CT CDEs and blood biomarkers GFAP and UCH - L1. Blood biomarkers like GFAP and UCH - L1 were among the significant variables for prediction, demonstrating the originality of our study.

## CLINICAL RELEVANCE/APPLICATION

These models may help physicians tailor individualized care plans and provide more accurate prognostic information for patients.

## W5A-SPNR- Asymmetric Cerebral Perfusion Abnormalities are Hallmark in Chronic Traumatic Brain Injury Imaging

Farzaneh Rahmani, MD, MPH (*Presenter*) Nothing to Disclose

## PURPOSE

Advanced MRI methods identify biomarkers of grey or white matter damage including perfusion defects, diffusion abnormalities or atrophy. These biomarkers might improve sensitivity for detection of chronic traumatic brain injury (TBI), even when acute evidence of the insult are subtle or absent on conventional imaging sequences.

## METHODS AND MATERIALS

Sixty-seven participants (29 men and 38 women, age:  $47.1 \pm 13.5$ ) with a history of traumatic brain injury were enrolled from individuals referred to the Neuroevolution LLC. under IRB exemption #Pro00071328. Participants were required to be at least 18 years old and have a T1-weighted brain MRI acquired within 3 months of the date of injury. Additionally, 60 participants (26 men and 34 women, age:  $47.8 \pm 13.1$ ) had arterial spin labeling (ASL) perfusion and 55 had diffusion MRI (dMRI) scans available. Volumetric assessments were done using the Neuroreader program which is FDA-cleared, yielding absolute, normalized and standardized volumes for 83 cortical and subcortical brain structures. The Neuro Reader index (NR-index was defined as the regional z-score divided by the size of the normative database, while the left-right asymmetry scores were calculated as described in prior work. ASL-MRICloud was used to extract relative regional cerebral blood flow (rCBF) and their respective z-score maps. Abnormal white matter (WM) fractional anisotropy (FA) was identified through comparison of automated ROI defined regions to age and sex-matched references.

## RESULTS

Regions with highest prevalence of abnormal NR-index included the bilateral cerebellar grey matters, lateral ventricles, pallidi and the right temporal lobe. Significant left-right asymmetry was seen in the frontal lobes in 31%, in parietal lobes in 25%, in occipital lobes, and in temporal lobes in 31% of the participants, while the pallidi were most likely to demonstrate left-right asymmetry among subcortical regions. Similarly, Figure 1 demonstrate a significant left-right asymmetry in the average perfusion z-score map of all participants, with a distinct right frontal: left parietal, coup-contrecoup pattern. WM FA was found to be abnormally low ( $< -2$  z-score) in 7.3% and 9.1% of participants in the right and left internal capsules. Rate of FA abnormality was even lower in the splenium (3.6%) and genu (1.8%) of IC, right and left parietal WM (0% AND 3.6), and right and left frontal WM (1.8% and 0%).

## CONCLUSION

Asymmetric abnormalities in brain perfusion are common in chronic post TBI setting and their prevalence exceeds those of volumetric or diffusion abnormalities.

## CLINICAL RELEVANCE/APPLICATION

This work establishes the added importance of advanced neuroimaging techniques, namely perfusion imaging, in identifying evidence of chronic TBI.

## W5A-SPNR- Differences in Corpus Callosum White Matter Integrity in mTBI Patients with and without PTSD Comorbidity

Santhanam, PhD (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study aims to compare corpus callosum diffusion tensor imaging (DTI) findings in mild traumatic brain injury (mTBI) patients who presented either with or without post-traumatic stress disorder (PTSD) symptomology.

## **METHODS AND MATERIALS**

DTI and clinical data were obtained from retrospective chart review of 451 civilian patients (mean age 43 years, range 13-82) with clinically diagnosed mTBI. Patients were identified as having PTSD if presenting with signs and symptoms consistent with the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-V) diagnostic criteria. The corpus callosum and its subregions (anterior/inferior, anterior, mid-body, posterior, posterior-inferior) were defined by hand tracing in Olea Sphere (v3.0 SP12). Fractional anisotropy (FA) values were compared between patients with mTBI only and those with mTBI+PTSD by Mann-Whitney U test.

## **RESULTS**

FA was lower in patients with mTBI+PTSD as compared to those with mTBI only in the corpus callosum overall and within all subregions. Statistical comparisons between groups found FA was significantly lower in the whole corpus callosum ( $p < 0.001$ ) as well as in the anterior/inferior ( $p = 0.003$ ), anterior ( $p < 0.001$ ), mid-body ( $p = 0.006$ ), posterior ( $p = 0.007$ ), and posterior/inferior ( $p = 0.017$ ) subregions individually.

## **CONCLUSION**

Patients with mTBI and comorbid PTSD had reduced white matter integrity across the corpus callosum. While the contribution of PTSD to brain injured patients is not well-understood, some prior research indicates a possible influence of PTSD in military TBI populations. Further examination is needed to determine any mechanism for concomitant trauma and PTSD in civilian patients.

## **CLINICAL RELEVANCE/APPLICATION**

White matter integrity in the corpus callosum of trauma patients may be further compromised for those with mTBI and PTSD comorbidity.

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## Abstract Archives of the RSNA, 2023

W5A-SPOB

### OB/Gynecology and Pediatric Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPOB- Black Hole Pattern on Diffusion Weighted Images (DWI) May Help Predict Placental Invasiveness in Women at High Risk for Placenta Accreta Spectrum (PAS) Disorders** 1

Charis Bourgioti, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To quantify placental inhomogeneity using 'black hole' pattern on diffusion weighted imaging (DWI) in women at high risk for placenta accreta spectrum (PAS) disorders; to investigate its predictive ability for presence and degree of placental invasiveness.

#### **METHODS AND MATERIALS**

Between 3/2018 and 9/2022, 59 pregnant women underwent dedicated prenatal MRI for placental evaluation with a 3.0T unit. All women underwent C-section within 6 weeks from MRI. DWI data were prospectively compiled for review by two experienced genitourinary radiologists and manual placental segmentation for each participant was performed. Black hole, a pattern previously observed by the readers only on high b value DWI, was defined by consensus as a discrete intraplacental areas of signal loss on high b value (1500) images. A semi-automated algorithm using 28.70 as a threshold pixel value was applied to locate placental holes and calculate the total number of placental voxels (3D), total number of hole voxels, volume of hole voxels (mm<sup>3</sup>) and % of hole voxels/total placental voxels. Statistical analysis was performed for possible association of the above parameters with presence and grade of PAS. Intraoperative/histological findings were the standard of reference. Statistical significance (p) was set to 0.05.

#### **RESULTS**

Fifty women (mean age:37 years, mean gestational age:33 weeks) were evaluable and formed the study group. Significant differences were detected between normal placenta and presence of PAS regarding the total number of placental voxels (p=0.02), number of hole voxels (p=0.02) and volume of holes (p=0.03). Total number of hole voxels and hole volume were significantly lower in normal placentas than in accreta/increta (grade I/II, p=0.04, p=0.04) or percreta (grade III, p=0.005, p=0.01) cases. No differences were detected in the above parameters for PAS grading.

#### **CONCLUSION**

Total number of voxels and volume of intraplacental black holes on DWI, may serve as yet another prognosticator for PAS disorders.

#### **CLINICAL RELEVANCE/APPLICATION**

Quantification of placental inhomogeneity on functional MRI may enable the development of deep learning algorithms for predicting PAS disorders.

#### **W5A-SPOB- Evaluating Fetal Bowel Wall Function by Ultrasound Microvascular Flow Imaging** 2

Xuelei Li, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study summarized the characteristics of fetal mesenteric blood flow perfusion at various gestational weeks, and aimed to establish the feasibility of microvascular flow (MV-Flow) technology in evaluating intestinal wall blood flow and function.

## **METHODS AND MATERIALS**

This retrospective study analyzed 35 meconium peritonitis (MP) fetuses and 160 healthy fetuses in our medical center from March 2020 to December 2022. The vascular index (VI) of superior mesenteric artery region obtained by automatic ellipse method and manual method were compared. The correlation between the region of interest VI and gestational weeks was analyzed. A subgroup analysis of MP operative group vs. MP non-operative group was performed, and a prediction model for surgical treatment was established.

## **RESULTS**

There was no difference in VI value of the mesenteric blood perfusion region between automatic ellipse method and manual method ( $51.40 \pm 8.58\%$  vs  $50.82 \pm 8.05\%$ ,  $p=0.534$ ). There was no significant change in VI as the gestational age increased (correlation coefficient=0.005,  $p=0.946$ ). Compared with MP non-operative group, the operative group has significantly more cesarean deliveries (100% vs 52.9%,  $p=0.003$ ), shorter pregnancy duration ( $34.76 \pm 2.16w$  vs.  $37.48 \pm 1.55w$ ,  $p<0.001$ ), lower infant weight ( $2762.141 \pm 452.76kg$  vs.  $3225.88 \pm 339.98kg$ ,  $p=0.003$ ), more persistent ascites cases (92.9% vs. 52.9%,  $p=0.021$ ), more intestinal wall echo reduction cases (57.1% vs. 5.9%,  $p=0.004$ ), and lower VI ( $18.57 \pm 5.51\%$  vs.  $39.41 \pm 7.02\%$ ,  $p<0.001$ ). In risk factor analysis, VI value was significantly associated with surgical treatment after birth (OR=0.689;95% CI: 0.511-0.929). A prediction model for surgical treatment of newborns was established: Logit (P)=8.86 - (0.37\* VI) +(1.49\* ascites). The AUC of the ROC curve of the prediction model is 0.857 (95% CI: 0.75-0.95), with 78.6% sensitivity, and 88.2% specificity.

## **CONCLUSION**

MV-Flow imaging can quantify the fetus bowel wall blood flow perfusion. There is no correlation between the VI value of mesenteric regional blood flow perfusion and gestational week. In fetuses with meconium peritonitis, the VI value of mesenteric blood flow is significantly reduced, suggesting the increased possibility of intestinal wall necrosis and post-natal surgical treatment.

## **CLINICAL RELEVANCE/APPLICATION**

The findings of the current study provide information about evaluating fetus bowel wall function using ultrasound MV-Flow imaging, which could improve the prenatal diagnosis of meconium peritonitis in the fetus, and predict surgical treatment after birth.

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## Abstract Archives of the RSNA, 2023

W5A-SPPD

### Pediatric Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### W5A-SPPD- Usefulness of the Air Gap Methods during Pediatric Computed Tomography

1

Takanori Masuda, PhD (*Presenter*) Nothing to Disclose

#### PURPOSE

Purpose: The air gap methods can be used as the primary scatter reduction method in order to reduce patient dose. The purpose of this study was to compare the radiation dose and image noise between conventional setting and air gap setting methods during the pediatric chest computed tomography (CT).

#### METHODS AND MATERIALS

We used newborn pediatric anthropomorphic phantom with a 64 detector-row CT scanner with helical scan modes from the apex of the lung to the diaphragm. Compare with the conventional setting (group A), the pediatric anthropomorphic phantom was positioned 10 cm away from the table using a plastic with low X-ray absorption in air gap methods (group B). A real-time skin dosimeter (RD - 1000; TORECK CO, Kanagawa, Japan) was placed and inserted into the phantom center of the body, the surface of the body back, and the right and left mammary glands. The phantom was then scanned 10 times using each protocol. The measured dose values of the RD - 1000 were compared for each methods.

#### RESULTS

The measured dose values of the group A were 1.44 at the center, 1.46 at the back, and 1.64 at the mammary gland, respectively. The measured dose values of the group B were 1.30 at the center, 1.35 at the back, and 1.53 at the mammary gland, respectively. Compared with the Group A, it was possible to reduce the exposure dose by approximately 10% at the group B ( $p < 0.05$ ). The image noises were 9.3 HU at the group A and 8.0 HU at the group B. Compared with the Group A, it was possible to reduce the image noise by approximately 15% at the group B ( $p < 0.05$ ).

#### CONCLUSION

By using the air gap methods, it is possible to reduce the exposure dose and image noise approximately 10 % during pediatric chest CT.

#### CLINICAL RELEVANCE/APPLICATION

The reduction of the radiation dose and image noise according to the as low as reasonably achievable (ALARA) principle requires optimizing the scan protocol by using air gap methods.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W5A-SPPH

### Physics Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPPH- Comparison of Conventional and Compressed SENSE Sequences on MRI of Brain in Paediatric Population**

Isha S. Shah, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the quality and image acquisition time between conventional and Compressed SENSE sequences on magnetic resonance imaging (MRI) of brain in paediatric population.

#### **METHODS AND MATERIALS**

Thirty children (below the age of 18 years) undergoing MRI of brain were included in this study after obtaining Ethical clearance from the institute. In addition to the routine clinical protocol for brain, one Compressed SENSE sequence was added. 2D - T1, T2, and FLAIR axial sequences were acquired for brain using conventional and Compressed SENSE techniques. One of each sequence was acquired in 10 patients undergoing an MRI brain study on a 3T MRI using coil 32 channel coil for adults and paediatric 8ch head coil for neonates. Two consultant radiologists (with 35 years and 5 years of experience in radiology) independently scored the image quality using the 5-point Likert scale based on resolution, visualisation of anatomical regions, grey-white matter differentiation, sharpness of the image and artefacts. The subjective criteria details for image quality as per the 5-point Likert scale were: non-diagnostic (1), poor (2), moderate (3), good (4) and excellent (5). 2D T1 sequence was acquired with parameters as FOV 230\*183\*130mm, voxel size 0.575\*0.75, TE-20ms, TR-2000ms, CS factor-2, 2D T2 sequence was acquired with parameters FOV 230\*230\*149mm, voxel size 0.55\*0.65, TE-3000ms, TR-80ms, CS factor-2.2 and 2D FLAIR was acquired with parameters FOV 210\*168\*149mm, voxel size 0.7\*1.42mm, TE-140ms, TR-11000ms, CS factor-2.

#### **RESULTS**

The time reduction achieved with 2D T1 at 2 reduction factor were 60 seconds(24%), with 2D T2 at reduction factor of 2.2 66 seconds(47.83%) and with 2D FLAIR at reduction factor 2 66 seconds(40%). Inter-rater agreement for overall diagnostic confidence was rated higher for Compressed SENSE (k - 0.632) than conventional (k - 0.464). Nonsignificant statistical difference was found regarding image quality and image contrast ratio between both techniques.

#### **CONCLUSION**

Compressed SENSE has potential in reducing the image acquisition time without compromising the image quality and diagnostic confidence. Motion artefacts are also reduced with reduction in time with the use of Compressed SENSE sequence.

#### **CLINICAL RELEVANCE/APPLICATION**

Acceleration achieved with compressed SENSE sequences can cause an overall reduction in the acquisition time without compromising image quality. This consequently results in reduction of anaesthetic dose administered which is of clinical concern in paediatric population.

#### **W5A-SPPH- Preliminary Study on the Clinical Staging of Primary Lower Extremity Lymphedema by STIR Soft Tissue Radial Measurements**

MENGKE LIU (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Exploring the value of magnetic resonance-based measurement of two-dimensional radial data of the limb in assessing the clinical staging of primary lower extremity lymphedema (PLEL)



## **METHODS AND MATERIALS**

A retrospective collection of 132 patients diagnosed with primary LEL by our hospital was made, and all patients underwent MR examination of the lower extremities. Short Time Inversion Recovery (STIR) sequences were used to measure the total longitudinal and transverse soft tissue diameter (TD), musculoskeletal diameter (MD) and subcutaneous soft tissue diameter (S) of the lower leg, and the difference between TD and SD on the affected and the healthy side (DTD, DSD) were calculated respectively. The patients were staged according to the International Society of Lymphology (ISL) clinical staging criteria in 2020. Statistical analysis of all measurements was performed to determine the feasibility of MRI measurements for clinical staging of PLEL.

## **RESULTS**

The correlation between the transverse diameter TD ( $R=0.492$ ), SD ( $R=0.596$ ), DTD ( $R=0.608$ ), and DSD ( $R=0.620$ ) and clinical stage was significantly greater than that between the longitudinal diameter TD ( $R=0.430$ ), SD ( $R=0.532$ ), DTD ( $R=0.547$ ), and DSD ( $R=0.519$ ), and the highest correlation between the transverse diameter DSD and clinical stage. The values of TD, SD, DTD and DSD in stage I were significantly lower than those in stage II and III ( $P<0.05$ ), but there was no significant difference between stage II and III ( $P>0.05$ ). The area under the curve (AUC) of the transverse diameter to identify clinical stage was greater than that of the longitudinal diameter, with the transverse DSD (AUC=0.930) having the highest AUC value to identify stage I with stage II.

## **CONCLUSION**

Based on the fact that MRI measurement of soft tissue trajectories can be used as a quantitative method for clinical staging of unilateral PLEL. We recommend the subcutaneous soft tissue difference of transverse diameter as the best measure to distinguish stage I from stage II lymphedema.

## **CLINICAL RELEVANCE/APPLICATION**

MRI can quantitatively assess the severity of primary lower extremity lymphedema, facilitating clinical decision making and improving prognosis.

## **W5A-SPPH- Radiomics Based on MRI to Distinguish between Stage I and II Primary Lower Extremity Lymphedema**

MENGKE LIU (*Presenter*) Nothing to Disclose

## **PURPOSE**

A feasible and valid method for detecting and staging LEL would facilitate clinical development of appropriate treatment and management strategies. The present study aims to establish an MRI-based imaging radiomics model and a radiomics-clinical model for primary lower extremity lymphedema (LEL) and to evaluate its role in identifying the clinical stages (stages I-II) of primary LEL.

## **METHODS AND MATERIALS**

96 patients with primary LEL were retrospectively collected (67 in the training cohort and 29 in the validation cohort) and classified into stage I and II according to the International Society of Lymphology (ISL) clinical staging criteria. Radiomics features were extracted automatically from the region of interest (ROI) manually outlined on the Short Time Inversion Recovery (STIR) sequence images by radiologists applying the Dr. Wise Multimodal Research Platform. Selected radiomics features were retained to construct the radiomics model. Clinical factors that are statistically significant in identifying stages I and II were selected, and a radiomics-clinical model combining imaging radiomics features and significant clinical factors was established. The performance of the two models was evaluated using ROC curves. The clinical usefulness of the models was assessed using decision curve analysis (DCA).

## **RESULTS**

A total of 1743 radiomics features were extracted, then the features were filtered by F Test, and finally, 20 features were selected to construct the radiomics model. The radiomics-clinical model, which was based on the radiomics signature and 4 clinical factors, showed superior discriminatory efficacy compared with the radiomics model alone (area under the curve (AUC) in the training cohort: 0.997 vs. 0.961, the validation cohort: 0.914 vs. 0.900). The clinical usefulness of radiomics-clinical model was confirmed by DCA.

## **CONCLUSION**

The MRI-based radiomics model was able to effectively identify the clinical stages I and II of primary LEL. The discrimination performance of the radiomics-clinical model was superior to that of the radiomics model alone.

## **CLINICAL RELEVANCE/APPLICATION**

A MRI-based radiomics model has the ability to identify the clinical stages of LEL of primary LEL.

Elena Greco, MD (*Presenter*) Nothing to Disclose

## **W5A-SPPH- White Matter Clustering using Conformal Mapping**

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### **PURPOSE**

Diffusion Tensor Imaging (DTI) facilitates the delineation of white matter fiber tracts in the brain. Clustering white matter fiber bundles by various methods has been a research focus over the past decade. We propose a deep neural network which requires a novel approach to data normalization, augmentation, and problem formulation.

### **METHODS AND MATERIALS**

Conformal mapping is a technique used to establish a bijective mapping of one shape into its topologically equivalent target shape; the bijectivity ensures that the mapping is invertible and unique. We used volumetric transformations in which not only the surface of the shape is reshaped into the target shape but every point inside the shape is also transformed. Eleven epilepsy patients without structural brain abnormalities were retrospectively reviewed. Diffusion-weighted imaging was obtained with a multiband spin-echo echo planar imaging sequence on a 3 Tesla MR system (Siemens Vida or Prisma) using a 64-channel head and neck coil. A total of 64 diffusion directions were obtained. Diffusion data were preprocessed, and orientation distribution function was estimated. Whole brain tractography was then created using deterministic tracking. Fiber tracts from the 11 patients are mixed forming the dataset comprising 2469292 fiber tracts. The dataset was divided into training, test, and validation sets in a 3:1:1 ratio. The neural network classifier is based on the VGG 16 architecture and contains two convolution layers with 32 and 64 feature maps followed by two fully connected dense layers. The network uses rectified linear units as the activation function. Fiber tracts with length less than 30 mm or greater than 300 mm are filtered out, and all the fiber tracts are resampled to contain 50 points, flipped in order, and convolved with a 1D Gaussian filter for data augmentation. The fiber tracts are then mapped into a spherical space using the conformal mapping. The neural network is trained with a batch size of 500 fibers, a learning rate of 0.0001, and categorical cross-entropy is minimized using Adam optimizer in 10 epochs.

### **RESULTS**

The confusion matrix for the classification is shown in figure 1. All accuracies for 26 tracts exceeded 0.890379.

### **CONCLUSION**

We presented a deep learning framework for clustering white matter fibers using a volumetric conformal mapping approach and the initial experiments showed promising results.

### **CLINICAL RELEVANCE/APPLICATION**

We aim to automate this process and further this algorithm such that the deep learning tools can eliminate all the noisy fibers and identify the appropriate anatomical clusters based on whole brain tractography. We also aim to expand this algorithm to identify white matter tracts in the presence of pathologies that can change the anatomy of the tracts.

## **W5A-SPPH- Investigation of the Inherent Challenges Associated with Quantitative <sup>90</sup>Y PET-CT Imaging towards Improved Dosimetric Accuracy in <sup>90</sup>Y SIRT Therapies**

2

Niamh McArdle, BSc, MSc (*Presenter*) Nothing to Disclose

### **PURPOSE**

Yttrium-90 (<sup>90</sup>Y) PET-CT imaging for dose verification following <sup>90</sup>Y selective internal radiation therapy (SIRT) has a number of associated dosimetric quantification challenges. SIRT tumours can be irregularly shaped, multi-nodular and have heterogeneous activity distributions. Partial volume effects (PVE) and high background activity due to low number of true coincidences further contribute to degradation of quantification accuracy. Accordingly, the objective of this research is to further investigate the effects of PVE, heterogeneity and background activity in <sup>90</sup>Y PET-CT imaging, towards more accurate patient dosimetry for <sup>90</sup>Y SIRT therapies.

### **METHODS AND MATERIALS**

<sup>90</sup>Y PET-CT imaging datasets were acquired using a Siemens Biograph Horizon PET-CT scanner. 3D-printed non-spherical objects, representative of clinical data and designed using a novel radiomics analysis approach, were employed to assess the effects of PVEs for non-spherical lesions. Recovery Coefficient (RC) curves were generated by filling spherical and non-spherical objects with known <sup>90</sup>Y activities, submerged in a water phantom for a range of object-to-background ratios (10:1, 20:1, 25:1, 30:1). The effects of tumour heterogeneity was investigated using novel 3D-printed phantoms, with phantom infills of 0%, 20%, 40% and 60%. <sup>90</sup>Y sensitivity measurements and the effects of inherent background activity from the lutetium oxyorthosilicate crystals were investigated using an anthropomorphic thorax phantom, assessing noise levels in the lung and liver fields.

### **RESULTS**

The effects of heterogeneous distributions and PVE for spherical and non-spherical objects on the quantitative accuracy of <sup>90</sup>Y PET-CT imaging will be presented. In addition, results on the implications of background activity on quantitative <sup>90</sup>Y imaging will be quantified by means of noise equivalent count rate, background variability and contrast recovery. Correction

factors accounting for heterogeneity, PVE, 90Y activity recovery (0.84) and LSO background activity (4 - 8 kBq/ml) will be investigated and presented.

#### **CONCLUSION**

Inherent background activity, low PET count rate, high random fractions and PVEs at small volumes are some of the inherent challenges associated with quantitative <sup>90</sup>Y PET-CT imaging following SIRT therapies. Evaluating and correcting for these limitations is necessary to improve quantification accuracy, and for identifying any mismatch between pre- and post-treatment dosimetry, thus allowing for improvements towards improved personalised dosimetry.

#### **CLINICAL RELEVANCE/APPLICATION**

This research aims to improve the quantitative accuracy of <sup>90</sup>Y PET-CT imaging post SIRT therapy to facilitate improved accuracy in the dosimetry estimation for SIRT therapy patients.

#### **W5A-SPPH- Deep Learning Image Reconstruction Impacts on Robustness of CT Radiomics Features: Opportunity for Minimizing Radiomics Variability**

Jingyu Zhong, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the influence of deep learning image reconstruction (DLIR) on robustness of CT radiomics features.

#### **METHODS AND MATERIALS**

A standardized phantom with sixteen clinical-relevant densities was scanned under single-energy CT (SECT) and dual-energy CT (DECT) modes at standard and half (20 and 10 mGy) dose level. Images of SECT 120 kVp and corresponding DECT 120 kVp-like virtual monochromatic images were generated with six reconstruction algorithms: filtered back-projection (FBP), adaptive statistical iterative reconstruction-Veo at 40% (AV-40) and 100% (AV-100) blending levels, and DLIR algorithm at low (DLIR-L), medium (DLIR-M) and high (DLIR-H) strength levels, resulting twenty-four image sets. 94 radiomic features were extracted via Pyradiomics. Reproducibility of radiomic features was evaluated between SECT and DECT scan modes, between standard and half dose levels, across reconstruction algorithms in reference to FBP images, and across all image sets, using intraclass correlation coefficient (ICC) and concordance correlation coefficient (CCC).

#### **RESULTS**

The average percentage of features with ICC > 0.90 and CCC > 0.90 were 11.35% and 11.17% between SECT and DECT scans. The reproducibility between scan modes did not obviously change with the increasing strength level of DLIR algorithm. The average percentage of features with ICC > 0.90 and CCC > 0.90 between images acquired at 10 and 20 mGy dose levels were 28.55% and 27.40%. The reproducibility between dose levels increased with the increasing strength level of DLIR algorithm within SECT scans, but DLIR-M images showed highest reproducibility within DECT scans. The average percentage of features with ICC > 0.90 and CCC > 0.90 in reference to FBP images decreased from 27.93% to 17.82%, and from 27.66% to 17.29%, respectively, with the increasing strength level of DLIR. The AV-40 images resulted average percentage of features with ICC > 0.90 and CCC > 0.90 of 26.06% and 25.80% in reference to FBP images, and 18.88% and 18.62% for AV-100 images, respectively. Within SECT scans, DLIR-H images at 10 mGy presented percentage of features with ICC > 0.90 and CCC > 0.90 of 79.78% and 76.60%, respectively, comparing to DLIR-M images at 20 mGy.

#### **CONCLUSION**

DLIR and IR algorithms potentially alter minable information in images, while DLIR algorithm provides opportunity for minimizing radiomics variability.

#### **CLINICAL RELEVANCE/APPLICATION**

DLIR and IR algorithms potentially alter deeper information hidden in the images, indicating that radiomics models based on images with different reconstruction algorithms must be interpreted with caution. However, DLIR algorithm has potential for minimizing radiomics variability, which opens possibility for generalizable radiomics model.

#### **W5A-SPPH- Using Fully Synthetic Training Data to Automate Clinical CT-ACR Phantom Analysis**

Morgan A. Daly, BSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

We aim to illustrate the feasibility of using a convolutional neural network (CNN) trained solely on simulated input data to perform meaningful clinical medical physics tasks. We demonstrate this by automating detection and alignment of the HU module of the CT-ACR phantom (Gammex 464).

#### **METHODS AND MATERIALS**

All training and validation data was generated on-the-fly using a computational phantom generator that uses four parameters to control phantom placement: x and y position, simulated reconstruction field of view (FOV), and rotation. These were

randomly sampled in the ranges: x, y position: [-50 mm, 50 mm], FOV: [200 mm, 510 mm], and rotation: [-50°, 50°]. A ResNet50-based network was trained to predict a feature vector consisting of the x, y position, FOV, and rotation for a given input 256x256 phantom image. The model was evaluated on 5 clinical images of the HU module acquired on a Siemens Force scanner with labels manually calculated by aligning simulated phantoms with the clinical image. Mean absolute error (MAE) between the network-predicted features and manually aligned features were quantified and reported, and a visual assessment was performed.

## RESULTS

The MAE of the features produced by the model on a computational phantom test set (n=100) were: x=0.90 ± 0.6mm, y=0.53 ± 0.4mm, FOV=2.81 ± 1.9mm, =0.84±0.7. The MAE of the transformations produced by the CNN on the set of 5 real ACR phantom scan images: x = 2.77 ± 5.0, y = 9.72 ± 20.3, FOV = 17.78± 24.4, rotation = 3.52±4.2. In a visual assessment, the model achieves excellent agreement with clinical scans that are moderately misaligned (the likeliest to occur in routine practice). In one test case with more substantial misalignment (a large FOV) the disagreement between the input and the model prediction was apparent.

## CONCLUSION

The trained network does an acceptable job of predicting the correct parameters to align the HU module of the CT-ACR phantom, which can be used to automate phantom analysis. Methodologically, we have illustrated that CNNs trained on fully-synthetic data can be directly applied to clinical tasks, and additional augmentation of the synthetic data (e.g., noise, table-like objects in frame) could further improve performance. Finally, we hope that interpretable feature outputs will help build confidence in the broader use of clinical AI in medical physics and quantitative imaging.

## CLINICAL RELEVANCE/APPLICATION

These methods could generalize automated analysis to any phantom without the need for image acquisition or manual annotation. Synthetic data as ground truth could aid in training networks for more complex clinical/medical tasks.

## W5A-SPPH- A Comparison Among LowRes, HighRes and Cascaded CNNs for Segmentation of Cardiac CT Images in TAVR Patients

James W. Goldfarb, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Cardiac CT is routinely used for pre-planning aortic valve repair. Segmentation of cardiac structures would enable the calculation of several quantitative values (e.g., EF, LVM). The optimal convolutional neural network (CNN) for this task can be limited by hardware memory, compute power, and segmentation speed. We compared the segmentation of cardiac CT images using three CNN architectures to determine which anatomical structures require a larger CNN.

## METHODS AND MATERIALS

We used 56 training and 200 testing contrast CT angiograms in patients with aortic valve disease for TAVR planning. Eleven regions were annotated for training: AscAorta, DescAorta, InfVenaCava, LeftAtrium, RightAtrium, LeftVentricle, RightVentricle, LVMycocardium, and aortic valve leaflets (calcified and non-calcified). We trained three CNN 3DUnet architectures with increasing memory and compute requirements: LowRes, HighRes, and Cascaded. We statistically analyzed the Dice Coefficient (DC), Intersection-over-Union (IoU), and volumes of regions at systole and diastole. Visual assessment of 3D renderings was performed to detect failed segmentations.

## RESULTS

DC and IoU were slightly higher ( $p < 0.001$ ) for the cascaded network compared to the low and high resolution CNNs (DC: 0.93 vs 0.92, 0.92) and (IoU: 0.87 vs 0.86, 0.86). Although the segmentation volume intraclass correlation (ICC) was excellent (0.94-0.99), 10% of the HighRes segmentations had at least one region with a failed segmentation vs 2% of LowRes vs 0% of the cascaded CNN ( $p < 0.001$ ). The cascaded CNN had a small (0.6%+/-0.58%) difference in large structures but a larger difference in smaller calcified structures (18.73%+/-13.8%).

## CONCLUSION

A cascaded CNN performs the best both qualitatively and quantitatively. For segmentation of large structures such as the left ventricle, small segmentation errors do not affect quantitative values. However, for finer segmentation such as aortic valve calcium or calcified leaflets, a cascaded or high-resolution network is necessary.

## CLINICAL RELEVANCE/APPLICATION

For segmentation of large structures such as the left ventricle or left atrium, a LowRes CNN is sufficient. However, if higher resolution structures are also segmented (as is done in an aortic valve calcium score), a cascaded CNN is necessary. This has implications for the required GPU/CPU memory and compute power for timely segmentation, especially when the typical 20 cardiac phases are segmented.

W5A-SPPH- Hernan Jara, PhD (*Presenter*) Author with royalties, World Scientific Publishing;

## High Spatial Resolution Diffusion Tensor Imaging Aided by Synthetic-MRI: An Application of Sixfold Multiparameter Quantitative MRI (MP6-qMRI)

In diffusion  
tensor MR

imaging (DTI), the spatial resolution of the mean diffusivity (MD) and fractional anisotropy (FA) maps depend on the spatial resolution of the diffusion encoded images ( $b > 0$ ) as well as the  $b_0$  images. We investigate spatial resolution improvements in DTI maps resulting from using high spatial resolution synthetic  $b_0$  images as substitute to the standard  $b_0$  images, which are acquired at lower resolution to shorten scan time.

### METHODS AND MATERIALS

Two healthy volunteers (37yo male, and 59yo male) were scanned with local IRB approval. The modular MP6-qMRI turbo spin echo (TSE) pulse sequence was implemented on a 3T Ingenia Elition X whole body scanner (Philips Healthcare) by concatenating with same pre-scan settings high resolution Triple-TSE and half in plane spatial resolution DTI-TSE modules (Fig. 1A). All modules were implemented without fat suppression and generated 80 contiguous slices. Key scanning parameters were a) Triple-TSE modules (9.5min):  $TR_{long} = 16s$ ,  $TR_{short} = 0.5s$ ,  $TE_1 = 10ms$ ,  $TE_2 = 110ms$ , voxel =  $0.47 \times 0.47 \times 2mm^3$  and b) DTI module (11min):  $TR = 25.4s$ ,  $TE_{eff} = 72ms$ , voxel =  $0.94 \times 0.94 \times 2mm^3$ . The unified MP6-qMRI relaxometry and DTI processing pipeline was programmed in Python (version 3.9.13) with the Anaconda Navigator (version 2.3.2). The primary (nPD-T1-T2) qMRI maps were calculated according to the Bloch equation solution as applicable for the Triple-TSE pulse sequence. DTI maps were calculated according to the Bloch-Torrey equation as in DIPY tensor reconstruction (<https://dipy.org/>).

### RESULTS

For both volunteers, the MP6-qMRI framework yielded high quality MD (Fig. 1B) and FA (Fig. 1C) maps with full head coverage and with imperceptible geometric distortion artifacts. Furthermore, MD and FA maps obtained with calibrated synthetic  $b_0$  had superior spatial resolution providing improved anatomic delineation that is most noticeable for white-to-gray matter differentiation and for improved delineation of the extra cranium.

### CONCLUSION

Added benefits of using turbo spin echo multiparameter qMRI frameworks are the opportunities of reducing magnetic inhomogeneity distortions, and of increasing the spatial resolution of DTI maps (MD and FA) by means of Synthetic MRI. Hence, MP6-qMRI can extend the usefulness of DTI to magnetically inhomogeneous regions such as the extra-cranium and the neck and with higher spatial resolution.

### CLINICAL RELEVANCE/APPLICATION

Use of turbo spin echo based MP6-qMRI and Synthetic MRI can extend clinical applications of diffusion tensor MRI for assessing the extra-cranium and nasal cavity structures with negligible geometric distortions.

## W5A-SPPH- To Biopsy or Not to Biopsy? Feasibility of Predicting Gleason Score as a Pre-biopsy Gatekeeper in Prostate Cancer Patients using Multimodal Patient Features

Nathalie Mertens (*Presenter*) Nothing to Disclose

### PURPOSE

The diagnosis of prostate cancer (PCa) is based on a prostate biopsy. Even though this diagnosis is important for further treatment decision, a biopsy is painful and can result in adverse effects for the patient. In this study, we aim at developing a biopsy gatekeeper by predicting the Gleason score (GS) using a machine learning (ML) classification model. Therefore, results from various diagnostic screening examinations are combined with patient-specific variables to explore the feasibility of a binary ML model to predict  $GS > 6$  and thus the need for biopsy in PCa patients.

### METHODS AND MATERIALS

Patients screened in our hospital ( $n=295$ ) underwent a digital rectal examination (DRE), transrectal ultrasound (TRUS) and a screening magnetic resonance (MR) examination. Preceding the MR examination, prostate-specific antigen (PSA) and prostate health index (PHI) blood tests were acquired on the same day. Patients obtained a TRUS-guided biopsy to detect PCa, as determined by the GS. Various classification models were explored to predict  $GS < 7$  and  $= 7$  using 7 features: TRUS- and DRE findings, PSA and PHI density results, prostate imaging-reporting and data system (PI-RADS) score, as well as patient-specific variables being age and genetic risk. 28 model architectures are constructed by combining 3 components: (1) a scaler (Robust or Standard); (2) a sampler to balance the dataset (Synthetic Minority Oversampling TEchnique or Adaptive Synthetic) and (3) a classifier (Logistic Regression - LR, Random Forest, K-Nearest Neighbours, Decision Tree, Support Vector Machine - SVM, Gaussian Naive Bayes - GNB, or Gradient Boosting). To minimize bias, a stratified 10-fold cross validation is implemented. Hyperparameter tuning for the 28 model architectures resulted in training 2188 models. All models are trained to maximize the area under the curve (AUC). The classification is done with threshold set to 0.35.

## RESULTS

The AUC for predictions of GS is 0.77 (95% CI 0.67-0.87). 3 features, being PI-RADS, PHI density and age, were revealed as significant predictors for GS ( $p=0.006$ ,  $p=0.001$  and  $p=0.001$  respectively). This finding was confirmed by the selectKBest algorithm selecting the 3 most important features for GS prediction. Repeating the model with these 3 features resulted in LR, SVM and GNB as best classifiers, with AUC respectively 0.81 (95% CI 0.66-0.97), 0.82 (95% CI 0.66-0.98) and 0.84 (95% CI 0.68-1.0).

## CONCLUSION

This study demonstrates the potential of using a ML algorithm to predict the need of prostate biopsy. This way, physicians could opt to eliminate a biopsy which is painful for the patients and could cause adverse effects.

## CLINICAL RELEVANCE/APPLICATION

This study aims at developing a ML model as a pre-biopsy gatekeeper to eliminate unneeded biopsies in PCa.

## W5A-SPPH- Quantitative Evaluation of Primary Lower Extremity Lymphedema Staging using STIR: A Preliminary Study

MENGKE LIU (*Presenter*) Nothing to Disclose

## PURPOSE

The staging of primary lower extremity lymphedema (LEL) is difficult and vital in clinical work, and Short time inversion recovery (STIR) sequence of MRI can be used for quantitative assessment of primary lower extremity lymphedema due to its high soft tissue resolution. So we evaluated the value of STIR-based soft tissue area measurements for staging primary lower extremity lymphedema.

## METHODS AND MATERIALS

90 consecutive patients with clinically diagnosed primary lower limb lymphoedema from January 2017 to December 2019 in Beijing Shijitan Hospital were enrolled retrospectively. STIR sequence was applied to measure the total, muscle, bone, and subcutaneous areas in the upper 1/3 level of the bilateral lower calf. The difference between the affected and unaffected calf regarding the subcutaneous area was obtained.  $(\text{Subcutaneous area})/(\text{bone area})$  and  $(\text{subcutaneous area})/(\text{muscle area})$  were calculated. According to the International Society of Lymphology (ISL) clinical staging standard in 2020, all patients were divided into stages I, II and III. Statistical analysis was performed to determine the validity of MRI measurements in staging LEL.

## RESULTS

Clinical stages were I in 33 patients, II in 44 patients, and III in 13 patients. There are significant differences in the difference in subcutaneous area of limbs, subcutaneous/bone and subcutaneous/muscle between stage I and II as well as between stage I and III ( $P<0.001$ ), but not between stage II and III ( $P=0.706$ ,  $0.329$ ,  $0.229$ , respectively). There was a positive correlation between the clinical stage and difference in subcutaneous area of limbs ( $\rho=0.752$ ,  $P<0.001$ ), subcutaneous/bone ( $\rho=0.747$ ,  $P<0.001$ ) and subcutaneous/muscle ( $\rho=0.709$ ,  $P<0.001$ ). For staging primary lower extremity lymphedema, receiver operator characteristic (ROC) curves indicated that difference in subcutaneous area of limbs had the best discrimination ability among parameters [area under the ROC curve (AUC) = 0.950; 95% Confidence Interval (CI): 0.875 - 0.987; sensitivity: 95.45%, specificity: 84.85%], followed by subcutaneous/bone [AUC = 0.930; 95%(CI): 0.848 - 0.975; sensitivity: 77.27%, specificity: 93.94%] and subcutaneous/muscle [AUC = 0.895; 95%(CI): 0.804 - 0.953; sensitivity: 77.27%, specificity: 90.91%].

## CONCLUSION

The measurement of the soft tissue area by STIR may be used as an auxiliary method for staging primary lower extremity lymphedema. For patients with unilateral primary lower extremity lymphedema, the difference in subcutaneous area of limbs could be a specific indicator to distinguish clinical stage I from II.

## CLINICAL RELEVANCE/APPLICATION

STIR enables quantitative assessment of primary lower extremity lymphedema.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5A-SPRO

### Radiation Oncology Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPRO-Can Serial Brain Metastases MRI Radiomics Kinetics Predict Stereotactic Radiation and Immunotherapy Outcomes?** 1

Hesham Elhalawani, MD, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiation necrosis (RN) remains to be the primary dose-limiting toxicity of stereotactic radiosurgery (SRS), especially in combination with immunotherapy (IO). This debilitating adverse event is often confused with tumor regrowth, posing significant diagnostic and therapeutic challenges. This study employed magnetic resonance imaging (MRI) radiomics to quantify sub-acute radiation-induced changes in irradiated BM and their value in predicting treatment response.

#### **METHODS AND MATERIALS**

Following IRB approval, we queried our single-institution dataset to identify adult patients with brain metastases managed with SRS and IO between 2006 and 2021. We collected patient, disease, and treatment variables. Specifically, per-BM outcomes were categorized as RN (radiographic and/or symptomatic), progressive disease (PD), or neither (NA). All patients had diagnostic pre- and post-SRS contrast-enhanced T1-weighted MRIs. Individual BMs were manually segmented in MIM Software (Beachwood, OH). 1061 hand-crafted radiomic features were computed per lesion using IBEX Software. Feature reduction followed using Spearman's correlation coefficient (0.3 cut-offs). Simple then multiple nominal logistic regressions (SLR and MLR) with Bonferroni correction ensued to model the risk of RN, PD, or NA using JMP software.

#### **RESULTS**

92 patients with 301 BM of NSCLC, melanoma, and renal cell carcinoma primaries were included. All patients received brain SRS and IO. RN, PD, or NA occurred in 74 (24.6%), 75 (24.9%), and 152 (50.5%) BM, respectively. 39 radiomic features significantly changed post-SRS ( $p < 0.01$ ). Using MLR modeling, we created a 3-feature radiomic RN predictor (ROC AUC 0.71). The model included post-SRS BM surface area, texture (GLCM 3D Homogeneity), and pre-RT BM roundness. A 5-feature radiomic signature could predict RN and PD risk (ROC AUC 0.71) based on pre-SRS GLCM 3D texture feature, 3 post-SRS shape features (surface area, mean breadth, and roundness), in addition to delta-volume.

#### **CONCLUSION**

SRS and IO induce changes in BM shape, MRI texture, and signal intensity that radiomics can capture. Pre-SRS, post-SRS, and percent changes of these radiomic feature values could correlate to post-therapy tumor control or radiation necrosis. Pursuing model external validation, combination with clinical variables, and integrating other MRI sequences is imperative before larger-scale adoption of this novel diagnostic approach.

#### **CLINICAL RELEVANCE/APPLICATION**

The premise of our study is to employ to develop an artificial intelligence-powered MRI radiomic predictor of BM treatment outcomes. These serial 'virtual digital biopsies' could guide cost-effective follow-ups and earlier personalized interventions to improve patients' quality of life.

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## Abstract Archives of the RSNA, 2023

W5A-SPVA

### Vascular Imaging Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-SPVA- Fast Imaging of Lenticulostriate Arteries by Combining High-Resolution Black-blood T1-weighted with Variable Flip Angles & Compressed Sensitivity Encoding** 1

Yukun Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To visualize and characterize lenticulostriate arteries (LSAs) in a short time on a 3.0T MR scanner, we investigated the feasibility of high-resolution black-blood T1-weighted with variable flip angles (T1w TSE-VFA) accelerated by compressed sensitivity encoding (CS-SENSE) and further identify the optimal acceleration factors (AF) for routine clinical use.

#### **METHODS AND MATERIALS**

Twenty-five healthy volunteers (13 males, and 12 females, the age ranged from 27 to 68 years, with a median age of 58 years) and 20 patients with cerebrovascular disease (12 males, 8 females, mean age:  $64.3 \pm 8.9$  years) were prospectively enrolled. Volunteers underwent T1w TSE-VFA sequences with different AFs, including conventional sensitivity encoding (SENSE) AF=3 and CS-SENSE AF=3, 4, 5, and 6 (The scanning time was 510s, 480s, 361s, 298s, and 245, respectively) at 3 Tesla. The image quality and the display of LSAs of T1w TSE-VFA protocols were evaluated through objective evaluation (contrast ratio [CR Callosum /WM, CR Brainstem /WM, CR Epencephalon /WM], number of LSAs, total length of LSAs, and average length of LSAs) and subjective evaluation (overall image quality, scores on LSAs). Comparisons were performed among the 5 sequences to select the best AF. All patients underwent both T1w TSE-VFA with optimal AF and digital subtraction angiography (DSA) examination, and the number of LSAs of both was compared.

#### **RESULTS**

The pair-wise comparisons among CS3, CS4, and SENSE3 showed no statistically significant differences in the objective measurement and subjective evaluation in (all  $P > 0.05$ , Fig.1 and Fig.2). There was no statistically significant difference in the LSA counts on 1 side measured by DSA and CS4 in patients (3, 3 - 3 and 3, 3 - 3,  $P = 0.384$ , Fig.3).

#### **CONCLUSION**

CS3 can provide a better LSA display but takes a long time (480s, 6% reduction); CS4 can balance the visualization of LSAs and acquisition time (361s, a 30% reduction) and is recommended for routine clinical application.

#### **CLINICAL RELEVANCE/APPLICATION**

T1w TSE-VFA accelerated by CS-SENSE can be used as a non-invasive head microvasculature examination in asymptomatic subjects and patients with cerebrovascular disease, which will be an important asset in preventive medicine.

#### **W5A-SPVA- Acceleration of Time-of-flight Magnetic Resonance Angiography by Intelligence-assisted Compressed Sensing** 2

Yukun Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare the image quality of time-of-flight magnetic resonance angiography (3D TOF-MRA) accelerated by sensitivity encoding (SENSE), compressed sensing (CS), and intelligence-assisted compressed sensing (ACS) with different acceleration factors (AF) to optimize the sequence



## **METHODS AND MATERIALS**

Fourteen healthy volunteers were prospectively recruited and underwent 3D TOF-MRA scans with different AFs, including SENSE AF = 3; CS AF=3; ACS AF = 3, 5, 7, and 9 (The scanning time was 189s, 170s, 165, 150s, 136, and 115, respectively) at 3.0 T. Two radiologists delineated the regions of interest (ROI) for the callosum, right and left middle cerebral artery (MCA), and adjacent white matter on raw images. The signal intensity and standard deviation were recorded for further calculation of the signal to noise ratio (SNR) and contrast to noise ratio (CNR). Meanwhile, the overall image quality of 3D TOF-MRA with different AFs and 9 pre-defined arteries structures (intracranial segment of the bilateral ICAs, the anterior cerebral artery, the MCA, the distal bilateral vertebral arteries, and the basilar artery) were scored using 4-point scale subjective criteria. The difference in measurement data and subjective score between different AFs was analyzed by pairs comparison (LSD-t test).

## **RESULTS**

In the objective evaluation (Table 2), ACS7 and ACS9 had significantly lower CNR callosum than SENSE3, CS3, ACS3, and ACS5 ( $P>0.05$ ); ACS3 was significantly higher than SENSE3 in SNRR-MCA, SNRL-MCA, CNR L-MCA ( $P>0.05$ ). In the subjective evaluation (Fig.1 and Table 2), CS3, CS5, and CS9 are different from SENSE3 in overall image quality evaluation ( $P>0.05$ ); and there was no significant difference in the evaluation of arteries structures ( $P<0.05$ ).

## **CONCLUSION**

Compared with SENSE and CS, the better imaging quality of craniocerebral arteries could be obtained using 3D TOF MRA based on ACS with a shorter time, especially with AF of 5

## **CLINICAL RELEVANCE/APPLICATION**

Compared with SENSE and CS, 3D TOF-MRA accelerated by ACS can further shorten the scanning time while maintaining the image quality, which greatly increases the comfort and success rate of MR Scanning

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## Abstract Archives of the RSNA, 2023

W5B-SPBR

### Breast Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPBR- Breast Cancer Risk Models: Observations From a Multi-Site Database of Women Screened for Breast Cancer** 1

Emily F. Conant, MD (*Presenter*) Research Grant, Hologic, Inc; Advisory Panel, Hologic, Inc; Research Grant, OM1, Inc; Research Grant, iCad, Inc; Advisory Panel, iCad, Inc; Speaker, WebMD LLC

#### **PURPOSE**

With emerging interest in risk-based screening strategies and known disparities in breast cancer outcomes by race, risk models need to address gaps in risk assessment. To inform questions about the inclusion of characteristics like race in these models, we explored associations between race, breast cancer risk factors (including Gail risk score) and breast cancer detection in a large, real-world cohort.

#### **METHODS AND MATERIALS**

This retrospective cohort study used electronic medical record, radiology, and tumor registry data from five healthcare organizations. Women 40–79 years old with no history of breast cancer, non-missing race data, and =1 screening exam between 2016–2020, were included. Cancer detection rates (CDR) were calculated per 1,000 screens. Logistic regression models were used to estimate odds ratios (OR) and 95% confidence intervals (CI) for the associations between age, race, breast density and risk status (Gail model) and CDR.

#### **RESULTS**

The cohort included 1,563,019 screenings (123,371 Asian, 203,412 Black, 56,961 Other, 1,179,274 White). Both Black and White women were on average  $58 \pm 10$  years of age and slightly older than Asian or women of Other race (mean age  $54 \pm 9$  years). Asian women had significantly higher breast density versus other groups (52% mostly heterogeneously dense; 15% extremely dense tissue). Elevated breast cancer risk status varied by race; 16% Asian, 23% Black, 17% Other, 31% White. Overall CDRs (per 1,000 screens) by race were; Asian 4.9 [95% CI 4.5, 5.3]; Black 5.3 [95% CI 5.0, 5.6]; Other 4.2 [95% CI 3.7, 4.7]; White 5.2 [95% CI 5.1, 5.3]. Among women identified as elevated risk, CDRs differed slightly as compared to White women: Asian 6.6 [95% CI 5.5, 7.8]  $p=0.26$ ; Black 6.7 [95% CI 6.0, 7.5]  $p=0.05$ ; Other 4.9 [95% CI 3.7, 6.5]  $p=0.20$ ; White 5.9 [95% CI 5.7, 6.2]. After adjusting for age ( $p<0.001$ ), density ( $p<0.001$ ) and risk ( $p=0.001$ ), no statistically significant association between race and CDR remained ( $p=0.25$ ) (Figure).

#### **CONCLUSION**

In a large real-world cohort, we observed meaningful differences in breast cancer risk factors and risk scores by race. Racial differences in cancer detection rates do not persist after adjusting for age, breast density and Gail score. Careful consideration should be given to the use of risk models in the clinical setting. The observed misalignment in risk scores and breast cancer detection rates suggest the potential for insufficient capture of risk factors and the need to better understand the drivers of racial differences in mammography outcomes.

#### **CLINICAL RELEVANCE/APPLICATION**

It is critical to understand which risk factors may underlie recognized racial disparities in breast cancer burden in order to optimize risk models used to support clinical decision making for screening prioritization.

#### **W5B-SPBR- Diagnostic Performance of Diffuse Optical Spectroscopic Imaging for Breast Cancer** 2 **According to Clinical Factors**

Yeji Kwon (*Presenter*) Nothing to Disclose

## PURPOSE

Although breast cancer screening programs have reduced the mortality rate of breast cancer patients by about 20%, the sensitivity of mammography decreases to 30-48% in dense breast. On the contrary, there are concerns regarding the potential elevation of false positive rates when ultrasound is employed. It has been suggested that optical imaging could enhance the specificity of breast imaging, but this has not been conclusively established. This study aims to evaluate the impact of clinical factors on the diagnostic performance of diffuse optical spectroscopic imaging/discrete multi-wavelength near-infrared spectrum (DOSI/DMW-NIRS) for breast malignancy.

## METHODS AND MATERIALS

Our institutional review board granted approval for this investigation, and signed informed consent was obtained. From September 2021 to June 2022. In this study, 85 participants were enrolled, of which 23 participants were excluded. Among the exclusions, 4 participants refused to participate or had unavailable biopsy results, 4 participants had absent raw or chromophore data, and 15 participants were unavailable for analysis due to the subareolar location of the lesion. Total of 62 women with 62 breast lesions (37 malignant, 25 benign) biopsied under US guidance were analyzed. DOSI/DMW-NIRS was used to quantify the chromophores (HbO<sub>2</sub>, HHb, THC, StO<sub>2</sub>, water, lipid, and TOI) of lesions and then the computed chromophore ratios were compared to those of contralateral normal breasts. Lesions were categorized by demographic (age, BMI, bra cup size, and menstrual cycle phase) and sonographic variables (tumor diameter, depth, distance from nipple, vascularity, breast thickness, and BI-RADS category), and areas under the curve (AUCs) were compared between subgroups.

## RESULTS

TOI ratio showed the highest AUC value (0.904, 95% confidence interval: 0.831-0.977), followed by water (0.836, 95% confidence interval: 0.736-0.936) for diagnosing breast malignancy among the seven chromophore values. TOI ratio demonstrated no significant difference in diagnostic performance among all subgroups (p-value>0.05). The diagnostic performance of water ratio differed according to breast thickness (p-value: 0.033) and distance from nipple (p-value: 0.011). The diagnostic performance of THC and HbO<sub>2</sub> differed according to BMI (p-value 0.0119 and 0.0056, respectively) and menstrual cycle (p-values: 0.011 and 0.006, respectively).

## CONCLUSION

TOI ratio evaluated with DOSI/DMW-NIRS shows strong diagnostic performance regardless of demographic and sonographic parameters.

## CLINICAL RELEVANCE/APPLICATION

TOI ratio evaluated with DOSI/DMW-NIRS has the potential to be generally applied to various clinicoradiologic condition to diagnose breast cancer.

## W5B-SPBR- A Systematic Review and Meta-Analysis of Online Patient Education Materials in Breast Cancer: Is Readability the Only Story

Joey Gu, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Online patient education materials (OPEMs) are an increasingly popular resource for women seeking information about breast cancer. The AMA recommends written patient material to be at or below a 6th grade level to meet the general public's health literacy, but breast cancer readability studies have found reading levels to be much higher than the AMA's recommended level. Metrics such as quality, understandability, and actionability also heavily influence the usability of health information, and thus should be evaluated alongside readability. A systematic review and meta-analysis was conducted to determine: 1) Average readability scores and reporting methodologies of breast cancer readability studies; and 2) Inclusion frequency of additional metrics associated with health literacy.

## METHODS AND MATERIALS

A registered systematic review and meta-analysis was conducted in Ovid MEDLINE, Web of Science, Embase.com, CENTRAL via Ovid, and ClinicalTrials.gov in June 2022 in adherence with the PRISMA 2020 statement. Eligible studies performed readability analyses on English-language breast cancer-related OPEMs. Study characteristics, readability data, and reporting of non-readability health literacy metrics were extracted. Meta-analysis estimates were derived from generalized linear mixed modeling.

## RESULTS

The meta-analysis included 30 studies yielding 4,462 OPEMs. Overall, average readability was 11.81 (95% CI [11.14, 12.49]), with a significant difference (p<0.001) when grouped by OPEM categories. Commercial and government organizations had the highest average readability at 12.2 [11.3, 13.0] and 12.0 [11.3, 12.7], respectively; non-profit organizations had one of the lowest at 11.3 [10.6, 12.0]. Readability also varied by index, with New Fog, Lexile, and FORCAST having the lowest average scores (9.4, 10.4, and 10.7, respectively). Only 57% of studies calculated average readability with more than two indices. Only 60% of studies assessed other OPEM metrics associated with health literacy.

## CONCLUSION

Average readability of breast cancer OPEMs is almost double the AMA's recommended 6<sup>th</sup> grade reading level. Readability reporting is currently not standardized - multiple indices should be used and averaged together with an interval estimate to capture a more comprehensive picture of reading grade level. Additional non-readability OPEM metrics are also inconsistently reported and may help convey the usefulness of information presented.

## CLINICAL RELEVANCE/APPLICATION

Beyond readability, the quality, understandability, and actionability of OPEMs are important components to aid shared decision-making and may be critical to increased screening rates and breast cancer awareness.

### W5B-SPBR- Examining the Barriers to Breast Cancer Early Diagnosis in Uganda: A Prospective Study 4

Adrian M. Jaramillo-Cardoso, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

Women diagnosed with breast cancer (BRC) in Uganda have a 5-year mortality rate of 50%. Early diagnosis is an appropriate strategy for downstaging disease in low-resource settings, but women face significant barriers to accessing care (e.g., clinical examination, ultrasound, tissue diagnosis); assessing these barriers is a key step in designing successful programs. For the first time, we report findings from a prospective study examining the trajectory of care among Ugandan women with breast symptoms presenting for care.

#### METHODS AND MATERIALS

450 symptomatic women attending 5 community health clinics in Uganda were recruited and followed for six months. Participants completed questionnaires at baseline and six months, which collected data on demographics, barriers to care, and provider's recommendations for care (baseline), and actions taken at 6-months (follow-up). Logistic regression and multiple regression models were used to assess the relationship between delay (< or > 90 days) and sociodemographic factors. Differences in adherence to provider recommendations at 6 months were assessed via Pearson X2 test/Wilcoxon Rank Sum test.

#### RESULTS

442 (98.2%) completed follow-up. Breast lumps and pain were the main symptoms. 57.3% waited >90 d before seeking care, of whom 27.9% delayed >1 year. After multivariate analysis, rural setting (OR=13.34) and symptoms at time of presentation (OR=0.30) were significantly associated with delay. At 6 months, 184/442 (41.6%) were referred to either diagnostic imaging or tissue biopsy (+/-) imaging. 137/184 (74.5%) did not adhere to recommendations. Positive initial breast symptoms (?2=9.3, P=0.01) and older women (P=0.002) were more likely to follow provider's recommendations. 22/47 (46.8%) were diagnosed with breast cancer, a diagnostic yield of 46.8%. Main reasons for no action at 6 mo. for the 137 were: resolution of breast symptoms (40.0%), decision to wait for symptoms to resolve (19.2%), provider said that it was nothing to worry about (18.3%), and financial barriers (17.5%), despite 85.6% endorsing full understanding of need for follow-up. We estimated an additional 32 undiagnosed cancers in this group, a BRC rate of 12%.

## CONCLUSION

Low adherence to follow-up recommendations for diagnostic care should be an area of focus for programs to improve BRC outcomes in Uganda.

## CLINICAL RELEVANCE/APPLICATION

To increase effectiveness of diagnosis programs in Uganda, interventions should prioritize breast health education in the community, and removing barriers to accessing diagnostic services.

### W5B-SPBR- Point of Care Breast Cancer Risk Assessment Increases Rates of Supplemental MRI 5 Screening Among Women Undergoing Screening Mammography

Jocelyn Cheng (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of our study was to examine the impact of providing point of care breast cancer risk assessment (CRA) with results provided to patients at the time of annual screening mammography on rates of supplemental screening completion with MRI.

#### METHODS AND MATERIALS

We performed a retrospective review of patients who underwent breast imaging from November 2019 through May 2021. We examined the total number of screening mammograms performed one year prior to the cancer risk assessment (CRA) intervention start date (n=5,431, (epoch 1) 11/1/2019-5/1/2020), the total number of screening mammograms performed in patients who completed CRA for six months after the CRA intervention start date (n=1,976, (epoch 2) 11/1/2020-5/1/2021),

and the total number of patients who underwent screening mammography but did not complete CRA intervention for six months after CRA intervention start date (n=4,578, (epoch 2) 11/1/2020-5/1/2021). We used an interrupted time series design and analysis with a natural control to evaluate rate of MRI completion before and following integration of the Tyrer-Cuzick CRA screening tool. We identified which patients underwent supplemental screening with MRI during the 12 months following each time period to calculate the change in rate of supplemental screening completion based on intervention. Supplemental imaging rates with MRI was modeled over time between pre- and post-intervention windows using a generalized linear mixed model (GLMM) with sandwich estimation and assuming binary distribution where observations are nested within patients.

## RESULTS

The cohort included 11,985 women who underwent screening mammography during the study period. During epoch 1, no patients received CRA, 0% (0/5,4315). During epoch 2, 30% (1,976/6,554) received CRA and 70% (4,578/6,554) did not. Before the implementation of CRA (epoch 1), the rate of MRI was 2.8% (152/5,431). After the implementation of CRA (epoch 2), the rate of MRI among patients who did NOT undergo CRA intervention was 3.2% (144/4,578); for those who did receive CRA, the MRI rate was 6.0% (118/1,976),  $p < .05$ .

## CONCLUSION

Receiving point of breast care risk assessment at time of screening mammography doubled the rate of follow-up screening with MRI as compared to the rate among patients who did not receive the intervention (3.1% to 6.0%,  $p < .05$ ). Our facility reached maximum capacity for MRI screening after implementation of CRA intervention; the increased volume of follow-up screening MRI following introduction of CRA was likely limited by this constraint.

## CLINICAL RELEVANCE/APPLICATION

Study findings will inform practices about supplemental screening yield after implementation of point of care risk assessment.

## W5B-SPBR- Pushing the Envelope in Breast Conserving Surgery: Is Multiple-wire Localization (3 or more wires) Associated with Increased Risk of Compromised Margins

Yoav Amitai, MD (*Presenter*) Nothing to Disclose

## PURPOSE

In the last two decades there has been a paradigm shift with breast conserving surgery (BCS) being applied to larger and more extensive breast malignancies. The aim of this study is to examine the success of BCS being performed in patients with extensive breast malignancies requiring at least 3 wires for localization, and to assess possible risk factors for failure.

## METHODS AND MATERIALS

We performed a retrospective single center review of 232 patients who underwent BCS between 2010 and 2020 requiring at least 3 wires for localization. The cohort included a control group of 232 single-wire BCS patients chronologically matched with the multiple-wire group. Patients with either invasive malignancy or ductal carcinoma in situ (DCIS) were included in the study. Clinical, radiological and pathological data was collected. Proportions of positive surgical margins, re-lumpectomies and conversion to mastectomy were calculated.

## RESULTS

In the multiple-wire group the patients were younger (mean age 57 vs 63.1,  $P < 0.001$ ), had larger tumors (mean size 5.1cm vs 1.2 cm,  $p < 0.001$ ), had higher rate calcifications on mammogram (71.9% vs 17.2%,  $P < 0.001$ ) and higher rate of DCIS component (72.3% vs 38.4%,  $P < 0.001$ ); a higher proportion underwent neoadjuvant treatment (29.9% vs 9.9%,  $P = 0.001$ ). Positive surgical margins were higher in the multiple-wire group (13.4% vs 7.3%,  $P = 0.03$ ), which lead to higher proportions of re-lumpectomies or conversion to mastectomies (7.3% vs 4.3%,  $P = 0.17$ ). On multivariate analysis, patients with positive margins were more likely to have a DCIS component (77.1% vs 52.8%,  $p = 0.006$ ) and positive ER hormonal status (93.5% vs 85.1%,  $p = 0.048$ ). The number of wires was not an independent predictor of positive margins. breast density, presence of calcifications on mammogram, type of tumor (unifocal vs multifocal/multicentric), tumor size, surgical specimen volume, undergoing Neoadjuvant treatment, undergoing magnetic resonance imaging and use of oncoplastic techniques did not predict margin status.

## CONCLUSION

BCS requiring 3 or more wires is associated with a higher proportion of positive margins. The increased risk of positive margins appears to be related to type of tumor (DCIS component and ER status) rather than to the number of wires.

## CLINICAL RELEVANCE/APPLICATION

This information may be useful for pretreatment planning of extensive breast malignancies, especially those suitable for BCS.

## W5B-SPBR- Upgrade Rates of Atypical Ductal Hyperplasia, Atypical Lobular Hyperplasia, and Flat Epithelial Atypia at a Community-based Breast Imaging Center

Posy J. Seifert, DO (*Presenter*) Nothing to Disclose

## **PURPOSE**

To review the prevalence of breast malignancy (invasive or noninvasive) at surgical excision in patients who had atypical ductal hyperplasia (ADH), atypical lobular hyperplasia (ALH) and flat epithelial atypia (FEA) on needle core biopsy.

## **METHODS AND MATERIALS**

A retrospective chart review was performed on patients who had atypical ductal hyperplasia (ADH), atypical lobular hyperplasia (ALH) or flat epithelial atypia (FEA) on breast needle core biopsy at a community-based breast center between 1/1/2011 to 12/31/2022. There was a total of approximately 909 atypical diagnoses on core needle biopsy in 876 patients during this time (ADH, ALH or FEA). Exclusion criteria included co-existing malignancy in the ipsilateral breast, or needle core biopsy pathology demonstrating atypia bordering on DCIS. Data collected included patient demographics, lesion characteristics, and correlation with surgical biopsy or follow-up imaging.

## **RESULTS**

There was a total of 909 diagnoses of ADH, ALH or FEA in 876 patients on needle core biopsy. The average patient age was 57.8 years. Diagnoses on needle core biopsy were as follows: 651 ADH, 180 ALH, 78 FEA. Collectively, the majority of ADH, ALH and FEA lesions were presented as microcalcifications (69%). Of the ADH lesions, the majority presented as microcalcifications (71%), followed by 16% masses. ALH most frequently presented as microcalcifications (56%), followed by 20% masses. Eighty-three percent of FEA presented as microcalcifications, followed by 6% architectural distortion. All were recommended for open surgical biopsy (OSB)- 46 lesions did not undergo excision. Twenty percent of the atypical lesions that underwent OSB (n=173/863) upgraded to malignancy at excision; 31% (n=53) invasive carcinoma and 69% (n=120) non-invasive. Specifically, 153/651 ADH upgraded (24%), 16/180 ALH upgraded (9%), and 4/78 FEA (5%).

## **CONCLUSION**

We found that 20% of the atypical lesions evaluated in this review upgraded to carcinoma at excision; most of the upgrades were ADH lesions. While surgical excision of ALH and FEA is controversial, our data suggests that it may be warranted. More research is needed to determine the optimal follow-up protocol for ALH and FEA.

## **CLINICAL RELEVANCE/APPLICATION**

ADH, ALH and FEA are some of the high-risk lesions that are frequently recommended for surgical excision when diagnosed on core needle biopsy, though controversy exists.

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## Abstract Archives of the RSNA, 2023

W5B-SPCA

### Cardiac Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### W5B-SPCA- Deep Learning for Contrast Medium and Radiation Reduction in Coronary CT

1

Giuseppe Tremamunno, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aim of the study was to evaluate the performance of high-strength deep learning image reconstructions (DLIR-H) in maintaining or improving image quality of coronary CT angiography (CCTA) under the "double low" condition (reduced radiation dose and contrast medium dose), compared with conventional 100kVp - ASiR-V protocol.

#### METHODS AND MATERIALS

In this single-center study, from June to December 2022, clinically indicated CCTA of consecutive patients with BMI < 30 kg/m<sup>2</sup> were prospectively included and randomly assigned (1:1 ratio) into three groups: group A (100 kVp, ASiR-V 50% and iodine delivery rate [IDR] =1.8); group B (80 kVp, DLIR-H, and IDR =1.4), and group C (80 kVp, DLIR-H and IDR =1.2). Radiation and contrast dose, objective image quality (vascular attenuation, image noise, contrast-to noise ratio [CNR], signal-to-noise ratio [SNR]) and subjective image quality were compared among the three groups. To assess the objective image quality, regions of interest were drawn in the left pectoral muscle as a reference, in the ascending aorta and in the main coronary arteries. Subjective image quality was rated using a 4-point Likert scale.

#### RESULTS

144 CCTA were evaluated. Group B and C significantly reduced radiation dose compared to Group A ( $2.16 \pm 0.8$  mSv and  $1.99 \pm 0.6$  mSv, respectively, VS  $3.6 \pm 1$  mSv;  $P < 0.001$ ). Group B and group C outperformed group A in terms of lower contrast media dose, with a decreasing trend from group A to group C ( $57.7 \pm 6.7$  mL,  $51.5 \pm 6.3$  mL, and  $42.9 \pm 3.8$  mL, respectively); all the differences among the groups were statistically significant ( $P < 0.001$ ). Group B and C also achieved significantly higher SNR, CNR, and lower background noise compared to group A (all  $P < 0.001$ ). In terms of subjective image quality, group B obtained the highest score, significantly higher than group A ( $P < 0.001$ ) and group C ( $P < 0.05$ ).

#### CONCLUSION

In non-obese patients, "double low" CCTA protocol coupled with DLIR-H significantly reduces radiation and contrast medium dose while improving image quality, compared to conventional CCTA protocol.

#### CLINICAL RELEVANCE/APPLICATION

The "double low" CCTA protocol coupled with DLIR-H allows us to have excellent image quality while reducing radiation and contrast media burden; therefore, it can be safely implemented in non-obese patients. Further investigations focused on diagnostic accuracy are needed.

#### W5B-SPCA- Basic Verification of Myocardial Extracellular Volume Quantification by Prototype Photon Counting Detector CT

2

Seitaro Oda, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

This study aimed to investigate the accuracy of myocardial extracellular volume (ECV) quantification by prototype photon counting detector CT (PCD-CT) and the influence of the radiation dose and spectral image settings.



## METHODS AND MATERIALS

We used a multi-energy CT phantom simulating the blood pool and myocardium. The solid rods representing blood and soft tissue were used as pre-contrast CT. Besides, the solid rods including different iodine concentrations (2 mgI/mL and 4 mgI/mL) were used as post-contrast CT. The tube voltage was set at 120 kVp and three types of tube current (105mAs, 150mAs, 300mAs) applied. Virtual monoenergetic images (VMI) at 50-100 keV were reconstructed. The ECV value was calculated from the CT numbers between pre-contrast and post-contrast. Hematocrit of blood for ECV calculation was fixed at 0.5. We compared the accuracy of ECV values at each monoenergetic level.

## RESULTS

There was a small but significant difference in ECV values at each keV level in each radiation dose setting. ECV tended to be overestimated at higher keV in all radiation dose settings. There was a significant difference in the variability of ECV values among keV levels in all three radiation dose settings, with higher keV having greater variability. The variation was particularly large in the low dose setting. In all radiation dose settings, the residual values were significantly larger at higher keV levels: the average residual values at 105mAs, 150mAs and 300mAs settings were 0.5%-6.1%, 0.4%-4.5% and 0.3%-4.9%, respectively. In 150mAs and 300mAs settings, the residual values were smaller at 50keV and 60keV with no significant difference.

## CONCLUSION

When quantifying myocardial ECV with PCD-CT, it was necessary to set appropriate VMI keV and radiation dose settings because the keV levels can cause differences in the quantification value and measurement variation. This PCD-CT system enabled accurate myocardial ECV quantification at 50 and 60 keV in 150mAs and 300mAs settings.

## CLINICAL RELEVANCE/APPLICATION

Accurate myocardial ECV quantification is feasible using PCD-CT with appropriate keV settings.

## W5B-SPCA- Evaluation of Coronary Artery Stents with Ultra-High-resolution Photon-Counting CT: Analysis Of the Optimal Reconstruction Kernel

Yue Sun (*Presenter*) Nothing to Disclose

## PURPOSE

To assess the impact of reconstruction kernel on the image quality of coronary artery stents with ultra-high-resolution photon-counting CT (UHR-PCCT) in a phantom model

## METHODS AND MATERIALS

Six different coronary stents in a coronary phantom were examined at a tube voltage of 120kV. Images were reconstructed using vascular kernels of 11 sharpness levels based on three matrix sizes (matrix size of 512×512 pixels: Bv44, Bv48, Bv56; matrix size of 768×768 pixels: Bv60, Bv64, Bv68; matrix size of 1024×1024 pixels: Bv72, Bv76, Bv80, Bv84 and Bv89), using quantum iterative reconstruction (QIR) at a strength level of 3, and a slice thickness of 0.2 mm. Images with the Bv44 kernel, QIR at a strength level of 3, and a slice thickness of 0.4 mm served as the reference. Image noise and signal-to-noise ratio (SNR) were measured automatically using Python (Version 3.5). The sharpness and the attenuation effects of the stents were objectively evaluated with 10%-90% edge rise distance (ERD), 10%- 90% edge rise slope (ERS) and stent lumen attenuation increase ratio (SAIR). The visible diameter of the coronary stent was measured by the peak-to-peak CT attenuation of stent strut. The overall image quality of the coronary stents was subjectively scored on a 5-point scale (1= poor [poor vessel definition, severe artifacts, diagnostic information impaired], 5= excellent [clear stent strut definition, minimal blooming artifacts from the stent, and diagnostic information sufficient]). Friedman test or Kruskal Wallis test was used to check for differences between the reconstructions as appropriate. The Benjamini-Hochberg procedure was used to adjust P values for multiple comparisons.

## RESULTS

Reconstructions with the Bv44 kernel and a slice thickness of 0.4 mm showed lowest image quality (3[2-3]) and lowest vessel sharpness (ERD:  $0.42 \pm 0.03$  mm; ERS:  $2498.25 \pm 403.83$  HU/mm) (all  $P < 0.05$ ). Considering reconstructions with a slice thickness of 0.2 mm, reconstructions with the Bv72 to the Bv89 kernel had highest image noise and lowest SNR (all  $P < 0.05$ ). Reconstructions with the Bv44 to the Bv56 kernel demonstrated a lower stent sharpness (all  $P < 0.05$ ). No difference was demonstrated among reconstruction kernels in terms of SAIR and the ratio of the visible stent lumen diameter to the true diameter. The overall image quality of coronary stents for reconstructions with the Bv60 to the Bv68 kernel (median score of 5) were favored by the readers.

## CONCLUSION

UHR-PCCT enables the visualization of coronary stents with an excellent image quality and high sharpness. Reconstructions with the Bv60 to the Bv68 kernel may be optimal for evaluation of coronary artery stents.



## CLINICAL RELEVANCE/APPLICATION

UHR-PCCT with the Bv60 to the Bv68 kernel allows improvement of coronary stent evaluation.

### W5B-SPCA- Photon-Counting Detector CT Angiography of the Coronary Arteries: Intra-Individual Comparison of Image Quality to Conventional Energy-integrating Detector CT Angiography

Daniel Pinos, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The aims of this study were to determine the objective and subjective image quality of coronary computed tomography angiography (CCTA) on a clinical dual-source photon-counting detector CT (PCD-CT) and to compare the image quality to conventional dual-source energy-integrating detector CT (EID-CT) in the same patients.

#### METHODS AND MATERIALS

Twenty prospectively enrolled patients ( $67.5 \pm 9.0$  years, 28.5 median BMI, 75% male) underwent PCD-CT and EID-CCTA at an average interval of 11 days. Contrast agent protocol and radiation dose were matched between the PCD- and EID-CCTA. Polychromatic images were reconstructed for both EID- and PCD-CT, while virtual monoenergetic images (VMI) were created at 40, 45, 50, 55, 60 and 70 keV for PCD-CT. Contrast-to-noise ratio (CNR) was calculated for each coronary artery by two blinded readers. Stratification analysis of patients was performed according to BMI [high ( $>30$  kg/m<sup>2</sup>) vs low ( $<30$  kg/m<sup>2</sup>)]. For subjective analysis, readers scored image noise, vessel attenuation, vessel sharpness and overall quality using a 1-5 Likert scale.

#### RESULTS

Compared with EID-CT, attenuation and image noise of the coronary arteries were higher for all PCD-CT VMI reconstructions (all  $p < 0.008$ ). Coronary artery CNR values from PCD-CT monoenergetic and polychromatic reconstructions were all significantly higher than CNR values from EID-CT (all  $p < 0.008$ ). A proportionally greater increase in CNR of 33.1% was found in high BMI patients averaged over all reconstructions. Subjective scores of image noise, vessel attenuation, vessel sharpness and overall quality were significantly higher for 55, 60, and 70 keV compared to EID-CT (all  $p < 0.05$ ).

#### CONCLUSION

The improved objective and subjective image quality of PCD-CCTA compared to EID-CCTA may offer better visualization of the coronary arteries for a wide array of patients, especially those with high BMI.

## CLINICAL RELEVANCE/APPLICATION

The improved image quality of CCTA with PCD has the potential advantages of lower radiation dose, better detection of coronary artery disease, and better visualization in obese patient.

### W5B-SPCA- Deep Learning-Based Myocardial Strain Analysis from Cine MR Image: A Comparative Study of Unet and ResUnet

Dayeong An, MSc (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study is to develop a deep learning (DL)-based network for measuring myocardial regional function from conventional cine magnetic resonance (MRI) images, combining the advantages of cardiac magnetic resonance feature tracking (CMR-FT) and MRI tagging while minimizing their respective limitations in assessing regional cardiac function.

#### METHODS AND MATERIALS

Modified Unet and ResUnet architectures were implemented and trained to handle spatiotemporal data. Deeper layers and dilated convolutional blocks were incorporated to increase the receptive field and improve multi-scale feature learning. A custom loss function was employed for better optimization. Paired cine MR images and myocardial displacement fields generated from corresponding tagged images were acquired at matching locations and timepoints. The dataset comprised 1280 images (64 MRI slices with 20 cine and tagged images per slice). Data were split into training, validation, and test datasets as 80%, 10%, and 10%, respectively. Random flip data augmentation was performed. Radial and circumferential strains at end-systolic were measured using the American Heart Association (AHA) 6-segment model.

#### RESULTS

After 100 epochs, accuracies were 87% for Unet and 86% for ResUnet with losses of 0.6% and 0.7%, respectively. Mean $\pm$ SD global strains for tagging, Unet, and ResUnet were Err =  $15.4 \pm 8.4$ , Ecc =  $-15.3 \pm 8.3$ ; Err =  $17.1 \pm 10.3$ , Ecc =  $-14.7 \pm 9.1$ ; and Err =  $17.8 \pm 10.2$ , Ecc =  $-15.6 \pm 9.2$ , respectively. Unet and ResUnet achieved mean squared errors (MSE) of 0.5 and 0.46, peak signal-to-noise ratios (PSNR) of 71.62 and 72.08, structural similarity indices (SSIM) of 91.7 and 92.4, and Pearson correlation coefficients (PCC) of 92.9 and 95.9, respectively, compared to MRI tagging. Paired t-test revealed no statistically significant differences in strains between conventional and Unet methods ( $p > 0.05$ ). However, significant differences were

observed in radial AHA sectors 2 and 4, and circumferential AHA sector 1 between conventional and ResUnet methods ( $p < 0.05$ ).

## **CONCLUSION**

The study results demonstrate the feasibility of using deep learning-based networks, particularly the modified Unet architecture adapted for spatiotemporal data analysis, for assessing regional cardiac function in a clinical setting without the need for acquiring MRI tagged images. Potentially, this network can be used to reduce MRI scan time and allow for more adoption of strain imaging for evaluating different cardiovascular diseases.

## **CLINICAL RELEVANCE/APPLICATION**

The deep learning-based networks adapted for spatiotemporal data analysis provides an efficient and accurate alternative to MRI tagging for assessment of regional cardiac function for early detection of cardiovascular diseases.

## **W5B-SPCA- Coronary Artery Calcium Quantification with Super Resolution Deep-learning Reconstruction 6 Algorithm: An Anthropomorphic Phantom Study**

Shinsuke Shigematsu (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate the impact of a novel super-resolution deep-learning reconstruction (SR-DLR) algorithm on coronary artery calcium (CAC) quantification in comparison with filtered back projection (FBP), hybrid iterative reconstruction (HIR), model-based iterative reconstruction (MBIR), and normal resolution deep-learning reconstruction (NR-DLR) algorithms.

## **METHODS AND MATERIALS**

A QRM Thorax phantom with cardiac calcification inserts containing three different amounts of hydroxyapatite with three different diameters was used for this study. The phantom was placed inside a body ring (400×300 mm diameter) and scanned on a 320-row scanner with a tube voltage of 120 kVp. Scanning was performed with six tube currents ranging from 100 to 350 mA in 50 mA increments (CTDIvol: 1.4 to 5.1 mGy). Images were reconstructed using FBP, HIR (AIDR3D), MBIR (FIRST), NR-DLR (AiCE), and SR-DLR (PIQE) at a 3 mm slice thickness. Image noise, contrast-to-noise ratio (CNR), and task-based detectability index of calcifications were quantified. CAC volume and Agatston score were measured semi-automatically; the relative volume measurement error from the nominal CAC volume (360.6 mm<sup>3</sup>) was calculated for each reconstruction at each radiation dose level. Using the Agatston scores obtained at 350 mA as a reference for each reconstruction, the relative measurement errors at lower radiation doses (100-300 mA) were calculated. Using the Agatston scores obtained on 350-mA FBP images as a clinical reference, the relative measurement errors of each reconstruction at each radiation dose were also calculated.

## **RESULTS**

SR-DLR yielded the lowest image noise, the highest CNR, and the highest CAC detectability index among all reconstructions at each radiation dose level. The lowest measurement errors in CAC volume relative to nominal volume and the Agatston score relative to reference dose (350 mA) were obtained with SR-DLR at all dose levels. When the Agatston score at 350-mA FBP was used as a reference, SR-DLR showed a systematic underestimation at all radiation doses (relative measurement error  $< -7.6\%$ ).

## **CONCLUSION**

SR-DLR may improve image quality and facilitate accurate CAC quantification even at lower radiation doses, but its clinical application requires caution due to the deviation of the Agatston score from the conventional high-dose FBP setting.

## **CLINICAL RELEVANCE/APPLICATION**

The novel SR-DLR algorithm may yield accurate detection and quantification of CAC due to its excellent noise and spatial resolution characteristics, but the clinical evaluation for potential impact on risk classification and patient management is warranted before routine clinical use.

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## Abstract Archives of the RSNA, 2023

W5B-SPCH

### Chest Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPCH- Deep Learning-Based Prediction of Left Ventricular Ejection Fraction Using Chest Radiographs: Potential Role in Pre-Screening Individuals in Health Checkup Populations** 1

Hye Soo Cho (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate deep learning automatic prediction algorithms (DLLV) for left ventricular ejection fraction (LVEF) from chest radiographs (CRs), and explore its potential role as pre-screening target individuals for echocardiography in health checkup populations.

#### **METHODS AND MATERIALS**

To develop DLLV, patients who received CR and echocardiography at the same day at Seoul National University Hospital (SNUH) between 2016 and 2021 were retrospectively collected. 32,137 CRs from 23,616 patients (12,854 men [54%]; mean age, 69 [IQR, 62-80] years old) were included and randomly split into training (n= 25,709), validation (n= 3,214), internal test (n= 3,214) datasets. LVEF measured on echocardiogram was used as reference standard. ResNet50 was used as backbone convolutional neural network while final layers were adapted to predict LVEF in ranges of [0, 35, 50, 65, 100] (classification branch) and exact LVEF values (regression branch). For external testing, two independent cohorts were collected: 1) 5440 patients (2867 men [53%]; 66 [55-66] years old) who received same day CR and echocardiography at SNUH in 2015 (SNUH cohort) and 2) 28,034 individuals (17252 men [62%]; 56 [50-63] years old) at Healthcare System Gangnam Center between 2015-2021 (HCS health checkup cohort) were retrospectively collected. Prediction performance of DLLV was evaluated using area under the receiver operating characteristic curve (AUROC).

#### **RESULTS**

In internal test dataset, DLLV showed AUROCs of 0.79 (95% CI, 0.78-0.81) and 0.80 (0.79-0.81) in predicting patients with LVEF =35% and =50%, respectively. In SNUH cohort, 8% (459/5440) and 2% (123/5440) of the patients showed LVEF =35% and 50% on same day echocardiogram, and DLLV exhibited AUROC of 0.85 (0.84-0.86) in predicting LVEF =35% and 0.78 (0.77-0.80) in predicting LVEF =50%. In HCS cohort, only 0.2% (62/28,034) of the individuals showed LVEF =50%, and none showed LVEF =35%. DLLV showed AUROC of 0.74 (0.74, 0.75) in detecting those with LVEF =50%. When selective recommendation of echocardiography was assumed depending on DLLV results from CRs (i.e., those with DLLV >5%), DLLV could screen 68% (42/62) of individuals with LVEF =50% by recommending echocardiography for 8655 among 28,034 individuals (70% reduction of examinations). Only 0.1% (20/19,329) showed abnormal LVEF among individuals echocardiography was not recommended by DLLV.

#### **CONCLUSION**

DLLV exhibited promising performance in predicting patients' LVEF from CRs. In a health checkup cohort, DLLV showed potential in pre-screening individuals who may need echocardiography.

#### **CLINICAL RELEVANCE/APPLICATION**

Selective recommendation of echocardiography using DLLV may enhance chance of opportunistic screening and reduce expanse from unnecessary examinations.

#### **W5B-SPCH- Missed Diagnosis on Chest X-Ray: Auditing Large Volumes of Data with the Help of Comprehensive Artificial Intelligence** 2

Arpit Talwar, MBBS, MMed (*Presenter*) Nothing to Disclose

## PURPOSE

Chest x-rays (CXR) are the most common imaging modality in radiology and also one of the earliest imaging modalities to be developed. Despite many decades of experience in this modality, the diagnostic error rate has remained relatively unchanged. This could partly due to the lack of consistent feedback to radiologists when reporting CXRs. The purpose of the current study was to detect the rate of missed diagnoses on CXRs reported in a busy teaching hospital environment and demonstrate an efficient method of auditing the CXRs.

## METHODS AND MATERIALS

A consecutive cohort of adult (= 18 years) CXRs reported normal within the St. Vincent's Hospital Melbourne Imaging Department were retrospectively collected and de-identified. A commercially available system (Annalise Enterprise CXR) was applied over included studies to identify cases predicted by the AI to contain one or more of 60 findings deemed significant/critical. The discrepancy between original radiology report and AI predictions were reviewed by a radiologist with over 10 years-experience to evaluate the level of agreement between radiologists and the AI-predictions, and the number of missed findings determined through subsequent review.

## RESULTS

A total of 1559 CXRs reported in 2016 were retrospectively collected and de-identified. All of these studies were successfully processed by the AI system. The AI detected significant abnormalities in 169 of the studies. Of these, 97 were confirmed to have significant missed findings by the reporting radiologist. The most common missed findings were pulmonary nodules (16%), pleural effusions (16%), spinal compression fractures (12%) airspace opacities (11%), acute rib fractures (9%) along with a number of other significant missed findings of hilar lymphadenopathy, pulmonary artery enlargement, bone lesions, interstitial thickening, pulmonary congestion, two shoulder dislocations and an acute clavicle fracture.

## CONCLUSION

The study demonstrates a time-effective means for auditing CXRs in a busy radiology department within a teaching hospital in order to provide constructive feedback to radiologists and trainees. A total of 1559 CXRs were automatically processed by AI allowing the radiologist to review the findings with 97 findings deemed significant out of the 169 studies detected by AI.

## CLINICAL RELEVANCE/APPLICATION

Integration of a comprehensive AI model in a real-world reporting environment has the potential to improve radiologist performance, ultimately improving patient care.

## **W5B-SPCH- Assessment of Intensive Care Unit Physician Performance and Perception towards AI Utilizing a Concurrent-Read Endotracheal Tube Detection Algorithm on Portable Chest Radiographs: A Multi-Reader, Multi-Case Study**

Kaustav Bera, MD (*Presenter*) Nothing to Disclose

## PURPOSE

AI tools to detect and measure endotracheal tubes (ETT) on frontal chest radiograph (CXRs) are primarily used by radiologists. The purpose of this study was to compare the interpretation time and performance improvement of ICU physicians for detection and measurement of ETT without and with concurrent AI assist. We also assessed the perception of the readers towards AI before and after the exercise in the form of multiple choice questionnaire.

## METHODS AND MATERIALS

A fully crossed multi-reader and multi-case reader study was conducted. 34 participating physicians engaged in critical care(16 fellowship-trained attendings; 18 physicians-in-training [15 fellows; 3 residents]) were enrolled and retrospectively interpreted 100 CXRs (50 with ET tube; 50 without) in two reading scenarios (once without and once with AI assist). Readers were also asked to self-record the interpretation times. Interpretations of any given case set with and without AI would be separated by 4 weeks of washout. The physician and AI interpretations were compared to the reference standard measurements by board-certified cardiothoracic radiologist (10 years experience). Sensitivity, specificity, PPV, NPV was used to evaluate performance. Performance and time to interpretation was compared between AI assisted and unassisted scenarios using Fisher's exact test and Wilcoxon rank sum test. A pre- and post-completion survey was also administered and analyzed using the Likert scale.

## RESULTS

We here present preliminary results for the first set before washout. Only completed surveys were taken for analysis (30%). AI had sensitivity, specificity, PPV, NPV and likelihood ratio of .98, .98, .98, .98, 49 ( $p < .001$ ) when compared to reference standard. Mean reader performance in terms of sensitivity, specificity and likelihood ratio were improved from 0.98, 0.91, 15 to 1, 0.97, 20 ( $p < .001$ ). The average interpretation time per case was significantly reduced by approximately 52% (median time 25 secs vs 16.5 secs;  $p < .01$ ). Following the completion of set 1 of the study, 75% of respondents expressed the desire to use AI in their clinical practice. Interestingly 63% of respondents had answered that they had no prior experience with AI at the beginning of the study.

## CONCLUSION

An FDA approved AI tool for detecting and measuring ETT distance on frontal CXRs showed excellent agreement with the ground truth, and significantly improved interpretation times as well as overall performance for ICU physicians across a broad spectrum of experience levels.

## CLINICAL RELEVANCE/APPLICATION

ETT AI tool showed excellent accuracy as well as helped ICU physicians improve their performance and time to interpretation. This paves the way for future prospective studies and ultimately bedside clinical deployment.

## W5B-SPCH- Consecutive Cohort Analysis with Natural Language Processing (NLP) and Multi-finding AI 4 Algorithm for Chest Radiographs: Multidimensional Opportunity for QA/QC

Emiliano Garza Frias, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To assess if comprehensive discrepancy analysis of findings between NLP-based radiology reports search and a multi-finding, image-based AI algorithm can help audit quality of chest radiograph (CXR) reporting in community and quaternary healthcare settings.

## METHODS AND MATERIALS

Our IRB-approved, HIPAA-compliant, retrospective study included 3760 consecutive CXRs (PA/AP /or lateral views) from 3760 adult patients (age>18years) in two community and quaternary care hospitals. We queried an NLP-based radiology report search engine (Microsoft Nuance) for the presence of following findings: optimal/misplaced/absent lines/tubes (endotracheal tube, esophageal tube, pulmonary arterial and central venous catheters), solitary pulmonary nodule (SPN), pneumonia, simple pneumothorax, tension pneumothorax, pneumomediastinum, pneumoperitoneum, osteopenia, and compression vertebral fractures. Each radiology report (Rad1) was manually reviewed for presence of these findings by at least 1/5 participating physicians. Each CXR was processed with a multi-finding AI algorithm (Annalise.AI) for presence of the same findings. CXRs with discrepant finding between the NLP-Rad1 and the AI was blindly assessed by either one or two thoracic radiologists (Rad2/3) based on the discrepancies to establish the standard of reference. The data were analyzed with descriptive statistics.

## RESULTS

NLP/Rad1 and AI had high true positive and true negative concordance for CXR findings (lowest: 86.7%, 3260/3760; highest 98.8%, 3708/3760). Among the 3760 CXRs, the AI correctly identified false-negative (FNr) and false positive findings (FPr) in radiology reports for simple pneumothorax (FNr 0.4% [13/3760], FPr 0.2% [7/3760]); pneumonia (7.1% [270/3760], 1.2% [44/3760]), SPN (1.6% [60/3760], 1.7%[65/3760]), osteopenia (5.3% [200/3760], 0.2% [8/3760]), and compression fractures (3.1%, [114/3760], 0.2% [8/3760])

## CONCLUSION

Consecutive discrepancy analysis of NLP-based radiology reports search and AI outputs can help identify a substantial proportion of missed and overcalled CXR findings with low false positive or false negative frequencies.

## CLINICAL RELEVANCE/APPLICATION

Our proposed framework of NLP/AI for consecutive discrepancy analysis has broad applications such as a second reader to avoid missed or miscalled findings, and in peer-review and QA/QC efforts.

## W5B-SPCH- Glucose Metabolic Rate from Dynamic <sup>18</sup>F-FDG PET/CT Scan to Differentiate Sarcoid Lymph 5 Nodes from Malignant Lesions

Akihiro Inoue, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Long-term fasting <sup>18</sup>F-Fludeoxyglucose positron emission tomography (FDG-PET) has contributed to the diagnosis of active inflammation in cardiac sarcoidosis(CS). In the diagnosis of FDG-PET, an accumulation of active sarcoid lymph nodes is often difficult to differentiate from lymphatic metastasis or lymphoma. In differentiating active sarcoid lymph nodes from malignant lesions, we investigate the potential of the glucose metabolic rate (MRglc, mg/min/100ml) that is a new quantification of glucose metabolic kinetics derived from dynamic FDG-PET scan with a silicon photomultiplier.

## METHODS AND MATERIALS

100 CS patients and 67 cancer-bearing patients who underwent dynamic FDG PET/CT scan with a silicon photomultiplier between March 2021 and December 2022 were enrolled. Mediastinal or hilar lymph nodes with SUVmax =3 in sarcoidosis patients and metastatic or primary lesions with SUVmax =3 in cancer-bearing patients were included in the analysis. MRglc was derived from tissue and plasma blood time-activity concentration curves using the Patlak linearization approach, with

data acquired between 30 and 50 min after injection in dynamic FDG-PET/CT. Then, 60 minutes later, a standard scan performed. Active lesion was defined as SUV<sub>max</sub> >3.0 on standard whole body image. Use of parametric horizontal-axial image, mean value in VOI (size 1.5cm<sup>3</sup>) was measured.

## RESULTS

Forty-seven lymph node lesions from 25 of 100 CS patients and 39 malignant lesions from 27 of 67 cancer-bearing patients were included in the analysis. SUV and MR<sub>glc</sub> for sarcoid lymph nodes were significantly lower than those for malignant lesions (SUV, 4.93±2.09 vs. 5.95±2.32; MR<sub>glc</sub>, 2.42±1.26 vs. 3.57±1.57; p<0.001). Receiver-operating-characteristic analysis revealed that the ability to discriminate sarcoid lymph nodes and malignant lesions was the area under the curve (AUC) of 0.71, 77% sensitivity, and 60% specificity for SUV, AUC of 0.74, 80% sensitivity, and 66% specificity for MR<sub>glc</sub>, and AUC of 0.76, 90% sensitivity, and 62% specificity for the ratio of MR<sub>glc</sub> to SUV, respectively.

## CONCLUSION

MR<sub>glc</sub> and the ratio of MR<sub>glc</sub> to SUV are significantly lower for sarcoid lymph nodules than malignant. The use of MR<sub>glc</sub> improves sarcoid lymph nodes identification over SUV alone.

## CLINICAL RELEVANCE/APPLICATION

The ability to distinguish between sarcoid and metastatic lymph nodes with FDG-PET will lead to accurate staging of malignant tumors.

## W5B-SPCH- Incremental Prognostic Value of Deep learning-based Quantification of Macroangiopathic Aortic Changes for Cardiovascular Mortality in Heavy Smokers

Alexander Rau, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Macroangiopathic changes of the aorta are a common manifestation of cardiovascular (CV) disease. Currently, maximum diameter is the only prognostic measure used in clinical practice, despite quantification of other macroangiopathic changes (e.g. calcification) is available on computed tomography (CT) imaging. Thus, we applied a deep learning model to automatically quantify macroangiopathic changes of the aorta and investigated their prognostic value for CV mortality in a high-risk population of heavy smokers.

## METHODS AND MATERIALS

We used a deep learning model to automatically segment the aorta on lung screening chest CTs of participants enrolled in the National Lung Screening Trial at baseline and one-year follow-up. The following features were quantified: maximum diameter (cm), volume (deciliter) and calcifications (ml, categorized into tertiles). We assessed the association between (I) baseline features and CV and (II) the change of features within one year and CV mortality via multivariable Cox proportional hazard regression adjusted for traditional CV risk factors including smoking and hypertension. Harrel's c-index was used to compare the predictive value of the features.

## RESULTS

Among 24,770 participants at baseline (mean age 61.4±5.0 years; 59.2% male) 440 (1.8%) CV deaths occurred over a mean follow-up of 6.3±1.0 years. In univariate models, C-index of aortic volume and calcifications were significantly higher compared to diameter (c-index 0.63 and 0.66 vs. 0.61; p=0.02) for the prediction of CV mortality. After adjustment for traditional CV risk factors, volume (aHR: 1.04 [1.01-1.08]; p=0.008) and calcification (aHR: 2.53 [1.87-3.41]; p<0.001) remained significantly associated with CV mortality whereas the association for diameter was attenuated. In subjects with one year follow-up available (n=22,140 individuals, mean age 61.4±4.9 years; 58.3% male with a 1.5% CV), the strongest association was found between an increase in calcifications and CV mortality (aHR highest tertile: of 1.74 [1.32-2.29], p<.001) after multivariable adjustment for traditional CV risk factors.

## CONCLUSION

Deep learning can automatically quantify macroangiopathic changes of the aorta on lung screening chest CTs and identify individuals at high risk of CV mortality beyond traditional risk factors.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-based quantification of macroangiopathic aortic changes can identify individuals at risk of CV mortality beyond traditional risk factors in a high-risk population of heavy smokers. This enables opportunistic risk assessment to improve personalized prevention and treatment strategies.

## W5B-SPCH- "Dependent Contrast Layering Sign" on CT: Preliminary Cross Sectional Descriptive Study

Youssef Mohsen, MD, MS (*Presenter*) Nothing to Disclose



## PURPOSE

CT findings of contrast layering in the dependent part of the central venous system have been reported to be associated with compromised cardiac function and imminent cardiac arrest. To the best of our knowledge, there is no systemic research on this finding and its association with cardiac arrest and mortality. Therefore we studied the radiologic findings of dependent contrast layering in vascular structures on CT and its clinical implications.

## METHODS AND MATERIALS

This single center retrospective study involved a list of 226 patients obtained by searching PACS reports for the keywords "layering of contrast", "pooling of contrast" or "dependent layering of contrast" in contrast enhanced CT chest and CT abdomen performed between Jan 2008 and Jan 2022. Two body radiologists reviewed for the dependent layering of contrast in vascular structures and parenchyma of abdominal organs. Clinical data were investigated from electronic medical records. The frequencies of the radiologic findings in association with clinical data were analyzed.

## RESULTS

Dependent contrast layering in the vascular structures is demonstrated in 21 patients (9.3%, mean age:  $67.4 \pm 12.4$ ). Layering of contrast is shown in the IVC (n=19, 90.4%), hepatic vein (n=17, 80.9%), liver parenchyma (n=7, 30.3%), right atrium (n=5, 23.8%), and other organs (n=10, 47.6%). Among the 21 patients, 6 patients (28.5%) had cardiac arrest within 24 hours, all of which occurred within 2 hours. 11 patients (52.3%) died during their hospital stay. Layering in the right atrium shows the highest rate of cardiac arrest within 2 hours (4 of 5, 80%) followed by liver parenchyma (5 of 7, 71.4%). Reflux into liver parenchyma shows the highest rate of death during the same hospital stay (4 of 7, 57.1%). The mean number of involved structures per patient is  $3.29 \pm 2.0$  (range 1-9). It is higher in patients who died during the same hospital stay ( $4.25 \pm 1.15$ ) compared to those who survived ( $3.3 \pm 2.02$ ). The mean number of involved structures is similar between the cardiac arrest ( $3.29 \pm 1.98$ ) and non-cardiac arrest ( $3.28 \pm 2.08$ ) groups. The mean left ventricular ejection fraction (LVEF) was  $38 \pm 12\%$  (range 15-67). LVEF was less than 40% in 52% (10 of 19) of patients. The shock index was 0.9 or higher in 66.6% (12 of 18) of patients and its mean was  $1.08 \pm 0.50$  (range 0.5-2.6).

## CONCLUSION

The CT findings of dependent contrast layering in the central venous system are related to high rates of imminent cardiac arrest and mortality.

## CLINICAL RELEVANCE/APPLICATION

Radiologists and technicians need to recognize these findings to alert clinicians the risk of cardiac arrest. Our study provides important preliminary data for radiologists and clinicians to recognize the significance of "Dependent contrast layering sign" for clinical decision-making.

## W5B-SPCH- Performance of a Novel Intravascular Tantalum Oxide-based CT Contrast for Enhancement and Conspicuity of Thoracic Vasculature in an Animal Model: Total and Relative Contrast Material Advantage

Maurice M. Heimer, MD (*Presenter*) Nothing to Disclose

## PURPOSE

To compare a novel intravenous tantalum oxide (TaCZ) nanoparticle CT contrast agent to conventional iodinated (Iopromide) CT contrast agent for thoracic artery and vein visualization in a rabbit model.

## METHODS AND MATERIALS

Five New Zealand White rabbits were serially placed in a human-torso-sized adipose-equivalent encasement and scanned on a clinical CT system (Philips IQon, Best, Netherlands) before and 6, 40, 75, 136, and 240 sec after IV injection of 540 mg element (Ta or I) per kilogram of body weight of TaCZ or Iopromide. Animals were scanned twice, once with each contrast agent. Absolute contrast enhancement of the aortic arch, pulmonary trunk, superior vena cava, and subclavian vein was measured in Hounsfield Units (HU) by averaging three regions of interest drawn in the center of the lumen minus corresponding non-contrast measurements. Randomized imaging series were viewed on a clinical PACS system to rate vascular conspicuity on a 5-point Likert scale (0 = no vascular enhancement; 1 = faintly seen or visible but discontinuous; 2 = adequate contrast of main vessel, not all branches seen; 3 = good contrast of main vessel and depiction of branches; 4 = excellent contrast of main vessel and deep branches).

## RESULTS

Mean vascular enhancement was significantly higher for TaCZ in all examined blood vessels at all time points compared to Iopromide; aortic arch at 6s (263 vs. 217;  $p < 0.01$ ), at 40s (265 vs. 145;  $p < 0.01$ ), at 75s (240 vs. 119;  $p < 0.01$ ), at 136s (217 vs. 93;  $p < 0.01$ ) and at 240s (183 vs. 73;  $p < 0.01$ ), pulmonary artery at 6s (296 vs. 266;  $p < 0.01$ ), at 40s (263 vs. 138;  $p < 0.01$ ), at 75s (246 vs. 102;  $p < 0.01$ ), at 136s (213 vs. 83;  $p < 0.01$ ) and at 240s (174 vs. 64;  $p < 0.01$ ), superior vena cava at 6s (307 vs. 211;  $p < 0.01$ ), at 40s (255 vs. 127;  $p < 0.01$ ), at 75s (239 vs. 96;  $p < 0.01$ ), at 136s (196 vs. 79;  $p < 0.01$ ) and at 240s (169 vs. 49;  $p < 0.01$ ) and the subclavian vein at 6s (280 vs. 225;  $p < 0.01$ ), at 40s

(254 vs. 111;  $p < 0.01$ ), at 75s (236 vs. 86;  $p < 0.01$ ), at 136s (205 vs. 67;  $p < 0.01$ ), and at 240s (170 vs. 54;  $p < 0.01$ ). The mean vascular enhancement of TaCZ at a 136s delay provided comparable results to the 6s arterial phase of Iopromide (213 vs. 223;  $p > 0.05$ ). Overall, vascular enhancement correlated well with perceived vascular conspicuity scores for both agents.

#### **CONCLUSION**

TaCZ provides both an absolute and relative contrast advantage compared to Iopromide for improved visualization of the thoracic arteries and veins across a broad range of timepoints after contrast injection.

#### **CLINICAL RELEVANCE/APPLICATION**

TaCZ gives superior prolonged thoracic vascular enhancement over iodine agents at CT and warrants clinical testing as a means to improve the quality and consistency of CT angiograms and venograms.

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## Abstract Archives of the RSNA, 2023

W5B-SPER

### Emergency Radiology Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPER- Channeling the Neuroradiology Crystal Ball: Predicting Presenting Symptoms Associated with Imaging-Proven Acute Cord Compression in the Emergency Department** 1

Mercy H. Mazurek (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Spinal cord compression (CC) can result from both atraumatic and traumatic causes. CC commonly presents with back pain, urinary incontinence, lower extremity weakness, and malignancy, among others. While the occurrence of these symptoms is high, the prevalence of CC due to both atraumatic and traumatic causes is low. Understanding the clinical symptoms that are associated with CC may better inform the utilization of imaging in the emergency department (ED) to reduce costs and provide efficient care.

#### **METHODS AND MATERIALS**

This retrospective study analyzed patients who underwent our ED's abbreviated survey spine MRI protocol for suspected CC from 2018 to 2022. The survey protocol includes sagittal T2 and short-TI inversion-recovery (STIR), with optional axial T2. Imaging reports were reviewed by a blinded, board-certified neuroradiologist and characterized as positive or negative for CC. Demographic factors and presenting symptoms were extracted from the electronic medical record and compared among patients with imaging-positive acute CC vs negative. Univariate analysis was performed using the student's t-test and chi-squared test. A multivariate logistic regression was performed with stepwise backwards elimination where the variable with the largest P value was removed in a stepwise fashion in each iteration until all variables on the final model had a  $P < .20$ .

#### **RESULTS**

A total of 845 patients (mean age  $57 \pm 19$  years, 45% female) received a survey spine MRI for suspected CC during the study period. Of these, 23% presented with trauma, 55% back pain, 29% lower extremity weakness, 5.7% history of malignancy, 14% urinary incontinence, 6.0% bowel incontinence, 14% neck pain, 20% numbness, 7.3% ataxia, and 6.4% hyperreflexia. There were 725 (85%) and 120 (14%) patients negative and positive for CC, respectively. In the univariate model, trauma, back pain, numbness, ataxia, and hyperreflexia were significantly associated with having a positive study (Table 1). In the multivariate model, trauma, back pain, lower extremity weakness, urinary or bowel incontinence, numbness, ataxia, and hyperreflexia were significantly associated with being positive for acute CC (Table 2).

#### **CONCLUSION**

Presenting symptoms of trauma, back pain, lower extremity weakness, urinary or bowel incontinence, numbness, ataxia, and hyperreflexia were significantly associated with positive CC findings on ED survey spine evaluation in the ED. These results may inform which patients should receive triage priority in the ED.

#### **CLINICAL RELEVANCE/APPLICATION**

Understanding the symptoms associated with acute CC informs efficient utilization of abbreviated, CC-specific survey spine MRI protocols to limit unnecessary imaging studies thereby expediting diagnosis and emergent treatment.

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## Abstract Archives of the RSNA, 2023

W5B-SPGI

### Gastrointestinal Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPGI- Preoperative Prediction of Ki-67 Expression in Hepatocellular Carcinoma by Spectral Imaging on Dual-Energy CT** 1

Caiyun Li, BMedSc, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the value of quantitative spectral parameters measured on a dual-energy CT in preoperative predicting the expression level of Ki-67 in HCC.

#### **METHODS AND MATERIALS**

91 HCC patients underwent both pathological examination and two-phase contrast-enhanced CT scanning with spectral imaging mode were included in this study. According to Ki-67 expression determined by the Ki-67 positivity rate (Ki-67%), patients were divided into two groups: high expression group (Ki-67% > 20%, n = 51) and low expression group (Ki-67% = 20%, n = 40). CT values on 100 and 140 keV monochromatic energy images (HU100-140keV), normalized effective atomic number (Neff-Z), water density (D<sub>water</sub>), fat density (D<sub>fat</sub>) were measured and calculated. The parameters comparison between groups, receiver operation curve for prediction efficacy evaluation were conducted.

#### **RESULTS**

The Neff-Z, D<sub>fat</sub>, HU100-140keV and D<sub>water</sub> in high expression group were significantly higher than those in low expression group (all P < 0.05). In prediction of Ki-67 expression, the AUCs of Neff-Z, D<sub>fat</sub>, HU100-140keV and D<sub>water</sub> were 0.650, 0.677, 0.692-0.750, 0.777. The corresponding sensitivities were 0.647, 0.804, 0.529-0.824 and 0.961, respectively. The specificities were 0.600, 0.525, 0.825-0.625 and 0.475, respectively. D<sub>water</sub> showed highest Ki-67 expression prediction performance, with AUC of 0.777. The multi-variable analysis combining spectral CT parameters and morphological characteristics improved the prediction efficiency (AUC=0.814).

#### **CONCLUSION**

The spectral parameters (Neff-Z, D<sub>fat</sub>, HU<sub>100-140keV</sub> and D<sub>water</sub>) obtained by contrast-enhanced spectral imaging on dual-energy CT can be used to predict Ki-67 expression in HCC, the efficiency would be improved by multi-parameter analysis combining spectral CT parameters and morphologic features.

#### **CLINICAL RELEVANCE/APPLICATION**

Ki-67 was a significant marker for HCC prognosis and clinical decision, however current method to evaluate Ki-67 always needs surgery, which is detrimental for assessing patients who lost surgery chance. Contrast-enhanced spectral imaging on dual-energy CT provides various parameters to predict cell proliferation in HCC with good performance, shedding lights in clinical diagnosis and therapeutic strategy decision.

#### **W5B-SPGI- The Added Value of Reduced field-of-view IRIS-DWI Sequence for T2WI Sequence in T Staging of Rectal Cancer** 2

Ziyou Wang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Oblique axial high-resolution T2WI(HR-T2WI)was the recommended sequence for rectal cancer T staging.We attempted to evaluate the added value of reduced field-of-view (rFOV) IRIS-DWI sequence for T2WI sequence in evaluating T staging of rectal cancer.

## METHODS AND MATERIALS

All patients underwent rectal MRI examinations in our institution between June 2022 and November 2022. rFOV IRIS-DWI and oblique axial HR-T2WI images were acquired using a 3.0T MR scanner (Ingenia Elition, Philips, Best, the Netherlands) (Table 1). All patients were evaluated in two rounds by two methods. First, one senior radiologist (Y.K.M.) with more than 7 years of experience in rectal cancer MRI evaluated the T staging based on oblique axial HR-T2WI images and recorded the diagnosis confidence. Second, the same radiologist (Y.K.M.) reevaluated the T staging based on rFOV IRIS-DWI and HR-T2WI images after one-week interval. The diagnosis confidence was also recorded. The radiologist was blind to the detailed pathologic T staging. MedCalc statistical software (version 20.116) was used for data analysis. The accuracy of two diagnosis methods between oblique axial HR-T2WI and T2WI + rFov IRIS were compared by paired  $\chi^2$ -test. Paired sample t-test was used to compare the diagnosis confidence between the two diagnosis methods. ROC curve was used to evaluate the diagnostic performance for pT3 staging.  $P < 0.05$  indicated the difference was statistically significant.

## RESULTS

Twenty-seven patients with rectal cancer were enrolled in this retrospective study. The average age was  $66.7 \pm 6.9$  years, and there were 15 (56%) males (Table 2). The diagnosis accuracy for pT1-pT2 and pT3 was 58.3% and 73.3% according to oblique axial HR-T2WI. According to the oblique axial HR-T2WI and rFOV IRIS-DWI, 11 patients (91.7%) in 12 pT1-T2 staging patients and 14 patients (93.3%) in 15 pT3 staging patients were accurately diagnosed ( $P < 0.0001$ ) (Table 3). Based on T2WI + rFOV IRIS-DWI imaging showed higher diagnosis confidence, and the diagnosis confidence were 2.9 and 2.37 in all patients ( $P < 0.001$ ). For pT2 and pT3 staging subgroups, the diagnosis confidence based on T2WI + rFOV IRIS-DWI imaging also showed higher confidence (2.8 vs. 2.1,  $P = 0.01$ ; 2.93 vs. 2.53,  $P = 0.009$ , respectively) (Table 4). ROC analysis showed the diagnosis performance based on T2WI + rFOV IRIS-DWI imaging was superior to T2WI sequence. The AUC, sensitivity and specificity were 0.928, 93.3%, 91.7% and 0.658, 73.3%, 58.3%, respectively ( $P = 0.002$ ) (Table 5, Figure 3).

## CONCLUSION

rFOV IRIS-DWI combined T2WI imaging provide higher diagnosis confidence and higher diagnosis accuracy for rectal cancer T staging.

## CLINICAL RELEVANCE/APPLICATION

rFOV IRIS-DWI improved the diagnosis performance in rectal cancer T staging.

## W5B-SPGI- Impact of MRI after CT on the Therapeutic Decision of Pancreatic Adenocarcinoma

3

Walid Tibermacine, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this work is to determine the impact of MRI after CT on the therapeutic decision of pancreatic adenocarcinoma.

## METHODS AND MATERIALS

It's a prospective, cross-sectional and evaluative study over 24 months from January 2020 to December 2021 of patients suspected of having pancreatic cancer.

## RESULTS

A total of 117 cases of patients were included, aged 34-91 years with an average age of  $62 \pm 11$  years and a sex ratio of 1.25. The average diameter is  $43.61 \pm 15.268$  mm. The TDM and MRI assessment of resectability was performed according to NCCN version 1.2020 criteria. 46 patients (i.e. 39.3%) were at the metastasis stage, 36 patients (i.e. 30.8%) resectable, 19 patients (i.e. 16.2%) locally advanced and 16 patients (i.e. 13.7%) borderline resectability. To determine the impact of MRI after CT on the treatment decision, we compared the staging of the resectability of each of the two techniques by referring to surgery for resectability and metastases and to MRI data for characterization of liver damage. The analysis showed that in 15 patients (i.e. 12.8%) the therapeutic approach was changed on MRI after CT.

## CONCLUSION

Complementary MRI to CT led to changes in resectability and therapeutic management in a significant proportion of patients with ADCP

## CLINICAL RELEVANCE/APPLICATION

Complementary MRI to CT => changed resectability and therapeutic management

## W5B-SPGI- Imaging Features Prognostic of Overall Survival in Patients with Advanced Hepatocellular

4

## Carcinoma Undergoing Systemic Therapy

Kathleen Ruchalski, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

Modified RECIST measures arterial enhancement of liver lesions in hepatocellular carcinoma (HCC), evaluating treatment related alterations in tumor viability not captured by size alone. However mRECIST clinical translation to advanced HCC and ability to predict response to systemic therapy is less well reported. Our objective is to evaluate for imaging features beyond RECIST 1.1 which correlate with overall survival (OS) in advanced HCC.

## **METHODS AND MATERIALS**

This is a retrospective study of patients with advanced HCC at our institution enrolled in clinical trials for systemic treatment between 2015-2022. Patient characteristics and OS were obtained. Liver tumor imaging features on baseline CT or MRI chest, abdomen pelvis were analyzed. Relationship to overall survival (OS) was assessed by cox regression model and log rank test.

## **RESULTS**

Of 74 patients, we identified 53 who met our criteria, enrolled in a clinical trial with baseline imaging. There were 40 (75.5%) men and 13 (24.5%) women with a mean age of 66.2 years (SD=9.5). Median OS was 31.5 months. Percent total liver tumor involvement n= (%) included: < 25% n=25 (47.2), 25-50% n=20 (37.7), 51-75% n=8 (15.1) patients. Multifocal liver disease and macrovascular invasion were present in 41 (77.4%) and 25 (47.2%) of patients respectively. Individual liver lesions measured on average 41.7mm (SD=28.2) on arterial phase. Lesion margins were characterized as infiltrative (n=14 (13.2%)), irregular (n=19 (17.9%)), well circumscribed (n=60 (56.6%)) and N/O (n=13 (12.3%)). Arterial enhancement patterns were described as central heterogeneous in 41 (38.6%), homogeneous: 24 (22.6%), partial enhancement: 15 (14.2%), rim only: 11 (10.4%) and no enhancement in 15 (14.2%) patients respectively. Multifocal liver disease was associated with significantly increased risk of death (p=0.043). Patients with partially enhancing liver lesion had improved survival compared to those with central heterogeneously enhancing tumor (HR=0.28; p=0.044). Individual liver lesion size (p=0.399), margin (p=0.289) and % liver involvement (p=0.125) did not correlate with OS.

## **CONCLUSION**

While lesion size was not prognostic, presence of multifocal liver disease and central heterogeneous tumor enhancement were poor prognostic features of OS for advanced HCC.

## **CLINICAL RELEVANCE/APPLICATION**

Although further investigation is required, reporting imaging findings on multifocal liver disease and arterial enhancement pattern may provide prognostic information for patients with advanced HCC undergoing systemic therapy.

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## Abstract Archives of the RSNA, 2023

W5B-SPGU

### Genitourinary Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### W5B-SPGU- Deep Learning Prostate MRI Progression Risk Interval Prediction

1

Christian Roest, MSc (*Presenter*) Grant, Siemens AG

#### PURPOSE

MRI follow up is increasingly used to manage patients with low-risk prostate cancer, (PCa) but lacks personalization of follow-up timing. Therefore, We propose a novel AI approach to predict the time to prostate cancer progression.

#### METHODS AND MATERIALS

This retrospective study was performed on a dataset of 875 patients that underwent an MRI of the prostate between 2014 and 2021. Patients received follow-up MRIs and targeted biopsy for all PI-RADS=3 lesions. This study defined progression as the detection of ISUP>1 PCa at follow-up. A novel deep learning model was developed and trained to predict progression-free survival (PFS) based on the MRI and available clinical parameters (PSA, PSA density, prostate volume, and age). Five-fold cross-validation was used to obtain likelihood scores for the three-year risk of progression in each patient. Patients were stratified into high- and low-risk groups based on their predicted likelihood of progression, with an equal number of patients in each group. Kaplan-Meier analyses validated whether the predicted likelihood accurately predicted PFS. Finally, the C-index was calculated to assess the prognostic accuracy of our model.

#### RESULTS

Our AI model's predictions were significantly associated with PFS in the test data ( $p < 0.0001$ ). The C-index was  $0.72 \pm 0.05$ , indicating that our model was a good predictor of PFS. PFS was significantly better in patients predicted to be at low-risk of disease progression, when measured after two years ( $95.3 \pm 0.04\%$  vs  $84.9 \pm 0.02\%$ ,  $p = 0.008$ ), three years ( $92.7 \pm 0.05\%$  vs  $73.3 \pm 0.04\%$ ,  $p = 0.008$ ) and four years ( $87.7 \pm 0.12\%$  vs  $62.8 \pm 0.04\%$ ,  $p = 0.008$ ).

#### CONCLUSION

Our novel AI approach accurately predicted PFS from prostate MRI and clinical information.

#### CLINICAL RELEVANCE/APPLICATION

An improved predictor for the time to progression based on MRI and clinical parameters may improve MRI follow-up protocols by enabling more personalized interval timing and decision making.

#### W5B-SPGU- Detection of Clinically Significant Prostate Cancer in Men with a Negative Initial Round of Targeted Biopsies and Highly Suspicious Multiparametric Magnetic Resonance Findings

2

Debora Z. Recchimuzzi, MD (*Presenter*) Nothing to Disclose

#### PURPOSE

The purpose of this study was to evaluate the frequency of imaging-pathology discordance and the rate of csPCa detection on repeat TBx.

#### METHODS AND MATERIALS

This single-center, retrospective study of prospectively generated data, included all men who underwent mpMRI and had a PIRADS score 4 or 5 at our institution between Jan/2017 and Nov/2022. The frequency of imaging pathology discordance (PI-RADS score 4 or 5 lesion and no csPCa on TBx) and the rate of csPCa (grade group 2 or higher) detection on a repeat TBx (MRI-TRUS fusion or in-bore biopsy) were determined. Univariate analysis and multiple analysis with logistical regression

were used to identify potential parameters associated with true-negative targeted biopsies, including PSA, PSA density, prostate volume as measured by MRI and ADC measurement.

## **RESULTS**

Of the 4047 men reviewed, 63% (2581/4047) had PI-RADS 4 or 5 lesions on mpMRI followed by TBx. In 40% (1050/2581) of these men, TBx did not reveal csPCa. Among these 1050 men with discordant imaging-pathology findings, 18% (191/1050) men had a repeat targeted biopsy (MRI-TRUS fusion or MRI guided inbore), and 40 men underwent radical prostatectomy for grade group 1 disease. Repeat TBx identified csPCa in 35% (67/191) of the men who underwent a second TBx. The frequency of csPCa at repeat biopsy was significantly higher for PIRADS 5 (45%; 32/70) compared to PIRADS 4 lesions (28%; 35 of 121) (p=).

## **CONCLUSION**

A negative targeted biopsy of a highly suspicious lesion on mpMRI must be interpreted with caution and early repeat biopsy should be considered, particularly in men with PI-RADS 5 lesions.

## **CLINICAL RELEVANCE/APPLICATION**

Multiple studies have demonstrated that men with highly suspicious (PI-RADS score 4 and 5) prostate lesions at multiparametric MRI (mpMRI) are highly likely to harbor clinically significant prostate cancer (csPCa). The degree of suspicion on multiparametric MRI is the strongest predictor of a positive targeted biopsy with positive rates of 70% to 90% when the MRI findings are highly suspicious for PCa. It is known that prostate biopsies - including targeted biopsies (TBx) - are vulnerable to sampling error. Discordance between histologic and imaging findings may indicate, therefore, that the lesion may not have been sampled adequately, highlighting the importance of a systematic post-biopsy imaging-pathology concordance review.

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## Abstract Archives of the RSNA, 2023

W5B-SPHN

### Head & Neck Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPHN-Quantitative Gland Function Analysis in Dry Mouth Patient using T1, T2 and PD Mapping 1 based on the Multi-dynamic Multi-echo Method**

Chena Lee, DDS, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Dry mouth is a subjective complaint of dryness of intraoral cavity and the primary etiology is the hypofunction of salivary gland. Clinical diagnosis is conducted by collecting patient's whole saliva and evaluate the volume and this is a time consuming cumbersome examination. Thus, the current study aimed to utilize T1, T2 and PD mapping as diagnostic tool for parotid gland dysfunction in dry mouth patients.

#### **METHODS AND MATERIALS**

Dry mouth (n = 32) and control subjects (n = 30) that underwent magnetic resonance imaging (MRI) from July 2020 to December 2022 were reviewed. The T1, T2, and PD mapping of the parotid gland were evaluated simultaneously based on the multi-dynamic multi-echo (MDME) MR imaging. The values from control and dry mouth group were compared using Mann-Whitney test and receiver operating characteristic (ROC) curve analyses.

#### **RESULTS**

The mean of T1, T2-relaxation time and PD value of the gland in dry mouth group were 606.90 ms, 91.63 ms, and 82.37 pu, respectively. The mean of T1, T2-relaxation time and PD value of control group were 628.08 ms, 80.69 ms and 91.12 pu. The T2- relaxation time and PD value showed significant difference between the dry mouth and control group while there no significant difference between two groups in T1-relaxation value. The area under the ROC curve (AUC) was 0.8164 and 0.7564 respectively for T2-relaxation time and PD value. The diagnostic performance between T2-relaxation time and PD value were not significantly different (p-value = 0.4851).

#### **CONCLUSION**

The T2-rexlation time and PD value can be used as quantitative indicators of dry mouth due to hypofunction of parotid gland and the performance of T2-relaxation time presented higher diagnostic ability. Further study with large population could be leaded to more accurate result.

#### **CLINICAL RELEVANCE/APPLICATION**

T2 and PD mapping, based on the MDME technique, presented diagnostic ability for detecting parotid gland hypo function and could be utilized as quantitative tool for dry mouth diagnosis in clinic.

#### **W5B-SPHN-From Suspected to Confirmed : Intrathecal Gadolinium-Enhanced MR Cisternography as a 2 Key Diagnostic Modality in CSF Rhinorrhoea**

Priyanka Prajapati, MBBS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To establish the role and diagnostic accuracy of Intrathecal gadolinium enhanced MR Cisternography in clinically suspected cases of CSF rhinorrhoea

#### **METHODS AND MATERIALS**

As of now, a total of 19 consecutive patients with active or suspected CSF rhinorrhea have been included in this study. History of trauma was present in 8 patients (42%), endoscopic surgery in 5 patients (26%), spontaneous in 6 patients (32%). Most



of the patients had CT PNS which showed evidence of skull base fractures, defects or erosions. We used mixture of non-ionic iodinated contrast (5 ml of iohexol; Omnipaque 300) with Gadolinium (0.4 ml of gadobutrol; Gadovist) along with normal saline (5 ml of 0.9 % normal saline) for injecting into the intrathecal space. MR sequences were taken approximately 30-40 minutes after the contrast injection. For all patients, hemodynamic studies (heart rate, blood pressure) and evaluation of neurologic status were performed.

## RESULTS

We observed objective CSF leakage in 11 of 19 patients (58%). The CSF leak was located in the cribriform plate in 7 patients (37%), in the superior wall of the sphenoid sinus/planum sphenoidale in 4 patients (21%), fovea ethmoidalis/roof of ethmoid sinus in 2 patients (11%), through the post-operative sella turcica defect in 1 patient (5%), including multiple defects identified in 4 patients (21%). No objective CSF leakage in spite of bony defect was seen in 4 patients (21%). No bony defect and no objective CSF leakage were seen in 4 patients (21%). Surgical closure of CSF leak was performed in all patients with positive findings on cisternography and the site of leak was confirmed intraoperatively. Post-procedure 6 patients (32%) had mild headache. No other adverse event were noted.

## CONCLUSION

MR cisternography after the intrathecal administration of gadolinium represents an effective and minimally invasive method for evaluating suspected CSF fistulas along the skull base. It provides multiplanar capabilities and high resolution without risk of radiation exposure and is an excellent approach to depict the anatomy of CSF spaces and CSF fistulas. Furthermore, use of combination of non-ionic iodinated contrast with gadolinium increase the distribution of contrast in subarachnoid space and improve the resolution when compared with just using gadolinium. No significant gross neurologic abnormalities were observed during the initial examination or during follow-up.

## CLINICAL RELEVANCE/APPLICATION

CSF rhinorrhoea is potentially very serious because of the risk of an ascending infection which could produce fulminant meningitis. Exact identification of the location of the CSF fistula is important for proper surgical planning, increases the chances of dural repair and can prevent complications.

## W5B-SPHN-Tracheal Cartilage Calcification and Glucose Metabolism in Aging Adults Assessed by 18F-NaF and 18F-FDG PET/CT

Niloofaralsadat Motamedi, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The purpose of this study was to examine if 18F-sodium fluoride (18F-NaF) and 18F-fluorodeoxyglucose (FDG) PET/CT can be used to measure physiological calcification and glucose metabolism of the tracheal cartilage, respectively, and whether there was any association with aging.

## METHODS AND MATERIALS

Out of 139 healthy control subjects from the CAMONA study (NCT01724749), a total of 128 subjects in whom tracheal cartilage could be segmented on 18F-NaF-PET/CT (mean age  $48.58 \pm 14.44$  years, 51.56% males) were included in the analysis. Similarly, a total of 119 subjects (mean age  $48.46 \pm 14.34$  years, 54% males) in whom tracheal cartilage could be segmented on FDG-PET/CT were included in the analysis. The PET/CT acquisitions were performed 90 minutes after 18F-NaF administration and 60 minutes after FDG administration. The mean standardized uptake value (SUV<sub>mean</sub>) of both tracers was measured by assigning regions of interest (ROIs) around the cartilage using OsiriX software (Pixmeo SARL, Bernex, Switzerland). To assess the relationship of tracheal calcification and glucose metabolism with aging, Pearson correlation analysis was performed between age and the 18F-NaF and FDG, respectively.

## RESULTS

A statistically insignificant positive correlation was present between age and 18F-NaF SUV<sub>mean</sub> ( $r=0.094$ ,  $p=0.28$ ) (Figure 1). Similarly, there was a statistically insignificant negative correlation observed between age and FDG SUV<sub>mean</sub> ( $r=-0.125$ ,  $p=0.17$ ) (Figure 2).

## CONCLUSION

18F-NaF- and FDG-PET/CT can be used to measure physiological calcification and glucose metabolism of the tracheal cartilage. Although the results were statistically insignificant, there was a trend of an increase in physiological calcification and a decrease in glucose metabolism of the tracheal cartilage with aging, as assessed by 18F-NaF- and FDG-PET/CT, respectively. Prospective studies with larger sample sizes and longitudinal in subjects of varying ages are needed to continue investigation into changes in tracheal cartilage calcification and metabolism with aging.

## CLINICAL RELEVANCE/APPLICATION

To assess calcification and glucose metabolism of tracheal cartilage with aging by 18F-NaF and FDG PET/CT, age-related trends were observed, and further studies are needed to confirm clinical significance.

Paloma Puyalto, PhD, MD (*Presenter*) Nothing to Disclose



## W5B-SPHN-Relationship between Cochlear Implant Patients' Auditory Outcomes and Insertion Length and Angulation

4

### PURPOSE

Cochlear implants are transducers that transform the acoustic waves into electrical signals to stimulate the cochlear nerve in patients that suffer unilateral or bilateral, deep or severe, neurosensorial deafness that do not benefit from an auditory prostheses. The main objective of this study was to determine whether a deeper cochlear implant insertion within the cochlea, in terms of length and grade, results in improved auditory performance.

### METHODS AND MATERIALS

After IRB approval a cohort of 46 patients with 50 cochlear implants were prospectively reviewed. A temporal bone HRCT was performed before and after cochlear implantation. Prior and post-implantation audiometric studies and functional clinical variables such as speaking on the phone, listening to music, or time in months needed till auditory rehabilitation was optimal were recorded and correlated to the electrode insertion depth in terms of length and insertion angle grades.

### RESULTS

21 men and 25 women (29-78 y.o) with a 2 to 63 years story of neurosensorial deafness were analyzed. 4-12 electrodes were encountered within the cochlea in HRCT. A median of 88.7% of the cochlea was covered. The insertion angle ranged between 90° and 720° with  $\mu=536^\circ$  and  $s=146.40^\circ$ . Two years after implantation, there was a median of 11 (3-12) final functioning electrodes. 76% of patients achieved >70% bisyllabic discrimination at 60 dB, 60% used phones after implantation, 26% listened to music, Less than a year was the median time to finish hearing rehabilitation for 38%, followed by 12 to 24 months for 34% and 24 months for 28%. There was a correlation between the angle of insertion and the length of the inserted implant with a correlation coefficient of 0.846 ( $p<0.01$ ). A statistical correlation between the number of electrodes, length and insertion angle within the cochlea, and audiometric values, speaking at the phone, or the number of months of rehabilitation after the procedure was found ( $p<0,01$ ) although the ability to listen to music after cochlear implantation showed no statistic correlation with radiographic variables.

### CONCLUSION

Better auditory outcomes are obtained in terms of audiometric values and functional recovery the deeper the cochlear implants are inserted into the cochlea.

### CLINICAL RELEVANCE/APPLICATION

The cochlear coverage of the implant should be checked using a post-operative HRCT in patients with insufficient auditory results. Since these patients' functional outcomes are suboptimal it will be necessary to intensify and optimize the implant programming strategies in those with fewer than 8 functional electrodes inside the cochlea in post-surgical HRCT, or even to consider early replacement.

## W5B-SPHN-A New XAI Framework with Feature Explainability for Tumors Decision-making in Ultrasound Data

6

Fajin Dong JR, MD,MD (Presenter) Nothing to Disclose

### PURPOSE

The value of implementing artificial intelligence (AI) on ultrasound screening for thyroid cancer has been acknowledged, with numerous early studies confirming AI might help physicians acquire more accurate diagnoses. However, the black box nature of AI decision-making process makes it difficult for users to grasp the foundation of AI's prediction. Furthermore, explainability is not only related to AI performance but also responsibility and risk in medical diagnosis. In this paper, we offer Explainer, an intrinsically explainable framework that can categorize images and create heatmaps highlighting the regions where its prediction is based on.

### METHODS AND MATERIALS

This study included 19341 2D ultrasound images (9171 horizontal views and 10170 vertical views) of 7714 thyroid nodules obtained from 7236 individuals from October 2019 to May 2021, with pathological results and physician annotated TI-RADS features are used to train and test the robustness of the proposed framework. Then we conducted a benign-malignant classification study to whether physicians perform better under the assistance of Explainer than diagnose alone or with Gradient-weighted Class Activation Mapping (Grad-CAM).

### RESULTS

Reader studies show that the Explainer can achieve more accurate diagnosis while providing explaining heatmaps and that physicians' performances are improved when assisted by the Explainer. Case study confirms that the Explainer can locate more reasonable and feature-related regions than the Grad-CAM.

## CONCLUSION

The Explainer offers physicians a tool to understand the basis of AI predictions and to evaluate its reliability, which has the potential to unbox the black box of medical imaging AI.

## CLINICAL RELEVANCE/APPLICATION

In the case study comparing heatmaps generated by Explainer and Grad-CAM, Explainer is capable of locating more reasonable and feature-related regions. Evidence proves that in ultrasound images explaining tasks, our method is more detailly.

## W5B-SPHN-Diagnosis of Malignancy in Surgery after Radiofrequency Ablation of Benign Thyroid Nodule 7

Jung Hee Shin, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Nodule regrowth after radiofrequency ablation (RFA) of symptomatic large benign thyroid nodules is sometimes diagnosed as malignancies during surgery. This study aimed to assess the ultrasound (US) characteristics of thyroid nodules later diagnosed as cancer, predictive factors for cancer after RFA, and preventive methods for these cancers to avoid RFA procedure.

## METHODS AND MATERIALS

We reviewed the medical records of 134 consecutive patients with 148 nodules who underwent RFA between 2008 and 2016 for the debulking of symptomatic benign thyroid nodules. We investigated the pre-RFA characteristics of the thyroid nodules, changes at follow-up after RFA, and final surgical pathology.

## RESULTS

Nodule regrowth after RFA for benign nodules was observed in 36 (24.3%) of the 148 nodules. Malignancies were confirmed in seven (19.4%) of the 36 regrown nodules. Of the 22 nodules removed surgically, pre-RFA mean maximal diameter was significantly higher for malignant nodules than for benign nodules ( $3.89 \pm 0.98$  vs  $5.23 \pm 1.52$  cm,  $P = .01$ ). There was no difference in the regrowth interval between benign and malignant nodules ( $P = .19$ ). Volume reduction rate at 12 months was lower for malignant nodules than for benign nodules ( $51.16 \pm 13.81\%$  vs  $73.68 \pm 20.15\%$ ,  $P = .02$ ). Pre-RFA benignity of all seven malignant nodules was confirmed using two ultrasound (US)-guided fine-needle aspirations (FNAs), except for one nodule confirmed using US-guided core needle biopsy (CNB). The regrown malignant nodules were diagnosed as suspicious for follicular neoplasms using CNB. Histological examination of the malignant nodules during surgery after RFA revealed follicular thyroid carcinomas, except for one follicular variant of papillary thyroid carcinoma.

## CONCLUSION

Symptomatic large thyroid nodules confirmed to be benign prior to RFA should be considered false-negative FNA results. In RFA patients, CNB prevents delay in cancer diagnosis.

## CLINICAL RELEVANCE/APPLICATION

Considering false-negative fine-needle aspiration results in symptomatic large benign thyroid nodules before radiofrequency ablation, core needle biopsies should be included in the revised RFA guidelines to prevent delayed cancer diagnosis.

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## Abstract Archives of the RSNA, 2023

W5B-SPIN

### Imaging Informatics Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPIN- Deep Learning Based Synthetic Contrast Enhanced T1 Map for Contrast Agent-free Myocardial Extracellular Volume (ECV) Mapping in Cardiac MRI**

Sebastian Nowak, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the utility of generative adversarial networks (GAN) to generate artificial contrast enhanced (CE) T1 maps for creation of synthetic extracellular volume (ECV) maps of the myocardium.

#### **METHODS AND MATERIALS**

This study includes 1086 cardiac MRI exams with native and CE T1 maps in 3 short axis slices of 986 patients undergoing MRI for various clinical indications between January 2019 and August 2021. Manual myocardium segmentations of 522 slices were used to develop a U-Net for image cropping prior to rigid registration. All registered native and CE T1 map pairs were inspected and excluded if rigid registration failed due to dissimilar contraction phase, resulting in 2074 curated T1 map pairs from 827 patients (age:  $48 \pm 19$  years, 344 female). Of those, 191 native and CE T1 map pairs from 78 patients were defined as hold-out test set with hematocrit available within 48h prior to imaging, allowing for creation of reference 'real' ECV maps. With the remaining cases a U-Net generator was trained with L1 loss and 5-fold cross validation in combination with a PatchGAN discriminator to generate synthetic CE T1 maps from native T1 maps. Note that for ECV calculation, the correct enhancement ratio of blood to myocardium is crucial rather than prediction of exact CE T1 values. Two ECV maps were created for the test set: one using the real and one using the synthetic CE T1 map. The difference between the synthetic and real mean ECV ( $\Delta$ ECV) within the myocardium was calculated, and their correlation was quantified with the Pearson correlation coefficient (R). To investigate whether the GAN simply linearly transforms the input native T1 maps, the correlation of the real mean ECV with the mean of the native T1 maps was also compared with the correlation between synthetic and real ECV. Bootstrapping with 1000 resamples were used for calculating 95% confidence intervals.

#### **RESULTS**

The synthetic mean ECV values in the myocardium showed a high correlation to the real ECV (R: 0.81 [0.74-0.86]), which was significantly higher compared to the correlation of the native T1 and real ECV values (R: 0.61 [0.51-0.69]). A mean  $\Delta$ ECV of  $2.30 \pm 2.04$  % was observed in the hold-out test set.

#### **CONCLUSION**

Generation of synthetic CE T1 maps from native T1 maps by GANs shows promising results for contrast agent-free estimation of myocardial ECV. The results motivate multicenter studies including more patients with appropriate MRI examination and hematocrit to also investigate direct generation of synthetic ECV without hematocrit and contrast agent use.

#### **CLINICAL RELEVANCE/APPLICATION**

Deep learning based generation of synthetic CE T1 maps from native T1 maps for synthetic ECV calculation might facilitate faster cardiac MRI examinations without the use of gadolinium-based contrast agents.

#### **W5B-SPIN- Development and Validation of a CAD System with Reduced False Positives for Bone Metastasis on Chest CT**

Yena C. Kang, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop and validate a computer-aided diagnosis (CAD) system using a deep learning (DL) with improved specificity for detecting bone metastasis on chest CT for accurate and efficient workflow in lung cancer screening.

## METHODS AND MATERIALS

In this retrospective study, a CAD system was developed using DL algorithm trained on 3,809 chest CT scans (age  $57.7 \pm 71$ ; women 3,533) obtained from the patients who had various cancer origins (breast: 131, colorectal: 24, lung: 11 and others 34), including 825 with confirmed bone metastasis. The diagnostic performance was evaluated using both internal and external test set of 200 (age  $55.7 \pm 58$ ; women 157; 40 confirmed bone metastasis) and 50 (age  $66.1 \pm 46$ ; women 15; all confirmed bone metastasis) chest CT scans, respectively. The bone metastasis was annotated slice-by-slice indicating whether the lesion exists or not, and the confirmed bone metastasis cases included up to 63 lesions in a single scan. A DL algorithm based on DenseNet-161 was trained with axial slices from CT scans. Each slice was individually assessed whether it contains bone metastasis or not. The axial slices were converted into window level of 800 and window width of 1,500, for better visualization of the bone area. Diagnostic performance was evaluated in a patient-based manner using the maximum prediction value of all slices as the representative prediction value for the patient. For internal test, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated and for external test, only sensitivity was evaluated as positive cases were considered only. Additionally, the performance of subgroups by primary cancer was evaluated.

## RESULTS

The DL based CAD system achieved specificity, sensitivity, PPV, and NPV of 92%, 70%, 92%, and 68% for the internal test, and sensitivity of 86% for the external test in patient-based manner. For the internal test, the specificity of subgroups by primary cancer was 90%, 100%, 88% and 93%, and the sensitivity was 63%, 100%, 100%, and 71% for breast, colorectal, lung and other origins.

## CONCLUSION

We successfully developed and validated a CAD system with high specificity thus reducing false positive cases for bone metastasis evaluation on chest CT.

## CLINICAL RELEVANCE/APPLICATION

The proposed system can be applied to lung cancer screening, providing a valuable tool for efficient workflow. Further studies are warranted to assess the performance in different clinical settings and malignancies.

## W5B-SPIN- Integrating Clinical Data with AI to Optimize Decision-making in Prostate MRI

5

Nadia S. Moreira Da Silva (*Presenter*) Employee, Lucida Medical

## PURPOSE

To determine whether combining prostate MRI AI-based decision support outputs, clinical data and PI-RADS scores in a multi-modal predictive model enhances detection of clinically significant prostate cancer.

## METHODS AND MATERIALS

MRI, clinical history, histopathology, and PI-RADS scores were obtained retrospectively from five sites in a multi-vendor, multiple field strength study. After exclusions for AI contraindications including prior treatment and quality issues, model training used data from 352 patients and a held-out test set comprised data from 235 patients (Gleason grade group (GGG)=2, prevalence 34%). Our automated multi-stage AI-based software segments and calculates the volume of prostate whole gland and transition zone (TZ) on MRI, and segments and scores lesions/patients for GGG=2 disease likelihood. Biopsy-verified GGG=2 was used as ground truth, with MRI-negative patients not undergoing biopsy assumed negative. Sensitivity, specificity, and AUC were evaluated at patient level on the held-out test set, with 95% confidence intervals obtained through bootstrapping. Combinations of AI, clinical and PI-RADS data were tested for significant improvement to the AI score and PI-RADS assessment, at pre-determined thresholds equivalent to PI-RADS 3.

## RESULTS

mpMRI PI-RADS scores alone detected GGG=2 with sensitivity 1.00 (95% CI 1.00-1.00), specificity 0.67 (0.61-0.75) and AUC 0.94 (0.91-0.97). GGG=2 was detected by bpMRI AI with sensitivity 0.97 (0.93-1.00), specificity 0.55 (0.47-0.62) and AUC 0.88 (0.84-0.92). Combining AI score and TZ-PSA density (PSAD) improved specificity (sensitivity 0.95 (0.90-0.99), specificity 0.70 (0.63-0.77) and AUC 0.90 (0.85-0.93)). The addition of AI and TZ-PSAD to PI-RADS scores maintained high sensitivity of 0.99 (0.96-1.00), while significantly improving specificity to 0.83 (0.77-0.89, KS p-value<0.001) and AUC to 0.96 (0.93-0.98, DeLong p-value 0.003). TZ volume based PSAD had modest additional benefit compared to whole-prostate PSAD. Other variables offered <5% specificity improvements or non-significant benefits. Findings with bpMRI and mpMRI AI models were similar. Limitations: Most MRI-negative cases did not receive biopsy in this retrospective study.

## CONCLUSION

The use of PSAD improves the predictive accuracy of prostate MRI AI decision support, with significant improvement in specificity at similar sensitivity. Combining PI-RADS, PSAD and AI offers substantial improvement compared to AI or PI-RADS assessments alone.

## CLINICAL RELEVANCE/APPLICATION

The improved specificity achieved through integrating patient PSAD and radiologists' PI-RADS scores with AI software can potentially reduce false positive cases, further aiding patient selection for biopsy using MRI.

## W5B-SPIN- Deep Learning to Predict Fat and Appendicular Skeletal Masses from Chest Radiograph

6

Ki Duk Kim, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To predict fat and appendicular skeletal muscle (ASM) masses from chest radiograph (CXR), which can be highly beneficial for analyzing the health impacts of body composition.

### METHODS AND MATERIALS

A total of 40,369 CXRs with body composition, including fat and ASM, from a tertiary hospital's health screening center was used. Fat and ASM were acquired using bioelectrical impedance analysis (BIA). The Inception v3 architecture was used to predict body composition, and assessment to determine the impact of demographics, such as age, sex, height, and weight, on the model's performance was conducted. Deep label distribution learning with additional Mean-Variance (MV) loss was used to train the network. Two independent unseen test datasets comprising 1,000 individuals each, which follows normal distribution and uniform distribution of age, from same center were used. The mean average error (MAE) and Pearson's correlation coefficient (r) between BIA and model prediction were evaluated. Correlation analyses and Bland-Altman plots were also presented.

### RESULTS

The age of test dataset was  $56.732 \pm 10.519$  and  $54.421 \pm 19.160$  (range from 20 to 90), respectively for test set of normal distribution and test set of uniform distribution. And the ASM was  $25.839 \pm 5.814$  and  $25.709 \pm 6.152$ , respectively. Sex was sampled evenly for both datasets. In the test set of normal distribution, MAEs of the models without information and without MV loss, without information and with MV loss, with information and without MV loss, and both with information and MV loss for predicting fat were 1.773, 1.673, 1.564, and 1.564, respectively. All model significantly correlated with BIA with decent r scores of 0.805, 0.839, 0.855, and 0.861, respectively ( $P < 0.001$  in all model). In the uniform distribution set, MAEs were 1.945, 1.844, 1.773, and 1.726 respectively, while r scores were 0.805, 0.849, 0.853, and 0.860, respectively ( $P < 0.001$  in all model). In the normal distribution set, MAEs of each model for ASM were 1.309, 1.181, 1.307, and 1.172 respectively. All model showed decent r scores of 0.927, 0.932, 0.981, and 0.940 ( $P < 0.001$  in all model) with the same order. In the uniform test dataset, MAEs were 1.424, 1.250, 1.376, and 1.278, respectively, while r scores were 0.920, 0.932, 0.930, and 0.932, respectively ( $P < 0.001$  in all model).

### CONCLUSION

deep learning model of CXR can precisely predict fat and muscle masses. Demographics and MV loss can significantly enhance the predicting power of the model

## CLINICAL RELEVANCE/APPLICATION

Prediction of fat and ASM from CXR can be applied to a variety of clinical fields, such as sarcopenia assessment, prognosis prediction of cancer patients, precision medicine for optimum drug dose estimation in inpatient settings.

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## Abstract Archives of the RSNA, 2023

W5B-SPIR

### Interventional Radiology Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPIR- Long-Term Survival after Percutaneous CT and US guided Microwave Ablation of Pathologically Proven Renal Cell Carcinoma** 1

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the long-term overall (OS), cancer-specific (CSS), and local tumor progression (LTP)-free survival of patients who underwent percutaneous microwave ablation (MWA) of pathologically proven renal cell carcinoma (RCC).

#### **METHODS AND MATERIALS**

This IRB-approved, HIPAA compliant study included patients who underwent percutaneous MWA between 2013 and 2017 of biopsy-proven RCCs. All patient demographics, tumor characteristics, procedural technical outcomes, and pre- and post-procedural estimated glomerular filtration rate (eGFR) were evaluated. OS, CSS, and LTP-free survival were calculated and Kaplan-Meier analysis was performed. Complications were classified per the Clavien-Dindo system.  $\chi^2$  test was used for proportions for categorical outcomes excluding repeated measures for patients and a paired t-test for differences in eGFR.

#### **RESULTS**

The study cohort comprised 86 biopsy-proven RCCs from 81 patients (mean age:  $67.6 \pm 16.9$ ) and were 62% male. The median follow-up period was 76.8 months (1 to 123 months). The mean tumor size was 2.8cm (0.7cm to 7.0cm) and RCC lesions were more commonly located on the right side (60.5%), anterior (41.9%), lower pole (44.2%), and endophytic (69.8%). Primary and secondary technical success was achieved in 88.4% (76/86) in a single session and 90% (9/10) in two sessions with overall technical success of 100%. The 5-year and 10-year OS, CSS, and LTP-free survival rates were 82.7%, 90.8%, and 84.3% and 75.7%, 84.7%, and 82.9%, respectively. RCC = 4cm ( $p=0.016$ ) was predictive of LTP. There were no significant changes in pre-ablation and 2-3 years post-ablation eGFR (58.5 vs 58.4 mL/min/1.73m<sup>2</sup>,  $p=0.932$ ). There was a 2% overall incidence of complications, all grade I.

#### **CONCLUSION**

Percutaneous CT and US guided MWA of biopsy-proven RCC was safe and effective with excellent long-term OS, CSS, and LTP-free outcomes within 10 years from initial treatment.

#### **CLINICAL RELEVANCE/APPLICATION**

Image-guided ablative therapies are a safe and effective treatment option for renal cell carcinoma with durable long-term survival rates.

#### **W5B-SPIR- Long-Term Survival after CT and US Guided Radiofrequency Ablations of T1a and T4 Pathologically Proven Renal Cell Carcinomas** 2

Daniel H. Kim, BA, MS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To determine the long-term overall, renal cell carcinoma (RCC)-specific, and progression-free survival of patients who underwent percutaneous radiofrequency ablation (RFA) of pathologically proven RCC.

#### **METHODS AND MATERIALS**

This IRB-approved, HIPAA compliant study included patients who underwent percutaneous RFA between 2004 and 2015 of their biopsy-proven RCCs. All patient demographics, tumor characteristics, procedural technical outcomes, and pre- and post-

procedural estimated glomerular filtration rate (eGFR) were collected. Overall survival (OS), and local tumor progression (LTP)-free survival were calculated by Kaplan-Meier survival curves. In addition, a subcohort analysis of the RCC T1a and T4 was conducted to examine the RCC-specific survival (RSS) rate with Kaplan Meier survival analysis. Complications were classified per the Clavien-Dindo system.  $\chi^2$  test was used for proportions for categorical outcomes and paired t test was used for changes in eGFR.

## RESULTS

The study cohort comprised 129 biopsy-proven RCCs from 101 patients (mean age:  $68.5 \pm 12.4$ ). Primary technical success was achieved in 91.5% (118/129) of ablations and secondary technical success was achieved in 90.9% (10/11) of ablations with remaining one lesion requiring three ablations. The median of the follow-up period was 136 months (1 to 230 months) with mean tumor size of 2.3cm (0.5cm to 8.0cm). RCC lesions were more commonly located on the right (52.7%), in the midpole (37.2%), and were endophytic (54.3%). The study cohort comprised the following RCC subtypes: clear cell (69%), epithelial neoplasm (16%), papillary (11%), and chromophobe (5%). There was a slight decrease in preprocedure eGFR relative to 2-3 years postprocedure eGFR (59.2 vs 55.4 mL/min/1.73m<sup>2</sup>;  $p=0.003$ ). There were 6 complications mostly grade I-III. The 15-year OS and LTP-free survival rates were 63.6% and 92.2% in 101 patients and 129 lesions. The T1a and T4 subcohorts comprised 65 patients and 32 patients with a 15-year RSS rate of 96.5% and 82.7%.

## CONCLUSION

Image-guided percutaneous RFA of RCCs was safe with durable 15-year OS rate of 63.6%, LTP-free survival rate of 92.2%, and RSS rate of 96.5% and 82.7% in the T1a and T4 subcohorts.

## CLINICAL RELEVANCE/APPLICATION

Percutaneous CT and US guided radiofrequency ablation was safe with excellent 15-year durable responses in both T1a and T4 subcohorts.

## W5B-SPIR- No-touch Radiofrequency Ablation versus Tumor Puncture Microwave Ablation for Small Hepatocellular Carcinoma: Comparison of Treatment Outcomes

3

Jae Hyun Kim, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The aim of this study was to compare the therapeutic outcomes between no-touch (NT) radiofrequency ablation (RFA) and tumor puncture microwave ablation (MWA) for single hepatocellular carcinomas  $\leq 4$  cm.

## METHODS AND MATERIALS

A total of 335 patients who underwent NT RFA ( $n=155$ ) or tumor puncture MWA ( $n=180$ ) for single HCCs  $\leq 4$  cm were included in this retrospective study. A matched cohort comprising 121 patients from each group was selected after propensity score matching analysis to adjust for potential biases. This study assessed the therapeutic outcomes after ablation including technical success, local tumor progression (LTP), and major complications. Cumulative LTP rates were estimated using the Kaplan-Meier method.

## RESULTS

A total of 242 patients (mean age, 66.2 years  $\pm$  9.5 [standard deviation]; 183 men) were evaluated. The technical success rates were 99.2% [120/121] vs. 100% [121/121] in the NT RFA and MWA groups, respectively ( $P>0.05$ ). The estimated 1- and 2-year cumulative LTP rates in the NT RFA were 2.2% and 3.1%, respectively, and were not significantly different from the 3.0% and 6.0% observed in the MWA group ( $P=0.279$ ). There was no significant difference in the major complication rate between the NT RFA and MWA groups (1.7% [2/121] vs. 0.8% [1/121],  $P=1.000$ ).

## CONCLUSION

Tumor puncture MWA showed comparable therapeutic outcomes including LTP and major complication rates to those of NT RFA in single HCCs ( $\leq 4$  cm).

## CLINICAL RELEVANCE/APPLICATION

NT RFA and tumor puncture MWA are potentially effective and safe treatment options for small HCCs ( $\leq 4$  cm).

## W5B-SPIR- Perfusion CT for Early Prediction of Treatment Response of Cryoablation in Renal Cell Carcinoma

4

Oyunbold Lamid-Ochir (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate quantitative analysis of perfusion CT (pCT) for assessment of early treatment response after cryoablation in renal tumors.



## METHODS AND MATERIALS

A total 54 patients with renal tumors who had treated by CT-guided percutaneous cryoablation in our institution from June 2014 to August 2016. Twenty-seven patients were selected, who underwent pCT before and after within 1 week, 1, 3, 6 months and 1-year treatment. Perfusion parameters including arterial flow perfusion (AFP) as tumor maximum, minimum, average and average changes and tumor diameter, freezing time, treatment cycles and progression-free-survival were analyzed and compared. The effects of treatment response were evaluated by RECIST standards version 1.1 as a non-responder and responder.

## RESULTS

Twenty-seven patients (22 men, 5 women: age,  $68 \pm 12$  y.o.) evaluated as quantitative analysis with pCT. Five of 27 patients were non-responders, and 22 patients were responder. The mean AFP values were significantly different between non-responder ( $46.6 \pm 25.8$ ) and responder ( $25.1 \pm 6.1$ ) at 1 month after cryoablation ( $p < 0.05$ ). ROC analysis demonstrated that tumor average (AFP) at 1 month had the cut-off of perfusion value (29.95) and area under curve (0.94), with sensitivity and specificity of 100% and 84.2%, respectively ( $p < 0.05$ ). Percent of progression free-survival was 100% (cut-off  $< 29.95$ ) and 66.7% (cut-off  $> 29.95$ ) for 32 months observation.

## CONCLUSION

pCT was able to evaluate and predict therapeutic effects of cryoablation at 1 month after treatment. It can offer both morphologic and functional evaluation, providing a quantitative assessment of residual tumor vascularization after treatment.

## CLINICAL RELEVANCE/APPLICATION

pCT can be predicted to responder and non-responder at 1 month after cryoablation and might be earlier than dynamic CE-CT. Also, it can detect minimal focal perfusion changes whether the tumor is shrinking or without tumor volume changes.

## W5B-SPIR- SAR-COOL: Sarcoma Cryoablation Outcomes and Optimization of Life

5

Koustav Pal, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

To evaluate the local tumor progression-free survival following cryoablation of recurrent or metastatic soft tissue sarcoma (STS) lesions.

## METHODS AND MATERIALS

A single-institution retrospective analysis of patients with a histopathological diagnosis of metastatic STS who underwent percutaneous cryoablation (PC) from January 2022 to April 2023 was performed. Patients with less than 60 days of follow-up and those treated for more than four lesions during one procedure were excluded. Complications were categorized based on the Common Terminology Criteria for Adverse Events (CTCAE) classification system. R software version 4.2.3 was used for analysis. (We aim to further analyze the outcomes of 239 patients with 391 procedures from Jan. 2016 to April 2023)

## RESULTS

61 patients who underwent PC for 84 STS lesions met the eligibility criteria. There were 21 different histological subtypes of sarcoma in the study, with the two most common being leiomyosarcoma (20/61) and liposarcoma (16/61). The median size of sarcoma lesions was 2.1 cm (range 0.4 to 13.4). Complete response at six months was achieved in 81% of the treated lesions. Local tumor progression-free survival was 86.1% at 6 months and 77.3% at 1 year. The overall survival was 97.2% at 1 year. Chemotherapy free time for patients was 54.57% at 6 months. The complication rate was 14%, with 56.55% classified as CTCAE grade 3 or higher. Subgroup analysis for leiomyosarcoma vs. liposarcoma demonstrated an overall survival of 100% vs. 90.9% at 12 months, respectively. Local tumor-free progression was 86.7% at 6 months and 86.7% at 12 months for liposarcoma. Leiomyosarcoma demonstrated 91.97% local tumor-free progression at 6 months and 46.4% at 12 months. There was no statistically significant difference between the two groups ( $p = 0.37$ ).

## CONCLUSION

PC of STS and its metastases is a safe and effective treatment modality.

## CLINICAL RELEVANCE/APPLICATION

Surgical resection is a cornerstone in the management of recurrent or oligometastatic soft tissue sarcoma. Percutaneous cryoablation is a minimally invasive technique that may complement surgical approaches. This study demonstrates that cryoablation can achieve high local control rates with durable responses in this patient population.



## Abstract Archives of the RSNA, 2023

W5B-SPMK

### Musculoskeletal Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPMK-The Next Frontier in Lumbar Spine MR Bone Imaging: Harnessing the Power of Super-Resolution Deep Learning Reconstruction**

Masamichi Hokamura (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to assess the effectiveness of super-resolution deep-learning-based reconstruction (SR-DLR), which leverages k-space properties, on the image quality of lumbar spine magnetic resonance (MR) bone imaging using a 3D multi-echo in-phase sequence.

#### **METHODS AND MATERIALS**

In this retrospective study, 29 patients who underwent lumbar spine MRI, including an MR bone imaging sequence, between January and April 2023, were analyzed. Images were reconstructed with and without SR-DLR (Matrix sizes: 960 x 960 and 320 x 320, respectively). The signal-to-noise ratio (SNR) of the vertebral body and spinal canal, along with the contrast and contrast-to-noise ratio (CNR) between the vertebral body and spinal canal, were quantitatively evaluated. Furthermore, the slope at half-peak points of the profile curve drawn across the posterior border of the vertebral body was calculated. Two radiologists independently assessed image noise, contrast, artifacts, sharpness, and overall image quality of both image types using a 4-point scale. Interobserver agreement was evaluated using weighted kappa coefficients, and quantitative and qualitative scores were compared via the Wilcoxon signed-rank test.

#### **RESULTS**

In this retrospective study, 29 patients who underwent lumbar spine MRI, including an MR bone imaging sequence, between January and April 2023, were analyzed. Images were reconstructed with and without SR-DLR (Matrix sizes: 960 x 960 and 320 x 320, respectively). The signal-to-noise ratio (SNR) of the vertebral body and spinal canal, along with the contrast and contrast-to-noise ratio (CNR) between the vertebral body and spinal canal, were quantitatively evaluated. Furthermore, the slope at half-peak points of the profile curve drawn across the posterior border of the vertebral body was calculated. Two radiologists independently assessed image noise, contrast, artifacts, sharpness, and overall image quality of both image types using a 4-point scale. Interobserver agreement was evaluated using weighted kappa coefficients, and quantitative and qualitative scores were compared via the Wilcoxon signed-rank test.

#### **CONCLUSION**

SR-DLR, which is based on k-space properties, has the potential to enhance the image quality of lumbar spine MR bone imaging utilizing a 3D gradient echo in-phase sequence.

#### **CLINICAL RELEVANCE/APPLICATION**

The application of SR-DLR can lead to improvements in lumbar spine MR bone imaging quality.

#### **W5B-SPMK-Application of Material Decomposition Technique based on Dual-energy CT in the Differential Diagnosis of Acute and Old Thoracolumbar Fracture**

Mingyue Wang, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To identify acute and old thoracolumbar vertebral compression fractures by using material decomposition technique based on dual-energy CT(DECT).

## METHODS AND MATERIALS

A total of 12 patients with acute trauma or diagnosed compression fracture who underwent thoracolumbar DECT and MR scanning in Shenzhen Qianhai Shekou Free Trade Zone Hospital from June 2022 to February 2023 were retrospectively collected. 24 cases about vertebral compression fracture was found in DECT and MRI (fat suppressed T2WI). The time about patients took DECT and MRI examination from the first day they get injured to 2 weeks after they got fractured. A total of 16 vertebral bodies' data were collected, including 8 patients with old fractures. All patients had a fracture injury time of more than six months. Water (Iodine), Water (Calcium) and Water (HAP)-based on material decomposition images were reconstructed. The signals of edema area is calculated from water density values and water difference values in three material decomposition images in both area of acute fractured vertebrae and old fractured vertebrae. With reference to bone marrow edema area of fracture based on MRI. A paired T test was used to compare the difference in water density between acute vertebral fracture edema and old compression fractures. A two-factor ANOVA was used to compare the difference in water density values between edematous fractured vertebrae and old compression fractured vertebrae among three material images sets.

## RESULTS

The water density values for Water (Iodine), Water (Calcium) and Water (HAP) images were significant higher in the acute fracture edema vertebral bodies compared to old compression fracture vertebral bodies (1147.6mg/cm<sup>3</sup> Vs 1040.9mg/cm<sup>3</sup>, 1089.4mg/cm<sup>3</sup> Vs 1014.4mg/cm<sup>3</sup> and 996.7mg/cm<sup>3</sup> Vs 972.2mg/cm<sup>3</sup>, respectively, all P < 0.001). There was a significant statistical difference in the water difference values between the acute fractured vertebrae and the old compression fractured vertebrae (P < 0.001), and with the largest water difference values in the Water (Iodine) image.

## CONCLUSION

The water density values for Water (Iodine), Water (Calcium) and Water (HAP)-based material decomposition images can distinguish acute thoracolumbar fractures from old compression fractures on dual-energy CT examination. Water (Iodine) images showed the best discrimination.

## CLINICAL RELEVANCE/APPLICATION

The measurement of water density values for material decomposition images based on dual-energy CT, can improve the clarity of diagnosis of acute thoracolumbar fractures and old compression fractures, and also avoid confusion caused by contraindications to MRI examination. This is a valuable aid for both patients and clinical practice.

## W5B-SPMK-Application of Dual-energy CT Single Energy Reconstruction Technique in Acute Fractures of Thoracolumbar Spine with Bone Marrow Edema

Mingyue Wang, BS (*Presenter*) Nothing to Disclose

## PURPOSE

To identify bone marrow edema in acute thoracolumbar fractures by using single-energy reconstruction technique based on dual-energy CT (DECT).

## METHODS AND MATERIALS

A total of 18 patients with acute trauma or diagnosed compression fracture who had thoracolumbar DECT and MR scanning in Shenzhen Qianhai Shekou Free Trade Zone Hospital from June 2022 to February 2023 were retrospectively collected. 20 cases about vertebral compression fracture was found in DECT and MRI (fat suppressed T2WI). The time about patients took DECT and MRI examination from the first day they get injured to 2 weeks after they got fractured. 40KeV images, 70KeV images, 100KeV images, 140KeV images-based on single energy reconstruction technique were reconstructed. On the median sagittal plane of the Water (Ca) pseudo-color image, the fracture bone marrow edema area was identified. According to the edema areas shown by MRI, manually delineated the region of interest. CT values of the edema area of the fractured vertebra and the normal vertebra were recorded at different Single energy. All edema areas of compression fractures were use MRI fat suppressed T2WI sequences as reference. A paired T test was used to compare the difference in CT values between the fractured edema vertebra and the normal vertebra under different single energies. A two-factor ANOVA was used to compare the difference in CT values between oedematous fractured vertebrae and normal vertebrae at four keV sets.

## RESULTS

The CT values of vertebrae with acute fracture edema vertebral bodies compared with normal vertebral bodies measured at 40KeV, 70 KeV, 100 KeV and 140KeV were (691.5Hu Vs 252.9Hu, 319.1Hu Vs 106.1Hu, 222.4Hu Vs 67.9Hu and 183.1Hu Vs 52.5Hu, respectively, all P < 0.001). There was a significant statistical difference in the difference in CT values between the acutely fractured vertebrae and the normal vertebrae (P < 0.001), and with the greatest difference in CT values in the 40KeV image.

## CONCLUSION

The single energy values of 40KeV, 70 KeV, 100 KeV and 140KeV images can differentiate bone marrow edema from normal vertebral body on acute thoracolumbar fracture dual-energy CT scan. The greatest difference in CT value is at 40KeV.

Combined with Water(Ca) material density film, it can provide a more accurate diagnosis of acute thoracolumbar fracture edema.

#### **CLINICAL RELEVANCE/APPLICATION**

The measurement of single-energy reconstruction on dual-energy CT, combined with Water(Ca) material density picture, can improve the clarity of diagnosis of thoracolumbar fractures and bone marrow edema, and also avoid confusion caused by contraindications to MRI examination. This is a valuable aid for both patients and clinical practice.

### **W5B-SPMK-Assessing the Combined Efficacy of Radiofrequency Ablation and Kyphoplasty with Radiation Treatment for Painful Spine Metastases**

Chloe Issa, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To compare kyphoplasty ablation with and without radiotherapy for the treatment of patients with painful metastatic neoplastic disease to the spine.

#### **METHODS AND MATERIALS**

Between 3/2019 and 08/2022, 59 kyphoplasty procedures were performed for palliation of metastatic spine disease. 21 patients (36.2%) with metastatic tumor received radiation in addition to kyphoplasty/RF ablation to palliate pain: 9 patients (47.4%) had prior radiation, 2 patients (10.5%) had concurrent, and 10 patients (1.4%) had radiation therapy after. 37 painful metastatic spinal tumors were treated with kyphoplasty ablation without radiation. The primary neoplastic disease was as follows: multiple myeloma (n=17, 28.8%), breast (n=15, 25.4%), lung (n=7, 11.9%), prostate (n= 6, 10.2%), lymphoma and colorectal (each n= 3, 5.1%), urothelial (n= 2, 3.4%), thyroid, pancreas adenocarcinoma, renal cell, and metastatic adenoid cystic (each n=1, 3.3%). Pain relief was evaluated by the visual analogue scale (VAS) score, disability by the Oswestry Disability Index (ODI), performance status by the Karnofsky Performance Status Scale (KPS) score and ECOG score before and within 3-months after the procedure. The highest documented VAS, ODI, KPSS, and ECOG scores pre- and post-procedure were recorded. A P value < 0.05 was considered statistically significant.

#### **RESULTS**

Technical success was achieved in all patients. Table 1 compares demographics, pre procedural and post procedural pain, disability, and functional scores between the two groups. The median change in VAS, ODI, KPSS, and ECOG scores from baseline to three months was not significantly different between the two groups. There were no major complications.

#### **CONCLUSION**

The study suggests adding radiation therapy to kyphoplasty/RFA for palliation of metastatic neoplastic disease to the spine may not significantly change pain, disability, or performance status scores. Further studies with a larger number of subjects and longer follow-up and prospective design are needed to validate these findings.

#### **CLINICAL RELEVANCE/APPLICATION**

MSK Interventional Radiology - Palliative Spine Intervention

### **W5B-SPMK-Symmetry Plane Analysis for Determination of Vertebral Rotation**

Dillon Haughton, BS (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Accurate vertebral rotation measurements are crucial in the understanding and treating of spinal pathologies. Many methods exist to aid in determining this metric, with the most common and widely accepted method utilizing axial CT scans being the Aaro-Dahlborn method. This method is simple and accurate but is limited due to errors when used by inexperienced users. It only considers one axial cut through the vertebra limiting its accuracy when the vertebra is rotated in sagittal and coronal planes. We propose a new method using symmetry planes calculated by iterative closest point registration and pairwise assignment of curves, as an alternative to the Aaro-Dahlborn method in determining vertebral rotation. Our method considers the entire vertebra and is an automated method applied post segmentation, which would limit operator error.

#### **METHODS AND MATERIALS**

Our method was coded in python utilizing a Jupyter notebook compatible with 3DSlicer. It was tested on segmented vertebrae from the VERSE2020 open-source dataset. 812 vertebrae with no gross pathology were selected from the VERSE2020 database and processed utilizing our method for feasibility analysis. Out of those 812, 96 vertebrae from 8 randomly selected CT scans were divided up among two medical students who performed measurements utilizing the Aaro-Dahlborn method. Correlation-coefficients and Bland-Altman plots were calculated to determine the alignment between the two methods.

## RESULTS

Out of 812 vertebrae analyzed, 799 had their vertebral rotation successfully calculated using our algorithm (98% success rate). Correlation coefficient was calculated at 87% amongst the 96 vertebrae whose vertebral rotation was determined manually against our method. Bland-Altman plotting showed mean difference of -0.51 degrees, a +2 standard deviation of 2.2 degrees and -2 standard deviation of -3.2 degrees.

## CONCLUSION

Our method had similar accuracy to the Aaro-Dahlborn manual method. Our method was also demonstrated to work with a wide variety of normal vertebrae. This provides a quick and efficient means of determining vertebral rotation and can act as an objective reference due to no post-segmentation user input. As segmentation algorithms for individual vertebrae become more accessible and the process is simple manually, we don't see this as a limiting factor to the utility of our method. An extension of our method can also be applied to determining the rotation of vertebrae in both sagittal and coronal planes, which could greatly contribute to our understanding of vertebral movements.

## CLINICAL RELEVANCE/APPLICATION

Improvement in speed and accuracy of methods of determining vertebral rotation will further our understanding of vertebral movements in pathologies such as back pain and scoliosis.

## W5B-SPMK-How Effective is Radiofrequency Ablation with Kyphoplasty at Decreasing Narcotic and Analgesic Requirements in Painful Spine Metastases

Chloe Issa, BS (*Presenter*) Nothing to Disclose

### PURPOSE

To determine the effect of radiofrequency ablation (RF) in conjunction with kyphoplasty on pain relief and analgesic requirements in patients with painful metastatic disease to the spine.

### METHODS AND MATERIALS

Between 3/2019 and 8/2022, 59 kyphoplasty/RF ablations were performed. The median age was 63 years old (IQR, 55-69) with a male-to-female ratio of 0.97. The primary neoplastic diseases were as follows: multiple myeloma (n=17, 28.8%), breast (n=15, 25.4%), lung (n=7, 11.9%), prostate (n= 6, 10.2%), lymphoma and colorectal (each n= 3, 5.1%), urothelial (n= 2, 3.4%), thyroid, pancreas adenocarcinoma, renal cell, and metastatic adenoid cystic carcinoma (each n=1, 3.3%). Pain relief was evaluated by the highest visual analogue scale (VAS) score before and within 3-months after the procedure. The number of non-opioid and opioid pain medications that were taken before, at 1-mo, and 3-mo after the procedure was recorded. A two tailed p value < 0.05 was considered statistically significant.

### RESULTS

Technical success was achieved in all patients. The median VAS score decreased from 10 (IQR, 8-10) to 2(IQR, 0-4) after the procedure (p< 0.001) and 2 (IQR, 2-3) at 3 months after procedure (p < 0.001). Table 1 demonstrates the number (and percentages) of patients who were taking non-opioid and opioid analgesics before the Kyphoplasty/ablation, and at 1-mo and 3-mo after the procedure. Overall, use of opioid medications decreased at 1-mo and 3-mo after the procedure.

### CONCLUSION

RFA in conjunction with kyphoplasty appears to provide meaningful clinical improvement in VAS pain scores and decrease requirements for narcotic medications in patients with metastatic disease to the spine.

### CLINICAL RELEVANCE/APPLICATION

MSK Interventional Radiology - Palliative Spine Intervention

## W5B-SPMK-How Effective is Radiofrequency Ablation with Kyphoplasty at Improving Pain Scores in Burdensome Spinal Metastases

Chloe Issa, BS (*Presenter*) Nothing to Disclose

### PURPOSE

To determine the improvement in pain, performance status and disability index, and the safety of radiofrequency ablation (RFA) in conjunction with kyphoplasty for the treatment of painful metastatic neoplastic disease to the spine.

### METHODS AND MATERIALS

Between 3/2019 and 8/2022, 59 kyphoplasty RFAs were performed. The median age was 63 (IQR, 55-69) with a M:F ratio of 0.97. There were 11 different primary cancers; multiple myeloma was the most prevalent (n=17, 28.8%). Pain relief was evaluated by the Visual Analog Scale (VAS); performance status by the ECOG and Karnofsky Performance Status Scale (KPS),

Disability by the Oswestry Disability Index (ODI). The highest VAS, ECOG, KPS and ODI score pre- and within 3 months post-procedure were recorded. A two-tailed p value < 0.05 was considered statistically significant.

## **RESULTS**

Technical success was achieved in all patients. Within 3 months from the procedure, the median VAS score decreased from 10 (IQR, 8-10) to 2 (IQR, 2-3,  $p < 0.001$ ). The median ECOG performance status score improved from 3 (IQR, 2-3) to 1 (IQR, 1-2) ( $p < 0.001$ ). The median KPS increased from 50 (IQR, 40-60) to 75 (IQR, 62.5-90) ( $p < 0.001$ ). The median ODI decreased from 66.5 (IQR, 49.8-80) to 20.5 (IQR, 13-26) ( $p < 0.001$ ). There were no major complications.

## **CONCLUSION**

RFA in conjunction with kyphoplasty is safe and provides meaningful clinical improvement in VAS, ECOG, KPS, and ODI scores in patients with pain due to metastatic disease to the spine, when measured at post procedure follow-up within 3 months of the procedure.

## **CLINICAL RELEVANCE/APPLICATION**

MSK Interventional Radiology - Palliative Spine Intervention

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## Abstract Archives of the RSNA, 2023

W5B-SPMS

### Multisystem Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPMS-Value of MRI in the Staging of Klippel-Trenaunay Syndrome Complicated with Lower 1 Extremity Lymphedema**

Xingpeng Li (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To investigate the value of MRI in the staging of Klippel-Trenaunay syndrome (KTS) complicated with lower extremity lymphedema.

#### **METHODS AND MATERIALS**

Thirty-four patients who were diagnosed as KTS complicated with lower extremity lymphedema were recruited in this retrospective study from July of 2011 to November of 2021. Referring to the clinical staging standard of lower extremity lymphedema of the international society of lymphology in 2020, all patients were divided into two groups including stable stage and advanced stage. The MRI indexes of the two groups were recorded and were statistically compared: longitudinal involvement range of lymphedema, thickened parts of skin and subcutaneous soft tissue, signs of subcutaneous soft tissue edema (parallel line sign, grid sign, band sign, honeycomb sign, lymph lake sign, crescent sign and star cloud sign).

#### **RESULTS**

Compared with stable stage, patients in advanced stage demonstrated older onset age ( $P < 0.05$ ). For imaging features, the proportion of honeycomb sign are higher in advanced stage than stable stage ( $P < 0.05$ ). While no statistical difference was found in the incidence of parallel line sign, grid sign, band sign, lymph lake sign, crescent sign, star cloud sign, skin and subcutaneous soft tissue thickening, range of lymphedema in lower limbs (all  $P > 0.05$ ). The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of honeycomb sign in the diagnosis of advanced lower extremity lymphedema were 55.00%, 92.86%, 91.67%, 59.09% and 70.59%, respectively.

#### **CONCLUSION**

MRI is of great value in KTS complicated with lower extremity lymphedema. Honeycomb sign is an important imaging index for the diagnosis of advanced KTS complicated with lower extremity lymphedema.

#### **CLINICAL RELEVANCE/APPLICATION**

It is necessary to evaluate the severity of edema with MR for KTS complicated with lower extremity lymphedema, which is very important for therapeutic options.

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## Abstract Archives of the RSNA, 2023

W5B-SPNMMI

### Nuclear Medicine & Molecular Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPNMMI-1 Correlation of FLT PET Findings with Histopathology in the Assessment of Response to Neoadjuvant Chemoradiotherapy in Pancreatic Cancer: Comparison with FDG PET**

Yuka Yamamoto, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Although the role of FDG PET has been proposed in pancreatic cancer, a high percentage of patients have diabetes due to pancreatic cancer. Therefore, the rate of false negative results is high due to elevated plasma glucose levels. On the other hand, 3'-deoxy-3'-18F-fluorothymidine (FLT) is being studied to assess tumor proliferating activity. We evaluated the ability of FLT PET to predict the response to neoadjuvant chemoradiotherapy in pancreatic cancer, in comparison with FDG.

#### **METHODS AND MATERIALS**

FDG and FLT PET/CT studies were performed before and after neoadjuvant chemoradiotherapy in 19 patients with pancreatic cancer. The values of maximum standardized uptake value (SUV<sub>max</sub>) at the primary tumor obtained before and after neoadjuvant chemoradiotherapy are SUV<sub>before</sub> and SUV<sub>after</sub>, respectively. Percent change was calculated according to the following equation:  $(SUV_{before} - SUV_{after}) \times 100 / SUV_{before}$ . In the FDG PET analysis, patients with a blood glucose level of 200 mg/dL or higher at the time of the FDG PET/CT scan were excluded from the analysis. Based on histopathological analysis of the specimens obtained at surgery, the patients were classified as pathologic responders or pathologic non-responders.

#### **RESULTS**

Nine patients were found to be pathologic responders and 10 pathologic non-responders. Three patients were excluded from before therapy FDG PET analysis due to their high blood glucose levels. The FDG SUV<sub>after</sub> in pathologic responders was significantly lower than that in pathologic non-responders ( $p=0.03$ ). The FLT percent change in pathologic responders was significantly higher than that in pathologic non-responders ( $p=0.028$ ).

#### **CONCLUSION**

Based on the results of this preliminary study in a small patient sample, FLT PET seems to be as useful as FDG PET for predicting response to neoadjuvant chemoradiotherapy in pancreatic cancer. FLT PET does not require fasting prior to imaging and is not dependent on blood glucose levels, making it a potentially more convenient technique of evaluation in pancreatic cancer.

#### **CLINICAL RELEVANCE/APPLICATION**

FLT PET does not require fasting prior to imaging and is not dependent on blood glucose levels, making it a potentially more convenient technique of evaluation in pancreatic cancer.

#### **W5B-SPNMMI-2 Textural Indices Extracted from FMISO and FLT PET/CT for Predicting IDH1 Mutation in Newly Diagnosed High-grade Gliomas**

Yuka Yamamoto, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Tumor hypoxia and proliferation have been recognized as determinant factors characterizing tumor aggressiveness in high-grade gliomas. To clarify in vivo hypoxia and proliferation in relation to isocitrate dehydrogenase (IDH) mutation, we retrospectively analyzed texture indices extracted from 18F-fluoromisonidazole (FMISO) PET/CT and 3'-deoxy-3'-18F-fluorothymidine (FLT) PET/CT in newly diagnosed high-grade gliomas.

## **METHODS AND MATERIALS**

Thirty-three patients with newly diagnosed high-grade (WHO grade III and IV) gliomas were included in this study. They underwent both PET/CT studies with FMISO and FLT before surgery. The maximal standardized uptake value (SUVmax) and 31 texture indices were measured. Texture indices were extracted from four different matrices computed for each volume of interest: gray-level co-occurrence matrix, gray-level run length matrix, neighborhood gray-level difference matrix, and gray-level zone length matrix. The PET parameters in relation to IDH1 mutation status were statistically analyzed.

## **RESULTS**

The value of FMISO SUVmax and FLT SUVmax of IDH1-mutant tumors was significantly lower than the corresponding value of IDH1-wildtype tumors. Fifteen of 31 texture indices (Homogeneity, Energy, Contrast, Dissimilarity, Short-run emphasis, Long-run emphasis, Low grey-level run emphasis, High grey-level run emphasis, Short-run low grey-level emphasis, Short-run high grey-level emphasis, Long-run low grey-level emphasis, Run percentage, Low grey-level zone emphasis, High grey-level zone emphasis, and Short-zone high grey-level emphasis) extracted from both FMISO and FLT PET/CT significantly differed between IDH1-mutant tumors and IDH1-wildtype tumors. In addition, 5 texture indices (Entropy, Short-zone low grey-level emphasis, Long-zone low grey-level emphasis, Zone length non-uniformity, and Zone percentage) extracted from FLT PET/CT significantly differed between IDH1-mutant tumors and IDH1-wildtype tumors. In receiver operating characteristic analysis, Entropy extracted from FLT PET/CT was the best discriminative index for predicting IDH1 mutation status.

## **CONCLUSION**

These preliminary results indicate that texture indices extracted from FMISO and FLT PET/CT, especially Entropy extracted from FLT PET/CT, seem to be useful for predicting IDH1 mutation status in patients with newly diagnosed high-grade gliomas.

## **CLINICAL RELEVANCE/APPLICATION**

Texture indices extracted from FMISO and FLT PET/CT, especially Entropy extracted from FLT PET/CT, seem to be useful for predicting IDH1 mutation status in patients with newly diagnosed high-grade gliomas.

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## Abstract Archives of the RSNA, 2023

W5B-SPNPM

### Noninterpretive Skills (Beyond Imaging) Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPNPM-1 Enhancing Patient Communication with Chat-GPT in Radiology: Evaluating the Efficacy and Readability of Answers to Common Imaging-related Questions**

Emile B. Gordon, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To assess ChatGPT's accuracy, relevance, and readability in answering common imaging-related questions and examine the effect of a simple prompt on these parameters.

#### **METHODS AND MATERIALS**

22 imaging-related questions were developed based on previously described categories important to patients: safety, report, procedure, preparation, meaning, and medical staff. Each question was asked three times on the ChatGPT-3.5 platform, both with and without a short prompt which instructed the model to "provide an accurate, and easy-to-understand response that is suited for an average person". Responses were evaluated by four board-certified radiologists for accuracy, consistency and relevance. Readability was assessed by Flesch Kincaid Grade Level (FKGL). Statistical comparisons were performed using chi-square tests, paired student's t-tests.

#### **RESULTS**

264 answers were assessed for both unprompted and prompted queries, resulting in a total of 528 evaluations. The model demonstrated a high degree of accuracy at 83% (218/264), with no significant difference for prompted responses at 87% (229/264,  $P=.2$ ). 72% (63/88) of answers were consistent across all three repeats, increasing to 86% (76/88) when prompted ( $P=0.02$ ). Essentially no responses were irrelevant, scoring at least partially relevant for 99% (261/264) of both sets of responses. Fewer responses were considered fully relevant at 67% (176/264), though this increased significantly to 80% when prompted (210/264) ( $P=.001$ ). The average FKGL was high at 13.6 [12.9-14.2] and did not significantly change with the prompt (13.0 [12.41-13.60],  $P=.2$ ). None of the responses reached the eighth grade readability level generally recommended for patient-facing materials.

#### **CONCLUSION**

ChatGPT demonstrates potential for accurate, consistent, and relevant imaging-related question responses. Readability levels exceed recommendations, reflecting currently available patient education materials. Prompts reduced response variability and yielded more targeted information but did not improve readability, possibly due to limitations in deviating from pre-trained knowledge without more detailed prompting.

#### **CLINICAL RELEVANCE/APPLICATION**

The study demonstrates ChatGPT's potential to increase accessibility to health information and to streamline production of patient-facing educational materials. Addressing readability limitations and employing prompt engineering strategies could optimize ChatGPT for imaging-related patient concerns, but cautious implementation and further research is needed.

#### **W5B-SPNPM-2 Evaluation of Accuracy, Completeness, and Length of Rads-Lit Outputs: A Novel Patient-Facing Artificial Intelligence Literacy Tool**

Rushabh H. Doshi, MPH, MSc (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Radiology reports frequently incorporate intricate medical jargon and lengthy text, which can lead to misunderstandings, anxiety, and erroneous interpretation for patients. By leveraging novel natural language processing (NLP) open-source

technology, we developed a patient-centric tool aimed at simplifying radiology reports. Here, we test the accuracy, completeness, and length of the outputs from our tool.

## **METHODS AND MATERIALS**

We engineered a proof-of-concept patient-facing radiology literacy website by harnessing OpenAI's application programming interface. Our model was specifically configured to optimize the readability of outputs (Flesch-Kincaid Grade Level: 6.68, Gunning Fog: 9.22, Coleman-Liau: 6.16, Automated Readability Index: 8.56). Three radiologists examined 62 radiology reports across modalities such as CT, MRI, X-Ray, PET, and U/S. For each of the 62 reports, the radiologists reviewed the clinical impressions and the corresponding simplified output, and evaluated the output for accuracy, completeness, and extraneous information using single-item Likert-type scales.

## **RESULTS**

Two attending radiologists and one radiology resident assessed 62 Rads-Lit outputs using a five-level Likert scale, ranging from 1 (Strongly Disagree, 0-20% agreement) to 5 (Strongly Agree, 80-100% agreement). The evaluations demonstrated that the Rads-Lit outputs were factually accurate, with a median rating of 5 (80-100% agreement), and the first and third quartiles at 4 (60-80% agreement) and 5 (80-100% agreement), respectively. The outputs were also found to be complete in relation to the original radiologist reports, with a median rating of 5 (80-100% agreement), and the first and third quartiles at 4 (60-80% agreement) and 5 (80-100% agreement), respectively. Furthermore, the radiologists strongly disagreed that the outputs were excessively long or filled with extraneous information, as indicated by median rating, first quartile, and third quartile at 1 (0-20% agreement).

## **CONCLUSION**

Our tool demonstrates promising results, showing that the Rads-Lit outputs frequently maintained factual accuracy and completeness in relation to the original radiologist reports while avoiding being lengthy or containing extraneous information. These findings suggest that the Rads-Lit tool has the potential to improve patient literacy and activation by enhancing the readability of their radiology reports. Further research is necessary to corroborate these findings and assess the broader impact of Rads-Lit on patient populations.

## **CLINICAL RELEVANCE/APPLICATION**

This study evaluates the potential of novel NLP technology to improve patient literacy and health outcomes by reducing anxiety and erroneous interpretations in radiology reports.

## **W5B-SPNPM-3 Which Procedures Bring in the Most Medicare Reimbursement and RVUs for the Individual Diagnostic Radiologist**

Aditya Khurana, MD (*Presenter*) Nothing to Disclose

## **PURPOSE**

To evaluate which specific imaging examinations result in the most wRVUs and reimbursement for individual radiologists serving the US Medicare population.

## **METHODS AND MATERIALS**

Imaging claims 2013-2020 submitted by diagnostic radiologists were extracted from the CMS POSPUF database outpatient imaging claims made for beneficiaries of US Medicare Part B. These data were merged with year specific CMS professional relative value unit (wRVU) files. The total number of wRVUs as well as standardized Medicare reimbursement produced by each imaging procedure, was calculated for each radiologist. For each radiologist, the imaging examination that resulted in the largest number of wRVUs and reimbursement from 2013 to 2020 was determined. The frequency in which each CPT code produced the most wRVUs or reimbursement for an individual radiologist per year was tallied.

## **RESULTS**

In 2013, 5992 individual radiologists (20.3% of all radiologists) produced the largest number of imaging exam specific wRVUs interpreting screening mammography (CPT G0202), followed by CT head without contrast (CPT 70450) for 5866 radiologists (19.8%), CT abdomen and pelvis with contrast (CPT 74177) for 4475 radiologists (15.1%), single view chest radiograph (CPT 71010) for 2542 radiologists (8.6%), and CT abdomen and pelvis with and without contrast (CPT 74176) for 1387 radiologists (4.7%). In 2020, 8095 individual radiologists (25.2% of all radiologists) produced the largest number of imaging exam specific wRVUs from CT abdomen and pelvis with contrast (CPT 74177), followed by screening mammography (CPT 77067) for 5932 radiologists (18.5%), CT head without contrast (CPT 70450) for 4691 radiologists (14.6%), single view chest radiograph (CPT 71045) for 2223 radiologists (6.9%), and MRI brain without and with contrast (CPT 70553) for 1318 radiologists (4.1%). For each year evaluated the order of the five CPT codes that most frequently produced the most Medicare reimbursement for individual radiologists was constant. Screening mammography (G0202/77067) was the most frequent highest reimbursed CPT code across diagnostic radiologists, followed by CT abdomen and pelvis with contrast (CPT 74177), CT head without contrast (CPT 70450), single view chest radiograph (CPT 71010), and MRI brain without and with contrast (CPT 70553).

## **CONCLUSION**

Over time, the same imaging exams have consistently brought in the most reimbursement for the individual radiologist. This study documents the procedures that are likely to be a larger proportion of any radiology practice participating in Medicare.

## **CLINICAL RELEVANCE/APPLICATION**

This data shows which exams are the most important for a practice to generate revenue to maintain quality services for patients.

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## Abstract Archives of the RSNA, 2023

W5B-SPNR

### Neuroradiology Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPNR- A Preliminary 4D Flow MRI Analysis of Blood Flow Characteristics in Cerebral Veins of Adults** **1**

Chihang Dai, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To evaluate blood flow characteristics in the cerebral veins of adults using 4-dimensional flow magnetic resonance (4D Flow MRI).

#### **METHODS AND MATERIALS**

A total of 65 volunteers prospectively underwent 4D Flow MRI and 12 volunteers underwent repeated scans during one month in a single center. Velocity, average blood flow rate (Flowavg), and blood flow patterns of cerebral sinuses were evaluated for each volunteer. The mastoid emissary veins, posterior condylar emissary veins, and oblique occipital sinuses were also evaluated.

#### **RESULTS**

The mean age of volunteers was  $36.31 \pm 11.05$  years old, including 3 (50.8%) females and 32 (49.2%) males. 4D Flow MRI data showed good reproducibility. The velocity and Flowavg of the superior sagittal sinus increased along the direction of flow. Flowavg near torcular herophili were 3.14 times that through the straight sinus. Slight fluctuations were found within a cardiac cycle. A vortex flow pattern was shown in 12.3% of torcular herophili, 7.5% of the transverse-sigmoid junction and 51.3% of jugular bulbs and was associated with increased blood flow velocity/rate in the upstream sinuses. Mastoid emissary veins, posterior condylar emissary veins and oblique occipital sinuses were all drained in the extracranial direction.

#### **CONCLUSION**

Cerebral veins, including venous sinuses and emissary veins, could be measured visually and quantitatively in vivo by 4D Flow MRI. Cerebral veins' velocity varied with segments and showed slight fluctuations within a cardiac cycle. The analysis of cerebral blood flow in healthy volunteers lays the foundation for the study of cerebral venous system diseases.

#### **CLINICAL RELEVANCE/APPLICATION**

4D Flow MRI is a reliable method for the evaluation of hemodynamic characteristics of intracranial venous sinuses. Intracranial venous blood flow, including venous sinuses and emissary veins, could be measured visually and quantitatively in vivo. Individual segments of venous sinuses show characteristic changes in velocity and slight fluctuations within a cardiac cycle were observed. The vortex flow pattern is not uncommon in normal individuals and may be related to increased blood flow in upstream sinuses. The mastoid emissary veins, posterior condylar emissary veins, and oblique occipital sinuses were all drained in the extracranial direction. The approaches used during the current study may enable further hemodynamic research into pulsatile tinnitus, idiopathic intracranial hypertension, vascular malformation and sinus thrombosis.

#### **W5B-SPNR- A New Era in Time-of-Flight MR Angiography: Assessing the Impact of High-Resolution Deep Learning Reconstruction on Intracranial MRA Image Quality** **10**

Masamichi Hokamura (*Presenter*) Nothing to Disclose

#### **PURPOSE**

This study aims to assess the effect of super-resolution deep learning-based reconstruction (SR-DLR), which uses k-space properties, on image quality of intracranial time-of-flight (TOF) magnetic resonance angiography (MRA) at 3T.

## METHODS AND MATERIALS

This retrospective study involved 35 patients who underwent MRA using a 3T MRI system with SR-DLR based on k-space properties in October and November 2022. We reconstructed MRA with SR-DLR (Matrix = 1008 x 1008) and without SR-DLR (Matrix = 336 x 336). We measured the SNR, contrast, and CNR in the basilar artery (BA) and the anterior cerebral artery (ACA) and the sharpness of the posterior cerebral artery (PCA) using the slope of the signal intensity profile curve at the half-peak points. Two radiologists evaluated image noise, artifacts, contrast, sharpness, and overall image quality of the two image types using a 4-point scale. We compared quantitative and qualitative scores between images with and without SR-DLR using the Wilcoxon signed-rank test.

## RESULTS

The SNRs, contrasts, and CNRs were significantly higher in images with SR-DLR than those without SR-DLR ( $p < 0.001$ ). The slope was significantly greater in images with SR-DLR than those without SR-DLR ( $p < 0.001$ ). The qualitative scores in MRAs with SR-DLR were significantly higher than MRAs without SR-DLR ( $p < 0.001$ ).

## CONCLUSION

SR-DLR with k-space properties can offer the benefits of increased spatial resolution without the associated drawbacks of longer scan times and reduced SNR and CNR in intracranial MRA.

## CLINICAL RELEVANCE/APPLICATION

SR-DLR can enhance the image quality of intracranial MRA.

## W5B-SPNR-Super-Resolution Deep Learning-Based Reconstruction in Hippocampal MRI: A Volunteer Study Emphasizing Comparison with Actual High-Resolution Images

Takeshi Nakaura, MD (*Presenter*) Nothing to Disclose

## PURPOSE

The objective of this study is to compare the impact of super-resolution deep learning-based reconstruction (SR-DLR) employing k-space properties and standard-resolution DLR on image quality for thin-slice T2-weighted hippocampal magnetic resonance imaging (MRI).

## METHODS AND MATERIALS

Thirteen healthy volunteers participated in this study, undergoing standard-resolution (Matrix = 320 x 320) and high-resolution thin-slice T2-weighted hippocampal MRI (Matrix = 960 x 960) on a 3-T MRI system. Standard-resolution MRI was reconstructed with and without DLR (Matrix = 320 x 320) and with SR-DLR (Matrix = 960 x 960), while high-resolution MRI was reconstructed with and without DLR (Matrix = 960 x 960). Signal-to-noise ratio (SNR), and contrast and contrast-to-noise ratio (CNR) between white and grey matter in the hippocampus, as well as the slope of the transparent septum, were measured. Two radiologists were asked to rank the image noise, contrast, artifacts, sharpness, and overall image quality of all five protocols. Results of quantitative and qualitative analyses are presented as the median and interquartile range (IQR), and those between standard-resolution MRI without DLR and other protocols were compared using the Wilcoxon signed-rank test with Holm correction.

## RESULTS

The SNRs and CNRs were significantly higher in standard-resolution images with SR-DLR (SNR: 21.01 (IQR:18.17, 29.5); CNR: 7.5 (IQR:6.4, 8.37)) than those without SR-DLR (SNR: 17.22 (IQR:14.46, 19.31); CNR: 7.5 (IQR:6.4, 8.37)) ( $p < 0.001$ ). The SNRs and CNRs were significantly lower in real high-resolution MRIs with DLR (SNR: 10.4 (IQR:9.91, 11.06); CNR: 4.84 (IQR:2.99, 5.43)) or without DLR (SNR: 10.4 (IQR:9.91, 11.06); CNR: 2.24 (IQR:1.43, 2.38)) than those in standard-resolution MRIs without DLR ( $p < 0.001$ ). There were no statistically significant differences in contrast in all protocols ( $p > 0.05$ ). The best ranks were assigned for the standard-resolution images with SR-DLR in all qualitative analyses, and these were significantly better than those of the standard-resolution images without DLR in the sharpness and overall image quality ( $p < 0.01$ ).

## CONCLUSION

In this volunteer study, the technique of enhancing the resolution of standard-resolution hippocampal MRI using SR-DLR demonstrated the potential to provide higher image quality in a shorter acquisition time compared to real high-resolution hippocampal MRI.

## CLINICAL RELEVANCE/APPLICATION

SR-DLR in standard-resolution hippocampal MRI improves image quality, including sharpness and overall quality, compared to actual high-resolution images. This technique offers the potential for higher image quality in a shorter acquisition time, enhancing the clinical utility of hippocampal MRI.

Hiroataka Takita, MD, PhD (*Presenter*) Nothing to Disclose

## **W5B-SPNR- AI-based Virtual Synthesis of Methionine PET from Contrast-Enhanced MRI: Development and External Validation Study**

### **PURPOSE**

To generate synthetic methionine PET images from contrast-enhanced MRI (CE-MRI) through an artificial intelligence (AI)-based image-to-image translation model and to compare its performance for grading and prognosis of gliomas with that of real PET.

### **METHODS AND MATERIALS**

An AI-based model to generate synthetic methionine PET images from CE-MRI was developed and validated from patients who underwent both methionine PET and CE-MRI at a university hospital from January 2007 through December 2018 (Institutional set). Pearson correlation coefficients of maximum and mean tumor-to-normal background uptake (T/Nmax, T/Nmean, respectively) ratios and lesion volume between synthetic and real PET were calculated. Two additional open-source glioma databases of preoperative CE-MRI without methionine PET were the external test set. Using the T/N ratio, the area under the curve of the receiver operating characteristic curve (AUC-ROC) for classifying high- and low-grade gliomas and an overall survival (OS) analysis was evaluated.

### **RESULTS**

The institutional set included 362 patients (mean age, 49±19 years; training=294, validation=34, test=34). In the institutional test set, Pearson correlation coefficients were 0.68 (95% CI: 0.47, 0.81), 0.76 (0.59, 0.86), and 0.92 (0.85, 0.95) for T/Nmax ratio, T/Nmean ratio, and lesion volume, respectively. The external test set included 344 patients with glioma (mean age, 53±15 years; high-grade=269). The AUC-ROC by T/Nmax ratio was 0.81 (95% CI: 0.75, 0.86) and the OS analysis showed a statistically significant difference between high- (two-year survival rate=27%) and low-T/Nmax ratio groups (two-year survival rate=71%;  $P<.001$ ).

### **CONCLUSION**

The AI-based model-generated synthetic methionine PET images strongly correlated with real PET, and showed good performance for glioma grading and prognostication.

### **CLINICAL RELEVANCE/APPLICATION**

Methionine PET is useful for the management of glioma. But radiation exposure and a lack of molecular imaging facilities limit its use. Since CE-MRIs are generally obtained for patients with suspected brain tumors in routine clinical situations, synthetic methionine PET images can be obtained from CE-MRIs without the aforementioned inconveniences or additional examination.

## **W5B-SPNR- Twinkling T2 STAR: Robust Radiomics Features for Reliable Cerebral Microbleeds Classifier**

Hiroki Nakajima, RT (*Presenter*) Nothing to Disclose

### **PURPOSE**

Cerebral microbleeds (MBs) have gained attention due to the increased availability of high-field-strength MR systems, as a higher microbleed burden is associated with an increased risk of ischemic stroke and cerebral hemorrhage. We aimed to identify robust Radiomics features between scans in the T2 GRE sequence and evaluate their diagnostic performance using machine learning-based classifiers.

### **METHODS AND MATERIALS**

We used two cohorts of subjects who underwent T2 GRE imaging in 3T MRI systems. We retrospectively reviewed 20 cases with twice T2 GRE sequences acquired in one examination from 2021 to 2022, and prospectively collected 75 subjects as hold-out test data in 2022. We defined 16x16px regions of interest (ROIs) based on a manual radiologist's annotation of MBs and randomly set up equal numbers of ROIs in other locations. We obtained 91 Radiomics features for these ROIs and measured intra-class coefficients (ICCs) to determine robust features between imaging sessions. Then, we selected seven features with ICCs greater than 0.95 to train and validate a support vector machine (SVM) classifier with the leave-one-out method. Furthermore, a radiologist randomly displayed 16x16px images for the hold-out test group and rated MBs-likeness on a 0-100 continuous variable. We evaluated the diagnostic performance using the area under the ROC curves (AUC) for univariate logistic analysis of each Radiomics feature, SVM classifier, and radiologist.

### **RESULTS**

For ICC evaluation and modeling, we used 212 MBs (432 total ROIs) and 192 MBs (387 total ROIs) for the test group. Regarding the inter-imaging reproducibility, 9 (10%) features had ICCs less than 0.8, and 26 (29%) had ICCs less than 0.9. Seven of the 32 (35%) features with ICCs greater than 0.95 were used to train SVM. In the test group, SVM's diagnostic performance was 0.96 recall, 0.67 precision, and 0.73 accuracy, with an AUC of 0.88 (0.85-0.92). The AUC for SVM was significantly higher ( $P<.01$ ) than the AUC for each feature alone (0.48-0.85) and not significantly lower than the radiologist's AUC of 0.91 (0.89-0.95) ( $P=.15$ ).

## CONCLUSION

We identified robust Radiomic features inter-imaging of the T2 GRE sequence and demonstrated that an SVM classifier with these features had a comparable AUC to the radiologist.

## CLINICAL RELEVANCE/APPLICATION

Assessing reproducibility of Radiomics features between two T2 GRE imaging sessions, we identified robust features and developed an SVM classifier to improve cerebral MB detection, potentially reducing stroke and hemorrhage risk.

## W5B-SPNR- Quantitative Multiparametric MRI and Machine Learning based Model to differentiate 14 Progression from Pseudo-progression in Glioblastoma: Towards Precision Neuro-Oncology

Archith Rajan, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

We hypothesize that radiomic features derived from conventional MRI sequences, diffusion tensor imaging(DTI) and dynamic susceptibility contrast(DSC)-perfusion-weighted imaging(PWI) along with molecular signatures will facilitate accurate distinction of true progression(TP) from pseudoprogression<sup>1,2</sup> (PsP) in glioblastoma(GBM) patients with high accuracy.

### METHODS AND MATERIALS

A cohort of 75 GBM patients exhibiting new/increasing enhancing lesions within 6 months after completion of standard-of-care therapy, were included in this study. These patients were classified as TP (n=55) or PsP (n=20) based on histological features or mRANO criteria<sup>3</sup>. Motion and eddy current corrected DTI derived maps [mean diffusivity(MD), fractional isotropy(FA), coefficient of linear(CL), planar(CP) and spherical anisotropy(CS)] and DSC-PWI derived cerebral blood volume(CBV) map, FLAIR images were co-registered to post-contrast(PC) T1-weighted images. A semiautomatic approach was used to segment contrast-enhancing regions. The median values of DTI metrics and CBV were computed. The CBV values were normalized with contralateral normal brain regions to obtain relative CBV(rCBV). The top 90th percentile rCBV values were also measured(rCBV<sub>90</sub>)<sup>4,5</sup>. O6-methylguanine-DNA-methyltransferase(MGMT) promoter status was noted from all of these patients. To address the issue of imbalanced sample size between TP and PsP, synthetic-minority-oversampling-technique(SMOTE) was applied to augment PsP cases from 20 to 35 resulting in a total sample size of 110. A random forest(RF) algorithm was applied to select the optimized features using a sequential forward feature selection(SFFS) approach. The data were randomly split into training (n=90) and testing (n=20) sets. A 6-fold cross-validation approach was also applied to training dataset. To develop a robust prediction model in distinguishing TP from PsP, several machine learning classifiers were employed. Receiver operating characteristic curve analyses were performed to determine the diagnostic accuracies.

### RESULTS

The best nine diagnostic performances of multiple machine learning algorithms, and feature selection modules are presented in Table 1. RBF support vector machine(SVM) classifier was selected to build the predictive model in distinguishing TP from PsP with a training accuracy of 90.9%, cross-validation accuracy of 85.5% and testing accuracy of 85%.

## CONCLUSION

Machine learning model using multi-parametric MRI and molecular signatures is a promising approach to differentiate TP from PsP in GBM patients.

## CLINICAL RELEVANCE/APPLICATION

Multiparametric MRI combined with machine learning could successfully differentiate True Progression from Pseudoprogression in Glioblastomas.

## W5B-SPNR- Impact of Radiographic Signs of Advanced and Severe Cerebral Venous Thrombosis on the 2 Efficacy of Endovascular Treatments

Mihir Khunte (*Presenter*) Nothing to Disclose

### PURPOSE

To study the benefit of endovascular treatment (EVT) with thrombolytics and/or thrombectomy as a treatment option for cerebral venous thrombosis (CVT) in comparison with conservative medical management.

### METHODS AND MATERIALS

The National Inpatient Sample database 2016-2020 was queried to identify adult patients (18 years or older) with CVT. Patient demographics, medical comorbidities, CVT risk factors, and CVT manifestations were identified. The presence of radiographic signs of advanced and severe CVT (venous stroke, cerebral edema, and intracranial hemorrhage) were recorded. Primary and secondary outcomes were good discharge outcomes and in-hospital mortality, respectively.



## RESULTS

17,130 CVT patients were identified; 945 (5.5%) received EVT. EVT patients were more likely to have strokes (35.4% vs. 21.8%,  $p<0.001$ ), edema (35.4% vs. 20.1%,  $p<0.001$ ), and hemorrhage (37.6% vs. 19.7%,  $p<0.001$ ). After multivariable adjustments, EVT for patients without stroke, edema, or hemorrhage was moderately associated with higher odds of good outcomes (OR 1.86 [95%CI 0.98 - 3.53],  $p=0.059$ ) and resulted in zero deaths. However, with increasing burden of radiographic signs of advanced CVT measured by the cumulative presence of stroke, edema, and hemorrhage, EVT was associated with decreasing odds of good outcomes and increasing odds of in-hospital mortality compared to medical management (interaction  $p=0.046$  and  $0.029$ , respectively).

## CONCLUSION

EVT may be beneficial for patients who have not yet developed overt parenchymal manifestations of backpressure changes, and the presence of stroke, edema, and hemorrhage may diminish the comparative effectiveness of EVT over medical management.

## CLINICAL RELEVANCE/APPLICATION

EVT may be beneficial in subset of patients with CVT who lack radiographic signs of advanced and severe CVT such as venous stroke, cerebral edema, and intracranial hemorrhage.

## W5B-SPNR- Associations of Quantitative and Qualitative Intracranial Aneurysm Wall Enhancement Indices to Wall Instability and Risk Stratification Scores

Abhinav Patel, MBBS (*Presenter*) Nothing to Disclose

## PURPOSE

The mortality and morbidity among patients with ruptured Intracranial Aneurysms (IAs) remain as high as 50% despite the low incidence of IAs (3-50/100000). The PHASES score was established to quantify IA rupture risk, whereas the ELAPSS score was established to quantify risk of growth in IA size. MR-Vessel Wall Imaging (VWI) has gained popularity in assessing a number neurovascular diseases including IAs. Aneurysm wall enhancement (AWE) is utilized as a marker of wall instability. We evaluate two distinct quantified measures of post-contrast T1-SPACE AWE in conjunction with the PHASES and ELAPSS scores as a sign of wall instability.

## METHODS AND MATERIALS

We conducted an IRB approved study of patients with unruptured IAs scanned using VWI protocol between January 2018 to December 2022. AWE was evaluated qualitatively and quantitatively on T1-SPACE sequences. IA Wall Morphology (IAWM) was evaluated on catheter angiography. Quantified AWE values were obtained using 3-point ROIs on the IA wall and normalized with white matter signal intensity obtained using 10 mm circular ROIs. Percentage change in normalized AWE from pre to post contrast imaging was calculated. Furthermore, a ratio of post-contrast quantified AWE to post-contrast pituitary infundibulum (PI) signal intensity (AWPI ratio) was also calculated. Pearson correlation test, and unpaired t-tests were used to assess statistical correlations in SPSS v28. P-value was set at 0.05.

## RESULTS

We evaluated 271 IAs in 219 patients (Age: 63.31 +/- 13.17, 24-89, 165 female). The mean size of IAs was 5.12mm +/- 3.91 mm, 2-30 and the mean PHASES score was 4.31 +/- 2.73, 0-16. Qualitatively, AWE was seen in 141 (52%) IAs and irregular IAWM in 132 (48.7%). PHASES score showed a moderately strong correlation to AWPI ratio,  $r = 0.439$ , and to percentage increase in AWE,  $r = 0.334$ . ELAPSS score also showed a moderately strong correlation to AWPI ratio,  $r = 0.487$  and percentage increase in AWE,  $r = 0.367$ . AWPI ratio showed as stronger correlation than percentage increase to both PHASES and ELAPSS scores. The mean PHASES and ELAPSS scores for IAs with AWE were 5.36 and 18.48 whereas in IAs without AWE, these scores calculated to be 3.31 and 10.93, respectively, ( $p<0.001$ )

## CONCLUSION

Our findings demonstrates a correlation between increased AWPI, Percentage Increase and higher PHASES score, ELAPSS score .

## CLINICAL RELEVANCE/APPLICATION

The results of this finding suggests a possible use of both qualitative and quantitative evaluation of AWE, particularly an increased AWPI ratio as a marker of wall instability. This could be utilized to evaluate the progression of wall instability and to guide therapeutic intervention.

## W5B-SPNR- Impact of White Matter Hyperintensities on Structural Connectivity and Cognition in Cognitively Intact Older Adults

Mohammad Taghvaei, MD, MPH (*Presenter*) Nothing to Disclose



## PURPOSE

White matter hyperintensities (WMH) on T2-weighted fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) are nearly ubiquitous in aging. Prior studies suggest that both the volume and the spatial distribution of WMH lesions are predictive of cognitive performance decrements. WMH lesion burden has also been associated with both the severity and progression rate of Alzheimer's pathology. We used indirect brain mapping with virtual lesion tractography in older control subjects from the Alzheimer's Disease Neuroimaging Initiative (ADNI) study to test the hypothesis that the extent of specific white matter (WM) tract disconnection due to WMH is associated with corresponding cognitive performance decrements.

## METHODS AND MATERIALS

Demographic information, structural MRI data, PET imaging, neuropsychological test scores, and CSF analysis from 481 cognitively intact ADNI subjects were obtained. WMH lesions mask were extracted from the FLAIR MRI of these subjects and applied as a region of avoidance for fiber tracking in 50 Human Connectome Project (HCP) subjects' diffusion MRI data to estimate tract disconnection caused by each WMH lesion mask for 8 WM pathways. The direct relationship of global WMH lesions burden or tract disconnections with performance in specific cognitive domains, as well as the mediation effect of specific tract disconnection on WMH lesion related cognitive performance decrement in the corresponding domain were assessed.

## RESULTS

Global WMH lesion burden was significantly associated with global cognitive measures ( $p=0.011$ ), episodic memory ( $p=0.015$ ), executive function, and processing speed ( $p=0.018$ ). Further, estimated tract disconnection in the right inferior fronto-occipital fasciculus, right frontal aslant tract, right inferior longitudinal fasciculus, and right superior longitudinal fasciculus disconnection mediated the effect of WMH lesion volume on executive function, the left uncinate fasciculus disconnection mediated the effect of WMH lesion volume on memory, and the right frontal aslant tract disconnection mediated the effect of WMH lesion volume on language.

## CONCLUSION

Tract-specific disconnections caused by WMH lesions mediate cognitive domain-specific decrements in cognitive performance in cognitively intact older adults.

## CLINICAL RELEVANCE/APPLICATION

The spatial distribution of WMH lesions and the extent of particular WM tracts involvement by them could predict decrement in corresponding cognitive domains.

## W5B-SPNR- Hyperintensities in the Anterior Portion of the Callosal Splenium on FLAIR: A Large Cohort Study

Sera Kasai (*Presenter*) Nothing to Disclose

## PURPOSE

Although hyperintensity in the anterior portion of the callosal splenium on FLAIR (aCS-hyperintensity) is a common finding in elderly adults (Figure), no previous studies with large sample sizes have examined the clinical significance of the aCS-hyperintensity. In this large elderly population study, we aimed to investigate the associations of aCS-hyperintensity with cerebro- and cardiovascular risk factors and cognitive decline. In addition, to illustrate the probable mechanism thereof, we compared the clinical significances of the aCS-hyperintensity with those of the other MRI measurements.

## METHODS AND MATERIALS

This cross-sectional study included 2,110 participants (median age, 69 years; 61.1% females) who underwent 3T MRI. The participants were grouped as 215 with mild cognitive impairment (MCI) and 1,895 cognitively normal older adults (NOAs). Two neuroradiologists evaluated aCS-hyperintensity by using a four-point scale (none, mild, moderate, and severe) (Figure). Periventricular hyperintensities (PVHs) were also rated on a four-point scale according to the Fazekas scale. The total intracranial volume (ICV), total brain volume, choroid plexus volume (CPV), and lateral ventricle volume (LVV) were calculated.

## RESULTS

For the cerebro- and cardiovascular risk factors, the logistic regression analysis showed that diabetes was the main predictor of aCS-hyperintensity after adjusting for potential confounders (age, sex, hypertension, hyperlipidemia, BMI, smoking status, alcohol frequency, and medical history) ( $p < 0.01$ ). On the other hand, PVH was associated with a presence of hypertension ( $p < 0.01$ ). The aCS-hyperintensity rated as "severe" was associated with a presence of MCI. The logistic regression analysis for the imaging factors showed that PVH was significant independent predictor of aCS-hyperintensity ( $p < 0.01$ ). The LVV was also an independent predictor of aCS-hyperintensity when brain volume and PVH grade was added to the analyses ( $p < 0.01$ ).

## CONCLUSION

Cerebral small vessel disease due to diabetes is a major contributor to the development of aCS-hyperintensity. Cerebrospinal fluid clearance failure may also relate to aCS-hyperintensity, which may offer new insights into the pathologic processes underlying MCI.

## CLINICAL RELEVANCE/APPLICATION

Although aCS-hyperintensity is a common finding in elderly adults, its severity may associate with cerebral small vessel disease due to diabetes and MCI presence.

## W5B-SPNR- Radiological and Clinical Characteristics of N<sub>2</sub>O Related Myeloneuropathy: A Multicenter Study

Paula Heredia Cacha, MD (*Presenter*) Nothing to Disclose

### PURPOSE

The aim of this work is to report the clinical and imaging features of nitrous oxide (N<sub>2</sub>O) recreational abuse related myeloneuropathy.

### METHODS AND MATERIALS

We conducted a retrospective multicenter study. The inclusion criteria were: (i) neurological symptoms, (ii) history of recreational N<sub>2</sub>O abuse, (iii) myeloneuropathy on MRI. The exclusion criteria were: (i) other causes of myelopathy (ii) absence of strong temporal association with N<sub>2</sub>O consumption. Demographic, clinical and laboratory data were collected. Imaging patterns, treatments and patients' outcomes were analyzed.

### RESULTS

We included 40 patients (age: 24 ± 4 years; 18 ?) from 8 tertiary care centers. The study period was from December 2020 to April 2023. A chronic consumption (at least weekly for = 3 months) of N<sub>2</sub>O was present in 77% of the patients (26/34). All patients (40/40) presented with paresthesia, 36/36 with distal onset. Other main complaints were unsteady gait (38/40; 95%) and limb weakness (23/40; 58%). When measured, homocysteine level was elevated (32/33; 97%), while vitamin B12 level was mostly normal (20/34; 58%). Nerve conduction studies were often altered (23/32; 72%). Typical MRI features of subacute combined degeneration (SCD) of the spinal cord in cervical and upper thoracic cord were often seen (35/40; 86%, fig. 1A). Contrast enhancement of SCD was present in 5/35 of the patients (14%, fig. 1B). In 3 patients, a brain MRI was performed in first place for ataxia and 3D-FLAIR sequence suggested upper cervical abnormalities in its lowest slices (Fig. 1C). Atypical MRI findings (5/40) consisted of (i) cone involvement associated with exclusively lateral columns involvement (1/5, fig. 1D) and (ii) abnormally extensive lesion to lower thoracic cord (4/5; fig. 1F). 20% (7/35) of patients showed cauda equina roots enhancement (Fig. 1E). Patients were treated mainly with vitamin B12 supplementation (36/38; 95%). When follow-up information was present (12/40), recovery was slowly progressive, with persistent paresthesia (10/12; 80%).

### CONCLUSION

N<sub>2</sub>O-induced myeloneuropathy, mostly due to functional vitamin B12 deficiency, typically appears on MRI as SCD involving the cervical and upper thoracic cord. However, atypical radiological findings exist, and cauda equina roots enhancement is possible, even though not described yet in literature. In addition, cerebral MRI can pinpoint the correct diagnosis when not suspected.

## CLINICAL RELEVANCE/APPLICATION

N<sub>2</sub>O is a popular recreational drug among young adults. Social awareness on N<sub>2</sub>O side effects is poor and clinicians lack on information on vitamin B12 deficiency-related myeloneuropathy, a common N<sub>2</sub>O toxic effect.

## W5B-SPNR- 3D SPACE MRI of the Transverse Ligament in Whiplash Associated Disorder

Bo Mi Chung, MD (*Presenter*) Nothing to Disclose

### PURPOSE

To describe the 3D SPACE MRI findings of transverse ligament (TL) in whiplash associated disorder (WAD), and to compare them with nontraumatic group.

### METHODS AND MATERIALS

Cervical spine MRIs were retrospectively analyzed including 46 patients with WAD and 62 patients in the nontraumatic group. Axial 2D T2-SPACE images were used for image analysis. The symmetry of lateral atlantodental interval (LADI) and the morphology grade of TL was evaluated by two radiologists, using a four-point scale (0 = homogeneous low SI with normal thickness, 1 = high SI with normal thickness, 2 = reduced thickness, 3 = full-thickness rupture or indistinguishable from surrounding structures). The presence of atlantoaxial instability and the number of cervical levels with degeneration was evaluated.

## RESULTS

Among the WAD patients, 17% showed asymmetric LADI and 39% showed high-grade TL morphology grade (grade 2 or 3). The high-grade TL change group had a significantly higher mean age than the low-grade group. There was no significant difference in WAD stage or grade between the high-grade and low-grade TL change groups. High-grade TL changes were significantly more frequent in the WAD group compared to the nontraumatic group, and the number of degenerative levels was lesser in the WAD group. Logistic regression analysis revealed that a lesser number of degenerative levels and high-grade TL changes were independent predictors for WAD.

## CONCLUSION

High-grade TL changes were significantly more frequent in the WAD group compared to the nontraumatic group.

## CLINICAL RELEVANCE/APPLICATION

The evaluation of TL using 3D SPACE MRI sequence can be useful in the evaluation and management of the WAD patients.

## W5B-SPNR- Predicting Outcome of the Epidural Blood Patch in Spontaneous Intracranial Hypotension by using an Artificial Intelligent Aided Quantitative MRI Approach

Jyhwen Chai, MD, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Spontaneous intracranial hypotension (SIH) is a disorder of spinal CSF leakage with uncertain pathogenesis that presents challenges in reliable diagnosis and treatment. Though epidural blood patching (EBP) is commonly used, response rates are variable and predictors are lacking. In this study, we aimed to predict the outcome of EBP treatment in SIH patients using a quantitative MRI approach aided by artificial intelligence (AI).

## METHODS AND MATERIALS

We recruited 30 SIH patients with typical orthostatic headache and characteristic MRI findings of spinal CSF leakages, and 26 healthy volunteers. In addition to brain MRI, we used retrospective ECG-gated cine phase-contrast (PC) sequences to measure fluctuating CSF flow, and a heavy 3D-T2WI of the whole spine to identify CSF leakage and quantify spinal CSF volume. We used YOLO algorithms of AI models for object detection and semantic segmentation of CSF space on spine images, and a pulsatility-based segmentation (PUBS) method combined to measure CSF flow dynamics in the cine PC-MRI.

## RESULTS

Our results showed that SIH patients had significantly lower mean and peak CSF flux at the level of the 2nd cervical spine and a smaller volume of whole spinal CSF compared to healthy volunteers. The optimal cut-off values to distinguish the two groups were 1.00 ml/s and 3.53 ml/s for mean and peak flux, respectively, with the best AUC of 0.821 and 0.833 ( $p < 0.001$ ). The cut-off value of whole spinal CSF volume was 64.9 ml/s with the AUC of 0.694 ( $p < 0.05$ ). Using these two cut-off values of CSF flux, we divided 25 of 30 SIH patients accepting EBP into two groups based on high and low CSF flow dynamics one week after treatment. 25 of 30 SIH patients who underwent EBP were divided into high and low CSF flow dynamics groups. Of the 13 patients with high CSF flow dynamics and much improvement in orthostatic headache, 10 received one EBP and 3 received two. Nine of the 12 patients with low flow dynamics and persistent symptoms required more than two EBPs.

## CONCLUSION

Our study suggests that CSF flow parameters in the upper cervical spine are more sensitive than spinal CSF volume measurement in detecting early pathophysiological alterations in SIH patients after EBP treatment. AI-aided quantitative MRI has the potential to effectively predict the treatment response of EBP in SIH patients.

## CLINICAL RELEVANCE/APPLICATION

AI-aided quantitative MRI could be an effective tool for predicting the treatment response of epidural blood patching in patients with spontaneous intracranial hypotension (SIH).

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## Abstract Archives of the RSNA, 2023

W5B-SPOB

### OB/Gynecology and Pediatric Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPOB- The Application of Radiomics in Predicting Intraoperative Massive Bleeding in Cesarean Scar Pregnancy Patients**

Feng Gao (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To develop a comprehensive model based on MRI radiomics signatures and independent risk factors for predicting the risk of intraoperative massive bleeding in cesarean scar pregnancy (CSP) patients.

#### **METHODS AND MATERIALS**

In total, 119 patients with CSP who underwent surgery were retrospectively reviewed. According to surgical records, intraoperative bleeding greater than 100ml was defined as intraoperative massive bleeding. All subjects were randomly separated into the training and testing sets at a ratio of 7:3. The radiomics signatures from the gestational sac (GS) and decidua (DEC) regions were respectively extracted in T2WI. Variance analysis, univariate correlation analysis (cutoff = 0.7), general univariate analysis and Gradient Boosting Decision Tree (GBDT) selection were performed orderly to select features. Seven image geometric features and eight clinical features were recorded and analyzed. Information with statistically significant differences was utilized in conjunction with the selected radiomics features to construct predictive models via the logistic regression model. Models were evaluated through ROC and AUC analysis. Decision curve analysis (DCA) evaluated the clinical usefulness of the constructed models, while Delong's test compared performance differences.

#### **RESULTS**

Thirty-seven patients suffered intraoperative massive bleeding and 82 patients did not. Five, eight, and nine radiomics features were selected from DEC, GS, and DEC+GS cohort, respectively. Seven features were statistically differently between GS and DEC (all  $p < 0.05$ ), and were included into the model as predictive features. AUCs of test datasets were 0.856, 0.843, and 0.846 for DEC, GS, and DEC+GS, respectively. Calibration curves with H-L test  $p$  values  $> 0.05$  showed good fitness for all three models. Delong's tests revealed no statistical differences among AUCs, indicating similar predictive abilities of the models. DCA showed that blood loss prediction models are beneficial when threshold probability ranges from 0.02 to 0.78.

#### **CONCLUSION**

A prediction model composed of T2WI-based radiomics features, image geometric features and clinical parameters could be applied to guide the gynecologists assess the risk of intraoperative bleeding in CSP patients before surgery.

#### **CLINICAL RELEVANCE/APPLICATION**

CSP refers to an ectopic pregnancy in which the GS is implanted into the scar of a previous cesarean section uterine incision. It may cause uncontrollable bleeding, uterine rupture, and even require hysterectomy during surgery. Our combined prediction model can preoperatively, accurately, and noninvasively identify high-risk individuals. For these high-risk individuals, preoperative intervention can be taken to avoid the massive bleeding.

#### **W5B-SPOB- Accelerated Three-dimensional Susceptibility Weighted Imaging of the Whole Spine of Fetus at 3T**

Ziyan Sun, MD, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The aims of this study were to evaluate the image quality, vertebral visibility and diagnostic performance in suspected fetal vertebral pathologies of three-dimensional (3D) susceptibility weighted imaging (SWI) of the whole spine column at 3T magnetic resonance imaging (MRI) and compared these with those of conventional protocol and ultrasonography (US).

## METHODS AND MATERIALS

A total of 37 pregnant women (gestation age 22 to 39 weeks, average  $29 \pm 3$  weeks) with suspected fetal vertebral anomalies by ultrasound (US) screening underwent 3.0T MR imaging with 3D SWI, conventional two-dimensional (2D) half-fourier acquisition single-shot turbo spin-echo (HASTE) and 3D true fast imaging with steady-state precession (True FISP). The acquisition time of each protocol was recorded. Signal-to-noise ratios (SNRs) and contrast-to-noise ratios (CNRs) were determined in representative interest regions of fetal thoracic vertebrae and compared among three pulse sequences. Two radiologists rated image quality independently in random order on a 5-point scale. Kappa coefficients were computed to assess inter-observer reliability. Receiver operating characteristic curves were generated, and the area under the curve (AUC) was used to compare the diagnostic performance of each protocol in vertebral deformities.

## RESULTS

The acquisition time was 15 s for 3D-SWI and 17 s for 3D True FISP, significantly shorter than conventional HASTE (37 s; both  $P < 0.01$ ). Of the three protocols, The SNR was highest on 3D True FISP, while the CNR was highest on 3D SWI. Visualization of all segments of the whole spine by 3D SWI was comparable with 3D True FISP. In contrast, 3D SWI and 3D True FISP depicted cervical and sacrococcygeal vertebrae better than HASTE. The weighted kappa statistic was 0.70-0.89 to evaluate the image quality of all segments of the whole spine, indicating good to excellent interobserver agreement. 3D SWI had the highest diagnostic performance for detecting fetal vertebral anomalies (AUC = 0.92).

## CONCLUSION

3D-SWI is feasible for improved visualization of the whole fetal vertebral column and their congenital malformations with adequate image quality, thereby providing a supplementary method to conventional MR imaging.

## CLINICAL RELEVANCE/APPLICATION

Our preliminary results suggest that 3D-SWI enables superior 3D visualization of 3D sequences take an advantage in display of the overall structure of the spine compared with conventional 2D sequences. A potential use of the 3D sequence is to define the degree of scoliosis or precise localization of deformed vertebrae. 3D sequences could be a useful addition to the routine examination of the fetal vertebrae, facilitating the incorporation of this technique into routine patient studies.

## W5B-SPOB- Doppler Ultrasound Gated Fetal Cardiac MRI in an Unselected Population: A Clinical Feasibility Study

Roland Cronenberg, MD (*Presenter*) Nothing to Disclose

## PURPOSE

Doppler ultrasound-based gating of fetal cardiac MRI has shown promising results in late pregnancy but has not been tested in younger fetuses <26 weeks of gestation in a clinical setting yet. The aim was to investigate the feasibility of ultrasound-gated fetal cardiac imaging in clinical routine during whole-body-MRI and the association of image quality with gestational age.

## METHODS AND MATERIALS

We included 23 singleton pregnancies with clinical indication for fetal whole-body-MRI with and without suspected cardiac anomalies. Standard protocols for body and CNS MRI were performed, followed by gated cine-balanced steady state free precession sequences of the fetal heart in three planes (four-chamber-view (4C), short (2S) and long (2L) axis two-chamber-views). Image quality was rated "good" if there was depiction of both atria and ventricles in the four-chamber-view, and of the left atrium and ventricle in the long and short axis two-chamber view without artifacts. In case of displaced planes or artifacts but possible identification of cardiac anatomic structures, image quality was rated as "moderate". If no recognizability was given, images were rated "non diagnostic". Image quality was correlated with gestational week (GW) groups (GW <26, GW 26-31, GW >31).

## RESULTS

We evaluated a total of 69 cardiac MRI sequences in 23 fetuses (70% with and 30% without suspected cardiac anomalies; GW <26: 30.4%, GW 26-31: 30.4%, GW >31: 39.1%; mean:  $28+6$  GW  $\pm$  30.4 days). Overall, image quality was "good" in 31 (45%) of the cardiac sequences and "moderate" in 21 (30%). Seventeen (25%) were "non diagnostic". Differences in image quality were significant between the cardiac planes ( $p=.013$ ) with best quality of the 2S and poorest quality of the 2L. Highest image quality was found in the youngest fetuses <26 GW ("good" in 57%, "moderate" in 19%, "non diagnostic" in 24%); followed by fetuses >31 GW ("good" in 48%, "moderate" in 41%, "non diagnostic" in 11%) and fetuses between 26 and 31 GW ("good" in 29%, "moderate" in 29%, "non diagnostic" in 43%). There was no significant difference between age groups ( $p=.158$  for 4C,  $p=.595$  for 2S,  $p=.178$  for 2L).

## CONCLUSION

Doppler ultrasound gated fetal cardiac MRI with diagnostic quality in 75% of cardiac planes is feasible during clinical routine whole-body-MRI already in the second trimester of pregnancy. Image quality is not associated with gestational age.

## CLINICAL RELEVANCE/APPLICATION

Fetal cardiac MRI in the second and third trimester of pregnancy could be included in a whole-body MRI protocol as a complementary imaging method to echocardiography in congenital heart disease when ultrasound conditions are limited.

## W5B-SPOB- Automatic Quantification of Fetal Brain Gyrfication Based on MRI in Control and in Fetuses with Polymicrogyria and Lissencephaly<sup>4</sup>

Dafna Ben Bashat, PhD (*Presenter*) Nothing to Disclose

### PURPOSE

Current imaging assessment of fetal brain gyrfication is performed qualitatively and subjectively using both ultrasound and MRI. A few previous studies suggested methods for quantification of fetal gyrfication based on 3D reconstruction of MRI, which requires unique data and is time-consuming. In this study, we aimed to develop an automatic pipeline for gyrfication assessment based on routinely acquired fetal MRI 2D data, quantify normal changes with gestation, and measure differences in fetuses with lissencephaly and polymicrogyria compared with controls (fetuses with normal gyrfication).

### METHODS AND MATERIALS

Coronal T2 weighted MRI data of 162 fetuses retrospectively collected from two clinical sites were included: 134 control fetuses, 12 with lissencephaly, 13 with polymicrogyria, and three suspected with lissencephaly based on ultrasound, yet with normal MRI diagnosis. The developed automatic pipeline included brain detection, brain component segmentation and identification of the right and left hemisphere, and calculating five gyrfication parameters separately for each hemisphere based on the area and ratio between the contours of the cerebrum and its convex hull.

### RESULTS

In control fetuses, all parameters were changed significantly along gestational age ( $p < 0.05$ ), providing developmental curves on a wide range of gestation (27-37 weeks). Compared with controls, fetuses with lissencephaly showed significant reductions in all gyrfication parameters ( $p = 0.02$ ). Similarly, but less pronounced, significant reductions were detected for fetuses with polymicrogyria in several parameters ( $p = 0.001$ ). The three suspected fetuses showed normal gyrfication, supporting MRI diagnosis.

### CONCLUSION

This study presents a pipeline for automatically quantifying fetal brain gyrfication and provides normal developmental curves from a large cohort. These curves differentiated fetuses with lissencephaly and polymicrogyria significantly, demonstrating lower values. The method may aid radiological assessment and improve the early identification of fetuses with cortical malformation.

## CLINICAL RELEVANCE/APPLICATION

The method suggested in this study provides a quantitative assessment of fetal brain gyrfication, and can aid radiological diagnosis and improve early identification of fetuses with cortical malformation.

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## Abstract Archives of the RSNA, 2023

W5B-SPPD

### Pediatric Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPPD- Deep-learning Reconstruction for Reducing Slice Thickness and Radiation Dose in Pediatric CT: Matched Pair Comparisons with Standard Dose Thick Slice Iterative Reconstruction**

Ryota Harai (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Low-dose and thin-slice image acquisition is desirable for pediatric CT, but increased image noise can compromise image quality and diagnostic confidence. Deep learning reconstruction (DLR) may be a promising technique to simultaneously reduce radiation dose and slice thickness due to its excellent noise reduction performance. This study aimed to compare the image quality between standard-dose, thick-slice (3 mm) hybrid iterative reconstruction (HIR) and low-dose, thin-slice (0.5 mm) deep-learning reconstruction DLR in pediatric CT.

#### **METHODS AND MATERIALS**

This retrospective study included 76 children (=6 years) who underwent 80-kVp contrast-enhanced CT using standard dose (n=38) and low dose (n=38) protocols on a 320-row scanner. Patient age and body weight were matched between the standard and low dose groups. The standard dose images were reconstructed at a 3 mm slice thickness using the HIR algorithm; the lower dose images were reconstructed at a 0.5 mm slice thickness using the HIR and DLR algorithms. The size-specific dose estimate (SSDE) was compared between groups. For quantitative image analysis, image noise and contrast-to-noise ratio (CNR) at the hepatic parenchyma, abdominal aorta, and portal vein were quantified. For qualitative assessment, noise magnitude, noise texture, edge sharpness, partial volume effect, artifacts, and diagnostic confidence were subjectively rated on a four-point scale.

#### **RESULTS**

There were no significant differences in age ( $24.1 \pm 23.0$  vs.  $24.2 \pm 23.0$  months,  $p=0.98$ ) and body weight ( $9.9 \pm 4.6$  vs.  $10.2 \pm 5.8$  kg,  $p=0.80$ ) between the standard and low dose groups. The SSDE of the low dose group was 60% lower than that of the standard dose group ( $3.3 \pm 0.9$  vs.  $8.3 \pm 1.6$  mGy,  $p<0.01$ ). DLR considerably reduced the quantitative image noise and improved CNR and subjective image quality of the low dose 0.5 mm images compared to HIR (all,  $p<0.001$ ). Compared to the standard dose 3 mm HIR images, the low dose 0.5 mm DLR images showed significantly lower quantitative image noise ( $p=0.02$ ) and equivalent CNR in all structures analyzed (all,  $p>0.11$ ). The low dose 0.5 mm DLR images achieved superior subjective scores for diagnostic confidence compared to standard-dose 3 mm HIR images ( $p<0.01$ ).

#### **CONCLUSION**

In pediatric CT, the application of DLR to low-dose thin-slice (0.5 mm) images can yield equivalent or even better subjective and objective quality compared to standard-dose thick-slice (3 mm) HIR images.

#### **CLINICAL RELEVANCE/APPLICATION**

DLR allows reduction of both radiation dose and slice thickness in pediatric CT without increasing image noise and degrading the subjective image quality compared to the HIR algorithm.

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## Abstract Archives of the RSNA, 2023

W5B-SPPH

### Physics Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPPH- Extending Coronary Calcium Scoring to New Protocols using a Specificity Criterion**

1

Scott Hsieh, PhD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

Coronary calcium is scored today using the Agatston algorithm, which was devised for 3-mm thick slices at 120 kVp. Scanners today offer protocols with thinner slices, better in-plane resolution, lower kVp, different mAs, advanced reconstruction, or new technologies such as multi-energy or photon counting detector CT. A framework is desired to adapt the Agatston algorithm threshold to these variations while maintaining an acceptable false positive rate. We propose to do this directly by imposing a specificity criterion. Because our interest is in detecting smaller calcifications, we do not impose a minimum size criterion.

#### **METHODS AND MATERIALS**

For each scan, we select a series of control regions (2 ml each, matching the volume of the coronary arteries) in a nearby, uniform anatomic area or in an anthropomorphic phantom of matched patient size and protocol. The 95th percentile of the maxima of these control regions is selected as the scoring threshold to ensure a Type I error rate of 5%. An adjustment is made for the mean difference in CT number between the control regions and coronary arteries, if any. We tested this framework on numerical simulations and an anthropomorphic phantom with 10 small calcifications (from 0.4 to 0.8 mm in size) that was scanned with different energy integrating detector CT (EID-CT) or photon counting detector CT (PCD-CT) protocols, all at matched dose.

#### **RESULTS**

In numerical simulations, our framework selected CT thresholds between 74 to 212 HU depending on the dose level and reconstruction kernel used. Higher doses improved sensitivity, but all scans had equivalent specificity. The sharper kernel increased sensitivity for small, bright calcifications but decreased sensitivity for large, less bright calcifications because the threshold increased with sharpness. In the anthropomorphic phantom, with a medium-sharp Qr54 EID-CT with 0.6 mm thick slices, a threshold of 410 HU was selected, and sensitivity was 40%. With a sharper Qr66 kernel, the threshold increased to 1015 HU and the sensitivity fell to 30%. With PCD-CT and a Qr68 kernel, the threshold decreased to 357 HU threshold because of the higher resolution capability of PCD-CT and sensitivity increased to 90%. No false positives were seen in these cases.

#### **CONCLUSION**

A specificity criterion provides a disciplined approach for selecting an Agatston scoring threshold. This allows objective detection of coronary calcium in new protocols and was demonstrated on high resolution protocols from PCD-CT.

#### **CLINICAL RELEVANCE/APPLICATION**

Coronary calcium scoring algorithms must be modified to take advantage of new scanner capabilities. We provide a general framework for making modifications that is especially useful for new, higher resolution CT protocols.

#### **W5B-SPPH- Impact of Deep Learning Reconstruction on Radiation Dose Reduction and Cancer Risk in CT Examinations: A Real-World Clinical Analysis**

10

Naoki Kobayashi, MD (*Presenter*) Nothing to Disclose

#### **PURPOSE**

The purpose of this study is to estimate the degree to which the introduction of Deep Learning Reconstruction (DLR) into clinical settings may reduce the radiation dose and the risk of radiation-induced cancer from CT examinations, utilizing real-



world clinical data.

## **METHODS AND MATERIALS**

In our institution, we retrospectively collected scanning information for two distinct periods based on the date of DLR implementation: the 12 months immediately prior to the introduction of DLR, when iterative reconstruction (IR) was used for routine CT, and the 12 months following the implementation of DLR, when the routine CT reconstruction was switched to DLR. Inclusion criteria consisted of adult patients (aged 20 to 100 years) who underwent body CT during this period on specific CT units where DLR was introduced. The dose management system, Radimetrics™ (Bayer), was used to collect dose data and to estimate the equivalent dose for each organ and the effective dose for the whole body. From the dose data, we calculated the reduction rate of the average dose upon the implementation of the DLR. Utilizing the R package, "LARisk 1.0.0", we also estimated the lifetime attributable risk (LAR) for each CT examination based on exposure dosage estimates. We summarized the LARs by age, gender, and organ, and evaluated the degree to which the LAR was altered before and after the implementation of DLR. The number of radiation-induced cancers before and after the introduction of DLR was also estimated.

## **RESULTS**

A total of 6,172 cases prior to and 6,423 cases following the implementation of DLR were incorporated into the analysis. The total effective dose in body CT was significantly lower post-DLR introduction ( $15.8 \pm 10.6$  mSv) compared to pre-DLR introduction ( $27.9 \pm 14.1$  mSv) ( $p < 0.001$ ), amounting to a 43% dose reduction. The decrease in radiation dose resulted in a substantial reduction in the risk of radiation-induced cancer, with particularly notable benefits in a group of relatively young women. The estimated annual incidence of radiation-induced cancers was 0.261% (16.1 out of 6,172) prior to the introduction of DLR and 0.139% (8.9 out of 6,423) following its implementation.

## **CONCLUSION**

Our single-center study suggests that the implementation of DLR has the possibility to reduce radiation dose and radiation-induced cancers by nearly half in the clinical routine CT compared with the iterative reconstruction.

## **CLINICAL RELEVANCE/APPLICATION**

This study shows the degree to which the introduction of DLR contributes to a reduction in radiation dose and thus in the incidence of radiation-induced cancer.

## **W5B-SPPH- A Fundamental Investigation into the Behavior of Active Collimators in Multi-detector CT** **11 Systems under Varying Imaging Conditions**

Ryo Moriwake, BS (*Presenter*) Nothing to Disclose

## **PURPOSE**

This study aims to investigate that the effects with and without active collimator usage on dose profiles in the body axis direction and over-range length when scan conditions are altered.

## **METHODS AND MATERIALS**

We used a 80-detector row CT scanner. A polymethyl methacrylate (PMMA) phantom with a diameter of 16 cm was placed at the center of the gantry rotation. The high-accuracy Thimble ionization chambers (10X6-0.6CT, Radcal) was inserted in the center of the phantom with a scan length of 10 cm to include scattered radiation. The scan parameters were set as follows: tube voltage of 120 kV, tube current and rotation speed set to 50 mAs, and various combinations of detector rows of  $0.5 \times 80$  mm,  $0.5 \times 64$  mm, and  $1.0 \times 40$  mm were used at three pitch factor levels: High Definition, Standard, and High Speed. Each measurement was performed three times, and the axial dose profiles and over-range lengths were determined for each scan condition.

## **RESULTS**

The dose profiles in the Z axial direction with and without AC were wider in each scan condition with AC than without AC. The dose profiles in the body axial direction during the change of imaging conditions tended to differ depending on the rotation speed and the number of detector rows. The widest dose profile was observed at high speeds. The over-range length was approximately 18 to 45 mm. The over-range length was particularly large at the combination of 0.5 sec,  $1.0 \times 40$  mm, and high speed.

## **CONCLUSION**

By comparing the dose profiles with and without AC, the operation of AC was confirmed. It was also confirmed that the operation of the AC depends on the imaging conditions. Overrange lengths ranged from about 18 to 45 mm, The overrange length was particularly large for the combination of 0.5 sec,  $1.0 \times 40$  mm, and high speed.

## **CLINICAL RELEVANCE/APPLICATION**

The use of active collimator may reduce over-range. Since the over-range varies depending on the scan conditions, it is important to understand the effect of overrange in advance for children with a short scan range. In addition, the use of a

semiconductor detector may make it possible to easily determine the effect of over-range.

## **W5B-SPPH- Effect of Radiation Dose on CT Attenuation of Photon Counting CT Scanner: A Phantom Study 12**

Jingjuan Liu, MD (*Presenter*) Nothing to Disclose

### **PURPOSE**

NAEOTOM Alpha is the new generation CT scanner (Siemens Healthineers, Forchheim, Germany) which epoch-makingly used the semiconductor material for detector. The new detector system could convert photons directly into electronic signals to improve the utilization of photons and result in a lower noise, a higher resolution and image quality. Compared with the mixed image in dual source system, NAEOTOM Alpha would generate a monoenergetic image of 70keV as the 'standard' image for doctors' diagnosis. In this project, we want to first evaluate the accuracy and change of CT attenuation with different mono-energetic images using a liver nodule phantom.

### **METHODS AND MATERIALS**

We applied a liver nodule phantom (QRM, Möhrendorf, Germany) consisting of the anthropomorphic abdomen phantom body, the liver and spleen insert in this project. The liver insert contains multiple oval and spherical lesions of different sizes and in two kinds of densities. The phantom was scanned with the standard QuantumPlus protocol on NAEOTOM Alpha in 3 different scanning modes (Spiral, Flash and Sequence). In each mode, the tube voltage was set at 120kV and 140kV. Each scan was performed for 3 times to reduce the errors. All images were reconstructed as SPP image with a kernel of Qr40, slice thickness of 2mm and increment of 2mm and imported into the post-processing workstation (Syngo.Via VB70, Siemens Healthineers, Forchheim, Germany) for measurement. All statistical analysis was performed with Python 3.10.11. The difference between measured results and standard CT attenuation was tested with student T test. A p value smaller than 0.05 was considered as significant.

### **RESULTS**

As shown in Fig.1, the CT attenuation is close to the standard value when the mono-energy is around 70keV for abdomen region, low-density and high-density lesions, with no significant difference when compared with the standard values. For liver region, for Spiral and Sequence mode, the CT values were close to the standard value when the mono-energy is around or lower than 55keV, while 60keV for Flash mode. For the spleen region, the CT attenuations are close to the standard value when the mono-energy is around 65keV.

### **CONCLUSION**

From the result, we could conclude that the CT attenuations of 70keV image are close to the standard value for the abdomen region, low-density and high-density lesions in the liver. However, 65keV image for spleen and 60keV image for liver seem to be closer to standard value. This could help the doctors in clinical routines to decide the parameters.

### **CLINICAL RELEVANCE/APPLICATION**

To lay the foundation for the further promotion of photon CT to clinical applications.

## **W5B-SPPH- Comparison of Non-gated, High-pitch Cardiac CTA in Pediatric Patients under 1 Year of Age: Energy Integrating Detector vs Photon Counting Detector CT 13**

Scott M. Bugenhagen, MD, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

To determine image quality and radiation doses on photon counting detector (PCD) CT compared to conventional energy-integrated detector (EID) CT in under 1 year old congenital heart disease (CHD) patients.

### **METHODS AND MATERIALS**

This study involved an Institutional-Review-Board (IRB) approved retrospective analysis of CHD patients that underwent clinically indicated CT angiography examinations using dual-source EID-CT (Siemens Healthineers, SOMATOM Force) and dual-source PCD-CT (Siemens Healthineers, NAEOTOM Alpha). All examinations, regardless of detector technologies, were acquired with non-gated, high-pitch technique (3.2) and automated exposure control. All PCD scans used 120kV and 55keV reconstructions, while EID scans used automated kV technology with tube potential of 70 and 80kV. Patient characteristics (age, body mass index, patient weight) as well as dose descriptors including volume CT dose index (CTDIvol), dose length product (DLP), and size-specific dose estimate (SSDE), were recorded and compared. Image quality assessment was based on review of the 4 major coronary arteries and was scored on an 8 point scale: 3 points for right coronary artery (RCA) (1 for origin, 2 for origin + proximal, 3 for origin + proximal + distal), 1 point for left main coronary artery (LMCA) (seen or not seen), and 2 points for the left anterior descending artery (LAD) and left circumflex artery (LCA) arteries (1 for proximal and 2 for proximal + distal). Parametric (t-test) testing was used for statistical evaluation.

## RESULTS

29 and 24 CT examinations were included for EID and PCD, respectively. There were no overall differences in demographic characteristics including mean (standard deviation) patient age [0.137 vs 0.157 years,  $P = 0.844$ ], body mass index [14.2 (+/- 2.5) vs 13.9 (+/-2/5) kg/m<sup>2</sup>,  $P = 0.5$ ], or patient weight [3.63 vs 3.62 kg,  $P = 0.9$ ]. In comparison with EID CT, PCD CT had significantly lower mean CTDIvol [0.48 vs 0.39 mGy,  $P=0.001$ ]. SSDE [1.005 vs 0.951 mGy,  $P = 0.11$ ] and DLP [7.07 vs 5.66 mGy cm,  $P =0.06$ ] differences were non-significant. There was negligible difference in image quality (visualization of coronary arteries) ( $P = 0.19$ ).

## CONCLUSION

Our experience indicates that radiation doses in non-gated high-pitch cardiac PCD-CT in children are similar to or lower than those of current EID-CT, while subjective image quality is maintained.

## CLINICAL RELEVANCE/APPLICATION

Similar to lower doses in non-gated high-pitch cardiac PCD-CT compared to EID-CT supports use of PCD-CT in cardiac imaging in children.

## W5B-SPPH- Correlation of Human Observer Impression of X-ray Fluoroscopy and Angiography Image Quality with Technical Changes to Image Quality

Jelena Mihailovic, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Perceived angiographic image quality is a combination of image formation technical factors and image processing. No standard methods to measure angiography quality exists due to the combination of spatio-temporal anatomical variability and non-linear image processing. However, methods to assess image quality are needed to optimize radiation dose and image quality in the clinical practice. The purpose of this work was to develop and validate methods to measure observer impression of angiographic image quality.

## METHODS AND MATERIALS

Multi-frame images of the thorax of a euthanized pig were acquired to provide an anatomical background. Detector dose (DD) was varied from 6 to 200 nGy (increments 2x) to provide background with a wide range of quantum SNR. For each DD images with 0.6 and 1.0 mm focal spots (FS) were acquired to assess FS blur. Two stents with/without 0.5 mm separation and a synthetic right coronary artery (RCA) with spherical defects were embedded as test objects into the pig images. Embedded test objects included motion to mimic cardiac function. Quantitative observer ( $n=14$ ) performance was measured through 2AFC test of whether stents were touching and by observer count of RCA defects. Subjective impressions of quality were measured through visual analog scale (VAS) response to statements assessing small object details, noise impression, and overall image quality. The paired t-test was used to describe significance of observer response changes associated with DD or FS size.

## RESULTS

Proportion of correct responses of stent separation and number of RCA defects reported changed significantly with DD increment in the range 6-100 nGy ( $p<0.05$ ). While there was a trend which favored the 0.6 vs. 1.0 mm FS for these quantitative assessments, this was not significant. VAS measurements changed significantly with both DD increment in the range 24-100 nGy and with FS size for a given DD ( $p<0.05$ ). Quantitative and subjective measurements were highly correlated. The most sensitive measurement was VAS assessment of small object details.

## CONCLUSION

Compared to quantitative human observer assessment, measurement of subjective impression of image quality demonstrated higher sensitivity for image quality changes associated with quantum SNR and focal spot size. These findings embolden future work to assess quality of fluoroscopy and angiography images using subjective measurements. Our strategy to ensure rigor is systematic, self-conscious study design, data collection, and interpretation.

## CLINICAL RELEVANCE/APPLICATION

For cardiovascular imaging procedures, defining image quality is complex task because it relates to numerous dynamic variables. Feedback from the end user can lead to more accurate and reproducible measurements.

## W5B-SPPH- Is it Possible to Achieve Consistent Outcomes in CT NSCLC Radiomics? An In-depth Exploration of the Sources of Uncertainties

Gary Ge, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

Radiomics features have been used in machine learning models to quantify tissue characteristics that are not observable by clinicians to aid in the prediction of clinical decisions and outcomes. However, there are still many uncertainties involved in this process which reduce the robustness of results and limit its clinical implementation. We investigate the impact of each component in the radiomics pipeline on predicting clinical outcomes.

## METHODS AND MATERIALS

A thorough review of over 120 CT lung radiomics studies was conducted to examine current. Patient images were retrospectively retrieved from a GE VCT scanner. The lung nodules were manually delineated using Eclipse to define a region of interest. First-order features were extracted with IBEX and high-order features were extracted using Python. Clinical features were retrieved from the Kentucky Cancer Registry (KCR). The features were organized into five feature sets, Radiomic (low), Radiomic (high), Radiomic (high+low), Clinical, and Radiomic+Clinical. Prediction of 2-year survival was investigated. Cohort size was examined by extracting balanced sub-cohorts of the original cohort to be run in parallel to the original cohort. The included feature selection methods are: ANOVA, LASSO, MI, mRMR, and Relief. The number of selected features used for model training was also established as a variable for examination, ranging from 5 to 25 features. The included predictive models are: SVC, Naïve-Bayes, DT, RF, LR, GBoost, and kNN. Model validation methods were also examined, using 2-, 5-, and 10-fold cross-validation (CV).

## RESULTS

496 patient image sets are retrieved for use in this analysis. CT datasets are fairly balanced, with 237 patients  $\leq$  2 years survival and 259 patients  $>$  2 years survival. A total of 1419 first-order features, 360 high-order wavelet features, and 9 clinical features are included in the feature sets. Statistical analysis is done using Kruskal-Wallis for within-group analysis and further pairwise testing establishes relative rankings. A total of 17220 AUCs involving all combinations shows certain trends. Overall CT lung cancer radiomic stability favors larger cohort size, Clinical and Radiomic+Clinical feature sets, mRMR feature selection, RF predictive model, and 10-fold CV.

## CONCLUSION

Radiomic feature selection and machine learning methods are inter-dependent. Appropriate inclusion of different feature types and choice of feature selection can improve predictive power for clinical outcome.

## CLINICAL RELEVANCE/APPLICATION

Conducting systematic analysis of each phase of the radiomic workflow may heighten general understanding of uncertainties that contribute to unstable outcomes, thus potentially improving the robustness of future radiomic studies.

## W5B-SPPH- A Data Dashboard Approach to Improving Image Analysis: Survival Prediction of Patients with Bladder Cancer after Cystectomy based on Clinical, Radiomics, and Deep Learning Descriptors

Di Sun, MEng, BEng (*Presenter*) Nothing to Disclose

## PURPOSE

To predict the 5-year survival of bladder cancer patients after radical cystectomy by combining clinical, radiomics, and deep learning (DL) descriptors (CRD).

## METHODS AND MATERIALS

With IRB approval, we collected clinical information and CTU scans from 163 patients with bladder cancer who underwent neoadjuvant chemotherapy followed by radical cystectomy. Five-year survival data were collected. We split the data into three sets: training (55 alive (A); 37 deceased (D)); validation (4 A; 3 D); and test (20 A; 44 D). The clinical information collected included post-surgery pathologic stage, lymphovascular invasion, pathologic node stage, if patients underwent chemotherapy, or adjuvant radiotherapy. The nomogram by Shariat was used to predict the survival of patients. Radiomics and DL descriptors were extracted from CTU images. Each patient had two CTU scans (before and during/after chemotherapy), forming a pre- and post-treatment pair. We used our AI-CALS algorithm to segment the lesions. To train and validate the DL convolution neural network (DL-CNN), hybrid ROIs extracted from the lesion area were used. A total of 182 radiomics features were extracted from the lesions, including grey level, morphological, and texture features from the post-treatment scans (post features) and the percentage difference between pre- and post-treatment features (difference features). Backpropagation neural network was used to classify the radiomics features. The area under receiver operating characteristic curve (AUC) and Kaplan-Meier analysis were used to evaluate the classification performance on the test set.

## RESULTS

The nomogram model achieved an AUC of  $0.82 \pm 0.06$  on the test set; DL-CNN achieved an AUC of  $0.71 \pm 0.07$ ; and the classification based on radiomics features had an AUC of  $0.73 \pm 0.07$ . By combining all CRD descriptors, we obtained an AUC of  $0.87 \pm 0.05$ . The differences between any pairs of AUCs did not reach significance ( $p > 0.05$ ), which likely relates to sample

size. The median survival times by Kaplan-Meier analysis for the two classes (deceased or alive) were 1.2 and 5 years ( $p < 0.001$ ) as estimated by the nomogram model, and 1.6 and 5 years ( $p = 0.007$ ) estimated based on CRD descriptors.

## **CONCLUSION**

While larger data sets are needed, this study demonstrates that combining the radiomics and DL descriptors with clinical information holds promise for improving the prediction of the 5-year survival of bladder cancer patients after radical cystectomy.

## **CLINICAL RELEVANCE/APPLICATION**

The CRD descriptors has the potential to improve the prediction of the 5-year survival of bladder cancer patients after radical cystectomy. Accurate assessment of 5-year survival offers potential benefits with patient counseling and postoperative surveillance strategies.

## **W5B-SPPH- Fissure Integrity Scores in Pre-treatment Chest CT Images as a Biomarker for Predicting a Target Lobar Collapse with Endobronchial Valve Implantation in Subjects with Emphysema**

Dallas Tada, PhD (*Presenter*) Nothing to Disclose

### **PURPOSE**

We propose to build an initial endobronchial valve (EBV) prediction model using quantitative CT measurements to evaluate the response of emphysema patients to EBV implantation for a targeted lobe.

### **METHODS AND MATERIALS**

The study retrospectively collected 127 anonymized pre-treatment EBV CT scans. Selection criteria for the targeted lobe for EBV implantation is based on the highest emphysema density and largest degree of heterogenous emphysema between the targeted and the ipsilateral adjacent lobe. A fissure integrity score (FIS) is used as a primary quantitative biomarker for the development of the EBV prediction model. Previous work on fissure segmentation and integrity assessment used a deep learning approach that segments pulmonary fissure and quantifies FIS for the right horizontal fissure (RHF), right oblique fissure (ROF), and left oblique fissure (LOF). An FIS is defined as the percentage of complete fissure voxels along the surface of the interlobar region. Fissures are categorized as complete with a FIS of = 90%; otherwise, a fissure is considered incomplete. Separate FIS for the right fissures are calculated based on the targeted lobe for lobar exclusion (i.e., upper lobar boundary for a targeted right upper lobe). Successful EBV placement in a targeted lobe is described as a reduction of = 50% of its total lung capacity (TLC). A reduction of less than 50% of targeted lobe volume reduction (TLVR) does not achieve the desired lobar collapse. Statistical analysis of FIS and EBV volume reduction is applied to assess the significance of fissure completeness and EBV placement.

### **RESULTS**

FIS and TLVR comparisons are separated by total sample size and targeted lobes. For all targeted lobes, a mean ( $\pm$ SD) FIS of 0.93 ( $\pm$ 0.05) and 0.72 ( $\pm$ 0.26) was attained for successful and unsuccessful TLVR, respectively. Subjects with complete target lobe fissure are likely to experience TLVR by six-fold compared to subjects with incomplete target lobe FIS (Odds Ratio = 6.05,  $p$ -value=0.001). All targeted lobes and the right upper lobe achieved a TLVR ( $p$ -value < 0.01); the left lobes and right lower lobe did not achieve statistical significance.

## **CONCLUSION**

Quantified fissure integrity scores are essential for the foundation of the EBV prediction model, but additional quantitative biomarkers may improve the efficacy for the model.

## **CLINICAL RELEVANCE/APPLICATION**

The development of a prediction model that will more successfully identify emphysema patients that respond to EBV treatment helps guide treatment decisions for clinicians and manages medical resources.

## **W5B-SPPH- Practicing Precision Medicine: Using Machine Learning to Predict Time-to-Surgery in Renal Cell Carcinoma under Active Surveillance**

Shiva Singh, MBBS (*Presenter*) Nothing to Disclose

### **PURPOSE**

Clear cell renal carcinomas (ccRCCs) in VHL patients are typically managed with active surveillance (AS) until the tumor reaches 3 cm, when surgical resection is recommended. While current guidelines suggest annual screening with abdominal imaging, tailoring imaging frequency to each patient's tumor growth rate can reduce unnecessary radiation exposure and metastasis risk. This study aims to use MRI-based machine learning algorithms to predict the time to 3 cm threshold and design personalized imaging protocols for VHL patients.

## METHODS AND MATERIALS

The retrospective study included 40 vHL patients with 68 histopathologically-confirmed ccRCCs (size 1-2 cm) undergoing AS according to institutional protocol. Tumor segmentation was performed on all available pre-operative scans using ITK-SNAP and radiomics features were extracted from co-registered pre-contrast and post-contrast sequences using PyRadiomics. A growth curve was plotted for each tumor, and the time taken for each tumor to grow to 3 cm (T3) from the initial time point was calculated using the respective growth curve's fitted line equation. Based on T3, the tumors were classified into three categories: aggressive (<365 days), moderate (1-3 years), and slow (>3 years). Stacked ensemble technique with random forest and XGBoost were used for training models to predict T3 based on radiomics features. Five-fold cross-validation was used and the model was benchmarked on 100 different combinations (85% train and 15% test) to find the best model which was reported with F1 score, and the area under the curve of the receiver operating characteristic curve (AUC-ROC).

## RESULTS

A total of 40 patients (28 males) with mean age of  $44 \pm 3$  years and mean follow-up of  $2.9 \pm 1$  year were studied. Median volumetric growth rate of 1.8 cm<sup>3</sup> and diametric growth rate of 0.91 cm/year was observed. The best model showed an accuracy of 0.67 and F1-score of 0.67, 0.70 and 0.62 was observed with aggressive, moderate and slow tumor class respectively. AUC of ROC drawn for aggressive, moderate, and slow class were 0.65, 0.71 and 0.76. A Matthews Correlation Coefficient of 0.58 reveals a moderately well predicted analysis.

## CONCLUSION

The use of MRI-based machine learning algorithms can predict the time to 3 cm threshold and classify tumors into aggressive, moderate, and slow-growing categories for VHL patients with ccRCCs, providing a personalized imaging protocol. However, moderate accuracy of the model suggests the need for large dataset and external validation to improve the performance.

## CLINICAL RELEVANCE/APPLICATION

Tailoring imaging frequency based on the predicted time to 3 cm can reduce unnecessary radiation exposure and financial burden for slow-growing tumors as well as enables timely resection of aggressive lesion.

## W5B-SPPH- Deep Learning-enabled Automatic Sarcopenia Analysis in Abdominal CT: Finding an Association with Cardiovascular Disease in Korean Population

Sihwan Kim, BSc (*Presenter*) Nothing to Disclose

## PURPOSE

Little studies have shown that sarcopenia can increase the risk of cardiovascular disease, we aimed to investigate the association between a sarcopenia and cardiovascular mortality for the Korean population.

## METHODS AND MATERIALS

Data were retrospectively collected from non-contrast enhanced abdominal CT scans between 2005 and 2017. The number of abdominal CT scans was 641, the CT data is scanned from 352 males (54.9%) and 289 females (45.1%). Among the abdominal CT data, 141 patients (21.9%) had cardiovascular disease (CVD). Mean age of studied data was about 64 yrs (64 for male and 63 for female). The sarcopenia is defined by the sex-specific L3 skeletal muscle area (SMA) threshold referenced as 117.04 cm<sup>2</sup> for male and 71.39 cm<sup>2</sup> for female. The SMA value of L3 vertebra level was calculated using automatic body composition analysis software (ClariMetabo, ClariPi, Seoul, Republic of Korea).

## RESULTS

In the study data (n = 641), 75 patients (11.7%) had the sarcopenia. The result showed that 46.7% of Sarcopenia group had the CVD, compared to 18.7% in the non-sarcopenia group. The odds ratio for CVD event was 3.79 [95%CI: 2.30-6.26]. However, the correlation was 0.22 (p<0.0001) in the Phi correlation coefficient analysis, indicating a weak positive correlation. Among the sarcopenia patients, the CVD risk was 2.83 [95%CI: 0.79-10.6] times higher in male than in female.

## CONCLUSION

Automated analysis of abdominal CT imaging markers based on deep learning showed that patients with sarcopenia are more likely to have the cardiovascular disease compared to normal people in the Korean population.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-based automatic muscle mass analysis in abdominal CT is expected to contribute to improving human survival by predicting the risk of cardiovascular disease due to the sarcopenia at an early stage.

## W5B-SPPH- Feasibility of Artificial Intelligence-supported Assessment of Dual-energy Computed Tomography for Measuring Bone Mineral Density: Correlation with Quantitative CT

Ya L. Li I (*Presenter*) Nothing to Disclose



## PURPOSE

To evaluate the precision and agreement between BMD measurements performed in DECT-derived hydroxyapatite (HAP) concentration of the L1 vertebra to L3 vertebra and automated, AI-supported assessment of DECT-derived HAP concentrations with European Spine Phantom (ESP) compared with quantitative CT (QCT).

## METHODS AND MATERIALS

Data acquisitions were performed on Revolution CT (GE Healthcare, Waukesha, WI) at 120kV with 0.8r/s and 100 and 500mA, fast tube voltage switching between high and low energy (140/80kVp) with 0.5r/s and 240 and 365mA using ESP (No. 145, Germany ORM company). Mindways QCT PRO workstation can automatically generate ROIs and analyze BMD. For DECT-derived HAP values, ROI (468.78mm<sup>2</sup>) was set as the median plane of the vertebral body avoiding cortical bone and its pedicle, and the HAP values of the L1, L2, and L3 were measured from the axial-view HAP (Water)-based material decomposition images on a dedicated GE AW 4.7 Workstation. For automated assessment of DECT-derived HAP concentration was performed by a new fully automatic BMD analysis with AI technology: Firstly, using spectral CT images as the original input, process detects, names, segments and recognizes the orientation of the vertebral body within the image; Secondly, system automatically selects the most suitable three vertebrae for evaluation, recognizes their direction and central plane, segments and extracts the three-dimensional structure of the vertebrae based on vertebral body segmentation; Thirdly, system automatically calculates ROIs in trabecular bone; Lastly, system generates personalized bone density reports. Paired t test and Pearson correlation were to determine the differences and association between two measurements.

## RESULTS

The CTDIvol with QCT were 5.53mGy in 100mA and 27.66mGy in 500mA, whilst DECT were 5.80mGy in 240mA and 9.25mGy in 365mA. QCT-derived BMD values of the L1, L2, and L3 were 53.60±0.27, 106.25±0.11, 202.76±0.23mg/cm<sup>3</sup>, respectively. The DECT-derived HAP-Water values of the L1, L2, and L3 were 45.25±0.42, 89.2±0.86, 180.00±0.15mg/cm<sup>3</sup> with tube current of 240mA, whilst 39.46±0.51, 88.64±0.74, 170.1±0.38mg/cm<sup>3</sup> with tube current of 365mA. The DECT-derived HAP-Water values of the L1, L2, and L3 with AI were 44.2±0.87, 94.73±0.32, 173.22±0.71mg/cm<sup>3</sup> with tube current of 240mA, and 41.23±0.23, 92.03±0.74, 173.79±0.78mg/cm<sup>3</sup> with tube current of 365mA. There was a strong positive correlation between two methods (r=0.91, P<0.0001).

## CONCLUSION

The automated, AI-supported assessment of DECT-derived HAP concentration of the three vertebrae is feasible to measure BMD values and potentially aid a help in opportunistic osteoporosis screening in high-risk populations.

## CLINICAL RELEVANCE/APPLICATION

none

## W5B-SPPH- External Review of High CT Doses: Reasons and Improvements

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William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

## PURPOSE

To review reasons for high CT dose cases during external review and implement improvements to improve review workflow.

## METHODS AND MATERIALS

An in-house built external CT dose review was clinically implemented in August of 2021. Cases exceeding machine Dose Notification Values are automatically retained for review. For each case a technologist records possible reasons for the high dose and final review, updating of reasons, and sign-off is performed in-system by a qualified medical physicist or a supervisor/team lead with physicist final review. Summary statistics related to number of review cases and the reason for high doses as well as the rate of cases referred for review were calculated.

## RESULTS

A total of 4,212 cases for 3098 unique patients were reviewed across our 21 CTAP sites. Mean CTDIvol was 62.3 Gy ± 22.9 Gy. Cases exceeded notification values by 15.5% ± 18.5% on average. 31.2% of cases exceed the notification value by less than 5%. A reason for the high dose was included in 3,994 cases (94.8%). In those that listed a reason for the high dose, 3,678 (92.1%) included large patient size at part or all of the reason for the high doses. Mean BMI of patients in reviewed cases was 42.5 ± 10.9. BMI data was missing from 791 cases (18.8%). The next most frequent reasons were presence of shoulders (typically in neck scans) at 250 cases (6.3%) and misplacement of arms at 174 cases (4.4%). The presence of implants and casts was mentioned in 68 cases (1.7%) and combo scan across anatomy 46 (1.2%). No other reason exceeded 1% of the cases.

## CONCLUSION

Most cases only exceed notification values by a small amount and represent only a small risk to the patient. The vast majority of external review cases are due to patient size and are generally considered appropriate. Other major issues include arm

placement, combinations studies, and studies across the neck and into the shoulders. Our external review software lists BMI when available to improve physics workflow.

**CLINICAL RELEVANCE/APPLICATION**

Physics workflow can be improved in external review by listing indicators of patient size along with other basic demographics to reduce the need for searching for such information. It is important that size indicators are available for systems to pull and autopopulate for external review.

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## Abstract Archives of the RSNA, 2023

W5B-SPVA

### Vascular Imaging Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **W5B-SPVA- Low-dose 4D Head and Neck Computed Tomography Angiography Conducted via Helical Scans Jointing with ECG-gated Axial Scans: Study in Image Quality**

Jinhui Zhang (*Presenter*) Nothing to Disclose

#### **PURPOSE**

To explore the image quality of low-dose 4D head and neck computed tomography angiography (CTA) conducted via helical scans jointing with ECG-gated axial scans, compared with conventional standard-dose spiral scanning.

#### **METHODS AND MATERIALS**

This study enrolled 100 patients suspected with Cerebral aneurysm and received head and neck CTA. The patients were divided into two groups according to the scanning methods. Group A (n=50) performed helical neck CTA jointing (pitch=0.992: 1) with ECG-gated axial head CTA at 20%-110% R-R interval in sequence, noise index (NI) was set as 8 HU and rotation time was 0.35 s. Group B (n=50) received normal conventional helical scanning with pitch of 0.984: 1, NI of 5 HU, rotation time of 5 s. Regions of interest were placed at the bifurcation of internal carotid artery and M1 segment of middle cerebral artery. CT values and SD values of ROIs and muscle or white matter were measured, and SNR and CNR were calculated. The overall image quality was subjectively scored using a 5-scale method. The radiation dose, subjective and objective image evaluation results were compared.

#### **RESULTS**

Compared with Group B, Group A had a decreased DLP by 34.6% (A vs. B: 558.92±57.01 vs. 944.88±86.05 mGy-cm,  $P<0.001$ ). For bifurcation of internal carotid artery, the two group images showed no statistical difference in CT values (A vs. B: 545.58±93.92 vs. 535.66± 71.30), SD (11.35±2.51 vs. 10.70±2.48), SNR [48.16 (20.99) vs. 49.43 (21.46)] and CNR (62.87±16.02 vs. 66.74±16.04), with all  $P>0.05$ . For M1 segment of middle cerebral artery, the two group images also showed no statistical difference in CT values (528.68±124.60 vs. 513.32±71.22), SD [14.09 (4.18) vs.11.94 (3.65)], SNR [39.99 (17.05) vs. 45.57 (17.60)] and CNR (54.99±14.56 vs. 50.83±12.76), with all  $P>0.05$ . Regarding subjective scoring, both the two-group images met diagnostic requirements and the difference was not statistically significant ( $P>0.05$ ).

#### **CONCLUSION**

For head and neck CTA, low-dose helical scans jointing with ECG-gated axial scans showed comparable head and neck artery displays with standard-dose conventional helical scanning.

#### **CLINICAL RELEVANCE/APPLICATION**

Aneurysm is at risk of rupture, and monitoring of its pulsatility with the cardiac cycle shows predictive value, where ECG-gated 4D CTA potentially be helpful. However, 4D scans may increase the risk of radiation doses, in this study, we found that helical combined ECG-gated axial scan with exposure during 20% -110% R-R interval could obtain comparable artery visualization with conventional helical

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## Abstract Archives of the RSNA, 2023

M2-QI

### Quality Improvement Reports Monday Poster Discussions

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **M2-QI-1 Expanded Scope of Practice Fellowships for Radiologists: A Survey of Interest Amongst Current Canadian Radiology Residents**

Nick N. Maizlin, MD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Radiology residents acquire a diverse educational experience and skill set, including a general internship year, which may enable the direct management of patients. However, in order for radiology residents to define new scopes of practice, additional fellowship training in clinic be warranted in certain instances. Indeed the lack of patient interaction and loss of control over patient referrals may be counterproductive to our specialty and one of the reasons interest in radiology residency is declining amongst medical students. Although the rise of interventional radiology as a distinct specialty has partially filled this void, there remains significant opportunity to expand the future scopes of practice available to motivated radiology trainees.

#### **METHODS**

Using the Canadian family medicine Enhanced Skills Program as a model, we conducted a Canada-wide survey of radiology residents to assess interest in additional fellowship training to expand their scope of practice. We undertook a national survey of radiology residents in Canada to determine their interest in completing further fellowship training in expanded scope of practice fellowships (referred to herein as "clinical fellowship"). We define a "clinical fellowship" as distinct from traditional diagnostic imaging and interventional fellowships and include low risk anesthesia, non-surgical breast disease, cancer screening, chronic pain, clinician scholar, diabetes and wound care, emergency medicine, hospital medicine, incidentaloma management, low risk obstetrics, medical oncology, palliative care, public or environmental health, renal stone disease, sports and exercise medicine, vascular/atherosclerosis medicine and "other", where we queried resident's interest.

#### **RESULTS**

Our results indicate that a majority of residents (69.2%) would like to routinely see patients in clinic and more than half (52%) are willing to undergo an additional year of fellowship to enhance their skill set. The most popular choices for such fellowships were sports medicine (22.8%), emergency medicine (19.6%) and vascular medicine (18.5%). In addition, a majority (52.9%) of residents felt capable of offering incidentaloma clinics without additional training beyond their core radiology residency.

#### **DISCUSSION**

Traditional diagnostic and interventional radiology fellowships must be reconsidered to reflect the interests and capabilities of modern radiology trainees. Expansion of training options into the domain of direct patient management will likely prove popular among current residents.

#### **M2-QI-2 Effect of Standardization on Time Spent by Patients in Recovery Nursing Units after Interventional Radiology Procedures**

Ashok Srinivasan, MD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

While there are society guidelines for withholding anti-coagulation medication for interventional radiology procedures, there are no universally accepted standards for post procedural observation times. Potential variations amongst proceduralists in prescribed recovery times for the same procedure can result in increased time spent by nursing staff clarifying the order accuracy (e.g., different providers prescribing 30 minutes versus 2 hours post lumbar punctures), and affecting room

efficiency in a busy practice. The goal of our study was to evaluate the effect of standardizing post procedural observation times for interventional procedures on actual times spent by patients in recovery units.

## **METHODS**

Post procedural recovery units at our institution cater to 3 cohorts of patients: Vascular interventional radiology (VIR), Neurointerventional Radiology (NIR) and Neurodiagnostic Radiology (NDR). A list of all procedures performed in each of the 3 areas was compiled and sent to the respective services to create a consensus list for recovery times per procedure. The final list was circulated to the proceduralist teams and nursing teams in recovery units for implementation. We monitored the overall time spent by patients in recovery units in each cohort before and after implementation. We also monitored risk reports prior to and after implementation to determine if there was any change in number or types of complications. Lastly, informal surveys of the nursing staff were conducted to understand whether standardization changed the frequency of phone calls to clarify orders.

## **RESULTS**

Pre implementation spanned Jan-Dec 2021 and post implementation Jan-Dec 2022. Our data demonstrated the following pre and post implementation recovery times (in minutes): - MEDIAN: Overall (56 vs 49), NIR (140 vs 134), NDR (123 vs 61), VIR (45 vs 45) AVERAGE: Overall (85 vs 73), NIR (154 vs 143), NDR (119 vs 61), VIR (69 vs 66) There were no changes in the number of risk reports related to post procedural complications after implementation. Informal surveys of the nursing staff post implementation revealed a significant drop in phone calls placed for order clarification.

## **DISCUSSION**

Post implementation, greater than 10% reduction in average and median times was achieved overall for all procedures. The largest effect was seen in NDR procedures with nearly 50% reduction (both median average) whereas the change in NIR procedures was 4/8% (median/average) and VIR procedures was 0/4% (median/average). Our results probably indicate that standardization can work in reducing variations but have limitations as well; the impact may be different from segment to segment based on the degree of pre-existing variations. However, even in areas where standardization did not change the times substantially, there was tangible benefit in terms of eliminating many phone calls placed for order clarification.

## **M2-QI-3 Quality Improvement of Transcatheter Aortic Valve Replacement with Femoral Access: Identifying the Femoral Artery Bifurcation Using CT and 3D Modeling**

Aniruddh Mandalapu (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Retroperitoneal hemorrhage (RPH) is a potentially fatal complication of cardiac catheterization using the transfemoral route, with an incidence ranging from 0.15-6%. Although the reported incidence appears small, considering the large number of percutaneous coronary interventions (PCIs) and diagnostic catheterizations performed in the United States, the absolute number of RPH cases is in the thousands. RPH carries a mortality risk of 4-12% and is associated with significant morbidity, including an increase in hospital stay and the need for blood transfusions. Reducing its incidence is crucial. This paper examines the implementation of a protocol at the University of Rochester Medical Center at the end of 2016 that aimed to reduce the incidence of RPH during cardiac catheterization procedures. The protocol involved radiologists giving the location of the femoral artery bifurcation relative to the inguinal ligament to interventional cardiologists for a Transcatheter Aortic Valve Replacement (TAVR) procedure using femoral access.

## **METHODS**

The protocol involved radiologists identifying the location of the femoral artery bifurcation relative to the inguinal ligament using CT with contrast and communicating it to interventional cardiologists through a report on eRecord as well as a visual representation from the university's 3D lab. The interventional cardiologists then used this information to determine whether there was an access site of adequate length for femoral access or if the femoral bifurcation was too high. In this scenario, they would avoid the femoral vessel.

## **RESULTS**

The implementation of the protocol led to greater confidence with femoral vessel access among cardiac proceduralists by adding an extra check to the existing methods of physical exam and ultrasound to prevent retroperitoneal bleeds. It led to a reduction in the incidence of retroperitoneal hematomas during TAVR procedures using femoral access with 0.47% of procedures resulting in a retroperitoneal hematoma from 2012 to 2016 compared to 0.29% from 2017 to 2023, representing a marked improvement in patient safety. Proceduralists at the institution continue to rely on the model between multidisciplinary meetings and the day of the procedure to inform their choice of access.

## **DISCUSSION**

The implementation of the protocol highlights the importance of effective communication and collaboration between radiologists and interventional cardiologists during TAVR procedures using femoral access. By ensuring clear communication between radiologists and proceduralists and creating 3D visual models as reference, patients can receive safer care with more safety measures to prevent retroperitoneal bleeds in TAVR procedures. This protocol can serve as a model for improving planning and reducing complications during other vascular procedures.

## **M2-QI-4 Assessment Driven Approach to Integrating Volumetric Software for MRI in Dementia**

Michelle Pisa, DO (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

In the workup of the dementia patient, brain MRI plays an important role in excluding alternate pathologies. It can also assess patterns of atrophy, potential imaging biomarkers which complement cognitive and laboratory testing in the dementia diagnosis. Existing visual grading scales depend on reader experience and lack reference to age-matched controls. As disease-modifying treatments are becoming available, separation of normal aging from early dementia is gaining increased urgency. Several commercially available software products perform MRI brain volumetry with reference to age-matched controls but lack clinical validation. At our institution, clinicians requested incorporation of volumetric software on MR imaging for dementia. We pursued an internal evaluation of how the addition of these Quantitative Reports (QR) would influence both our standard Radiology reporting and clinical practice.

### **METHODS**

We used an Ai platform (Blackford) to sequentially enable QR from two different software vendors, Cortechs.ai (NeuroQuant Age-related Atrophy) and Icometrix (Icobrain DM). For both products, the manufacturer-specified imaging sequence was incorporated into our existing MRI Dementia protocol. The routine MR images were interpreted by 1 of 6 CAQ-certified Neuroradiologists. Several months later, they were presented with the corresponding QR, asked to re-review the MRI exam in context, and prompted with a questionnaire to assess the impact of the QR on their original interpretation. The QR was also sent to 1 of 4 participating Neurologists, who were asked to review the routine MR images, the QR, and prompted with a questionnaire to assess the impact of the QR on the imaging interpretation and their clinical management.

### **RESULTS**

For Radiologists and Neurologists, the QR presented from both products affected the interpretation of the conventional MRI imaging in 1 of every 4/5 cases (19-29%). The most frequently reported change was the detection of atrophy, in particular hippocampal atrophy. For both products, and compared with Radiologists, the Neurologists indicated increased confidence in both the imaging exam and the interpretation with the addition of the QR. For both products, Neurologists indicated the influence of QR on their clinical interpretation in 9 out of 10 cases (90-97%), with a strong influence in 1 out of 3 cases (27-37%). Neurologists also indicated a change in management in 1 of 3 cases (27-34%) based on the input of QR.

### **DISCUSSION**

Addition of QR affected the MR imaging interpretation for both Neurologists and Neuroradiologists, mainly with regard to hippocampal atrophy. Neurologists indicated a stronger influence of the additional data on their interpretation of the MRI and on clinical management. Assessment data was used to inform the purchasing decision, establish interpretation standards, and outline a clinical workflow.

## **M2-QI-5 Implementation of a Structured Observership Program for Improving Recruitment of Radiology Trainees: A Novel Analysis**

Indrajeet Mandal, MBBS (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Diagnostic Interventional Radiology continues to increase in demand. Despite this, there is a significant workforce shortage of radiologists in the UK (vacancy rate of 10%) and Europe. There is therefore a clear need to recruit more radiologists in order to meet this increased demand for imaging and image-guided therapy. There are many factors influencing choice of Radiology as career, including "current exposure", "work life balance" and "diversity of the field". Early exposure through observerships is proven to increase interest in radiology. Medical school exposure remains universally low, and there are very few intern level rotations in radiology within the UK (20-30 rotations out of 8000 per year). Therefore, junior doctors are reliant on observerships as their primary exposure to radiology. Here, we provide novel insight into the activities during a tailored Radiology Observership at our institution.

### **METHODS**

Over the course of one year, our department of radiology ran a programme for rotating junior doctors. A feedback form was distributed. Candidates were asked multiple of questions, including ranking options on a Likert scale and free text responses.

## RESULTS

A total of 22 responses were obtained. 100% met their aims. The experience influenced the likelihood of applying to radiology in 92% of respondents; 4% were less likely to apply, 88% were more likely to apply for a radiology program. All sessions were well received. Interventional radiology was the highest rated activity (83% very satisfied), followed by emergency room duty radiology (75% very satisfied) and acute CT reporting (69% very satisfied). Free text comments suggested that participants found the MDT difficult to engage with and experienced lower levels of satisfaction compared to other activities.

## DISCUSSION

All participants met their aim. A total of 88% of participants were more likely to apply for Radiology, supporting the evidence that an observership is an influential factor in specialty selection. The high satisfaction with IR demonstrates that practical opportunities were very well received. The same trend was not observed for ultrasound. Simulation offers a potential adjunctive solution. Generally, participants were most satisfied with one-to-one sessions. This highlights the importance of a named mentor, and adds further support that role models are a crucial part of the experience. The MDT content was too advanced their level, highlighting an educational gap. Future work should identify strategies to improve engagement with this activity e.g. virtual MDTs to present practice cases. In conclusion, providing high value educational opportunities is vital to ensure future recruitment to radiology. To our knowledge, our study is the first to analyse the activities within an observership week. Maximising engagement and participation as well as role models are crucial in these settings.

### M2-QI-6 Reducing Unnecessary OR Calls Related to Specimen Imaging

Uzma Waheed, MD (*Presenter*) Consultant, Becton, Dickinson and Company

#### INTRODUCTION

After pre-operative localization and surgical excision a specimen radiograph is obtained to confirm excision of the targeted lesion. Unfortunately, our radiologists are often contacted by the surgical team before the specimen radiographs are available on our PACS. This delays specimen image interpretation and prolongs patient time in the OR. A quality initiative was initiated to correct this suboptimal workflow. Baseline data showed that 35% of all OR specimen radiograph orders result in multiple calls to breast imaging. Our goal was to reduce unnecessary phone calls from 35% of OR specimen radiographs in December 2022 to 10% by April 2023.

#### METHODS

At our center, specimen imaging is performed in the OR by surgical staff on a dedicated specimen x-ray unit. Surgical staff transfer tissue to the specimen radiograph unit, select the correct patient/accession number, obtain the image, which is sent to PACS, and call the breast imaging on-call phone to discuss results with the breast radiologist. Should technical issues arise during this process, the OR staff calls the lead breast imaging technologist for assistance. During 5-day data collection periods, the breast radiologists and lead breast imaging technologist completed a standardized form when they received unnecessary phone calls including: images not available in PACS, images in the wrong accession number, or calling the wrong phone number for image interpretation. These forms were compiled and reviewed, and a root cause analysis was performed. Unnecessary calls were categorized into workflow error and equipment error. We then designed and implemented interventions targeted to address these causes including updated signage, and easy to read operating instructions for specimen radiograph units.

#### RESULTS

Pre-intervention data showed 17 OR specimen radiographs were ordered in a 5-day period. 35% (6/17) of OR specimen had unnecessary phone calls. 83% (5/6) of calls were workflow related and 17% (1/6) were equipment error. Our interventions were aimed at improving workflow by (1) providing clear, written instructions for OR staff and (2) promoting engagement with OR staff, (3) creating reference user-guides posted in the OR and (4) providing OR technologist in-service training. These interventions reduced unnecessary OR specimen phone calls from 35% to 0% between December 2022 and April 2023.

#### DISCUSSION

With multidisciplinary engagement and basic interventions, we were able to reduce unnecessary interruptions in our department from 35% to 0%. These interventions enabled OR staff to independently troubleshoot prior to engaging with the breast imaging department. Limitations: Our OR specimen workflow may not be consistent with all breast imaging/surgery departments. Our data collection periods were short (5 days) with a small sample size. We did not directly measure time savings achieved by workflow improvements.

### M2-QI-7 New Approach to Staff Performance Evaluation: A Proof of Concept Pilot

Nadja Kadom, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

**Problem Description:** Our current staff performance metrics do not match our organization's stated goals  
**Available Knowledge:** Traditional staff performance metrics require that supervisors rate their reports on scales, typically ranging from "exceeds expectations" to "needs improvement". The system has been widely criticized as performance ratings may be

affected when the rater harbors biases against a staff member, when there is lack of clearly stated performance standards and lack of transparency regarding objective means of performance measurement. Purpose: Pilot testing of new staff performance evaluation approach

## **METHODS**

Context and Intervention: The new performance evaluation system was piloted throughout 2022 at one of our Healthcare System sites ("test site"). Staff are evaluated on a number of metrics reflecting various experience levels (Figure 1). Study of the Intervention: We compared retention rates and distribution of performance categories between the test site and another site ("comparison site") from 2020 through 2022. Measures/Metrics: Retention rates, Percent of performance ratings in the categories: (1) Needs improvement, (2) Meets expectations, (3) Does NOT meet expectations, (4) Exceeds expectations, (5) Commendable. Analysis: We used staff retention rates and staff engagement scores and simple descriptive statistics

## **RESULTS**

Retention rates: After a significant decrease in staff retention in 2020 and 2021, the test site almost completely recovered to pre-pandemic retention rates in 2022. The comparison site experienced only a minimal decrease in the retention rate in 2021, but a dramatic drop in 2022. Performance categories in 2022: The test site added a new performance category of "commendable" and almost 10% of staff met the criteria for this category, the comparison site did not have this category. Staff at the test site met the criteria for "exceeds expectations" in almost 35%, while this category was met by only 21% of staff at the comparison site. The "needs improvement" category applied to 4% at the test site versus 11% at the comparison site. In addition, the staff engagement scores (maximum score 5.0), unavailable for 2020) continuously improved at the test site (2019: 3.65, 2021: 4.16, 2022: 4.25) while they trended downward at the comparison site (2019: 4.04, 2021: 3.83, 2022: 3.78).

## **DISCUSSION**

We successfully piloted a new performance evaluation system at one of our radiology service sites. We developed a set of performance metrics with definitions and explanations on how performance is measured and that was shared with our staff. The data has us hypothesize that the new process may have an effect on higher retention and that it may serve as a driver for better employee performance. Engagement scores at the test site are more favorable, which could, at least in part, be attributed to the new performance evaluation system.

## **M2-QI-8 Improving In-patients Access to MRI Through Enhanced Communication and Optimized Scheduling Process: A Tertiary Hospital Experience**

Abrar Hlwani, MSc, BSc (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Access to inpatient MRI is a challenge affecting the length of stay, and treatment management plan which negatively affects patient experience, staff satisfaction, and increases cost of service. Improving access to inpatient MRI is complex due to predominantly outpatient based service, long exams time, safety procedures, and increased demand. Our institution is a 400 beds tertiary center operating 2 MRI scanners. Inpatient MRI imaging accounts for 20% of our MRI workload. The turnaround time (TAT) for inpatient MRI was approximately 2-3 Days. We initiated this project to improve the efficiency of Radiology processes in MRI, to achieve 80% of inpatients MRI within 24 hours.

## **METHODS**

6 months baseline data were collected to identify the TAT from MRI requests until the patient had access to MRI. Root cause analysis (RCA) was performed to identify the major causes of delays. MRI section based daily inpatient MRI access TAT review; department based weekly and organizational-based monthly review of progress was commenced. The data was analyzed by Control Chart and one way ANOVA, considering a significance level of less than 0.05.

## **RESULTS**

Baseline review of MRI access TAT data showed that only 65% of the patients received MRI scans within 24 hrs. in a period of 6 months. Median access time was 30 hours (Range from 3 to 169 hrs). RCA identified multiple causes of delays. The 3 main causes included no inpatient MRI slots, no general anesthesia slots, and incomplete MRI consent forms. Patient care was improved by increasing inpatient MRI slots. Technologists' workflow and shifts were adjusted to maintain outpatient productivity. Electronic MRI preparation and consent forms were launched. Frequent education sessions were done to inpatient units and referring teams to unify the workflow. After 7 months of multiple PDSA cycles, a sustained monthly target of achieving 80% inpatient TAT within 24hrs was achieved. After all performance improvement interventions, the median access time for MRI was 10 hrs. (Range from 1 - 90 hrs.) One way ANOVA was performed and found a significant improvement from baseline in TAT during PDSA cycles and postproject period with a P value of 0.001. A control chart assessed progress during the project and sustainment of the improvement. Two data points were found to lie outside the control limits around the same month in 2 consecutive years. This was due to a national holiday where only emergent cases were given priority.



## DISCUSSION

A robust process improvement initiative focused on capacity planning and enhanced communication helped reduce median access time to MRI by 67% (from 30 hrs. to 10 hrs.). Approximately 94% of the in-patient had access to MRI within 24hrs. Maintaining quality improvements is crucial; our data analysis shows the sustainment of the improvement 27 months after completing PDSA cycles.

## M2-QI-8HC Enhanced Detection of Brain Aneurysm on CT Angiography using an AI Solution in a Private Practice Outpatient Setting

Bruno A. Rocha, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Unruptured intracranial aneurysms are a relatively common pathology, with data estimating a prevalence of around 3% in the adult population. Their incidental diagnosis has raised over time due to the increased use of intracranial contrast imaging tests for various reasons, whether in outpatient or hospital settings. We also know that the use of artificial intelligence for medical image analysis has been widely discussed and implemented in various areas of radiological knowledge. Within this context, the purpose of this study was to evaluate the impact that the use of an AI tool for screening aneurysms in contrast-enhanced CT cranial exams would have in an outpatient setting in relation to an enhancement in the aneurysm detection rate.

## METHODS

A retrospective study to identify 2,560 contrast-enhanced CT cranial scans were performed between 4/7/2022 - 5/31/2022 at a large, private practice, primarily focused on reading for outpatient clinics. The images and reports were classified using an AI algorithm and natural language processing (NLP) algorithm. For concordant cases, the ground truth was assumed. Cases found to be negative by report (NLP) and positive by AI were re-reviewed by two neuroradiologists to establish a consensus-based ground truth.

## RESULTS

The prevalence of BA was 1.0% (26/2560). AI detected 10 additional discordant cases, as negative by report but positive by AI. Of these, 90% (9/10) were considered a true positive on the neuroradiologist's secondary review. The AI-enhanced detection rate was 34.6% (9/26).

## DISCUSSION

In this hypothetical retrospective scenario, the AI triage tool demonstrated a significant increase in the detection rate of incidental small aneurysms. Upon reviewing the additional 9 cases that were missed by the radiologists but detected by the AI screening system, we noticed that they were all cases of small aneurysms (<7 mm) in exams where clinical suspicion was not focused on the detection of aneurysms or intracranial bleeding. This finding highlights how the use of this tool in an outpatient work routine can bring benefits by increasing the safety of not missing incidental small aneurysms in contrast-enhanced CT exams in a radiological routine. Our focus in the study was not to perform an accuracy study per se, analyzing the entire confusion matrix of false positives and negatives of the tool, but rather to analyze the impact of implementation in real-life scenario if the screening tool were to be operational in increasing the capacity to detect new positive cases.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-QI-1

### Expanded Scope of Practice Fellowships for Radiologists: A Survey of Interest Amongst Current Canadian Radiology Residents

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Nick N. Maizlin, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Radiology residents acquire a diverse educational experience and skill set, including a general internship year, which may enable the direct management of patients. However, in order for radiology residents to define new scopes of practice, additional fellowship training in clinic be warranted in certain instances. Indeed the lack of patient interaction and loss of control over patient referrals may be counterproductive to our specialty and one of the reasons interest in radiology residency is declining amongst medical students. Although the rise of interventional radiology as a distinct specialty has partially filled this void, there remains significant opportunity to expand the future scopes of practice available to motivated radiology trainees.

#### METHODS

Using the Canadian family medicine Enhanced Skills Program as a model, we conducted a Canada-wide survey of radiology residents to assess interest in additional fellowship training to expand their scope of practice. We undertook a national survey of radiology residents in Canada to determine their interest in completing further fellowship training in expanded scope of practice fellowships (referred to herein as "clinical fellowship"). We define a "clinical fellowship" as distinct from traditional diagnostic imaging and interventional fellowships and include low risk anesthesia, non-surgical breast disease, cancer screening, chronic pain, clinician scholar, diabetes and wound care, emergency medicine, hospital medicine, incidentaloma management, low risk obstetrics, medical oncology, palliative care, public or environmental health, renal stone disease, sports and exercise medicine, vascular/atherosclerosis medicine and "other", where we queried resident's interest.

#### RESULTS

Our results indicate that a majority of residents (69.2%) would like to routinely see patients in clinic and more than half (52%) are willing to undergo an additional year of fellowship to enhance their skill set. The most popular choices for such fellowships were sports medicine (22.8%), emergency medicine (19.6%) and vascular medicine (18.5%). In addition, a majority (52.9%) of residents felt capable of offering incidentaloma clinics without additional training beyond their core radiology residency.

#### DISCUSSION

Traditional diagnostic and interventional radiology fellowships must be reconsidered to reflect the interests and capabilities of modern radiology trainees. Expansion of training options into the domain of direct patient management will likely prove popular among current residents.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M2-QI-2

### Effect of Standardization on Time Spent by Patients in Recovery Nursing Units after Interventional Radiology Procedures

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Ashok Srinivasan, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

While there are society guidelines for withholding anti-coagulation medication for interventional radiology procedures, there are no universally accepted standards for post procedural observation times. Potential variations amongst proceduralists in prescribed recovery times for the same procedure can result in increased time spent by nursing staff clarifying the order accuracy (e.g., different providers prescribing 30 minutes versus 2 hours post lumbar punctures), and affecting room efficiency in a busy practice. The goal of our study was to evaluate the effect of standardizing post procedural observation times for interventional procedures on actual times spent by patients in recovery units.

#### METHODS

Post procedural recovery units at our institution cater to 3 cohorts of patients: Vascular interventional radiology (VIR), Neurointerventional Radiology (NIR) and Neurodiagnostic Radiology (NDR). A list of all procedures performed in each of the 3 areas was compiled and sent to the respective services to create a consensus list for recovery times per procedure. The final list was circulated to the proceduralist teams and nursing teams in recovery units for implementation. We monitored the overall time spent by patients in recovery units in each cohort before and after implementation. We also monitored risk reports prior to and after implementation to determine if there was any change in number or types of complications. Lastly, informal surveys of the nursing staff were conducted to understand whether standardization changed the frequency of phone calls to clarify orders.

#### RESULTS

Pre implementation spanned Jan-Dec 2021 and post implementation Jan-Dec 2022. Our data demonstrated the following pre and post implementation recovery times (in minutes): - MEDIAN: Overall (56 vs 49), NIR (140 vs 134), NDR (123 vs 61), VIR (45 vs 45) AVERAGE: Overall (85 vs 73), NIR (154 vs 143), NDR (119 vs 61), VIR (69 vs 66) There were no changes in the number of risk reports related to post procedural complications after implementation. Informal surveys of the nursing staff post implementation revealed a significant drop in phone calls placed for order clarification.

#### DISCUSSION

Post implementation, greater than 10% reduction in average and median times was achieved overall for all procedures. The largest effect was seen in NDR procedures with nearly 50% reduction (both median/average) whereas the change in NIR procedures was 4/8% (median/average) and VIR procedures was 0/4% (median/average). Our results probably indicate that standardization can work in reducing variations but have limitations as well; the impact may be different from segment to segment based on the degree of pre-existing variations. However, even in areas where standardization did not change the times substantially, there was tangible benefit in terms of eliminating many phone calls placed for order clarification.

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## Abstract Archives of the RSNA, 2023

M2-QI-3

### Quality Improvement of Transcatheter Aortic Valve Replacement with Femoral Access: Identifying the Femoral Artery Bifurcation Using CT and 3D Modeling

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Aniruddh Mandalapu (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Retroperitoneal hemorrhage (RPH) is a potentially fatal complication of cardiac catheterization using the transfemoral route, with an incidence ranging from 0.15-6%. Although the reported incidence appears small, considering the large number of percutaneous coronary interventions (PCIs) and diagnostic catheterizations performed in the United States, the absolute number of RPH cases is in the thousands. RPH carries a mortality risk of 4-12% and is associated with significant morbidity, including an increase in hospital stay and the need for blood transfusions. Reducing its incidence is crucial. This paper examines the implementation of a protocol at the University of Rochester Medical Center at the end of 2016 that aimed to reduce the incidence of RPH during cardiac catheterization procedures. The protocol involved radiologists giving the location of the femoral artery bifurcation relative to the inguinal ligament to interventional cardiologists for a Transcatheter Aortic Valve Replacement (TAVR) procedure using femoral access.

#### METHODS

The protocol involved radiologists identifying the location of the femoral artery bifurcation relative to the inguinal ligament using CT with contrast and communicating it to interventional cardiologists through a report on eRecord as well as a visual representation from the university's 3D lab. The interventional cardiologists then used this information to determine whether there was an access site of adequate length for femoral access or if the femoral bifurcation was too high. In this scenario, they would avoid the femoral vessel.

#### RESULTS

The implementation of the protocol led to greater confidence with femoral vessel access among cardiac proceduralists by adding an extra check to the existing methods of physical exam and ultrasound to prevent retroperitoneal bleeds. It led to a reduction in the incidence of retroperitoneal hematomas during TAVR procedures using femoral access with 0.47% of procedures resulting in a retroperitoneal hematoma from 2012 to 2016 compared to 0.29% from 2017 to 2023, representing a marked improvement in patient safety. Proceduralists at the institution continue to rely on the model between multidisciplinary meetings and the day of the procedure to inform their choice of access.

#### DISCUSSION

The implementation of the protocol highlights the importance of effective communication and collaboration between radiologists and interventional cardiologists during TAVR procedures using femoral access. By ensuring clear communication between radiologists and proceduralists and creating 3D visual models as reference, patients can receive safer care with more safety measures to prevent retroperitoneal bleeds in TAVR procedures. This protocol can serve as a model for improving planning and reducing complications during other vascular procedures.

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## Abstract Archives of the RSNA, 2023

M2-QI-4

### Assessment Driven Approach to Integrating Volumetric Software for MRI in Dementia

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Michelle Pisa, DO (*Presenter*) Nothing to Disclose

#### INTRODUCTION

In the workup of the dementia patient, brain MRI plays an important role in excluding alternate pathologies. It can also assess patterns of atrophy, potential imaging biomarkers which complement cognitive and laboratory testing in the dementia diagnosis. Existing visual grading scales depend on reader experience and lack reference to age-matched controls. As disease-modifying treatments are becoming available, separation of normal aging from early dementia is gaining increased urgency. Several commercially available software products perform MRI brain volumetry with reference to age-matched controls but lack clinical validation. At our institution, clinicians requested incorporation of volumetric software on MR imaging for dementia. We pursued an internal evaluation of how the addition of these Quantitative Reports (QR) would influence both our standard Radiology reporting and clinical practice.

#### METHODS

We used an Ai platform (Blackford) to sequentially enable QR from two different software vendors, Cortechs.ai (NeuroQuant Age-related Atrophy) and Icometrix (Icobrain DM). For both products, the manufacturer-specified imaging sequence was incorporated into our existing MRI Dementia protocol. The routine MR images were interpreted by 1 of 6 CAQ-certified Neuroradiologists. Several months later, they were presented with the corresponding QR, asked to re-review the MRI exam in context, and prompted with a questionnaire to assess the impact of the QR on their original interpretation. The QR was also sent to 1 of 4 participating Neurologists, who were asked to review the routine MR images, the QR, and prompted with a questionnaire to assess the impact of the QR on the imaging interpretation and their clinical management.

#### RESULTS

For Radiologists and Neurologists, the QR presented from both products affected the interpretation of the conventional MRI imaging in 1 of every 4/5 cases (19-29%). The most frequently reported change was the detection of atrophy, in particular hippocampal atrophy. For both products, and compared with Radiologists, the Neurologists indicated increased confidence in both the imaging exam and the interpretation with the addition of the QR. For both products, Neurologists indicated the influence of QR on their clinical interpretation in 9 out of 10 cases (90-97%), with a strong influence in 1 out of 3 cases (27-37%). Neurologists also indicated a change in management in 1 of 3 cases (27-34%) based on the input of QR.

#### DISCUSSION

Addition of QR affected the MR imaging interpretation for both Neurologists and Neuroradiologists, mainly with regard to hippocampal atrophy. Neurologists indicated a stronger influence of the additional data on their interpretation of the MRI and on clinical management. Assessment data was used to inform the purchasing decision, establish interpretation standards, and outline a clinical workflow.

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## Abstract Archives of the RSNA, 2023

M2-QI-5

### Implementation of a Structured Observership Program for Improving Recruitment of Radiology Trainees: A Novel Analysis

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Indrajeet Mandal, MBBS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Diagnostic Interventional Radiology continues to increase in demand. Despite this, there is a significant workforce shortage of radiologists in the UK (vacancy rate of 10%) and Europe. There is therefore a clear need to recruit more radiologists in order to meet this increased demand for imaging and image-guided therapy. There are many factors influencing choice of Radiology as career, including "current exposure", "work life balance" and "diversity of the field". Early exposure through observerships is proven to increase interest in radiology. Medical school exposure remains universally low, and there are very few intern level rotations in radiology within the UK (20-30 rotations out of 8000 per year). Therefore, junior doctors are reliant on observerships as their primary exposure to radiology. Here, we provide novel insight into the activities during a tailored Radiology Observership at our institution.

#### METHODS

Over the course of one year, our department of radiology ran a programme for rotating junior doctors. A feedback form was distributed. Candidates were asked multiple of questions, including ranking options on a Likert scale and free text responses.

#### RESULTS

A total of 22 responses were obtained. 100% met their aims. The experience influenced the likelihood of applying to radiology in 92% of respondents; 4% were less likely to apply, 88% were more likely to apply for a radiology program. All sessions were well received. Interventional radiology was the highest rated activity (83% very satisfied), followed by emergency room duty radiology (75% very satisfied) and acute CT reporting (69% very satisfied). Free text comments suggested that participants found the MDT difficult to engage with and experienced lower levels of satisfaction compared to other activities.

#### DISCUSSION

All participants met their aim. A total of 88% of participants were more likely to apply for Radiology, supporting the evidence that an observership is an influential factor in specialty selection. The high satisfaction with IR demonstrates that practical opportunities were very well received. The same trend was not observed for ultrasound. Simulation offers a potential adjunctive solution. Generally, participants were most satisfied with one-to-one sessions. This highlights the importance of a named mentor, and adds further support that role models are a crucial part of the experience. The MDT content was too advanced their level, highlighting an educational gap. Future work should identify strategies to improve engagement with this activity e.g. virtual MDTs to present practice cases. In conclusion, providing high value educational opportunities is vital to ensure future recruitment to radiology. To our knowledge, our study is the first to analyse the activities within an observership week. Maximising engagement and participation as well as role models are crucial in these settings.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-QI-6

### Reducing Unnecessary OR Calls Related to Specimen Imaging

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Uzma Waheed, MD (*Presenter*) Consultant, Becton, Dickinson and Company

#### INTRODUCTION

After pre-operative localization and surgical excision a specimen radiograph is obtained to confirm excision of the targeted lesion. Unfortunately, our radiologists are often contacted by the surgical team before the specimen radiographs are available on our PACS. This delays specimen image interpretation and prolongs patient time in the OR. A quality initiative was initiated to correct this suboptimal workflow. Baseline data showed that 35% of all OR specimen radiograph orders result in multiple calls to breast imaging. Our goal was to reduce unnecessary phone calls from 35% of OR specimen radiographs in December 2022 to 10% by April 2023.

#### METHODS

At our center, specimen imaging is performed in the OR by surgical staff on a dedicated specimen x-ray unit. Surgical staff transfer tissue to the specimen radiograph unit, select the correct patient/accession number, obtain the image, which is sent to PACS, and call the breast imaging on-call phone to discuss results with the breast radiologist. Should technical issues arise during this process, the OR staff calls the lead breast imaging technologist for assistance. During 5-day data collection periods, the breast radiologists and lead breast imaging technologist completed a standardized form when they received unnecessary phone calls including: images not available in PACS, images in the wrong accession number, or calling the wrong phone number for image interpretation. These forms were compiled and reviewed, and a root cause analysis was performed. Unnecessary calls were categorized into workflow error and equipment error. We then designed and implemented interventions targeted to address these causes including updated signage, and easy to read operating instructions for specimen radiograph units.

#### RESULTS

Pre-intervention data showed 17 OR specimen radiographs were ordered in a 5-day period. 35% (6/17) of OR specimen had unnecessary phone calls. 83% (5/6) of calls were workflow related and 17% (1/6) were equipment error. Our interventions were aimed at improving workflow by (1) providing clear, written instructions for OR staff and (2) promoting engagement with OR staff, (3) creating reference user-guides posted in the OR and (4) providing OR technologist in-service training. These interventions reduced unnecessary OR specimen phone calls from 35% to 0% between December 2022 and April 2023.

#### DISCUSSION

With multidisciplinary engagement and basic interventions, we were able to reduce unnecessary interruptions in our department from 35% to 0%. These interventions enabled OR staff to independently troubleshoot prior to engaging with the breast imaging department. Limitations: Our OR specimen workflow may not be consistent with all breast imaging/surgery departments. Our data collection periods were short (5 days) with a small sample size. We did not directly measure time savings achieved by workflow improvements.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-QI-7

### New Approach to Staff Performance Evaluation: A Proof of Concept Pilot

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Nadja Kadom, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

**Problem Description:** Our current staff performance metrics do not match our organization's stated goals. **Available Knowledge:** Traditional staff performance metrics require that supervisors rate their reports on scales, typically ranging from "exceeds expectations" to "needs improvement". The system has been widely criticized as performance ratings may be affected when the rater harbors biases against a staff member, when there is lack of clearly stated performance standards and lack of transparency regarding objective means of performance measurement. **Purpose:** Pilot testing of new staff performance evaluation approach

#### METHODS

**Context and Intervention:** The new performance evaluation system was piloted throughout 2022 at one of our Healthcare System sites ("test site"). Staff are evaluated on a number of metrics reflecting various experience levels (Figure 1). **Study of the Intervention:** We compared retention rates and distribution of performance categories between the test site and another site ("comparison site") from 2020 through 2022. **Measures/Metrics:** Retention rates, Percent of performance ratings in the categories: (1) Needs improvement, (2) Meets expectations, (3) Does NOT meet expectations, (4) Exceeds expectations, (5) Commendable. **Analysis:** We used staff retention rates and staff engagement scores and simple descriptive statistics

#### RESULTS

**Retention rates:** After a significant decrease in staff retention in 2020 and 2021, the test site almost completely recovered to pre-pandemic retention rates in 2022. The comparison site experienced only a minimal decrease in the retention rate in 2021, but a dramatic drop in 2022. **Performance categories in 2022:** The test site added a new performance category of "commendable" and almost 10% of staff met the criteria for this category, the comparison site did not have this category. Staff at the test site met the criteria for "exceeds expectations" in almost 35%, while this category was met by only 21% of staff at the comparison site. The "needs improvement" category applied to 4% at the test site versus 11% at the comparison site. In addition, the staff engagement scores (maximum score 5.0), unavailable for 2020) continuously improved at the test site (2019: 3.65, 2021:4.16, 2022: 4.25) while they trended downward at the comparison site (2019: 4.04, 2021: 3.83, 2022: 3.78).

#### DISCUSSION

We successfully piloted a new performance evaluation system at one of our radiology service sites. We developed a set of performance metrics with definitions and explanations on how performance is measured and that was shared with our staff. The data has us hypothesize that the new process may have an effect on higher retention and that it may serve as a driver for better employee performance. Engagement scores at the test site are more favorable, which could, at least in part, be attributed to the new performance evaluation system.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M2-QI-8

### Improving In-patients Access to MRI Through Enhanced Communication and Optimized Scheduling Process: A Tertiary Hospital Experience

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Abrar Hlwani, MSc, BSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Access to inpatient MRI is a challenge affecting the length of stay, and treatment management plan which negatively affects patient experience, staff satisfaction, and increases cost of service. Improving access to inpatient MRI is complex due to predominantly outpatient based service, long exams time, safety procedures, and increased demand. Our institution is a 400 beds tertiary center operating 2 MRI scanners. Inpatient MRI imaging accounts for 20% of our MRI workload. The turnaround time (TAT) for inpatient MRI was approximately 2-3 Days. We initiated this project to improve the efficiency of Radiology processes in MRI, to achieve 80% of inpatients MRI within 24 hours.

#### METHODS

6 months baseline data were collected to identify the TAT from MRI requests until the patient had access to MRI. Root cause analysis (RCA) was performed to identify the major causes of delays. MRI section based daily inpatient MRI access TAT review; department based weekly and organizational-based monthly review of progress was commenced. The data was analyzed by Control Chart and one way ANOVA, considering a significance level of less than 0.05.

#### RESULTS

Baseline review of MRI access TAT data showed that only 65% of the patients received MRI scans within 24 hrs. in a period of 6 months. Median access time was 30 hours (Range from 3 to 169 hrs). RCA identified multiple causes of delays. The 3 main causes included no inpatient MRI slots, no general anesthesia slots, and incomplete MRI consent forms. Patient care was improved by increasing inpatient MRI slots. Technologists' workflow and shifts were adjusted to maintain outpatient productivity. Electronic MRI preparation and consent forms were launched. Frequent education sessions were done to inpatient units and referring teams to unify the workflow. After 7 months of multiple PDSA cycles, a sustained monthly target of achieving 80% inpatient TAT within 24hrs was achieved. After all performance improvement interventions, the median access time for MRI was 10 hrs. (Range from 1 - 90 hrs.) One way ANOVA was performed and found a significant improvement from baseline in TAT during PDSA cycles and postproject period with a P value of 0.001. A control chart assessed progress during the project and sustainment of the improvement. Two data points were found to lie outside the control limits around the same month in 2 consecutive years. This was due to a national holiday where only emergent cases were given priority.

#### DISCUSSION

A robust process improvement initiative focused on capacity planning and enhanced communication helped reduce median access time to MRI by 67% (from 30 hrs. to 10 hrs.). Approximately 94% of the in-patient had access to MRI within 24hrs. Maintaining quality improvements is crucial; our data analysis shows the sustainment of the improvement 27 months after completing PDSA cycles.

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## Abstract Archives of the RSNA, 2023

M2-QI-8HC

### Enhanced Detection of Brain Aneurysm on CT Angiography using an AI Solution in a Private Practice Outpatient Setting

Monday, Nov. 27 9:00AM - 9:30AM Room: Learning Center

Bruno A. Rocha, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Unruptured intracranial aneurysms are a relatively common pathology, with data estimating a prevalence of around 3% in the adult population. Their incidental diagnosis has raised over time due to the increased use of intracranial contrast imaging tests for various reasons, whether in outpatient or hospital settings. We also know that the use of artificial intelligence for medical image analysis has been widely discussed and implemented in various areas of radiological knowledge. Within this context, the purpose of this study was to evaluate the impact that the use of an AI tool for screening aneurysms in contrast-enhanced CT cranial exams would have in an outpatient setting in relation to an enhancement in the aneurysm detection rate.

#### METHODS

A retrospective study to identify 2,560 contrast-enhanced CT cranial scans were performed between 4/7/2022 - 5/31/2022 at a large, private practice, primarily focused on reading for outpatient clinics. The images and reports were classified using an AI algorithm and natural language processing (NLP) algorithm. For concordant cases, the ground truth was assumed. Cases found to be negative by report (NLP) and positive by AI were re-reviewed by two neuroradiologists to establish a consensus-based ground truth.

#### RESULTS

The prevalence of BA was 1.0% (26/2560). AI detected 10 additional discordant cases, as negative by report but positive by AI. Of these, 90% (9/10) were considered a true positive on the neuroradiologist's secondary review. The AI-enhanced detection rate was 34.6% (9/26).

#### DISCUSSION

In this hypothetical retrospective scenario, the AI triage tool demonstrated a significant increase in the detection rate of incidental small aneurysms. Upon reviewing the additional 9 cases that were missed by the radiologists but detected by the AI screening system, we noticed that they were all cases of small aneurysms (<7 mm) in exams where clinical suspicion was not focused on the detection of aneurysms or intracranial bleeding. This finding highlights how the use of this tool in an outpatient work routine can bring benefits by increasing the safety of not missing incidental small aneurysms in contrast-enhanced CT exams in a radiological routine. Our focus in the study was not to perform an accuracy study per se, analyzing the entire confusion matrix of false positives and negatives of the tool, but rather to analyze the impact of implementation in real-life scenario if the screening tool were to be operational in increasing the capacity to detect new positive cases.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5A-QI

### Quality Improvement Reports Monday Poster Discussions I

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### M5A-QI-1 Revamping Feedback from Radiologists to Technologists

Nadja Kadom, MD (*Presenter*) Nothing to Disclose

##### INTRODUCTION

**Problem Description:** In our large, multi-hospital pediatric facility radiologists have used the electronic medical record system functionality to give feedback to technologists on image quality issues. The technologists perceived the feedback as not helpful and sometimes inappropriate in tone. **Available Knowledge:** A literature search and an online radiology quality community query were conducted and provided limited existing information for designing a better feedback system. **Purpose:** To develop a more effective feedback system from radiologists to technologists.

##### RESULTS

The survey was sent to 40 members of the department and here were 36 responses inclusive of all imaging modalities, the response rate was 90%. We received 8 suggestions for improvement that were incorporated in the final version of the feedback categories and explanations, otherwise respondents agreed with the proposed categories and explanations/examples. After incorporation of the suggestions from the survey, the final feedback system covers six modalities (CT, MRI, radiography, Ultrasound, fluoroscopy and nuclear medicine) (Table 1).

##### METHODS

**Context and Intervention:** The study was performed in an academic pediatric radiology department. New feedback categories were developed iteratively using a team approach. **Study of the Intervention:** A proposed feedback system containing various feedback categories specific to each modality along with examples for each category and a survey were sent to radiologist modality champions, leaders, technologists, modality managers, and members of the quality team. Respondents rated each category and explanation and were able to submit feedback. **Measures/Metrics:** Survey response rates, agreement rates, and qualitative feedback. **Analysis:** Descriptive statistics were used to analyze survey responses.

##### DISCUSSION

We used an iterative interprofessional approach to develop modality specific feedback categories and examples that can be implemented through our electronic medical record system, where each feedback category can be selected as a button, hovering the mouse over the button gives examples for that category, and an open comment box invites the radiologist to add more detail. Technologists felt strongly that the "Excellent!" feedback should be included, but should be defined more clearly. In addition, technologists requested that radiologists can submit interesting learning cases for technologists. The new feedback categories and process reflect a change in our culture that emphasizes learning, coaching, and quality improvement. As a result, our departmental performance assessment policy for technologists was revised.

#### M5A-QI-2 Effect of Financial Incentive on Radiologist Compliance with Quality Metric Placement in Knee Radiograph Reports

Shuda Xia (*Presenter*) Nothing to Disclose

##### INTRODUCTION

Ongoing quality improvement processes in our department include insertion of standardized Kellgren-Lawrence (KL) grade templates in the knee x-ray reports. Grade III and IV templates also include a statement indicating that MRI is typically not useful for further assessment of internal derangement. It was previously shown that this approach results in a significant decrease in unnecessary MRIs. However, uniform adoption of this grading system is lacking due to the time pressures, and additional effort needed. In a department-wide effort at our large University system, financial incentives were instituted for different divisions to improve compliance with such metrics. The purpose of this study was to evaluate the effect of financial

incentives as a pay bonus on the percentage of final radiology reports that contained KL grading system. We also compared compliance of musculoskeletal (MSK) radiologists to the compliance of general radiologists whose incentive bonus was based on metrics other than KL grading.

## **METHODS**

Knee x-ray reports stored in our PACS system were searched to determine the percentages of all knee radiograph reports that contained KL grading with standardized follow-up recommendations before and after introduction of the new quality-based incentive bonus. The radiologists were made aware of the new incentive plan in May 2022 during the general faculty meeting and again in June 2022 during the MSK divisional meeting. We compared compliance rates during the first six months of 2022 to the last six months of the same year. Rates of compliance by musculoskeletal radiologists were compared to rates of compliance by general radiologists.

## **RESULTS**

There was a 10% increase in KL grading statement compliance by MSK radiologists during the three months immediately after the introduction of the new incentive bonus. Both musculoskeletal radiologists and general radiologists demonstrated steady improvement in compliance over time before and after introduction of incentive plan averaging 2% of improvement per month. Musculoskeletal radiologists' rates of compliance were on average 24% higher than general radiologists.

## **DISCUSSION**

Introduction of financial incentives results in accelerated adoption of the required QA practice with steady and progressive improvements, more so among MSK than the non-incentivized general radiologists.

### **M5A-QI-3 Online Teaching Promotes Equity in Radiology Education by Improving Outreach and Reducing Disparity**

Akshay D. Baheti, MD (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Formal radiology training in our setting is stronger in tier I city hospitals and academic institutions compared to smaller residency programs. The former also provides more opportunities for attending conferences and external lectures. Trainees and practicing radiologists in tier II and III cities have lesser opportunities for radiology education. Similarly, less developed nations in Asia and Africa do not have high quality residency programs with advanced imaging. This leads to a discordance in both national and international radiology training and practice standards. The authors manage the Radiology Education Foundation and the Café Roentgen educational initiatives. In order to overcome these barriers, we conduct regular free-to-attend Zoom-based radiology webinars since May 2019, and have completed over 525 webinars. The purpose of this study was to analyze the reach of the webinars.

## **METHODS**

The webinars were conducted on Zoom™ platform as triweekly one-hour sessions (Wednesday, Saturday and Sunday evenings). A national speaker spoke every Wednesday and an international speaker every Sunday, while an interactive case-based session was conducted on Saturdays. No pre-registration was required. The schedule was made available on website, email, Whatsapp, Facebook, Telegram and Twitter. Majority sessions had two-four panelists (speaker and moderators). Attendance related data from the last 307 consecutive webinars was available on Zoom and was downloaded as a .csv file. Unique viewers were defined as those who viewed the webinar via their computers; phone logins were excluded. Attendees who logged in multiple times or using multiple devices were counted only once. Maximum concurrent viewers were defined as the maximum viewers logged in at the same time, excluding panelists. Country wise login data was available for analysis. The data was analyzed using descriptive statistics.

## **RESULTS**

307 consecutive webinars by 236 different speakers were conducted between Oct 2020 - Apr 2023. The webinars had a median of 256 unique attendees (mean: 278.5; range: 67-654). They had a median of 194 maximum concurrent viewers (mean: 212.6; range: 46-514). Overall, viewers from a median of 28 countries (mean: 27.6; range:14-41) across all six continents attended the webinars.

## **DISCUSSION**

Our webinars had a median of 256 unique and 194 maximum concurrent attendees from 28 countries. More granular level data as for example audience feedback and duration of attendance per attendee was not available for analysis. Regular online webinars are a sustainable model of radiology education and cut across local, national and international barriers. The individual and country-wise attendance per session exceeds that of most conferences. Educators should consider focusing more on the webinar model of education.

### **M5A-QI-4 Frequency and Impact of Using Incomplete Information When Assessing Patients with Active Implants for MR Scanning**

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Implants are an additional risk in the MR environment due to potential heating and displacement. Active implants have a power source and may also malfunction in the MR environment. Scanning implant patients safety requires collecting all relevant patient and device data and adhering to the vendor manual to assess ability to scan and ensure safe technique when scanning. This project assessed how often collected data was incomplete, what was missing, whether it could impact patient assessment or scanning, and whether an intervention to make downloading the most recent manual was effective.

## METHODS

A workflow management system for active implant scanning was implemented in April of 2020. Information in each patient (including vendor device manual) is collected by the MR Safety Officer and sent to the MR Safety Expert for analysis and determination. Summary statistics related to percentage of cases where information was incomplete was determined. Further, whether the incomplete data impacted decisions or scanning was determined. Finally, on December 27th of 2021, a "two-click" option for the MR safety officer to collect the most recent information was implemented. Success of this intervention is determined.

## RESULTS

The MR safety Officer report was assessed for 755 cases (518 unique patients). The assessing physicist recorded incomplete or incorrect data in 122 cases (16.2%). Of the 122 cases with incomplete/incorrect data 109 cases (89.3%) recorded the reason. Of the cases with a recorded reason 81 cases (74.3%) were due to upload of an outdated manual. The system recorded whether the error/omission could impact decision or scanning in 66 cases (54.1%). Of those, 31 cases (47%) could have impacted decisions or scanning. An improvement to ease access to the most recent manual was implemented. Initially the completion rate plummeted due to increased surveillance of old manuals, but quickly recovered and improved.

## DISCUSSION

This project reports rates of incomplete information being used for assessment of MR active implant patients. While the percentage is low, does indicate a potential issue. It identified the largest source of incomplete data (old device manuals) and implemented a method to make pulling manuals easier. The intervention resulted in improvement in of the completion percentage once the new methods diffused through the pool of MR Safety Officers.

## M5A-QI-5 The Implementation and Impact of a Medical-Student Reading Room Assistant Program

Lindsey K. Greenlund, BS (*Presenter*) Nothing to Disclose

## INTRODUCTION

On average, Radiologists are interrupted from image interpretation every 12.1 minutes. During after-hour call, these interruptions are not only increased, but managed by a single resident, increasing turn-around time and errors. Additionally, selecting the appropriate technique (protocol) for cross sectional scans is a task requiring significant resident time and is frequently delayed due to high volumes. Delayed protocolling can result in lack of prior authorization and issues with insurance reimbursement. Medical students were identified as motivated individuals who can make drastic contributions in the reading room by triaging pages and protocolling select non-contrast CT and MRI imaging. In this study, we report the results of nearly two years of the implementation and utilization of a paid medical student Reading Room Assistant (RRA) for weekend call shifts at our institution.

## METHODS

Jan 2020- Jun 2020 was utilized to document the extent of interruptions for the Radiology residents. Jun 2020- Aug 2021 was spent creating the RRA position and training modules. Six medical students were selected for the position in Fall 2021 with training completed by May 2022. RRAs worked 5-hour segments on the busiest weekend shifts; data was collected on the position over a subsequent 10-month period. Interruptions, scans protocollered by RRAs, and brief medical student RRA feedback was collected in a survey at the end of each RRA shift. Further feedback on the position was collected from the RRAs 10 months into the program. Data and responses were analyzed.

## RESULTS

During Jan 2020- Jun 2020, on-call residents were interrupted an average of 10.3 times per hour by incoming pages and clinician calls, technologist questions, protocol requests, and outgoing pages. Over the 10-month data collection period, RRAs responded to 854 incoming calls, 474 pages, 765 technologist questions, and made 688 outgoing calls. They also protocollered 3681 chest CTs, 145 neuro MRIs, and 169 abdominal CTs. Per resident survey responses, 100% reported being better physicians while working with an RRA and preferred the RRA program to continue. The majority of medical student RRAs reported in a survey being "Extremely likely" to apply to Radiology residency positions following involvement with the program. Respondents reported the most valuable aspects of the program to be exposure to Radiology, learning the flow of the reading room, and getting to know the residents.

## DISCUSSION

The implementation of the RRA program at our institution was successful and valuable as medical students were able to significantly decrease interruptions, protocol thousands of non-contrast CT and MRI exams, and improve resident reported quality of work. Further, this program allowed medical student RRAs to explore their interest in Radiology and has the benefit of attracting hard-working, motivated candidates to the field.

### **M5A-QI-6 Communicating Urgent Discrepancies Between Preliminary and Final Reports: Increasing Trust Between Radiology and Emergency Departments**

Andrew Johnston, MD, MBA (*Presenter*) Nothing to Disclose

## INTRODUCTION

Radiology residents in our hospital system publish full-length preliminary reports while on call. With increasing emergency department volumes, emergency physicians rely on preliminary reports to make triage and treatment decisions. Though one meta-analysis (Wu M, Radiology 2014) showed no significant difference in resident-to-attending and attending-to-attending interpretation discrepancy rates, the addition of a more experienced reader leads to changes that require alerting the ED. The goal of our project was to increase the rate of communication of urgent discrepancies between preliminary and final radiology reports for cross-sectional studies from 75% to 90% in 20 weeks.

## RESULTS

The run chart shows an increase in the percentage of documented communication events for urgent changes of cross-sectional study reports from 75% to 90.6%. Additionally, the interventions increased the percentage of documented communication events for all report discrepancies from 6.6% to 7.0%.

## METHODS

A team of stakeholders from radiology and emergency medicine developed an improvement process via a guided quality improvement curriculum. The team performed a detailed analysis of the current state and identified potential root causes and key drivers. We documented our analysis using a structured problem-solving tool. All radiology reports for studies ordered through the emergency department during the intervention period were queried via the PowerScribe web API and categorized according to modality (cross-sectional or plain film) and type of report discrepancy (no change, non-urgent change, or urgent change). Key drivers and interventions were developed and refined through Plan-Do-Study-Act cycles. Interventions implemented during this project included linking a secure messaging system to our PACS, adding options for multiple methods of communication to our standard reporting template, and educating radiologists about the process for communicating report discrepancies.

## DISCUSSION

Our study showed an increased rate of communication for urgent changes between preliminary and final reports of cross-sectional studies. Limitations of the study include variation in opinions of what constitutes an urgent or non-urgent change, interventions were performed with a small subset of the radiology department, and our reliance on report text to identify communication events may underestimate the true volume of communication. The next steps for our project aim to increase communication across all study types and urgency levels. We will do this by developing a reliable process for rapidly identifying report discrepancies not communicated, organizing focused interdepartmental meetings to operationalize the definition of urgent and non-urgent changes, and incorporating a review of communication errors into peer learning meetings.

### **M5A-QI-7 QI Bootcamp - A Novel Approach to Engage Radiology Residents in QI**

Pratik V. Rachh, MD, MBA (*Presenter*) Nothing to Disclose

## INTRODUCTION

Problem Statement Per ACGME QI Milestones for Diagnostic Imaging, residents are required to demonstrate skills and knowledge related to Quality and Safety, including completion of a QI project. Most residents work on their project requirement in the 4th year once they have passed boards and have a less demanding schedule. Informal interviews showed that residents felt unsupported in meeting QI milestones and quality leadership noted that some resident QI projects lacked rigor and correct application of QI tools. Several residents stated there was no single list of QI projects that they could access and that they often had to find a project by themselves. ACGME requirements was perceived as a formality to be checked off to graduate. Purpose The goal of the bootcamp was to serve as a refresher for QI knowledge and to provide coaching for project completion.

## METHODS

1st and 4th year DR, IR and NM residents were emailed to voluntarily sign up for a 4.5-hour "QI Bootcamp" in March 2023. We invited 1st and 4th year residents as they tend to have the most time available for a QI project. The QI bootcamp was led by a 1st year QI Track resident (QI Track is one of the several tracks available to trainees to enhance their skills beyond clinical radiology) and by the Interim Medical Director for Quality in Radiology. A list of potential QI projects, and agenda was

emailed to attendees in advance. Measures We administered a pre- and post-knowledge assessment survey. Post survey included supplemental questions to assess bootcamp objectives. Survey data was analyzed using Microsoft Excel.

## **RESULTS**

19 residents signed up and 13 attended the session. 13 residents completed the pre-survey and 12 completed the post-survey resulting in a 92% response rate. In aggregate, correct response to knowledge items improved from 55% to 74% pre and post-survey respectively. A detailed review showed baseline proficiency with Lean concepts (waste, value add vs. non-value add, and process mapping) where 92% of the respondents selected correct responses. Residents were less knowledgeable of driver diagram, fishbone diagram, run charts and change management for which the pre-survey correct response rate ranged from 15-50%. However, residents made the most improvement in those concepts after the didactics. Pre and post-survey analysis showed resident QI project participation improved from 31% to 82%, respectively. Analysis of the feedback questions indicated that 85% of respondents rated the bootcamp favorably. Review of "what went well?" and "what could be improved?" questions gave perspective for future improvement.

## **DISCUSSION**

The QI bootcamp was well perceived and is probably best suited for R1 and R4. The event resulted in increased knowledge and a higher number of residents committed to a QI project. Group activities were most popular, especially brainstorming QI project ideas.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-QI-1

### Revamping Feedback from Radiologists to Technologists

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Nadja Kadom, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

**Problem Description:** In our large, multi-hospital pediatric facility radiologists have used the electronic medical record system functionality to give feedback to technologists on image quality issues. The technologists perceived the feedback as not helpful and sometimes inappropriate in tone. **Available Knowledge:** A literature search and an online radiology quality community query were conducted and provided limited existing information for designing a better feedback system. **Purpose:** To develop a more effective feedback system from radiologists to technologists.

#### RESULTS

The survey was sent to 40 members of the department and here were 36 responses inclusive of all imaging modalities, the response rate was 90%. We received 8 suggestions for improvement that were incorporated in the final version of the feedback categories and explanations, otherwise respondents agreed with the proposed categories and explanations/examples. After incorporation of the suggestions from the survey, the final feedback system covers six modalities (CT, MRI, radiography, Ultrasound, fluoroscopy and nuclear medicine) (Table 1).

#### METHODS

**Context and Intervention:** The study was performed in an academic pediatric radiology department. New feedback categories were developed iteratively using a team approach. **Study of the Intervention:** A proposed feedback system containing various feedback categories specific to each modality along with examples for each category and a survey were sent to radiologist modality champions, leaders, technologists, modality managers, and members of the quality team. Respondents rated each category and explanation and were able to submit feedback. **Measures/Metrics:** Survey response rates, agreement rates, and qualitative feedback. **Analysis:** Descriptive statistics were used to analyze survey responses.

#### DISCUSSION

We used an iterative interprofessional approach to develop modality specific feedback categories and examples that can be implemented through our electronic medical record system, where each feedback category can be selected as a button, hovering the mouse over the button gives examples for that category, and an open comment box invites the radiologist to add more detail. Technologists felt strongly that the "Excellent!" feedback should be included, but should be defined more clearly. In addition, technologists requested that radiologists can submit interesting learning cases for technologists. The new feedback categories and process reflect a change in our culture that emphasizes learning, coaching, and quality improvement. As a result, our departmental performance assessment policy for technologists was revised.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-QI-2

### Effect of Financial Incentive on Radiologist Compliance with Quality Metric Placement in Knee Radiograph Reports

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Shuda Xia (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Ongoing quality improvement processes in our department include insertion of standardized Kellgren-Lawrence (KL) grade templates in the knee x-ray reports. Grade III and IV templates also include a statement indicating that MRI is typically not useful for further assessment of internal derangement. It was previously shown that this approach results in a significant decrease in unnecessary MRIs. However, uniform adoption of this grading system is lacking due to the time pressures, and additional effort needed. In a department-wide effort at our large University system, financial incentives were instituted for different divisions to improve compliance with such metrics. The purpose of this study was to evaluate the effect of financial incentives as a pay bonus on the percentage of final radiology reports that contained KL grading system. We also compared compliance of musculoskeletal (MSK) radiologists to the compliance of general radiologists whose incentive bonus was based on metrics other than KL grading.

#### METHODS

Knee x-ray reports stored in our PACS system were searched to determine the percentages of all knee radiograph reports that contained KL grading with standardized follow-up recommendations before and after introduction of the new quality-based incentive bonus. The radiologists were made aware of the new incentive plan in May 2022 during the general faculty meeting and again in June 2022 during the MSK divisional meeting. We compared compliance rates during the first six months of 2022 to the last six months of the same year. Rates of compliance by musculoskeletal radiologists were compared to rates of compliance by general radiologists.

#### RESULTS

There was a 10% increase in KL grading statement compliance by MSK radiologists during the three months immediately after the introduction of the new incentive bonus. Both musculoskeletal radiologists and general radiologists demonstrated steady improvement in compliance over time before and after introduction of incentive plan averaging 2% of improvement per month. Musculoskeletal radiologists' rates of compliance were on average 24% higher than general radiologists.

#### DISCUSSION

Introduction of financial incentives results in accelerated adoption of the required QA practice with steady and progressive improvements, more so among MSK than the non-incentivized general radiologists.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5A-QI-3

### Online Teaching Promotes Equity in Radiology Education by Improving Outreach and Reducing Disparity

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Akshay D. Baheti, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Formal radiology training in our setting is stronger in tier I city hospitals and academic institutions compared to smaller residency programs. The former also provides more opportunities for attending conferences and external lectures. Trainees and practicing radiologists in tier II and III cities have lesser opportunities for radiology education. Similarly, less developed nations in Asia and Africa do not have high quality residency programs with advanced imaging. This leads to a discordance in both national and international radiology training and practice standards. The authors manage the Radiology Education Foundation and the Café Roentgen educational initiatives. In order to overcome these barriers, we conduct regular free-to-attend Zoom-based radiology webinars since May 2019, and have completed over 525 webinars. The purpose of this study was to analyze the reach of the webinars.

#### METHODS

The webinars were conducted on Zoom™ platform as triweekly one-hour sessions (Wednesday, Saturday and Sunday evenings). A national speaker spoke every Wednesday and an international speaker every Sunday, while an interactive case-based session was conducted on Saturdays. No pre-registration was required. The schedule was made available on website, email, Whatsapp, Facebook, Telegram and Twitter. Majority sessions had two-four panelists (speaker and moderators). Attendance related data from the last 307 consecutive webinars was available on Zoom and was downloaded as a .csv file. Unique viewers were defined as those who viewed the webinar via their computers; phone logins were excluded. Attendees who logged in multiple times or using multiple devices were counted only once. Maximum concurrent viewers were defined as the maximum viewers logged in at the same time, excluding panelists. Country wise login data was available for analysis. The data was analyzed using descriptive statistics.

#### RESULTS

307 consecutive webinars by 236 different speakers were conducted between Oct 2020 - Apr 2023. The webinars had a median of 256 unique attendees (mean: 278.5; range: 67-654). They had a median of 194 maximum concurrent viewers (mean: 212.6; range: 46-514). Overall, viewers from a median of 28 countries (mean: 27.6; range:14-41) across all six continents attended the webinars.

#### DISCUSSION

Our webinars had a median of 256 unique and 194 maximum concurrent attendees from 28 countries. More granular level data as for example audience feedback and duration of attendance per attendee was not available for analysis. Regular online webinars are a sustainable model of radiology education and cut across local, national and international barriers. The individual and country-wise attendance per session exceeds that of most conferences. Educators should consider focusing more on the webinar model of education.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5A-QI-4

### Frequency and Impact of Using Incomplete Information When Assessing Patients with Active Implants for MR Scanning

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

William F. Sensakovic, PhD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Implants are an additional risk in the MR environment due to potential heating and displacement. Active implants have a power source and may also malfunction in the MR environment. Scanning implant patients safety requires collecting all relevant patient and device data and adhering to the vendor manual to assess ability to scan and ensure safe technique when scanning. This project assessed how often collected data was incomplete, what was missing, whether it could impact patient assessment or scanning, and whether an intervention to make downloading the most recent manual was effective.

#### METHODS

A workflow management system for active implant scanning was implemented in April of 2020. Information in each patient (including vendor device manual) is collected by the MR Safety Officer and sent to the MR Safety Expert for analysis and determination. Summary statistics related to percentage of cases where information was incomplete was determined. Further, whether the incomplete data impacted decisions or scanning was determined. Finally, on December 27th of 2021, a "two-click" option for the MR safety officer to collect the most recent information was implemented. Success of this intervention is determined.

#### RESULTS

The MR safety Officer report was assessed for 755 cases (518 unique patients). The assessing physicist recorded incomplete or incorrect data in 122 cases (16.2%). Of the 122 cases with incomplete/incorrect data 109 cases (89.3%) recorded the reason. Of the cases with a recorded reason 81 cases (74.3%) were due to upload of an outdated manual. The system recorded whether the error/omission could impact decision or scanning in 66 cases (54.1%). Of those, 31 cases (47%) could have impacted decisions or scanning. An improvement to ease access to the most recent manual was implemented. Initially the completion rate plummeted due to increased surveillance of old manuals, but quickly recovered and improved.

#### DISCUSSION

This project reports rates of incomplete information being used for assessment of MR active implant patients. While the percentage is low, does indicate a potential issue. It identified the largest source of incomplete data (old device manuals) and implemented a method to make pulling manuals easier. The intervention resulted in improvement in of the completion percentage once the new methods diffused through the pool of MR Safety Officers.

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## Abstract Archives of the RSNA, 2023

M5A-QI-5

### The Implementation and Impact of a Medical-Student Reading Room Assistant Program

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Lindsey K. Greenlund, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

On average, Radiologists are interrupted from image interpretation every 12.1 minutes. During after-hour call, these interruptions are not only increased, but managed by a single resident, increasing turn-around time and errors. Additionally, selecting the appropriate technique (protocol) for cross sectional scans is a task requiring significant resident time and is frequently delayed due to high volumes. Delayed protocolling can result in lack of prior authorization and issues with insurance reimbursement. Medical students were identified as motivated individuals who can make drastic contributions in the reading room by triaging pages and protocolling select non-contrast CT and MRI imaging. In this study, we report the results of nearly two years of the implementation and utilization of a paid medical student Reading Room Assistant (RRA) for weekend call shifts at our institution.

#### METHODS

Jan 2020- Jun 2020 was utilized to document the extent of interruptions for the Radiology residents. Jun 2020- Aug 2021 was spent creating the RRA position and training modules. Six medical students were selected for the position in Fall 2021 with training completed by May 2022. RRAs worked 5-hour segments on the busiest weekend shifts; data was collected on the position over a subsequent 10-month period. Interruptions, scans protocollered by RRAs, and brief medical student RRA feedback was collected in a survey at the end of each RRA shift. Further feedback on the position was collected from the RRAs 10 months into the program. Data and responses were analyzed.

#### RESULTS

During Jan 2020- Jun 2020, on-call residents were interrupted an average of 10.3 times per hour by incoming pages and clinician calls, technologist questions, protocol requests, and outgoing pages. Over the 10-month data collection period, RRAs responded to 854 incoming calls, 474 pages, 765 technologist questions, and made 688 outgoing calls. They also protocollered 3681 chest CTs, 145 neuro MRIs, and 169 abdominal CTs. Per resident survey responses, 100% reported being better physicians while working with an RRA and preferred the RRA program to continue. The majority of medical student RRAs reported in a survey being "Extremely likely" to apply to Radiology residency positions following involvement with the program. Respondents reported the most valuable aspects of the program to be exposure to Radiology, learning the flow of the reading room, and getting to know the residents.

#### DISCUSSION

The implementation of the RRA program at our institution was successful and valuable as medical students were able to significantly decrease interruptions, protocol thousands of non-contrast CT and MRI exams, and improve resident reported quality of work. Further, this program allowed medical student RRAs to explore their interest in Radiology and has the benefit of attracting hard-working, motivated candidates to the field.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5A-QI-6

### Communicating Urgent Discrepancies Between Preliminary and Final Reports: Increasing Trust Between Radiology and Emergency Departments

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Andrew Johnston, MD, MBA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Radiology residents in our hospital system publish full-length preliminary reports while on call. With increasing emergency department volumes, emergency physicians rely on preliminary reports to make triage and treatment decisions. Though one meta-analysis (Wu M, Radiology 2014) showed no significant difference in resident-to-attending and attending-to-attending interpretation discrepancy rates, the addition of a more experienced reader leads to changes that require alerting the ED. The goal of our project was to increase the rate of communication of urgent discrepancies between preliminary and final radiology reports for cross-sectional studies from 75% to 90% in 20 weeks.

#### RESULTS

The run chart shows an increase in the percentage of documented communication events for urgent changes of cross-sectional study reports from 75% to 90.6%. Additionally, the interventions increased the percentage of documented communication events for all report discrepancies from 6.6% to 7.0%.

#### METHODS

A team of stakeholders from radiology and emergency medicine developed an improvement process via a guided quality improvement curriculum. The team performed a detailed analysis of the current state and identified potential root causes and key drivers. We documented our analysis using a structured problem-solving tool. All radiology reports for studies ordered through the emergency department during the intervention period were queried via the PowerScribe web API and categorized according to modality (cross-sectional or plain film) and type of report discrepancy (no change, non-urgent change, or urgent change). Key drivers and interventions were developed and refined through Plan-Do-Study-Act cycles. Interventions implemented during this project included linking a secure messaging system to our PACS, adding options for multiple methods of communication to our standard reporting template, and educating radiologists about the process for communicating report discrepancies.

#### DISCUSSION

Our study showed an increased rate of communication for urgent changes between preliminary and final reports of cross-sectional studies. Limitations of the study include variation in opinions of what constitutes an urgent or non-urgent change, interventions were performed with a small subset of the radiology department, and our reliance on report text to identify communication events may underestimate the true volume of communication. The next steps for our project aim to increase communication across all study types and urgency levels. We will do this by developing a reliable process for rapidly identifying report discrepancies not communicated, organizing focused interdepartmental meetings to operationalize the definition of urgent and non-urgent changes, and incorporating a review of communication errors into peer learning meetings.

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## Abstract Archives of the RSNA, 2023

M5A-QI-7

### QI Bootcamp - A Novel Approach to Engage Radiology Residents in QI

Monday, Nov. 27 12:15PM - 12:45PM Room: Learning Center

Pratik V. Rachh, MD, MBA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Problem Statement Per ACGME QI Milestones for Diagnostic Imaging, residents are required to demonstrate skills and knowledge related to Quality and Safety, including completion of a QI project. Most residents work on their project requirement in the 4th year once they have passed boards and have a less demanding schedule. Informal interviews showed that residents felt unsupported in meeting QI milestones and quality leadership noted that some resident QI projects lacked rigor and correct application of QI tools. Several residents stated there was no single list of QI projects that they could access and that they often had to find a project by themselves. ACGME requirements was perceived as a formality to be checked off to graduate. Purpose The goal of the bootcamp was to serve as a refresher for QI knowledge and to provide coaching for project completion.

#### METHODS

1st and 4th year DR, IR and NM residents were emailed to voluntarily sign up for a 4.5-hour "QI Bootcamp" in March 2023. We invited 1st and 4th year residents as they tend to have the most time available for a QI project. The QI bootcamp was led by a 1st year QI Track resident (QI Track is one of the several tracks available to trainees to enhance their skills beyond clinical radiology) and by the Interim Medical Director for Quality in Radiology. A list of potential QI projects, and agenda was emailed to attendees in advance. Measures We administered a pre- and post-knowledge assessment survey. Post survey included supplemental questions to assess bootcamp objectives. Survey data was analyzed using Microsoft Excel.

#### RESULTS

19 residents signed up and 13 attended the session. 13 residents completed the pre-survey and 12 completed the post-survey resulting in a 92% response rate. In aggregate, correct response to knowledge items improved from 55% to 74% pre and post-survey respectively. A detailed review showed baseline proficiency with Lean concepts (waste, value add vs. non-value add, and process mapping) where 92% of the respondents selected correct responses. Residents were less knowledgeable of driver diagram, fishbone diagram, run charts and change management for which the pre-survey correct response rate ranged from 15-50%. However, residents made the most improvement in those concepts after the didactics. Pre and post-survey analysis showed resident QI project participation improved from 31% to 82%, respectively. Analysis of the feedback questions indicated that 85% of respondents rated the bootcamp favorably. Review of "what went well?" and "what could be improved?" questions gave perspective for future improvement.

#### DISCUSSION

The QI bootcamp was well perceived and is probably best suited for R1 and R4. The event resulted in increased knowledge and a higher number of residents committed to a QI project. Group activities were most popular, especially brainstorming QI project ideas.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-QI

### Quality Improvement Reports Monday Poster Discussions II

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **M5B-QI-2 Improving Workflow in Nuclear Medicine to Ensure Correct Radiopharmaceutical Injection**

PAULINE SIAW HUNG WONG, BSc (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Radiopharmaceutical syringes were prepared and labeled with different syringe codes, types of scans, and radioactivity. As these syringes are delivered in bulk from the authorized manufacturer, they do not contain any patient details due to the Personal Data Protection Act. The busy workload, with the number of radiopharmaceutical injections nearing 20 every day as well as handling different types of radiopharmaceutical injections within a short period, could ultimately lead to a higher probability of wrong radiopharmaceutical injections. This study aims to deduce the likelihood of wrong radiopharmaceutical injections.

#### **RESULTS**

The results showed that there have been zero wrong radiopharmaceutical injections since the implementation of the patient label and the second verifier. Random audits were performed and found that 100% of the staff complied since the changes were implemented. A survey was conducted among 38 Nuclear Medicine staff (5 radiographers, 2 doctors, 11 cardiac technologists, and 1 other) on their confidence level in performing injections. It showed that the average confidence level for the patient label with a second verifier scored the highest (8.11) and with a 100% compliance rate

#### **METHODS**

The study was carried out from February 2020 to February 2023. In early Jan 2020, a wrong radiopharmaceutical injection happened when the staff who prepared the bone radiopharmaceutical syringe injected it into a cardiac patient. A team was immediately set up to rectify the problem. We used root-cause analysis and plan-do-study-act to identify the best solution. The first PDSA is to have staff carry a laptop for verification purposes before injection. However, this method was not promising as they need to handle both the laptop and syringe at the same time which may compromise the hygiene. The second PDSA introduces the tagging of patient sticky labels on the radiopharmaceutical syringes. The label contains the patient's name, identity card number, and type of scan which could help in the verification process before injection. This method is further improved with a second staff verifying the information on the radiopharmaceutical syringe and the patient's sticky label against the patient before injection. Both staffs need to ensure the correct patient's two identifiers, type of scan, type of radiopharmaceutical, and radioactivity. The training was done for all the staff working in Nuclear Medicine. Measurements on the number of wrongful injections, the confidence level of staff when performing injections, and the compliance rate to the changed workflow were collected as the success indicators.

#### **DISCUSSION**

This improved workflow has ensured the correct radiopharmaceutical injection is performed by the staff at all times. Having a patient label tag on syringes and the presence of a second verifier do minimize the possibility of selecting the wrong syringe.

#### **M5B-QI-3 Quality Assessment of Fluoroscopic Imaging Obtained during Neonatal Contrast Enema Exams**

Devyn C. Rigsby (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

The American College of Radiology (ACR) and Society for Pediatric Radiology (SPR) have published practice parameters for pediatric fluoroscopic contrast enema (CE) exams. Peer quality review of neonatal CEs performed at our tertiary care pediatric hospital demonstrated a high level of adherence to these parameters. The purpose of this CE quality improvement study was to identify areas for further improvement.

## **METHODS**

Image database review identified all CE exams performed on children = 2 days old at our institution from February 2019 to August 2022. 6 subjective and 7 objective quality assurance criteria for CE exams were defined. Two pediatric radiologists conducted independent review of CE imaging and reports for subjective quality criteria. One radiologist also assessed for objective quality metrics. Data were summarized as counts and percentages for each reviewer. Observed inter-reviewer agreement po was calculated for metrics evaluated by two readers.

## **RESULTS**

70 neonatal CEs met inclusion criteria and were reviewed. For the objective quality metrics: 83% of CEs included a scout image. Lateral rectal imaging included visualization of the sacrum in 91% of cases. Radiation dose and fluoroscopy time were documented in 90% of cases. 63% of cases were performed without direct exposures, and 70% included a post-evacuation film. Complications were not documented for any CE. For the subjective quality criteria: A small-caliber rectal catheter was used in 93% (R1) to 94% (R2) of cases. 96-97% of exams included a true lateral rectal view; this view was obtained at early filling in 83-86% of cases. The rectosigmoid index was readily assessed in nearly all studies (100% R1; 97% R2). The entirety of the colon was visualized through to the cecum in 87% of studies. In 74-76% of cases, the appendix and/or terminal ileum were visualized. Observed inter-reader agreement was substantial for all metrics, ranging from 83% to 97%.

## **DISCUSSION**

Lateral rectal imaging generally met quality metrics, though further education regarding imaging timing at early filling may be warranted. Although the majority of studies included a scout image, radiation dose, fluoroscopy time, and post-evacuation film, operators should be reminded to collect and store these basic components for every exam. Similarly, while most cases used an appropriately small rectal catheter, staff should be aware to do so in every exam. Approximately one-fourth of studies did not include visualization of the appendix and/or terminal ileum, which may reflect the difficulty of obtaining these views for certain pathologic entities in neonatal practice. Finally, although ACR-SPR guidelines discourage direct exposures during CE exams, 37% of cases included such images; promoting use of last-image hold instead of direct exposure can reduce patient radiation dose.

### **M5B-QI-4 Radiographers' Perceptions Regarding Establishing a Self Regulatory Body**

Lungile N. Dlamini (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Eswatini remains one of the countries in Southern Africa without a regulating authority for radiation safety in the radiography departments. Quality control (QC) tests and radiation protection practices are unmonitored. This study sought to explore radiographers' perceptions regarding establishing a self-regulatory body that will formulate, implement and monitor compliance of standardised guidelines for radiation safety.

## **METHODS**

A qualitative, exploratory and descriptive research approach was undertaken. Radiographers currently registered and practicing in Eswatini were purposively selected and invited to participate. Data was collected using semi-structured interviews. Audiotapes and field notes were used. Audio taped interviews were transcribed verbatim and then analyzed using qualitative content analysis.

## **RESULTS**

Six themes emerged from the analysis of data, namely; a) awareness of the need for QC tests, b) radiation protection and safety in the radiography departments, c) radiographers' responsibility towards radiation protection, d) education and training in radiation safety for radiographers and other stakeholders, e) support from governmental and management structures and f) the need for the self-regulatory body in the radiography departments.

## **DISCUSSION**

The study demonstrated that there is awareness among radiographers in Eswatini that radiation safety practices are necessary in the radiography departments. Continuous education and training were deemed as imperative to improve radiation safety in the radiography departments. There is also support for the idea of establishing the self-regulatory body. Implications for practice: The need for monitoring structures in order to ensure radiation safety in the radiography departments is highlighted in this study. Government officials and hospital management are crucial in ensuring radiation safety in radiography departments.

### **M5B-QI-5 More Bang for the Healthcare Buck: Addressing the Emergency and Urgent Care Elephant in Pulmonary Nodule Follow-up Loss with Smart HL7 Workflow**

Kyle Jackson, BSc, MSc (*Presenter*) Nothing to Disclose

## INTRODUCTION

The overwhelming majority of incomplete imaging incidental findings follow-up results from emergency (ED) and urgent care (UC) visits. While there have been extensive talks about the need for automated imaging tracking and provider notification systems in healthcare, the complexity of the ED/UC setting has prevented hospitals from addressing this majority contributor to lost follow-up. We present ED/UC-capable system architecture managing HL7 workflow for pulmonary nodule incidental findings that may be paired with a knowledge-based AI or be used in conjunction with a nurse navigator, depending on hospital infrastructure. We address lack of high-level performance evaluation of published tools in the clinical setting by evaluating clinical performance within a large academic medical center.

## METHODS

Monitoring at a southeastern academic medical center interpreting 1.2M imaging exams annually revealed most (71%) lost pulmonary nodule follow-up exams were from ED and UC settings. We previously reported on a LSTM AI model recognizing pulmonary nodule follow-up recommendations (1,970 retrospectively annotated reports, 60/20/20% training/validation/test split, accuracy 94%). To generate ED/UC-capable workflow, we paired this LSTM with a knowledge-based AI to assign patients into follow-up intervals: high risk (= 3 months), medium risk (> 3 months but = 6 months), and low risk (> 6 months and = 12 months). Clinical performance was assessed by retrospective manual validation of 200 reports (CT 85, XR 16, US 3, uncategorized 96) followed by key word inclusion/exclusion modifications. Real-time clinical performance was again assessed by prospective manual validation of 200 reports (CT 125, XR 64, MR 6, US 5). Fleischner Society Guidelines and logic governing NLP system-to-EMR communication were leveraged to develop risk-stratified ED/UC-capable HL7-based workflow.

## RESULTS

The macro-averaged F0.5 score for retrospective performance was 0.79 (accuracy by risk class: high risk 94.5%, medium risk 99%, low risk 97%) and for prospective performance was 0.93 (accuracy by risk class: high risk 98.5%, medium risk 100%, low risk 95%). F0.5 score was selected to optimize clinical practice performance by penalizing false positives more than false negatives, where false reminders would undermine provider system use. Knowledge-based AI modifications resulted in 14% improvement in prospective performance.

## DISCUSSION

There are no published automated system workflows addressing the safety gap presented by ED/UC settings. The proposed ED/UC-capable HL7 logic and knowledge-based AI can help hospitals implement tracking and reminder systems capable of capturing the overwhelming majority of lost follow-up and meet ACR-issued Closing the Recommendations Follow-Up Loop measures. High-level clinical performance evaluation underscored the validity of this approach.

## **M5B-QI-6 Reinterpretation of Hepatopancreaticobiliary Imaging Exams by Subspecialty Radiologists: Assessment of Clinical Impact, Radiologist Peer Learning, and Referring Physician Satisfaction**

Gregory S. Photopoulos, BSC (*Presenter*) Nothing to Disclose

## INTRODUCTION

Imaging of hepatopancreaticobiliary (HPB) diseases is often complex and may require reinterpretation by subspecialty abdominal radiologists and discussion at multidisciplinary tumor board. Studies show high discrepancy rates (19.9%-68.9%) between primary radiologist reports and reinterpretations. To our knowledge, the potential of reinterpretations for radiologist peer learning has not been evaluated. At our centre, reinterpretations are sent to the referring physician and radiologist who issued the primary report. The objectives of this study were to assess the impact of reinterpretations on clinical management, the potential for peer learning for radiologists, and referring physician satisfaction.

## METHODS

This quality improvement project included HPB CT and MRI exams that were reinterpreted by two subspecialty radiologists between March 2021 to August 2022. Agreement with the primary report was categorized using the American College of Radiology RADPEER system. Electronic medical records were reviewed for information regarding change in management (yes/no/unavailable). Separate surveys using 5-point Likert scale questions were sent to radiologists who issued primary reports and referring physicians. Quantitative results were reported using descriptive statistics.

## RESULTS

250 imaging exams (122 CT, 128 MRI) reported by 96 radiologists were reinterpreted as requested by 19 referring physicians. RADPEER scores 1-3 distribution was 131/250 (52%), 86/250 (34%) and 33/250 (13%), respectively. Of 213 cases with adequate clinical data, 75/213 (35%) were associated with a change in management; of these, 71/75 (95%) were RADPEER 2 or 3. Survey response rates were 34/86 (40%) for radiologists and 7/18 (39%) for referring physicians practicing in the region. Most radiologists agreed or strongly agreed with the following: prefer to receive reinterpretations (32/34, 94%); reinterpretations changed reporting practices (22/34, 65%); and reinterpretations support peer learning and quality assurance (32/34, 94%). Referring physicians agreed or strongly agreed that reinterpretations assist complex HPB disease management (7/7, 100%) and subspecialty radiologists should reinterpret more cases (6/7, 86%).



## DISCUSSION

Our study found a high discrepancy rate with HPB imaging reinterpretations, congruent with the literature. A change in clinical management was found in over one-third of cases. Reinterpretation reports were almost unanimously well received by radiologists and referring physicians. Strengths of this study include the large sample size and good survey response rates. Limitations include the retrospective design and potential lack of generalizability. In conclusion, radiologists and referring physicians are in strong agreement that HPB imaging reinterpretations support peer learning and patient management, respectively.

### **M5B-QI-7 The Sliding Sign Initiative: Facilitating Earlier Detection of Deep Endometriosis in an Academic Ultrasound Department**

#### **Awards**

##### **Quality Improvement Reports Award**

Emily Pang, MD, FRCPC (*Presenter*) Nothing to Disclose

## INTRODUCTION

Delayed diagnosis of endometriosis is common and has a negative impact on quality of life. A simple, quick ultrasound-based sliding sign (SS) maneuver can help detect the most common form of deep endometriosis, facilitating earlier diagnosis and treatment. The primary aim of our study was to implement a SS protocol for patients presenting to our ultrasound department with risk factors for the disease (such as chronic pelvic pain, infertility) and have it consistently performed and reported.

## METHODS

Plan-Do-Study-Act (PDSA) methodology was used for this project, which took place in the ultrasound department of a tertiary-care teaching hospital between Oct 2021 and May 2023. The reports and imaging for pelvic ultrasounds performed in patients meeting inclusion criteria were reviewed by two ultrasound experts in consensus during a baseline period and during each intervention to assess for 1) whether the SS was performed and 2) whether SS results were reported and interpreted correctly. Additionally, in patients for whom follow-up was available, confirmation of a new endometriosis diagnosis was recorded. Initial planning involved consultation with gynecology, radiology and sonographer stakeholders. For the first PDSA cycle, a protocol was distributed by e-mail alongside an educational campaign which included in-service training and grand rounds. PDSA cycle 2 involved an updated protocol emailed and posted in the staff lounge, as well as a reminder poster displayed in the probe sanitation room. For PDSA cycle 3, the posters were revised to improve readability in low-lighting conditions and displayed in individual ultrasound rooms. Sonographer worksheets were modified to include a SS field.

## RESULTS

The SS was not performed on any patients at baseline prior to the initiative. The number of eligible patients per month ranged from n=28 to 52. On average, the SS was performed on 57.7%, 68.2% and 85.2% of eligible patients and reported and interpreted correctly 66.7%, 83.3% and 73.9% of the time after PDSA cycles 1, 2, and 3 respectively. All abnormal SS cases were reported. Over a period of 1 year for which 6 month follow-up data was available (Oct 2021-Oct 2022), a total of 22 patients had a new confirmed diagnosis of endometriosis as a result of the initiative, with 2 false positives.

## DISCUSSION

The sliding sign initiative is a relatively simple protocol modification but has made a significant impact on the early diagnosis of endometriosis, allowing for earlier treatment and improved quality of life. Interventions aimed at increasing consistent performance of the SS amongst sonographers have proven successful. Limitations included difficulties performing the SS in retroverted uteri, variable buy-in/familiarity with the SS amongst radiologists, and lack of follow-up data on every patient. Additional interventions targeting reporting radiologists will be needed for future work.

### **M5B-QI-8HC Improving Outpatient CT Access by Reducing CT Backlogs**

Ben C. Wandtke, MD, MS (*Presenter*) Clinical Advisory Board, CAK Tech, Inc

## INTRODUCTION

Long wait times for CT appointments result in delayed diagnosis, patient and provider dissatisfaction, and loss of referrals. CT scans are expected to be performed within a reasonable time (7-10 days). At our institution, patients were waiting on average 4 to 6 weeks for a routine outpatient CT appointment. The purpose of this project was to reduce the time outpatients were waiting for CT appointments. The goal of this project was to decrease the time from the CT scheduling to the exam performed from an average of 6 weeks to 2 weeks within 6 months.

## METHODS

This project was performed in two outpatient imaging centers affiliated with a large academic health system. The "next available" CT appointment date was defined as the nearest date with more than one available slot, measured weekly. A balancing metric was utilized, measuring the time between scheduled and actual exam time start with a goal of <15 minutes.



Several performance improvement methodologies including PDSA cycles, gemba walks, fishbone diagrams, and control charts were utilized.

## RESULTS

Over the course of 5 months, the lack of CT appointment capacity and workflow inefficiencies were determined as root causes of outpatient CT appointment access issues. A control chart was used to demonstrate the average weeks to schedule a CT appointment at outpatient imaging sites. In October 2022, outpatient CT time slots were temporarily double booked, immediately reducing the length of time patients waited for CT appointments from an average of 6 weeks to an average of 1.7 weeks (72%). All outpatient CT exam durations were then reduced from 20 minutes to 15-minute time slots further reducing wait times from 1.7 weeks to 1 week (41%). The average monthly CT exam volume increased from 3,254 to 3,688 (88%). Overall, a 95% decrease in time between schedule request and scheduled exam date was achieved. CT exams consistently began on average within 15 minutes of their scheduled table time. Clinical managers continue to monitor patient access, staff satisfaction, and exam start delays.

## DISCUSSION

In the absence of an effort to reduce demand for CT services, it was clear that reducing the scheduling backlog would require an increase in exam volume. This was particularly challenging in the short term, given limitations of technologist staffing shortages. After benchmarking CT exam duration at our most efficient sites, improved technologist and machine efficiency was achieved by reducing outpatient CT exam durations from 20 minutes to 15 minutes, adding one additional CT appointment per hour. Additional CT volume gained through this project resulted in an estimated \$5 million annual revenue increase with minimal expense increase. The increased volume of CT exams performed had a temporary negative impact on report turnaround time and increased work burden on prior authorization and scheduling services.

## M5B-QI-9HC Impact of Early Direct Patient Notification of Non-Urgent Incidental Radiology Findings Requiring Follow-up

James R. Loftus, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

The need for informing patients directly in radiology is prompted by a high number of follow-up recommendations for incidental findings that are not being completed. In 2018, the state of Pennsylvania (PA) passed Act 112 with the goal of increasing compliance with follow-up recommendations by requiring diagnostic imaging facilities to directly notify patients within 20 days of "significant" abnormalities which would require follow-up within three months. The purpose of our study was to determine whether early notification could further improve the follow-up completion rates achieved by our existing recommendation tracking system ("Backstop").

## METHODS

Patients with radiologic findings requiring follow-up set to undergo our Backstop communication schedule were randomized into four groups: Group 1 receiving additional early direct notification via a mailed letter (similar to PA Act 112), Group 2 via phone, Group 3 via electronic portal message, and Group 4, the control, only following the Backstop communication schedule. Backstop includes four stages of escalation of communication amongst health care providers at one, two, and three months overdue, and a letter directly sent to the patient if follow-up is not completed after the first three stages. Patients randomized into early direct notification received a survey by letter one month after the follow-up notification occurred to assess patients' perceived value, attitudes, and preferences on early direct notification. The survey comprised of 13 items in total, 5 utilizing a 5-point Likert scale, 1 question ranking communication modality preference between 5 options, and 7 items were binary yes/no questions designed ad hoc by the study team as no previously validated questionnaires on this topic exist.

## RESULTS

Data from 2,548 randomized patients were analyzed for the study, including 593 patients notified by letter, 637 by phone, 701 by portal, and 617 control patients. Group 3 demonstrated the lowest rate of follow-up completion within one month of due date at 36.4%, compared to 58.7% for Group 1, 60.4% for group 2, and 53.2% for Group 4 (all  $p < 0.0001$ ). The difference in completion rates was statistically significant ( $p = 0.014$ ) between Group 2 and Group 4. Patients responded positively regarding early notification with approximately 90% stating they wanted to continue receiving notifications and ranked electronic portal as their most preferred communication modality.

## DISCUSSION

The impact of early direct notification on follow-up examination completion rates was small or negative depending upon the communication method utilized. However, our survey results demonstrated trust and positive patient engagement built through notification. Thus, we conclude that early direct notification may have healthcare benefits when encompassed within a recommendation tracking system to ensure follow-up completion.

## Abstract Archives of the RSNA, 2023

M5B-QI-2

### Improving Workflow in Nuclear Medicine to Ensure Correct Radiopharmaceutical Injection

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

PAULINE SIAW HUNG WONG, BSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Radiopharmaceutical syringes were prepared and labeled with different syringe codes, types of scans, and radioactivity. As these syringes are delivered in bulk from the authorized manufacturer, they do not contain any patient details due to the Personal Data Protection Act. The busy workload, with the number of radiopharmaceutical injections nearing 20 every day as well as handling different types of radiopharmaceutical injections within a short period, could ultimately lead to a higher probability of wrong radiopharmaceutical injections. This study aims to deduce the likelihood of wrong radiopharmaceutical injections.

#### RESULTS

The results showed that there have been zero wrong radiopharmaceutical injections since the implementation of the patient label and the second verifier. Random audits were performed and found that 100% of the staff complied since the changes were implemented. A survey was conducted among 38 Nuclear Medicine staff (5 radiographers, 2 doctors, 11 cardiac technologists, and 1 other) on their confidence level in performing injections. It showed that the average confidence level for the patient label with a second verifier scored the highest (8.11) and with a 100% compliance rate

#### METHODS

The study was carried out from February 2020 to February 2023. In early Jan 2020, a wrong radiopharmaceutical injection happened when the staff who prepared the bone radiopharmaceutical syringe injected it into a cardiac patient. A team was immediately set up to rectify the problem. We used root-cause analysis and plan-do-study-act to identify the best solution. The first PDSA is to have staff carry a laptop for verification purposes before injection. However, this method was not promising as they need to handle both the laptop and syringe at the same time which may compromise the hygiene. The second PDSA introduces the tagging of patient sticky labels on the radiopharmaceutical syringes. The label contains the patient's name, identity card number, and type of scan which could help in the verification process before injection. This method is further improved with a second staff verifying the information on the radiopharmaceutical syringe and the patient's sticky label against the patient before injection. Both staffs need to ensure the correct patient's two identifiers, type of scan, type of radiopharmaceutical, and radioactivity. The training was done for all the staff working in Nuclear Medicine. Measurements on the number of wrongful injections, the confidence level of staff when performing injections, and the compliance rate to the changed workflow were collected as the success indicators.

#### DISCUSSION

This improved workflow has ensured the correct radiopharmaceutical injection is performed by the staff at all times. Having a patient label tag on syringes and the presence of a second verifier do minimize the possibility of selecting the wrong syringe.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-QI-3

### Quality Assessment of Fluoroscopic Imaging Obtained during Neonatal Contrast Enema Exams

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Devyn C. Rigsby (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The American College of Radiology (ACR) and Society for Pediatric Radiology (SPR) have published practice parameters for pediatric fluoroscopic contrast enema (CE) exams. Peer quality review of neonatal CEs performed at our tertiary care pediatric hospital demonstrated a high level of adherence to these parameters. The purpose of this CE quality improvement study was to identify areas for further improvement.

#### METHODS

Image database review identified all CE exams performed on children = 2 days old at our institution from February 2019 to August 2022. 6 subjective and 7 objective quality assurance criteria for CE exams were defined. Two pediatric radiologists conducted independent review of CE imaging and reports for subjective quality criteria. One radiologist also assessed for objective quality metrics. Data were summarized as counts and percentages for each reviewer. Observed inter-reviewer agreement  $\rho$  was calculated for metrics evaluated by two readers.

#### RESULTS

70 neonatal CEs met inclusion criteria and were reviewed. For the objective quality metrics: 83% of CEs included a scout image. Lateral rectal imaging included visualization of the sacrum in 91% of cases. Radiation dose and fluoroscopy time were documented in 90% of cases. 63% of cases were performed without direct exposures, and 70% included a post-evacuation film. Complications were not documented for any CE. For the subjective quality criteria: A small-caliber rectal catheter was used in 93% (R1) to 94% (R2) of cases. 96-97% of exams included a true lateral rectal view; this view was obtained at early filling in 83-86% of cases. The rectosigmoid index was readily assessed in nearly all studies (100% R1; 97% R2). The entirety of the colon was visualized through to the cecum in 87% of studies. In 74-76% of cases, the appendix and/or terminal ileum were visualized. Observed inter-reader agreement was substantial for all metrics, ranging from 83% to 97%.

#### DISCUSSION

Lateral rectal imaging generally met quality metrics, though further education regarding imaging timing at early filling may be warranted. Although the majority of studies included a scout image, radiation dose, fluoroscopy time, and post-evacuation film, operators should be reminded to collect and store these basic components for every exam. Similarly, while most cases used an appropriately small rectal catheter, staff should be aware to do so in every exam. Approximately one-fourth of studies did not include visualization of the appendix and/or terminal ileum, which may reflect the difficulty of obtaining these views for certain pathologic entities in neonatal practice. Finally, although ACR-SPR guidelines discourage direct exposures during CE exams, 37% of cases included such images; promoting use of last-image hold instead of direct exposure can reduce patient radiation dose.

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## Abstract Archives of the RSNA, 2023

M5B-QI-4

### **Radiographers' Perceptions Regarding Establishing a Self Regulatory Body**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Lungile N. Dlamini (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Eswatini remains one of the countries in Southern Africa without a regulating authority for radiation safety in the radiography departments. Quality control (QC) tests and radiation protection practices are unmonitored. This study sought to explore radiographers' perceptions regarding establishing a self-regulatory body that will formulate, implement and monitor compliance of standardised guidelines for radiation safety.

#### **METHODS**

A qualitative, exploratory and descriptive research approach was undertaken. Radiographers currently registered and practicing in Eswatini were purposively selected and invited to participate. Data was collected using semi-structured interviews. Audiotapes and field notes were used. Audio taped interviews were transcribed verbatim and then analyzed using qualitative content analysis.

#### **RESULTS**

Six themes emerged from the analysis of data, namely; a) awareness of the need for QC tests, b) radiation protection and safety in the radiography departments, c) radiographers' responsibility towards radiation protection, d) education and training in radiation safety for radiographers and other stakeholders, e) support from governmental and management structures and f) the need for the self-regulatory body in the radiography departments.

#### **DISCUSSION**

The study demonstrated that there is awareness among radiographers in Eswatini that radiation safety practices are necessary in the radiography departments. Continuous education and training were deemed as imperative to improve radiation safety in the radiography departments. There is also support for the idea of establishing the self-regulatory body. Implications for practice: The need for monitoring structures in order to ensure radiation safety in the radiography departments is highlighted in this study. Government officials and hospital management are crucial in ensuring radiation safety in radiography departments.

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## Abstract Archives of the RSNA, 2023

M5B-QI-5

### More Bang for the Healthcare Buck: Addressing the Emergency and Urgent Care Elephant in Pulmonary Nodule Follow-up Loss with Smart HL7 Workflow

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Kyle Jackson, BSc, MSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The overwhelming majority of incomplete imaging incidental findings follow-up results from emergency (ED) and urgent care (UC) visits. While there have been extensive talks about the need for automated imaging tracking and provider notification systems in healthcare, the complexity of the ED/UC setting has prevented hospitals from addressing this majority contributor to lost follow-up. We present ED/UC-capable system architecture managing HL7 workflow for pulmonary nodule incidental findings that may be paired with a knowledge-based AI or be used in conjunction with a nurse navigator, depending on hospital infrastructure. We address lack of high-level performance evaluation of published tools in the clinical setting by evaluating clinical performance within a large academic medical center.

#### METHODS

Monitoring at a southeastern academic medical center interpreting 1.2M imaging exams annually revealed most (71%) lost pulmonary nodule follow-up exams were from ED and UC settings. We previously reported on a LSTM AI model recognizing pulmonary nodule follow-up recommendations (1,970 retrospectively annotated reports, 60/20/20% training/validation/test split, accuracy 94%). To generate ED/UC-capable workflow, we paired this LSTM with a knowledge-based AI to assign patients into follow-up intervals: high risk (= 3 months), medium risk (> 3 months but = 6 months), and low risk (> 6 months and = 12 months). Clinical performance was assessed by retrospective manual validation of 200 reports (CT 85, XR 16, US 3, uncategorized 96) followed by key word inclusion/exclusion modifications. Real-time clinical performance was again assessed by prospective manual validation of 200 reports (CT 125, XR 64, MR 6, US 5). Fleischner Society Guidelines and logic governing NLP system-to-EMR communication were leveraged to develop risk-stratified ED/UC-capable HL7-based workflow.

#### RESULTS

The macro-averaged F0.5 score for retrospective performance was 0.79 (accuracy by risk class: high risk 94.5%, medium risk 99%, low risk 97%) and for prospective performance was 0.93 (accuracy by risk class: high risk 98.5%, medium risk 100%, low risk 95%). F0.5 score was selected to optimize clinical practice performance by penalizing false positives more than false negatives, where false reminders would undermine provider system use. Knowledge-based AI modifications resulted in 14% improvement in prospective performance.

#### DISCUSSION

There are no published automated system workflows addressing the safety gap presented by ED/UC settings. The proposed ED/UC-capable HL7 logic and knowledge-based AI can help hospitals implement tracking and reminder systems capable of capturing the overwhelming majority of lost follow-up and meet ACR-issued Closing the Recommendations Follow-Up Loop measures. High-level clinical performance evaluation underscored the validity of this approach.

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## Abstract Archives of the RSNA, 2023

M5B-QI-6

### Reinterpretation of Hepatopancreaticobiliary Imaging Exams by Subspecialty Radiologists: Assessment of Clinical Impact, Radiologist Peer Learning, and Referring Physician Satisfaction

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Gregory S. Photopoulos, BSC (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Imaging of hepatopancreaticobiliary (HPB) diseases is often complex and may require reinterpretation by subspecialty abdominal radiologists and discussion at multidisciplinary tumor board. Studies show high discrepancy rates (19.9%-68.9%) between primary radiologist reports and reinterpretations. To our knowledge, the potential of reinterpretations for radiologist peer learning has not been evaluated. At our centre, reinterpretations are sent to the referring physician and radiologist who issued the primary report. The objectives of this study were to assess the impact of reinterpretations on clinical management, the potential for peer learning for radiologists, and referring physician satisfaction.

#### METHODS

This quality improvement project included HPB CT and MRI exams that were reinterpreted by two subspecialty radiologists between March 2021 to August 2022. Agreement with the primary report was categorized using the American College of Radiology RADPEER system. Electronic medical records were reviewed for information regarding change in management (yes/no/unavailable). Separate surveys using 5-point Likert scale questions were sent to radiologists who issued primary reports and referring physicians. Quantitative results were reported using descriptive statistics.

#### RESULTS

250 imaging exams (122 CT, 128 MRI) reported by 96 radiologists were reinterpreted as requested by 19 referring physicians. RADPEER scores 1-3 distribution was 131/250 (52%), 86/250 (34%) and 33/250 (13%), respectively. Of 213 cases with adequate clinical data, 75/213 (35%) were associated with a change in management; of these, 71/75 (95%) were RADPEER 2 or 3. Survey response rates were 34/86 (40%) for radiologists and 7/18 (39%) for referring physicians practicing in the region. Most radiologists agreed or strongly agreed with the following: prefer to receive reinterpretations (32/34, 94%); reinterpretations changed reporting practices (22/34, 65%); and reinterpretations support peer learning and quality assurance (32/34, 94%). Referring physicians agreed or strongly agreed that reinterpretations assist complex HPB disease management (7/7, 100%) and subspecialty radiologists should reinterpret more cases (6/7, 86%).

#### DISCUSSION

Our study found a high discrepancy rate with HPB imaging reinterpretations, congruent with the literature. A change in clinical management was found in over one-third of cases. Reinterpretation reports were almost unanimously well received by radiologists and referring physicians. Strengths of this study include the large sample size and good survey response rates. Limitations include the retrospective design and potential lack of generalizability. In conclusion, radiologists and referring physicians are in strong agreement that HPB imaging reinterpretations support peer learning and patient management, respectively.

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## Abstract Archives of the RSNA, 2023

M5B-QI-7

### **The Sliding Sign Initiative: Facilitating Earlier Detection of Deep Endometriosis in an Academic Ultrasound Department**

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

#### **Awards**

##### **Quality Improvement Reports Award**

Emily Pang, MD, FRCPC (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Delayed diagnosis of endometriosis is common and has a negative impact on quality of life. A simple, quick ultrasound-based sliding sign (SS) maneuver can help detect the most common form of deep endometriosis, facilitating earlier diagnosis and treatment. The primary aim of our study was to implement a SS protocol for patients presenting to our ultrasound department with risk factors for the disease (such as chronic pelvic pain, infertility) and have it consistently performed and reported.

#### **METHODS**

Plan-Do-Study-Act (PDSA) methodology was used for this project, which took place in the ultrasound department of a tertiary-care teaching hospital between Oct 2021 and May 2023. The reports and imaging for pelvic ultrasounds performed in patients meeting inclusion criteria were reviewed by two ultrasound experts in consensus during a baseline period and during each intervention to assess for 1) whether the SS was performed and 2) whether SS results were reported and interpreted correctly. Additionally, in patients for whom follow-up was available, confirmation of a new endometriosis diagnosis was recorded. Initial planning involved consultation with gynecology, radiology and sonographer stakeholders. For the first PDSA cycle, a protocol was distributed by e-mail alongside an educational campaign which included in-service training and grand rounds. PDSA cycle 2 involved an updated protocol emailed and posted in the staff lounge, as well as a reminder poster displayed in the probe sanitation room. For PDSA cycle 3, the posters were revised to improve readability in low-lighting conditions and displayed in individual ultrasound rooms. Sonographer worksheets were modified to include a SS field.

#### **RESULTS**

The SS was not performed on any patients at baseline prior to the initiative. The number of eligible patients per month ranged from n=28 to 52. On average, the SS was performed on 57.7%, 68.2% and 85.2% of eligible patients and reported and interpreted correctly 66.7%, 83.3% and 73.9% of the time after PDSA cycles 1, 2, and 3 respectively. All abnormal SS cases were reported. Over a period of 1 year for which 6 month follow-up data was available (Oct 2021-Oct 2022), a total of 22 patients had a new confirmed diagnosis of endometriosis as a result of the initiative, with 2 false positives.

#### **DISCUSSION**

The sliding sign initiative is a relatively simple protocol modification but has made a significant impact on the early diagnosis of endometriosis, allowing for earlier treatment and improved quality of life. Interventions aimed at increasing consistent performance of the SS amongst sonographers have proven successful. Limitations included difficulties performing the SS in retroverted uteri, variable buy-in/familiarity with the SS amongst radiologists, and lack of follow-up data on every patient. Additional interventions targeting reporting radiologists will be needed for future work.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

M5B-QI-8HC

### Improving Outpatient CT Access by Reducing CT Backlogs

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

Ben C. Wandtke, MD, MS (*Presenter*) Clinical Advisory Board, CAK Tech, Inc

#### INTRODUCTION

Long wait times for CT appointments result in delayed diagnosis, patient and provider dissatisfaction, and loss of referrals. CT scans are expected to be performed within a reasonable time (7-10 days). At our institution, patients were waiting on average 4 to 6 weeks for a routine outpatient CT appointment. The purpose of this project was to reduce the time outpatients were waiting for CT appointments. The goal of this project was to decrease the time from the CT scheduling to the exam performed from an average of 6 weeks to 2 weeks within 6 months.

#### METHODS

This project was performed in two outpatient imaging centers affiliated with a large academic health system. The "next available" CT appointment date was defined as the nearest date with more than one available slot, measured weekly. A balancing metric was utilized, measuring the time between scheduled and actual exam time start with a goal of <15 minutes. Several performance improvement methodologies including PDSA cycles, gemba walks, fishbone diagrams, and control charts were utilized.

#### RESULTS

Over the course of 5 months, the lack of CT appointment capacity and workflow inefficiencies were determined as root causes of outpatient CT appointment access issues. A control chart was used to demonstrate the average weeks to schedule a CT appointment at outpatient imaging sites. In October 2022, outpatient CT time slots were temporarily double booked, immediately reducing the length of time patients waited for CT appointments from an average of 6 weeks to an average of 1.7 weeks (72%). All outpatient CT exam durations were then reduced from 20 minute to 15-minute time slots further reducing wait times from 1.7 weeks to 1 week (41%). The average monthly CT exam volume increased from 3,254 to 3,688 (88%). Overall, a 95% decrease in time between schedule request and scheduled exam date was achieved. CT exams consistently began on average within 15 minutes of their scheduled table time. Clinical managers continue to monitor patient access, staff satisfaction, and exam start delays.

#### DISCUSSION

In the absence of an effort to reduce demand for CT services, it was clear that reducing the scheduling backlog would require an increase in exam volume. This was particularly challenging in the short term, given limitations of technologist staffing shortages. After benchmarking CT exam duration at our most efficient sites, improved technologist and machine efficiency was achieved by reducing outpatient CT exam durations from 20 minutes to 15 minutes, adding one additional CT appointment per hour. Additional CT volume gained through this project resulted in an estimated \$5 million annual revenue increase with minimal expense increase. The increased volume of CT exams performed had a temporary negative impact on report turnaround time and increased work burden on prior authorization and scheduling services.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

M5B-QI-9HC

### Impact of Early Direct Patient Notification of Non-Urgent Incidental Radiology Findings Requiring Follow-up

Monday, Nov. 27 12:45PM - 1:15PM Room: Learning Center

James R. Loftus, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The need for informing patients directly in radiology is prompted by a high number of follow-up recommendations for incidental findings that are not being completed. In 2018, the state of Pennsylvania (PA) passed Act 112 with the goal of increasing compliance with follow-up recommendations by requiring diagnostic imaging facilities to directly notify patients within 20 days of "significant" abnormalities which would require follow-up within three months. The purpose of our study was to determine whether early notification could further improve the follow-up completion rates achieved by our existing recommendation tracking system ("Backstop").

#### METHODS

Patients with radiologic findings requiring follow-up set to undergo our Backstop communication schedule were randomized into four groups: Group 1 receiving additional early direct notification via a mailed letter (similar to PA Act 112), Group 2 via phone, Group 3 via electronic portal message, and Group 4, the control, only following the Backstop communication schedule. Backstop includes four stages of escalation of communication amongst health care providers at one, two, and three months overdue, and a letter directly sent to the patient if follow-up is not completed after the first three stages. Patients randomized into early direct notification received a survey by letter one month after the follow-up notification occurred to assess patients' perceived value, attitudes, and preferences on early direct notification. The survey comprised of 13 items in total, 5 utilizing a 5-point Likert scale, 1 question ranking communication modality preference between 5 options, and 7 items were binary yes/no questions designed ad hoc by the study team as no previously validated questionnaires on this topic exist.

#### RESULTS

Data from 2,548 randomized patients were analyzed for the study, including 593 patients notified by letter, 637 by phone, 701 by portal, and 617 control patients. Group 3 demonstrated the lowest rate of follow-up completion within one month of due date at 36.4%, compared to 58.7% for Group 1, 60.4% for group 2, and 53.2% for Group 4 (all  $p < 0.0001$ ). The difference in completion rates was statistically significant ( $p = 0.014$ ) between Group 2 and Group 4. Patients responded positively regarding early notification with approximately 90% stating they wanted to continue receiving notifications and ranked electronic portal as their most preferred communication modality.

#### DISCUSSION

The impact of early direct notification on follow-up examination completion rates was small or negative depending upon the communication method utilized. However, our survey results demonstrated trust and positive patient engagement built through notification. Thus, we conclude that early direct notification may have healthcare benefits when encompassed within a recommendation tracking system to ensure follow-up completion.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-QI

### Quality Improvement Reports Thursday Poster Discussions

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **R2-QI-1 Switching Neutral Oral Contrast from VoLumen® to Breeza® to Improve Patient Tolerance and Acceptability of MRE (Magnetic Resonance Enterography) and CTE (Computed Tomography Enterography)**

Sindhura Tadisetty, MBBS (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

The purpose of this study was to evaluate oral contrast patient tolerance to decrease the need to re-scan patients undergoing MRE and CTE. MRE and CTE are imaging tests that use oral and intravenous contrast agents to evaluate and diagnose small bowel diseases, commonly inflammatory bowel disease. There are two commercially available neutral oral barium-containing contrast agents, VoLumen® (by Bracco Diagnostics, Milan, Italy) and Breeza® (by Beekley Medical, Bristol). Volumen® is the oral contrast that was traditionally used. The known adverse effects of VoLumen® are undesirable taste and texture, nausea, cramping, and diarrhea. These side effects cause the patient discomfort; also, if the patient is unable to consume the contrast or throws up, it leads to increased inadequate distension. Breeza® is better tolerated and hence is used more commonly in pediatric patients. It is also known that both contrast materials provide similar bowel distention to Volumen. This project will evaluate the feasibility of switching the oral contrast to Breeza® in adults and evaluate patient tolerance.

#### **METHODS**

Adult patients undergoing MRE and CTE at our institution were given both contrast media along with a questionnaire for each media; they were asked to choose one for their exam. The questionnaire contained questions such as "How do you rate the taste and texture of the contrast given to you?", "Would you be willing to consume this contrast again" and "What is your perceived state of health post consuming the contrast." Their choice of contrast was also noted. We analyzed the answers to these questions to determine which contrast was better tolerated. Patient registered-Arrives at MR/CT waiting room-MRI Screening- Labs checked-Peripheral IV placed-Oral contrast administration in Zone II -Questionnaire to assess the taste perseveres and comfort level post oral contrast> MRE/CTE protocol- patient returns to the clinic/inpatient or ER room.

#### **RESULTS**

We recruited 20 patients undergoing MRE and CTE between March 15th, 2023, to April 15th, 2023. Among them, 19 patients chose Breeza® over Volumen®, which is a 95% acceptance rate for Breeza®. Among the people who chose Breeza®, the taste, and texture were ranked superior to Volumen®. None of the patients who chose Breeza® had problems consuming the contrast and keeping it down.

#### **DISCUSSION**

Breeza® has shown to have increased tolerance and better taste and texture profile when compared to Volumen®. We advocate for the shift to Breeza as the preferred contrast in adult patients who undergo CTE and MRE. We did not compare the image quality of studies performed with Breeza® and those performed with Volumen® in the short duration. We intend to perform this comparison in the coming months.

#### **R2-QI-2 Structured Computed Tomography Quality Assurance Program in Neuroradiology**

Kayla Nakashima, BS (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Computed Tomography (CT) scans are essential in healthcare to diagnose diseases and injury. The lack of action and transparency to improve image quality can undermine patient care and hinder radiologist workflow. To decrease the amount of Quality Assurance (QA) flags, a process with standard documentation and increased communication was created to improve image quality in the CT department. This project aims to determine whether a structured QA process in the

neuroradiology section can decrease the number of QA flags, improve patient care, strengthen physician trust and improve department efficiency.

## **METHODS**

This study was conducted in the Department of Radiology at UC Irvine Medical Center, an academic hospital. The QA process proceeds as follows: first, a radiologist flags an error in the Picture Archiving and Communication System (PACS) with (1) a categorization of either "protocol," "technique," "reconstruction," "scanner," or "other;" (2) a severity of "0" or "1" (0 patient care is not affected; 1 patient care is affected), and (3) comments. Next, the Quality Nurse collects this information and also acquires the following data: date performed, patient information, study description, scanner, radiologist, and technologist. This data is logged using a HIPAA compliant tracker. This tracker is sent to CT leadership (CT supervisor and Senior CT Technologist), who discusses each QA flag with the technologists. To ensure change and accountability, each technologist with a QA flag is emailed an explanation of the issue and how to improve that must be acknowledged within one week. Additionally, CT leadership anonymizes and discusses common QA trends at department group huddles and during one-on-one technologist training. To increase communication with the neuroradiologists, a group message between CT leadership and the neuroradiologists was created to discuss day to day questions about study protocols. Additionally, CT leadership and the neuroradiologists meet monthly to review each QA flag to identify trends and develop resolutions efficiently. This process was repeated monthly for the past year.

## **RESULTS**

The number of QA flags per month decreased after implementation of the QA process. The number of QA flags per category each month.

## **DISCUSSION**

The marking of QA flags, followed by the implementation of structured documentation and action toward reducing errors, has increased technologist and radiologist engagement and improved image quality. By creating a multidisciplinary approach to standardizing CT scans, radiologists can use automated feedback to enhance image quality, ultimately contributing to better patient care. Although continued research is needed, the goal is to use this form of standard documentation and quality assurance program for image quality improvement in all radiology sections.

## **R2-QI-3 Improving Quantitative Report Turn-around Time using Digital Technology for Clinical Trials**

Ceylan A. Taslicay, MD (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Tumor metrics criteria such as RECIST1.1, Lugano, etc, are used for clinical trials to assess response to treatment. The Quantitative Imaging Analysis Core -QIAC provides a centralized clinical imaging research platform at the tertiary Cancer Center. In QIAC, Imaging research specialists-IRS evaluate scans based on tumor metrics criteria and submit preliminary reports, which the radiologists then finalize. These reports help clinicians decide whether to continue or terminate chemotherapy. Thus the report must be available before patient's clinical appointment. To ensure this, a digital system was introduced to alert the radiologist of the available preliminary report in QIAC.

## **METHODS**

The automated digital alert was deployed to decrease submitted to finalized-SOF of QIAC reports, i.e. the TAT for expedited and non-expedited cases. IRS preliminary report submitted time and the radiologist report finalized time was recorded digitally in the database. Data before and after implementing the digital system was extracted from the QIAC digital database. TAT time was calculated in hours by comparing the pre-deployment (12193 reports) and post-deployment (6504 reports). TAT was summarized using mean, standard deviation, median, Q1 (25th) and Q3 (75th) quantiles. Comparison between pre and post-deployment was performed using Wilcoxon Rank Sum test. The categorical time difference was summarized using frequencies and percentages. P-value less than 0.05 was considered statistically significant. Statistical analyses were conducted using R-version 3.6.3 R Development Core Team, Vienna, Austria.

## **RESULTS**

Distribution of TAT was heavily right-skewed and close to an exponential distribution, with a mean of 33.2 (SD = 76.8) for post-deployment and a mean of 83.4 (SD = 166.9) for pre-deployment. There was a statistically significant difference in TAT between the pre-deployment and post-deployment of the digital alert system. TAT was significantly less post-deployment than pre-deployment overall ( $p=0.0016$ ). For expedited reports,  $p<0.020$ , and for non-expedited  $p<0.001$ . The digital alert system significantly decreased mean TAT from 44.9 hours to 16.4 hours for expedited cases  $p=0.0022$  (Table 1 Graph 1).

## **DISCUSSION**

There were several limitations. While deploying the alerts it was challenging to track if the radiologist were out of the office, on paid time off, or on a rotation where they were away from their computers and could not sign the reports. It was thus difficult to account for these unforeseen consequences and may have caused a delay in signing the reports despite the digital alert. However, using the digital alert system, the TAT for all reports decreased whether they were expedited or non-expedited providing the QIAC reports in time for patient appointments and facilitating better therapeutic decision-making and clinical care.

## **R2-QI-4 Enhancing Patient Safety by Implementing a Digital Centralized Dose Management Program within a Large-scale Healthcare Organization Across 13 Countries and 120 CT Scanners**

Chryssa Paraskevopoulou, MSc (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

According to the European Directive 2013/59/EURATOM, any justified medical exposure should be optimized in terms of image quality and dose, setting the frame for dose management. Radiation Dose Monitoring Systems (RDMS) are used to record exam dose levels and can aid the dose optimization process. While several guidelines on dose management have been published, CT practice can differ among centers, organizations and countries, making the optimization process challenging. The purpose of this study is to describe the Dose Management Program (DMP) implemented in a large healthcare organization and present the results of its deployment across 13 countries and 120 CT systems.

### **METHODS**

A DMP was launched in 2014 in a European Healthcare Organization and has been gradually deployed in 13 countries. The dose management process uses a list of 104 CT protocols per anatomical area and clinical indication, mapped to a RadLex Playbook radiology lexicon code (RPID) with established Organizational Diagnostic Reference Levels (DRLs). A unique RDIM system (DoseWatch, GE) is connected to 120 CT scanners and is used to collect exam data. Exams performed with mapped CT protocols are considered standardized while those performed with dose within DRLs are considered optimized. Data is monitored on local and global level using a business intelligence tool (Imaging Insights, GE). Dose Optimization is achieved by creating a culture of dose awareness, training of people involved, data analysis and CT protocol parameters optimization. A multidisciplinary team in center, country and group level collaborates to achieve best practice. Program's success is monitored using a set of Key Performance Indicators (KPIs): Standardization >75% and Optimization >70%. More than 70.000 exams are collected monthly, allowing for analysis at Group, country and center level and gives the ability for targeted improvement actions. Patient safety is ensured by real time monitoring of standardization and optimization of CT practice.

### **RESULTS**

For each country, data were collected for 30 days for benchmarking. During this period, several educational sessions were organized while best practice from other countries was shared. CT protocol parameters were adjusted to reduce dose while preserve image quality. As a result of the DMP implementation the percentage of standard exams across 13 countries and 120 centers is 90% while the percentage of exams performed with dose within DRLs is 71%.

### **DISCUSSION**

The implementation of a DMP within a large-scale organization allows practice unification, best practice sharing and optimized dose across countries. Results analysis leads to improvement initiatives like training on Dose Management and optimization of CT protocol parameters. Knowledge, experience, and image quality feedback is shared between different countries to achieve optimum results to enhance patient safety.

## **R2-QI-5 Strategies to Improve Communication in Clinical Imaging in Manaus - AM during Covid-19 Pandemic**

Aline Souza, MD, MSc (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Effective communication in healthcare is important for both patient safety and value based healthcare. In our practice, we have observed failures in the communication process, especially between nursing technicians and radiologists. Communication problems are the cause of most adverse events. The notification system in state of Amazonas in 2022 showed that the most common errors in clinics were related to patient identification, healthcare assistance and documentation (BRAZIL, 2022). A recent survey showed that communication and empathy are the most important non-technical skills in the patient's view (KWEE et al., 2021).

### **METHODS**

This cross-sectional study consisted of theoretical-practical training with realistic simulation and formative evaluation, aimed at professionals who work in imaging clinic in Brazil. The training took place between 2020 and 2021, in small groups of 8 people, following the recommendation of The Brazil Ministry of Health. In January 2021, during the peak of the COVID-19 pandemic in Manaus, face to face training was replaced by remote training.

## RESULTS

A total of 111 (one hundred and eleven) employees participated, representing 82% of the staff. The study occurred in two parts. In the first, participants attended an interactive 60 minutes lecture, which included video demonstration and encouraged participation. At this stage, two tools were presented to improve communication: SBAR (Situation, Background, Assessment and Recommendation), to improve communication between the healthcare team, and AIDET® (Acknowledge, Introduce, Duration, Explanation and Thank You), to improve communication between healthcare professionals and patient/families. In the second part of the training, professionals were individually evaluated according to Table 1, by two evaluators (Picture 1). At the end, they received feedback on their performance, and those who obtained the highest scores in the formative evaluation were awarded. As a product of the training, a small book was created with recommendation for best practices, addressing communication with the patient and among the work team, communication with the requesting physician and value-based radiology.

## DISCUSSION

The implementation of SBAR and AIDET protocols proved effective in improving communication between healthcare teams and patients/families in imaging clinic. Despite the difficulties imposed by the COVID-19 pandemic, the training had significant adherence from the participants. However, further studies are needed to evaluate the effectiveness in developing specific communication skills for radiology. The book with best practice recommendations offers a useful source of information and can encourage professionals in the field to adopt a new behavior, with patient-centered actions.

### R2-QI-6 "My Attending Really Wants it!" Manual Clinical Decision Support Adjudicating the "Better Look" Inpatient MRI at an Academic Medical Center

Ashlesha S. Udare, MBBS, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Inpatient MRI utilization at our hospital is among the highest in the nation, leading to challenges accommodating high demand resulting in diagnostic delays, increased length of stay, and difficulty prioritizing patients. Inpatient MRI incurs significant cost, diagnostic utility may be degraded in the setting of acute illness and decision making is often fragmented. The specific aims of our radiologist decision support project were to reduce inappropriate exams or redirect nonurgent body MRI orders to the outpatient setting. Additional aims were to understand order patterns, identify opportunities for improvement, and confirm appropriate indications for inpatient exams.

## METHODS

To address overutilization of inpatient body MRI, a 9-item questionnaire was incorporated into our protocoling process to gather information about clinical decision making and necessity of inpatient MRI orders and the final disposition was recorded and compared with the baseline cancellation rate of 0.6%. The percentage of orders with no appropriate indication, orders recommended by consultants or radiology reports and reasons why MRI cannot be performed as an outpatient were recorded.

## RESULTS

Among 846 orders, 112 (13%) had no specific clinical question. 582 (69%) were recommended by non-radiology consulting services and 136 (16%) were recommended in radiology reports. 144 (17%) were considered appropriate for and 197 (23%) were considered possibly appropriate for outpatient imaging. The most frequent reason cited for inpatient imaging was "attending really wants it" (34%), followed by potential to be "lost to follow-up" (13%) and patient/family pressure (2%). 27% were not associated with an urgent procedure or inpatient management decision. Responses to whether the MRI could be performed after discharge were: No (60%), Maybe (23%), and Yes (17%). Final dispositions for the orders included routine inpatient study (68%), urgent inpatient study (18%), outpatient imaging (5%), on hold pending more information (5%), and study not performed (4%).

## DISCUSSION

The questionnaire served a consultative role by prompting discussion between radiology and the clinical services to assess appropriateness and appropriately triage inpatient orders. The implementation of the questionnaire resulted in a reduction of inpatient body MRI utilization up to 8% (from 0.6% cancellation to 9% cancellation + conversion). 85% of orders were recommended by consultants (69%) and radiology reports (16%) and frequent lack of understanding of the indication by the ordering clinician was evident. Limitations of our study include absent data on the disposition of "on hold" orders, the manual approach not sustainable in most practices and the retrospective analysis. Our study shows limited understanding of inpatient MRI appropriateness and potential for reducing utilization and outpatient conversion.

### R2-QI-8 Patient Friendly Reporting for Lung Cancer Screening CTs

Austin J. Fullenkamp, BS, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Patients often receive radiology reports using complex terminology that only physicians can decipher. Sometimes, these reports cause anxiety, confusion and decreased satisfaction. Graphics have been proven to decrease mental effort needed to

understand information and speaking to the audience's knowledge base improves understanding. The purpose of this project was to create patient friendly reports to improve patient satisfaction by increasing patients' confidence in understanding and comfort reading radiology reports.

## **METHODS**

Radiology reports are often difficult for patients to understand. To address this, two interventions were performed: Terminology was simplified and sections not useful to patient understanding were deleted from the report. 3D color graphics with explanations representing emphysema, lung nodules and coronary calcium were created using Siemens AIRAD companion software and syngovia. 10 standard reports and 10 patient friendly reports were prepared. 32 lung cancer screening clinic patients and members of patient and family advisory council were surveyed on the patient friendly and standard reports. 3-4 reports from each category were given to participants. Survey questions included report appearance (Ratings: very good, good, ok, bad, very bad), confidence in understanding the reports (Ratings: very confident, confident, neutral, not confident, not at all confident), and comfortability with the words/descriptions (Ratings: very comfortable, comfortable, neutral, not comfortable, and not at all comfortable). Ratings were combined into the top two categories (e.g. very comfortable and comfortable) and compared against the bottom three categories (e.g. neutral, not comfortable, and not at all comfortable) using chi-square tests. Statistical significance was set at the  $\alpha = .05$  threshold and two-sided p-values are reported.

## **RESULTS**

The patient friendly report was significantly more likely to have a rating of comfortable or very comfortable than the standard report ( $p < .001$ ). The patient friendly report was significantly more likely to have a confident rating than the standard report ( $p = .02$ ). The patient friendly report was significantly more likely to have a good rating than the standard report ( $p = .002$ ).

## **DISCUSSION**

Limitations of this study are the small sample size of 32 participants and the confidence survey question was added after the initial 12 participants were surveyed. Patient friendly reports improved participants comfort with words/descriptions in the report and improved their confidence in understanding the report.

## **R2-QI-9HC Improving Lung Cancer Screening Utilization**

### **Awards**

#### **Quality Improvement Reports Award**

Erin Panter (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Nearly 90% of patients who are eligible for Lung Cancer Screening (LCS) nationally are not screened each year. Approximately 22,000 patients in the region served by our health system met LCS eligibility criteria and only 4,800 (24%) obtained a low dose CT (LDCT) scan in 2021. Without screening, only 1 in 4 lung cancer patients are diagnosed at an early treatable stage. With screening, the rate rises to 60%. The goal of this project was to improve early detection of lung cancer by increasing the rate of LCS participation.

## **METHODS**

In partnership with the ACR Learning Network® this project was performed in the diagnostic radiology division of a health system containing a large urban academic center and multiple affiliated community hospitals. We aimed to increase the volume of low-dose CT exams performed weekly from an average of 105 to 195 (85%) within 9 months. Using several performance improvement methodologies including rapid PDSA cycles, gemba walks, control charts and fishbone diagrams, our multidisciplinary team was able to identify multiple potential root causes. Key drivers were determined and interventions tested and implemented. Weekly volumes of completed new LDCT and follow-up LDCT were tracked. Reports were generated and analyzed to provide the project team valuable information including the number of active but unscheduled LDCT orders and patients who met screening eligibility criteria.

## **RESULTS**

Weekly volumes of LDCT new and follow-up patients were aggregated. Average weekly LDCT exams increased from a baseline of 105 exams to 177 exams per week (69%)

## **DISCUSSION**

Several interventions were made to increase the number of LDCT exams including; direct marketing to the community, dedicated LDCT appointment time slots and provider education. The intervention most crucial to the success of the project was understanding the eligible patient population and standardizing smoking documentation in the EMR. The project team worked with population health management to establish reports that determined eligible patients that met United State Preventative Services Taskforce smoking criteria but had not been screened in the past year. We were able to identify over 20,000 eligible patients who had been seen in our hospital system in the past 3 years. With this list, we directly educated over 6,000 eligible patients with a positive impact. This also allowed us to create an EMR based best practice advisory pop-up facilitating one click LDCT ordering. Currently, LCS is not a performance metric recognized by the Center for Medicare and

Medicaid Services which prohibits it from being a pay for performance metric for our primary care providers. Working with primary care and population health leadership we were able to add LCS performance metrics to our preventative health maintenance dashboard used to transparently track primary care provider and practice performance

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## Abstract Archives of the RSNA, 2023

R2-QI-1

### **Switching Neutral Oral Contrast from VoLumen® to Breeza® to Improve Patient Tolerance and Acceptability of MRE (Magnetic Resonance Enterography) and CTE (Computed Tomography Enterography)**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Sindhura Tadisetty, MBBS (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

The purpose of this study was to evaluate oral contrast patient tolerance to decrease the need to re-scan patients undergoing MRE and CTE. MRE and CTE are imaging tests that use oral and intravenous contrast agents to evaluate and diagnose small bowel diseases, commonly inflammatory bowel disease. There are two commercially available neutral oral barium-containing contrast agents, VoLumen® (by Bracco Diagnostics, Milan, Italy) and Breeza® (by Beekley Medical, Bristol). VoLumen® is the oral contrast that was traditionally used. The known adverse effects of VoLumen® are undesirable taste and texture, nausea, cramping, and diarrhea. These side effects cause the patient discomfort; also, if the patient is unable to consume the contrast or throws up, it leads to increased inadequate distension. Breeza® is better tolerated and hence is used more commonly in pediatric patients. It is also known that both contrast materials provide similar bowel distention to VoLumen. This project will evaluate the feasibility of switching the oral contrast to Breeza® in adults and evaluate patient tolerance.

#### **METHODS**

Adult patients undergoing MRE and CTE at our institution were given both contrast media along with a questionnaire for each media; they were asked to choose one for their exam. The questionnaire contained questions such as "How do you rate the taste and texture of the contrast given to you?", "Would you be willing to consume this contrast again" and "What is your perceived state of health post consuming the contrast." Their choice of contrast was also noted. We analyzed the answers to these questions to determine which contrast was better tolerated. Patient registered-Arrives at MR/CT waiting room-MRI Screening- Labs checked-Peripheral IV placed-Oral contrast administration in Zone II -Questionnaire to assess the taste perseveres and comfort level post oral contrast> MRE/CTE protocol- patient returns to the clinic/inpatient or ER room.

#### **RESULTS**

We recruited 20 patients undergoing MRE and CTE between March 15th, 2023, to April 15th, 2023. Among them, 19 patients chose Breeza® over VoLumen®, which is a 95% acceptance rate for Breeza®. Among the people who chose Breeza®, the taste, and texture were ranked superior to VoLumen®. None of the patients who chose Breeza® had problems consuming the contrast and keeping it down.

#### **DISCUSSION**

Breeza® has shown to have increased tolerance and better taste and texture profile when compared to VoLumen®. We advocate for the shift to Breeza as the preferred contrast in adult patients who undergo CTE and MRE. We did not compare the image quality of studies performed with Breeza® and those performed with VoLumen® in the short duration. We intend to perform this comparison in the coming months.

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## Abstract Archives of the RSNA, 2023

R2-QI-2

### Structured Computed Tomography Quality Assurance Program in Neuroradiology

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Kayla Nakashima, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Computed Tomography (CT) scans are essential in healthcare to diagnose diseases and injury. The lack of action and transparency to improve image quality can undermine patient care and hinder radiologist workflow. To decrease the amount of Quality Assurance (QA) flags, a process with standard documentation and increased communication was created to improve image quality in the CT department. This project aims to determine whether a structured QA process in the neuroradiology section can decrease the number of QA flags, improve patient care, strengthen physician trust and improve department efficiency.

#### METHODS

This study was conducted in the Department of Radiology at UC Irvine Medical Center, an academic hospital. The QA process proceeds as follows: first, a radiologist flags an error in the Picture Archiving and Communication System (PACS) with (1) a categorization of either "protocol," "technique," "reconstruction," "scanner," or "other," (2) a severity of "0" or "1" (0 patient care is not affected; 1 patient care is affected), and (3) comments. Next, the Quality Nurse collects this information and also acquires the following data: date performed, patient information, study description, scanner, radiologist, and technologist. This data is logged using a HIPAA compliant tracker. This tracker is sent to CT leadership (CT supervisor and Senior CT Technologist), who discusses each QA flag with the technologists. To ensure change and accountability, each technologist with a QA flag is emailed an explanation of the issue and how to improve that must be acknowledged within one week. Additionally, CT leadership anonymizes and discusses common QA trends at department group huddles and during one-on-one technologist training. To increase communication with the neuroradiologists, a group message between CT leadership and the neuroradiologists was created to discuss day to day questions about study protocols. Additionally, CT leadership and the neuroradiologists meet monthly to review each QA flag to identify trends and develop resolutions efficiently. This process was repeated monthly for the past year.

#### RESULTS

The number of QA flags per month decreased after implementation of the QA process. The number of QA flags per category each month.

#### DISCUSSION

The marking of QA flags, followed by the implementation of structured documentation and action toward reducing errors, has increased technologist and radiologist engagement and improved image quality. By creating a multidisciplinary approach to standardizing CT scans, radiologists can use automated feedback to enhance image quality, ultimately contributing to better patient care. Although continued research is needed, the goal is to use this form of standard documentation and quality assurance program for image quality improvement in all radiology sections.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R2-QI-3

### Improving Quantitative Report Turn-around Time using Digital Technology for Clinical Trials

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Ceylan A. Taslicay, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Tumor metrics criteria such as RECIST1.1, Lugano, etc, are used for clinical trials to assess response to treatment. The Quantitative Imaging Analysis Core -QIAC provides a centralized clinical imaging research platform at the tertiary Cancer Center. In QIAC, Imaging research specialists-IRS evaluate scans based on tumor metrics criteria and submit preliminary reports, which the radiologists then finalize. These reports help clinicians decide whether to continue or terminate chemotherapy. Thus the report must be available before patient's clinical appointment. To ensure this, a digital system was introduced to alert the radiologist of the available preliminary report in QIAC.

#### METHODS

The automated digital alert was deployed to decrease submitted to finalized-SOF of QIAC reports, i.e. the TAT for expedited and non-expedited cases. IRS preliminary report submitted time and the radiologist report finalized time was recorded digitally in the database. Data before and after implementing the digital system was extracted from the QIAC digital database. TAT time was calculated in hours by comparing the pre-deployment (12193 reports )and post-deployment (6504 reports). TAT was summarized using mean, standard deviation, median, Q1 (25th) and Q3 (75th) quantiles. Comparison between pre and post-deployment was performed using Wilcoxon Rank Sum test. The categorical time difference was summarized using frequencies and percentages. P-value less than 0.05 was considered statistically significant. Statistical analyses were conducted using R-version 3.6.3 R Development Core Team, Vienna, Austria.

#### RESULTS

Distribution of TAT was heavily right-skewed and close to an exponential distribution, with a mean of 33.2 (SD = 76.8) for post-deployment and a mean of 83.4 (SD = 166.9) for pre-deployment. There was a statistically significant difference in TAT between the pre-deployment and post-deployment of the digital alert system. TAT was significantly less post-deployment than pre-deployment overall ( $p=0.0016$ ). For expedited reports,  $p<0.020$ , and for non-expedited  $p<0.001$ . The digital alert system significantly decreased mean TAT from 44.9 hours to 16.4 hours for expedited cases  $p=0.0022$  (Table 1 Graph 1).

#### DISCUSSION

There were several limitations. While deploying the alerts it was challenging to track if the radiologist were out of the office, on paid time off, or on a rotation where they were away from their computers and could not sign the reports. It was thus difficult to account for these unforeseen consequences and may have caused a delay in signing the reports despite the digital alert. However, using the digital alert system, the TAT for all reports decreased whether they were expedited or non-expedited providing the QIAC reports in time for patient appointments and facilitating better therapeutic decision-making and clinical care.

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## Abstract Archives of the RSNA, 2023

R2-QI-4

### Enhancing Patient Safety by Implementing a Digital Centralized Dose Management Program within a Large-scale Healthcare Organization Across 13 Countries and 120 CT Scanners

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Chryssa Paraskevopoulou, MSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

According to the European Directive 2013/59/EURATOM, any justified medical exposure should be optimized in terms of image quality and dose, setting the frame for dose management. Radiation Dose Monitoring Systems (RDMS) are used to record exam dose levels and can aid the dose optimization process. While several guidelines on dose management have been published, CT practice can differ among centers, organizations and countries, making the optimization process challenging. The purpose of this study is to describe the Dose Management Program (DMP) implemented in a large healthcare organization and present the results of its deployment across 13 countries and 120 CT systems.

#### METHODS

A DMP was launched in 2014 in a European Healthcare Organization and has been gradually deployed in 13 countries. The dose management process uses a list of 104 CT protocols per anatomical area and clinical indication, mapped to a RadLex Playbook radiology lexicon code (RPID) with established Organizational Diagnostic Reference Levels (DRLs). A unique RDIM system (DoseWatch, GE) is connected to 120 CT scanners and is used to collect exam data. Exams performed with mapped CT protocols are considered standardized while those performed with dose within DRLs are considered optimized. Data is monitored on local and global level using a business intelligence tool (Imaging Insights, GE). Dose Optimization is achieved by creating a culture of dose awareness, training of people involved, data analysis and CT protocol parameters optimization. A multidisciplinary team in center, country and group level collaborates to achieve best practice. Program's success is monitored using a set of Key Performance Indicators (KPIs): Standardization >75% and Optimization >70%. More than 70,000 exams are collected monthly, allowing for analysis at Group, country and center level and gives the ability for targeted improvement actions. Patient safety is ensured by real time monitoring of standardization and optimization of CT practice.

#### RESULTS

For each country, data were collected for 30 days for benchmarking. During this period, several educational sessions were organized while best practice from other countries was shared. CT protocol parameters were adjusted to reduce dose while preserve image quality. As a result of the DMP implementation the percentage of standard exams across 13 countries and 120 centers is 90% while the percentage of exams performed with dose within DRLs is 71%.

#### DISCUSSION

The implementation of a DMP within a large-scale organization allows practice unification, best practice sharing and optimized dose across countries. Results analysis leads to improvement initiatives like training on Dose Management and optimization of CT protocol parameters. Knowledge, experience, and image quality feedback is shared between different countries to achieve optimum results to enhance patient safety.

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## Abstract Archives of the RSNA, 2023

R2-QI-5

### Strategies to Improve Communication in Clinical Imaging in Manaus - AM during Covid-19 Pandemic

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Aline Souza, MD, MSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Effective communication in healthcare is important for both patient safety and value based healthcare. In our practice, we have observed failures in the communication process, especially between nursing technicians and radiologists. Communication problems are the cause of most adverse events. The notification system in state of Amazonas in 2022 showed that the most common errors in clinics were related to patient identification, healthcare assistance and documentation (BRAZIL, 2022). A recent survey showed that communication and empathy are the most important non-technical skills in the patient's view (KWEE et al., 2021).

#### METHODS

This cross-sectional study consisted of theoretical-practical training with realistic simulation and formative evaluation, aimed at professionals who work in imaging clinic in Brazil. The training took place between 2020 and 2021, in small groups of 8 people, following the recommendation of The Brazil Ministry of Health. In January 2021, during the peak of the COVID-19 pandemic in Manaus, face to face training was replaced by remote training.

#### RESULTS

A total of 111 (one hundred and eleven) employees participated, representing 82% of the staff. The study occurred in two parts. In the first, participants attended an interactive 60 minutes lecture, which included video demonstration and encouraged participation. At this stage, two tools were presented to improve communication: SBAR (Situation, Background, Assessment and Recommendation), to improve communication between the healthcare team, and AIDET® (Acknowledge, Introduce, Duration, Explanation and Thank You), to improve communication between healthcare professionals and patient/families. In the second part of the training, professionals were individually evaluated according to Table 1, by two evaluators (Picture 1). At the end, they received feedback on their performance, and those who obtained the highest scores in the formative evaluation were awarded. As a product of the training, a small book was created with recommendation for best practices, addressing communication with the patient and among the work team, communication with the requesting physician and value-based radiology.

#### DISCUSSION

The implementation of SBAR and AIDET protocols proved effective in improving communication between healthcare teams and patients/families in imaging clinic. Despite the difficulties imposed by the COVID-19 pandemic, the training had significant adherence from the participants. However, further studies are needed to evaluate the effectiveness in developing specific communication skills for radiology. The book with best practice recommendations offers a useful source of information and can encourage professionals in the field to adopt a new behavior, with patient-centered actions.

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## Abstract Archives of the RSNA, 2023

R2-QI-6

### **“My Attending Really Wants it!” Manual Clinical Decision Support Adjudicating the “Better Look” Inpatient MRI at an Academic Medical Center**

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Ashlesha S. Udare, MBBS, MD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Inpatient MRI utilization at our hospital is among the highest in the nation, leading to challenges accommodating high demand resulting in diagnostic delays, increased length of stay, and difficulty prioritizing patients. Inpatient MRI incurs significant cost, diagnostic utility may be degraded in the setting of acute illness and decision making is often fragmented. The specific aims of our radiologist decision support project were to reduce inappropriate exams or redirect nonurgent body MRI orders to the outpatient setting. Additional aims were to understand order patterns, identify opportunities for improvement, and confirm appropriate indications for inpatient exams.

#### **METHODS**

To address overutilization of inpatient body MRI, a 9-item questionnaire was incorporated into our protocoling process to gather information about clinical decision making and necessity of inpatient MRI orders and the final disposition was recorded and compared with the baseline cancellation rate of 0.6%. The percentage of orders with no appropriate indication, orders recommended by consultants or radiology reports and reasons why MRI cannot be performed as an outpatient were recorded.

#### **RESULTS**

Among 846 orders, 112 (13%) had no specific clinical question. 582 (69%) were recommended by non-radiology consulting services and 136 (16%) were recommended in radiology reports. 144 (17%) were considered appropriate for and 197 (23%) were considered possibly appropriate for outpatient imaging. The most frequent reason cited for inpatient imaging was "attending really wants it" (34%), followed by potential to be "lost to follow-up" (13%) and patient/family pressure (2%). 27% were not associated with an urgent procedure or inpatient management decision. Responses to whether the MRI could be performed after discharge were: No (60%), Maybe (23%), and Yes (17%). Final dispositions for the orders included routine inpatient study (68%), urgent inpatient study (18%), outpatient imaging (5%), on hold pending more information (5%), and study not performed (4%).

#### **DISCUSSION**

The questionnaire served a consultative role by prompting discussion between radiology and the clinical services to assess appropriateness and appropriately triage inpatient orders. The implementation of the questionnaire resulted in a reduction of inpatient body MRI utilization up to 8% (from 0.6% cancellation to 9% cancellation + conversion). 85% of orders were recommended by consultants (69%) and radiology reports (16%) and frequent lack of understanding of the indication by the ordering clinician was evident. Limitations of our study include absent data on the disposition of "on hold" orders, the manual approach not sustainable in most practices and the retrospective analysis. Our study shows limited understanding of inpatient MRI appropriateness and potential for reducing utilization and outpatient conversion.

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## Abstract Archives of the RSNA, 2023

R2-QI-8

### Patient Friendly Reporting for Lung Cancer Screening CTs

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

Austin J. Fullenkamp, BS, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Patients often receive radiology reports using complex terminology that only physicians can decipher. Sometimes, these reports cause anxiety, confusion and decreased satisfaction. Graphics have been proven to decrease mental effort needed to understand information and speaking to the audience's knowledge base improves understanding. The purpose of this project was to create patient friendly reports to improve patient satisfaction by increasing patients' confidence in understanding and comfort reading radiology reports.

#### METHODS

Radiology reports are often difficult for patients to understand. To address this, two interventions were performed: Terminology was simplified and sections not useful to patient understanding were deleted from the report. 3D color graphics with explanations representing emphysema, lung nodules and coronary calcium were created using Siemens AIRAD companion software and syngovia. 10 standard reports and 10 patient friendly reports were prepared. 32 lung cancer screening clinic patients and members of patient and family advisory council were surveyed on the patient friendly and standard reports. 3-4 reports from each category were given to participants. Survey questions included report appearance (Ratings: very good, good, ok, bad, very bad), confidence in understanding the reports (Ratings: very confident, confident, neutral, not confident, not at all confident), and comfortability with the words/descriptions (Ratings: very comfortable, comfortable, neutral, not comfortable, and not at all comfortable). Ratings were combined into the top two categories (e.g. very comfortable and comfortable) and compared against the bottom three categories (e.g. neutral, not comfortable, and not at all comfortable) using chi-square tests. Statistical significance was set at the  $\alpha = .05$  threshold and two-sided p-values are reported.

#### RESULTS

The patient friendly report was significantly more likely to have a rating of comfortable or very comfortable than the standard report ( $p < .001$ ). The patient friendly report was significantly more likely to have a confident rating than the standard report ( $p = .02$ ). The patient friendly report was significantly more likely to have a good rating than the standard report ( $p = .002$ ).

#### DISCUSSION

Limitations of this study are the small sample size of 32 participants and the confidence survey question was added after the initial 12 participants were surveyed. Patient friendly reports improved participants comfort with words/descriptions in the report and improved their confidence in understanding the report.

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## Abstract Archives of the RSNA, 2023

R2-QI-9HC

### Improving Lung Cancer Screening Utilization

Thursday, Nov. 30 9:00AM - 9:30AM Room: Learning Center

#### Awards

##### Quality Improvement Reports Award

Erin Panter (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Nearly 90% of patients who are eligible for Lung Cancer Screening (LCS) nationally are not screened each year. Approximately 22,000 patients in the region served by our health system met LCS eligible criteria and only 4,800 (24%) obtained a low dose CT (LDCT) scan in 2021. Without screening, only 1 in 4 lung cancer patients are diagnosed at an early treatable stage. With screening, the rate rises to 60%. The goal of this project was to improve early detection of lung cancer by increasing the rate of LCS participation.

#### METHODS

In partnership with the ACR Learning Network® this project was performed in the diagnostic radiology division of a health system containing a large urban academic center and multiple affiliated community hospitals. We aimed to increase the volume of low-dose CT exams performed weekly from an average of 105 to 195 (85%) within 9 months. Using several performance improvement methodologies including rapid PDSA cycles, gemba walks, control charts and fishbone diagrams, our multidisciplinary team was able to identify multiple potential root causes. Key drivers were determined and interventions tested and implemented. Weekly volumes of completed new LDCT and follow-up LDCT were tracked. Reports were generated and analyzed to provide the project team valuable information including the number of active but unscheduled LDCT orders and patients who met screening eligibility criteria.

#### RESULTS

Weekly volumes of LDCT new and follow-up patients were aggregated. Average weekly LDCT exams increased from a baseline of 105 exams to 177 exams per week (69%)

#### DISCUSSION

Several interventions were made to increase the number of LDCT exams including; direct marketing to the community, dedicated LDCT appointment time slots and provider education. The intervention most crucial to the success of the project was understanding the eligible patient population and standardizing smoking documentation in the EMR. The project team worked with population health management to establish reports that determined eligible patients that met United State Preventative Services Taskforce smoking criteria but had not been screened in the past year. We were able to identify over 20,000 eligible patients who had been seen in our hospital system in the past 3 years. With this list, we directly educated over 6,000 eligible patients with a positive impact. This also allowed us to create an EMR based best practice advisory pop-up facilitating one click LDCT ordering. Currently, LCS is not a performance metric recognized by the Center for Medicare and Medicaid Services which prohibits it from being a pay for performance metric for our primary care providers. Working with primary care and population health leadership we were able to add LCS performance metrics to our preventative health maintenance dashboard used to transparently track primary care provider and practice performance

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## Abstract Archives of the RSNA, 2023

R5A-QI

### Quality Improvement Reports Thursday Poster Discussions I

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **R5A-QI-1 Anesthesia and MRI Safety: Burning Questions and the Road to Better Practice**

Hamilton Shoji, MD (*Presenter*) Nothing to Disclose

##### **INTRODUCTION**

Burns are the most frequent MRI-related adverse event, per a 10-year FDA reports review. An analysis of our institution data revealed that burns are a rare event on the MRI (8 events in 319215 examinations in a 4-year span), with all episodes occurring on patients under anesthesia. No awaken individual reported MRI-related burns. To our knowledge, this is a risk factor not previously reported. The aim of this study is to propose a new workflow for MRI orders with anesthesia to tackle some of the proposed factors that may play a role in these incidents.

##### **RESULTS**

Decrease in the proportion of MRI under full anesthesia (100% to 59,9%). Increase in the proportion of MRI under mild sedation or anxiolysis (0 to 31%), or fully awoken (from 0 to 7,5%). Decrease in continuous scanning time in patients under anesthesia, both with reduced or optimized protocols (19%), or by withdrawals of segments for examination. Register of a checklist for patient positioning with special attention to correct padding and isolation of wires, cables and other devices. Register of patient temperatures monitoring during scan. Register of skin conditions prior and after the examinations.

##### **METHODS**

Review of the current literature of proposed mechanisms of burns in the MRI and strategies to avoid them. Redesign the workflow (from scheduling to patient positioning and monitoring) to capitalize on opportunities to clear known risks.

##### **DISCUSSION**

Although known as a safe procedure and with more widespread use of Choosing Wisely based strategies for diagnostic imaging that shifts CT to other methods, the MRI may impose health risks that are not fully understood. We hope that a deeper knowledge of the mechanisms involved in adverse events will help to avoid serious complications. Until then, we are focused on honing our workflow to decrease incidents to a minimum, without limiting access to adequate diagnostic testing.

#### **R5A-QI-2 Patient Safety in Diagnostic Imaging: Proposal to Mitigate Identification Errors**

Aline Souza, MD, MSc (*Presenter*) Nothing to Disclose

##### **INTRODUCTION**

The Brazil Ministry of Health created the National Patient Safety Program in 2013, which instituted actions to prevent and reduce incidents in healthcare services and has settled the mandatory creation of the Patient Safety Nucleus (PSN). However, many healthcare institutions have not yet implemented their PSN. In the State of Amazonas (AM), in January 2023, there were 98 NSP. This represents about 8% of healthcare organizations in the region. Identification errors are frequent in AM. From September 2019 to August 2020, patient identification failure was the most common in radiology, along with documentation failure. The objective was to create an electronic notification system in an imaging clinic in Manaus, and to develop a proposal for the correct identification of patients submitted to exams.

##### **METHODS**

Design Thinking, as an approach to solving complex problems. The following steps were taken: 1) Discovery of the problem, through a questionnaire about the safety culture, process mapping and event notification. 2) Summary, registration of the NSP at ANVISA and development of the action plan. 3) Ideation, which consisted into the creation of the electronic notification model and 4) Prototyping, system validation and standardization of successful strategies.



## RESULTS

In 18 months, 608 events were reported. Near miss represented 68.6% (n=417), event without harm 28.1% (n=171) and adverse event 3.3% (n=20). The most reported isolated error was the patient's name, corresponding to 20.6% (n=125). When classified by categories, document errors represented 44.2% (n=269) and patient identification 29.4% (n=179). The number of events corresponded to 0.36% of all exams performed and adverse events represented 0.01% of them. The highest percentage of errors was in MRI scans (0.88%, n=227), CT scans (0.67%, n=122) and x-rays (0.49% n=101), that correspond to the exams most performed in the organization. After adoption of healthcare policies, there was a reduction in events related to patient identification, from 13.6% to 4.8%; the sum of type, side and site errors from 21.2% to 7.6% and procedural error from 28.8% to 12.4% (Table 1).

## DISCUSSION

The association of an electronic notification system, process improvement and training reduced 64,7% patient identification errors. Additionally, there was also a 64,1% reduction in the sum of type, side and site exam errors, and 56,9% in procedural errors.

### **R5A-QI-3 Quality Process Design to Change Radiodiagnostic Equipment to Minimize the Impact on Waiting Lists in a Public Health Imaging Diagnostic Provider**

Virginia Benavente (*Presenter*) Nothing to Disclose

## INTRODUCTION

Our institution is a public company of the National Health System (NHS), whose function is the direction, management, and provision of diagnostic imaging and nuclear medicine services. In 2021, the Spanish Government launched the Investment Plan for High Technology Equipment (INVEAT), aimed at reducing the obsolescence of the current technological park of the NHS. It will allow our institution to implement 17 new high-tech equipment in 7 hospitals throughout a regional territory between 2022 and 2023. Before regulatory changes related to the Nuclear Safety Council (CSN) authorisation, the Spanish competent authority for radiological protection, the administrative procedures and works to deregister, install and start up our equipment did not affect waiting lists as all administrative procedures could be processed after equipment installation and start-up. In 2022, CSN regulatory changes modified the procedures, and all the authorizations are required before installing new equipment. Consequently, our INVEAT plan needed to be redesigned to meet its deadlines and reduce its impact on the waiting lists and preserve patient care. The purpose of the study is to redesign our INVEAT plan to minimize its impact on waiting lists.

## RESULTS

The new process takes 95 days after the redesigning (Figure 2). The actions implemented were the following:

## METHODS

The process involves the radiological protection area (RPA) and the infrastructure area (AU). As it can be seen in Figure 1, it involves equipment deregistration (in orange) and installation (in blue) with tasks requiring the collaboration between RPA, IA and external stakeholders. Before the redesigning it took 117 days to complete the process. The process redesign was focused on all administrative procedures. To this end, a digital documentation structure and workflow were implemented for each work team depending on members roles, the step of the process and deadlines and milestones to meet.

## DISCUSSION

This redesigned process involving actions on the administrative tasks to improve communication and team building is useful and allows us to reduce the whole process of deregistration, removal, installation and start-up in 22 days. Compliance with this new working procedure is key to obtaining optimal results and reducing the impact on waiting lists. The critical point of this procedure is the interdependence between the parts involved. Most of documentation required also depends on the external companies and it can affect the flow of the process.

### **R5A-QI-4 Improving Overnight Turn-around-time and Restoring On-call Resident Responsibility in an Academic Medical Center**

Johannes H. Decker, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Emergency departments (ED) increasingly demand rapid final interpretations of ED radiology studies. Academic medical centers must balance demands for fast report turn-around-time (TAT) against the educational value of call for residents. A departmental resident task force identified facilitation of resident published preliminary reports as an improvement opportunity, based on evidence that autonomy increased ratings of educational experience. A call system was developed with the goals of enhancing resident autonomy while improving patient care through shorter final report TATs.

## METHODS

To review resident contribution (No Contribution, Draft, Prelim) over our phased transition, we summarize weekly call data for 2 categories of cross-sectional exams - adult Non-Neuro (Body, Chest, CVI, MSK) and adult Neuro. No Contribution indicates a fellow/attending reported the exam directly. Draft indicates a resident created an initial draft without publishing. Prelim indicates a resident published a preliminary report. Attending-signed final reports (final TAT) were expected within 90 minutes of the end of an exam. Data included studies between the hours of 8:45 PM - 7:30 AM 7-days a week. Baseline (12/2018 - 12/2019): Fellows publish prelims overnight, residents draft reports (discouraged from publishing prelims). Final reports followed in the morning. 1st Intervention (01/2020): Instituted neuro attending finals overnight, residents encouraged but not required to publish prelims. 2nd Intervention (11/2021): Instituted non-neuro teleradiology attending finals overnight, residents encouraged but not required to publish prelims. To accommodate increased volume, an additional swing resident (5 PM - 2 AM) was added 07/2020.

## RESULTS

At baseline, median final TAT was around 6-10 hours. Residents issued drafts for 75% and 90% of Neuro and Non-Neuro ED studies, and 40% and 50% of Neuro and Non-Neuro IP studies, rarely publishing prelims. After implementation of Neuro attending overnight final reads, median Neuro final TAT decreased to 60 minutes (excluding weeks with 1st year fellow coverage). Resident publication of prelim reports for Neuro ED studies increased: 30% (early 2020), 70% (early 2021), 84% (early 2022), and 65% (early 2023). After implementation of Non-Neuro teleradiology to provide overnight attending final reads, median Non-Neuro final TAT decreased to 40 minutes. Residents published prelim reports for most Non-Neuro ED studies (90%). No increase in ED-reported safety events arising from overread changes was seen despite increases in resident published preliminary reports. No increase in preliminary TAT.

## DISCUSSION

Providing attending overnight coverage improved final TAT for ED reports. This change also facilitated resident comfort with voluntarily publishing preliminary reports, a marker of call autonomy, while mitigating patient risk.

## **R5A-QI-5 Applying Lean Six Sigma Techniques to Patient Flow in the Breast Imaging Service: A Tertiary Center's Experience and Process of Improvement**

Nader Ashraf, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

With the total number of screening mammograms conducted in the United States reaching almost 40 million, it is estimated that 10% of those cases necessitate further workup to reach a diagnostic resolution on whether the lesion is cancerous or not, which is called time to resolution (TTR). Breast imaging services often experience a significant degree of variability in patient flow, as the flow varies depending on whether the patient requires extensive testing or not, which adds to clinic inefficiency. The Lean Six Sigma Methodology (LSSM) was developed to give near-perfect services to huge operations by lowering the improbable occurrence. Hence, we applied LSSM in our breast imaging service to reduce TTR and improve patient flow, enhancing efficiency and patient outcomes.

## METHODS

An electronic medical record integrated system was put in place to track the TTR from the time the screening study is input until diagnostic resolution is reached. A baseline audit followed by a post-implementation audit were conducted. Multidisciplinary meetings, alongside a study of patient complaint data, were utilized to identify issues that were causing prolonged TTR leading to patient flow inefficiencies. The resulting sources of variability were recognized and analyzed using an Ishikawa fishbone diagram to classify sources of variation. To address these root causes, possible solutions were proposed and implemented. Significant differences in TTR were assessed using the Mann-Whitney-U test.

## RESULTS

During the baseline audit of 8 months, 589 cases of mammographic recalls (BI-RADS 0) were recruited. The average TTR for this group was 86.3 days. To reflect the required change in the mindset to adopt a patient-centric approach instead of the traditional exam/modality-focused one, there will be proposed improvement plans. Due to the lack of funding received for this project, some gaps, like staff shortages, were not able to be addressed. During the post-implementation period of 3 months, 370 cases of mammographic recalls (BI-RADS 0) were made. The average TTR for this group was 36.0 days. After applying LSSM, we managed to significantly reduce our TTR by at least 58% ( $P < 0.01$ ).

## DISCUSSION

With the application of LSSM in our breast imaging service, we managed to reduce our TTR by 58%. This was mainly related to the effect of training the coordinators to capture the screening recalls and schedule the recommended examinations. Moreover, there was an observed increase in the numbers of same-day nonscheduled targeted US generated and performed by the radiologist due to their commitment to embracing patient-centered care. These changes should be there to stay, incorporated into our culture, to facilitate continuous improvement and cost reduction. As the need for healthcare resources grows in the future, LSSM may play an increasingly essential role in enhancing healthcare service delivery.

## **R5A-QI-6 Lateral Knee Radiograph Quality Improvement Project**

Lindsay M. Ranschau, BS, ARRT (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Description: Our radiology department has a focus on image quality. Complaints received from radiologist indicate that the quality of lateral knee radiographs was lower than expected. Knowledge: Higher quality images allow for more accurate and expedited diagnoses. A point scale of 1-15 (15 being highest quality) can be used to measure acceptability of images. Images that score between 10 - 12 are the lowest acceptable scores for our departments. Purpose: The goal of this study was to have a 10% increase in the number of radiographs with an acceptable quality score (>11), without adversely impacting staff satisfaction.

### **METHODS**

Intervention: Initial assessment included a survey of 50 lateral knee images with the scoring rubric. A fishbone diagram was used to identify potential causes contributing to a gap in quality. The potential causes identified were: Incorrect position, rotation, radiation techniques and missing required elements like marking and measuring tools. A staff satisfaction survey was given to the participating staff as a balancing measure. Then, education was implemented focusing on positioning, marking, centering and techniques. Also, standardization of image marking supplies were reviewed and replenished. Study of the intervention: The Define Measure Analyze Improve Control (DMAIC) method of quality improvement was used for this project. Initial assessment found that 62% of images surveyed were above the 11-point threshold. Measures: A scoring rubric was used to analyze each image. Points are given for technical aspects of the image. The staff survey was used to ensure the staff did not feel the education measures were punitive. Analysis: Post intervention, 59 lateral knee images were surveyed. A second staff satisfaction survey was provided and analyzed.

### **RESULTS**

Post intervention, 90% of the lateral knee radiographs surveyed scored 11 points or more. Lateral knee images scoring more than 11 points had an increase of 28%. The survey of job satisfaction initially scored an average of 50%. The post intervention survey scored an average of 73%. In addition, lateral knee examination times were reduced by 15.9 minutes per month due to a decrease in repeat radiographs.

### **DISCUSSION**

Continuous education for technologists is critical for maintaining image quality. The score of the post intervention staff satisfaction survey proved that the techs were appreciative of the education and desired to improve the image quality for their patients.

## **R5A-QI-7 Minimising Claustrophobia and Scanxiety in Radiology**

Kenneth Jacob, MBA, BMedSc (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Training patients before scanning is a conventional method of managing Claustrophobia and Scanxiety which requires more staff resources and scanner time. The advancement in technology with wider bore scanners has helped reduce claustrophobia. Use of Virtual Reality (VR) is under testing and could help Claustrophobic patients. Medical Imaging Vendors are always looking toward reducing scan time by, for example, the recent implementation of new reconstruction deep learning software and advanced hardware as other methods of improving the patient experience.

### **METHODS**

Total scanning time can be reduced by customising scan parameters according to the need of the patients, balancing the quality vs time. Position of the patient in the scanner also plays a key role in reducing claustrophobia. In some cases feet first is a more preferred position for claustrophobic patients. If the patient prefers the eye mask and headphones with relaxing music also helps calm patients with claustrophobia and helps them tolerate a scan.

### **RESULTS**

Our analysis indicates up to a 50% reduction in the number of abandoned MRI scans since the introduction of new technology. We assess this as occurring across the period of time that wider bores and faster scans were introduced.

### **DISCUSSION**

Many studies conducted show that patients with claustrophobic anxiety are more likely to be frightened and experience a feeling of confinement or being closed in during imaging (BMC Med Imaging 2011 Feb). A Research study at our site is underway to test a virtual tour of the PET-CT procedure and environment to reduce anxiety in claustrophobic patients. Wider bore scanners reduce claustrophobia to a limit however training patients prior to a scan is the most successful method, which could also be done using VR headset under testing which could enable the patient to experience the whole procedure in a safe and immersive way before the real scan and potentially help utilise the scanner and staff time more efficiently. If this is successful in PET then we can test this in the MRI environment.

## **R5A-QI-9HC Fake It Till You Make It-Preparing Radiology Residents to Manage Contrast Reactions Using High-Fidelity Simulation**

### **Awards**

#### **Quality Improvement Reports Award**

Anna R. Menezes, MBBS (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

A challenge encountered in medical education is the application of knowledge in a clinical environment. Our country's 3-year radiology residency program concentrates on a theoretical approach, leading to knowledge and confidence deficits in treatment algorithms for managing contrast reactions. While many institutes impart training in conventional radiology and modern imaging, the statistics still need improvement, as there is nearly one radiologist per 100,000 people. This necessitates every resident to be well-equipped to manage common and rare emergencies in radiology. Abroad, a dedicated simulation laboratory training program is a well-received method to train radiology residents in the low-frequency yet high-acuity, dangerous clinical scenarios practicing radiologists face. Our study is the first of its kind in our country. Our objective with this research study was to improve contrast reaction preparedness by assessing resident knowledge, identifying areas for improvement, implementing simulation-based training, and observing its efficacy.

### **METHODS**

Radiology residents were randomly assigned into two cohorts. A Likert and knowledge-based assessment of both cohorts was conducted to identify demographic characteristics and areas for improvement. Using 11 core competencies, the first cohort underwent a conventional one-hour lecture-based, and the second cohort underwent simulation training using a SimMan 3G® model, preventing surveillance bias. A post-test questionnaire was administered in two phases, i.e., at one-month- post-test and three months-delayed post-tests containing different questions to avoid a recall bias. Questionnaires were answered using Google® forms. Scores were tabulated using means. Knowledge-based pre and post-test scores were compared using paired T-tests and Likert scores using the Wilcoxon-signed rank test.

### **RESULTS**

The sample size of the lecture-based and simulation-based cohorts were 16 and 17, respectively. All participants completed questionnaires. Pre- and post-test scores were improved among both the simulation and lecture-based cohorts, although only the former was statistically significant. Score improvement also occurred when the lecture-based group underwent simulation training. Delayed post-test scores maintained a significantly positive result. Passive recall was fostered using mini-cards attached to resident badges.

### **DISCUSSION**

Our study showed that simulation training is a superior model compared to the conventional lecture-based approach, even after reducing biases that plague questionnaire-based studies. The study is an ongoing quality improvement project and plans to involve fellows and faculty. Potential limitations to our study included its need for equipment and decreased power due to a small sample size.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-QI-1

### Anesthesia and MRI Safety: Burning Questions and the Road to Better Practice

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Hamilton Shoji, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Burns are the most frequent MRI-related adverse event, per a 10-year FDA reports review. An analysis of our institution data revealed that burns are a rare event on the MRI (8 events in 319215 examinations in a 4-year span), with all episodes occurring on patients under anesthesia. No awoken individual reported MRI-related burns. To our knowledge, this is a risk factor not previously reported. The aim of this study is to propose a new workflow for MRI orders with anesthesia to tackle some of the proposed factors that may play a role in these incidents.

#### RESULTS

Decrease in the proportion of MRI under full anesthesia (100% to 59,9%). Increase in the proportion of MRI under mild sedation or anxiolysis (0 to 31%), or fully awoken (from 0 to 7,5%). Decrease in continuous scanning time in patients under anesthesia, both with reduced or optimized protocols (19%), or by withdrawals of segments for examination. Register of a checklist for patient positioning with special attention to correct padding and isolation of wires, cables and other devices. Register of patient temperatures monitoring during scan. Register of skin conditions prior and after the examinations.

#### METHODS

Review of the current literature of proposed mechanisms of burns in the MRI and strategies to avoid them. Redesign the workflow (from scheduling to patient positioning and monitoring) to capitalize on opportunities to clear known risks.

#### DISCUSSION

Although known as a safe procedure and with more widespread use of Choosing Wisely based strategies for diagnostic imaging that shifts CT to other methods, the MRI may impose health risks that are not fully understood. We hope that a deeper knowledge of the mechanisms involved in adverse events will help to avoid serious complications. Until then, we are focused on honing our workflow to decrease incidents to a minimum, without limiting access to adequate diagnostic testing.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5A-QI-2

### Patient Safety in Diagnostic Imaging: Proposal to Mitigate Identification Errors

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Aline Souza, MD, MSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The Brazil Ministry of Health created the National Patient Safety Program in 2013, which instituted actions to prevent and reduce incidents in healthcare services and has settled the mandatory creation of the Patient Safety Nucleus (PSN). However, many healthcare institutions have not yet implemented their PSN. In the State of Amazonas (AM), in January 2023, there were 98 NSP. This represents about 8% of healthcare organizations in the region. Identification errors are frequent in AM. From September 2019 to August 2020, patient identification failure was the most common in radiology, along with documentation failure. The objective was to create an electronic notification system in an imaging clinic in Manaus, and to develop a proposal for the correct identification of patients submitted to exams.

#### METHODS

Design Thinking, as an approach to solving complex problems. The following steps were taken: 1) Discovery of the problem, through a questionnaire about the safety culture, process mapping and event notification. 2) Summary, registration of the NSP at ANVISA and development of the action plan. 3) Ideation, which consisted into the creation of the electronic notification model and 4) Prototyping, system validation and standardization of successful strategies.

#### RESULTS

In 18 months, 608 events were reported. Near miss represented 68.6% (n=417), event without harm 28.1% (n=171) and adverse event 3.3% (n=20). The most reported isolated error was the patient's name, corresponding to 20.6% (n=125). When classified by categories, document errors represented 44.2% (n=269) and patient identification 29.4% (n=179). The number of events corresponded to 0.36% of all exams performed and adverse events represented 0.01% of them. The highest percentage of errors was in MRI scans (0.88%, n=227), CT scans (0.67%, n=122) and x-rays (0.49% n=101), that correspond to the exams most performed in the organization. After adoption of healthcare policies, there was a reduction in events related to patient identification, from 13.6% to 4.8%; the sum of type, side and site errors from 21.2% to 7.6% and procedural error from 28.8% to 12.4% (Table 1).

#### DISCUSSION

The association of an electronic notification system, process improvement and training reduced 64,7% patient identification errors. Additionally, there was also a 64,1% reduction in the sum of type, side and site exam errors, and 56,9% in procedural errors.

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## Abstract Archives of the RSNA, 2023

R5A-QI-3

### Quality Process Design to Change Radiodiagnostic Equipment to Minimize the Impact on Waiting Lists in a Public Health Imaging Diagnostic Provider

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Virginia Benavente (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Our institution is a public company of the National Health System (NHS), whose function is the direction, management, and provision of diagnostic imaging and nuclear medicine services. In 2021, the Spanish Government launched the Investment Plan for High Technology Equipment (INVEAT), aimed at reducing the obsolescence of the current technological park of the NHS. It will allow our institution to implement 17 new high-tech equipment in 7 hospitals throughout a regional territory between 2022 and 2023. Before regulatory changes related to the Nuclear Safety Council (CSN) authorisation, the Spanish competent authority for radiological protection, the administrative procedures and works to deregister, install and start up our equipment did not affect waiting lists as all administrative procedures could be processed after equipment installation and start-up. In 2022, CSN regulatory changes modified the procedures, and all the authorizations are required before installing new equipment. Consequently, our INVEAT plan needed to be redesigned to meet its deadlines and reduce its impact on the waiting lists and preserve patient care. The purpose of the study is to redesign our INVEAT plan to minimize its impact on waiting lists.

#### RESULTS

The new process takes 95 days after the redesigning (Figure 2). The actions implemented were the following:

#### METHODS

The process involves the radiological protection area (RPA) and the infrastructure area (AU). As it can be seen in Figure 1, it involves equipment deregistration (in orange) and installation (in blue) with tasks requiring the collaboration between RPA, IA and external stakeholders. Before the redesigning it took 117 days to complete the process. The process redesign was focused on all administrative procedures. To this end, a digital documentation structure and workflow were implemented for each work team depending on members roles, the step of the process and deadlines and milestones to meet.

#### DISCUSSION

This redesigned process involving actions on the administrative tasks to improve communication and team building is useful and allows us to reduce the whole process of deregistration, removal, installation and start-up in 22 days. Compliance with this new working procedure is key to obtaining optimal results and reducing the impact on waiting lists. The critical point of this procedure is the interdependence between the parts involved. Most of documentation required also depends on the external companies and it can affect the flow of the process.

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## Abstract Archives of the RSNA, 2023

R5A-QI-4

### Improving Overnight Turn-around-time and Restoring On-call Resident Responsibility in an Academic Medical Center

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Johannes H. Decker, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Emergency departments (ED) increasingly demand rapid final interpretations of ED radiology studies. Academic medical centers must balance demands for fast report turn-around-time (TAT) against the educational value of call for residents. A departmental resident task force identified facilitation of resident published preliminary reports as an improvement opportunity, based on evidence that autonomy increased ratings of educational experience. A call system was developed with the goals of enhancing resident autonomy while improving patient care through shorter final report TATs.

#### METHODS

To review resident contribution (No Contribution, Draft, Prelim) over our phased transition, we summarize weekly call data for 2 categories of cross-sectional exams - adult Non-Neuro (Body, Chest, CVI, MSK) and adult Neuro. No Contribution indicates a fellow/attending reported the exam directly. Draft indicates a resident created an initial draft without publishing. Prelim indicates a resident published a preliminary report. Attending-signed final reports (final TAT) were expected within 90 minutes of the end of an exam. Data included studies between the hours of 8:45 PM - 7:30 AM 7-days a week. Baseline (12/2018 - 12/2019): Fellows publish prelims overnight, residents draft reports (discouraged from publishing prelims). Final reports followed in the morning. 1st Intervention (01/2020): Instituted neuro attending finals overnight, residents encouraged but not required to publish prelims. 2nd Intervention (11/2021): Instituted non-neuro teleradiology attending finals overnight, residents encouraged but not required to publish prelims. To accommodate increased volume, an additional swing resident (5 PM - 2 AM) was added 07/2020.

#### RESULTS

At baseline, median final TAT was around 6-10 hours. Residents issued drafts for 75% and 90% of Neuro and Non-Neuro ED studies, and 40% and 50% of Neuro and Non-Neuro IP studies, rarely publishing prelims. After implementation of Neuro attending overnight final reads, median Neuro final TAT decreased to 60 minutes (excluding weeks with 1st year fellow coverage). Resident publication of prelim reports for Neuro ED studies increased: 30% (early 2020), 70% (early 2021), 84% (early 2022), and 65% (early 2023). After implementation of Non-Neuro teleradiology to provide overnight attending final reads, median Non-Neuro final TAT decreased to 40 minutes. Residents published prelim reports for most Non-Neuro ED studies (90%). No increase in ED-reported safety events arising from overread changes was seen despite increases in resident published preliminary reports. No increase in preliminary TAT.

#### DISCUSSION

Providing attending overnight coverage improved final TAT for ED reports. This change also facilitated resident comfort with voluntarily publishing preliminary reports, a marker of call autonomy, while mitigating patient risk.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

R5A-QI-5

### Applying Lean Six Sigma Techniques to Patient Flow in the Breast Imaging Service: A Tertiary Center's Experience and Process of Improvement

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Nader Ashraf, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

With the total number of screening mammograms conducted in the United States reaching almost 40 million, it is estimated that 10% of those cases necessitate further workup to reach a diagnostic resolution on whether the lesion is cancerous or not, which is called time to resolution (TTR). Breast imaging services often experience a significant degree of variability in patient flow, as the flow varies depending on whether the patient requires extensive testing or not, which adds to clinic inefficiency. The Lean Six Sigma Methodology (LSSM) was developed to give near-perfect services to huge operations by lowering the improbable occurrence. Hence, we applied LSSM in our breast imaging service to reduce TTR and improve patient flow, enhancing efficiency and patient outcomes.

#### METHODS

An electronic medical record integrated system was put in place to track the TTR from the time the screening study is input until diagnostic resolution is reached. A baseline audit followed by a post-implementation audit were conducted. Multidisciplinary meetings, alongside a study of patient complaint data, were utilized to identify issues that were causing prolonged TTR leading to patient flow inefficiencies. The resulting sources of variability were recognized and analyzed using an Ishikawa fishbone diagram to classify sources of variation. To address these root causes, possible solutions were proposed and implemented. Significant differences in TTR were assessed using the Mann-Whitney-U test.

#### RESULTS

During the baseline audit of 8 months, 589 cases of mammographic recalls (BI-RADS 0) were recruited. The average TTR for this group was 86.3 days. To reflect the required change in the mindset to adopt a patient-centric approach instead of the traditional exam/modality-focused one, there will be proposed improvement plans. Due to the lack of funding received for this project, some gaps, like staff shortages, were not able to be addressed. During the post-implementation period of 3 months, 370 cases of mammographic recalls (BI-RADS 0) were made. The average TTR for this group was 36.0 days. After applying LSSM, we managed to significantly reduce our TTR by at least 58% ( $P < 0.01$ ).

#### DISCUSSION

With the application of LSSM in our breast imaging service, we managed to reduce our TTR by 58%. This was mainly related to the effect of training the coordinators to capture the screening recalls and schedule the recommended examinations. Moreover, there was an observed increase in the numbers of same-day nonscheduled targeted US generated and performed by the radiologist due to their commitment to embracing patient-centered care. These changes should be there to stay, incorporated into our culture, to facilitate continuous improvement and cost reduction. As the need for healthcare resources grows in the future, LSSM may play an increasingly essential role in enhancing healthcare service delivery.

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## Abstract Archives of the RSNA, 2023

R5A-QI-6

### Lateral Knee Radiograph Quality Improvement Project

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Lindsay M. Ranschau, BS, ARRT (*Presenter*) Nothing to Disclose

#### INTRODUCTION

**Description:** Our radiology department has a focus on image quality. Complaints received from radiologist indicate that the quality of lateral knee radiographs was lower than expected. **Knowledge:** Higher quality images allow for more accurate and expedited diagnoses. A point scale of 1-15 (15 being highest quality) can be used to measure acceptability of images. Images that score between 10 - 12 are the lowest acceptable scores for our departments. **Purpose:** The goal of this study was to have a 10% increase in the number of radiographs with an acceptable quality score (>11), without adversely impacting staff satisfaction.

#### METHODS

**Intervention:** Initial assessment included a survey of 50 lateral knee images with the scoring rubric. A fishbone diagram was used to identify potential causes contributing to a gap in quality. The potential causes identified were: Incorrect position, rotation, radiation techniques and missing required elements like marking and measuring tools. A staff satisfaction survey was given to the participating staff as a balancing measure. Then, education was implemented focusing on positioning, marking, centering and techniques. Also, standardization of image marking supplies were reviewed and replenished. **Study of the intervention:** The Define Measure Analyze Improve Control (DMAIC) method of quality improvement was used for this project. Initial assessment found that 62% of images surveyed were above the 11-point threshold. **Measures:** A scoring rubric was used to analyze each image. Points are given for technical aspects of the image. The staff survey was used to ensure the staff did not feel the education measures were punitive. **Analysis:** Post intervention, 59 lateral knee images were surveyed. A second staff satisfaction survey was provided and analyzed.

#### RESULTS

Post intervention, 90% of the lateral knee radiographs surveyed scored 11 points or more. Lateral knee images scoring more than 11 points had an increase of 28%. The survey of job satisfaction initially scored an average of 50%. The post intervention survey scored an average of 73%. In addition, lateral knee examination times were reduced by 15.9 minutes per month due to a decrease in repeat radiographs.

#### DISCUSSION

Continuous education for technologists is critical for maintaining image quality. The score of the post intervention staff satisfaction survey proved that the techs were appreciative of the education and desired to improve the image quality for their patients.

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## Abstract Archives of the RSNA, 2023

R5A-QI-7

### Minimising Claustrophobia and Scanxiety in Radiology

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

Kenneth Jacob, MBA, BMedSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Training patients before scanning is a conventional method of managing Claustrophobia and Scanxiety which requires more staff resources and scanner time. The advancement in technology with wider bore scanners has helped reduce claustrophobia. Use of Virtual Reality (VR) is under testing and could help Claustrophobic patients. Medical Imaging Vendors are always looking toward reducing scan time by, for example, the recent implementation of new reconstruction deep learning software and advanced hardware as other methods of improving the patient experience.

#### METHODS

Total scanning time can be reduced by customising scan parameters according to the need of the patients, balancing the quality vs time. Position of the patient in the scanner also plays a key role in reducing claustrophobia. In some cases feet first is a more preferred position for claustrophobic patients. If the patient prefers the eye mask and headphones with relaxing music also helps calm patients with claustrophobia and helps them tolerate a scan.

#### RESULTS

Our analysis indicates up to a 50% reduction in the number of abandoned MRI scans since the introduction of new technology. We assess this as occurring across the period of time that wider bores and faster scans were introduced.

#### DISCUSSION

Many studies conducted show that patients with claustrophobic anxiety are more likely to be frightened and experience a feeling of confinement or being closed in during imaging (BMC Med Imaging 2011 Feb). A Research study at our site is underway to test a virtual tour of the PET-CT procedure and environment to reduce anxiety in claustrophobic patients. Wider bore scanners reduce claustrophobia to a limit however training patients prior to a scan is the most successful method, which could also be done using VR headset under testing which could enable the patient to experience the whole procedure in a safe and immersive way before the real scan and potentially help utilise the scanner and staff time more efficiently. If this is successful in PET then we can test this in the MRI environment.

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## Abstract Archives of the RSNA, 2023

R5A-QI-9HC

### **Fake It Till You Make It-Preparing Radiology Residents to Manage Contrast Reactions Using High-Fidelity Simulation**

Thursday, Nov. 30 12:15PM - 12:45PM Room: Learning Center

#### **Awards**

##### **Quality Improvement Reports Award**

Anna R. Menezes, MBBS (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

A challenge encountered in medical education is the application of knowledge in a clinical environment. Our country's 3-year radiology residency program concentrates on a theoretical approach, leading to knowledge and confidence deficits in treatment algorithms for managing contrast reactions. While many institutes impart training in conventional radiology and modern imaging, the statistics still need improvement, as there is nearly one radiologist per 100,000 people. This necessitates every resident to be well-equipped to manage common and rare emergencies in radiology. Abroad, a dedicated simulation laboratory training program is a well-received method to train radiology residents in the low-frequency yet high-acuity, dangerous clinical scenarios practicing radiologists face. Our study is the first of its kind in our country. Our objective with this research study was to improve contrast reaction preparedness by assessing resident knowledge, identifying areas for improvement, implementing simulation-based training, and observing its efficacy.

#### **METHODS**

Radiology residents were randomly assigned into two cohorts. A Likert and knowledge-based assessment of both cohorts was conducted to identify demographic characteristics and areas for improvement. Using 11 core competencies, the first cohort underwent a conventional one-hour lecture-based, and the second cohort underwent simulation training using a SimMan 3G® model, preventing surveillance bias. A post-test questionnaire was administered in two phases, i.e., at one-month- post-test and three months-delayed post-tests containing different questions to avoid a recall bias. Questionnaires were answered using Google® forms. Scores were tabulated using means. Knowledge-based pre and post-test scores were compared using paired T-tests and Likert scores using the Wilcoxon-signed rank test.

#### **RESULTS**

The sample size of the lecture-based and simulation-based cohorts were 16 and 17, respectively. All participants completed questionnaires. Pre- and post-test scores were improved among both the simulation and lecture-based cohorts, although only the former was statistically significant. Score improvement also occurred when the lecture-based group underwent simulation training. Delayed post-test scores maintained a significantly positive result. Passive recall was fostered using mini-cards attached to resident badges.

#### **DISCUSSION**

Our study showed that simulation training is a superior model compared to the conventional lecture-based approach, even after reducing biases that plague questionnaire-based studies. The study is an ongoing quality improvement project and plans to involve fellows and faculty. Potential limitations to our study included its need for equipment and decreased power due to a small sample size.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-QI

### Quality Improvement Reports Thursday Poster Discussions II

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **R5B-QI-1 A Novel Contrast Extravasation Intake Form to Foster Standardized Data Collection and Quality Improvement**

Dongming Xu, MD, PhD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Contrast media extravasation (CMEX): is a complication with leakage of IV contrast into the surrounding soft-tissues, vary in severity: minor to skin ulceration, compartment syndrome, with incidence: 0.2% - 0.23%. It is one of the most frequent adverse events in radiology but are much less studied than others such as contrast-associated acute kidney injury. It is important to recognize the risk factors to reduce complications, improve patient satisfaction at a stressful time.

#### **METHODS**

Review current reporting system - Safety Net, and identify shortages of reporting system to 1) create standardized and mandatory data collecting system; 2) reduce data input time; 3) better track risk factors; 4) facilitate future data retrieval, analysis quality improvement; 5) improve patient care safety.

#### **RESULTS**

Feedback from circulating novel input form: 1) Data/information being collected: satisfactory 2) Mostly quick-input process 3) Risk factor collection: thorough inclusive 4) Educational intake form 5) Informative form

#### **DISCUSSION**

Quality improvement activities include: 1) Frequent small improvement efforts conducted in close association with the management front-line technicians, as well as spreadsheet design constant improvement 2) Dedicated improvement projects: To identify potential risk factors reduce contrast extravasation rate. 3) Regular follow-up 4) Frequent visit to the CT/MRI scan room 5) Forming a project team 6) Project Leader 7) Project Coach

#### **R5B-QI-10HC Implementation and Assessment of a Novel Online Cardiac MRI Anatomy Atlas: A Quality Improvement Project in Cardiac Radiology Trainee Education**

Douglas C. Pierce, MD, MS (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Learning to interpret cardiac magnetic resonance (CMR) studies in unfamiliar double oblique projections is a formidable challenge for radiology and cardiology trainees. Although the current generation of trainees is accustomed to online reference material, to date there is no accessible comprehensive online atlas of CMR anatomy. This negatively impacts trainees' potential to learn CMR morphology and function efficiently within clinical contexts. We have therefore developed a novel online CMR web atlas. The purpose of this study is to assess the efficacy of this intervention at our institution.

#### **METHODS**

To build the atlas, deidentified steady state free precession CMR images in standard cardiac double oblique projections were exported from healthy normal patients, anatomical labels were added, and a simple HTML interface was designed linking each image/series to a central homepage. For the assessment tool, an anatomy quiz of eight unlabeled CMR structures in double oblique projections was distributed to radiology and cardiology trainees. Questions required identification of key structures without reference materials initially, then a link to the atlas homepage was given, and the same eight questions were presented again. In order to simulate a realistic interpretive environment, quiz images were not rigorously controlled for quality. Respondents rated their comfort level with CMR anatomy without and with the atlas and gauged its overall utility. Quiz score data was obtained by a blinded study author and a paired student's T-test was used for analysis.

## RESULTS

Five radiology and four cardiology trainees completed the quiz and accompanying survey questions. Average overall scores among all respondents improved from 66.7% correct without the atlas to 93.1% correct with the atlas ( $p=0.0007$ ). The majority (77%) of respondents referred to the atlas for most of the questions when completing the quiz the second time. Comfort level with CMR anatomy, self-assessed on a 5-point Likert scale, increased for both cardiac and extracardiac anatomy ( $p = 0.04$  and  $0.03$ , respectively). All participants responded either "agree" or "strongly agree" when asked whether the atlas would be helpful in clinical practice. All participants with plans to read cardiac MR in their future practice indicated they would be "very likely" to refer to it.

## DISCUSSION

Implementation of a novel online CMR anatomy atlas at our institution significantly increased trainees' confidence level and augmented their ability to correctly identify structures in a simulated environment. The atlas is a useful long-term standard even when examination quality is suboptimal. Although improvement in all areas was noted, neither the atlas nor the quiz images showed significant pathological findings, so further work is needed to evaluate enhanced recognition of CMR disease states following similar interventions.

### **R5B-QI-2 Machine Learning for Identification of Acute Adverse Reactions to Iodinated Contrast Media using Routine Clinical and Laboratory Data in Cancer Patients**

Qiong Li (*Presenter*) Nothing to Disclose

## INTRODUCTION

Cancer patients undergo routine computed-tomography scans and iodinated contrast media (ICM) administration. This study was carried out to explore the risk factors of acute adverse reactions (AARs) associated with iodinated contrast media in cancer patients, to develop a prediction model based on routine clinical and laboratory data using machine-learning.

## METHODS

Between January 2019 to December 2021, a total of 208035 cancer patients who underwent ICM administration were enrolled from our hospital. Their demographic information, clinical and laboratory data, CT scan protocol and AARs of iodinated contrast media were collected. Several machine learning methods were performed to construct the prediction model. We also used feature selection and analysis techniques to identify risk factors that predict occurrence of AAR.

## RESULTS

Among 208035 cancer patients who underwent ICM administration, the overall prevalence of AARs was 0.205%. A CatBoost model was more accurate than other machine learning models, with an AUC of 0.959, a sensitivity of 0.929. Several variables significantly associated with AARs were history of hypersensitivity reaction to ICM, iopromide, immunotherapy, excessive MRI enhancement scan, and younger age.

## DISCUSSION

A large number of radiological examinations, mainly contrast-enhanced CT scans, are conducted worldwide each year, especially in cancer patients. A machine-learning model was more accurate for predict the occurrence of AARs associated with iodinated contrast media, which can offer useful guidance to clinicians and patients for individually adjuvant therapy. This result indicates that radiologists need to pay greater attention to a patient's cancer history, especially with regard to current antineoplastic treatments.

### **R5B-QI-3 Improving On-time Starts for Pediatric Cardiac Magnetic Resonance Imaging (cMRI)**

Susan Ferry (*Presenter*) Nothing to Disclose

## INTRODUCTION

cMRI exam start delays result in longer patient fasts, extended patient wait times, and poor synchronization of anesthesia induction and contrast administration. Coordinating multiple services creates a domino of inefficiencies. We sought to target on-time start improvements from our baseline of 10%, where on-time was defined as the first image taken within 5 minutes of the scheduled time.

## METHODS

A multidisciplinary team from Cardiac and Radiology Services utilized a local version of the Stanford RITE improvement methodology to target several process improvements to patient flow. We focused on understanding our current state by enhancing data visualization to easily identify where delays were occurring. Two key causes of delay were late outpatient arrival and variations in patient prep timing for anesthesia patients. Families were surveyed to identify reasons for late arrivals, which led to a standard script for pre-visit calls with detailed instructions for traffic, parking, and registration location. A patient-ready time stamp was utilized for anesthesia patients to better coordinate patient prep activities and timely induction. Finally, process mapping demonstrated a rework pattern that required a complete redesign of the scheduling

and protocolling process steps. A new workflow that allows protocolling before scheduling has been developed and is currently in the testing phase.

## **RESULTS**

Defining performance and visualizing it in a meaningful way created a slight Hawthorne effect with an increase in on-time starts from 10% to 21% during our current state analysis. Timing of standard script implementation right before Thanksgiving and through the winter holidays impacted our measurable improvement with significantly lower volumes. We attribute the "rebound" in January to the continued use of the script as well as the efforts to improve anesthesia patient prep times. Shared situational awareness of patient flow time points, equipment readiness, and efforts by the sedation team to orchestrate IV placement, physical examination, and the consent process brought our on-time starts to 34% by the end of the program.

## **DISCUSSION**

There was value in using a systematic team approach to understanding and solving this problem. Team members were unaware of what the process looked like to our patients because they only knew their small piece of the larger workflow. Team members Gemba walked all areas of the process to gain perspective, build engagement, and facilitate teamwork. Areas of focus initially centered on low-effort interventions because redesigning the scheduling and protocolling steps of the process required more time and outside resources than expected. We anticipate this much-needed change will have a dramatic effect on our metric when we are able to go live.

### **R5B-QI-4 Imaging Stewardship: Defining STAT Exams in the Cardiac Intensive Care Unit**

#### **Awards**

#### **Quality Improvement Reports Award**

Eatrice Hinton (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

We cannot ensure that high priority Exams are being prioritized and performed in a consistent manner. This is critical for us to provide accurate high priority responses to those with the greatest need. The problem is particularly apparent in X-ray services which has the highest case volume. The current workflow is believed to be inefficient, i.e., delays in care, delay in processing results to ordering practitioners, and stress on X-ray techs. Most ICU exams are requested as high priority (STAT) without considering the appropriateness or demand of the present patient condition. "If everything is STAT, nothing is STAT" because the X-ray team is unable to respond to everything at the same time. We aimed to reduce the response time for high priority portables with this project

## **METHODS**

The team included clinicians from the Cardiac Intensive Care unit and Radiology. The Quality improvement approach used was Realizing Improvement through Team Empowerment (RITE) process improvement program. The program guides teams through didactic education and practical application of quality improvement tools. The tools used included a process map to understand the workflow. Gemba walks to see how the work is done and factors that contributed to the problem. The data collected was used to create fishbone diagrams and Pareto charts to quantify key causes of the problem. From that information the top key drivers for improvement were identified and included the need for technologist to have a consistent workflow, and the need for closed loop communications between clinicians and technologists. One of the most impactful communication interventions was the creation of the Clinical criteria for STAT priority exams. That and other interventions were tested using small test of change, Plan-Do-Study-Act cycles. Improvement was measured by quantifying the time from notice of exam need to the time of exam completion.

## **RESULTS**

Using RITE methodology helped the team to decrease the turn-a-round time for STAT portable exams from a median of 24 minutes to a median of 15 minutes by the end of the six-month program. The key interventions that lead to this improvement were changing the notification from a phone call to a secure chat notification which allowed the Technologist to better triage STAT request. Also, development of the clinical criteria list decreased the number of STAT requests to those of the highest clinical priority.

## **DISCUSSION**

Development of a shared understanding between the Cardiac ICU and Radiology as to what makes an exam STAT and how we best communicate that to illicit a timely response was crucial. Using a systematic, team-based approach to improvement contributed to the success by improving communication between the two departments. Subsequently, the key interventions have been spread to the neonatal intensive care unit and improved data analysis methods of current performance are underway.

### **R5B-QI-5 Teach the Mentor: A Six Week Intensive Program Universally Improves Mentorship Skills Among a Diverse Group of Faculty**

Hannah Milch, MD (*Presenter*) Nothing to Disclose



## INTRODUCTION

Quality mentorship leads to more successful academic careers, stronger clinical program development, and increased authorship and federal funding. Mentorship is lower for women and people of color. During the COVID-19 pandemic, a significant strain was placed on mentorship relationships with physical distancing and a focus on essential clinical needs. The purpose of this study was to determine if an intensive, case-based, in-person mentorship program would improve self-reported mentorship skills among a diverse group of faculty at a large multi-site academic institution.

## METHODS

Faculty were recruited to participate in a mentorship course aimed at improving the pool of high quality mentors in the radiology department. Selection of participants focused on creating a balanced group with diverse backgrounds and levels of experience. The course curriculum was adopted from established predicates and was developed for clinician scientists, with prior proven success. Participants met weekly for two hours over 6 weeks in an informal and confidential setting. Participants completed a 19 question survey about mentorship skills before the first session (pre-test) and within one week following the last session (post-test). Respondents rated their mentorship skills based on a Likert scale ranging from 1 (not at all skilled) to 7 (highly skilled). Paired t-tests were performed to assess differences in mean responses.

## RESULTS

Eleven faculty completed the course and their survey response rate was 100%. The group was gender balanced (six women and five men) and at varying career stages (4 Professors, 2 Associate Professors, and 5 Assistant Professors). Mean score for each of the 19 survey questions significantly increased on the post-test by an average of 2.22 points, from 3.78-6.00 ( $p < 0.001$ ). Scores demonstrated high reliability across all questions (Cronbach's alpha of 0.96). For 18 of the 19 questions there was no significant difference in score improvement between Professors and Associate/Assistant Professors. For a single question (Question 10: Working with trainees to set research goals), Professors demonstrated less improvement compared to Associate/Assistant Professors (mean score difference of 1 versus 3,  $p = 0.014$ ).

## DISCUSSION

By discussing provocative mentorship dilemmas in a confidential small group of peers, radiology faculty with all levels of experience reported a large improvement in mentorship skills after just six weekly sessions. Strengthening faculty mentorship through an in-person case-based course may help narrow gender and race disparities in radiology, improve departmental collegiality, and lead to greater overall job satisfaction and academic success.

## R5B-QI-6 Reimagining a Virtual Radiology QI Structured Problem Solving Program

Amin Etemad, MBA (*Presenter*) Nothing to Disclose

## INTRODUCTION

An experiential program at an academic medical center to support small- to medium-size improvement projects in radiology (named 52in52) experienced challenges during the COVID pandemic. Meetings had to be transitioned to a virtual environment, and the department experienced staffing shortages that limited the ability to provide frontline staff with time to engage in improvement projects. The program was also asked to strengthen its support of radiology trainees in meeting their requirement to complete a program-based project prior to graduation from residency. Given the new demands on this program from its original conception in 2017, the 52in52 team used stakeholder input to develop a virtual 52in52 program that accommodated these new needs.

## METHODS

Opportunities for improvement were gathered by program managers through 1:1 interviews and surveys directed at stakeholders, which included modality leaders, department education leaders, operational leaders, and prior resident and staff participants. Based on the feedback, the following interventions were successfully implemented: 1. Modifying the program frequency to 3 cohorts per year, with cohorts lasting approximately 14 weeks. 2. Implemented virtual check-ins for project leaders, stakeholders, and program leaders. 3. Developing an "idea repository" for potential improvement projects. 4. Utilizing a committee of faculty division performance leaders to vet and approve project ideas submitted by trainees.

## RESULTS

Following our QI efforts, participation increased from an average of 1.5 project proposals per cohort submitted at baseline after the COVID pandemic began to 4.5 proposals per cohort. The program included two multi-departmental projects: breast surgery partnered with mammography to reduce the number of unnecessary phone calls regarding specimen imaging questions, and orthopedic surgery partnered with diagnostic x-ray to reduce the number of incorrect orders being placed by referring providers. Resident participation in operations-led projects increased 65% since FY2021.

## DISCUSSION

Sustaining an intra-departmental project-based improvement program during and after the COVID pandemic required rethinking the fundamental aspects of program, with the goal of maintaining the outcomes of increasing improvement capability within the department and providing a structured venue for problem solving. Through stakeholder feedback, the



program management team implemented changes that have allowed the program to continue to serve as a valuable resource for the department, despite pandemic and post-pandemic related challenges.

## **R5B-QI-8 Improving Radiologist Interpretation Confidence for Appendix Ultrasound through Standardized Performance and Reporting**

Harpreet S. Grewal, MD (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Increasing radiologist certainty in the ultrasound diagnosis of acute appendicitis through standardized exam performance and reporting has been proven to decrease CT utilization, unnecessary surgeries and hospital length of stay. The goal of this project was to decrease the number of indeterminate studies in a community hospital setting and two free-standing emergency departments (FSEDs) by 50% over a period of 9 months.

### **METHODS**

This project was performed in a combined adult and children's hospital in a suburban setting with two other affiliated FSEDs. A nationally standardized pediatric appendix ultrasound protocol, sonographer worksheet and reporting template were implemented after offering live training to all sonographers and radiologists in September 2021. In March of 2022 a 2-hour virtual training with CME was mandated for all reading radiologists and all sonographers. We tracked utilization of each component over time, additional imaging post-appendix ultrasound, length of stay, diagnostic accuracy and certainty of report impression defined as: positive for appendicitis, negative for appendicitis, equivocal (conflicting US findings), or merely descriptive. Seven radiologists (five pediatric and two body imagers) retrospectively reviewed the data from before live training (n=61), after live training (n= 159) and after virtual mandated training (n=63) for 285 patients requiring undergoing appendix ultrasound between December 2020 and June 2022.

### **RESULTS**

Patients ranged in age from 1-70 years with a mean of 10.2 years for the before-training group, 13.6 years for the after-live training group and 11.9 years for the after-virtual training group. Fifteen-minute mean scan times were the same in all groups. There was a significant decrease in both descriptive and equivocal impressions following training (graph 1). Length of stay was not significantly different between the three groups, 15.5 hours before training, 38.8 hours after live training and 16.1 hours after mandatory training. There were 2 false positive cases before training, none after live training and one after virtual training. There was one false negative study in each of the groups. There was a 74 percent decrease in descriptive interpretations.

### **DISCUSSION**

While there was a 74 percent decrease in descriptive US impressions, we did not see any significant change in length of stay or post-appendix ultrasound imaging utilization in our care setting during this time frame. Limitations include undefined impact of Covid 19 pandemic on healthcare utilization and other variable.

## **R5B-QI-9HC Comparison of shielding effectiveness using microorganisms in X-ray diagnostic factors for shielding materials**

Sejeong An, MS (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Diagnostic radiology is an essential field that relies on radiation-based imaging tests like X-rays, CT scans, and interventional procedures. However, frequent exposure to radiation can increase the risk of harm and the development of additional diseases. Therefore, there is a need for mitigation measures to reduce radiation exposure. Currently, lead aprons made of heavy metals like lead and tungsten are used for shielding, but they have disadvantages like causing occupational diseases and environmental problems. To find a substitute for lead, researchers are investigating microorganisms that can absorb scattered radiation

### **METHODS**

In this study, *Cladosporium cladosporioides* microorganisms were used to develop a microbial shielding sheet to replace lead. A nano-material sheet was coated with the microorganisms, and four sheets were produced with varying amounts of microbial mass. To compare the effectiveness of the microbial shielding sheet, a lead apron was used as a control group. Radiation monitors were used to compare changes in radiation dose with or without the shielding material. Single sheets and combinations of sheets were tested to determine the shielding level

### **RESULTS**

In this study, when comparing None and single sheet, the order of effectiveness in factor 1 was sheet 1 (44.7%) > sheet 3 (44.4%) > sheet 2 (44%) > sheet 4 (40.2%), and in factor 2, it was sheet 3 (48.1%) > sheet 2 (46.7%) > sheet 1 (46.4%) > sheet 4 (42.8%). For factor 3, it was sheet 3 (52.1%) > sheet 1 (50.8%) > sheet 2 (47.6%) > sheet 4 (44.7%), and for factor 4, it was sheet 3 (95.6%) > sheet 2 (95.2%) > sheet 1 (95.1%) > sheet 4 (93.6%). When applying two sheets to the

composite sheet, in all factors, sheet 2+3 (Factor 1 - 68.2%, Factor 2 - 75.4%, Factor 3 - 74.4%, Factor 4 - 99.4%) > sheet 1+2 (Factor 1 - 67.9%, Factor 2 - 73.6%, Factor 3 - 78.7%, Factor 4 - 99.4%) > sheet 2+4 (Factor 1 - 65.8%, Factor 2 - 71.4%, Factor 3 - 72.1%, Factor 4 - 99.3%). When applying three sheets, sheet 1+2+3 (Factor 1 - 80.5%, Factor 2 - 86.7%, Factor 3 - 86.5%, Factor 4 - 99.7%) > sheet 1+2+4 (Factor 1 - 80%, Factor 2 - 85.7%, Factor 3 - 85.4%, Factor 4 - 99.7%). When applying four sheets, in factor 4 (99.8%) > factor 2 (92.9%) > factor 3 (92%) > factor 1 (87.4%).

## **DISCUSSION**

The study confirmed that microbial-based shielding materials have the potential to overcome the disadvantages of existing commercial materials. The use of microorganisms for radiation shielding could reduce occupational diseases and environmental problems associated with heavy metal-based shielding materials

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-QI-1

### **A Novel Contrast Extravasation Intake Form to Foster Standardized Data Collection and Quality Improvement**

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Dongming Xu, MD, PhD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Contrast media extravasation (CMEX): is a complication with leakage of IV contrast into the surrounding soft-tissues, vary in severity: minor to skin ulceration, compartment syndrome, with incidence: 0.2% - 0.23%. It is one of the most frequent adverse events in radiology but are much less studied than others such as contrast-associated acute kidney injury. It is important to recognize the risk factors to reduce complications, improve patient satisfaction at a stressful time.

#### **METHODS**

Review current reporting system - Safety Net, and identify shortages of reporting system to 1) create standardized and mandatory data collecting system; 2) reduce data input time; 3) better track risk factors; 4) facilitate future data retrieval, analysis quality improvement; 5) improve patient care safety.

#### **RESULTS**

Feedback from circulating novel input form: 1) Data/information being collected: satisfactory 2) Mostly quick-input process 3) Risk factor collection: thorough inclusive 4) Educational intake form 5) Informative form

#### **DISCUSSION**

Quality improvement activities include: 1) Frequent small improvement efforts conducted in close association with the management front-line technicians, as well as spreadsheet design constant improvement 2) Dedicated improvement projects: To identify potential risk factors reduce contrast extravasation rate. 3) Regular follow-up 4) Frequent visit to the CT/MRI scan room 5) Forming a project team 6) Project Leader 7) Project Coach

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## Abstract Archives of the RSNA, 2023

R5B-QI-10HC

### Implementation and Assessment of a Novel Online Cardiac MRI Anatomy Atlas: A Quality Improvement Project in Cardiac Radiology Trainee Education

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Douglas C. Pierce, MD, MS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Learning to interpret cardiac magnetic resonance (CMR) studies in unfamiliar double oblique projections is a formidable challenge for radiology and cardiology trainees. Although the current generation of trainees is accustomed to online reference material, to date there is no accessible comprehensive online atlas of CMR anatomy. This negatively impacts trainees' potential to learn CMR morphology and function efficiently within clinical contexts. We have therefore developed a novel online CMR web atlas. The purpose of this study is to assess the efficacy of this intervention at our institution.

#### METHODS

To build the atlas, deidentified steady state free precession CMR images in standard cardiac double oblique projections were exported from healthy normal patients, anatomical labels were added, and a simple HTML interface was designed linking each image/series to a central homepage. For the assessment tool, an anatomy quiz of eight unlabeled CMR structures in double oblique projections was distributed to radiology and cardiology trainees. Questions required identification of key structures without reference materials initially, then a link to the atlas homepage was given, and the same eight questions were presented again. In order to simulate a realistic interpretive environment, quiz images were not rigorously controlled for quality. Respondents rated their comfort level with CMR anatomy without and with the atlas and gauged its overall utility. Quiz score data was obtained by a blinded study author and a paired student's T-test was used for analysis.

#### RESULTS

Five radiology and four cardiology trainees completed the quiz and accompanying survey questions. Average overall scores among all respondents improved from 66.7% correct without the atlas to 93.1% correct with the atlas ( $p=0.0007$ ). The majority (77%) of respondents referred to the atlas for most of the questions when completing the quiz the second time. Comfort level with CMR anatomy, self-assessed on a 5-point Likert scale, increased for both cardiac and extracardiac anatomy ( $p = 0.04$  and  $0.03$ , respectively). All participants responded either "agree" or "strongly agree" when asked whether the atlas would be helpful in clinical practice. All participants with plans to read cardiac MR in their future practice indicated they would be "very likely" to refer to it.

#### DISCUSSION

Implementation of a novel online CMR anatomy atlas at our institution significantly increased trainees' confidence level and augmented their ability to correctly identify structures in a simulated environment. The atlas is a useful long-term standard even when examination quality is suboptimal. Although improvement in all areas was noted, neither the atlas nor the quiz images showed significant pathological findings, so further work is needed to evaluate enhanced recognition of CMR disease states following similar interventions.

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## Abstract Archives of the RSNA, 2023

R5B-QI-2

### Machine Learning for Identification of Acute Adverse Reactions to Iodinated Contrast Media using Routine Clinical and Laboratory Data in Cancer Patients

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Qiong Li (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Cancer patients undergo routine computed-tomography scans and iodinated contrast media (ICM) administration. This study was carried out to explore the risk factors of acute adverse reactions (AARs) associated with iodinated contrast media in cancer patients, to develop a prediction model based on routine clinical and laboratory data using machine-learning.

#### METHODS

Between January 2019 to December 2021, a total of 208035 cancer patients who underwent ICM administration were enrolled from our hospital. Their demographic information, clinical and laboratory data, CT scan protocol and AARs of iodinated contrast media were collected. Several machine learning methods were performed to construct the prediction model, We also used feature selection and analysis techniques to identify risk factors that predict occurrence of AAR.

#### RESULTS

Among 208035 cancer patients who underwent ICM administration, the overall prevalence of AARs was 0.205%. A CatBoost model was more accurate than other machine learning models, with an AUC of 0.959 , a sensitivity of 0.929. Several variates significantly associated with AARs were history of hypersensitivity reaction to ICM, iopromide , immunotherapy, excessive MRI enhancement scan, and younger age.

#### DISCUSSION

A large number of radiological examinations, mainly contrast-enhanced CT scans, are conducted worldwide each year, especially in cancer patients. A machine-learning model was more accurate for predict the occurrence of AARs associated with iodinated contrast media, which can offer useful guidance to clinicians and patients for individually adjuvant therapy. This result indicates that radiologists need to pay greater attention to a patient's cancer history, especially with ragard to current antineoplastic treatments.

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## Abstract Archives of the RSNA, 2023

R5B-QI-3

### Improving On-time Starts for Pediatric Cardiac Magnetic Resonance Imaging (cMRI)

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Susan Ferry (*Presenter*) Nothing to Disclose

#### INTRODUCTION

cMRI exam start delays result in longer patient fasts, extended patient wait times, and poor synchronization of anesthesia induction and contrast administration. Coordinating multiple services creates a domino of inefficiencies. We sought to target on-time start improvements from our baseline of 10%, where on-time was defined as the first image taken within 5 minutes of the scheduled time.

#### METHODS

A multidisciplinary team from Cardiac and Radiology Services utilized a local version of the Stanford RITE improvement methodology to target several process improvements to patient flow. We focused on understanding our current state by enhancing data visualization to easily identify where delays were occurring. Two key causes of delay were late outpatient arrival and variations in patient prep timing for anesthesia patients. Families were surveyed to identify reasons for late arrivals, which led to a standard script for pre-visit calls with detailed instructions for traffic, parking, and registration location. A patient-ready time stamp was utilized for anesthesia patients to better coordinate patient prep activities and timely induction. Finally, process mapping demonstrated a rework pattern that required a complete redesign of the scheduling and protocolling process steps. A new workflow that allows protocolling before scheduling has been developed and is currently in the testing phase.

#### RESULTS

Defining performance and visualizing it in a meaningful way created a slight Hawthorne effect with an increase in on-time starts from 10% to 21% during our current state analysis. Timing of standard script implementation right before Thanksgiving and through the winter holidays impacted our measurable improvement with significantly lower volumes. We attribute the "rebound" in January to the continued use of the script as well as the efforts to improve anesthesia patient prep times. Shared situational awareness of patient flow time points, equipment readiness, and efforts by the sedation team to orchestrate IV placement, physical examination, and the consent process brought our on-time starts to 34% by the end of the program.

#### DISCUSSION

There was value in using a systematic team approach to understanding and solving this problem. Team members were unaware of what the process looked like to our patients because they only knew their small piece of the larger workflow. Team members Gemba walked all areas of the process to gain perspective, build engagement, and facilitate teamwork. Areas of focus initially centered on low-effort interventions because redesigning the scheduling and protocolling steps of the process required more time and outside resources than expected. We anticipate this much-needed change will have a dramatic effect on our metric when we are able to go live.

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## Abstract Archives of the RSNA, 2023

R5B-QI-4

### Imaging Stewardship: Defining STAT Exams in the Cardiac Intensive Care Unit

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

#### Awards

##### Quality Improvement Reports Award

Eatrice Hinton (*Presenter*) Nothing to Disclose

#### INTRODUCTION

We cannot ensure that high priority Exams are being prioritized and performed in a consistent manner. This is critical for us to provide accurate high priority responses to those with the greatest need. The problem is particularly apparent in X-ray services which has the highest case volume. The current workflow is believed to be inefficient, i.e., delays in care, delay in processing results to ordering practitioners, and stress on X-ray techs. Most ICU exams are requested as high priority (STAT) without considering the appropriateness or demand of the present patient condition. "If everything is STAT, nothing is STAT" because the X-ray team is unable to respond to everything at the same time. We aimed to reduce the response time for high priority portables with this project

#### METHODS

The team included clinicians from the Cardiac Intensive Care unit and Radiology. The Quality improvement approach used was Realizing Improvement through Team Empowerment (RITE) process improvement program. The program guides teams through didactic education and practical application of quality improvement tools. The tools used included a process map to understand the workflow. Gemba walks to see how the work is done and factors that contributed to the problem. The data collected was used to create fishbone diagrams and Pareto charts to quantify key causes of the problem. From that information the top key drivers for improvement were identified and included the need for technologist to have a consistent workflow, and the need for closed loop communications between clinicians and technologists. One of the most impactful communication interventions was the creation of the Clinical criteria for STAT priority exams. That and other interventions were tested using small test of change, Plan-Do-Study-Act cycles. Improvement was measured by quantifying the time from notice of exam need to the time of exam completion.

#### RESULTS

Using RITE methodology helped the team to decrease the turn-a-round time for STAT portable exams from a median of 24 minutes to a median of 15 minutes by the end of the six-month program. The key interventions that lead to this improvement were changing the notification from a phone call to a secure chat notification which allowed the Technologist to better triage STAT request. Also, development of the clinical criteria list decreased the number of STAT requests to those of the highest clinical priority.

#### DISCUSSION

Development of a shared understanding between the Cardiac ICU and Radiology as to what makes an exam STAT and how we best communicate that to illicit a timely response was crucial. Using a systematic, team-based approach to improvement contributed to the success by improving communication between the two departments. Subsequently, the key interventions have been spread to the neonatal intensive care unit and improved data analysis methods of current performance are underway.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

R5B-QI-5

### Teach the Mentor: A Six Week Intensive Program Universally Improves Mentorship Skills Among a Diverse Group of Faculty

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Hannah Milch, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Quality mentorship leads to more successful academic careers, stronger clinical program development, and increased authorship and federal funding. Mentorship is lower for women and people of color. During the COVID-19 pandemic, a significant strain was placed on mentorship relationships with physical distancing and a focus on essential clinical needs. The purpose of this study was to determine if an intensive, case-based, in-person mentorship program would improve self-reported mentorship skills among a diverse group of faculty at a large multi-site academic institution.

#### METHODS

Faculty were recruited to participate in a mentorship course aimed at improving the pool of high quality mentors in the radiology department. Selection of participants focused on creating a balanced group with diverse backgrounds and levels of experience. The course curriculum was adopted from established predicates and was developed for clinician scientists, with prior proven success. Participants met weekly for two hours over 6 weeks in an informal and confidential setting. Participants completed a 19 question survey about mentorship skills before the first session (pre-test) and within one week following the last session (post-test). Respondents rated their mentorship skills based on a Likert scale ranging from 1 (not at all skilled) to 7 (highly skilled). Paired t-tests were performed to assess differences in mean responses.

#### RESULTS

Eleven faculty completed the course and their survey response rate was 100%. The group was gender balanced (six women and five men) and at varying career stages (4 Professors, 2 Associate Professors, and 5 Assistant Professors). Mean score for each of the 19 survey questions significantly increased on the post-test by an average of 2.22 points, from 3.78-6.00 ( $p < 0.001$ ). Scores demonstrated high reliability across all questions (Cronbach's alpha of 0.96). For 18 of the 19 questions there was no significant difference in score improvement between Professors and Associate/Assistant Professors. For a single question (Question 10: Working with trainees to set research goals), Professors demonstrated less improvement compared to Associate/Assistant Professors (mean score difference of 1 versus 3,  $p = 0.014$ ).

#### DISCUSSION

By discussing provocative mentorship dilemmas in a confidential small group of peers, radiology faculty with all levels of experience reported a large improvement in mentorship skills after just six weekly sessions. Strengthening faculty mentorship through an in-person case-based course may help narrow gender and race disparities in radiology, improve departmental collegiality, and lead to greater overall job satisfaction and academic success.

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## Abstract Archives of the RSNA, 2023

R5B-QI-6

### Reimagining a Virtual Radiology QI Structured Problem Solving Program

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Amin Etemad, MBA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

An experiential program at an academic medical center to support small- to medium-size improvement projects in radiology (named 52in52) experienced challenges during the COVID pandemic. Meetings had to be transitioned to a virtual environment, and the department experienced staffing shortages that limited the ability to provide frontline staff with time to engage in improvement projects. The program was also asked to strengthen its support of radiology trainees in meeting their requirement to complete a program-based project prior to graduation from residency. Given the new demands on this program from its original conception in 2017, the 52in52 team used stakeholder input to develop a virtual 52in52 program that accommodated these new needs.

#### METHODS

Opportunities for improvement were gathered by program managers through 1:1 interviews and surveys directed at stakeholders, which included modality leaders, department education leaders, operational leaders, and prior resident and staff participants. Based on the feedback, the following interventions were successfully implemented: 1. Modifying the program frequency to 3 cohorts per year, with cohorts lasting approximately 14 weeks. 2. Implemented virtual check-ins for project leaders, stakeholders, and program leaders. 3. Developing an "idea repository" for potential improvement projects. 4. Utilizing a committee of faculty division performance leaders to vet and approve project ideas submitted by trainees.

#### RESULTS

Following our QI efforts, participation increased from an average of 1.5 project proposals per cohort submitted at baseline after the COVID pandemic began to 4.5 proposals per cohort. The program included two multi-departmental projects: breast surgery partnered with mammography to reduce the number of unnecessary phone calls regarding specimen imaging questions, and orthopedic surgery partnered with diagnostic x-ray to reduce the number of incorrect orders being placed by referring providers. Resident participation in operations-led projects increased 65% since FY2021.

#### DISCUSSION

Sustaining an intra-departmental project-based improvement program during and after the COVID pandemic required rethinking the fundamental aspects of program, with the goal of maintaining the outcomes of increasing improvement capability within the department and providing a structured venue for problem solving. Through stakeholder feedback, the program management team implemented changes that have allowed the program to continue to serve as a valuable resource for the department, despite pandemic and post-pandemic related challenges.

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## Abstract Archives of the RSNA, 2023

R5B-QI-8

### Improving Radiologist Interpretation Confidence for Appendix Ultrasound through Standardized Performance and Reporting

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Harpreet S. Grewal, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Increasing radiologist certainty in the ultrasound diagnosis of acute appendicitis through standardized exam performance and reporting has been proven to decrease CT utilization, unnecessary surgeries and hospital length of stay. The goal of this project was to decrease the number of indeterminate studies in a community hospital setting and two free-standing emergency departments (FSEDs) by 50% over a period of 9 months.

#### METHODS

This project was performed in a combined adult and children's hospital in a suburban setting with two other affiliated FSEDs. A nationally standardized pediatric appendix ultrasound protocol, sonographer worksheet and reporting template were implemented after offering live training to all sonographers and radiologists in September 2021. In March of 2022 a 2-hour virtual training with CME was mandated for all reading radiologists and all sonographers. We tracked utilization of each component over time, additional imaging post-appendix ultrasound, length of stay, diagnostic accuracy and certainty of report impression defined as: positive for appendicitis, negative for appendicitis, equivocal (conflicting US findings), or merely descriptive. Seven radiologists (five pediatric and two body imagers) retrospectively reviewed the data from before live training (n=61), after live training (n= 159) and after virtual mandated training (n=63) for 285 patients requiring undergoing appendix ultrasound between December 2020 and June 2022.

#### RESULTS

Patients ranged in age from 1-70 years with a mean of 10.2 years for the before-training group, 13.6 years for the after-live training group and 11.9 years for the after-virtual training group. Fifteen-minute mean scan times were the same in all groups. There was a significant decrease in both descriptive and equivocal impressions following training (graph 1). Length of stay was not significantly different between the three groups, 15.5 hours before training, 38.8 hours after live training and 16.1 hours after mandatory training. There were 2 false positive cases before training, none after live training and one after virtual training. There was one false negative study in each of the groups. There was a 74 percent decrease in descriptive interpretations.

#### DISCUSSION

While there was a 74 percent decrease in descriptive US impressions, we did not see any significant change in length of stay or post-appendix ultrasound imaging utilization in our care setting during this time frame. Limitations include undefined impact of Covid 19 pandemic on healthcare utilization and other variable.

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## Abstract Archives of the RSNA, 2023

R5B-QI-9HC

### Comparison of shielding effectiveness using microorganisms in X-ray diagnostic factors for shielding materials

Thursday, Nov. 30 12:45PM - 1:15PM Room: Learning Center

Sejeong An, MS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Diagnostic radiology is an essential field that relies on radiation-based imaging tests like X-rays, CT scans, and interventional procedures. However, frequent exposure to radiation can increase the risk of harm and the development of additional diseases. Therefore, there is a need for mitigation measures to reduce radiation exposure. Currently, lead aprons made of heavy metals like lead and tungsten are used for shielding, but they have disadvantages like causing occupational diseases and environmental problems. To find a substitute for lead, researchers are investigating microorganisms that can absorb scattered radiation

#### METHODS

In this study, *Cladosporium cladosporioides* microorganisms were used to develop a microbial shielding sheet to replace lead. A nano-material sheet was coated with the microorganisms, and four sheets were produced with varying amounts of microbial mass. To compare the effectiveness of the microbial shielding sheet, a lead apron was used as a control group. Radiation monitors were used to compare changes in radiation dose with or without the shielding material. Single sheets and combinations of sheets were tested to determine the shielding level

#### RESULTS

In this study, when comparing None and single sheet, the order of effectiveness in factor 1 was sheet 1 (44.7%) > sheet 3 (44.4%) > sheet 2 (44%) > sheet 4 (40.2%), and in factor 2, it was sheet 3 (48.1%) > sheet 2 (46.7%) > sheet 1 (46.4%) > sheet 4 (42.8%). For factor 3, it was sheet 3 (52.1%) > sheet 1 (50.8%) > sheet 2 (47.6%) > sheet 4 (44.7%), and for factor 4, it was sheet 3 (95.6%) > sheet 2 (95.2%) > sheet 1 (95.1%) > sheet 4 (93.6%). When applying two sheets to the composite sheet, in all factors, sheet 2+3 (Factor 1 - 68.2%, Factor 2 - 75.4%, Factor 3 - 74.4%, Factor 4 - 99.4%) > sheet 1+2 (Factor 1 - 67.9%, Factor 2 - 73.6%, Factor 3 - 78.7%, Factor 4 - 99.4%) > sheet 2+4 (Factor 1 - 65.8%, Factor 2 - 71.4%, Factor 3 - 72.1%, Factor 4 - 99.3%). When applying three sheets, sheet 1+2+3 (Factor 1 - 80.5%, Factor 2 - 86.7%, Factor 3 - 86.5%, Factor 4 - 99.7%) > sheet 1+2+4 (Factor 1 - 80%, Factor 2 - 85.7%, Factor 3 - 85.4%, Factor 4 - 99.7%). When applying four sheets, in factor 4 (99.8%) > factor 2 (92.9%) > factor 3 (92%) > factor 1 (87.4%).

#### DISCUSSION

The study confirmed that microbial-based shielding materials have the potential to overcome the disadvantages of existing commercial materials. The use of microorganisms for radiation shielding could reduce occupational diseases and environmental problems associated with heavy metal-based shielding materials

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## Abstract Archives of the RSNA, 2023

S3A-QI

### Quality Improvement Reports Sunday Poster Discussions I

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

#### Sub-Events

#### S3A-QI-1 Community Centered Process Mapping to Identify Breast Cancer Screening Barriers

Arisa Milton, BS (*Presenter*) Nothing to Disclose

##### INTRODUCTION

Breakdowns in breast cancer screening and diagnosis are the leading cause of breast cancer mortality disparities. Process mapping is a quality improvement tool that can be used to visually describe the flow of healthcare processes. Process mapping can be used to reveal specific components of the screening process that can be targeted to reduce breast cancer disparities. The objective of our study was to develop a community centered process map to identify barriers and potential solutions to improve access to mammographic screening.

##### METHODS

To develop the community centered process map, we included participants from the Wisconsin Network for Research Support (WINRS) Community Advisory on Research Design and Strategies (CARDS). CARDS participants are recruited from community centers and food banks that serve individuals from diverse racial, socioeconomic, and educational backgrounds. A community-centered process map describing the screening mammography process was developed from the lived experiences, concerns, and storytelling of community advisory group members. Patients, clinicians, and academic researchers were involved in the map development using structured quality improvement guidelines. After development of the process map, structured brainstorming exercises were conducted to facilitate divergent thinking. Barriers and potential solutions were identified by CARDS participants and categorized. Four 90-minute group meetings were held between May and September 2022. Members were compensated for their time and participation. All sessions were audio- recorded and transcribed verbatim by HIPAA-trained transcribers to prepare for analysis.

##### RESULTS

Community advisory focus group was composed of 22 adults from low-income neighborhoods in Madison, including 17 African Americans and 1 Latinx member. Community centered process mapping led to the creation of a mammography screening timeline (Figure 1). Steps in the mammography screening timeline included: 1) due for mammogram 2) schedule and prepare for mammogram 3) transportation to the breast center 4) check-in and waiting area 5) complete mammogram exam 6) results 7) billing. Top barriers (cited 6 times or more) were 1) pain/ discomfort 2) cost/coverage 3) fear/anxiety 4) lack of information/ unfamiliarity. Top solutions (cited 7 times or more) were 1) relationships, reassurance and safe or comforting physicians 2) reminders 3) more information 4) free/ low-cost mammograms.

##### DISCUSSION

Community centered process maps can be used to create step by step breakdowns of the mammographic screening process. Multiple barriers and potential solutions were identified to improve access and adherence to mammography screening. Future studies will use structured quality improvement methods to test the impact of these potential interventions on improving mammography screening percentages.

#### S3A-QI-2 The Impact of Online Self-Scheduling Platform Optimization on Patient Directed Access to Screening Mammography Appointments During the COVID-19 Pandemic

Megan J. Kalambo, MD (*Presenter*) Nothing to Disclose

##### INTRODUCTION

During the COVID-19 pandemic, screening mammography (SM) utilization declined nationally by nearly 65% compared to pre-pandemic volumes. This study assessed the impact of screening mammography online self-scheduling platform (OSS)

optimization on patient scheduling, rescheduling and cancellation rates during the COVID-19 pandemic at a multi-site academic breast radiology department.

## **METHODS**

A retrospective review of online SM scheduling utilization between October 1, 2019, and December 31, 2022 was performed. The electronic health record (EHR) was queried to extract the total number of SMs performed, online scheduling, rescheduling and cancellation rates during the busiest screening mammography months of October through December in 2019 and 2022.

## **RESULTS**

October to December online SM scheduling patient activity rose from 57 to 1481 patients when comparing 2019 and 2022 performance, representing a 26-fold increase in online platform utilization after EHR-tethered scheduling integration ( $p=0.013$ ). This resulted in a concurrent 16x fold reduction in patient access specialist SM scheduling engagement. Concurrently, SM scheduling automation resulted in increases in appointment rescheduling and cancellation rates, from 14% to 22% ( $p=0.005$ ) and 18% to 38% ( $p=0.000$ ), respectively.

## **DISCUSSION**

Optimization of our online self-scheduling platform with EHR integration resulted in a 26-fold increase in online self-scheduling patient utilization and a 16x fold reduction in DI-PAS hands on SM scheduling engagement. The rates of OSS patient appointment rescheduling and cancellation also increased but the overall net gain in self-scheduling automation should not deter continued use and implementation of this program.

### **S3A-QI-3 Let It Shine! 5S + Safety: A Biopsy Training Equipment Quality Improvement Example**

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

## **INTRODUCTION**

Before a trainee performs a biopsy on a patient, they must demonstrate competency using phantom simulation, which builds their confidence to perform the procedure on a patient. Biopsy materials used for training were spread over several offices and located on the floor, on top of cabinets, on top of desks, and under desks. As part of a process improvement project, a 5S of the space was performed, allowing for inventory of biopsy probes, space organization, and an efficient and safe work environment.

## **RESULTS**

Before and after photographs documented the 5S project, labeled cabinets make it easy to identify the materials needed by trainees.

## **METHODS**

Utilizing the concepts of sort, set in order, shine, standardize, and sustain, the 5S project was undertaken. First, the stakeholders were identified and included in the process. A plan of action was devised, and a location was identified to consolidate the biopsy training material. Facilities workers were involved in the process since moving furniture was a necessary step. A cabinet was organized with biopsy probes, guide wires, wireless localizers, and commercial and institution-created breast phantoms. The sharps were decluttered and disposed of properly. Only the required biopsy probes and needles were maintained. Finally, a plan to sustain the organized cabinet was devised. This included communicating to nurses and technologists not to dump sharps in the training area unless requested by the lead radiologists involved in the project.

## **DISCUSSION**

Messiness and clutter lead to mistakes and present a safety hazard. Therefore, a 6th S (safety) is often included in the 5S projects to decrease or eliminate risk. The success of a 5S depends on communication, standardization, and general cleanliness. The process included proper quantities of biopsy probes for training and eliminating unnecessary items. We keep only what is needed on hand, and those items are consolidated into one location accessible to the point of use. We also relied on visual labeling to make finding what is needed efficient. 5S involves SORT - throw away items that are not used, adjust the quantity to keep on hand only what is required, SET IN ORDER - even when the residents are unfamiliar with the space, they can find what they need. This is achieved by using labels/colors, arranging by frequency of use, and grouping like items together. SHINE - like it is new! That way, people feel comfortable in the environment (another safety item- mental health). STANDARDIZE - a regular cleaning schedule and audit are performed, and communication with our technologists not to dump expired or unused probes in the biopsy training cabinet has been vital to keeping the system going. SUSTAIN - ensure that everything is maintained by creating a plan and making 5S part of the culture. And the 6th S: SAFETY - in our example, numerous sharps hazards were decluttered and organized to create a safe environment.

### **S3A-QI-4 Taking Time for Timing Out: An Improvement Initiative for Time-out Documentation**

Kerry L. Thomas, MD (*Presenter*) Stockholder, Medtronic plc; Stockholder, UnitedHealth Group; Stockholder, Amgen Inc; Stockholder, AbbVie Inc

## INTRODUCTION

Universal Protocol is a TJC National Patient Safety Goal® to prevent wrong site or patient procedures. Adherence to a standard process of performing and documenting the pre-procedural time-out is critical for ensuring patient safety and Universal Protocol compliance. Our institution did not have a standardized time out process for diagnostic radiology procedures and there was no monitoring process to assess compliance. A random audit revealed a poor rate of time-out documentation. This quality initiative aimed developed a standard time out process and improve time-out compliance rates in diagnostic radiology.

## METHODS

A random audit time out documentation for procedures completed in the 3 months before intervention documented 61% compliance. Key stakeholder (physicians, nurses, technologists) focus group discussions were held to evaluate how different team members understood the required time-out processes. These discussions exposed barriers to adherence, including lack of nursing support or real time access to the EMR for documentation, no standard wording for dictated procedural reports, and no specific education of necessary components of the time out process. Several interventions were introduced to address barriers. A standardized time-out process was created and attending physicians were designated as the individual responsible for initiating the time out. Education on the standard process was provided to faculty and trainees as well as to technologist and nurse supervisors, who disseminated this material to their respective units. Computers with real time EMR access were placed in the procedure area. A dictation template was also created for facile inclusion to the procedural report. We performed monthly audits to assess compliance, with a goal of 100% compliance.

## RESULTS

Monthly auditing revealed successful response to interventions. Rate of documented time out completion increased from 61% to 97% month following intervention. Improvement was sustained over the following months, reaching 100% at 5 months. Approximately 6 months after the interventions began, a status update was disseminated to the relevant stakeholders, which also served as a reminder for continued compliance.

## DISCUSSION

Our objective was to improve adherence to The Universal Protocol to reduce the risk of wrong site/wrong patient procedures in diagnostic radiology. Compliance after intervention was at or nearly at goal. Because multiple interventions were introduced simultaneously, it is difficult to discern which had greatest impact, which interventions worked synergistically, or if any were ineffective. It would be ideal to directly quantify the effect of this initiative on patient, but because wrong site/patient procedures are infrequent, this would rely on "near miss" documentation, which was unavailable.

## S3A-QI-5 Reducing Turnaround Time For Routine Neurology Inpatient MRIs to Improve Length of Stay

Ashima Lall, MD, MBA (*Presenter*) Nothing to Disclose

## INTRODUCTION

Our Health System has focused on identifying barriers to discharge and utilizing the electronic medical record (EMR) to improve system-wide processes and reduce length of stay to control health care costs. Using an interdisciplinary team, we found that there was no system to alert technologists and radiologists of routine inpatient studies on patients who were awaiting imaging results for discharge. The purpose of this study was to develop a signal in the EMR to identify patients who were pending discharge within 24 hours of an MRI result. By identifying these patients, our goal was to reduce the length of stay (LOS) and ultimately decrease health care costs.

## METHODS

We developed a "demand signal" in the EMR to signify which inpatients could be discharged within 24 hours of receiving the imaging results back. The demand signal would help technologist and radiologists prioritize orders of these inpatients ahead of other routine inpatient studies. The target was to reduce turnaround time for routine Neuro inpatient and observation patients between MRI ordered, MRI performed, and results dictated for these patients. Our study excluded MRIs ordered for septic and obstetric patients. We measured the use of the demand signal from March 2022 through August 2022, annualized the results and compared to the baseline metrics from May 2020 through May 2021

## RESULTS

Initial pilot data demonstrates over 50% of patients selected "pending discharge" were discharged in less than 24 hours and 70% were discharged within 48 hours. The average time reduction between scan ordered and scan begin, scan end to dictation, and dictation to discharge were all significantly reduced ( $p < 0.001$ ). The annualized data analysis shows that demand signal patients were associated with 300 inpatient days and 34.5 observation days less compared to controls, with variance annualized savings of \$170,595. The demand signal was used consistently across all campuses of our health system (Figure 5).

## DISCUSSION

Implementing the demand signal was associated with significant impact on LOS and reduced health care costs. This has other secondary effects such as reducing ED holds by opening bed faster, especially when systems are seeing record patient volumes. Next steps include identifying similar opportunities and scaling the demand signal to inpatients undergoing other imaging exams such as CT and ultrasound with the goal of achieving a larger impact for the health system.

### S3A-QI-6 Reducing Redundant Imaging Orders using a Targeted Best Practice Advisory

Ashima Lall, MD, MBA (*Presenter*) Nothing to Disclose

## INTRODUCTION

Our health system has focused on identifying areas to reduce redundant imaging orders by utilizing the electronic medical record (EMR) to improve system-wide processes and reduce cost of care. Using an interdisciplinary team, we specifically looked at minimizing redundant ordering of neurology studies in the inpatient and emergency department setting. A recurring scenario was identified where a patient had an MRA head/neck ordered within seven days after having a CTA head/neck completed. Additionally, our goal was to educate ordering providers that a CTA head/neck can not only satisfy imaging needs but is also the better diagnostic test except for a few clinical scenarios where a follow up MRA head/Neck is appropriate.

## METHODS

We developed a targeted best practice advisory (BPA) to alert ordering physicians of an existing CTA that had been completed within seven days and would likely address the diagnostic need. The BPA provided a live link bringing the provider directly to the existing CTA report. We measured the use of the BPA over a one-year period and calculated the BPA effectiveness. Our data was compared to a one-year control period. A BPA is considered effective with a minimum score of 35-40%. We determined the total labor cost per MRA head and MRA neck that can be utilized to estimate the potential reduction of cost.

## RESULTS

Over a one-year period, the neuro BPA fired 247 times. For all BPA fires, 58.7% of orders were completely cancelled and 10.5% of orders were changed to a different study. Only 30.8% of original orders were performed. This resulted in a potential maximal direct financial impact of \$42,834 in one year based on total average cost per MRA. The data analysis shows the percentage of MRA studies performed on inpatients with recent CTA studies decreased from 5.8% to 3.01% ( $p < 0.009$ ). The calculated neuro MRA BPA effectiveness rate is 58.7%, which is well above the standard and even further above the average effectiveness rates of other physician-based BPAs in the Health System (=10%).

## DISCUSSION

The implementation of the BPA had a significant impact on reducing redundant MRA head/neck studies. A three-month pre and post BPA implementation analysis demonstrated significant reduction in reducing MRAs performed within seven days of a completed CTA ( $p=0.009$ ). The data shows that our highly targeted "non-nuisance" BPA achieved the intended impact and next steps include identifying other similar opportunities in the system.

### S3A-QI-7 Trends in the Proportion of Female Presenters, Keynote Speakers and Award Recipients at the Radiology Society of North America Conferences from 2013 till 2019

Lina El Bejjani, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Primary objective: Determine the trend between 2013 and 2019 of the proportion of presenters, keynote speakers and award recipients who were women at the RSNA conferences. Secondary objective: Determine the trends among scientific versus educational sessions. Determine the trends among conventional versus interventional radiology subspecialties. Determine the trends between second day and last day of the conference.

## METHODS

Design, settings and participants This is a cross sectional study aiming at determining the gender of presenters, keynote speakers and award recipients at the RSNA conferences of the years 2013, 2015, 2017 and 2019. The validated genderize.io tool was used to find the gender of the radiologists. Main outcomes and measures Evaluate the trend over the years of the percentage of women presenting in educational versus scientific sessions, during the second day of the conference versus the last day and in conventional radiology versus interventional radiology.

## RESULTS

Four RSNA conferences were evaluated for the years 2013, 2015, 2017 and 2019 with a total of 2049 presenters between scientific and educational sessions, 115 keynote speakers and 2225 award recipients. The proportion of female presenters significantly increased from 2013 to 2017 ( $p=0.001$ ). However women are still less represented with a maximum of female presenters of 35.9% reached for the year 2017. For keynote speakers and for awards recipients, the trends of female representation is not statistically significant, and women continue to be underrepresented reaching a maximum of 33.3% of



keynote speakers in 2013 and around 35% for award recipients for the different years. The proportion of female presenting educational sessions significantly increased ( $p=0.01$ ) from 2013 (20.5%) to reach 40.6% in 2017. The proportion of female presenting scientific sessions also significantly increased ( $p=0.04$ ) from 2013 (26%) to 2015 (36.2%). It slightly dropped in 2017 to reach 32.5% and slightly increased again in 2019 to 33.9%. The proportion of women presenting for conventional radiology (34.8%) is significantly higher than those for interventional radiology (18.6%) in all years ( $p<0.0001$ ). We found no significant change between day 2 and Day 7 in the proportion of females and males

## **DISCUSSION**

The proportion of female presenters increased over the years at the RSNA conferences, however women continue to be underrepresented as presenters in medical conferences. This disparity is noted for the radiology specialty in general and especially in the field of interventional radiology.

## **S3A-QI-8HC Radiology Reported Incidental Nodules: Improving Outcomes in Thoracic Oncology Service Line Through Data Mining**

Roger Su, MD (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Incidental pulmonary nodules described in radiology reports are a key source of data for identifying unsuspected lung cancers. The detection of early stage lung cancers through screening is inadequate, so expansion of early detection beyond USPSTF screening guidelines are imperative. Lack of follow-up of incidental nodules can have serious consequences, which is why we developed a protocol for detecting and managing incidental pulmonary nodules. Over a period of 30 months, we analyzed 160,000 radiology reports for verbiage reflecting the presence of pulmonary nodules in imaging exams performed for indications other than pulmonary nodules.

## **METHODS**

We applied a natural language processing (NLP) algorithm (in Lung Cancer Orchestrator™, Philips, Medtronic) to our radiology reports prospectively over a period of 31 months. Applying Fleischner's criteria and an internal codified triage process, we discovered 84 lung cancers and 10 other non-pulmonary cancers that, absent such a process, would increase the potential of being left unfollowed and untreated.

## **RESULTS**

Of the incidentally discovered lung cancers, 55% (45) were early stage (stage I and II), 20% (16) were in never-smokers, and 45% (36) did not fit the criteria for lung screening under the revised United States Preventive Services Task Force guidelines. These outcomes allowed us to demonstrate the value of radiology reporting of incidental nodules and the application of NLP for data mining and subsequent referrals for management by a dedicated team. We also discovered opportunities for structured reporting, semantic radiology reports, and enhanced NLP algorithms.

## **DISCUSSION**

Applying NLP to radiology reports enables the detection of occult lung (and other) cancers in patients imaged for other reasons. This expands the discovery of early-stage lung cancers, prolonging survival, reducing the cost of care, and improving patients' quality of life. A complete early detection program for lung cancer should have both an incidental nodule program and a lung screening program. Our findings underscore the importance of incorporating an incidental nodule program into thoracic oncology service lines to improve patient outcomes.

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## Abstract Archives of the RSNA, 2023

S3A-QI-1

### Community Centered Process Mapping to Identify Breast Cancer Screening Barriers

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Arisa Milton, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Breakdowns in breast cancer screening and diagnosis are the leading cause of breast cancer mortality disparities. Process mapping is a quality improvement tool that can be used to visually describe the flow of healthcare processes. Process mapping can be used to reveal specific components of the screening process that can be targeted to reduce breast cancer disparities. The objective of our study was to develop a community centered process map to identify barriers and potential solutions to improve access to mammographic screening.

#### METHODS

To develop the community centered process map, we included participants from the Wisconsin Network for Research Support (WINRS) Community Advisory on Research Design and Strategies (CARDS). CARDS participants are recruited from community centers and food banks that serve individuals from diverse racial, socioeconomic, and educational backgrounds. A community-centered process map describing the screening mammography process was developed from the lived experiences, concerns, and storytelling of community advisory group members. Patients, clinicians, and academic researchers were involved in the map development using structured quality improvement guidelines. After development of the process map, structured brainstorming exercises were conducted to facilitate divergent thinking. Barriers and potential solutions were identified by CARDS participants and categorized. Four 90-minute group meetings were held between May and September 2022. Members were compensated for their time and participation. All sessions were audio- recorded and transcribed verbatim by HIPAA-trained transcribers to prepare for analysis.

#### RESULTS

Community advisory focus group was composed of 22 adults from low-income neighborhoods in Madison, including 17 African Americans and 1 Latinx member. Community centered process mapping led to the creation of a mammography screening timeline (Figure 1). Steps in the mammography screening timeline included: 1) due for mammogram 2) schedule and prepare for mammogram 3) transportation to the breast center 4) check-in and waiting area 5) complete mammogram exam 6) results 7) billing. Top barriers (cited 6 times or more) were 1) pain/ discomfort 2) cost/coverage 3) fear/anxiety 4) lack of information/ unfamiliarity. Top solutions (cited 7 times or more) were 1) relationships, reassurance and safe or comforting physicians 2) reminders 3) more information 4) free/ low-cost mammograms.

#### DISCUSSION

Community centered process maps can be used to create step by step breakdowns of the mammographic screening process. Multiple barriers and potential solutions were identified to improve access and adherence to mammography screening. Future studies will use structured quality improvement methods to test the impact of these potential interventions on improving mammography screening percentages.

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## Abstract Archives of the RSNA, 2023

S3A-QI-2

### **The Impact of Online Self-Scheduling Platform Optimization on Patient Directed Access to Screening Mammography Appointments During the COVID-19 Pandemic**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Megan J. Kalambo, MD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

During the COVID-19 pandemic, screening mammography (SM) utilization declined nationally by nearly 65% compared to pre-pandemic volumes. This study assessed the impact of screening mammography online self-scheduling platform (OSS) optimization on patient scheduling, rescheduling and cancellation rates during the COVID-19 pandemic at a multi-site academic breast radiology department.

#### **METHODS**

A retrospective review of online SM scheduling utilization between October 1, 2019, and December 31, 2022 was performed. The electronic health record (EHR) was queried to extract the total number of SMs performed, online scheduling, rescheduling and cancellation rates during the busiest screening mammography months of October through December in 2019 and 2022.

#### **RESULTS**

October to December online SM scheduling patient activity rose from 57 to 1481 patients when comparing 2019 and 2022 performance, representing a 26-fold increase in online platform utilization after EHR-tethered scheduling integration ( $p=0.013$ ). This resulted in a concurrent 16x fold reduction in patient access specialist SM scheduling engagement. Concurrently, SM scheduling automation resulted in increases in appointment rescheduling and cancellation rates, from 14% to 22% ( $p=0.005$ ) and 18% to 38% ( $p=0.000$ ), respectively.

#### **DISCUSSION**

Optimization of our online self-scheduling platform with EHR integration resulted in a 26-fold increase in online self-scheduling patient utilization and a 16x fold reduction in DI-PAS hands on SM scheduling engagement. The rates of OSS patient appointment rescheduling and cancellation also increased but the overall net gain in self-scheduling automation should not deter continued use and implementation of this program.

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## Abstract Archives of the RSNA, 2023

S3A-QI-3

### Let It Shine! 5S + Safety: A Biopsy Training Equipment Quality Improvement Example

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Haydee Ojeda-Fournier, MD (*Presenter*) Research Consultant, View Point Medical, Inc; Stock options, CureMetrix, Inc

#### INTRODUCTION

Before a trainee performs a biopsy on a patient, they must demonstrate competency using phantom simulation, which builds their confidence to perform the procedure on a patient. Biopsy materials used for training were spread over several offices and located on the floor, on top of cabinets, on top of desks, and under desks. As part of a process improvement project, a 5S of the space was performed, allowing for inventory of biopsy probes, space organization, and an efficient and safe work environment.

#### RESULTS

Before and after photographs documented the 5S project, labeled cabinets make it easy to identify the materials needed by trainees.

#### METHODS

Utilizing the concepts of sort, set in order, shine, standardize, and sustain, the 5S project was undertaken. First, the stakeholders were identified and included in the process. A plan of action was devised, and a location was identified to consolidate the biopsy training material. Facilities workers were involved in the process since moving furniture was a necessary step. A cabinet was organized with biopsy probes, guide wires, wireless localizers, and commercial and institution-created breast phantoms. The sharps were decluttered and disposed of properly. Only the required biopsy probes and needles were maintained. Finally, a plan to sustain the organized cabinet was devised. This included communicating to nurses and technologists not to dump sharps in the training area unless requested by the lead radiologists involved in the project.

#### DISCUSSION

Messiness and clutter lead to mistakes and present a safety hazard. Therefore, a 6th S (safety) is often included in the 5S projects to decrease or eliminate risk. The success of a 5S depends on communication, standardization, and general cleanliness. The process included proper quantities of biopsy probes for training and eliminating unnecessary items. We keep only what is needed on hand, and those items are consolidated into one location accessible to the point of use. We also relied on visual labeling to make finding what is needed efficient. 5S involves SORT - throw away items that are not used, adjust the quantity to keep on hand only what is required, SET IN ORDER - even when the residents are unfamiliar with the space, they can find what they need. This is achieved by using labels/colors, arranging by frequency of use, and grouping like items together. SHINE - like it is new! That way, people feel comfortable in the environment (another safety item- mental health). STANDARDIZE - a regular cleaning schedule and audit are performed, and communication with our technologists not to dump expired or unused probes in the biopsy training cabinet has been vital to keeping the system going. SUSTAIN - ensure that everything is maintained by creating a plan and making 5S part of the culture. And the 6th S: SAFETY - in our example, numerous sharps hazards were decluttered and organized to create a safe environment.

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## Abstract Archives of the RSNA, 2023

S3A-QI-4

### Taking Time for Timing Out: An Improvement Initiative for Time-out Documentation

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Kerry L. Thomas, MD (*Presenter*) Stockholder, Medtronic plc;Stockholder, UnitedHealth Group;Stockholder, Amgen Inc;Stockholder, AbbVie Inc

#### INTRODUCTION

Universal Protocol is a TJC National Patient Safety Goal® to prevent wrong site or patient procedures. Adherence to a standard process of performing and documenting the pre-procedural time-out is critical for ensuring patient safety and Universal Protocol compliance. Our institution did not have a standardized time out process for diagnostic radiology procedures and there was no monitoring process to assess compliance. A random audit revealed a poor rate of time-out documentation. This quality initiative aimed developed a standard time out process and improve time-out compliance rates in diagnostic radiology.

#### METHODS

A random audit time out documentation for procedures completed in the 3 months before intervention documented 61% compliance. Key stakeholder (physicians, nurses, technologists) focus group discussions were held to evaluate how different team members understood the required time-out processes. These discussions exposed barriers to adherence, including lack of nursing support or real time access to the EMR for documentation, no standard wording for dictated procedural reports, and no specific education of necessary components of the time out process. Several interventions were introduced to address barriers. A standardized time-out process was created and attending physicians were designated as the individual responsible for initiating the time out. Education on the standard process was provided to faculty and trainees as well as to technologist and nurse supervisors, who disseminated this material to their respective units. Computers with real time EMR access were placed in the procedure area. A dictation template was also created for facile inclusion to the procedural report. We performed monthly audits to assess compliance, with a goal of 100% compliance.

#### RESULTS

Monthly auditing revealed successful response to interventions. Rate of documented time out completion increased from m 61% to 97% month following intervention. Improvement was sustained over the following months, reaching 100% at 5 months. Approximately 6 months after the interventions began, a status update was disseminated to the relevant stakeholders, which also served as a reminder for continued compliance.

#### DISCUSSION

Our objective was to improve adherence to The Universal Protocol to reduce the risk of wrong site/wrong patient procedures in diagnostic radiology. Compliance after intervention was at or nearly at goal. Because multiple interventions were introduced simultaneously, it is difficult to discern which had greatest impact, which interventions worked synergistically, or if any were ineffective. It would be ideal to directly quantify the effect of this initiative on patient, but because wrong site/patient procedures are infrequent, this would rely on "near miss" documentation, which was unavailable.

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## Abstract Archives of the RSNA, 2023

S3A-QI-5

### Reducing Turnaround Time For Routine Neurology Inpatient MRIs to Improve Length of Stay

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ashima Lall, MD, MBA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Our Health System has focused on identifying barriers to discharge and utilizing the electronic medical record (EMR) to improve system-wide processes and reduce length of stay to control health care costs. Using an interdisciplinary team, we found that there was no system to alert technologists and radiologists of routine inpatient studies on patients who were awaiting imaging results for discharge. The purpose of this study was to develop a signal in the EMR to identify patients who were pending discharge within 24 hours of an MRI result. By identifying these patients, our goal was to reduce the length of stay (LOS) and ultimately decrease health care costs.

#### METHODS

We developed a "demand signal" in the EMR to signify which inpatients could be discharged within 24 hours of receiving the imaging results back. The demand signal would help technologist and radiologists prioritize orders of these inpatients ahead of other routine inpatient studies. The target was to reduce turnaround time for routine Neuro inpatient and observation patients between MRI ordered, MRI performed, and results dictated for these patients. Our study excluded MRIs ordered for septic and obstetric patients. We measured the use of the demand signal from March 2022 through August 2022, annualized the results and compared to the baseline metrics from May 2020 through May 2021

#### RESULTS

Initial pilot data demonstrates over 50% of patients selected "pending discharge" were discharged in less than 24 hours and 70% were discharged within 48 hours. The average time reduction between scan ordered and scan begin, scan end to dictation, and dictation to discharge were all significantly reduced ( $p < 0.001$ ). The annualized data analysis shows that demand signal patients were associated with 300 inpatient days and 34.5 observation days less compared to controls, with variance annualized savings of \$170,595. The demand signal was used consistently across all campuses of our health system (Figure 5).

#### DISCUSSION

Implementing the demand signal was associated with significant impact on LOS and reduced health care costs. This has other secondary effects such as reducing ED holds by opening bed faster, especially when systems are seeing record patient volumes. Next steps include identifying similar opportunities and scaling the demand signal to inpatients undergoing other imaging exams such as CT and ultrasound with the goal of achieving a larger impact for the health system.

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## Abstract Archives of the RSNA, 2023

S3A-QI-6

### Reducing Redundant Imaging Orders using a Targeted Best Practice Advisory

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Ashima Lall, MD, MBA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Our health system has focused on identifying areas to reduce redundant imaging orders by utilizing the electronic medical record (EMR) to improve system-wide processes and reduce cost of care. Using an interdisciplinary team, we specifically looked at minimizing redundant ordering of neurology studies in the inpatient and emergency department setting. A recurring scenario was identified where a patient had an MRA head/neck ordered within seven days after having a CTA head/neck completed. Additionally, our goal was to educate ordering providers that a CTA head/neck can not only satisfy imaging needs but is also the better diagnostic test except for a few clinical scenarios where a follow up MRA head/Neck is appropriate.

#### METHODS

We developed a targeted best practice advisory (BPA) to alert ordering physicians of an existing CTA that had been completed within seven days and would likely address the diagnostic need. The BPA provided a live link bringing the provider directly to the existing CTA report. We measured the use of the BPA over a one-year period and calculated the BPA effectiveness. Our data was compared to a one-year control period. A BPA is considered effective with a minimum score of 35-40%. We determined the total labor cost per MRA head and MRA neck that can be utilized to estimate the potential reduction of cost.

#### RESULTS

Over a one-year period, the neuro BPA fired 247 times. For all BPA fires, 58.7% of orders were completely cancelled and 10.5% of orders were changed to a different study. Only 30.8% of original orders were performed. This resulted in a potential maximal direct financial impact of \$42,834 in one year based on total average cost per MRA. The data analysis shows the percentage of MRA studies performed on inpatients with recent CTA studies decreased from 5.8% to 3.01% ( $p < 0.009$ ). The calculated neuro MRA BPA effectiveness rate is 58.7%, which is well above the standard and even further above the average effectiveness rates of other physician-based BPAs in the Health System (=10%).

#### DISCUSSION

The implementation of the BPA had a significant impact on reducing redundant MRA head/neck studies. A three-month pre and post BPA implementation analysis demonstrated significant reduction in reducing MRAs performed within seven days of a completed CTA ( $p=0.009$ ). The data shows that our highly targeted "non-nuisance" BPA achieved the intended impact and next steps include identifying other similar opportunities in the system.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-QI-7

### Trends in the Proportion of Female Presenters, Keynote Speakers and Award Recipients at the Radiology Society of North America Conferences from 2013 till 2019

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Lina El Bejjani, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Primary objective: Determine the trend between 2013 and 2019 of the proportion of presenters, keynote speakers and award recipients who were women at the RSNA conferences. Secondary objective: Determine the trends among scientific versus educational sessions. Determine the trends among conventional versus interventional radiology subspecialties. Determine the trends between second day and last day of the conference.

#### METHODS

Design, settings and participants This is a cross sectional study aiming at determining the gender of presenters, keynote speakers and award recipients at the RSNA conferences of the years 2013, 2015, 2017 and 2019. The validated genderize.io tool was used to find the gender of the radiologists. Main outcomes and measures Evaluate the trend over the years of the percentage of women presenting in educational versus scientific sessions, during the second day of the conference versus the last day and in conventional radiology versus interventional radiology.

#### RESULTS

Four RSNA conferences were evaluated for the years 2013, 2015, 2017 and 2019 with a total of 2049 presenters between scientific and educational sessions, 115 keynote speakers and 2225 award recipients. The proportion of female presenters significantly increased from 2013 to 2017 ( $p=0.001$ ). However women are still less represented with a maximum of female presenters of 35.9% reached for the year 2017. For keynote speakers and for awards recipients, the trends of female representation is not statistically significant, and women continue to be underrepresented reaching a maximum of 33.3% of keynote speakers in 2013 and around 35% for award recipients for the different years. The proportion of female presenting educational sessions significantly increased ( $p=0.01$ ) from 2013 (20.5%) to reach 40.6% in 2017. The proportion of female presenting scientific sessions also significantly increased ( $p=0.04$ ) from 2013 (26%) to 2015 (36.2%). It slightly dropped in 2017 to reach 32.5% and slightly increased again in 2019 to 33.9%. The proportion of women presenting for conventional radiology (34.8%) is significantly higher than those for interventional radiology (18.6%) in all years ( $p<0.0001$ ). We found no significant change between day 2 and Day 7 in the proportion of females and males

#### DISCUSSION

The proportion of female presenters increased over the years at the RSNA conferences, however women continue to be underrepresented as presenters in medical conferences. This disparity is noted for the radiology specialty in general and especially in the field of interventional radiology.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3A-QI-8HC

### **Radiology Reported Incidental Nodules: Improving Outcomes in Thoracic Oncology Service Line Through Data Mining**

Sunday, Nov. 26 11:45AM - 12:15PM Room: Learning Center

Roger Su, MD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Incidental pulmonary nodules described in radiology reports are a key source of data for identifying unsuspected lung cancers. The detection of early stage lung cancers through screening is inadequate, so expansion of early detection beyond USPSTF screening guidelines are imperative. Lack of follow-up of incidental nodules can have serious consequences, which is why we developed a protocol for detecting and managing incidental pulmonary nodules. Over a period of 30 months, we analyzed 160,000 radiology reports for verbiage reflecting the presence of pulmonary nodules in imaging exams performed for indications other than pulmonary nodules.

#### **METHODS**

We applied a natural language processing (NLP) algorithm (in Lung Cancer Orchestrator™, Philips, Medtronic) to our radiology reports prospectively over a period of 31 months. Applying Fleischner's criteria and an internal codified triage process, we discovered 84 lung cancers and 10 other non-pulmonary cancers that, absent such a process, would increase the potential of being left unfollowed and untreated.

#### **RESULTS**

Of the incidentally discovered lung cancers, 55% (45) were early stage (stage I and II), 20% (16) were in never-smokers, and 45% (36) did not fit the criteria for lung screening under the revised United States Preventive Services Task Force guidelines. These outcomes allowed us to demonstrate the value of radiology reporting of incidental nodules and the application of NLP for data mining and subsequent referrals for management by a dedicated team. We also discovered opportunities for structured reporting, semantic radiology reports, and enhanced NLP algorithms.

#### **DISCUSSION**

Applying NLP to radiology reports enables the detection of occult lung (and other) cancers in patients imaged for other reasons. This expands the discovery of early-stage lung cancers, prolonging survival, reducing the cost of care, and improving patients' quality of life. A complete early detection program for lung cancer should have both an incidental nodule program and a lung screening program. Our findings underscore the importance of incorporating an incidental nodule program into thoracic oncology service lines to improve patient outcomes.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3B-QI

### Quality Improvement Reports Sunday Poster Discussions II

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### S3B-QI-1 A New Peer Learning Tool - Concepts, Iterative Improvement, and Scaling Up

Nadja Kadom, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

**Problem Description:** Many radiology groups are abandoning random score-based peer review in lieu of Peer Learning (PL). **Available Knowledge:** There is currently no widely available tool to assist with the various functions of a PL program. **Purpose:** To make our PL process more efficient

#### METHODS

**Context and Intervention:** This tool was developed in free-standing pediatric hospital with academic affiliation. A peer learning program was established for the neuroradiology group in 2021 and was scaled up to include pediatric body imaging in January 2023. There was no budget for this intervention.

#### RESULTS

**The Intervention:** We developed a PL tool using an existing research database tool (REDCap®) and set-up a workflow between existing members of our team, such as a physician PL leader(s), radiologists, administrative assistants, and film library staff (Figure 1). A team approach was used to design and iteratively refine the PL tool. **Concepts:** Case submission: submit a wide variety of learning and improvement opportunities such as discrepancies, interesting cases, great catch, issues related to protocols, communication etc). **Clinical care:** accountability for providing appropriate clinical care lies with the radiologist submitting a case. **PL Conference preparation:** radiologists indicate whether the case is worth discussing in the PL conference. **PL Conference:** Each conference is recorded and can be viewed asynchronously. **Anonymized case review in PACS.** **Program targets:** case submissions per month per faculty and 50% attendance of PL sessions. **ACR Annual Reporting:** The database tool tracks case submissions per faculty per month. **PL Conference attendance** tracked by an administrative assistant. **Iterative Improvements:** most impactful was blinding who submitted a case in the feedback document that is sent to the original reviewer. **Scaling Up:** The tool was tested in the neuroradiology section for 1 year, then reviewed by the general pediatric imaging group, and adopted in January 2023. **Analysis:** For the neuroradiology faculty, there have been 147 case submissions in 2022, which represents a monthly submission average of 12 cases. After the final modification to the tool, blinding who submitted a case in the feedback document that is sent to the original reviewer, the monthly case submission average for this group in 2023 has increased to 29 cases. **Summary:** We used existing resources to build a PL tool as part of a PL process which facilitates clinical accountability, fosters individual and group learning through feedback and discussion, and meets the requirements for ACR accreditation under the PL pathway.

#### DISCUSSION

We are working with OPPE to define qualitative/quantitative data stewardship for The Joint Commission reporting, and delineate the radiology process for monitoring radiologist competency/performance.

#### S3B-QI-2 Pre-appointment Texting for Screening Breast Exams: Impact on Reducing Patient No Shows and Improving Exam Completion

Jay K. Pahade, MD (*Presenter*) Consultant, General Electric Company; Consultant, Clario Medical Imaging, Inc;

#### INTRODUCTION

Screening and diagnostic breast imaging (mammography and/or ultrasound) has been shown to improve early diagnosis and reduce mortality rates of breast cancer in women globally. However, adherence is variable with screening underutilization known to be associated with race, dialect and socioeconomic factors. We hypothesized that creation of a novel automated pre-appointment communication program in both English and Spanish could better engage our patients and improve our

rates of successfully completing a scheduled breast imaging exam. The method of delivery was primarily text messaging, but also including interactive voice response (IVR) for those that opted out of texts. Message content incorporated appointment reminders with the ability to confirm/cancel exam, exam preparation information, and way-finding (driving/parking instructions and directions from parking to reception desk).

## **METHODS**

A retrospective analysis was completed assessing same day cancellation / no show rate and number of screening or diagnostic breast imaging exams completed at our tertiary care center (5 independent locations) for 3 months prior (5/1 - 7/31/22) and 3 months after (9/1 - 11/30/22) the communication program was launched on 8/20/22. Chi square analysis was performed to assess change in rates. Breast biopsy procedures and breast MRI were excluded.

## **RESULTS**

After launching the pre-appointment communication program, the mean no show/same day cancel rate for breast exams significantly declined from 13% to 6% (54% relative reduction,  $p < 0.001$ ). Overall response rate from patients was 49% (19103 reminders sent, 9435 responses). Most reminders were sent via text (14386/19103, 75%) and response rate with texting (59%) was greater than IVR (21%). Most reminders were in English (94% English, 6% Spanish). Of those that responded, 3% (290/9435) canceled their appointment electronically through the program.

## **DISCUSSION**

Creation of a pre-appointment communication program for screening breast imaging exams which incorporates exam reminders, exam preparation information, and way finding can significantly decrease (54% relative reduction) no show / same day cancel rates thereby reducing missed care opportunities for a critical important cancer detection program spearheaded by Radiology. Patient engagement with the messaging was high (49% overall response rate) with texting eliciting more patient responses compared to IVR .

## **S3B-QI-3 5-year Quality Improvement in Radiology Specialty Training at a UK Tertiary Cardiothoracic Centre**

Monika Radike, MD, PhD (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

In 2017, a tertiary cardiothoracic centre had a low radiology training ranking (23/24) in the North West of England with 2-3 rotations every 2-3 months, in the context of national radiologist shortage. The aim of this project was to foster radiology training by improving quality.

## **METHODS**

To study the problem and intervene timely, simultaneous methods were applied: 1.A local post-placement feedback survey created; 2.Placement reorganisation: rotas revised based on training goals and Consultant-led clinical sessions with added hands-on cardiac imaging training; pre-placement info and reading emailed; Journal Club start; pre-scheduled Consultant-/Radiographer-led teaching sessions; formal trainee encouragement for audit and academic activities; trainee study room optimisation; Consultants encouraged to train in supervision with protected time; a departmental education portal created; public publication board with trainees' academic output. 3.Unpaid Visiting Fellowships from 2018; 4.Salaried Clinical Fellowships from 2019. Alongside the project, the following were addressed: a)radiologists and radiographers recruited, b)regular departmental audit days scheduled. Regional ranking was monitored (available 2017-2019). Local feedback survey was distributed (2017-2022) and analysed (descriptive statistics).

## **RESULTS**

The site regionally ranked 9/19 in 2 years. 55 obtained local survey responses showed continuous improvement; cardiothoracic subspecialty interest increased after (37%) and before (23%) the placement; audit/academic project involvement increased (+36%). 14 Visiting and 6.5 1-year Clinical Fellowships completed. Consultant number increased (5 to 11), 8/11 trained as supervisors. Unintended consequences: per increased demand, compulsory posts were changed to motivation-based (2020). An additional salaried training post was offered by the deanery (2021). International externally funded Visiting Fellowships were agreed (2021). 5 Fellows were retained in the region as subspecialist consultants.

## **DISCUSSION**

Unexpected challenges: space and workstations (incl. trainee room) were lost/under-sourced with service expansion; no regional surveys since 2019, global pandemic. Regardless, the results were overwhelmingly positive with increase in the subspecialty interest and projected reputational effect. Local long-term survey was a sustainable data source in detecting improvement areas. Local improvement, along with rising regional ranking and reputation, showed increased national and international interest. Given the national radiologist shortage, the results show a positive impact of similar interventions including workforce retention/recruitment and thus improving patient care. Continuous feedback and QI maintenance are valuable to enhance training quality locally and beyond.

## **S3B-QI-4 Improving First Case Start Times in the NORA IR Setting**

Benjamin Tran (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Operational inefficiencies result in significant health care waste and are linked with decreased capacity within the OR setting. On-time start percentage has been suggested to correlate with more efficient flow, and this correlation is established within the surgical space. Non OR Anesthesia (NORA) is rapidly becoming a staple in many high volume institutions, and efficiency in these spaces has yet to be optimized.

## **METHODS**

A detailed table of time metrics was introduced into the perioperative workflow in January of 2023. The new workflow included time targets for the following elements: Patient arrival in registration, to pre-op time, IV placement and lab draws, CRNA assessment and MDA sign-off, Wheels in time, and Procedure start time. On time start data was collected for the 3 months prior to and 3 months following implementation (Oct 2022-March 2023). Primary metric for on time start was defined as Procedure start time for the First case of the day in all procedural rooms. All reasons for delay were categorized into Patient, Provider, or Process origins.

## **RESULTS**

All anesthesia-supported first start cases in our interventional radiology suite were included, totaling 124 across the study period. On-time first start percentage improved from around 34% pre-implementation to 55% post implementation, resulting from an 11-minute improvement in average procedure start time. However, the greatest on-time start percentage (~60%) was seen in the first two months after implementation, with a subsequent decrease (47%) in March. Improved on-time first starts were also coupled with an increase in room utilization (57% pre-intervention; 59% post-intervention), an increase in average monthly case count (62 pre-intervention; 69 post-intervention), and a decrease in average monthly end-of-day block overrun minutes (170 pre-intervention; 134 post-intervention).

## **DISCUSSION**

Development of more detailed time metrics to modify daily workflow improved overall on-time first start rate, particularly on non-Tuesdays. This improvement in efficiency and throughput results in increased room utilization, improved case throughput, and decreased block overrun times, all of which contribute toward increased revenues, decreased costs, and thus improved return on investment. Despite our successes, additional opportunities for sustained improvement remain beyond simply staff education and goal identification. Next steps include identification of barriers to each step of the delineated time table as well as a critical path analysis.

## **S3B-QI-5 Design and Impact of an Imaging-Based Health Disparities Lecture in the Medical Student Radiology Curriculum**

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

There have been increased efforts within medicine to highlight and address health disparities, many of which are rooted in imaging access and utilization. Studies have found several examples of imaging-based health disparities, such as racial differences in utilization of lung and breast cancer screening. Trainee education is critical for improving healthy equity. Medical student radiology education revolves around anatomy and basic interpretive skills but is an appealing avenue for promoting early recognition of imaging-based health disparities, as many students will become referring physicians rather than radiologists. We aimed to develop a lecture on imaging-based health disparities, implement it in our introductory medical student radiology course, and measure its impact on student knowledge and awareness.

## **METHODS**

A 45-minute teaching session was developed utilizing PowerPoint. Learning objectives focus on highlighting sources of imaging-based inequities through open-ended audience questions, clinical case examples with real imaging exams, and review of pertinent literature. In order to evaluate educational impact, pre- and post-session surveys are administered using a combination of multiple-choice questions and 5-point Likert scale questions to measure knowledge gain and improved student confidence with discussion of imaging-based disparities. The session was initially presented in March 2023, embedded in a highly subscribed introductory diagnostic radiology course in our medical school curriculum. As this new session is only recently implemented, sample size is currently low and statistical analysis is therefore not yet performed.

## **RESULTS**

Our session focuses on four disparity categories: (1) race, (2) social, cultural, and economic factors, (3) sexual orientation and gender identity, and (4) physical and mental disability. 11 students attended the initial learning session and completed pre-and-post surveys. For each category, students reported improved confidence in discussing examples following the lecture (Figure 1). The percentage of students selecting the correct answer on multiple-choice questions also improved for each question after completion of the teaching session.

## DISCUSSION

We developed an interactive learning session for medical students to promote understanding of potential imaging-based health care disparities and strategies to counteract them. Following the session, students felt more comfortable discussing examples of imaging-based health disparities across all four of our selected categories. Our results are limited by a low sample size. However, the session is being presented on a monthly basis; we anticipate data from approximately 100 participants as we approach the end of the calendar year. Based on the success of this initial work, the session may be expanded to our radiology resident curriculum.

### **S3B-QI-6 Repurposing Radiological Data for Different Needs Using Interactive Multimedia Reporting**

David J. Vining, MD (*Presenter*) Royalties, Bracco Group;CEO, VisionSR, Inc;Stockholder, VisionSR, Inc

## INTRODUCTION

Conventional radiology reporting often consists of unstructured descriptions of image findings presented in static documents that have limited utility. Interactive multimedia reporting (IMR) represents an advance over the standard practice as it integrates images, video, graphs, and tables in an interactive environment to better communicate complex information. In this presentation, an additional benefit of IMR is demonstrated whereby structured radiological data can be displayed in different formats to meet the specific needs of clinicians and other end-users.

## METHODS

We developed an IMR system that works by recording key images and voice descriptions of radiological findings, tagging the information with metadata (i.e., anatomy, diagnosis, common data elements) from an ontology using natural language processing, and assembling a composite multimedia report with related items linked in timelines to represent findings. Each finding is tagged with additional elements including a number indicating when it first appeared in the report, disease metrics, target lesion assignment (i.e., for use in disease response assessment such as RECIST), and user-defined labels. The ontology used to label findings includes attributes indicating to which physiological category a particular anatomical location belongs and common data elements to provide details about each diagnosis. The combination of tags/labels assigned to each radiological finding enables them to be dynamically sorted and displayed to meet the needs of different users, including arranging findings by an anatomical hierarchy to mimic a conventional report, sorting findings by physiological categories for use by clinical specialists, grouping findings by TNM (tumor, nodes, metastasis) to facilitate disease staging, or sorting findings by disease metrics or sequence of appearance in the report.

## RESULTS

The IMR system is in use at our institution where it supports 40 clinical trials with the purpose of performing disease response assessments. To date the system has generated 2,956 reports on 639 patients with a total of 50,563 items of information linked in timelines representing 17,157 findings. Radiologists typically use the anatomical presentation of findings when interpreting exams and linking new findings to prior reports, whereas clinicians prefer the TNM display of findings for disease staging.

## DISCUSSION

IMR represents a significant advance over conventional radiology reporting, especially as it can repurpose radiological data to meet the needs of different stakeholders. By tagging radiological findings with an array of metadata, findings can be sorted and presented in several ways, including by anatomical hierarchies, physiological groups, or TNM staging categories. IMR transforms a radiology report from a static document to a dynamic set of elements with greater utility.

### **S3B-QI-7 Strategies to Get the Most Out of a Journal Club: Our Experience After Ten Years and More than Two Million Visits**

Dario Herran de la Gala, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Journal clubs provide a platform for members to critically evaluate and discuss research articles and publications, leading to a deeper understanding of the topic and improving scientific literacy. However, they must work in a structured way and with enough frequency to allow their long-term growth. With the increasing reliance on technology and social media in modern society, it has become imperative for journal clubs to keep up-to-date with these trends to improve their reach and appeal to medicine residents. By incorporating these tools into journal clubs, healthcare professionals can increase their visibility and attract a broader audience. The purpose of this study was to analyze the evolution and statistics of the Spanish Society of Medical Radiology's Journal Club (CB SERAM), a club created and managed entirely by residents, during its 10 years of existence and to analyze its internal organization and content diffusion strategies.

## METHODS

Define the workflow strategies within CB SERAM. Analyze the statistics of CB SERAM since its creation (march 2013). Analyze the number of visits and the number of entries on CB SERAM's website and possible strategies for future improvement.

## RESULTS

A Journal Club with a peer-review based review process favors scientific writing but also constructive criticism between members. Monthly frequency of content seems to be ideal. Webinars about critical article review help members to better read scientific literature. Since its creation in 2013, the CB SERAM has had 155 reviewers from 54 different hospitals from 2 different countries (Spain and Argentina). The annual number of reviewers has grown progressively, being most notable during the COVID-19 pandemic. Web entries and published content has also increased, as well as the number of visits to our website, which now averages 4000 visits per month, mostly from the Spanish-speaking community. - The use of social network managers favors the dissemination of content.

## DISCUSSION

By participating in a journal club, members can learn about the latest research methodologies, experimental techniques, and findings in their field, as well as engage in meaningful discussions with peers about the implications of the research. This not only creates a supportive and inclusive environment but also encourages members to stay motivated and engaged in their work. The use of technology can make the journal club experience more interactive and engaging. With the help of virtual meeting platforms, members can join meetings from anywhere and discussions can take place in real-time. Keeping up-to-date with technology and social media trends is essential for journal clubs to increase their reach and appeal to medicine residents. By utilizing these tools, journal club experience can be more engaging, interactive, and accessible, ultimately improving the quality of medical education.

## S3B-QI-8HC Leveraging Natural Language Processing Models for Improving Resident Education with Radiology Report Corrections

### Awards

#### Quality Improvement Reports Award

Kyle Tegtmeyer, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Imaging volumes are increasing in academic practices, leaving less time for one-on-one resident education. Trainees must often rely on reviewing their attendings' final review of their preliminary reports as a proxy for in-person teaching. However, long shifts and higher case volumes often leave little time to review attending edits to reports. Furthermore, there is no mechanism for residents to prioritize review of studies upon which substantive changes were made to the report content. Many reports are therefore never reviewed by residents, representing many possible missed learning opportunities. Prior studies have emphasized the importance of reviewing edits to reports as a method for resident learning, including the use of a "compare changes" feature in Powerscribe. To date, no studies have sought to highlight cases with substantive, and not simply stylistic, changes that offer the greatest learning opportunity for residents. The purpose of this project is to build a natural language processing (NLP) model to review attending changes to resident dictations and highlight report with meaningful changes to facilitate more focused review of high value learning opportunity cases.

## METHODS

Resident reports with attending corrections were downloaded from Powerscribe, and scores were assigned differentiating degree of stylistic and meaningful changes made by attendings with the following guidelines: 1 = no changes made; 2 = minor, stylistic change; 3 = major stylistic changes or additions, without impacting the overall report impression; 4 = major changes that impact the report impression. 1662 resident reports were manually scored by three authors (KT, JL, VT), and any disagreements were settled by a separate author (SC). Multiple NLP models were trained using random samples of prescored data with the goal of maximizing accuracy in matching human-assigned scores.

## RESULTS

An NLP model trained on the base BERT model achieved an accuracy of up to 76% in assigning scores to resident reports based on degree of stylistic and meaningful changes made to reports. Multiple regression-based models were trained on the same dataset using a BERT encoder and a linear classification head, and achieved the following accuracies in assigning scores to resident reports: simple linear regression (68.4 - 69.6%), K-Nearest Neighbors (68.1-72.3%), and XGBoost (78.0 - 84.6%).

## DISCUSSION

NLP models demonstrate a high degree of accuracy in differentiating stylistic from meaningful changes to resident reports, with accuracy of up to 84.6%. Implementing such a model may allow residents to focus greater attention on reviewing learning opportunity cases while allowing them to bypass cases without substantial changes. Further study is needed to assess perceived usefulness to residents and impact on overall resident education of implementing these models before more widespread implementation.

## Abstract Archives of the RSNA, 2023

S3B-QI-1

### A New Peer Learning Tool - Concepts, Iterative Improvement, and Scaling Up

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Nadja Kadom, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

**Problem Description:** Many radiology groups are abandoning random score-based peer review in lieu of Peer Learning (PL). **Available Knowledge:** There is currently no widely available tool to assist with the various functions of a PL program. **Purpose:** To make our PL process more efficient

#### METHODS

**Context and Intervention:** This tool was developed in free-standing pediatric hospital with academic affiliation. A peer learning program was established for the neuroradiology group in 2021 and was scaled up to include pediatric body imaging in January 2023. There was no budget for this intervention.

#### RESULTS

**The Intervention:** We developed a PL tool using an existing research database tool (REDCap®) and set-up a workflow between existing members of our team, such as a physician PL leader(s), radiologists, administrative assistants, and film library staff (Figure 1). A team approach was used to design and iteratively refine the PL tool. **Concepts:** Case submission: submit a wide variety of learning and improvement opportunities such as discrepancies, interesting cases, great catch, issues related to protocols, communication etc). **Clinical care:** accountability for providing appropriate clinical care lies with the radiologist submitting a case. **PL Conference preparation:** radiologists indicate whether the case is worth discussing in the PL conference. **PL Conference:** Each conference is recorded and can be viewed asynchronously. Anonymized case review in PACS. **Program targets:** case submissions per month per faculty and 50% attendance of PL sessions. **ACR Annual Reporting:** The database tool tracks case submissions per faculty per month. **PL Conference attendance** tracked by an administrative assistant. **Iterative Improvements:** most impactful was blinding who submitted a case in the feedback document that is sent to the original reviewer. **Scaling Up:** The tool was tested in the neuroradiology section for 1 year, then reviewed by the general pediatric imaging group, and adopted in January 2023. **Analysis:** For the neuroradiology faculty, there have been 147 case submissions in 2022, which represents a monthly submission average of 12 cases. After the final modification to the tool, blinding who submitted a case in the feedback document that is sent to the original reviewer, the monthly case submission average for this group in 2023 has increased to 29 cases. **Summary:** We used existing resources to build a PL tool as part of a PL process which facilitates clinical accountability, fosters individual and group learning through feedback and discussion, and meets the requirements for ACR accreditation under the PL pathway.

#### DISCUSSION

We are working with OPPE to define qualitative/quantitative data stewardship for The Joint Commission reporting, and delineate the radiology process for monitoring radiologist competency/performance.

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## Abstract Archives of the RSNA, 2023

S3B-QI-2

### Pre-appointment Texting for Screening Breast Exams: Impact on Reducing Patient No Shows and Improving Exam Completion

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Jay K. Pahade, MD (*Presenter*) Consultant, General Electric Company; Consultant, Clario Medical Imaging, Inc;

#### INTRODUCTION

Screening and diagnostic breast imaging (mammography and/or ultrasound) has been shown to improve early diagnosis and reduce mortality rates of breast cancer in women globally. However, adherence is variable with screening underutilization known to be associated with race, dialect and socioeconomic factors. We hypothesized that creation of a novel automated pre-appointment communication program in both English and Spanish could better engage our patients and improve our rates of successfully completing a scheduled breast imaging exam. The method of delivery was primarily text messaging, but also including interactive voice response (IVR) for those that opted out of texts. Message content incorporated appointment reminders with the ability to confirm/cancel exam, exam preparation information, and way-finding (driving/parking instructions and directions from parking to reception desk).

#### METHODS

A retrospective analysis was completed assessing same day cancelation / no show rate and number of screening or diagnostic breast imaging exams completed at our tertiary care center (5 independent locations) for 3 months prior (5/1 - 7/31/22) and 3 months after (9/1 - 11/30/22) the communication program was launched on 8/20/22. Chi square analysis was performed to assess change in rates. Breast biopsy procedures and breast MRI were excluded.

#### RESULTS

After launching the pre-appointment communication program, the mean no show/same day cancel rate for breast exams significantly declined from 13% to 6% (54% relative reduction,  $p < 0.001$ ). Overall response rate from patients was 49% (19103 reminders sent, 9435 responses). Most reminders were sent via text (14386/19103, 75%) and response rate with texting (59%) was greater than IVR (21%). Most reminders were in English (94% English, 6% Spanish). Of those that responded, 3% (290/9435) canceled their appointment electronically through the program.

#### DISCUSSION

Creation of a pre-appointment communication program for screening breast imaging exams which incorporates exam reminders, exam preparation information, and way finding can significantly decrease (54% relative reduction) no show / same day cancel rates thereby reducing missed care opportunities for a critical important cancer detection program spearheaded by Radiology. Patient engagement with the messaging was high (49% overall response rate) with texting eliciting more patient responses compared to IVR .

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

S3B-QI-3

### 5-year Quality Improvement in Radiology Specialty Training at a UK Tertiary Cardiothoracic Centre

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Monika Radike, MD, PhD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

In 2017, a tertiary cardiothoracic centre had a low radiology training ranking (23/24) in the North West of England with 2-3 rotations every 2-3 months, in the context of national radiologist shortage. The aim of this project was to foster radiology training by improving quality.

#### METHODS

To study the problem and intervene timely, simultaneous methods were applied: 1. A local post-placement feedback survey created; 2. Placement reorganisation: rotas revised based on training goals and Consultant-led clinical sessions with added hands-on cardiac imaging training; pre-placement info and reading emailed; Journal Club start; pre-scheduled Consultant-/Radiographer-led teaching sessions; formal trainee encouragement for audit and academic activities; trainee study room optimisation; Consultants encouraged to train in supervision with protected time; a departmental education portal created; public publication board with trainees' academic output. 3. Unpaid Visiting Fellowships from 2018; 4. Salaried Clinical Fellowships from 2019. Alongside the project, the following were addressed: a) radiologists and radiographers recruited, b) regular departmental audit days scheduled. Regional ranking was monitored (available 2017-2019). Local feedback survey was distributed (2017-2022) and analysed (descriptive statistics).

#### RESULTS

The site regionally ranked 9/19 in 2 years. 55 obtained local survey responses showed continuous improvement; cardiothoracic subspecialty interest increased after (37%) and before (23%) the placement; audit/academic project involvement increased (+36%). 14 Visiting and 6.5 1-year Clinical Fellowships completed. Consultant number increased (5 to 11), 8/11 trained as supervisors. Unintended consequences: per increased demand, compulsory posts were changed to motivation-based (2020). An additional salaried training post was offered by the deanery (2021). International externally funded Visiting Fellowships were agreed (2021). 5 Fellows were retained in the region as subspecialist consultants.

#### DISCUSSION

Unexpected challenges: space and workstations (incl. trainee room) were lost/under-sourced with service expansion; no regional surveys since 2019, global pandemic. Regardless, the results were overwhelmingly positive with increase in the subspecialty interest and projected reputational effect. Local long-term survey was a sustainable data source in detecting improvement areas. Local improvement, along with rising regional ranking and reputation, showed increased national and international interest. Given the national radiologist shortage, the results show a positive impact of similar interventions including workforce retention/recruitment and thus improving patient care. Continuous feedback and QI maintenance are valuable to enhance training quality locally and beyond.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

S3B-QI-4

### Improving First Case Start Times in the NORA IR Setting

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Benjamin Tran (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Operational inefficiencies result in significant health care waste and are linked with decreased capacity within the OR setting. On-time start percentage has been suggested to correlate with more efficient flow, and this correlation is established within the surgical space. Non OR Anesthesia (NORA) is rapidly becoming a staple in many high volume institutions, and efficiency in these spaces has yet to be optimized.

#### METHODS

A detailed table of time metrics was introduced into the perioperative workflow in January of 2023. The new workflow included time targets for the following elements: Patient arrival in registration, to pre-op time, IV placement and lab draws, CRNA assessment and MDA sign-off, Wheels in time, and Procedure start time. On time start data was collected for the 3 months prior to and 3 months following implementation (Oct 2022-March 2023). Primary metric for on time start was defined as Procedure start time for the First case of the day in all procedural rooms. All reasons for delay were categorized into Patient, Provider, or Process origins.

#### RESULTS

All anesthesia-supported first start cases in our interventional radiology suite were included, totaling 124 across the study period. On-time first start percentage improved from around 34% pre-implementation to 55% post implementation, resulting from an 11-minute improvement in average procedure start time. However, the greatest on-time start percentage (~60%) was seen in the first two months after implementation, with a subsequent decrease (47%) in March. Improved on-time first starts were also coupled with an increase in room utilization (57% pre-intervention; 59% post-intervention), an increase in average monthly case count (62 pre-intervention; 69 post-intervention), and a decrease in average monthly end-of-day block overrun minutes (170 pre-intervention; 134 post-intervention).

#### DISCUSSION

Development of more detailed time metrics to modify daily workflow improved overall on-time first start rate, particularly on non-Tuesdays. This improvement in efficiency and throughput results in increased room utilization, improved case throughput, and decreased block overrun times, all of which contribute toward increased revenues, decreased costs, and thus improved return on investment. Despite our successes, additional opportunities for sustained improvement remain beyond simply staff education and goal identification. Next steps include identification of barriers to each step of the delineated time table as well as a critical path analysis.

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## Abstract Archives of the RSNA, 2023

S3B-QI-5

### Design and Impact of an Imaging-Based Health Disparities Lecture in the Medical Student Radiology Curriculum

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Siddhant Dogra, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

There have been increased efforts within medicine to highlight and address health disparities, many of which are rooted in imaging access and utilization. Studies have found several examples of imaging-based health disparities, such as racial differences in utilization of lung and breast cancer screening. Trainee education is critical for improving healthy equity. Medical student radiology education revolves around anatomy and basic interpretive skills but is an appealing avenue for promoting early recognition of imaging-based health disparities, as many students will become referring physicians rather than radiologists. We aimed to develop a lecture on imaging-based health disparities, implement it in our introductory medical student radiology course, and measure its impact on student knowledge and awareness.

#### METHODS

A 45-minute teaching session was developed utilizing PowerPoint. Learning objectives focus on highlighting sources of imaging-based inequities through open-ended audience questions, clinical case examples with real imaging exams, and review of pertinent literature. In order to evaluate educational impact, pre- and post-session surveys are administered using a combination of multiple-choice questions and 5-point Likert scale questions to measure knowledge gain and improved student confidence with discussion of imaging-based disparities. The session was initially presented in March 2023, embedded in a highly subscribed introductory diagnostic radiology course in our medical school curriculum. As this new session is only recently implemented, sample size is currently low and statistical analysis is therefore not yet performed.

#### RESULTS

Our session focuses on four disparity categories: (1) race, (2) social, cultural, and economic factors, (3) sexual orientation and gender identity, and (4) physical and mental disability. 11 students attended the initial learning session and completed pre-and-post surveys. For each category, students reported improved confidence in discussing examples following the lecture (Figure 1). The percentage of students selecting the correct answer on multiple-choice questions also improved for each question after completion of the teaching session.

#### DISCUSSION

We developed an interactive learning session for medical students to promote understanding of potential imaging-based health care disparities and strategies to counteract them. Following the session, students felt more comfortable discussing examples of imaging-based health disparities across all four of our selected categories. Our results are limited by a low sample size. However, the session is being presented on a monthly basis; we anticipate data from approximately 100 participants as we approach the end of the calendar year. Based on the success of this initial work, the session may be expanded to our radiology resident curriculum.

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## Abstract Archives of the RSNA, 2023

S3B-QI-6

### Repurposing Radiological Data for Different Needs Using Interactive Multimedia Reporting

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

David J. Vining, MD (*Presenter*) Royalties, Bracco Group;CEO, VisionSR, Inc;Stockholder, VisionSR, Inc

#### INTRODUCTION

Conventional radiology reporting often consists of unstructured descriptions of image findings presented in static documents that have limited utility. Interactive multimedia reporting (IMR) represents an advance over the standard practice as it integrates images, video, graphs, and tables in an interactive environment to better communicate complex information. In this presentation, an additional benefit of IMR is demonstrated whereby structured radiological data can be displayed in different formats to meet the specific needs of clinicians and other end-users.

#### METHODS

We developed an IMR system that works by recording key images and voice descriptions of radiological findings, tagging the information with metadata (i.e., anatomy, diagnosis, common data elements) from an ontology using natural language processing, and assembling a composite multimedia report with related items linked in timelines to represent findings. Each finding is tagged with additional elements including a number indicating when it first appeared in the report, disease metrics, target lesion assignment (i.e., for use in disease response assessment such as RECIST), and user-defined labels. The ontology used to label findings includes attributes indicating to which physiological category a particular anatomical location belongs and common data elements to provide details about each diagnosis. The combination of tags/labels assigned to each radiological finding enables them to be dynamically sorted and displayed to meet the needs of different users, including arranging findings by an anatomical hierarchy to mimic a conventional report, sorting findings by physiological categories for use by clinical specialists, grouping findings by TNM (tumor, nodes, metastasis) to facilitate disease staging, or sorting findings by disease metrics or sequence of appearance in the report.

#### RESULTS

The IMR system is in use at our institution where it supports 40 clinical trials with the purpose of performing disease response assessments. To date the system has generated 2,956 reports on 639 patients with a total of 50,563 items of information linked in timelines representing 17,157 findings. Radiologists typically use the anatomical presentation of findings when interpreting exams and linking new findings to prior reports, whereas clinicians prefer the TNM display of findings for disease staging.

#### DISCUSSION

IMR represents a significant advance over conventional radiology reporting, especially as it can repurpose radiological data to meet the needs of different stakeholders. By tagging radiological findings with an array of metadata, findings can be sorted and presented in several ways, including by anatomical hierarchies, physiological groups, or TNM staging categories. IMR transforms a radiology report from a static document to a dynamic set of elements with greater utility.

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## Abstract Archives of the RSNA, 2023

S3B-QI-7

### Strategies to Get the Most Out of a Journal Club: Our Experience After Ten Years and More than Two Million Visits

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

Dario Herran de la Gala, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Journal clubs provide a platform for members to critically evaluate and discuss research articles and publications, leading to a deeper understanding of the topic and improving scientific literacy. However, they must work in a structured way and with enough frequency to allow their long-term growth. With the increasing reliance on technology and social media in modern society, it has become imperative for journal clubs to keep up-to-date with these trends to improve their reach and appeal to medicine residents. By incorporating these tools into journal clubs, healthcare professionals can increase their visibility and attract a broader audience. The purpose of this study was to analyze the evolution and statistics of the Spanish Society of Medical Radiology's Journal Club (CB SERAM), a club created and managed entirely by residents, during its 10 years of existence and to analyze its internal organization and content diffusion strategies.

#### METHODS

Define the workflow strategies within CB SERAM. Analyze the statistics of CB SERAM since its creation (march 2013). Analyze the number of visits and the number of entries on CB SERAM's website and possible strategies for future improvement.

#### RESULTS

A Journal Club with a peer-review based review process favors scientific writing but also constructive criticism between members. Monthly frequency of content seems to be ideal. Webinars about critical article review help members to better read scientific literature. Since its creation in 2013, the CB SERAM has had 155 reviewers from 54 different hospitals from 2 different countries (Spain and Argentina). The annual number of reviewers has grown progressively, being most notable during the COVID-19 pandemic. Web entries and published content has also increased, as well as the number of visits to our website, which now averages 4000 visits per month, mostly from the Spanish-speaking community. - The use of social network managers favors the dissemination of content.

#### DISCUSSION

By participating in a journal club, members can learn about the latest research methodologies, experimental techniques, and findings in their field, as well as engage in meaningful discussions with peers about the implications of the research. This not only creates a supportive and inclusive environment but also encourages members to stay motivated and engaged in their work. The use of technology can make the journal club experience more interactive and engaging. With the help of virtual meeting platforms, members can join meetings from anywhere and discussions can take place in real-time. Keeping up-to-date with technology and social media trends is essential for journal clubs to increase their reach and appeal to medicine residents. By utilizing these tools, journal club experience can be more engaging, interactive, and accessible, ultimately improving the quality of medical education.

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## Abstract Archives of the RSNA, 2023

S3B-QI-8HC

### Leveraging Natural Language Processing Models for Improving Resident Education with Radiology Report Corrections

Sunday, Nov. 26 12:15PM - 12:45PM Room: Learning Center

#### Awards

##### Quality Improvement Reports Award

Kyle Tegtmeyer, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Imaging volumes are increasing in academic practices, leaving less time for one-on-one resident education. Trainees must often rely on reviewing their attendings' final review of their preliminary reports as a proxy for in-person teaching. However, long shifts and higher case volumes often leave little time to review attending edits to reports. Furthermore, there is no mechanism for residents to prioritize review of studies upon which substantive changes were made to the report content. Many reports are therefore never reviewed by residents, representing many possible missed learning opportunities. Prior studies have emphasized the importance of reviewing edits to reports as a method for resident learning, including the use of a "compare changes" feature in Powerscribe. To date, no studies have sought to highlight cases with substantive, and not simply stylistic, changes that offer the greatest learning opportunity for residents. The purpose of this project is to build a natural language processing (NLP) model to review attending changes to resident dictations and highlight report with meaningful changes to facilitate more focused review of high value learning opportunity cases.

#### METHODS

Resident reports with attending corrections were downloaded from Powerscribe, and scores were assigned differentiating degree of stylistic and meaningful changes made by attendings with the following guidelines: 1 = no changes made; 2 = minor, stylistic change; 3 = major stylistic changes or additions, without impacting the overall report impression; 4 = major changes that impact the report impression. 1662 resident reports were manually scored by three authors (KT, JL, VT), and any disagreements were settled by a separate author (SC). Multiple NLP models were trained using random samples of prescored data with the goal of maximizing accuracy in matching human-assigned scores.

#### RESULTS

An NLP model trained on the base BERT model achieved an accuracy of up to 76% in assigning scores to resident reports based on degree of stylistic and meaningful changes made to reports. Multiple regression-based models were trained on the same dataset using a BERT encoder and a linear classification head, and achieved the following accuracies in assigning scores to resident reports: simple linear regression (68.4 - 69.6%), K-Nearest Neighbors (68.1-72.3%), and XGBoost (78.0 - 84.6%).

#### DISCUSSION

NLP models demonstrate a high degree of accuracy in differentiating stylistic from meaningful changes to resident reports, with accuracy of up to 84.6%. Implementing such a model may allow residents to focus greater attention on reviewing learning opportunity cases while allowing them to bypass cases without substantial changes. Further study is needed to assess perceived usefulness to residents and impact on overall resident education of implementing these models before more widespread implementation.

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## Abstract Archives of the RSNA, 2023

T2-QI

### Quality Improvement Reports Tuesday Poster Discussions

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### **T2-QI-1 Development Of Structured Percutaneous Transhepatic Cholangial Drainage Tube Home Care Educational Curriculum for Malignant Obstructive Jaundice Patients**

Suiling Liu (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

The home care of the percutaneous transhepatic cholangial drainage(PTCD) tube after discharge is particularly important, or it may lead to biliary tract infection, blockage of the drainage tube, or even disconnection of the tube and other complications, which seriously affect the quality of life of patients. In China, the home care of the tube is usually guided verbally by nurses upon discharge, but this method is ineffective and difficult for patients and their families to master, resulting in poor home self-care level of the tube. This study aims to develop a structured education curriculum of home care for Chinese adults after PTCD for malignant obstructive jaundice.

#### **METHODS**

The initial framework of structured education for malignant obstructive jaundice after PTCD was revised by expert consultation. Based on the revised results, the curriculum was developed and modified to form a preliminary curriculum. The research team verified the clinical effect of the revised curriculum and completed the curriculum optimization. Then we recruited 20 patients with their main caregivers to participate in this curriculum, and have an examination (theoretical and operational) to test the understanding of this curriculum as well as its satisfaction and practicability.

#### **RESULTS**

The initial framework of structured education course for tube home care included 4 topics from 4 curriculum dimensions. Experts reached consensus on all 4 topics after consultation, and split "tube management" into 2 topics and put forward suggestions for modification, thus the optimized final version of the course identified 4 dimensions and a total of 5 topics. The scores of the theoretical test were 80-100 ( $93.90 \pm 4.07$ ), the scores of the operational test were 94-100 ( $97.40 \pm 1.53$ ). The degree of satisfaction and practicability of the course were evaluated by patients and their family members at 95% or above.

#### **DISCUSSION**

This study successfully set up a structured education curriculum for the home care of patients after PTCD for malignant obstructive jaundice, which combined the Chinese cultural background and the characteristics of Chinese patients, and shown to be applicable under local medical, social, and cultural environment. The limitations of this study are as follows: First, the sample size is small; second, we haven't do the follow up study.

#### **T2-QI-2 Establishing Access to Obstetric Ultrasound Services in Remote Areas through a Teleradiology Platform for Reporting**

Uzma Qureishi (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Access to obstetric ultrasound is challenging in remote areas due to shortage of trained personnel, leading to delays in diagnosis and increased maternal-fetal morbidity and mortality. WHO and FIGO recommend at least 1 or 2 obstetric ultrasounds before 24 weeks. Our primary study objective was to evaluate the performance of the VISIQ ultrasound scanner and a teleradiology platform for transmitting ultrasound images from remote clinics to radiologists. The secondary objective included assessing implementation of quality control protocol and enhancing education and teleradiology for more effective examinations by inexperienced users.

## RESULTS

282 ultrasound exams were performed and evaluated. Reporting accuracy was 99.63% for scans performed by midwives, confirming that the training was adequate. Data analysis also showed that no further imaging was necessary after radiologist review. Report validation took 15 minutes after scan completion. Study success was achieved with a 10-minute scan time and 35-minute maximum turnaround. No problem arose with the equipment and no difference in transmission time, or image quality deterioration occurred.

## METHODS

A 4-week curriculum was developed to train 3 midwives with no ultrasound experience. Midwives were selected from clinics at varying distances from the study centre to assess image transfer times and teleradiology system efficacy. After scanning patients, writing provisional reports and uploading these to the Philips website, radiologists were informed who then reviewed and validated the studies. Feedback was given to the midwives. Validated reports were released to the patient if no further imaging was needed. The study utilized Philips tablets, modems, computers, and a 3G network to connect the equipment. Initially, the images and reports that were uploaded to the website were not of diagnostic quality. Our challenge was to transfer lossless images which was achieved by modifying the teleradiology algorithm using a second network configured to connect the tablets to a PACS server. This allowed improved image quality for diagnosis.

## DISCUSSION

This study was limited by small catchment area and suboptimal image quality on the website. Despite this, the sample size sufficiently powered the study. Cell phone communication between the radiologist and midwife was successful and connectivity was constant. Distance from the primary centre did not affect transmission time or image quality. Post-delivery tracing determined the final outcome for 220 patients, while 51 could not be contacted. Training midwives to perform obstetric ultrasound can help practically address the shortage of trained personnel in resource-limited countries. Collaborating with radiologists and using modern technology can be cost-effective and efficient. Future research should focus on scalability, sustainability, and long-term impact.

## T2-QI-3 Evaluation of Diagnostic Reference Levels and Achievable Doses for Digital Radiographic Images

Alex Khammang, PhD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Diagnostic Reference Levels (DRL) are used to benchmark patient exposures like entrance air kerma (EAK) and to identify high exposures. The goal is to optimize patient exposures and image quality, while using recommended Achievable Doses (AD) or lower. Digital radiography carries the potential risk of dose creep over time without impacting image quality. The purpose of this study aimed to quantify the patient EAK on one radiographic unit, for an adult PA chest (with grid), AP abdomen, digital radiographic protocols and compare them to the NCRP Report No 172 recommended DRLs and AD to determine the opportunity for dose and image quality optimization. Expansion of this process would then occur based on these initial findings.

## RESULTS

The initial EAK results, representing the techniques in clinical use were 0.132 mGy and 3.41 mGy for the chest and abdomen protocols respectively. The NCRP Report 172 PA Chest DRL is 0.15 mGy and AD is 0.11 mGy. The AP abdomen DRL is 3.4 mGy and AD is 2.4 mGy. These results reveal current EAK values slightly lower than (chest) or the same (abdomen) as the referenced DRL but above the AD. The spatial resolution for the initial chest protocol technique was consistently 2.34-line pairs/mm. After reducing the mAs by 25% and 50%, the spatial resolution for the abdomen protocol reduced from 2.24 lp/mm to 2 lp/mm. Both protocols showed a reduction of low contrast detection from 1.7% to 2.2% as the EAK dropped.

## METHODS

The study utilized a Siemens DR Multix Fusion Max using the Siemens recommended PA chest protocol at 125 kVp, automatic exposure control (AEC), and 72" source to image distance (SID). The AP abdomen protocol was 81 kVp, AEC, and 40" SID. The digital detectors utilized were a PIXIUUM 4343 RCE for chest protocols and a PIXIUUM 3543 EZH for abdomen protocols. An aluminum blocks, 19 mm thick, and copper sheet, 1 mm thick, were used to simulate a 20 cm thick patient. Evaluation of high and low contrast resolution was performed with a Leeds Torr 18FG phantom. EAK measurements were taken with a RaySafe X2 RAD probe. Three mAs settings were used for EAK and image quality determinations, starting with the current protocol in use.

## DISCUSSION



Following NCRP 172, the measured EAK values for the current clinical PA chest and AP abdomen protocols were slightly below or at the DRL, but above the AD, thus allowing further dose reduction with minimal impact on image quality. Based on the phantom image quality testing, the EAK can potentially be reduced by 25% or even 50% to be below the AD while maintaining essentially equivalent image quality. The limitations of these physics tests are that they aren't necessarily representative of real patients. The clinical image testing is ongoing with radiologist image quality evaluation. This quality improvement program is expected to also encompass lumbosacral spine EAK, DRL and AD.

## **T2-QI-4 "How was My Experience? Well, Thanks for Asking!"**

Latasha Paige, MEng, RN (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Purpose: To better understand the "Voice Of Customer" and the state of mind behavior of our patients going through the MRI process, we employed the Kano Empathy Mapping techniques. The resulting patient feedback provided an invaluable foundation upon which we built our Ideal State Future State. Problem Description: MRI services are not keeping up with demand, resulting in long wait times for our patients. A Value Stream Analysis was conducted, resulting in a plan of rapid improvement events, projects, just-do-its and just-stop-its. Foundational to this analysis, was gaining a deep understanding of our patients needs and experiences. In addition to improving timely access to MRI services, the improvement plan also aims to reduce defects and cost and prepare the organization for future growth. Critical to the success of this work will be a lasting Lean management system culture grounded in respect for people and continuous improvement.

### **METHODS**

The Kano Diagram technique explores 3 dimensions of customer needs along the axes of provided services and impact on customer satisfaction: 1. Unspoken Basics - assumed basic services. 2. Spoken Performers - articulated services seen as competitive advantages. 3. Unspoken Delighters - unexpected services that delight the customer. The Empathy Map technique gauges four dimensions of the Patient's persona: 1. The observable: what the Patient: a. Does b. Says 2. The non-observable: what the Patient: a. Thinks b. Feels We conducted 3 web-based interviews with patients who regularly experience the MRI process. We used the collaborative software LucidChart.

### **RESULTS**

1. Empathy map revealed that we are not: a. Informing patients of delays. b. Valuing Patient's time. c. Customer service oriented. d. Fixing wasteful processes. e. Addressing patients' frustrated-, annoyed-, anxious-, and overwhelmed feelings. 2. Kano diagram revealed: a. Basics - wayfinding, customer service, efficient processes, and clean/organized environment. b. Performers - minimal waiting, excellent doctors, good overall experience. c. Delighters - timely results, rapport with physicians, and improving their experience. 3. Technique Feedback: a. Found digital post its distracting. Asked to have conversation instead. b. Appreciative of us asking questions. c. Interested in improvements that would come from interviews.

### **DISCUSSION**

- Learn when and how to use the Empathy map and Kano diagram for patients as well as team members to create an improvement plan where all key stakeholders' perspectives are considered.
- Learn how to respond to criticism from patients and team members. This is a skill set that for many is not developed because: oHCAHPS Press Ganey surveys do not provide the same level of personal and emotional feedback that the Kano and Empathy maps do. oHCAHPS Press Ganey also do not require direct conversations with patients and team members.

## **T2-QI-5 Patient Navigation Improves Diagnostic Imaging Timeliness Among Mammography Van Patients with BIRADS-0**

Nita Amornsiripanitch, MD (*Presenter*) Nothing to Disclose

### **INTRODUCTION**

Mobile mammography vans have improved access to cancer screening among minorities and the uninsured. However, increasing access to screening alone is insufficient as mobile screening patients with abnormal results (BIRADS-0) are more likely to experience delay in follow-up imaging (defined as >30 days after screening), which is specifically linked to overall delay in cancer diagnosis. The purpose of this QI initiative is to reduce breast imaging follow-up time for women screened by our institutional van.

### **METHODS**

This IRB exempted study began with creating a Process Map and Driver Diagram, which identified possible barriers to timely BIRADS-0 follow-up, namely delay in patient communication, lack of patient education, and complexity of scheduling workflow. Baseline follow-up time (7/1/2021-6/30/2022) and variables including location of screening van were collected from Epic Hyperspace (Verona, WI) and internal database to validate hypotheses. Intervention on 8/16/2022 aimed to improve patient communication of abnormal results and increase scheduling ease. Patient at four pilot sites, who previously relied on local community health centers for follow-up arrangements, were instead outreach by institutional patient navigators to schedule follow-up. Outcome data (follow-up time in days) was collected for 6 months before and after the intervention and analyzed by Statistical Process Controlled (SPC) X Chart by Rule for Special Cause (QI Macro, Denver, CO).



Percent of patients reached by institutional staff pre vs post intervention were collected as process data to ensure intervention's functionality.

## RESULTS

Baseline callback rate was 12.9% (239/1848). Mean follow-up time was 49.7 days (range = 6-345) with 62% of patients (148/239) with follow-up delay. Mean follow-up time at different van sites ranged 7-96 days. Four sites with mean follow-up time >49.7 days agreed to participate in the pilot. Six patients (3/period) were lost to follow-up and excluded. Pre intervention (2/1/2022-8/15/2022), 17% (6/35) of patients at piloted sites were contacted by patient navigators to schedule follow-up compared to 74% (23/31) post intervention (collected during 8/17/2022-2/28/2023; however, van did not service pilot sites during 2/1/2023-2/28/2023). SPC-X chart demonstrated significant (3s) downward trend in follow-up time after intervention (fig. 1), with decrease in mean follow-up time by 12.9 days (from 50.1 to 37.2) and decreased in patients with follow-up delays by 11% (from 66% to 55%).

## DISCUSSION

Patient outreach by language concordant, culturally competent, and knowledgeable navigators has potential to improve timely follow-up, a vital step in achieving equitable early cancer diagnosis. Planned future PDSA cycles include standardizing follow-up scheduling, synergizing with community health sites to streamline communication and patient education.

## T2-QI-7 Evaluating the Resident Call Structure in Canadian Diagnostic Radiology Postgraduate Medical Education Programs

Hang Yu, MD (*Presenter*) Nothing to Disclose

### INTRODUCTION

Canadian Diagnostic Radiology (DR) postgraduate medical training (i.e., residency) requires residents to independently cover after-hours imaging interpretation ("call") as part of the formal curriculum. Increasing expectations for on-call duties have contributed to rising resident burnout. There is paucity of publicly available information on the call structure at each Canadian institution. This lack of transparency hinders the ability of a program to learn from another's experience. Access to such resources may facilitate advocacy effort and can contribute to streamlining call expectations across Canadian institutions. We hope to delineate the call structure at each institution and create an up-to-date database where this information is readily available.

### METHODS

A questionnaire was distributed to the senior/chief/lead residents at each of the 16 Canadian DR residency programs. The questions pertained to: 1) Institutional information such as affiliated university and hospitals, city and catchment size, and resident body demographics; 2) Call structure including shift type, the start and end of independent call, and ability for home call/remote PACS access; 3) Call responsibilities such as modality and procedural responsibilities, preliminary report requirements, and protocoling responsibilities; 4) Call support by attendings, fellows, and technologists; 5) Preparation for call including dedicated resources and a summary of the "buddy call" system; and 5) Pre- and post-call including pre-call time off, and requirements for post-call review or performance evaluation.

### RESULTS

All 16 Canadian DR residency programs completed our questionnaire. The data collected reflects call structures in these programs as of December 2022. There is considerable heterogeneity across the 16 Canadian DR residency programs regarding call structure. Notably, 12 (75%) programs have call shifts that necessitate residents to work continuously for =24 hours. All programs cover CT and 15 (94%) cover ultrasound—out of the 15, eight (53%) have scanning responsibilities for residents. Nine (56%) institutions require residents dictate full reports. Although 7 (44%) programs allow remote PACS access, none allow residents to be on-call remotely. Seven (44%) programs require residents to stay post-call to review their cases with attendings in the morning.

### DISCUSSION

Independent call is a major stressor for DR residents. We hope this data can serve as a transparent and informative resource for Canadian DR residency programs to understand successful call structure strategies being implemented across the country and target areas for improvement at their home institution in the face of growing diagnostic imaging volumes and call burden nationwide. Future research directions include studying resident satisfaction after implementation of new call structure strategies.

## T2-QI-8HC Reducing Length of Stay for Inpatients Awaiting MRI Exams

Erin Panter (*Presenter*) Nothing to Disclose

### INTRODUCTION

Patients who are medically ready for discharge pending only an MRI evaluation wait on average 2-3 additional days in our hospital due to higher MRI demand than capacity. Length of stay (LOS) is an important indicator of the efficient use of

hospital resources. The purpose of this project was to develop sustainable workflows conducive for inpatient providers to identify select inpatient MRI exams that can safely be performed as an outpatient within two weeks of discharge.

## **METHODS**

This project was performed in the diagnostic radiology division of a large urban academic center. In February 2021, Imaging leadership engaged Neurology to identify inpatient populations and select MRI studies that could safely transition to an outpatient MRI appointment within two weeks of discharge. The goal of our project was to improve inpatient flow by reducing the length of hospitalization for 10 patients each month totaling 25 bed days saved. Using performance improvement methodologies including process maps and control charts our project team developed a workflow conducive for both departments. The number of patients discharged and performed as outpatient MRI studies was measured monthly

## **RESULTS**

From February 2021 to February 2022, 340 hospital bed days were saved by improving communication and streamlining workflows to safely discharge select inpatients requiring MRI exams. The initial goal of 25 bed days per month was met, averaging 26 bed days/month during this time frame. Imaging continued to engage inpatient teams by sharing data and established workflows. From March 2022-February 2023, the number of bed days saved increased from 340 bed days to 430 bed days (26%). For continuous performance improvement, June 2022, the monthly goal was increased from 25 to 35 bed days saved (40%).

## **DISCUSSION**

Imaging fostered a culture of trust by streamlining a workflow that was conducive for inpatient providers to efficiently communicate with the MRI department and outpatient scheduling. The hospital was able to incrementally care for more patients who required admission while improving patient satisfaction by facilitating earlier discharge. Additionally, inpatient MRI could their focus their resources and scanning efforts for inpatients who required MRI exams during their admission. Collaboration with multidisciplinary teams from Neurology, Radiologists, MRI staff and scheduling support was essential for the new workflow to be successful. The financial impact from this project measured in hospital costs avoided and incremental revenue generated of approximately \$1.5 million. Imaging leadership intends to implement additional efforts to reduce length of stay for patients awaiting other types of imaging studies that can be performed as outpatient exams by partnering with additional service lines.

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## Abstract Archives of the RSNA, 2023

T2-QI-1

### Development Of Structured Percutaneous Transhepatic Cholangial Drainage Tube Home Care Educational Curriculum for Malignant Obstructive Jaundice Patients

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Suiling Liu (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The home care of the percutaneous transhepatic cholangial drainage(PTCD) tube after discharge is particularly important, or it may lead to biliary tract infection, blockage of the drainage tube, or even disconnection of the tube and other complications, which seriously affect the quality of life of patients. In China, the home care of the tube is usually guided verbally by nurses upon discharge, but this method is ineffective and difficult for patients and their families to master, resulting in poor home self-care level of the tube. This study aims to develop a structured education curriculum of home care for Chinese adults after PTCD for malignant obstructive jaundice.

#### METHODS

The initial framework of structured education for malignant obstructive jaundice after PTCD was revised by expert consultation. Based on the revised results, the curriculum was developed and modified to form a preliminary curriculum. The research team verified the clinical effect of the revised curriculum and completed the curriculum optimization. Then we recruited 20 patients with their main caregivers to participate in this curriculum, and have an examination(theoretical and operational) to test the understanding of this curriculum as well as its satisfaction and practicability.

#### RESULTS

The initial framework of structured education course for tube home care included 4 topics from 4 curriculum dimensions. Experts reached consensus on all 4 topics after consultation, and split "tube management" into 2 topics and put forward suggestions for modification, thus the optimized final version of the course identified 4 dimensions and a total of 5 topics. The scores of the theoretical test were 80-100 ( $93.90 \pm 4.07$ ), the scores of the operational test were 94-100 ( $97.40 \pm 1.53$ ). The degree of satisfaction and practicability of the course were evaluated by patients and their family members at 95% or above.

#### DISCUSSION

This study successfully set up a structured education curriculum for the home care of patients after PTCD for malignant obstructive jaundice, which combined the Chinese cultural background and the characteristics of Chinese patients, and shown to be applicable under local medical, social, and cultural environment. The limitations of this study are as follows: First, the sample size is small; second, we haven't do the follow up study.

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## Abstract Archives of the RSNA, 2023

T2-QI-2

### Establishing Access to Obstetric Ultrasound Services in Remote Areas through a Teleradiology Platform for Reporting

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Uzma Qureishi (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Access to obstetric ultrasound is challenging in remote areas due to shortage of trained personnel, leading to delays in diagnosis and increased maternal-fetal morbidity and mortality. WHO and FIGO recommend at least 1 or 2 obstetric ultrasounds before 24 weeks. Our primary study objective was to evaluate the performance of the VISIQ ultrasound scanner and a teleradiology platform for transmitting ultrasound images from remote clinics to radiologists. The secondary objective included assessing implementation of quality control protocol and enhancing education and teleradiology for more effective examinations by inexperienced users.

#### RESULTS

282 ultrasound exams were performed and evaluated. Reporting accuracy was 99.63% for scans performed by midwives, confirming that the training was adequate. Data analysis also showed that no further imaging was necessary after radiologist review. Report validation took 15 minutes after scan completion. Study success was achieved with a 10-minute scan time and 35-minute maximum turnaround. No problem arose with the equipment and no difference in transmission time, or image quality deterioration occurred.

#### METHODS

A 4-week curriculum was developed to train 3 midwives with no ultrasound experience. Midwives were selected from clinics at varying distances from the study centre to assess image transfer times and teleradiology system efficacy. After scanning patients, writing provisional reports and uploading these to the Philips website, radiologists were informed who then reviewed and validated the studies. Feedback was given to the midwives. Validated reports were released to the patient if no further imaging was needed. The study utilized Philips tablets, modems, computers, and a 3G network to connect the equipment. Initially, the images and reports that were uploaded to the website were not of diagnostic quality. Our challenge was to transfer lossless images which was achieved by modifying the teleradiology algorithm using a second network configured to connect the tablets to a PACS server. This allowed improved image quality for diagnosis.

#### DISCUSSION

This study was limited by small catchment area and suboptimal image quality on the website. Despite this, the sample size sufficiently powered the study. Cell phone communication between the radiologist and midwife was successful and connectivity was constant. Distance from the primary centre did not affect transmission time or image quality. Post-delivery tracing determined the final outcome for 220 patients, while 51 could not be contacted. Training midwives to perform obstetric ultrasound can help practically address the shortage of trained personnel in resource-limited countries. Collaborating with radiologists and using modern technology can be cost-effective and efficient. Future research should focus on scalability, sustainability, and long-term impact.

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## Abstract Archives of the RSNA, 2023

T2-QI-3

### Evaluation of Diagnostic Reference Levels and Achievable Doses for Digital Radiographic Images

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Alex Khammang, PhD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Diagnostic Reference Levels (DRL) are used to benchmark patient exposures like entrance air kerma (EAK) and to identify high exposures. The goal is to optimize patient exposures and image quality, while using recommended Achievable Doses (AD) or lower. Digital radiography carries the potential risk of dose creep over time without impacting image quality. The purpose of this study aimed to quantify the patient EAK on one radiographic unit, for an adult PA chest (with grid), AP abdomen, digital radiographic protocols and compare them to the NCRP Report No 172 recommended DRLs and AD to determine the opportunity for dose and image quality optimization. Expansion of this process would then occur based on these initial findings.

#### RESULTS

The initial EAK results, representing the techniques in clinical use were 0.132 mGy and 3.41 mGy for the chest and abdomen protocols respectively. The NCRP Report 172 PA Chest DRL is 0.15 mGy and AD is 0.11 mGy. The AP abdomen DRL is 3.4 mGy and AD is 2.4 mGy. These results reveal current EAK values slightly lower than (chest) or the same (abdomen) as the referenced DRL but above the AD. The spatial resolution for the initial chest protocol technique was consistently 2.34-line pairs/mm. After reducing the mAs by 25% and 50%, the spatial resolution for the abdomen protocol reduced from 2.24 lp/mm to 2 lp/mm. Both protocols showed a reduction of low contrast detection from 1.7% to 2.2% as the EAK dropped.

#### METHODS

The study utilized a Siemens DR Multix Fusion Max using the Siemens recommended PA chest protocol at 125 kVp, automatic exposure control (AEC), and 72" source to image distance (SID). The AP abdomen protocol was 81 kVp, AEC, and 40" SID. The digital detectors utilized were a PIXIUM 4343 RCE for chest protocols and a PIXIUM 3543 EZH for abdomen protocols. An aluminum blocks, 19 mm thick, and copper sheet, 1 mm thick, were used to simulate a 20 cm thick patient. Evaluation of high and low contrast resolution was performed with a Leeds Torr 18FG phantom. EAK measurements were taken with a RaySafe X2 RAD probe. Three mAs settings were used for EAK and image quality determinations, starting with the current protocol in use.

#### DISCUSSION

Following NCRP 172, the measured EAK values for the current clinical PA chest and AP abdomen protocols were slightly below or at the DRL, but above the AD, thus allowing further dose reduction with minimal impact on image quality. Based on the phantom image quality testing, the EAK can potentially be reduced by 25% or even 50% to be below the AD while maintaining essentially equivalent image quality. The limitations of these physics tests are that they aren't necessarily representative of real patients. The clinical image testing is ongoing with radiologist image quality evaluation. This quality improvement program is expected to also encompass lumbosacral spine EAK, DRL and AD.

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## Abstract Archives of the RSNA, 2023

T2-QI-4

### “How was My Experience? Well, Thanks for Asking!”

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Latasha Paige, MEng, RN (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Purpose: To better understand the "Voice Of Customer" and the state of mind behavior of our patients going through the MRI process, we employed the Kano Empathy Mapping techniques. The resulting patient feedback provided an invaluable foundation upon which we built our Ideal State Future State. Problem Description: MRI services are not keeping up with demand, resulting in long wait times for our patients. A Value Stream Analysis was conducted, resulting in a plan of rapid improvement events, projects, just-do-its and just-stop-its. Foundational to this analysis, was gaining a deep understanding of our patients needs and experiences. In addition to improving timely access to MRI services, the improvement plan also aims to reduce defects and cost and prepare the organization for future growth. Critical to the success of this work will be a lasting Lean management system culture grounded in respect for people and continuous improvement.

#### METHODS

The Kano Diagram technique explores 3 dimensions of customer needs along the axes of provided services and impact on customer satisfaction: 1. Unspoken Basics - assumed basic services. 2. Spoken Performers - articulated services seen as competitive advantages. 3. Unspoken Delighters - unexpected services that delight the customer. The Empathy Map technique gauges four dimensions of the Patient's persona: 1. The observable: what the Patient: a. Does b. Says 2. The non-observable: what the Patient: a. Thinks b. Feels We conducted 3 web-based interviews with patients who regularly experience the MRI process. We used the collaborative software LucidChart.

#### RESULTS

1. Empathy map revealed that we are not: a. Informing patients of delays. b. Valuing Patient's time. c. Customer service oriented. d. Fixing wasteful processes. e. Addressing patients' frustrated-, annoyed-, anxious-, and overwhelmed feelings. 2. Kano diagram revealed: a. Basics - wayfinding, customer service, efficient processes, and clean/organized environment. b. Performers - minimal waiting, excellent doctors, good overall experience. c. Delighters - timely results, rapport with physicians, and improving their experience. 3. Technique Feedback: a. Found digital post its distracting. Asked to have conversation instead. b. Appreciative of us asking questions. c. Interested in improvements that would come from interviews.

#### DISCUSSION

- Learn when and how to use the Empathy map and Kano diagram for patients as well as team members to create an improvement plan where all key stakeholders' perspectives are considered.
- Learn how to respond to criticism from patients and team members. This is a skill set that for many is not developed because: oHCAHPS Press Ganey surveys do not provide the same level of personal and emotional feedback that the Kano and Empathy maps do. oHCAHPS Press Ganey also do not require direct conversations with patients and team members.

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## Abstract Archives of the RSNA, 2023

T2-QI-5

### Patient Navigation Improves Diagnostic Imaging Timeliness Among Mammography Van Patients with BIRADS-0

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Nita Amornsiripanitch, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Mobile mammography vans have improved access to cancer screening among minorities and the uninsured. However, increasing access to screening alone is insufficient as mobile screening patients with abnormal results (BIRADS-0) are more likely to experience delay in follow-up imaging (defined as >30 days after screening), which is specifically linked to overall delay in cancer diagnosis. The purpose of this QI initiative is to reduce breast imaging follow-up time for women screened by our institutional van.

#### METHODS

This IRB exempted study began with creating a Process Map and Driver Diagram, which identified possible barriers to timely BIRADS-0 follow-up, namely delay in patient communication, lack of patient education, and complexity of scheduling workflow. Baseline follow-up time (7/1/2021-6/30/2022) and variables including location of screening van were collected from Epic Hyperspace (Verona, WI) and internal database to validate hypotheses. Intervention on 8/16/2022 aimed to improve patient communication of abnormal results and increase scheduling ease. Patient at four pilot sites, who previously relied on local community health centers for follow-up arrangements, were instead outreach by institutional patient navigators to schedule follow-up. Outcome data (follow-up time in days) was collected for 6 months before and after the intervention and analyzed by Statistical Process Controlled (SPC) X Chart by Rule for Special Cause (QI Macro, Denver, CO). Percent of patients reached by institutional staff pre vs post intervention were collected as process data to ensure intervention's functionality.

#### RESULTS

Baseline callback rate was 12.9% (239/1848). Mean follow-up time was 49.7 days (range = 6-345) with 62% of patients (148/239) with follow-up delay. Mean follow-up time at different van sites ranged 7-96 days. Four sites with mean follow-up time >49.7 days agreed to participate in the pilot. Six patients (3/period) were lost to follow-up and excluded. Pre intervention (2/1/2022-8/15/2022), 17% (6/35) of patients at piloted sites were contacted by patient navigators to schedule follow-up compared to 74% (23/31) post intervention (collected during 8/17/2022-2/28/2023; however, van did not service pilot sites during 2/1/2023-2/28/2023). SPC-X chart demonstrated significant (3s) downward trend in follow-up time after intervention (fig. 1), with decrease in mean follow-up time by 12.9 days (from 50.1 to 37.2) and decreased in patients with follow-up delays by 11% (from 66% to 55%).

#### DISCUSSION

Patient outreach by language concordant, culturally competent, and knowledgeable navigators has potential to improve timely follow-up, a vital step in achieving equitable early cancer diagnosis. Planned future PDSA cycles include standardizing follow-up scheduling, synergizing with community health sites to streamline communication and patient education.

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## Abstract Archives of the RSNA, 2023

T2-QI-7

### Evaluating the Resident Call Structure in Canadian Diagnostic Radiology Postgraduate Medical Education Programs

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Hang Yu, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Canadian Diagnostic Radiology (DR) postgraduate medical training (i.e., residency) requires residents to independently cover after-hours imaging interpretation ("call") as part of the formal curriculum. Increasing expectations for on-call duties have contributed to rising resident burnout. There is paucity of publicly available information on the call structure at each Canadian institution. This lack of transparency hinders the ability of a program to learn from another's experience. Access to such resources may facilitate advocacy effort and can contribute to streamlining call expectations across Canadian intuitions. We hope to delineate the call structure at each institution and create an up-to-date database where this information is readily available.

#### METHODS

A questionnaire was distributed to the senior/chief/lead residents at each of the 16 Canadian DR residency programs. The questions pertained to: 1) Institutional information such as affiliated university and hospitals, city and catchment size, and resident body demographics; 2) Call structure including shift type, the start and end of independent call, and ability for home call/remote PACS access; 3) Call responsibilities such as modality and procedural responsibilities, preliminary report requirements, and protocoling responsibilities; 4) Call support by attendings, fellows, and technologists; 5) Preparation for call including dedicated resources and a summary of the "buddy call" system; and 5) Pre- and post-call including pre-call time off, and requirements for post-call review or performance evaluation.

#### RESULTS

All 16 Canadian DR residency programs completed our questionnaire. The data collected reflects call structures in these programs as of December 2022. There is considerable heterogeneity across the 16 Canadian DR residency programs regarding call structure. Notably, 12 (75%) programs have call shifts that necessitate residents to work continuously for =24 hours. All programs cover CT and 15 (94%) cover ultrasound—out of the 15, eight (53%) have scanning responsibilities for residents. Nine (56%) institutions require residents dictate full reports. Although 7 (44%) programs allow remote PACS access, none allow residents to be on-call remotely. Seven (44%) programs require residents to stay post-call to review their cases with attendings in the morning.

#### DISCUSSION

Independent call is a major stressor for DR residents. We hope this data can serve as a transparent and informative resource for Canadian DR residency programs to understand successful call structure strategies being implemented across the country and target areas for improvement at their home institution in the face of growing diagnostic imaging volumes and call burden nationwide. Future research directions include studying resident satisfaction after implementation of new call structure strategies.

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## Abstract Archives of the RSNA, 2023

T2-QI-8HC

### Reducing Length of Stay for Inpatients Awaiting MRI Exams

Tuesday, Nov. 28 9:00AM - 9:30AM Room: Learning Center

Erin Panter (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Patients who are medically ready for discharge pending only an MRI evaluation wait on average 2-3 additional days in our hospital due to higher MRI demand than capacity. Length of stay (LOS) is an important indicator of the efficient use of hospital resources. The purpose of this project was to develop sustainable workflows conducive for inpatient providers to identify select inpatient MRI exams that can safely be performed as an outpatient within two weeks of discharge.

#### METHODS

This project was performed in the diagnostic radiology division of a large urban academic center. In February 2021, Imaging leadership engaged Neurology to identify inpatient populations and select MRI studies that could safely transition to an outpatient MRI appointment within two weeks of discharge. The goal of our project was to improve inpatient flow by reducing the length of hospitalization for 10 patients each month totaling 25 bed days saved. Using performance improvement methodologies including process maps and control charts our project team developed a workflow conducive for both departments. The number of patients discharged and performed as outpatient MRI studies was measured monthly

#### RESULTS

From February 2021 to February 2022, 340 hospital bed days were saved by improving communication and streamlining workflows to safely discharge select inpatients requiring MRI exams. The initial goal of 25 bed days per month was met, averaging 26 bed days/month during this time frame. Imaging continued to engage inpatient teams by sharing data and established workflows. From March 2022-February 2023, the number of bed days saved increased from 340 bed days to 430 bed days (26%). For continuous performance improvement, June 2022, the monthly goal was increased from 25 to 35 bed days saved (40%).

#### DISCUSSION

Imaging fostered a culture of trust by streamlining a workflow that was conducive for inpatient providers to efficiently communicate with the MRI department and outpatient scheduling. The hospital was able to incrementally care for more patients who required admission while improving patient satisfaction by facilitating earlier discharge. Additionally, inpatient MRI could their focus their resources and scanning efforts for inpatients who required MRI exams during their admission. Collaboration with multidisciplinary teams from Neurology, Radiologists, MRI staff and scheduling support was essential for the new workflow to be successful. The financial impact from this project measured in hospital costs avoided and incremental revenue generated of approximately \$1.5 million. Imaging leadership intends to implement additional efforts to reduce length of stay for patients awaiting other types of imaging studies that can be performed as outpatient exams by partnering with additional service lines.

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## Abstract Archives of the RSNA, 2023

T5A-QI

### Quality Improvement Reports Tuesday Poster Discussions I

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **T5A-QI-1 Too Much Information? A Clinical Audit on Patient Access to a Digital Record System and Discrepancies Between Clinical Notes and Radiology Reports Causing Potential Emotional Harm to Pediatric Scoliosis Patients**

Sana Rashid (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

The Cobb method is the gold standard for measuring scoliosis curves, but it remains subject to measurement error. It is acceptable to have a discrepancy of up to 5 degrees with minimal impact on clinical outcomes. While this is known to clinicians, patients may not be aware. Patients now have online access to their medical records with a new digital system at our institution. Pediatric scoliosis patients have 2 sources of information: the measurement done by the orthopedic surgeon in clinic and the measurement on the radiology report, which are not always the same. Differences in reports can pose emotional harm to patients, as evidenced by previous studies showing increased levels of anxiety after patients were given access to reports particularly for patients with the expectation of treatment changes when curves meet specific threshold measurements. The purpose was to perform an audit to assess differences between scoliosis measurements done by radiologists versus those reported by orthopedic surgeons in clinic notes to understand the potential impact on patients.

#### **METHODS**

This study was done in the radiology department of an academic children's hospital. At our institution, pediatric scoliosis patients are followed by orthopedic surgeons where they receive a baseline radiograph, followed by serial radiographs to measure progression/ stability. A search was conducted on our local PACS system for all scoliosis radiographs from July to September 2022. The search was limited to patients < 18 years old. Post-surgical patients, curves described as "kyphosis", and studies that did not report measurements in the radiology report and/or orthopedic note were excluded. A total of 159 radiographs were reviewed. The corresponding radiology report and orthopedic clinic notes were reviewed. Patient identification numbers, ages and scoliosis measurements were recorded.

#### **RESULTS**

Out of 159 radiographs, 121 met inclusion criteria. In 53.7% of studies, the radiologist report and orthopedic clinic note differed by > 5 degrees. Of these 65 studies, 34 had additional differences in the vertebral levels of curves or the number of curves reported. The largest discrepancy found was 20 degrees with mean differences of 9.85, 6.79, and 13.25 for the upper, lower, and middle curves respectively.

#### **DISCUSSION**

A large proportion of reported scoliosis radiographs differ from the corresponding orthopedic clinic note beyond the accepted standard. Even small differences in reports can induce patient anxiety and confusion particularly when measurements meet thresholds for changes in treatment. To improve patient experiences, recommendations include liaising with orthopedic surgeons to gauge patient feedback and review standard measurement protocols to improve consistency between orthopedics and radiology. Limitations of the study include its retrospective nature.

#### **T5A-QI-2 The Measure of Truth: Determining Whether Absolute Values of Leg Lengths are Incorrectly being Measured and Reported on Pediatric Teleoroentgenogram Leg Length Studies: A Clinical Audit**

Sana Rashid (*Presenter*) Nothing to Disclose

## INTRODUCTION

Leg length discrepancies (LLDs) are relatively common. Only 25-50% of the general population have legs of equal length. A LLD > 2 cm is clinically significant. LLDs should be diagnosed in childhood to allow for the best prognosis and avoid future issues with gait, osteoarthritis, or scoliosis. While it seems beneficial to include these measurements, a teleoroentgenogram is not the best study for measuring leg lengths. While useful for assessing lower limb alignment, teleoroentgenograms use a single AP radiograph, which is subject to magnification error. The ideal method for measurement of leg lengths is an orthoroentgenogram where measurements are calibrated with a ruler. The goal of this audit was to assess whether absolute leg length values are being included in teleoroentgenogram reports to provide feedback to radiologists to improve accuracy of their reports.

## RESULTS

Leg length measurements were included in 31/100 of teleoroentgenograms reports. Right leg lengths were reported in all 31 studies, whereas left leg lengths were only reported in 30 studies. There was only one case where the discrepancy was > 2 cm and therefore clinically significant. The PACS system measurement tool overestimated leg lengths by an average of 1.6 cm. The older the patient, the greater the overestimation with the highest difference being 2.2 cm.

## METHODS

This study was conducted at an academic children's hospital. A search was conducted on our local PACS system for all teleoroentgenogram radiographs from April to May 2022. One hundred pediatric (age <18) lower limb teleoroentgenogram reports were reviewed. Patient identification numbers and ages were recorded. "Yes" or "No" was assigned and recorded based on whether there was inclusion of leg lengths on the report. For the studies in the "Yes" category, leg length measurements were recorded. On 4 of these teleoroentgenograms, a technologist added a ruler to confirm magnification error between the ruler measurement and the PACS system measurement tool. Results were analyzed using frequency counts.

## DISCUSSION

Absolute leg length values were included in 30% of leg length teleoroentgenogram reports. The literature has shown that teleoroentgenograms can have magnification errors up to 5% when measuring leg lengths. While this seems insignificant, it can have implications for orthopedic management. Instead of providing absolute leg length measurements, we suggest reporting relative leg lengths; that is, the percentage difference between both legs. The goal of this would be to minimize inaccuracy in radiology reports while also including clinically relevant information. Study limitations include the small sample size. Although we preliminarily showed leg length measurement differed between teleoroentgenograms and orthoroentgenograms, further studies using a larger sample size can be performed to confirm this generally accepted notion.

## T5A-QI-3 Patient Perspectives on AI Implementation in Radiology, From Generation to Generation

Nabid Ahmed, MD, MS (*Presenter*) Nothing to Disclose

## INTRODUCTION

Artificial Intelligence (AI) solutions are increasingly being adopted by medical specialties, especially radiology. Learning how patients perceive these changes is an important aspect of upholding patient-centered care. The aim of our survey study is to improve understanding of patient perspectives on AI usage in interpreting radiologic images and generating reports, with regards to specific aspects such as comfort level, costs, favorability, and legal liability. Moreover, the study seeks to probe for similarities and differences of these perspectives between and within generational cohorts.

## RESULTS

Our ongoing survey has collected over 100 survey results to date, with 3% of responses from the Post-war generation, 50% from the Baby Boomer generation, 27% from Gen X, 18% from Millennial, and 2% from Gen Z. Initial results show that only 7% of all participants were not in favor of AI algorithms assisting the radiologist in daily practice (48% were in favor, 47% were neutral). Moreover, 20% of those in favor were willing to pay extra for reports interpreted by both a radiologist and an AI algorithm, which increased to 52% if it was proven that less findings were missed with AI assistance. Only 14% are in favor of reports completely generated by AI. If there were diagnostic errors with AI implementation, 70% of participants would find the AI developer, the hospital, and the radiologist all at fault and legally liable, while only 5% would find just the radiologist at fault.

## METHODS

Surveys on AI usage in radiology were distributed to patients at an outpatient imaging center associated with an academic hospital. Survey questions provided scenarios and statements regarding AI in radiology in which the participant could pick 'Yes', 'No' or 'Neutral'. Descriptive statistics of the survey answers were calculated from total number of participants and with respect to cohorts. A Chi-square test of independence was done with each survey question to determine if a survey response had a significant association with a cohort.

## DISCUSSION

Millennials were most aware that AI was already being used in radiology at our institution, having 55% of 'Yes' responses to the respective question. Currently, this is the only statistically significant association in our study. 60% of participants said 'Yes' to being asked if they wanted to learn more about how AI algorithms work in radiology, which did not have a significant association with a cohort. In fact, many written comments stated that the participant did not know enough about the subject to formulate a stance. These insights will aid discussions between the radiologist and patient regarding AI-incorporated imaging reports (and possibly AI generated follow-up recommendations), in outlining legal responsibilities of all parties involved, and in the design of educational material that will keep patients informed of the changing healthcare landscape.

### **T5A-QI-4 Case-Based Intro to Radiology: Enhancing Radiology Education through an e-Learning Platform**

Kevin Pierre (*Presenter*) Nothing to Disclose

## INTRODUCTION

Over-utilization of imaging in healthcare can harm patients and burden the radiology workforce. Health profession students often receive insufficient radiology education. Scottish Medical Schools (Chew 2021) report radiology accounting for only 0.3% of total teaching time. In a US study (Rohren 2022), 72% of students felt they received too little radiology education. Among the top skills teachers believed students need for graduation are the type of imaging to request and appropriate imaging use (Chew 2021). However, 65% of students were unaware of American College of Radiology appropriateness criteria, and 33% had heard but never used it (Rohren 2022). This study aimed to develop and assess a case-based e-learning platform section to teach imaging utilization, basic interpretation skills, and integration into medical decision-making workflows for medical students, physician assistant students, first-year radiology residents, and non-radiologist clinicians.

## METHODS

A "Case-Based Intro to Radiology" section with 80+ modules was developed on our departmental e-learning platform. Modules include patient history, physical findings, lab results, and guided learners through diagnosis, imaging selection, interpretation, and developing a working diagnosis, assessment, and disposition. Interactive features comprise immediate feedback, short videos, full Digital Imaging and Communications in Medicine (DICOM) image sets, learning points, and socioeconomic factors. A focus group of 20 MD, PA, PhD, and undergraduate students assessed module quality, educational content, and instructional methods through a survey. Descriptive statistics analyzed survey responses.

## RESULTS

Most students agreed that the modules enhanced imaging interpretation, complemented curricula, encouraged critical thinking, and covered appropriate clinical and imaging details. They rated module quality, educational content, and videos as very good. Students preferred flipped classroom or proctored didactic approaches over traditional methods.

## DISCUSSION

The study relied on a small sample size and self-reported outcomes. More research is needed to determine the long-term impact on performance and clinical practice. The case-based e-learning platform section showed potential in improving radiology education for medical and PA students. Next steps involve integrating the platform into the PA school curriculum, completing 140 proposed cases, developing an educator and user guide, conducting external peer reviews, and performing outcome studies.

### **T5A-QI-5 Developing an AI Model to Identify Malignancy Results on Imaging Reports to Delay Release to the Electronic Patient Portal**

Lucy Chow, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Federal CURES Act requires all results to be immediately released to the patient portal unless it qualifies for an exception, such as state law. New California law stipulates imaging scans that reveal a new or recurrent malignancy shall not be electronically disclosed to the patient until a healthcare professional has discussed the results. While radiologists can flag reports to prevent immediate release to the patient portal, relying on this manual method presents a challenge in consistency, especially in a high-volume academic medical center. This study aimed to improve the accuracy and efficiency of this workflow by creating an AI model that combines a rule-based natural language processing (NLP) approach with deep learning techniques to automate the process.

## METHODS

The dataset is comprised of approximately 61,000 multi-modality diagnostic imaging reports from 12/01/2022-12/31/2022, while procedure reports were excluded. Subsets from this dataset were extracted using two rule-based approaches to preprocess the training data. The first rule identified any report containing -RADS classification categories (i.e., BI-RADS), which yielded 8,345 reports. Of this set, 341 reports were identified to be withheld from immediate release based on predetermined criteria (i.e., BI-RADS=4). A second rule was applied to the remaining 53,000 reports, which identified

approximately 4,500 reports that contained one of 12 malignancy-related keywords (i.e., cancer). This formed the training set for the NLP deep neural network (DNN) model, which was independently labeled by a group of 22 physician informaticists (PIs) as either 'withhold' or 'release.' Any indeterminate reports were discussed to reach consensus and develop labeling guidelines. Upon review, withholding scans demonstrating progressive malignancy became clinically necessary and rational. About 40% of the training set was reviewed, and 2,677 labeled reports were used for initial DNN model development. Subsequently, 49,318 reports generated between 01/19/2023- 02/12/2023 were analyzed for model validation.

## RESULTS

In the model validation dataset, 293 reports (0.6%) contained the -RADS classification and 996 reports (2.0%) were identified from DNN, resulting in 1,289 reports (2.6%) withheld from immediate release. Preliminary results of the model performance yielded a 99.4% accuracy based on the final test set, consisting of 14,759 cases.

## DISCUSSION

The model has demonstrated promising results, and the existing IT infrastructure was leveraged to incorporate the functionality into the electronic health record. Both manual flagging by the radiologist and automated flagging by the AI algorithm will be implemented. Manually flagged reports will further train and refine the AI model's accuracy. The two methods will be compared to determine if manual flagging remains necessary for the workflow.

### T5A-QI-6 An Artificial Intelligence (AI) Boost to MRI Lumbar Spine Reporting

Sze Ying Yee, MBChB, FRCR (*Presenter*) Nothing to Disclose

## INTRODUCTION

Lumbar spine magnetic resonance imaging (MRI) is commonly performed for back pain assessment. The interpretation involves grading spinal stenosis at multiple levels, which is repetitive and time-consuming. Machine learning algorithms are postulated to improve reporting productivity while maintaining consistency. This study aims to assess the reporting speed and diagnostic accuracy with and without assistance from an artificial intelligence (AI) reading assistive tool.

## METHODS

MRI lumbar spine studies of patients aged 18 and older performed for back pain from 1 to 10 December 2022 were randomly selected. These studies were initially read by four board-certified musculoskeletal and neuroradiologists with at least 8 years of consultant experience. Studies with instrumentation and scoliosis were excluded. The time taken to verify the radiology reports for each study was extracted from the RIS logs - this was deemed time taken without AI assistance. The DICOM data for these studies were processed by a commercial deep learning-based solution - CoLumbo (Smart Soft Healthcare, Bulgaria) on an AI orchestration platform (CARPL.AI, US). The AI solution segments, measures, and classifies MR images to provide suspected pathology descriptions, findings, and measurements. It then outputs annotated post-processed MRI images and an auto-generated report which is editable. These studies were randomly assigned to three final-year radiology residents who were blinded to the original finalized reports. The reporting time and corrections to the pre-populated report were logged. The time taken with and without AI assistance was documented and compared. A paired t-test was performed for the calculation of statistical significance.

## RESULTS

A total of 31 MRI studies were processed. The mean interpretation time with AI assistance was significantly lower than without ( $8.47 \pm 3.77$  minutes versus  $22.44 \pm 10.90$  minutes,  $p < 0.001$ ). The interquartile range (IQR) for interpretation time with AI assistance was 4.78 minutes, while the IQR for interpretation time without AI assistance was 14.15 minutes. The smaller IQR indicates that the interpretation times were more consistent and less variable when radiologists used the AI-powered assistive tool. A paired t-test showed that the mean difference in interpretation times between the two groups was -13.97 minutes (95% CI: -16.66 to -11.28), which was statistically significant ( $p < 0.001$ ). Diagnostic accuracy (stenosis grading and incidental findings) was not significantly different between the two groups.

## DISCUSSION

AI assistance for MRI lumbar spine reporting resulted in a significant reduction in reporting time with equivalent diagnostic accuracy compared to experienced radiologists without AI assistance. The more objective and consistent AI evaluation also provides a more standardized report and reduces interobserver variation.

### T5A-QI-7 Learning Styles and Preferences of Current Generation of Training Radiologists: A Survey Analysis

Alok Kale, MBBS, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

The current generation (GEN) of radiology trainees (RT) have grown up in the digitalised world are conversant with digital tools social media utilisation. It has become imperative to study the their learning styles, preferences to identify gaps in teaching methodology.

## METHODS

Qualitative study was undertaken in 2022 targeting RT recent Board-certified radiologists(0-5 years experience). A questionnaire(Qn) of 10 questions consisted of understanding preferences for learning tools(LT) styles, problem solving(PS) skills, type of individual learner, preferences for teaching modules, awareness of their role in the department, preferences for exit-exam pattern was issued on social media. Each question had several choices (eg."which is most preferred mode of learning?" had responses such as textbook, teaching website(TW) etc). Each choice had a response option from least-likely to most-likely on a scale of 1to5(5 pointer Likert's scale). Of 119participants, 68were males, 50females 1 other category. Analysis of the responses was done by calculating percentage and weighted average. The association for age, gender, years of experience(YoE) practicing institute(PI) with every aspect of study Qn was assessed using Chi Square test. SPSS version 20 was used P-value  $\leq 0.05$  was considered significant.

## RESULTS

TW were most preferred mode of LT followed by textbooks among journals, conferences, lectures video media channels, latter being the least preferred. For PS, responders tend to prefer consulting teachers peers(60%) followed by utilising help of TW journals. In our survey, only 36% 1st RT preferred TW as compared to 81% of 4thyr RT, indicating increasing trend with increase YoE. However,63% of 4thyr. RT tend to prefer textbook among others. Majority(74%) of them consider to be visual-learners followed by logical kinaesthetic. Linguistic were only45%. However, no significant statistical difference was found for gender, YoE or PI. For preference in teaching modules, majority preferred interactive case-based discussions(CBD)(70%) followed by simulations. With increase in YoE, CBD flipped classroom(FC) were preferred. Preference for FC was significantly differed among type of PI.( $p < 0.05$ ) Statistically significant increasing trend was seen for awareness of curricular goals with gender age. In a preference for mode of exam, institutional exam(64%) was most favoured. Online exam was least preferred had no statistical difference among PI.

## DISCUSSION

Current GEN's learning styles are different from preceding GEN which relied on didactic lectures textbooks. However, they do require precise instructions, simulations mentoring. This requires consideration when framing radiology training curriculum. The limitation of study is the subjective nature of the assessment by the participants which needs to be validated by objective methods.

### **T5A-QI-8HC Maximizing the Usefulness of limited aspirated synovial fluid samples in musculoskeletal fluoroscopy procedures: A Quality Improvement Approach for Optimal Lab Order Decision Making**

Aiah Alatoum, MBBS (*Presenter*) Nothing to Disclose

## INTRODUCTION

In many instances in musculoskeletal fluoroscopy-guided aspirations, only a limited amount of synovial fluid can be aspirated, which poses a challenge in deciding to send the fluid to the most clinically appropriate lab orders. At our institution, we did a retrospective review of all fluoroscopic guided joint aspirations performed between January 2022 and August 2022 on different body joints for various indications. 97 aspirations were reviewed, and we found that in 32% of these cases, the yield of aspirated fluid was 1 ml or less. This study aims to generate and implement an algorithm to guide the clinician to send the limited amount of aspirated fluid to the most clinically appropriate test based on the patient's condition and history.

## METHODS

Our musculoskeletal team collaborated with the orthopedic department to create a decision tree that outlines the preferred tests for patients with limited synovial fluid. This tree was made by order of importance of the tests based on the patient's clinical scenario. All synovial fluid aspirations were made by the musculoskeletal fellows supervised by well-experienced musculoskeletal radiologists.

## RESULTS

After creating the decision tree, a retrospective audit was made on the previous 25 patients with limited amount of aspirated synovial fluid to check if it was sent to the preferred lab test. The retrospective audit showed that only 20% of the patients received the preferred test. The next step was educating the team via a lecture about the order of importance of the tests, distributing the decision tree to the residents and fellows, and conducting another audit after six months. In February 2023, a second audit was conducted after implanting the decision tree on 30 patients with limited amount of aspirated synovial fluid. The results showed that in 100% of the cases, the fluid was sent to the preferred test order.

## DISCUSSION

There were several limitations to this study. The study was retrospective in nature, with few subjects. However, implementing the decision tree led to significant improvement in deciding the preferred lab test for patients with limited aspirated fluid and provided the best quality of care. The decision tree is now part of the fluoroscopy procedures routine.

### **T5A-QI-9HC Standardization of incidental thyroid nodule characterization, follow-up recommendations, and patient education resources: A quality improvement project at an academic medical**



(Presenter) Nothing to Disclose

## **INTRODUCTION**

**Problem Description:** Incidental thyroid nodules (ITNs) are frequently encountered on cross-sectional studies that include the neck, yet ITN descriptions and management recommendations are variable. Further, as patient access to electronic medical records becomes standard of care, knowledge of an ITN can be distressing. **Available Knowledge:** The American College of Radiology (ACR) published guidelines in 2015 to standardize ITN characterization and management, yet ITN reporting remains heterogenous and potentially discordant. Radiology reports rarely supply patient-friendly educational material when ITNs are discovered. **Purpose:** The purpose of this study was to use a dictation template-based approach to 1) simplify and standardize ITN descriptions and recommendations, and 2) provide a patient-friendly educational resource for patients reading their reports.

## **METHODS**

**Context and Intervention:** Beginning August 2022, a dedicated thyroid field was added to our hospital's dictation templates for MR and CT neck studies. Using a picklist, the field generates text with ACR-compliant recommendations and a link to our department-sponsored patient education webpage. **Study of the Intervention:** Neck CT and MR reports were reviewed to determine compliance. Patient education webpage traffic was monitored using a web-analytics platform. **Measures/Metrics:** Compliance with ACR-based ITN guidelines was defined as a correct ITN description and recommendation. Monthly ITN detection rate was monitored as an in-process metric. Webpage traffic and search engine results were monitored periodically. **Analysis:** The above metrics were tracked and analyzed to study the intervention's impact during the study period.

## **RESULTS**

Between 8/22-4/23 and across 7,830 studies, compliance with ACR guidelines was 98% (Figure). Over time, monthly thyroid nodule detection rate increased from 3.5% to 4.5% (Figure). Webpage traffic increased rapidly after implementation with a total of 4,910 organic accesses between August 2022 and March 2023. 50 of 130 patients with a nodule requiring follow up completed laboratory testing, 28 received a dedicated thyroid ultrasound, and 6 underwent thyroid biopsy.

## **DISCUSSION**

Simple radiology dictation template modifications can drastically improve proper ITN reporting and documentation using evidence-based guidelines and recommendations. This, in turn, can enhance patient care and standardize practice patterns with minimal additional time and cost. Further, providing links to patient-centered educational material is a straightforward way for radiology practices to engage patients and mitigate distress about incidental findings. While this data is limited to a single academic institution, this approach could be scaled and applied to other practices and types of incidental findings such as pancreatic cysts or liver lesions.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5A-QI-1

### **Too Much Information? A Clinical Audit on Patient Access to a Digital Record System and Discrepancies Between Clinical Notes and Radiology Reports Causing Potential Emotional Harm to Pediatric Scoliosis Patients**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Sana Rashid (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

The Cobb method is the gold standard for measuring scoliosis curves, but it remains subject to measurement error. It is acceptable to have a discrepancy of up to 5 degrees with minimal impact on clinical outcomes. While this is known to clinicians, patients may not be aware. Patients now have online access to their medical records with a new digital system at our institution. Pediatric scoliosis patients have 2 sources of information: the measurement done by the orthopedic surgeon in clinic and the measurement on the radiology report, which are not always the same. Differences in reports can pose emotional harm to patients, as evidenced by previous studies showing increased levels of anxiety after patients were given access to reports particularly for patients with the expectation of treatment changes when curves meet specific threshold measurements. The purpose was to perform an audit to assess differences between scoliosis measurements done by radiologists versus those reported by orthopedic surgeons in clinic notes to understand the potential impact on patients.

#### **METHODS**

This study was done in the radiology department of an academic children's hospital. At our institution, pediatric scoliosis patients are followed by orthopedic surgeons where they receive a baseline radiograph, followed by serial radiographs to measure progression/ stability. A search was conducted on our local PACS system for all scoliosis radiographs from July to September 2022. The search was limited to patients < 18 years old. Post-surgical patients, curves described as "kyphosis", and studies that did not report measurements in the radiology report and/or orthopedic note were excluded. A total of 159 radiographs were reviewed. The corresponding radiology report and orthopedic clinic notes were reviewed. Patient identification numbers, ages and scoliosis measurements were recorded.

#### **RESULTS**

Out of 159 radiographs, 121 met inclusion criteria. In 53.7% of studies, the radiologist report and orthopedic clinic note differed by > 5 degrees. Of these 65 studies, 34 had additional differences in the vertebral levels of curves or the number of curves reported. The largest discrepancy found was 20 degrees with mean differences of 9.85, 6.79, and 13.25 for the upper, lower, and middle curves respectively.

#### **DISCUSSION**

A large proportion of reported scoliosis radiographs differ from the corresponding orthopedic clinic note beyond the accepted standard. Even small differences in reports can induce patient anxiety and confusion particularly when measurements meet thresholds for changes in treatment. To improve patient experiences, recommendations include liaising with orthopedic surgeons to gauge patient feedback and review standard measurement protocols to improve consistency between orthopedics and radiology. Limitations of the study include its retrospective nature.

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## Abstract Archives of the RSNA, 2023

T5A-QI-2

### **The Measure of Truth: Determining Whether Absolute Values of Leg Lengths are Incorrectly being Measured and Reported on Pediatric Teleoroentgenogram Leg Length Studies: A Clinical Audit**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Sana Rashid (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Leg length discrepancies (LLDs) are relatively common. Only 25-50% of the general population have legs of equal length. A LLD > 2 cm is clinically significant. LLDs should be diagnosed in childhood to allow for the best prognosis and avoid future issues with gait, osteoarthritis, or scoliosis. While it seems beneficial to include these measurements, a teleoroentgenogram is not the best study for measuring leg lengths. While useful for assessing lower limb alignment, teleoroentgenograms use a single AP radiograph, which is subject to magnification error. The ideal method for measurement of leg lengths is an orthoroentgenogram where measurements are calibrated with a ruler. The goal of this audit was to assess whether absolute leg length values are being included in teleoroentgenogram reports to provide feedback to radiologists to improve accuracy of their reports.

#### **RESULTS**

Leg length measurements were included in 31/100 of teleoroentgenograms reports. Right leg lengths were reported in all 31 studies, whereas left leg lengths were only reported in 30 studies. There was only one case where the discrepancy was > 2 cm and therefore clinically significant. The PACS system measurement tool overestimated leg lengths by an average of 1.6 cm. The older the patient, the greater the overestimation with the highest difference being 2.2 cm.

#### **METHODS**

This study was conducted at an academic children's hospital. A search was conducted on our local PACS system for all teleoroentgenogram radiographs from April to May 2022. One hundred pediatric (age <18) lower limb teleoroentgenogram reports were reviewed. Patient identification numbers and ages were recorded. "Yes" or "No" was assigned and recorded based on whether there was inclusion of leg lengths on the report. For the studies in the "Yes" category, leg length measurements were recorded. On 4 of these teleoroentgenograms, a technologist added a ruler to confirm magnification error between the ruler measurement and the PACS system measurement tool. Results were analyzed using frequency counts.

#### **DISCUSSION**

Absolute leg length values were included in 30% of leg length teleoroentgenogram reports. The literature has shown that teleoroentgenograms can have magnification errors up to 5% when measuring leg lengths. While this seems insignificant, it can have implications for orthopedic management. Instead of providing absolute leg length measurements, we suggest reporting relative leg lengths; that is, the percentage difference between both legs. The goal of this would be to minimize inaccuracy in radiology reports while also including clinically relevant information. Study limitations include the small sample size. Although we preliminarily showed leg length measurement differed between teleoroentgenograms and orthoroentgenograms, further studies using a larger sample size can be performed to confirm this generally accepted notion

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## Abstract Archives of the RSNA, 2023

T5A-QI-3

### Patient Perspectives on AI Implementation in Radiology, From Generation to Generation

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Nabid Ahmed, MD, MS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Artificial Intelligence (AI) solutions are increasingly being adopted by medical specialties, especially radiology. Learning how patients perceive these changes is an important aspect of upholding patient-centered care. The aim of our survey study is to improve understanding of patient perspectives on AI usage in interpreting radiologic images and generating reports, with regards to specific aspects such as comfort level, costs, favorability, and legal liability. Moreover, the study seeks to probe for similarities and differences of these perspectives between and within generational cohorts.

#### RESULTS

Our ongoing survey has collected over 100 survey results to date, with 3% of responses from the Post-war generation, 50% from the Baby Boomer generation, 27% from Gen X, 18% from Millennial, and 2% from Gen Z. Initial results show that only 7% of all participants were not in favor of AI algorithms assisting the radiologist in daily practice (48% were in favor, 47% were neutral). Moreover, 20% of those in favor were willing to pay extra for reports interpreted by both a radiologist and an AI algorithm, which increased to 52% if it was proven that less findings were missed with AI assistance. Only 14% are in favor of reports completely generated by AI. If there were diagnostic errors with AI implementation, 70% of participants would find the AI developer, the hospital, and the radiologist all at fault and legally liable, while only 5% would find just the radiologist at fault.

#### METHODS

Surveys on AI usage in radiology were distributed to patients at an outpatient imaging center associated with an academic hospital. Survey questions provided scenarios and statements regarding AI in radiology in which the participant could pick 'Yes', 'No' or 'Neutral'. Descriptive statistics of the survey answers were calculated from total number of participants and with respect to cohorts. A Chi-square test of independence was done with each survey question to determine if a survey response had a significant association with a cohort.

#### DISCUSSION

Millennials were most aware that AI was already being used in radiology at our institution, having 55% of 'Yes' responses to the respective question. Currently, this is the only statistically significant association in our study. 60% of participants said 'Yes' to being asked if they wanted to learn more about how AI algorithms work in radiology, which did not have a significant association with a cohort. In fact, many written comments stated that the participant did not know enough about the subject to formulate a stance. These insights will aid discussions between the radiologist and patient regarding AI-incorporated imaging reports (and possibly AI generated follow-up recommendations), in outlining legal responsibilities of all parties involved, and in the design of educational material that will keep patients informed of the changing healthcare landscape.

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## Abstract Archives of the RSNA, 2023

T5A-QI-4

### Case-Based Intro to Radiology: Enhancing Radiology Education through an e-Learning Platform

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Kevin Pierre (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Over-utilization of imaging in healthcare can harm patients and burden the radiology workforce. Health profession students often receive insufficient radiology education. Scottish Medical Schools (Chew 2021) report radiology accounting for only 0.3% of total teaching time. In a US study (Rohren 2022), 72% of students felt they received too little radiology education. Among the top skills teachers believed students need for graduation are the type of imaging to request and appropriate imaging use (Chew 2021). However, 65% of students were unaware of American College of Radiology appropriateness criteria, and 33% had heard but never used it (Rohren 2022). This study aimed to develop and assess a case-based e-learning platform section to teach imaging utilization, basic interpretation skills, and integration into medical decision-making workflows for medical students, physician assistant students, first-year radiology residents, and non-radiologist clinicians.

#### METHODS

A "Case-Based Intro to Radiology" section with 80+ modules was developed on our departmental e-learning platform. Modules include patient history, physical findings, lab results, and guided learners through diagnosis, imaging selection, interpretation, and developing a working diagnosis, assessment, and disposition. Interactive features comprise immediate feedback, short videos, full Digital Imaging and Communications in Medicine (DICOM) image sets, learning points, and socioeconomic factors. A focus group of 20 MD, PA, PhD, and undergraduate students assessed module quality, educational content, and instructional methods through a survey. Descriptive statistics analyzed survey responses.

#### RESULTS

Most students agreed that the modules enhanced imaging interpretation, complemented curricula, encouraged critical thinking, and covered appropriate clinical and imaging details. They rated module quality, educational content, and videos as very good. Students preferred flipped classroom or proctored didactic approaches over traditional methods.

#### DISCUSSION

The study relied on a small sample size and self-reported outcomes. More research is needed to determine the long-term impact on performance and clinical practice. The case-based e-learning platform section showed potential in improving radiology education for medical and PA students. Next steps involve integrating the platform into the PA school curriculum, completing 140 proposed cases, developing an educator and user guide, conducting external peer reviews, and performing outcome studies.

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## Abstract Archives of the RSNA, 2023

T5A-QI-5

### Developing an AI Model to Identify Malignancy Results on Imaging Reports to Delay Release to the Electronic Patient Portal

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Lucy Chow, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Federal CURES Act requires all results to be immediately released to the patient portal unless it qualifies for an exception, such as state law. New California law stipulates imaging scans that reveal a new or recurrent malignancy shall not be electronically disclosed to the patient until a healthcare professional has discussed the results. While radiologists can flag reports to prevent immediate release to the patient portal, relying on this manual method presents a challenge in consistency, especially in a high-volume academic medical center. This study aimed to improve the accuracy and efficiency of this workflow by creating an AI model that combines a rule-based natural language processing (NLP) approach with deep learning techniques to automate the process.

#### METHODS

The dataset is comprised of approximately 61,000 multi-modality diagnostic imaging reports from 12/01/2022-12/31/2022, while procedure reports were excluded. Subsets from this dataset were extracted using two rule-based approaches to preprocess the training data. The first rule identified any report containing -RADS classification categories (i.e., BI-RADS), which yielded 8,345 reports. Of this set, 341 reports were identified to be withheld from immediate release based on predetermined criteria (i.e., BI-RADS=4). A second rule was applied to the remaining 53,000 reports, which identified approximately 4,500 reports that contained one of 12 malignancy-related keywords (i.e., cancer). This formed the training set for the NLP deep neural network (DNN) model, which was independently labeled by a group of 22 physician informaticists (PIs) as either 'withhold' or 'release.' Any indeterminate reports were discussed to reach consensus and develop labeling guidelines. Upon review, withholding scans demonstrating progressive malignancy became clinically necessary and rational. About 40% of the training set was reviewed, and 2,677 labeled reports were used for initial DNN model development. Subsequently, 49,318 reports generated between 01/19/2023- 02/12/2023 were analyzed for model validation.

#### RESULTS

In the model validation dataset, 293 reports (0.6%) contained the -RADS classification and 996 reports (2.0%) were identified from DNN, resulting in 1,289 reports (2.6%) withheld from immediate release. Preliminary results of the model performance yielded a 99.4% accuracy based on the final test set, consisting of 14,759 cases.

#### DISCUSSION

The model has demonstrated promising results, and the existing IT infrastructure was leveraged to incorporate the functionality into the electronic health record. Both manual flagging by the radiologist and automated flagging by the AI algorithm will be implemented. Manually flagged reports will further train and refine the AI model's accuracy. The two methods will be compared to determine if manual flagging remains necessary for the workflow.

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## Abstract Archives of the RSNA, 2023

T5A-QI-6

### An Artificial Intelligence (AI) Boost to MRI Lumbar Spine Reporting

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Sze Ying Yee, MBChB, FRCR (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Lumbar spine magnetic resonance imaging (MRI) is commonly performed for back pain assessment. The interpretation involves grading spinal stenosis at multiple levels, which is repetitive and time-consuming. Machine learning algorithms are postulated to improve reporting productivity while maintaining consistency. This study aims to assess the reporting speed and diagnostic accuracy with and without assistance from an artificial intelligence (AI) reading assistive tool.

#### METHODS

MRI lumbar spine studies of patients aged 18 and older performed for back pain from 1 to 10 December 2022 were randomly selected. These studies were initially read by four board-certified musculoskeletal and neuroradiologists with at least 8 years of consultant experience. Studies with instrumentation and scoliosis were excluded. The time taken to verify the radiology reports for each study was extracted from the RIS logs - this was deemed time taken without AI assistance. The DICOM data for these studies were processed by a commercial deep learning-based solution - CoLumbo (Smart Soft Healthcare, Bulgaria) on an AI orchestration platform (CARPL.AI, US). The AI solution segments, measures, and classifies MR images to provide suspected pathology descriptions, findings, and measurements. It then outputs annotated post-processed MRI images and an auto-generated report which is editable. These studies were randomly assigned to three final-year radiology residents who were blinded to the original finalized reports. The reporting time and corrections to the pre-populated report were logged. The time taken with and without AI assistance was documented and compared. A paired t-test was performed for the calculation of statistical significance.

#### RESULTS

A total of 31 MRI studies were processed. The mean interpretation time with AI assistance was significantly lower than without ( $8.47 \pm 3.77$  minutes versus  $22.44 \pm 10.90$  minutes,  $p < 0.001$ ). The interquartile range (IQR) for interpretation time with AI assistance was 4.78 minutes, while the IQR for interpretation time without AI assistance was 14.15 minutes. The smaller IQR indicates that the interpretation times were more consistent and less variable when radiologists used the AI-powered assistive tool. A paired t-test showed that the mean difference in interpretation times between the two groups was -13.97 minutes (95% CI: -16.66 to -11.28), which was statistically significant ( $p < 0.001$ ). Diagnostic accuracy (stenosis grading and incidental findings) was not significantly different between the two groups.

#### DISCUSSION

AI assistance for MRI lumbar spine reporting resulted in a significant reduction in reporting time with equivalent diagnostic accuracy compared to experienced radiologists without AI assistance. The more objective and consistent AI evaluation also provides a more standardized report and reduces interobserver variation.

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## Abstract Archives of the RSNA, 2023

T5A-QI-7

### Learning Styles and Preferences of Current Generation of Training Radiologists: A Survey Analysis

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Alok Kale, MBBS, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The current generation (GEN) of radiology trainees (RT) have grown up in the digitalised world are conversant with digital tools social media utilisation. It has become imperative to study their learning styles, preferences to identify gaps in teaching methodology.

#### METHODS

Qualitative study was undertaken in 2022 targeting RT recent Board-certified radiologists (0-5 years experience). A questionnaire (Qn) of 10 questions consisted of understanding preferences for learning tools (LT) styles, problem solving (PS) skills, type of individual learner, preferences for teaching modules, awareness of their role in the department, preferences for exit-exam pattern was issued on social media. Each question had several choices (eg. "which is most preferred mode of learning?" had responses such as textbook, teaching website (TW) etc). Each choice had a response option from least-likely to most-likely on a scale of 1 to 5 (5 pointer Likert's scale). Of 119 participants, 68 were males, 50 females 1 other category. Analysis of the responses was done by calculating percentage and weighted average. The association for age, gender, years of experience (YoE) practicing institute (PI) with every aspect of study Qn was assessed using Chi Square test. SPSS version 20 was used P-value  $\leq 0.05$  was considered significant.

#### RESULTS

TW were most preferred mode of LT followed by textbooks among journals, conferences, lectures video media channels, latter being the least preferred. For PS, responders tend to prefer consulting teachers peers (60%) followed by utilising help of TW journals. In our survey, only 36% 1st RT preferred TW as compared to 81% of 4thyr RT, indicating increasing trend with increase YoE. However, 63% of 4thyr. RT tend to prefer textbook among others. Majority (74%) of them consider to be visual-learners followed by logical kinaesthetic. Linguistic were only 45%. However, no significant statistical difference was found for gender, YoE or PI. For preference in teaching modules, majority preferred interactive case-based discussions (CBD) (70%) followed by simulations. With increase in YoE, CBD flipped classroom (FC) were preferred. Preference for FC was significantly differed among type of PI. ( $p < 0.05$ ) Statistically significant increasing trend was seen for awareness of curricular goals with gender age. In a preference for mode of exam, institutional exam (64%) was most favoured. Online exam was least preferred had no statistical difference among PI.

#### DISCUSSION

Current GEN's learning styles are different from preceding GEN which relied on didactic lectures textbooks. However, they do require precise instructions, simulations mentoring. This requires consideration when framing radiology training curriculum. The limitation of study is the subjective nature of the assessment by the participants which needs to be validated by objective methods.

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## Abstract Archives of the RSNA, 2023

T5A-QI-8HC

### Maximizing the Usefulness of limited aspirated synovial fluid samples in musculoskeletal fluoroscopy procedures: A Quality Improvement Approach for Optimal Lab Order Decision Making

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Aiah Alatoum, MBBS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

In many instances in musculoskeletal fluoroscopy-guided aspirations, only a limited amount of synovial fluid can be aspirated, which poses a challenge in deciding to send the fluid to the most clinically appropriate lab orders. At our institution, we did a retrospective review of all fluoroscopic guided joint aspirations performed between January 2022 and August 2022 on different body joints for various indications. 97 aspirations were reviewed, and we found that in 32% of these cases, the yield of aspirated fluid was 1 ml or less. This study aims to generate and implement an algorithm to guide the clinician to send the limited amount of aspirated fluid to the most clinically appropriate test based on the patient's condition and history.

#### METHODS

Our musculoskeletal team collaborated with the orthopedic department to create a decision tree that outlines the preferred tests for patients with limited synovial fluid. This tree was made by order of importance of the tests based on the patient's clinical scenario. All synovial fluid aspirations were made by the musculoskeletal fellows supervised by well-experienced musculoskeletal radiologists.

#### RESULTS

After creating the decision tree, a retrospective audit was made on the previous 25 patients with limited amount of aspirated synovial fluid to check if it was sent to the preferred lab test. The retrospective audit showed that only 20% of the patients received the preferred test. The next step was educating the team via a lecture about the order of importance of the tests, distributing the decision tree to the residents and fellows, and conducting another audit after six months. In February 2023, a second audit was conducted after implanting the decision tree on 30 patients with limited amount of aspirated synovial fluid. The results showed that in 100% of the cases, the fluid was sent to the preferred test order.

#### DISCUSSION

There were several limitations to this study. The study was retrospective in nature, with few subjects. However, implementing the decision tree led to significant improvement in deciding the preferred lab test for patients with limited aspirated fluid and provided the best quality of care. The decision tree is now part of the fluoroscopy procedures routine.

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## Abstract Archives of the RSNA, 2023

T5A-QI-9HC

### **Standardization of incidental thyroid nodule characterization, follow-up recommendations, and patient education resources: A quality improvement project at an academic medical center**

Tuesday, Nov. 28 12:15PM - 12:45PM Room: Learning Center

Brandon K.K. K. Fields, MD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

**Problem Description:** Incidental thyroid nodules (ITNs) are frequently encountered on cross-sectional studies that include the neck, yet ITN descriptions and management recommendations are variable. Further, as patient access to electronic medical records becomes standard of care, knowledge of an ITN can be distressing. **Available Knowledge:** The American College of Radiology (ACR) published guidelines in 2015 to standardize ITN characterization and management, yet ITN reporting remains heterogenous and potentially discordant. Radiology reports rarely supply patient-friendly educational material when ITNs are discovered. **Purpose:** The purpose of this study was to use a dictation template-based approach to 1) simplify and standardize ITN descriptions and recommendations, and 2) provide a patient-friendly educational resource for patients reading their reports.

#### **METHODS**

**Context and Intervention:** Beginning August 2022, a dedicated thyroid field was added to our hospital's dictation templates for MR and CT neck studies. Using a picklist, the field generates text with ACR-compliant recommendations and a link to our department-sponsored patient education webpage. **Study of the Intervention:** Neck CT and MR reports were reviewed to determine compliance. Patient education webpage traffic was monitored using a web-analytics platform. **Measures/Metrics:** Compliance with ACR-based ITN guidelines was defined as a correct ITN description and recommendation. Monthly ITN detection rate was monitored as an in-process metric. Webpage traffic and search engine results were monitored periodically. **Analysis:** The above metrics were tracked and analyzed to study the intervention's impact during the study period.

#### **RESULTS**

Between 8/22-4/23 and across 7,830 studies, compliance with ACR guidelines was 98% (Figure). Over time, monthly thyroid nodule detection rate increased from 3.5% to 4.5% (Figure). Webpage traffic increased rapidly after implementation with a total of 4,910 organic accesses between August 2022 and March 2023. 50 of 130 patients with a nodule requiring follow up completed laboratory testing, 28 received a dedicated thyroid ultrasound, and 6 underwent thyroid biopsy.

#### **DISCUSSION**

Simple radiology dictation template modifications can drastically improve proper ITN reporting and documentation using evidence-based guidelines and recommendations. This, in turn, can enhance patient care and standardize practice patterns with minimal additional time and cost. Further, providing links to patient-centered educational material is a straightforward way for radiology practices to engage patients and mitigate distress about incidental findings. While this data is limited to a single academic institution, this approach could be scaled and applied to other practices and types of incidental findings such as pancreatic cysts or liver lesions.

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## Abstract Archives of the RSNA, 2023

T5B-QI

### Quality Improvement Reports Tuesday Poster Discussions II

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### **T5B-QI-1 Criteria for Placing Extravasation Sensor Devices on Patients to Prevent Massive Extravasation of Contrast Material at Contrast Enhanced CT**

Yoriaki Matsumoto, PhD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Massive contrast material (CM) extravasation at contrast enhanced CT (CECT) leads to serious complications such as compartment syndrome. While extravasation sensors may be highly sensitive for the detection of extravasation and may prevent serious complications, in terms of time and cost they are not practical for all patients. The purpose of this study was to identify risk factors for extravasations during CECT in a large population and to establish criteria for placing the sensor device on patients.

#### **METHODS**

This retrospective study included 144,277 patients who underwent CECT at our hospital between April 2012 and July 2022. We performed multivariate logistic regression analysis between patients with- (n = 350) and randomly-selected patients without CM extravasation (n = 350). The outcome variable was the presence or absence of extravasation; the explanatory variables were the age, sex, body mass index, hospitalization status, hemodialysis and diabetes mellitus, the use of anticancer drugs, total serum protein, the injection rate, catheter gauge, catheter location, use of existing catheters, and the years of nurse CT experience. We investigated the percentage of patients with sensor devices (50-100%, 5% steps) and their sensitivity for detecting extravasation using receiver-operating characteristic curve analysis.

#### **RESULTS**

The extravasation rate was 0.27%. The median estimated extravasation volume was 10 ml (range, 1-140 ml). Multivariate logistic regression analysis showed that the injection rate [odds ratio (OR) = 1.61; 95% confidence interval (CI): 1.33-1.95, p < 0.001], a small-diameter catheter gauge (OR = 3.86, 95% CI = 1.92-7.76; p < 0.001), the use of anticancer drugs (OR = 1.81, 95% CI = 1.32-2.50; p < 0.001), and existing catheters (OR = 1.52, 95% CI = 1.10-2.11; p = 0.009) were significantly associated with extravasation (Table 1). To achieve a sensitivity of 90-, 80-, 70-, 60-, and 50%; 80, 50, 40, and 28% of all patients required the placement of a sensor device (Table 2).

#### **DISCUSSION**

Consistent with earlier reports, risk factors for extravasation were the injection rate, catheter gauge, and the use of anticancer drugs and of existing catheters. The sensitivity for detecting extravasation decreased as the proportion of patients with sensors decreased. The percentage of patients appropriately fit with sensors must consider the time required for their placement, their cost, and their sensitivity for detecting extravasation. We think that placing a sensor on 40% of patients, and a sensor sensitivity of 60% are reasonable in clinical practice.

#### **T5B-QI-2 Time-Cost Efficiencies and Experiences with Implementation of a Peer Learning System from a Tertiary Academic Center**

Daniel H. Kwak, MD, PhD (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

To examine the experiences, perceptions, and time-cost efficiency for practicing radiologists towards both models of quality improvement during a transition from a traditional peer review system to a peer learning system.

## METHODS

Faculty radiologists (N = 27) of a multispecialty radiology group at a single tertiary academic center completed 5-point Likert scale surveys prior to and 1-year following the transition to the new peer learning system in June 2021. Eight questions inquired about the positive aspects of each system, while two questions inquired about the negative aspects. Differences in survey responses prior to and following intervention were evaluated by Mann-Whitney U test.

## RESULTS

There was a significantly decreased amount of time per month used to complete the peer learning exercises versus the peer review exercises ( $1.71 \pm 1.84$  hours, N = 34 vs.  $0.76 \pm 0.45$  hours, N = 27,  $p = 0.011$ ). The result was a difference of  $0.95 \pm 1.89$  hours per month ( $11.4 \pm 22.7$  hours per year), which translated to an estimated direct salary time-cost saving of \$1653.68 per year per radiologists and a direct productivity time-cost saving of \$3,469.39 per year per radiologist when utilizing the peer learning system. Percent differences between expected and actual case submissions for each subspecialty section were as follows: Abdominal (+33.3%), Breast (-10.0%), Chest (+73.3%), ED (-93.3%), Musculoskeletal (+6.7%), Neuroradiology (-36.7%), Nuclear Medicine (+23.3%), and Pediatric (-53.3%). All positive impacts were rated significantly higher for the peer learning system. There was a significantly lower rating with respect to workflow disruption for the peer learning system. There was no significant difference in rating with respect to negative impact on the radiologist as an individual. When asked directly which system they preferred, 70.4% (19 of 27) of radiologists preferred the new system, 25.9% (7 of 27) preferred the old system, and 3.7% (1 of 27) did not respond.

## DISCUSSION

There was a strongly positive perception of the new peer learning system; however, the level of participation in the system was highly dependent on subspecialty section. There was a substantial implied direct time-cost saving from the cost-neutral transition to the peer learning system.

### **T5B-QI-3 Objective Improvements in Mammography Image Quality following Individualized Breast Positioning Training Informed by Artificial Intelligence**

Melissa L. Hill, PHD (*Presenter*) Consultant, Volpara Health Technologies Limited

## INTRODUCTION

Mammography image quality (IQ) is critical to optimal screening sensitivity. However, visual assessment is subjective and time-consuming. Artificial Intelligence (AI)-based methods of IQ analysis can provide automated objective evaluation at scale, enabling continuous individualized feedback to technologists (Techs) for performance improvement. To evaluate the IQ impact of expert hands-on breast positioning training, individualized to Techs as informed by an AI IQ assessment system.

## METHODS

The prospective study was conducted at 2 private breast imaging organizations, which had installations of commercially available Volpara Analytics™ AI software for >2 years prior to the study. Techs at the Intervention Site (55 Techs, 15 clinics; OH, USA) received individualized training from Mammography Educator trainers. The Control Site (45 Techs, 8 clinics; NC, AL IL, USA) continued to use the software as per usual. Five 30-day evaluation phases ran in parallel for both sites, including pre-training (Eval 12) and post-training (Eval 3-5). Prior to training, the IQ software's automated performance reports were used to create Targeted Training Profiles for each Tech to identify breast positioning metrics to focus on in training. After excluding Techs who had not completed training (Intervention Site) or acquired >90 images per evaluation phase (both Sites), 33 and 22 Techs were included in final analyses. De-identified study data included exam and patient characteristics, automated Perfect/Good/Moderate/Inadequate (PGMI) scores, % images with target compression pressure (7-15 kPa), and Quality Score (QS; a weighted breast positioning and compression score from 0-4). Paired t-test was used to compare IQ between evaluation periods.

## RESULTS

A 4.8% relative increase in QS was observed for the Intervention Site Techs post-training (Eval 2-3, 2.29 to 2.4;  $p < 0.05$ ) and QS improvement was sustained for the remaining post-training phases (Eval 4-5, 2.4 to 2.38;  $p < 0.05$ ). The early post-training improvements were driven by an increase in %P+G (57.8 to 61.4 60.8%;  $p < 0.05$ ). Whereas the last evaluation period saw an increase in %target compression (55.6 to 58.3%,  $p < 0.05$ ). In the same period, no changes across any of the aggregated IQ metrics were observed for Control Site Techs (QS=2.12—2.11,  $p = 0.96$ ; %P+G=53.6—54.1%,  $p = 0.78$ ; %target compression=50.1—48.8%,  $p = 0.85$ ).

## DISCUSSION

Personalized Tech training informed by AI IQ assessment resulted in significant and sustained improvements in QS. Although the QS increase remained 180 days post-training, the underlying drivers of quality improvement changed over time, suggesting monitoring is important to identify changing areas of focus and new training opportunities on an ongoing basis. Limitations include differences in gantry vendors between Sites, a lack of multivariate analysis, and use of a single AI IQ Software.

**T5B-QI-4** Choong Beom Seo, RT, BS (*Presenter*) Nothing to Disclose

# Evaluating the Usefulness of Contrast Medium Injection Protocol Changes to Prevent Large Amounts of Air Injection in Contrast-enhanced CT Scans

## INTRODUCTION

Some CT power injectors use the function of stopping an injection by recognizing it as air when less than a certain standard psi is detected; however in recent clinical environments, tubes with filters have been used to prevent reflux and remove impurities that then raise the basic psi. This has led to the problem of injecting a large amount of air into a patient's veins. Therefore, confirming the effectiveness of the anti-air injection function based on psi, and that it is necessary to find a suitable contrast medium injection protocol for a clinical environment.

## RESULTS

At the flow rate of 1.0cc/sec or lower, the injector recognized air injection, but not at 1.5cc/sec. Among other variables, only the ratio of the syringe's internal contrast medium and the air was a factor affecting psi, whereas other factors did not affect psi changes. In contrast to the air ratio, the higher the contrast medium ratio, the higher the psi, and the injection was not stopped at 7:3, 8:2, and 9:1.

## METHODS

Nemoto Dual Shot Alpha 7 injector was used; it recognized that air was injected when the psi remained below 4 during the initial 10cc injection, and stopped the injection. In consideration of this, the protocol was altered by injecting a contrast medium for contrast enhancement after the injection of volume 10cc and the flow rate was 0.5, 1.0, and 1.5cc/sec; experiments were conducted by changing factors that could affect psi to reproduce the environment while injecting a contrast medium into actual patients. The syringe internal contrast medium, air ratio with the total amount being 100cc, contrast medium concentration was 350, 400 mgI/mL, needle gauge, and IV cannula angle was 45, 90 were finally tested by changing the upper and lower directions of the injector with regards to the pressure tube method. After measuring one time, the air inside the syringe was compressed to fully emit all of the air and air was injected again for this experiment.

## DISCUSSION

Initially, it was important to lower the pressure inside the syringe. At first, the psi remained low, then the air was compressed. Even when there was no ejection from the syringe, the psi rose and the injector did not recognize the air. Depending on the ratio of Syringe internal contrast medium to air, the injection stop system may sometimes not work, so it is recommended that the injector be used facing down. In addition, injecting 10cc of contrast medium first at a low flow rate before an injection can prevent an examiner's carelessness without affecting the contrast enhancement. Therefore, in the case of an injector that does not have an air detector and recognizes air injection based on psi, injecting first at a low flow rate before injecting a contrast medium can be useful to prevent a large amount of air injection.

## T5B-QI-5 Improving the Efficiency of a LVEF Measurement Service through Adoption of AI Auto-contouring for MUGA Scans

Jonathan Taylor, PhD, MSc (*Presenter*) Nothing to Disclose

## INTRODUCTION

Multi Gated Acquisition (MUGA) is a Nuclear Medicine technique used to measure Left Ventricular Ejection Fraction (LVEF). Calculation involves segmentation of the radiolabelled blood inside the left ventricle for each phase of the cardiac cycle. Segmentation is a manual process. Delays in providing the results are common due to rising workloads. AI methods can be used to improve efficiency and reduce variability. The purpose of this project was to: 1) Train an in-house automated segmentation algorithm for MUGA scans 2) Integrate it with existing systems to provide a first "guess" of MUGA contours 3) Assess efficiency gains by auditing the time taken to calculate LVEF before and after the introduction of AI-assisted processing in clinic.

## METHODS

Algorithm development: 1793 historical MUGA images and associated 24-frame segmentations were used for algorithm training. An automated segmentation tool was created using an established network architecture (U-net). The algorithm was packaged as a DICOM service, configured to send segmented images to the NM server where users could check and edit results. Auditing: The time taken for 4 experienced users to process MUGA data using conventional manual methods (in commercial NM software) was assessed through self-reporting for 20 consecutive scans. Following AI tool implementation, the time taken for users to review, edit and approve AI-generated contours and associated LVEF results was automatically captured in a mysql database. The LVEF results generated from the AI contour alone and with the addition of human edits were automatically recorded in the same database. Database records were extracted 6 months after the introduction of AI-assisted processing. Records were screened in order to exclude cases where the outcome of processing wasn't clear.

## RESULTS

Mean processing time for the manual MUGA processing method was 9.7 min (SD 4.5 min). After the introduction of AI-assisted processing mean processing time reduced to 3.5 min (SD 2.5 min) across 92 cases (56 records were excluded).

There was a mean absolute difference in LVEF of 2.1% (SD 2.1%) between MUGA processing with the AI contour alone and following user editing.

## **DISCUSSION**

An AI tool was successfully trained for segmentation of MUGA scans and was subsequently integrated in clinic. Results demonstrated a significant time saving for AI-assisted processing compared to manual processing (6.2 minutes saved per case). Results also showed that LVEF figures calculated from the AI contour alone were very similar to those recorded after user editing. This suggests that much less human interaction is now required for processing MUGA scans, reducing overall inter-operator variability. Results provide impetus for greater use of AI to increase efficiency, and show that it is possible to achieve noticeable performance gains from in-house developed and deployed algorithms.

## **T5B-QI-6 Improving Mammography Positioning at Two Community Mammography Centers by Asking Why**

### **Awards**

#### **Quality Improvement Reports Award**

Chirag R. Parghi, MD, MBA (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Mammography positioning is an often overlooked, but real component of imaging quality that can be compromised in high volume facilities. Technical repeats are encouraged, though rarely performed due to the inevitable inconveniences posed to patients and staff alike. With regards to mammography positioning, traditional parameters of success have been defined at a binary, concrete level: MQSA accreditation pass rate. Though MQSA accreditation is important, positioning improvement may be attainable at a higher threshold of success, and at the local level.

## **RESULTS**

The baseline audit revealed a pass rate of 55% of total screening mammograms at both facilities. An image auditing process that included participation from the frontline technologists was developed and shared at group and individual levels. Frontline staff empowerment yielded an increase to an 85% of images passing. That level of performance was sustained for 10 weeks through additional interventions such as improving tech and radiologist communication, standardization of new technologist onboarding, and structured and frequent feedback to the technologists.

## **METHODS**

Two imaging facilities within the same organization in non-contiguous states enrolled in the ACR Learning Collaborative focused on Mammographic Positioning with an emphasis on behavioral modification, which consisted of a 27-week improvement program. Both sites were part of the first cohort of this program and had previously passed all MQSA accreditations over the last 5 years. The collaborative developed a performance measure that consisted of 7 major and 6 minor positioning criteria. Each week, the teams performed an internal audit of at least 45 screening mammograms (after an initial audit of 263 mammograms) according to the identified positioning criteria, and displayed aggregate results on a run chart. The teams participated in a structured improvement program to evaluate the current state, understand root causes of problems, develop and test various interventions and gauge improvement.

## **DISCUSSION**

The binary (pass/fail) threshold of MQSA Accreditation is inadequate by itself for quality assessment. Mammography positioning is a dynamic target that is comprised of individual, varying attributes. Identifying root causes with heightened attention to behaviors and conditions can result in sustainable improvement in image quality. Given the success of the facilities that participated in the first cohort of the Mammography Positioning Improvement Collaborative, three additional sites from the same organization have enrolled in the second cohort of the collaborative, with goals of expanding the learnings across the Solis enterprise to over 100 clinics. Applying these lessons at scale requires maintaining the essence of the improvement collaborative while customizing the process in order to minimize resource redundancy.

## **T5B-QI-7 The Impact of New Inflammatory Bowel Disease (IBD)-specific Materials on Patients' Preparedness and Image Quality of MR Enterography (MRE)**

Meghavi Mashar, MBBChir, MA (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Patients with IBD report that the most unpleasant part of MRE is the oral preparation (e.g.mannitol) and repeated breath holds (Miles et al. 2019). We compared new patient-focused materials covering these aspects of MRE delivered via an online platform - IBDmate (www.ibdmate.com) - to generic MR information and assessed the impact on patients' preparedness and image quality.

## METHODS

IBD patients with upcoming MRE scans were asked to participate and assigned to the control (Con) or intervention (Int) cohorts. The proportion of patients with unanswered questions was compared using the Chi-squared test. MRE images were reviewed by a blinded radiologist for image quality. Small bowel distention was scored between 0 (very poor distention) and 4 (excellent); respiratory motion artefact was graded between 0 (significant artefact) and 2 (no artefact) and compared with the Wilcoxon-sign test.

## RESULTS

152 patients were contacted, 78 Int, and 74 Con; response rate was 36% vs 45% ( $p = 0.35$ ). 36% of the Int cohort were attending their first MR vs 39% of Con ( $p = 0.98$ ). 75% of Int watched all videos before completing the survey. In both groups, 85% of questionnaire respondents read the information provided but in the Con group, 10 / 33 (30%) had unanswered questions compared to 1 / 28 (4%) in the Int group ( $p = 0.02$ ). Free text questions included what the mannitol was, taking medication and what happened following the scan. MRE images from 55 patients from the Int ( $N = 26$ ) or Con ( $N = 29$ ) groups, were included in the image quality analysis. Patients with prior small bowel resection ( $N = 13$ ) were excluded from the TI diameter measurements ( $N = 17$  intervention;  $N = 22$  control). The median (Q1; Q3) respiratory motion score was 2 'No artefact' (2; 2) in the Int and 2 'No artefact' (1; 2) in the Con groups ( $p = 0.49$ ). The median (Q1; Q3) distension score was 3 'Good' (2; 4) in the Int and 3 'Good' (3; 4) in the Con groups ( $p = 0.16$ ). The mean  $\pm$  S.D TI diameter was  $16 \pm 4$  mm in both groups ( $p = 0.85$ ).

## DISCUSSION

We had similar response rates across our groups. Our results indicate the new patient-focused materials reduced the number of unanswered questions patients had prior to scans. Given IBD patients have life-long imaging and continuous follow-up, educating them well early in the patient journey is vital for a positive experience. This may improve patient compliance with follow-up imaging, a potential area of study. There was no statistically significant difference seen in this gross assessment of scan quality on this particular study. We believe this is mostly due to methodological limitations including subjective assessment of distention, professional patient cohort (IBD patients for many years) and pathology on scans affecting TI measurements. Developing a validated and objective method to assess small bowel distention in an MR naive cohort as part of a longitudinal study would be useful.

## **T5B-QI-9HC** How Radiology Dashboard Technology is Transforming Workflow: Enhancing Report Turnaround Time and Patient Satisfaction in Radiology

Danilo Manuel C. Costa, MD, MBA (*Presenter*) Nothing to Disclose

## INTRODUCTION

In our hospitals, the Imaging Report Turnaround Time (RTAT) has been falling short of our Service Level Agreement (SLA) target, resulting in a decline in patient satisfaction. To address these challenges, a Radiology Dashboard (RDT) can provide valuable insights into the department's status, consolidate data, and enable real-time decision-making to improve workflow efficiency. Therefore, the aim of this study is to demonstrate how implementing a RDT can improve RTAT and evaluate its impact on patient satisfaction.

## METHODS

This study was conducted in 14 hospitals that use an integrated RIS/PACS system and perform approximately 90,000 exams per month. The hospitals aimed to achieve a 93% or higher rate within the RTAT cutoff for urgent, inpatient, and outpatient cases. However, the performance was significantly below the target and negatively affected the patient Net Promoter Score (NPS). To improve these indicators, the following interventions were implemented in July 2022: 1 - A dashboard with an interface integrated into the RIS/PACS was built to access the periods with the worst percentage of achieving the RTAT cutoff by day of the week, shift, and specialty (figure 1). 2 - The causes of the lower performance in some periods were categorized into three main reasons, and the following actions were taken: • Reduced radiology staff: Checked delay by subspecialty and increased the team. • Workflow: Eliminated waste, standardized work processes, and improved flow in all processes. • Information Technology: Proposed improvement actions according to the main weaknesses. 3 - Tracking of patient NPS for radiology exams. 4 - Recurring meetings involving the radiology team and managers.

## RESULTS

The t-test analysis showed that the intervention resulted in a significant increase in the average percentage of RTAT within the SLA. There was an increase from 87.2% to 95.7% for urgent RTAT ( $p < 0.05$ ), an increase from 80.2% to 90.1% for inpatient RTAT ( $p < 0.05$ ), and an increase from 88.8% to 97.8% for outpatient RTAT ( $p < 0.05$ ) (Figure 2). There was also an increase in the average patient exams NPS from 60 to 66.

## DISCUSSION

The study's limitations include not evaluating other factors that may impact report delays and the lack of information on the pre-analytical data. Nevertheless, the detailed, clear, and reliable identification of the weekly periods with the highest report delays and determining the main causes of the problems allowed for the implementation of assertive actions to improve

results in all areas of operation. In conclusion, implementing a RDT can improve the RTAT and patient satisfaction by providing real-time data insights and enabling targeted interventions to improve workflow efficiency.

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## Abstract Archives of the RSNA, 2023

T5B-QI-1

### Criteria for Placing Extravasation Sensor Devices on Patients to Prevent Massive Extravasation of Contrast Material at Contrast Enhanced CT

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Yoriaki Matsumoto, PhD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Massive contrast material (CM) extravasation at contrast enhanced CT (CECT) leads to serious complications such as compartment syndrome. While extravasation sensors may be highly sensitive for the detection of extravasation and may prevent serious complications, in terms of time and cost they are not practical for all patients. The purpose of this study was to identify risk factors for extravasations during CECT in a large population and to establish criteria for placing the sensor device on patients.

#### METHODS

This retrospective study included 144,277 patients who underwent CECT at our hospital between April 2012 and July 2022. We performed multivariate logistic regression analysis between patients with- (n = 350) and randomly-selected patients without CM extravasation (n = 350). The outcome variable was the presence or absence of extravasation; the explanatory variables were the age, sex, body mass index, hospitalization status, hemodialysis and diabetes mellitus, the use of anticancer drugs, total serum protein, the injection rate, catheter gauge, catheter location, use of existing catheters, and the years of nurse CT experience. We investigated the percentage of patients with sensor devices (50-100%, 5% steps) and their sensitivity for detecting extravasation using receiver-operating characteristic curve analysis.

#### RESULTS

The extravasation rate was 0.27%. The median estimated extravasation volume was 10 ml (range, 1-140 ml). Multivariate logistic regression analysis showed that the injection rate [odds ratio (OR) = 1.61; 95% confidence interval (CI): 1.33-1.95,  $p < 0.001$ ], a small-diameter catheter gauge (OR = 3.86, 95% CI = 1.92-7.76;  $p < 0.001$ ), the use of anticancer drugs (OR = 1.81, 95% CI = 1.32-2.50;  $p < 0.001$ ), and existing catheters (OR = 1.52, 95% CI = 1.10-2.11;  $p = 0.009$ ) were significantly associated with extravasation (Table 1). To achieve a sensitivity of 90-, 80-, 70-, 60-, and 50%; 80, 50, 40, and 28% of all patients required the placement of a sensor device (Table 2).

#### DISCUSSION

Consistent with earlier reports, risk factors for extravasation were the injection rate, catheter gauge, and the use of anticancer drugs and of existing catheters. The sensitivity for detecting extravasation decreased as the proportion of patients with sensors decreased. The percentage of patients appropriately fit with sensors must consider the time required for their placement, their cost, and their sensitivity for detecting extravasation. We think that placing a sensor on 40% of patients, and a sensor sensitivity of 60% are reasonable in clinical practice.

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## Abstract Archives of the RSNA, 2023

T5B-QI-2

### Time-Cost Efficiencies and Experiences with Implementation of a Peer Learning System from a Tertiary Academic Center

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Daniel H. Kwak, MD, PhD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

To examine the experiences, perceptions, and time-cost efficiency for practicing radiologists towards both models of quality improvement during a transition from a traditional peer review system to a peer learning system.

#### METHODS

Faculty radiologists (N = 27) of a multispecialty radiology group at a single tertiary academic center completed 5-point Likert scale surveys prior to and 1-year following the transition to the new peer learning system in June 2021. Eight questions inquired about the positive aspects of each system, while two questions inquired about the negative aspects. Differences in survey responses prior to and following intervention were evaluated by Mann-Whitney U test.

#### RESULTS

There was a significantly decreased amount of time per month used to complete the peer learning exercises versus the peer review exercises ( $1.71 \pm 1.84$  hours, N = 34 vs.  $0.76 \pm 0.45$  hours, N = 27,  $p = 0.011$ ). The result was a difference of  $0.95 \pm 1.89$  hours per month ( $11.4 \pm 22.7$  hours per year), which translated to an estimated direct salary time-cost saving of \$1653.68 per year per radiologists and a direct productivity time-cost saving of \$3,469.39 per year per radiologist when utilizing the peer learning system. Percent differences between expected and actual case submissions for each subspecialty section were as follows: Abdominal (+33.3%), Breast (-10.0%), Chest (+73.3%), ED (-93.3%), Musculoskeletal (+6.7%), Neuroradiology (-36.7%), Nuclear Medicine (+23.3%), and Pediatric (-53.3%). All positive impacts were rated significantly higher for the peer learning system. There was a significantly lower rating with respect to workflow disruption for the peer learning system. There was no significant difference in rating with respect to negative impact on the radiologist as an individual. When asked directly which system they preferred, 70.4% (19 of 27) of radiologists preferred the new system, 25.9% (7 of 27) preferred the old system, and 3.7% (1 of 27) did not respond.

#### DISCUSSION

There was a strongly positive perception of the new peer learning system; however, the level of participation in the system was highly dependent on subspecialty section. There was a substantial implied direct time-cost saving from the cost-neutral transition to the peer learning system.

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## Abstract Archives of the RSNA, 2023

T5B-QI-3

### Objective Improvements in Mammography Image Quality following Individualized Breast Positioning Training Informed by Artificial Intelligence

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Melissa L. Hill, PHD (*Presenter*) Consultant, Volpara Health Technologies Limited

#### INTRODUCTION

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#### METHODS

The prospective study was conducted at 2 private breast imaging organizations, which had installations of commercially available Volpara Analytics™ AI software for >2 years prior to the study. Techs at the Intervention Site (55 Techs, 15 clinics; OH, USA) received individualized training from Mammography Educator trainers. The Control Site (45 Techs, 8 clinics; NC, AL IL, USA) continued to use the software as per usual. Five 30-day evaluation phases ran in parallel for both sites, including pre-training (Eval 12) and post-training (Eval 3-5). Prior to training, the IQ software's automated performance reports were used to create Targeted Training Profiles for each Tech to identify breast positioning metrics to focus on in training. After excluding Techs who had not completed training (Intervention Site) or acquired >90 images per evaluation phase (both Sites), 33 and 22 Techs were included in final analyses. De-identified study data included exam and patient characteristics, automated Perfect/Good/Moderate/Inadequate (PGMI) scores, % images with target compression pressure (7-15 kPa), and Quality Score (QS; a weighted breast positioning and compression score from 0-4). Paired t-test was used to compare IQ between evaluation periods.

#### RESULTS

A 4.8% relative increase in QS was observed for the Intervention Site Techs post-training (Eval 2-3, 2.29 to 2.4;  $p < 0.05$ ) and QS improvement was sustained for the remaining post-training phases (Eval 4-5, 2.4 to 2.38;  $p < 0.05$ ). The early post-training improvements were driven by an increase in %P+G (57.8 to 61.4 60.8%;  $p < 0.05$ ). Whereas the last evaluation period saw an increase in %target compression (55.6 to 58.3%,  $p < 0.05$ ). In the same period, no changes across any of the aggregated IQ metrics were observed for Control Site Techs (QS=2.12—2.11,  $p = 0.96$ ; %P+G=53.6—54.1%,  $p = 0.78$ ; %target compression=50.1—48.8%,  $p = 0.85$ ).

#### DISCUSSION

Personalized Tech training informed by AI IQ assessment resulted in significant and sustained improvements in QS. Although the QS increase remained 180 days post-training, the underlying drivers of quality improvement changed over time, suggesting monitoring is important to identify changing areas of focus and new training opportunities on an ongoing basis. Limitations include differences in gantry vendors between Sites, a lack of multivariate analysis, and use of a single AI IQ Software.

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## Abstract Archives of the RSNA, 2023

T5B-QI-4

### Evaluating the Usefulness of Contrast Medium Injection Protocol Changes to Prevent Large Amounts of Air Injection in Contrast-enhanced CT Scans

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Choong Beom Seo, RT, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Some CT power injectors use the function of stopping an injection by recognizing it as air when less than a certain standard psi is detected; however in recent clinical environments, tubes with filters have been used to prevent reflux and remove impurities that then raise the basic psi. This has led to the problem of injecting a large amount of air into a patient's veins. Therefore, confirming the effectiveness of the anti-air injection function based on psi, and that it is necessary to find a suitable contrast medium injection protocol for a clinical environment.

#### RESULTS

At the flow rate of 1.0cc/sec or lower, the injector recognized air injection, but not at 1.5cc/sec. Among other variables, only the ratio of the syringe's internal contrast medium and the air was a factor affecting psi, whereas other factors did not affect psi changes. In contrast to the air ratio, the higher the contrast medium ratio, the higher the psi, and the injection was not stopped at 7:3, 8:2, and 9:1.

#### METHODS

Nemoto Dual Shot Alpha 7 injector was used; it recognized that air was injected when the psi remained below 4 during the initial 10cc injection, and stopped the injection. In consideration of this, the protocol was altered by injecting a contrast medium for contrast enhancement after the injection of volume 10cc and the flow rate was 0.5, 1.0, and 1.5cc/sec; experiments were conducted by changing factors that could affect psi to reproduce the environment while injecting a contrast medium into actual patients. The syringe internal contrast medium, air ratio with the total amount being 100cc, contrast medium concentration was 350, 400 mgI/mL, needle gauge, and IV cannula angle was 45, 90 were finally tested by changing the upper and lower directions of the injector with regards to the pressure tube method. After measuring one time, the air inside the syringe was compressed to fully emit all of the air and air was injected again for this experiment.

#### DISCUSSION

Initially, it was important to lower the pressure inside the syringe. At first, the psi remained low, then the air was compressed. Even when there was no ejection from the syringe, the psi rose and the injector did not recognize the air. Depending on the ratio of Syringe internal contrast medium to air, the injection stop system may sometimes not work, so it is recommended that the injector be used facing down. In addition, injecting 10cc of contrast medium first at a low flow rate before an injection can prevent an examiner's carelessness without affecting the contrast enhancement. Therefore, in the case of an injector that does not have an air detector and recognizes air injection based on psi, injecting first at a low flow rate before injecting a contrast medium can be useful to prevent a large amount of air injection.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

T5B-QI-5

### Improving the Efficiency of a LVEF Measurement Service through Adoption of AI Auto-contouring for MUGA Scans

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Jonathan Taylor, PhD, MSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Multi Gated Acquisition (MUGA) is a Nuclear Medicine technique used to measure Left Ventricular Ejection Fraction (LVEF). Calculation involves segmentation of the radiolabelled blood inside the left ventricle for each phase of the cardiac cycle. Segmentation is a manual process. Delays in providing the results are common due to rising workloads. AI methods can be used to improve efficiency and reduce variability. The purpose of this project was to: 1) Train an in-house automated segmentation algorithm for MUGA scans 2) Integrate it with existing systems to provide a first "guess" of MUGA contours 3) Assess efficiency gains by auditing the time taken to calculate LVEF before and after the introduction of AI-assisted processing in clinic.

#### METHODS

Algorithm development: 1793 historical MUGA images and associated 24-frame segmentations were used for algorithm training. An automated segmentation tool was created using an established network architecture (U-net). The algorithm was packaged as a DICOM service, configured to send segmented images to the NM server where users could check and edit results. Auditing: The time taken for 4 experienced users to process MUGA data using conventional manual methods (in commercial NM software) was assessed through self-reporting for 20 consecutive scans. Following AI tool implementation, the time taken for users to review, edit and approve AI-generated contours and associated LVEF results was automatically captured in a mysql database. The LVEF results generated from the AI contour alone and with the addition of human edits were automatically recorded in the same database. Database records were extracted 6 months after the introduction of AI-assisted processing. Records were screened in order to exclude cases where the outcome of processing wasn't clear.

#### RESULTS

Mean processing time for the manual MUGA processing method was 9.7 min (SD 4.5 min). After the introduction of AI-assisted processing mean processing time reduced to 3.5 min (SD 2.5 min) across 92 cases (56 records were excluded). There was a mean absolute difference in LVEF of 2.1% (SD 2.1%) between MUGA processing with the AI contour alone and following user editing.

#### DISCUSSION

An AI tool was successfully trained for segmentation of MUGA scans and was subsequently integrated in clinic. Results demonstrated a significant time saving for AI-assisted processing compared to manual processing (6.2 minutes saved per case). Results also showed that LVEF figures calculated from the AI contour alone were very similar to those recorded after user editing. This suggests that much less human interaction is now required for processing MUGA scans, reducing overall inter-operator variability. Results provide impetus for greater use of AI to increase efficiency, and show that it is possible to achieve noticeable performance gains from in-house developed and deployed algorithms.

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## Abstract Archives of the RSNA, 2023

T5B-QI-6

### Improving Mammography Positioning at Two Community Mammography Centers by Asking Why

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

#### Awards

##### Quality Improvement Reports Award

Chirag R. Parghi, MD, MBA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Mammography positioning is an often overlooked, but real component of imaging quality that can be compromised in high volume facilities. Technical repeats are encouraged, though rarely performed due to the inevitable inconveniences posed to patients and staff alike. With regards to mammography positioning, traditional parameters of success have been defined at a binary, concrete level: MQSA accreditation pass rate. Though MQSA accreditation is important, positioning improvement may be attainable at a higher threshold of success, and at the local level.

#### RESULTS

The baseline audit revealed a pass rate of 55% of total screening mammograms at both facilities. An image auditing process that included participation from the frontline technologists was developed and shared at group and individual levels. Frontline staff empowerment yielded an increase to an 85% of images passing. That level of performance was sustained for 10 weeks through additional interventions such as improving tech and radiologist communication, standardization of new technologist onboarding, and structured and frequent feedback to the technologists.

#### METHODS

Two imaging facilities within the same organization in non-contiguous states enrolled in the ACR Learning Collaborative focused on Mammographic Positioning with an emphasis on behavioral modification, which consisted of a 27-week improvement program. Both sites were part of the first cohort of this program and had previously passed all MQSA accreditations over the last 5 years. The collaborative developed a performance measure that consisted of 7 major and 6 minor positioning criteria. Each week, the teams performed an internal audit of at least 45 screening mammograms (after an initial audit of 263 mammograms) according to the identified positioning criteria, and displayed aggregate results on a run chart. The teams participated in a structured improvement program to evaluate the current state, understand root causes of problems, develop and test various interventions and gauge improvement.

#### DISCUSSION

The binary (pass/fail) threshold of MQSA Accreditation is inadequate by itself for quality assessment. Mammography positioning is a dynamic target that is comprised of individual, varying attributes. Identifying root causes with heightened attention to behaviors and conditions can result in sustainable improvement in image quality. Given the success of the facilities that participated in the first cohort of the Mammography Positioning Improvement Collaborative, three additional sites from the same organization have enrolled in the second cohort of the collaborative, with goals of expanding the learnings across the Solis enterprise to over 100 clinics. Applying these lessons at scale requires maintaining the essence of the improvement collaborative while customizing the process in order to minimize resource redundancy.

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## Abstract Archives of the RSNA, 2023

T5B-QI-7

### The Impact of New Inflammatory Bowel Disease (IBD)-specific Materials on Patients' Preparedness and Image Quality of MR Enterography (MRE)

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Meghavi Mashar, MBBChir, MA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Patients with IBD report that the most unpleasant part of MRE is the oral preparation (e.g.mannitol) and repeated breath holds (Miles et al. 2019). We compared new patient-focused materials covering these aspects of MRE delivered via an online platform - IBDmate (www.ibdmate.com) - to generic MR information and assessed the impact on patients' preparedness and image quality.

#### METHODS

IBD patients with upcoming MRE scans were asked to participate and assigned to the control (Con) or intervention (Int) cohorts. The proportion of patients with unanswered questions was compared using the Chi-squared test. MRE images were reviewed by a blinded radiologist for image quality. Small bowel distention was scored between 0 (very poor distention) and 4 (excellent); respiratory motion artefact was graded between 0 (significant artefact) and 2 (no artefact) and compared with the Wilcoxon-sign test.

#### RESULTS

152 patients were contacted, 78 Int, and 74 Con; response rate was 36% vs 45% ( $p = 0.35$ ). 36% of the Int cohort were attending their first MR vs 39% of Con ( $p = 0.98$ ). 75% of Int watched all videos before completing the survey. In both groups, =85% of questionnaire respondents read the information provided but in the Con group, 10 / 33 (30%) had unanswered questions compared to 1 / 28 (4%) in the Int group ( $p = 0.02$ ). Free text questions included what the mannitol was, taking medication and what happened following the scan. MRE images from 55 patients from the Int ( $N = 26$ ) or Con ( $N = 29$ ) groups, were included in the image quality analysis. Patients with prior small bowel resection ( $N = 13$ ) were excluded from the TI diameter measurements ( $N = 17$  intervention;  $N = 22$  control). The median (Q1; Q3) respiratory motion score was 2 'No artefact' (2; 2) in the Int and 2 'No artefact' (1; 2) in the Con groups ( $p = 0.49$ ). The median (Q1; Q3) distension score was 3 'Good' (2; 4) in the Int and 3 'Good' (3; 4) in the Con groups ( $p = 0.16$ ). The mean  $\pm$  S.D TI diameter was  $16 \pm 4$  mm in both groups ( $p = 0.85$ ).

#### DISCUSSION

We had similar response rates across our groups. Our results indicate the new patient-focused materials reduced the number of unanswered questions patients had prior to scans. Given IBD patients have life-long imaging and continuous follow-up, educating them well early in the patient journey is vital for a positive experience. This may improve patient compliance with follow-up imaging, a potential area of study. There was no statistically significant difference seen in this gross assessment of scan quality on this particular study. We believe this is mostly due to methodological limitations including subjective assessment of distention, professional patient cohort (IBD patients for many years) and pathology on scans affecting TI measurements. Developing a validated and objective method to assess small bowel distention in an MR naive cohort as part of a longitudinal study would be useful.

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## Abstract Archives of the RSNA, 2023

T5B-QI-9HC

### How Radiology Dashboard Technology is Transforming Workflow: Enhancing Report Turnaround Time and Patient Satisfaction in Radiology

Tuesday, Nov. 28 12:45PM - 1:15PM Room: Learning Center

Danilo Manuel C. Costa, MD, MBA (*Presenter*) Nothing to Disclose

#### INTRODUCTION

In our hospitals, the Imaging Report Turnaround Time (RTAT) has been falling short of our Service Level Agreement (SLA) target, resulting in a decline in patient satisfaction. To address these challenges, a Radiology Dashboard (RDT) can provide valuable insights into the department's status, consolidate data, and enable real-time decision-making to improve workflow efficiency. Therefore, the aim of this study is to demonstrate how implementing a RDT can improve RTAT and evaluate its impact on patient satisfaction.

#### METHODS

This study was conducted in 14 hospitals that use an integrated RIS/PACS system and perform approximately 90,000 exams per month. The hospitals aimed to achieve a 93% or higher rate within the RTAT cutoff for urgent, inpatient, and outpatient cases. However, the performance was significantly below the target and negatively affected the patient Net Promoter Score (NPS). To improve these indicators, the following interventions were implemented in July 2022: 1 - A dashboard with an interface integrated into the RIS/PACS was built to access the periods with the worst percentage of achieving the RTAT cutoff by day of the week, shift, and specialty (figure 1). 2 - The causes of the lower performance in some periods were categorized into three main reasons, and the following actions were taken: • Reduced radiology staff: Checked delay by subspecialty and increased the team. • Workflow: Eliminated waste, standardized work processes, and improved flow in all processes. • Information Technology: Proposed improvement actions according to the main weaknesses. 3 - Tracking of patient NPS for radiology exams. 4 - Recurring meetings involving the radiology team and managers.

#### RESULTS

The t-test analysis showed that the intervention resulted in a significant increase in the average percentage of RTAT within the SLA. There was an increase from 87.2% to 95.7% for urgent RTAT ( $p < 0.05$ ), an increase from 80.2% to 90.1% for inpatient RTAT ( $p < 0.05$ ), and an increase from 88.8% to 97.8% for outpatient RTAT ( $p < 0.05$ ) (Figure 2). There was also an increase in the average patient exams NPS from 60 to 66.

#### DISCUSSION

The study's limitations include not evaluating other factors that may impact report delays and the lack of information on the pre-analytical data. Nevertheless, the detailed, clear, and reliable identification of the weekly periods with the highest report delays and determining the main causes of the problems allowed for the implementation of assertive actions to improve results in all areas of operation. In conclusion, implementing a RDT can improve the RTAT and patient satisfaction by providing real-time data insights and enabling targeted interventions to improve workflow efficiency.

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## Abstract Archives of the RSNA, 2023

W2-Q1

### Quality Improvement Reports Wednesday Poster Discussions

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

#### Sub-Events

#### W2-QI-1 Optimizing Patient Safety and Clinical Work-flow with Digital Radiation Management System

Mingjun Wang (*Presenter*) Nothing to Disclose

##### INTRODUCTION

Some patients received high radiation dose over threshold for different reasons. Radiologists are responsible for improving clinical imaging work-flow and patient safety optimization intently. The patient safety and radiation dose can be effectively optimized with dose tracking and dose responsibility map using digital radiology management system.

##### METHODS

11 radiologists were enrolled in patient safety optimization program (Fig. 1) from Dec. 2021 to Jan. 2023. The patient radiation information and imaging device information were analyzed using Radimetrics, a digital radiation management system. The patient who cumulative dose over threshold were collected and analyze the primary reason. Among the most common four CT protocols, the number of radiation dose over threshold were recorded every quarter. The device operation information and radiologists working details were also analyzed and improved along the program.

##### RESULTS

The radiation doses of 21,839 CT examinations performed on 15,372 patients from Jan. 2022 to Jan. 2023 were collected and analyzed. The median DLP (mGy.cm) for each scanning region was 225 (heart), 205 (chest), 450 (abdomen) and 610 (head). With dose tracking, the number of radiation dose over threshold constantly decreased among all four CT protocols. The main reasons for over-high radiation dose were shown as follow: improper imaging protocols, wrong patient action, improper imaging operation.

##### DISCUSSION

The preliminary result shows the program can highly protect patients from excessive radiation dose, and also improve radiologists operation and patient care sense. The program should be promoted to other hospitals.

#### W2-QI-2 Data Driven Strategies for an Education Program to Improve Diversity, Equity, and Inclusion in Radiology

Viraja Alluri, BS (*Presenter*) Nothing to Disclose

##### INTRODUCTION

The persistent gender, racial, and ethnicity imbalance in the training and radiology workforce has been well-documented. Despite growing awareness of the gap and initiatives, there have not been improvements as seen in other disciplines of medicine. To increase awareness, knowledge, and interest in radiology among our institution's medical and undergraduate students, a longitudinal education program has been designed and implemented since 2022. The goal is to target leaky pipelines and increase the gender and racial diversity of medical students applying to radiology residency. The 5C's of Radiology (5C's) (curriculum, coaching, collaborating, career, and commitment) are applied as a framework for our program. Data-driven strategies have been incorporated to collect quantitative and qualitative data for baseline evaluation and continued monitoring and improvement?.

##### METHODS

Events were conducted at an urban, academic medical school and affiliated university. Medical student events included two shadowing/mentorship programs, two faculty-led career advising events, three M4-led post-MATCH panels, five skills workshops, one women and URM in radiology panel, and three procedure workshops; two introduction to radiology events were held for undergraduates. At the end of each event, students completed a demographics and knowledge



questionnaire. The demographics questionnaire gathered information regarding gender, race/ethnicity, school year, and radiology exposure; the knowledge questionnaire assessed students' misconceptions and perception of work-life balance along with event quality and future interest. Responses were obtained using a Likert scale. Surveys were analyzed for trends by question type, race/ethnicity, gender, radiology exposure, and school year. There were 222 attendees with a 45% survey completion rate (100 responses). Two-tailed test assessed statistical significance for race/ethnicity, gender, radiology exposure, and year in medical school trends.

## RESULTS

Data demonstrates a statistically significant positive impact in addressing misconceptions, promoting work-life balance, and increasing interest of undergraduates. Significantly higher positive ranks are seen in procedure workshops and undergraduate events. There was a positive trend in promoting work-life balance for women. Programs were effective; undergraduate events and shadowing/mentorship programs significantly peaked interest.

## DISCUSSION

Limitations include limited emphasis on the 5C's coaching and collaborating factors. Future programming includes undergraduate events for women and URM, skills and procedure workshops, and shadowing. Events will be expanded upon in the upcoming semesters. Future data analysis includes results from targeted outreach to underrepresented groups in undergraduate and preclinical medical students.

### W2-QI-3 Reducing Radiology Reporting Workstation Energy Consumption

Donald Leith, MBBS, BSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Radiology departments are intense consumers of energy in healthcare with high carbon footprints that contribute to climate change. This is due to the non-stop diagnostic examinations undertaken by CT MR scanners and interventional suites. Numerous high-specification reporting PACS workstations will also contribute. Anecdotally, at the Royal London and St Bartholomew's hospitals, numerous reporting workstations are active 24 h/day even if not in use. We aim to accurately estimate the annual energy consumption of these workstations and to identify an energy saving strategy.

#### METHODS

Electricity consumption metered plugs were used to calculate workstation electricity consumption (kWh) over 12 hours. Each workstation consists of a central processing unit (CPU) and two large high resolution diagnostic monitors. Workstation energy states (WES) were categorised as either IN-USE, ACTIVE NOT IN-USE (CPU and monitors switched ON but not in use), IDLE (CPU switched ON but monitors OFF), SLEEP or OFF. The energy states of 41 workstations were manually assessed on three occasions at the end of a working week and taken to represent energy states throughout a night shift. WES for evening/weekend and daytime hours were estimated based on night shift workstation states and the highest number of rostered radiologists on duty during these shifts. Current annual workstation energy consumption was calculated. Workstations cannot be safely switched OFF every night, as essential cybersecurity and software updates cannot be missed. To reduce energy consumption, workstations should ideally be scheduled to SLEEP when not IN-USE. We therefore compared estimated energy savings for scenarios in which all workstations are programmed to either SLEEP or OFF when not IN-USE.

#### RESULTS

The average WES for night shifts (84 h/week) were 3 IN-USE, 17 ACTIVE NOT IN-USE, 15.7 IDLE, 0 SLEEP and 5.3 OFF. For evening/weekend shifts (44 h/week), estimated WES were 6 IN-USE, 14 ACTIVE NOT IN-USE, 15.7 IDLE, 0 SLEEP and 5.3 OFF. During day shifts (40h/week), estimated WES were 41 IN-USE and 0 for all other energy states. Based on the activity of 41 workstations, annual energy consumption totalled 51,414.6 kWh, costing £17,481/y at the current energy cost rate of £0.34/kWh. If workstations are programmed to either SLEEP or OFF when not IN-USE, energy consumption is predicted to fall to 27,440.1 kWh/y (£9,329.6) or 25,291 kWh/y (£8,599) respectively. Annual estimated energy savings are 23,974.4 kWh (£8151.3) or 26,123.5 kWh (£8882) respectively.

#### DISCUSSION

Long periods of workstations remaining IDLE or ACTIVE NOT IN-USE contribute to high energy consumption in our radiology department. A simple green initiative to programme these workstations to SLEEP when not IN-USE is estimated to reduce departmental energy consumption by approximately 23,974 kWh/y, also saving the department £8,151 per year.

### W2-QI-6 Automated Assessment of Breast Positioning and Image Quality in Digital Breast Tomosynthesis (DBT) Screening using Synthetically Reconstructed Projection Images

Ying Guo (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Digital breast tomosynthesis (DBT) is an imaging modality used for breast cancer detection, which requires accurate breast positioning and image quality. Automating the assessment of these parameters can provide consistency and reliability in DBT



screening. This study aimed to evaluate the accuracy of an artificial intelligence based tool for automated assessment of breast positioning and image quality in DBT, using synthetically reconstructed projection images.

## RESULTS

The AI algorithm demonstrated high accuracy in distinguishing between adequate and inadequate images, with an overall accuracy of 93%, sensitivity of 94% and specificity of 92% for FFDM and an accuracy of 92%, sensitivity of 95 and specificity of 91% for DBT with 2D-SM. In terms of breast positioning, the AUC of poor imaging quality prediction by AI system according to incomplete gland, incomplete pectoralis muscle, over or insufficient exposure was (0.903 vs 0.937 vs 0.982). Overall accuracy of AI system was 0.958 for FFDM and 0.932 for DBT with 2D-SM. Inter-observer agreement for image quality assessment was found to be 0.82 (95% confidence interval [CI]: 0.77-0.87), indicating substantial agreement between radiologists and AI system using 2D-SM images. The kappa coefficients for breast positioning assessment were also calculated and found to be moderate to substantial, with values ranging from 0.57 to 0.83 (95% CI: 0.48-0.67 and 0.78-0.88, respectively).

## METHODS

A total of 150 mammography examinations were enrolled in this study. Subjects underwent screening mammography including DBT with 2D-SM and FFDM. The AI-assisted system automatically evaluated the quality of breast positioning in each image set. Nine image quality criteria evaluating the appearance of the nipple, breast rotation, pectoral muscle, inframammary fold, pectoral nipple line, shoulder overlap shadow, abdominal skin, contralateral breast and foreign body were used for craniocaudal and mediolateral-oblique views. Image quality of cases were also evaluated with the standards of Mammography Quality Standards Act (MQSA) as grade "adequate" or "inadequate". The performance of the AI system was evaluated using accuracy, sensitivity, and specificity. The inter-rater agreement and comparison of their findings with those reported by the AI system was calculated using Cohen's kappa coefficient.

## DISCUSSION

The results showed a high degree of agreement between the automated and manual assessments, also indicating the performance of the AI tool in assessing breast positioning and image quality in DBT using 2D-SM images was comparable with that in FFDM. The use of synthetic projection images may be a reliable option for the automated assessment of breast positioning and image quality in DBT screening, but caution should be noted in the interpretation of the diagnostic accuracy of DBT images obtained using synthetic projection images.

## W2-QI-7 Automating and Integrating Breast Imaging Workflows to Improve Efficiency and Quality

Clayton R. Taylor, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Optimizing workflows for the interpretation of breast imaging studies is increasingly important given patient and referring clinician needs for rapid turnaround times, increasing imaging volumes and the scarcity of breast imaging radiologists. These workflows must accommodate immediate interpretation for some imaging studies and batch offline interpretation for others while addressing quality and prior comparison needs. Our goal was to decrease the turnaround time for breast imaging studies while more efficiently and equitably assigning studies to radiologists.

## RESULTS

Our process improvement project has allowed for an automated system that immediately and equally distributes breast imaging cases amongst radiologists and creates closed loop workflows for technical repeats and obtaining prior imaging studies. This has led to a significant reduction in report turnaround times (TAT) for screening mammograms from 109 minutes prior to implementation to 90 minutes post implementation and for breast MRI median from 287 minutes prior to implementation to 169 minutes post implementation. At least 7.5 hours per week of time is saved each week by our lead technologists by the use of these automated workflows.

## METHODS

Our breast center is a part of a tertiary care academic medical center providing breast cancer screening and diagnostic evaluations as well as supporting busy breast specialty practices. Before our process improvement project, our lead technologists would intermittently drag and drop screening mammograms to static worklists. This was inefficient, time-consuming and led to delays in the assignment of mammograms. Our project addressed this problem by integrating our scheduling software with our worklist application and leveraging a function within our worklist application to immediately, equitably and automatically assign screening mammograms, screening breast ultrasound and breast MRIs to each radiologist working a shift. Separately, our technologists add a modifier to each screening mammogram for patients seen by practitioners in the clinic the same day, moving the study to the diagnostic (immediate interpretation) worklist. At the same time, we deployed a solution allowing radiologists to instantly request priors or ask for technical repeats causing those studies to immediately populate unique worklists monitored by our lead technologists and assistants who upload priors or address the issues before releasing the studies to be assigned automatically once again, creating a closed loop quality workflow.

## DISCUSSION

Our improved breast imaging workflows improved efficiency with a direct positive impact on report turnaround times. These changes have also eliminated time consuming manual processes and created closed loop systems to improve quality by obtaining prior imaging studies and addressing technical issues.

### W2-QI-8HC Optimizing Workflows and Work-Life Balance in General Radiology

Molly M. Boelter, MBA, RN (*Presenter*) Nothing to Disclose

#### INTRODUCTION

This team, like many others, has experienced workflow and staffing challenges since the COVID-19 pandemic began. Staffing levels and morale among technologists were low. The team came together to optimize workflows and improve staff satisfaction in a hospital-based General Radiology practice. The purpose of this project was to decrease lead times by 15% without negatively impacting staff satisfaction.

#### METHODS

A team of radiographers, desk operations specialists, employee safety professionals, and quality improvement personnel approached this issue with the DMAIC (Define, Measure, Analyze, Improve, Control) framework. The current condition of the practice was studied with measures such as lead time, staff satisfaction, and Radiology to Emergency Department (ED) response times. A Fishbone Diagram was utilized to understand root causes. Data analysis showed inequities in technologist workload level-loading, protracted lead times and wait times, and an increase in Radiology-ED response times. The team devised many PDSA (Plan, Do, Study, Act) cycles and implementations to improve workflow efficiency, staff satisfaction, and team morale.

#### RESULTS

Interventions centered around three themes: workflows, staff, and the electronic environment. A variety of workflow variations were tested for inpatients, outpatients, ED patients, and portable exams. Staffing models, schedules, level-loading, and communication were also discussed. Optimizations were made to the exam worklists used by multiple roles in the work area. The team improved level-loading of exams per technologist through several iterations of PDSAs, modifying how exams are assigned to each technologist. The team also incorporated a new role to the department, the Radiology Imaging Specialist (RIS), into their workflows. Support from the RIS allowed the technologists to focus more of their time providing tailored patient care during their exams. The team trialed and implemented an additional shift start time along with 12-hour shifts to improve work-life-balance among the technologists. Through these and many other interventions, the team saw a 46% reduction in lead time (Figure 1.), a 29% decrease in General Radiology Emergency Department response times (Figure 2.), and a 15% increase in staff satisfaction (Figure 3.).

#### DISCUSSION

The General Radiology practice is complex and fast-paced; however, the team made substantial improvements despite staffing and other challenges experienced in the Department of Radiology throughout this project. The team learned some valuable lessons along the way, such as: providing adequate time for testing is essential to seeing the full impact of the PDSA, having connections and outside resources can be invaluable, and the importance of thinking big while also being realistic about what we can impact and control.

### W2-QI-9HC Improving first case starts and resource utilization in pediatric interventional radiology (PIR)

Seth Vatsky, DO (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Pediatric interventional radiology (PIR) has grown rapidly, and become an essential service for acute pediatric care. Despite a 3-fold increase in patient volume, the allocation of additional resources (rooms, personnel, ancillary services), has remained mostly stable. Under these conditions, procedural delays represent costly waste, leading to patient and staff dissatisfaction, revenue loss, and lost opportunities for emergent patient care in the form of add-on cases. In 2021 alone, first case procedural delays were estimated at over 8000-minutes with a cost of over \$90,000.

#### METHODS

The section practice is within a quaternary care children's hospital, performing approximately 6000 cases per year. We used ACR-RITE and institutional improvement frameworks to understand reasons for first case delays. We focused on a partnership with anesthesia, inpatient oncology and the pre-procedure unit to include workflows outside PIR that affect first case delays. Process maps, fishbone diagrams, pareto charts, and Gemba walks were used to identify reasons for delays. Interventions included standardized communication of procedure preparation instructions and scheduled procedure time, installation of patient status boards in the pre-procedure unit, hybridization of pre-procedure care with both procedural and pre-op nurses, and creation of first case scheduling criteria with a formalized checklist. Baseline and outcome performance of three key metrics were monitored: 1) % On Time Start; 2) Complete IR Start time; and 3) Mean first case length of delay. Periodic staff

interviews were also performed in a leaderless forum. Outcomes were analyzed using a statistical process control assessment (p or x chart as appropriate) with additional descriptive statistics.

## **RESULTS**

Following sequential implementation of the described countermeasures, time to full department operation improved from a mean of 9:01 am to 8:29 am. Additionally, the mean length of first case delay improved from 15.1 minutes to 10.4 minutes. Reduced variability within the delay length was also noted, consistent with improved process stability. Overall % on time start for first case did not show a meaningful change but may represent an insensitive measurement for early improvement. Qualitative results from PIR, anesthesia providers and IR team members also suggested a marked improvement in departmental performance.

## **DISCUSSION**

Our multi-disciplinary demonstrates how a QI team using formal methodology can engage across care silos to improve on-time starts and decrease variability in start times with improved system reliability. The scope for this project was intentionally limited to the first case of the day. Future improvement will target data based scheduling to predict procedures overrunning their scheduled time, the overall most common cause of lateral case delays.

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## Abstract Archives of the RSNA, 2023

W2-QI-1

### Optimizing Patient Safety and Clinical Work-flow with Digital Radiation Management System

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Mingjun Wang (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Some patients received high radiation dose over threshold for different reasons. Radiologists are responsible for improving clinical imaging work-flow and patient safety optimization intently. The patient safety and radiation dose can be effectively optimized with dose tracking and dose responsibility map using digital radiology management system.

#### METHODS

11 radiologists were enrolled in patient safety optimization program (Fig. 1) from Dec. 2021 to Jan. 2023. The patient radiation information and imaging device information were analyzed using Radimetrics, a digital radiation management system. The patient who cumulative dose over threshold were collected and analyze the primary reason. Among the most common four CT protocols, the number of radiation dose over threshold were recorded every quarter. The device operation information and radiologists working details were also analyzed and improved along the program.

#### RESULTS

The radiation doses of 21,839 CT examinations performed on 15,372 patients from Jan. 2022 to Jan. 2023 were collected and analyzed. The median DLP (mGy.cm) for each scanning region was 225 (heart), 205 (chest), 450 (abdomen) and 610 (head). With dose tracking, the number of radiation dose over threshold constantly decreased among all four CT protocols. The main reasons for over-high radiation dose were shown as follow: improper imaging protocols, wrong patient action, improper imaging operation.

#### DISCUSSION

The preliminary result shows the program can highly protect patients from excessive radiation dose, and also improve radiologists operation and patient care sense. The program should be promoted to other hospitals.

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## Abstract Archives of the RSNA, 2023

W2-QI-2

### Data Driven Strategies for an Education Program to Improve Diversity, Equity, and Inclusion in Radiology

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Viraja Alluri, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The persistent gender, racial, and ethnicity imbalance in the training and radiology workforce has been well-documented. Despite growing awareness of the gap and initiatives, there have not been improvements as seen in other disciplines of medicine. To increase awareness, knowledge, and interest in radiology among our institution's medical and undergraduate students, a longitudinal education program has been designed and implemented since 2022. The goal is to target leaky pipelines and increase the gender and racial diversity of medical students applying to radiology residency. The 5C's of Radiology (5C's) (curriculum, coaching, collaborating, career, and commitment) are applied as a framework for our program. Data-driven strategies have been incorporated to collect quantitative and qualitative data for baseline evaluation and continued monitoring and improvement?.

#### METHODS

Events were conducted at an urban, academic medical school and affiliated university. Medical student events included two shadowing/mentorship programs, two faculty-led career advising events, three M4-led post-MATCH panels, five skills workshops, one women and URM in radiology panel, and three procedure workshops; two introduction to radiology events were held for undergraduates. At the end of each event, students completed a demographics and knowledge questionnaire. The demographics questionnaire gathered information regarding gender, race/ethnicity, school year, and radiology exposure; the knowledge questionnaire assessed students' misconceptions and perception of work-life balance along with event quality and future interest. Responses were obtained using a Likert scale. Surveys were analyzed for trends by question type, race/ethnicity, gender, radiology exposure, and school year. There were 222 attendees with a 45% survey completion rate (100 responses). Two-tailed test assessed statistical significance for race/ethnicity, gender, radiology exposure, and year in medical school trends.

#### RESULTS

Data demonstrates a statistically significant positive impact in addressing misconceptions, promoting work-life balance, and increasing interest of undergraduates. Significantly higher positive ranks are seen in procedure workshops and undergraduate events. There was a positive trend in promoting work-life balance for women. Programs were effective; undergraduate events and shadowing/mentorship programs significantly peaked interest.

#### DISCUSSION

Limitations include limited emphasis on the 5C's coaching and collaborating factors. Future programming includes undergraduate events for women and URM, skills and procedure workshops, and shadowing. Events will be expanded upon in the upcoming semesters. Future data analysis includes results from targeted outreach to underrepresented groups in undergraduate and preclinical medical students.

Printed on: 08/22/24

## Abstract Archives of the RSNA, 2023

W2-QI-3

### Reducing Radiology Reporting Workstation Energy Consumption

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Donald Leith, MBBS, BSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Radiology departments are intense consumers of energy in healthcare with high carbon footprints that contribute to climate change. This is due to the non-stop diagnostic examinations undertaken by CT MR scanners and interventional suites. Numerous high-specification reporting PACS workstations will also contribute. Anecdotally, at the Royal London and St Bartholomew's hospitals, numerous reporting workstations are active 24 h/day even if not in use. We aim to accurately estimate the annual energy consumption of these workstations and to identify an energy saving strategy.

#### METHODS

Electricity consumption metered plugs were used to calculate workstation electricity consumption (kWh) over 12 hours. Each workstation consists of a central processing unit (CPU) and two large high resolution diagnostic monitors. Workstation energy states (WES) were categorised as either IN-USE, ACTIVE NOT IN-USE (CPU and monitors switched ON but not in use), IDLE (CPU switched ON but monitors OFF), SLEEP or OFF. The energy states of 41 workstations were manually assessed on three occasions at the end of a working week and taken to represent energy states throughout a night shift. WES for evening/weekend and daytime hours were estimated based on night shift workstation states and the highest number of rostered radiologists on duty during these shifts. Current annual workstation energy consumption was calculated. Workstations cannot be safely switched OFF every night, as essential cybersecurity and software updates cannot be missed. To reduce energy consumption, workstations should ideally be scheduled to SLEEP when not IN-USE. We therefore compared estimated energy savings for scenarios in which all workstations are programmed to either SLEEP or OFF when not IN-USE.

#### RESULTS

The average WES for night shifts (84 h/week) were 3 IN-USE, 17 ACTIVE NOT IN-USE, 15.7 IDLE, 0 SLEEP and 5.3 OFF. For evening/weekend shifts (44 h/week), estimated WES were 6 IN-USE, 14 ACTIVE NOT IN-USE, 15.7 IDLE, 0 SLEEP and 5.3 OFF. During day shifts (40h/week), estimated WES were 41 IN-USE and 0 for all other energy states. Based on the activity of 41 workstations, annual energy consumption totalled 51,414.6 kWh, costing £17,481/y at the current energy cost rate of £0.34/kWh. If workstations are programmed to either SLEEP or OFF when not IN-USE, energy consumption is predicted to fall to 27,440.1 kWh/y (£9,329.6) or 25,291 kWh/y (£8,599) respectively. Annual estimated energy savings are 23,974.4 kWh (£8151.3) or 26,123.5 kWh (£8882) respectively.

#### DISCUSSION

Long periods of workstations remaining IDLE or ACTIVE NOT IN-USE contribute to high energy consumption in our radiology department. A simple green initiative to programme these workstations to SLEEP when not IN-USE is estimated to reduce departmental energy consumption by approximately 23,974kWh/y, also saving the department £8,151 per year.

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## Abstract Archives of the RSNA, 2023

W2-QI-6

### Automated Assessment of Breast Positioning and Image Quality in Digital Breast Tomosynthesis (DBT) Screening using Synthetically Reconstructed Projection Images

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Ying Guo (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Digital breast tomosynthesis (DBT) is an imaging modality used for breast cancer detection, which requires accurate breast positioning and image quality. Automating the assessment of these parameters can provide consistency and reliability in DBT screening. This study aimed to evaluate the accuracy of an artificial intelligence based tool for automated assessment of breast positioning and image quality in DBT, using synthetically reconstructed projection images.

#### RESULTS

The AI algorithm demonstrated high accuracy in distinguishing between adequate and inadequate images, with an overall accuracy of 93%, sensitivity of 94% and specificity of 92% for FFDM and an accuracy of 92%, sensitivity of 95 and specificity of 91% for DBT with 2D-SM. In terms of breast positioning, the AUC of poor imaging quality prediction by AI system according to incomplete gland, incomplete pectoralis muscle, over or insufficient exposure was (0.903 vs 0.937 vs 0.982). Overall accuracy of AI system was 0.958 for FFDM and 0.932 for DBT with 2D-SM. Inter-observer agreement for image quality assessment was found to be 0.82 (95% confidence interval [CI]: 0.77-0.87), indicating substantial agreement between radiologists and AI system using 2D-SM images. The kappa coefficients for breast positioning assessment were also calculated and found to be moderate to substantial, with values ranging from 0.57 to 0.83 (95% CI: 0.48-0.67 and 0.78-0.88, respectively).

#### METHODS

A total of 150 mammography examinations were enrolled in this study. Subjects underwent screening mammography including DBT with 2D-SM and FFDM. The AI-assisted system automatically evaluated the quality of breast positioning in each image set. Nine image quality criteria evaluating the appearance of the nipple, breast rotation, pectoral muscle, inframammary fold, pectoral nipple line, shoulder overlap shadow, abdominal skin, contralateral breast and foreign body were used for craniocaudal and mediolateral-oblique views. Image quality of cases were also evaluated with the standards of Mammography Quality Standards Act (MQSA) as grade "adequate" or "inadequate". The performance of the AI system was evaluated using accuracy, sensitivity, and specificity. The inter-rater agreement and comparison of their findings with those reported by the AI system was calculated using Cohen's kappa coefficient.

#### DISCUSSION

The results showed a high degree of agreement between the automated and manual assessments, also indicating the performance of the AI tool in assessing breast positioning and image quality in DBT using 2D-SM images was comparable with that in FFDM. The use of synthetic projection images may be a reliable option for the automated assessment of breast positioning and image quality in DBT screening, but caution should be noted in the interpretation of the diagnostic accuracy of DBT images obtained using synthetic projection images.

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## Abstract Archives of the RSNA, 2023

W2-QI-7

### Automating and Integrating Breast Imaging Workflows to Improve Efficiency and Quality

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Clayton R. Taylor, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Optimizing workflows for the interpretation of breast imaging studies is increasingly important given patient and referring clinician needs for rapid turnaround times, increasing imaging volumes and the scarcity of breast imaging radiologists. These workflows must accommodate immediate interpretation for some imaging studies and batch offline interpretation for others while addressing quality and prior comparison needs. Our goal was to decrease the turnaround time for breast imaging studies while more efficiently and equitably assigning studies to radiologists.

#### RESULTS

Our process improvement project has allowed for an automated system that immediately and equally distributes breast imaging cases amongst radiologists and creates closed loop workflows for technical repeats and obtaining prior imaging studies. This has led to a significant reduction in report turnaround times (TAT) for screening mammograms from 109 minutes prior to implementation to 90 minutes post implementation and for breast MRI median from 287 minutes prior to implementation to 169 minutes post implementation. At least 7.5 hours per week of time is saved each week by our lead technologists by the use of these automated workflows.

#### METHODS

Our breast center is a part of a tertiary care academic medical center providing breast cancer screening and diagnostic evaluations as well as supporting busy breast specialty practices. Before our process improvement project, our lead technologists would intermittently drag and drop screening mammograms to static worklists. This was inefficient, time-consuming and led to delays in the assignment of mammograms. Our project addressed this problem by integrating our scheduling software with our worklist application and leveraging a function within our worklist application to immediately, equitably and automatically assign screening mammograms, screening breast ultrasound and breast MRIs to each radiologist working a shift. Separately, our technologists add a modifier to each screening mammogram for patients seen by practitioners in the clinic the same day, moving the study to the diagnostic (immediate interpretation) worklist. At the same time, we deployed a solution allowing radiologists to instantly request priors or ask for technical repeats causing those studies to immediately populate unique worklists monitored by our lead technologists and assistants who upload priors or address the issues before releasing the studies to be assigned automatically once again, creating a closed loop quality workflow.

#### DISCUSSION

Our improved breast imaging workflows improved efficiency with a direct positive impact on report turnaround times. These changes have also eliminated time consuming manual processes and created closed loop systems to improve quality by obtaining prior imaging studies and addressing technical issues.

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## Abstract Archives of the RSNA, 2023

W2-QI-8HC

### Optimizing Workflows and Work-Life Balance in General Radiology

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Molly M. Boelter, MBA, RN (*Presenter*) Nothing to Disclose

#### INTRODUCTION

This team, like many others, has experienced workflow and staffing challenges since the COVID-19 pandemic began. Staffing levels and morale among technologists were low. The team came together to optimize workflows and improve staff satisfaction in a hospital-based General Radiology practice. The purpose of this project was to decrease lead times by 15% without negatively impacting staff satisfaction.

#### METHODS

A team of radiographers, desk operations specialists, employee safety professionals, and quality improvement personnel approached this issue with the DMAIC (Define, Measure, Analyze, Improve, Control) framework. The current condition of the practice was studied with measures such as lead time, staff satisfaction, and Radiology to Emergency Department (ED) response times. A Fishbone Diagram was utilized to understand root causes. Data analysis showed inequities in technologist workload level-loading, protracted lead times and wait times, and an increase in Radiology-ED response times. The team devised many PDSA (Plan, Do, Study, Act) cycles and implementations to improve workflow efficiency, staff satisfaction, and team morale.

#### RESULTS

Interventions centered around three themes: workflows, staff, and the electronic environment. A variety of workflow variations were tested for inpatients, outpatients, ED patients, and portable exams. Staffing models, schedules, level-loading, and communication were also discussed. Optimizations were made to the exam worklists used by multiple roles in the work area. The team improved level-loading of exams per technologist through several iterations of PDSAs, modifying how exams are assigned to each technologist. The team also incorporated a new role to the department, the Radiology Imaging Specialist (RIS), into their workflows. Support from the RIS allowed the technologists to focus more of their time providing tailored patient care during their exams. The team trialed and implemented an additional shift start time along with 12-hour shifts to improve work-life-balance among the technologists. Through these and many other interventions, the team saw a 46% reduction in lead time (Figure 1.), a 29% decrease in General Radiology Emergency Department response times (Figure 2.), and a 15% increase in staff satisfaction (Figure 3.).

#### DISCUSSION

The General Radiology practice is complex and fast-paced; however, the team made substantial improvements despite staffing and other challenges experienced in the Department of Radiology throughout this project. The team learned some valuable lessons along the way, such as: providing adequate time for testing is essential to seeing the full impact of the PDSA, having connections and outside resources can be invaluable, and the importance of thinking big while also being realistic about what we can impact and control.

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## Abstract Archives of the RSNA, 2023

W2-QI-9HC

### Improving first case starts and resource utilization in pediatric interventional radiology (PIR)

Wednesday, Nov. 29 9:00AM - 9:30AM Room: Learning Center

Seth Vatsky, DO (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Pediatric interventional radiology (PIR) has grown rapidly, and become an essential service for acute pediatric care. Despite a 3-fold increase in patient volume, the allocation of additional resources (rooms, personnel, ancillary services), has remained mostly stable. Under these conditions, procedural delays represent costly waste, leading to patient and staff dissatisfaction, revenue loss, and lost opportunities for emergent patient care in the form of add-on cases. In 2021 alone, first case procedural delays were estimated at over 8000-minutes with a cost of over \$90,000.

#### METHODS

The section practice is within a quaternary care children's hospital, performing approximately 6000 cases per year. We used ACR-RITE and institutional improvement frameworks to understand reasons for first case delays. We focused on a partnership with anesthesia, inpatient oncology and the pre-procedure unit to include workflows outside PIR that affect first case delays. Process maps, fishbone diagrams, pareto charts, and Gemba walks were used to identify reasons for delays. Interventions included standardized communication of procedure preparation instructions and scheduled procedure time, installation of patient status boards in the pre-procedure unit, hybridization of pre-procedure care with both procedural and pre-op nurses, and creation of first case scheduling criteria with a formalized checklist. Baseline and outcome performance of three key metrics were monitored: 1) % On Time Start; 2) Complete IR Start time; and 3) Mean first case length of delay. Periodic staff interviews were also performed in a leaderless forum. Outcomes were analyzed using a statistical process control assessment (p or x chart as appropriate) with additional descriptive statistics.

#### RESULTS

Following sequential implementation of the described countermeasures, time to full department operation improved from a mean of 9:01 am to 8:29 am. Additionally, the mean length of first case delay improved from 15.1 minutes to 10.4 minutes. Reduced variability within the delay length was also noted, consistent with improved process stability. Overall % on time start for first case did not show a meaningful change but may represent an insensitive measurement for early improvement. Qualitative results from PIR, anesthesia providers and IR team members also suggested a marked improvement in departmental performance.

#### DISCUSSION

Our multi-disciplinary demonstrates how a QI team using formal methodology can engage across care silos to improve on-time starts and decrease variability in start times with improved system reliability. The scope for this project was intentionally limited to the first case of the day. Future improvement will target data based scheduling to predict procedures overrunning their scheduled time, the overall most common cause of lateral case delays.

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## Abstract Archives of the RSNA, 2023

W5A-QI

### Quality Improvement Reports Wednesday Poster Discussions I

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

#### Sub-Events

#### **W5A-QI-1 Impact of EHR Driven Force Function on Pregnancy Screening Compliance Rates in Fluoroscopy**

Janelle Van Luling, RT, ARRT (*Presenter*) Nothing to Disclose

##### **INTRODUCTION**

Work environment and human factors impact staff compliance rates for ensuring proper pregnancy screening prior to relevant radiologic exams. Failure to screen for pregnancy may be viewed as a serious safety event due to potential subsequent radiation exposure to a fetus. This QI project is phase two of an initial pregnancy screening compliance initiative which was successfully initiated in CT scan. This project aimed to expand an automated technologist reminder question embedded into the electronic health record (EHR) when beginning an exam. We aimed to improve compliance from baseline of 65% to 95%.

##### **RESULTS**

Baseline data obtained from February 1, 2022-January 29, 2023, for a randomized cohort of 50 female patients (4-5 patients per month) between ages 10 and 55 with an order for a fluoroscopic exam involving the abdomen/pelvic regions revealed 65% compliance in documenting appropriate pregnancy screening. EHR-driven question was implemented on January 30, 2023. Post intervention random audit of 27 exams performed from February 1 - April 20, 2023 revealed 100% screening documentation compliance (Figure 1).

##### **METHODS**

A team composed of subspecialty radiologists, x-ray technologists and quality improvement specialists worked to identify contributing factors leading to non-compliance in pregnancy screening on fluoroscopy exams. A3 methodology, process mapping, manual chart audits and frontline staff feedback were utilized to focus our interventions. An EHR-driven force function reminder was created using human-centered design principles. This mandatory question only fires on relevant exams (fluoroscopic studies that radiate the abdomen and/or pelvic regions) and a specific patient population (female sex assigned at birth and age 10-55). Interventional Radiology exam codes were excluded. To avoid click fatigue, the hard stop question was designed to incorporate recent negative pregnancy test results within 48 hours (or current hospital stay) creating a targeted, logical reminder. Screening compliance rate was analyzed before and after implementation.

##### **DISCUSSION**

While institutional radiation safety and pregnancy testing policies are designed to optimize patient safety and avoid unintended fetal radiation, compliance in following the policy by front line staff is variable due to environment and human factors. Confusion on who needs pregnancy screening, what exact exams require screening and lack of standard process can all contribute to non-compliance. Originally built for our CT technologists, this QI initiative expanded a successfully implemented logical reminder in our EHR to our fluoroscopy department. This project successfully increased compliance in having pregnancy status verified from 65% to 100%. Following success at our main tertiary center, the initiative was expanded to 4 other hospitals within our health system.

#### **W5A-QI-2 Reporting Backlog Clearance Campaign**

Nameet Hattangadi, FRCR, DMRD (*Presenter*) Nothing to Disclose

##### **INTRODUCTION**

By March 2022, most of the coronavirus restrictions in the UK had been lifted with surge in CT scan and MRI requests across our Trust and from primary care. With the increasing demand, we were not able to report all the additional burden. Our traditional additional reporting system failed to motivate majority of radiologists to work outside contractual hours. It also could not prevent preferential reporting based on individual liking for some type of scans. This resulted in relatively complex

and time-consuming scans as a major contribution to reporting backlog. We started outsourcing for reporting scans in July 2022. However, even with the added capacity, we could not cope up with the increasing demand, resulting in a backlog reaching above 11,000 in January 2023. The diagnoses were delayed for about 6-8 months, further delaying treatment and compromising patient safety. The reporting backlog was escalated as the highest risk on our Trust register requiring some effective strategy to be implemented.

## **METHODS**

To tackle this biggest challenge, we introduced a new system for additional reporting with some added monetary incentives, wherein scans would be allocated to individual radiologists, mapping the pattern of unreported scans. We set different worklist configurations named as 'Packets'. Each packet consisting of 12 to 17 scans, about 50-70% of complex/ time consuming scans and remainder with different subspecialty interests. This configuration was intended to prevent preferential reporting as per individual liking. This was not a time bound activity, but we set a goal of completing each packet within 48 hours of assignment with a penalty clause for delay in reporting. We also ensured escalating any new diagnosis or disease progression to be acted upon to keep the patient as safe as possible.

## **RESULTS**

Total 22 out of 38 radiologists (58%) participated in this initiative, 7 out of these (18%) newly started contributing to additional reporting, 5 (13%) switched over from traditional system to new system, whereas 10 (26%) participated through both systems with more inclination towards the 'Packets'. Under this activity, we could report 6,229 scans helping 55% of the total backlog with maximum turnaround time being 2 days bringing down the backlog from 11,180 to 476 in 15 weeks. The waiting time for reporting CT and MRI scans from request to report came down to less than 6 weeks.

## **DISCUSSION**

Wider participation from the radiologists showcased motivation and teamwork. Apart from clearing the reporting backlog this project prevented any further addition to the backlog. The improvement has positively impacted multidisciplinary team meetings, overall patient experience, patient care, and patient safety. With the various advantages and success, we have achieved with this project, other NHS Trusts with backlog could also consider this approach while tackling their backlog.

## **W5A-QI-3 Deferral of eGFR Testing in Low Risk Patients Prior to Contrast Enhanced CT: Impact on Emergency Room (ER) Imaging Throughput**

Gowthaman Gunabushanam, MD (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

Deferral of eGFR testing prior to performing contrast enhanced CT scans (CECT) in patients at low risk for kidney disease has been safely demonstrated in outpatient settings. However, at our institution eGFR testing was routinely required before CECT in the ER. The purpose of this QI project was to improve timeliness of care in the ER by eliminating need for an eGFR value prior to CECT in patients deemed low risk for significant kidney disease.

## **METHODS**

Baseline (12/28/2021 - 3/7/2022, weeks 1-10) CECT order-to-protocol (O to P) and order-to-exam begin (O to B) times were measured. A question was added to the ordering screen in the EHR for all CECTs ordered in the ER which allowed providers the option of scanning without an eGFR value if the patient was deemed low risk. Low risk was defined as: (a) no history of chronic kidney disease (CKD), (b) no risk factors for CKD (diabetes, hypertension, prior kidney surgery, etc) or known to be on dialysis, and (c) no risk factors for AKI (sepsis, dehydration, drug toxicity, altered mental status, etc).

## **RESULTS**

In the initial pilot phase (3/8/2022 - 6/13/2022, weeks 11-24), the EHR question was implemented as optional, resulting in low utilization rates (5-14%). Subsequently, in the launch phase (6/14/2022 - 8/15/2022, weeks 25-33), the question was implemented as a hard-stop requiring an answer to proceed (100% utilization). A total of 16,446 CECT exams were included in this study (4,456 baseline, 6,933 pilot phase, 5,057 launch phase) for 4 ERs within our health system: 2 adult 1 pediatric hospital-based ER, and 1 freestanding ER. In the launch phase, 68% (3,451 of 5,057) studies were categorized by ER providers as low risk for kidney disease (OK to scan without eGFR value). In the launch phase, 0.3% (2/646) studies deemed low risk were completed that had an eGFR subsequently result as  $< 30 \text{ mL/min/1.73m}^2$ . Median O to P time across all ERs improved from 23.93 min at baseline to 13.02 min in the launch phase. Median O to B time across all ERs improved from 80.34 min at baseline to 76.48 min in the launch phase with median O to B times for low risk patients improving to 72.08 min. Sub analysis showed net improvements in the median O to B were greater in the freestanding ER (36.33 vs. 22.98 min) and pediatric ER (147.65 min vs. 132.80 min).

## **DISCUSSION**

This QI project successfully created an eGFR deferral process embedded into our EHR based on risk factor assessment. Slightly over two-thirds of patients were deemed as low risk and safe to scan without an eGFR value. Patient safety was preserved with only 0.3% of patients having severe renal impairment (eGFR < 30) discovered after CECT that were deemed low risk upon order entry. This project led to improved study CECT order-to-begin times for low risk patients in the ER by 8 minutes, potentially allowing for improved throughput and earlier time to diagnosis.

#### **W5A-QI-4 Evaluation of a Medical Decision Support System for the Prescription of Medical Imaging Examinations: Qualitative and Quantitative Studies with Radiologists and Radiology Residents in France**

Justine SPRIET (*Presenter*) Nothing to Disclose

##### **INTRODUCTION**

Medical imaging is at the heart of medical care, because of its contribution to the diagnosis, follow-up and treatment of numerous pathologies. The appropriateness and indication of imaging examinations play a crucial role in healthcare, especially at a time of increasing demand which impacts timing, cost, radiation exposure and the environment. With a constant concern for quality care and equal access, the French Society of Radiology (SFR) developed the "Guide du Bon Usage" ("Proper Use Guide") followed by an online version, primarily intended for general practitioners. The main objective of our study was to evaluate the use of this new tool by radiologists and collect their opinion, in order to improve and promote this guide, toward more efficient and relevant patient care.

##### **METHODS**

Qualitative then quantitative studies carried out with radiologists and radiology residents in France to evaluate our tool. The qualitative study consisted of data collection during focus group interviews then thematic analysis using the SWOT technique. Based on this preliminary work, a questionnaire was developed and sent to radiologists on a broader scale to collect their opinions on the website.

##### **RESULTS**

Radiologists' initial opinion of the guide was mostly positive, particularly as to the layout, the ease of use, and the quick turnaround. However, modifications and additions had to be made to the first version in order to accommodate clinicians' requests, i.e. reasons for consultations, optimization of users experience and quality of information. The guide was also redesigned to address a more specialized audience, such as radiologists. In order to promote the use of our guide, its name was modified for a more intuitive one, active promotion and ultimately, the development of a smartphone application were done.

##### **DISCUSSION**

Our study has identified many opportunities for improvement to facilitate the use of this tool in order to optimize the relevance and efficiency of imaging examinations for requesting physicians. Learning from other decision support systems, in particular the ACR Appropriateness Criteria (AC), and creating an application with a decision algorithm were found to be useful toward more comprehensive, generalize and optimal care for patients.

#### **W5A-QI-5 Enhancing Efficiency in MRI Protocols: A Quality Improvement Initiative**

Marie Hausner, MPH, ARRT (*Presenter*) Nothing to Disclose

##### **INTRODUCTION**

The protocoling process for MRI exams can be time-consuming and burdensome for radiologists. While the process can better define the exact type of study to perform, for many exams with a standard imaging protocol, assigning a protocol manually adds little value and creates waste. This can result in increased workload and delays in patient care. Our department's QI team launched a quality improvement project to reduce the burden of protocoling for MRI exams, based on successful outcomes from a similar project in CT. A selected group of MRI codes were enrolled in an electronic health record (EHR)-driven auto-protocol program for adult patients. The purpose of this study was to implement and evaluate the effectiveness of the auto-protocol program for MRI exams with a goal of reducing the protocoling burden by 20%.

##### **METHODS**

The intervention enrolled a selected group of MRI codes, as determined by the QI team and divisional leadership, into an auto-protocol program eliminating the need for manual protocol assignment by radiologists or technologists. Codes that were selected for enrollment were removed from protocol lists. They received a protocol designation in our health system's EHR (Epic, Verona WI) through creation of a programming script that automatically inserted the words "Perform as ordered per policy" into the protocol field. The program was implemented for ten MRI sites across three hospital networks covered by our academic radiology group on 1/12/23. Three months of baseline data was collected (October-December 2022) to assess baseline rate of exams that received a human-assigned manual protocol from a radiologist and to predict the expected reduction in manual protocoling after project launch. Three months of post intervention data (January-April 2023) was collected to assess project impact. A time savings calculation was also calculated.

## RESULTS

The auto-protocol program enrolled 58 of 300 (19% of available MRI codes). Analysis of the baseline data revealed that these codes reflected 23% of the exams protocolled by our academic radiology practice. At baseline 98% of MR orders received a radiologist protocol monthly which decreased to 76-78% (mean = 77%) after project launch (Figure 1). Mean time to protocol an MRI was approximated at 15 seconds. Based on this, we estimated the project would reduce time spent protocoling by 5 hours monthly and 60.5 hours annually.

## DISCUSSION

The implementation of an auto-protocol program for MRI exams has been successful in enhancing efficiency and reducing protocol workload for radiologists while maintaining the quality and safety of patient care. The project has resulted in a 21% decrease in the number MRI orders needing manual assignment of a protocol with estimated time savings of 60.5 hours annually.

### **W5A-QI-6 Breaking Bad News to Patients on the Breast Imaging Service: Designing a Resident Curriculum**

Julia Gerras, MD, BS (*Presenter*) Nothing to Disclose

## INTRODUCTION

Breast cancer is increasingly common, and patients experience significant anxiety when presenting for breast imaging studies. Non-interpretive skills on how to communicate and share difficult results with patients are central to improving patient care and trainee education. There is currently no standardized curriculum in the Department of Radiology to teach residents how to effectively communicate with patients. We created a curriculum designed for residents to improve their effective communication skills when on the breast imaging service. This curriculum includes undergoing standardized patient (SP) encounters and watching a clinically driven educational video demonstrating two clinical encounters where a physician delivers "good" and "bad" news to a patient.

## METHODS

At the start of the rotation residents will complete a self-evaluation utilizing a 5-point Likert scale determining their comfort level with delivering results. Each resident then undergoes two SP encounters representing common clinical scenarios seen in breast radiology. Residents will be evaluated by an attending with a standardized scoring sheet utilizing the established SPIKES protocol outlining a six-step technique on how to appropriately deliver bad news. An attending will debrief with the resident, providing feedback and constructive criticism. The resident will then watch the educational video. At the end of the rotation, they will undergo two additional SP encounters and again be evaluated by an attending with the same scoring sheet as before. Lastly, the resident will complete the same self-evaluation.

## RESULTS

Resident 1 showed a 20% increase in the SP encounter score while resident 2 showed a 5% increase in the SP encounter score. The overall average percent change between pre- and post-curriculum encounters is +12.5%. Post-curriculum self-evaluation scores showed a general increase in resident confidence in their ability to deliver news to patients. Residents do not begin rotating through breast imaging at UCLA until R2 year. As such there is currently a small sample size as only two new R2's have rotated through the breast department since implementation. There is an anticipated increase in response data beginning July 2023 once the new academic year begins which will give us more data points to analyze.

## DISCUSSION

Implementing a standardized curriculum for radiology residents completing their first breast imaging rotation will increase their confidence and ability to effectively deliver patient results. The overall goal is to ease patients allowing them to feel as comfortable and confident with their providers as possible, thus decreasing anxiety when presenting to the breast imaging department. We believe that this standardized curriculum will be successful at our institution, and hope that it will ultimately be adopted by other institutions in training their residents.

### **W5A-QI-7 Iodine Contrast Media Volume and CT Enhancement: When Less is More**

Larissa Marciano, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Increased iodine enhancement with lower kVp can be used as a complementary approach to reduce contrast media (CM) dose as maintaining noise image level and image diagnostic quality. Manufactures technologies as automated dose modulation and iterative reconstruction (IR) enable reducing kVp values and radiation exposure as consequence. Reducing iodine intake during computer tomography (CT) improves safety and tolerability of CM injections. The objective of this study was to achieve ideal iodine enhancement in abdominal CT image associating lower kVp protocols and reduced CM volume.



## METHODS

In order to promote CM reduction protocol, this project was developed in the CT unit of a Brazilian tertiary hospital (4 CT scanners) during January 1st and 1st February, 2023. The following steps were implemented: \*Step 1- high iodine concentration CM multidose injection in order to save iodine CM due to Global iodine CM shortage during the study duration; \*Step 2- Optimization of protocol parameters according to manufactures recommendations in order to improve abdominal contrast CT image quality with reduced CM volume; \*Step 3- Application of a new formula to calculate CM volume for abdominal CT exams according to manufactures kVp reduction recommendations; \*Step 4- Qualitative and quantitative data analyses and comparisons.

## RESULTS

100 CT scans were performed during the study period. Our results demonstrated a nearly 40% reduction in CM volume with no image quality loss. We also ensure ideal hepatic parenchyma enhancement level (around 50 HU) as recommend in the literature.

## DISCUSSION

Global iodine CM shortage in the second semester of 2022, and beginning of 2023 led to its rational in health centers and clinical practice. It is possible to achieve ideal vessels and parenchyma enhancement with low volume and/or low flow rate injection using high iodine concentration CM. Reducing CM volume is beneficial in patients with risk factors for kidney injury. Reducing CM volume requires a balance between injection flow rate and other protocols parameters, such as kVp modulation and IR technology, in order to improve image diagnostic quality.

## **W5A-QI-8HC**    **Setting the bar higher: Implementing a quality control program to improve US image quality.**

Aiah Alatoum, MBBS (*Presenter*) Nothing to Disclose

## INTRODUCTION

This quality improvement project aimed to establish a continued program to ensure high-quality ultrasound exams in our institution by updating our protocols, performing a standardized review of our US exams, and monthly discussing the areas for improvement.

## METHODS

Our US protocols were reviewed to reflect the AIUM and ACR guidelines. An image library was created with high-quality images of all types of exams performed. A senior sonographer with 15 years of experience performed a Quality Control (QC) role and reviewed 570 exams over one year. The quality of grayscale, color Doppler, Spectral Doppler images, and protocol adherence were evaluated. The results and cases needing improvement were discussed in a monthly meeting. In the first, 6th, and 12th months, 100 exams were reviewed. The project targeted a >20% decrease in the number of exams graded needing improvement. Statistical comparisons were performed using the Chi-square test, with  $P < .05$  as the significance threshold.

## RESULTS

The QC audit in Mar/21, Sep/21, and Feb/22 showed a significant decrease in the number of studies overall graded needing improvement from 23% in Mar/21 to 13% in Sep/21 and 5% in Feb/22 ( $P=0.001$ ). There was a high protocol adherence throughout the study 97% of the exams graded good or satisfactory in Mar/21 and Sep/21, and 100% graded good or satisfactory in Feb/22 ( $P=0.21$ ). There was a significant decrease in the number of studies with grayscale images graded as needing improvement, from 7% in Mar/21 to 1% in Sep/21 and Feb/22 ( $P=0.016$ ). There was a significant decrease in the number of studies with color Doppler graded as needing improvement, from 19% in Mar/21 to 7% in Sep/21 and 3% in Feb/22 ( $P=0.0003$ ). There was a significant decrease in the number of studies with Spectral Doppler graded as needing improvement, from 33% in Mar/21 to 18% in Sep/21 and 2% in Feb/22 ( $P<0.0001$ ). The number of studies with missing protocol images or non-contributing images decreased from 44% in Mar/21 to 38% in Sep/21 and 21% in Feb/22 ( $P=0.0018$ ).

## DISCUSSION

Our findings showed significant improvement in the measured image quality parameters over time. There was a 78% reduction in the number of exams graded needing improvement in at least one parameter. Our ultrasound protocols were highly adhered to throughout the study, reflecting the sonographer's engagement and collaboration. This project also allowed us to recognize outstanding sonographers' work, by which we could leverage their strengths and enhance job satisfaction. Limitations of this project included that the examinations were not blinded. There is also subjectivity in the scoring of the ultrasound parameters. However, this study shows a practical real-life clinical process that was implemented. As a result of the project's success, the implemented changes are now part of our ultrasound routine, and other divisions are starting to implement similar programs.

## **W5A-QI-9HC**    **Improving General Radiology Technologist Inequalities Through Standardized Workflows and Expectations**

Jensen, BS (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

The purpose of this study was to create a workflow that would reduce inequities among technologist workloads, which were unbalanced and unpredictable. The goal of the project was to improve the range of exams performed per technologist from fourteen to seven, during a one-week Kaizen event, without negatively impacting on time starts (OTS).

## **METHODS**

A team of General Radiology, Desk Operations, clinical and quality improvement personnel approached this issue using the Define-Measure-Analyze-Improve-Control (DMAIC) and A3 framework to advise a solution strategy using a series of Plan-Do-Study-Act (PDSA) cycles. Qualitative and quantitative measures were used to monitor progress. Exam accession numbers completed per technologist, per shift were monitored daily to show the range of exams performed between technologists. Department OTS were monitored as a counterbalance. A root cause analysis was performed to determine all possible solutions and then placed into a Fishbone Diagram and Impact Effort Grid to prioritize possible approaches. The team worked through many PDSA cycles of different workflow options to standardize level-loading technologist workloads. Patients were scheduled to specific exam rooms and technologists stuck to their own scheduled list. Patients were brought back to the exam rooms based on their appointment times, not check in times. The team also agreed on standard electronic cues that were used to alert them when their next patient was ready for their exam. Each technologist would now know the schedule for their exam room, which patient was coming to them next, and when the patient was moved to the dressing room to prepare for their exam. A detailed review of technologist exam ranges were considered after each PDSA cycle to determine success.

## **RESULTS**

The outcome of this project proved to be successful, with a sample size of 441 patients the range of exam accession numbers stayed under the goal of seven exams per technologist (Figure 1). This PDSA was implemented within the department, successfully balancing the technologists' workload, and allowing more predictability for the technologists' daily schedule. OTS were maintained throughout the PDSA cycle and continue to stay above the baseline of 97% (Figure 2).

## **DISCUSSION**

Many lessons were learned throughout the PDSA cycles. The importance of communication between teams in the area was the most vital lesson learned. Throughout the PDSA cycles, team members learned what their expectations from the department were for their workday, allowing the new standard process to equally level out the workload between all staff. The team learned that by having these standards in place, there was more predictability in the workday and fewer frustrations among technologists. Limitations of the project included critical staffing status during PDSA cycles.

Printed on: 08/22/24



## Abstract Archives of the RSNA, 2023

W5A-QI-1

### Impact of EHR Driven Force Function on Pregnancy Screening Compliance Rates in Fluoroscopy

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Janelle Van Luling, RT, ARRT (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Work environment and human factors impact staff compliance rates for ensuring proper pregnancy screening prior to relevant radiologic exams. Failure to screen for pregnancy may be viewed as a serious safety event due to potential subsequent radiation exposure to a fetus. This QI project is phase two of an initial pregnancy screening compliance initiative which was successfully initiated in CT scan. This project aimed to expand an automated technologist reminder question embedded into the electronic health record (EHR) when beginning an exam. We aimed to improve compliance from baseline of 65% to 95%.

#### RESULTS

Baseline data obtained from February 1, 2022-January 29, 2023, for a randomized cohort of 50 female patients (4-5 patients per month) between ages 10 and 55 with an order for a fluoroscopic exam involving the abdomen/pelvic regions revealed 65% compliance in documenting appropriate pregnancy screening. EHR-driven question was implemented on January 30, 2023. Post intervention random audit of 27 exams performed from February 1 - April 20, 2023 revealed 100% screening documentation compliance (Figure 1).

#### METHODS

A team composed of subspecialty radiologists, x-ray technologists and quality improvement specialists worked to identify contributing factors leading to non-compliance in pregnancy screening on fluoroscopy exams. A3 methodology, process mapping, manual chart audits and frontline staff feedback were utilized to focus our interventions. An EHR-driven force function reminder was created using human-centered design principles. This mandatory question only fires on relevant exams (fluoroscopic studies that radiate the abdomen and/or pelvic regions) and a specific patient population (female sex assigned at birth and age 10-55). Interventional Radiology exam codes were excluded. To avoid click fatigue, the hard stop question was designed to incorporate recent negative pregnancy test results within 48 hours (or current hospital stay) creating a targeted, logical reminder. Screening compliance rate was analyzed before and after implementation.

#### DISCUSSION

While institutional radiation safety and pregnancy testing policies are designed to optimize patient safety and avoid unintended fetal radiation, compliance in following the policy by front line staff is variable due to environment and human factors. Confusion on who needs pregnancy screening, what exact exams require screening and lack of standard process can all contribute to non-compliance. Originally built for our CT technologists, this QI initiative expanded a successfully implemented logical reminder in our EHR to our fluoroscopy department. This project successfully increased compliance in having pregnancy status verified from 65% to 100%. Following success at our main tertiary center, the initiative was expanded to 4 other hospitals within our health system.

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## Abstract Archives of the RSNA, 2023

W5A-QI-2

### Reporting Backlog Clearance Campaign

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Nameet Hattangadi, FRCR, DMRD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

By March 2022, most of the coronavirus restrictions in the UK had been lifted with surge in CT scan and MRI requests across our Trust and from primary care. With the increasing demand, we were not able to report all the additional burden. Our traditional additional reporting system failed to motivate majority of radiologists to work outside contractual hours. It also could not prevent preferential reporting based on individual liking for some type of scans. This resulted in relatively complex and time-consuming scans as a major contribution to reporting backlog. We started outsourcing for reporting scans in July 2022. However, even with the added capacity, we could not cope up with the increasing demand, resulting in a backlog reaching above 11,000 in January 2023. The diagnoses were delayed for about 6-8 months, further delaying treatment and compromising patient safety. The reporting backlog was escalated as the highest risk on our Trust register requiring some effective strategy to be implemented.

#### METHODS

To tackle this biggest challenge, we introduced a new system for additional reporting with some added monetary incentives, wherein scans would be allocated to individual radiologists, mapping the pattern of unreported scans. We set different worklist configurations named as 'Packets'. Each packet consisting of 12 to 17 scans, about 50-70% of complex/ time consuming scans and remainder with different subspecialty interests. This configuration was intended to prevent preferential reporting as per individual liking. This was not a time bound activity, but we set a goal of completing each packet within 48 hours of assignment with a penalty clause for delay in reporting. We also ensured escalating any new diagnosis or disease progression to be acted upon to keep the patient as safe as possible.

#### RESULTS

Total 22 out of 38 radiologists (58%) participated in this initiative, 7 out of these (18%) newly started contributing to additional reporting, 5 (13%) switched over from traditional system to new system, whereas 10 (26%) participated through both systems with more inclination towards the 'Packets'. Under this activity, we could report 6,229 scans helping 55% of the total backlog with maximum turnaround time being 2 days bringing down the backlog from 11,180 to 476 in 15 weeks. The waiting time for reporting CT and MRI scans from request to report came down to less than 6 weeks.

#### DISCUSSION

Wider participation from the radiologists showcased motivation and teamwork. Apart from clearing the reporting backlog this project prevented any further addition to the backlog. The improvement has positively impacted multidisciplinary team meetings, overall patient experience, patient care, and patient safety. With the various advantages and success, we have achieved with this project, other NHS Trusts with backlog could also consider this approach while tackling their backlog.

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## Abstract Archives of the RSNA, 2023

W5A-QI-3

### Deferral of eGFR Testing in Low Risk Patients Prior to Contrast Enhanced CT: Impact on Emergency Room (ER) Imaging Throughput

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Gowthaman Gunabushanam, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Deferral of eGFR testing prior to performing contrast enhanced CT scans (CECT) in patients at low risk for kidney disease has been safely demonstrated in outpatient settings. However, at our institution eGFR testing was routinely required before CECT in the ER. The purpose of this QI project was to improve timeliness of care in the ER by eliminating need for an eGFR value prior to CECT in patients deemed low risk for significant kidney disease.

#### METHODS

Baseline (12/28/2021 - 3/7/2022, weeks 1-10) CECT order-to-protocol (O to P) and order-to-exam begin (O to B) times were measured. A question was added to the ordering screen in the EHR for all CECTs ordered in the ER which allowed providers the option of scanning without an eGFR value if the patient was deemed low risk. Low risk was defined as: (a) no history of chronic kidney disease (CKD), (b) no risk factors for CKD (diabetes, hypertension, prior kidney surgery, etc) or known to be on dialysis, and (c) no risk factors for AKI (sepsis, dehydration, drug toxicity, altered mental status, etc).

#### RESULTS

In the initial pilot phase (3/8/2022 - 6/13/2022, weeks 11-24), the EHR question was implemented as optional, resulting in low utilization rates (5-14%). Subsequently, in the launch phase (6/14/2022 - 8/15/2022, weeks 25-33), the question was implemented as a hard-stop requiring an answer to proceed (100% utilization). A total of 16,446 CECT exams were included in this study (4,456 baseline, 6,933 pilot phase, 5,057 launch phase) for 4 ERs within our health system: 2 adult 1 pediatric hospital-based ER, and 1 freestanding ER. In the launch phase, 68% (3,451 of 5,057) studies were categorized by ER providers as low risk for kidney disease (OK to scan without eGFR value). In the launch phase, 0.3% (2/646) studies deemed low risk were completed that had an eGFR subsequently result as  $< 30$  mL/min/1.73m<sup>2</sup>. Median O to P time across all ERs improved from 23.93 min at baseline to 13.02 min in the launch phase. Median O to B time across all ERs improved from 80.34 min at baseline to 76.48 min in the launch phase with median O to B times for low risk patients improving to 72.08 min. Sub analysis showed net improvements in the median O to B were greater in the freestanding ER (36.33 vs. 22.98 min) and pediatric ER (147.65 min vs. 132.80 min).

#### DISCUSSION

This QI project successfully created an eGFR deferral process embedded into our EHR based on risk factor assessment. Slightly over two-thirds of patients were deemed as low risk and safe to scan without an eGFR value. Patient safety was preserved with only 0.3% of patients having severe renal impairment (eGFR  $< 30$ ) discovered after CECT that were deemed low risk upon order entry. This project led to improved study CECT order-to-begin times for low risk patients in the ER by 8 minutes, potentially allowing for improved throughput and earlier time to diagnosis.

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## Abstract Archives of the RSNA, 2023

W5A-QI-4

### **Evaluation of a Medical Decision Support System for the Prescription of Medical Imaging Examinations: Qualitative and Quantitative Studies with Radiologists and Radiology Residents in France**

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Justine SPRIET (*Presenter*) Nothing to Disclose

#### **INTRODUCTION**

Medical imaging is at the heart of medical care, because of its contribution to the diagnosis, follow-up and treatment of numerous pathologies. The appropriateness and indication of imaging examinations play a crucial role in healthcare, especially at a time of increasing demand which impacts timing, cost, radiation exposure and the environment. With a constant concern for quality care and equal access, the French Society of Radiology (SFR) developed the "Guide du Bon Usage" ("Proper Use Guide") followed by an online version, primarily intended for general practitioners. The main objective of our study was to evaluate the use of this new tool by radiologists and collect their opinion, in order to improve and promote this guide, toward more efficient and relevant patient care.

#### **METHODS**

Qualitative then quantitative studies carried out with radiologists and radiology residents in France to evaluate our tool. The qualitative study consisted of data collection during focus group interviews then thematic analysis using the SWOT technique. Based on this preliminary work, a questionnaire was developed and sent to radiologists on a broader scale to collect their opinions on the website.

#### **RESULTS**

Radiologists' initial opinion of the guide was mostly positive, particularly as to the layout, the ease of use, and the quick turnaround. However, modifications and additions had to be made to the first version in order to accommodate clinicians' requests, i.e. reasons for consultations, optimization of users experience and quality of information. The guide was also redesigned to address a more specialized audience, such as radiologists. In order to promote the use of our guide, its name was modified for a more intuitive one, active promotion and ultimately, the development of a smartphone application were done.

#### **DISCUSSION**

Our study has identified many opportunities for improvement to facilitate the use of this tool in order to optimize the relevance and efficiency of imaging examinations for requesting physicians. Learning from other decision support systems, in particular the ACR Appropriateness Criteria (AC), and creating an application with a decision algorithm were found to be useful toward more comprehensive, generalize and optimal care for patients.

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## Abstract Archives of the RSNA, 2023

W5A-QI-5

### Enhancing Efficiency in MRI Protocols: A Quality Improvement Initiative

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Marie Hausner, MPH, ARRT (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The protocoling process for MRI exams can be time-consuming and burdensome for radiologists. While the process can better define the exact type of study to perform, for many exams with a standard imaging protocol, assigning a protocol manually adds little value and creates waste. This can result in increased workload and delays in patient care. Our department's QI team launched a quality improvement project to reduce the burden of protocoling for MRI exams, based on successful outcomes from a similar project in CT. A selected group of MRI codes were enrolled in an electronic health record (EHR)-driven auto-protocol program for adult patients. The purpose of this study was to implement and evaluate the effectiveness of the auto-protocol program for MRI exams with a goal of reducing the protocoling burden by 20%.

#### METHODS

The intervention enrolled a selected group of MRI codes, as determined by the QI team and divisional leadership, into an auto-protocol program eliminating the need for manual protocol assignment by radiologists or technologists. Codes that were selected for enrollment were removed from protocol lists. They received a protocol designation in our health system's EHR (Epic, Verona WI) through creation of a programming script that automatically inserted the words "Perform as ordered per policy" into the protocol field. The program was implemented for ten MRI sites across three hospital networks covered by our academic radiology group on 1/12/23. Three months of baseline data was collected (October-December 2022) to assess baseline rate of exams that received a human-assigned manual protocol from a radiologist and to predict the expected reduction in manual protocoling after project launch. Three months of post intervention data (January-April 2023) was collected to assess project impact. A time savings calculation was also calculated.

#### RESULTS

The auto-protocol program enrolled 58 of 300 (19% of available MRI codes). Analysis of the baseline data revealed that these codes reflected 23% of the exams protocolled by our academic radiology practice. At baseline 98% of MR orders received a radiologist protocol monthly which decreased to 76-78% (mean = 77%) after project launch (Figure 1). Mean time to protocol an MRI was approximated at 15 seconds. Based on this, we estimated the project would reduce time spent protocoling by 5 hours monthly and 60.5 hours annually.

#### DISCUSSION

The implementation of an auto-protocol program for MRI exams has been successful in enhancing efficiency and reducing protocol workload for radiologists while maintaining the quality and safety of patient care. The project has resulted in a 21% decrease in the number MRI orders needing manual assignment of a protocol with estimated time savings of 60.5 hours annually.

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## Abstract Archives of the RSNA, 2023

W5A-QI-6

### Breaking Bad News to Patients on the Breast Imaging Service: Designing a Resident Curriculum

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Julia Gerras, MD, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Breast cancer is increasingly common, and patients experience significant anxiety when presenting for breast imaging studies. Non-interpretive skills on how to communicate and share difficult results with patients are central to improving patient care and trainee education. There is currently no standardized curriculum in the Department of Radiology to teach residents how to effectively communicate with patients. We created a curriculum designed for residents to improve their effective communication skills when on the breast imaging service. This curriculum includes undergoing standardized patient (SP) encounters and watching a clinically driven educational video demonstrating two clinical encounters where a physician delivers "good" and "bad" news to a patient.

#### METHODS

At the start of the rotation residents will complete a self-evaluation utilizing a 5-point Likert scale determining their comfort level with delivering results. Each resident then undergoes two SP encounters representing common clinical scenarios seen in breast radiology. Residents will be evaluated by an attending with a standardized scoring sheet utilizing the established SPIKES protocol outlining a six-step technique on how to appropriately deliver bad news. An attending will debrief with the resident, providing feedback and constructive criticism. The resident will then watch the educational video. At the end of the rotation, they will undergo two additional SP encounters and again be evaluated by an attending with the same scoring sheet as before. Lastly, the resident will complete the same self-evaluation.

#### RESULTS

Resident 1 showed a 20% increase in the SP encounter score while resident 2 showed a 5% increase in the SP encounter score. The overall average percent change between pre- and post-curriculum encounters is +12.5%. Post-curriculum self-evaluation scores showed a general increase in resident confidence in their ability to deliver news to patients. Residents do not begin rotating through breast imaging at UCLA until R2 year. As such there is currently a small sample size as only two new R2's have rotated through the breast department since implementation. There is an anticipated increase in response data beginning July 2023 once the new academic year begins which will give us more data points to analyze.

#### DISCUSSION

Implementing a standardized curriculum for radiology residents completing their first breast imaging rotation will increase their confidence and ability to effectively deliver patient results. The overall goal is to ease patients allowing them to feel as comfortable and confident with their providers as possible, thus decreasing anxiety when presenting to the breast imaging department. We believe that this standardized curriculum will be successful at our institution, and hope that it will ultimately be adopted by other institutions in training their residents.

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## Abstract Archives of the RSNA, 2023

W5A-QI-7

### Iodine Contrast Media Volume and CT Enhancement: When Less is More

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Larissa Marciano, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Increased iodine enhancement with lower kVp can be used as a complementary approach to reduce contrast media (CM) dose as maintaining noise image level and image diagnostic quality. Manufactures technologies as automated dose modulation and interative reconstruction (IR) enable reducing kVp values and radiation exposure as consequence. Reducing iodine intake during computer tomography (CT) improves safety and tolerability of CM injections. The objective of this study was to achieve ideal iodine enhancement in abdominal CT image associating lower kVp protocols and reduced CM volume.

#### METHODS

In order to promote CM reduction protocol, this project was developed in the CT unit of a Brazilian tertiary hospital (4 CT scanners) during January 1st and 1st February , 2023. The following steps were implemented: \*Step 1- high iodine concentration CM multidose injection in order to save iodine CM due to Global iodine CM shortage during the study duration; \*Step 2- Optimization of protocol parameters according to manufactures recommendations in order to improve abdominal contrast CT image quality with reduced CM volume; \*Step 3- Application of a new formula to calculate CM volume for abdominal CT exams according to manufactures kVp reduction recommendations; \*Step 4- Qualitative and quantitative data analyses and comparisons.

#### RESULTS

100 CT scans were performed during the study period. Our results demonstrated a nearly 40% reduction in CM volume with no image quality loss. We also ensure ideal hepatic parenchyma enhancement level (around 50 HU) as recommend in the literature.

#### DISCUSSION

Global iodine CM shortage in the second semester of 2022, and beginning of 2023 led to its rational in health centers and clinical practice. It is possible to achieve ideal vessels and parenchyma enhancement with low volume and/or low flow rate injection using high iodine concentration CM. Reducing CM volume is beneficial in patients with risk factors for kidney injury. Reducing CM volume requires a balance between injection flow rate and other protocols parameters, such as kVp modulation and IR technology, in order to improve image diagnostic quality.

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## Abstract Archives of the RSNA, 2023

W5A-QI-8HC

### Setting the bar higher: Implementing a quality control program to improve US image quality.

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Aiah Alatoum, MBBS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

This quality improvement project aimed to establish a continued program to ensure high-quality ultrasound exams in our institution by updating our protocols, performing a standardized review of our US exams, and monthly discussing the areas for improvement.

#### METHODS

Our US protocols were reviewed to reflect the AIUM and ACR guidelines. An image library was created with high-quality images of all types of exams performed. A senior sonographer with 15 years of experience performed a Quality Control (QC) role and reviewed 570 exams over one year. The quality of grayscale, color Doppler, Spectral Doppler images, and protocol adherence were evaluated. The results and cases needing improvement were discussed in a monthly meeting. In the first, 6th, and 12th months, 100 exams were reviewed. The project targeted a >20% decrease in the number of exams graded needing improvement. Statistical comparisons were performed using the Chi-square test, with  $P < .05$  as the significance threshold.

#### RESULTS

The QC audit in Mar/21, Sep/21, and Feb/22 showed a significant decrease in the number of studies overall graded needing improvement from 23% in Mar/21 to 13% in Sep/21 and 5% in Feb/22 ( $P=0.001$ ). There was a high protocol adherence throughout the study 97% of the exams graded good or satisfactory in Mar/21 and Sep/21, and 100% graded good or satisfactory in Feb/22 ( $P=0.21$ ). There was a significant decrease in the number of studies with grayscale images graded as needing improvement, from 7% in Mar/21 to 1% in Sep/21 and Feb/22 ( $P=0.016$ ). There was a significant decrease in the number of studies with color Doppler graded as needing improvement, from 19% in Mar/21 to 7% in Sep/21 and 3% in Feb/22 ( $P=0.0003$ ). There was a significant decrease in the number of studies with Spectral Doppler graded as needing improvement, from 33% in Mar/21 to 18% in Sep/21 and 2% in Feb/22 ( $P<0.0001$ ). The number of studies with missing protocol images or non-contributing images decreased from 44% in Mar/21 to 38% in Sep/21 and 21% in Feb/22 ( $P=0.0018$ ).

#### DISCUSSION

Our findings showed significant improvement in the measured image quality parameters over time. There was a 78% reduction in the number of exams graded needing improvement in at least one parameter. Our ultrasound protocols were highly adhered to throughout the study, reflecting the sonographer's engagement and collaboration. This project also allowed us to recognize outstanding sonographers' work, by which we could leverage their strengths and enhance job satisfaction. Limitations of this project included that the examinations were not blinded. There is also subjectivity in the scoring of the ultrasound parameters. However, this study shows a practical real-life clinical process that was implemented. As a result of the project's success, the implemented changes are now part of our ultrasound routine, and other divisions are starting to implement similar programs.

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## Abstract Archives of the RSNA, 2023

W5A-QI-9HC

### Improving General Radiology Technologist Inequalities Through Standardized Workflows and Expectations

Wednesday, Nov. 29 12:15PM - 12:45PM Room: Learning Center

Michelle J. Jensen, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The purpose of this study was to create a workflow that would reduce inequities among technologist workloads, which were unbalanced and unpredictable. The goal of the project was to improve the range of exams performed per technologist from fourteen to seven, during a one-week Kaizen event, without negatively impacting on time starts (OTS).

#### METHODS

A team of General Radiology, Desk Operations, clinical and quality improvement personnel approached this issue using the Define-Measure-Analyze-Improve-Control (DMAIC) and A3 framework to advise a solution strategy using a series of Plan-Do-Study-Act (PDSA) cycles. Qualitative and quantitative measures were used to monitor progress. Exam accession numbers completed per technologist, per shift were monitored daily to show the range of exams performed between technologists. Department OTS were monitored as a counterbalance. A root cause analysis was performed to determine all possible solutions and then placed into a Fishbone Diagram and Impact Effort Grid to prioritize possible approaches. The team worked through many PDSA cycles of different workflow options to standardize level-loading technologist workloads. Patients were scheduled to specific exam rooms and technologists stuck to their own scheduled list. Patients were brought back to the exam rooms based on their appointment times, not check in times. The team also agreed on standard electronic cues that were used to alert them when their next patient was ready for their exam. Each technologist would now know the schedule for their exam room, which patient was coming to them next, and when the patient was moved to the dressing room to prepare for their exam. A detailed review of technologist exam ranges were considered after each PDSA cycle to determine success.

#### RESULTS

The outcome of this project proved to be successful, with a sample size of 441 patients the range of exam accession numbers stayed under the goal of seven exams per technologist (Figure 1). This PDSA was implemented within the department, successfully balancing the technologists' workload, and allowing more predictability for the technologists' daily schedule. OTS were maintained throughout the PDSA cycle and continue to stay above the baseline of 97% (Figure 2).

#### DISCUSSION

Many lessons were learned throughout the PDSA cycles. The importance of communication between teams in the area was the most vital lesson learned. Throughout the PDSA cycles, team members learned what their expectations from the department were for their workday, allowing the new standard process to equally level out the workload between all staff. The team learned that by having these standards in place, there was more predictability in the workday and fewer frustrations among technologists. Limitations of the project included critical staffing status during PDSA cycles.

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## Abstract Archives of the RSNA, 2023

W5B-QI

### Quality Improvement Reports Wednesday Poster Discussions II

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

#### Sub-Events

#### W5B-QI-1 Credenciamento de Qualidade CBR em Mamografia para o diagnóstico correto

Adriano Tachibana, MD, MBA (*Presenter*) Research Grant, Guerbet SA

#### INTRODUCTION

Thirty years ago, the Mammography Committee of the Brazilian College of Radiology and Image Diagnosis (CBR) created the first Quality Certification Program in Mammography. It played a fundamental role in assisting in the evolution of care and protocols for the diagnosis and treatment of breast cancer in the country and proved the importance of focusing on Quality in Health. One of the stages of certification in mammography is the technical evaluation of the exams, where one of the evaluated criteria is the correct classification of the international systematization BI-RADS (Breast Imaging Reporting and Data System) for breast evaluation, interpretation and reports of breast imaging exams. The BI-RADS classification helps to estimate the chance that a given mammogram image is cancer. After many disapprovals due to the incorrect classification of the BI-RADS, the CBR Mammography Commission established the obligation of carrying out the PEC BI-RADS course, as an educational process for physicians who performed incorrect classification. The objective of this work is to demonstrate the effectiveness of the mandatory conclusion of the PEC BI-RADS course, in relation to the correct BI-RADS classification in mammography exams after the conclusion of the course.

#### METHODS

We surveyed the number of clinics that failed the program due to the incorrect BI-RADS classification, from September 2018 to September 2021, a period in which there was no obligation to take the course, and we compared the number of clinics that failed from September 2021 to September 2022, when it was established that the course was mandatory.

#### RESULTS

Of the 106 clinics that participated in the certification process from September 2018 to September 2021, 9 clinics failed the program due to incorrect BI-RADS classification. After the mandatory completion of the course, the clinics that had their exams failed, were informed that all doctors who performed mammography exams at the clinic, were obliged to present the certificate of conclusion of the PEC-BIRADS course, in order to return to the certification program Of Quality. After completing the course, the service could resend new exams for a new quality assessment. This process started in September 2021. Of the 43 clinics that entered the certification process from September 2021 to September 2022, 10 clinics had failed exams in the first evaluation, took the course and were approved in the second post-course evaluation. All clinics achieved quality certification in mammography.

#### DISCUSSION

We conclude that the implementation of the PEC BI-RADS course was effective, since the physicians who carried out the course were able to correctly classify the BI-RADS in the mammography exams evaluated, avoiding diagnostic errors and failures in indicating the best treatment for the patient.

#### W5B-QI-2 Coronary CTA Retrospective Protocol: Is More Always Better

Larissa Marciano, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Coronary artery computed tomography angiography (CCTA) is a well-established method to evaluate symptomatic and asymptomatic patients with suspected coronary artery disease (CAD). This image method applicability in clinical practice raises concerns about radiation exposure in patients. The CCTA triggered acquisition with retrospective helical ECG allows dose modulation using the maximum dose during predefined range of the cardiac cycle, allowing ECG edition after acquisition

and reconstruction in different phases of the cycle in cases of image breathing artifacts or arrhythmias. The objective of this study was to test a strategy to improve image quality and radiation exposure in CCTA retrospective protocols.

## **METHODS**

In order to promote improvements in image quality in CCTA exams, protocol parameters optimization in computed tomography (CT) unit of Brazil tertiary hospital (2 dual source CT scanners) were made: use of different iterative reconstruction (IR) algorithm and new protocols implementation according to patient's body mass index (BMI). In order to reduce patient's radiation exposure undergone CCTA retrospective acquisition, it was established the following steps: 1. Data from 120 CCTA retrospective scans were collected; 2. Observed average phase for image reconstruction selected by the CT scanner (FLASH versus FORCE CT); 3. Established shorter acquisition range for each CT dual source scanner according to the average observed; 4. Team update regarding the new range and awareness about increase in dose length product (DLP) when larger ranges were used.

## **RESULTS**

A median reduction of 33.9% in Dose-Length Product (DLP) values was observed across all scans, with no apparent compromise to image quality. We observed 30,7% and 36,7% DLP median values reduction in FLASH and FORCE CT scanners, respectively.

## **DISCUSSION**

Greater image quality and reduction of radiation exposure during CCTA exams can be achieved through simple measures, such as good patient positioning, correct planning of the study area and control of cardiac heart rate by the use of beta-blockers. Protocol parameters optimization, as interactive reconstruction and automatic exposure control can also be used. In ECG triggered retrospective acquisition, the maximum radiation dose is given only in a pre-established range of the cardiac cycle, preferably in diastole. Therefore, determining more restricted reconstruction range in this acquisition mode implies in reducing patient's radiation exposure CCTA exams, without compromising image quality. Limitation of our study include use of larger ranges in cases of patients with limitations to perform the exam, as elderly patients with difficulty to follow apnea orders and patients with beta-blockers contraindications.

## **W5B-QI-3 Evaluation of MRI Images and Reports in an Accreditation Program**

Adriano Tachibana, MD, MBA (*Presenter*) Research Grant, Guerbet SA

## **INTRODUCTION**

Since 2015, the Brazilian College of Radiology (CBR) promotes an Accreditation Program in Diagnostic Imaging (PADI) that verifies 201 standard criteria, grouped into five principles: 1- Governance and administrative/financial management 2- Quality management 3- Service provisioning 4- Diagnostic support services 5- Security, Radiation and Infrastructure Before entering into the assessment of the aforementioned principles, services must undergo a technical assessment of the quality of images and reports anonymously. As far as we know, this is the only accreditation program, certified by ISQua (International Society for Quality in Health Care) that performs this assessment. The objective of the study was to verify the performance of services for sending images and magnetic resonance reports during the year 2022 in a specific program of image accreditation.

## **METHODS**

During the year 2022, 72 exams from 6 different services were evaluated. Thirteen criteria were evaluated for each exam, where each criterion was classified as "Adequate" or "Inadequate", regarding the quality of the images, congruence of laterality and efficacy of the report.

## **RESULTS**

Of a total of 852 (eight hundred and fifty-two) criteria evaluated, 694 (81%) were considered adequate and 158 (19%) inadequate. Of the evaluated criteria, 40% were considered adequate in terms of image quality, 28% had the congruence of the report considered adequate and 14% of the criteria were adequate in terms of laterality. The item with the highest percentage of inadequate was the Report. The criteria with the highest disapproval were related to the content of the medical report, with 54% of the evaluated criteria considered inadequate; the criterion related to the description of the pathology in the report had 53% of inadequacy.

## **DISCUSSION**

Most of the problems found in magnetic resonance images and reports concerned the content of the medical report in relation to the demonstration and description of the pathology, respectively.

## **W5B-QI-4 Implementating a Mindfulness Training Program for Healthcare Professionals at Radiology Department of a Tertiary Hospital: A Brazilian Experience**

Paula C. Lucio, MSc (*Presenter*) Nothing to Disclose

## INTRODUCTION

Mindfulness has gained attention in the literature as a promising intervention for healthcare professionals who experience stress and burnout. In addition to reducing anxiety and depression, it can improve focus, decision-making, communication, and time management skills. However, achieving adherence to the practice, which has been shown to be effective in studies lasting at least eight weeks, remains a challenge. This study aimed to assess the adherence and efficacy of an eight-week mindfulness training program among healthcare professionals at a radiology department of a private tertiary hospital in Brazil.

## METHODS

The intervention consisted of an eight-week training program comprising virtual sessions with guided mindfulness practices, supplemented by daily meditation practices, offered to healthcare professionals. Eight workshop sessions were conducted between June and July 2022, and voluntary participation was sought from the target audience. Daily meditative practices were shared, and forums were created for the possibility of clarifying doubts. Information was collected through standardized forms and instruments, including Conscientious Attention Awareness Scale (MAAS) and Perceived Stress Scale (PSS10), in a before-and-after design to assess changes in well-being outcomes

## RESULTS

The final sample was composed of 22 health professionals (mostly nurses and biomedical scientists) that volunteered to participate, and ten professionals (45%) fully adhered to the training (group 1). For the PSS10 questionnaire, all the participants obtained the highest score for question 12 ("Have you been thinking about the things you should do?") before the intervention. Following the intervention, all the participants agreed with two specific statements of MASS: "I tend to walk fast to reach my destination, without paying attention to what I experience on the way" (answer 4) and "I am worried about the future and the past" (answer 13); irrespective of whether they completed all eight sessions (group 1) or not (group 2). Of note, the group 2 had higher response scores for a specific question of MASS after the intervention: "I don't usually notice pain or physical discomfort until they really call my attention"(question 5); when compared to the group 1.

## DISCUSSION

The described intervention was related to response changes regarding to the perception of pain and physical discomfort among all participants of the program, even if they were unable to adhere to the eight weeks of practice. Following the intervention, both groups exhibited greater attention to the present moment and reduced concern for future events, indicating that the program may have provided benefits in terms of self-perception and attention. These results suggest that the intervention was effective in enhancing participants' well-being, despite incomplete adherence to the practice.

## W5B-QI-5 Technologist Experience Implementing a Mammographic Image Quality Improvement Program using Automated Artificial Intelligence Based Software

Melissa L. Hill, PHD (*Presenter*) Consultant, Volpara Health Technologies Limited

## INTRODUCTION

Automated mammography image quality (IQ) assessment enabled by Artificial Intelligence (AI) promises to provide objective evaluation towards optimizing screening program performance, especially by providing continuous feedback to technologists (Techs). However, the experience of Techs using such automated software for quality improvement has not been well described. Here we evaluate Tech experience with, and attitudes toward the use of, an automated IQ assessment system following individualized hands-on mammography positioning training, tailored by AI-derived metrics.

## RESULTS

Immediately post-training, survey responses showed 87% and 91.3% of Techs were satisfied or very satisfied with the TTP consultation and hands-on training, respectively. Furthermore, 71.8% responded that their software engagement would increase. The proportion of Techs that had not used the software reduced from 45.7% to 23.9% post-training (Eval 2-3), with a trend ( $p < 0.05$ ) for persistence of these login behaviors. Post-training survey responses show Techs planned for software use to improve breast positioning (>67%, Survey 3-5) and compression (>73%, Survey 3-5). At baseline, 52.2% of Techs reported physical discomfort believed to be related to acquiring mammograms. Post-training, most Techs (87%) responded that they frequently implemented changes that improved ergonomics. Also, >45% of Techs reported increased frequency of feeling confident in communicating with patients.

## METHODS

The prospective study included 55 Techs at a private breast imaging organization (15 clinics, OH, USA), already using a commercially available AI-based IQ software, Volpara Analytics™, for >2 years prior to study commencement. Hands-on breast positioning training was carried out by Mammography Educators, with feedback individualized for Techs in a Targeted Training Profile (TTP) according to the IQ software's automated performance reports. Five 30-day Evaluation periods were included to measure IQ changes pre (Eval. 1-2) and post-training (Eval. 3-5). Software login frequencies were also measured. Surveys were electronically delivered to Techs pre- and post-training. The pre-training survey captured prior experience. Four post-training surveys (2-5) focused on experience and engagement behaviors with the AI IQ software. Analysis included data from 46 Techs who completed all surveys.

## DISCUSSION

Following a training intervention, individualized with objectively measured breast positioning metrics, most Techs reported and showed a positive response toward the AI IQ software. While software use and positioning training is explicitly intended to improve IQ, results suggest additional benefits may be realized that support the staff and clinical practice, such as improved ergonomics and confidence in communication. Limitations include analysis did not factor experience level.

### W5B-QI-6 Implementation of a Radiology Patient Experience Council in an Academic Institution

Stephanie Shieh, RN, MS (*Presenter*) Nothing to Disclose

## INTRODUCTION

Patients' experience is an important performance measure of health care worldwide. Alongside measures of clinical effectiveness and patient safety, the patients' views of their experience and their satisfaction with care are now commonly used to judge the quality of care. Studies show that improving a patient's experience can provide important benefits to both the healthcare provider and the patient. Further, recently healthcare legislation and the associated payment reforms have shifted the focus from traditional fee for service models to value based models where adding value is linked to improve quality metrics that are linked to patients' experience and outcome. To address this need, our team implemented the Radiology Patient Experience Council with the primary objective of delivering patient-centered care and improving patient experience.

## METHODS

Starting in September 2022, a Radiology Patient Experience Council was created at the department of radiology of a tertiary academic health center in southern California. The council had member representation from quality and business systems, imaging modality supervisors, operation managers, radiology physicians, patient experience leaders and a Patient Family Advisory Council member. The council had an hour monthly meeting to review the Department National Research Corporation (NRC) Health data, prioritize patient-centered quality improvement initiatives, and discuss strategies to implement and sustain practice changes. Department NRC data from May to August 2022 was analyzed and patient feedbacks were categorized to determine action plans. We then performed literature review to guide the implementation of the initiatives. The initiatives included improving communication to inform about delays, addressing perception of staff caring and professionalism, increasing comfort during exam, improving scheduling process, improving wayfinding experiences.

## RESULTS

Some of our successful initiatives included training staff on standardized scripting for communication delays and improving patients' comfort in our radiology environment. We have also discussed patient experiences with regard to price transparency, scheduling as well as issues that concern the LGBTQIA+ community. There was an increase in likelihood to recommend the Radiology department from 81.3% in August 2022 to 83.9% in March 2023 (Figure 1).

## DISCUSSION

Keeping patient experience as a topic that is at top of mind is critical to improving the patient's experience. Having a dedicated council where the patient experience data is reviewed monthly by the radiology leadership team to ensure that appropriate patient-centric initiatives can be implemented to address patients' concerns and information can be disseminated to the radiology team members will help the entire department keep committed and accountable to improving patient care.

### W5B-QI-7 AI Automated Opportunistic Screening for Cardiomegaly on CT

Asser Abou Elkassem, MD (*Presenter*) Nothing to Disclose

## INTRODUCTION

Cardiovascular disease (CVD) is a major U.S. health concern, and current screening methods are inadequate, particularly for underrepresented minorities. Cardiomegaly is often asymptomatic but linked to various heart conditions. Opportunistic cardiomegaly screening on routine CT exams may reduce CVD burden. In this project, we developed, patented, and commercialized an AI algorithm to measure the cardiothoracic ratio (CTR) on routine CT exams for cardiomegaly screening.

## METHODS

We manually segmented the heart and inner chest on a multi-institutional set of CT exams (N=1500) to train an AI algorithm (AI Cardiomegaly v1.0) to quantify area-based CTR. The patented algorithm was validated in a large study and implemented on an iMac server receiving all CT exams. The output includes a PDF report and a spreadsheet with CTR and patient information. We assessed the medical records of patients in the top 10th percentile for heart disease management. A startup was formed, and an FDA 510(k) application was submitted in May 2023.

## RESULTS

The AI Cardiomegaly algorithm processes 220 CT exams daily (around 80,000 per year). Over two weeks, we found that 40% of the top 10th percentile (N=3,200 patients) had unmanaged cardiomegaly. Unmanaged cardiomegaly occurs in 4% of

routine CT exams, corresponding to nearly 1.6 million patients yearly in the U.S. We expect issued patent claims and FDA 510(k) clearance in late 2023.

## **DISCUSSION**

Opportunistic screening for unmanaged cardiomegaly in routine CT exams could reduce the healthcare burden of CVD. We're partnering with cardiologists to coordinate care and arrange echocardiograms and clinical visits for identified patients. Most patients will receive ongoing care, while a subset will undergo advanced cardiac imaging, stress tests, coronary studies/interventions, valvular heart repair, and pacemaker/defibrillator placement. The average Medicare reimbursement for severe CVD is nearly \$20,000. Providing appropriate management for 25% of patients with unmanaged cardiomegaly detected through screening at our institution could generate \$16M in total reimbursement annually.

## **W5B-QI-8HC Decision Trees automate the scheduling rules for Radiology appointments improving access, efficiency, call times and overall patient experience.**

Crystal Blank (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

As radiological exams become more prevalent in healthcare, institutions need to find efficient ways for patients and providers to schedule these exams. An ideal scheduling system needs to be the least time-consuming, catered towards specific patient needs, and provide as many options as possible for patients to choose from. This study's purpose was to improve the Radiology call center scheduling process to address the increased volume of calls, leading to excessive wait times and abandoned calls at a large academic institution.

## **METHODS**

The time period for this initiative's roll out spanned about 1 year. Integrating external scheduling guides directly into the decision tree account for multiple scheduling outcomes via logic and scheduler facing instructions. The available options for scheduling are filtered as the user answers the questions reducing scheduling errors, increasing scheduling efficiency, and allowing for affinity scheduling. In preparation for implementation of Radiology Practice Optimization Initiative (POI), each modality team internally reviewed and revised their scheduling guidelines. The Cadence team gathered the decision tree requirements and drafted decision tree workflows on Visio software with the Radiology modality teams. The Cadence team documented needed template changes for Radiology within Radiant. The Cadence Core Team then built the trees. The modalities were grouped into three phases to stage the roll out. Each phase concentrated on two to four modality teams to finalize decision trees, go-live, and provide follow up support over consecutive five-month periods.

## **RESULTS**

Beginning in July 2022, on a monthly basis we monitored the utilization and the volume of visits scheduled using the decision tree. We compared with data related to the wait times and total number of calls handled, PDCA cycles were initiated when the end users identified problems. Eight months post go-live, phase one modalities had decision tree utilization of 89.25% overall with 228,000 exams scheduled.

## **DISCUSSION**

Radiology decision trees can be integrated with scheduling systems to improve the efficiency of patient care. By automating the decision-making process, scheduling systems can help to reduce wait times, improve patient flow, and ensure that patients receive the appropriate care in a timely manner. Challenges that we encountered related to the length and complexity of the scheduling guidelines, delaying the training of affinity schedulers and the option of self-scheduling. Overall, the integration of radiology decision trees with scheduling systems can help to improve the efficiency and effectiveness of patient care, reduce costs, and enhance the patient experience. By automating the decision-making process, healthcare providers can focus on providing high-quality care to their patients, while also improving their own workflow and productivity.

## **W5B-QI-9HC Trans-Inclusive Chest Cancer Screening: A Pilot Training for Imaging Professionals**

Jasmine Haraburda, BS (*Presenter*) Nothing to Disclose

## **INTRODUCTION**

The risk of breast/chest cancer in transgender patients has been underreported and not thoroughly assessed in modern research. Transgender patients face many social and systemic barriers that hinder them from accessing preventative and curative medical care. This pilot study aimed to create a reproducible training for healthcare staff involved in providing imaging for chest cancer screenings. The wider purpose of this project was to foster a more inclusive healthcare environment for LGBTQIA2+ patients, particularly transgender and gender non-conforming patients.

## **METHODS**

We developed a pilot training program with staff at the University of Cincinnati Health Department of Radiology and Mobile Diagnostics Van. The training was a 45-minute virtual presentation, which discussed the LGBTQIA2+ community, inclusive screenings, current guidelines for chest/breast cancer screenings in the transgender community, and tangible steps to increase inclusivity. Pre- and post-training surveys included various metrics like prior exposure to the LGBTQIA2+ community,

self-reported knowledge, directly assessed competencies, and a gender attitudes scale. Data was collected using the secure server REDCap; identifying information was not collected and participation was voluntary.

## **RESULTS**

The training session had 26 attendees, 19 of which underwent training. 19 pre-survey (100% response rate) and 10-17 post-survey responses were collected (53-89% response rate) per question. 47% of participants were mammography technicians. 77% reported interacting often or sometimes with nonbinary (n=17) and 77% reported interacting very often to sometimes with trans (n=17) patients. 65% felt they had inadequate access to resources for LGBTQIA2+ patients (n=11). There were significant increases in self-reported understanding of multiple LGBTQIA2+-related topics. There was also an overall increase in accuracy across all measured knowledge competencies.

## **DISCUSSION**

Limitations of this pilot study were the small sample size and study withdrawal rates. Future studies would benefit from increased sample size, consideration of intersectionality, and wider implementation. Expanding future training via online modules with multiple language options would further improve accessibility. This training improved our cohort of healthcare staff's self-reported and measured understanding of gender-inclusive breast/chest cancer screening imaging encounters. This approach could serve as a model for inclusivity training for other medical encounters with the LGBTQIA2+ community. Our pilot study was an effective proof of concept, demonstrating the feasibility and potential efficacy of a gender inclusivity training for medical workers, and providing valuable insights for future research on this topic.

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## Abstract Archives of the RSNA, 2023

W5B-QI-1

### Credenciamento de Qualidade CBR em Mamografia para o diagnóstico correto

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Adriano Tachibana, MD, MBA (*Presenter*) Research Grant, Guerbet SA

#### INTRODUCTION

Thirty years ago, the Mammography Committee of the Brazilian College of Radiology and Image Diagnosis (CBR) created the first Quality Certification Program in Mammography. It played a fundamental role in assisting in the evolution of care and protocols for the diagnosis and treatment of breast cancer in the country and proved the importance of focusing on Quality in Health. One of the stages of certification in mammography is the technical evaluation of the exams, where one of the evaluated criteria is the correct classification of the international systematization BI-RADS (Breast Imaging Reporting and Data System) for breast evaluation, interpretation and reports of breast imaging exams. The BI-RADS classification helps to estimate the chance that a given mammogram image is cancer. After many disapprovals due to the incorrect classification of the BI-RADS, the CBR Mammography Commission established the obligation of carrying out the PEC BI-RADS course, as an educational process for physicians who performed incorrect classification. The objective of this work is to demonstrate the effectiveness of the mandatory conclusion of the PEC BI-RADS course, in relation to the correct BI-RADS classification in mammography exams after the conclusion of the course.

#### METHODS

We surveyed the number of clinics that failed the program due to the incorrect BI-RADS classification, from September 2018 to September 2021, a period in which there was no obligation to take the course, and we compared the number of clinics that failed from September 2021 to September 2022, when it was established that the course was mandatory.

#### RESULTS

Of the 106 clinics that participated in the certification process from September 2018 to September 2021, 9 clinics failed the program due to incorrect BI-RADS classification. After the mandatory completion of the course, the clinics that had their exams failed, were informed that all doctors who performed mammography exams at the clinic, were obliged to present the certificate of conclusion of the PEC-BIRADS course, in order to return to the certification program Of Quality. After completing the course, the service could resend new exams for a new quality assessment. This process started in September 2021. Of the 43 clinics that entered the certification process from September 2021 to September 2022, 10 clinics had failed exams in the first evaluation, took the course and were approved in the second post-course evaluation. All clinics achieved quality certification in mammography.

#### DISCUSSION

We conclude that the implementation of the PEC BI-RADS course was effective, since the physicians who carried out the course were able to correctly classify the BI-RADS in the mammography exams evaluated, avoiding diagnostic errors and failures in indicating the best treatment for the patient.

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## Abstract Archives of the RSNA, 2023

W5B-QI-2

### Coronary CTA Retrospective Protocol: Is More Always Better

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Larissa Marciano, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Coronary artery computed tomography angiography (CCTA) is a well-established method to evaluate symptomatic and asymptomatic patients with suspected coronary artery disease (CAD). This image method applicability in clinical practice raises concerns about radiation exposure in patients. The CCTA triggered acquisition with retrospective helical ECG allows dose modulation using the maximum dose during predefined range of the cardiac cycle, allowing ECG edition after acquisition and reconstruction in different phases of the cycle in cases of image breathing artifacts or arrhythmias. The objective of this study was to test a strategy to improve image quality and radiation exposure in CCTA retrospective protocols.

#### METHODS

In order to promote improvements in image quality in CCTA exams, protocol parameters optimization in computed tomography (CT) unit of Brazil tertiary hospital (2 dual source CT scanners) were made: use of different interactive reconstruction (IR) algorithm and new protocols implementation according to patient's body mass index (BMI). In order to reduce patient's radiation exposure undergone CCTA retrospective acquisition, it was established the following steps: 1. Data from 120 CCTA retrospective scans were collected; 2. Observed average phase for image reconstruction selected by the CT scanner (FLASH versus FORCE CT); 3. Established shorter acquisition range for each CT dual source scanner according to the average observed; 4. Team update regarding the new range and awareness about increase in dose length product (DLP) when larger ranges were used.

#### RESULTS

A median reduction of 33.9% in Dose-Length Product (DLP) values was observed across all scans, with no apparent compromise to image quality. We observed 30,7% and 36,7% DLP median values reduction in FLASH and FORCE CT scanners, respectively.

#### DISCUSSION

Greater image quality and reduction of radiation exposure during CCTA exams can be achieved through simple measures, such as good patient positioning, correct planning of the study area and control of cardiac heart rate by the use of beta-blockers. Protocol parameters optimization, as interactive reconstruction and automatic exposure control can also be used. In ECG triggered retrospective acquisition, the maximum radiation dose is given only in a pre-established range of the cardiac cycle, preferably in diastole. Therefore, determining more restricted reconstruction range in this acquisition mode implies in reducing patient's radiation exposure CCTA exams, without compromising image quality. Limitation of our study include use of larger ranges in cases of patients with limitations to perform the exam, as elderly patients with difficulty to follow apnea orders and patients with beta-blockers contraindications.

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## Abstract Archives of the RSNA, 2023

W5B-QI-3

### Evaluation of MRI Images and Reports in an Accreditation Program

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Adriano Tachibana, MD, MBA (*Presenter*) Research Grant, Guerbet SA

#### INTRODUCTION

Since 2015, the Brazilian College of Radiology (CBR) promotes an Accreditation Program in Diagnostic Imaging (PADI) that verifies 201 standard criteria, grouped into five principles: 1- Governance and administrative/financial management 2- Quality management 3- Service provisioning 4- Diagnostic support services 5- Security, Radiation and Infrastructure Before entering into the assessment of the aforementioned principles, services must undergo a technical assessment of the quality of images and reports anonymously. As far as we know, this is the only accreditation program, certified by ISQua (International Society for Quality in Health Care) that performs this assessment. The objective of the study was to verify the performance of services for sending images and magnetic resonance reports during the year 2022 in a specific program of image accreditation.

#### METHODS

During the year 2022, 72 exams from 6 different services were evaluated. Thirteen criteria were evaluated for each exam, where each criterion was classified as "Adequate" or "Inadequate", regarding the quality of the images, congruence of laterality and efficacy of the report.

#### RESULTS

Of a total of 852 (eight hundred and fifty-two) criteria evaluated, 694 (81%) were considered adequate and 158 (19%) inadequate. Of the evaluated criteria, 40% were considered adequate in terms of image quality, 28% had the congruence of the report considered adequate and 14% of the criteria were adequate in terms of laterality. The item with the highest percentage of inadequate was the Report. The criteria with the highest disapproval were related to the content of the medical report, with 54% of the evaluated criteria considered inadequate; the criterion related to the description of the pathology in the report had 53% of inadequacy.

#### DISCUSSION

Most of the problems found in magnetic resonance images and reports concerned the content of the medical report in relation to the demonstration and description of the pathology, respectively.

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## Abstract Archives of the RSNA, 2023

W5B-QI-4

### Implementing a Mindfulness Training Program for Healthcare Professionals at Radiology Department of a Tertiary Hospital: A Brazilian Experience

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Paula C. Lucio, MSc (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Mindfulness has gained attention in the literature as a promising intervention for healthcare professionals who experience stress and burnout. In addition to reducing anxiety and depression, it can improve focus, decision-making, communication, and time management skills. However, achieving adherence to the practice, which has been shown to be effective in studies lasting at least eight weeks, remains a challenge. This study aimed to assess the adherence and efficacy of an eight-week mindfulness training program among healthcare professionals at a radiology department of a private tertiary hospital in Brazil.

#### METHODS

The intervention consisted of an eight-week training program comprising virtual sessions with guided mindfulness practices, supplemented by daily meditation practices, offered to healthcare professionals. Eight workshop sessions were conducted between June and July 2022, and voluntary participation was sought from the target audience. Daily meditative practices were shared, and forums were created for the possibility of clarifying doubts. Information was collected through standardized forms and instruments, including Conscientious Attention Awareness Scale (MAAS) and Perceived Stress Scale (PSS10), in a before-and-after design to assess changes in well-being outcomes

#### RESULTS

The final sample was composed of 22 health professionals (mostly nurses and biomedical scientists) that volunteered to participate, and ten professionals (45%) fully adhered to the training (group 1). For the PSS10 questionnaire, all the participants obtained the highest score for question 12 ("Have you been thinking about the things you should do?") before the intervention. Following the intervention, all the participants agreed with two specific statements of MASS: "I tend to walk fast to reach my destination, without paying attention to what I experience on the way" (answer 4) and "I am worried about the future and the past" (answer 13); irrespective of whether they completed all eight sessions (group 1) or not (group 2). Of note, the group 2 had higher response scores for a specific question of MASS after the intervention: "I don't usually notice pain or physical discomfort until they really call my attention"(question 5); when compared to the group 1.

#### DISCUSSION

The described intervention was related to response changes regarding to the perception of pain and physical discomfort among all participants of the program, even if they were unable to adhere to the eight weeks of practice. Following the intervention, both groups exhibited greater attention to the present moment and reduced concern for future events, indicating that the program may have provided benefits in terms of self-perception and attention. These results suggest that the intervention was effective in enhancing participants' well-being, despite incomplete adherence to the practice.

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## Abstract Archives of the RSNA, 2023

W5B-QI-5

### Technologist Experience Implementing a Mammographic Image Quality Improvement Program using Automated Artificial Intelligence Based Software

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Melissa L. Hill, PHD (*Presenter*) Consultant, Volpara Health Technologies Limited

#### INTRODUCTION

Automated mammography image quality (IQ) assessment enabled by Artificial Intelligence (AI) promises to provide objective evaluation towards optimizing screening program performance, especially by providing continuous feedback to technologists (Techs). However, the experience of Techs using such automated software for quality improvement has not been well described. Here we evaluate Tech experience with, and attitudes toward the use of, an automated IQ assessment system following individualized hands-on mammography positioning training, tailored by AI-derived metrics.

#### RESULTS

Immediately post-training, survey responses showed 87% and 91.3% of Techs were satisfied or very satisfied with the TTP consultation and hands-on training, respectively. Furthermore, 71.8% responded that their software engagement would increase. The proportion of Techs that had not used the software reduced from 45.7% to 23.9% post-training (Eval 2-3), with a trend ( $p < 0.05$ ) for persistence of these login behaviors. Post-training survey responses show Techs planned for software use to improve breast positioning (>67%, Survey 3-5) and compression (>73%, Survey 3-5). At baseline, 52.2% of Techs reported physical discomfort believed to be related to acquiring mammograms. Post-training, most Techs (87%) responded that they frequently implemented changes that improved ergonomics. Also, >45% of Techs reported increased frequency of feeling confident in communicating with patients.

#### METHODS

The prospective study included 55 Techs at a private breast imaging organization (15 clinics, OH, USA), already using a commercially available AI-based IQ software, Volpara Analytics™, for >2 years prior to study commencement. Hands-on breast positioning training was carried out by Mammography Educators, with feedback individualized for Techs in a Targeted Training Profile (TTP) according to the IQ software's automated performance reports. Five 30-day Evaluation periods were included to measure IQ changes pre (Eval. 1-2) and post-training (Eval. 3-5). Software login frequencies were also measured. Surveys were electronically delivered to Techs pre- and post-training. The pre-training survey captured prior experience. Four post-training surveys (2-5) focused on experience and engagement behaviors with the AI IQ software. Analysis included data from 46 Techs who completed all surveys.

#### DISCUSSION

Following a training intervention, individualized with objectively measured breast positioning metrics, most Techs reported and showed a positive response toward the AI IQ software. While software use and positioning training is explicitly intended to improve IQ, results suggest additional benefits may be realized that support the staff and clinical practice, such as improved ergonomics and confidence in communication. Limitations include analysis did not factor experience level.

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## Abstract Archives of the RSNA, 2023

W5B-QI-6

### Implementation of a Radiology Patient Experience Council in an Academic Institution

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Stephanie Shieh, RN, MS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Patients' experience is an important performance measure of health care worldwide. Alongside measures of clinical effectiveness and patient safety, the patients' views of their experience and their satisfaction with care are now commonly used to judge the quality of care. Studies show that improving a patient's experience can provide important benefits to both the healthcare provider and the patient. Further, recently healthcare legislation and the associated payment reforms have shifted the focus from traditional fee for service models to value based models where adding value is linked to improve quality metrics that are linked to patients' experience and outcome. To address this need, our team implemented the Radiology Patient Experience Council with the primary objective of delivering patient-centered care and improving patient experience.

#### METHODS

Starting in September 2022, a Radiology Patient Experience Council was created at the department of radiology of a tertiary academic health center in southern California. The council had member representation from quality and business systems, imaging modality supervisors, operation managers, radiology physicians, patient experience leaders and a Patient Family Advisory Council member. The council had an hour monthly meeting to review the Department National Research Corporation (NRC) Health data, prioritize patient-centered quality improvement initiatives, and discuss strategies to implement and sustain practice changes. Department NRC data from May to August 2022 was analyzed and patient feedbacks were categorized to determine action plans. We then performed literature review to guide the implementation of the initiatives. The initiatives included improving communication to inform about delays, addressing perception of staff caring and professionalism, increasing comfort during exam, improving scheduling process, improving wayfinding experiences.

#### RESULTS

Some of our successful initiatives included training staff on standardized scripting for communication delays and improving patients' comfort in our radiology environment. We have also discussed patient experiences with regard to price transparency, scheduling as well as issues that concern the LGBTQIA+ community. There was an increase in likelihood to recommend the Radiology department from 81.3% in August 2022 to 83.9% in March 2023 (Figure 1).

#### DISCUSSION

Keeping patient experience as a topic that is at top of mind is critical to improving the patient's experience. Having a dedicated council where the patient experience data is reviewed monthly by the radiology leadership team to ensure that appropriate patient-centric initiatives can be implemented to address patients' concerns and information can be disseminated to the radiology team members will help the entire department keep committed and accountable to improving patient care.

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## Abstract Archives of the RSNA, 2023

W5B-QI-7

### AI Automated Opportunistic Screening for Cardiomegaly on CT

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Asser Abou Elkassem, MD (*Presenter*) Nothing to Disclose

#### INTRODUCTION

Cardiovascular disease (CVD) is a major U.S. health concern, and current screening methods are inadequate, particularly for underrepresented minorities. Cardiomegaly is often asymptomatic but linked to various heart conditions. Opportunistic cardiomegaly screening on routine CT exams may reduce CVD burden. In this project, we developed, patented, and commercialized an AI algorithm to measure the cardiothoracic ratio (CTR) on routine CT exams for cardiomegaly screening.

#### METHODS

We manually segmented the heart and inner chest on a multi-institutional set of CT exams (N=1500) to train an AI algorithm (AI Cardiomegaly v1.0) to quantify area-based CTR. The patented algorithm was validated in a large study and implemented on an iMac server receiving all CT exams. The output includes a PDF report and a spreadsheet with CTR and patient information. We assessed the medical records of patients in the top 10th percentile for heart disease management. A startup was formed, and an FDA 510(k) application was submitted in May 2023.

#### RESULTS

The AI Cardiomegaly algorithm processes 220 CT exams daily (around 80,000 per year). Over two weeks, we found that 40% of the top 10th percentile (N=3,200 patients) had unmanaged cardiomegaly. Unmanaged cardiomegaly occurs in 4% of routine CT exams, corresponding to nearly 1.6 million patients yearly in the U.S. We expect issued patent claims and FDA 510(k) clearance in late 2023.

#### DISCUSSION

Opportunistic screening for unmanaged cardiomegaly in routine CT exams could reduce the healthcare burden of CVD. We're partnering with cardiologists to coordinate care and arrange echocardiograms and clinical visits for identified patients. Most patients will receive ongoing care, while a subset will undergo advanced cardiac imaging, stress tests, coronary studies/interventions, valvular heart repair, and pacemaker/defibrillator placement. The average Medicare reimbursement for severe CVD is nearly \$20,000. Providing appropriate management for 25% of patients with unmanaged cardiomegaly detected through screening at our institution could generate \$16M in total reimbursement annually.

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## Abstract Archives of the RSNA, 2023

W5B-QI-8HC

**Decision Trees automate the scheduling rules for Radiology appointments improving access, efficiency, call times and overall patient experience.**

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Crystal Blank (*Presenter*) Nothing to Disclose

### INTRODUCTION

As radiological exams become more prevalent in healthcare, institutions need to find efficient ways for patients and providers to schedule these exams. An ideal scheduling system needs to be the least time-consuming, catered towards specific patient needs, and provide as many options as possible for patients to choose from. This study's purpose was to improve the Radiology call center scheduling process to address the increased volume of calls, leading to excessive wait times and abandoned calls at a large academic institution.

### METHODS

The time period for this initiative's roll out spanned about 1 year. Integrating external scheduling guides directly into the decision tree account for multiple scheduling outcomes via logic and scheduler facing instructions. The available options for scheduling are filtered as the user answers the questions reducing scheduling errors, increasing scheduling efficiency, and allowing for affinity scheduling. In preparation for implementation of Radiology Practice Optimization Initiative (POI), each modality team internally reviewed and revised their scheduling guidelines. The Cadence team gathered the decision tree requirements and drafted decision tree workflows on Visio software with the Radiology modality teams. The Cadence team documented needed template changes for Radiology within Radiant. The Cadence Core Team then built the trees. The modalities were grouped into three phases to stage the roll out. Each phase concentrated on two to four modality teams to finalize decision trees, go-live, and provide follow up support over consecutive five-month periods.

### RESULTS

Beginning in July 2022, on a monthly basis we monitored the utilization and the volume of visits scheduled using the decision tree. We compared with data related to the wait times and total number of calls handled, PDCA cycles were initiated when the end users identified problems. Eight months post go-live, phase one modalities had decision tree utilization of 89.25% overall with 228,000 exams scheduled.

### DISCUSSION

Radiology decision trees can be integrated with scheduling systems to improve the efficiency of patient care. By automating the decision-making process, scheduling systems can help to reduce wait times, improve patient flow, and ensure that patients receive the appropriate care in a timely manner. Challenges that we encountered related to the length and complexity of the scheduling guidelines, delaying the training of affinity schedulers and the option of self-scheduling. Overall, the integration of radiology decision trees with scheduling systems can help to improve the efficiency and effectiveness of patient care, reduce costs, and enhance the patient experience. By automating the decision-making process, healthcare providers can focus on providing high-quality care to their patients, while also improving their own workflow and productivity.

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## Abstract Archives of the RSNA, 2023

W5B-QI-9HC

### Trans-Inclusive Chest Cancer Screening: A Pilot Training for Imaging Professionals

Wednesday, Nov. 29 12:45PM - 1:15PM Room: Learning Center

Jasmine Haraburda, BS (*Presenter*) Nothing to Disclose

#### INTRODUCTION

The risk of breast/chest cancer in transgender patients has been underreported and not thoroughly assessed in modern research. Transgender patients face many social and systemic barriers that hinder them from accessing preventative and curative medical care. This pilot study aimed to create a reproducible training for healthcare staff involved in providing imaging for chest cancer screenings. The wider purpose of this project was to foster a more inclusive healthcare environment for LGBTQIA2+ patients, particularly transgender and gender non-conforming patients.

#### METHODS

We developed a pilot training program with staff at the University of Cincinnati Health Department of Radiology and Mobile Diagnostics Van. The training was a 45-minute virtual presentation, which discussed the LGBTQIA2+ community, inclusive screenings, current guidelines for chest/breast cancer screenings in the transgender community, and tangible steps to increase inclusivity. Pre- and post-training surveys included various metrics like prior exposure to the LGBTQIA2+ community, self-reported knowledge, directly assessed competencies, and a gender attitudes scale. Data was collected using the secure server REDCap; identifying information was not collected and participation was voluntary.

#### RESULTS

The training session had 26 attendees, 19 of which underwent training. 19 pre-survey (100% response rate) and 10-17 post-survey responses were collected (53-89% response rate) per question. 47% of participants were mammography technicians. 77% reported interacting often or sometimes with nonbinary (n=17) and 77% reported interacting very often to sometimes with trans (n=17) patients. 65% felt they had inadequate access to resources for LGBTQIA2+ patients (n=11). There were significant increases in self-reported understanding of multiple LGBTQIA2+-related topics. There was also an overall increase in accuracy across all measured knowledge competencies.

#### DISCUSSION

Limitations of this pilot study were the small sample size and study withdrawal rates. Future studies would benefit from increased sample size, consideration of intersectionality, and wider implementation. Expanding future training via online modules with multiple language options would further improve accessibility. This training improved our cohort of healthcare staff's self-reported and measured understanding of gender-inclusive breast/chest cancer screening imaging encounters. This approach could serve as a model for inclusivity training for other medical encounters with the LGBTQIA2+ community. Our pilot study was an effective proof of concept, demonstrating the feasibility and potential efficacy of a gender inclusivity training for medical workers, and providing valuable insights for future research on this topic.

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